WSM

WORKSHOP MANUAL
KUBOTA EXCAVATOR

U45-3α
U50-3α
U45S/ST
U45-3S/ST
KX121-3α
KX161-3α
KX121-3S/ST
KX161-3S/ST

Kubota

Code No.97899-61530

Record of Revisions

Symbol	Date	Main Revised Points & Corrective Measures	Person-in-charge
△1			
△2			
△3			
△4			

EU-version	**KX121-3α, KX161-3α, U45-3α, U50-3α**
KTC, KCL-version	**KX121-3S/ST, KX161-3S/ST, U45S/ST**
KTA-version	**KX121-3S/ST, KX161-3S/ST, U45-3S/ST**

Note: EU-version is for KE, KUK, and KBM
PP - version is for KTC, KCL, and KTA

CONTENTS

I. GENERAL I-S-1

II. MACHINE BODY II-S-1

III. ENGINE
- Mechanism Section III-M-1
- Service Section III-S-1

IV. HYDRAULIC SYSTEM
- Mechanism Section IV-M-1
- Service Section IV-S-1

V. ELECTRICAL SYSTEM
- Mechanism Section V-M-1
- Service Section V-S-1

CONTENTS

VI. OPTIONAL UNIT: AIR CONDITIONER

- Mechanism Section VI-M-1
- Service Section VI-S-1

VII. OPTIONAL UNIT: ANGLE DOZER VII-S-1

Model Names:

EU-version;	**KX121-3α, KX161-3α, U45-3α, U50-3α**
KTC, KCL-version;	**KX121-3S/ST, KX161-3S/ST, U45S/ST**
KTA-version;	**KX121-3S/ST, KX161-3S/ST, U45-3S/ST**

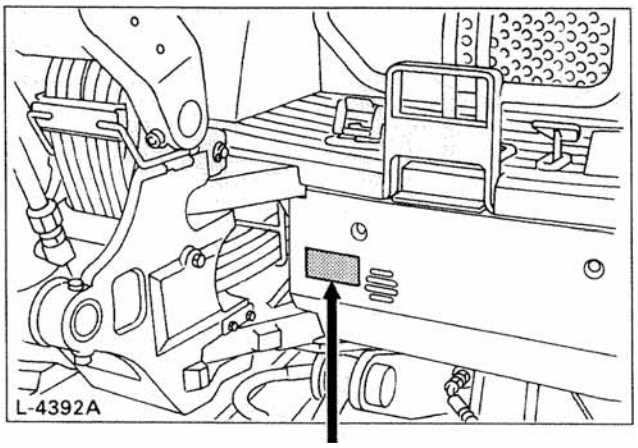
Note: EU-version is for KE, KUK, and KBM
PP - version is for KTC, KCL, and KTA

I. GENERAL

(A) BODY AND ENGINE IDENTIFICATION MARKS I-S-3
(B) SAFETY PRECAUTIONS FOR SERVICING, DISASSEMBLY AND REASSEMBLY . I-S-5
a) Safety Measures before Starting Work I-S-5
b) Safety Measures during Work I-S-5
c) Preparation for Disassembly I-S-6
d) Precautions for Disassembly and Reassembly I-S-6
e) Maintenance I-S-7
f) Waste Disposal I-S-7
(C) IMPORTANT SAFETY PROCESS AND CRITICAL FUNCTIONAL PROCESS I-S-9
a) Essential Adhesives I-S-9
b) Important Safety Process I-S-9
c) Important Critical Functional Process I-S-9
(D) IMPORTANT INSPECTION ITEMS AFTER REASSEMBLING I-S-11
(E) SERVICING FUNDAMENTALS I-S-13
a) Items for Servicing I-S-13
b) O-ring, Oil Seal, Circlip and Roll Pin I-S-15
c) Piping I-S-17
(F) MAINTENANCE INTERVALS I-S-25
a) EU-version I-S-25
b) KTC, KCL-version I-S-26
c) KTA-version I-S-28
d) Hydraulic Oil Check for Machines with Hydraulic Breakers I-S-29
e) Periodic Replacement of Important Parts I-S-30
f) Water and Oil Quantity I-S-31
g) Recommended Oil I-S-32
h) Filters I-S-33
(G) PRODUCT FEATURE I-S-35
a) Quick Chart I-S-35
b) Comparison of Main Specifications for U45S I-S-37
c) New Engineering Points I-S-37
d) Photos of Main Modified Parts I-S-38
e) Major Specifications Incorporated I-S-39
f) Major Points Incorporated in Minor Change I-S-40
(H) MACHINE QUALITY SPECIFICATIONS I-S-43
a) KX121-3S, 161-3S, U45S, U45-3S: KTC, KCL, KTA-version I-S-43
b) U50-3α, KX121-3α, KX161-3α, U45-3α, KE, KDG, KUK-version I-S-50
c) KX121-3S, 161-3S, U45S: KTC, KCL, KTA-version I-S-58
d) Traveling Performance I-S-67
e) Major Components Comparison I-S-68

(A) BODY AND ENGINE IDENTIFICATION MARKS

If a trouble occurs during use, or if servicing is necessary, contact your dealer. Please inform the machine model, engine type and serial numbers.



KTC, KCL, KTA-version

KUBOTA Corporation
2-47, Shikitsuhigasi 1-Chome, Naniwa-ku, Osaka, 556-8601 JAPAN

MODEL	①
SERIAL No.	②
ENGINE No.	③
PRODUCT IDENTIFICATION NUMBER	④

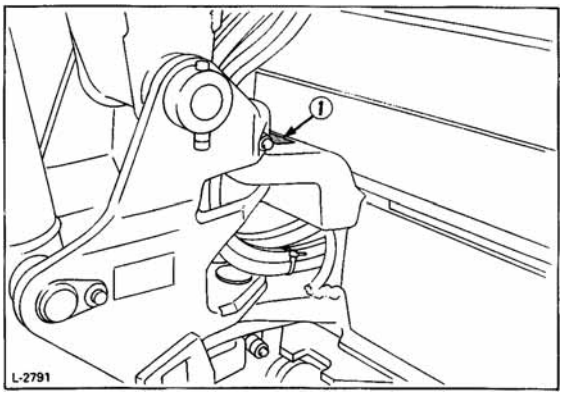
Name plate: Code No. RA018-57721

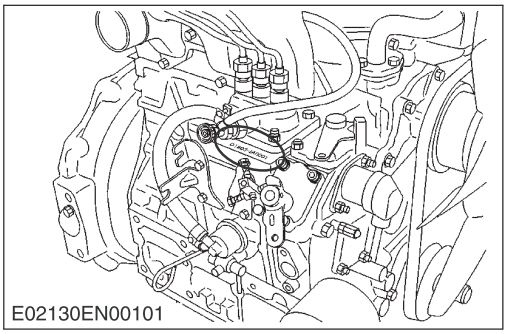
No.	Items	Contents / Example
①	Machine model	KX121-3S
②	Serial No.	70001
③	Engine No.	
④	PRODUCT IDENTIFICATION No.	>JKUK1213CO1H70001<

Example: S/N 20001

(1) Machine serial number

(2) Engine serial number
e.g. V2203-2L0025
"2" indicates year of 2002 and "L" indicates June.
2L means the engine was manufactured in June 2002.




E02130EN00101

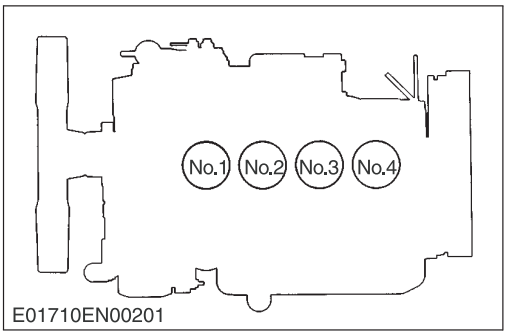
• Month of manufacture

Month	Engine Serial Number	
	0001 ~ 9999	10000 ~
January	A0001 ~ A9999	B0001 ~
February	C0001 ~ C9999	D0001 ~
March	E0001 ~ E9999	F0001 ~
April	G0001 ~ G9999	H0001 ~
May	J0001 ~ J9999	K0001 ~
June	L0001 ~ L9999	M0001 ~
July	N0001 ~ N9999	P0001 ~
August	Q0001 ~ Q9999	R0001 ~
September	S0001 ~ S9999	T0001 ~
October	U0001 ~ U9999	V0001 ~
November	W0001 ~ W9999	X0001 ~
December	Y0001 ~ Y9999	Z0001 ~

• Year of manufacture

Alphabet or Number	Year	Alphabet or Number	Year
1	2001	F	2015
2	2002	G	2016
3	2003	H	2017
4	2004	J	2018
5	2005	K	2019
6	2006	L	2020
7	2007	M	2021
8	2008	N	2022
9	2009	P	2023
A	2010	R	2024
B	2011	S	2025
C	2012	T	2026
D	2013	V	2027
E	2014		

(3) Cylinder Number



E01710EN00201

The cylinder number of 03-M Series diesel engine are designated as shown in the figure.
The sequence of cylinder numbers is given as No. 1, No. 2, No. 3 and No. 4 starting from the gear case side.

(B) SAFETY PRECAUTIONS FOR SERVICING, DISASSEMBLY AND REASSEMBLY

⚠ Safety Precautions for Servicing

Most accidents during servicing arise from carelessness. Please remember that safety involves both the welfare of the employees and improved work efficiency.

⚠ Safety Precautions for Disassembly and Reassembly

Machines must be disassembled and assembled efficiently and safely.
It is very important to thoroughly understand the construction and function of the machine, to make all appropriate preparations, and start operations according to the specified working procedures.

a) Safety Measures before Starting Work

(1) Work clothes

1. Wear specified work cap and clothes. (In any situations workers must not wear undershirts only.) Cuffs must be kept buttoned, and any torn part must be mended.)
2. Wear safety shoes.
3. Do not wear cotton gloves when working on the internal section of engine, reduction gears or hydraulic units for repair or others, or when using a hammer. Wear leather gloves, when hoisting wires.

(2) Inspecting equipment and tools

1. Prepare equipment (cranes, fork lifts, tool, etc.) required for servicing and inspect for any problems before starting work.
2. Hammer heads (metal parts) must be firmly secured to their handles.
3. Check hosting tools (wire ropes, hoisting chains, etc.) before use.

(3) Keep workshop in order

1. Secure appropriate space needed for disassembly to do the job.
2. Secure a clean, safe place for arranging disassembled parts.
3. Store volatile substances (gasoline, light oil, thinner, oily articles, etc.) in appropriate containers at selected locations to prevent fire hazards.

b) Safety Measures during Work

(1) Protectors

1. Wear goggles when using chisels for chipping.
2. Use appropriate protectors during welding.
3. Wear a helmet when working with a crane or at elevated locations.

(2) Team work

1. When working with two or more people, divide the work and maintain close communication.
2. Clane work must be carried out using predetermined signals.

(3) Disassembly and assembly

1. Do not wear gloves when using hammers.
2. Use rods of the specified soft material for removing pins. Do not use a hammer as a pad.
3. Do not place fingers in holes when centering.
4. Heavy parts must be adequately supported before removing bolts.

(4) Cranes

1. In principle, use a crane for objects heavier than 44 lb (20 kg).
2. Crane operation and hoisting must be performed only by qualified personal.
3. Pay careful attention to the center of gravity when hoisting, and do not stand under the lifted objects.

(5) Others

1. To work under a jacked-up carrier, be sure to place wood pieces under it.
2. When charging battery, make sure there are no open flames in the immediate vicinity.
3. All electric tools must be grounded.
4. Before welding the machine, remove the battery.
   - When removing the battery, be sure to disconnect negative (-) cord first.
   - When mounting the battery, be sure to connect the positive (+) cord first.

c) Preparation for Disassembly

(1) Cleaning

Remove mud and dirt from the body before disassembly.

(2) Receiving inspection

The machine must be checked before it is disassembled to record existing conditions, such as those listed below.
Model, serial number, and hour meter reading
- Reason for repair and repair history
- Element stains
- Fuel and oil condition
- Parts damage *(Take photographs if nessesary.)

(3) Equipment and tools

Prepare equipment, tools, cranes and parts storage racks as required.

d) Precautions for Disassembly and Reassembly

(1) Disassembly

1. Follow the specified disassembly procedures.
2. Make alignment marks to insure correct reassembly.
3. Arrange disassembled parts in an orderly way, and attach identification tags or put marks if needed.

(2) Reassembly

1. Clean all parts before assembly. Repair any scratches or dents. Take special precautions against dirt and dust.
2. Parts with rust-preventive coatings must be assembled only after removing the corting.
3. Separated parts must be correctly reassembled using alignment marks.
4. As a rule, use a press to reassemble bearings, bushing and oil seals. Use pads when using a hammer.

e) Maintenance

CAUTION

When adding oil and servicing

1. Park the machine on a large, flat place.
2. Place the bucket and dozer on the ground.
3. Stop the engine
4. Move the attachment control lever and dozer lever to make sure the remaining pressure is relieved. In case of pilot operated models, turn the starter switch to the “ON“ position (1st stage), lift down the safety lock lever and shift both control levers. (English doesn’t need to start.)
5. Pull out the starter key and check around the machine for safety. Before starting the job, carefully read the Operational Manual in " ! Servicing Precautions" on the yellow pages.

f) Waste Disposal

WARNING

Do not carelessly throw away and burn the waste materials. Such actions may lead to environmental pollution and punishment by local laws.

When disposing of waste:

* Let out waste fluid from the machine into a container.
* Do not let waste fluid flow out on the ground nor into a river, lake, marsh, or sea.
* Contact your dealer or a qualified industrial waste handler to treat (dispose of or incinerate) harmful waste materials. Those materials include waste oil, fuel, cooling water (anti-freeze), coolant, solvent, filters, batteries, rubber and other toxic substances.

(C) IMPORTANT SAFETY PROCESS AND CRITICAL FUNCTIONAL PROCESS

The following instructions are related to essential adhesives, important safety process [S] and critical functional process [A]. Pay special attention in servicing these process. (Pay also close attention in reconnecting the electrical cables.)

a) Essential Adhesives

Type of screw adhesive
- Unless otherwise specified, use Three-Bond 1324 adhesive (medium-duty type). Keep the screw threads free of oil and water.

Type of instantaneous adhesive
- Use Three-Bond 1733 or Three-Bond 1741E adhesive. Keep the bond areas free of oil and water.

b) Important Safety Process [S]

1. Reconnecting the fuel hose (clearance, hose routes, clamps, etc.)
2. Electrical cabling (engine, instrument panal, controls, etc.) (wiring routes, clamps and couplers)

c) Important Critical Functional Process [A]

1. Setting up the travel wheel motor (tightening torque)
2. Reassembling the rotary joints (joint direction and shaft set-up)
3. Installing the swivel base bearing and the swivel motor (tightening torque)
4. Fitting the pump couplings (tightening torque)

(D) IMPORTANT INSPECTION ITEMS AFTER REASSEMBLING

a) Operate the machine and check for unusual noise and vibrations.

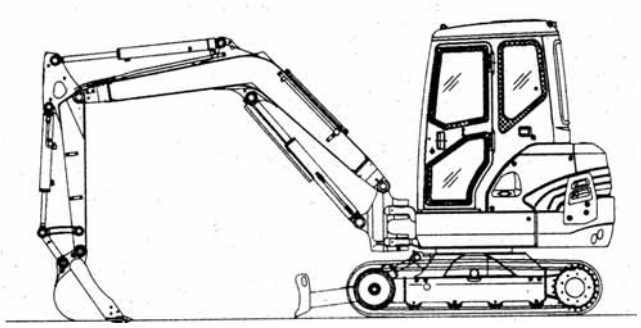
b) Make sure the safety decals and wireharness clamps are in their specified positions.

c) With the machine front in a specified posture, check the amount of hydrauric oil.

Checking the oil level (For further datails, refer to the Operator's Manual of each model.)

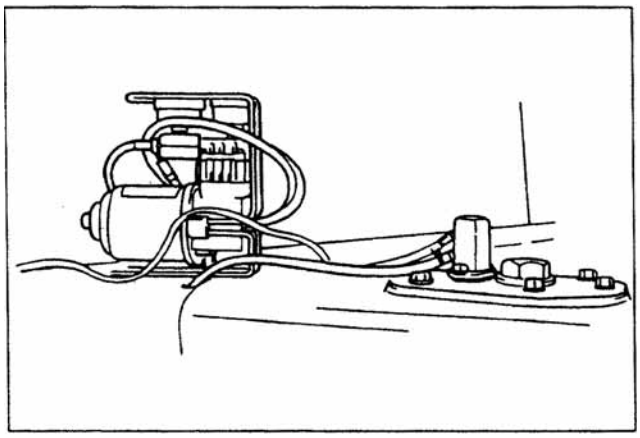
1) Park the machine on a level ground.
2) Make sure the hydrauric oil temperature is in the range of 10 ~ 30°C (50 ~ 86°F) and see if the oil level is within the specified zone of the oil level gauge.
3) Keep the machine front as shown as following posture.

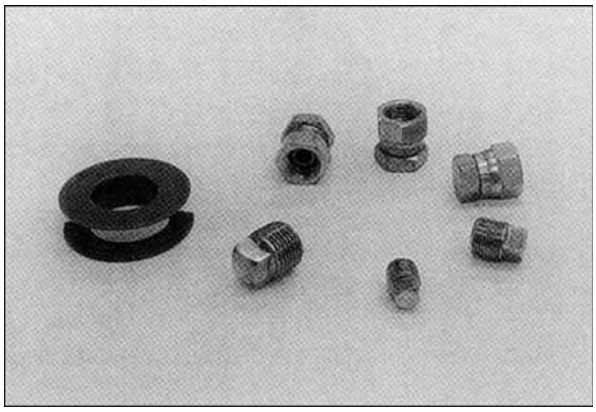
Posture: Extend the rods of the arm and bucket cylinders nearly half. Place the bucket on the ground, the offset swing at the center, and the dozer also on the ground.

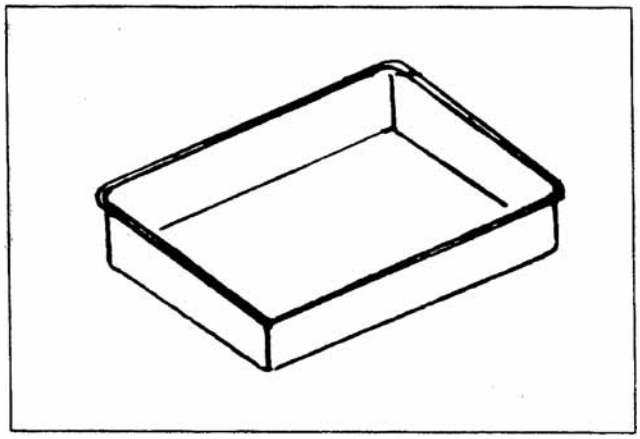


(E) SERVICING FUNDAMENTALS

Locking adhesive







a) Items for Servicing

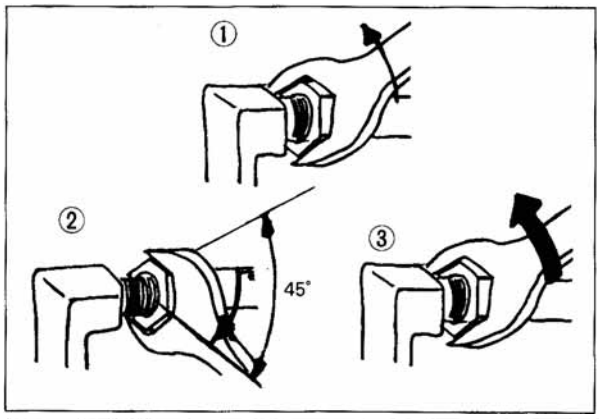
1) Tighten bolts, nuts, adapters, and similar parts to their specified torques which are given in the list of tightening torques and adhesive as well as in this manual. Be sure to observe the specified torques for important tightened parts and components.
2) Wipe out water, oil and grease off the screws on which loctite adhesive is to be applied. Be sure to apply the adhesive to specified locations.

Liquid color	Feature
Red	Heavy-duty
Blue	Medium-duty

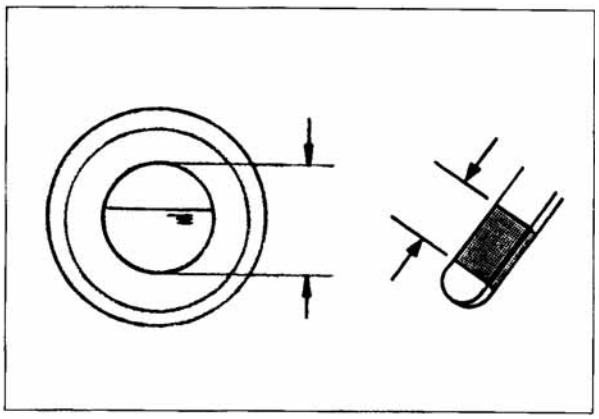
The word “LOCTITE“ in this manual denotes the red-color type.

3) Precautions in disassembling the hydraulic equipment
   - Use a vacuum pump, pulgs, oil pans, waste cloth and the like to prevent oil from running out or splashing.
   - Wipe out leaking oil completely first and then add oil as required.
   - Protect the openings with plugs, covers or the like to keep off foreign matters. Most of hydraulic system troubles are caused by the entry of foreign matters.
   - Before reassembling, clean up the parts and components and apply hydraulic oil on them.
   - The system consists of precision parts. Be careful not to scratch them and apply excessive force on them.

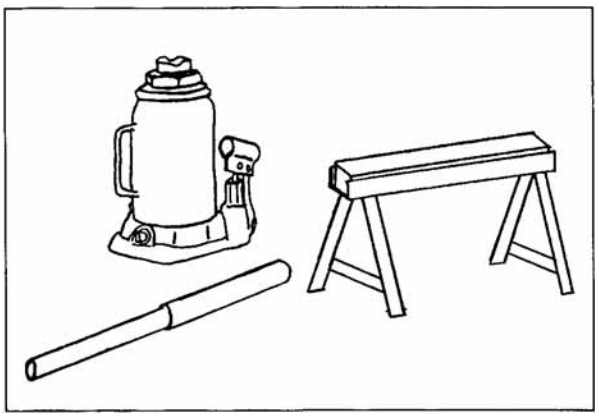
4) Precautions in tightening hoses and pipes.
   - Flexible hoses have a slight natural bend of their own. Utilize the natural bend. Be also careful not to twist them.
   - Be careful not to confuse the routes of the hoses.
   - Do not hold the hoses in tight contact with their adjacent parts and surfaces.



- Tightening steps
  1. First tighten the nut to its specified torque.
  2. Then loosen the nut by about 45° to fit the seat of the joint to the connection.

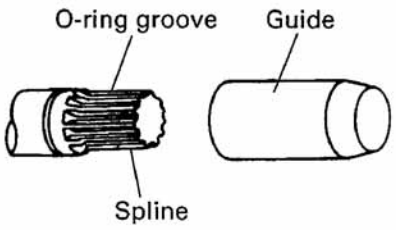


5) The quantities of oil, fuel, water and others, except for the oil to be filled in the track rollers and idlers, are listed just as reference. Fill up the fluid up to the specified center level of a level gauge if it is provided.

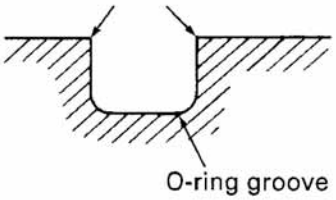


6) Securely support the machine with a jack and a supporting jig when it is jacked up for servicing.
7) Be sure to use a crane in disassembling and reassembling heavy parts and components (frame, front attachment, crawler, etc.).

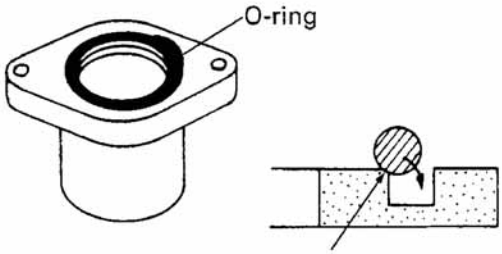
b) O-ring, Oil Seal, Circlip and Roll Pin



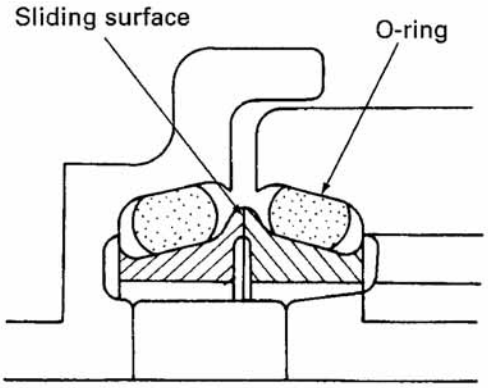
(1) General precautions
- Make sure the O-ring and the oil seal are free of anything unusual (uneven surface, scratches, chipping, etc.).
- Check the O-ring groove for burrs. Correct, if any, using an oil stone or the like.
- When putting a part past a sharp edge into position, protect such edge with a cover or get the part chamfered.

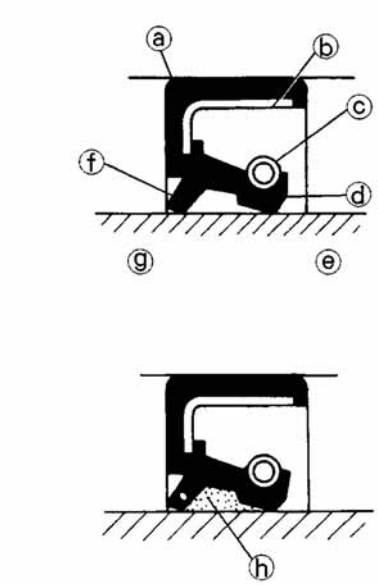


(2) O-ring
- Clean up the O-ring groove and deburr its edge as required.
- Before installing the ring, be sure to apply lubricant (grease) over it. (Do not do this to the floating seal.)
- Fit the O-ring into its groove without twist. With your fingertip, push the ring gently and evenly into the final position. Otherwise the ring would easily get twisted in contact with the inner edge of the groove.



(3) Floating seal
- Be sure to wipe oil off the O-ring and the O-ring contact surface. (Note, however, that oil must be applied thinly over those of the wheel motor.)
- In fitting the O-ring into the floating seal, be careful not to twist the O-ring.
- Before installing the floating seal together with the O-ring, apply sealing oil thinly over the sliding surface. Be careful to keep the sliding surface and O-ring in alignment with the housing.
- Finally turn hte floating seal 2 or 3 times by hand in order to form an oil film over the sliding surface as well as to make the sealing surface fixed.

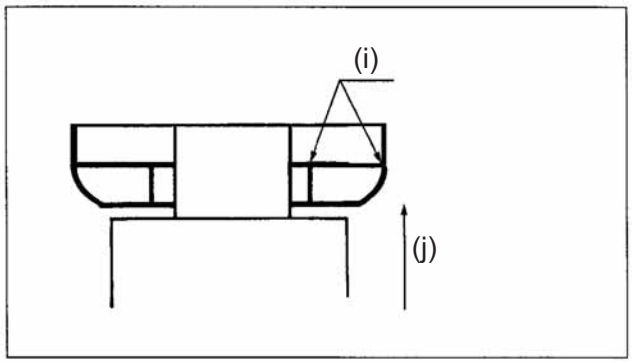




(4) Oil seal
- Do not confuse the orientation of the oil seal lips. Direct the main lip toward the oil chamber; in other word, toward what is to be sealed.

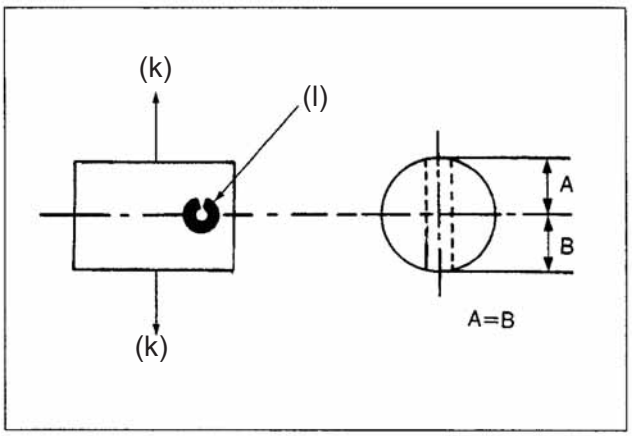
a.	Packing	f.	Dustproof lip
b.	Metal ring	g.	Atmosphere (outside)
c.	Spring	h.	Grease
d.	Main lip		
e.	Oil chamber (inside)		

- In dry state, the oil seal may wear out when running in the machine. To prevent this, be sure to apply lubricant (grease) over the lip sliding surface. If provided also with a dustproof lip, fill the space between this lip and the main lip with grease.
- As a rule, use a press to press-fit the oil seal. If not available, apply a suitable tool and tap it evenly without allowing any tilt. Press-fit the oil seal deep down to the bottom of the oil seal fitting boss.



(5) Mounting the circlip
- Place the circlip with its sharp edge facing outward (in the locking direction).
- Fit the circlip securely in the groove. For the hole circlip in particular, install and turn it slightly to make sure it fits well.

(i) Edge: Outside
(j) Force direction



(6) Tapping the roll pin (spring pin)
- Place the roll pin (spring pin) with its opening perpendicular to the load.
- Place the roll pin (spring pin) with its opening in the turning direction.
- Evenly tap the roll pin (spring pin) into position.

(k) Revolving
(l) Spring pin

c) Piping

(1) General precautions

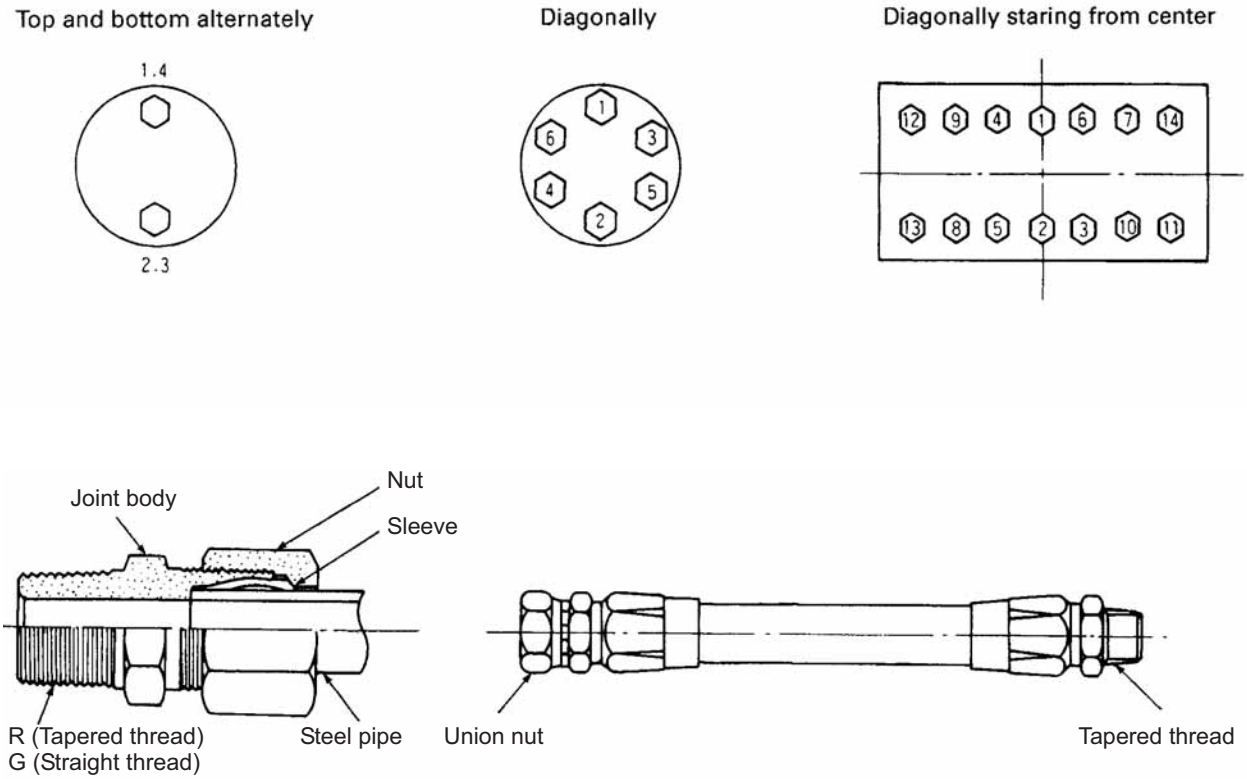
- Tightening the pipe socket to the specified torque. If too tight, the socket itself or a hydraulic component may get damaged. If too loose, an oil leak may result.
- In connecting a new hose or pipe, tighten its nut first to the specified torque and then turn it back (about 45°). Then tighten it again to the specified torque. (Do not this to the sealing tape-applied hose or pipe.)
- When disconnecting a vertical hose or pipe, separate its bottom connection first.
- In desconnecting and reconnecting the hose and pipe, be sure to use two wrenches. With one wrench, restrain the mating part to allow no twist.
- Check the mating connector's sleeve and the hose's taper for dust deposits and scratches.
- When the pipe socket has been tightened up, wipe the joint clean. Apply the maximum operating pressure 2 or 3 times to make sure there is no oil leak.

(2) Hydraulic hose

Check if the hydraulic hose is connected too tight or twisted.
Excessivly tight contact:
Let's suppose that a hose is in contact with another hose or other part and pulled away by a force of 2 kg but still in contact, it means the contact is too tight.

(3) Precautions in tightening the bolts and nuts

- Use bolts of specified length.
- Do not over tighten the bolts: Its threads may get deformed or the fixed part may get damaged. Do not undertighten the bolt either: It may get loose.
- In other words, tighten the bolt to the specified torque.
- Tighten the bolts and nuts diagonally for even tightness.



(4) Hose screw

Thread size (piping screw)	Tightening torque N·m kgf·m ft·lbf		Wrench size (reference)
	Union nut section	Taper thread section	
1/8”	7.8 ~ 11.8 N·m 0.8 ~ 1.2 kgf·m 5.8 ~ 8.7 ft·lbf	14.71 ~ 19.61 N·m 1.5 ~ 20 kgf·m 10.85 ~ 14.47 ft·lbf	17 mm 0.67 in
1/4”	24.5 ~ 29.4 2.5 ~ 3.0 18.1 ~ 21.7	36.3 ~ 44.1 3.7 ~ 4.5 26.8 ~ 32.5	19 mm 0.75 in
3/8”	49.0 ~ 53.9 5.0 ~ 5.5 36.2 ~ 39.8	49.0 ~ 68.6 5.0 ~ 7.0 36.2 ~ 50.6	22 mm 0.87 in
1/2”	58.8 ~ 63.7 6.0 ~ 6.5 43.4 ~ 47.0	83.4 ~ 88.3 8.5 ~ 9.0 61.5 ~ 65.1	27 mm 1.06 in
3/4”	117.7 ~ 127.5 12.0 ~ 13.0 86.8 ~ 94.0	127.5 ~ 147.1 13.0 ~ 15.0 94.0 ~ 108.5	36 mm 1.42 in
1”	137.3 ~ 147.1 14.0 ~ 15.0 101.3 ~ 108.5	147.1 ~ 166.7 15.0 ~ 17.0 108.5 ~ 123.0	41 mm 1.61 in

Metric Size Hose

Thread size (piping screw)	Torque N·m kgf·m ft·lbf
M12 × 1.5	20 ~ 30 2.0 ~ 3.1 14.75 ~ 22.13
M14 × 1.5	20 ~ 30 2.0 ~ 3.1 14.75 ~ 22.13
M16 × 1.5	30 ~ 50 3.1 ~ 5.1 22.13 ~ 36.9
M18 × 1.5	30 ~ 50 3.1 ~ 5.1 22.13 ~ 36.9
M22 × 1.5	40 ~ 60 4.1 ~ 6.1 29.5 ~ 44.25

(5) Joint bodies

Thread size (piping screw)	Tightening torque N·m kgf·m ft·lbf		Spanner size (reference)	Remarks Steel pipe (OD)	
	R (tapered thread)	G (straight thread)			
1/8”	19.6 ~ 29.4 N·m 2.0 ~ 3.0 kgf·m 14.5 ~ 21.7 ft·lbf	-	17 mm 0.67 in	When in steel pipe is in use.	8 mm 0.31 in
1/4”	36.3 ~ 44.1 3.7 ~ 4.5 26.8 ~ 32.5	W/O-ring *Joint Torque* 58.8 ~ 78.5 6 ~ 8 43.4 ~ 57.9	19 mm 0.75 in		12 mm 0.47 in
3/8”	39.2 ~ 49.0 4.0 ~ 5.0 28.9 ~ 36.2	W/O-ring *Joint Torque* 78.5 ~ 98.1 8 ~ 10 57.9 ~ 72.3	23 mm 0.91 in		15 mm 0.59 in
1/2”	49.0 ~ 68.6 5.0 ~ 7.0 36.2 ~ 50.6	W/O-ring *Joint Torque* 117.7 ~ 137.3 12 ~ 14 86.8 ~ 101.3	26 mm 1.02 in		16 mm 0.63 in

(6) Tightening torque table for hose clamp (Screw type)

No.	Dia. (mm)	Code No.	Tightening torque N·m kgf·m ft·lbf
1	Ø12 ~ 16	09318-89016	2.5 ~ 3.4 25 ~ 35 1.84 ~ 2.51
2	Ø19 ~ 25	09318-89024	
3	Ø31 ~ 40	09318-89039	
4	Ø36 ~ 46	09318-89045	
5	Ø15 ~ 25	RC101-64580	4.9 ~ 5.9 50 ~ 60 3.61 ~ 4.35
6	Ø26 ~ 38	68311-72820	
7	Ø13 ~ 20	RB101-63630	3.4 ~ 4.4 35 ~ 45 2.58 ~ 3.31
8	Ø40 ~ 55	RC411-63180	4.9 ~ 5.9 50 ~ 60 3.61 ~ 4.35
9	Ø77 ~ 95	69284-63170	
10	Ø50 ~ 60	RC401-63190	
11	Ø32 ~ 44	RD411-63820	

(7) Nuts for piping

Steel pipe size (O.D. × I.D. × Thickness)	Tightening torque N·m kgf·m ft·lbf	Spanner size (reference)	Remarks
8 × 6 × 1 mm 0.31 × 0.24 × 0.04 in	29.4 ~ 39.2 3.0 ~ 4.0 21.7 ~ 28.9	17 mm 0.67 in	When sleeve nut is in use.
10 × 7 × 1.5 mm 0.39 × 0.28 × 0.06 in	39.2 ~ 44.1 4.0 ~ 4.5 28.9 ~ 32.5	19 mm 0.75 in	
12 × 9 × 1.5 mm 0.47 × 0.35 × 0.06 in	53.9 ~ 63.7 5.5 ~ 6.5 39.7 ~ 47.0	21 mm 0.83 in	
16 × 12 × 2 mm 0.63 × 0.47 × 0.08 in	88.3 ~ 98.1 9.0 ~ 10.0 65.1 ~ 72.3	29 mm 1.14 in	
18 × 14 × 2 mm 0.71 × 0.55 × 0.08 in	127.5 ~ 137.3 13.0 ~ 14.0 94.0 ~ 101.3	32 mm 1.26 in	
27.2 × 21.6 × 2.8 mm 1.07 × 0.85 × 0.11 in	235.4 ~ 254.97 24.0 ~ 16.0 173.6 ~ 188.1	41 mm 1.61 in	

(8) Tightening torque of bolts and nuts

Refere to the tightening torque table below.

Bolts, Nuts / Nomial Dia.	4T	7T	9T
	SS41	S40C, S45C	SCr4
M6	7.8 ~ 9.3 N·m 0.80 ~ 0.95 kgf·m 5.8 ~ 6.9 ft·lbf	9.8 ~ 11.3 N·m 1.00 ~ 1.15 kgf·m 7.2 ~ 8.3 ft·lbf	12.3 ~ 14.2 N·m 1.25 ~ 1.45 kgf·m 9.0 ~ 10.5 ft·lbf
M8	17.7 ~ 20.6 N·m 1.80 ~ 2.10 kgf·m 13.0 ~ 15.2 ft·lbf	23.5 ~ 27.5 N·m 2.40 ~ 2.80 kgf·m 17.4 ~ 20.3 ft·lbf	29.4 ~ 34.3 N·m 3.00 ~ 3.50 kgf·m 21.7 ~ 25.3 ft·lbf
M10	39.2 ~ 45.1 N·m 4.00 ~ 4.60 kgf·m 28.9 ~ 33.3 ft·lbf	48.0 ~ 55.9 N·m 4.90 ~ 5.70 kgf·m 35.4 ~ 41.2 ft·lbf	60.8 ~ 70.6 N·m 6.20 ~ 7.20 kgf·m 44.8 ~ 52.1 ft·lbf
M12	62.8 ~ 72.6 N·m 6.40 ~ 7.40 kgf·m 46.3 ~ 53.5 ft·lbf	77.5 ~ 90.2 N·m 7.90 ~ 9.20 kgf·m 57.1 ~ 66.5 ft·lbf	103.0 ~ 117.7 N·m 10.50 ~ 12.00 kgf·m 75.9~ 86.8 ft·lbf
M14	107.9 ~ 125.5 N·m 11.00 ~ 12.80 kgf·m 79.6 ~ 92.6 ft·lbf	123.6 ~ 147.1 N·m 12.60 ~ 15.0 kgf·m 91.1 ~ 108.5 ft·lbf	166.7 ~ 196.1 N·m 17.00 ~ 20.00 kgf·m 123.0 ~ 144.7 ft·lbf
M16	166.7 ~ 191.2 N·m 17.00 ~ 19.50 kgf·m 123.0 ~ 141.0 ft·lbf	196.1 ~ 225.6 N·m 20.00 ~ 23.00 kgf·m 144.7 ~ 166.4 ft·lbf	259.9 ~ 304.0 N·m 26.50 ~ 31.00 kgf·m 191.7 ~ 224.2 ft·lbf
M18	245.2 ~ 284.4 N·m 25.00 ~ 29.0 kgf·m 180.8 ~ 209.7 ft·lbf	274.6 ~ 318.7 N·m 28.00 ~ 32.50 kgf·m 202.5 ~ 235.1 ft·lbf	343.2~ 402.1 N·m 35.00 ~ 41.00 kgf·m 253.2 ~ 296.5 ft·lbf
M20	333.4~ 392.2 N·m 34.00 ~ 40.00 kgf·m 245.9 ~ 389.3 ft·lbf	367.7 ~ 431.5 N·m 37.50 ~ 44.0 kgf·m 271.2 ~ 318.2 ft·lbf	519.8 ~ 568.8 N·m 53.00 ~ 58.00 kgf·m 383.3 ~ 419.5 ft·lbf

(9) Types and materials of bolts and nuts

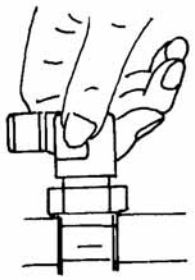
[ex. bolts]

Types	Material	Tensile strength	Hardness	Bolt head marking	
4T	SS41	Over 392 MPa 4000 kgf/cm^2 56892 lbf/in^2	H_RB 62 ~ 98		No mark or marked 4
7T	S40C S45C	Over 686 MPa 7000 kgf/cm^2 99561 lbf/in^2	H_RC 20 ~ 28		Marked 7
9T	SCr4	Over 882 MPa 9000 kgf/cm^2 128007 lbf/in^2	H_RC 28 ~ 34		Marked 9

(10) Washer-equipped elbow

Tightening torque

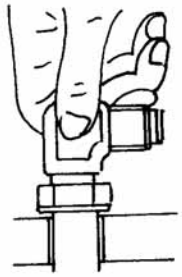
Size	N·m	kgf·m	ft·lbs
G1/4	25 ~ 30	2.5 ~ 3.0	18 ~ 22
G3/8	49 ~ 54	5.0 ~ 5.5	36 ~ 40
G1/2	59 ~ 64	6.0 ~ 6.5	43 ~ 47
G3/4 G1	118 ~ 127	12.0 ~ 13.0	87 ~ 94



Tightening procedure

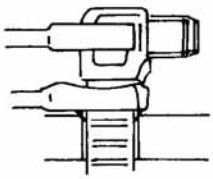
1) Connecting with the valve
   • Screw in the elbow by hand until the washer comes into contact.

Note: Clean up the mating seal beforehand.



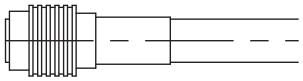
2) Positioning
   • Turn the elbow back to its set position.

Note: Do not make any more than one turn back.



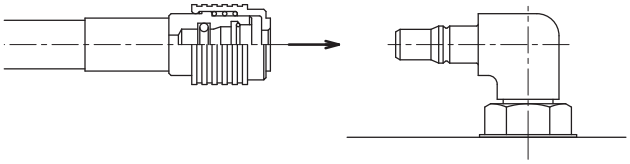
3) Fixing
   • Tighten up the lock nut with a wrench.
   • Lock nut tightening torque
     G1/4: 25 ~ 30 N·m (2.5 ~ 3.0 kgf·m, 18 ~ 22 ft·lbs)
     G3/8: 50 ~ 55 N·m (5.0 ~ 5.5 kgf·m, 36 ~ 40 ft·lbs)
     G1/2: 60 ~ 65 N·m (6.0 ~ 6.5 kgf·m, 43 ~ 47 ft·lbs)
     G3/4: 118 ~ 127 N·m (12.0 ~ 13.0 kgf·m, 87 ~ 94 ft·lbs)
     G1: 118 ~ 127 N·m (12.0 ~ 13.0 kgf·m, 87 ~ 94 ft·lbs)

(11) Installation of a quick-coupling type

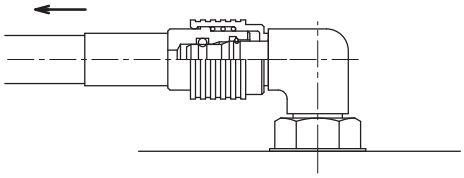


G1-1/4 size
Couple the hose in position as shown at left.
Make sure the hose does not come off.

Connecting the quick-coupling type hose



1) Couple the hose onto the joint until it clicks (in the direction of arrow).



2) Pull the hose in the direction of arrow, as shown at left. Make sure it does not come off the joint.

(12) Pipe threads

British Standard Pipe Threads and Japanese Industrial standard Pipe Threads
BSP threads are used commonly in many countries outside the U.S. There are two types of BSP threads: BSPT (British Standard Pipe Taper) and BSPP (British Standard Pipe Parallel). These two styles are not interchangeable.
BSPP threads are straight (parallel) threads. They are used where pressure tight joints are obtained with a sealing ring.
BSPT threads are tapered, and pressure tight joints are achieved by the threads.
See the tables below for BSPP and BSPT pipe sizes and the corresponding threads per inch.

British standard Pipe Threads and Japanese Industrial standard Pipe Threads are identical to each other as shown in the following pages.

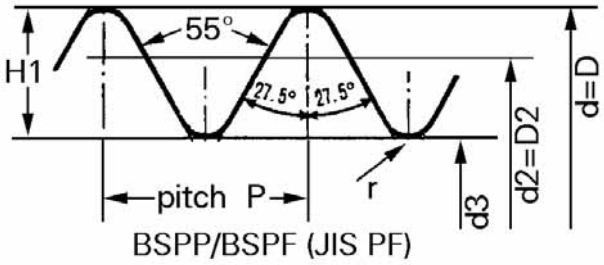
British Standard Pipe Parallel Threads

Parallel Pipe Size	Thread Size	Threads Per inch
G 1/8"	3/8"	28
G 1/4"	1/2"	19
G 3/8"	5/8"	19
G 1/2"	3/4"	14
G 3/4"	1"	14
G 1"	1 3/8"	11

British Standard Pipe Tapered Threads

Parallel Pipe Size	Thread Size	Threads Per inch
R 1/8"	3/8"	28
R 1/4"	1/2"	19
R 3/8"	5/8"	19
R 1/2"	3/4"	14
R 3/4"	1"	14
R 1"	1 3/8"	11

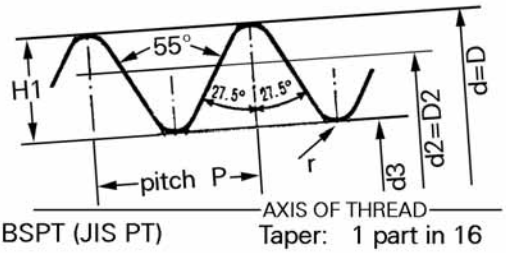
Pipe Thread -- British Standard Pipe Parallel -- BSPP/BSPF
Pipe Thread -- Japanese Pipe Parallel -- PF



BSPP/BSPF (JIS PF)

Thread Data Chart:									
British Pipe Thread (Whitworth Form) -- Parallel (BSPP/BSPF)									
Thread Designation BSPP/BSPF	Nominal Size BSPP/BSPF	Thread Form Type	Major Diameter mm d=D	Pitch mm p	Threads per inch tpi	Pitch Diameter mm d2=D2	Minor Diameter Male Thd. d3	Thread Height H1	Tap Drill Diameter mm
G 1/8	1/8"	BSPP/BSPF	9.728	0.907	28	9.147	8.566	0.581	8.7
G 1/4	1/4"	BSPP/BSPF	13.157	1.337	19	12.301	11.445	0.856	11.6
G 3/8	3/8"	BSPP/BSPF	16.662	1.337	19	15.806	14.95	0.856	15
G 1/2	1/2"	BSPP/BSPF	20.955	1.814	14	19.793	18.631	1.162	19
G 5/8	5/8"	BSPP/BSPF	22.911	1.814	14	21.749	20.587	1.162	20.75
G 3/4	3/4"	BSPP/BSPF	26.441	1.814	14	25.279	24.117	1.162	24.5
G 7/8	7/8"	BSPP/BSPF	30.201	1.814	14	29.039	27.877	1.162	28
G 1	1"	BSPP/BSPF	33.249	2.309	11	31.77	30.291	1.479	30.5

Pipe Thread -- British Standard Pipe Taper -- BSPT
Pipe Thread -- Japanese Pipe Taper -- PT



BSPT (JIS PT) Taper: 1 part in 16

Thread Data Chart:										
British Pipe Thread (Whitworth Form) -- Taper (BSPT)										
Thread Designation BSPT	Nominal Size BSPT	Thread Form Type	Major Diameter mm d=D	Pitch mm p	Threads per inch tpi	Pitch Diameter mm d2=D2	Minor Diameter Male Thd. d3	Thread Height H1	Rounding r	Tap Drill Diameter mm
R 1/16	1/16"	BSPT	7.723	0.907	28	7.142	6.561	0.581	0.125	6.4
R 1/8	1/8"	BSPT	9.728	0.907	28	9.147	8.566	0.581	0.125	8.4
R 1/4	1/4"	BSPT	13.157	1.337	19	12.301	11.445	0.856	0.184	11.2
R 3/8	3/8"	BSPT	16.662	1.337	19	15.806	14.950	0.856	0.184	14.75
R 1/2	1/2"	BSPT	20.955	1.814	14	19.793	18.631	1.162	0.249	18.25
R 3/4	3/4"	BSPT	26.441	1.814	14	25.279	24.117	1.162	0.249	23.75
R 1	1"	BSPT	33.249	2.309	11	31.77	30.291	1.479	0.317	30

(F) MAINTENANCE INTERVALS

a) EU-version

	General Maintenance	Elapsed Operating Hours *																			Interval	Section
		50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000		
Operator Services	Check engine oil level																					daily	
	Check hydraulic oil level																					daily	
	Check fuel level																					daily	
	Check coolant level																					daily	
	Grease front attachments																					daily	
	Check V-belt																					daily	
	Check water separator																					daily	
	Tracks and chassis: clean, visual inspection and check tension	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	weekly (50 hrs)	
	Grease swivel gear	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	50 hrs	
	Check, clean air filter 1.)	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	50 hrs	
	Check nuts and bolts		❍		❍		❍		❍		❍		❍		❍		❍		❍		❍	100 hrs	
	Grease swivel gear bearing				❍				❍				❍				❍				❍	200 hrs	
	Check battery electrolyte level										❍										❍	500 hrs	
	Drain water in fuel tank										❍										❍	500 hrs	

* The services identified with ● must be carried out at the specified service hours after initial operation.

1.) Under dusty conditions the air filter must be cleaned more frequently or renewed.

2.) When using a hydraulic hammer over 20 % every 800 h. When using a hydraulic hammer over 60 % every 300 h.
When using a hydraulic hammer over 40 % every 400 h. When using a hydraulic hammer over 80 % every 200 h.

3.) When using a hydraulic hammer up to 50 % every 200 h. When using a hydraulic hammer over 50 % every 100 h.

4.) Earlier if necessary.

5.) At least annually.

	Service	Elapsed Operating Hours *																			Interval	Section
		50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000		
Servicing by skilled personnel or KUBOTA dealer	Change engine oil and oil filter										❍					❍					❍	500h	
	Inspect coolant hoses and clamps					❍					❍					❍					❍	250 h	
	Check/adjust V-belt tension					❍					❍					❍					❍	250 h	
	Grease pilot valve linkage					❍					❍					❍					❍	250 h	
	Change fuel filter 4.)										❍										❍	500 h	
	Change hydraulic return line filter element 3.)					●					❍										❍	500 h	
	Change drive unit oil 5.)	●									❍										❍	500 h	
	Change hydraulic oil and suction filter 2.)																				❍	1000 h	
	Renewing/Cleaning the Hydraulic Oil Tank Breather Filter 1.)																				❍	1000 h	
	Renewing the Pilot Circuit Filter																				❍	1000 h	
	Change air filter elements 1.)																				❍	1000 h	
	Change idler and track roller oil																					2000 h	
	Check alternator and starter motor						Please contact your KUBOTA dealer.															2000 h	
	Inspect electric cables and connections						Please contact your KUBOTA dealer.															annually	
	Change coolant																					every 2 years	
	Change hydraulic hoses						Please contact your KUBOTA dealer.															every 6 years	
	Safety inspection																					annually	

Note: When engine oil of API service classification, CF/CF-4 is used, change interval of engine oil and oil filter shall be evenly 500 hours.

b) KTC, KCL-version

No.	Check points		Intervals	Hour meter indicator									Consequently		
				50	100	150	200	250	300	350	400	450			
1	Coolant		check	Daily check											
			change										every 2 years		
2	Fuel		check	Daily check											
3	Engine oil (CF)		check	Daily check											
			change										every 500 hrs or every 1 year		
4	Hydraulic oil		check	Daily check											
			change										every 1000 hrs	*1	
5	Lubrication points		-	Daily check											
6	Radiator and oil cooler		check	Daily check											
7	Washer liquid (CAB type)		check	Daily check											
8	Engine and electrical wiring		check	Daily check											
9	Fuel tank, Water separator		drain	○	○	○	○	○	○	○	○	○	every 50 hrs		
10	Battery condition		check	○	○	○	○	○	○	○	○	○	every 50 hrs		
11	Greasing swing bearing teeth		-	○	○	○	○	○	○	○	○	○	every 50 hrs		
12	Fan belt tension		adjust				○				○		every 200 hrs		
13	Radiator hoses and clamps		check				○				○		every 200 hrs		
			replace										every 2 years		
14	Air filter element	Outer element	clean				○				○		every 200 hrs	*2	@
			replace										every 1000 hrs	*2	
		Inner element	replace										every 1000 hrs	*2	
15	Greasing swing ball bearings		-				○				○		every 200 hrs		
16	Fuel filter cartridge		replace										every 500 hrs		@
17	Engine oil filter		replace										every 500 hrs or every 1 year		
18	Drive unit oil		change		◉								every 500 hrs		
19	Hydraulic return filter element		replace					◉					every 500 hrs		
20	Hydraulic breather filter element		replace										every 1000 hrs		
21	Hydraulic suction filter element		replace										every 1000 hrs		
22	Filter in the pilot hydraulic system		replace										every 1000 hrs		
23	Fuel injection nozzle injection pressure		check										every 1500 hrs	*4	@
24	Front idler and track roller oil		change										every 2000 hrs		
25	Alternator and starter motor		check										every 2000 hrs		
26	Injection pump		check										every 3000 hrs	*4	@
27	Radiator system		rinse										every 2 years		
28	Fuel line and Intake air line		check				○				○		every 200 hrs		@
			replace										every 2 years	*3	

* 500 thru 1000 continued to the following table.
* The table above should be applied except KTA market.
  As for KTA market, change interval of engine oil and oil filter should be followed in the previous pages, even if CF/CF-4 engine oil is used.

No.	Check points		Intervals	Hour meter indicator								Consequently		
				500	550	600	650	700	750	800	1000			
1	Coolant		check	Daily check										
			change									every 2 years		
2	Fuel		check	Daily check										
3	Engine oil (CF)		check	Daily check										
			change	○							○	every 500 hrs or every 1 year		
4	Hydraulic oil		check	Daily check										
			change								○	every 1000 hrs	*1	
5	Lubrication points		-	Daily check										
6	Radiator and oil cooler		check	Daily check										
7	Washer liquid (CAB type)		check	Daily check										
8	Engine and electrical wiring		check	Daily check										
9	Fuel tank, Water separator		drain	○	○	○	○	○	○	○	○	every 50 hrs		
10	Battery condition		check	○	○	○	○	○	○	○	○	every 50 hrs		
11	Greasing swing bearing teeth		-	○	○	○	○	○	○	○	○	every 50 hrs		
12	Fan belt tension		adjust			○				○	○	every 200 hrs		
13	Radiator hoses and clamps		check			○				○	○	every 200 hrs		
			replace									every 2 years		
14	Air filter element	Outer element	clean			○				○	○	every 200 hrs	*2	
			replace								○	every 1000 hrs	*2	@
		Inner element	replace								○	every 1000 hrs	*2	
15	Greasing swing ball bearings		-			○				○	○	every 200 hrs		
16	Fuel filter cartridge		replace	○							○	every 500 hrs		@
17	Engine oil filter		replace	○							○	every 500 hrs or every 1 year		
18	Drive unit oil		change			○						every 500 hrs		
19	Hydraulic return filter element		replace						○			every 500 hrs		
20	Hydraulic breather filter element		replace								○	every 1000 hrs		
21	Hydraulic suction filter element		replace								○	every 1000 hrs		
22	Filter in the pilot hydraulic system		replace								○	every 1000 hrs		
23	Fuel injection nozzle injection pressure		check									every 1500 hrs	*4	@
24	Front idler and track roller oil		change									every 2000 hrs		
25	Alternator and starter motor		check									every 2000 hrs		
26	Injection pump		check									every 3000 hrs	*4	@
27	Radiator system		rinse									every 2 years		
28	Fuel line and Intake air line		check			○				○	○	every 200 hrs		@
			replace									every 2 years	*3	

* The engine oil is gradually consumed and reduced with engine operation. The consumption depends on the type of job and the model of engine. Before operation, make sure that the oil level is between the upper and lower limits of the oil level gauge. Add oil as required. To avoid a shortened service life or burn-out of the engine, use a Kubota-specified oil and genuine Kubota filter. Keep their specified replacement intervals in mind.

c) KTA-version

No.	Check points		Intervals	Hour meter indicator																	Consequently		
				50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	1000			
1	Coolant		check	Daily check																			
			change																		every 2 years		
2	Fuel		check	Daily check																			
3	Engine oil		check	Daily check																			
			change	⊙					❍					❍					❍		every 250 hrs	*5	
4	Hydraulic oil		check	Daily check																			
			change																	❍	every 1000 hrs	*1	
5	Lubrication points		–	Daily check																			
6	Radiator and oil cooler		check	Daily check																			
7	Washer liquid (cabin type)		check	Daily check																			
8	Engine and electrical wiring		check	Daily check																	every year		
9	Fuel tank, Fuel filter		drain	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	every 50 hrs		
10	Battery condition		check	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	every 50 hrs		
11	Greasing swing bearing teeth		–	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	every 50 hrs		
12	Fan belt tension		adjust				❍				❍				❍				❍	❍	every 200 hrs		
13	Radiator hoses and clamps		check				❍				❍				❍				❍	❍	every 200 hrs		
			replace																		every 2 years		
14	Air filter element	Outer element	clean				❍				❍				❍				❍	❍	every 200 hrs	*2	
			replace																	❍	every 1000 hrs	*2	@
		Inner element	replace																	❍	every 1000 hrs	*2	
15	Greasing swing ball bearings		–				❍				❍				❍				❍	❍	every 200 hrs		
16	Fuel filter element		replace																❍		every 400 hrs		@
17	Engine oil filter	KX91-3/S/S2	replace	⊙					❍					❍					❍		every 250 hrs	*5	
		KX121-3/S		⊙										❍							every 500 hrs		
18	Drive unit oil		change		⊙										❍						every 500 hrs		
19	Hydraulic return filter element		replace					⊙										❍			every 500 hrs		
20	Hydraulic suction filter element		replace																	❍	every 1000 hrs		
21	Filter in the pilot hydraulic system		replace																	❍	every 1000 hrs		
22	Fuel injection nozzle injection pressure		check																		every 1500 hrs	*4	@
23	Front idler and track roller oil		change																		every 2000 hrs		
24	Alternator and starter motor		check																		every 2000 hrs		
25	Injection pump		check																		every 3000 hrs	*4	@
26	Radiator system		rinse																		every 2 years		
27	Fuel line and Intake air line		check				❍				❍				❍				❍	❍	every 200 hrs		@
			replace																		every 2 years	*3	

IMPORTANT:

⊙ First operation

*1 When using a hydraulic breaker, change hydraulic oil and return filter according to the table on "Hydraulic Oil Change (Including Exchange of the Suction Filter in the Hydraulic Tank) under "EVERY 1000 SERVICE HOURS" in the chapter "REGULAR CHECKS AND MAINTENANCE WORK".

*2 Clean and replace the air filter more frequently if used under dusty conditions. By heavy soiling, replace the filter.

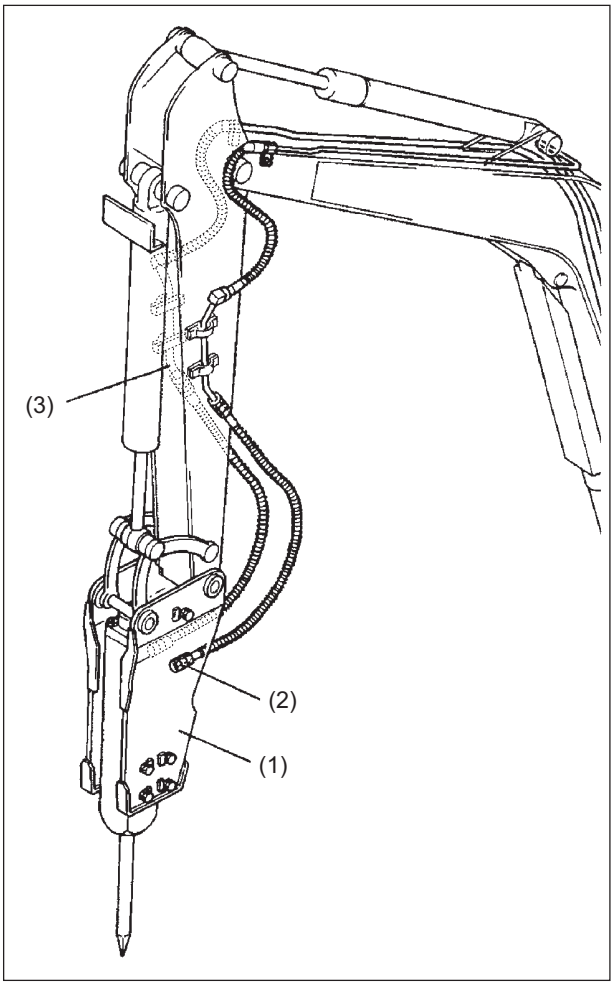
*3 Replace only if necessary.

*4 Consult your local KUBOTA Dealer for this service.

- The items listed above (@ marked) are registered as emission related critical parts by KUBOTA in the U.S.EPA nonroad emission regulation. As the engine owner, you are responsible for the performance of the required maintenance on the engine according to the above instruction.
  Please see the Warranty Statement in detail.

*5 Replacement intervals of engine oil and engine oil filter should be applied only when using CD class engine oil.

d) Hydraulic Oil Check for Machines with Hydraulic Breakers



The hydraulic oil change after 1000 operating hours in the operator's manual is based on the type of work to be done. Following inspection measure are valid when hydraulic breakers are used:

1. Changing and filling up of hydraulic oil
   1) The hydraulic oil must be changed more often when breakers are used because the machine is subject to harder conditions than at normal excavating work.
   2) Use only the recommended oils mentioned in the operator's manual when changing or filling oil.
   3) When filling up oil, never mix oils of different brands.
2. Changing the return filter and oil
   1) The filter must be changed more often because of contamination resulting from the frequent assembly and disassembly of the hoses.
   2) Use the correct replacement filter.
   3) Oil change according to operating hours.

		Hydraulic oil	Return Filter	Suction Filter
Normal excavator work		every 1000 Hrs.	500 Hrs.	1000 Hrs.
Breaker work portion	20%	every 800 Hrs.	300 Hrs.	
	40%	every 400 Hrs.		
	60%	every 300 Hrs.	100 Hrs.	
	More than 80%	every 200 Hrs.		

(1) Breaker
(2) P-port
(3) T-port

e) Periodic Replacement of Important Parts

To ensure safety in traveling and operating the machine, the user is strongly requested to carry out periodic inspection and servicing. For added safety, the following important parts, related to safety and fire hazards in particular, must be replaced at their specified intervals.
With the passage of time, these parts easily get degraded in material or worn out. They are difficult to check for anything unusual even at periodic inspection and servicing. Even if nothing unusual is found, it is essential to replace them with new ones after their specified service life, in order to maintain complete function.
If by any chance any of these parts gets in trouble even before its service life, it must be repaired or replaced as usual.
In replacing the hoses, check also the hose clamps for deformation, cracks and other troubles. Replace the hose clamps too with new ones, as required.
Check all the hydraulic hoses, including those to be replaced at regular intervals, for the following points. Tighten up or replace them, as required.
When replacing the hydraulic hoses, change their O-rings and sealing for new ones at the same time.

• Check the fuel and hydraulic hoses too at the following periodic inspections.

Inspection intervals	Inspection item
Daily inspection	Fuel and hydraulic hose connections as well as crimped parts for oil leak
Monthly inspection	Fuel and hydraulic hose connections as well as crimped parts for oil leak Fuel and hydraulic hoses for damages (cracks, wear-out and peel-off)
Specified self-imposed (yearly) inspection	Fuel and hydraulic hose connections as well as crimped parts for oil leak Fuel and hydraulic hoses for interference, deformation, degrading, twist and other damages (cracks, wear-out, peel-off)

• List of important parts

No.	Periodic-replaced parts	Q'ty	Replacement intervals
1	Fuel hose (Fuel tank ~ Fuel filter)	1	2 years or 4000 operating hours, whichever comes earlier
2	Fuel hose (Fuel filter ~ Fuel pump)	1	
3	Fuel hose (Fuel pump ~ Fuel nozzle)	1	
4	Fuel hose (Fuel nozzle ~ Fuel tank)	1	
5	Hydraulic hose (Main pump suction)	1	
6	Hydraulic hose (Main pump delivery)	4	
7	Hydraulic hose (Boom cylinder)	4	
8	Hydraulic hose (Arm cylinder)	4	
9	Hydraulic hose (Bucket cylinder)	4	
10	Hydraulic hose (Swing cylinder)	2	
11	Hydraulic hose (Dozer cylinder)	4	
12	Hydraulic hose (Service port)	4	
13	Hydraulic hose (Swivel motor)	2	

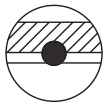
f) Water and Oil Quantity

	Unit	KX121-3S KX121-3α	U45S U45-3S U45-3α U50-3α	KX161-3S KX161-3α	Remarks : (Filled at the factory)
Radiator	L gal	7.4 (7.7) 1.96 (2.04)	←	←	L.L.C-N-50F (Cab-version)
Reserve tank	L gal	1.1 0.29	←	←	
Engine Crank case	L gal	8.5 2.25	←	←	SAE10W30 (CF/CF-4)
Hydraulic oil (Angle blade) Full	L gal	75 (76) 19.8 (20.1)	←	←	ISO 46
Hydraulic oil (Angle blade) Tank	L gal	46 (47) 12.2 (12.4)	←	←	ISO 46
Wheel motor	L gal	0.5 0.13	0.9 0.24	←	SAE90 (API GL-4)
Track roller	cc gal	80 0.021	←	←	SAE30 (CD)
Upper roller	cc gal	60 0.016	←	←	SAE30 (CD)
Front idler	cc gal	80 0.021	50 0.013	←	SAE30 (CD)
Fuel tank	L gal	64 16.9	←	←	JIS 3

NOTE: 1) In the super series-3S series, coolant amount has been increased due to the warming line of the service port solenoid valve. From recent minor change, this is not applied as the solenoid valve has been changed.
2) Engline oil amount is to be checked at the gauge center.

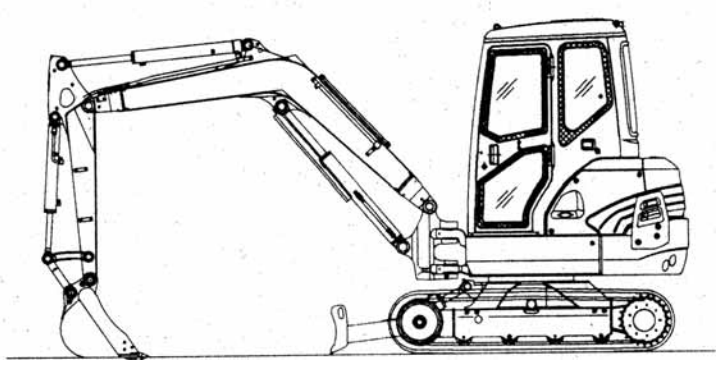
Inspection of hydraulic oil

When checking the hydraulic oil level, satisfy the following conditions and make sure the oil level is above the center the oil gauge.



The oil level is within the shaded area shown in the figure at left.

1) Oil temp. should be between 10 ~ 30 °C, 50 ~ 86 °F.
2) Stance of front attachment :
   Swing: Straight forward
   Arm: Vertical to the ground
   Bucket: On the ground at its bottom
   Dozer blade: Down to the ground



3) Air breather hose is connected to the oil tank. (Not pressurized type.)

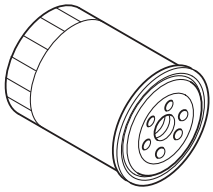
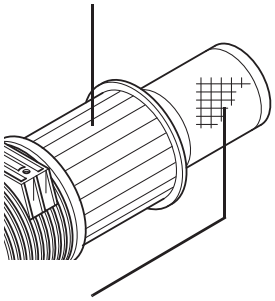
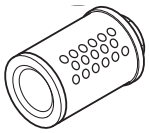
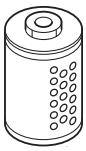
g) Recommended Oil

IMPORTANT:

1. Before delivery the hydraulic oil used was an ISO 46 viscosity grade.
2. Use engine oil API service classification: CF/CF-4 for EU-version and North American-version, CD, CE or CF for Oceanian-version.
3. Use SAE 90 (API, CLA/GL5) as drive unit oil for all seasons.

	Application	Viscosity	Shell	Mobil	Exxon	MIL-Standard
Engine oil	In winter or by low temperatures	SAE 10W	Shell Rotella T10W Shell Rimula 10W	Mobil Delvac 1310	XD-3 10W XD-3 Extra 10W	MIL-L-2104C MIL-L-2104D
		SAE 20W	Shell Rotella T20W-2 Shell Rimula 20W-2	Mobil Delvac 1320	XD-3 20W-20 XD-3 Extra 20W-20	
	In summer or by high ambient temperatures	SAE 30	Shell Rotella T30 Shell Rimula 30	Mobil Delvac 1330	XD-3 30 XD-3 Extra 30	
		SAE 40	Shell Rotella T40 Shell Rimula 40	Mobil Delvac 1340	XD-3 40 XD-3 Extra 40	
		SAE 50	Shell Rotella 50	Mobil Delvac 1350		
	All-Season Engine oil	Multi-purpose	Shell Rotella T15W		XD-3 15W-40 XD-3 Extra 15W-40	
Gear oil	In winter or by low temperatures	SAE 75		Mobilube HD80W-90		MIL-L-2105C
			Shell Oil S8643			
		SAE 80		Mobilube HD80W-90		
			Shell Spirax HD80W			
	In summer or by high ambient temperatures	SAE 90		Mobilube 46		MIL-L-2105
			Shell Spirax HD90	Mobilube HD80W-90		MIL-L-2105C
		SAE 140		Mobilube HD85W-140		MIL-L-2105C
			Shell Spirax HD140	Mobilube HD80W-140		MIL-L-2105C
	All-weather gear oil	Multi-purpose	Shell Spirax HD80W Shell Spirax HD85W	Mobilube HD80W-90	GX80W-90	MIL-L-2105C
Hydraulic oil	In winter or by low temperatures	ISO 32	Shell Tellus T32	Mobil DTE-Oil 13	NUTO H32	
		ISO 46	Shell Tellus T46	Mobil DTE-Oil 15	NUTO H46	
	In summer or by high ambient temperatures	ISO 68	Shell Tellus T68	Mobil DTE-Oil 16	NUTO H68	
Grease			Shell Alvania EP2	Mobilux EP2	BEACON Q2	
Fuel			Light oil No. 2-D (ASTM D975)			
Fuel under -5 °C (+23 °F)			Light oil No. 1-D (ASTM D975)			

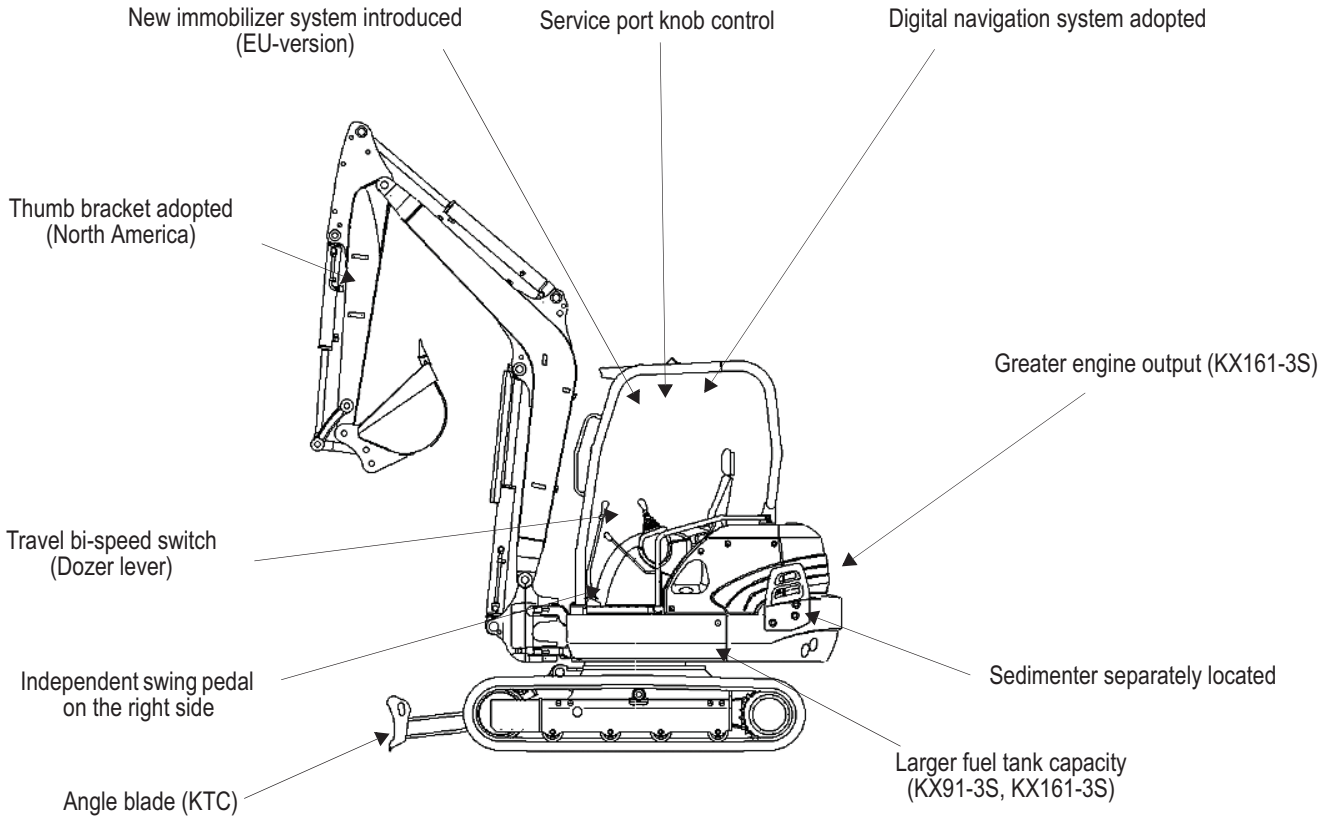
h) Filters

Name & Fig.	Specifications item	KX121-3S, KX121-3α, KX161-3S, KX161-3α, U45S, U45-3S, U45-3α, U50-3α	Remarks
Engine oil filter 	Cartridge code No.	15831-3243-1	
	Percolation area	0.29 m^2, 3.12 sq.ft	
	Percolation grade		
	Relief valve setting	$1.0^{+0.3}_{-0.1}$ kgf/cm^2, 0.1 MPa, 14.2 psi	
	Element material	Paper	
	Max. burst pressure	15 kgf/cm^2, 1.47 MPa, 213 psi	
Air cleaner, outer  Air clreaner, inner	Outer filter code No.	R1401-42271	
	Percolation area	1 m^2, 10.76 sq.ft	
	Percolation grade		
	Element material	Paper	
	Inner element code No.	R2401-42281	
	Percolation area	262 cm^2, 40.61 sq.in	
	Percolation grade	250 mesh	
	Element material	SUS 304	
Fuel filter	Element code No.	RA211-51280	
	Filtering area	800 cm^2, 124 sq.in	
	Percolating grade	15 ± 5 μ at 0.4l/min	
Suction filter 	Strainer code No.	RD411-62211	
	Percolation area	1350 cm^2, 209.25 sq.in	
	Percolation grade	150 mesh (105 μ)	
	Screen material	BSW2-1/2H	
	Flow amount	300 l/min, 76.25 USgal/min	
Return filter 	Filter code No.	RD411-62121	
	Percolation area	5500 cm^2, 5.92 sq.ft	
	Percolation grade	10 μ	
	Pressure loss		
	Relief valve setting	1.0 ± 0.15 kgf/cm^2, 0.1 ± 0.015 MPa	
	Burst pressure in new		
	Element material	Filter paper	
	Max. flow amount	120 l/min, 31.70 USgal/min	
Pilot filter	Element kit code No.	RD401-61270	
	Filtering rate	10 μ	
	Durable pressure	70 kgf/cm^2, 6.86 MPa	
	Valve setting pressure	1.5 kgf/cm^2, 0.14 MPa	

(G) PRODUCT FEATURE

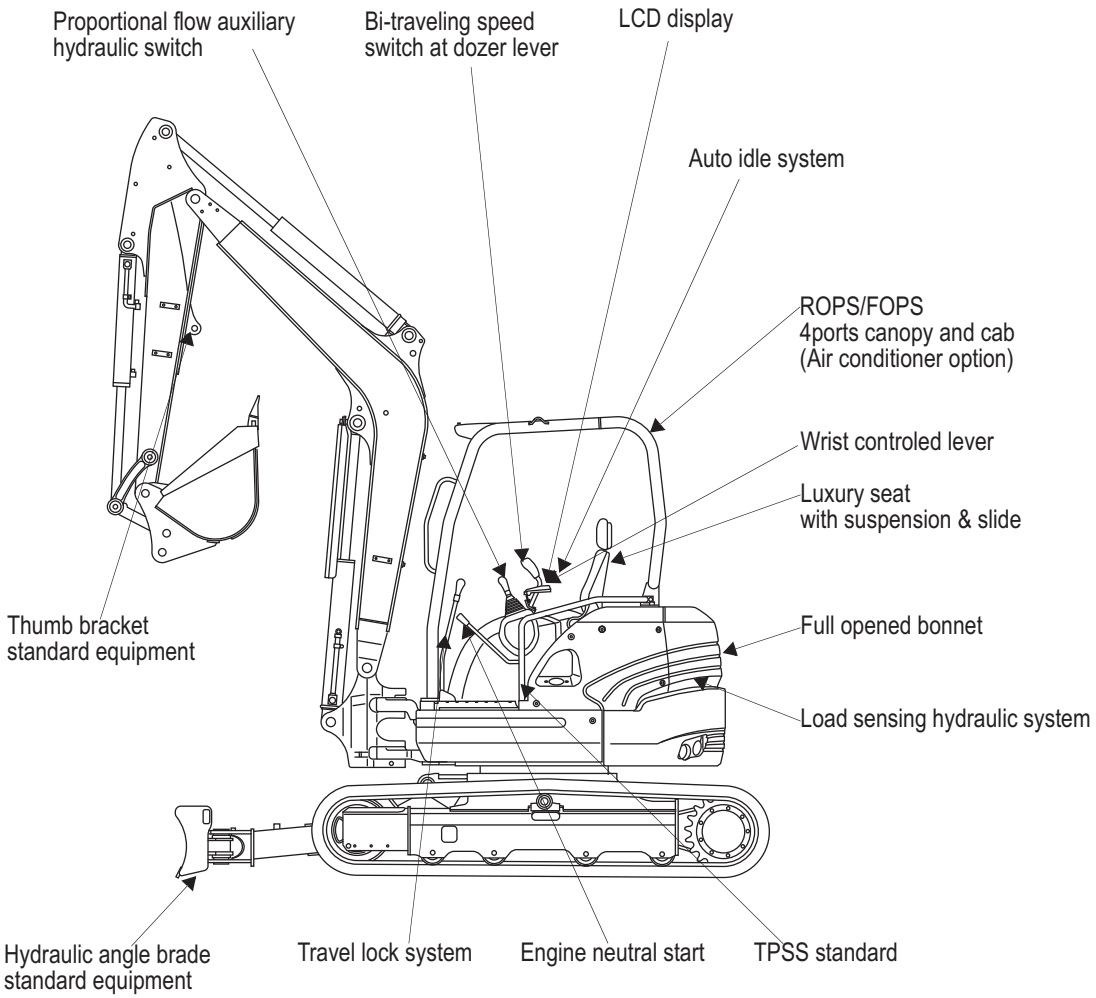
a) Quick Chart

1. **KX121-3S, KX121-3α, KX161-3S, KX161-3α, U45-3α, U50-3α**



North America, Australia, Europe

2. Sales features: **U45S**



b) Comparison of Main Specifications for **U45S**

Mode				U45S	Kubota KX121-3S	Kubota KX161-3S	BobCat 435 (long arm)
Type of ROPS/FOPS				Canopy / Cab	Canopy / Cab	Canopy / Cab	Canopy
Type of tracks				Steel / Rubber	Steel / Rubber	Steel / Rubber	Rubber
Engine	Model			KUBOTA V2203-M	KUBOTA V2203-M	KUBOTA V2403-M	Kubota V2203-M-DI
	Type			4 cylinder, liquid-cooled, overhead valve diesel engine	4 cylinder, liquid-cooled, overhead valve diesel engine	4 cylinder, liquid-cooled, overhead valve diesel engine	4 cylinder, liquid-cooled, overhead valve diesel engine
	Output (SAE J1349 gross) / rated speed		HP (kW) / rpm	42.0 (30.7) / 2250	42.0 (30.7) / 2250	47.0 (34.6) / 2200	49.5 (36.5) / 2500
	Displacement		cu.in. (cc)	134.1 (2197)	134.1 (2197)	148.6 (2434)	122 (1999)
	Tail turning radius		ft.in.	3'3"	4'3.2"	3'6.9"	3'1.6"
Performance	Maximum digging depth		ft.in.	11'9.7"	11'6"	12'6.8"	12'4.5"
	Maximum digging radius at ground		ft.in.	19'3.3"	17'11.6"	20'1.3"	19'6.9"
	Maximum bucket breakout force (Curl/ Power)		lbs	7882/9685	6626/8758	9047/11118	7892
Weight	Operating weight	Steel	lbs	11685/11850	9504/9702	12170/12335	-
		Rubber		11465/11630	9437/9636	11950/12115	10802

c) New Engineering Points

No.	New contents	PP-version (KTC, KCL, KTA)		EU-version			
		KX91-3S, U35S, U35-3S	KX121-3S, KX161-3S, U45-3S, U45S	KX91-3α, KX101-3α	U35-3α	KX121-3α, KX161-3α	U45-3α
1	Finger control service port	○	○	○	○	○	○
2	Proportional control solenoid valve	○	○	○	○	○	○
3	Breaker switch	○	○	○	○	○	○
4	Arm with thumb bracket, option (KTC, KCL)	○	○	-	-	-	-
5	Accumulator in pilot control line	○	○	○	○	○	○
6	Fuel-water separator	○	○	○	○	○	○
7	Two speed switch	○	○	○	○	○	○
8	Digital panel	○	○	○	○	○	○
9	Anti-theft system	-	-	○	○	○	○
10	Upgraded engine V2403-M	-	KX161-3S PP-version only ○	-	-	-	-
11	Travel alarm system	○ (KTA : STD)	○ (KTA : STD)	-	-	-	-
12	Angle blade	-	○ (KTC : STD)	-	-	-	-

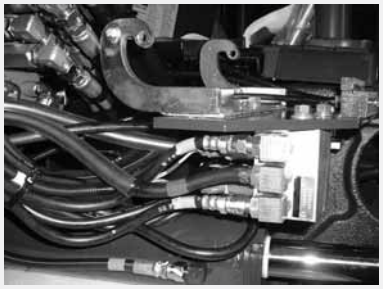
d) Photos of Main Modified Parts

No.1 Knob switch

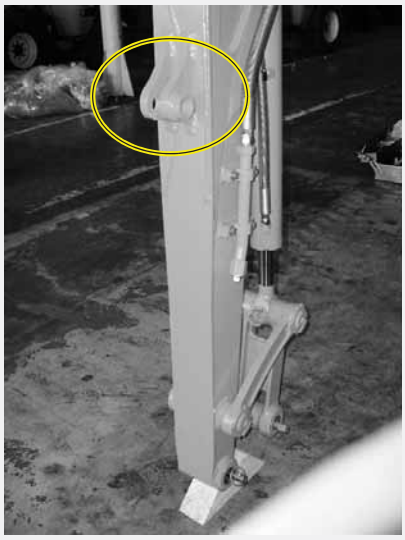
No.2 S/P solenoid valve
(After minor change)

No.8 Digital meter panel, AI-version

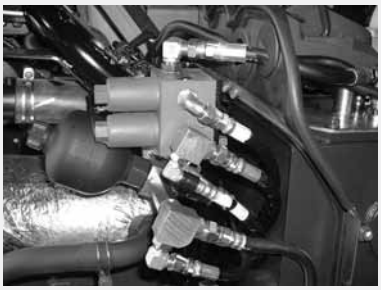
No.8 Digital meter panel, A/C-version



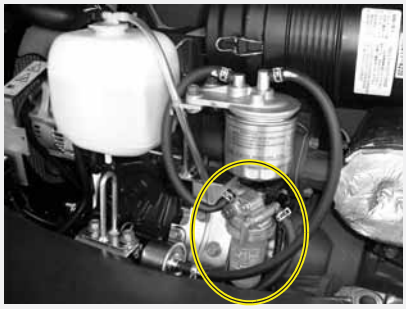
No.2 S/P solenoid valve
(Before minor change)



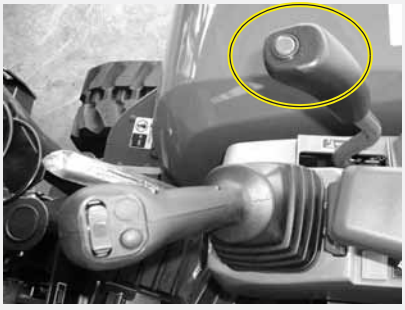
No.4 Arm with thumb bracket



No.5 Accumulator in pilot line



No.6 Fuel-water separator



No.7 Two speed switch

No.9 Anti-theft system
(EU-version)

e) Major Specifications Incorporated

- KX121-3S, KX121-3α, KX161-3S, KX161-3α, U45-3S, U45S, U45-3α, U50-3α -

Specs.		KX121-3S		KX121-3α	KX161-3S		KX161-3α	U45-3S	U45S	U45-3α
		KTC, KCL	KTA	EU	KTC, KCL	KTA	EU	KTA	KTC	EU
STD arm		1600 mm	←	1300 mm	1780 mm	←	1480 mm	1360 mm	←	←
Rubber track		350 mm	←	←	400 mm	←	←	400 mm	←	←
Iron track		350 mm	←	←	400 mm/ 550 mm	←	←	400 mm/ 550 mm	←	←
Cab (Rops / Fops)		○		←	○	○	←	←	←	←
Canopy (Rops / Fops)		○		←	○	○	←	←	←	←
Telescopic arm (1246 - 2046)		×	×	×	×	×	×	×	×	×
Bucket		Local content		←	Local content		←	←	←	←
Travel alarm		×	○	×	×	○	×	○	Option	×
Canopy light		×	○	×	×	○	×	○	Option	×
Arm rest		Wrist rest	○	Wrist rest	←	○	Wrist rest	←	○	Wrist rest
TPSS		○		×	○		×	○	○	×
Engine type	STD	V2203-M-E2BH-2-N			V2403-M-E2BH-1		V2203-M-E2BH-2-N			
	Air con.	V2203-M-E2BH-3-N			V2403-M-E2BH-2		V2203-M-E2BH-3-N			
Third line valve		×	○	○	×	○	○	×	×	○
Angle blade		○(KTC)	×	×	○(KTC)	×	×	×	○(KTC)	×
Arm with thumb bracket		○	×	×	○	×	×	×	○	×

- Summary of minor change: 2008-version -

Machine Models		KX121-3α		KX161-3α		U45-3α		U50-3α	
Changing points			Starting S/N		Starting S/N		Starting S/N		Starting S/N
Actual Minor Change Features	S/P oil flow controller by dashboard	●	75899	●	77728	●	76703	●	76628
	Delete heat-up circuit for S/P proportional valve	●		●		●		●	
	A/C filter improvement	●		●		●		●	
	Bolt-on type boom and bucket cylinders	●		●		Current model has already		Current model has already	
	Swing cylinder supplier change from KYB to Koretsune	n/a		●		n/a		n/a	
Other changes	Dozer Assy (blade, cylinder + pins + piping) from Japan instead of KBM	●	75899	●	78325 (KBT: 59024)	●	76914 (KBT: 57061)	●	76859

NOTE:
Machine and maintenance specifications are identical to those of the current models, as shown.

f) Major Points Incorporated in Minor Change

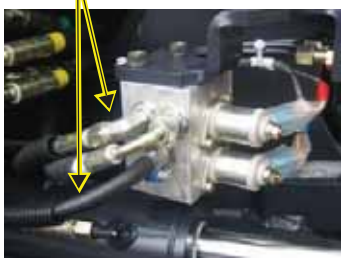
KX121-3ST, KX121-3α, KX161-3ST, KX161-3α, U45-3ST, U45ST, U45-3α, U50-3α

1. Proportional Valve

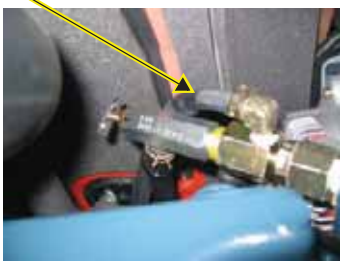
Current

New

- New supplier – KPM (Kawasaki Precision Machinery Co.)
- Works better at cold temperature without heat-up circuit



Side view



Engine rear view

- New hydraulic hoses & adapter

2. Auxiliary Oil Flow Control

- S/P oil flow control by meter panel

* Same as KX080-3

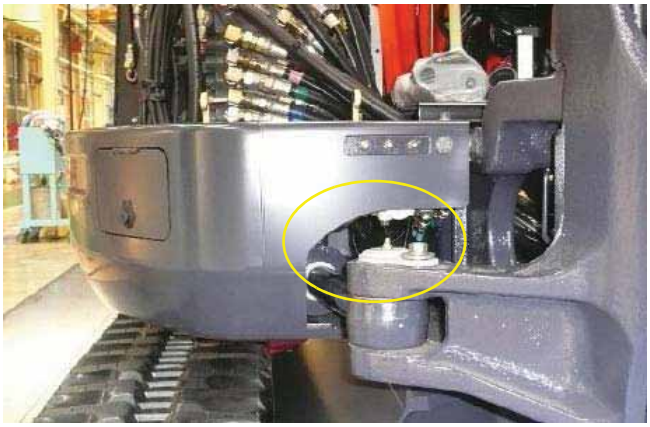
- Setting of limited flow volume, S/P 1

Machine model	Applied S/N (JPN)	Applied S/N (KBM)
KX121-3α	56121 ~	75899 ~
KX161-3α	58404 ~	77728 ~
U45-3α	56840 ~	76703 ~
U50-3α	56834 ~	76628 ~

3. Cover Shapes

■ Advanced cutting shape

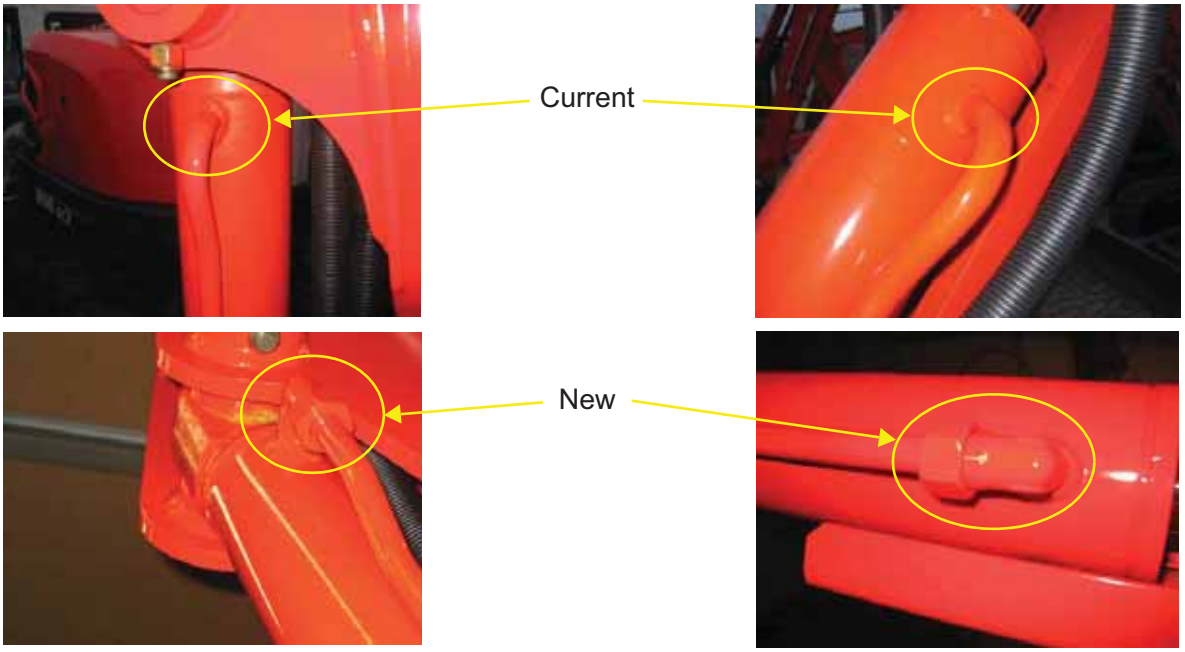
Current



New

4. Cylinder Pipe Structure

■ Modified from welding to O-ring fitting type



Bucket cylinder

Boom cylinder

5. Cylinder Pipe Structure

■ Modified from welding to O-ring fitting type

Cylinder (Blade)

6. Cartridge Filter System (A/C model)

■ Easy replacement

Current (Only filter)

New (With cartridge frame)

7. Procurement for Cylinders

■ New supplier – Koretsune: (blade and swing) for KX161-3α
■ Same hydraulic specifications
■ Interchangeable assembly: NOT interchangeable inner parts

(H) MACHINE QUALITY SPECIFICATIONS

a) KX121-3S, 161-3S, U45S, U45-3S: KTC, KCL, KTA-version

Machine specification: Service port, TPSS, Long arm, 4-Post canopy, KTC-bucket

No		Specificatios Items			Unit	KX121-3S	KX161-3S	U45S (KTC, KCL)	U45-3S (KTA)	Remarks
Q1		**Main Speed JIS A8404**								
1	1	Machine size	Total length (Transport)		mm	5090 ± 102	5540 ± 111	5385 ± 108	5340 ± 107	
					inch	200.4 ± 4.0	218.1 ± 4.4	212.0 ± 4.3	210.2 ± 4.2	
	2		Total width		mm	1700 ± 17	1960 ± 20	1960 ± 20	1960 ± 20	
					inch	66.9 ± 0.7	77.2 ± 0.8	77.2 ± 0.8	77.2 ± 0.8	
	3		Total height (Canopy)		mm	2495 ± 25	2540 ± 25	2540 ± 25	2540 ± 25	Include grouser height
					inch	98.2 ± 1.0	100.0 ± 1.0	100.0 ± 1.0	100.0 ± 1.0	
	4		Total height (Cabin)		mm	2480 ± 25	2540 ± 25	2540 ± 25	2540 ± 25	
					inch	97.6 ± 1.0	100.0 ± 1.0	100.0 ± 1.0	100.0 ± 1.0	
2	1	Weight	Machine weight (Canopy)		kg	3990 ± 81	5065 ± 101	5200 ± 104	4425 ± 89	Fuel tank:Full
					lbs	8796.4 ± 178.6	11166.3 ± 222.7	11463.9 ± 229.3	9755.4 ± 196.2	
	2		Machine weight (Cabin)		kg	4080 ± 82	5140 ± 103	5275 ± 106	4520 ± 90	
					lbs	8994.8 ± 180.8	11331.6 ± 227.1	11629.3 ± 233.7	9964.8 ± 198.4	
3	1	Performance	Swivel speed	L/R	rpm	9.2 ± 0.9	9.3 ± 0.9	9.1 ± 0.9	9.1 ± 0.9	
	3		Travel speed	Rubber F1	km/h	2.7 ± 0.3	**2.5 ± 0.2**	**2.5 ± 0.3**	**2.6 ± 0.3**	Traveling stance: Engine Max.speed Oil temp.: 50 ± 5°C (122 ± 9°F)
					mph	1.68 ± 0.19	**1.55 ± 0.12**	**1.55 ± 0.19**	**1.62 ± 0.19**	
	4			Rubber F2	km/h	5.0 ± 5	**4.6 ± 0.5**	**4.6 ± 0.5**	**4.6 ± 0.5**	
					mph	3.11 ± 3.11	**2.86 ± 0.31**	**2.86 ± 0.31**	**2.86 ± 0.31**	
	5			Steel F1	km/h	2.6 ± 0.3	**2.3 ± 0.2**	**2.3 ± 0.2**	**2.4 ± 0.2**	
					mph	1.62 ± 0.19	**1.43 ± 0.12**	**1.43 ± 0.12**	**1.49 ± 0.12**	
	6			Steel F2	km/h	4.7 ± 0.5	**4.2 ± 0.4**	**4.2 ± 0.4**	**4.3 ± 0.4**	
					mph	2.92 ± 0.31	**2.61 ± 0.25**	**2.61 ± 0.25**	**2.67 ± 0.25**	
	7		Gradeability		deg.	30	30	30	30	
4	1	Rear end min. turning radius			mm	1300 ± 26	1090 ± 22	990 ± 20	990 ± 20	
					inch	51.2 ± 1.0	42.9 ± 0.9	39.0 ± 0.8	39.0 ± 0.8	
	2	Swivel frame rear ground clearance			mm	574 ± 11	620 ± 12	620 ± 10	620 ± 10	
					inch	22.6 ± 0.4	24.4 ± 0.5	24.4 ± 0.4	24.4 ± 0.4	
	3	Tambler center distance			mm	1710 ± 51	1990 ± 60	1990 ± 60	1990 ± 60	
					inch	67.3 ± 2.0	78.3 ± 2.4	78.3 ± 2.4	78.3 ± 2.4	
	4	Crawler total length			mm	2175 ± 65	2500 ± 75	2500 ± 75	2500 ± 75	
					inch	85.6 ± 2.6	98.4 ± 3.0	98.4 ± 3.0	98.4 ± 3.0	
	5	Crawler total width			mm	1700 ± 34	1960 ± 39	1960 ± 40	1960 ± 40	
					inch	66.9 ± 1.3	77.2 ± 1.5	77.2 ± 1.6	77.2 ± 1.6	
	6	Min. ground clearance			mm	330 ± 10	320 ± 10	320 ± 10	320 ± 10	
					inch	13.0 ± 0.4	12.6 ± 0.4	12.6 ± 0.4	12.6 ± 0.4	
5	1	Front attachment	Bucket heaped capacity	SAE, JIS	m3	0.12 ± 0.005	0.14 ± 0.005	0.135 ± 0.005	←	Slope angle: 1 x 1
					yd3	0.157 ± 0.007	0.183 ± 0.007	0.177 ± 0.007	←	
	2		Bucket struck capacity		m3	0.09 ± 0.004	0.106 ± 0.005	0.095 ± 0.005	←	
					yd3	0.118 ± 0.005	0.139 ± 0.007	0.124 ± 0.007	←	
	3		Bucket width		mm	600 ± 12	650 ± 13	550 ± 10	←	Without side cutter
					inch	23.6 ± 0.5	25.6 ± 0.5	21.7 ± 0.4	←	
	4		Swing angle	Canopy L	deg	75 ± 2	←	v	←	
	5			Canopy R	deg	47 ± 2	48 ± 2	48 ± 2	48 ± 2	
	6			Cabin L	deg	75 ± 2	←	←	←	
	7			Cabin R	deg	47 ± 2	48 ± 2	48 ± 2	48 ± 2	
	8		Max. digging radius		mm	5600 ± 16	6260 ± 94	6010 ± 90	5755 ± 85	
					inch	220.5 ± 0.6	246.5 ± 3.7	236.6 ± 3.5	226.6 ± 3.3	

No		Specificatios Items			Unit	KX121-3S	KX161-3S	U45S (KTC, KCL)	U45-3S (KTA)	Remarks
5	9	Front attach-ment	Ground level Max. dig-ging radius		mm	5475 ± 82	6130 ± 92	5875 ± 88	5615 ± 85	
					inch	215.6 ± 3.2	241.3 ± 3.6	231.3 ± 3.5	221.1 ± 3.3	
	10		Ground level Min. fin-ish radius		mm	1805 ± 36	1940 ± 39	1895 ± 38	2030 ± 40	Bucket bottom horizontal
					inch	71.1 ± 1.4	76.4 ± 1.5	74.6 ± 1.5	79.9 ± 1.6	
	11		Max. digging depth		mm	3505 ± 70	3830 ± 77	3600 + 72	3350 + 30, -100	
					inch	138.0 ± 2.8	150.8 ± 3.0	141.7 + 2.8	131.9 + 1.2, -3.9	
	12		Max. vertical digging depth		mm	2480 ± 74	2585 ± 78	2400 + 72	2700 + 60, -100	
					inch	97.6 ± 2.9	101.8 ± 3.1	94.5 + 2.8	106.3 + 2.4, -3.9	
	13		Max. dig-ging height	Canopy	mm	5420 ± 108	5715 ± 14	5520 + 110	5430 + 65, -150	
					inch	213.4 ± 4.3	225.0 ± 0.6	217.3 + 4.3	213.8 + 2.6, -5.9	
	14			Cabin	mm	5420 ± 108	5715 ± 14	5520 + 110	5430 + 65, -150	
					inch	213.4 ± 4.3	225.0 ± 0.6	217.3 + 4.3	213.8 + 2.6, -5.9	
	15		Max. dump height	Canopy	mm	3890 ± 78	4155 ± 83	3970 + 79	3800 + 30, -120	
					inch	153.1 ± 3.1	163.6 ± 3.3	156.3 + 3.1	149.6 + 1.2, -4.7	
	16			Cabin	mm	3890 ± 78	4155 ± 83	3970 + 79	3800 + 30, -120	
					inch	153.1 ± 3.1	163.6 ± 3.3	156.3 + 3.1	149.6 + 1.2, -4.7	
	17		Max. dump height (Arm vertical)	Canopy/ Cab	mm	1250 ± 37	1285 ± 39	1290 + 39	1560 ± 45	
					inch	49.2 ± 1.5	50.6 ± 1.5	50.8 + 1.5	61.4 ± 1.8	
	19		Min. turning radius	Canopy/ Cab	mm	2060 ± 62	2420 ± 73	2360 ± 71	2310 ± 70	
					inch	81.1 ± 2.4	95.3 ± 2.9	92.9 ± 2.8	90.9 ± 2.8	
	21		Min. turning radius (Left swing)	Canopy/ Cab	mm	1665 ± 50	1955 ± 59	1905 ± 57	1825 ± 20	
					inch	65.6 ± 2.0	77.0 ± 2.3	75.0 ± 2.2	71.9 ± 0.8	
6	1	Blade	Width		mm	1700 ± 5	1960 ± 5	**See another sheet (Angle Blade)**	1960 ± 5	
					inch	66.9 ± 0.2	77.2 ± 0.2		77.2 ± 0.2	
	2		Height		mm	350 ± 20	360 ± 10		385 ± 10	
					inch	13.8 ± 0.8	14.2 ± 0.4		15.2 ± 0.4	
	3		Max. lift above GL		mm	400 ± 50	455 ± 50		455 ± 50	
					inch	15.7 ± 2.0	17.9 ± 2.0		17.9 ± 2.0	
	4		Max. below GL		mm	405 ± 50	370 ± 50		370 ± 50	
					inch	15.9 ± 2.0	14.6 ± 2.0		14.6 ± 2.0	
Q2		**Main Specs JIS A8404**								
1	1	Bucket tooth slaggish			mm	50 , 73≧	←	←	←	Without shockless F=30 kgf (66 lbf)
					inch	1.97 , 2.87≧	←	←	←	
	2	Tilt amount of front attachment			mm	0 , 10>	←	←	←	
					inch	0 , 0.39>	←	←	←	
	3	Declination of blade			mm	3 , 10>	←	←	←	
					inch	0.12 , 0.39>	←	←	←	
2	1	Clearance between bucket crow and boom cylinder cover			mm	195	170	192	154	From swivel center
					inch	7.68	6.69	7.56	6.06	
	2	(Min.value; reference)			mm	110	140	124	124	
					inch	4.33	5.51	4.88	4.88	
3	1	Blade approach angle			deg.	30 ± 3	←	**See another sheet**	30 ± 3	
4	1	Crawler height			mm	470 ± 9	520 ± 10	520 ± 10	520 ± 10	Include grouser on the spocket
					inch	18.50 ± 0.35	20.47 ± 0.39	20.47 ± 0.39	20.47 ± 0.39	
	2	Max. crawler height			mm	490 ± 10	550 ± 11	550 ± 11	550 ± 11	
					inch	19.29 ± 0.39	21.65 ± 0.43	21.65 ± 0.43	21.65 ± 0.43	

No		Specificatios Items		Unit	KX121-3S	KX161-3S	U45S (KTC, KCL)	U45-3S (KTA)	Remarks
Q3		**Engine performance**							
1	1	Max, engine rpm	no load	rpm	2450 ≧	**2400 ≧**	**2450 ≧**	**2450 ≧**	
	2		1 pump relief	rpm	-	-	-	-	
	3		2 pump relief	rpm	-	-	-	-	
	4		3 pump relief	rpm	-	-	-	-	Boom, arm, swivel
	5		2 pump relief	rpm	2250 , 2150≧	**2200 , 2100≧**	**2250 , 2100≧**	**2250 , 2100≧**	
	6		Blade+2 pump relief	rpm	2250	**2200 , 2100≧**	**2250 , 2100≧**	**2250 , 2100≧**	
2	1	Idling RPM		rpm	1100 +50, -150	**1200 +50, -150**	**1200 +50, -150**	**1200 +50, -150**	
Q4		**Travelling performance**							
1	1	Travel motor block performance	L/R	mm	272 , 300≧	261 , 300≧	272 , 300≧	272 , 300≧	20 deg. slope, 10 min
				inch	10.71 , 11.8≧	10.28 , 11.8≧	10.71 , 11.8≧	10.71 , 11.8≧	
2	1	Max, Traction force	F1	kgf	3081	4083	4083	3562	Slip. 70% of absolute traction force.
				kN	30.2	40.0	40.0	34.9	
				lbf	6792	9001	9001	7853	
	2		F2	kgf	1455	1972	1972	1724	Relief. 60% of absolute traction force.
				kN	14.3	19.3	19.3	16.9	
				lbf	3208	4348	4348	3801	
3	1	Travel straightness	F1/F2	mm	600	←	←	←	10m distance Engine Max. speed
				inch	23.62	←	←	←	
	3		Blade F1/F2	mm	600	←	←	←	Blade up & down 10 m distance
				inch	23.62	←	←	←	
4	1	Track shoe sag distance	Steel	mm	40 ± 5	←	←	←	
				inch	1.57 ± 0.20	←	←	←	
	2		Rubber	mm	10 ± 5	←	←	←	
				inch	0.39 ± 0.20	←	←	←	
Q5		**Work performance**							
1	1	Boom lifting capacity		kgf	734	790	700	870	Front end, Arm extend, Bucket crowd, at tooth
				kN	7.2	7.7	6.9	8.5	
				lbf	1618	1742	1543	1918	
	2	Arm digging force		kgf	1790	2253	2110	2350	Bucket tooth root
				kN	17.6	22.1	20.7	23.0	
				lbf	3946	4967	4652	5181	
	3	Bucket digging force		kgf	3005	5043	3575	3350	Machine stance to JIS bucket tooth root
				kN	29.5	49.5	35.1	32.9	
				lbf	6625	11118	7882	7385	
	4	Blade force	down	kgf	3160	4170	3625	4115	Cutting edge down force at ground level
				kN	31.0	40.9	35.5	40.4	
				lbf	6967	9193	7992	9072	
2	1	Boom speed	Canopy	up (G→T)	sec.	**2.7 ± 0.3**	←	**2.6 ± 0.3**	**2.6 ± 0.3**	Oil temp.: 50 ± 5°C (122 ± 9°F) Ground to max. height (excu-lude cushioning)
	2			up (L→T)	sec.	4.9 ± 0.3	**4.7 ± 0.3**	**4.8 ± 0.3**	**4.7 ± 0.3**	
	3			down (T→G)	sec.	**2.7 ± 0.3**	←	**2.6 ± 0.3**	**2.6 ± 0.3**	
	4			down	sec.	5.1 ± 0.3	**4.6 ± 0.3**	**4.3 ± 0.3**	**4.7 ± 0.3**	
	5		Cabin	up 1st	sec.	**2.7 ± 0.3**	←	**2.6 ± 0.3**	**2.6 ± 0.3**	
	6			up 2nd	sec.	4.9 ± 0.3	**4.7 ± 0.3**	**4.8 ± 0.3**	**4.8 ± 0.3**	
	7			down	sec.	**2.7 ± 0.3**	←	**2.6 ± 0.3**	**2.6 ± 0.3**	
	8			down	sec.	5.1 ± 0.3	**4.6 ± 0.3**	**4.3 ± 0.3**	**4.7 ± 0.3**	
3	1	Arm speed		crowd	sec.	3.2 ± 0.3	3.1 ± 0.3	3.0 ± 0.3	3.0 ± 0.3	
	2			dump	sec.	2.8 ± 0.3	**3.1 ± 0.3**	**2.8 ± 0.3**	**2.8 ± 0.3**	
4	1	Bucket speed		crowd	sec.	2.7 ± 0.3	**2.9 ± 0.3**	**2.9 ± 0.3**	**2.9 ± 0.3**	Oil temp.: 50 ± 5°C (122 ± 9°F)
	2			dump	sec.	2.2 ± 0.3	2.0 ± 0.3	**2.1 ± 0.3**	**2.1 ± 0.3**	

No		Specificatios Items		Unit	KX121-3S	KX161-3S	U45S (KTC, KCL)	U45-3S (KTA)	Remarks
5	1	Blade speed	up (G→T)	sec.	1.2 ± 0.3	1.5 ± 0.3	**See another sheet (Angle Blade)**	1.5 ± 0.3	Ground to max. up
	2		up (L→T)	sec.	**2.3 ± 0.3**	**2.5 ± 0.3**		**2.8 ± 0.3**	Max. down to max. up
	3		down (T→G)	sec.	1.4 ± 0.3	**1.9 ± 0.3**		**1.4 ± 0.3**	Max. up to ground
	4		down (T→L)	sec.	**3.0 ± 0.3**	**3.8 ± 0.3**		**2.9 ± 0.3**	Max. up to max. down
6	1	Arm cylinder cavitation		mm	0, 5 ≧	0, 5 ≧	0, 5 ≧	0, 5 ≧	Oil temp.: 95 ± 5°C (203 ± 9°F) Engine speed: 1300 rpm
				inch	0,0.2 ≧	0,0.2 ≧	0,0.2 ≧	0,0.2 ≧	
7	1	Max. digging height radius	Canopy/ Cab	mm	2825 ± 282	3640 ± 364	**3495 ± 350**	←	
				inch	111.22 ± 11.10	143.31 ± 14.33	**137.60 ± 13.78**	←	
	3	Max. dump height radius	Canopy/ Cab	mm	2790 ± 167	**3325 ± 200**	**3620 ± 217**	←	at bucket pin
				inch	109.84 ± 6.57	**130.91 ± 7.87**	**142.52 ± 8.54**	←	
	5	Bucket bottom height at arm vertical	Canopy/ Cab	mm	1585 ± 415	1600 **± 48**	**1605 ± 48**	←	Bucket horizontal
				inch	62.40 ± 16.34	62.99 **± 1.89**	**63.19 ± 1.89**	←	
	7	Bucket wrist angle		deg.	197 ± 3	168.5 ± 3	168.5 + 3.5, -2.5	177 ± 3	
Q6		**Swivel, swing performance**							
1	1	Swivel torque	L/R	kgf·m	840	1265	1195	1195	Arm extend, Slow/Quick operation
				kN·m	8.2	12.4	11.7	11.7	
				ft·lbf	6075	9149	8643	8643	
2	1	Swivel capable slope angle	L/R	deg.	20	17	17	18	Bucket load=JIS heaped x1.8 Bucket loaded at heaped. Engine idling, lever lock released.
3	1	Swivel block performance	L/R	deg.	5 >	5 >	5 >	5 >	
	3		L/R	deg.	30 >	30 >	30 >	30 >	
4	1	Swivel start-up speed	L/R	sec.	2.1 ± 0.3	2.5 ± 0.3	2.5 ± 0.3	2.5 ± 0.3	0~90 deg. swivel
5	1	Swing speed Canopy/Cab	L	sec.	**6.7 ± 0.7**	6.7 ± 0.5	6.0 ± 0.5	←	
	2		R	sec.	**6.5 ± 0.7**	7.7 ± 0.5	6.7 ± 0.5	←	
6	1	Swing Lock	Swivel R&L	mm	2,10 >	2, 10 >	2, 10 >	2, 10 >	90 deg-swivel, 100 times actual digging cylinder dislocation
				inch	0.08,0.39 >	0.08,0.39 >	0.08,0.39 >	0.08,0.39 >	
	2	Reciprocating motion L / R	Swing	mm					90 deg-swivel, 100 times
				inch					
Q7		**Hydraulic performance**							
1	1	Relief pressure setting	P1	kgf/cm^2	250 +10, -5	**245 +10, -5**	**245 +10, -5**	**245 +10, -5**	At pump delivery 50 ± 5°C (122 ± 9°F)
				MPa	24.5 +1.0, -0.5	**24.0 +1.0, -0.5**	**24.0 +1.0, -0.5**	**24.0 +1.0, -0.5**	
				bar	245.2 +10, -5	**240.3 +10, -5**	**240.3 +10, -5**	**240.3 +10, -5**	
				psi	3556 +140, -70	**3485 +140, -70**	**3485 +140, -70**	**3485 +140, -70**	
	2		P2	kgf/cm^2	-	-	-	-	
				MPa	-	-	-	-	
				bar	-	-	-	-	
				psi	-	-	-	-	
	3		P3	kgf/cm^2	-	-	-	-	
				MPa	-	-	-	-	
				bar	-	-	-	-	
				psi	-	-	-	-	
	4		P4	kgf/cm^2	40 ± 5.1	←	←	←	
				MPa	3.9 ± 5.0	←	←	←	
				bar	39.2 ± 5.0	←	←	←	
				psi	569 ± 73	←	←	←	

No		Specificatios Items			Unit	KX121-3S	KX161-3S	U45S (KTC, KCL)	U45-3S (KTA)	Remarks
2	1	Cylin-der oil sealing capacity	Boom	50 ± 5 °C (122 ± 9 °F)	mm	20	←	←	←	Arm extend, Bucket height 1 m, 10 min. Bucket load= JIS heaped x1.8
					inch	0.79	←	←	←	
	2			95 ± 5 °C (203 ± 9 °F)	mm	20	←	←	←	
					inch	0.79	←	←	←	
	3		Arm	50 ± 5 °C (122 ± 9 °F)	mm	20	←	←	←	
					inch	0.79	←	←	←	
	4		Bucket	50 ± 5 °C (122 ± 9 °F)	mm	10	←	15	15	
					inch	0.39	←	0.59	0.59	
	5		Blade		mm	20	←	**See another sheet (Angle Blade)**	20	Arm vertical, blade cylinder extended for 10 min. engine stop.
					inch	0.79	←		0.79	
3	1	Boom cushioning per-formance		30 °C (86 °F)	sec	3	←	←	←	Arm extended, bucket crowd with no road. Engine Max. speed.
	2			50 °C (122 °F)	sec	0.4 to 1.3	←	←	←	
	3			80 °C (176 °F)	sec	0.3	←	←	←	
Q8		Lever operating force & stroke					←	←	←	
1	1	Boom lever operating force		up	kgf	**1.8 ± 0.5**	←	←	←	Measuring point: 20 mm lower from the lever top. Pilot lever with engine Max. speed.
					N	**17.65 ± 4.90**	←	←	←	
					lbf	**4.0 ± 1.1**	←	←	←	
	2			down	kgf	1.5 ± 0.5	←	←	←	
					N	14.71 ± 4.90	←	←	←	
					lbf	3.3 ± 1.1	←	←	←	
	3	Arm lever		crowd	kgf	**1.8 ± 0.5**	←	←	←	Dump & crowd
					N	**17.65 ± 4.90**	←	←	←	
					lbf	**4.0 ± 1.1**	←	←	←	
	4			dump	kgf	1.5 ± 0.5	←	←	←	
					N	14.71 ± 4.90	←	←	←	
					lbf	3.3 ± 1.1	←	←	←	
	5	Bucket lever		crowd	kgf	1.5 ± 0.5	←	←	←	Dump & crowd
					N	14.71 ± 4.90	←	←	←	
					lbf	3.3 ± 1.1	←	←	←	
	6			dump	kgf	**1.8 ± 0.5**	←	←	←	
					N	**17.65 ± 4.90**	←	←	←	
					lbf	**4.0 ± 1.1**	←	←	←	
	7	Swivel lever		R/L	kgf	1.5 ± 0.5	←	←	←	Left & right
					N	14.71 ± 4.90	←	←	←	
					lbf	3.3 ± 1.1	←	←	←	
	9	Blade lever		up	kgf	**1.0 ± 0.5**	1.0 ± 0.5	See another sheet (Angle Blade)	1.0 ± 0.5	Up&down Measuring point: 15 mm lower from the lever top
					N	**9.81 ± 4.90**	9.81 ± 4.90		9.81 ± 4.90	
					lbf	**2.2 ± 1.1**	2.2 ± 1.1		2.2 ± 1.1	
	10			down	kgf	**1.5 ± 0.5**	1.5 ± 0.5		1.5 ± 0.5	
					N	**14.71 ± 4.90**	14.71 ± 4.90		14.71 ± 4.90	
					lbf	**3.3 ± 1.1**	3.3 ± 1.1		3.3 ± 1.1	
	11	Travel lever	L/R	Forward	kgf	**1.2 ± 0.5**	1.2 ± 0.5	1.2 ± 0.5	1.2 ± 0.5	Measuringpoint: 20 mm lower from the lever top.
					N	**11.77 ± 4.90**	11.77 ± 4.90	11.77 ± 4.90	11.77 ± 4.90	
					lbf	**2.6 ± 1.1**	2.6 ± 1.1	2.6 ± 1.1	2.6 ± 1.1	
	12			Back	kgf	**1.2 ± 0.5**	1.2 ± 0.5	1.2 ± 0.5	1.2 ± 0.5	
					N	**11.77 ± 4.90**	11.77 ± 4.90	11.77 ± 4.90	11.77 ± 4.90	
					lbf	**2.6 ± 1.1**	2.6 ± 1.1	2.6 ± 1.1	2.6 ± 1.1	

No		Specificatios Items			Unit	KX121-3S	KX161-3S	U45S (KTC, KCL)	U45-3S (KTA)	Remarks
1	15	Accelerator lever		up /down	kgf		-	-	-	AI-version has accel dial not a lever. Measuring point: 30 mm lower from the lever top
					N		-	-	-	
					lbf		-	-	-	
	17	Swing pedal		R	kgf	**3.4 ± 1.0**	←	←	←	Pedal edge. 45 degree inward
					N	**33.34 ± 9.81**	←	←	←	
					lbf	**7.5 ± 2.2**	←	←	←	
	18			L	kgf	**4.1 ± 1.0**	←	←	←	
					N	**40.21 ± 9.81**	←	←	←	
					lbf	**9.0 ± 2.2**	←	←	←	
	19	Safety lock lever	R	up	kgf	0.8 ± 0.2	←	←	←	Up & down
					N	7.85 ± 1.96	←	←	←	
					lbf	1.8 ± 0.4	←	←	←	
	20			down	kgf	0.4 ± 0.2	←	←	←	
					N	3.92 ± 1.96	←	←	←	
					lbf	0.9 ± 0.4	←	←	←	
	21	Safety lock lever	L	up	kgf	2.7 ± 1.0	←	←	←	Up & down
					N	26.48 ± 9.81	←	←	←	
					lbf	6.0 ± 2.2	←	←	←	
	22			down	kgf	**4.5 ± 1.0**	←	←	←	
					N	**44.13 ± 9.81**	←	←	←	
					lbf	**9.9 ± 2.2**	←	←	←	
	23	Travel Hi-Lo change			kgf	-	-	-	-	Super series have a switch
					N	-	-	-	-	
					lbf	-	-	-	-	
2	1	Boom lever stroke		up/down	mm	**72 ± 10**	←	←	←	
					inch	**2.83 ± 0.39**	←	←	←	
	3	Arm lever stroke		crowd/ dump	mm	**72 ± 10**	←	←	←	
					inch	**2.83 ± 0.39**	←	←	←	
	5	Bucket lever stroke		crowd/ dump	mm	**72 ± 10**	←	←	←	
					inch	**2.83 ± 0.39**	←	←	←	
	7	Swivel lever stroke		R/L	mm	**72 ± 10**	←	←	←	
					inch	**2.83 ± 0.39**	←	←	←	
	9	Blade lever stroke		up/down	mm	60 ± 10	←	See another sheet (Angle Blade)	60 ± 10	
					inch	2.36 ± 0.39	←		2.36 ± 0.39	
	11	Travel lever stroke	L/R	Forward	mm	**70 ± 10**	←	**70 ± 10**	**75 ± 10**	
					inch	**2.76 ± 0.39**	←	**2.76 ± 0.39**	**2.95 ± 0.39**	
	12			Back	mm	**70 ± 10**	←	**70 ± 10**	**75 ± 10**	
					inch	**2.76 ± 0.39**	←	**2.76 ± 0.39**	**2.95 ± 0.39**	
Q9		**Stability**								
1	1	Stan-dard arm, Dynamic opera-tion load limit	Bucket load to 10 degrees tip-ping	Side, blade up	kgf	-	-	-	-	Arm extend, bucket crowd oil temp. 50 ± 5°C (122 ± 9°F) U45S: KTA only
					N	-	-	-	-	
					lbf	-	-	-	-	
	2			Front, blade up	kgf	-	-	-	-	
					N	-	-	-	-	
					lbf	-	-	-	-	
	3		Bucket load to tip fully	Side, blade up	kgf	-	327 ,≧ 294	-	327 ,≧ 294	
					N	-	3207 ,≧ 2886	-	3207 ,≧ 2886	
					lbf	-	721 ,≧ 649	-	721 ,≧ 649	
	4			Front, blade up	kgf	-	385 ,≧ 347	-	420 ,≧ 378	
					N	-	3776 ,≧ 3398	-	4119 ,≧ 3707	
					lbf	-	849 ,≧ 764	-	926 ,≧ 833	

No		Specificatios Items			Unit	KX121-3S	KX161-3S	U45S (KTC, KCL)	U45-3S (KTA)	Remarks
1	5	Stan-dard arm, Static limited load	Bucket load to tip fully	Side	kgf	-	554 ,≧ 499	-	540 ,≧ 486	Front horizontal bucket crowd, load at arm tip end. U45S: KTA only
					N	-	5433 ,≧ 4890	-	5296 ,≧ 4766	
					lbf	-	1221 ,≧ 1099	-	1190 ,≧ 1071	
	6			Front	kgf	-	644 ,≧ 580	-	640 ,≧ 576	
					N	-	6315 ,≧ 5684	-	6276 ,≧ 5649	
					lbf	-	1420 ,≧ 1278	-	1411 ,≧ 1270	
2	1	Long arm, Dynamic opera-tion load limit	Bucket load to 10 degrees tip-ping	Side, blade up	kgf	-	-	-	-	Arm extend, bucket crowd Oil temp. 50 ± 5°C (122 ± 9°F) U45S: KTC, KCL only
					N	-	-	-	-	
					lbf	-	-	-	-	
	2			Front, blade up	kgf	-	-	-	-	
					N	-	-	-	-	
					lbf	-	-	-	-	
	3		Bucket load to tip fully	Side, blade up	kgf	394 ,≧ 355	-	370 ,≧ 333	-	
					N	3864 ,≧ 3478	-	3628 ,≧ 3266	-	
					lbf	869 ,≧ 782	-	816 ,≧ 734	-	
	4			Front, blade up	kgf	405 ,≧ 365	-	374 ,≧ 337	-	
					N	3972 ,≧ 3575	-	3668 ,≧ 3301	-	
					lbf	893 ,≧ 804	-	825 ,≧ 742	-	
	5	Long arm, Static limited load	Bucket load to tip fully	Side	kgf	542 ,≧ 488	-	607 ,≧ 546	-	Front horizontal bucket crowd, load at arm tip end. U45S: KTC, KCL only
					N	5315 ,≧ 4784	-	5953 ,≧ 5358	-	
					lbf	1195 ,≧ 1075	-	1338 ,≧ 1205	-	
	6			Front	kgf	624 ,≧ 562	-	622 ,≧ 560	-	
					N	6119 ,≧ 5508	-	6100 ,≧ 5490	-	
					lbf	1376 ,≧ 1238	-	1371 ,≧ 1234	-	
Q10		Comfortability								
1	1	Noise level	At operator's ear LPA	Canopy	dB(A)	79 ,≧ 81	←	←	←	
	2			Cabin	dB(A)	79 ,≧ 81	←	←	←	Cabin door close
	3		Noise source; LWA	7m	dB(A)	≧ 65.4	←	←	←	
	4		Sonic power level (JIS)		dB(A)	95 ,≧ 94	←	←	←	

b) U50-3α, KX121-3α, KX161-3α, U45-3α, KE, KDG, KUK-version

Machine specification: Service port, Wrist rest, STD-arm, FM-cab, KBM-bucket

No		Specificatios Items			Unit	KX121-3α	KX161-3α	U45-3α	**U50-3α**	Remarks
Q1		Main Speed JIS A8404								
1	1	Machine size	Total length (Transport)		mm	5090 ± 102	5540 ± 111	5340 ± 107	5385 ± 108	
					inch	200.4 ± 4.0	218.1 ± 4.4	210.2 ± 4.2	212.0 ± 4.3	
	2		Total width		mm	1700 ± 17	1960 ± 20	1960 ± 20	1960 ± 20	
					inch	66.9 ± 0.7	77.2 ± 0.8	77.2 ± 0.8	77.2 ± 0.8	
	3		Total height (Canopy)		mm	2495 ± 25	2540 ± 25	±	-	Include grouser height
					inch	98.2 ± 1.0	100.0 ± 1.0	±	-	
	4		Total height (Cabin)		mm	2480 ± 25	2540 ± 25	2540 ± 25	2540 ± 25	
					inch	97.6 ± 1.0	100.0 ± 1.0	100.0 ± 1.0	100.0 ± 1.0	
2	1	Weight	Machine weight (Canopy)		kg	4030 ± 81	5065 ± 101	-	-	Fuel tank:Full
					lbs	8884.5 ± 178.6	11166.3 ± 222.7	-	-	
	2		Machine weight (Cabin)		kg	4095 ± 82	5140 ± 103	4500 ± 90	4890 ± 98	
					lbs	9027.8 ± 180.8	11331.6 ± 227.1	9920.7 ± 198.4	10781 ± 216	
3	1	Performance	Swivel speed	L	rpm	9.2 ± 0.9	9.3 ± 0.9	9.1 ± 0.9	9.1 ± 0.9	
	2			R	rpm	9.2 ± 0.9	9.3 ± 0.9	9.1 ± 0.9	9.1 ± 0.9	
	3		Travel speed	Rubber F1	km/h	3.0 ± 0.3	2.5 ± 0.3	2.6 ± 0.3	2.3 ± 0.2	Traveling stance: Engine Max.speed Oil temp.: 50 ± 5°C (122 ± 9°F)
					mph	1.86 ± 0.19	1.55 ± 0.19	1.62 ± 0.19	1.43 ± 0.12	
	4			Rubber F2	km/h	5.0 ± 0.5	4.2 ± 0.4	4.6 ± 0.5	4.3 ± 0.4	
					mph	3.11 ± 0.31	2.61 ± 0.25	2.86 ± 0.31	2.67 ± 0.25	
	5			Steel F1	km/h	2.9 ± 0.3	2.2 ± 0.2	2.4 ± 0.2	2.2 ± 0.2	
					mph	1.80 ± 0.19	1.37 ± 0.12	1.49 ± 0.12	1.37 ± 0.12	
	6			Steel F2	km/h	4.7 ± 0.5	3.9 ± 0.4	4.3 ± 0.4	4.0 ± 0.4	
					mph	2.92 ± 0.31	2.42 ± 0.25	2.67 ± 0.25	2.48 ± 0.25	
	7		Gradeability		deg	30	30	30	30	
4	1	Rear end min. turning radius			mm	1300 ± 26	1090 ± 22	990 ± 20	←	
					inch	51.2 ± 1.0	42.9 ± 0.9	39.0 ± 0.8	←	
	2	Swivel frame rear ground clearance			mm	574 ± 11	620 ± 12	620 ± 10	←	
					inch	22.6 ± 0.4	24.4 ± 0.5	24.4 ± 0.4	←	
	3	Tumbler center distance			mm	1710 ± 51	1990 ± 60	1990 ± 60	←	
					inch	67.3 ± 2.0	78.3 ± 2.4	78.3 ± 2.4	←	
	4	Crawler total length			mm	2175 ± 65	2500 ± 75	2500 ± 75	←	
					inch	85.6 ± 2.6	98.4 ± 3.0	98.4 ± 3.0	←	
	5	Crawler total width			mm	1700 ± 34	1960 ± 39	1960 ± 40	←	
					inch	66.9 ± 1.3	77.2 ± 1.5	77.2 ± 1.6	←	
	6	Min. ground clearance			mm	330 ± 10	320 ± 10	320 ± 10	←	
					inch	13.0 ± 0.4	12.6 ± 0.4	12.6 ± 0.4	←	

No		Specificatios Items			Unit	KX121-3α	KX161-3α	U45-3α	**U50-3α**	Remarks
5	1	Front attachment	Bucket heaped capacity	CECE	m^3	±	±	±	←	
					yd^3	0.000 ± 0.000	±	0.000 ± 0.000	←	
	2			SAE, JIS	m^3	0.12 ± 0.005	±	0.135 ± 0.005	←	Slope angle: 1x1
					yd^3	0.157 ± 0.007	±	0.177 ± 0.007	←	
	2		Bucket struck capacity		m^3	0.09 ± 0.004	±	0.095 ± 0.005	←	
					yd^3	0.118 ± 0.005	±	0.124 ± 0.007	←	
	3		Bucket width		mm	600 ± 12	±	550 ± 10	←	Without side cutter
					inch	23.6 ± 0.5	±	21.7 ± 0.4	←	
	4		Swing angle	Canopy L	deg	75 ± 2	75 ± 2	±	←	
	5			Canopy R	deg	48 ± 2	48 ± 2	±	←	
	6			Cabin L	deg	75 ± 2	75 ± 2	75 ± 2	←	
	7			Cabin R	deg	48 ± 2	48 ± 2	48 ± 2	←	
	8		Max. digging radius		mm	5600 ± 84	6260 ± 94	5755 ± 85	6030 ± 90	
					inch	220.5 ± 3.3	246.5 ± 3.7	226.6 ± 3.3	237.4 ± 3.5	
	9		Ground level Max. digging radius		mm	5475 ± 82	6130 ± 92	5615 ± 85	5900 ± 88	
					inch	215.6 ± 3.2	241.3 ± 3.6	221.1 ± 3.3	232.3 ± 3.5	
	10		Ground level Min. finish radius		mm	1805 ± 36	1940 ± 39	2030 ± 40	1835 ± 37	Bucket bottom horizontal
					inch	71.1 ± 1.4	76.4 ± 1.5	79.9 ± 1.6	72.2 ± 1.5	
	11		Max. digging depth		mm	3505 ± 70	3830 ± 77	3400 -150, +80	3650 ± 73	
					inch	138.0 ± 2.8	150.8 ± 3.0	133.9 -5.9, +3.1	143.7 ± 2.9	
	12		Max. vertical digging depth		mm	2480 ± 74	2585 ± 78	2700 -100, +60	3000 ± 90	
					inch	97.6 ± 2.9	101.8 ± 3.1	106.3 3.9, +2.4	118.1 ± 3.5	
	13		Max. digging height	Canopy	mm	5420 ± 108	5715 ± 114	-	-	
					inch	213.4 ± 4.3	225.0 ± 4.5	-	-	
	14			Cabin	mm	5420 ± 108	5715 ± 114	5430 -150, +65	5620 ± 112	
					inch	213.4 ± 4.3	225.0 ± 4.5	213.8 -5.9, +2.6	221.3 ± 4.4	
	15		Max. dump height	Canopy	mm	3890 ± 78	4155 ± 83	-	-	
					inch	153.1 ± 3.1	163.6 ± 3.3	-	-	
	16			Cabin	mm	3890 ± 78	4155 ± 83	3800 -120, +30	3985 ± 80	
					inch	153.1 ± 3.1	163.6 ± 3.3	149.6 -4.7, +1.2	156.9 ± 3.1	
	17		Max. dump height (Arm vertical)	Canopy	mm	1250 -37, +38	1285 39			
					inch	49.2 -1.5,+1.5	50.6 1.5			
	18			Cabin	mm	1250 -37, +38	1285 39	1560 45	1045 31	
					inch	49.2 -1.5,+1.5	50.6 1.5	61.4 1.8	41.1 1.2	
	19	Front attachment	Mini. turning radius	Canopy	mm	2060 ± 62	2420 ± 73	-	-	
					inch	81.1 ± 2.4	95.3 ± 2.9	-	-	
	20			Cabin	mm	2060 ± 62	2420 ± 73	2310 ± 70	2340 -96, +42	
					inch	81.1 ± 2.4	95.3 ± 2.9	90.9 ± 2.8	92.1 -3.8,+1.7	
	21		Mini. turning radius (Left swing)	Canopy	mm	1665 ± 50	1955 ± 59	-	-	
					inch	65.6 ± 2.0	77.0 ± 2.3	-	-	
	22			Cabin	mm	1665 ± 50	1955 ± 59	1825 -20, +95	1825 -20, +95	
					inch	65.6 ± 2.0	77.0 ± 2.3	71.9 -0.8, +3.7	71.9 -0.8,+3.7	
6	1	Blade	Width		mm	1700 ± 5	1960 ± 5	1960 ± 5	←	
					inch	66.9 ± 0.2	77.2 ± 0.2	77.2 ± 0.2	←	
	2		Height		mm	350 ± 10	360 ± 10	360 ± 10	←	
					inch	13.8 ± 0.4	14.2 ± 0.4	14.2 ± 0.4	←	
	3		Max. lift above GL		mm	395 ± 50	455 ± 50	455 ± 50	←	
					inch	15.6 ± 2.0	17.9 ± 2.0	17.9 ± 2.0	←	
	4		Max. below GL		mm	410 ± 50	370 ± 50	370 ± 50	←	
					inch	16.1 ± 2.0	14.6 ± 2.0	14.6 ± 2.0	←	

No		Specificatios Items		Unit	KX121-3α	KX161-3α	U45-3α	**U50-3α**	Remarks
Q2		Main Specs JIS A8404							
1	1	Bucket tooth slaggish		mm	50	50	50		Without shockless F=30 kgf (66 lbf)
				inch	1.97	1.97	1.97	←	
	2	Front boom declination		mm	0	0	0 < 10	←	
				inch	0	0	0 < 0.39	←	
	3	Blade's declination		mm	3	3	0 < 10	←	
				inch	0.12	0.12	0 < 0.39	←	
2	1	Clearance between bucket crow and boom cylinder cover		mm	195 -29, +49	170 -30, +50	154 -30, +50	←	From swivel center
				inch	7.7 -1.1,+1.9	6.7 -1.2,+2.0	6.1 -1.2, +2.0	←	
	2	(Min.value; reference)		mm	110		-	-	
				inch	4.3		-	-	
3	1	Approach angle		deg	30 ± 3	30 ± 3	30 ± 3	←	
4	1	Crawler height		mm	470 ± 9	520 ± 11	520 ± 10	←	Include grouser on the spocket
				inch	18.50 ± 0.35	20.47 ± 0.43	20.47 ± 0.39	←	
	2	Max. crawler height		mm	490 ± 10	550 ± 11	550 ± 10	←	
				inch	19.29 ± 0.39	21.65 ± 0.43	21.65 ± 0.39	←	
Q3		Engine performance							
1	1	Max, engine rpm	no load	rpm	2450	2450	2450	←	
	2		1 pump relief	rpm	-	-	-	-	
	3		2 pump relief	rpm	-	-	-	-	
	4		3 pump relief	rpm	-	-	-	-	Boom, arm, swivel
	5		2 pump relief	rpm	2250	2250	2250	←	
	6		Blade+2 pump relief	rpm	2250	2250	2250	←	
2	1	Idling RPM	Canopy	rpm	1100 -150,+50	1200 -150,+50	1200 -150, +50	←	
	2		Cabin	rpm	1200 -150,+50	1200 -150,+50	1200 -150, +50	←	
Q4		Travelling performance		mm					
1	1	Travel motor block performance	L	inch	272	261	272	←	20 deg, slope, 10min
					10.71	10.28	10.71	←	
		Travel motor block performance	R	inch	272	261	272	←	20 deg. slope, 10min
					10.71	10.28	10.71	←	
2	1	Max, Traction force	F1	kgf.m	3081	4083	3562	←	Slip. 70% of absolute traction force.
				kN.m	30.2	40.0	34.9	←	
				ft.lbf	22284	29531	25763	←	
	2		F2	kgf.m	1455	1972	1724	←	Relief. 60% of absolute traction force.
				kN.m	14.30	19.3	16.90	←	
				ft.lbf	10524	14263	12469	←	
3	1	Travel straightness	F1	mm	600	600	600	←	10mdistance Engine Max. speed
				inch	23.62	23.62	23.62	←	
	2		F2	mm	600	600	600	←	
				inch	23.62	23.62	23.62	←	
	3		Blade F1	mm	600	600	600	←	Blade up & down 10m distance
				inch	23.62	23.62	23.62	←	
	4		Blade R1	mm	600	600	600	←	
				inch	23.62	23.62	23.62	←	
4	1	Track shoe sag distance	Steel	mm	40	40	40 +5	←	
				inch	1.57	1.57	1.57	←	
	2		Rubber	mm	10	10	10 +5	←	
				inch	0.39	0.39	0.39	←	

No		Specificatios Items			Unit	KX121-3α	KX161-3α	U45-3α	**U50-3α**	Remarks
Q5		Work performance								
1	1	Boom lifting capacity			kgf	734.2	785.2	866.8	←	Front end, Arm extend bucket crowd, at tooth
					kN	7.2	7.7	8.5	←	
					lbf	1618.6	1731.0	1910.9	←	
1	2	Arm digging force			kgf	1784.5	2253.6	2345.4	←	Bucket tooth root
					kN	17.5	22.1	23.0	←	
					lbf	3934.2	4968.3	5170.6	←	
	3	Bucket digging force			kgf	3008.2	5047.6	3354.9	←	Machine stance to JIS bucket tooth root
					kN	29.5	49.5	32.9	←	
					lbf	6631.9	11128.0	7396.2	←	
	4	Blade force		down	kgf	3161.1	4170.7	4170.7	←	Cutting edge down force at ground level
					kN	31.0	40.9	40.9	←	
					lbf	6969.1	9194.7	9194.7	←	
2	1	Boom speed	Canopy	up 1st	sec.	2.7 ± 0.3	2.8 ± 0.3	-	-	Oil temp. 50±5°C (122±9°F) Ground to max. height (exclude cushioning)
	2			up 2nd	sec.	4.9 ± 0.3	4.7 ± 0.3	-	-	
	3			down	sec.	2.7 ± 0.3	2.9 ± 0.3	-	-	
	4			down	sec.	5.1 ± 0.3	5.0 ± 0.3	-	-	
	5		Cabin	up 1st	sec.	2.7 ± 0.3	2.8 ± 0.3	2.6 ± 0.3	←	
	6			up 2nd	sec.	4.9 ± 0.3	4.7 ± 0.3	4.8 ± 0.3	←	
	7			down	sec.	2.7 ± 0.3	2.9 ± 0.3	2.6 ± 0.3	←	
	8			down	sec.	5.1 ± 0.3	5.0 ± 0.3	4.7 ± 0.3	←	
3	1	Arm speed		crowd	sec.	3.2 ± 0.3	3.3 ± 0.3	3.0 ± 0.3	←	
	2			dump	sec.	2.8 ± 0.3	2.7 ± 0.3	2.8 ± 0.3	←	
4	1	Bucket speed		crowd	sec.	2.7 ± 0.3	2.9 ± 0.3	2.9 ± 0.3	←	Oil temp. 50±5°C (122±9°F)
	2			dump	sec.	2.2 ± 0.3	2.1 ± 0.3	2.1 ± 0.3	←	
5	1	Blade speed		up 1st	sec.	1.2 ± 0.3	1.5 ± 0.3	1.8 ± 0.3	←	Ground to max. up
	2			up 2nd	sec.	2.3 ± 0.3	3.1 ± 0.3	3.1 ± 0.3	←	Max. down to max. up
	3			down	sec.	1.4 ± 0.3	1.3 ± 0.3	1.6 ± 0.3	←	Max. up to ground
	4			down	sec.	3.0 ± 0.3	3.1 ± 0.3	3.1 ± 0.3	←	Max. up to max. down
6	1	Arm cylinder cavitation			mm	0	0	0	←	Oil temp. 95±5°C(203±9°F) Engine speed : 1300 rpm
					inch	0	0	0	←	
7	1	Max. digging height radius	Canopy		mm	2825 -282,+283	3640 ± 364	-	-	
					inch	111.22 -11.10,+11.14	143.31 ± 14.33	-	-	
	2		Cabin		mm	2825 -282,+283	3640 ± 364	3150 ± 315	3275 ± 327	
					inch	111.22 -11.10,+11.14	143.31 ± 14.33	124.02 ± 12.40	128.94 ± 12.87	
	3	Max. dump height radius	Canopy		mm	2790 ± 167	3325 -199, +200	-	-	at bucket pin
					inch	109.84 ± 6.57	130.91 +7.83, +7.87	-	-	
	4		Cabin		mm	2790 ± 167	3325 -199, +200	3350 ± 200	3500 -350, +50	
					inch	109.84 ± 6.57	130.91 +7.83, +7.87	131.89 ± 7.87	137.80 -13.8, +2.0	
	5	Bucket bottom height at arm vertical	Canopy		mm	1585 ± 48	1600 ± 48	-	-	Bucket horizontal
					inch	62.40 ± 1.89	62.99 ± 1.89	-	-	
	6		Cabin		mm	1585 ± 48	1600 ± 48	1940 ± 60	1670 ± 50	
					inch	62.40 ± 1.89	62.99 ± 1.89	76.38 ± 2.36	65.75 ± 1.97	
	7	Bucket wrist angle			deg.	197 ± 3	168.5 -2.5,+3.5"	177 ± 3	177 ± 3	

No		Specificatios Items			Unit	KX121-3α	KX161-3α	U45-3α	**U50-3α**	Remarks
Q6		Swivel, swing performance								
1	1	Swivel torque		L	kgf.m	840	1265	1195	←	Arm extend, Slow/Quick operation
					kN.m	8.2	12.4	11.7	←	
					ft.lbf	6075	9149	8643	←	
	2			R	kgf.m	840	1265	1195	←	
					kN.m	8.2	12.4	11.7	←	
					ft.lbf	6075	9149	8643	←	
2	1	Swivel capable slope angle		L	deg.	20	17	18	←	Bucket load=JIS heapedx1.8
	2			R	deg.	20	17	18	←	
3	1	Swivel block performance		L	deg.	0	0	0	←	Bucket loaded at heaped. Slope angle at 20° for 1 min. Engine idling, lever lock released.
	2			R	deg.	0	0	0	←	
	3			L	deg.	30	30	30	←	
	4			R	deg.	30	30	30	←	
4	1	Swivel start-up speed		L	sec.	2.1 ± 0.3	2.5 ± 0.3	2.5 ± 0.3	←	0~90 deg. swivel
	2			R	sec.	2.1 ± 0.3	2.5 ± 0.3	2.5 ± 0.3	←	
5	1	Swing speed	Canopy	L	sec.	6.7 ± 0.7	6.7 ± 0.5	±	←	
	2			R	sec.	6.5 ± 0.7	7.7 ± 0.5	±	←	
	3		Cabin	L	sec.	6.7 ± 0.7	6.7 ± 0.5	6.0 ± 0.5	←	
	4			R	sec.	6.5 ± 0.7	7.7 ± 0.5	6.7 ± 0.5	←	
6	1	Swing Lock		Swivel R&L	mm	2	2	2	←	90 deg-swivel, 100 times actual digging cylinder dislocation
					inch	0.08	0.08	0.08	←	
	2	Reciprocating motion	L / R	Swing	mm					90 deg-swivel, 100 times
					inch					
Q7		Hydraulic performance								
1	1	Relief pressure setting		P1	kgf/cm^2	250 ± 5.0	245 ± 5.0	245 ± 5.1	←	At pump delivery 50±5°C (122±9°F)
					MPa	24.5 ± 0.5	24.0 ± 0.5	24.0 ± 0.5	←	
					bar	245.2 ± 5.0	240.3 ± 5.0	240.3 ± 5.0	←	
					psi	3556 ± 71	3485 ± 71	3485 ± 73	←	
	2			P2	kgf/cm^2	-	-	-	-	
					MPa	-	-	-	-	
					bar	-	-	-	-	
					psi	-	-	-	-	
	3			P3	kgf/cm^2	-	-	-	-	
					MPa	-	-	-	-	
					bar	-	-	-	-	
					psi	-	-	-	-	
	4			P4	kgf/cm^2	40 ± 5.0	40 ± 5.0	40 ± 5.1	←	
					MPa	3.9 ± 0.5	3.9 ± 0.5	3.9 ± 0.5	←	
					bar	39.2 ± 5.0	39.2 ± 5.0	39.2 ± 5.0	←	
					psi	569 ± 71	569 ± 71	569 ± 73	←	

No		Specificatios Items			Unit	KX121-3α	KX161-3α	U45-3α	**U50-3α**	Remarks
2	1	Cylinder oil sealing capacity	Boom	50±5°C (122±9°F)	mm	20	20	20	←	Armextend, Bucket height 1m, 10min. Bucket load=JIS heapedx1.8
					inch	0.79	0.79	0.79	←	
	2			95±5°C (203±9°F)	mm	20	20	20	←	
					inch	0.79	0.79	0.79	←	
	3		Arm	50±5°C (122±9°F)	mm	20	20	11	←	
					inch	0.79	0.79	0.43	←	
	4		Bucket	50±5°C (122±°F)	mm	10	10	10	←	
					inch	0.39	0.39	0.39	←	
	5		Blade	50±5°C (122±9°F)	mm	20	20	20	←	Arm vertical, blade cylinder extended for 10 min. engine stop."
					inch	0.79	0.79	0.79	←	
3	1	Boom cushioning performance		30±C (86±F)	sec.	3	3	3	←	Arm extended, bucket crowd with no road. Engine Max. speed."
	2			50±5°C (122±9°F)	sec.	0.4 ~ 1.3	0.4 ~ 1.3	0.4 ~ 1.3	←	
	3			80°C (176°F)	sec.	0.3	0.3	0.3	←	
Q8		Lever operating force & stroke								
1	1	Boom lever operating force		UP	kgf	1.8 0.5	1.8 0.5	1.5 0.5	←	Measuring point: 20 mm lower from the lever top. Pilot lever with engine Max. speed.
					N	18 ± 5	18 ± 5	15 ± 5	←	
					lbf	4.0 ± 1.1	4.0 ± 1.1	3.4 ± 1.1	←	
	2			down	kgf	1.5 ± 0.5	1.5 ± 0.5	1.5 ± 0.5	←	
					N	15 ± 5	15 ± 5	15 ± 5	←	
					lbf	3.4 ± 1.1	3.4 ± 1.1	3.4 ± 1.1	←	
	3	Arm lever		crowd	kgf	1.8 ± 0.5	1.8 ± 0.5	1.5 ± 0.5	←	Dump & crowd
					N	18 ± 5	18 ± 5	15 ± 5	←	
					lbf	4.0 ± 1.1	4.0 ± 1.1	3.4 ± 1.1	←	
	4			dump	kgf	1.5 ± 0.5	1.5 ± 0.5	1.5 ± 0.5	←	
					N	15 ± 5	15 ± 5	15 ± 5	←	
					lbf	3.4 ± 1.1	3.4 ± 1.1	3.4 ± 1.1	←	
	5	Bucket lever		crowd	kgf	1.5 ± 0.5	1.50 ± 0.5	1.5 ± 0.5	←	Dump & crowd
					N	15 ± 5	15 ± 5	15 ± 5	←	
					lbf	3.4 ± 1.1	10.8 ± 3.7	3.4 ± 1.1	←	
	6			dump	kgf	1.8 ± 0.5	1.8 ± 0.5	1.5 ± 0.5	←	
					N	18 ± 5	18 ± 5	15 ± 5	←	
					lbf	4.0 ± 1.1	4.0 ± 1.1	3.4 ± 1.1	←	
	7	Swivel lever		R	kgf	1.5 ± 0.5	1.50 ± 0.5	1.5 ± 0.5	←	Left & right
					N	15 ± 5	15 ± 5	15 ± 5	←	
					lbf	3.4 ± 1.1	10.8 ± 3.7	3.4 ± 1.1	←	
	8			L	kgf	1.5 ± 0.5	1.50 ± 0.5	1.5 ± 0.5	←	
					N	15 ± 5	15 ± 5	15 ± 5	←	
					lbf	3.4 ± 1.1	10.8 ± 3.7	3.4 ± 1.1	←	
	9	Blade lever		up	kgf	1.0 ± 0.5	1.0 ± 0.5	2.4 ± 0.5	←	Up&down Measuring point: 15 mm lower from the lever top
					N	10 ± 5	10 ± 5	24 ± 5	←	
					lbf	2.2 ± 1.1	2.2 ± 1.1	5.4 ± 1.1	←	
	10			down	kgf	1.5 ± 0.5	1.5 ± 0.5	2.4 ± 0.5	←	
					N	15 ± 5	15 ± 5	24 ± 5	←	
					lbf	3.4 ± 1.1	3.4 ± 1.1	5.4 ± 1.1	←	

No		Specificatios Items			Unit	KX121-3α	KX161-3α	U45-3α	**U50-3α**	Remarks
1	11	Travel lever	L	Forward	kgf	1.2 ± 0.5	1.2 ± 0.5	1.5 ± 0.5	←	Measuring point: 20 mm lower from the lever top.
					N	12 ± 5	12 ± 5	15 ± 5	←	
					lbf	2.7 ± 1.1	2.7 ± 1.1	3.4 ± 1.1	←	
	12			Back	kgf	1.2 ± 0.5	1.2 ± 0.5	1.5 ± 0.5	←	
					N	12 ± 5	12 ± 5	15 ± 5	←	
					lbf	2.7 ± 1.1	2.7 ± 1.1	3.4 ± 1.1	←	
	13		R	Forward	kgf	1.2 ± 0.5	1.2 ± 0.5	1.5 ± 0.5	←	
					N	12 ± 5	12 ± 5	15 ± 5	←	
					lbf	2.7 ± 1.1	2.7 ± 1.1	3.4 ± 1.1	←	
	14			Back	kgf	1.2 ± 0.5	1.2 ± 0.5	1.5 ± 0.5	←	
					N	12 ± 5	12 ± 5	15 ± 5	←	
					lbf	2.7 ± 1.1	2.7 ± 1.1	3.4 ± 1.1	←	
	15	Accelerator lever		up	kgf	-	-	-	-	AI-version has accel dial not a lever. Measuring point: 30 mm lower from the lever top
					N	-	-	-	-	
					lbf	-	-	-	-	
	16			down	kgf	-	-	-	-	
					N	-	-	-	-	
					lbf	-	-	-	-	
	17	Swing pedal		R	kgf	3.4 ± 0.5	3.4 ± 0.5	7.1 ± 1.0	←	Pedal edge. 45 degree inward
					N	33 ± 5	33 ± 5	70 ± 10	←	
					lbf	7.4 ± 1.1	7.4 ± 1.1	15.7 ± 2.2	←	
	18			L	kgf	4.1 ± 0.5	4.1 ± 0.5	7.1 ± 1.0	←	
					N	40 ± 5	40 ± 5	70 ± 10	←	
					lbf	9.0 ± 1.1	9.0 ± 1.1	15.7 ± 2.2	←	
	19	Safety lock lever	R	up	kgf	0.8 ± 0.2	0.8 ± 0.2	-	-	Up & down
					N	8 ± 2	8 ± 2	-	-	
					lbf	1.8 ± 0.4	1.8 ± 0.4	-	-	
	20			down	kgf	0.4 ± 0.2	0.4 ± 0.2	-	-	
					N	4 ± 2	4 ± 2	-	-	
					lbf	0.9 ± 0.4	0.9 ± 0.4	-	-	
	21	Safety lock lever	L	up	kgf	2.7 ± 1.0	2.7 ± 1.0	2.7 ± 1.0	←	Up & down
					N	26 ± 10	26 ± 10	26 ± 10	←	
					lbf	5.8 ± 2.2	5.8 ± 2.2	5.8 ± 2.2	←	
	22			down	kgf	4.5 ± 1.0	4.5 ± 1.0	5.0 ± 1.0	←	
					N	44 ± 10	44 ± 10	49 ± 10	←	
					lbf	9.9 ± 2.2	9.9 ± 2.2	11.0 ± 2.2	←	
	23	Travel Hi-Lo change			kgf	-	-	4.0 ± 1.0	←	Super series have a switch
					N	-	-	39 ± 10	←	
					lbf	-	-	8.8 ± 2.2	←	

No		Specificatios Items			Unit	KX121-3α	KX161-3α	U45-3α	**U50-3α**	Remarks
2	1	Boom lever stroke		up	mm	72 ± 10	72 ± 10	72 ± 10	←	
					inch	2.83 ± 0.39	2.83 ± 0.39	2.83 ± 0.39	←	
	2			down	mm	72 ± 10	72 ± 10	72 ± 10	←	
					inch	2.83 ± 0.39	2.83 ± 0.39	2.83 ± 0.39	←	
	3	Arm lever stroke		crowd	mm	72 ± 10	72 ± 10	72 ± 10	←	
					inch	2.83 ± 0.39	2.83 ± 0.39	2.83 ± 0.39	←	
	4			dump	mm	72 ± 10	72 ± 10	72 ± 10	←	
					inch	2.83 ± 0.39	2.83 ± 0.39	2.83 ± 0.39	←	
	5	Bucket lever stroke		crowd	mm	72 ± 10	72 ± 10	72 ± 10	←	
					inch	2.83 ± 0.39	2.83 ± 0.39	2.83 ± 0.39	←	
	6			dump	mm	72 ± 10	72 ± 10	72 ± 10	←	
					inch	2.83 ± 0.39	2.83 ± 0.39	2.83 ± 0.39	←	
	7	Swivel lever stroke		R	mm	72 ± 10	72 ± 10	72 ± 10	←	
					inch	2.83 ± 0.39	2.83 ± 0.39	2.83 ± 0.39	←	
	8			L	mm	72 ± 10	72 ± 10	72 ± 10	←	
					inch	2.83 ± 0.39	2.83 ± 0.39	2.83 ± 0.39	←	
	9	Blade lever stroke		up	mm	60 ± 10	60 ± 10	60 ± 10	←	
					inch	2.36 ± 0.39	2.36 ± 0.39	2.36 ± 0.39	←	
	10			down	mm	60 ± 10	60 ± 10	60 ± 10	←	
					inch	2.36 ± 0.39	2.36 ± 0.39	2.36 ± 0.39	←	
	11	Travel lever stroke	L	Forward	mm	70 ± 10	70 ± 10	75 ± 10	←	
					inch	2.76 ± 0.39	2.76 ± 0.39	2.95 ± 0.39	←	
	12			Back	mm	70 ± 10	70 ± 10	75 ± 10	←	
					inch	2.76 ± 0.39	2.76 ± 0.39	2.95 ± 0.39	←	
	13		R	Forward	mm	70 ± 10	70 ± 10	75 ± 10	←	
					inch	2.76 ± 0.39	2.76 ± 0.39	2.95 ± 0.39	←	
	14			Back	mm	70 ± 10	70 ± 10	75 ± 10	←	
					inch	2.76 ± 0.39	2.76 ± 0.39	2.95 ± 0.39	←	
Q9		Stability								
1	1	Standard arm, Dynamic operation load limit	Bucket load to 10 degrees tipping	Side, blade up	kgf.m	-	-	-	-	Arm extend, bucketcrowd oil temp.50±5°C (122±9°F)
					N.m	-	-	-	-	
					ft.lbf	-	-	-	-	
	2			Front, blade up	kgf.m	-	-	-	-	
					N.m	-	-	-	-	
					ft.lbf	-	-	-	-	
	3		Bucket load to tip fully	Side, blade up	kgf.m	394	327	327		
					N.m	3864	3207	3207		
					ft.lbf	2850	2365	2365		
	4			Front, blade up	kgf.m	405	385	420		
					N.m	3972	3776	4119		
					ft.lbf	2929	2785	3038		
	5	Standard arm, static limited load	Bucket load to tip fully	Side	kgf.m	542	554	540	580	Front horizontal bucket crowd, load at arm tip end.
					N.m	5315	5433	5296	5688	
					ft.lbf	3920	4007	3906	4195	
	6			Front	kgf.m	624	644	640	700	
					N.m	6119	6315	6276	6865	
					ft.lbf	4513	4658	4629	5063	
Q10		Comfortability								
1	1	Noise level	At operator's ear LPA	Canopy	dB(A)	79	79	-	-	
	2			Cabin	dB(A)	79	79	79	79	Cabin door close
	3		Noise source;LWA	7m	dB(A)	65.4 >				
	4		Sonic power level (JIS)		dB(A)	95	95	95	95	

c) KX121-3S, 161-3S, U45S: KTC, KCL, KTA-version

Machine specification: Service port, TPSS, Long arm, 4-Post canopy, KTC-bucket

No		Specificatios Items			Unit	KX121-3ST	KX161-3ST	U45ST(KTC)	U45-3ST(KTA)	Remarks
Q1		Main Speed JIS A8404								
1	1	Machine size	Total length (Transport)		mm	5090 ± 102	5540 ± 111	5385 ± 108	5340 ± 107	
					inch	200.4 ± 4.0	218.1 ± 4.4	212.0 ± 4.3	210.2 ± 4.2	
	2		Total width		mm	1700 ± 17	1960 ± 20	1960 ± 20	1960 ± 20	
					inch	66.9 ± 0.7	77.2 ± 0.8	77.2 ± 0.8	77.2 ± 0.8	
	3		Total height (Canopy)		mm	2495 ± 25	2540 ± 25	2540 ± 25	2540 ± 25	Include grouser height
					inch	98.2 ± 1.0	100.0 ± 1.0	100.0 ± 1.0	100.0 ± 1.0	
	4		Total height (Cabin)		mm	2480 ± 25	2540 ± 25	2540 ± 25	2540 ± 25	
					inch	97.6 ± 1.0	100.0 ± 1.0	100.0 ± 1.0	100.0 ± 1.0	
2	1	Weight	Machine weight (Canopy)		kg	4110 ± 82	5230 ± 105	5200 ± 104	4425 ± 89	Fuel tank:Full
					lbs	9061 ± 181	11530 ± 231	11464 ± 229	9755 ± 196	
	2		Machine weight (Cabin)		kg	4200 ± 84	5305 ± 106	5275 ± 106	4520 ± 90	
					lbs	9259 ± 185	11695 ± 234	11629 ± 234	9965 ± 198	
3	1	Perfor-mance	Swivel speed	L	rpm	9.2 ± 0.9	9.3 ± 0.9	9.1 ± 0.9	9.1 ± 0.9	
	2			R	rpm	9.2 ± 0.9	9.3 ± 0.9	9.1 ± 0.9	9.1 ± 0.9	
	3		Travel speed	Rubber F1	km/h	3.0 ± 0.3	2.5 , -0.2/0.3	2.3 ± 0.2	2.3 ± 0.2	Traveling stance: Engine Max.speed Oil temp. : 50±5°C (122±9°F)
					mph	1.86 ± 0.19	1.55 , -0.12/0.19	1.43 ± 0.12	1.43 ± 0.12	
	4			Rubber F2	km/h	5.0 ± 0.5	4.6 ± 0.5	4.3 ± 0.4	4.3 ± 0.4	
					mph	3.11 ± 0.31	2.86 ± 0.31	2.67 ± 0.25	2.67 ± 0.25	
	5			Steel F1	km/h	2.9 ± 0.3	2.3 ± 0.2	2.2 ± 0.2	2.2 ± 0.2	
					mph	1.80 ± 0.19	1.43 ± 0.12	1.37 ± 0.12	1.37 ± 0.12	
	6			Steel F2	km/h	4.7 ± 0.5	4.2 ± 0.4	4.0 ± 0.4	4.0 ± 0.4	
					mph	2.92 ± 0.31	2.61 ± 0.25	2.49 ± 0.25	2.49 ± 0.25	
	7		Gradeability		deg.	30 ,≧ 30	←	←	←	
4	1	Rear end min. turning radius			mm	1300 ± 26	1090 ± 22	990 ± 20	990 ± 20	
					inch	51.2 ± 1.0	42.9 ± 0.9	39.0 ± 0.8	39.0 ± 0.8	
	2	Swivel frame rear ground clearance			mm	574 ± 11	620 ± 12	620 ± 12	620 ± 10	
					inch	22.6 ± 0.4	24.4 ± 0.5	24.4 ± 0.5	24.4 ± 0.4	
	3	Tambler center distance			mm	1710 ± 51	1990 ± 60	1990 ± 60	1990 ± 60	
					inch	67.3 ± 2.0	78.3 ± 2.4	78.3 ± 2.4	78.3 ± 2.4	
	4	Crawler total length			mm	2175 ± 65	2500 ± 75	2500 ± 75	2500 ± 75	
					inch	85.6 ± 2.6	98.4 ± 3.0	98.4 ± 3.0	98.4 ± 3.0	
	5	Crawler total width			mm	1700 ± 34	1960 ± 39	1960 ± 39	1960 ± 40	
					inch	66.9 ± 1.3	77.2 ± 1.5	77.2 ± 1.5	77.2 ± 1.6	
	6	Min. ground clearance			mm	330 ± 10	320 ± 10	320 ± 10	320 ± 10	
					inch	13.0 ± 0.4	12.6 ± 0.4	12.6 ± 0.4	12.6 ± 0.4	
5	1	Front attachment	Bucket heaped capacity	CECE	m^3					
					yd^3					
	2			SAE, JIS	m^3	0.12 (0.115~0.125)	0.196 (0.188~0.204)			Slope angle: 1 x 1
					yd^3	0.157	0.256			
			Bucket struck capacity		m^3	0.09 (0.086~0.094)	0.131 (0.126~0.136)			
					yd^3	0.1	0.171			
	3		Bucket width		mm	600 ± 12				Without side cutter
					inch	23.6 ± 0.5				
	4		Swing angle	Canopy L	deg	75 ± 2	←	←	←	
	5			Canopy R	deg	48 ± 2	←	←	←	
	6			Cabin L	deg	75 ± 2	←	←	←	
	7			Cabin R	deg	48 ± 2	←	←	←	

No		Specificatios Items			Unit	KX121-3ST	KX161-3ST	U45ST(KTC)	U45-3ST(KTA)	Remarks
5	8	Front attachment	Max. digging radius		mm	5600 ± 84	6260 ± 94	6010 ± 90	5755 ± 85	
					inch	220.5 ± 3.3	246.5 ± 3.7	236.6 ± 3.5	226.6 ± 3.3	
	9		Ground level Max. digging radius		mm	5475 ± 82	6130 ± 92	5875 ± 88	5615 ± 85	
					inch	215.6 ± 3.2	241.3 ± 3.6	231.3 ± 3.5	221.1 ± 3.3	
	10		Ground level Min. finish radius		mm	1805 ± 36	1940 ± 39	1895 ± 38	2030 ± 40	Bucket bottom horizontal
					inch	71.1 ± 1.4	76.4 ± 1.5	74.6 ± 1.5	79.9 ± 1.6	
	11		Max. digging depth		mm	3505 ± 70	3830 ± 77	3600 + 72	3350 + 30, -100	
					inch	138.0 ± 2.8	150.8 ± 3.0	141.7 + 2.8	131.9 + 1.2, -3.9	
	12		Max. vertical digging depth		mm	2480 ± 74	2585 ± 78	2400 + 72	2700 + 60, -100	
					inch	97.6 ± 2.9	101.8 ± 3.1	94.5 + 2.8	106.3 + 2.4, -3.9	
	13		Max. digging height	Canopy	mm	5420 ± 108	5715 ± 14	5520 + 110	5430 + 65, -150	
					inch	213.4 ± 4.3	225.0 ± 0.6	217.3 + 4.3	213.8 + 2.6, -5.9	
	14			Cabin	mm	5420 ± 108	5715 ± 14	5520 + 110	5430 + 65, -150	
					inch	213.4 ± 4.3	225.0 ± 0.6	217.3 + 4.3	213.8 + 2.6, -5.9	
	15		Max. dump height	Canopy	mm	3890 ± 78	4155 ± 83	3970 + 79	3800 + 30, -120	
					inch	153.1 ± 3.1	163.6 ± 3.3	156.3 + 3.1	149.6 + 1.2, -4.7	
	16			Cabin	mm	3890 ± 78	4155 ± 83	3970 + 79	3800 + 30, -120	
					inch	153.1 ± 3.1	163.6 ± 3.3	156.3 + 3.1	149.6 + 1.2, -4.7	
	17		Max. dump height (Arm vertical)	Canopy	mm	1250 ± 37	1285 ± 39	1290 + 39	1560 ± 45	
					inch	49.2 ± 1.5	50.6 ± 1.5	50.8 + 1.5	61.4 ± 1.8	
	18			Cabin	mm	1250 ± 37	1285 ± 39	1290 + 39	1560 ± 45	
					inch	49.2 ± 1.5	50.6 ± 1.5	50.8 + 1.5	61.4 ± 1.8	
	19		Min. turning radius	Canopy	mm	2060 ± 62	2420 ± 73	2360 ± 71	2310 ± 70	
					inch	81.1 ± 2.4	95.3 ± 2.9	92.9 ± 2.8	90.9 ± 2.8	
	20			Cabin	mm	2060 ± 62	2420 ± 73	2360 ± 71	2310 ± 70	
					inch	81.1 ± 2.4	95.3 ± 2.9	92.9 ± 2.8	90.9 ± 2.8	
	21		Min. turning radius (Left swing)	Canopy	mm	1665 ± 50	1955 ± 59	1905 ± 57	1825 + 95, -20	
					inch	65.6 ± 2.0	77.0 ± 2.3	75.0 ± 2.2	71.9 + 3.7, -0.79	
	22			Cabin	mm	1665 ± 50	1995 ± 59	1905 ± 57	1825 + 95, -20	
					inch	65.6 ± 2.0	78.5 ± 2.3	75.0 ± 2.2	71.9 + 3.7, -0.79	
6	1	Blade	Width		mm	1700 ± 5	1960 ± 5	See another sheet (Angle Blade)	1960 ± 5	
					inch	66.9 ± 0.2	77.2 ± 0.2		77.2 ± 0.2	
	2		Height		mm	350 ± 10	360 ± 10		385 ± 10	
					inch	13.8 ± 0.4	14.2 ± 0.4		15.2 ± 0.4	
	3		Max. lift above GL		mm	395 ± 50	455 ± 50		455 ± 50	
					inch	15.6 ± 2.0	17.9 ± 2.0		17.9 ± 2.0	
	4		Max. below GL		mm	410 ± 50	370 ± 50		370 ± 50	
					inch	16.1 ± 2.0	14.6 ± 2.0		14.6 ± 2.0	
Q2		Main Specs JIS A8404								
1	1	Bucket tooth slaggish			mm	50 ,≦ 73	←	←	←	Without shockless F=30 kgf (66 lbf)
					inch	1.97 ,≦ 2.9	←	←	←	
	2	Tilt amount of front attachment			mm	0 ,≦ 10	←	←	←	
					inch	0 ,≦ 0.39	←	←	←	
	3	Declination of blade			mm	3 ,≦ 10.0	←	0 ,≦ 10.0	←	
					inch	0.12 ,≦ 0.4	←	0 ,≦ 0.4	←	
2	1	Clearance between bucket crow and boom cylinder cover			mm	195 , 166 to 244	170 , 140 to 220	192 , 162 to 242	154 , 120 to 204	From swivel center
					inch	7.68 , 6.5 to 8.7	6.69 , 5.5 to 8.7	7.56 , 6.4 to 9.5	6.06 , 8.0 to 4.7	
	2	(Min.value; reference)			mm	110	-	-	-	
					inch	4.33	-	-	-	
3	1	Blade approach angle			deg.	30 ± 3	←	See another sheet	30 ± 3	
4	1	Crawler height			mm	470 ± 9	520 ± 10	520 ± 10	520 ± 10	Include grouser on the spocket
					inch	18.50 ± 0.35	20.47 ± 0.39	20.47 ± 0.39	20.47 ± 0.39	
	2	Max. crawler height			mm	490 ± 10	550 ± 11	550 ± 10	550 ± 10	
					inch	19.29 ± 0.39	21.65 ± 0.43	21.65 ± 0.39	21.65 ± 0.39	

No		Specificatios Items		Unit	KX121-3ST	KX161-3ST	U45ST(KTC)	U45-3ST(KTA)	Remarks
Q3		Engine performance							
1	1	Max, engine rpm	no load	rpm	2450 , 2450 ≧	2500 , 2500 ≧	2450 , 2450 ≧	2450 , 2450 ≧	
	2		1 pump relief	rpm	-	-	-	-	
	3		2 pump relief	rpm	-	-	-	-	
	4		3 pump relief	rpm	-	-	-	-	Boom, arm, swivel
	5		2 pump relief	rpm	2250 , 2150≦	2200 , 2100≦	2250 , 2150≦	2250 , 2150≦	
	6		Blade+2 pump relief	rpm	2250 , 2150≦	2200 , 2100≦	2250 , 2150≦	2250 , 2150≦	
2	1	Idling RPM		rpm	1200 +100,-50	1200 +100,-50	1200 +100,-50	1200 +100,-50	
Q4		Travelling performance							
1	1	Travel motor block performance	L	mm	272 ,≦ 300	261 ,≦ 300	272 ,≦ 300	272 ,≦ 300	20 deg. slope, 10 min
				inch	10.7 ,≦ 11.8	10.3 ,≦ 11.8	10.7 ,≦ 11.8	10.7 ,≦ 11.8	
	2		R	mm	272 ,≦ 300	261 ,≦ 300	272 ,≦ 300	272 ,≦ 300	
				inch	10.7 ,≦ 11.8	10.3 ,≦ 11.8	10.7 ,≦ 11.8	10.7 ,≦ 11.8	
2	1	Max, Traction force	F1	kgf	3081 ,≧ 1305	4083 ,≧ 3671	4083 ,≧ 3671	3562 ,≧ 3202	Slip. 70% of absolute traction force.
				kN	30.2 ,≧ 12.8	40.0 ,≧ 36.0	40.0 ,≧ 36.0	34.9 ,≧ 31.4	
				lbf	6792 ,≧ 2878	9001 ,≧ 8093	9001 ,≧ 8093	7853 ,≧ 7059	
	2		F2	kgf	1455 ,≧ 1305	1972 ,≧ 1774	1972 ,≧ 1774	1724 ,≧ 1550	Relief. 60% of absolute traction force.
				kN	14.3 ,≧ 12.8	19.3 ,≧ 17.40	19.3 ,≧ 17.4	16.9 ,≧ 15.2	
				lbf	3208 ,≧ 2878	4348 ,≧ 3912	4348 ,≧ 3912	3801 ,≧ 3417	
3	1	Travel straightness	F1	mm	600 ,≦ 600	←	←	←	10m distance Engine Max. speed
				inch	23.6 ,≦ 23.6	←	←	←	
	2		F2	mm	600 ,≦ 600	←	←	←	
				inch	23.6 ,≦ 23.6	←	←	←	
	3		Blade F1	mm	600 ,≦ 600	←	←	←	Blade up & down 10m distance
				inch	23.6 ,≦ 23.6	←	←	←	
	4		Blade R1	mm	600 ,≦ 600	←	←	←	
				inch	23.6 ,≦ 23.6	←	←	←	
4	1	Track shoe sag distance	Steel	mm	40 + 5	←	←	←	
				inch	1.57 + 0.20	←	←	←	
	2		Rubber	mm	10 + 5	←	←	←	
				inch	0.39 + 0.20	←	←	←	
Q5		Work performance							
1	1	Boom lifting capacity		kgf	734 ,≧ 663	790 ,≧ 714	700 ,≧ 632	870 ,≧ 785	Front end, Arm extend, Bucket crowd, at tooth
				kN	7.2 ,≧ 6.5	7.7 ,≧ 7.0	6.9 ,≧ 6.2	8.5 ,≧ 7.7	
				lbf	1618 ,≧ 1461	1742 ,≧ 1574	1543 ,≧ 1394	1918 ,≧ 1731	
	2	Arm digging force		kgf	1790 ,≧ 1693	2253 ,≧ 2141	2110 ,≧ 2009	2350 ,≧ 2233	Bucket tooth root
				kN	17.6 ,≧ 16.6	22.1 ,≧ 21.0	20.7 ,≧ 19.7	23.0 ,≧ 21.9	
				lbf	3946 ,≧ 3732	4967 ,≧ 4721	4652 ,≧ 4429	5181 ,≧ 4923	
	3	Bucket digging force		kgf	3005 ,≧ 2855	5043 ,≧ 4793	3575 ,≧ 3396	3350 ,≧ 3182	Machine stance to JIS bucket tooth root
				kN	29.5 ,≧ 28.0	49.5 ,≧ 47.0	35.1 ,≧ 33.3	32.9 ,≧ 31.2	
				lbf	6625 ,≧ 6295	11118 ,≧ 10566	7882 ,≧ 7486	7385 ,≧ 7014	
	4	Blade force	down	kgf	3160 ,≧ 2998	4170 ,≧ 3967	3625 ,≧ 3447	4115 ,≧ 3906	Cutting edge down force at ground level
				kN	31.0 ,≧ 29.4	40.9 ,≧ 38.9	35.5 ,≧ 33.8	40.4 ,≧ 38.3	
				lbf	6967 ,≧ 6609	9193 ,≧ 8745	7992 ,≧ 7599	9072 ,≧ 8610	

No		Specificatios Items			Unit	KX121-3ST	KX161-3ST	U45ST(KTC)	U45-3ST(KTA)	Remarks
2	1	Boom speed	Canopy	up (G→T)	sec.	2.7 ± 0.3	←	2.6 ± 0.3	2.6 ± 0.3	Oil temp. :50±5°C (122±9°F) Ground to max. height (exculude cushioning)
	2			up (L→T)	sec.	4.9 ± 0.3	4.7 ± 0.3	4.8 ± 0.3	4.8 ± 0.3	
	3			down (T→G)	sec.	2.7 ± 0.3	←	2.6 ± 0.3	2.6 ± 0.3	
	4			down	sec.	5.1 ± 0.3	4.6 ± 0.3	4.3 ± 0.3	4.7 ± 0.3	
	5		Cabin	up 1st	sec.	2.7 ± 0.3	←	2.6 ± 0.3	2.6 ± 0.3	
	6			up 2nd	sec.	4.9 ± 0.3	4.7 ± 0.3	4.8 ± 0.3	4.8 ± 0.3	
	7			down	sec.	2.7 ± 0.3	←	2.6 ± 0.3	2.6 ± 0.3	
	8			down	sec.	5.1 ± 0.3	4.6 ± 0.3	4.3 ± 0.3	4.7 ± 0.3	
3	1	Arm speed		crowd	sec.	3.2 ± 0.3	3.1 ± 0.3	3.0 ± 0.3	3.0 ± 0.3	
	2			dump	sec.	2.8 ± 0.3	3.1 ± 0.3	2.8 ± 0.3	2.8 ± 0.3	
4	1	Bucket speed		crowd	sec.	2.7 ± 0.3	2.9 ± 0.3	2.9 ± 0.3	2.9 ± 0.3	Oil temp. 50±5°C (122±9°F)
	2			dump	sec.	2.2 ± 0.3	2.0 ± 0.3	2.1 ± 0.3	2.1 ± 0.3	
5	1	Blade speed		up (G→T)	sec.	1.2 ± 0.3	1.5 ± 0.3	See another sheet (Angle Blade)	1.5 ± 0.3	Ground to max. up
	2			up (L→T)	sec.	2.3 ± 0.3	3.1 ± 0.3		2.8 ± 0.3	Max. down to max. up
	3			down (T→G)	sec.	1.4 ± 0.3	1.3 ± 0.3		1.4 ± 0.3	Max. up to ground
	4			down (T→L)	sec.	3.0 ± 0.3	3.1 ± 0.3		2.9 ± 0.3	Max. up to max. down
6	1	Arm cylinder cavitation			mm	0 ,≦ 5	←	←	←	Oil temp. 95±5°C (203±9°F) Engine speed : 1300 rpm
					inch	0 ,≦ 0.2	←	←	←	
7	1	Max. digging height radius		Canopy	mm	2825 ± 282	3640 ± 364	3495 ± 350	-	
					inch	111.2 ± 11.10	143.3 ± 14.33	137.6 ± 13.78	-	
	2			Cabin	mm	2825 ± 282	3640 ± 364	3495 ± 350	3150 ± 315	
					inch	111.2 ± 11.10	143.3 ± 14.33	137.6 ± 13.78	124.0 ± 12.40	
	3	Max. dump height radius		Canopy	mm	2790 ± 167	3325 ± 200	3620 ± 217	-	at bucket pin
					inch	109.8 ± 6.57	130.9 ± 7.87	142.5 ± 8.54	-	
	4			Cabin	mm	2790 ± 167	3325 ± 200	3620 ± 217	3350 ± 200	
					inch	109.8 ± 6.57	130.9 ± 7.87	142.5 ± 8.54	131.9 ± 7.87	
	5	Bucket bottom height at arm vertical		Canopy	mm	1585 ± 48	1600 ± 48	1605 ± 48	-	Bucket horizontal
					inch	62.4 ± 1.89	62.99 ± 1.89	63.2 ± 1.89	-	
	6			Cabin	mm	1585 ± 48	1600 ± 48	1605 ± 48	1940 ± 60	
					inch	62.4 ± 1.89	62.99 ± 1.89	63.2 ± 1.89	76.4 ± 2.36	
	7	Bucket wrist angle			deg.	197 ± 3	168.5 ± 3	168.5 +3.5, -2.5	177 ± 3	
Q6		Swivel, swing performance								
1	1	Swivel torque		L	kgf.m	840 ,≧ 714	1265 ,≧ 1071	1195 ,≧ 1020	1195 ,≧ 1020	Arm extend, Slow/Quick operation
					kN.m	8.2 ,≧ 7.0	12.4 ,≧ 10.5	11.7 ,≧ 10.0	11.7 ,≧ 10.0	
					ft.lbf	6075 ,≧ 5164	9149 ,≧ 7746	8643 ,≧ 7377	8643 ,≧ 7377	
	2			R	kgf.m	840 ,≧ 714	1265 ,≧ 1071	1195 ,≧ 1020	1195 ,≧ 1020	
					kN.m	8.2 ,≧ 7.0	12.4 ,≧ 10.5	11.7 ,≧ 10.0	11.7 ,≧ 10.0	
					ft.lbf	6075 ,≧ 5164	9149 ,≧ 7746	8643 ,≧ 7377	8643 ,≧ 7377	
2	1	Swivel capable slope angle		L	deg.	20 ,≧ 18	17 ,≧ 15	17 ,≧ 15	18 ,≧ 16	Bucket load=JIS heaped x 1.8
	2			R	deg.	20 ,≧ 18	17 ,≧ 15	17 ,≧ 15	18 ,≧ 16	
3	1	Swivel block perfor-mance	Engine stop	L	deg.	0 ,≦ 5	0 ,≦ 5	0 ,≦ 5	0 ,≦ 5	Bucket loaded at heaped.
	2			R	deg.	0 ,≦ 5	0 ,≦ 5	0 ,≦ 5	0 ,≦ 5	Slope angle at 20° for 1 min.
	3		Engine run	L	deg.	30 ,≦ 30	30 ,≦ 30	30 ,≦ 30	30 ,≦ 30	Engine idling, negative brake released.
	4			R	deg.	30 ,≦ 30	30 ,≦ 30	30 ,≦ 30	30 ,≦ 30	

No		Specificatios Items			Unit	KX121-3ST	KX161-3ST	U45ST(KTC)	U45-3ST(KTA)	Remarks
4	1	Swivel start-up speed		L	sec.	2.1 ± 0.3	2.5 ± 0.3	2.5 ± 0.3	2.5 ± 0.3	0~90 deg. swivel
	2			R	sec.	2.1 ± 0.3	2.5 ± 0.3	2.5 ± 0.3	2.5 ± 0.3	
5	1	Swing speed	Canopy	L	sec.	6.7 ± 0.7	6.7 ± 0.5	6.0	-	
	2			R	sec.	6.5 ± 0.7	7.7 ± 0.5	6.7	-	
	3		Cabin	L	sec.	6.7 ± 0.7	6.7 ± 0.5	6.0 ± 0.5	6.0 ± 0.5	
	4			R	sec.	6.5 ± 0.7	7.7 ± 0.5	6.7 ± 0.5	6.7 ± 0.5	
6	1	Swing Lock		Swivel R&L	mm	2 ,≦ 10	←	←	←	90 deg-swivel, 100 times actual digging cylinder dislocation
					inch	0.08 ,≦ 0.39	←	←	←	
	2	Reciprocating motion	L / R	Swing	mm					90 deg-swivel, 100 times
					inch					
Q7		Hydraulic performance								
1	1	Relief pressure setting		P1	kgf/cm^2	250 +5, -10	245 +10, -5	245 +10, -5	245 +10, -5	At pump delivery 50±5°C (122±9°F)
					MPa	24.5 +0.5, -1.0	24.0 +1.0, -0.5	24.0 +1.0, -0.5	24.0 +1.0, -0.5	
					bar	245.2 +5, -10	240.3 +10, -5	240.3 +10, -5	240.3 +10, -5	
					psi	3556 +71, -142	3485 +140, -70	3485 +140, -70	3485 +140, -70	
	2			P2	kgf/cm^2	-	-	-	-	
					MPa	-	-	-	-	
					bar	-	-	-	-	
					psi	-	-	-	-	
	3			P3	kgf/cm^2	-	-	-	-	
					MPa	-	-	-	-	
					bar	-	-	-	-	
					psi	-	-	-	-	
	4			P4	kgf/cm^2	40 ± 5.1	←	←	←	
					MPa	3.9 ± 0.5	←	←	←	
					bar	39.2 ± 5.0	←	←	←	
					psi	569 ± 73	←	←	←	
2	1	Cylinder oil sealing capacity	Boom	50±5°C	mm	3 ,≦ 20	←	←	←	Arm extend, Bucket height 1m, 10 min. Bucket load= JIS heaped x 1.8
				(122±9°F)	inch	0.12 ,≦ 1	←	←	←	
	2			95±5°C	mm	10 ,≦ 20	←	←	←	
				(203±9°F)	inch	0.39 ,≦ 1	←	←	←	
	3		Arm	50±5°C	mm	20 ,≦ 20	←	←	←	
				(122±9°F)	inch	0.79 ,≦ 1	←	←	←	
	4		Bucket	50±5°C	mm	15 ,≦ 15	←	←	←	
				(122±9°F)	inch	0.59 ,≦ 1	←	←	←	
	5		Blade	50±5°C	mm	12 ,≦ 20	←	See another sheet (Angle Blade)	12 ,≦ 20	Arm vertical, blade cylinder extended for 10 min. engine stop.
				(122±9°F)	inch	0.47 ,≦ 1	←		0.47 ,≦ 1	
3	1	Boom cushioning performance		30°C (86°F)	sec	3 ,≦ 3	←	←	←	Arm extended, bucket crowd with no road. Engine Max. speed.
	2			50°C (122°F)	sec	0.4 to 1.3	←	←	←	
	3			80°C (176°F)	sec	0.3 ,≧ 0.3	←	←	←	

No		Specificatios Items		Unit	KX121-3ST	KX161-3ST	U45ST(KTC)	U45-3ST(KTA)	Remarks
Q8		Lever operating force & stroke							
1	1	Boom lever operating force	up	kgf	1.8 ± 0.5	←	←	←	Measuring point : 20 mm lower from the lever top. Pilot lever with engine Max. speed.
				N	17.65 ± 4.90	←	←	←	
				lbf	4.0 ± 1.1	←	←	←	
	2		down	kgf	1.5 ± 0.5	←	←	←	
				N	14.71 ± 4.90	←	←	←	
				lbf	3.3 ± 1.1	←	←	←	
	3	Arm lever	crowd	kgf	1.8 ± 0.5	←	←	←	Dump & crowd
				N	17.65 ± 4.90	←	←	←	
				lbf	4.0 ± 1.1	←	←	←	
	4		dump	kgf	1.5 ± 0.5	←	←	←	
				N	14.71 ± 4.90	←	←	←	
				lbf	3.3 ± 1.1	←	←	←	
	5	Bucket lever	crowd	kgf	1.5 ± 0.5	←	←	←	Dump & crowd
				N	14.71 ± 4.90	←	←	←	
				lbf	3.3 ± 1.1	←	←	←	
	6		dump	kgf	1.8 ± 0.5	←	←	←	
				N	17.65 ± 4.90	←	←	←	
				lbf	4.0 ± 1.1	←	←	←	
	7	Swivel lever	R	kgf	1.5 ± 0.5	←	←	←	Left & right
				N	14.71 ± 4.90	←	←	←	
				lbf	3.3 ± 1.1	←	←	←	
	8		L	kgf	1.5 ± 0.5	←	←	←	
				N	14.71 ± 4.90	←	←	←	
				lbf	3.3 ± 1.1	←	←	←	
	9	Blade lever	up	kgf	1.0 ± 0.5	1.0 ± 0.5	See another sheet (Angle Blade)	1.0 ± 0.5	Up&down Measuring point : 15 mm lower from the lever top
				N	9.81 ± 4.90	9.81 ± 4.90		9.81 ± 4.90	
				lbf	2.2 ± 1.1	2.2 ± 1.1		2.2 ± 1.1	
	10		down	kgf	1.5 ± 0.5	1.5 ± 0.5		1.5 ± 0.5	
				N	14.71 ± 4.90	14.71 ± 4.90		14.71 ± 4.90	
				lbf	3.3 ± 1.1	3.3 ± 1.1		3.3 ± 1.1	
	11	Travel lever L	Forward	kgf	1.2 ± 0.5	1.2 ± 0.5	1.2 ± 0.5	1.2 ± 0.5	Measuring point : 20 mm lower from the lever top.
				N	11.77 ± 4.90	11.77 ± 4.90	11.77 ± 4.90	11.77 ± 4.90	
				lbf	2.6 ± 1.1	2.6 ± 1.1	2.6 ± 1.1	2.6 ± 1.1	
	12		Back	kgf	1.2 ± 0.5	1.2 ± 0.5	1.2 ± 0.5	1.2 ± 0.5	
				N	11.77 ± 4.90	11.77 ± 4.90	11.77 ± 4.90	11.77 ± 4.90	
				lbf	2.6 ± 1.1	2.6 ± 1.1	2.6 ± 1.1	2.6 ± 1.1	
	13	R	Forward	kgf	1.2 ± 0.5	1.2 ± 0.5	1.2 ± 0.5	1.2 ± 0.5	
				N	11.77 ± 4.90	11.77 ± 4.90	11.77 ± 4.90	11.77 ± 4.90	
				lbf	2.6 ± 1.1	2.6 ± 1.1	2.6 ± 1.1	2.6 ± 1.1	
	14		Back	kgf	1.2 ± 0.5	1.2 ± 0.5	1.2 ± 0.5	1.2 ± 0.5	
				N	11.77 ± 4.90	11.77 ± 4.90	11.77 ± 4.90	11.77 ± 4.90	
				lbf	2.6 ± 1.1	2.6 ± 1.1	2.6 ± 1.1	2.6 ± 1.1	
	15	Accelerator lever	up	kgf	-	-	-	-	AI-version has accel dial not a lever. Measuring point : 30 mm lower from the lever top
				N	-	-	-	-	
				lbf	-	-	-	-	
	16		down	kgf	-	-	-	-	
				N	-	-	-	-	
				lbf	-	-	-	-	

No		Specificatios Items			Unit	KX121-3ST	KX161-3ST	U45ST(KTC)	U45-3ST(KTA)	Remarks
1	17	Swing pedal		R	kgf	3.4 ± 1.0	←	←	←	Pedal edge. 45 degree inward
					N	33.34 ± 9.81	←	←	←	
					lbf	7.5 ± 2.2	←	←	←	
	18			L	kgf	4.1 ± 1.0	←	←	←	
					N	40.21 ± 9.81	←	←	←	
					lbf	9.0 ± 2.2	←	←	←	
	19	Safety lock lever	R	up	kgf	0.8 ± 0.2	←	←	←	Up & down
					N	7.85 ± 1.96	←	←	←	
					lbf	1.8 ± 0.4	←	←	←	
	20			down	kgf	0.4 ± 0.2	←	←	←	
					N	3.92 ± 1.96	←	←	←	
					lbf	0.9 ± 0.4	←	←	←	
	21		L	up	kgf	2.7 ± 1.0	←	←	←	Up & down
					N	26.48 ± 9.81	←	←	←	
					lbf	6.0 ± 2.2	←	←	←	
	22			down	kgf	4.5 ± 1.0	←	←	←	
					N	44.13 ± 9.81	←	←	←	
					lbf	9.9 ± 2.2	←	←	←	
	23	Travel Hi-Lo change			kgf	-	-	-	-	Super series have a switch
					N	-	-	-	-	
					lbf	-	-	-	-	
2	1	Boom lever stroke		up	mm	72 ± 10	←	←	←	
					inch	2.83 ± 0.39	←	←	←	
	2			down	mm	72 ± 10	←	←	←	
					inch	2.83 ± 0.39	←	←	←	
	3	Arm lever stroke		crowd	mm	72 ± 10	←	←	←	
					inch	2.83 ± 0.39	←	←	←	
	4			dump	mm	72 ± 10	←	←	←	
					inch	2.83 ± 0.39	←	←	←	
	5	Bucket lever stroke		crowd	mm	72 ± 10	←	←	←	
					inch	2.83 ± 0.39	←	←	←	
	6	Bucket lever stroke		dump	mm	72 ± 10	←	←	←	
					inch	2.83 ± 0.39	←	←	←	
	7	Swivel lever stroke		R	mm	72 ± 10	←	←	←	
					inch	2.83 ± 0.39	←	←	←	
	8			L	mm	72 ± 10	←	←	←	
					inch	2.83 ± 0.39	←	←	←	
	9	Blade lever stroke		up	mm	60 ± 10	←	See another sheet (Angle Blade)	60 ± 10	
					inch	2.36 ± 0.39	←		2.36 ± 0.39	
	10			down	mm	60 ± 10	←		60 ± 10	
					inch	2.36 ± 0.39	←		2.36 ± 0.39	
	11	Travel lever stroke	L	Forward	mm	70 ± 10	←	←	75 ± 10	
					inch	2.76 ± 0.39	←	←	2.95 ± 0.39	
	12			Back	mm	70 ± 10	←	←	75 ± 10	
					inch	2.76 ± 0.39	←	←	2.95 ± 0.39	
	13		R	Forward	mm	70 ± 10	←	←	75 ± 10	
					inch	2.76 ± 0.39	←	←	2.95 ± 0.39	
	14			Back	mm	70 ± 10	←	←	75 ± 10	
					inch	2.76 ± 0.39	←	←	2.95 ± 0.39	

No		Specificatios Items			Unit	KX121-3ST	KX161-3ST	U45ST(KTC)	U45-3ST(KTA)	Remarks
Q9		Stability								
1	1	Standard arm, Dynamic operation load limit	Bucket load to 10 degrees tip-ping	Side, blade up	kgf	-	-	-	-	Arm extend, bucket crowd oil temp.50±5°C (122±9°F) U45S : KTA only
					N	-	-	-	-	
					lbf	-	-	-	-	
	2			Front, blade up	kgf	-	-	-	-	
					N	-	-	-	-	
					lbf	-	-	-	-	
	3		Bucket load to tip fully	Side, blade up	kgf	-	327 ,≧ 294	-	327 ,≧ 294	
					N	-	3207 ,≧ 2886	-	3207 ,≧ 2886	
					lbf	-	721 ,≧ 649	-	721 ,≧ 649	
	4			Front, blade up	kgf	-	385 ,≧ 347	-	420 ,≧ 378	
					N	-	3776 ,≧ 3398	-	4119 ,≧ 3707	
					lbf	-	849 ,≧ 764	-	926 ,≧ 833	
	5	Standard arm, Static limited load	Bucket load to tip fully	Side	kgf	-	554 ,≧ 499	-	540 ,≧ 486	Front horizontal bucket crowd, load at arm tip end. U45S : KTA only
					N	-	5433 ,≧ 4890	-	5296 ,≧ 4766	
					lbf	-	1221 ,≧ 1099	-	1190 ,≧ 1071	
	6			Front	kgf	-	644 ,≧ 580	-	640 ,≧ 576	
					N	-	6315 ,≧ 5684	-	6276 ,≧ 5649	
					lbf	-	1420 ,≧ 1278	-	1411 ,≧ 1270	
2	1	Long arm, Dynamic operation load limit	Bucket load to 10 degrees tip-ping	Side, blade up	kgf	-	-	-	-	Arm extend, bucket crowd oil temp.50±5°C (122±9°F) U45S : KTC, KCL only
					N	-	-	-	-	
					lbf	-	-	-	-	
	2			Front, blade up	kgf	-	-	-	-	
					N	-	-	-	-	
					lbf	-	-	-	-	
	3			Side, blade up	kgf	394 ,≧ 355	-	370 ,≧ 333	-	
					N	3864 ,≧ 3478	-	3628 ,≧ 3266	-	
					lbf	869 ,≧ 782	-	816 ,≧ 734	-	
	4			Front, blade up	kgf	405 ,≧ 365	-	374 ,≧ 337	-	
					N	3972 ,≧ 3575	-	3668 ,≧ 3301	-	
					lbf	893 ,≧ 804	-	825 ,≧ 742	-	
	5	Longarm, Static lim-ited load	Bucket load to tip fully	Side	kgf	542 ,≧ 488	-	607 ,≧ 546	-	Front horizon-tal bucket crowd, load at arm tip end. U45S : KTC, KCL only
					N	5315 ,≧ 4784	-	5953 ,≧ 5358	-	
					lbf	1195 ,≧ 1075	-	1338 ,≧ 1205	-	
	6			Front	kgf	624 ,≧ 562	-	622 ,≧ 560	-	
					N	6119 ,≧ 5508	-	6100 ,≧ 5490	-	
					lbf	1376 ,≧ 1238	-	1371 ,≧ 1234	-	
Q10		Comfortability								
1	1	Noise level	At operator's ear LPA	Canopy	dB(A)	79 ,≦ 81	80 ,≦ 82	79 ,≦ 81	←	
	2			Cabin	dB(A)	79 ,≦ 81	80 ,≦ 82	79 ,≦ 81	←	Cabin door close
	3		Noise source; LWA	7m	dB(A)	≦ 65.4	-	95,AC98 ,≦ 94.94	95,AC98	
	4		Sonic power level (JIS)		dB(A)	95 ,≦ 94	97 ,≦ 97	95,AC99 ,≦ 94.94	←	
2	1	Vibration level	Seat		G	0.1 ,≦ 0.1	←	←	←	
	2		Bonnet		G	3.0 ,≦ 3.0	←	←	←	
	3		Step		G	1.0 ,≦ 1.0	←	←	←	
	4		Battery		G	1.0 ,≦ 1.0	←	←	←	
	5		Lever grip		G	0.5 ,≦ 0.5	←	←	←	
	6		Hydraulic tank		G	1.0 ,≦ 1.0	←	←	←	
	7		Fuel tank		G	1.0 ,≦ 1.0	←	←	←	
	8		Radiator		G	4.0 ,≦ 4.0	←	←	←	
	9		Engine		G	7.0 ,≦ 7.0	←	←	←	

No		Specificatios Items		Unit	KX121-3ST	KX161-3ST	U45ST(KTC)	U45-3ST(KTA)	Remarks
3	1	Max. vibration amplitude	Seat	mm	0.3 ,≦ 0.3	←	←	←	
				inch	0.01 ,≦ 0.01	←	←	←	
	2		Bonnet	mm	0.5 ,≦ 0.5	←	←	←	
				inch	0.02 ,≦ 0.02	←	←	←	
	3		Step	mm	0.5 ,≦ 0.5	←	←	←	
				inch	0.02 ,≦ 0.02	←	←	←	
	4		Battery	mm	0.3 ,≦ 0.3	←	←	←	
				inch	0.01 ,≦ 0.01	←	←	←	
	5		Lever grip	mm	0.5 ,≦ 0.5	←	←	←	
				inch	0.02 ,≦ 0.02	←	←	←	
	6		Hydraulic tank	mm	0.5 ,≦ 0.5	←	←	←	
				inch	0.02 ,≦ 0.02	←	←	←	
	7		Fuel tank	mm	0.5 ,≦ 0.5	←	←	←	
				inch	0.02 ,≦ 0.02	←	←	←	
	8		Radiator	mm	3.0 ,≦ 3.0	←	←	←	
				inch	0.12 ,≦ 0.12	←	←	←	
	9		Engine	mm	6.0 ,≦ 6.0	←	←	←	
				inch	0.24 ,≦ 0.24	←	←	←	

d) Traveling Performance

		Unit	KX121-3α	KX161-3α	U45-3α	U50-3α	Remarks
			KX121-3S	-	U45S/U45-3S	KX161-3S	
Manufacturer			KAYABA industry	KAYABA industry	KAYABA industry	KAYABA industry	
Model			MAG-26V-380F-1	MAG-33V-550F-3	MAG-33V-480F-1	MAG-33V-550F-1	
Kubota part No.			RD138-6129-0	RD531-6129-0	RD431-6129-0	RD538-6129-0	
Capacity	1st	cc/rev cu.in./rev	26.3 1.61	28.4 1.73	30.8 1.88	28.4 1.73	
	2nd	cc/rev cu.in./rev	14.6 0.89	16.0 0.98	17.4 1.06	15.0 0.92	
Reduction ratio			1/41.923	1/58.943	1/47.406	1/58.943	
Total displacement	1st	cc/rev cu.in./rev	1103 67.29	1674 102.16	1460 89.11	1674 102.16	
	2nd	cc/rev cu.in./rev	612 37.35	943 57.55	825 50.34	884 53.96	
Rated oil flow		L/min USGPM	41.0 10.83	49.0 12.94	46.0 12.15	56.0 14.79	
Theoretical torque	1F	N·m kgf·m ft·lbf	4302 438.7 3172.9	6261 638.4 4617.8	5469 557.7 4033.7	6261 638.4 4617.8	KX121-3S/α, U45-3S/α, U45S: at 24.5 MPa (250 kg/cm^2, 3556 psi) KX161-3S/α, U50-3α: at 23.5 MPa (240 kg/cm^2, 3414 psi)
	2F	N·m kgf·m ft·lbf	2388 243.5 1761.3	3527 359.6 2601.3	3090 315.1 2279.0	3307 337.2 2439.1	
Theoretical speed	1F	rpm	37.2	29.3	31.5	33.5	KX121-3S/α: at 41.0 L/min (10.83 USGPM) KX161-3S: at 49.0 L/min (12.94 USGPM) U45-3S/α, U45S: at 46.0 L/min (12.15 USGPM) KX161-3α, U50-3α: at 56.0 L/min (14.79 USGPM)
	2F		67.0	52.0	55.8	63.3	
Relief valve pressure		Mpa kg/cm^2 psi	24.5 250 3556	23.5 240 3414	24.5 250 3556	23.5 240 3414	
Climbing ability		deg.	30	30	30	30	
Max. traction force	1F	N kgf lbf	30.2 3081 6793.6	40.0 4083 9003.0	34.9 3562 7854.2	40.0 4083 9003.0	Slip 70% theoretical torque Oil temp.: 50 ± 5°C (122 ± 9°F)
	2F	N kgf lbf	14.3 1455 3208.3	19.3 1972 4348.3	16.9 1724 3801.4	19.3 1972 4348.3	Relief 60% theoretical torque
Traveling block performance		mm/10min in./10min	272, 300 ≧ 10.71, 11.81 ≧	261, 300 ≧ 10.28, 11.81 ≧	272, 300 ≧ 10.71, 11.81 ≧	261, 300 ≧ 10.28, 11.81 ≧	10 min engine stop Testing angle: 20 deg
Traveling speed (Rubber/Steel)	1st	km/h mph	3.0 2.9 1.86 1.80	2.5 2.3 1.55 1.43	2.3 2.2 1.43 1.37	2.3 - 1.43 -	
	2nd	km/h mph	5.0 4.7 3.11 2.92	4.6 4.2 2.86 2.61	4.3 4.0 2.67 2.49	4.3 - 2.67 -	
10m(32.8ft) traveling time (Rubber crawler)	1F	sec./10m sec./32.8ft	16.0 8.6	14.0 8.0	14.0 8.0	14.0 8.0	
	2F						
Straight travel performance	1F/2F	mm/10m in./32.8ft	600 ≧ 23.62 ≧	← ←	← ←	← ←	
Drain amount at lock	1F/2F	L/min GPM	4.00 ≧ 1.06 ≧	← ←	← ←	← ←	

		Unit	KX121-3α KX121-3S	KX161-3α -	U45-3α U45S/U45-3S	U50-3α KX161-3S	Remarks
Drain amount while rotating	1F	L/min GPM	0.5 ≧ 0.13 ≧	← ←	← ←	← ←	
	2F	L/min GPM	0.75 ≧ 0.20 ≧	← ←	← ←	← ←	
Hi-speed change pressure	1st to 2nd	MPa kgf/cm^2 psi	0.9 9.0 128	0.70 7.1 101	← ← ←	← ← ←	
	2nd to 1st	MPa kgf/cm^2 psi	0.7 7.0 100	0.59 6.0 85	← ← ←	← ← ←	

e) Major Components Comparison

Component		U45-3α	U50-3α	Remarks
Arm	Length mm	1360	1650	Operating space should be different. Refer to QA specification table.
	Code No.			
Counterweight	Weight kgf	272	625	Machine size, weight and stability should be different. Refer to QA specification table.
	Code No.	RD417-48117	RD517-48211	
Travel motor	Motor type	MAG-33V-480F-1	MAG-33V-550F-1	Travel speed should be different. Refer to QA specification table and next page.
	Code No.	RD431-61291	RD538-61291	

II. MACHINE BODY

(A) SPECIFICATIONS II-S-3
a) Machine Weight II-S-3
b) Machine Specifications II-S-5
c) Lever Stroke and Operating Force II-S-7
d) Dimensions of Parts II-S-9
(B) COMPONENT INTERCHANGEABILITY II-S-25
a) Bucket Interchangeability II-S-25
b) Arm II-S-27
(C) MACHINE STRUCTURE II-S-29
a) Front Attachment II-S-29
b) Seat & Control Box II-S-30
c) Control Linkage II-S-31
d) Engine Mount: KX161-3/α/S II-S-33
e) Undercarriage: KX121-3/α/S II-S-35
f) Rubber Track II-S-37
g) Iron Track II-S-38
h) Track Conversion II-S-40
(D) FRONT ATTACHMENT II-S-45
a) Parts Designation II-S-45
b) Exchange of Bucket (Kubota Japan Bucket) II-S-48
c) Exchange of Bucket Teeth and Side Cutter II-S-49
d) Installing Direction of Dust Seal II-S-50
e) Installation of Thrust Collar on The Swing Bracket II-S-51
f) Installing Pin, Bush and Shim (1): KX121-3S, KTC, KCL, KTA-version II-S-52
g) Installing Pin, Bush and Shim (2): KX121-3S, KX161-3S II-S-53
h) Installing Pin, Bush and Shim of Bucket: KX121-3S, KX161-3S II-S-54
i) Installing Local Bucket: KX121-3S, KX161-3S II-S-55
j) Greasing Points II-S-56
k) Front Hoses and Clamps: KX121-3S II-S-57
f') Installing Pin, Bush and Shim (1): KX161-3S KTC, KCL, KTA II-S-59
g') Installing Pin, Bush and Shim (2): KX161-3S, KTC, KCL, KTA II-S-60
h') Installing Pin, Bush and Shim of Bucket: KX161-3S, KTC, KCL, KTA II-S-61
l) Installing Direction of Fixing Pin Bolts: KX121-3S II-S-63
(E) UPPER STRUCTURE II-S-65
a) Swivel Bearing II-S-65
b) Pilot Control Lever: KX121-3S/ST/α, KX161-3S/ST/α II-S-72
c) Traveling Lever II-S-73
d) Traveling Lever Adjustment: KX121-3S/ST/α, KX161-3S/ST/α II-S-74
e) Traveling Lever Lock II-S-75
f) Dozer Lever II-S-76
g) TPSS Lever II-S-78
h) Swing & Pedal II-S-79
i) Control Valve Links II-S-80
j) Limit Switch Installation II-S-81
k) Control Stand II-S-82
l) Noise Absorber and Trim II-S-84
m) Partition Plate II-S-93
n) Step Plate II-S-94
o) Installing Weight II-S-95
p) Bonnet, Rear II-S-97

q) Installing Covers. II-S-98
(F) CAB INSTALLATION II-S-99
a) Mounting Bolt II-S-99
b) Seal Rubber II-S-100
c) Wiper II-S-101
d) Heater Hose II-S-102
e) Defroster Hose II-S-103
f) Cab Wire Harness II-S-105
g) Cab Glass Replacement Procedure. II-S-106
h) Rops Canopy II-S-116
(G) NAMEPLATE. II-S-117
a) Nameplates List and Their Quantities Per Machine. II-S-117
b) Label Location II-S-118
(H) UNDERCARRIAGE. II-S-127
a) Track Conversion 1 . . . . . II-S-127
b) Track Conversion 2 . . . . . II-S-128
c) Crawler Installation. II-S-134
d) Track Roller and Upper Roller Installation II-S-135

(A) SPECIFICATIONS

a) Machine Weight

(1) EU-version

	Truck	Arm	Unit	KX121-3α	KX161-3α	U45-3α	**U50-3α**
Canopy	Rubber	STD.	kgf	4030	5065	-	
			(lbs)	(8885)	(11166)	-	
		Long	kgf	-	-	2480	2480
			(lbs)	-	-	(5467)	(5467)
	Steel	STD.	kgf	4090	5135	-	-
			(lbs)	(9017)	(11321)	-	-
		Long	kgf	-	-		
			(lbs)	-	-		
Cabin	Rubber	STD.	kgf	4095	5140	4500-	-
			(lbs)	(9028)	(11332)	(9921)-	-
		Long	kgf	-	-	-	4890-
			(lbs)	-	-	-	(10781)-
	Steel	STD.	kgf	4155	5210	4570-	-
			(lbs)	(9160)	(11486)	(10075)-	-
		Long	kgf	-	-	-	4960-
			(lbs)	-	-	-	(10935)-

Major difference between U45-3α and U50-3α are the following three components.

Component		U45-3α	**U50-3α**	Remarks
Arm	Length mm	1360	1650	Operating space should be different. Refer to QA specification table.
	Code No.	RD418-6660-0	RD439-6720-0	
Counterweight	Weight kgf	300	600	Machine size, weight and stability should be different. Refer to QA specification table.
	Code No.	RD417-48117	RD517-48211	
Travel motor	Motor type	MAG-33V-480F-1	MAG-33V-550F-1	Travel speed should be different. Refer to QA specification table.
	Code No.	RD431-61291	RD538-61291	

(2) KTC/KCL/KTA-version

	Crawler	Arm	Blade	Unit	KX121-3S	KX161-3S	U45S (KTC/KCL)	U45-3S (KTA)
Canopy	Rubber	STD.	STD.	kg	-	-	-	4425
				(lbs)	-	-	-	(9755)
		Long	STD.	kg	4030	5065	-	-
				(lbs)	(8885)	(11166)	-	-
			Angle	kg	4200	5340	5200	-
				(lbs)	(9259)	(11773)	(11464)	-
	Steel	STD.	STD.	kg	-	-	-	4495
				(lbs)	-	-	-	(9910)
		Long	STD.	kg	4090	5135	-	-
				(lbs)	(9017)	(11321)	-	-
			Angle	kg	4260	5410	5270	-
				(lbs)	(9392)	(11927)	(11618)	-
Cabin	Rubber	STD.	STD.	kg	-	-	-	4520
				(lbs)	-	-	-	(9965)
		Long	STD.	kg	4095	5140	-	-
				(lbs)	(9028)	(11332)	-	-
			Angle	kg	4265	5415	5275	-
				(lbs)	(9403)	(11938)	(11629)	-
	Steel	STD.	STD.	kg	-	-	-	4590
				(lbs)	-	-	-	(10119)
		Long	STD.	kg	4155	5210	-	-
				(lbs)	(9160)	(11486)	-	-
			Angle	kg	4325	5485	5345	-
				(lbs)	(9535)	(12092)	(11784)	-

b) Machine Specifications

(1) EU-version

		Unit		KX121-3α		KX161-3α		U45-3α		**U50-3α**	
Engine											
Type				Vertical, water-cooled 4 cycle, 4 cylinders diesel							
Model	Cabin			V2203-M-EBH-2-N, H		←		←		←	
	Cabin with AC			V2203-M-EBH-3-N, AC		←		←		←	
Rated engine output	ISO 3046 Net	kW/rpm		27.5/2250		←		←		←	
		PS/rpm		37.3/2250		←		←		←	
	ISO J1349 Net	HP/rpm		36.7/2250		←		←		←	
	ISO J1995 Gross	HP/rpm		38.2/2250		←		←		←	
Displacement		cc	in^3	2197.0	134.1						
Dimensions											
Overall length		mm	in	5090	200.4	5540	218.1	5340	210.2	5385	212.0
Overall width		mm	in	1700	66.9	1960	77.2	1960	77.2	1960	77.2
Overall crawler width		mm	in	1700	66.9	1960	77.2	1960	77.2	1960	77.2
Overall height	Canopy	mm	in	-	-	-	-	-	-	-	-
	Cabin	mm	in	2480	97.6	2540	100.0	2540	100.0	2540	100.0
Min. ground clearance		mm	in	330	13.0	320	12.6	300	11.8	300	11.8
Max. digging depth	Canopy	mm	in	-	-	-	-	-	-	-	-
	Cabin	mm	in	3505	138.0	3830	105.8	3400	133.9	3650	143.7
Max. digging height	Canopy	mm	in	-	-	-	-	-	-	-	-
	Cabin	mm	in	5420	213.4	5715	225.0	5430	213.8	5620	221.3
Max. digging radius	Canopy	mm	in	-	-	-	-	-	-	-	-
	Cabin	mm	in	5600	220.5	6260	246.5	5755	226.6	5900	232.3
Max. dumping height	Canopy	mm	in	-	-	-	-	-	-	-	-
	Cabin	mm	in	3890	153.1	4155	163.6	3800	149.6	3985	156.9
Swing angle (left/right)		deg.		9.2		←		←		←	
Travel speed	Low speed	km/h	mph	3.0	1.9	2.5	1.6	2.6	1.6	2.3	1.4
	High speed	km/h	mph	5.0	3.1	4.2	2.6	4.6	2.9	4.3	2.7
Swivel speed		rpm		9.2		9.3		9.1		9.1	
Max. traction force	Low speed	kN	lbf	30.2	6.8	40.0	9.0	34.9	7.9	40.0	9.0
		kgf		3081		4083		3562		4083	
	High speed	kN	lbf	14.3	3.2	19.3	4.3	16.9	3.8	19.2	4.3
		kgf		1455		1972		1724		1962	
Performance											
Tumbler distance		mm	in	1710	67.3	1990	78.3	1990	78.3	1990	78.3
Tread		mm	in	1700	66.9	1960	77.2	1960	77.2	1960	77.2
Crawler width x No. of shoe x pitch (Rubber crawler)		mm		350 x 86 x 54.5		400 x 74 x 72.5		←		←	
		in		13.8 x 86 x 2.1		15.7 x 74 x 2.9		←		←	
Bucket											
Capacity CECE Heaped		m^3	yd^3	0.12	0.157	0.14	0.183				
Width		mm	in	600	23.6	650	25.6				
Blade											
Width x height		mm	in	1700 x 350	66.9 x 13.8	1960 x 360	77.2 x 14.2	1960 x 385	77.2 x 15.2	1960 x 385	77.2 x 15.2
Life above GL / below GL		mm	in	395 / 410	15.6 / 16.1	455 / 370	17.9 / 14.6	455 / 370	17.9 / 14.6	455 / 370	17.9 / 14.6

(2) KTC/KCL/KTA-version

		Unit		KX121-3S		KX161-3S		U45S (KTC/KCL)		U45-3S (KTA)	
Engine											
Type				Vertical, water-cooled 4 cycle, 4 cylinders diesel							
Model	Canopy			V2203-M-E2BH-2-N		V2403-M-E2BH-2-N		V2203-M-E2BH-2-N		←	
	Cabin			V2203-M-E2BH-2-N, H		V2403-M-E2BH-2-N, H		V2203-M-E2BH-2-N, H		←	
	Cabin with A/C			V2203-M-E2BH-3-N, AC		V2403-M-E2BH-3-N, AC		V2203-M-E2BH-5-N, AC		V2203-M-E2BH-3-N, AC	
Rated engine output	ISO-3046 Net	kW/rpm		27.4/2250		31.3/2200		26.6/2250		←	
		PS/rpm		37.3/2250		42.6/2200		36.2/2250		←	
	SAE J1349 Net	HP/rpm		36.7/2250		42.0/2200		35.7/2250		←	
	SAE J1995 Gross	HP/rpm		38.2/2250		44.0/2200		38.2/2250		←	
Displacement		cc	in^3	2197	134.1	2434	148.5	2197	134.1	←	
Dimensions											
Overall length		mm	in	5090	200.4	5540	218.1	5385	212.0	5340	210.2
Overall width		mm	in	1700	66.9	1960	77.2	1960	77.2	←	
Overall crawler width		mm	in	1700	66.9	1960	77.2	1960	77.2	←	
Overall height	Canopy	mm	in	2495	98.2	2540	100.0	2540	100.0	←	
	Cabin	mm	in	2480	97.6	2540	100.0	2540	100.0	←	
Min. ground clearance		mm	in	330	13.0	320	12.6	320	12.6	←	
Max. digging depth	Canopy	mm	in	3505	138.0	3830	150.8	3600	141.7	3350	131.9
	Cabin	mm	in	3505	138.0	3830	150.8	3600	141.7	3350	131.9
Max. digging height	Canopy	mm	in	5420	213.4	5715	225.0	5520	217.3	5430	213.8
	Cabin	mm	in	5420	213.4	5715	225.0	5520	217.3	5430	213.8
Max. digging radius	Canopy	mm	in	5600	220.5	6260	246.5	6010	236.6	5755	226.6
	Cabin	mm	in	5600	220.5	6260	246.5	6010	236.6	5755	226.6
Max. dumping height	Canopy	mm	in	3890	153.1	4155	163.6	3970	156.3	3800	149.6
	Cabin	mm	in	3890	153.1	4155	163.6	3970	156.3	3800	149.6
Swing angle (left/right)		deg.		75/48		←		←		←	
Travel speed (Rubber crawler)	Low speed	km/h	mph	3.0	1.9	2.5	1.6	2.5	1.6	2.6	1.6
	High speed	km/h	mph	5.0	3.1	4.6	2.9	4.6	2.9	4.6	2.9
Swivel speed		rpm		9.2		9.3		9.1		9.1	
Max. traction force	Low speed	kN	lbf	30.2	6.8	40.0	9.0	40.0	9.0	34.9	7.9
		kgf		3081		4083		4083		3562	
	High speed	kN	lbf	14.3	3.2	19.3	4.3	←		16.9	3.8
		kgf		1455		1972		←		1724	
Performance											
Tumbler distance		mm	in	1710	67.3	1990	78.3	←		←	
Tread		mm	in	1700	66.9	1960	77.2	←		←	
Crawler width x No. of shoe x pitch (Rubber crawler)		mm		350 x 86 x 54.5		400 x74 x 72.5		←		←	
		in		13.8 x 86 x 2.1		15.7 x 74 x 2.9		←		←	
Bucket											
Capacity SAE/JIS heaped		m^3	yd^3	0.12	0.157	0.14	0.183		0.000		0.000
Width		mm	in	600	23.6	650	25.6		0.0		0.0
Blade											
Width x height	STD.Blade	mm	in	1700 x 350	66.9 x 13.8	1960 x 360	77.2 x 14.2	-		1960 x 385	77.2 x 15.2
	Angle Blade	mm	in	1700 x 395	66.9 x 15.6	1960 x 385	77.2 x 15.2	←		-	
Lift above GL / below GL	STD.Blade	mm	in	400 / 405	15.7 / 15.9	455 / 370	17.9 / 14.6	-		455 / 370	17.9 / 14.6
	Angle Blade	mm	in	425 / 500	16.7 / 19.7	460 / 480	18.1 / 18.6	←		-	

c) Lever Stroke and Operating Force

(1) EU-version

		Unit	KX121-3α		KX161-3α		U45-3α, U50-3α		Remarks
Boom	Stroke	mm	72.0	72.0	←	←	←	←	Up/Down
		in.	2.8	2.8	←	←	←	←	
	Force	N	18	15	←	←	15	15	
		kgf	1.80	1.50	←	←	1.50	1.50	
		lbf	4.0	3.3	←	←	3.3	3.3	
Arm	Stroke	mm	72.0	72.0	←	←	←	←	Crowd/Dump
		in.	2.8	2.8	←	←	←	←	
	Force	N	18	15	←	←	15	15	
		kgf	1.80	1.50	←	←	1.50	1.50	
		lbf	4.0	3.3	←	←	3.3	3.3	
Bucket	Stroke	mm	72.0	72.0	←	←	←	←	Crowd/Dump
		in.	2.8	2.8	←	←	←	←	
	Force	N	15	18	←	←	15	15	
		kgf	1.50	1.80	←	←	1.50	1.50	
		lbf	3.3	4.0	←	←	3.3	3.3	
Swivel	Stroke	mm	72.0	72.0	←	←	←	←	Left/Right
		in.	2.8	2.8	←	←	←	←	
	Force	N	15	15	←	←	15	15	
		kgf	1.50	1.50	←	←	1.50	1.50	
		lbf	3.3	3.3	←	←	3.3	3.3	
Travel (Left/Right)	Stroke	mm	70.0	70.0	←	←	75.0	75.0	F/R
		in.	2.8	2.8	←	←	3.0	3.0	
	Force	N	12	12	←	←	15	15	
		kgf	1.20	1.20	←	←	1.50	1.50	
		lbf	2.6	2.6	←	←	3.3	3.3	
Blade	Stroke	mm	60.0	60.0	←	←	←	←	Up/Down
		in.	2.4	2.4	←	←	←	←	
	Force	N	10	15	←	←	24	24	
		kgf	1.0	1.5	←	←	2.4	2.4	
		lbf	2.2	3.3	←	←	5.3	5.3	
Acceleration	Force	N	-	-	-	-	-	-	α-series have acceleration dial, not lever
		kgf	-	-	-	-	-	-	
		lbf	-	-	-	-	-	-	
Swing pedal	Force	N	40	33	←	←	70	70	Left/Right
		kgf	4.1	3.4	←	←	7.1	7.1	
		lbf	9.0	7.5	←	←	15.7	15.7	
Safety lock lever (Left)	Force	N	26	44	←	←	26	49	Up/Down
		kgf	2.7	4.5	←	←	2.7	5.0	
		lbf	6.0	9.9	←	←	6.0	11.0	

(2) KTC/KCL/KTA-version

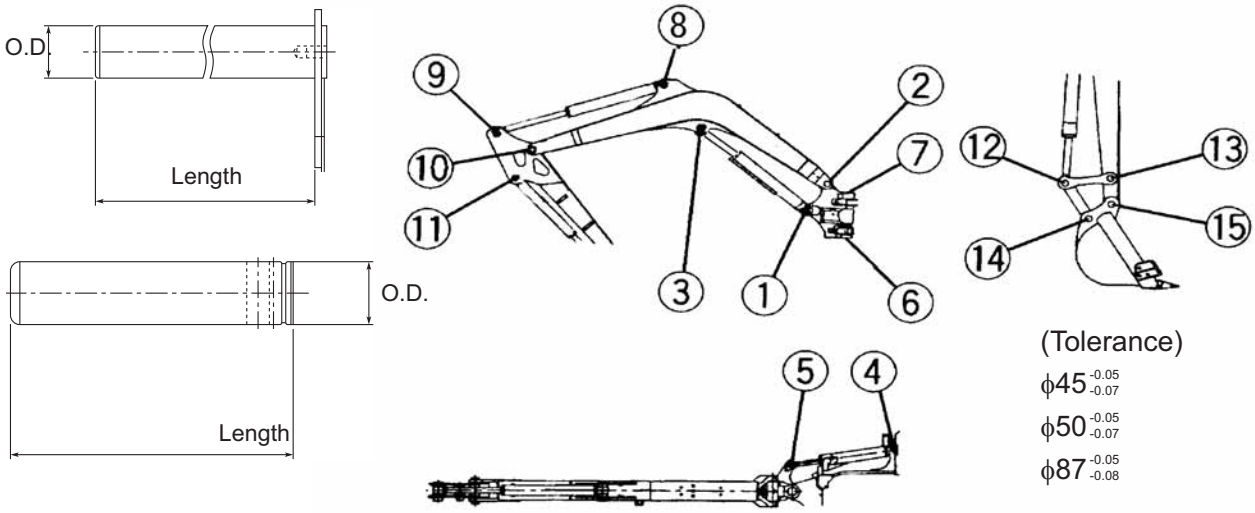
			Unit	KX121-3S		KX161-3S		U45S (KTC/KCL)		U45-3S (KTA)		Remarks
Boom		Stroke	mm	72.0	72.0	←	←	←	←	←	←	Up/Down
			in.	2.8	2.8	←	←	←	←	←	←	
		Force	N	18	15	←	←	←	←	←	←	
			kgf	1.80	1.50	←	←	←	←	←	←	
			lbf	4.0	3.3	←	←	←	←	←	←	
Arm		Stroke	mm	72.0	72.0	←	←	←	←	←	←	Crowd/Dump
			in.	2.8	2.8	←	←	←	←	←	←	
		Force	N	18	15	←	←	←	←	←	←	
			kgf	1.80	1.50	←	←	←	←	←	←	
			lbf	4.0	3.3	←	←	←	←	←	←	
Bucket		Stroke	mm	72.0	72.0	←	←	←	←	←	←	Crowd/Dump
			in.	2.8	2.8	←	←	←	←	←	←	
		Force	N	15	18	←	←	←	←	←	←	
			kgf	1.50	1.80	←	←	←	←	←	←	
			lbf	3.3	4.0	←	←	←	←	←	←	
Swivel		Stroke	mm	72.0	72.0	←	←	←	←	←	←	Left/Right
			in.	2.8	2.8	←	←	←	←	←	←	
		Force	N	15	15	←	←	←	←	←	←	
			kgf	1.50	1.50	←	←	←	←	←	←	
			lbf	3.3	3.3	←	←	←	←	←	←	
Travel (Left/Right)		Stroke	mm	70.0	70.0	←	←	←	←	←	←	F/R
			in.	2.8	2.8	←	←	←	←	←	←	
		Force	N	12	12	←	←	←	←	←	←	
			kgf	1.20	1.20	←	←	←	←	←	←	
			lbf	2.6	2.6	←	←	←	←	←	←	
Blade	STD. Blade	Stroke	mm	60.0	60.0	←	←	-	-	60.0	60.0	Up/Down
			in.	2.4	2.4	←	←	-	-	2.4	2.4	
		Force	N	10	15	←	←	-	-	10	15	
			kgf	1.0	1.5	←	←	-	-	1.0	1.5	
			lbf	2.2	3.3	←	←	-	-	2.2	3.3	
	Angle Blade	Stroke	mm	60.0	60.0	←	←	←	←	-	-	Up/Down
			in.	2.4	2.4	←	←	←	←	-	-	
		Force	N	28	28	←	←	←	←	-	-	
			kgf	2.9	2.9	←	←	←	←	-	-	
			lbf	6.4	6.4	←	←	←	←	-	-	
		Stroke	mm	60.0	60.0	←	←	←	←	-	-	Float On/Off
			in.	2.4	2.4	←	←	←	←	-	-	
		Force	N	98	39	←	←	←	←	-	-	
			kgf	10.0	4.0	←	←	←	←	-	-	
			lbf	22.0	8.8	←	←	←	←	-	-	
		Stroke	mm	60.0	60.0	←	←	←	←	-	-	Left/Right
			in.	2.4	2.4	←	←	←	←	-	-	
		Force	N	47	47	←	←	←	←	-	-	
			kgf	4.8	4.8	←	←	←	←	-	-	
			lbf	10.6	10.6	←	←	←	←	-	-	
Acceleration		Force	N	-	-	-	-	-	-	-	-	Super series have acceleration dial, not lever
			kgf	-	-	-	-	-	-	-	-	
			lbf	-	-	-	-	-	-	-	-	
Swing pedal		Force	N	40	33	←	←	←	←	←	←	Left/Right
			kgf	4.1	3.4	←	←	←	←	←	←	
			lbf	9.0	7.5	←	←	←	←	←	←	
Safety lock lever (Left)		Force	N	26	44	←	←	←	←	←	←	Up/Down
			kgf	2.7	4.5	←	←	←	←	←	←	
			lbf	6.0	9.9	←	←	←	←	←	←	

d) Dimensions of Parts

(1) Front pins

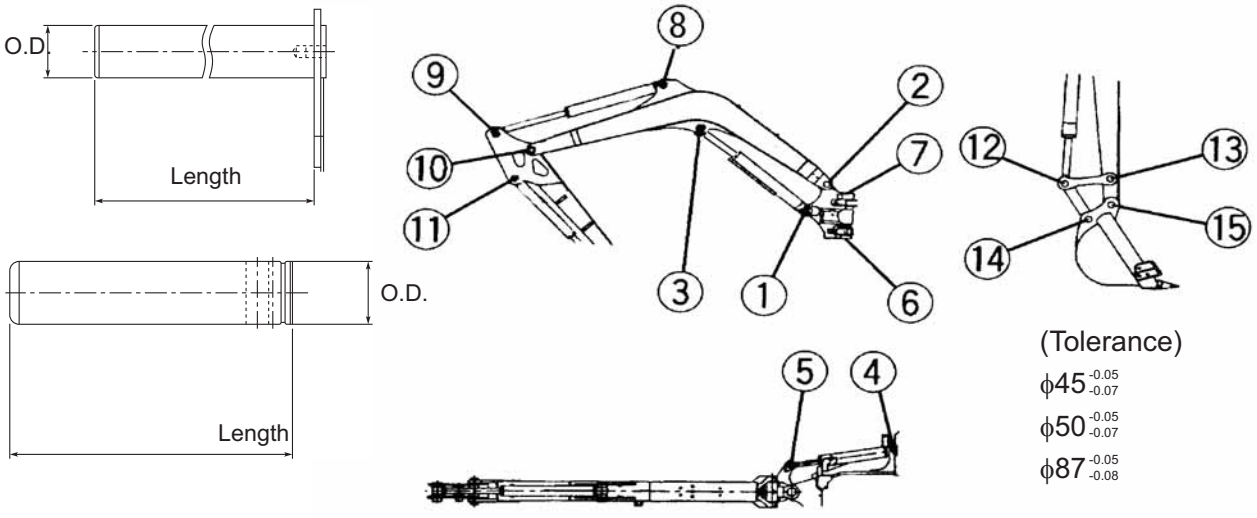
1) EU-version

No.		Unit	KX121-3α	KX161-3α	U45-3α, U50-3α	Position
1	Pin diameter x length	mm	ϕ50.0 x 154.0	ϕ50.0 x 194.0	←	Swing bracket - Boom cylinder
		in.	ϕ1.97 x 6.06	ϕ1.97 x 7.64		
2	Pin diameter x length	mm	ϕ50.0 x 338.0	ϕ50.0 x 338.0	ϕ50.0 x 278.0	Swing bracket - Boom
		in.	ϕ1.97 x 13.31	ϕ1.97 x 13.31	ϕ1.97 x 10.94	
3	Pin diameter x length	mm	ϕ50.0 x 205.0	←	ϕ50.0 x 197.0	Boom - Boom cylinder
		in.	ϕ1.97 x 8.07		ϕ1.97 x 7.76	
4	Pin diameter x length	mm	ϕ45.0 x 153.0	←	←	Swivel frame - Swing cylinder
		in.	ϕ1.77 x 6.02			
5	Pin diameter x length	mm	ϕ45.0 x 134.0	←	←	Swing bracket - Swing cylinder
		in.	ϕ1.77 x 5.28			
6	Pin diameter x length	mm	ϕ87.0 x 135.0	←	←	Swing bracket - Swivel frame (Lower)
		in.	ϕ3.43 x 5.31			
7	Pin diameter x length	mm	ϕ87.0 x 182.0	←	←	Swing bracket - Swivel frame (Upper)
		in.	ϕ3.43 x 7.17			
8	Pin diameter x length	mm	ϕ45.0 x 210.0	←	ϕ45.0 x 195.0	Boom - Arm cylinder
		in.	ϕ1.77 x 8.27		ϕ1.77 x 7.68	
9	Pin diameter x length	mm	ϕ45.0 x 172.0	←	ϕ45.0 x 163.0	Arm - Arm cylinder
		in.	ϕ1.77 x 6.77		ϕ1.77 x 6.42	
10	Pin diameter x length	mm	ϕ50.0 x 248.0	←	←	Boom - Arm
		in.	ϕ1.97 x 9.76			
11	Pin diameter x length	mm	ϕ40.0 x 168.0	ϕ50.0 x 170.0	ϕ45.0 x 163.0	Arm - Bucket cylinder
		in.	ϕ1.57 x 6.61	ϕ1.97 x 6.69	ϕ1.77 x 6.42	
12	Pin diameter x length	mm	ϕ40.0 x 210.0	ϕ50.0 x 236.0	ϕ45.0 x 215.0	Bucket links 1, 2, 3 - Bucket cylinder
		in.	ϕ1.57 x 8.27	ϕ1.97 x 9.29	ϕ1.77 x 8.46	
13	Pin diameter x length	mm	ϕ40.0 x 210.0	ϕ45.0 x 246.0	ϕ45.0 x 215.0	Arm - Bucket links 2, 3
		in.	ϕ1.57 x 8.27	ϕ1.77 x 9.69	ϕ1.77 x 8.46	
14	Pin diameter x length	mm	ϕ40.0 x 244.0	ϕ45.0 x 263.0	←	Bucket - Bucket link 1
		in.	ϕ1.57 x 9.61	ϕ1.77 x 10.35		
15	Pin diameter x length	mm	ϕ40.0 x 244.0	ϕ45.0 x 263.0	←	Arm - Bucket
		in.	ϕ1.57 x 9.61	ϕ1.77 x 10.35		



2) KTC/KCL/KTA-version

No.		Unit	KX121-3S	KX161-3S, U45S (KTC/KCL), U45-3S (KTA)	Position
1	Pin diameter x length	mm	ϕ50 x 143	ϕ50 x 183	Swing bracket - Boom cylinder
		in.	ϕ1.97 x 5.63	ϕ1.97 x 7.20	
2	Pin diameter x length	mm	ϕ50 x 327	←	Swing bracket - Boom
		in.	ϕ1.97 x 12.87		
3	Pin diameter x length	mm	ϕ50 x 186	←	Boom - Boom cylinder
		in.	ϕ1.97 x 7.32		
4	Pin diameter x length	mm	ϕ45 x 153	←	Swivel frame - Swing cylinder
		in.	ϕ1.77 x 6.02		
5	Pin diameter x length	mm	ϕ45 x 123	←	Swing bracket - Swing cylinder
		in.	ϕ1.77 x 4.84		
6	Pin diameter x length	mm	ϕ87 x 135	ϕ87 x 145	Swing bracket - Swivel frame (Lower)
		in.	ϕ3.43 x 5.31	ϕ3.43 x 5.71	
7	Pin diameter x length	mm	ϕ87 x 161	ϕ87 x 171	Swing bracket - Swivel frame (Upper)
		in.	ϕ3.43 x 6.34	ϕ3.43 x 6.73	
8	Pin diameter x length	mm	ϕ45 x 185	←	Boom - Arm cylinder
		in.	ϕ1.77 x 7.28		
9	Pin diameter x length	mm	ϕ45 x 152	←	Arm - Arm cylinder
		in.	ϕ1.77 x 5.98		
10	Pin diameter x length	mm	ϕ50 x 237	←	Boom - Arm
		in.	ϕ1.97 x 9.33		
11	Pin diameter x length	mm	ϕ40 x 152	ϕ50 x 152	Arm - Bucket cylinder
		in.	ϕ1.57 x 5.98	ϕ1.97 x 5.98	
12	Pin diameter x length	mm	ϕ40 x 193	ϕ50 x 204	Bucket links 1, 2, 3 - Bucket cylinder
		in.	ϕ1.57 x 7.60	ϕ1.97 x 8.03	
13	Pin diameter x length	mm	ϕ40 x 193	ϕ45 x 204	Arm - Bucket links 2, 3
		in.	ϕ1.57 x 7.60	ϕ1.77 x 8.03	
14	Pin diameter x length	mm	ϕ40 x 233	ϕ45 x 252	Bucket - Bucket link 1
		in.	ϕ1.57 x 9.17	ϕ1.77 x 9.92	
15	Pin diameter x length	mm	ϕ40 x 233	ϕ45 x 252	Arm - Bucket
		in.	ϕ1.57 x 9.17	ϕ1.77 x 9.92	

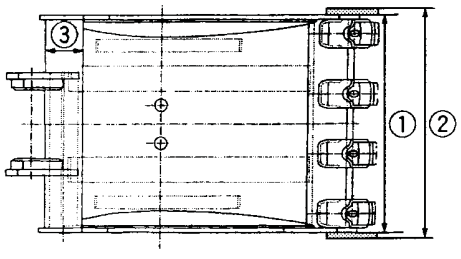


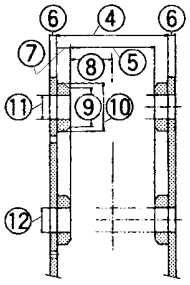
(2)Bucket

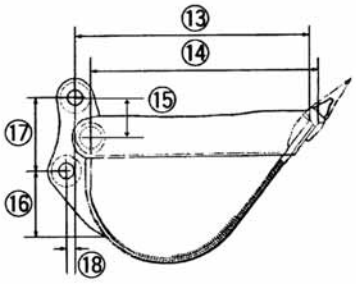
1) Bucket dimensions, EU-version

No.	Unit	KX121-3α	KX161-3α	U45-3α, U50-3α
1	mm	600	650	550
	in.	23.62	25.59	21.65
2	mm	624	680	580
	in.	24.57	26.77	22.83
3	mm	ϕ101.6 x t8.8	ϕ114.3 x t9	ϕ101.6 x t8.5
	in.	ϕ4.00 x t0.35	ϕ4.50 x t0.35	ϕ4.00 x t0.33
4	mm	204	215	←
	in.	8.03	8.46	
5	mm	134	145	←
	in.	5.28	5.71	
6	mm	15	18	16
	in.	0.59	0.71	0.63
7	mm	35	←	←
	in.	1.38		
8	mm	67	72.5	←
	in.	2.64	2.85	
9	mm	ϕ75	ϕ83	←
	in.	ϕ2.95	ϕ3.27	
10	mm	ϕ90	ϕ100	←
	in.	ϕ3.54	ϕ3.94	
11	mm	$\phi 40^{+0.10}_{+0.05}$	$\phi 45^{+0.10}_{+0.05}$	←
	in.	$\phi 1.57^{+0.004}_{+0.002}$	$\phi 1.77^{+0.004}_{+0.002}$	
12	mm	$\phi 40^{+0.10}_{+0.05}$	$\phi 45^{+0.10}_{+0.05}$	←
	in.	$\phi 1.57^{+0.004}_{+0.002}$	$\phi 1.77^{+0.004}_{+0.002}$	
13	mm	670	751.5	725
	in.	26.38	29.59	28.54
14	mm	617	700	652
	in.	24.29	27.56	25.67
15	mm	89	126	113
	in.	3.50	4.96	4.45
16	mm	175	175.9	150
	in.	6.89	6.93	5.91
17	mm	180	244.5	230
	in.	7.09	9.63	9.06
18	mm	10	20	←
	in.	0.39	0.79	

NOTE: KUBOTA JAPAN BUCKET



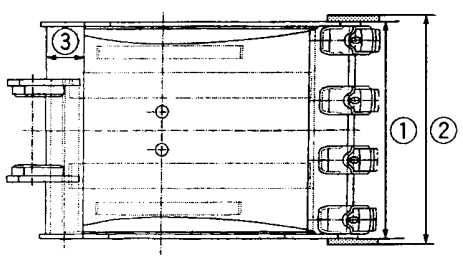


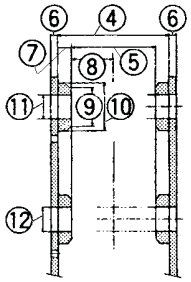


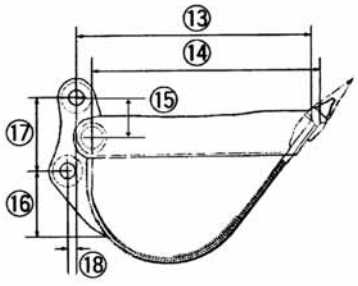
2) Bucket dimensions, KTC/KCL/KTA-version

No.	Unit	KX121-3α	KX161-3α	U45-3α, U50-3α
1	mm	600	650	550
	in.	23.62	25.59	21.65
2	mm	624	680	580
	in.	24.57	26.77	22.83
3	mm	ϕ101.6 x t8.8	←	←
	in.	ϕ4.00 x t0.33		
4	mm	204	215	←
	in.	8.03	8.46	
5	mm	134	145	←
	in.	5.28	5.71	
6	mm	12	16	←
	in.	0.47	0.63	
7	mm	35	←	←
	in.	1.38		
8	mm	67	72.5	←
	in.	2.64	2.85	
9	mm	ϕ75	ϕ83	←
	in.	ϕ2.95	ϕ3.27	
10	mm	ϕ90	ϕ100	←
	in.	ϕ3.54	ϕ3.94	
11	mm	$\phi 40^{+0.10}_{+0.05}$	$\phi 45^{+0.10}_{+0.05}$	←
	in.	$\phi 1.57^{+0.004}_{+0.002}$	$\phi 1.77^{+0.004}_{+0.002}$	
12	mm	$\phi 40^{+0.10}_{+0.05}$	$\phi 45^{+0.10}_{+0.05}$	←
	in.	$\phi 1.57^{+0.004}_{+0.002}$	$\phi 1.77^{+0.004}_{+0.002}$	
13	mm	670	725	←
	in.	26.38	28.54	
14	mm	617	652	←
	in.	24.29	25.67	
15	mm	89	113	←
	in.	3.50	4.45	
16	mm	175	150	←
	in.	6.89	5.91	
17	mm	180	230	←
	in.	7.09	9.06	
18	mm	10	20	←
	in.	0.39	0.79	

NOTE: KUBOTA JAPAN BUCKET



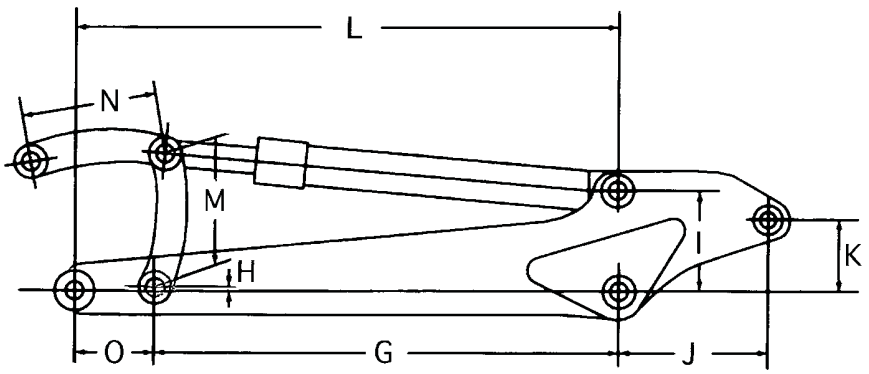


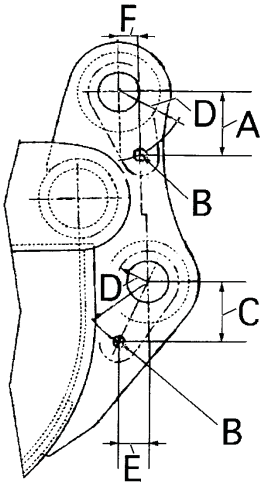


3) Bucket installation relevant dimensions, EU-version

No.	Unit	KX121-3α	KX161-3α	U45-3α	U50-3α
A	mm	64.5	77.5	←	
	in.	2.54	3.05		
B	mm	ϕ20	←	←	M16 x 1.5
	in.	ϕ0.79			
C	mm	45	78.6	80	
	in.	1.77	3.09	3.15	
D	mm	65	80.0	←	
	in.	2.56	3.15		
E	mm	46.9	-	0	
	in.	1.85	-	0	
F	mm	8.1	-	←	20
	in.	0.32	-		0.79
G	mm	1135	1280	1160	1450
	in.	44.68	50.39	45.67	57.09
H	mm	10	←	←	
	in.	0.39			
I	mm	260	310	←	
	in.	10.24	12.20		
J	mm	310	340	←	
	in.	12.20	13.39		
K	mm	200	215	←	
	in.	7.87	8.46		
L	mm	1260	1400	1335	
	in.	49.61	55.12	52.56	
M	mm	310	350	330	
	in.	12.20	13.78	12.99	
N	mm	310	320	310	
	in.	12.20	12.60	12.20	
O	mm	165	200	←	
	in.	6.50	7.87		

NOTE: KUBOTA JAPAN BUCKET, STANDARD ARM

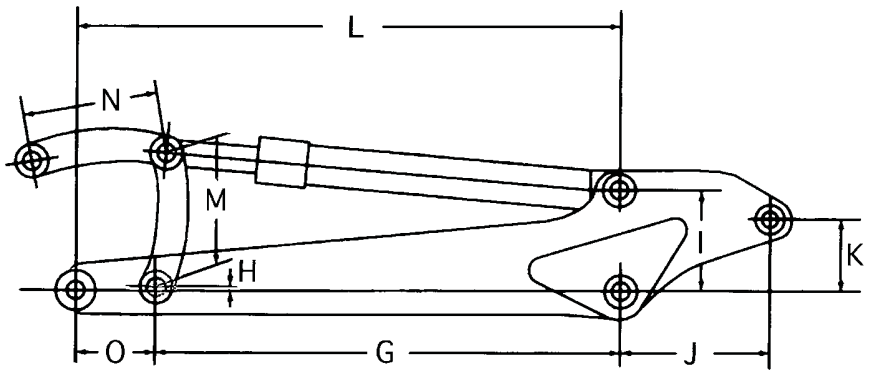


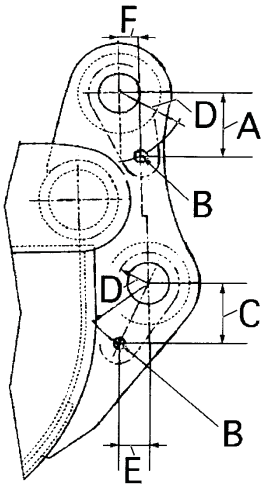


4) Bucket installation relevant dimensions, KTC/KCL/KTA-version

No.	Unit	KX121-3S	KX161-3S	U45S (KTC/KCL)	U45-3S (KTA)
A	mm	64.5	77.5	←	←
	in.	2.54	3.05		
B	mm	f20	←	←	←
	in.	f0.79			
C	mm	45	80	←	←
	in.	1.77	3.15		
D	mm	65	80.0	←	←
	in.	2.56	3.15		
E	mm	-	-	-	-
	in.	-	-	-	-
F	mm	-	-	-	-
	in.	-	-	-	-
G	mm	1425	1580	1450	1160
	in.	56.10	62.20	57.09	45.67
H	mm	10	←	←	←
	in.	0.39			
I	mm	260	310	←	←
	in.	10.24	12.20		
J	mm	310	340	←	←
	in.	12.20	13.39		
K	mm	200	215	←	←
	in.	7.87	8.46		
L	mm	1235	1335	←	←
	in.	48.62	52.56		
M	mm	310	330	←	←
	in.	12.20	12.99		
N	mm	310	←	←	←
	in.	12.20			
O	mm	175	200	←	←
	in.	6.89	7.87		

NOTE: KUBOTA JAPAN BUCKET, LONG ARM





(3) Rubber crawler

(US/CA/AU)	Unit	KX121-3S	KX161-3S	U45S/U45-3S	Remarks
(EU)		KX121-3α	KX161-3α	U45-3α, U50-3α	
Crawler ass'y code No.		RD118-2231-0	RD411-2231-0	←	
Identification mark (Core metal rapping position)		∞			
A: Lug height	mm	25	23	←	
	in.	0.98	0.91	←	
B: Link height	mm	23	24.5	←	
	in.	0.91	0.96	←	
C: Crawler width	mm	350	400	←	
	in.	13.78	15.75	←	
D: Crawler sag distance	mm	10 to15	10 to15	←	
	in.	0.39 to 0.59	0.39 to 0.59	←	
E: Crawler height	mm	85.0	92.0	←	
	in.	3.35	3.62	←	
Number of core metal		86	74	←	KX121-3S: FCD450T
					KX161-3S, U45-3S: FCD450-10
Circumference	mm	4687	5365	←	
	in.	184.53	211.22	←	
Core metal pitch	mm	54.5	72.5	←	
	in.	2.15	2.85	←	
Rubber thickness	mm	39	45.5	←	
	in.	1.54	1.79	←	

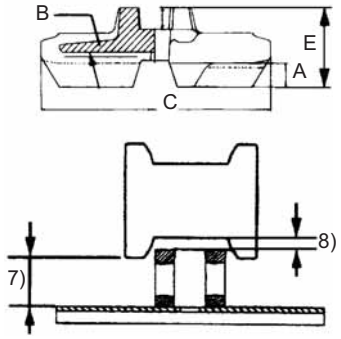
(4) Steel crawler

(US/CA/AU) / (EU)	Unit	KX121-3S / KX121-3α	KX161-3S, U45-3S (STD) / KX161-3α, U45-3α, U50-3α (STD)	KX161-3S (Wide) / KX161-3α (Wide)	Remarks
Crawler ass'y code No.		RD108-2210-0	RD411-2220-0	RD519-2250-0	
Crawler width	mm	350.0	400.0	550.0	
	in.	13.78	15.75	21.65	
1) 4 links length (A)/(B)	mm	406.4	540.0	←	
	in.	16.00	21.26	←	
2) Height	mm	70.5	67.0	←	
	in.	2.78	2.64	←	
3) Bushing O. D. (A)/(B)	mm	ϕ32.2 / ϕ31.2	ϕ35.0 / ϕ34.0	←	
	in.	ϕ1.27 / ϕ1.23	ϕ1.38 / ϕ1.34	←	
4) Bushing I. D. (A)/(B)	mm	ϕ19.0 / ϕ20.0	ϕ22.3 / ϕ23.3	←	
	in.	ϕ0.75 / ϕ0.79	ϕ0.88 / ϕ0.92	←	
5) Master pin O. D. (A)/(B)	mm	ϕ19.0 / ϕ18.0	ϕ22.3 / ϕ21.3	←	
	in.	ϕ0.75 / ϕ0.71	ϕ0.88 / ϕ0.84	←	
6) Grouser height	mm	22.5	20.0	←	
	in.	0.89	0.79	←	
7) Crawler sag distance	mm	85 to 90	80 to 85	←	
	in.	3.35 to 3.54	3.15 to 3.35	←	
Number of links		45	39	←	

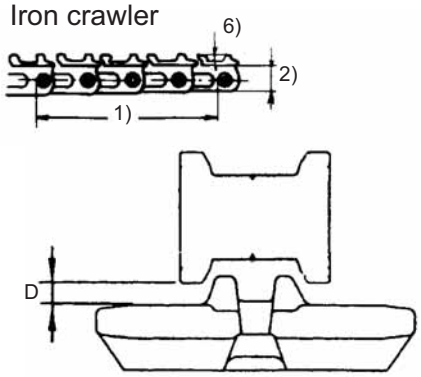
(A) New machine reference value
(B) Allowable limit

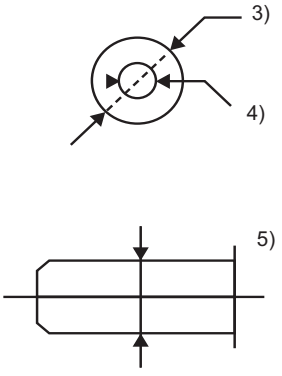
(A) New machine reference value
(B) Allowable limit

Rubber crawler



Iron crawler



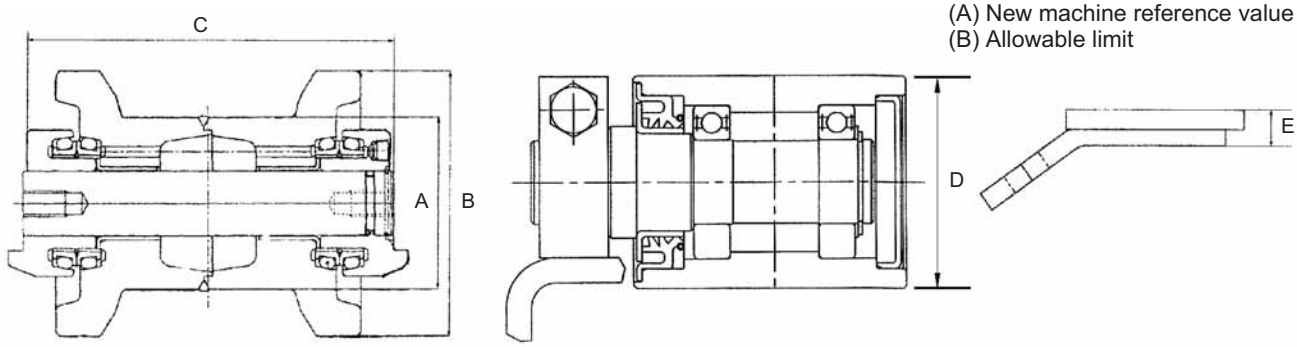


(5) Track roller, idler, sprocket

1) EU/US/CA/AU

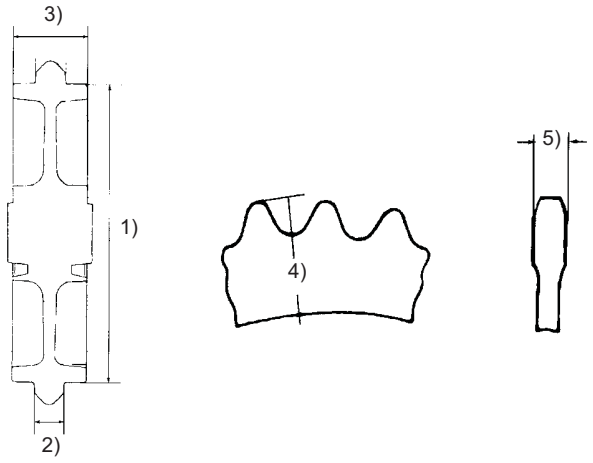
(US/CA/AU) / (EU)		Unit	KX121-3S / KX121-3α	KX161-3S, U45S, U45-3S / KX161-3α, U45-3α, U50-3α	Remarks
A: Guide diameter	(A)/(B)	mm	ϕ80 / ϕ76	85 / 81	
		in.	ϕ3.15 / ϕ2.99	3.35 / 3.19	
B: Outer diameter	(A)/(B)	mm	ϕ124 / ϕ120	ϕ135 / ϕ131	
		in.	ϕ4.88 / ϕ4.72	ϕ5.31 / ϕ5.16	
C: Roller width		mm	175 / 167	200 / 192	
		in.	6.89 / 6.57	7.87 / 7.56	
D: Upper roller diameter	(A)/(B)	mm	ϕ80.0 / ϕ76.0	←	
		in.	ϕ3.15 / ϕ2.99	←	
E: Sliding plate thickness	(A)/(B)	mm	25 / 12.5	19 / 10	
		in.	0.98 / 0.49	0.75 / 0.37	

(A) New machine reference value
(B) Allowable limit



(US/CA/AU) / (EU)		Unit	KX121-3S / KX121-3α	KX161-3S, U45S, U45-3S / KX161-3α, U45-3α, U50-3α	Remarks
1) Idler O.D.	(A)/(B)	mm	ϕ305 / ϕ299	ϕ330 / ϕ323	
		in.	ϕ12.01 / ϕ11.77	ϕ12.99 / ϕ12.73	
2) Guide width	(A)/(B)	mm	40 / 37	52 / 47	
		in.	1.57 / 1.46	2.05 / 1.85	
3) Idler width	(A)/(B)	mm	80 / 71	93 / 79	
		in.	3.15 / 2.80	3.66 / 3.11	
4) Sprocket wheel O.D.	(A)/(B)	mm	ϕ390 / ϕ382	ϕ429 / ϕ421	
		in.	ϕ15.35 / ϕ15.04	ϕ16.89 / ϕ16.57	
5) Sprocket wheel width	(A)/(B)	mm	38 / 34	43 / 39	
		in.	1.50 / 1.34	1.69 / 1.54	

(A) New machine reference value
(B) Allowable limit



(6) Blade

(US/CA/AU)	Unit	KX121-3S		KX161-3S, U45S, U45-3S (STD)	KX161-3S, U45S (Angle)	KX161-3S (Wide)	Remarks
		STD.	Angle				
(EU)		KX121-3α		KX161-3α, U45-3α, U50-3α (STD)	-	KX161-3α (Wide)	
Blade ass'y code No. (US/CA/AU)		RD118-7421-0	RD118-7451-0	RD538-7441-0	RD538-7451-0	RD538-7421-0	(Angle blade)
			RD118-7452-0		RD538-7452-0		(Angle frame)
Blade ass'y code No. (EU)		RG718-7441-0	-	RG928-7441-0	-	RG928-7421-0	
A: Pin diameter x length	mm	ϕ40 x 167	←	ϕ45 x 175	←	←	Blade arm - Track frame
	in.	ϕ1.57 x 6.57		ϕ1.77 x 6.89			
B: Pin diameter x length	mm	ϕ45 x 141	←	ϕ55 x 175	←	←	Blade cylinder - Track frame
	in.	ϕ1.77 x 5.55		ϕ2.17 x 6.89			
C: Pin diameter x length	mm	ϕ45 x 141	←	ϕ55 x 175	←	←	Blade cylinder - Blade
	in.	ϕ1.77 x 5.55		ϕ2.17 x 6.89			
D: Blade width	mm	1700	←	1960	←	2110	
	in.	66.93		77.17		83.07	
E: Blade height	mm	336.5	385	387	385	387	
	in.	13.25	15.16	15.24	15.16	15.24	
F: Blade length	mm	1200	1370	1333	1513	1333	Angle blade: neutral position
	in.	47.24	53.93	52.48	59.56	52.48	
G: Blade tip plate height x thickness	mm	65 x 12	←	←	←	←	
	in.	2.56 x 0.47					
H: Length between blade arms	mm	490	←	600	←	←	
	in.	19.29		23.62			
I: Pin diameter x length	mm	-	ϕ55 x 194	-	ϕ70 x 200	-	Angle center
	in.		ϕ2.17 x 7.64		ϕ2.76 x 7.87		
J: Pin diameter x length	mm	-	ϕ30 x 115.5	-	ϕ40 x 132	-	Angle cylinder - Blade
	in.		ϕ1.18 x 4.55		ϕ1.57 x 5.20		
K: Pin diameter x length	mm	-	ϕ30 x 115.5	-	ϕ40 x 132	-	Angle cylinder - Blade frame
	in.		ϕ1.18 x 4.55		ϕ1.57 x 5.20		

Note: Angle blade is for KTC only

(7) Parts weight

1) EU-version

		Unit	KX121-3α	KX161-3α	U45-3α	U50-3α	Remarks
Track frame		kgf	418	553	←		
		(lbs)	(921.5)	(1219.2)			
Swivel frame		kgf	532	566	←		
		(lbs)	(1172.9)	(1247.8)			
Swing bracket		kgf	89	92	←		
		(lbs)	(196.2)	(202.8)			
Boom		kgf	164	197	178		
		(lbs)	(361.6)	(434.3)	(391.3)		
Arm	STD.	kgf	71	89	82		
		(lbs)	(156.5)	(196.2)	(179.7)		
	Long	kgf	93	109	-		
		(lbs)	(205.0)	(240.3)	-		
Bucket	For STD. arm	kgf	78	114	92		Japan STD Bucket
		(lbs)	(172.0)	(251.3)	(202.8)		
	For Long arm	kgf	-	-	-		
		(lbs)	-	-	-		
Blade		kgf	139	192	←		
		(lbs)	(306.4)	(423.3)			
Weight (left)		kgf	24.5	-	-		
		(lbs)	(54.0)	-	-		
Weight (right)		kgf	24.7	-	-		
		(lbs)	(54.5)	-	-		
Weight (rear)		kgf	494	824	272	625	
		(lbs)	(1089.1)	(1816.6)	(599.7)	(1377.9)	
Rubber crawler		kgf	190	250	←		
		(lbs)	(418.9)	(551.2)			
Steel crawler (STD.)		kgf	215	285	←		
		(lbs)	(474.0)	(628.3)			
Steel crawler (wide)		kgf	-	385	-		
		(lbs)	-	(848.8)	-		
Arch frame		kgf	42	50	←		
		(lbs)	(92.6)	(110.2)			
Engine		kgf	180	←	←		Dry weight
		(lbs)	(396.8)				
Hydraulic tank		kgf	31	27	←		With filter
		(lbs)	(68.3)	(59.5)			
Fuel tank		kgf	5	←	←		
		(lbs)	(11.0)				
Swivel bearing		kgf	45	62	←		
		(lbs)	(99.2)	(136.7)			
Battery		kgf	20	←	←		
		(lbs)	(44.1)				

	Unit	KX121-3α	KX161-3α	U45-3α	U50-3α	Remarks
Track roller	kgf	7.3	9	←		
	(lbs)	(16.1)	(19.8)			
Upper roller	kgf	3	←	←		
	(lbs)	(6.6)				
ROPS/FOPS canopy	kgf	-	-	-		
	(lbs)	-	-	-		
ROPS/FOPS cabin	kgf	230	←	←		
	(lbs)	(507.1)				
Hydraulic pump	kgf	30	35	←		
	(lbs)	(66.1)	(77.2)			
Traveling motor	kgf	40	57	←		
	(lbs)	(88.2)	(125.7)			
Swivel motor	kgf	33	23	←		
	(lbs)	(72.8)	(50.7)			
Sprocket	kgf	12.3	15	←		
	(lbs)	(27.1)	(33.1)			
Idler ass'y	kgf	35	55	←		
	(lbs)	(77.2)	(121.3)			
Control valve	kgf	32	58	←		Without adaptors
	(lbs)	(70.5)	(127.9)			
Boom cylinder	kgf	42.5	48.5	48		Canopy / Cabin
	(lbs)	(93.7)	(106.9)	(105.8)		
Arm cylinder	kgf	38	51	44		
	(lbs)	(83.8)	(112.4)	(97.0)		
Bucket cylinder	kgf	22	28	26		
	(lbs)	(48.5)	(61.7)	(57.3)		
Swing cylinder	kgf	30	36	33		
	(lbs)	(66.1)	(79.4)	(72.8)		
Blade cylinder	kgf	25	33.2	←		
	(lbs)	(55.1)	(73.2)			
Rotary joint	kgf	17	27	←		
	(lbs)	(37.5)	(59.5)			

The weights listed above are based on calculations and slightly different from actual ones.

2) KTC/KCL/KTA-version

		Unit	KX121-3S	KX161-3S	U45-3S	Remarks
Track frame		kgf	420	553	←	
		(lbs)	(925.9)	(1219.2)		
Swivel frame		kgf	532	566	←	
		(lbs)	(1172.9)	(1247.8)		
Swing bracket		kgf	89	92	←	
		(lbs)	(196.2)	(202.8)		
Boom		kgf	168	195	178	
		(lbs)	(370.4)	(429.9)	(391.3)	
Arm	STD.	kgf	71	89	82	
		(lbs)	(156.5)	(196.2)	(179.7)	
	Long	kgf	98.7	122	-	
		(lbs)	(217.6)	(269.0)	-	
Bucket	For STD. arm	kgf				J.S.T.D.
		(lbs)	(0.0)	(0.0)	(0.0)	
	For Long arm	kgf	62		-	
		(lbs)	(136.7)	(0.0)	-	
Blade		kgf	139	192	←	
		(lbs)	(306.4)	(423.3)		
Weight (left)		kgf	24.5	-	-	
		(lbs)	(54.0)	-	-	
Weight (right)		kgf	24.7	-	-	
		(lbs)	(54.5)	-	-	
Weight (rear)		kgf	494	824	272	
		(lbs)	(1089.1)	(1816.6)	(599.7)	
Rubber crawler		kgf	190	250	←	
		(lbs)	(418.9)	(551.2)		
Steel crawler(STD.)		kgf	215	285	←	
		(lbs)	(474.0)	(628.3)		
Steel crawler(wide)		kgf	-	385	-	
		(lbs)	-	(848.8)	-	
Arch frame		kgf	42	50	←	
		(lbs)	(92.6)	(110.2)		
Engine		kgf	180	←	←	Dry weight
		(lbs)	(396.8)			
Hydraulic tank		kgf	31	27	←	With filter
		(lbs)	(68.3)	(59.5)		
Fuel tank		kgf	5	←	←	
		(lbs)	(11.0)			
Swivel bearing		kgf	45	62	←	
		(lbs)	(99.2)	(136.7)		
Battery		kgf	20	←	←	
		(lbs)	(44.1)			
Track roller		kgf	7.3	9	←	
		(lbs)	(16.1)	(19.8)		

	Unit	KX121-3S	KX161-3S	U45-3S	Remarks
Upper roller	kgf	3	←	←	
	(lbs)	(6.6)			
ROPS/FOPS canopy	kgf	90	←	-	
	(lbs)	(198.4)		-	
ROPS/FOPS cabin	kgf	230	←	←	
	(lbs)	(507.1)			
Hydraulic pump	kgf	30	35	←	
	(lbs)	(66.1)	(77.2)		
Traveling motor	kgf	40	57	←	
	(lbs)	(88.2)	(125.7)		
Swivel motor	kgf	33	23	23	
	(lbs)	(72.8)	(50.7)	(50.7)	
Sprocket	kgf	12.3	15	←	
	(lbs)	(27.1)	(33.1)		
Idler ass'y	kgf	35	55	←	
	(lbs)	(77.2)	(121.3)		
Control valve	kgf	32	58	←	Without adaptors
	(lbs)	(70.5)	(127.9)		
Boom cylinder	kgf	44	56	48	Canopy / Cabin
	(lbs)	(97.0)	(123.5)	(105.8)	
Arm cylinder	kgf	34	49	44	
	(lbs)	(75.0)	(108.0)	(97.0)	
Bucket cylinder	kgf	23	29	26	
	(lbs)	(50.7)	(63.9)	(57.3)	
Swing cylinder	kgf	30	36	33	
	(lbs)	(66.1)	(79.4)	(72.8)	
Blade cylinder	kgf	28	35	←	
	(lbs)	(61.7)	(77.2)		
Angle cylinder	kgf	12	18	←	
	(lbs)	(26.5)	(39.7)		
Rotary joint	kgf	17	27	←	
	(lbs)	(37.5)	(59.5)		

The weights listed above are based on calculations and slightly different from actual ones.

(8) Water and Oil Quantity

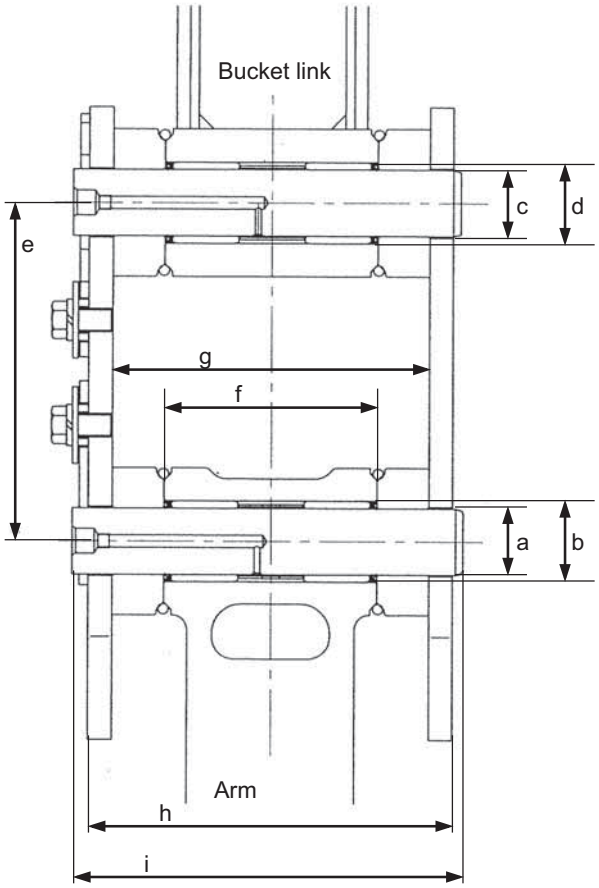
1) EU/US/CA/AU

(US/CA/AU) / (EU)		Unit	KX121-3S / KX121-3α	KX161-3S, U45S, U45-3S / KX161-3α, U45-3α, U50-3α	Remarks
Radiator	Canopy/Cabin	L	7.4 / 7.7	←	Kubota LLC-N-50F 50%
		US gal	1.95 / 2.03		
Reserve tank		L	1.1	←	
		US gal	0.29		
Engine crank case		L	8.5	←	SAE 10W-30 (CD)
		US gal	2.25		
Hydraulic oil	Full STD.blade/Angle blade	L	75.0 / 76.0	←	ISO VG46
		US gal	19.81 / 20.08		
Hydraulic oil	Tank STD.blade/Angle blade	L	46.0 / 47.0	←	ISO VG46
		US gal	12.15 /12.42		
Wheel motor		L	0.50	0.90	SAE90 (API GL-4)
		US gal	0.13	0.24	
Track roller		ml	80.0	←	SAE30 (CD)
		cu.in	4.88		
Upper roller		ml	60.0	←	SAE30 (CD)
		cu.in	3.66		
Front idler		ml	80.0	50.0	SAE30 (CD)
		cu.in	4.88	3.05	
Fuel tank		L	64.0	←	Diesel Fuel JIS #3 (Initial)
		US gal	16.91		

(B) COMPONENT INTERCHANGEABILITY

a) Bucket Interchangeability

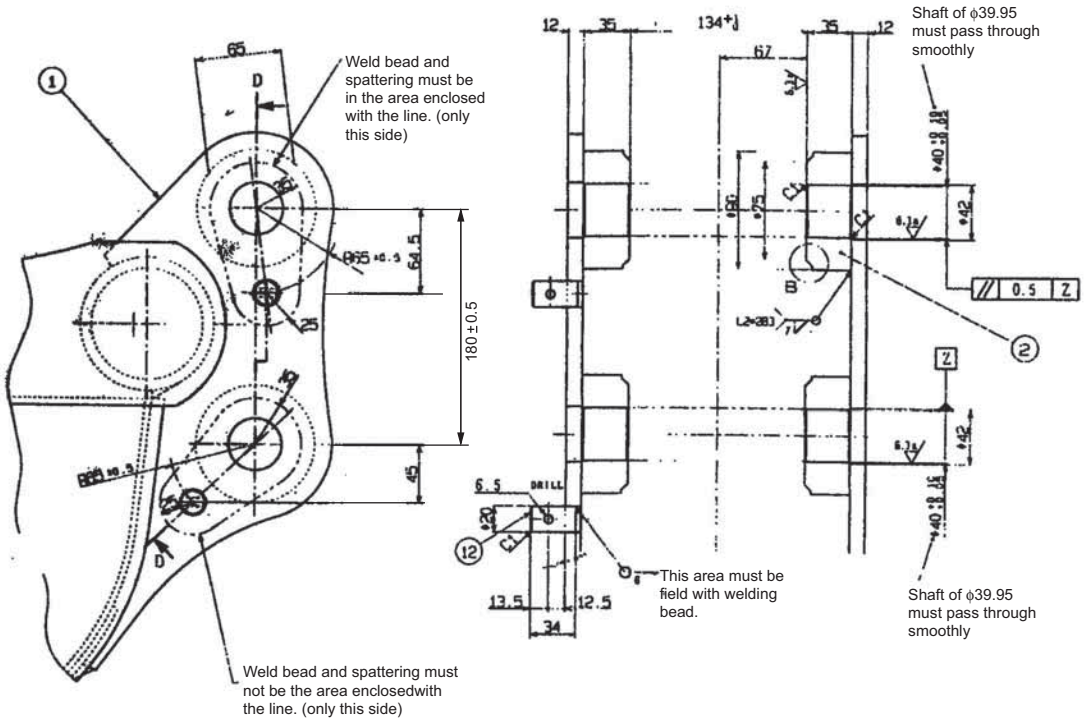
Bucket can be mounted between KX-2 and KX-3 series in each local bucket as shown in the below table. Also below dimensions are for your reference to process local bucket in your place. Still bucket size and weight should be considered for safety, stability and performance.



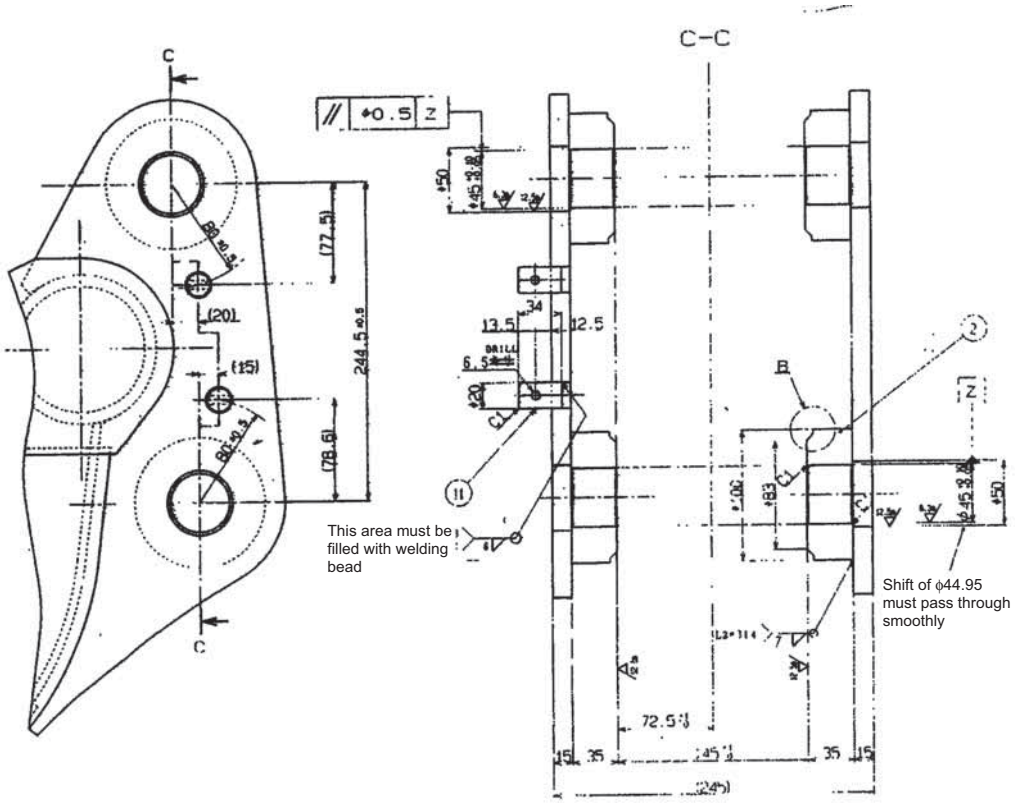
Unit: mm (in.)

	KX121-3/S/α	KX161-3/S/α
a (Bush) inner dia.	$40^{+0.12}_{+0.09}$ (1.58)	$45^{+0.12}_{+0.09}$ (1.77)
b (Arm) boss inner dia.	$50^{+0.03}_{0}$ (1.97)	$55^{+0.03}_{0}$ (2.17)
c (Bucket) boss inner dia.	$40^{+0.1}_{-0.05}$ (1.58)	$45^{+0.1}_{-0.05}$ (1.77)
d (Link)	$50^{+0.025}_{0}$ (1.97)	$55^{+0.03}_{0}$ (2.17)
e	$180^{\pm0.5}$ (7.09)	$244.5^{\pm0.5}$ (9.63)
f	$134^{-0.3}_{-0.6}$ (5.28)	$145^{-0.3}_{-0.6}$ (5.71)
g	204 (8.03)	215 (8.47)
h	228 (8.98)	245 (9.65)
i	244 (9.61)	
j (pin dia.)	$40^{-0.05}_{-0.07}$ (1.58)	$45^{-0.05}_{-0.07}$ (1.77)

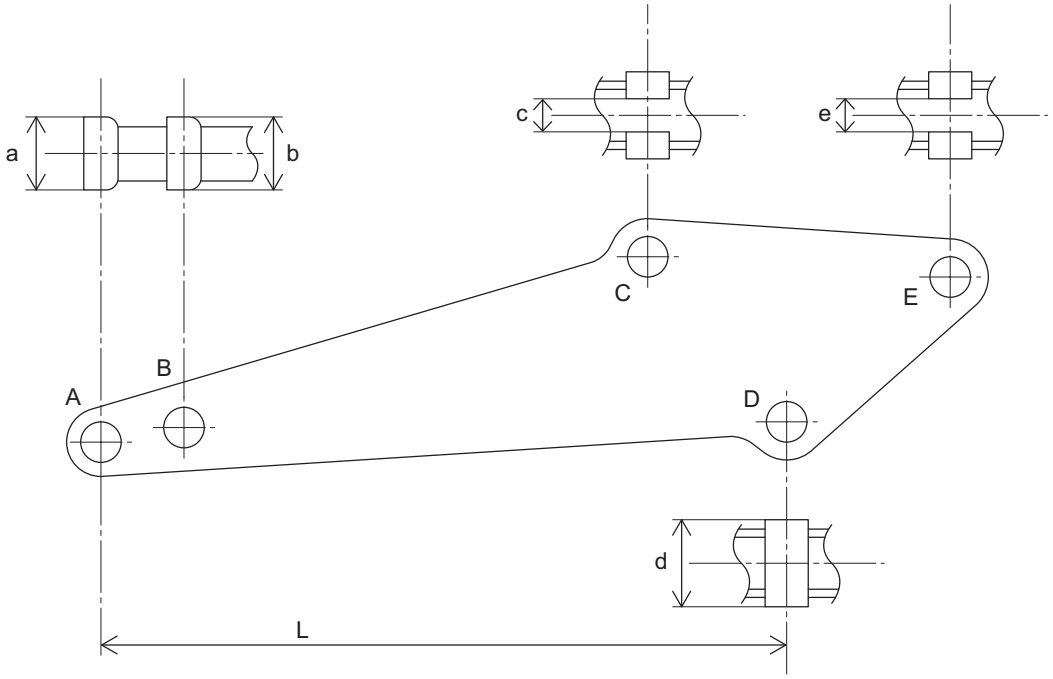
KX121-3/α: KBM-make bucket



KX161-3/α: KBM-make bucket



b) Arm



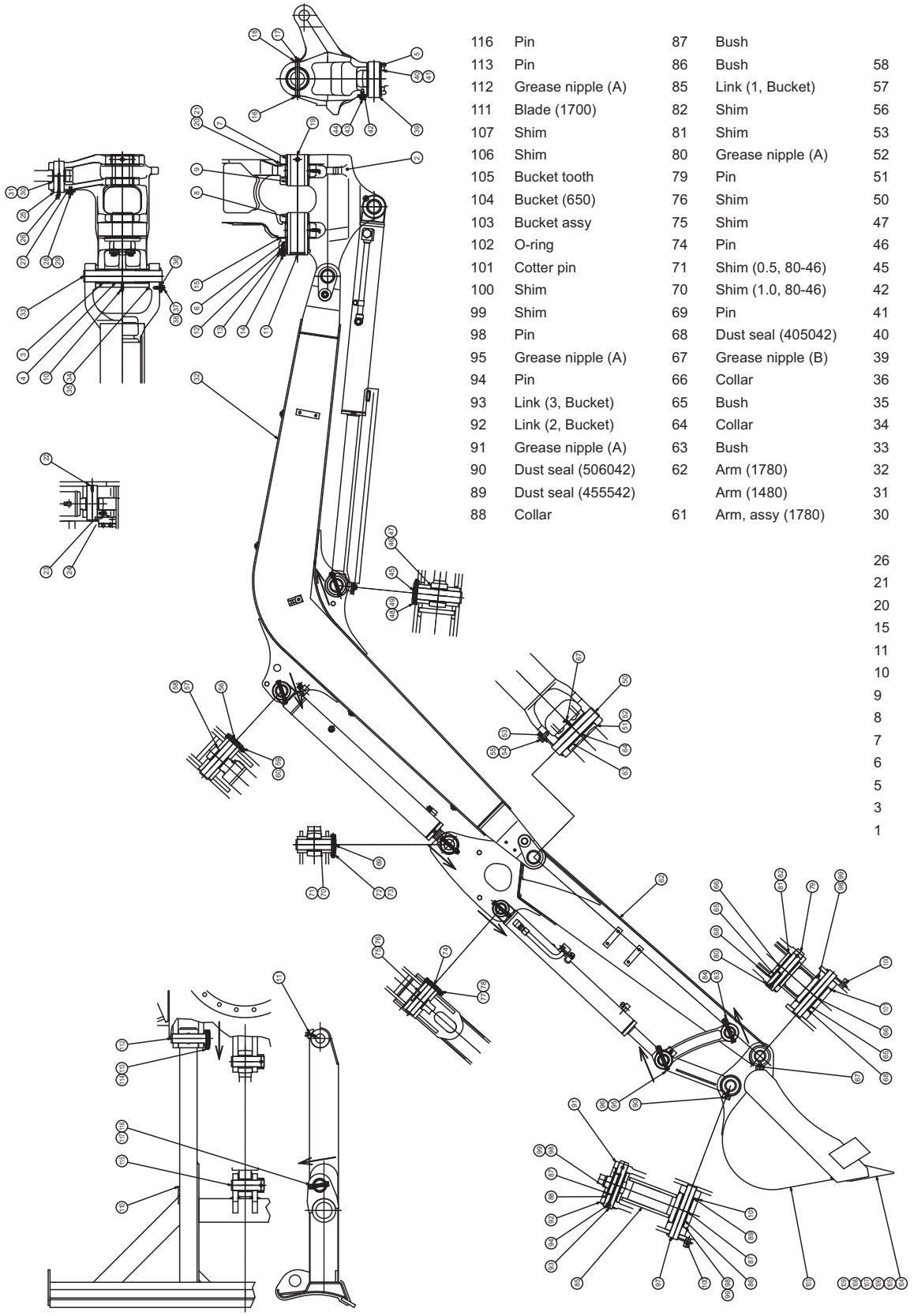
mm (inch)

		KX121-2, KX121-3/α/S		U45-3/α, U50-3α	**KX161-3/α**	**KX161-3/S (KTC, KCL, KTA)**
Arm boss inner dia.	A	40 (1.57”)		$55\ ^{+0.030}_{0}$ (2.17”)		
	B	40 (1.57”)		$55\ ^{+0.030}_{0}$ (2.17”)		
	C	40 (1.57”)		$45\ ^{+0.10}_{+0.05}$ (1.77”)		
	D	50 (1.97”)		$60\ ^{+0.025}_{0}$ (2.36”)		
	E	40 (1.57”)		$45\ ^{+0.10}_{+0.05}$ (1.77”)		
Arm boss width	a	134 (5.28”)		$145\ ^{-0.3}_{-0.6}$ (5.71”)		
	b	134 (5.28”)		$145\ ^{-0.3}_{-0.6}$ (5.71”)		
	c	157 (6.18”)		61 ± 0.5 (2.40”)		
	d	144 (5.67”)		$159\ ^{-0.3}_{-0.6}$ (6.26”)		
	e	157 (6.18”)		61 ± 0.5 (2.40”)		
Arm length: L		1300 (51.2”)	1600 (63.0”)	1360 ± 2 (53.5”)	1480 ± 2 (58.3”)	1780 ± 2 (70.1”)
Weight		75.0 kgf (165 lbs)	97.0 kgf (214 lbs)	81.54 kgf (180 lbs)	89.3 kgf (197 lbs)	121.5 kgf (268 lbs)
Code No.		RD118-66611	RD118-67111	RD418-66611	RG918-66611	RD518-67111

The bucket is interchangeable, but the other components are not. The boom fixtures at the arm, in particular, are redesigned for more ruggedness on the KX161-3/S/α.

(C) MACHINE STRUCTURE

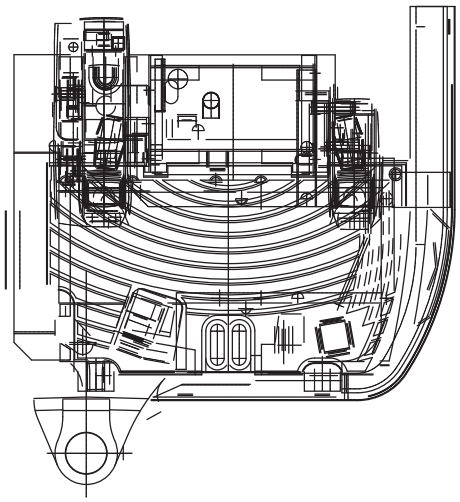
a) Front Attachment



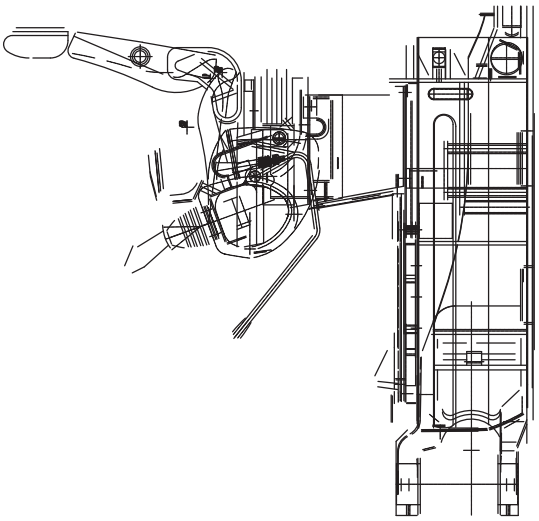
116	Pin	87	Bush		Arm, assy (1480)
113	Pin	86	Bush	58	Shim (0.5, 80-46)
112	Grease nipple (A)	85	Link (1, Bucket)	57	Shim (1.0, 80-46)
111	Blade (1700)	82	Shim	56	Pin
107	Shim	81	Shim	53	Spacer
106	Shim	80	Grease nipple (A)	52	Shim (0.5, 90-51)
105	Bucket tooth	79	Pin	51	Shim (1.0, 90-51)
104	Bucket (650)	76	Shim	50	Pin
103	Bucket assy	75	Shim	47	Shim (0.5, 80-51)
102	O-ring	74	Pin	46	Shim (1.0, 80-51)
101	Cotter pin	71	Shim (0.5, 80-46)	45	Pin
100	Shim	70	Shim (1.0, 80-46)	42	Spacer
99	Shim	69	Pin	41	Shim (0.5, 90-51)
98	Pin	68	Dust seal (405042)	40	Shim (1.0, 90-51)
95	Grease nipple (A)	67	Grease nipple (B)	39	Pin
94	Pin	66	Collar	36	Spacer
93	Link (3, Bucket)	65	Bush	35	Shim (0.5, 110-52)
92	Link (2, Bucket)	64	Collar	34	Shim (1.0, 110-52)
91	Grease nipple (A)	63	Bush	33	Pin
90	Dust seal (506042)	62	Arm (1780)	32	Boom (2870)
89	Dust seal (455542)		Arm (1480)	31	Shim (0.5)
88	Collar	61	Arm, assy (1780)	30	Shim 2

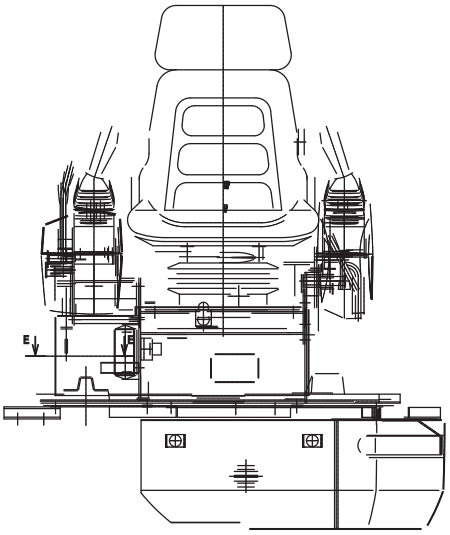
26	Grease nipple (A)
21	Thrust collar (3.5)
20	Thrust collar (3.2)
15	Thrust collar (3.2)
11	Pin
10	Grease nipple (B)
9	Bush
8	Bush
7	Bush
6	Bush
5	Bush
3	Bush (506060)
1	Swing bracket

b) Seat & Control Box

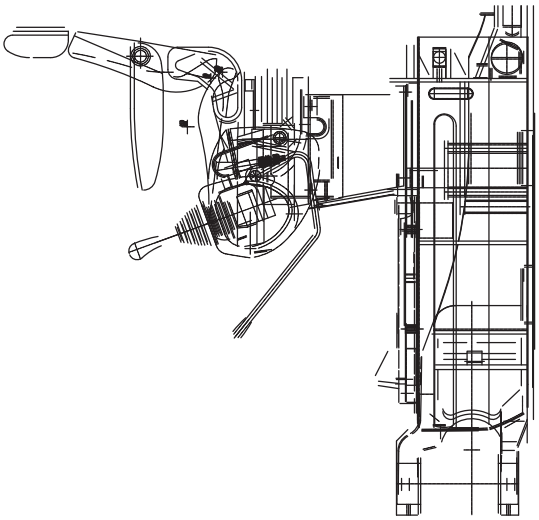


EU-version



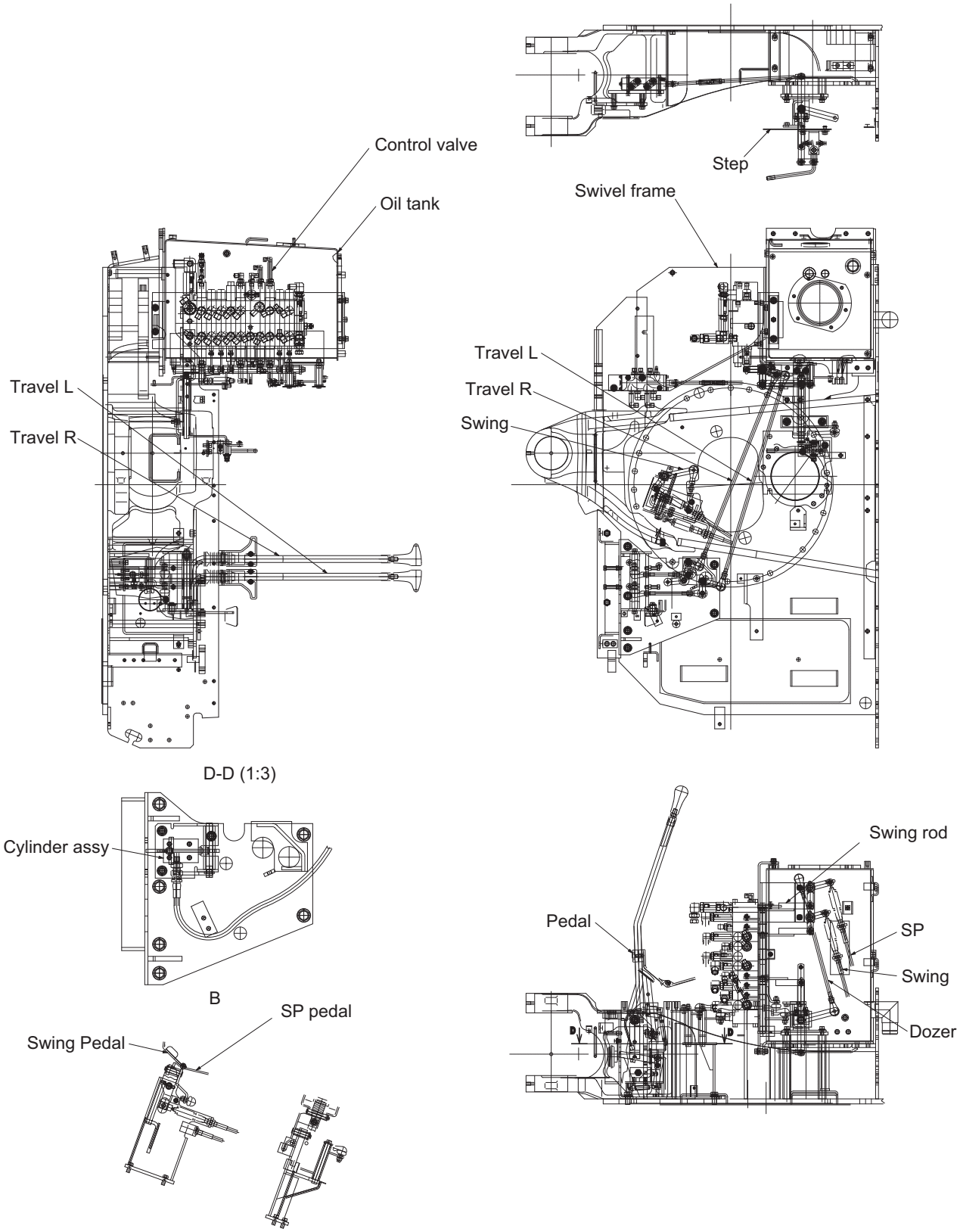


KTC, KCL, KTA-version

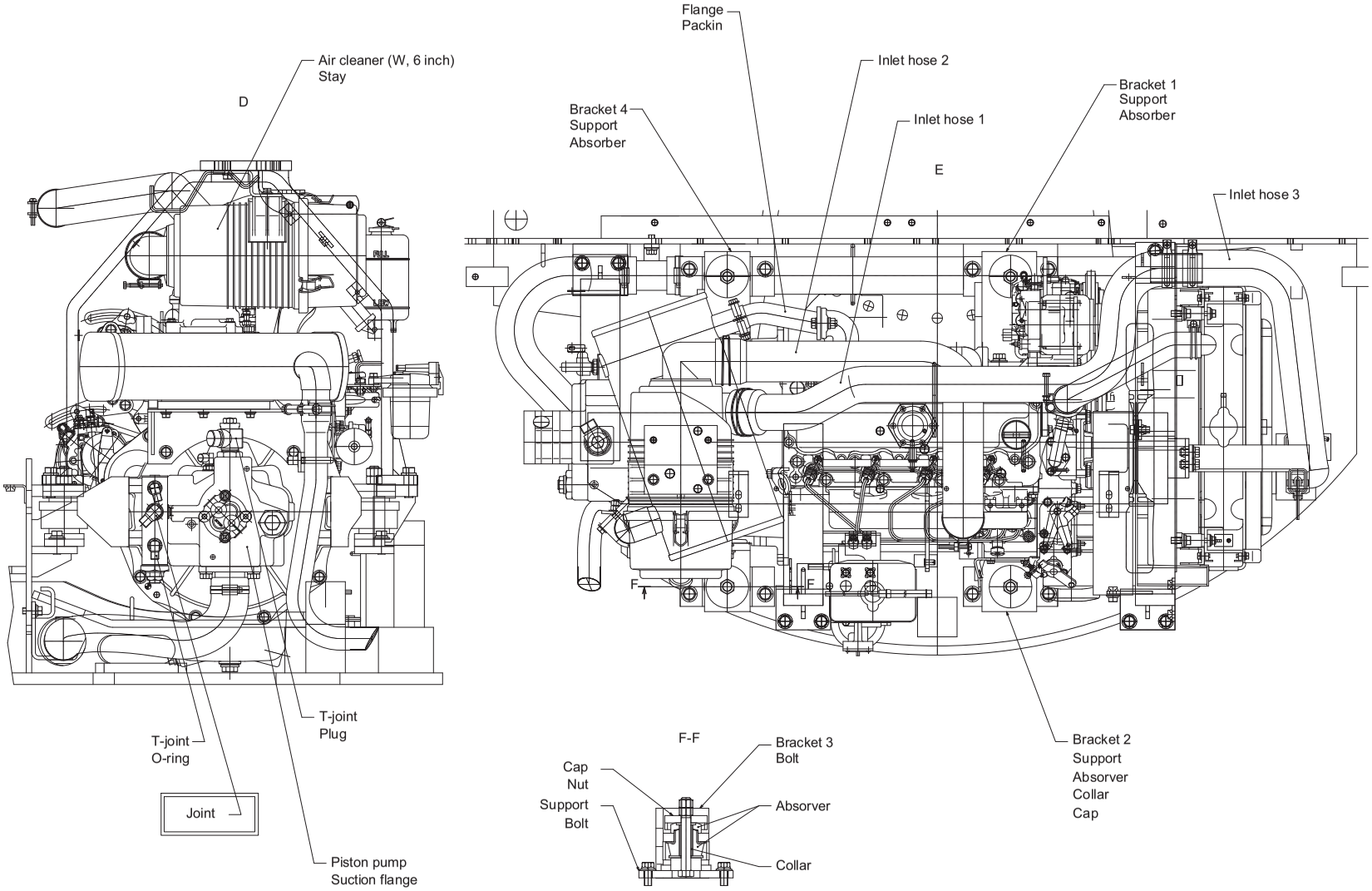


1. Seat
   EU-version: Wrist rest type
   KTC, KCL, KTA-version: Arm rest type

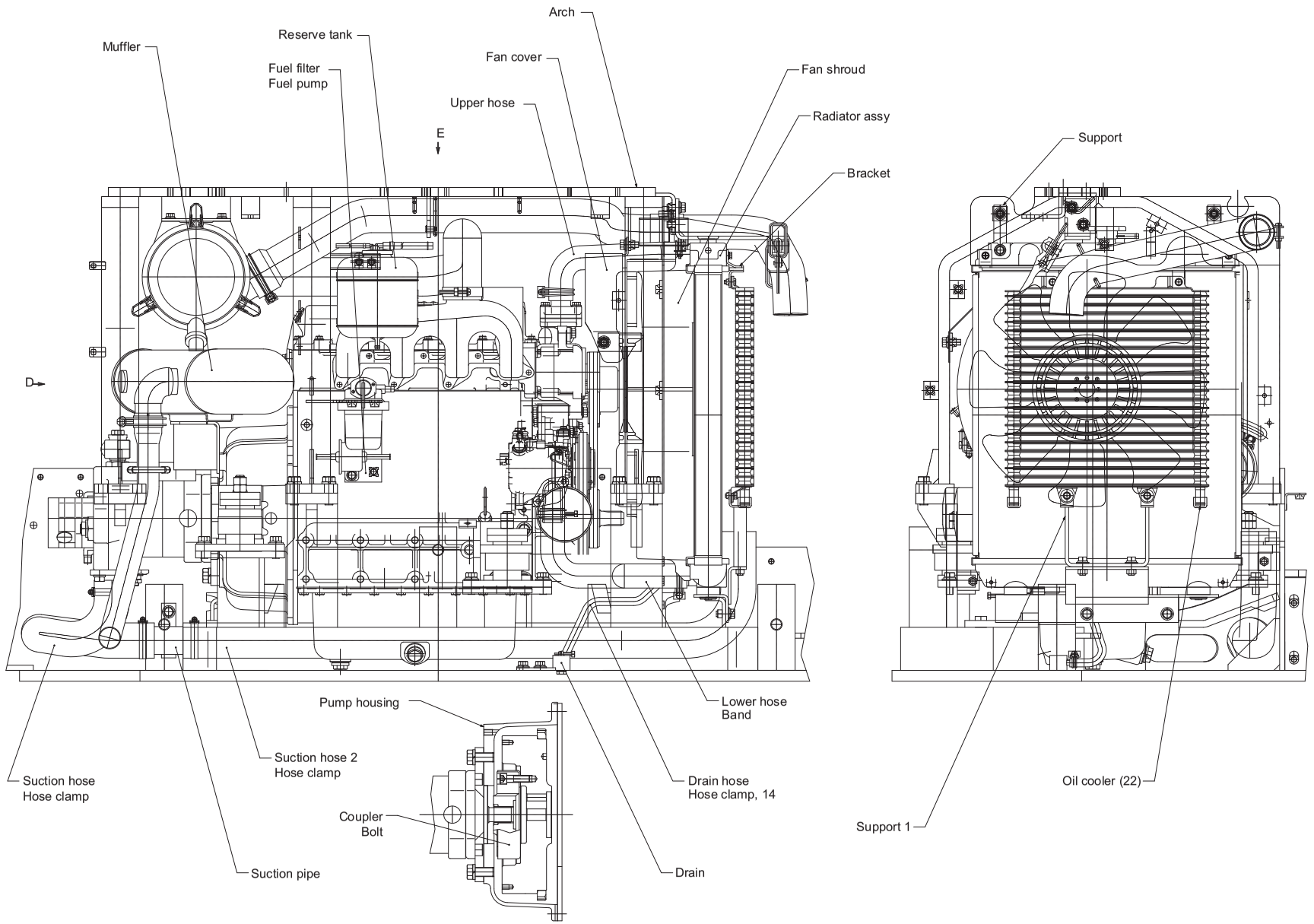
c) Control Linkage



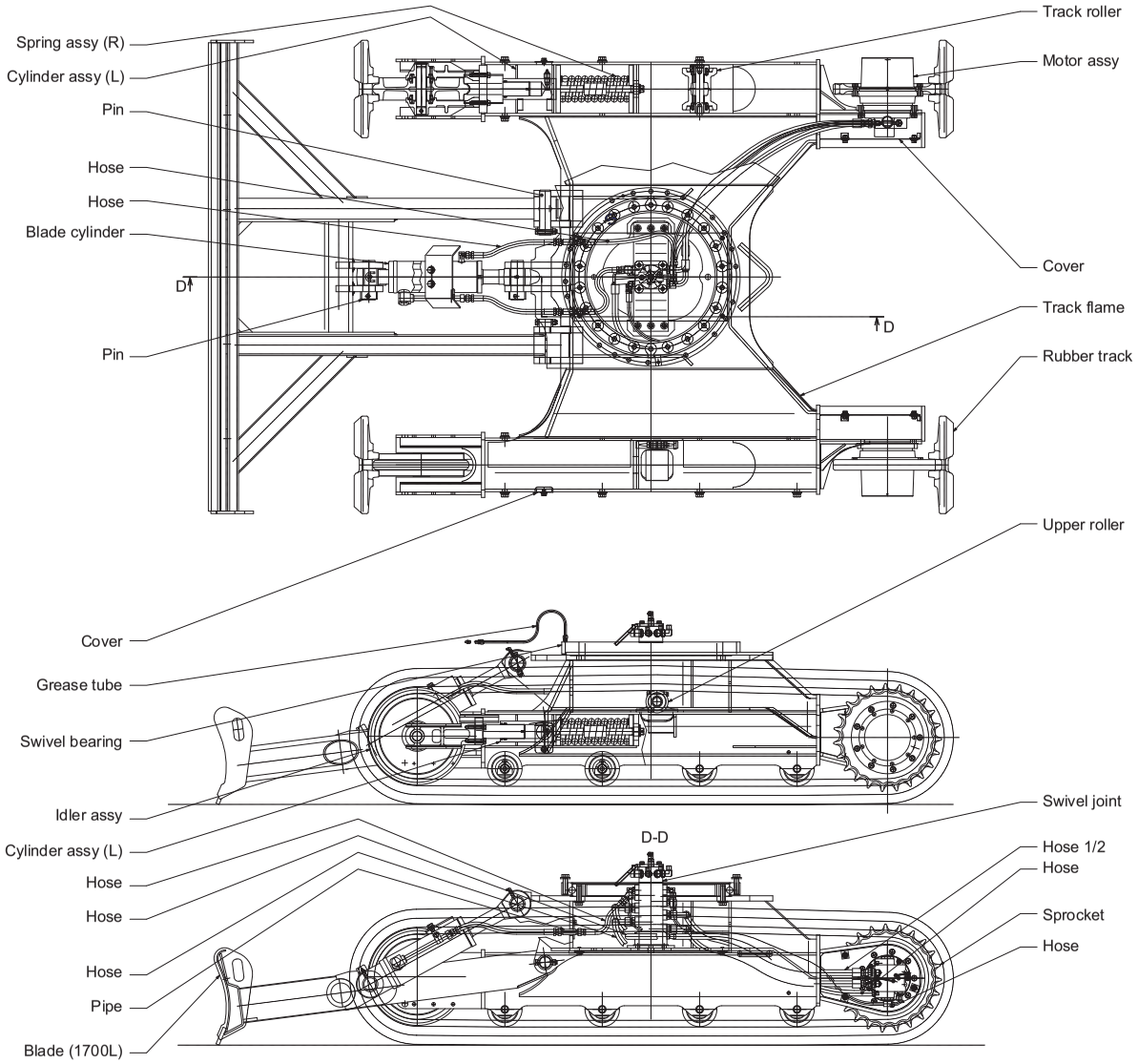
d) Engine Mount: KX161-3/α/S



Engine mount: KX161-3/α/S



e) Undercarriage: KX121-3/α/S

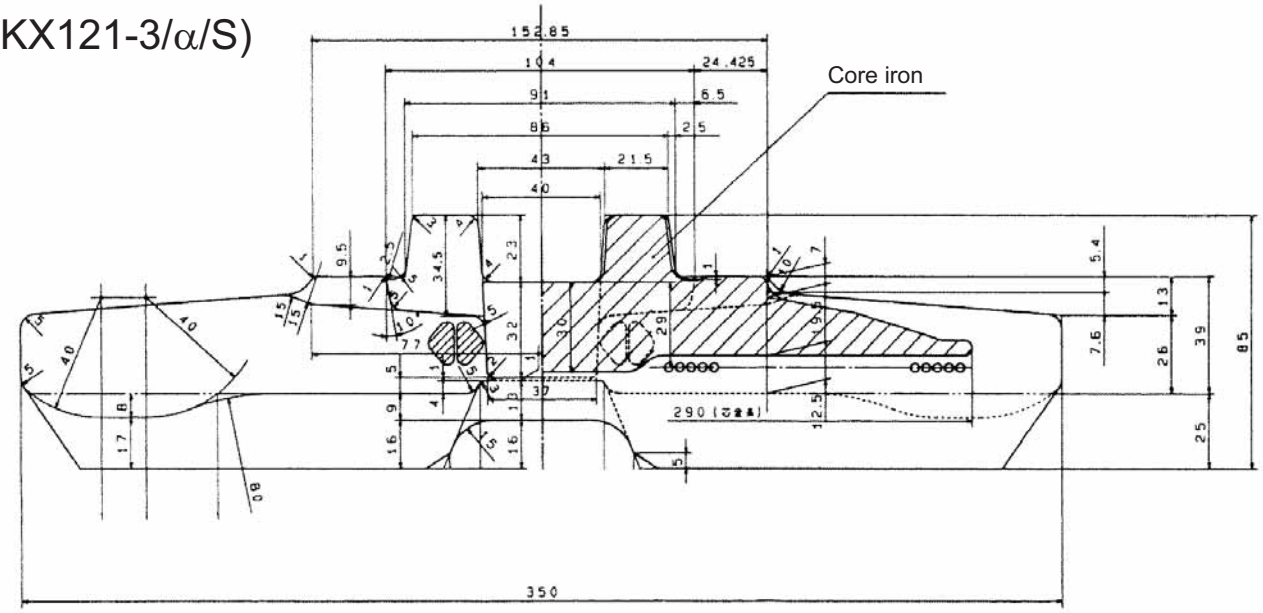


f) Rubber Track

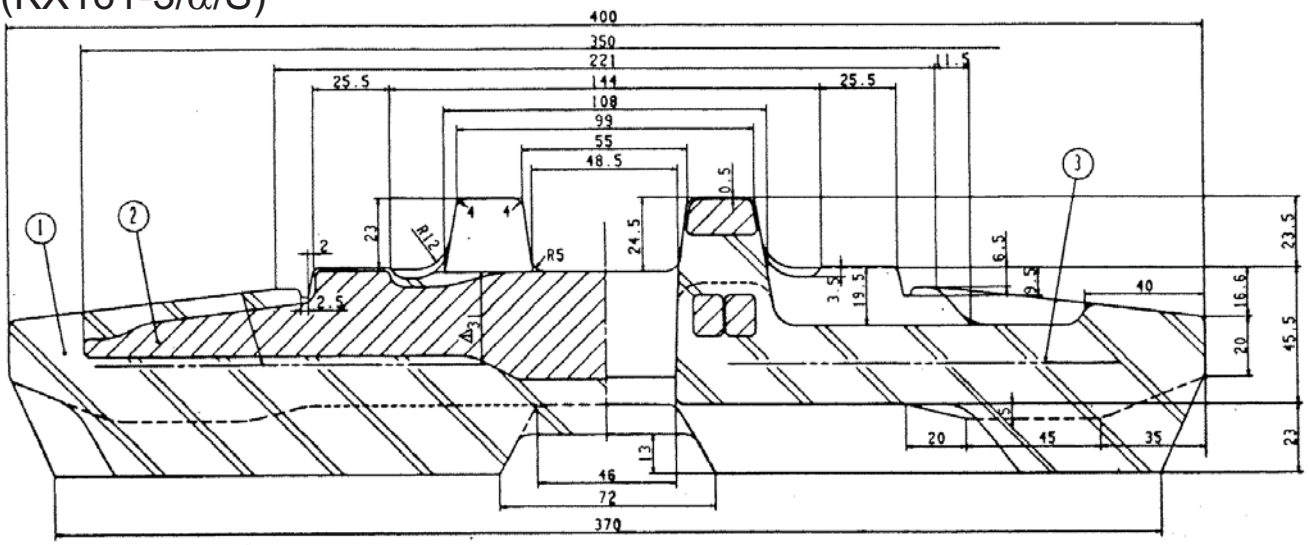
(inch)

Model	KX121-3/α/S	KX161-3/α/S
Part No.	RD118-2231-1	RD411-22313
Normal size	350 × 54.5 × 86	40 × 72.5 × 74
Center circumference	4687 ± 10 (54.5 × 86) wire	5365 mm, (211.2)
Steel cord strength	8.8 kN/piece ϕ 2.9	9320 N/piece
Steel cord number	52	30 × 2
Rubber thickness / Endless	39 / 44	
Rubber strength	13.7 MPa or more	
Steel cord overlap length		475 mm, (18.7)
Rubber material	NR/SBR blended	

(KX121-3/α/S)

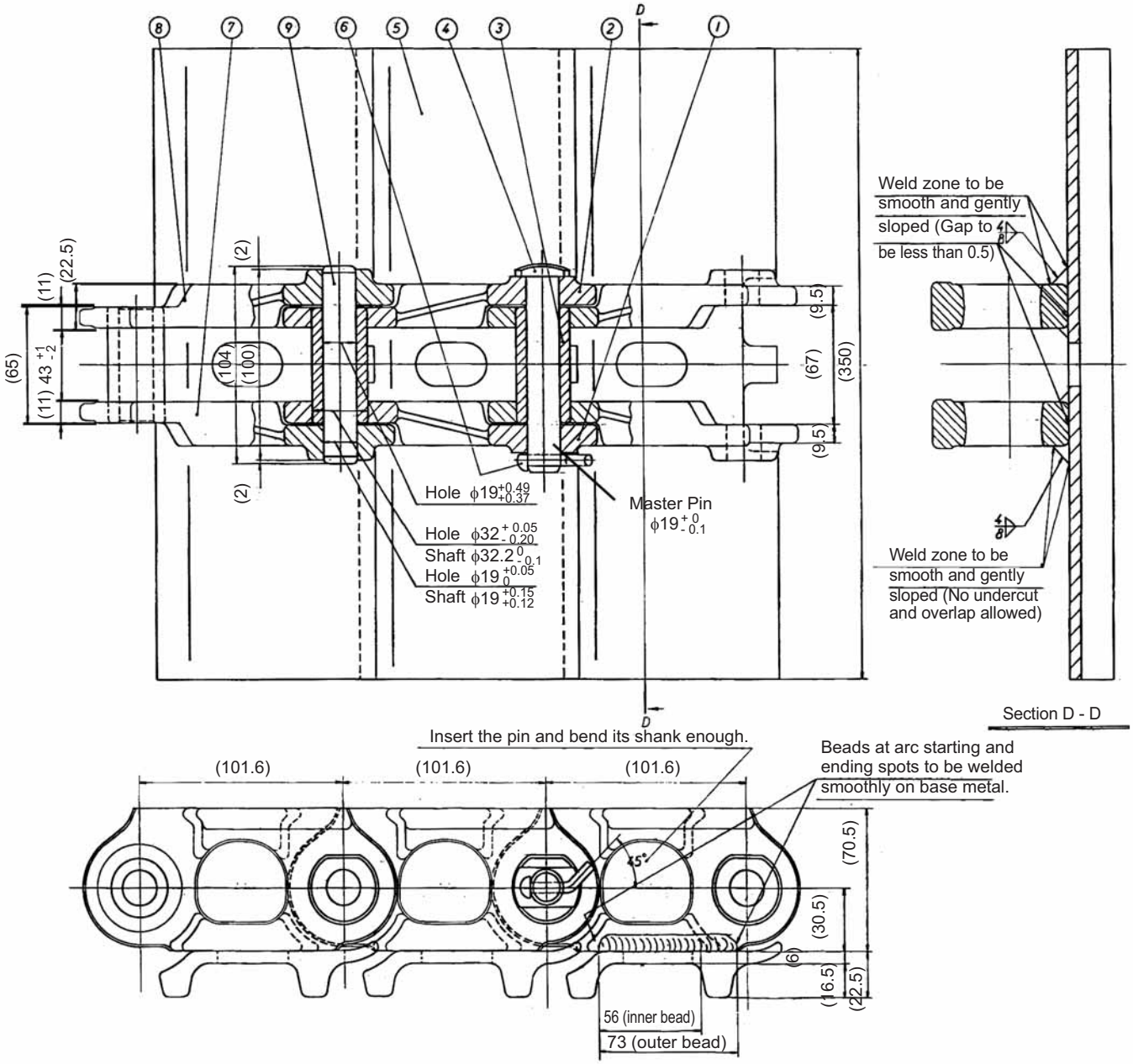


(KX161-3/α/S)



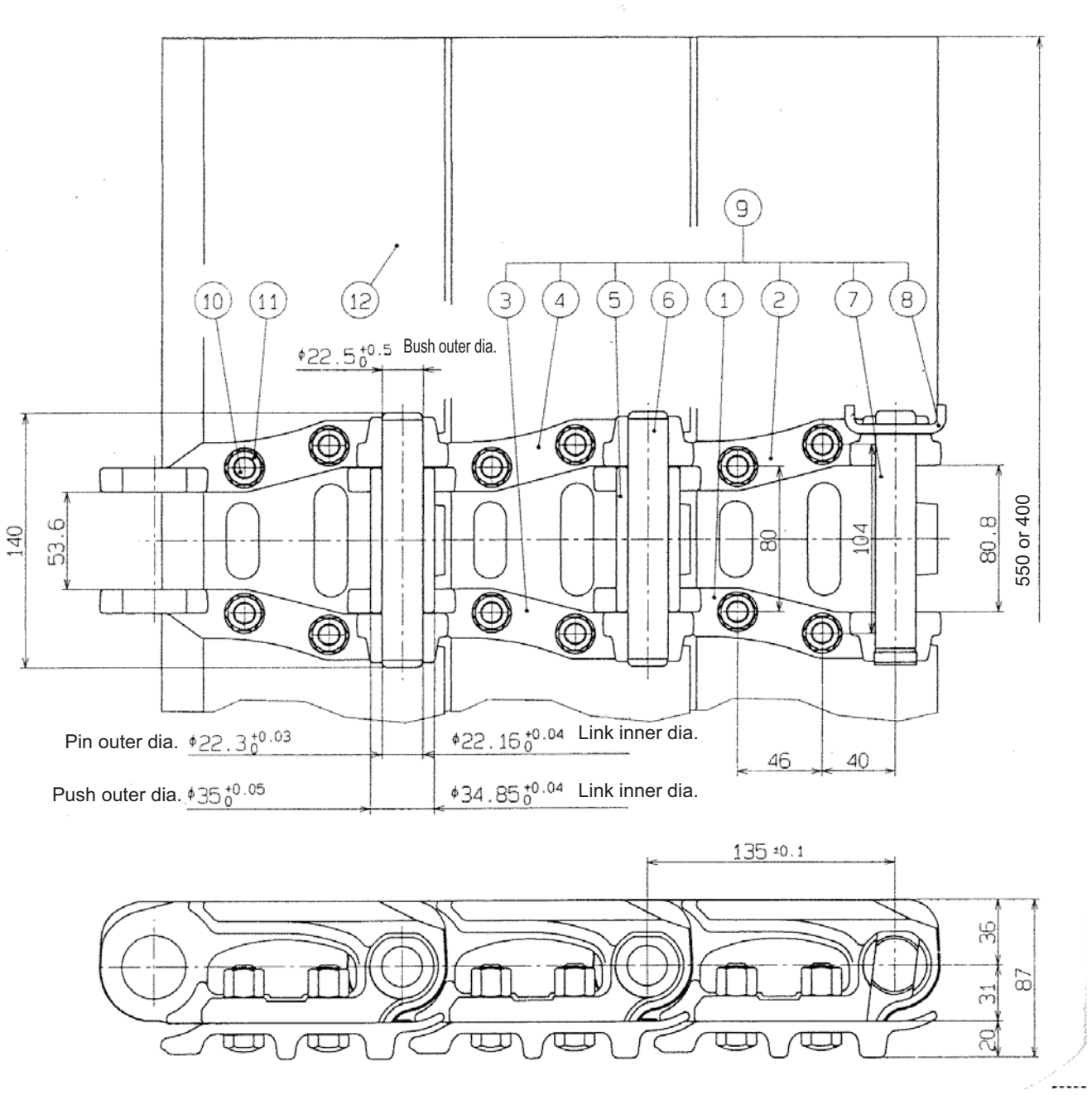
g) Iron Track

Weld-on shoe: KX121-3/α/S



(1)	Master link, L	(4)	Master pin	(7)	Track link, L
(2)	Master link, R	(5)	Track shoe	(8)	Track link, R
(3)	Bush	(6)	Pin	(9)	Track pin

Bolt-on shoe: KX161-3/α/S



h) Track Conversion

1. Models

KX121-3α, KX121-3S

2. Comparison photo

(Sample: KX121-3S, Rubber track)

(Sample: KX121-3S, Iron track)

(1) Rubber track
(2) Iron track
(3) Track guide
(4) Bolt

3. Parts requirement to change or add

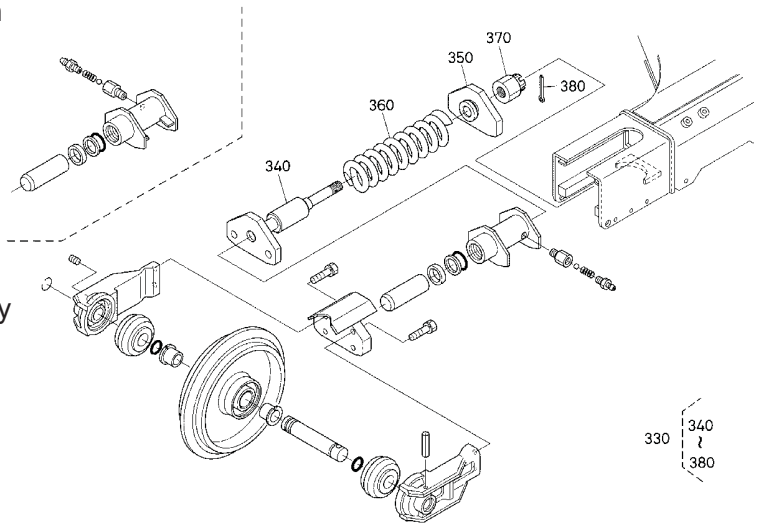
No.	Parts Name	Code No.	Q'ty	Rubber track	Iron track
1	Rubber track	RD118-2231-0	2	○	
2	Iron track (400 mm)	RD108-2210-0	2		○
3	Track guide	RD118-2182-0	4		○
4	Bolt	01133-61225	12		○

(Spring tension assy)

	S/N ≦ 20824	S/N ≧ 20825
Iron track	RD118-2145-0	RD118-2140-3
Rubber track	RD118-2140-0	

Spring tension assy is identical between iron and rubber track for S/N 20825 and on.

330: Spring tension assy
360: Spring



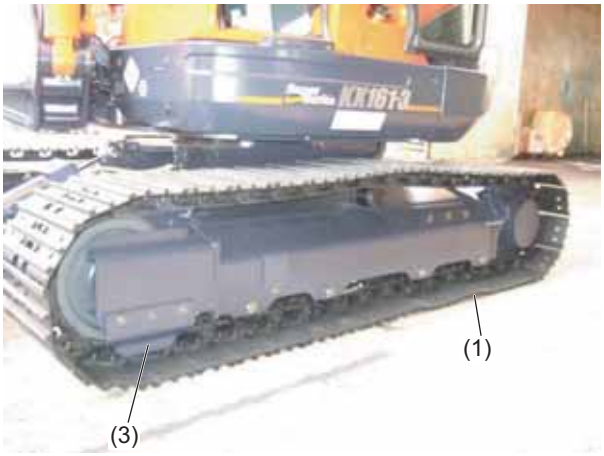
4. Models

KX161-3S, KX161-3α, U45-3α, U45S, U45-3S

5. Comparison photo

(Sample: KX161-3S, Rubber track)

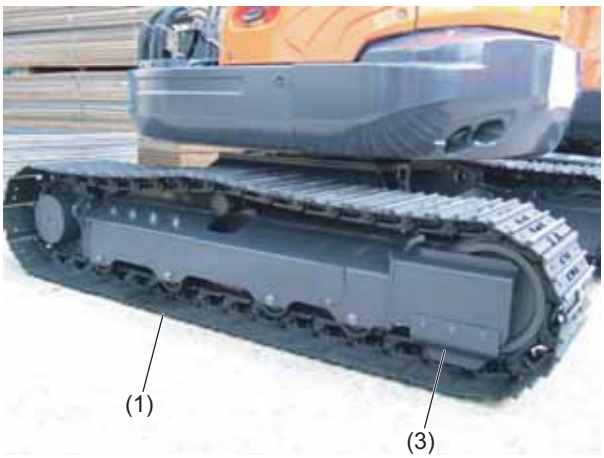
(Sample: KX161-3S, Iron track)



(1) Iron track (2) Rubber track (3) Track guide

(Sample: U45S, Rubber track)

(Sample: U45S, Iron track)



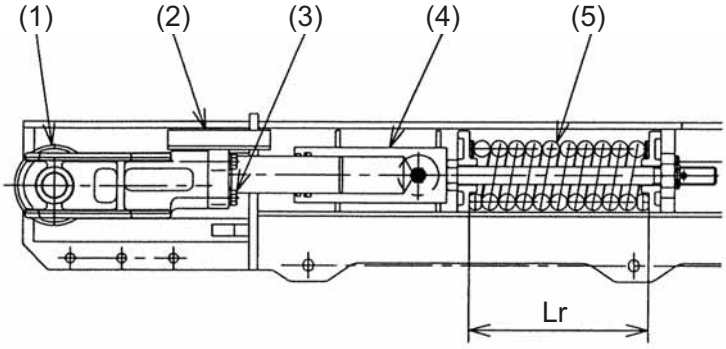
(1) Iron track (2) Rubber track (3) Track guide

6. Parts requirement to change or add

No.	Parts Name	Code No.	Q'ty	Rubber track	Iron track
1	Rubber track	RD411-2231-3	2	○	
2	Iron track (400 mm)	RP411-2220-0	2		○
3	Iron track (550 mm)	RD519-2250-0	2		○
4	Spring tension (Rubber)	RD411-2140-0	2	○	
5	Spring tension (Iron)	RD411-2145-0	2		○
6	Track guide	RD411-2118-0	4		○
7	Bolt	RP411-2183-0	12		○

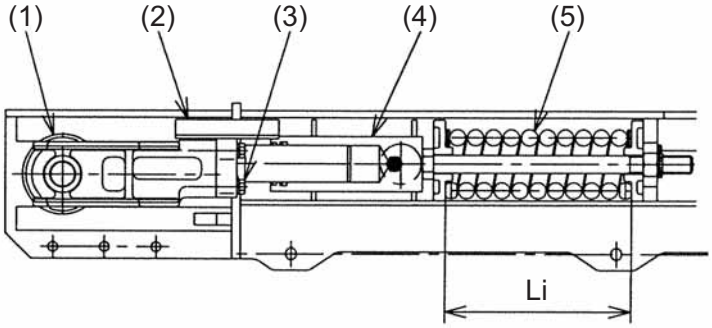
7. Track tension device: **KX121-3S, KX161-3S, U45S, U45-3S, KX121-3α, KX161-3α, U45-3α, U50-3α**

Rubber crawler type



(1) Assy Idler
(2) Plate Idler
(3) Bolt
(4) Assy cylinder
(5) Assy spring

Iron crawler type

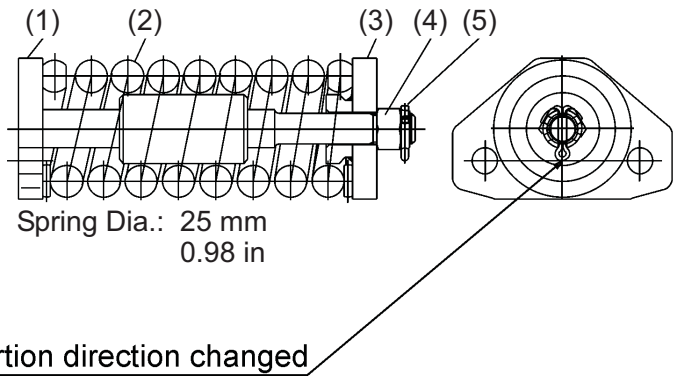


(1) Assy Idler
(2) Plate Idler
(3) Bolt
(4) Assy cylinder
(5) Assy spring

Tension spring pre-set

Model	Rubber track type: Lr	Iron track type: Li
KX121-3S KX121-3α	241.5 mm (9.51 in)	←
KX161-3S KX161-3α U45S U45-3S U45-3α U50-3α	227.5 ± 1 mm (8.96 ± 0.04 in)	242.5 ± 1 mm (9.55 ± 0.04 in)

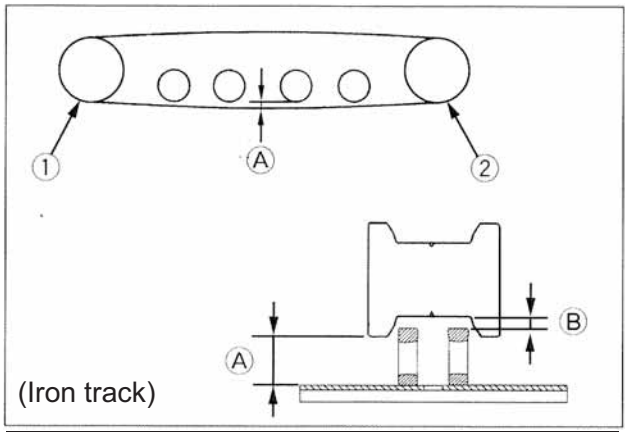
Spring assy for KX121-3S, KX121-3α
Code No. RD118-21402
This is identical for rubber and iron trades.



(1) Bolt (Spring) RD118-21443
(2) Spring RD411-2142Δ
(3) Retainer (Spring) RD118-21433
(4) Grooved nut 68311-2153Δ
(5) Spring pin 05511-50645

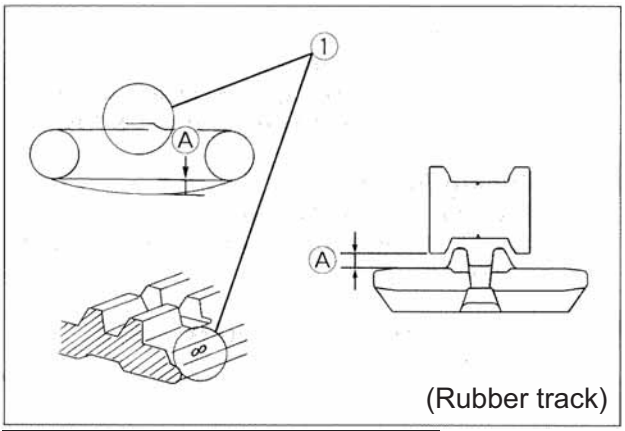
NOTE: Never confuse the direction.
Otherwise it may come into contact with the track frame.

8. Track sag distance



(Iron track)

Iron track	(A) mm (in)	(B) mm (in)
KX91-3α/S KX101-3α/S U35-3α/S, U35S	75 ~ 80 (3.0 ~ 3.5)	40 ~ 45 (1.57 ~ 1.77)
KX121-3α/S	85 ~ 90 (3.3 ~ 3.5)	
KX161-3α/S U45-3α/S U45S	80 ~ 85 (3.2 ~ 3.3)	

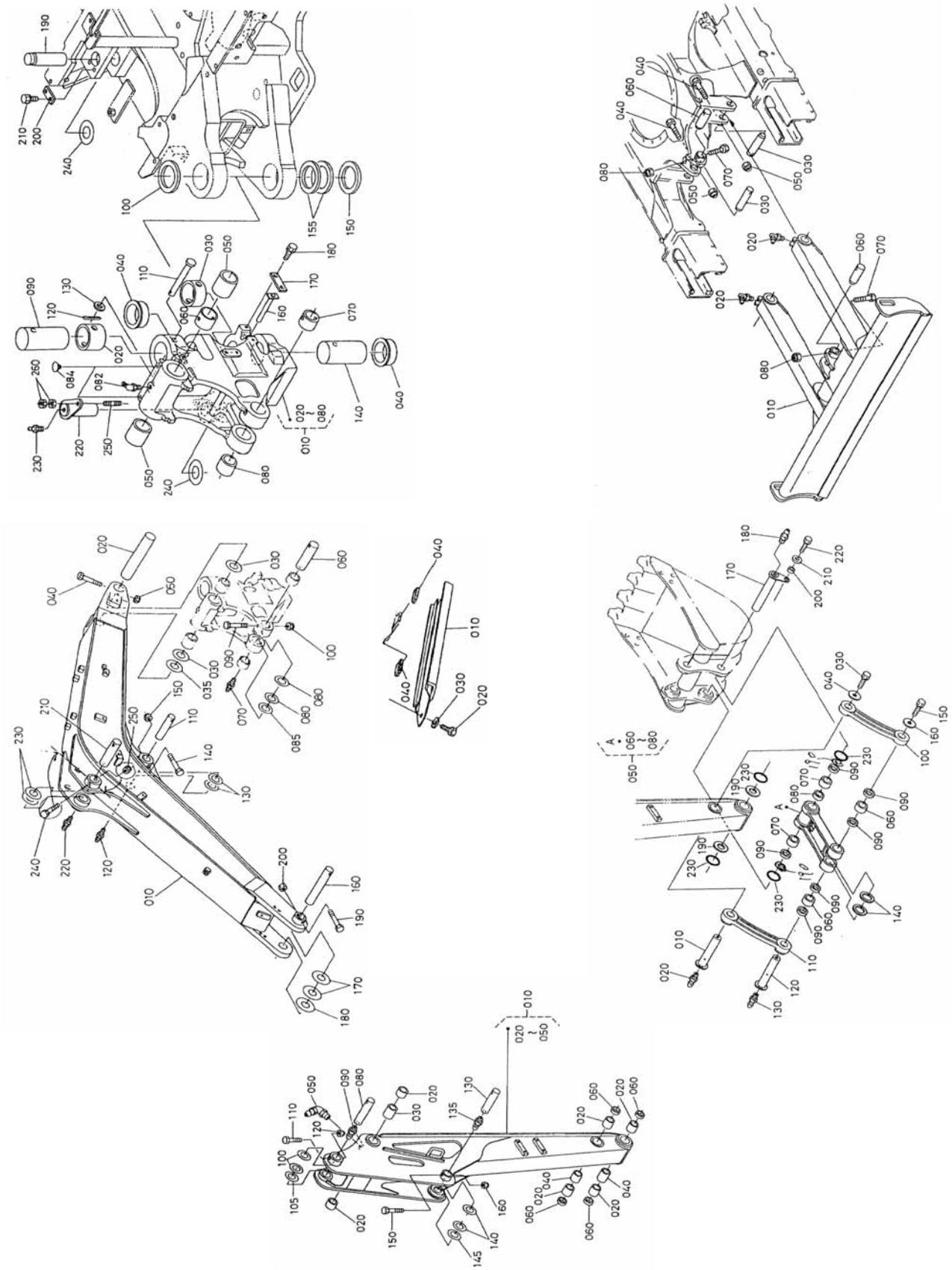


(Rubber track)

Rubber track	(A) mm (in)
KX91-3α/S KX101-3α KX121-3α/S KX161-3α/S U35-3α/S, U35S U45-3α/S, U45S	10 ~ 15 (0.4 ~ 0.6)

(D) FRONT ATTACHMENT

a) Parts Designation



(1) Swing bracket

010	Assy bracket, swing	090	Pin	180	Bolt
020	Bush	100	Collar, Thrust	190	Pin
030	Bush	110	Pin, Joint	200	Plate, Key
040	Bush	120	Pin, Sprit	210	Bolt
050	Bush	130	washer, Plain	220	Pin
060	Collar	140	Pin	230	Nipple, Grease
070	Bush	150	Collar, Thrust	240	Shim
080	Bush	155	Shim	250	Stud
082	Nipple, Grease	160	Pin	260	Nut
084	Plug	170	Plate, Retainer		

(2) Boom

010	Boom	085	Shim	170	Shim
020	Pin	090	Bolt	180	Shim
030	Shim	100	Nut, Lock	190	Bolt
035	Shim	110	Pin	200	Nut, Lock
040	Bolt	120	Nipple, Grease	210	Pin
050	Pin	130	Shim	220	Nipple, Grease
060	Pin	140	Bolt	230	Shim
070	Nipple, Grease	150	Nut, lock	240	Bolt
080	Shim	160	Pin	250	Nut, Lock

(3) Boom Cylinder Cover

010	Cover, Cylinder	030	Washer, Plain
020	Bolt	040	Cap, Cylinder cover

(4) Arm

010	Assy, Arm	080	Pin	130	Pin
020	Bush	090	Nipple, Grease	135	Nipple, Grease
030	Collar	100	Shim	140	Shim
040	Collar	105	Shim	145	Shim
050	Nipple, Grease	110	Bolt	150	Bolt
060	Seal, Dust	120	Nut, Lock	160	Nut, Lock
070	Blank				

(5) Bracket Link

010	Pin	090	Seal, Dust	170	Pin
020	Nipple, Grease	100	Link, Bucket	180	Nipple, Grease
030	Bolt	110	Link, Bucket	190	Shim
040	Washer	120	Pin	200	Spacer
050	Assy link, Bucket	130	Nipple, Grease	210	Washer, Plain
060	Bush	140	Shim	220	Bolt
070	Bush	150	Bolt	230	O-ring
080	Collar	160	Washer	240	Cap

(6) Blade

010	Blade	040	Bolt	070	Bolt
020	Nipple, Grease	050	Nut, Lock	080	Nut, Lock
030	Pin	060	Pin		

b) Exchange of Bucket (Kubota Japan Bucket)

CAUTION

* When replacing the bucket, wear a hard helmet, goggles and other protective gears.
* When working in buddy system, fully understand signals from each other for added safety.

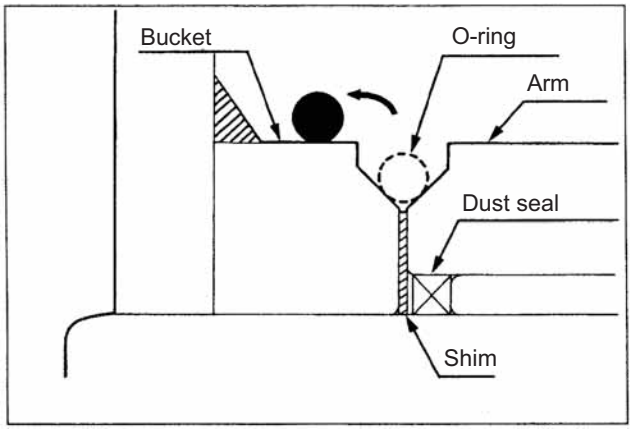
Take the following procedures to replace the bucket.

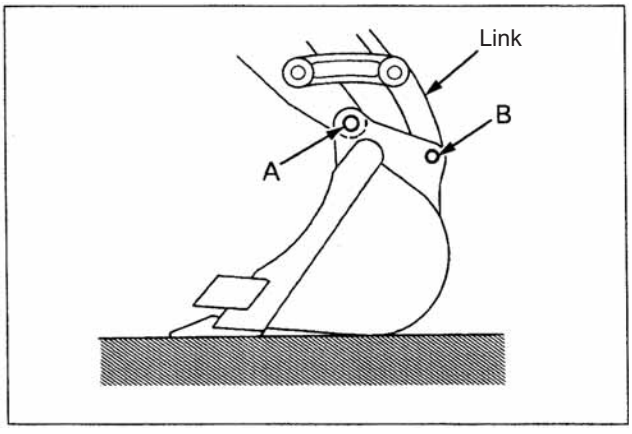
IMPORTANT

* Be careful to keep the drawn-out pins free of sand and mud.
* A dust seal is attached at each end of the bushing. In removing and fitting the pins, be careful not to damage the dust seals.

■ Removing the bucket

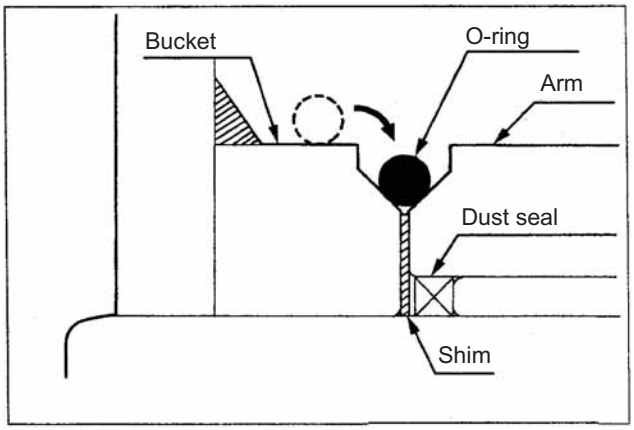
1. Place the bucket just on a flat, level ground.
2. Stop the engine and let out pressure from the hydraulic system.
3. Detach the O-ring from the groove and draw out the pins A and B.





■ Fitting the bucket

1. Place the O-ring on the boss of the bucket.
2. Align the arm with the hole A, put the shims at both ends of the arm, and couple them with the pins. Align the link with the hole B, put the shims at both ends of the link, and couple them with the pins.
3. Apply and tighten up the pin fixing bolts.
4. Fit the O-ring in the groove.



5. Grease up the pins.

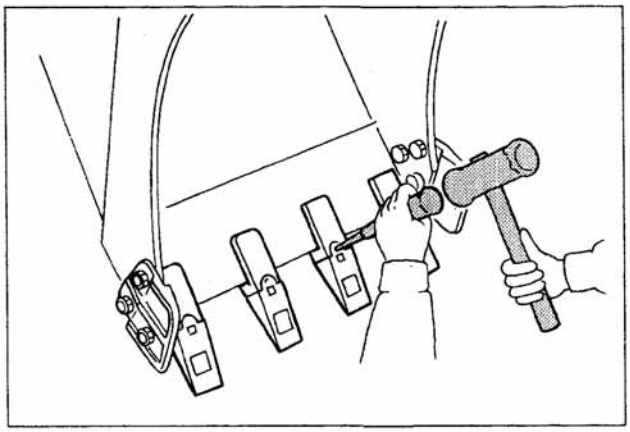
c) Exchange of Bucket Teeth and Side Cutter

■ Replacing the bucket tooth

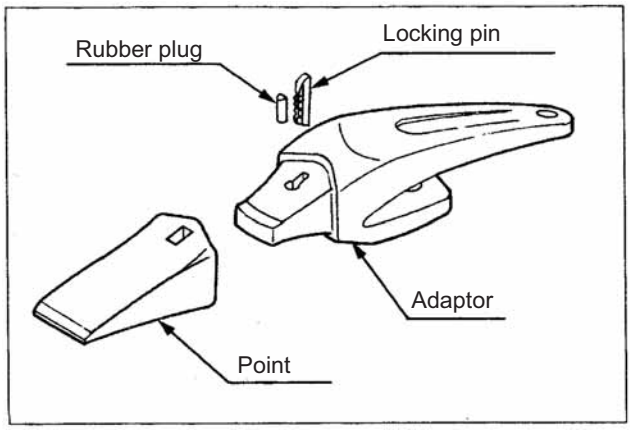
WARNING

* When replacing the bucket tooth, wear goggles and other protective gears.

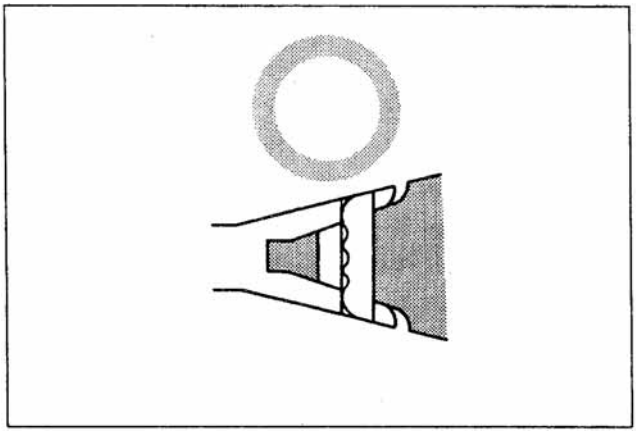
1. Apply a punch on each locking pin. Using a hammer, strike out all the locking pins.
2. Using the hammer or the like, detach a worn-out point from the adaptor.
3. Remove soil deposit off the adaptor.

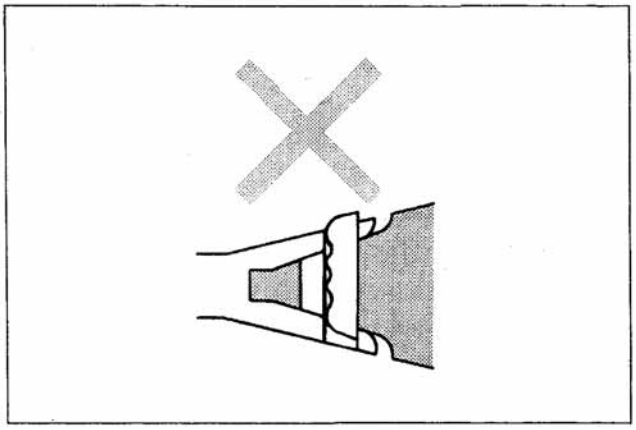


4. Fit a new point to the adaptor.



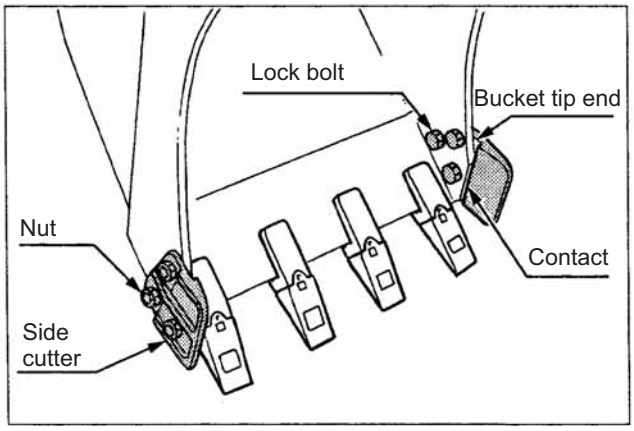
5. Align the point's hole and the adaptor's hole with each other and drive the rubber plug and locking pin into position. Finally make sure that the pin's top is flush with the adaptor's top. (When changing the point for new one, it is advisable to replace also its rubber plug and locking pin with new ones.)





■ Replacing the side cutter

1. Using a box wrench and an adjustable wrench, remove the side cutter lock bolts.
2. Fit new side cutters. Temporarily tighten the bolts.
3. Make sure the side cutters are in close contact with the bucket tip ends. Then tighten up the bolts.



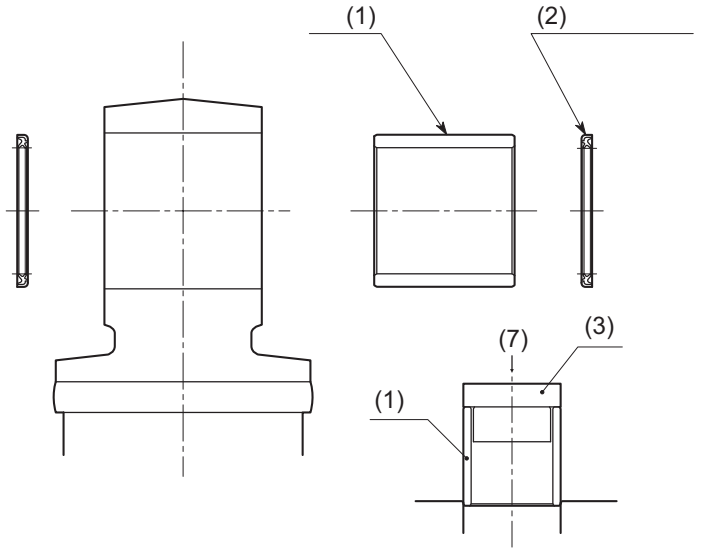
- Tighten the bolts to the torque of 260 to 304 Nm (26.5 to 31 kgf·m).
- If the side cutters are out of contact, or in poor contact with the bucket tip ends, the bolts may get loose.

d) Installing Direction of Dust Seal

Install the dust seals in the direction as shown at left. If in the wrong direction, the sealing effect is adversely affected, which may get the pins worn out earlier.

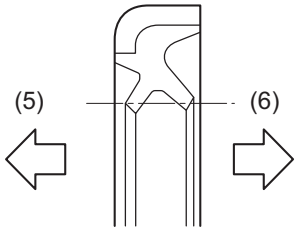
1. Fitting of the bushings
   Press-fit the bushings with a metallic block or the like.
   * Do not hit directly on the bushings.
2. Inserting dimensions of the bushings
   1) When no dust seal is provided, make sure the bushings do not stretch out of both sides.
   2) When the dust seals are provided, ensure the dimensions enough to insert the dust seals at both sides. (It may also be possible to control the dimensions in the press-fitting direction.)

   Fitting direction of the dust seals
   Fit the dust seals as shown at left.
3. Inserting direction of the bushings
   Insert the bushings from the 15°-chamfered side.

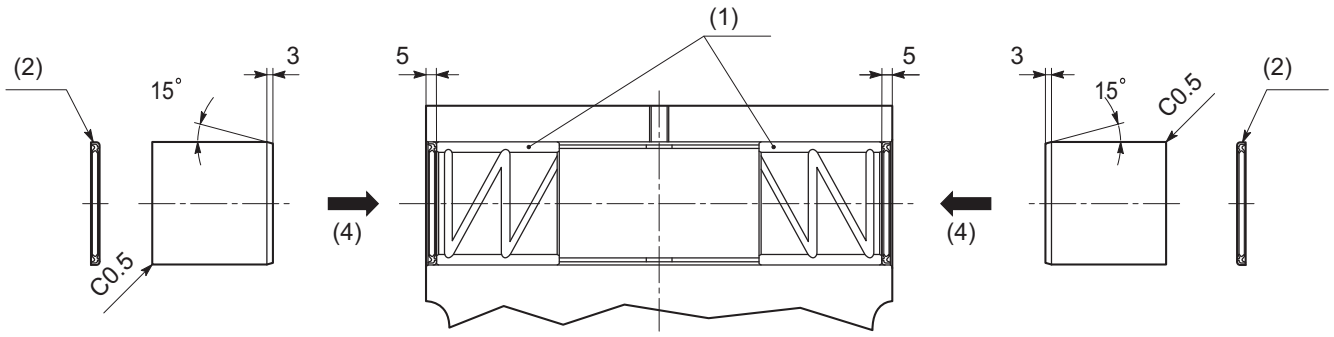


1) No dust seal provided	2) Dust seals provided
* Boom support: 2 pcs. * Arm support: 2 pcs.	* Bucket link 1: 6 pcs. * Arm end: 4 pcs.

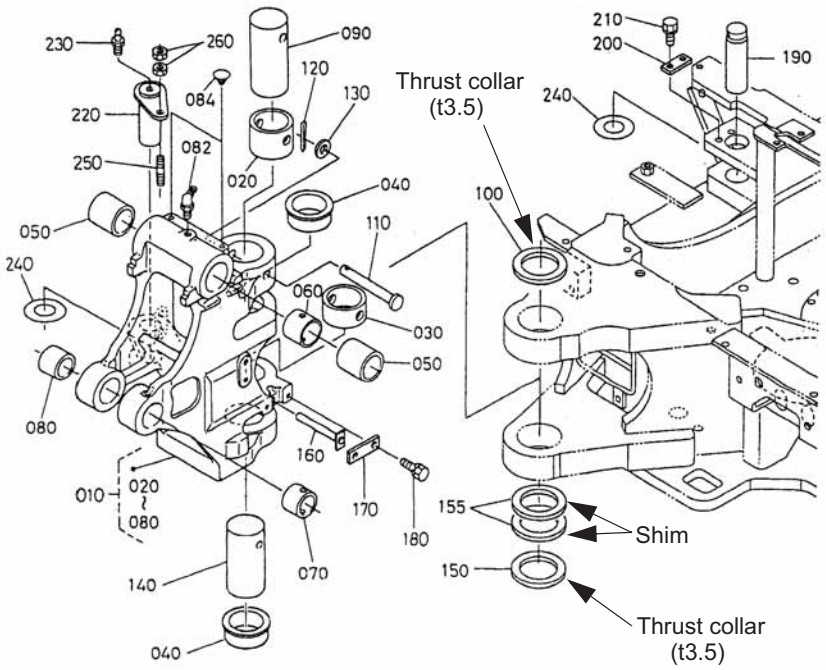
(Enlarged view of dust seal)



(1) Bush
(2) Dust seal
(3) Jig
(4) Bush direction
(5) Toward the Bushing
(6) OutSide
(7) Press in



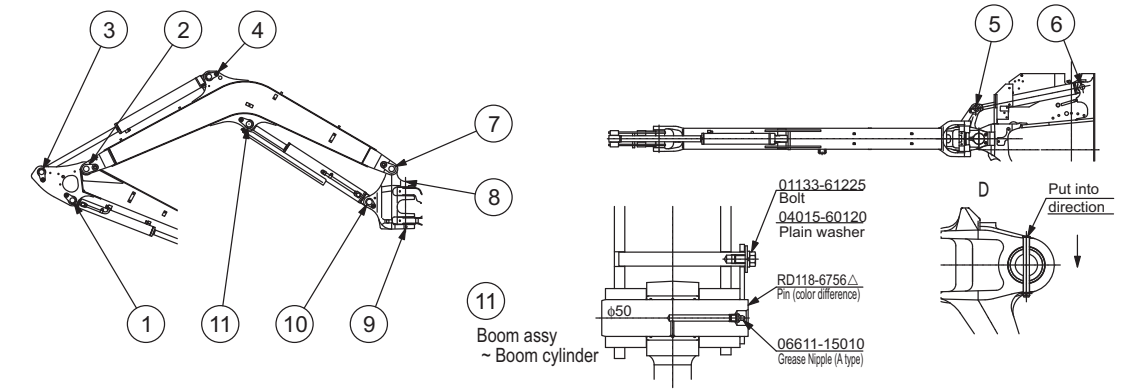
e) Installation of Thrust Collar on The Swing Bracket

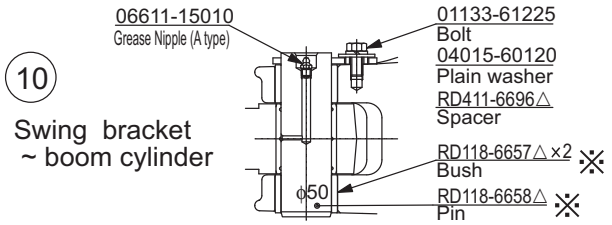


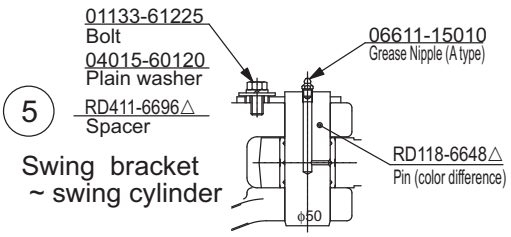
1. Install the thrust collar (t3.5), with its grooved face downward, on top of the swivel frame.
2. Select and install a 0.5 or 1.0 mm (0.02 ~ 0.04”) thick shim to have the clearance smaller than 0.5 mm (0.02”).

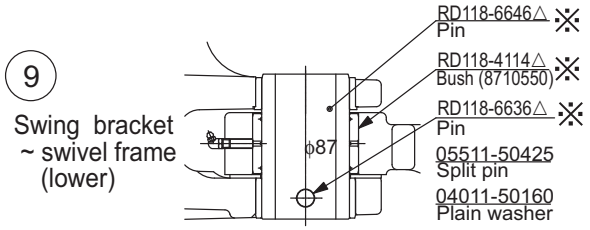
f) Installing Pin, Bush and Shim (1): KX121-3S, KTC, KCL, KTA-version

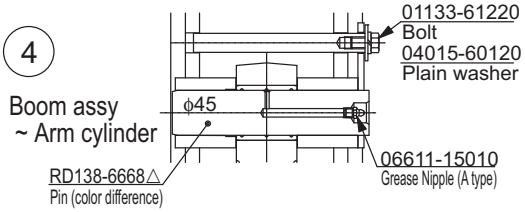
Asterisked (※) parts are for KX121-3S only, KX161-3S has different parts number.

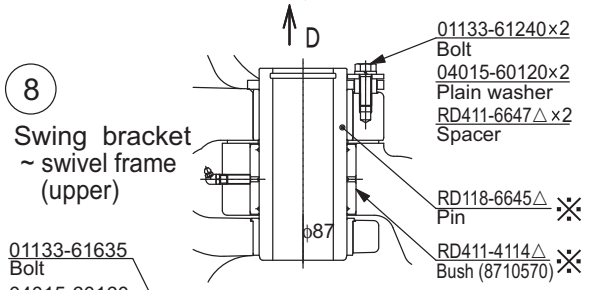


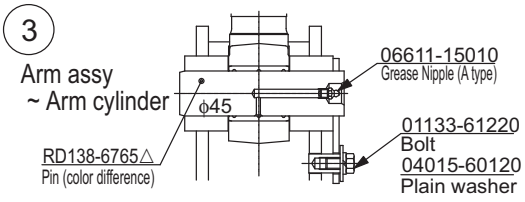


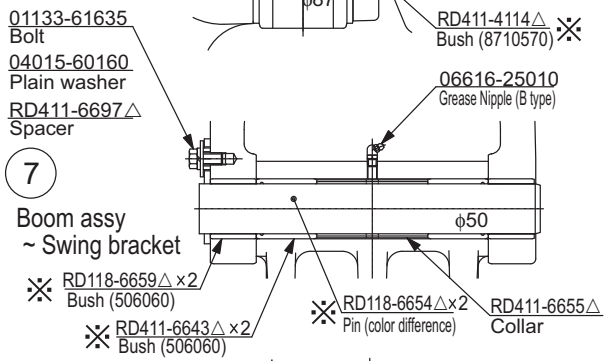


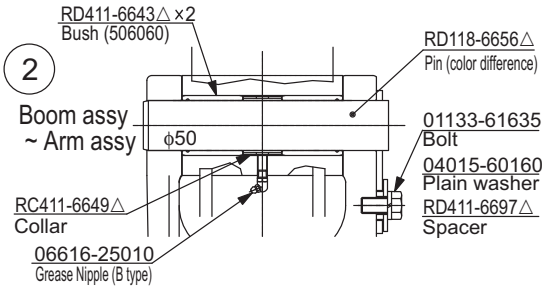


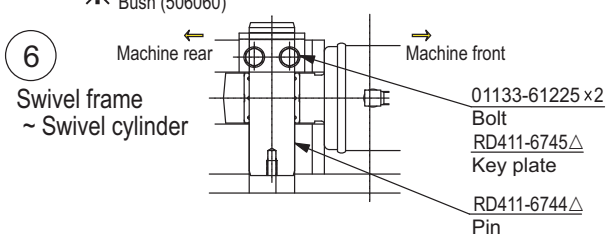


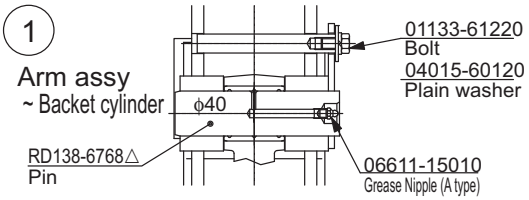












g) Installing Pin, Bush and Shim (2): KX121-3S, KX161-3S

Asterisked (※) parts are for KX121-3S only, KX161-3S has different parts number.

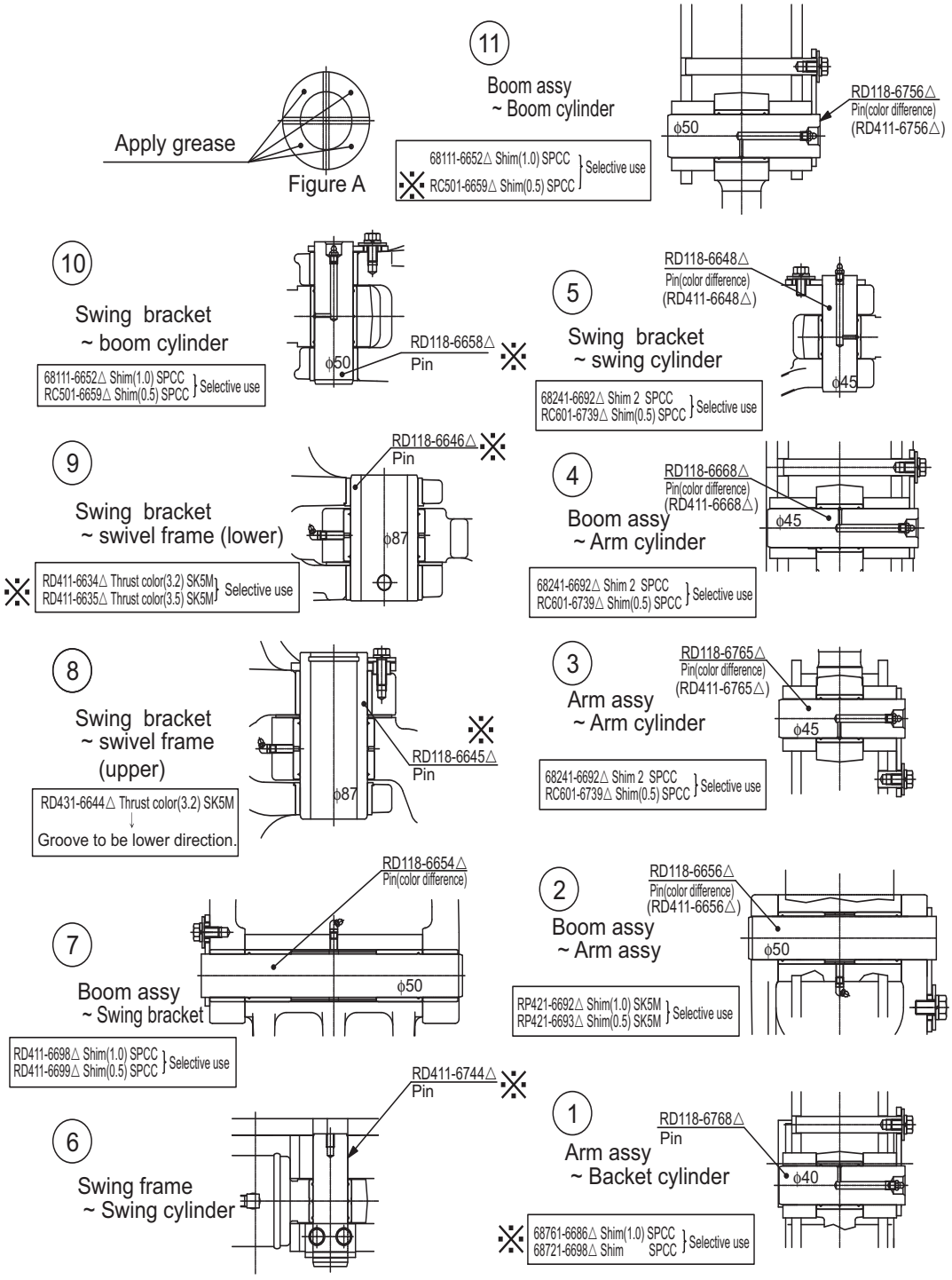
1 **Looseness at the front**
*** Thrust-oriented gaps at support pins**
Below 0.6 mm
* If over 0.6 mm, add shims for readjustment. (For additional shims, see the drawings.)

2 **Lengthwise gaps between swivel frame and swing bracket**
0.1 ~ 1.0 mm (0.004 ~ 0.04 in)

3 **Positioning of pin lock bolts**
All bolts to be installed as shown at right

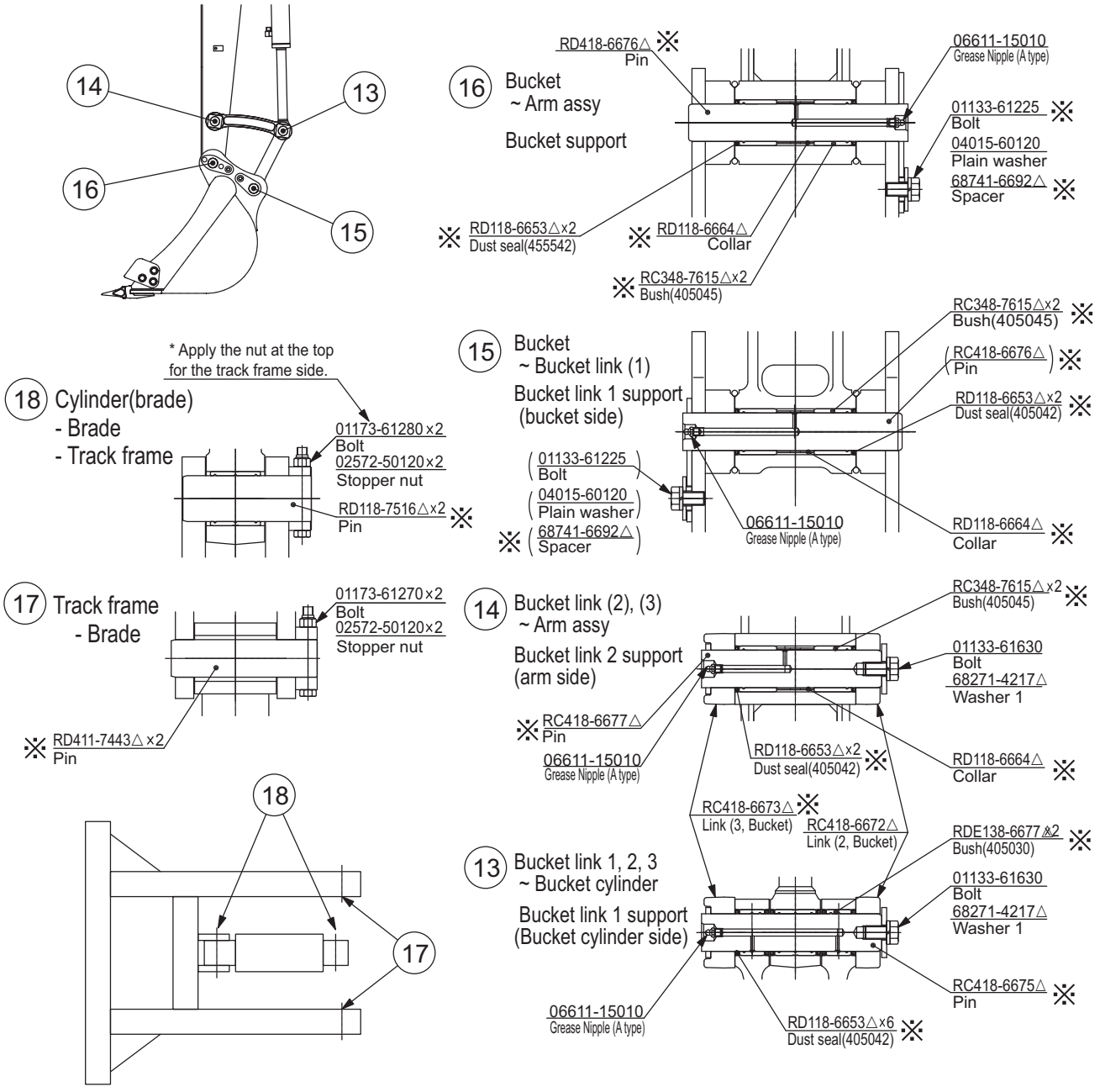
4 **Positioning of thrust collars at upper swing support**
Grooved side to fit on swivel frame

Installing the thrust collars (8) and (9)
1. Fit the grooved thrust collar (with the grooved side downward) at the top. Apply grease to 4 pints of each side. (See Figure A.) (Molybdenum anti-seizing agent also applicable)
2. Prepare 2 different-thickness thrust collars for the lower side. First place the 3.5 mm thick (galvanized) thrust collar. Use this if it fits in smoothly. If not, use the 3.2 mm thick (non-galvanized) thrust collar instead. (In other words, select the better thrust collar.)



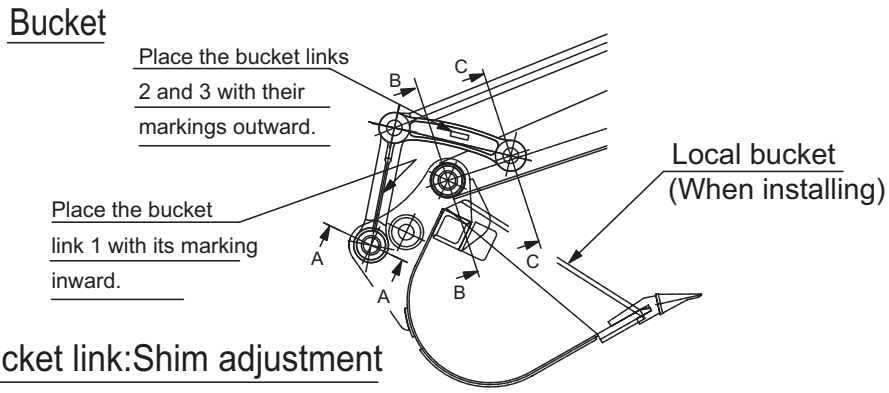
h) Installing Pin, Bush and Shim of Bucket: KX121-3S, KX161-3S

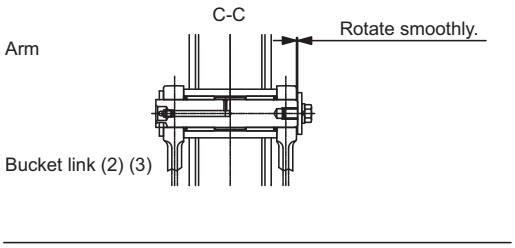
Asterisked (※) parts are for KX121-3S only, KX161-3S has different parts number.

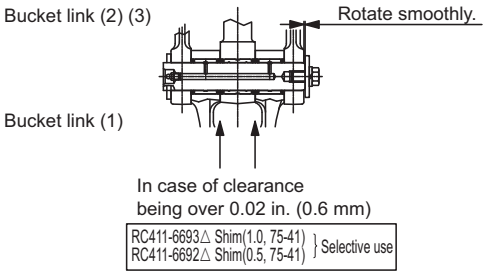


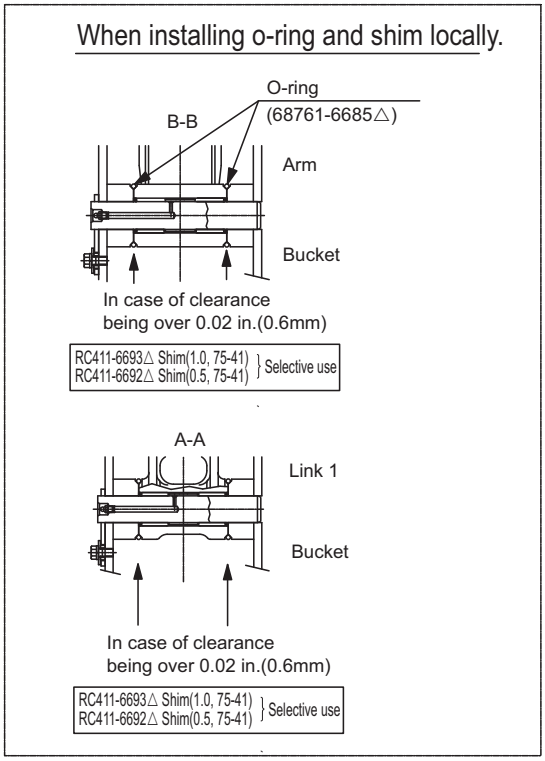
i) Installing Local Bucket: KX121-3S, KX161-3S

1 **Looseness at the front attachment**
*** Thrust-oriented gaps at pins & bushes**
Below 0.6 mm
* If over 0.6 mm, add shims for readjustment. (For additional shims, see the drawings.)



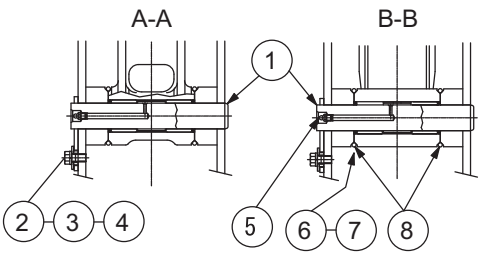






[Machine version without bucket: Parts included]

No	Part	Code No.	Q'ty
1	Pin	RC418-6676	2
2	Spacer	68741-6692	2
3	Plain washer	04014-60120	2
4	Bolt	01133-61225	2
5	Grease nipple	06611-15010	2
6	Shim (1.0, 75-41)	RC411-6693	2
7	Shim (0.5, 75-41)	RC411-6692	2
8	O-ring	68761-6685	4

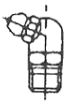


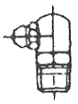
Additional note: For KTC-destined machines, Nos. 6, 7 and 8 (shims and O-ring) alone are supplied.

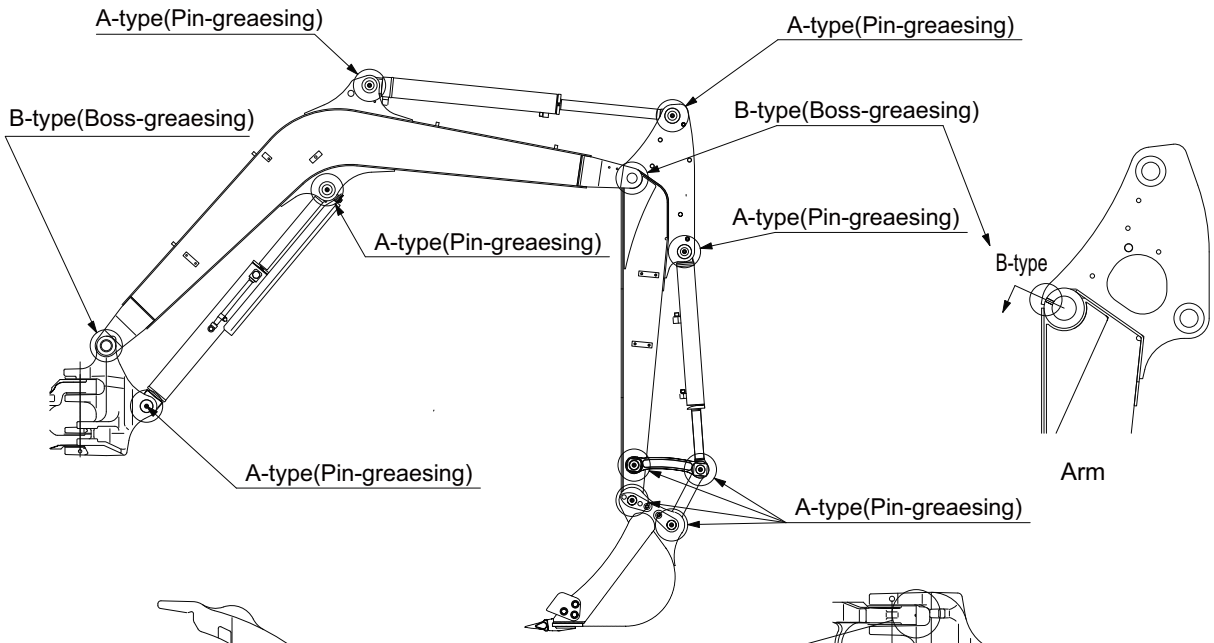
j) Greasing Points

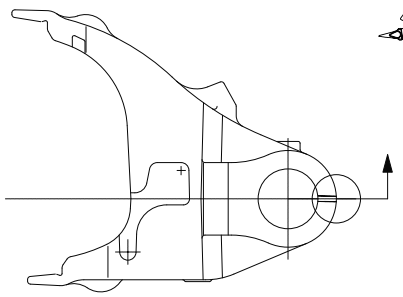
(1) Keep applying grease until it comes out of the circumference at the other end surface of each rotating part.
(2) Apply grease to the end surfaces of all the rotating parts and their related shims.
Apply grease until it seeps out of the other side of the turning end.

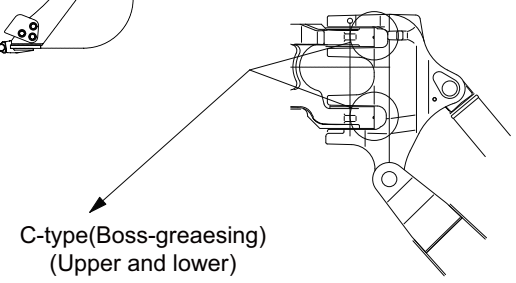
A-type: Straight type
(06611-15010)

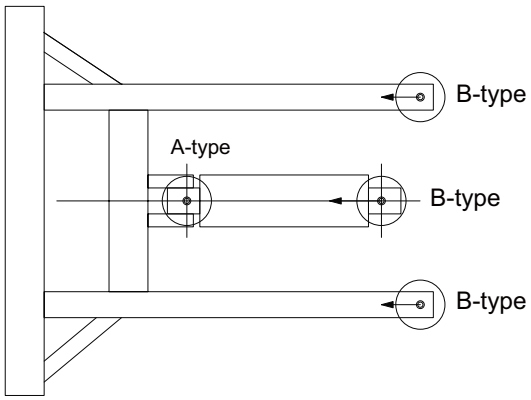

B-type: 67°C
(06616-25010)

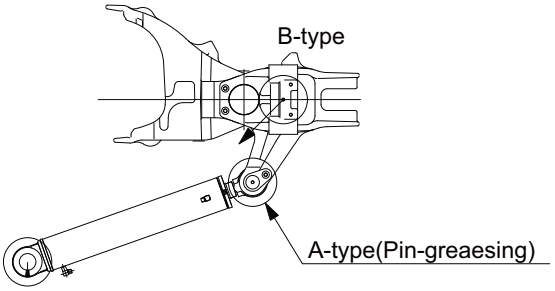

C-type: 90°C
(06616-35010)



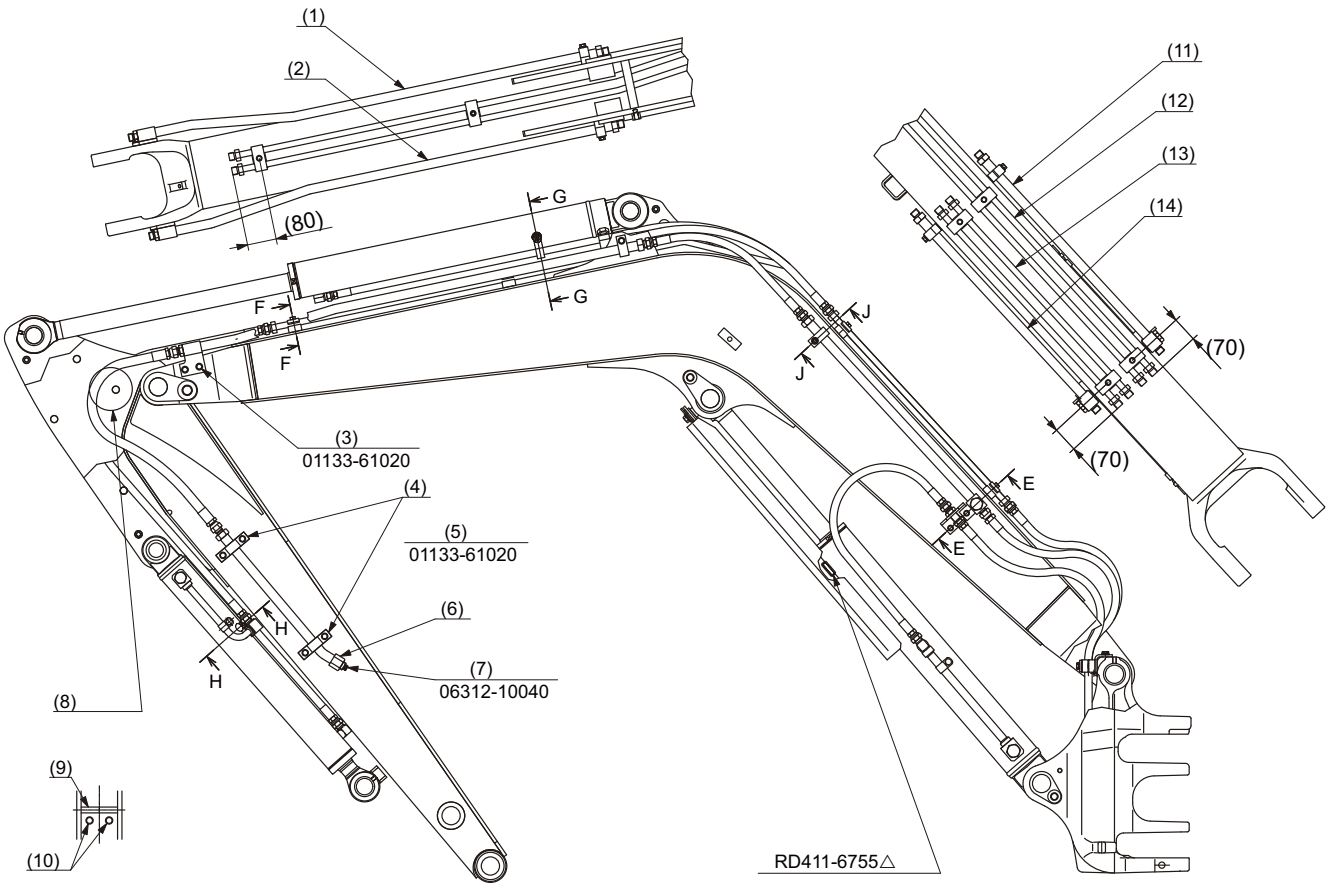

Swivel frame





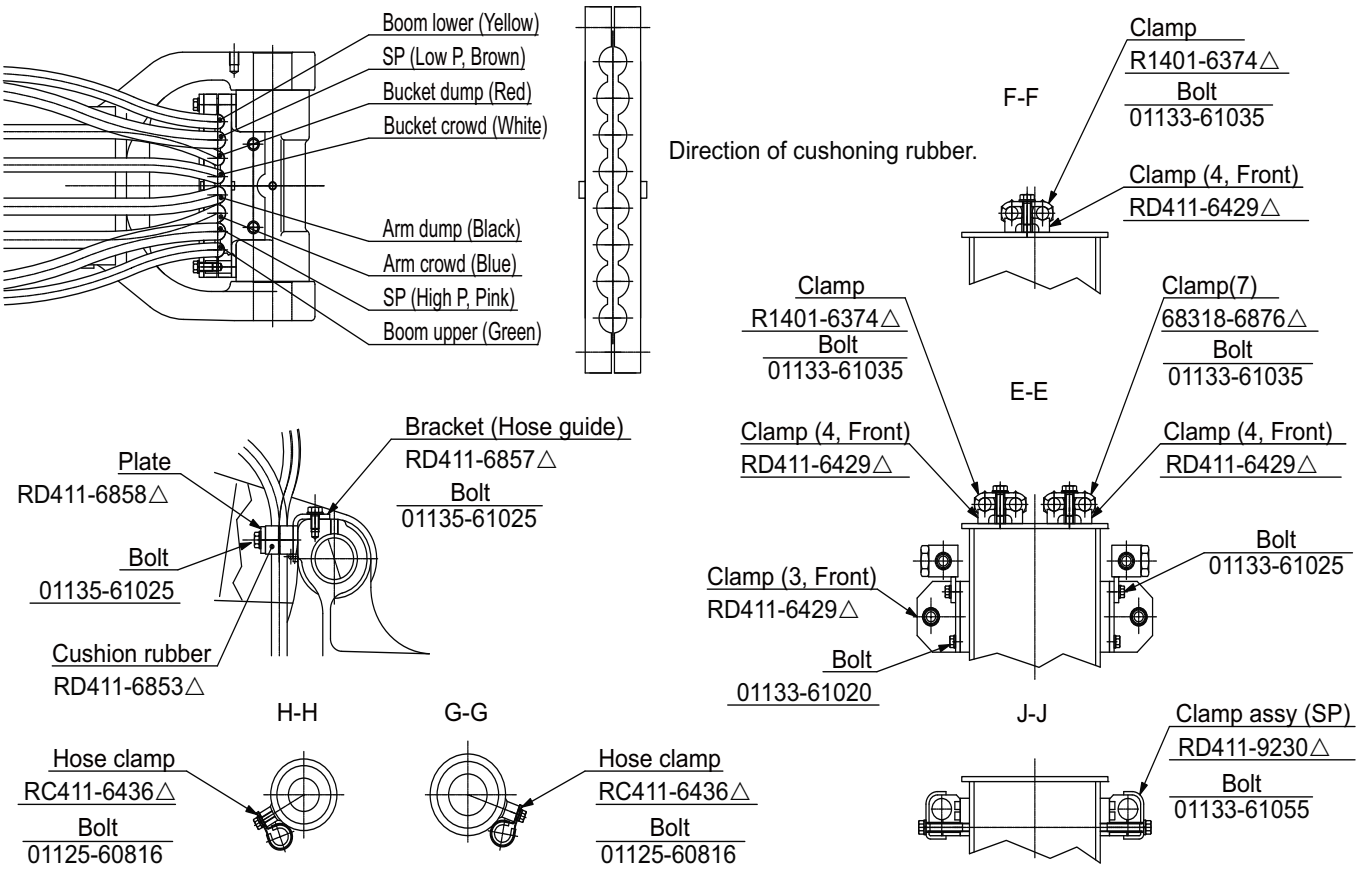


k) Front Hoses and Clamps: KX121-3S

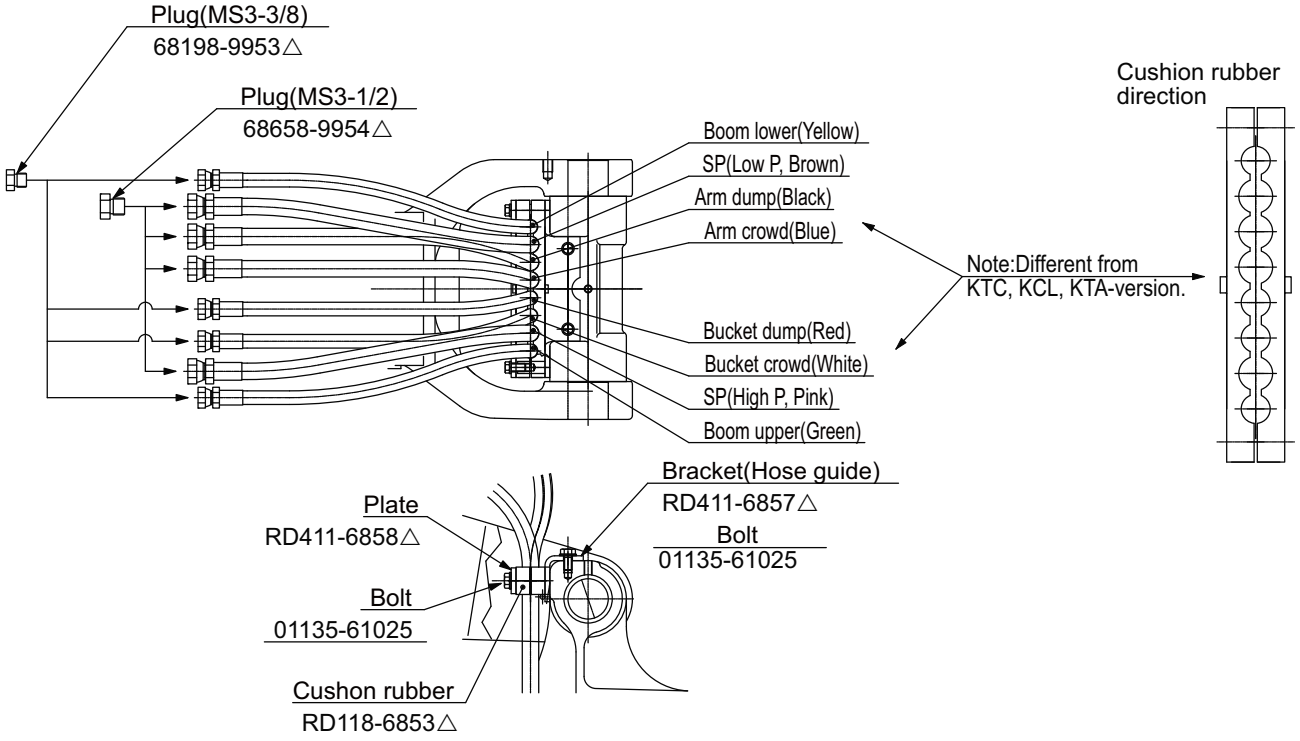


(1) Pipe (R, F, SP)
(2) Pipe (L, F, SP)
(3) Bolt
(4) Clamp
(5) Bolt
(6) Pipe
(7) Plug
(8) Bucket hose route.
Go under hose guide.
(9) Hose guide
(10) Hose
(11) Pipe (R, F, SP)
(12) Pipe (Oil pressure)
(13) Pipe (Oil pressure)
(14) Pipe (L, F, SP)

KX121-3S (KTC, KCL, KTA)

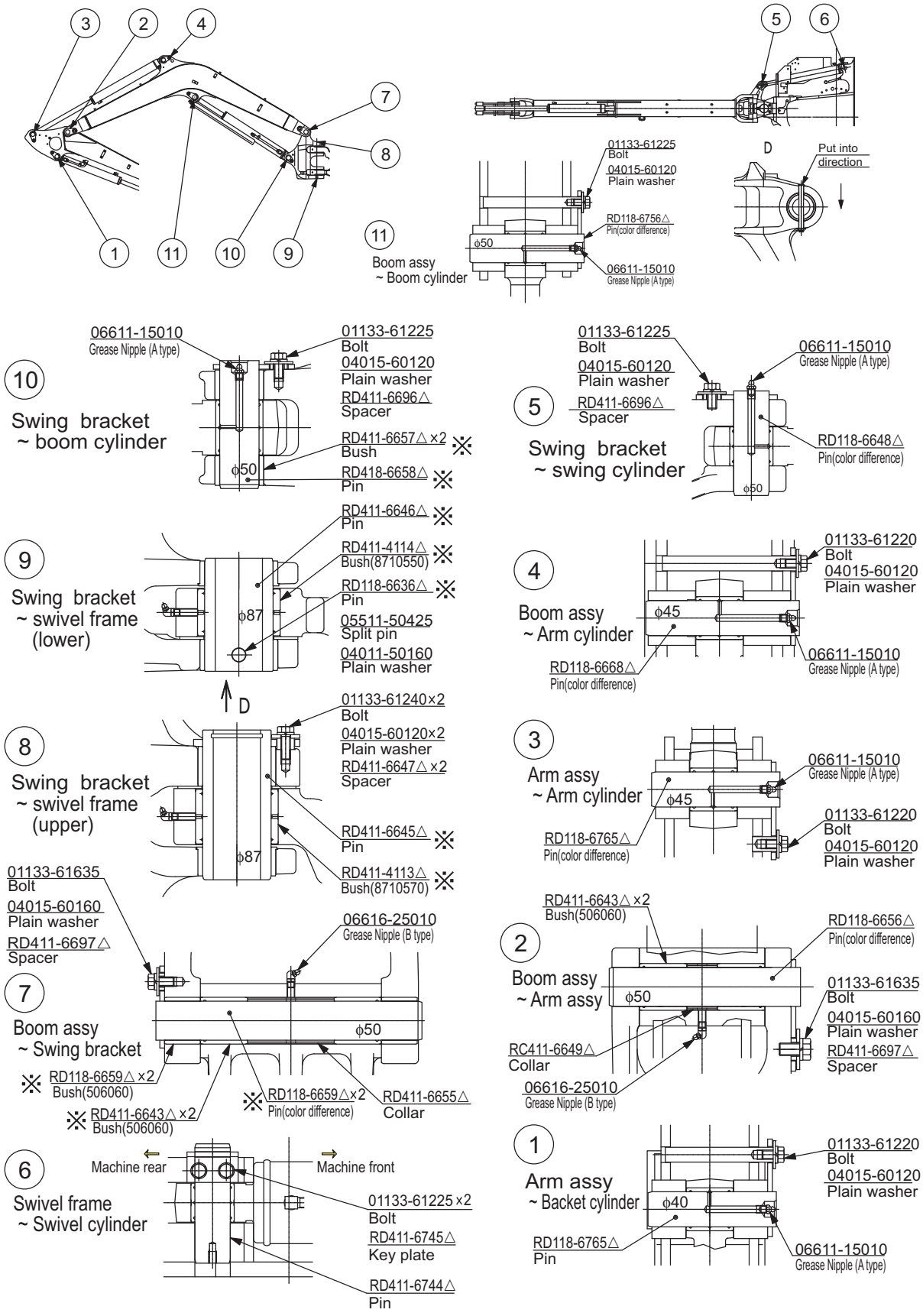


KX121-3 (EU)



f') Installing Pin, Bush and Shim (1): KX161-3S KTC, KCL, KTA

Asterisked (※) parts are different from KX121-3S.



g')Installing Pin, Bush and Shim (2): KX161-3S, KTC, KCL, KTA

Asterisked (※) parts are different from KX121-3S.

1 **Looseness at the front**
*** Thrust-oriented gaps at support pins**
Below 0.6 mm
* If over 0.6 mm, add shims for readjustment. (For additional shims, see the drawings.)

2 **Lengthwise gaps between swivel frame and swing bracket**
0.1 ~ 1.0 mm (0.004 ~ 0.04 in)

3 **Positioning of pin lock bolts**
All bolts to be installed as shown at right

4 **Positioning of thrust collars at upper swing support**
Grooved side to fit on swivel frame

Installing the thrust collars (8) and (9)
1. Fit the grooved thrust collar (with the grooved side downward) at the top. Apply grease to 4 pints of each side. (See Figure A.) (Molybdenum anti-seizing agent also applicable)
2. Prepare 2 different-thickness thrust collars for the lower side. First place the 3.5 mm thick (galvanized) thrust collar. Use this if it fits in smoothly. If not, use the 3.2 mm thick (non-galvanized) thrust collar instead. (In other words, select the better thrust collar.)

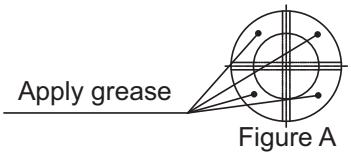
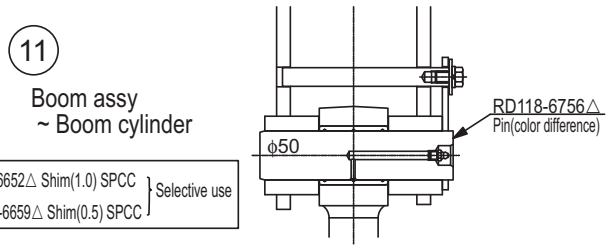
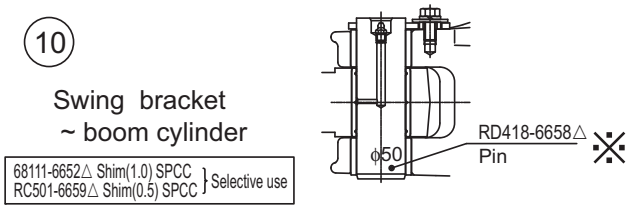
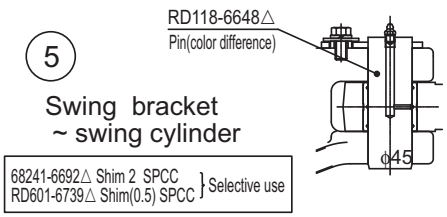
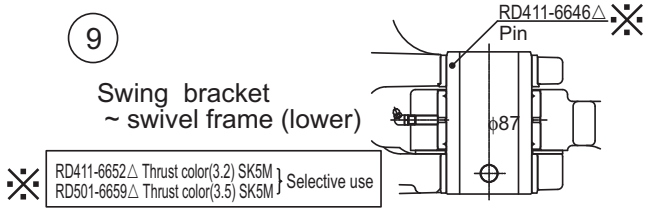


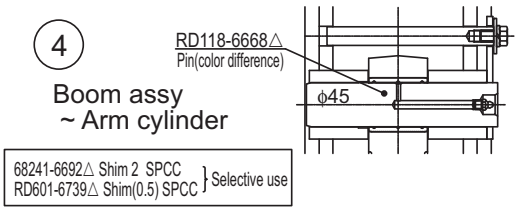
Figure A

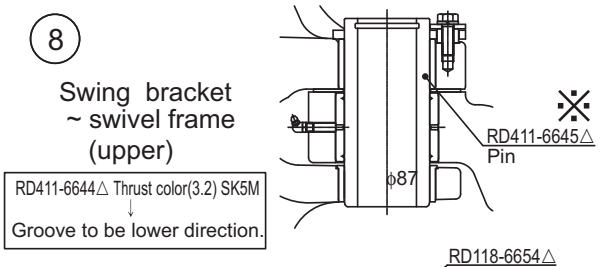


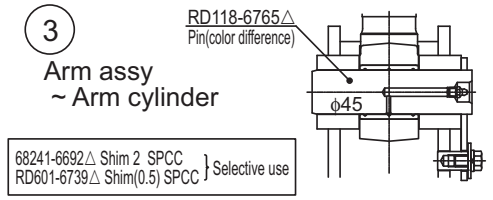


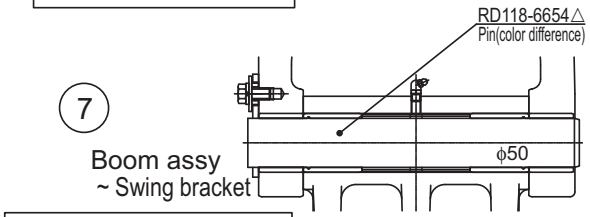


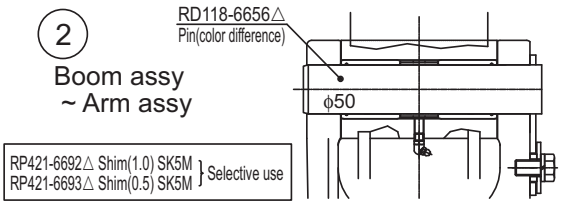


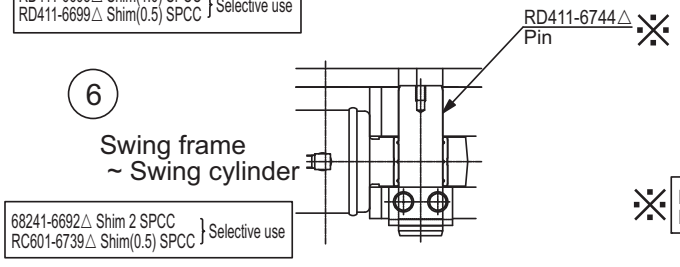


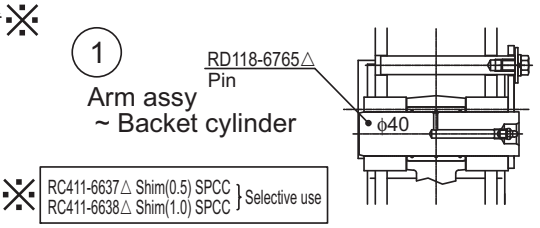






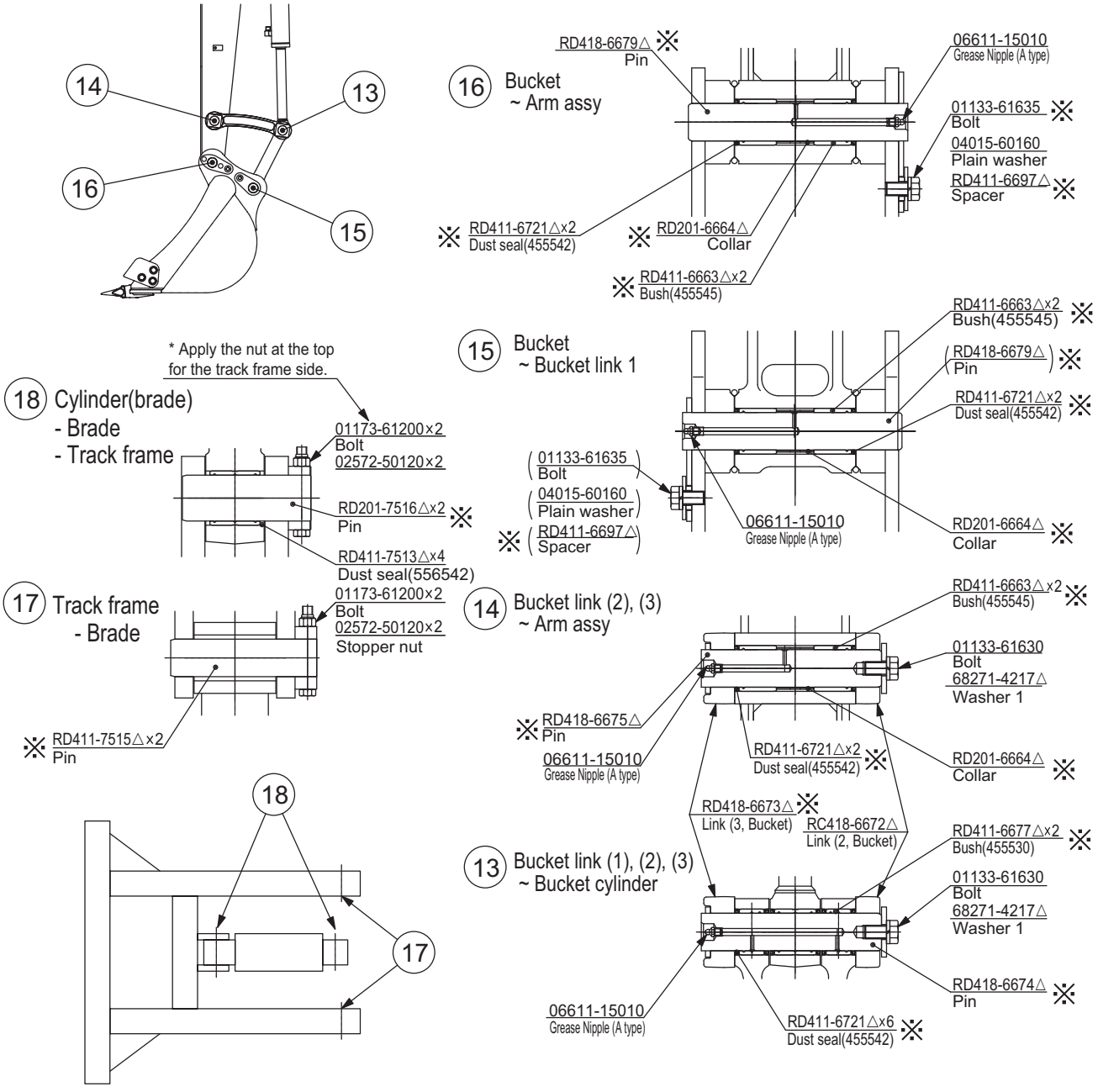




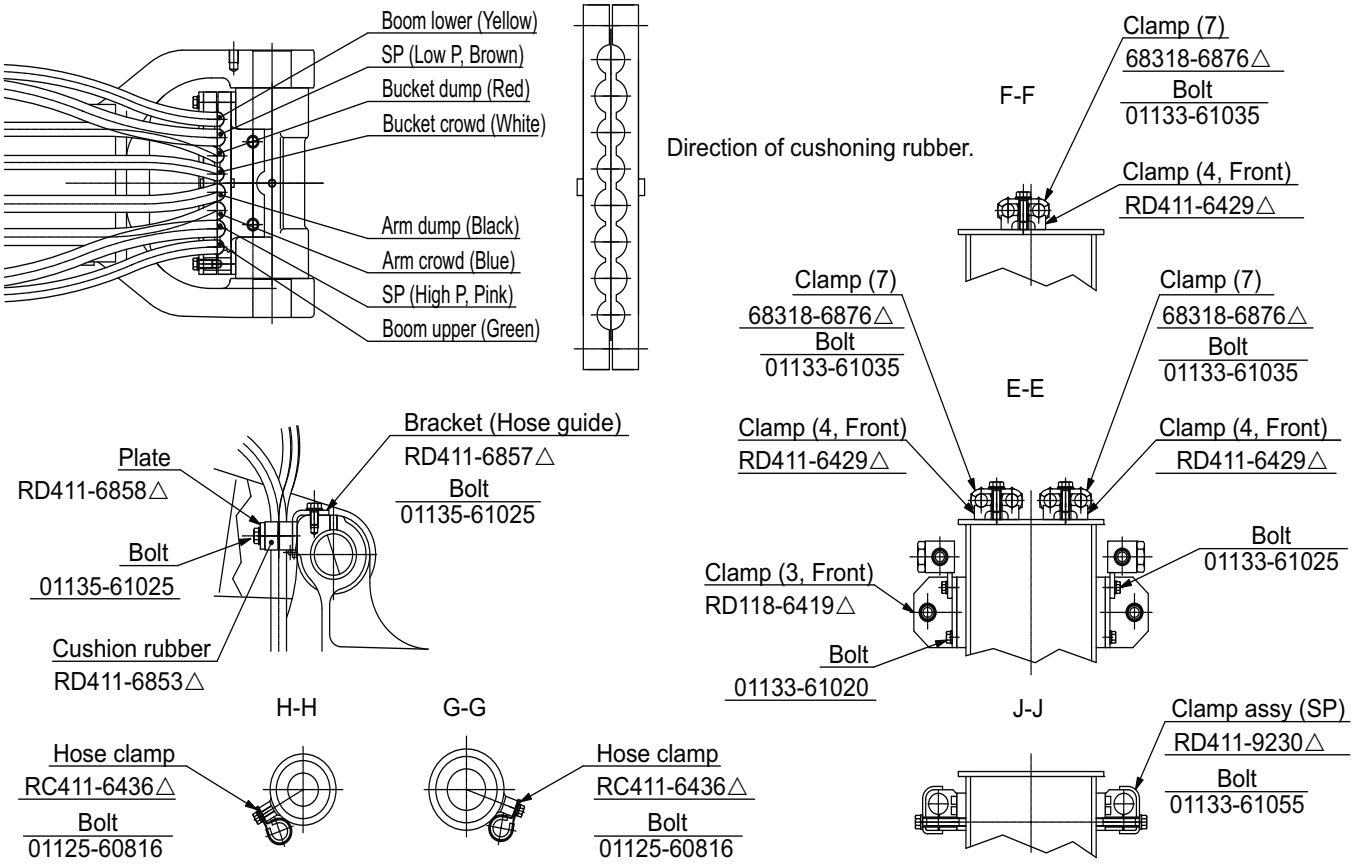


h')Installing Pin, Bush and Shim of Bucket: KX161-3S, KTC, KCL, KTA

Asterisked (※) parts are different from KX121-3S.

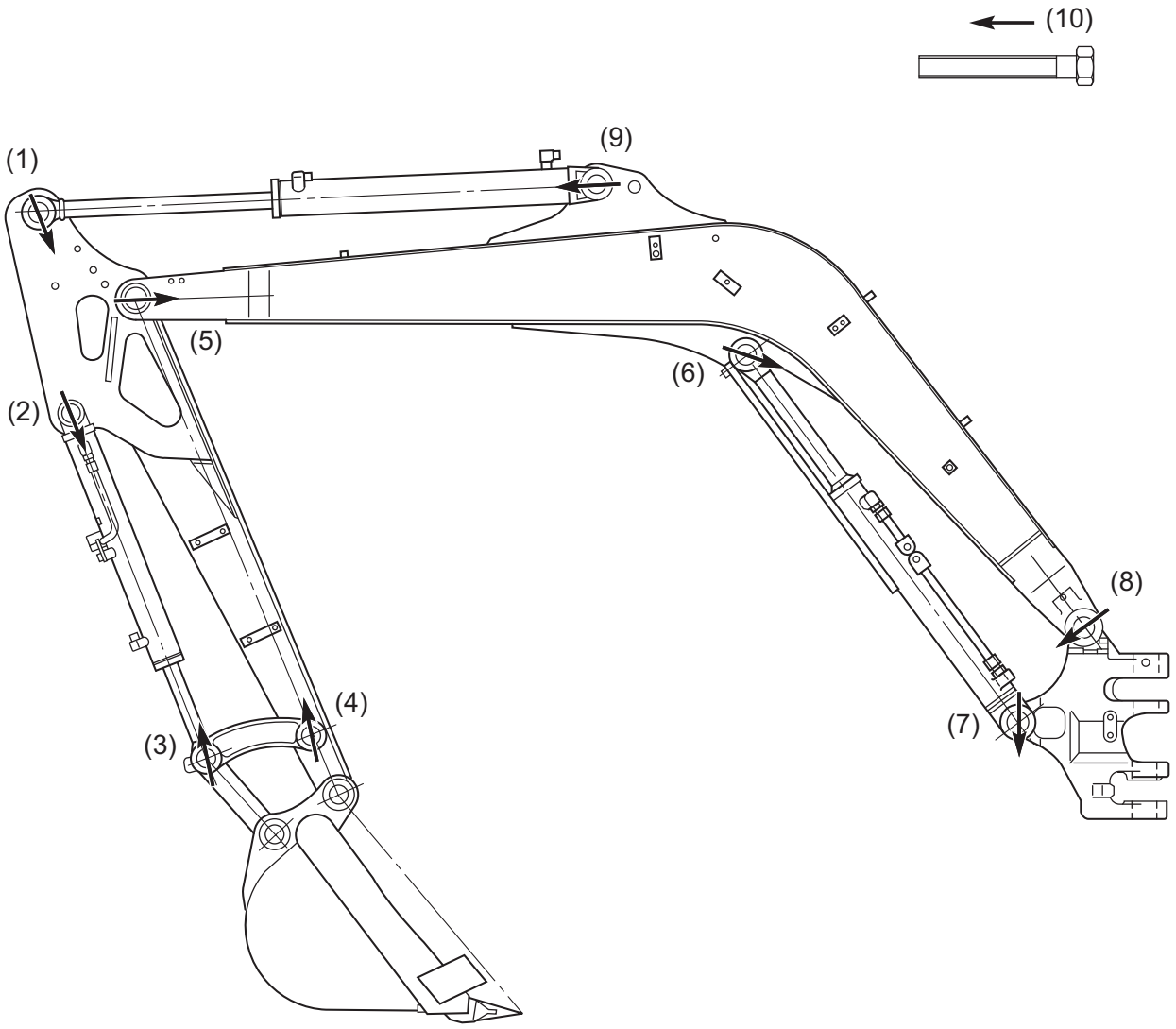


KX161-3S (KTC, KCL, KTA)



l) Installing Direction of Fixing Pin Bolts: KX121-3S

1. Insert the pin fixing bolts in the arrow-marked direction in this drawing.
2. Apply the double nuts at the ✶-marked points, and the self-locking nuts at the other points.
3. In tightening the nuts, ensure a clearance of about 1 mm between the boss and the nut.

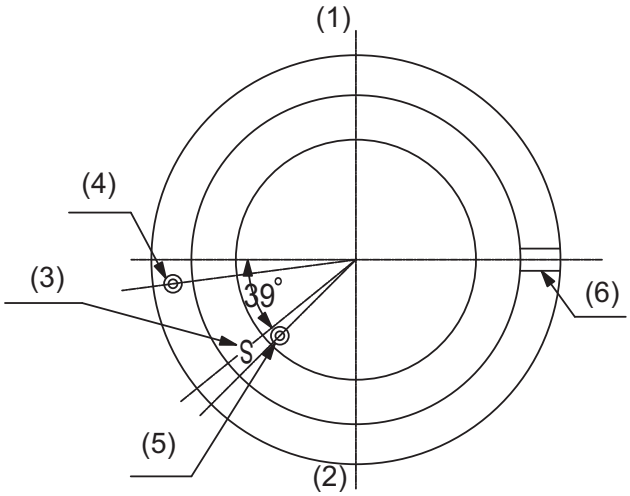


(1)	Bolt 01173-61290 Nut, Self-Locking 02572-50120	(2)	Bolt 01173-61275 Nut, Self-Locking 02572-50120	(3)	Bolt 01173-61202 Nut 02174-60120 x 2	(4)	Bolt 01173-61202 Nut 02174-60120 x 2	(5)	Bolt 01173-61280 Nut, Self-Locking 02572-50120
(6)	Bolt 01173-61290 Nut, Self-Locking 02572-50120	(7)	Bolt 01173-61202 Nut, Self-Locking 02572-50120	(8)	Bolt 01173-61202 Nut, Self-Locking 02572-50120	(9)	Bolt 01173-61290 Nut, Self-Locking 02572-50120	(10)	✶ Bolt inserting direction

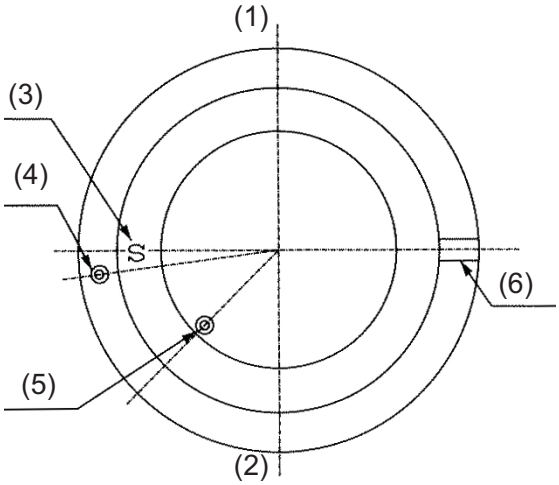
(E) UPPER STRUCTURE

a) Swivel Bearing

KX121-3, KX121-3S, KX121-3α



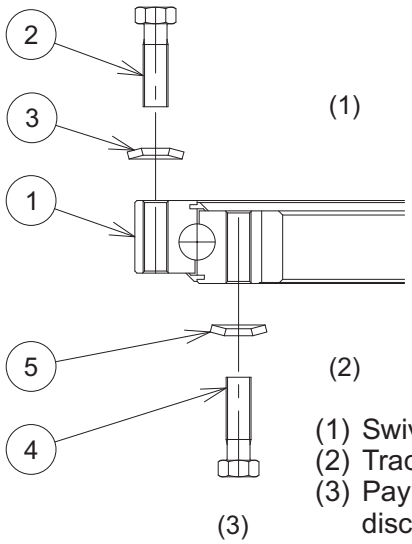
KX161-3, KX161-3S, KX161-3α
U45S, U45-3S, U45-3α, U50-3α



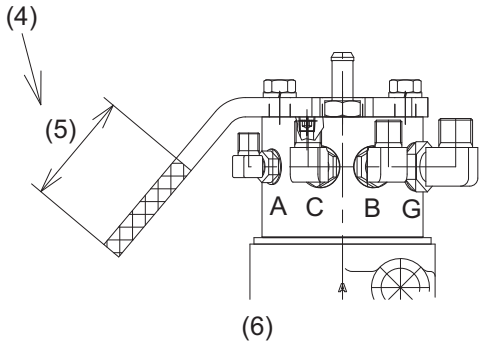
(1) Machine rear
(2) Machine front
(3) Marked "S" (Soft zone of inside gear)
(4) Hole of grease supply (part of ball)
(Must be faced of the hole on the frame)
(5) Grease supply to teeth
(6) The gate of balls (Soft zone of outside gear)

1. Inner race soft zone: S mark
   • Set “S” mark at its right position.
2. Outer race soft zone: Ball inlet
   • This soft zone should be at its left side.
3. Align the grease nipple hole of the swivel frame with the nipple on the bearing.

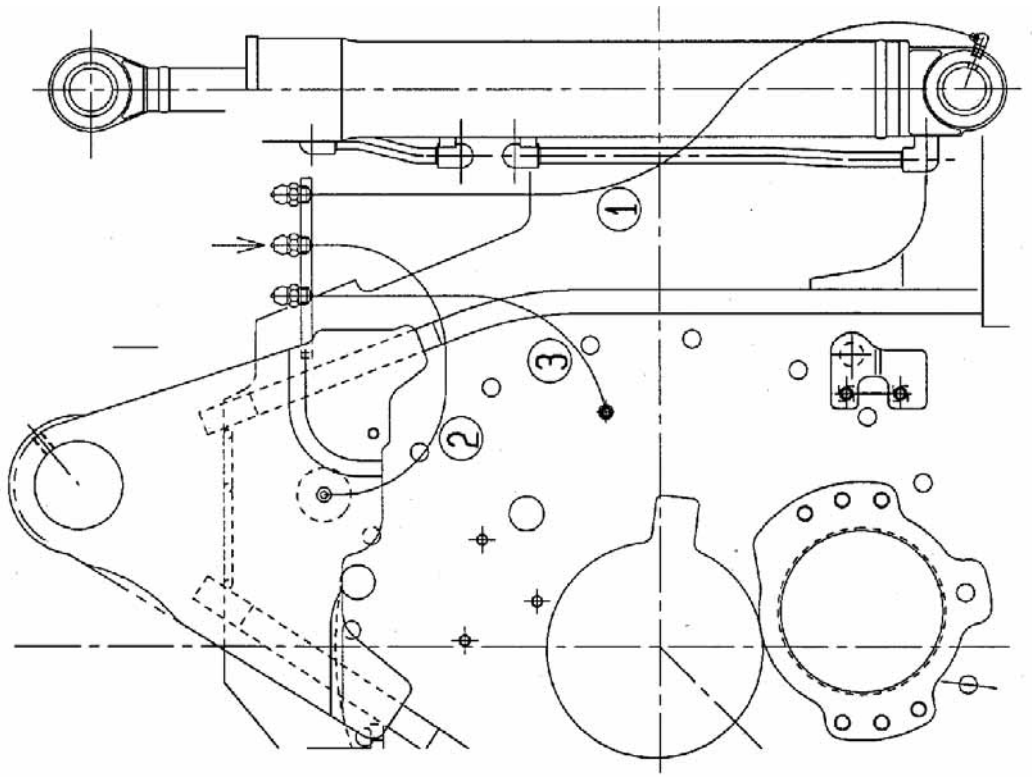
A 4. Swivel Bearing Tightening
   • Apply Locktite #271 on the bolts.
   • Tightening torque: 259.9 ~ 304.0 N·m
     26.5 ~ 31.0 kgf·m
     191.7 ~ 224.2 ft·lbs
   • Apply grease to the entire surface of the bearing teeth uniformly.

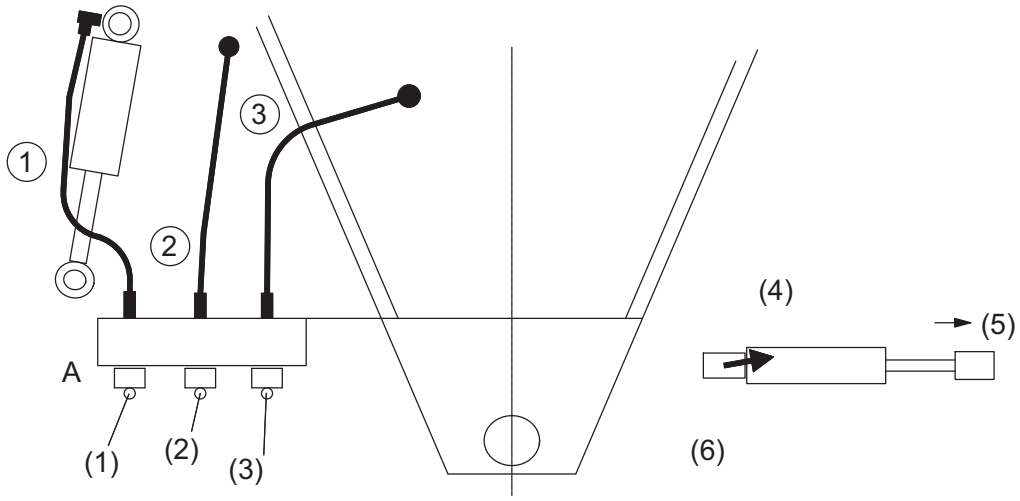


(1) Swivel frame side
(2) Track frame side
(3) Pay attention to the disc spring direction.



(4) Using a brush, apply grease on both sides of the stopper over this hatched range.
(5) About 70
(6) Subject: KX161-3S, U-45S and angle-dozer type

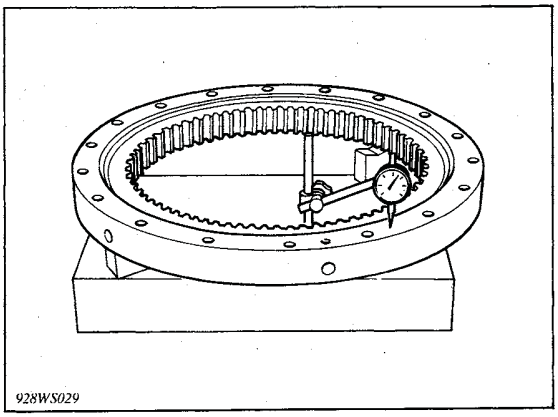




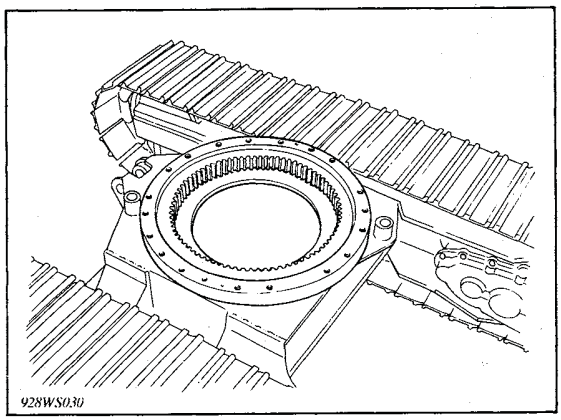
(1) Swing
(2) Ball
(3) Teeth
(4) Upper angle 10°
(5) Front
(6) Direction of adapter (swing cylinder) (view right side of machine)

Unit: mm (inch)

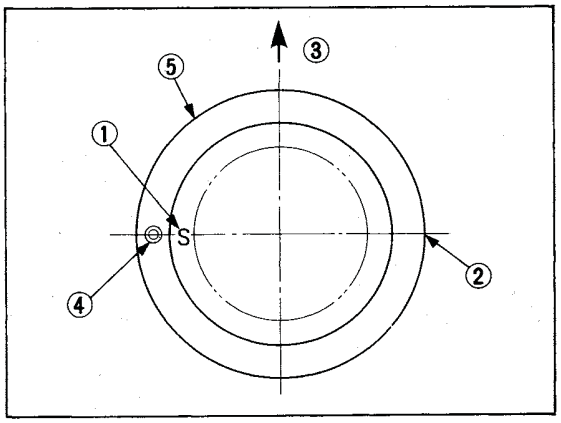
Grease tube (L)	**KX121-3S, KX121-3α**	**KX161-3S, KX161-3α U45S, U45-3S, U45-3α, U50-3α**
①	900 (35.4)	900 (35.4)
②	600 (23.6)	850 (33.5)
③	600 (23.6)	700 (27.6)



5. Inspection
   1. Check the clearance by fixing the inner race and strongly pushing the outer race vertically.
   2. Check the bearing for smooth rotation by the inner race and rotating the outer race with one hand.
      - Reference value ... Clearance: Less than 0.012 in (0.3 mm)
      - Allowable limit ..... Clearance: 0.024 in (0.6 mm)
      - The swivel bearing shall rotate smoothly.



[Precautions when reassembling]
- Clean up the swivel bearing and wipe the threads of the mounting bolts clean.
- Sling up the swivel bearing and place it onto the lower structure. In so doing, carefully align the “S” mark of the bearing’s inner race with the side on the lower structure.



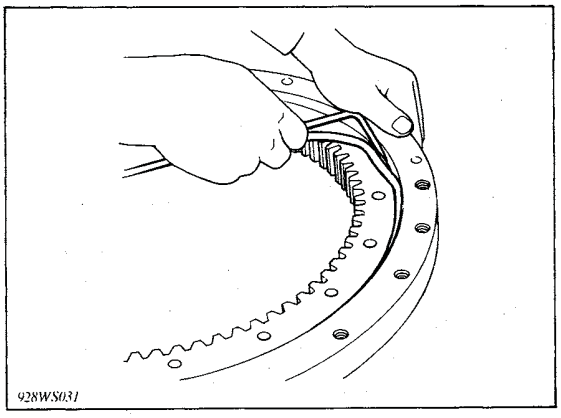
(When reassembling)
- Pay attention to the position of the soft zone (S mark).

1. The S marked portion of the inner race should be positioned to the left of the macine body.
2. The knock pin portion of the outer race should be positioned to the right of the machine body.

- Align the grease nipple hole of the swivel frame with the bearing nipple.
- Bolts should be tightened diagonally by turns.
- Apply grease to the entire surface of the bearing teeth uniformly.

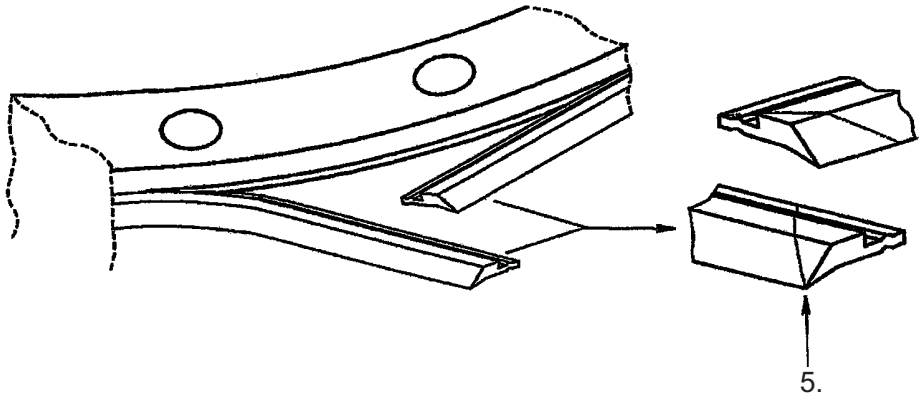
(1) S mark on the inner race
(2) Outer race (knock pin)
(3) Machine front
(4) Grease fitting
(5) Outer ring

* The arrangement depends on machine models.



- To remove the seal, take the steps as shown.

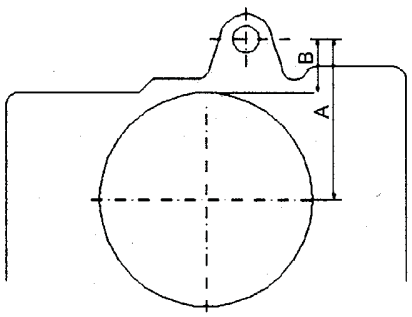
6. Replacement step for the seal in the swivel bearing
   1. Remove the seal and the adhesive left in the seal groove.
   2. Wash with thinner-absorbed cotton and let it dry.
   3. Put the adhesive (Three Bond 1745) into all round of seal groove.
      The adhesive must use a nitrite rubber type.
   4. Put the new seal into the seal groove. It will be easier to use a spatula.



   5. The both ends of seal are to be cut at 45 degrees to have much surface for bonding.
   6. Apply the adhesive (Three Bond 1701) on both cut surfaces and put into the seal groove.

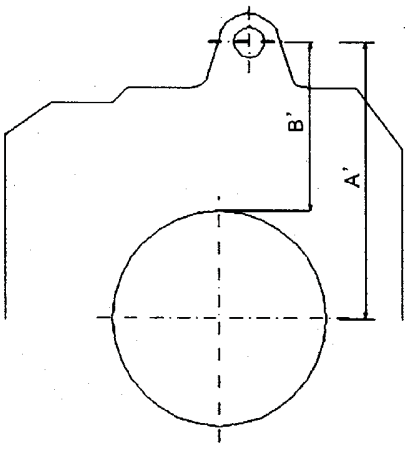
7. Measuring the swivel bearing play
   1. MODEL: KX121-3, KX161-3, U45-3, KX121-3S, KX161-3S, U45S, KX121-3α, KX161-3α, U45-3α, U50-3α
   2. Background
      On the above models, the swivel bearing on the swivel frame was installed in a different location from the series 2 machines.
      "Tight tail" is the basic design concept of the above models, the swivel bearing is at the center of the swivel frame and the distance between the swivel center and the swing supporting point is longer than the series 2 machines. (See the sketch below.) In such architecture, the swivel frame is more flexible than the series 2 machines. Some operators might think this swivel frame flexure as excessive swivel bearing play.
      From the viewpoint of durability, however, the entire mechanism is flexible structure for stress reduction. In this way, there is no problem with the durability of swivel bearing. The procedure for measuring the swivel bearing play of following page is greatly affected by measurement position. It should be noted that the measurement results do not reflect the swivel bearing play alone, but include the swivel frame bending. Please explain your measurement results to your customers with the above structural feature in mind.

Swivel bearing position on KX161-2



A < A'
B < B'

Swivel bearing position on KX161-3



(Sample illustration)

3. Sample data for your reference
   - Measurement results before shipment
   - Meaurement results at KUBOTA (11 machines): Average 0.51 mm (0.02 in) [0.48 ~ 0.6 mm (0.019 ~ 0.024 in)]
   - Measurement results at KBM: 0.75 ~ 0.8 mm (0.0295 ~ 0.0315 in)
   - Reference: Play criterion of 0.3 mm (0.0118 in) or less for the swivel bearing alone on models KX161-2 and KX161-3
   - Allowable backlash in the measurement procedure discussed below
   - Tolerance: 1.6 mm (0.063 in)
   - Procedure of measuring the swivel bearing backlash
   - Refer to the following procedure.
4. Measurement procedure

   Notes:
   - Park the machine on a level surface and bring the attachments on the ground.
   - Before starting measurement, make sure there is nobody around the machine.

   1) Measuring instrument and fixture
      Dial gauge (1/100), dial gauge fixture
   2) Attach the dial gauge fixture on the machine front so that the dial gauge's measuring point should be 20 mm (0.787 in) away from the swivel race.

Fig. 1 Dial gauge location

(3) Fully stretch the arm and place the bucket in the crowded position (see Fig. 2). Set the dial gauge to the zero pint.

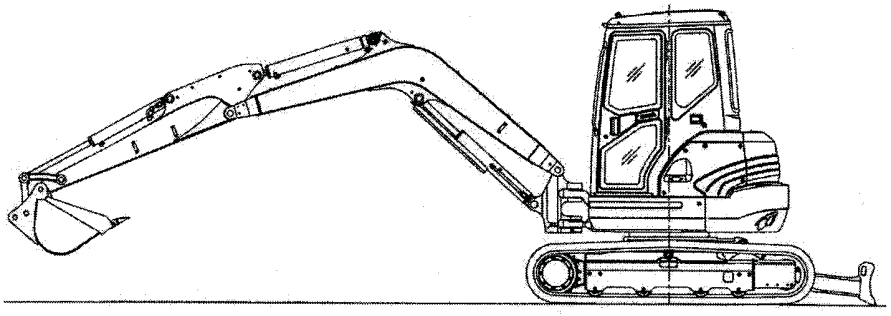


Fig. 2

4. Using the attachment, tilt up the machine body as shown in Fig. 3 below, and take the dial gauge reading. Make this measurement several times and take their average as the final measurement.

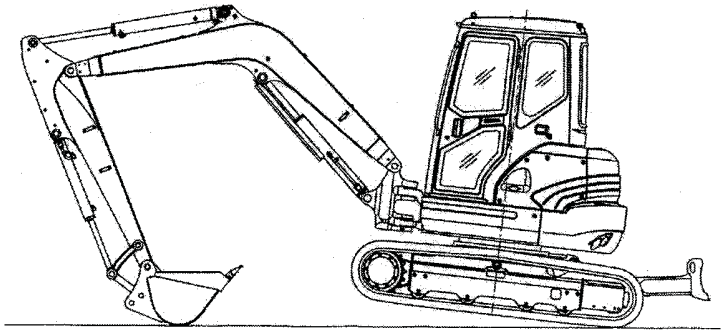
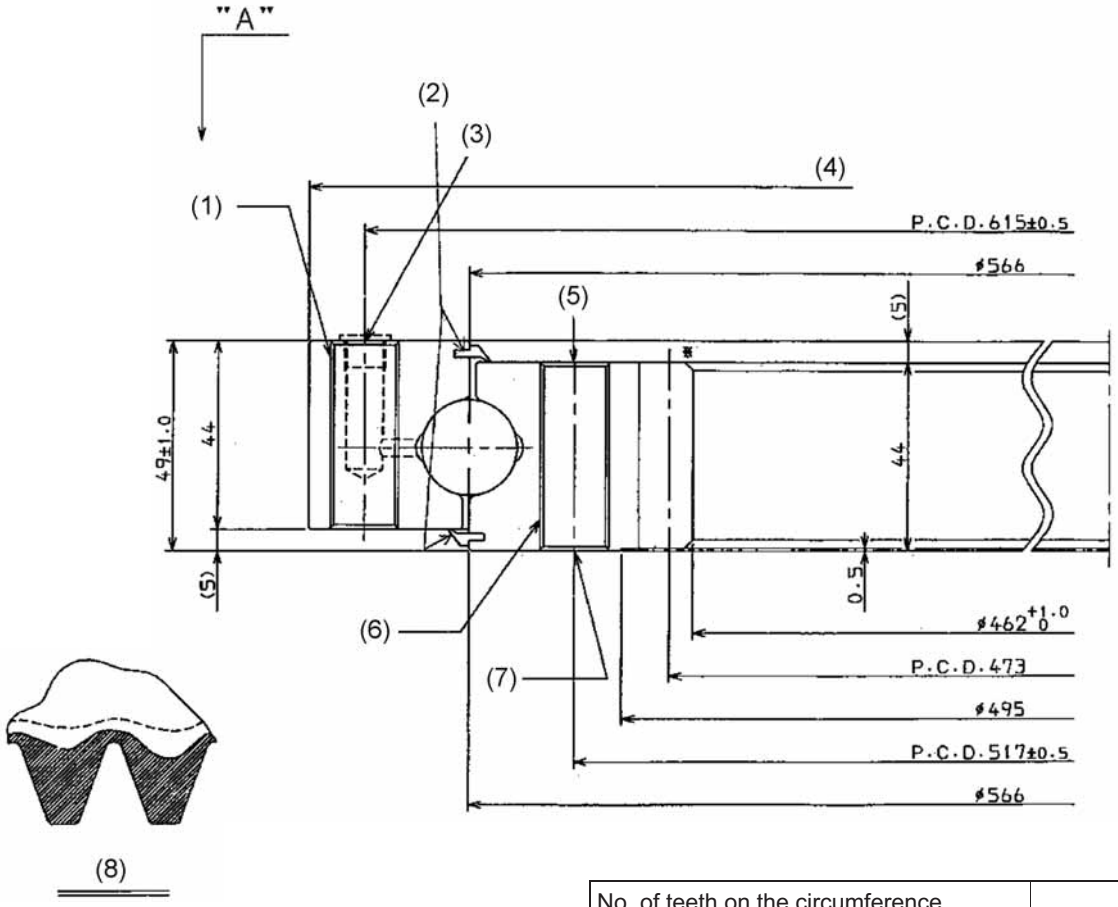


Fig. 3

8. Specifications

1) KX121-3S

Code No. RD118-19112



(1) 22-M16 x 1.5 Unequally spaced
(2) RD118-1913Δ Sealing kit (one each for top and bottom)
(3) Rc1/8 greasing port, 1 location (Plug with the plastic cap.)
(4) (Remaining mill scale allowable) ø641
(5) "S" mark
(6) 22-M16 x 1.5 Unequally spaced
(7) "S" mark
(8) Gear teeth hardening pattern

Unit: mm (in.)

No. of teeth on the circumference	86
Reference pitch diameter	ø473, (18.6)
Backlash	0.10 ~ 0.40, ((3.9 ~ 15.7) x 10^{-3}) (Pinion not included)
Over pin dimension	ø463.374 $^{+1.89}_{+0.29}$ (Pin diameter: ø8.5)
Radial clearance (load measured:)	
Axial clearance (load measured:)	0.03 ~ 0.15, ((1.2 ~ 5.9) x 10^{-3})

KX121-3S: RD118-19112	At loading	At digging
Moment load (kN-m)	27.29	81.29 (189.5)
Axial load (kN)	30.14	24.99 (24.99)
Radial load (kN)	11.12	21.66 (30.09)

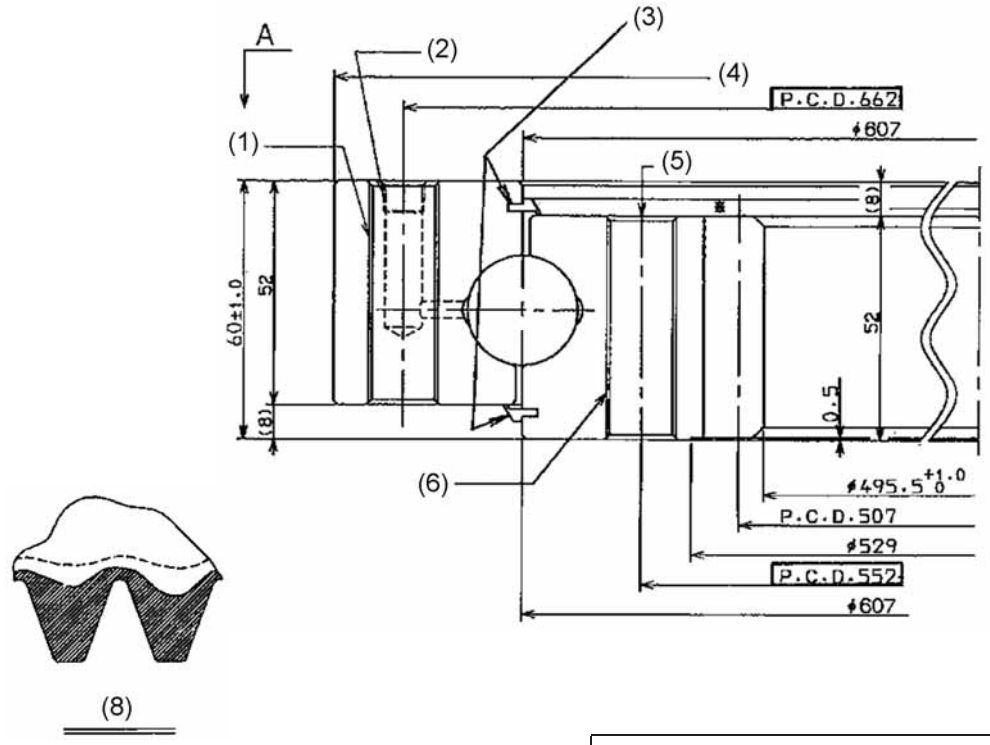
The figures in parentheses are given when the machine's rollover or tilting is not considered.

RD118-1913Δ	Seal B	1	NBR
Sealing kit	Seal A	1	NBR

Notes:

1. The inner and outer race tracks as well as the tooth faces and bottoms are induction-hardened.
   Track surface hardness: Over 55 HRC
   Tooth face/bottom hardness: 52-60 HRC
   Effective hardening depth: Over 2.0 mm (7.9 x 10^{-2} in.) on tooth faces and over 0.5 mm (2.0 x 10^{-2} in.) on tooth bottoms
2. The "S" marks on the inner race and the plug of the outer race stopper are located in the soft zone. In setting up the bearing, position its soft zone as free from loads as possible.

2) KX161-3S
Code No. RD538-19111



(8)

Unit: mm (in.)

(1) 24-M16 x 1.5 (Unequally spaced)
(2) Rc1/8 greasing port, 1 location
(Plug with the plastic cap.)
(3) RD538-1921AΔ Sealing kit
(one each for top and bottom)
(4) (Remaining mill scale allowable) ø694
(5) "S" mark
(6) 24-M16 x 1.5
(26 locations equally spaced, except for 2 locations)
(8) Gear teeth hardening pattern

KX161-3S: RD538-19111	At loading	At digging
Moment load (kN-m)	46.45	131.90 (252.20)
Axial load (kN)	40.05	34.24 (34.24)
Radial load (kN)	17.80	29.81 (34.65)
Gear tangential force (kN)	48.9	

The figures in parentheses are given when the machine's rollover or tilting is not considered.

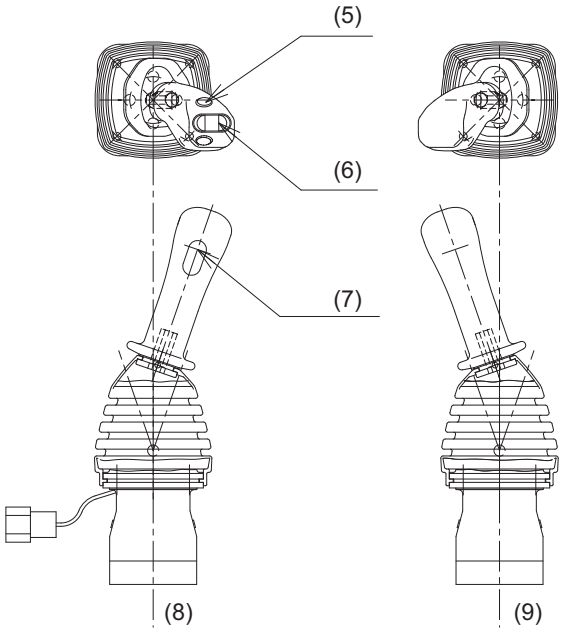
No. of teeth on the circumference	78
Reference pitch diameter	ø507, (20.0)
Backlash (pinion not included)	0.05 ~ 0.39, (2.0×10^{-3} ~ 1.5×10^{-2})
Over pin dimension	$493.797^{+1.163}_{+0.163}$ (Pin diameter: ø10.5)
Radial clearance (load measured:)	
Axial clearance (load measured:)	0.03 ~ 0.15, (1.2×10^{-3} ~ 5.9×10^{-3})

RD118-1913Δ	Seal B	1	NBR
Sealing kit	Seal A	1	NBR

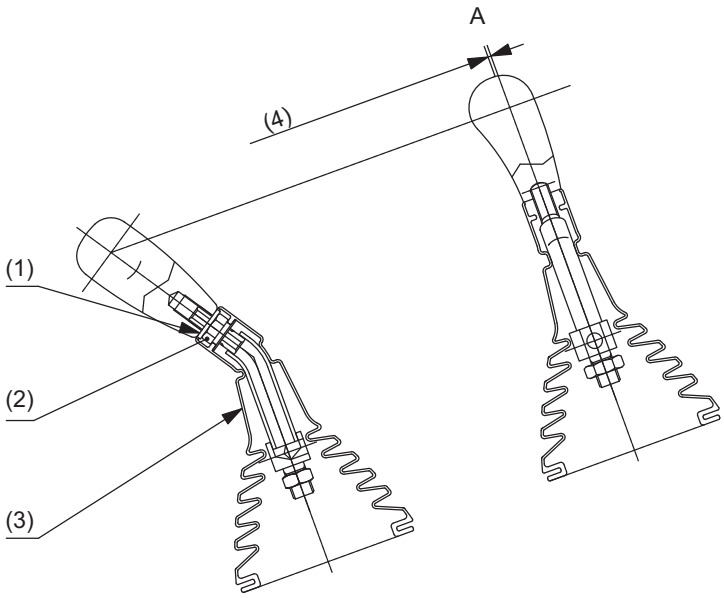
Notes:
1. The inner and outer race tracks as well as the tooth faces and bottoms are induction-hardened.
Track surface hardness: Over 55 HRC
Tooth face/bottom hardness: 52-60 HRC
Effective hardening depth: Over 2.0 mm (7.9×10^{-2} in.) on tooth faces and over 0.5 mm (2.0×10^{-2} in.) on tooth bottoms
2. The "S" marks on the inner race and the plug of the outer race stopper are located in the soft zone.
In setting up the bearing, position its soft zone as free from loads as possible.

b) Pilot Control Lever: KX121-3S/ST/α, KX161-3S/ST/α

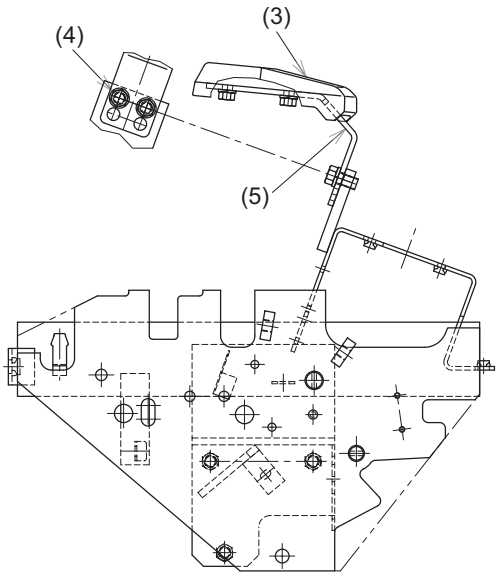
Lock nut of grip
Tightening torque: 25.0 ~ 27.0 N·m (2.5 ~ 2.8 kgf·m) 18.0 ~ 20.3 ft·lbs



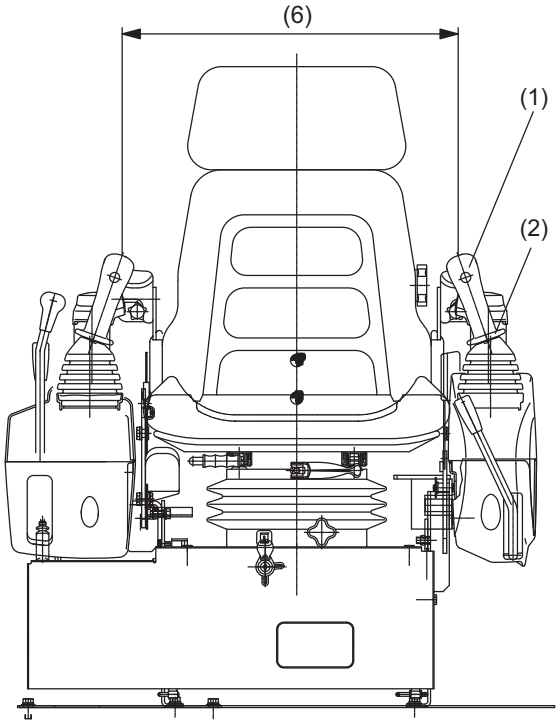
Place the stepped side away from the grip. Cover the step tightly with the rubber bellows.



(1) Plain washer
(2) Nut
(3) Bellows
(4) Free move:within 2 mm (0.08 in)
(5) Hone switch
(6) SP slide switch
(7) SP lock switch
(8) Pilot valve, R
(9) Pilot valve, L



(1) Grip to front
(2) Lever to inward
(3) Wrist rest, nut, washer
(4) Tighten the bolt at upper hole of the bracket.
(5) Bracket (Wrist rest) R, bolt
(6) EU, KTC, KCL: Wrist rest (537, 21.1 inch)



Note: KTA has the arm rest version and the wrist rest is not needed. EU, KTC, KCL are wrist rest types.

c) Traveling Lever

1) Fitting of the bushings
Link (travel L, 2)
Link (travel R, 2)
Fit the bushings deep to the end face.
Keep the inner surfaces from scratches.

DU bushing bearing
08511-01615, 2 pcs. each
Apply grease.

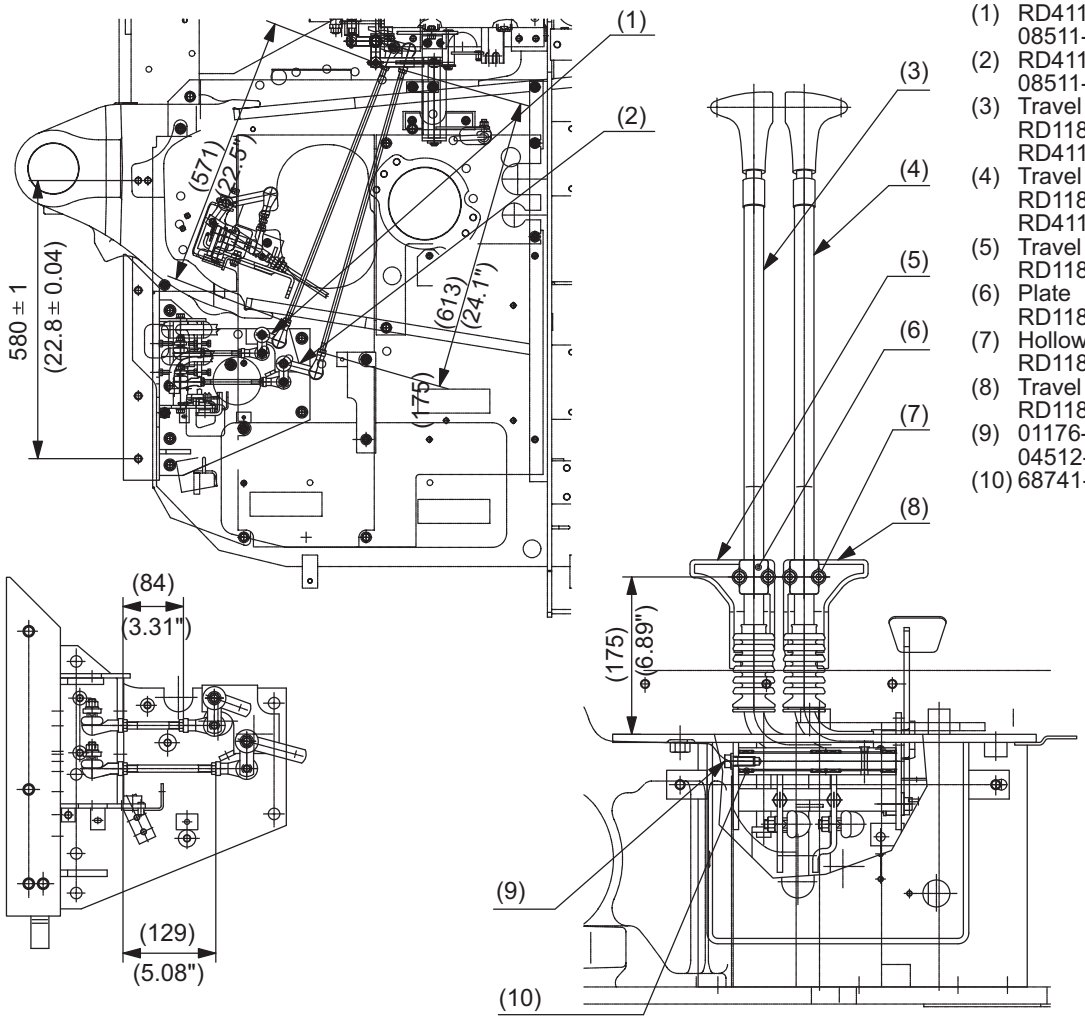
2) Fitting of the needle bearings
Lever (travel left)
Lever (travel right)
68741-6536Δ, 4 pcs.
Fit the bearings deep to the end face.
Install them finally and make sure the support shafts and levers turn smoothly.
In fitting the bearings, apply grease.

Mounting bolt (01176-61025) tightening torque: 60 ~ 70 N·m
6.2 ~ 7.2 kgf·m
44.3 ~ 51.6 ft·lbf

3) Link ball tightening torque: 48 ~ 56 N·m
4.9 ~ 5.7 kgf·m
35.4 ~ 41.3 ft·lbf

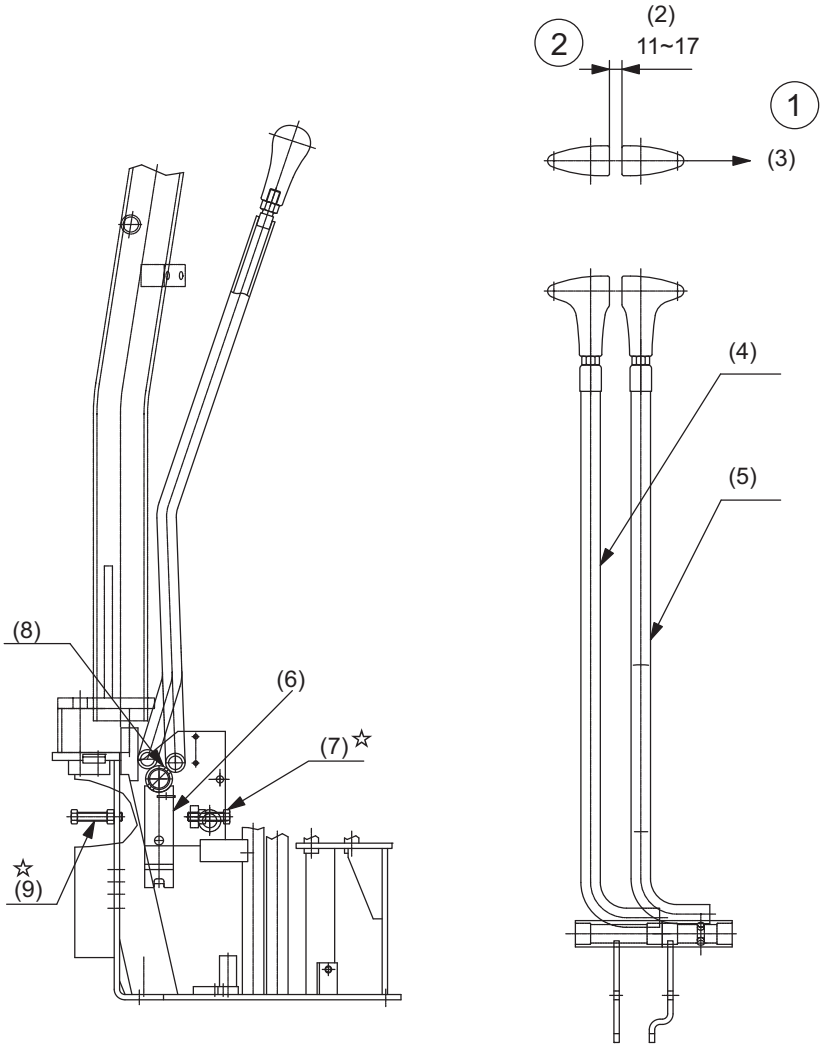
4) Final dimensions of the rods (between rod ends)
Right: Lever side (84 mm)
Control valve side (571 mm) (22.5 in.)
Left: Lever side (129 mm)
Control valve side (613 mm) (24.1 in.)

5) Position of the steering unit (B)
M14 tapped hole distance for mounting the cabin: 580 ± 1 mm (22.8 in.)



(1) RD411-6548Δ Link (travel R, 2)
08511-01615 Bush
(2) RD411-6546Δ Link (travel L, 2)
08511-01615 Bush
(3) Travel lever assy, R
RD118-6535Δ: KX121-3
RD411-6536Δ: KX161-3
(4) Travel lever assy, L
RD118-6530Δ: KX121-3
RD411-6531Δ: KX161-3
(5) Travel pedal, R
RD118-9672Δ
(6) Plate
RD118-9677Δ
(7) Hollow bolt
RD118-9678Δ
(8) Travel pedal, L
RD118-9671Δ
(9) 01176-61025 Bolt
04512-60100 Spring washer
(10) 68741-6536Δ Needle bearing

d) Traveling Lever Adjustment: KX121-3S/ST/α, KX161-3S/ST/α



1) Adjusting of the lever neutral position
   Fit the lever as shown at left.
2) Movement of the travel levers
   Move the levers and make sure they smoothly come back to the neutral position.
3) Check points after fitting
   Make sure the valve spool moves over the entire stroke.
   Make sure the valve spool moves smoothly.
   Retighten up the stopper bolts and nuts.

(2) Clearance: 11 ~ 17 mm (0.43 ~ 0.67 in)
(3) Gap of L & R levers.
   within 2 mm (0.08 in)
(4) Lever assy R
   RD118-6535Δ
(5) Lever assy L
   RD118-6530Δ
(6) With the lever at the neutral position, make sure this part stands upright.
(7) Stopper bolt
   01175-61040
(8) Poly-cap
   68741-6543Δ
(9) Stopper bolt
   01175-61050

Fixing the stopper bolts (marked with ☆)
Bring the stays of the levers (travel right and travel left) into contact, and then loosen them by 90 degrees and lock the bolts.
This is to ensure the stroke of the valve spool.

Adjust the traveling lever as shown below table.

No.	Items	Dimensions	Remarks
1	Gap between left and right lever to longitudinal direction.	under 2 mm under 0.08 in	
2	Clearance between left and right lever.	11 ~ 17 mm 0.43 ~ 0.67 in	

Travel lever stand mounting bolt: 01133-61425 6 pieces
Tightening torque: 123.6 ~ 147.1 N·m (12.6 ~ 15.0 kgf·m) 91.1 ~ 108.5 ft·lbs

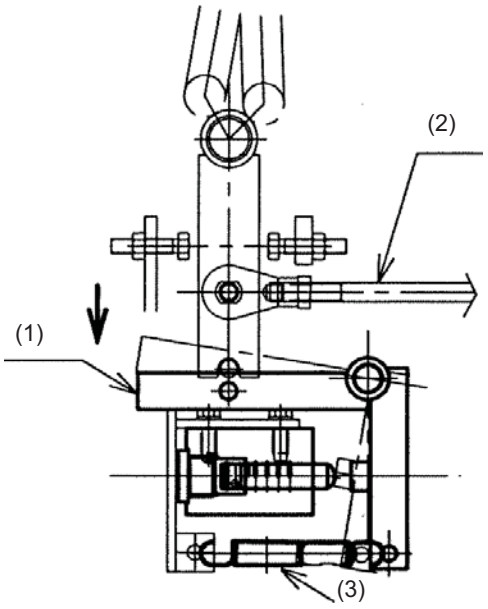
e) Traveling Lever Lock

This machine is equipped with the traveling lever lock. When the engine gets started, the pressure oil from the hydraulic pilot pump surpasses the spring force, which unlocks the lever. When the engine stops, the spring force locks the lever again.
Take the following steps to adjust the neutral position.

Adjusting the lever's neutral position

1. Lower the lever (TL) against the spring force to unlock the traveling lever.

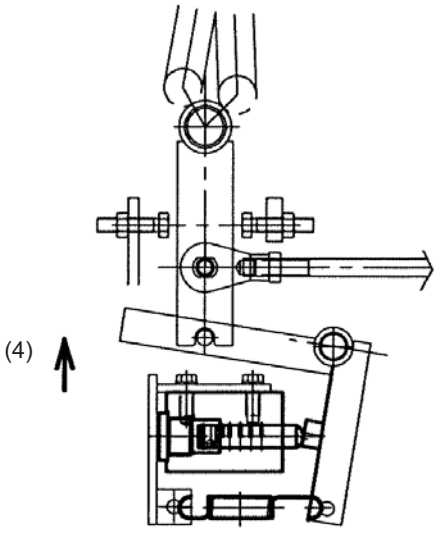
(1) Lever (TL)
(2) Rod
(3) Spring



2. Adjust the rod so that the traveling lever should be positioned to and fro as specified. (See previous page.)

3. Return the lever (TL) to the initial position, and make sure the traveling lever gets locked tight again.

(4) Traveling lever lock condition



f) Dozer Lever

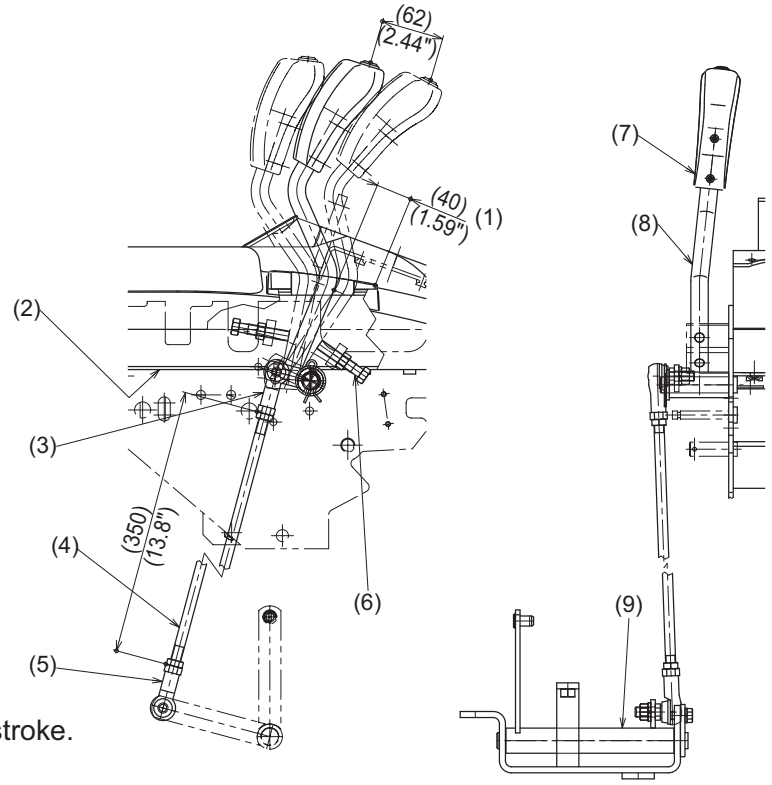
(1) KX121-3α

(1) Adjusting the lever' s neutral position
Fit the lever as shown at right.

(2) Check points after the setup
Valve spool to move over its stroke
Valve spool to move smoothly

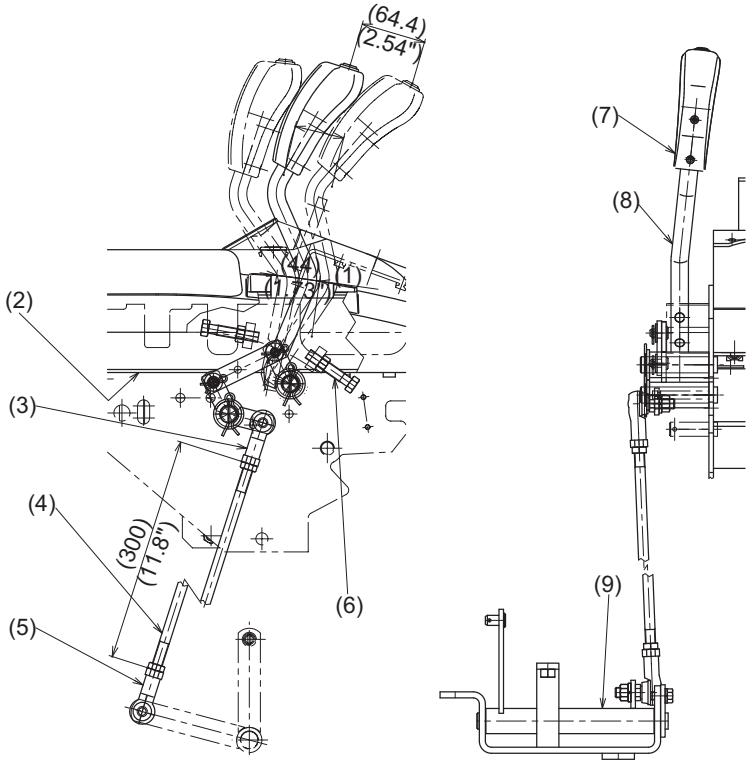
(3) DU bushing bearing
Apply grease.

(1) At neutral position
(2) Cover (right, top)
(3) Link ball 2
Nut
Spring washer
(4) Rod assembly (dozer lever)
Rod
Nut
Left-hand lock nut
(5) Link ball 1
Nut
Spring washer
(6) Bolt
Nut
(7) Grip (bi-speed)
Pan-head machine screw
(8) Lever assembly (dozer)
Lever (dozer)
Bushing
Flat spring
Snap pin
(9) Bracket assembly (dozer link)
Bracket (dozer)
Link assembly (dozer, 2)
Link (dozer, 2)
Bushing
Shaft (dozer)
Bolt



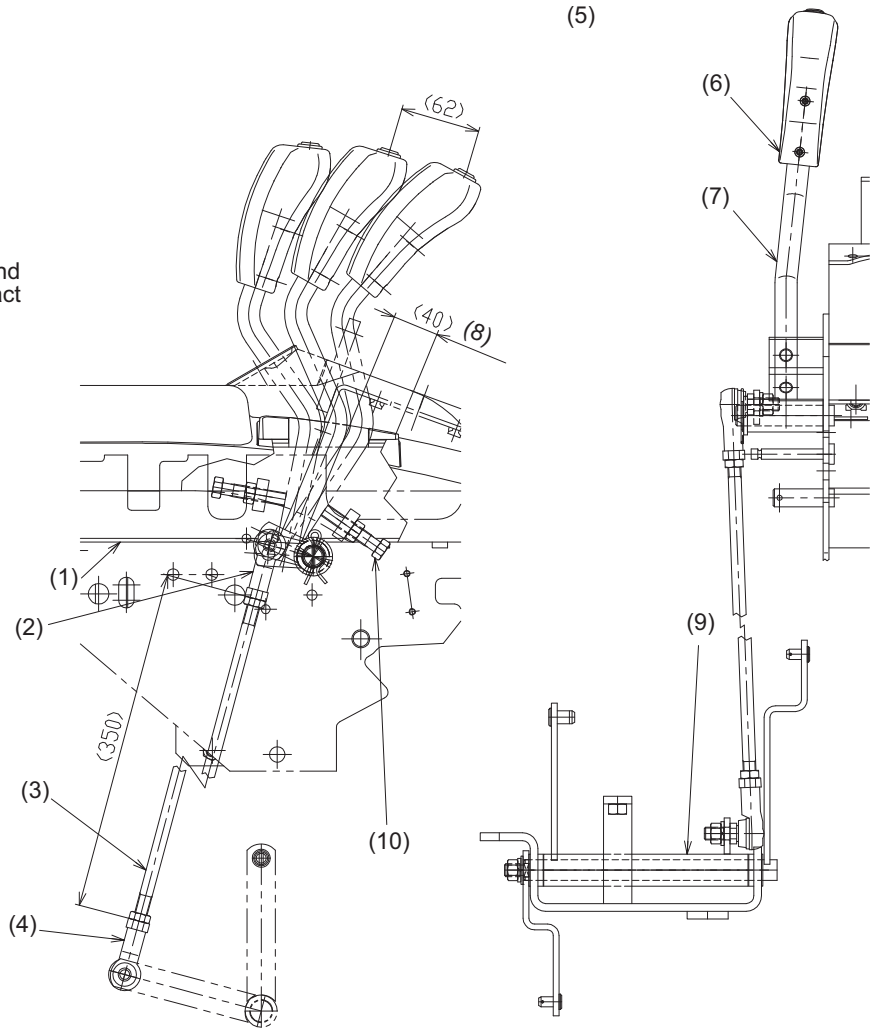
Dozer lever should not contact with at its full stroke.

(2) KX161-3α, U45-3α, U50-3α



(3) KX121-3S, KX161-3S, U45S, U45-3S

(1) Cover (right, top)
(2) Link ball 2
Nut
Spring washer
(3) Rod assembly (dozer lever)
Rod (380)
Nut
Left-hand lock nut
(4) Link ball 1
Nut
Spring washer
(5) Move the lever over the full stroke and make sure it does not come in contact with the cover (right, top).
(6) Grip (dual-speed)
Pan-head machine screw
(7) Lever assembly (dozer)
Lever (dozer)
Bushing
Plain washer
Snap pin
(8) (40 at neutral)
(9) Bracket assembly (TPSS)
Bracket assembly (dozer, TPSS)
Bracket (dozer, TPSS)
Bushing
Link assembly (dozer, 2TPSS)
Link (dozer, 2TPSS)
Bushing
Shaft (dozer, TPSS)
Link (TPSS)
Nut
Plain washer
Spring washer
(10) Bolt
Nut



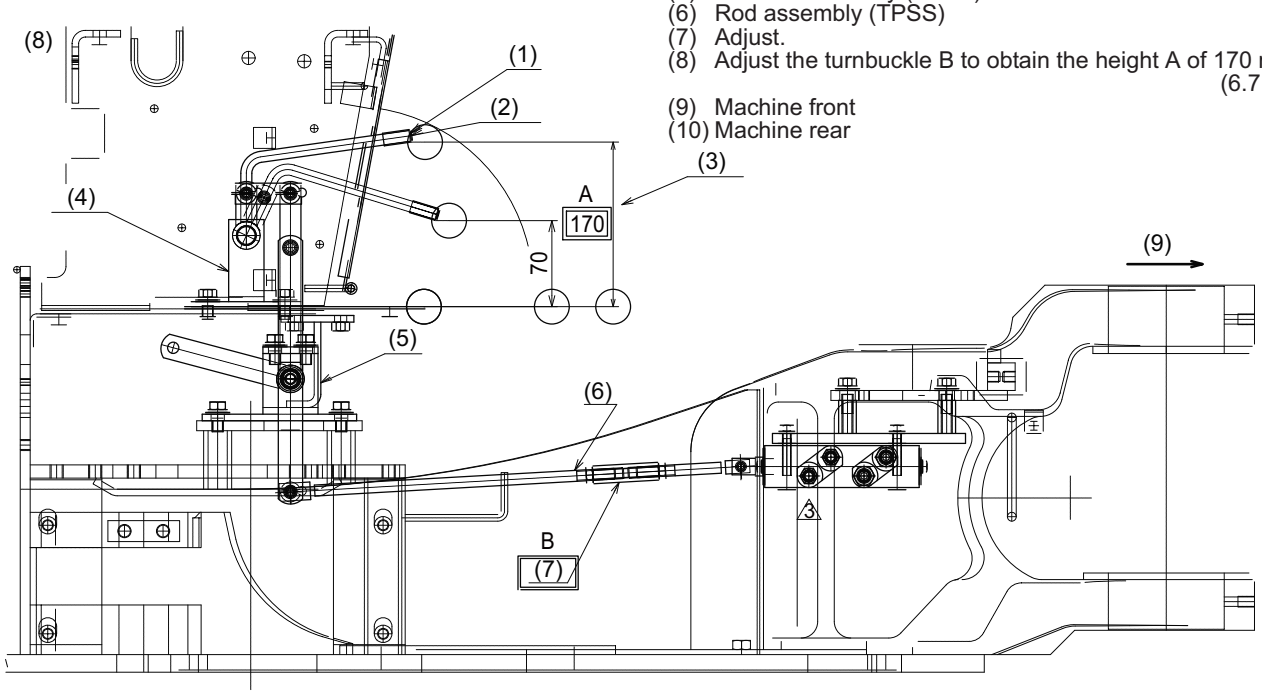
g) TPSS Lever

(1) KTC, KCL, KTA-version: KX121-3S

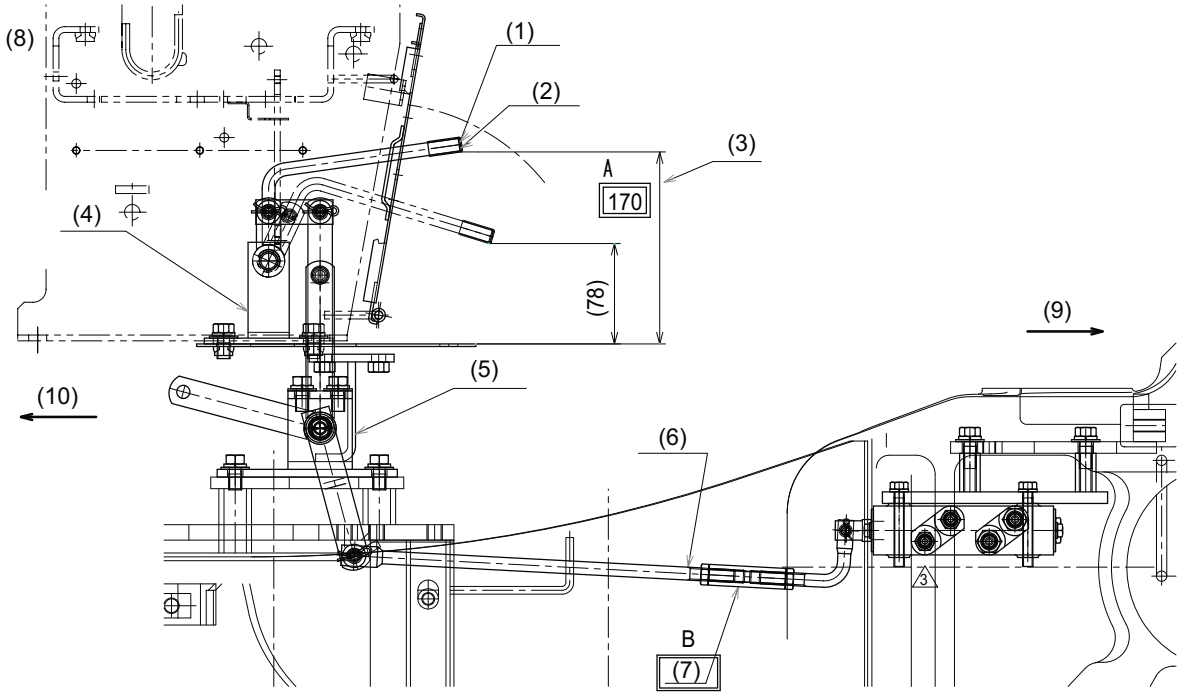
(1) Adjusting the TPSS lever's neutral position
Lever to be fitted as shown below.

(2) Checking the lever after fitting
Valve spool to move over the stroke smoothly.

(1) At the ISO pattern position (upper), no contact is allowed when opening and closing the cover (seat support).
(2) Lever assembly (TPSS)
(3) Height from the step at the JIS pattern position (lower) The TPSS valve spool must be switched over.
(4) Bracket (TPSS)
(5) Bracket assembly (TPSS)
(6) Rod assembly (TPSS)
(7) Adjust.
(8) Adjust the turnbuckle B to obtain the height A of 170 mm. (6.7 in.).
(9) Machine front
(10) Machine rear



(2) KX161-3S TPSS lever adjustment:



h) Swing & Pedal

(1) Pedal adjustment
To be symmetrical right and left
(Horizontal at the center)
Right-and-left: Swing

(2) Pedal operation
Spool of swing port should move over entire strokes and return newtral smothly.

(3) Cable to cable connector 2 (31355-8294△) Screw length
Screw length: 2 ~ 3 mm (0.08 ~ 0.12 in)

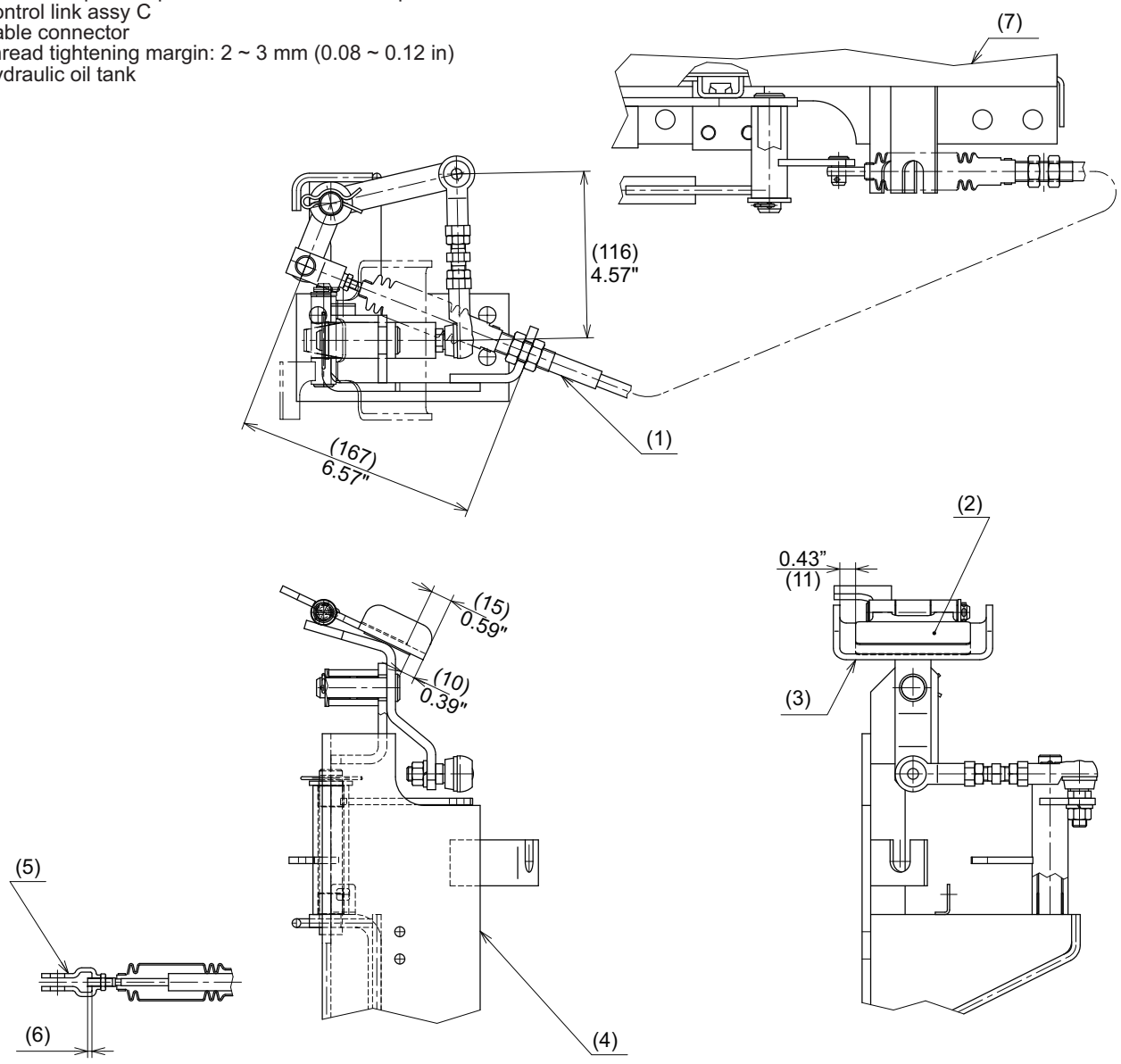
(4) Cable outer shield end not to bend
20 mm (0.79 in) or more
Keep straight part

(5) Allowable cable bending radius
150 mm (5.9 “) radius or more

(6) Installation of cable
Cable not to be twisted
Lock nut to be tightened up with 2 wrenches

(7) DU bush
Apply grease

(1) Swing cable
(2) Pedal seat
(3) Fit with the pedal top horizontal at the neutral position.
(4) Control link assy C
(5) Cable connector
(6) Thread tightening margin: 2 ~ 3 mm (0.08 ~ 0.12 in)
(7) Hydraulic oil tank



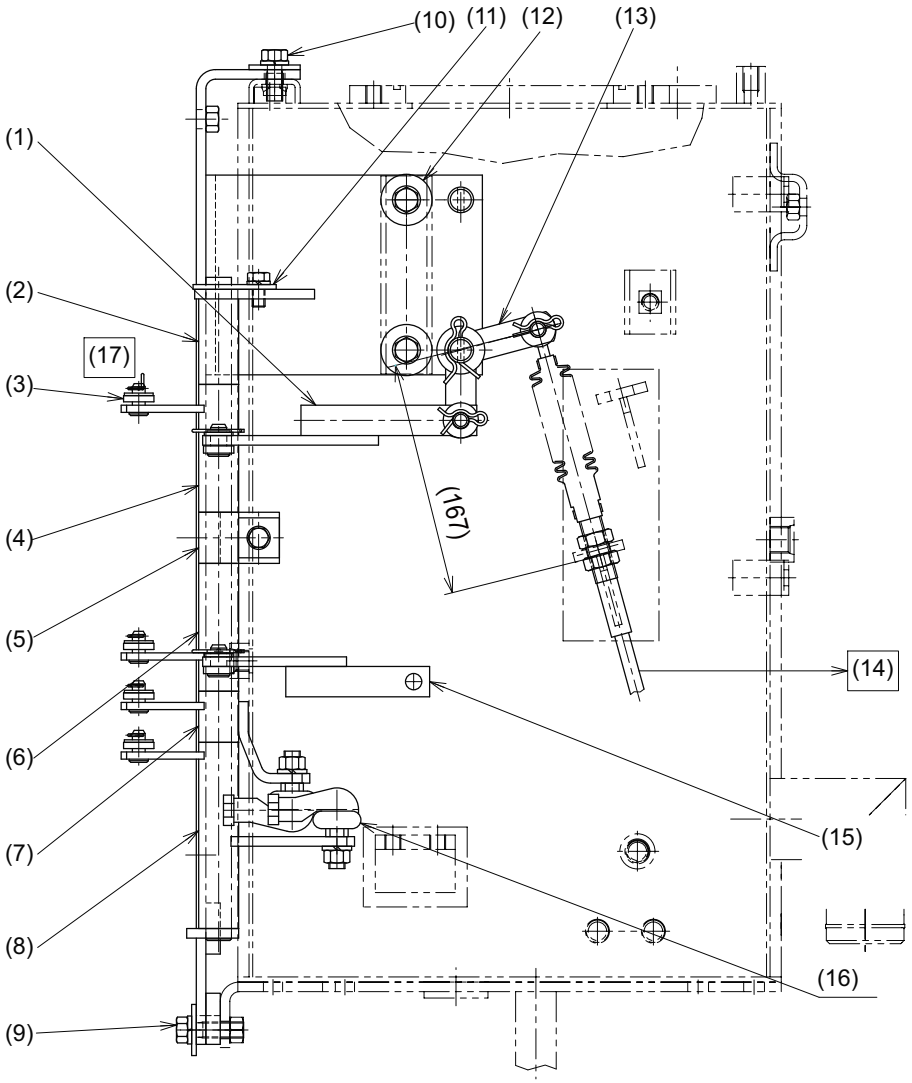
i) Control Valve Links

(1) Installation of each link
Each link should rotate smoothly.

(2) Installation of DU-bush and shaft
Apply grease.

(3) Tightening torque of bracket mount bolt
48.1 ~ 55.9 N·m
(4.9 ~ 5.7 kgf·m)
35.4 ~ 41.2ft·lbs

(1) Rod (CV, swing)
Flat washer
Snap pin
Flat washer
Snap pin
(2) Collar assembly (SP)
Collar (SP)
Bushing
(3) Plate (50)
Pin
Snap pin
Flat washer
Pin
(4) Link assembly (swing)
Link (swing)
Bushing
(5) Stay assembly (shaft)
Stay (shaft)
Bushing
Bolt
(6) Link assembly (dozer)
Link (dozer)
Bushing
(7) Link assembly (travel, R)
Link (travel, R)
Bushing
(8) Link assembly (travel, L)
Link (travel, L)
Bushing
(9) Bolt
Flat washer
(10) Bolt
Flat washer
(11) Shaft (link)
Bolt
(12) Bolt
Flat washer
(13) Link assembly (CV, 2)
Link (CV, 2)
Bushing
Flat washer
Snap pin
(14) Swing
(15) Rod (CV, dozer)
Flat washer
Snap pin
(16) Link ball 1
Spring washer
Nut
(17) The flat head pin to be inserted from lower side and the snap pin to be securely bent.



j) Limit Switch Installation

(1) Limit switch performance
Limit switch setup
Limit switch to perform as specified
* Apply screw loctite (Three Bond TB1401B).
No gap at points (A) and (B) with limit switch activated

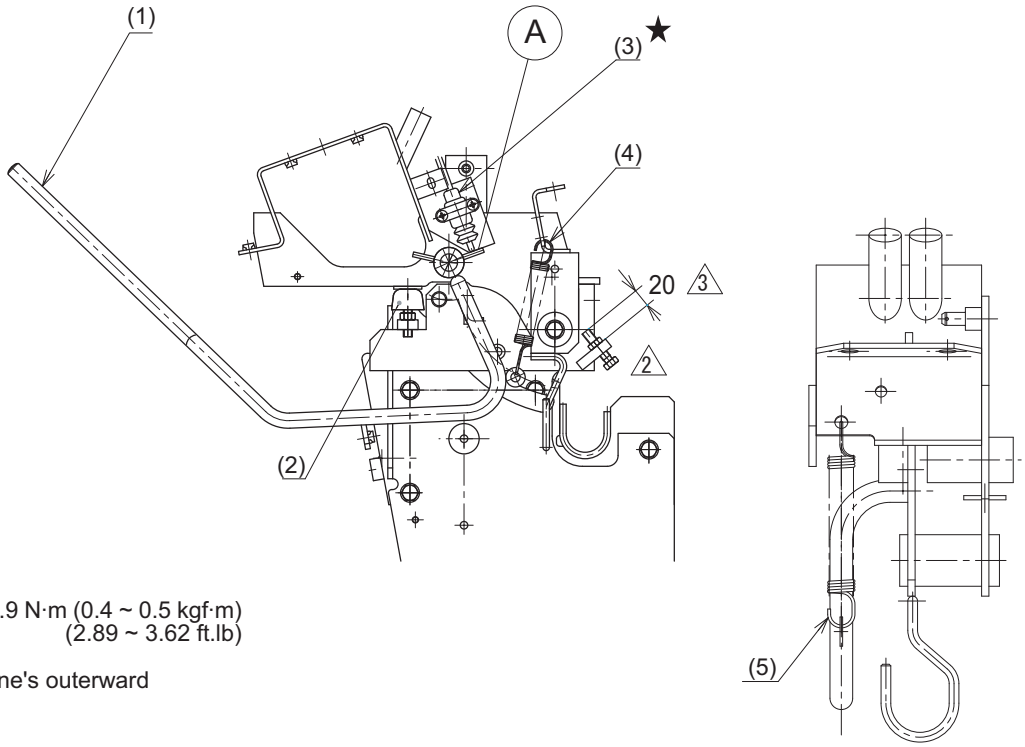
(2) Rubber cover fitting on the acceleration pedal
* Apply instantaneous adhesive beforehand.

(3) Tension spring fitting on the unload lever (left)
Hook tip of the spring (to hook on the unload lever) to face the machine's outside.

(4) Squeeze of the seat support rubber 2
1 ~ 2 mm (0.04 ~ 0.08 in.)

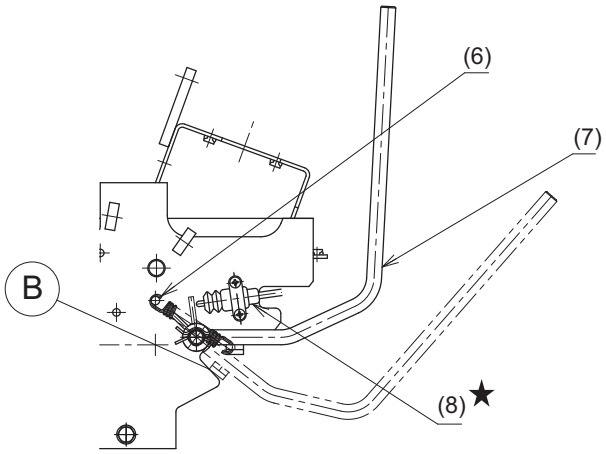
(5) DU-bush
Apply grease.

Unload lever, L



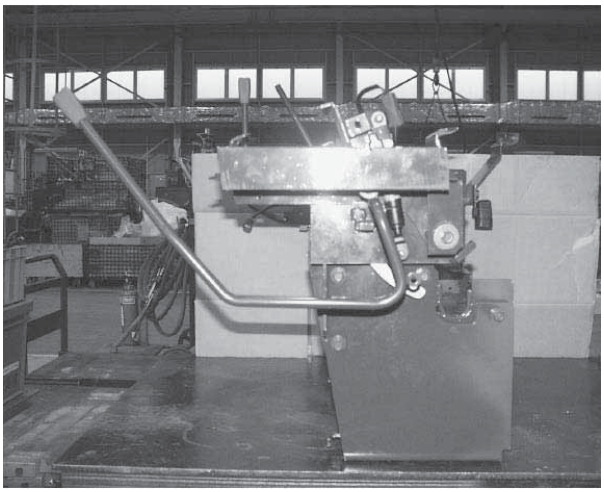
(1) Lock lever 1
Spring pin
(2) Seat support rubber
(3) Limit switch
Tightening torque: 3.9 ~ 4.9 N·m (0.4 ~ 0.5 kgf·m)
(2.89 ~ 3.62 ft.lb)
(4) Tension spring
(5) Hook tip should be machine's outerward

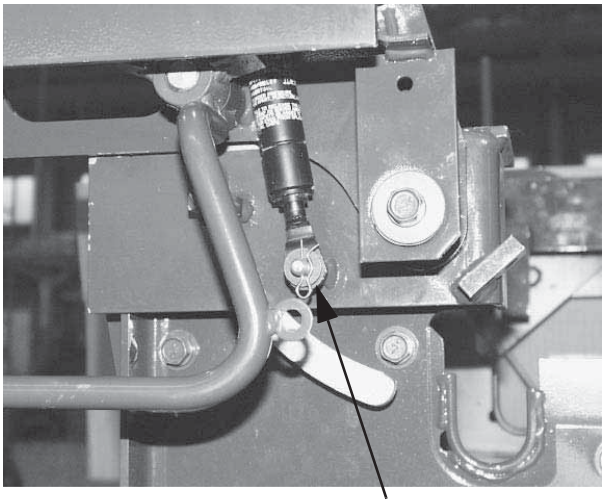
Unload lever, R (PP canopy-version only)



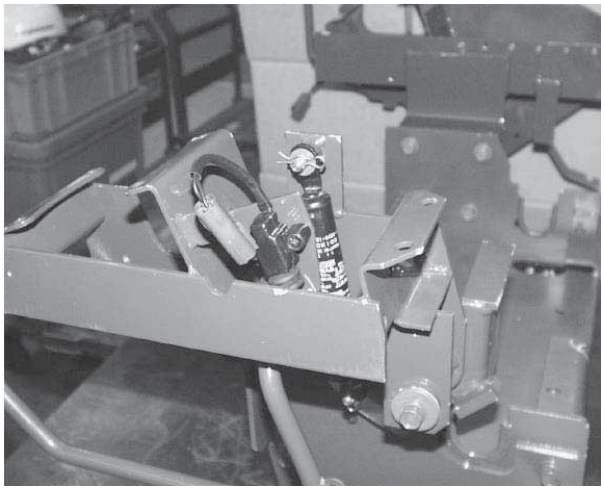
(6) Tension spring
(7) Lever assembly (lock, R)
Lever (lock, R)
Bushing
Flat washer
Snap pin
(8) Limit switch
Tightening torque: 3.9 ~ 4.9 N·m (0.4 ~ 0.5 kgf·m)
(2.89 ~ 3.62 ft.lb)

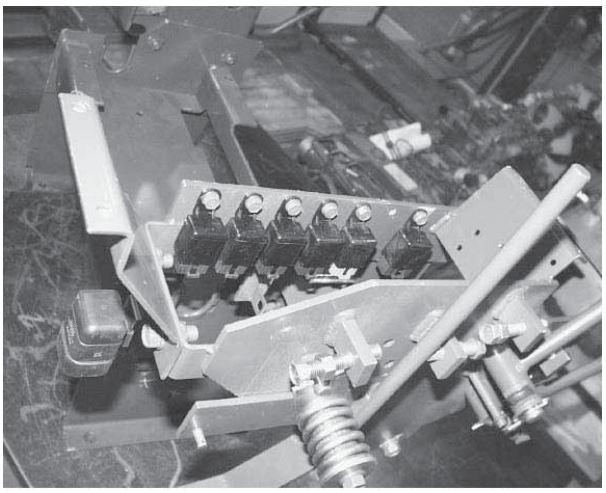
k) Control Stand

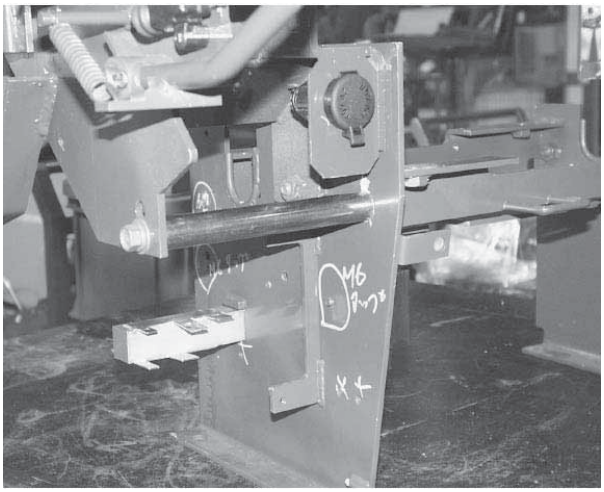


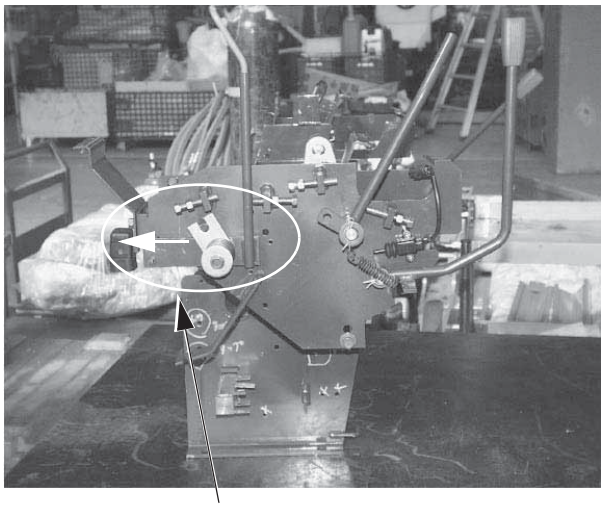


Insert the snap pin from below
(to protect the hose).

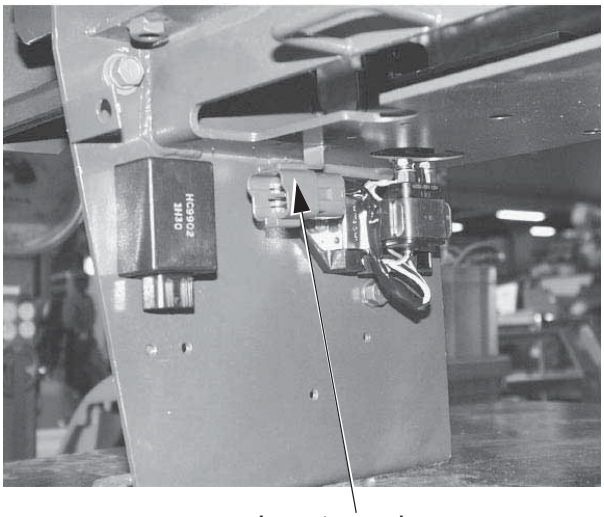




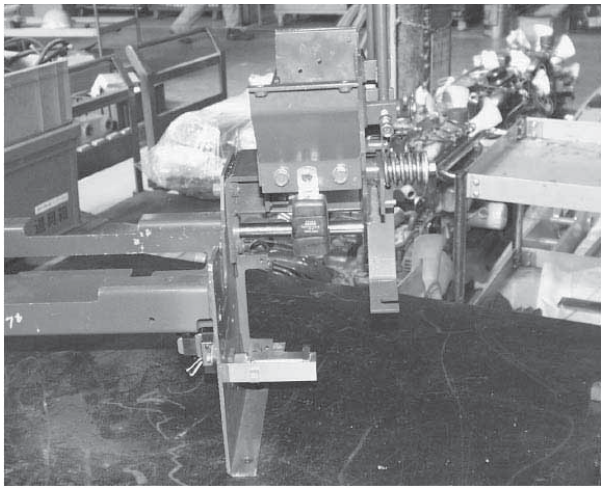




Direction of KTC, KCL, KTA-version.

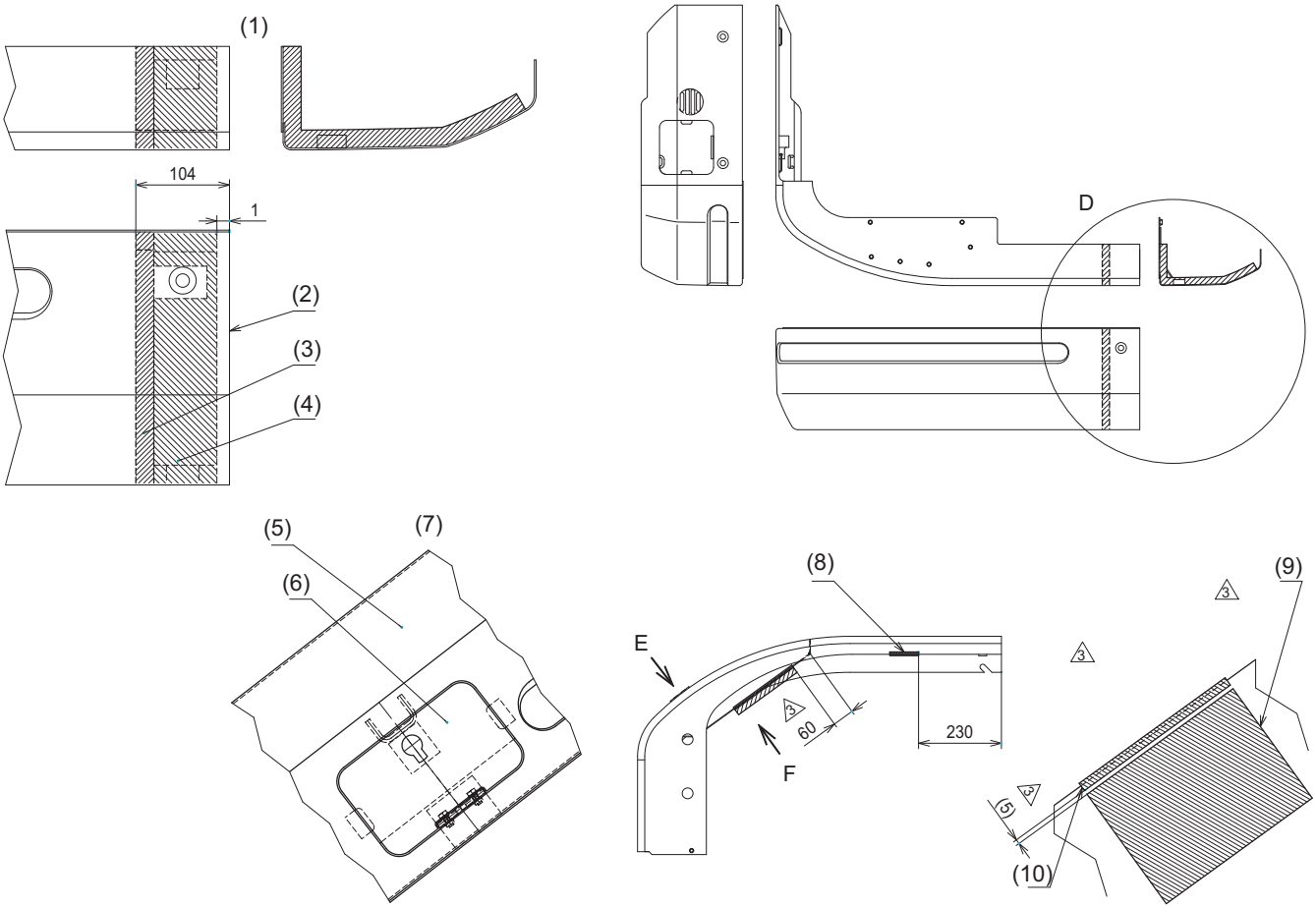


Insert coupler



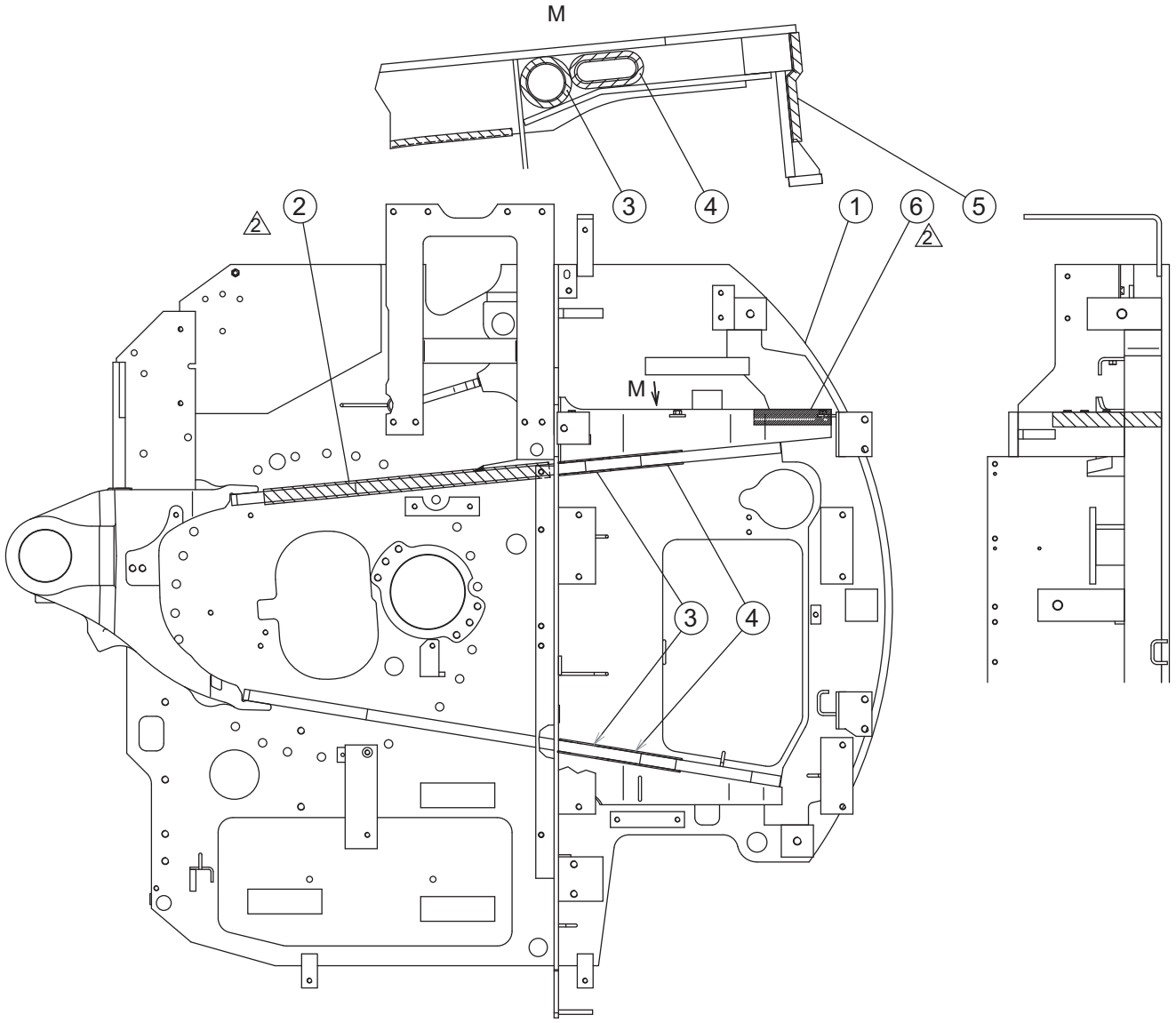
I) Noise Absorber and Trim

(1) Swivel cover



(1) Enlarged view of D
(2) Cover (left)
(3) Noise absorber (cover, left)
(4) Noise absorber (cover, left 1)
(5) Cover (right)
(6) Cover (right, 2)
(7) Enlarged view of E
(8) Trim (80)
(9) Noise absorber (cover, right)
(10) Enlarged view of F
(11) Grommet (200)

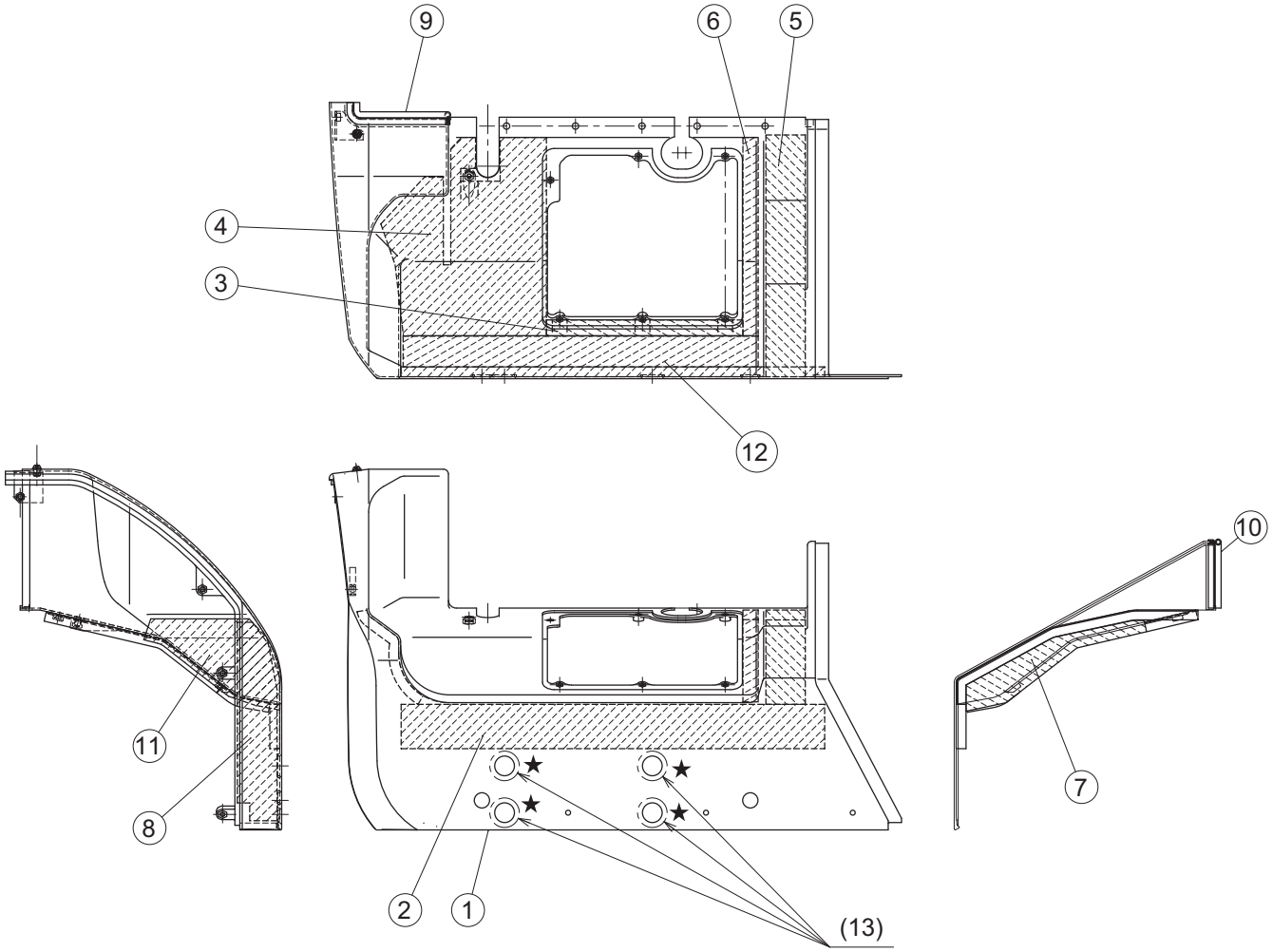
(2) Swivel frame



(1)	Frame (swivel)	1
(2)	Trim (580, T22, U rubber)	1
(3)	Grommet (1, swivel frame)	2
(4)	Grommet (2, swivel frame)	2
(5)	Noise absorber (1, swivel)	1
(6)	Noise absorber (partition, 3)	1

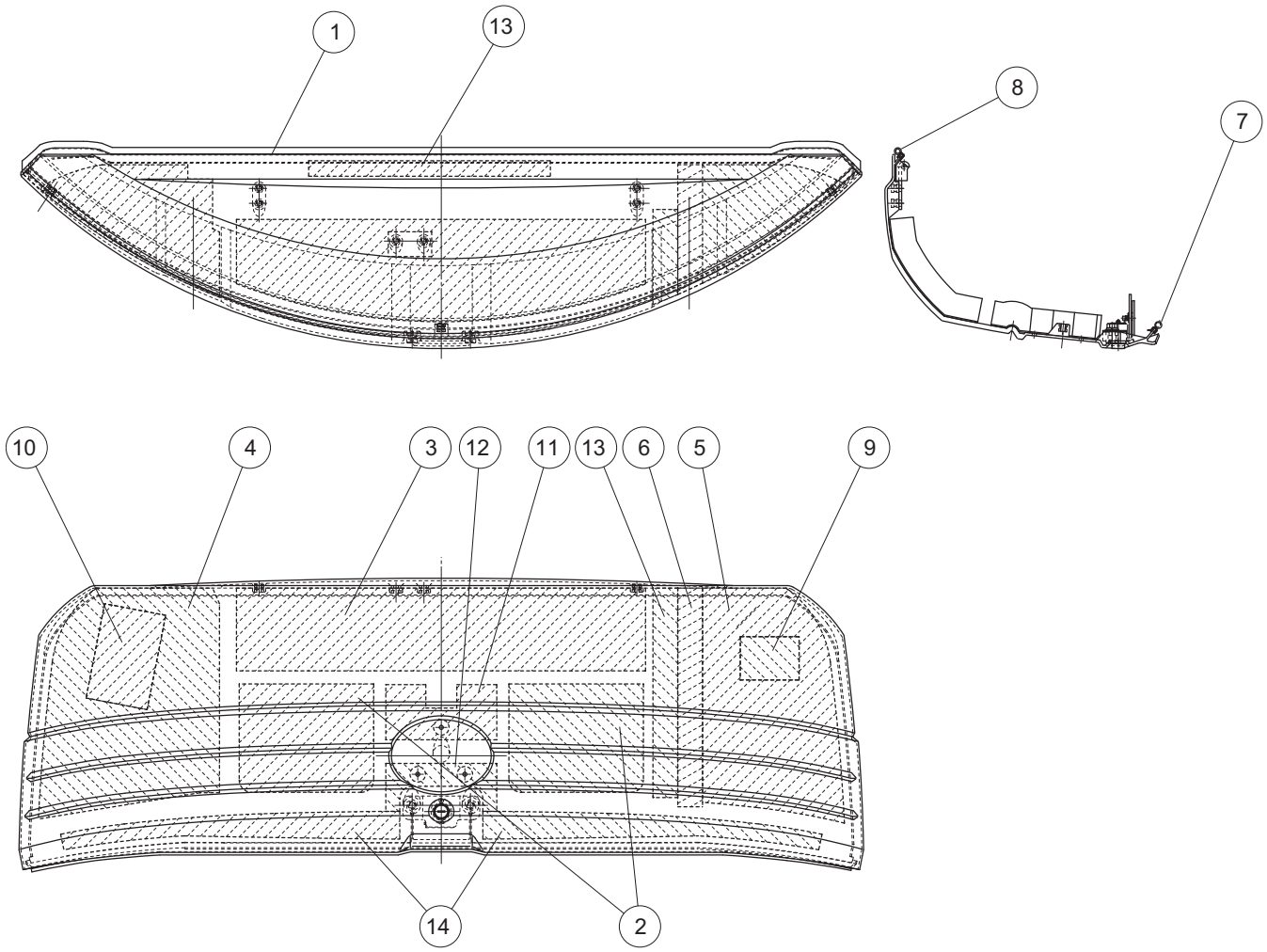
Apply instant adhesive to the parts (2), (3) and (4).

(3) Bonnet, L



(1)	Bonnet (1, left)	1
(2)	Noise absorber (1, bonnet, left)	1
(3)	Noise absorber (2, bonnet, left)	1
(4)	Noise absorber (3, bonnet, left)	1
(5)	Noise absorber (4, bonnet, left)	1
(6)	Noise absorber (5, bonnet, left)	1
(7)	Noise absorber (6, bonnet, left)	1
(8)	Noise absorber (7, bonnet, left)	1
(9)	Trim (5)	1
(10)	Trim (6)	1
(11)	Noise absorber (8, bonnet, left)	1
(12)	Noise absorber (9, bonnet, left)	1
(13)	Label (Red No. 1)	4 sheets (★)

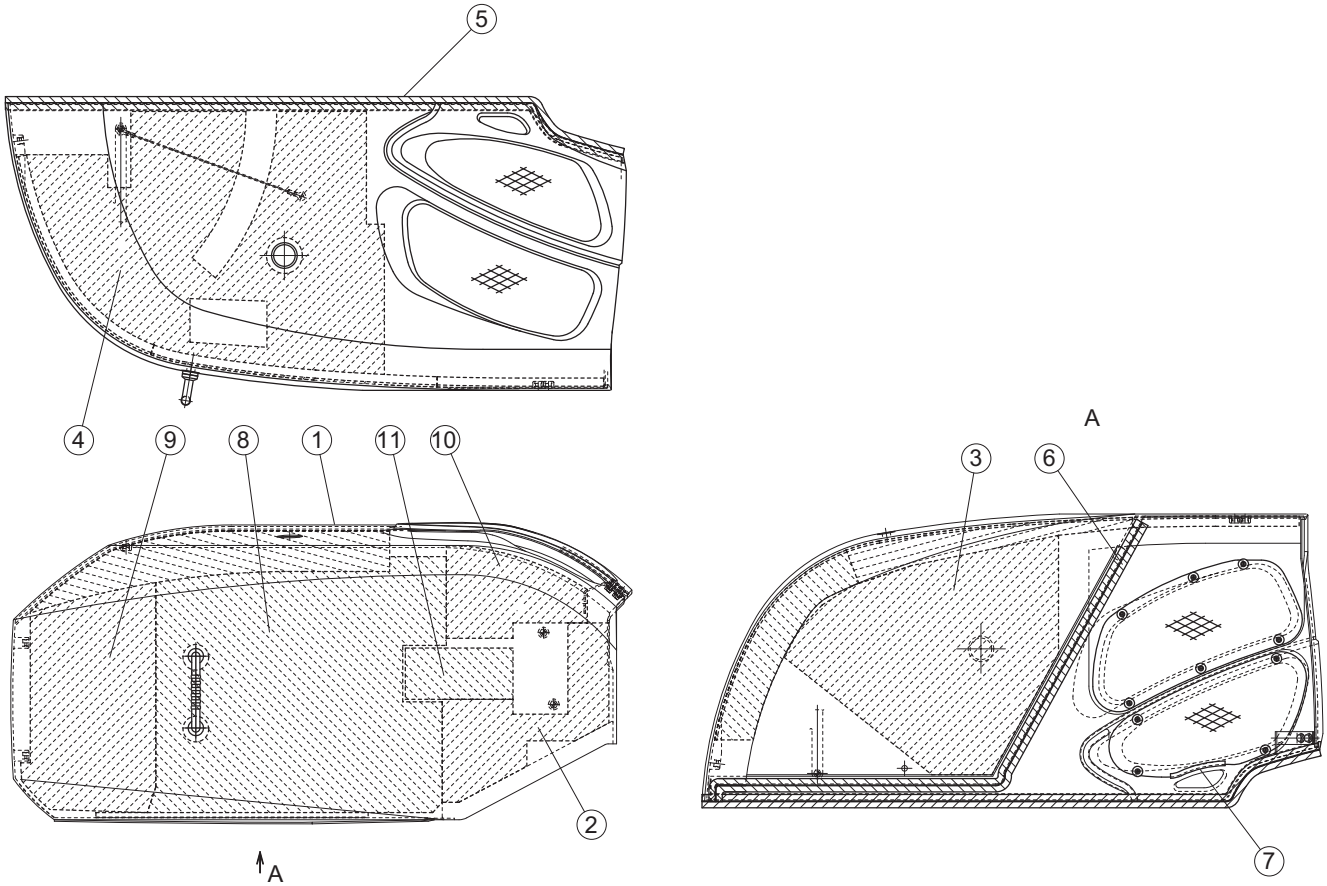
(4) Bonnet, rear



(1)	Bonnet (rear)	PP-version	1
		EU-version	1
(2)	Noise absorber (1, bonnet, rear)		2
(3)	Noise absorber (2, bonnet, rear)		1
(4)	Noise absorber (3, bonnet, rear)		1
(5)	Noise absorber (4, bonnet, rear)		1
(6)	Noise absorber (7, bonnet, rear)		1
(7)	Trim (1)		1
(8)	Trim (2)		1
(9)	Noise absorber (8, bonnet, rear)		1
(10)	Noise absorber (9, bonnet, rear)		1
(11)	Noise absorber (10, bonnet, rear)		1
(12)	Noise absorber (11, bonnet, rear)		1
(13)	Noise absorber (12, bonnet, rear)		2
(14)	Noise absorber (13, bonnet, rear)		2

★ Paint color
PP-version (KX121-3S, KX161-3S, U45S, U45-3S, U45-3α): Red No. 1 + Black No. 7
EU-version (KX121-3α, KX161-3α): Red No. 1 only

(5) Bonnet, R

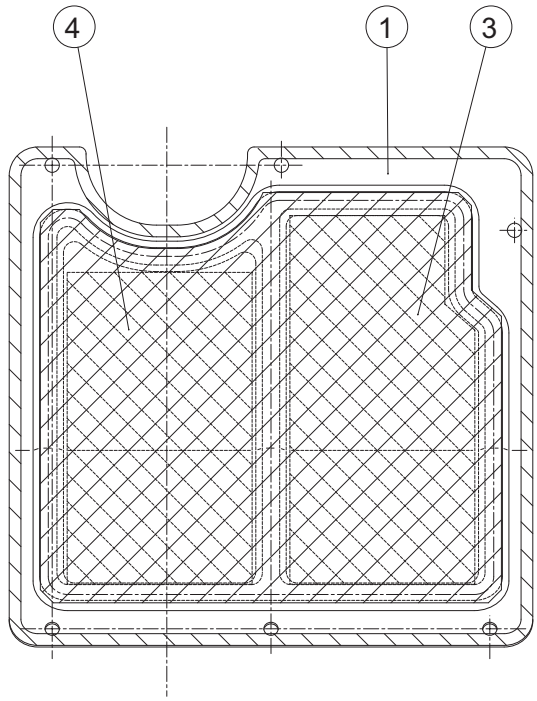


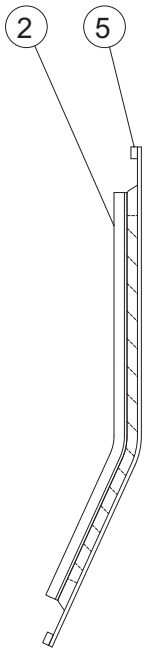
(1)	Bonnet (right)	PP-version	1
		EU-version	1
(2)	Noise absorber (1, bonnet, right)		1
(3)	Thermal insulation (1, bonnet, right)		1
(4)	Noise absorber (2, bonnet, right)		1
(5)	Trim (3)		1
(6)	Trim (4)		1
(7)	Trim (2, air intake)		1
(8)	Noise absorber (3, bonnet, right)		1
(9)	Noise absorber (4, bonnet, right)		1
(10)	Noise absorber (5, bonnet, right)		1
(11)	Noise absorber (6, bonnet, right)		1

★ Paint color
PP-version (KX121-3S, KX161-3S, U45S, U45-3S, U45-3α): Red No. 1 + Black No. 7
EU-version (KX121-3α, KX161-3α): Red No. 1 only

(6) Cover, middle, L

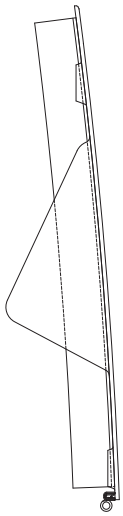
Cover

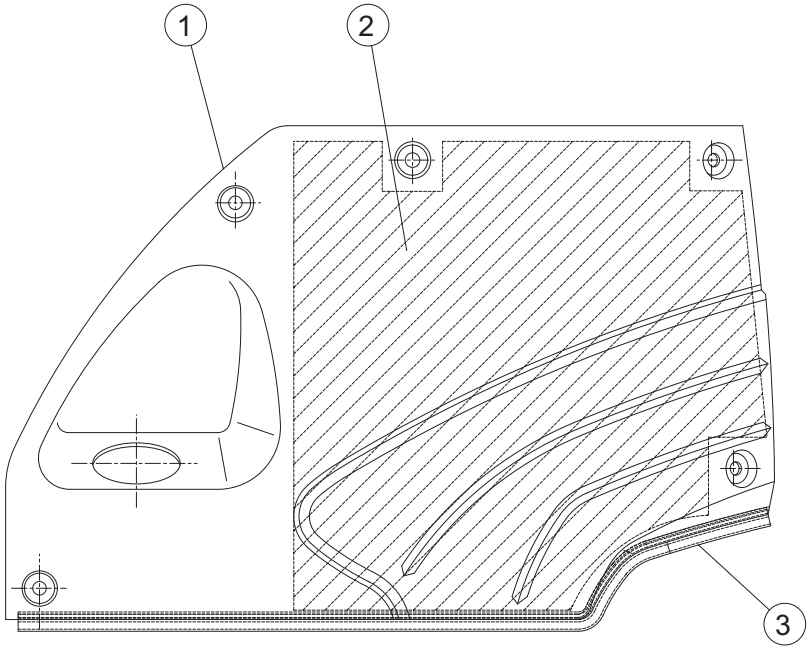




(1)	Cover (1, bonnet)	1
(2)	Noise absorber (cover)	1
(3)	Thermal insulation (1, cover)	1
(4)	Thermal insulation (2, cover)	1
(5)	Tape (sealing)	1

Bonnet

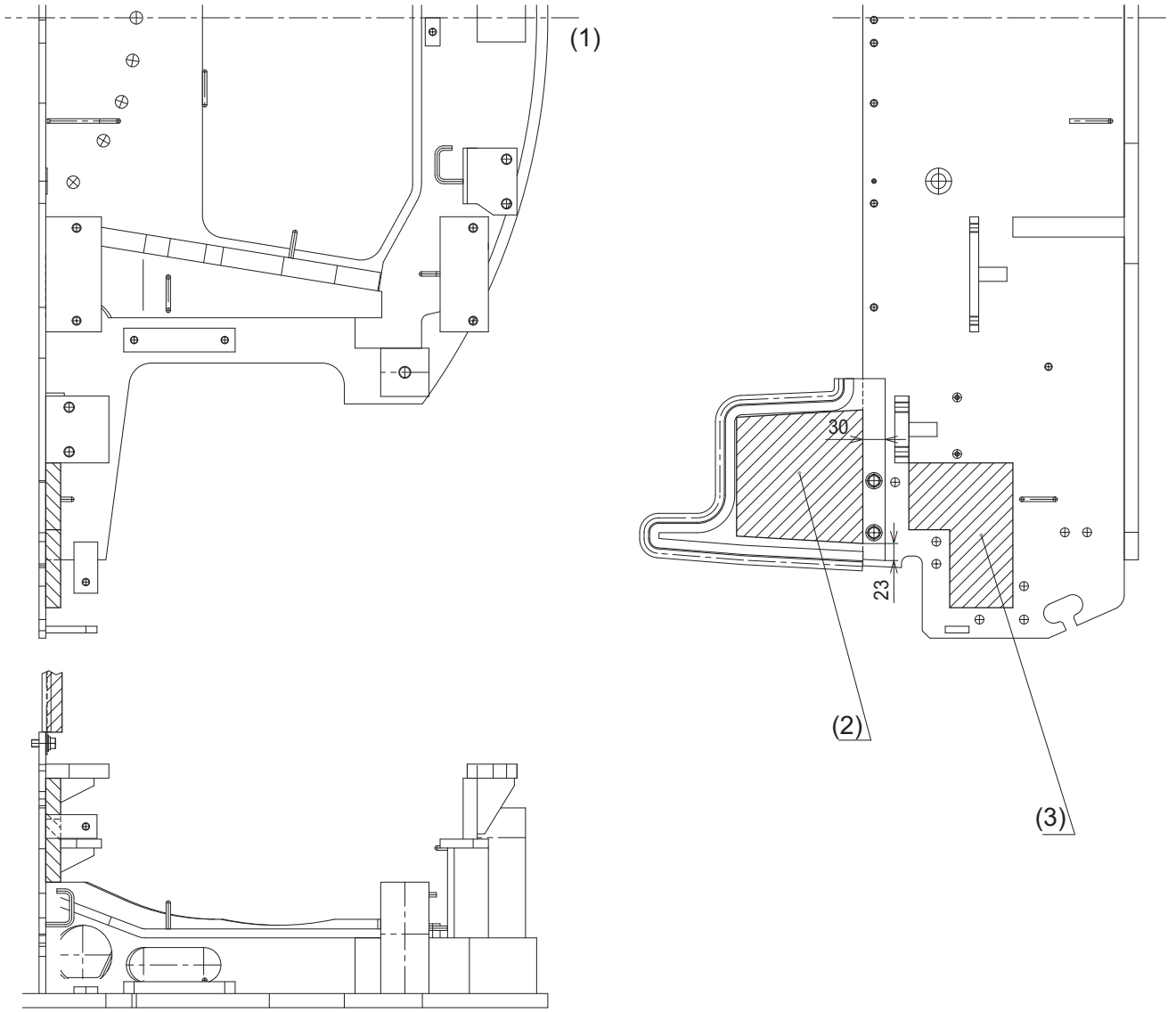




(1)	Bonnet (2, left)	1
(2)	Noise absorber (bonnet, left, 2)	1
(3)	Trim (7)	1

★ Paint color
PP-version (KX121-3S, KX161-3S, U45S, U45-3S, U45-3α): Red No. 1 + Black No. 7
EU-version (KX121-3α, KX161-3α): Red No. 1 only

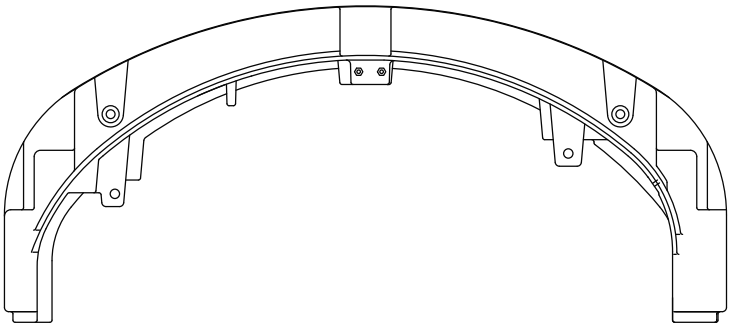
(7) Pump around

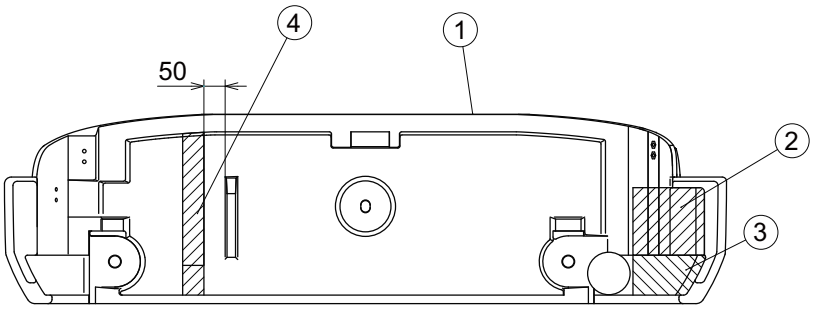


KX121-3S, KX121-3α:

(1) Machine rear
(2) Noise absorber (partition, 3)
(3) Noise absorber (5, swivel)

(8) Counterweight

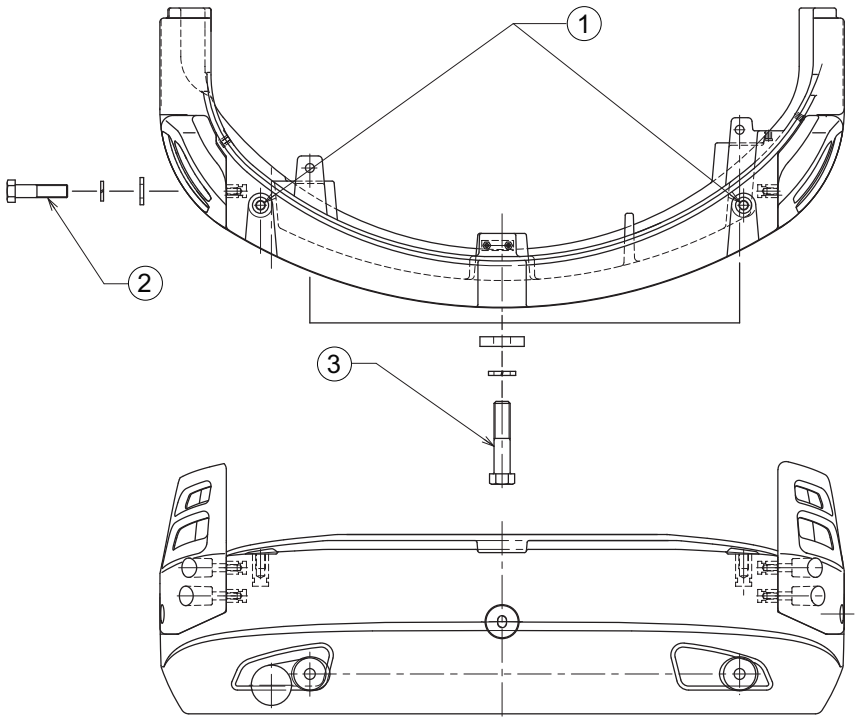




KX121-3S/ST:

(1)	Weight (510)	1
(2)	Noise absorber (2, weight)	1
(3)	Noise absorber (3, weight)	1
(4)	Noise absorber (4, weight)	1

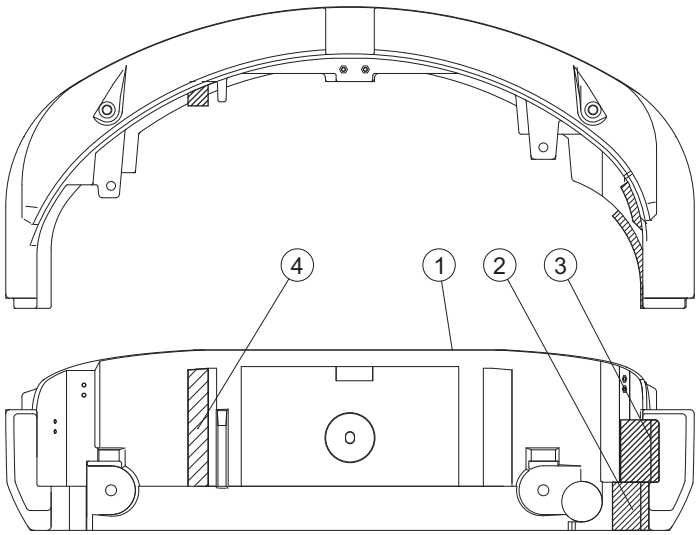
Counterweight code number:
KX121-3S/ST: R118-4811△



1. Weight installation
   Mount bolt: M20 x 2.5, B30-90
   (RC411-48411, 3pcs)
   Torque: 367.7 ~ 431.5 N·m
   (37.5 ~ 44.0 kgf·m)
   271 ~ 318 ft·lbs
   Apply screw lock agent (Locktite 271)

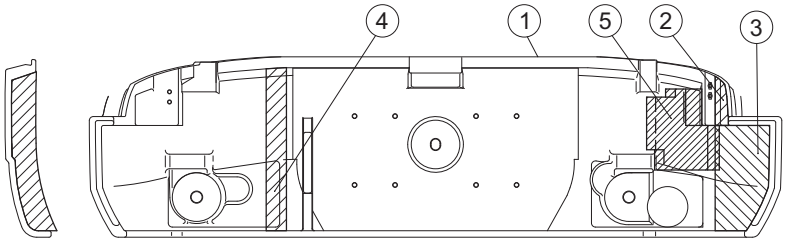
2. Side protector installation
   Mount bolt: M16 x 2.0, B24-65
   (RD118-4835△)
   Torque: 196.1 ~ 225.6 N·m
   (20.0 ~ 23.0 kgf·m)
   145 ~ 168 ft·lbs

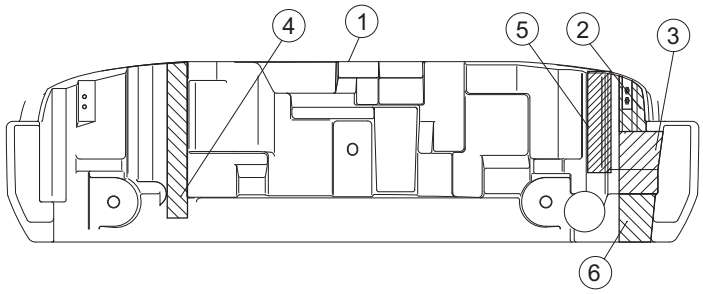
(1) Lifting bolt size: M24 x 2
(2) Bolt (M16 P2.0, B24-65)
(RD118-4835△) 6pcs
Spring washer, plain washer
(3) Bolt (RC411-4841△) 3pcs
Spring washer, plain washer



KX161-3S, KX161-3α:

(1) Weight (800) 1
(2) Noise absorber (2, weight) 1
(3) Noise absorber (3, weight) 1
(4) Noise absorber (4, weight) 1

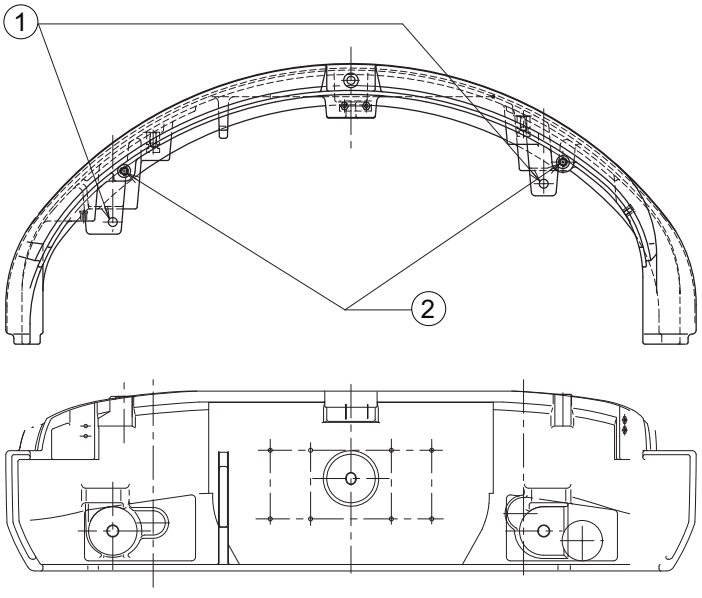




U45-3S, U45-3α , U45S:

Arm length = 1360 mm (53.5 in.)
(1) Weight (300) 1
(2) Noise absorber (1, weight) 1
(3) Noise absorber (2, weight) 1
(4) Noise absorber (4, weight) 1
(5) Noise absorber (6, weight) 1

Arm length = 1650 mm (65.0 in.)
(1) Weight (600) 1
(2) Noise absorber (1, weight) 1
(3) Noise absorber (2, weight) 1
(4) Noise absorber (4, weight) 1
(5) Noise absorber (5, weight) 1
(6) Noise absorber (3, weight) 1



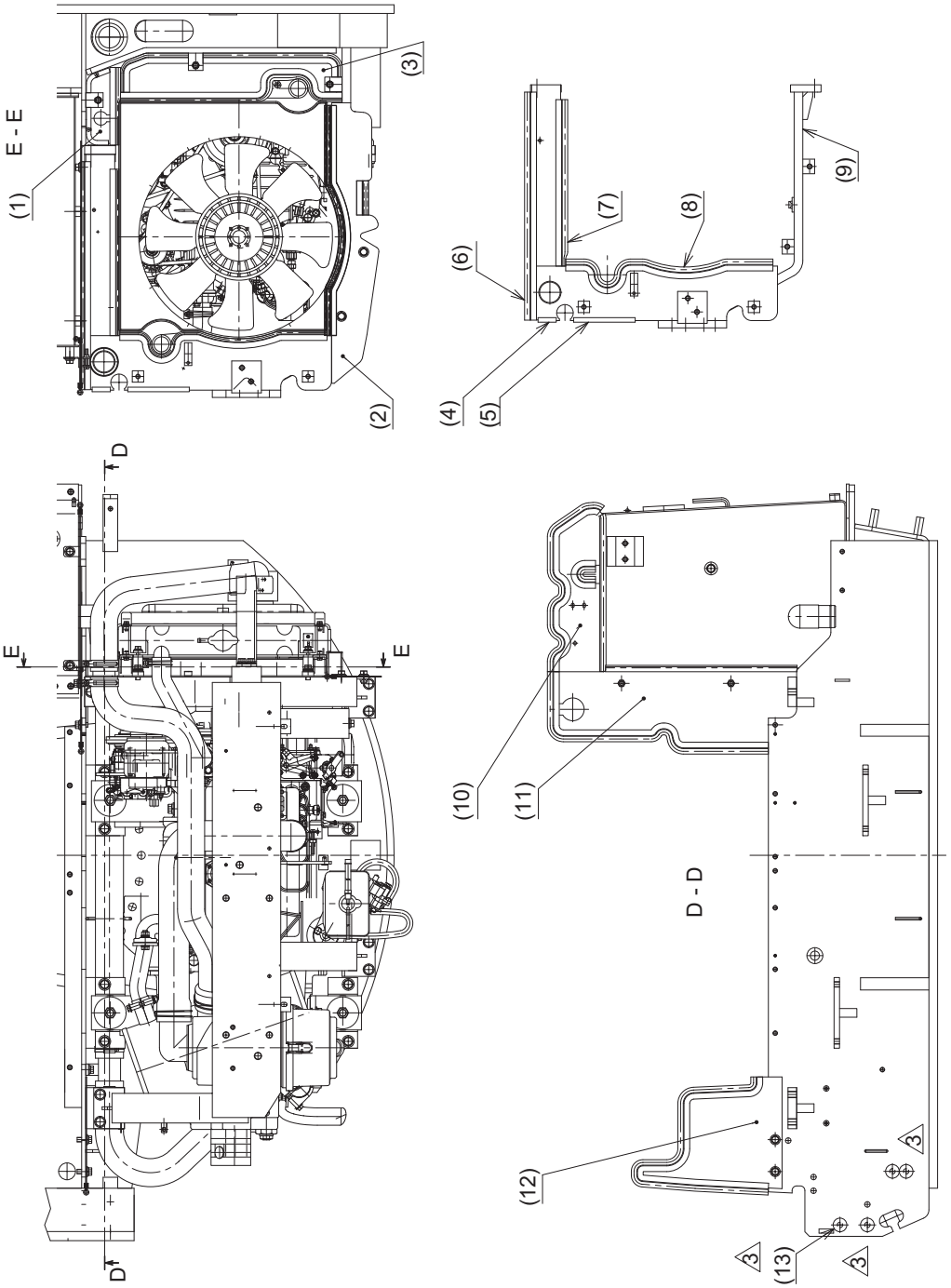
1. Counterweight and installation

Model	Arm Length	Weight code No.
U45-3S U45-3ST U45-3α	1360 mm (53.5 in.)	RD418-4817△ (300)
	1650 mm (65.0 in.)	RD518-4821△ (600)
KX161-3S KX161-3ST KX161-3α	1780 mm (70.1 in.)	RD518-4811△ (800)

2. Mounting bolt
Inside vertical bolt:
M16 x 2.0, (01135-61660) 2pcs
Torque: 196.1 ~ 225.6 N·m
(20.0 ~ 23.0 kgf·m)
145 ~ 168 ft·lbs
Rear horizontal bolt:
M20 x 2.5, (RC411-48411, 3pcs)
Torque: 367.7 ~ 431.5 N·m
(37.5 ~ 44.0 kgf·m)
271 ~ 318 ft·lbs
Apply screw lock agent (Locktite 271)

3. Lifting bolt size:
Weight 300: M16 x 2.0
Weight 600: M20 x 2.5
Weight 800: M24 x 3.0

m) Partition Plate



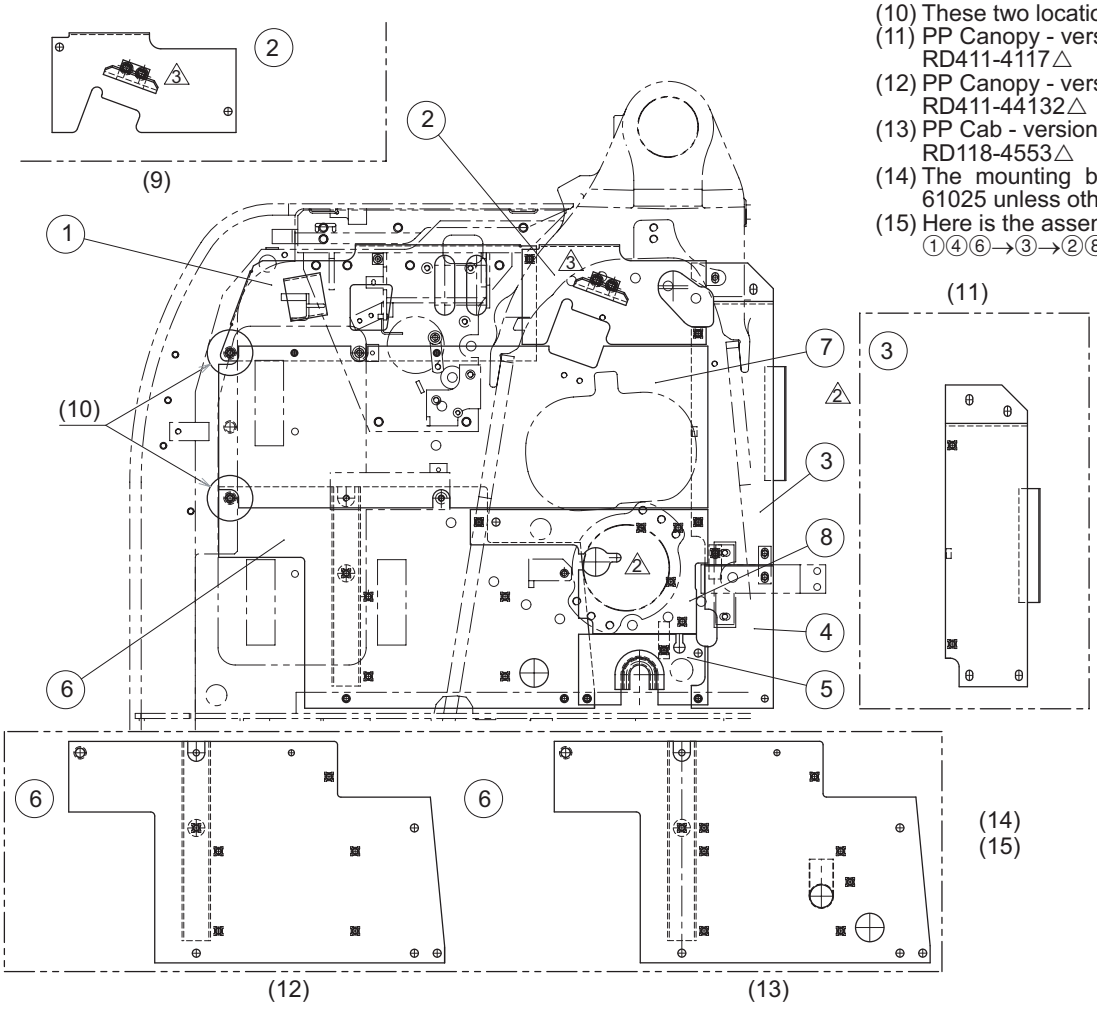
KX121-3S, KX121-3α:

(1) Partition plate assembly (6)
Partition plate (6)
Trim (80)
Trim (115)
Trim (170)
Bolt
(2) Partition plate assembly (arch)
Partition plate (arch)
Trim (515)
Trim (75)
Bolt
(3) Partition plate assembly (5)
Partition plate (5)
Trim (325)
Trim (550)
Trim (195)
Bolt
(4) Trim (40)
(5) Trim (135)
(6) Trim (500)
(7) Trim (365)
(8) Trim (515)
(9) Frame (arch)
(10) Partition plate assembly (1)
Partition plate (1)
Trim (460)
Trim (345)
Trim (110)
Bolt
(11) Partition plate assembly (2)
Partition plate (2)
Trim (420)
Trim (630)
Bolt
(12) Partition plate assembly (3)
Partition plate (3)
Trim (710)
Bolt
(13) Label (canopy)

n) Step Plate

KTC, KCL, KTA KX121-3S		EU KX121-3α			
Canopy	Cab	Cab	Code No.	Part name	Location
O	O	O	RD118-4411△	Step1, L	1
O			RD138-4402△	Step assy 1, R	2
	O	O	RD538-4402△	Step assy (1, R, cab)	2
O			RD411-4119△	Support (Step)	3
	O	O	RD118-4565△	Support (Step, defrostor)	3
O	O	O	RD118-4119△	Support (Step 2)	4
O	O	O	RD431-4403△	Step assy 5	5
O			RD411-4413△	step 3	6
	O		RD118-4553△	step 3 (defroster)	6
		O	RD119-4553△	step 3 (defroster)	6
O	O	O	RD411-4412△	step 2	7
O	O	O	RD431-4417△	step 4	8

(9) PP Canopy - version RD138-4402△
(10) These two locations only
(11) PP Canopy - version RD411-4117△
(12) PP Canopy - version RD411-44132△
(13) PP Cab - version RD118-4553△
(14) The mounting bolts are coded 01135-61025 unless otherwise specified.
(15) Here is the assembling order.
①④⑥→③→②⑧→⑤⑦



o) Installing Weight

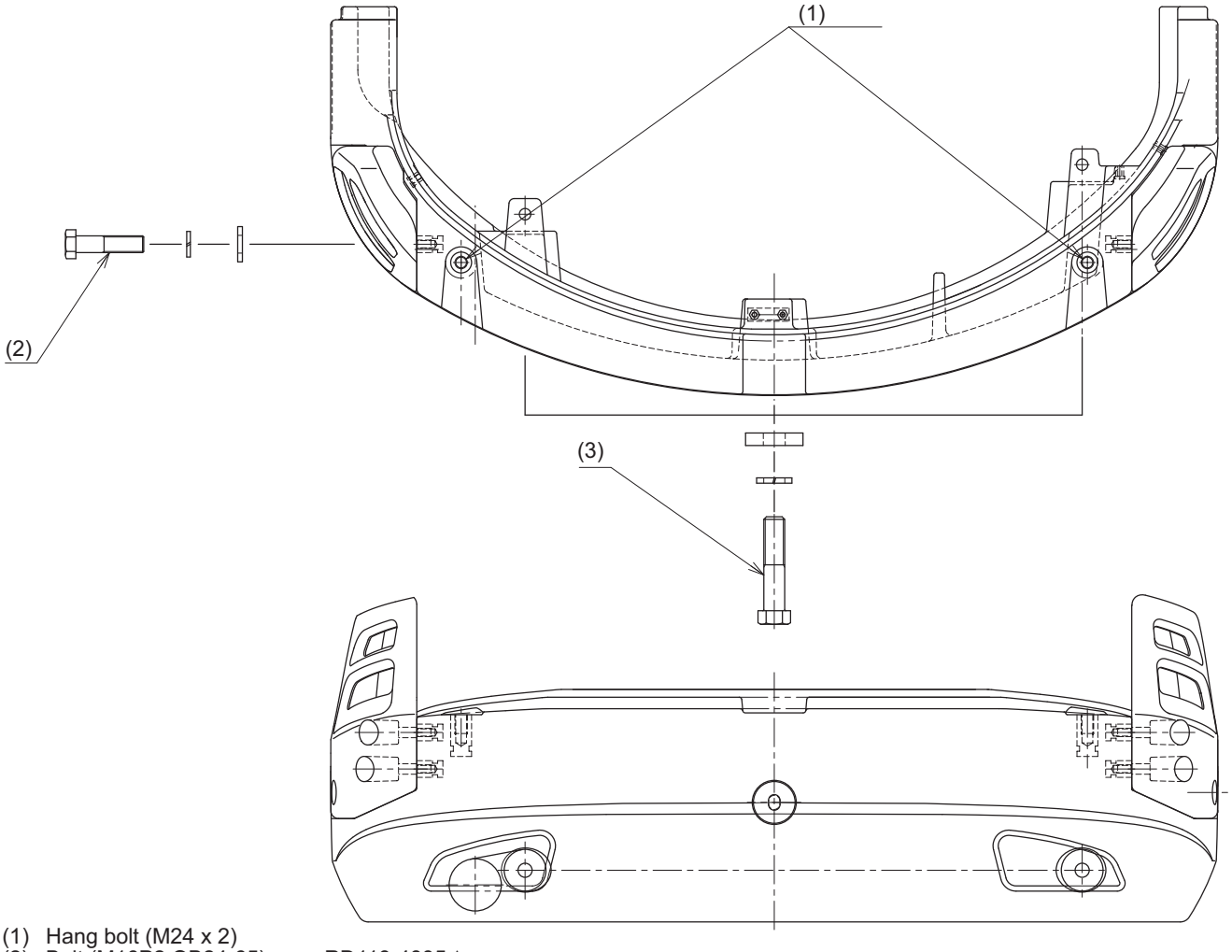
(1) Weight installation: KX121-3S/α

Bolt	Tightening torque
M20 × 90, 3pcs	367.7 ~ 431.5 N·m (37.5 ~ 44.0 kgf·m) (271.2 ~ 318.3 ft.lbs) Apply screw-lock agent. (Locktite 271)
M16 × 60, 2pcs	196.1 ~ 225.6 N·m (20.0 ~ 23.0 kgf·m) (144.7 ~ 166.4 ft.lbs)

(2) Protector (L, R) Installation: KX121-3S/α

Bolts: M16 × 65, 6pcs
Tightening torque
196.1 ~ 225.6 N·m
(20.0 ~ 23.0 kgf·m) (144.7 ~ 166.4 ft.lbs)
Apply screw-lock agent. (High power)

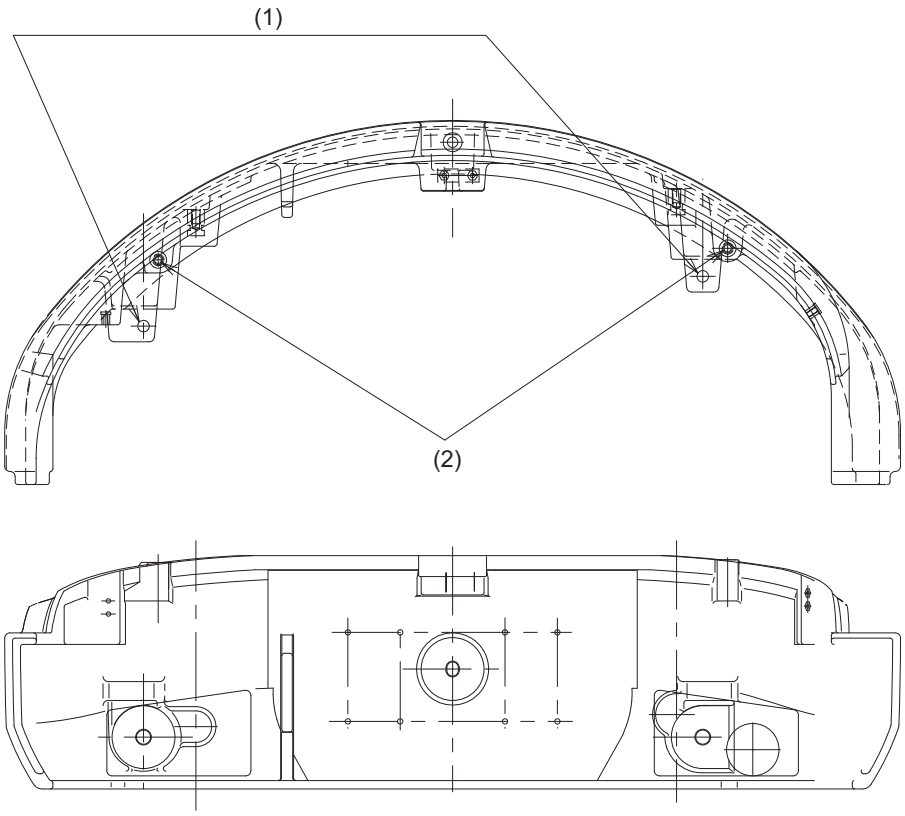
KX121-3S: RD118-4811△



(1)	Hang bolt (M24 x 2)	
(2)	Bolt (M16P2.OB24-65)	RD118-4835△
	Spring washer	04512-60160
	Plain washer	RD411-1914△
(3)	Bolt	RC411-4841△
	Spring washer	04512-60200
	Washer	RP801-4812△

(3) Weight mounting: KX161-3S, KX161-3α

1. Fitting of the counterweight
   Tightening torque
   Hanging bolt
   367.7 ~ 431.5 N·m
   (37.5 ~ 44.0 kgf·m)
   (271 ~ 318 ft.lbs)
   Apply screw adhesive.
   (Loctite 271)
   M16 bolt
   196.1 ~ 225.6 N·m
   (20.0 ~ 23.0 kgf·m)
   (145 ~ 166 ft.lbs)



(1) M16 bolt x2
Plain washer x2
same for all models
(2) Hanging bolt
Plug

U45S, U45-3S, U45-3a Arm length 1360

RD418-4817Δ	Counterweight (300)
Hanging bolt	M16 x 2
90585-1199Δ	Plug

U45S, U45-3S, U45-3α Arm length 1650

RD518-4821Δ	Counterweight (600)
Hanging bolt	M20 x 2.5
RD541-4818Δ	Plug (M20)

KX161-3S, KX161-3α

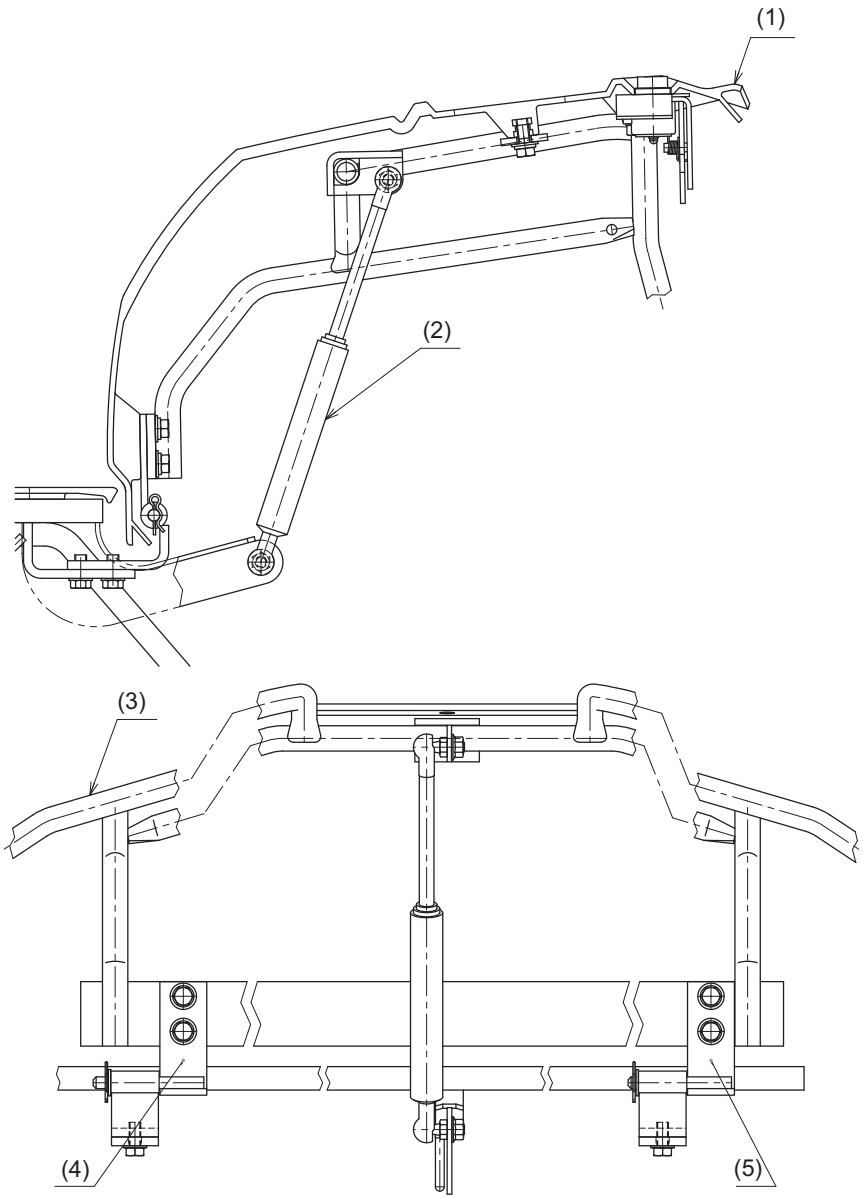
RD518-4811Δ	Counterweight (800)
Hanging bolt	M24 x 3
RD118-4818Δ	Plug (M24)

Remove and clean the hardened screw lock agent before remounting.

p) Bonnet, Rear

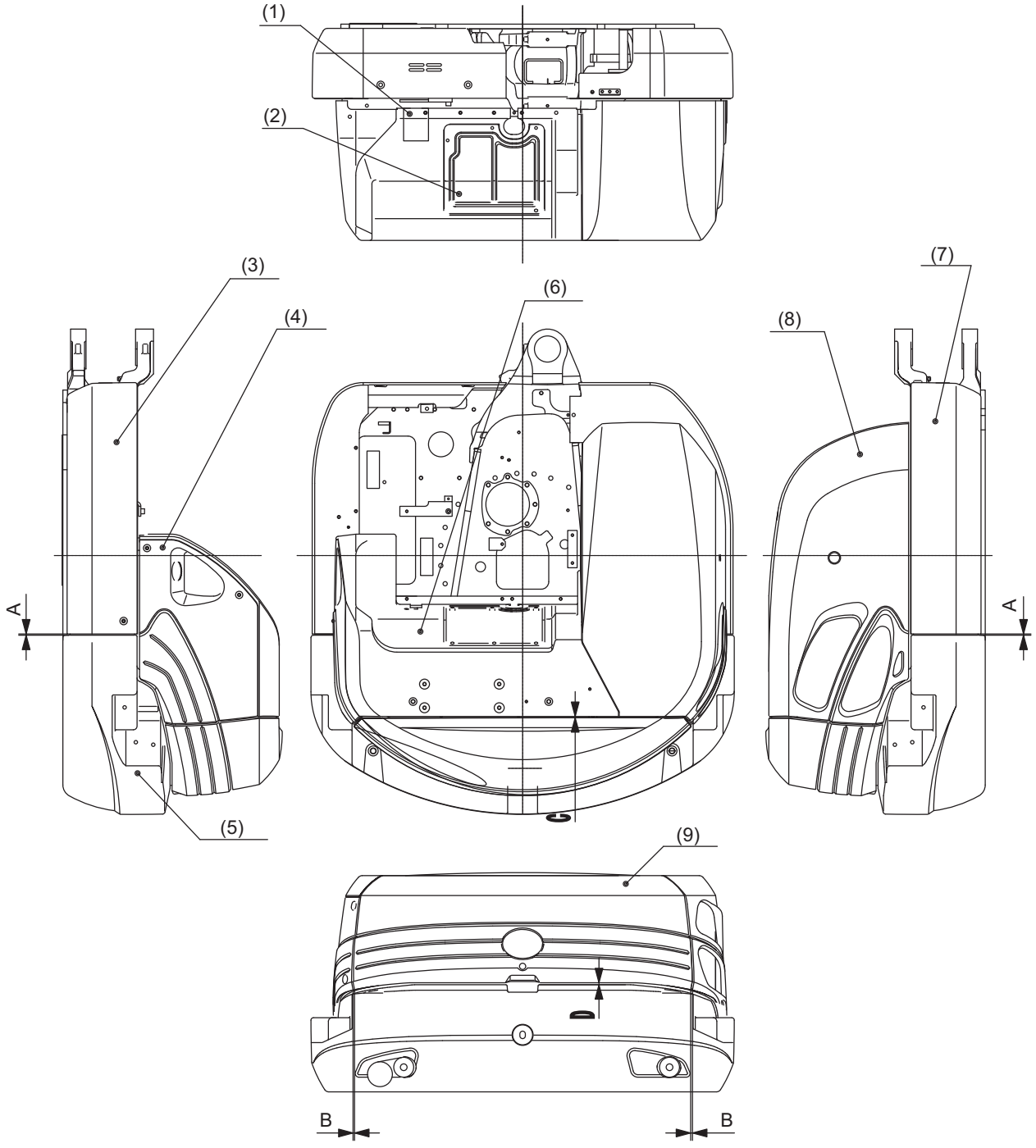
1. Tightening torque for gas damper 9.8 ~ 11.3 N·m (1.0 ~ 1.15 kgf·m) 7.23 ~ 8.32 ft·lbs

   Fix the damper' s bottom to the arch.



(1) Bonnet assembly (rear) KX121-3S KX121-3α
(2) Gas damper
Flange nut
(3) Frame (bonnet, rear)
Bolt
Bolt
(4) Support (1, bonnet, rear)
Flat washer
Snap pin
(5) Support (1, bonnet, rear)
Flat washer
Snap pin

q) Installing Covers

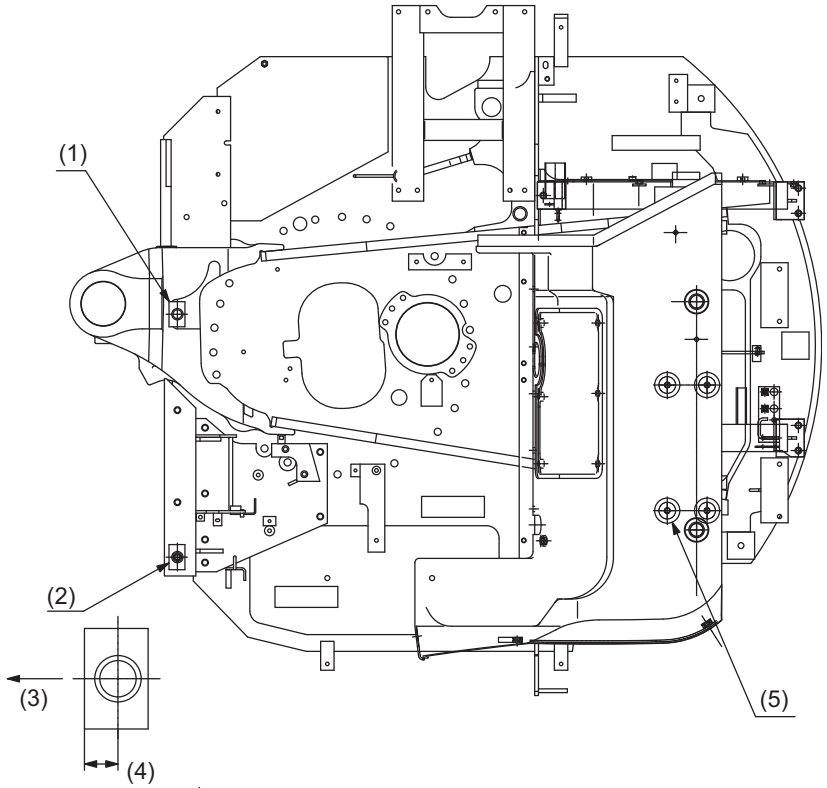


Mounting bolt tightening torque
M8: 8.8 ~ 13.7 N·m
(0.90 ~ 1.40 kgf·m)
(6.51 ~ 10.2 ft·lbs)
M12: 18.1 ~ 28.9 N·m
(1.85 ~ 2.95 kgf·m)
(13.4 ~ 21.3 ft·lbs)
(In case, nut is the insented in the resin.)

(1)	Cover (2, bonnet)	RD118-4328△
(2)	Cover assy (1, bonnet)	RD411-4305△
(3)	Cover assy (L)	RD138-4150△
(4)	Cover assy (2, L)	RD118-4304△
(5)	Weight (500)	RD118-4811△
(6)	Bonnet assy (1, L)	RD118-4301△
(7)	Cover assy (R)	RD118-4160△
(8)	Bonnet assy (R)	RD118-4326△
(9)	Bonnet assy (rear)	RD118-4303△

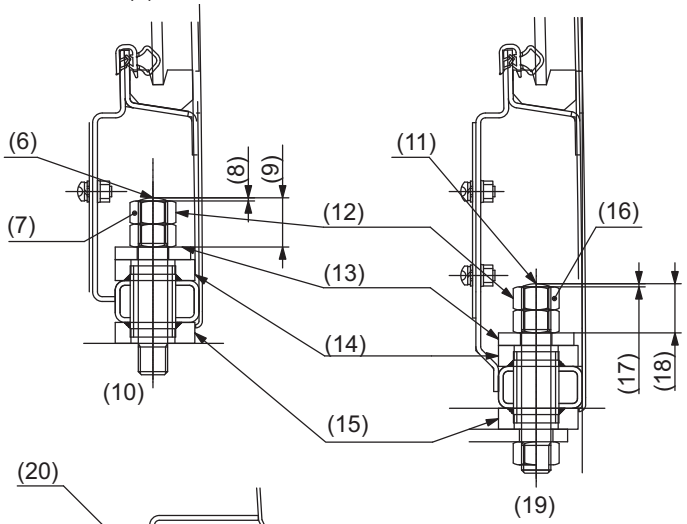
(F) CAB INSTALLATION

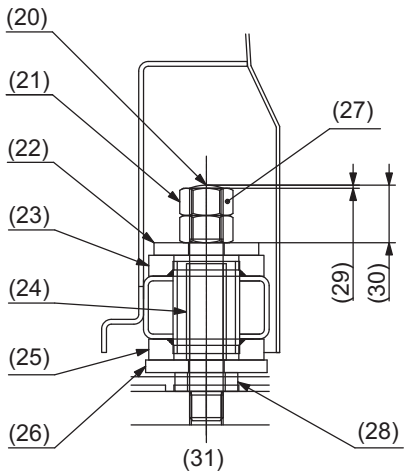
a) Mounting Bolt



S Rops cab mounting nut tightening torque
Nut : 02176-60140 (M14 x 1.5, 6T)
107.9 ~ 125.5 N·m
(11.0 ~ 12.8 kgf·m) (4T)
(79.6 ~ 92.6 ft·lbs)
Nut : 02176-60160 (M16 x 1.5, 6T)
166.7 ~ 191.2 N·m
(17.0 ~ 19.5 kgf·m) (4T)
(123.0 ~ 141.0 ft·lbs)

S Stud bolt tightening torque
M14 x 1.5 (RC411-48501, RP421-48511)
107.9 ~ 125.5 N·m
(11.0 ~ 12.8 kgf·m) (4T)
(79.6 ~ 92.6 ft·lbs)
M16 x 1.5 (RC411-48041)
166.7 ~ 191.2 N·m
(17.0 ~ 19.5 kgf·m)
(123.0 ~ 141.0 ft·lbs)

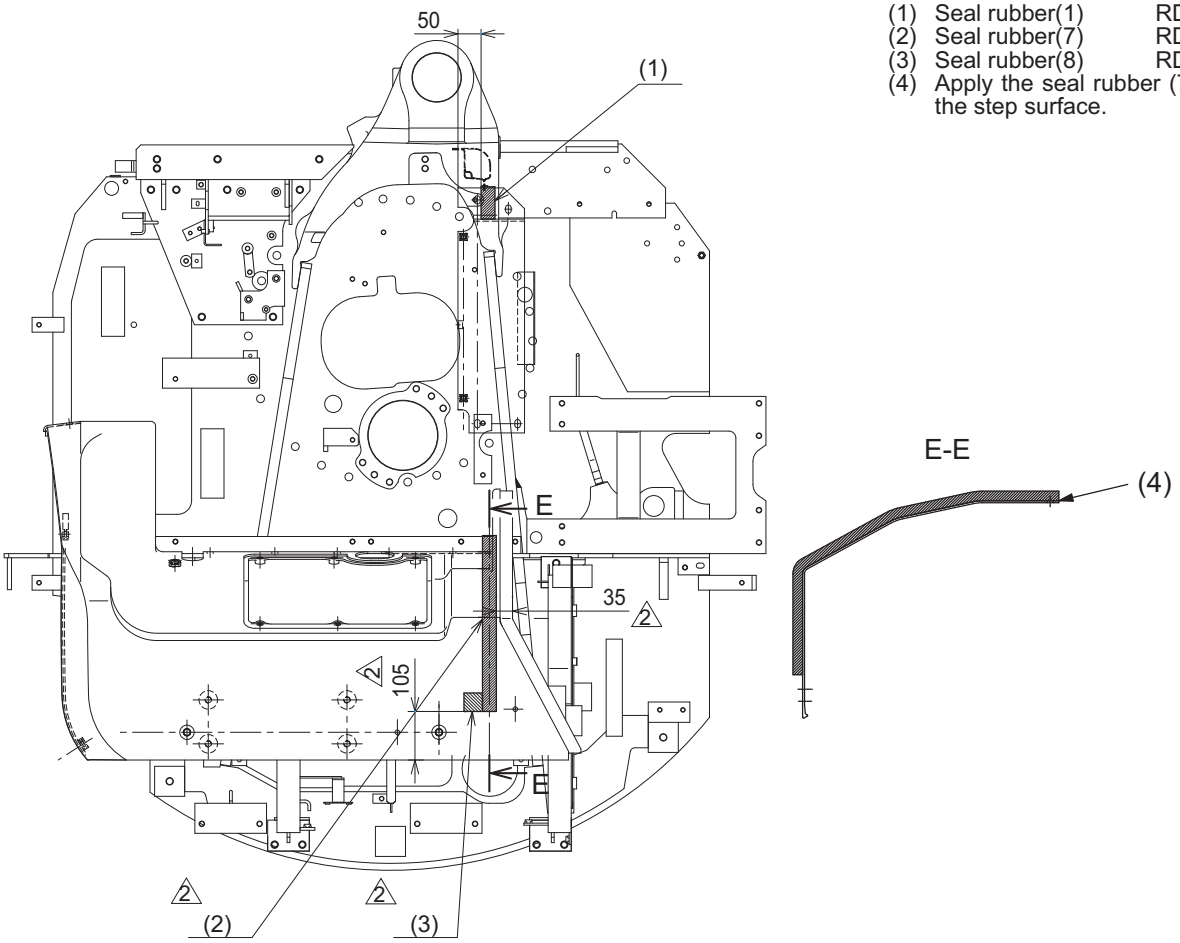




(1) Front, R
(2) Front, L
(3) Label RD118-4519△
(4) Front
(5) Thicker in front
(6) Stud (F, R) RC411-4850△
(7) Tightening torque: 107.9 ~ 125.5 N·m (11.0 ~ 12.8 kgf·m) (79.6 ~ 92.6 ft.lbs)
(8) 1.5 (Ref. value)
(9) 23.5 (Ref. value)
(10) (Front, R)
(11) Stud (F, L) RP421-4851△
(12) Nut x 2 02176-50140
(13) Washer (F) RC411-4853△
(14) Cushion rubber (F) RC411-4852△
(15) Cushion rubber (F) RC411-4852△
(16) Tightening torque: 107.9 ~ 125.5 N·m (11.0 ~ 12.8 kgf·m) (79.6 ~ 92.6 ft.lbs)
(17) 1.5 (Ref. value)
(18) 23.5 (Ref. value)
(19) (Front, L)
(20) Stud (R) RC411-4854△
(21) Nut x 2 02176-60160
(22) Washer (1, R) RC411-4857△
(23) Cushion rubber (R) RC411-4856△
(24) Tube (Stud, R) RC411-4855△
(25) Cushion rubber (R) RC411-4856△
(26) Washer (2, R) RC411-4858△
(27) Tightening torque: 166.7 ~ 191.2 N·m (17.0 ~ 19.5 kgf·m) (123 ~ 141.0 ft.lbs)
(28) Color RP401-42561△
(29) 1.5 (Ref. value)
(30) 27.5 (Ref. value)
(31) (Rear, R&L)

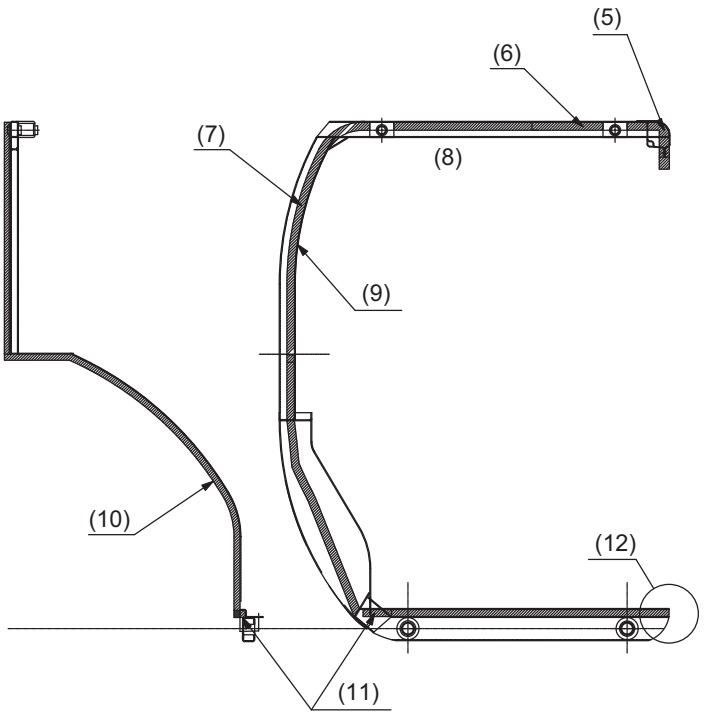
b) Seal Rubber

(1) Machine body



(1) Seal rubber(1) RD411-4860△
(2) Seal rubber(7) RD411-4866△
(3) Seal rubber(8) RD411-4867△
(4) Apply the seal rubber (7) starting from the step surface.

(2) Cab



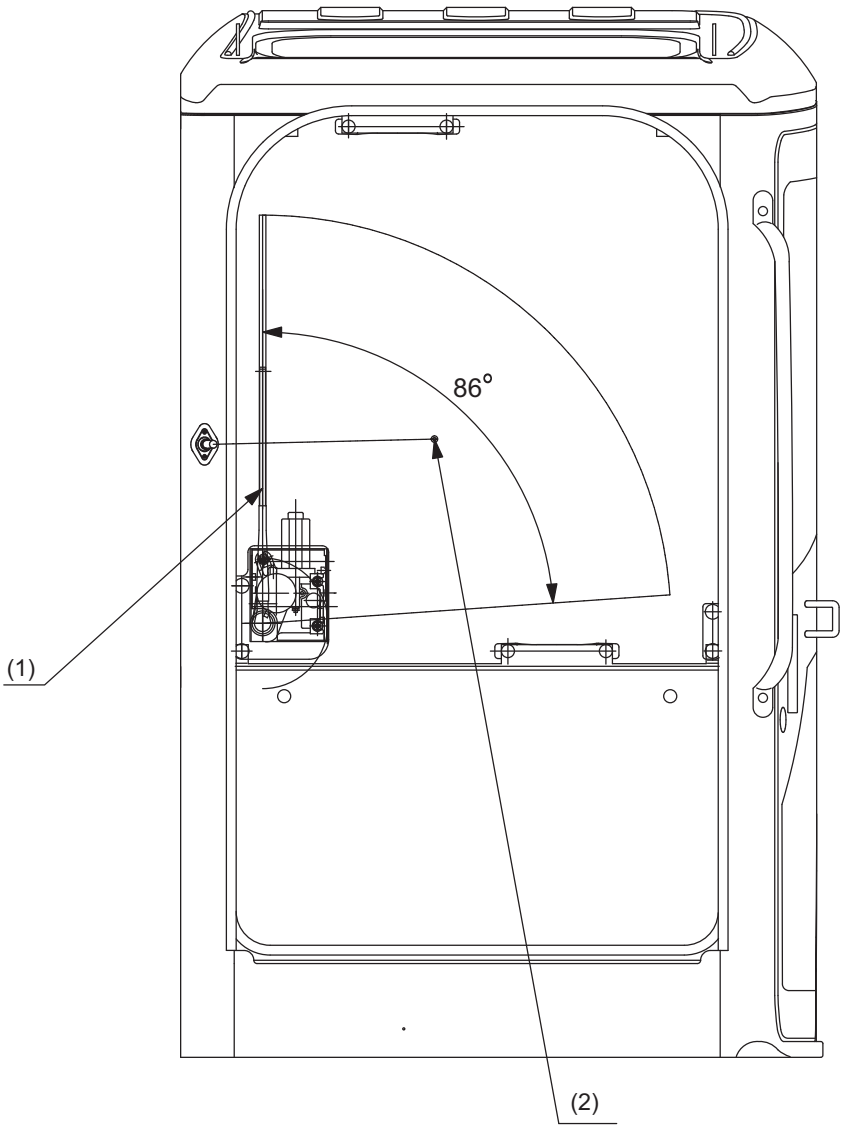
(5) Seal rubber(2) RD411-4861△
(6) Seal rubber(3) RD411-4862△
(7) Seal rubber(4) RD411-4863△
(8) Align the seal rubber accurately along the front. Apply the edge tightly in contact with the anti-vibration rubber.
(9) Align with the inner line of the square pipe.
(10) Seal rubber(5) RD411-4864△
Align with the inside of the press line.
(11) Seal rubber(6) RD411-4865△
Apply fittingly in the cab's groove.
(12) Place the edge in contact with the wall.

c) Wiper

(1) Nozzle adjustment
Water to be jetted out on the center of the windshield

(2) Blade stop position
To be positioned vertical at stop

(3) Fluid amount in the washer tank
No fluid left inside the tank



(1) Wiper blade stop position
To be vertical at stop
(2) Washer jet-out point
Adjust the nozzle so that fluid is jetted out nearly at the center of the windshield.

d) Heater Hose

(1) Heater hose

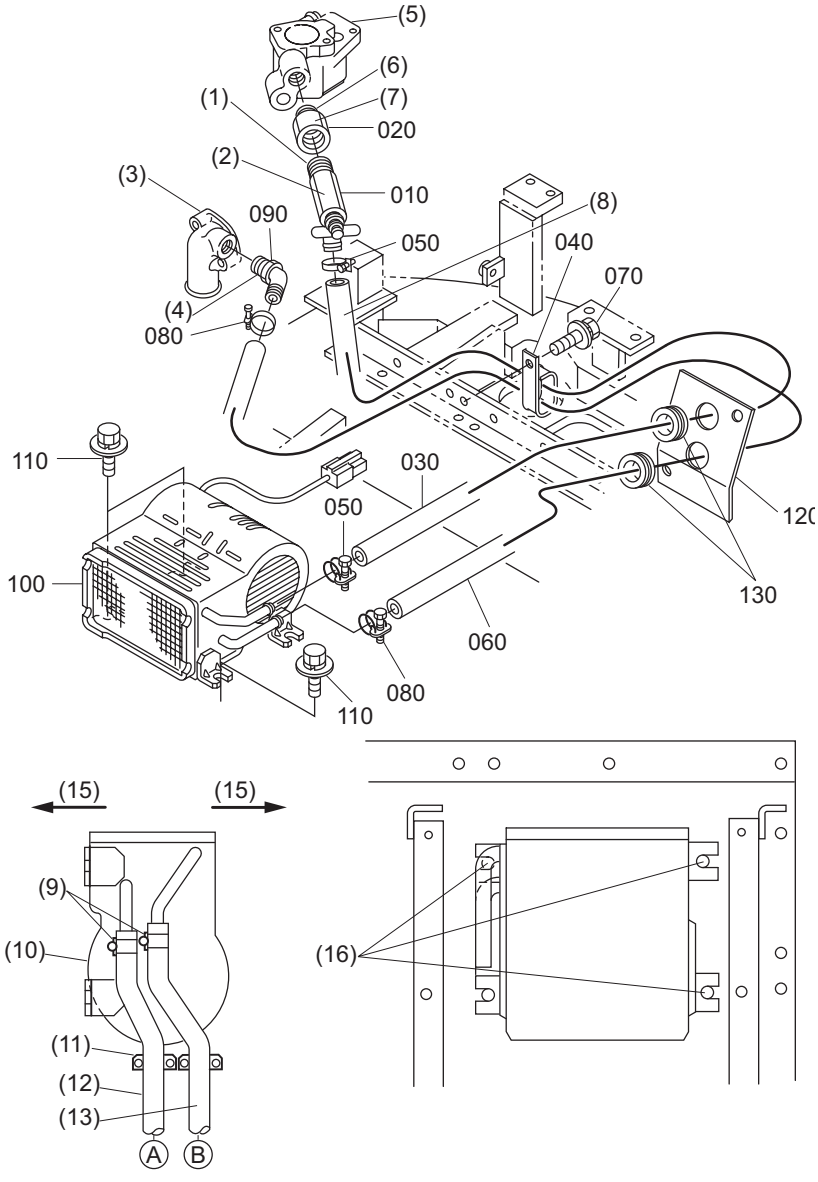
No kink.

Keep appropriate clearance.

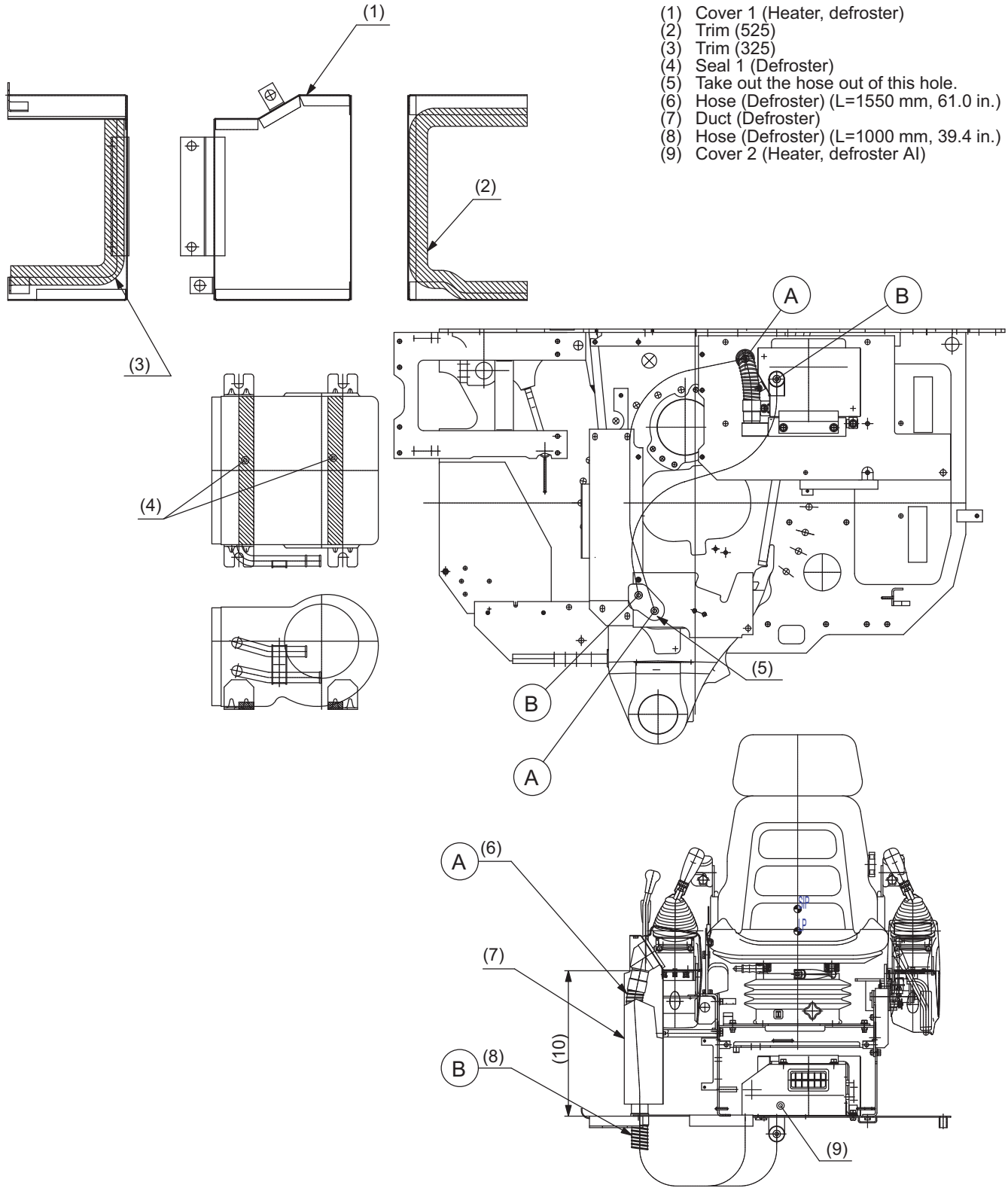
Heater hose	Hose length
(A)	880 mm (34.6 in) (RD411-4582△)
(B)	1000 mm (29.4 in) (RD411-4581△)

No.	Code No.	Name	Q'ty	No.	Code No.	Name	Q'ty
010	90038-1112△	Valve	1	080	09318-88185	Hose clamp	2
020	68723-4685△	Adaptor	1	090	T1065-7282△	Pipe joint	1
030	RD411-4581△	Hose 1	1	100	TA043-7241△	Heater assy	1
040	90038-1118△	Clamp 2	1	110	01135-61020	Bolt	3
050	09318-88185△	Hose clamp	2	120	RD411-4329△	Cover 2	1
060	RD411-4582△	Hose 2	1	130	RC411-4309△	Grommet	2
070	01135-61020△	Bolt	1				

(1) Use seal tape
(2) In assembling the valve, fix the adaptor with a wrench or the like and connect the valve. (Otherwise the flange may get damaged.)
Lay the Ø14 pipe at an angle of 15° with respect to the machine front. Tighten the adaptor to a torque of 9.0-9.8 N-m first and then tighten it further up to its specified setup angle.
(3) 1A085-7280
(4) Use seal tape
(5) 1A085-7270
(6) Use seal tape
(7) Adaptor's tightening torque (R3/8): Over 9.0-9.8 N-m
(8) Ensure a clearance of 20 mm (0.79 in) or more with the exhaust manifold.
(9) Hose clamp 09318-88185
(10) Heater assy 68311-5351△
(11) Grommet RC411-4309△
(12) Hose 2 RD411-4582△
(13) Hose 1 RD411-4581△
(14) Lower
(15) Upper
(16) Bolt x 3 01135-61020

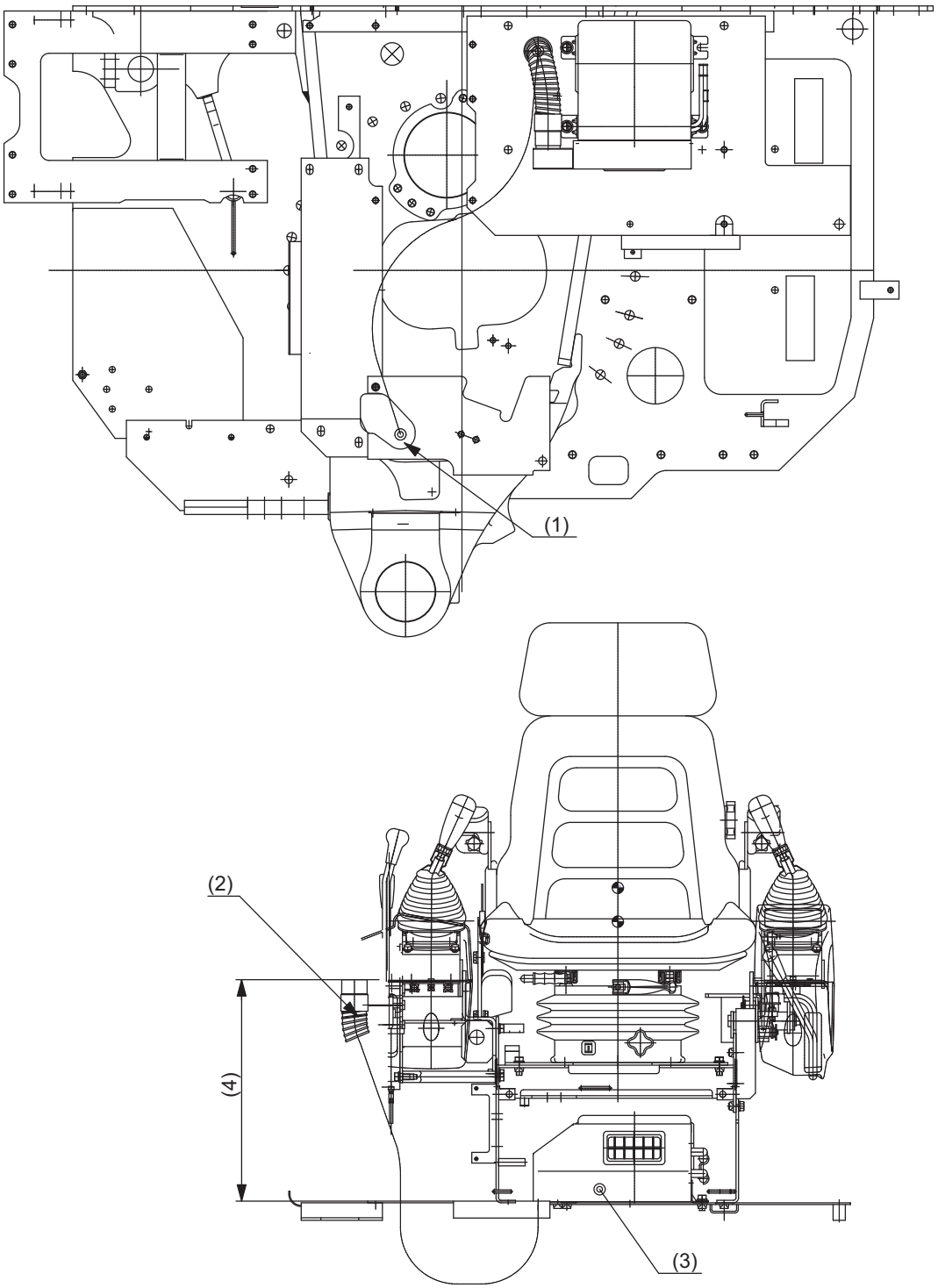


e) Defroster Hose
(KTC, KCL, KTA)



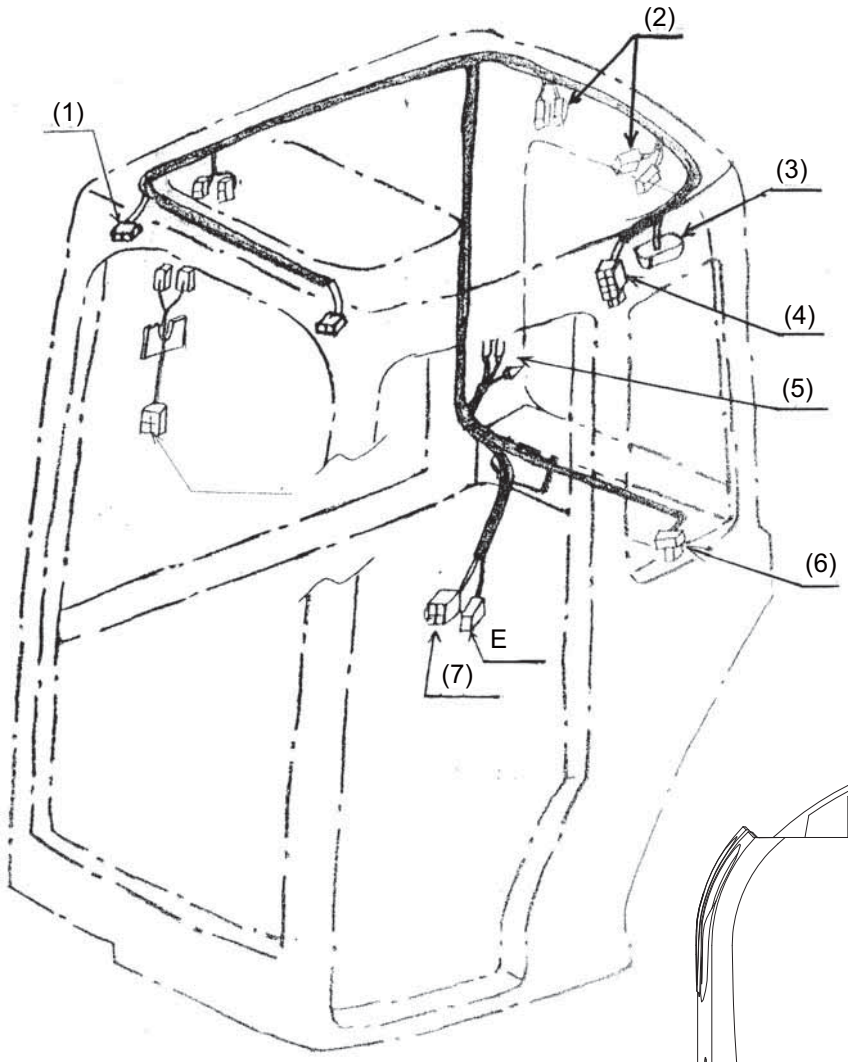
(1) Cover 1 (Heater, defroster)
(2) Trim (525)
(3) Trim (325)
(4) Seal 1 (Defroster)
(5) Take out the hose out of this hole.
(6) Hose (Defroster) (L=1550 mm, 61.0 in.)
(7) Duct (Defroster)
(8) Hose (Defroster) (L=1000 mm, 39.4 in.)
(9) Cover 2 (Heater, defroster AI)

(EU)

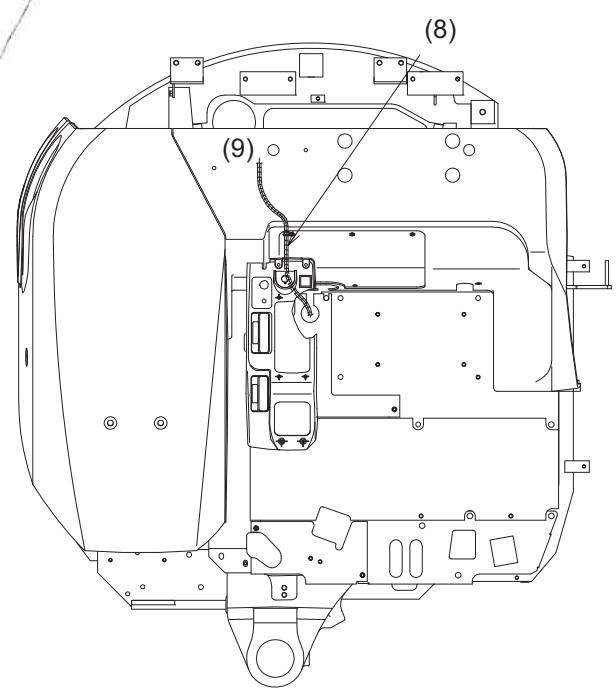


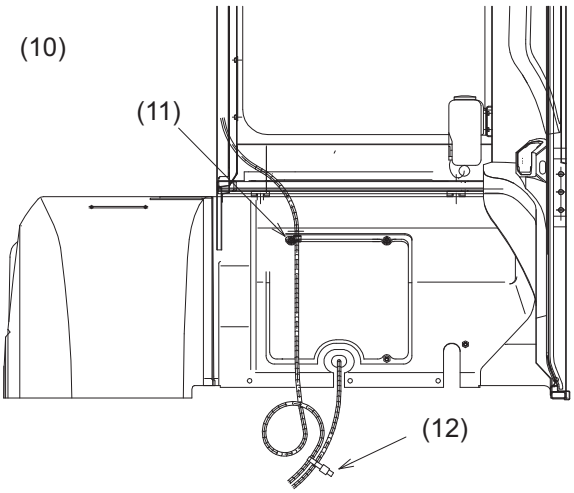
(1) Take out the hose out of this hole.
(2) Hose, defroster (L=1550 mm, 61.0 in.)
(3) Cover (Heater, Al)
(4) 400 (Ref.)

f) Cab Wire Harness



(1) Work lamp, 2
(2) Speaker
(3) Room lamp
(4) Wiper/washer SW
(5) Radio
(6) Washer tank
(7) Main
(8) Go through rear side of control box
(9) From cab
(10) Clamp with cover mounting bolt.
(11) Code clamp 34150-2939△
(12) Code band 55311-4126△





g) Cab Glass Replacement Procedure

Cab glass manufacturing method and adhering procedure are different between North American and European specifications in the points as shown in the table below.

KTC, KCL, KTA-version KBT make (Ninomiya Industry)	Adhesion type glass: Door glasses (upper and lower), left-side glass, front glass H-rubber fixation: Rear glass, right-side cover glass Slide type glass: Right-side slide glass
EU-version KBM make (Fritzmyer)	Adhesion type glass: Front glass H-rubber fixation: Door glasses (upper and lower), left-side glass, rear glass, right-side cover glass Slide type glass: Right-side slide glass

Below is described how to replace the cab glass KX91-3, KX101-3, KX121-3 and KX161-3 made by KBT.
The replacement procedure of cab glass is classified roughly into the following two, depending on the type of adhesive.

(1) SIKAFLEX/ULTRA-FAST
Curing time is short after application (but longer than one hour).
It is necessary to warm adhesive before application.
Heat box and electric cartridge gun are needed.
Since the replacement/adhering procedure is the same as repairing of car, it should be applied at car repair shop.

(2) SIKAFLEX/255 EXTRA
Curing time is long. (8 hours)
No special tools are needed.

Please refer to the replacement/adhering procedures, using two types of adhesive which are described in the following two pages. As for the adhesive to be used, ask your local SIKAFLEX dealer and get SIKAFLEX/255 EXTRA or equivalent.

Note:
For your reference, the H-rubber replacement procedure and KBT-make KX-2 Series glass replacement procedure are described in the latter half part of the following section.

(1) Application Procedure if SIKAFLEX (ULTRA-FAST)

	SIKAFLEX	Cab	Glass
Start	Put SIKAFLEX in hot box and heat it. 40 ~ 60 min.	Remove dust, oil and moisture. Use thinner or the like.	Remove dirt and moisture by No.1 cleaner. (Not necessary unless the glass is stained.)
5 min.		Apply activator. Drying time: Approx. 20 min.	Apply activator. Drying time: Approx. 20 min.
10 min.		↓	
		(Application of dam rubber)	
15 min.		(Dam rubber can be applied any time.)	
20 min.		↓	
25 min.			
30 min.		Apply primer. Drying time: Approx. 20 min.	
35 min.		↓	
40 min.		(Application of dam rubber)	
45 min.		↓	
50 min.	Apply it to glass.	Adhesion of glass	Apply SIKAFLEX around the glass. (Complete adhesion to cab within 10 min.)
55 min.			It will harden in 30 min. Fix it temporarily by adhesive tape, if necessary.
60 min.			↓
			Shower test can be conducted after 30 min.

Notes:

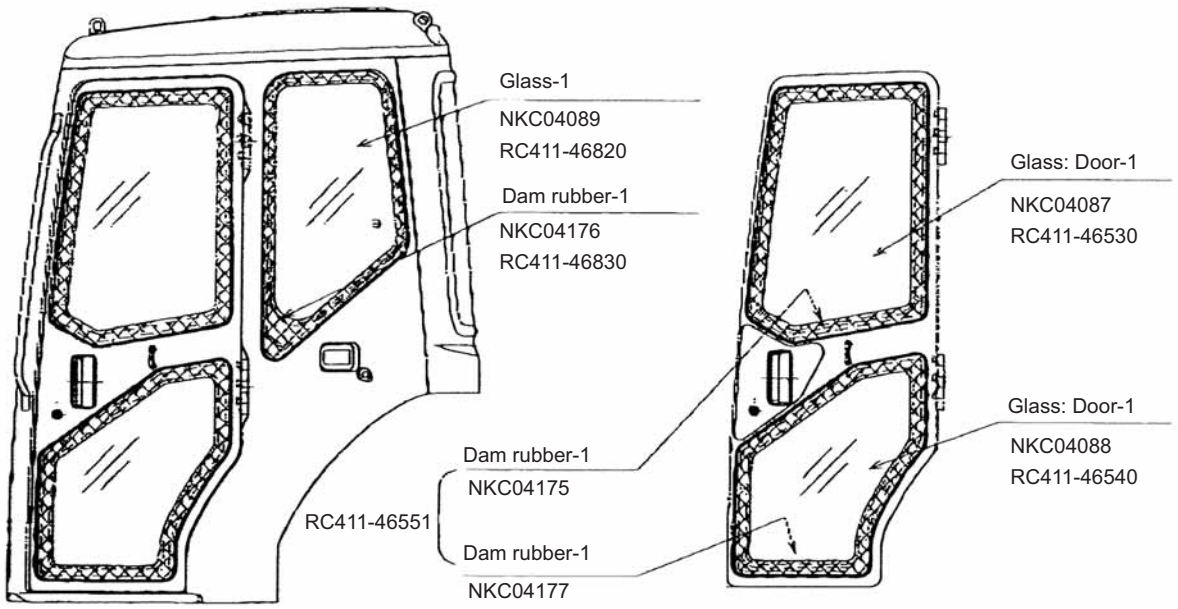
One bottle of SIKAFLEX enables adhesion of 2-2.5 sheets of KUBOTA CAB glass. One bottle of activator/primer (separately sold) reportedly enables application to about 9 sheets of glass.

To adhere glass, first press the glass gently to the cab, and then press it with force after appropriately positioned. If it is pressed at first with force, positioning of glass will be difficult.

(2) ULTRA-FAST application manual

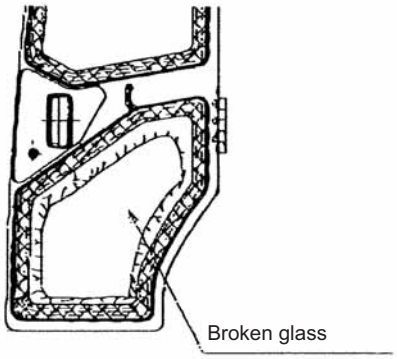
Broken glass replacement procedure: KX91-3, KX121-3, KX161-3

a. Check the following points prior to replacement of glass.



1. Check the part No. of broken glass.
2. In the replacement of door glass, do not dismount the door from the cab.
3. The part Nos. of glass and those of accessories are as shown in the figure above.

b. The following description exemplifies the replacement procedure for broken lower glass of the door.



Prepare the following items before starting replacement:

1.	Glass: Door/NKC04088		1 sheet
2.	Dam rubber /NKC04177		1 set
3.	SIKAFLEX/ULTRA-FAST	330 ml	1 bottle
4.	SIKA activator	30 ml	1 bottle
5.	SIKA primer	30ml	1 bottle

6. Others: Cutter, waste cloth, suction cup, two paint brushes, hot box*, electric cartridge gun* (battery-powered type), adhesive tape.

Note:

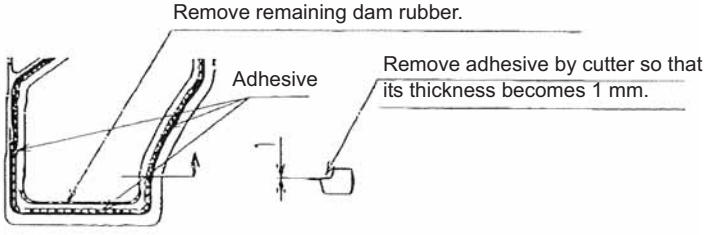
Power supply is needed for *-marked items.
Be sure to use the hot box and electric cartridge gun.

Procedure

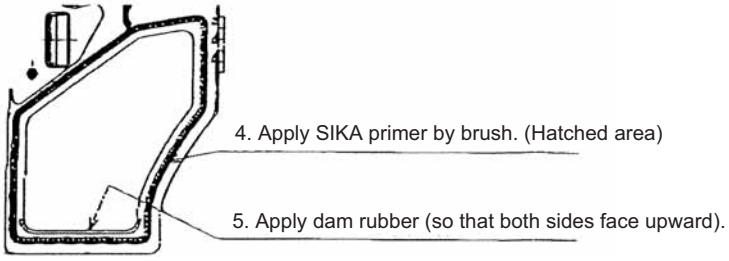
1. Put SIKAFLEX/ULTRA-FAST (hereafter called "SIKA UF") in the hot box. (Heat it for 20 ~ 30 min.)
2. Remove broken glass. Remove old adhesive by cutter.

Note!

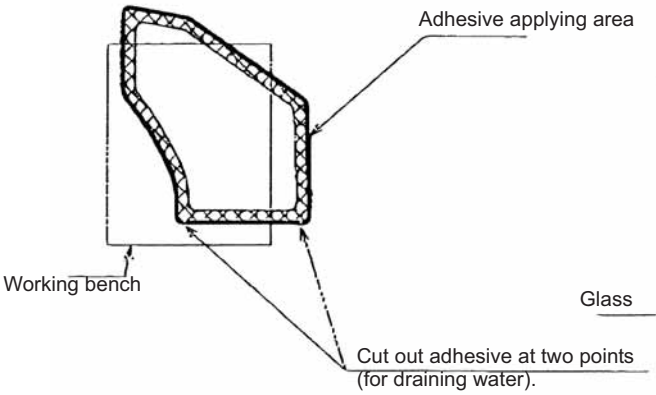
When the paint is marred by cutter, repair it after the completion of replacing work. Adhesive does not stick to the repaired paint.

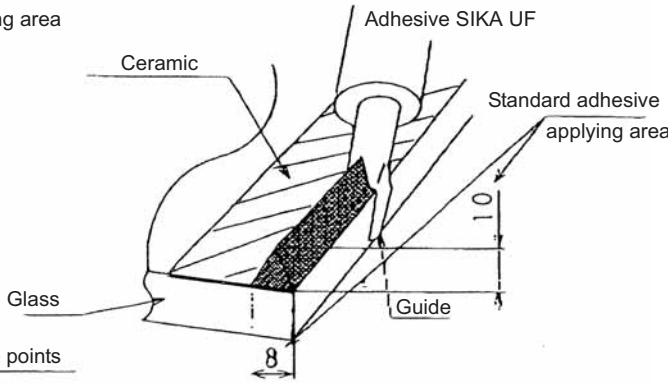


3. Clean the adhering area (of glass side and door side) by SIKA activator. (See the SIKAFLEX/ ULTRA-FAST application procedure.)
4. Apply SIKA primer only to door side.



5. Apply dam rubber.
6. Apply adhesive SIKA UF to glass.

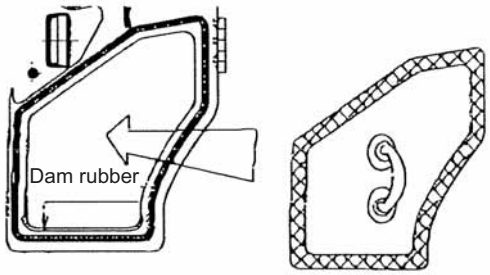




Point:

Application work becomes easy by turning the glass. Pay attention not to damage the glass by turning.

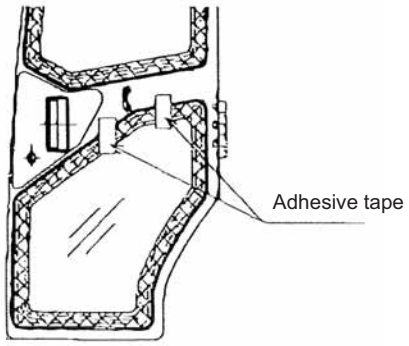
7. Bring up the glass by suction cup and set it to the door. (Clearance between the periphery of glass and the door frame should be uniform.)



Point:

Press the glass gently to the door frame. Adhere the glass while slowly pressing so that the clearance around the glass should become uniform.
When the clearance becomes uniform, then press the entire glass so that it sinks 1 ~ 2 mm ((3.9 ~ 7.9) x 10^{-2} in.) below the height of door frame.
(When the glass contacts the dam rubber, it sinks 2 mm (7.9 x 10^{-2} in.). Keep this in mind for reference.)

8. Fix the glass to the door frame by adhesive tape, if necessary (to prevent the glass from shifting downward).



The above completes the work.
It is okay to splash water over the glass after drying for 30 min, but do not give a strong impact.
Do not give an impact by open/close action at least within one hour.

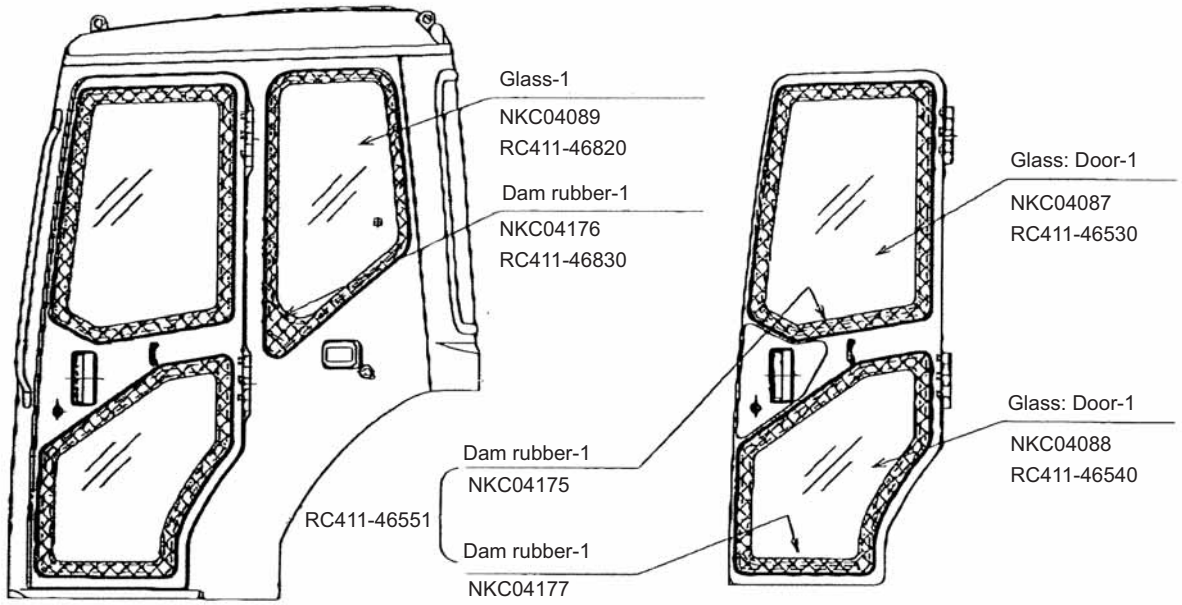
Note

If the door is dismounted from the cab for application work, adjust opening and closing of the door at the time of re-mounting it after the completion of application work.

(3) 255 EXTRA application manual

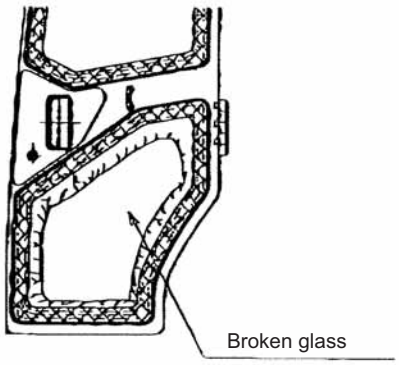
Broken glass replacement procedure

a. Check the following points prior to replacement of glass.



1. Check the article No. of broken glass.
2. In the replacement of door glass, do not dismount the door from the cab.
3. The article Nos. of glass and those of accessories are as shown in the figure above.

b. The following description exemplifies the replacement procedure for broken lower glass of the door.



Prepare the following items before starting replacement:

1.	Glass: Door/NKC04088		1 sheet
2.	Dam rubber/NKC04177		1 set
3.	SIKAFLEX/255 EXTRA	320 ml	1 bottle
4.	SIKA activator	30 ml	1 bottle
5.	SIKA primer	30ml	1 bottle

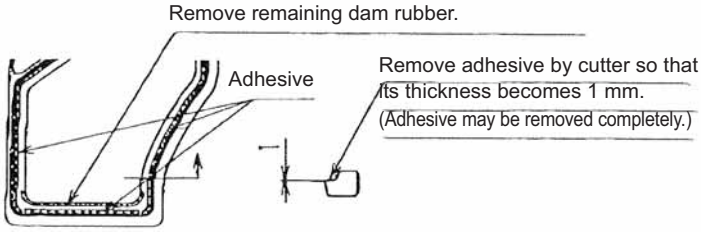
6. Others: Cutter, waste cloth, suction cup, two paint brushes, and adhesive tape.

Procedure

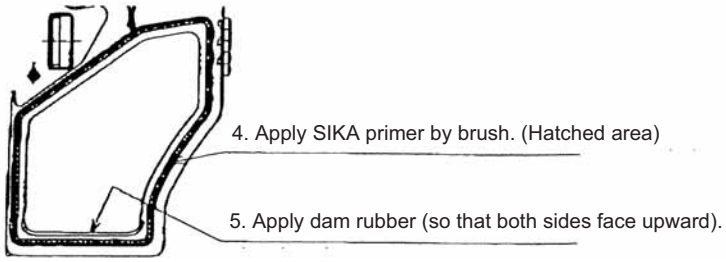
1. Remove broken glass. Remove old adhesive by cutter.

Note!

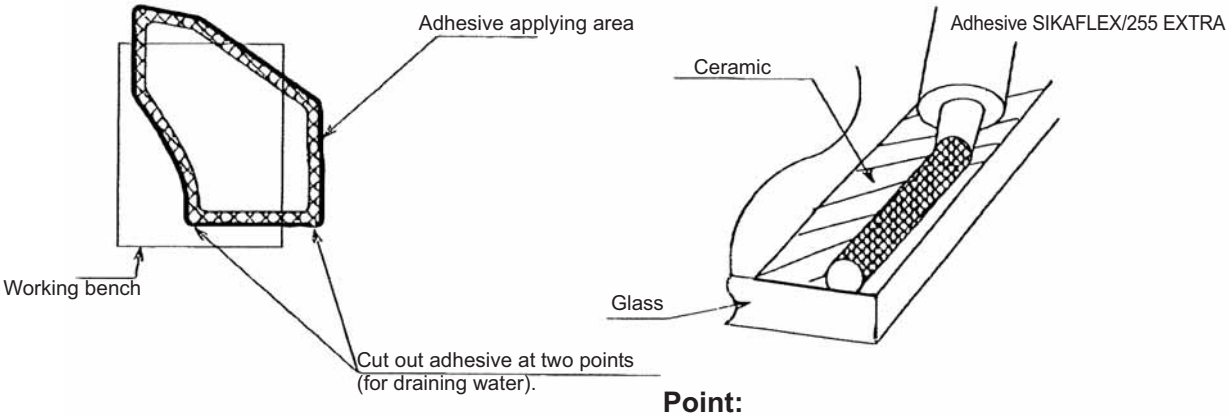
When the paint is marred by cutter, repair it after the completion of replacing work. Adhesive does not stick to the repaired paint.



2. Clean the adhering area (of glass side and door side) by SIKA activator.
3. Apply SIKA primer only to door side.



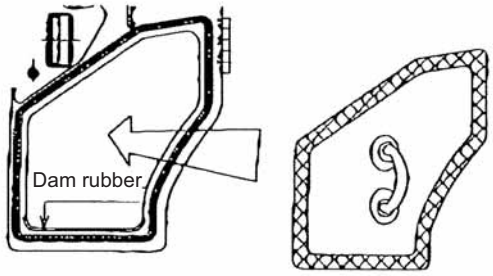
4. Apply dam rubber.
5. Apply adhesive SIKAFLEX/255 EXTRA to the glass.



Point:

Application work becomes easy by turning the glass.

6. Bring up the glass by suction cup and set it to the door. (Clearance between the periphery of glass and the door frame should be uniform.)



Note!

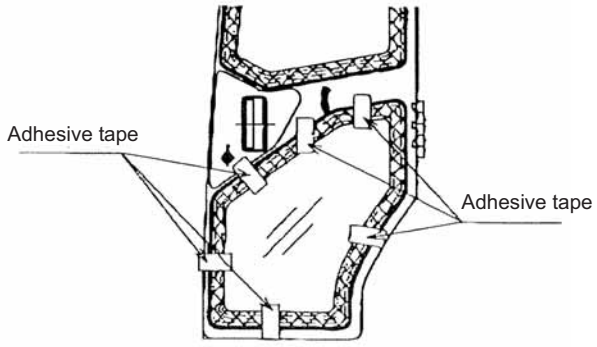
Pay attention not to give damage to the glass while turning.

Point:

Press the glass gently to the door frame. Adhere the glass while slowly pressing so that the clearance around the glass should become uniform.

When the clearance becomes uniform, then press the entire glass so that it sinks 1 ~ 2 mm below the height of door frame. (When the glass contacts the dam rubber, it sinks 2 mm. Keep this in mind for reference.)

7. Fix the glass to the door frame by adhesive tape (to prevent the glass from displacing downward).



The above completes the work.
Leave it in this state for longer than 8 hours.

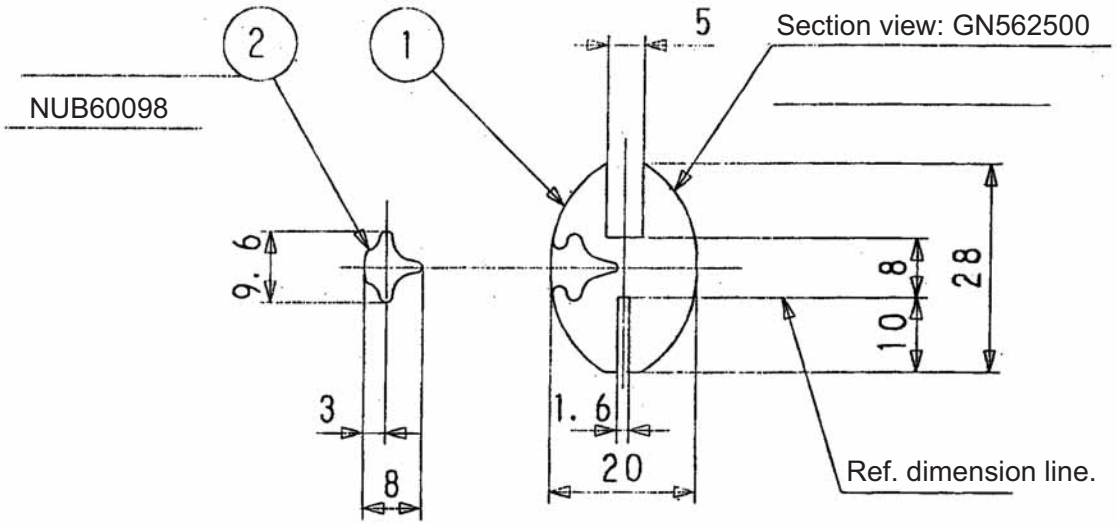
Leave it for 8 hours. Do not open and close the door.

Note

If the door is dismounted from the cab for application work, adjust opening and closing of the door at the time of remounting it after the completion of application work.

(4) H-rubber replacement procedure

As shown in SEC A, the glass is fixed to the metal part by inserting the part (2) into the part (1). Thus, it has such advantages that no curing time is needed and replacement is easy, and (though the adhesion method assures a good appearance,) this insertion method is applied extensively in overseas countries. Glass can be removed after inserting a screwdriver into the notch of rubber wedge and removing the rubber wedge. Our experience reveals that the glass, which is bordered with rubber, will not "slip out suddenly" (when it is tapped repeatedly). However, pay due attention not to shed it off when removing.

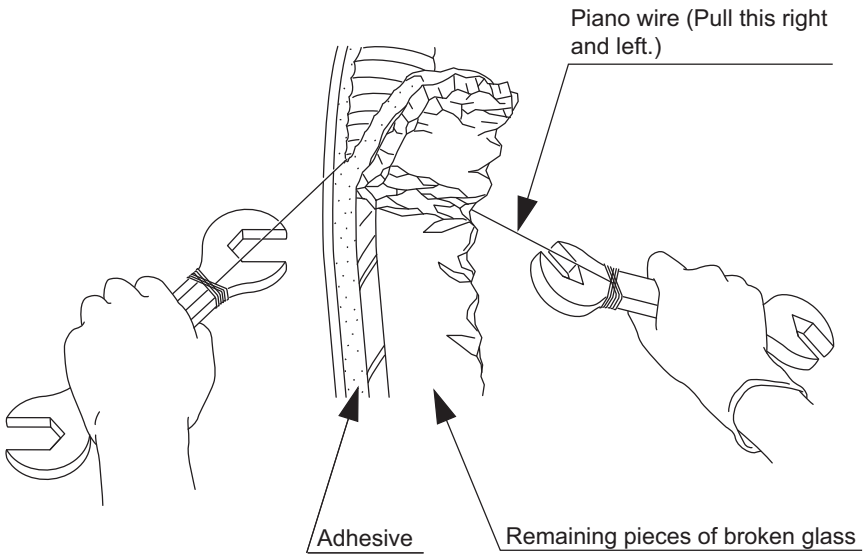


SEC A

(5) Broken glass repairing procedure (for adhered glass KX-2 Series made by KBT)

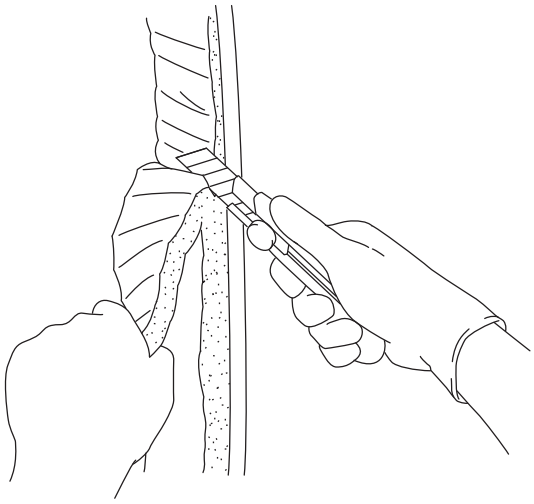
a. Restoration of broken glass

1. Remove pieces of broken glass remaining on the door frame



Remove the remaining pieces of broken glass while cutting hardened rubber-like adhesive by piano wire of about 0.4 mm dia. (Pay due attention not to injure your hand by broken glass and piano wire.)

2. Remove old adhesive remaining after removal of pieces of broken glass.



Cut off the old adhesive evenly.

- Pull the rubber adhesive and remove it while cutting off rubber at the frame side by cutter.
- Adhesive remaining thick on the frame will cause projection of the glass to be mounted anew or water leakage.

3. Cleaning of frame
   Wipe off wastes of dam rubber and adhesive remaining on the frame by isopropyl alcohol.

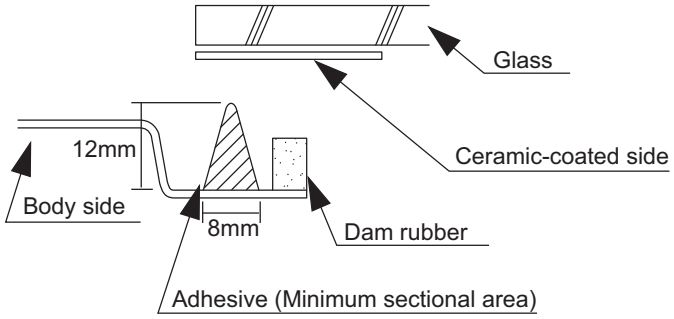
b. Adhesion of glass

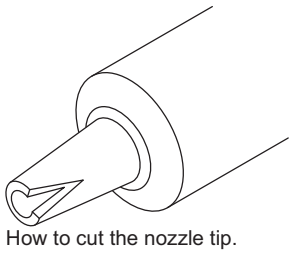
1. Apply primer to the adhering area of window frame.
   (1) Stir primer by shaking the bottle well.
   (2) Film thickness should be thicker than 5 micron without irregularity.
   (3) Primer drying time
   Natural drying: Longer than 2 min. and shorter than 3 hrs.

2. Apply dam rubber to the indoor side of window frame.

3. Cleaning of glass
   Clean stained glass by isopropyl alcohol.

4. Apply adhesive to the applying area (of ceramic-coated side) or the body side.



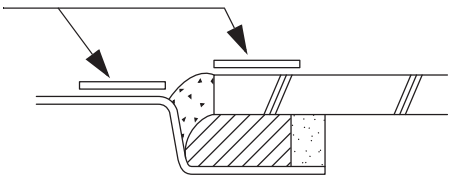

How to cut the nozzle tip.

   • Apply adhesive either to glass side or to body side for easiness of work depending on the width of adhesive application and other conditions.

5. Adhere the glass by pressing while positioning it.

6. For good appearance, apply adhesive around the glass.

Apply masking tape.



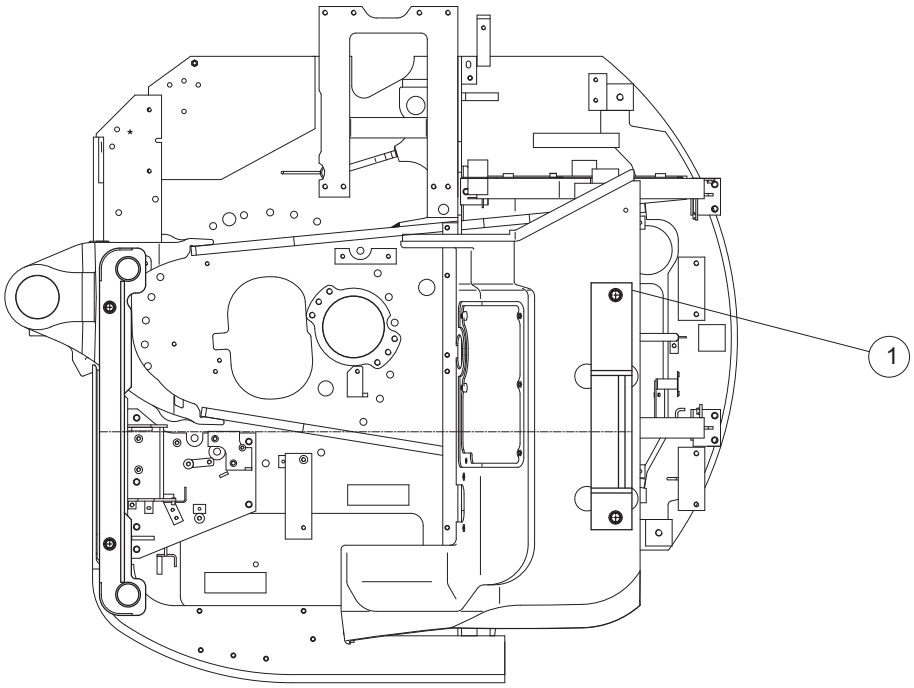
7. Leave it not applying any impact until the adhesive dries completely.
   Summer season: Approx. 12 hours
   Winter season: Approx. 24 hours

8. Completion of application work

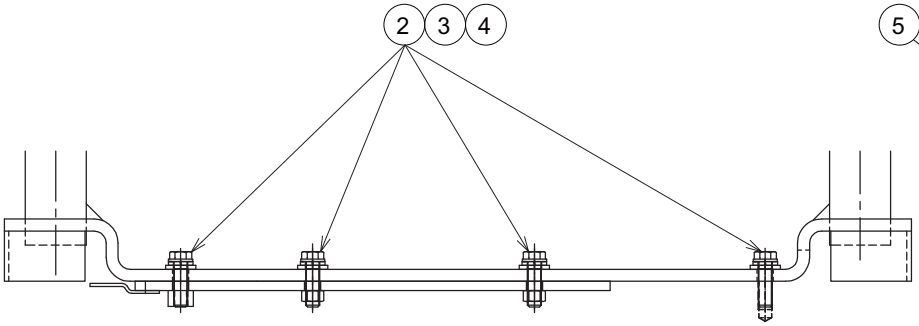
   Adhesive: Sika Japan, Ltd. SIKAFLEX 250-Z
   Primer: Sika Japan, LTD. SIKA PRIMER
   As for overseas market, please ask your local SIKAFLEX dealer and get the equivalent adhesives and primer.

h) Rops Canopy

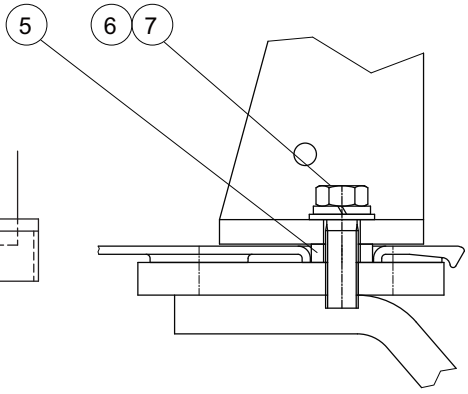
S	Fitting the canopy (ROPS) (M14 x 1.5, 9T) (M16 x 1.5, 9T)	Tightening torque (7T) 123.6 ~ 147.1 N·m (12.6 ~ 15.0 kgf·m) 91.1 ~ 108.5 ft·lbs 196.1 ~ 225.6 N·m (20.0 ~ 23.0 kgf·m) 144.7 ~ 166.4 ft·lbs	Poor tightening ↓ Loose bolt ↓ Come-off, damaged



(Front mounting bolt)



(Rear mounting bolt)



(1)	Canopy (ROPS)	RD118-4530△	1	
(2)	Bolt	RD431-45411	4	M14 x 1.5, 9T
(3)	Spring washer	04512-60140	4	
(4)	Flat washer	RD431-45391	4	
(5)	Collar	RP401-4526△	2	
(6)	Bolt	01138-61650	2	M16 x 1.5, 9T
(7)	Flat washer	04013-60160	2	
(8)	Front			
(9)	Rear			

(G) NAMEPLATE

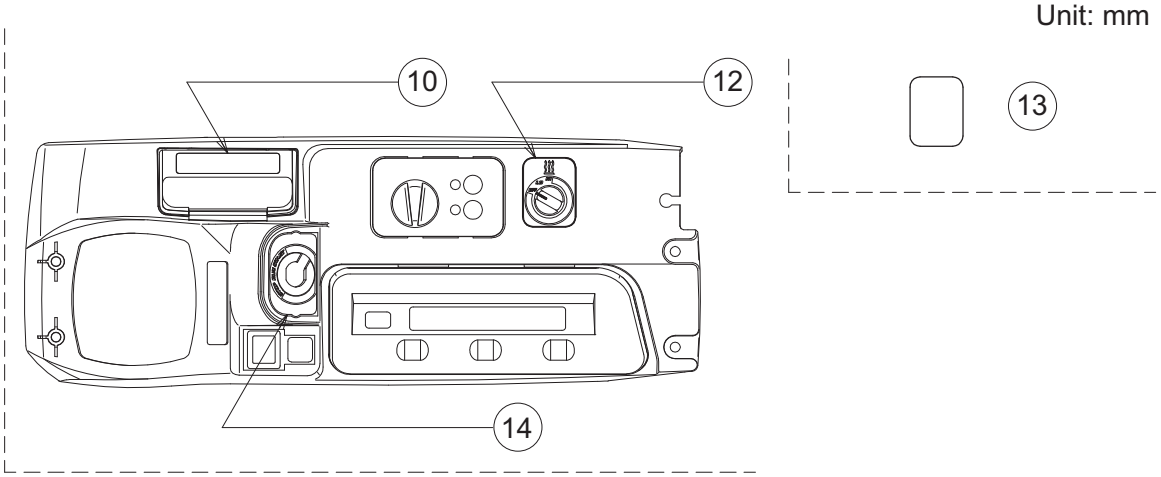
a) Nameplates List and Their Quantities Per Machine

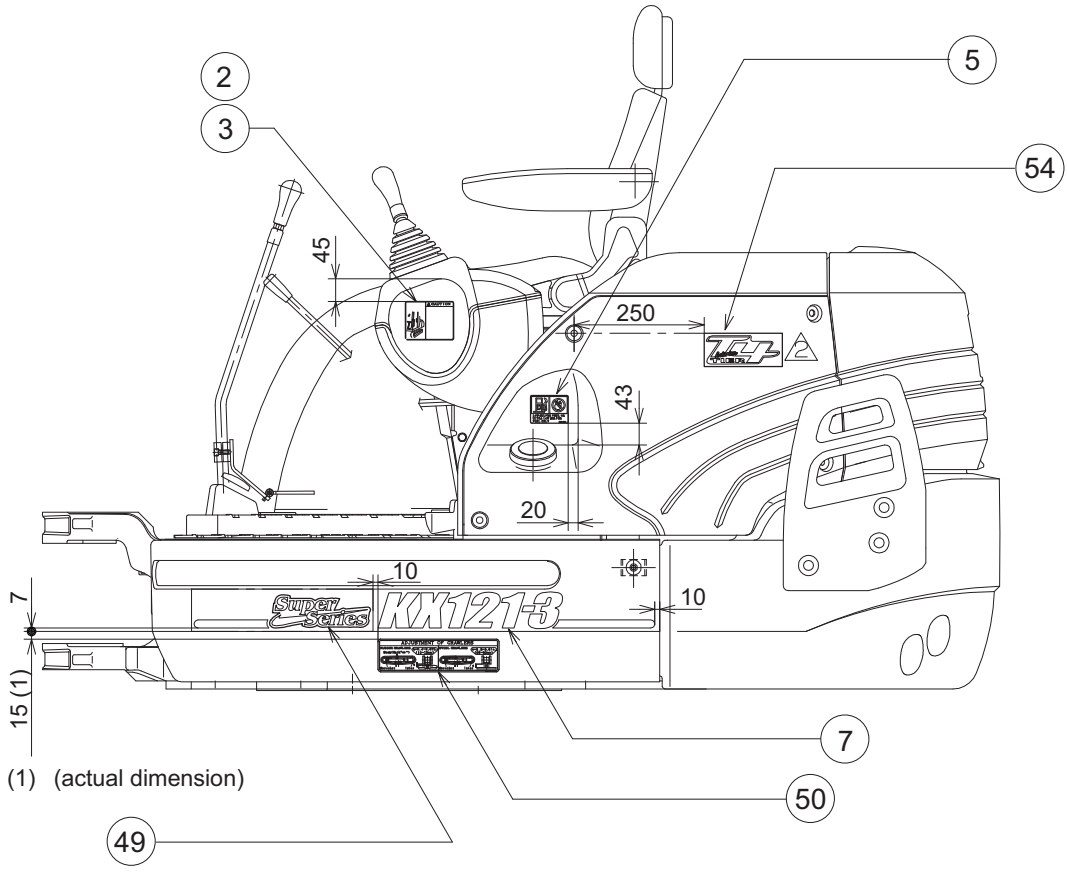
No	Part name	Part code	KX121-3ST	KX161-3ST	U45-3ST	Remarks
1	Label (lubrication)	RC418-5745Δ	1	1	1	
2	Label (get-on/off caution)	RD118-5763Δ	1	1	1	Canopy
3	Label (get-on/off caution)	RC108-5765Δ	1	1	1	Cabin
4	Label (power)	RC418-5746Δ	1	1	1	
5	Label (refuel)	RB148-5736Δ	1	1	1	
6	Label (SUPER SERIES)	RC448-5716Δ	2	2	2	
7	Marking (model, left)	RD138-5712Δ	1	-	-	
8	Marking (model, left)	RD538-5712Δ	-	1	-	
8	Marking (model, left)	RD438-5712Δ	-	-	1	
9	Label (new-vehicle sticker)	RC108-5797Δ	1	1	1	
10	Label (blade)	RC101-5743Δ	1	1	1	
11	Label (cover)	RD517-6742Δ	1	-	-	
12	Label (heater)	RC418-5742Δ	1	1	1	Cabin
13	Label (panel)	RB238-5744Δ	1	1	1	Canopy
14	Label (main switch)	RB238-5775Δ	1	1	1	
15	Label (muffler, caution)	TA040-4958Δ	1	1	1	
16	Label (fan, caution)	TA040-4957Δ	1	1	1	
17	Label (scald caution, 1)	RC108-5754Δ	1	1	1	
18	Label (hydraulic oil)	RC108-5747Δ	1	1	1	
19	Label (battery)	6C040-5559Δ	1	1	1	
20	Label (red, No. 1)	RD118-4519Δ	-	-	4	Europe, semi-finished, 6 sheets
21	Label (lever lock)	RC418-5753Δ	2	2	2	Canopy
			1	1	1	Cabin
22	Label (operation pattern)	RC418-5731Δ	1	1	1	
23	Label (keep out)	RC418-5725Δ	2	2	2	
24	Label (KUBOTA)	TC220-8093Δ	3	3	3	
25	Label (engine start caution)	RC108-5718Δ	1	1	1	
26	Marking (K, emblem)	3M740-8319Δ	1	1	1	
27	Label (engine stop)	RD118-5737Δ	1	1	1	
28	Label (lifting)	RC108-5796Δ	4	4	4	
29	Label (caution)	68328-5735Δ	2	2	2	
30	Marking (frame, right)	RD138-5718Δ	1	1	1	
31	Label (lifting load)	RD118-5747Δ	1	-	-	Destined for North America
31	Label (lifting load)	RD518-5747Δ	-	1	-	Destined for North America
31	Label (lifting load)	RD438-5747Δ	-	-	1	Destined for North America
31	Label (lifting load)	RD118-5748Δ	1	-	-	Destined for Australia
31	Label (lifting load)	RD518-5748Δ	-	1	-	Destined for Australia
31	Label (lifting load)	RD418-5748Δ	-	-	1	Destined for Australia
32	Marking (model, right)	RD138-5713Δ	1	-	-	
33	Marking (model, right)	RD538-5713Δ	-	1	-	
33	Marking (model, right)	RD438-5713Δ	-	-	1	
34	Label (book)	RC418-5783Δ	1	1	1	
35	Label (fuse)	RC418-5781Δ	1	1	1	
36	Label (caution, operation pattern)	RC418-5732Δ	1	1	1	
37	Label (get-on/off prohibited)	RD118-5764Δ	1	1	1	Canopy
38	Label (refuel)	RB208-5745Δ	1	1	1	
39	Nameplate (machine number)	RA018-5772Δ	1	1	1	
40	Label (electric shock)	RC418-5733Δ	1	1	1	
41	Label (caution)	RC418-5727Δ	1	1	1	
42	Label (third line)	RD148-5787Δ				Type with third line
42	Label (adjustment, SP)	RC348-5742Δ				For SP-fitted type only
43	Label (caution)	RC418-5728Δ	1	1	1	
44	Label (swing)	RB238-5757Δ	1	1	1	
45		Unused	-	-	-	
46	Label (step-on prohibited)	RD118-5765Δ	1	1	1	
47	Marking (auto idling)	RD411-5774Δ	-	1	1	AI
48	Label (defroster)	RC418-4922Δ	1	1	1	Cabin
49	Marking (frame, left)	RD138-5717Δ	4	4	4	
50	Label (crawler adjustment)	RD118-5752Δ	1	1	1	
51	Label (lifting prohibited, EU)	RB419-5796Δ	2	2	2	Canopy
			4	4	4	Cabin
52	Label (barcode)	RD138-8211Δ	1	1	1	
53	Nameplate (ROPS, E)	RC448-5855Δ	1	1	1	
54	Label (INT TIER4)	RD148-5796Δ				
55						
56	Label (attachment caution)	RD809-5738Δ				

Note: ST means Interim Tier 4.

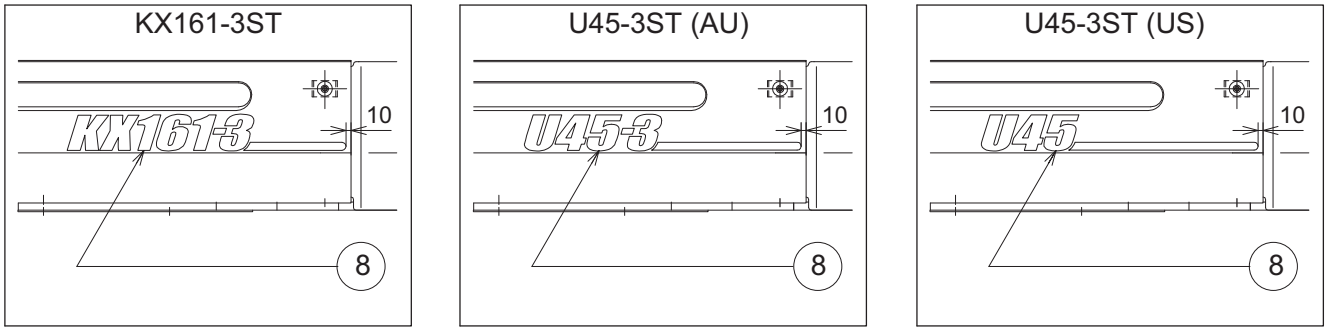
b) Label Location

Unit: mm

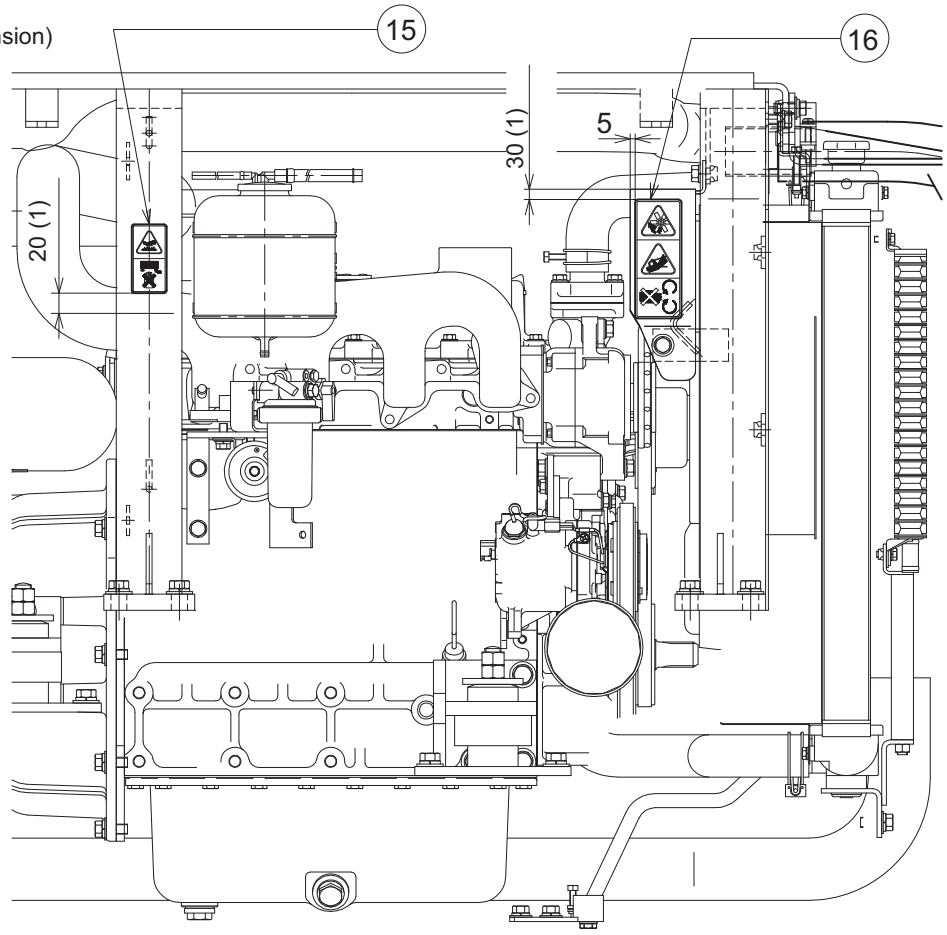


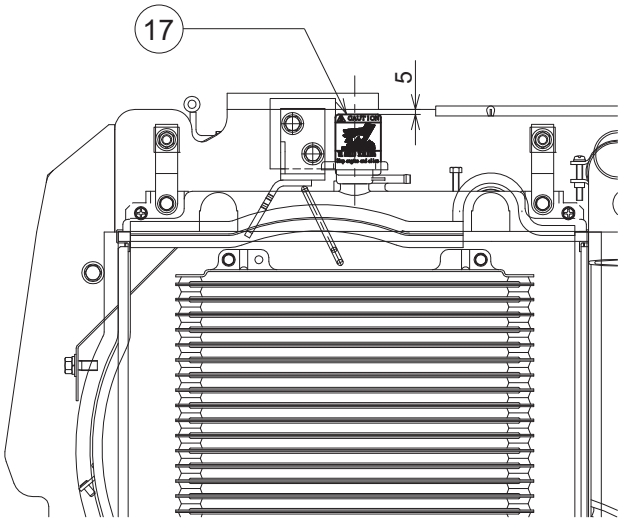


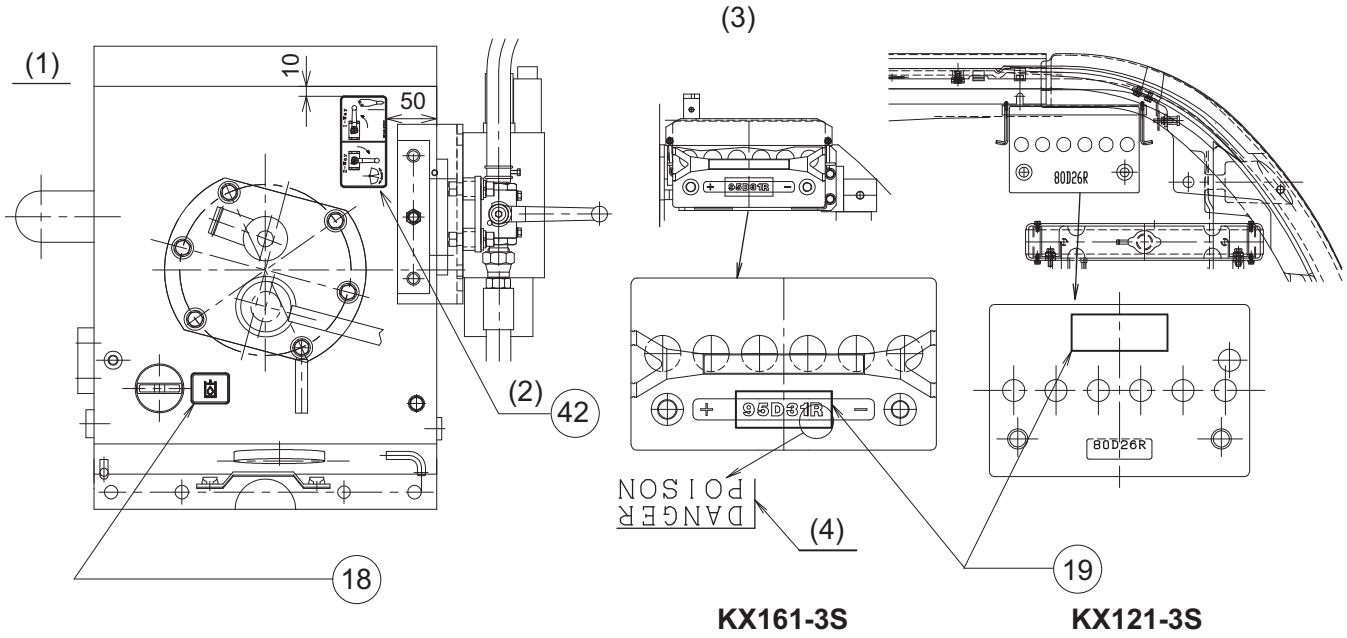
(1) (actual dimension)

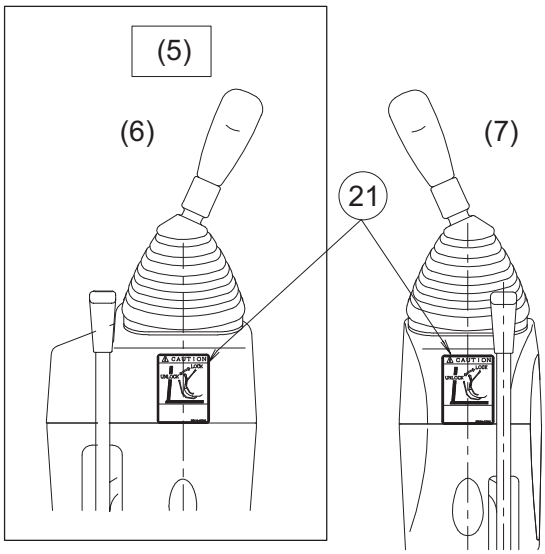


(1) (actual dimension)

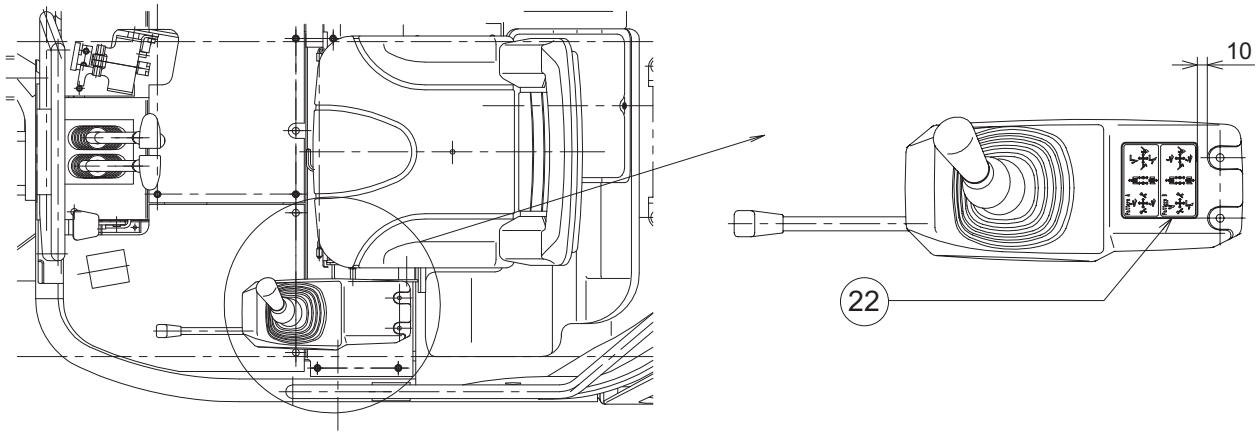


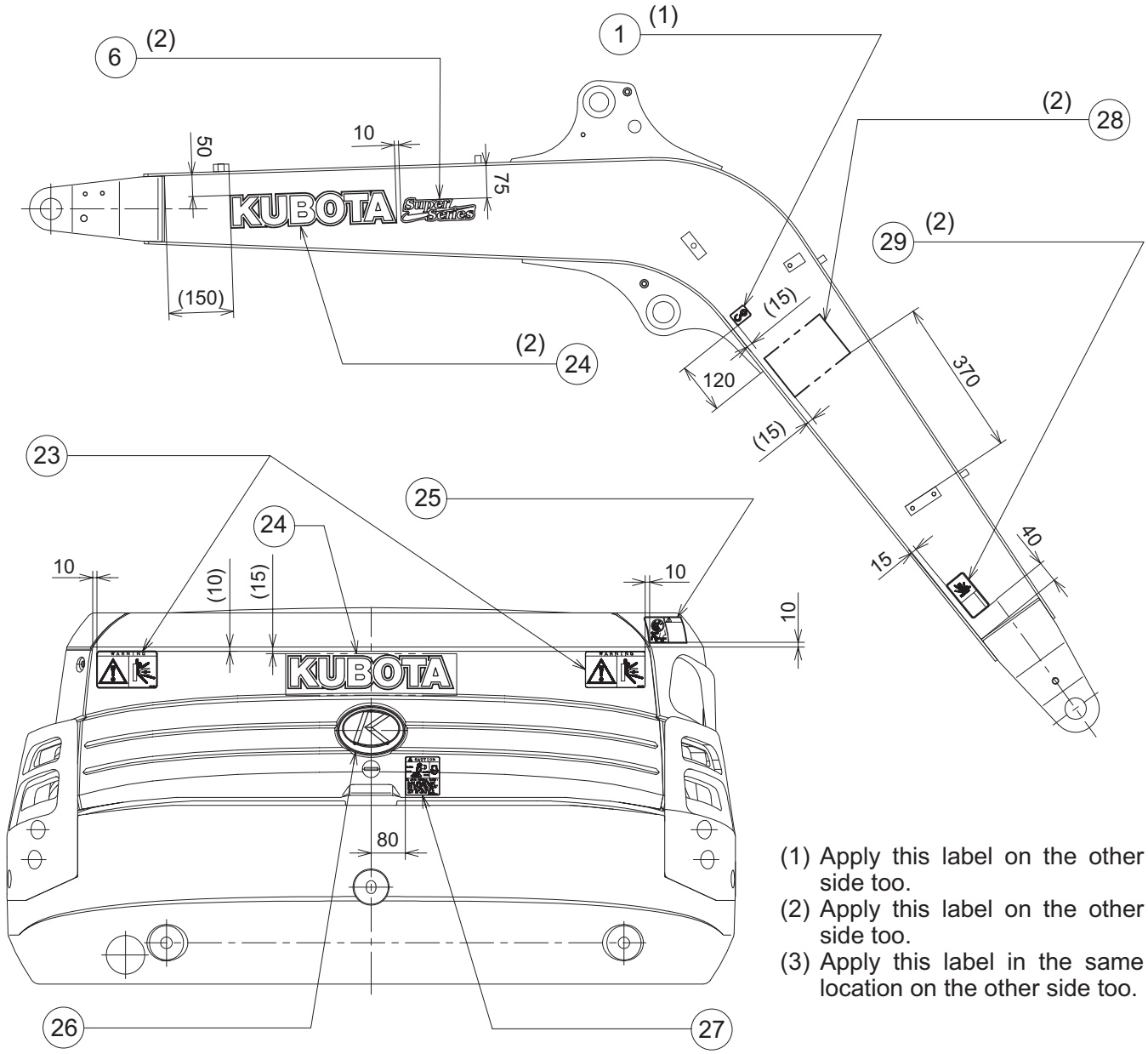




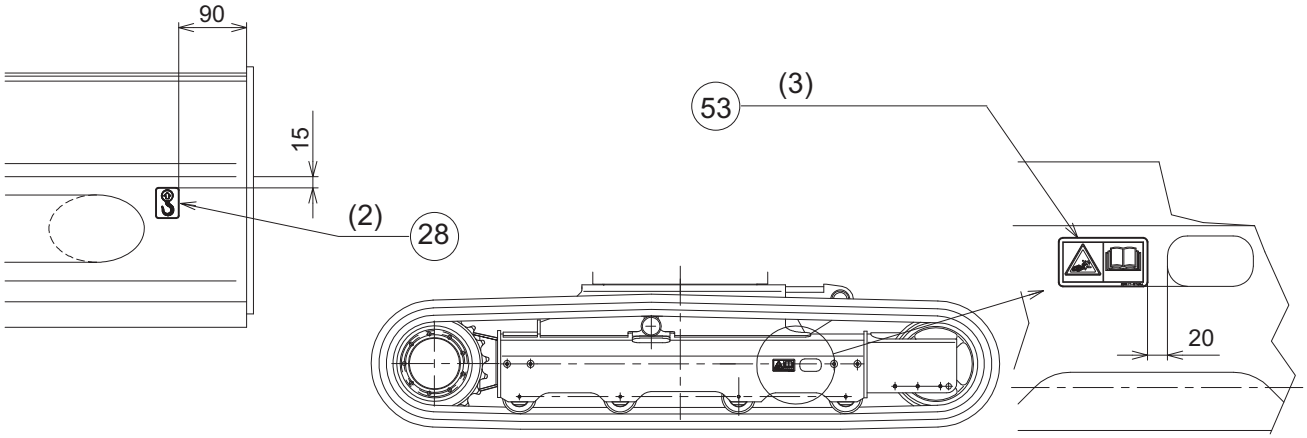


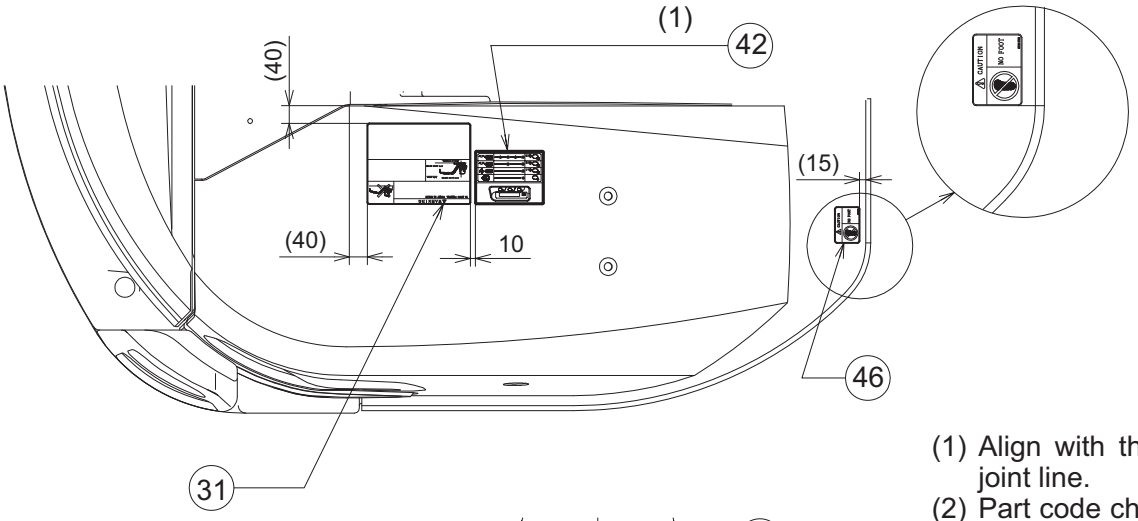
(1) Top of hydraulic oil tank
(2) (Type with third line)
Label (third line)
(3) Battery
(4) Attention to the label direction
(5) For canopy type only
(6) Right-hand control cover
(7) Left-hand control cover

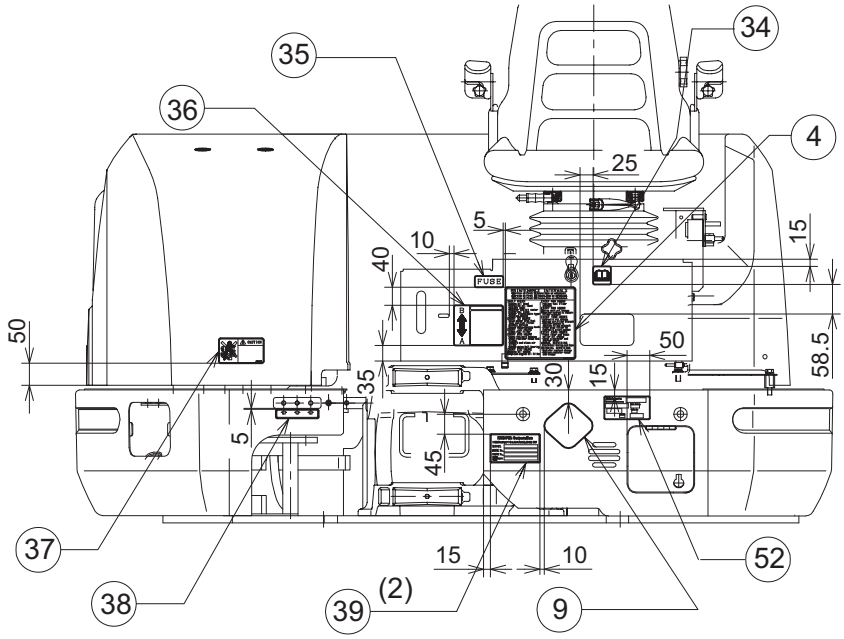


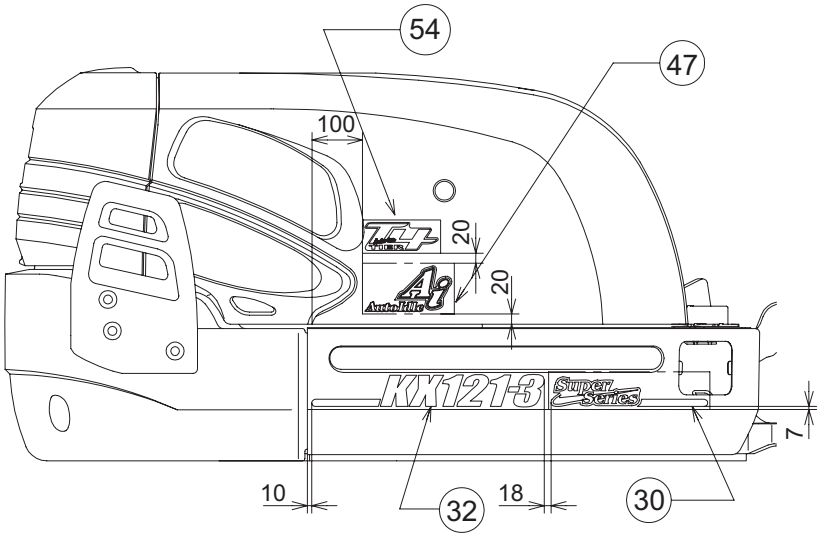


(1) Apply this label on the other side too.
(2) Apply this label on the other side too.
(3) Apply this label in the same location on the other side too.

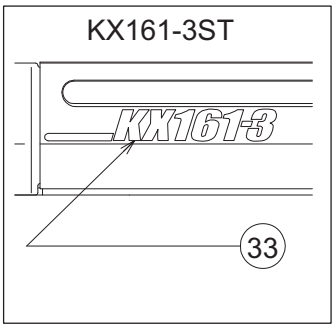


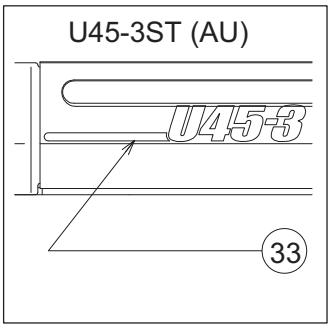


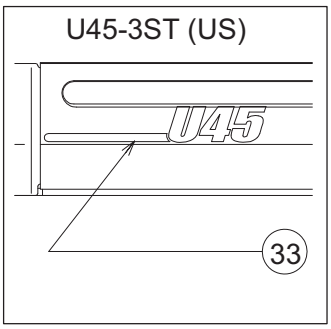




(1) Align with the swivel cover joint line.
(2) Part code changed by introducing PIN (Personal Identification Number)

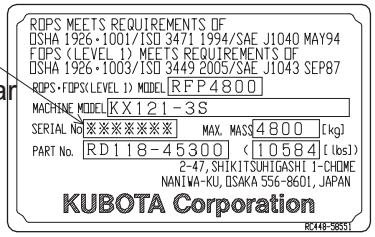


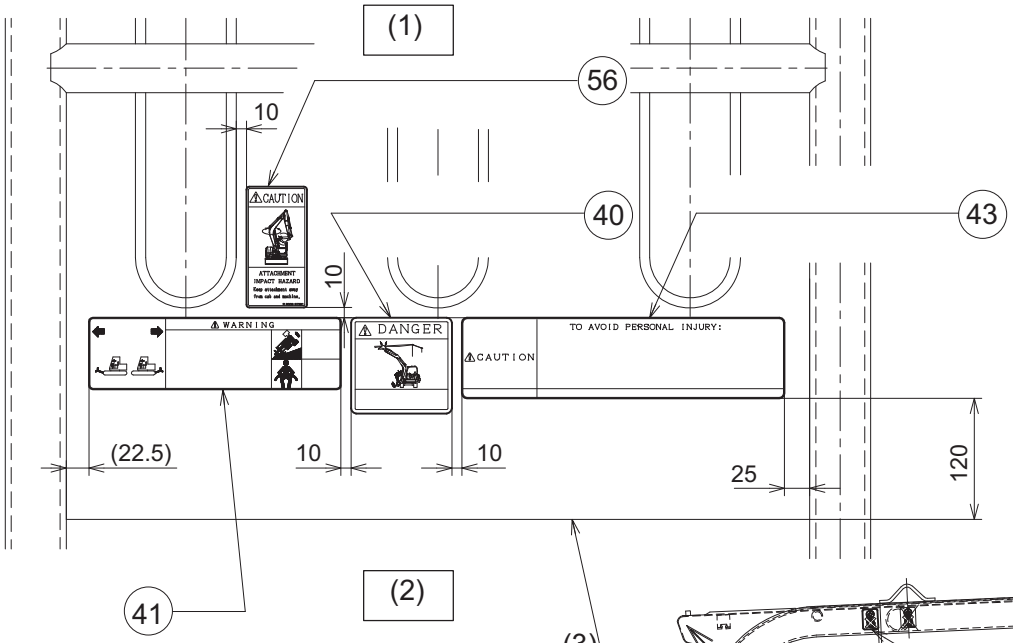


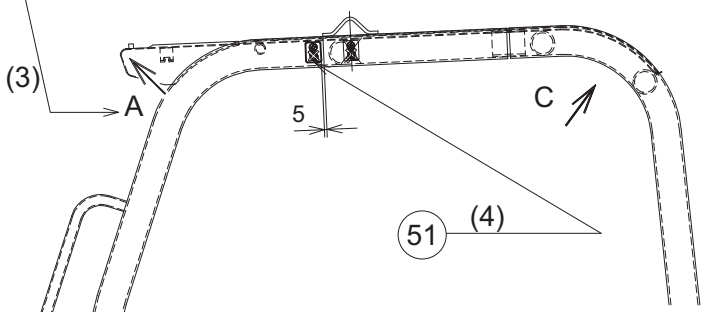


Stamping procedure
Nameplate (ROPS, E)
RC448-5855Δ

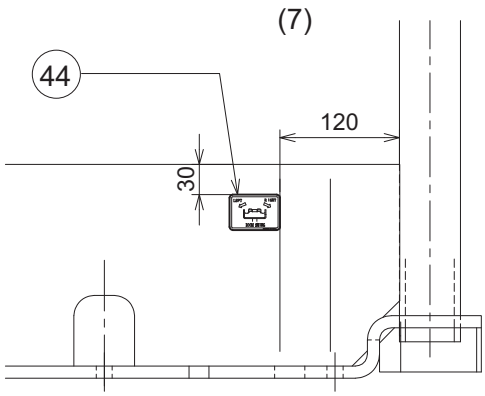
Serial number
Description of serial numbers stamped
1st and 2nd digits: Last two digits of calendar year
3rd: Production month (1 thru 9, X thru Z)
4th to 7th digits: Lot number of production month
ROPS cabin part code
KX121: RD118-45300
KX161: RD518-45300

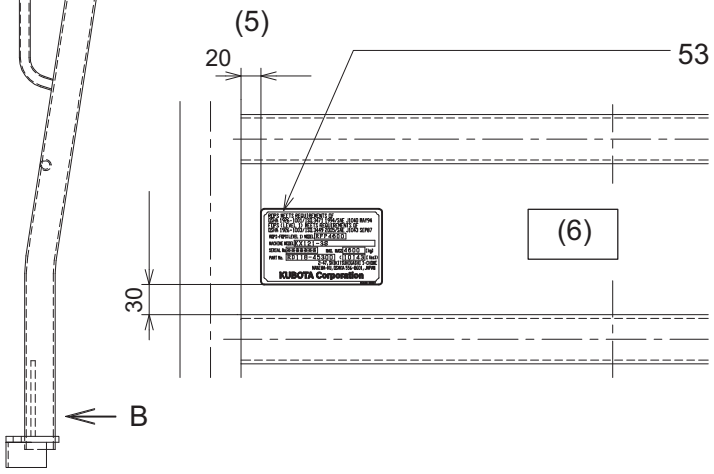






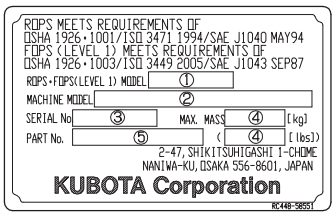
(1) Canopy type
(2) View when sitting on the seat and looking forward
(3) This line indicates the folding line of Part A.
(4) Apply this label on the other side too.
(5) View C
(6) View when sitting on the seat and looking back
(7) View B



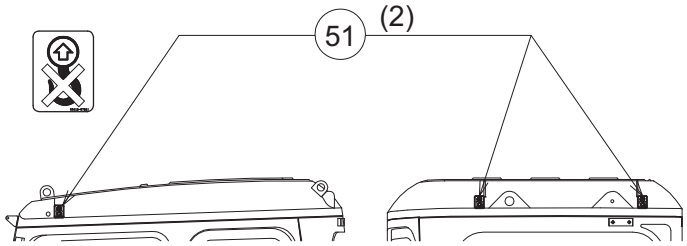


Stamping procedure
Nameplate (ROPS, E)
RC448-5855Δ

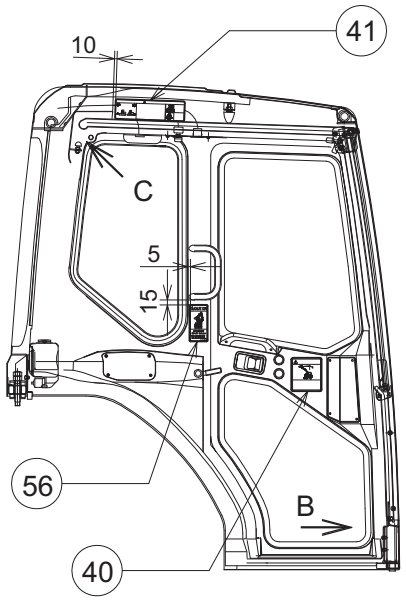
① ROPS model number
② Machine's model number
③ Description of serial numbers stamped
1st and 2nd digits: Last two digits of calendar year
3rd: Production month (1 thru 9, X thru Z)
4th to 7th digits: Lot number of production month
④ Maximum machine weight
⑤ ROPS cabin part code
Cabin type: RD138-46000
Cabin, air-conditioned type: RD138-47000

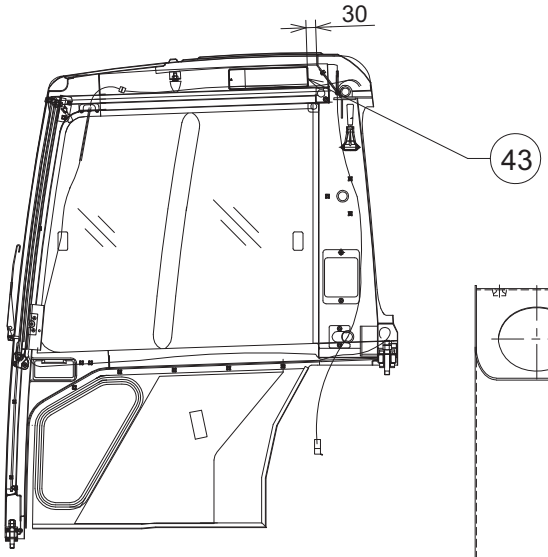


(1)

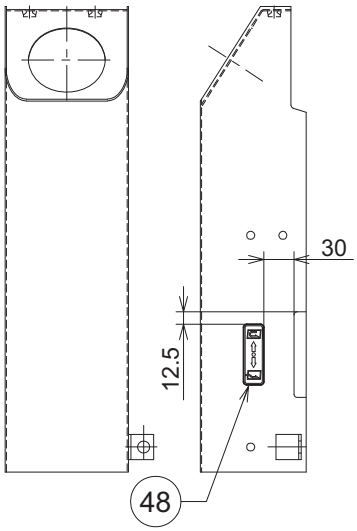


(1) Side and back of cabin
(2) Apply this label on the other side too.
(3) Defroster outer air intake duct
(4) Top at back right
(5) (View when looking forward from inside the cabin)

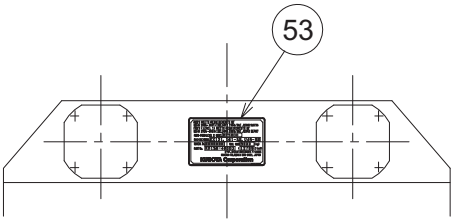


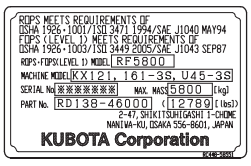


(3)

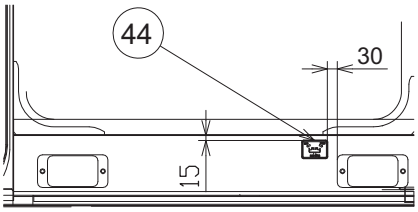


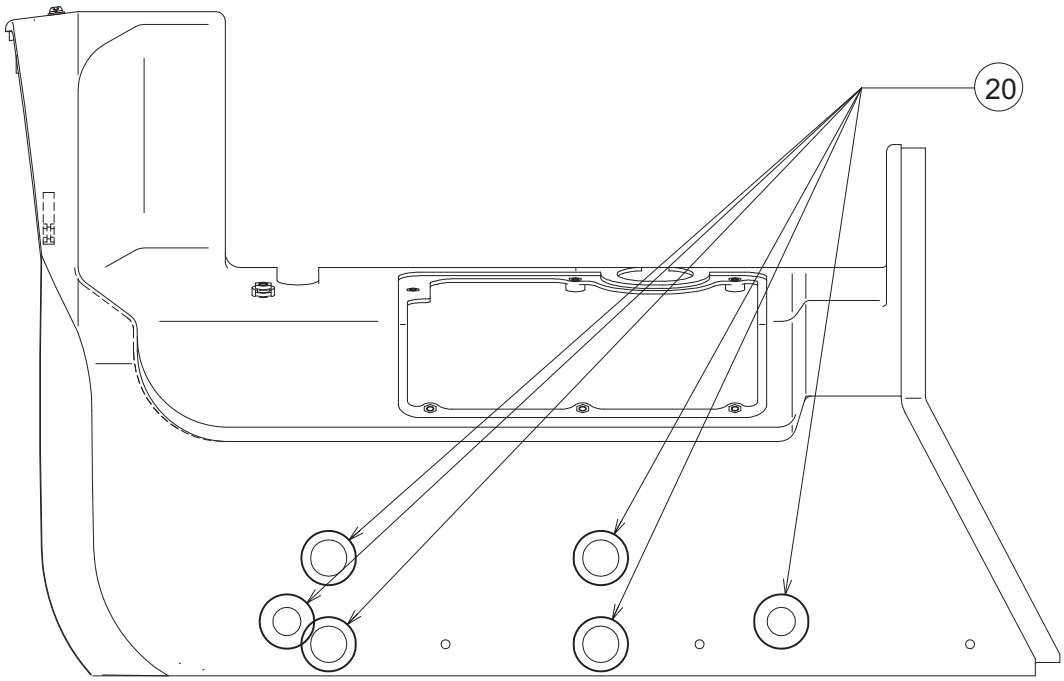
C (4)





B (5)




20

(H) UNDERCARRIAGE

a) Track Conversion 1

1. Models

KX121-3α, KX121-3S/ST

2. Comparison photo

(Sample: KX121-3S, Rubber track)

(Sample: KX121-3S, Iron track)

(1) Rubber track
(2) Iron track
(3) Track guide
(4) Bolt

3. Parts requirement to change or add

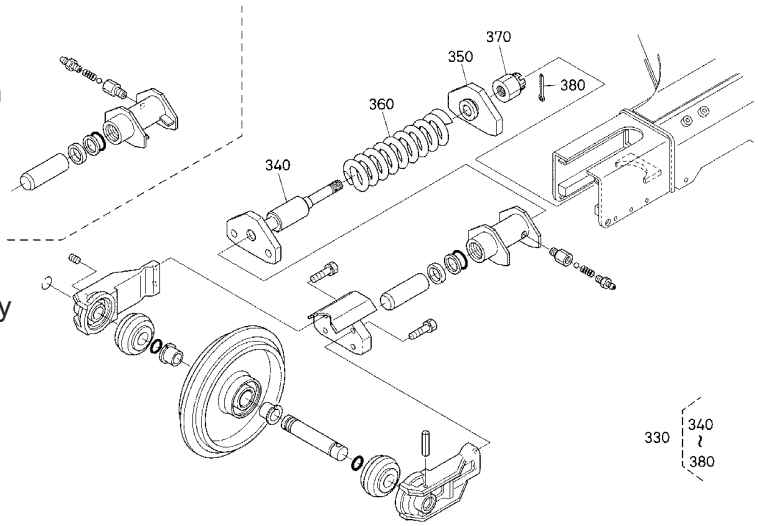
No.	Parts Name	Code No.	Q'ty	Rubber track	Iron track
1	Rubber track	RD118-2231-0	2	○	
2	Iron track (400 mm)	RD108-2210-0	2		○
3	Track guide	RD118-2182-0	4		○
4	Bolt	01133-61225	12		○

(Spring tension assy)

	S/N ≦ 20824	S/N ≧ 20825
Iron track	RD118-2145-0	RD118-2140-3
Rubber track	RD118-2140-0	

Spring tension assy is identical between iron and rubber track for S/N 20825 and on.

330: Spring tension assy
360: Spring



b) Track Conversion 2

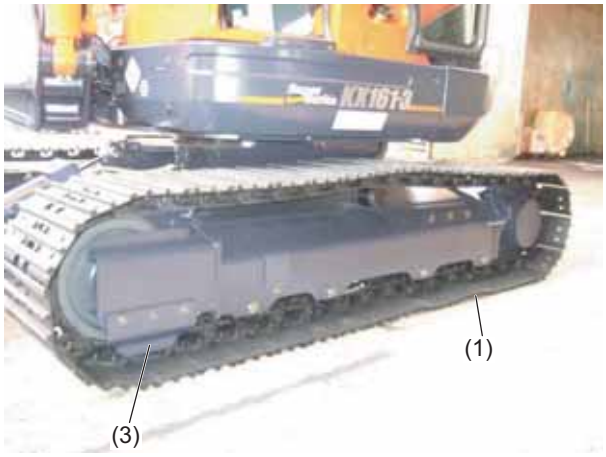
1. Models

KX161-3S/ST, KX161-3α, U45-3α, U45S/ST, U45-3S/ST

2. Comparison photo

(Sample: KX161-3S, Rubber track)

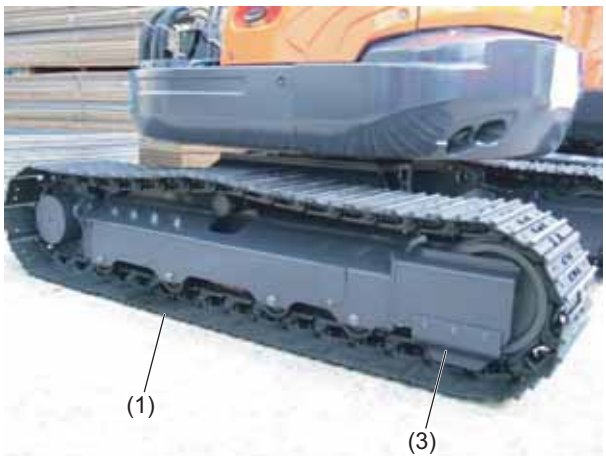
(Sample: KX161-3S, Iron track)



(1) Iron track (2) Rubber track (3) Track guide

(Sample: U45S, Rubber track)

(Sample: U45S, Iron track)



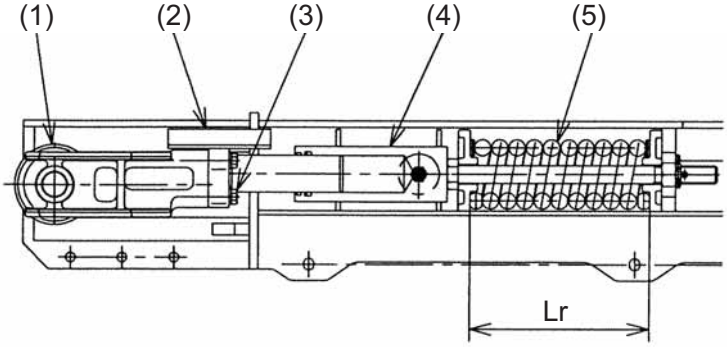
(1) Iron track (2) Rubber track (3) Track guide

3. Parts requirement to change or add

No.	Parts Name	Code No.	Q'ty	Rubber track	Iron track
1	Rubber track	RD411-2231-3	2	○	
2	Iron track (400 mm)	RP411-2220-0	2		○
3	Iron track (550 mm)	RD519-2250-0	2		○
4	Spring tension (Rubber)	RD411-2140-0	2	○	
5	Spring tension (Iron)	RD411-2145-0	2		○
6	Track guide	RD411-2118-0	4		○
7	Bolt	RP411-2183-0	12		○

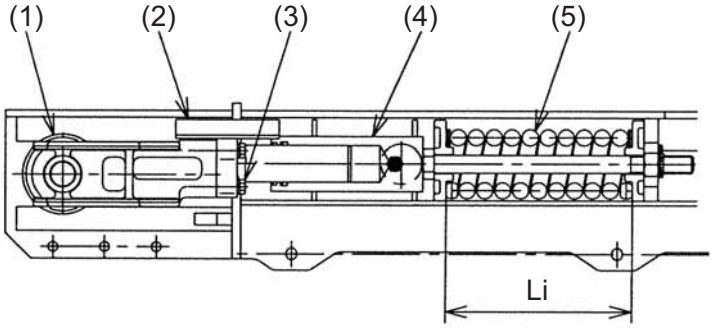
4. Track tension device: **KX121-3S/ST, KX161-3S/ST, U45S/ST, U45-3S/ST, KX121-3α, KX161-3α, U45-3α, U50-3α**

Rubber crawler type



(1) Assy Idler
(2) Plate Idler
(3) Bolt
(4) Assy cylinder
(5) Assy spring

Iron crawler type

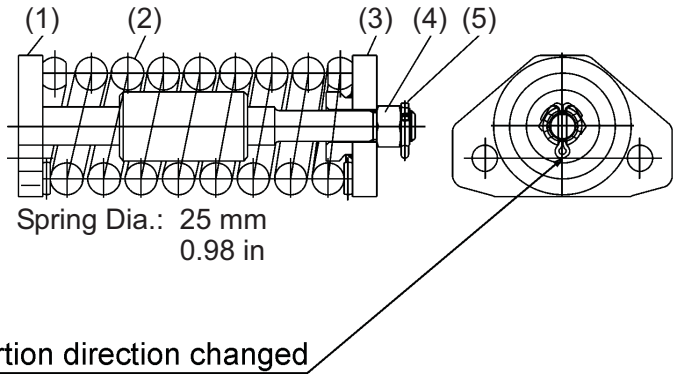


(1) Assy Idler
(2) Plate Idler
(3) Bolt
(4) Assy cylinder
(5) Assy spring

Tension spring pre-set

Model	Rubber track type: Lr	Iron track type: Li
KX121-3S/ST KX121-3α	241.5 mm (9.51 in)	←
KX161-3S/ST KX161-3α U45S/ST U45-3S/ST U45-3α U50-3α	227.5 ± 1 mm (8.96 ± 0.04 in)	242.5 ± 1 mm (9.55 ± 0.04 in)

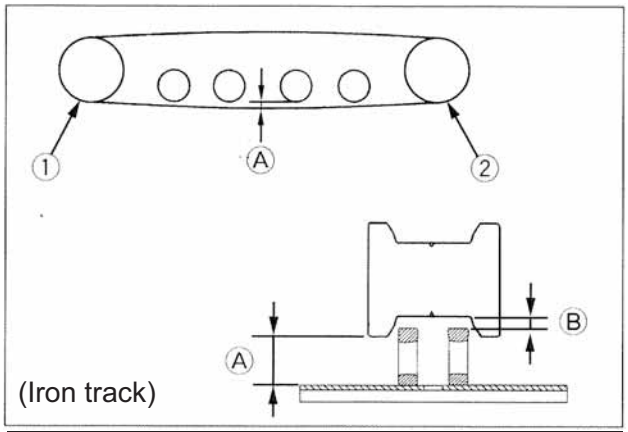
Spring assy for KX121-3S, KX121-3α
Code No. RD118-21402
This is identical for rubber and iron tracks.



(1) Bolt (Spring) RD118-21443
(2) Spring RD411-2142Δ
(3) Retainer (Spring) RD118-21433
(4) Grooved nut 68311-2153Δ
(5) Spring pin 05511-50645

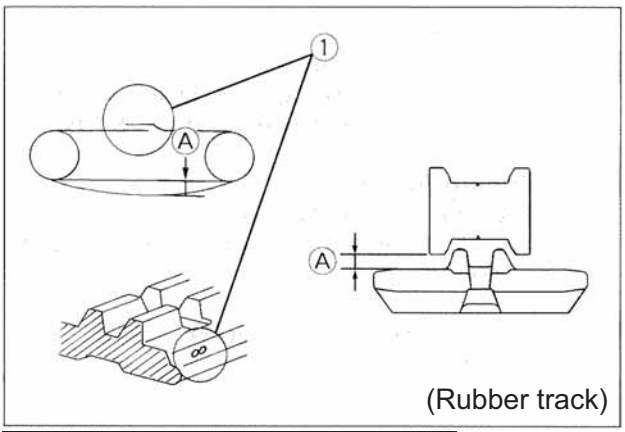
NOTE: Never confuse the direction.
Otherwise it may come into contact with the track frame.

5. Track sag distance



(Iron track)

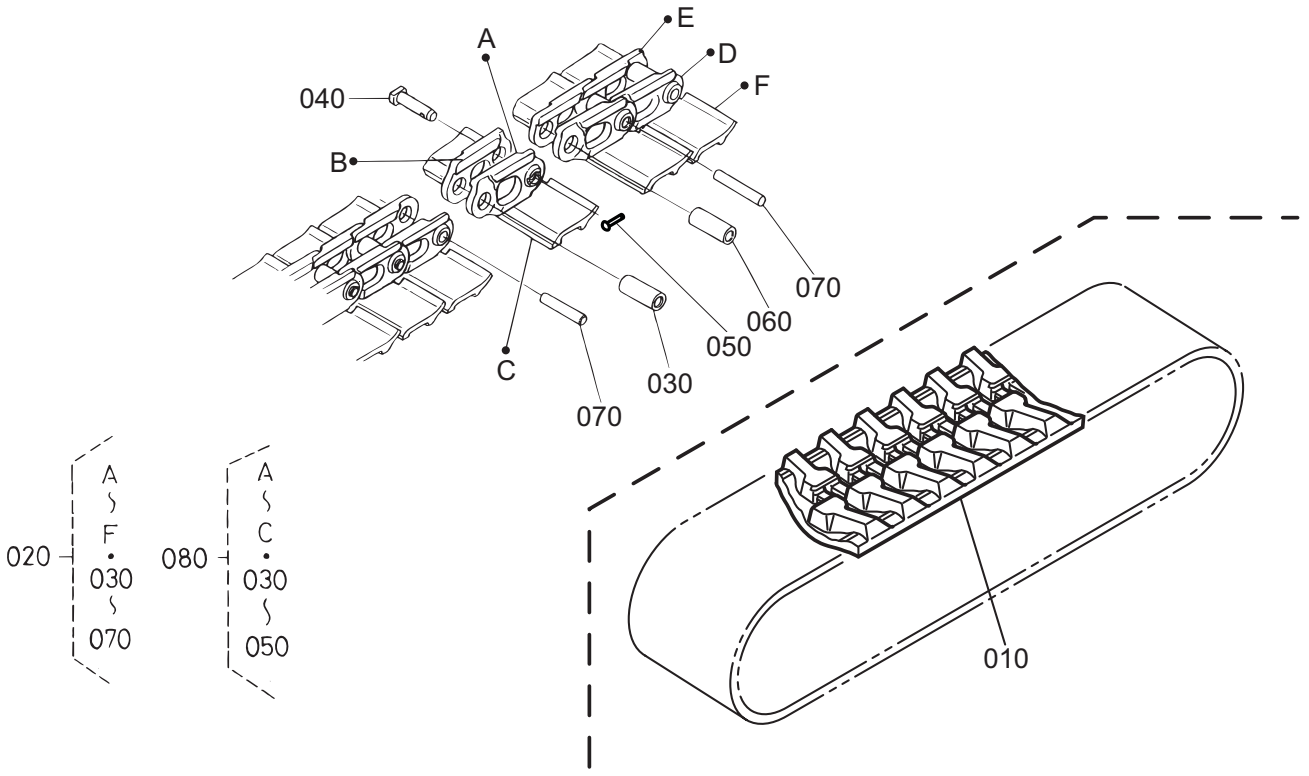
Iron track	(A) mm (in)	(B) mm (in)
KX91-3α/S2 KX101-3α/S2 U35-3α/S, U35S2	75 ~ 80 (3.0 ~ 3.5)	40 ~ 45 (1.57 ~ 1.77)
KX121-3α/S/ST	85 ~ 90 (3.3 ~ 3.5)	
KX161-3α/S/ST U45-3α/S/ST U45S/ST U50-3α	80 ~ 85 (3.2 ~ 3.3)	



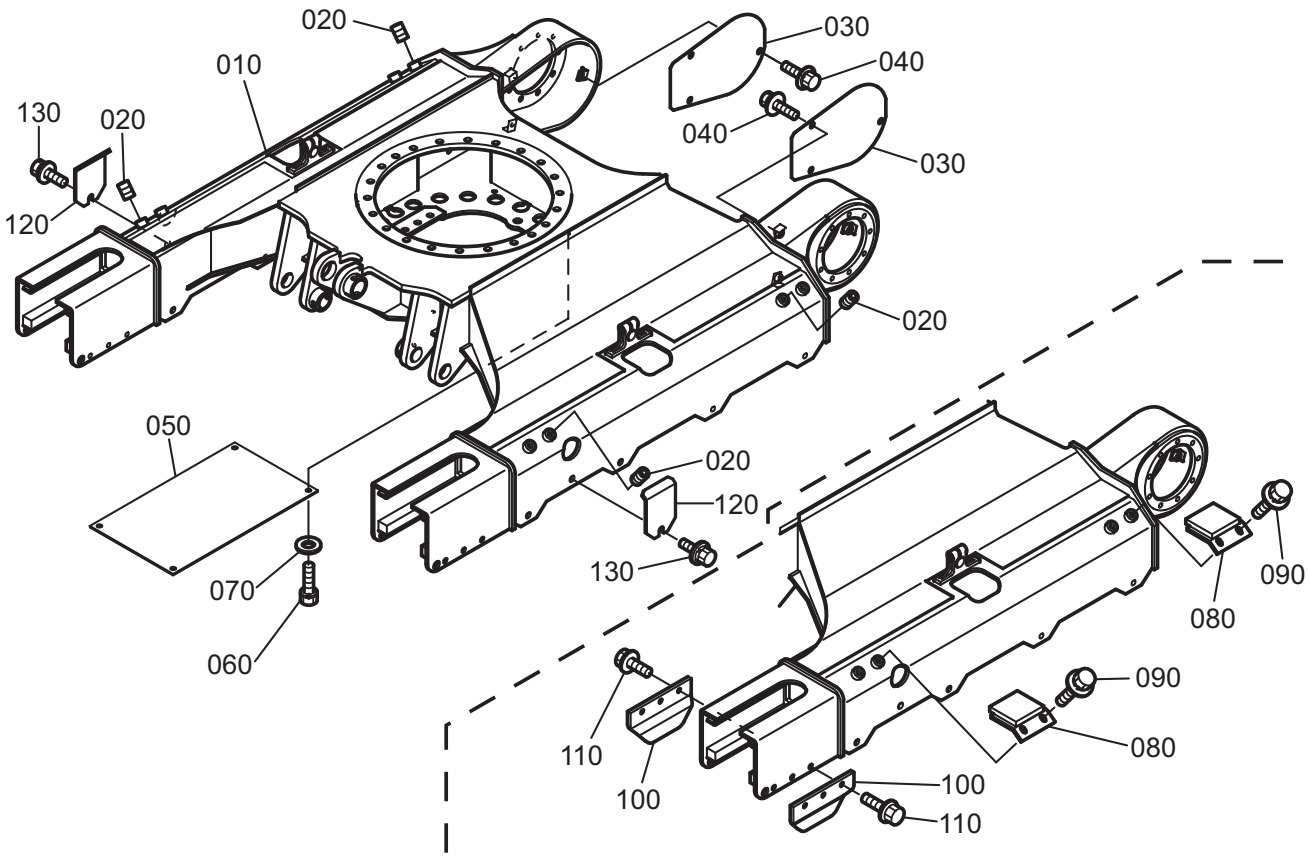
(Rubber track)

Rubber track	(A) mm (in)
KX91-3α/S2 KX101-3α/S2 KX121-3α/S/ST KX161-3α/S/ST U35-3α/S, U35S U45-3α/S, U45S/ST U50-3α	10 ~ 15 (0.4 ~ 0.6)

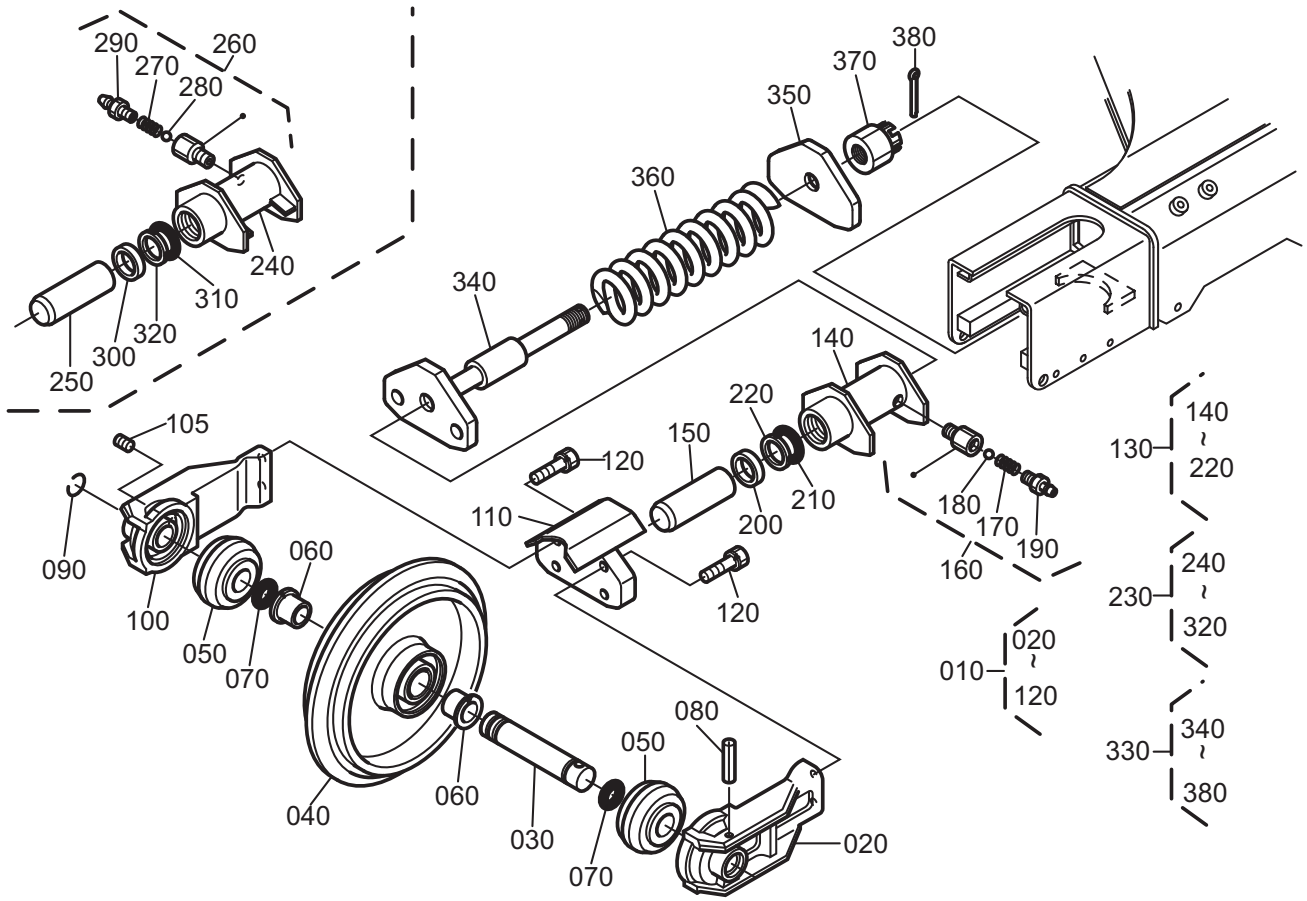
6. Part Fig.



Ref. No.	Part name	Q'ty	Remarks
010	Crawler, Rubber	2	Rubber crawler
020	Assy crawler	2	Iron crawler



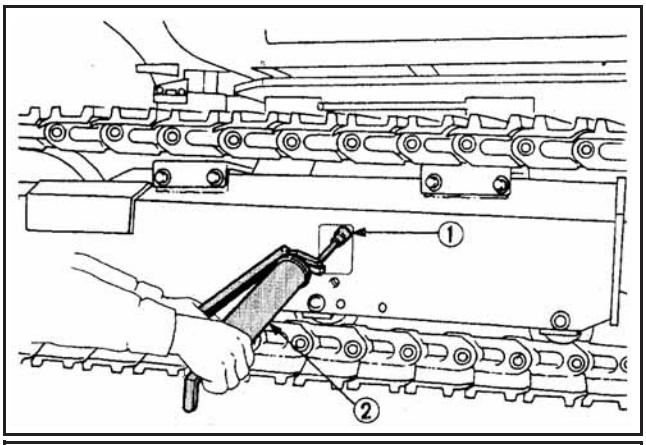
Ref. No.	Part name	Q'ty	Remarks
020	Plug	8	Rubber crawler
080	Plate	4	Iron crawler
090	Bolt	8	Iron crawler
100	Guide	4	Iron crawler
110	Bolt	12	Iron crawler



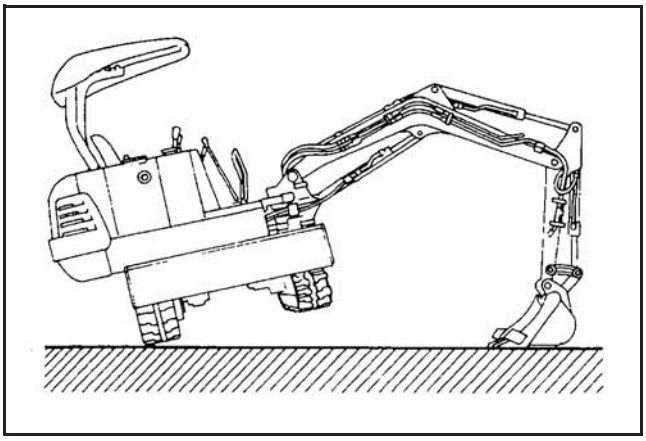
Ref. No.	Part name	Q'ty	Remarks
330	Assy spring	2	Rubber crawler
330	Assy spring	2	Iron crawler
340	Bolt, Spring	2	
350	Retainer, Spring	2	
360	Spring	2	
370	Nut	2	
380	Pin, Split	2	

c) Crawler Installation

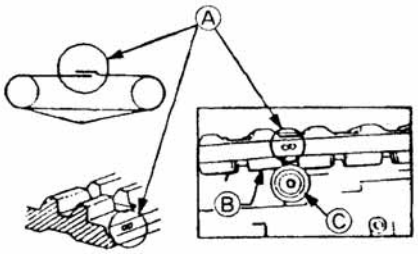
1. Feed grease into the nipple (1) with a grease gun (2).

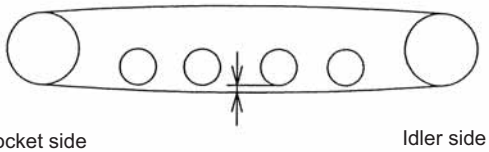


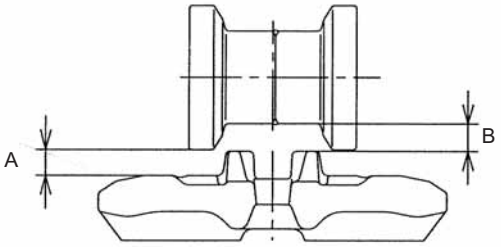
2. Proper crawler tightness is such that the clearance between track roller and link tread is as below table when one crawler is lifted as shown in the figure.



* The rubber crawler has a seam. When adjusting the crawler, this seam must be held at the upper center. With a machine having the upper roller, the upper roller should be positioned in between the two links next to the seam marking.

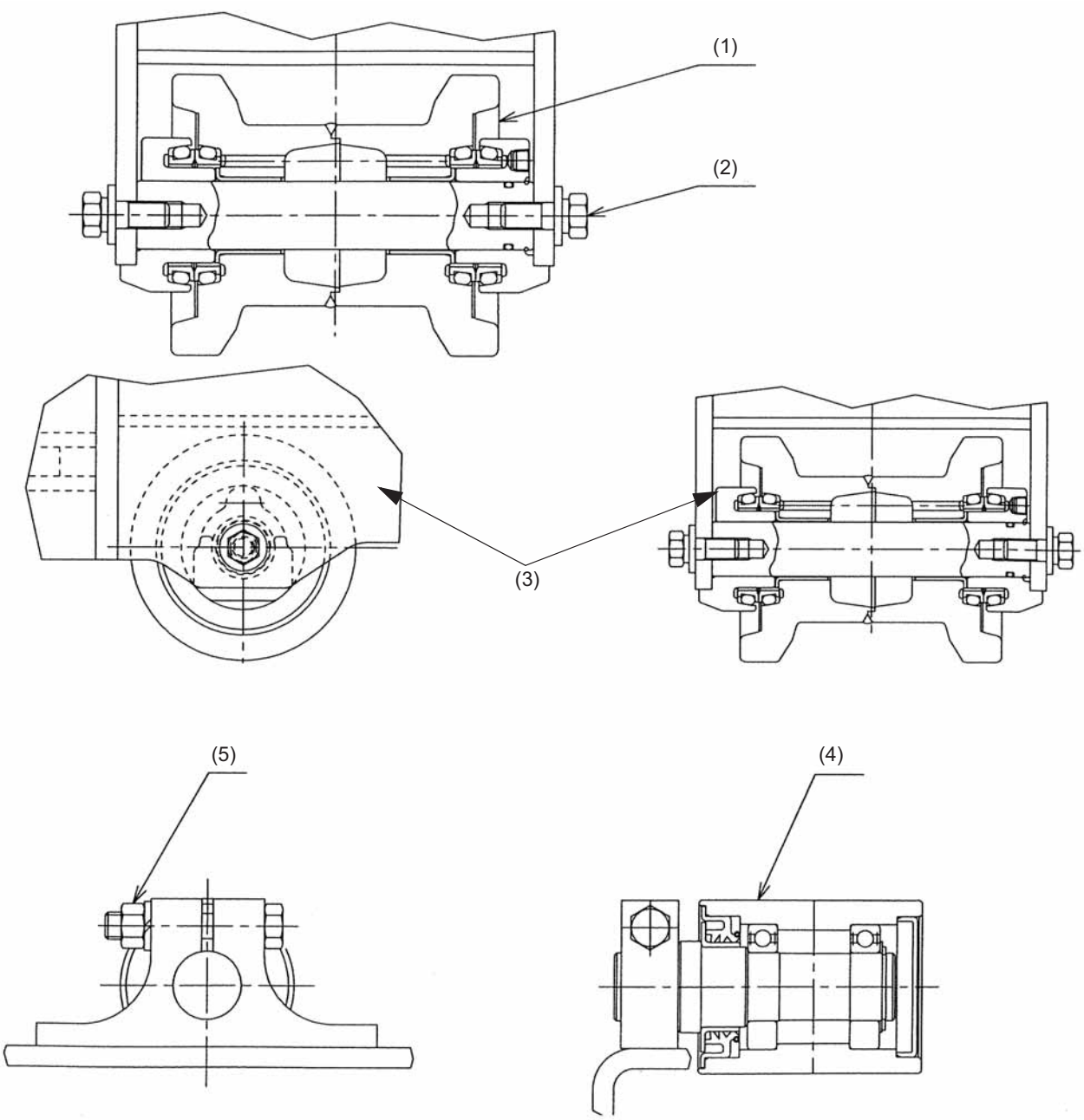






	A	B
Rubber track	10 ~ 15 mm (0.39 ~ 0.59 in)	-
Iron track	85 ~ 90 mm (3.35 ~ 3.54 in)	40 ~ 45 mm (1.57 ~ 1.77 in)

d) Track Roller and Upper Roller Installation



1. Remove the stuck oil and paint on the track roller and track frame for mounting track roller.
2. Tightening torque for mounting track roller.
   259.9 ~ 304.0 N·m
   26.5 ~ 31.0 kgf·m
   191.7 ~ 224.2 ft·lbf
   Apply threebond #1305 on the femail thread.
3. Tightening torque for mounting upper roller.
   77.5 ~ 90.2 N·m
   7.9 ~ 9.2 kgf·m
   57.2 ~ 66.5 ft·lbf
   Apply locktite #271.

(1) Truck roller, Assy
(2) Bolt
    Washer, Spring
    Washer, Plain
(3) Mount track rollers to the track frame without clearance on this portion.
(4) Carrier roller, Assy
(5) Bolt
    Washer, Spring
    Nut

III. ENGINE

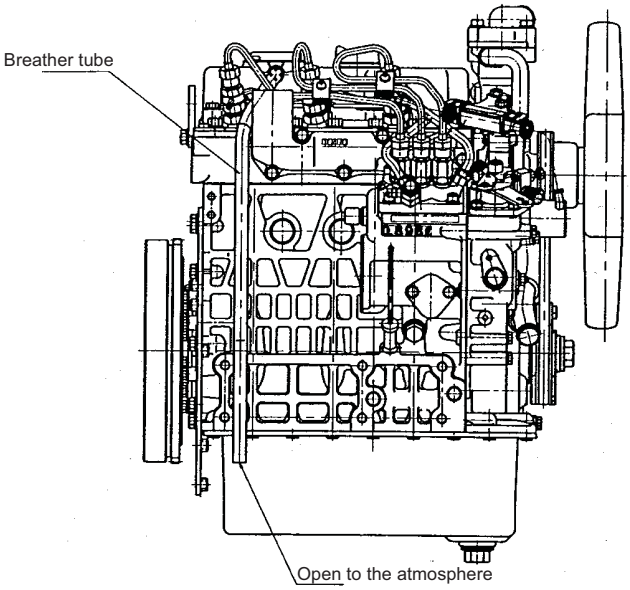
Mechanism Section

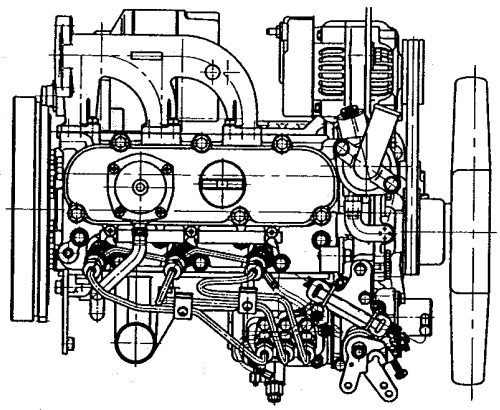
(A) GENERAL III-M-3
(B) ENGINE SPECIFICATIONS III-M-7
(C) PERFORMANCE CURVE III-M-13
(D) NEW EMISSIONS CONTROL ENGINES III-M-17
a) Outline III-M-17
b) Engine List for Minor Change. III-M-18
c) Major Engine Specifications for Tier 4 / Interim Tier 4 Engines III-M-19
d) Performance Curve III-M-21

(A) GENERAL

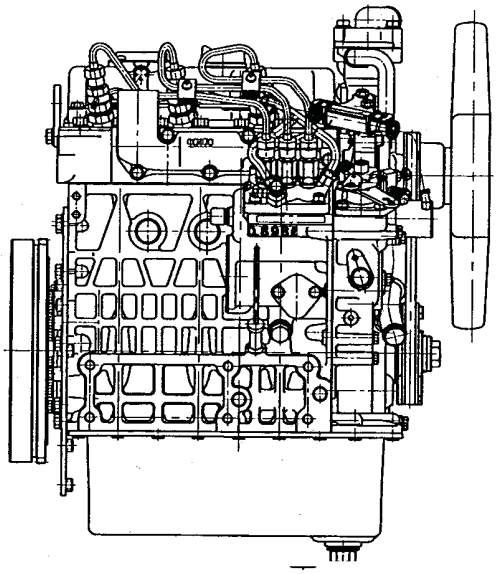
1. The engine of KX161-3S for PP-version (KTC, KCL, KTA) has been upgraded due to the strong market requirement. In this regards, LS pump's P-Q performance has been upgraded for this model, KX161-3S.
2. As viewed from outside, the breather tube has been changed to the closed breather type. Inside the breather cover, on the other hand, the rubber-made breather compressor valve (1G911-05203) has been added.
   Because of development as secondary emission control measure, the combustion chamber and other factors are not modified. The model numbers are expressed with "E2" instead of "E". Here is an example.
   D902-EBH (1G220-00000) ==> D902-E2-BH (1G224-00000)

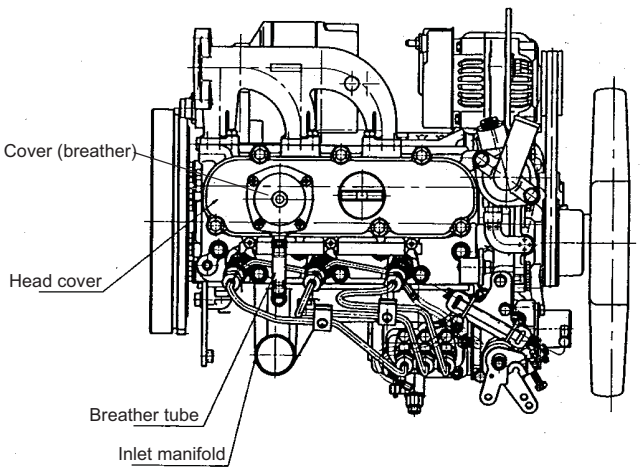
Before Tier 2:
Blow-by gas (crankcase emission) is released through the head cover and breather tube to the atmosphere.





After Tier 2:
Blow-by gas (crankcase emission) is fed through the head cover and breather tube into the inlet manifold.

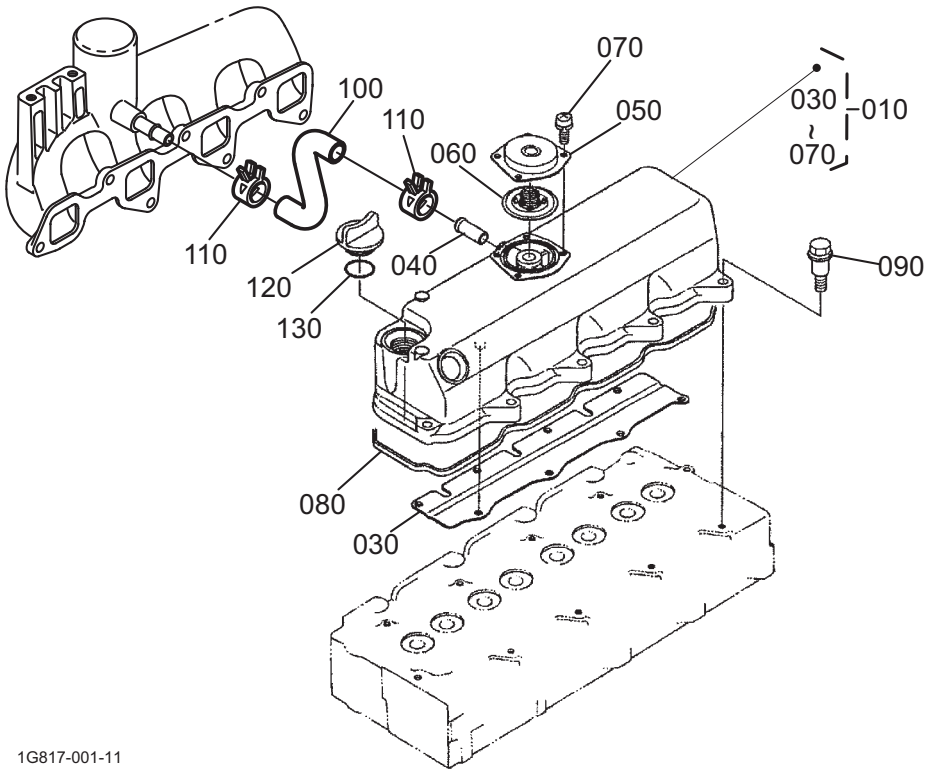




* This drawing shows the modified locations of D902-EBH.

V2203-M-E2BH-2-N/3-N, V2403-M-E3-BH-US1/2

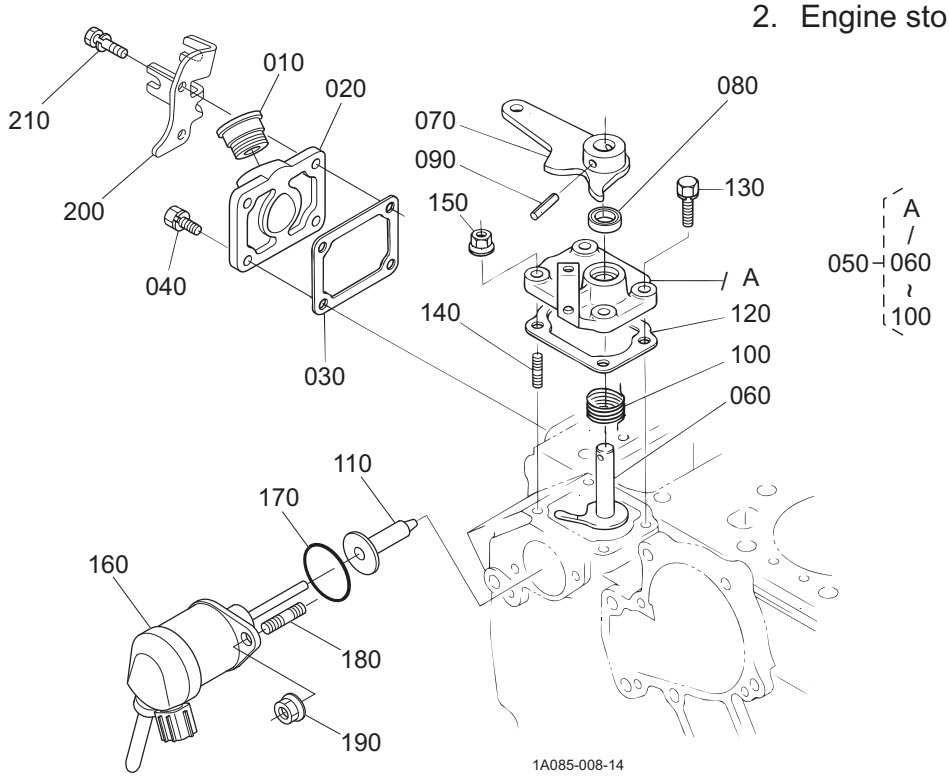
1. Cylinder head cover



1G817-001-11

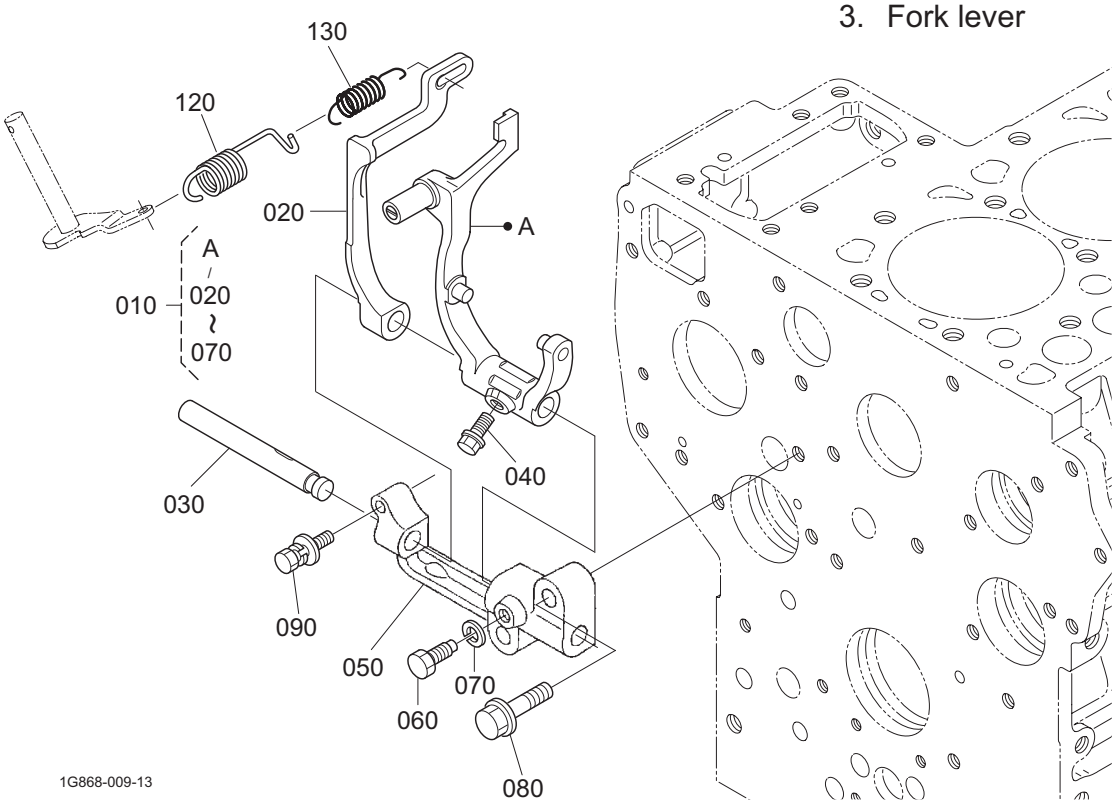
010	Assy cover, cyl. head
030	Shield, breather
040	Pipe, water return
050	Cover, breather
060	Comp. valve, breather
070	Screw, with washer
080	Gasket, head cover
090	Bolt
100	Tube, breather
110	Clamp, hose
120	Plug, oil filler
130	O-ring

2. Engine stop solenoid

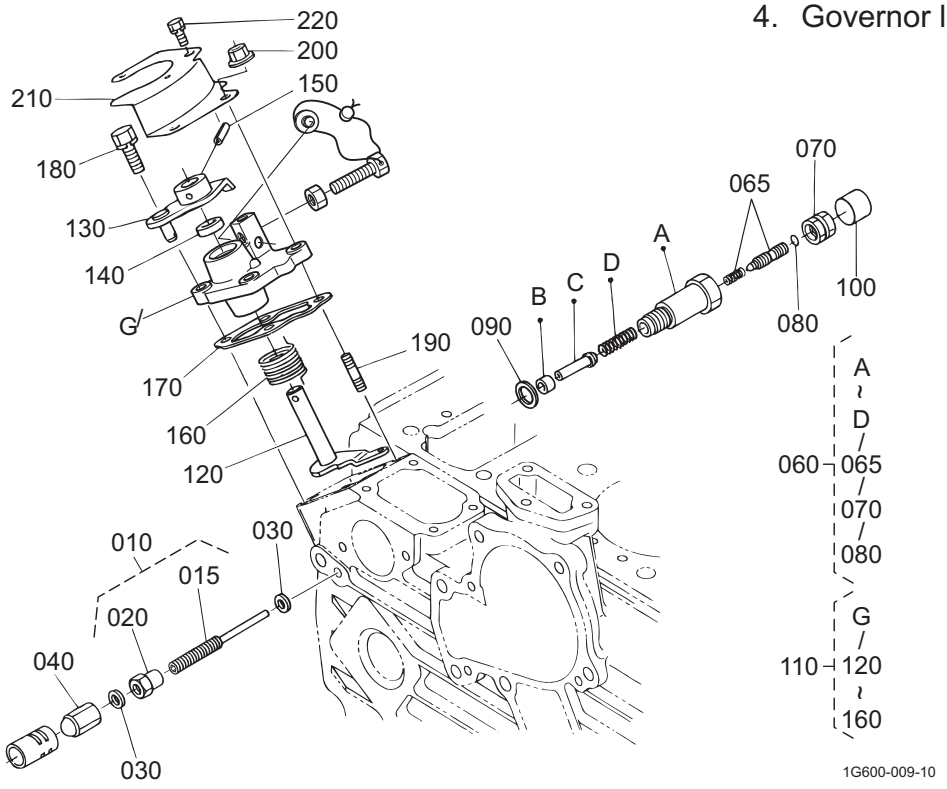


1A085-008-14

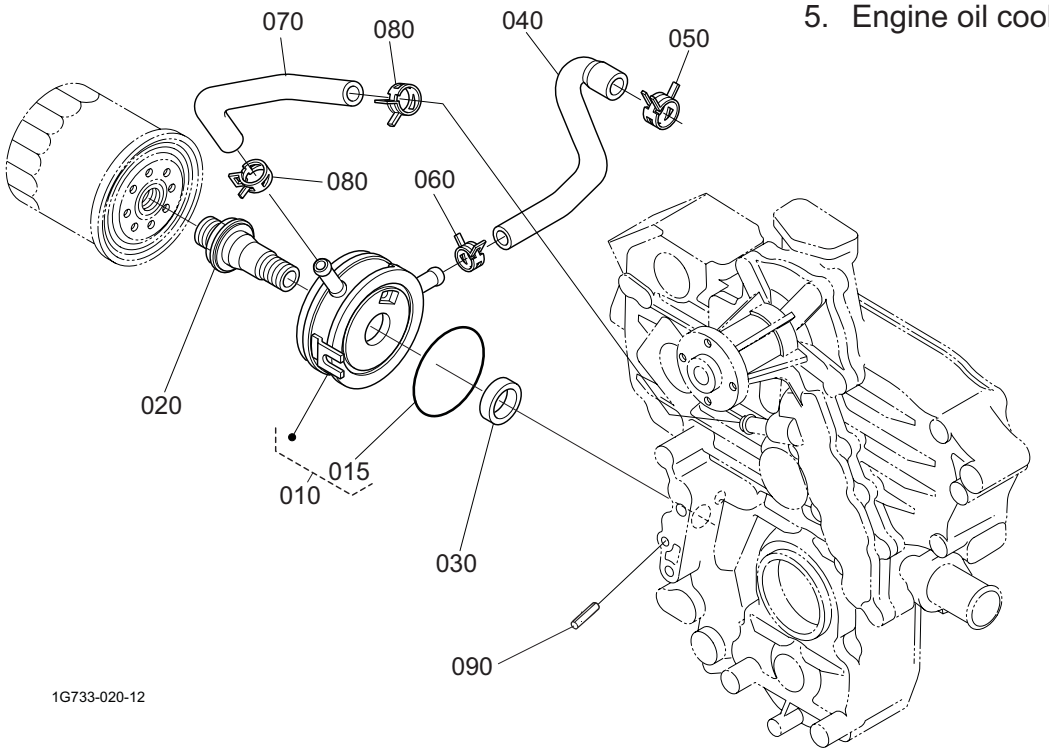
3. Fork lever



4. Governor lever



5. Engine oil cooler



(B) ENGINE SPECIFICATIONS

(1) Output

Market area				EU-version
Machine model				KX121-3α, KX161-3α, U45-3α
Engine code No.				1G78810000
Engine type				V2203-M-EBH-2-N
Rated output	Engine speed	rpm		2250
	Net	kW		27.4
		PS	ISO-3046	37.3
		HP	SAE J1349	36.7
	Gross	HP	SAE J1995	38.2
Max. engine torque	Engine speed	rpm		1600
	Net	N·m		141.3
		kgf·m	ISO-3046	14.4
		lb·ft	SAE J1349	104.2
	Gross	lb·ft	SAE J1995	106.9
Injection timing		°BTDC		17
Max. speed no load	Gross	rpm	Engine unit	<2520
Idling speed	Gross	rpm	Engine unit	900 ~ 950

Market area				KTC, KCL, KTA (PP-version)	
Machine model				KX121-3S	KX161-3S
Engine code No.				1G81710000	1G86800000
Engine type				V2203-M-E2BH-2-N	V2403-M-E2BH-1
Rated output	Engine speed	rpm		2250	2200
	Net	kW		27.4	31.3
		PS	ISO-3046	37.3	42.6
		HP	SAE J1349	36.7	42.0
	Gross	HP	SAE J1995	38.2	44.0
Max. engine torque	Engine speed	rpm		1600	1600
	Net	N·m		141.3	158.9
		kgf·m	ISO-3046	14.4	16.2
		lb·ft	SAE J1349	104.2	117.2
	Gross	lb·ft	SAE J1995	106.9	120.6
Injection timing		°BTDC		17	17
Max. speed no load	Gross	rpm	Engine unit	<2520	<2470
Idling speed	Gross	rpm	Engine unit	900 ~ 950	900 ~ 950

Market area				KTC, KCL, KTA (PP-version)		
Machine model				KX121-3S (A/C)	U45S (A/C) U45-3S (A/C)	KX161-3S (A/C)
Engine code No.				1G81810000	1G81820000	1G86810000
Engine type				V2203-M-E2BH-3-N	V2203-M-E2BH-5-N	V2203-M-E2BH-2
Rated output	Engine speed	rpm		2250	2250	2200
	Net	kW		27.1	26.6	30.9
		PS	ISO-3046	36.8	36.2	42.0
		HP	SAE J1349	36.3	35.7	41.4
	Gross	HP	SAE J1995	38.2	38.2	44.0
Max. engine torque	Engine speed	rpm		1600	1600	1600
	Net	N·m		140.7	139.7	157.9
		kgf·m	ISO-3046	14.3	14.2	16.1
		lb·ft	SAE J1349	103.8	103.0	116.5
	Gross	lb·ft	SAE J1995	106.9	106.9	120.6
Injection timing		°BTDC		17	17	17
Max. speed no load	Gross	rpm	Engine unit	<2520	<2520	<2470
Idling speed	Gross	rpm	Engine unit	900 ~ 950	900 ~ 950	900 ~ 950

(2) Engine main specifications

Machine model				KX121-3S/α KX161-3α U45S, U45-3S/α	Remarks
Engine model				V2203-M-EBH-2-N, V2203-M-E2BH-2-N	
Rated output	Engine speed		rpm	2250	
	Engine output	Net	kW	27.4	
			PS	37.3	JIS B8002-1
			HP	36.7	SAE J1349
		Gross	HP	38.2	SAE J1995
Max. engine torque	Engine speed		rpm	1600	
	Max. torque	Net	Nm	141.3	
			kgfm	14.4	JIS B8002-1
			lb·ft	104.2	SAE J1349
		Gross	lb·ft	106.9	SAE J1995
	Torque rise		%	21.5	
Engine speed	Idling speed		rpm	950 ~ 1150 (1050 ~ 1250)	( ) Cab-version
	Max. speed, no load		rpm	< 2450	No load
	Max. speed with system relief		rpm	< 2150	Arm & bucket relief
General specification	Bore × Stroke		mm (in)	ϕ 87 × 92.4 (3.43 × 3.64)	
	Total displacement		CC (cu.in)	2197 (134.07)	
	No of cylinder			4	
	Injection timing before TDC		degree	18°, 0.314 rad	
	Injection pressure			13.73 MPa (140 kgf/cm^2, 1991 psi)	
	Compression ratio			22.6	
	Starter motor			12 V, 1.4 kW	
	Battery				
	Alternator			12 V, 480 W	
	Fuel comsumption ratio, be		g/ps·h		
	Dimension: L × W × H		mm (in)	667.1 × 507.1 × 635 (26.3 × 20.0 × 25.0)	
	Weight		kg (lbs)	180 (397)	

		KX161-3S
Model		V2403-M-E2BH-1 (Standard-version) V2403-M-E2BH-2 (Air conditioner-version)
No. of cylinder		4
Bore × Stroke	mm	87 × 102.4
	in	3.43 × 4.03
Displacement	cc	2.434
	in^3	148.5
Max. output/rpm SAE, J1995 (gross)	KW/rpm	32.8/2200
	PS/rpm	44.6/2200
	HP/rpm	44.0/2200
Compression ratio		23.8
Max. torque (gross)	N·m	163.5
	kgf·m	16.7
	ft·lbf	120.6
Dimensions: L × W × H	mm	705 × 511 × 700
	in.	27.8 × 20.1 × 27.6
Dry weight	kg	180
	lbs	396.8
Valve clearance	mm	0.18-0.22
	in.	0.0071-0.0087
Firing sequence		1-3-4-2
Compression pressure (A)/(B)	Mpa	3.53-4.02/2.55
	kgf/cm^2	36-41/26
	psi	512-583/370
Fan belt		REMF6405
Fuel consumption ratio	g/kWh	299
	g/Psh	220
	lbs/Hph	0.49
Fuel consumption	l/h	11.4
	gal/h	3.01
Max. speed without load	rpm	2470
Engine oil pressure with rated engine rpm	kPa	294-441
	kgf/cm^2	3.0-4.5
	psi	42.7-64.0
Injection pressure	MPa	13.7-14.7
	kgf/cm^2	140-150
	psi	1991-2133
Engine oil consumption ratio	g/kWh	1.36
	g/Psh	1
	lbs/Hph	0.002

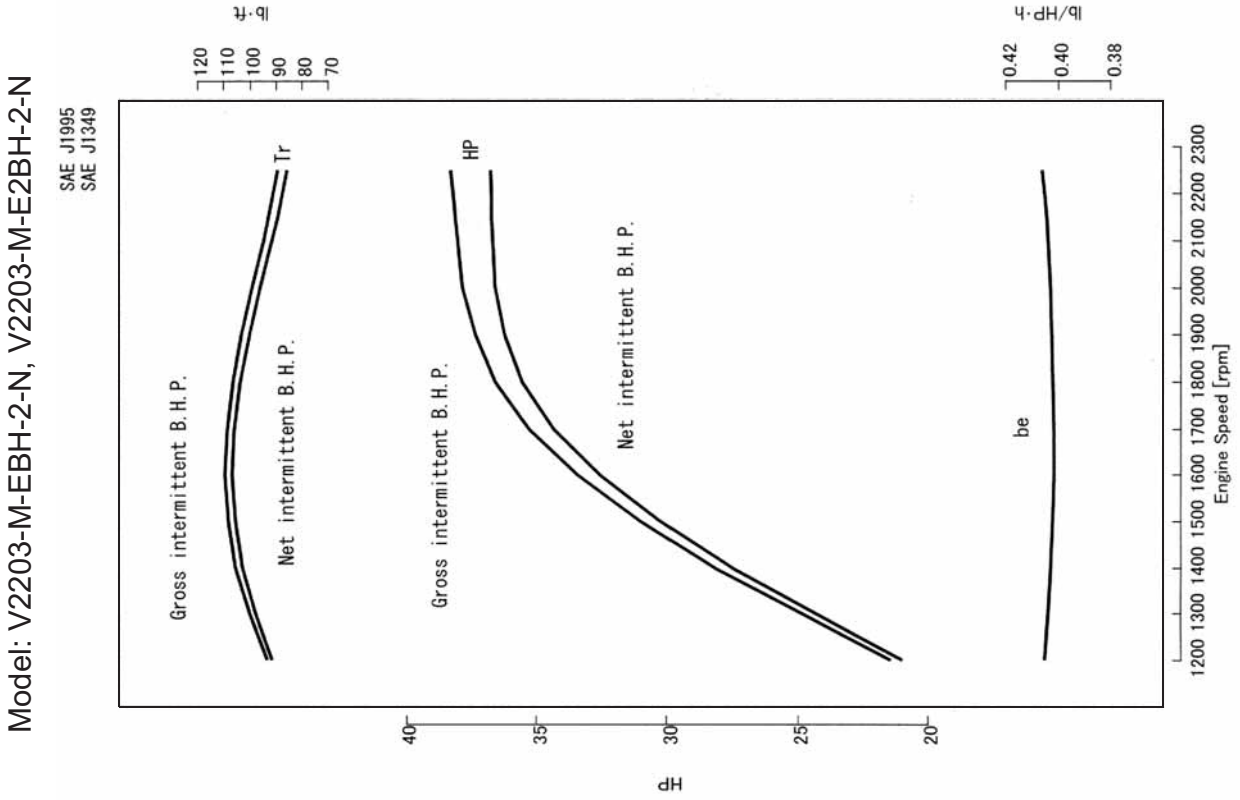
(3) Engine electric components

		KX161-3S
Fuel injection pump type		PFR4Mtype mini-pump
Nozzle type		DNOPD mini-nozzle
Injection pressure	Mpa	13.7-14.7
	kgf/cm^2	140-150
	psi	1991-2133
Dynomo		12V540W
Manufacturer P/N		101211-3781
Regulator adjusting voltage	V	14-15
Battery type		90D26R
Nominal capacity of 5hrs rating	Ah	55
Specific gravity of electrolite		1.28
Starter motor		12V2.0KW
Manufacturer P/N		228000-4593
Glow plug	Ω	1

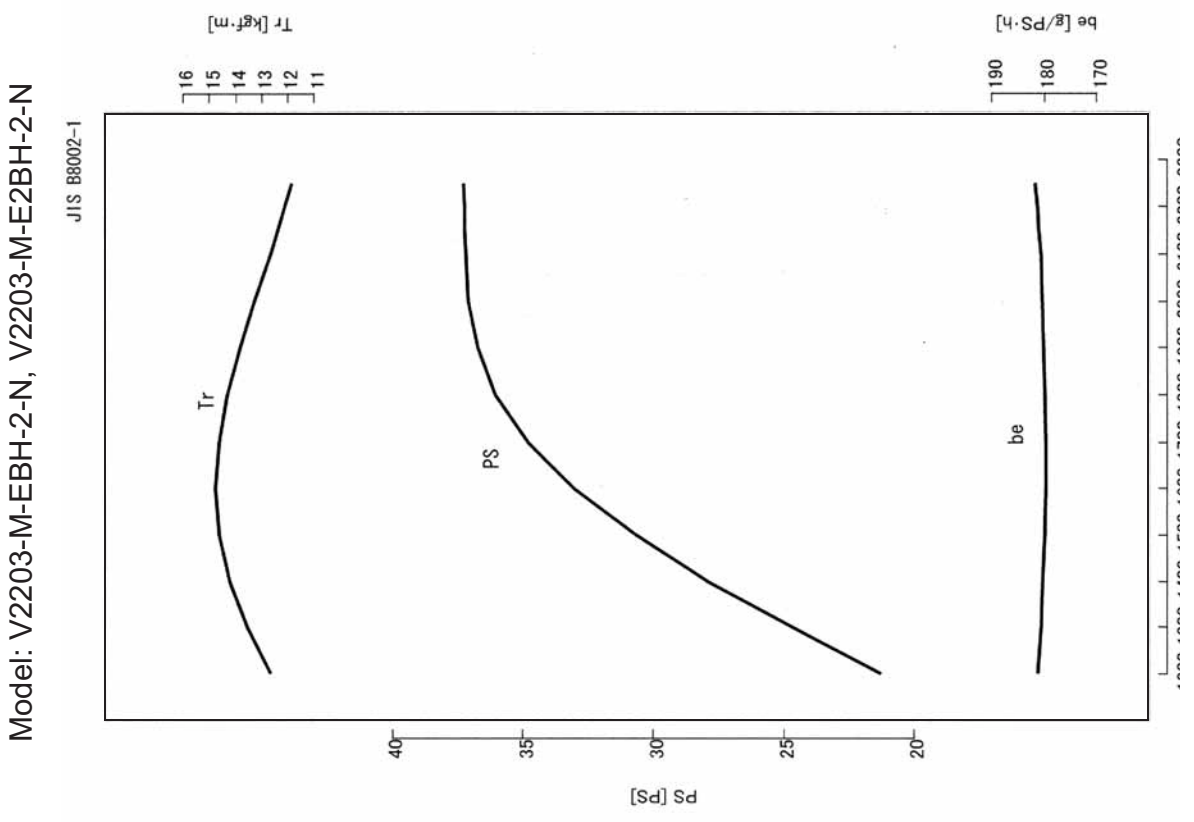
(C) PERFORMANCE CURVE

(1) KX121-3α, KX121-3S, KX161-3α, U45-3α, U50-3α, U45S, U45-3S

Model: V2203-M-EBH-2-N, V2203-M-E2BH-2-N

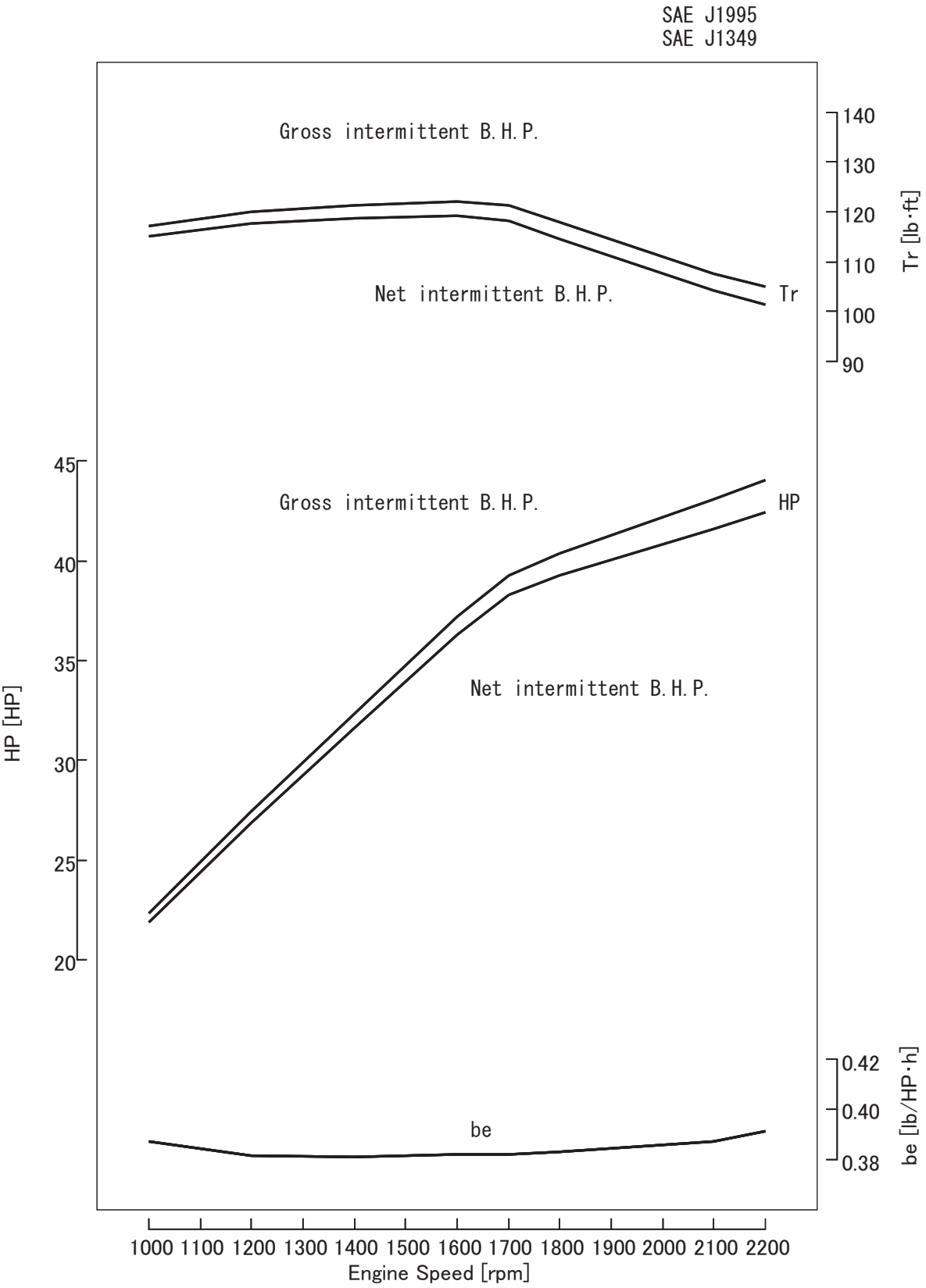


Model: V2203-M-EBH-2-N, V2203-M-E2BH-2-N

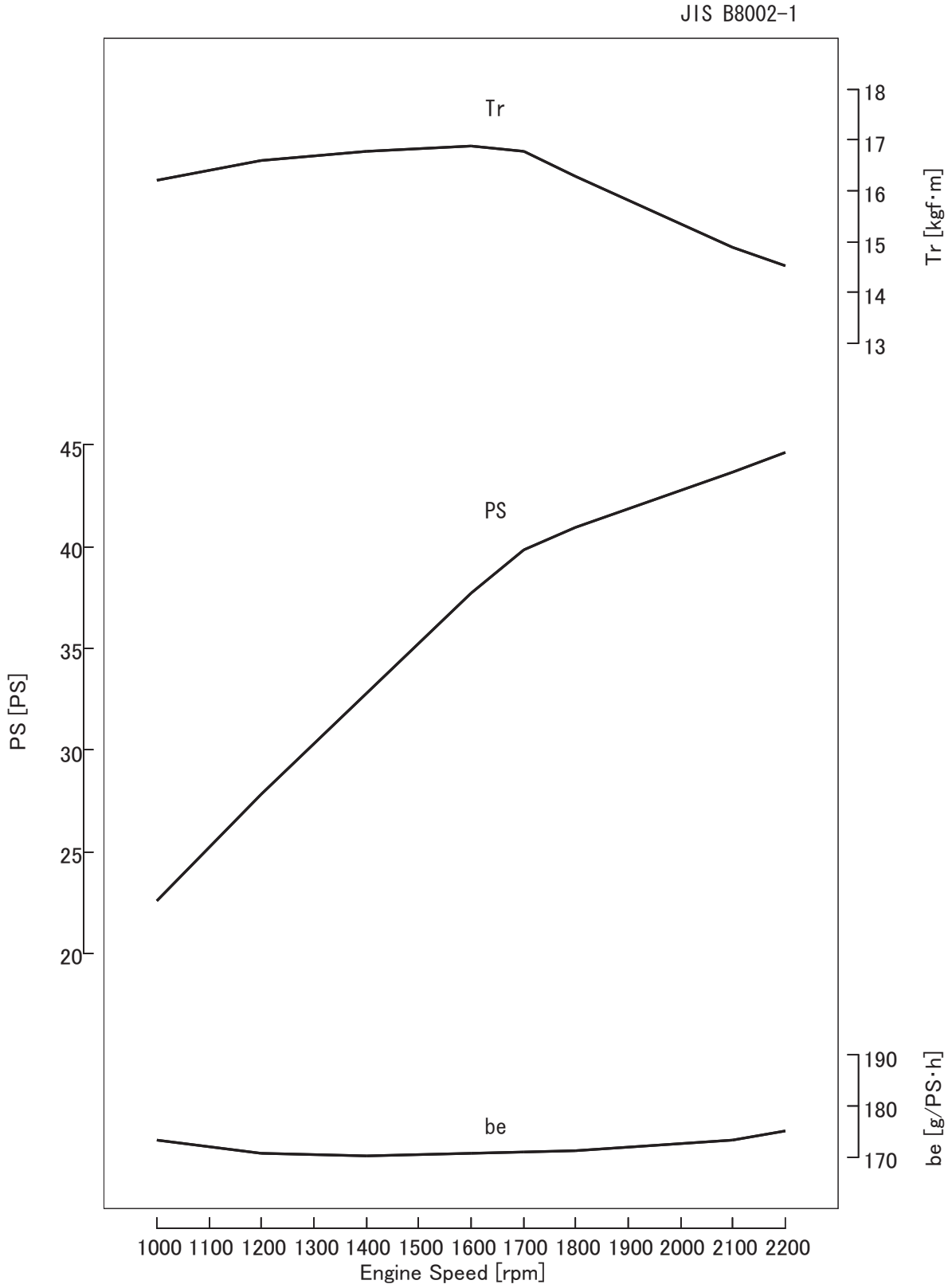


(2)KX161-3S

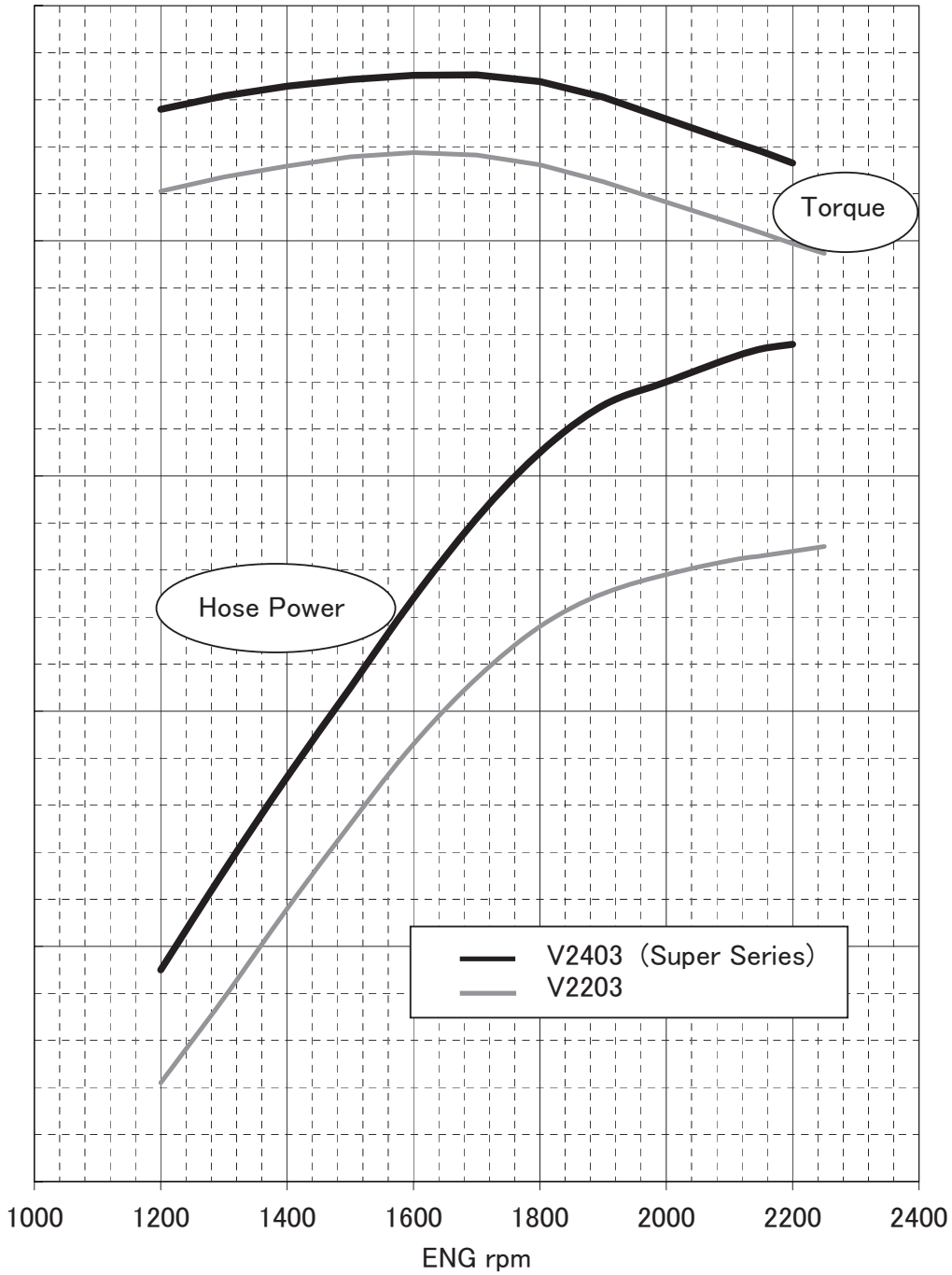
Model:V2403-M-E2BH-1



Model:V2403-M-E2BH-1



Engine performance of KX161-3 Super Series V2403 vs V2203



(D) NEW EMISSIONS CONTROL ENGINES

a) Outline

Tier 4 and Interim Tier 4 Engines for North American Market and Stage III A Engines for EU requirements have been launched and mounted on Kubota Construction Machinery.

FEATURES and BENEFITS

Emissions

- Kubota Super Mini Series, the most compact multi-cylinder liquid cooled industrial diesel engines, complies with EPA Tier 4 emissions regulations. These are the most stringent emissions regulations in the world in this class.
- The 03-M Series engine complies with EPA Interim Tier 4 emissions regulations that are effective through the end of 2012. This engine also complies with EU Stage III A requirements that are effective through 2012 and beyond in the European market.

Durable Power

- The Kubota Super Mini Series has been chosen as a power source for a variety of applications since it was first launched 25 years ago. It has become the benchmark in the compact diesel engine market.
- The D722 engine offers a seamless transition from Tier 2 to Tier 4 by totally maintaining the same performance and physical characteristics of the previous Tier 2 engines.
- The Kubota 03-M Series is well recognized for industrial applications. With numerous features such as a built-in solenoid, low fan position, and single side serviceability, this engine offers excellent performance characteristics and application flexibility.
- The cooling water passages between the cylinder bores, using Kubota's original casting technology as a countermeasure against heat load of high power density, provides both superior endurance and reliable engine characteristics.
- The 03-M engine offers a seamless transition from Tier 2 to Interim Tier 4 by maintaining the same footprint and hard mounting points with only slight performance changes from the Tier 2 engine.

Clean and Quiet Power

- Kubota's original E-TVCS (Three Vortex Combustion System) has been improved. The airflow, combustion chamber and piston recess were optimized to provide a 50% lower particulate matter (PM) level, the same stringent level as above the 37kW class (EPA Interim Tier 4 Option 1).
- The half-float valve cover and MoS_2 coated pistons lower noise levels by 1.0-2.0 dBA over conventional diesel engines and provide reduced transmitted vibration from the valve area for better noise characteristics.

b) Engine List for Minor Change

No.	Machine Model	Market	Engine type	Code No.	Rated output SAE1349 NET (kW/rpm)	Rated Torque SAE1349 NET (N·m)	Fuel consumption ratio SAE 1349 NET g/kWh	Remarks
1	**K008-3**	PP	D722-E3-BH-3	1G408-01000	7.5/2050	39.1	255	Tier 4
2	**U15**	PP	D782-E3-BH-4	1G409-00000	9.3/2300	43.3	270	↓
3	**KX41-3**	PP	D902-E3-BH	1G709-00000	11.3/2300	50.1	265	↓
4	**U25S**	PP	D1105-E3-BH-14	1G873-20000	14.8/2400	69.2	269	↓
5	**KX71-3S**	PP	V1505-E3-BH-10	1G090-30000	19.0/2300	90.9	267	Interim Tier 4
6	**KX91-3S2**	PP	D1703-M-E3-BH-US2	1G652-10000	20.1/2250	99.6	259	
7	**U35S2**	PP	D1703-M-E3-BH-US1	1G652-00000	20.1/2250	99.6	259	↓
8	**KX91-3α**	EU	D1503-M-EBH-3-EC-N	1G723-50000				Stage III A
9	**KX101-3α**	EU	D1503-M-EBH-4-EC-N	1G724-60000				↓
10	**U35-3α**	EU	D1503-M-EBH-4-EC-N	1G724-60000				↓
11	**KX121-3α**	EU	V2203-M-EBH-2-N	1G788-10000				↓
			V2203-M-EBH-3-N (AC)	1G797-10000	27.1/2250	140.7/1600	248	↓
12	**KX161-3α**	EU	V2203-M-EBH-2-N	1G788-10000				↓
			V2203-M-EBH-3-N (AC)	1G797-10000	27.1/2250	140.7/1600	248	↓
13	**U45-3α**	EU	V2203-M-EBH-2-N	1G788-10000				↓
			V2203-M-EBH-3-N (AC)	1G797-10000	27.1/2250	140.7/1600	248	↓
14	**KX121-3ST**	PP	V2203-M-E3-BH-US1	1G655-00000	27.7/2250	137.0/1600	250	Interim Tier 4
			V2203-M-E3-BH-US2 (AC)	1G655-10000 (AC)	27.4/2250	136.4/1600	253	↓
15	**U45ST**	PP	V2203-M-E3-BH-US1	1G655-00000	27.7/2250	137.0/1600	250	↓
			V2203-M-E3-BH-US3 (AC)	1G655-20000 (AC)	26.9/2250	135.4/1600	257	↓
16	**KX161-3ST**	PP	V2403-M-E3-BH-US1	1G604-00000	31.1/2300	151.4/1600	256	↓
			V2403-M-E3-BH-US2 (AC)	1G604-10000 (AC)	30.6/2300	150.4/1600	260	↓
17	**R310α**	EU	V1305-E2-RP-2	1G078-20000				Stage III A
18	**R320S**	PP	V1305-E3-RP	1G078-30000	17.3/2600	75.6/1900	274	Tier 4
19	**R420S**	PP	D1503-M-TE3-WL-US1	1G497-00000	27.7/2600	122.2/1600	268	Interim Tier 4
20	**R420α**	EU	D1503-M-T-E2RP-1	1G734-00000				Stage III A
21	**R520S**	PP	V2203-M-E3-WL-US1	1G493-00000	31.1/2600	139.8/1600	261	Interim Tier 4
22	**R520α**	EU	V2203-M-E2RP	1G789-00000				Stage III A

PP: Pan-pacific-version, KTA, KCL, KTC
EU: European-version

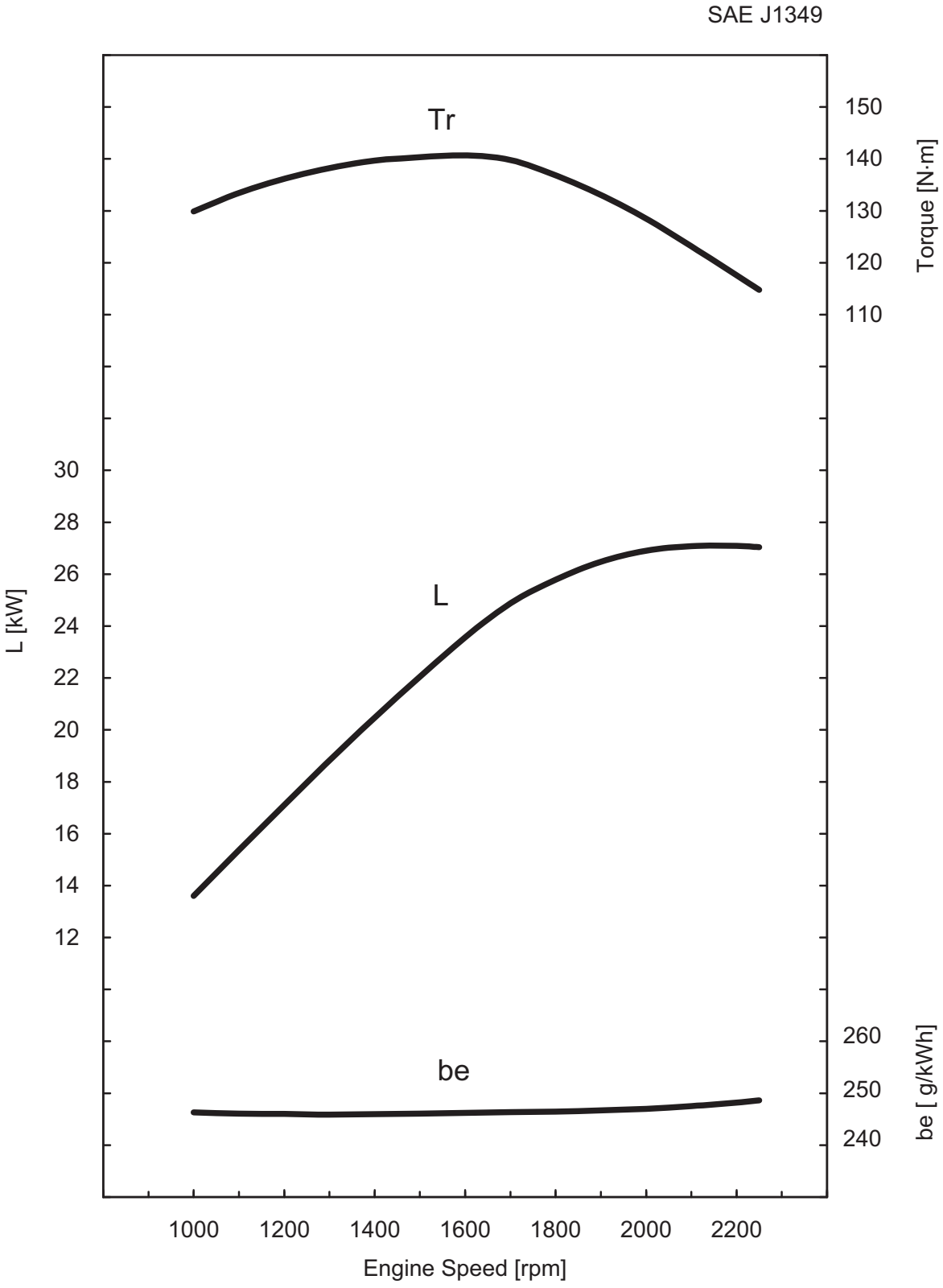
c) Major Engine Specifications for Tier 4 / Interim Tier 4 Engines

Distributors				KTC, KCL, KTA							EU-nations
Engine code number				1G652-10000	1G652-00000	1G655-00000	1G655-10000	1G655-20000	1G604-00000	1G604-10000	1G797-10000
Engine type				D1703-M-E3-BH-US2	D1703-M-E3-BH-US1	V2203-M-E3-BH-US1	V2203-M-E3-BH-US2	V2203-M-E3-BH-US3	V2403-M-E3-BH-US1	V2403-M-E3-BH-US2	V2203-M-EBH-3-N
Machine model				**KX91-3S2**	**U35S2**	**KX121-3ST**	**KX121-3ST AC**	**U45ST AC**	**KX161-3ST**	**KX161-3ST AC**	**KX121-3α AC**
						U45S					**KX161-3α AC**
											U45-3α AC
Rated Output	Engine Speed	rpm		2250	2250	2250	2250	2250	2300	2300	2250
	NET	kW	SAE J1349	20.1	20.1	27.7	27.4	26.9	31.1	30.6	27.1
		PS	SAE J1349	27.3	27.3	37.7	37.3	36.6	42.3	41.6	36.8
		HP	SAE J1349	27.0	27.0	37.1	36.7	36.1	41.7	41.0	36.3
	Gross	kW	SAE J1995	21.0	21.0	28.8	28.8	28.8	32.7	32.7	28.5
		PS	SAE J1995	28.6	28.6	39.2	39.2	39.2	44.5	44.5	38.7
		HP	SAE J1995	28.2	28.2	38.6	38.6	38.6	43.9	43.9	38.2
Max. engine torque	Engine Speed	rpm		1600	1600	1600	1600	1600	1600	1600	1600
	NET	N·m	SAE J1349	99.6	99.6	137.0	136.4	135.4	151.4	150.4	140.7
		kgf·m	SAE J1349	10.2	10.2	14.0	13.9	13.8	15.4	15.3	14.3
		lb·ft	SAE J1349	73.5	73.5	101.0	100.6	99.9	111.7	110.9	103.8
	Gross	N·m	SAE J1995	102.5	102.5	140.7	140.7	140.7	155.9	155.9	145.0
		kgf·m	SAE J1995	10.5	10.5	14.3	14.3	14.3	15.9	15.9	14.8
		lb·ft	SAE J1995	75.6	75.6	103.8	103.8	103.8	115.0	115.0	106.9
Fuel injection timing (Conventional)		degree of BTDC		15	15	14	14	14	14	14	17
Max speed, no-load	Gross	rpm		<2500	<2500	<2520	<2520	<2520	<2570	<2570	<2520
Idling speed	Gross	rpm		850~900	850~900	850~900	850~900	850~900	900~950	900~950	900~950
Fuel consumption ratio (Engine unit only at rated out put)	NET	g/kWh	SAE J1349	259	259	250	253	257	256	260	248
		g/PSh		191	191	184	186	190	188	192	183
		lbs/HPh		0.425	0.425	0.410	0.414	0.422	0.419	0.426	0.407
Fuel consumption (Engine unit only at rated out put)	NET	l/h		6.4	6.4	8.5	8.5	8.5	9.8	9.8	8.3
		gal/h		1.70	1.70	2.26	2.26	2.26	2.59	2.59	2.19
Performance curve		SAE J1349									
		SAE J1349/J1995									

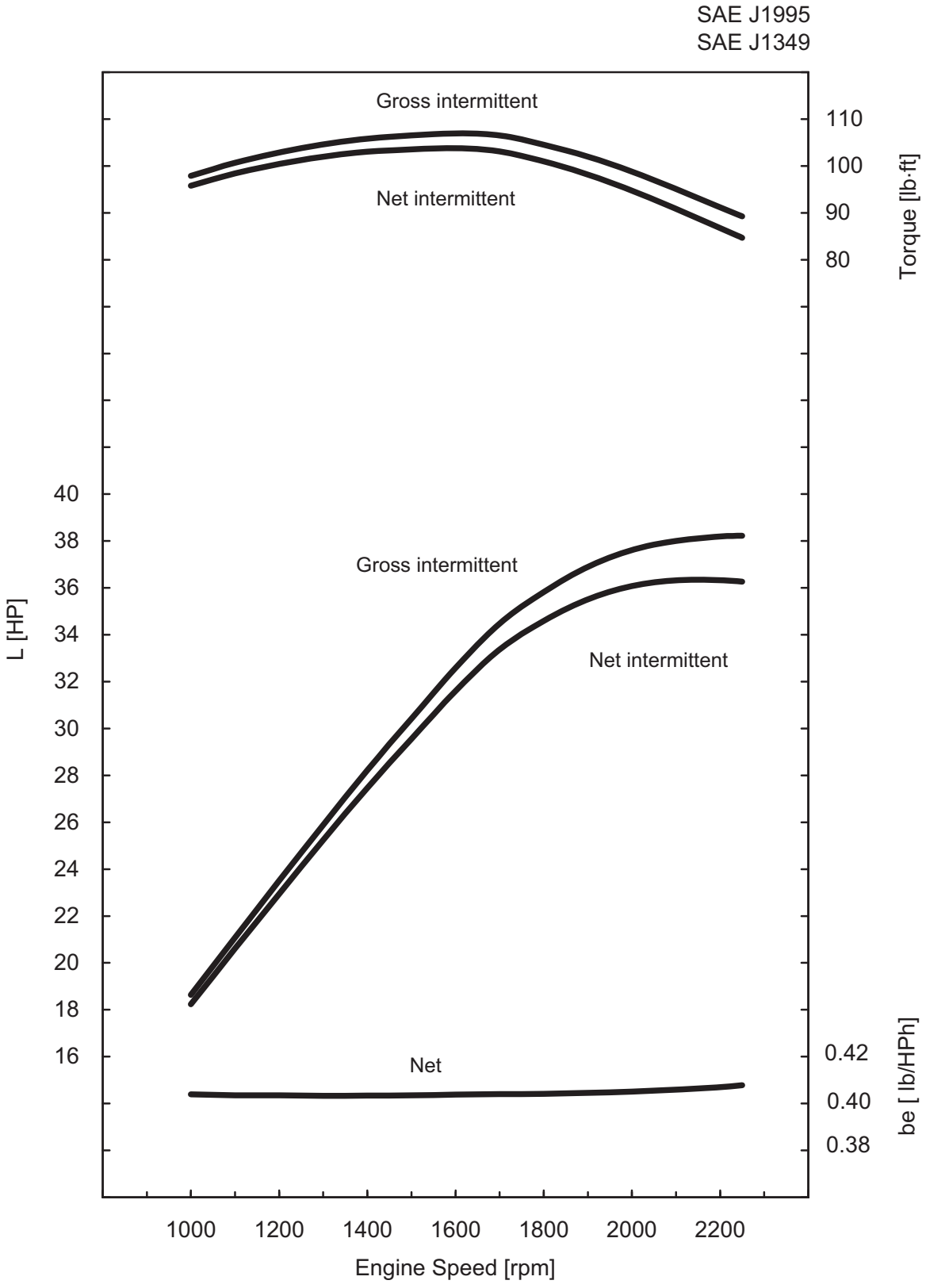
Note: The idling speed in the above table is set on engine unit by the engine assembly line.
It should be set another when mounting on construction machines.

d) Performance Curve

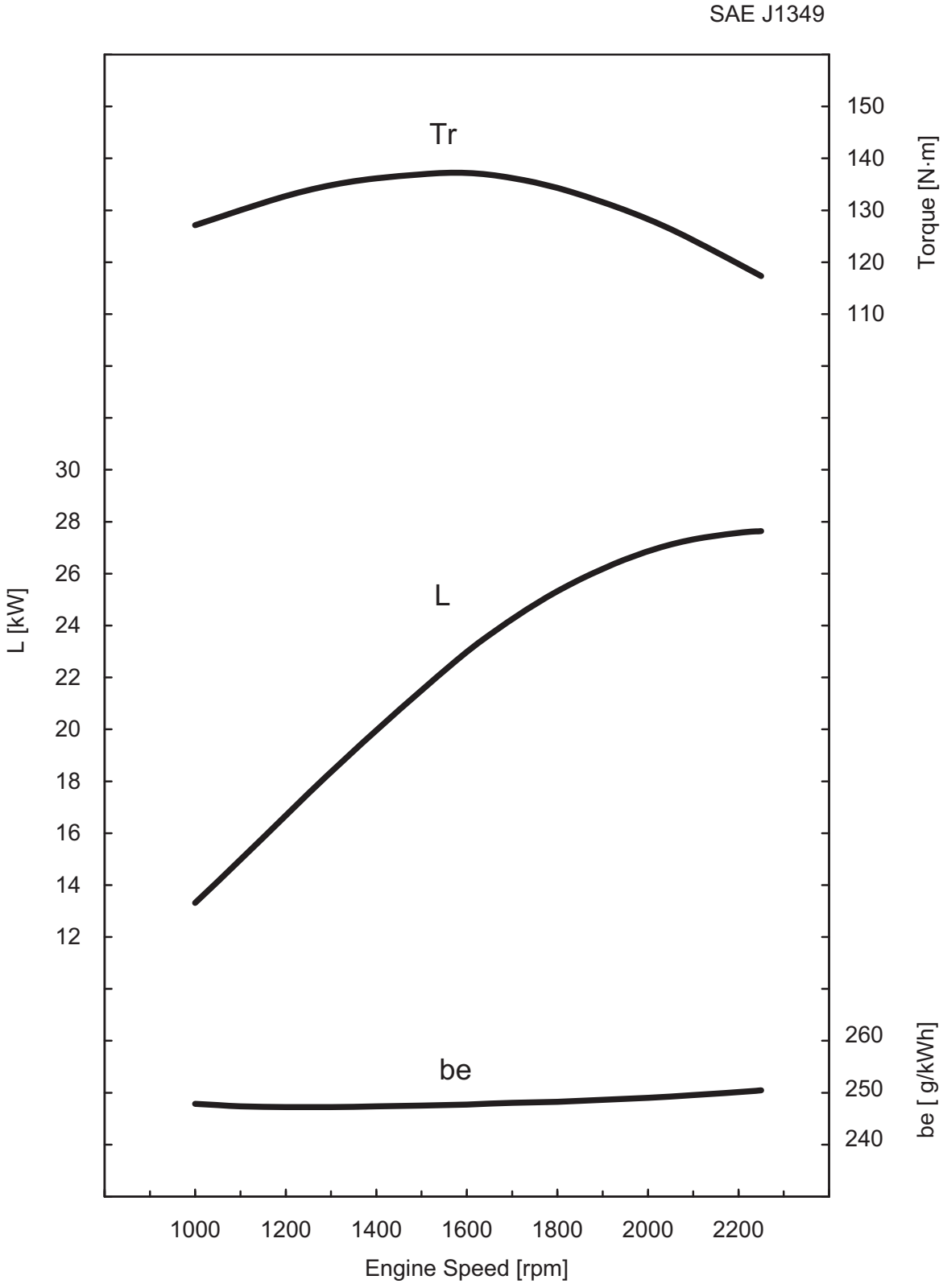
(1) Machine model: **U45-3α (AC-version)**
Engine model: V2203-M-EBH-3-N



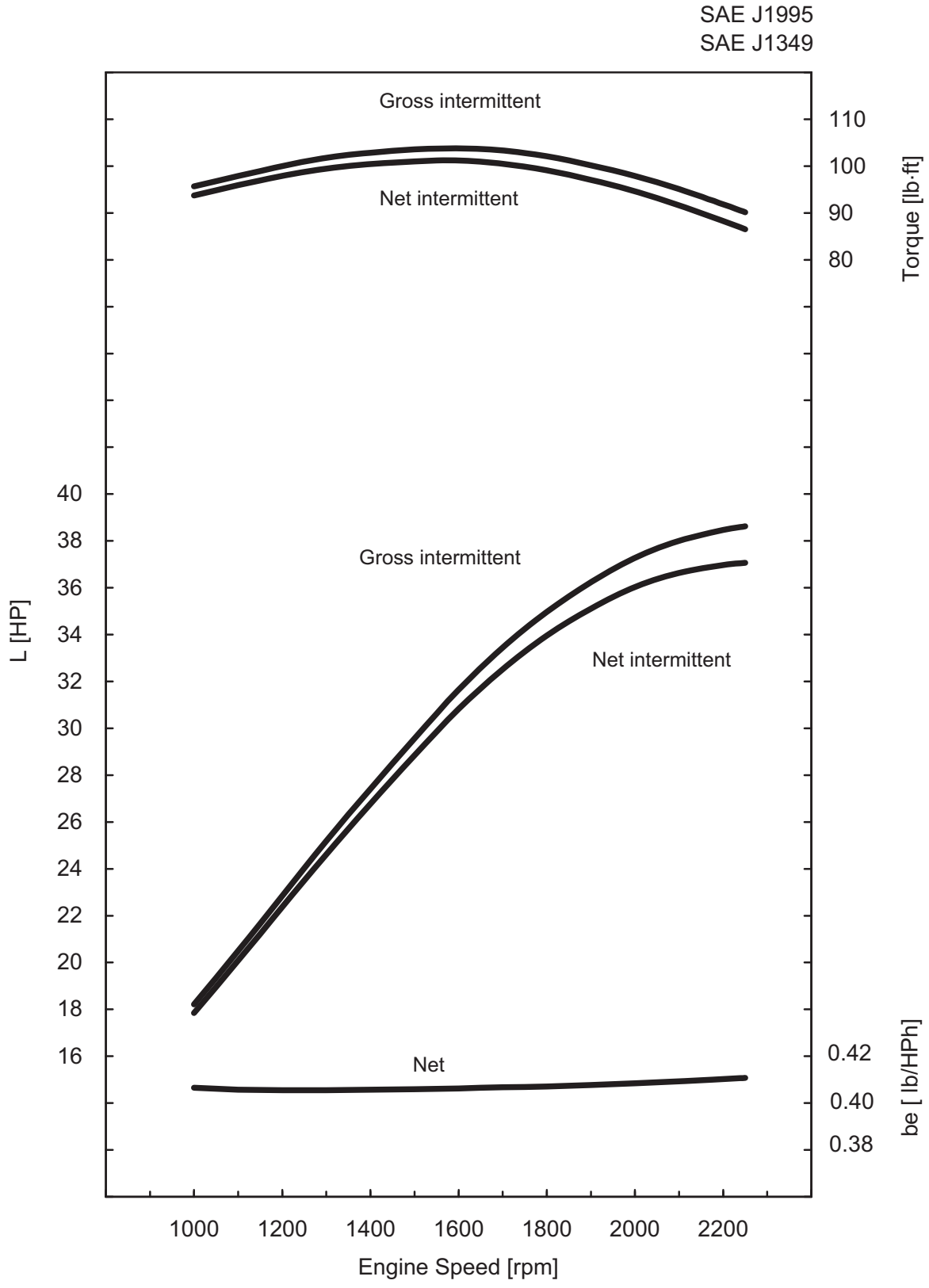
(2) Machine model: **U45-3α (AC-version)**
Engine model: V2203-M-EBH-3-N



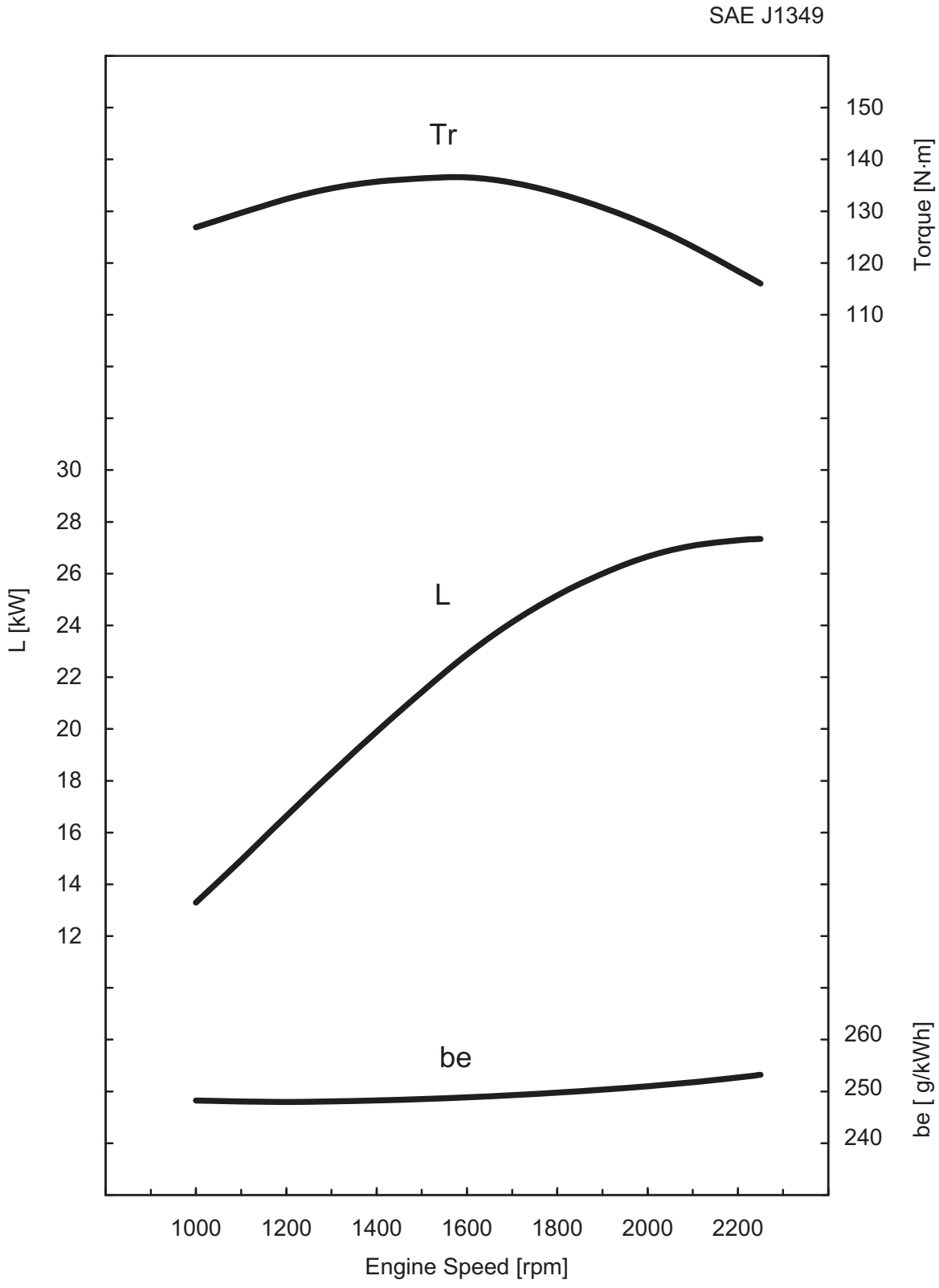
(3) Machine model: **KX121-3ST, U45ST**
Engine model: V2203-M-E3-BH-US1



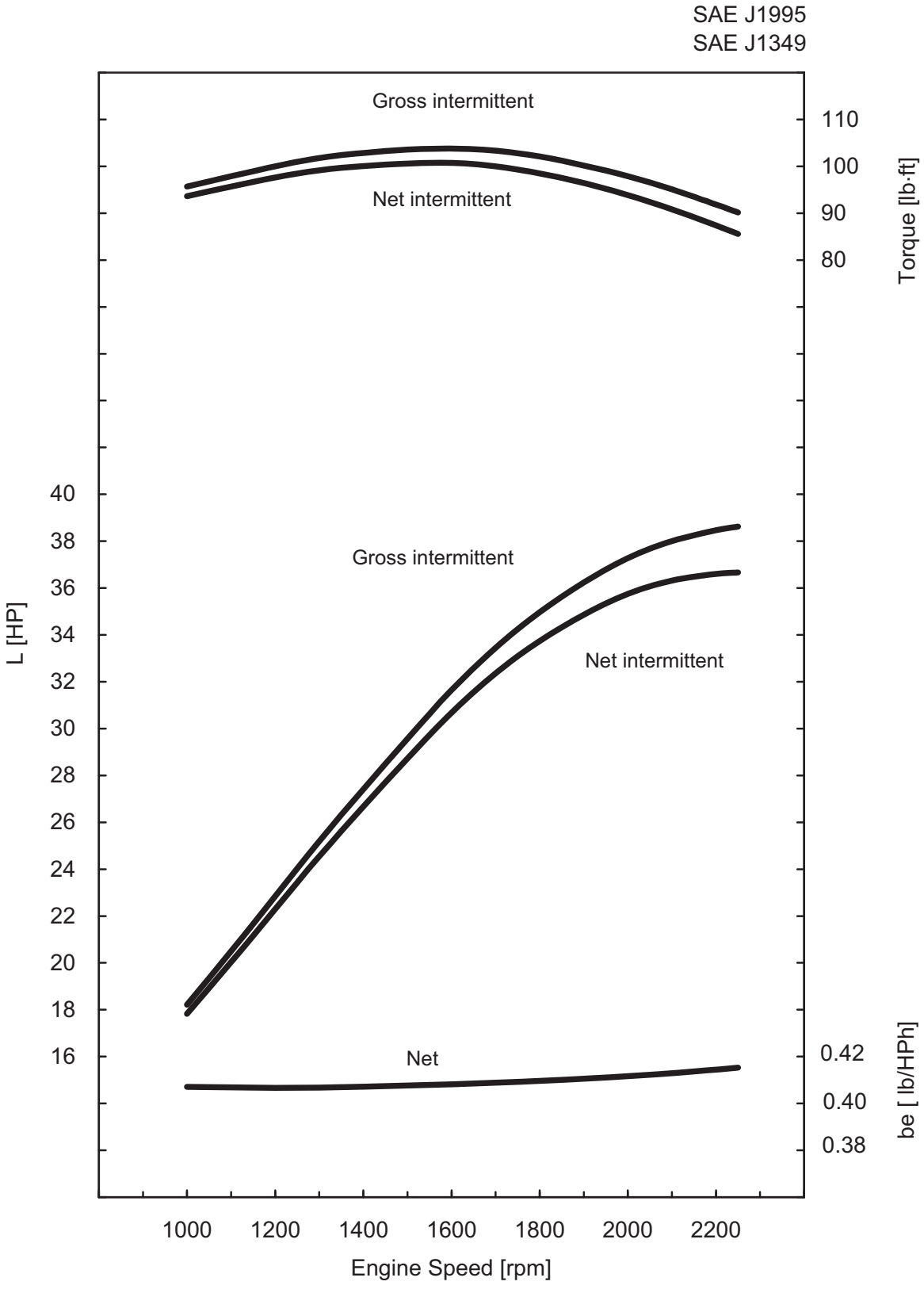
(4) Machine model: **KX121-3ST, U45ST**
Engine model: V2203-M-E3-BH-US1



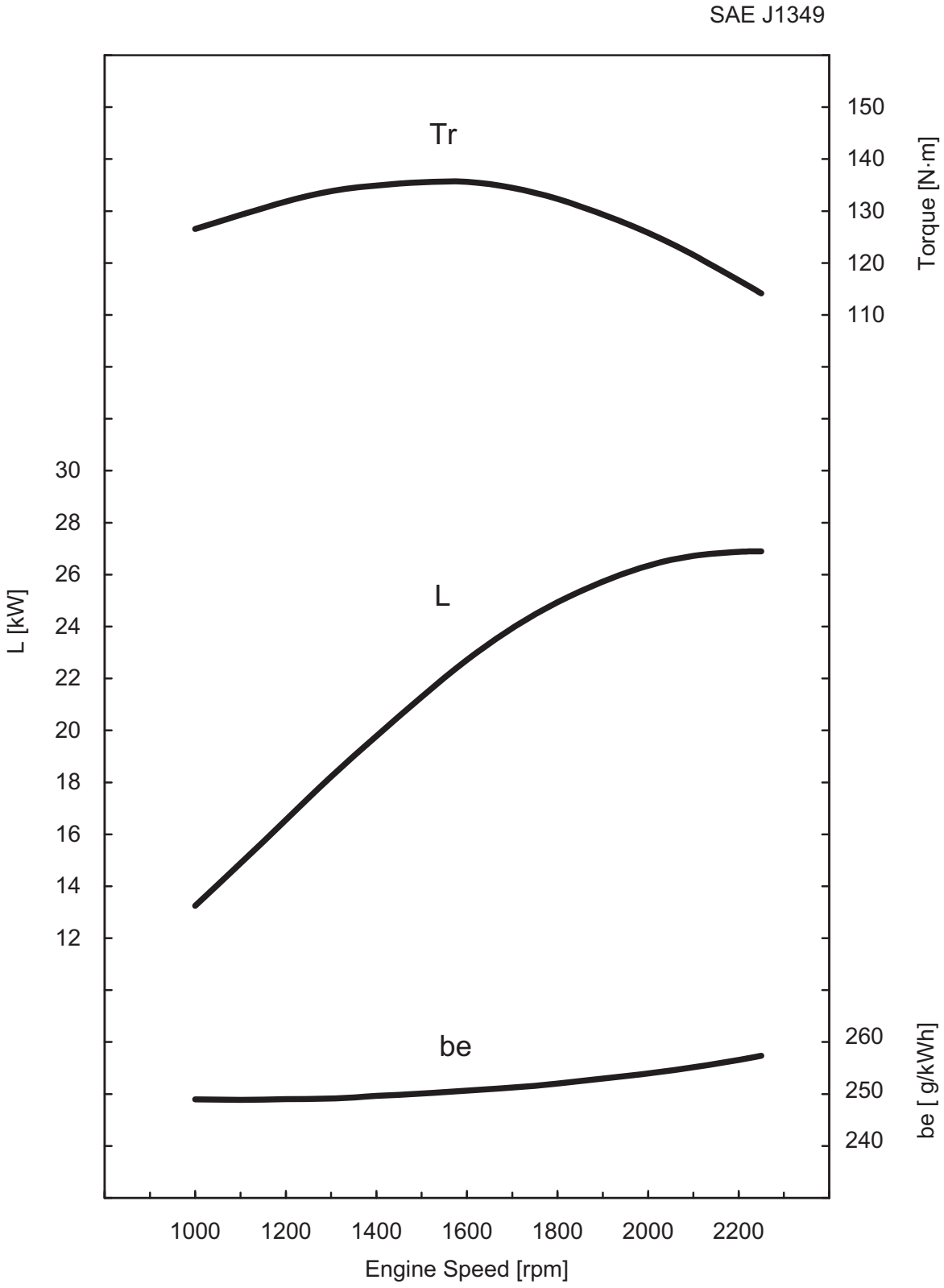
(5) Machine model: **KX121-3ST (AC-version)**
Engine model: V2203-M-E3-BH-US2



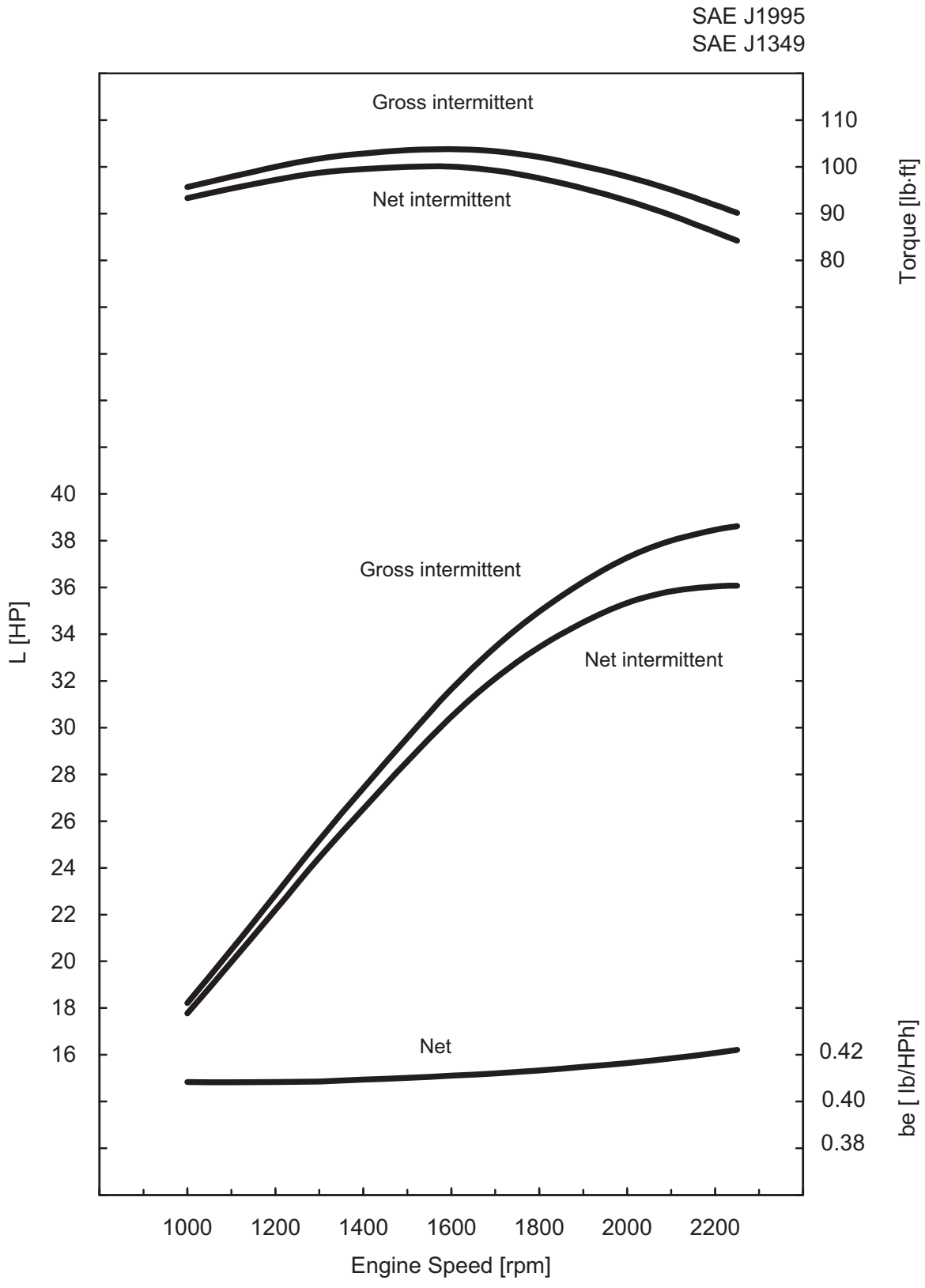
(6) Machine model: **KX121-3ST (AC-version)**
Engine model: V2203-M-E3-BH-US2



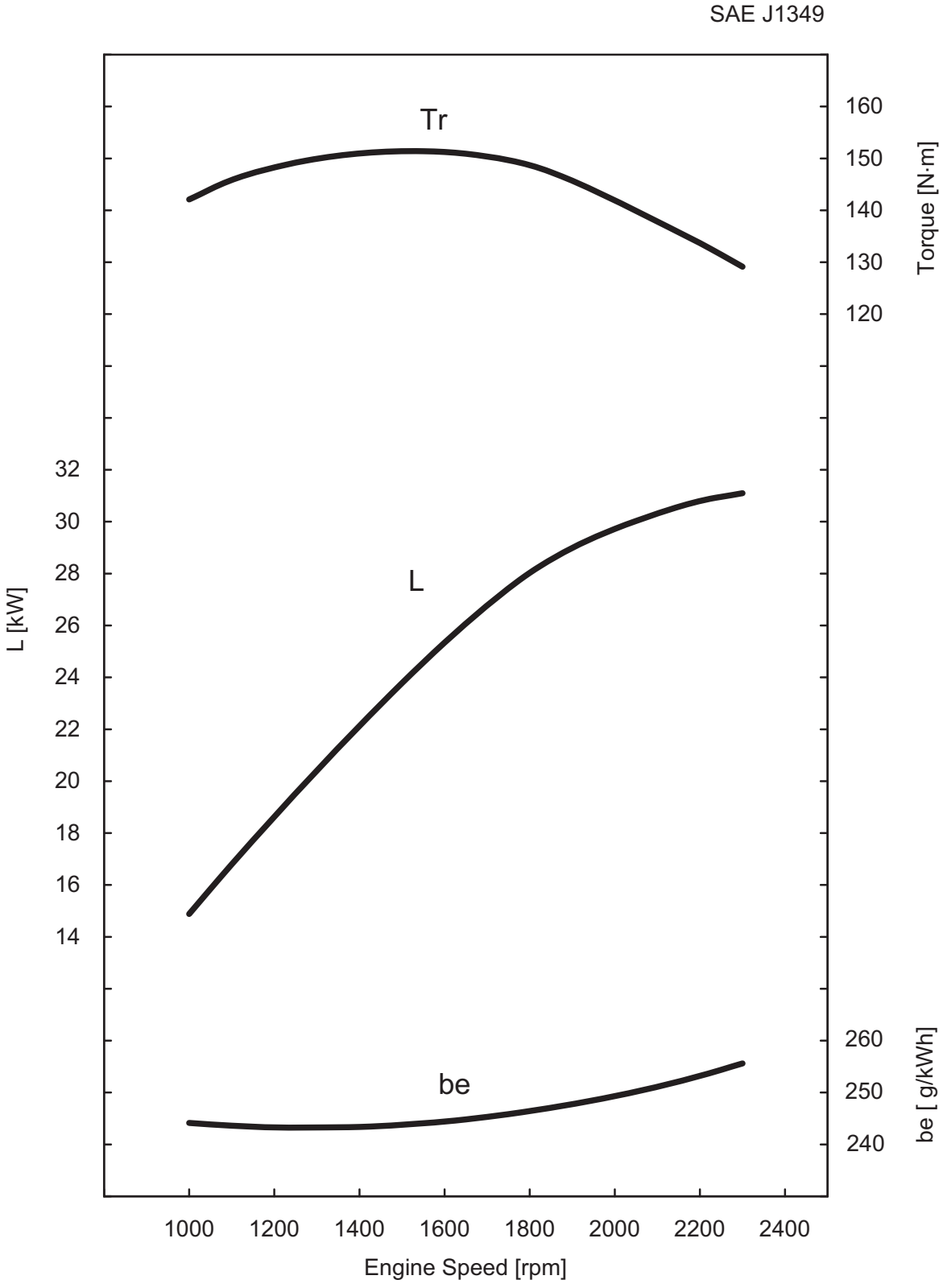
(7) Machine model: **U45ST (AC-version)**
Engine model: V2203-M-E3-BH-US3



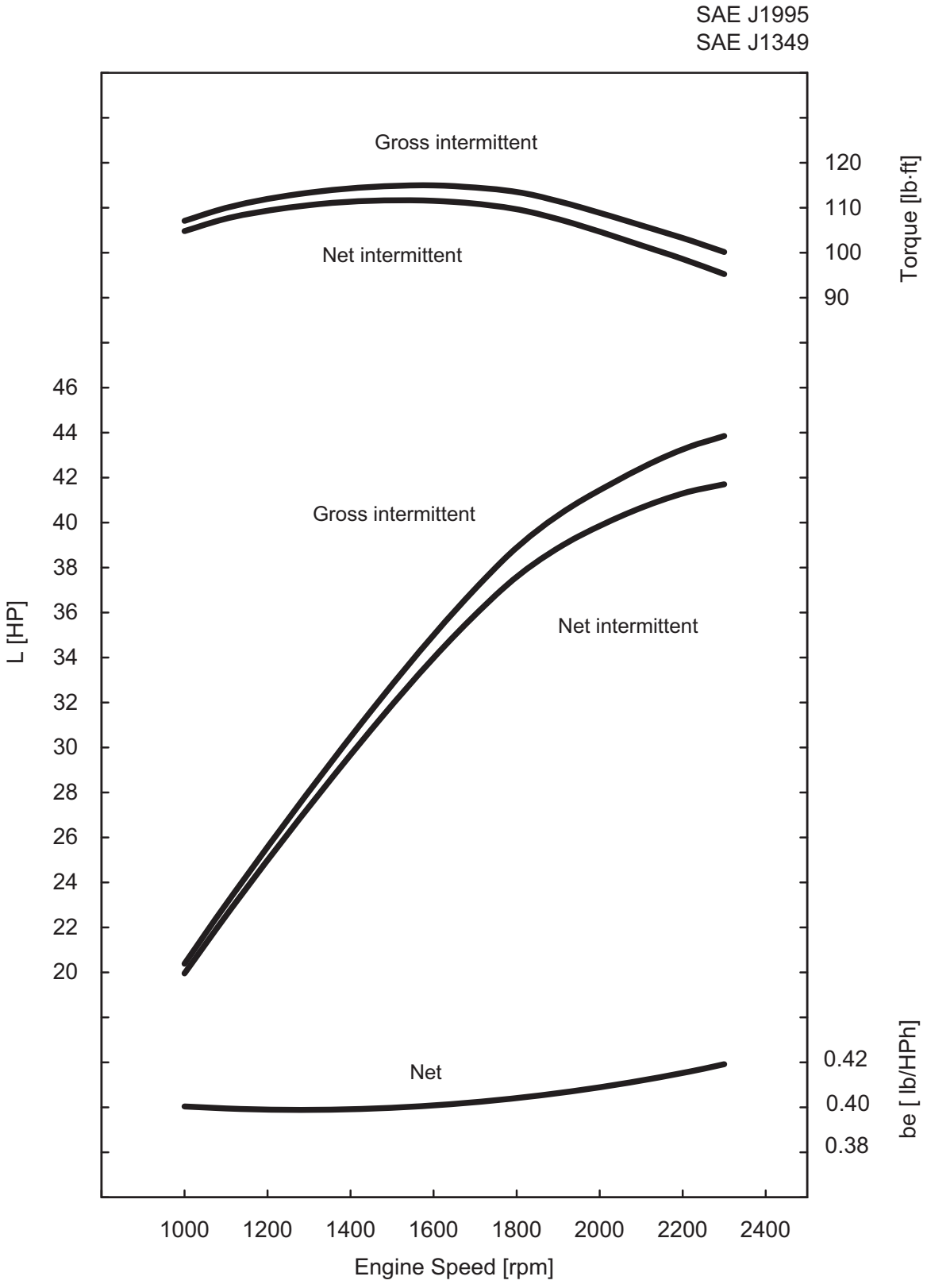
(8) Machine model: **U45ST (AC-version)**
Engine model: V2203-M-E3-BH-US3



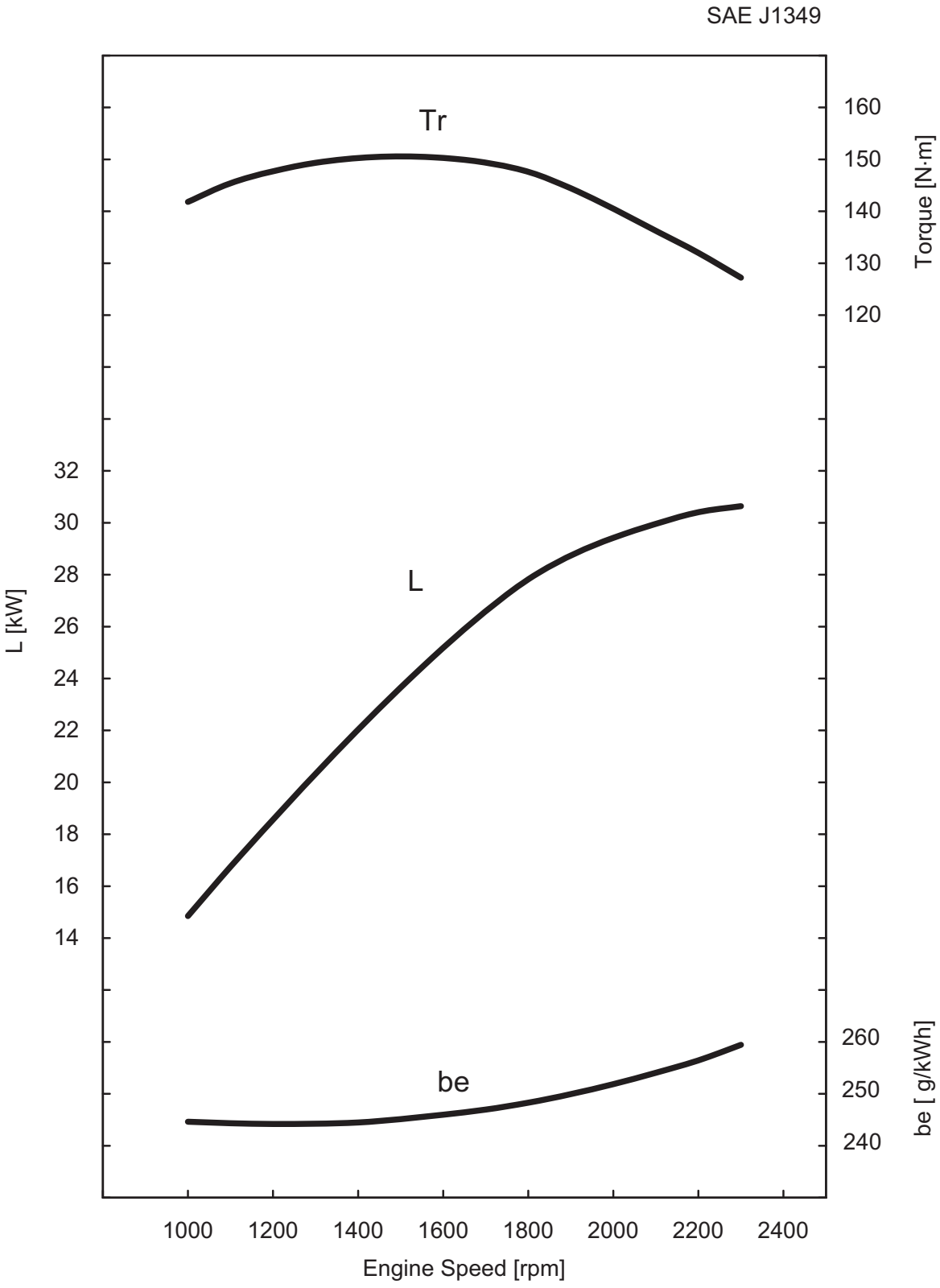
(9) Machine model: **KX161-3ST**
Engine model: V2403-M-E3-BH-US1



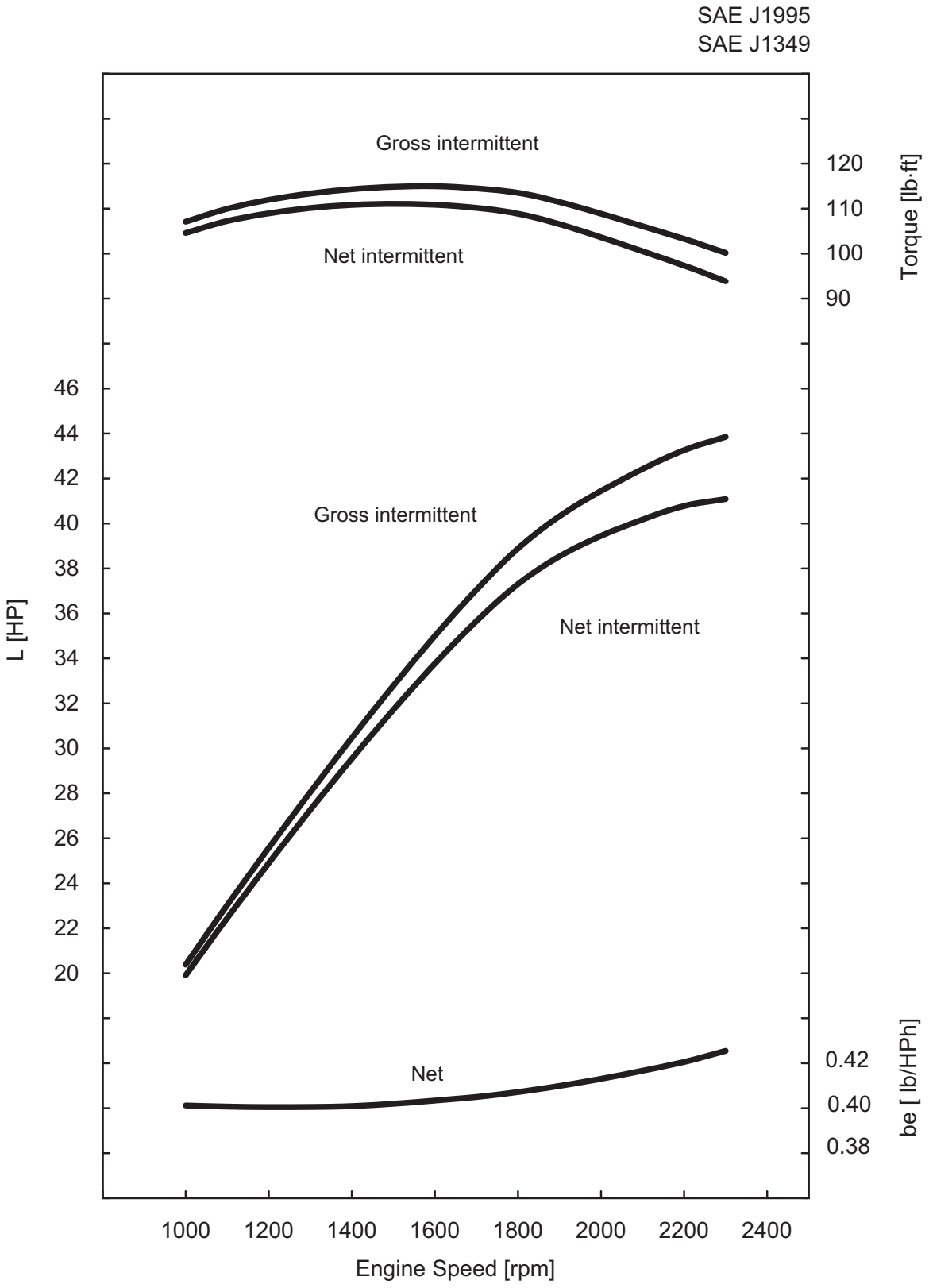
(10) Machine model:**KX161-3ST**
Engine model: V2403-M-E3-BH-US1



(11) Machine model: **KX161-3ST (AC-version)**
Engine model: V2403-M-E3-BH-US2



(12) Machine model:**KX161-3ST (AC-version)**
Engine model: V2403-M-E3-BH-US2



III. ENGINE

Service Section

(A) ENGINE MOUNTING PROCEDURE. III-S-3
a) Engine Mount III-S-3
b) Engine Mount: KX161-3/α/S III-S-5
c) Air Cleaner III-S-8
d) Radiator III-S-9
e) Muffler III-S-15
f) Pump Coupling III-S-16
g) Fuel Tank Installation III-S-18
h) Fuel Tank Cushion III-S-19
i) Fuel Hoses III-S-20
j) Accel Control (AI-version) III-S-30

Engine WSM : 03-M-E3B, 03-M-DI-E3B, 03-M-E3BG

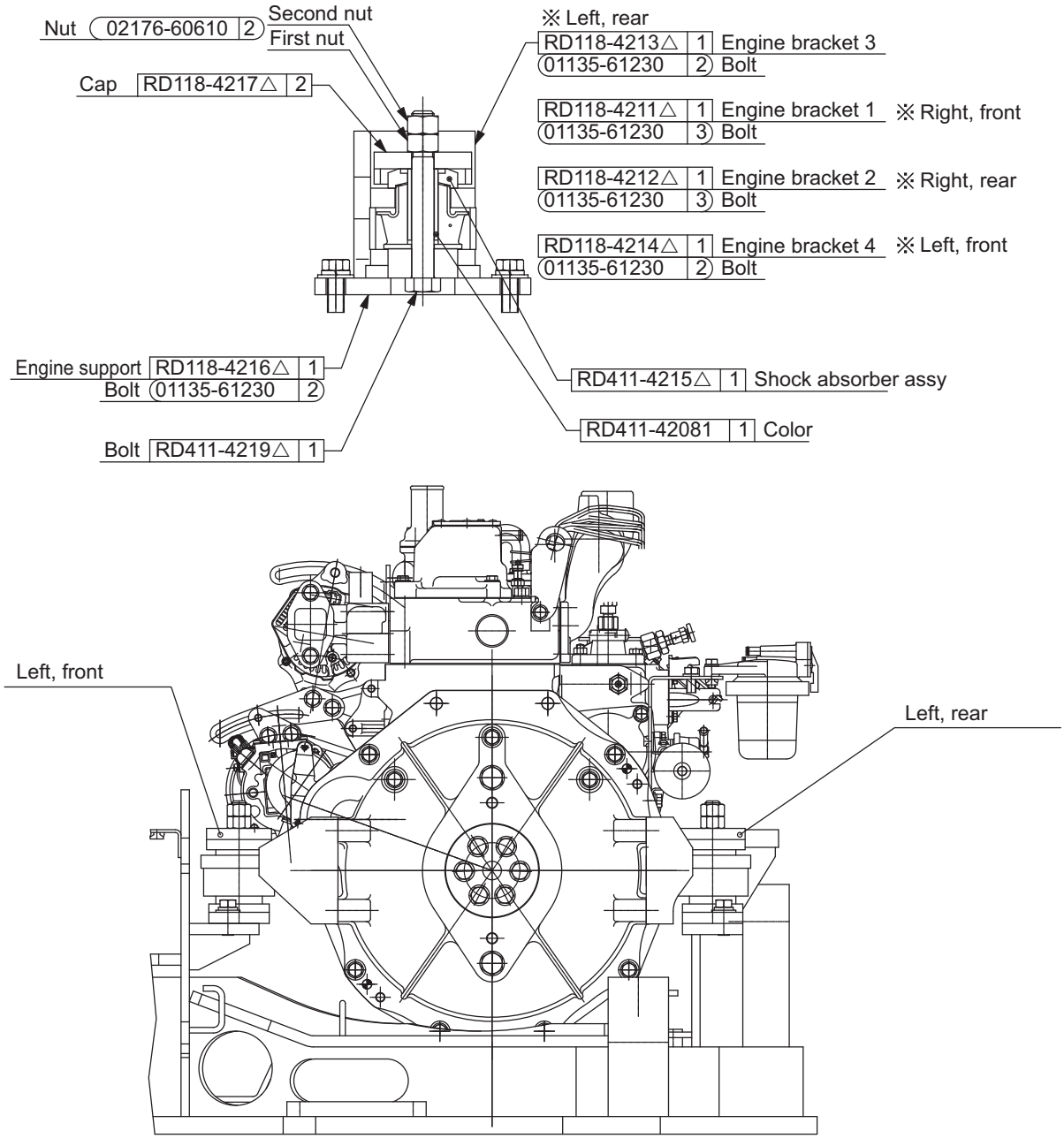
(A) ENGINE MOUNTING PROCEDURE

a) Engine Mount

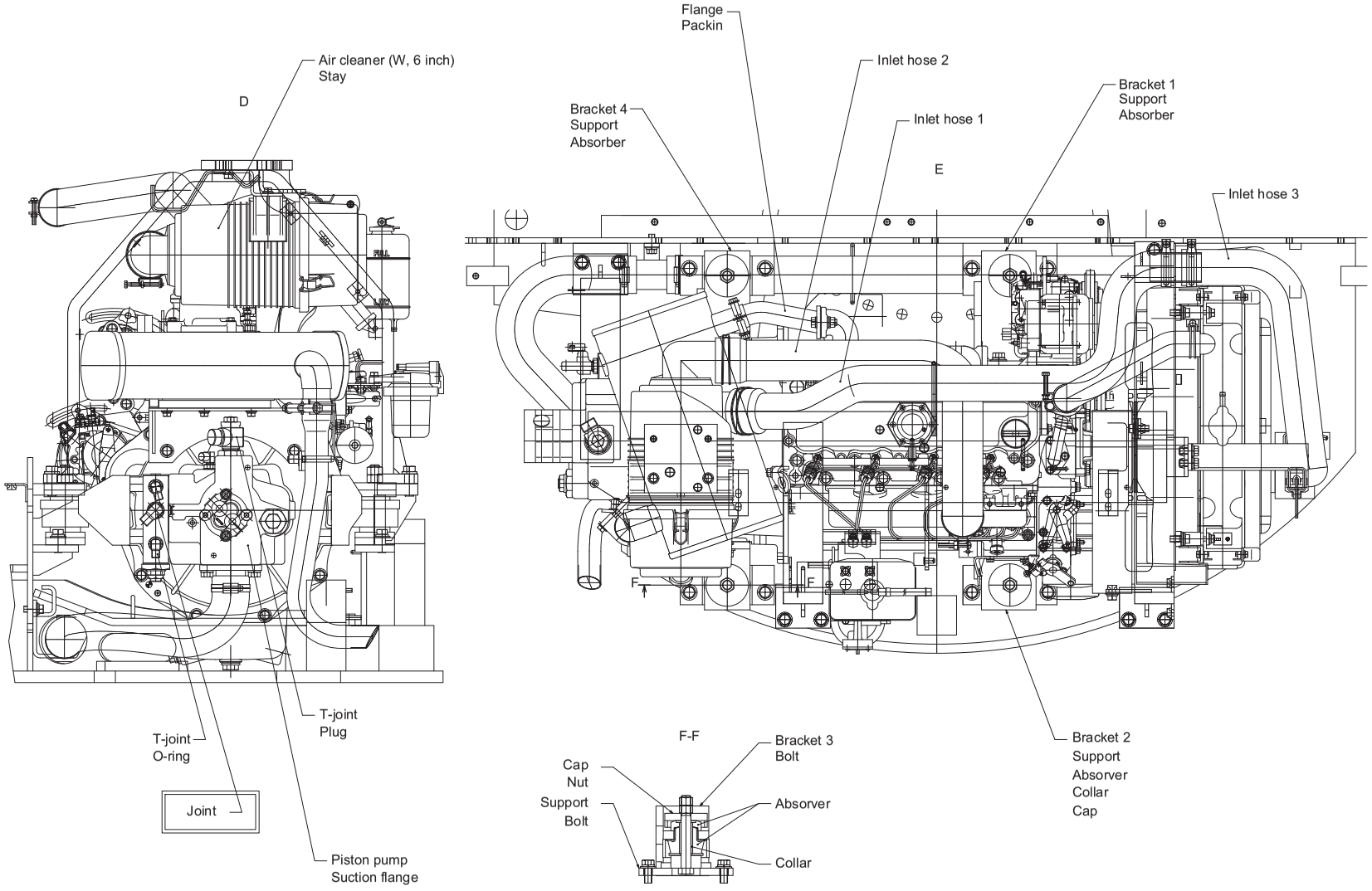
(1) Engine support mouting
Tightening torque
77.5 ~ 90.2 N·m (7.9 ~ 9.2 kgf·m) 57.1 ~ 66.5 ft·lbs
Apply screw locktiteagent. (Locktite 271)

(2) Engine bracket mounting
Tightening torque
77.5 ~ 90.2N·m (7.9 ~ 9.2 kgf·m) 57.1 ~ 66.5 ft·lbs
Apply screw locktiteagent. (Locktite 271)

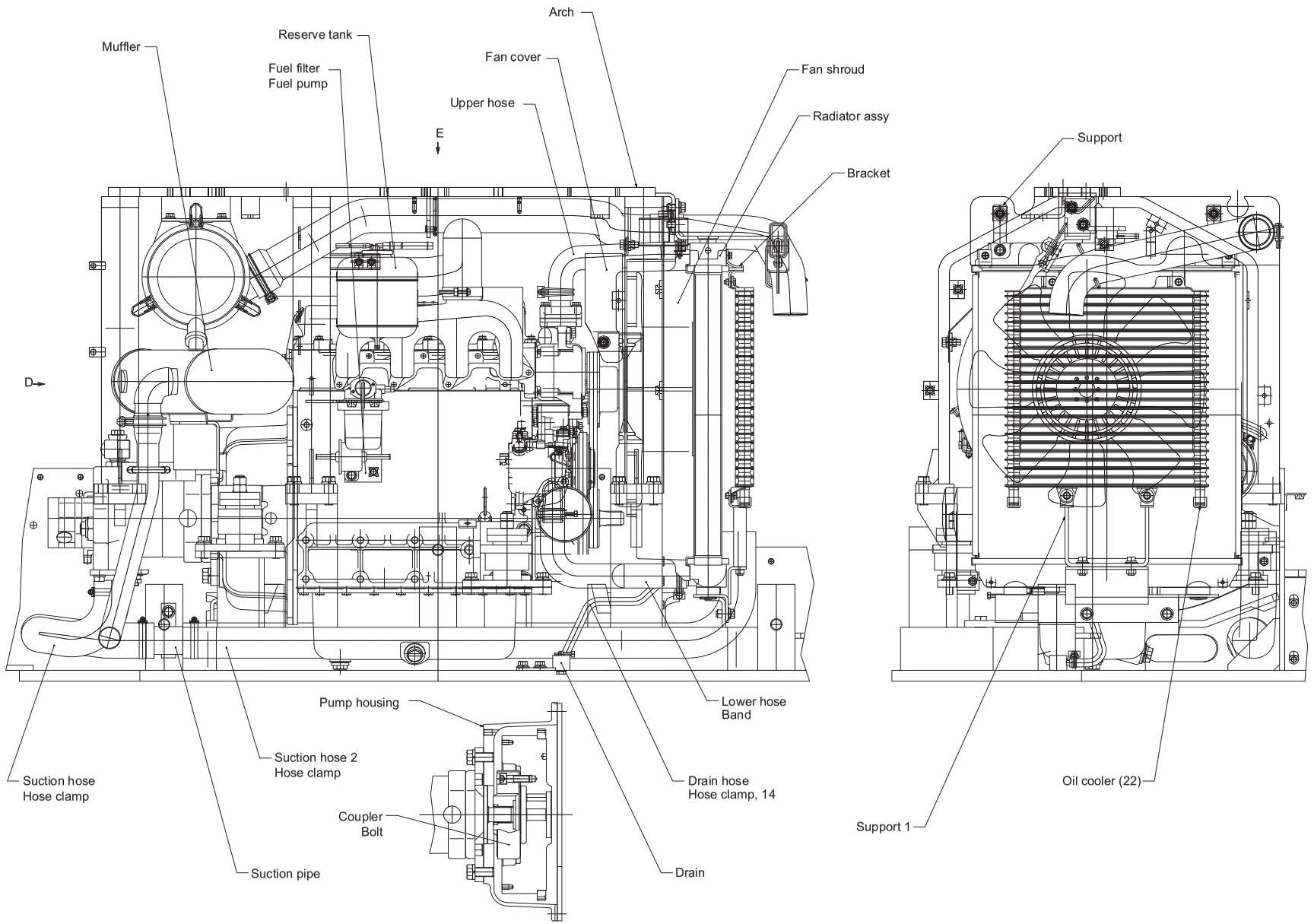
(3) Shock absorber installation
Install as shown in Fig.
Double nuts tightening torque
First nut
166 ~ 191 N·m (17.0 ~ 19.5 kgf·m)
123.0 ~ 141.0 ft·lbs
Second nut
166 ~ 191 N·m (17.0 ~ 19.5 kgf·m)
123.0 ~ 141.0 ft·lbs
Apply screw locktiteagent. (Locktite 271)



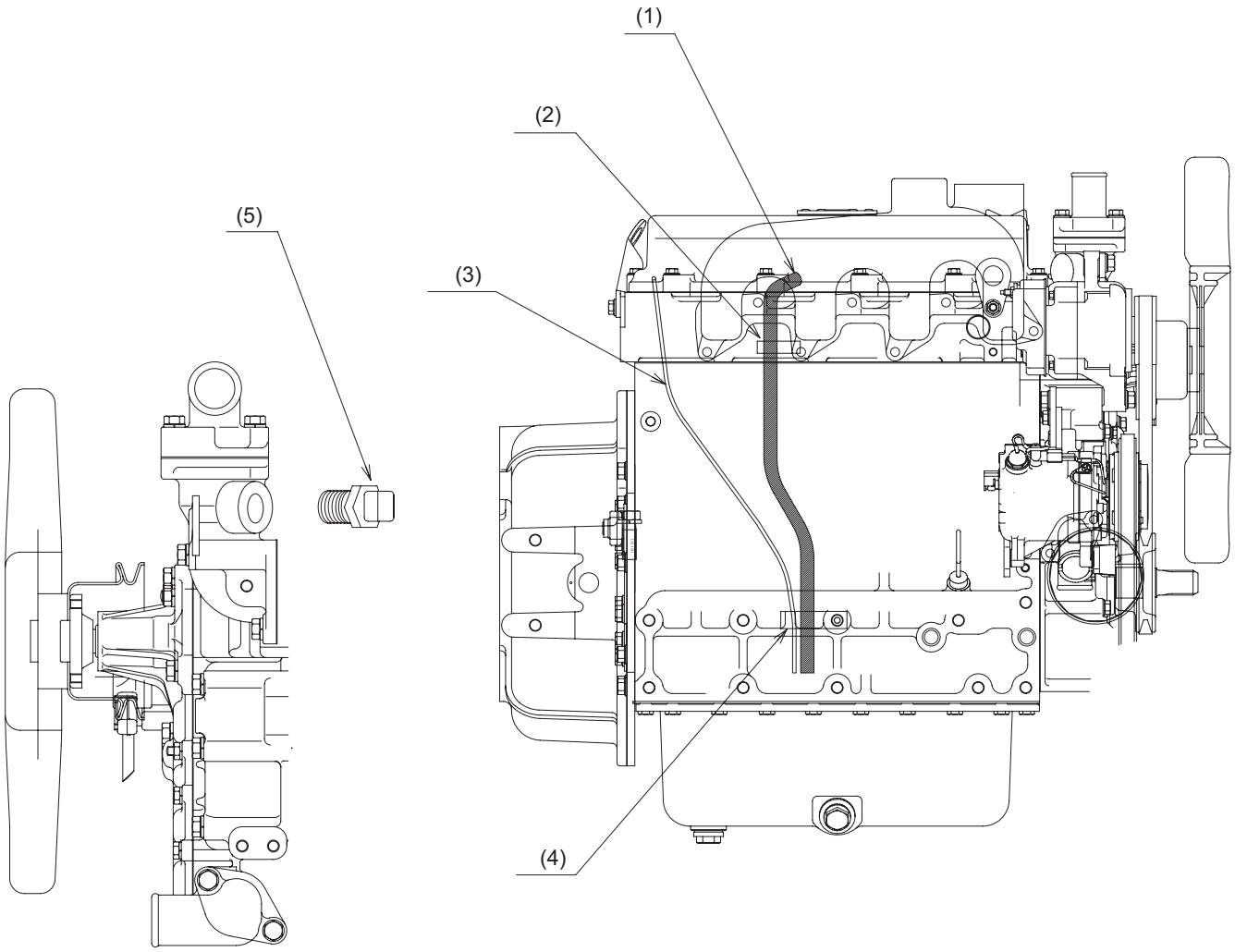
b) Engine Mount: KX161-3/α/S



Engine mount: KX161-3/α/S



Breather



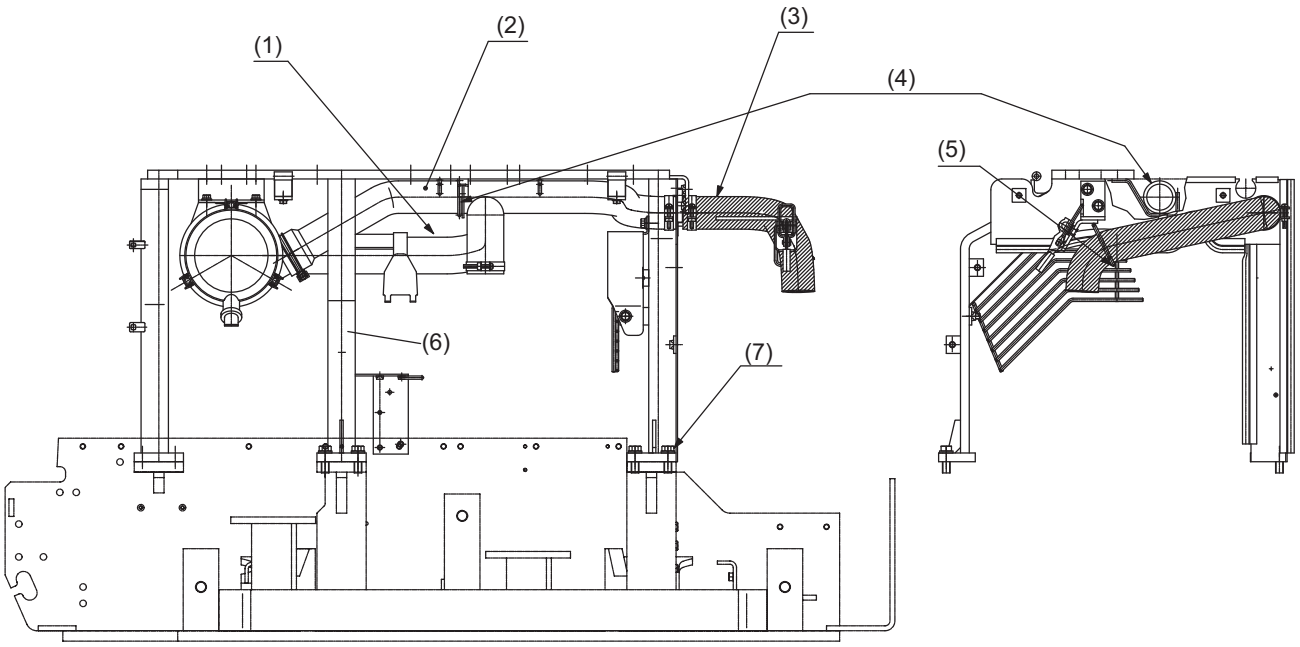
(1) Breather tube
(1A053-0551Δ)
(2) Be sure to pass behind the clamp.
(3) Fuel return hose
(4) Clamp
(5) Temperature sensor

c) Air Cleaner

(1) Inlet hose 3 installation (RD411-4224△)
Refer to the Fig.

(2) Arch frame mounting
Bolt M14
Apply screw lock agent.

(3) Install air cleaner assy
B. H M8
Tightening torque: 23.5 ~ 25.5 N·m (2.4 ~ 2.6 kgf·m) 17.4 ~ 18.8 ft·lbs



(1) Inlet hoes 2
Hose clamp (screw type)
Connecting band
(2) Inlet hoes 1
Hose clamp (screw type)
Pipe band
(3) Inlet hoes 3
Pipe band
(4) Fit the hose on the arch frame guide.
(5) Put on the lock bracket guide.
(6) Arch frame
(7) Bolt (M14, arch), 7 pcs
RD118-41271

d) Radiator

(1) Stretch of fan out of fan shroud Part (A)
Refer to the Fig.
Fan to stretch uniformly out of its shroud

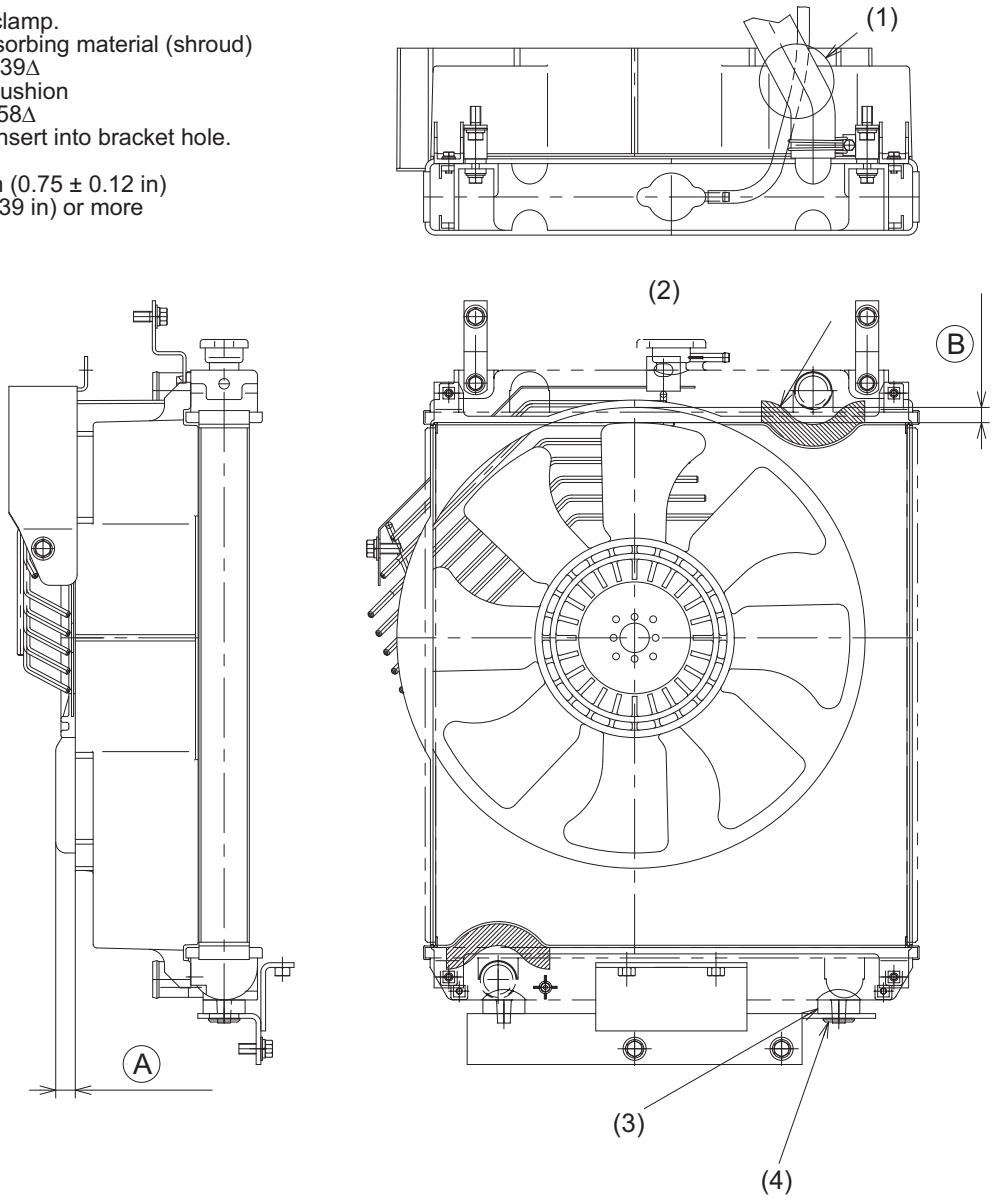
(2) Clearance between fan and fan shroud Part (B)
10 mm (0.39 inch) or more to be ensured

(3) Bracket fitting on the radiator cushion (6C040-5858)
Rubber catch to hook on tightly

(4) Fitting of the shroud (fan)(M6 bolt)
Tightening torque
4.5 ~ 5.5 N·m
(0.46 ~ 0.56 kgf·m)
3.32 ~ 4.06 ft·lbs

(1) Securely clamp.
(2) Sound absorbing material (shroud) RD431-4139Δ
(3) Radiator cushion 6C040-5858Δ
(4) Securely insert into bracket hole.

Ⓐ 19 ± 3 mm (0.75 ± 0.12 in)
Ⓑ 10 mm (0.39 in) or more

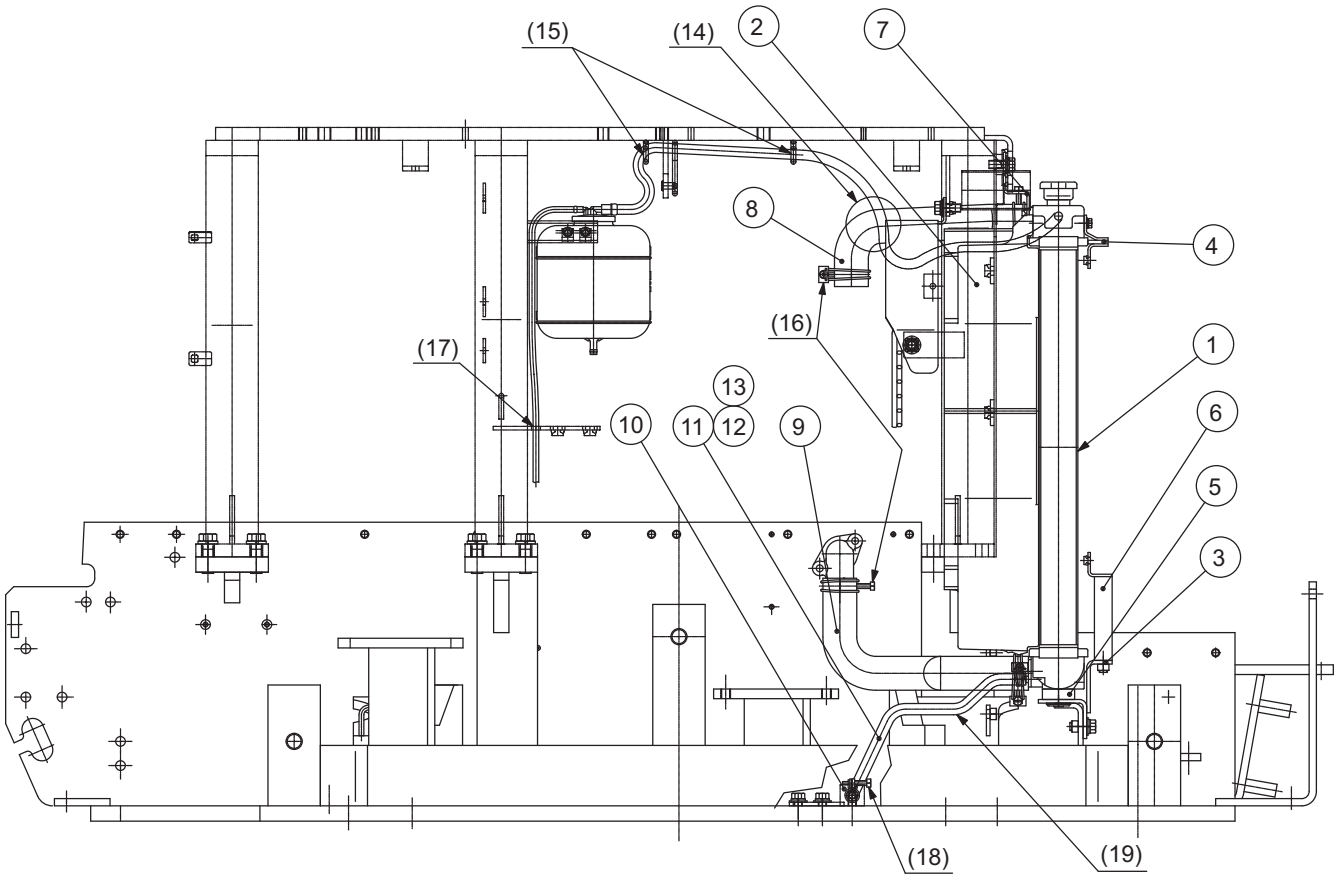


Sample: KX121-3ST

Radiator and relevant

No	Part name	Q'ty
1	Radiator assy	1
2		1
3	Bracket (1, Radiator)	1
4	Bracket (2, Radiator)	1
5	Cushion (Radiator)	2
6	Support (1, Bracket)	1
7	Support (2, Bracket)	1
8	Hose (upper, WP)	1
9	Hose (lower, WP)	1
10	Adaputor (Drain)	1
11	Hose (Drain)	1
12	Plug	1
13	Rubber washer	1

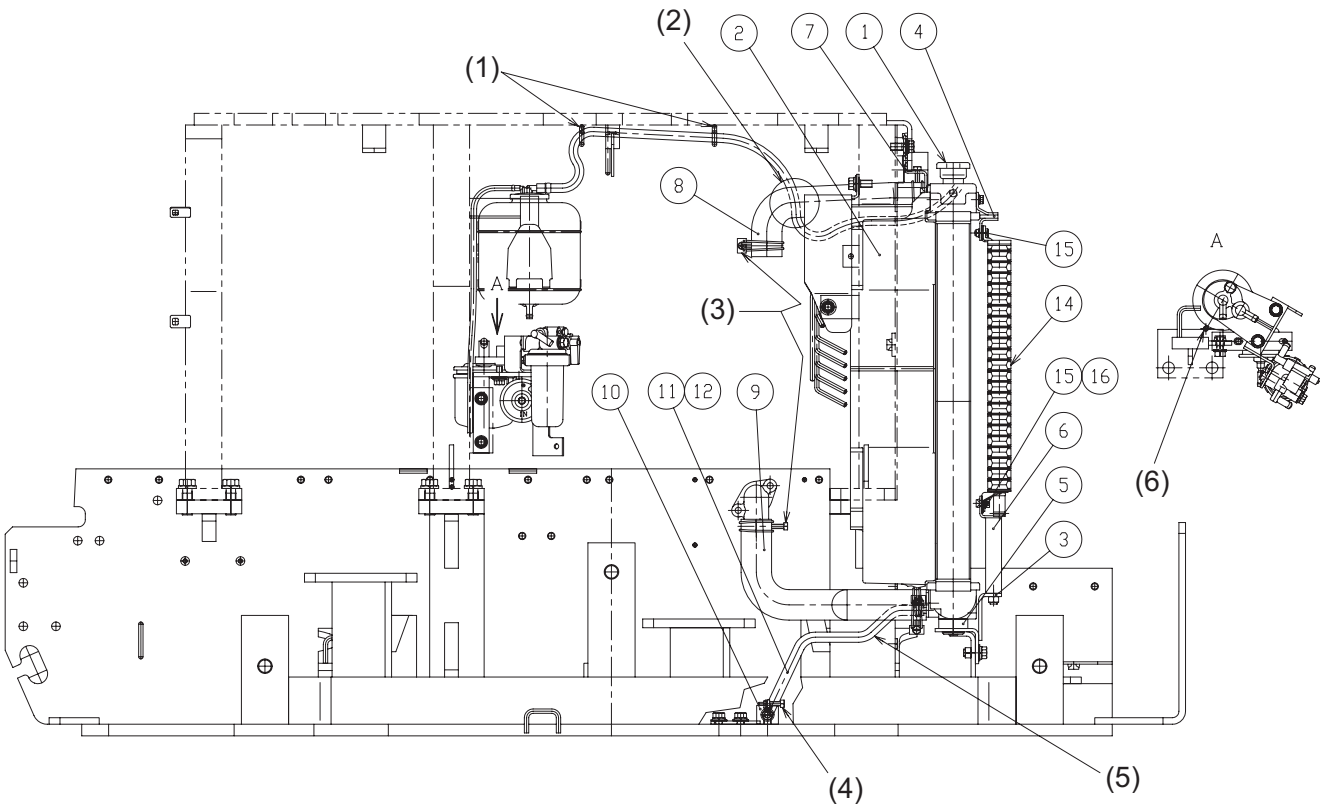
(14) Clamp with upper water pipe.
Never contact with fan.
(15) Reserve tank connecting hose should go through in the tank.
(16) Go through in the hose.
(17) Band
15108-7287Δ x 4
(18) Hose clamp (Screw type 14)
6C040-5872 x 2
(19) Drain hose to go under water pipe.



Radiator and relevants: KX121-3ST

(1) Fitting of the radiator hoses
Tightening torque: 3.9 ~ 4.9 N·m (0.40 ~ 0.50 kgf·m) 2.89 ~ 3.62 ft·lbs

<Failure case>
Insufficient tightness
↓
Hose loose
↓
Water leak



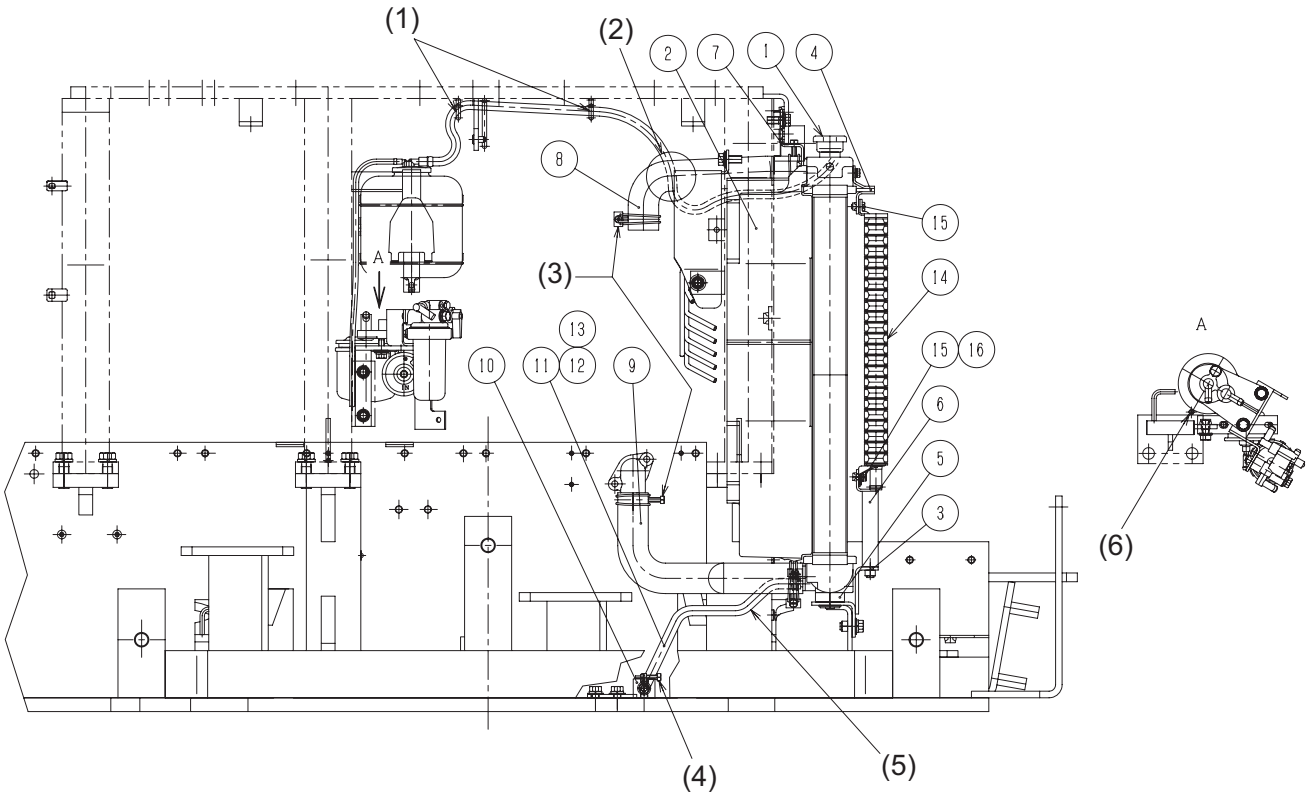
(1) Pass the reserve tank connection hose through these hooks.
(2) Clamp together with the hose (WP, upper).
Keep the hose out of contact with the fan.
(3) Band
(4) Hose clamp (screw-on type, 14)
(5) Pass the drain hose below the WP hose.
(6) Insert the pipe through this clearance.

No	Part name	Q'ty
1	Radiator assembly	1
2	Shroud (fan)	1
3	Bracket (1, radiator)	1
4	Bracket (2, radiator)	1
5	Cushion (radiator)	2
6	Support (1, bracket)	1
7	Support (2, bracket)	1
8	Hose (upper, WP)	1
9	Hose (lower, WP)	1
10	Joint (drain)	1
11	Hose (drain)	1
12	Plug	1
13	Rubber-fitted washer	1
14	Oil cooler (22)	1
15	Bolt	4
16	Plain washer	2

Radiator and relevants: KX161-3α, U45-3α, U45-3ST

(1) Fitting of the radiator hoses
Tightening torque: 3.9 ~ 4.9 N·m (0.40 ~ 0.50 kgf·m) 2.89 ~ 3.62 ft·lbs

<Failure case>
Insufficient tightness
↓
Hose loose
↓
Water leak



(1) Pass the reserve tank connection hose through these hooks.
(2) Pass this hose toward the front of the machine and clamp it together with the hose (WP, upper). Keep the hose out of contact with the fan.
(3) Band
(4) Hose clamp (screw-on type, 14)
(5) Pass the drain hose below the WP hose.
(6) Insert the pipe through this clearance.

No	Part name	Q'ty
1	Radiator assembly	1
2	Shroud (fan)	1
3	Bracket (1, radiator)	1
4	Bracket (2, radiator)	1
5	Cushion (radiator)	2
6	Support (1, radiator)	1
7	Support (2, radiator)	1
8	Hose (upper, WP)	1
9	Hose (lower, WP)	1
10	Joint (drain)	1
11	Hose (drain)	1
12	Plug	1
13	Rubber-fitted washer	1
14	Oil cooler (22)	1
15	Bolt	4
16	Plain washer	2

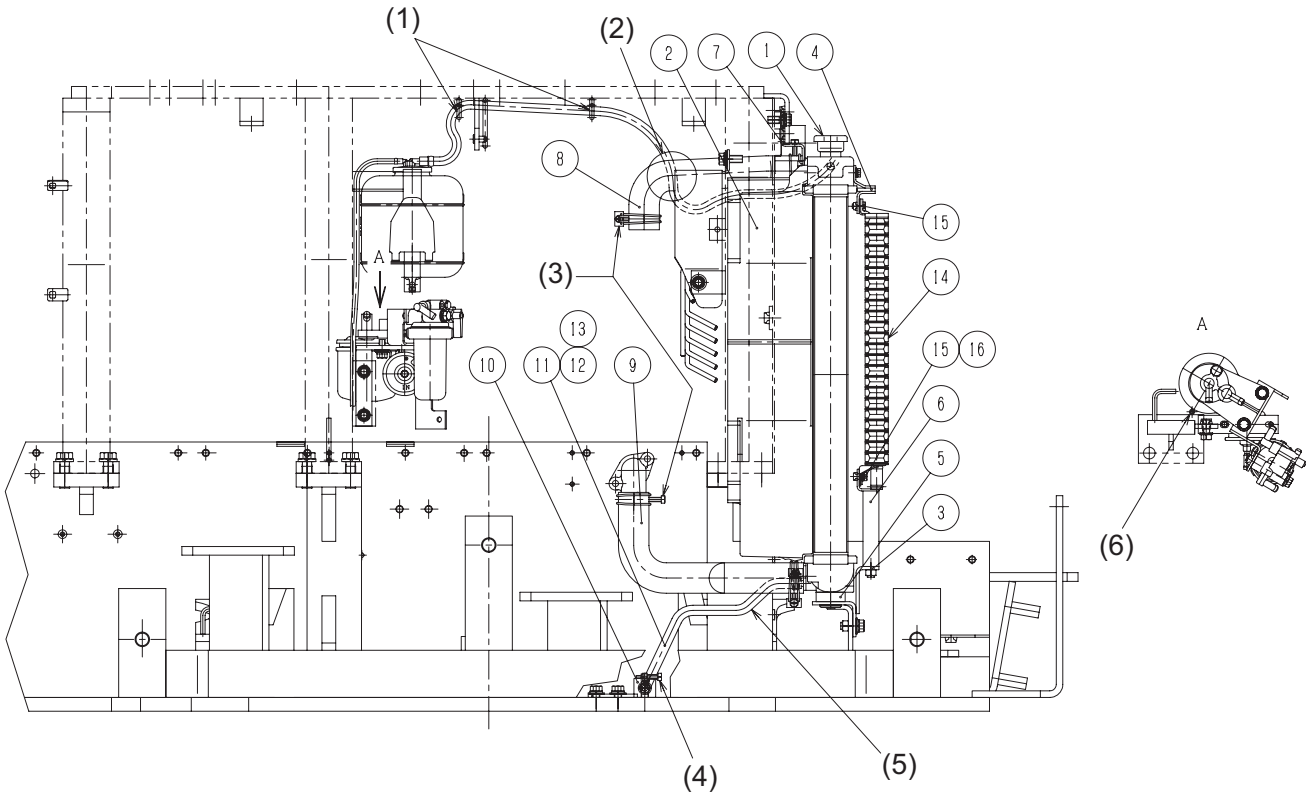
Radiator and relevants: KX161-3ST, U45ST

(1) Fitting of the radiator hoses

Tightening torque: 3.9 ~ 4.9 N·m (0.40 ~ 0.50 kgf·m) 2.88 ~ 3.61 ft·lbs

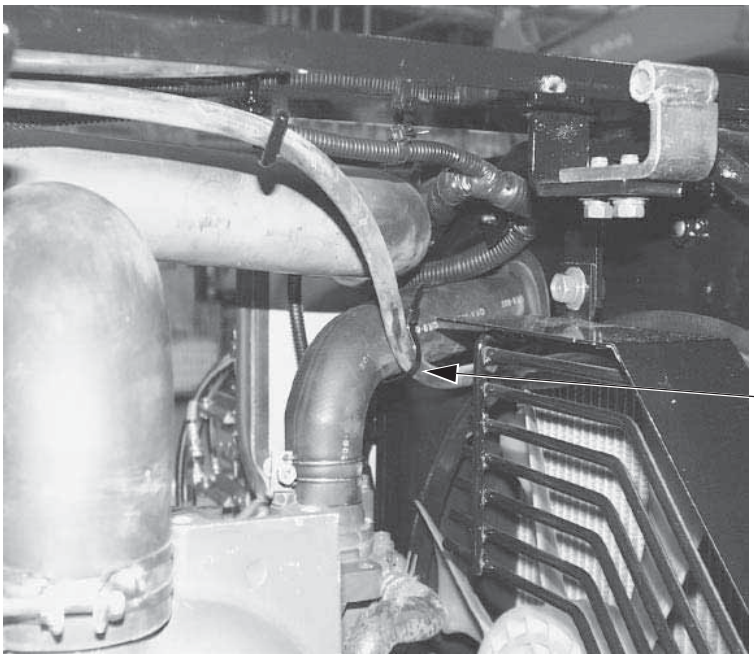
<Failure case>

Insufficient tightness
↓
Hose loose
↓
Water leak

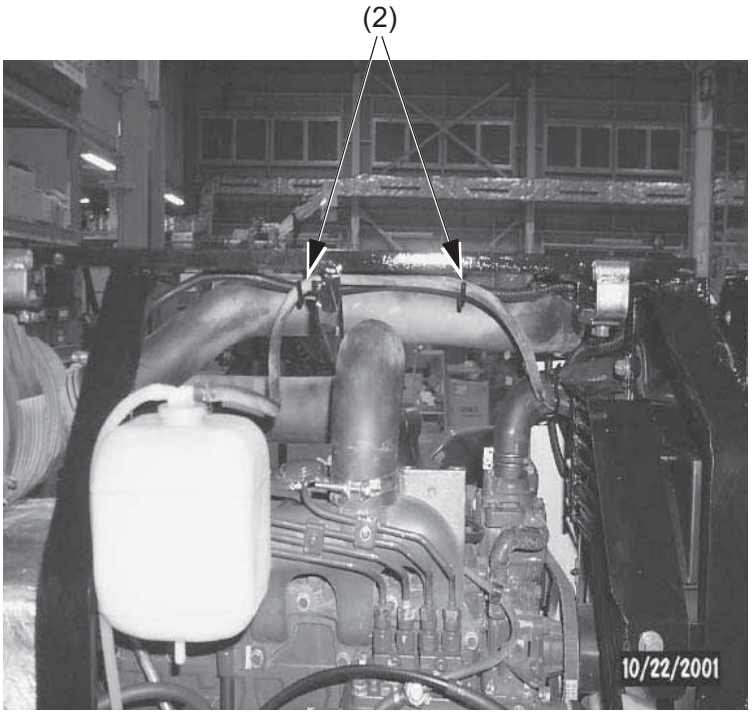


(1) Pass the reserve tank connection hose through these hooks.
(2) Pass this hose toward the front of the machine and clamp it together with the hose (WP, upper). Keep the hose out of contact with the fan.
(3) Band
(4) Hose clamp (screw-on type, 14)
(5) Pass the drain hose below the WP hose.
(6) Insert the pipe through this clearance.

No	Part name	Q'ty
1	Radiator assembly	1
2	Shroud (fan)	1
3	Bracket (1, radiator)	1
4	Bracket (2, radiator, AC)	1
5	Cushion (radiator)	2
6	Support (1, radiator, AC)	1
7	Support (2, radiator)	1
8	Hose (upper, WP)	1
9	Hose (lower, WP)	1
10	Joint (drain)	1
11	Hose (drain)	1
12	Plug	1
13	Rubber-fitted washer	1
14	Oil cooler (24)	1
15	Bolt	4
16	Plain washer	2
17	Support (condenser)	1
18	Bolt	4



(1) Clamp



(2) Go in the hose.

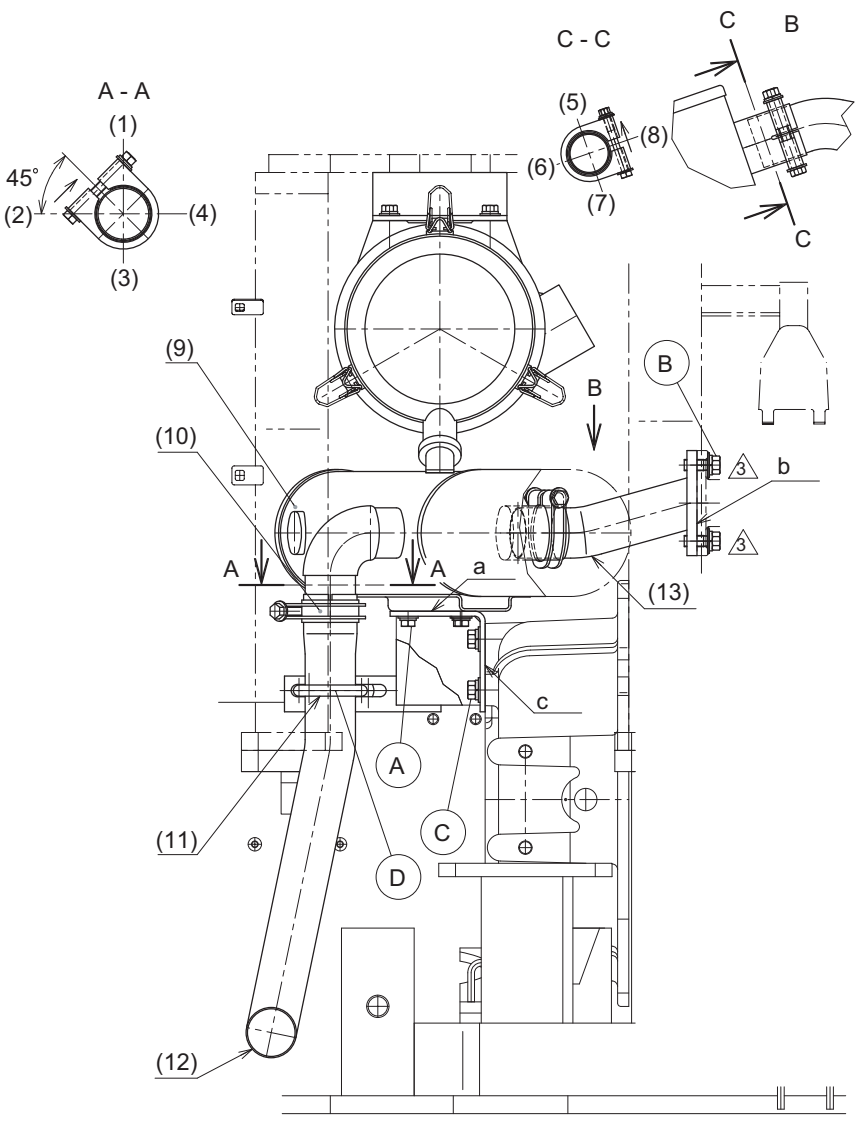
e) Muffler

(1) Clamping the muffler pipe
Tightening torque: 3.9 ~ 5.9 N·m (0.4 ~ 0.6 kgf·m) 2.89 ~ 4.34 ft·lbs

(2) Ensuring the clearance between muffler pipe outlet and weight hole
1/ Clearance to be over 15 mm (0.59 inch)
2/ Tail pipe
3/ Weight
4/ Tail pipe not to stretch out of the weight end

(3) Applying the thermal insulators (1, muffler) (RC411-4246△) and (2, muffler) (RD411-4247△)
Apply the thermal insulator (1, muffler) on both sides of the muffler first and then another thermal insulator (2, muffler).
Finally bind the muffler's both ends with the wires (07811-10984).

(4) Assembling order
*** Temporarily tighten the bolts (A), (B) and (C).**
No gaps at the tightened faces (a, b and c)
*** (A): First to tighten up**
*** (B): Second to tighten up**
*** (C): Third to tighten up**
*** (D): Fourth to tighten up**
Tightening torque: 48.1 ~ 55.9 N·m (4.9 ~ 5.7 kgf·m) 35.4 ~ 41.2 ft·lbs



(1) Front
(2) Left
(3) Rear
(4) Right
(5) Front
(6) Lower
(7) Rear
(8) Upper
(9) Muffler assembly
(10) Muffler pipe band
Bolt
Flat washer x 2
Spring washer
Nut
(See Section A-A for tightening direction.)
(11) Bolt (U)
Nut
Flat washer
(12) Muffler pipe
(13) Muffler flange
Muffler gasket (NA)
Bolt x 2
Pipe band
Bolt
Flat washer x 2
Spring washer
Nut

f) Pump Coupling

(1) Apply grease on spline section
Proper amount to be applied (No overflow allowed)
No grease to be stuck on the rubber
Wipe off grease immediately as required.

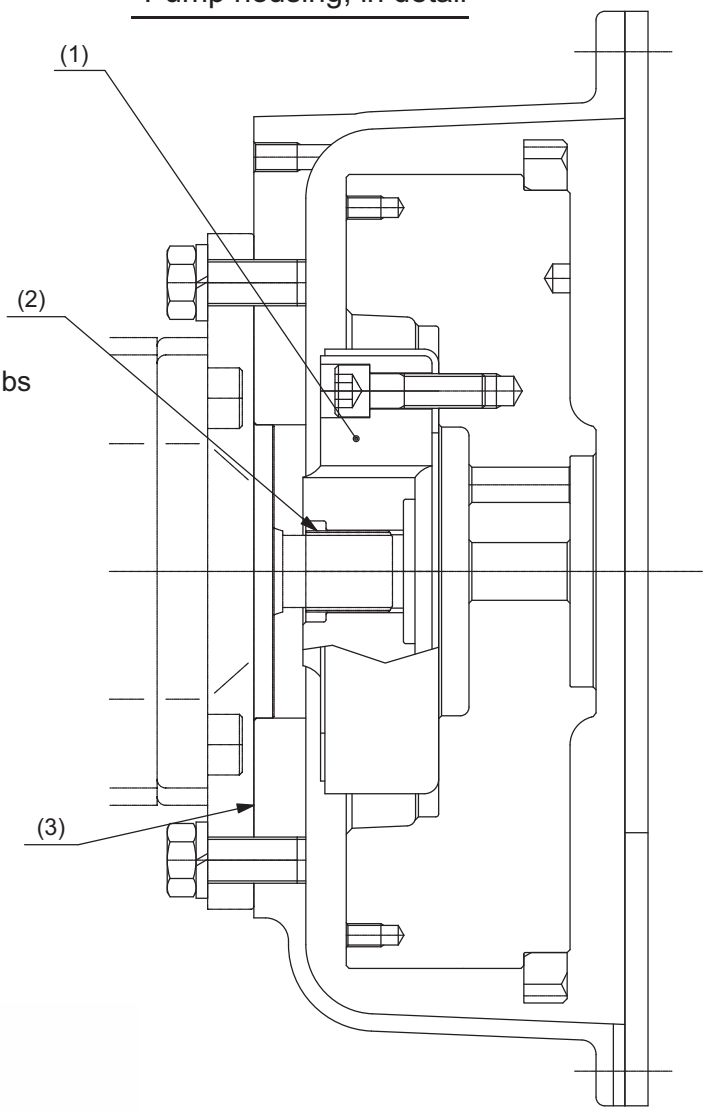
(2) Tighten coupling bolts(RC601-4263△)

A *** Locking/sealing-processed**

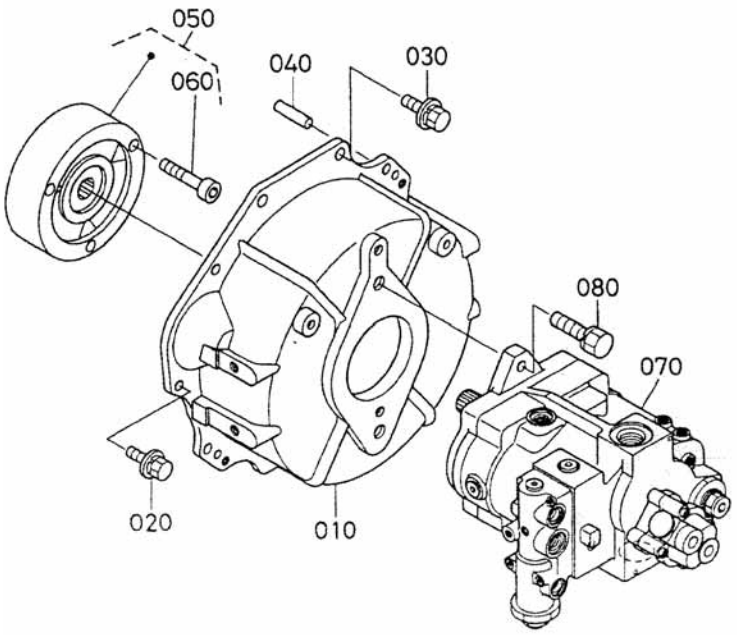
Tightening torque
107 ~ 117N·m (11 ~ 12 kgf·m) 79.6 ~ 86.8 ft·lbs
Do not use screw lock agent.

The bolts are the MEC processed bolt.

Pump housing, in detail



(1) Pump coupling
Bolt (RC601-4263△) 3pcs
(2) Spline section
Apply grease
(3) Pump housing



010	Housing, pump
020	Bolt
030	Bolt
040	Pin, Straight
050	Coupling
060	Bolt, Hex-Soc-HD
070	Assy pump, Piston
080	Bolt

FYI (For Your Information)

Precoat Bolt MEC process

1. Outline

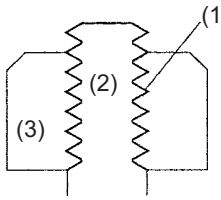
Precoat bolt is a functional part that can provide screws themselves with the features such as sealing, locking, adjusting, and lubricating by coating microencapsulated reactive resin or special blended synthetic resin on the thread part of screws, bolts, plugs, and pipes in advance. Although there were disadvantages such as working time, environmental pollution, spotty coating, inadequate coating, eruption, and delayed hardening expression for liquid-type sealing agents and locking agents previously used at work places to mount screws, in order to resolve these problems precoat bolt was developed with the precoating technology that coats thread part directly in advance.

Precoat bolts have product groups such as sealock process, MEC process, and threelock process from their characteristics, and they have been field-proven in the automotive industry and electronic/electric industry for many years.

In this process, organic solvent is typically used as a diluent solvent for precoat resin, and it is the current situation that this solvent is vaporized in the air during the dry process.
Note: MEC is an abbreviation for microencapsulation.

2. Hardening mechanism

The resistance when the screw is fastened ruptures the microcapsules and the adhesives in the microcapsules ooze out. Those adhesives harden in short period of time at room temperature, and demonstrate the adhesive strength.



(1) The microcapsule is ruptured.
(2) Bolt
(3) Nut

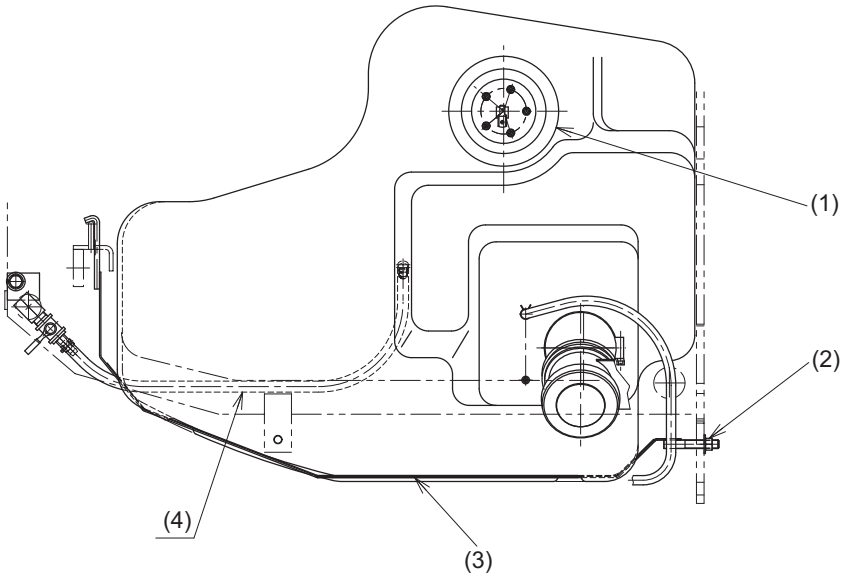
g) Fuel Tank Installation

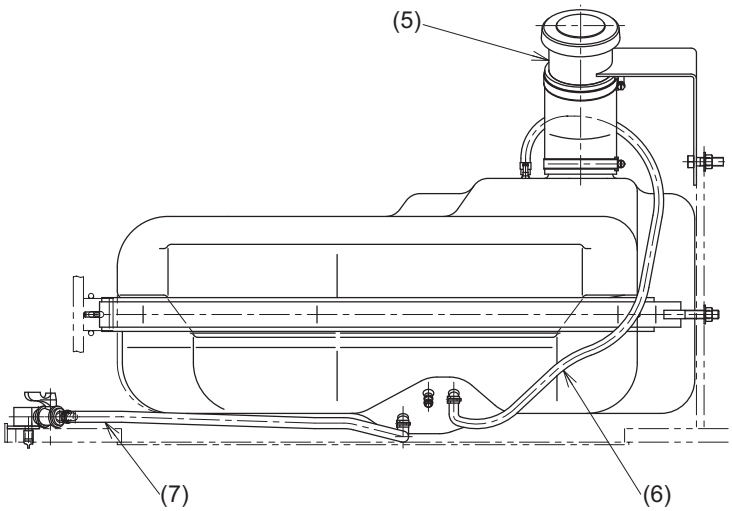
(1) Fuel sensor assembly (RD411-5114△)
Tightening torque: 3 ~ 4 N·m (0.3 ~ 0.4 kgf·m) 2.17 ~ 2.89 ft·lbs

(2) Hose (Fuel, RD411-5118△)
Hose clamp (77 - 95, 69284-6317△)
Tightening torque
- Pipe upper: 4.9 ~ 5.9 N·m (0.5 ~ 0.6 kgf·m) 3.62 ~ 4.34 ft·lbs
- Tank lower: 2.9 ~ 3.9 N·m (0.3 ~ 0.4 kgf·m) 2.17 ~ 2.89 ft·lbs

(3) Fitting of the fuel tank assembly
In setting up the tank, make sure the fuel tube (09664-80500) is not caught by the swivel frame (RD138-4111△).

(4) Fitting of the drain cock (RD431-5131△)
Keep the cock closed for shipment.
(Fit it at the angle specified in the figure.)





(1) Fuel sensor
Spring washer
Nut
(2) Anti-rotation nut
Flat washer
(3) Fuel tank band assembly
(4) Be careful not to get the hose caught between the swivel frame and fuel tank.
(5) Fuel pipe
Fuel hose
Hose clamp (77-95)
Fuel cap assembly
Flat washer
Anti-rotation nut
(6) Fuel tube (dummy)
Hose clamp (spring-loaded, 10.5): at the tank top
Pipe clip: at the tank bottom
(7) Fuel tube
Pipe clip: at the tank side
Drain cock
Drain cock pipe joint
Hose clamp (spring-loaded): at the joint side
Drain plug
Bolt

Fuel tank assembly
KX121-3ST/α: RD138-5110△
KX161-3ST/α: RD538-5111△

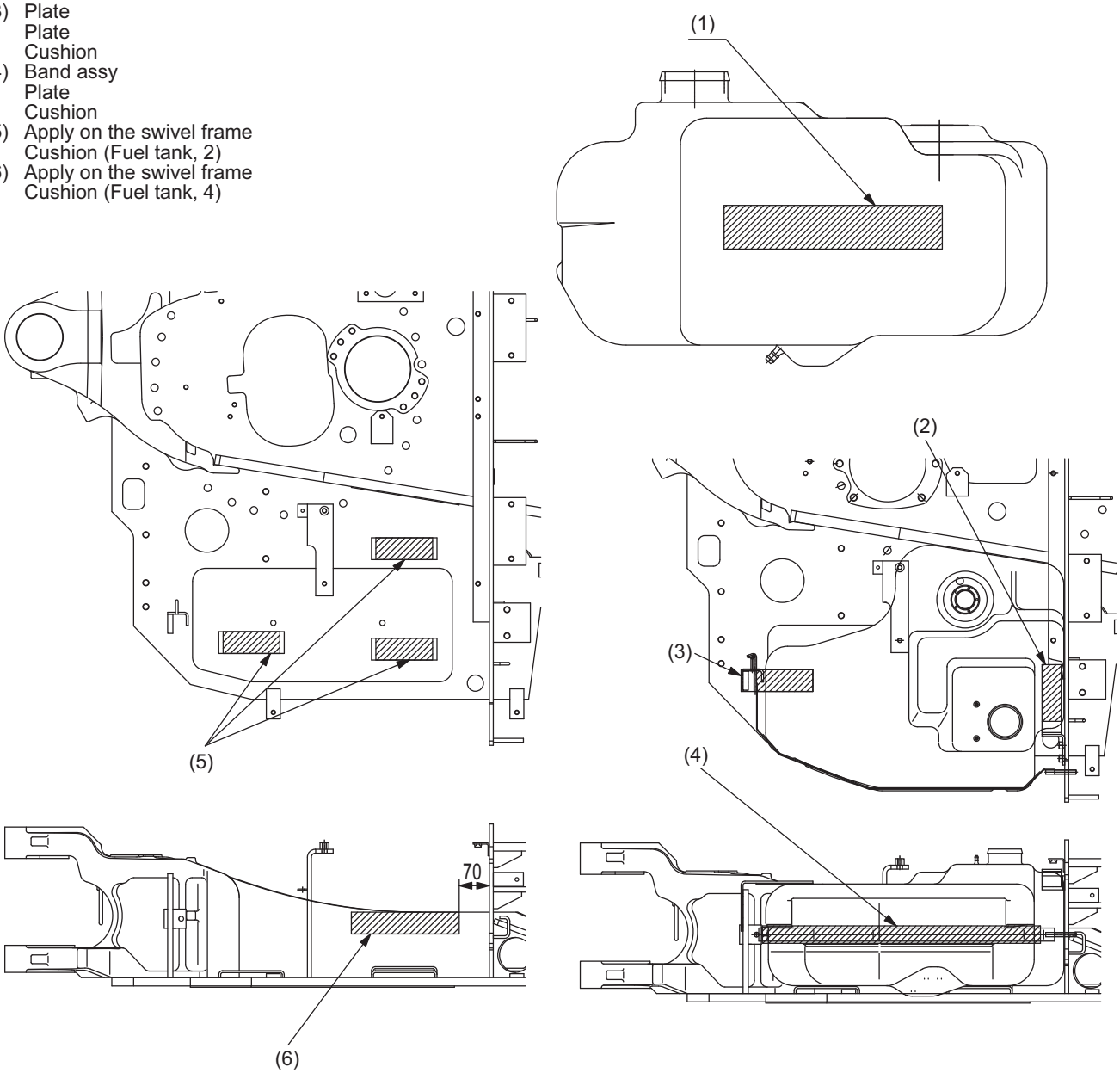
h) Fuel Tank Cushion

(1) Cushion application

Apply the cushion in place.

* Clean up the cushion before being applied.

(1) Apply on the fuel tank
Cushion (Fuel tank, 4)
(2) Plate
Plate
Cushion
(3) Plate
Plate
Cushion
(4) Band assy
Plate
Cushion
(5) Apply on the swivel frame
Cushion (Fuel tank, 2)
(6) Apply on the swivel frame
Cushion (Fuel tank, 4)



i) Fuel Hoses

(1) S Fuel hose route

No contact with sharp edge, hot surface and moving part
No clamping between the fuel hose and electrical cables
Over-tightness and local slack not allowed
Hose not to be flattened
* Be careful when clamping the hose.
Specified dimensions to be strictly followed

(2) Protection tube

Hose Length should be securely correct.

(3) Orifice should be in T-joint

KX121-3S/α, KX161-3α, U45-3α, U50-3α, U45-3S

Fuel tube	Length	Protect-tube L
(A)	2200 mm (09664-82200)	2000 mm (RC301-5141△)
(B)	280 mm (09664-80280)	-
(C)	280 mm (09664-80280)	-
(D)	320 mm (09664-80320)	240 mm (RD138-5146△)
(E)	320 mm (09664-80320)	240 mm (RD138-5146△)
(F)	800 mm (09664-80800)	705 mm (68841-5131△)
(G)	240 mm (09664-40240)	200 mm (RD138-5148△)
(H)	2000 mm (09664-42000)	1900 mm (RD138-5149△)

Hose clamp
(A)(B)(C)(D)(E)(F) → Pipe clip 14911-4275△
(G)(H) → Pipe clip 14971-4275△

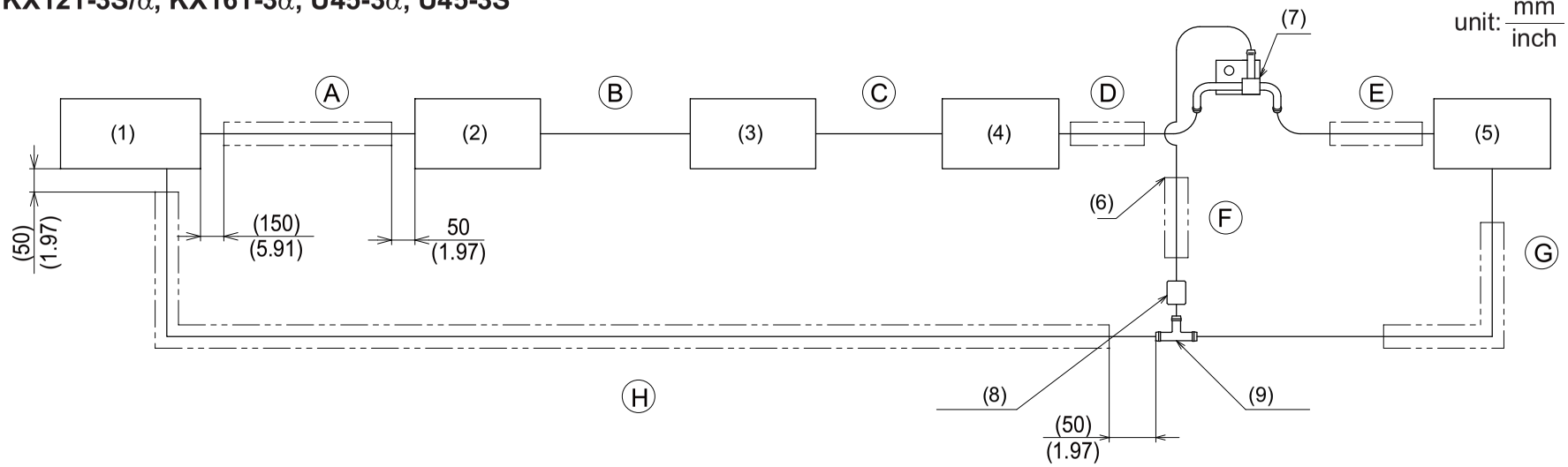
KX161-3S, U45S

Fuel tube	Length	Protect-tube L	
(A)	2200 mm (09664-82200)	2000 mm (RD411-5141△)	
(B)	280 mm (09664-80280)	-	
(C)	280 mm (09664-80280)	-	
(D)	320 mm (09664-80320)	240 mm (RD138-5146△)	
(E)	320 mm (09664-80320)	240 mm (RD138-5146△)	
(F)	800 mm (09664-80800)	705 mm (68841-5131△)	
(G)	240 mm (09664-40240)	200 mm (RD138-5148△)	
(H)	3000 mm (09664-43000)	1450 mm (RD538-5155△)	1450 mm (KX161-3 ST, U45ST)
(I)	1450 mm (09664-41450)	1350 mm (RD538-5154△)	

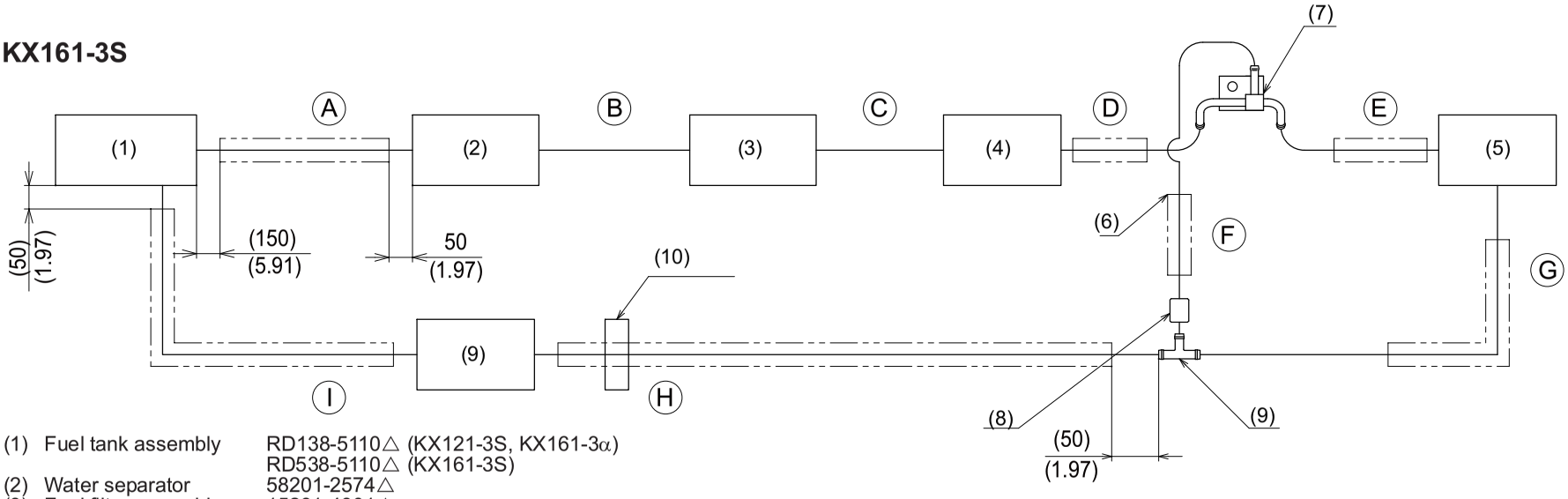
Hose clamp
(A)(B)(C)(D)(E)(F) → Pipe clip 14911-4275△
(G)(H)(I) → Pipe clip 14971-4275△

KX121-3S/α, KX161-3α, U45-3α, U45-3S

unit: mm / inch

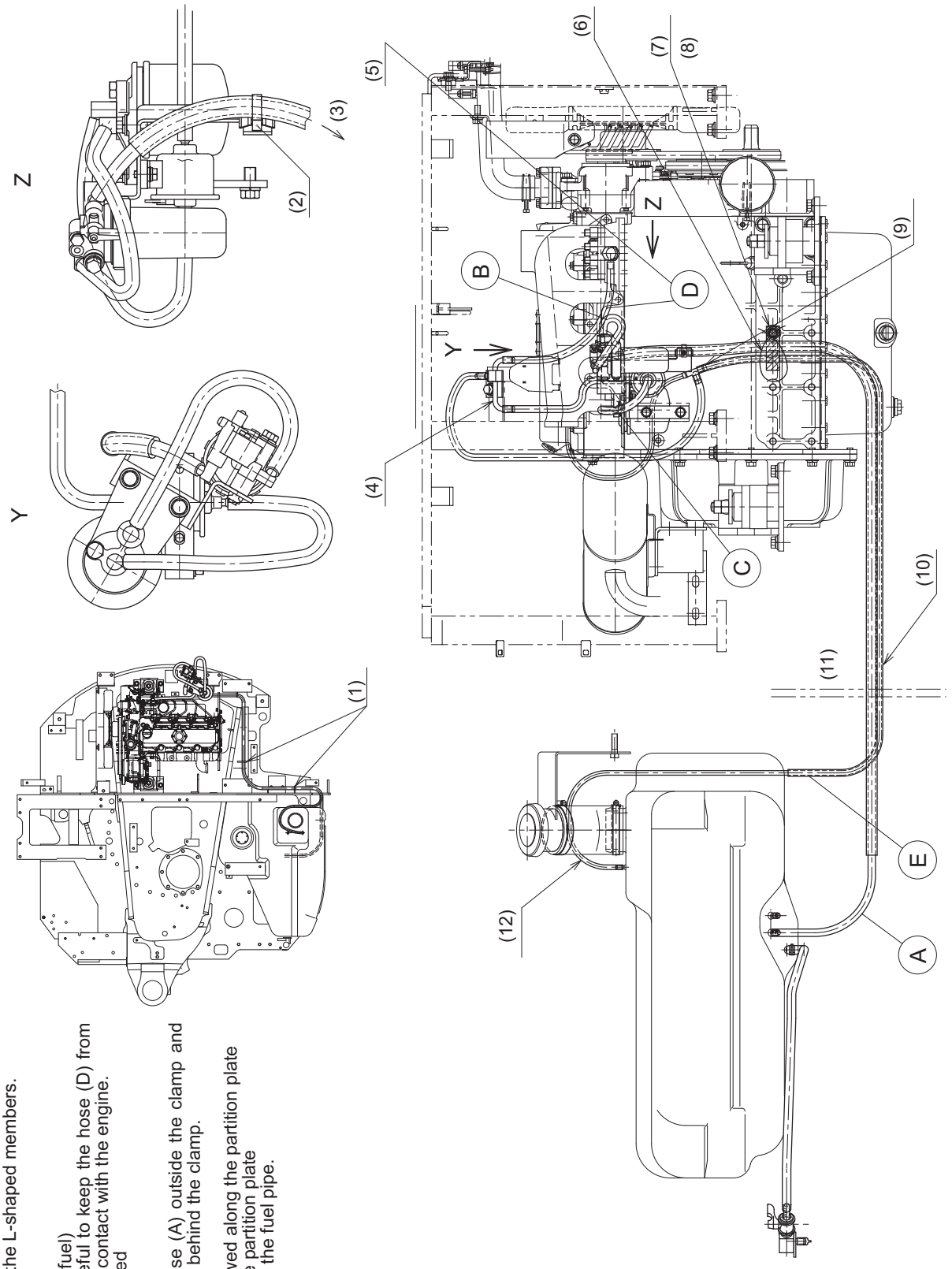


KX161-3S



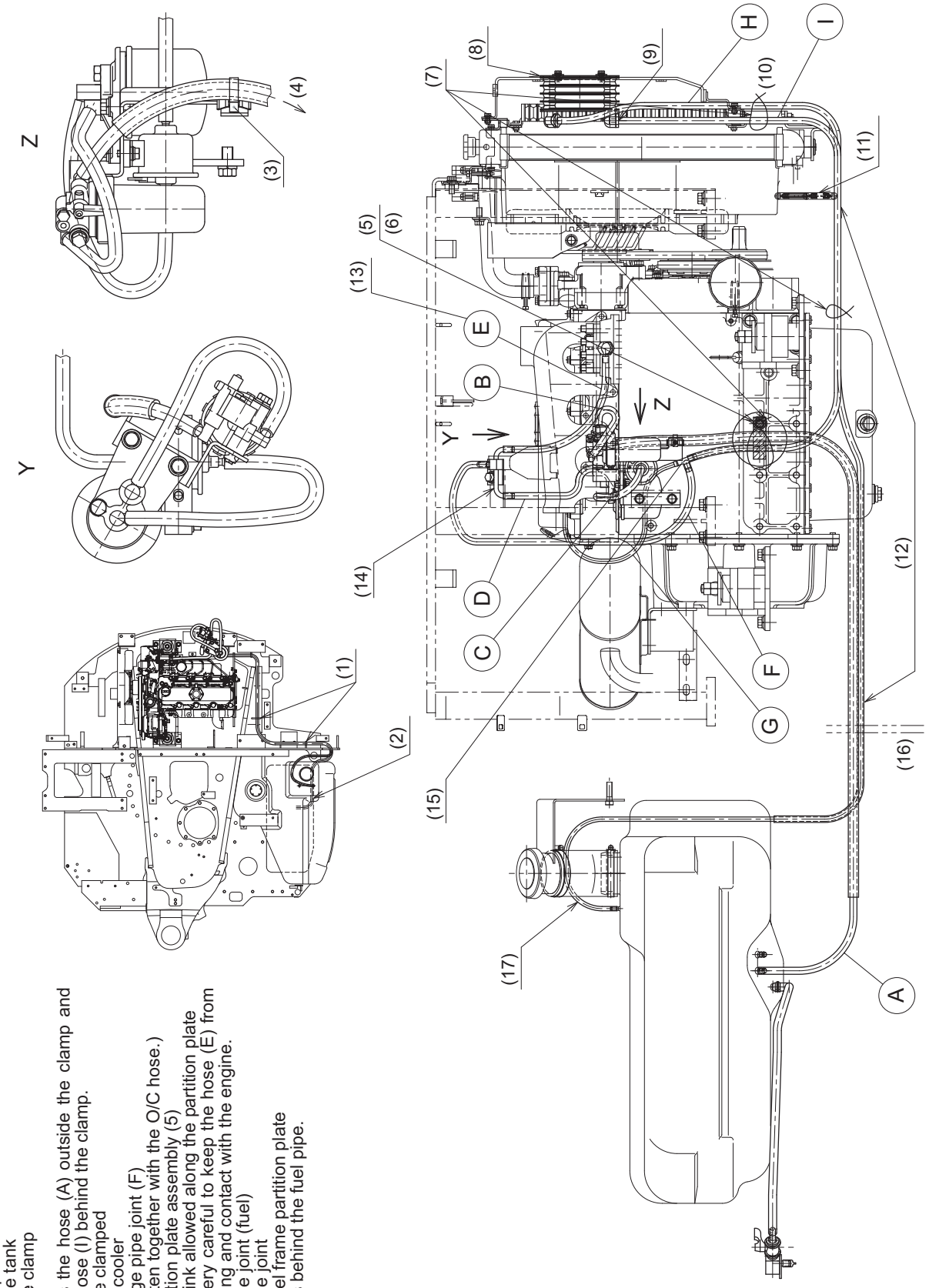
(1)	Fuel tank assembly	RD138-5110△ (KX121-3S, KX161-3α) RD538-5110△ (KX161-3S)
(2)	Water separator	58201-2574△
(3)	Fuel filter assembly	15291-4301△
(4)	Fuel pump	RD411-5135△
(5)	Engine	
(6)	Taping	
(7)	T pipe joint (fuel)	RD138-5139△
(8)	Orifice	RC441-5117△
(9)	T pipe joint	17454-4236△
(10)	Fuel cooler	RD538-5150
(11)	Red tape	

(4) Routes of fuel supply and return hoses



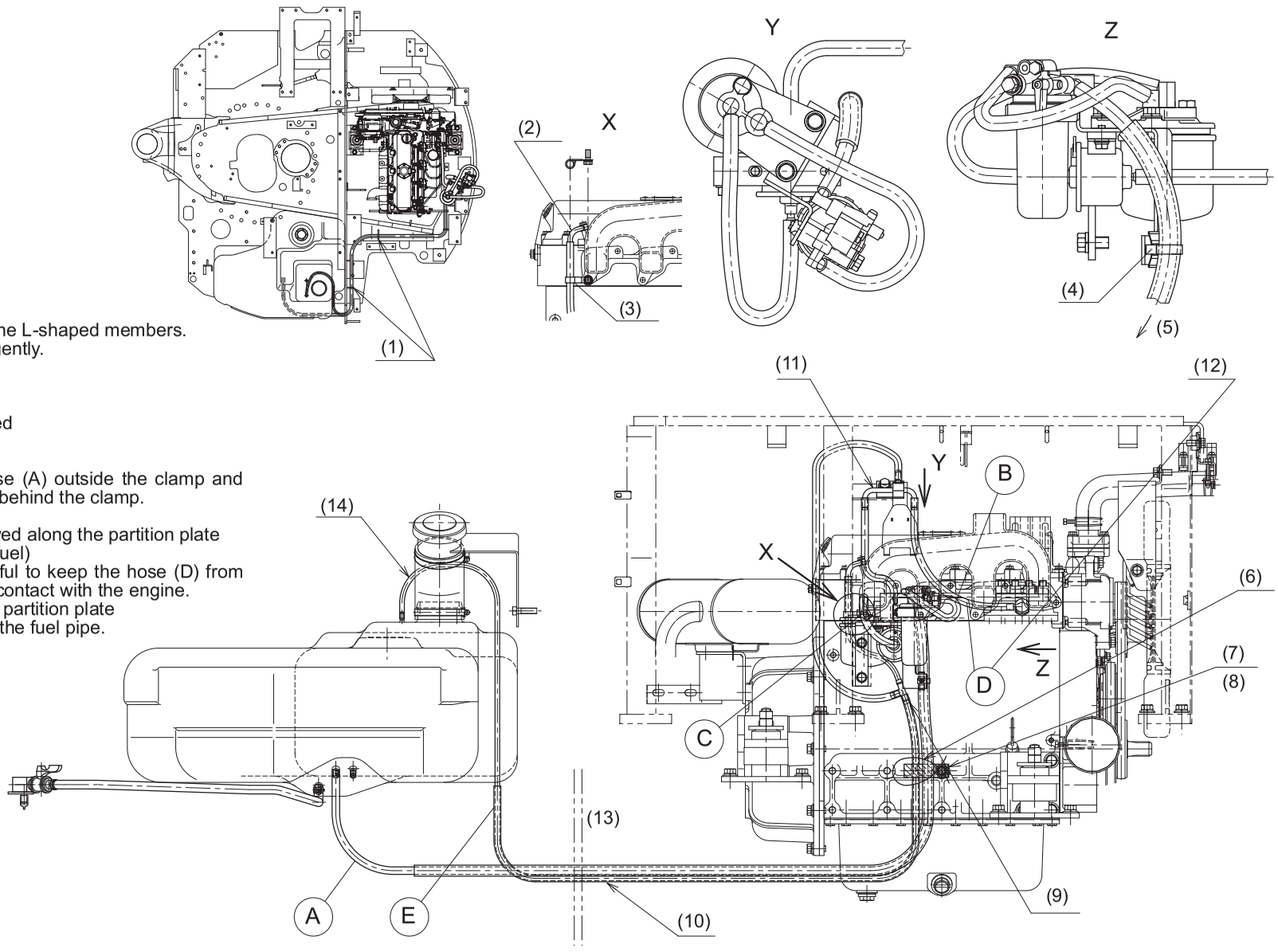
KX161-3α, U45-3α, U50-3α, U45-3S

(1) Hook along the L-shaped members.
(2) Clamp
(3) To the tank
(4) T pipe joint (fuel)
(5) Be very careful to keep the hose (D) from twisting and contact with the engine.
(6) To be clamped
(7) Hose clamp
(8) Bolt
(8) Pass the hose (A) outside the clamp and the hose (E) behind the clamp.
(9) T pipe joint
(10) No kink allowed along the partition plate
(11) Swivel frame partition plate
(12) Pass behind the fuel pipe.

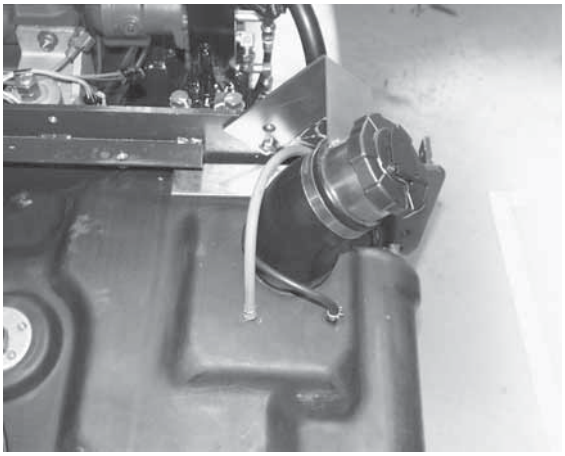


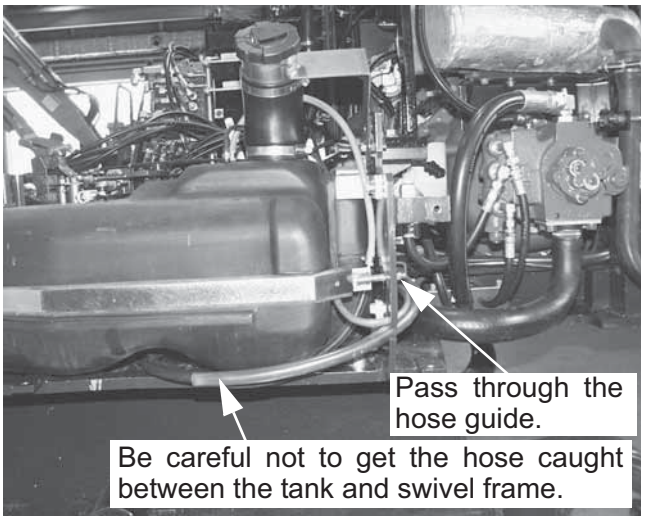
KX161-3S, U45S

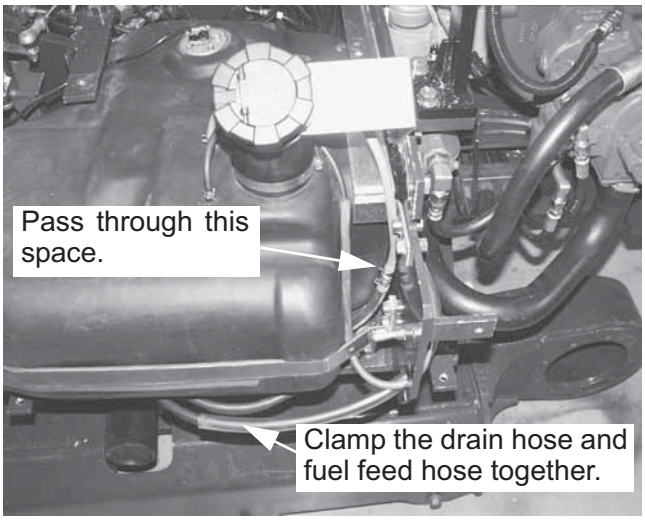
(1) Hook along the L-shaped members.
(2) Lay along in the concave of the swivel frame.
(3) Clamp
(4) To the tank
(5) Hose clamp
Bolt
(6) Pass the hose (A) outside the clamp and the hose (I) behind the clamp.
(7) To be clamped
(8) Fuel cooler
(9) Flange pipe joint (F)
(10) (Fasten together with the O/C hose.)
(11) Partition plate assembly (5)
(12) No kink allowed along the partition plate
(13) Be very careful to keep the hose (E) from twisting and contact with the engine.
(14) T pipe joint (fuel)
(15) T pipe joint
(16) Swivel frame partition plate
(17) Pass behind the fuel pipe.

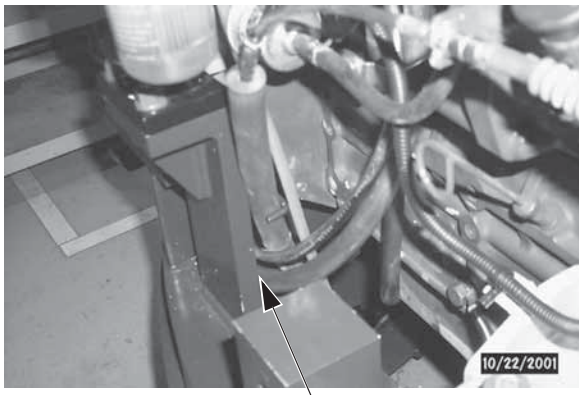


(1) Hook along the L-shaped members.
(2) Bend along gently.
(3) Clamp here.
(4) Clamp
(5) To the tank
(6) To be clamped
(7) Hose clamp
Bolt
(8) Pass the hose (A) outside the clamp and the hose (E) behind the clamp.
(9) T pipe joint
(10) No kink allowed along the partition plate
(11) T pipe joint (fuel)
(12) Be very careful to keep the hose (D) from twisting and contact with the engine.
(13) Swivel frame partition plate
(14) Pass behind the fuel pipe.

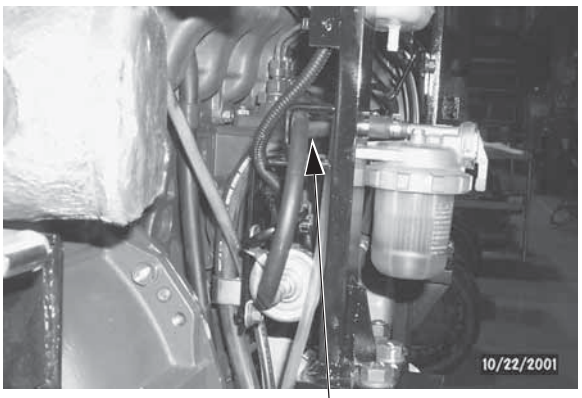



Pass through the hose guide.
Be careful not to get the hose caught between the tank and swivel frame.


Pass through this space.
Clamp the drain hose and fuel feed hose together.

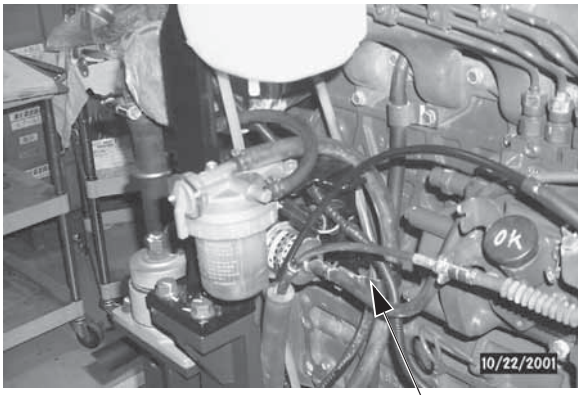


Pass between the acceleration cable and swivel frame.

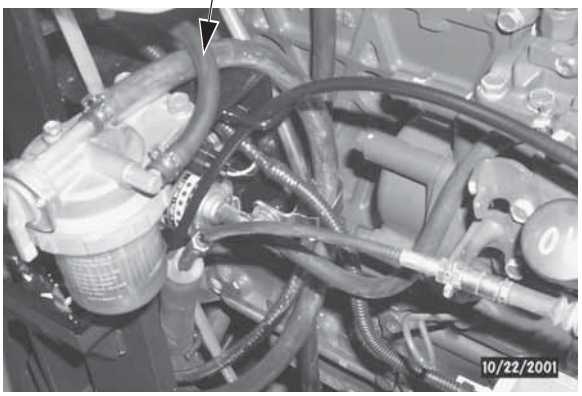


Pass through the guide (do not pass the harness).

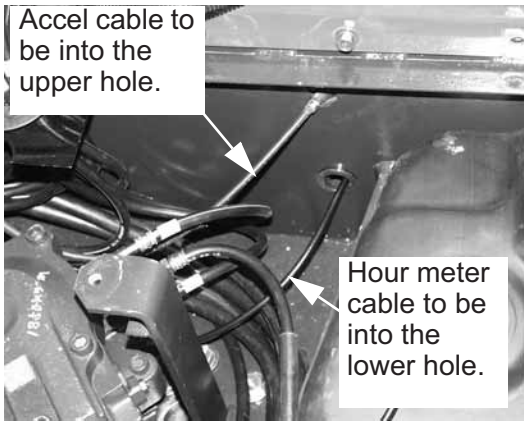
Pay attention to the vertical positioning.

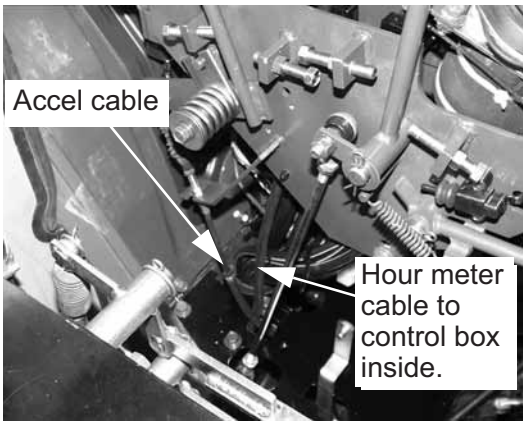


Be sure to fold the clamp tightly.

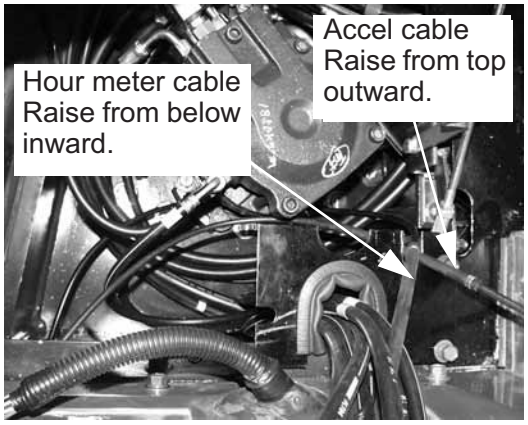


Route of accel cable and hour meter cable (Swivel frame inside)
Swivel frame partition plate

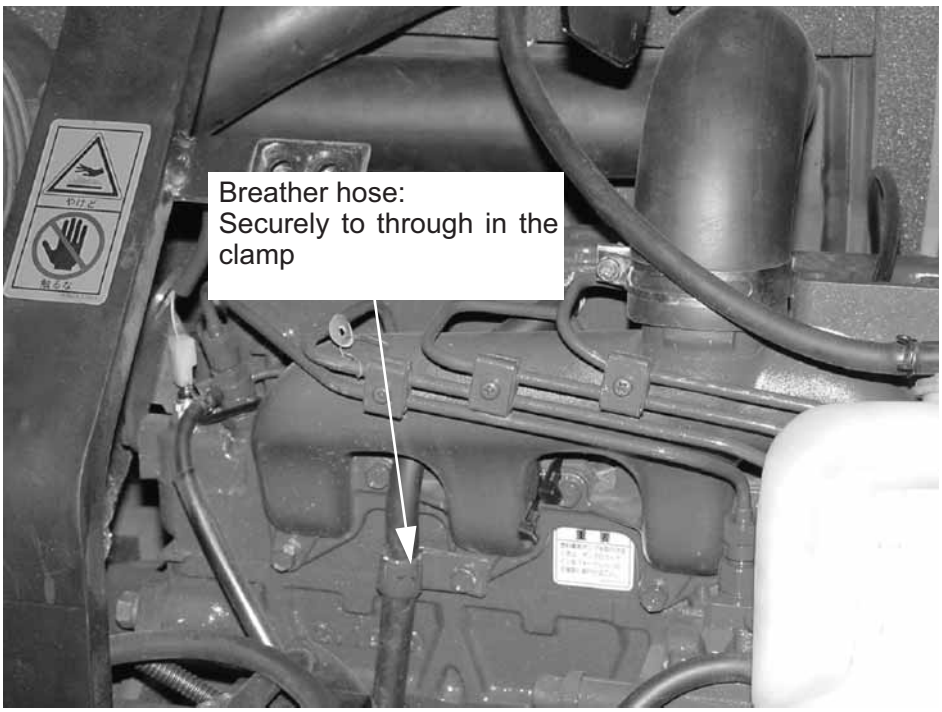




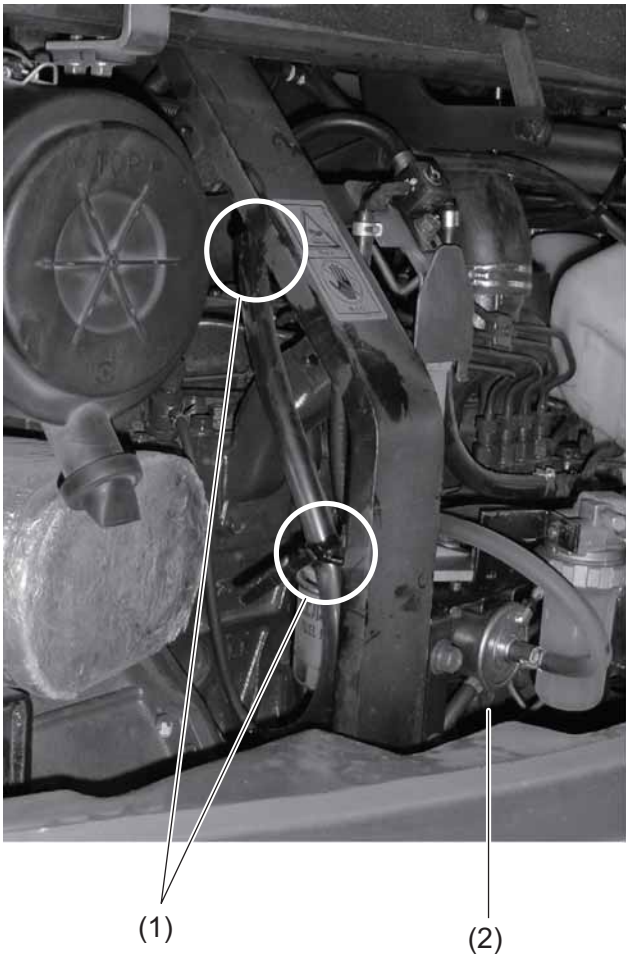
Machine front direction

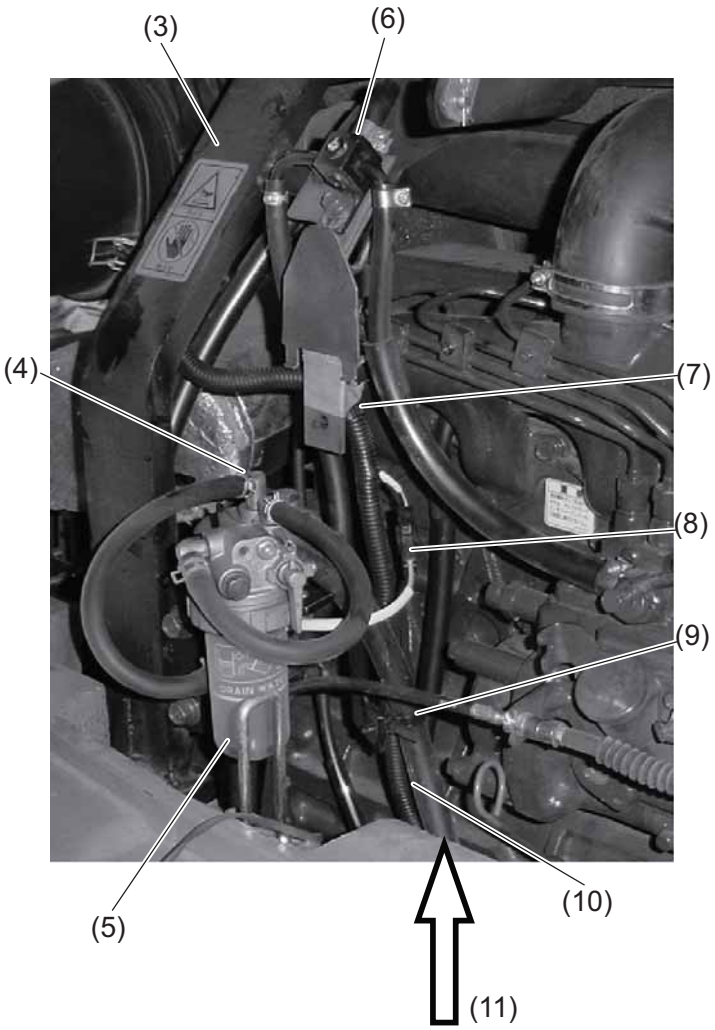


Machine rear direction



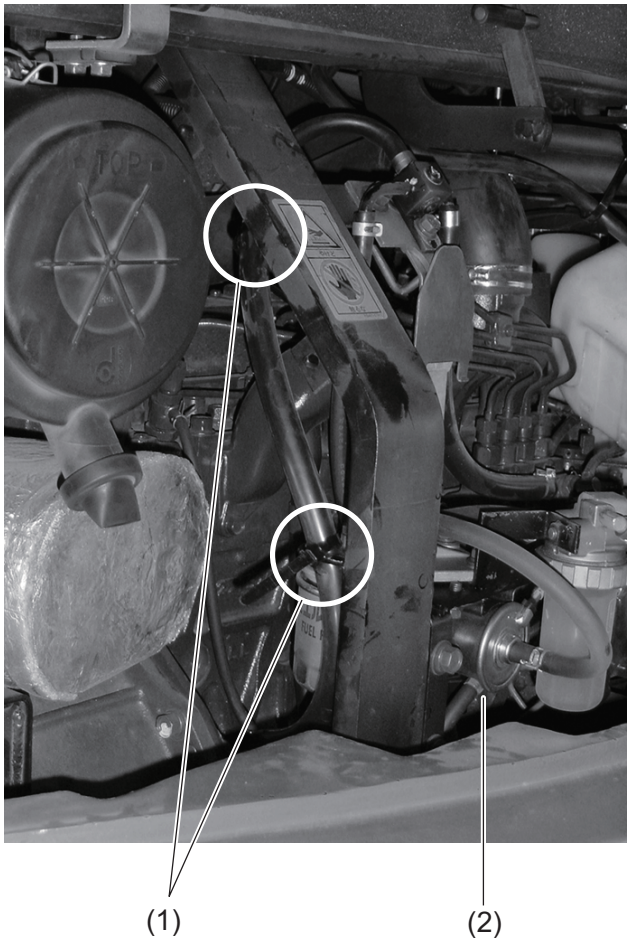
Fuel hose route: KX121-3ST

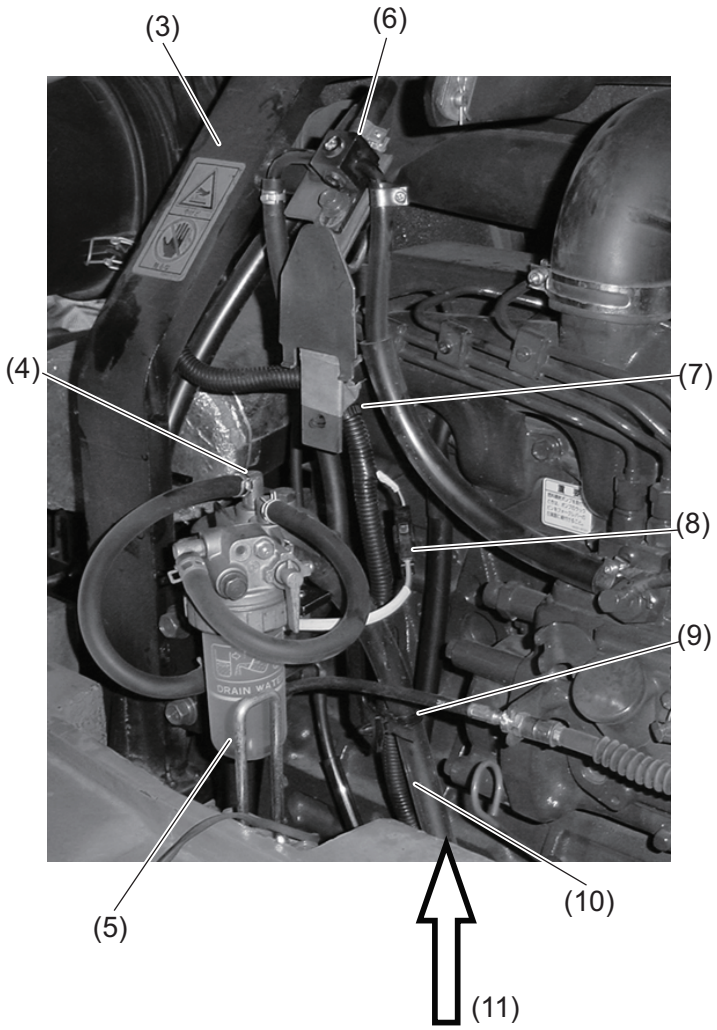




(1) Clamp to the frame (arch)
(2 spots: cord clamp)
(2) Fuel feed pump
(3) Frame (arch)
(4) Fuel filter
(5) Fuel element assy
(6) Pipe joint
(7) Clamp (wire harness)
(8) Clamp (wire harness)
(9) Clamp (fuel filter)
(10) Wiring is at the engine side
(11) from the tank

Fuel hose: KX161-3ST



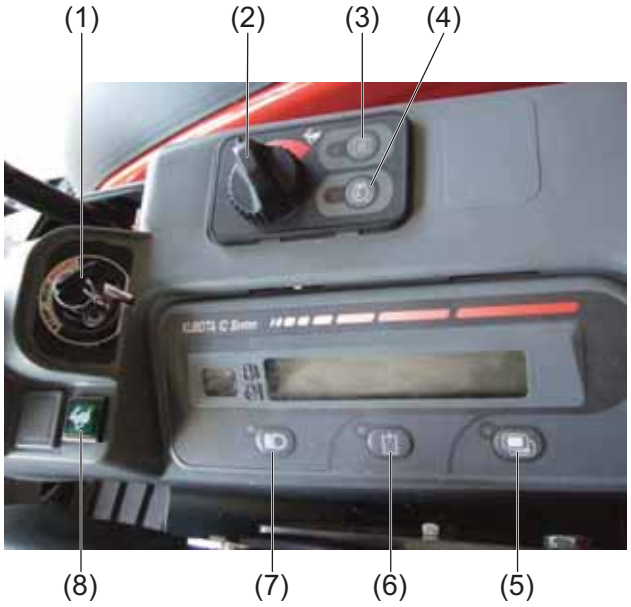


(1) Clamp to the frame (arch)
(2 spots: cord clamp)
(2) Fuel feed pump
(3) Frame (arch)
(4) Fuel filter
(5) Fuel element assy
(6) Pipe joint
(7) Clamp (wire harness)
(8) Clamp (wire harness)
(9) Clamp (fuel filter)
(10) Wiring is at the engine side
(11) from the tank

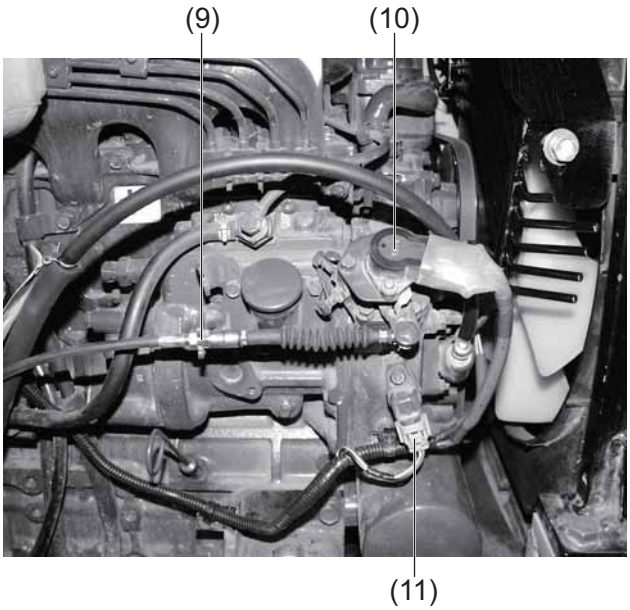
j) Accel Control (AI-version)

1. Engine idling speed: Canopy type: 1100 ± 50 rpm
   Cab type: 1200 ± 50 rpm

2. Engine Max.speed
   Engine side lever should securely come to the Max. stopper to adjust.



(1) Starter switch
(2) Electric accelerator
(3) S/P flow volume setting switch
(4) AI operation switch
(5) Display selector switch
(6) S/P activation switch
(7) Work lamp switch
(8) Travel Hi-Low lamp



(9) Cable to AI motor
(10) Governor sensor
(11) Engine speed sensor

Anti-theft version
Air conditioner version

(4) Accel. cable and governor sensor

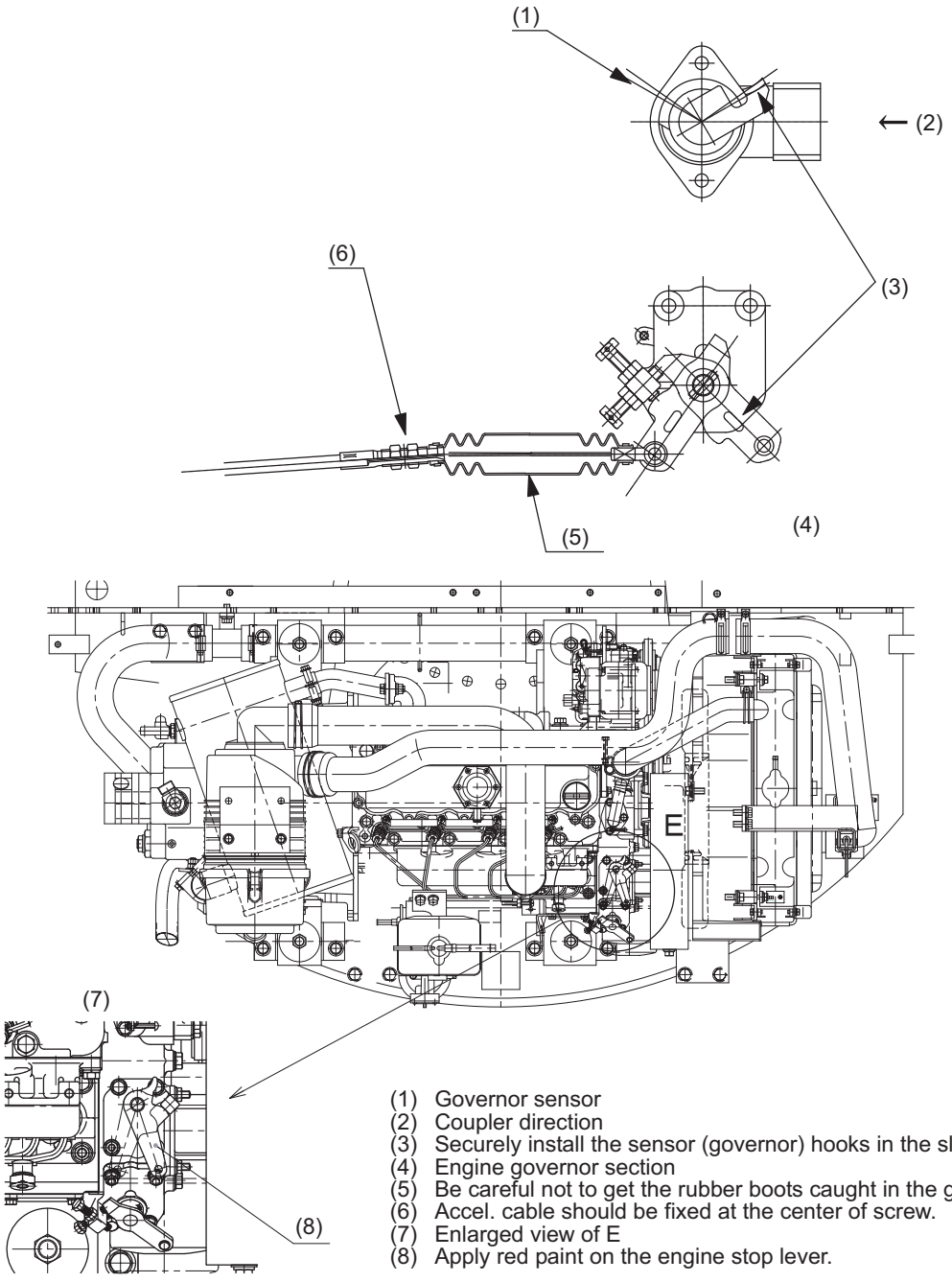
1. **Install accel cable.**
   Fix at the center of screw.

2. **Accel sensor: T1062-3228△**
   No bends or kinks in any part of the circuit.

3. **Governor sensor: T1062-3228△**
   See the illustration.

4. **Mounting bolt: 03024-60412**
   Al-version only
   Tightening torque:
   1.47 ~ 1.96 N·m (0.15 ~ 0.20 kgf·m) 1.08 ~ 1.45 ft·lbs

5. **Handling caution!**
   Do not apply shocks to the sensor (governor) lever area.
   * Do not strike it with the fingers, etc.



(1) Governor sensor
(2) Coupler direction
(3) Securely install the sensor (governor) hooks in the slots in the governor lever.
(4) Engine governor section
(5) Be careful not to get the rubber boots caught in the governor lever.
(6) Accel. cable should be fixed at the center of screw.
(7) Enlarged view of E
(8) Apply red paint on the engine stop lever.

WSM

WORKSHOP MANUAL
DIESEL-ENGINES

03-M-E3B
03-M-DI-E3B
03-M-E3BG

Kubota

Code No.95121-00412

TO THE READER

This Workshop Manual has been prepared to provide servicing personnel with information on the mechanism, service and maintenance of 03-M-E3B, 03-M-DI-E3B and 03-M-E3BG series. It is divided into three parts, “General”, “Mechanism” and “Servicing”.

■ **General**

Information on the engine identification, the general precautions, maintenance check list, check and maintenance and special tools are described.

■ **Mechanism**

Information on the construction and function are included. This part should be understood before proceeding with troubleshooting, disassembling and servicing.

Refer to Diesel Engine Mechanism Workshop Manual (Code No. 9Y021-01875) for the one which has not been described to this workshop manual.

■ **Servicing**

Information on the troubleshooting, servicing specification lists, tightening torque, checking and adjusting, disassembling and assembling, and servicing which cover procedures, precautions, factory specifications and allowable limits.

All information illustrations and specifications contained in this manual are based on the latest product information available at the time of publication.

The right is reserved to make changes in all information at any time without notice.

Due to covering many models of this manual, information or picture being used, have not been specified as one model.

March 2008

© KUBOTA Corporation 2008

This engine WSM has been compiled by Kubota Kikai Service Ltd. in Sakai and the Engine Division. Kubota produces basic standard engine WSM per its series. Adding this WSM to Construction Machinery WSM is to meet requests from the dealers in overseas, which is required when they overhaul and assemble. Engine performance is optimized for each use so that some main data, such as engine output, torque and RPM may differ from basic specifications. About those main specifications, please refer to the data regarding engines mounted on construction machinery at the Chapter III.

Thank you for you understanding and cooperation.

July 2008

SAFETY FIRST

This symbol, the industry's "Safety Alert Symbol", is used throughout this manual and on labels on the machine itself to warn of the possibility of personal injury. Read these instructions carefully.

It is essential that you read the instructions and safety regulations before you attempt to repair or use this unit.

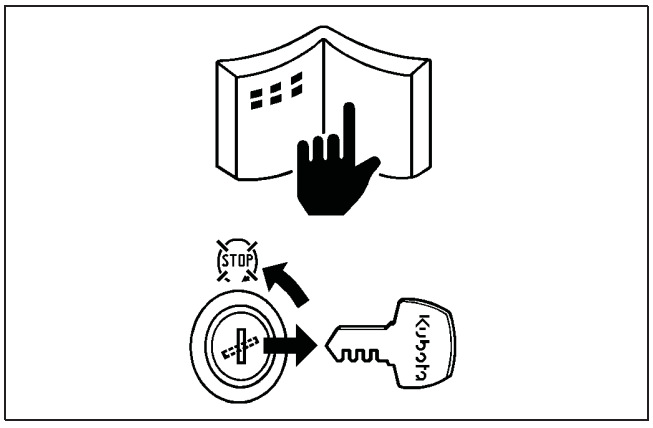
DANGER : Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING : Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION : Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

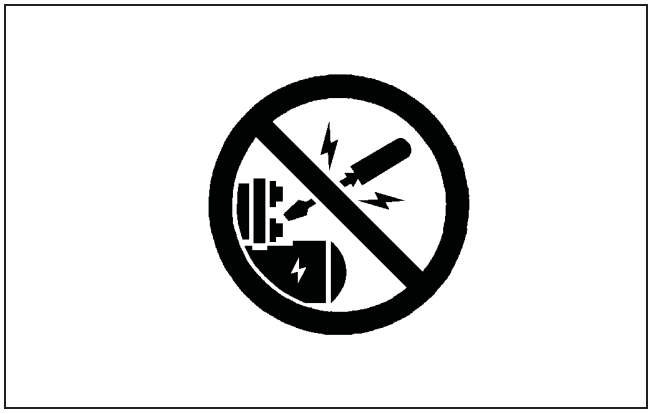
■ IMPORTANT : Indicates that equipment or property damage could result if instructions are not followed.

■ NOTE : Gives helpful information.



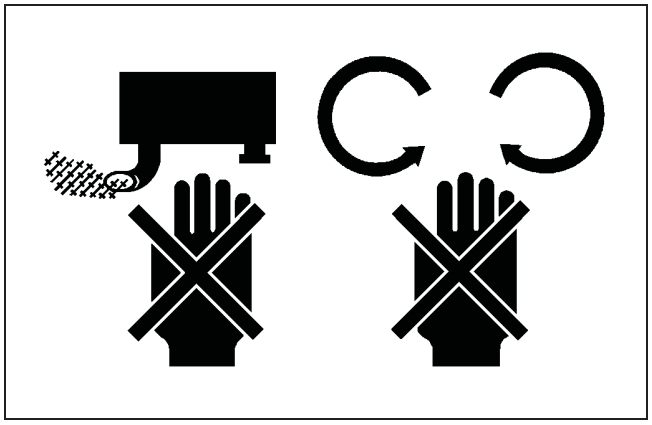
BEFORE SERVICING AND REPAIRING

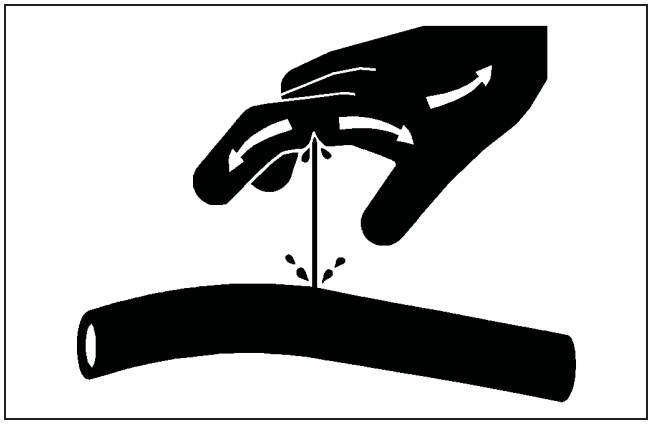
- Read all instructions and safety instructions in this manual and on your engine safety decals.
- Clean the work area and engine.
- Park the machine on a firm and level ground.
- Allow the engine to cool before proceeding.
- Stop the engine, and remove the key.
- Disconnect the battery negative cable.
- Hang a "**DO NOT OPERATE**" tag in operator station.

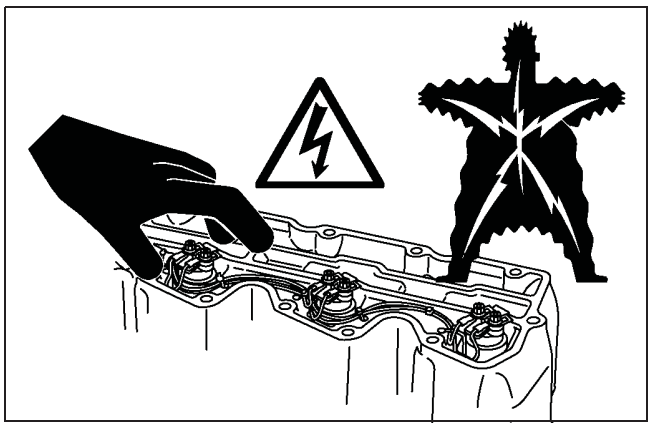


SAFETY STARTING

- Do not start the engine by shorting across starter terminals or bypassing the safety start switch.
- Unauthorized modifications to the engine may impair the function and / or safety and affect engine life.

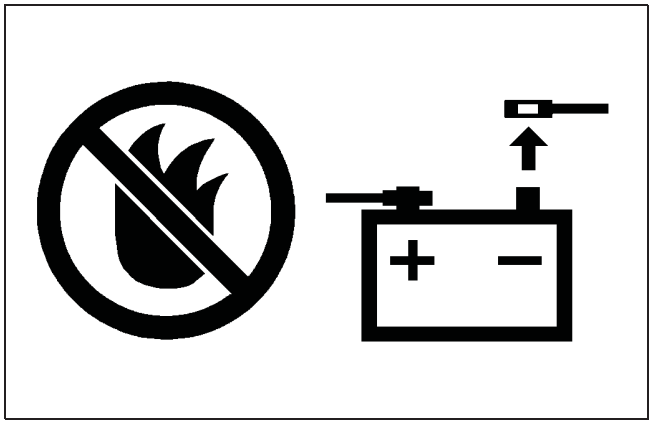






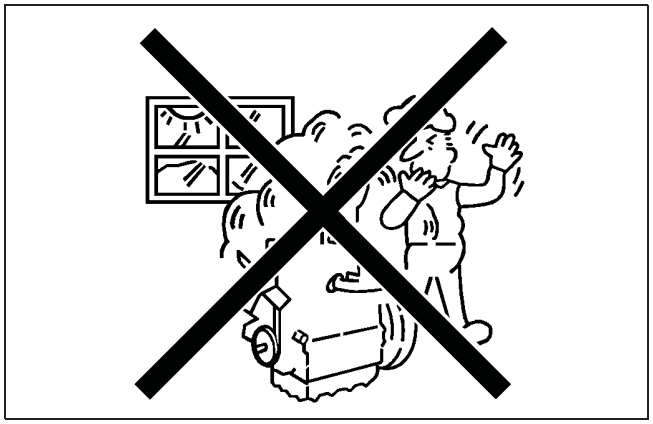
SAFETY WORKING

- Do not work on the machine while under the influence of alcohol, medication, or other substances or while fatigued.
- Wear close fitting clothing and safety equipment appropriate to the job.
- Use tools appropriate to the work. Makeshift tools, parts, and procedures are not recommended.
- When servicing is performed together by two or more persons, take care to perform all work safely.
- Do not touch the rotating or hot parts while the engine is running.
- Never remove the radiator cap while the engine is running, or immediately after stopping. Otherwise, hot water will spout out from radiator. Only remove radiator cap when cool enough to touch with bare hands. Slowly loosen the cap to first stop to relieve pressure before removing completely.
- Escaping fluid (fuel or hydraulic oil) under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting hydraulic or fuel lines. Tighten all connections before applying pressure.
- Wear a suitable hearing protective device such as earmuffs or earplugs to protect against objectionable or uncomfortable loud noises.
- Do not open high-pressure fuel system.
  High-pressure fluid remaining in fuel lines can cause serious injury. Do not disconnect or attempt to repair fuel lines, sensors, or any other components between the high-pressure fuel pump and injectors on engines with high pressure common rail fuel system.
- High voltage exceeding 100 V is generated in the ECU, and is applied to the injector.
  Pay sufficient caution to electric shock when performing work activities.



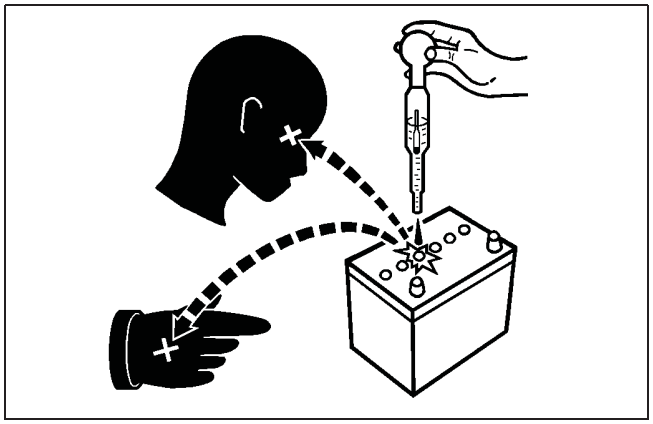
AVOID FIRES

- Fuel is extremely flammable and explosive under certain conditions. Do not smoke or allow flames or sparks in your working area.
- To avoid sparks from an accidental short circuit, always disconnect the battery negative cable first and connect it last.
- Battery gas can explode. Keep sparks and open flame away from the top of battery, especially when charging the battery.
- Make sure that no fuel has been spilled on the engine.



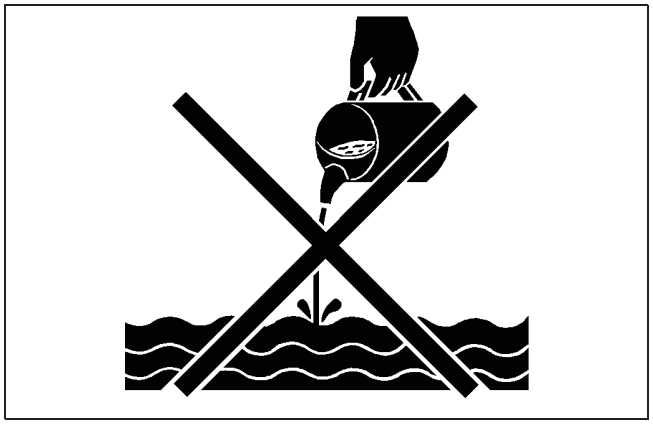
VENTILATE WORK AREA

- If the engine must be running to do some work, make sure the area is well ventilated. Never run the engine in a closed area. The exhaust gas contains poisonous carbon monoxide.



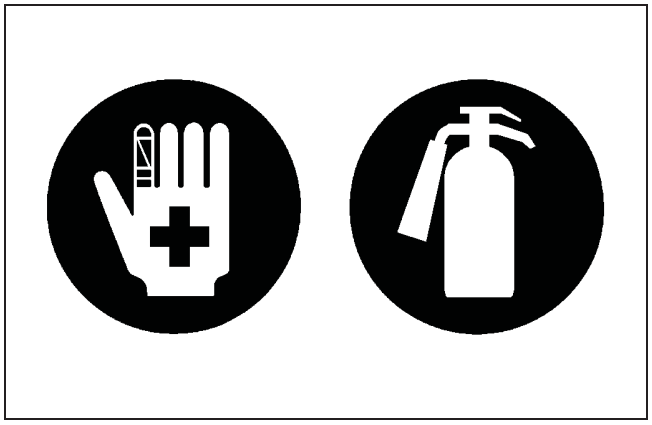
PREVENT ACID BURNS

- Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, clothing and cause blindness if splashed into eyes. Keep electrolyte away from eyes, hands and clothing. If you spill electrolyte on yourself, flush with water, and get medical attention immediately.



DISPOSE OF FLUIDS PROPERLY

- Do not pour fluids into the ground, down a drain, or into a stream, pond, or lake. Observe relevant environmental protection regulations when disposing of oil, fuel, coolant, electrolyte and other harmful waste.



PREPARE FOR EMERGENCIES

- Keep a first aid kit and fire extinguisher handy at all times.
- Keep emergency numbers for doctors, ambulance service, hospital and fire department near your telephone.

SPECIFICATIONS

Model		D1503-M	D1703-M
Number of Cylinders		3	
Type		Vertical, Water-cooled, 4 cycle diesel engine	
Bore × Stroke		83.0 X 92.4 mm (3.27 X 3.64 in.)	87.0 X 92.4 mm (3.43 X 3.64 in.)
Total Displacement		1499 cm^3 (91.47 cu.in.)	1647 cm^3 (100.5 cu.in.)
ISO Net Continuous		19.5 KW / 2800 min^{-1} (rpm) (26.1 HP / 2800 min^{-1} (rpm))	21.2 KW / 2800 min^{-1} (rpm) (28.4 HP / 2800 min^{-1} (rpm))
ISO/SAE Net Intermittent		22.4 KW / 2800 min^{-1} (rpm) (30.0 HP / 2800 min^{-1} (rpm))	24.4 KW / 2800 min^{-1} (rpm) (32.7 HP / 2800 min^{-1} (rpm))
SAE Gross Intermittent		23.8 KW / 2800 min^{-1} (rpm) (31.9 HP / 2800min^{-1} (rpm))	26.1 KW / 2800 min^{-1} (rpm) (35.0 HP / 2800 min^{-1} (rpm))
Maximum Bare Speed		3020 min^{-1} (rpm)	
Minimum Bare Idling Speed		750 to 850 min^{-1} (rpm)	
Combustion Chamber		Spherical Type (E-TVCS)	
Fuel Injection Pump		PFR 3M Type Mini Pump (DENSO)	
Governor		Mechanical all speed governor	
Direction of Rotation		Counter-clockwise (viewd from flywheel side)	
Injection Nozzle		OPD Mini Nozzle (DENSO)	
Injection Timing		0.2662 rad (15.25 °) before T.D.C.	0.2836 rad (16.25 °) before T.D.C.
Firing Order		1-2-3	
Injection Pressure		13.73 MPa (140.0 kgf/cm^2, 1991 psi)	
Compression Ratio		22.8 : 1	22.0 : 1
Lubricating System		Forced Lubrication by Trochoid Pump	
Oil Pressure Indicating		Electrical type switch	
Lubricating Filter		Full flow paper filter (cartridge type)	
Cooling System		Pressurized radiator, forced circulation with water pump	
Starting System		Electric Starting with Starter	
Starting Motor		12 V, 1.2 kW	
Starting Support Device		By glow plug in combustion chamber	
EGR		NONE	
Battery		12 V, 60 AH equivalent	
Charging Alternator		12 V, 360 W	
Fuel		Diesel Fuel No.2-D (ASTM D975)	
Lubricating Oil		Class CF lubricating oil as per API classification is recommended. For details on recommended lubricating oils, see page G-7, 10	
Lubricating Oil Capacity	Oil Pan Depth 90 mm (3.5 in.)	5.6 L (1.5 U.S.gals)	
	Oil Pan Depth 124 mm (4.88 in.)	7.0 L (1.8 U.S.gals)	
Weight (Dry)		148 kg (326 lbs)	

* The specification described above is of the standard engine of each model.
* Conversion Formula : HP = 0.746 kW, PS = 0.7355 kW

W10275180

Model		**D1803-M**
Number of Cylinders		3
Type		Vertical, Water-cooled, 4 cycle diesel engine
Bore × Stroke		87.0 X 102.4 mm (3.43 X 4.031 in.)
Total Displacement		1826 cm^3 (111.4 cu.in.)
ISO Net Continuous		22.8 KW / 2700 min^{-1} (rpm) (30.6 HP / 2700 min^{-1} (rpm))
ISO/SAE Net Intermittent		26.3 KW / 2700 min^{-1} (rpm) (35.3 HP / 2700 min^{-1} (rpm))
SAE Gross Intermittent		27.9 KW / 2700 min^{-1} (rpm) (37.4 HP / 2700 min^{-1} (rpm))
Maximum Bare Speed		3020 min^{-1} (rpm)
Minimum Bare Idling Speed		750 to 850 min^{-1} (rpm)
Combustion Chamber		Spherical Type (E-TVCS)
Fuel Injection Pump		PFR 3M Type Mini Pump (DENSO)
Governor		Mechanical all speed governor
Direction of Rotation		Counter-clockwise (viewd from flywheel side)
Injection Nozzle		OPD Mini Nozzle (DENSO)
Injection Timing		0.2836 rad (16.25 °) before T.D.C.
Firing Order		1-2-3
Injection Pressure		13.73 MPa (140.0 kgf/cm^2, 1991 psi)
Compression Ratio		24.3 : 1
Lubricating System		Forced Lubrication by Trochoid Pump
Oil Pressure Indicating		Electrical type switch
Lubricating Filter		Full flow paper filter (cartridge type)
Cooling System		Pressurized radiator, forced circulation with water pump
Starting System		Electric Starting with Starter
Starting Motor		12 V, 2.0 kW
Starting Support Device		By glow plug in combustion chamber
EGR		NONE
Battery		12 V, 92 AH equivalent
Charging Alternator		12 V, 360 W
Fuel		Diesel Fuel No.2-D (ASTM D975)
Lubricating Oil		Class CF lubricating oil as per API classification is recommended. For details on recommended lubricating oils, see page G-7, 10
Lubricating Oil Capacity	Oil Pan Depth 90 mm (3.5 in.)	5.6 L (1.5 U.S.gals)
	Oil Pan Depth 124 mm (4.88 in.)	7.0 L (1.8 U.S.gals)
Weight (Dry)		151 kg (333 lbs)

* The specification described above is of the standard engine of each model.
* Conversion Formula : HP = 0.746 kW, PS = 0.7355 kW

W10316200

Model		**V2003-M**	**V2203-M**
Number of Cylinders		4	
Type		Vertical, Water-cooled, 4 cycle diesel engine	
Bore × Stroke		83.0 X 92.4 mm (3.27 X 3.64 in.)	87.0 X 92.4 mm (3.43 X 3.64 in.)
Total Displacement		1999 cm^3 (122.0 cu.in.)	2197 cm^3 (134.1 cu.in.)
ISO Net Continuous		26.7 KW / 2800 min^{-1} (rpm) (35.8 HP / 2800 min^{-1} (rpm))	29.6 KW / 2800 min^{-1} (rpm) (39.7 HP / 2800 min^{-1} (rpm))
ISO/SAE Net Intermittent		30.8 KW / 2800 min^{-1} (rpm) (41.3 HP / 2800 min^{-1} (rpm))	34.1 KW / 2800 min^{-1} (rpm) (45.7 HP / 2800 min^{-1} (rpm))
SAE Gross Intermittent		32.6 KW / 2800 min^{-1} (rpm) (43.7 HP / 2800 min^{-1} (rpm))	35.9 KW / 2800 min^{-1} (rpm) (48.1 HP / 2800 min^{-1} (rpm))
Maximum Bare Speed		3020 min^{-1} (rpm)	
Minimum Bare Idling Speed		750 to 850 min^{-1} (rpm)	
Combustion Chamber		Spherical Type (E-TVCS)	
Fuel Injection Pump		PFR 4M Type Mini Pump (DENSO)	
Governor		Mechanical all speed governor	
Direction of Rotation		Counter-clockwise (viewd from flywheel side)	
Injection Nozzle		OPD Mini Nozzle (DENSO)	
Injection Timing		0.2836 rad (16.25 °) before T.D.C.	
Firing Order		1-3-4-2	
Injection Pressure		13.73 MPa (140.0 kgf/cm^2, 1991 psi)	
Compression Ratio		22.8 : 1	22.0 : 1
Lubricating System		Forced Lubrication by Trochoid Pump	
Oil Pressure Indicating		Electrical type switch	
Lubricating Filter		Full flow paper filter (cartridge type)	
Cooling System		Pressurized radiator, forced circulation with water pump	
Starting System		Electric Starting with Starter	
Starting Motor		12 V, 1.4 kW	
Starting Support Device		By glow plug in combustion chamber	
EGR		NONE	
Battery		12 V, 88 AH equivalent	
Charging Alternator		12 V, 480 W	
Fuel		Diesel Fuel No.2-D (ASTM D975)	
Lubricating Oil		Class CF lubricating oil as per API classification is recommended. For details on recommended lubricating oils, see page G-7, 10	
Lubricating Oil Capacity	Oil Pan Depth 90 mm (3.5 in.)	7.6 L (2.0 U.S.gals)	
	Oil Pan Depth 124 mm (4.88 in.)	9.5 L (2.5 U.S.gals)	
Weight (Dry)		180 kg (397 lbs)	

* The specification described above is of the standard engine of each model.
* Conversion Formula : HP = 0.746 kW, PS = 0.7355 kW

W10384770

Model		**V2403-M**	**V2403-M-T**
Number of Cylinders		4	
Type		Vertical, Water-cooled, 4 cycle diesel engine	
Bore × Stroke		87.0 X 102.4 mm (3.43 X 4.031 in.)	
Total Displacement		2434 cm^3 (148.5 cu.in.)	
ISO Net Continuous		30.2 KW / 2700 min^{-1} (rpm) (40.5 HP / 2700 min^{-1} (rpm))	36.4 KW / 2700 min^{-1} (rpm) (48.8 HP / 2700 min^{-1} (rpm))
ISO/SAE Net Intermittent		34.8 KW / 2700 min^{-1} (rpm) (46.7 HP / 2700 min^{-1} (rpm))	41.9 KW / 2700 min^{-1} (rpm) (56.2 HP / 2700 min^{-1} (rpm))
SAE Gross Intermittent		36.5 KW / 2700 min^{-1} (rpm) (48.9 HP / 2700 min^{-1} (rpm))	44.0 KW / 2700 min^{-1} (rpm) (59.0 HP / 2700 min^{-1} (rpm))
Maximum Bare Speed		3020 min^{-1} (rpm)	2950 min^{-1} (rpm)
Minimum Bare Idling Speed		750 to 850 min^{-1} (rpm)	750 min^{-1} (rpm)
Combustion Chamber		Spherical Type (E-TVCS)	
Fuel Injection Pump		PFR 4M Type Mini Pump (DENSO)	
Governor		Mechanical all speed governor	
Direction of Rotation		Counter-clockwise (viewd from flywheel side)	
Injection Nozzle		OPD Mini Nozzle (DENSO)	
Injection Timing		0.2836 rad (16.25 °) before T.D.C.	0.14 rad (8.3 °) before T.D.C.
Firing Order		1-3-4-2	
Injection Pressure		13.73 MPa (140.0 kgf/cm^2, 1991 psi)	
Compression Ratio		23.2 : 1	23.0 : 1
Lubricating System		Forced Lubrication by Trochoid Pump	
Oil Pressure Indicating		Electrical type switch	
Lubricating Filter		Full flow paper filter (cartridge type)	
Cooling System		Pressurized radiator, forced circulation with water pump	
Starting System		Electric Starting with Starter	
Starting Motor		12 V, 2.0 kW	
Starting Support Device		By glow plug in combustion chamber	
EGR		NONE	
Battery		12 V, 92 AH equivalent	
Charging Alternator		12 V, 480 W	
Fuel		Diesel Fuel No.2-D (ASTM D975)	
Lubricating Oil		Class CF lubricating oil as per API classification is recommended. For details on recommended lubricating oils, see page G-7, 10	
Lubricating Oil Capacity	Oil Pan Depth 90 mm (3.5 in.)	7.6 L (2.0 U.S.gals)	–
	Oil Pan Depth 124 mm (4.88 in.)	9.5 L (2.5 U.S.gals)	
Weight (Dry)		184 kg (406 lbs)	190 kg (419 lbs)

* The specification described above is of the standard engine of each model.
* Conversion Formula : HP = 0.746 kW, PS = 0.7355 kW

W10334350

Model		**D1803-M-DI**
Number of Cylinders		3
Type		Vertical, Water-cooled, 4 cycle diesel engine
Bore × Stroke		87.0 X 102.4 mm (3.43 X 4.031 in.)
Total Displacement		1826 cm^3 (111.4 cu.in.)
ISO Net Continuous		23.2 KW / 2700 min^{-1} (rpm) (31.1 HP / 2700 min^{-1} (rpm))
ISO/SAE Net Intermittent		26.7 KW / 2700 min^{-1} (rpm) (35.8 HP / 2700 min^{-1} (rpm))
SAE Gross Intermittent		27.9 KW / 2700 min^{-1} (rpm) (37.4 HP / 2700 min^{-1} (rpm))
Maximum Bare Speed		2920 min^{-1} (rpm)
Minimum Bare Idling Speed		850 to 950 min^{-1} (rpm)
Combustion Chamber		Reentrant Type (Direct Injection)
Fuel Injection Pump		Bosch "**K**" Type Mini Pump
Governor		Mechanical all speed governor
Direction of Rotation		Counter-clockwise (viewd from flywheel side)
Injection Nozzle		Bosch "**P**" Type Hole Nozzle
Injection Timing		0.087 rad (5.0 °) before T.D.C.
Firing Order		1-2-3
Injection Pressure	1st stage	18.63 MPa (190.0 kgf/cm^2, 2702 psi)
	2nd stage	22.56 MPa (230.0 kgf/cm^2, 3271 psi)
Compression Ratio		20.5 : 1
Lubricating System		Forced Lubrication by Trochoid Pump
Oil Pressure Indicating		Electrical type switch
Lubricating Filter		Full flow paper filter (cartridge type)
Cooling System		Pressurized radiator, forced circulation with water pump
Starting System		Electric Starting with Starter
Starting Motor		12 V, 1.4 kW
Starting Support Device		By glow plug in combustion chamber
EGR		NONE
Battery		12 V, 88 AH equivalent
Charging Alternator		12 V, 360 W
Fuel		Diesel Fuel No.2-D (ASTM D975)
Lubricating Oil		Class CF lubricating oil as per API classification is recommended. For details on recommended lubricating oils, see page G-7, 10
Lubricating Oil Capacity	Oil Pan Depth 90 mm (3.5 in.)	5.6 L (1.5 U.S.gals)
	Oil Pan Depth 124 mm (4.88 in.)	7.0 L (1.8 U.S.gals)
Weight (Dry)		151 kg (333 lbs)

* The specification described above is of the standard engine of each model.
* Conversion Formula : HP = 0.746 kW, PS = 0.7355 kW

W10343470

Model		**V2403-M-DI**	**V2403-M-DI-T**
Number of Cylinders		4	
Type		Vertical, Water-cooled, 4 cycle diesel engine	
Bore × Stroke		87.0 X 102.4 mm (3.43 X 4.031 in.)	
Total Displacement		2434 cm^3 (148.5 cu.in.)	
ISO Net Continuous		30.5 KW / 2700 min^{-1} (rpm) (40.9 HP / 2700 min^{-1} (rpm))	30.7 KW / 2400 min^{-1} (rpm) (41.2 HP / 2400 min^{-1} (rpm))
ISO/SAE Net Intermittent		35.1 KW / 2700 min^{-1} (rpm) (47.1 HP / 2700 min^{-1} (rpm))	35.3 KW / 2400 min^{-1} (rpm) (47.3 HP / 2400 min^{-1} (rpm))
SAE Gross Intermittent		36.5 KW / 2700 min^{-1} (rpm) (48.9 HP / 2700 min^{-1} (rpm))	36.5 KW / 2400 min^{-1} (rpm) (48.9 HP / 2400 min^{-1} (rpm))
Maximum Bare Speed		2920 min^{-1} (rpm)	2450 min^{-1} (rpm)
Minimum Bare Idling Speed		850 to 950 min^{-1} (rpm)	900 min^{-1} (rpm)
Combustion Chamber		Reentrant Type (Direct Injection)	
Fuel Injection Pump		Bosch “**K**” Type Mini Pump	
Governor		Mechanical all speed governor	
Direction of Rotation		Counter-clockwise (viewd from flywheel side)	
Injection Nozzle		Bosch “**P**” Type Hole Nozzle	
Injection Timing		0.087 rad (5.0 °) before T.D.C.	0.096 rad (5.5 °) before T.D.C.
Firing Order		1-3-4-2	
Injection Pressure	1st stage	18.63 MPa (190.0 kgf/cm^2, 2702 psi)	
	2nd stage	22.56 MPa (230.0 kgf/cm^2, 3271 psi)	
Compression Ratio		20.5 : 1	20.2 : 1
Lubricating System		Forced Lubrication by Trochoid Pump	
Oil Pressure Indicating		Electrical type switch	
Lubricating Filter		Full flow paper filter (cartridge type)	
Cooling System		Pressurized radiator, forced circulation with water pump	
Starting System		Electric Starting with Starter	
Starting Motor		12 V, 2.0 kW	
Starting Support Device		By glow plug in combustion chamber	
EGR		NONE	
Battery		12 V, 92 AH equivalent	
Charging Alternator		12 V, 480 W	
Fuel		Diesel Fuel No.2-D (ASTM D975)	
Lubricating Oil		Class CF lubricating oil as per API classification is recommended. For details on recommended lubricating oils, see page G-7, 10	
Lubricating Oil Capacity	Oil Pan Depth 90 mm (3.5 in.)	7.6 L (2.0 U.S.gals)	
	Oil Pan Depth 124 mm (4.88 in.)	9.5 L (2.5 U.S.gals)	
Weight (Dry)		184 kg (406 lbs)	190 kg (416 lbs)

* The specification described above is of the standard engine of each model.
* Conversion Formula : HP = 0.746 kW, PS = 0.7355 kW

W10452650

Model		**D1703-M-BG**	
Number of Cylinders		3	
Type		Vertical, Water-cooled, 4 cycle diesel engine	
Bore × Stroke		87.0 X 92.4 mm (3.43 X 3.64 in.)	
Total Displacement		1647 cm^3 (100.5 cu.in.)	
ISO Net Continuous		14.0 KW / 1500 min^{-1} (rpm) (18.8 HP / 1500 min^{-1} (rpm))	16.9 KW / 1800 min^{-1} (rpm) (22.7 HP / 1800 min^{-1} (rpm))
ISO/SAE Net Intermittent		16.1 KW / 1500 min^{-1} (rpm) (21.6 HP / 1500 min^{-1} (rpm))	19.5 KW / 1800 min^{-1} (rpm) (26.1 HP / 1800 min^{-1} (rpm))
SAE Gross Intermittent		16.6 KW / 1500 min^{-1} (rpm) (22.3 HP / 1500 min^{-1} (rpm))	20.2 KW / 1800 min^{-1} (rpm) (27.1 HP / 1800 min^{-1} (rpm))
Maximum Bare Speed		2120 min^{-1} (rpm)	
Minimum Bare Idling Speed		2120 min^{-1} (rpm)	
Combustion Chamber		Spherical Type (E-TVCS)	
Fuel Injection Pump		PFR 3M Type Mini Pump (DENSO)	
Governor		Mechanical all speed governor + Electronic Governor	
Direction of Rotation		Counter-clockwise (viewd from flywheel side)	
Injection Nozzle		OPD Mini Nozzle (DENSO)	
Injection Timing		0.2487 rad (14.25 °) before T.D.C.	
Firing Order		1-2-3	
Injection Pressure		13.73 MPa (140.0 kgf/cm^2, 1991 psi)	
Compression Ratio		22.0 : 1	
Lubricating System		Forced Lubrication by Trochoid Pump	
Oil Pressure Indicating		Electrical type switch	
Lubricating Filter		Full flow paper filter (cartridge type)	
Cooling System		Pressurized radiator, forced circulation with water pump	
Starting System		Electric Starting with Starter	
Starting Motor		12 V, 1.4 kW	
Starting Support Device		By glow plug in combustion chamber	
EGR		NONE	
Battery		12 V, 60 AH equivalent	
Charging Alternator		12 V, 480 W	
Fuel		Diesel Fuel No.2-D (ASTM D975)	
Lubricating Oil		Class CF lubricating oil as per API classification is recommended. For details on recommended lubricating oils, see page G-7, 10	
Lubricating Oil Capacity	Oil Pan Depth 90 mm (3.5 in.)	5.6 L (1.5 U.S.gals)	
	Oil Pan Depth 124 mm (4.88 in.)	7.0 L (1.8 U.S.gals)	
Weight (Dry)		164 kg (362 lbs)	

* The specification described above is of the standard engine of each model.
* Conversion Formula : HP = 0.746 kW, PS = 0.7355 kW

W10336120

Model		**V2003-M-BG**	
Number of Cylinders		4	
Type		Vertical, Water-cooled, 4 cycle diesel engine	
Bore × Stroke		83.0 X 92.4 mm (3.27 X 3.64 in.)	
Total Displacement		1999 cm^3 (122.0 cu.in.)	
ISO Net Continuous		17.5 KW / 1500 min^{-1} (rpm) (23.5 HP / 1500 min^{-1} (rpm))	20.3 KW / 1800 min^{-1} (rpm) (27.2 HP / 1800 min^{-1} (rpm))
ISO/SAE Net Intermittent		20.1 KW / 1500 min^{-1} (rpm) (27.0 HP / 1500 min^{-1} (rpm))	23.4 KW / 1800 min^{-1} (rpm) (31.4 HP / 1800 min^{-1} (rpm))
SAE Gross Intermittent		20.6 KW / 1500 min^{-1} (rpm) (27.6 HP / 1500 min^{-1} (rpm))	24.3 KW / 1800 min^{-1} (rpm) (32.6 HP / 1800 min^{-1} (rpm))
Maximum Bare Speed		2120 min^{-1} (rpm)	
Minimum Bare Idling Speed		2120 min^{-1} (rpm)	
Combustion Chamber		Spherical Type (E-TVCS)	
Fuel Injection Pump		PFR 4M Type Mini Pump (DENSO)	
Governor		Mechanical all speed governor + Electronic Governor	
Direction of Rotation		Counter-clockwise (viewd from flywheel side)	
Injection Nozzle		OPD Mini Nozzle (DENSO)	
Injection Timing		0.2487 rad (14.25 °) before T.D.C.	
Firing Order		1-3-4-2	
Injection Pressure		13.73 MPa (140.0 kgf/cm^2, 1991 psi)	
Compression Ratio		22.8 : 1	
Lubricating System		Forced Lubrication by Trochoid Pump	
Oil Pressure Indicating		Electrical type switch	
Lubricating Filter		Full flow paper filter (cartridge type)	
Cooling System		Pressurized radiator, forced circulation with water pump	
Starting System		Electric Starting with Starter	
Starting Motor		12 V, 1.4 kW	
Starting Support Device		By glow plug in combustion chamber	
EGR		NONE	
Battery		12 V, 88 AH equivalent	
Charging Alternator		12 V, 480 W	
Fuel		Diesel Fuel No.2-D (ASTM D975)	
Lubricating Oil		Class CF lubricating oil as per API classification is recommended. For details on recommended lubricating oils, see page G-7, 10	
Lubricating Oil Capacity	Oil Pan Depth 90 mm (3.5 in.)	7.6 L (2.0 U.S.gals)	
	Oil Pan Depth 124 mm (4.88 in.)	9.5 L (2.5 U.S.gals)	
Weight (Dry)		195 kg (430 lbs)	

* The specification described above is of the standard engine of each model.
* Conversion Formula : HP = 0.746 kW, PS = 0.7355 kW

W10389960

Model		**V2003-M-T-BG**	
Number of Cylinders		4	
Type		Vertical, Water-cooled, 4 cycle diesel engine	
Bore × Stroke		83.0 X 92.4 mm (3.27 X 3.64 in.)	
Total Displacement		1999 cm^3 (122.0 cu.in.)	
ISO Net Continuous		22.3 KW / 1500 min^{-1} (rpm) (29.9 HP / 1500 min^{-1} (rpm))	25.7 KW / 1800 min^{-1} (rpm) (34.5 HP / 1800 min^{-1} (rpm))
ISO/SAE Net Intermittent		25.7 KW / 1500 min^{-1} (rpm) (34.5 HP / 1500 min^{-1} (rpm))	29.6 KW / 1800 min^{-1} (rpm) (39.7 HP / 1800 min^{-1} (rpm))
SAE Gross Intermittent		26.2 KW / 1500 min^{-1} (rpm) (35.1 HP / 1500 min^{-1} (rpm))	30.6 KW / 1800 min^{-1} (rpm) (41.0 HP / 1800 min^{-1} (rpm))
Maximum Bare Speed		2120 min^{-1} (rpm)	
Minimum Bare Idling Speed		2120 min^{-1} (rpm)	
Combustion Chamber		Spherical Type (E-TVCS)	
Fuel Injection Pump		PFR 4M Type Mini Pump (DENSO)	
Governor		Mechanical all speed governor + Electronic Governor	
Direction of Rotation		Counter-clockwise (viewd from flywheel side)	
Injection Nozzle		OPD Mini Nozzle (DENSO)	
Injection Timing		0.2662 rad (15.25 °) before T.D.C.	
Firing Order		1-3-4-2	
Injection Pressure		13.73 MPa (140.0 kgf/cm^2, 1991 psi)	
Compression Ratio		21.7 : 1	
Lubricating System		Forced Lubrication by Trochoid Pump	
Oil Pressure Indicating		Electrical type switch	
Lubricating Filter		Full flow paper filter (cartridge type)	
Cooling System		Pressurized radiator, forced circulation with water pump	
Starting System		Electric Starting with Starter	
Starting Motor		12 V, 1.4 kW	
Starting Support Device		By glow plug in combustion chamber	
EGR		NONE	
Battery		12 V, 88 AH equivalent	
Charging Alternator		12 V, 480 W	
Fuel		Diesel Fuel No.2-D (ASTM D975)	
Lubricating Oil		Class CF lubricating oil as per API classification is recommended. For details on recommended lubricating oils, see page G-7, 10	
Lubricating Oil Capacity	Oil Pan Depth 90 mm (3.5 in.)	7.6 L (2.0 U.S.gals)	
	Oil Pan Depth 124 mm (4.88 in.)	9.5 L (2.5 U.S.gals)	
Weight (Dry)		208 kg (459 lbs)	

* The specification described above is of the standard engine of each model.
* Conversion Formula : HP = 0.746 kW, PS = 0.7355 kW

W10413710

Model		**V2203-M-BG**	
Number of Cylinders		4	
Type		Vertical, Water-cooled, 4 cycle diesel engine	
Bore × Stroke		87.0 X 92.4 mm (3.43 X 3.64 in.)	
Total Displacement		2197 cm^3 (134.1 cu.in.)	
ISO Net Continuous		18.8 KW / 1500 min^{-1} (rpm) (25.2 HP / 1500 min^{-1} (rpm))	22.6 KW / 1800 min^{-1} (rpm) (30.3 HP / 1800 min^{-1} (rpm))
ISO/SAE Net Intermittent		21.7 KW / 1500 min^{-1} (rpm) (29.1 HP / 1500 min^{-1} (rpm))	26.0 KW / 1800 min^{-1} (rpm) (34.9 HP / 1800 min^{-1} (rpm))
SAE Gross Intermittent		22.2 KW / 1500 min^{-1} (rpm) (29.8 HP / 1500 min^{-1} (rpm))	26.9 KW / 1800 min^{-1} (rpm) (36.1 HP / 1800 min^{-1} (rpm))
Maximum Bare Speed		2120 min^{-1} (rpm)	
Minimum Bare Idling Speed		2120 min^{-1} (rpm)	
Combustion Chamber		Spherical Type (E-TVCS)	
Fuel Injection Pump		PFR 4M Type Mini Pump (DENSO)	
Governor		Mechanical all speed governor + Electronic Governor	
Direction of Rotation		Counter-clockwise (viewd from flywheel side)	
Injection Nozzle		OPD Mini Nozzle (DENSO)	
Injection Timing		0.2487 rad (14.25 °) before T.D.C.	
Firing Order		1-3-4-2	
Injection Pressure		13.73 MPa (140.0 kgf/cm^2, 1991 psi)	
Compression Ratio		22.0 : 1	
Lubricating System		Forced Lubrication by Trochoid Pump	
Oil Pressure Indicating		Electrical type switch	
Lubricating Filter		Full flow paper filter (cartridge type)	
Cooling System		Pressurized radiator, forced circulation with water pump	
Starting System		Electric Starting with Starter	
Starting Motor		12 V, 1.4 kW	
Starting Support Device		By glow plug in combustion chamber	
EGR		NONE	
Battery		12 V, 88 AH equivalent	
Charging Alternator		12 V, 480 W	
Fuel		Diesel Fuel No.2-D (ASTM D975)	
Lubricating Oil		Class CF lubricating oil as per API classification is recommended. For details on recommended lubricating oils, see page G-7, 10	
Lubricating Oil Capacity	Oil Pan Depth 90 mm (3.5 in.)	7.6 L (2.0 U.S.gals)	
	Oil Pan Depth 124 mm (4.88 in.)	9.5 L (2.5 U.S.gals)	
Weight (Dry)		195 kg (430 lbs)	

* The specification described above is of the standard engine of each model.
* Conversion Formula : HP = 0.746 kW, PS = 0.7355 kW

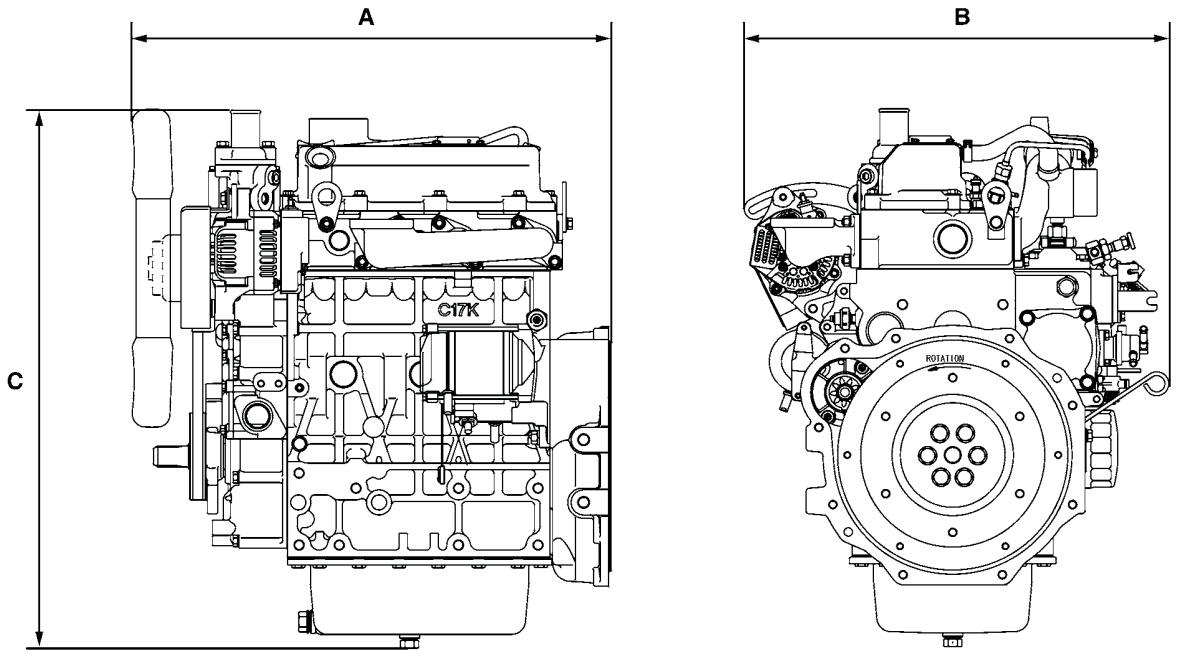
W10419300

Model		**V2403-M-BG**	
Number of Cylinders		4	
Type		Vertical, Water-cooled, 4 cycle diesel engine	
Bore × Stroke		87.0 X 102.4 mm (3.43 X 4.031 in.)	
Total Displacement		2434 cm^3 (148.5 cu.in.)	
ISO Net Continuous		21.5 KW / 1500 min^{-1} (rpm) (28.8 HP / 1500 min^{-1} (rpm))	25.1 KW / 1800 min^{-1} (rpm) (33.7 HP / 1800 min^{-1} (rpm))
ISO/SAE Net Intermittent		24.8 KW / 1500 min^{-1} (rpm) (33.3 HP / 1500 min^{-1} (rpm))	28.9 KW / 1800 min^{-1} (rpm) (38.8 HP / 1800 min^{-1} (rpm))
SAE Gross Intermittent		25.3 KW / 1500 min^{-1} (rpm) (33.9 HP / 1500 min^{-1} (rpm))	29.8 KW / 1800 min^{-1} (rpm) (40.0 HP / 1800 min^{-1} (rpm))
Maximum Bare Speed		2120 min^{-1} (rpm)	
Minimum Bare Idling Speed		2120 min^{-1} (rpm)	
Combustion Chamber		Spherical Type (E-TVCS)	
Fuel Injection Pump		PFR 4M Type Mini Pump (DENSO)	
Governor		Mechanical all speed governor + Electronic Governor	
Direction of Rotation		Counter-clockwise (viewd from flywheel side)	
Injection Nozzle		OPD Mini Nozzle (DENSO)	
Injection Timing		0.2487 rad (14.25 °) before T.D.C.	
Firing Order		1-3-4-2	
Injection Pressure		13.73 MPa (140.0 kgf/cm^2, 1991 psi)	
Compression Ratio		23.2 : 1	
Lubricating System		Forced Lubrication by Trochoid Pump	
Oil Pressure Indicating		Electrical type switch	
Lubricating Filter		Full flow paper filter (cartridge type)	
Cooling System		Pressurized radiator, forced circulation with water pump	
Starting System		Electric Starting with Starter	
Starting Motor		12 V, 2.0 kW	
Starting Support Device		By glow plug in combustion chamber	
EGR		NONE	
Battery		12 V, 88 AH equivalent	
Charging Alternator		12 V, 480 W	
Fuel		Diesel Fuel No.2-D (ASTM D975)	
Lubricating Oil		Class CF lubricating oil as per API classification is recommended. For details on recommended lubricating oils, see page G-7, 10	
Lubricating Oil Capacity	Oil Pan Depth 90 mm (3.5 in.)	7.6 L (2.0 U.S.gals)	
	Oil Pan Depth 124 mm (4.88 in.)	9.5 L (2.5 U.S.gals)	
Weight (Dry)		190 kg (419 lbs)	

* The specification described above is of the standard engine of each model.
* Conversion Formula : HP = 0.746 kW, PS = 0.7355 kW

W10424850

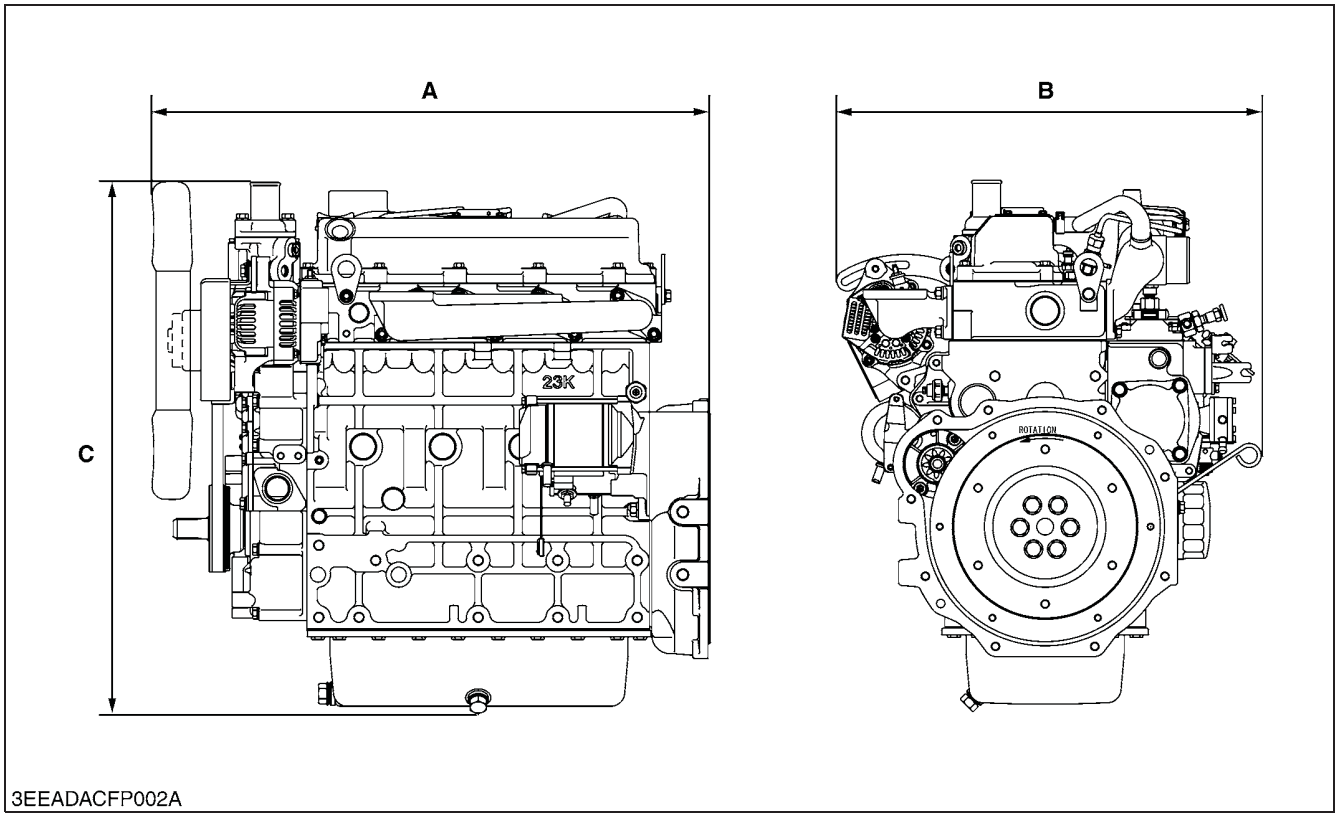
DIMENSIONS



3EEADACFP001A

	D1503-M	D1703-M	D1803-M
A	567.0 mm (22.32 in.)	560.0 mm (22.05 in.)	560.0 mm (22.05 in.)
B	512.0 mm (20.16 in.)	480.0 mm (18.90 in.)	480.0 mm (18.90 in.)
C	643.0 mm (25.31 in.)	643.0 mm (25.31 in.)	648.0 mm (25.51 in.)

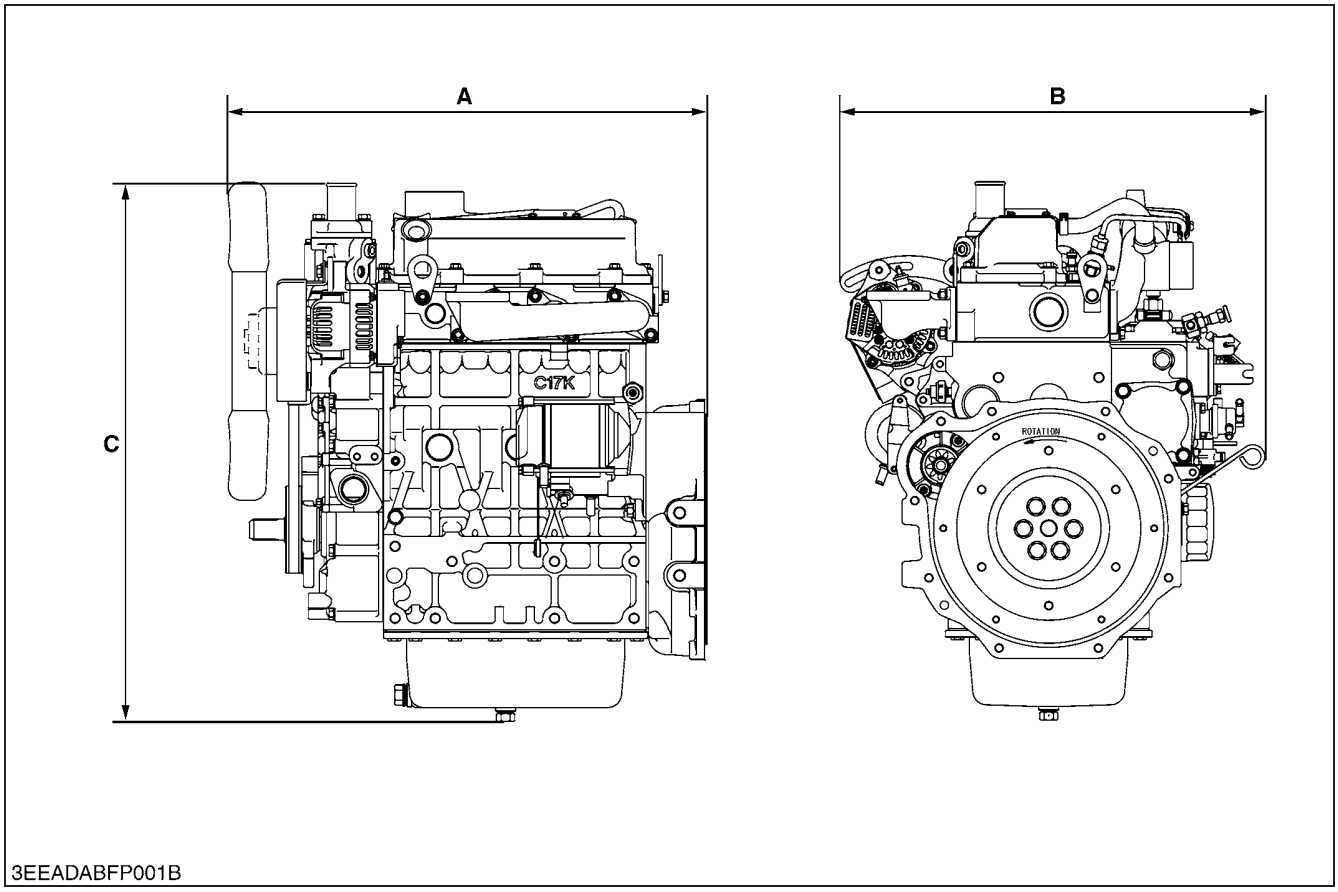
W1031045



3EEADACFP002A

	V2003-M	V2203-M	V2403-M	V2403-M-T
A	652.0 mm (25.67 in.)	652.0 mm (25.67 in.)	652.0 mm (25.67 in.)	667.1 mm (26.26 in.)
B	480.0 mm (18.90 in.)	480.0 mm (18.90 in.)	480.0 mm (18.90 in.)	449.0 mm (17.68 in.)
C	643.0 mm (25.31 in.)	643.0 mm (25.31 in.)	648.0 mm (25.51 in.)	737.3 mm (29.03 in.)

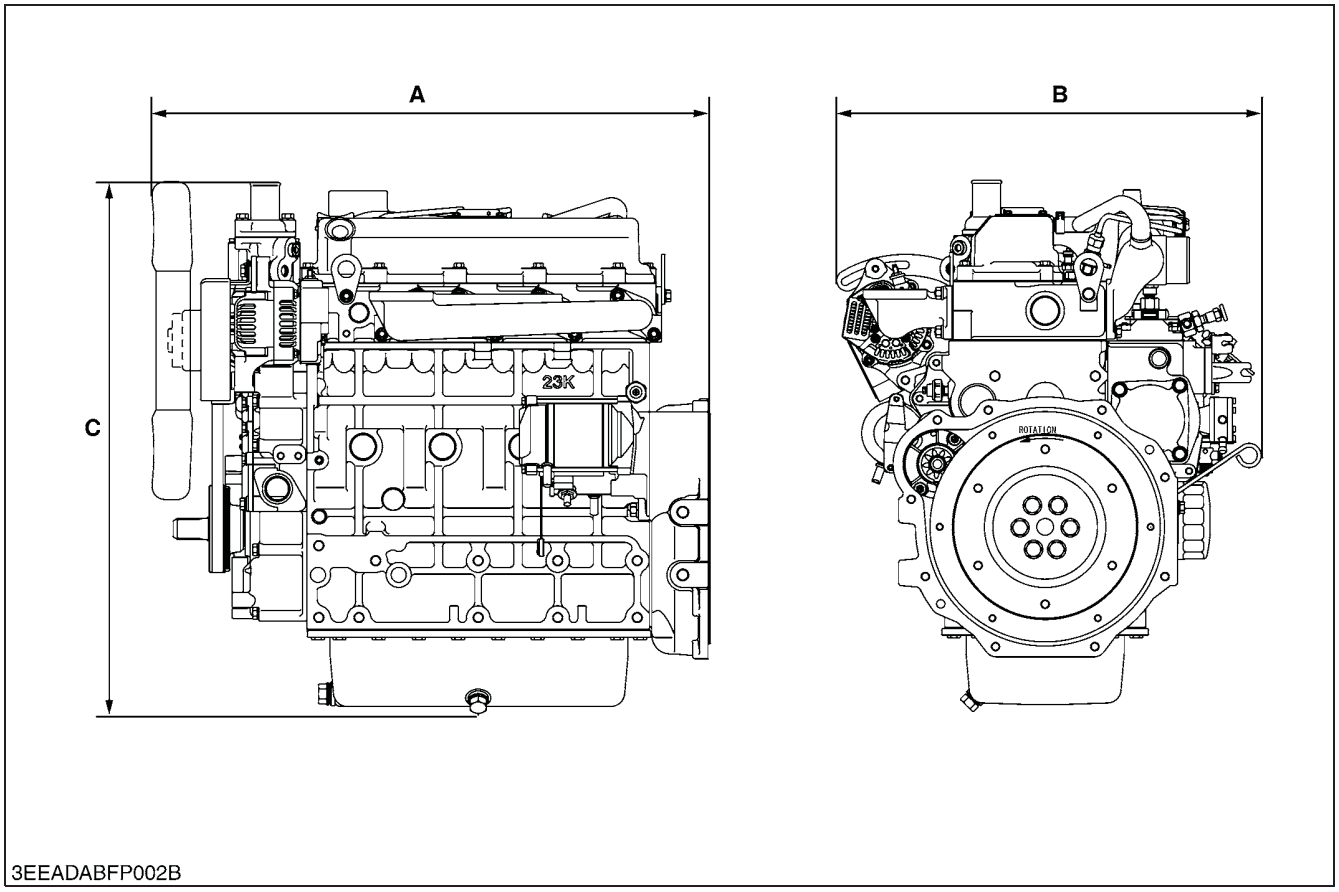
W1028881



3EEADABFP001B

	D1803-M-DI
A	560.0 mm (22.05 in.)
B	492.0 mm (19.37 in.)
C	636.0 mm (25.04 in.)

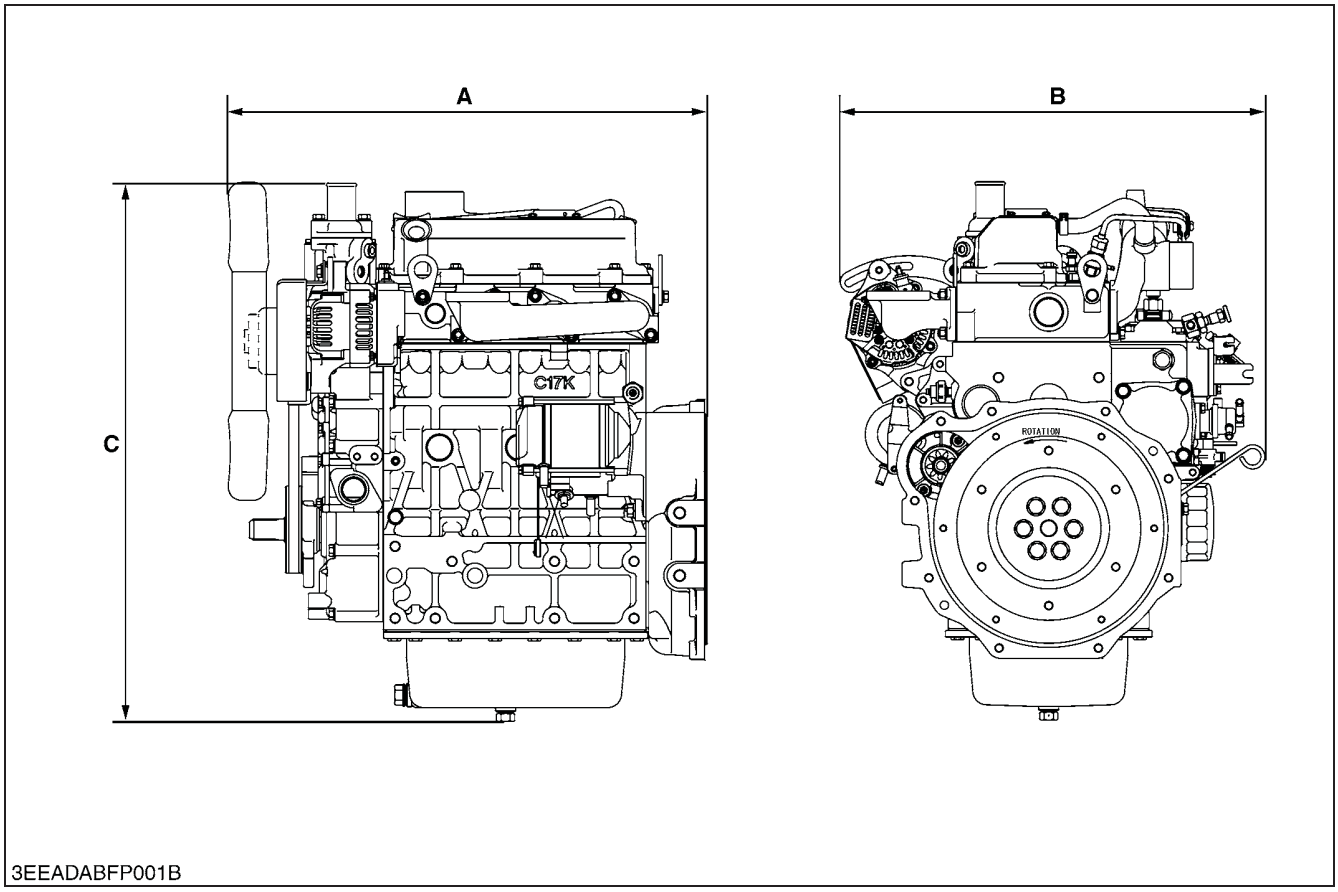
W1035766



3EEADABFP002B

	V2403-M-DI	V2403-M-DI-T
A	655.0 mm (25.79 in.)	667.1 mm (26.26 in.)
B	492.0 mm (19.37 in.)	449.0 mm (17.68 in.)
C	636.0 mm (25.04 in.)	737.3 mm (29.03 in.)

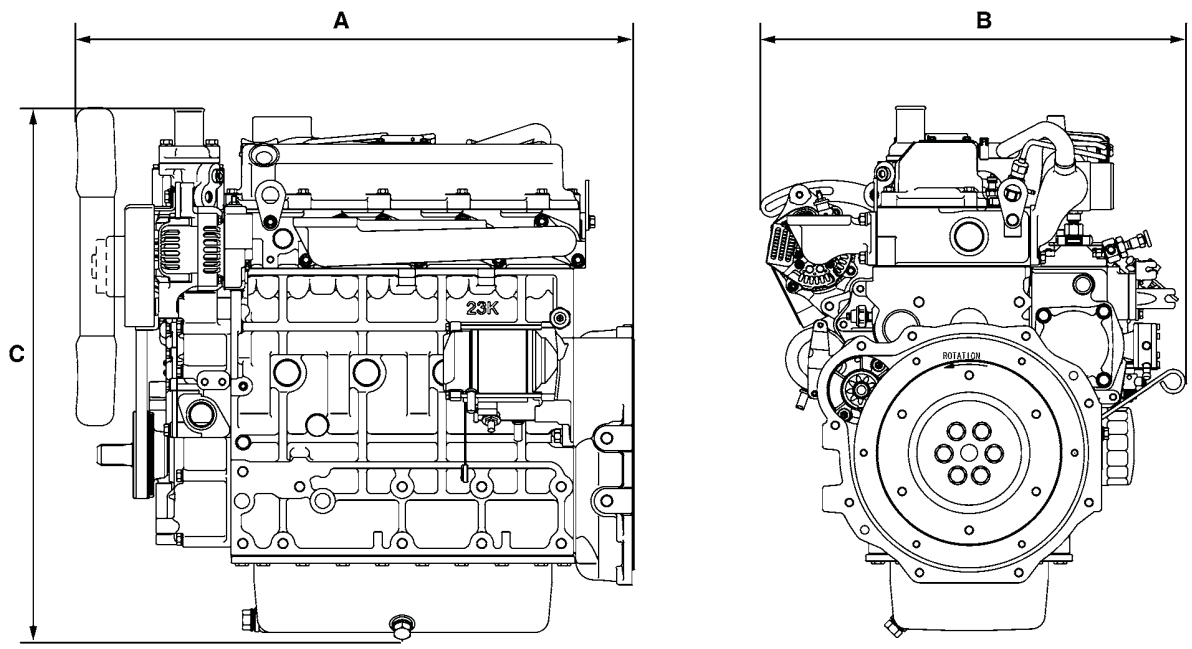
W1035816



3EEADABFP001B

	D1703-M-BG
A	605.6 mm (23.84 in.)
B	505.0 mm (19.88 in.)
C	642.8 mm (25.31 in.)

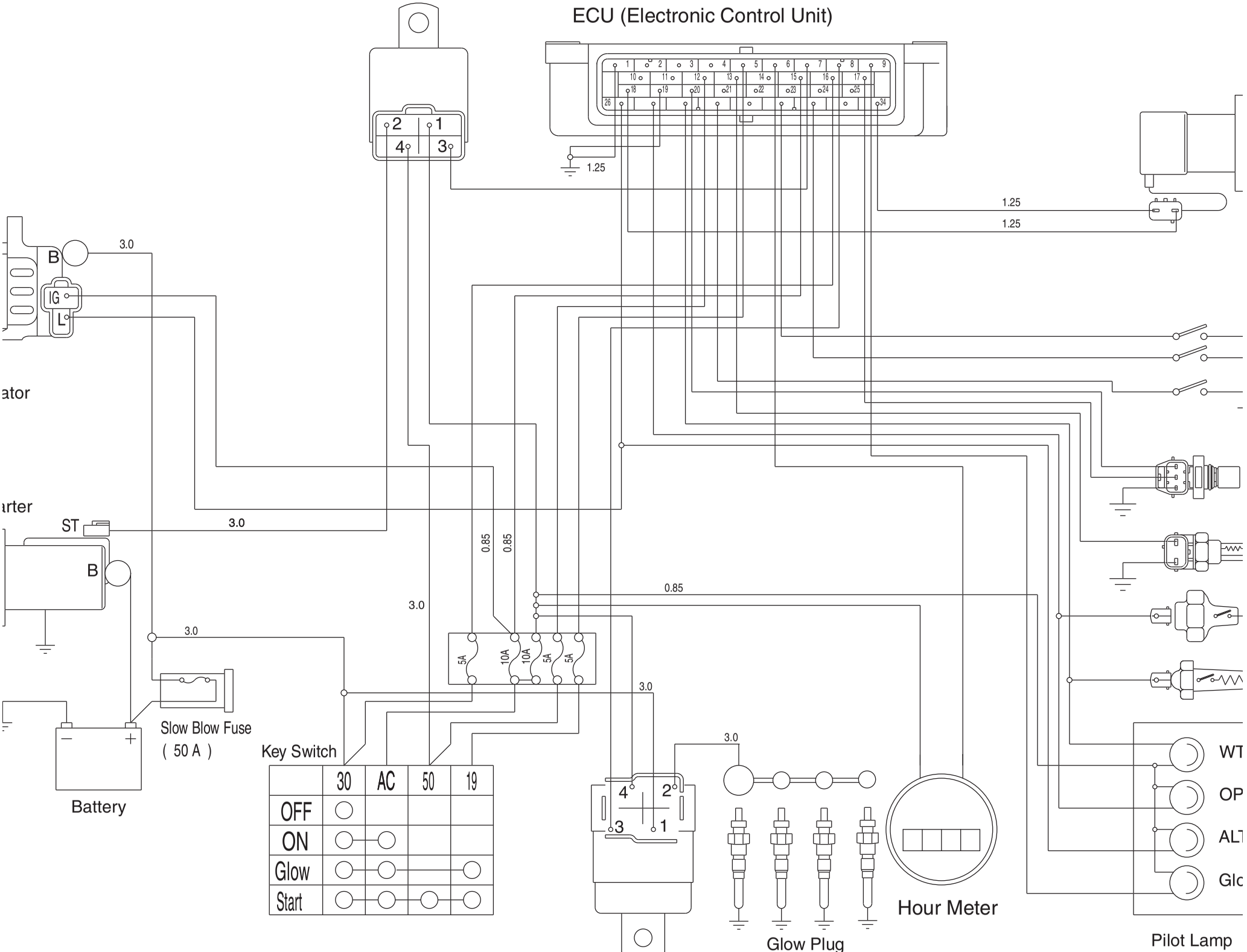
W1036026



3EEADABFP002B

	V2003-M-BG	V2003-M-T-BG	V2203-M-BG	V2403-M-BG
A	700.6 mm (27.58 in.)	700.6 mm (27.58 in.)	700.6 mm (27.58 in.)	700.6 mm (27.58 in.)
B	505.0 mm (19.88 in.)	505.0 mm (19.88 in.)	505.0 mm (19.88 in.)	505.0 mm (19.88 in.)
C	633.3 mm (24.93 in.)	674.0 mm (26.54 in.)	633.3 mm (24.93 in.)	684.0 mm (26.93 in.)

W1035948


ECU (Electronic Control Unit)
1.25
1.25
1.25
3.0
B
IG
L
ator
arter
ST
3.0
B
3.0
0.85
0.85
0.85
3.0
3.0
5A
10A
10A
5A
5A
3.0
3.0
Slow Blow Fuse
(50 A)
Battery
Key Switch
30
AC
50
19
OFF
ON
Glow
Start
Glow Plug
Hour Meter
WT
OP
ALT
Glo
Pilot Lamp

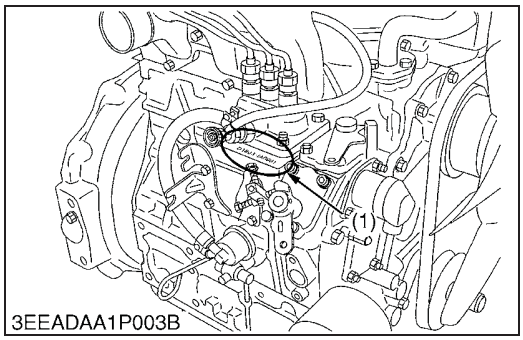
GENERAL

CONTENTS

1. ENGINE IDENTIFICATION G-1
   [1] MODEL NAME AND ENGINE SERIAL NUMBER G-1
   [2] E3B ENGINE G-3
   [3] CYLINDER NUMBER G-3
2. GENERAL PRECAUTIONS G-4
3. MAINTENANCE CHECK LIST G-5
4. CHECK AND MAINTENANCE G-8
   [1] DAILY CHECK POINTS G-8
   [2] CHECK POINTS OF INITIAL 50 HOURS G-10
   [3] CHECK POINTS OF EVERY 50 HOURS G-12
   [4] CHECK POINTS OF EVERY 100 HOURS G-13
   [5] CHECK POINTS OF EVERY 150 HOURS G-15
   [6] CHECK POINTS OF EVERY 200 HOURS G-17
   [7] CHECK POINTS OF EVERY 400 HOURS G-21
   [8] CHECK POINTS OF EVERY 500 HOURS G-23
   [9] CHECK POINTS OF EVERY 1 OR 2 MONTHS G-25
   [10]CHECK POINTS OF EVERY YEAR G-26
   [11]CHECK POINTS OF EVERY 800 HOURS G-27
   [12]CHECK POINTS OF EVERY 1500 HOURS G-28
   [13]CHECK POINTS OF EVERY 3000 HOURS G-31
   [14]CHECK POINTS OF EVERY 2 YEARS G-34
5. SPECIAL TOOLS G-38

1. ENGINE IDENTIFICATION

[1] MODEL NAME AND ENGINE SERIAL NUMBER



When contacting the manufacture, always specify your engine model name and serial number.

The engine model and its serial number need to be identified before the engine can be serviced or parts replaced.

■ **Engine Serial Number**

The engine serial number is an identified number for the engine. It is marked after the engine model number.

It indicates month and year of manufacture as follows.

• **Year of manufacture**

Alphabet or Number	Year	Alphabet or Number	Year
1	2001	F	2015
2	2002	G	2016
3	2003	H	2017
4	2004	J	2018
5	2005	K	2019
6	2006	L	2020
7	2007	M	2021
8	2008	N	2022
9	2009	P	2023
A	2010	R	2024
B	2011	S	2025
C	2012	T	2026
D	2013	V	2027
E	2014		

(1) Engine Model Name and Serial Number

W1010477

- **Month of manufacture**

Month	Engine Lot Number	
January	A0001 ~ A9999	B0001 ~ BZ999
February	C0001 ~ C9999	D0001 ~ DZ999
March	E0001 ~ E9999	F0001 ~ FZ999
April	G0001 ~ G9999	H0001 ~ HZ999
May	J0001 ~ J9999	K0001 ~ KZ999
June	L0001 ~ L9999	M0001 ~ MZ999
July	N0001 ~ N9999	P0001 ~ PZ999
August	Q0001 ~ Q9999	R0001 ~ RZ999
September	S0001 ~ S9999	T0001 ~ TZ999
October	U0001 ~ U9999	V0001 ~ VZ999
November	W0001 ~ W9999	X0001 ~ XZ999
December	Y0001 ~ Y9999	Z0001 ~ ZZ999

* Alphabetical letters "**I**" and "**O**" are not used.

e.g. D1803 - 7 B A001
(a) (b)(c) (d)

(a) Engine Model Name : **D1803**
(b) Year : **7** indicates **2007**
(c) Month : **A** or **B** indicates **January**
(d) Lot number : (**0001 ~ 9999** or **A001 ~ Z999**)

W1011076

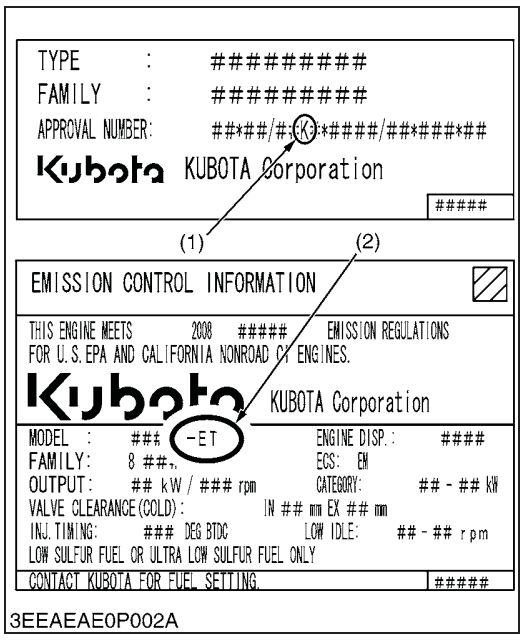
[2] E3B ENGINE

[Example : Engine Model Name D1803-M-**E3B**-XXXX or D1803-M-DI-**E3B**-XXXX]

The emission controls previously implemented in various countries to prevent air pollution will be stepped up as Non-Road Emission Standards continue to change. The timing or applicable date of the specific Non-Road Emission regulations depends on the engine output classification.

Over the past several years, Kubota has been supplying diesel engines that comply with regulations in the respective countries affected by Non-Road Emission regulations. For Kubota Engines, E3B will be the designation that identifies engine models affected by the next emission phase (See the table below).

When servicing or repairing ###-E3B series engines, use only replacement parts for that specific E3B engine, designated by the appropriate E3B Kubota Parts List and perform all maintenance services listed in the appropriate Kubota Operator's Manual or in the appropriate E3B Kubota Workshop Manual. Use of incorrect replacement parts or replacement parts from other emission level engines (for example: E2B engines), may result in emission levels out of compliance with the original E3B design and EPA or other applicable regulations.Please refer to the emission label located on the engine head cover to identify Output classification and Emission Control Information. E3B engines are identified with "ET" at the end of the Model designation, on the US EPA label. Please note : E3B is not marked on the engine.



3EEAEAE0P002A

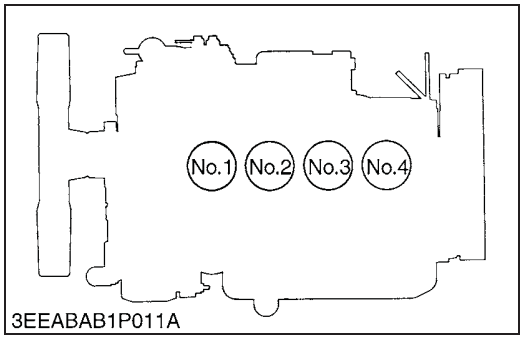
Category (1)	Engine output classification	EU regulation
K	From 19 to less than 37 kW	STAGE IIIA
J	From 37 to less than 75 kW	STAGE IIIA
I	From 75 to less than 130 kW	STAGE IIIA

Category (2)	Engine output classification	EPA regulation
ET	Less than 19kW	Tier 4
	From 19 to less than 56 kW	Interim Tier 4
	From 56 to less than 75 kW	Tier 3
	From 75 to less than 130 kW	Tier 3

(1) EU regulation engine output classification category
(2) “E3B” engines are identified with “ET” at the end of the Model designation, on the US EPA label.
“E3B” designates Tier 3 and some Interim Tier 4 / Tier 4 models, depending on engine output classification.

W1031971

[3] CYLINDER NUMBER



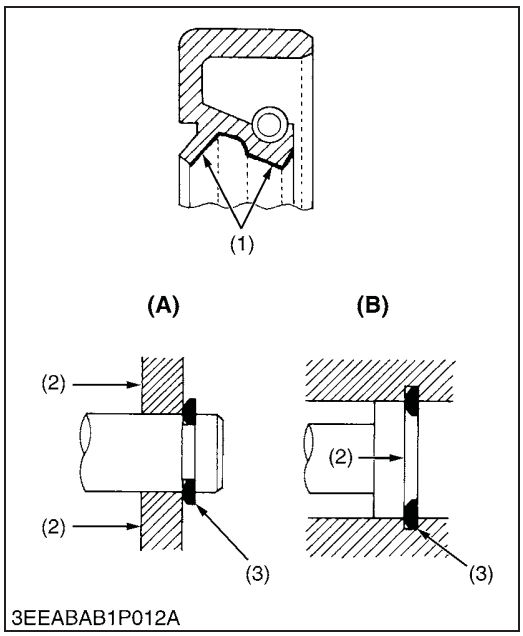
3EEABAB1P011A

The cylinder numbers of KUBOTA diesel engine are designated as shown in the figure.

The sequence of cylinder numbers is given as No.1, No.2, No.3 and No.4 starting from the gear case side.

W1011077

2. GENERAL PRECAUTIONS



3EEABAB1P012A

- During disassembly, carefully arrange removed parts in a clean area to prevent confusion later. Screws, bolts and nuts should be replaced in their original position to prevent reassembly errors.
- When special tools are required, use KUBOTA genuine special tools. Special tools which are not frequently used should be made according to the drawings provided.
- Before disassembling or servicing live wires, make sure to always disconnect the grounding cable from the battery first.
- Remove oil and dirt from parts before measuring.
- Use only KUBOTA genuine parts for parts replacement to maintain engine performance and to ensure safety.
- Gaskets and O-rings must be replaced during reassembly. Apply grease to new O-rings or oil seals before assembling.
- When reassembling external or internal snap rings, position them so that the sharp edge faces against the direction from which force is applied.
- Be sure to perform run-in the serviced or reassembled engine. Do not attempt to give heavy load at once, or serious damage may result to the engine.

(1) Grease
(2) Force
(3) Place the Sharp Edge against the Direction of Force

(A) External Snap Ring
(B) Internal Snap Ring

W1011734

3. MAINTENANCE CHECK LIST

To maintain long-lasting and safe engine performance, make it a rule to carry out regular inspections by following the table below.

[D1503-M, D1703-M, D1803-M, V2003-M, V2203-M, V2403-M, V2403-M-T]
[D1703-M-BG, V2003-M-BG, V2003-M-T-BG, V2203-M-BG, V2403-M-BG]

Item		Service Interval Every											
		50 hrs	100 hrs	150 hrs	200 hrs	400 hrs	500 hrs	1 or 2 months	1 year	800 hrs	1500 hrs	3000 hrs	2 years
* Checking fuel hoses and clamp bands		☆											
Changing engine oil (depending on the oil pan)	(1) Oil pan depth (90 mm, 3.5 in.)	★		☆									
	(2) Oil pan depth (124 mm, 4.88 in.)	★			☆								
*Cleaning air cleaner element (replace the element after 6-times cleanings)			☆										
*Cleaning fuel filter (Element type)			☆										
Checking battery electrolyte level			☆										
Checking fan belt tension and damage			☆										
Replacing oil filter cartridge	(1) Oil pan depth (90 mm, 3.5 in.)	★		☆									
	(2) Oil pan depth (124 mm, 4.88 in.)	★			☆								
Checking radiator hoses and clamp bands					☆								
* Checking intake air line					☆								
Replacing fuel filter cartridge						☆							
Cleaning water jacket and radiator interior							☆						
Replacing fan belt							☆						
Recharging battery								☆					
* Replacing air cleaner element									☆				
Checking valve clearance										☆			
* Checking injection nozzle condition											☆		
* Checking turbocharger												☆	
* Checking injection pump												☆	
* Replacing intake air line													☆
Replacing battery													☆
Replacing radiator hoses and clamp bands													☆
* Replacing fuel hoses and clamps													☆
Changing radiator coolant (L.L.C.)													☆

★ Change engine oil and replace oil filter cartridge after the first 50 hours of operation.

* The items listed above (* marked) are registered as emission related critical parts by KUBOTA in the U.S. EPA nonroad emission regulation. As the engine owner, you are responsible for the performance of the required maintenance on the engine according to the above instruction.

W1029462

[D1803-M-DI, V2403-M-DI, V2403-M-DI-T]

Item		Service Interval Every										
		50 hrs	100 hrs	200 hrs	400 hrs	500 hrs	1 or 2 months	1 year	800 hrs	1500 hrs	3000 hrs	2 years
* Checking fuel hoses and clamp bands		☆										
Changing engine oil (depending on the oil pan)	(1) Oil pan depth (90 mm, 3.5 in.)	★		☆								
	(2) Oil pan depth (124 mm, 4.88 in.)	★			☆							
*Cleaning air cleaner element (replace the element after 6-times cleanings)			☆									
*Cleaning fuel filter (Element type)			☆									
Checking battery electrolyte level			☆									
Checking fan belt tension and damage			☆									
Replacing oil filter cartridge	(1) Oil pan depth (90 mm, 3.5 in.)	★		☆								
	(2) Oil pan depth (124 mm, 4.88 in.)	★			☆							
Checking radiator hoses and clamp bands				☆								
* Checking intake air line				☆								
Replacing fuel filter cartridge					☆							
Cleaning water jacket and radiator interior						☆						
Replacing fan belt						☆						
Recharging battery							☆					
* Replacing air cleaner element								☆				
Checking valve clearance									☆			
* Checking injection nozzle condition										☆		
* Checking turbocharger											☆	
* Checking injection pump											☆	
* Replacing intake air line												☆
Replacing battery												☆
Replacing radiator hoses and clamp bands												☆
* Replacing fuel hoses and clamps												☆
Changing radiator coolant (L.L.C.)												☆

★ Change engine oil and replace oil filter cartridge after the first 50 hours of operation.

* The items listed above (* marked) are registered as emission related critical parts by KUBOTA in the U.S. EPA nonroad emission regulation. As the engine owner, you are responsible for the performance of the required maintenance on the engine according to the above instruction.

W1032664

CAUTION

- **When changing or inspecting, be sure to level and stop the engine.**

■ **NOTE**

Engine Oil :

- **Refer to the following table for the suitable American Petroleum Institute (API) classification of engine oil according to the engine type (with internal EGR, external EGR or non-EGR) and the Fuel Type Used : (Low Sulfur, Ultra Low Sulfur or High Sulfur Fuels).**

Fuel Type	Engine oil classification (API classification)	
	Engines with non-EGR Engines with internal EGR	Engines with external EGR
High Sulfur Fuel [0.05 % (500 ppm) ≤ Sulfur Content < 0.50 % (5000 ppm)]	**CF** (If the "CF-4, CG-4, CH-4, or CI-4" engine oil is used with a high-sulfur fuel, change the engine oil at shorter intervals. (approximately half))	–
Low Sulfur Fuel [Sulfur Content < 0.05 % (500 ppm)] or Ultra Low Sulfur Fuel [Sulfur Content < 0.0015 % (15 ppm)]	**CF, CF-4, CG-4, CH-4** or **CI-4**	**CF** or **CI-4** (Class CF-4, CG-4 and CH-4 engine oils cannot be used on EGR type engines.)

EGR : Exhaust Gas Re-circulation

W1024941

- **CJ-4 classification oil is intended for use in engines equipped with DPF (Diesel Particulate Filter) and is Not Recommended for use in Kubota E3 specification engines.**
- **Oil used in the engine should have API classification and Proper SAE Engine Oil Viscosity according to the ambient temperatures where the engine is operated.**
- **With strict emission control regulations now in effect, the CF-4 and CG-4 engine oils have been developed for use with low sulfur fuels, for On-Highway vehicle engines. When a Non-Road engine runs on high sulfur fuel, it is advisable to use a "CF or better" classification engine oil with a high Total Base Number (a minimum TBN of 10 is recommended).**

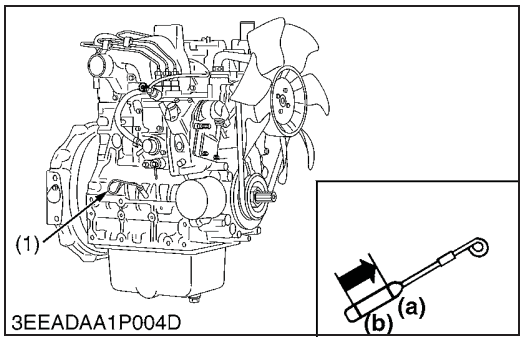
Fuel :

- **Cetane Rating : The minimum recommended Fuel Cetane Rating is 45. A cetane rating greater than 50 is preferred, especially for ambient temperatures below −20 °C (−4 °F) or elevations above 1500 m (5000 ft).**
- **Diesel Fuel Specification Type and Sulfur Content % (ppm) used, must be compliant with all applicable emission regulations for the area in which the engine is operated.**
- **Use of diesel fuel with sulfur content less than 0.10 % (1000 ppm) is strongly recommended.**
- **If high-sulfur fuel (sulfur content 0.50 % (5000 ppm) to 1.0 % (10000 ppm)) is used as a diesel fuel, change the engine oil and oil filter at shorter intervals. (approximately half)**
- **DO NOT USE Fuels that have sulfur content greater than 1.0 % (10000 ppm).**
- **Diesel fuels specified to EN 590 or ASTM D975 are recommended.**
- **No.2-D is a distillate fuel of lower volatility for engines in industrial and heavy mobile service. (SAE J313 JUN87)**
- **Since KUBOTA diesel engines of less than 56 kW (75 hp) utilize EPA Tier 4 and Interim Tier 4 standards, the use of low sulfur fuel or ultra low sulfur fuel is mandatory for these engines, when operated in US EPA regulated areas. Therefore, please use No.2-D S500 or S15 diesel fuel as an alternative to No.2-D, and use No.1-D S500 or S15 diesel fuel as an alternative to No.1-D for ambient temperatures below −10 °C (14 °F).**

1) SAE : Society of Automotive Engineers
2) EN : European Norm
3) ASTM : American Society of Testing and Materials
4) US EPA : United States Environmental Protection Agency
5) No.1-D or No.2-D, S500 : Low Sulfur Diesel (LSD) less than 500 ppm or 0.05 wt.%
   No.1-D or No.2-D, S15 : Ultra Low Sulfur Diesel (ULSD) 15 ppm or 0.0015 wt.%

4. CHECK AND MAINTENANCE

[1] DAILY CHECK POINTS



Checking Engine Oil Level

1. Level the engine.
2. To check the oil level, draw out the dipstick (1), wipe it clean, reinsert it, and draw it out again.
   Check to see that the oil level lies between the two notches.
3. If the level is too low, add new oil to the specified level.

■ **IMPORTANT**

- **When using an oil of different maker or viscosity from the previous, drain old oil. Never mix two different types of oil.**

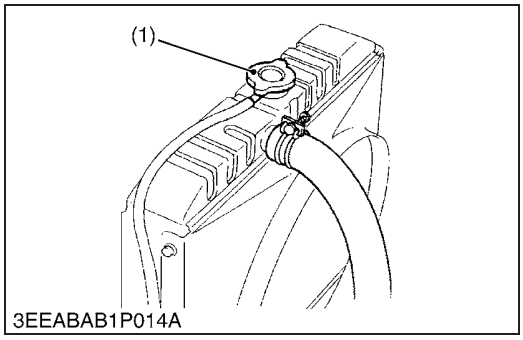
■ **NOTE**

- **Be sure to inspect the engine, locating it on a horizontal place. If placed on gradients, accurately, oil quantity may not be measured.**
- **Be sure to keep the oil level between upper and lower limits of the dipstick. Too much oil may cause a drop in output or excessive blow-by gas. On the closed breather type engine in which mist is sucked through port, too much oil may caused oil hammer. While too little oil, may seize the engine's rotating and sliding parts.**

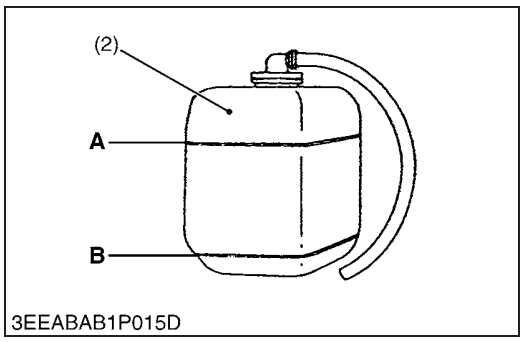
(1) Dipstick

(a) Maximum
(b) Minimum

W1016222



3EEABAB1P014A



3EEABAB1P015D

Checking and Replenish Coolant

1. Without recovery tank :
   Remove the radiator cap (1) and check to see that the coolant level is just below the port.
   With recovery tank (2) :
   Check to see that the coolant level lies between **FULL** (**A**) and **LOW** (**B**).
2. If coolant level is too low, check the reason for decreasing coolant.
   (Case 1)
   If coolant is decreasing by evaporation, replenish only fresh, soft water.
   (Case 2)
   If coolant is decreasing by leak, replenish coolant of the same manufacture and type in the specified mixture ratio (fresh, soft water and L.L.C.). If the coolant brand cannot be identified, drain out all of the remaining coolant and refill with a totally new brand of coolant mix.

CAUTION

- **Do not remove the radiator cap until coolant temperature is below its boiling point. Then loosen the cap slightly to relieve any excess pressure before removing the cap completely.**

■ **IMPORTANT**

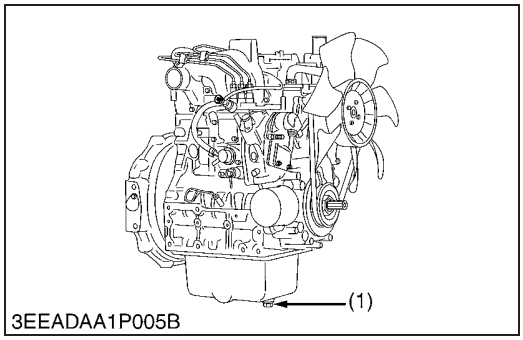
- **During filling the coolant, air must be vented from the engine coolant passages. The air vents by jiggling the radiator upper and lower hoses.**
- **Be sure to close the radiator cap securely. If the cap is loose or improperly closed, coolant may leak out and the engine could overheat.**
- **Do not use an antifreeze and scale inhibitor at the same time.**
- **Never mix the different type or brand of L.L.C..**

(1) Radiator Cap
(2) Recovery Tank

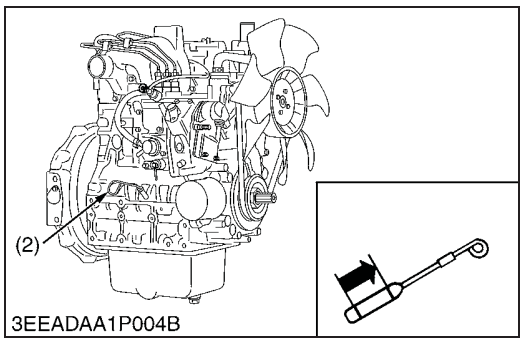
A : FULL
B : LOW

W1035779

[2] CHECK POINTS OF INITIAL 50 HOURS



3EEADAA1P005B



3EEADAA1P004B

Changing Engine Oil

CAUTION

- **Be sure to stop engine before changing engine oil.**

1. Start and warm up the engine for approx. 5 minutes.
2. Place an oil pan underneath the engine.
3. To drain the used oil, remove the drain plug (1) at the bottom of the engine and drain the oil completely.
4. Screw the drain plug (1).
5. Fill new oil up to upper line on the dipstick (2).

■ **IMPORTANT**

- **When using an oil of different maker or viscosity from the previous one, remove all of the old oil.**
- **Never mix two different types of oil.**
- **Engine oil should have properties of API classification CF (See page G-7).**
- **Use the proper SAE Engine Oil according to ambient temperature.**

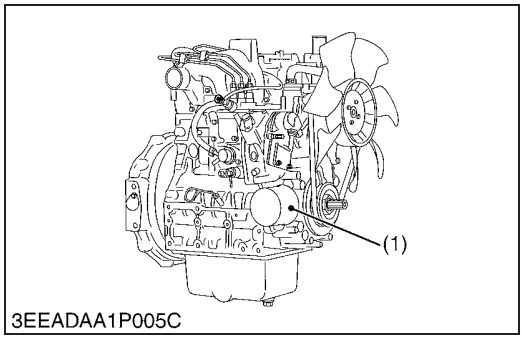
Above 25 °C (77 °F)	SAE 30 or SAE 10W-30 SAE 10W-40
0 °C to 25 °C (32 °F to 77 °F)	SAE 20 or SAE 10W-30 SAE 10W-40
Below 0 °C (32 °F)	SAE 10W or SAE 10W-30 SAE 10W-40

Models	Oil pan depth	
	124 mm (4.88 in.)	*90 mm (3.5 in.)
D1503-M, D1703-M D1803-M, D1803-M-DI D1703-M-BG	7.0 L 1.8 U.S.gals	5.6 L 1.5 U.S.gals
V2003-M, V2203-M V2403-M, V2403-M-DI, V2403-M-DI-T V2003-M-BG, V2003-M-T-BG V2203-M-BG, V2403-M-BG	9.5 L 2.5 U.S.gals	7.6 L 2.0 U.S.gals
V2403-M-T	9.5 L 2.5 U.S.gals	–

*90 mm (3.5 in.) oil pan depth is optional.

(1) Drain Plug (2) Dipstick

W1016604



3EEADAA1P005C

Replacing Oil Filter Cartridge

CAUTION

- **Be sure to stop the engine before replacing filter cartridge.**

1. Remove the oil filter cartridge (1) with the filter wrench.
2. Apply a slight coat of oil onto the new cartridge gasket.
3. To install the new cartridge, screw it in by hand. Over tightening may cause deformation of rubber gasket.
4. After the new cartridge has been replaced, the engine oil normally decrease a little. Thus see that the engine oil does not leak through the seal and be sure to read the oil level on the dipstick. Then, replenish the engine oil up to the specified level.

IMPORTANT

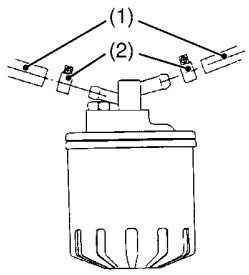
- **To prevent serious damage to the engine, replacement element must be highly efficient. Use only a KUBOTA genuine filter or its equivalent.**

(1) Engine Oil Filter Cartridge

W1013487

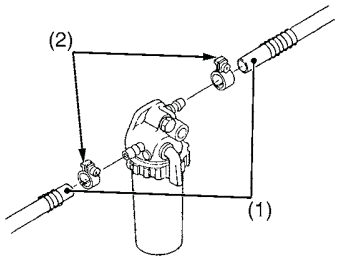
[3] CHECK POINTS OF EVERY 50 HOURS

[A]



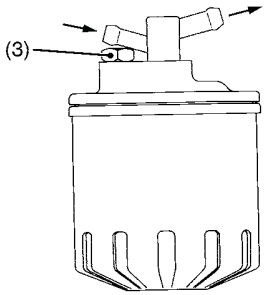
3EEACAA1P057D

[B]



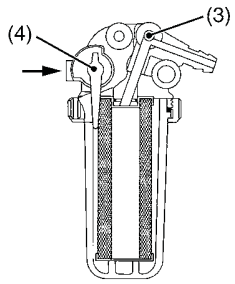
3EEACAA1P058B

[A]

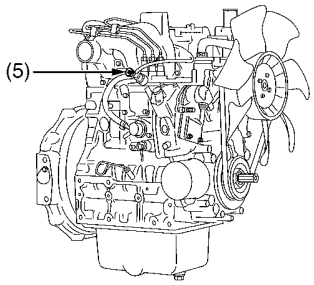


3EEACAA1P059A

[B]



3EEACAA1P060A



3EEADAA1P005A

Checking Fuel Hoses and Clamp Bands

1. If the clamp (2) is loose, apply oil to the threads and securely retighten it.
2. The fuel hose (1) is made of rubber and ages regardless of the period service.
   Change the fuel hose together with the clamp every two years.
3. However, if the fuel hose and clamp are found to be damaged or deteriorate earlier than two years, then change or remedy.
4. After the fuel hose and the clamp have been changed, bleed the fuel system.

CAUTION

- **Stop the engine when attempting the check and change prescribed above.**

(When bleeding fuel system)

1. Fill the tank with fuel and open the fuel cock (4). (**[B]** only.)
2. Loosen the air vent plug (3) of the fuel filter a few turns.
3. Screw back the plug when bubbles do not come up any more.
4. Open the air vent cock (5) on top of the fuel injection pump.
5. If equipped electrical fuel feed pump, turn the key to **AC** position and pump the fuel up for 10 to 15 seconds.
   If equipped mechanical fuel feed pump, set the stop lever on stop position and crank the engine for 10 to 15 seconds.
6. Close securely the air vent cock after air bleeding.

■ **NOTE**

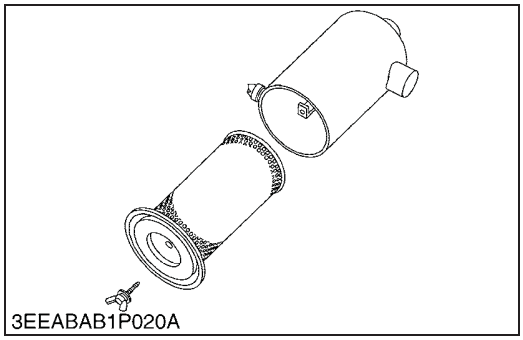
- **Always keep the air vent cock on the fuel injection pump closed except when air is vented, or it may cause the engine to stop.**

(1) Fuel Hose
(2) Clamp
(3) Air Vent Plug
(4) Fuel Cock
(5) Air Vent Cock

[A] Cartridge Type
[B] Element Type

W1035921

[4] CHECK POINTS OF EVERY 100 HOURS


3EEABAB1P020A

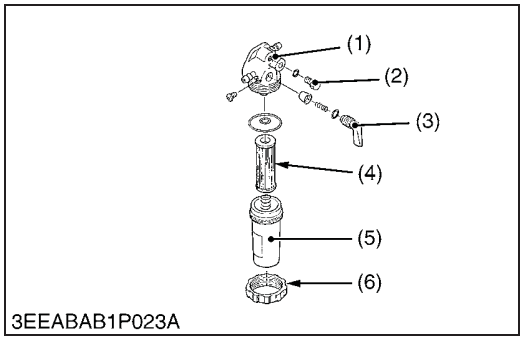
Cleaning Air Cleaner Element

1. Remove the air cleaner element.
2. Use clean dry compressed air on the inside of the element.
   Pressure of compressed air must be under 210 kPa (2.1 kgf/cm^2, 30 psi).
   Maintain reasonable distance between the nozzle and the filter.

■ **NOTE**

- **The air cleaner uses a dry element. Never apply oil to it.**
- **Do not run the engine with filter element removed.**
- **Change the element once a year or every 6th cleaning.**

W1045746



3EEABAB1P023A

Cleaning Fuel Filter (Element Type only)

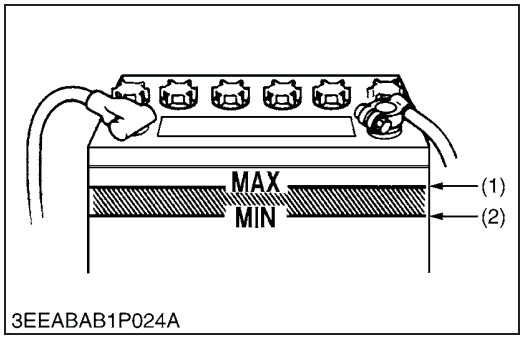
1. Close the fuel cock (3).
2. Unscrew the retaining ring (6) and remove the filter cup (5), and rinse the inside with kerosene.
3. Take out the element (4) and dip it in the kerosene to rinse.
4. After cleaning, reassemble the fuel filter, keeping out dust and dirt.
5. Bleed the fuel system.

■ **IMPORTANT**

- **If dust and dirt enter the fuel, the fuel injection pump and injection nozzle will wear quickly. To prevent this, be sure to clean the fuel filter cup (5) periodically.**

(1) Cock Body
(2) Air Vent Plug
(3) Fuel Cock
(4) Filter Element
(5) Filter Cup
(6) Retaining Ring

W1046058



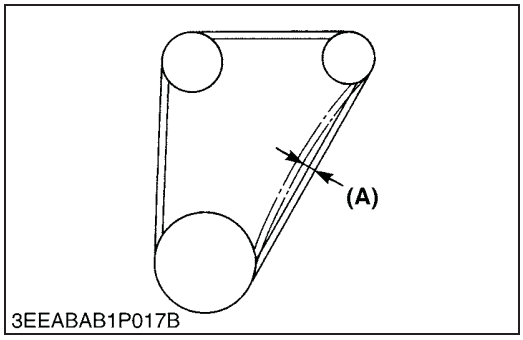
3EEABAB1P024A

Checking Battery Electrolyte Level

1. Check the battery electrolyte level.
2. If the level is below than lower level line (2), and the distilled water to pour level of each cell.

(1) Upper Level Line
(2) Lower Level Line

W1047154



3EEABAB1P017B

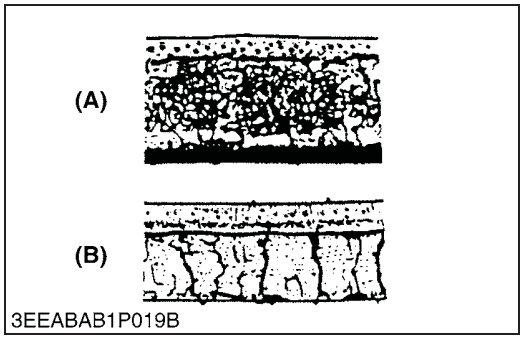
Fan Belt Tension

1. Measure the deflection **(A)**, depressing the belt halfway between the fan drive pulley and alternator pulley at specified force 98 N (10 kgf, 22 lbf).
2. If the measurement is not within the factory specifications, loosen the alternator mounting screws and relocate the alternator to adjust.

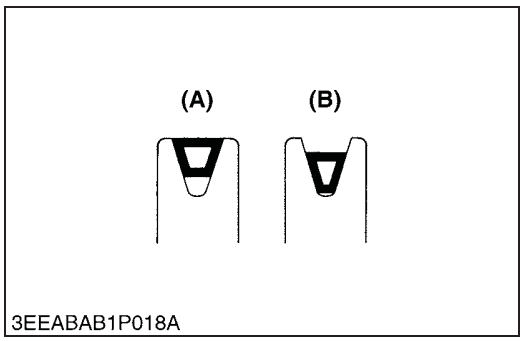
Deflection **(A)**	Factory spec.	7.0 to 9.0 mm 0.28 to 0.35 in.

(A) Deflection

W1208957



3EEABAB1P019B



3EEABAB1P018A

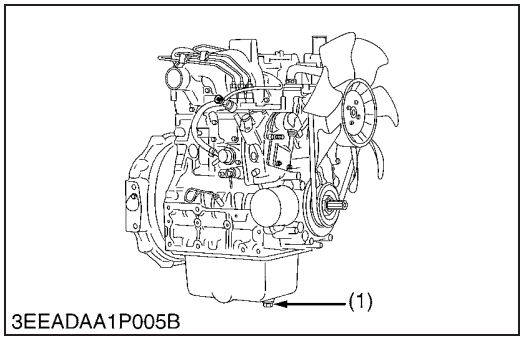
Fan Belt Damage and Wear

1. Check the fan belt for damage.
2. If the fan belt is damaged, replace it.
3. Check if the fan belt is worn and sunk in the pulley groove.
4. If the fan belt is nearly worn out and deeply sunk in the pulley groove, replace it.

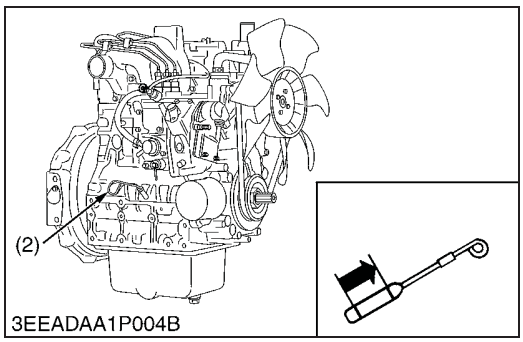
(A) Good **(B) Bad**

W1057475

[5] CHECK POINTS OF EVERY 150 HOURS



3EEADAA1P005B



3EEADAA1P004B

Changing Engine Oil (for 90 mm (3.5 in.) Depth Oil Pan)

[D1503-M, D1703-M, D1803-M, V2003-M, V2203-M, V2403-M] [D1703-M-BG, V2003-M-BG, V2003-M-T-BG, V2203-M-BG, V2403-M-BG]

CAUTION

- **Be sure to stop engine before changing engine oil.**

1. Start and warm up the engine for approx. 5 minutes.
2. Place an oil pan underneath the engine.
3. To drain the used oil, remove the drain plug (1) at the bottom of the engine and drain the oil completely.
4. Screw the drain plug (1).
5. Fill new oil up to upper line on the dipstick (2).

■ **IMPORTANT**

- **When using an oil of different maker or viscosity from the previous one, remove all of the old oil.**
- **Never mix two different types of oil.**
- **Engine oil should have properties of API classification CF (See page G-7).**
- **Use the proper SAE Engine Oil according to ambient temperature.**

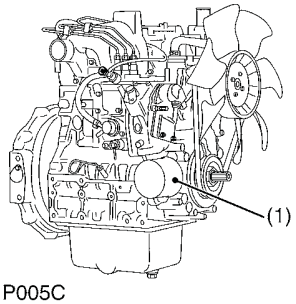
Above 25 °C (77 °F)	SAE 30 or SAE 10W-30 SAE 10W-40
0 °C to 25 °C (32 °F to 77 °F)	SAE 20 or SAE 10W-30 SAE 10W-40
Below 0 °C (32 °F)	SAE 10W or SAE 10W-30 SAE 10W-40

Models	Oil pan depth	
	124 mm (4.88 in.)	*90 mm (3.5 in.)
D1503-M D1703-M D1803-M D1703-M-BG	7.0 L 1.8 U.S.gals	5.6 L 1.5 U.S.gals
V2003-M V2203-M V2403-M V2003-M-BG V2003-M-T-BG V2203-M-BG V2403-M-BG	9.5 L 2.5 U.S.gals	7.6 L 2.0 U.S.gals

*90 mm (3.5 in.) oil pan depth is optional.

(1) Drain Plug (2) Dipstick

W1022029



3EEADAA1P005C

Replacing Oil Filter Cartridge (for 90 mm (3.5 in.) Depth Oil Pan)

[D1503-M, D1703-M, D1803-M, V2003-M, V2203-M, V2403-M] [D1703-M-BG, V2003-M-BG, V2003-M-T-BG, V2203-M-BG, V2403-M-BG]

CAUTION

- **Be sure to stop the engine before replacing filter cartridge.**

1. Remove the oil filter cartridge (1) with the filter wrench.
2. Apply a slight coat of oil onto the new cartridge gasket.
3. To install the new cartridge, screw it in by hand. Over tightening may cause deformation of rubber gasket.
4. After the new cartridge has been replaced, the engine oil normally decrease a little. Thus see that the engine oil does not leak through the seal and be sure to read the oil level on the dipstick. Then, replenish the engine oil up to the specified level.

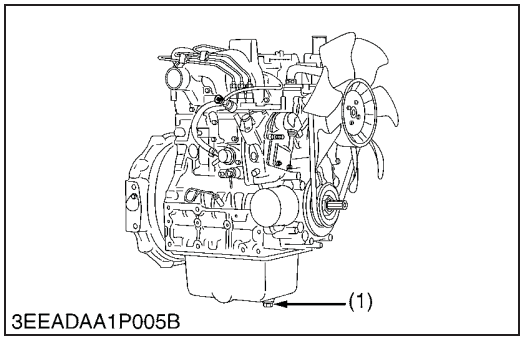
IMPORTANT

- **To prevent serious damage to the engine, replacement element must be highly efficient. Use only a KUBOTA genuine filter or its equivalent.**

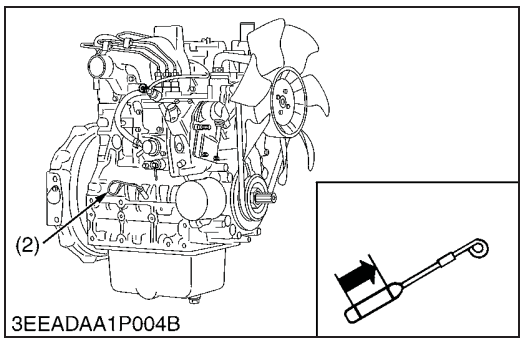
(1) Engine Oil Filter Cartridge

W1022423

[6] CHECK POINTS OF EVERY 200 HOURS



3EEADAA1P005B



3EEADAA1P004B

Changing Engine Oil (for 124 mm (4.88 in.) Depth Oil Pan)

[D1503-M, D1703-M, D1803-M, V2003-M, V2203-M, V2403-M, V2403-M-T]

[D1703-M-BG, V2003-M-BG, V2003-M-T-BG, V2203-M-BG, V2403-M-BG]

CAUTION

- **Be sure to stop engine before changing engine oil.**

1. Start and warm up the engine for approx. 5 minutes.
2. Place an oil pan underneath the engine.
3. To drain the used oil, remove the drain plug (1) at the bottom of the engine and drain the oil completely.
4. Screw the drain plug (1).
5. Fill new oil up to upper line on the dipstick (2).

■ **IMPORTANT**

- **When using an oil of different maker or viscosity from the previous one, remove all of the old oil.**
- **Never mix two different types of oil.**
- **Engine oil should have properties of API classification CF (See page G-7).**
- **Use the proper SAE Engine Oil according to ambient temperature.**

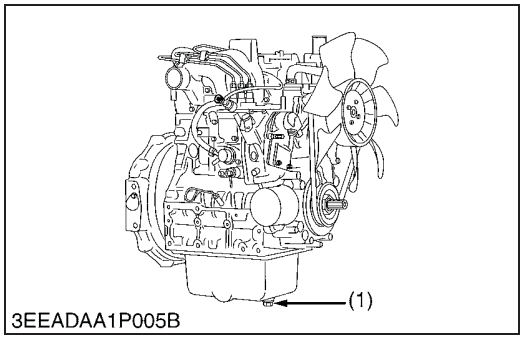
Above 25 °C (77 °F)	SAE 30 or SAE 10W-30 SAE 10W-40
0 °C to 25 °C (32 °F to 77 °F)	SAE 20 or SAE 10W-30 SAE 10W-40
Below 0 °C (32 °F)	SAE 10W or SAE 10W-30 SAE 10W-40

Models	Oil pan depth	
	124 mm (4.88 in.)	*90 mm (3.5 in.)
D1503-M D1703-M D1803-M D1703-M-BG	7.0 L 1.8 U.S.gals	5.6 L 1.5 U.S.gals
V2003-M V2203-M V2403-M V2003-M-BG V2003-M-T-BG V2203-M-BG V2403-M-BG	9.5 L 2.5 U.S.gals	7.6 L 2.0 U.S.gals
V2403-M-T	9.5 L 2.5 U.S.gals	–

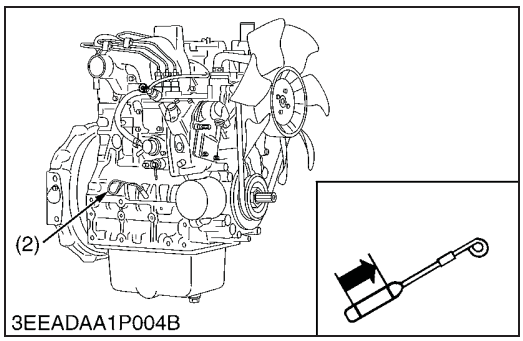
*90 mm (3.5 in.) oil pan depth is optional.

(1) Drain Plug (2) Dipstick

W1022765



3EEADAA1P005B



3EEADAA1P004B

Changing Engine Oil (for 90 mm (3.5 in.) Depth Oil Pan)

[D1803-M-DI, V2403-M-DI, V2403-M-DI-T]

CAUTION

- **Be sure to stop engine before changing engine oil.**

1. Start and warm up the engine for approx. 5 minutes.
2. Place an oil pan underneath the engine.
3. To drain the used oil, remove the drain plug (1) at the bottom of the engine and drain the oil completely.
4. Screw the drain plug (1).
5. Fill new oil up to upper line on the dipstick (2).

■ **IMPORTANT**

- **When using an oil of different maker or viscosity from the previous one, remove all of the old oil.**
- **Never mix two different types of oil.**
- **Engine oil should have properties of API classification CF (See page G-7).**
- **Use the proper SAE Engine Oil according to ambient temperature.**

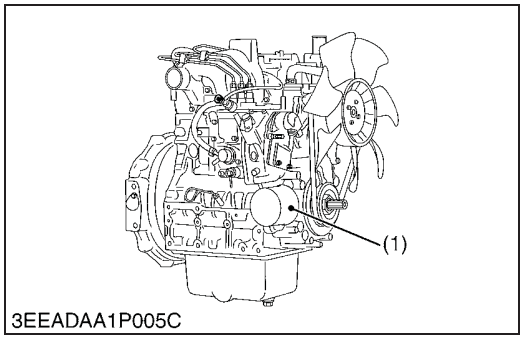
Above 25 °C (77 °F)	SAE 30 or SAE 10W-30 SAE 10W-40
0 °C to 25 °C (32 °F to 77 °F)	SAE 20 or SAE 10W-30 SAE 10W-40
Below 0 °C (32 °F)	SAE 10W or SAE 10W-30 SAE 10W-40

Models	Oil pan depth	
	124 mm (4.88 in.)	*90 mm (3.5 in.)
D1803-M-DI	7.0 L 1.8 U.S.gals	5.6 L 1.5 U.S.gals
V2403-M-DI V2403-M-DI-T	9.5 L 2.5 U.S.gals	7.6 L 2.0 U.S.gals

*90 mm (3.5 in.) oil pan depth is optional.

(1) Drain Plug (2) Dipstick

W1034539



3EEADAA1P005C

Replacing Oil Filter Cartridge (for 124 mm (4.88 in.) Depth Oil Pan)

[D1503-M, D1703-M, D1803-M, V2003-M, V2203-M, V2403-M, V2403-M-T]
[D1703-M-BG, V2003-M-BG, V2003-M-T-BG, V2203-M-BG, V2403-M-BG]

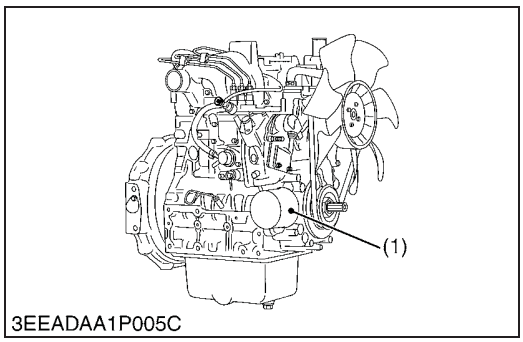
CAUTION
- **Be sure to stop the engine before replacing filter cartridge.**

1. Remove the oil filter cartridge (1) with the filter wrench.
2. Apply a slight coat of oil onto the new cartridge gasket.
3. To install the new cartridge, screw it in by hand. Over tightening may cause deformation of rubber gasket.
4. After the new cartridge has been replaced, the engine oil normally decrease a little. Thus see that the engine oil does not leak through the seal and be sure to read the oil level on the dipstick. Then, replenish the engine oil up to the specified level.

IMPORTANT
- **To prevent serious damage to the engine, replacement element must be highly efficient. Use only a KUBOTA genuine filter or its equivalent.**

(1) Engine Oil Filter Cartridge

W1023046



3EEADAA1P005C

Replacing Oil Filter Cartridge (for 90 mm (3.5 in.) Depth Oil Pan)

[D1803-M-DI, V2403-M-DI, V2403-M-DI-T]

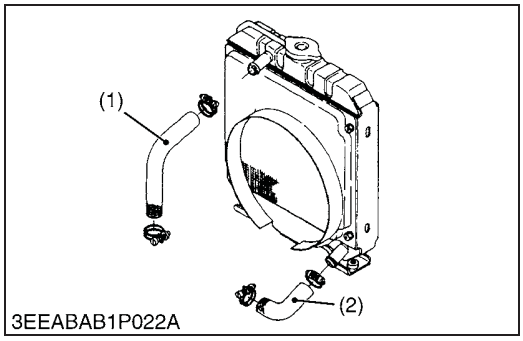
CAUTION
- **Be sure to stop the engine before replacing filter cartridge.**

1. Remove the oil filter cartridge (1) with the filter wrench.
2. Apply a slight coat of oil onto the new cartridge gasket.
3. To install the new cartridge, screw it in by hand. Over tightening may cause deformation of rubber gasket.
4. After the new cartridge has been replaced, the engine oil normally decrease a little. Thus see that the engine oil does not leak through the seal and be sure to read the oil level on the dipstick. Then, replenish the engine oil up to the specified level.

IMPORTANT
- **To prevent serious damage to the engine, replacement element must be highly efficient. Use only a KUBOTA genuine filter or its equivalent.**

(1) Engine Oil Filter Cartridge

W1035283



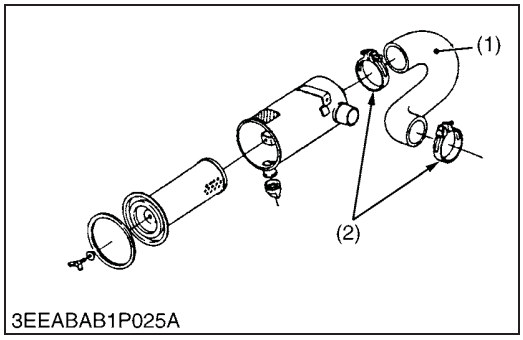
3EEABAB1P022A

Checking Radiator Hoses and Clamp Bands

1. Check to see if the radiator hoses are properly fixed every 200 hours of operation or every six months, whichever comes first.
2. If the clamp is loose, apply oil to the threads and retighten it securely.
3. The water hose is made of rubber and tends to age. It must be replaced every two years. Also replace the clamp and tighten it securely.

(1) Upper Hose (2) Lower Hose

W1029518



3EEABAB1P025A

Checking Intake Air Line

1. Check to see if the intake air hose(s) are properly fixed every 200 hours of operation.
2. If the clamp is loose, apply oil to the threads and retighten it securely.
3. The intake air hose(s) is made of rubber and tends to age. It must be changed every two years. Also change the clamp and tighten it securely.

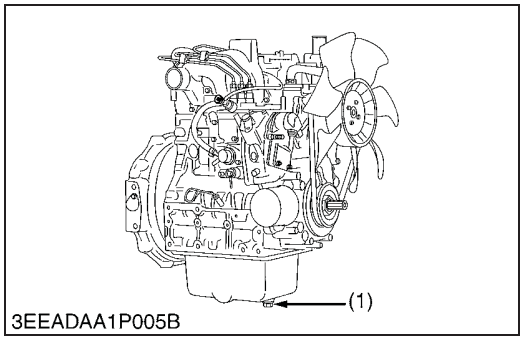
■ **IMPORTANT**

- **To prevent serious damage to the engine, keep out any dust inside the intake air line.**

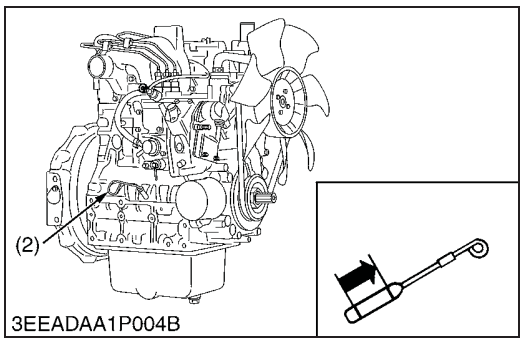
(1) Intake Air Hose (2) Clamp

W1029631

[7] CHECK POINTS OF EVERY 400 HOURS



3EEADAA1P005B



3EEADAA1P004B

Changing Engine Oil (for 124 mm (4.88 in.) Depth Oil Pan)
[D1803-M-DI, V2403-M-DI, V2403-M-DI-T]

CAUTION

- **Be sure to stop engine before changing engine oil.**

1. Start and warm up the engine for approx. 5 minutes.
2. Place an oil pan underneath the engine.
3. To drain the used oil, remove the drain plug (1) at the bottom of the engine and drain the oil completely.
4. Screw the drain plug (1).
5. Fill new oil up to upper line on the dipstick (2).

■ IMPORTANT

- **When using an oil of different maker or viscosity from the previous one, remove all of the old oil.**
- **Never mix two different types of oil.**
- **Engine oil should have properties of API classification CF (See page G-7).**
- **Use the proper SAE Engine Oil according to ambient temperature.**

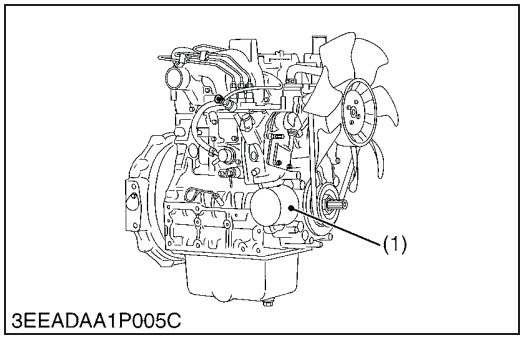
Above 25 °C (77 °F)	SAE 30 or SAE 10W-30 SAE 10W-40
0 °C to 25 °C (32 °F to 77 °F)	SAE 20 or SAE 10W-30 SAE 10W-40
Below 0 °C (32 °F)	SAE 10W or SAE 10W-30 SAE 10W-40

Models	Oil pan depth	
	124 mm (4.88 in.)	*90 mm (3.5 in.)
D1803-M-DI	7.0 L 1.8 U.S.gals	5.6 L 1.5 U.S.gals
V2403-M-DI V2403-M-DI-T	9.5 L 2.5 U.S.gals	7.6 L 2.0 U.S.gals

*90 mm (3.5 in.) oil pan depth is optional.

(1) Drain Plug (2) Dipstick

W1035850



3EEADAA1P005C

Replacing Oil Filter Cartridge (for 124 mm (4.88 in.) Depth Oil Pan)

[D1803-M-DI, V2403-M-DI, V2403-M-DI-T]

CAUTION

- **Be sure to stop the engine before replacing filter cartridge.**

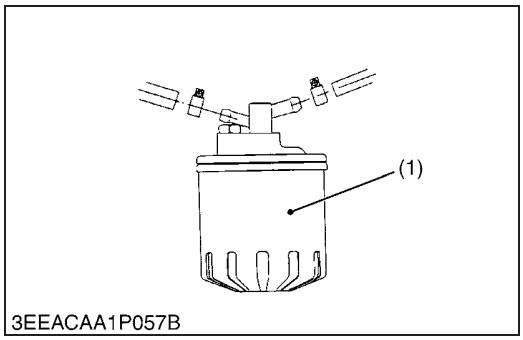
1. Remove the oil filter cartridge (1) with the filter wrench.
2. Apply a slight coat of oil onto the new cartridge gasket.
3. To install the new cartridge, screw it in by hand. Over tightening may cause deformation of rubber gasket.
4. After the new cartridge has been replaced, the engine oil normally decrease a little. Thus see that the engine oil does not leak through the seal and be sure to read the oil level on the dipstick. Then, replenish the engine oil up to the specified level.

IMPORTANT

- **To prevent serious damage to the engine, replacement element must be highly efficient. Use only a KUBOTA genuine filter or its equivalent.**

(1) Engine Oil Filter Cartridge

W1036519



3EEACAA1P057B

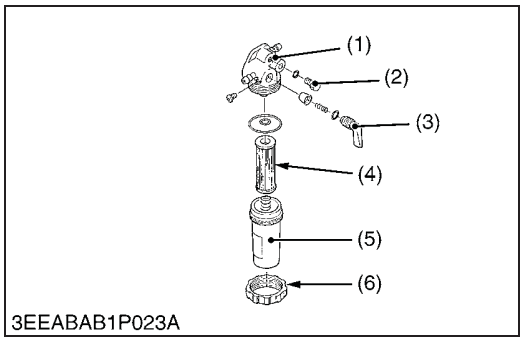
Replacing Fuel Filter Cartridge (Cartridge Type)

Water and dust in fuel are collected in the filter cartridge. So, change the filter cartridge every 400 hours service.

1. Remove the used filter cartridge with filter wrench.
2. Apply a thin film of fuel to the surface of new filter cartridge gasket before screwing on.
3. Then tighten enough by hand.
4. Loosen the air vent plug to let the air out.
5. Start engine and check for fuel leakage.

(1) Fuel Filter Cartridge

W1050548



3EEABAB1P023A

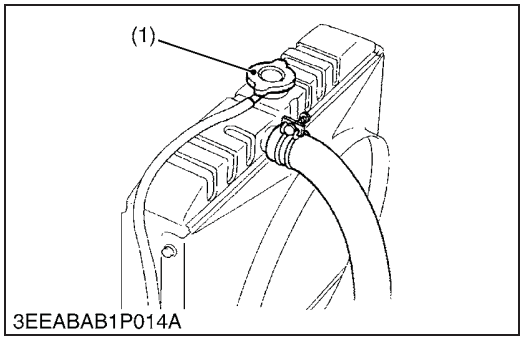
Replacing Fuel Filter Element (Element Type)

1. Close the fuel cock (3).
2. Unscrew the retaining ring (6) and remove the filter cup (5), and rinse the inside with kerosene.
3. Replace the filter element (4).
4. Reassemble the fuel filter, keeping out dust and dirt.
5. Bleed the fuel system.

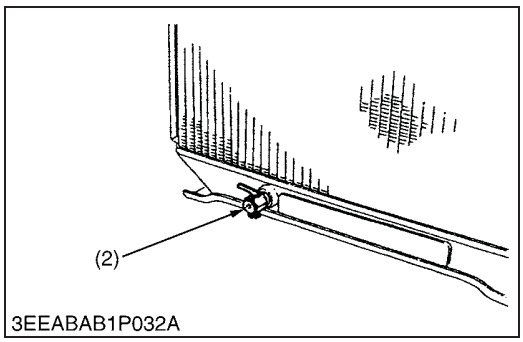
(1) Cock Body
(2) Air Vent Plug
(3) Fuel Cock
(4) Filter Element
(5) Filter Cup
(6) Retaining Ring

W1050583

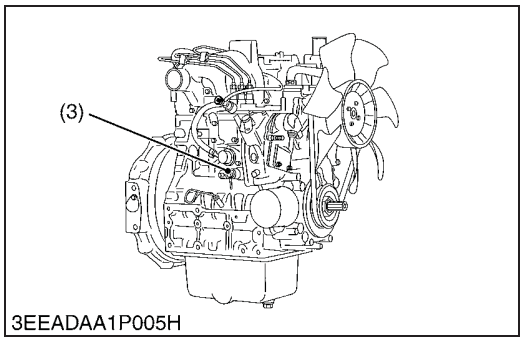
[8] CHECK POINTS OF EVERY 500 HOURS



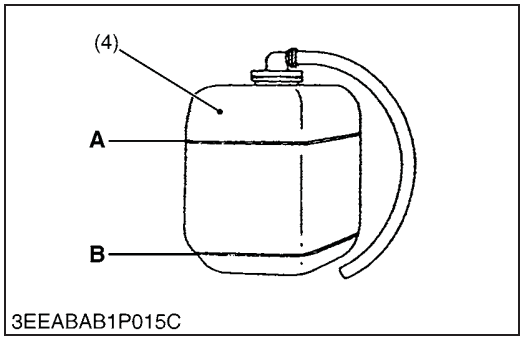
3EEABAB1P014A



3EEABAB1P032A



3EEADAA1P005H



3EEABAB1P015C

Cleaning Water Jacket and Radiator Interior

CAUTION

- **Do not remove the radiator cap when the engine is hot. Then loosen cap slightly to the stop to relieve any excess pressure before removing cap completely.**

1. Stop the engine and let cool down.
2. To drain the coolant, open the radiator drain plug (2) and remove the radiator cap (1). Then radiator cap (1) must be removed to completely drain the coolant. And open the drain cock (3).
3. After all coolant is drained, close the drain plug.
4. Fill with clean water and cooling system cleaner.
5. Follow directions of the cleaner instruction.
6. After flushing, fill with clean water and anti-freeze until the coolant level is just below the port. Install the radiator cap (1) securely.
7. Fill with coolant up to “FULL” (**A**) mark on the recovery tank (4).
8. Start and operate the engine for few minutes.
9. Stop the engine and let cool. Check coolant level of radiator and recovery tank (4) and add coolant if necessary.

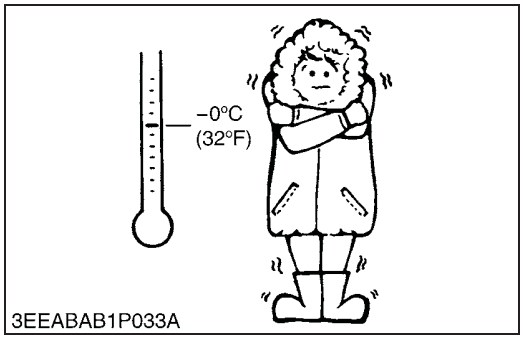
■ **IMPORTANT**

- **Do not start engine without coolant.**
- **Use clean, fresh, soft water and anti-freeze to fill the radiator and recovery tank.**
- **When the anti-freeze is mixed with fresh, soft water, the anti-freeze mixing ratio must be less than 50 %.**
- **Securely tighten radiator cap. If the cap is loose or improperly fitted, water may leak out and the engine could overheat.**

(1) Radiator Cap
(2) Drain Plug
(3) Drain Cock
(4) Recovery Tank

A : Full
B : Low

W1038102



Anti-Freeze

- There are two types of anti-freeze available: use the permanent type (PT) for this engine.
- Before adding anti-freeze for the first time, clean the radiator interior by pouring fresh, soft water and draining it a few times.
- The procedure for mixing water and anti-freeze differs according to the make of the anti-freeze and the ambient temperature. Basically, it should be referred to SAE J1034 standard, more specifically also to SAE J814c.
- Mix the anti-freeze with fresh, soft water, and then fill into the radiator.

■ **IMPORTANT**

- **When the anti-freeze is mixed with fresh, soft water, the anti-freeze mixing ratio must be less than 50 %.**

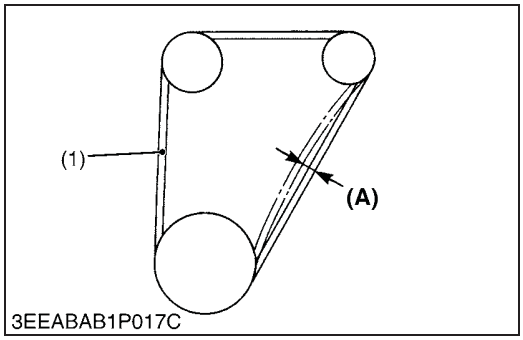
Vol % anti-freeze	Freezing point		Boiling point*	
	°C	°F	°C	°F
40	–24	–11	106	223
50	–37	–35	108	226

* At 1.01 × 100000 Pa (760 mmHg) pressure (atmospheric). A higher boiling point is obtained by using a radiator pressure cap which permits the development of pressure within the cooling system.

■ **NOTE**

- **The above data represents industrial standards that necessitate a minimum glycol content in the concentrated anti-freeze.**
- **When the coolant level drops due to evaporation, add fresh, soft water only to keep the anti-freeze mixing ratio less than 50 %. In case of leakage, add anti-freeze and fresh, soft water in the specified mixing ratio.**
- **Anti-freeze absorbs moisture. Keep unused anti-freeze in a tightly sealed container.**
- **Do not use radiator cleaning agents when anti-freeze has been added to the coolant.**
  (Anti-freeze contains an anti-corrosive agent, which will react with the radiator cleaning agent forming sludge which will affect the engine parts.)

W1039218



Replacing Fan Belt

1. Remove the alternator.
2. Remove the fan belt (1).
3. Replace new fan belt.
4. Install the alternator.
5. Check the fan belt tension.

Deflection **(A)**	Factory spec.	7.0 to 9.0 mm / 98 N 0.28 to 0.35 in. / 98 N (10 kgf, 22 lbf)

(1) Fan Belt **(A) Deflection**

W1052220

[9] CHECK POINTS OF EVERY 1 OR 2 MONTHS

Recharging

CAUTION

- **When the battery is being activated, hydrogen and oxygen gases in the battery are extremely explosive. Keep open sparks and flames away from the battery at all times, especially when charging the battery.**
- **When charging battery, remove battery vent plugs.**
- **When disconnecting the cable from the battery, start with the negative terminal first. When connecting the cable to the battery, start with the positive terminal first.**
- **Never check battery charge by placing a metal object across the posts.**
  Use a voltmeter or hydrometer.

1) Slow Charging

1. Add distilled water if the electrolyte level is low. When charging, the amount of electrolyte should be slightly lower than the specified level to prevent overflow.
2. Connect the battery to the charging unit, following the manufacture's instructions.
3. As the electrolyte generates gas while charging, remove all port caps.
4. The electrolyte temperature must not exceed 40 °C (104 °F) during charging.
   If it exceed 40 °C (104 °F), decrease the charging amperage or stop charging for a while.
5. When charging several batteries in series, charge at the rate of the smallest battery in the line.

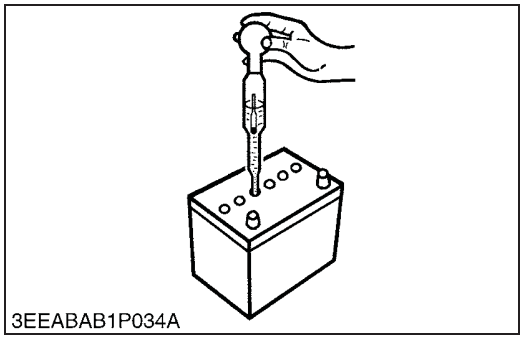
2) Quick Charging

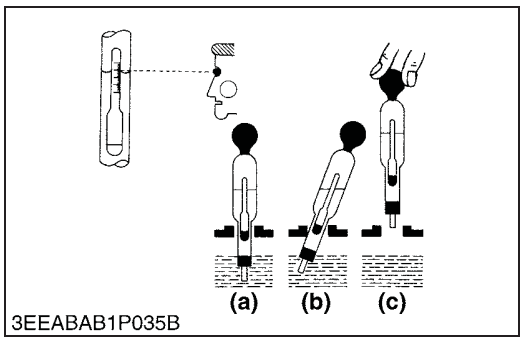
1. Determine the proper charging current and charging time with the tester attached to the quick charger.
2. Determine the proper charging current as 1/1 of the battery capacity. If the battery capacity exceeds 50 Ah, consider 50 A as the maximum.

■ **Precaution for Operating a Quick Charger**

- Operate with a quick charger differs according to the type.
  Consult the instruction manual and use accordingly.

W1052658


3EEABAB1P034A



3EEABAB1P035B

Battery Specific Gravity

1. Check the specific gravity of the electrolyte in each cell with a hydrometer.
2. When the electrolyte temperature differs from that at which the hydrometer was calibrated, correct the specific gravity reading following the formula mentioned in **(Reference)**.
3. If the specific gravity is less than 1.215 (after it is corrected for temperature), charge or replace the battery.
4. If the specific gravity differs between any two cells by more than 0.05, replace the battery.

■ **NOTE**

- **Hold the hydrometer tube vertical without removing it from the electrolyte.**
- **Do not suck too much electrolyte into the tube.**
- **Allow the float to move freely and hold the hydrometer at eye level.**
- **The hydrometer reading must be taken at the highest electrolyte level.**

(Reference)

- Specific gravity slightly varies with temperature. To be exact, the specific gravity decreases by 0.0007 with an increase of 1 °C (0.0004 with an increase of 1 °F) in temperature, and increases by 0.0007 with a decreases of 1 °C (0.0004 with a decrease of 1 °F).

  Therefore, using 20 °C (68 °F) as a reference, the specific gravity reading must be corrected by the following formula :
  - Specific gravity at 20 °C = Measured value + 0.0007 × (electrolyte temperature : 20 °C)
  - Specific gravity at 68 °F = Measured value + 0.0004 × (electrolyte temperature : 68 °F)

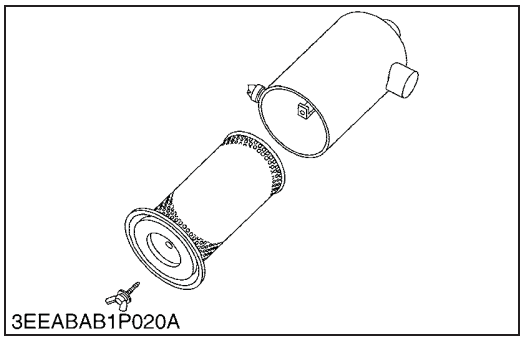
Specific Gravity	State of Charge
1.260 Sp. Gr.	100 % Charged
1.230 Sp. Gr.	75 % Charged
1.200 Sp. Gr.	50 % Charged
1.170 Sp. Gr.	25 % Charged
1.140 Sp. Gr.	Very Little Useful Capacity
1.110 Sp. Gr.	Discharged

At an electrolyte temperature of 20 °C (68 °F)

(a) Good
(b) Bad
(c) Bad

W1012763

[10] CHECK POINTS OF EVERY YEAR


3EEABAB1P020A

Replacing Air Cleaner Element

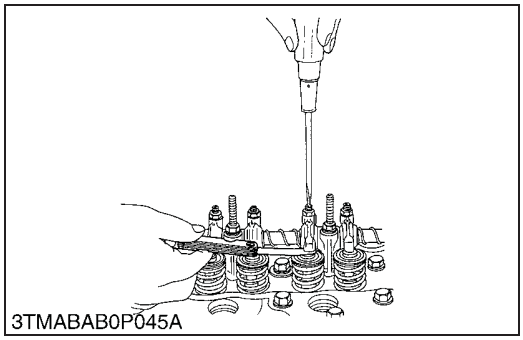
1. Remove used air cleaner element.
2. Replace new air cleaner element.

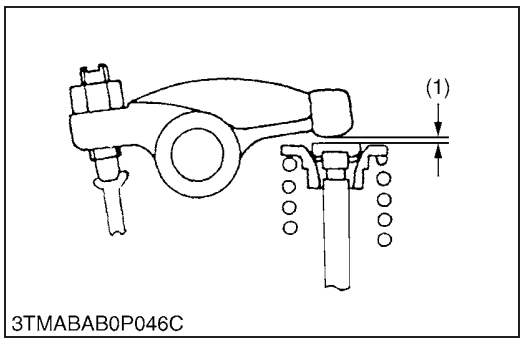
■ **NOTE**

- **The air cleaner uses a dry element. Never apply oil to it.**
- **Do not run the engine with filter element removed.**

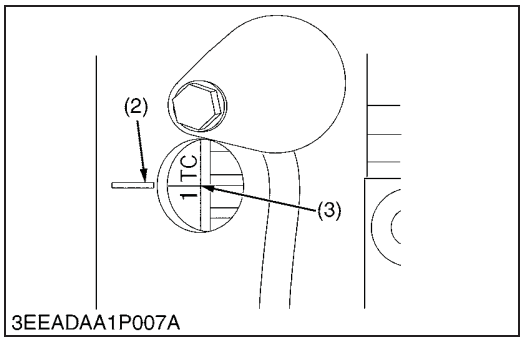
W1020554

[11] CHECK POINTS OF EVERY 800 HOURS


3TMABAB0P045A



3TMABAB0P046C



3EEADAA1P007A

Valve Clearance

■ **IMPORTANT**

- **Valve clearance must be checked and adjusted when engine is cold.**

1. Remove the head cover.
2. Align the **"1TC"** mark line (3) on the flywheel and projection (2) on the housing so that the No.1 piston comes to the compression or overlap top dead center.
3. Check the following valve clearance (1) marked with "☆" using a feeler gauge.
4. If the clearance is not within the factory specifications, adjust with the adjusting screw.

Valve clearance	Factory spec.	0.18 to 0.22 mm 0.0071 to 0.0086 in.

■ **NOTE**

- **The "1TC" mark line on the flywheel is just for No. 1 cylinder. There is no "TC" marking for the other cylinders.**
- **No. 1 piston comes to the top dead center position when the "TC" marking is aligned with the projection (2) in the window on flywheel-housing. Turn the flywheel 0.26 rad (15 °) clockwise and counterclockwise to see if the piston is at the compression top dead center or the overlap position. Now referring to the table below, readjust the valve clearance (1). (The piston is at the top dead center when both the IN. and EX. valves do not move; it is at the overlap position when both the valves move.)**
- **Finally turn the flywheel 6.28 rad (360 °) and align the "1TC" mark line and the projection (2) perfectly. Adjust all the other valve clearance as required.**
- **After turning the flywheel counterclockwise twice or three times, recheck the valve clearance (1).**
- **After adjusting the valve clearance (1), firmly tighten the lock nut of the adjusting screw.**

Valve arrangement / Adjustable cylinder location of piston		3 Cylinder		4 Cylinder	
		IN.	EX.	IN.	EX.
When No. 1 piston is at compression top dead center	No. 1	☆	☆	☆	☆
	No. 2		☆	☆	
	No. 3	☆			☆
	No. 4	–	–		
When No. 1 piston is at overlap position	No. 1				
	No. 2	☆			☆
	No. 3		☆	☆	
	No. 4	–	–	☆	☆

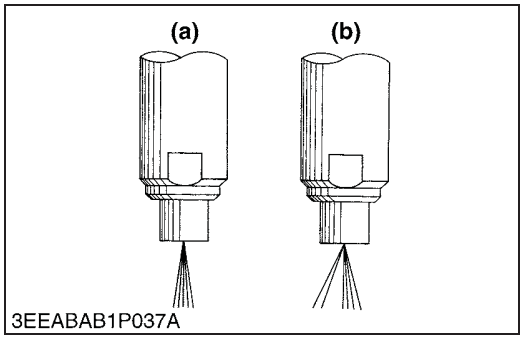
(1) Valve Clearance
(2) Projection
(3) 1TC Mark Line

W10113200

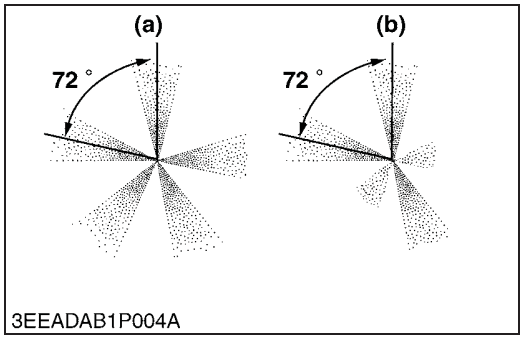
[12] CHECK POINTS OF EVERY 1500 HOURS

CAUTION

- **Check the injection pressure and condition after confirming that there is nobody standing in the direction the fume goes.**
- **If the fume from the nozzle directly contacts the human body, cells may be destroyed and blood poisoning may be caused.**



3EEABAB1P037A



3EEADAB1P004A

Nozzle Spraying Condition

[D1503-M, D1703-M, D1803-M, V2003-M, V2203-M, V2403-M, V2403-M-T]
[D1703-M-BG, V2003-M-BG, V2003-M-T-BG, V2203-M-BG, V2403-M-BG]

1. Set the injection nozzle to a nozzle tester, and check the nozzle spraying condition.
2. If the spraying condition is defective, replace the nozzle piece.

(a) Good **(b) Bad**

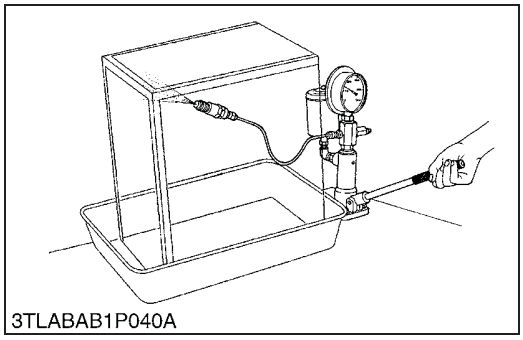
W10411400

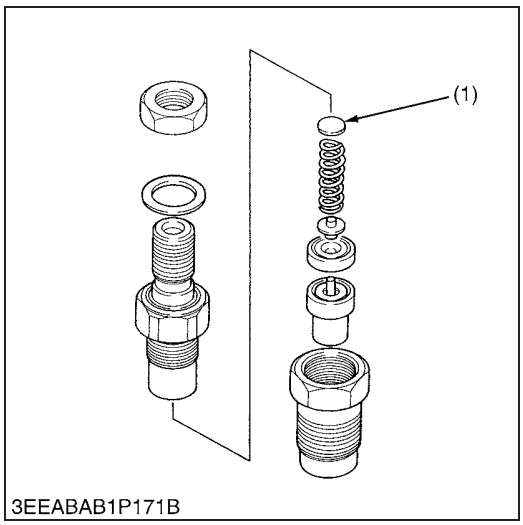
[D1803-M-DI, V2403-M-DI, V2403-M-DI-T]

1. Set the injection nozzle to a nozzle tester, and check the nozzle spraying condition.
2. If the spraying condition is defective, replace the injection nozzle assembly.

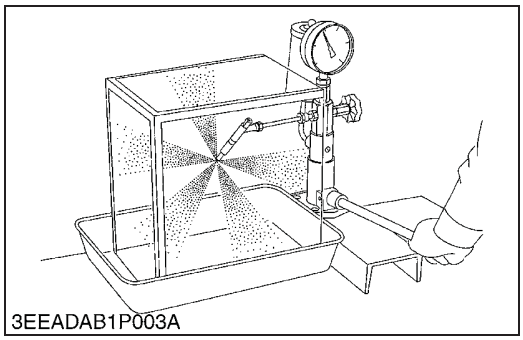
(a) Good **(b) Bad**

W1037040


3TLABAB1P040A



3EEABAB1P171B


3EEADAB1P003A

Fuel Injection Pressure

[D1503-M, D1703-M, D1803-M, V2003-M, V2203-M, V2403-M, V2403-M-T]
[D1703-M-BG, V2003-M-BG, V2003-M-T-BG, V2203-M-BG, V2403-M-BG]

1. Set the injection nozzle to a nozzle tester.
2. Slowly move the tester handle to measure the pressure at which fuel begins jetting out from the nozzle.
3. If the measurement is not within the factory specifications, replace the adjusting washer (1) in the nozzle holder to adjust it.

(Reference)

- Pressure variation with 0.025 mm (0.00098 in.) difference of adjusting washer thickness.
  Approx. 590 kPa (6.0 kgf/cm^2, 85 psi)

Fuel injection pressure	Factory spec.	13.73 to 14.70 MPa 140.0 to 150.0 kgf/cm^2 1992 to 2133 psi

(1) Adjusting Washer

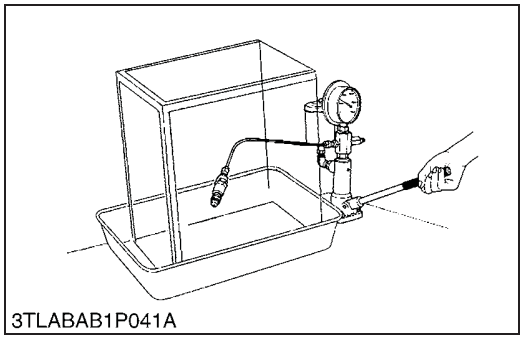
W10182100

[D1803-M-DI, V2403-M-DI, V2403-M-DI-T]

1. Set the injection nozzle to a nozzle tester.
2. Slowly move the tester handle to measure the pressure at which fuel begins jetting out from the nozzle.
3. If the measurement is not within the factory specifications, replace the injection nozzle assembly.

Fuel injection pressure (1st stage)	Factory spec.	18.64 to 20.10 MPa 190.0 to 205.0 kgf/cm^2 2703 to 2915 psi

W10408820


3TLABAB1P041A

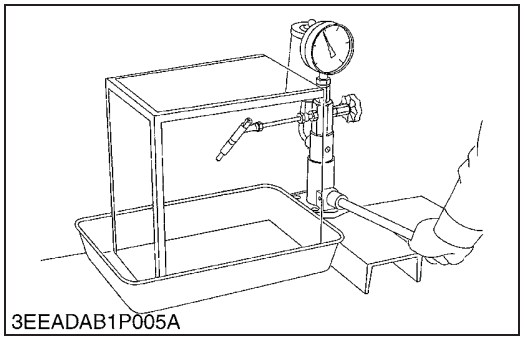
Valve Seat Tightness

[D1503-M, D1703-M, D1803-M, V2003-M, V2203-M, V2403-M, V2403-M-T]
[D1703-M-BG, V2003-M-BG, V2003-M-T-BG, V2203-M-BG, V2403-M-BG]

1. Set the injection nozzle to a nozzle tester.
2. Raise the fuel pressure, and keep at 12.75 MPa (130.0 kgf/cm^2, 1849 psi) for 10 seconds.
3. If any fuel leak is found, replace the nozzle piece.

Valve seat tightness	Factory spec.	No fuel leak at 12.75 MPa 130.0 kgf/cm^2 1849 psi

W10412730

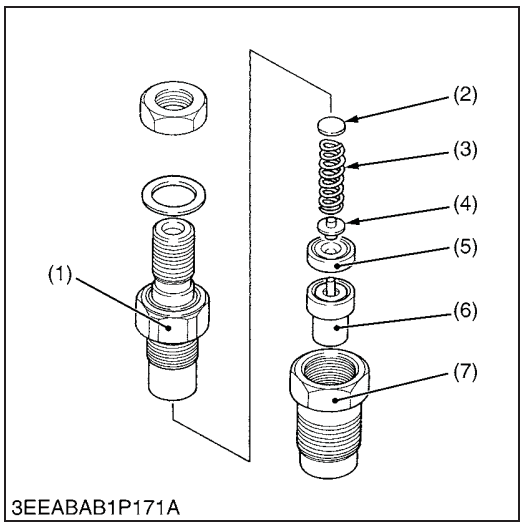

3EEADAB1P005A

[D1803-M-DI, V2403-M-DI, V2403-M-DI-T]

1. Set the injection nozzle to a nozzle tester.
2. Raise the fuel pressure, and keep at 16.67 MPa (170.0 kgf/cm^2, 2418 psi) for 10 seconds.
3. If any fuel leak is found, replace the injection nozzle assembly.

Valve seat tightness	Factory spec.	No fuel leak at 16.67 MPa 170.0 kgf/cm^2 2418 psi

W1037135



3EEABAB1P171A

Nozzle Holder

[D1503-M, D1703-M, D1803-M, V2003-M, V2203-M, V2403-M, V2403-M-T]
[D1703-M-BG, V2003-M-BG, V2003-M-T-BG, V2203-M-BG, V2403-M-BG]

1. Secure the nozzle retaining nut (7) with a vise.
2. Remove the nozzle holder (1), and take out parts inside.

(When reassembling)

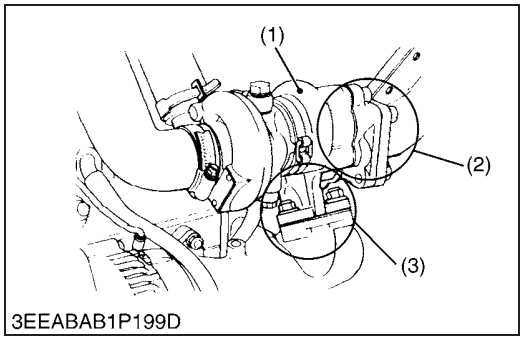
- Assemble the nozzle in clean fuel oil.
- Install the push rod (4), noting its direction.
- After assembling the nozzle, be sure to adjust the fuel injection pressure.

Tightening torque	Nozzle holder	35 to 39 N·m 3.5 to 4.0 kgf·m 26 to 28 lbf·ft
	Overflow pipe retaining nut	20 to 24 N·m 2.0 to 2.5 kgf·m 15 to 18 lbf·ft
	Nozzle holder assembly	49 to 68 N·m 5.0 to 7.0 kgf·m 37 to 50 lbf·ft

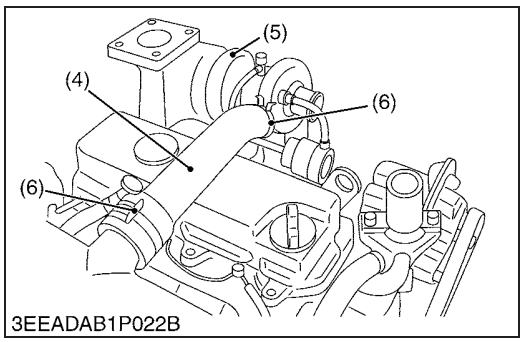
(1) Nozzle Holder
(2) Adjusting Washer
(3) Nozzle Spring
(4) Push Rod
(5) Distance Piece
(6) Nozzle Piece
(7) Nozzle Retaining Nut

W1018491

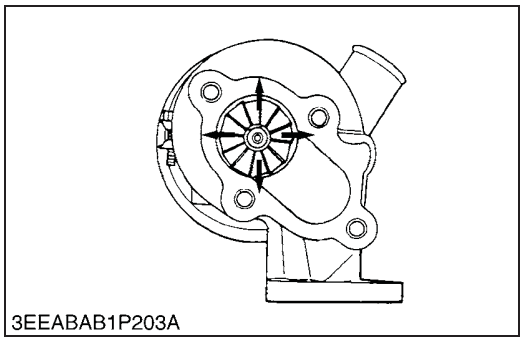
[13] CHECK POINTS OF EVERY 3000 HOURS



3EEABAB1P199D



3EEADAB1P022B


3EEABAB1P203A

Checking Turbocharger

(Turbine Side)

1. Check the exhaust port (2) and inlet port (3) side of turbine housing (1) to see if there is no exhaust gas leak.
2. If any gas leak is found, retighten the bolts and nuts or replace the gasket with new one.

(Compressor Side)

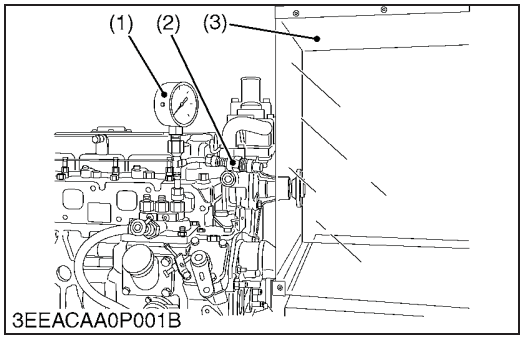
1. Check the inlet hose (4) of the compressor cover (5) to see if there is no air leak.
2. Check for loose connections or cracks in the suction side of the intake hose.
3. If any air leak is found, change the clamp (6) and / or inlet hoses.

(Radial Clearance)

1. If the wheel contact to the housing, replace the turbocharger assembly with new one.

(1) Turbine Housing
(2) Exhaust Port
(3) Inlet Port
(4) Inlet Hose
(5) Compressor Cover
(6) Clamp

W1022082



Checking Injection Pump

[D1503-M, D1703-M, D1803-M, V2003-M, V2203-M, V2403-M, V2403-M-T]
[D1703-M-BG, V2003-M-BG, V2003-M-T-BG, V2203-M-BG, V2403-M-BG]

(Fuel Tightness of Pump Element)

1. Remove the solenoid.
2. Remove the injection pipes and glow plugs.
3. Install the injection pump pressure tester to the injection pump.
4. Install the injection nozzle (2) jetted with the proper injection pressure to the injection pump pressure tester (1). (Refer to the figure.)
5. Set the speed control lever to the maximum speed position.
6. Run the starter to increase the pressure.
7. If the pressure can not reach the allowable limit, replace the pump with new one or repair with a Kubota-authorized pump service shop.

(Fuel Tightness of Delivery Valve)

1. Remove the solenoid.
2. Remove the injection pipes and glow plugs.
3. Set a pressure tester to the fuel injection pump.
4. Install the injection nozzle (2) jetted with the proper injection pressure to the injection pump pressure tester (1).
5. Run the starter to increase the pressure.
6. Stop the starter when the fuel jets from the injection nozzle. After that, turn the flywheel by the hand and raise the pressure to approx. 13.73 MPa (140.0 kgf/cm^2, 1991 psi).
7. Now turn the flywheel back about half a turn (to keep the plunger free). Maintain the flywheel at this position and clock the time taken for the pressure to drop from 13.73 to 12.75 MPa (from 140.0 to 130.0 kgf/cm^2, from 1991 to 1849 psi).
8. Measure the time needed to decrease the pressure from 13.73 to 12.75 MPa (from 140.0 to 130.0 kgf/cm^2, from 1991 to 1849 psi).
9. If the measurement is less than allowable limit, replace the pump with new one or repair with a Kubota-authorized pump service shop.

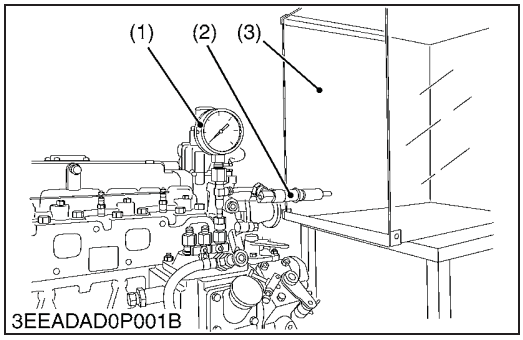
Fuel tightness of pump element	Allowable limit	13.73 MPa 140.0 kgf/cm^2 1991 psi
Fuel tightness of delivery valve	Factory spec.	10 seconds 13.73 → 12.75 MPa 140.0 → 130.0 kgf/cm^2 1991 → 1849 psi
	Allowable limit	5 seconds 13.73 → 12.75 MPa 140.0 → 130.0 kgf/cm^2 1991 → 1849 psi

■ **NOTE**

- **Never try to disassemble the injection pump assembly. For repairs, you are strongly requested to contact a Kubota-authorized pump service shop.**

(1) Injection Pump Pressure Tester
(2) Injection Nozzle
(3) Protection Cover for Jetted Fuel

W1022357



Checking Injection Pump

[D1803-M-DI, V2403-M-DI, V2403-M-DI-T]
(Fuel Tightness of Pump Element)

1. Remove the solenoid.
2. Remove the injection pipes and glow plugs.
3. Install the injection pump pressure tester to the injection pump.
4. Install the injection nozzle (2) jetted with the proper injection pressure to the injection pump pressure tester (1). (Refer to the figure.)
5. Set the speed control lever to the maximum speed position.
6. Run the starter to increase the pressure.
7. If the pressure can not reach the allowable limit, replace the pump with new one or repair with a Kubota-authorized pump service shop.

(Fuel Tightness of Delivery Valve)

1. Remove the solenoid.
2. Remove the injection pipes and glow plugs.
3. Set a pressure tester to the fuel injection pump.
4. Install the injection nozzle (2) jetted with the proper injection pressure to the injection pump pressure tester (1).
5. Run the starter to increase the pressure.
6. Stop the starter when the fuel jets from the injection nozzle. After that, turn the flywheel by the hand and raise the pressure to approx. 18.63 MPa (190.0 kgf/cm^2, 2702 psi).
7. Now turn the flywheel back about half a turn (to keep the plunger free). Maintain the flywheel at this position and clock the time taken for the pressure to drop from 18.63 to 17.65 MPa (from 190.0 to 180.0 kgf/cm^2, from 2702 to 2560 psi).
8. Measure the time needed to decrease the pressure from 18.63 to 17.65 MPa (from 190.0 to 180.0 kgf/cm^2, from 2702 to 2560 psi).
9. If the measurement is less than allowable limit, replace the pump with new one or repair with a Kubota-authorized pump service shop.

Fuel tightness of pump element	Allowable limit	18.63 MPa 190.0 kgf/cm^2 2702 psi
Fuel tightness of delivery valve	Factory spec.	10 seconds 18.63 → 17.65 MPa 190.0 → 180.0 kgf/cm^2 2702 → 2560 psi
	Allowable limit	5 seconds 18.63 → 17.65 MPa 190.0 → 180.0 kgf/cm^2 2702 → 2560 psi

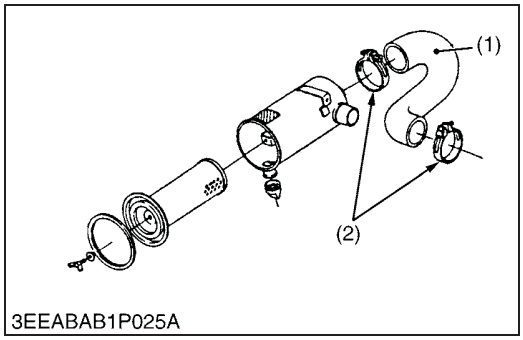
■ **NOTE**

- **Never try to disassemble the injection pump assembly. For repairs, you are strongly requested to contact a Kubota-authorized pump service shop.**

(1) Injection Pump Pressure Tester
(2) Injection Nozzle
(3) Protection Cover for Jetted Fuel

W1037269

[14] CHECK POINTS OF EVERY 2 YEARS



3EEABAB1P025A

Replacing Intake Air Line

1. Loosen the clamp (2).
2. Remove the intake air hose (1) and clamp (2).
3. Replace new intake air hose (1) and new clamp (2).
4. Tighten the clamp (2).

■ **NOTE**

- **To prevent serious damage to the engine, keep out any dust inside the intake air line.**

(1) Intake Air Hose (2) Clamp

W1023867

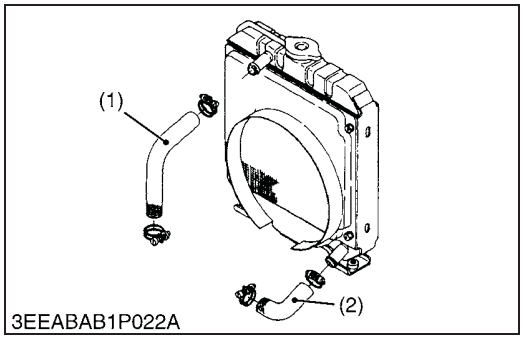
Replacing Battery

CAUTION

- **When the battery is being activated, hydrogen and oxygen gases in the battery are extremely explosive. Keep open sparks and flames away from the battery at all times, especially when charging the battery.**
- **When charging battery, remove battery vent plugs.**
- **When disconnecting the cable from the battery, start with the negative terminal first. When connecting the cable to the battery, start with the positive terminal first.**
- **Never check battery charge by placing a metal object across the posts.**

1. Disconnect the negative terminal and positive terminal.
2. Remove the battery holder.
3. Remove the used battery.
4. Replace the new battery.
5. Tighten the battery holder.
6. Connect the positive terminal.
7. Connect the negative terminal.

W1023996



3EEABAB1P022A

Replacing Radiator Hoses and Clamp Bands

CAUTION

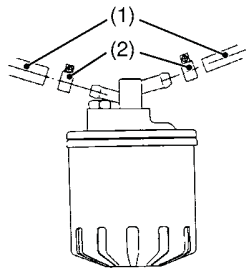
- **Do not remove the radiator cap when the engine is hot. Then loosen cap slightly to the stop to relieve any excess pressure before removing cap completely.**

1. Drain the coolant.
2. Loosen the clamp bands.
3. Remove the upper hose (1) and lower hose (2).
4. Replace new upper / lower hose (1), (2) and clamp bands.
5. Tighten the clamp bands.
6. Fill with clean water and anti-freeze until the coolant level is just below the port. Install the radiator cap securely.

(1) Upper Hose (2) Lower Hose

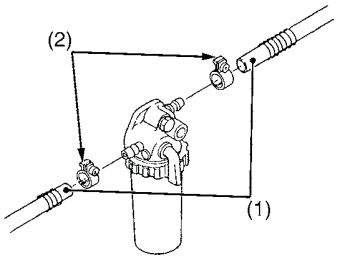
W1024178

[A]



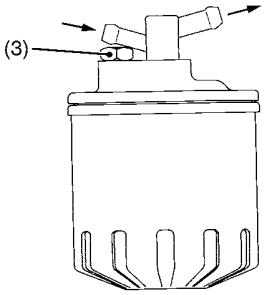
3EEACAA1P057D

[B]



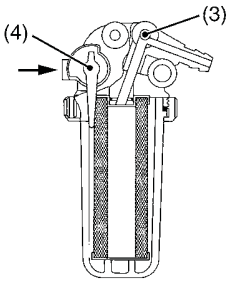
3EEACAA1P058B

[A]



3EEACAA1P059A

[B]



3EEACAA1P060A

Replacing Fuel Hoses and Clamp Bands

1. Loosen the clamp (2) and remove the fuel hose (1).
2. Replace new fuel hose (1) and new clamp (2).
3. Tighten the clamp (2).

CAUTION

- **Stop the engine when attempting the check and change prescribed above.**

(When bleeding fuel system)

1. Fill the tank with fuel and open the cock (4). (**[B]** only.)
2. Loosen the air vent plug (3) of the fuel filter a few turns.
3. Screw back the plug when bubbles do not come up any more.
4. Open the air vent cock on top of the fuel injection pump.
5. If equipped electrical fuel feed pump, turn the key to **AC** position and pump the fuel up for 10 to 15 seconds.
   If equipped mechanical fuel feed pump, set the stop lever on stop position and crank the engine for 10 to 15 seconds.
6. Close securely the air vent cock after air bleeding.

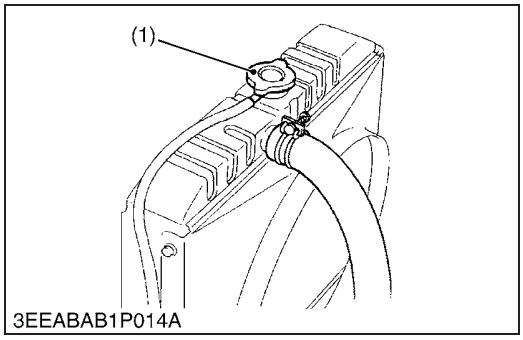
■ NOTE

- **Always keep the air vent cock on the fuel injection pump closed except when air is vented, or it may cause the engine to stop.**

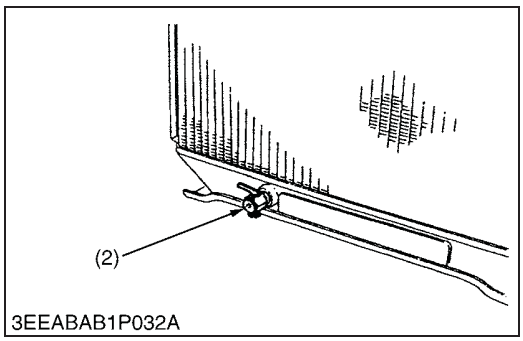
(1) Fuel Hose
(2) Clamp
(3) Air Vent Plug
(4) Fuel Cock

[A] Cartridge Type
[B] Element Type

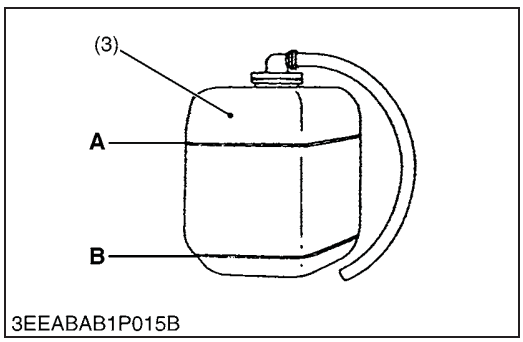
W1024305



3EEABAB1P014A



3EEABAB1P032A



3EEABAB1P015B

Changing Radiator Coolant (L.L.C.)

CAUTION

- **Do not remove the radiator cap when the engine is hot. Then loosen cap slightly to the stop to relieve any excess pressure before removing cap completely.**

1. Stop the engine and let cool down.
2. To drain the coolant, open the radiator drain plug (2) and remove the radiator cap (1). Then radiator cap (1) must be removed to completely drain the coolant. And open the drain cock of engine body.
3. After all coolant is drained, close the drain plug.
4. Fill with clean water and cooling system cleaner.
5. Follow directions of the cleaner instruction.
6. After flushing, fill with clean water and anti-freeze until the coolant level is just below the port. Install the radiator cap (1) securely.
7. Fill with coolant up to “FULL” (**A**) mark on the recovery tank (3).
8. Start and operate the engine for few minutes.
9. Stop the engine and let cool. Check coolant level of radiator and recovery tank (3) and add coolant if necessary.

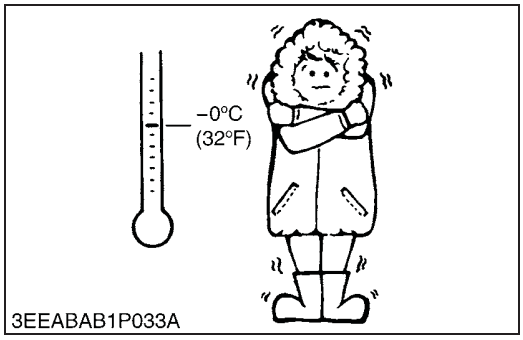
■ **IMPORTANT**

- **Do not start engine without coolant.**
- **Use clean, fresh, soft water and anti-freeze to fill the radiator and recovery tank.**
- **When the anti-freeze is mixed with fresh, soft water, the anti-freeze mixing ratio must be less than 50 %.**
- **Securely tighten radiator cap. If the cap is loose or improperly fitted, water may leak out and the engine could overheat.**

(1) Radiator Cap
(2) Drain Plug
(3) Recovery Tank

A : Full
B : Low

W1024599



Changing Radiator Coolant (L.L.C.) (Continued)

(Anti-freeze)

- There are two types of anti-freeze available: use the permanent type (PT) for this engine.
- Before adding anti-freeze for the first time, clean the radiator interior by pouring fresh, soft water and draining it a few times.
- The procedure for mixing water and anti-freeze differs according to the make of the anti-freeze and the ambient temperature. Basically, it should be referred to SAE J1034 standard, more specifically also to SAE J814c.
- Mix the anti-freeze with fresh, soft water, and then fill into the radiator.

■ **IMPORTANT**

- **When the anti-freeze is mixed with fresh, soft water, the anti-freeze mixing ratio must be less than 50 %.**

Vol % anti-freeze	Freezing point		Boiling point*	
	°C	°F	°C	°F
40	–24	–11	106	223
50	–37	–35	108	226

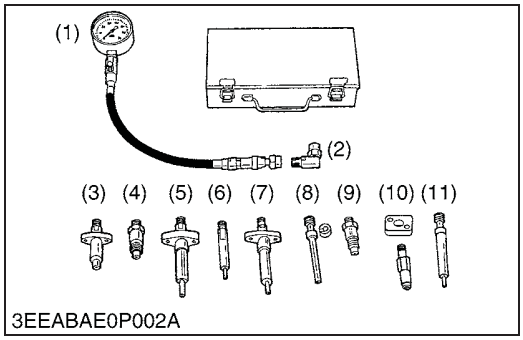
* At 1.01 × 100000 Pa (760 mmHg) pressure (atmospheric). A higher boiling point is obtained by using a radiator pressure cap which permits the development of pressure within the cooling system.

■ **NOTE**

- **The above data represents industrial standards that necessitate a minimum glycol content in the concentrated anti-freeze.**
- **When the coolant level drops due to evaporation, add fresh, soft water only to keep the anti-freeze mixing ratio less than 50 %. In case of leakage, add anti-freeze and fresh, soft water in the specified mixing ratio.**
- **Anti-freeze absorbs moisture. Keep unused anti-freeze in a tightly sealed container.**
- **Do not use radiator cleaning agents when anti-freeze has been added to the coolant.**
  (Anti-freeze contains an anti-corrosive agent, which will react with the radiator cleaning agent forming sludge which will affect the engine parts.)

W1024852

5. SPECIAL TOOLS



Diesel Engine Compression Tester

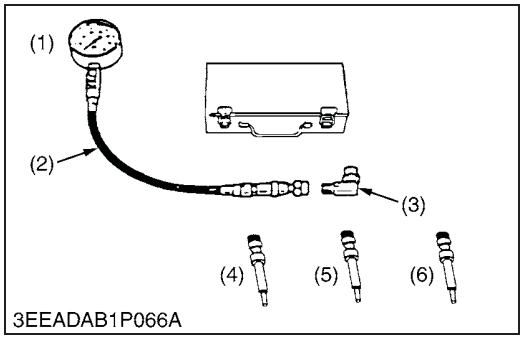
[D1503-M, D1703-M, D1803-M, V2003-M, V2203-M, V2403-M, V2403-M-T]
[D1703-M-BG, V2003-M-BG, V2003-M-T-BG, V2203-M-BG, V2403-M-BG]

Code No: 07909-30208 (Assembly), 07909-30934 (A to F), 07909-31211 (E and F), 07909-31231 (H), 07909-31251 (G), 07909-31271 (I), 07909-31281 (J)

Application: Use to measure diesel engine compression and diagnosis of need for major overhaul.

(1) Gauge
(2) **L** Joint
(3) Adaptor **A**
(4) Adaptor **B**
(5) Adaptor **C**
(6) Adaptor **E**
(7) Adaptor **F**
(8) Adaptor **G**
(9) Adaptor **H**
(10) Adaptor **I**
(11) Adaptor **J**

W1024200



Diesel Engine Compression Tester (for Glow Plug)

[D1803-M-DI, V2403-M-DI, V2403-M-DI-T]

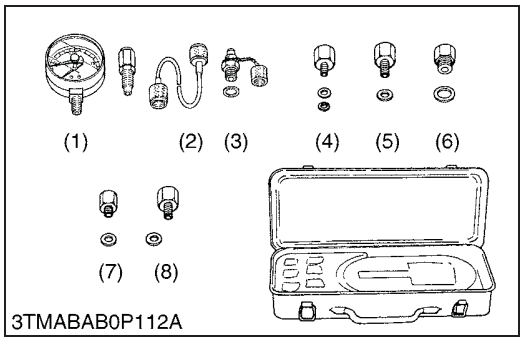
Code No.: 07909-39081 (Assembly), 07909-31291 (**K**), 07909-31301 (**L**), 07909-31311 (**M**)

Application: Use to measure diesel engine compression and diagnosis of need for major overhaul.

Adaptor: The adaptor **K** is required for 03-M-DI.

(1) Gauge
(2) Hose Assembly
(3) L Joint
(4) Adaptor **K**
(5) Adaptor **L**
(6) Adaptor **M**

W1206183



Oil Pressure Tester

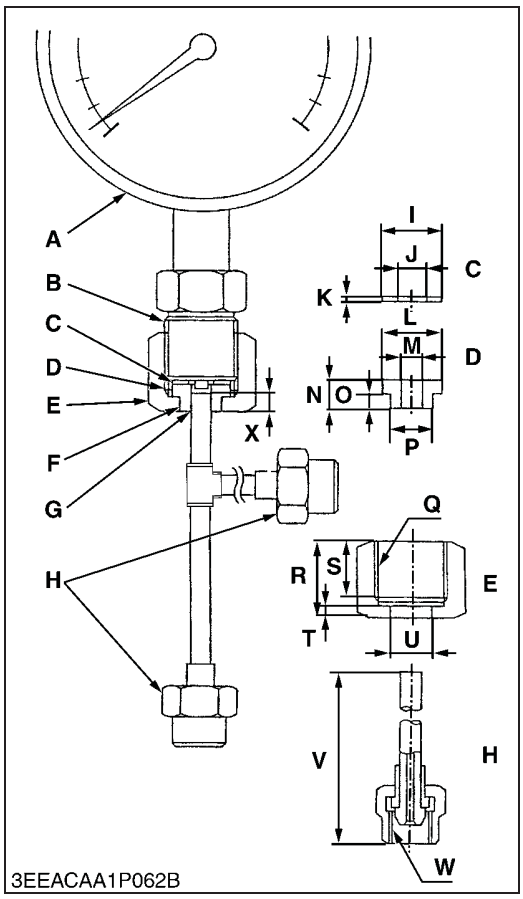
Code No: 07916-32032

Application: Use to measure lubricating oil pressure.

(1) Gauge
(2) Cable
(3) Threaded Joint
(4) Adaptor **1**
(5) Adaptor **2**
(6) Adaptor **3**
(7) Adaptor **4**
(8) Adaptor **5**

W1024318

■ **NOTE**
- **The following special tools are not provided, so make them referring to the figure.**



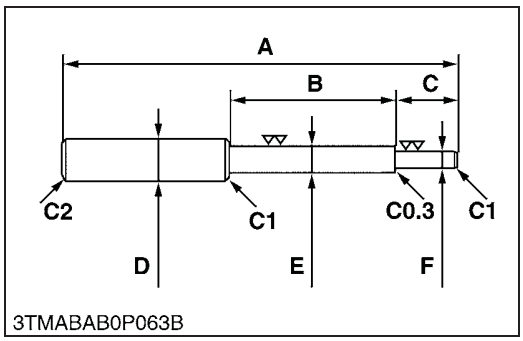
3EEACAA1P062B

Injection Pump Pressure Tester

Application: Use to check fuel tightness of injection pumps.

A	Pressure gauge full scale : More than 29.4 MPa (300 kgf/cm^2, 4267 psi)
B	PF 1/2
C	Copper gasket
D	Flange (Material : Steel)
E	Hex. nut 27 mm (1.1 in.) across the plat
F	Adhesive application
G	Fillet welding on the enter circumference
H	Retaining nut
I	17 mm dia. (0.67 in. dia.)
J	8 mm dia. (0.3 in. dia.)
K	1.0 mm (0.039 in.)
L	17 mm dia. (0.67 in. dia.)
M	6.10 to 6.20 mm dia. (0.241 to 0.244 in. dia.)
N	8 mm (0.3 in.)
O	4 mm (0.2 in.)
P	11.97 to 11.99 mm dia. (0.4713 to 0.4720 in. dia.)
Q	PF 1/2
R	23 mm (0.91 in.)
S	17 mm (0.67 in.)
T	4 mm (0.2 in.)
U	12.00 to 12.02 mm dia. (0.4725 to 0.4732 in. dia.)
V	100 mm (3.94 in.)
W	M12 × P1.5
X	5 mm (0.2 in.)

W10252400



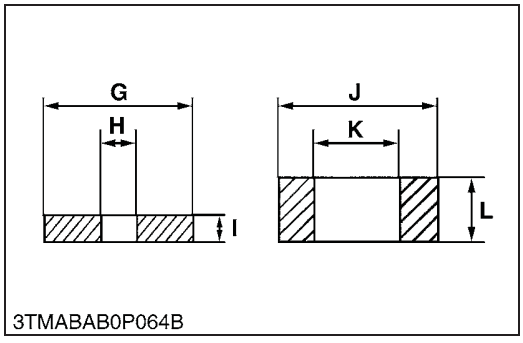
3TMABAB0P063B

Valve Guide Replacing Tool

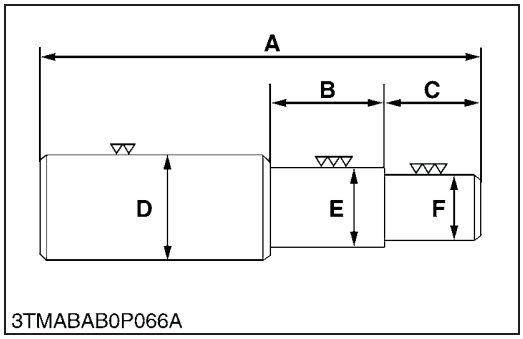
Application: Use to press out and press fit the valve guide.

A	225 mm (8.86 in.)
B	70 mm (2.8 in.)
C	45 mm (1.8 in.)
D	20 mm dia. (0.79 in. dia.)
E	12.7 to 12.9 mm dia. (0.500 to 0.507 in. dia.)
F	7.50 to 7.60 mm dia. (0.296 to 0.299 in. dia.)
G	25 mm dia. (0.98 in. dia.)
H	7.70 to 8.00 mm dia. (0.304 to 0.314 in. dia.)
I	5 mm (0.2 in.)
J	20 mm dia. (0.79 in. dia.)
K	13.5 to 13.8 mm dia. (0.532 to 0.543 in. dia.)
L	8.90 to 9.10 mm (0.351 to 0.358 in.)
C1	Chamfer 1.0 mm (0.039 in.)
C2	Chamfer 2.0 mm (0.079 in.)
C0.3	Chamfer 0.3 mm (0.01 in.)

W1025017



3TMABAB0P064B



3TMABAB0P066A

Bushing Replacing Tools

Application: Use to press out and to press fit the bushing.

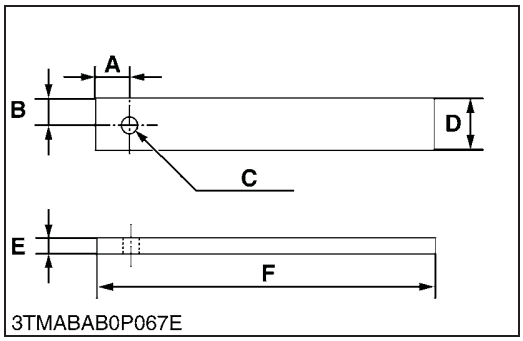
1. For small end bushing

A	162 mm (6.38 in.)
B	35 mm (1.4 in.)
C	27 mm (1.1 in.)
D	35 mm dia. (1.4 in. dia.)
E	27.90 to 27.95 mm dia. (1.099 to 1.100 in. dia.)
F	25.00 to 25.01 mm dia. (0.9843 to 0.9846 in. dia.)

2. For idle gear bushing

A	175 mm (6.89 in.)
B	40 mm (1.6 in.)
C	38 mm (1.5 in.)
D	45 mm dia. (1.8 in. dia.)
E	41.90 to 41.95 mm dia. (1.650 to 1.651 in. dia.)
F	37.950 to 37.970 mm dia. (1.4941 to 1.4948 in. dia.)

W1025500



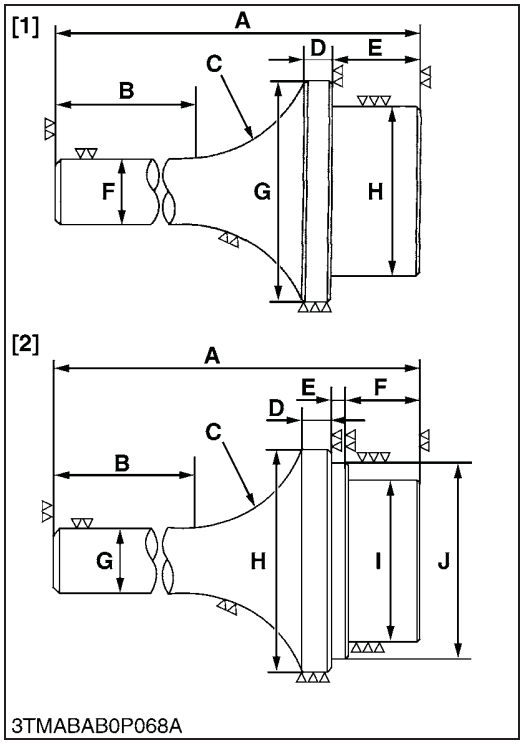
3TMABAB0P067E

Flywheel Stopper

Application: Use to loosen and tighten the flywheel screw.

A	20 mm (0.79 in.)
B	15 mm (0.59 in.)
C	10 mm dia. (0.39 in. dia.)
D	30 mm (1.2 in.)
E	8 mm (0.3 in.)
F	200 mm (7.87 in.)

W10259480



3TMABAB0P068A

Crankshaft Bearing 1 Replacing Tool

Application: Use to press out and press fit the crankshaft bearing 1.

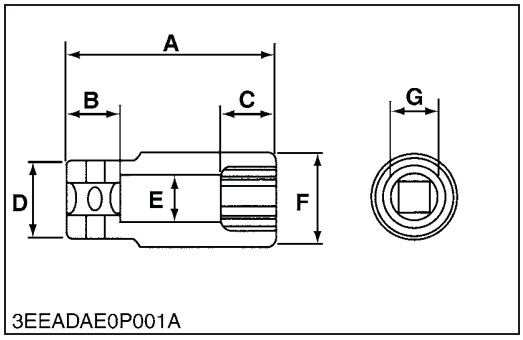
1. Extracting tool

A	135 mm (5.31 in.)
B	72 mm (2.8 in.)
C	40 mm radius (1.6 in. radius)
D	10 mm (0.39 in.)
E	20 mm (0.79 in.)
F	20 mm dia. (0.79 in. dia.)
G	64.80 to 64.90 mm dia. (2.552 to 2.555 in. dia.)
H	59.80 to 59.90 mm dia. (2.355 to 2.358 in. dia.)

2. Inserting tool

A	130 mm (5.12 in.)
B	72 mm (2.8 in.)
C	40 mm radius (1.6 in. radius)
D	9 mm (0.4 in.)
E	4 mm (0.2 in.)
F	20 mm (0.79 in.)
G	20 mm dia. (0.79 in. dia.)
H	68 mm dia. (2.7 in. dia.)
I	59.80 to 59.90 mm dia. (2.355 to 2.358 in. dia.)
J	64.80 to 64.90 mm dia. (2.552 to 2.555 in. dia.)

W1026139



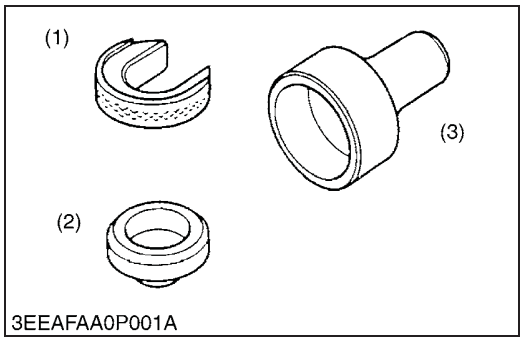
3EEADAE0P001A

Socket Wrench for Crank Pulley Nut (46 mm Deep Socket Wrench)

Application: Use to loosen and tighten the fan drive pulley mounting nut.

A	100 mm (3.94 in.)
B	25.0 mm (0.984 in.)
C	27.0 mm (1.06 in.)
D	45.0 mm dia. (1.77 in. dia.)
E	35.0 mm dia. (1.38 in. dia.)
F	62.5 mm dia. (2.46 in. dia.)
G	46.0 mm (1.81 in.)

W1044361

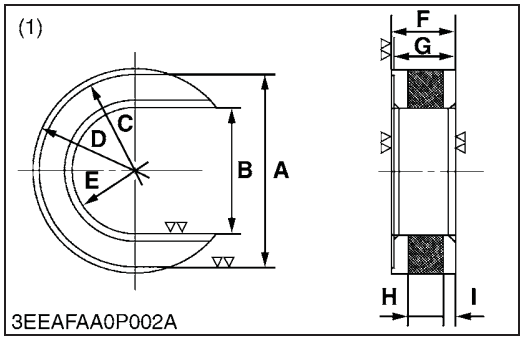


3EEAFAA0P001A

Auxiliary Socket for Fixing Crankshaft Sleeve

Application: Use to fix the crankshaft sleeve of the diesel engine.

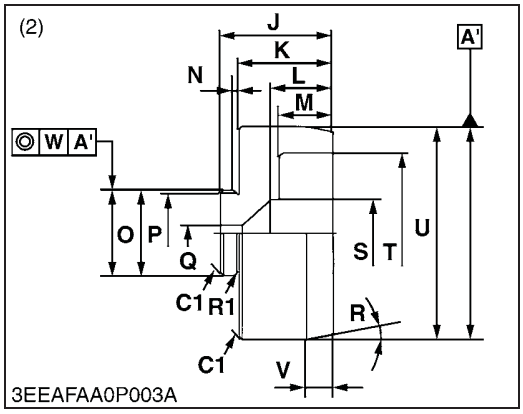
A	80.0 mm (3.15 in.)
B	60.10 to 60.30 mm (2.367 to 2.374 in.)
C	80.0 mm dia. (3.15 in. dia.)
D	85.0 mm dia. (3.35 in. dia.)
E	60.10 to 60.30 mm dia. (2.367 to 2.374 in. dia.)
F	26.30 to 26.40 mm (1.036 to 1.039 in.)
G	25.85 to 25.90 mm (1.018 to 1.019 in.)
H	15.0 mm (0.591 in.)
I	5.0 mm (0.20 in.)

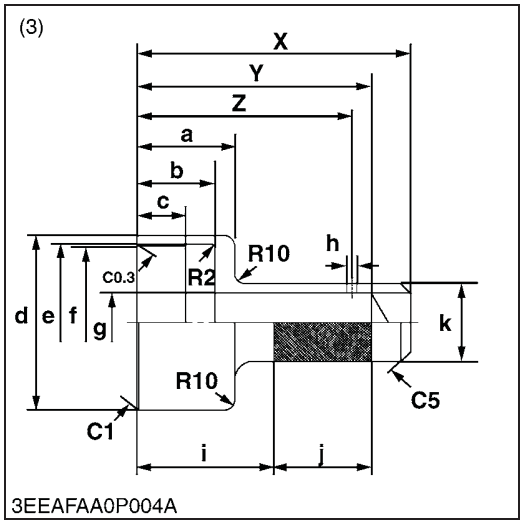


3EEAFAA0P002A

(1) Stopper
(2) Sleeve Guide
(3) Auxiliary Socket for Pushing

W1027695





Auxiliary Socket for Fixing Crankshaft Sleeve (Continued)

Application: Use to fix the crankshaft sleeve of the diesel engine.

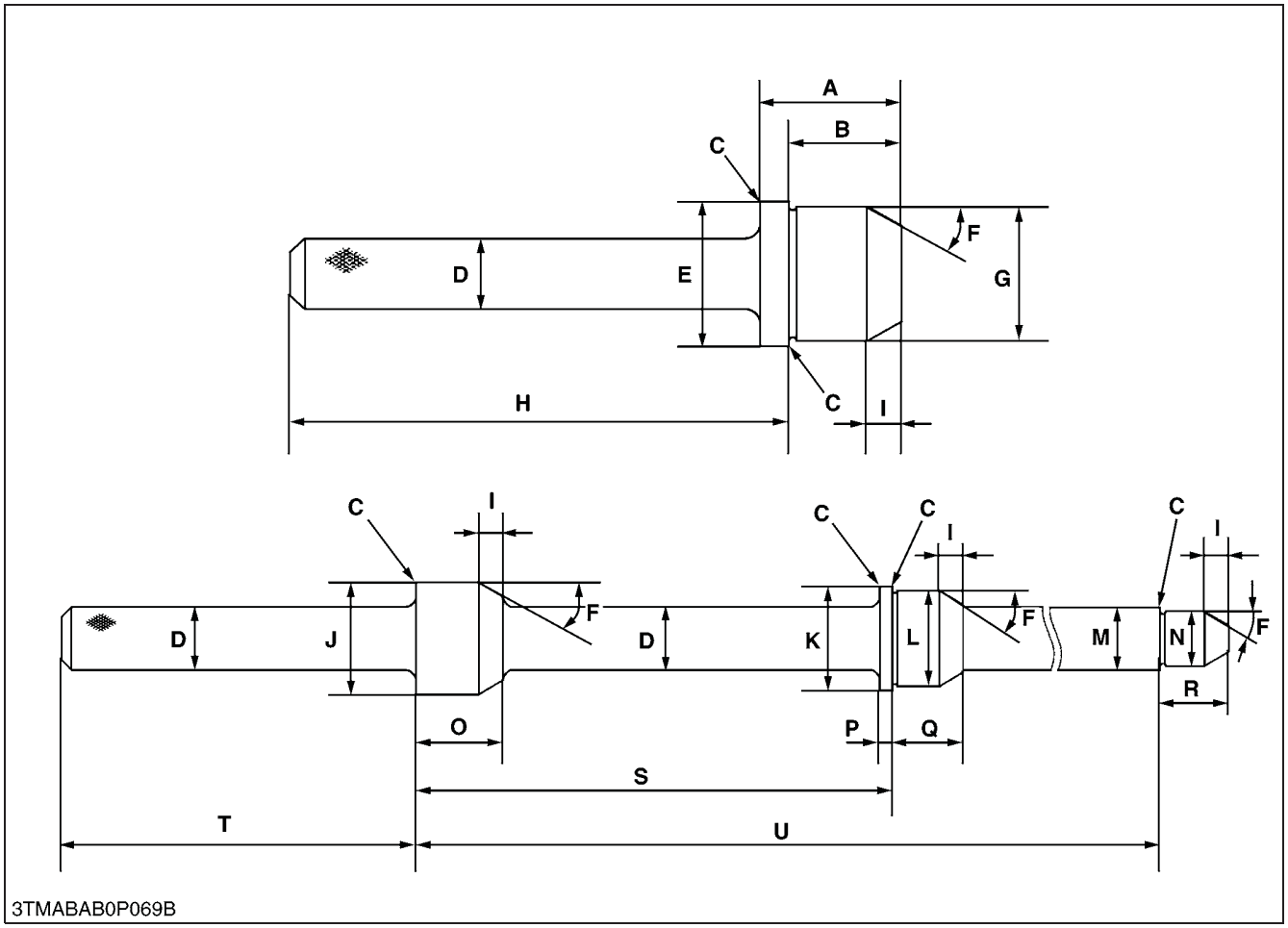
J	42.0 mm (1.65 in.)
K	30.50 to 30.60 mm (1.201 to 1.204 in.)
L	23.0 mm (0.906 in.)
M	20.0 mm (0.787 in.)
N	2.0 mm (0.079 in.)
O	31.911 to 31.950 mm dia. (1.2564 to 1.2578 in. dia.)
P	30.0 mm dia. (1.18 in. dia.)
Q	5.0 mm dia. (0.20 in. dia.)
R	0.09 rad (5 °)
S	25.0 mm dia. (0.984 in. dia.)
T	60.0 mm dia. (2.36 in. dia.)
U	79.80 to 79.85 mm dia. (3.142 to 3.143 in. dia.)
V	10.0 mm (0.394 in.)
W	0.04 mm dia. (0.002 in. dia.)
X	140 mm (5.51 in.)
Y	120 mm (4.72 in.)
Z	110 mm (4.33 in.)
a	50.0 mm (1.97 in.)
b	39.90 to 40.00 mm (1.571 to 1.574 in.)
c	25.0 mm (0.984 in.)
d	90.0 mm dia. (3.54 in. dia.)
e	81.0 mm dia. (3.19 in. dia.)
f	80.10 to 80.15 mm dia. (3.154 to 3.155 in. dia.)
g	30.0 mm dia. (1.18 in. dia.)
h	5.0 mm dia. (0.20 in. dia.)
i	70.0 mm (2.76 in.)
j	50.0 mm (1.97 in.)
k	40.0 mm dia. (1.57 in. dia.)
C1	Chamfer 1.0 mm (0.039 in.)
C5	Chamfer 5.0 mm (0.20 in.)
C0.3	Chamfer 0.3 mm (0.01 in.)
R1	1.0 mm radius (0.039 in. radius)
R2	2.0 mm radius (0.079 in. radius)
R10	10.0 mm radius (0.394 in. radius)

(2) Sleeve Guide (3) Auxiliary Socket for Pushing

W1027898

Balancer Metal Replacing Tool (for Removing)

Application: Use to remove the metal bearing.

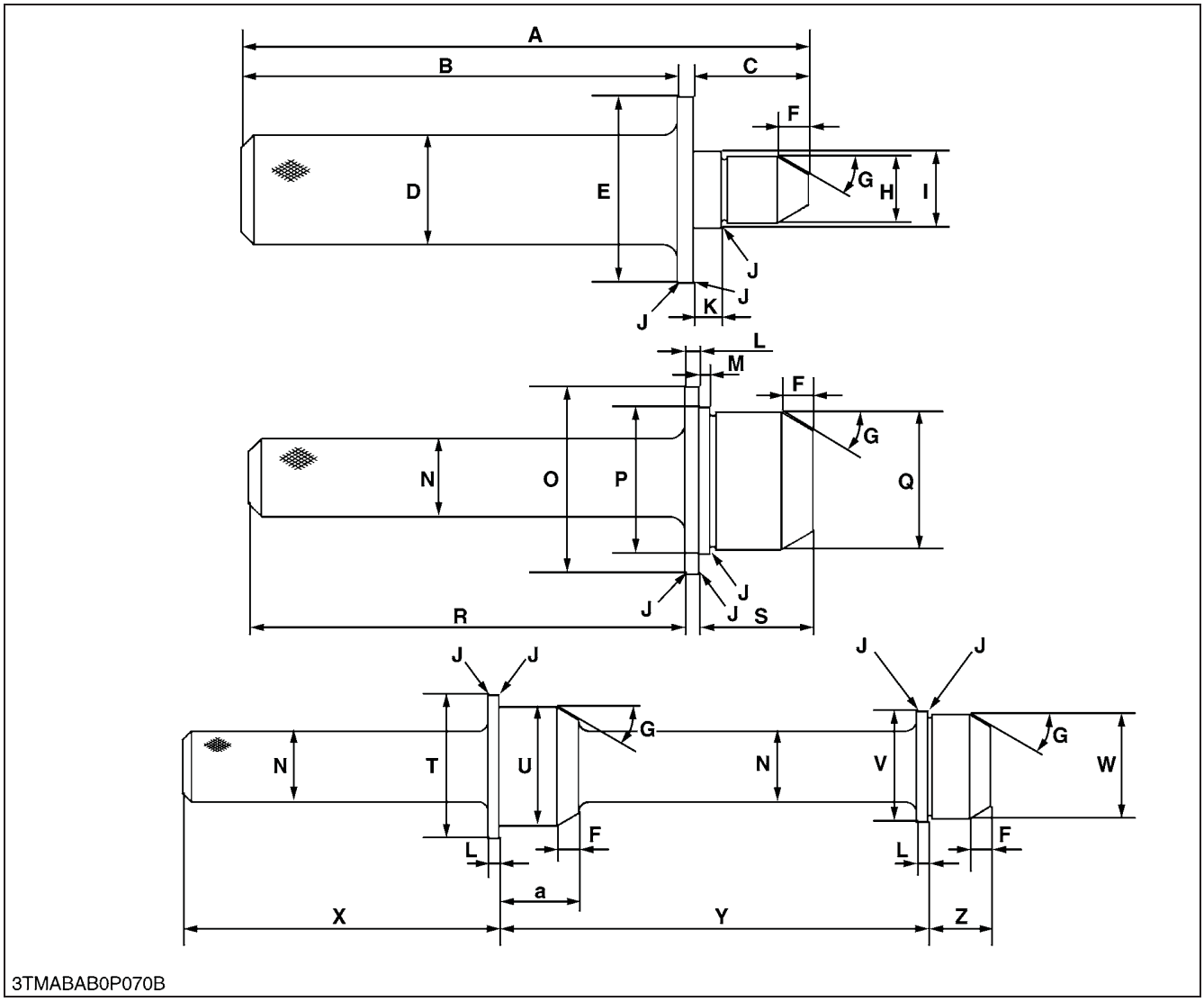


3TMABAB0P069B

A	41 mm (1.6 in.)	L	41.934 to 41.950 mm dia. (1.6510 to 1.6515 in. dia.)
B	32.5 mm (1.28 in.)	M	24.959 to 24.980 mm dia. (0.98264 to 0.98346 in. dia.)
C	Chamfer 0.3 mm (0.01 in.)	N	21.947 to 21.960 mm dia. (0.86406 to 0.86456 in. dia.)
D	25 mm dia. (0.98 in. dia.)	O	36 mm (1.4 in.)
E	46.950 to 46.975 mm dia. (1.8485 to 1.8494 in. dia.)	P	5 mm (0.2 in.)
F	0.52 rad (30 °)	Q	29.0 mm (1.14 in.)
G	43.934 to 43.950 mm dia. (1.7297 to 1.7303 in. dia.)	R	28.0 mm (1.10 in.)
H	148.5 mm (5.846 in.)	S	195.25 to 195.75 mm (7.6870 to 7.7066 in.)
I	10 mm (0.39 in.)	T	145 mm (5.71 in.)
J	46.50 to 46.75 mm dia. (1.831 to 1.840 in. dia.)	U	384.75 to 385.25 mm (15.148 to 15.167 in.)
K	44.950 to 44.975 mm dia. (1.7697 to 1.7706 in. dia.)		

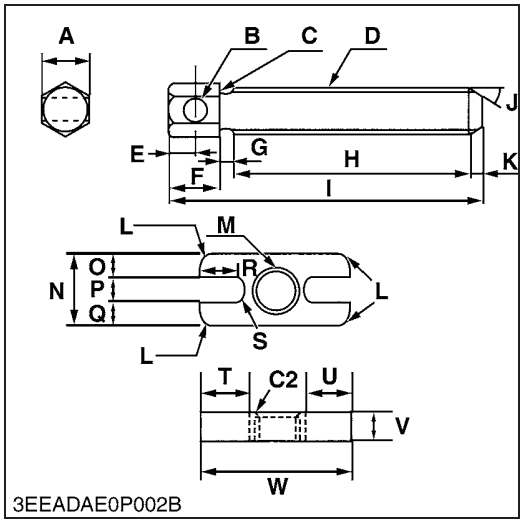
Balancer Metal Replacing Tool (for Fitting)

Application: Use to press fit the metal bearing.



3TMABAB0P070B

A	182 mm (7.17 in.)	O	60 mm dia. (2.4 in. dia.)
B	140 mm (5.51 in.)	P	46.950 to 46.975 mm dia. (1.8485 to 1.8494 in. dia.)
C	37 mm (1.5 in.)	Q	43.934 to 43.950 mm dia. (1.7297 to 1.7303 in. dia.)
D	35 mm dia. (1.4 in. dia.)	R	140 mm (5.51 in.)
E	60 mm dia. (2.4 in. dia.)	S	36 mm (1.4 in.)
F	10 mm (0.39 in.)	T	60 mm dia. (2.4 in. dia.)
G	0.52 rad (30 °)	U	46.950 to 46.975 mm dia. (1.8485 to 1.8494 in. dia.)
H	21.947 to 21.960 mm dia. (0.86406 to 0.86456 in. dia.)	V	44.950 to 44.975 mm dia. (1.7697 to 1.7706 in. dia.)
I	24.959 to 24.980 mm dia. (0.98264 to 0.98346 in. dia.)	W	41.934 to 41.950 mm dia. (1.6510 to 1.6515 in. dia.)
J	Chamfer 0.3 mm (0.01 in.)	X	145 mm (5.71 in.)
K	8.8 to 9.2 mm (0.35 to 0.36 in.)	Y	195.25 to 195.75 mm (7.6870 to 7.7066 in.)
L	5 mm (0.2 in.)	Z	29 mm (1.1 in.)
M	3.3 to 3.7 mm (0.13 to 0.14 in.)	a	36 mm (1.4 in.)
N	25 mm dia. (0.98 in. dia.)		



Idle Gear 2 Puller

Application: Use for remove the idle gear 2 from the shaft.

A	24 mm (0.94 in.)
B	10 mm dia. (0.39 in. dia.)
C	0.5 mm radius (0.02 in. radius)
D	M20 x Pitch 2.0
E	10 mm (0.39 in.)
F	20 mm (0.79 in.)
G	5 mm (0.2 in.)
H	95 mm (3.7 in.)
I	125 mm (4.92 in.)
J	0.87 rad (50 °)
K	5 mm (0.2 in.)
L	60 mm radius (2.4 in. radius)
M	M20 x Pitch 2.0
N	30 mm (1.2 in.)
O	10 mm (0.39 in.)
P	10 mm (0.39 in.)
Q	10 mm (0.39 in.)
R	35.5 mm (1.40 in.)
S	4.5 mm radius (0.18 in. radius)
T	40 mm (1.6 in.)
U	40 mm (1.6 in.)
V	12 mm (0.47 in.)
W	120 mm (4.72 in.)
C2	Chamfer 2.0 mm (0.079 in.)

W1028521

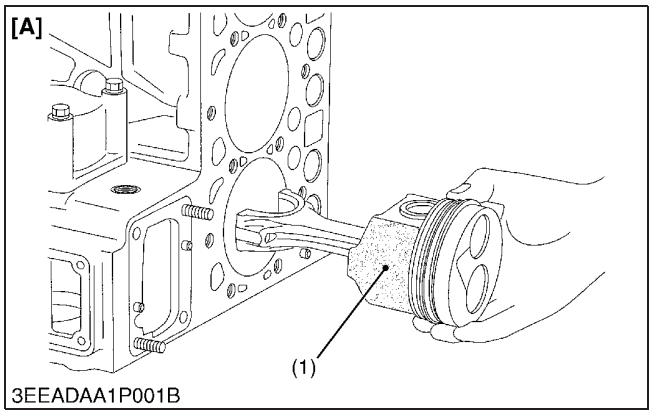
MECHANISM

CONTENTS

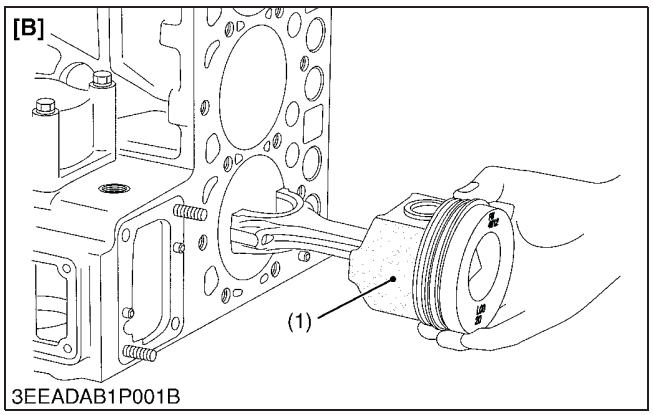
1. ENGINE BODY M-1
   [1] PISTON M-1
   [2] BUILT-IN DYNAMIC BALANCER (BALANCER MODEL ONLY) M-2
   [3] HALF-FLOATING HEAD COVER M-3
2. COOLING SYSTEM M-4
   [1] BOTTOM BYPASS SYSTEM M-4
3. FUEL SYSTEM M-5
   [1] GOVERNOR M-5
4. TURBOCHARGER SYSTEM M-6
   [1] BOOST COMPENSATOR M-6

1. ENGINE BODY

[1] PISTON



3EEADAA1P001B



3EEADAB1P001B

Piston's skirt is coated with **molybdenum disulfide★**, which reduces the piston slap noise and thus the entire operating noise.

★Molybdenum disulfide (MoS_2)

The molybdenum disulfide (1) serves as a solid lubricant, like a Graphite or Teflon. This material helps resist metal wears even with little lube oil.

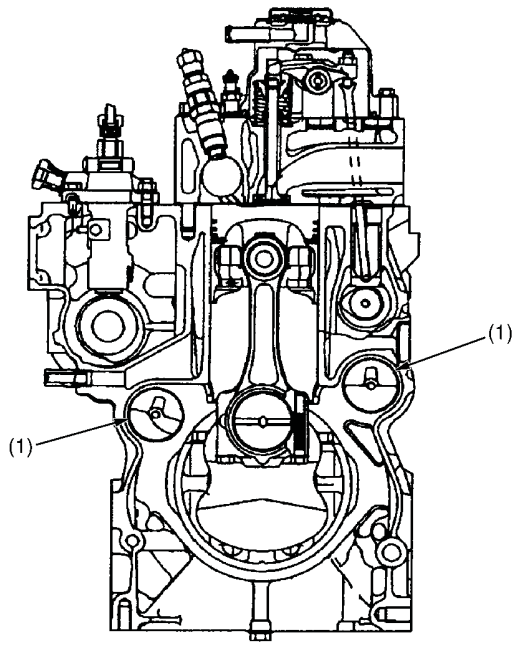
(1) Molybdenum Disulfide

[A] D1503-M, D1703-M
D1803-M, V2003-M
V2203-M, V2403-M
V2403-M-T
D1703-M-BG, V2003-M-BG
V2003-M-T-BG, V2203-M-BG
V2403-M-BG
[B] D1803-M-DI, V2403-M-DI
V2403-M-DI-T

W1013114

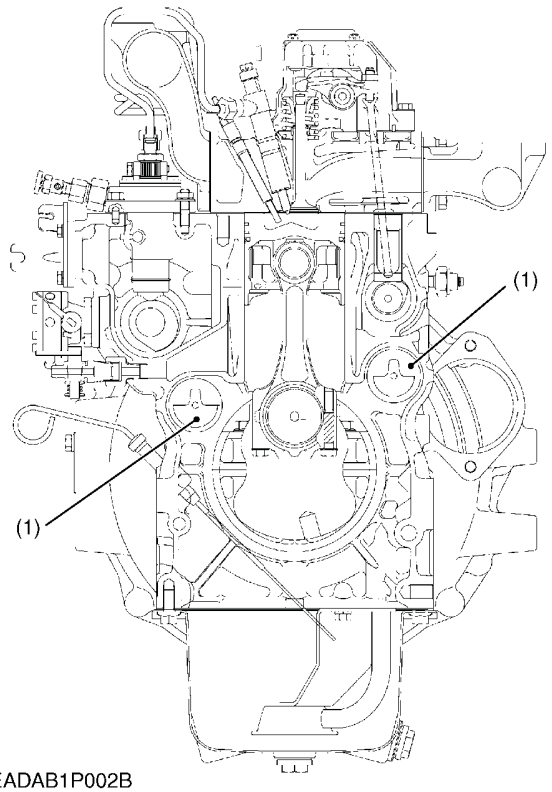
[2] BUILT-IN DYNAMIC BALANCER (BALANCER MODEL ONLY)

[A]



3EEADAA1P002B

[B]



3EEADAB1P002B

Engine are sure to vibrate by piston's reciprocation. Theoretically, three-cylinder engines are much less prone to cause vibration than four-cylinder ones (second inertia, etc.). However, any engine has many moving parts in addition to its pistons and cannot be completely free from vibration.

The four cylinders engine can be fitted with balance weight on crankcase to absorb the second inertia mentioned above and reduce vibration.

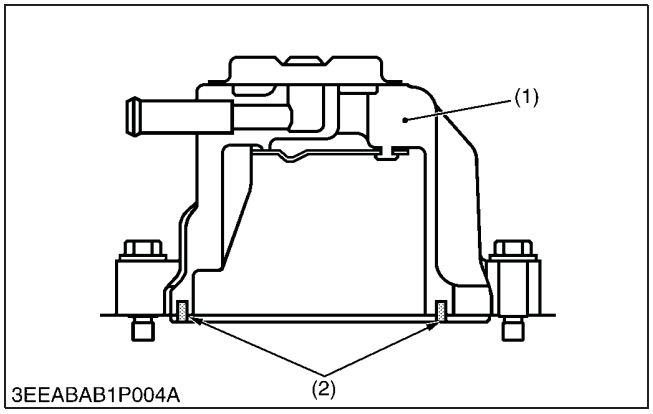
This engine is internally provide with two balancers (1), one at the suction side and the other at the exhaust side.

(1) Balancer

[A] D1503-M, D1703-M
D1803-M, V2003-M
V2203-M, V2403-M
V2403-M-T
[B] D1803-M-DI, V2403-M-DI
V2403-M-DI-T

W1013221

[3] HALF-FLOATING HEAD COVER



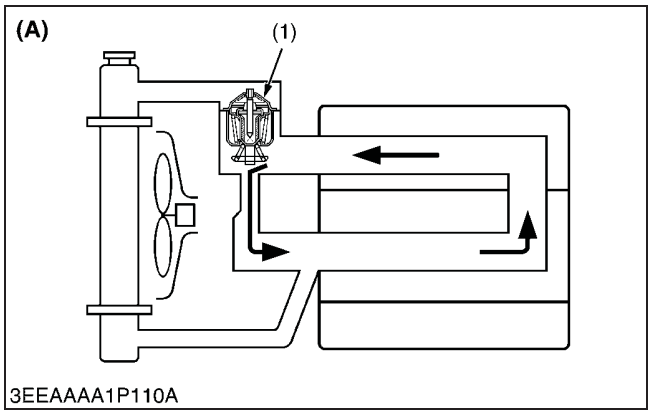
The rubber packing is fitted in to maintain the cylinder head cover 0.5 mm (0.02 in.) or so off the cylinder head. This arrangement helps reduce noise coming from the cylinder head.

(1) Cylinder Head Cover (2) Rubber Packing

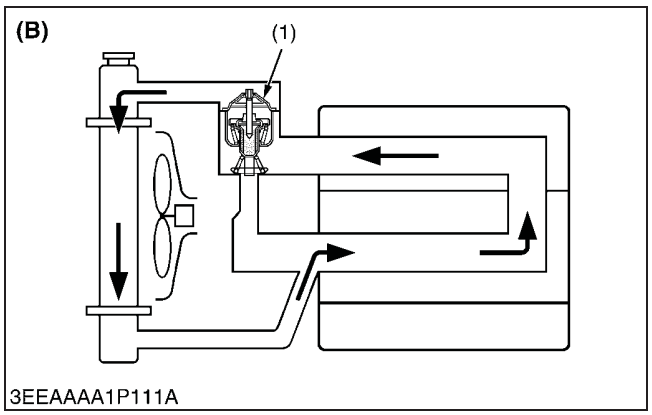
W1013327

2. COOLING SYSTEM

[1] BOTTOM BYPASS SYSTEM



3EEAAAA1P110A



3EEAAAA1P111A

Bottom bypass system is introduced in 03-M Series for improving the cooling performance of the radiator.

While the temperature of coolant in the engine is low, the thermostat (1) is held closed and the coolant is allowed to flow through the bypass pipe and to circulate in the engine.

When the temperature exceeds the thermostat valve opening level, the thermostat (1) fully opens itself to prevent the hot coolant from flowing through the bypass into the engine.

In this way, the radiator can increase its cooling performance.

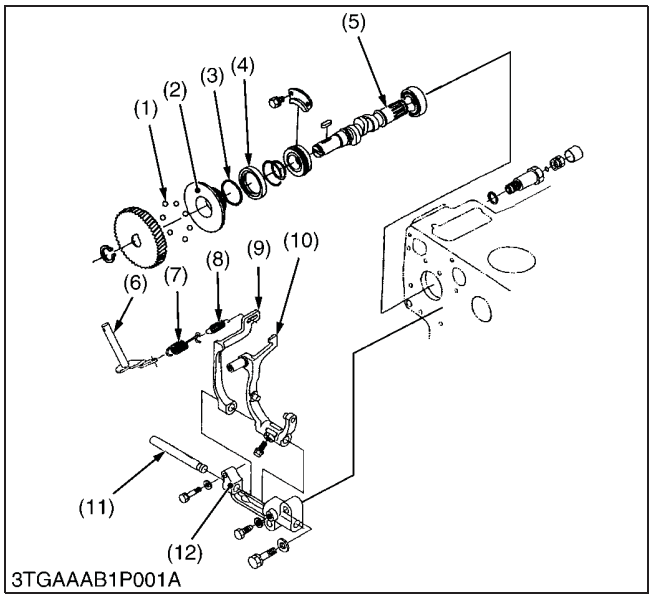
(1) Thermostat

(A) Bypass Opened
(B) Bypass Closed

W1013406

3. FUEL SYSTEM

[1] GOVERNOR



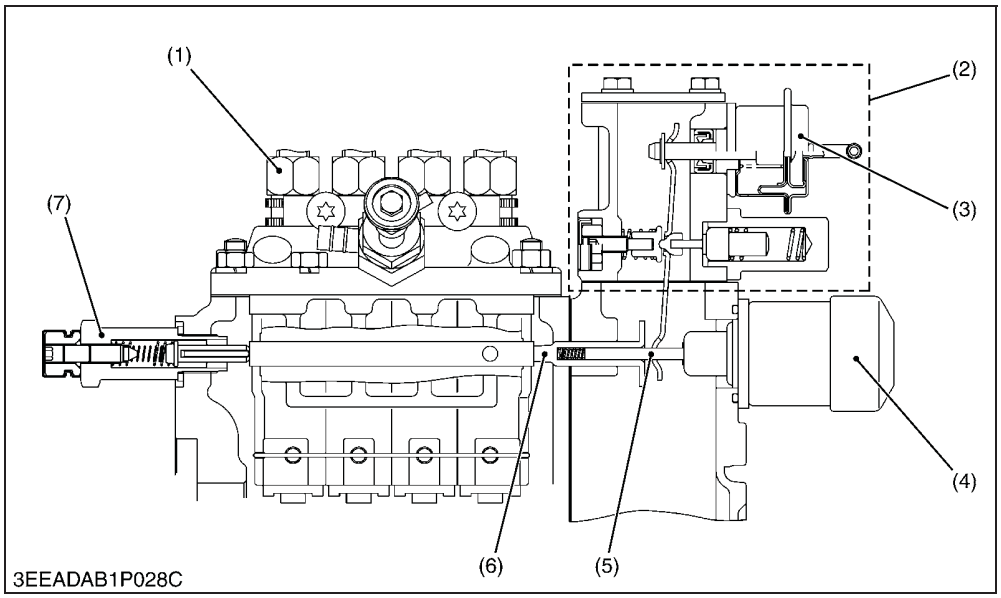
The governor serves to keep engine speed constant by automatically adjusting the amount of fuel supplied to the engine according to changes in the load. This engine employs an all-speed governor which controls the centrifugal force of the steel ball (1) weight, produced by rotation of the fuel camshaft (5), and the tension of the governor spring 1 (7) and 2 (8) are balanced.

(1) Steel Ball
(2) Governor Sleeve
(3) Steel Ball
(4) Governor Ball Case
(5) Fuel Camshaft
(6) Governor Lever
(7) Governor Spring 1
(8) Governor Spring 2
(9) Fork Lever 2
(10) Fork Lever 1
(11) Fork Lever Shaft
(12) Fork Lever Holder

W1017186

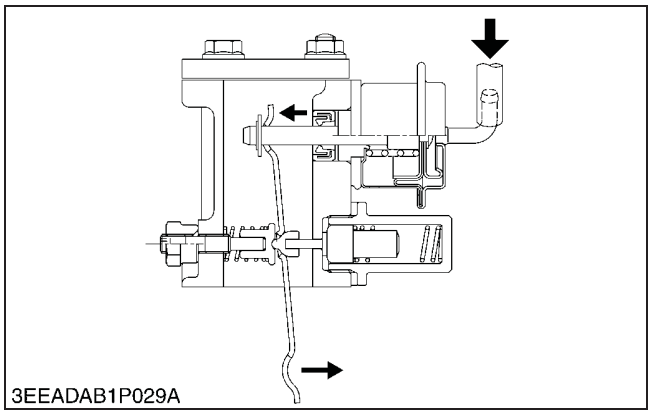
4. TURBOCHARGER SYSTEM

[1] BOOST COMPENSATOR



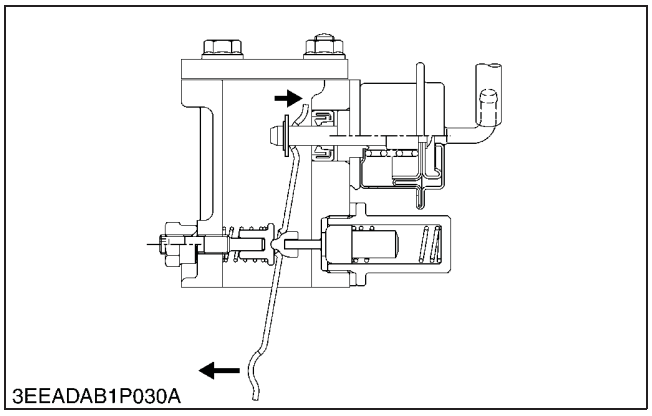
(1) Injection Pump Assembly
(2) Boost Compensator Assembly
(3) Actuator
(4) Solenoid
(5) Plunger
(6) Solenoid Guide
(7) Hi-Idling Body

W1014318



The higher the boost pressure rises, the more fuel is fed. In this way, the turbocharger proves itself for high-power performance.

W1014402



When the boost pressure drops, excess fuel is cut down, allowing much less black emission.

The system is tremendously efficient in cutting down on the emission; under low boost pressures at quick speed-up or start-up, in particular.

W1014432

SERVICING

CONTENTS

1. TROUBLESHOOTING S-1
   [1] ENGINE BODY S-1
   [2] ELECTRONIC GOVERNOR S-5
2. SERVICING SPECIFICATIONS S-7
3. TIGHTENING TORQUES S-19
   [1] TIGHTENING TORQUES FOR GENERAL USE SCREWS, BOLTS AND NUTS S-19
   [2] TIGHTENING TORQUES FOR SPECIAL USE SCREWS, BOLTS AND NUTS S-20
4. CHECKING, DISASSEMBLING AND SERVICING S-21
   [1] CHECKING AND ADJUSTING S-21
      (1) Engine Body S-21
      (2) Lubricating System S-24
      (3) Cooling System S-24
      (4) Fuel System S-27
      (5) Electrical System S-36
      (6) Turbocharger S-40
      (7) Electronic Governor S-41
   [2] DISASSEMBLING AND ASSEMBLING S-46
      (1) Draining Oil and Coolant S-46
      (2) External Components S-46
      (3) Cylinder Head and Valves S-48
      (4) Gear Case and Timing Gears S-54
      (5) Piston and Connecting Rod S-63
      (6) Flywheel and Crankshaft S-68
      (7) Starter S-71
      (8) Alternator S-72
   [3] SERVICING S-73
      (1) Cylinder Head and Valves S-73
      (2) Timing Gears S-81
      (3) Piston and Connecting Rod S-87
      (4) Crankshaft S-91
      (5) Cylinder S-96
      (6) Oil Pump S-98
      (7) Starter S-98
      (8) Alternator S-102

1. TROUBLESHOOTING

[1] ENGINE BODY

Symptom	Probable Cause	Solution	Reference Page
Engine Does Not Start	No fuel	Replenish fuel	G-12
	Air in the fuel system	Vent air	G-12
	Water in the fuel system	Change fuel and repair or replace fuel system	–
	Fuel hose clogged	Clean or replace	G-12
	Fuel filter clogged	Replace	G-22
	Excessively high viscosity of fuel or engine oil at low temperature	Use specified fuel or engine oil	5 to 15, G-10
	Fuel with low cetane number	Use specified fuel	5 to 15
	Fuel leak due to loose injection pipe retaining nut	Tighten retaining nut	S-48
	Incorrect injection timing	Adjust	S-27, 28
	Fuel camshaft worn	Replace	S-62
	Injection nozzle clogged	Clean or replace (IDI) Repair or replace (DI)	S-33, 34, 35, 49 S-33, 34, 35, 49
	Injection pump malfunctioning	Repair or replace	S-29, 30, 31, 32, 54, 55
	Seizure of crankshaft, camshaft, piston, cylinder or bearing	Repair or replace	S-61 to 67 S-90 to 96
	Compression leak from cylinder	Replace head gasket, tighten cylinder head screw, glow plug and nozzle holder	S-49, 50, 51, 52
	Improper valve timing	Correct or replace timing gear	S-60, 61
	Piston ring and cylinder worn	Replace	S-21, 22, 64 to 67, 88, 89, 95
	Excessive valve clearance	Adjust	S-23
	Solenoid malfunctioning	Replace	S-40, 54, 55
Starter Does Not Run	Battery discharged	Charge	G-25, 26
	Starter malfunctioning	Repair or replace	S-38, 46, 71, 97
	Key switch malfunctioning	Replace	–
	Wiring disconnected	Connect	–

W1114419

Symptom	Probable Cause	Solution	Reference Page
Engine Revolution Is Not Smooth	Fuel filter clogged or dirty	Replace	G-22
	Air cleaner clogged	Clean or replace	G-13, 20, 26
	Fuel leak due to loose injection pipe retaining nut	Tighten retaining nut	S-48
	Injection pump malfunctioning	Repair or replace	S-29, 30, 31, 32, 54, 55
	Incorrect nozzle opening pressure	Adjust (IDI) Repair or replace (DI)	S-34, 49 S-34, 49
	Injection nozzle stuck or clogged	Repair or replace	S-34, 49
	Governor malfunctioning	Repair	S-56, 57, 62
	Turbocharger bearing worn out	Replace the turbocharger assembly	S-47
	Turbocharger shaft bent	Replace the turbocharger assembly	S-47
	Turbocharger fin or other part damaged due to foreign matters	Replace the turbocharger assembly	S-47
Either White or Blue Exhaust Gas Is Observed	Excessive engine oil	Reduce to specified level	G-8
	Piston ring and cylinder worn or stuck	Repair or replace	S-21, 22, 64 to 67, 88, 89, 95
	Incorrect injection timing	Adjust	S-27, 28
Oil Leak into Exhaust Pipe or Suction Pipe	Oil pipe clogged or deformed	Repair or replace	S-47
	Turbocharger's piston ring seal faulty	Replace the turbocharger assembly	S-47
Either Black or Dark Gray Exhaust Gas Is Observed	Overload	Reduce the load	–
	Low grade fuel used	Use specified fuel	5 to 15
	Fuel filter clogged	Replace	G-22
	Air cleaner clogged	Clean or replace	G-13, 20, 26
	Deficient nozzle injection	Repair or replace nozzle	S-33, 34, 35, 49

W1011567

Symptom	Probable Cause	Solution	Reference Page
Deficient Output	Incorrect injection timing	Adjust	S-27, 28
	Engine's moving parts seem to be seizing	Repair or replace	–
	Injection pump malfunctioning	Repair or replace	S-29, 30, 31, 32, 54, 55
	Deficient nozzle injection	Repair or replace nozzle	S-33, 34, 35, 49
	Compression leak	Check the compression pressure and repair	S-21, 22
	Gas leak from exhaust system	Repair or replace	S-40, 47
	Air leak from compressor discharge side	Repair or replace	S-40, 47
	Air cleaner dirty or clogged	Clean or replace	G-13, 20, 26
	Turbocharger compressor wheel turning heavily	Replace the turbocharger assembly	S-47
Excessive Lubricant Oil Consumption	Piston ring's gap facing the same direction	Shift ring gap direction	S-64, 65
	Oil ring worn or stuck	Replace	S-66, 67, 88, 89
	Piston ring groove worn	Replace piston	S-66, 67, 89
	Valve stem and valve guide worn	Replace	S-53, 76
	Crankshaft bearing, and crank pin bearing worn	Replace	S-64, 65, 70, 91, 92, 93
	Oil leaking due to defective seals or packing	Replace	–
Fuel Mixed into Lubricant Oil	Injection pump's plunger worn	Repair or replace	S-29, 30, 31, 32, 54, 55
	Deficient nozzle injection	Repair or replace nozzle	S-33, 34, 35, 49
	Injection pump broken	Replace	S-54, 55
Water Mixed into Lubricant Oil	Head gasket defective	Replace	S-51, 52
	Cylinder block or cylinder head flawed	Replace	S-51, 74

W1012032

Symptom	Probable Cause	Solution	Reference Page
Low Oil Pressure	Engine oil insufficient	Replenish	G-8
	Oil strainer clogged	Clean	S-63
	Relief valve stuck with dirt	Clean	–
	Relief valve spring weaken or broken	Replace	–
	Excessive oil clearance of crankshaft bearing	Replace	S-70, 92, 93
	Excessive oil clearance of crankpin bearing	Replace	S-64, 65, 91
	Excessive oil clearance of rocker arm	Replace	S-50, 80
	Oil passage clogged	Clean	–
	Different type of oil	Use specified type of oil	5 to 15, G-10
	Oil pump defective	Replace	S-24, 62, 97
High Oil Pressure	Different type of oil	Use specified type of oil	5 to 15, G-10
	Relief valve defective	Replace	–
Engine overheated	Engine oil insufficient	Replenish	G-10
	Fan belt broken or elongated	Replace or adjust	G-14, 24
	Coolant insufficient	Replenish	G-9
	Radiator net and radiator fin clogged with dust	Clean	–
	Inside of radiator corroded	Clean or replace	G-23
	Coolant flow route corroded	Clean or replace	G-23, 24
	Radiator cap defective	Replace	S-25
	Overload running	Reduce the load	–
	Head gasket defective	Replace	S-51, 52
	Incorrect injection timing	Adjust	S-27, 28
	Unsuitable fuel used	Use specified fuel	5 to 15
Battery Quickly Discharged	Battery electrolyte insufficient	Replenish distilled water and charge	G-13, 25
	Fan belt slips	Adjust belt tension or replace	G-13, 14, 24
	Wiring disconnected	Connect	–
	Rectifier defective	Replace	S-72, 102
	Alternator defective	Replace	S-72, 101
	Battery defective	Replace	–

W1012501

[2] ELECTRONIC GOVERNOR

■ **IMPORTANT**

- **The engine trouble divides into an electronic governor, the main body of the engine, and the operating constancy.**
  This manual describes it concerning the check of an electronic governor.
  Refer to WSM of engine and operator's manual if you cannot find trouble related to an electronic governor by checking an electronic governor.

Engine will not start.

Cause	Corrections	Refer to Checking
Starter Operating but Not Cranking the Engine	Check operation of the solenoid	Solenoid
	Check harness of the solenoid	Solenoid
	Check harness of the glow plug	Glow plug
Starter Does Not Operate	Check emergency stop switch	Emergency stop switch

W1039573

Engine stopped automatically. Engine can be started again and stops again 10 seconds later.

Cause	Corrections	Refer to Checking
Trouble in the electronic governor composition parts	Check blinking pattern of the glow lamp (1) 	Signal pattern sheet (1) Glow Lamp

W1041393

Engine speed cannot be controlled.

Cause	Corrections	Refer to Checking
Engine speed does not increase/ decrease	Check slow down switch	Slow down switch
	Check speed switch	Speed switch
	Check operation of the solenoid	Solenoid
	Check harness of speed sensor	Harness
Engine runs rough	Check operation of the solenoid	Solenoid
	Check harness of speed sensor	Harness

W1041483

Blinking Pattern of Glow Lamp	Cause	Refer to Checking
(1-Long and 1-Short) 3EEAAAB1P005A	Overrunning (more than 115 %)	Solenoid
(1-Long and 2-Short) 3EEAAAB1P006A	Low oil pressure	Oil sensor
(1-Long and 3-Short) 3EEAAAB1P007A	Defect of alternator	Alternator
(1-Long and 4-Short) 3EEAAAB1P008A	Coolant temperature is abnormal	Water temperature sensor
(1-Long and 5-Short) 3EEAAAB1P009A	Emergency stop switch operated	Emergency stop switch
(2-Long and 1-Short) 3EEAAAB1P010A	Abnormality of speed sensor	Speed sensor
(2-Long and 2-Short) 3EEAAAB1P011A	Solenoid malfunction	Solenoid
(2-Long and 4-Short) 3EEAAAB1P012A	Disconnection of water temperature sensor	Water temperature sensor
(2-Long and 5-Short) 3EEAAAB1P013A	Short circuit of water temperature sensor	Water temperature sensor
(2-Long and 6-Short) 3EEAAAB1P014A	Disconnection of alternator **L** Terminal	Alternator **L** Terminal

W1042224

2. SERVICING SPECIFICATIONS

ENGINE BODY

Item		Factory Specification	Allowable Limit
Valve Clearance (When Cold)		0.18 to 0.22 mm 0.0071 to 0.0086 in.	–
Compression Pressure (When Cranking with Starting Motor) **[D1503-M], [D1703-M]** **[D1803-M], [V2003-M]** **[V2203-M], [V2403-M]** **[V2403-M-T]** **[D1703-M-BG], [V2003-M-BG]** **[V2003-M-T-BG], [V2203-M-BG]** **[V2403-M-BG]**		3.24 to 3.72 MPa / 290 min^{-1} (rpm) 33.0 to 38.0 kgf/cm^2 / 290 min^{-1} (rpm) 470 to 540 psi / 290 min^{-1} (rpm)	2.55 MPa / 290 min^{-1} (rpm) 26.0 kgf/cm^2 / 290 min^{-1} (rpm) 370 psi / 290 min^{-1} (rpm)
Compression Pressure (When Cranking with Starting Motor) **[D1803-M-DI], [V2403-M-DI]** **[V2403-M-DI-T]**		2.95 to 3.23 MPa / 290 min^{-1} (rpm) 30.0 to 33.0 kgf/cm^2 / 290 min^{-1} (rpm) 427 to 469 psi / 290 min^{-1} (rpm)	2.35 MPa / 290 min^{-1} (rpm) 24.0 kgf/cm^2 / 290 min^{-1} (rpm) 341 psi / 290 min^{-1} (rpm)
Difference among Cylinders		–	10 % or less
Top Clearance **[D1503-M], [D1703-M]** **[D1803-M], [V2003-M]** **[V2203-M], [V2403-M]** **[V2403-M-T]** **[D1703-M-BG], [V2003-M-BG]** **[V2003-M-T-BG], [V2203-M-BG]** **[V2403-M-BG]**		0.575 to 0.675 mm 0.0227 to 0.0265 in.	–
Top Clearance **[D1803-M-DI], [V2403-M-DI]** **[V2403-M-DI-T]**		0.60 to 0.70 mm 0.024 to 0.027 in.	–
Cylinder Head Surface	Flatness	–	0.05 mm / 500 mm 0.002 in. / 19.7 in.
Valve Recessing (Protrusion to Recessing) **[D1503-M], [D1703-M]** **[D1803-M], [V2003-M]** **[V2203-M], [V2403-M]** **[V2403-M-T]** **[D1703-M-BG], [V2003-M-BG]** **[V2003-M-T-BG], [V2203-M-BG]** **[V2403-M-BG]**	Protrusion Recessing	0.05 mm 0.002 in. 0.15 mm 0.0059 in.	– 0.40 mm 0.016 in.
Valve Recessing **[D1803-M-DI], [V2403-M-DI]** **[V2403-M-DI-T]**	Recessing	0.65 to 0.85 mm 0.026 to 0.033 in.	–

W1116131

ENGINE BODY (Continued)

Item		Factory Specification	Allowable Limit
Valve Stem to Valve Guide	Clearance	0.040 to 0.070 mm 0.0016 to 0.0027 in.	0.10 mm 0.0039 in.
Valve Stem	O.D.	7.960 to 7.975 mm 0.3134 to 0.3139 in.	–
Valve Guide	I.D.	8.015 to 8.030 mm 0.3156 to 0.3161 in.	–
Valve Face **[D1503-M], [D1703-M]** **[D1803-M], [V2003-M]** **[V2203-M], [V2403-M]** **[V2403-M-T]** **[D1703-M-BG], [V2003-M-BG]** **[V2003-M-T-BG], [V2203-M-BG]** **[V2403-M-BG]**	Angle (Intake)	1.0 rad 60 °	–
	Angle (Exhaust)	0.79 rad 45 °	–
Valve Face **[D1803-M-DI], [V2403-M-DI]** **[V2403-M-DI-T]**	Angle (Intake)	0.79 rad 45 °	–
	Angle (Exhaust)	0.79 rad 45 °	–
Valve Seat	Width (Intake)	2.12 mm 0.0835 in.	–
	Width (Exhaust)	2.12 mm 0.0835 in.	–
Valve Seat **[D1503-M], [D1703-M]** **[D1803-M], [V2003-M]** **[V2203-M], [V2403-M]** **[V2403-M-T]** **[D1703-M-BG], [V2003-M-BG]** **[V2003-M-T-BG], [V2203-M-BG]** **[V2403-M-BG]**	Angle (Intake)	1.0 rad 60 °	–
	Angle (Exhaust)	0.79 rad 45 °	–
Valve Seat **[D1803-M-DI], [V2403-M-DI]** **[V2403-M-DI-T]**	Angle (Intake)	0.79 rad 45 °	–
	Angle (Exhaust)	0.79 rad 45 °	–
Valve Timing (Intake Valve) **[D1503-M]** **[D1703-M-BG]**	Open	0.1 rad (8 °) before T.D.C.	–
	Close	0.35 rad (20 °) after B.D.C.	–
Valve Timing (Intake Valve) **[D1703-M], [D1803-M]** **[V2003-M], [V2203-M]** **[V2403-M], [V2403-M-DI-T]** **[V2003-M-BG], [V2203-M-BG]** **[V2403-M-BG]**	Open	0.21 rad (12 °) before T.D.C.	–
	Close	0.63 rad (36 °) after B.D.C.	–

W1014004

ENGINE BODY (Continued)

Item		Factory Specification	Allowable Limit
Valve Timing (Intake Valve) **[V2403-M-T]** **[V2003-M-T-BG]**	Open	0.35 rad (20 °) before T.D.C.	–
	Close	0.79 rad (45 °) after B.D.C.	–
Valve Timing (Intake Valve) **[D1803-M-DI]** **[V2403-M-DI]**	Open	0.2 rad (9 °) before T.D.C.	–
	Close	0.68 rad (39 °) after B.D.C.	–
Valve Timing (Exhaust Valve) **[D1503-M]** **[V2003-M]**	Open	1.0 rad (60 °) before B.D.C.	–
	Close	0.21 rad (12 °) after T.D.C.	–
Valve Timing (Exhaust Valve) **[D1703-M], [D1803-M]** **[V2203-M], [V2403-M]** **[V2403-M-BG]**	Open	0.99 rad (57 °) before B.D.C.	–
	Close	0.21 rad (12 °) after T.D.C.	–
Valve Timing (Exhaust Valve) **[V2403-M-T]** **[V2403-M-DI-T]** **[D1703-M-BG]** **[V2003-M-BG]** **[V2203-M-BG]**	Open	0.87 rad (50 °) before B.D.C.	–
	Close	0 rad (0 °) after T.D.C.	–
Valve Timing (Exhaust Valve) **[D1803-M-DI]** **[V2403-M-DI]**	Open	0.72 rad (41 °) before B.D.C.	–
	Close	0.2 rad (9 °) after T.D.C.	–
Valve Timing (Exhaust Valve) **[V2003-M-T-BG]**	Open	0.96 rad (55 °) before B.D.C.	–
	Close	0.24 rad (14 °) after T.D.C.	–
Valve Spring	Free Length	41.7 to 42.2 mm 1.65 to 1.66 in.	41.2 mm 1.62 in.
	Setting Load / Setting Length	118 N / 35.0 mm 12.0 kgf / 35.0 mm 26.5 lbf / 1.38 in.	100 N / 35.0 mm 10.2 kgf / 35.0 mm 22.5 lbf /1.38 in.
	Tilt	–	1.0 mm 0.039 in.

W1014959

ENGINE BODY (Continued)

Item		Factory Specification	Allowable Limit
Rocker Arm Shaft to Rocker Arm	Oil Clearance	0.016 to 0.045 mm 0.00063 to 0.0017 in.	0.10 mm 0.0039 in.
Rocker Arm Shaft	O.D.	13.973 to 13.984 mm 0.55012 to 0.55055 in.	–
Rocker Arm	I.D.	14.000 to 14.018 mm 0.55119 to 0.55188 in.	–
Push Rod	Alignment	–	0.25 mm 0.0098 in.
Tappet to Tappet Guide	Oil Clearance	0.020 to 0.062 mm 0.00079 to 0.0024 in.	0.07 mm 0.003 in.
Tappet	O.D.	23.959 to 23.980 mm 0.94327 to 0.94409 in.	–
Tappet Guide	I.D.	24.000 to 24.021 mm 0.94489 to 0.94570 in.	–
Timing Gear Crank Gear to Idle Gear	Backlash	0.04150 to 0.1122 mm 0.001634 to 0.004417 in.	0.15 mm 0.0059 in.
Idle Gear to Cam Gear	Backlash	0.04150 to 0.1154 mm 0.001634 to 0.004543 in.	0.15 mm 0.0059 in.
Idle Gear to Injection Pump Gear	Backlash	0.04150 to 0.1154 mm 0.001634 to 0.004543 in.	0.15 mm 0.0059 in.
Crank Gear to Oil Pump Gear	Backlash	0.04150 to 0.1090 mm 0.001634 to 0.004291 in.	0.15 mm 0.0059 in.
Idle Gear to Balancer Gear (Balancer Model Only)	Backlash	0.03500 to 0.1160 mm 0.001378 to 0.004566 in.	0.15 mm 0.0059 in.
Cam Gear to Balancer Gear (Balancer Model Only)	Backlash	0.03500 to 0.1160 mm 0.001378 to 0.004566 in.	0.15 mm 0.0059 in.
Crank Gear to Idle Gear 2 (Side PTO Model Only)	Backlash	0.04150 to 0.1154 mm 0.001634 to 0.004543 in.	0.15 mm 0.0059 in.
Idle Gear 2 to Hydraulic Pump Drive Gear (Side PTO Model Only)	Backlash	0.03080 to 0.1062 mm 0.001213 to 0.004181 in.	0.15 mm 0.0059 in.
Idle Gear	Side Clearance	0.12 to 0.48 mm 0.0048 to 0.018 in.	0.9 mm 0.04 in.
Idle Gear Shaft to Idle Gear Bushing	Oil Clearance	0.025 to 0.066 mm 0.00099 to 0.0025 in.	0.10 mm 0.0039 in.
Idle Gear Shaft	O.D.	37.959 to 37.975 mm 1.4945 to 1.4950 in.	–
Idle Gear Bushing	I.D.	38.000 to 38.025 mm 1.4961 to 1.4970 in.	–

W1015276

ENGINE BODY (Continued)

Item		Factory Specification	Allowable Limit
Camshaft	Side Clearance	0.070 to 0.22 mm 0.0028 to 0.0086 in.	0.30 mm 0.012 in.
Camshaft	Alignment	–	0.01 mm 0.0004 in.
Cam (Intake) **[D1503-M]** **[D1703-M-BG]** **[V2003-M]** **[V2403-M-DI-T]** **[V2003-M-BG]** **[V2203-M-BG]** **[D1703-M], [D1803-M]** **[V2203-M], [V2403-M]** **[V2403-M-T]** **[D1803-M-DI], [V2403-M-DI]** **[V2003-M-T-BG]** **[V2403-M-BG]**	Height	 33.27 mm 1.310 in. 33.47 mm 1.318 in. 33.90 mm 1.335 in.	 33.22 mm 1.308 in. 33.42 mm 1.316 in. 33.85 mm 1.333 in.
Cam (Exhaust) **[V2403-M-DI-T]** **[V2403-M-T]** **[D1703-M-BG], [V2003-M-BG]** **[V2203-M-BG]** **[D1503-M], [D2003-M]** **[V2003-M-T-BG]** **[D1703-M], [D1803-M]** **[V2203-M], [V2403-M]** **[V1803-M-DI], [V2403-M-DI]** **[V2403-M-BG]**	Height	 33.00 mm 1.299 in. 33.27 mm 1.310 in. 33.47 mm 1.318 in. 33.90 mm 1.335 in.	 33.95 mm 1.297 in. 33.22 mm 1.308 in. 33.42 mm 1.316 in. 33.85 mm 1.333 in.
Camshaft Journal to Cylinder Block Bore	Oil Clearance	0.050 to 0.091 mm 0.0020 to 0.0035 in.	0.15 mm 0.0059 in.
Camshaft Journal	O.D.	39.934 to 39.950 mm 1.5722 to 1.5728 in.	–
Cylinder Block Bore	I.D.	40.000 to 40.025 mm 1.5748 to 1.5757 in.	–
Balancer Shaft (Balancer Model Only)	Side Clearance	0.070 to 0.22 mm 0.0028 to 0.0086 in.	0.30 mm 0.012 in.
Balancer Shaft (Balancer Model Only)	Alignment	–	0.02 mm 0.0008 in.

W1117772

ENGINE BODY (Continued)

Item		Factory Specification	Allowable Limit
Balancer Shaft Journal 1 to Balancer Shaft Bearing 1 (Balancer Model Only)	Oil Clearance	0.0300 to 0.111 mm 0.00119 to 0.00437 in.	0.20 mm 0.0079 in.
Balancer Shaft Journal 1	O.D.	43.934 to 43.950 mm 1.7297 to 1.7303 in.	–
Balancer Shaft Bearing 1	I.D.	43.980 to 44.045 mm 1.7315 to 1.7340 in.	–
Balancer Shaft Journal 2 to Balancer Shaft Bearing 2 (Balancer Model Only)	Oil Clearance	0.0300 to 0.111 mm 0.00119 to 0.00437 in.	0.20 mm 0.0079 in.
Balancer Shaft Journal 2	O.D.	41.934 to 41.950 mm 1.6509 to 1.6515 in.	–
Balancer Shaft Bearing 2	I.D.	41.980 to 42.045 mm 1.6528 to 1.6553 in.	–
Balancer Shaft Journal 3 to Balancer Shaft Bearing 3 (Balancer Model Only)	Oil Clearance	0.020 to 0.094 mm 0.00079 to 0.0037 in.	0.20 mm 0.0079 in.
Balancer Shaft Journal 3	O.D.	21.947 to 21.960 mm 0.86406 to 0.86456 in.	–
Balancer Shaft Bearing 3	I.D.	21.980 to 22.041 mm 0.86536 to 0.86775 in.	–
Piston Pin Bore	I.D.	25.000 to 25.013 mm 0.98426 to 0.98476 in.	25.05 mm 0.9862 in.
Top Ring to Ring Groove **[D1803-M-DI]** **[V2403-M-DI]**	Clearance	0.050 to 0.090 mm 0.0020 to 0.0035 in.	0.20 mm 0.0079 in.
Second Ring to Ring Groove **[D1503-M], [D1703-M]** **[D1803-M], [V2003-M]** **[V2203-M], [V2403-M]** **[V2403-M-T], [V2403-M-DI-T]** **[D1703-M-BG], [V2003-M-BG]** **[V2003-M-T-BG], [V2203-M-BG]** **[V2403-M-BG]**	Clearance	0.0930 to 0.128 mm 0.00367 to 0.00503 in.	0.20 mm 0.0079 in.
Second Ring to Ring Groove **[D1803-M-DI], [V2403-M-DI]**	Clearance	0.0780 to 0.110 mm 0.00307 to 0.00433 in.	0.20 mm 0.0079 in.
Oil Ring to Ring Groove **[D1503-M], [D1703-M]** **[D1803-M], [V2003-M]** **[V2203-M], [V2403-M]** **[V2403-M-T], [V2403-M-DI-T]** **[D1703-M-BG], [V2003-M-BG]** **[V2003-M-T-BG], [V2203-M-BG]** **[V2403-M-BG]**	Clearance	0.020 to 0.060 mm 0.00079 to 0.0023 in.	0.15 mm 0.0059 in.
Oil Ring to Ring Groove **[D1803-M-DI], [V2403-M-DI]**	Clearance	0.030 to 0.070 mm 0.0012 to 0.0027 in.	0.15 mm 0.0059 in.

W1119370

ENGINE BODY (Continued)

Item		Factory Specification	Allowable Limit
Top Ring **[D1503-M], [V2003-M], [V2403-M-T]** **[D1803-M-DI], [V2403-M-DI]** **[V2403-M-DI-T]** **[V2003-M-BG], [V2003-M-T-BG],**	Ring Gap	0.20 to 0.35 mm 0.0079 to 0.013 in.	1.25 mm 0.0492 in.
Top Ring **[D1703-M], [D1803-M]** **[V2203-M], [V2403-M]** **[D1703-M-BG], [V2203-M-BG]** **[V2403-M-BG]**	Ring Gap	0.25 to 0.40 mm 0.0099 to 0.015 in.	1.25 mm 0.0492 in.
Second Ring **[D1503-M], [D1703-M]** **[D1803-M], [V2203-M]** **[V2403-M]** **[D1803-M-DI], [V2403-M-DI]** **[D1703-M-BG], [V2003-M-BG]** **[V2203-M-BG], [V2403-M-BG]**	Ring Gap	0.30 to 0.45 mm 0.012 to 0.017 in.	1.25 mm 0.0492 in.
Second Ring **[V2003-M], [V2403-M-T]**, **[V2403-M-DI-T]** **[V2003-M-T-BG]**	Ring Gap	0.40 to 0.55 mm 0.016 to 0.021 in.	1.25 mm 0.0492 in.
Oil Ring **[D1503-M], [D1703-M]** **[D1803-M], [V2003-M]** **[V2203-M], [V2403-M], [V2403-M-T]** **[V2403-M-DI-T]** **[D1703-M-BG], [V2003-M-BG]** **[V2003-M-T-BG], [V2203-M-BG]** **[V2403-M-BG]**	Ring Gap	0.25 to 0.45 mm 0.0099 to 0.017 in.	1.25 mm 0.0492 in.
Oil Ring **[D1803-M-DI], [V2403-M-DI]**	Ring Gap	0.20 to 0.40 mm 0.0079 to 0.015 in.	1.25 mm 0.0492 in.
Connecting Rod	Alignment	–	0.05 mm 0.002 in.
Piston Pin to Small End Bushing	Oil Clearance	0.014 to 0.036 mm 0.00056 to 0.0014 in.	0.15 mm 0.0059 in.
Piston Pin	O.D.	25.004 to 25.011 mm 0.98441 to 0.98468 in.	–
Small End Bushing	I.D.	25.025 to 25.040 mm 0.98524 to 0.98582 in.	–
Crankshaft	Alignment	–	0.02 mm 0.0008 in.
Crankshaft Journal to Crankshaft Bearing 1	Oil Clearance	0.0400 to 0.118 mm 0.00158 to 0.00464 in.	0.20 mm 0.0079 in.
Crankshaft Journal	O.D.	59.921 to 59.940 mm 2.3591 to 2.3598 in.	–
Crankshaft Bearing 1	I.D.	59.980 to 60.039 mm 2.3615 to 2.3637 in.	–

W1086708

ENGINE BODY (Continued)

Item		Factory Specification	Allowable Limit
Crankshaft Journal to Crankshaft Bearing 2	Oil Clearance	0.0400 to 0.104 mm 0.00158 to 0.00409 in.	0.20 mm 0.0079 in.
Crankshaft Journal	O.D.	59.921 to 59.940 mm 2.3591 to 2.3598 in.	–
Crankshaft Bearing 2	I.D.	59.980 to 60.025 mm 2.3615 to 2.3631 in.	–
Crankpin to Crankpin Bearing	Oil Clearance	0.025 to 0.087 mm 0.00099 to 0.0034 in.	0.20 mm 0.0079 in.
Crankpin	O.D.	46.959 to 46.975 mm 1.8488 to 1.8494 in.	–
Crankpin Bearing	I.D.	47.000 to 47.046 mm 1.8504 to 1.8522 in.	–
Crankshaft	Side Clearance	0.15 to 0.31 mm 0.0059 to 0.012 in.	0.5 mm 0.02 in.
Cylinder Bore (Standard) **[D1503-M], [V2003-M]** **[V2003-M-BG], [V2003-M-T-BG]**	I.D.	83.000 to 83.022 mm 3.2678 to 3.2685 in.	83.170 mm 3.2744 in.
Cylinder Bore (Standard) **[D1703-M], [D1803-M]** **[V2203-M], [V2403-M], [V2403-M-T]** **[D1803-M-DI], [V2403-M-DI]** **[V2403-M-DI-T]** **[D1703-M-BG], [V2203-M-BG]** **[V2403-M-BG]**	I.D.	87.000 to 87.022 mm 3.4252 to 3.4260 in.	87.170 mm 3.4319 in.
Cylinder Bore (Oversize) **[D1503-M], [V2003-M]** **[V2003-M-BG], [V2003-M-T-BG]**	I.D.	83.250 to 83.272 mm 3.2776 to 3.2784 in.	83.420 mm 3.2843 in.
Cylinder Bore (Oversize) **[D1703-M], [D1803-M]** **[V2203-M], [V2403-M], [V2403-M-T]** **[D1803-M-DI], [V2403-M-DI]** **[V2403-M-DI-T]** **[D1703-M-BG], [V2203-M-BG]** **[V2403-M-BG]**	I.D.	87.250 to 87.272 mm 3.4351 to 3.4359 in.	87.420 mm 3.4417 in.
Difference among Minimum Wear to Maximum Wear		–	0.15 mm 0.0059 in.

W1054843

LUBRICATING SYSTEM

Item		Factory Specification	Allowable Limit
Engine Oil Pressure	At Idle Speed	More than 98 kPa 1.0 kgf/cm^2 14 psi	50 kPa 0.5 kgf/cm^2 7 psi
	At Rated Speed	300 to 440 kPa 3.0 to 4.5 kgf/cm^2 43 to 64 psi	250 kPa 2.5 kgf/cm^2 36 psi
Engine Oil Pressure Switch	Working Pressure	50 kPa 0.5 kgf/cm^2 7 psi	–
Inner Rotor to Outer Rotor	Clearance	0.030 to 0.14 mm 0.0012 to 0.0055 in.	0.2 mm 0.008 in.
Outer Rotor to Pump Body	Clearance	0.11 to 0.19 mm 0.0044 to 0.0074 in.	0.25 mm 0.0098 in.
Inner Rotor to Cover	Clearance	0.105 to 0.150 mm 0.00414 to 0.00590 in.	0.20 mm 0.008 in.

W1120963

COOLING SYSTEM

Fan Belt	Tension	7.0 to 9.0 mm (0.28 to 0.35 in.) deflection at 98 N (10 kgf, 22 lbf) of force	–
Thermostat **[D1503-M], [D1703-M]** **[D1803-M], [V2003-M]** **[V2203-M], [V2403-M]**	Valve Opening Temperature (At Beginning)	69.5 to 72.5 °C 157.1 to 162.5 °F	–
[V2403-M-T] **[D1703-M-BG], [V2003-M-BG]** **[V2003-M-T-BG], [V2203-M-BG]** **[V2403-M-BG]**	Valve Opening Temperature (Opened Completely)	85 °C 185 °F	–
Thermostat **[D1803-M-DI], [V2403-M-DI]** **[V2403-M-DI-T]**	Valve Opening Temperature (At Beginning)	80.5 to 83.5 °C 176.9 to 182.3 °F	–
	Valve Opening Temperature (Opened Completely)	95 °C 203 °F	–
Radiator	Water Tightness	No leak at specified pressure	–
Radiator Cap	Pressure Falling Time	More than 10 seconds for pressure fall from 90 to 60 kPa from 0.9 to 0.6 kgf/cm^2 from 10 to 9 psi	–

W1122456

FUEL SYSTEM

Item		Factory Specification	Allowable Limit
Injection Pump **[D1503-M], [V2003-M-T-BG]**	Injection Timing	0.253 to 0.279 rad (14.5 to 16.0 °) before T.D.C.	–
Injection Pump **[D1703-M], [D1803-M]** **[V2003-M], [V2203-M]** **[V2403-M]**	Injection Timing	0.271 to 0.296 rad (15.5 to 17.0 °) before T.D.C.	–
Injection Pump **[V2403-M-T]**	Injection Timing	0.132 to 0.157 rad (7.55 to 9.05 °) before T.D.C.	–
Injection Pump **[D1803-M-DI], [V2403-M-DI]**	Injection Timing	0.0742 to 0.100 rad (4.25 to 5.75 °) before T.D.C.	–
Injection Pump **[V2403-M-DI-T]**	Injection Timing	0.0829 to 0.109 rad (4.75 to 6.25 °) before T.D.C.	–
Injection Pump **[D1703-M-BG], [V2003-M-BG]** **[V2203-M-BG], [V2403-M-BG]**	Injection Timing	0.236 to 0.261 rad (13.5 to 15.0 °) before T.D.C.	–
Pump Element **[D1503-M], [D1703-M]** **[D1803-M], [V2003-M]** **[V2203-M], [V2403-M]** **[V2403-M-T]** **[D1703-M-BG], [V2003-M-BG]** **[V2003-M-T-BG], [V2203-M-BG]** **[V2403-M-BG]**	Fuel Tightness	–	13.73 MPa 140.0 kgf/cm^2 1991 psi
Pump Element **[D1803-M-DI], [V2403-M-DI]** **[V2403-M-DI-T]**	Fuel Tightness	–	18.63 MPa 190.0 kgf/cm^2 2702 psi
Delivery Valve **[D1503-M], [D1703-M]** **[D1803-M], [V2003-M]** **[V2203-M], [V2403-M]** **[V2403-M-T]** **[D1703-M-BG], [V2003-M-BG]** **[V2003-M-T-BG], [V2203-M-BG]** **[V2403-M-BG]**	Fuel Tightness	10 seconds 13.73 → 12.75 MPa 140.0 → 130.0 kgf/cm^2 1991 → 1849 psi	5 seconds 13.73 → 12.75 MPa 140.0 → 130.0 kgf/cm^2 1991 → 1849 psi
Delivery Valve **[D1803-M-DI], [V2403-M-DI]** **[V2403-M-DI-T]**	Fuel Tightness	10 seconds 18.63 → 17.65 MPa 190.0 → 180.0 kgf/cm^2 2702 → 2560 psi	5 seconds 18.63 → 17.65 MPa 190.0 → 180.0 kgf/cm^2 2702 → 2560 psi

W1123952

FUEL SYSTEM (Continued)

Item		Factory Specification	Allowable Limit
Injection Nozzle **[D1503-M], [D1703-M]** **[D1803-M], [V2003-M]** **[V2203-M], [V2403-M]** **[V2403-M-T]** **[D1703-M-BG], [V2003-M-BG]** **[V2003-M-T-BG], [V2203-M-BG]** **[V2403-M-BG]**	Injection Pressure	13.73 to 14.70 MPa 140.0 to 150.0 kgf/cm^2 1992 to 2133 psi	–
Injection Nozzle **[D1803-M-DI], [V2403-M-DI]** **[V2403-M-DI-T]**	Injection Pressure (1st stage)	18.64 to 20.10 MPa 190.0 to 205.0 kgf/cm^2 2703 to 2915 psi	–
Injection Nozzle Valve Seat **[D1503-M], [D1703-M]** **[D1803-M], [V2003-M]** **[V2203-M], [V2403-M]** **[V2403-M-T]** **[D1703-M-BG], [V2003-M-BG]** **[V2003-M-T-BG], [V2203-M-BG]** **[V2403-M-BG]**	Valve Seat Tightness	When the pressure is 12.75 MPa (130.0 kgf/cm^2, 1849 psi), the valve seat must be fuel tightness.	–
Injection Nozzle Valve Seat **[D1803-M-DI], [V2403-M-DI]** **[V2403-M-DI-T]**	Valve Seat Tightness	When the pressure is 16.67 MPa (170.0 kgf/cm^2, 2418 psi), the valve seat must be fuel tightness.	–

W1041294

ELECTRICAL SYSTEM

Item		Factory Specification	Allowable Limit
Starter			
Commutator **[D1503-M], [D1703-M]** **[V2003-M], [V2203-M]** **[D1803-M-DI]** **[D1703-M-BG], [V2003-M-BG]** **[V2003-M-T-BG], [V2203-M-BG]**	O.D.	30.0 mm 1.18 in.	29.0 mm 1.14 in.
Commutator **[D1803-M], [V2403-M]** **[V2403-M-DI], [V2403-M-T]** **[V2403-M-DI-T]** **[V2403-M-BG]**	O.D.	35.0 mm 1.38 in.	34.0 mm 1.34 in.
Mica **[D1503-M], [D1703-M]** **[D1803-M], [V2003-M]** **[V2203-M], [V2403-M]** **[V2403-M-T]** **[D1803-M-DI], [V2403-M-DI]** **[V2403-M-DI-T]** **[D1703-M-BG], [V2003-M-BG]** **[V2003-M-T-BG], [V2203-M-BG]**	Under Cut	0.45 to 0.75 mm 0.018 to 0.029 in.	0.20 mm 0.0079 in.
Mica **[V2403-M-BG]**	Under Cut	0.55 to 0.85 mm 0.022 to 0.033 in.	0.20 mm 0.0079 in.
Brush **[D1503-M], [D1703-M]** **[V2003-M], [V2203-M]** **[D1803-M-DI]** **[D1703-M-BG], [V2003-M-BG]** **[V2003-M-T-BG], [V2203-M-BG]**	Length	15.0 mm 0.591 in.	11.0 mm 0.433 in.
Brush **[D1803-M], [V2403-M]** **[V2403-M-DI], [V2403-M-T]** **[V2403-M-DI-T]**	Length	15.0 mm 0.591 in.	9.0 mm 0.35 in.
Brush **[V2403-M-BG]**	Length	15.0 mm 0.591 in.	12.0 mm 0.472 in.
Brush Holder and Holder Support	Resistance	Infinity	–
Alternator	No-load voltage	More than 13.5 V	–
Stator	Resistance	Less than 1.0 Ω	–
Rotor	Resistance	2.9 Ω	–
Slip Ring	O.D.	14.4 mm 0.567 in.	14.0 mm 0.551 in.
Brush	Length	10.5 mm 0.413 in.	8.4 mm 0.33 in.
Glow Plug	Resistance	Approx. 0.9 Ω	–

W1125417

3. TIGHTENING TORQUES

Screws, bolts and nuts must be tightened to the specified torque using a torque wrench, several screws, bolts and nuts such as those used on the cylinder head must be tightened in proper sequence and the proper torque.

[1] TIGHTENING TORQUES FOR GENERAL USE SCREWS, BOLTS AND NUTS

When the tightening torques are not specified, tighten the screws, bolts and nuts according to the table below.

Grade / Nominal Diameter / Unit	Standard Screw and Bolt ⟨4⟩			Special Screw and Bolt ⟨7⟩		
	N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft
M6	7.9 to 9.3	0.80 to 0.95	5.8 to 6.8	9.81 to 11.2	1.00 to 1.15	7.24 to 8.31
M8	18 to 20	1.8 to 2.1	13 to 15	24 to 27	2.4 to 2.8	18 to 20
M10	40 to 45	4.0 to 4.6	29 to 33	49 to 55	5.0 to 5.7	37 to 41
M12	63 to 72	6.4 to 7.4	47 to 53	78 to 90	7.9 to 9.2	58 to 66

W10371750

Screw and bolt material grades are shown by numbers punched on the screw and bolt heads. Prior to tightening, be sure to check out the numbers as shown below.

Punched number	Screw and bolt material grade
None or 4	Standard screw and bolt SS41, S20C
7	Special screw and bolt S43C, S48C (Refined)

W1012705

[2] TIGHTENING TORQUES FOR SPECIAL USE SCREWS, BOLTS AND NUTS

■ **NOTE**

- **For "*" marked screws, bolts and nuts on the table, apply engine oil to their threads and seats before tightening.**
- **The letter "M" in Size x Pitch means that the screw, bolt or nut dimension stands for metric. The size is the nominal outside diameter in mm of the threads. The pitch is the nominal distance in mm between two threads.**

Item	Size x Pitch	N·m	kgf·m	lbf·ft
Cylinder head cover screw	M6 x 1.0	9.81 to 11.2	1.00 to 1.15	7.24 to 8.31
*Cylinder head screw	M11 x 1.25	93.2 to 98.0	9.50 to 10.0	68.8 to 72.3
*Main bearing case screw 1	M9 x 1.25	46 to 50	4.7 to 5.2	34 to 37
*Main bearing case screw 2	M10 x 1.25	69 to 73	7.0 to 7.5	51 to 54
*Flywheel screw	M12 x 1.25	98.1 to 107	10.0 to 11.0	72.4 to 79.5
*Connecting rod screw	M8 x 1.0	45 to 49	4.5 to 5.0	33 to 36
*Rocker arm bracket screw	M8 x 1.25	24 to 27	2.4 to 2.8	18 to 20
*Idle gear shaft screw	M8 x 1.25	24 to 27	2.4 to 2.8	18 to 20
Fan drive pulley mounting nut	M30 x 1.5	138 to 156	14.0 to 16.0	102 to 115
*Bearing case cover mounting screw	M8 x 1.25	24 to 27	2.4 to 2.8	18 to 20
Glow plug	M10 x 1.25	20 to 24	2.0 to 2.5	15 to 18
Nozzle holder assembly (IDI)	M20 x 1.5	49 to 68	5.0 to 7.0	37 to 50
Nozzle holder (IDI)	–	35 to 39	3.5 to 4.0	26 to 28
Nozzle holder clamp screw (DI)	M10 x 1.25	26 to 29	2.6 to 3.0	19 to 21
Oil pressure switch	R 1/8	15 to 19	1.5 to 2.0	11 to 14
Injection pipe retaining nut (IDI)	M12 x 1.5	25 to 34	2.5 to 3.5	18 to 25
Injection pipe retaining nut (DI)	M12 x 1.5	15 to 24	1.5 to 2.5	11 to 18
Overflow pipe assembly retaining nut (IDI)	M12 x 1.5	20 to 24	2.0 to 2.5	15 to 18
Overflow pipe assembly retaining screw (DI)	M6 x 1.0	9.81 to 11.2	1.00 to 1.15	7.24 to 8.31
Camshaft set screw	M8 x 1.25	24 to 27	2.4 to 2.8	18 to 20
Hi-idling body	M14 x 1.0	45 to 49	4.5 to 5.0	33 to 36
Balancer shaft set bolt (Balancer model only)	M8 x 1.25	24 to 27	2.4 to 2.8	18 to 20
Alternator's pulley nut	–	58.4 to 78.9	5.95 to 8.05	43.1 to 58.2
Idle gear 2 stopper set screw (Side PTO model only)	–	49 to 55	5.0 to 5.7	37 to 41
Idle gear 2 shaft set screw (Side PTO model only)	–	24 to 27	2.4 to 2.8	18 to 20
Starter's terminal **B** mounting nut	M8	5.9 to 11	0.60 to 1.2	4.4 to 8.6

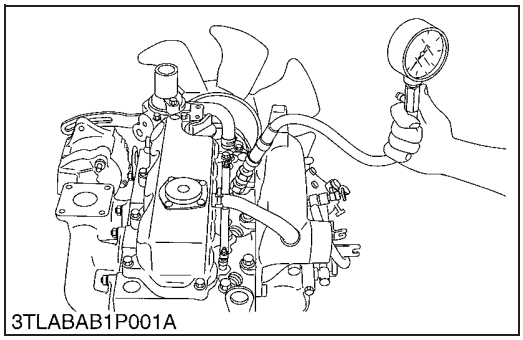
IDI : D1503-M, D1703-M, D1803-M, V2003-M, V2203-M, V2403-M, V2403-M-T
D1703-M-BG, V2003-M-BG, V2003-M-T-BG, V2203-M-BG, V2403-M-BG
DI : D1803-M-DI, V2403-M-DI, V2403-M-DI-T

W1013236

4. CHECKING, DISASSEMBLING AND SERVICING

[1] CHECKING AND ADJUSTING

(1) Engine Body


3TLABAB1P001A

Compression Pressure

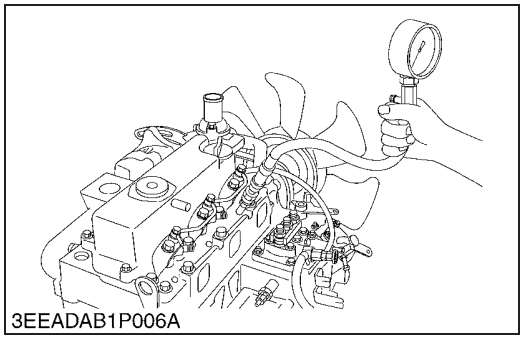
[D1503-M, D1703-M, D1803-M, V2003-M, V2203-M, V2403-M, V2403-M-T]
[D1703-M-BG, V2003-M-BG, V2003-M-T-BG, V2203-M-BG, V2403-M-BG]

1. Run the engine until it is warmed up.
2. Stop the engine and disconnect the **2P** connector from the stop solenoid in order not to inject fuel.
3. Remove the air cleaner, the muffler and all injection nozzles.
4. Set a compression tester with the adaptor to the nozzle hole.
5. After making sure that the stop lever is set at the stop position (non-injection).
6. While cranking the engine with the starter, measure the compression pressure.
7. Repeat steps 4 through 6 for each cylinder.
8. If the measurement is below the allowable limit, apply a small amount of oil to the cylinder wall through the nozzle hole and measure the compression pressure again.
9. If the compression pressure is still less than the allowable limit, check the top clearance, valve and cylinder head.
10. If the compression pressure increases after applying oil, check the cylinder wall and piston rings.

■ **NOTE**
- **Check the compression pressure with the specified valve clearance.**
- **Always use a fully charged battery for performing this test.**
- **Variances in cylinder compression values should be under 10 %.**

Compression pressure	Factory spec.	3.24 to 3.72 MPa 33.0 to 38.0 kgf/cm^2 470 to 540 psi
	Allowable limit	2.55 MPa 26.0 kgf/cm^2 370 psi

W1018639


3EEADAB1P006A

Compression Pressure

[D1803-M-DI, V2403-M-DI, V2403-M-DI-T]

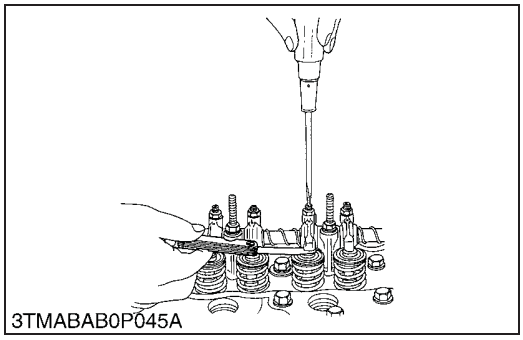
1. Run the engine until it is warmed up.
2. Stop the engine and disconnect the **2P** connector from the stop solenoid in order not to inject fuel.
3. Remove the air cleaner, the muffler and all glow plugs.
4. Set a compression tester (07909-39081) with the adaptor **K** (07909-31291) to the glow plug hole.
5. While cranking the engine with the starter, measure the compression pressure.
6. Repeat steps 4 through 5 for each cylinder.

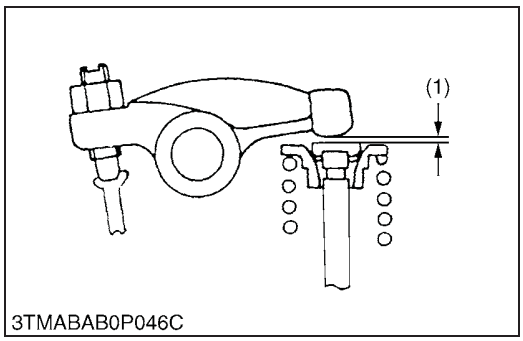
■ **NOTE**

- **Check the compression pressure with the specified valve clearance.**
- **Always use a fully charged battery for performing this test.**
- **Variances in cylinder compression values should be under 10 %.**

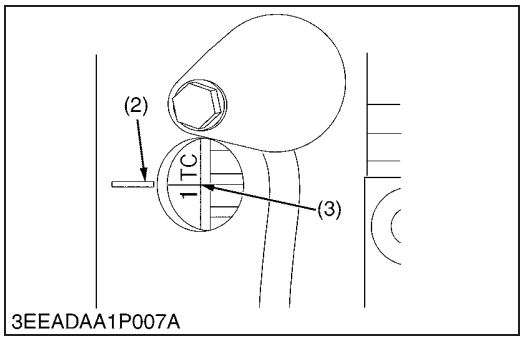
Compression pressure	Factory spec.	2.95 to 3.23 MPa 30.0 to 33.0 kgf/cm^2 427 to 469 psi
	Allowable limit	2.35 MPa 24.0 kgf/cm^2 341 psi

W1111297


3TMABAB0P045A



3TMABAB0P046C



3EEADAA1P007A

Valve Clearance

■ **IMPORTANT**

- **Valve clearance must be checked and adjusted when engine is cold.**

1. Remove the head cover.
2. Align the **"1TC"** mark line (3) on the flywheel and projection (2) on the housing so that the No.1 piston comes to the compression or overlap top dead center.
3. Check the following valve clearance (1) marked with "☆" using a feeler gauge.
4. If the clearance is not within the factory specifications, adjust with the adjusting screw.

Valve clearance	Factory spec.	0.18 to 0.22 mm 0.0071 to 0.0086 in.

■ **NOTE**

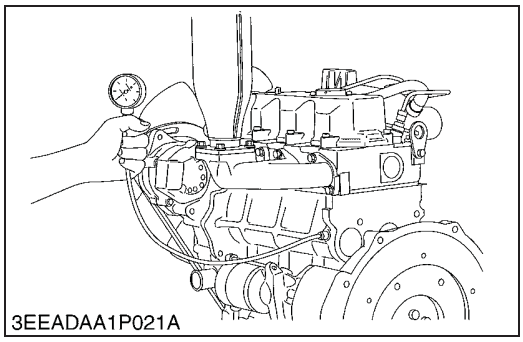
- **The "1TC" mark line on the flywheel is just for No. 1 cylinder. There is no "TC" marking for the other cylinders.**
- **No. 1 piston comes to the top dead center position when the "TC" marking is aligned with the projection (2) in the window on flywheel-housing. Turn the flywheel 0.26 rad (15 °) clockwise and counterclockwise to see if the piston is at the compression top dead center or the overlap position. Now referring to the table below, readjust the valve clearance (1). (The piston is at the top dead center when both the IN. and EX. valves do not move; it is at the overlap position when both the valves move.)**
- **Finally turn the flywheel 6.28 rad (360 °) and align the "1TC" mark line and the projection (2) perfectly. Adjust all the other valve clearance as required.**
- **After turning the flywheel counterclockwise twice or three times, recheck the valve clearance (1).**
- **After adjusting the valve clearance (1), firmly tighten the lock nut of the adjusting screw.**

Valve arrangement / Adjustable cylinder location of piston		3 Cylinder		4 Cylinder	
		IN.	EX.	IN.	EX.
When No. 1 piston is at compression top dead center	No. 1	☆	☆	☆	☆
	No. 2		☆	☆	
	No. 3	☆			☆
	No. 4	–	–		
When No. 1 piston is at overlap position	No. 1				
	No. 2	☆			☆
	No. 3		☆	☆	
	No. 4	–	–	☆	☆

(1) Valve Clearance
(2) Projection
(3) 1TC Mark Line

W10379490

(2) Lubricating System


3EEADAA1P021A

Engine Oil Pressure

1. Remove the engine oil pressure switch, and set an oil pressure tester (Code No.: 07916-32032). (Adaptor screw size : PT 1/8)
2. Start the engine. After warming up, measure the oil pressure of both idling and rated speeds.
3. If the oil pressure is less than the allowable limit, check the following.

- Engine oil insufficient.
- Oil pump defective
- Oil strainer clogged
- Oil filter cartridge clogged
- Oil gallery clogged
- Excessive oil clearance
- Foreign matter in the relief valve

Engine oil pressure	At idle speed	Factory spec.	More than 98 kPa 1.0 kgf/cm^2 14 psi
		Allowable limit	50 kPa 0.5 kgf/cm^2 7 psi
	At rated speed	Factory spec.	300 to 440 kPa 3.0 to 4.5 kgf/cm^2 43 to 64 psi
		Allowable limit	250 kPa 2.5 kgf/cm^2 36 psi

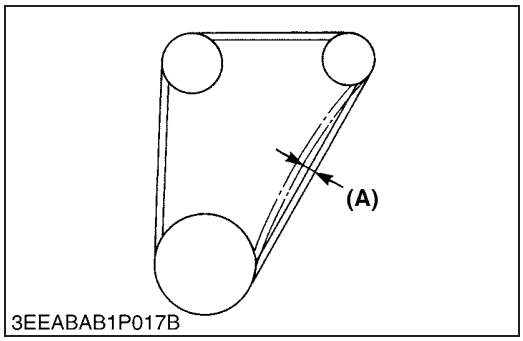
(When reassembling)

- After checking the engine oil pressure, tighten the engine oil pressure switch to the specified torque.

Tightening torque	Oil pressure switch	15 to 19 N·m 1.5 to 2.0 kgf·m 11 to 14 lbf·ft

W1034952

(3) Cooling System



3EEABAB1P017B

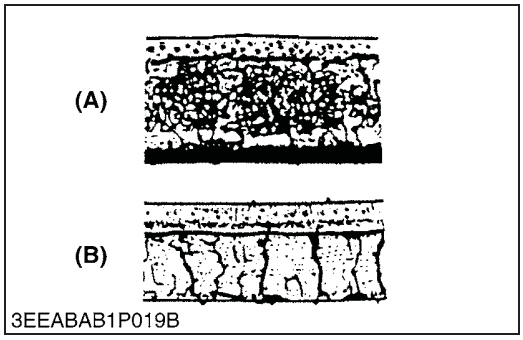
Fan Belt Tension

1. Measure the deflection **(A)**, depressing the belt halfway between the fan drive pulley and alternator pulley at specified force 98 N (10 kgf, 22 lbf).
2. If the measurement is not within the factory specifications, loosen the alternator mounting screws and relocate the alternator to adjust.

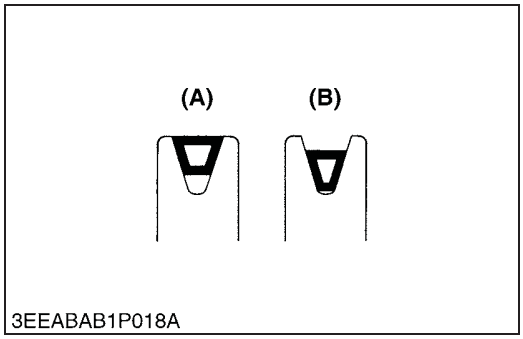
Deflection **(A)**	Factory spec.	7.0 to 9.0 mm 0.28 to 0.35 in.

(A) Deflection

W10356670



3EEABAB1P019B



3EEABAB1P018A

Fan Belt Damage and Wear

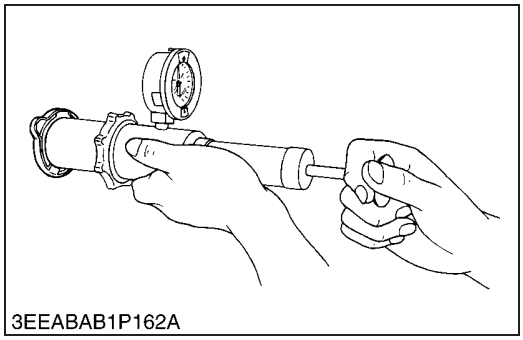
1. Check the fan belt for damage.
2. If the fan belt is damaged, replace it.
3. Check if the fan belt is worn and sunk in the pulley groove.
4. If the fan belt is nearly worn out and deeply sunk in the pulley groove, replace it.

(A) Good **(B) Bad**

W1020602

CAUTION

- **When removing the radiator cap, wait at least ten minutes after the engine has stopped and cooled down. Otherwise, hot water may gush out, scalding nearby people.**

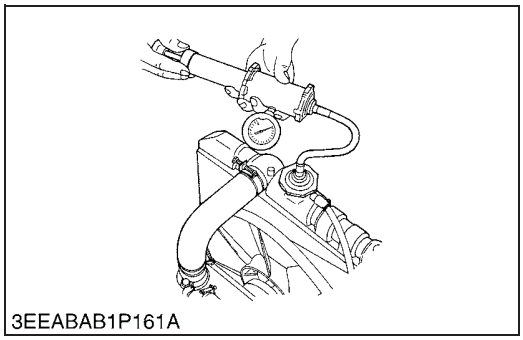

3EEABAB1P162A

Radiator Cap Air Leakage

1. Set a radiator tester and an adaptor on the radiator cap.
2. Apply the specified pressure 90 kPa (0.9 kgf/cm^2, 10 psi), and measure the time for the pressure to fall to 60 kPa (0.6 kgf/cm^2, 9 psi).
3. If the measurement is less than the factory specification, replace the radiator cap.

Pressure falling time	Factory spec.	More than 10 seconds for pressure fall from 90 to 60 kPa (from 0.9 to 0.6 kgf/cm^2, from 10 to 9 psi)

W10387530


3EEABAB1P161A

Radiator Water Leakage

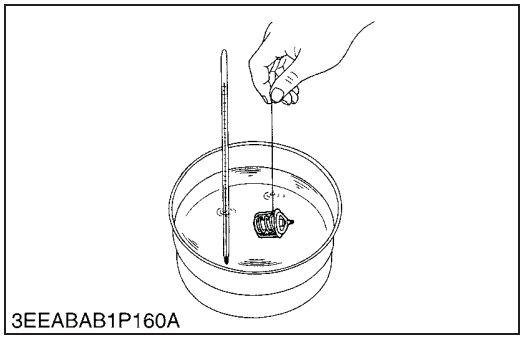
1. Pour a specified amount of water into the radiator.
2. Set a radiator tester and an adaptor and raise the water pressure to the specified pressure.
3. Check the radiator for water leaks.
4. For water leak from the pinhole, replace the radiator or repair with the radiator cement. When water leak is excessive, replace the radiator.

Radiator water leakage test pressure	Factory spec.	No leak at specified pressure

■ **NOTE**

- **The pressure of the leak test is different from each radiator specification.**
  Thus, do the leak test, refer to the test pressure of each radiator specification.

W10389070


3EEABAB1P160A

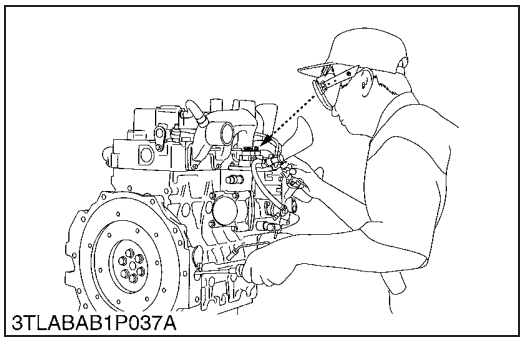
Thermostat Valve Opening Temperature

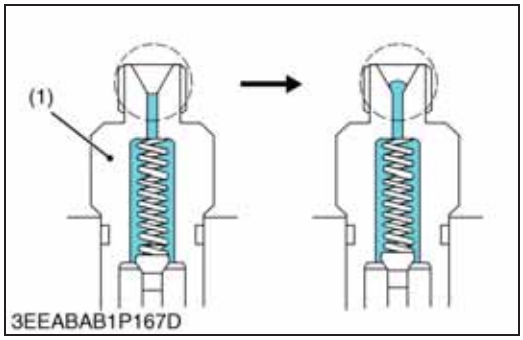
1. Suspend the thermostat in the water by a string with its end inserted between the valve and seat.
2. Heating the water gradually, read the temperature when the valve opens and leaves the string.
3. Continue heating and read the temperature when the valve opens approx. 6 mm (0.2 in.).
4. If the measurement is not within the factory specifications, replace the thermostat.

Thermostat's valve opening temperature	Factory spec.	D1503-M D1703-M D1803-M V2003-M V2203-M V2403-M V2403-M-T D1703-M-BG V2003-M-BG V2003-M-T-BG V2203-M-BG V2403-M-BG	69.5 to 72.5 °C 157.1 to 162.5 °F
		D1803-M-DI V2403-M-DI V2403-M-DI-T	80.5 to 83.5 °C 176.9 to 182.3 °F
Temperature at which thermostat completely opens	Factory spec.	D1503-M D1703-M D1803-M V2003-M V2203-M V2403-M V2403-M-T D1703-M-BG V2003-M-BG V2003-M-T-BG V2203-M-BG V2403-M-BG	85 °C 185 °F
		D1803-M-DI V2403-M-DI V2403-M-DI-T	95 °C 203 °F

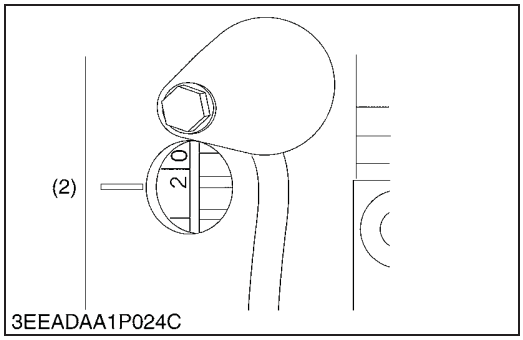
W1035849

(4) Fuel System

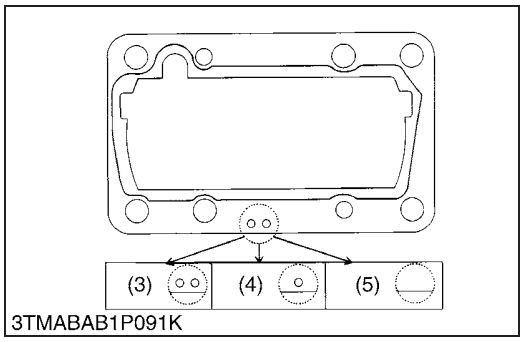

3TLABAB1P037A



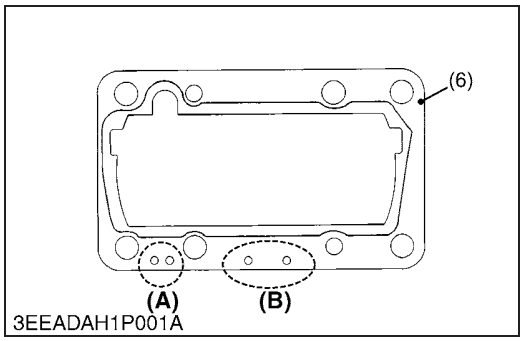
3EEABAB1P167D



3EEADAA1P024C



3TMABAB1P091K



3EEADAH1P001A

Injection Timing

[D1503-M, D1703-M, D1803-M, V2003-M, V2203-M, V2403-M, V2403-M-T]

[D1703-M-BG, V2003-M-BG, V2003-M-T-BG, V2203-M-BG, V2403-M-BG]

1. Remove the stop solenoid.
2. Remove the injection pipes and nozzle.
3. Set the speed control lever to maximum fuel discharge position.

(Reference)

- Turn the flywheel with screwdriver.

4. Turn the flywheel counterclockwise (facing the flywheel) until the fuel fills up to the hole of the delivery valve holder for 1st cylinder.
5. Turn the flywheel further and stop turning when the fuel begins to flow over, to get the present injection timing.
6. (The flywheel has mark 1TC and four lines indicating every 0.09 rad (5 °) of crank angle from 0.17 rad (10 °) to 0.44 rad (25 °) before mark 1TC) Calculate the angle which the center of the window points out. If the calculation differs from specified injection timing, add or remove the shim to adjust.

(Injection Timing)

Model	Injection timing
D1503-M V2003-M-T-BG	0.253 to 0.279 rad (14.5 to 16.0 °) before T.D.C.
D1703-M, D1803-M V2003-M, V2203-M V2403-M	0.271 to 0.296 rad (15.5 to 17.0 °) before T.D.C.
V2403-M-T	0.132 to 0.157 rad (7.55 to 9.05 °) before T.D.C.
D1703-M-BG V2003-M-BG V2203-M-BG V2403-M-BG	0.236 to 0.261 rad (13.5 to 15.0 °) before T.D.C.

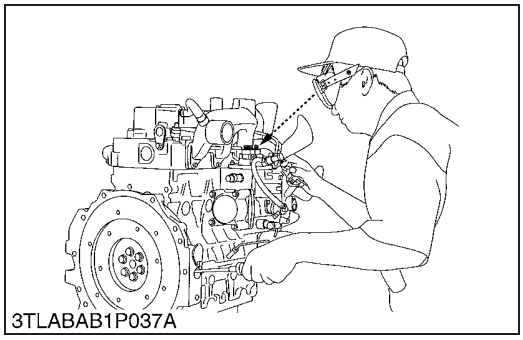
■ **NOTE**

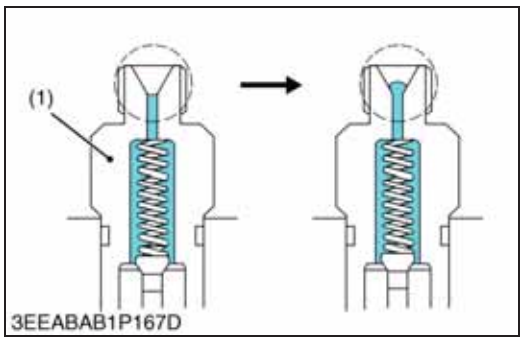
- **The sealant is applied to both sides of the soft metal gasket shim. The liquid gasket is not required for assembling.**
- **Shims are available in thickness of 0.175 mm (6), 0.20 mm (3), 0.25 mm (4) and 0.30 mm (5). Combine these shims for adjustments.**
- **The 0.175 mm thick shim is coated only on the lower face. Therefore, do not use the 0.175 mm thick shim as the top shim of the combination (injection pump side), because this cause oil leakage.**
- **Addition or reduction of shim (0.05 mm, 0.002 in.) delays or advances the injection timing by approx. 0.009 rad (0.5 °).**
- **In disassembling and replacing, be sure to use the same number of new gasket shims with the same thickness.**

(1) Delivery Valve Holder
(2) Timing Mark
(3) 2-Holes: 0.20 mm (Shim)
(4) 1-hole: 0.25 mm (Shim)
(5) Without hole: 0.30 mm (Shim)
(6) 2-Holes: 0.175 mm (Shim)

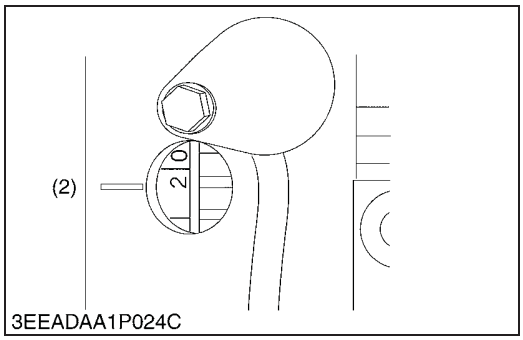
(A) 3 Cylinder
(B) 4 Cylinder

W1036402

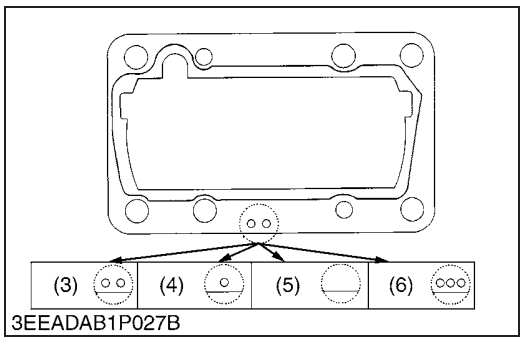

3TLABAB1P037A



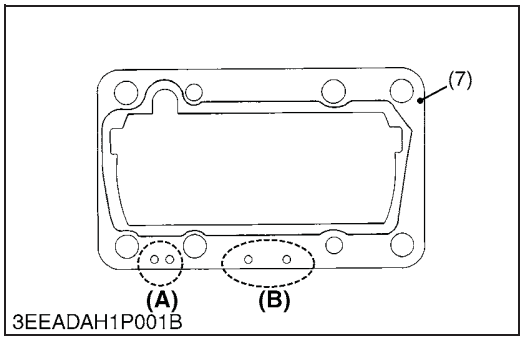
3EEABAB1P167D



3EEADAA1P024C



3EEADAB1P027B



3EEADAH1P001B

Injection Timing

[D1803-M-DI, V2403-M-DI, V2403-M-DI-T]

1. Remove the stop solenoid.
2. Remove the injection pipes and nozzle.
3. Set the speed control lever to maximum fuel discharge position.

(Reference)

- Turn the flywheel with screwdriver.

4. Turn the flywheel counterclockwise (facing the flywheel) until the fuel fills up to the hole of the delivery valve holder for 1st cylinder.
5. Turn the flywheel further and stop turning when the fuel begins to flow over, to get the present injection timing.
6. (The flywheel has mark 1TC and four lines indicating every 0.09 rad (5 °) of crank angle from 0.17 rad (10 °) to 0.44 rad (25 °) before mark 1TC) Calculate the angle which the center of the window points out. If the calculation differs from specified injection timing, add or remove the shim to adjust.

(Injection Timing)

Model	Injection Timing
D1803-M-DI V2403-M-DI	0.0742 to 0.100 rad (4.25 ° to 5.75 °) before T.D.C.
V2403-M-DI-T	0.0829 to 0.109 rad (4.75 ° to 6.25 °) before T.D.C.

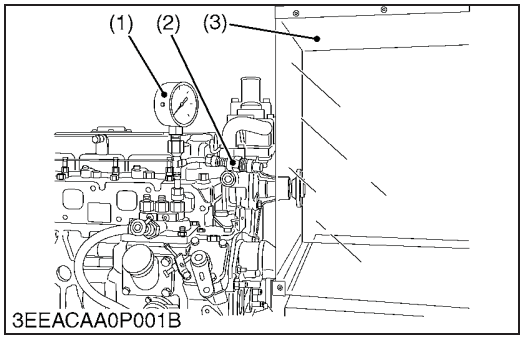
■ **NOTE**

- **The sealant is applied to both sides of the soft metal gasket shim. The liquid gasket is not required for assembling.**
- **Shims are available in thickness of 0.175 mm (7), 0.20 mm (3), 0.25 mm (4), 0.30 mm (5) and 0.35 mm (6). Combine these shims for adjustments.**
- **The 0.175 mm thick shim is coated only on the lower face. Therefore, do not use the 0.175 mm thick shim as the top shim of the combination (injection pump side), because this cause oil leakage.**
- **Addition or reduction of shim (0.05 mm, 0.002 in.) delays or advances the injection timing by approx. 0.009rad (0.5 °).**
- **In disassembling and replacing, be sure to use the same number of new gasket shims with the same thickness.**

(1) Delivery Valve Holder
(2) Timing Mark
(3) 2-Holes: 0.20 mm (Shim)
(4) 1-hole: 0.25 mm (Shim)
(5) Without hole: 0.30 mm (Shim)
(6) 3-Holes: 0.35 mm (Shim)
(7) 2-Holes: 0.175 mm (Shim)

(A) 3 Cylinder
(B) 4 Cylinder

W1047775



Fuel Tightness of Pump Element

[D1503-M, D1703-M, D1803-M, V2003-M, V2203-M, V2403-M, V2403-M-T]
[D1703-M-BG, V2003-M-BG, V2003-M-T-BG, V2203-M-BG, V2403-M-BG]

1. Remove the solenoid.
2. Remove the injection pipes and glow plugs.
3. Install the injection pump pressure tester to the injection pump.
4. Install the injection nozzle (2) jetted with the proper injection pressure to the injection pump pressure tester (1). (Refer to the figure.)
5. Set the speed control lever to the maximum speed position.
6. Run the starter to increase the pressure.
7. If the pressure can not reach the allowable limit, replace the pump with new one or repair with a Kubota-authorized pump service shop.

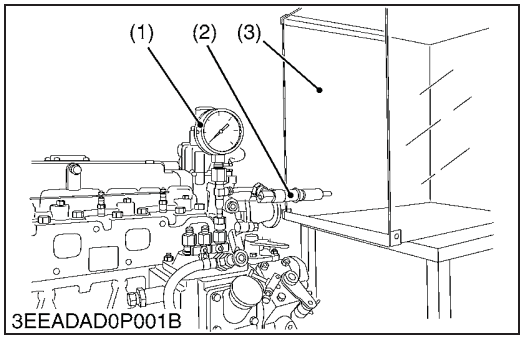
Fuel tightness of pump element	Allowable limit	13.73 MPa 140.0 kgf/cm^2 1991 psi

■ **NOTE**

- **Never try to disassemble the injection pump assembly. For repairs, you are strongly requested to contact a Kubota-authorized pump service shop.**

(1) Injection Pump Pressure Tester
(2) Injection Nozzle
(3) Protection Cover for Jetted Fuel

W1017430



Fuel Tightness of Pump Element

[D1803-M-DI, V2403-M-DI, V2403-M-DI-T]

1. Remove the solenoid.
2. Remove the injection pipes and glow plugs.
3. Install the injection pump pressure tester to the injection pump.
4. Install the injection nozzle (2) jetted with the proper injection pressure to the injection pump pressure tester (1). (Refer to the figure.)
5. Set the speed control lever to the maximum speed position.
6. Run the starter to increase the pressure.
7. If the pressure can not reach the allowable limit, replace the pump with new one or repair with a Kubota-authorized pump service shop.

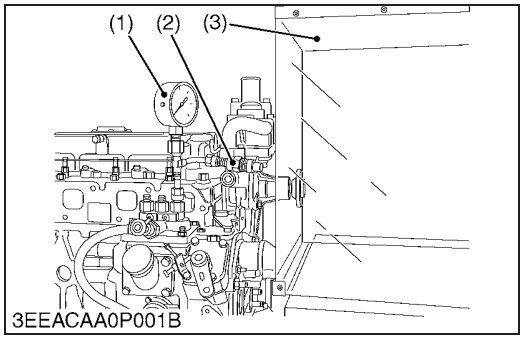
Fuel tightness of pump element	Allowable limit	18.63 MPa 190.0 kgf/cm^2 2702 psi

■ **NOTE**

- **Never try to disassemble the injection pump assembly. For repairs, you are strongly requested to contact a Kubota-authorized pump service shop.**

(1) Injection Pump Pressure Tester
(2) Injection Nozzle
(3) Protection Cover for Jetted Fuel

W1104546



Fuel Tightness of Delivery Valve

[D1503-M, D1703-M, D1803-M, V2003-M, V2203-M, V2403-M, V2403-M-T]
[D1703-M-BG, V2003-M-BG, V2003-M-T-BG, V2203-M-BG, V2403-M-BG]

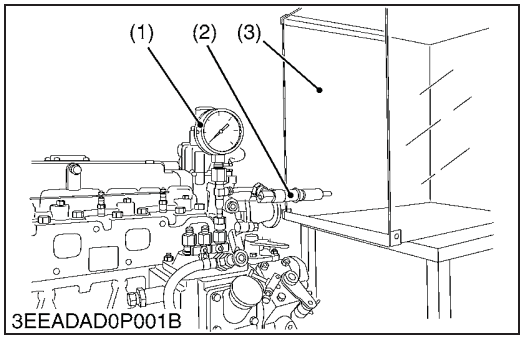
1. Remove the solenoid.
2. Remove the injection pipes and glow plugs.
3. Set a pressure tester to the fuel injection pump.
4. Install the injection nozzle (2) jetted with the proper injection pressure to the injection pump pressure tester (1).
5. Run the starter to increase the pressure.
6. Stop the starter when the fuel jets from the injection nozzle. After that, turn the flywheel by the hand and raise the pressure to approx. 13.73 MPa (140.0 kgf/cm^2, 1991 psi).
7. Now turn the flywheel back about half a turn (to keep the plunger free). Maintain the flywheel at this position and clock the time taken for the pressure to drop from 13.73 to 12.75 MPa (140.0 to 130.0 kgf/cm^2, 1991 to 1849 psi).
8. Measure the time needed to decrease the pressure from 13.73 to 12.75 MPa (140.0 to 130.0 kgf/cm^2, 1991 to 1849 psi).
9. If the measurement is less than allowable limit, replace the pump with new one or repair with a Kubota-authorized pump service shop.

Fuel tightness of delivery valve	Factory spec.	10 seconds 13.73 → 12.75 MPa 140.0 → 130.0 kgf/cm^2 1991 → 1849 psi
	Allowable limit	5 seconds 13.73 → 12.75 MPa 140.0 → 130.0 kgf/cm^2 1991 → 1849 psi

■ **NOTE**
- **Never try to disassemble the injection pump assembly. For repairs, you are strongly requested to contact a Kubota-authorized pump service shop.**

(1) Injection Pump Pressure Tester
(2) Injection Nozzle
(3) Protection Cover for Jetted Fuel

W1017786



Fuel Tightness of Delivery Valve

[D1803-M-DI, V2403-M-DI, V2403-M-DI-T]

1. Remove the solenoid.
2. Remove the injection pipes and glow plugs.
3. Set a pressure tester to the fuel injection pump.
4. Install the injection nozzle (2) jetted with the proper injection pressure to the injection pump pressure tester (1).
5. Run the starter to increase the pressure.
6. Stop the starter when the fuel jets from the injection nozzle. After that, turn the flywheel by the hand and raise the pressure to approx. 18.63 MPa (190.0 kgf/cm^2, 2702 psi).
7. Now turn the flywheel back about half a turn (to keep the plunger free). Maintain the flywheel at this position and clock the time taken for the pressure to drop from 18.63 to 17.65 MPa (190.0 to 180.0 kgf/cm^2, 2702 to 2560 psi).
8. Measure the time needed to decrease the pressure from 18.63 to 17.65 MPa (190.0 to 180.0 kgf/cm^2, 2702 to 2560 psi).
9. If the measurement is less than allowable limit, replace the pump with new one or repair with a Kubota-authorized pump service shop.

Fuel tightness of delivery valve	Factory spec.	10 seconds 18.63 → 17.65 MPa 190.0 → 180.0 kgf/cm^2 2702 → 2560 psi
	Allowable limit	5 seconds 18.63 → 17.65 MPa 190.0 → 180.0 kgf/cm^2 2702 → 2560 psi

■ **NOTE**

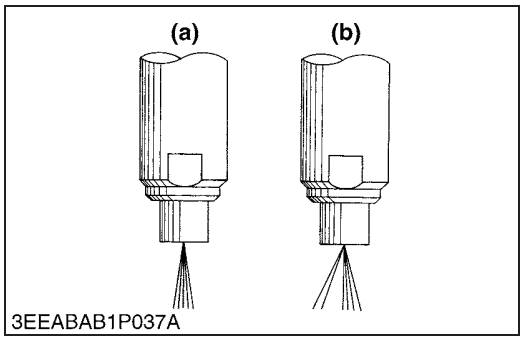
- **Never try to disassemble the injection pump assembly. For repairs, you are strongly requested to contact a Kubota-authorized pump service shop.**

(1) Injection Pump Pressure Tester
(2) Injection Nozzle
(3) Protection Cover for Jetted Fuel

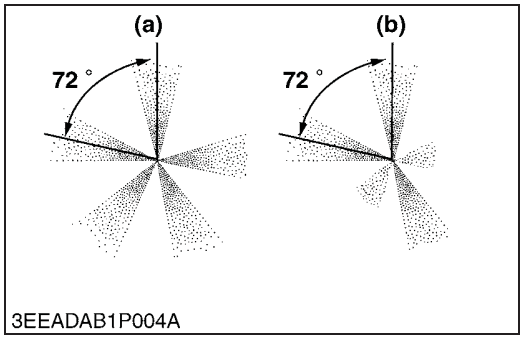
W1108296

CAUTION

- **Check the injection pressure and condition after confirming that there is nobody standing in the direction the fume goes.**
- **If the fume from the nozzle directly contacts the human body, cells may be destroyed and blood poisoning may be caused.**



3EEABAB1P037A



3EEADAB1P004A

Nozzle Spraying Condition

[D1503-M, D1703-M, D1803-M, V2003-M, V2203-M, V2403-M, V2403-M-T]
[D1703-M-BG, V2003-M-BG, V2003-M-T-BG, V2203-M-BG, V2403-M-BG]

1. Set the injection nozzle to a nozzle tester, and check the nozzle spraying condition.
2. If the spraying condition is defective, replace the nozzle piece.

(a) Good **(b) Bad**

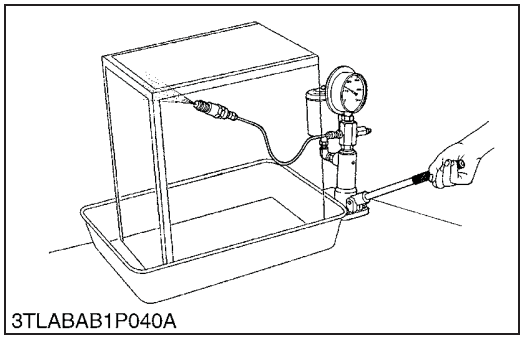
W10181310

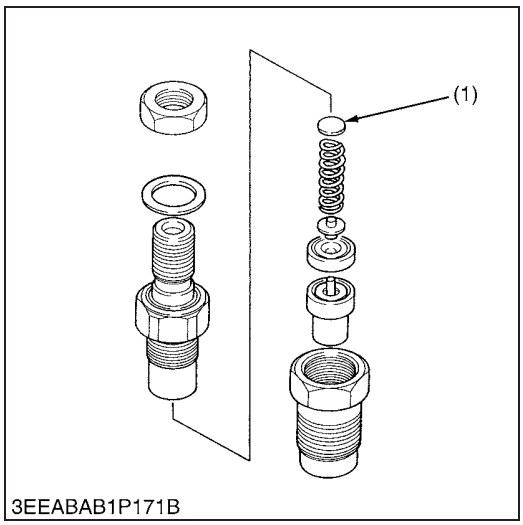
[D1803-M-DI, V2403-M-DI, V2403-M-DI-T]

1. Set the injection nozzle to a nozzle tester, and check the nozzle spraying condition.
2. If the spraying condition is defective, replace the injection nozzle assembly.

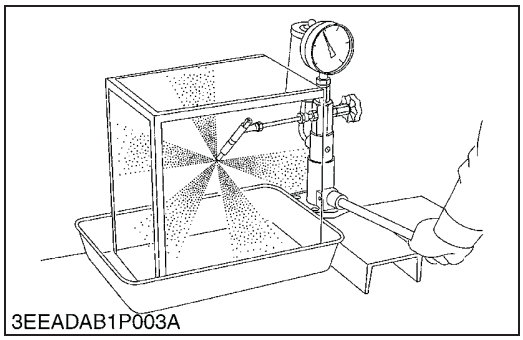
(a) Good **(b) Bad**

W10226470


3TLABAB1P040A



3EEABAB1P171B


3EEADAB1P003A

Fuel Injection Pressure

[D1503-M, D1703-M, D1803-M, V2003-M, V2203-M, V2403-M, V2403-M-T]

[D1703-M-BG, V2003-M-BG, V2003-M-T-BG, V2203-M-BG, V2403-M-BG]

1. Set the injection nozzle to a nozzle tester.
2. Slowly move the tester handle to measure the pressure at which fuel begins jetting out from the nozzle.
3. If the measurement is not within the factory specifications, replace the adjusting washer (1) in the nozzle holder to adjust it.

(Reference)

- Pressure variation with 0.025 mm (0.00098 in.) difference of adjusting washer thickness.
  Approx. 590 kPa (6.0 kgf/cm^2, 85 psi)

Fuel injection pressure	Factory spec.	13.73 to 14.70 MPa 140.0 to 150.0 kgf/cm^2 1992 to 2133 psi

(1) Adjusting Washer

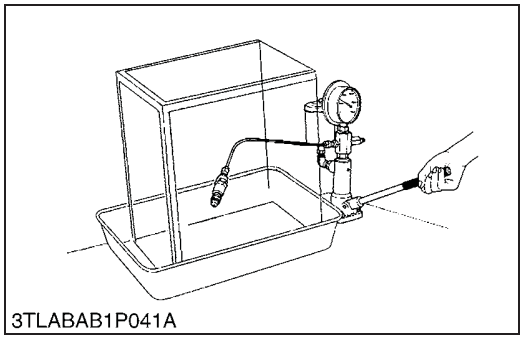
W10476390

[D1803-M-DI, V2403-M-DI, V2403-M-DI-T]

1. Set the injection nozzle to a nozzle tester.
2. Slowly move the tester handle to measure the pressure at which fuel begins jetting out from the nozzle.
3. If the measurement is not within the factory specifications, replace the injection nozzle assembly.

Fuel injection pressure (1st stage)	Factory spec.	18.64 to 20.10 MPa 190.0 to 205.0 kgf/cm^2 2703 to 2915 psi

W10227280


3TLABAB1P041A

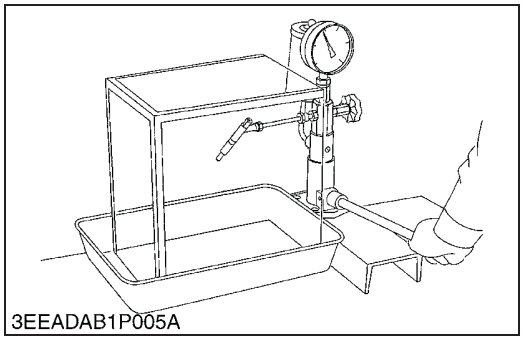
Valve Seat Tightness

[D1503-M, D1703-M, D1803-M, V2003-M, V2203-M, V2403-M, V2403-M-T]
[D1703-M-BG, V2003-M-BG, V2003-M-T-BG, V2203-M-BG, V2403-M-BG]

1. Set the injection nozzle to a nozzle tester.
2. Raise the fuel pressure, and keep at 12.75 MPa (130.0 kgf/cm^2, 1849 psi) for 10 seconds.
3. If any fuel leak is found, replace the nozzle piece.

Valve seat tightness	Factory spec.	No fuel leak at 12.75 MPa 130.0 kgf/cm^2 1849 psi

W10183690

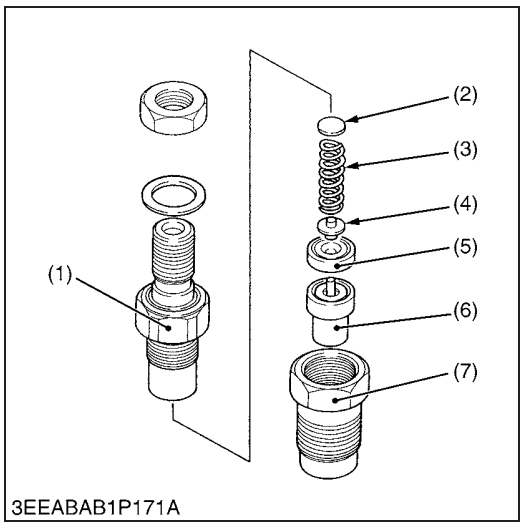

3EEADAB1P005A

[D1803-M-DI, V2403-M-DI, V2403-M-DI-T]

1. Set the injection nozzle to a nozzle tester.
2. Raise the fuel pressure, and keep at 16.67 MPa (170.0 kgf/cm^2, 2418 psi) for 10 seconds.
3. If any fuel leak is found, replace the injection nozzle assembly.

Valve seat tightness	Factory spec.	No fuel leak at 16.67 MPa 170.0 kgf/cm^2 2418 psi

W10228300



3EEABAB1P171A

Nozzle Holder

[D1503-M, D1703-M, D1803-M, V2003-M, V2203-M, V2403-M, V2403-M-T]
[D1703-M-BG, V2003-M-BG, V2003-M-T-BG, V2203-M-BG, V2403-M-BG]

1. Secure the nozzle retaining nut (7) with a vise.
2. Remove the nozzle holder (1), and take out parts inside.

(When reassembling)

- Assemble the nozzle in clean fuel oil.
- Install the push rod (4), noting its direction.
- After assembling the nozzle, be sure to adjust the fuel injection pressure.

Tightening torque	Nozzle holder	35 to 39 N·m 3.5 to 4.0 kgf·m 26 to 28 lbf·ft
	Overflow pipe retaining nut	20 to 24 N·m 2.0 to 2.5 kgf·m 15 to 18 lbf·ft
	Nozzle holder assembly	49 to 68 N·m 5.0 to 7.0 kgf·m 37 to 50 lbf·ft

(1) Nozzle Holder
(2) Adjusting Washer
(3) Nozzle Spring
(4) Push Rod
(5) Distance Piece
(6) Nozzle Piece
(7) Nozzle Retaining Nut

W1018491

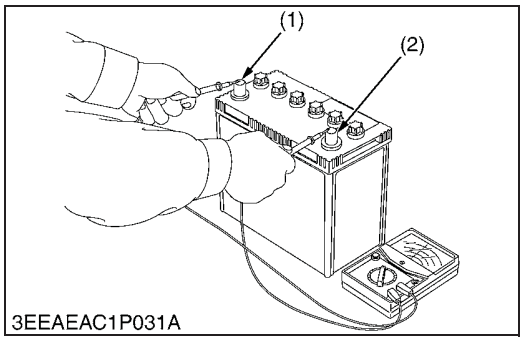
(5) Electrical System

CAUTION

- **To avoid accidental short circuit, be sure to attach the positive cable to the positive terminal before the negative cable is attached to the negative terminal.**
- **Never remove the battery cap while the engine is running.**
- **Keep electrolyte away from eyes, hands and clothes. If you are spattered with it, wash it away completely with water immediately.**
- **Keep open sparks and flames away from the battery at all times. Hydrogen gas mixed with oxygen becomes very explosive.**

IMPORTANT

- **If the machine is to be operated for a short time without battery (using a slave battery for starting), use additional current (lights) while engine is running and insulate terminal of battery. If this advice is disregarded, damage to alternator and regulator may result.**



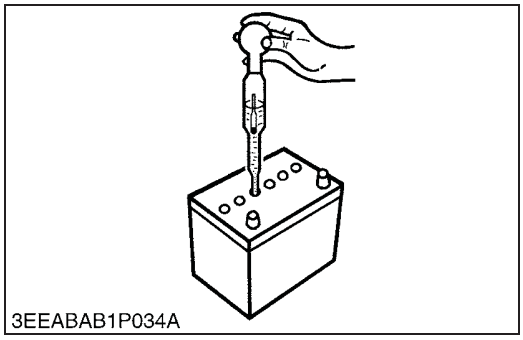
Battery Voltage

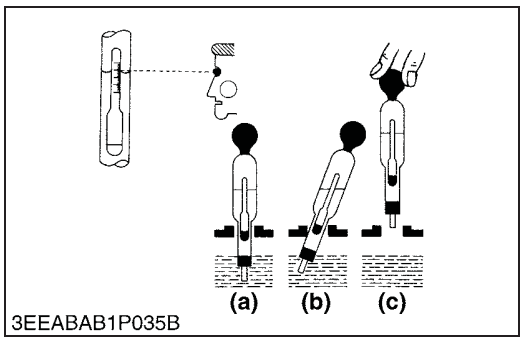
1. Stop the engine.
2. Measure the voltage with a circuit tester between the battery terminals.
3. If the battery voltage is less than the factory specification, check the battery specific gravity and recharge the battery.

Battery voltage	Factory spec.	More than 12 V

(1) Positive Terminal (2) Negative Terminal

W10125620


3EEABAB1P034A



3EEABAB1P035B

Battery Specific Gravity

1. Check the specific gravity of the electrolyte in each cell with a hydrometer.
2. When the electrolyte temperature differs from that at which the hydrometer was calibrated, correct the specific gravity reading following the formula mentioned in **(Reference)**.
3. If the specific gravity is less than 1.215 (after it is corrected for temperature), charge or replace the battery.
4. If the specific gravity differs between any two cells by more than 0.05, replace the battery.

■ **NOTE**

- **Hold the hydrometer tube vertical without removing it from the electrolyte.**
- **Do not suck too much electrolyte into the tube.**
- **Allow the float to move freely and hold the hydrometer at eye level.**
- **The hydrometer reading must be taken at the highest electrolyte level.**

(Reference)

- Specific gravity slightly varies with temperature. To be exact, the specific gravity decreases by 0.0007 with an increase of 1 °C (0.0004 with an increase of 1 °F) in temperature, and increases by 0.0007 with a decreases of 1 °C (0.0004 with a decrease of 1 °F).

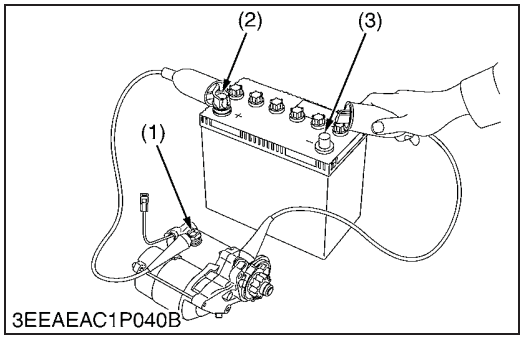
  Therefore, using 20 °C (68 °F) as a reference, the specific gravity reading must be corrected by the following formula :
  - Specific gravity at 20 °C = Measured value + 0.0007 × (electrolyte temperature : 20 °C)
  - Specific gravity at 68 °F = Measured value + 0.0004 × (electrolyte temperature : 68 °F)

Specific Gravity	State of Charge
1.260 Sp. Gr.	100 % Charged
1.230 Sp. Gr.	75 % Charged
1.200 Sp. Gr.	50 % Charged
1.170 Sp. Gr.	25 % Charged
1.140 Sp. Gr.	Very Little Useful Capacity
1.110 Sp. Gr.	Discharged

At an electrolyte temperature of 20 °C (68 °F)

(a) Good
(b) Bad
(c) Bad

W1019017



Motor Test

CAUTION

- **Secure the starter to prevent it from jumping up and down while testing the motor.**

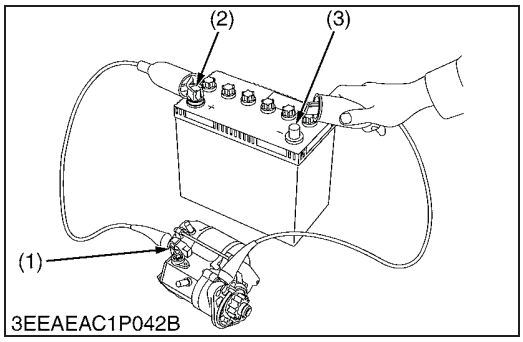
1. Disconnect the battery negative cable from the battery.
2. Disconnect the battery positive cable from the battery.
3. Disconnect the leads from the starter **B** terminal.
4. Remove the starter from the engine.
5. Connect a jumper lead from the starter **C** terminal (1) to the battery positive terminal (2).
6. Connect a jumper lead momentarily between the starter's body and the battery negative terminal (3).
7. If the motor does not run, starter is failure.
   Repair or replace the starter.

■ **NOTE**

- **B terminal : It is the terminal which connects the cable from the battery to the starter.**
- **C terminal : It is the terminal which connects the cable from the motor to the magnet switch.**

(1) **C** Terminal
(2) Positive Terminal
(3) Negative Terminal

W1019297



Magnetic Switch Test

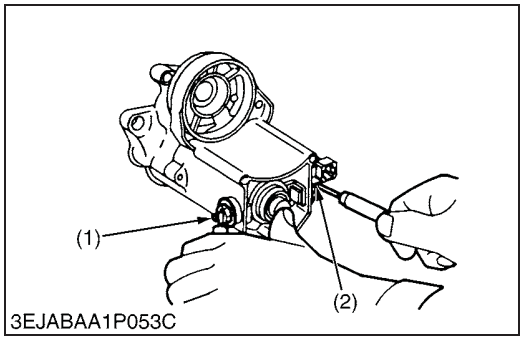
1. Disconnect the battery negative cable from the battery.
2. Disconnect the battery positive cable from the battery.
3. Disconnect the leads from the starter **B** terminal.
4. Remove the starter from the engine.
5. Connect a jumper lead from the starter **S** terminal (1) to the battery positive terminal (2).
6. Connect a jumper lead momentarily between the starter's body and the battery negative terminal (3).
7. If the pinion gear does not pop out, the magnetic switch is failure.
   Repair or replace the starter.

■ **NOTE**

- **B terminal : It is the terminal which connects the cable from the battery to the starter.**
- **S terminal : It is the terminal which connects the cable from the starter switch to the magnet switch.**

(1) **S** Terminal
(2) Positive Terminal
(3) Negative Terminal

0000010743E



Magnet Switch Continuity Test

1. Check the continuity across the **C** terminal (1) and the **B** terminal (2) with a circuit tester, pushing in the plunger.
2. If not continuous or if a certain value is indicated, replace the magnet switch.

(1) **C** Terminal
(2) **B** Terminal

0000010771E

Alternator on Unit Test

(Before testing)

- Before alternator on unit test, check the battery terminal connections, circuit connection, fan belt tension, charging indicator lamp, fuses on the circuit, and abnormal noise from the alternator.
- Prepare full charged battery for the test.

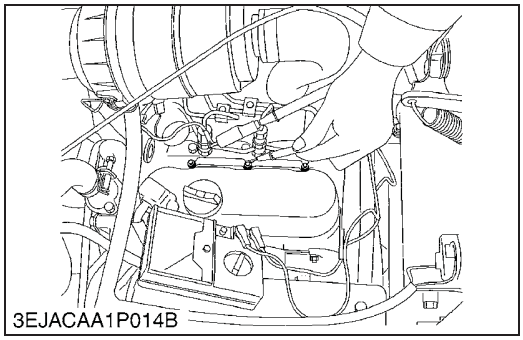
■ **NOTE**

- **Be careful not to touch the rotating engine parts while engine is running.**
  Keep safety distance from the engine rotating parts.

1. Start the engine.
2. When the engine is operating measure the voltage between two battery terminals. If the voltage is between 13.8 V and 14.8 V, the alternator is operating normally.
3. If the results of alternator on unit test are not within the specifications, disassemble the alternator and check the each component part for finding out the failure. See the "DISASSEMBLING AND ASSEMBLING" and "SERVICING" for alternator.

Regulating voltage at no load	Factory spec.	13.8 to 14.8 V at 25 °C (77 °F)

0000010745E

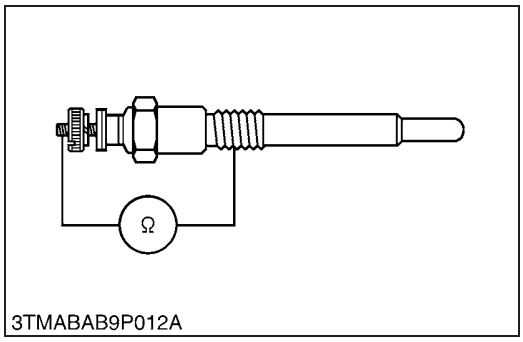


Glow Plug Lead Terminal Voltage

1. Turn the key switch to the "**GLOW** (or **PREHEAT**)" position, and measure the voltage with a circuit tester between the lead terminal and the engine body.
2. If the voltage differs from the battery voltage, the wiring harness or main switch is faulty.

Voltage	Main switch key at **GLOW** (or **PREHEAT**)	Approx. battery voltage

0000010725E

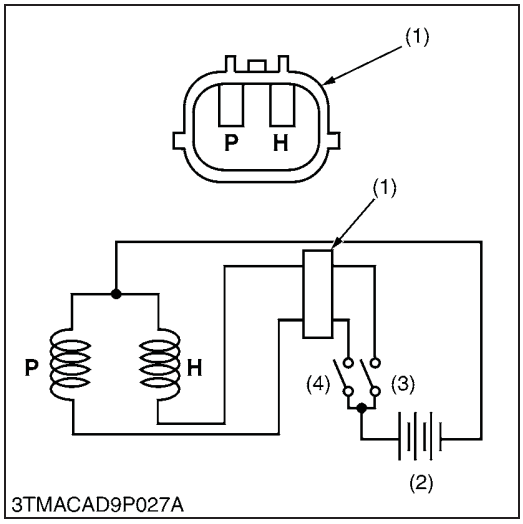


Glow Plug Continuity

1. Remove the glow plug.
2. Measure the resistance with a circuit tester between the glow plug terminal and the glow plug housing.
3. If the factory specification is not indicated, glow plug is faulty.

Resistance	Factory spec.	Approx. 0.9 Ω

0000010726E



3TMACAD9P027A

Engine Stop Solenoid

1. Remove the engine stop solenoid from the engine.
2. Connect the jumper leads from the pulling coil **P** terminal to the switch (3), and from switch (3) to the battery positive terminal.
3. Connect the jumper leads from the holding coil **H** terminal to the switch (4), and from switch (4) to the battery positive terminal.
4. Connect the jumper leads from the engine stop solenoid body to the battery negative terminal.
5. When switch (4) is turn on, the plunger pull into the solenoid body and then turn off the switch (4), the plunger comes out.
6. Turn on the switch (3) then turn on the switch (4), the plunger pull into the solenoid body and it keep in holding position after turn off the switch (4).
7. If the plunger is not attracted, the engine stop solenoid is faulty.

■ **IMPORTANT**

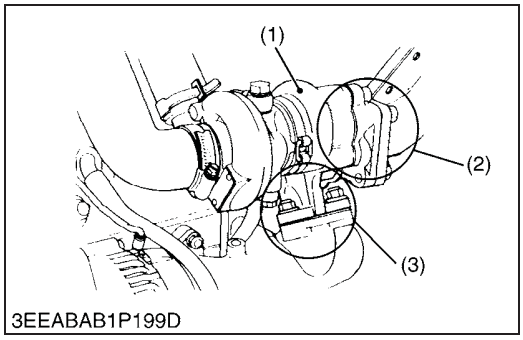
- **Never apply the current for pulling coil more than two seconds when inspecting.**

(1) Connector
(2) Battery
(3) Switch for Holding Coil
(4) Switch for Pulling Coil

P : Terminal for Pulling Coil
H : Terminal for Holding Coil

W1020600

(6) Turbocharger



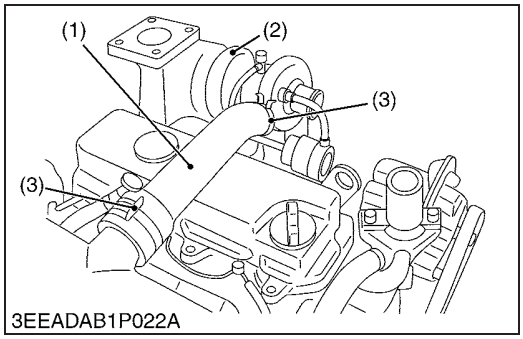
3EEABAB1P199D

Turbine Side

1. Check the exhaust port (2) and inlet port (3) side of the turbine housing (1) to see if there is no exhaust gas leak.
2. If any gas leak is found, retighten the bolts and nuts or replace the gasket with new one.

(1) Turbine Housing
(2) Exhaust Port
(3) Inlet Port

W1069824



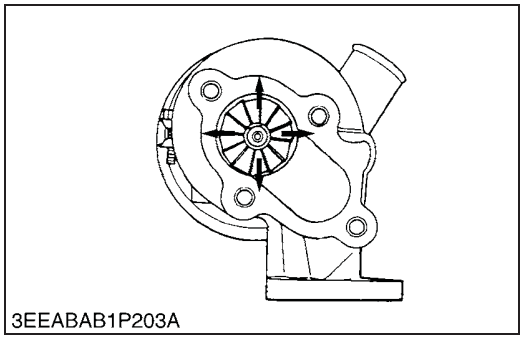
3EEADAB1P022A

Compressor Side

1. Check the inlet hose (1) of the compressor cover (2) to see if there is no air leak.
2. Check for loose connections or cracks in the suction side of the intake hose.
3. If any air leak is found, change the clamp (3) and / or inlet hoses.

(1) Inlet Hose
(2) Compressor Cover
(3) Clamp

W1069939

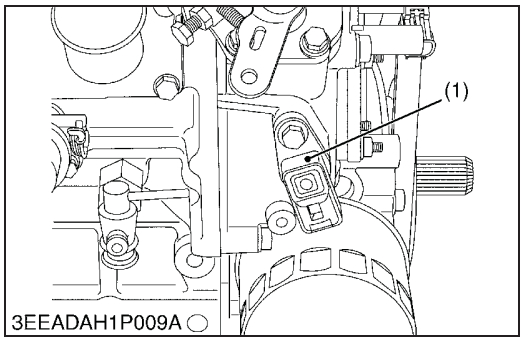

3EEABAB1P203A

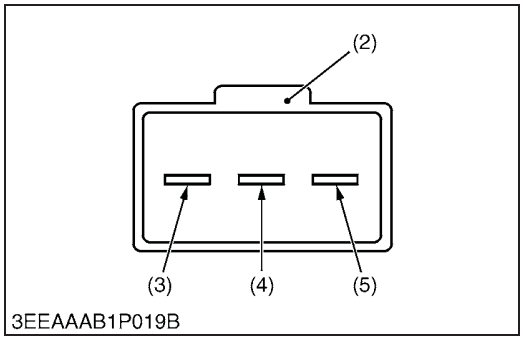
Radial Clearance

1. If the wheel contact to the housing, replace the turbocharger assembly with new one.

W1077353

(7) Electronic Governor





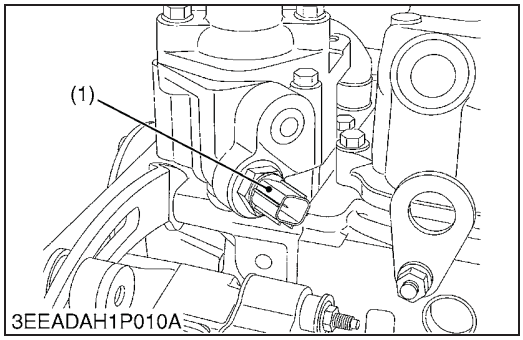
Speed Sensor

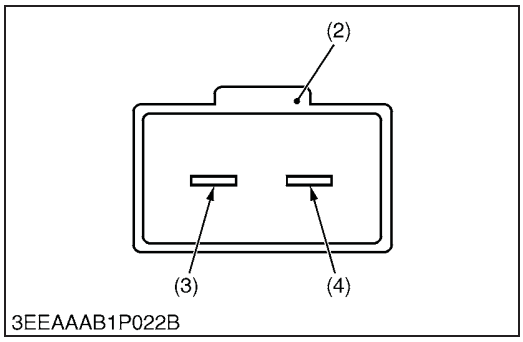
1. Disconnect the speed sensor connector (2) (3P).
2. Check the state of the harness and if it is abnormal, please replace it.
3. Turn the key switch to the ACC position.
4. Measure the voltage between the terminals of the connector (2) (harness side).
5. When the measurements are the below table value.
   The ECU is normal. The speed sensor (1) is failure, then please replace it.
6. When the measurements are out of the below table value.
   The ECU is failure, then please replace it.

Voltage	Terminal **1** - Terminal **3**	12 V
	Terminal **1** - Terminal **2**	5 V

(1) Speed Sensor
(2) Speed Sensor Connector (Harness Side)
(3) Terminal **3** (+)
(4) Terminal **2** (Signal)
(5) Terminal **1** (GND)

W1058552





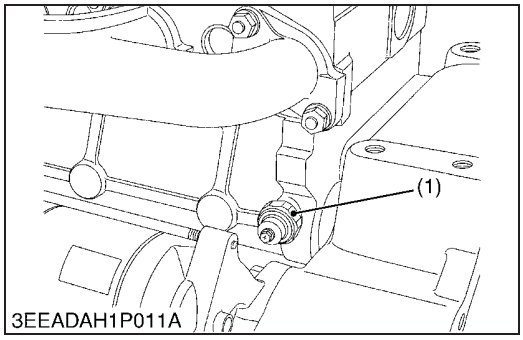
Water Temperature Sensor

1. Disconnect the water temperature sensor connector (2) (2P).
2. Check the state of the harness and if it is abnormal, please replace it.
3. Turn the key switch to the ACC position.
4. Measure the voltage between the terminals of the connector (2) (harness side).
5. When the measurements are the below table value.
   The ECU is normal. The water temperature sensor (1) is failure, then please replace it.
6. When the measurements are out of the below table value.
   The ECU is failure, then please replace it.

Voltage	Terminal **1** - Terminal **2**	5 V

(1) Water Temperature Sensor
(2) Water Temperature Sensor Connector (Harness Side)
(3) Terminal **2** (–)
(4) Terminal **1** (+)

W1059499



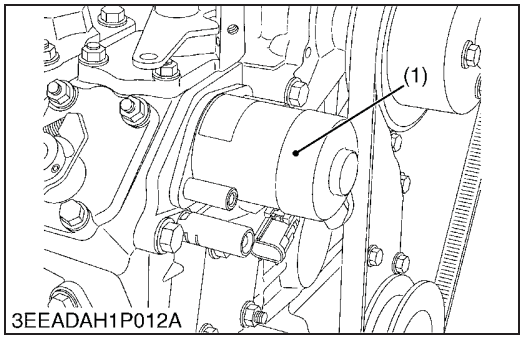
Oil Pressure Switch

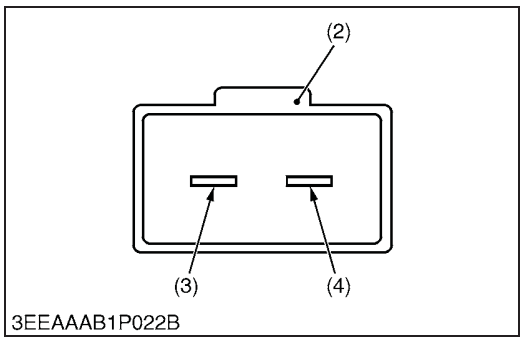
1. Disconnect the connector of the oil pressure switch connector (1P).
2. Check the state of the harness and if it is abnormal, please replace it.
3. Measure the resistance between the terminal of the connector (harness side) and chassis.
4. When the measurements are the below table value.
   The ECU is normal. The oil pressure switch (1) is failure, then please replace it.
5. When the measurements are out of the below table value.
   The ECU is failure, then please replace it.

Resistance	Terminal **1** - Chassis	Infinity

(1) Oil Pressure Switch

W1059711





Solenoid

1. Disconnect the connector of solenoid (2) (2P).
2. Check the state of the harness and if it is abnormal, please replace it.
3. Turn the key switch to the ACC position.
4. Measure the voltage between the connector of solenoid (2) (harness side).
5. When the measurements are the below table value.
   The ECU is normal. Check the solenoid (1) according to the procedure of confirming the solenoid's movement.
6. When the measurements are out of the below table value.
   The ECU is failure, then please replace it.

Voltage	Terminal **1** - Terminal **2**	12 V

(Reference)

- The procedure of confirming the solenoid's movement

1. Measure the resistance between the connector of solenoid (2).
2. When the measurements are the below table value.
   The solenoid (1) is normal electrically. Check the solenoid's movement.
3. When the measurements are out of the below table value.
   The solenoid (1) is failure, then please replace it.
4. Remove the solenoid (1) from the engine.
5. Supply the voltage (12 V) to the solenoid (1).
6. When the rod of the solenoid (1) moves smoothly.
   The solenoid (1) is normal.
7. When the rod of the solenoid (1) does not move smoothly.
   The solenoid (1) is failure, then please replace it.

CAUTION

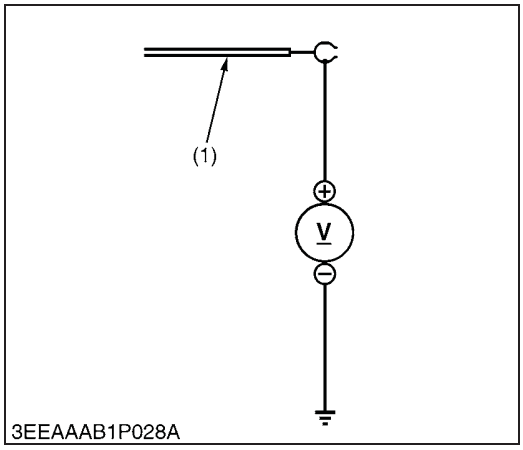
- Please note handling, the solenoid (1) becomes a high temperature.

Resistance	Terminal **1** - Terminal **2**	2 to 4 Ω

(1) Solenoid
(2) Connector of Solenoid
(3) Terminal **2** (–)
(4) Terminal **1** (+)

(A) Key Switch OFF Position
(B) Key Switch ON Position

W1060938



3EEAAAB1P028A

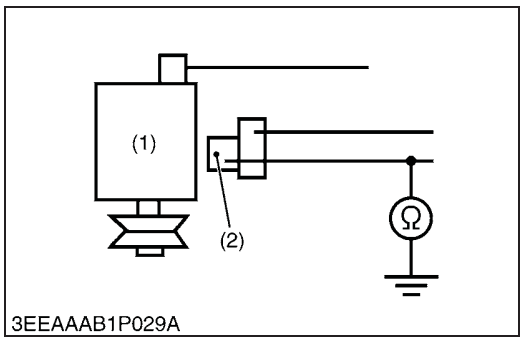
Glow Plug Harness

1. Disconnect the glow plug terminal (1).
2. Check the state of the harness and if it is abnormal, please replace it.
3. Turn the key switch to the ACC position.
4. Measure the voltage between the glow pulg terminal (1) of the connector (harness side) and chassis.
5. When the measurements are the below table value.
   The ECU is normal. Some of the glow plugs are failure, then please replace them.
6. When the measurements are out of the below table value.
   The ECU is failure, then please replace it.

Voltage	Terminal - Chassis	12 V

(1) Glow Plug Terminal

W1061770



3EEAAAB1P029A

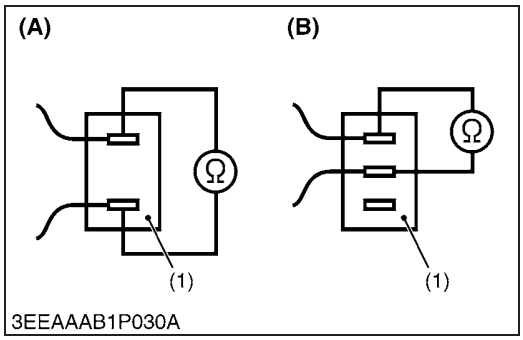
Alternator

1. Disconnect the terminal **L** (2) of the alternator (2P).
2. Check the state of the harness and if it is abnormal, please replace it.
3. Measure the resistance between the terminal **L** (2) of the connector (harness side) and chassis.
4. When the measurements are the below table value.
   The ECU is normal. The alternator is failure, then please replace it.
5. When the measurements are out of the below table value.
   The ECU is failure, then please replace it.

Resistance	Terminal **L** - Chassis	Infinity

(1) Alternator (2) Terminal **L** (Harness Side)

W1063000



3EEAAAB1P030A

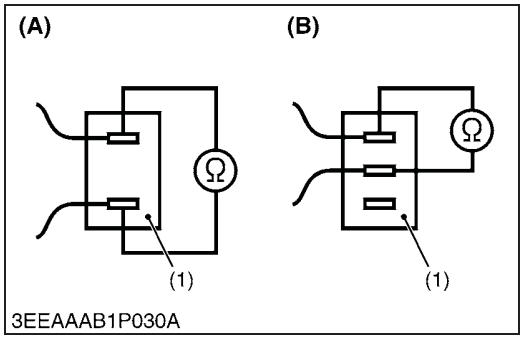
Speed Switch

1. Check the state of the harness and if it is abnormal, please replace it.
2. When the speed switch is turned **ON** and **OFF**, measure the resistance between the speed switch (terminal side) (1) of it each time.
3. When the measurements are the below table value.
   The speed switch is normal. The ECU is failure, then please replace it.
4. When the measurements are out of the below table value.
   The speed switch is failure, then please replace it.

Resistance	**ON**	0 Ω
	OFF	Infinity

(1) Speed Switch (Terminal Side)
(A) Single Pole, Single Throw
(B) Single Pole, Double Throw

W1063856



3EEAAAB1P030A

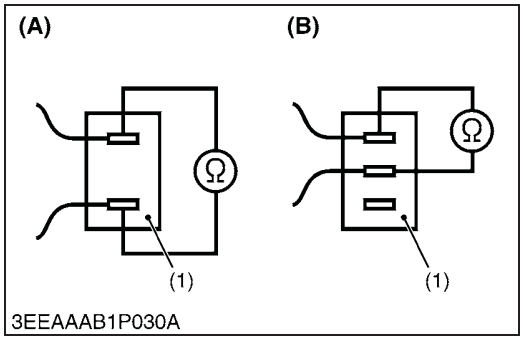
Emergency Stop Switch

1. Check the state of the harness and if it is abnormal, please replace it.
2. When the emergency stop switch is turned **ON** and **OFF**, measure the resistance between the emergency stop switch (terminal side) (1) of it each time.
3. When the measurements are the below table value.
   The emergency stop switch is normal. The ECU is failure, then please replace it.
4. When the measurements are out of the below table value.
   The emergency stop switch is failure, then please replace it.

Resistance	**ON**	0 Ω
	OFF	Infinity

(1) Emergency Stop Switch (Terminal Side)
(A) Single Pole, Single Throw
(B) Single Pole, Double Throw

W1066629



3EEAAAB1P030A

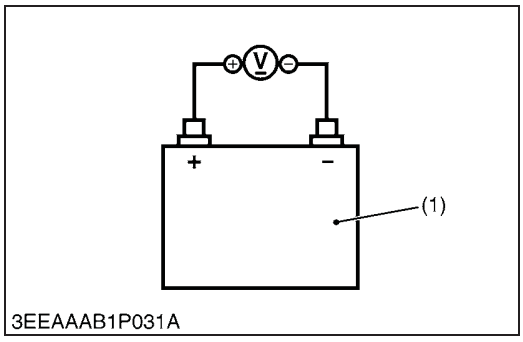
Slow Down Switch

1. Check the state of the harness and if it is abnormal, please replace it.
2. When the slow down switch is turned **ON** and **OFF**, measure the resistance between the slow down switch (terminal side) (1) of it each time.
3. When the measurements are the below table value.
   The slow down switch is normal. The ECU is failure, then please replace it.
4. When the measurements are out of the below table value.
   The slow down switch is failure, then please replace it.

Resistance	**ON**	0 Ω
	OFF	Infinity

(1) Slow Down Switch (Terminal Side)
(A) Single Pole, Single Throw
(B) Single Pole, Double Throw

W1067200



3EEAAAB1P031A

Battery

1. Measure the voltage of the battery (1) with the engine stopped.
2. When the measurements are the below table value.
   The battery is normal. The ECU is failure, then please replace it.
3. When the measurements are out of the below table value.
   The battery is failure, then please replace it.

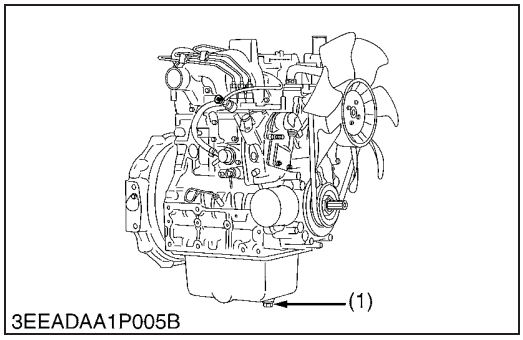
Voltage	**+** terminal - – terminal	12 V

(1) Battery

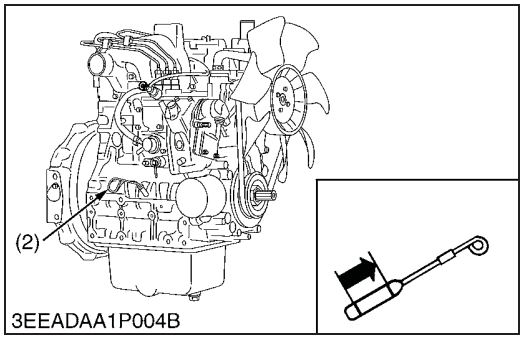
W1067456

[2] DISASSEMBLING AND ASSEMBLING

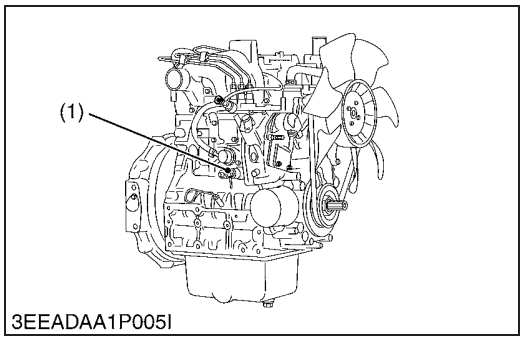
(1) Draining Oil and Coolant



3EEADAA1P005B



3EEADAA1P004B



3EEADAA1P005I

Draining Engine Oil

1. Start and warm up the engine for approx. 5 minutes.
2. Place an oil pan underneath the engine.
3. Remove the drain plug (1) to drain oil.
4. After draining, screw in the drain plug.

(When refilling)

- Fill the engine oil up to the upper line on the dipstick (2).

■ **IMPORTANT**

- **Never mix two different types of oil.**
- **Use the proper SAE Engine Oil according to ambient temperature.**

(1) Drain Plug (2) Dipstick

W1028998

Draining Coolant

CAUTION

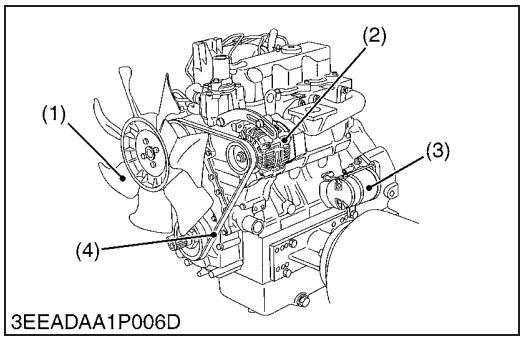
- **Never remove radiator cap while operating or immediately after stopping. Otherwise, hot water will spout out from the radiator. Wait for more than ten minutes to cool the radiator, before opening the cap.**

1. Prepare a bucket. Open the coolant drain cock.

(1) Coolant Drain Cock

W1029172

(2) External Components



3EEADAA1P006D

Air Cleaner, Muffler and Others

1. Remove the air cleaner and muffler.
2. Remove the fan (1), fan belt (4), alternator (2) and starter (3).

(When reassembling)

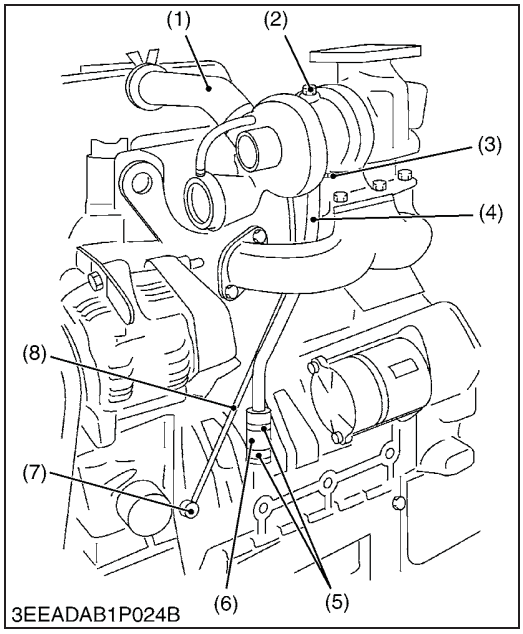
- Check to see that there are no cracks on the belt surface.

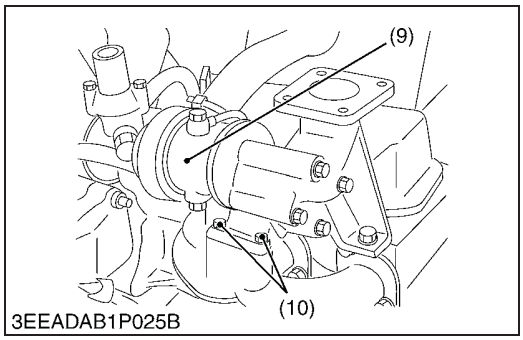
■ **IMPORTANT**

- **After reassembling the fan belt, be sure to adjust the fan belt tension.**
- **Do not confuse the direction of the fan.**

(1) Fan (3) Starter
(2) Alternator (4) Fan Belt

W1060302





Turbocharger (equipped with Turbocharger Model)

CAUTION

- **While the engine is running and or just after it stops, the turbocharger is hot, be careful not to touch the turbocharger.**

■ **NOTE**

- **When detaching and attaching the turbocharger assembly, be very careful not to allow dust, dirt and other foreign matters in the oil pipes.**
- **When the turbocharger assembly has been replaced, pour fresh engine oil through the oil filter port of the turbocharger.**
- **Before starting the engine, make sure that the air cleaner is in position.**

1. Disconnect the inlet hose (1).
2. Remove the joint bolt (2), (7) and take off the oil pipe 1 (8).
3. Remove the bolts 1 (3) and release the clamp (5).
4. Disconnect the oil pipe 2 (4) and pipe 3 (6).
5. Remove the bolts 2 (10).
6. Take off the turbocharger assembly (9).

(When reassembling)

- Pour fresh engine oil through the oil filter port of the turbocharger.
- Replace the gaskets with new one.
- Be careful not to allow dust, dirt and other foreign matters in the oil pipes.

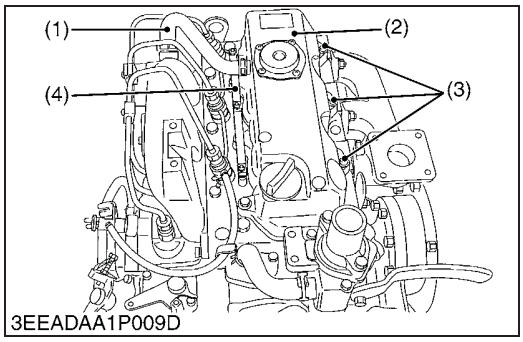
■ **NOTE**

- **Tape or plug all opening to prevent foreign matters from damaging the oil cavities in the turbocharger.**

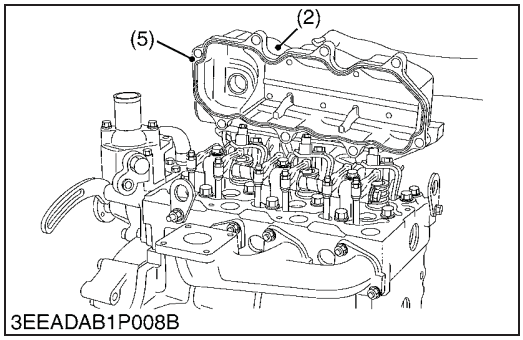
(1) Inlet Hose
(2) Joint Bolt
(3) Bolt 1
(4) Oil Pipe 2
(5) Clamp
(6) Oil Pipe 3
(7) Joint Bolt
(8) Oil Pipe 1
(9) Turbocharger Assembly
(10) Bolt 2

W1021474

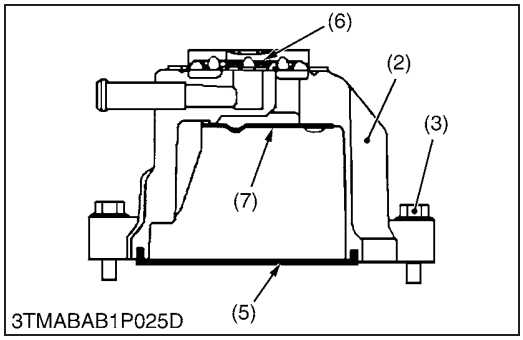
(3) Cylinder Head and Valves



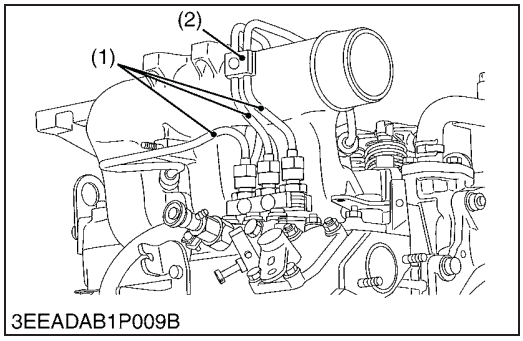
3EEADAA1P009D



3EEADAB1P008B



3TMABAB1P025D



3EEADAB1P009B

Cylinder Head Cover

1. Remove the lead (4).
2. Remove the breather hose (1).
3. Remove the head cover screws (3).
4. Remove the cylinder head cover (2).

(When reassembling)

- Check to see if the cylinder head cover gasket (5) is not defective.

Tightening torque	Cylinder head cover screw	9.81 to 11.2 N·m 1.00 to 1.15 kgf·m 7.24 to 8.31 lbf·ft

(1) Breather Hose
(2) Cylinder Head Cover
(3) Head Cover Screw
(4) Lead
(5) Cylinder Head Cover Gasket
(6) Breather Valve
(7) Plate

W1060460

Injection Pipes

1. Loosen the screws on the pipe clamps (2).
2. Detach the injection pipes (1).

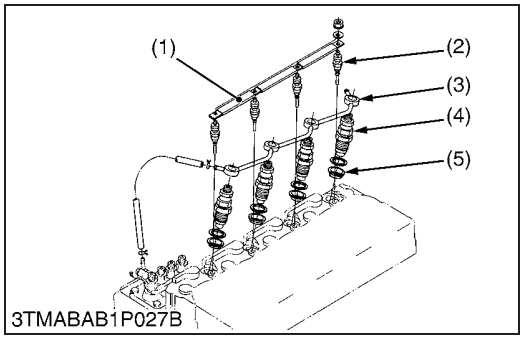
(When reassembling)

- Blow out dust inside the pipes.

Tightening torque	Injection pipe retaining nut	D1503-M D1703-M D1803-M V2003-M V2203-M V2403-M V2403-M-T D1703-M-BG V2003-M-BG V2003-M-T-BG V2203-M-BG V2403-M-BG	25 to 34 N·m 2.5 to 3.5 kgf·m 18 to 25 lbf·ft
		D1803-M-DI V2403-M-DI V2403-M-DI-T	15 to 24 N·m 1.5 to 2.5 kgf·m 11 to 18 lbf·ft

(1) Injection Pipe
(2) Pipe Clamp

W1060970



Nozzle Holder Assembly and Glow Plug

[D1503-M, D1703-M, D1803-M, V2003-M, V2203-M, V2403-M, V2403-M-T]
[D1703-M-BG, V2003-M-BG, V2003-M-T-BG, V2203-M-BG, V2403-M-BG]

1. Remove the overflow pipe assembly (3).
2. Remove the nozzle holder assemblies (4) using a 21 mm deep socket wrench.
3. Remove the copper gasket and heat seal (5).
4. Remove the glow plugs (2).

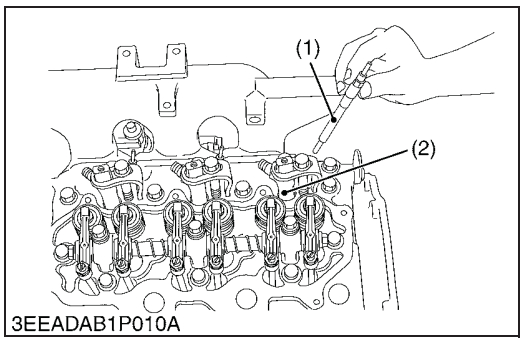
(When reassembling)

- Replace the copper gasket and heat seal with new one.

Tightening torque	Nozzle holder assembly	D1503-M D1703-M D1803-M V2003-M V2203-M V2403-M V2403-M-T D1703-M-BG V2003-M-BG V2003-M-T-BG V2203-M-BG V2403-M-BG	49 to 68 N·m 5.0 to 7.0 kgf·m 37 to 50 lbf·ft
	Overflow pipe assembly retaining nut		20 to 24 N·m 2.0 to 2.5 kgf·m 15 to 18 lbf·ft
	Glow plug		20 to 24 N·m 2.0 to 2.5 kgf·m 15 to 18 lbf·ft

(1) Lead
(2) Glow Plug
(3) Overflow Pipe Assembly
(4) Nozzle Holder Assembly
(5) Heat Seal

W1020917



[D1803-M-DI, V2403-M-DI, V2403-M-DI-T]

1. Remove the overflow pipe assembly.
2. Remove the nozzle holder assemblies (2).
3. Remove the glow plugs (1).

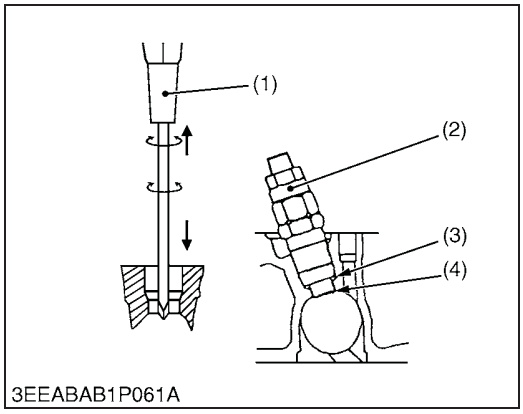
(When reassembling)

- Replace the copper gasket with new one.

Tightening torque	Nozzle holder clamp screw	D1803-M-DI V2403-M-DI V2403-M-DI-T	26 to 29 N·m 2.6 to 3.0 kgf·m 19 to 21 lbf·ft
	Overflow pipe assembly retaining screw		9.81 to 11.2 N·m 1.00 to 1.15 kgf·m 7.24 to 8.31 lbf·ft
	Glow plug		20 to 24 N·m 2.0 to 2.5 kgf·m 15 to 18 lbf·ft

(1) Glow Plug
(2) Nozzle Holder Assembly

W1111628



3EEABAB1P061A

Nozzle Heat Seal Service Removal Procedure

[D1503-M, D1703-M, D1803-M, V2003-M, V2203-M, V2403-M, V2403-M-T]
[D1703-M-BG, V2003-M-BG, V2003-M-T-BG, V2203-M-BG, V2403-M-BG]

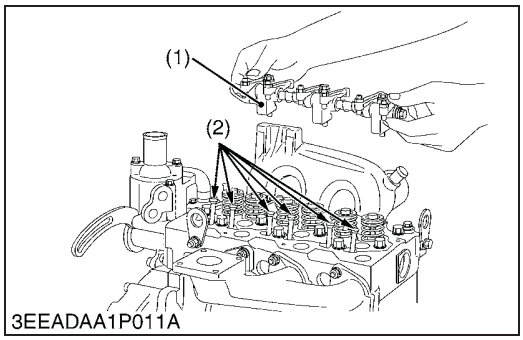
■ **IMPORTANT**
- **Use a plus (phillips head) screw driver (1) that has a diameter which is bigger than the heat seal hole (Approx. 6 mm (1/4 in.)).**

1. Drive screw driver (1) lightly into the heat seal hole.
2. Turn screw driver three or four times each way.
3. While turning the screw driver, slowly pull the heat seal (4) out together with the injection nozzle gasket (3).
4. If the heat seal drops, repeat the above procedure.

(When reassembling)
- Heat seal and injection nozzle gasket must be changed when the injection nozzle is removed for cleaning or for service.

(1) Plus Screw Driver
(2) Injection Nozzle
(3) Injection Nozzle Gasket
(4) Heat Seal

W1021255



3EEADAA1P011A

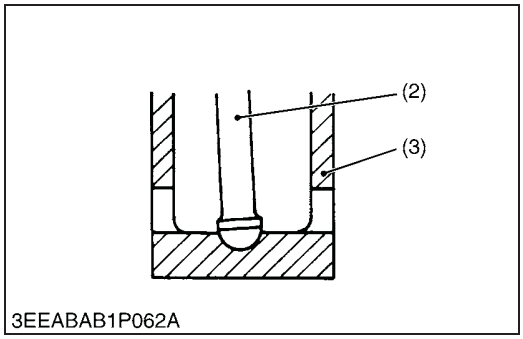
Rocker Arm and Push Rod

1. Remove the rocker arm bracket screws.
2. Detach the rocker arm assembly (1).
3. Remove the push rods (2).

(When reassembling)
- When putting the push rods (2) onto the tappets (3), check to see if their ends are properly engaged with the grooves.

■ **IMPORTANT**
- **After installing the rocker arm, be sure to adjust the valve clearance.**

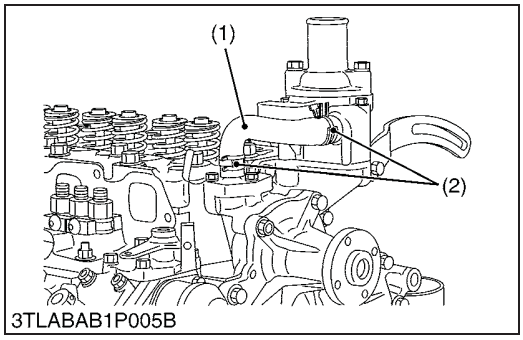
Tightening torque	Rocker arm bracket screw	24 to 27 N·m 2.4 to 2.8 kgf·m 18 to 20 lbf·ft



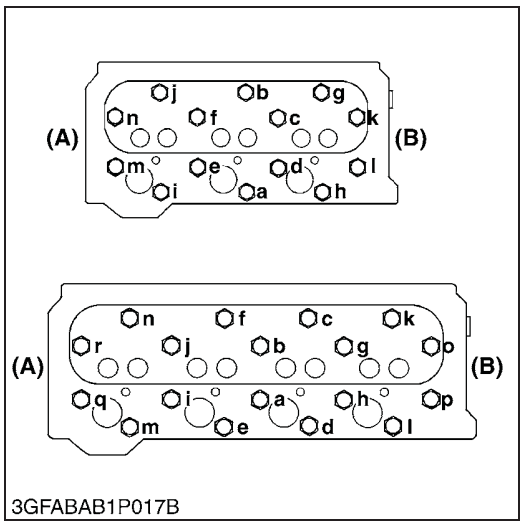
3EEABAB1P062A

(1) Rocker Arm Assembly
(2) Push Rod
(3) Tappet

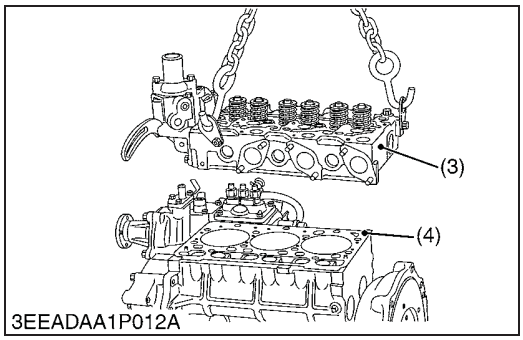
W1021437



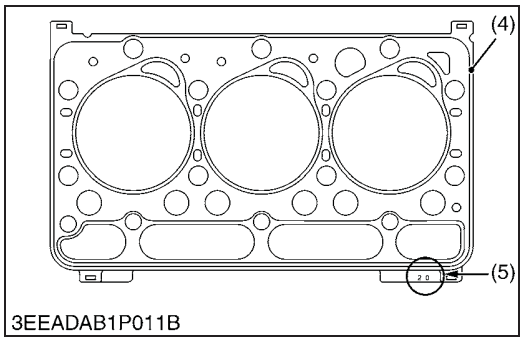
3TLABAB1P005B



3GFABAB1P017B



3EEADAA1P012A



3EEADAB1P011B

Cylinder Head

1. Loosen the pipe clamp (2), and remove the water return pipe (1).
2. Remove the cylinder head screw in the order of **(n or r)** to **(a)**.
3. Lift up the cylinder head (3) to detach.
4. Remove the cylinder head gasket (4).

(When reassembling)

- Replace the cylinder head gasket (4) with a new one.
- Tighten the cylinder head screws after applying sufficient oil.
- Tighten the cylinder head screws in diagonal sequence starting from the center in the order of **(a)** to **(n or r)**.
- Tighten them uniformly, or the head may deform in the long run.

Tightening torque	Cylinder head screw	93.2 to 98.0 N·m 9.50 to 10.0 kgf·m 68.8 to 72.3 lbf·ft

■ **IMPORTANT**

- **To replace the cylinder head gasket (4), in advance make sure the marking (5) of cylinder head gasket in the original engine, and replace the same marking as the original cylinder head gasket.**

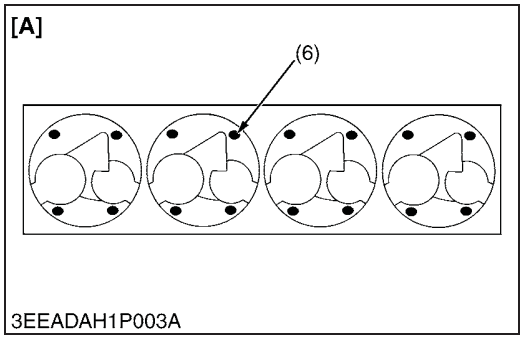
Gasket Marking & Code Number	Model			
	D1503-M	D1703-M D1803-M D1803-M-DI	V2003-M	V2203-M V2403-M V2403-M-T V2403-M-DI V2403-M-DI-T
15	1G720-03600	1G750-03600	1G464-03600	1G790-03600
20	1G720-03310	1G750-03310	1G464-03310	1G790-03310
25	1G720-03610	1G750-03610	1G464-03610	1G790-03610
30	1G720-03620	1G750-03620	1G464-03620	1G790-03620
35	1G720-03630	1G750-03630	1G464-03630	1G790-03630

Gasket Marking & Code Number	Model			
	D1703-M-BG	V2003-M-BG	V2003-M-T-BG	V2203-M-BG V2403-M-BG
15	1G750-03600	1G464-03600	1G770-03600	1G790-03600
20	1G750-03310	1G464-03310	1G770-03310	1G790-03310
25	1G750-03610	1G464-03610	1G770-03610	1G790-03610
30	1G750-03620	1G464-03620	1G770-03620	1G790-03620
35	1G750-03630	1G464-03630	1G770-03630	1G790-03630

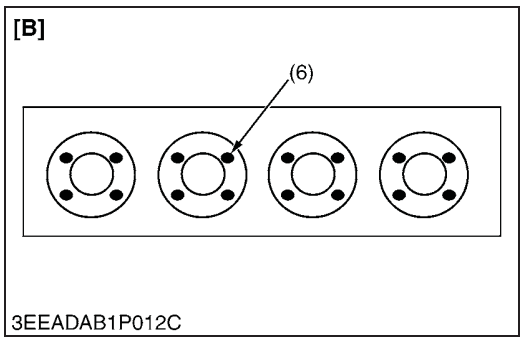
(1) Return Pipe
(2) Pipe Clamp
(3) Cylinder Head
(4) Cylinder Head Gasket
(5) Marking

(n or r) to (a) : To Loosen
(a) to (n or r) : To Tighten
(A) Gear Case Side
(B) Flywheel Side

W1112015



3EEADAH1P003A



3EEADAB1P012C

Cylinder Head (Continued)

■ **IMPORTANT**

- **When replacing piston, piston pin, small end bushing, connecting rod, or crankpin bearings, measure piston head's protrusion or recessing from the level of crankcase cylinder face (average of all pistons) after installing the pistons, and select the cylinder head gasket following the below table.**

Selecting the cylinder head gasket

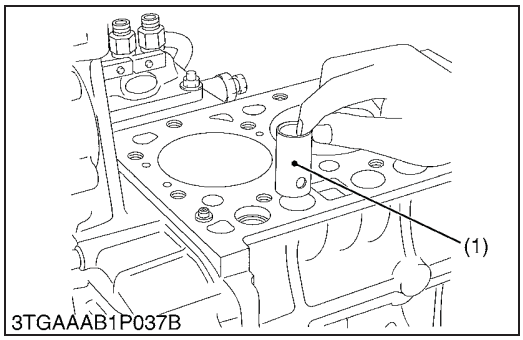
1. Measure the piston head's protrusion or recessing from the crankcase cylinder face 4 spots per each piston (average of all pistons) using the dial gauge.
2. Select the suitable cylinder need gasket refer to the table below.

Gasket Size (Number)	Piston Protrusion	
	D1503-M, D1703-M D1803-M, V2003-M V2203-M, V2403-M V2403-M-T D1703-M-BG V2003-M-BG V2003-M-T-BG V2203-M-BG V2403-M-BG	D1803-M-DI V2403-M-DI V2403-M-DI-T
15	0.500 to 0.540 mm 0.0197 to 0.0212 in.	0.475 to 0.525 mm 0.0187 to 0.0206 in.
20	0.550 to 0.590 mm 0.0217 to 0.0232 in.	0.525 to 0.575 mm 0.0206 to 0.0227 in.
25	0.600 to 0.640 mm 0.0237 to 0.0251 in.	0.575 to 0.625 mm 0.0227 to 0.0246 in.
30	0.650 to 0.690 mm 0.0256 to 0.0271 in.	0.625 to 0.675 mm 0.0246 to 0.0266 in.
35	0.700 to 0.740 mm 0.0276 to 0.0291 in.	0.675 to 0.725 mm 0.0266 to 0.0285 in.

(6) Measuring Points

[A] D1503-M, D1703-M, D1803-M
V2003-M, V2203-M, V2403-M
V2403-M-T
D1703-M-BG, V2003-M-BG
V2003-M-T-BG, V2203-M-BG
V2403-M-BG
[B] D1803-M-DI, V2403-M-DI
V2403-M-DI-T

W1085632



3TGAAAB1P037B

Tappets

1. Remove the tappets (1) from the crankcase.

(When reassembling)

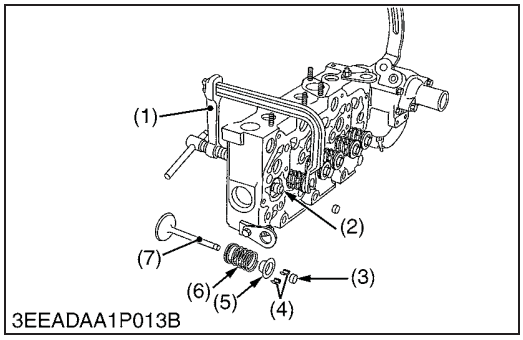
- Visually check the contact between tappets and cams for proper rotation. If defect is found, replace tappets.
- Before installing the tappets, apply engine oil thinly around them.

■ **IMPORTANT**

- **Do not change the combination of tappet and tappet guide.**

(1) Tappet

W1022001



3EEADAA1P013B

Valves

1. Remove the valve caps (3).
2. Remove the valve spring collet (4), pushing the valve spring retainer (5) by valve spring replacer (1).
3. Remove the valve spring retainer (5), valve spring (6) and valve stem seal (2).
4. Remove the valve (7).

(When reassembling)

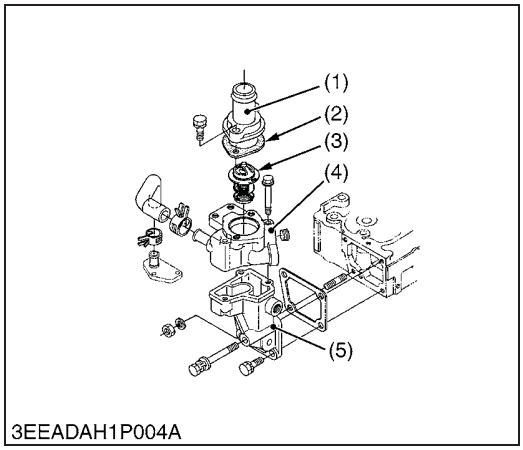
- Wash the valve stem and valve guide hole, and apply engine oil sufficiently.
- After installing the valve spring collets (4), lightly tap the stem to assure proper fit with a plastic hammer.

■ **IMPORTANT**

- **Do not change the combination of valve and valve guide.**

(1) Valve Spring Replacer
(2) Valve Stem Seal
(3) Valve Cap
(4) Valve Spring Collet
(5) Valve Spring Retainer
(6) Valve Spring
(7) Valve

W1022102



3EEADAH1P004A

Thermostat Assembly

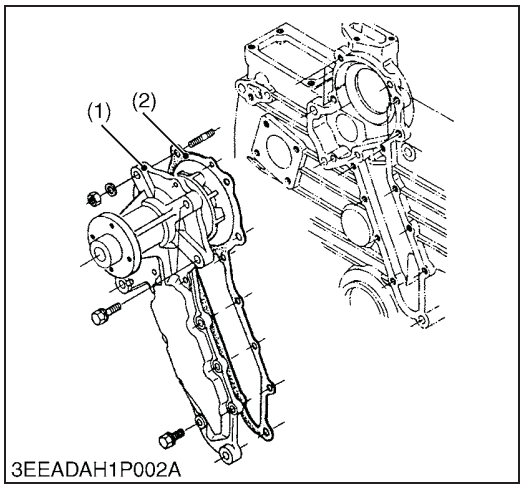
1. Remove the thermostat cover mounting screws, and remove the thermostat cover (1).
2. Remove the thermostat assembly (3).

(When reassembling)

- Replace the thermostat cover gasket (2) with new one.
- Apply a liquid gasket (Three Bond 1215 or equivalent) to the water flange 1 (4) and flange 2 (5)

(1) Thermostat Cover
(2) Thermostat Cover Gasket
(3) Thermostat Assembly
(4) Water Flange 1
(5) Water Flange 2

W1105115



3EEADAH1P002A

Water Pump Assembly (If necessary)

1. Remove the water pump assembly (1) from the gear case.

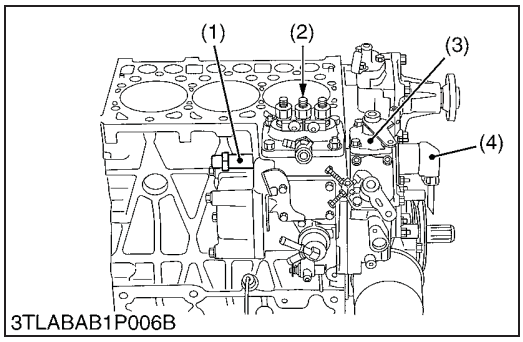
(When reassembling)

- Replace the gasket (2) with new one.

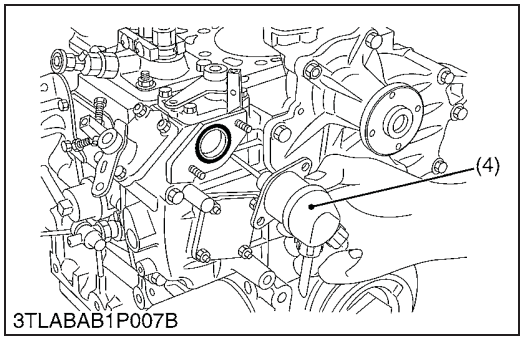
(1) Water Pump Assembly
(2) Gasket

W1051957

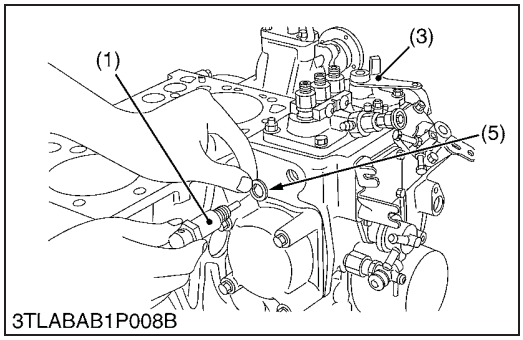
(4) Gear Case and Timing Gears



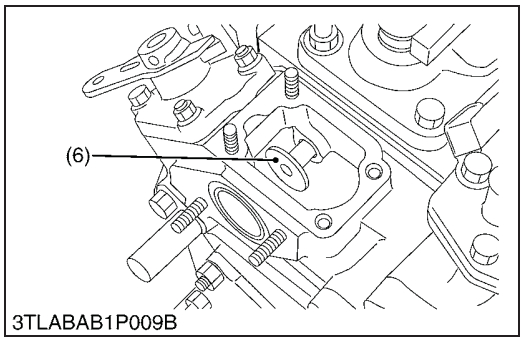
3TLABAB1P006B



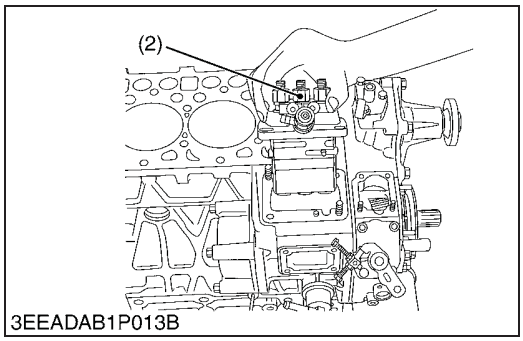
3TLABAB1P007B



3TLABAB1P008B



3TLABAB1P009B



3EEADAB1P013B

Injection Pump (for Non Turbocharger Model)

1. Remove the solenoid (4) and hi-idling body (1).
2. Remove the engine stop lever (3) and solenoid guide (6).
3. Remove the fuel injection pump assembly (2).

■ **IMPORTANT**

- **Before removing the injection pump assembly (2), be sure to remove the solenoid (4), hi-idling body (1), engine stop lever (3) and solenoid guide (6).**

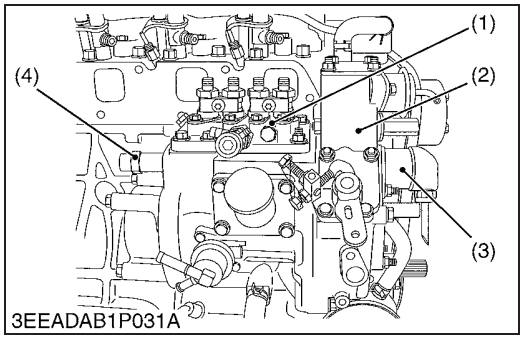
(When reassembling)

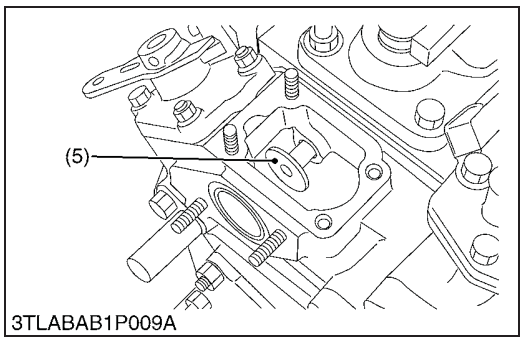
- Before attaching the solenoid (4), hi-idling body (1) and solenoid guide (6), install the injection pump first into position.
- Replace the hi-idling body gasket (5) with a new one.
- Before fitting the stop lever (3) to the gear case, install the solenoid guide (6) first into position. Then attach the stop lever and use it to see if it functions well.
- When installing the solenoid (4), be careful to keep the O-ring in place.
- Be sure to insert the push rod of the solenoid into the hole at the center of the solenoid guide (6).

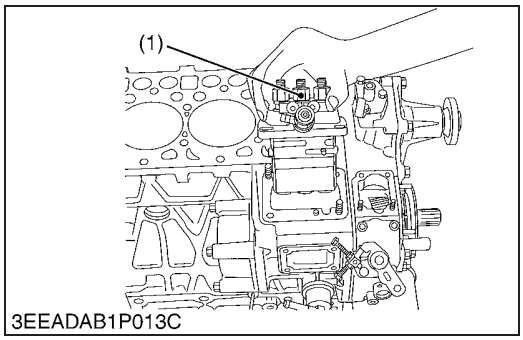
Tightening torque	Hi-idling body	45 to 49 N·m 4.5 to 5.0 kgf·m 33 to 36 lbf·ft

(1) Hi-idling Body
(2) Injection Pump Assemply
(3) Stop Lever
(4) Slenoid
(5) Hi-idling Body Gasket
(6) Solenoid Guide

W1023686







Injection Pump (for Turbocharger Model)

1. Remove the boost compensator assembly (2).
2. Remove the hi-idling body (4).
3. Remove the solenoid (3).
4. Remove the solenoid guide (5).
5. Remove the injection pump assembly (1).

■ **IMPORTANT**

- **Before removing the injection pump assembly (1), be sure to remove the boost compensator assembly (2), hi-idling body (4), solenoid (3) and solenoid guide (5).**

(When reassembling)

- Before attaching the boost compensator assembly (2), hi-idling body (4), solenoid (3) and solenoid guide (5), install the injection pump first into position.
- Replace the hi-idling body gasket with a new one.
- Before fitting the boost compensator assembly (2) to the gear case, make sure that the solenoid guide (5) is at the initial position.
- When installing the solenoid (3), be careful to keep the O-ring in place.
- Be sure to insert the push rod of the solenoid into the hole at the center of the solenoid guide (5).

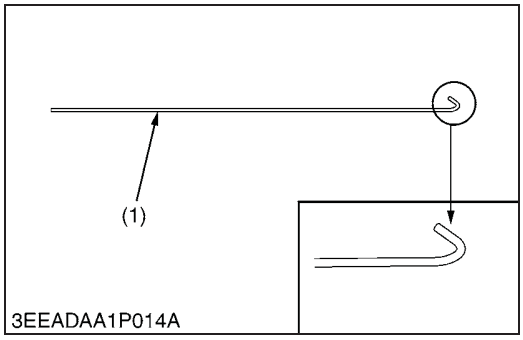
■ **IMPORTANT**

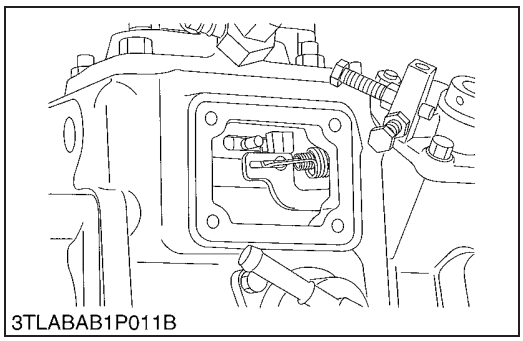
- **If you replace new boost compensator, it is necessary to adjust it.**
  Get the adjustment procedure from KUBOTA.

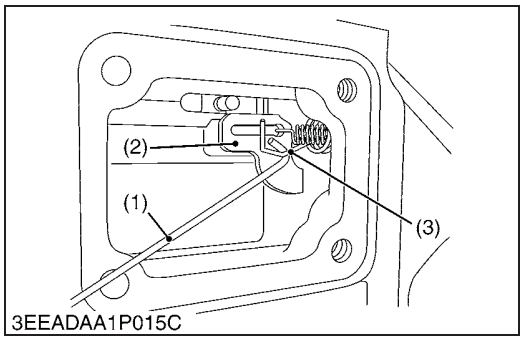
Tightening torque	Hi-idling body	45 to 49 N·m 4.5 to 5.0 kgf·m 33 to 36 lbf·ft

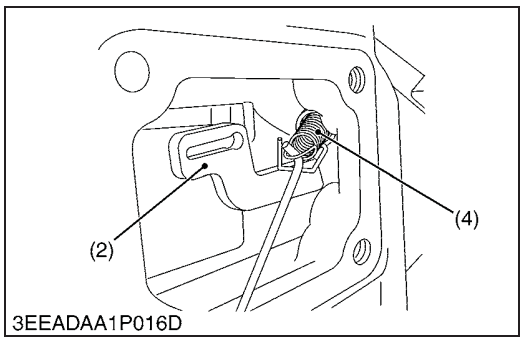
(1) Injection Pump Assembly
(2) Boost Compensator Assembly
(3) Solenoid
(4) Hi-idling Body
(5) Solenoid Guide

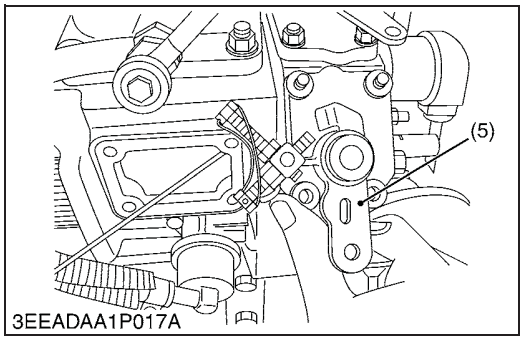
W1032355









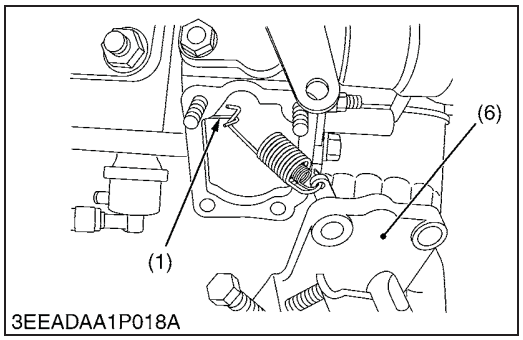


Governor Springs and Speed Control Plate

■ **NOTE**

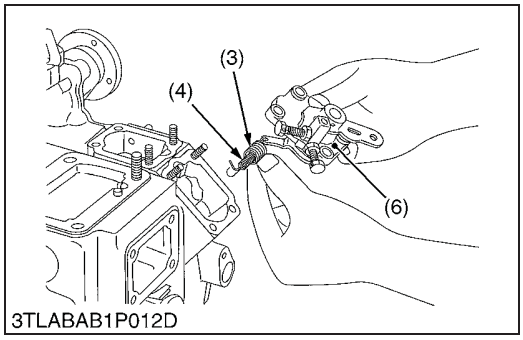
- **Specific tool (1) :**
  1.2 mm diameter hard wire with its end hooked, overall length 200 mm (7.87 in.).
  The tip of wire is bent like the hook to hang governor springs.

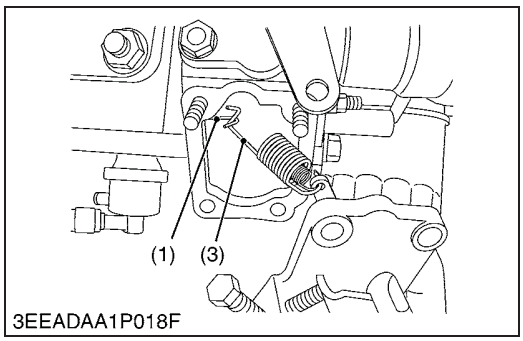
1. Remove the injection pump cover.
2. Remove the speed control plate (6) mounting nuts and bolts.
3. Using the specific tool (1), undo the large governor spring (3) from the fork lever (2).
4. Using the specific tool (1), undo the small governor spring (4) from the fork lever (2).
5. Set the speed control lever (5) as shown in the figure.
6. Take out the speed control plate (6) with care not to let the large (3) and small (4) governor springs come off this plate and fall in to the gear case.

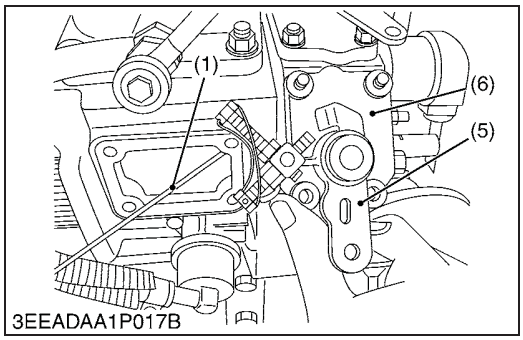


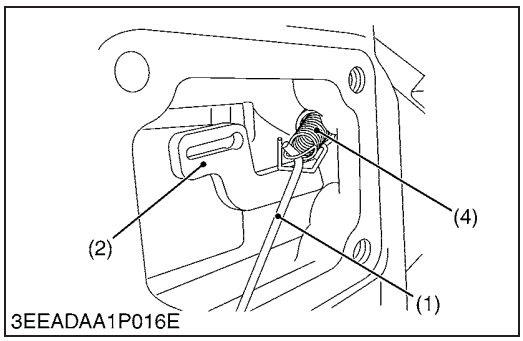
(1) Specific Tool
(2) Fork Lever
(3) Large Governor Spring
(4) Small Governor Spring
(5) Speed Control Lever
(6) Speed Control Plate

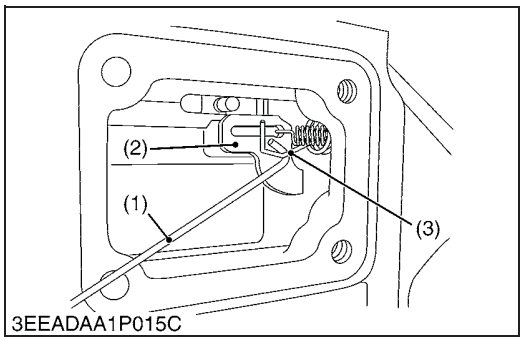
W1148604











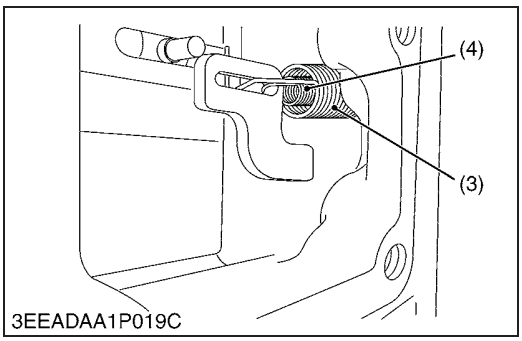
Governor Springs and Speed Control Plate (Continued)

(When reassembling)

- Hook the small spring (4) first and then the large governor spring (3) on the speed control plate (6).
- Put the specific tool (1) from the injection pump side to catch the large governor spring (3). Keep this spring slightly extended and place the speed control plate (6) in its specified position.
- Using the specific tool (1), hook the small governor spring (4) onto the fork lever (2).

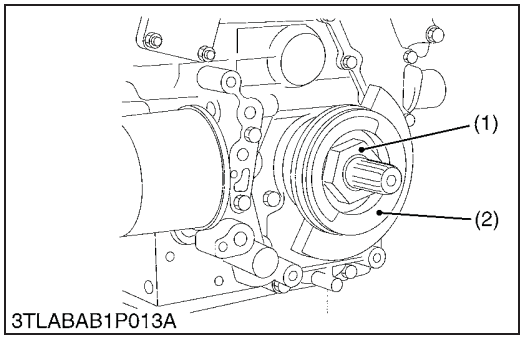
■ **NOTE**

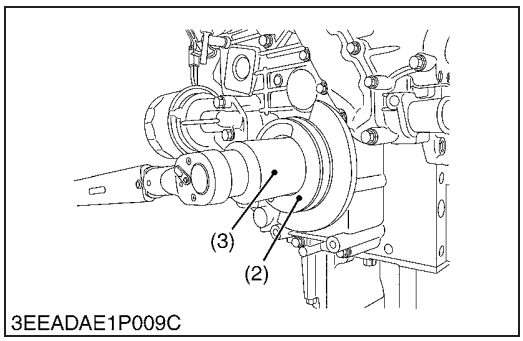
- **Be careful not to stretch the small governor spring (4) too long because otherwise it may get deformed permanently.**
- **Using the specific tool (1), hook the large governor spring (3) onto the fork lever (2).**
- **Make sure both the governor springs (3), (4) are tight on the fork lever (2).**
- **Apply and tighten up the two bolts and two nuts on the speed control plate (6).**
- **Check that the speed control lever (5) positions low idle, after assembling governor springs.**
- **Check that the speed control lever (5) returns to the high idle position rather than the low idle position, after moving the lever to the maximum speed position.**
- **Finally attach the injection pump cover in position.**

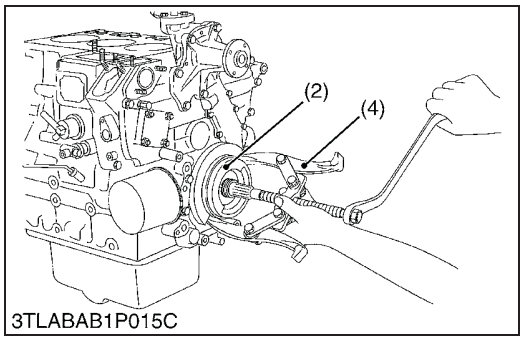


(1) Specific Tool
(2) Fork Lever
(3) Large Governor Spring
(4) Small Governor Spring
(5) Speed Control Lever
(6) Speed Control Plate

W1152334







Fan Drive Pulley

1. Lock the flywheel not to turn using the flywheel stopper.
2. Remove the fan drive pulley mounting nut (1) using 46 mm deep socket wrench (3).
3. Remove the fan drive pulley (2) with gear puller (4).
4. Remove the feather key.

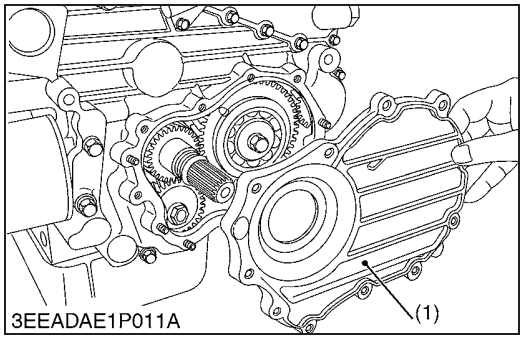
(When reassembling)

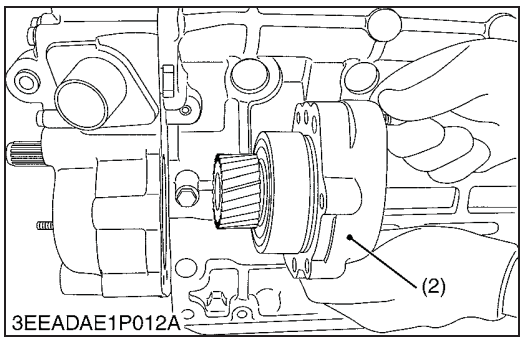
- Apply grease to the splines of coupling.

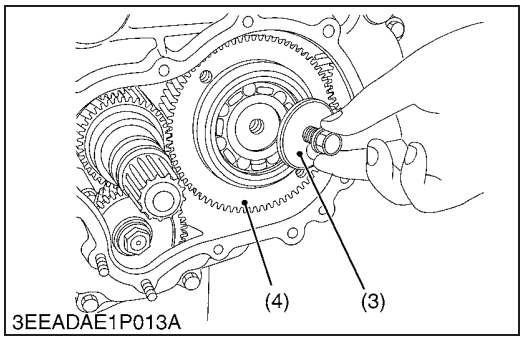
Tightening torque	Fan drive pulley mounting nut	138 to 156 N·m 14.0 to 16.0 kgf·m 102 to 115 lbf·ft

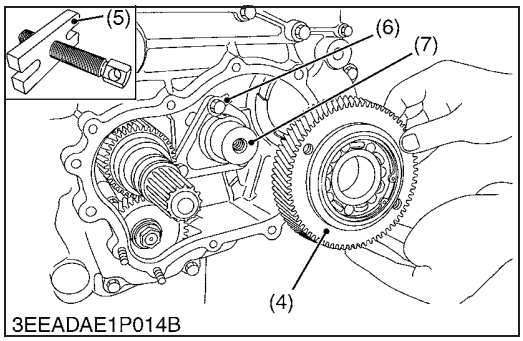
(1) Nut
(2) Fan Drive Pulley
(3) 46 mm Deep Socket Wrench
(4) Gear Puller

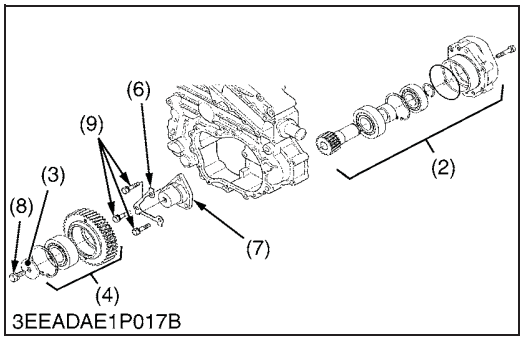
W1024348











Idle Gear 2 and Hydraulic Pump Base Assembly (for Side PTO Model)

1. Remove the hour meter gear case (if equipped).
2. Remove the gear case cover (1).
3. Remove the hydraulic pump base assembly (2).
4. Remove the idle gear 2 stopper (3).
5. Remove the idle gear 2 (4) using the puller (5).
6. Remove the idle gear 2 shaft (7).

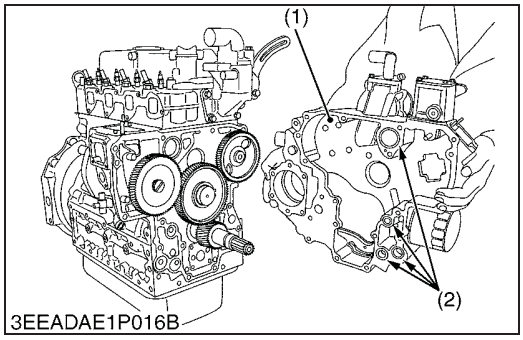
(When reassembling)

- Replace the washer (6) and gear case cover gasket.
- Replace the gear case cover gasket with new one.

Tightening torque	Idle gear 2 shaft set screw	24 to 27 N·m 2.4 to 2.8 kgf·m 18 to 20 lbf·ft
	Idle gear 2 stopper set screw	49 to 55 N·m 5.0 to 5.7 kgf·m 37 to 41 lbf·ft

(1) Gear Case Cover
(2) Hydraulic Pump Base Assembly
(3) Idle Gear 2 Stopper
(4) Idle Gear 2
(5) Puller
(6) Washer
(7) Idle Gear 2 Shaft
(8) Idle Gear 2 Stopper Set Screw
(9) Idle Gear 2 Shaft Set Screw

W1034122



Gear Case (for Side PTO Model)

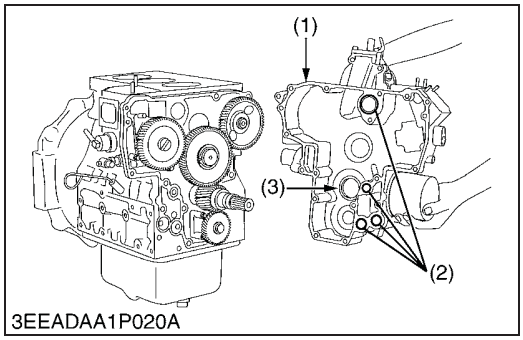
1. Remove the gear case (1).
2. Remove the O-rings (2).

(When reassembling)

- Replace the gear case gasket and O-rings.
- Check to see if there are four O-rings (2) inside the gear case (1).
- Apply a thin film of engine oil to the oil seal, and install it, noting the lip come off.
- Before installing the gear case gasket, apply a non-drying adhesive.

(1) Gear Case (2) O-rings

W1034671



Gear Case

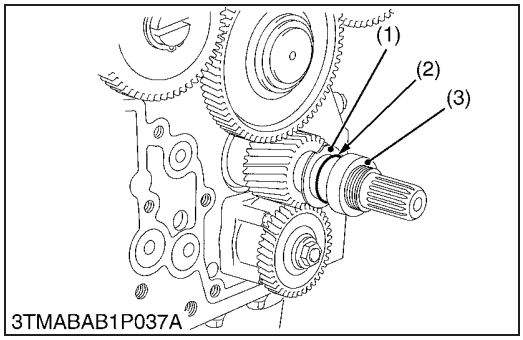
1. Remove the hour meter gear case (if equipped).
2. Remove the gear case (1).
3. Remove the O-rings (2).

(When reassembling)

- Replace the gear case gasket and O-rings (2).
- Replace the hour meter gear case gasket with new one.
- Check to see if there are four O-rings (2) inside the gear case (1).
- Apply a thin film of engine oil to the oil seal (3), and install it, noting the lip come off.
- Before installing the gear case gasket, apply a non-drying adhesive.

(1) Gear Case (3) Oil Seal
(2) O-ring

W1024531



Crankshaft Oil Slinger

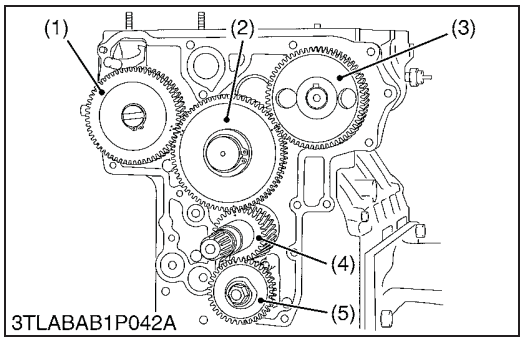
1. Remove the crankshaft collar (3).
2. Remove the O-ring (2).
3. Detach the crankshaft oil slinger (1).

(When reassembling)

- Insert the crankshaft collar (3) after install the gear case to cylinder body.

(1) Crankshaft Oil Slinger (3) Crankshaft Collar
(2) O-ring

W1024731



Idle Gear

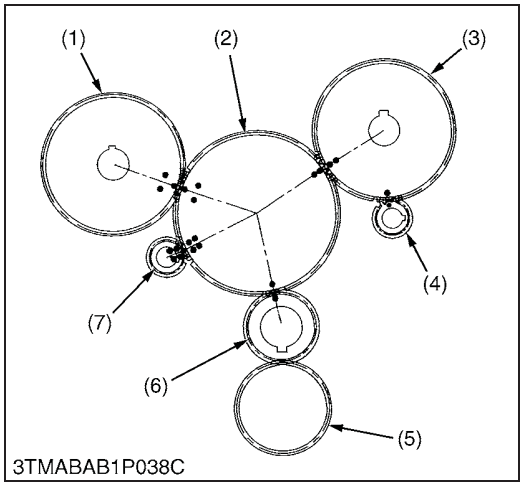
1. Remove the external snap ring.
2. Detach the idle gear collar.
3. Detach the idle gear (2).

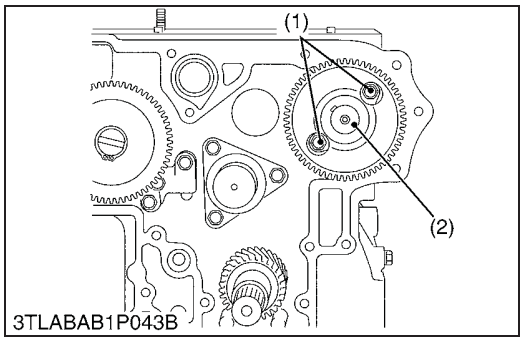
(When reassembling)

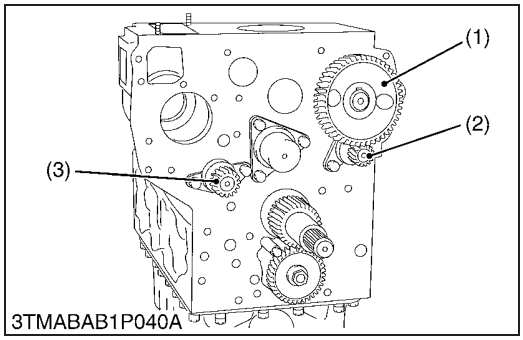
- Check to see each gear is aligned with its aligning mark
  - Idle gear (2) and crank gear (4)
  - Idle gear (2) and cam gear (3)
  - Idle gear (2) and injection pump gear (1)

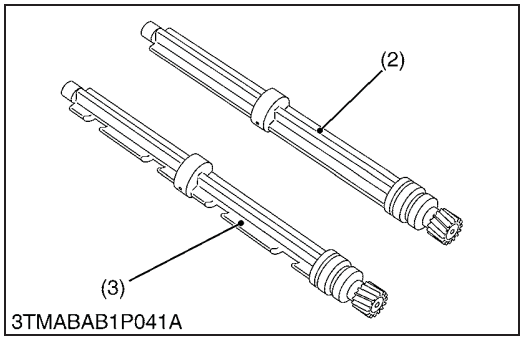
(1) Injection Pump Gear (4) Crank Gear
(2) Idle Gear (5) Oil Pump Drive Gear
(3) Cam Gear

W1024941









Idle Gear (For Balancer Model)

1. Remove the external snap ring.
2. Detach the idle gear collar.
3. Detach the idle gear (2).

(When reassembling)

- Check to see each gear is aligned with its aligning mark:
  - Idle gear (2) and crank gear (6), cam gear (3) and balancer gear (4)
  - Cam gear (3) and idle gear (2)
  - Idle gear (2) and injection pump gear (1)
  - Idle gear (2) and balancer gear (7)

(1) Injection Pump Gear
(2) Idle Gear
(3) Cam Gear
(4) Balancer Gear
(5) Oil Pump Drive Gear
(6) Crank Gear
(7) Balancer Gear

W1097988

Camshaft

1. Remove the camshaft set screws (1) and draw out the camshaft (2).

(When reassembling)

- When installing the idle gear, be sure to align the alignment marks on gears.

Tightening torque	Camshaft set screw	24 to 27 N·m 2.4 to 2.8 kgf·m 18 to 20 lbf·ft

(1) Camshaft Set Screw
(2) Camshaft

W1025098

Camshaft and Balancer Shaft (For Balancer Model)

1. Remove the camshaft set screws and draw out the camshaft (1).
2. Remove the balancer shaft 1 (2) set bolts and draw out the balancer shaft 1 (2).
3. Remove the balancer shaft 2 (3) set bolts and draw out the balancer shaft 2 (3).

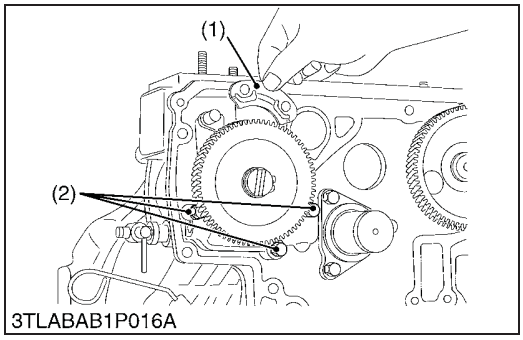
(When reassembling)

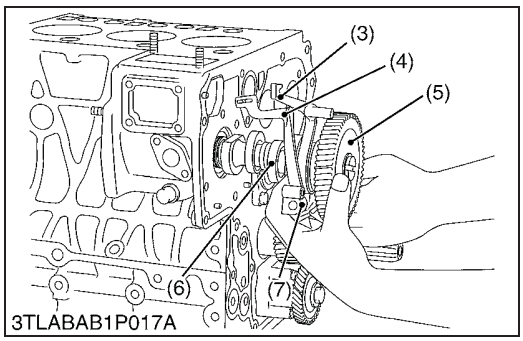
- When install the balancer shaft 1 (2) and 2 (3), be sure to place the 1st. and 4th. cylinders piston at the top dead center in compression then, align all mating marks on each gear to assemble the timing gears, set the idle gear last.

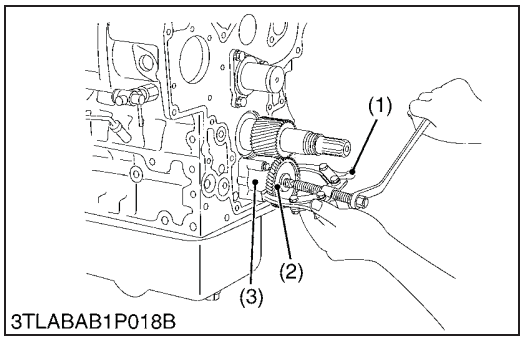
Tightening torque	Camshaft set screw	24 to 27 N·m 2.4 to 2.8 kgf·m 18 to 20 lbf·ft
	Balancer shaft set bolt	24 to 27 N·m 2.4 to 2.8 kgf·m 18 to 20 lbf·ft

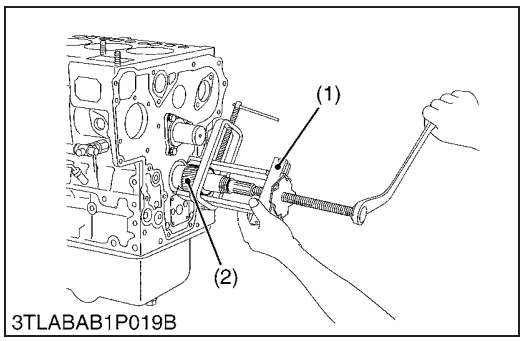
(1) Camshaft
(2) Balancer Shaft 1
(3) Balancer Shaft 2

W1099079









Fuel Camshaft and Fork Lever Assembly

1. Remove the fuel feed pump.
2. Detach the fuel camshaft stopper (1).
3. Remove the three fork lever holder mounting screws (2).
4. Draw out the fuel camshaft assembly (5), (6) and fork lever assembly (3), (4), (7) at the same time.

(When reassembling)

- After installation, check to see that the fork lever 1 (3) and lever 2 (4) are fixed to the fork lever shaft, and that they can turn smoothly in the holder (7).

(1) Fuel Camshaft Stopper
(2) Fork Lever Holder Mounting Screws
(3) Fork Lever 1
(4) Fork Lever 2
(5) Injection Pump Gear
(6) Fuel Camshaft
(7) Fork Lever Holder

W1025309

Oil Pump

1. Remove the nut.
2. Draw out the oil pump drive gear (2) with gear puller (1).
3. Remove the four oil pump mounting screws. Detach the oil pump (3).

(1) Gear Puller
(2) Oil Pump Drive Gear
(3) Oil Pump

W1025581

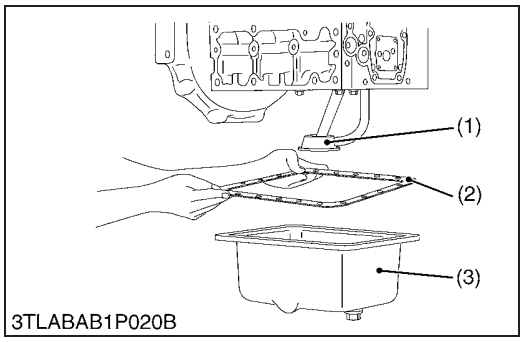
Crank Gear

1. Draw out the crank gear (2) with a puller (1).
2. Remove the feather key.

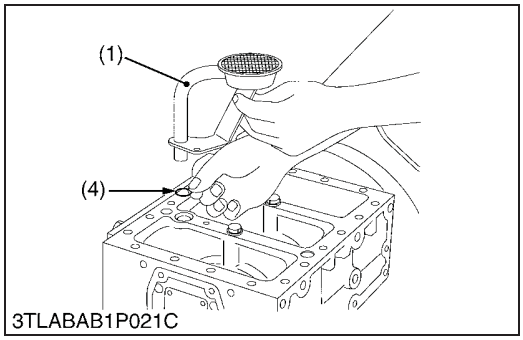
(1) Crank Puller
(2) Crank Gear

W1025476

(5) Piston and Connecting Rod



3TLABAB1P020B



3TLABAB1P021C

Oil Pan and Oil Strainer

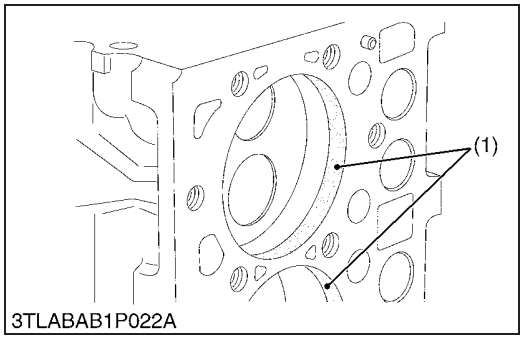
1. Remove the oil pan mounting screws.
2. Remove the oil pan (3) by lightly tapping the rim of the pan with a wooden hammer.
3. Remove the oil pan gasket (2).
4. Remove the oil strainer (1) and O-ring (4).

(When reassembling)

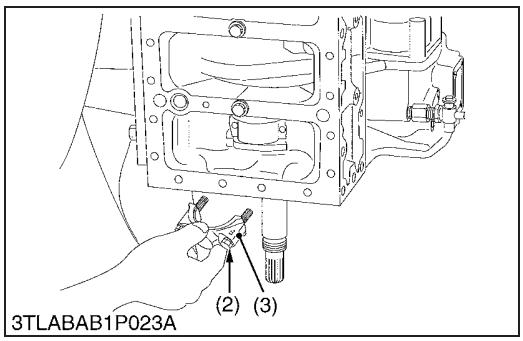
- After cleaning the oil strainer (1), check to see that the filter mesh in clean, and install it.
- Visually check the O-ring (4), apply engine oil, and install it.
- Securely fit the O-ring (4) to the oil strainer (1).
- Replace the oil pan gasket (2) with new one.
- To avoid uneven tightening, tighten oil pan mounting screws in diagonal order from the center.

(1) Oil Strainer
(2) Oil Pan Gasket
(3) Oil Pan
(4) O-ring

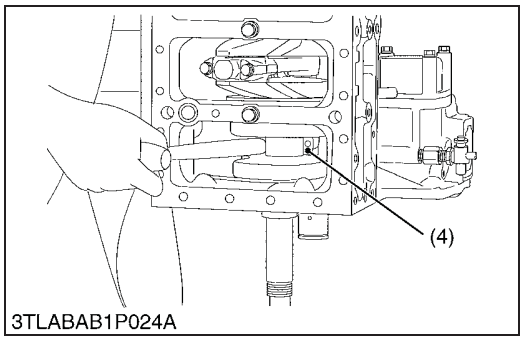
W1025687



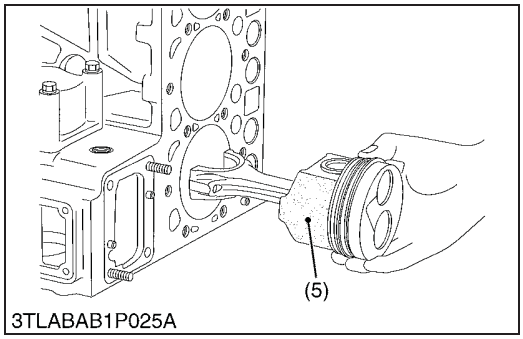
3TLABAB1P022A



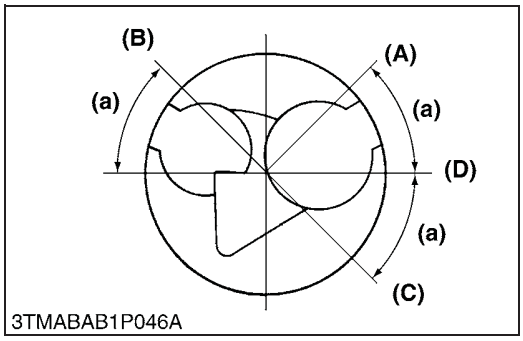
3TLABAB1P023A



3TLABAB1P024A



3TLABAB1P025A



3TMABAB1P046A

Pistons

[D1503-M, D1703-M, D1803-M, V2003-M, V2203-M, V2403-M, V2403-M-T]
[D1703-M-BG, V2003-M-BG, V2003-M-T-BG, V2203-M-BG, V2403-M-BG]

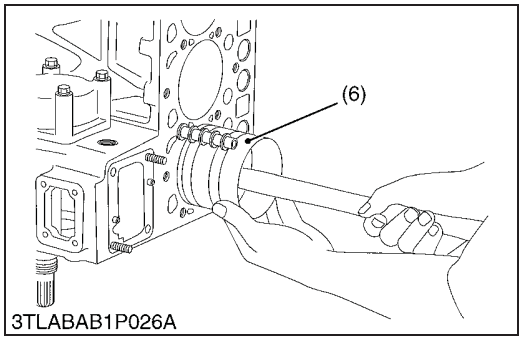
1. Completely clean carbon (1) in the cylinders.
2. Remove the connecting rod cap (3).
3. Turn the flywheel and bring the piston to top dead center.
4. Draw out the piston upward by lightly tapping it from the bottom of the crankcase with the grip of a hammer.
5. Draw out the other piston in the same method as above.

(When reassembling)

- Before inserting piston into the cylinder, apply enough engine oil to the piston.
- When inserting the piston into the cylinder, face the mark on the connecting rod to the injection pump.

■ **IMPORTANT**

- **Do not change the combination of cylinder and piston. Make sure of the position of each piston by marking. For example, mark "1" on the No. 1 piston.**
- **Place the piston rings with their gaps at 0.79 rad (45 °) from the piston pin's direction as shown in the figure.**
- **Carefully insert the pistons using a piston ring compressor (6).**
- **When inserting the piston in place, be careful not to get the molybdenum disulfide coating torn off its skirt. This coating is useful in minimizing the clearance with the cylinder liner. Just after the piston pin has been press-fitted, in particular, the piston is still hot and the coating is easy to peel off. Wait until the piston cools down.**



3TLABAB1P026A

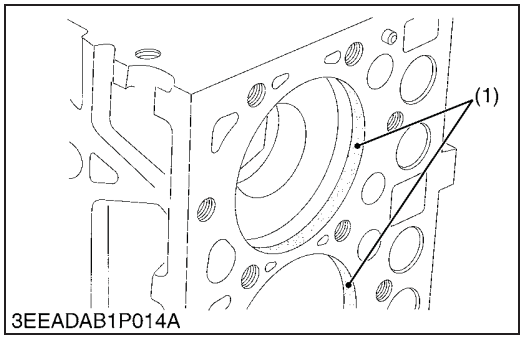
Tightening torque	Connecting rod screw	45 to 49 N·m 4.5 to 5.0 kgf·m 33 to 36 lbf·ft

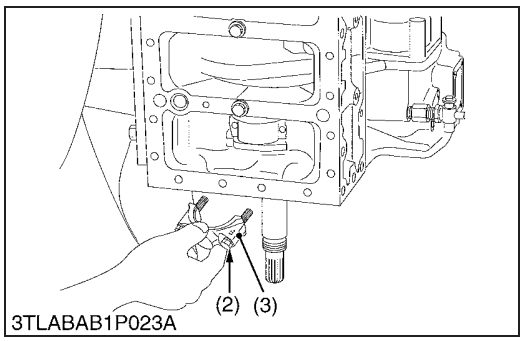
(1) Carbon
(2) Connecting Rod Screw
(3) Connecting Rod Cap
(4) Connecting Rod
(5) Molybdenum Disulfide Coating in Piston Skirt
(6) Piston Ring Compressor

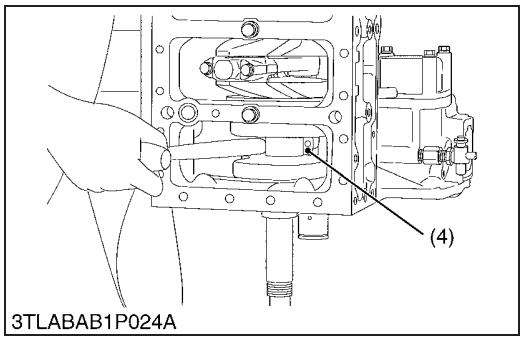
(A) Top Ring Gap
(B) Second Ring Gap
(C) Oil Ring Gap
(D) Piston Pin Hole

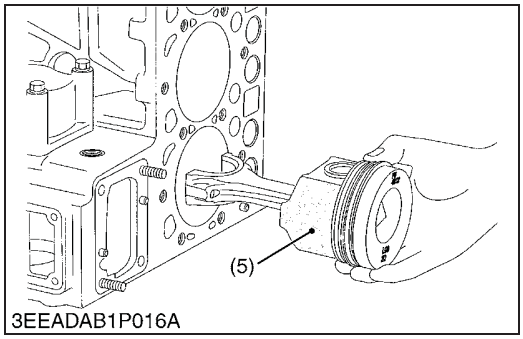
(a) 0.79 rad (45 °)

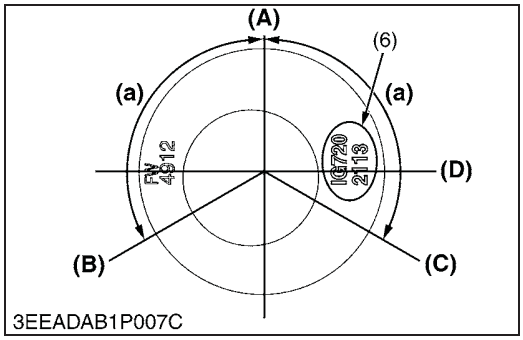
W1026141











Pistons

[D1803-M-DI, V2403-M-DI, V2403-M-DI-T]

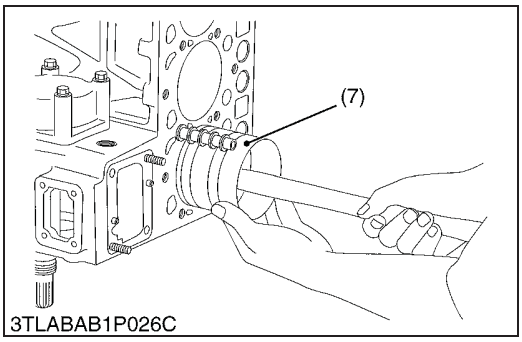
1. Completely clean carbon (1) in the cylinders.
2. Remove the connecting rod cap (3).
3. Turn the flywheel and bring the piston to top dead center.
4. Draw out the piston upward by lightly tapping it from the bottom of the crankcase with the grip of a hammer.
5. Draw out the other piston in the same method as above.

(When reassembling)

- Before inserting piston into the cylinder, apply enough engine oil to the piston.
- When inserting the piston into the cylinder, face the mark on the connecting rod to the injection pump.

■ **IMPORTANT**

- **Do not change the combination of cylinder and piston. Make sure of the position of each piston by marking. For example, mark "1" on the No. 1 piston.**
- **Place the piston rings with their gaps at 2.09 rad (120 °) from the piston pin's direction as shown in the figure.**
- **Carefully insert the pistons using a piston ring compressor (7).**
- **When inserting the piston in place, be careful not to get the molybdenum disulfide coating torn off its skirt. This coating is useful in minimizing the clearance with the cylinder liner. Just after the piston pin has been press-fitted, in particular, the piston is still hot and the coating is easy to peel off. Wait until the piston cools down.**
- **When replacing the piston, look at the code number (6) marked on top of the piston. Use a replacement piston with the same code number.**



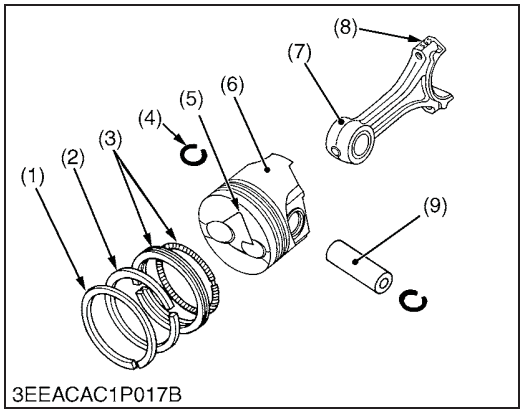
Tightening torque	Connecting rod screw	45 to 49 N·m 4.5 to 5.0 kgf·m 33 to 36 lbf·ft

(1) Carbon
(2) Connecting Rod Screw
(3) Connecting Rod Cap
(4) Connecting Rod
(5) Molybdenum Disulfide Coating in Piston Skirt
(6) Code Number
(7) Piston Ring Compressor

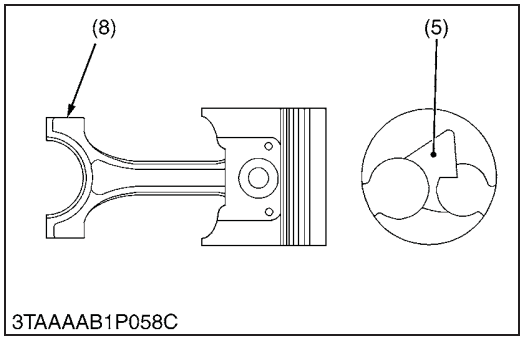
(A) Top Ring Gap
(B) Second Ring Gap
(C) Oil Ring Gap
(D) Piston Pin Hole

(a) 2.09 rad (120 °)

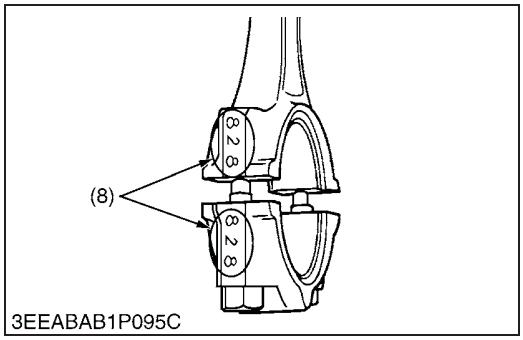
W1126904



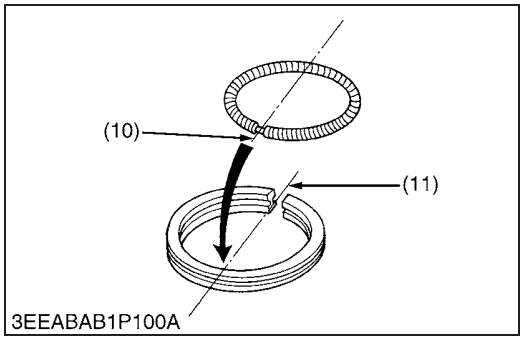
3EEACAC1P017B



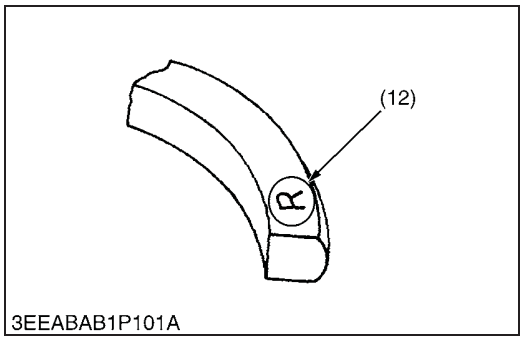
3TAAAAB1P058C



3EEABAB1P095C



3EEABAB1P100A



3EEABAB1P101A

Piston Ring and Connecting Rod

[D1503-M, D1703-M, D1803-M, V2003-M, V2203-M, V2403-M, V2403-M-T]
[D1703-M-BG, V2003-M-BG, V2003-M-T-BG, V2203-M-BG, V2403-M-BG]

1. Remove the piston rings (1), (2), (3) using a piston ring tool.
2. Remove the piston pin (9), and separate the connecting rod (7) from the piston (6).

(When reassembling)

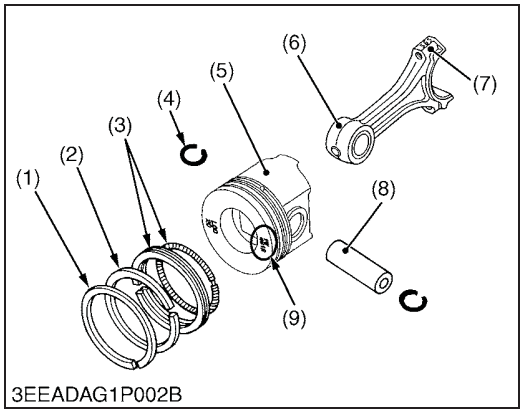
- When installing the rings, assemble the rings so that the manufacturer's mark (12) near the gap faces the top of the piston (6).
- When installing the oil ring (3) onto the piston (6), place the expander joint (10) on the opposite side of the oil ring gap (11).
- Apply engine oil to the piston pin (9).
- When installing the connecting rod (7) to the piston (6), immerse the piston (6) in 80 °C (176 °F) oil for 10 to 15 minutes and insert the piston pin (9) to the piston (6).
- When installing the connecting rod (7) to the piston (6), align the mark (8) on the connecting rod (7) to the fan-shaped concave (5).

■ **NOTE**

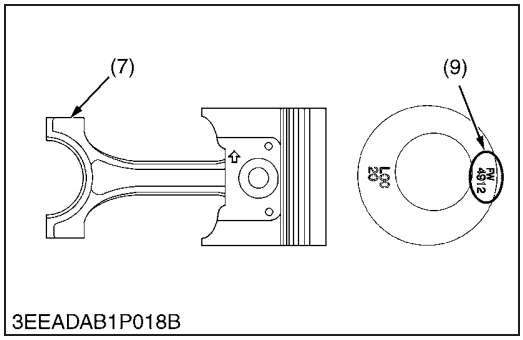
- **Mark the same number on the connecting rod (7) and the piston (6) so as not to change the combination.**

(1) Top Ring
(2) Second Ring
(3) Oil Ring
(4) Piston Pin Snap Ring
(5) Fan-Shaped Concave
(6) Piston
(7) Connecting Rod
(8) Mark
(9) Piston Pin
(10) Expander Joint
(11) Oil Ring Gap
(12) Manufacturer's Mark

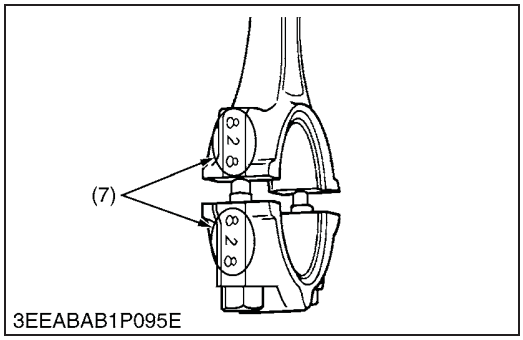
W1026376



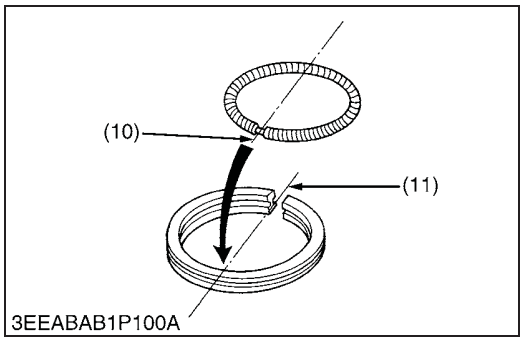
3EEADAG1P002B



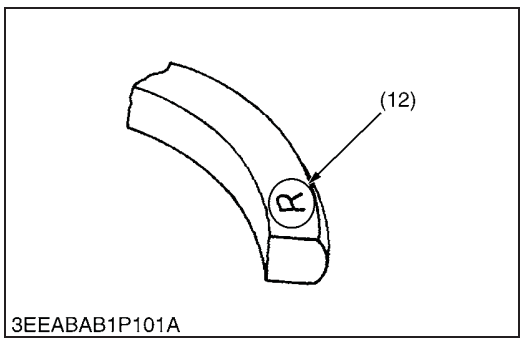
3EEADAB1P018B



3EEABAB1P095E



3EEABAB1P100A



3EEABAB1P101A

Piston Ring and Connecting Rod

[D1803-M-DI, V2403-M-DI, V2403-M-DI-T]

1. Remove the piston rings (1), (2), (3) using a piston ring tool.
2. Remove the piston pin (8), and separate the connecting rod (6) from the piston (5).

(When reassembling)

- When installing the ring, assemble the rings so that the manufacturer's mark (12) near the gap faces the top of the piston (5).
- When installing the oil ring (3) onto the piston (5), place the expander joint (10) on the opposite side of the oil ring gap (11).
- Apply engine oil to the piston pin (8).
- When installing the connecting rod (6) to the piston (5), immerse the piston (5) in 80 °C (176 °F) oil for 10 to 15 minutes and insert the piston pin (8) to the piston (5).
- Assemble the piston (5) to the connecting rod (6) with the FW mark (9) facing the flywheel side and the connecting rod mark (7) facing the injection pump side.

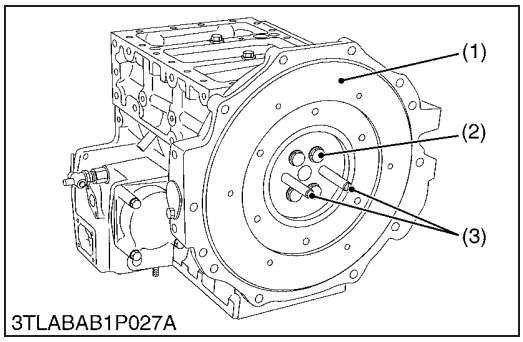
■ **NOTE**

- **Mark the same number on the connecting rod (6) and the piston (5) so as not to change the combination.**

(1) Top Ring
(2) Second Ring
(3) Oil Ring
(4) Piston Pin Snap Ring
(5) Piston
(6) Connecting Rod
(7) Mark
(8) Piston Pin
(9) FW Mark
(10) Expander Joint
(11) Oil Ring Gap
(12) Manufacturer's Mark

W1127943

(6) Flywheel and Crankshaft



Flywheel

1. Fit the stopper to the flywheel (1).
2. At first, remove two pieces of the flywheel screws (2).
3. Insert two pieces of the flywheel guide screws (3) in the holes.
4. Remove the all flywheel screws (2).
5. Remove the flywheel (1) slowly along the flywheel guide screws (3).

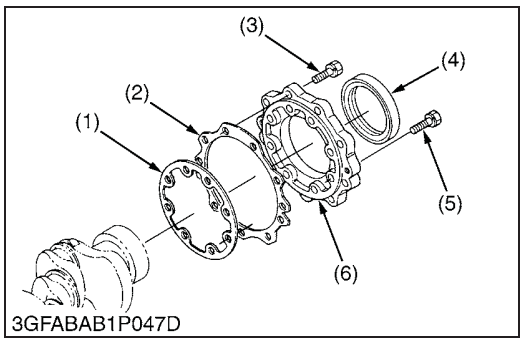
(When reassembling)

- Insert two pieces of the flywheel guide screws (3).
- Check to see that there are no metal particles left on the flywheel mounting surfaces.
- Apply engine oil to the threads and the undercut surface of the flywheel bolt and fit the bolt.

Tightening torque	Flywheel screw	98.1 to 107 N·m 10.0 to 11.0 kgf·m 72.4 to 79.5 lbf·ft

(1) Flywheel
(2) Flywheel Screw
(3) Flywheel Guide Screws

W1026863



Bearing Case Cover

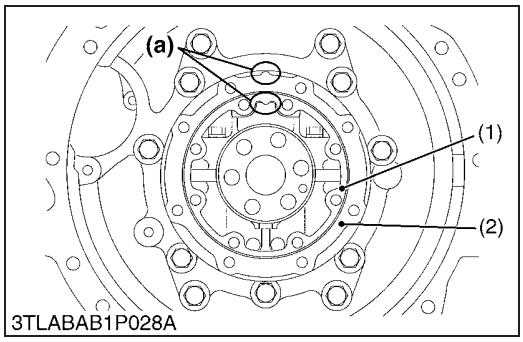
1. Remove the bearing case cover mounting screws. First, remove inside screws (5) and then outside screws (3).
2. Screw two removed screws into the screw hole of bearing case cover (6) to remove it.

■ **IMPORTANT**

- **The length of inside screws (5) and outside screws (3) are different. Do not take a mistake using inside screws and outside screws.**

(When reassembling)

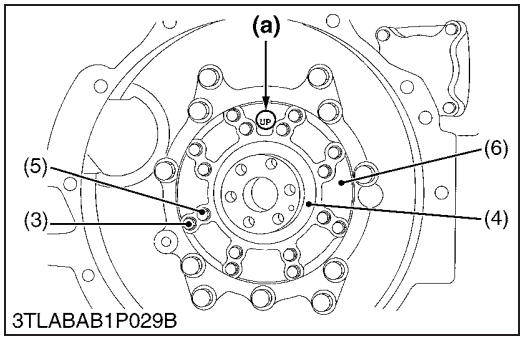
- Fit the bearing case gasket (1) and the bearing case cover gasket (2) with correct directions.
- Install the bearing case cover (6) to position the casting mark **"UP"** on it upward.
- Apply engine oil to the oil seal lip and take care that it is not rolled when installing.
- Tighten the bearing case cover mounting screws with even force on the diagonal line.

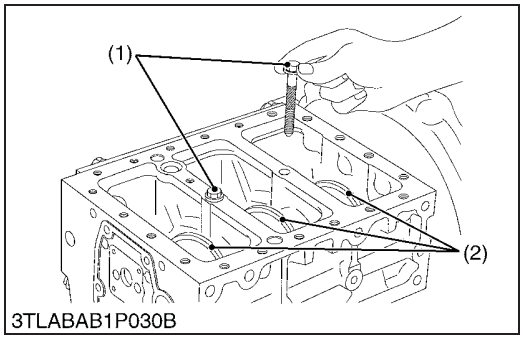


Tightening torque	Bearing case cover mounting screw	24 to 27 N·m 2.4 to 2.8 kgf·m 18 to 20 lbf·ft

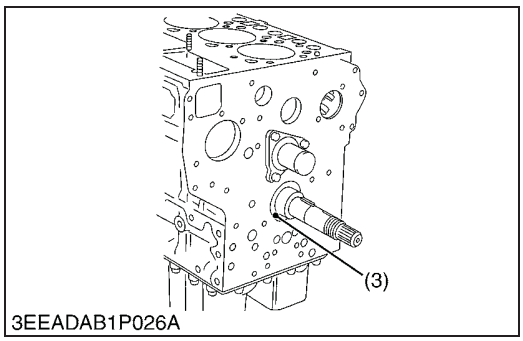
(1) Bearing Case Gasket
(2) Bearing Case Cover Gasket
(3) Bearing Case Cover Mounting Screw
(4) Oil Seal
(5) Bearing Case Cover Mounting Screw
(6) Bearing Case Cover
(a) Upside

W10292140

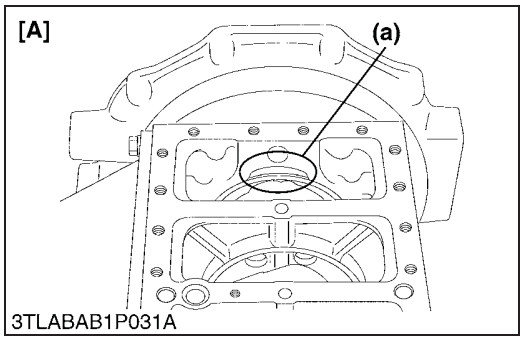




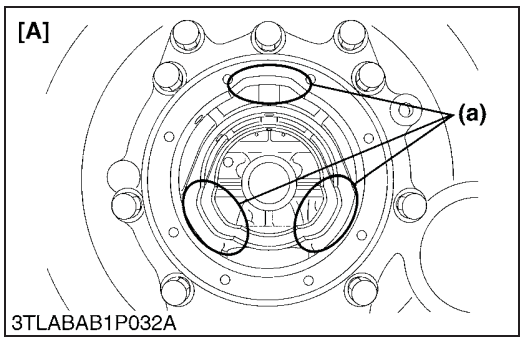
3TLABAB1P030B



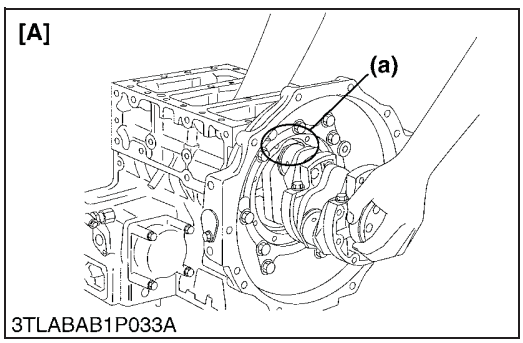
3EEADAB1P026A



3TLABAB1P031A



3TLABAB1P032A



3TLABAB1P033A

Crankshaft

■ **NOTE**

- **Before disassembling, check the side clearance of crankshaft. Also check it during reassembling.**

For D1503-M, D1703-M, V2003-M, V2203-M, D1703-M-BG, V2003-M-BG, V2003-M-T-BG and V2203-M-BG

1. Remove the main bearing case screw 2 (1).
2. Pull out the crankshaft assembly, taking care not to damage the crankshaft bearing 1 (3).

For D1803-M and D1803-M-DI

1. Remove the main bearing case screw 2 (1).
2. Turn the crankshaft to set the crank pin of the third cylinder to the bottom dead center. Then draw out the crankshaft until the crank pin of the second cylinder comes to the center of the third cylinder.
3. Turn the crankshaft by 2.09 rad (120 °) counterclockwise to set the crank pin of the second cylinder to the bottom dead center. Draw out the crankshaft until the crank pin of the first cylinder comes to the center of the third cylinder
4. Repeat the above steps to draw out all the crankshaft.

For V2403-M, V2403-M-DI, V2403-M-T, V2403-M-DI-T and V2403-M-BG

1. Remove the main bearing case screw 2 (1).
2. Turn the crankshaft to set the crank pin of the 4th cylinder to the horizontal directions (Right or Left). Then draw out all the crankshaft, holding the crank pins to the horizontal directions (Right or Left).

(When reassembling)

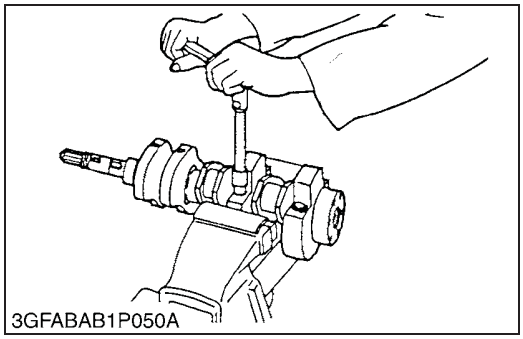
■ **IMPORTANT**

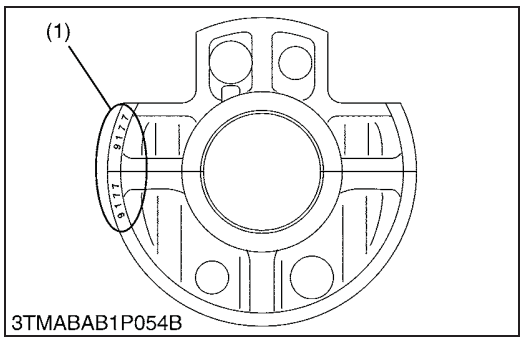
- **Install the crankshaft sub assembly, aligning the screw hole of main bearing case 2 (2) with the screw hole of cylinder block.**
- **When tightening the main bearing case screw 2 (1), apply oil to the screw and screw by hand before tightening the specific torque.**
  If not smooth to screw by hand, align the screw holes between the cylinder block and the main bearing case.

Tightening torque	Main bearing case screw 2	69 to 73 N·m 7.0 to 7.5 kgf·m 51 to 54 lbf·ft

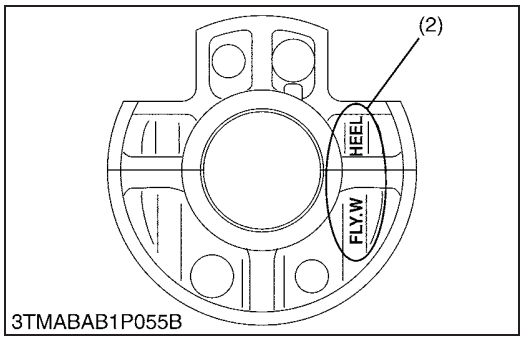
(1) Main Bearing Case Screw 2
(2) Main Bearing Case 2
(3) Crankshaft Bearing 1
(a) Cut place for removing and installing the crankshaft
[A] D1803-M, D1803-M-DI

W1066311

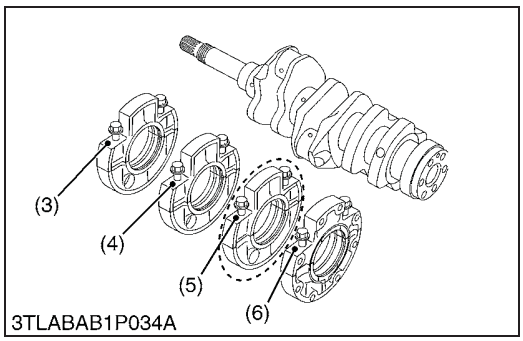

3GFABAB1P050A



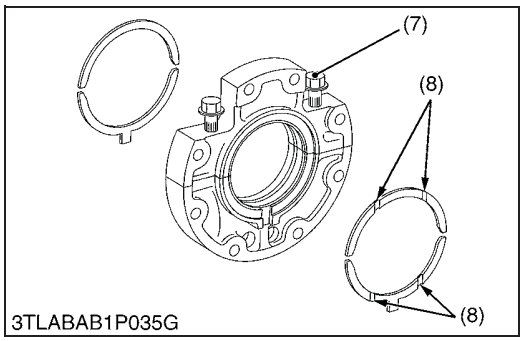
3TMABAB1P054B



3TMABAB1P055B



3TLABAB1P034A



3TLABAB1P035G

Main Bearing Case Assembly

1. Remove the two main bearing case screws 1 (7), and remove the main bearing case assembly being careful with thrust bearing and crankshaft bearing.
2. Remove the main bearing case 1, 2 as above.

(When reassembling)

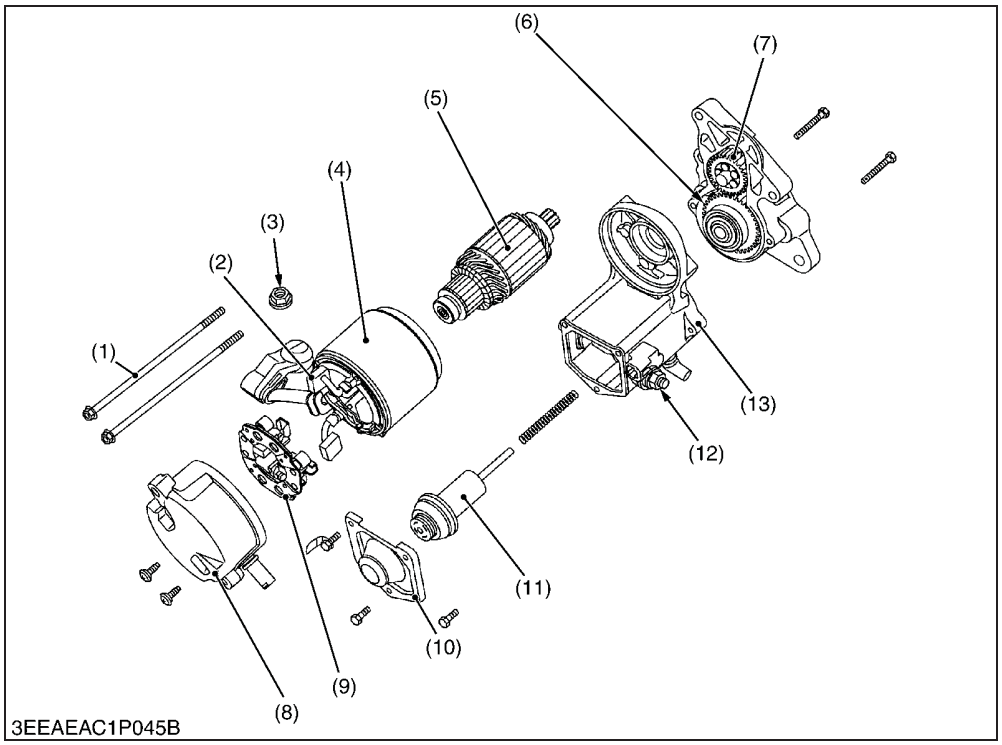
- Clean the oil passage in the main bearing case.
- Apply clean engine oil on the bearings.
- Install the main bearing case assemblies in the original positions. Since diameters of main bearing cases vary, install them in order of makings (A, B for 3 cylinders and A, B, C for 4 cylinders) from the gear case side.
- Match the alignment numbers (1) and mark (2) on the main bearing case.
- When installing the main bearing case 1 and 2, face the mark **"FLYWHEEL"** to the flywheel.
- Install the thrust bearing with its oil groove (8) facing outward.
- Confirm that the main bearing case moves smoothly after tightening the main bearing case screw 1 (7) to the specified torque.

Tightening torque	Main bearing case screw 1	46 to 50 N·m 4.7 to 5.2 kgf·m 34 to 37 lbf·ft

(1) Alignment Number
(2) Alignment Mark
(3) A
(4) B
(5) C
(6) No Mark
(7) Main Bearing Case Screw 1
(8) Oil Groove

W1027366

(7) Starter



(1) Through Bolt
(2) Brush
(3) **C** Terminal Nut
(4) Yoke
(5) Armature
(6) Overrunning Clutch
(7) Idle Gear
(8) End Frame
(9) Brush Holder
(10) Magnet Switch Cover
(11) Plunger
(12) **B** Terminal Nut
(13) Housing

W1222714

1. Unscrew the **C** terminal nut (3), and disconnect the connecting lead.
2. Remove the two through bolts (1).
3. Detach the motor.
4. Remove the end frame (8).
5. Remove the brush from the brush holder while holding the spring up.
6. Remove the brush holder (9).
7. Draw out the armature (5) from the yoke (4).
8. Remove the housing (13).
9. Remove the idle gear (7) and the overrunning clutch (6).
10. Remove the magnet switch cover (10).
11. Remove the plunger (11).

■ **NOTE**

- **Do not damage to the brush and commutator.**

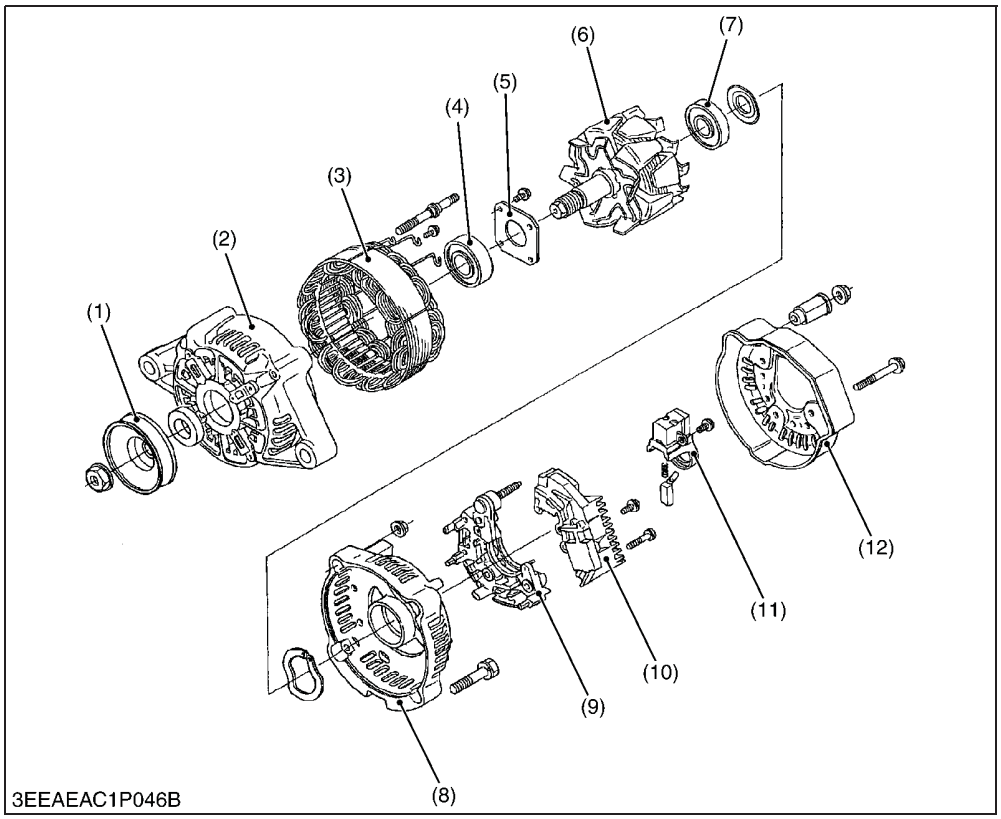
(When reassembling)

- Apply grease (DENSO No. 50 or equivalent) to the idle gear and overrunning clutch portions.

Tightening torque	**B** terminal nut	5.9 to 11 N·m 0.60 to 1.2 kgf·m 4.4 to 8.6 lbf·ft

W1131675

(8) Alternator



(1) Pulley
(2) Drive End Frame
(3) Stator
(4) Bearing
(5) Retainer Plate
(6) Rotor
(7) Bearing
(8) Rear End Frame
(9) Rectifier
(10) IC Regulator
(11) Brush Holder
(12) Rear End Cover

W1224079

1. Remove the pulley (1).
2. Remove the rear end cover (12).
3. Remove the brush holder (11).
4. Remove the IC regulator (10).
5. Remove the four screws holding the stator lead wires.
6. Remove the rectifier (9).
7. Remove the rear end frame (8).
8. Press out the rotor (6) from drive end frame (2).
9. Remove the retainer plate (5).
10. Press out the bearing (4) from drive end frame (2) with a press and jig.
11. Lightly secure the rotor with a vise to prevent damage, and remove the bearing (7) with a puller.

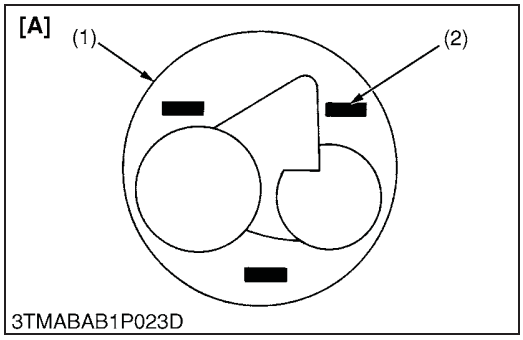
(When reassembling)

Tightening torque	Pulley nut	58.4 to 78.9 N·m 5.95 to 8.05 kgf·m 43.1 to 58.2 lbf·ft

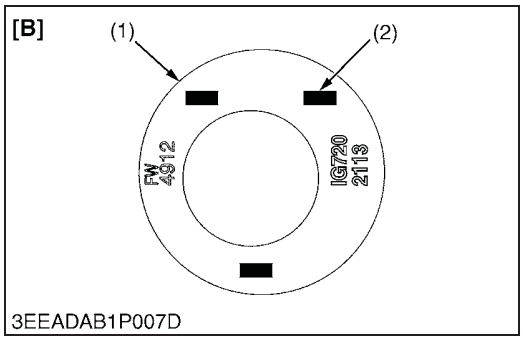
W1224556

[3] SERVICING

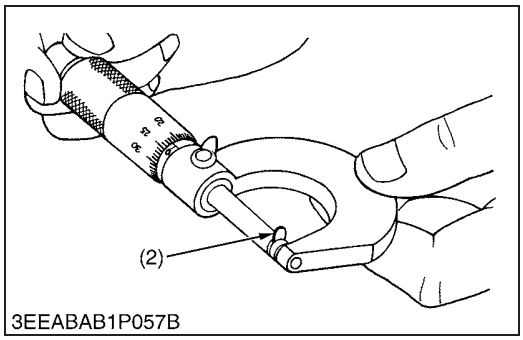
(1) Cylinder Head and Valves



3TMABAB1P023D



3EEADAB1P007D



3EEABAB1P057B

Top Clearance

1. Remove the cylinder head.
2. Move the piston up and stick a strip of fuse on the piston head at three position with grease.
3. Lower the piston and install the cylinder head. (Use a new cylinder head gasket and tighten with a specified tightening torque.)
4. Turn the flywheel until the piston exceeds top dead center.
5. Remove the cylinder head and measure the thickness of the fuses.
6. If the measurement is not within the factory specifications, check the oil clearances between the crankpin and bearing and between the piston pin and bushing.

■ **NOTE**

- **After checking the top clearance, be sure to assemble the cylinder head with a new cylinder head gasket.**

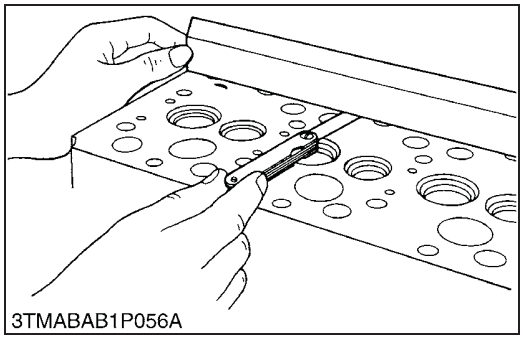
Top clearance	Factory spec.	D1503-M D1703-M D1803-M V2003-M V2203-M V2403-M V2403-M-T D1703-M-BG V2003-M-BG V2003-M-T-BG V2203-M-BG V2403-M-BG	0.575 to 0.675 mm 0.0227 to 0.0265 in.
		D1803-M-DI V2403-M-DI V2403-M-DI-T	0.60 to 0.70 mm 0.024 to 0.027 in.

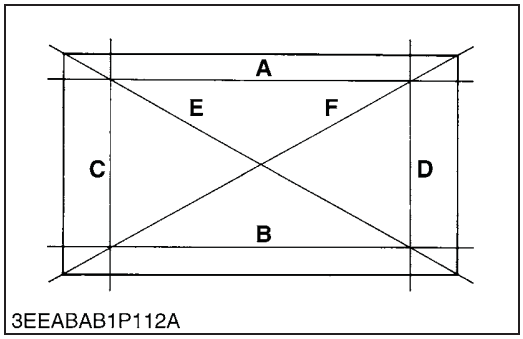
Tightening torque	Cylinder head screws	93.2 to 98.0 N·m 9.50 to 10.0 kgf·m 68.8 to 72.3 lbf·ft

(1) Piston
(2) Fuse

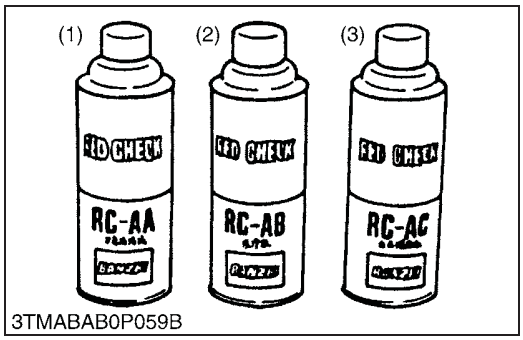
[A] D1503-M, D1703-M, D1803-M
V2003-M, V2203-M, V2403-M
V2403-M-T
D1703-M-BG, V2003-M-BG
V2003-M-T-BG, V2203-M-BG
V2403-M-BG
[B] D1803-M-DI, V2403-M-DI
V2403-M-DI-T

W1020190


3TMABAB1P056A



3EEABAB1P112A



3TMABAB0P059B

Cylinder Head Surface Flatness

1. Clean the cylinder head surface.
2. Place a straightedge on the cylinder head's four sides (**A**), (**B**), (**C**) and (**D**) and two diagonal (**E**) and (**F**) as shown in the figure.
3. Measure the clearance with a feeler gauge.
4. If the measurement exceeds the allowable limit, correct it with a surface grinder.

■ **IMPORTANT**

- **Do not place the straightedge on the combustion chamber.**
- **Be sure to check the valve recessing after correcting.**

Cylinder head surface flatness	Allowable limit	0.05 mm 0.002 in.

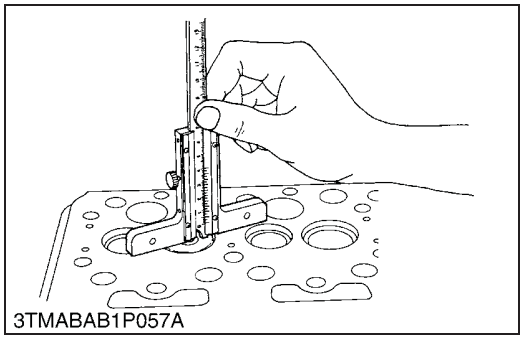
W1027737

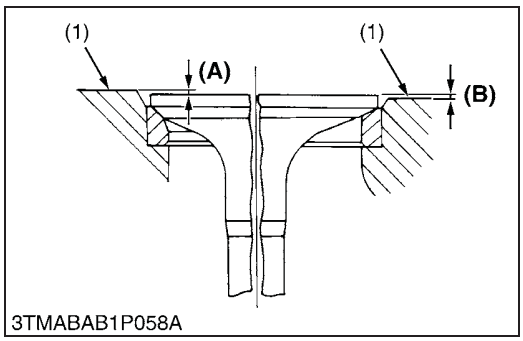
Cylinder Head Flaw

1. Prepare an air spray red check.
2. Clean the surface of the cylinder head with the detergent (2).
3. Spray the cylinder head surface with the red permeative liquid (1). Leave it five to ten minutes after spraying.
4. Wash away the red permeative liquid on the cylinder head surface with the detergent (2).
5. Spray the cylinder head surface with the white developer (3).
6. If flawed, it can be identified as red marks.

(1) Red Permeative Liquid
(2) Detergent
(3) White Developer

W1076542


3TMABAB1P057A



3TMABAB1P058A

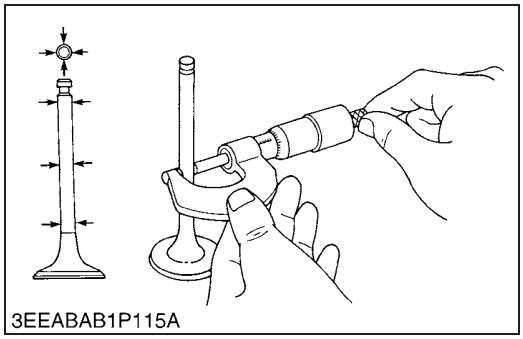
Valve Recessing

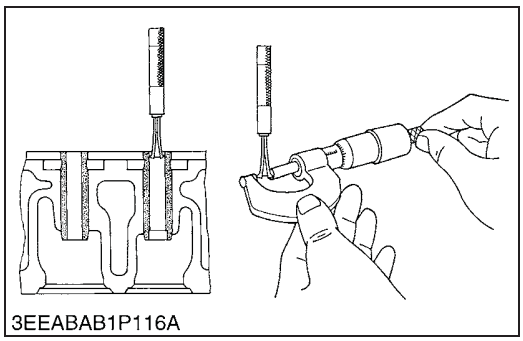
1. Clean the cylinder head surface, valve face and valve seat.
2. Insert the valve into the valve guide.
3. Measure the valve recessing with a depth gauge.
4. If the measurement exceeds the allowable limit, replace the valve.
5. If it still exceeds the allowable limit after replacing the valve, replace the cylinder head.

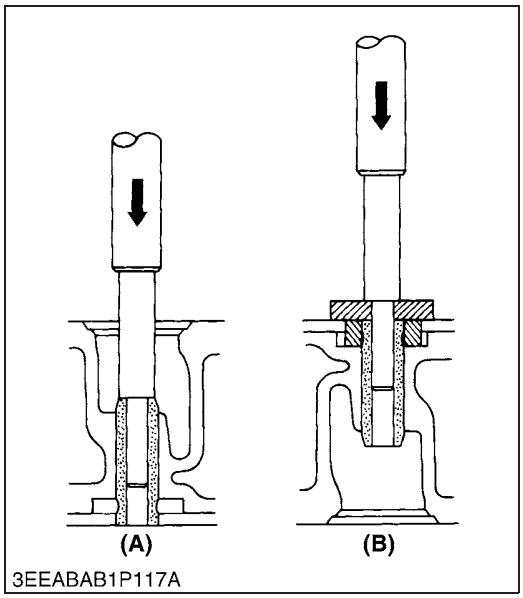
Valve recessing	Factory spec.	D1503-M D1703-M D1803-M V2003-M V2203-M V2403-M V2403-M-T D1703-M-BG V2003-M-BG V2003-M-T-BG V2203-M-BG V2403-M-BG	0.05 (protrusion) to 0.15 (recessing) mm 0.002 (protrusion) to 0.0059 (recessing) in.
		D1803-M-DI V2403-M-DI V2403-M-DI-T	0.65 to 0.85 mm 0.026 to 0.033 in.
	Allowable limit	D1503-M D1703-M D1803-M V2003-M V2203-M V2403-M V2403-M-T D1703-M-BG V2003-M-BG V2003-M-T-BG V2203-M-BG V2403-M-BG	0.40 (recessing) mm 0.016 (recessing) in.
		D1803-M-DI V2403-M-DI V2403-M-DI-T	–

(1) Cylinder Head Surface **(A) Recessing** **(B) Protrusion**

W10768800


3EEABAB1P115A


3EEABAB1P116A



3EEABAB1P117A

Clearance between Valve Stem and Valve Guide

1. Remove carbon from the valve guide section.
2. Measure the valve stem O.D. with an outside micrometer.
3. Measure the valve guide I.D. with a small hole gauge, and calculate the clearance.
4. If the clearance exceeds the allowable limit, replace the valves. If it still exceeds the allowable limit, replace the valve guide.

Clearance between valve stem and valve guide	Factory spec.	0.040 to 0.070 mm 0.0016 to 0.0027 in.
	Allowable limit	0.10 mm 0.0039 in.

Valve stem O.D.	Factory spec.	7.960 to 7.975 mm 0.3134 to 0.3139 in.
Valve guide I.D.	Factory spec.	8.015 to 8.030 mm 0.3156 to 0.3161 in.

W10774950

Replacing Valve Guide

(When removing)

1. Press out the used valve guide using a valve guide replacing tool. (See page **"SPECIAL TOOLS"**.)

(When installing)

1. Clean a new valve guide and valve guide bore, and apply engine oil to them.
2. Press in a new valve guide using a valve guide replacing tool.
3. Ream precisely the I.D. of the valve guide to the specified dimension.

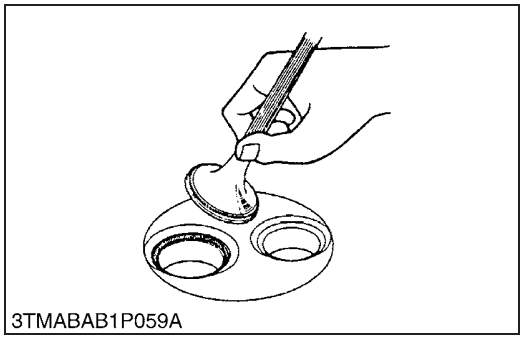
Valve guide I.D. (Intake and exhaust)	Factory spec.	8.015 to 8.030 mm 0.3156 to 0.3161 in.

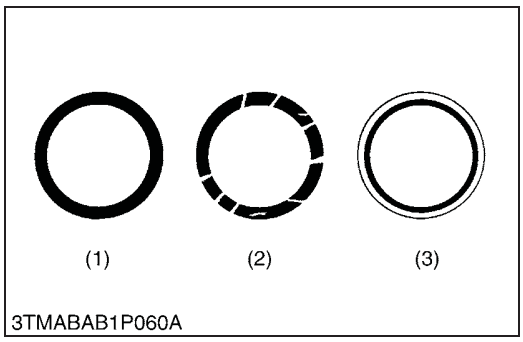
■ **IMPORTANT**

- **Do not hit the valve guide with a hammer during replacement.**

(A) When Removing **(B) When Installing**

W10278890


3TMABAB1P059A



3TMABAB1P060A

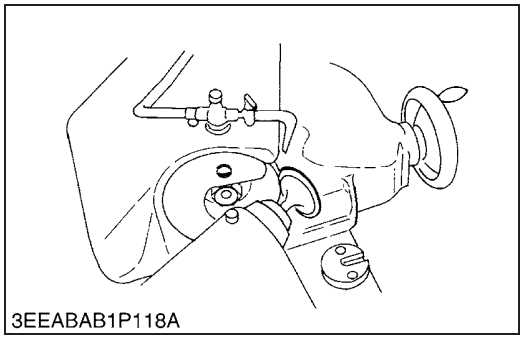
Valve Seating

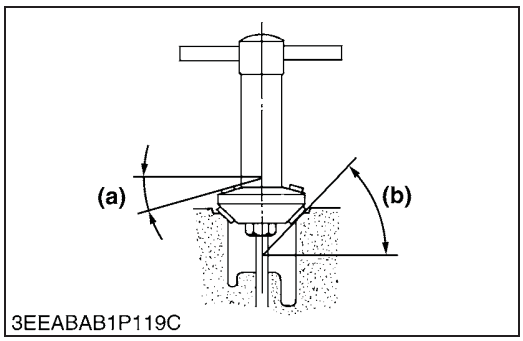
1. Coat the valve face lightly with prussian blue and put the valve on its seat to check the contact.
2. If the valve does not seat all the way around the valve seat or the valve contact is less than 70 %, correct the valve seating as follows.
3. If the valve contact does not comply with the reference value, replace the valve or correct the contact of valve seating.

Valve seat width	Factory spec.	2.12 mm 0.0835 in.

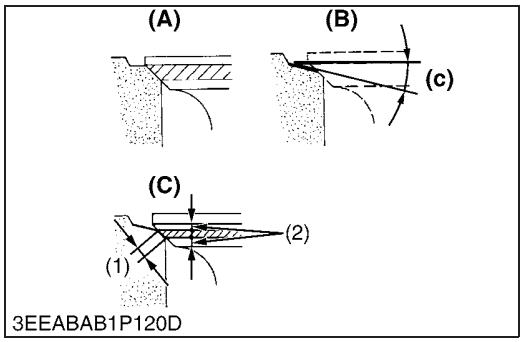
(1) Correct
(2) Incorrect
(3) Incorrect

W10282190


3EEABAB1P118A



3EEABAB1P119C



3EEABAB1P120D

Correcting Valve and Valve Seat

■ **NOTE**
- **Before correcting the valve and seat, check the valve stem and the I.D. of valve guide section, and repair them if necessary.**
- **After correcting the valve seat, be sure to check the valve recessing.**

1) Correcting Valve

1. Correct the valve with a valve refacer.

[D1503-M, D1703-M, D1803-M, V2003-M, V2203-M, V2403-M, V2403-M-T]
[D1703-M-BG, V2003-M-BG, V2003-M-T-BG, V2203-M-BG, V2403-M-BG]

Valve face angle	Factory spec.	IN.	1.0 rad 60 °
		EX.	0.79 rad 45 °

[D1803-M-DI, V2403-M-DI, V2403-M-DI-T]

Valve face angle	Factory spec.	IN.	0.79 rad 45 °
		EX.	0.79 rad 45 °

2) Correcting Valve Seat

1. Slightly correct the seat surface with a 1.0 rad (60 °) or 0.79 rad (45 °) valve seat cutter.
2. Resurface the seat surface with a 0.52 rad (30 °) valve seat cutter or 0.26 rad (15 °) valve seat cutter to valve seat so that the width is close to specified valve seat width (2.12 mm, 0.0835 in.).
3. After resurfacing the seat, inspect for even valve seating, apply a thin film of compound between the valve face and valve seat, and fit them with valve lapping tool.
4. Check the valve seating with prussian blue. The valve seating surface should show good contact all the way around.

[D1503-M, D1703-M, D1803-M, V2003-M, V2203-M, V2403-M, V2403-M-T]
[D1703-M-BG, V2003-M-BG, V2003-M-T-BG, V2203-M-BG, V2403-M-BG]

Valve seat angle	Factory spec.	IN.	1.0 rad 60 °
		EX.	0.79 rad 45 °

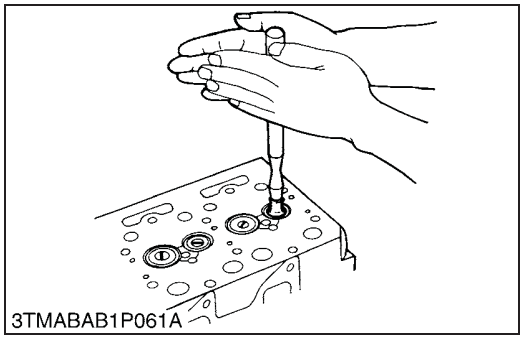
[D1803-M-DI, V2403-M-DI, V2403-M-DI-T]

Valve seat angle	Factory spec.	IN.	0.79 rad 45 °
		EX.	0.79 rad 45 °

(1) Valve Seat Width
(2) Identical Dimensions

(A) Check Contact
(B) Correct Seat Width
(C) Check Contact
(a) 0.26 rad (15 °) or 0.52 rad (30 °)
(b) 0.79 rad (45 °) or 1.0 rad (60 °)
(c) 0.52 rad (30 °) or 0.26 rad (15 °)

W10283500


3TMABAB1P061A

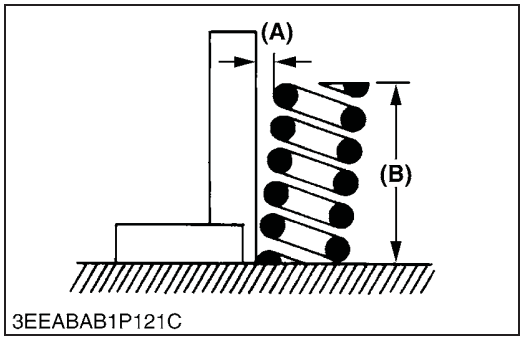
Valve Lapping

1. Apply compound evenly to the valve lapping surface.
2. Insert the valve into the valve guide. Lap the valve onto its seat with a valve flapper or screwdriver.
3. After lapping the valve, wash the compound away and apply oil, then repeat valve lapping with oil.
4. Apply prussian blue to the contact surface to check the seated rate. If it is less than 70 %, repeat valve lapping again.

■ **IMPORTANT**

- **When valve lapping is performed, be sure to check the valve recessing and adjust the valve clearance after assembling the valve.**

W10288140



3EEABAB1P121C

Free Length and Tilt of Valve Spring

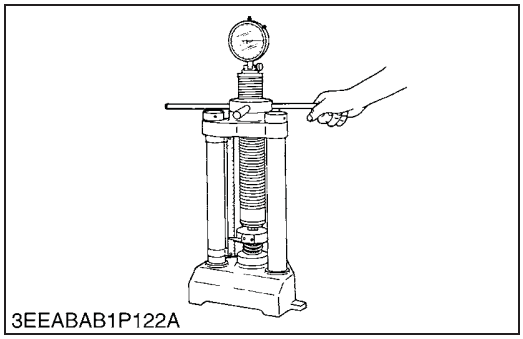
1. Measure the free length **(B)** of valve spring with vernier calipers. If the measurement is less than the allowable limit, replace it.
2. Put the valve spring on a surface plate, place a square on the side of the valve spring.
3. Check to see if the entire side is in contact with the square. Rotate the valve spring and measure the maximum tilt **(A)**. If the measurement exceeds the allowable limit, replace it.
4. Check the entire surface of the valve spring for scratches. If there is any defect, replace it.

Tilt **(A)**	Allowable limit	1.0 mm 0.039 in.

Free length **(B)**	Factory spec.	41.7 to 42.2 mm 1.65 to 1.66 in.
	Allowable limit	41.2 mm 1.62 in.

(A) Tilt **(B) Free Length**

W10289350

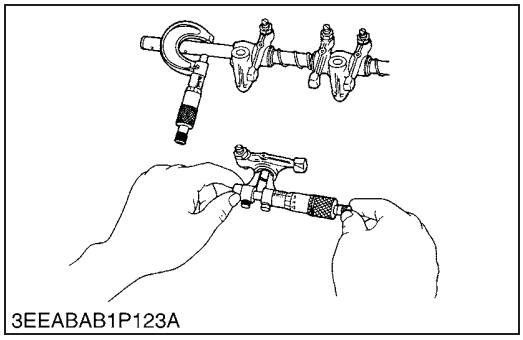

3EEABAB1P122A

Valve Spring Setting Load

1. Place the valve spring on a tester and compress it to the same length it is actually compressed in the engine.
2. Read the compression load on the gauge.
3. If the measurement is less than the allowable limit, replace it.

Setting load / Setting length	Factory spec.	118 N / 35.0 mm 12.0 kgf / 35.0 mm 26.5 lbf / 1.38 in.
	Allowable limit	100 N / 35.0 mm 10.2 kgf / 35.0 mm 22.5 lbf / 1.38 in.

W10784360


3EEABAB1P123A

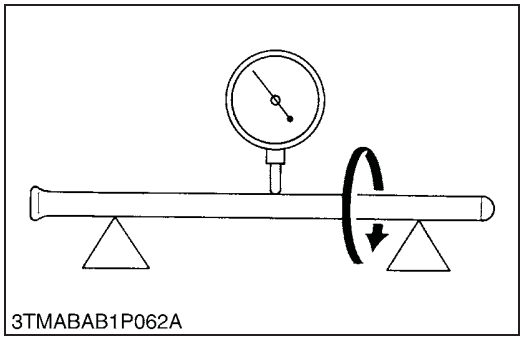
Oil Clearance between Rocker Arm and Rocker Arm Shaft

1. Measure the rocker arm shaft O.D. with an outside micrometer.
2. Measure the rocker arm I.D. with an inside micrometer, and then calculate the oil clearance.
3. If the oil clearance exceeds the allowable limit, replace the rocker arm and measure the oil clearance again. If it still exceeds the allowable limit, replace also the rocker arm shaft.

Oil clearance between rocker arm and rocker arm shaft	Factory spec.	0.016 to 0.045 mm 0.00063 to 0.0017 in.
	Allowable limit	0.10 mm 0.0039 in.

Rocker arm shaft O.D.	Factory spec.	13.973 to 13.984 mm 0.55012 to 0.55055 in.
Rocker arm I.D.	Factory spec.	14.000 to 14.018 mm 0.55119 to 0.55188 in.

W1029150

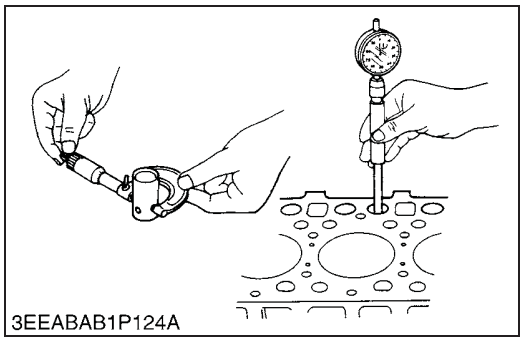

3TMABAB1P062A

Push Rod Alignment

1. Place the push rod on V blocks.
2. Measure the push rod alignment.
3. If the measurement exceeds the allowable limit, replace the push rod.

Push rod alignment	Allowable limit	0.25 mm 0.0098 in.

W10292900


3EEABAB1P124A

Oil Clearance between Tappet and Tappet Guide Bore

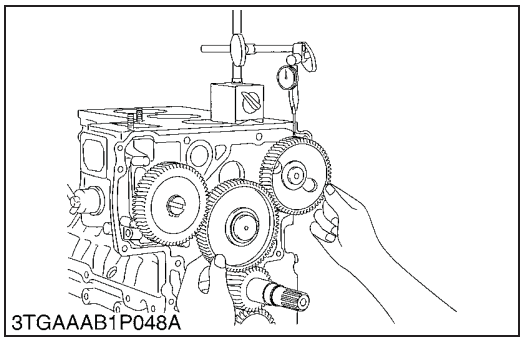
1. Measure the tappet O.D. with an outside micrometer.
2. Measure the I.D. of the tappet guide bore with a cylinder gauge, and calculate the oil clearance.
3. If the oil clearance exceeds the allowable limit or the tappet is damaged, replace the tappet.

Oil Clearance between tappet and tappet guide bore	Factory spec.	0.020 to 0.062 mm 0.00079 to 0.0024 in.
	Allowable limit	0.07 mm 0.003 in.

Tappet O.D.	Factory spec.	23.959 to 23.980 mm 0.94327 to 0.94409 in.
Tappet guide bore I.D.	Factory spec.	24.000 to 24.021 mm 0.94489 to 0.94570 in.

W1029366

(2) Timing Gears


3TGAAAB1P048A

Timing Gear Backlash

1. Set a dial indicator (lever type) with its tip on the gear tooth.
2. Move the gear to measure the backlash, holding its mating gear.
3. If the backlash exceeds the allowable limit, check the oil clearance of the shafts and the gear.
4. If the oil clearance is proper, replace the gear.

Backlash between idle gear and crank gear	Factory spec.	0.04150 to 0.1122 mm 0.001634 to 0.004417 in.
	Allowable limit	0.15 mm 0.0059 in.
Backlash between idle gear and cam gear	Factory spec.	0.04150 to 0.1154 mm 0.001634 to 0.004543 in.
	Allowable limit	0.15 mm 0.0059 in.
Backlash between idle gear and injection pump gear	Factory spec.	0.04150 to 0.1154 mm 0.001634 to 0.004543 in.
	Allowable limit	0.15 mm 0.0059 in.
Backlash between crank gear and oil pump gear	Factory spec.	0.04150 to 0.1090 mm 0.001634 to 0.004291 in.
	Allowable limit	0.15 mm 0.0059 in.

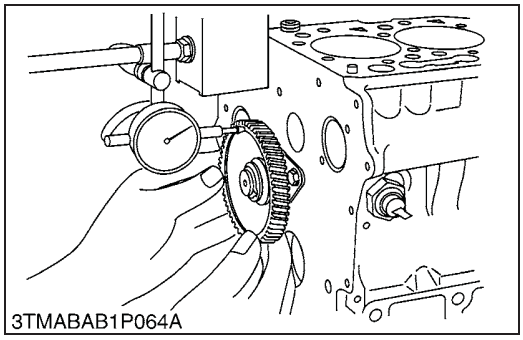
For Balancer Model Only

Backlash between idle gear and balancer gear (Intake side)	Factory spec.	0.03500 to 0.1160 mm 0.001378 to 0.004566 in.
	Allowable limit	0.15 mm 0.0059 in.
Backlash between cam gear and balancer gear (Exhaust side)	Factory spec.	0.03500 to 0.1160 mm 0.001378 to 0.004566 in.
	Allowable limit	0.15 mm 0.0059 in.

For Side PTO Model Only

Backlash between crank gear and idle gear 2	Factory spec.	0.04150 to 0.1154 mm 0.001634 to 0.004543 in.
	Allowable limit	0.15 mm 0.0059 in.
Backlash between idle gear 2 and hydraulic pump drive gear	Factory spec.	0.03080 to 0.1062 mm 0.001213 to 0.004181 in.
	Allowable limit	0.15 mm 0.0059 in.

W1029564

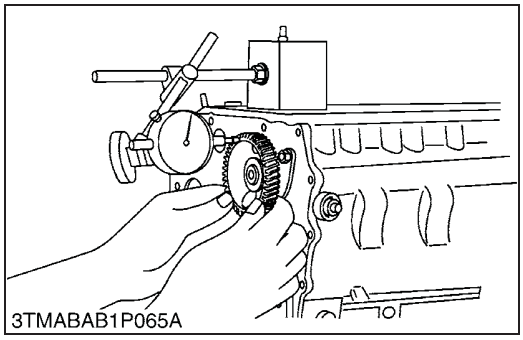

3TMABAB1P064A

Idle Gear Side Clearance

1. Set a dial indicator with its tip on the idle gear.
2. Measure the side clearance by moving the idle gear to the front and rear.
3. If the measurement exceeds the allowable limit, replace the idle gear collar.

Idle gear side clearance	Factory spec.	0.12 to 0.48 mm 0.0048 to 0.018 in.
	Allowable limit	0.9 mm 0.04 in.

W1029843

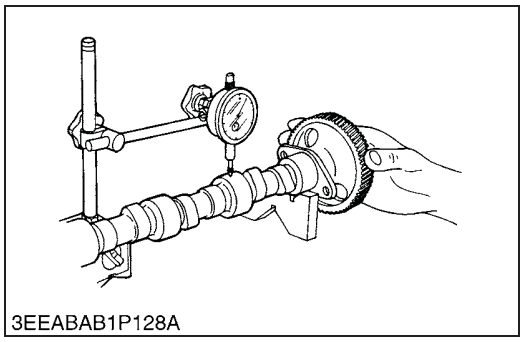

3TMABAB1P065A

Camshaft Side Clearance

1. Set a dial indicator with its tip on the camshaft.
2. Measure the side clearance by moving the cam gear to the front to rear.
3. If the measurement exceeds the allowable limit, replace the camshaft stopper.

Camshaft side clearance	Factory spec.	0.070 to 0.22 mm 0.0028 to 0.0086 in.
	Allowable limit	0.30 mm 0.012 in.

W1030012

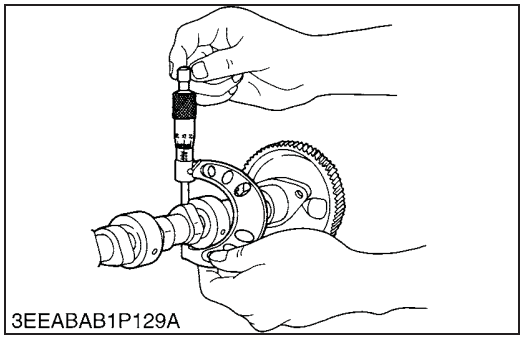

3EEABAB1P128A

Camshaft Alignment

1. Support the camshaft with V blocks on the surface plate at both end journals.
2. Set a dial indicator with its tip on the intermediate journal.
3. Measure the camshaft alignment.
4. If the measurement exceeds the allowable limit, replace the camshaft.

Camshaft alignment	Allowable limit	0.01 mm 0.0004 in.

W1031413

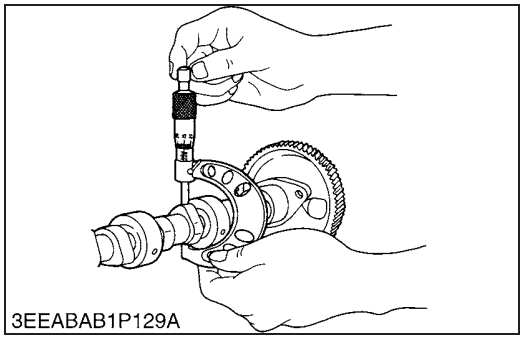

3EEABAB1P129A

Cam Height

1. Measure the height of the cam at its highest point with an outside micrometer.
2. If the measurement is less than the allowable limit, replace the camshaft.

Cam height of intake	Factory spec.	D1503-M D1703-M-BG	33.27 mm 1.310 in.
		V2003-M V2403-M-DI-T V2003-M-BG V2203-M-BG	33.47 mm 1.318 in.
		D1703-M D1803-M V2203-M V2403-M V2403-M-T D1803-M-DI V2403-M-DI V2003-M-T-BG V2403-M-BG	33.90 mm 1.335 in.
	Allowable limit	D1503-M D1703-M-BG	33.22 mm 1.308 in.
		V2003-M V2403-M-DI-T V2003-M-BG V2203-M-BG	33.42 mm 1.316 in.
		D1703-M D1803-M V2203-M V2403-M V2403-M-T D1803-M-DI V2403-M-DI V2003-M-T-BG V2403-M-BG	33.85 mm 1.333 in.

W1031532

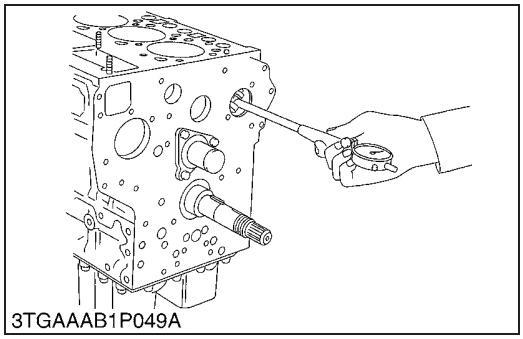

3EEABAB1P129A

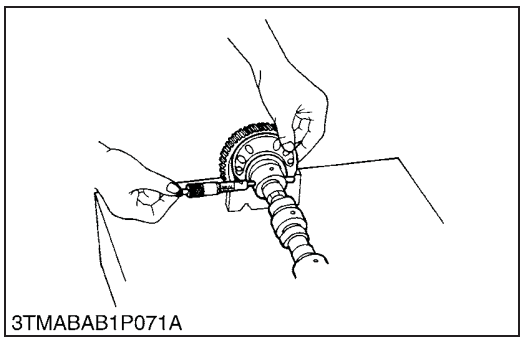
Cam Height (Continued)

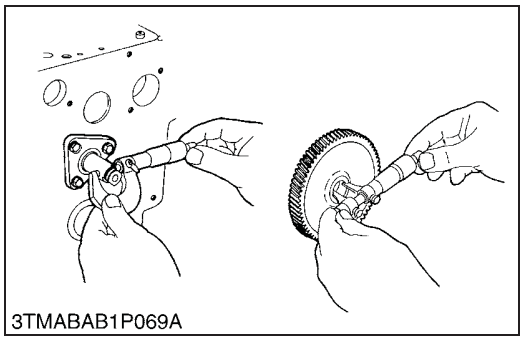
1. Measure the height of the cam at its highest point with an outside micrometer.
2. If the measurement is less than the allowable limit, replace the camshaft.

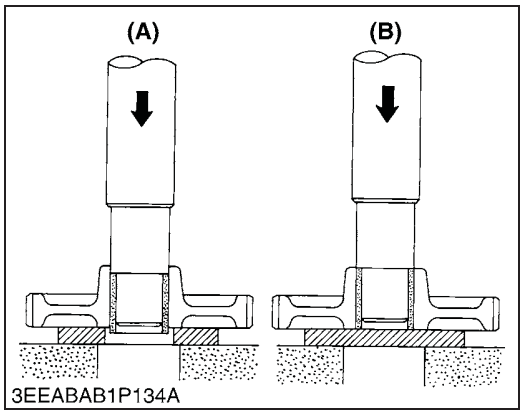
Cam height of exhaust	Factory spec.	V2403-M-DI-T	33.00 mm 1.299 in.
		V2403-M-T D1703-M-BG V2003-M-BG V2203-M-BG	33.27 mm 1.310 in.
		D1503-M V2003-M V2003-M-T-BG	33.47 mm 1.318 in.
		D1703-M D1803-M V2203-M V2403-M D1803-M-DI V2403-M-DI V2403-M-BG	33.90 mm 1.335 in.
	Allowable limit	V2403-M-DI-T	32.95 mm 1.297 in.
		V2403-M-T D1703-M-BG V2003-M-BG V2203-M-BG	33.22 mm 1.308 in.
		D1503-M V2003-M V2003-M-T-BG	33.42 mm 1.316 in.
		D1703-M D1803-M V2203-M V2403-M D1803-M-DI V2403-M-DI V2403-M-BG	33.85 mm 1.333 in.

W1111109


3TGAAAB1P049A


3TMABAB1P071A


3TMABAB1P069A



3EEABAB1P134A

Oil Clearance of Camshaft Journal

1. Measure the camshaft journal O.D. with an outside micrometer.
2. Measure the cylinder block bore I.D. for camshaft with a cylinder gauge, and calculate the oil clearance.
3. If the oil clearance exceeds the allowable limit, replace the camshaft.

Oil clearance of camshaft journal	Factory spec.	0.050 to 0.091 mm 0.0020 to 0.0035 in.
	Allowable limit	0.15 mm 0.0059 in.

Camshaft journal O.D.	Factory spec.	39.934 to 39.950 mm 1.5722 to 1.5728 in.
Cylinder block bore I.D.	Factory spec.	40.000 to 40.025 mm 1.5748 to 1.5757 in.

W1031662

Oil Clearance between Idle Gear Shaft and Idle Gear Bushing

1. Measure the idle gear shaft O.D. with an outside micrometer.
2. Measure the idle gear bushing I.D. with an inside micrometer, and calculate the oil clearance.
3. If the oil clearance exceeds the allowable limit, replace the bushing.
   If it still exceeds the allowable limit, replace the idle gear shaft.

Oil clearance between idle gear shaft and idle gear bushing	Factory spec.	0.025 to 0.066 mm 0.00099 to 0.0025 in.
	Allowable limit	0.10 mm 0.0039 in.

Idle gear shaft O.D.	Factory spec.	37.959 to 37.975 mm 1.4945 to 1.4950 in.
Idle gear bushing I.D.	Factory spec.	38.000 to 38.025 mm 1.4961 to 1.4970 in.

W1030933

Replacing Idle Gear Bushing

(When removing)

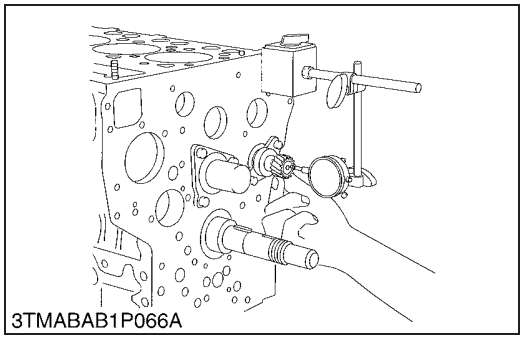
1. Press out the used idle gear bushing using an idle gear bushing replacing tool. (See page **"SPECIAL TOOLS"**.)

(When installing)

1. Clean a new idle gear bushing and idle gear bore, and apply engine oil to them.
2. Press in a new bushing using an idle gear bushing replacing tool, until it is flush with the end of the idle gear.

(A) When Removing **(B) When Installing**

W1031083

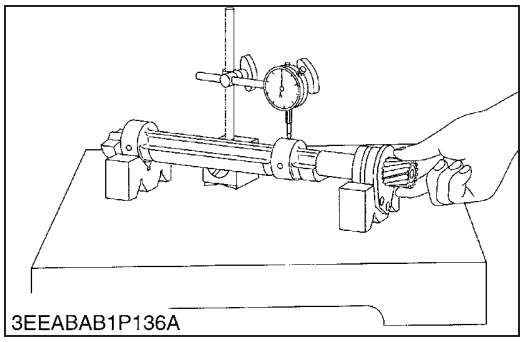

3TMABAB1P066A

Balancer Shaft Side Clearance (for Balancer Model Only)

1. Set a dial indicator with tip on the balancer shaft.
2. Measure the side clearance by moving the balancer shaft to the front and rear.
3. If the measurement exceeds the allowable limit, replace the balancer shaft.

Balancer shaft side clearance	Factory spec.	0.070 to 0.22 mm 0.0028 to 0.0086 in.
	Allowable limit	0.30 mm 0.012 in.

W1030111

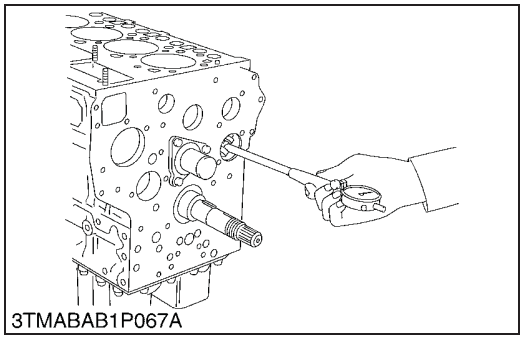

3EEABAB1P136A

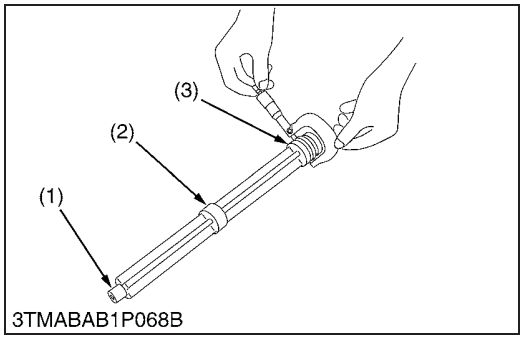
Balancer Shaft Alignment (for Balancer Model Only)

1. Support the balancer shaft with V blocks on the surface plate and set a dial indicator with its tip on the intermediate journal at high angle.
2. Rotate the balancer shaft on the V block and get the misalignment (half of the measurement).
3. If the misalignment exceeds the allowable limit, replace the balancer shaft.

Balancer shaft alignment	Allowable limit	0.02 mm 0.0008 in.

W1042630


3TMABAB1P067A



3TMABAB1P068B

Oil Clearance of Balancer Shaft Journal (for Balancer Model Only)

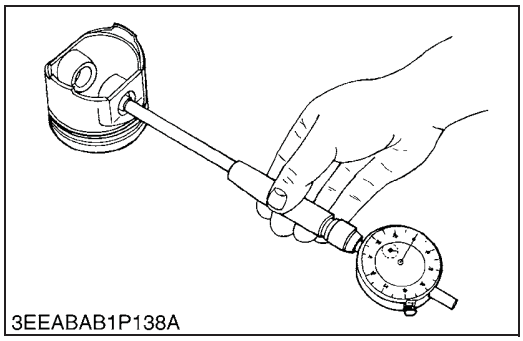
1. Measure the balancer shaft journal O.D. with an outside micrometer.
2. Measure the cylinder block bore I.D. for balancer shaft with an inside micrometer or cylinder gauge.
3. If the clearance exceeds the allowable limit, replace the balancer shaft.

Oil clearance of balancer shaft journal 1	Factory spec.	0.0300 to 0.111 mm 0.00119 to 0.00437 in.
	Allowable limit	0.20 mm 0.0079 in.
Balancer shaft journal 1 O.D.	Factory spec.	43.934 to 43.950 mm 1.7297 to 1.7303 in.
Balancer shaft bearing 1 I.D.	Factory spec.	43.980 to 44.045 mm 1.7315 to 1.7340 in.
Oil clearance of balancer shaft journal 2	Factory spec.	0.0300 to 0.111 mm 0.00119 to 0.00437 in.
	Allowable limit	0.20 mm 0.0079 in.
Balancer shaft journal 2 O.D.	Factory spec.	41.934 to 41.950 mm 1.6509 to 1.6515 in.
Balancer shaft bearing 2 I.D.	Factory spec.	41.980 to 42.045 mm 1.6528 to 1.6553 in.
Oil clearance of balancer shaft journal 3	Factory spec.	0.020 to 0.094 mm 0.00079 to 0.0037 in.
	Allowable limit	0.20 mm 0.0079 in.
Balancer shaft journal 3 O.D.	Factory spec.	21.947 to 21.960 mm 0.86406 to 0.86456 in.
Balancer shaft bearing 3 I.D.	Factory spec.	21.980 to 22.041 mm 0.86536 to 0.86775 in.

(1) Balancer Shaft Journal 3
(2) Balancer Shaft Journal 2
(3) Balancer Shaft Journal 1

W1030206

(3) Piston and Connecting Rod

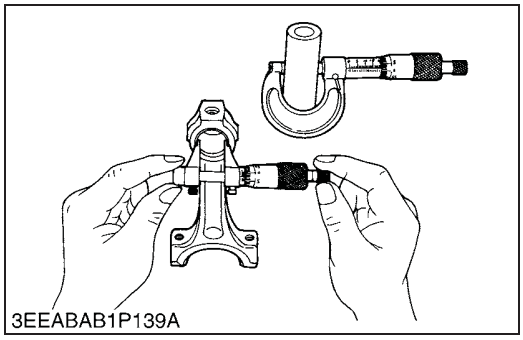

3EEABAB1P138A

Piston Pin Bore I.D.

1. Measure the piston pin bore I.D. in both the horizontal and vertical directions with a cylinder gauge.
2. If the measurement exceeds the allowable limit, replace the piston.

Piston pin bore I.D.	Factory spec.	25.000 to 25.013 mm 0.98426 to 0.98476 in.
	Allowable limit	25.05 mm 0.9862 in.

W1031817


3EEABAB1P139A

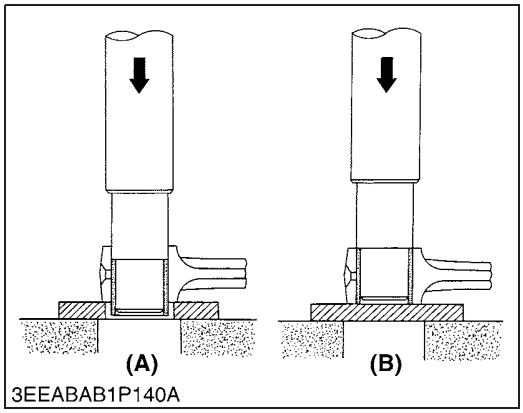
Oil Clearance between Piston Pin and Small End Bushing

1. Measure the piston pin O.D. where it contacts the bushing with an outside micrometer.
2. Measure the small end bushing I.D. with an inside micrometer, and calculate the oil clearance.
3. If the oil clearance exceeds the allowable limit, replace the bushing. If it still exceeds the allowable limit, replace the piston pin.

Oil clearance between piston pin and small end bushing	Factory spec.	0.014 to 0.036 mm 0.00056 to 0.0014 in.
	Allowable limit	0.15 mm 0.0059 in.

Piston pin O.D.	Factory spec.	25.004 to 25.011 mm 0.98441 to 0.98468 in.
Small end bushing I.D.	Factory spec.	25.025 to 25.040 mm 0.98524 to 0.98582 in.

W1031982



3EEABAB1P140A

Replacing Connecting Rod Small End Bushing

(When removing)

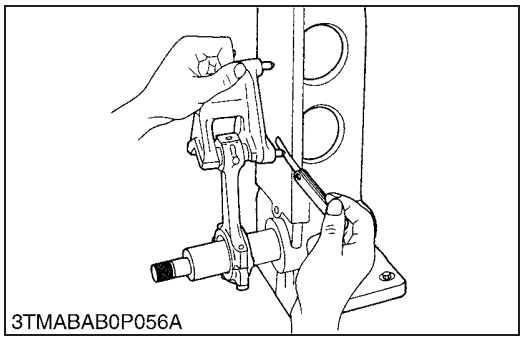
1. Press out the used small end bushing using a small end bushing replacing tool. (See page **"SPECIAL TOOLS"**.)

(When installing)

1. Clean a new small end bushing and bore, and apply engine oil to them.
2. Using a small end bushing replacing tool, press in a new bushing taking due care to see that the connecting rod oil hole matches the bushing hole.

(A) When removing **(B) When installing**

W1032140


3TMABAB0P056A

Connecting Rod Alignment

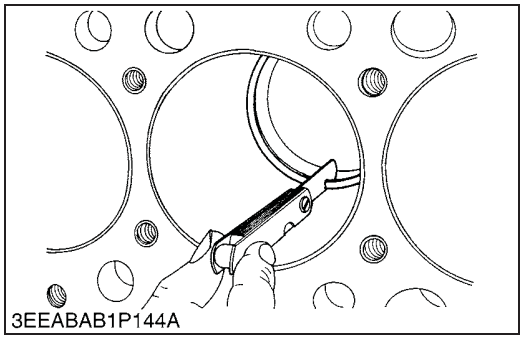
■ **NOTE**

- **Since the I.D. of the connecting rod small end bushing is the basis of this check, check bushing for wear beforehand.**

1. Install the piston pin into the connecting rod.
2. Install the connecting rod on the connecting rod alignment tool.
3. Put a gauge over the piston pin, and move it against the face plate.
4. If the gauge does not fit squarely against the face plate, measure the space between the pin of the gauge and the face plate.
5. If the measurement exceeds the allowable limit, replace the connecting rod.

Connecting rod alignment	Allowable limit	0.05 mm 0.002 in.

W10314620



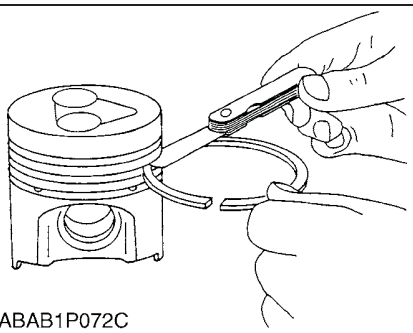
Piston Ring Gap

1. Insert the piston ring into the lower part of the liner (the least worn out part) with the piston.
2. Measure the ring gap with a feeler gauge.
3. If the gap exceeds the allowable limit, replace the ring.

Top ring	Factory spec.	D1503-M V2003-M V2403-M-T D1803-M-DI V2403-M-DI V2403-M-DI-T V2003-M-BG V2003-M-T-BG	0.20 to 0.35 mm 0.0079 to 0.013 in.
		D1703-M D1803-M V2203-M V2403-M D1703-M-BG V2203-M-BG V2403-M-BG	0.25 to 0.40 mm 0.0099 to 0.015 in.
	Allowable limit		1.25 mm 0.0492 in.
Second ring	Factory spec.	D1503-M D1703-M D1803-M V2203-M V2403-M D1803-M-DI V2403-M-DI D1703-M-BG V2003-M-BG V2203-M-BG V2403-M-BG	0.30 to 0.45 mm 0.012 to 0.017 in.
		V2003-M V2403-M-T V2403-M-DI-T V2003-M-T-BG	0.40 to 0.55 mm 0.016 to 0.021 in.
	Allowable limit		1.25 mm 0.0492 in.
Oil ring	Factory spec.	D1503-M D1703-M D1803-M V2003-M V2203-M V2403-M V2403-M-T V2403-M-DI-T D1703-M-BG V2003-M-BG V2003-M-T-BG V2203-M-BG V2403-M-BG	0.25 to 0.45 mm 0.0099 to 0.017 in.
		D1803-M-DI V2403-M-DI	0.20 to 0.40 mm 0.0079 to 0.015 in.
	Allowable limit		1.25 mm 0.0492 in.

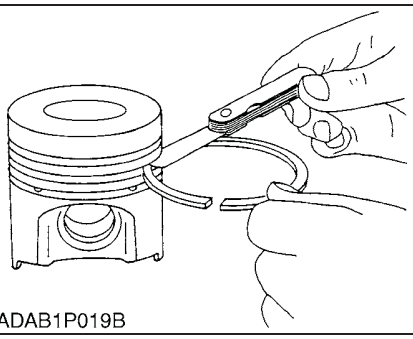
W1032246

[A]



3TMABAB1P072C

[B]



3EEADAB1P019B

Clearance between Piston Ring and Groove

1. Clean the rings and the ring grooves, and install each ring in its groove.
2. Measure the clearance between the ring and the groove with a feeler gauge or depth gauge.
3. If the clearance exceeds the allowable limit, replace the piston ring.
4. If the clearance still exceeds the allowable limit with new ring, replace the piston.

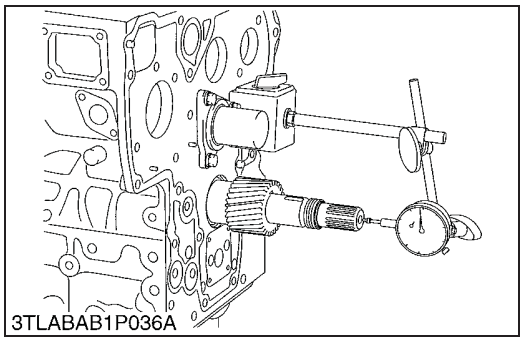
Top Ring	Factory spec.	D1803-M-DI V2403-M-DI	0.050 to 0.090 mm 0.0020 to 0.0035 in.
	Allowable limit		0.20 mm 0.0079 in.
Second ring	Factory spec.	D1503-M D1703-M D1803-M V2003-M V2203-M V2403-M V2403-M-T V2403-M-ID-T D1703-M-BG V2003-M-BG V2003-M-T-BG V2203-M-BG V2403-M-BG	0.0930 to 0.128 mm 0.00367 to 0.00503 in.
		D1803-M-DI V2403-M-DI	0.0780 to 0.110 mm 0.00307 to 0.00433 in.
	Allowable limit		0.20 mm 0.0079 in.
Oil ring	Factory spec.	D1503-M D1703-M D1803-M V2003-M V2203-M V2403-M V2403-M-T V2403-M-DI-T D1703-M-BG V2003-M-BG V2003-M-T-BG V2203-M-BG V2403-M-BG	0.020 to 0.060 mm 0.00079 to 0.0023 in.
		D1803-M-DI V2403-M-DI	0.030 to 0.070 mm 0.0012 to 0.0027 in.
	Allowable limit		0.15 mm 0.0059 in.

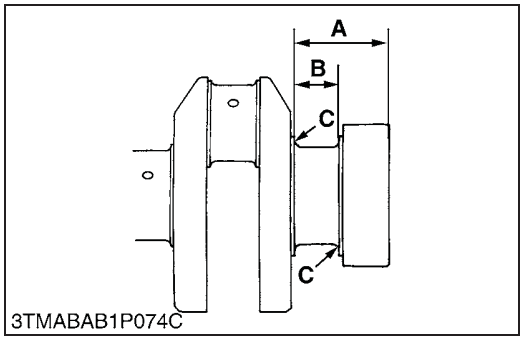
(A) D1503-M, D1703-M, D1803-M V2003-M, V2203-M, V2403-M V2403-M-T D1703-M-BG, V2003-M-BG V2003-M-T-BG, V2203-M-BG V2403-M-BG

(B) D1803-M-DI, V2403-M-DI V2403-M-DI-T

W1032489

(4) Crankshaft


3TLABAB1P036A



3TMABAB1P074C

Side Clearance of Crankshaft

1. Set a dial indicator with its tip on the end of the crankshaft.
2. Measure the side clearance by moving the crankshaft to the front and rear.
3. If the measurement exceeds the allowable limit, replace the thrust bearings.
4. If the same size bearing is useless because of the crankshaft journal wear, replace it with an oversize one referring to the table and figure.

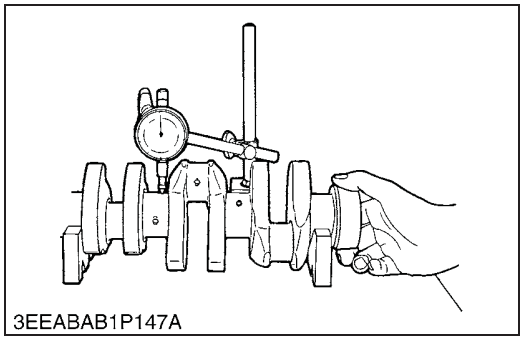
Crankshaft side clearance	Factory spec.	0.15 to 0.31 mm 0.0059 to 0.012 in.
	Allowable limit	0.5 mm 0.02 in.

(Reference)

- Oversize dimensions of crankshaft journal

Oversize	0.2 mm 0.008 in.	0.4 mm 0.02 in.
Dimension **A**	54.50 to 54.70 mm 2.146 to 2.153 in.	54.60 to 54.80 mm 2.150 to 2.157 in.
Dimension **B**	26.20 to 26.25 mm 1.032 to 1.033 in.	26.40 to 26.45 mm 1.040 to 1.041 in.
Dimension **C**	2.8 to 3.2 mm radius 0.11 to 0.12 in. radius	2.8 to 3.2 mm radius 0.11 to 0.12 in. radius
The crankshaft journal must be fine-finished to higher than ∇∇∇∇		(0.4S)

W1032880

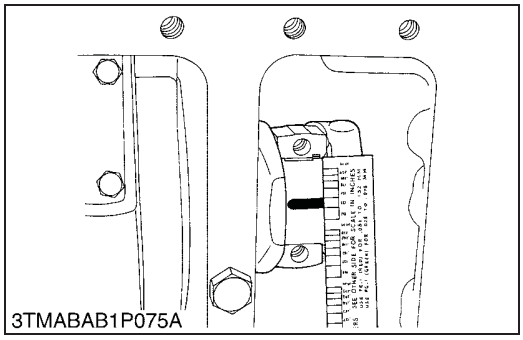

3EEABAB1P147A

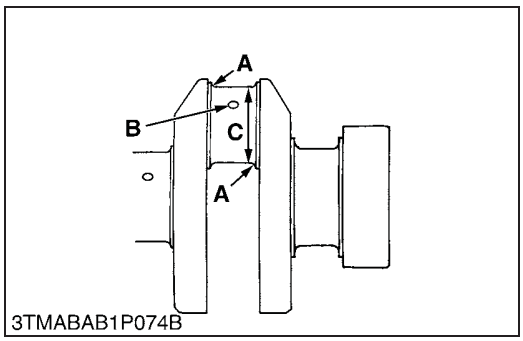
Crankshaft Alignment

1. Support the crankshaft with V blocks on the surface plate at both end journals.
2. Set a dial indicator with its tip on the intermediate journal.
3. Measure the crankshaft alignment.
4. If the measurement exceeds the allowable limit, replace the crankshaft.

Crankshaft alignment	Allowable limit	0.02 mm 0.0008 in.

W1033001


3TMABAB1P075A



3TMABAB1P074B

Oil Clearance between Crankpin and Crankpin Bearing

1. Clean the crankpin and crankpin bearing.
2. Put a strip of plastigage on the center of the crankpin.
3. Install the connecting rod cap and tighten the connecting rod screws to the specified torque, and remove the cap again.
4. Measure the amount of the flattening with the scale, and get the oil clearance.
5. If the oil clearance exceeds the allowable limit, replace the crankpin bearing.
6. If the same size bearing is useless because of the crankpin wear, replace it with an undersize one referring to the table and figure.

■ **NOTE**

- **Never insert the plastigage into the crankpin oil hole.**
- **Be sure not to move the crankshaft while the connecting rod screws are tightened.**

Oil clearance between crankpin and crankpin bearing	Factory spec.	0.025 to 0.087 mm 0.00099 to 0.0034 in.
	Allowable limit	0.20 mm 0.0079 in.

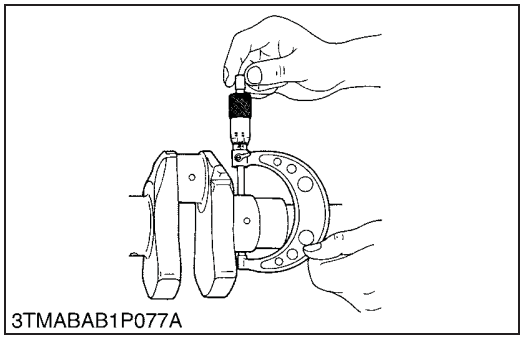
Crankpin O.D.	Factory spec.	46.959 to 46.975 mm 1.8488 to 1.8494 in.
Crankpin bearing I.D.	Factory spec.	47.000 to 47.046 mm 1.8504 to 1.8522 in.

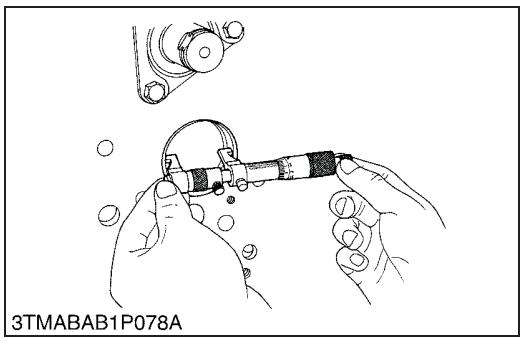
(Reference)

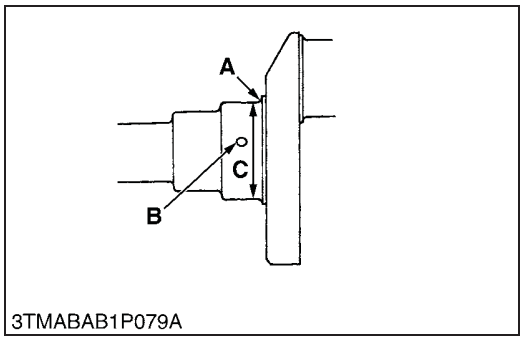
- Undersize dimensions of crankpin

Undersize	0.2 mm 0.008 in.	0.4 mm 0.02 in.
Dimension **A**	3.3 to 3.7 mm radius 0.13 to 0.14 in. radius	3.3 to 3.7 mm radius 0.13 to 0.14 in. radius
*Dimension **B**	1.0 to 1.5 mm relief 0.040 to 0.059 in. relief	1.0 to 1.5 mm relief 0.040 to 0.059 in. relief
Dimension **C**	46.759 to 46.775 mm dia. 1.8409 to 1.8415 in. dia.	46.559 to 46.575 mm dia. 1.8331 to 1.8336 in. dia.
(0.4S) The crankpin must be fine-finished to higher than ∇∇∇∇ *Holes to be de-burred and edges rounded with 1.0 to 1.5 mm (0.040 to 0.059 in.) relief.		

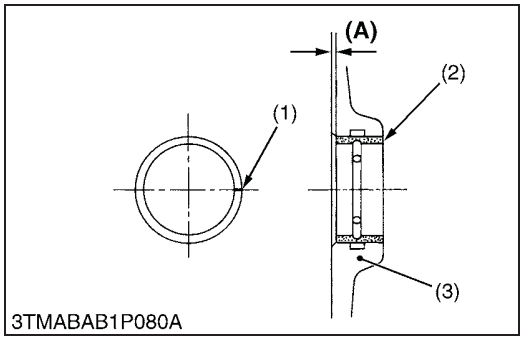
W1033106


3TMABAB1P077A


3TMABAB1P078A



3TMABAB1P079A



3TMABAB1P080A

Oil Clearance between Crankshaft Journal and Crankshaft Bearing 1

1. Measure the O.D. of the crankshaft journal with an outside micrometer.
2. Measure the I.D. of the crankshaft bearing 1 with an inside micrometer, and calculate oil clearance.
3. If the clearance exceeds the allowable limit, replace the crankshaft bearing 1.
4. If the same size bearing is useless because of the crankshaft journal wear, replace it with an undersize one referring to the table and figure.

Oil clearance between crankshaft journal and crankshaft bearing 1	Factory spec.	0.0400 to 0.118 mm 0.00158 to 0.00464 in.
	Allowable limit	0.20 mm 0.0079 in.

Crankshaft journal O.D.	Factory spec.	59.921 to 59.940 mm 2.3591 to 2.3598 in.
Crankshaft bearing 1 I.D.	Factory spec.	59.980 to 60.039 mm 2.3615 to 2.3637 in.

(Reference)

- Undersize dimensions of crankshaft journal

Undersize	0.2 mm 0.008 in.	0.4 mm 0.02 in.
Dimension **A**	2.8 to 3.2 mm radius 0.11 to 0.12 in. radius	2.8 to 3.2 mm radius 0.11 to 0.12 in. radius
*Dimension **B**	1.0 to 1.5 mm relief 0.040 to 0.059 in. relief	1.0 to 1.5 mm relief 0.040 to 0.059 in. relief
Dimension **C**	59.721 to 59.740 mm dia. 2.3513 to 2.3519 in. dia.	59.521 to 59.540 mm dia. 2.3434 to 2.3440 in. dia.
(0.4S) The crankshaft journal must be fine-finished to higher than ▽▽▽▽ *Holes to be de-burred and edges rounded with 1.0 to 1.5 mm (0.040 to 0.059 in.) relief.		

W1033717

Replacing Crankshaft Bearing 1

(When removing)

1. Press out the used crankshaft bearing 1 using a crankshaft bearing 1 replacing tool. (See page **"SPECIAL TOOLS"**.)

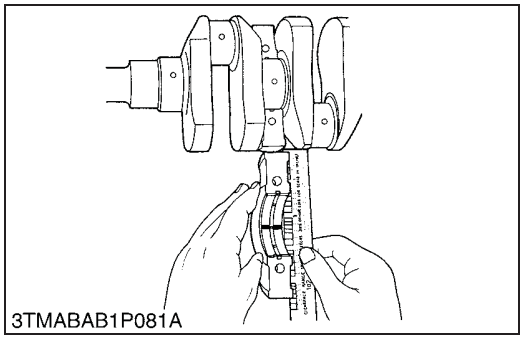
(When installing)

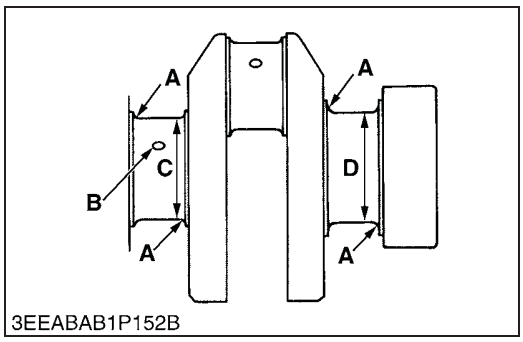
1. Clean a new crankshaft bearing 1 and crankshaft journal bore, and apply engine oil to them.
2. Using a crankshaft bearing 1 replacing tool, press in a new bearing 1 (2) so that its seam (1) directs toward the exhaust manifold side. (See figure.)

Dimension **(A)**	Factory spec.	4.20 to 4.50 mm 0.166 to 0.177 in.

(1) Seam
(2) Crankshaft Bearing 1
(3) Cylinder Block
(A) Dimension

W1033946


3TMABAB1P081A



3EEABAB1P152B

Oil Clearance between Crankshaft Journal and Crankshaft Bearing 2

1. Put a strip of plastigage on the center of the journal.
2. Install the bearing case and tighten the baring case screws 1 to the specified torque, and remove the bearing case again.
3. Measure the amount of the flattening with the scale and get the oil clearance.
4. If the clearance exceeds the allowable limit, replace the crankshaft bearing 2.
5. If the same size bearing is useless because of the crankshaft journal wear, replace it with an undersize one referring to the table and figure.

■ **NOTE**

- **Be sure not to move the crankshaft while the bearing case screws are tightened.**

Oil clearance between crankshaft and crankshaft bearing 2	Factory spec.	0.0400 to 0.104 mm 0.00158 to 0.00409 in.
	Allowable limit	0.20 mm 0.0079 in.

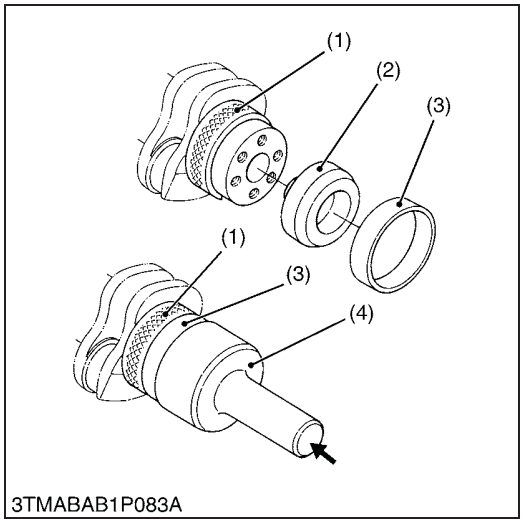
Crankshaft journal O.D.	Factory spec.	59.921 to 59.940 mm 2.3591 to 2.3598 in.
Crankshaft bearing 2 I.D.	Factory spec.	59.980 to 60.025 mm 2.3615 to 2.3631 in.

(Reference)

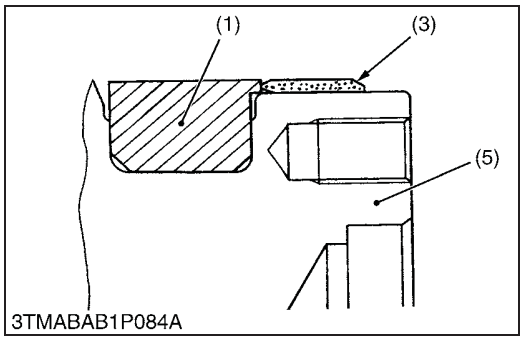
- Undersize dimensions of crankshaft journal

Undersize	0.2 mm 0.008 in.	0.4 mm 0.02 in.
Dimension **A**	2.8 to 3.2 mm radius 0.11 to 0.12 in. radius	2.8 to 3.2 mm radius 0.11 to 0.12 in. radius
*Dimension **B**	1.0 to 1.5 mm relief 0.040 to 0.059 in. relief	1.0 to 1.5 mm relief 0.040 to 0.059 in. relief
Dimension **C, D**	59.721 to 59.740 mm dia. 2.3513 to 2.3519 in. dia.	59.521 to 59.540 mm dia. 2.3434 to 2.3440 in. dia.
The crankshaft journal must be fine-finished to higher than ▽▽▽▽ (0.4S) *Holes to be de-burred and edges rounded with 1.0 to 1.5 mm (0.040 to 0.059 in.) relief.		

W1083821



3TMABAB1P083A



3TMABAB1P084A

Replacing Crankshaft Sleeve

1. Remove the used crankshaft sleeve (3).
2. Set the sleeve guide (2) to the crankshaft (5).
3. Set the stopper (1) to the crankshaft (5) as shown in figure.
4. Heat a new sleeve to a temperature between 150 and 200 °C (302 and 392 °F), and fix the sleeve to the crankshaft (5) as shown in figure.
5. Press fit the sleeve using the auxiliary socket for pushing (4). (Refer to **"SPECIAL TOOLS"**.)

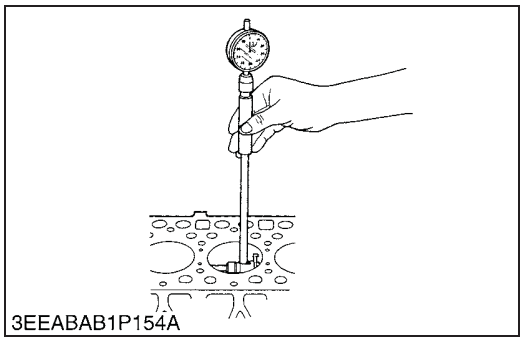
■ **NOTE**

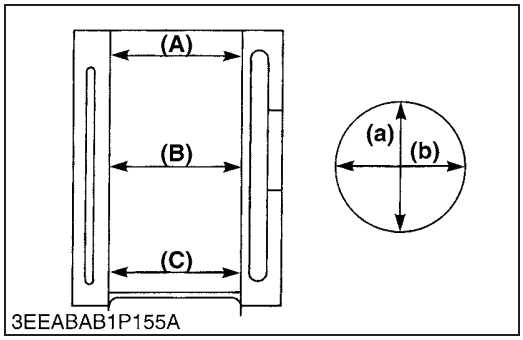
- **Mount the sleeve with its largely chamfered surface facing outward.**
- **Should heating is not enough, a sleeve might stop halfway, so careful.**

(1) Stopper
(2) Sleeve Guide
(3) Crankshaft Sleeve
(4) Auxiliary Socket for Pushing
(5) Crankshaft

W1033503

(5) Cylinder


3EEABAB1P154A



3EEABAB1P155A

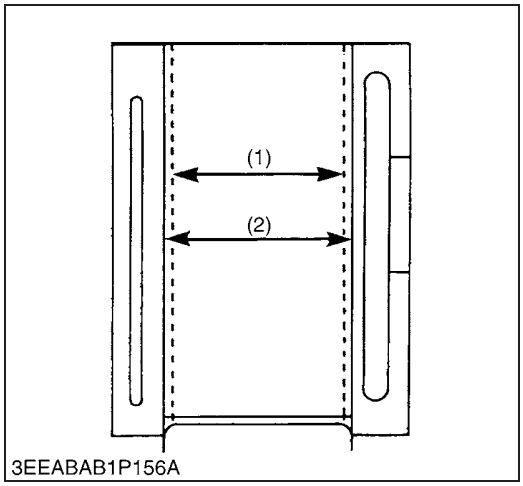
Cylinder Wear

1. Measure the I.D. of the cylinder at the six positions (see figure) with a cylinder gauge to find the maximum and minimum I.D.'s.
2. Get the difference (Maximum wear) between the maximum and the minimum I.D.'s.
3. If the wear exceeds the allowable limit, bore and hone to the oversize dimension. (Refer to **"Correcting Cylinder"**.)
4. Visually check the cylinder wall for scratches. If deep scratches are found, the cylinder should be bored. (Refer to **"Correcting Cylinder"**.)

Cylinder I.D.	Factory spec.	D1503-M V2003-M V2003-M-BG V2003-M-T-BG	83.000 to 83.022 mm 3.2678 to 3.2685 in.
		D1703-M D1803-M V2203-M V2403-M V2403-M-T D1803-M-DI V2403-M-DI V2403-M-DI-T D1703-M-BG V2203-M-BG V2403-M-BG	87.000 to 87.022 mm 3.4252 to 3.4260 in.
	Allowable limit	D1503-M V2003-M V2003-M-BG V2003-M-T-BG	83.170 mm 3.2744 in.
		D1703-M D1803-M V2203-M V2403-M V2403-M-T D1803-M-DI V2403-M-DI V2403-M-DI-T D1703-M-BG V2203-M-BG V2403-M-BG	87.170 mm 3.4319 in.

A : Top
B : Middle
C : Bottom (Skirt)
(a) Right-angled to Piston Pin
(b) Piston Pin Direction

W1034389



Correcting Cylinder (Oversize)

1. When the cylinder is worn beyond the allowable limit, bore and hone it to the specified dimension.

Oversize cylinder I.D.	Factory spec.	D1503-M V2003-M V2003-M-BG V2003-M-T-BG	83.250 to 83.272 mm 3.2776 to 3.2784 in.
		D1703-M D1803-M V2203-M V2403-M V2403-M-T D1803-M-DI V2403-M-DI V2403-M-DI-T D1703-M-BG V2203-M-BG V2403-M-BG	87.250 to 87.272 mm 3.4351 to 3.4359 in.
	Allowable limit	D1503-M V2003-M V2003-M-BG V2003-M-T-BG	83.420 mm 3.2843 in.
		D1703-M D1803-M V2203-M V2403-M V2403-M-T D1803-M-DI V2403-M-DI V2403-M-DI-T D1703-M-BG V2203-M-BG V2403-M-BG	87.420 mm 3.4417 in.
Finishing	Hone to 2.2 to 3.0 μmRz (0.000087 to 0.000118 in.Rz) ∇∇∇.		

2. Replace the piston and piston rings with oversize ones.
   Oversize : 0.25 mm (0.0098 in.)

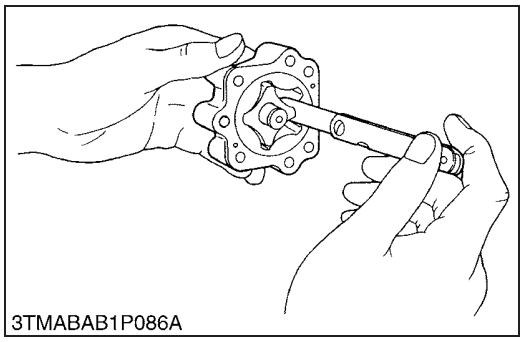
■ **NOTE**

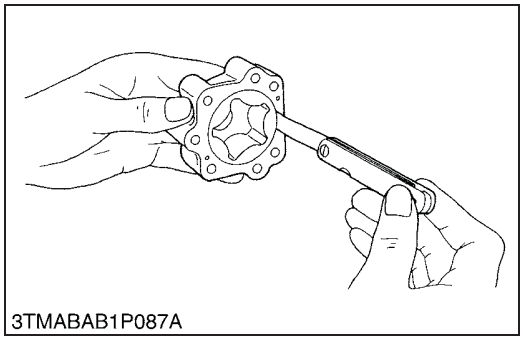
- **When the oversize cylinder is worn beyond the allowable limit, replace the cylinder block with a new one.**

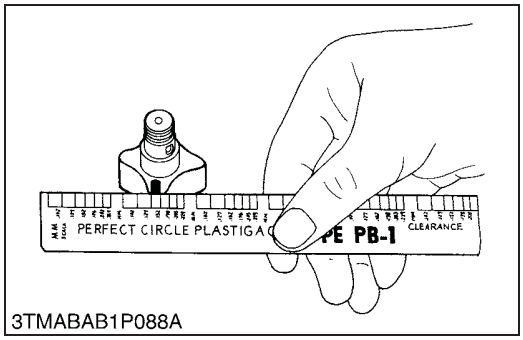
(1) Cylinder I.D. (Before Correction) (2) Cylinder I.D. (Oversize)

W1034448

(6) Oil Pump


3TMABAB1P086A


3TMABAB1P087A



3TMABAB1P088A

Rotor Lobe Clearance

1. Measure the clearance between lobes of the inner rotor and the outer rotor with a feeler gauge.
2. Measure the clearance between the outer rotor and the pump body with a feeler gauge.
3. If the clearance exceeds the factory specifications, replace the oil pump rotor assembly.

Clearance between inner rotor and outer rotor	Factory spec.	0.030 to 0.14 mm 0.0012 to 0.0055 in.
	Allowable limit	0.2 mm 0.008 in.

Clearance between outer rotor and pump body	Factory spec.	0.11 to 0.19 mm 0.0044 to 0.0074 in.
	Allowable limit	0.25 mm 0.0098 in.

W1035296

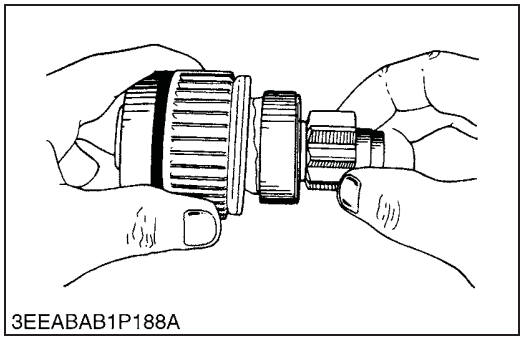
Clearance between Rotor and Cover

1. Put a strip of plastigage onto the rotor face with grease.
2. Install the cover and tighten the screws.
3. Remove the cover carefully, and measure the width of the press gauge with a sheet of gauge.
4. If the clearance exceeds the factory specifications, replace oil pump rotor assembly.

Clearance between inner rotor and cover	Factory spec.	0.105 to 0.150 mm 0.00414 to 0.00590 in.
	Allowable limit	0.20 mm 0.008 in.

W1035444

(7) Starter


3EEABAB1P188A

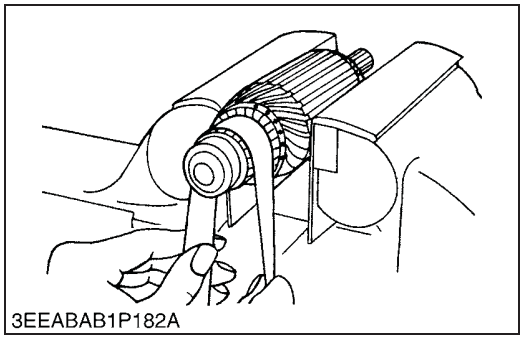
Overrunning Clutch

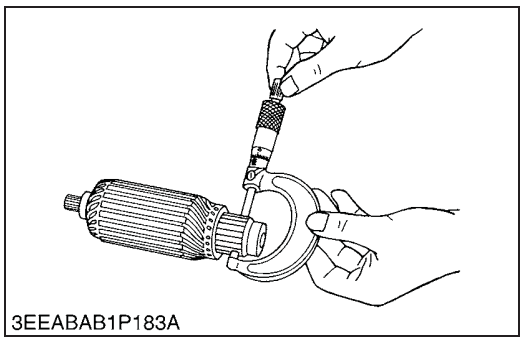
1. Check the pinion and if worn or damage, replace the clutch assembly.
2. Check that the pinion turns freely and smoothly in the overrunning direction and does not slip in the cranking direction.
3. If the pinion slips or does not turn in both directions, replace the overrunning clutch assembly.

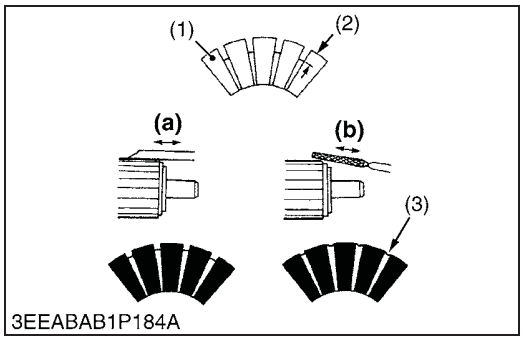
■ **NOTE**

- **Do not wash off the grease in the overrunning clutch with the chemicals or oils.**

W1156799


3EEABAB1P182A


3EEABAB1P183A



3EEABAB1P184A

Commutator and Mica

1. Check the contact of the commutator for wear, and grind the commutator with emery paper if it is slightly worn.
2. Measure the commutator O.D. with an outside micrometer at several points.
3. If the minimum O.D. is less than the allowable limit, replace the armature.
4. If the difference of the O.D.'s exceeds the allowable limit, correct the commutator on a lathe to the factory specification.
5. Measure the mica undercut.
6. If the undercut is less than the allowable limit, correct it with a saw blade and chamfer the segment edges.

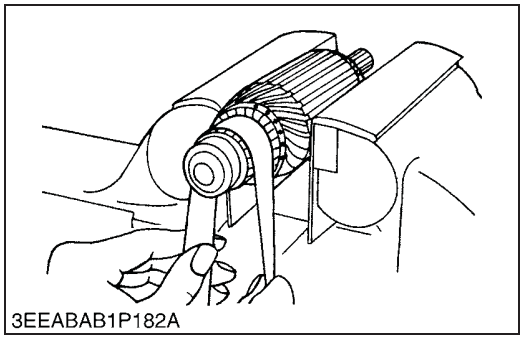
Commutator O.D.	Factory spec.	D1503-M D1703-M V2003-M V2203-M D1803-M-DI D1703-M-BG V2003-M-BG V2003-M-T-BG V2203-M-BG	30.0 mm 1.18 in.
		D1803-M V2403-M V2403-M-T V2403-M-DI V2403-M-DI-T V2403-M-BG	35.0 mm 1.38 in.
	Allowable limit	D1503-M D1703-M V2003-M V2203-M D1803-M-DI D1703-M-BG V2003-M-BG V2003-M-T-BG V2203-M-BG	29.0 mm 1.14 in.
		D1803-M V2403-M V2403-M-T V2403-M-DI V2403-M-DI-T V2403-M-BG	34.0 mm 1.34 in.

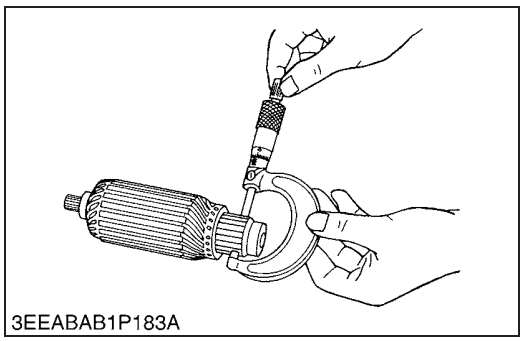
Difference of O.D.'s	Factory spec.	Less than 0.02 mm 0.0008 in.
	Allowable limit	0.05 mm 0.002 in.

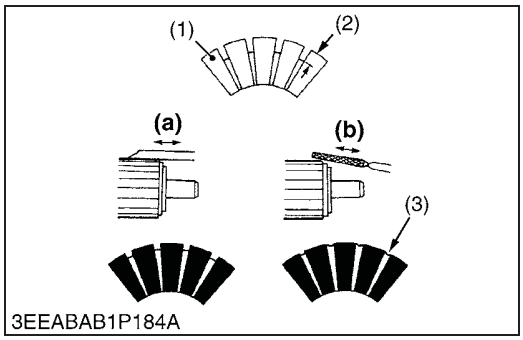
(1) Segment
(2) Depth of Mica
(3) Mica

(a) Correct
(b) Incorrect

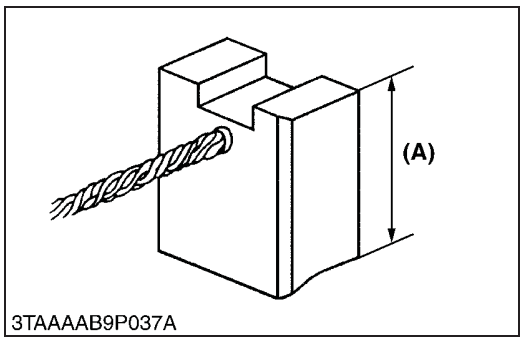
W1112444


3EEABAB1P182A


3EEABAB1P183A



3EEABAB1P184A



3TAAAAB9P037A

Commutator and Mica (Continued)

1. Check the contact of the commutator for wear, and grind the commutator with emery paper if it is slightly worn.
2. Measure the commutator O.D. with an outside micrometer at several points.
3. If the minimum O.D. is less than the allowable limit, replace the armature.
4. If the difference of the O.D.'s exceeds the allowable limit, correct the commutator on a lathe to the factory specification.
5. Measure the mica undercut.
6. If the undercut is less than the allowable limit, correct it with a saw blade and chamfer the segment edges.

Mica under cut	Factory spec.	D1503-M D1703-M D1803-M V2003-M V2203-M V2403-M V2403-M-T D1803-M-DI V2403-M-DI V2403-M-DI-T D1703-M-BG V2003-M-BG V2003-M-T-BG V2203-M-BG	0.45 to 0.75 mm 0.018 to 0.029 in.
		V2403-M-BG	0.55 to 0.85 mm 0.022 to 0.033 in.
	Allowable limit		0.20 mm 0.0079 in.

(1) Segment
(2) Depth of Mica
(3) Mica

(a) Correct
(b) Incorrect

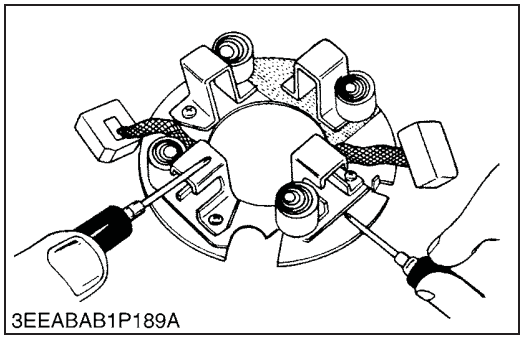
W1155802

Brush Wear

1. If the contact face of the brush is dirty or dusty, clean it with emery paper.
2. Measure the brush length **(A)** with vernier caliper.
3. If the length is less than the allowable limit, replace the yoke assembly and brush holder.

Brush length **(A)**	Factory spec.		15.0 mm 0.591 in.
	Allowable limit	D1503-M D1703-M V2003-M V2203-M D1803-M-DI D1703-M-BG V2003-M-BG V2003-M-T-BG V2203-M-BG	11.0 mm 0.433 in.
		D1803-M V2403-M V2403-M-T V2403-M-DI V2403-M-DI-T	9.0 mm 0.35 in.
		V2403-M-BG	12.0 mm 0.472 in.

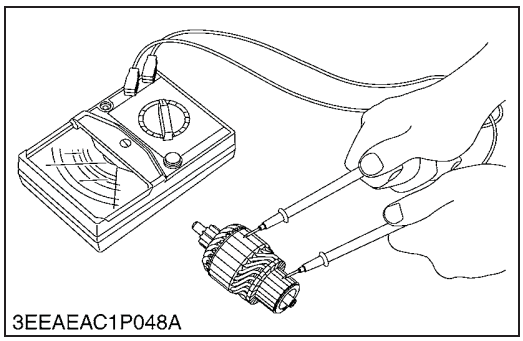
W1156360


3EEABAB1P189A

Brush Holder

1. Check the continuity across the brush holder and the holder support with a circuit tester.
2. If it conducts, replace the brush holder.

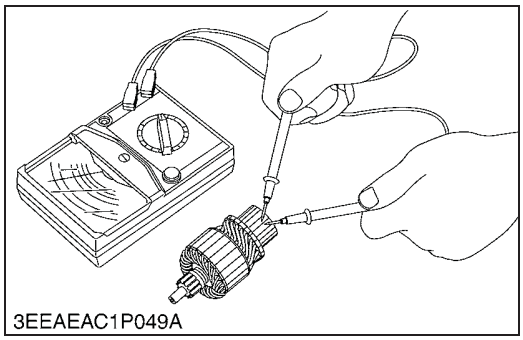
W1156895

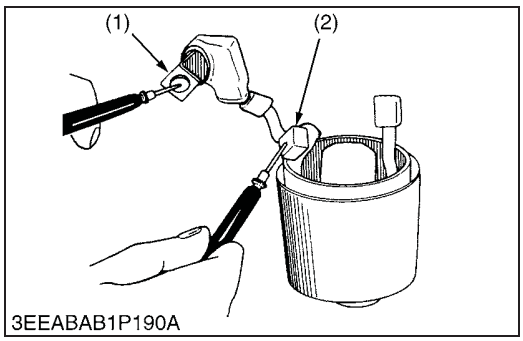

3EEAEAC1P048A

Armature Coil

1. Check the continuity across the commutator and armature coil core with resistance range of circuit tester.
2. If it conducts, replace the armature.
3. Check the continuity across the segments of the commutator with resistance range of circuit tester.
4. If it does not conduct, replace the armature.

W1156507


3EEAEAC1P049A



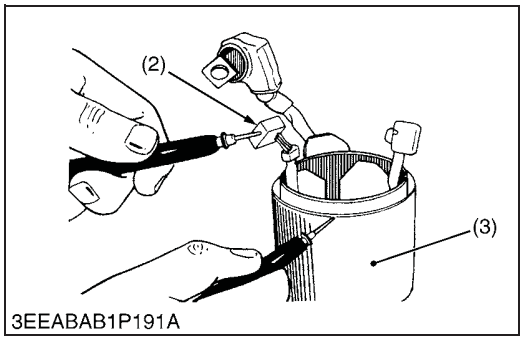
3EEABAB1P190A

Field Coil

1. Check the continuity across the lead (1) and brush (2) with a circuit tester.
2. If it does not conduct, replace the yoke assembly.
3. Check the continuity across the brush (2) and yoke (3) with a circuit tester.
4. If it conducts, replace the yoke assembly.

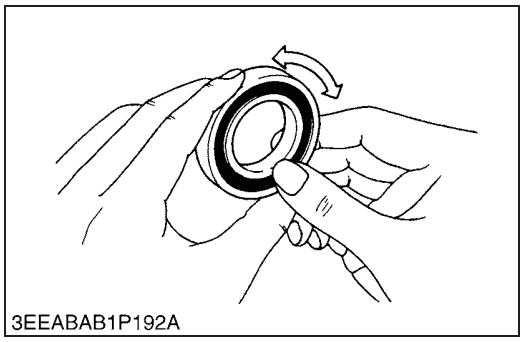
(1) Lead
(2) Bush
(3) Yoke

W1156968



3EEABAB1P191A

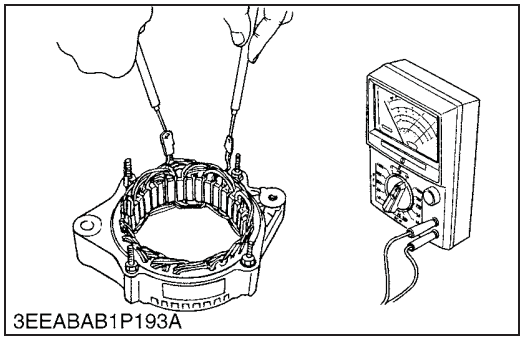
(8) Alternator


3EEABAB1P192A

Bearing

1. Check the bearing for smooth rotation.
2. If it does not rotate smoothly, replace it.

W1019790

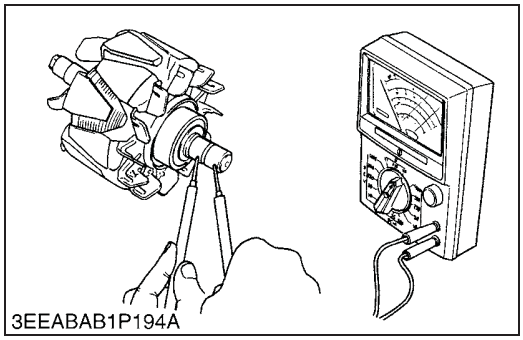

3EEABAB1P193A

Stator

1. Measure the resistance across each lead of the stator coil with resistance range of circuit tester.
2. If the measurement is not within factory specification, replace it.
3. Check the continuity across each stator coil lead and core with resistance range of circuit tester.
4. If infinity is not indicated, replace it.

Resistance	Factory spec.	Less than 1.0 Ω

W1019964

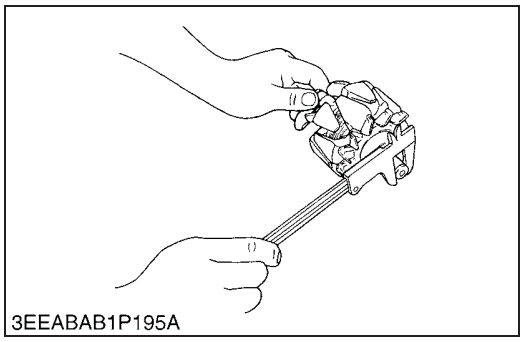

3EEABAB1P194A

Rotor

1. Measure the resistance across the slip rings.
2. If the resistance is not the factory specification, replace it.
3. Check the continuity across the slip ring and core with resistance range of circuit tester.
4. If infinity is not indicated, replace it.

Resistance	Factory spec.	2.9 Ω

W1020094

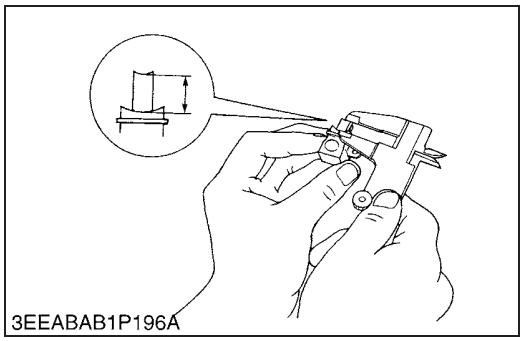

3EEABAB1P195A

Slip Ring

1. Check the slip ring for score.
2. If scored, correct with an emery paper or on a lathe.
3. Measure the O.D. of slip ring with vernier calipers.
4. If the measurement is less than the allowable limit, replace it.

Slip ring O.D.	Factory spec.	14.4 mm 0.567 in.
	Allowable limit	14.0 mm 0.551 in.

W1020208

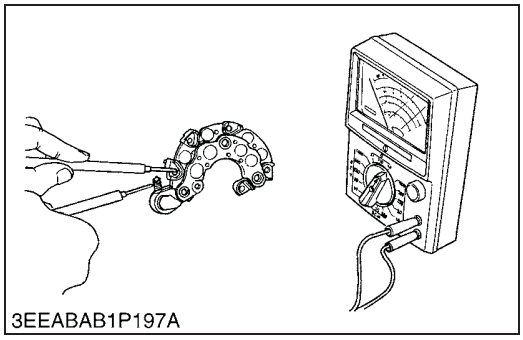

3EEABAB1P196A

Brush Wear

1. Measure the brush length with vernier calipers.
2. If the measurement is less than allowable limit, replace it.
3. Make sure that the brush moves smoothly.
4. If the brush is defective, replace it.

Brush length	Factory spec.	10.5 mm 0.413 in.
	Allowable limit	8.4 mm 0.33 in.

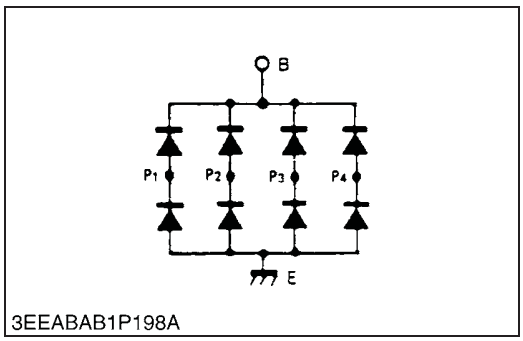
W1020329


3EEABAB1P197A

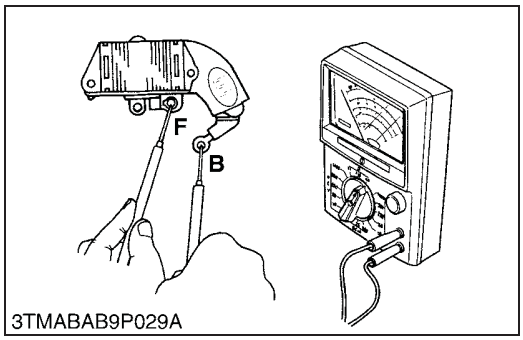
Rectifier

1. Check the continuity across each diode of rectifier with resistance range of circuit tester.
2. The rectifier is normal if the diode in the rectifier conducts in one direction and does not conduct in the reverse direction.

W1020452



3EEABAB1P198A



3TMABAB9P029A

IC Regulator

1. Check the continuity across the **B** terminal (2) and the **F** terminal (1) of IC regulator with resistance range of circuit tester.
2. The IC regulator is normal if the conducts in one direction and does not conduct in the reverse direction.

(1) **F** Terminal (2) **B** Terminal

W1020645

IV. HYDRAULIC SYSTEM

Mechanism Section

(A) FEATURES OF HYDRAULIC SYSTEM IV-M-3
(B) HYDRAULIC PUMP IV-M-5
(C) CONTROL VALVE IV-M-13
a) Specifications IV-M-13
b) Main Spool's Max. Flow Amount IV-M-16
c) Overall View IV-M-17
d) Control Valve Inner Parts IV-M-19
e) Control Valve Section Cutaway IV-M-21
f) Control Valve Assy IV-M-22
g) Load Sensing Type Hydraulic Pump Operating Principle IV-M-27
h) Operating Principle IV-M-40
i) Boom Anti-drift Valve IV-M-48
j) Automatic Air Bleeding in Hydraulic Pilot Section IV-M-53
k) Relief Valve/Anti-cavitation Valve IV-M-54
(D) HYDRAULIC SYSTEM MODIFICATION IV-M-55
a) Outline IV-M-55
b) Hydraulic Pump IV-M-56
c) Accumulator IV-M-59
d) Hydraulic System Line IV-M-61
(E) TRAVEL MOTOR IV-M-65
a) Traveling Performance Specifications IV-M-65
b) Structure IV-M-67
c) Operation of Piston Motor IV-M-76
d) Function of Anti-cavitation Valve IV-M-77
e) Travel Motor Minor Change IV-M-83
(F) SWIVEL MOTOR IV-M-85
a) Swivel Performance Specifications IV-M-85
b) Structure IV-M-86
c) Function of Negative Brake IV-M-92
d) Function of Valve Section IV-M-93
(G) ROTARY JOINT (SWIVEL JOINT) IV-M-95
(H) PILOT VALVE IV-M-97
a) Structure & Specifications IV-M-97
b) Pilot Valve Control Diagram IV-M-101
c) Hydraulic Circuit Diagram Symbol IV-M-102
d) Hydraulic Components Layout IV-M-116

(A) FEATURES OF HYDRAULIC SYSTEM

No.	Function	Detail
1	Higher hydraulic pressure. (250 k on P1 and P2 only) (About 120% higher than ever before)	The powerful hydraulic system (with higher relief pressure) provides the following good points in terms of the power (size) and speed (flow rate) required. 1. Smaller actuators (boom, arm, bucket cylinder and travel motor) 2. Smaller pump and control valve and improved heat balance (passage pressure loss) thanks to low flow rate. Which in turn contribute to the advantages below. 3. Right-side centralized arrangement of hydraulic equipment 4. Improved stability (lighter-weight attachment cylinder) 5. Total hydraulic cost cutting, and others.
2	Redesigned boom anti-drift valve.	The minimum boom down speed can be controlled by the main spool, which helps inch the attachment more finely. (On conventional types, the inching is limited by the drain circuit's minimum leak amount.)
3	Straight travel circuit adopted.	In traveling and moving the front attachment at once, the third pump's flow rate serves to control the attachment. This circuit is activated once the machine travels to the right or left and the front attachment is moved.
4	Reduced shock at a stop of upcoming boom.	The control valve's main spool works to make fine-tuning. (The boom up/slow-return throttle and the pilot valve (boom down) primary-pressure shortcut are left out.)
5	Pilot valve (Kawasaki-made) redesigned.	The vertical stroke is made greater from 5.2 mm to 6.4 mm (to eliminate jerking at vertical rotation). The secondary pressure is also made higher from 19.5 kgf/cm^2 to 27.0 kgf/cm^2 for improved controllability.
6	Swivel negative brake and planetary single-step reduction gear adopted.	Release the lever lock, and the negative brake gets activated to keep the parked machine even on a slope. The number of reduction gearing parts has been cut down, and the cylinder block is commonly used.
7	Filter added to swivel make-up circuit.	An 80-mesh filter has been additionally mounted at the swivel make-up port adaptor to keep clean the make-up check valve in the motor.
8	Travel motor swash plate reconfigured and travel bi-speed circuit redesigned.	Simpler structure and better function.
9	Hydraulic equipment back pressures reduced.	The circuitry is configured to keep the travel motor, swivel motor, pilot valve and other related devices nearly free from back pressure. The pilot valve push-rod sealing effect in particular is highly expected.
10	Brand-new change valve introduced (lever lock and bi-speed travel).	Cost cutting advantage.

(11) Arm regeneration
(12) Variable displacement pump
(13) Priority throttle of boom-bucket simultaneous operation
(14) Check valve for swivel anti-cavitation
(15) Auto idle version: Machines bigger than 3.0 ton

(B) HYDRAULIC PUMP

1. Specifications of pump

Model: PSVL-54CG (KX161-3S/α, U45S, U45-3S/α, U50-3α)

Item			Specifications	Remarks
Basic spec.	Displacement	Piston pump	13.0 ~ 54.0 cm^3/rev (0.79 ~ 3.30 cu.in)	
		Gear pump	-	
		Pilot pump	4.0 cm^3/rev (0.24)	Gear pump
	Direction of rotation		Right (Clockwise)	As seen from the shaft
	Pilot relief set press		3.9 MPa (565.7 psi) (39.8 kgf/cm^2)	
	Drain pressure		Less than 0.098 MPa	
	Section press		-0.04 ~ 0.07 MPa	HYD. oil: VG46, HYD. oil temp: 50 °C, 2450 rpm
	Filter		10 μm equivalent	
	Strainer		150 mesh	
	HYD. contamination classes		Within NAS 9	
Customer spec.	Engine horse power	KX161-3α, U45-3α, U50-3α	28.7 / 29.4 kw	
		KX161-3S	34.6 kw (Gross)	
	Shaft speed	KX161-3α, U45-3α, U50-3α	1000 ~ 2250 rpm Max. unloaded: less than 2450 rpm	
		KX161-3S	1000 ~ 2200 rpm Max. unloaded: less than 2450 rpm	
	Max. working Pressure	Piston pump	24.5 MPa (249.8 kgf/cm^2) (3.55 x 10^3 psi)	Piston pump pressure: P
		Gear pump	-	
		Pilot pump	4.12 MPa (42.0 kgf/cm^2) (597.6 psi)	Pilot pump pressure: P_p
	Max. pump flow	Piston pump	118.8 (121.5) LPM (31.4 (32.1) GPM)	at 2200 (2250) rpm
		Gear pump	-	
		Pilot pump	8.8 (9.0) LPM (2.33 (2.38) GPM)	at 2200 (2250) rpm
	Max. input torque	KX161-3α, U45-3α, U50-3α	108.0 (108.0) N·m	at 2200 (2250) rpm
		KX161-3S	118.0 N·m	at 2200 rpm
	HYD. oil		Oaphny super hydro 46 Shell terras K46	VG46 equivalent
	Hydraulic oil temperature at tank		Ordinary use: -10 ~ +80°C	
			Short time use: -20 ~ +90°C	
	Drive system		Input shaft: Direct drive	No radial load
General spec.	All efficiency (Typical value)		79%	VG46, 50 °C, 2200 rpm, 13.7 MPa
	Control method		Power constant control Load sensing control	Proportional LS control pressure
	Horse power setting		24.8 kw	at 2200 rpm
	Max. pump flow (Piston pump)		118.8 ± 2.5 L/min	VG46, 50 °C, 2200 rpm, P=Min.
	Max. input torque		105.1 ~ 108.0 N·m	at 2200 rpm
	Pilot pump flow		More than 8.0 L/min	VG46, 50 °C, 2200 rpm, P_0=4.12 MPa
	LS control pressure		1.45 ± 0.05 MPa	VG46, 50 °C, 2200 rpm, P_{LS}=9.8 MPa
	Proportional LS control pressure		118.8 ± 2.5 LPM (at 2250 rpm) 71.3 ± 7 LPM (at 1000 rpm)	VG46, 50 °C, P_{LS}=9.8 MPa
	Stand-by flow amount		12.4 cc/rev x N (rpm): at 1000 rpm = 12.4 LPM at 1500 rpm = 18.6 LPM at 2000 rpm = 29.8 LPM	

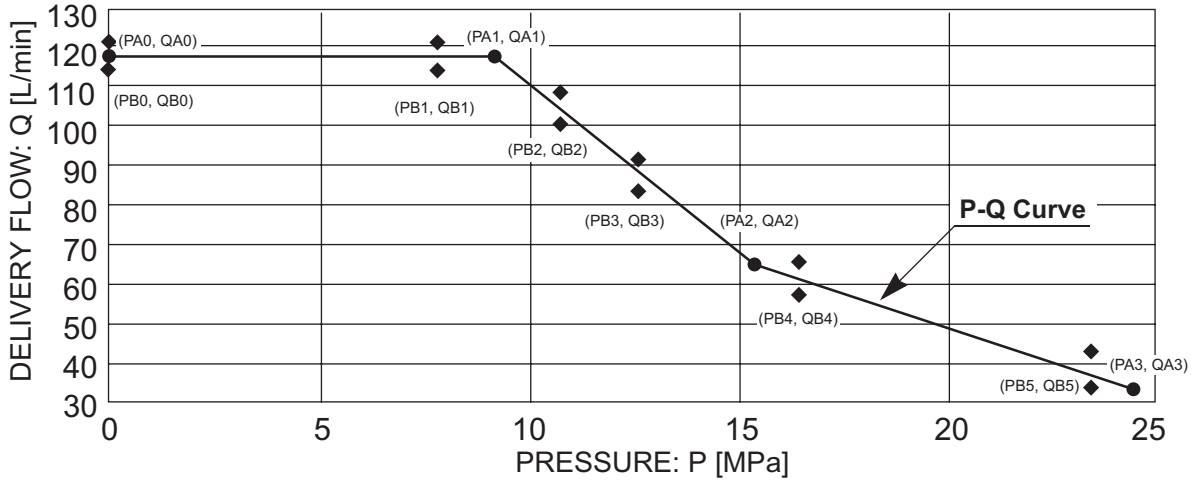
Model: PSVL-54CG (KX161-3S, U45ST, U45-3ST)

Item			KX161-3ST	U45ST, U45-3ST	Remarks
Basic spec.	Displacement	Piston pump	12.4 ~ 51.7 cm^3/rev	13.0 ~ 54.0 cm^3/rev	
		Gear pump	-	-	
		Pilot pump	4.0 cm^3/rev	4.0 cm^3/rev	
	Direction of rotation		Right (Clockwise)	Right (Clockwise)	
	Pilot relief set press		-	-	
	Drain pressure		Less than 0.098 MPa	Less than 0.098 MPa	
	Section press		-0.04 ~ 0.07 MPa	-0.04 ~ 0.07 MPa	
	Filter		10 μm equivalent	10 μm equivalent	
	Strainer		150 mesh	150 mesh	
	HYD. contamination classes		Within NAS 9	Within NAS 9	
Customer spec.	Engine horse power		kw	kw	
	Shaft speed		~ 2300 rpm Max. unloaded: less than 2450 rpm	~ 2250 rpm Max. unloaded: less than 2450 rpm	
	Max. working Pressure	Piston pump	24.5 MPa	24.5 MPa	
		Gear pump	-	-	
		Pilot pump	4.12 MPa	4.12 MPa	
	Max. pump flow	Piston pump	118.9 L/min	118.8(121.5) L/min	
		Gear pump	-	-	
		Pilot pump	9.2 L/min	8.8(9.0) L/min	
	Max. input torque		115.0 N·m	105.0(105.0) N·m	
	HYD. oil				
	Hydraulic oil temperature at tank		Ordinary use: -10 ~ +80°C	Ordinary use: -10 ~ +80°C	
			Short time use: -20 ~ +90°C	Short time use: -20 ~ +90°C	
General spec.	All efficiency (Typical value)		79%	79%	
	Control method		Power constant control Load sensing control	Power constant control Load sensing control	
	Horse power setting		27.7 kw	24.2 kw	
	Max. pump flow (Piston pump)		118.9 ± 2.5 L/min	118.8 ± 2.5 L/min	
	Max. input torque		112.1 ~ 115.0 N·m	102.1 ~ 105.0 N·m	
	Pilot pump flow		More than 8.0 L/min	More than 8.0 L/min	
	LS control flow		Q_{LS} = 53.0 ± 0.4 L/min	Q_{LS} = 50.8 ± 0.4 L/min	
	Proportional LS control flow		Q_{LS} (at 2300 rpm) Q_{LS} X (60% ± 10%)(at 1000 rpm)	Q_{LS} (at 2200 rpm) Q_{LS} X (60% ± 10%)(at 1000 rpm)	

Model: PSVL-42CG (KX121-3S/α, KX121-3ST)

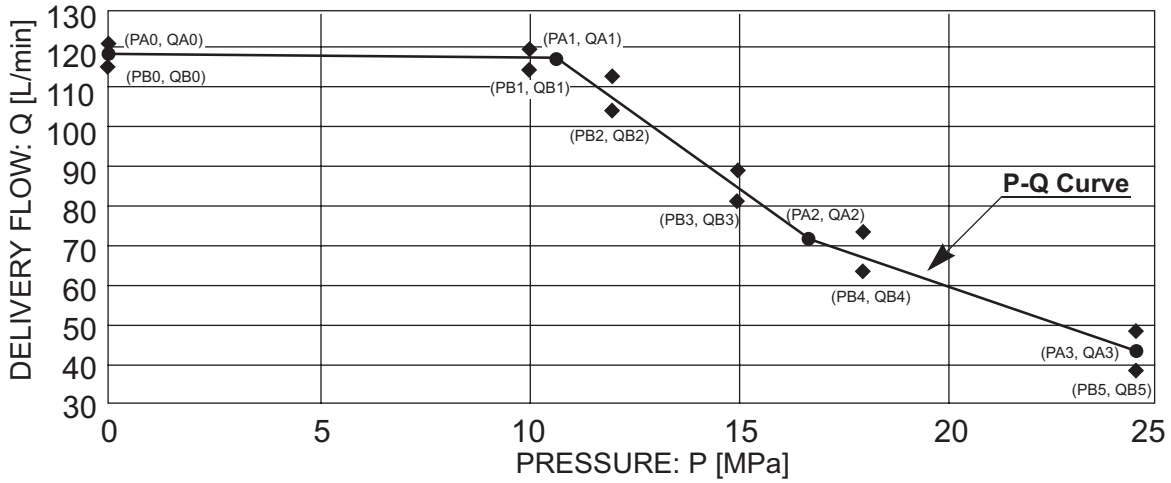
Item			KX121-3S/α	KX121-3ST	Remarks
Basic spec.	Displacement	Piston pump	10.0 ~ 42.0 cm^3/rev	10.0 ~ 42.0 cm^3/rev	
		Gear pump	-	-	
		Pilot pump	4.0 cm^3/rev	4.0 cm^3/rev	
	Direction of rotation		Right (Clockwise)	Right (Clockwise)	
	Pilot relief set press		-	-	
	Drain pressure		Less than 0.098 MPa	Less than 0.098 MPa	
	Section press		-0.04 ~ 0.07 MPa	-0.04 ~ 0.07 MPa	
	Filter		10 μm equivalent	10 μm equivalent	
	Strainer		150 mesh	150 mesh	
	HYD. contamination classes		Within NAS 9	Within NAS 9	
Customer spec.	Engine horse power		kw	kw	
	Shaft speed		~ 2200 rpm Max. unloaded: less than 2450 rpm	~ 2200 rpm Max. unloaded: less than 2450 rpm	
	Max. working Pressure	Piston pump	24.5 MPa	24.5 MPa	
		Gear pump	-	-	
		Pilot pump	4.12 MPa	4.12 MPa	
	Max. pump flow	Piston pump	92.4 L/min	92.4 L/min	
		Gear pump	-	-	
		Pilot pump	8.8 L/min	8.8 L/min	
	Max. input torque		108.0 N·m	105.0 N·m	
	HYD. oil				
	Hydraulic oil temperature at tank		Ordinary use: -10 ~ +80°C	Ordinary use: -10 ~ +80°C	
			Short time use: -20 ~ +90°C	Short time use: -20 ~ +90°C	
General spec.	All efficiency (Typical value)		79%	79%	
	Control method		Power constant control Load sensing control	Power constant control Load sensing control	
	Horse power setting		24.8 kw	24.2 kw	
	Max. pump flow (Piston pump)		92.4 ± 2.5 L/min	92.4 ± 2.5 L/min	
	Max. input torque		105.1 ~ 108.0 N·m	102.1 ~ 105.0 N·m	
	Pilot pump flow		More than 8.0 L/min	More than 8.0 L/min	
	LS control flow		Q_{LS} = 50.5 ± 0.4 L/min	Q_{LS} = 50.5 ± 0.4 L/min	
	Proportional LS control flow		Q_{LS} (at 2250 rpm) Q_{LS} X (60% ± 10%)(at 1000 rpm)	Q_{LS} (at 2250 rpm) Q_{LS} X (60% ± 10%)(at 1000 rpm)	

Piston pump power constant characteristics: KX161-3α, U45-3α, U45-3S, U45S, U50-3α



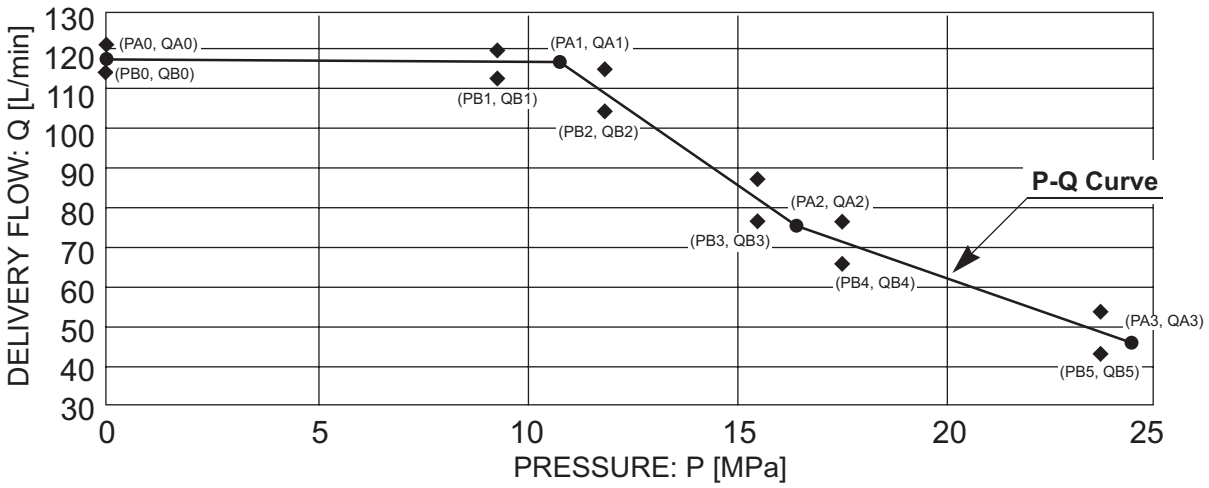
SHAFT SPEED 2200 rpm				TOTAL INPUT TORQUE $108.0^{0}_{-2.9}$			
PRESSURE [MPa]		DELIVERY FLOW [L/min]		PRESSURE [MPa]		DELIVERY FLOW [L/min]	
PA0=	0.0	QA0=	118.8	PB0=	0.0	QB0=	118.8 ± 2.5
PA1=	9.2	QA1=	117.8	PB1=	7.8	QB1=	117.2 ± 2.5
PA2=	15.3	QA2=	66.0	PB2=	10.8	QB2=	104.1 ± 4.0
PA3=	24.5	QA3=	33.5	PB3=	12.7	QB3=	87.0 ± 4.0
				PB4=	16.6	QB4=	61.4 ± 5.0
				PB5=	23.5	QB5=	37.0 ± 5.0

Piston pump power constant characteristics: KX161-3S



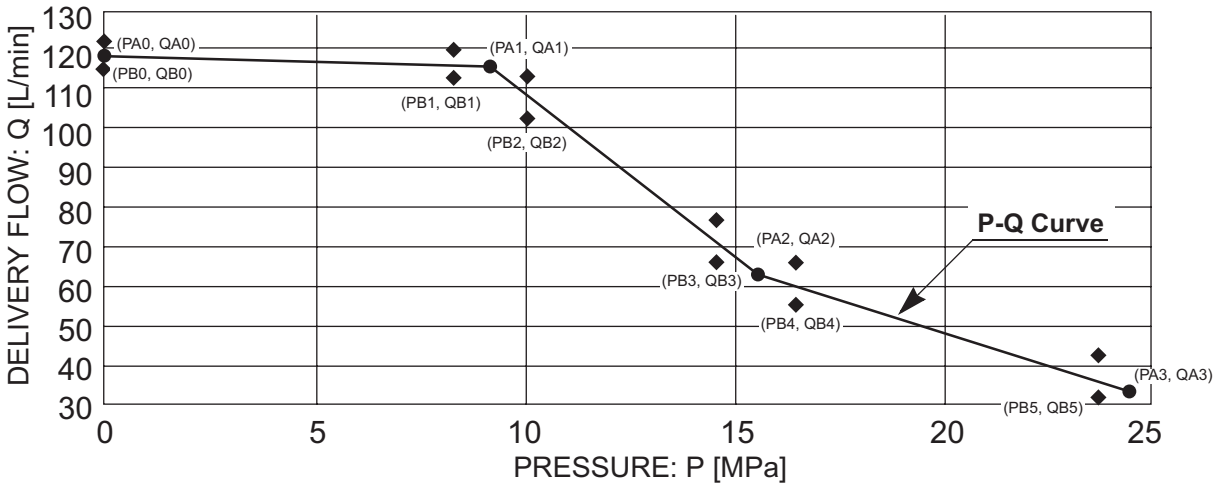
SHAFT SPEED 2200 rpm				TOTAL INPUT TORQUE $108.0^{0}_{-2.9}$			
PRESSURE [MPa]		DELIVERY FLOW [L/min]		PRESSURE [MPa]		DELIVERY FLOW [L/min]	
PA0=	0.0	QA0=	118.8	PB0=	0.0	QB0=	118.8 ± 2.5
PA1=	10.7	QA1=	117.3	PB1=	10.0	QB1=	117.3 ± 2.5
PA2=	16.7	QA2=	72.0	PB2=	12.0	QB2=	109.0 ± 4.0
PA3=	24.5	QA3=	43.8	PB3=	15.0	QB3=	85.5 ± 4.0
				PB4=	18.0	QB4=	68.8 ± 5.0
				PB5=	24.5	QB5=	43.8 ± 5.0

KX161-3ST (PSVL-54CG)



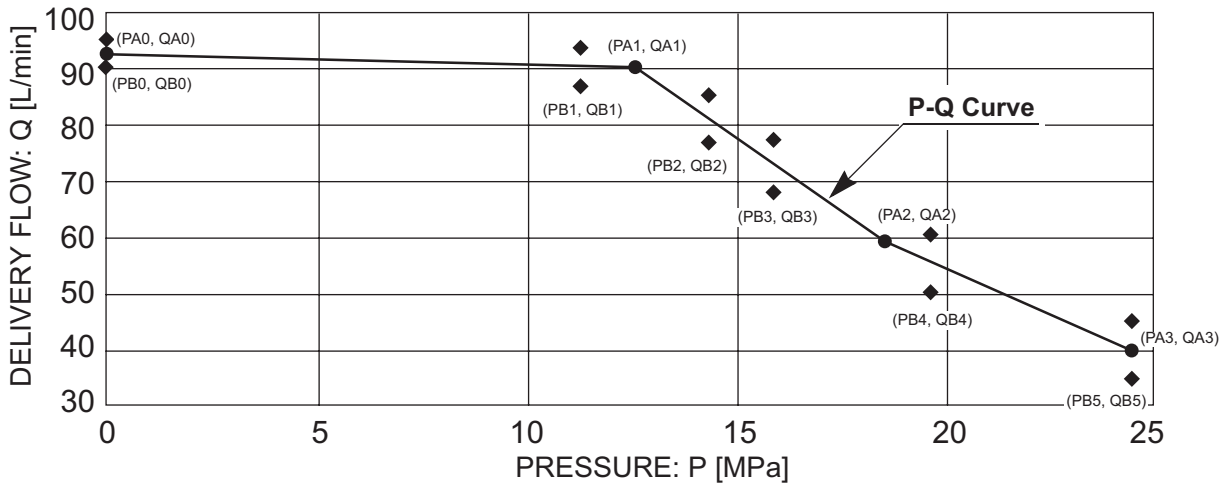
SHAFT SPEED 2300 rpm				TOTAL INPUT TORQUE $115.0^{0}_{-2.9}$			
PRESSURE [MPa]		DELIVERY FLOW [L/min]		PRESSURE [MPa]		DELIVERY FLOW [L/min]	
PA0=	0.0	QA0=	118.9	PB0=	0.0	QB0=	118.9 ± 2.5
PA1=	10.6	QA1=	117.0	PB1=	9.6	QB1=	117.2 ± 2.5
PA2=	16.3	QA2=	75.0	PB2=	11.6	QB2=	109.6 ± 4.0
PA3=	24.5	QA3=	45.0	PB3=	15.3	QB3=	82.4 ± 4.0
				PB4=	17.3	QB4=	71.3 ± 5.0
				PB5=	23.5	QB5=	48.7 ± 5.0

U45ST, U45-3ST (PSVL-54CG-16)



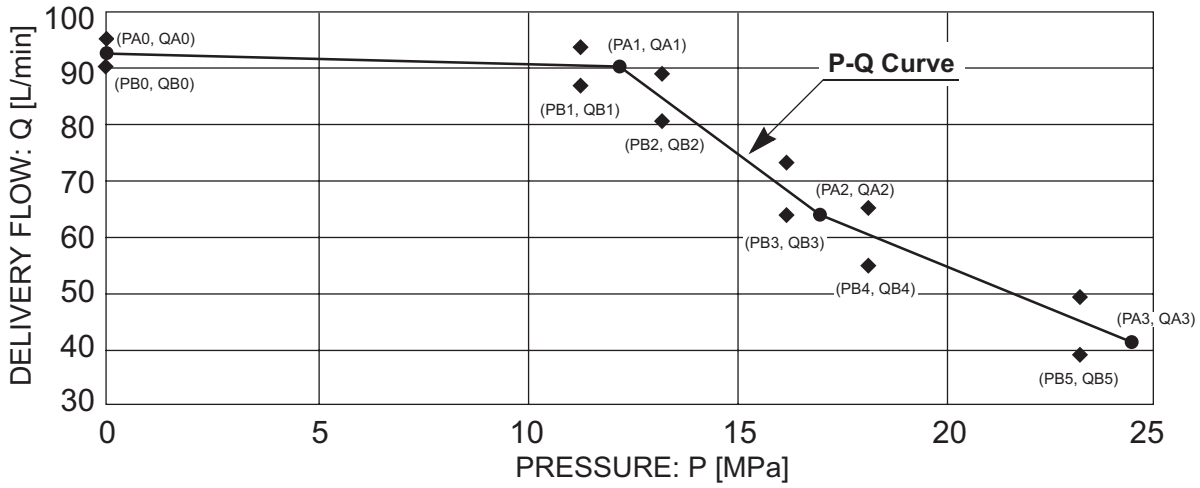
SHAFT SPEED 2200 rpm				TOTAL INPUT TORQUE $115.0^{0}_{-2.9}$			
PRESSURE [MPa]		DELIVERY FLOW [L/min]		PRESSURE [MPa]		DELIVERY FLOW [L/min]	
PA0=	0.0	QA0=	118.8	PB0=	0.0	QB0=	118.8 ± 2.5
PA1=	9.0	QA1=	115.8	PB1=	8.0	QB1=	116.2 ± 2.5
PA2=	15.6	QA2=	62.7	PB2=	10.0	QB2=	107.5 ± 4.0
PA3=	24.5	QA3=	32.8	PB3=	14.8	QB3=	70.7 ± 4.0
				PB4=	18.8	QB4=	59.3 ± 5.0
				PB5=	23.5	QB5=	35.8 ± 5.0

KX121-3S, KX121-3α



SHAFT SPEED 2200 rpm				TOTAL INPUT TORQUE $108.0^{0}_{-2.9}$			
PRESSURE [MPa]		DELIVERY FLOW [L/min]		PRESSURE [MPa]		DELIVERY FLOW [L/min]	
PA0=	0.0	QA0=	92.4	PB0=	0.0	QB0=	92.4 ± 1.9
PA1=	12.5	QA1=	90.4	PB1=	11.3	QB1=	90.7 ± 3.8
PA2=	18.2	QA2=	59.0	PB2=	14.2	QB2=	80.0 ± 5.3
PA3=	24.5	QA3=	40.0	PB3=	15.7	QB3=	72.0 ± 5.5
				PB4=	19.6	QB4=	55.0 ± 6.0
				PB5=	24.5	QB5=	40.0 ± 6.2

KX121-3ST (PSVL-42CG)

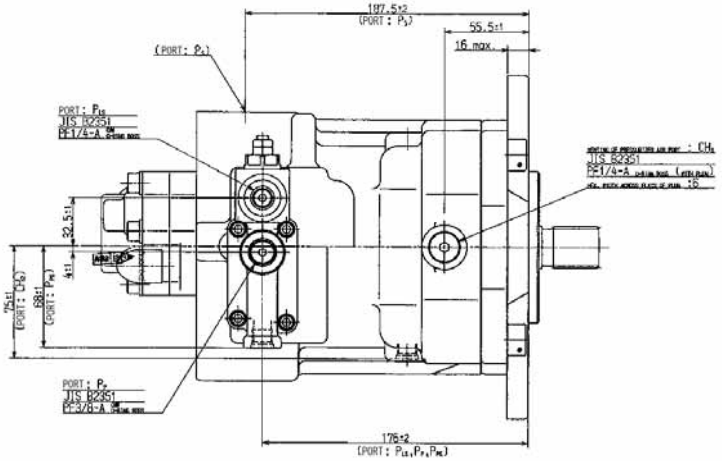


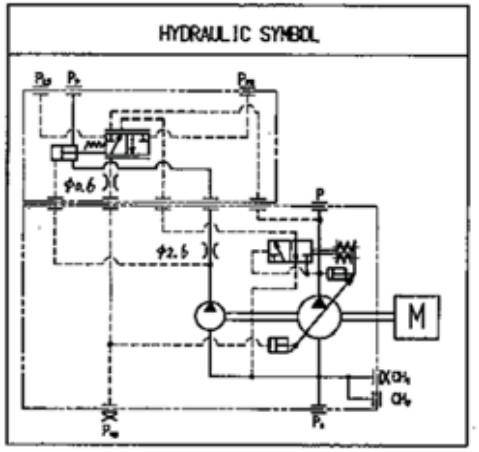
SHAFT SPEED 2200 rpm				TOTAL INPUT TORQUE $105.0^{0}_{-2.9}$			
PRESSURE [MPa]		DELIVERY FLOW [L/min]		PRESSURE [MPa]		DELIVERY FLOW [L/min]	
PA0=	0.0	QA0=	92.4	PB0=	0.0	QB0=	92.4 ± 2.5
PA1=	12.1	QA1=	90.4	PB1=	11.1	QB1=	90.6 ± 2.5
PA2=	16.9	QA2=	64.0	PB2=	13.1	QB2=	84.9 ± 4.0
PA3=	24.5	QA3=	41.1	PB3=	15.9	QB3=	69.5 ± 4.0
				PB4=	17.9	QB4=	61.0 ± 5.0
				PB5=	23.5	QB5=	44.1 ± 5.0

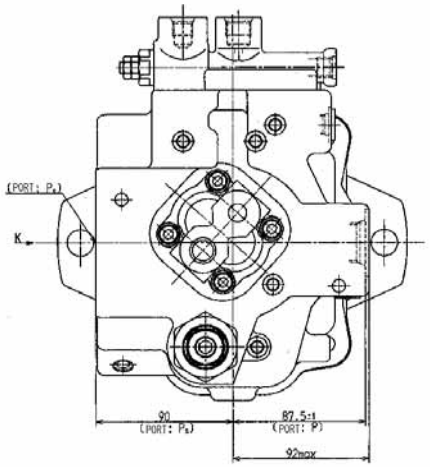
2. Piston pump: **KX161-3S/ST (PP), KX161-3α (EU), U45-3α, U50-3α (EU), U45-3S/ST (KTA), U45S/ST (KTC, KCL)**

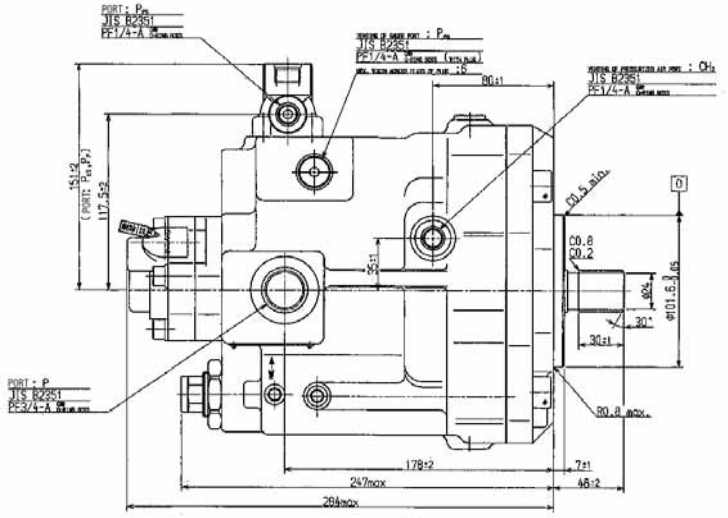
1) SPECIFICATION

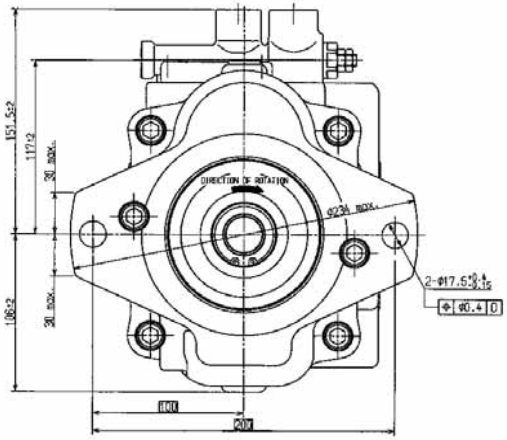
Piston pump	Max. displacement	cm^3/rev	54.0
	Max. pressure	MPa	24.5
Pilot pump (Gear pump)	Max. displacement	cm^3/rev	4.0
	Max. pressure	MPa	4.12
Max. shaft speed	KX161-3α,U45-3α,U50-3α	r.p.m	2250
	KX161-3S		2200
Direction of rotation (Viewed from shaft end)			Right (Clockwise)
Weight		kg	34





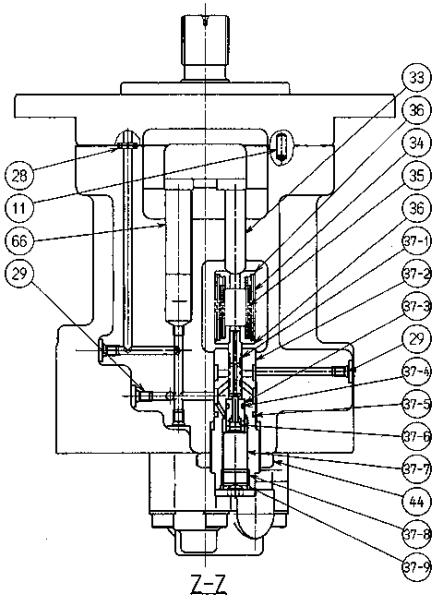


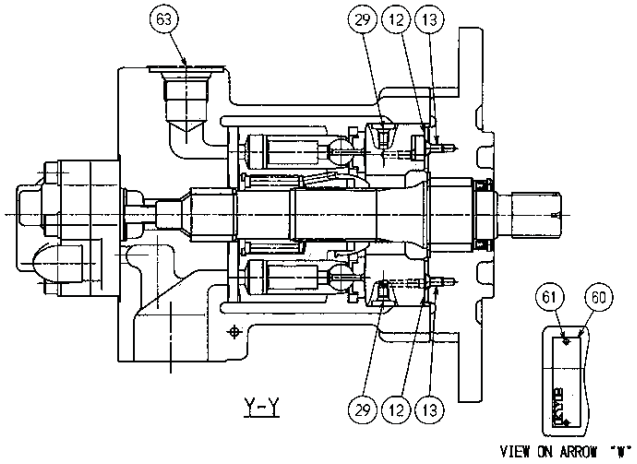




NOTES
1. FILL PUMP CASE WITH OIL BEFORE STARTING.
2. WHEN A COUPLING IS INSTALLED INTO A SHAFT, DO NOT HIT THE SHAFT.
3. "▽" MARK SHOWS THE UNMACHINED SURFACE OF THE PUMP.

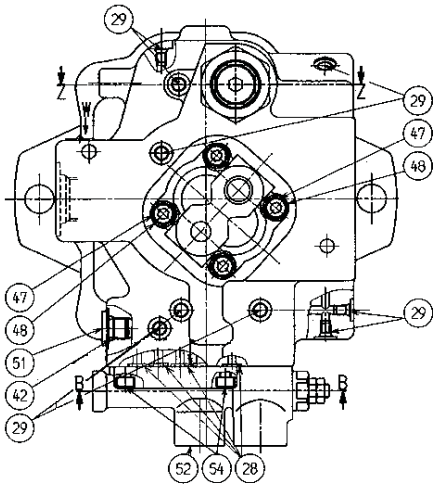
2) TIGHTENING TORQUE

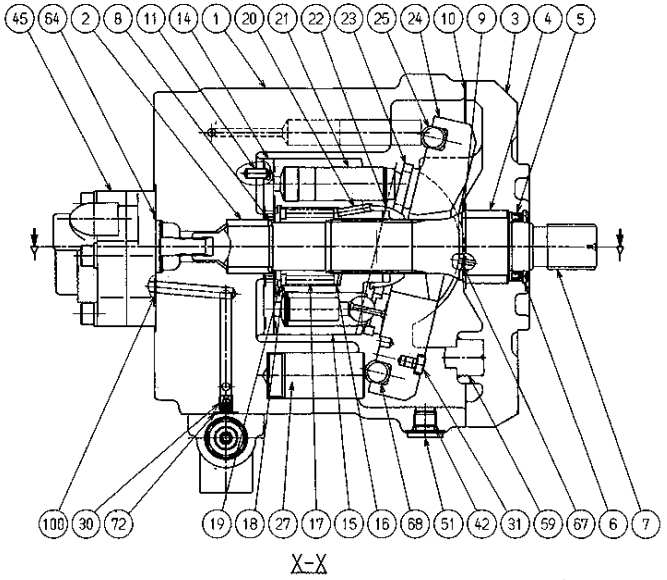


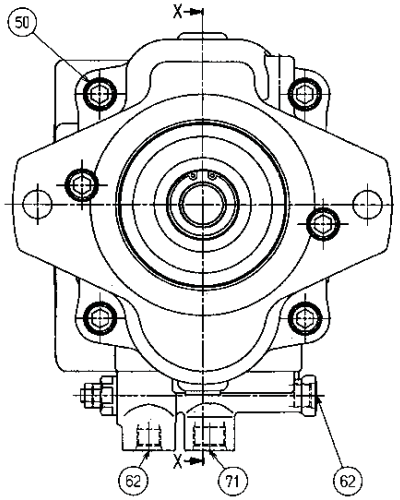


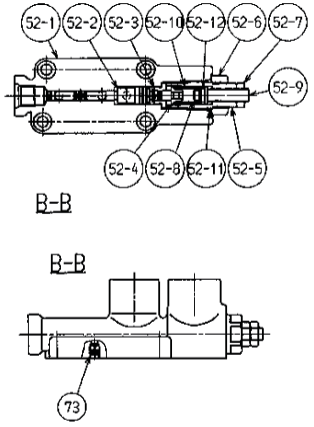
Item No.	Description	Size	Tightening torque (N·m)
13	Screw	M5	5.9 ± 10%
30	Orifice	M8	10.3 ± 10%
37-2	Sleeve, valve	M30	-
37-8	Plug	PF 3/8	57.0 ± 10%
44	Nut	M30	68.6 ± 10%
47	Bolt, sch.	M8	28.9 ± 10%
50	Bolt, sch.	M12	106.9 ± 10%
51	Plug	PF1/4	29.4 ± 10%
52-5	Cap	M18	23.6 ± 10%
52-6	Nut	M16	40.0 ± 10%
52-7	Nut	M8	8.9 ± 10%
52-9	Set screw	M8	-
54	Bolt, sch.	M6	12.65 ± 10%
73	Orifice	M6	2.45 ± 10%

(1) Case
(2) Bearing, needle
(3) Flange
(4) Bearing, needle
(5) Seal, oil
(6) Ring, snap
(7) Shaft
(8) Washer, thrust
(9) Washer, thrust
(10) Gasket
(11) Pin
(12) Bushing
(13) Screw
(14) Plate, valve
(15) Block, cylinder
(16) Collar
(17) Spring
(18) Collar
(19) Ring, snap
(20) Pin
(21) Piston assy
(22) Holder, retainer
(23) Plate, retainer
(24) Plate, swash
(25) Pin
(27) Pin
(28) O-ring
(29) Plug
(30) Orifice
(31) Stopper
(33) Pin
(34) Spring
(35) Spring
(36) Seat, spring
(37) Valve assy
(37-1) Spool
(37-2) Sleeve, valve
(37-3) Piston, servo
(37-4) O-ring
(37-5) O-ring
(37-6) Pin
(37-7) Collar
(37-8) Plug
(37-9) O-ring
(42) O-ring
(44) Nut
(45) Pump, gear
(47) Bolt, SCH
(48) Washer
(50) Bolt, SCH
(51) Plug
(52) Valve assy
(52-1) Body, valve
(52-2) Spool
(52-3) Bushing
(52-4) Seat, spring
(52-5) Cap
(52-6) Nut
(52-7) Nut
(52-8) Holder
(52-9) Screw, set
(52-10) Spring
(52-11) O-ring
(52-12) O-ring
(54) Bolt, SCH
(59) Stopper
(60) Plate, name
(61) Screw, drive
(62) Plug, shipping
(63) Plug, shipping
(64) O-ring
(66) Pin









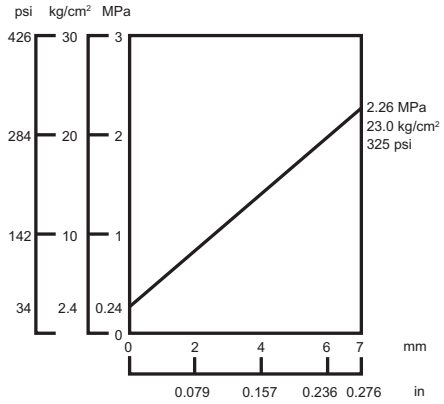
(C) CONTROL VALVE

a) Specifications

1. KX121-3, KX121-3S/ST, KX121-3α

Manual Operating Section
- Travel Left
- Travel Right
- Dozer
- Swing
- Service

Pilot Operating Section
- Swivel
- Arm
- Boom
- Bucket



Spool operating force (Manual Operating Section) Return spring at neutral at full stroke	 71 N 7.2 kgf 16.0 lbf 88 N 9.0 kgf 19.8 lbf
Spool leakage, condition Boom lock (A6) port Swing (A8, B8) port Others (Exclude Traveling Port: A2, A3, B2, B3)	6.9 MPa 70 kgf/cm^2 995 psi 50°C, 122°F Under 1.2 cm^3/min, 0.07 in^3/min 1.5 ~ 4.0 cm^3/min, 0.09 ~ 0.24 in^3/min 2.0 ~ 10.0 cm^3/min, 0.12 ~ 0.61 in^3/min
Allowable back pressure	Peak: 1.5 MPa 15.3 kgf/cm^2 21.3 psi Usual: 0.35 MPa 3.6 kgf/cm^2 5.0 psi

Machine model		KX121-3, KX121-3S, KX121-3α
Main relief pressure setting		$24.5^{+0.3}_{-0.2}$ MPa, 250^{+3}_{-2} kgf/cm^2, 3555^{+43}_{+28} psi at 37 L/min 9.8 gal/min
Overload relief pressure setting	Dozer rod (B3)	$11.8^{+0.5}_{0}$ MPa, 120^{+5}_{0} kgf/cm^2, 1705^{+71}_{0} psi at 5 L/min 1.3 gal/min
	Dozer bottom (B4) Arm bottom (A5) Arm rod (B5) Boom bottom (A6) Boom rod (B6) Bucket rod (A7) Bucket bottom (B7)	$27.4^{+0.5}_{0}$ MPa, 280^{+5}_{0} kgf/cm^2, 3985^{+71}_{0} psi at 5 L/min 1.3 gal/min
Unload relief pressure setting		2.5 ± 0.2 MPa, 25 ± 2 kgf/cm^2, 355 ± 28 psi at 22 L/min 5.8 gal/min

Control valve type		KVSX-12-9
Section width		31 mm 1.22 in
Total length		400 mm 15.75 in
Main spool dia.		mm
Spool stroke	Mechanism operating section	7 mm 0.28 in
	Pilot operating section	7 mm 0.28 in
Pilot line air-bleeding	Orifice dia.	ϕ 0.50 mm equiv. ϕ 0.02 in equiv.
	Stroke	6 ~ 7 mm, 0.24 ~ 0.28 in

2. KX121-3S/ST, KX121-3α

Port size

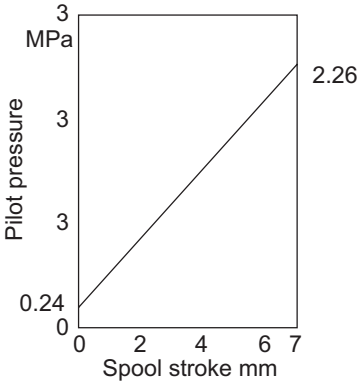
Size	Port name
PF3/4	P, T1
PF1/2	T2, T3
PF3/8	A1 ~ A10, B1 ~ B10
PF1/4	PPS1, PPS2, PLS, PP1, PP2, Pi, Dr, Pa1, Pa5, PA6, Pa7, Pa9, Pb1, Pb5, Pb6, Pb7, Pb9

Specifications

1. Maximum flowrate: 100.8 L/min (maximum pump inlet flowrate)
   60 L/min (maximum one-section control flowrate)
2. Flowrate (pump) control pressure difference: 1.4 MPa
3. Service pressure: 24.5 MPa
4. Hydraulic oil used: ISO VG46 or equivalent
5. Hydraulic oil temperature range: -20 ~ 100 °C
6. Unload valve set pressure (under no load pressure): 2.5 ± 0.1 MPa at 22 L/min.
7. Main relief valve set pressure: $24.5^{+0.3}_{-0.2}$ MPa at 37 L/min.
8. Overload relief valve set pressure:
   A4 (Dozer, rod): $11.8^{+0.5}_{0}$ MPa at 5 L/min.
   B4 (Dozer, bottom): $27.4^{+0.5}_{0}$ MPa at 5 L/min.
   A5 (Arm, rod): $27.4^{+0.5}_{0}$ MPa at 5 L/min.
   B5 (Arm, bottom): $27.4^{+0.5}_{0}$ MPa at 5 L/min.
   A6 (Boom, rod): $27.4^{+0.5}_{0}$ MPa at 5 L/min.
   B6 (Boom, bottom): $27.4^{+0.5}_{0}$ MPa at 5 L/min.
   A7 (Bucket, rod): $27.4^{+0.5}_{0}$ MPa at 5 L/min.
   B7 (Bucket, bottom): $27.4^{+0.5}_{0}$ MPa at 5 L/min.
   A9 (Angle, rod): $27.4^{+0.5}_{0}$ MPa at 5 L/min.
   B9 (Angle, bottom): $19.0^{+0.5}_{0}$ MPa at 5 L/min.

Spool pressure characteristics

Pilot section spool stroke 7 mm
Pilot pressure tolerance: Within ± 8%, including (1) spring tolerance,
(2) land size and (3) sliding resistance (at the back pressure of 0 MPa)



Note:
Air bleed from pilot section
ϕ 0.5 or equivalent, stroke 6 ~ 7 mm
Travel left/right communicating throttle dia. 0.8 x 2
(Usually communicating)

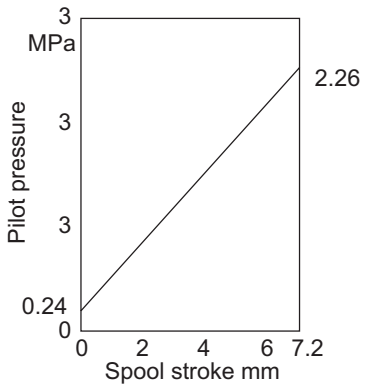
3. KX161-3S/ST, KX161-3α, U45S/ST, U45-3S/ST/α, U50-3α

Specifications

1. Maximum flowrate: 119 L/min (maximum pump inlet flow rate)
   78 L/min (maximum one-section control flowrate)
2. Flow rate (pump) control pressure difference: 1.27 MPa at 2200 rpm
3. Service pressure: 23.5 MPa
4. Hydraulic oil used: ISO VG46 or equivalent
5. Hydraulic oil temperature range: -20 ~ 100 °C
   Momentary maximum oil temperature: 100 °C
6. Unload valve set pressure (under no load pressure): 2.16 ± 0.1 MPa at 29 L/min.
7. Main relief valve set pressure: $23.5^{+0.3}_{-0.2}$ MPa at 44 L/min.
8. Overload relief valve set pressure:
   B4 (Dozer, rod): $11.8^{+0.5}_{0}$ MPa at 5 L/min.
   A4 (Dozer, bottom), A5 (Arm, bottom), B5 (Arm, rod), A6 (Boom, bottom), B6 (Boom, rod), A7 (Bucket, bottom), B7 (Bucket, rod): $26.5^{+0.5}_{0}$ MPa at 5 L/min.
   A9 (Angle, rod): $27.4^{+0.5}_{0}$ MPa at 5 L/min.
   B9 (Angle, bottom): $19.0^{+0.5}_{0}$ MPa at 5 L/min.

Spool pressure characteristics

Pilot section spool stroke 7.2 mm
Pilot pressure tolerance: Within ± 8%, including (1) spring tolerance, (2) land size and (3) sliding resistance (at the back pressure of 0 MPa)



This product is technically different in the following points from Kubota Part Code RD619-6113-5 (Kayaba Part Code C0070-36907).

1. Unload valve compatible for series circuit, unload valve PDS damper chamber added.
2. Main relief valve modified (same as KVSX-12 for KX121-3).
3. Quantity of AI Pp1 plugs from one to two.
4. Swivel, arm and bucket compensating spools: ϕ0.6, not drawn.
5. Shuttle plate modified (valve housing finish dimensions changed).
6. S/P section changed from manual control to pilot control.
7. Nameplate color changed from silver to green.
8. Dozer spool modified (rod and bottom reversed).
9. Arm, boom and bucket spools modified.
10. B4 overload relief modified (reseating improved).
11. Overload relief modified (low-temperature reseating improved).

Note:Air bleed from pilot section
ϕ 0.5 or equivalent, stroke 5.7 ~ 7.2 mm

Travel left/right communicating circuit behavior

Introducing the travel left/right communicating system (anti-zigzagging measure)
The travel left/right ports communicate with each other when the following three conditions are met at the same time. (Communicating tube dia. ϕ 0.5)

1. Travel left and right activated at once.
2. Travel left and right activated in the same direction.
3. Both of travel left and right spool strokes over 6.8 mm.

b) Main Spool's Max. Flow Amount

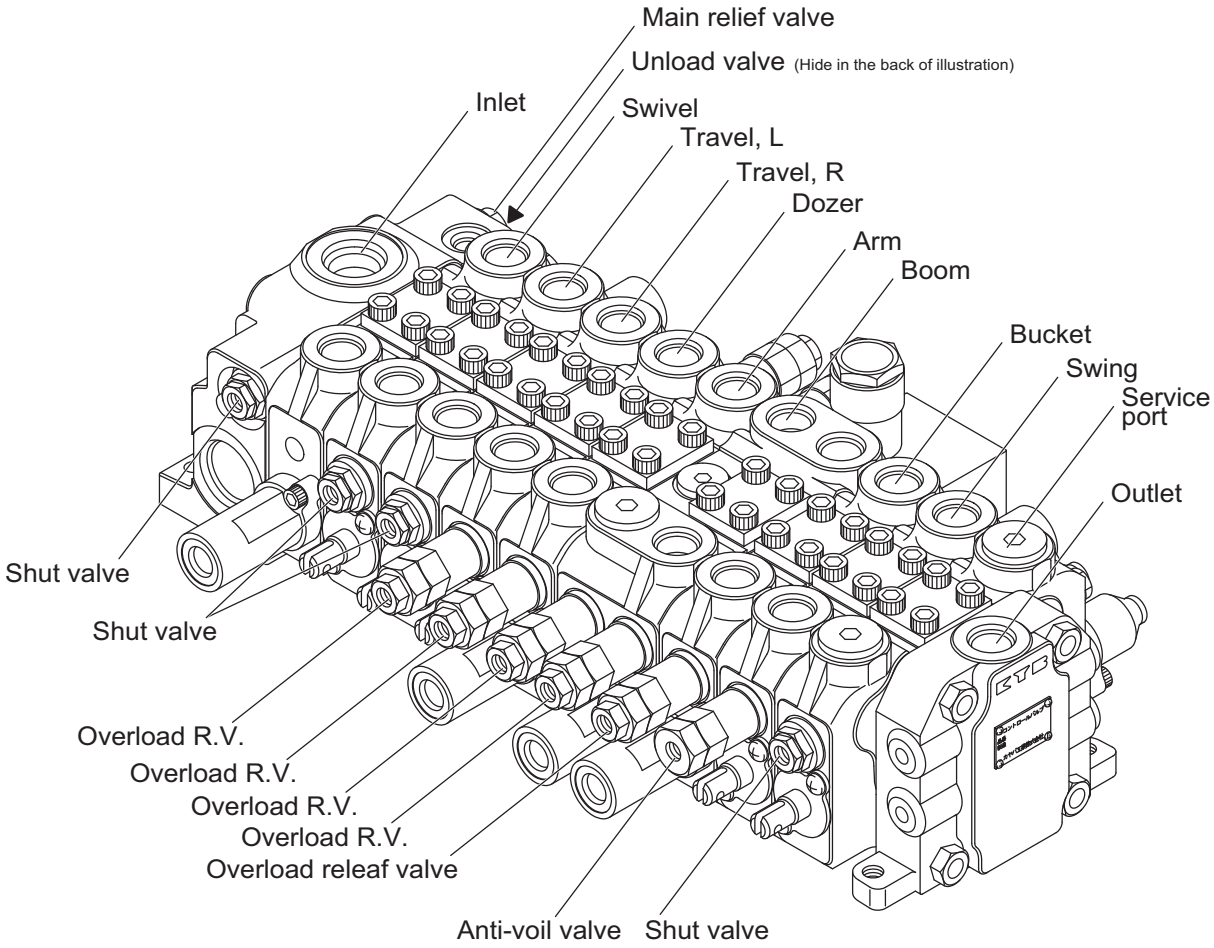
	KX121-3S/ST, KX121-3α		KX161-3S/ST, KX161-3α, U45-3ST, U45-3α, U50-3α, U45ST		U45S, U45-3, U45-α	
	A port	B port	A port	B port	A port	B port
Swivel	23 (6.08)	←	41.5 (10.0)	←	←	←
Travel LH	41 (10.8)	←	53 (14.0)	←	←	←
Travel RH	41 (10.8)	←	53 (14.0)	←	←	←
Dozer	16 (4.23)	19 (5.02)	29 (7.66)	21 (5.55)	29 (7.66)	21 (5.55)
Arm	60 (15.9)	40 (10.6)	81 (21.4)	57 (15.1)	75 (19.8)	47 (12.4)
Boom	50 (13.2)	30 (7.93)	56 (14.8)	41 (10.8)	56 (14.8)	41 (10.8)
Bucket	40 (10.6)	45 (11.9)	57 (15.1)	57 (15.1)	47 (12.4)	47 (12.4)
Swing	22.5 (5.94)	15 (3.96)	28 (7.40)	18 (4.76)	28 (7.40)	18 (4.76)
Angle	40 (10.6)	40 (10.6)	28 (7.40)	40 (10.6)	28 (7.40)	40 (10.6)
Service port	60 (15.9)	←	65 (17.2)	←	←	←
Spool dia.	ϕ12, 0.472"		ϕ14, 0.551"		←	←
Main pump stand-by flow	22 (5.81)		29 (7.66)			

The pump swash plate does not tilt back under the standby flow which is the least amount of pump discharge. The LS pump feeds the required quantity of oil to the C/V spool and the remainder is relieved through the LS unload valve.

Above each C/V service port flow is at rated engine speed and with certain test load condition.
Angle section flow is only for the angle blade version.

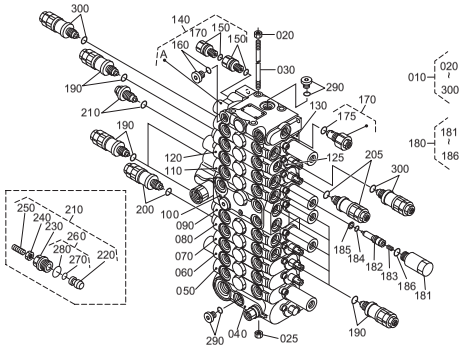
c) Overall View

KX161-3S/ST, KX161-3α, U45S/ST, U45-3S/ST, U45-3α, U50-3α

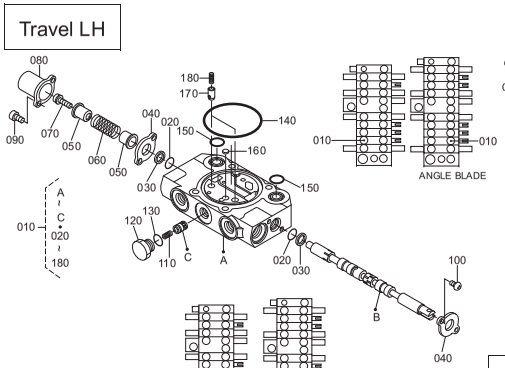


d) Control Valve Inner Parts

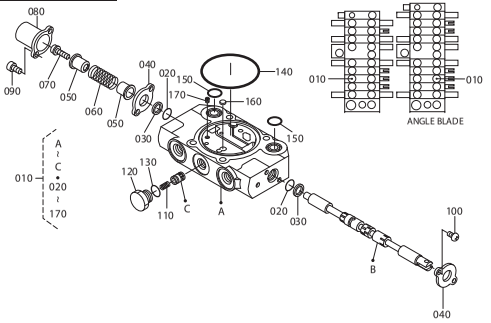
1. KX121-3S, KX121-3ST, Angle-version



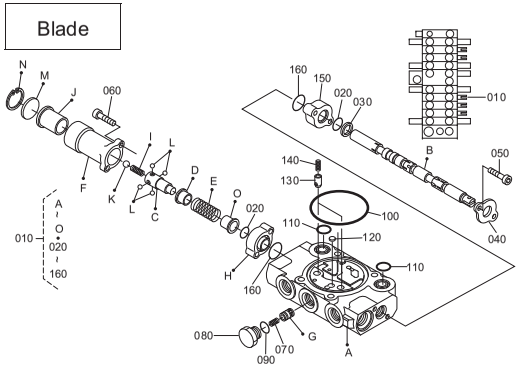
Travel LH



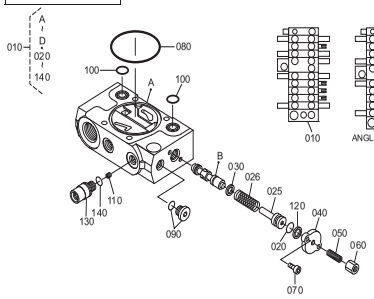
Travel RH



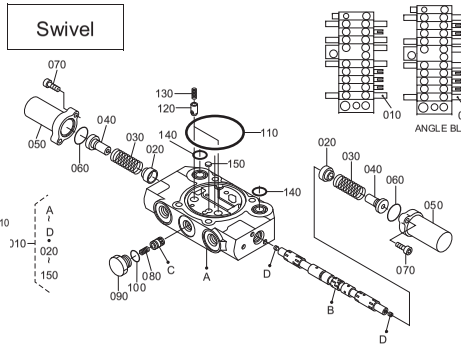
Blade



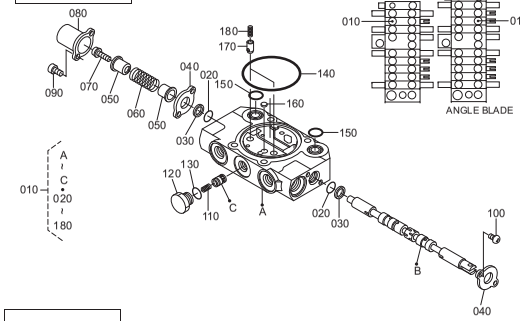
Inlet



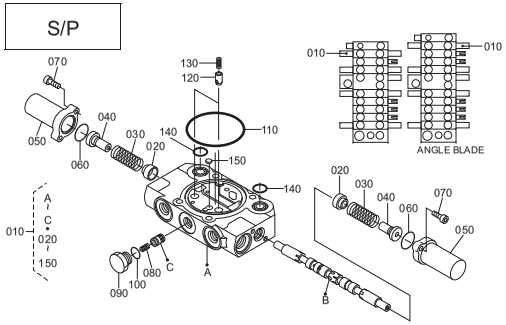
Swivel



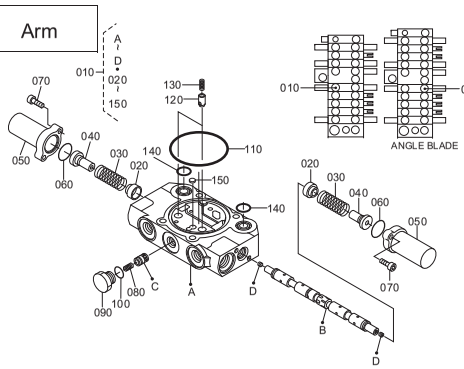
Swing



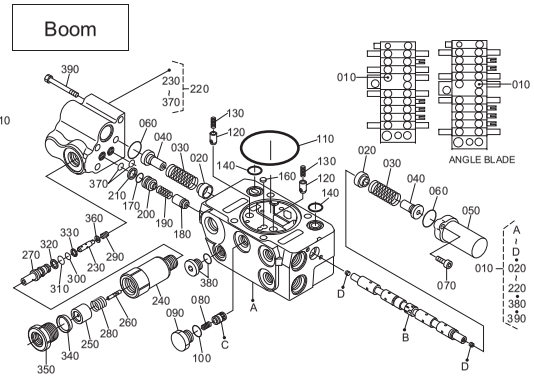
S/P



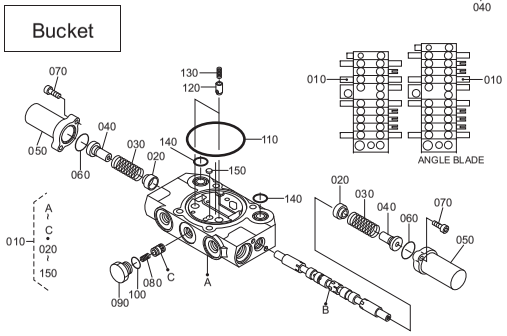
Arm



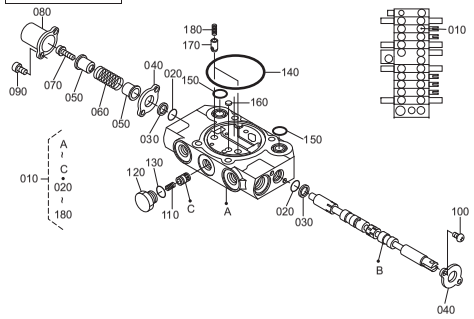
Boom



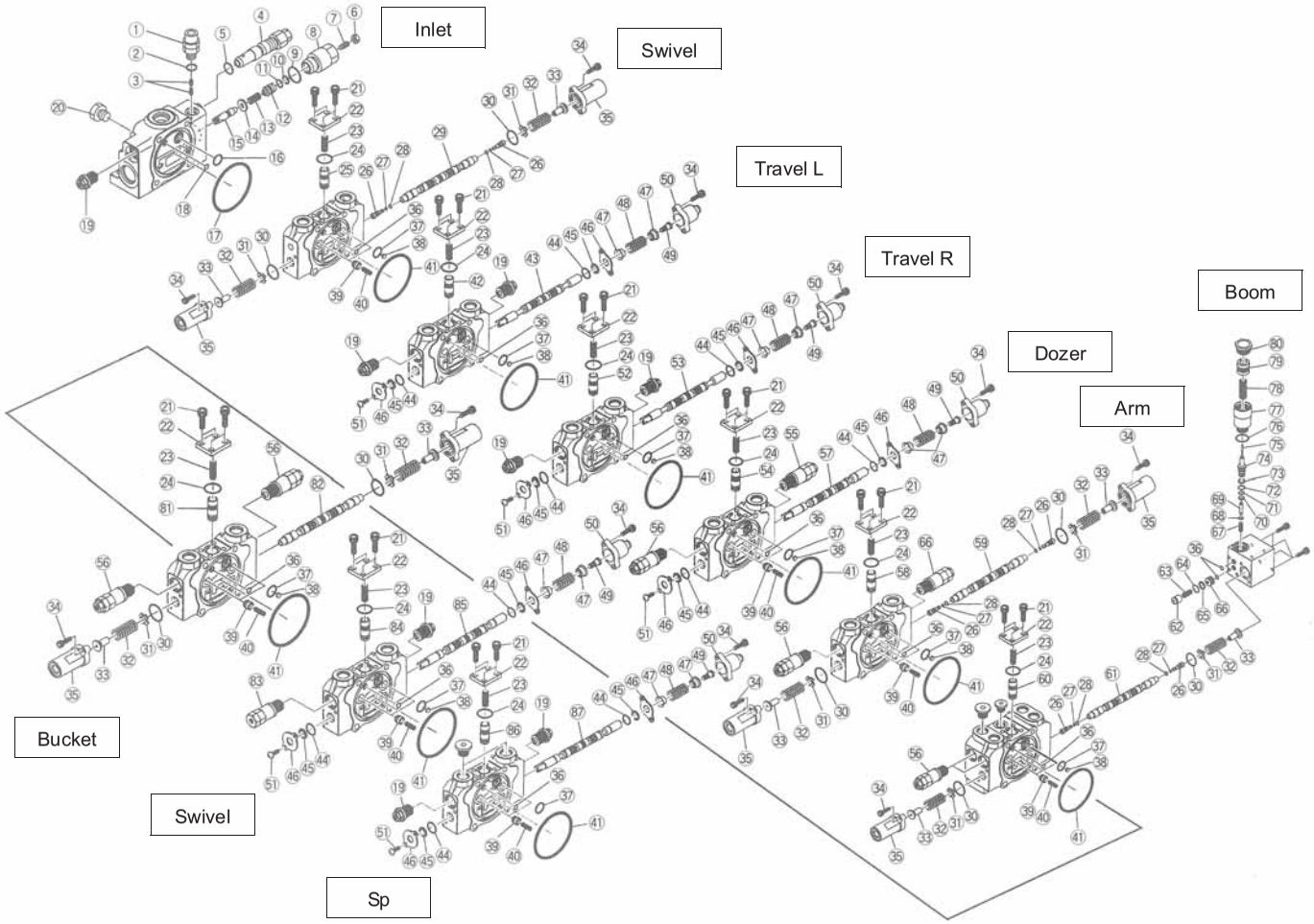
Bucket



Angle Blade



2. KX161-3S, KX161-3α, U45S, U45-3S, U45-3α, U50-3α



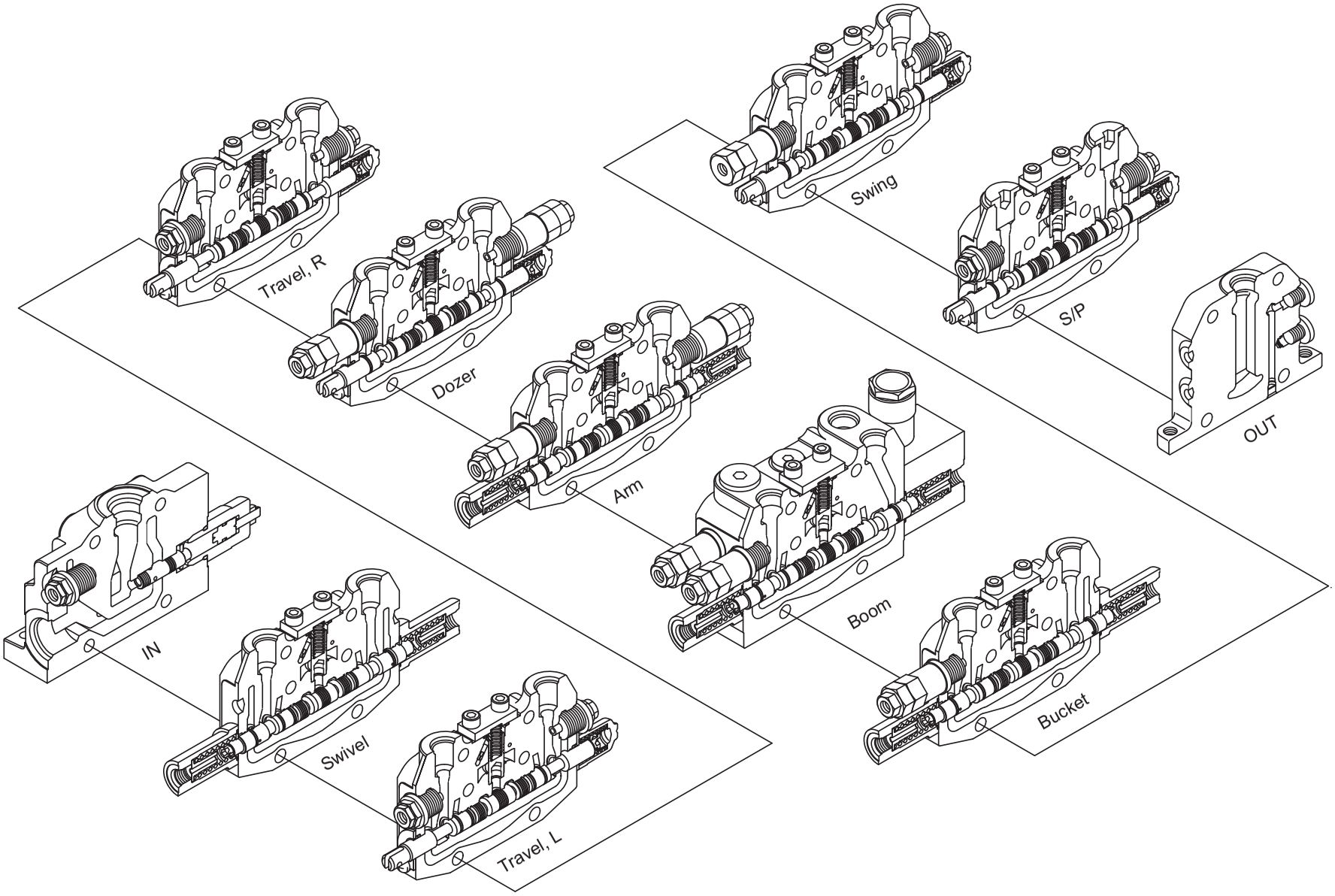
(1) Parts list

No	Name
1	Plug
2	O-ring
3	Orifice
4	Inlet valve assy
5	O-ring
6	Nut
7	set bolt
8	Plug
9	O-ring
10	Backup ring
11	O-ring
12	Poppet
13	Spring
14	Spring seat
15	Poppet
16	O-ring
17	O-ring
18	O-ring
19	Shut-off valve assy
20	Plug assy
21	Hex. bolt
22	Flange
23	Spring
24	O-ring
25	Compe. spool
26	Plug
27	Backup ring
28	O-ring
29	Spool
30	O-ring
31	Spring plate
32	Spring
33	spring seat
34	Hex. bolt
35	Cap
36	O-ring
37	O-ring
38	Plate
39	Poppet
40	Spring
41	O-ring
42	Compe. spool
43	Spool
44	O-ring

No	Name
45	Wiper
46	Seal plate
47	Spring seat
48	Spring
49	Cap screw
50	Cap
51	Screw
52	Compe. spool
53	Spool
54	Compe. spool
55	Relief valve assy
56	Relief valve assy
57	Spool
58	Compe. spool
59	Spool
60	Compe. spool
61	Spool
62	Poppet
63	Spool
64	O-ring
65	Backup ring
66	Spacer
67	Spring
68	Spring seat
69	Spool
70	Backup ring
71	O-ring
72	O-ring
73	Backup ring
74	Sleeve
75	Poppet
76	O-ring
77	Plug
78	Spring
79	Piston
80	Plug assy
81	Compe. spool
82	Plug assy
83	Spool
84	Compe. spool
85	Anti-void valve assy
86	Compe. spool
87	Spool

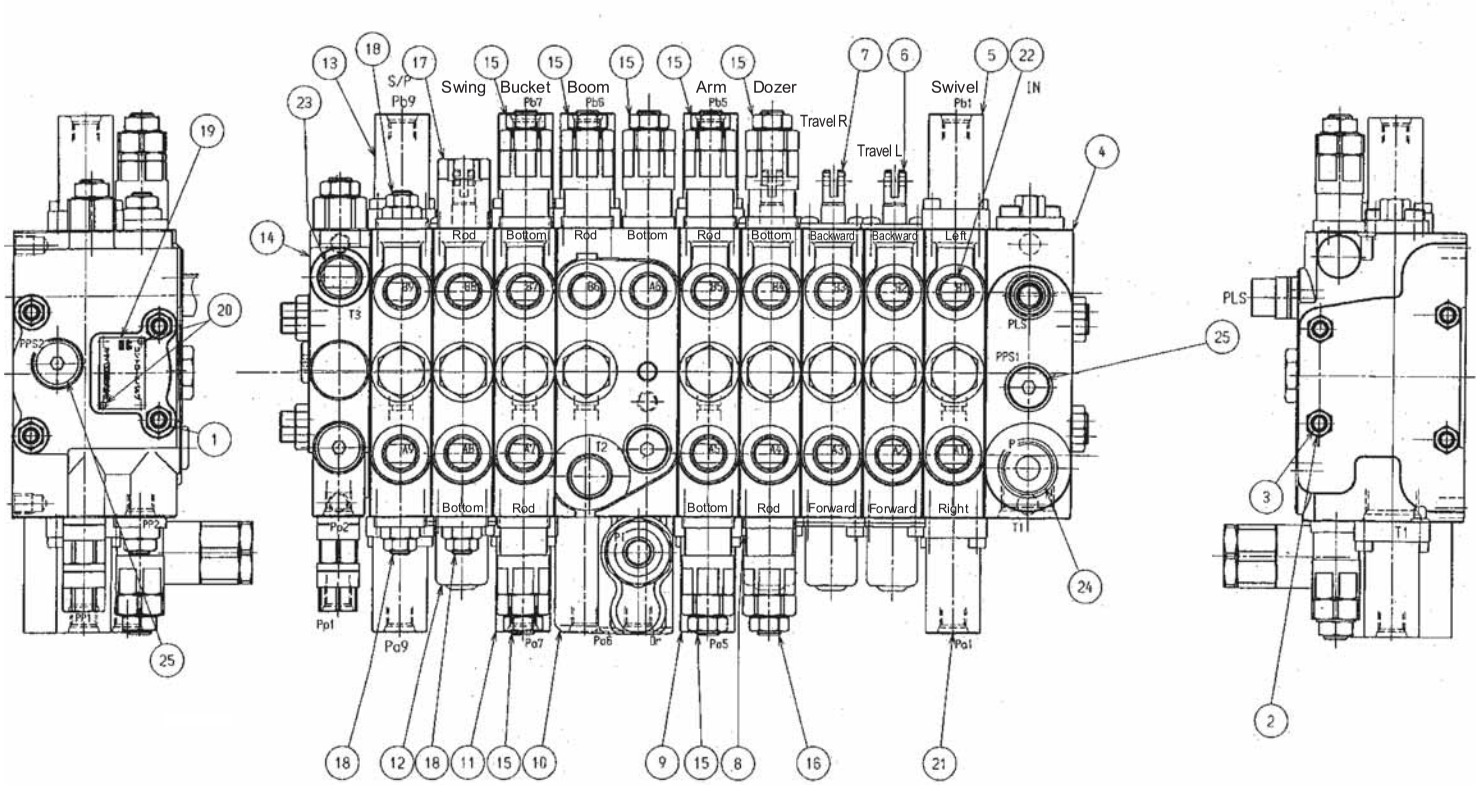
e) Control Valve Section Cutaway

1. KX161-3S, KX161-3α, U45S, U45-3S, U45-3α, U50-3α

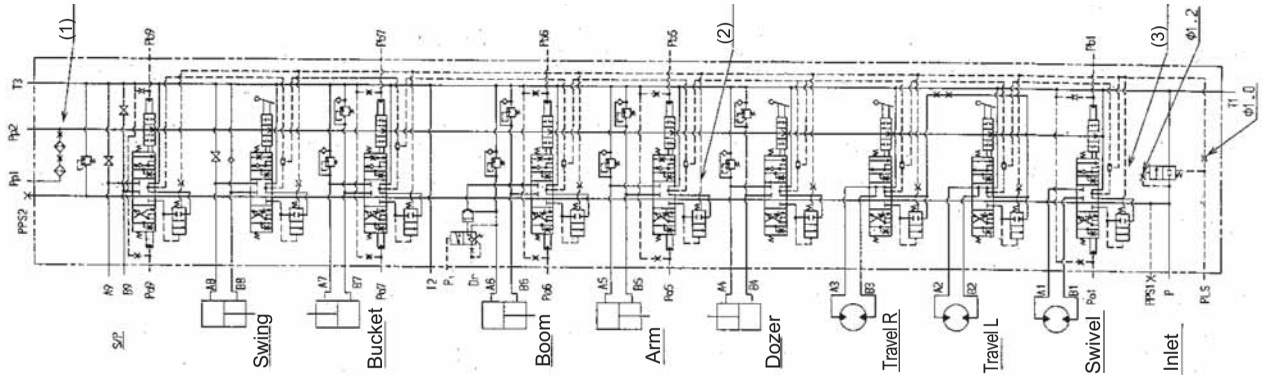


f) Control Valve Assy

1. KX121-3S, KX121-3α

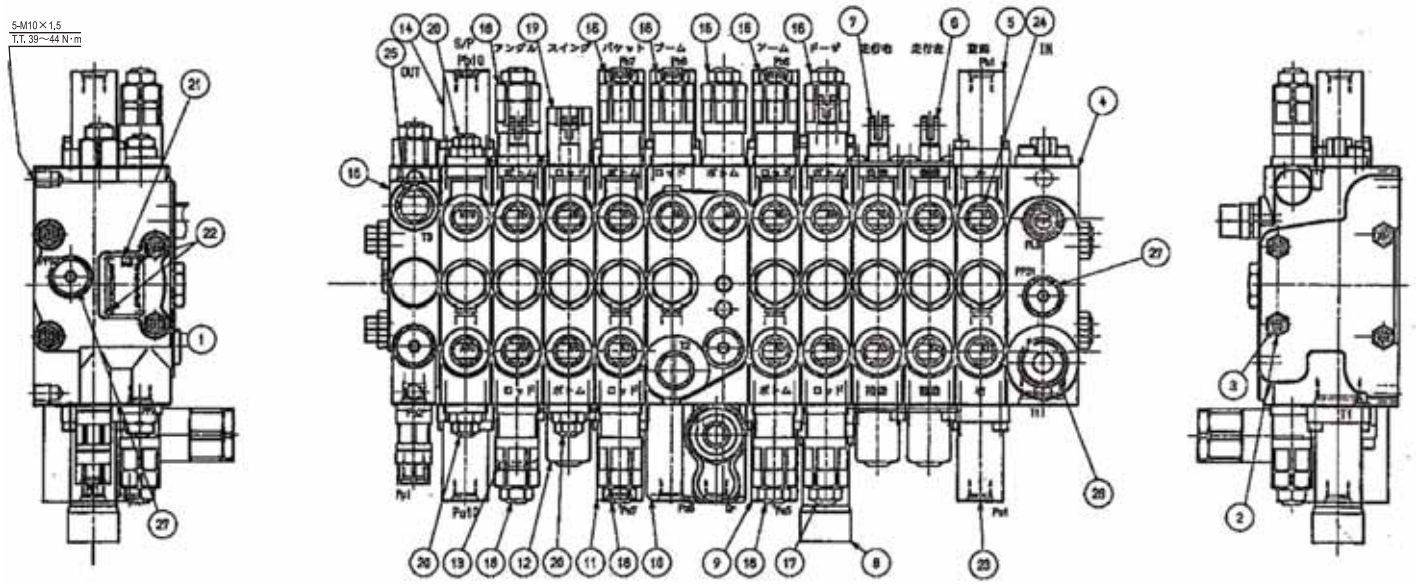


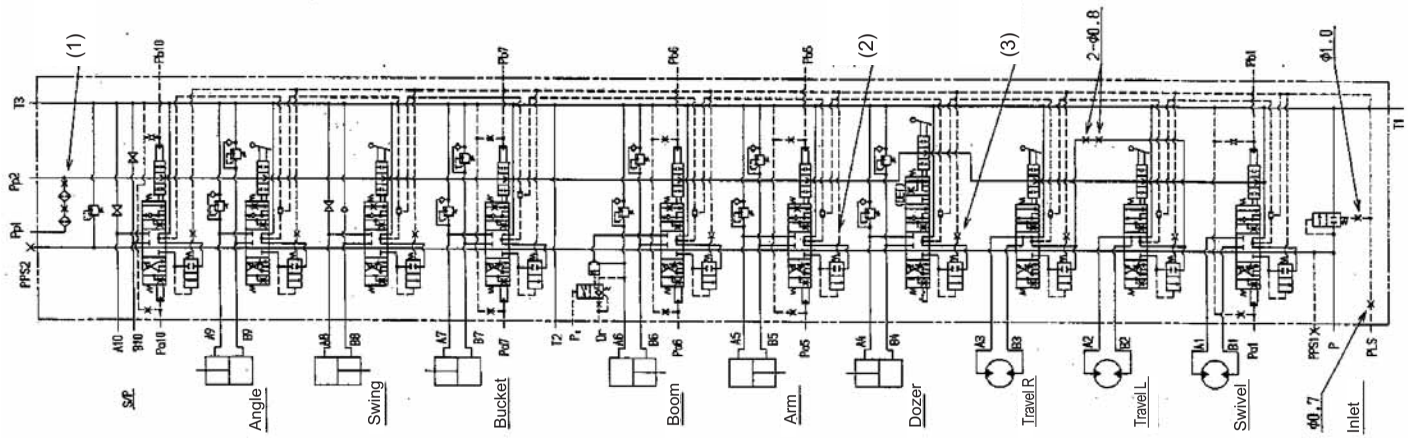
No.	Parts name	Q'ty	Remarks
1	Nut	4	
2	Nut	4	With sealing compound
3	Tie - rod	4	L = 407
4	Inlet section assy	1	
5	Spool section assy	1	Swivel
6	Spool section assy	1	Travel, L
7	Spool section assy	1	Travel, R
8	Spool section assy	1	Dozer
9	Spool section assy	1	Arm
10	Spool section assy	1	Boom
11	Spool section assy	1	Bucket
12	Spool section assy	1	Swing
13	Spool section assy	1	S/P
14	Outlet section assy	1	
15	Port relief valve assy	7	$27.4^{+0.5}_{0}$MPa at 5 L/min
16	Port relief valve assy	1	$11.8^{+0.5}_{0}$MPa at 5 L/min
17	Anti-void valve assy	1	
18	Shut-off valve assy	3	
19	Name plate	1	
20	Screw	2	
21	Plug	13	PF1/4 JIS "O" ring type (A_1 ~ A_9, B_1 ~ B_9)
22	Plug	18	PF3/8 JIS "O" ring type (P_{PS1}, P_{PS2}, P_{LS}, P_{P1}, P_{P2}, P_a, P_b, P_i, Dr)
23	Plug	2	PF1/2 JIS "O" ring type (T2, T3)
24	Plug	2	PF3/4 JIS "O" ring type (P, T1)
25	Plug assy	2	PF1/4 JIS "O" ring type (P_{P1}, P_{P2}, P_{PS1}, P_{PS2})



(1) Two plugs with ϕ0.4 orifice (Two 100-mesh elements)
(2) ϕ0.6, not drawn (arm, bucket, swivel)
(3) ϕ0.6, not drawn (6 locations)

2. KX121-3S, Angle dozer-version



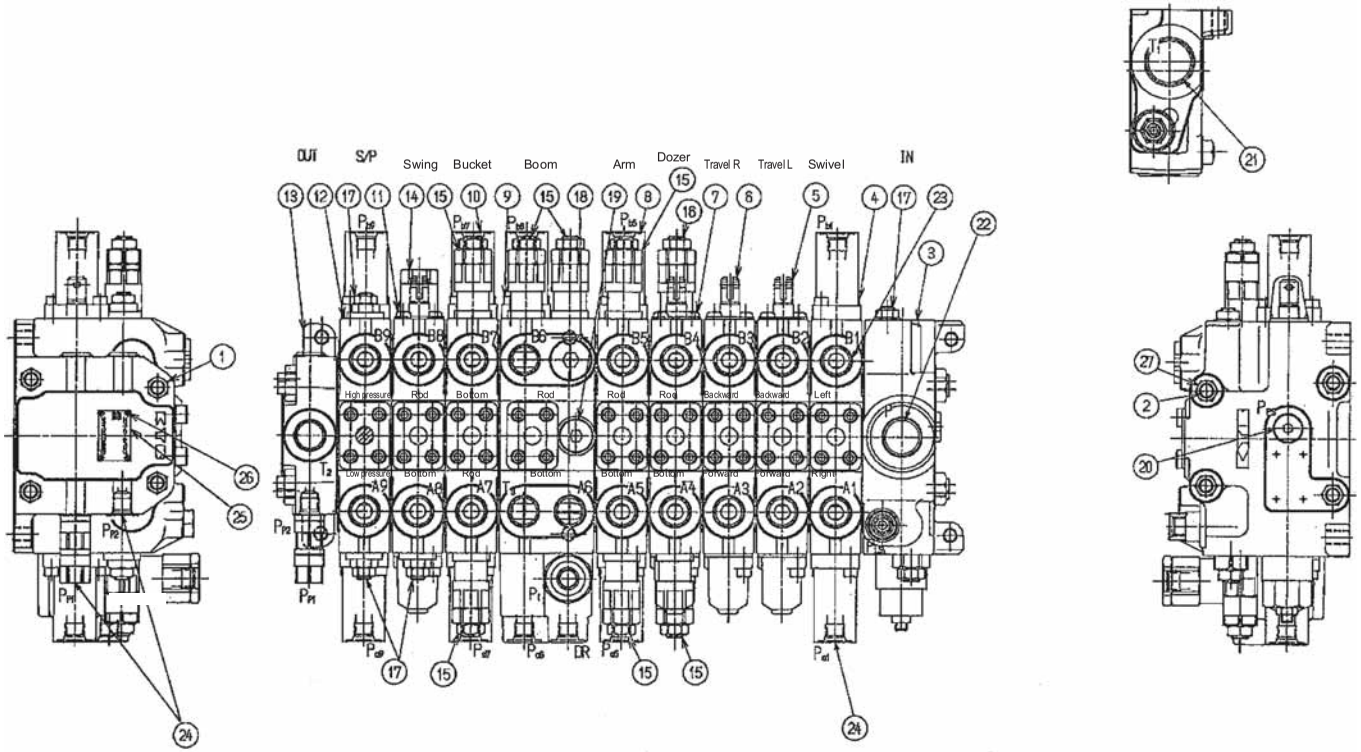


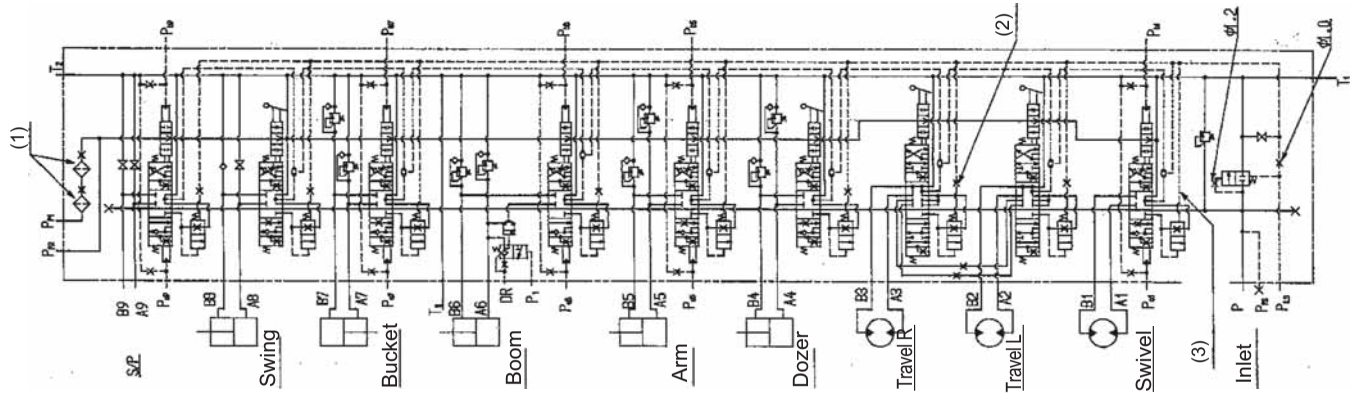
(1) Parts list

No	Name	Q'ty	Remarks
1	Nut	4	
2	Nut	4	T.T. :27~30 N·m With sealing compound
3	Tie - rod	4	L = 438
4	Inlet section assy	1	
5	Spool section assy	1	Swivel
6	Spool section assy	1	Travel, L
7	Spool section assy	1	Travel, R
8	Spool section assy	1	Dozer
9	Spool section assy	1	Arm
10	Spool section assy	1	Boom
11	Spool section assy	1	Bucket
12	Spool section assy	1	Swing
13	Spool section assy	1	Angle
14	Spool section assy	1	S/P
15	Outlet section assy	1	
16	Port relief valve assy	8	$27.4^{+0.5}_{0}$MPa at 5 L/min
17	Port relief valve assy	1	$11.8^{+0.5}_{0}$MPa at 5 L/min
18	Port relief valve assy	1	$19.0^{+0.5}_{0}$MPa at 5 L/min
19	Anti-void valve assy	1	
20	Shut-off valve assy	3	
21	Name plate	1	
22	Screw	2	
23	Plug	15	PF1/4 JIS "O" ring type (P_{PS1}, P_{PS2}, P_{LS}, P_{P1}, P_{P2}, P_a, P_b, P_i, Dr)
24	Plug	20	PF3/8 JIS "O" ring type (A_1 ~ A_{10}, B_1 ~ B_{10})
25	Plug	2	PF1/2 JIS "O" ring type (T2, T3)
26	Plug	2	PF3/4 JIS "O" ring type (P, T1)
27	Plug assy	2	PF1/4 JIS "O" ring type (P_{PS1}, P_{PS2}) T.T. : 28.4~30.4 N·m

(1) Two plugs with ϕ0.4 orifice (Two 100-mesh elements)
(2) ϕ0.6, not drawn (arm, bucket, swivel)
(3) ϕ0.6, not drawn (7 locations)

3. KX161-3S, KX161-3α, U45S, U45-3S, U45-3α, U50-3α





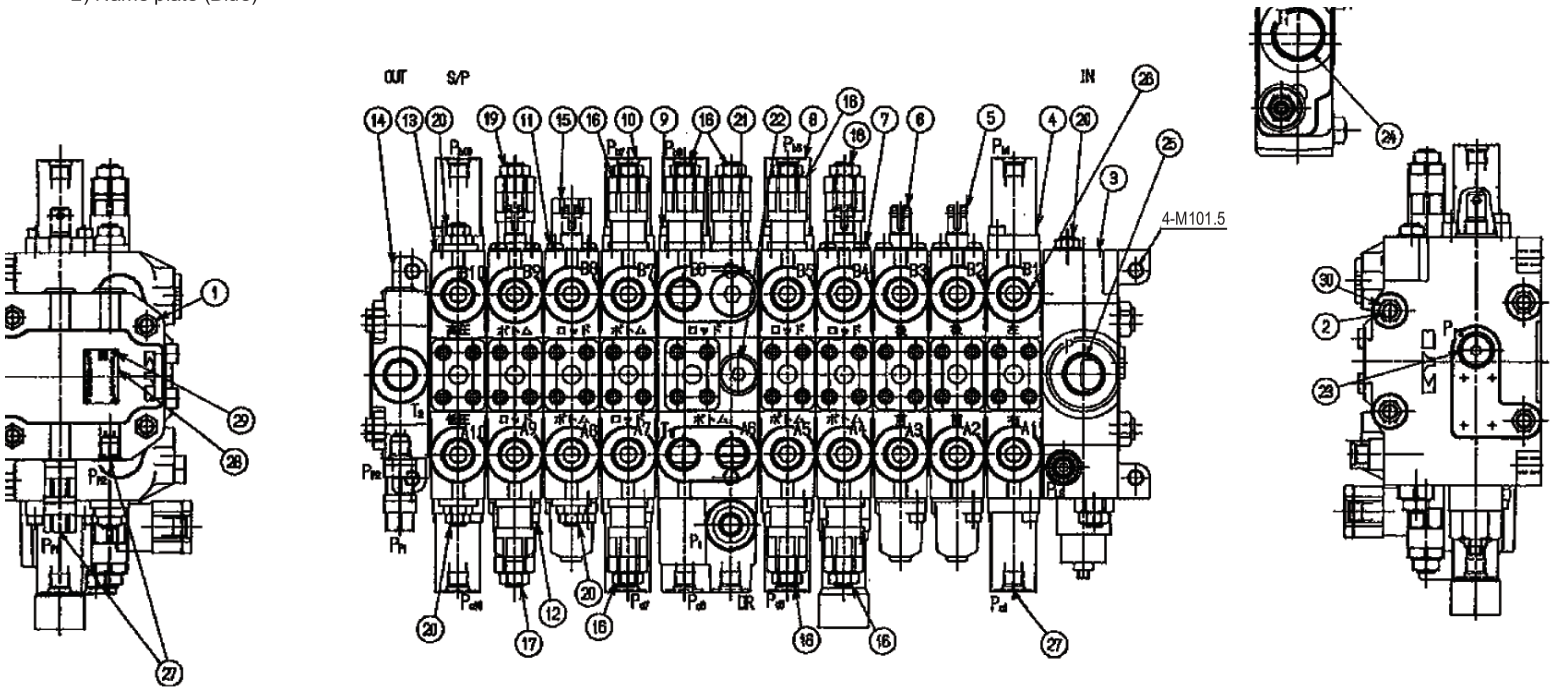
No.	Parts name	Q'ty	Remarks
1	Nut	4	
2	Tie - rod	4	L = 478
3	Inlet section assy	1	Inlet
4	Spool section assy	1	Swivel
5	Spool section assy	1	Travel, L
6	Spool section assy	1	Travel, R
7	Spool section assy	1	Dozer
8	Spool section assy	1	Arm
9	Spool section assy	1	Boom
10	Spool section assy	1	Bucket
11	Spool section assy	1	Swing
12	Spool section assy	1	S/P
13	Outlet section assy	1	Outlet
14	Anti-void valve assy	1	B8
15	Port relief valve assy	7	A4, A5, B5, A6, B6, A7, B7 $26.5^{+0.5}_{0}$MPa at 5 L/min
16	Port relief valve assy	1	B4 $11.8^{+0.5}_{0}$MPa at 5 L/min
17	Shut-off valve assy	4	IN, A8, A9, B9
18	Plug assy	1	PF1/2 JIS "O" ring type. T.T. : 105.9 ~ 141.2 N·m
19	Plug assy	1	PF3/8 JIS "O" ring type. T.T. : 49 ~ 53 N·m
20	Plug assy	1	PF1/4 JIS "O" ring type. T.T. : 22.6 ±1 N·m
21	Plug	1	PF1 JIS "O" ring type
22	Plug	1	PF3/4 JIS "O" ring type
23	Plug	20	PF1/2 JIS "O" ring type (A_1, A_2, T_1, T_2)
24	Plug	15	PF1/4 JIS "O" ring type (P_{PS1}, P_{PS2}, P_{LS}, P_{P1}, P_{P2}, P_a, P_b, P_i, Dr)
25	Name plate	1	Green
26	Screw	2	
27	Nut	4	With sealing compound. T.T. : 46.1 ±2 N·m

(1) Two plugs with ϕ0.4 orifice (Two 100-mesh elements)
(2) ϕ0.6 (6 locations)
(3) ϕ0.6, not drawn (arm, bucket, swivel)

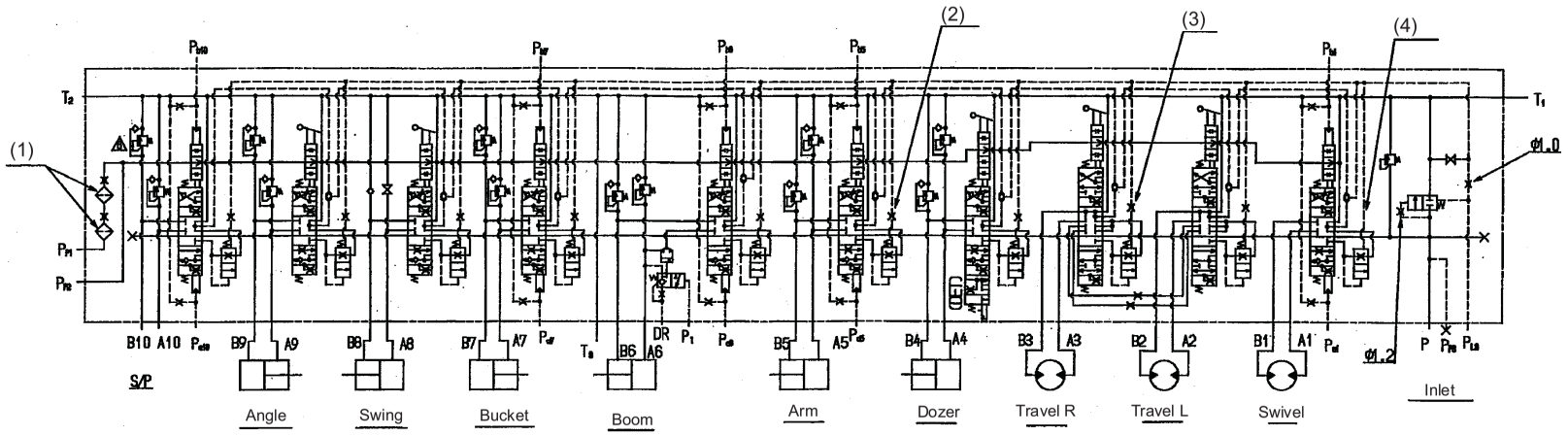
4. KX161-3S/ST, U45S/ST, U45-3S/ST, Angle dozer-version

Differences between KX161-3S and U45S are;

1) Spools' shape of boom, arm and bucket and those flow amount.
2) Name plate (Blue)



No.	Parts name	Q'ty	Remarks
1	Nut	4	
2	Tie - rod	4	L = 516
3	Inlet section assy	1	
4	Spool section assy	1	Swivel
5	Spool section assy	1	Travel, L
6	Spool section assy	1	Travel, R
7	Spool section assy	1	Dozer
8	Spool section assy	1	Arm
9	Spool section assy	1	Boom
10	Spool section assy	1	Bucket
11	Spool section assy	1	Swing
12	Spool section assy	1	Angle
13	Spool section assy	1	S/P
14	Outlet section assy	1	Outlet
15	Anti-void valve assy	1	B8
16	Port relief valve assy	7	A4, A5, B5, A6, B6, A7, B7 $26.5^{+0.5}_{0}$MPa at 5 L/min
17	Port relief valve assy	1	A9 $27.4^{+0.5}_{0}$MPa at 5 L/min
18	Port relief valve assy	1	B4 $11.8^{+0.5}_{0}$MPa at 5 L/min
19	Port relief valve assy	1	B9 $19.0^{+0.5}_{0}$MPa at 5 L/min
20	Shut-off valve assy	4	IN, A8, A10, B10
21	Plug assy	1	PF1/2 JIS "O" ring type. T.T. : 105.9 ~ 141.2 N·m
22	Plug assy	1	PF3/8 JIS "O" ring type. T.T. : 49 ~ 53 N·m
23	Plug assy	1	PF1/4 JIS "O" ring type. T.T. : 22.6 ±1 N·m
24	Plug	1	PF1 JIS "O" ring type
25	Plug	1	PF3/4 JIS "O" ring type
26	Plug	22	PF1/2 JIS "O" ring type (A_1, B_1, T_1, T_2)
27	Plug	15	PF1/4 JIS "O" ring type (P_{PS1}, P_{PS2}, P_{LS}, P_{P1}, P_{P2}, P_a, P_b, P_i, DR)
28	Name plate	1	Green
29	Screw	2	
30	Nut	4	With sealing compound. T.T. : 46.1 ±2 N·m

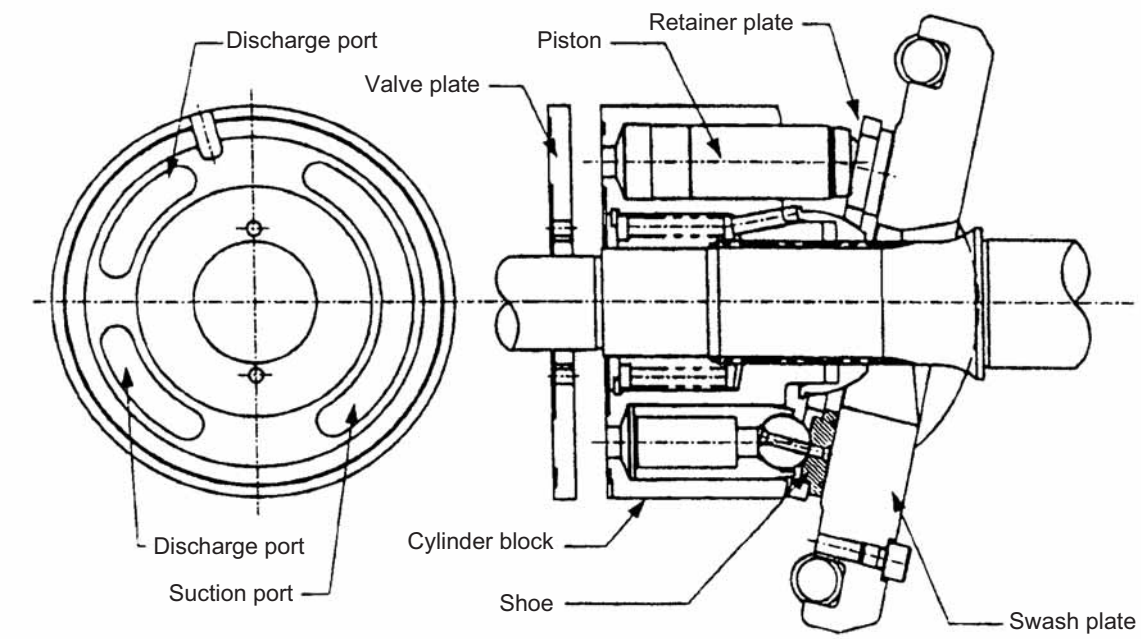


(1) Orifice plug, 2 pcs (100-mesh, ϕ0.4)
(2) ϕ0.4 orifice (arm, bucket)
(3) ϕ0.6 (7 locations)
(4) No orifice (swivel)

g) Load Sensing Type Hydraulic Pump Operating Principle

KX121-3S, KX121-3α, KX161-3S, KX161-3α, U45S, U45-3S, U45-3α, U50-3α

(1) Variable displacement pump



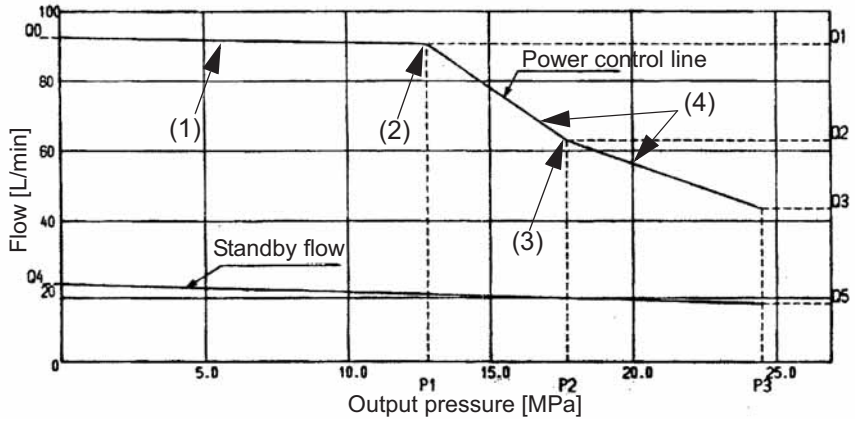
The cylinder block has 9 pistons incorporated and spline shaft coupling.
The cylinder block is also connected, with the valve plate in between, with the suction and discharge ports. When the cylinder block turns, the pistons in the 180-degree range get connected to the suction side and those in the other range to the discharge side.
Each piston end is ball-and-socket-coupled with the shoe, which is kept pressed onto the swash plate by the retainer plate.
In this way, the shoe moves in constant contact with the swash plate. When the swash plate angle varies, the piston's stroke also changes, which controls the pump's delivery rate accordingly.
With the cylinder block turning, some pistons are pushed along the swash plate into the cylinder block, whereas the other pistons are pulled out of the cylinder block. The former side makes for an exhaust stroke. The cylinder block chambers under compression are connected to the valve plate's discharge side. The latter side provides for a suction stroke. The cylinder block chambers are connected to the valve plate's suction side.
While the cylinder block makes a turn, accordingly, one piston gets connected to the suction side for suction stroke and then to the discharge side for exhaust stroke. All the 9 pistons carries on the cycle of suction and exhaust strokes one by one for smooth pumping.

(2) Power control

The pump feeds an oil flow that corresponds to the load. This helps keep the consumed horsepower (torque) of the pump below the set horsepower (torque). The flow rate is regulated by controlling the angle of the pump's swash plate.

The pump's flow rate is regulated with the control valve inlet pressure (P_{PS}), load pressure (P_{LS}) and LS regulator's spring force (F_{LS}). The pump's swash plate is controlled to maintain the equation $P_{PS} = P_{LS} + F_{LS}$.

The greater the load becomes, the higher the pump's discharge pressure becomes. (Let's see the equation $P_{PS} = P_{LS} + F_{LS}$. The greater P_{LS}, the greater P_{PS}. And the pump's discharge pressure P also gets higher.)



The power is controlled along the power control line as shown at left. While under power control, the load sensing control function, discussed later, stays deactivated. The load sensing regulator spool is located at the left.

Fig. 2-1

Let's suppose that the swash plate is at its maximum tilt. The load pressure is low and the flow rate is maximum ((1) in Fig. 2-1). The pressure oil coming out of the pump keeps pressing on the control pin (A). It is also fed behind the reaction pin and keeps pushing this pin to the right. However the horsepower spring force upon the horsepower control spool is greater than the oil pressure, this spool remains at the left side. In this relationship, the passages (A) and (B) run through the horsepower control spool and reach the tank (in the pump case), which means no pressure is applied to the control pin (B). In this way, the swash plate is kept at maximum tilt.(Fig. 2-2)

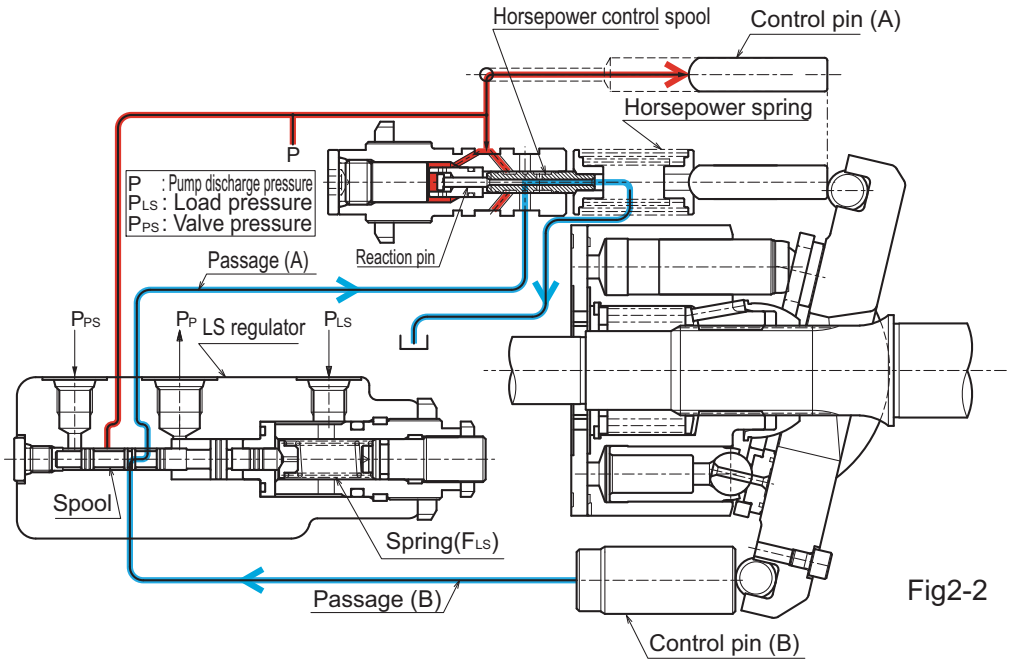


Fig2-2

This is as shown in the circuit diagram in Fig. 2-3. The oil flow through the horsepower control spool is referred to in Fig. 2-4.

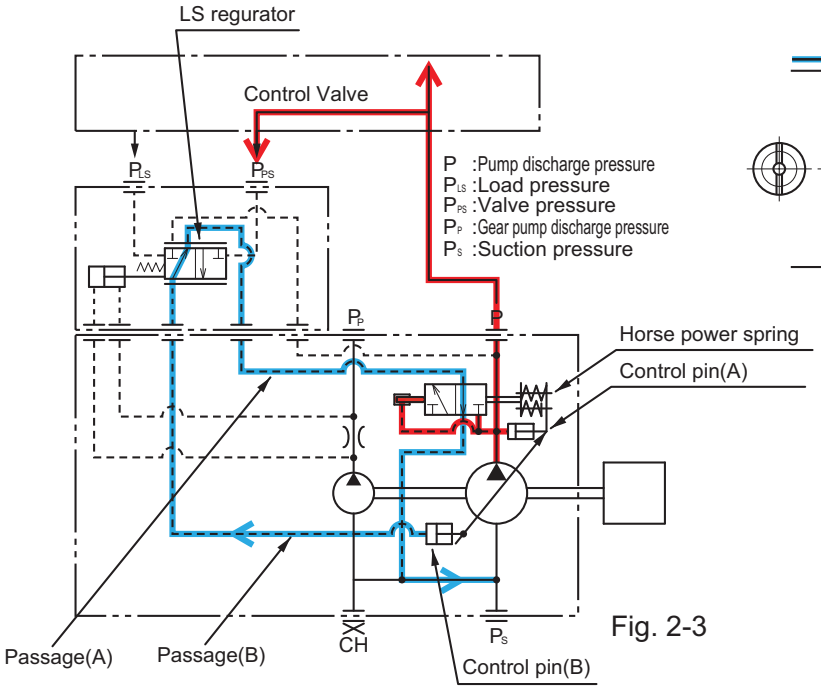


Fig. 2-3

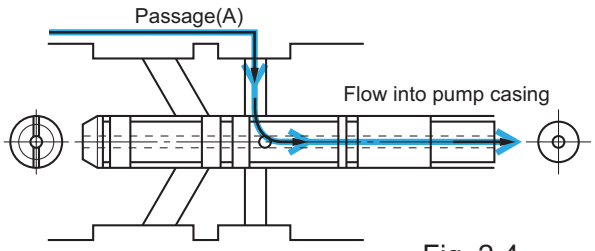


Fig. 2-4

The higher the load pressure becomes, the higher the discharge pressure is. Finally the pressure gets grater than the horsepower spring force and shifts the horsepower control spool to the right. Points (2) and (3) in Fig. 2-1 are where the outer spring and the inner spring, respectively, start being compressed. When the horsepower control spool has been shifted to the right, the pressure oil from the pump passes through the horsepower control spool first and then through the passages (A) and (B), thereby working on the control pin (B). This pressure oil also affects the control pin (A). But the control pin (B), larger in area than the control pin (A), is more affected, which gets the swash plate tilted down (control along the line (4) in Fig. 2-1). When the load pressure becomes lower, to the contrary, the swash plate gets tilted more.

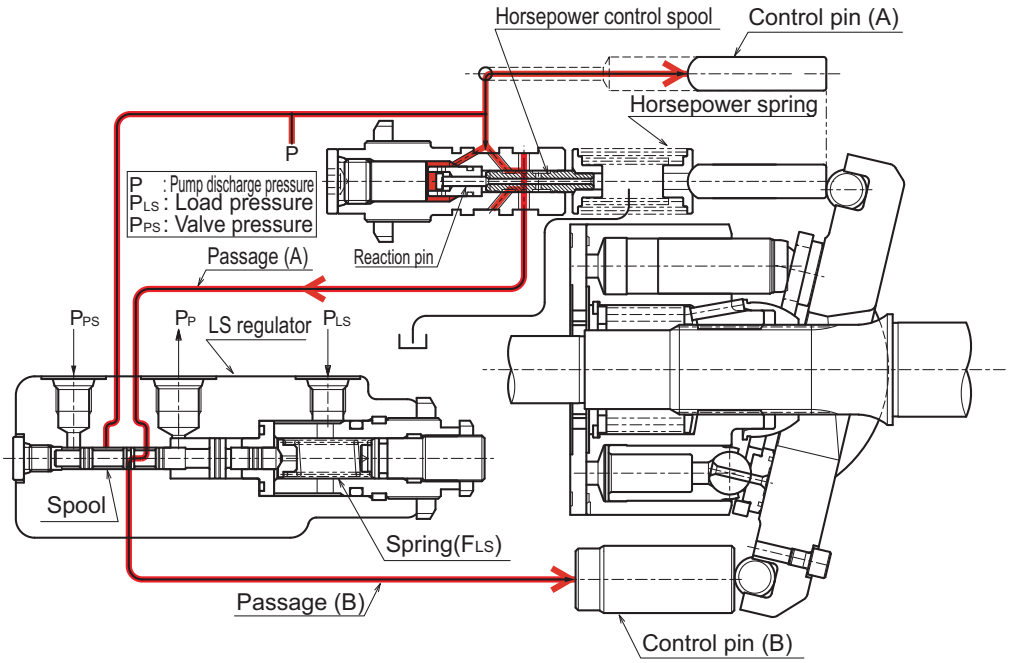


Fig. 2-5

This is as shown in the circuit diagram in Fig. 2-6. The oil flow through the horsepower control spool is referred to in Fig. 2-7.

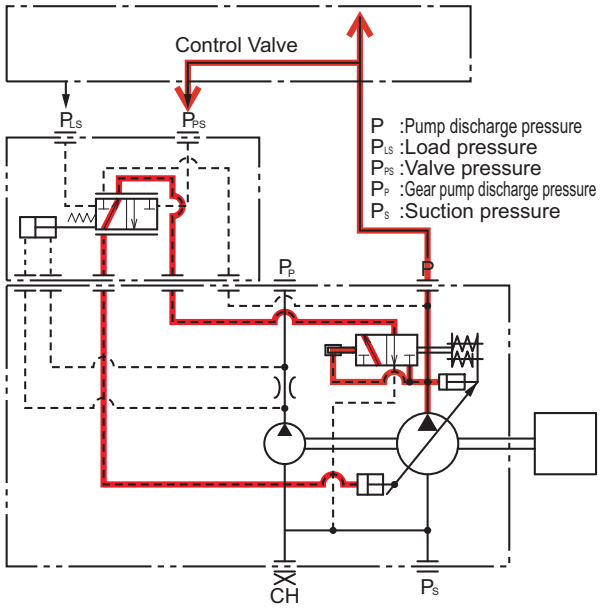


Fig. 2-6

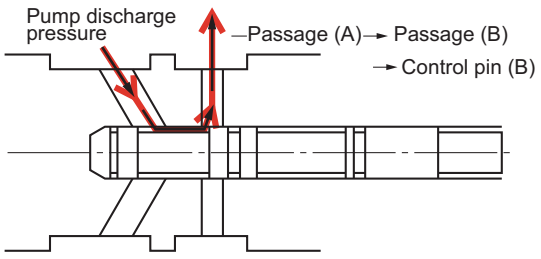


Fig. 2-7

(3) Load sensing control

Load sensing control enables the pressure and flow rate that meet the load in the horsepower control range.

With this function, the discharge pressure and flow rate are fed so that the pump should perform in the equation $P_{PS} = P_{LS} + F_{LS}$.

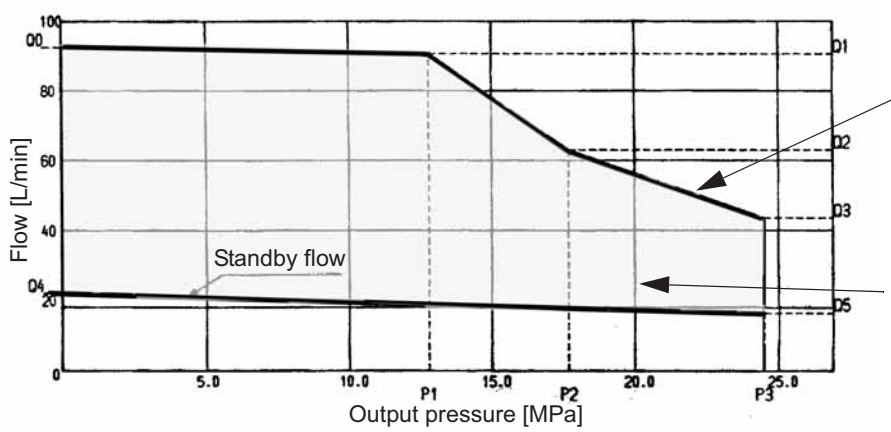


Fig. 3-1

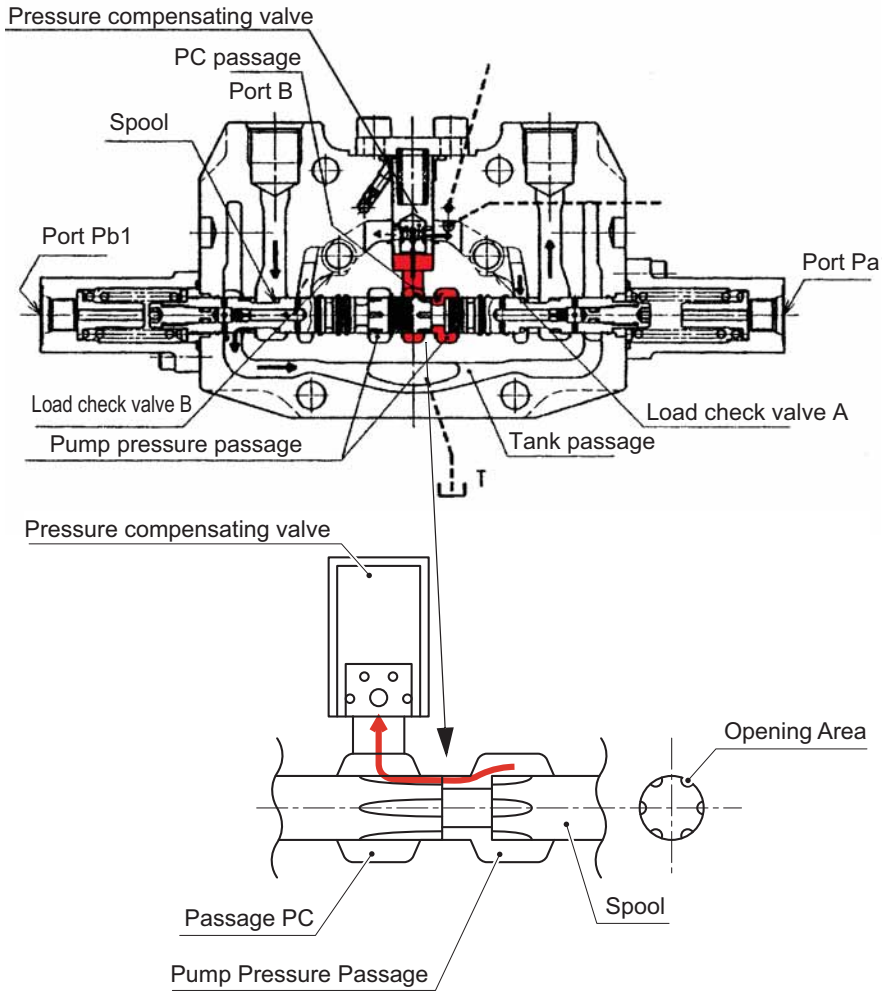


Fig. 3-2

The larger the opening of the control valve spool is controlled, the smaller the difference between the P_{PS} and P_{LS} becomes temporarily. Thus we have $P_{PS} < P_{LS} + F_{LS}$, and the load sensing regulator spool shifts to the left and connects to the passages (A) and (B).

With power control off, the horsepower control spool stays at the left and the passage (A) is connected with the tank (in the pump case). The pressure oil working on the control pin (B) is thus fed through the passages (B) and (A) and the horsepower control spool back to the tank (in the pump case). By so doing, the swash plate's tilt angle gets larger and the discharge rate increases. (Figs. 3-3 and 3-4)

The spool's opening area is shown Fig. 3-2.

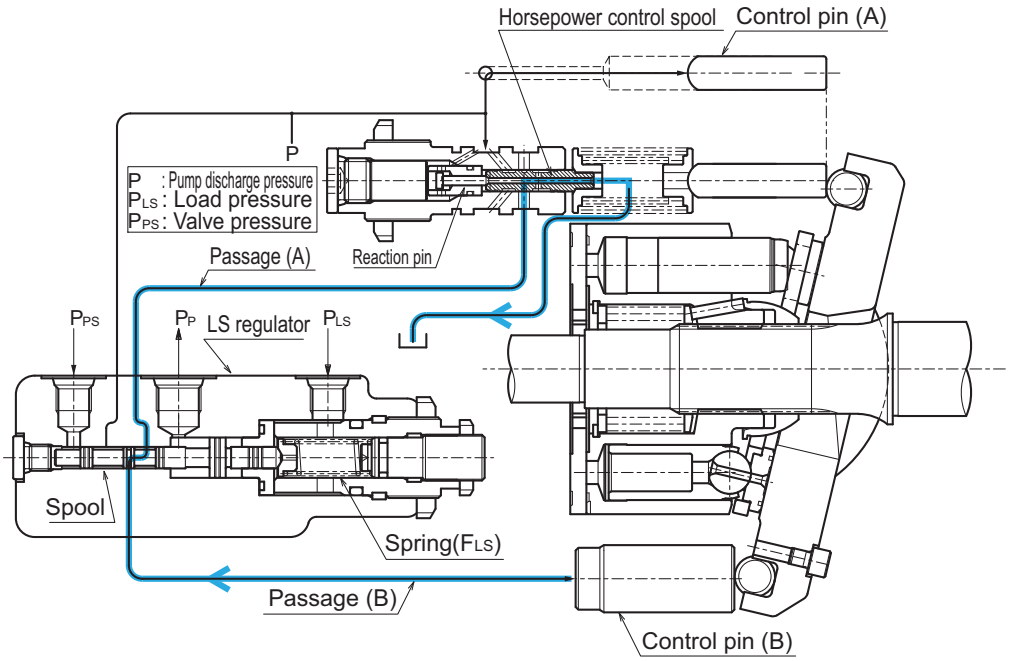

Horsepower control spool
Control pin (A)
P
P : Pump discharge pressure
PLS : Load pressure
PPS : Valve pressure
Passage (A)
Reaction pin
PPS
PP
LS regulator
PLS
Spool
Spring(FLS)
Passage (B)
Control pin (B)

Fig. 3-3

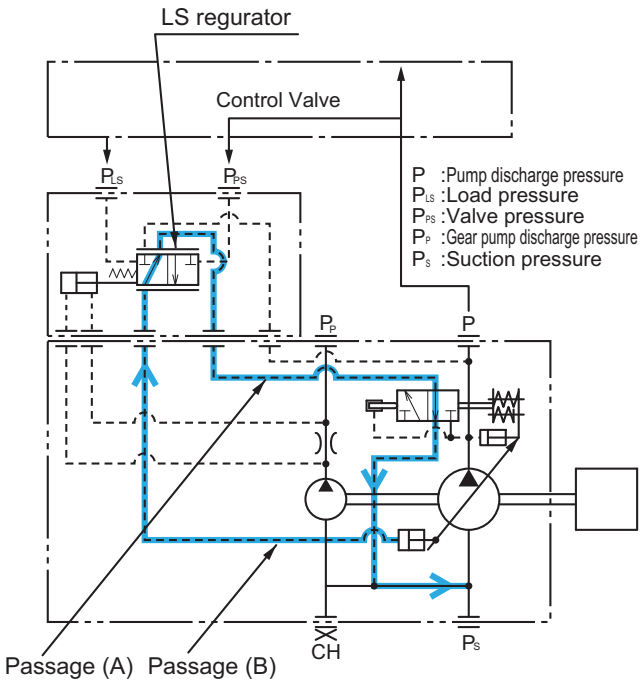

LS regurator
Control Valve
PLS
PPS
P :Pump discharge pressure
PLS :Load pressure
PPS :Valve pressure
PP :Gear pump discharge pressure
PS :Suction pressure
PP
P
CH
PS
Passage (A)
Passage (B)

Fig. 3-4

The smaller the opening of the control valve spool is controlled, the larger the difference between the P_{PS} and P_{LS} becomes temporarily. Thus we have $P_{PS} > P_{LS} + F_{LS}$, and the load sensing regulator spool shifts to the right and connects to the passages (B) and (C). Now the pressure oil from the pump works on the control pin (B), getting the swash plate's tilt angle smaller and the discharge rate lower. (Figs. 3-5 and 3-6)

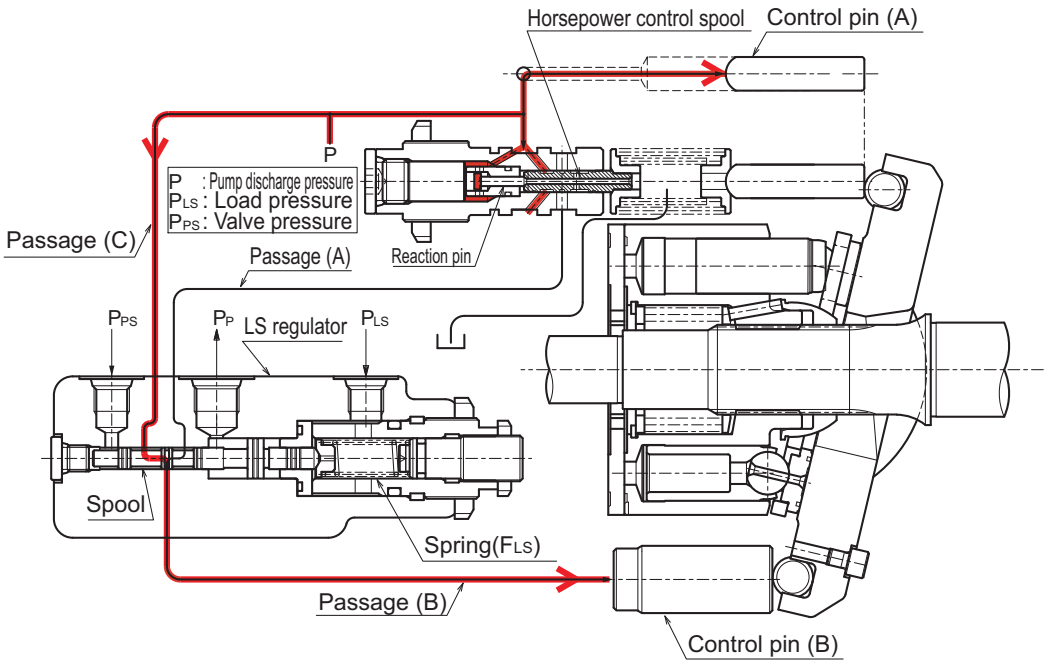


Fig. 3-5

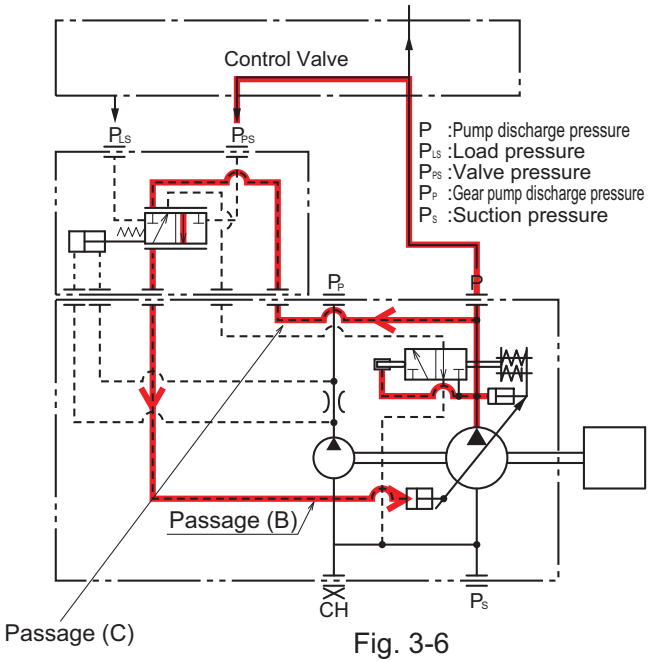
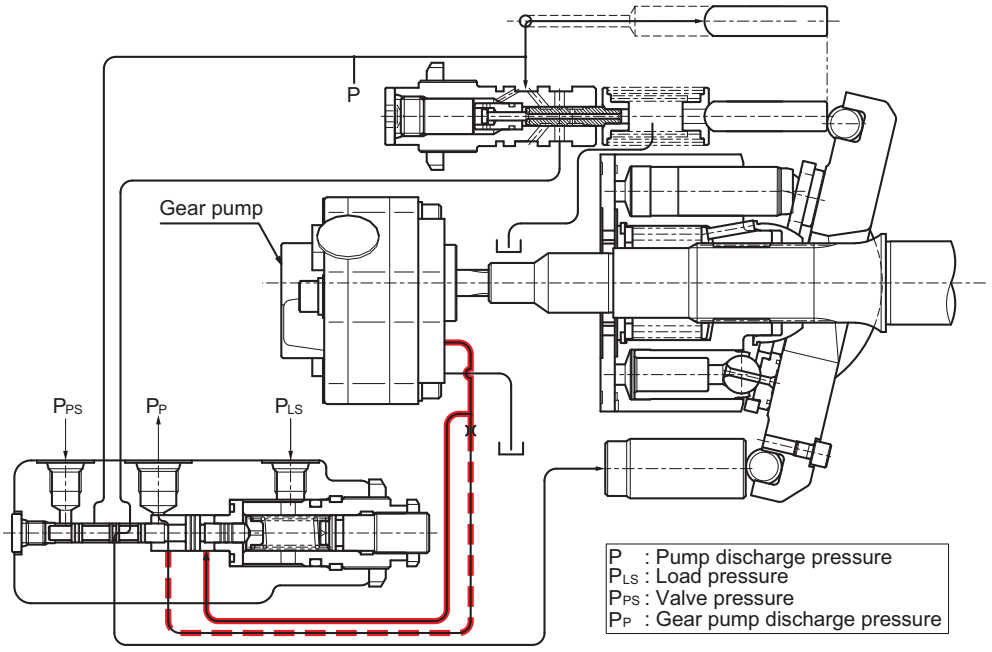
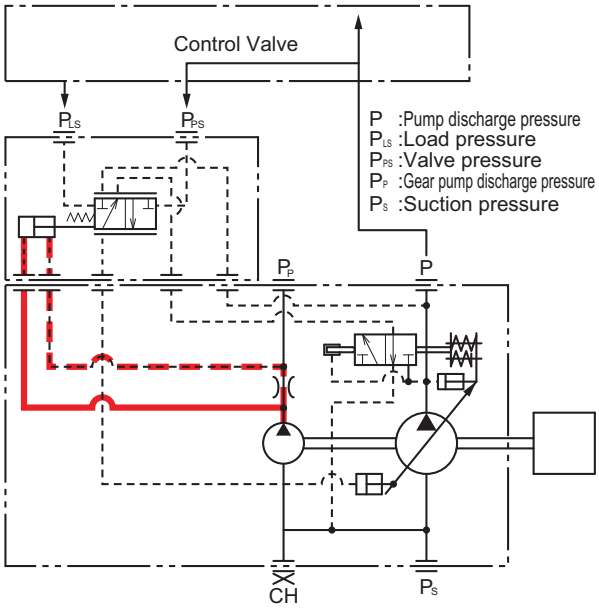


Fig. 3-6

(4) Gain control





The pump's discharge rate is controlled, depending on the pressure difference between P_{PS} and P_{LS} not on the engine speed. The swash plate is controlled all the time so that $P_{PS} = P_{LS} + F_{LS}$.

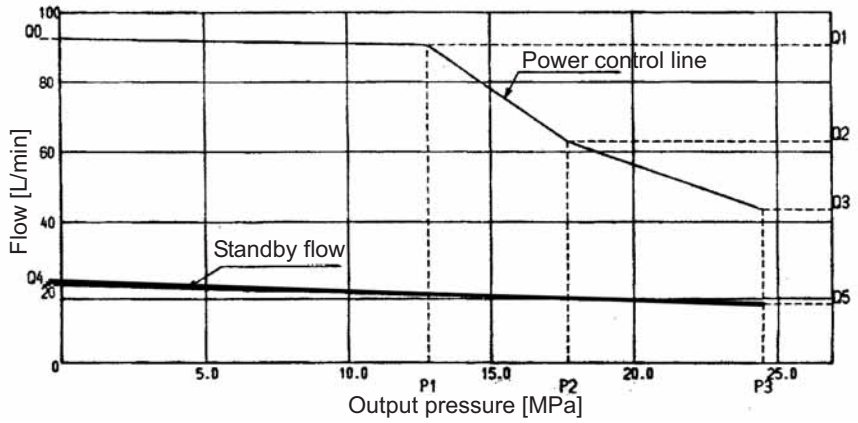
In working at low speed in a narrow space, we used to have the engine speed at low level. The load sensing function, however, keeps up the working speed regardless of the engine speed.

The gain control is designed to achieve the flow rate (speed) in proportion with the engine speed.

A fixed throttle is provided downstream of the gear pump for hydraulic pilot control. The pressure difference caused by a rise in engine speed is introduced to the LS regulator.

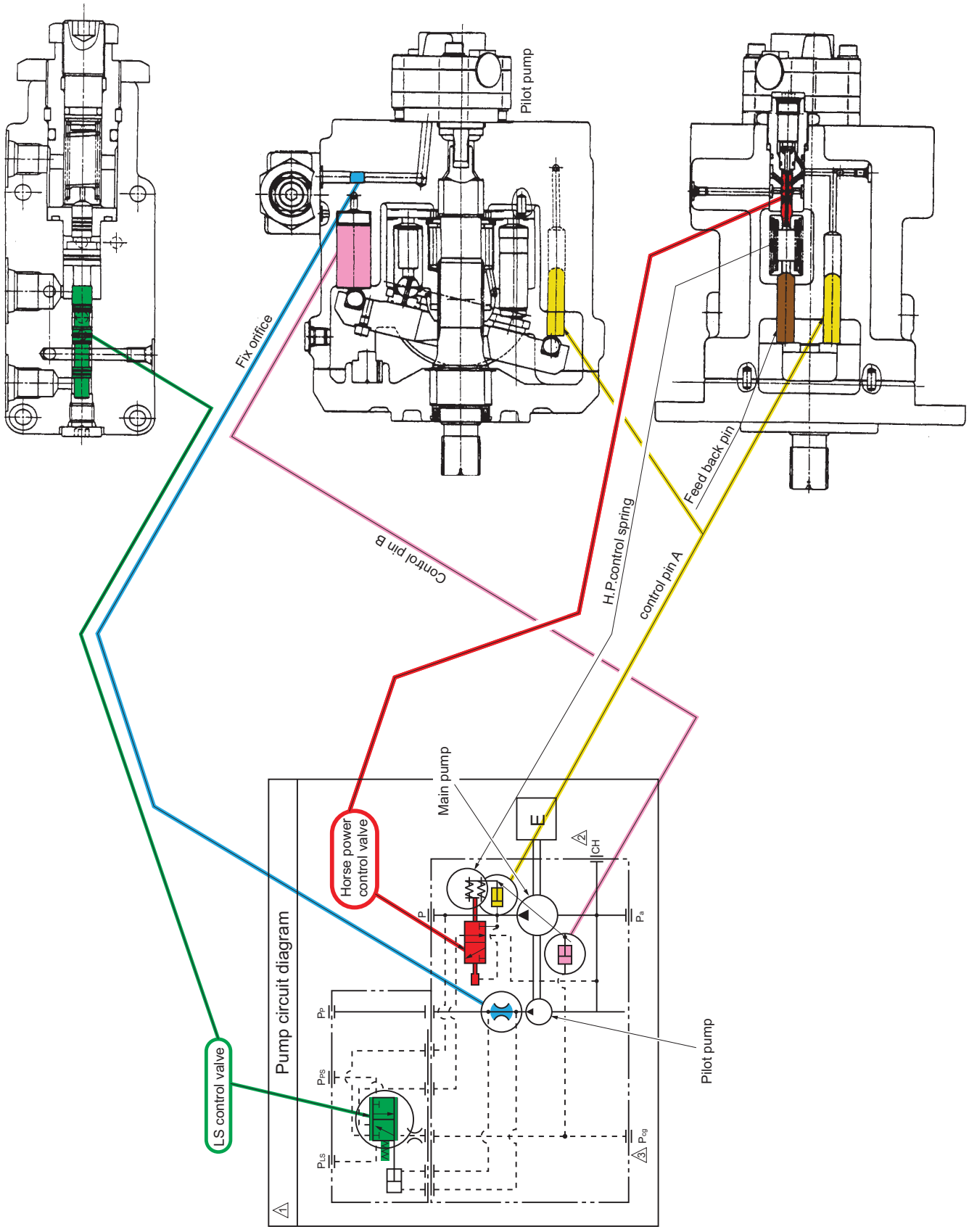
Taking the pressure difference across the fixed throttle as $\triangle P$, we have $P_{PS} = P_{LS} + F_{LS} + \triangle P$. As the pressure difference $\triangle P$ (engine speed) varies, the pressure P_{PS} also fluctuates. In this way, the flow rate can be controlled in proportion with the engine speed.

(5) Standby Flow

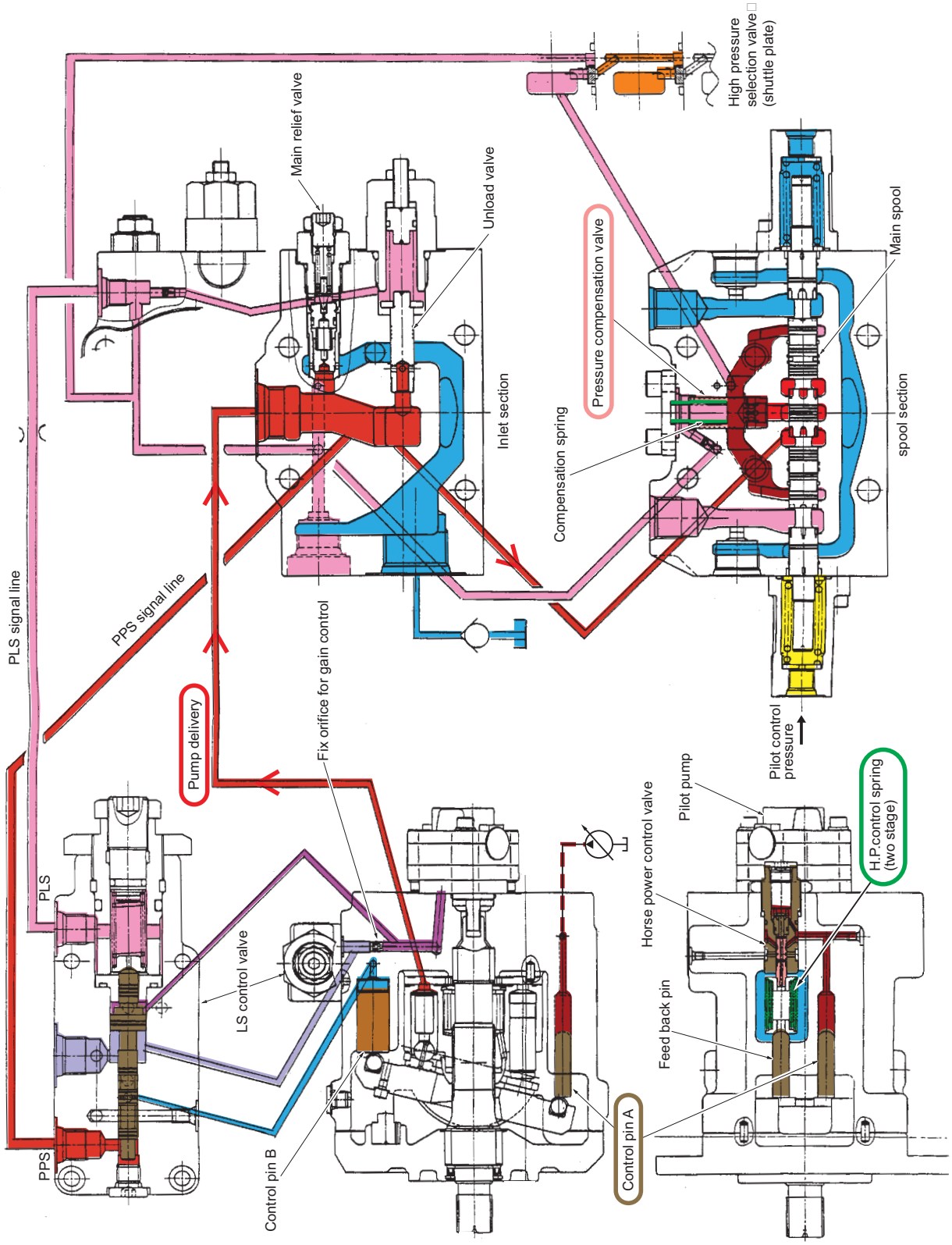


Standby flow is provided in order to allow oil flow in the hydraulic system all the time, even with the engine idling. The oil is kept flowing to the oil cooler, which keeps down the oil temperature and makes for more effective pile driving. The standby flow is achieved by tilting the swash plate to 3-4 degrees.
The control valve is of center-closed circuit type. When all the sections are at neutral, the standby flow goes through the unload valve back to the tank.

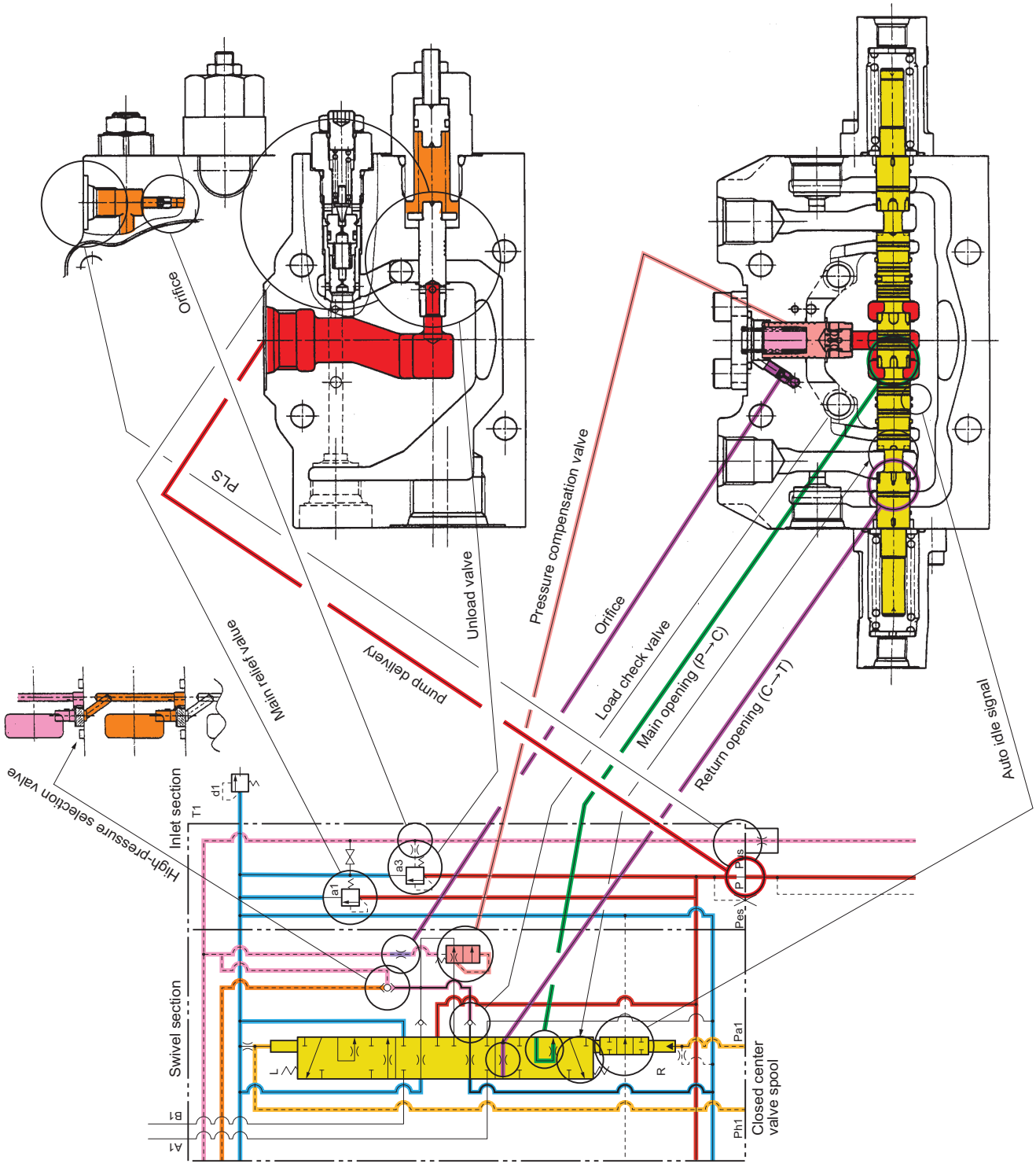
(6) Circuit diagram vs. pump inner parts



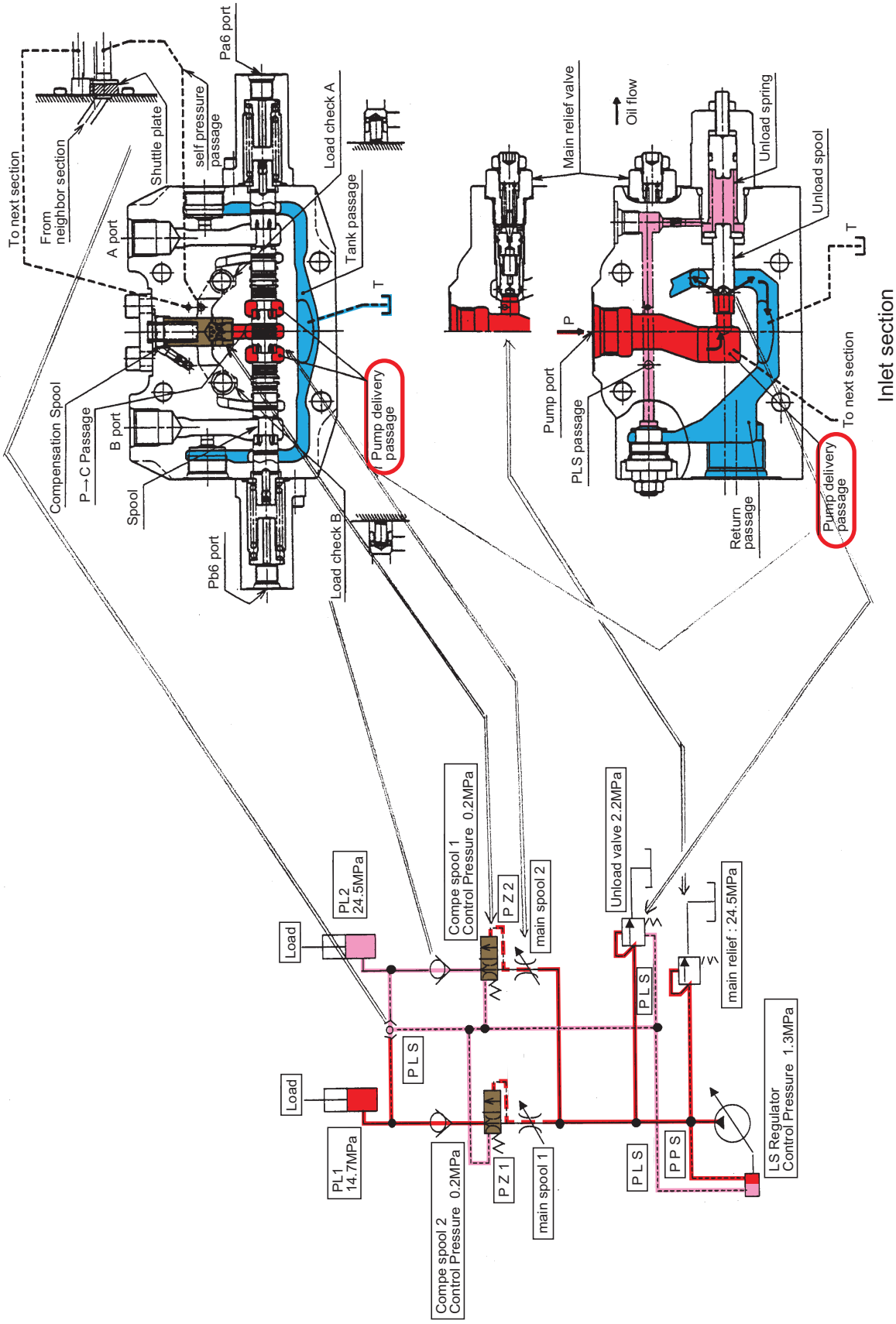
(7) Load Sensing hydraulic system



(8) Control valve circuit and inner parts



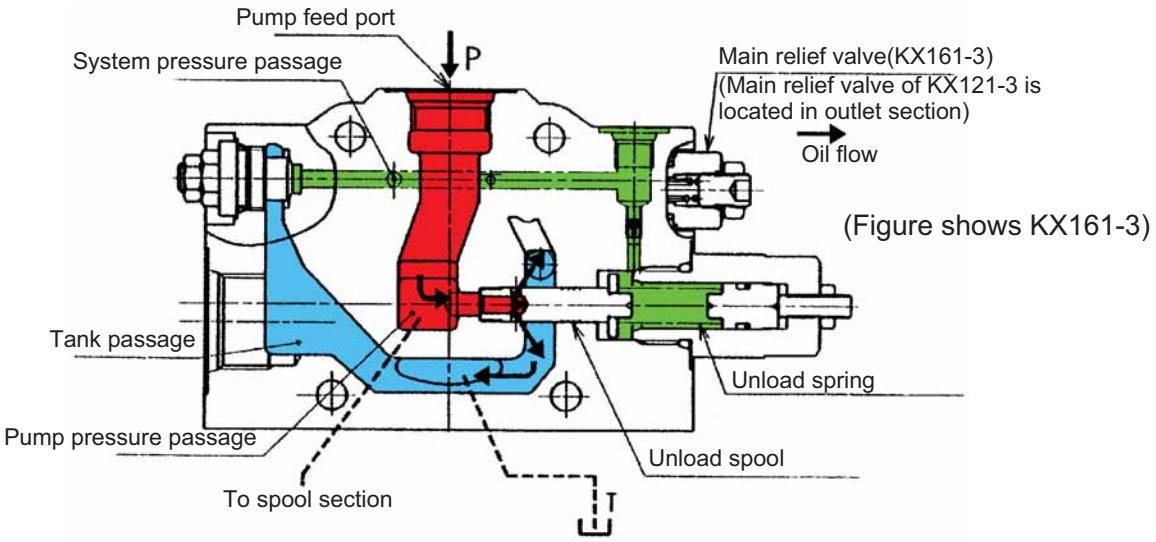
(9) Control valve inner parts vs. LS function circuit diagram



h) Operating Principle

KX121-3S, KX121-3α, KX161-3S, KX161-3α, U45-3, U45-3S, U45-3α, U45S, U50-3α

(1) Unload valve



The unload valve is located at the inlet section. With all the spools at neutral, the oil flowing from the pump is interrupted at the pump pressure passage, which raise the oil pressure. When the pressure has risen enough to push up the unload spool, the oil flows through the unload spool and the tank passage back into the tank. Now the pressure P_{LS} is 0. (Fig.1-1)

When a spool is selected, the oil coming from the pump flows into the section of the selected spool. The highest selected pressure (P_{LS}) between the spool sections is applied through the system pressure passage into the spring chamber of the unload valve. (The highest selected pressure is discussed later.)

Under the condition $P_{PS} > P_{LS}$ + (Unload spring force), the pressure oil flows through the unload spool and tank passage back into the tank. (Fig. 1-2)

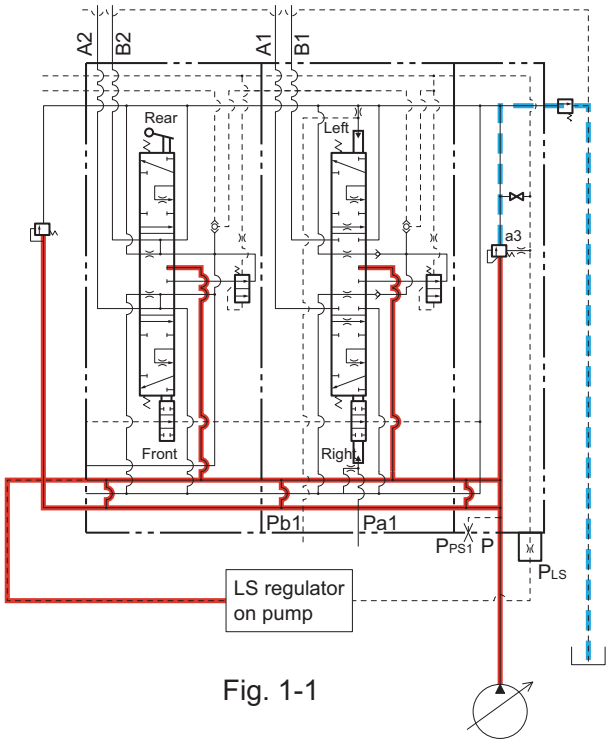


Fig. 1-1

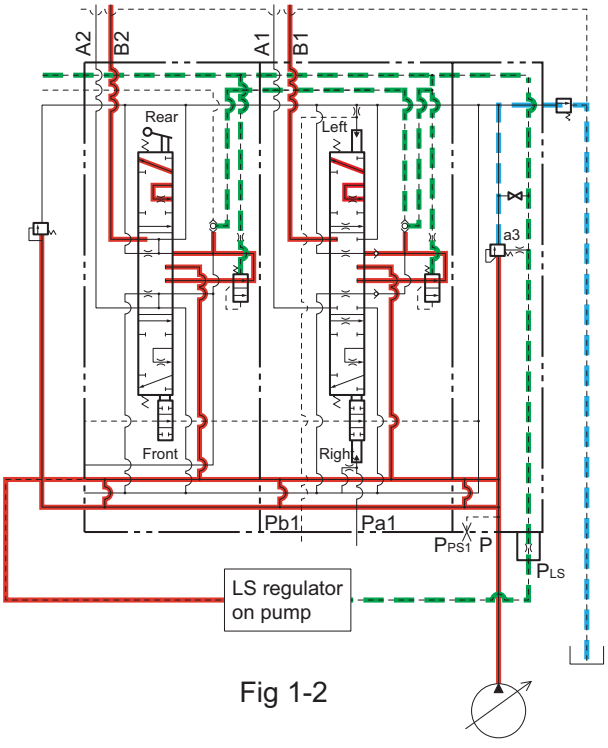
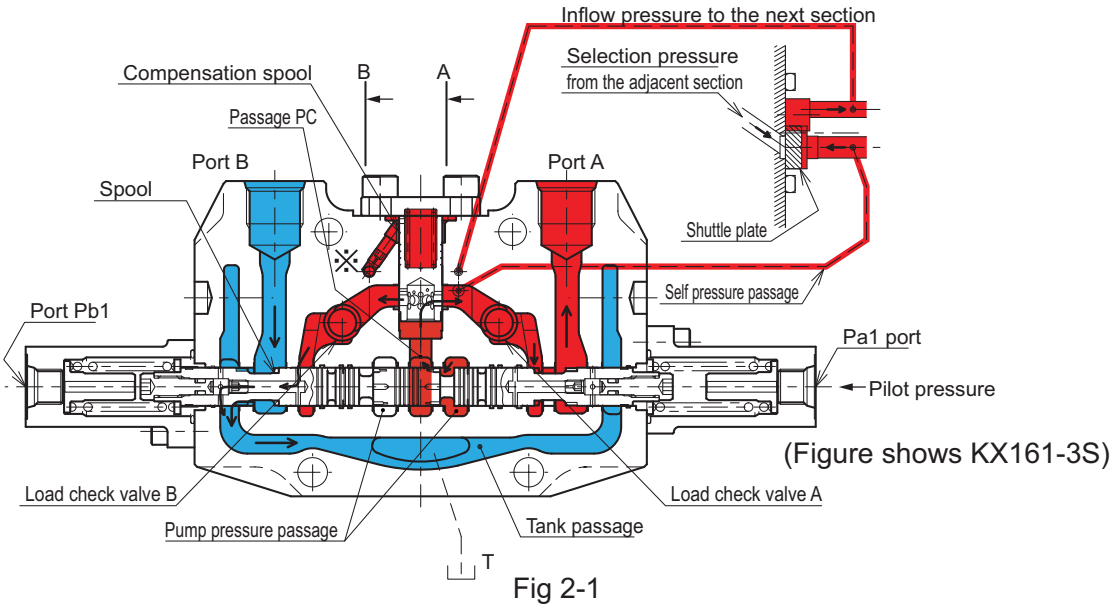


Fig 1-2

(2) High-pressure selector valve

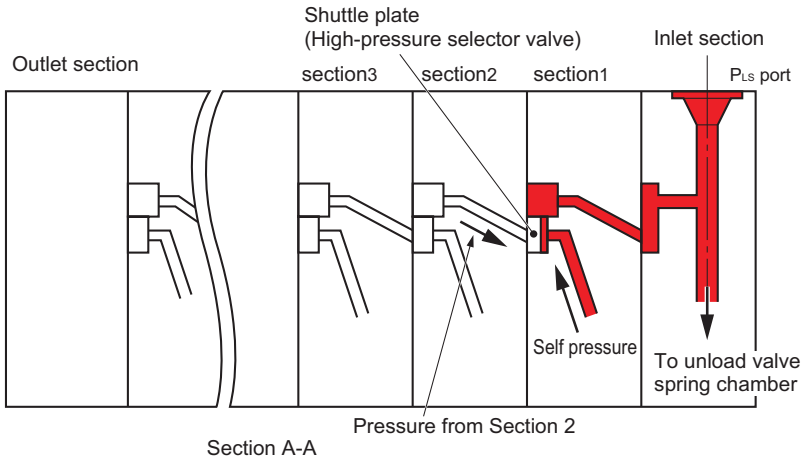


(Figure shows KX161-3S)

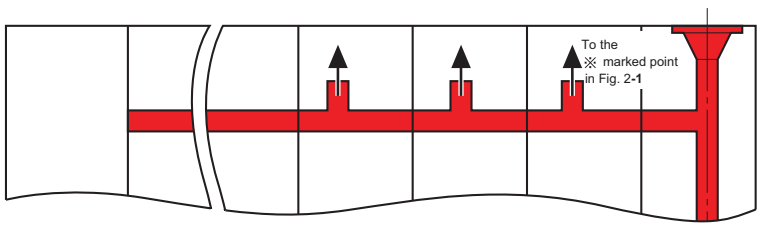
Fig 2-1

When the port Pa1 gets under pressure to switch the spool, the oil in the pump pressure passage flows through the passage PC to push up the compensation spool as well as the load check valve A, and keeps flowing into the port A. The oil is also fed through the self pressure passage to get the shuttle plate activated.

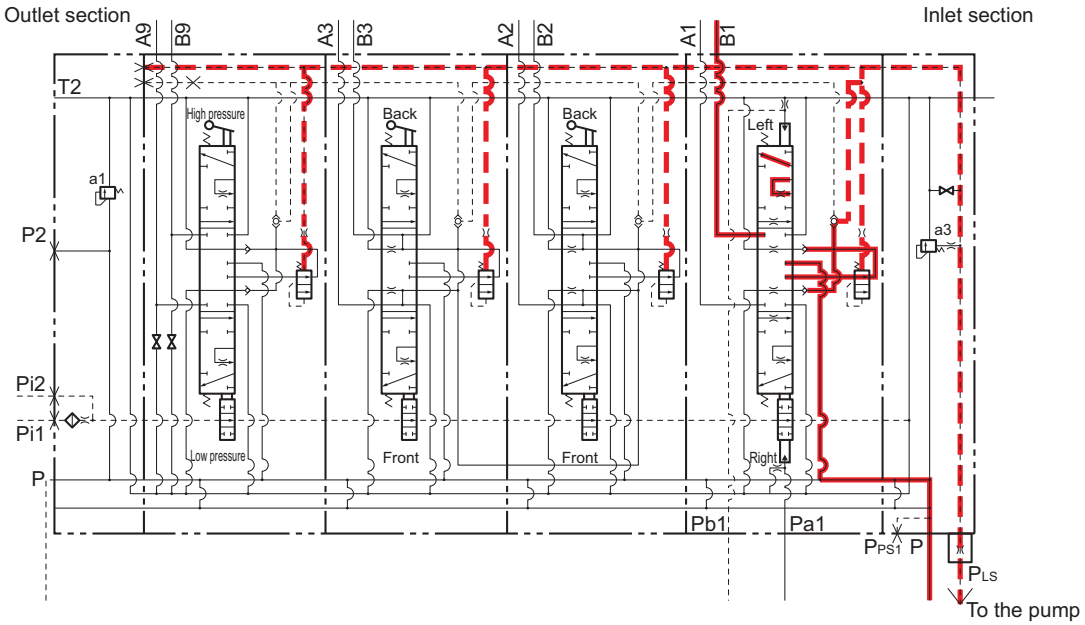
1) When the spool of Section 1 alone is activated:
   Because there is no pressure from Section 2, the self pressure (load pressure) of Section 1 pushes the shuttle plate and the oil is introduced into the inlet section and the unload valve spring chamber. The oil also flows via the port P_{LS} to the port P_{LS} of the pump's LS control valve. In other words, this self pressure serves as the P_{LS} pressure.
   This self pressure is also applied via the inlet section and the passage of each section upon the spring chamber that is located behind the compensation spool.



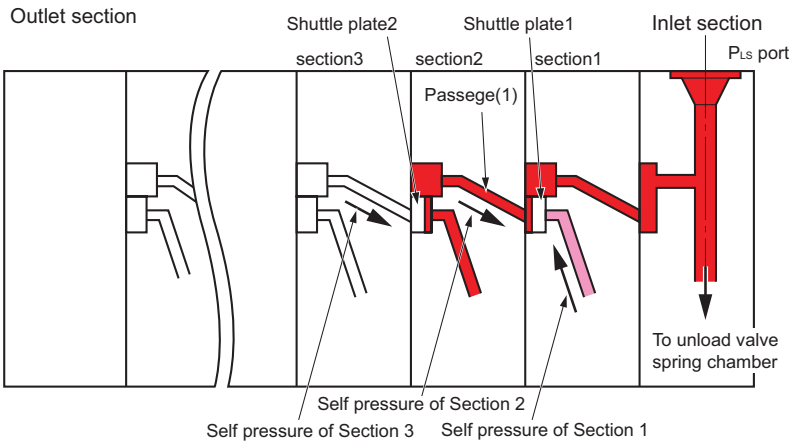
Section A-A

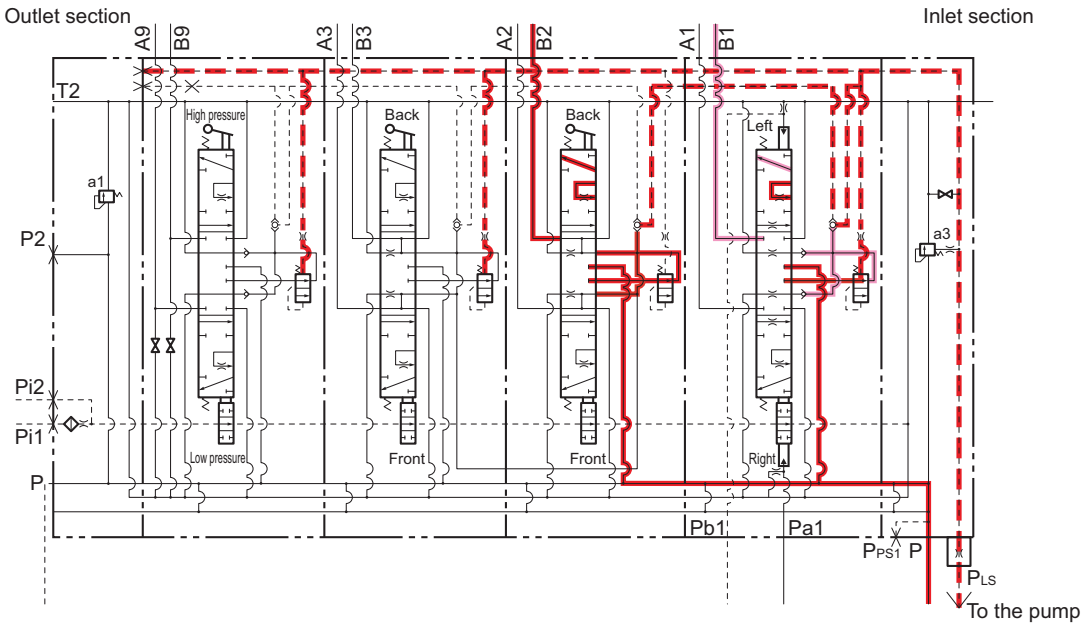


Section B-B

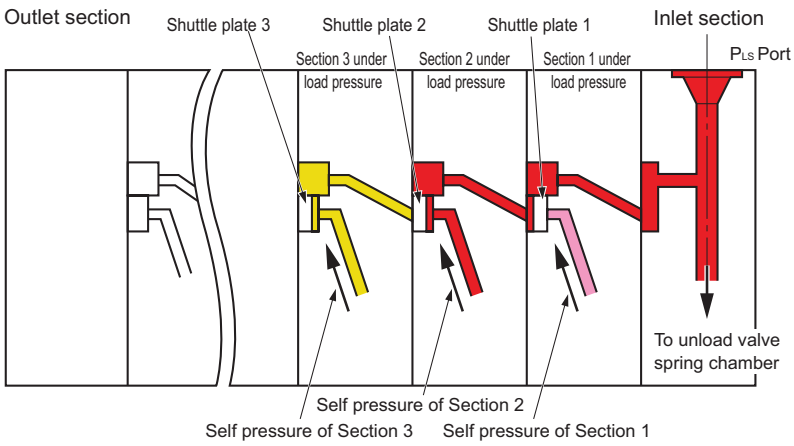


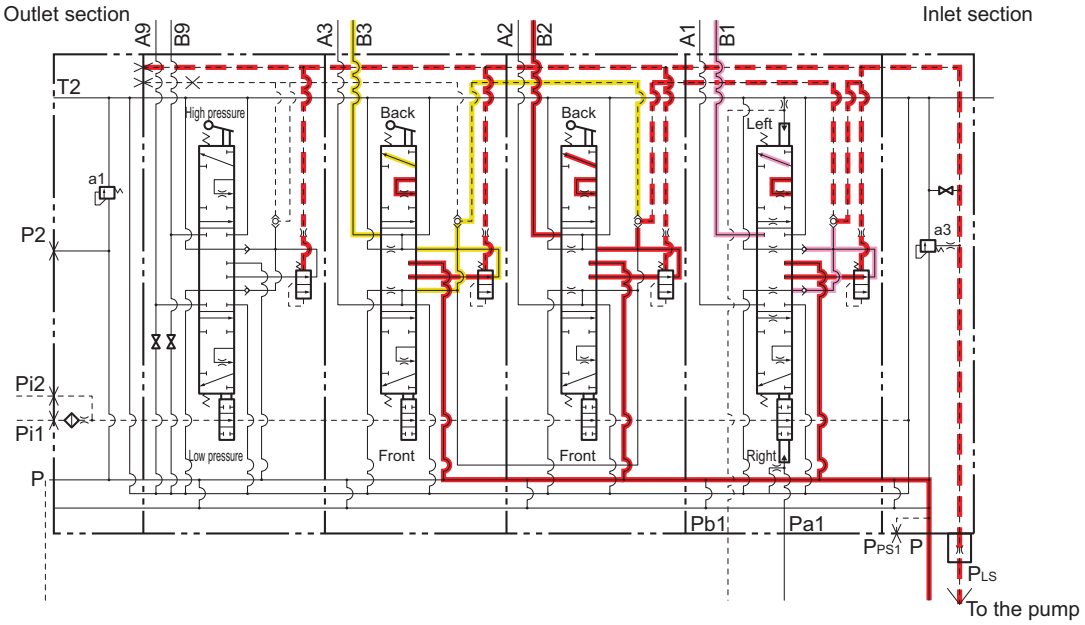
2) When the spools of Sections 1 and 2 are activated and the load pressure of Section 2 is higher:
Because there is no pressure from Section 3, the self pressure of Section 2 is introduced into the passage (1). Now the self pressure of Section 2 is higher than that of Section 1. The shuttle plate 1 moves to the right and the self pressure of section 2 is introduced into the inlet section. In other words, this self pressure serves as the P_{LS} pressure.





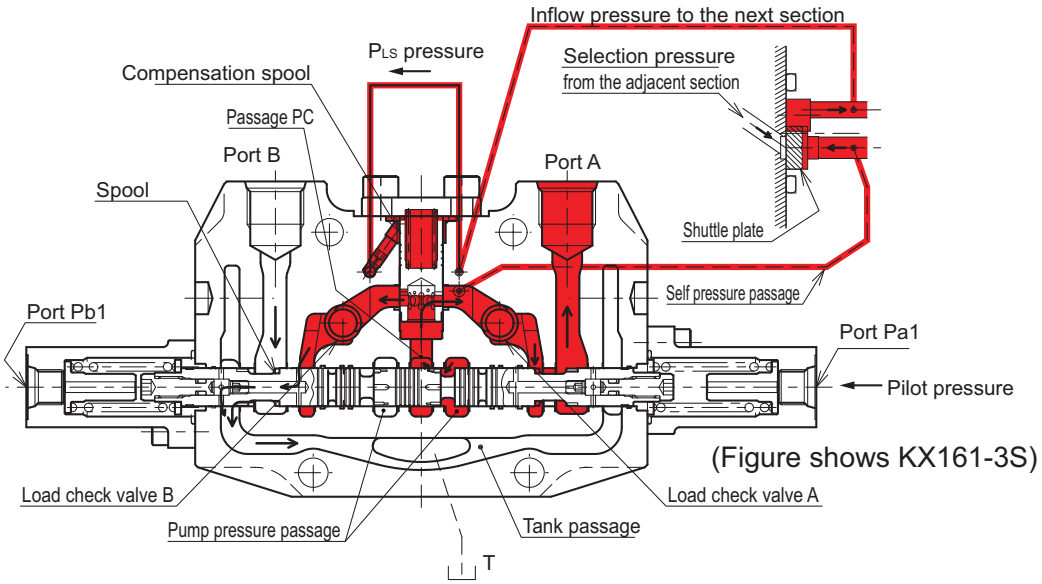
3) When the spools of Sections 1, 2 and 3 are activated and the relationship of load pressures is Section 2 > Section 3 > Section 1:
The self pressure of Section 3 moves the shuttle plate 3 to the left and is introduced into the shuttle plate 2.
The self pressure of Section 2 is equally introduced into the shuttle plate 2. Because the load pressure of Section 2 is higher than that of Section 3, the shuttle plate 2 moves to the left and the self pressure of Section 2 is introduced into the shuttle plate 1.
Now because the self pressure of Section 2 is higher than that of Section 1, the shuttle plate 1 moves to the right and the self pressure of Section 2 is introduced into the inlet section. In other words, section 2 self pressure serves as the P_{LS} pressure.





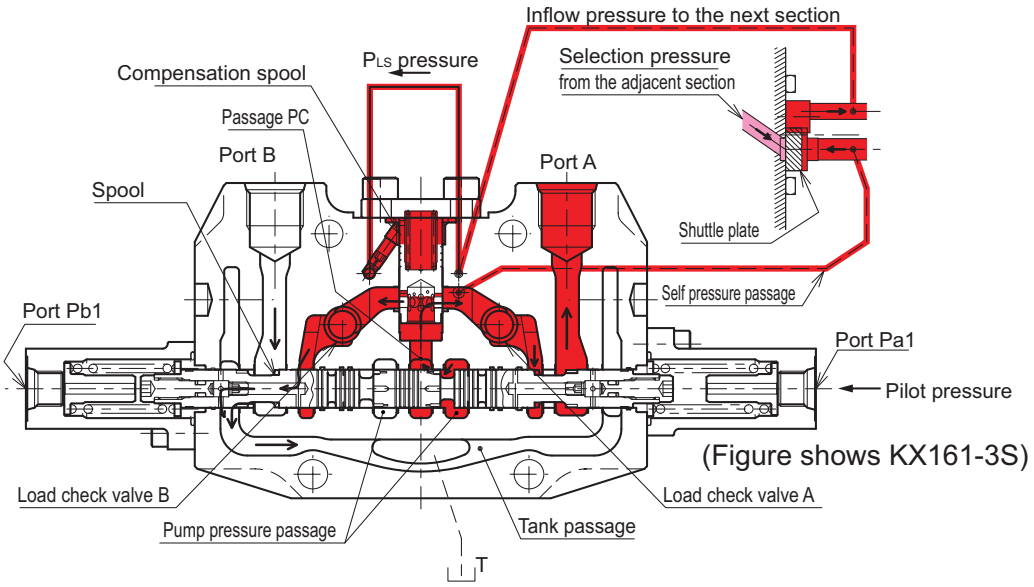
(3) Pressure compensating valve

1) With only one section being activated
When only one section is operated, the pressure, which is applied through the pump pressure passage, passage PC and compensating spool, is introduced as the self pressure (load pressure) into the pressure compensating valve spring chamber that is located behind the compensation spool. In other words, the self pressure (load pressure) serves as the P_{LS} pressure. The P_{LS} pressure plus pressure compensating valve spring force equals the pressure of passage PC.

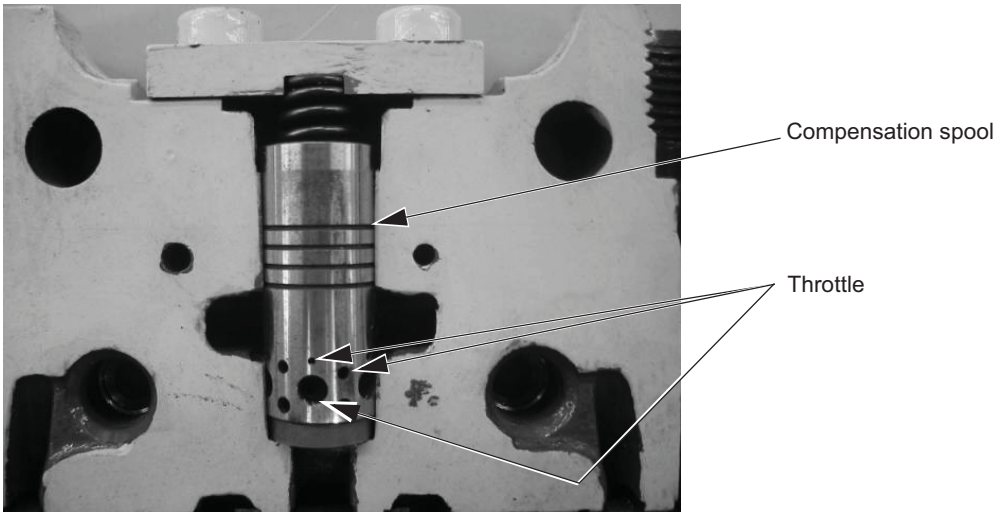


2) With two sections being activated
When two sections are operated simultaneously and the load pressure of one section is higher than that of the other:
1. Section with higher load pressure
The pressure, which is applied through the pump pressure passage, passage PC and compensation spool, is selected by the high-pressure selector valve as the P_{LS} pressure. (This is because the load pressure [self pressure] of one section is higher than that of the other.) The system behaves the same way as with only one section operated.

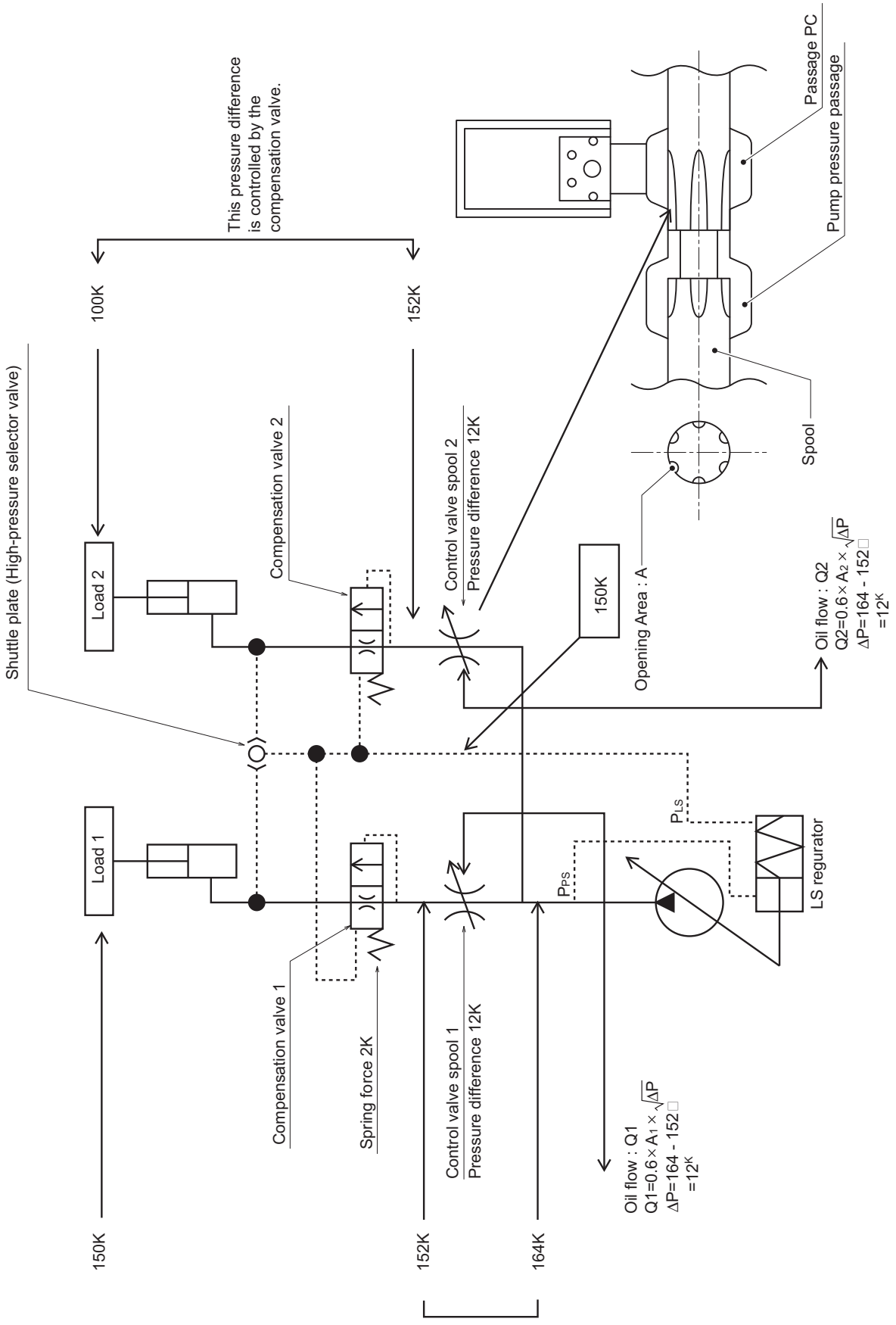
2. Section with lower load pressure
The Shuttle plate selects the self pressure of the higher-load-pressure section as the P_{LS} pressure. Due to this P_{LS} pressure, the pump's swash plate is controlled (in the equation $P_{PS} = P_{LS} + F_{LS}$). No matter how high the load pressure is, the passages PC of the sections are under almost the same pressure. The difference between the passage PC pressure and the self pressure of the lower-load-pressure section is caused at the throttle located at the compensation spool. This pressure difference moves the compensation spool to a well-balanced position. (With the compensation spool lower, the throttle becomes smaller and the difference between the passage PC pressure and self pressure becomes larger.)
Even if the load pressures of the two sections are different, the compensation spool puts the passages PC under nearly the same pressure. In this way, the flow rate is free from load fluctuations and can only be controlled according to the spool's openness.



(Figure shows KX161-3S)

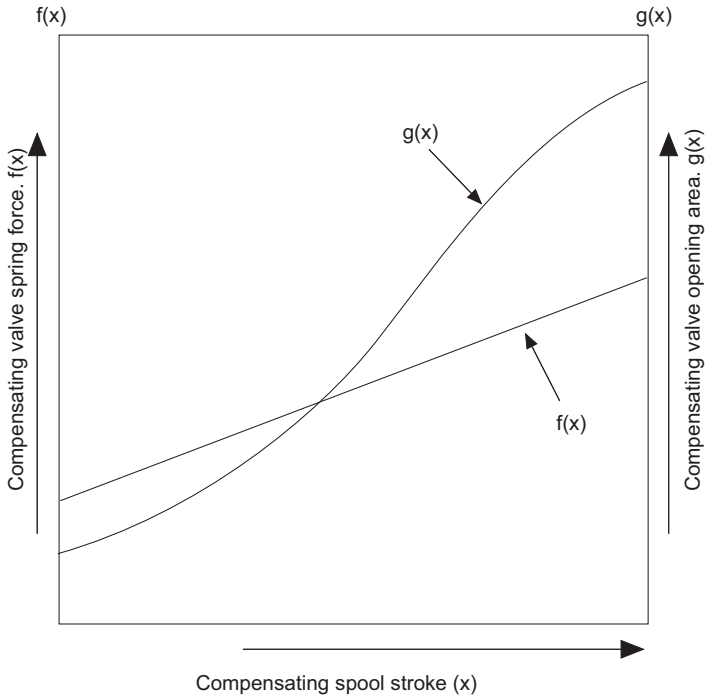


Operation of compensation valve



Details of the pressure compensating valve

On the preceding page, the compensating valve spring force is considered to be fixed at 2K. In practice, the following relationship is seen among the pressure compensating spool stroke, the compensating valve spring force and the compensating valve opening area.



where f(x): Compensating valve spring force (function of stroke x)
g(x): Compensating valve opening area (function of stroke x)

When the compensating valve is at the lowest position (compensating spool stroke at 0), the spring force is weak and the compensating valve's opening area is narrow.
As the compensating valve surpasses the spring force and moves upward, the spring force gets stronger and the compensating valve' opening area larger.
Let's say, the pressure difference across the compensating valve, discussed on the preceding page, is $\triangle P_P$. And take an example of maximum load pressure of the arm circuit at 150K. We have

$Q = 0.6 \times g(x) \times \sqrt{\triangle P_P}$

When the load pressure is 130K, we have

$Q1 = 0.6 \times g_1(x) \times \sqrt{152\text{-}130}$

When the load pressure is 80K, we have

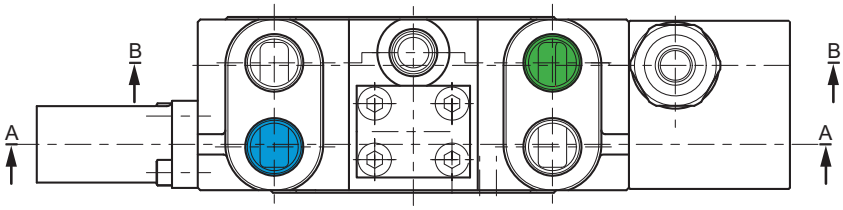
$Q2 = 0.6 \times g_2(x) \times \sqrt{152\text{-}80}$

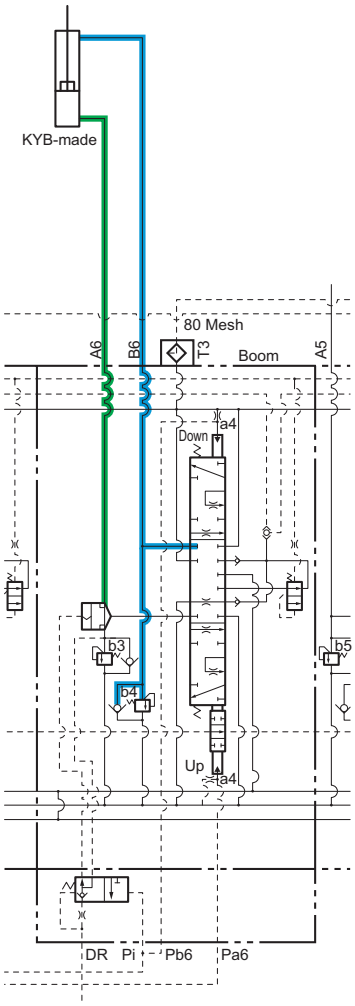
For calculation, f(x) is considered fixed at 2K.)
On the other hand, Q1 = Q2.
So, $g_2(x) < g_1(x)$.
This means the following points. When the pressure difference across the compensating valve is small, the compensating spool is kept balanced upward. When it is large, the spool is kept balanced downward with the throttle opening area small.

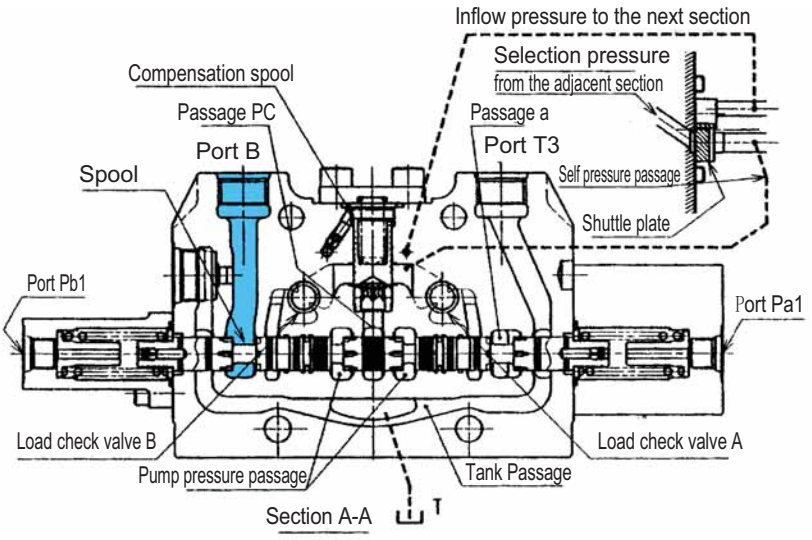
i) Boom Anti-drift Valve

(1) With the boom section at neutral

The hydraulic oil at port B (cylinder rod side) is shut off.
The hydraulic oil at port A (cylinder bottom side) flows through the passage C and poppet “d” into the chamber Z. Now the anti-drift poppet gets closed, which prevents the boom from falling.







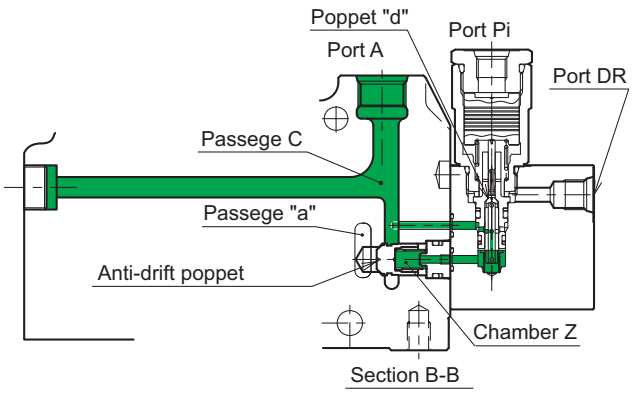
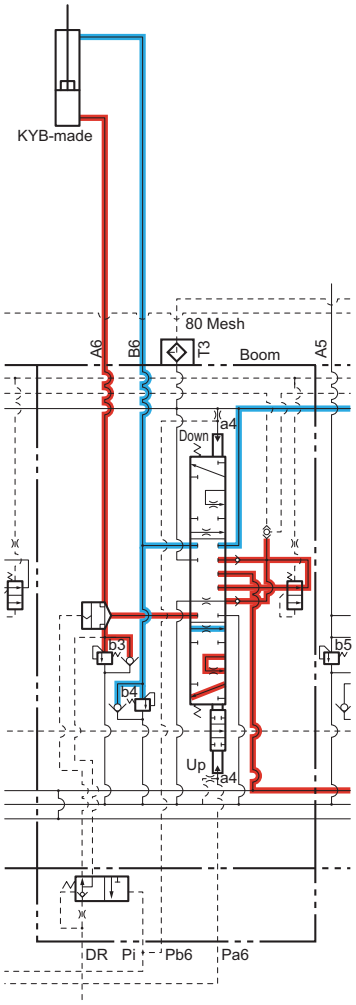


Figure shows KX161-3S

(2) With port Pa under pressure (Boom up)

When the boom is lifted, the oil from the pilot valve is introduced into the port Pa and the control valve spool is moved to the left.
The hydraulic oil in the pump pressure passage flows through the passage PC, pushing up the compensation spool first and then the load check valve A. The oil then flows through the passage “a”, pushing up the anti-drift poppet. The oil further goes through the port A.
The return oil from the port B comes through the throttle into the tank.



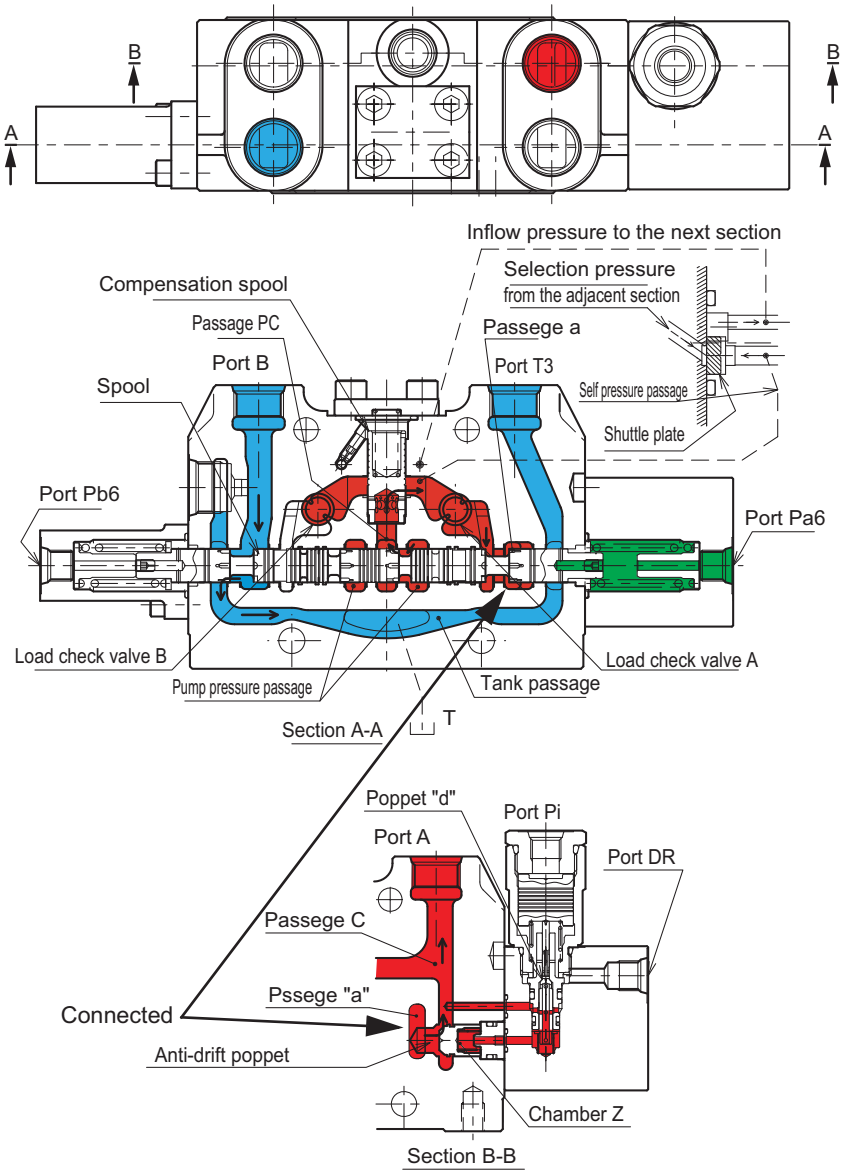
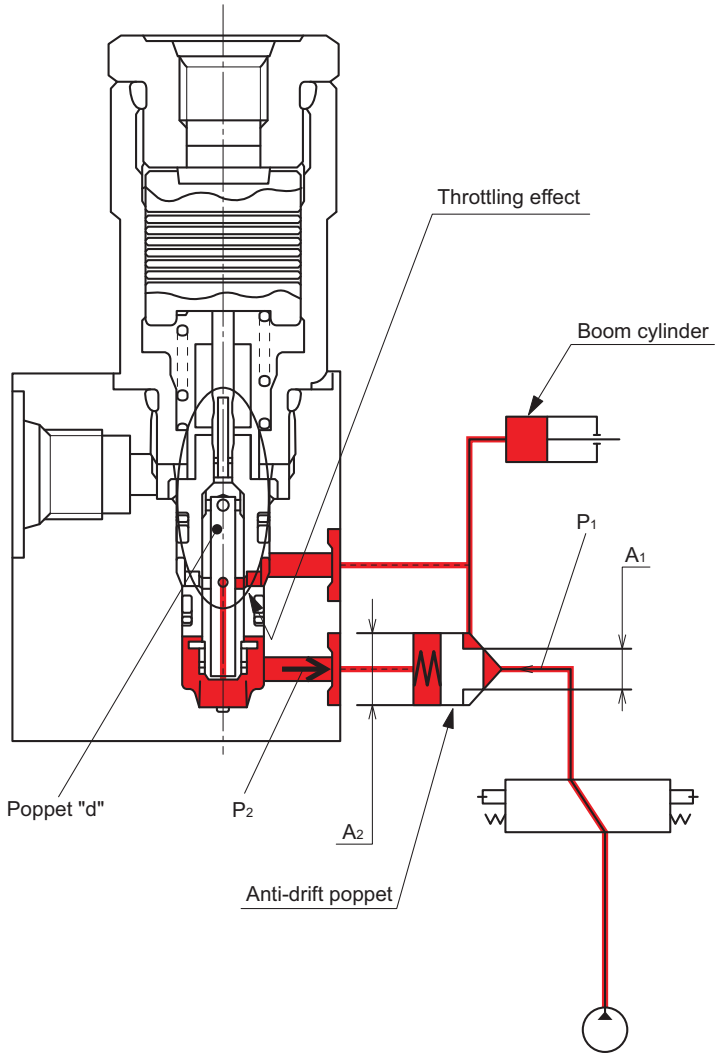


Figure shows KX161-3S

Details of the anti-drift valve operation



The oil from the pump comes pushing through the anti-drift poppet into the boom cylinder. The oil also passes through the poppet "d" and reaches behind the anti-drifty poppet.
The power balance at this time is expresses as $P_1 \times A_1 > P_2 \times A_2$.
WhereP_1: Pressure of the oil from the pump
P_2: Pressure applied behind the anti-drift poppet ($P_1 > P_2$ because of the throttling effect of poppet "d")
A_1: Area exposed to the pressure P_1
A_2: Area exposed to the pressure P_2
The anti-drift poppet shifts to the left in the above figure.
$A_1 < A_2$ but $P_1 >> P_2$, Thus we have $P_1 \times A_1 > P_2 \times A_2$.

(3) With port Pb under pressure (Boom down)

When the boom is lowered, the oil from the pilot valve is introduced into the port Pb and the control valve spool is moved to the right. The hydraulic oil in the pump pressure passage flows through the passage PC, pushing up the compensation spool first and then the load check valve B. The oil further goes through the port B.
The oil from the pilot valve, on the other hand, is also introduced to the port Pi, pushing down the piston, pin and poppet “d“. The oil in the chamber Z flows through the poppet “d“ and the pin’s internal hole and then via the drain port back into the tank.
Now the pressure in the chamber Z goes down, and the return oil from the port A pushes open the anti-drift poppet. It further flows through the passage a, the spool’s throttle and the tank passage back into the tank.

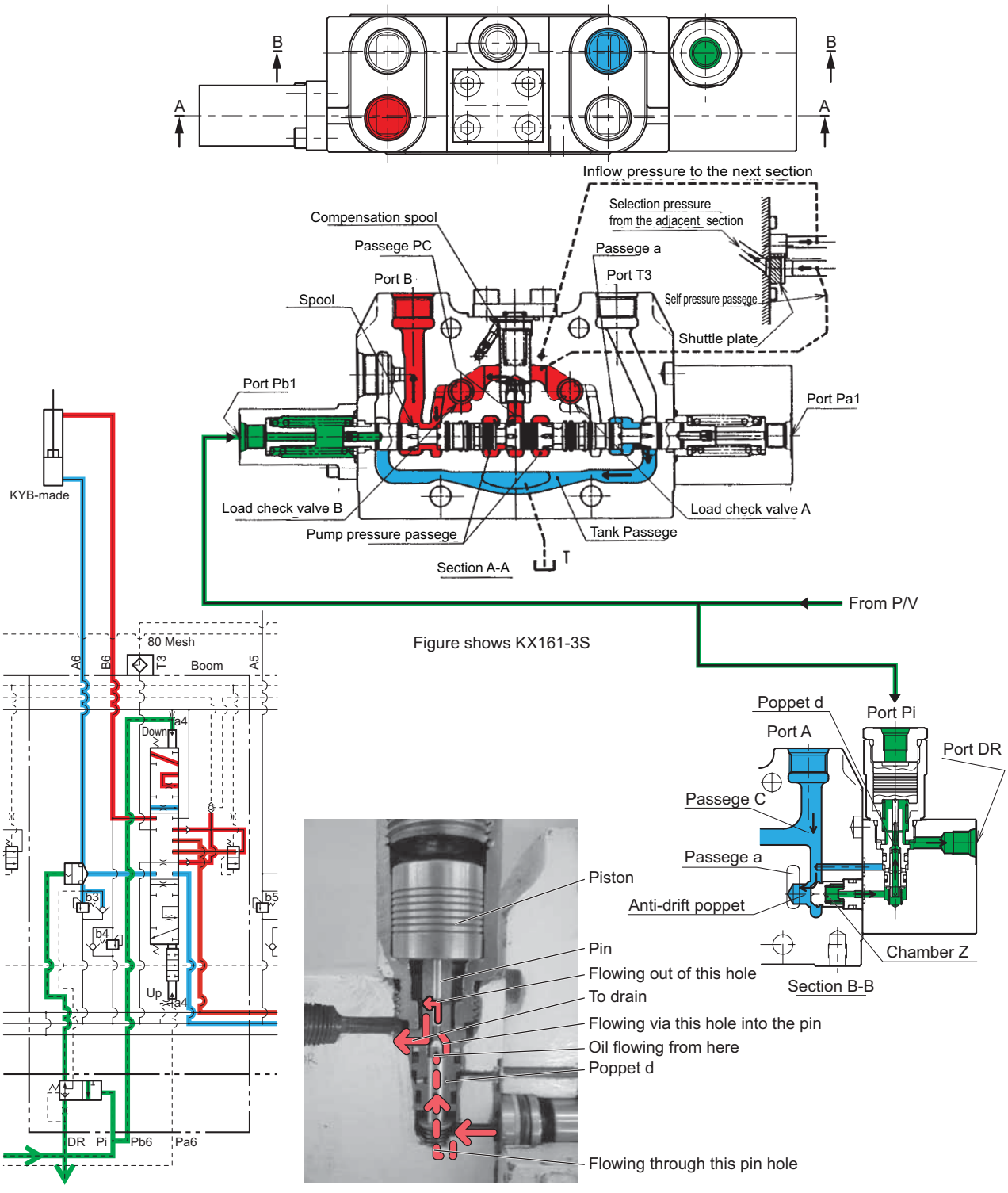
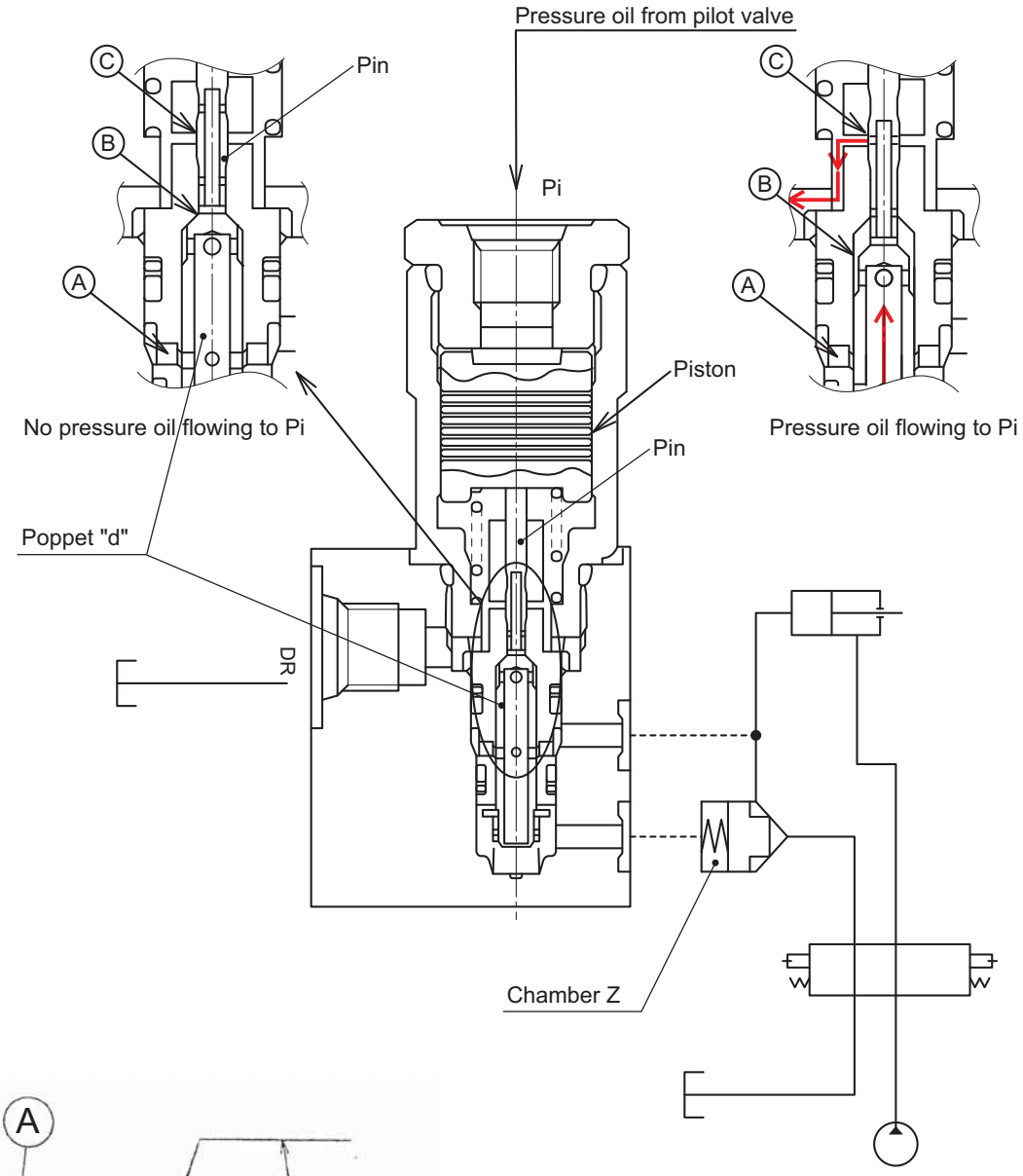
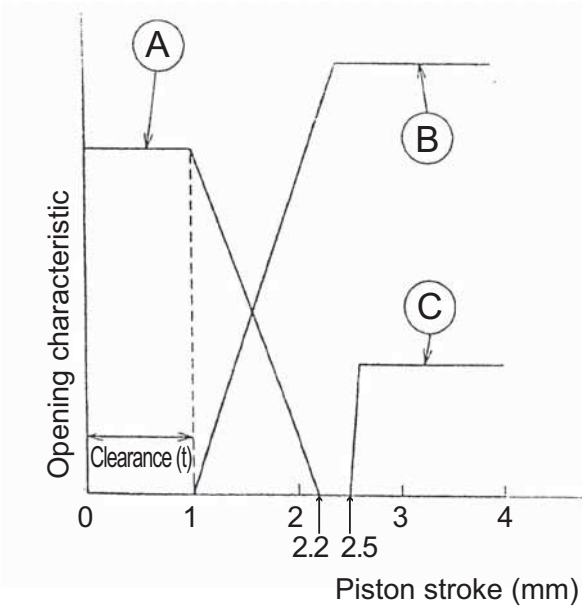


Figure shows KX161-3S

Details of the anti-drift valve operation



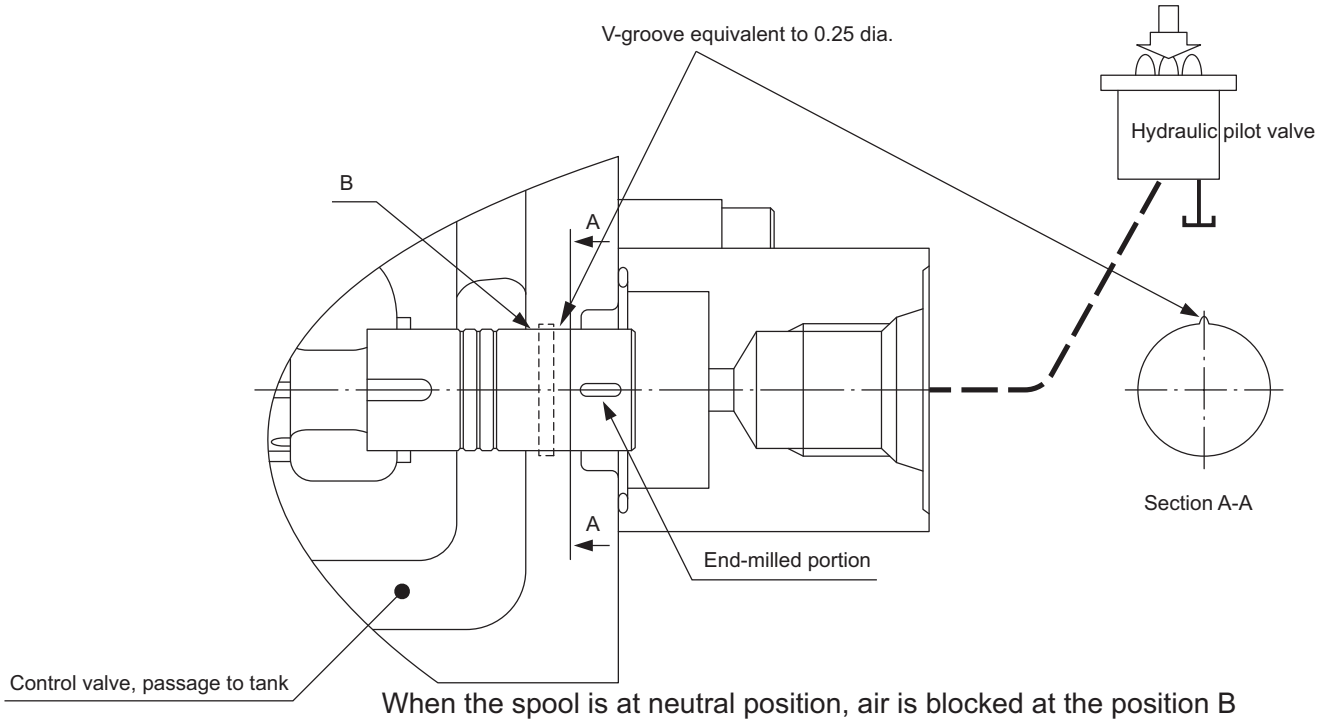


Part of the oil from the pilot valve is introduced into port Pi of the anti-drift valve, thereby pushing down the piston. Part (A) gets shut off first. Part (C) then gets open, which feeds the oil from chamber Z, through the poppet "d" and the pin, and into the tank. In this design - shutting off part (A) before opening part (C), the oil at the boom cylinder bottom is kept from flowing to the tank. Thus the anti-drift poppet can be perfectly pushed open. As a result, the oil at the boom cylinder bottom is all fed through the control valve back into the tank.

j) Automatic Air Bleeding in Hydraulic Pilot Section

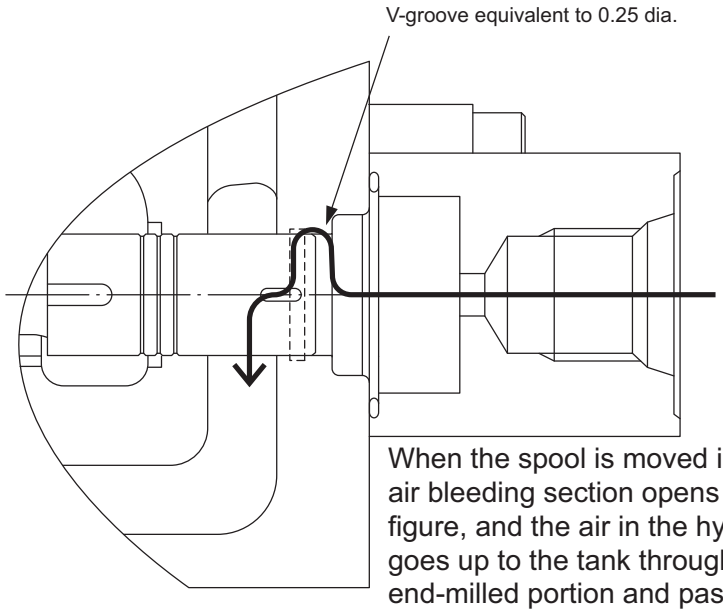
- Automatic air bleeding mechanism is provided at the control valve spool which is operated by hydraulic pilot valve.

(1) When the spool of the control valve is at neutral position.



When the spool is at neutral position, air is blocked at the position B as shown in the figure above and the air in the hydraulic pilot circuit does not return to the tank.

(2) When the spool of the control pilot valve is moved in full stroke.



When the spool is moved in full stroke, the air bleeding section opens as shown in the figure, and the air in the hydraulic pilot circuit goes up to the tank through the V-groove, end-milled portion and passage to the tank.

k) Relief Valve/Anti-cavitation Valve

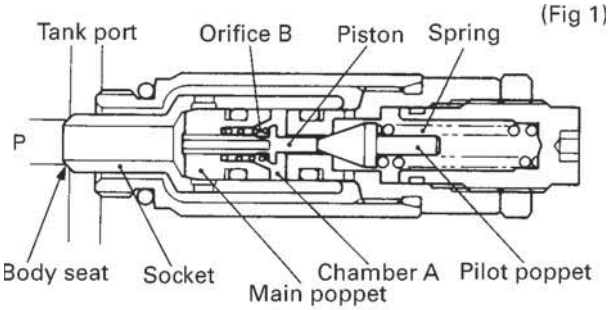
Function of relief valve

(1) The pressure oil passes first through the piston that is built in the main poppet. It then goes through the orifice B and fills the chamber A. Now the main poppet and socket are well fitted, whereas the socket and body seat are also ensured together. (Fig. 1)
(2) When the pressure oil at the port P has reached the spring's set pressure, the piston is pushed, which in turn pushes the pilot poppet open.
Now the pressure oil flows in this way: piston, orifice B, chamber A, ring orifice A, and port D. It finally passes around the socket into the tank port. (Fig. 2)
(3) With the pilot valve open, the pressure in the chamber A drops. The main poppet then opens, and the pressure oil at the port P goes through the port E and directly reaches the tank port. (Fig. 3)
(4) When the pressure at the port P has dropped below the spring's set pressure, the pilot poppet is pressed against the seat by the spring force and the pressure of chamber A becomes equal to that of port A. The main poppet is also pressed against the socket seat resulting in the original state (Fig. 1).

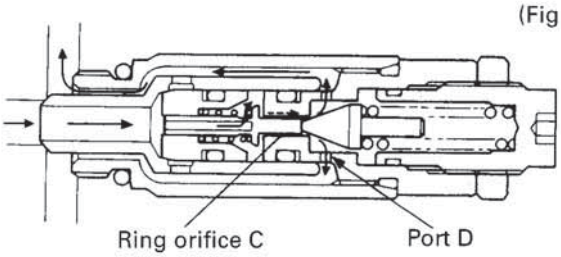
Function of anti-cavitation valve

(1) This valve works to feed the oil from the tank port if a negative pressure occurs at the port P.
When the pressure at the tank port has risen above that at the port P, the socket is activated upward.
This upward force makes a space between the body seat and the socket. The oil now comes through the tank port into the port P and fills the space. (Fig. 4)
(2) This valve works to feed the oil from the tank port if a negative pressure occurs at the port P.
When the pressure at the tank port has risen above that at the port P, the valve is activated upward.
This upward force makes a space between the body seat and the valve. The oil now comes through the tank port into the port P and fills the space. (Fig. 5)

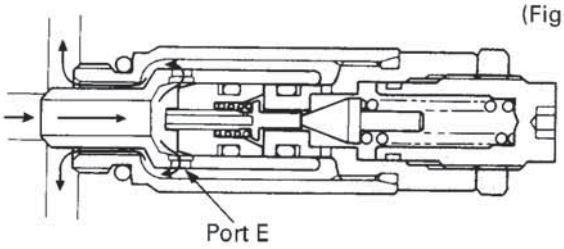
(Fig 1)



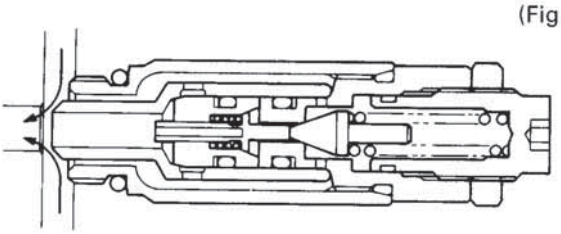
(Fig 2)



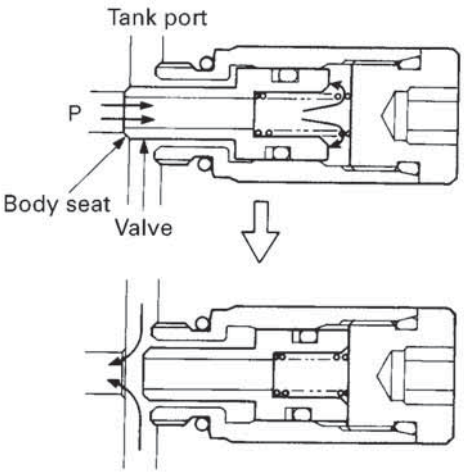
(Fig 3)



(Fig 4)



(Fig 5)



(D) HYDRAULIC SYSTEM MODIFICATION

a) Outline

In order to improve further “Load Sensing Performance”, pump and control valve have been changed in several parts. Main parts of minor change are as follows. Following modifications are from ‘-3 series’ to ‘-3S/α series’.

1. Hydraulic pump: **KX121-3S/α, 161-3S/α, U45-3S/α, U45S, U50-3α**
   (1) Valve plate opening performance improved
   End milling finish to V-shape notch
   (2) Piston shoe type change
   Multi-pad type to single-pad type
   (3) Cylinder block center spring foree upgraded
   (4) Swash plate shape change
   (5) Swash plate pin shape change
   (6) PC regulate spool pin dia. $\phi 3.5 \rightarrow \phi 3.2$
   Horse power spring change
   (7) LS valve compact size
   PC orifice $\phi 0.6$ added

2. Control valve: **KX121-3S/α, 161-3S/α, U45-3S/α, U45S, U50-3α**
   (1) Damper chamber added in the unload valve (orifice $\phi 1.2$)
   (2) In order to achieve the stable response of PLS signal line;
   $\phi 1.0$ orifice added in valve’s PLS port plug.
   Hose volume (1/4” $\times$ 350mm length) added.
   (3) Shuttle plate change;
   Outer dia. is approx. 20μm larger in minor change
   (4) Compensation spools of arm, bucket and swivel;
   orifice machining deleted.

3. Travel motor: **KX121-3S/α, 161-3S/α, U45-3S/α, U45S, U50-3α**

(1) Motor swash plate:	Light weight type
(2) Hi-Low piston:	Shape change
(3) Thrust plate:	Shape change
(4) Sun gear:	Snap ring removed
(5) Ring nut:	Casting iron to steel iron
(6) Reduction gear case drain port size:	G 1/4, hex. 6 $\rightarrow$ G 3/8, hex. 8

4. Role of hose volume (1/4” $\times$ 350mm)
   The hose volume control that is attached on the control valve serves as a sort of damper. At a start of operation in particular (to start traveling, for example), it is effective in avoiding a sudden surge pressure and preventing the machine from starting with a jerk. In other words, violent fluctuations of load pressure can be eased, which improves the operator’s control feeling. Below discussed is a theoretical explanation of the hose volume control behavior.
   At very low temperatures, the throttling effect of the orifice in the system is greatly affected, usually causing delays in response. Let’s suppose shifting the travel lever forward under low temperatures, for example. Possibly the machine may fail to respond quickly or it may take too much time to get started. In such cases, preferably remove the hose volume control for better damping effect, and install the plug attached on previous models. Keep in mind, however, that the higher the oil temperature rises, the quicker the reaction becomes.

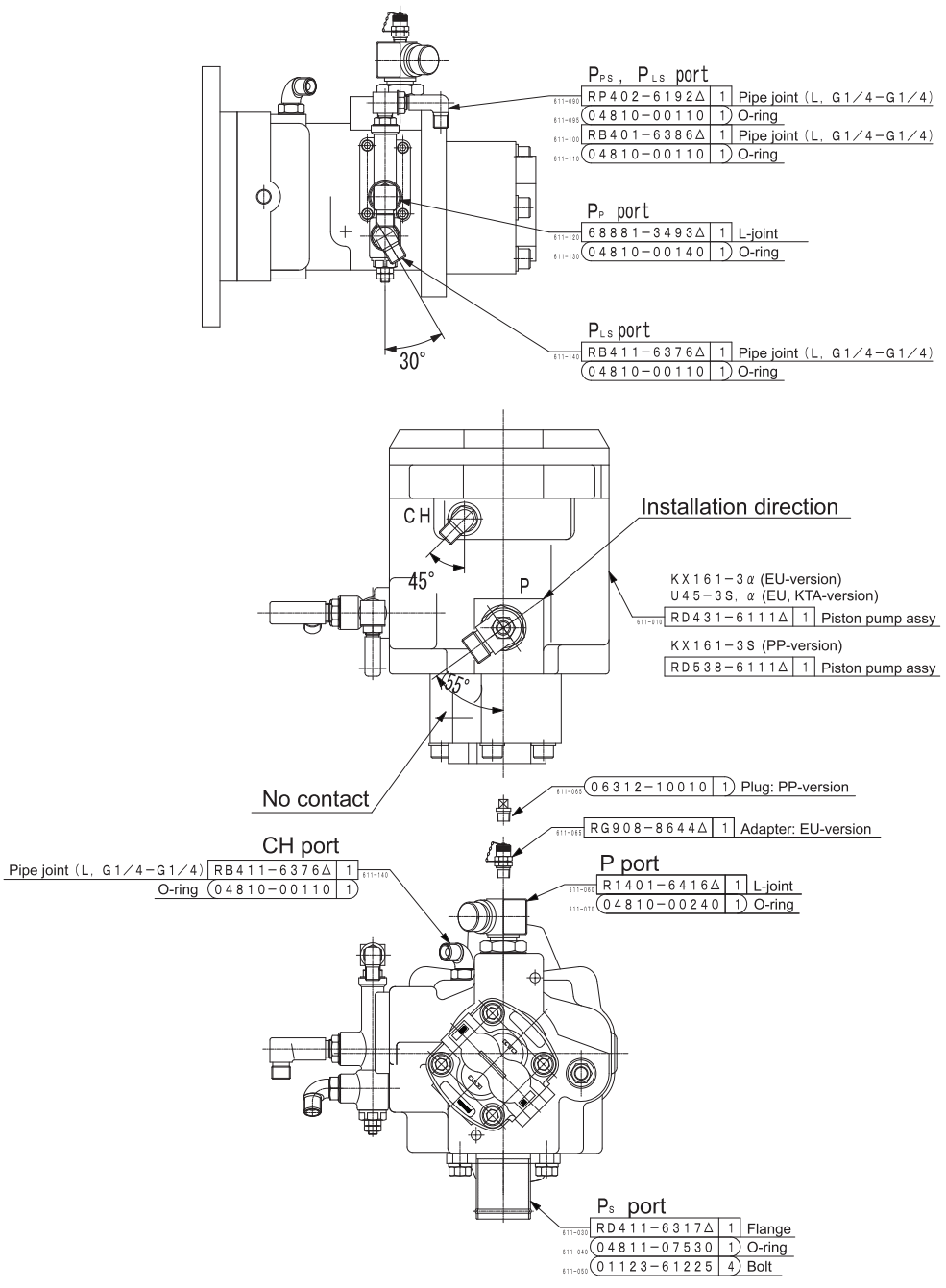
b) Hydraulic Pump

KX161-3S, KX161-3α

1. Pump installation: 161-3S/α, U45-3S/α, U45S, U50-3α

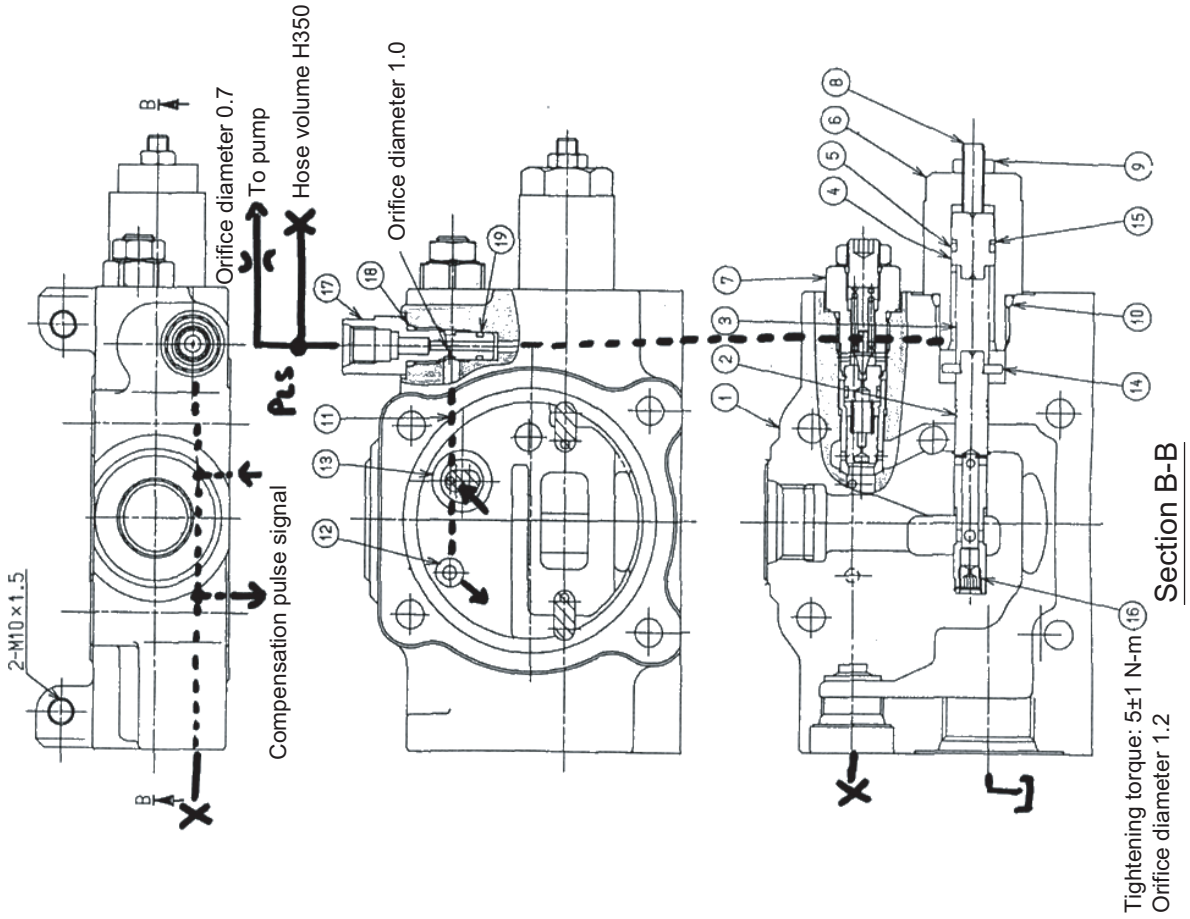
(1) Adapter tightening torque

P port (G3/4)	117.6 ~ 127.4 N·m (12.0 ~ 13.0 kgf·m) 86.8 ~ 94.0 ft·lbs
P_{PS}, P_{LS}, CH port (G1/4)	24.5 ~ 29.4 N·m (2.5 ~ 3.0 kgf·m) 18.1 ~ 21.7 ft·lbs
P_P port (G3/8)	49.0 ~ 53.9 N·m (5.0 ~ 5.5 kgf·m) 36.2 ~ 39.8 ft·lbs

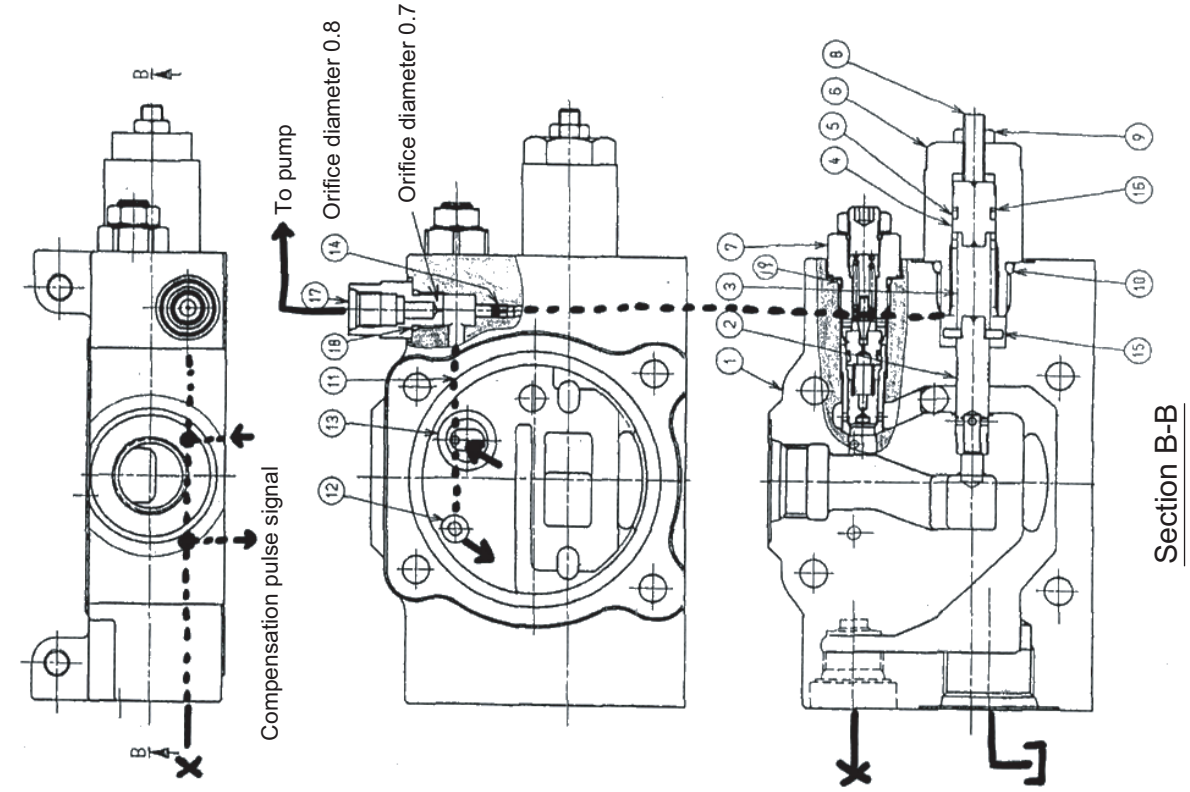


2. Inlet section: **KX121-3S/α, 161-3S/α, U45S, U45-3S, U45-3α, U50-3α**

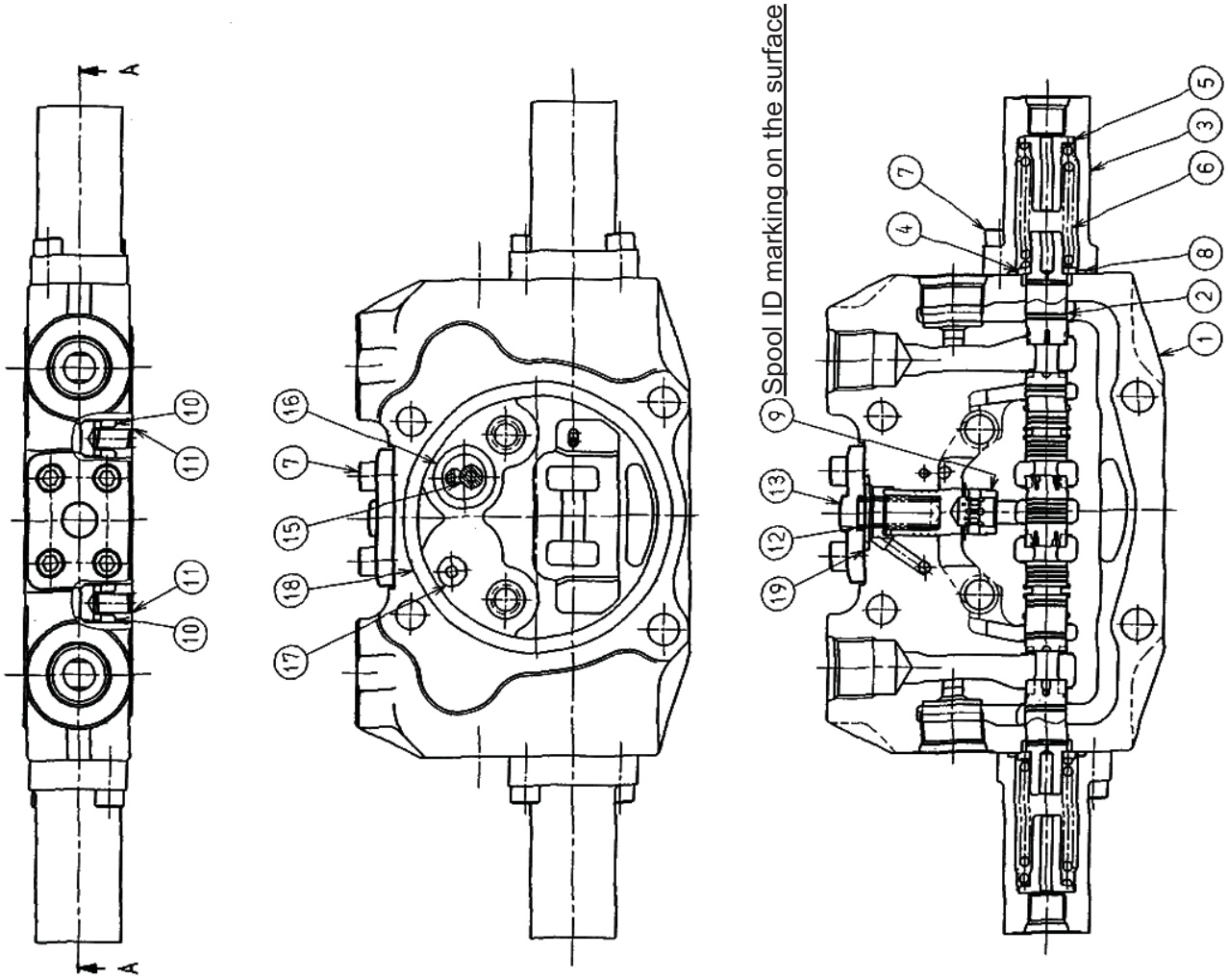
(After minor change)



(Before minor change)



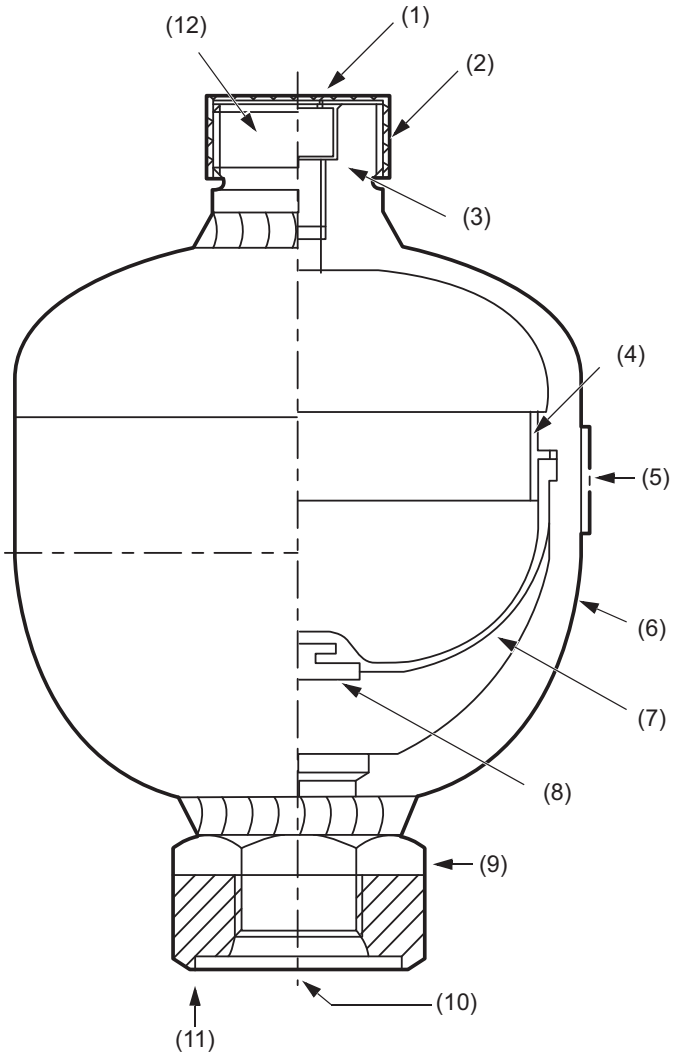
3. Other section, shuttle plate change



c) Accumulator

1. Structure and specifications: PP-version

PP-version has newly adopted the accumulator.



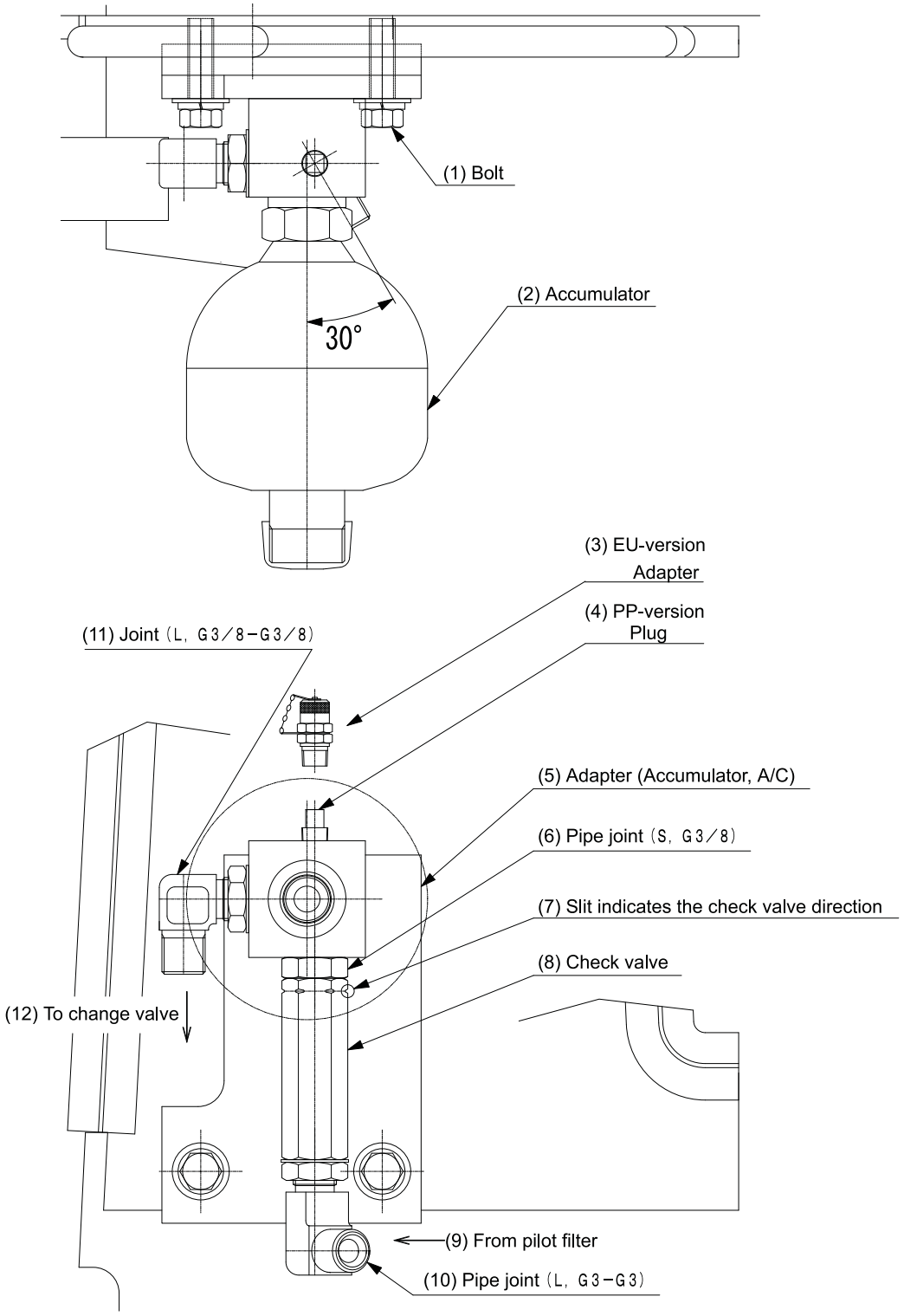
(1) Valve screw
(2) Protecting cop
(3) Seal ring
(4) Retainer
(5) Marking
(6) Shell
(7) Diaphragm
(8) Valve poppet
(9) Hex. screw 36
(10) Protecting plug
(11) Screw type: G 1/2
JIS B2351 Type 0
(12) The gas pressure po is variable with our charging and gouging set.
Starting torque screw 20 N·m

1) Type code: SB0210-0.32E1/663U-210LH010
2) Manufacture:HYDAC GMBH
3) Specification

(1)	Volume	:	0.32 L (0.027 us gal)
(2)	Permissible max. working pressure	:	210 bar (214 kg·f/cm^2) 21 MPa (3047 psi)
(3)	Charge gas	:	Nitrogen (N_2 gas)
(4)	Charge pressure	:	10 ± 1 bar (10.2 ± 1 kg·f/cm^2) 1 ± 0.1 MPa (145 ± 1.4 psi)
(5)	Media	:	Mineral oil
(6)	Allowable pressure ratio (Max. pressure / charging pressure)	:	Under 8 / 1 Example When charging pressure is set 10 bar, should set max. pressure under 80 bar for use.
(7)	Temperature of oil	:	-30° ~ +80°C (-86° ~ +176°F)
(8)	Weight	:	1.3 kg (2.87 lbs)
(9)	Surface treatment	:	Black primer

2. Accumulator installation: **KX121-3S, KX161-3S**

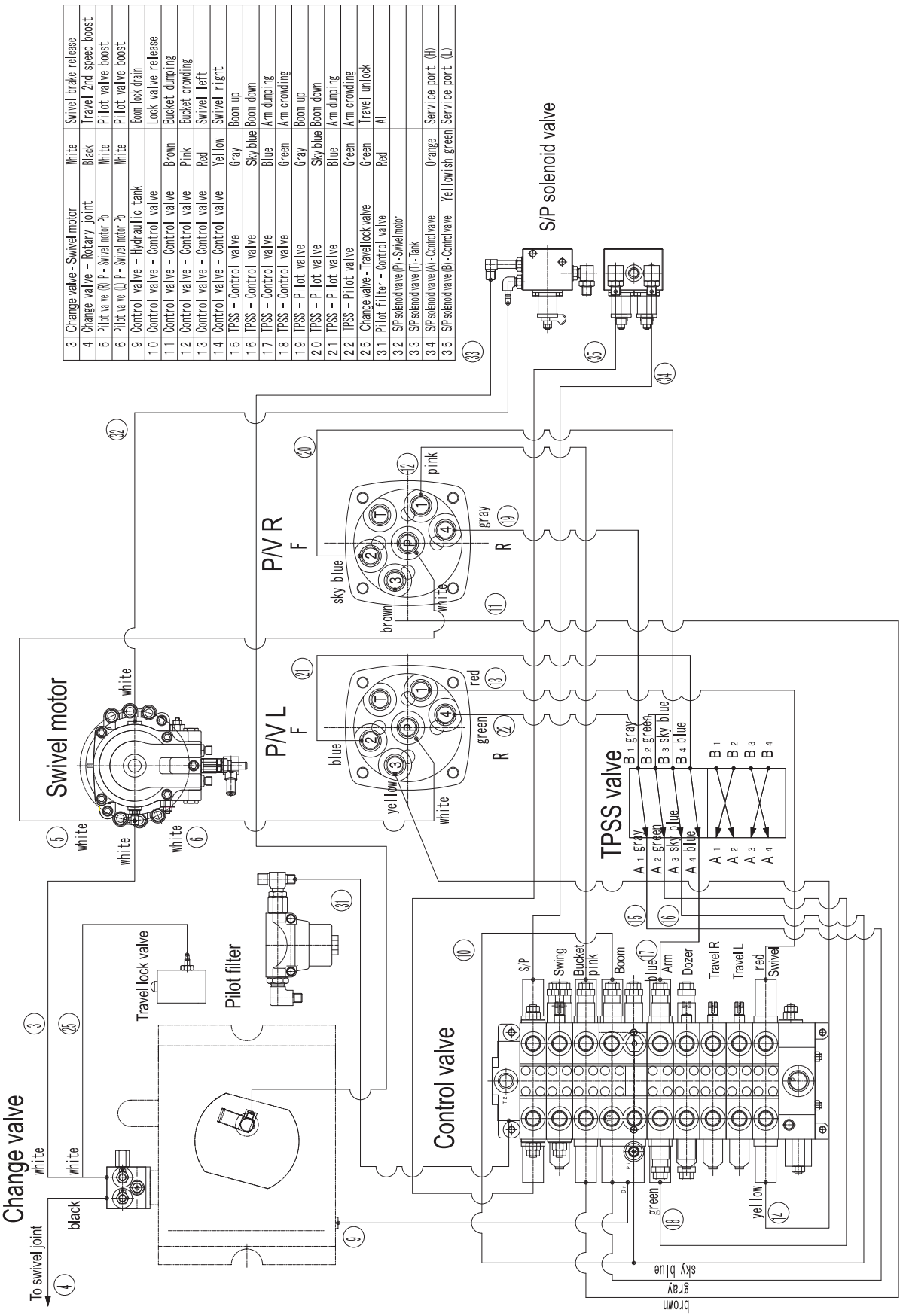
1) Bolt tightening torque
   48.1 ~ 55.9 N·m (4.9 ~ 5.7 kgf·m) 35.4 ~ 41.2 ft ·lbs
2) Adapter G3/8 tightening torque
   37.2 ~ 42.1 N·m (3.8 ~ 4.3 kgf·m) 27.5 ~ 31.1 ft ·lbs



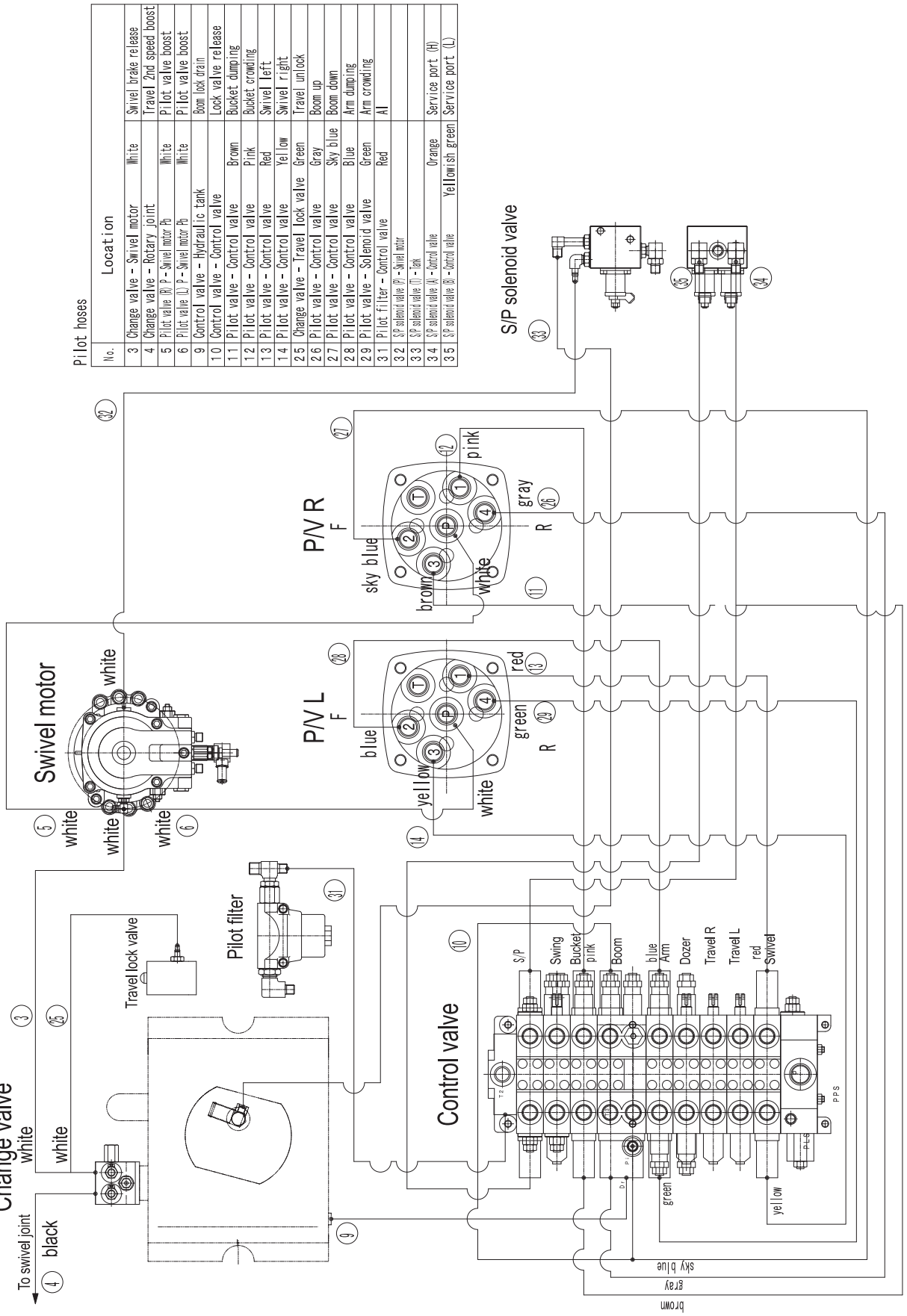
d) Hydraulic System Line

1. Pilot control line: PP-version, KX161-3S

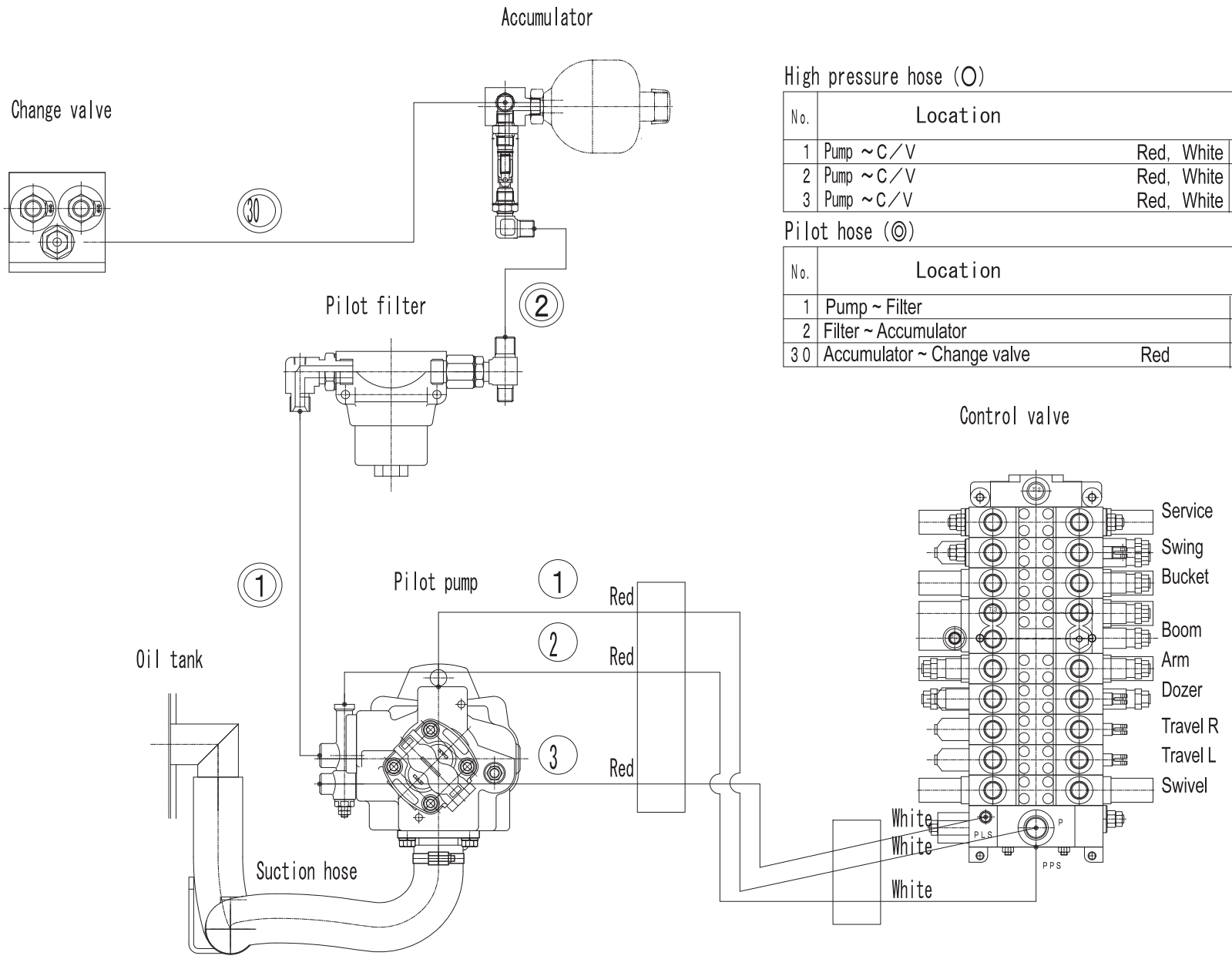
KX121-3S is almost same except control valve.



2. Pilot control line: EU-version, **KX161-3α**



3. Pilot delivery line: **KX161-3S**



High pressure hose (O)

No.	Location		
1	Pump ~C/V	Red, White	P (Delivery)
2	Pump ~C/V	Red, White	PPS
3	Pump ~C/V	Red, White	PLS

Pilot hose (◎)

No.	Location		
1	Pump ~ Filter		P4
2	Filter ~ Accumulator		P4
30	Accumulator ~ Change valve	Red	P4

(E) TRAVEL MOTOR

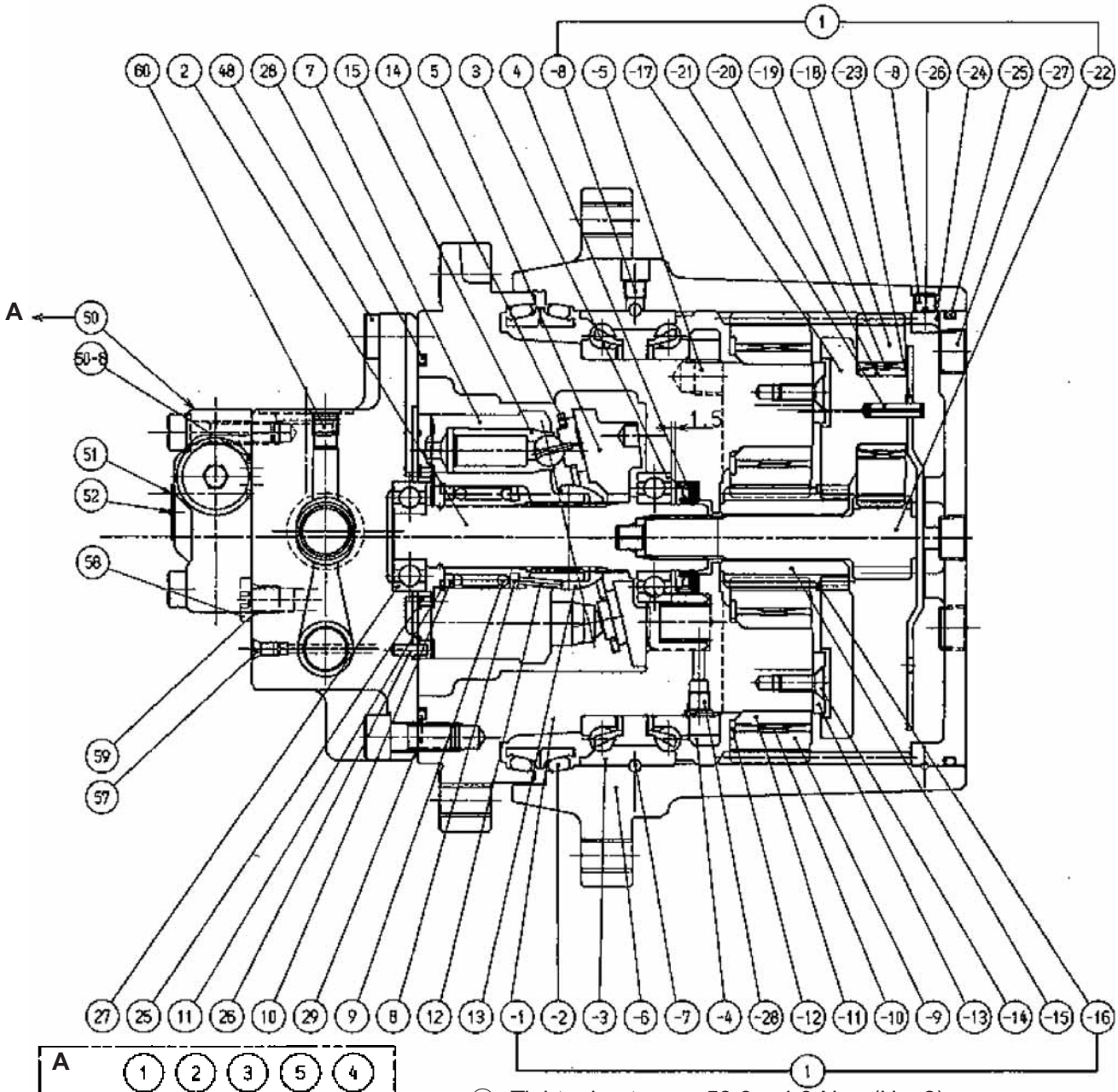
a) Traveling Performance Specifications

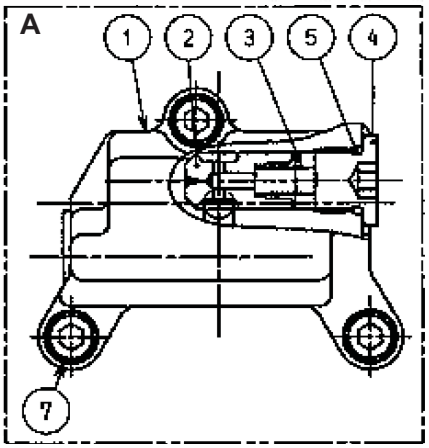
		Unit	KX121-3α	KX161-3α	U45-3α	U50-3α	Remarks
			KX121-3S	-	U45S/U45-3S	KX161-3S	
Manufacturer			KAYABA industry	KAYABA industry	KAYABA industry	KAYABA industry	
Model			MAG-26V-380F-1	MAG-33V-550F-3	MAG-33V-480F-1	MAG-33V-550F-1	
Kubota part No.			RD138-6129-0	RD531-6129-0	RD431-6129-0	RD538-6129-0	
Capacity	1st	cc/rev cu.in./rev	26.3 1.61	28.4 1.73	30.8 1.88	28.4 1.73	
	2nd	cc/rev cu.in./rev	14.6 0.89	16.0 0.98	17.4 1.06	15.0 0.92	
Reduction ratio			1/41.923	1/58.943	1/47.406	1/58.943	
Total displacement	1st	cc/rev cu.in./rev	1103 67.29	1674 102.16	1460 89.11	1674 102.16	
	2nd	cc/rev cu.in./rev	612 37.35	943 57.55	825 50.34	884 53.96	
Rated oil flow		L/min USGPM	41.0 10.83	49.0 12.94	46.0 12.15	56.0 14.79	
Theoretical torque	1F	N·m kgf·m ft·lbf	4302 438.7 3172.9	6261 638.4 4617.8	5469 557.7 4033.7	6261 638.4 4617.8	KX121-3S/α, U45-3S/α, U45S: at 24.5 MPa (250 kg/cm^2, 3556 psi) KX161-3S/α, U50-3α: at 23.5 MPa (240 kg/cm^2, 3414 psi)
	2F	N·m kgf·m ft·lbf	2388 243.5 1761.3	3527 359.6 2601.3	3090 315.1 2279.0	3307 337.2 2439.1	
Theoretical speed	1F	rpm	37.2	29.3	31.5	33.5	KX121-3S/α: at 41.0 L/min (10.83 USGPM) KX161-3S: at 49.0 L/min (12.94 USGPM) U45-3S/α, U45S: at 46.0 L/min (12.15 USGPM) KX161-3α, U50-3α: at 56.0 L/min (14.79 USGPM)
	2F		67.0	52.0	55.8	63.3	
Relief valve pressure		Mpa kg/cm^2 psi	24.5 250 3556	23.5 240 3414	24.5 250 3556	23.5 240 3414	
Climbing ability		deg.	30	30	30	30	
Max. traction force	1F	N kgf lbf	30.2 3081 6793.6	40.0 4083 9003.0	34.9 3562 7854.2	40.0 4083 9003.0	Slip 70% theoretical torque Oil temp.: 50 ± 5°C (122 ± 9°F)
	2F	N kgf lbf	14.3 1455 3208.3	19.3 1972 4348.3	16.9 1724 3801.4	19.3 1972 4348.3	Relief 60% theoretical torque
Traveling block performance		mm/10min in./10min	272, 300 ≧ 10.71, 11.81 ≧	261, 300 ≧ 10.28, 11.81 ≧	272, 300 ≧ 10.71, 11.81 ≧	261, 300 ≧ 10.28, 11.81 ≧	10 min engine stop Testing angle: 20 deg
Traveling speed (Rubber/Steel)	1st	km/h mph	3.0 2.9 1.86 1.80	2.5 2.3 1.55 1.43	2.3 2.2 1.43 1.37	2.3 - 1.43 -	
	2nd	km/h mph	5.0 4.7 3.11 2.92	4.6 4.2 2.86 2.61	4.3 4.0 2.67 2.49	4.3 - 2.67 -	
10m(32.8ft) traveling time (Rubber crawler)	1F	sec./10m sec./32.8ft	16.0 8.6	14.0 8.0	14.0 8.0	14.0 8.0	
	2F						
Straight travel performance	1F/2F	mm/10m in./32.8ft	600 ≧ 23.62 ≧	← ←	← ←	← ←	
Drain amount at lock	1F/2F	L/min GPM	4.00 ≧ 1.06 ≧	← ←	← ←	← ←	

		Unit	KX121-3α	KX161-3α	U45-3α	U50-3α	Remarks
			KX121-3S	-	U45S/U45-3S	KX161-3S	
Drain amount while rotating	1F	L/min GPM	0.5 ≧ 0.13 ≧	← ←	← ←	← ←	Motor: 1000rpm at 70 ± 5 kgf/cm^2 (6.9 MPa)
	2F	L/min GPM	0.75 ≧ 0.20 ≧	← ←	← ←	← ←	Motor: 2000rpm at 180 ± 5 kgf/cm^2 (17.6 MPa)
Hi-speed change pressure	1st to 2nd	MPa kgf/cm^2 psi	0.9 9.0 128	0.70 7.1 101	← ← ←	← ← ←	
	2nd to 1st	MPa kgf/cm^2 psi	0.7 7.0 100	0.59 6.0 85	← ← ←	← ← ←	

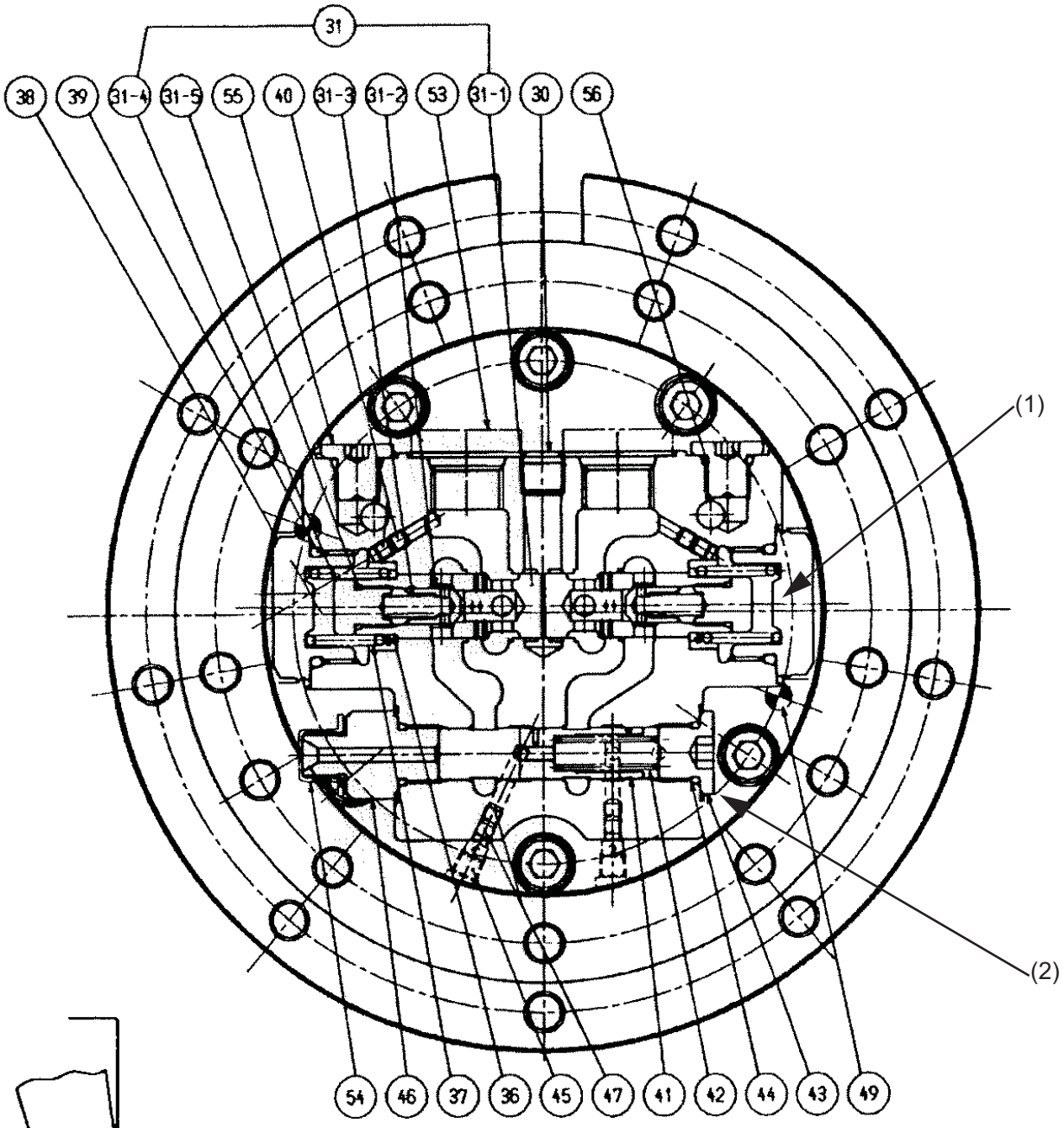
b) Structure

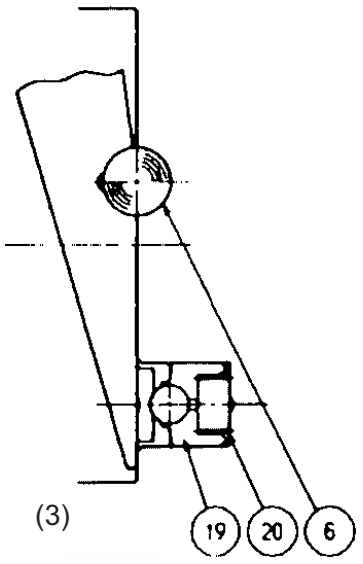
1. KX121-3S, KX121-3α





④ Tightening torque 53.9 ± 4.9 N·m (Hex8)
⑦ Tightening torque 29.4 ± 2.0 N·m (Hex6)
①-⑤ Tightening torque 14.7 ± 4.9 N·m (Hex6)
①-⑧ Tightening torque 7.8 ± 1.0 N·m (Hex5)
①-⑭ Tightening torque 6.1 ± 2.0 N·m (Hex4)
Apply the locktight #262 before tightening
①-㉗ Tightening torque 34.3 ± 4.9 N·m (Hex8)
①-㉘ Tightening torque 9.8 ± 1.0 N·m (Hex3.96)
㊽ Tightening torque 63.7 ± 4.9 N·m (Hex2.5)
㊿ Tightening torque 12.3 ± 2.5 N·m (Hex6)





㉛-㉞ Tightening torque 31.9 ± 2.45 N·m (3.3 ± 0.25 kgf·m) (23.5 ± 1.81 ft·lbs) (Hex6)
㊳ Tightening torque 240 ± 5 N·m (24.5 ± 0.51 kgf·m) (23.5 ± 3.69 ft·lbs) (Hex36)
㊵ Tightening torque 2.45 ± 0.49 N·m (0.25 ± 0.05 kgf·m) (1.81 ± 0.36 ft·lbs) (Hex2.5)
㊸ Tightening torque 53.7 ± 4.9 N·m (5.5 ± 0.50 kgf·m) (39.6 ± 3.61 ft·lbs) (Hex8)
㊺ Tightening torque 9.8 ± 1.0 N·m (1.0 ± 0.1 kgf·m) (7.23 ± 0.74 ft·lbs) (Hex3.96)
㊻ Tightening torque 53.9 ± 4.9 N·m (5.5 ± 0.5 kgf·m) (39.76 ± 3.61 ft·lbs) (Hex22)
㊼ Tightening torque 2.45 ± 0.49 N·m (0.25 ± 0.05 kgf·m) (1.81 ± 0.36 ft·lbs) (Hex2.5)
㊺ Tightening torque 34.3 ± 4.9 N·m (3.5 ± 0.5 kgf·m) (25.3 ± 3.61 ft·lbs) (Hex6)

(1) Counter balance valve
(2) High-Low change valve
(3) Detail of 2 speed lean turning portion

Notes:
1. Use one of drain ports T1 and T2, and plug the other port.
2. Fill the motor case with clean oil through the drain port before operating.
3. The mag motor is shipped with 0.35 l gear lubrication.
4. When 2-speed pilot port (Ps) is connected to the tank, the motor rotates at low speed.
   When (Ps) port is connected to the pump, the motor rotates at high speed.

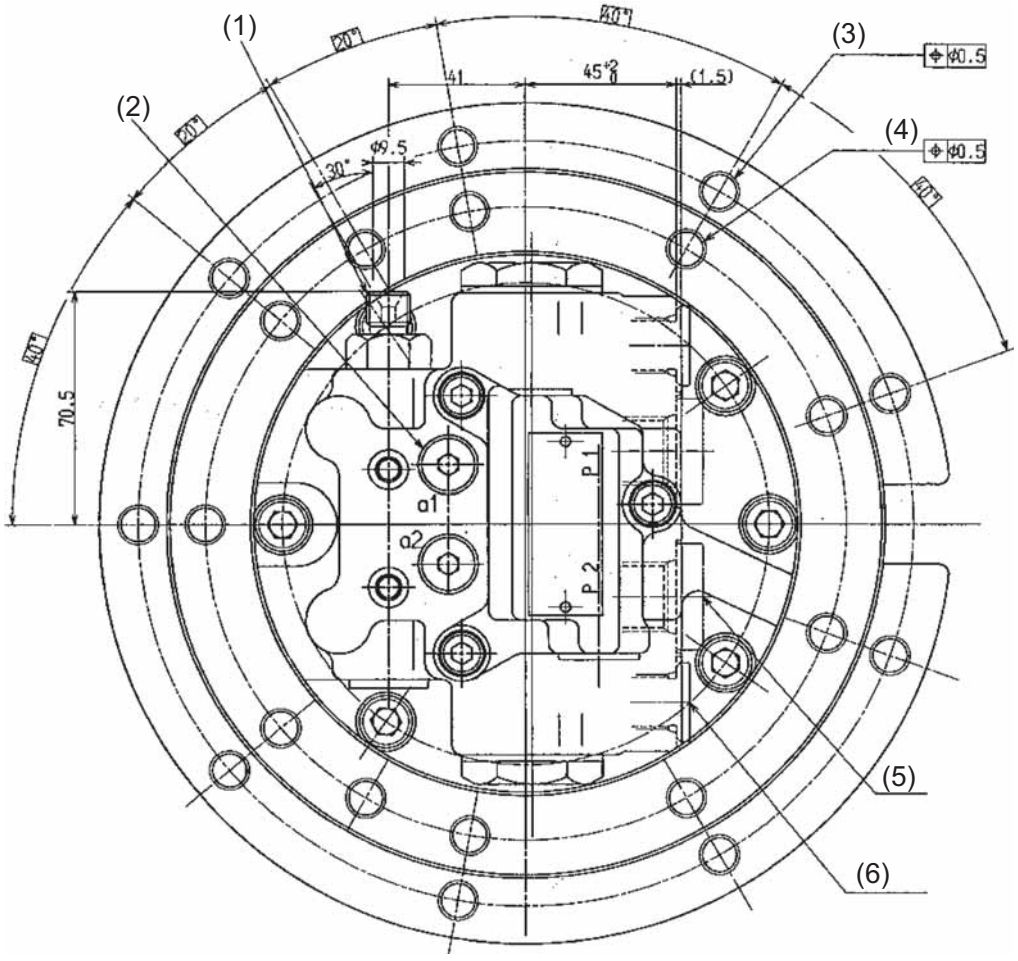
Part No.: B0240-26015
Model : MAG-26V-380F1
Serial No. :S/N ··· KX121-3S

For example) S/N 2X0001

Number of production
Production month
(X: October, Y: November, Z: December)
Final figure of the christian era

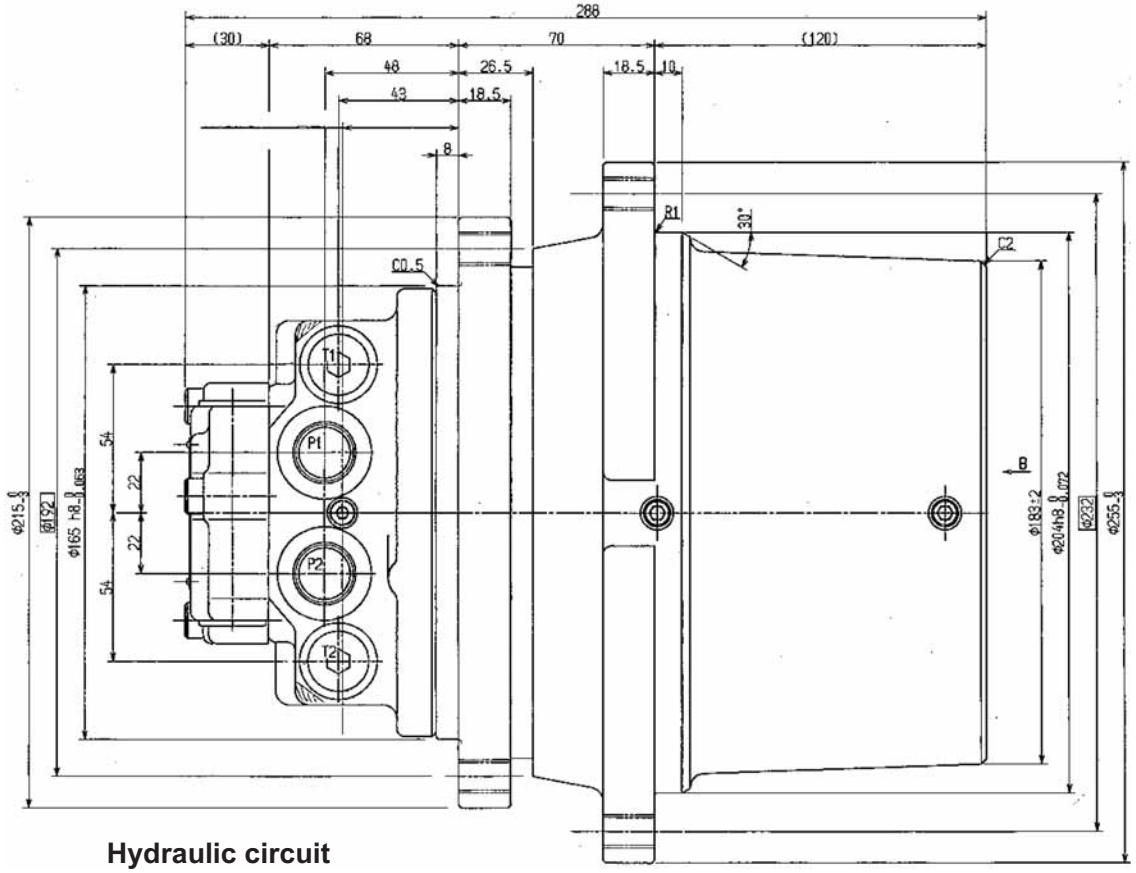
Name plate

* The above serial number (S/N) is indicated first production on october 2002.

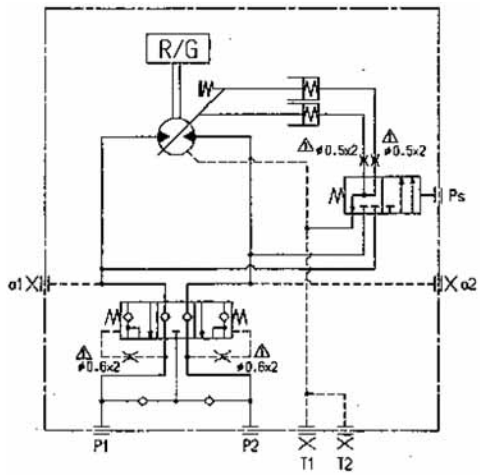


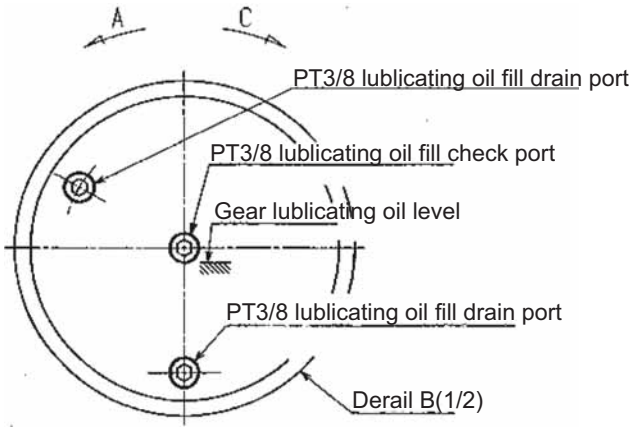
(1) PF1/4 Ps port (Ps port, with cap)
(2) 2-PF1/8 for pressure gauge (a1, a2: Hex 5, with plug)
(3) 9-M12x1.75 Effective thread depth 18.5 (Equally Spaced in 9)
(4) 11-M12x1.75 Effective thread depth 18.5
(5) 2-holes PF1/2 P port JIS B2351 O-ring boss (P1, P2: with shipping plug)
(6) 2-holes PF3/8 T port JIS B2351 O-ring boss (T1, T2: Hex 6, with plug)

Notes:
1. Scrape the two *-marked corners (for improved fitting).
2. This product is the standard one back from the poorly machined base plate. (S/N 4Z0001 and on)



Hydraulic circuit





Note:
Position is different from the side view.

Direction of rotation as seen from B

		Flow inlet	Flow outlet	Direction of rotation
Left motor forward	Right motor back	P1 port	P2 port	A: Anti-clockwise
Left motor back	Right motor forward	P2 port	P1 port	C: Clockwise

2. KX161-3S, KX161-3α

Notes:

1. Use one of drain ports T1 and T2, and plug the other port.
2. Fill the motor case with clean oil through the drain port before operating.
3. The mag motor is shipped with 0.9 l gear lubrication.
4. When 2-speed pilot port (Ps) is connected to the tank, the motor rotates at low speed.
   When (Ps) port is connected to the pump, the motor rotates at high speed.

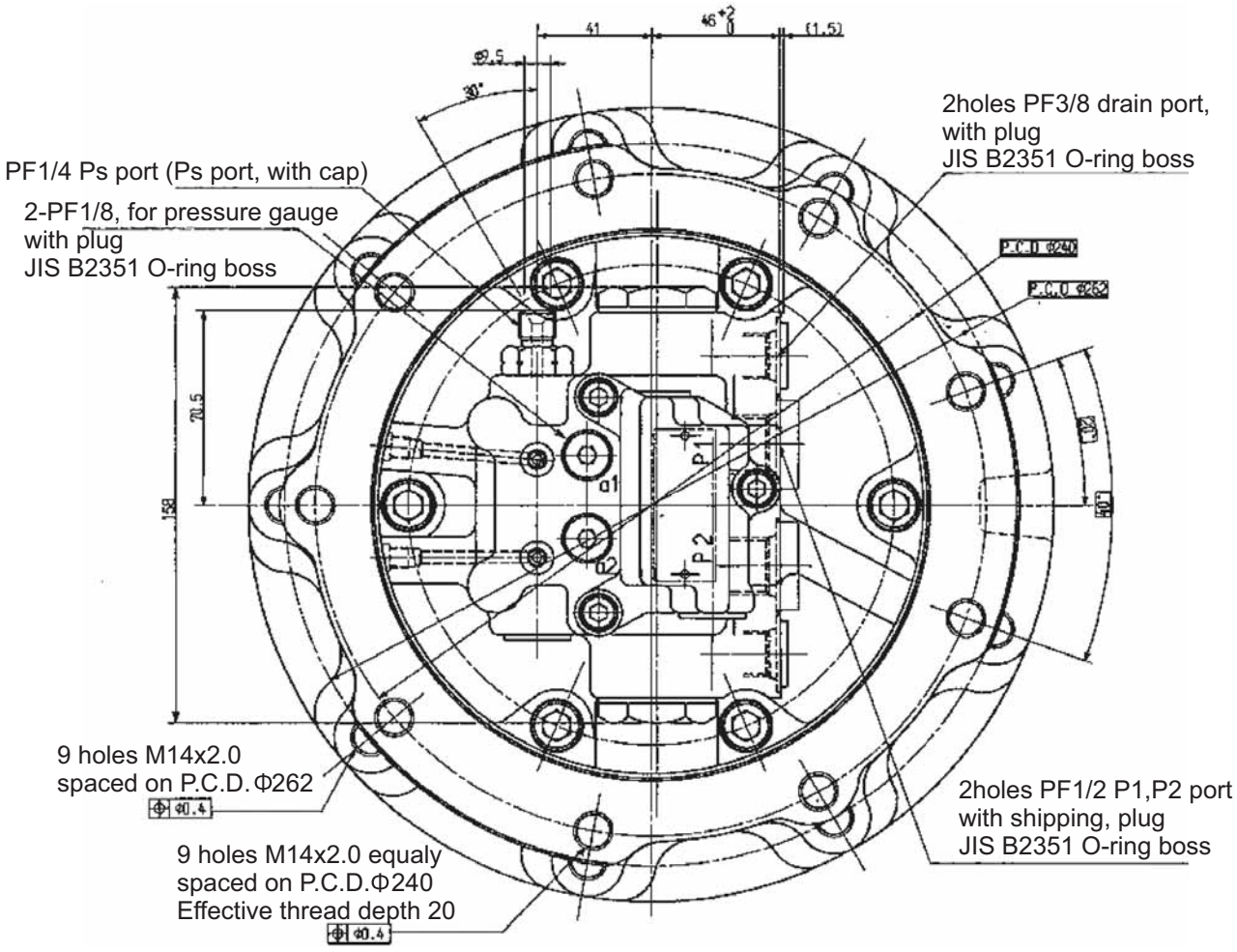
Part No.: B0240-33055
Model : MAG-33V-550F-1
Serial No. :S/N ··· KX161-3SS US

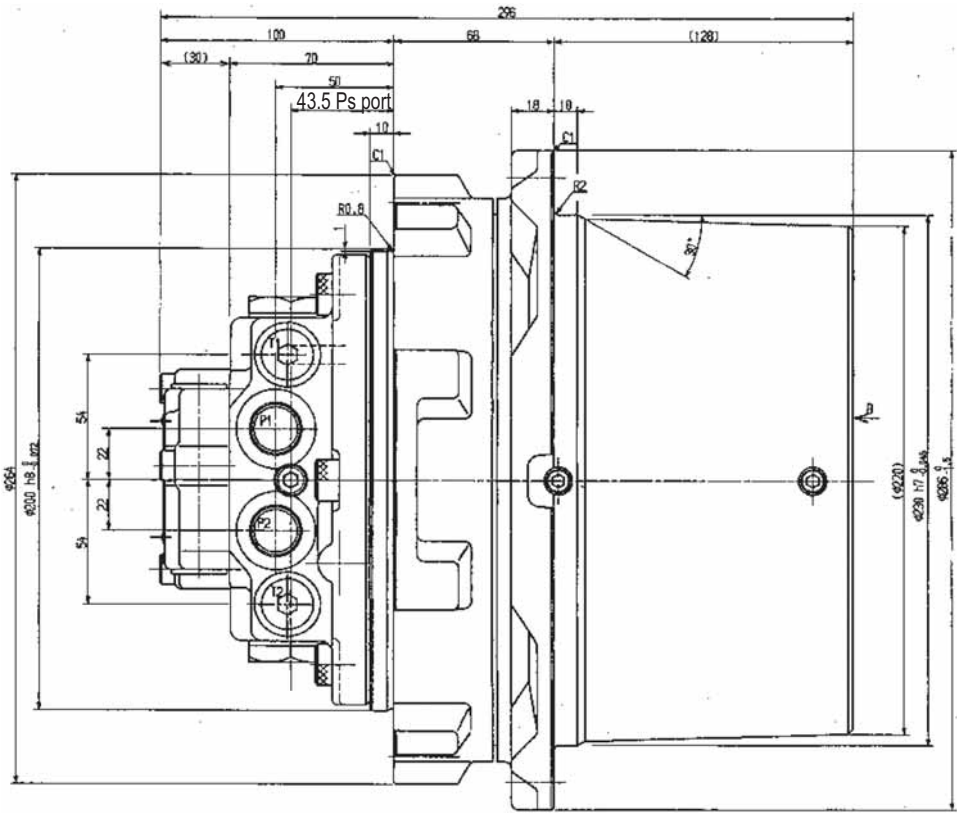
For example) S/N 2X0001

- Number of production
- Production month (X: October, Y: November, Z: December)
- Final figure of the christian era

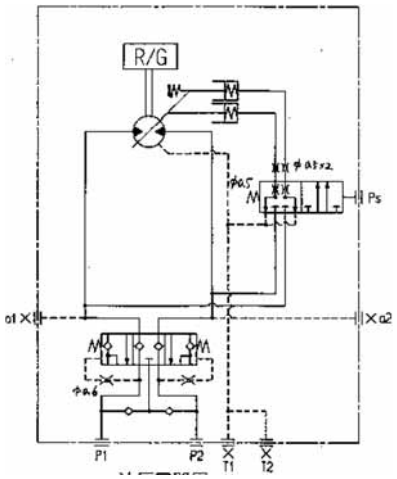
Name plate

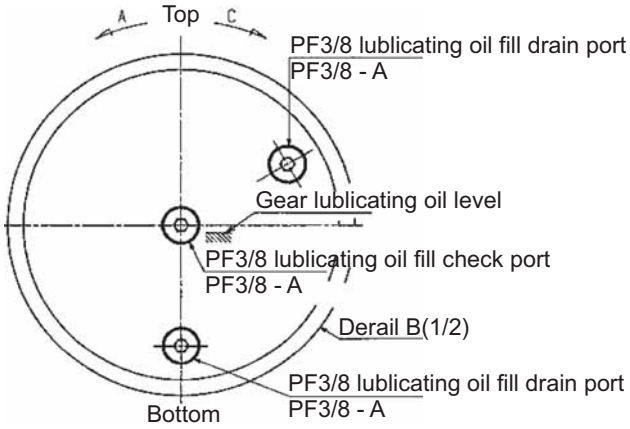
* The above serial number (S/N) is indicated first production on october 2002.





Hydraulic circuit

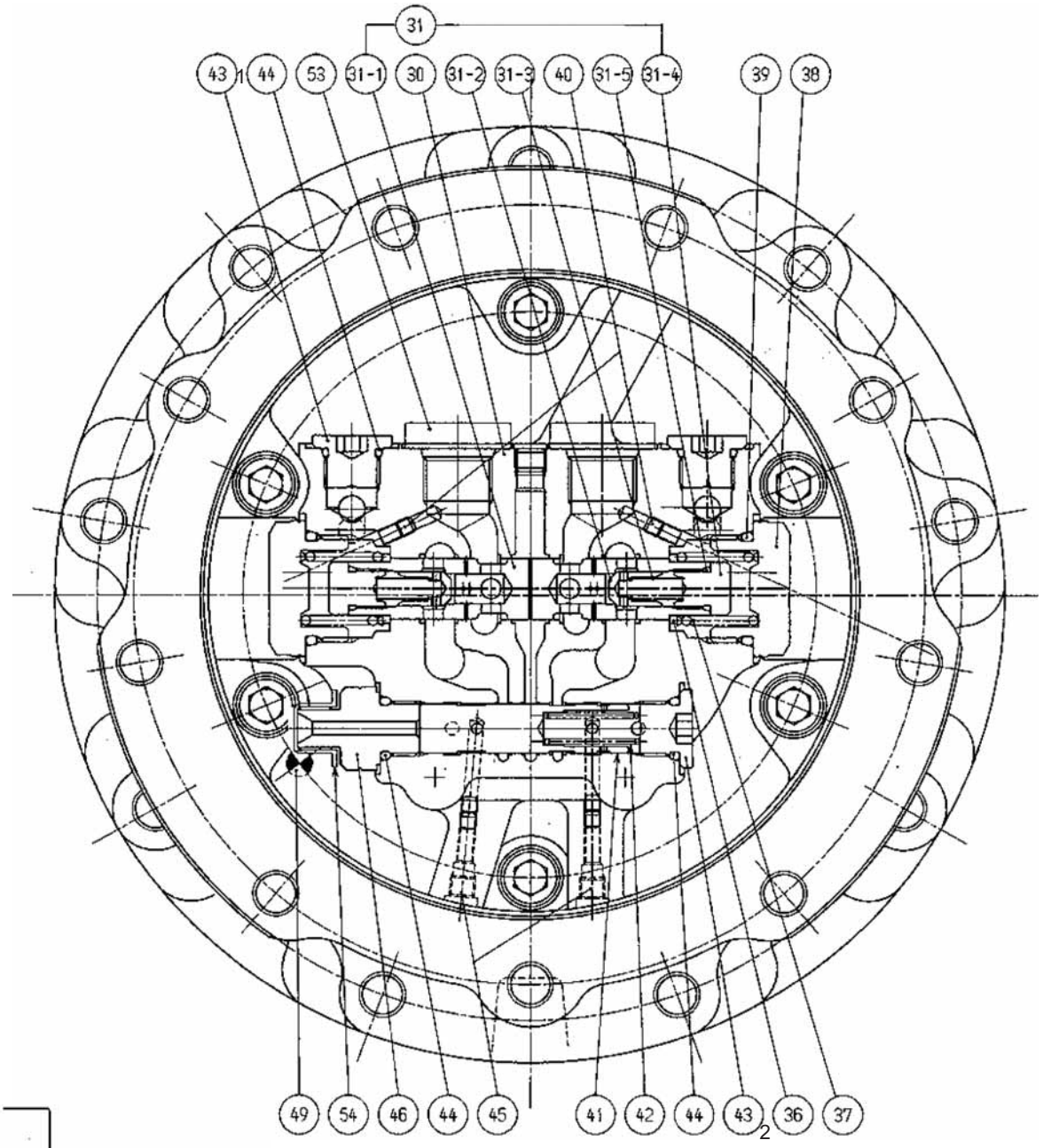


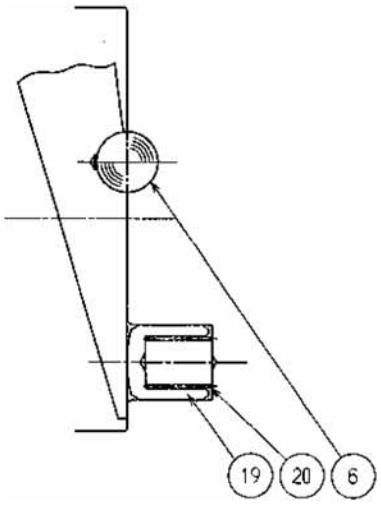


Note:
Position is different from the side view.

Direction of rotation as seen from B

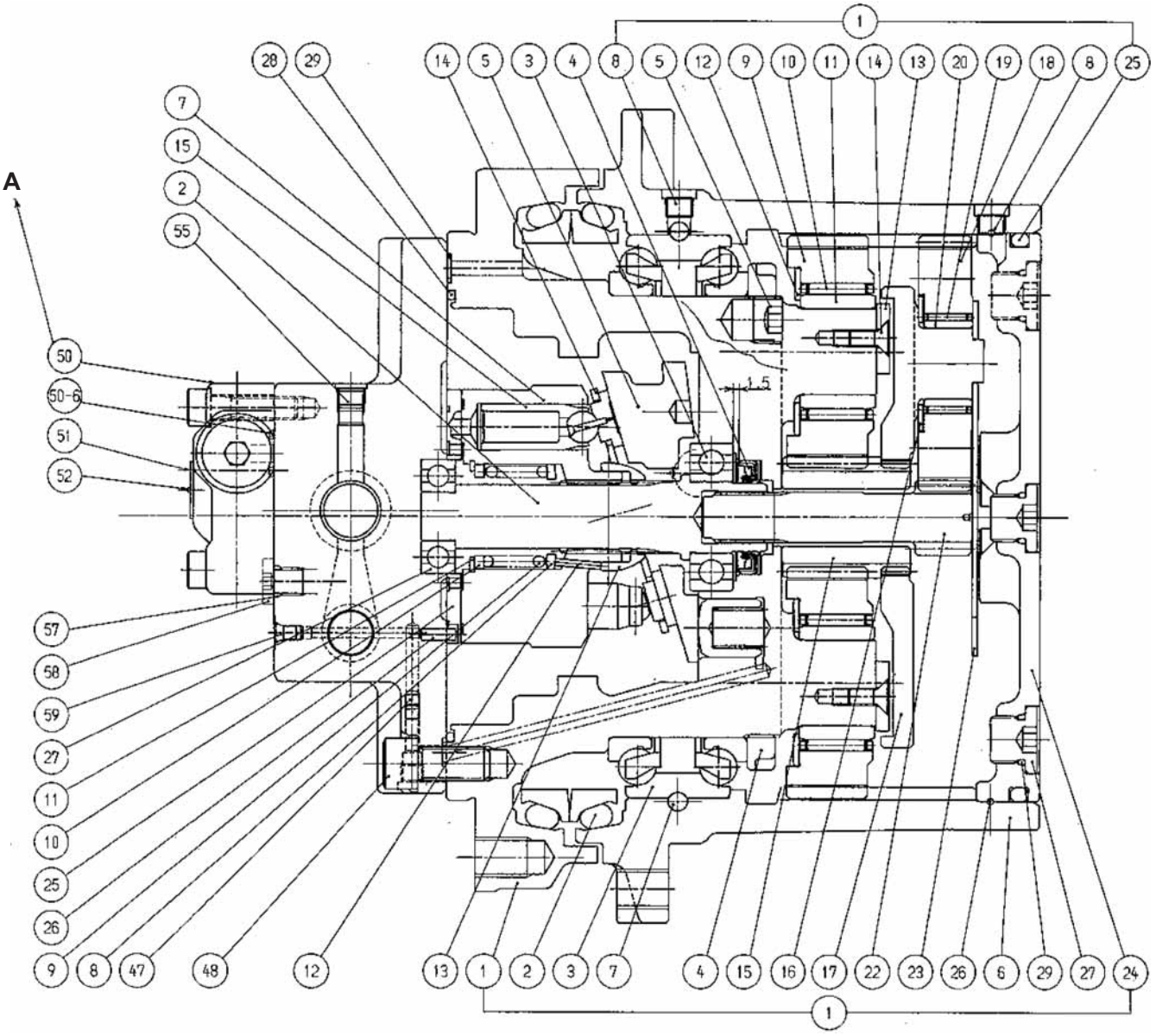
		Flow inlet	Flow outlet	Direction of rotation
Left motor forward	Right motor back	P1 port	P2 port	A: Anti-clockwise
Left motor back	Right motor forward	P2 port	P1 port	C: Clockwise

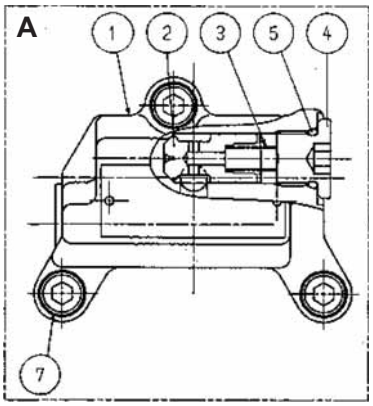




㉛-㉞ Tightening torque 31.9 ± 2.45 N·m (Hex12)
㊳ Tightening torque 240 ± 5 N·m (Hex36)
㊵ Tightening torque 2.45 ± 0.49 N·m (Hex2.5)
Finally crimp all around.
㊸$_1$ Tightening torque 39.2 ± 2.0 N·m (Hex8)
㊸$_2$ Tightening torque 53.9 ± 4.9 N·m (Hex8)
㊺ Tightening torque 9.8 ± 1.0 N·m (Hex3.96)
㊻ Tightening torque 53.9 ± 4.9 N·m (Hex22)
㊸ Tightening torque 1.72 ± 0.25 N·m (Hex8)

(1) Detail of 2 speed lean turning portion





④ Tightening torque 53.9 ± 4.9 N·m (5.5 ± 0.5 kgf·m) (39.76 ± 3.61 ft.lbs) (Hex8)
⑦ Tightening torque 36.9 ± 1.9 N·m (3.76 ± 0.19 kgf·m) (27.22 ± 1.4 ft.lbs) (Hex5)
①-⑤ Tightening torque 34.3 ± 4.9 N·m (3.5 ± 0.5 kgf·m) (25.3 ± 3.61 ft.lbs) (Hex8)
①-⑧ Tightening torque 7.8 ± 1.0 N·m (0.8 ± 0.1 kgf·m) (5.75 ± 0.74 ft.lbs) (Hex5)
①-⑭ Tightening torque 12.7 ± 0.6 N·m (1.3 ± 0.06 kgf·m) (9.37 ± 0.44 ft.lbs) (Hex4)
①-㉗ Tightening torque 39.2 ± 2.0 N·m (4.0 ± 0.2 kgf·m) (28.9 ± 1.48 ft.lbs) (Hex8)
㊼ Tightening torque 2.45 ± 0.49 N·m (0.25 ± 0.05 kgf·m) (1.81 ± 0.36 ft.lbs) (Hex2.5)
㊽ Tightening torque 182.5 ± 6.9 N·m (18.6 ± 0.7 kgf·m) (134.6 ± 5.09 ft.lbs) (Hex10)
㊺ Tightening torque 12.3 ± 2.5 N·m (1.26 ± 0.26 kgf·m) (9.07 ± 1.84 ft.lbs) (Hex6)
㊽ Tightening torque 15.3 ± 3.0 N·m (1.56 ± 0.31 kgf·m) (11.29 ± 2.21 ft.lbs) (Hex5)

No.	Description	Q'ty	Remarks
1	Gear box	1	
1-1	Holder, flange	1	
1-2	Seal, floating	2	
1-3	Bearing, angular	1	
1-4	Nut, ring	1	
1-5	Plug	2	
1-6	Housing	1	
1-7	Ball, steel	99	JIS B1501, 1/4
1-8	Plug	2	PT1/8
1-9	Gear, planetary B	4	
1-10	Bearing, needle	4	
1-11	Race, inner	4	
1-12	Plate, thrust	4	
1-13	Washer, thrust	1	
1-14	Screw	4	
1-15	Gear, sun	1	
1-16	Washer, thrust	3	JIS B 2804, 42 shaft
1-17	Holder	1	
1-18	Gear, planetary A	3	
1-19	Bearing, needle	3	
1-20	Race, inner	3	
1-22	Gear, drive	1	
1-23	Plate, thrust	1	
1-23	Plate, thrust	1	
1-23	Plate, thrust	1	
1-24	Cover	1	
1-25	O-ring	1	JIS B 2401, 1B, G190
1-26	Wire	1	
1-27	Plug	3	
1-29	O-ring	3	JIS B 2401, 1B, P11
2	Shaft	1	
3	Bearing, ball	1	
4	Seal, oil	1	
5	Plate, swash	1	
6	Ball, steel	2	
7	Block, cylinder	1	
8	Collar	1	
9	Spring	1	
10	Washer	1	
11	Ring, snap	1	JIS B 2804, 37, hole
12	Pin	3	2.5 x 15.8L
13	Holder, retainer	1	
14	Plate, retainer	1	
15	Piston assy	9	

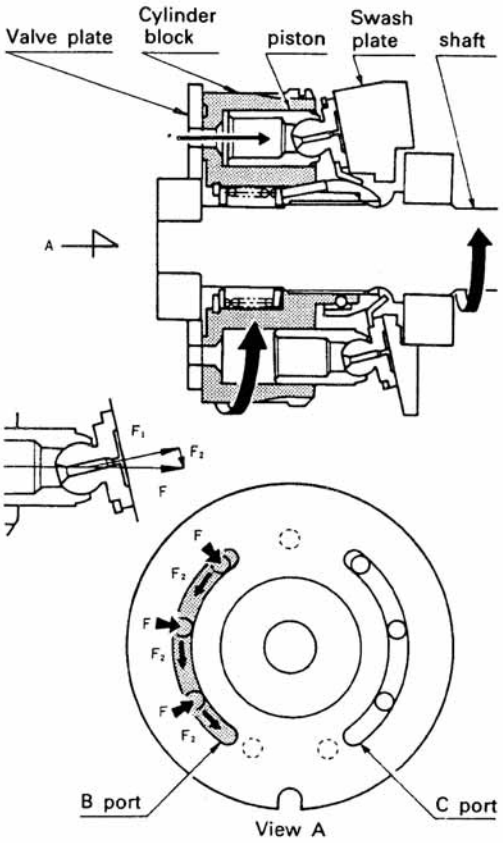
No.	Description	Q'ty	Remarks
19	2-speed piston	2	
20	Spring	2	
25	Plate, valve	1	
26	Pin	1	4x12L
27	Bearing, ball	1	
28	O-ring	1	A5568-258, 1A
29	O-ring	3	JIS B 2401, 1B, P7
30	Plate, base	1	
31	Spool assy	1	
31-1	Spool	1	
31-2	Valve, check	2	
31-3	Spring	2	
31-4	Plug	2	
31-5	O-ring	2	JIS B 2401, 1B, P10
36	Seat, spring	2	
37	Spring	2	
38	Cap	2	
39	O-ring	2	JIS B 2401, 1B, P29
40	Orifice	2	M4 x 0.8 x 5L 0.6
41	Spool	1	
42	Spring	1	
43	Plug	3	PF3/8
44	O-ring	4	JIS B 2401, 1B, P14
45	Plug	2	NPFT 1/16
46	Plug	1	
47	Orifice	4	M5 x 0.8 x 5L 0.5
48	Bolt, sch	6	JIS B 1176, M12 x 25L
49	PIn	2	
50	Assy, valve	1	
50-1	Body, valve	1	
50-2	Valve, check	2	
50-3	Spring	2	
50-4	Plug	2	PF3/8
50-5	O-ring	2	JIS B 2401, 1B, P14
50-6	O-ring	3	JIS B 2401, 1B, P12
50-7	Bolt, sch	3	JIS B 1176, M8 x 30L
51	Plate, name	1	
52	Screw, drive	2	1.85 x 4.8L
53	Plug, shipping	2	PT1/2
54	Plug, shipping	1	9/16UNF
55	Plug	1	PT1/4
57	O-ring	2	JIS B 2401, 1B, P8
58	Plug	2	PF1/8
59	Plug	2	

c) Operation of Piston Motor

Nine pistons have been incorporated in cylinder block, and its one end is touching a valve plate having two crescent ports B & C. Besides, the cylinder block is free to rotate and is coupled to a shaft through splines. On the other hand, the swash plate is fixed to the housing.

As high-pressure oil is led to port B, the swash plate is pressed with force F per piston. F = P × A, whereas P is pressure, and A is piston sectional area.

Force F a piston pushes the swash plate is divided into two components, i.e., force F_1 to push the shaft and force F_2 to rotate the cylinder block. And a turning force is generated in the cylinder block by the sum total of rotation directional components of pistons on the high-Pressure side, torque is transmitted to the shaft through splines and thus the shaft rotates. As high-pressure oil is led to port C conversely, rotation resulted becomes reverse to the aforementioned. The output torque and number of revolution of a piston motor obtained according to the aforementioned principle of operation are calculated by the following formulae determined by pressure (P) and inflow quantity (O) supplied to the motor:



$$T=\frac{P\times q\times \eta_m}{2\times \pi\times 10^2}$$

$$N=\frac{Q\times 10^3\times \eta_v}{q}$$

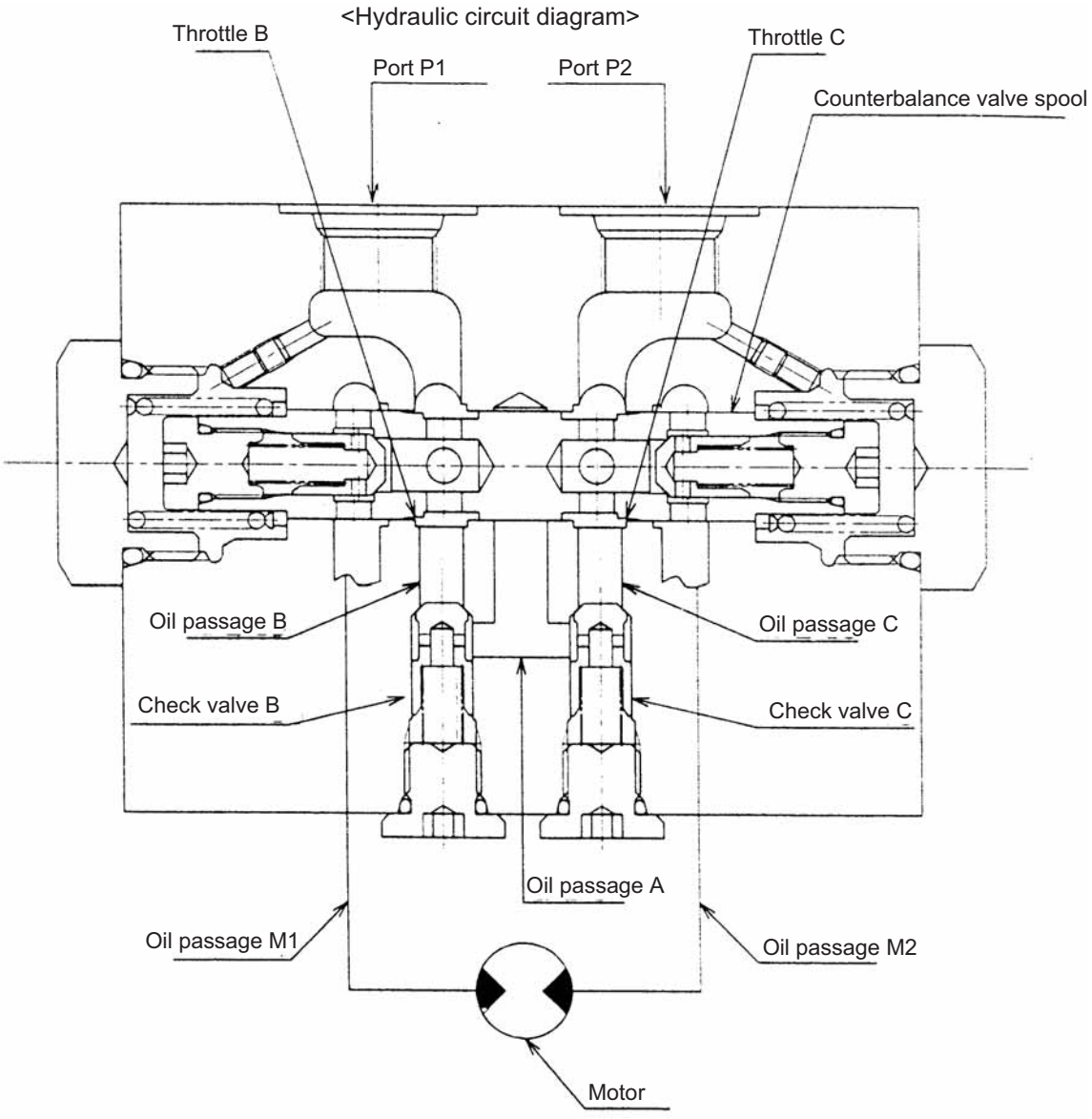
T:Output torque (kgf·m)
N:Revolution speed (rpm)
P:Operating pressure (kgf/cm^2)
Q:Pump flow rate (l/min)
q:Theoretical displacement (cc/rev)
η_m:Mechanical efficiency
η_v:Volumetric efficiency

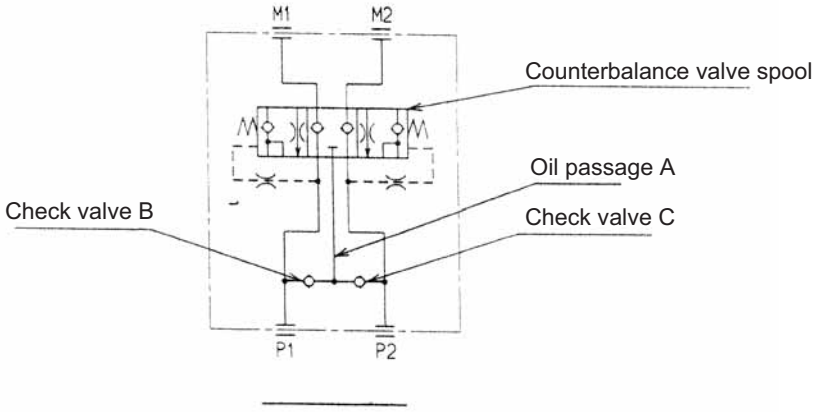
d) Function of Anti-cavitation Valve

(1) Construction

The anti-cavitation mechanism functions in sync with the counterbalance mechanism.
Unlike conventional types of counterbalance mechanism, the oil passages A, B and C as well as the check valves B and C are added in this circuit.

<Hydraulic circuit diagram>



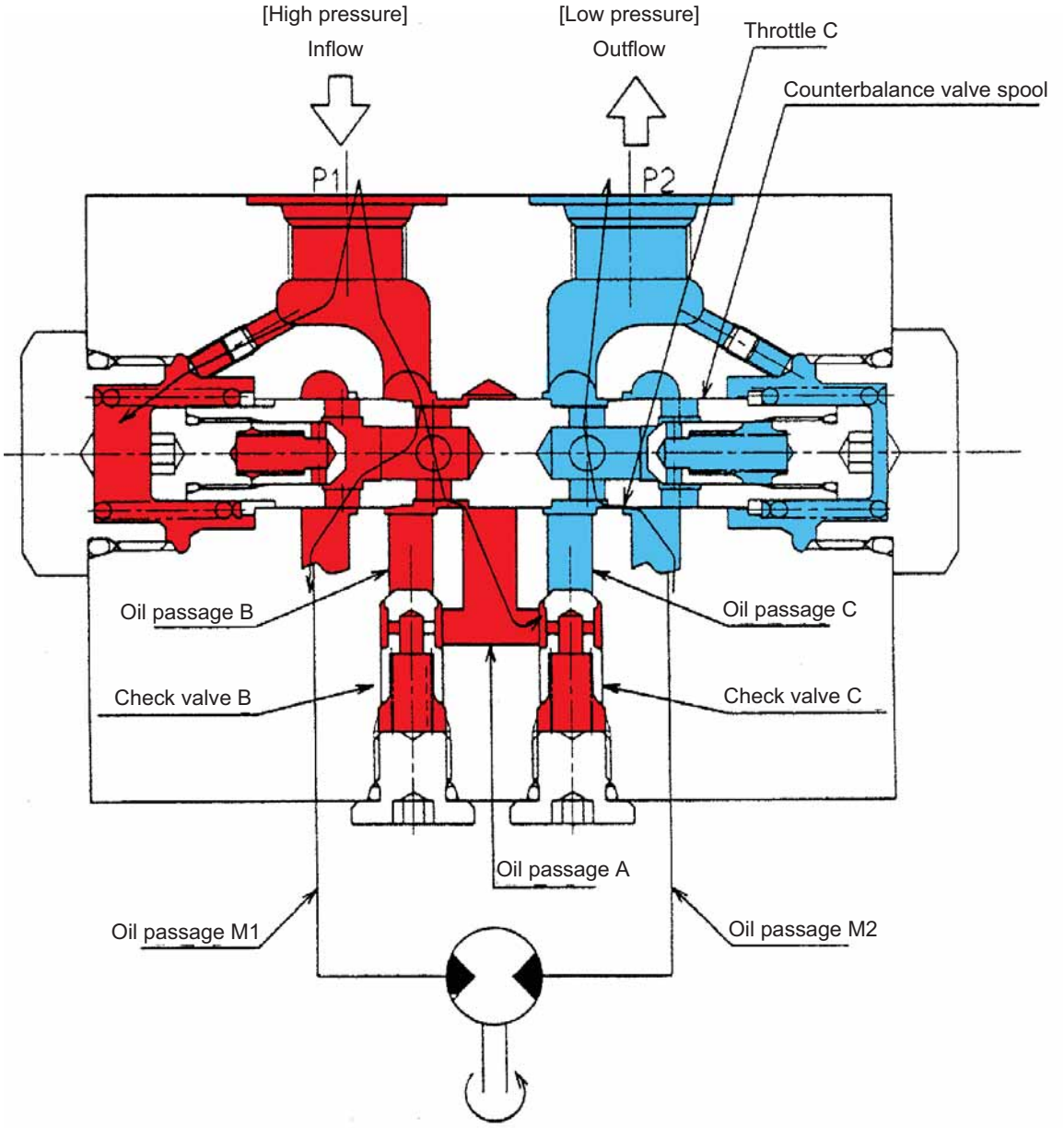


(2) Circuit behavior

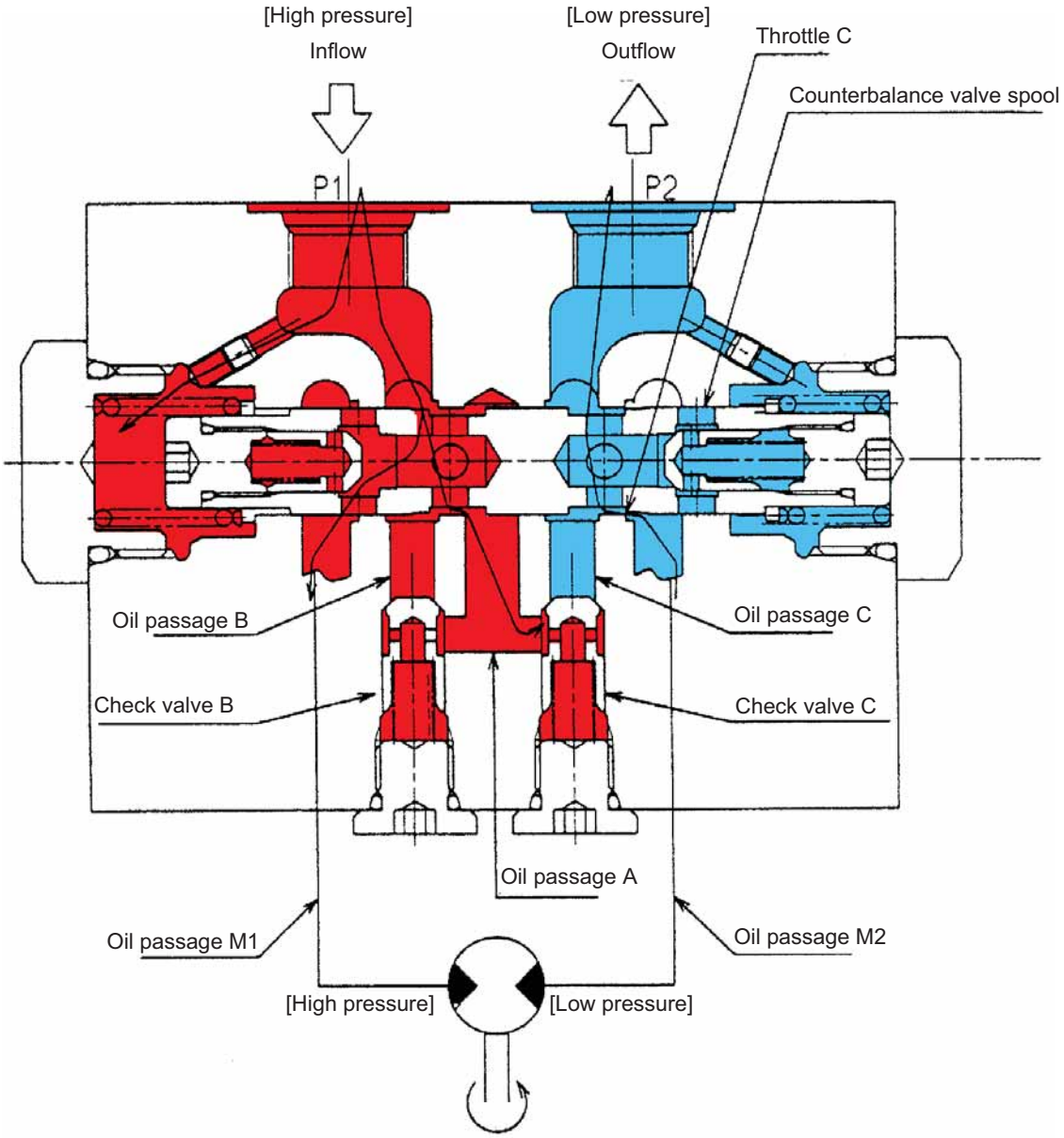
1) Motor start-up

When the hydraulic pressure is applied to P1, the counterbalance valve spool overcomes the spring's counter-force and shifts to the right as shown in the figure below. In the meanwhile, the valve switches from M2 to P2, which gets the motor started. (Usual counterbalance action)

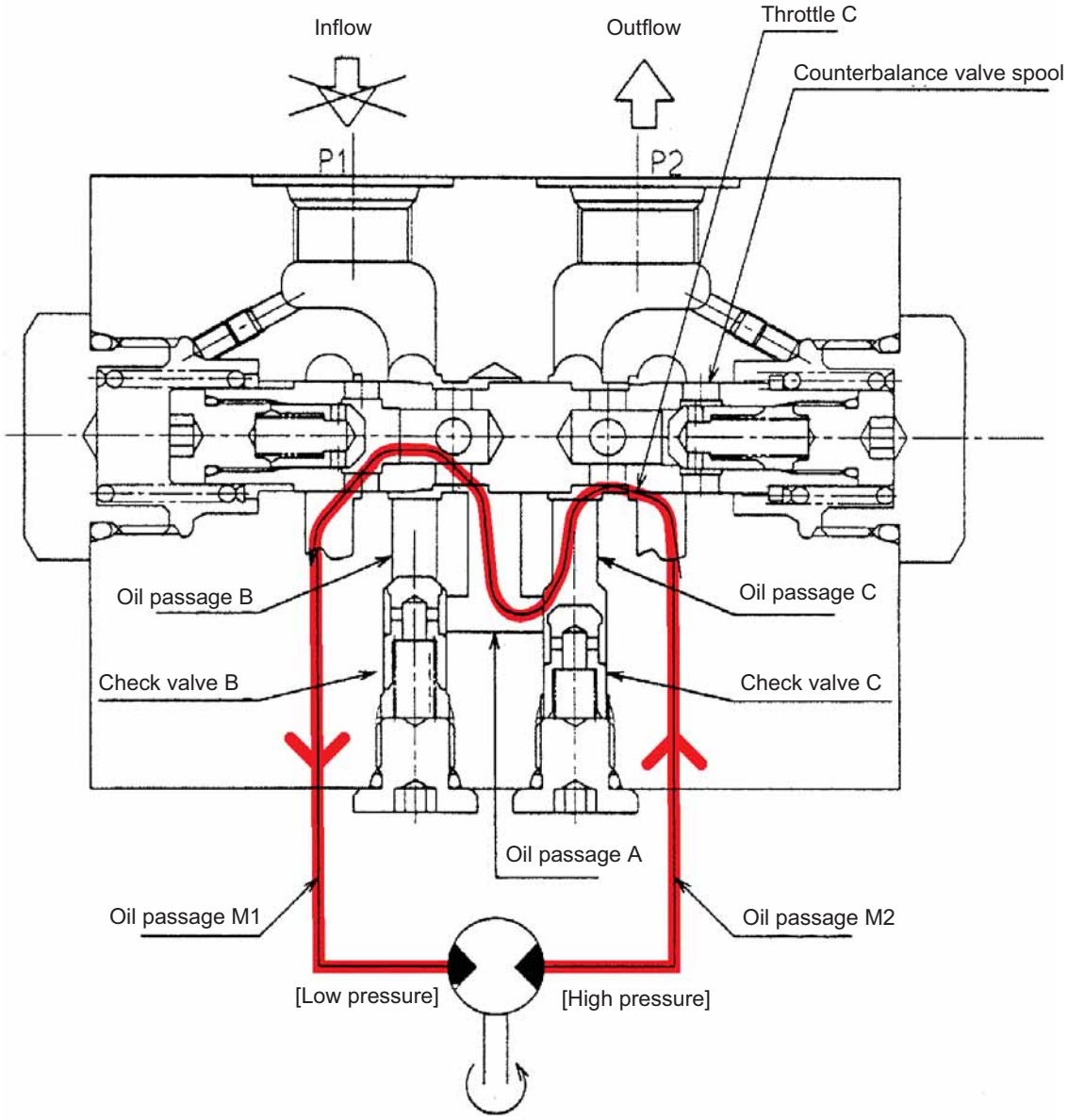
At the same time, the oil passage A goes under high pressure. Thanks to the action of the check valve C, however, the pressure oil is kept from leaking out toward the low-pressure side (oil passage C).



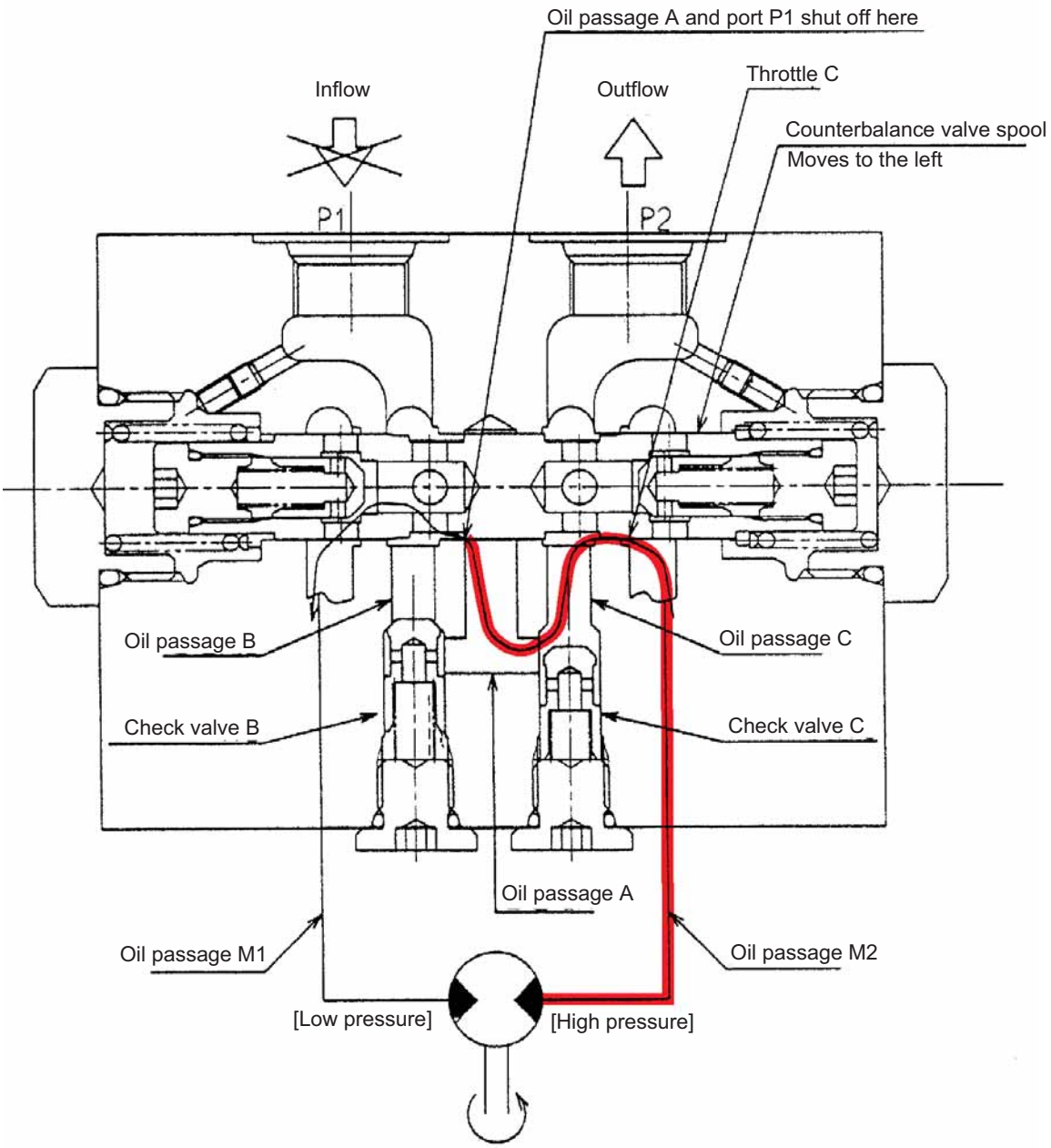
2) Motor running at constant speed
With the motor running at constant speed, the oil passage A stays under high pressure. Thanks to the action of the check valve C, however, the pressure oil is kept from leaking out toward the low-pressure side.
Thus the motor runs stably with the anti-cavitation mechanism intact.



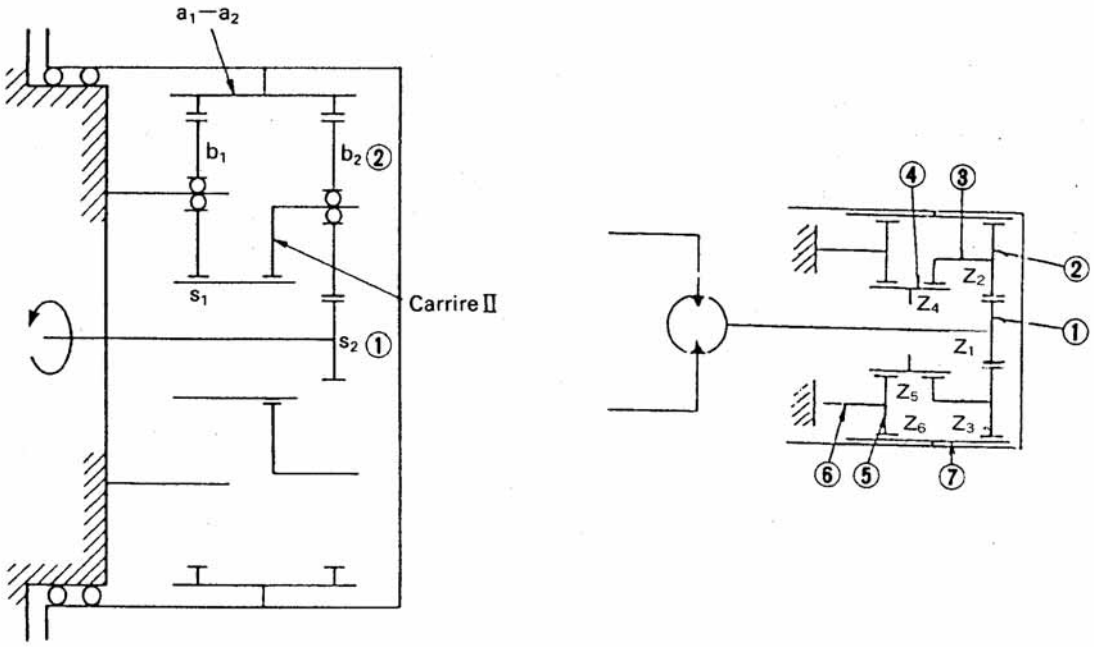
3) Motor slowing down
When being slowed down, the motor keeps running for a while by its inertia force. While the counterbalance valve is open, however, the hydraulic oil flows through the oil passage M2 into the port P2. Because there is no enough oil flow from P1, cavitation occurs at P1 and M1.
The anti-cavitation mechanism works to avoid this. Until the counterbalance valve returns to its original state, P1 is connected with the oil passage A. In this condition, the hydraulic oil flows in this route: oil passage M2, counterbalance throttle C, oil passage C, check valve C, oil passage A, port P1 and oil passage M1. It finally flows back to the motor. In this way, cavitation is minimized.



4) Motor stop
The anti-cavitation function keeps on until the oil passage A and port P1 are shut off as shown in the figure below (at the indicated positions).



Planetary reduction gear case.
This speed reducer consists of a two-stage planetary gear mechanism.



Drive gear (1) intermeshes with the first-stage planetary gear (2); the second-stage sun gear (4), the second-stage planetary gear (5). And the second-stage planetary carrier is fixed to the body. Planetary gears (2) & (5) intermesh with ring gear (7) (housing). A driving force from a piston motor is transmitted to the drive gear (1) and then reduced in speed by the respective gears. Driving force reduced in speed is transmitted to the ring gear (7) through the planetary gear (5) of planetary carrier (6) which is fixed to the final-stage body. (A driving force is transmitted also from the first-stage planetary gear (2).) Incidentally, input rotation is reverse to the output rotation, vice versa.
Reduction gear ratio i becomes as follows according to the first-stage and second-stage reduction gear ratios i_1 & i_2:

Reduction gear ratio (i)

$$T = -(i_1 \times i_2 - 1) = -\left(\frac{Z_1+Z_3}{Z_1} \times \frac{Z_4+Z_6}{Z_4} - 1\right)$$

Z_1:Drive gear (1) teeth No.
Z_3:Drive gear (7) teeth No.
Z_4:Drive gear (4) teeth No.
Z_6:Drive gear (7) teeth No.

Reduction gear case output torque (T)

$T = T_M \times i \times \eta_m$

T_M:Input torque (Motor output torque)
i: Reduction gear ratio
η_m: Mechanical efficiency

Reduction gear case output speed (N)

$$T = \frac{N_M}{i}$$

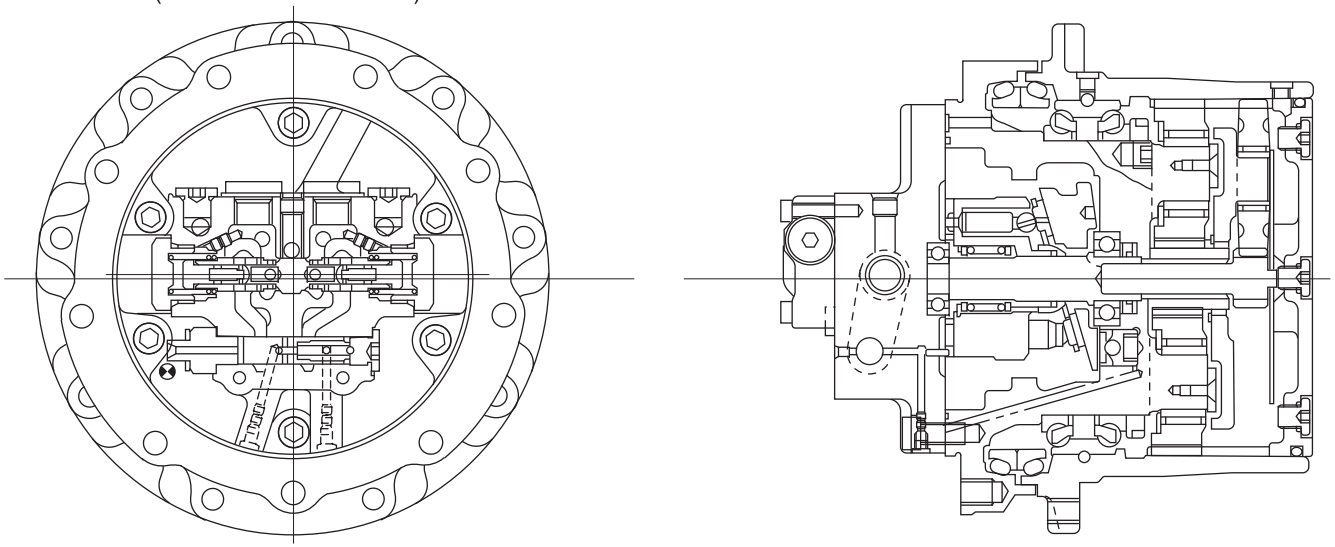
N_M:Input rotation speed (Motor output speed)

e) Travel Motor Minor Change

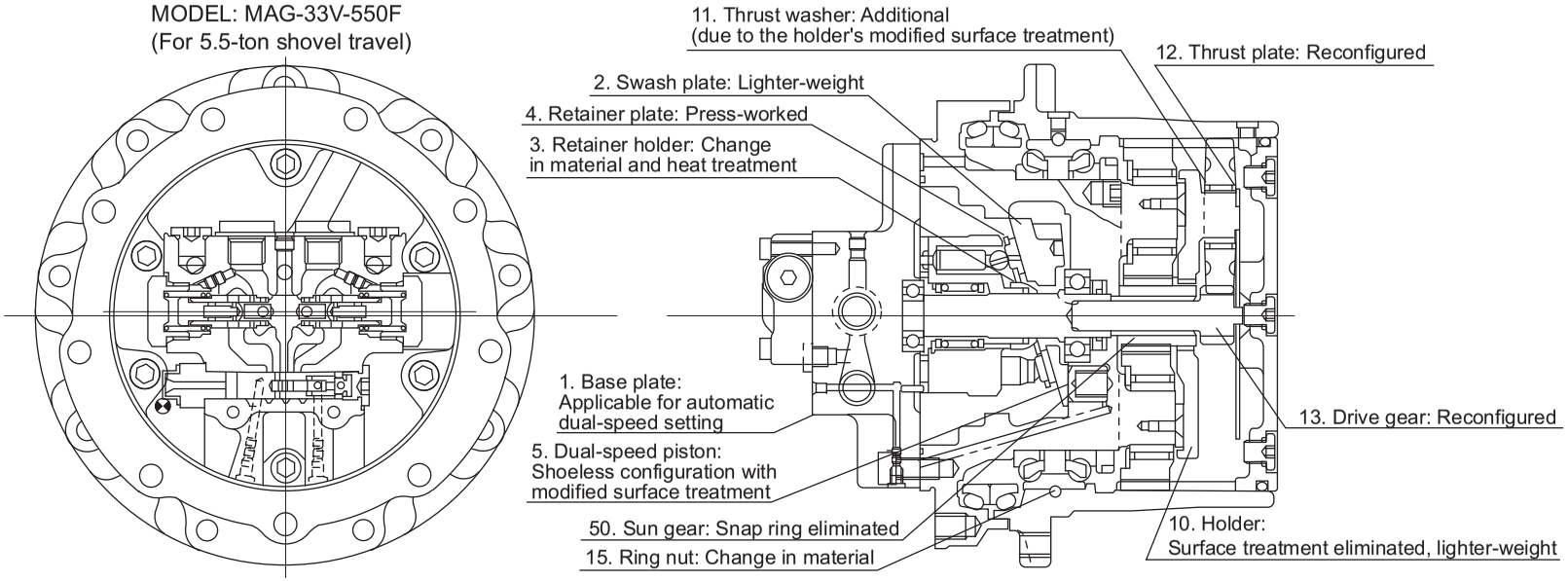
KX121-3S, KX121-3α, KX161-3S, KX161-3α, U45-3α, U45S

1. Motor change points

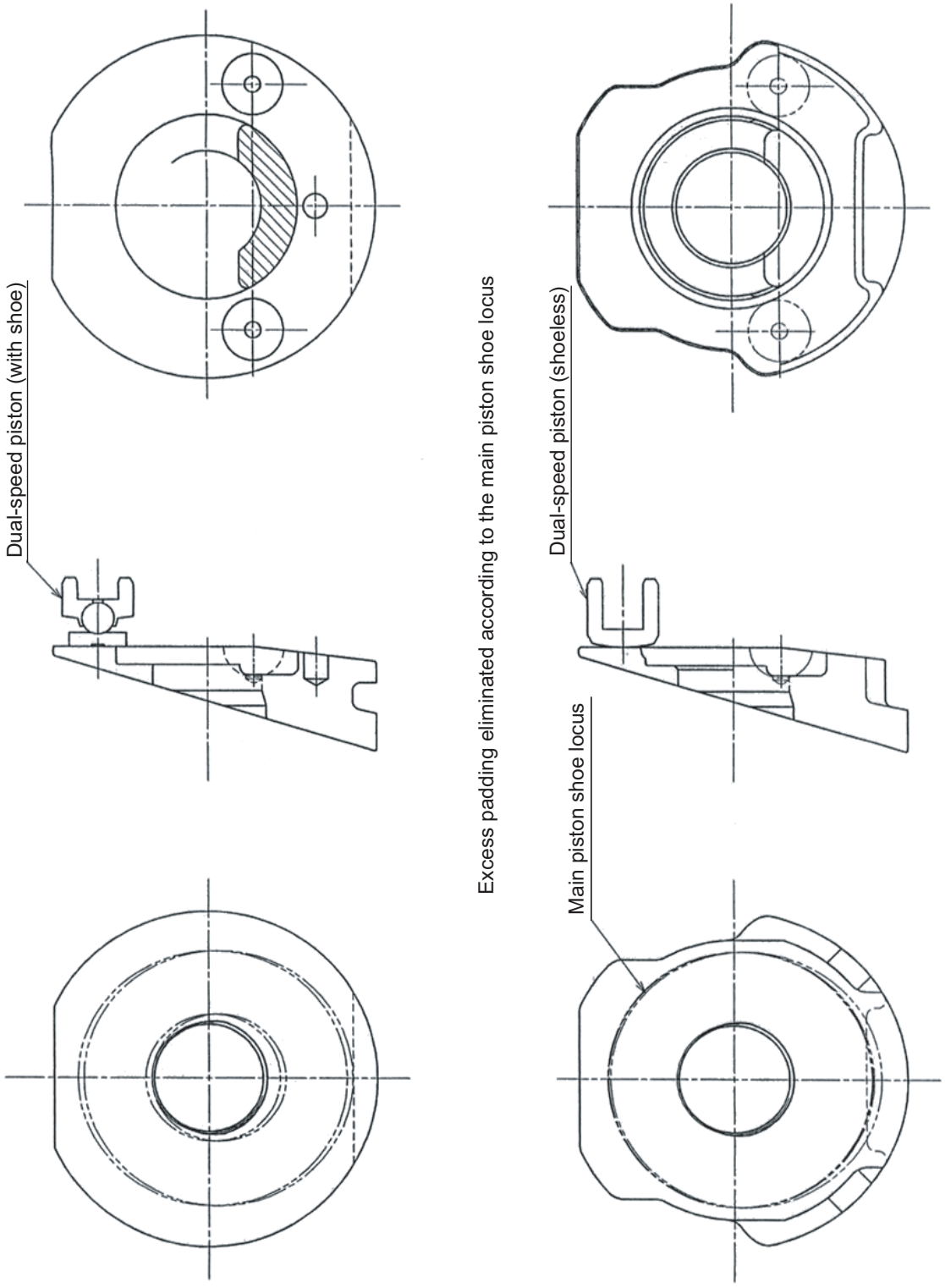
MODEL: MAG-33V-550E
(For 5.5-ton shovel travel)



MODEL: MAG-33V-550F
(For 5.5-ton shovel travel)



2. Swash plate and Hi-Low piston



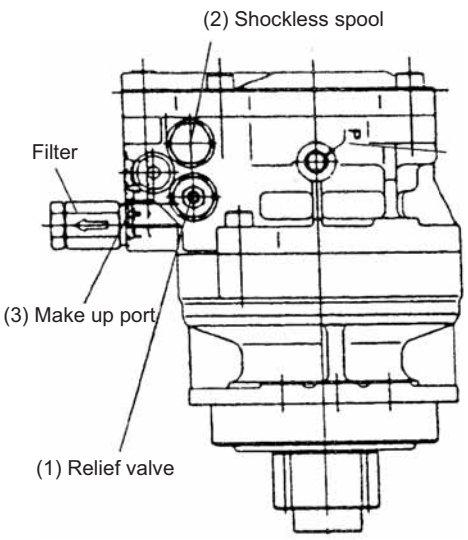
(F) SWIVEL MOTOR

a) Swivel Performance Specifications

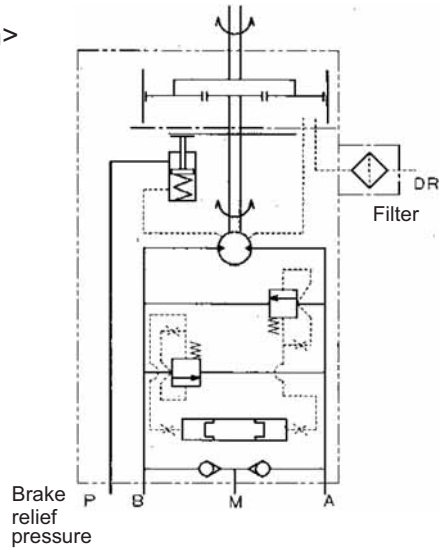
	Unit	KX121-3α	KX161-3α	U45-3α/**U50-3**α	Remarks
Manufacturer		Kubota Seiki	Kubota Seiki	Kubota Seiki	
Kubota part No.		RD118-6170-0	RD511-6170-0	RD411-6170-0	
Displacement	cc/rev	29.271	←	←	
	cu.in/rev	1.79	←	←	
Reduction ratio		9.90	21.263	←	
Max.oil flow	L/min	22	38	←	Rated flow rate
	USGPM	5.81	10.04	←	
Motor speed	rpm	75.9	61.1	←	KX121-3α: at 22 L/min (5.81 USGPM) KX161-3α,U45-3α, U50-3α: at 38 L/min (10.04 USGPM)
Brake valve pressure (at bench)	MPa	20.6	17.7	16.7	KX121-3α: at 22 L/min (5.81 USGPM) KX161-3α,U45-3α,U50-3α: at 38 L/min (10.04 USGPM)
	kgf/cm^2	210	180	170	
	psi	2987	2560	2418	
Theoretical output torque	N.m	950	1749	1651	KX121-3α: at 20.6MPa ($210kgf/cm^2$, 2987psi) KX161-3α: at 16.2MPa ($180kgf/cm^2$, 2560psi) U45-3α, U50-3α: at 16.7MPa ($170kgf/cm^2$, 2418psi)
	kgf.m	96.9	178.3	168.4	
	ft.lbs	701	1290	1218	
Drain amount at lock	L/min	4.0 ≧	←	←	New machine
	cu.in/min	244.1 ≧	←	←	
Drain amount while rotating	L/min	0.5 ≧	←	←	New machine
	cu.in/min	3.05 ≧	←	←	
Max. drain pressure	MPa	0.3	←	←	
	kgf/cm^2	3	←	←	
	psi	43	←	←	
Swivel speed	rpm	9.2	9.3	9.1	pinion / swivel teeth KX121-3α: 10/86 KX161-3α, U45-3α, U50-3α: 11/78
3 times rotation swivel time	sec.	17.8~21.7	17.6~21.4	←	
Swivel block performance at engine stop	deg.	5	←	←	
Swivel block performance at engine running	deg.	30 ≧	←	←	Bucket empty
Capable swivel rotation angle	deg.	20	17	18	Bucket crowded, Arm extended
Play at the tip of bucket	mm	50 ≧	←	←	Reference value
	in.	1.97 ≧	←	←	
Brake release pressure	MPa	1.5	←	←	
	kgf/cm^2	15	←	←	
	psi	213	←	←	

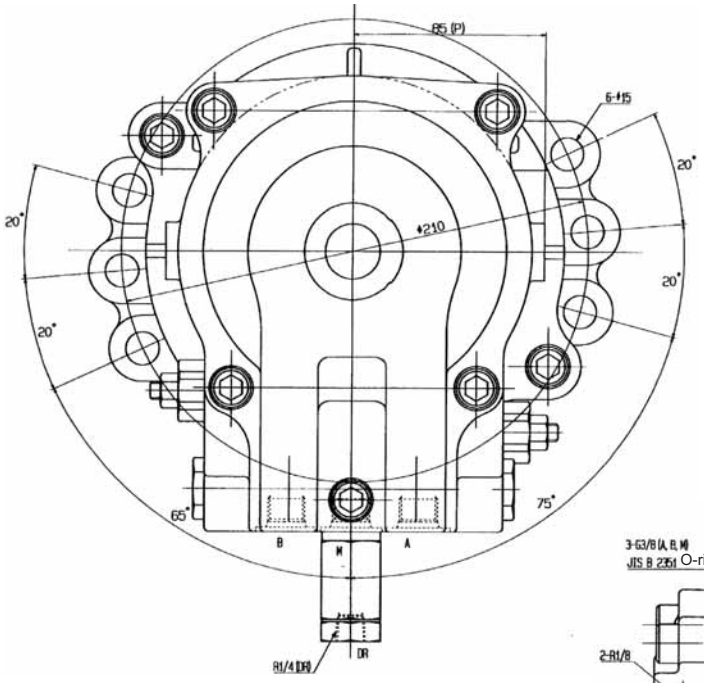
b) Structure

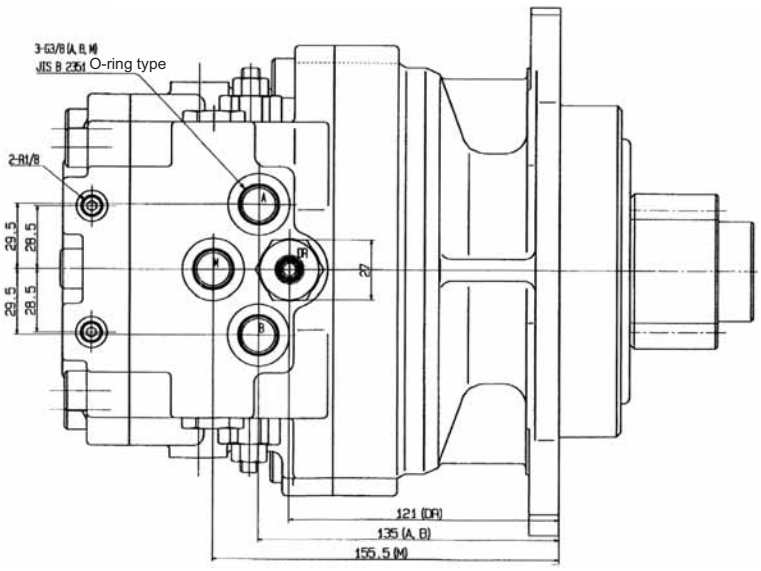
1. KX121-3S, KX121-3α



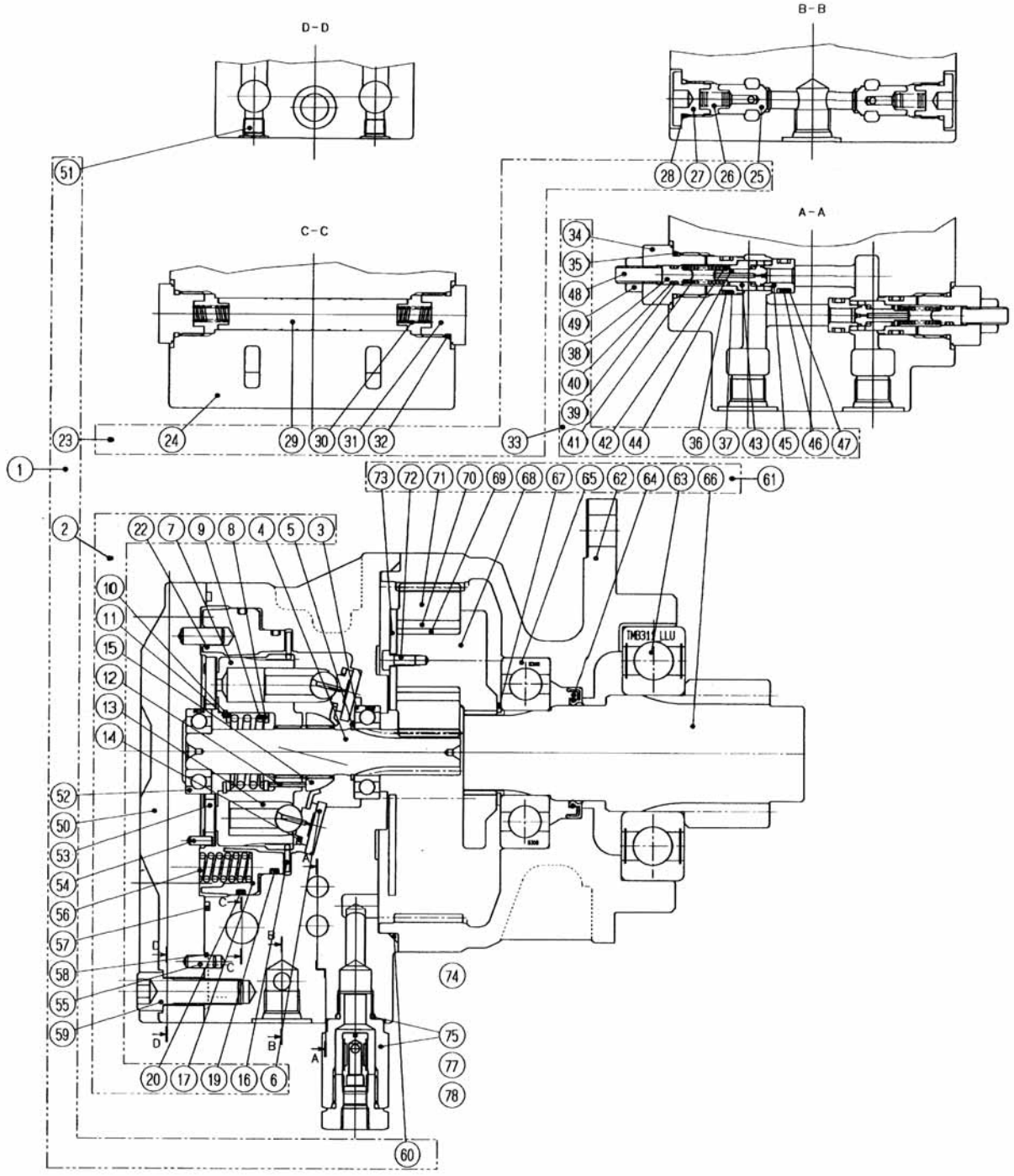
<Circuit diagram>







(One-stage planetary reduction case)

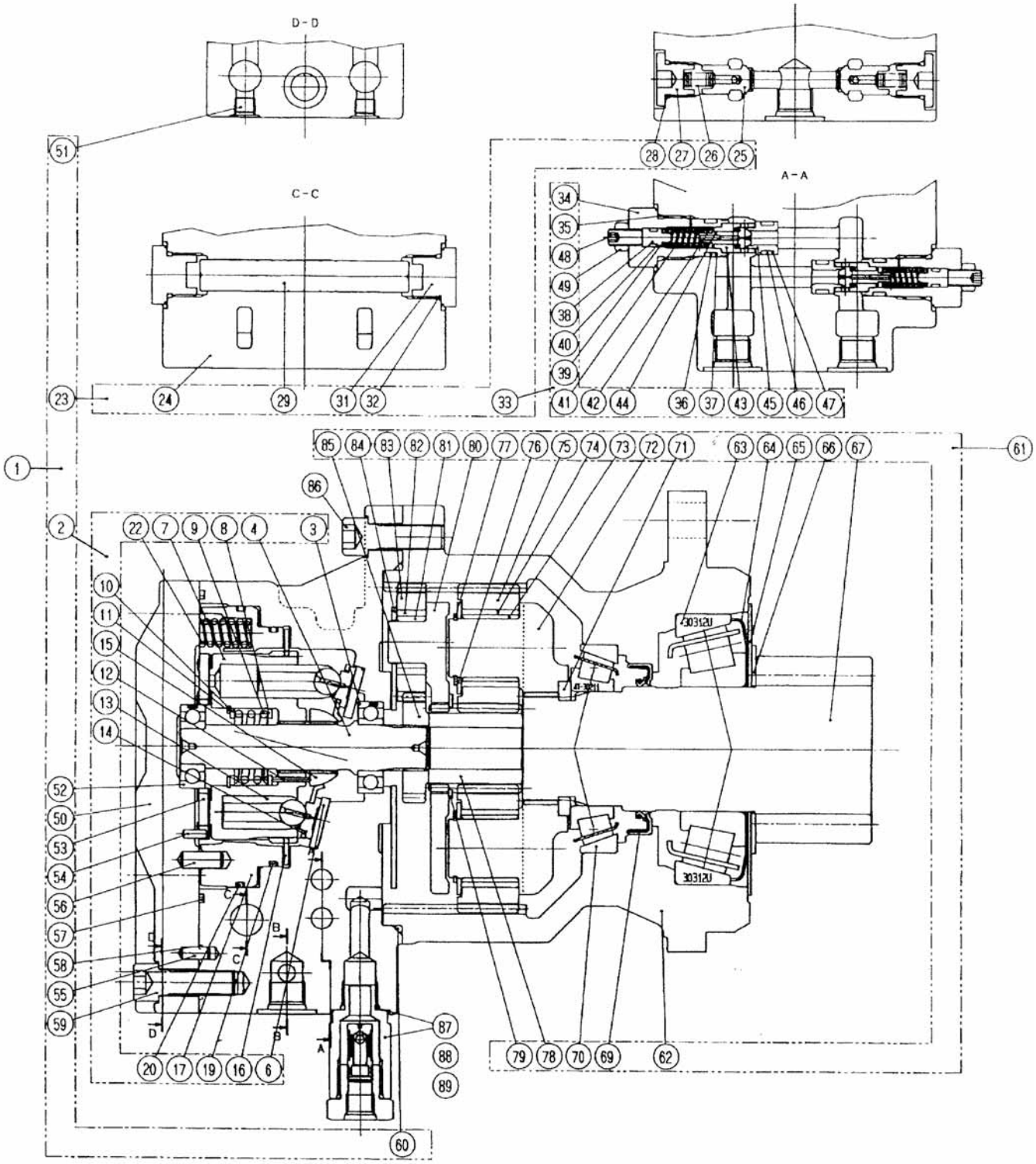


(3)	Ball bearing	(17)	Brake piston	(38)	Spring guide
(4)	Shaft	(23)	Valve assy	(43)	Poppet guide
(5)	Circlip	(24)	Valve housing	(61)	Gear case assy
(6)	Thrust plate	(25)	Poppet	(66)	Pinion shaft
(7)	Cylinder block	(29)	Shockless piston	(71)	Planetary gear
(13)	Piston plate	(33)	Relief valve assy	(73)	Thrust plate
(15)	Retainer holder	(34)	Valve housing	(75)	Filter
(16)	Friction plate				

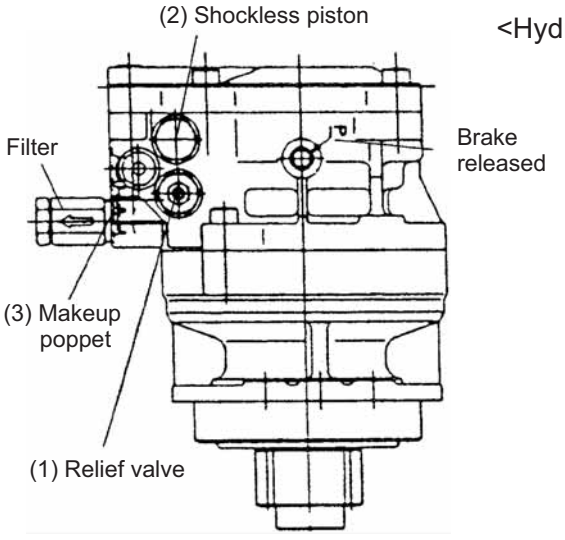
2. KX161-3S/α, U45S, U45-3S/α, U50-3α

(Two-stage planetary reduction case)

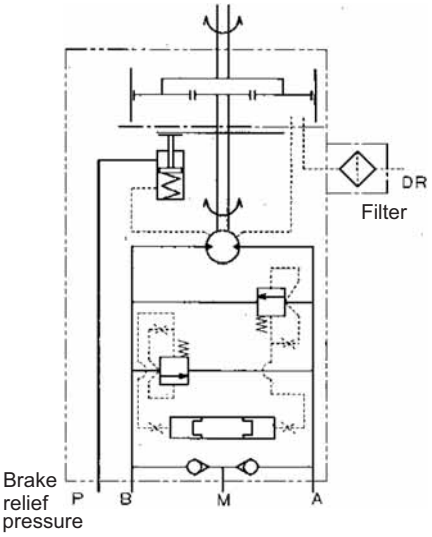
Type: SM29GL
Maker: kubota seiki



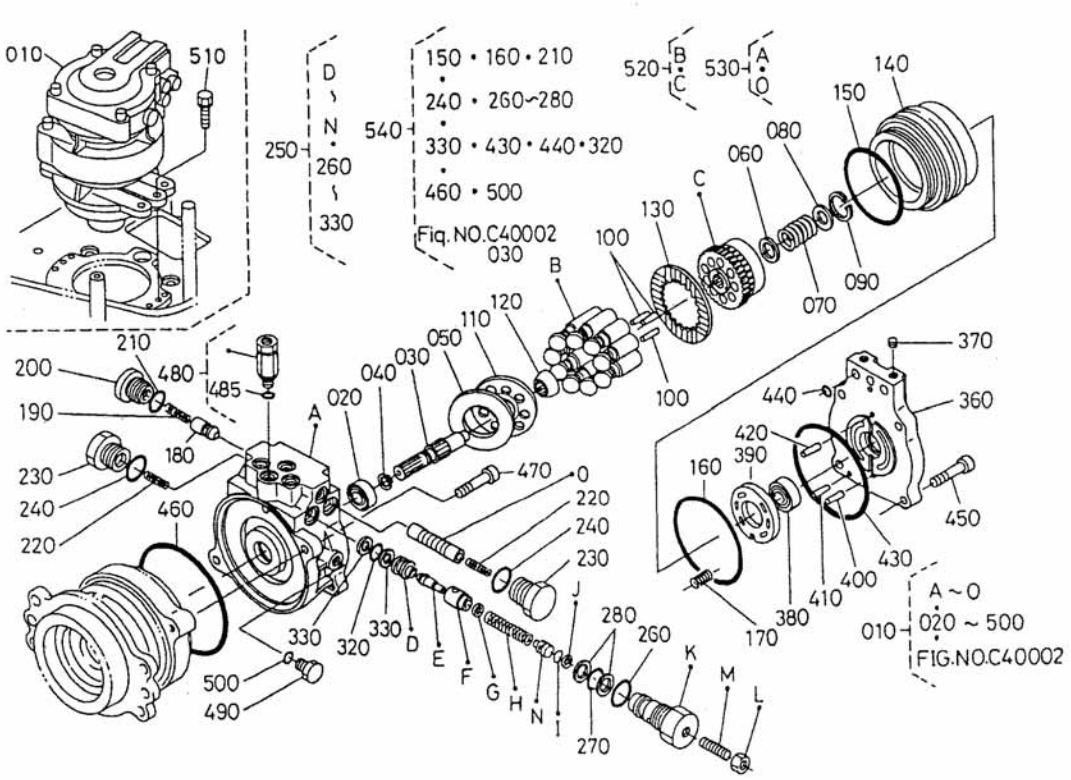
1	Motor, assy, with valve	31	Plug	61	Gear case, assy
2	Motor, assy	32	O-ring	62	Gear case
3	Ball bearing	33	Valve, assy (Relief)	63	Taper roller bearing
4	Shaft	34	Housing (Relief)	64	Seal plate
5	-	35	O-ring	65	Plate, piston
6	Plate thrust	36	O-ring	66	Plate, pinion 2
7	Cylinder Block	37	Ring, backup	67	Shaft, pinion
8	Washer spring	38	Guide (Spring)	68	-
9	Spring	39	O-ring	69	Oil seal
10	Washer, Spring	40	Ring, backup	70	Taper roller bearing
11	Circlip	41	Spring	71	Spacer
12	Pin	42	Ring, Spring seat	72	Holder 2
13	Piston, assy	43	Guide, poppet	73	Color 2
14	Plate, retainer	44	Poppet	74	Needle bearing
15	Holder, retainer	45	Ring, poppet seat	75	Planetary gear 2
16	Plate, friction	46	O-ring	76	Thrust plate 2
17	Piston, brake	47	Ring, backup	77	Circlip
18	-	48	Bolt	78	Sun gear
19	O-ring	49	Nut	79	Circlip
20	O-ring	50	Cover, motor	80	Holder 1
21	-	51	Plug	81	Color 1
22	Spring	52	Ball bearing	82	Needle bearing
23	Valve assy	53	Plate, valve	83	Planetary gear 1
24	Housing	54	Pin	84	Thrust plate
25	Poppet	55	Pin	85	Drive gear
26	Spring	56	Pin	86	Hex. bolt
27	Plug	57	O-ring	87	Filter
28	O-ring	58	O-ring	88	Plug 5
29	Shockless piston	59	Bolt	89	O-ring
30	-	60	O-ring		



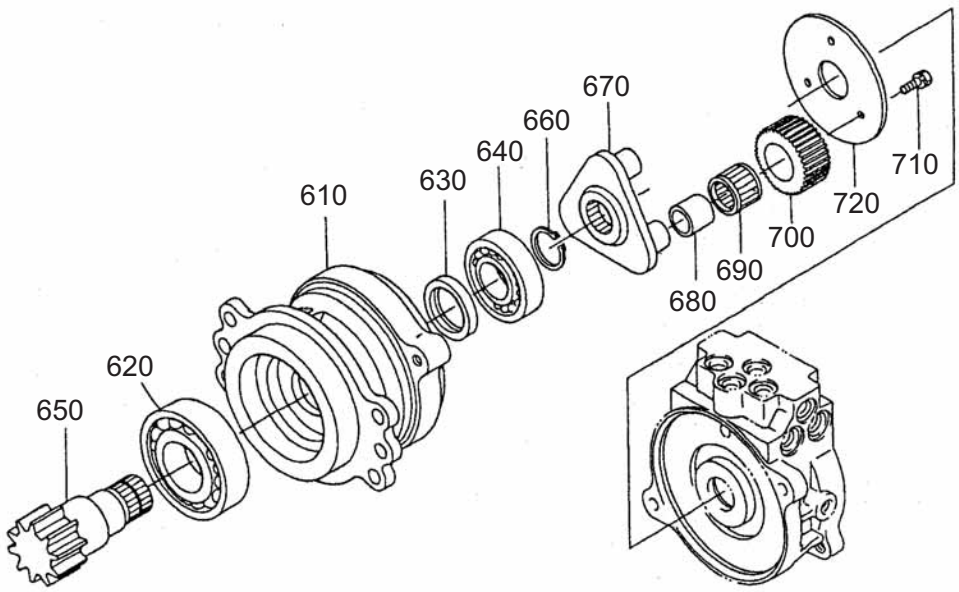
<Hydraulic Circuit Diagram>



Parts development

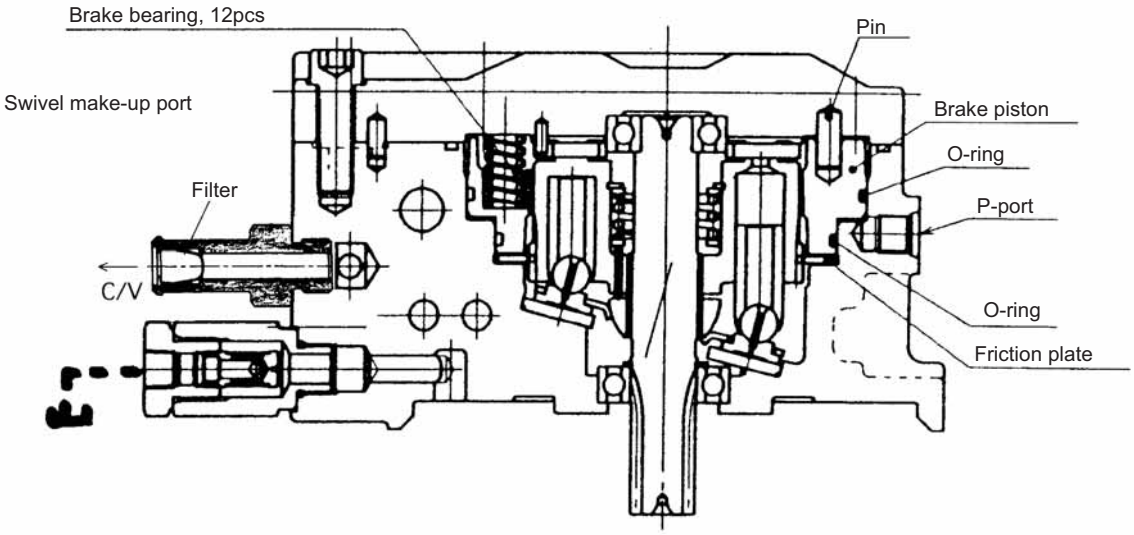


010	Motor, assy (Swivel)	200	Spring	380	Ball bearing
020	Ball bearing	210	O-ring	390	Plate, valve
030	Shaft	220	Spring	400	Pin
040	Circlip	230	Plug	410	Pin
050	Plate, thrust	240	O-ring	420	Pin
060	Washer, spring	250	Valve, assy (Relief)	430	O-ring
070	Spring	260	O-ring	440	O-ring
080	Washer, spring	270	O-ring	450	Bolt
090	Circlip	280	Ring, backup	460	O-ring
100	Pin	290	Blank	470	Bolt
110	Plate, retainer	300	Blank	480	Filter
120	Holder, retainer	310	Blank	485	O-ring
130	Plate, friction	320	O-ring	490	Plug
140	Piston, brake	330	Ring, backup	500	O-ring
150	O-ring	340	Blank	510	Bolt
160	O-ring	350	Blank	520	Cylinder Block, assy
170	Spring	360	Cover, motor	530	Housing, assy
180	Poppet	370	Plug	540	Seal, kit
190	Spring				



610	Case, gear	650	Shaft, pinion	690	Needle bearing
620	Ball bearing	660	Circlip	700	Gear (Planetary)
630	Seal, oil	670	Holder	710	Bolt
640	Ball bearing	680	Collar	720	Plate, thrust

c) Function of Negative Brake

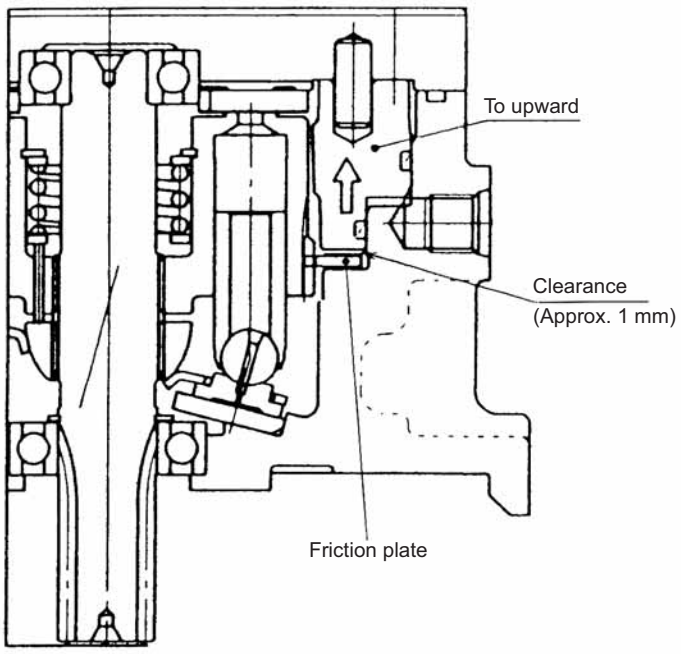


(1) Negative brake function (Unload condition)

No pressure is applied at the P-port, which means there is no piston driving force.
In this state, the force of negative brake springs pushes down the negative brake piston to get the friction plate between the piston and the casing. By so doing, the friction plate is held in this position by a friction force.
Because the motor's cylinder block and the friction plate are spline-coupled, the cylinder block is held and thus the motor is braked.

(2) Negative brake release (On-load condition)

A pilot pressure is applied at the P-port, generating a driving force to the negative brake piston.
In this state, the piston driving force surpasses the force of negative brake springs to push up the negative brake piston.
By so doing, the friction plate gets free from the friction force, allowing the motor to run freely.



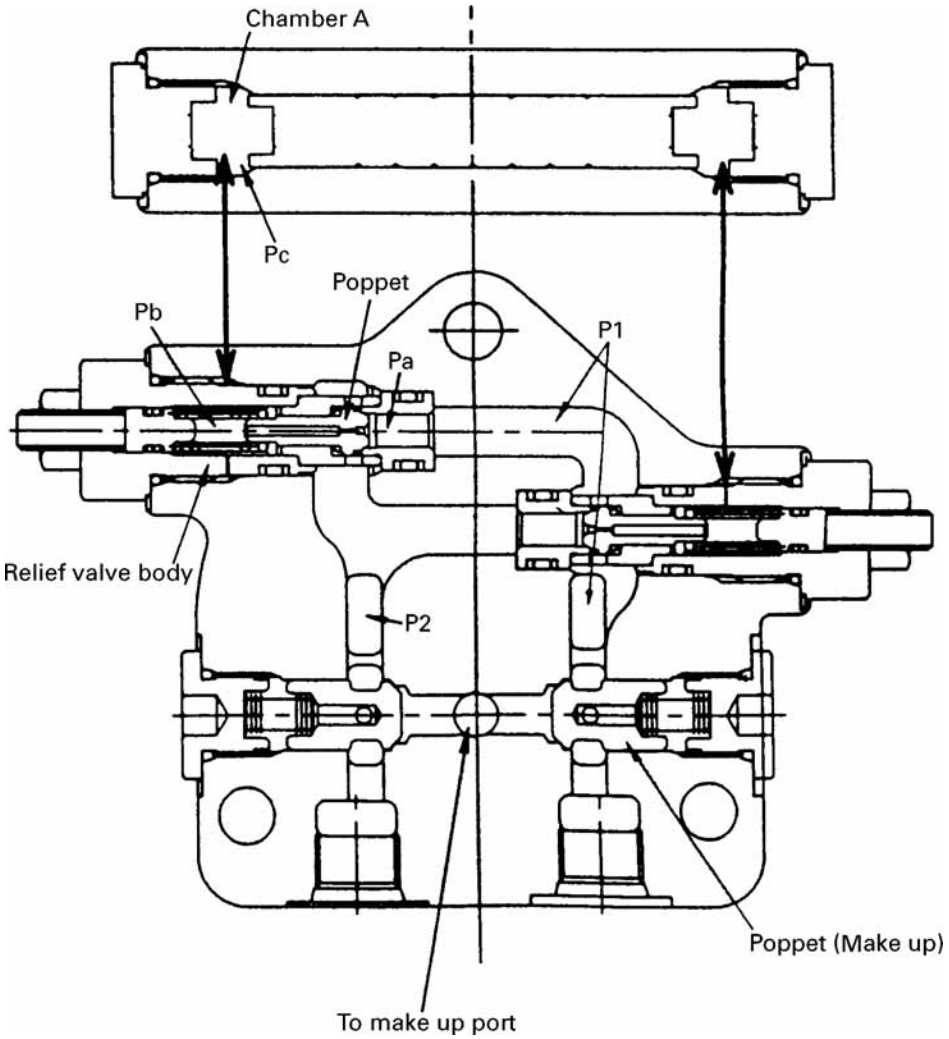
d) Function of Valve Section

(1)Make-up valve

When the swivel frame has been once accelerated and then decelerated with the control lever, the oil supplied to the P1 port by the pump drops. But the inertia of the swivel frame forces the hydraulic motor to run for pumping. By this, the oil amount being supplied runs short and the P1 port comes under a slightly negative pressure. To avoid this, as the P1 port pressure drops, the make-up valve's poppet is opened to allow in the return oil to compensate for such oil shortage.

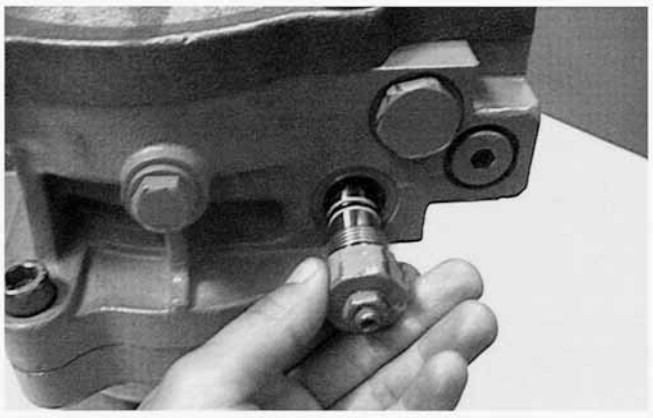
(2)Function of shockless valve

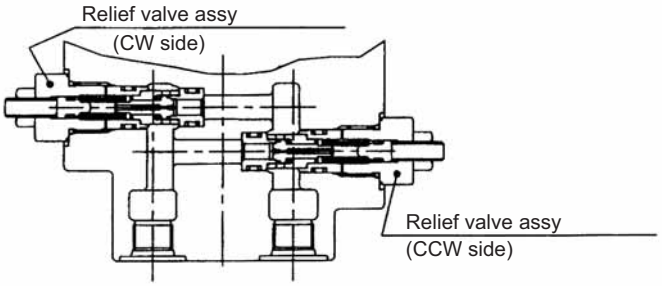
1) When the pressure oil comes to the P1 port at a start or stop, the oil flows through the orifice, which is located in the poppet and relief valve body, and into the chamber A of the free piston. With the orifice in effect, the back pressure (Pb) of the poppet is kept below the pressure (Pa) being exerted on the poppet (Pa > Pb). In this design, the relief valve works at a pressure below the set pressure, allowing the pressure oil into the low-pressure (P2) side. (Primary relief pressure)
2) The primary relief pressure continues to work until the free piston reaches its stroke end. The free piston's stroke speed is controlled by 4 orifices: 2 orifices at the inlet relief valve and 2 at the outlet one.
3) When the free piston has reached its stroke end, the pressure loss due to the above orifice effect turns zero. This means that the poppet's back pressure (Pb) becomes equal to the pressure (Pa) applied on the poppet (Pa = Pb). The relief valve that has worked at the primary relief pressure is now activated by the set pressure. (Secondary relief pressure)



Above illustration is taken from U-WSM for functional explanation purpose.

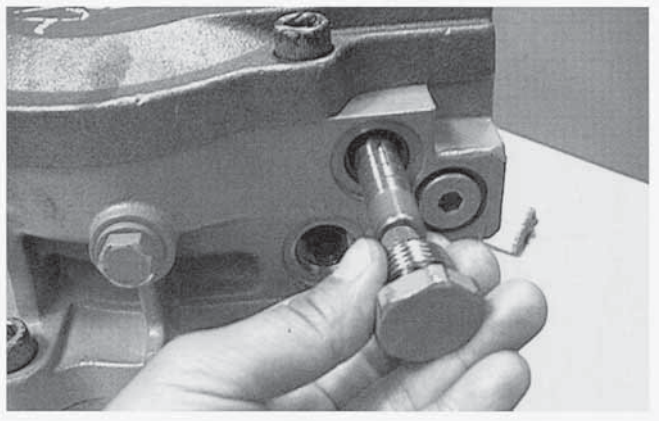
(3) Relief valve

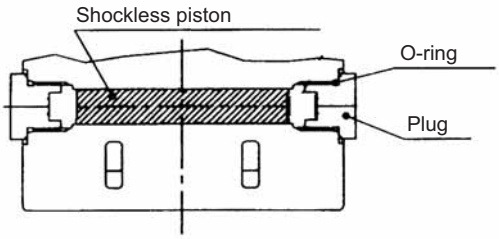




Valve tightening torque: 58.8 ~ 68.6 N·m (6.0 ~ 7.0 kgf·m)

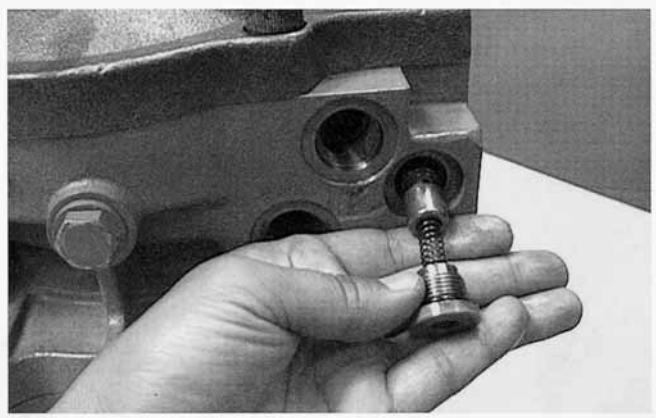
(4) Shockless piston

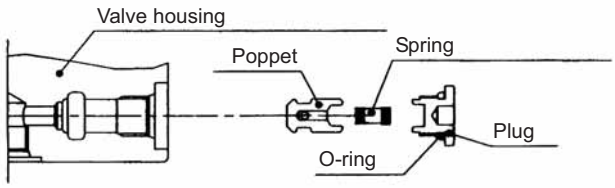




Plug tightening torque: 58.8 ~ 68.6 N·m (6.0 ~ 7.0 kgf·m)

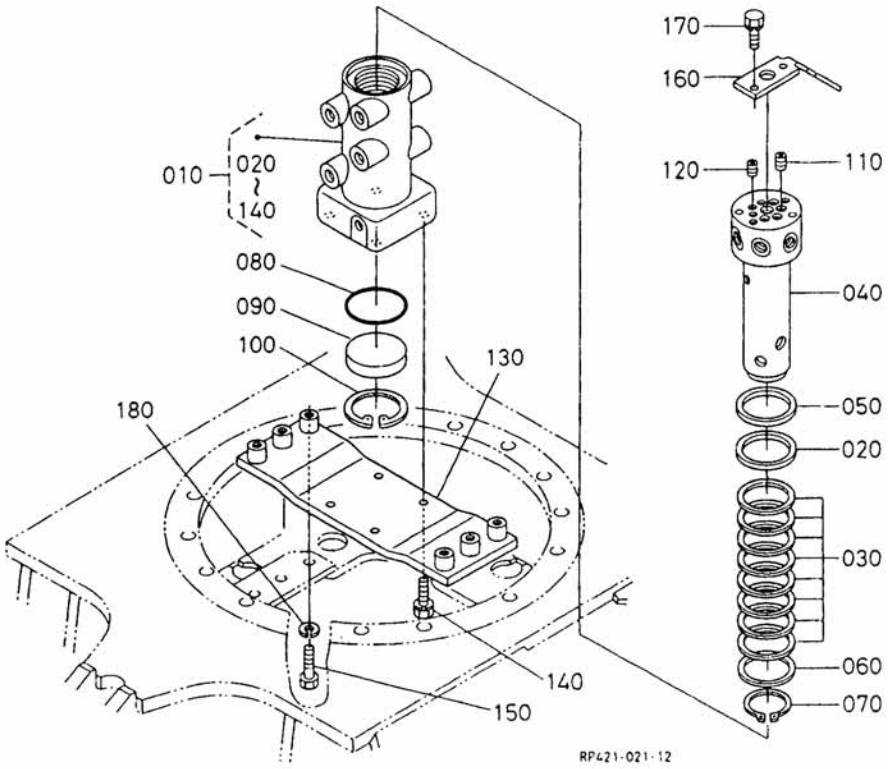
(5) Make-up poppet



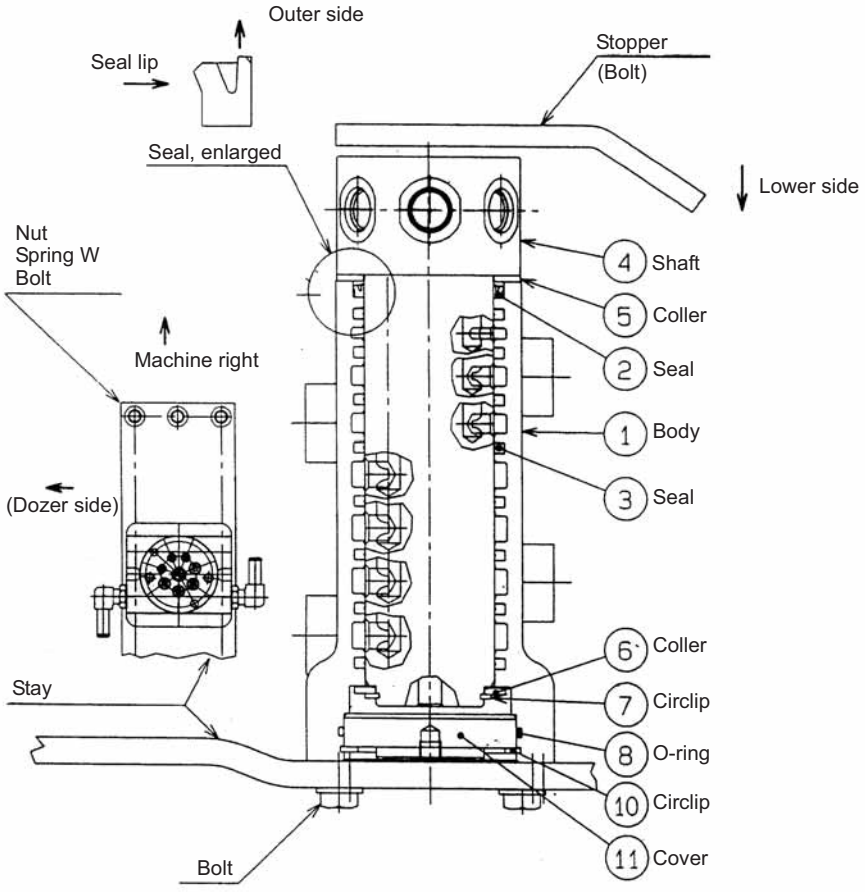


Plug tightening torque: 49.0 ~ 58.8 N·m (5.0 ~ 6.0 kgf·m)

(G) ROTARY JOINT (SWIVEL JOINT)



020:Packing
030:Packing
040:Shaft
050, 060:Spacer
080:O-ring
090:Cover
130:Stay
160:Stopper



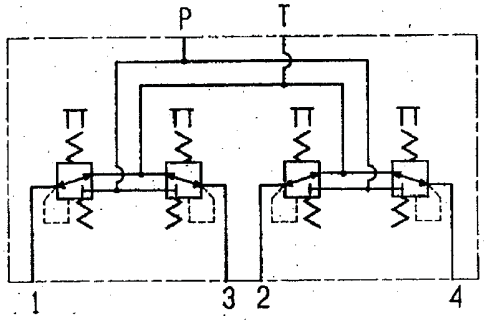
(H) PILOT VALVE

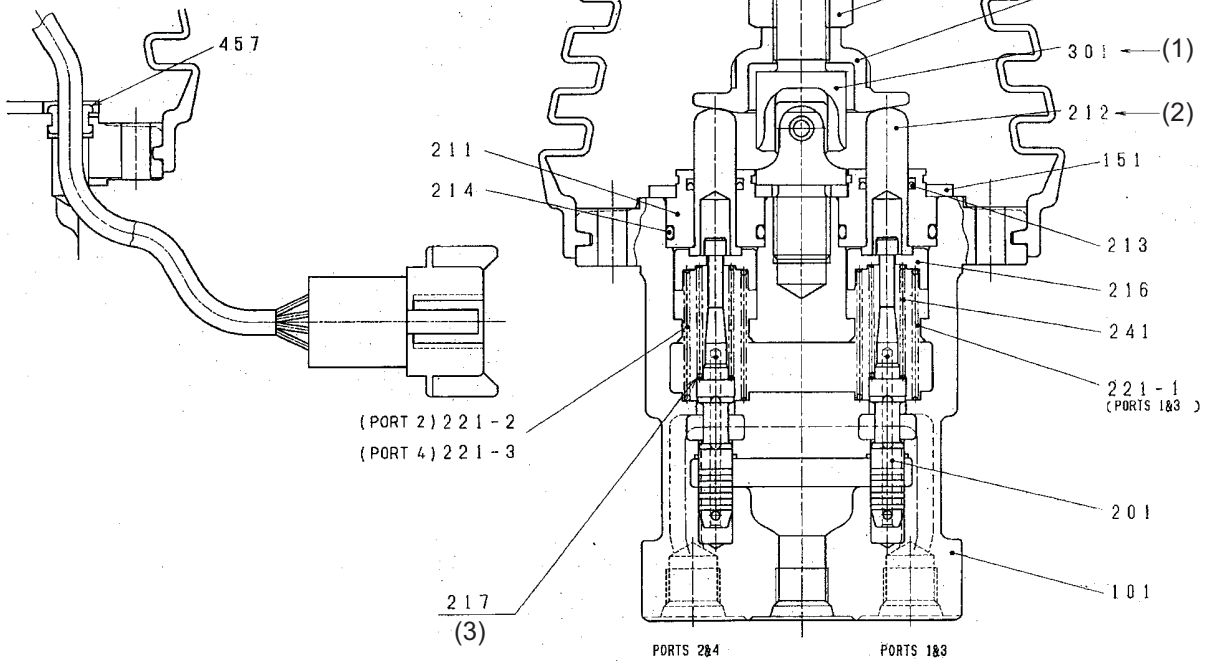
a) Structure & Specifications

Tightening torque list

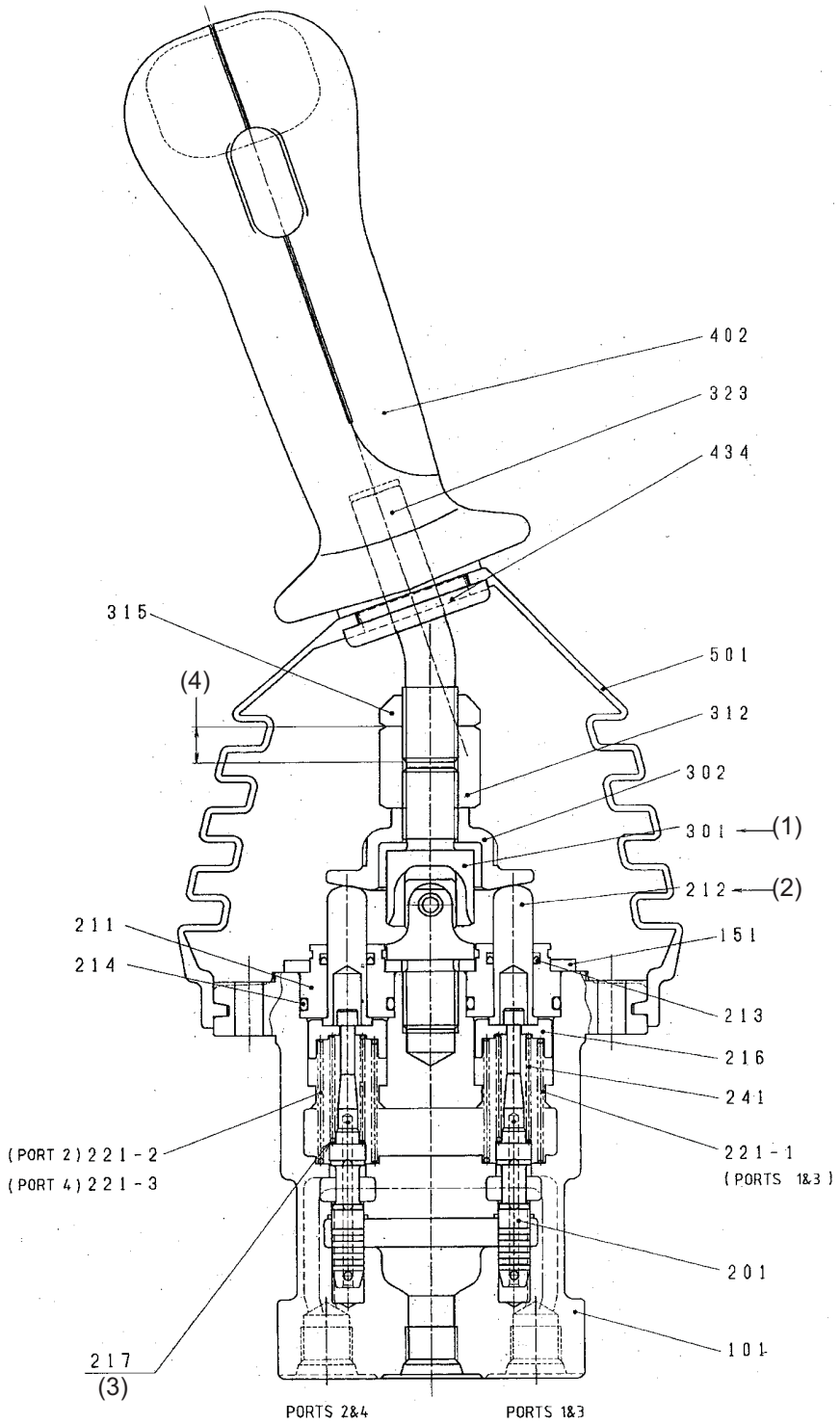
No.	Screw size	Tightening torque
301	M14	47.1 ± 2.9 N·m (480 ± 30 kgf·cm) 34.7 ± 2.14 ft·lbs
302, 312	M14	68.6 ± 4.9 N·m (700 ± 50 kgf·cm) 50.6 ± 3.61 ft·lbs
315	M14	49 ± 3.4 N·m (500 ± 35 kgf·cm) 36.1 ± 2.51 ft·lbs

Hydraulic symbol





(1) Grease is applied on each rotational part of the universal joint.
Pay attention to the direction of assembling the universal joint.
(2) Grease is applied on each top part.
(3) Shim for adjusting secondary pressure 1 sheet with designed thickness T = 0.4.
(4) Screwing depth of lever (323)



(1) Grease is applied on each rotational part of the universal joint.
Pay attention to the direction of assembling the universal joint.
(2) Grease is applied on each top part.
(3) Shim for adjusting secondary pressure 1 sheet with designed thickness T = 0.4.
(4) Screwing depth of lever (323)

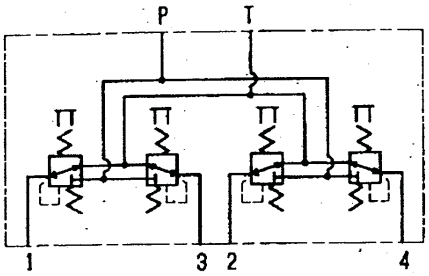
No.	Part name	Material	Q'ty	Remarks
101	Casing	Al alloy	1	
151	Plate	Steel	1	Chromating
201	Spool	Carbon steel	4	
211	Plug	Copper alloy	4	
212	Rod, push	Stainless steel	4	
213	Seal	NBR	4	HS70
214	O-ring	NBR	4	JIS B2401 P20 HS90
216	Seat, spring	Alloy steel	4	For 7 mm stroke
217	Washer 2	Steel	4	
221-1	Spring	Piano wire	2	For return 29.4 ~ 39.2 N (3.0 ~ 4.0 kgf) (For port 1 &3)
221-2	Spring	Piano wire	1	For return 44.1 ~ 76.5 N (4.5 ~ 7.8 kgf) (For port 2)
221-3	Spring	Piano wire	1	For return 33.3 ~ 59.0 N (3.4 ~ 6.0 kgf) (For port 4)
241	Spring	Piano wire	4	For secondary pressure 0.83 ~ 65 MPa (8.5 ~ 27K)
301	Joint	Alloy steel	1	Strong type
302	Plate, circular	Alloy steel	1	
312	Nut, adjusting	Carbon steel	1	Phosphate coating
315	Nut, lock	Carbon steel	1	Phosphate coating
323	Lever	Steel	1	Chromating
402	Handle	-	1	ERUH1-2.0-BH05-CA
434	Pin, spring	Tool steel	1	JIS B 2808 SPV-5x28
457	Bush	Synthetic rubber	1	HS70
501	Bellows	Synthetic rubber	1	

Specifications

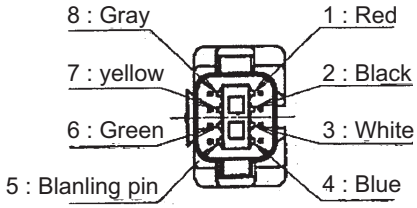
(1)	MAX PRIMARY PRESSURE:	6.9 NPa (70 kgf/cm^2)
(2)	MAX BACK PRESSURE:	0.3 NPa (3 kgf/cm^2)
(3)	RATED FLOW:	15 l/min
(4)	SECONDARY PRESSURE CHARACTRISTICS:	Refer to the “Control Diagram“ shown below.
(5)	OPRERATING TORQUE:	Refer to the “Control Diagram“ shown below.
(6)	MAX. ALLOWABLE EXTERNAL TORQUE:	Refer to the “MAX. allowable external torque“ shown below.
(7)	HYDRAULIC OIL:	MINERAL HYDRAULIC OIL
(8)	OIL TEMP. RANGE:	-20°C ~ 90°C
(9)	FILTER:	A filter of 40 ~ mesh and ever should be applied at the entrance of port P for preventins the spool stickine.

Operating specifications

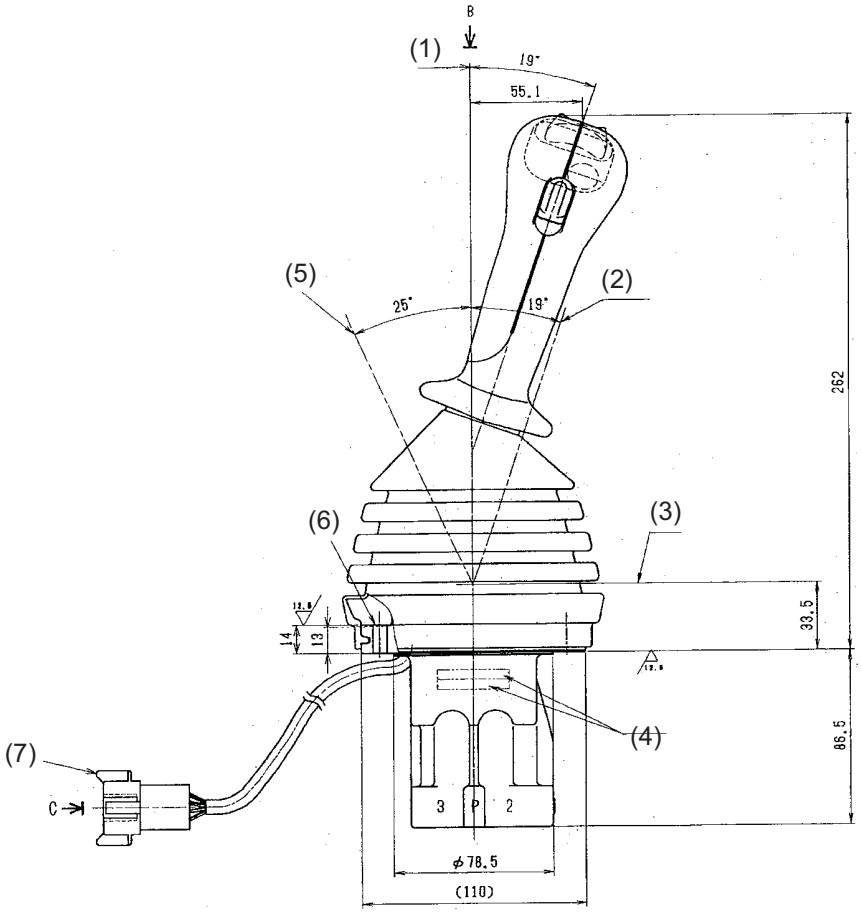
(1)	PRIMARY PRESSURE:	3.9 NPa (40 kgf/cm^2)



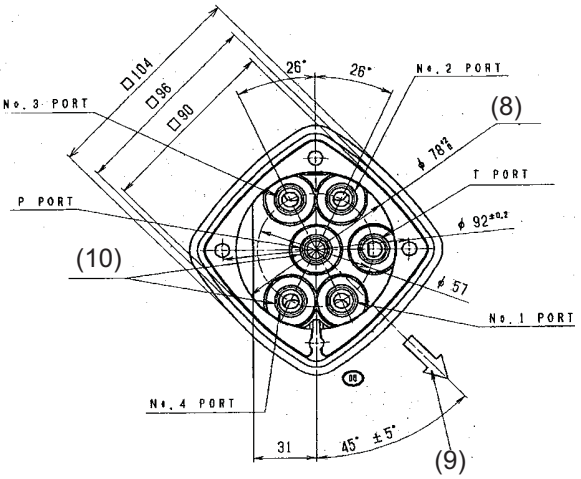
Hydraulic symbol



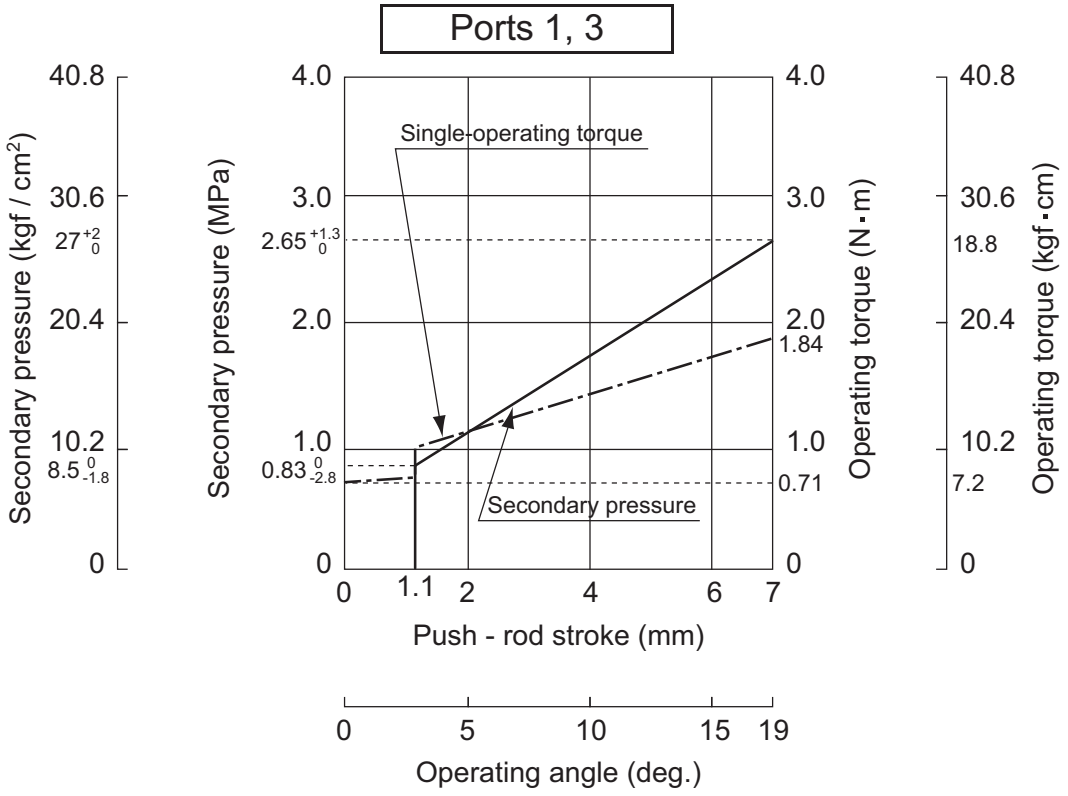
View C

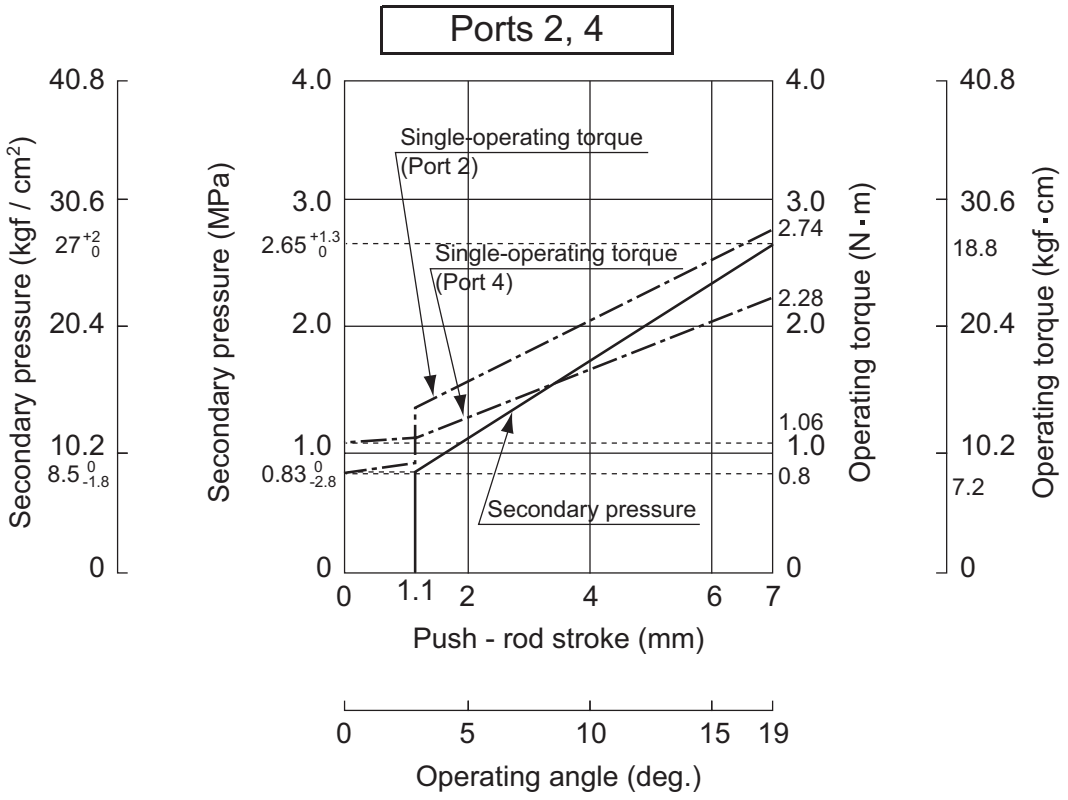


(1) Tilting angle of handle
(2) Single-operating angle
(3) Lean center position
(4) Stamping of model name & serial No.
(5) Double-operating angle
(6) 4-ϕ7 Through
Insert washers (outer dia. is over ϕ12 and under ϕ13), or use flange sockets, when mounting flange of casing by the bolts M6 (Screw, hex, S, H, C)
(7) Deutch
Receptacle: DT04-8PA-CE02
Wedge: W8P
Pin: 0460-202-16141
Plug: 114017
(8) (Outer dia. of the port-part)
(9) Tilted direction of handle (no. 1 push-rod direction)
(10) 6-G1/4 thread depth 12 (O-ring seal to JIS B 2351)
Spot fancing dia. ϕ24 depth 1
Tightening torque 29.4 ± 2.0 N·m (300 ± 20 kgf·cm)



b) Pilot Valve Control Diagram





c) Hydraulic Circuit Diagram Symbol

Glossary of hydraulic/hydrostatic symbols for excavators

1) Cylinder:
Equipment to convert hydraulic energy into linear energy and in which the fluid pressure operates alternately in both directions (forward and backward strokes)

Symbol	Description
	Double acting hydraulic cylinder, unequal displacement - With single piston rod
	Double acting hydraulic cylinder, unequal displacement and cushion on one end - With single piston rod

2) Pump:
To convert mechanical energy into hydraulic energy

Symbol	Description
	Fixed capacity displacement hydraulic pump -With one direction of flow
	Variable capacity displacement bidirectional hydraulic pump - With two directions of flow (bidirectional)

Fixed displacement		Variable displacement Non-compensated
	Unidirectional	
	Bidirectional	

3) Motor:
To convert hydraulic energy into rotary mechanical energy

Symbol	Description
	Fixed capacity displacement bidirectional hydraulic motor - With two directions of flow (bidirectional)

Fixed displacement		Variable displacement Non-compensated
	Unidirectional	
	Bidirectional	

4) Control Mechanisms

Symbol	Description
	Control valve with detent (holds valve in position) - device for maintaining a given position (mechanical)
	Control valve activated by a lever (manual)
	Control valve activated by a pedal (manual)
	Control valve with spring return (mechanical)
	Control valve activated by an electric solenoid (electrical)
	Control valve activated by pilot pressure (indirect control, pilot actuated by application of pressure)

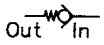
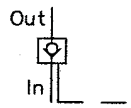
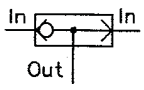
5) Flow Lines and Connections

Symbol	Description
	Working circuits - Continuous, solid line - Working (main) line, return line (line conducting fluid from working devices to the reservoir) and feed line (main line conductor)
	Pilot pressure - Dashed line - Pilot line (line which conducts control fluid)
	Drain circuits - dotted line - Drain line (drain or bleed line - line conducting fluid from a component housing to the reservoir)
	Mechanical connections - Double line (shaft, lever, piston rod)
	Connected junction of oil lines (flow line connection)
	Oil lines crossing (not connected)
	Coupler - Quick-acting coupling (uncoupled, closed by non-return valve)

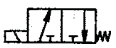
6) Basic and Miscellaneous Symbols

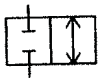
Symbol	Description
	Restriction - Line with fixed restriction - Affected by viscosity (property of resistance to flowing fluid)
	Variable adjustment restriction - Regulated or variable restriction
	Temperature control - (indication of temperature)
	Temperature indicator - (temperature measurement - thermometer)
	Filter (strainer or screen) - For fluid conditioning
	Oil cooler (heat exchanger) - The arrows in the diamond indicate the extraction of heat (heat dissipation)
	Muffler (silencer) - Reduces noise

7) Check valve (non-return valve, shuttle valve):
Valve which allows free flow in one direction only

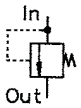
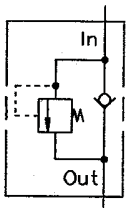
Symbol	Description
	Non-return valve (check valve) - Used as replenishing valve, load check valve or anticavitation valve - Opens if the inlet pressure is higher than the outlet pressure. Often contains internal spring which has NO significant pressure value
	Spring loaded valve (bypass valve) - Opens if the inlet pressure is grater than the outlet pressure plus the spring pressure
	Pilot controlled non-return valve - It is possible to open the valve by pilot pressure
	Shuttle valve - The inlet port connected to the higher pressure is automatically connected to the outlet port while the other inlet port is closed

8) Directional control valve:
Valve providing for the opening (fully or restricted) or the closing of one or more flow paths (represented by several squares)

Symbol	Description
	Two ports and closed flow paths
	Solenoid activated directional control valve (two position) - controlled by an electric solenoid (with return spring)
	Pilot activated directional control valve (two position) - controlled by pressure (with return spring)

Infinite positioning	Three position		Two position
			
Flow in one direction	Parallel flow	Cross flow	Flow allowed in either direction

9) Pressure control valve:
Valve ensuring the control of pressure

Symbol	Description
	Relief valve - When the inlet pressure overcomes the opposing force of the spring, the valve opens permitting flow from the outlet port.
	Relief/replenishing valve or relief/anticavitation valve - When the inlet pressure overcomes the opposing force of the spring, the valve opens permitting flow from the outlet port - allows free flow in the opposite direction

10) Flow control valve:
Valve controlling the flow in one or both directions

Symbol	Description
	One way restrictor valve (non-return valve with restriction) - Unit allowing free flow in one direction but restricted flow in the other direction
	Tow valve - Normally in closed position

11) Others
Hydraulic tank

Vented

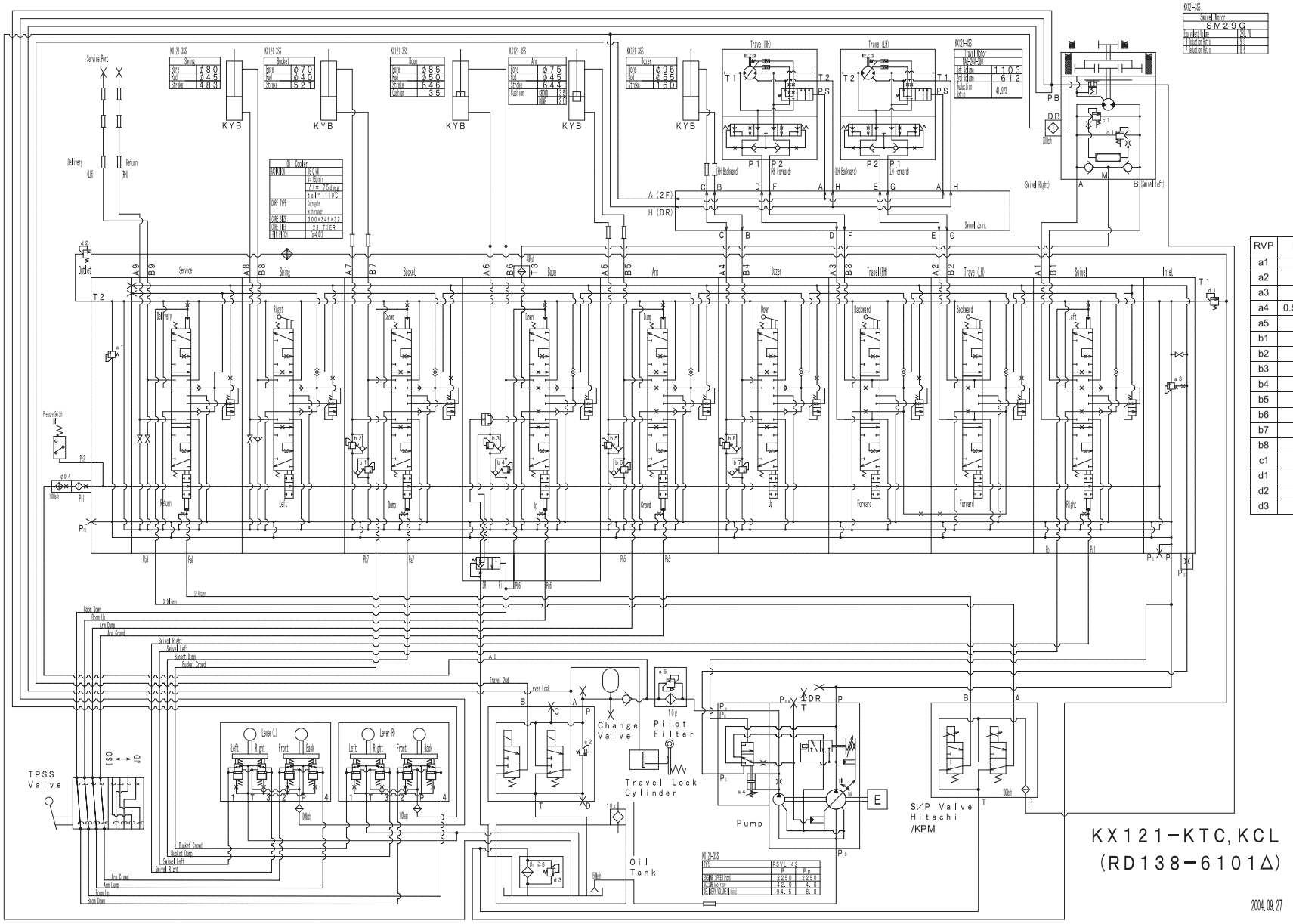
Pressurized

Accumulators

Spring loaded

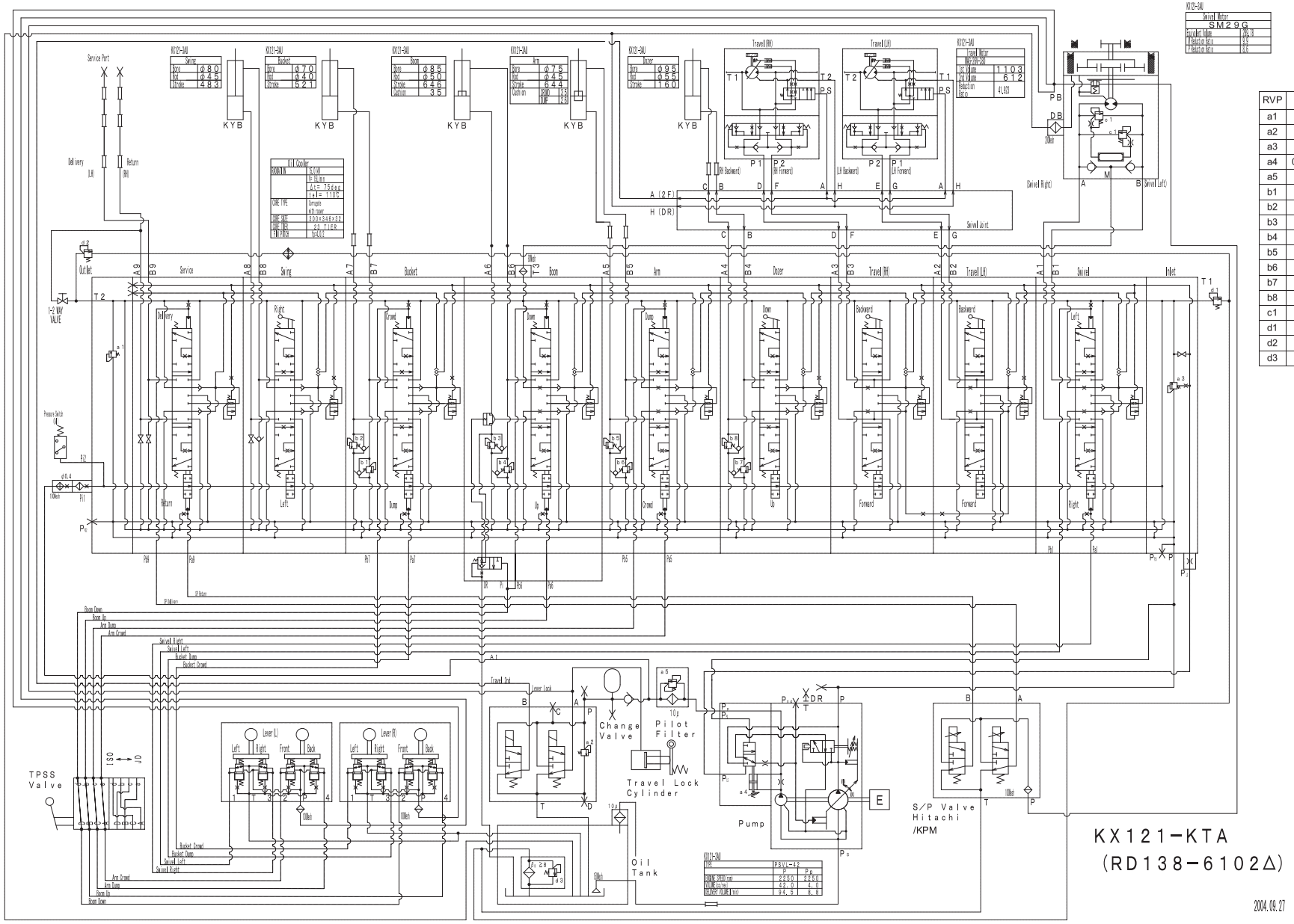
Gas charged

1. KX121-3S: KTC, KCL-version



RVP	MPa	kgf/cm^2	Psi	Name
a1	24.5	250	3556	Main Relief
a2	3.9	40	569	Pilot Relief
a3	2.5	25.5	363	Unload
a4	0.5 ~ 1.4	5.0 ~ 14.5	71 ~ 206	Pump Control
a5	0.15	1.5	21	Line Filter
b1	2.7	280	3983	Bucket Bottom
b2	2.7	280	3983	Bucket Rod
b3	2.7	280	3983	Boom bottom
b4	2.7	280	3983	Boom Rod
b5	2.7	280	3983	Arm Bottom
b6	2.7	280	3983	Arm Rod
b7	2.7	280	3983	Dozer Bottom
b8	11.8	120	1707	Dozer Rod
c1	20.6	210	2987	Swivel Relief
d1	0.4	4	57	Back Pressure
d2	0.1	1	14	Back Pressure
d3	0.15	1.5	21	Return Filter

2. KX121-3S: KTA-version

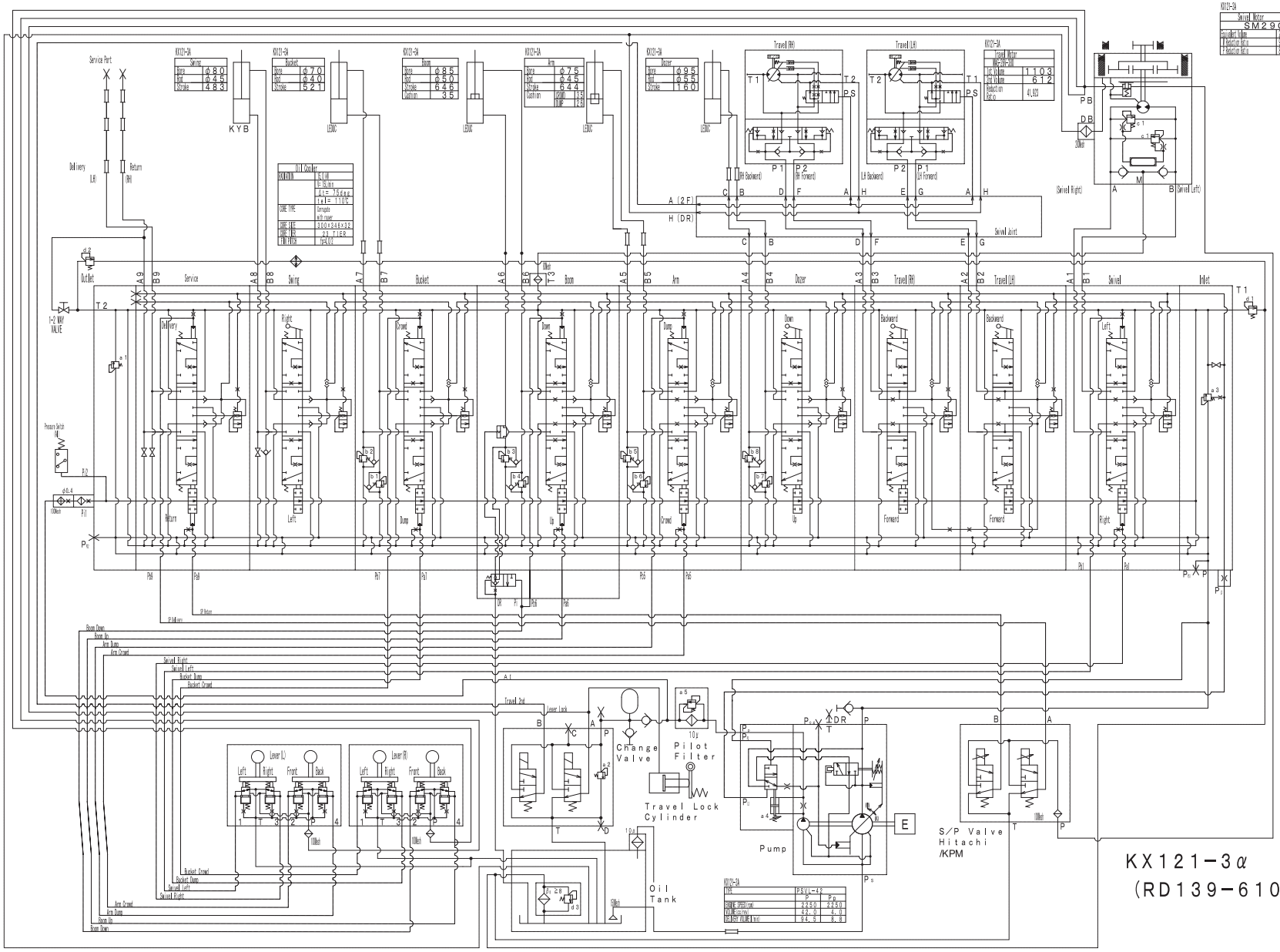


RVP	MPa	kgf/cm^2	Psi	Name
a1	24.5	250	3556	Main Relief
a2	3.9	40	569	Pilot Relief
a3	2.5	25.5	363	Unload
a4	0.5 ~ 1.4	5.0 ~ 14.5	71 ~ 206	Pump Control
a5	0.15	1.5	21	Line Filter
b1	2.7	280	3983	Bucket Bottom
b2	2.7	280	3983	Bucket Rod
b3	2.7	280	3983	Boom bottom
b4	2.7	280	3983	Boom Rod
b5	2.7	280	3983	Arm Bottom
b6	2.7	280	3983	Arm Rod
b7	2.7	280	3983	Dozer Bottom
b8	11.8	120	1707	Dozer Rod
c1	20.6	210	2987	Swivel Relief
d1	0.4	4	57	Back Pressure
d2	0.1	1	14	Back Pressure
d3	0.15	1.5	21	Return Filter

KX121-KTA
(RD138-6102Δ)

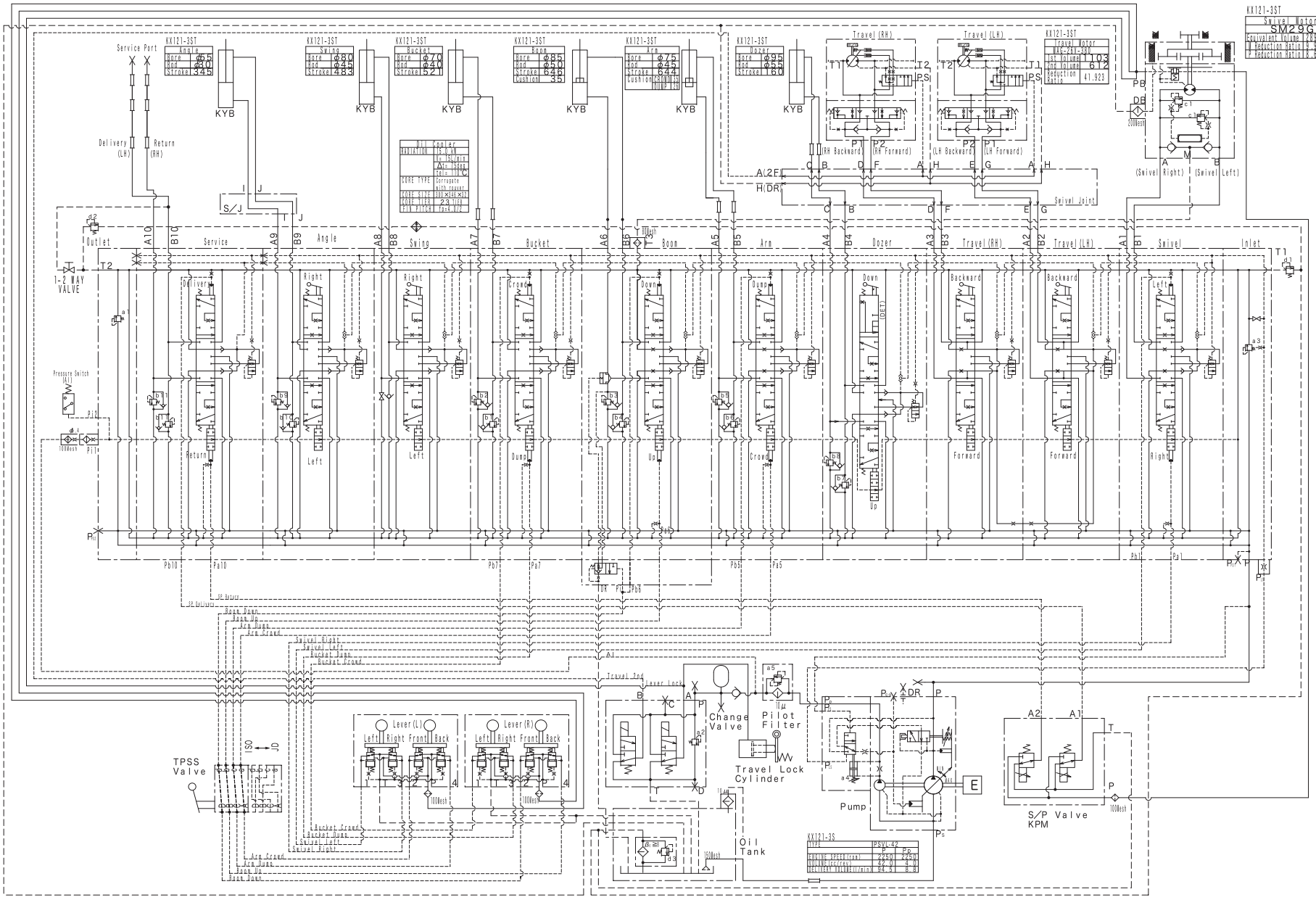
2004.09.27

3. KX121-3α: EU-version



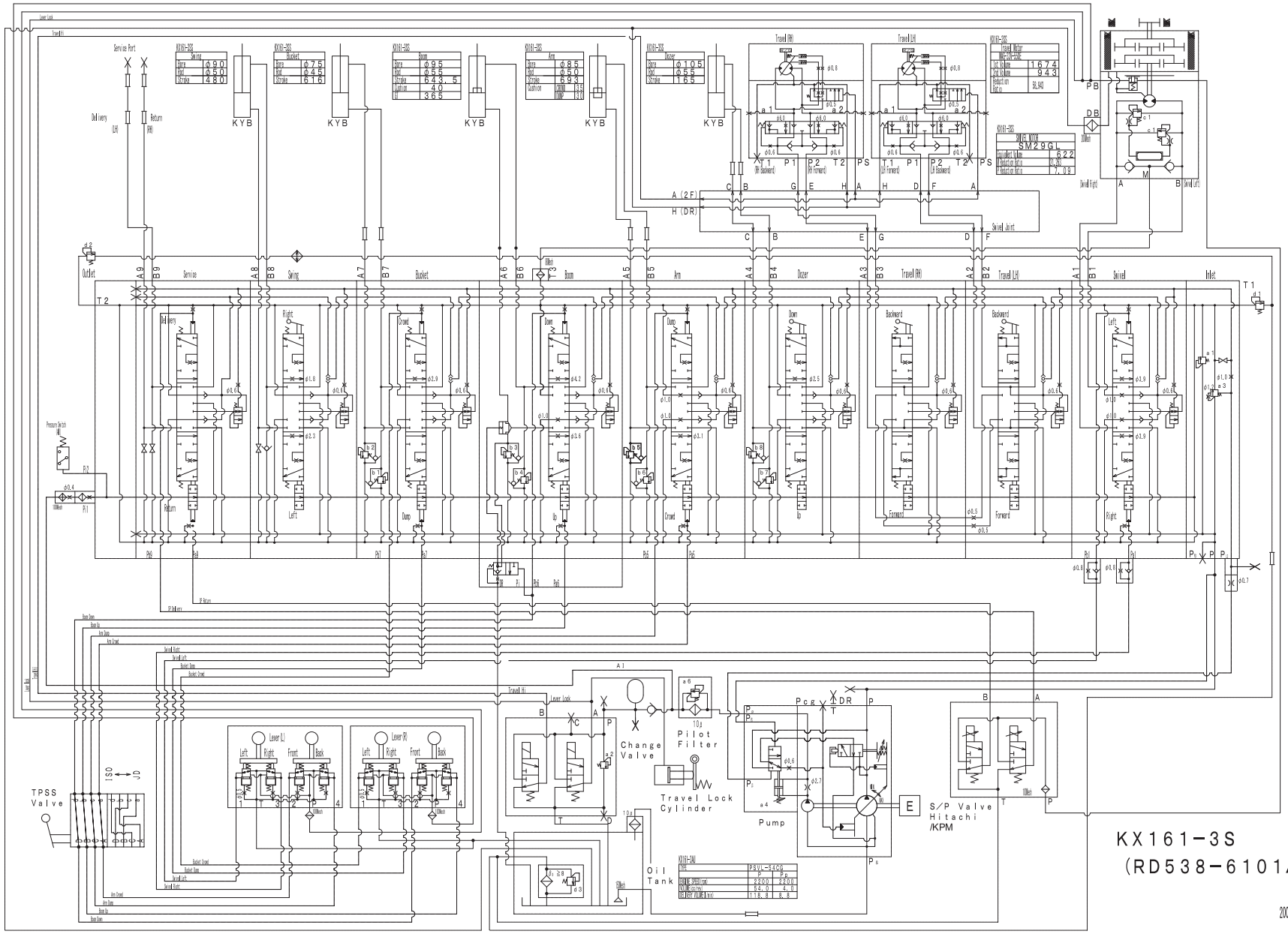
RVP	MPa	kgf/cm^2	Psi	Name
a1	24.5	250	3556	Main Relief
a2	3.9	40	569	Pilot Relief
a3	2.5	25.5	363	Unload
a4	0.5 ~ 1.4	5.0 ~ 14.5	71 ~ 206	Pump Control
a5	0.15	1.5	21	Line Filter
b1	2.7	280	3983	Bucket Bottom
b2	2.7	280	3983	Bucket Rod
b3	2.7	280	3983	Boom bottom
b4	2.7	280	3983	Boom Rod
b5	2.7	280	3983	Arm Bottom
b6	2.7	280	3983	Arm Rod
b7	2.7	280	3983	Dozer Bottom
b8	11.8	120	1707	Dozer Rod
c1	20.6	210	2987	Swivel Relief
d1	0.4	4	57	Back Pressure
d2	0.1	1	14	Back Pressure
d3	0.15	1.5	21	Return Filter

4. KX121-3S/ST: KTC (Angle blade)-version



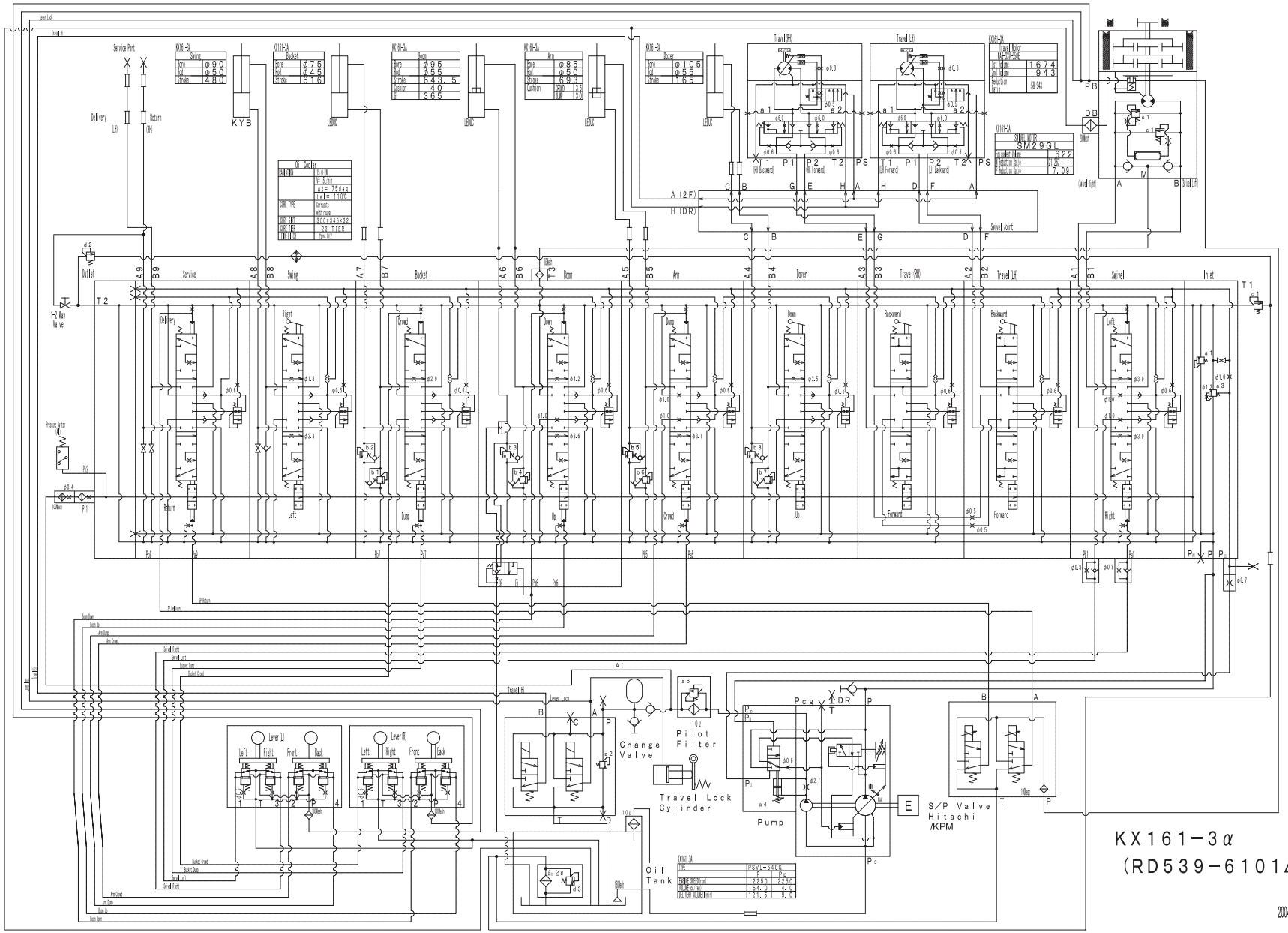
RVP	MPa	kgf/cm²	Psi	Name
a1	24.5	250	3556	Main Relief
a2	3.9	40	569	Pilot Relief
a3	2.5	25.5	363	Unload
a4	0.5~1.4	5.0~14.5	71~206	Pump Control
a5	0.15	1.5	21	Line Filter
b1	2.7	280	3983	Bucket Bottom
b2	2.7	280	3983	Bucket Rod
b3	2.7	280	3983	Boom bottom
b4	2.7	280	3983	Boom Rod
b5	2.7	280	3983	Arm Bottom
b6	2.7	280	3983	Arm Rod
b7	2.7	280	3983	Dozer Bottom
b8	11.8	120	1707	Dozer Rod
c1	20.6	210	2987	Swivel Relief
d1	0.4	4	57	Back Pressure
d2	0.1	1	14	Back Pressure
d3	0.15	1.5	21	Return Filter

5. KX161-3S/ST: KTC, KCL, KTA-version



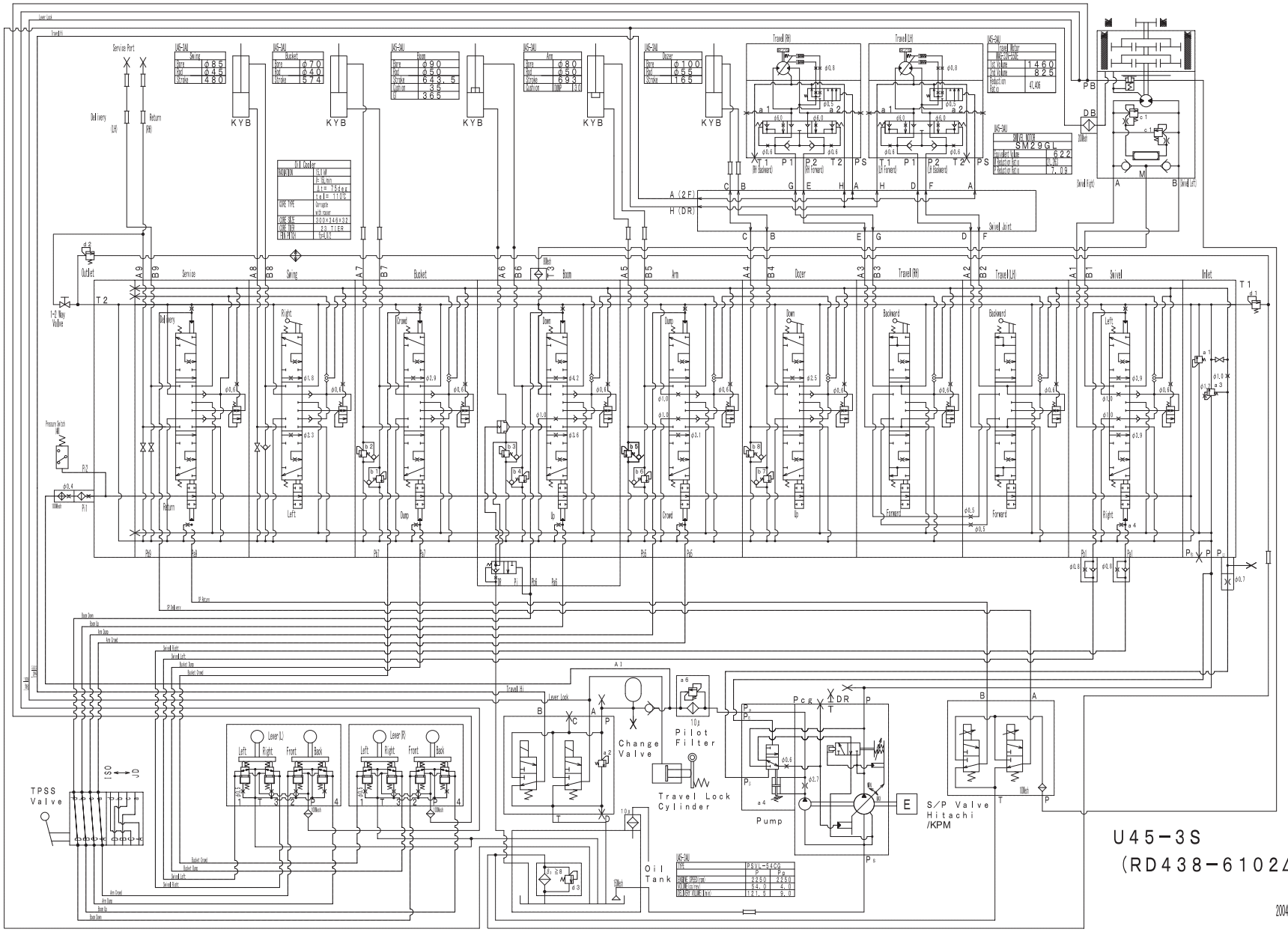
RVP	MPa	kgf/cm^2	Psi	Name
a1	23.6	240	3414	Main Relief
a2	3.9	40	569	Pilot Relief
a3	2.16	22	313	Unload
a4	0.7 ~ 1.5	7 ~ 15	100 ~ 213	Pump Control
a5	0.15	1.5	21	Line Filter
b1	2.65	270	3840	Bucket Bottom
b2	2.65	270	3840	Bucket Rod
b3	2.65	270	3840	Boom bottom
b4	2.65	270	3840	Boom Rod
b5	2.65	270	3840	Arm Bottom
b6	2.65	270	3840	Arm Rod
b7	2.65	270	3840	Dozer Bottom
b8	11.8	120	1707	Dozer Rod
c1	17.7	180	2560	Swivel Relief
d1	0.4	4	57	Back Pressure
d2	0.1	1	14	Back Pressure
d3	0.15	1.5	21	Return Filter

6. KX161-3α: EU-version



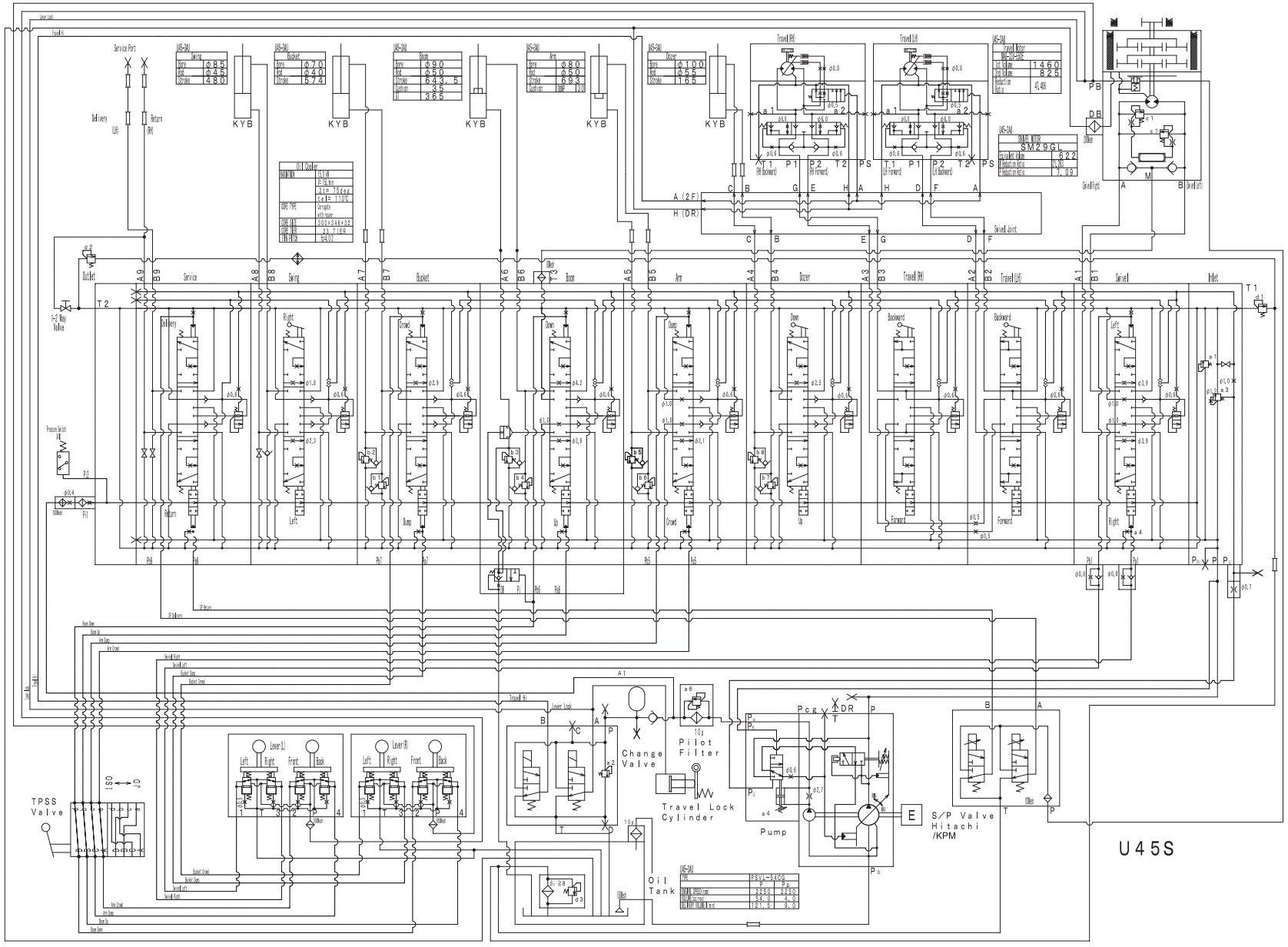
RVP	MPa	kgf/cm^2	Psi	Name
a1	23.6	240	3414	Main Relief
a2	3.9	40	569	Pilot Relief
a3	2.16	22	313	Unload
a4	0.7 ~ 1.5	7 ~ 15	100 ~ 213	Pump Control
a5	0.15	1.5	21	Line Filter
b1	2.65	270	3840	Bucket Bottom
b2	2.65	270	3840	Bucket Rod
b3	2.65	270	3840	Boom bottom
b4	2.65	270	3840	Boom Rod
b5	2.65	270	3840	Arm Bottom
b6	2.65	270	3840	Arm Rod
b7	2.65	270	3840	Dozer Bottom
b8	11.8	120	1707	Dozer Rod
c1	17.7	180	2560	Swivel Relief
d1	0.4	4	57	Back Pressure
d2	0.1	1	14	Back Pressure
d3	0.15	1.5	21	Return Filter

7. U45-3S: KTA-version



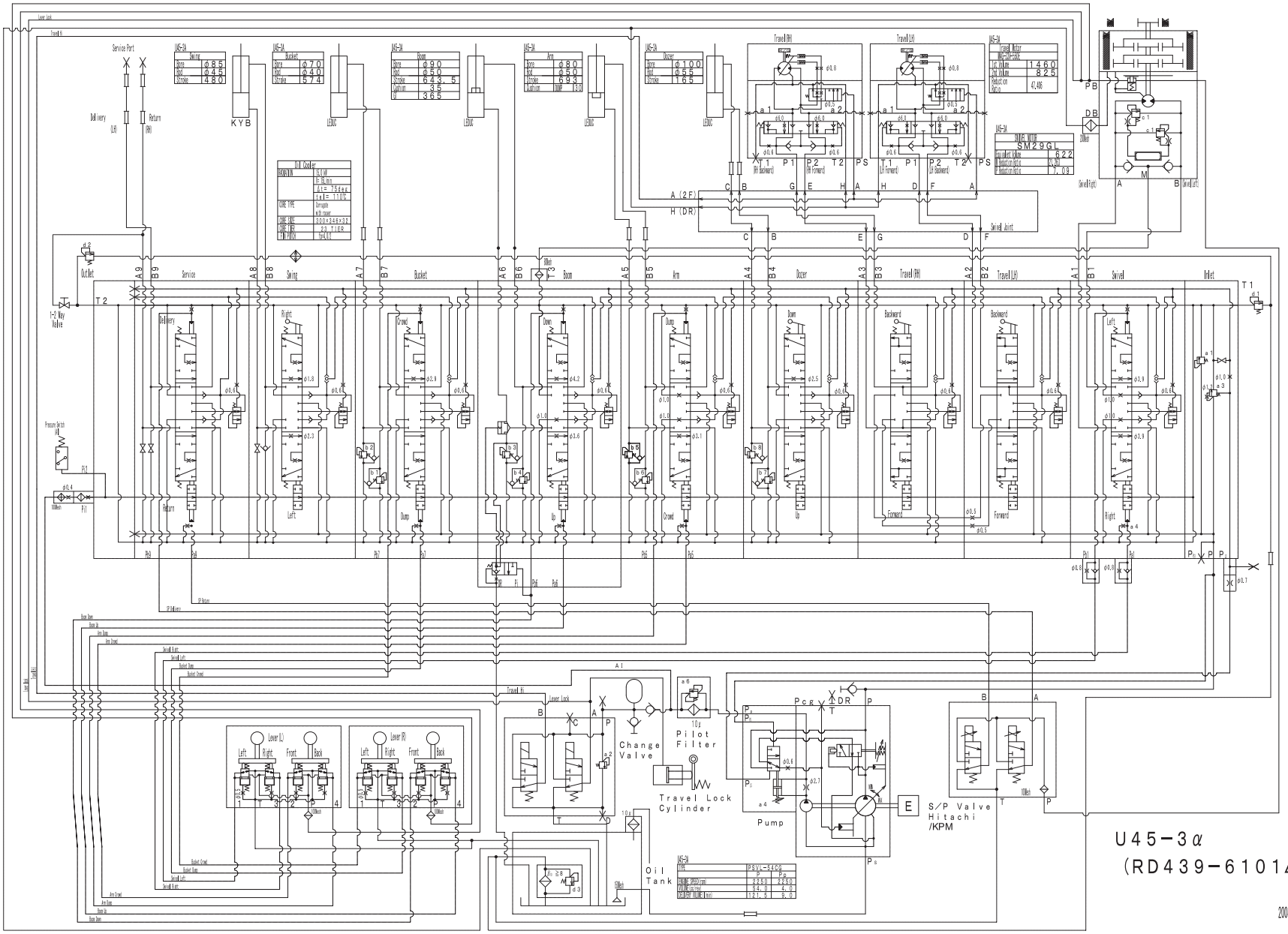
RVP	MPa	kgf/cm^2	Psi	Name
a1	23.6	240	3414	Main Relief
a2	3.9	40	569	Pilot Relief
a3	2.16	22	313	Unload
a4	0.7 ~ 1.5	7 ~ 15	100 ~ 213	Pump Control
a5	0.15	1.5	21	Line Filter
b1	2.65	270	3840	Bucket Bottom
b2	2.65	270	3840	Bucket Rod
b3	2.65	270	3840	Boom bottom
b4	2.65	270	3840	Boom Rod
b5	2.65	270	3840	Arm Bottom
b6	2.65	270	3840	Arm Rod
b7	2.65	270	3840	Dozer Bottom
b8	11.8	120	1707	Dozer Rod
c1	17.7	180	2560	Swivel Relief
d1	0.4	4	57	Back Pressure
d2	0.1	1	14	Back Pressure
d3	0.15	1.5	21	Return Filter

8. U45S: KCL-version



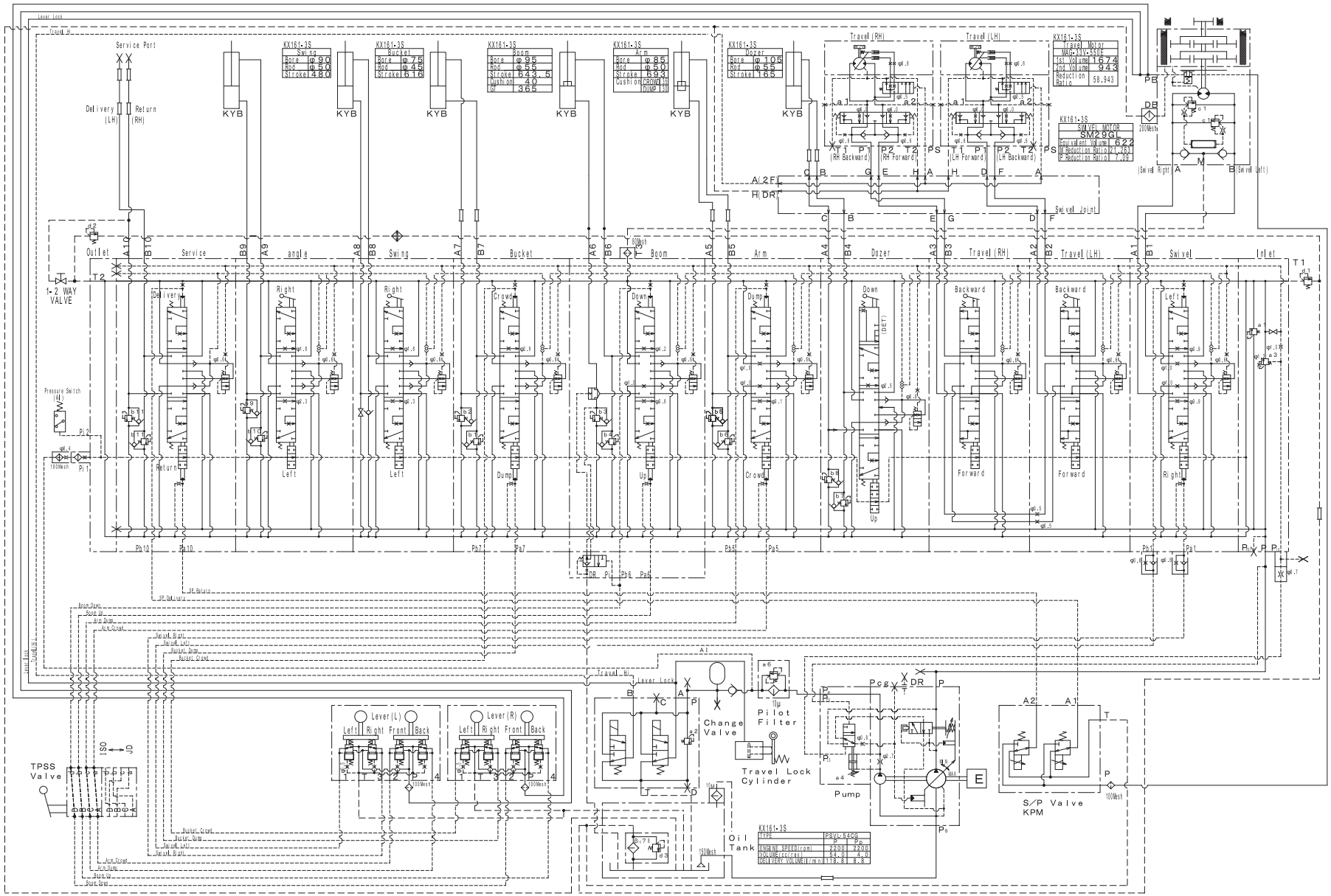
RVP	MPa	kgf/cm^2	Psi	Name
a1	23.6	240	3414	Main Relief
a2	3.9	40	569	Pilot Relief
a3	2.16	22	313	Unload
a4	0.7 ~ 1.5	7 ~ 15	100 ~ 213	Pump Control
a5	0.15	1.5	21	Line Filter
b1	2.65	270	3840	Bucket Bottom
b2	2.65	270	3840	Bucket Rod
b3	2.65	270	3840	Boom bottom
b4	2.65	270	3840	Boom Rod
b5	2.65	270	3840	Arm Bottom
b6	2.65	270	3840	Arm Rod
b7	2.65	270	3840	Dozer Bottom
b8	11.8	120	1707	Dozer Rod
c1	17.7	180	2560	Swivel Relief
d1	0.4	4	57	Back Pressure
d2	0.1	1	14	Back Pressure
d3	0.15	1.5	21	Return Filter

9. U45-3α, U50-3α: EU-version



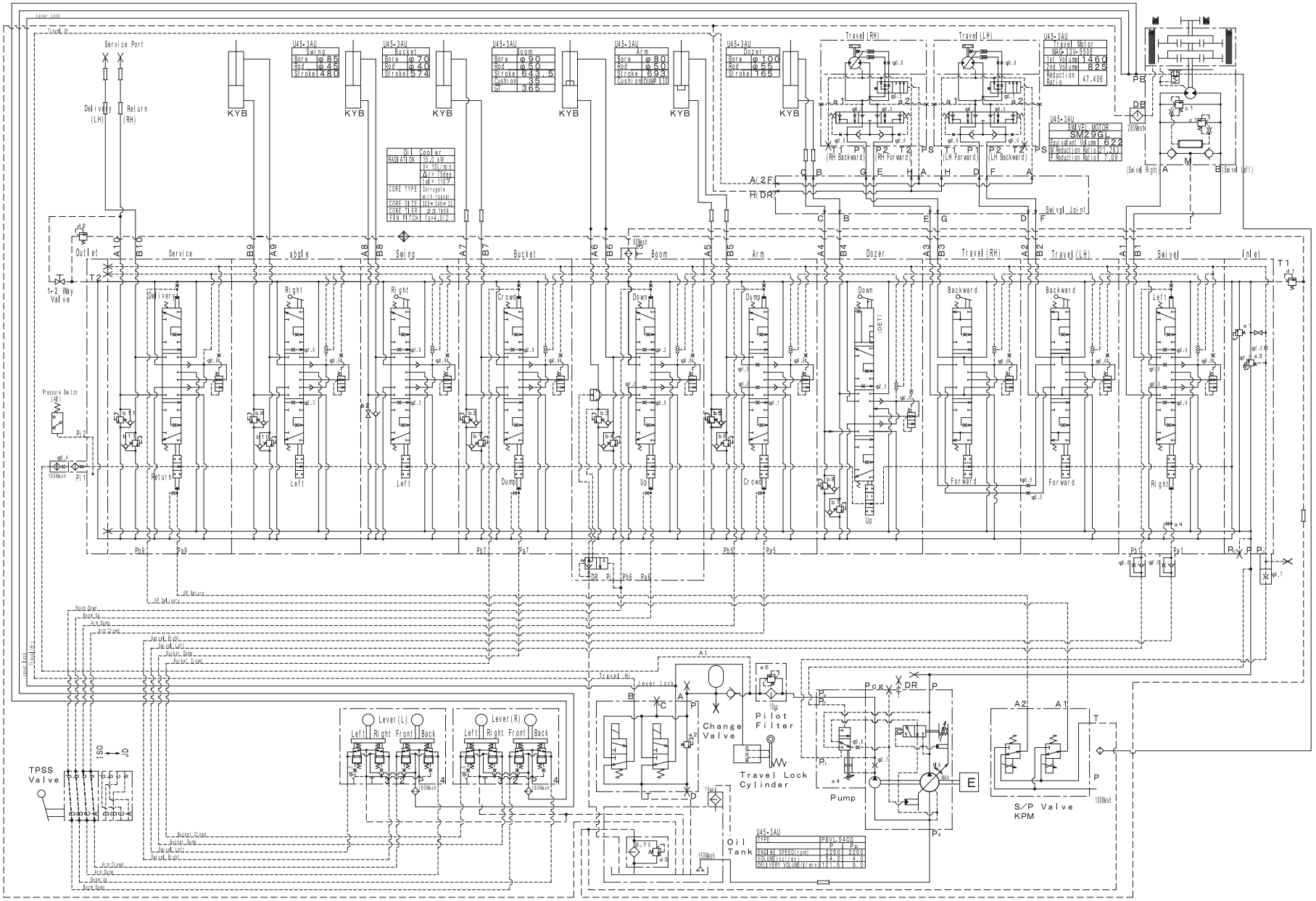
RVP	MPa	kgf/cm^2	Psi	Name
a1	23.6	240	3414	Main Relief
a2	3.9	40	569	Pilot Relief
a3	2.16	22	313	Unload
a4	0.7 ~ 1.5	7 ~ 15	100 ~ 213	Pump Control
a5	0.15	1.5	21	Line Filter
b1	2.65	270	3840	Bucket Bottom
b2	2.65	270	3840	Bucket Rod
b3	2.65	270	3840	Boom bottom
b4	2.65	270	3840	Boom Rod
b5	2.65	270	3840	Arm Bottom
b6	2.65	270	3840	Arm Rod
b7	2.65	270	3840	Dozer Bottom
b8	11.8	120	1707	Dozer Rod
c1	17.7	180	2560	Swivel Relief
d1	0.4	4	57	Back Pressure
d2	0.1	1	14	Back Pressure
d3	0.15	1.5	21	Return Filter

10.KX161-3S/ST: KTC (Angle blade)-version



RVP	MPa	kgf/cm^2	Psi	Name
a1	23.6	240	3414	Main Relief
a2	3.9	40	569	Pilot Relief
a3	2.16	22	313	Unload
a4	0.7~1.5	7~15	100~213	Pump Control
a5	0.15	1.5	21	Line Filter
b1	2.65	270	3840	Bucket Bottom
b2	2.65	270	3840	Bucket Rod
b3	2.65	270	3840	Boom bottom
b4	2.65	270	3840	Boom Rod
b5	2.65	270	3840	Arm Bottom
b6	2.65	270	3840	Arm Rod
b7	2.65	270	3840	Dozer Bottom
b8	11.8	120	1707	Dozer Rod
b9	19.0	195	1989	
b10	27.4	280	2856	
c1	17.7	180	2560	Swivel Relief
d1	0.4	4	57	Back Pressure
d2	0.1	1	14	Back Pressure
d3	0.15	1.5	21	Return Filter

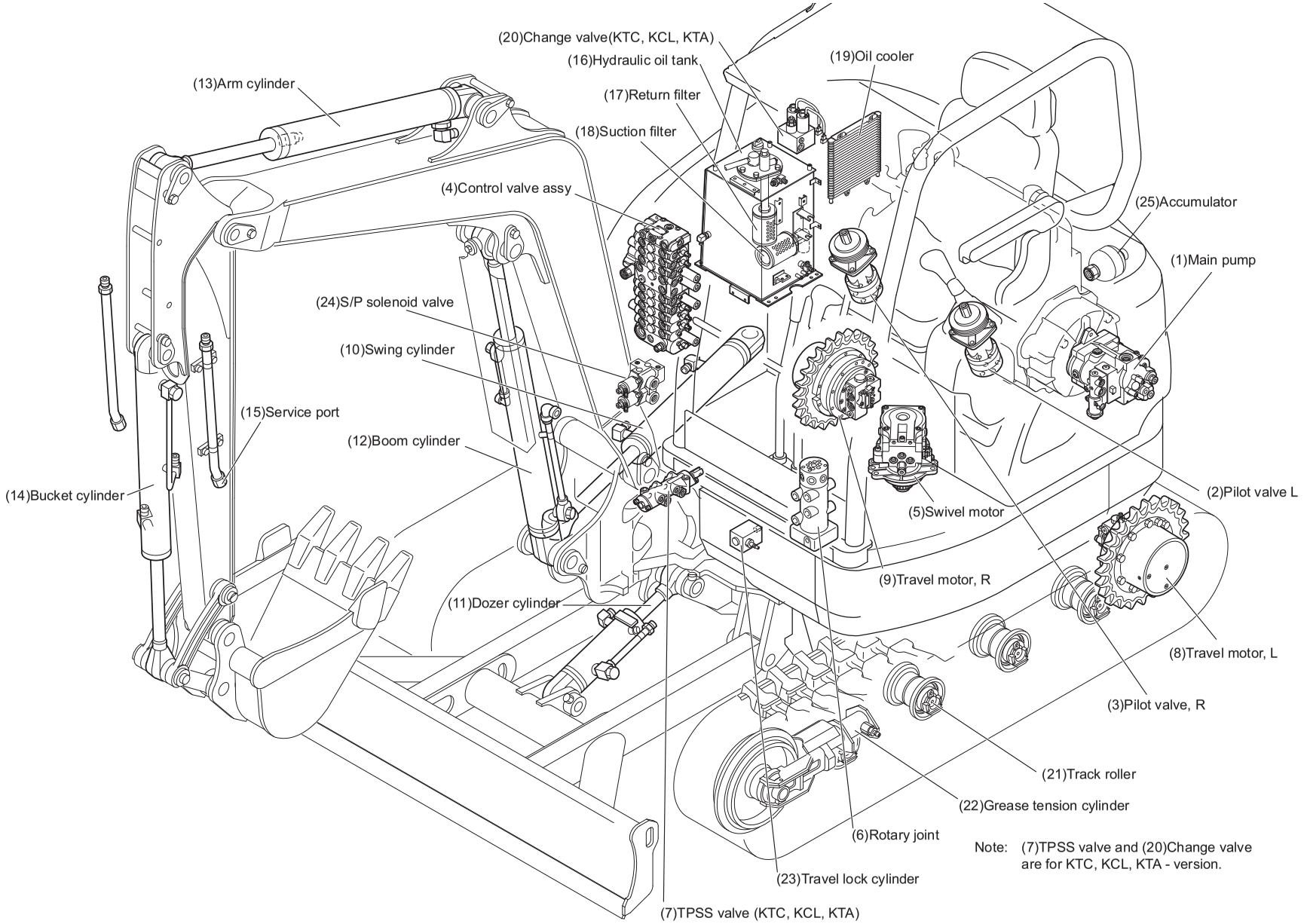
11.U45S/ST: KTC (Angle blade)-version



RVP	MPa	kgf/cm²	Psi	Name
a1	23.6	240	3414	Main Relief
a2	3.9	40	569	Pilot Relief
a3	2.16	22	313	Unload
a4	0.7~1.5	7~15	100~213	Pump Control
a5	0.15	1.5	21	Line Filter
b1	2.65	270	3840	Bucket Bottom
b2	2.65	270	3840	Bucket Rod
b3	2.65	270	3840	Boom bottom
b4	2.65	270	3840	Boom Rod
b5	2.65	270	3840	Arm Bottom
b6	2.65	270	3840	Arm Rod
b7	2.65	270	3840	Dozer Bottom
b8	11.8	120	1707	Dozer Rod
b9	19.0	195	1989	
b10	27.4	280	2856	
c1	17.7	180	2560	Swivel Relief
d1	0.4	4	57	Back Pressure
d2	0.1	1	14	Back Pressure
d3	0.15	1.5	21	Return Filter

d) Hydraulic Components Layout

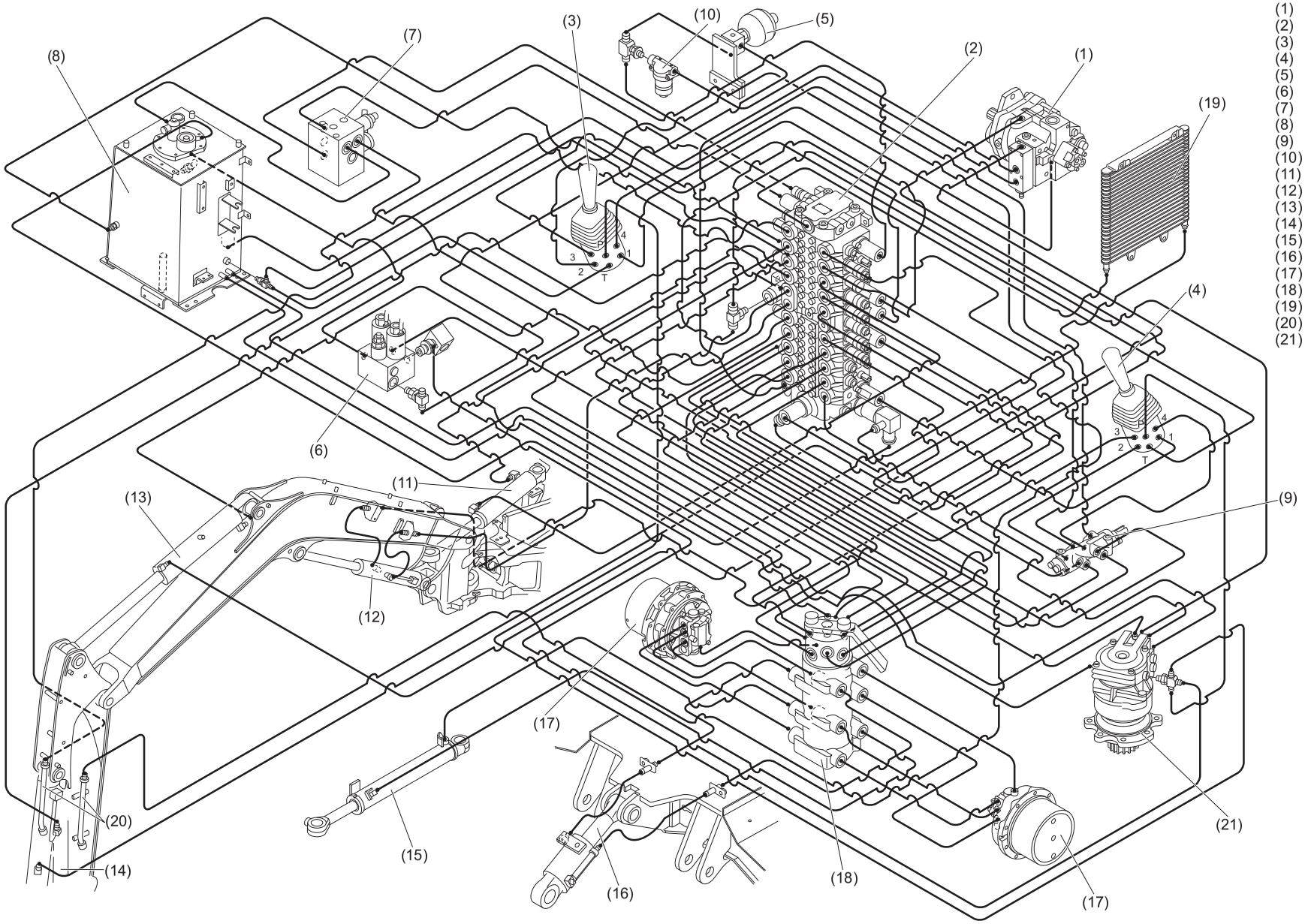
1. KX121-3α/S/ST, KX161-3α/S/ST, U45S/ST, U45-3α/S/ST, U50-3α



Note: (7)TPSS valve and (20)Change valve are for KTC, KCL, KTA - version.

2. Hydraulic components and hose connection

Sample: KX161-3S/ST



(1) Main pump
(2) Control valve
(3) Pilot control valve R
(4) Pilot control valve L
(5) Accumulator
(6) Change valve
(7) S/P proportional solenoid valve
(8) Hydraulic tank
(9) TPSS (Two pattern selection system)
(10) Pilot filter
(11) Swing cylinder
(12) Boom cylinder
(13) Arm cylinder
(14) Bucket cylinder
(15) Angle cylinder
(16) Blade cylinder
(17) Travel motor R, L
(18) Rotary joint
(19) Oil cooler
(20) Service ports
(21) Swivel motor

IV. HYDRAULIC SYSTEM

Service Section

(A) TROUBLESHOOTING IV-S-3
a) Case Study: Abnormal speed IV-S-3
b) Case Study: The power is weak. IV-S-5
c) Case Study: Poor Manipulation and Abnormal Operation IV-S-6
d) LS Control System Troubleshooting IV-S-9
e) Pump Component Trouble Causes and Remedy IV-S-14
f) Control Valve Component Troubleshooting IV-S-16
g) Travel Motor Component Troubleshooting. IV-S-18
h) Service Port Function Troubleshooting IV-S-22
(B) SPECIFICATIONS IV-S-23
a) Relief Valve Pressure Setting IV-S-23
b) Pump IV-S-25
c) Load Sensing Control Flow Amount through Main Spool IV-S-30
d) Cylinder IV-S-34
e) Swivel Performance IV-S-41
f) Traveling Performance IV-S-42
g) Major Components Comparison IV-S-43
(C) TESTING IV-S-45
a) Testing Instruments & Special Tools IV-S-45
b) Precautions in Handling the Pump IV-S-47
c) Pilot Pressure IV-S-50
d) Main Relief Valve IV-S-52
e) Unload Valve IV-S-54
f) Overload Relief Valve IV-S-55
g) Swivel Brake Valve Pressure IV-S-57
h) Measuring the Main Pump Max. Flow Rate IV-S-59
i) Measuring the Main Pump's Stand-by Flow Rate IV-S-61
j) LS Control Pressure IV-S-62
k) Traveling Motor Drain Amount IV-S-63
l) Swivel Motor Drain Amount IV-S-64
m) Swivel Motor Block Performance IV-S-65
n) Traveling Motor Block Performance IV-S-66
o) Operating Speed IV-S-67
p) Straight Travel Performance IV-S-69
q) Cylinder Natural Fall Amount IV-S-70
r) Control and Traveling Lever Operating Force IV-S-70
s) Lever Stroke IV-S-70
(D) DISASSEMBLING AND ASSEMBLING. IV-S-71
a) Coupling Flange IV-S-71
b) Piston Pump IV-S-73
c) Pump: KX121-3α/S/ST, KX161-3α/S/ST IV-S-75
d) Control Valve IV-S-114
e) Pilot Valve IV-S-159

f) Swivel Motor. IV-S-177
g) Wheel Motor: KX121-3S/α, 161-3S/α IV-S-192
h) Rotary Joint IV-S-219
i) Cylinder (KE, KDG, KUK-version) IV-S-222
j) Cylinder (KTC, KCL, KTA-version). IV-S-230
k) Proportional Solenoid Valve. IV-S-237
l) Other Hydraulic Device IV-S-238
m) Hoses. IV-S-251

(A) TROUBLESHOOTING

a) Case Study: Abnormal speed

	Problems	Probable causes	Remedies	Ref. Fig.
1	The speed of all actuators is low.	1) The engine rpm is low.	1) Adjust the accelerator cable or link. 2) Check the engine systems (fuel system, compression system).	
		2) The quantity of working fluid in the hydraulic oil tank is too small. The oil quality is poor.	1) Replenish or replace the working fluid.	
		3) The suction line (suction filter) is clogged.	1) Check the suction line. Replace the suction filter.	
		4) The control differential pressure of the LS regulator is too low. The locknut of the differential pressure control spring in the LS regulator is loosened or maladjusted. (If the speed of all actuators is too high, suspect that the control differential pressure is too high.)	1) Actually measure the front unit or the swivel speed and make an adjustment so as to bring the setting of the spring within specifications. In the figure, tightening the setscrew increases the actuator speed and loosening the setscrew decreases the speed.	Fig. 15
		5) Gear pump volumetric efficiency is too low, so that LS control pressure difference is not enough.	1) Check gear pump delivery pressure and volumetric efficiency. Renew gear pump.	
		6) Leak from the PLS signal circuit (abnormal conditions of the PLS signal circuit in the control valve)	1) Check the hose connections for leak. Disassemble and check the PLS signal circuit in the control valve.	
		7) Insufficient pressure due to defects in the unload valve seat	1) Measure the unload pressure. Disassemble and clean the unload valve seat.	Fig. 2
		8) Insufficient pressure due to defects in the main relief valve seat	1) Measure and readjust the main relief pressure. Disassemble and clean the relief valve seat.	Fig. 1
		9) Shut-off valve of inlet section is loosened, so that main pump pressure got down to tank.	1) Check shut-off valve and retighten.	
		10) Defects or wear in the pump-mounting coupling	1) Repair or replace the pump coupling.	
		11) Breakage or wear in the pump drive shaft	1) Replace the shaft.	
		12) Seizure, breakage or wear in the pump internal parts	1) Repair or replace the pump.	
2	The speed of all the actuators in the hydraulic pilot system is too low.	1) The pilot filter is clogged.	1) Clean the pilot filter. Replace the filter if necessary.	Fig. 6
		2) Dust caught in the changeover valve or wear has caused the pilot primary pressure to drop.	1) Disassemble and clean the changeover valve and adjust the pilot relief pressure.	Fig. 7
		3) Pilot primary relief valve is misadjusted.	1) Check the pressure and readjust it with shim.	
		4) Insufficient discharge quantity of the pilot pump	1) Test the pilot pump performance. Replace the pump if it is defective.	
3	All the speeds on the R or L side in the pilot manipulation system are too low or the manipulation is poor.	1) The screen built in the pilot valve on the R or L side is clogged.	1) Disassemble and clean the screen.	
		2) The pilot primary line on the R or L side is defective or the pilot valve is defective.	1) Check the defective pilot valve primary line. Replace the pilot valve assembly if necessary.	Fig. 8, 9
4	The speed of a certain hydraulic pilot section is too low.	1) The control spool has got stuck in the neutral position.	1) Disassemble and service the pilot valve. Eliminate the cause of the stick. Replace the assembly if necessary.	Fig. 10
		2) The relevant spool of the pilot valve has got stuck. (In both the A and B ports, a stick is rare.)	1) Measure the pilot secondary pressure. Adjust the pressure using a shim.	Fig. 8, 9
		3) The pilot secondary pressure is too low.	1) Check the pilot spool for abnormal wear. Replace the valve assembly if necessary.	

Fig.1 Main relief valve

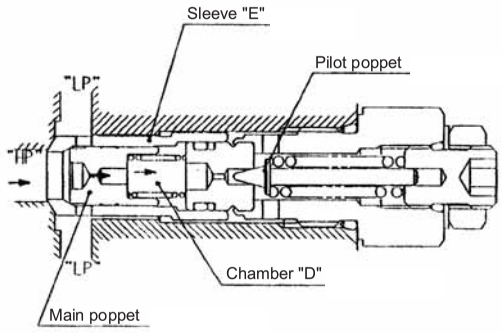


Fig. 2 Unload valve(KX161-3)

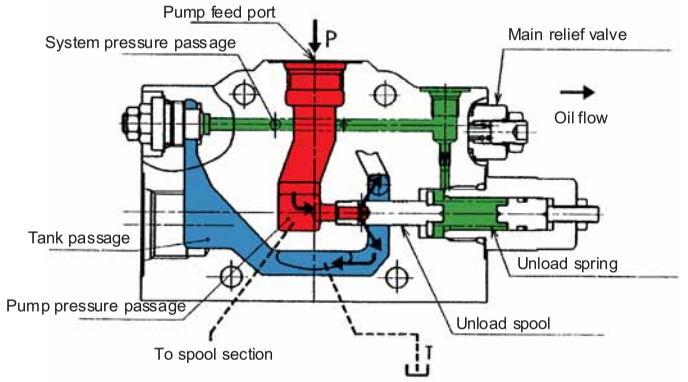
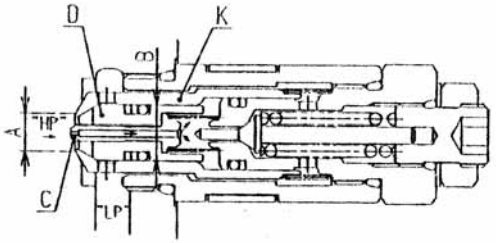


Fig. 3 Overload relief valve



a) Case Study: Abnormal speed

	Problems	Probable causes	Remedies	Ref. Fig.
5	The speed of a certain actuator is too low.	1) Swing: The swing pedal and the link are maladjusted.	1) Check and adjust the pedal and the link.	
		2) Dozer: The dozer lever and the cable are maladjusted.	1) Check and adjust the lever and the cable.	
		3) Service port: The service port pedal and the link are maladjusted.	1) Check the pedal and the link.	
		4) Hydraulic pilot system: Poor operation of the relevant pilot valve	1) Measure the pilot secondary pressure. Disassemble and check the pilot valve.	
		5) Actuator in the cylinder system: An internal leak is increased due to breakage in the cylinder packing.	1) Disassemble the cylinder and replace the seal.	
		6) Poor operation of the spool in the control valve section	1) Disassemble and check the control valve.	
		7) A leak from the overload relief valve or improper pressure	1) Disassemble, clean and adjust the relief valve or replace it.	Fig. 3
		8) Misassembling of the main C/V spool The max speed of the actuator depends on the machined opening in the spool. If the spool is misassembled, therefore, the max speed may not be achieved.	1) If the spool or the spring is misassembled, replace it with a normal part.	
		9) Misassembling of the compensation spool		Fig. 1
		10) Misassembling of the compensation spring		Fig. 1
		11) Compensation spool stick If the compensation spool does not open, the required quantity of fluid does not flow to the actuator and the necessary speed is not achieved.	1) Eliminate the cause of the stick completely or replace the entire assembly.	Fig. 1
		12) Shuttle plate is sticking. All of downstream sections pressure became low.	1) Check the corresponding shuttle plate.	
6	The speed of the arm crowd and boom lowering section is too low.	This problem arises when the pilot valve types for KX91-3 and KX121-3 are confused.	1) Replace it with a normal pilot valve.	Fig. 12
7	The speed of a certain C/V section and its downstream actuator is too low.	1) The shuttle valve has got stuck. A shuttle valve stick causes a leak of high pressure and the PLS pressure does not increase. As a result, the pump swash plate does not tilt correctly.	1) Eliminate the cause of the stick completely or replace the valve assembly if necessary.	
8	The traveling speed only is too low.	1) Improper setting of the horsepower control valve	1) Readjust the horsepower control valve. At a low temperature, the effect of pressure loss increases, causing the traveling second gear to slow down occasionally. Warm up the traveling motor up to 50°C or so and make a retest.	Fig. 14
9	The speed on the arm or bucket crowd side decreases occasionally. (Especially, in the engine's low-range or midrange)	1) Hitch of the pump LS regulator spool The PLS pressure is low when the load pressure on the crowd side is low. The force that pushes the LS regulator spool is therefore weak, so that the tilting of the pump swash plate delays momentarily. However, the PLS is sufficiently high at high load pressure and the spool shifts normally.	1) Disassemble and clean the spool to eliminate the cause of the hitch. Replace the regulator valve assembly if necessary.	Fig. 13
10	The traveling speed decreases when the front system is relieved during traveling.	When the load pressure increases, the system enters the horsepower control area, causing the pump discharge quantity to decrease. In the relief mode, the pump discharge quantity decreases to approximately 40 liters/min.	1) This action is normal, since the horsepower control is exercised.	
11	The port A or B speed in a certain hydraulic pilot section is too low.	1) The control spool has got stuck on one side.	1) Disassemble and service the control valve. Eliminate the cause of the stick. Replace the valve assembly if necessary.	Fig. 10
		2) The relevant spool of the pilot valve has got stuck.	1) Disassemble and service the pilot valve. Eliminate the cause of the stick. Replace the assembly if necessary.	Fig. 8, 9
12	The swivel speed is low in the arm relief or backet relief mode.	The swivel compensation spool is wrong.	1) Replace it with a normal compensation spool.	

Fig. 4 Relief valve layout ; KX121-3

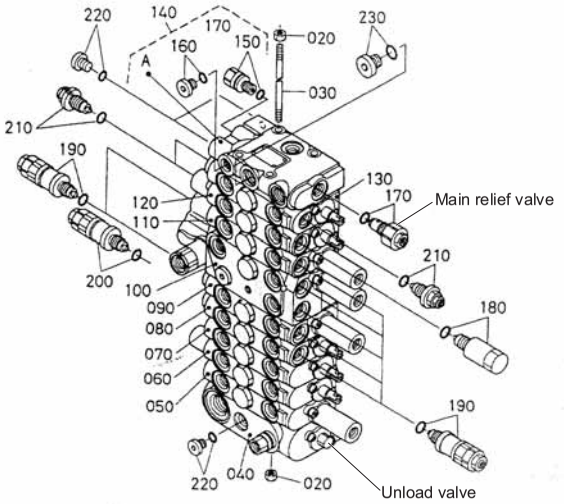


Fig. 5 Relief valve layout ; KX161-3

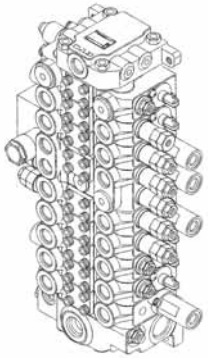


Fig. 6 Pilot filter

Fig. 7 Change valve

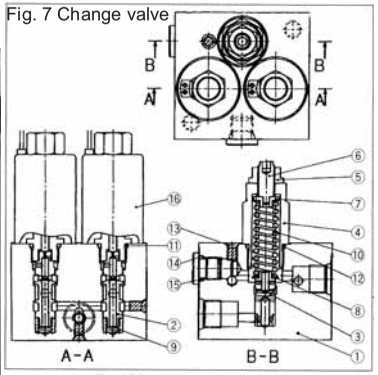
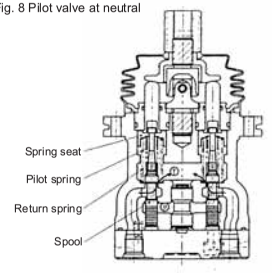


Fig. 8 Pilot valve at neutral



b) Case Study: The power is weak.

	Problems	Probable causes	Remedies	Ref. Fig.
1	The entire actuator power is weak.	1) Poor operation or maladjustment of the main relief valve	1) Disassemble, clean and reset the main relief valve.	Fig. 1
		2) The unload relief valve is defective. A leak is increased.	1) Disassemble, clean and reset the unload valve.	Fig. 2
		3) Decrease in the regulator control differential pressure. Loose setscrew.	1) Readjust the LS control differential pressure.	Fig. 3
		4) Leak of pressure from the shuttle plate.	1) Measure the pressure. Disassemble and clean or replace the assembly.	
2	The power of a certain actuator is weak.	1) For the actuator with an overload relief valve, the relief valve operation is poor or maladjusted.	1) Disassemble, clean and reset the overload relief valve.	
		2) A leak from the inside of the cylinder is increased. (An increased leak causes work to slow down.)	1) Disassemble and clean the cylinder. Replace the seal.	
		3) The shuttle valve has got stuck.	1) Disassemble and clean the control valve. Replace the assembly if necessary.	
3	The swivel actions in the right and left directions are different from each other and the swivel power is weak.	1) The pressure of the swivel motor relief valve is low.	1) Measure the swivel relief valve pressure. Readjust the relief pressure.	
		2) The swivel pilot pressure on one side is low.	1) Interchange the right and left pilot hoses to make a check.	
		3) The stroke of the control spool is insufficient. It has got stuck on one side.	1) Check the sliding of the control spool.	Fig. 1
4	The traveling power is weak	1) Poor operation or maladjustment of the main relief valve	1) Disassemble, clean and reset.	Fig. 2
		2) Poor operation or maladjustment of the unload valve	1) Disassemble, clean and reset.	
		3) Decrease in the regulator control differential pressure. Loose setscrew	1) Measure the pressure. Disassemble and clean. Replace the assembly if necessary.	
		4) Pressure leak from the shuttle valve	1) Reset the LS control differential pressure.	
		5) The traveling lever does not full-stroke shift.	1) Readjust the traveling lever link.	
		6) Pump volumetric efficiency decreased.	1) Test pump efficiency and replace if needed.	

Fig. 13 Pump control

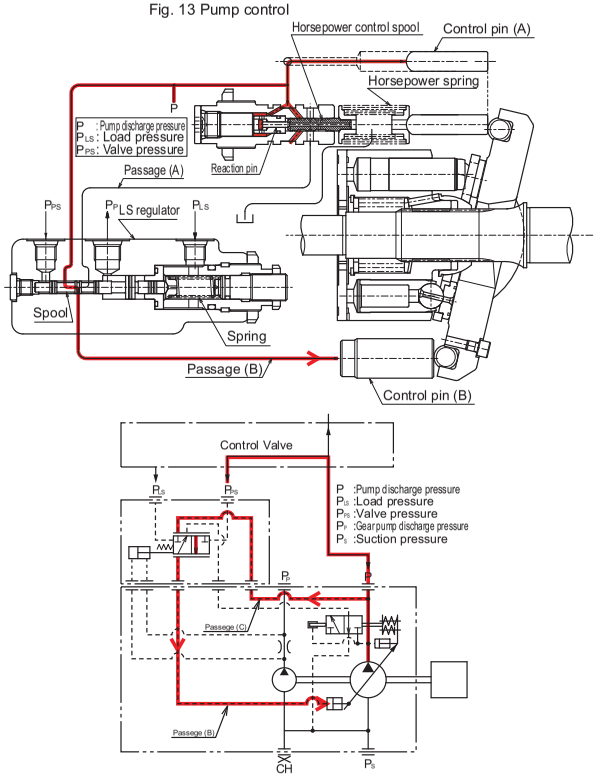


Fig. 9 Pilot valve, tilted

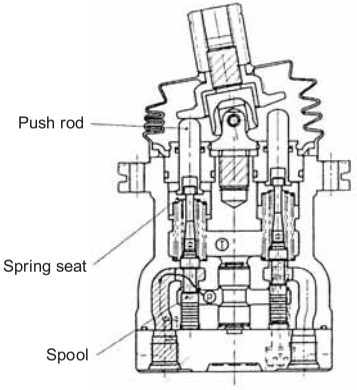


Fig. 10 Control valve : KX121-3

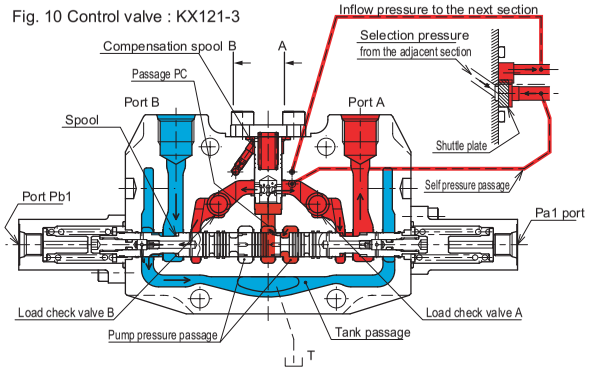
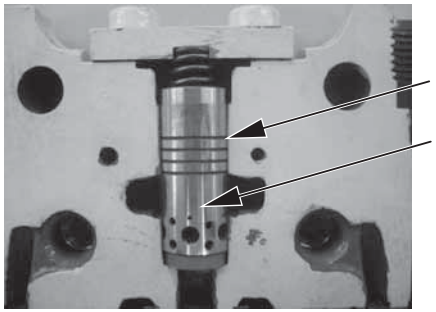


Fig. 11 Compensation spool



c) Case Study: Poor Manipulation and Abnormal Operation

	Problems	Probable causes	Remedies	Ref. Fig.
1	The engine stalls at the rated rpm when a load (traveling filter, etc.) is imposed.	1) The feedback control pin has got stuck.	1) Eliminate the cause of the stick completely or replace the pin assembly.	Fig. 13
		2) There is a control pressure leak due to wear in the control pin B (large diameter pin).	2) If the control pressure leak is caused by wear, replace the pump assembly.	
		3) The control spool of the horsepower control valve has got stuck.	3) If the horsepower control valve is set improperly, reset it.	
		4) The horsepower control valve is set improperly.	For the resetting of the horsepower control valve, refer to the P-Q characteristic diagram.	Fig. 14
2	The response of the work machine is abnormally slow. (Especially, at low temperatures)	1) The orifice in the pump is clogged with dirt.	1) Disassemble and clean.	
		2) The unload valve orifice is clogged with dirt.	1) Disassemble and clean.	
		3) The PLS line orifice is clogged with dirt.	1) Disassemble and clean.	
3	An abnormal sound is heard from the pump.	1) Air bleeding hose is kept open.	1) Bleed the air from the pump and plug the hose.	
		2) The quantity of working fluid is smaller than the required quantity.	1) Check the quantity of working fluid and replenish.	
		3) The working fluid viscosity is improper.	1) Use the recommended working fluid.	
		4) Air is sucked through the suction hose or pipes.	1) Check and retighten the hose and pipe. Bleed them.	
		5) There are contaminants or pieces of metal.	1) Overhaul and clean the pump. Replace the pump assembly if necessary.	
4	Loud noise is heard from around the control unit.	1) The delivery hose touches something and rattles.	1) Reinstall the hose. Prevent the hose from touching.	
		2) The relief valve makes squeaking noises.	1) Check the relief pressure. Disassemble and clean the relief valve. Replace the relief valve assembly if necessary.	
5	The boom is not raised when horizontal work is done through simultaneous manipulation of the boom and the arm at idle or low rpm.	There is a possibility that the arm compensation spool has got stuck on the open side. (Principle) When the boom is manipulated, the arm compensation spool works in the direction where it is closed, since the operating pressure for raising the boom is high. However, the pressure compensation is not made due to a stick and the pump flow is directed to the arm crowd side under light load. As a result, the pressure for raising the boom is not built up.	1) Eliminate the cause of a compensation spool stick completely. 2) Replace the arm section assembly of the control valve.	Fig. 11
6	The spontaneous boom fall amount is large.	1) Failure of the seal in the cylinder	1) Replace the seal.	
		2) Failure of the boom overload relief valve	1) Disassemble and clean the relief valve.	
		3) Failure of the load check valve	1) Check the load check valve.	
		4) Failure of the fall prevention valve seat	1) Disassemble and clean the fall prevention valve.	
7	The swivel does not stop.	The makeup poppet has got stuck. It is clogged with dirt.	Disassemble and clean the poppet.	
		The swivel main spool has got stuck.	Disassemble and clean the control valve swivel portion.	
		The relief valve of the swivel motor is clogged with dirt.	Disassemble and clean the relief valve.	

Fig. 14 Horse power control setting(KX121-3)

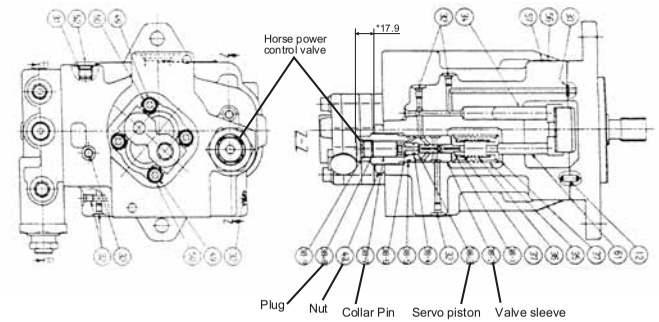


Fig. 15 LS regulation

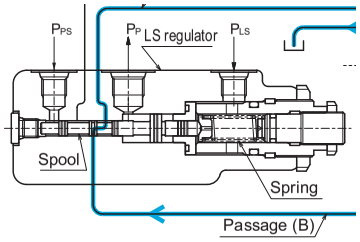
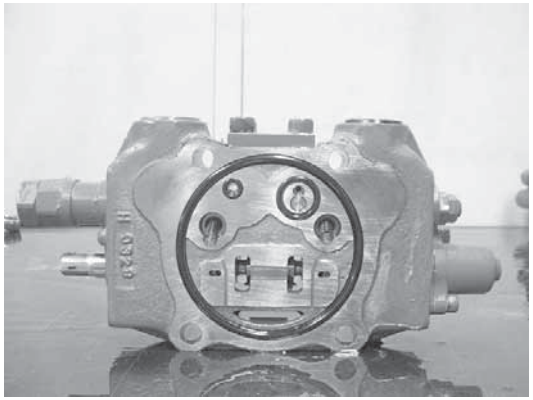
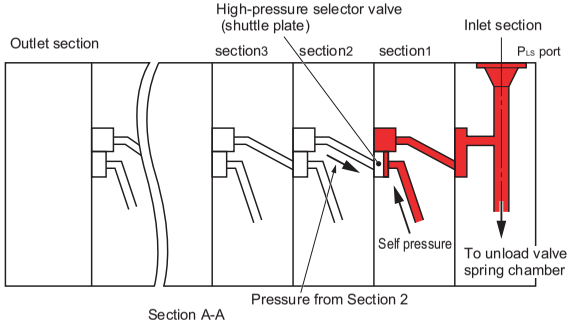
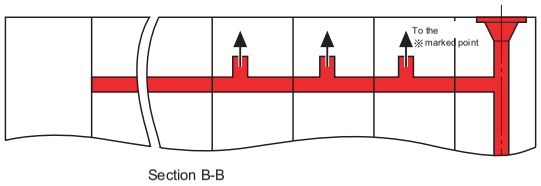


Fig. 12 High pressure selection valve(Shuttle plate)
Model : KX161-3







c) Case Study: Poor Manipulation and Abnormal Operation

	Problems	Probable causes	Remedies	Ref. Fig.
8	Swivel stop can't be not locked.	The swivel slow return check-valve is clogged with dirt.	Disassemble and clean the check-valve.	
		The swivel motor relief valve is clogged with dirt.	Disassemble and clean the relief valve.	
		The swivel motor relief pressure is too low.	Measure and readjust the swivel relief pressure.	
9	When any other actuator is relieved in the engine's idle-range or midrange during swivel, the swivel speed increases.	When an actuator is relieved, the swivel speed increases according to the LS differential pressure control characteristics. (Principle) When the swivel alone is manipulated at idle rpm, it swivels at 4.8 rpm or so under the LS control. If any other actuator is relieved, PPS becomes equal to PLS (PPS = PLS) with the circuit relieved and the relation with the LS control becomes PPS < PLS + FLS. Therefore, the swivel speed increases, since the pump swash plate is controlled in the direction where the discharge quantity increases. The actual measurement shows that it increases to approximately 8 rpm. In this case, the flow to the swivel motor is controlled by the under lap opening area of the C/V compensation spool. On the other hand, the tilting angle of the pump swash plate is horsepower controlled to the position where it is balanced with the engine horsepower used. The pump discharge quantity is so large that extra flow is returned to the tank through the main relief valve.	This phenomenon, which occurs unavoidably according to the control characteristics, is normal. (Actual measurement example) Swivel alone: Approx. 4.8 rpm at KX121-3 idle rpm Boom relief + Swivel approx. 8 rpm	
10	An abnormal sound is heard when the swivel is stopped.	1) The swivel makeup filter is clogged.	1) Clean the filter.	
		2) Failure of swivel negative brake release	1) Check the brake release pressure (pilot primary pressure).	
		3) Pressure escape due to brake seal failure	1) Check the brake seal. Replace it if necessary.	
		4) Damage to the friction plate	1) Overhaul the brake unit.	
11	Skew (Oblique) traveling	1) Te stopper bolt for the adjustment of the manipulation lever stroke in the traveling link is maladjusted. The main spool hits the stopper bolt before it is fully pulled (pushed).	Set free the stopper bolt first and readjust the link length. Pull the lever and return the bolt a half turn after the bolt is hit.	Fig. 16
		2) Play in the traveling link causes the spool to hit the stopper bolt before it is fully pulled (pushed).	Replace the link bushing.	
		3) The traveling orifice in the C/V is clogged.	Disassemble and clean the orifice.	Fig. 17
		4) One side of compensation spool sticks.	1) Eliminate the cause of the stick and reassemble.	
		5) One of the shuttle plate sticks. (Normally RH side.)	1) Eliminate the cause of the stick and reassemble.	
		6) If a skew takes place when the dozer or the front is relieved, the right and left traveling pressure compensation spools are misused.	Check the pressure compensation spools. Reassemble using normal parts.	
12	When the machine is jacked up, the R and L revolutions differ from each other during idle traveling. (The machine travels straight on a level ground.)	This phenomenon, which is caused by a difference in the piping pressure loss, is normal.	Normal	
13	Traveling does not stop even when the lever is returned to the neutral position on a downward slope. (Poor travel block performance)	1) Dirt has caused the travel counterbalance spool to get stuck.	1) Disassemble, clean and correct the counterbalance spool.	
14	When making a travel turn, the travel section on the stop side turns together and the machine goes straight.	1) Dirt has caused the travel counterbalance spool to get stuck.	1) Disassemble, clean and correct the counterbalance spool.	
		2) A heat shock has caused the travel counterbalance spool to get stuck.	1) Lift the body and warm up the travel motor.	
		3) Travel lever return failure	1) Check the travel lever link.	
		4) The control valve spool has got stuck.	1) Disassemble and correct the spool in the control section.	
15	The traveling speed decreases to about one half when the dozer UP is relieved.	1) The set pressure of the relief valve for dozer UP (rod side) is too high.	1) Measure and readjust the relief pressure on the dozer UP side.	

Fig. 16 Travel stopper

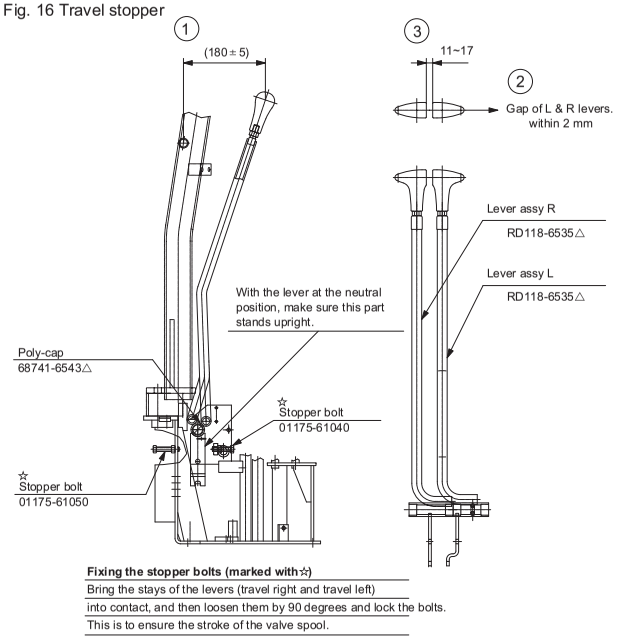
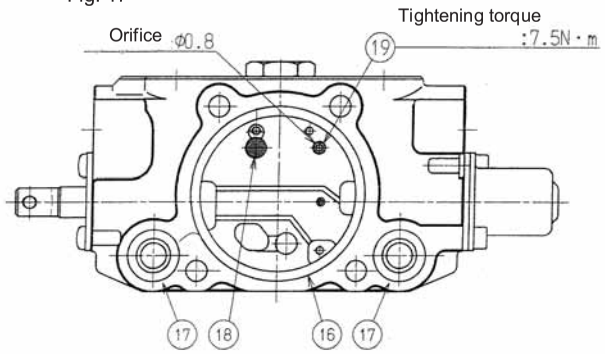


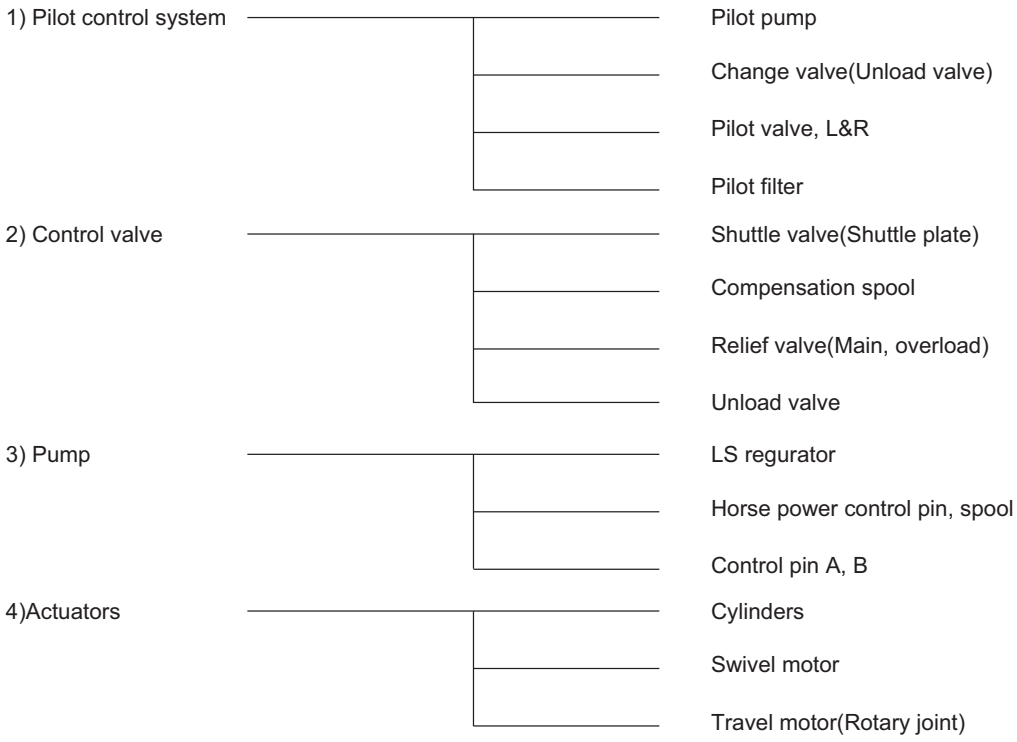
Fig. 17



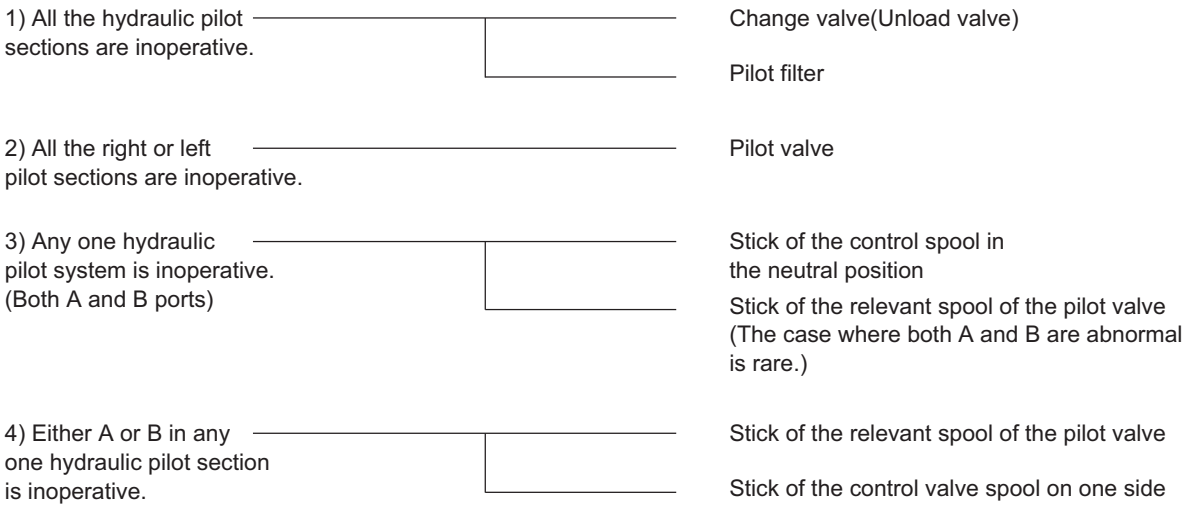
d) LS Control System Troubleshooting

(1) General

The core of the hydraulic system KX121-3/S/α, KX161-3/S/α is a combination of horsepower control and LS control.
Trouble with the hydraulic system is therefore attributed chiefly to hydraulic equipment such as pumps and control valves.
There may be cases where the hydraulic pilot system that controls the stroke of a control valve spool is secondarily involved in trouble.
Of course, individual actuators may have trouble.
Troubleshooting is therefore performed in the following four portions to determine the causes of trouble with the hydraulic system.



(2) Procedures for Hydraulic Pilot System Troubleshooting



(3) Procedures for LS Control Valve Troubleshooting

In the event of hydraulic trouble with the LS controller for KX121-3/S/α, KX161-3/S/α, complete the following basic check items and check the manipulation of the hydraulic pilot system.

(1) Basic check items: Quantity of oil, quality of oil, filter clogging, oil leak, air suction, engine conditions and the method of manipulating this machine
(2) Trouble with the hydraulic pilot system?
  1) All the hydraulic pilot systems?
  2) Certain hydraulic pilot system?
(3) Trouble with the actuator side?

If the check above detects no trouble, suspect the control valve or the pump.
With the following five items related to the control valve in mind, manipulate this machine or measure the pressure to pinpoint defective portions.
The use of the five check items makes it relatively easy to pinpoint trouble in detail. Get to work on the control valve first.

Basically, the control valve consists of the following parts. Trouble phenomena occur as shown below. It is preferable that the following steps be performed to determine the cause of trouble.

1) Unload valve

Check if the unload pressure is not built up at the maximum rpm under no load with the valve placed in the neutral position.

KX121-3/S/α: 25 kgf/cm^2, 2.45 MPa, 356 psi
KX161-3/S/α: 22 kgf/cm^2, 2.16 MPa, 313 psi
(Check the pump discharge quantity.)

2) Main relief valve

Check if the main relief pressure is not built up.

KX121-3/S/α: 250 kgf/cm^2, 24.5 MPa, 3556 psi
KX161-3/S/α: 240 kgf/cm^2, 23.5 MPa, 3414 psi
If any one actuator is relieved, the main relief pressure is built up.
(For the dozer UP only, however, there is a 120 k overload relief valve.)

3) Spool in the valve section

1. The spool must work at a full stroke under the secondary pressure of the pilot valve.
2. If the spool does not work at a full stroke even when the secondary pressure is the specified pressure, suspect that the spool has got stuck.
3. If the cylinder speed does not increase even when the spool works at a full stroke, suspect that the spool is misassembled.

4) Shuttle valve (Shuttle plate, high pressure selection valve)

1. If the shuttle valve does not move normally due to a stick, its own high pressure leaks from the shuttle valve, causing the PLS pressure to the compensation spool and the PLS pressure to the LS regulator to decrease, respectively. As a result, tilting takes place so as to reduce the pump discharge quantity, so that the actuator speed decreases.
2. Similar phenomena occur in the sections downstream from the section of the defective shuttle valve.
3. The sections upstream from the section of the defective shuttle valve work normally.
4. If the section of the defective shuttle valve and the sections upstream from it are manipulated at the same time, the PLS pressure to the pump acts on the upstream sections and the pump is normally LS-controlled.
5. If the shuttle valve gets stuck, the same phenomena occur in both the A and B ports.

5) Compensation spool

1. The compensation spool moves approximately 6.5 mm (0.26 inch) based on a balance between the PC pressure and the load pressure. However, the symptom depends on the position in which a stick occurs.
2. If a stick occurs in the stroke-0 position, i.e. in a state of the so-called under lap, the cylinder speed decreases, since the opening in the spool is small. The speed is almost the same as that obtained when other sections are relieved and manipulated simultaneously.
   (The simultaneous manipulation must be in the horsepower control area.)
3. If the compensation spool gets stuck in the full open position during the simultaneous manipulation under light and heavy loads, the pump flow is apt to be directed to the light load side when the compensation spool on the light load side gets stuck in the full open position, making it difficult to control the heavy load side.
4. If a stick occurs in the intermediate stroke position, it is difficult to control the heavy load side up to the stick position of the compensation spool.
   In the operation conditions beyond the stick position, the cylinder speed is lower than normal.
5. What will happen if the compensation spool is misassembled?
   In a state of the under lap, compare the cylinder speed with a normal machine.
   The cylinder speed decreases with decreasing under lap opening area.
6. If the compensation spool gets stuck as shown above, disassemble and clean the spool. Eliminate the cause of trouble completely and reassemble the spool. Replace parts if necessary. In some cases, replace the section assembly.

(4) Procedures for LS control Pump Troubleshooting

1) General

The pump mainly exercises the following two types of control.

1. Exercises horse power control over the hydraulic system to prevent the maximum horsepower of the engine from being exceeded. That is, prevention of stall.
2. Exercises load sensing control (i.e. "Load sensing") to allow the pump to discharge the flow required on the load side.

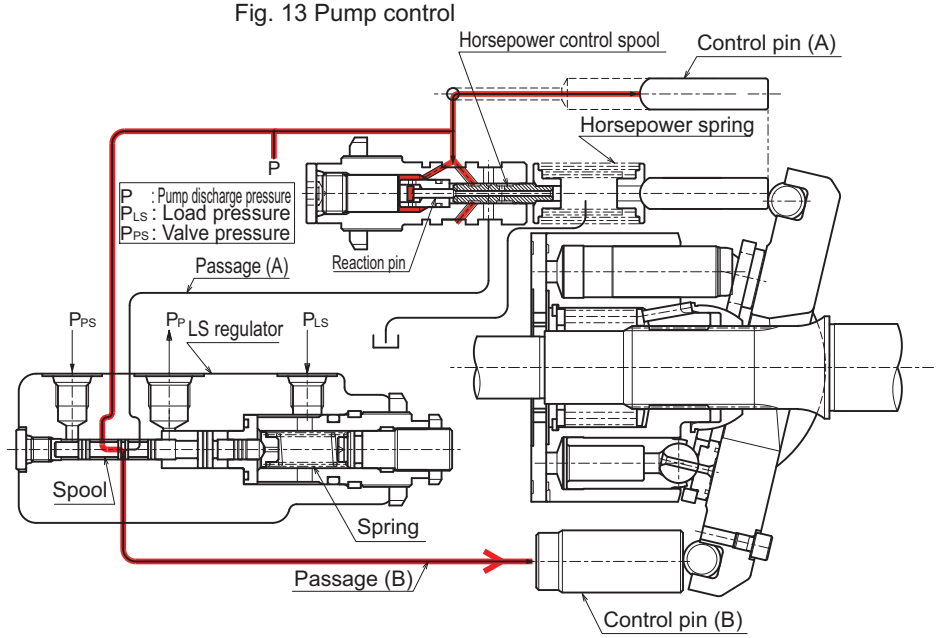
In addition, the pump is set at the minimum tilting angle, so that the pump discharges the standby flow before the LS control. KX121-3/S/α: 22.5 LPM (5.94 GPM), KX161-3/S/α: 29.3 LPM (7.73 GPM)

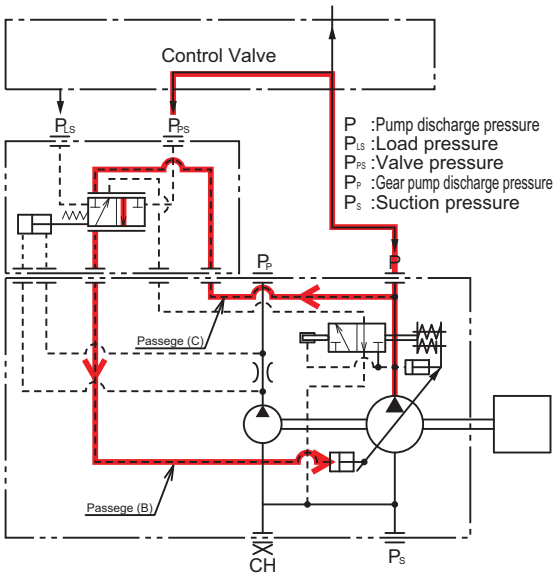
Therefore, the pump failure symptoms are broadly classified into the following two types.

1. The speed of the work machine is low, since the required flow is not discharged from the pump.
   → Failure of LS control
2 The engine stalls in certain conditions. → Failure of horsepower control

These problems are basically attributed to the failure of pump swash plate control. The probable causes of this failure are malfunctions such as a stick of each control portion due to contamination. The fundamentals of LS pump troubleshooting are shown on the next page using the figure below.

Fig. 13 Pump control





2) Fundamentals of LS Pump Troubleshooting (Defective Portions and Symptoms)

Failure symptom		**Pump performance**	
Portion contributable to the failure of pump swash plate control		**The speed of the work machines is low, since the required flow is not discharged from the pump. (LS control failure)**	**The engine stalls in certain conditions. (Horsepower control failure)**
1. Increased pressure leak due to wear in the control pin A (small diameter pin)		The swash plate tilting power is weak and the required flow is not discharged, since the pressure that acts on the control pin A (small diameter pin) leaks. (The speed decreases especially in the arm rake-up mode at low rpm.)	The engine does not stall.
2. Increased pressure leak due to wear in the control pin B (large diameter pin)		The LS control is disturbed, since the power to return the swash plate to a small tilting angle is weak. The pump discharge quantity is slightly larger than usual.	The engine is apt to stall, since the control power to move the swash plate to a small tilting angle is weak even when the load pressure is increased. The horsepower control is disturbed.
3. Stick of the horsepower control feedback pin		A pin stick causes the control spring to push in the control spool all the time, to lead the pressure of the control pin B to the tank. When PPS < PLS + FLS, the tilting angle of the pump swash plate is maximized. When PPS > PLS + FLS, the LS flow control is exercised up to the pin stick position.	The engine stalls when a load that decreases the swash plate tilting beyond the pin stick position is imposed, since the horsepower control is disabled.
4. Stick of the control spool of the horsepower control valve	The passage A pressure always gets stuck on the tank side.	In the area of PPS < PLS + FLS, the pump swash plate is always forced to be held at the maximum tilting angle. It looks like a fixed capacity motor of approx. 94 liters. In the area of PPS > PLS + FLS, the flow is LS-controlled.	The engine stalls if the load pressure increases in excess of the control horsepower. In the LS control area, the flow is controlled with the LS regulator and the normal flow is obtained.
	Stick in the position where the passage A pressure is always open to the P pressure.	The high pressure that has acted on the control pin B is not released, since the control pressure of the control pin B is not linked to the tank in the control spool section. As a result, the pump swash plate tilts in the direction that decreases the discharge quantity. The work speed decreases. Running in the standby flow state. It works like a fixed capacity motor in the standby state.	The engine does not stall, since it is fixed in the standby flow position when the PPS pressure from the LS spool acts on the control pin B. It goes into the standby state.
5. Stick of the LS regulator spool	Stick in the position where the A and B passage are linked to each other.	The tilting angle of the pump swash plate is maximized and the pump works like a conventional variable capacity pump. The extra flows through the unload valve. The LS regulator-based LS control is disabled.	The pump works like a conventional variable capacity pump and the engine does not stall.
	Stick in the position where the passage B and C are linked to each other.	All the work speed decreases, since the swash plate is held in the standby flow position. The LS control is disabled.	The engine does not stall, since the pump swash plate is always controlled to a small tilting angle.

e) Pump Component Trouble Causes and Remedy

(1) General precaution

The pump works normally for a long period of time as far as it is operated under appropriate condition. If it will not work as planned, it is necessary first to check to see if the cause of trouble is derived from either the pump itself or other equipment.
Although it is not easy to clarify the cause of trouble with hydraulic oil system, it is important to check and investigate the following points and identify the location of abnormality.

1. Checking of filter
   Check the filter element periodically. Check whether or not abnormal impurities are generated in large amount. The cause of trouble may be predicted depending on the type of impurity.
2. Checking of drain oil
   Check drain oil coming from the pump, motor etc. The cause of trouble can be predicted from drain flow-rate and type of impurity contained in drain oil.
3. Checking for abnormal noise and vibration.
   Check various equipment for any abnormal noise and vibration.
   Discovery of the source of abnormal noise and vibration leads to the clue of clarification of cause of trouble.
4. Checking of pressure at various parts
   Do not disassemble and check irrelevant equipment unnecessarily, but check the pressure by means of pressure gauge and investigate the cause of trouble.

(2) Trouble shooting

Failure symptom	Suspected causes	Remedy
1. Pump will not discharge oil.	1. Oil in the tank is decreased to such extent that the end of the suction pipe emerges above the oil level in the tank.	Replenish the tank. Raise the oil level or immerse the end of the pipe in oil.
	2. Pump case is not filled with hydraulic oil.	Fill the pump case with hydraulic oil.
	3. Strainer of suction pipe is closed, or clogged.	Clean the strainer. Open the suction pipe.
	4. Damage of pump key part(s). Trouble with input shaft and coupling.	Disassemble the pump and replace damaged part(s). Clean all the parts completely before re-assembling.
2. Pump discharge amount is small. Circuit pressure will not be raised.	1. Pressure is not raised or oil flowrate does not reach the specified level due to trouble with other hydraulic equipment than the pump, such as hydraulic motor and various control valves.	Replace, repair or check faulty hydraulic equipment.
	2. Large amount of high-pressure oil leaks due to abrasion of pump sliding parts.	Disassemble the pump. If sliding surfaces are roughened, repair them by re-polishing or lapping. Pay particular attention to damage to the valve plate. If damage is irreparable, replace part(s) and clean all the parts completely before re-assembling.
	3. Air is sucked in through suction side of the pump.	Check or replace the suction pipe and packings, or check tightened parts for any looseness and re-tighten, if any.
	4. Strainer is clogged, or air is sucked in due to lowering of oil level.	Clean or replace the strainer.

Failure symptom	Suspected causes	Remedy
	5. Suction resistance develops excessively, resulting in generation of cavitation due to abnormal oil temperature, abnormal hydraulic oil viscosity and other causes.	Reduce suction resistance.
3. Pump generates abnormal noise.	1. Air is sucked in due to lowering of oil level in the tank.	Supply oil and eliminate air under no-load operation.
	2. Suction hose and pipe are inappropriate, resulting in increase of suction resistance of the pump.	Reduce suction resistance.
	3. Cavitation is generated by clogged strainer.	Clean the strainer. If clogging of strainer is severe, flush the circuit and replace hydraulic oil.
	4. Inadequate capacity of the strainer	Select a strainer having the capacity 2 to 3 times larger than the maximum discharge amount.
	5. Cavitation generated due to too low oil temperature or too high viscosity.	Carry out warming up operation. Select oil and set the oil temperature according to the instruction manual.
	6. Defective coupling	Check it for any deviation.
	7. Pump vibrates with other equipment.	Check the set bolts for any looseness.
4. Overload to engine (Extreme lowering of engine rotating speed or engine stall)	1. Horse-power control torque is set too high.	Re-adjust it by setscrew.
	2. Clogging of internal pilot oil passage and orifice, or seizure or scuffing of parts.	If the condition remains unchanged even after re-adjustment by setscrew, disassemble and check the pump.
	4. Seizure or abrasion of pump internal parts	Repair the pump.
5. Oil leaks.	1. Drain oil flowrate increases to boost the pressure in the pump case until oil seal is broken, thus resulting in oil leakage. (Oil seal withstand pressure: 0.3 MPa (3 kgf/cm^2, 43 psi)	Repair the pump.

f) Control Valve Component Troubleshooting

--Control valve in general--

Failure symptom	Suspected causes	Remedy
1. Spool will not stroke. (Machine will not pick up speed.)	1. Oil temperature is raised abnormally.	Remove something which hampers oil flow in the piping system.
	2. Contamination of hydraulic oil.	Replace hydraulic oil, and clean the circuit at the same time.
	3. Over-tightening of the piping port joint.	Check the tightening torque.
	4. Valve housing is distorted after mounting.	Loosen the set bolt and check the housing for distortion.
	5. Pressure is too high.	Set a pressure gauge between the pump port and the cylinder port, and check the pressure.
	6. Spool is bent.	Replace the valve assembly.
	7. Return spring is damaged.	Replace the damaged spring.
	8. Spring or cap is displaced.	Loosen the cap to make centering and then tighten.
	9. Temperature distribution in the valve is not uniform.	Warm up the whole circuit.
	10. Valve is clogged with dust.	Remove (Brush off) dust.
	11. Pilot pressure is insufficient.	Check the pressure of the pilot valve and pilot relief valve.
	12. Compensation spool is seized.	Replace the compensation spool or section assembly.
2. Load cannot be held.	1. Oil leaks from the cylinder.	Check the cylinder seal.
	2. Oil bypasses from the spool.	Check the spool for any defect.
	3. Oil leaks from the overload relief valve.	Clean the valve housing seat and relief valve seat.
	4. Oil leaks from the anti-drift valve.	Disassemble the anti-drift valve, and clean the seats of parts. If seat is damaged, replace the poppet, or lap the poppet and seat. If any abnormality exists at the spool of ant-drift valve, replace both the spool and sleeve, which are fitted in mutually.
3. Load drops when the spool is switched from neutral to high position.	1. Load check valve is clogged with dust.	Disassemble the check valve and clean it.
	2. Poppet or seat of the check valve is damaged.	Replace the poppet, or lap the poppet and seat.

--Relief valve, unload valve and shuttle valve --

Trouble	Possible cause	Remedy
1. Pressure will not be raised at all.	1. Main poppet, sleeve or pilot poppet is seized and kept open, or dust exists at the valve seat.	Replace the relief valve.
2. Relief pressure is unstable.	1. Seat of the pilot poppet is damaged.	
	2. Piston or main poppet is seized.	
3. Relief pressure is out of the preset range.	1. Abrasion of seat by dust.	
	2. Lock nut and adjuster are loosened.	Re-set the pressure and tighten the lock nut with specified torque.
	3. Pressure regulating nut of the unload valve is loosened.	Re-set the pressure and tighten the lock nut with specified torque.
	4. Spool of the unload valve is seized and kept open, or dust exist at the spool of the unload valve.	Replace either of the spool of the unload valve or the inlet housing, or replace both.
	5. Shuttle plate is damaged. 6. Shuttle plate is seized.	Replace the shuttle plate or the section assembly.
4. Oil leaks.	1. Relief valve seat is damaged.	Replace the relief valve.
	2. Parts are seized by dust.	
	3. Abrasion of O-ring.	Replace the adjuster or O-ring of valve mounting part.

--General hydraulic oil system --

Trouble	Possible cause	Remedy
1. Hydraulic system malfunctions or does not function at all.	1. Trouble with pump	Check oil pressure, or replace the pump.
	2. Trouble with relief valve	Replace the relief valve.
	3. Trouble with cylinders	Repair or replace.
	4. Pump load pressure is too high.	Check the pressure in the circuit.
	5. Valve is cracked.	Replace the valve in assembly.
	6. Spool does not stroke.	Check the spool motion.
	7. Oil level in the oil tank is too low.	Add hydraulic oil.
	8. Filter in the circuit is clogged.	Clean or replace the filter.
	9. Pipes in the circuit are choked.	Check pipes.

g) Travel Motor Component Troubleshooting

In case of any trouble arising during running, investigate the cause and take an appropriate remedial measure by referring to the Table of Troubleshooting shown below.

(1) Main function

Trouble	Possible Cause	Remedy
1. Motor will not rotate.	Any other equipment than motor, counter-balance valve and reduction gear malfunctions	Check to see if specified pressure of hydraulic oil reaches the motor inlet side, and then check and repair the relevant equipments.
	Hydraulic pressure is relieved due to abnormal abrasion of the motor sliding part.	Replace abnormally worn part(s). Eliminate flaws and burrs on the surface and clean all the parts before re-assembling.
	Malfunction due to damaged major part(s) of the motor	Disassemble the motor and replace the damaged part(s). After cleaning all the parts, re-assemble them, using care not to allow entry of foreign matter.
2. Motor rotating speed is slow.	Due to any trouble with the hydraulic pump and pressure control valve, oil is not fed at specified flowrate, thus lowering the motor rotating speed.	Check to see if oil flows to the motor inlet side at specified flowrate, and then check and repair the relevant equipments.
	Due to lowering of volumetric efficiency, specified motor rotating speed cannot be attained.	After disassembling the motor, check the sliding parts for any abnormal abrasion. If any, repair or replace worn part(s).
3. Motor rotating speed fluctuates considerably.	Due to abrasion of motor sliding parts, a large amount of high-pressure oil leaks and flows out of the drain port, thus lowering and fluctuating the motor rotating speed considerably. Abrasion of bearing causes also fluctuation of motor rotating speed.	Disassemble the motor and replace worn parts if any. After cleaning all the parts, re-assemble them, using care not to allow entry of foreign matter.
4. Oil leak	Oil leaks due to damaged oil seal(s) or O-ring(s).	Replace damaged oil seal(s) or O-ring(s) with new one(s). At this time, use due care not to damage the oil seal lip. Apply grease slightly to O-ring before re-assembling.

(2) Counterbalance valve function

Trouble	Possible Cause	Remedy
1. Motor will not rotate or rotates but slow.	Plunger does not switch.	
	1) Hydraulic pressure is not generated.	Check whether piping is damaged or not.
	2) Foreign matter exists between the plunger and the base plate.	Remove foreign matter completely. Repair damaged part and re-assemble it after cleaning. If the damage and leakage are severe, replace the part.
	3) Orifice is clogged.	Clean it with washing oil and re-assemble.
2. Motor will not stop or stops but slow.	Plunger does not restore.	
	1) Foreign matter exists between the plunger and the base plate.	Remove foreign matter completely. Repair damaged part and re-assemble it after cleaning. If the damage and leakage are severe, replace the part.
	2) Spring is not set properly.	Set the spring at proper position.
	3) Spring is damaged or broken.	Replace the spring. Remove foreign matter completely. Repair damaged part and re-assemble it after cleaning.
	4) Orifice is clogged.	Clean it with washing oil and re-assemble.
3. Machine is shocked severely when traveling is stopped.	Plunger returns too quickly.	
	Spring seat is not set properly.	Set the spring seat at proper position.
4. Abnormal noise is heard.	Plunger does not restore.	
	1) Foreign matter exists between the plunger and the base plate.	Remove foreign matter completely. Repair damaged part and re-assemble it after cleaning. If the damage and leakage are severe, replace the part.
	2) Spring is damaged or broken.	Replace the spring. Remove foreign matter completely. Repair damaged part and re-assemble it after cleaning.
	3) Orifice is clogged.	Clean it with washing oil and re-assemble.

(3) Anti-cavitation valve function

Trouble	Possible Cause	Remedy
Motor will not rotate or rotates but slow.	Defective check valve seat	
	1) Foreign matter exists inside.	Remove foreign matter completely. Repair damaged part and re-assemble it after cleaning. If the damage and leakage are severe, replace the part.
	2) Spring is damaged or broken.	Replace the spring. Remove foreign matter completely. Repair damaged part and re-assemble it after cleaning.
Cavitation sound is heard loud during traveling.	Check valve is seized.	
	Foreign matter exists between the check valve and the valve body.	Remove foreign matter completely. Repair damaged part and re-assemble it after cleaning. If the damage and leakage are severe, replace the part.

(4) Hi-Low speed function

Trouble	Possible Cause	Remedy
Machine turns during traveling.	Spool does not switch.	
	1)Foreign matter exists between the spool and the valve body.	Remove foreign matter completely. Repair damaged part and re-assemble it after cleaning. If the damage and leakage are severe, replace the part.
	2) Spring is not set properly.	Set the spring at proper position.
	3) Spring is damaged or broken.	Replace the spring. Remove foreign matter completely. Repair damaged part and re-assemble it after cleaning.
	Hydraulic oil leaks due to abnormal abrasion of the 2-stage speed control piston.	Replace the 2-stage speed control piston. Remove foreign matter completely. Repair damaged part and re-assemble it after cleaning.
	2-stage speed control piston is not set properly.	Set the 2-stage speed control piston at proper position.
	Foreign matter existing between the 2-stage speed control piston at the right side and the valve body blocks motion of the piston.	Remove foreign matter completely. Repair damaged part and re-assemble it after cleaning. If the damage and leakage are severe, replace the part.
	Abnormal abrasion of steel ball.	Replace the steel ball. Remove foreign matter completely. Repair damaged part and re-assemble it after cleaning.
Piston speed will not switch between two stages.	Foreign matter existing between the 2-stage speed control spool and the valve body blocks motion of the spool.	Remove foreign matter completely. Repair damaged part and re-assemble it after cleaning. If the damage and leakage are severe, replace the part.
	Foreign matter existing between the 2-stage speed control piston and the valve body blocks motion of the piston.	Remove foreign matter completely. Repair damaged part and re-assemble it after cleaning. If the damage and leakage are severe, replace the part.
	Hydraulic oil leaks due to abnormal abrasion of the 2-stage speed control piston.	Replace the 2-stage speed control piston. Remove foreign matter completely. Repair damaged part and re-assemble it after cleaning.
	Orifice of the 2-stage speed control signal passage is clogged.	Remove foreign matter completely.

h) Service Port Function Troubleshooting

Following troubleshooting is based on below preconditions.

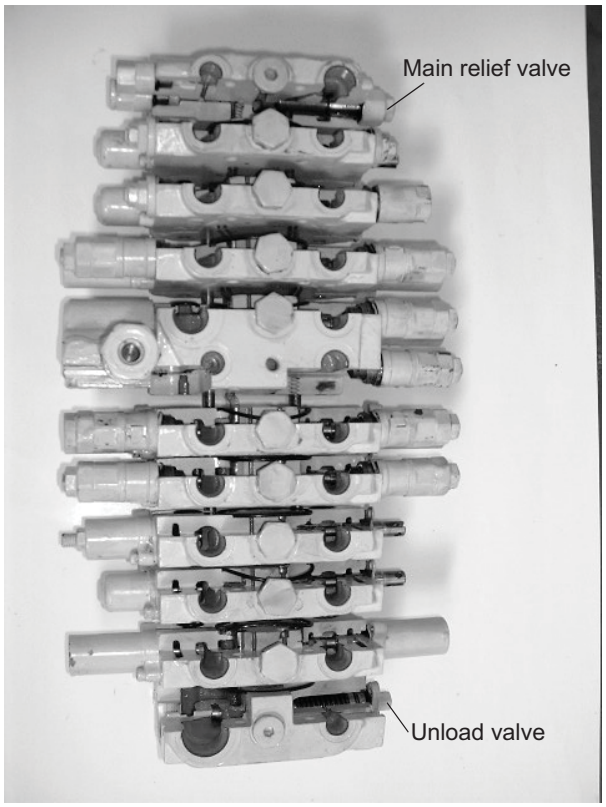
1. Hydraulic oil quality and quantity are normal.
2. Hydraulic pump P_1, P_2, P_3, P_4 are OK.
3. All the functions except service port system are normal.

Fail symptom	Suspected causes	Check points
1. Service port attachment does not work at all. (Thumb's failure to move in both directions; Breaker's failure to crush; Auger's failure to turn)	1. Knob switch harness is cut or coupler is disconnected.	Knob harness, fuse and switch coupler.
	2. S/P valve harness is broken or coupler is disconnected.	S/P valve harness and coupler.
	3. S/P valve spool is stuck inside.	S/P valve spool.
	4. Main S/P valve spool is stuck inside.	Main control valve S/P section.
	5. S/P valve pressure is quite low in both side.	Test the S/P valve pressure.
2. Thumb does not work in one direction at all.	1. S/P valve solenoid harness is broken one side.	S/P valve harness.
	2. S/P valve spool is stuck inside.	S/P valve spool.
	3. Main control valve S/P section is stuck one side.	Main control valve S/P section.
	4. Knob switch initial setting error.	Knob switch initial setting.
	5. S/P valve pressure is quite low in one side.	Test the S/P valve pressure.
3. Service port attachment moves slower than specified in both directions.	1. S/P valve start-up setting error.	Do S/P valve start-up setting.
	2. Current amount from the controller is not enough.	Knob switch initial setting.
		Meter panel (Controller) output current.
	3. S/P valve spool moves heavy and slow.	S/P valve spool.
	4. S/P valve pressure is low in both sides.	Test the S/P valve pressure.
	5. Main control valve S/P section spool won't shift at full stroke.	Main control valve S/P section spool.
4. Service port attachment moves slower than specified in one direction.	1. Knob switch initial setting error.	Do knob switch initial setting.
	2. S/P valve start-up setting error.	Do S/P valve start-up setting.
	3. Manual feeling setting error.	Do manual feeling setting.
	4. Main control valve S/P section spool one side won't shift at full stroke.	Main control valve S/P section spool.
5. S/P attachment moves at neutral position of knob switch	1. Knob switch initial setting error.	Do knob switch initial setting.
	2. S/P valve spool is stuck at one side.	S/P valve spool.
	3. Main control valve S/P section spool is stuck at one side.	Main control valve S/P section spool.

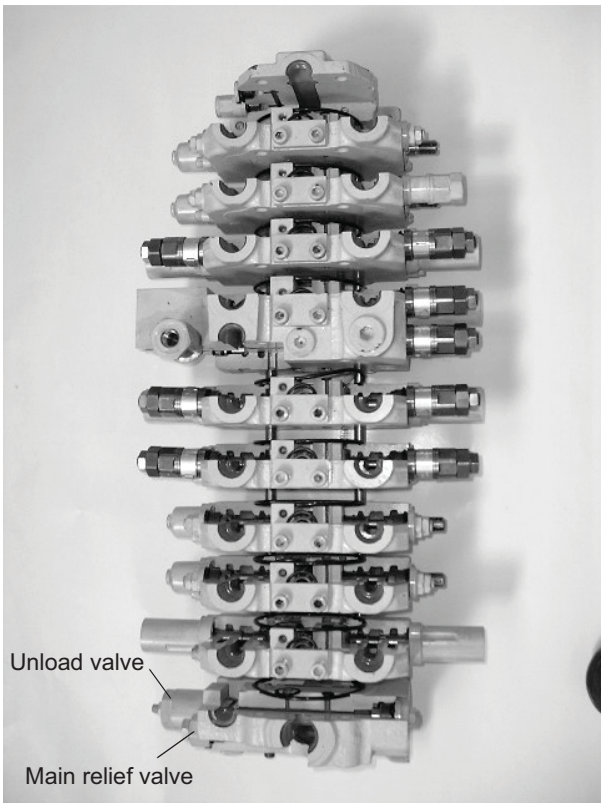
(B) SPECIFICATIONS

a) Relief Valve Pressure Setting

(KX121-3α/S/ST cut-model)



(KX161-3α/S/ST cut-model)



Relief valve (bench data)

No.	Valve location	Operating work	Unit	KX121-3α/S/ST	KX161-3α/S/ST		Remarks
1	Main relief valve	All actuators	MPa kgf/cm^2 psi	24.5 250 3556	23.5 240 3414		KX121-3α/S/ST: at 37 l/min (9.8 us gal) KX161-3α/S/ST: at 44 l/min (11.6 us gal)
2	Unload relief valve		MPa kgf/cm^2 psi	2.5 25 356	2.2 22 313		KX121-3α/S/ST: at 22 l/min (5.8 us gal) KX161-3α/S/ST: at 29 l/min (7.7 us gal)
3	Pump LS control pressure	LS regulator	MPa kgf/cm^2 psi	0.5 ~ 1.4 5 ~ 14 71 ~ 199	0.6 ~ 1.3 6 ~ 13 85 ~ 185		
4	Pilot primary pressure	All pilot lines	MPa kgf/cm^2 psi	3.9 40 569	←		

Main relief valve (at the measurement port on the machine) KTC, KCL, KTA version

No.	Valve location	Operating work	Unit	KX121-3α/S/ST	KX161-3α/S/ST		Remarks
1	Main relief valve	All actuators	MPa kgf/cm^2 psi	24.5 $^{+1.0}_{-0.5}$ 250 $^{+10}_{-5}$ 3556 $^{+140}_{-70}$	24.0 $^{+1.0}_{-0.5}$ 245 $^{+10}_{-5}$ 3485 $^{+140}_{-70}$		
2	Unload relief valve		MPa kgf/cm^2 psi				
3	Pump LS control pressure	LS regulator	MPa kgf/cm^2 psi				
4	Pilot primary pressure	All pilot lines	MPa kgf/cm^2 psi	3.9 ± 0.5 40 ± 5 569 ± 70	←		

Overload relief valve (bench data)

No.	Valve location	Operating work	Unit	KX121-3α/S/ST	KX161-3α/S/ST		Remarks
5	Control valve	Boom up Boom down	MPa kgf/cm^2 psi	27.4 280 3983	26.5 270 3840		at 5 l/min (1.32 us gal)
6	Control valve	Bucket crowd					
7	Control valve	Arm dump Arm crowd					
8	Control valve	Dozer down					
9	Control valve	Dozer up	MPa kgf/cm^2 psi	11.8 120 1707	←		
10	Swivel motor	Swivel, R & L	MPa kgf/cm^2 psi	20.6 210 2987	17.6 180 2560		

Overload relief valve (at the measurement port on the machine)

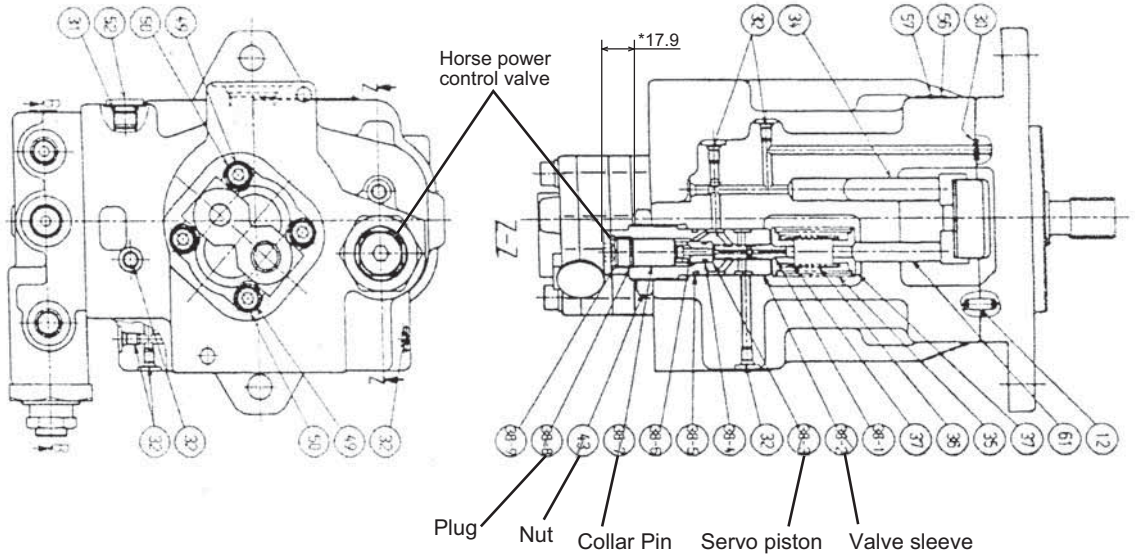
No.	Valve location	Operating work	Unit	KX121-3α/S/ST	KX161-3α/S/ST		Remarks
5 6 7 8	Control valve	Boom up, down Arm dump, crowd Bucket dump, crowd Dozer down	MPa kgf/cm^2 psi				
9	Control valve	Dozer up					
10	Swivel motor	Swivel R & L					

b) Pump

(1) Specifications

		Unit	KX121-3α/S/ST	KX161-3α/S/ST		Remarks
Manufacturer			Kayaba Industry Co. Ltd.			
Model			PSVL-42CG	PSVL-54CG		
Rated pump rpm		rpm	2250	2250		
Rated load pressure	Main relief pressure	MPa kgf/cm^2 psi	24.5 250 3556	23.5 240 3414		
	Unload relief valve	MPa kgf/cm^2 psi	2.5 25 356	2.2 22 313		
	Pilot primary pressure	MPa kgf/cm^2 psi	3.9 40 569	←		
Theoretical discharge capacity	Main pump	cc/rev in^3/rev	10 ~ 42 0.61 ~ 2.56	13 ~ 54 0.8 ~ 3.3		
	Pilot pump	cc/rev in^3/rev	4.0 0.24	←		
Theoretical discharge capacity at rated load	Main pump	L/min gal/min	22.5 ~ 94.5 5.94 ~ 25.0	29.3 ~ 121.5 7.74 ~ 32.1		
	Pilot pump	L/min gal/min	9.0 2.38	←		

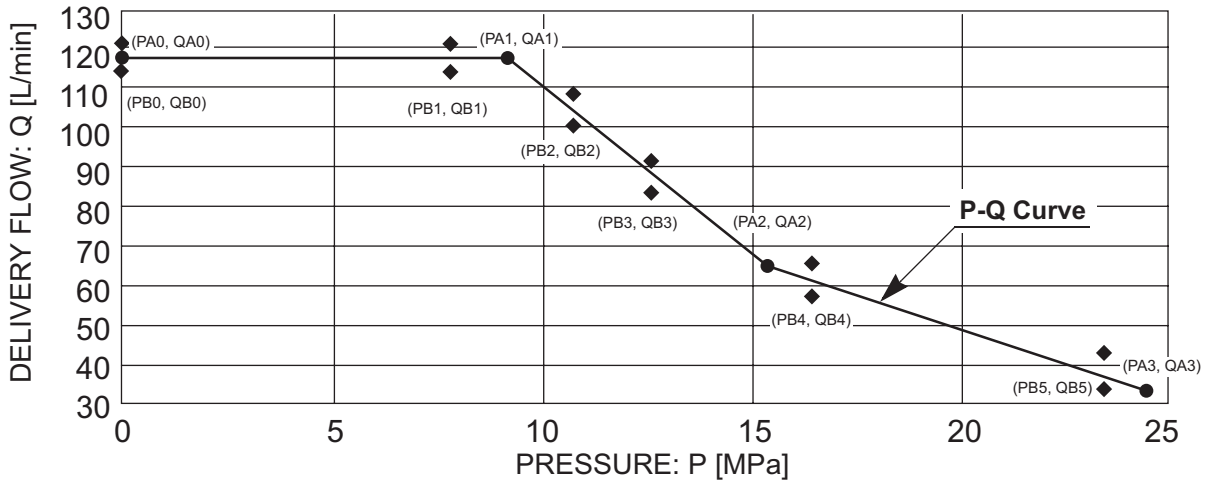
Horse power control setting



* Mark 17.9 mm (0.7”) is for your rough value for tentative reassembly purpose of KX121-3α/S/ST, For accurate adjustment should be followed according to the P-Q performance specifications.

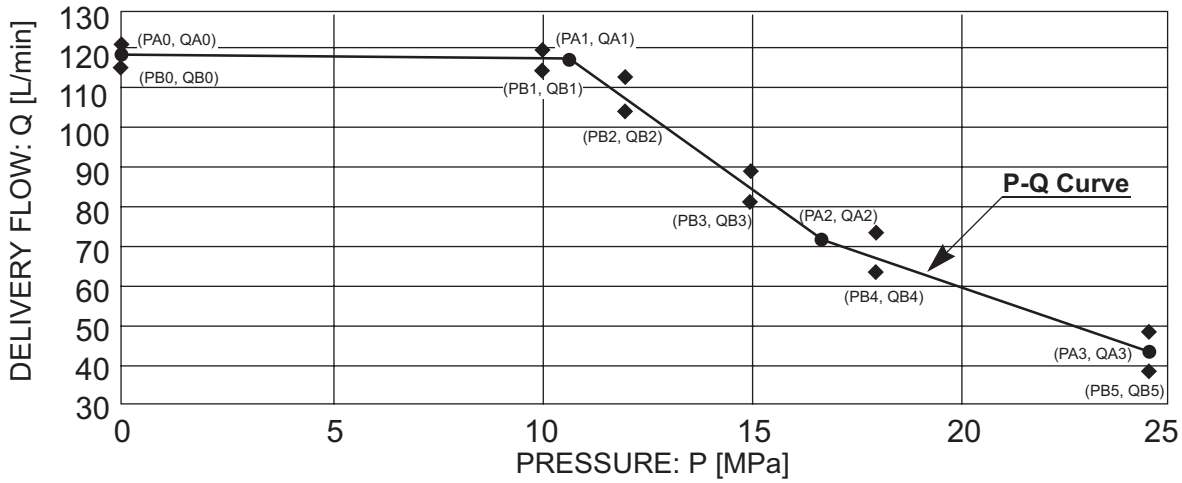
(2) Piston pump P-Q performance curve (Theoretical)

Piston pump power constant characteristics: KX161-3α, U45-3α, U45-3S, U45S, U50-3α



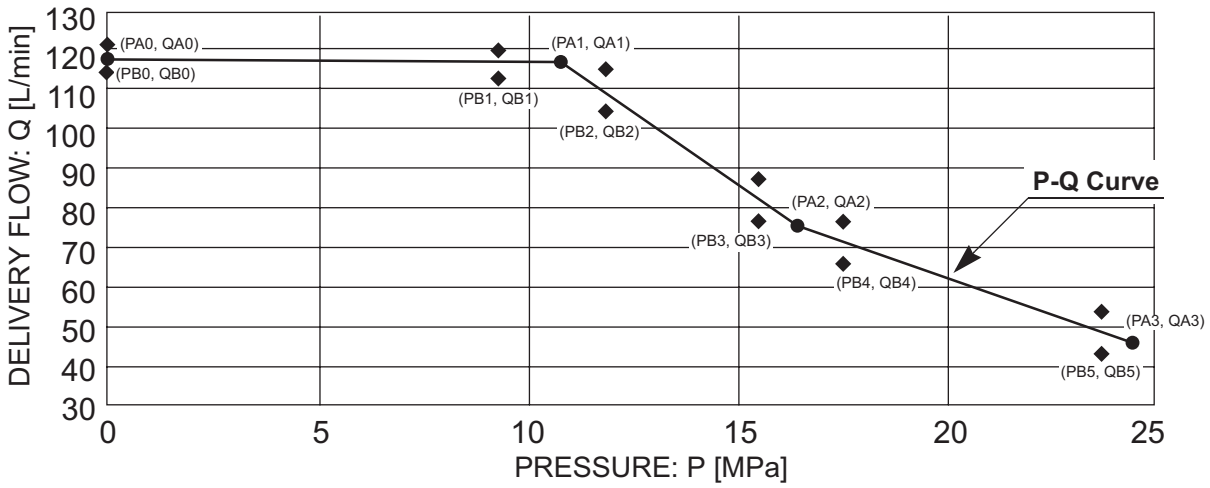
SHAFT SPEED 2200 rpm				TOTAL INPUT TORQUE $108.0^{0}_{-2.9}$			
PRESSURE [MPa]		DELIVERY FLOW [L/min]		PRESSURE [MPa]		DELIVERY FLOW [L/min]	
PA0=	0.0	QA0=	118.8	PB0=	0.0	QB0=	118.8 ± 2.5
PA1=	9.2	QA1=	117.8	PB1=	7.8	QB1=	117.2 ± 2.5
PA2=	15.3	QA2=	66.0	PB2=	10.8	QB2=	104.1 ± 4.0
PA3=	24.5	QA3=	33.5	PB3=	12.7	QB3=	87.0 ± 4.0
				PB4=	16.6	QB4=	61.4 ± 5.0
				PB5=	23.5	QB5=	37.0 ± 5.0

Piston pump power constant characteristics: KX161-3S



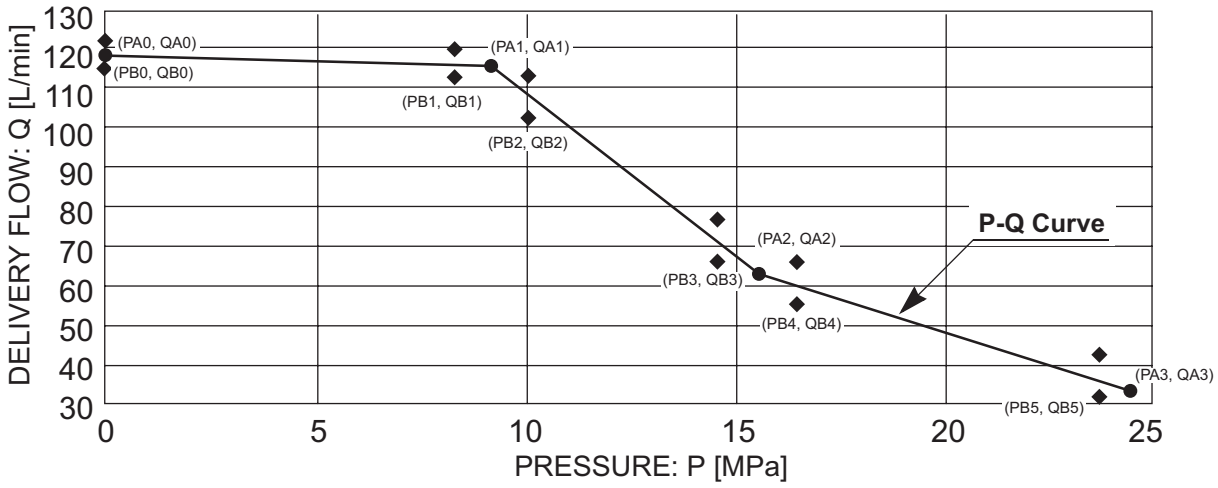
SHAFT SPEED 2200 rpm				TOTAL INPUT TORQUE $108.0^{0}_{-2.9}$			
PRESSURE [MPa]		DELIVERY FLOW [L/min]		PRESSURE [MPa]		DELIVERY FLOW [L/min]	
PA0=	0.0	QA0=	118.8	PB0=	0.0	QB0=	118.8 ± 2.5
PA1=	10.7	QA1=	117.3	PB1=	10.0	QB1=	117.3 ± 2.5
PA2=	16.7	QA2=	72.0	PB2=	12.0	QB2=	109.0 ± 4.0
PA3=	24.5	QA3=	43.8	PB3=	15.0	QB3=	85.5 ± 4.0
				PB4=	18.0	QB4=	68.8 ± 5.0
				PB5=	24.5	QB5=	43.8 ± 5.0

KX161-3ST (PSVL-54CG)



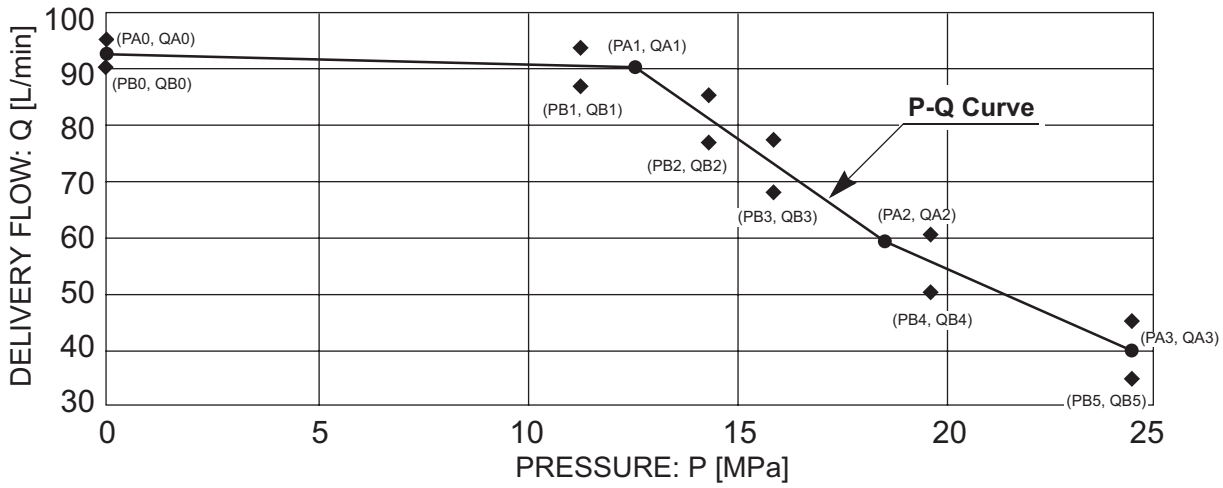
SHAFT SPEED 2300 rpm				TOTAL INPUT TORQUE 115.0 $^{0}_{-2.9}$			
PRESSURE [MPa]		DELIVERY FLOW [L/min]		PRESSURE [MPa]		DELIVERY FLOW [L/min]	
PA0=	0.0	QA0=	118.9	PB0=	0.0	QB0=	118.9 ± 2.5
PA1=	10.6	QA1=	117.0	PB1=	9.6	QB1=	117.2 ± 2.5
PA2=	16.3	QA2=	75.0	PB2=	11.6	QB2=	109.6 ± 4.0
PA3=	24.5	QA3=	45.0	PB3=	15.3	QB3=	82.4 ± 4.0
				PB4=	17.3	QB4=	71.3 ± 5.0
				PB5=	23.5	QB5=	48.7 ± 5.0

U45ST, U45-3ST (PSVL-54CG-16)



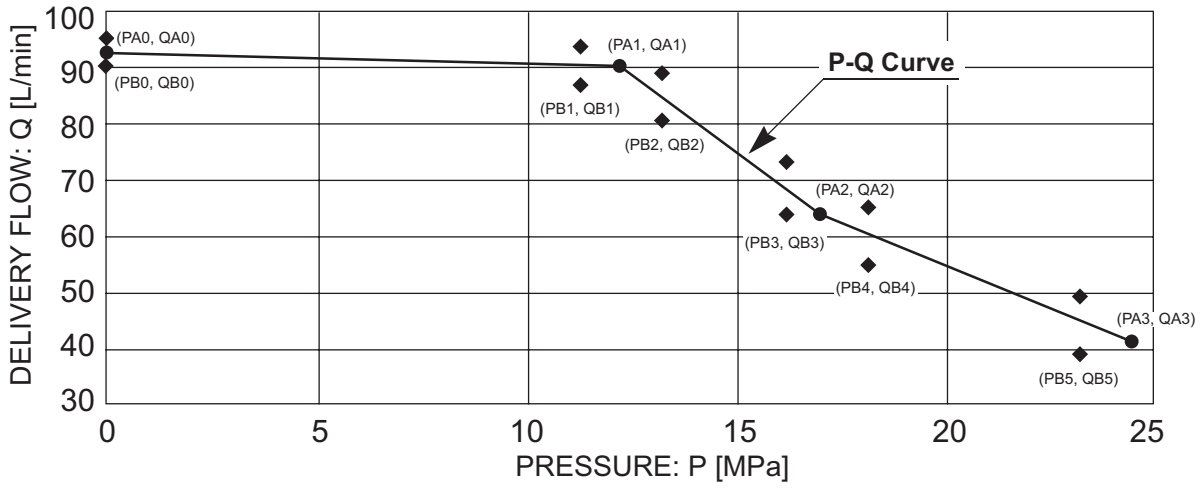
SHAFT SPEED 2200 rpm				TOTAL INPUT TORQUE 115.0 $^{0}_{-2.9}$			
PRESSURE [MPa]		DELIVERY FLOW [L/min]		PRESSURE [MPa]		DELIVERY FLOW [L/min]	
PA0=	0.0	QA0=	118.8	PB0=	0.0	QB0=	118.8 ± 2.5
PA1=	9.0	QA1=	115.8	PB1=	8.0	QB1=	116.2 ± 2.5
PA2=	15.6	QA2=	62.7	PB2=	10.0	QB2=	107.5 ± 4.0
PA3=	24.5	QA3=	32.8	PB3=	14.8	QB3=	70.7 ± 4.0
				PB4=	18.8	QB4=	59.3 ± 5.0
				PB5=	23.5	QB5=	35.8 ± 5.0

KX121-3S, KX121-3α



SHAFT SPEED 2200 rpm				TOTAL INPUT TORQUE $108.0^{0}_{-2.9}$			
PRESSURE [MPa]		DELIVERY FLOW [L/min]		PRESSURE [MPa]		DELIVERY FLOW [L/min]	
PA0=	0.0	QA0=	92.4	PB0=	0.0	QB0=	92.4 ± 1.9
PA1=	12.5	QA1=	90.4	PB1=	11.3	QB1=	90.7 ± 3.8
PA2=	18.2	QA2=	59.0	PB2=	14.2	QB2=	80.0 ± 5.3
PA3=	24.5	QA3=	40.0	PB3=	15.7	QB3=	72.0 ± 5.5
				PB4=	19.6	QB4=	55.0 ± 6.0
				PB5=	24.5	QB5=	40.0 ± 6.2

KX121-3ST (PSVL-42CG)



SHAFT SPEED 2200 rpm				TOTAL INPUT TORQUE $105.0^{0}_{-2.9}$			
PRESSURE [MPa]		DELIVERY FLOW [L/min]		PRESSURE [MPa]		DELIVERY FLOW [L/min]	
PA0=	0.0	QA0=	92.4	PB0=	0.0	QB0=	92.4 ± 2.5
PA1=	12.1	QA1=	90.4	PB1=	11.1	QB1=	90.6 ± 2.5
PA2=	16.9	QA2=	64.0	PB2=	13.1	QB2=	84.9 ± 4.0
PA3=	24.5	QA3=	41.1	PB3=	15.9	QB3=	69.5 ± 4.0
				PB4=	17.9	QB4=	61.0 ± 5.0
				PB5=	23.5	QB5=	44.1 ± 5.0

(3) New pump discharge rate specifications

Inspection conditions:

1. Below data is at bench test value
2. Return back pressure is almost zero.
   Therefore, when you test the flow rate, return hose should be directly back to oil tank.
3. Oil temp. 50 ± 5°C, 122 ± 9°F

Adjusting procedure:

Precaution

This adjustment should be taken very carefully after understanding the structure and function of LS control system and pump.
When discharge amount is less than above specification; slightly screw in the plug.
When discharge amount is more than above specification; slightly screw back the plug.

c) Load Sensing Control Flow Amount through Main Spool

(1) KX121-3S (RD138-61153)

Control Valve Section	A port		B port		Pressure Compensation Spool Underlap Area	
	LPM	GPM	LPM	GPM	mm^2	in^2
Service Port	60	15.6	60	15.6	4.5	0.007
Swing	22.5	5.85	15	3.9	2.7	0.004
Bucket	40	10.4	45	11.7	4.5	0.007
Boom	50	13	30	7.8	4.5	0.007
Arm	60	15.6	40	10.4	5.7	0.009
Dozer	18	4.68	22	5.72	2.7	0.004
Travel R	41	10.66	41	10.66	4.5	0.007
Travel L	41	10.66	41	10.66	4.5	0.007
Swivel	23	5.98	23	5.98	2.7	0.004

LPM: Liter per min. / GPM: Gallon per min.

(Bench Set Value)
1. Valve control flow: QC=50L/min at control pressure difference of 1.2 MPa
2. Max. pump delivery amount: Q max=100.8 L/min
3. One section's Max. control flow: Qc max= 60 L/min
4. Pump control pressure differential: Pc= 1.4 MPa
5. LS unload valve pressure: Pun= 2.5 ± 0.1 Mpa at 22L/min.

(2) KX121-3ST Angle-version (RD138-74017)

Control Valve Section	A port		B port		Pressure Compensation Spool Underlap Area	
	LPM	GPM	LPM	GPM	mm^2	in^2
Service Port	60	15.6	60	15.6	4.5	0.007
Angle	19.2	4.992	27.8	7.228	4.5	0.007
Swing	22.5	5.85	15	3.9	2.7	0.004
Bucket	40	10.4	45	11.7	4.5	0.007
Boom	50	13	30	7.8	4.5	0.007
Arm	60	15.6	40	10.4	5.7	0.009
Dozer	16	4.16	19	4.94	2.7	0.004
Travel R	41	10.66	41	10.66	4.5	0.007
Travel L	41	10.66	41	10.66	4.5	0.007
Swivel	23	5.98	23	5.98	2.7	0.004
Spool dia.	ϕ12 (0.472")					

(3)KX161-3S (RD538-61153)

Control Valve Section	A port		B port		Pressure Compensation Spool Underlap Area	
	LPM	GPM	LPM	GPM	mm^2	in^2
Service Port	65	16.9	65	16.9	6.2	0.010
Swing	28	7.28	18	4.68	1.8	0.003
Bucket	57	14.82	57	14.82	3.7	0.006
Boom	56	14.56	41	10.66	6.2	0.010
Arm	81	21.06	57	14.82	6.2	0.010
Dozer	29	7.54	21	5.46	1.8	0.003
Travel R	53	13.78	53	13.78	6.2	0.010
Travel L	53	13.78	53	13.78	6.2	0.010
Swivel	41.5	10.79	41.5	10.79	4.5	0.007

(4)KX161-3ST Angle-version (RD538-74018)

Control Valve Section	A port		B port		Pressure Compensation Spool Underlap Area	
	LPM	GPM	LPM	GPM	mm^2	in^2
Service Port	65	16.9	65	16.9	6.2	0.010
Angle	28	7.28	40	10.4	1.8	0.003
Swing	28	7.28	18	4.68	1.8	0.003
Bucket	57	14.82	57	14.82	3.7	0.006
Boom	56	14.56	41	10.66	6.2	0.010
Arm	81	21.06	57	14.82	6.2	0.010
Dozer	29	7.54	21	5.46	1.8	0.003
Travel R	53	13.78	53	13.78	6.2	0.010
Travel L	53	13.78	53	13.78	6.2	0.010
Swivel	41.5	10.79	41.5	10.79	4.5	0.007
Spool dia.	ϕ14 (0.551”)					

(5) U45ST Angle-version (RD438-74016)

Control Valve Section	A port		B port		Pressure Compensation Spool Underlap Area	
	LPM	GPM	LPM	GPM	mm^2	in^2
Service Port	65	16.9	65	16.9	6.2	1.0
Angle	28	7.28	40	10.4	1.8	0.3
Swing	28	7.28	18	4.68	1.8	0.3
Bucket	47	12.22	47	12.22	3.7	0.6
Boom	56	14.56	41	10.66	6.2	1.0
Arm	75	19.5	47	12.22	6.2	1.0
Dozer	29	7.54	21	5.46	1.8	0.3
Travel R	48	12.48	48	12.48	6.2	1.0
Travel L	48	12.48	48	12.48	6.2	1.0
Swivel	41.5	10.79	41.5	10.79	4.5	0.7
Spool dia.	ϕ14 (0.551")					

(About Travel Right and Left Communication Circuit Operation)
Adopting travel right and left communication (Measures against oblique-travelling)
Travel right and left ports communicate when these three conditions happen simultaneously.

- Operate right and left at the same time
- Operate right and left at the same direction
- Spool stroke at right and left both over 6.8 mm

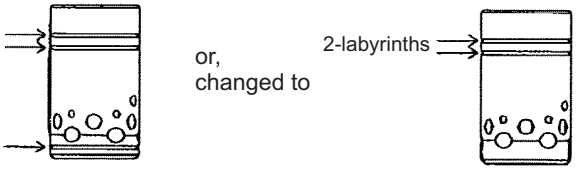
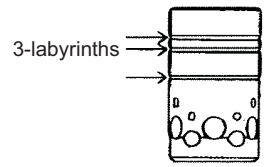
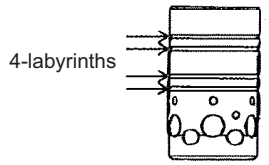
The maximum speed does not change even when the actuator in the above sections whose flow is less than the standby flow is manipulated in any manner.
The pump swash plate does not tilt up to the standby flow. The actuator feeds the required quantity to the C/V spool and the remainder is relieved through the unload valve.

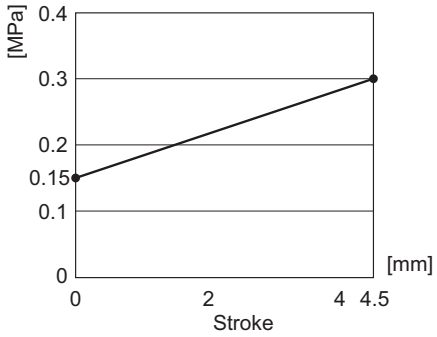
When the main relief valve is in action, the full flow is not necessarily directed to the cylinder, since the compensation spool is kept in the under lap state even if the main spool in any section other than the relieved section is moved at a full stroke. It is affected by the under lap opening area of the compensation spool.
A comparison between the following reference values gives guidelines for the assembling of a different compensation spool product.

Note: The main relief valve must be operated with the actuator in any section other than the C/V section that is to be actually measured relieved. However, the port relief pressure in the dozer-UP/swivel section is lower than the main relief pressure. Any other section must be therefore relieved.

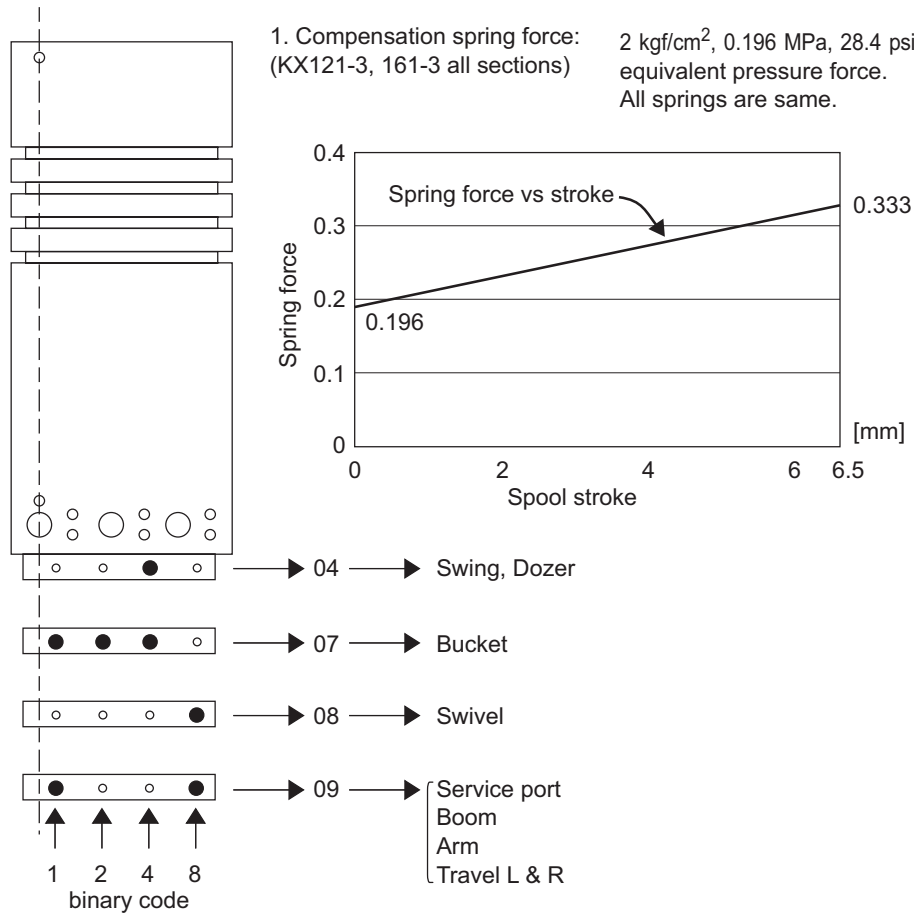
(6) Identification of compensation spool

KX121-3α/S/ST: Identified by the number of labyrinth

Valve section	Compensation spool
Swivel Swing Dozer (2.7 mm^2)	
Boom Travel L & R Bucket Service port (4.5 mm^2)	
Arm (5.7 mm^2)	



KX161-3α/S/ST: Identified by punch mark.



d) Cylinder

(1) Cylinder operating speed

Unit				KX121-3α/S/ST		KX161-3α/S/ST		Remarks
				(A)	(B)	(A)	(B)	
Boom cylinder	Up	KTC	sec.	2.4 ~ 3.0	3.6	2.4 ~ 3.0	3.6	GL to Max. height (exclude cushion time)
		EU	sec.	2.6 ~ 3.2	3.8	3.6 ~ 3.2	3.8	
Boom cylinder	Down		sec.	2.4 ~ 3.0	3.6	2.4 ~ 3.0	3.6	Max. height to GL
Boom cylinder	cushion		sec.	0.4 ~ 1.3	1.6	0.4 ~ 1.3	1.6	50°C (122°F)
Arm cylinder	Crowd		sec.	2.9 ~ 3.5	4.2	2.8 ~ 3.4	4.1	Cylinder full stroke
Arm cylinder	Dump		sec.	2.5 ~ 3.1	3.8	2.8 ~ 3.4	4.1	
Bucket cylinder	Crowd		sec.	2.4 ~ 3.0	3.6	2.6 ~ 3.2	3.8	Cylinder full stroke
Bucket cylinder	Dump		sec.	1.9 ~ 2.5	3.0	1.7 ~ 2.3	2.8	
Swing cylinder	Left		sec.	6.0 ~ 7.4	8.9	6.2 ~ 7.2	8.6	Cylinder full stroke
Swing cylinder	Right		sec.	5.8 ~ 7.2	8.6	7.2 ~ 8.2	9.8	
Dozer cylinder	Up		sec.	2.0 ~ 2.6	3.1	2.8 ~ 3.4	4.1	Cylinder full stroke
Dozer cylinder	Down		sec.	2.7 ~ 3.3	4.0	2.8 ~ 3.4	4.1	

(A) New machine reference value
(B) Allowable limit

(2) Cylinder natural fall amount

Unit		KX121-3α/S/ST		KX161-3α/S/ST		Remarks
		(A)	(B)	(A)	(B)	
Load weight	kg lbs	216 476	-	353 778	-	•exclude bucket weight
Boom cylinder	mm in.	20 0.79	100 3.94	20 0.79	100 3.94	Boom raise, Arm extend, Bucket crowd, Bucket load: heaped capacity 10 min engine stop
Arm cylinder	mm in.	20 0.79	100 3.94	20 0.79	100 3.94	
Bucket cylinder	mm in.	15 0.59	75 2.95	15 0.59	75 2.95	
Dozer cylinder	mm in.	20 0.79	100 3.94	20 0.79	100 3.94	Arm vertical

Oil temp.: 50 ± 5°C, 10 minutes

(A) New machine reference value
(B) Allowable limit

(3) Cylinder specifications

1) KE, KDG, KUK-version

		Unit	KX121-3α	KX161-3α		Remarks
Boom	Tube I.D. × Rod O.D.	mm in	85 × 50 3.35 × 1.97	95 × 55 3.74 × 2.17		
	Stroke	mm in	582 22.9	643.5 25.3		
	Max.retraction length	mm in	996 39.2	1004.5 39.5		
	Seal Kit No.					
	Piston tightening torque	N·m kgf·m ft·lbf	900 91.8 664	800 81.6 590		
	Piston screw size	mm in	M36 × 2	M36 × 2		
	Width for tightening by spanner	mm in	SW60	SW75		
Arm	Tube I.D. × Rod O.D.	mm in	75 × 45 2.95 × 1.77	85 × 50		
	Stroke	mm in	646 25.4	693 27.3		
	Max. retraction length	mm in	981.5 38.6	1059.5 41.7		
	Seal Kit No.					
	Piston tightening torque	N·m kgf·m ft·lbf	900 91.8 664	900 91.8 664		
	Piston screw size	mm in	M33 × 2	M33 × 2		
	Width for tightening by spanner	mm in	SW60	SW60		
Bucket	Tube I.D. × Rod O.D.	mm in	70 × 40 2.76 × 1.57	75 × 45		
	Stroke	mm in	525 20.7	615 24.2		
	Max. retraction length	mm in	840 33.1	915 36.0		
	Seal Kit No.					
	Piston tightening torque	N·m kgf·m ft·lbf	800 81.6 590	800 81.6 590		
	Piston screw size	mm in	M33 × 2	M36 × 1.5		
	Width for tightening by spanner	mm in	SW55	SW60		
Swing	Tube I.D. × Rod O.D.	mm in	80 × 45 3.15 × 1.77	90 × 50 3.54 × 1.97		
	Stroke	mm in	483 19.0	483 19.0		
	Max. retraction length	mm in	790 31.1	790 31.1		
	Seal Kit No.		RD118-71271	RD511-71271		
	Piston tightening torque	N·m kgf·m ft·lbf	1320 (134.6) 974	1400 (143) 1034		
	Piston screw size	mm in	M36 × 3	M39 × 3		
	Width for tightening by spanner	mm in	55 2.17	60 2.36		
Dozer	Tube I.D. × Rod O.D.	mm in	95 × 55 3.74 × 2.17	105 × 55		
	Stroke	mm in	160 6.30	165 6.50		
	Max. retraction length	mm in	525 20.7	515 20.3		
	Seal Kit No.					
	Piston tightening torque	N·m kgf·m ft·lbf	900 91.8 664	900 91.8 664		
	Piston screw size	mm in	M45 × 1.5	M45 × 1.5		
	Width for tightening by spanner	mm in	SW75	SW75		

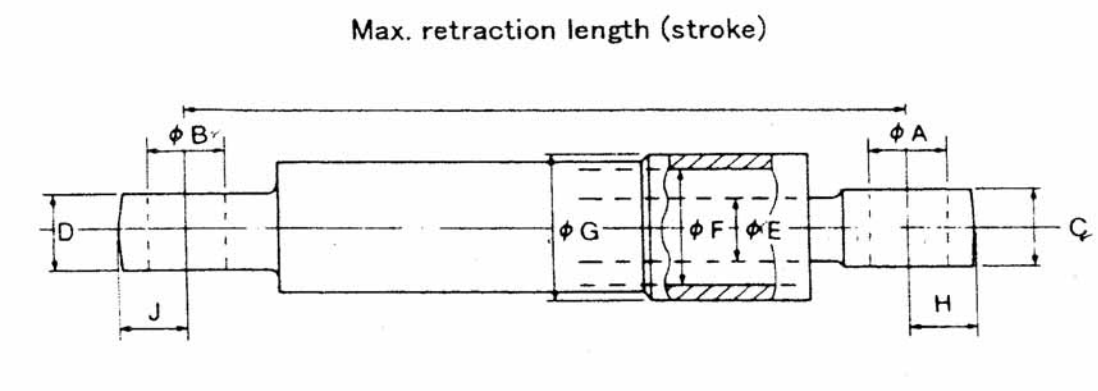
2) KTC, KCL, KTA-version

		Unit	KX121-3S/ST	KX161-3S/ST	Remarks
Boom	Tube I.D. × Rod O.D.	mm in.	85 × 50 3.15 × 1.77	95 × 55 3.74 × 2.17	
	Stroke	mm in.	646 19.9	643.5 25.3	
	Max. retraction length	mm in.	996 34.3	1004.5 39.5	
	Seal Kit No.		RD118-71401	RD511-71491	
	Piston tightening torque	N·m kgf·m ft·lbf	1620	2090 (213) 1541	
	Piston screw size	mm in.	M39 × 3	M42 × 3	
	Width for tightening by spanner	mm in.	60 2.17	65 2.56	
Arm	Tube I.D. × Rod O.D.	mm in.	75 × 45 2.95 × 1.77	85 × 50 3.35 × 1.97	
	Stroke	mm in.	644 25.4	693 27.3	
	Max. retraction length	mm in.	981 38.6	1038 40.9	
	Seal Kit No.		RD188-71641	RD511-71641	
	Piston tightening torque	N·m kgf·m ft·lbf	1080 110.2 799	1560 (159) 1150	
	Piston screw size	mm in.	M33 × 2	M39 × 3	
	Width for tightening by spanner	mm in.	55 2.17	60 2.40	
Bucket	Tube I.D. × Rod O.D.	mm in.	70 × 40 2.76 × 1.57	75 × 45 2.95 × 1.77	
	Stroke	mm in.	521 20.5	574 22.6	
	Max. retraction length	mm in.	815 32.1	870 34.3	
	Seal Kit No.		RD411-71821	RD511-71821	
	Piston tightening torque	N·m kgf·m ft·lbf	679 69.3 500.8	826 (84) 608	
	Piston screw size	mm in.	M30 × 2	M33 × 2	
	Width for tightening by spanner	mm in.	50 1.97	55 2.17	
Swing	Tube I.D. × Rod O.D.	mm in.	80 × 45	90 × 50 3.54 × 1.97	
	Stroke	mm in.	483	483 19.0	
	Max. retraction length	mm in.	790	790 31.1	
	Seal Kit No.		RD118-71271	RD511-71271	
	Piston tightening torque	N·m kgf·m ft·lbf	1320 134.6 973.6	1400 (143) 1034	
	Piston screw size	mm in.	M36 × 3	M39 × 3	
	Width for tightening by spanner	mm in.	55 2.17	60 2.36	
Dozer	Tube I.D. × Rod O.D.	mm in.	95 × 55 3.17 × 2.17	105 × 55 4.13 × 2.17	
	Stroke	mm in.	160 6.30	165 6.50	
	Max. retraction length	mm in.	525 20.7	515 20.3	
	Seal Kit No.		RD118-71871	RD511-71871	
	Piston tightening torque	N·m kgf·m ft·lbf	1740 177.5 1283	2290 (233) 1685	
	Piston screw size	mm in.	M42 × 3	M45 × 3	
	Width for tightening by spanner	mm in.	65 2.56	70 2.76	

3) Cylinder dimensional specifications

KX121-3α/S/ST

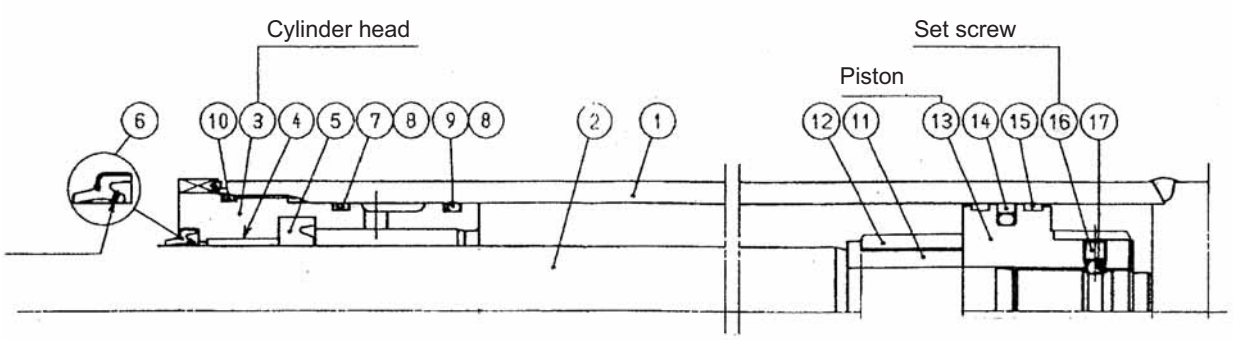
	Unit	A	B	C	D	E	F	G	H	J	Port screw size	Remarks
Boom	mm in.	50 1.97	50 1.97	70 2.76	70 2.76	50 1.97	85 3.35	103 4.06	50 1.97	50 1.97	PF1/2	
Arm	mm in.	45 1.77	45 1.77	60 2.36	60 2.36	45 1.77	75 2.95	91 3.58	42 1.65	40 1.57	PF1/2	
Bucket	mm in.	40 1.57	40 1.57	50 1.97	50 1.97	40 1.57	70 2.76	85 3.35	39 1.54	39 1.54	PF1/2	
Swing	mm in.	45 1.77	45 1.77	50 1.97	50 1.97	45 1.77	80 3.15	96 3.78	44 1.73	48 1.89	PF1/4	
Dozer	mm in.	45 1.77	45 1.77	60 2.36	60 2.36	55 2.17	95 3.74	112 4.01	40 1.57	50 1.97	PF3/8	



KX161-3α/S/ST

	Unit	A	B	C	D	E	F	G	H	J	Port screw size	Remarks
Boom	mm in.	50 1.97	50 1.97	70 2.76	70 2.76	55 2.17	95 3.74	115 4.53	55 2.17	50 1.97	G1/2	
Arm	mm in.	45 1.77	45 1.77	60 2.36	60 2.36	50 1.97	85 3.35	103 4.06	49 1.93	50 1.97	G1/2	
Bucket	mm in.	45 1.77	45 1.77	60 2.36	60 2.36	45 1.77	75 2.95	90 3.54	39 1.54	99 3.90	PF1/2	
Swing	mm in.	45 1.77	45 1.77	50 1.97	50 1.97	50 1.97	90 3.54	108 4.25	49 1.93	50 1.97	PF1/2	
Dozer	mm in.	55 2.17	55 2.17	70 2.76	70 2.76	55 2.17	105 4.13	124 4.88	55 2.17	55 2.17	G3/8	

4) Tightening torque: KE, KDG, KUK-version



1. Boom cylinder

	Tightening torque: N·m (kgf·m) ft.lbs		Thread size		Adhesive
	KX121-3α/S/ST	KX161-3α/S/ST	KX121-3α/S/ST	KX161-3α/S/ST	
Cylinder head					
Piston	900 (91.8) 664	800 (81.6) 590	M36 × 2	←	
Set screw					

2. Arm cylinder

	Tightening torque: N·m (kgf·m) ft.lbs		Thread size		Adhesive
	KX121-3α/S/ST	KX161-3α/S/ST	KX121-3α/S/ST	KX161-3α/S/ST	
Cylinder head					
Piston	900 (91.8) 664	←	M33 × 2	M36 × 2	
Set screw					

3. Bucket cylinder

	Tightening torque: N·m (kgf·m) ft.lbs		Thread size		Adhesive
	KX121-3α/S/ST	KX161-3α/S/ST	KX121-3α/S/ST	KX161-3α/S/ST	
Cylinder head					
Piston	800 (81.6) 590	←	M33 × 2	M36 × 1.5	
Set screw					

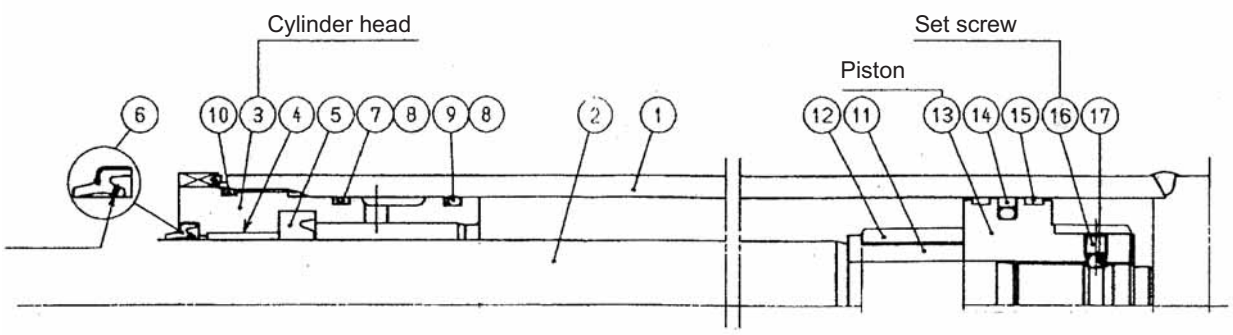
4. Dozer cylinder

	Tightening torque: N·m (kgf·m) ft.lbs		Thread size		Adhesive
	KX121-3α/S/ST	KX161-3α/S/ST	KX121-3α/S/ST	KX161-3α/S/ST	
Cylinder head					
Piston	900 (91.8) 664	←	M45 × 1.5	←	
Set screw					

5. Swing cylinder

	Tightening torque: N·m (kgf·m) ft.lbs		Thread size		Adhesive
	KX121-3α/S/ST	KX161-3α/S/ST	KX121-3α/S/ST	KX161-3α/S/ST	
Cylinder head					
Piston	1320 (134.6) 974	1400 (143) 1034	M36 × 3	M39 × 3	
Set screw					

5) Tightening torque: KTC, KCL, KTA-version



1. Boom cylinder

	Tightening torque: N·m (kgf·m) ft·lbf		Thread size		Adhesive
	KX121-3α/S/ST	KX161-3α/S/ST	KX121-3α/S/ST	KX161-3α/S/ST	
Cylinder head	490 (50.0) 362		M92 × 2		Threebond #1901
Piston	1620 (165) 1193	2090 (213) 1541	M39 × 2	M42 × 3	-
Set screw	16.2 (1.65) 11.9		M8 × 1.25 Punch at two positions on the other of the set screw.		-

2. Arm cylinder

	Tightening torque: N·m (kgf·m) ft·lbf		Thread size		Adhesive
	KX121-3α/S/ST	KX161-3α/S/ST	KX121-3α/S/ST	KX161-3α/S/ST	
Cylinder head	422 (43) 311		M82 × 2		Threebond #1901
Piston	1080 (110) 796	1560 (159) 1150	M33 × 2	M39 × 3	-
Set screw	16.2 (1.65) 11.9		M8 × 1.25 Punch at two positions on the other of the set screw.		-

3. Bucket cylinder

	Tightening torque: N·m (kgf·m) ft·lbf		Thread size		Adhesive
	KX121-3α/S/ST	KX161-3α/S/ST	KX121-3α/S/ST	KX161-3α/S/ST	
Cylinder head	655 (66.8) 483		M77 × 2		Threebond #1901
Piston	679 (69.3) 501	826 (84) 608	M30 × 2	M33 × 2	-
Set screw	16.2 (1.65) 11.9		M8 × 1.25		-

4. Dozer cylinder

	Tightening torque: N·m (kgf·m) ft·lbf		Thread size		Adhesive
	KX121-3α/S/ST	KX161-3α/S/ST	KX121-3α/S/ST	KX161-3α/S/ST	
Cylinder head	570 (58.1) 420		M102 × 2		Threebond #1901
Piston	1740 (177.5) 1284	2290 (233) 1685	M42 × 3	M45 × 3	-
Set screw	31.5 (3.2) 23.1		M10 × 1.5		-

5. Swing cylinder

	Tightening torque: N·m (kgf·m) ft·lbf		Thread size		Adhesive
	KX121-3α/S/ST	KX161-3α/S/ST	KX121-3α/S/ST	KX161-3α/S/ST	
Cylinder head	451 (46) 333		M87 × 2		Threebond #1901
Piston	1320 (134.6) 974	1400 (143) 1034	M36 × 3	M39 × 3	-
Set screw	16.2 (1.7) 12.3		M8 × 1.25		-

e) Swivel Performance

		KX121-3α/S/ST	KX161-3α/S/ST	Remarks
Manufacturer		Kubota	Kubota	
Model		SM29G	SM29GL	
Displacement	cc/rev in^3/rev	29.271 1.79	←	
Motor reduction ratio		9.90	21.263	
Swivel reduction ratio		8.60	7.09	
Max. oil flow	l/min gal/min	23.0 6.08	40.0 10.6	
Motor speed	rpm	79.4	64.3	
Capacity	cc/rev in^3/rev	289.78 17.7	622.4 38.0	
Brake valve pressure	Mpa kg/cm^2 psi	20.6 210 2987	←	
Drain amount at lock	l/min gal/min	4.0 ≧ 1.06 ≧	←	at brake pressure
Drain amount while rotating	l/min gal/min	0.5 ≧ 0.13 ≧	←	at 90kgf/cm^2, 8.82MPa, 1280 psi
Swivel speed	rpm	9.2	9.3	pinion/swivel teeth KX121-3α/S/ST = 10T/86T KX161-3α/S/ST = 11T/78T
3 times rotation swivel speed	sec	17.8 ~ 21.7	17.6 ~ 21.4	
Swivel block performance at engine stop	mm/min in/min	5 > 0.2	←	
Swivel block performance at engine running	mm/min in/min	30 1.18	←	
Capable swivel rotation angle	deg.	20, 18 <	17, 15 <	
Play at the tip of bucket	mm in.	50, 73 > 1.97, 2.87 >	←	Reference value

f) Traveling Performance

		Unit	KX121-3α KX121-3S	KX161-3α -	U45-3α U45S/U45-3S	U50-3α KX161-3S	Remarks
Manufacturer			KAYABA industry	KAYABA industry	KAYABA industry	KAYABA industry	
Model			MAG-26V-380F-1	MAG-33V-550F-3	MAG-33V-480F-1	MAG-33V-550F-1	
Kubota part No.			RD138-6129-0	RD531-6129-0	RD431-6129-0	RD538-6129-0	
Capacity	1st	cc/rev cu.in./rev	26.3 1.61	28.4 1.73	30.8 1.88	28.4 1.73	
	2nd	cc/rev cu.in./rev	14.6 0.89	16.0 0.98	17.4 1.06	15.0 0.92	
Reduction ratio			1/41.923	1/58.943	1/47.406	1/58.943	
Total displacement	1st	cc/rev cu.in./rev	1103 67.29	1674 102.16	1460 89.11	1674 102.16	
	2nd	cc/rev cu.in./rev	612 37.35	943 57.55	825 50.34	884 53.96	
Rated oil flow		L/min USGPM	41.0 10.83	49.0 12.94	46.0 12.15	56.0 14.79	
Theoretical torque	1F	N·m kgf·m ft·lbf	4302 438.7 3172.9	6261 638.4 4617.8	5469 557.7 4033.7	6261 638.4 4617.8	KX121-3S/α, U45-3S/α, U45S: at 24.5 MPa (250 kg/cm^2, 3556 psi) KX161-3S/α, U50-3α: at 23.5 MPa (240 kg/cm^2, 3414 psi)
	2F	N·m kgf·m ft·lbf	2388 243.5 1761.3	3527 359.6 2601.3	3090 315.1 2279.0	3307 337.2 2439.1	
Theoretical speed	1F	rpm	37.2	29.3	31.5	33.5	KX121-3S/α: at 41.0 L/min (10.83 USGPM) KX161-3S: at 49.0 L/min (12.94 USGPM) U45-3S/α, U45S: at 46.0 L/min (12.15 USGPM) KX161-3α, U50-3α: at 56.0 L/min (14.79 USGPM)
	2F		67.0	52.0	55.8	63.3	
Relief valve pressure		Mpa kg/cm^2 psi	24.5 250 3556	23.5 240 3414	24.5 250 3556	23.5 240 3414	
Climbing ability		deg.	30	30	30	30	
Max. traction force	1F	N kgf lbf	30.2 3081 6793.6	40.0 4083 9003.0	34.9 3562 7854.2	40.0 4083 9003.0	Slip 70% theoretical torque Oil temp.: 50 ± 5°C (122 ± 9°F)
	2F	N kgf lbf	14.3 1455 3208.3	19.3 1972 4348.3	16.9 1724 3801.4	19.3 1972 4348.3	Relief 60% theoretical torque
Traveling block performance		mm/10min in./10min	272, 300 ≧ 10.71, 11.81 ≧	261, 300 ≧ 10.28, 11.81 ≧	272, 300 ≧ 10.71, 11.81 ≧	261, 300 ≧ 10.28, 11.81 ≧	10 min engine stop Testing angle: 20 deg
Traveling speed (Rubber/Steel)	1st	km/h mph	3.0 / 2.9 1.86 / 1.80	2.5 / 2.3 1.55 / 1.43	2.3 / 2.2 1.43 / 1.37	2.3 / - 1.43 / -	
	2nd	km/h mph	5.0 / 4.7 3.11 / 2.92	4.6 / 4.2 2.86 / 2.61	4.3 / 4.0 2.67 / 2.49	4.3 / - 2.67 / -	
10m(32.8ft) traveling time (Rubber crawler)	1F	sec./10m sec./32.8ft	16.0 8.6	14.0 8.0	14.0 8.0	14.0 8.0	
	2F						
Straight travel performance	1F/2F	mm/10m in./32.8ft	600 ≧ 23.62 ≧	← ←	← ←	← ←	
Drain amount at lock	1F/2F	L/min GPM	4.00 ≧ 1.06 ≧	← ←	← ←	← ←	

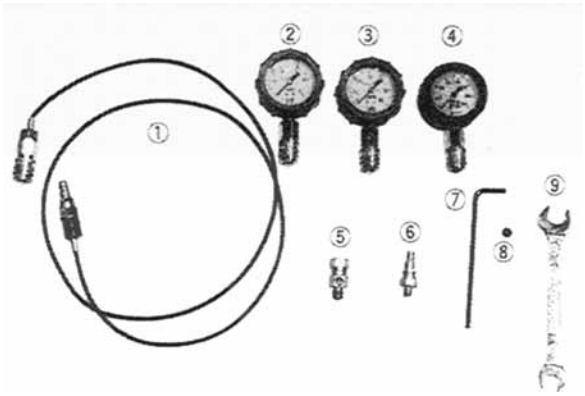
		Unit	KX121-3α	KX161-3α	U45-3α	U50-3α	Remarks
			KX121-3S	-	U45S/U45-3S	KX161-3S	
Drain amount while rotating	1F	L/min GPM	0.5 ≧ 0.13 ≧	← ←	← ←	← ←	Motor: 1000 rpm at 70 ± 5 kgf/cm^2 (6.9 MPa)
	2F	L/min GPM	0.75 ≧ 0.20 ≧	← ←	← ←	← ←	Motor: 2000 rpm at 18 ± 5 kgf/cm^2 (17.6 MPa)
Hi-speed change pressure	1st to 2nd	MPa kgf/cm^2 psi	0.9 9.0 128	0.70 7.1 101	← ← ←	← ← ←	
	2nd to 1st	MPa kgf/cm^2 psi	0.7 7.0 100	0.59 6.0 85	← ← ←	← ← ←	

g) Major Components Comparison

Component		U45-3α	U50-3α	Remarks
Arm	Length mm	1360	1650	Operating space should be different. Refer to QA specification table.
	Code No.			
Counterweight	Weight kgf	272	625	Machine size, weight and stability should be different. Refer to QA specification table.
	Code No.	RD417-48117	RD517-48211	
Travel motor	Motor type	MAG-33V-480F-1	MAG-33V-550F-1	Travel speed should be different. Refer to QA specification table and next page.
	Code No.	RD431-61291	RD538-61291	

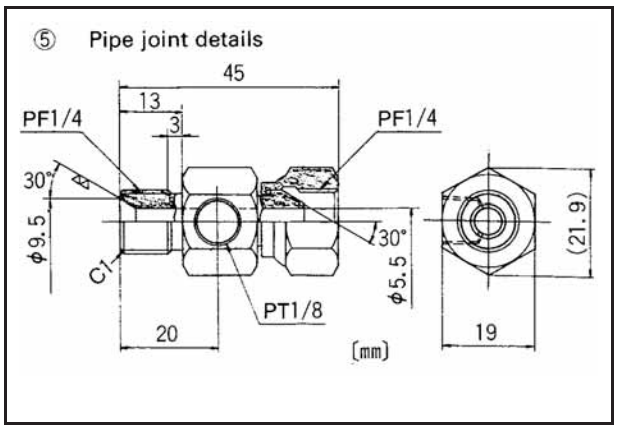
(C) TESTING

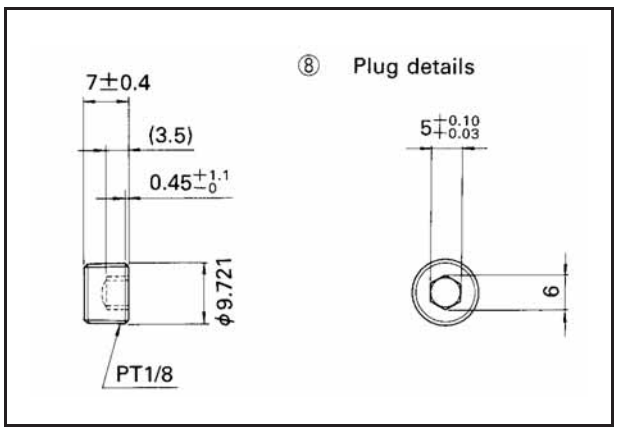
a) Testing Instruments & Special Tools

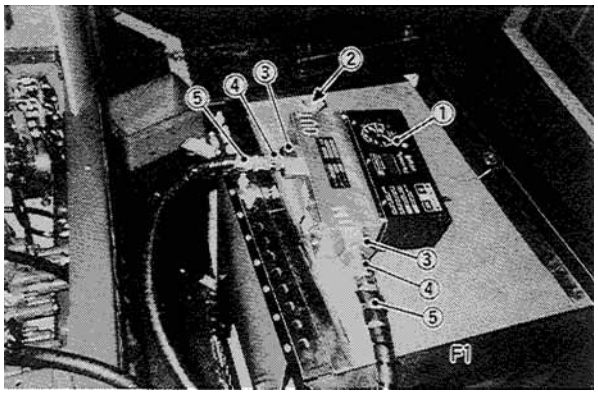


(1) Gauges and special tools for pressure testing

1. Pressure hose
2. Pressure gauge: 2.94 MPa, 30kgf/cm^2, 427 psi
   For secondary pilot pressure test.
3. Pressure gauge: 5.88 MPa, 60kgf/cm^2, 853psi
   For primary pilot pressure test.
4. Pressure gauge: 64.3 MPa, 350kgf/cm^2, 4978psi
   For main relief pressure and overload relief pressure test.
5. Pipe joint (S, F2 - F2)
   Code No. 69181-63191
6. Pressure test plug: PT 1/8
7. Allen wrench: M5
8. Plug: PT 1/8 Code No. 68311-13381
9. Wrench: Size 17 - 19 mm

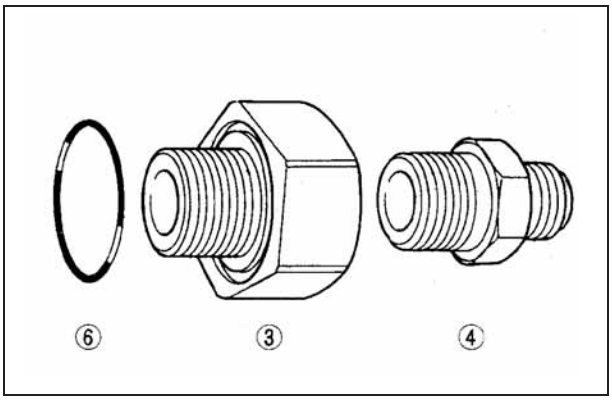


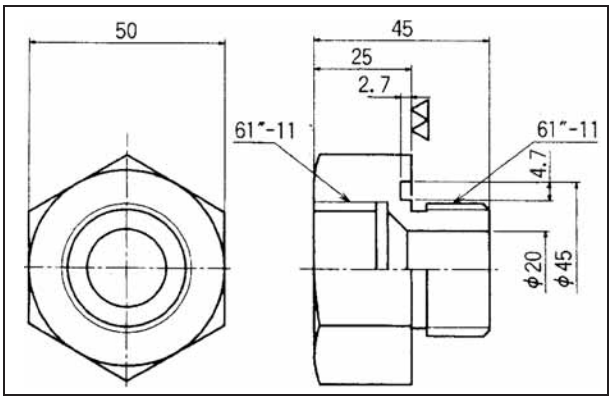




(2) Flow meter and special tools for flow testing

1. Flow meter; Flowtech Inc. make
2. Loading handle
3. Male-female joint 1” × 1”
4. joint 1” × 1/2”
5. Hose 1/2”
6. O-ring

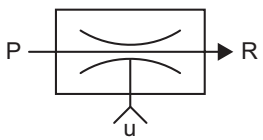




Drawing of (3) Male - female joint 1” × 1”

Vacuum pump

FESTO VAD-1/4 9334



b) Precautions in Handling the Pump

(1) Points to remember when replacing the pump or using a vacuum pump

(Without taking the following steps, unusual noise may be heard and what's worse, the pump may get damaged.)

Take the following procedure after replacing the pump before starting the engine.

1) Unclamp the air bleeder hose that comes out from the top of the pump, and pull it toward yourself. Press in the hex plug and the black lock as well. Then hold the black lock and pull put the hex plug.
2) With the hex plug out, reclamp the hose back into position.
3) Wait for 30 seconds or so in this state.
4) Insert the hex plug. (Make sure it is deep enough in place.)

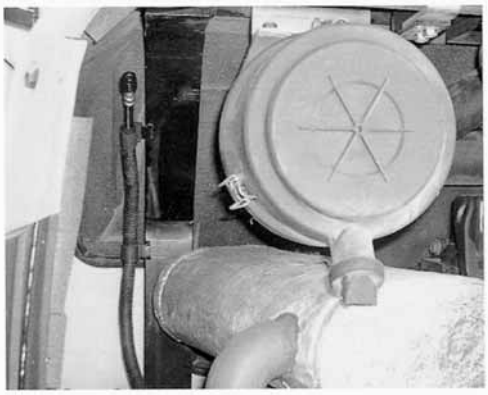
Note:

Be careful never to raise the engine rpm without the hex plug in place. Air may sucked in, getting the pump damaged.

5) Reclamp the air bleeder hose back into position.
6) Start the engine at the idling speed.
7) Try to raise the dozer at this speed. If it is not lifted, stop the engine, remove the plug again, and bleed air.
8) Still at the idling speed, move the lever to the neutral position. Wait until there is no cavitation noise heard.
9) Finally increase the engine speed by about 500 rpm step by step up to the maximum speed. Make sure no cavitation noise is heard. Return the engine speed back to the idling rpm. Move the arm and bucket until there is no cavitation noise heard. Now again increase the engine speed by about 500 rpm, and move the arm and bucket. Repeat this up to the maximum engine speed and make sure no cavitation noise is heard.

(2) Air bleeding method in case the hydraulic oil in the tank looks cloudy with air bubbled

(Without taking the following steps, unusual noise may heard and what's worse, the pump may get damaged.)



Be sure to keep the engine running at the idling speed in the following procedure.

1) Unclamp the air bleeder hose that comes out from the top of the pump, and pull it toward yourself. Press in the hex plug and the black lock as well. Then hold the black lock and pull out the hex plug.
2) With the hex plug out, reclamp the hose back into position.
3) Start the engine at the idling speed. Move the lever to the neutral position and keep running the engine for 10 seconds or so. Stop this engine and wait for 10 seconds. With the lever still at the neutral position, run the engine again for 10 seconds. Repeat this step about 20 times (until the hydraulic oil does not look cloudy any longer).

* The pump's centrifugal force is utilized for this step. The hydraulic oil is forced to flow along the inner wall of the pump, whereas air bubbles are collected toward the center of the pump. Each time the engine is stopped, collected air bubbles go out through the bleeder hose atop the pump. The engine is thus started and stopped repeatedly to allow such collection and discharging of air bubbles.

Note:

Be sure to run the engine at the idling speed. If higher than this, air is sucked into the bleeder hose.

4) Finally insert the hex plug. (Make sure it is deep enough in place.) Be careful never to raise the engine rpm without the hex plug in place. Air may sucked in, getting the pump damaged.

(3) Handling of the air bleeding hose

(1) Fitting of the plug (Easy Touch)

Fit the plug tight in position.

<Failure case>

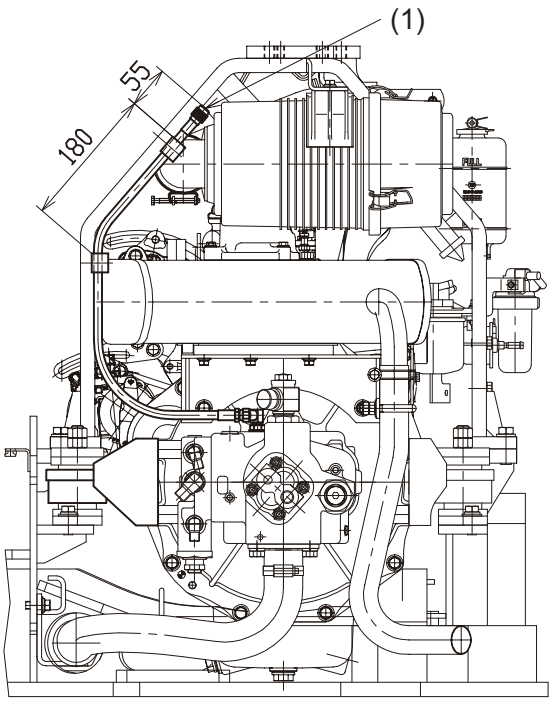
Failure to install
↓
Air sucked in (pump damaged)

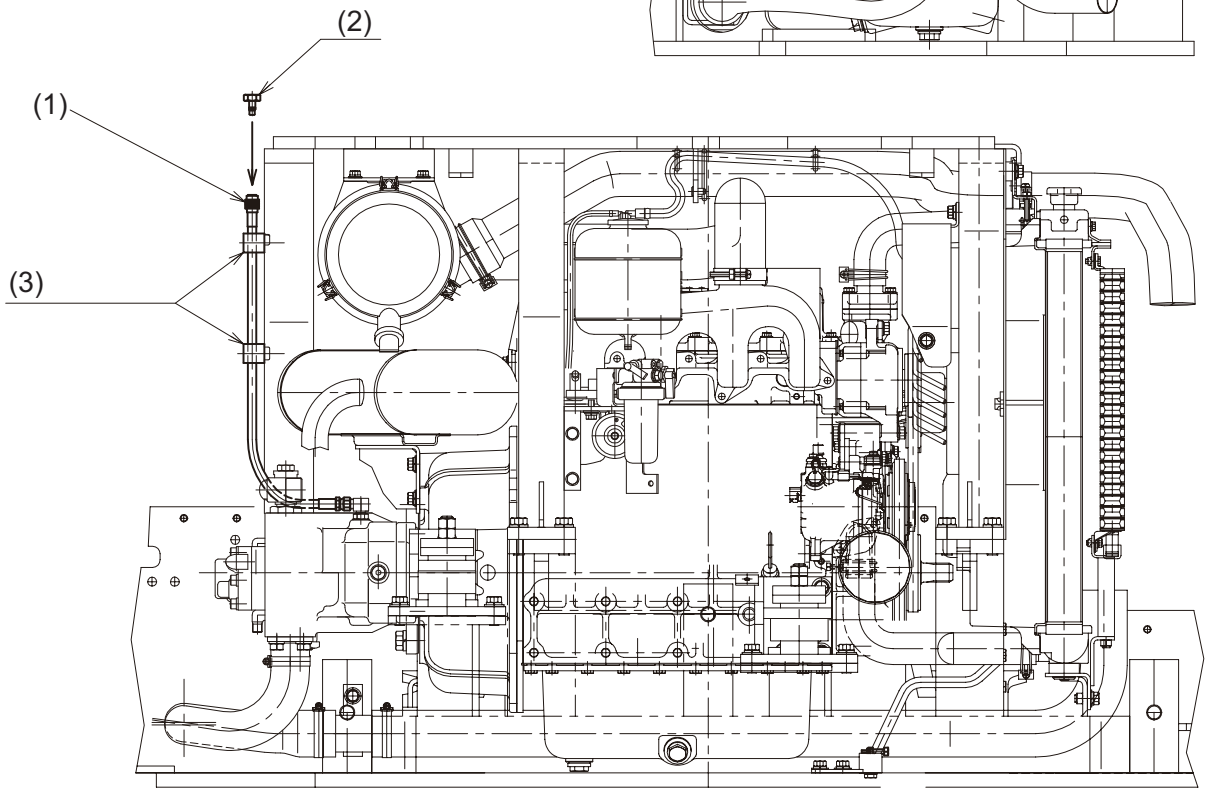
(2) Clamping of the hydraulic hose

Make sure the clamp is tightly hooked.
Tighten the clamp until it clicks. (Retry it if it does not click.)
Finally pull the hydraulic hose lightly to make sure it does not come off.

<Failure case>

Insufficient tightness
↓
Coupler disconnected
↓
Damage due to contact with the muffler





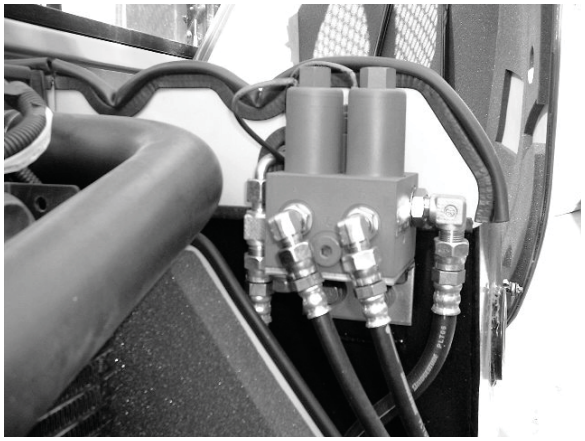
(1) Hydraulic hose
(2) Plug (Easy Touch)
(3) Inserting the clamps

Before pouring hydraulic oil, remove the plug (Easy Touch). Be sure to tighten up the plug (Easy Touch) after pouring the oil and before getting the engine started. Finally pull the hydraulic hose lightly to make sure it does not come off.

c) Pilot Pressure

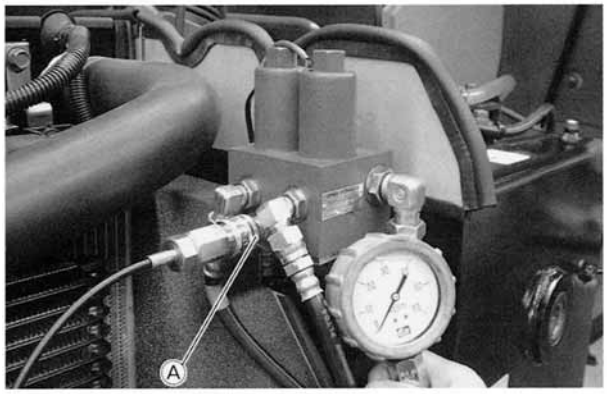
(1) Primary pressure

- Measurement method: KTC, KCL, KTA-version

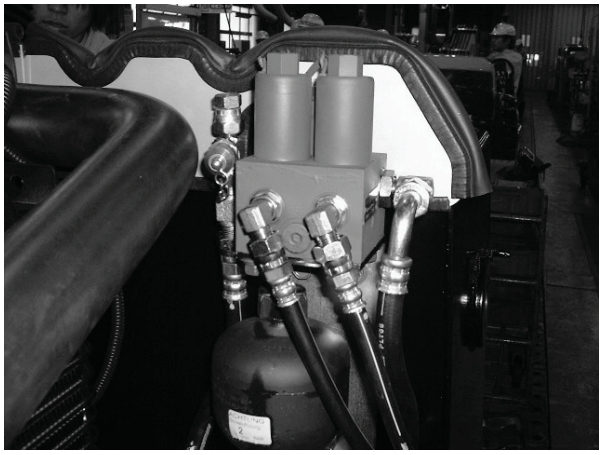


1. Remove the side cover of the tank.
2. Set a pressure gauge to the measuring port.
3. Start the engine and run it at the maximum speed. Take 2 or 3 measurements to have an exact reading.
4. Hydraulic oil temperature must be 50 ± 5°C, 122 ± 9°F.

Reference Value	3.9 ± 0.5 MPa 40 ± 5 kgf/cm^2 569 ± 70 psi



- EU-version

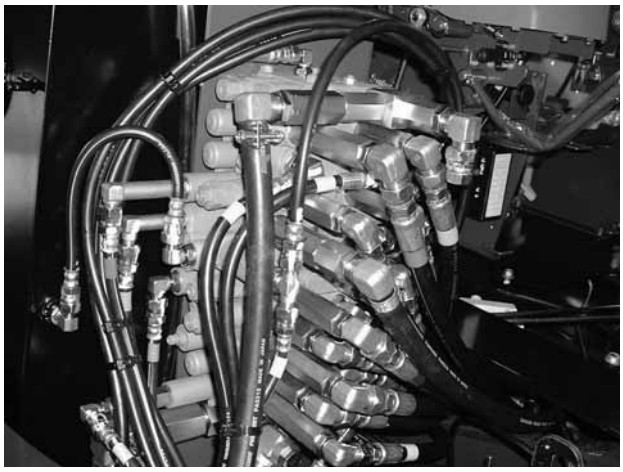


CAUTION

EU-version: Relieve the pilot line pressure before removing the pressure port.
Otherwise, oil will splash out by accumulated pressure.

(2) Secondary pressure

- Measurement method
  KX121-3α/S/ST



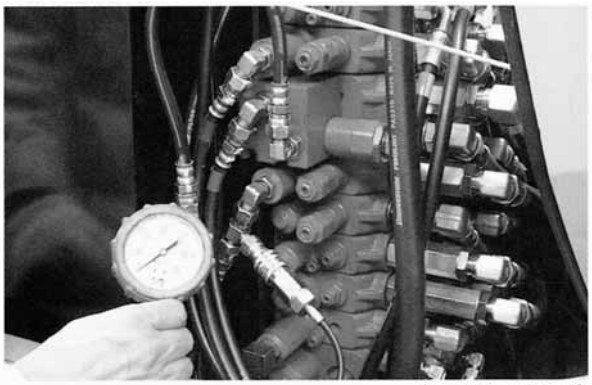
[Ex: Measurement with the arm crowd]

1. Remove the side cover of the tank.
2. Connect a T joint to the arrow-marked point and set the pressure gauge there.
3. Start the engine and run it at the maximum speed. Take 2 or 3 measurements to have an exact reading.
4. Hydraulic oil temperature must be 50 ± 5°C, 122 ± 9°F.

Reference value

Initial set pressure	$0.83\,^{0}_{-0.15}$ MPa $(8.5\,^{0}_{-0.15}$ kgf/cm^2) $121\,^{0}_{-21}$ psi
At full stroke	$2.65\,^{+0.3}_{0}$ MPa $(27.0\,^{+3}_{0}$ kgf/cm^2) $384\,^{+43}_{0}$ psi

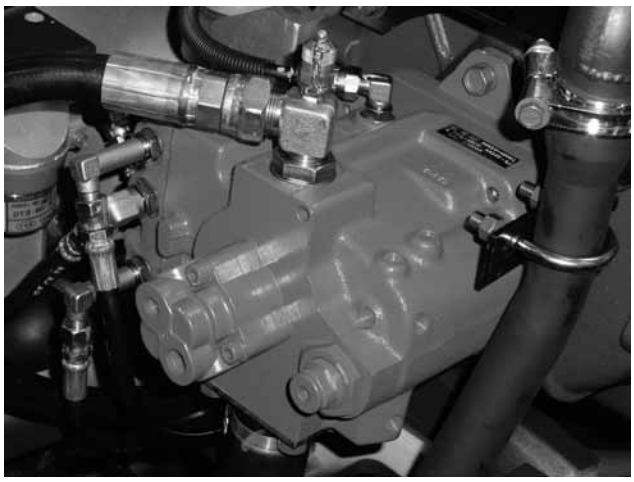
KX161-3α/S/ST



(U-40-3, U-50-3)

d) Main Relief Valve

- Measurement method



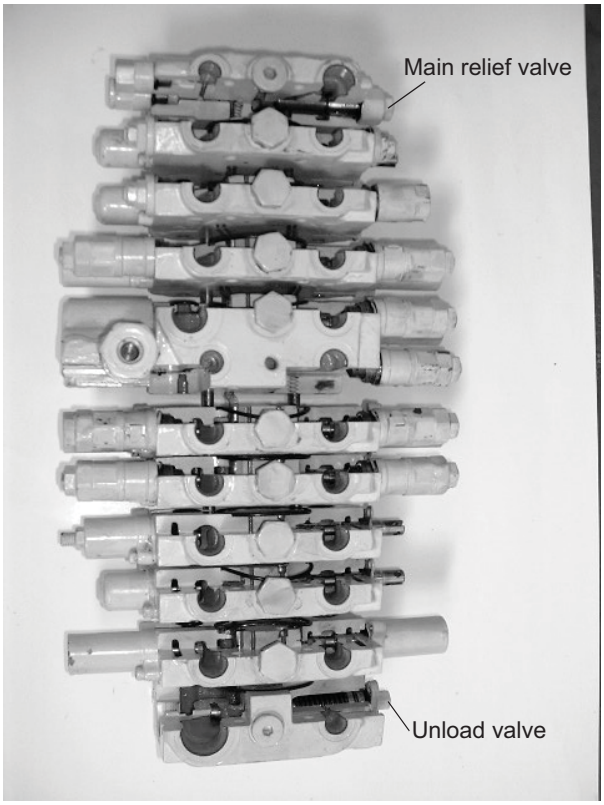
KE, KDG, KUK-version

KTC, KCL, KTA-version

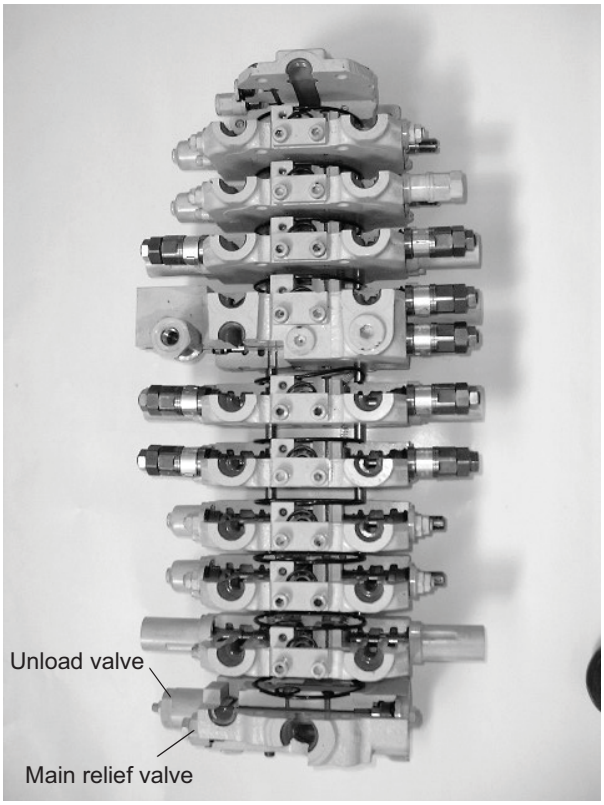
1. Set the pressure gauge to the coupler at the main pump discharge side. Or remove the plug off the main pump discharge side and set the pressure gauge there.
2. Start the engine and run it at the maximum speed. Get the following main relief valves activated.
3. Take 2 or 3 measurements to have their respective exact readings.
4. Hydraulic oil temperature must be 50 ± 5°C, 122 ± 9°F.

• Location of the Main relief valve

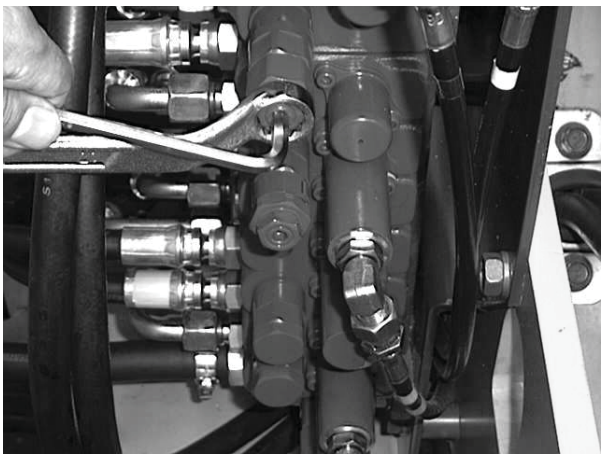
(KX121-3α/S/ST cut-model)



(KX161-3α/S/ST cut-model)



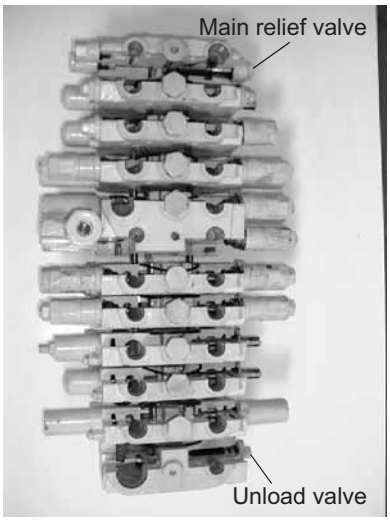
• Adjustment of the relief valve



1. Loosen the lock nut of the relief valve. Using a hex wrench, turn the adjusting screw to reach the specified setting. Then tighten up the lock nut. Clockwise turn raises the pressure, and counterclockwise turn lowers it.
2. Run the engine at the maximum speed. Move the levers and make sure the pressure setting.

e) Unload Valve

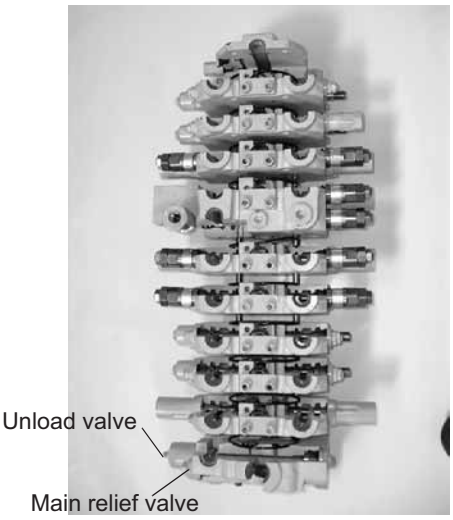
- Measurement method



1. Set the pressure gauge to the coupler at the main pump discharge side. Or remove the plug off the main pump discharge side and set the pressure gauge there.
   Pressure gauge range: 0 ~ 60 kgf/cm^2
   6.0 MPa
   3514 psi
2. Start the engine and run it at the maximum speed.
3. Measure the unload valve pressure. At this measurement, all control levers should be at neutral position.

CAUTION

Never shift the control lever, or you'll damage your sensitive pressure gauge.

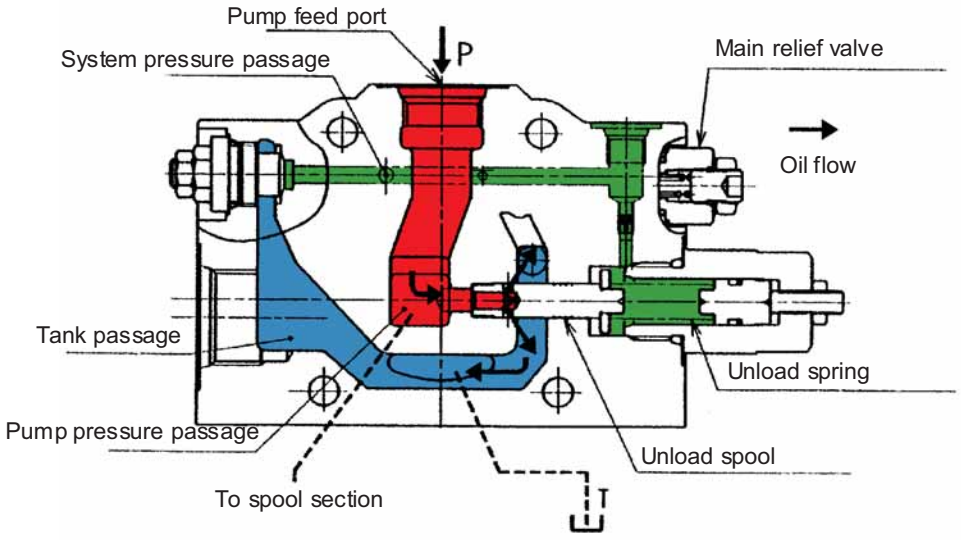


4. Take 2 or 3 measurements to have their respection exact readings.
5. Hydraulic oil and temperature are as follows.
   Oil: ISO VG46
   Temp: 50 ± 5°C, 122 ± 9°F

Reference value:

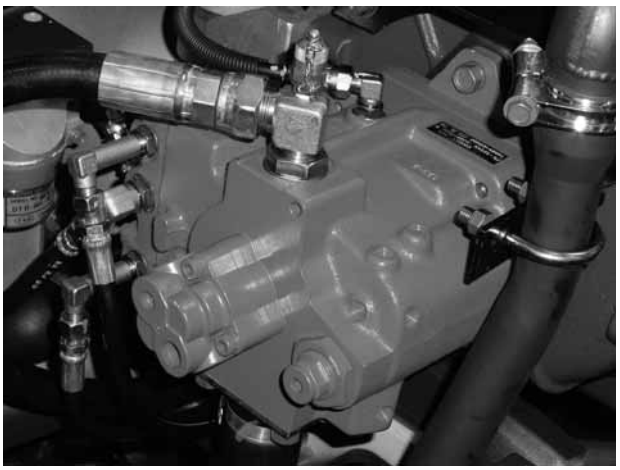
	Before 2006 Aug.	After 2006 Aug.
Bench set value	2.14 MPa (22.0 kgf/cm^2) 312 psi	2.84 MPa (25.0 kgf/cm^2) 355 psi
Machine set value	2.45 ± 0.3 MPa (25 ± 3 kgf/cm^2) 355 ± 42 psi	2.94 ± 0.5 MPa (30 ± 5 kgf/cm^2) 425 ± 71 psi

- Adjustment
  If the measured pressure is lower than specification, screw in the set screw.
  And vice-versa.

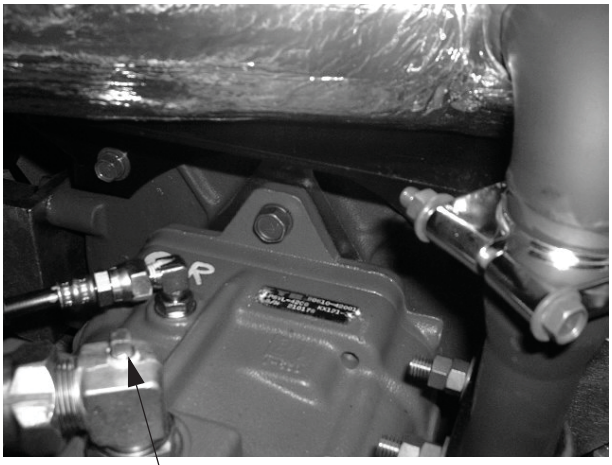


f) Overload Relief Valve

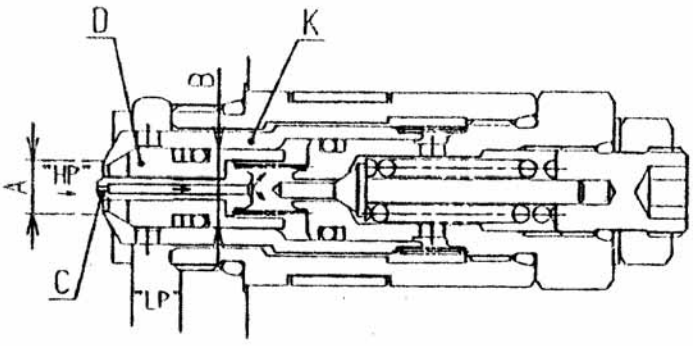
• Measurement method



KE, KDG, KUK-version



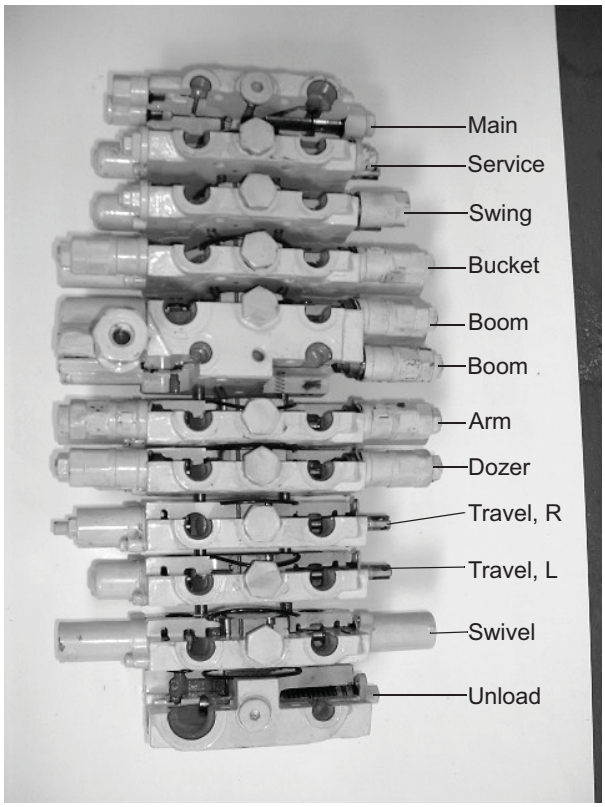
KTC, KCL, KTA-version



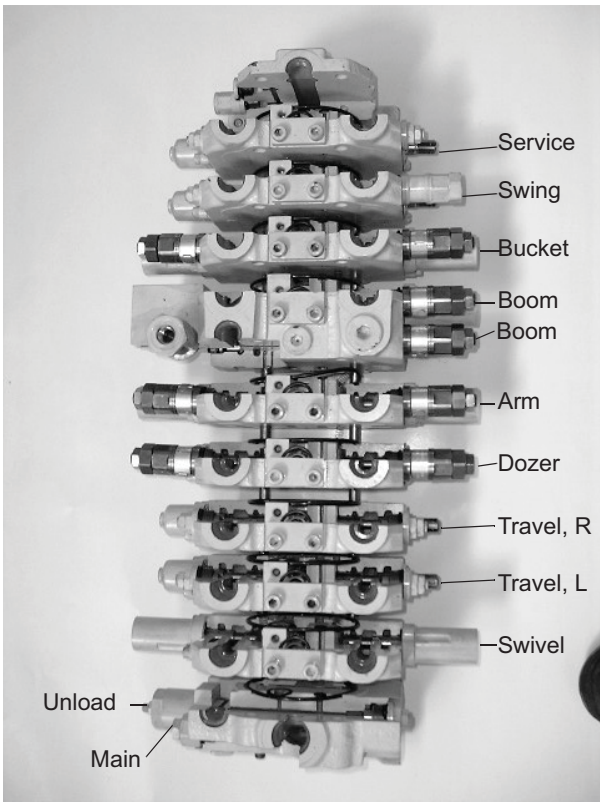
1. Set the pressure gauge to the coupler at the main pump discharge side. Or remove the plug off the main pump discharge side and set the pressure gauge there.
2. Raise the pressure setting of the main relief valve about 0.98 MPa (10 kgf/cm^2, 142 psi) over that of the overload relief valve.
3. Run the engine at 1500 rpm. Move the levers to get the overload relief valve activated. Measure the pressure setting.
4. Take 2 or 3 measurements to have the exact reading.

• Location of the overload relief valve

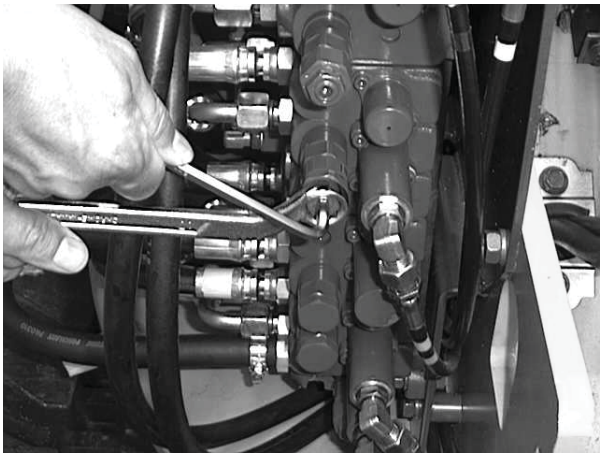
KX121-3α/S/ST



KX161-3α/S/ST



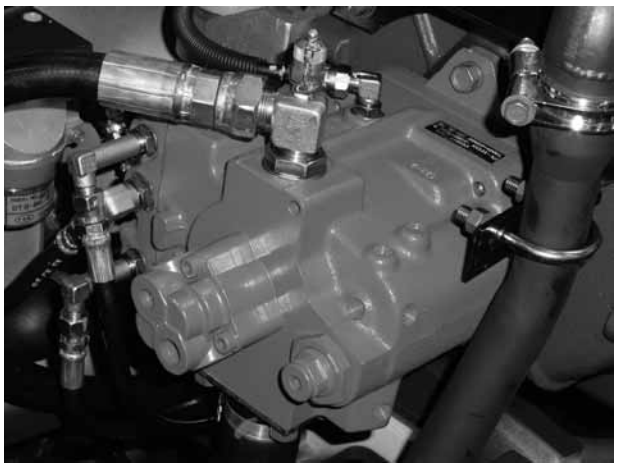
• Adjustment of the overload relief valve



1. Loosen the lock nut of the overload relief valve. Using a hex wrench, turn the adjusting screw to reach the specified setting. Then tighten up the lock nut.
2. Run the engine at the maximum speed. Move the levers and make sure the pressure setting.

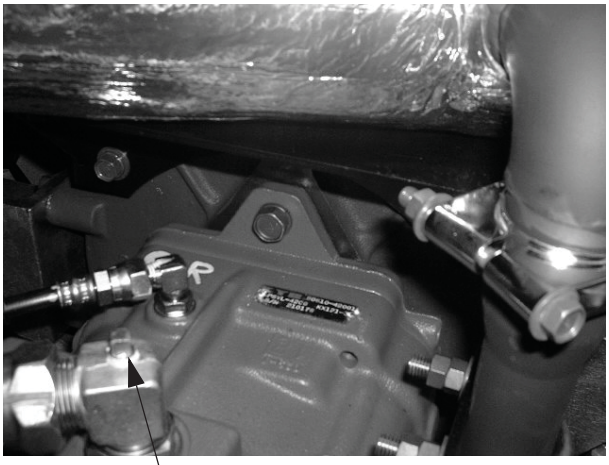
g) Swivel Brake Valve Pressure

• Measurement method

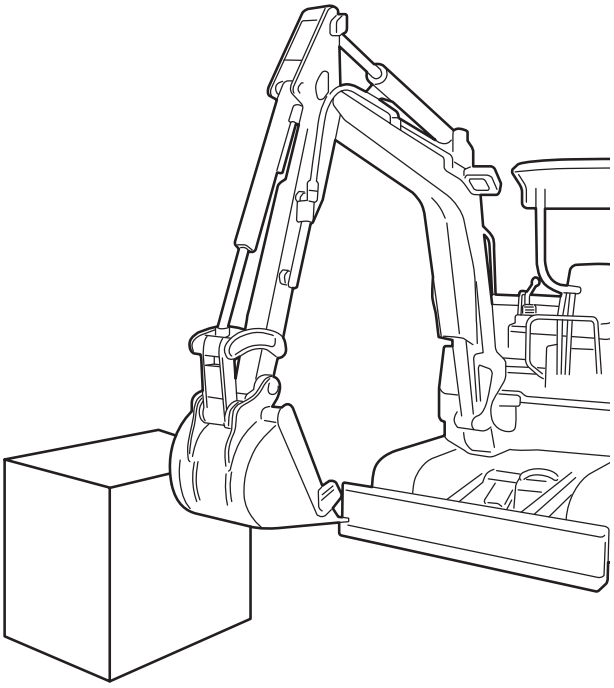


KE, KDG, KUK-version

1. Set the pressure gauge to the coupler at the main pump discharge side. Or remove the plug off the main pump discharge side and set the pressure gauge there.
2. Bring the bucket in contact with a solid block. Slowly move the bucket toward the block. With the engine at 1500 rpm, measure the relief pressure.
3. Hydraulic oil temperature must be 50 ± 5°C, 122 ± 9°F.



KTC, KCL, KTA-version

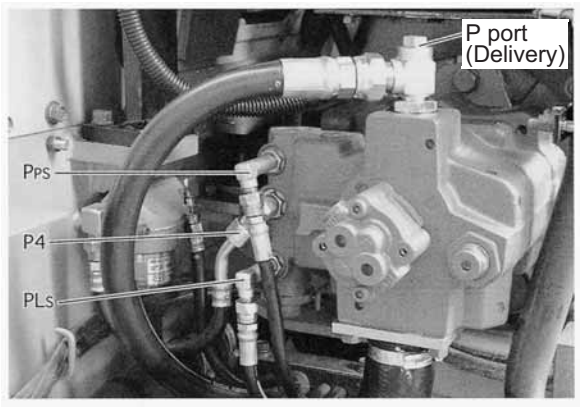


• Adjustment of the brake

Relief valve

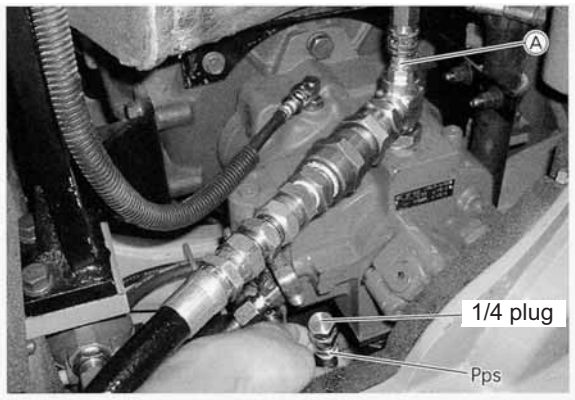
1. Loosen the lock nut of the relief valve.
2. Using a hex wrench, turn the adjusting screw to reach the specified setting. Then tighten up the lock nut.
3. Run the engine at 1500 rpm. Move the levers and feel the pressure setting.
4. Hydraulic oil temperature must be 50 ± 5°C, 122 ± 9°F.

h) Measuring the Main Pump Max. Flow Rate



[Procedure]
1. Park the machine on a flat, solid ground.
2. Connect a vacuum pump.
3. Disconnect the hose from port P (delivery).
4. Connect joint A and measuring hose (1/2) to pipe joint T of the pump (port P). Connect the other end of the hose to the IN socket of a flowmeter.
5. Connect joint B and measuring hose (1/2) to the hose at port P (delivery). Connect the other end of the hose to the OUT socket the flowmeter.
6. **Disconnect hose Pps and attach plug (1/4) to this hose's end. Keep joint Pps (at the pump) intact. (Place an oil pan to receive out-coming oil.)**

* **This is because the pump's swash plate is fixed at its maximum tilt angle.**



7. Detach plug (1/4) at port P and hook up a pressure gauge (at point A).

* This is because the flowmeter's readings fluctuate depending on the size of a measuring hose.

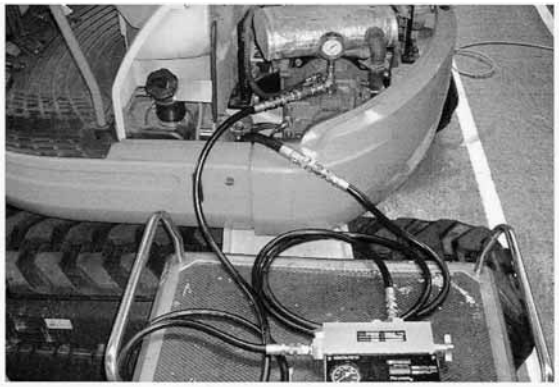
8. Disconnect the vacuum pump.
9. Air-bleed the pump according to the air bleeding procedure.
10. Fully open the flowmeter's loading valve and start the engine. Finally make sure there is no oil leak at the pressure gauge connection.

(Ref.)

Joint A
(3/4 Nut, 1/2 male)

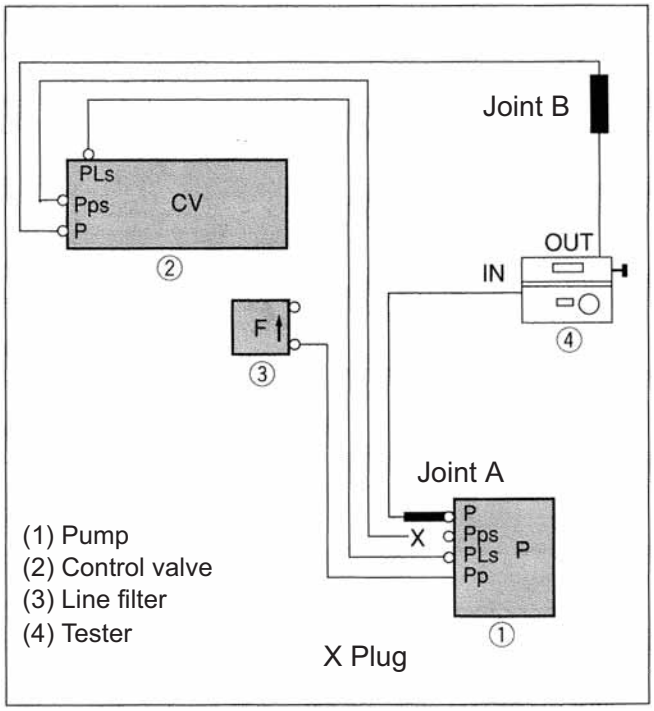
Joint B
(3/4 male, 2/1 male)

Plug (1/4)



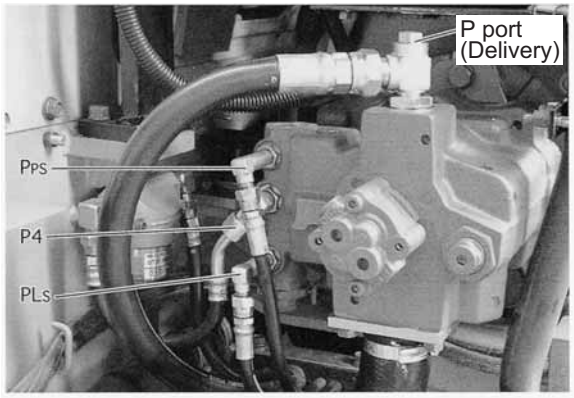
[Measurement]
1. Raise the engine speed to the maximum rpm.
2. Gradually close the flowmeter's loading valve and measure the flowrate and engine rpm at each pressure point in the P-Q curve.
3. Take the measurements 3 times.
   Determine the averages and take them as the final ones.

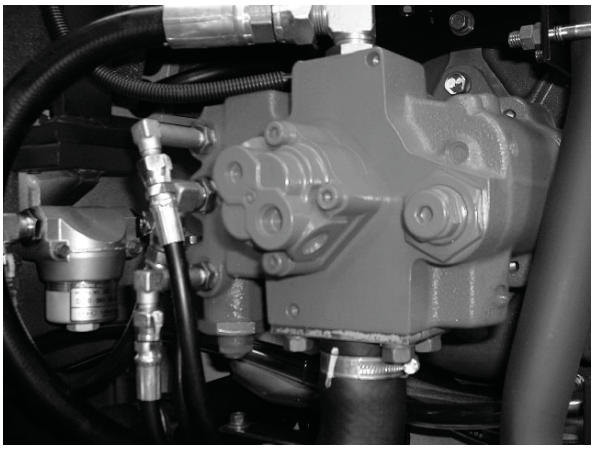
* Keep the oil temperature at 50 ± 5°C (122 ± 9°F) for the measurements.



Note: New hose connection layout is also recommendable. That is, just swap the P_{PS} line and P_{LS} line at the LS control valve. In this way also, the pump's swash plate is fixed at its max. tilt angle.

i) Measuring the Main Pump's Stand-by Flow Rate





Preparations are almost same as in pump's Max. flow rate.

1 ~ 5. Same as in pump's Max. flowrate.

6. Not required because:
   The pump's stand-by flow is the flow rate that the pump delivers minimum flow at its minimum swash plate tilt angle.
   What you should do: connect the flow meter, start the engine, keep all control levers at neutral, obtain the stand-by flow rate.

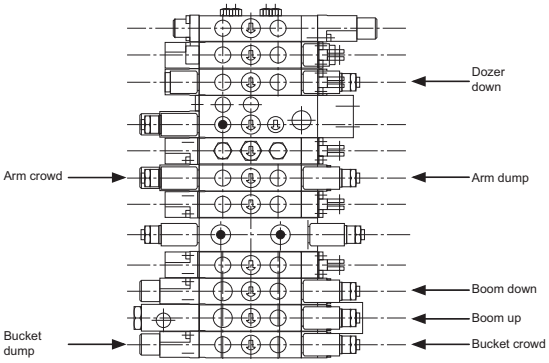
7 ~ 10. Same as in pump's Max. flowrate.

L/min (G/min)

Pump discharge amount		KX121-3S/ST	KX161-3S/ST
Pump stand - by flow rate	at unload pressure	20.0 ~ 22.5 (5.28 ~ 5.94)	24.8 ~ 29.3 (6.55 ~ 7.73)
Pump flow at Max relief pressure	at Max. relief pressure	16.8 ± 1.7 (4.44 ± 0.45)	20.9 ± 2.1 (5.51 ± 0.55)
Actual measurement of pump flow	at unload pressure		
	at Max. relief pressure		

j) LS Control Pressure

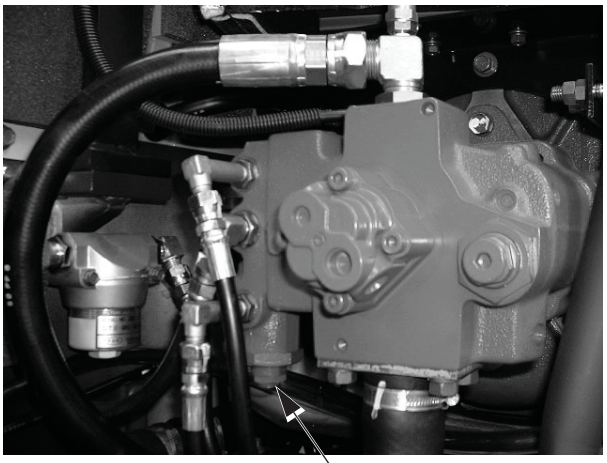
The actual measurement of LS control differential pressure requires special equipment such as a differential pressure instrument. General maintenance shops do not have such a expertise measuring device. This section introduces a simple method that makes use of the swivel motion of an actual machine.



1. Place the machine on hard ground.
2. Warm up the machine to the oil temp. of 50 ± 5°C (122 ± 9°F).
3. Raise up the engine speed at Max. rpm.
4. Measure the time for three turns constant swivel function

[seconds/three turns]

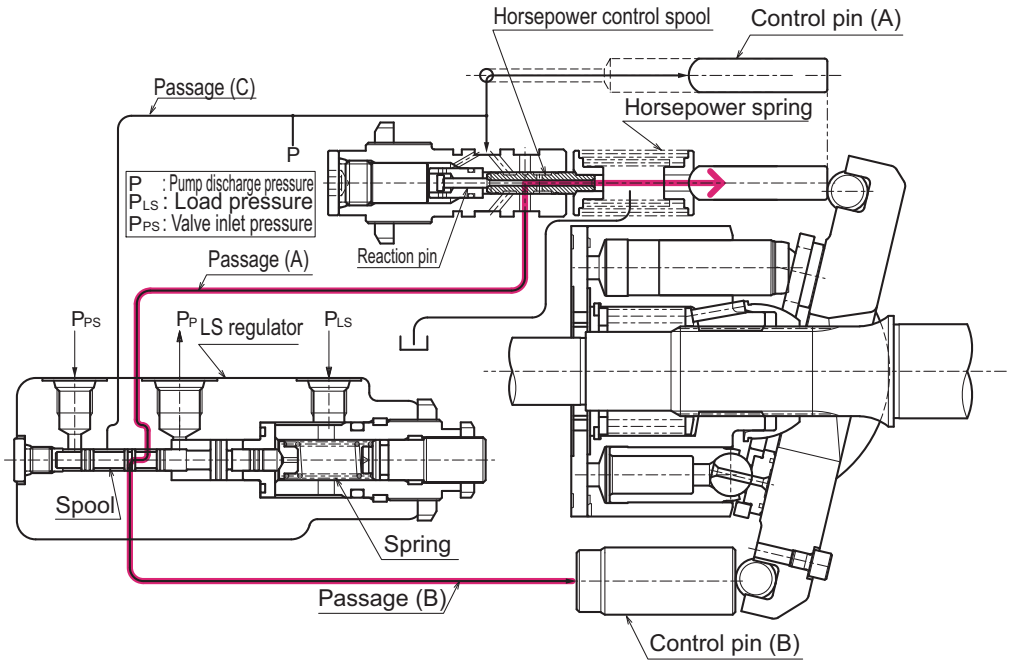
Swivel function	KX121-3α/S/ST	KX161-3α/S/ST	U45S/ST
Reference value	17.8 ~ 21.7	17.6 ~ 21.4	18.0 ~ 22.0
Actual measurement			



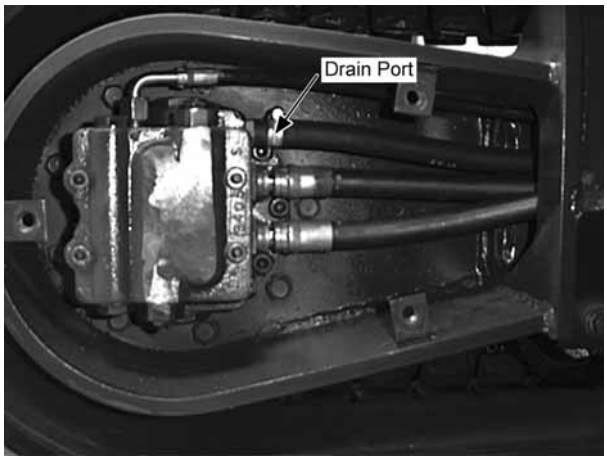
Machine condition:
Boom raised, arm & bucket crowd
Dozer-down on ground.

5. Adjustment
   1) If actual measurement speed is slower than specification, loosen the lock nut and screw in the set screw.
   2) If actual measurement speed is faster than specification, loosen the lock nut and screw back the set screw.

   Note: Before loosening the nut, put alignment mark on body, lock nut and set screw.

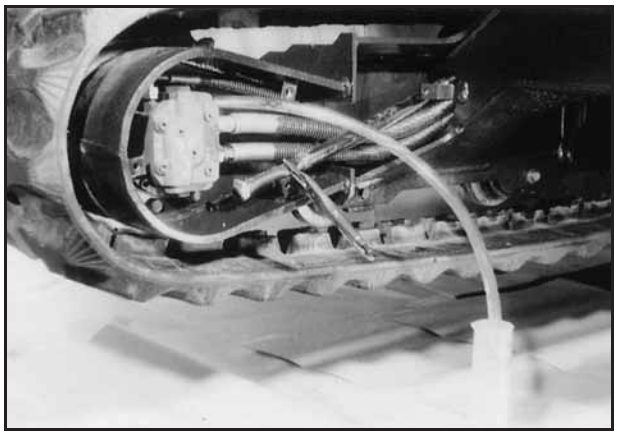


k) Traveling Motor Drain Amount

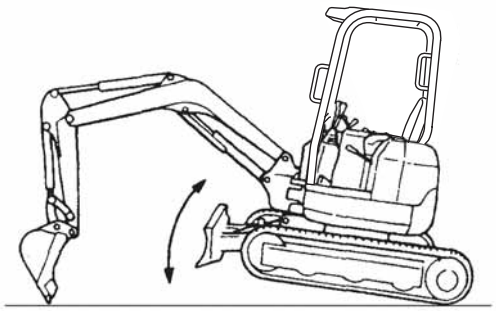


1. Disconnect the drain hose from the travel motor and connect another hose (the pressure gauge hose will do) where the drain hose was disconnected.
2. Float the crawlers as shown as below.
3. Run the engine one minute at max. rpm with the lever in the forward position and measure the amount of hydraulic oil in the pan.
4. If the measurement exceeds the specification, determine the cause and replace the assembly.
5. Hydraulic oil temperature must be 50 ± 5°C, 122 ± 9°F.

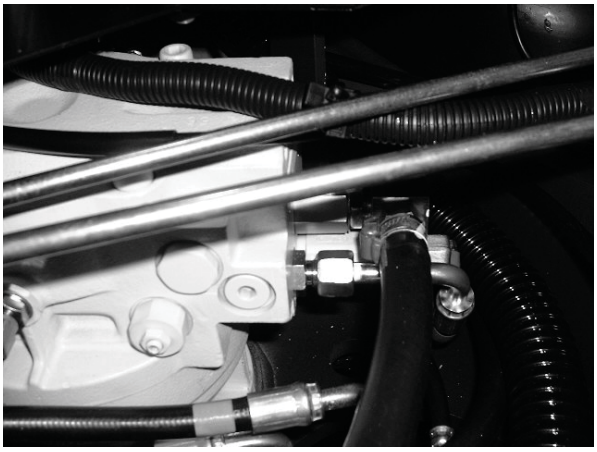
Reference Value	1F	0.5 L/min (0.13 US gal/min)
	2F	0.75 L/min (0.20 US gal/min)
	Lock condition	4.0 L/min (1.06 US gal/min)



⚠ Never place your body under the crawler.



I) Swivel Motor Drain Amount

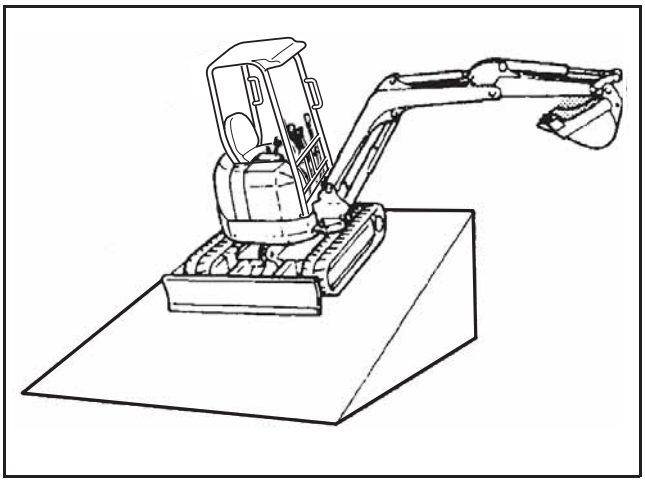


1. Remove right side cover.
2. Locate front attachment to traveling position. Bucket should be located 1 m above from ground.
3. Remove drain hose of the swivel motor and receive drain oil in a suitable reservoir.
4. Swivel the machine one minute at max. engine rpm and measure amount of hydraulic oil in the reservoir.

⚠ Make sure nobody is around swivel radius area.

Reference Value KX121-3α/S/ST, KX161-3α/S/ST	at lock	4.0 L/min 1.06 G/min
	rotating	0.5 L/min 0.13 G/min

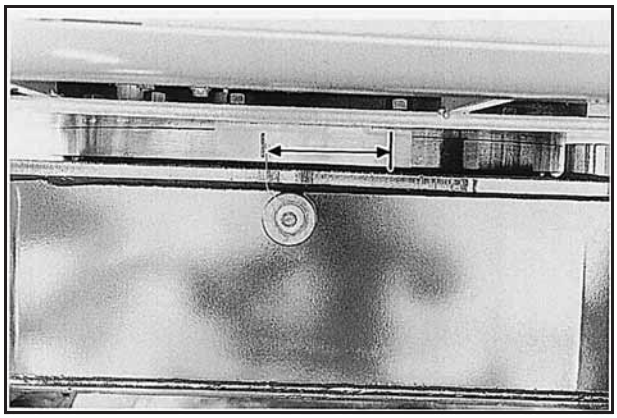
m)Swivel Motor Block Performance



1. Locate the machine on the 20 deg. slope.
2. The front position is of arm dump and bucket crowd. Keep the boom so that the boom end pin is aligned with the bucket pin.
3. Mark the outer ring of swivel bearing and truck frame.
4. Unlock the safety lock lever, and measure the one minute shifting distance between them with engine idling rpm.
5. Load on the bucket should be as follows.
   KX121-3α/S/ST: 216 kg (476 lbs)-exclude bucket weight
   KX161-3α/S/ST: 353kg (778 lbs)-exclude bucket weight

Reference Value	Brake applied	5 degrees/min.
	Brake released	30 degrees/min.

6. Hydraulic oil temperature must be 50 ± 5°C, 122 ± 9°F.

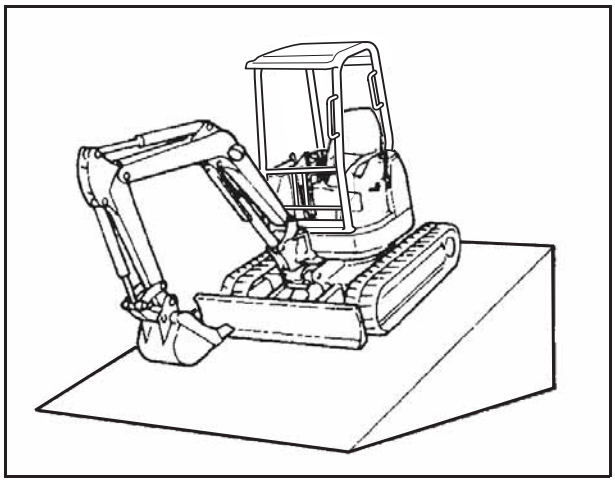


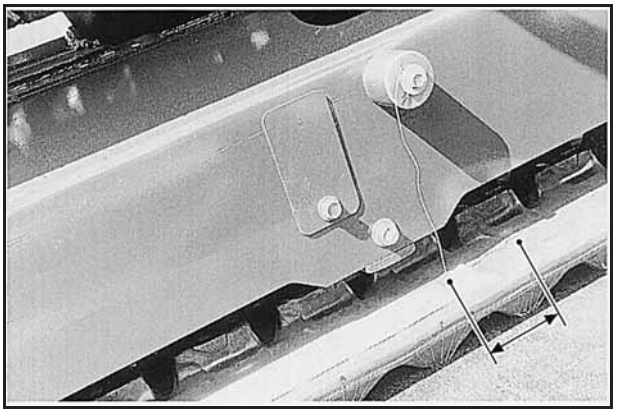
(FYI: For Your Information)

mm (inch)

Model	Circumference length		
	360°	5°	30°
KX121-3α KX121-3S KX121-3ST	2014 (79)	28 (1.1)	168 (6.6)
KX161-3α KX161-3S KX161-3ST	2180 (86)	30 (1.2)	182 (7.2)
U45S U45-3α U50-3α U45-3S U45ST	2180 (86)	30 (1.2)	182 (7.2)

n) Traveling Motor Block Performance





1. Park the machine on a 20deg. slope. Keep front at traveling position.
2. Put marks on the truck frame and the crawler.
3. Measure 10 minutes slip-distance without engine running.
4. Hydraulic oil temperature must be 50 ± 5°C, 122 ± 9°F.

Reference Value	≦300 mm/10 min ≦0.98 ft/10 min

o) Operating Speed

(1) Checking each operating speed.

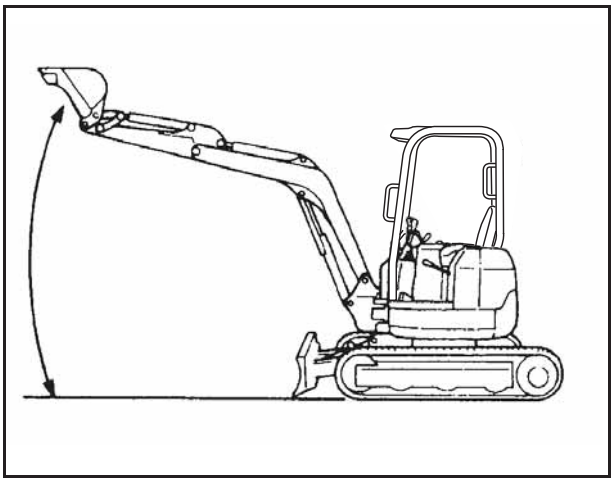
[Important points]

1. Measure full stroke operating time with no load on the standard bucket.
2. Make several measurement and use average time for judgement.
3. Two different measurements are expected for the forward and backward movements as well as the right and left swivelling.
   Obtain their respective measurements. Do not calculate for their average.
4. Before operation, make sure nobody is around the machine.

[Measurement conditions]

1. Engine rpm is max.
2. Hydraulic temperature is 50 ± 5°C, 122 ± 9°F.
3. Ground is flat.
4. Measure time after several pre-operation.

(2) Boom cylinder



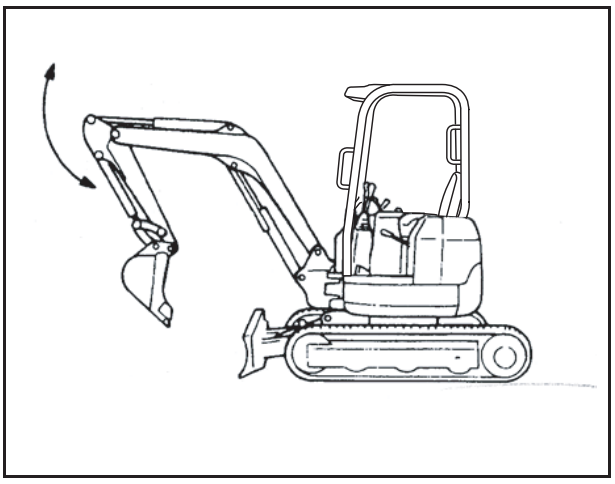
1. Arm and bucket cylinder should be most shortened position.
2. Measure the time from the bucket is on the ground to the boom highest position, and from the boom highest position to the ground.

Note: The cushioning time is not included.

[sec]

			EU-version	PP-version
Reference Value	KX121-3α/S/ST	Up	2.6 ~ 3.2	2.4 ~ 3.0
		Down	2.8 ~ 3.4	2.4 ~ 3.0
	KX161-3α/S/ST	Up	3.6 ~ 3.2	←
		Down	2.4 ~ 3.0	

(3) Arm cylinder

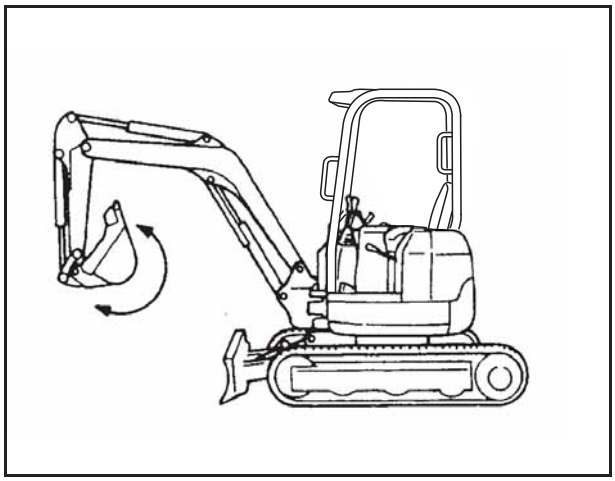


1. Position the boom and arm as shown at left.
2. Measure the arm cylinder full stroke operating time.

[sec]

			KE, KDG, KUK-version	KTC, KCL, KTA-version
Reference Value	KX121-3α/S/ST	Crowd	2.9 ~ 3.5	←
		Dump	2.5 ~ 3.1	←
	KX161-3α/S/ST	Crowd	2.8 ~ 3.4	←
		Dump	2.2 ~ 2.8	2.8 ~ 3.4

(4) Bucket cylinder

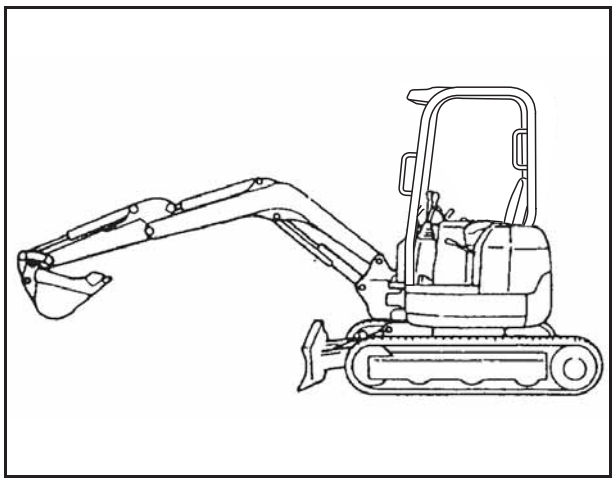


1. Position the boom and arm as shown at left.
2. Measure the bucket cylinder full stroke operating time.

[sec]

			KE, KDG, KUK-version	KTC, KCL, KTA-version
Reference Value	KX121-3α/S/ST	Crowd	2.4 ~ 3.0	←
		Dump	1.9 ~ 2.5	←
	KX161-3α/S/ST	Crowd	2.9 ~ 3.5	2.6 ~ 3.2
		Dump	1.7 ~ 2.3	1.7 ~ 2.3

(5) Swing cylinder

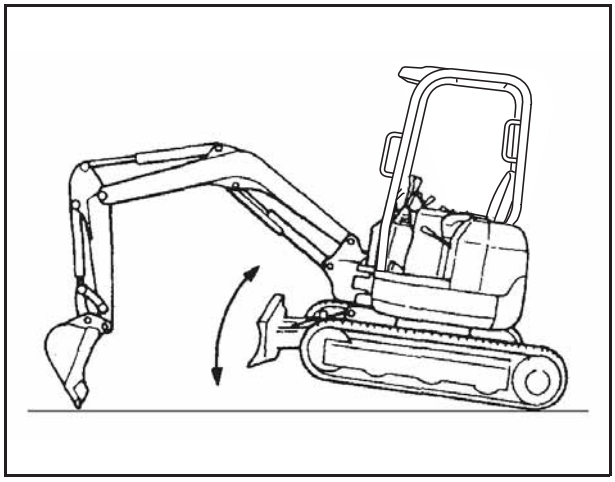


1. Position the boom, arm and bucket as shown at left. (with the bottom of the bucket about 1 m (33 ft) above from the ground.)
2. Measure the swing cylinder full stroke operating time. (right to left and left to right)

[sec]

			KE, KDG, KUK-version	KTC, KCL, KTA-version
Reference Value	KX121-3α/S/ST	Left	4.7 ~ 5.7	6.0 ~ 7.4
		Right	5.5 ~ 6.5	5.8 ~ 7.2
	KX161-3α/S/ST	Left	6.2 ~ 7.2	6.2 ~ 7.2
		Right	7.2 ~ 8.2	7.2 ~ 8.2

(6) Dozer cylinder

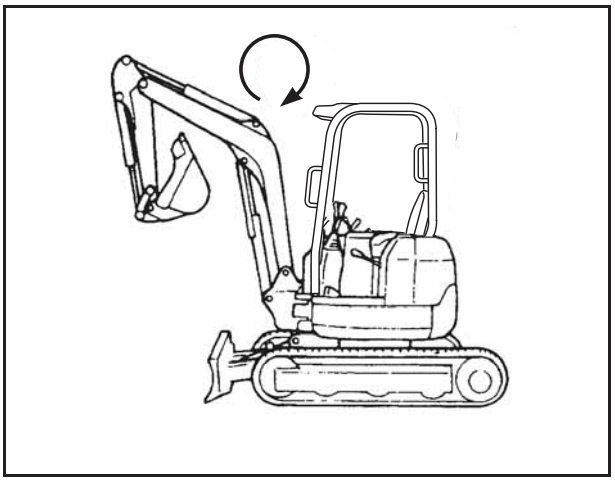


1. Place the bucket on the ground. Position the machine as shown at left for the dozer to make a full stroke.
2. Measure the dozer cylinder full stroke operating time.

[sec]

			KE, KDG, KUK-version	KTC, KCL, KTA-version
Reference Value	KX121-3α/S/ST	Up	2.3 ~ 2.9	2.0 ~ 2.6
		Down	2.9 ~ 3.5	2.7 ~ 3.3
	KX161-3α/S/ST	Up	2.8 ~ 3.4	2.8 ~ 3.4
		Down	2.7 ~ 3.3	2.8 ~ 3.4

(7) Swivel speed

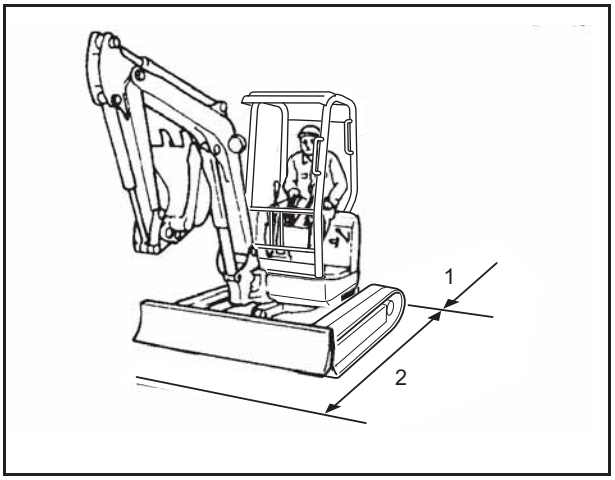


1. Position the boom, arm and bucket as shown at left.
2. Measure three times rotation time.

[sec/three turns]

		KE, KDG, KUK-version	KTC, KCL, KTA-version
Reference Value	KX121-3α/S/ST	17.8 ~ 21.7	17.8 ~ 21.7
	KX161-3α/S/ST	17.6 ~ 21.4	17.6 ~ 21.4

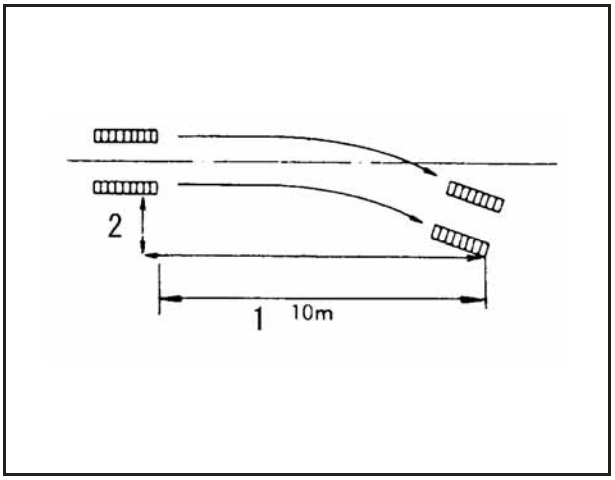
(8) Traveling speed



1. Travel the machine until getting max. speed.
2. After getting max. speed, measure the 10 mm (33 ft) traveling time.

			KE, KDG, KUK-version	KTC, KCL, KTA-version
Reference Value (Rubber)	KX121-3α/S/ST	1F	10.9 ~ 13.3	←
		2F	6.5 ~ 8.0	←
	KX161-3α/S/ST	1F	12.8 ~ 15.7	12.8 ~ 15.6
		2F	7.5 ~ 9.0	7.0 ~ 8.8
Reference Value (Iron)	KX121-3α/S/ST	1F	12.4 ~ 13.8	11.2 ~ 13.9
		2F	6.9 ~ 8.6	6.9 ~ 8.6
	KX161-3α/S/ST	1F	15.0 ~ 18.0	14.5 ~ 17.2
		2F	8.4 ~ 10.3	7.8 ~ 9.4

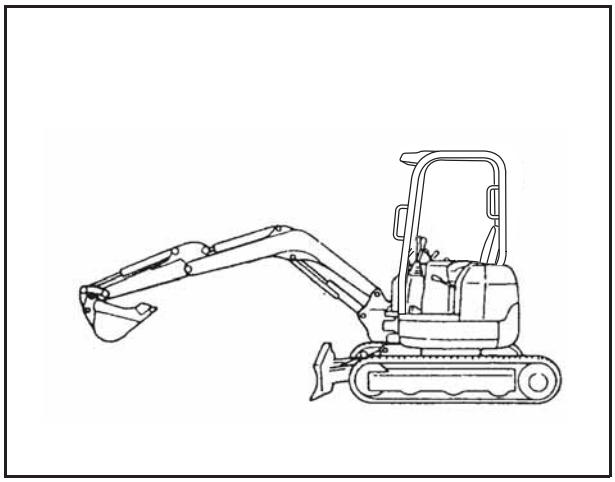
p) Straight Travel Performance



1. Travel the machine until getting max. speed.
2. Measure the vertical distance from the traveling line.

Reference Value	Under 600 mm/10 m 1.97 ft/32.8 ft

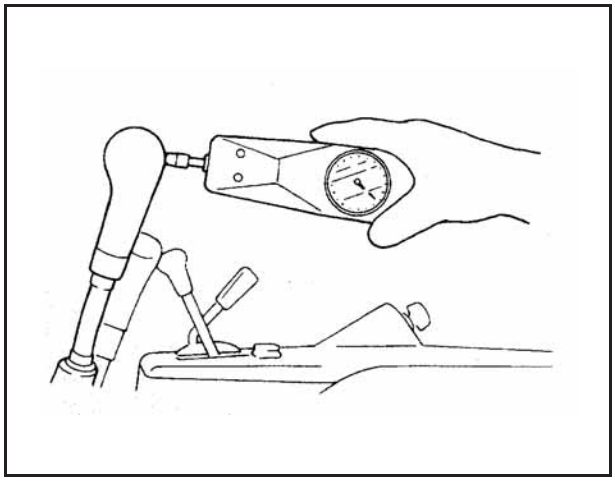
q) Cylinder Natural Fall Amount



1. Locate the machine on the flat ground, and put the load the bucket.
   Load on the bucket should be as follows.
   KX121-3α/S/ST:214 kgf (472 lbs)-exclude bucket weight
   KX161-3α/S/S/ST:299 kgf (659 lbs)-exclude bucket weight
2. Arm cylinder must be fully retracted. Bucket cylinder must be fully extended.
3. Locate the bottom of bracket about 1 m above from the ground. Stop the engine.
4. Mark on the rod of each cylinder.
5. Measure the fall distance after 10 min.

Reference Value	See Specifications

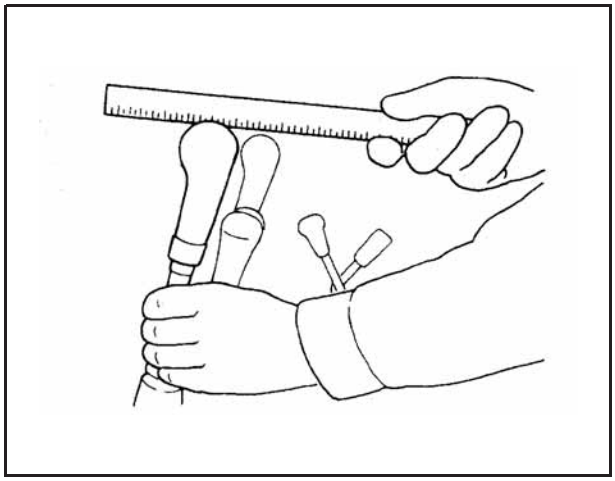
r) Control and Traveling Lever Operating Force



1. Stop the engine.
2. Measure force of right and left control and traveling levers.
3. Start the engine, operate the control lever or traveling lever for a full stroke, and measure the max. operating force.
4. Make three measurements and take their average.
5. Hydraulic oil temperature must be 50 ± 5°C, 122 ± 9°F.

Reference Value	See Specifications

s) Lever Stroke

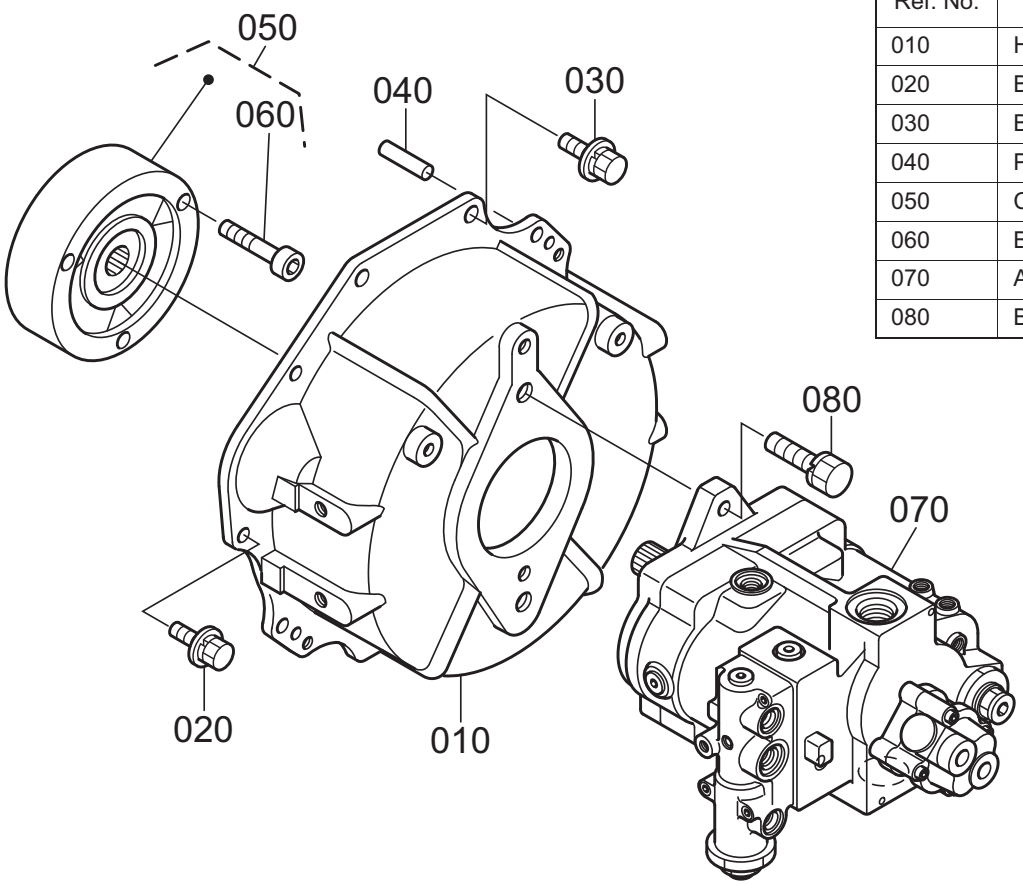


1. Stop the engine.
2. Move each lever from neutral to full stroke end, and measure each stroke with respect to the top center of the each lever grip.
3. If any lever is loose at its neutral position, measure the stroke from each loose end.
4. Make three measurements and take their average.

Reference Value	See Specifications

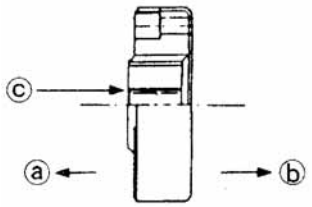
(D) DISASSEMBLING AND ASSEMBLING

a) Coupling Flange



Ref. No.	Part Name
010	Housing, Pump
020	Bolt
030	Bolt
040	Pin, Straight
050	Coupling
060	Bolt, Hex-Soc-HD
070	Assy pump, Piston
080	Bolt

1. Apply a proper amount of grease on the splines.
   • Otherwise the splines may get burnt, making it difficult to remove the pump.
2. Keep the rubber free from grease. Immediately wipe it clean if stained with grease.
   • Otherwise the rubber may get deteriorated by the grease.
3. Fitting the coupling.
   See the figure here.
   (a) Toward the pump.
   (b) Toward the flywheel.
   (c) Splines (apply grease)

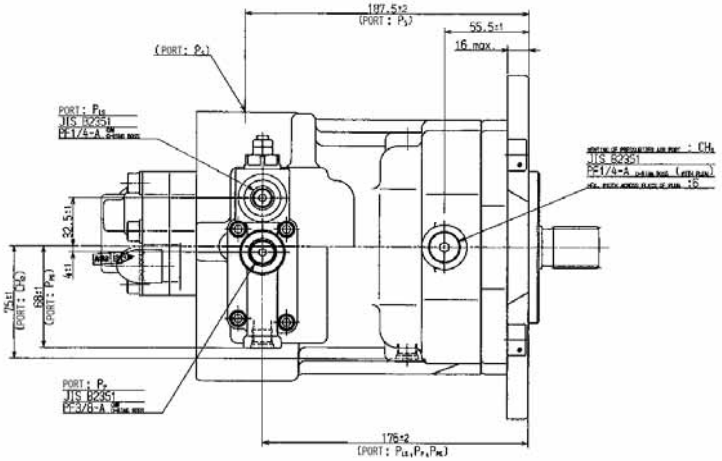


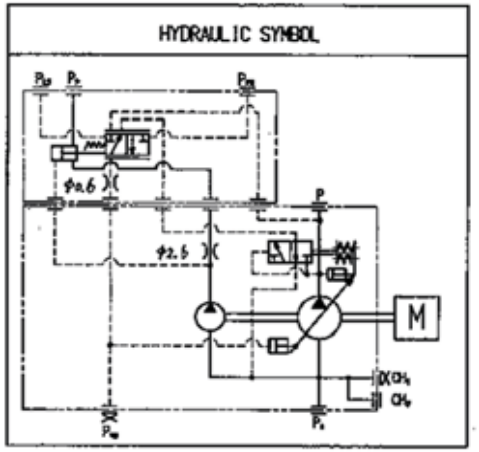
4. Tightening torque of the coupling mounting bolt: 107 ~ 117N·m, 11.0 ~ 12.0 kgf·m, 78.9 ~ 86.3 ft·lbf
   • Do not apply any adhesive.
   • Be sure to use a torque wrench to tighten up the bolts. Do not employ an impact wrench, because otherwise the coupling may be damaged.

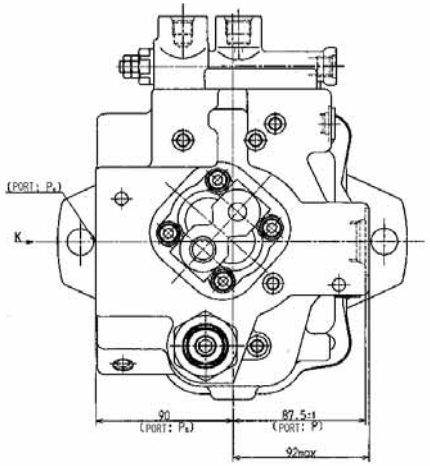
b) Piston Pump

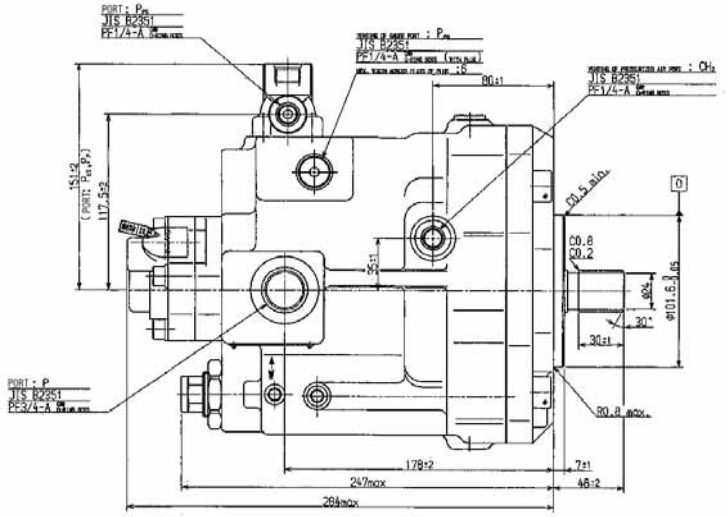
1) SPECIFICATION

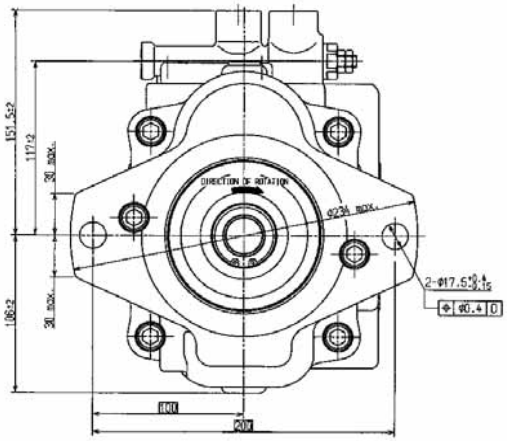
Piston pump	Max. displacement	cm^3/rev	54.0
	Max. pressure	MPa	24.5
Pilot pump (Gear pump)	Max. displacement	cm^3/rev	4.0
	Max. pressure	MPa	4.12
Max. shaft speed	KX161-3α,V45α	r.p.m	2250
	KX161-3S		2200
Direction of rotation (Viewed from shaft end)			Right (Clockwise)
Weight		kg	34











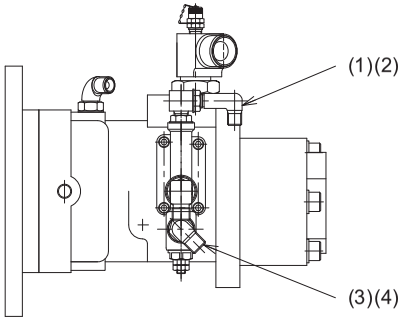
NOTES
1. FILL PUMP CASE WITH OIL BEFORE STARTING.
2. WHEN A COUPLING IS INSTALLED INTO A SHAFT, DO NOT HIT THE SHAFT.
3. "▽" MARK SHOWS THE UNMACHINED SURFACE OF THE PUMP.

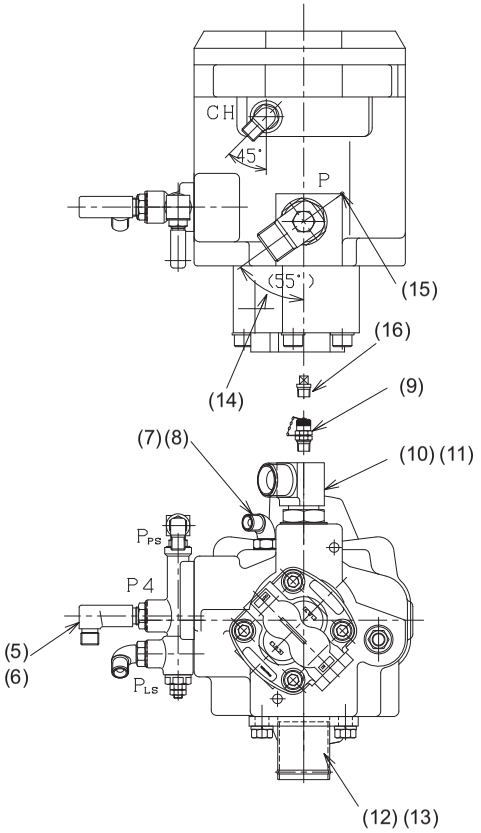
(1) Angle of the adapters
Fit the adapters as shown at left.
Make sure there is no tight contact with other parts along the hose route.

(2) Tightening of the adapters
Tightening torque
Port P (G3/4): 117.6 ~ 127.4 N.m (12.0 ~ 13.0 kgf.m)
Ports PPS, PLS and CH (G1/4): 24.5 ~ 29.4 N.m (2.5 ~ 3.0 kgf.m)
Port P4 (G3/8): 49.0 ~ 53.9 N.m (5.0 ~ 5.5 kgf.m)

<Failure case>
Wrong angle
↓
Difficult to connect the hose
Hose in contact
↓
Vibration-caused rubbing
↓
Hose damaged
Insufficient tightness
↓
Adapter loose
↓
Oil leak

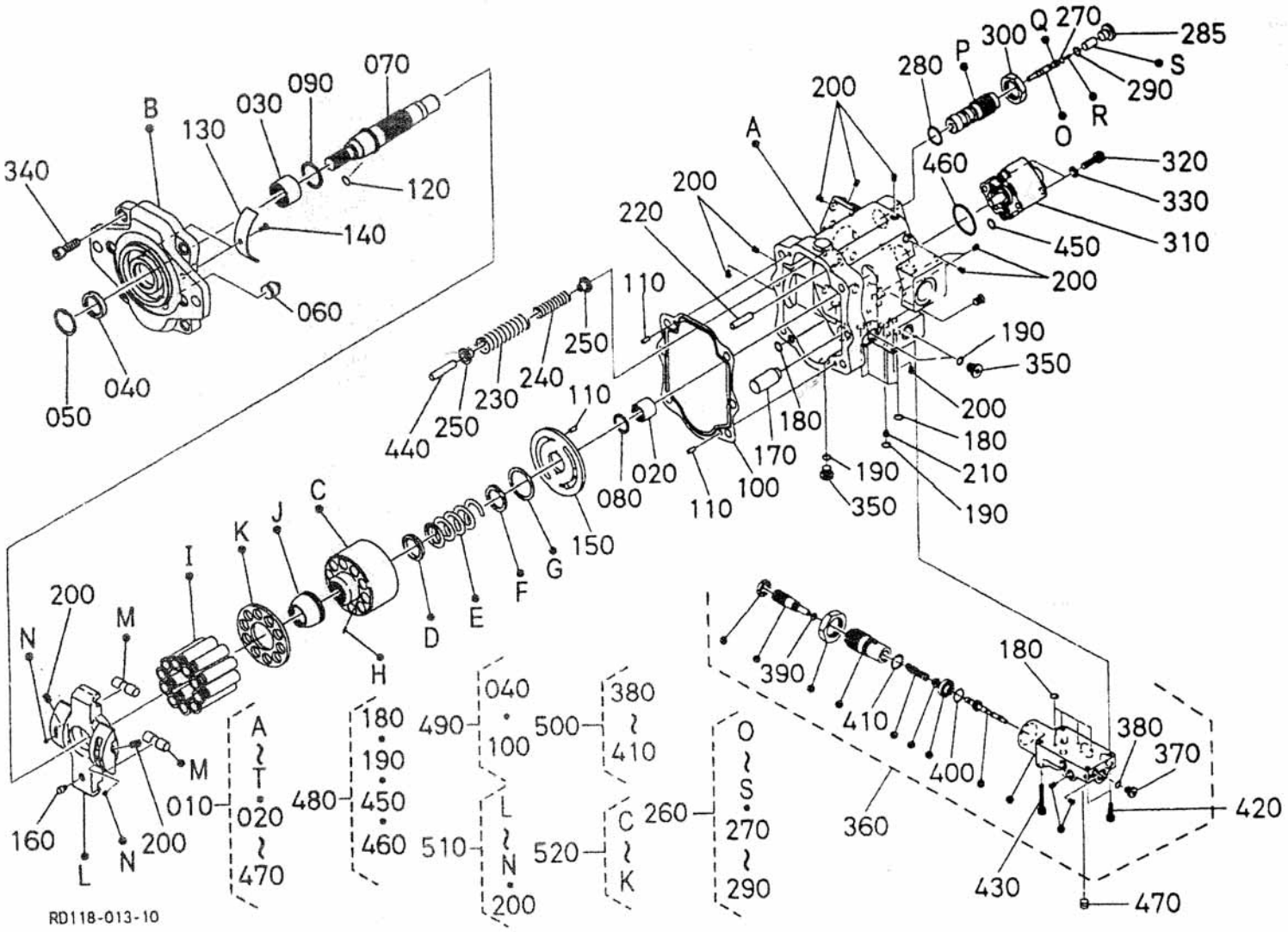
(1) Port PPS
(2) RP402-6192Δ Pipe joint (L, G1/4-G1/4)
04810-00110 O-ring
RB401-6386Δ Pipe joint (L, G1/4-G1/4)
04810-00110 O-ring
(3) Port PLS
(4) RB411-6376Δ Pipe joint (L, G1/4-G1/4)
04810-00110 O-ring
(5) Port P4
(6) 68881-3493Δ Washer-fitted elbow joint
04810-00140 O-ring
(7) Port CH
(8) RB411-6376Δ Pipe joint (L, G1/4-G1/4)
04810-3110 O-ring
(9) RG908-8644Δ Adapter, destined for Europe
(10) Port P
(11) R1410-6416Δ Elbow pipe joint
04810-00240 O-ring
(12) Port PS
(13) RC411-6317Δ Flange (suction)
04811-10400 O-ring
01123-01225 Bolt
(14) The delivery hose must be out of contact with the counterweight.
(15) Orient the adapter toward this corner.
(16) 06312-10010 Plug, destined for North America





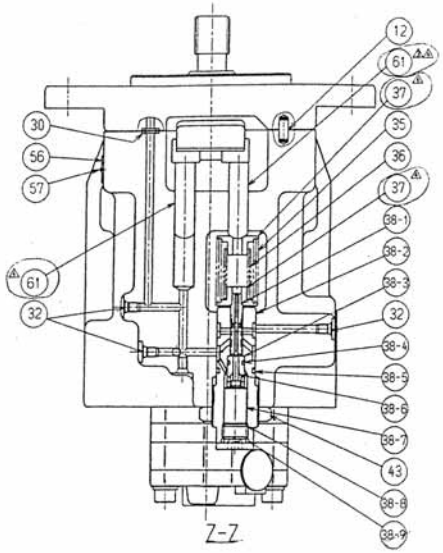
c) Pump: KX121-3α/S/ST, KX161-3α/S/ST

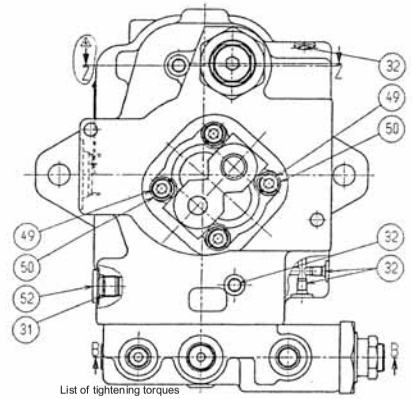
(1) Components of pump

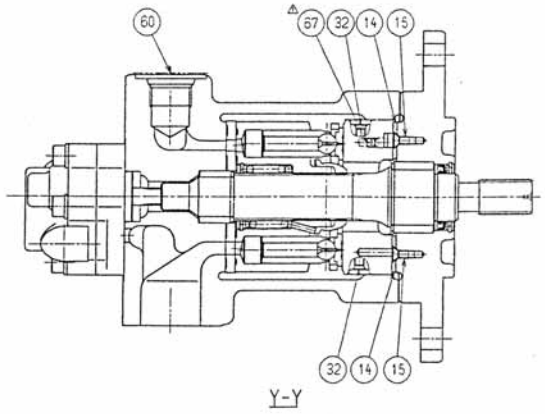


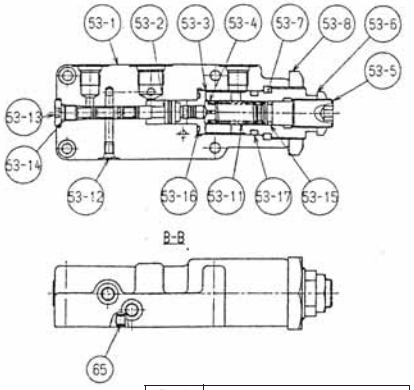
010	Assy pump, Piston	280	O-ring
020	Bearing, Needle	285	Plug
030	Bearing, Needle	290	O-ring
040	Seal, Oil	300	Nut
050	Circlip, Internal	310	Pump, Gear
060	Stopper	320	Bolt, Hex-Soc-HD
070	Shaft	330	Washer, Plain
080	Washer, Thrust	340	Bolt, Hex-Soc-HD
090	Washer, Thrust	350	Plug
100	Gasket	360	Assy valve
110	Pin, Straight	370	Plug
120	O-ring	380	O-ring
130	Bush	390	O-ring
140	Bolt	400	O-ring
150	Plate, Valve	410	O-ring
160	Stopper	420	Bolt, Hex-Soc-HD
170	Pin	430	Bolt, Hex-Soc-HD
180	O-ring	440	Pin
190	O-ring	450	O-ring
200	Plug	460	O-ring
210	Orifice	470	Orifice
220	Pin	480	Kit seal
230	Spring	490	Kit seal
240	Spring	500	Kit seal, Valve
250	Seat, Spring	510	Kit plate
260	Assy valve	520	Assy cylinder
270	O-ring		

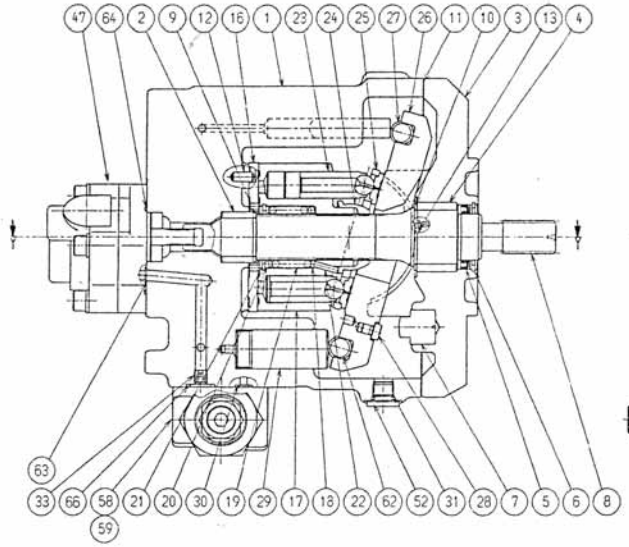
Pump structure of KX121-3α/S/ST and KX161-3α/S/ST are basically similar. Size and performance are different.

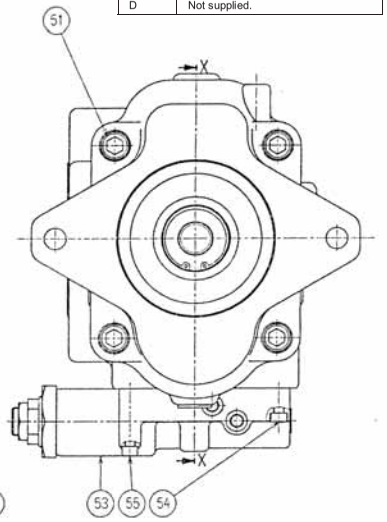












Repair section	Meaning
A	Parts to be replaced when disassembling and reassembling. Supplied in the repair kit.
B	Parts supplied for quality assurance and assembling purposes.
C	Supplied as individual parts.
D	Not supplied.

List of tightening torques

Ref. No	Name	Size	Tightening torque N·m	Remarks
15	Screw	M5	5.9	-
33	Orifice	M8	10.3	-
38-2	Sleeve, valve	M30	-	24 across (PC adjuster)
38-8	Plug	PF 3/8	57.0	-
43	Nut	M30	68.6	Hexagonal, 41 across (PC lock nut)
49	Socket head bolt	M8	28.9	-
51	Socket head bolt	M12	106.9	-
52	Plug	PF 1/4	29.4	-
53-5	Set screw	M18	-	Hex socket 8 (LS adjuster)
53-6	Nut	M18	29.4	Hexagonal, 24 across (LS lock nut)
53-7	Adjuster	M33	29.4	23 across
53-8	Nut	M33	68.6	Hexagonal, 46 across
53-13	Plug	PF 1/8	15.0	-
54, 55	Socket head bolt	M6	12.65	-
65, 67	Orifice	M6	2.45	-

Note:
1. The tightening torque settings are specified for the tightening tools.
2. The general tightening torque allowances are ±10%.

No	Name	Q'ty
1	Earth	1
2	Needle bearing	1
3	Flange	1
4	Needle bearing	1
5	Oil seal	1
6	Snap ring	1
7	Stopper	1
8	Shaft	1
9	Washer, Thrust	1
10	Washer, Thrust	1
11	Gasket	1
12	Pin	3
13	O-ring	1
14	Bush	2
15	Screw	2
16	Valve plate	1
17	Cylinder block	1
18	Color	1
19	Spring	1
20	Spring holder	1
21	Snap ring	1
22	Pin	3
23	Piston assy	10
24	Retainer holder	1
25	Retainer plate	1
26	Swash plate	1
27	Pin	1
28	Stopper	1
29	Pin	1
30	O-ring	6
31	O-ring	3
32	Plug	13
33	Orifice	1
34	Pin	1
35	Spring	1
36	Spring	1
37	Spring seat	2
38	Assy, Valve	1
38-1	Spool	1
38-2	Sleeve, Valve	1
38-3	Servo piston	1
38-4	O-ring	1

No	Name	Q'ty
38-5	O-ring	1
38-6	Pin	1
38-7	Color	1
38-8	Plug	1
38-9	O-ring	1
43	Nut	1
47	Gear pump	1
49	Socket head bolt	2
50	Washer	2
51	Socket head bolt	4
52	Plug	3
53	Valve assy	1
53-1	Valve body	1
53-2	Spool	1
53-3	Bush	1
53-4	Spring seat	1
53-5	Set screw	1
53-6	Nut	1
53-7	Adjuster	1
53-8	Nut	1
53-11	Spring	1
53-12	Plug	4
53-13	Plug	1
53-14	O-ring	1
53-15	O-ring	1
53-16	O-ring	1
53-17	O-ring	1
54	Socket head bolt	2
55	Socket head bolt	2
56	Name plate	1
57	Drive screw	2
58	Shipping plug	2
59	Shipping plug	1
60	Shipping plug	1
61	Pin	1
62	Pin	1
63	O-ring	1
64	O-ring	1
65	Orifice	1
66	O-ring	1
67	Orifice	1

(2) Pump installing precaution

1) Checking

Check the following points before mounting the piston pump.

- Is there any part damaged or lost during transportation?
- Is there any looseness at tightened parts?
- Are the port flange and drain port closed so tight as not to allow dust entry into the piston pump?

2) Hydraulic oil

1. Recommended oil

Hydraulic oil is an important element which plays the role of power transmission and lubrication of various parts in hydraulic equipment. Selection and handling of hydraulic oil significantly affect the performance and service life of hydraulic equipment.

Hydraulic oil being used generally is lubricating oil of very good quality which must be excellent in lubricity, oxidation stability, anti-rust property and anti-emulsion property. In addition, it should have such a property as not to damage packings and seals.

Strictly avoid mixing different types of hydraulic oil.

2. Oil viscosity / Oil temperature: Recommendable

Oil viscosity [mm^2/s]	Oil temperature (ISO VG 46)
10 ~ 1000	-10 ~ +80°C (14 ~ 176°F)

When using the pump in cold season, carry out warming up operation.

3) Filter

The piston pump, which is comprised of high-precision parts and so designed as to provide very small clearance between parts, is particularly vulnerable to contamination.

It is therefore necessary to control contamination level in order to prevent deterioration of piston pump performance and abrasion of sliding parts.

In order to keep the hydraulic oil in the hydraulic system always clean and use this unit as a reliable hydraulic device which withstands long-time use with least repair and check, it is necessary to provide an appropriate filter, and control and maintain the contamination less than the level of NAS9 class.

Provide a filter of less than 10-micron mesh (nominal) at hydraulic pump discharge side or an appropriate position of the actuator's return side.

If the filter element is clogged, use a filter incorporating an indicator by which filter clogging condition can be monitored from outside and a relief valve which can bypass flowing oil according to clogging condition.

Keep the level of hydraulic oil contamination less than NAS9 class.

4) Mounting

- Be sure to carry out acid-cleaning of pipes before assembling, and remove scales completely from them.
- Pay due attention not to let foreign matter into the piston pump case through ports during piping work.
- When the piping work is over, flush the pipes completely.

Connect the suction pipe so that pressure inside the piston pump case should be kept always less than 0.1 Mpa (1.0 kgf/cm^2, 14.2 psi).

5) Before starting the pump

When a new pump has been mounted or pump has been re-mounted on the machine after maintenance and check, check it again and make preparations for starting in the procedure as follows:

1. Fill the pump case with hydraulic oil.
   At this time, oil can be fed easily by loosening the plug of air bleeding port (PF1/4).

Caution

When using a hand pump or electric pump of small capacity, take care so that the pressure in the case should not exceed 0.3 Mpa (3.0 kgf/cm^2, 43 psi).

2. Purge air from pipes.
3. Start the engine and operate it at low speed. At this time, abnormal sound may be generated by influence of air inside the circuit. Keep operating the engine for a while at low speed. Then, idle the engine until it gradually picks up the specified speed.
4. Operate equipments several times with a light load and purge air completely from pipes. At this time, also check the equipment and pipes for any oil leak.
5. After air purge and checking of oil leak, conduct no-load operation to make sure before starting actual operation that no abnormal sound and vibration are generated from the pump.
   Air bleeding method is described in detail in the pages later.

6) Oil temperature

In hydraulic system, it is very important at what level the oil temperature should be controlled. When the oil temperature is high, anti-oxidation ability of oil is decreased, accelerating deterioration of hydraulic oil. Therefore, keep in mind and observe the following points:

- When conducting continuous operation, control the oil temperature so that it is kept within the range of -10 to +80°C (14 ~ 176°F).
- The minimum starting temperature should be higher than -20°C, but it may be up to +90°C if the running time is short.

These are determined depending on the viscosity and anti-oxidation ability of hydraulic oil and deterioration of O-rings and oil seals. However, if the pump is operated continuously at the temperature higher than +80°C, the life of the pump is also affected and shortened.

7) Maintenance

Check the pump for the following points unless there is any abnormality in operation of equipment.

- Check for oil leak from pipe flanges and joints of equipment
- Check for loosened set bolts of equipment
- Appearance check (for damage)

(3) Periodical inspection and maintenance interval

1) Hydraulic oil

Hydraulic oil, though clean at the initial period, is gradually contaminated by precipitates such as sludge, etc. that are accumulated in the circuit and tank in the course of long-time operation. Hydraulic oil which contains sludge and flows into the circuit causes damage to the piston pump. Besides, hydraulic oil itself is gradually deteriorated, and abrasion of sliding parts develops with lowering of lubricity

Therefore, it is desirable to check hydraulic oil periodically and determine the degree of deterioration before replacement, but in actual field, it would be difficult to periodically check the degree of contamination or deterioration of hydraulic oil. For your reference, the method of judgment in visual checking is shown (in the table below) as criteria for determination.

It is recommended to replace hydraulic oil after the first 500 operating hours.

Since deteriorated oil, sludge and other precipitates and moisture remains in the tank, be sure to clean the tank and flush the pipes completely before replacing oil with new one.

• Criteria for Determination by Visual Checking

Appearance	Smell	Condition	Countermeasure
Transparent (without change in color) Good	Good	Good	Use as it is.
Transparent (with small black specks)	Good	Entry of foreign matter	Use after filtered.
Changed to milky white	Good	Entry of moisture	Replace oil.
Changed to black	Bad	Oxidized and deteriorated	Replace oil.

2) Filter

Since clogged filter element deteriorates the filter performance and makes the filter ineffective, periodical check is essential.

Check the filter after the first 50 operating hours, and every 250 operating hours thereafter. When the indicator shows clogging of the filter element, replace the element with new one.

When using a filter not incorporating clogging indicator, it is recommended to replace the element with new one after the first 250 operating hours and every 500 operating hours thereafter.

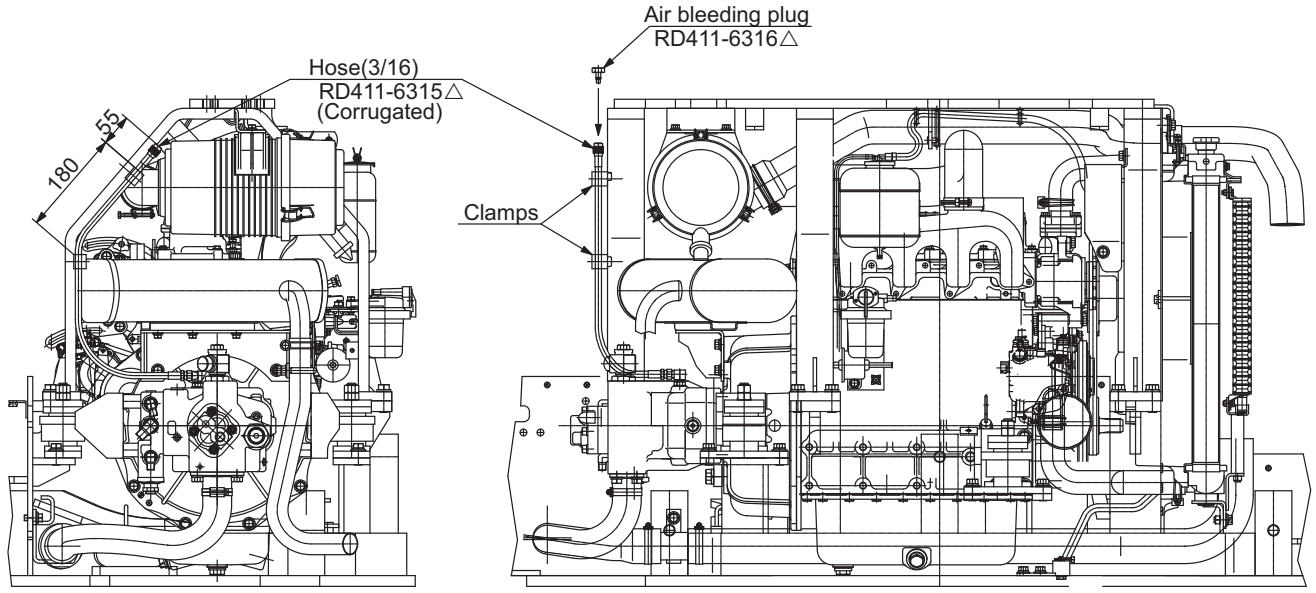
Be sure to replace the element particularly when hydraulic oil is replaced with new oil.

(4) Pump air bleeding hose

(1) Installing the air bleeding plug.
To be fitted tightly.

(2) Clamp the hose.
Clamp to be securely hooked.
Insert the plug until it clicks.
(If it does not click, pull it out and insert again.)
Finally pull the plug lightly to make sure it does not come off.

*1 Remove the bleeding plug to pour hydraulic oil. After putting in the oil, be sure to insert the plug back in place. Pull the plug lightly to make sure it is tight in position. Then start the engine.



(5) Pump air bleeding

Precautions in handling the pump

1. Points to remember when replacing the pump or using a vacuum pump

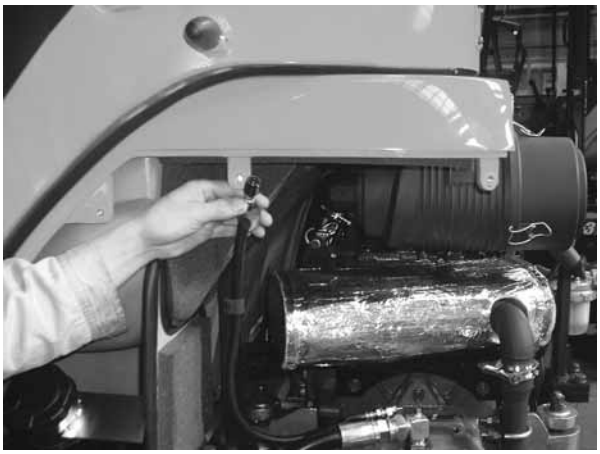
(Without taking the following steps, unusual noise may be heard and what's worse, the pump may get damaged.)

Take the following procedure after replacing the pump but before starting the engine.

1) Unclamp the air bleeder hose that comes out from the top of the pump, and pull it toward yourself. Press in the hex plug and the black lock as well. Then hold the black lock and pull out the hex plug.
2) With the hex plug out, reclamp the hose back into position.
3) Wait for 30 seconds or so in this state.
4) Insert the hex plug. (Make sure it is deep enough in place.)

NOTE:

Be careful never to raise the engine rpm without the hex plug in place. Air may sucked in, getting the pump damaged.



5) Reclamp the air bleeder hose back into position.
6) Start the engine at the idling speed.
7) Try to raise the dozer at this speed. If it is not lifted, stop the engine, remove the plug again, and bleed air.
8) Still at the idling speed, move the lever to the neutral position. Wait until there is no cavitation noise heard.
9) Finally increase the engine speed by about 500 rpm step by step up to the maximum speed. Make sure no cavitation noise is heard. Return the engine speed back to the idling rpm. Move the arm and bucket until there is no cavitation noise heard. Now again increase the engine speed by about 500 rpm, and move the arm and bucket. Repeat this up to the maximum engine speed and make sure no cavitation noise is heard.

2. Air-bleeding method in case the hydraulic oil in the tank looks cloudy with air bubbles

(Without taking the following steps, unusual noise may be heard and what's worse, the pump may get damaged.)

Be sure to keep the engine running at the idling speed in the following procedure.

1) Unclamp the air bleeder hose that comes out from the top of the pump, and pull it toward yourself. Press in the hex plug and the black lock as well. Then hold the black lock and pull out the hex plug.
2) With the hex plug out, reclamp the hose back into position.
3) Start the engine at the idling speed. Move the lever to the neutral position and keep running the engine for 10 seconds or so. Stop this engine and wait for 10 seconds. With the lever still at the neutral position, run the engine again for 10 seconds or so. Stop this engine and wait for 10 seconds. Repeat this step about 20 times (until the hydraulic oil does not look cloudy any longer).

3) Start the engine at the idling speed. Move the lever to the neutral position and keep running the engine for 10 seconds or so. Stop this engine and wait for 10 seconds. With the lever still at the neutral position, run the engine again for 10 seconds or so. Stop this engine and wait for 10 seconds. Repeat this step about 20 times (until the hydraulic oil does not look cloudy any longer).

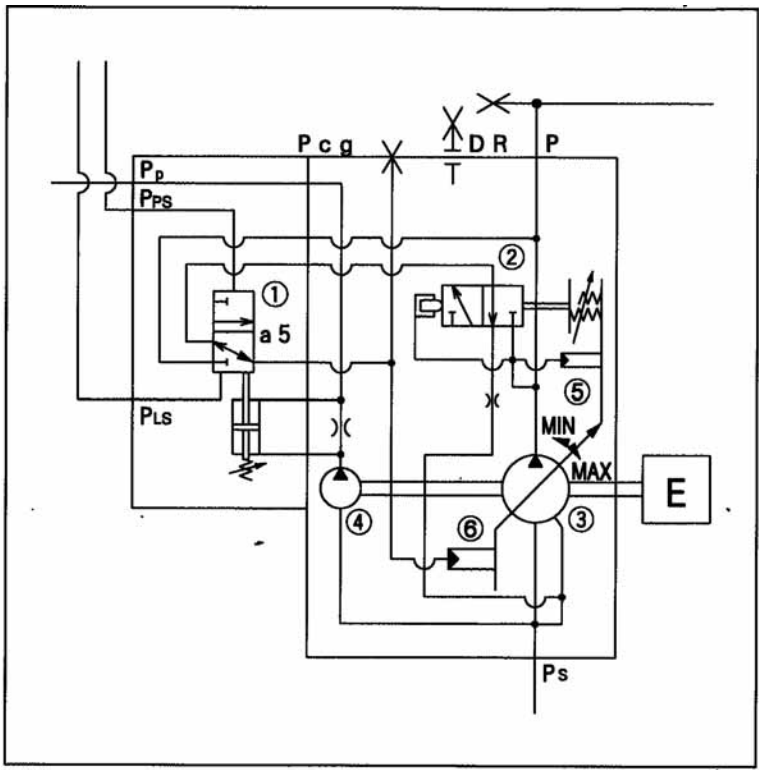
- The pump's centrifugal force is utilized for this step. The hydraulic oil is forced to flow along the inner wall of the pump, whereas air bubbles are collected toward the center of the pump. Each time the engine is stopped, collected air bubbles go out through the bleeder hose atop the pump. The engine is thus started and stopped repeatedly to allow such collection and discharging of air bubbles.

NOTE:

Be sure to run the engine at the idling speed. If higher than this, air is sucked into the bleeder hose.

4) Finally insert the hex plug. (Make sure it is deep enough in place.) Be careful never to raise the engine rpm without the hex plug in place. Air may sucked in, getting the pump damaged.

(6) Pump circuit diagram



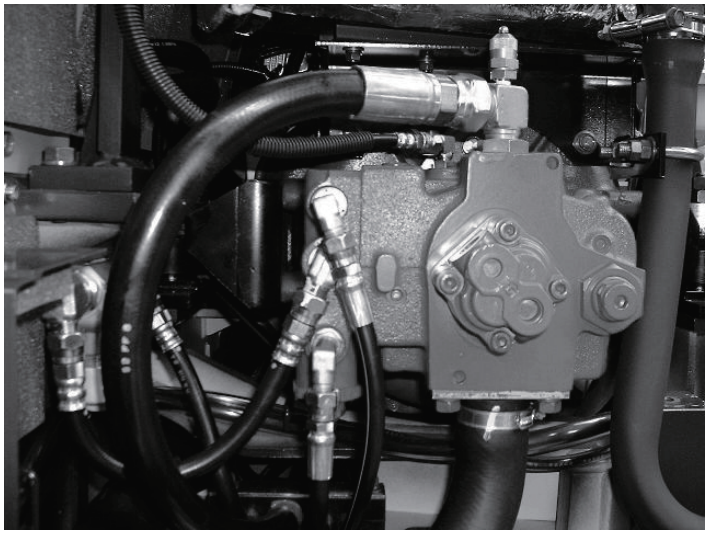
(1) LS regulator (Flow control valve)
(2) Horse power control valve
(3) Variable displacement pump
(4) Pilot pump
(5) Control pin A
(6) Control pin B

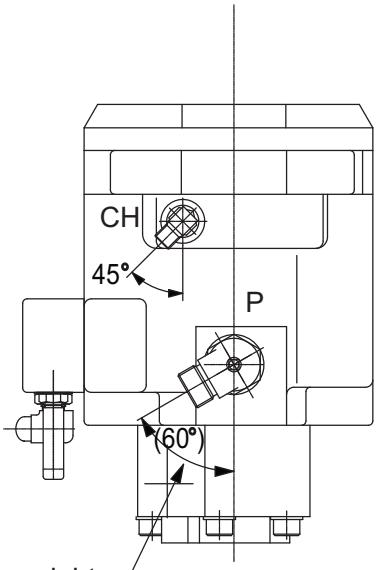
Machine model		KX121-3S/α		KX161-3S/α	
Pump type		PSVL-42CG		PSVL-54CG	
Pump speed		2250		2250	
Displace-ment	cc	42	4.0	54	4.0
	cu.in.	2.56	0.24	3.29	0.24
Delivery rate	LPM	94.5	9.0	121.5	9.0
	GPM	25.0	2.4	32.1	2.4

(7) Adaptor installation on the pump

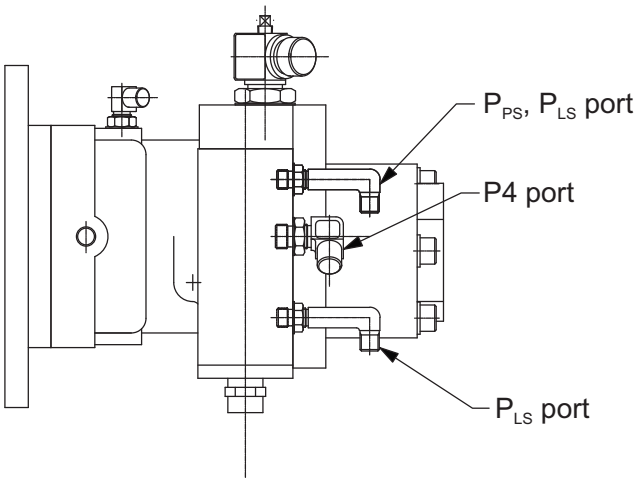
(1) Adapter Installing angle
No heavy contact with anything else along the route. See the figure below.

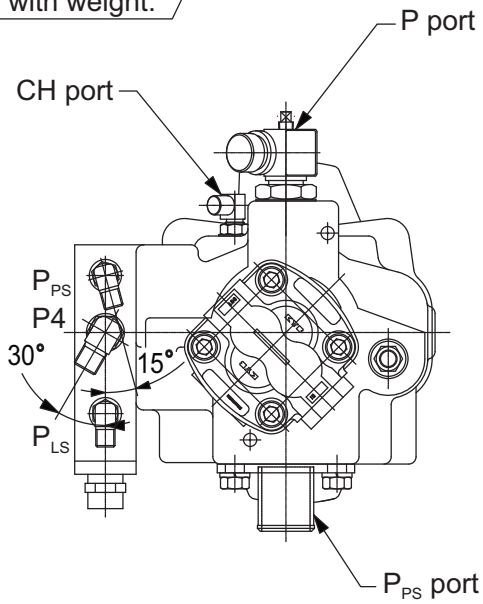
(2) Adapter tightening torque
P port (G3/4) 117.6 ~ 127.4 N·m (86.8 ~ 94.0 ft·lbf)
P_{PS}, P_{LS}, CH port (G1/4) 24.5 ~ 29.4 N·m (18.1 ~ 21.7 ft·lbf)
P4 port (G3/8) 49.0 ~ 53.9 N·m (36.2 ~ 39.8 ft·lbf)





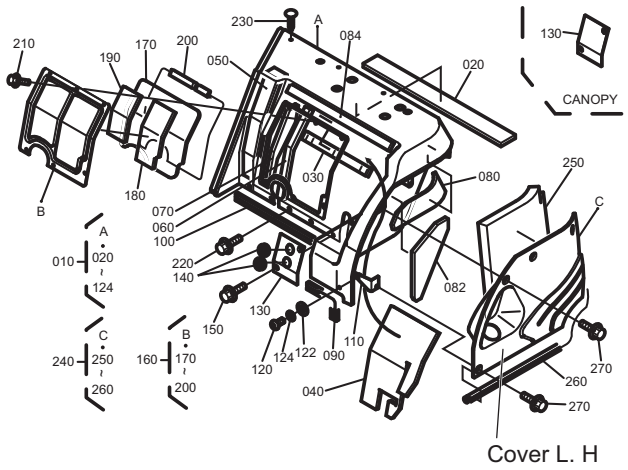
Delivery hose should not be contacted with weight.

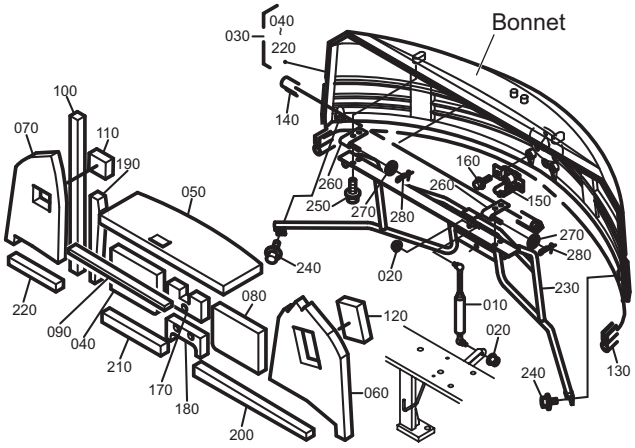


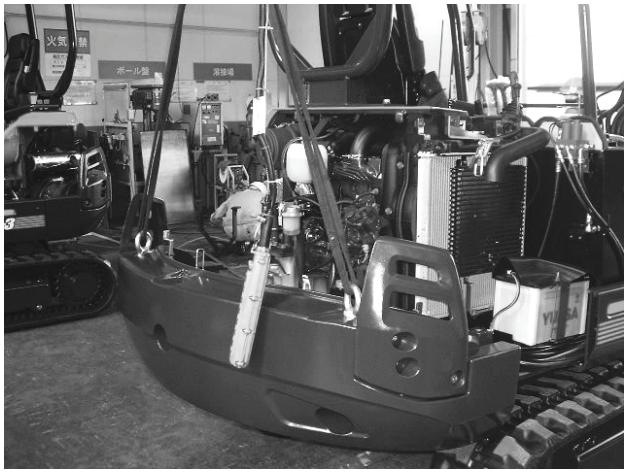


(8) Pump assy dismounting procedure

1. Park the machine on a flat surface. Bring the attachment blade completely on the ground.
2. Remove assy cover, LH.
3. Remove rear bonnet.

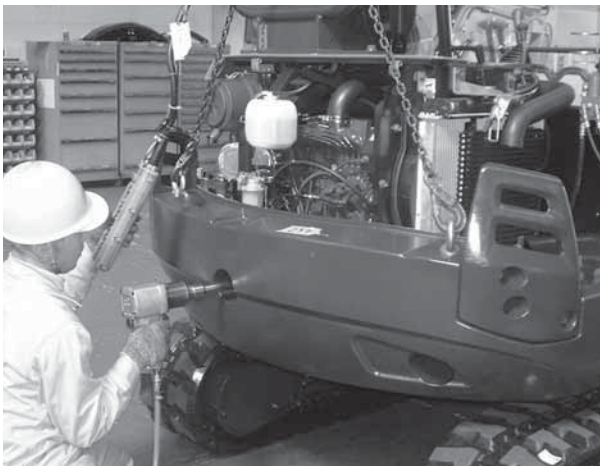






4. Install two hang bolts.
   Hang bolt: M24 × P3

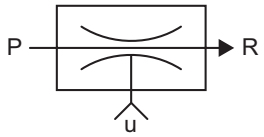
5. Install the chain (or wire) through the hang bolts and crane as shown in photo.

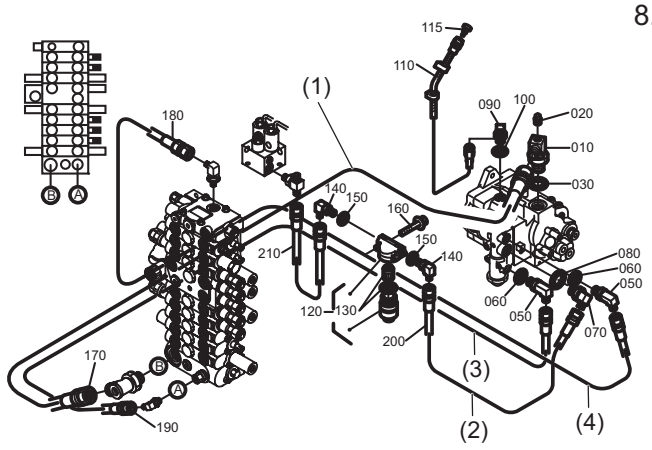


6. Remove mounting bolts of counterweight, hanging it with crane.
   First, horizontal direction bolts; M20 × 90
   Second, vertical direction bolts; M16 × 65

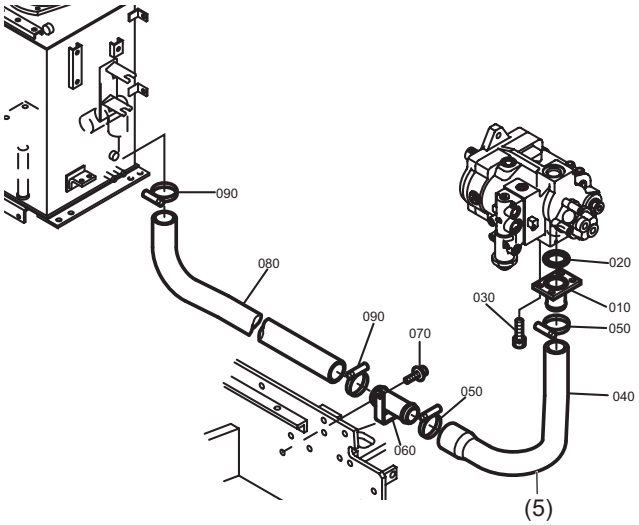
7. Connect the vacuum pump.

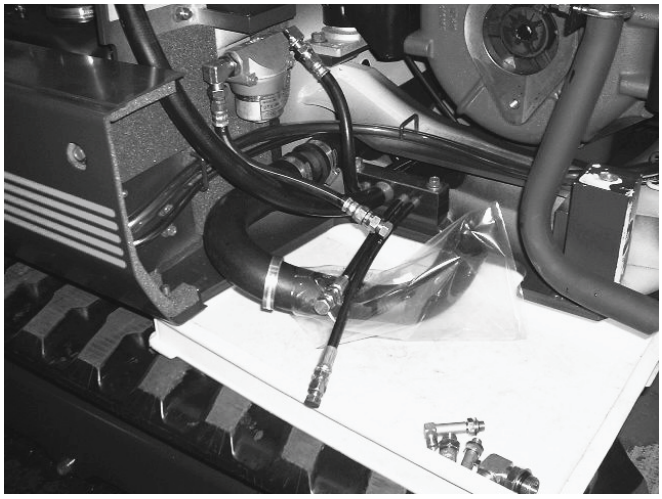
FESTO VAO-1/4 9314

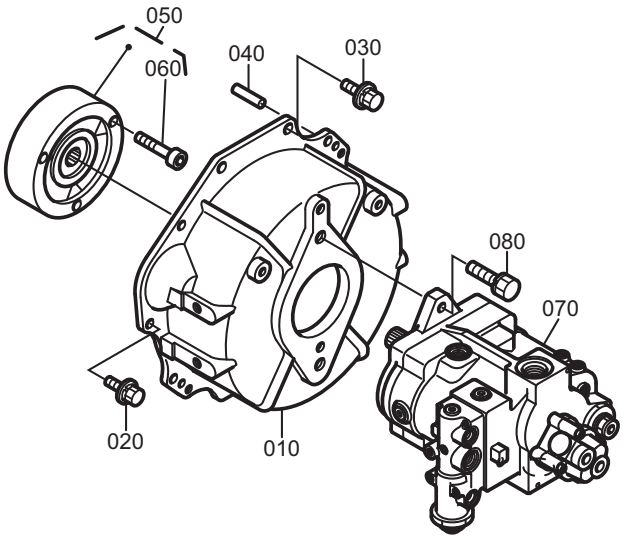




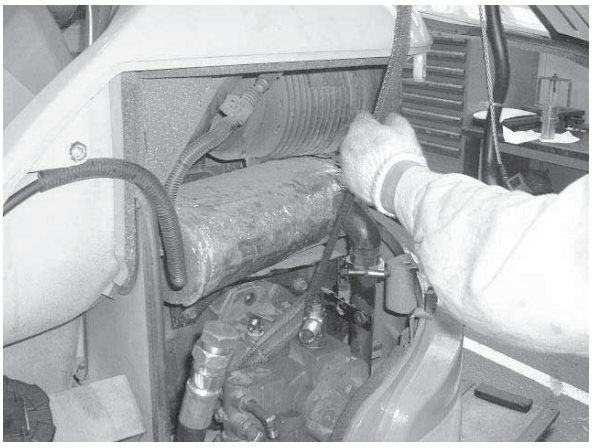
8. Disconnect hoses from the pump assembly. Suction hose should be removed with the flange.
   After disconnecting, plug all hose ends.
   (1) Delivery hose
   (2) Pilot hose
   (3) P_{LS} hose
   (4) P_{PS} hose
   (5) Suction hose



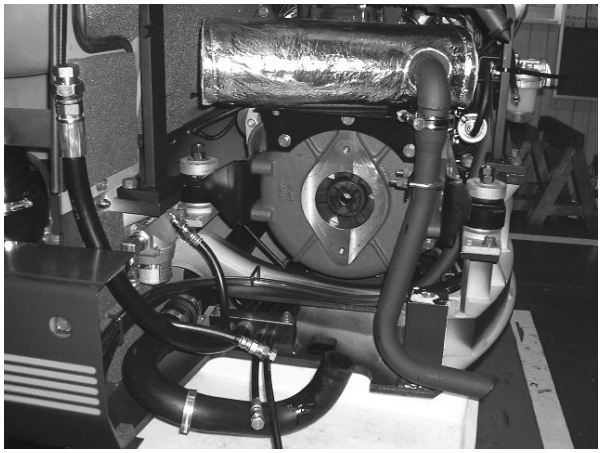




9. Wind nylon slings around the pump assy and hang with crane.
10. Loosen the two mounting bolts.
    (Leave the bolts still in place with their 3 or 4 threads inside their mating holes.)
    Mounting bolts 080: M12 × 35, 7T
    Tightening torque: 77.5 ~ 90.2 N·m
    7.9 ~ 9.2 kgf·m
    57.1 ~ 66.5 ft·lbs

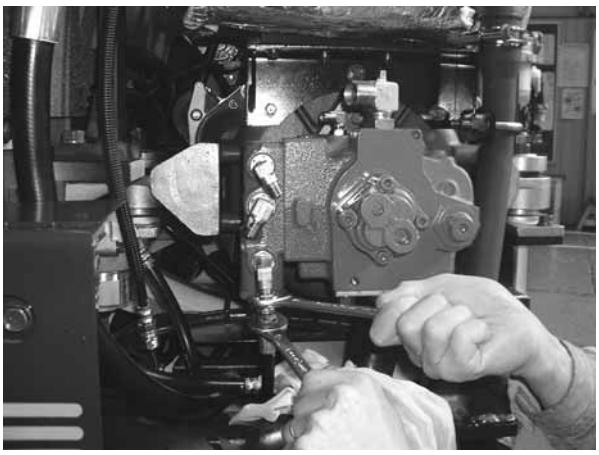


11. Slightly hoisting, move the pump out in the direction opposite of the splines.



(When remounting the pump assy:)
Basically remounting procedure is from the end to the first steps of pump removing. Still there are some additional jobs required.

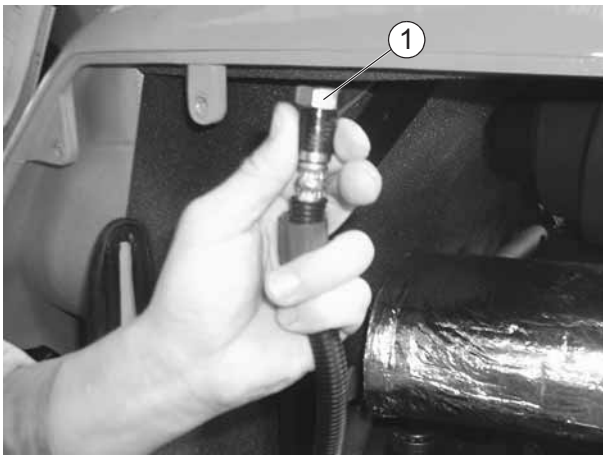
1. Install pump assy onto pump housing and coupling flange.
   Clean pump spline shaft and apply new grease.



2. Install vacuum pump and connect all hoses.
   Hose ; 180, 190 : 1/4" Hose; 170 : 6/8"
   Hose ; 200 : 3/8"
   After connecting hoses, clean and flash oil around joints and hoses.

3. Remove vacuum pump and connect the breather hose.

4. Air bleeding procedure.
   1) Disconnect air bleeding hose. Push the nail to release the stopper inside and pull the hose.



2) Pull out the hose cap (Hex plug).
   Push down and hold the black colored sleeve and pull out.
3) With the hose cap out, reclamp the hose back into position.
   Wait for 30 seconds or so in this state.
4) Insert the hose cap. (Make sure it is deep enough in place.)

   (1) Hex. plug (Hose cap)

Note:
Be careful never to raise the engine rpm without the hex plug in place. Air may sucked in, getting the pump damaged.

5) Reclamp the air bleeder hose back into posotion.
6) Start the engine at the idling speed.
7) Try to raise the dozer at the speed. If it is not lifted, stop the engine, remove the plug again, and bleed air.
8) Still at the idling speed, move the lever to the neutral position. Wait until there is no cavitation noise heard.
9) Finally increase the engine speed by about 500 rpm step by step up to the maximum speed. Make sure no cavitation noise is heard. Return the engine speed back to the idling rpm. Move the arm and bucket until there is no cavitation noise heard. Now again increase the engine speed by about 500 rpm, and move the arm and bucket. Repeat this up to the maximum engine speed and make sure no cavitation noise is heard.

5. Inspect joint and hoses for oil leakage.

6. To remove and clean the handled screw lock agent in the hole thread, tap the screw holes for counter weight mounting bolt.

7. Mount the counterweight.
   Bolt size and tightening torque
   M20 × 90: 367.7 ~ 431.5 N·m (37.5 ~ 44 kgf·m)
   271.2 ~ 318.2 ft·lbs

   Apply screw lock agent.

   M16 × 65: 196.1 ~ 225.6 N·m (20.0 ~ 23.0 kgf·m)
   144.7 ~ 166.4 ft·lbs

(9) Tools and jigs

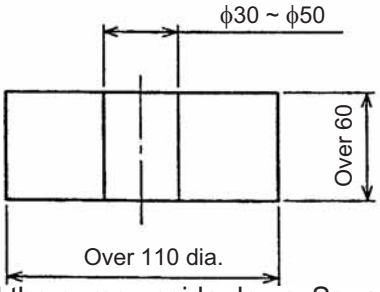
1) Tools

The following tools and jigs are required in disassembling and reassembling the pump.

Name	Q'ty	Size (nominal)
Hex wrench	1 each	
Hex wrench	1	6 L=35
Monkey wrench	1	14, 17, 24
Plastic hammer	1	Medium size
Snap ring pliers	1	For holes (for snap ring 62.25)
Snap ring pliers	1	For shafts (for snap ring 25)
Bladed screwdriver	2	Medium size
Torque wrench	-	For specified tightening torques
Grease	Small amount	

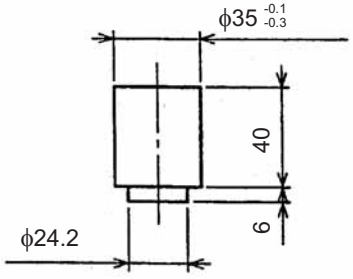
2) Jigs

1. Disassembling/reassembling mount

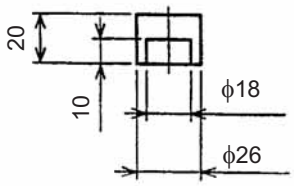


This circular mount is used to stand the pump upside down. Square blocks may also be used if the shaft end can be kept out of contact.

2. Oil seal fitting jig



3. Bearing fitting jig



3) Notice for disassembling and assembling

1. Precautions in disassembling
   (1) Unless otherwise specified, never handle the adjusting screws. The horsepower setting may vary, adversely affecting the machine.
   (2) Be very careful not to hit or drop the parts.

2. Precautions in reassembling
   (1) Before reassembling, clean up the parts.
   (2) Be very careful not to scratch the parts and not to allow foreign matters inside.
   (3) Basically do not reuse the O-rings and oil seals.
   (4) At Kubota, the tightening torques are controlled using torque wrenches. Employ a suitable torque wrench.

(10) Pilot pump disassembly

PP-version

Pilot pump on the machine
KX121-3α, KX121-3S, KX121-3ST
(1) Pilot pump
(2) Accumulator
(3) P_4 pressure port

EU-version

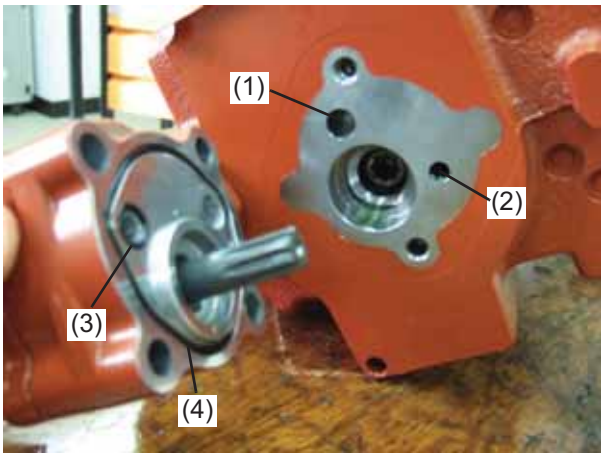
PP-version

KX161-3α, KX161-3S, KX161-3ST

Important: If once the gear pump is disassemble and/or reassembled, its functioning would not be guaranteed because of vulnerable material. The original manufacturers accept no responsibility and make no warranties on disassembling and/or reassembling the gear pump. Take full of self - responsibility.

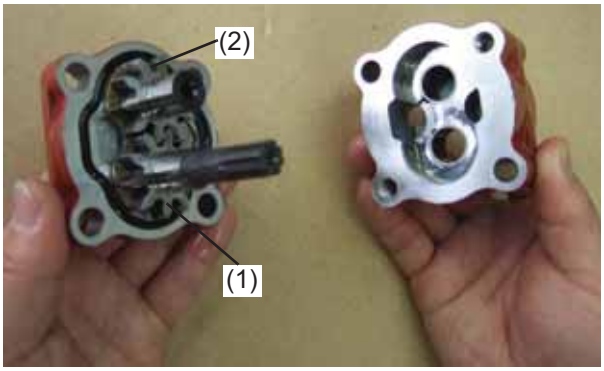
Sample: KX121-3S, KX121-3α

1. Loosen the mounting bolts of the pilot pump.
   Hollow bolts:M8×25(2 pcs)
   M8×55(2 pcs)
   Wrench: 6 mm
   Tightening torque:



2. Pull out and separate the pilot pump from the main pump.

   (1) Suction port
   (2) Delivery port
   (3) O-ring
   (4) Seal



3. Separate the casing.

   (1) Drive gear
   (2) Driven gear

4. Check the valve plate.

   (1) Drive gear, width = 8.70 mm (0.34 in.), z = 10
   (2) Driven gear, width = 8.70 mm (0.34 in.), z = 10
   (3) Valve plate
   (4) Seal
   (5) Seal
   (6) Bush

5. Comparison of pilot pump
   Upper side photo: KX121-3S, KX121-3α
   Lower side photo: KX161-3S, KX161-3α

   Drive gear: z = 14
   width = 20.00 mm (0.79 in.)
   Driven gear

(11) LS regulator (Load sensing valve)

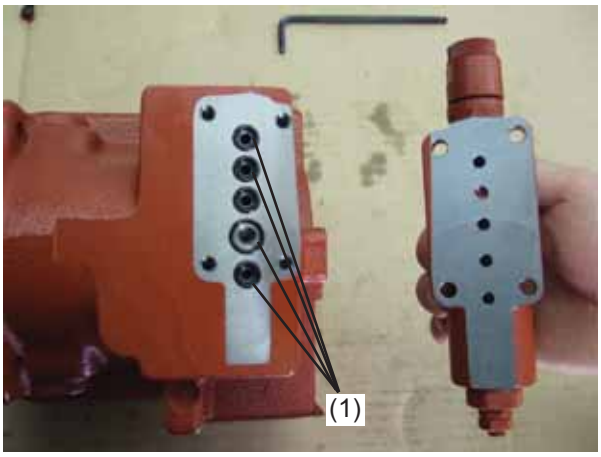
Precaution

Removing and loosening the adjusting screw shall result in the performance variance. Therefore, any failure after this adjustment should not be covered by warranty. You're suppose to proceed at your own cost.

1. For reassembling reference, take measurement of the screw length.
   Sample data taken from several units:
   L = 12.9 ~ 13.2 mm (0.51 ~ 0.52 in.)
   12.8 ~ 12.9 mm (0.50 ~ 0.51 in.)
   13.7 ~ 13.8 mm (0.54 ~ 0.55 in.)

   Service tip: Before loosening the adjusting nuts and bolts, put an alignment mark.

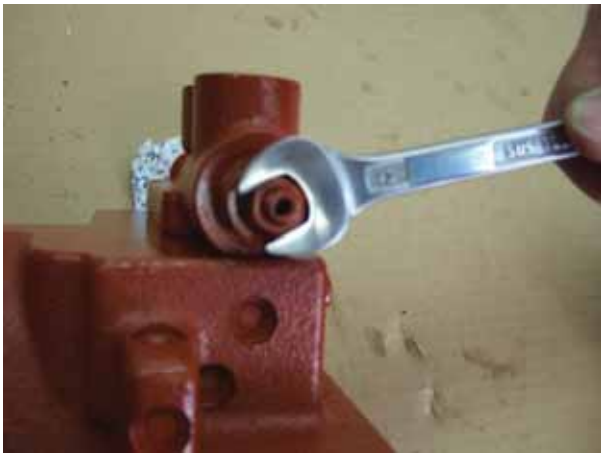
2. Loosen the mounting bolts.



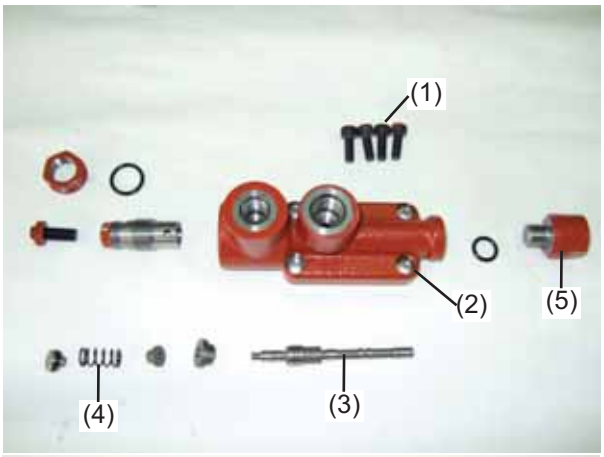
3. Remove the LS valve.

   (1) O-rings

4. Loosen the lock nut.



5. Loosen the double nuts.



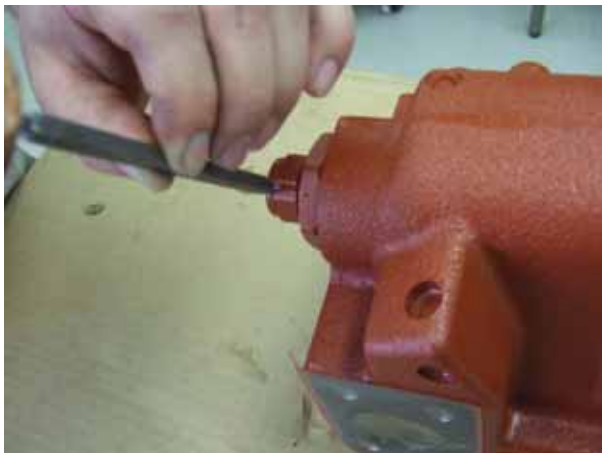
6. Inner parts

(1) Bolts
(2) Valve body
(3) Spool
(4) Spring
(5) Plug (ϕ1.9)

d_1 = 6 mm (0.24 in.)
d_2 = 11 mm (0.43 in.)

LS spring

(12) Horse power control valve



Precaution

Removing and loosening the adjusting screw will result in the performance variance after reassembling. Therefore, it is not recommended to readjust the screw.

1. Preparation
   In need of overhaul, do this with your own risk and expense.
   When measuring L-length, draw the mating line and put the alignment mark.

   (1) Horse power control valve

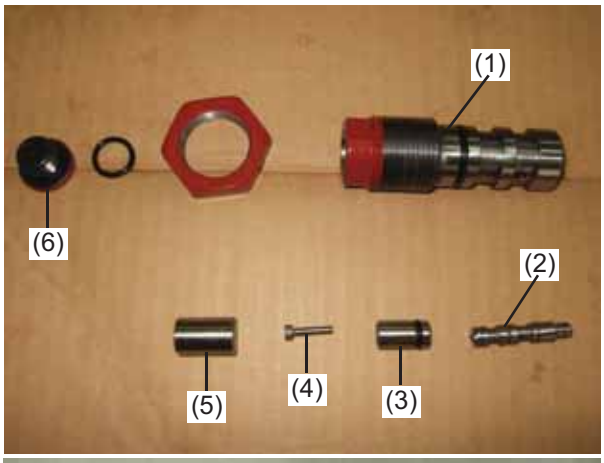
   Sample data taken from 3 pumps:
   L = 17.5 ~ 17.7 mm (0.69 ~ 0.70 in.)
   17.5 ~ 18.0 mm (0.69 ~ 0.71 in.)
   17.8 ~ 18.0 mm (0.70 ~ 0.71 in.)

2. Loosen the lock nut.
   Wrench size = 41 mm

3. Remove the valve assy.
   L-wrench = 8 mm

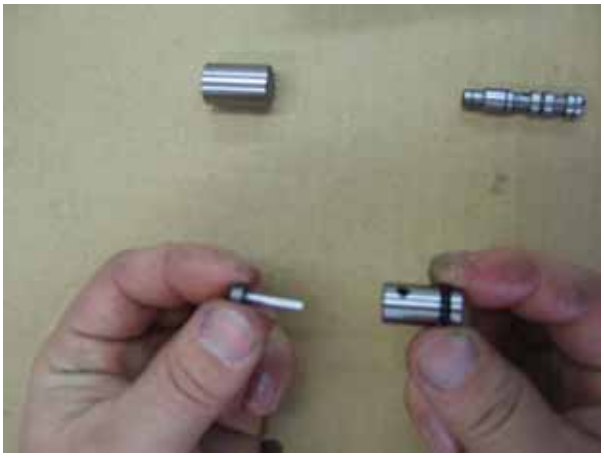
4. Remove the valve assy.

5. Loosen the end plug.



6. Inner parts

   (1) Sleeve
   (2) Spool
   (3) Collar
   (4) Reaction pin
   (5) Spacer
   (6) Plug



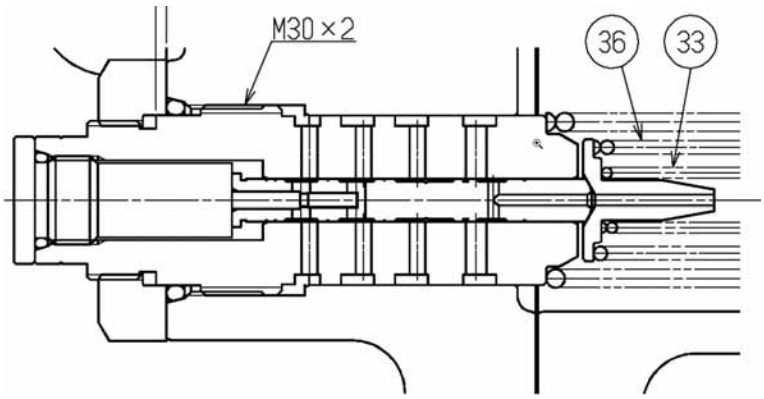
7. Put the reaction pin into the collar.

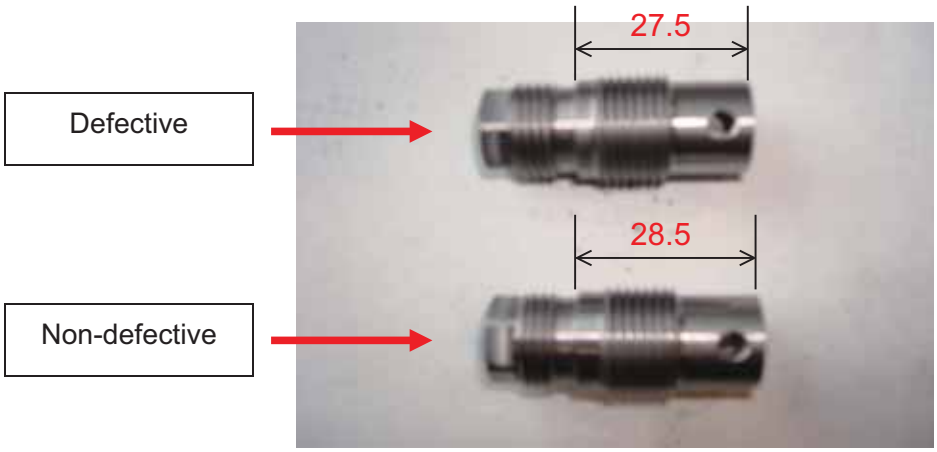
8. Put the reaction pin and collar into the sleeve.

9. Put the spacer into the sleeve.

10. Put the spool into the sleeve.
    Be aware of the direction.

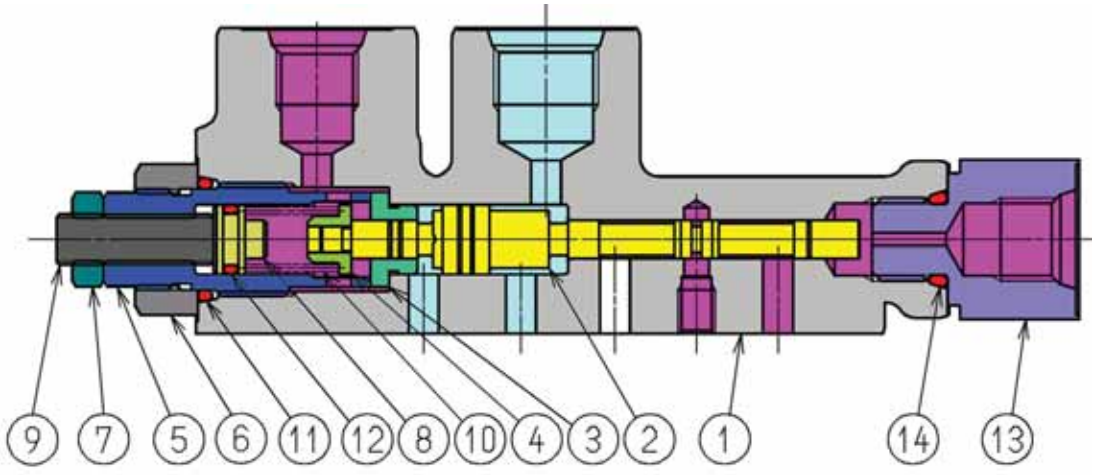
PC valve





LS valve

The part ⑤ is “cap”.



(13) Piston pump assy

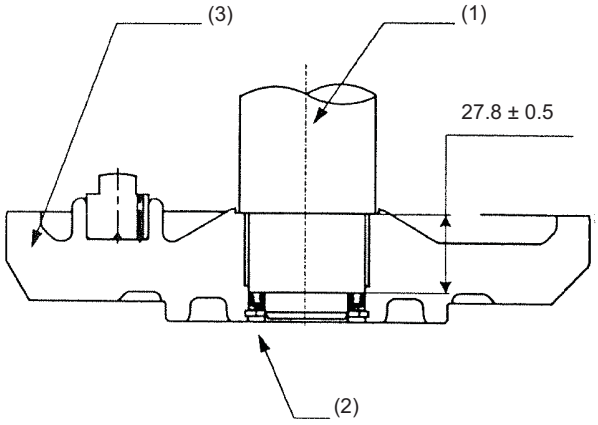
1. Loosen and remove the mounting bolts.
   Socket head bolt: M12×35
   L-wrench = 10 mm
   Tightening torque: 128.4 N·m (13.1 kgf·m) 94.7 ft·lbs

2. Detach the flange.

   (1) Stopper pin for mini-swash angle
   (2) Lubrication passages
   (3) Swash plate

3. Loosen the socket head bolt and remove the metal plate if found any damage.
   L-wrench = 3 mm
   As the screw is very tight with lock-agent, burn the screw head and loosen it.

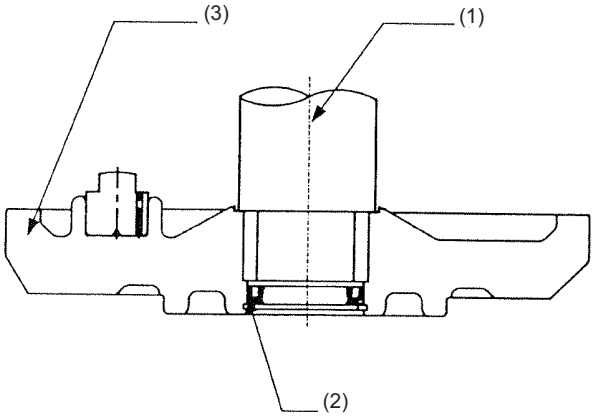
4. Attach the snap ring to the flange.
   Place the snap ring with its punched-out side facing toward the load side.



5. Using the specific jig, insert the oil seal in the flange.
   Position: Make sure the oil seal is 27.8 ± 0.5 mm (1.09 ± 0.02 in.) deep from the step.

   Note:
   Apply lithium grease on inner side of oil seal lip.

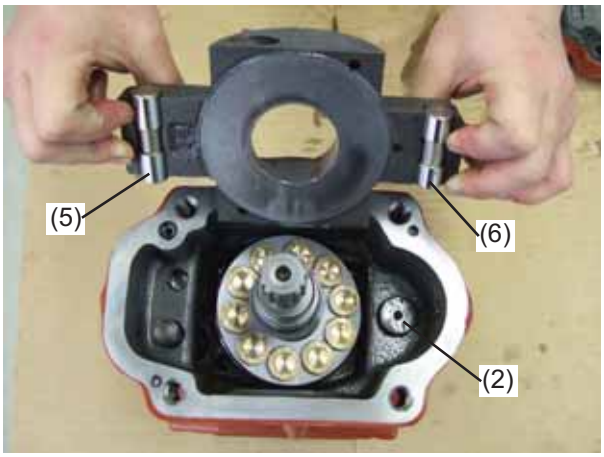
   (1) Jig
   (2) Oil seal
   (3) Flange



6. Install the needle bearing in the flange by using jig.
   Position: Make sure the bearing is flush with the step.

   Note:
   Press-fit the bearing with its marked side upward.

   (1) Jig
   (2) Needle bearing
   (3) Flange



7. Remove the swash plate.

   (1) Control pin A,
   (2) Control pin B,
   (3) Feed back pin,
   (4) Cylinder block, 10 pistons
   (5) Receive pin A, ϕ15×49 mm
   (6) Receive pin B, ϕ15×40 mm

(When reassembly)
Tighten up the bushes with the screws, and place the flange over it.
Tightening torque: 5.9 N·m (0.6 kgf·m) 4.35 ft·lbs

Note:
Be careful not to get your fingers caught between the flange and case.
Be also careful not to get the oil seal's lip scratched.

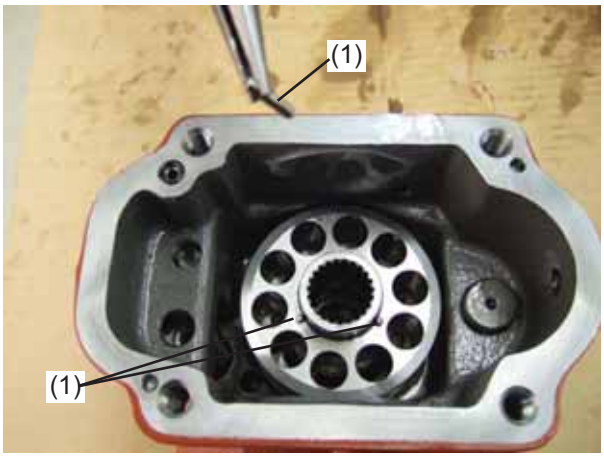
Tighten flange with socket head bolt.
Tightening torque: 128.4 N·m (13.1 kgf·m) 94.7 ft·lbs

8. Remove the feed back pin.
   Feed back pin: ϕ15 × 47.5 mm (ϕ0.59 in. x 1.87 in.)
   When reinstall, the half round end should be inside.

9. Remove the shaft and thrust washer.

10. Remove the piston assy.

11. Remove the cone.



12. Remove 3 pins.

(1) Pin

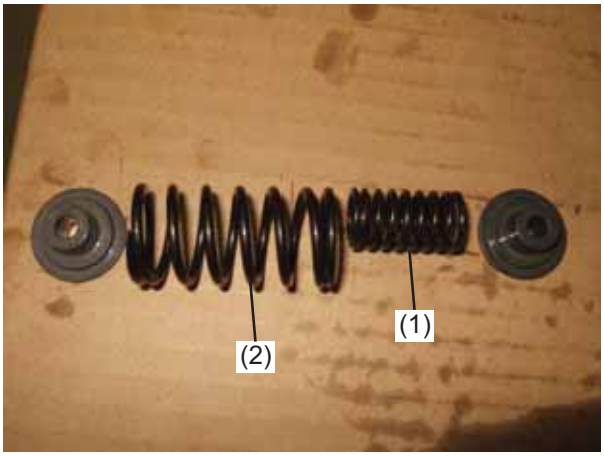
13. Remove the cylinder block.

14. Check the valve plate for any scratch.

15. Pick up the thrust washer.

16. Remove the control pin A.
    φ12.5 × 50.85 mm (φ0.492 x 2.00 in.)
    Control pin A falls down by itself.

17. Remove horse power control springs.



18. Horse power control springs

    (1) Inner spring
    (2) Outer spring

19. Remove pin B.

KX121-3α, KX121-3S/ST: ϕ25 (0.984 in.)
KX161-3α, KX161-3S/ST, U45-3α, U45-3S/ST
U45S/ST, U50-3α: ϕ28 (11.02 in.)

(When reassembly)
Place the valve plate.
Must meet the pin of the housing and the groove of the valve plate.

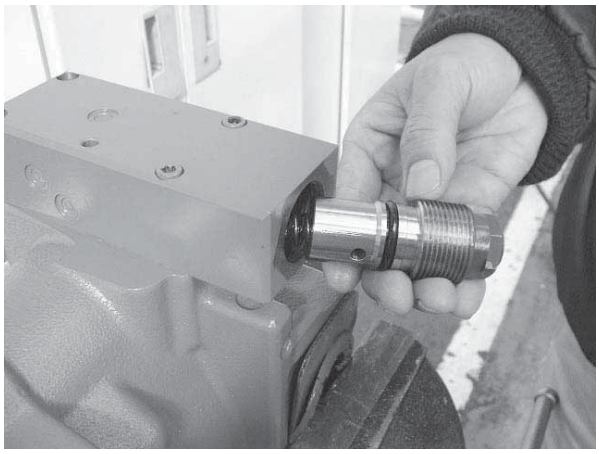
(When reassembly)
Place the thrust spacer.

(14) Main pump reassembly

Precautions before disassembly

- Remove all mud and dirt deposits off the pump surface. (Clean up the surface enough.)
- Let hydraulic oil out of the piston pump case and port hydraulic circuit.
- Choose a clean work spot. Be very careful not to allow any mud and dirt on the component parts.
- Handle the parts with enough care against dropping, hitting and scratching.
- If the case (1) or flange (3) is found damaged, replace the entire pump assembly with new one.

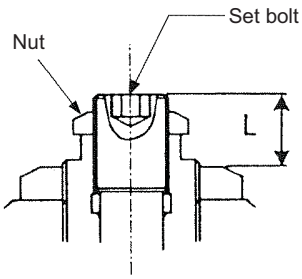
Pump disassembly

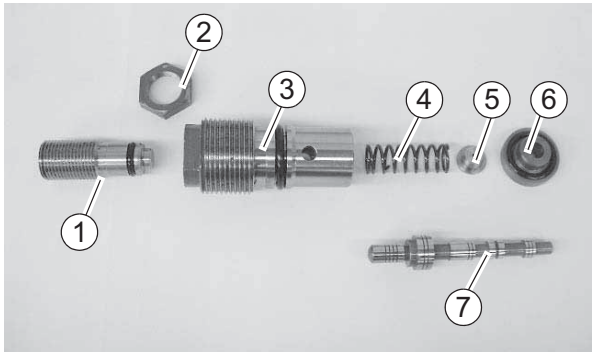


1) LS regulator (Flow control valve reassembly)

1. Screw the adjuster fully into the valve body.
2. Tighten the nut.
   Tightening torque: 689.9 N·m
3. Adjust the dimension L of the set bolt to that before disassembling. Tighten up the nut.

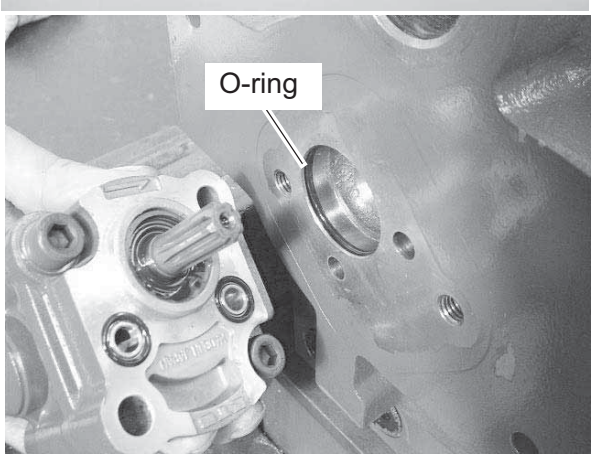
   Note:
   Measure the L length before disassembling.
   Final precise adjustment is required after mounting the pump on the machine. Refer to performance test.





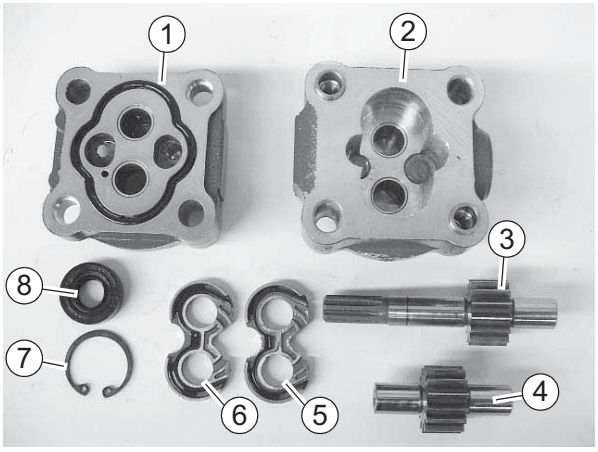
4. Inner parts

(1)	Set bolt	(5)	Spring holder
(2)	Nut	(6)	Bush
(3)	Adjuster	(7)	Spool
(4)	Spring		



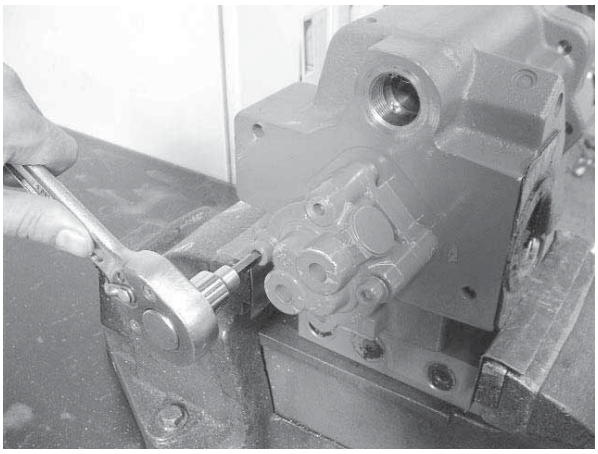
2) Gear pump reassembly

1. Place the oil seal in position at the gear pump-mounting side of the case. Then install the gear pump on the case.

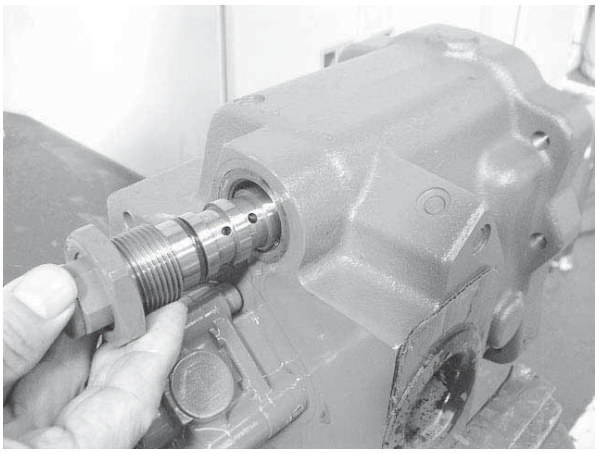


2. Gear pump inner parts

(1)	Flange	(5)	Bushing
(2)	Housing	(6)	Bushing
(3)	Drive gear	(7)	Snap ring
(4)	Driven gear	(8)	Oil seal



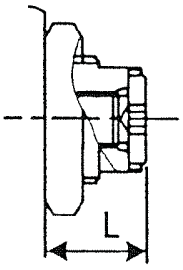
3. Use the hex socket bolts and plain washers to fix the gear pump.
   Tightening torque: 36.9 N·m



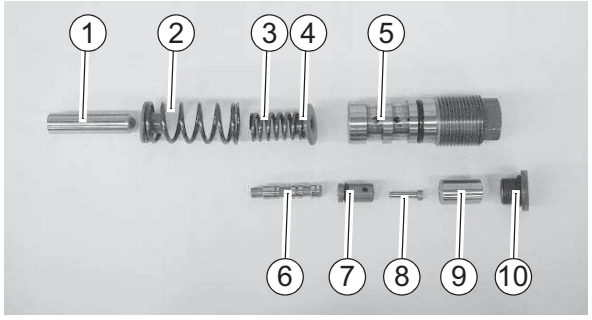
3)Horse power control valve assembling

1. Apply fresh hydraulic oil thinly over the sliding surface of the sleeve. Insert the sleeve assembly as well as the set of springs and spring seat into the case.
   Put your hand in the case from the other side to hold the spring seat and keep it from dropping.

2. Screw the sleeve into position.
   Adjust the dimension L, as shown below, to that before disassembling.
   Now tighten up the nut

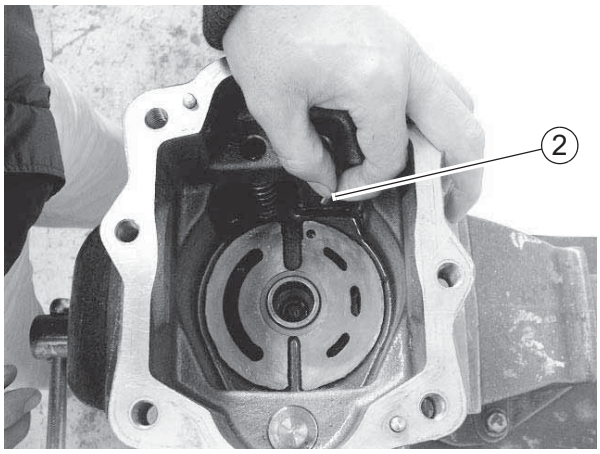


   Note:
   Measure L length before disassembling.Final precise adjustment is required after mounting the pump on the machine. Refer to performance test.

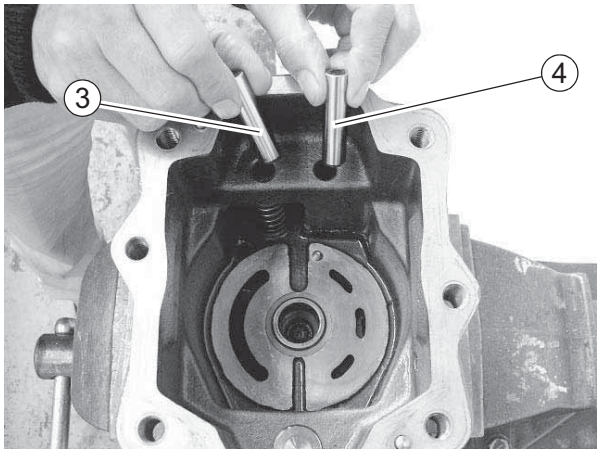


3. Inner parts.

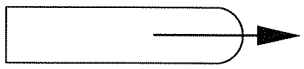
(1)	Feel back pin	(6)	Spool
(2)	Spring	(7)	Collar
(3)	Spring	(8)	Pin
(4)	Spring seat	(9)	Spacer
(5)	Sleeve	(10)	Plug

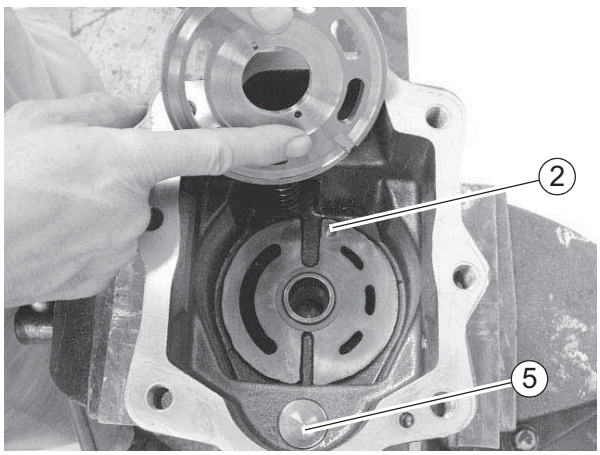


4. Fix the case in a vise with care not to scratch the suction and discharge ports. Fit the pin (1) and parallel pin (2) in place.



5. Insert pin (3), (4).
   Pin (3): Feel back pin
   KX121-3S/α/ST: ϕ 12.5 → ϕ 15.0 (0.59 in.)
   KX161-3S/α/ST: ϕ 12.5 (0.492 in.)
   Pin (4): Control pin A
   KX121-3S/α/ST: ϕ 12.5 (0.492 in.)
   KX161-3S/α/ST: ϕ 12.5 (0.492 in.)
   Note:
   Be sure the direction of pin (3), (4).

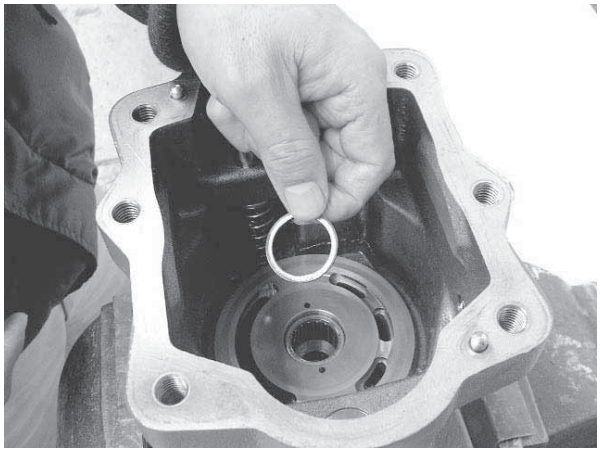




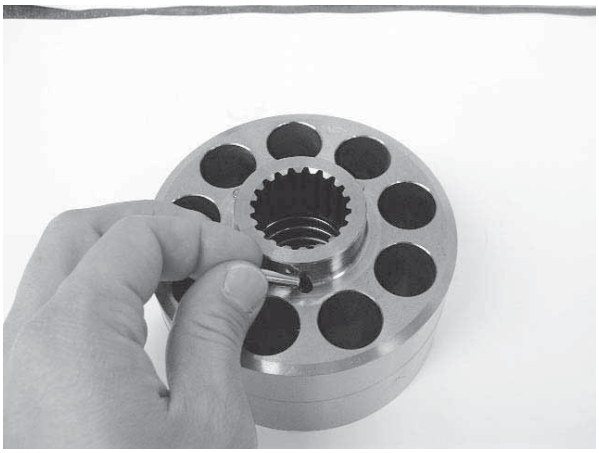
6. Place the valve plate.

   Note:
   Position the valve plate so that the notch should be in alignment with the parallel pin (2).
   Be sure to apply hydraulic oil on both sides of the valve plate before placing it.

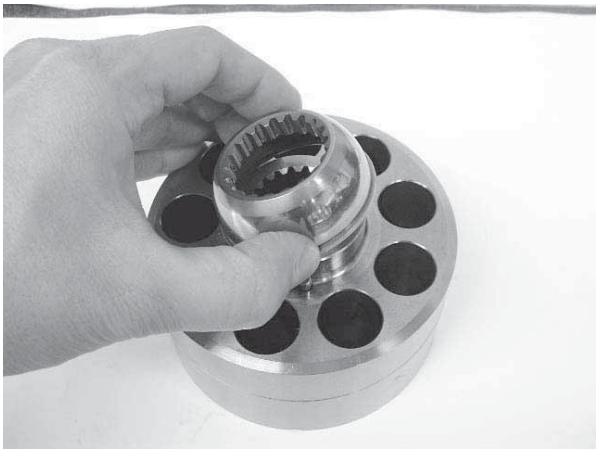
   Pin (5): Control pin B
   KX121-3/α/S/ST: ϕ 25 (0.984 in.)
   KX161-3/α/S/ST: ϕ 28 (11.02 in.)



7. Place the thrust washer.

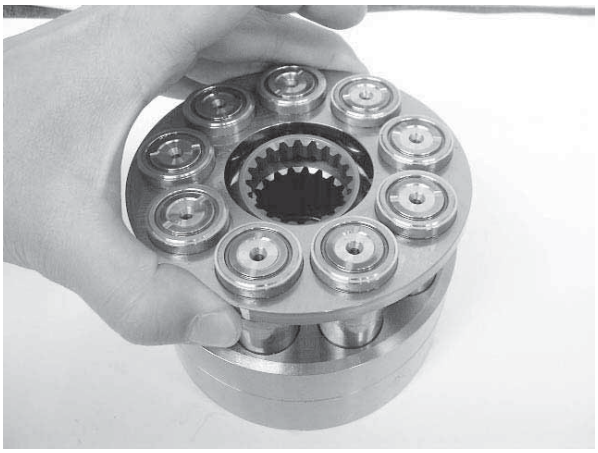


8. Apply lithium grease thinly over the pins. Insert them in the three holes of the cylinder block.



9. Place the retainer holder onto the cylinder block.

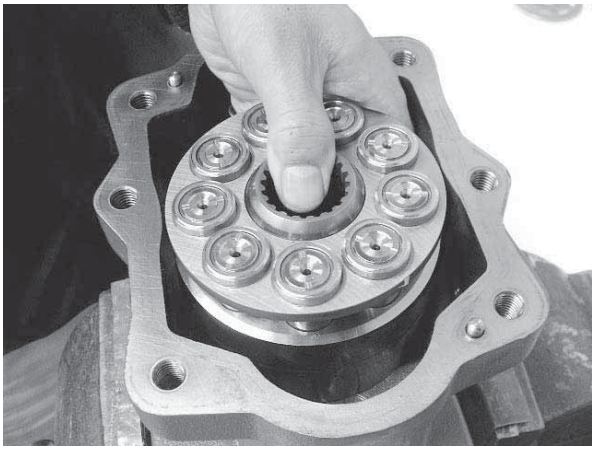
   Note:
   Be sure to apply the hydraulic oil on outer surface of retainer holder and inner surface of cylinder block.



10. Fit the piston assembly in the retainer plate. Positioning them with your hand, fit them into the cylinder block.

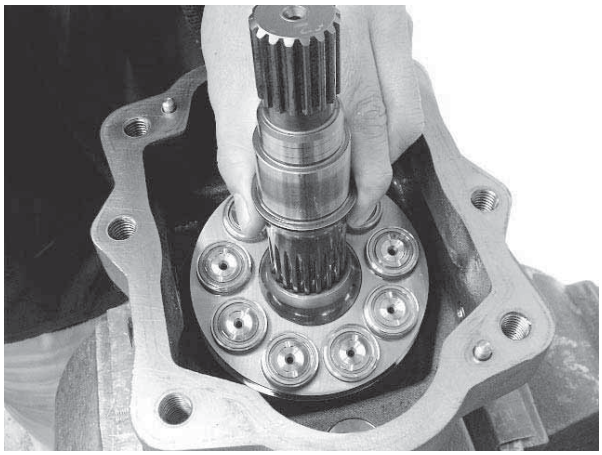
Assembly direction (Retainer holder side)

   Note:
   Be careful not to get the assembly scratched. Do not use a hammer.
   Also be sure to apply hydraulic oil over the outer surface of the piston assembly and the shoe surface.

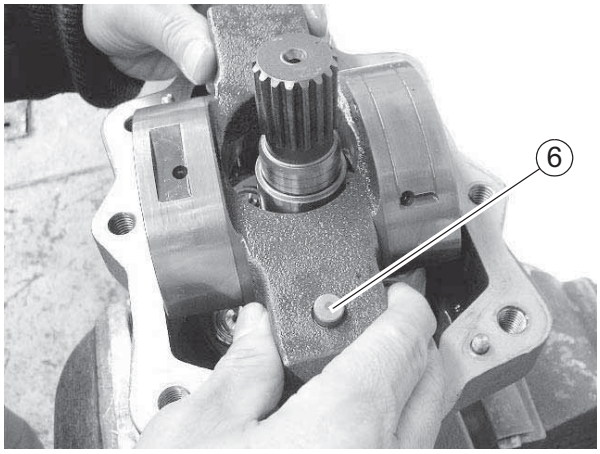


11. Install the cylinder block assy

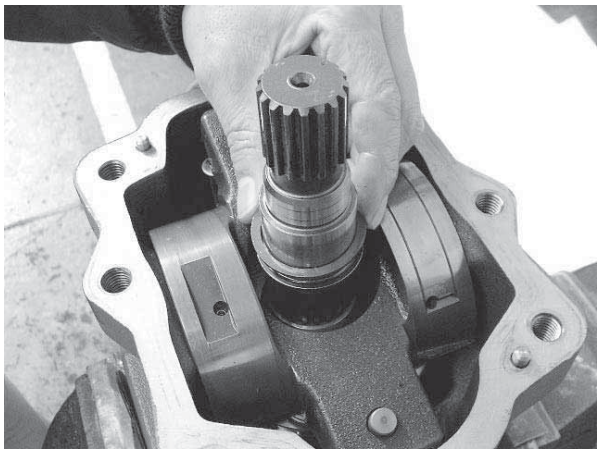
   Note:
   Be sure to apply grease on the bottom surface of cylinder block assy.
   Special cave should be taken not to get any damage.



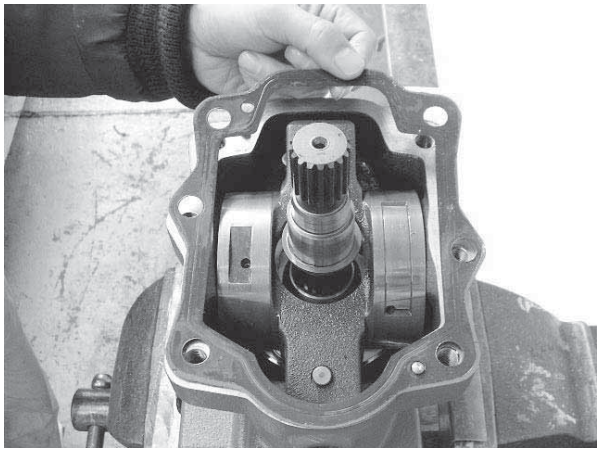
12. Install the shaft.



13. Place the swash plate with its stopper (6) on the side of the control pin B.



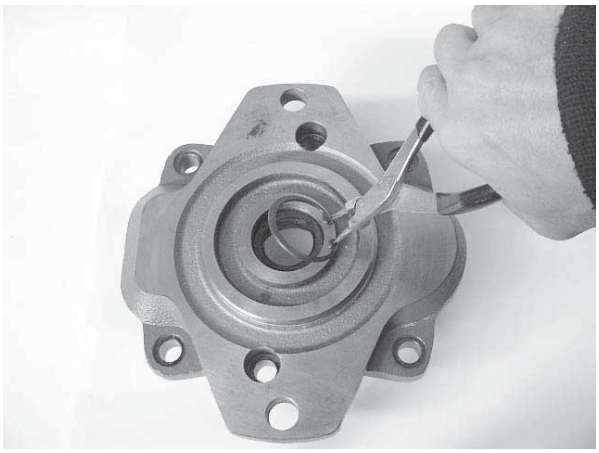
14.Place the thrust washer into the shaft.



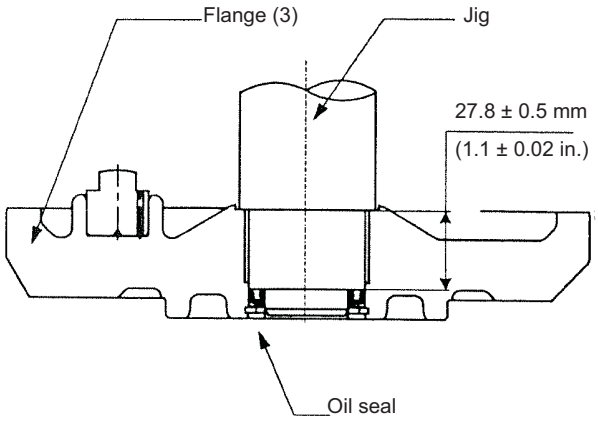
15.Place the gasket.

Danger

Never get hurt your hand or finger by the edge of the gasket.

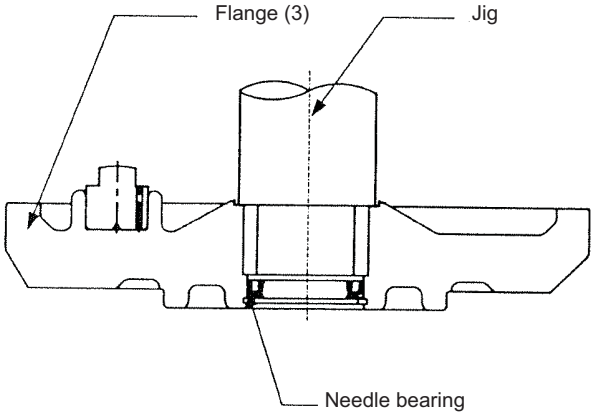


16. Attach the snap ring to the flange.
    Place the snap ring with its punched-out side facing toward the load side.



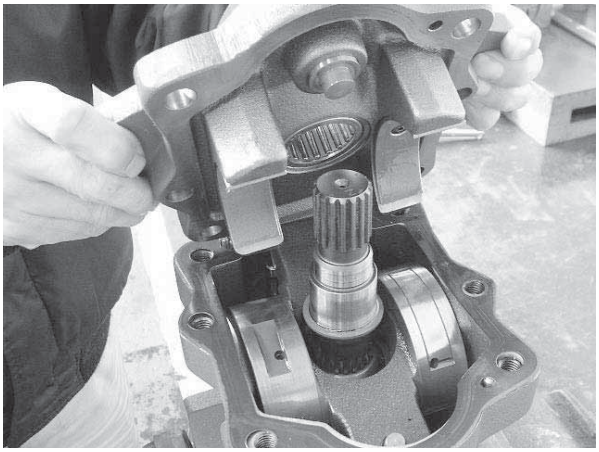
17. Using the specific jig, insert the oil seal in the flange.
    Position: Make sure the oil seal is 27.8 ± 0.5 mm (1.1 ± 0.02 in.) deep from the step.

    Note:
    Apply lithium grease on inner side of oil seal lip.



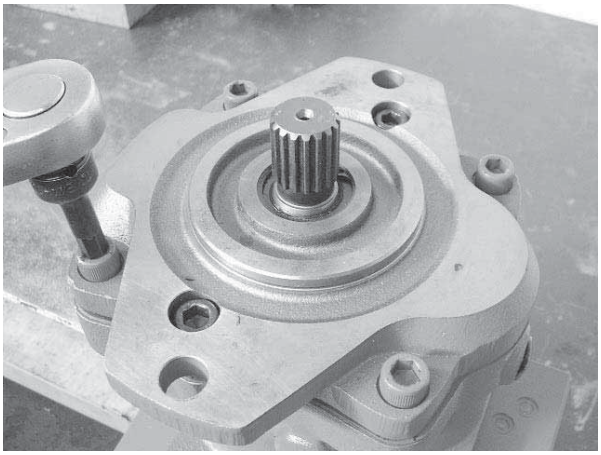
18. Install the needle bearing in the flange by using jig.
    Position: Make sure the bearing is flush with the step.

    Note:
    Press-fit the bearing with its marked side upward.



19. Tighten up the bushes with the screws (tightening torque: 5.9 N·m), and place the flange over it.

    Note:
    Be careful not to get your fingers caught between the flange and case.
    Be also careful not to get the oil seal's lip scratched.



20. Tighten flange with socket head bolt.
    Tightening torque: 128.4 N·m (13.1 kgf·m) 94.7 ft·lbs

d) Control Valve

(1) Precautions in disassembling and reassembling

1) Precautions in disassembling

1. Most hydraulic system components are precision-machined and have specified small clearances. With this in mind, disassemble and reassemble these components in a clean place.
2. Use clean tools and fresh cleaning oil. Handle them with care.
3. When taking out an assembly, clean up the outer surface of the assembly first.
4. Before starting the job, have the internal construction in mind, and prepare parts that are necessary for the disassembling purpose and scope. Before reassembling, basically replace the seals and O-rings with new ones. Some parts are not supplied alone, but their related subassemblies themselves may have to be replaced. Get them prepared beforehand, referring to the Parts Catalog.

2) Precautions in reassembling

Handling the O-rings

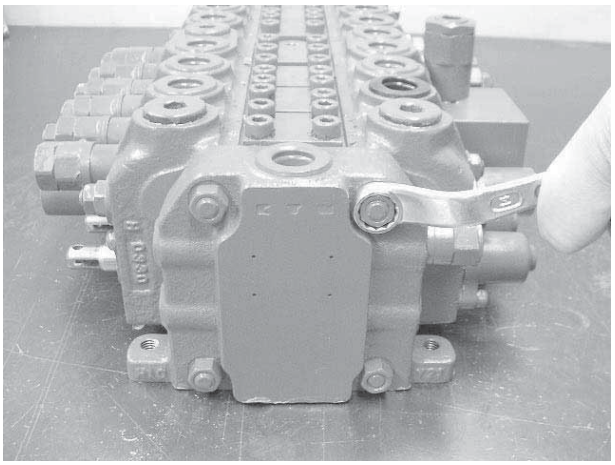
1. Apply fresh grease or hydraulic oil to the O-rings and their counter-sunk spots.
2. Make sure the O-rings are not poorly molded, scratched or thermally deformed.
3. Do not expand the O-rings too much. They may get permanently deformed.
   (Pass the O-rings over the spool edge with care not to scratch them.)
4. Do not place the O-rings into position by turning them.
   (They may get dirty and stuck, causing an oil leak.)
   Before reassembling, look at the mating faces of each section to make sure that the outer faces of the O-ring grooves are not covered with cleaning oil or hydraulic oil.
   (If the mating faces are covered with oil, such oil may be regarded as an oil leak during operation.)

3) Disassembling and reassembling the control valve

1. Fix one nut with a wrench and loosen the other nut.
   Tightening torque: 46.1 ± 2 N·m (4.7 ± 2 kgf·m)
   34 ± 14.5 ft·lbs
2. Draw each section out of the tie rod. Place all the sections in order on a clean workbench.

Notes:

1. When taking out each section, be very careful not to lose the load check valve, spring and shuttle plate.
2. Place the load check valve, spring and shuttle plate for each section in order to identify them.
3. Put a position marking to each section.



Model: KX161-3/S/α/ST

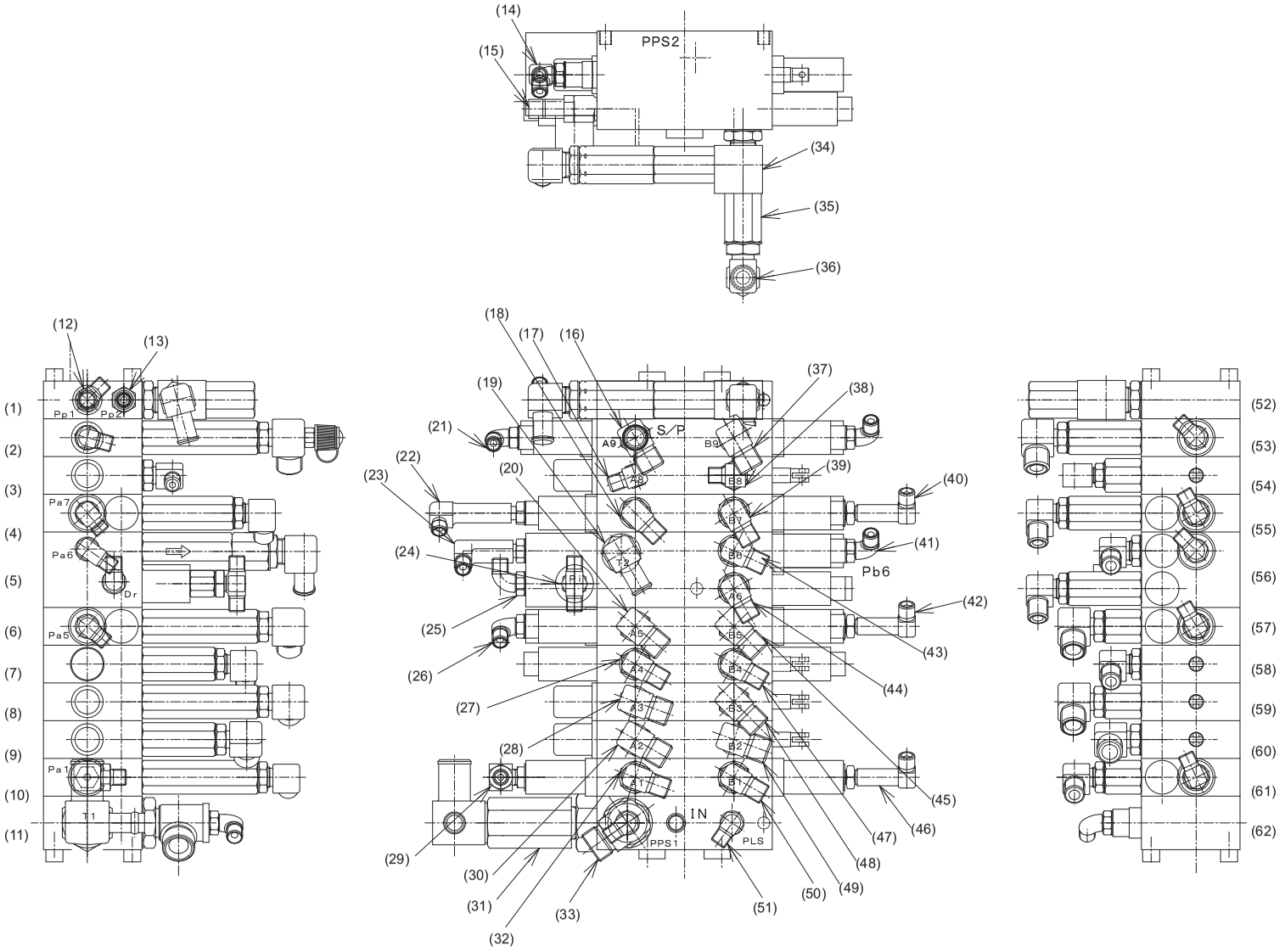
<Service point>

- When disassembling the valves, be careful of the adhesion of the garbage sufficiently.
- Check the poppet seat for scratches, the spring for deformation, and the sealings for deterioration.
- Check the spool to see if it is free from scratches and if it slides smoothly on the body.

Check the spool for dust deposits in and around the throttle opening.

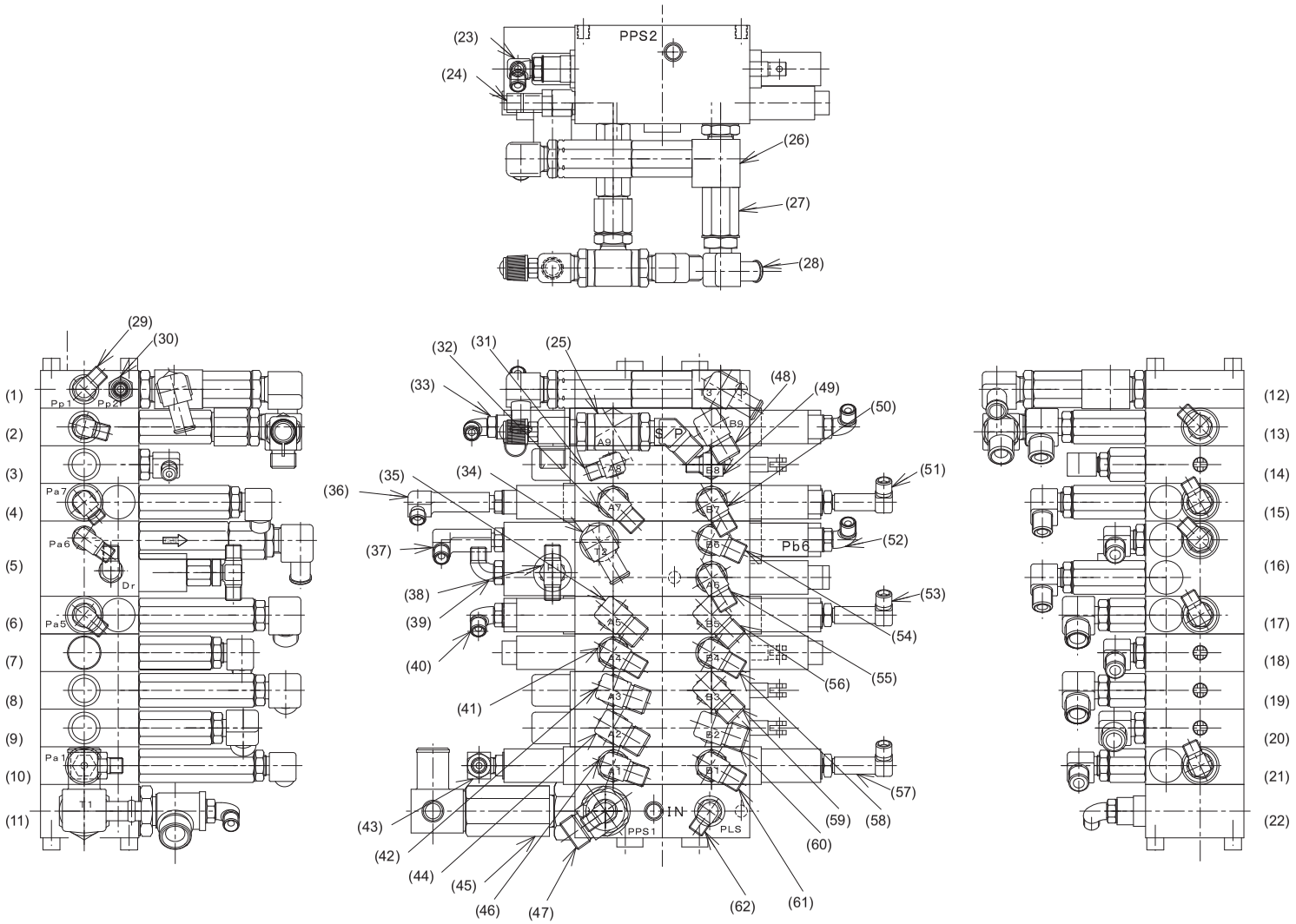
(2)Adapters

Model: KX121-3/S/ST/α



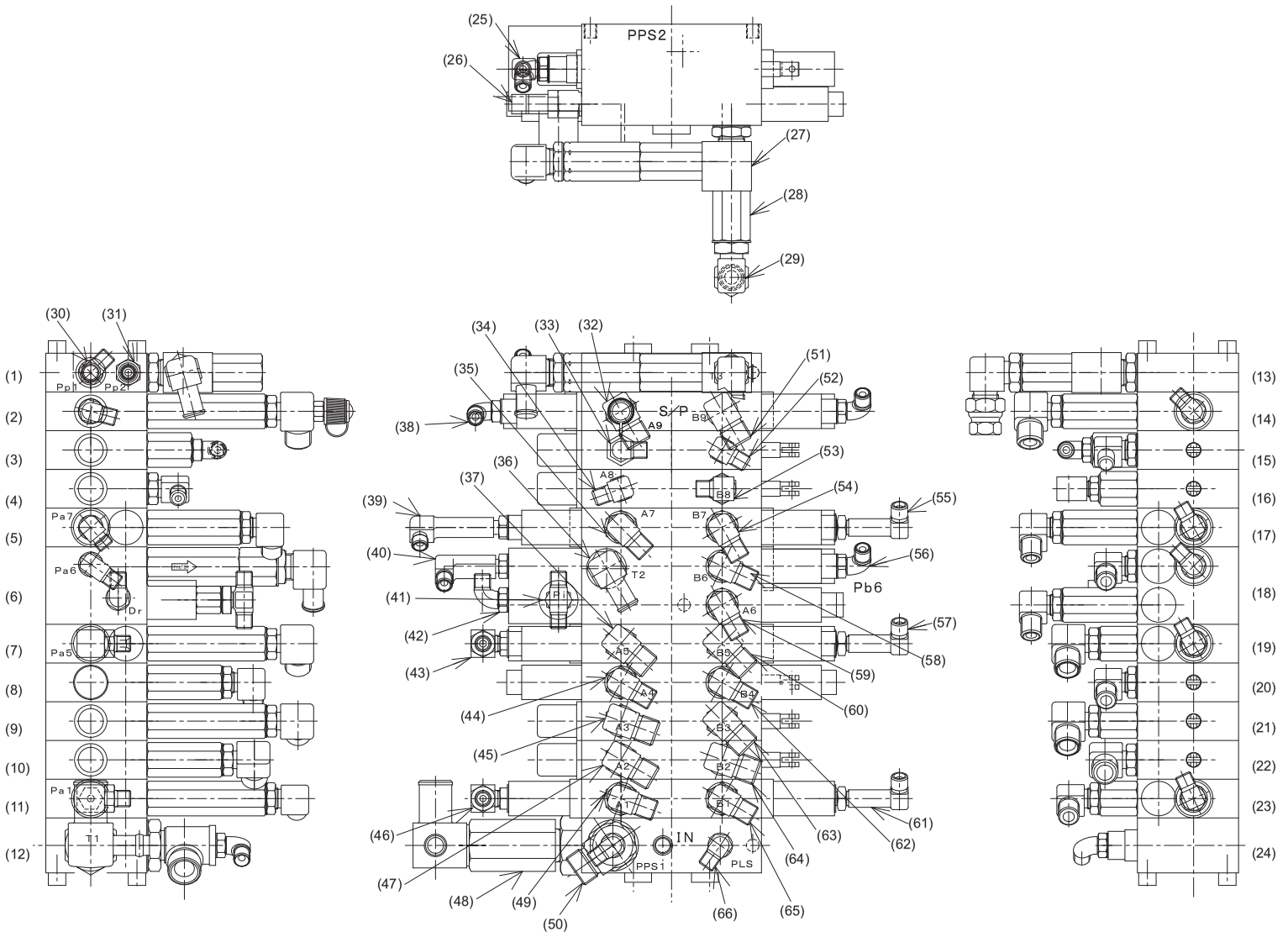
(1) Outlet
(2) Service port
(3) Swing
(4) Bucket
(5) Boom
(6) Arm
(7) Dozer
(8) Travel right
(9) Travel left
(10) Swivel
(11) Inlet
(12) Pipe joint (L, G1/4-G1/4)
(13) Pipe joint (S, G1/4-M10)
witch (pressure, 25, OK)
O-ring
(14) Pipe joint (L, G1/4-G1/4)
O-ring
(15) Pipe joint (S, G1/4-M10)
O-ring
Switch (pressure, 25, OK)
(16) Pipe joint (S, G3/8-G3/8)
Elbow pipe joint (3-4-25)
Adapter (gauge)
(17) Pipe joint (L, F3-F2)
O-ring
(18) Pipe joint (L, G3/8-G3/8)
O-ring
Pipe joint (S, G3/8-G3/8)
O-ring
(19) Filter
Pipe joint (L, F1/2-15.9)
O-ring
(20) Pipe joint (L, G3/8-G1/2)
Pipe joint (S, G3/8-G3/8)
(21) Pipe joint (L, G1/4-G1/4)
(22) Elbow pipe joint (2)
O-ring
(23) Elbow pipe joint (1)
O-ring
(24) Pipe joint (S, G1/4-G1/4)
O-ring
T pipe joint (F2)
O-ring
(25) Pipe joint (L, G1/4-G1/4)
(26) Pipe joint (L, G1/4-G1/4)
(27) Pipe joint (L, G3/8-G3/8)
O-ring
Pipe joint (S, G3/8-G3/8)
(28) Pipe joint (L, G3/8-G1/2)
Pipe joint (S, G3/8-G3/8)
(29) Pipe joint (L, G1/4-G1/4)
O-ring
Straight pipe joint
O-ring
(30) Pipe joint (L, G3/8-G1/2)
Pipe joint (S, G3/8-G3/8)
(31) Valve assembly (check, 15)
(32) Pipe joint (L, G3/8-G3/8)
O-ring
Pipe joint (S, G3/8-G3/8)
(33) T pipe joint (G6-G6-G2)
Pipe joint (L, G1/4-G1/4)
(34) Elbow pipe joint (G1/2-3)
Pipe joint (S, G1/2-G1/2)
O-ring
Valve assembly (check, 12)
(35) Pipe joint (S, G1/2-G1/2)
O-ring
(36) Elbow pipe joint
O-ring
Plug
(37) Pipe joint (S, G3/8-G3/8)
Pipe joint (L, G3/8-G1/2)
(38) Pipe joint (S, G3/8-G3/8)
Pipe joint (L, F3-F2)
O-ring
(39) Pipe joint (L, G3/8-G3/8)
O-ring
Pipe joint (S, G3/8-G3/8)
(40) Pipe joint (L, G1/4-G1/4)
O-ring
(41) Pipe joint (L, G1/4-G1/4)
(42) Pipe joint (L, G1/4-G1/4)
O-ring
(43) Pipe joint (L, G3/8-G3/8)
O-ring
(44) Pipe joint (S, G3/8-G3/8)
Pipe joint (L, G3/8-G3/8)
O-ring
(45) Pipe joint (S, G3/8-G3/8)
Pipe joint (L, G3/8-G1/2)
(46) Pipe joint (L, G1/4-G1/4)
O-ring
(47) Pipe joint (L, G3/8-G3/8)
O-ring
(48) Pipe joint (L, G3/8-G1/2)
Pipe joint (S, G3/8-G3/8)
(49) Pipe joint (L, G3/8-G1/2)
(50) Pipe joint (L, G3/8-G3/8)
O-ring
Pipe joint (S, G3/8-G3/8)
(51) Pipe joint (L, G1/4-G1/4)
(52) Outlet
(53) Service port
(54) Swing
(55) Bucket
(56) Boom
(57) Arm
(58) Dozer
(59) Travel right
(60) Travel left
(61) Swivel
(62) Inlet

Model: KX121-3S/ST/α, Third line



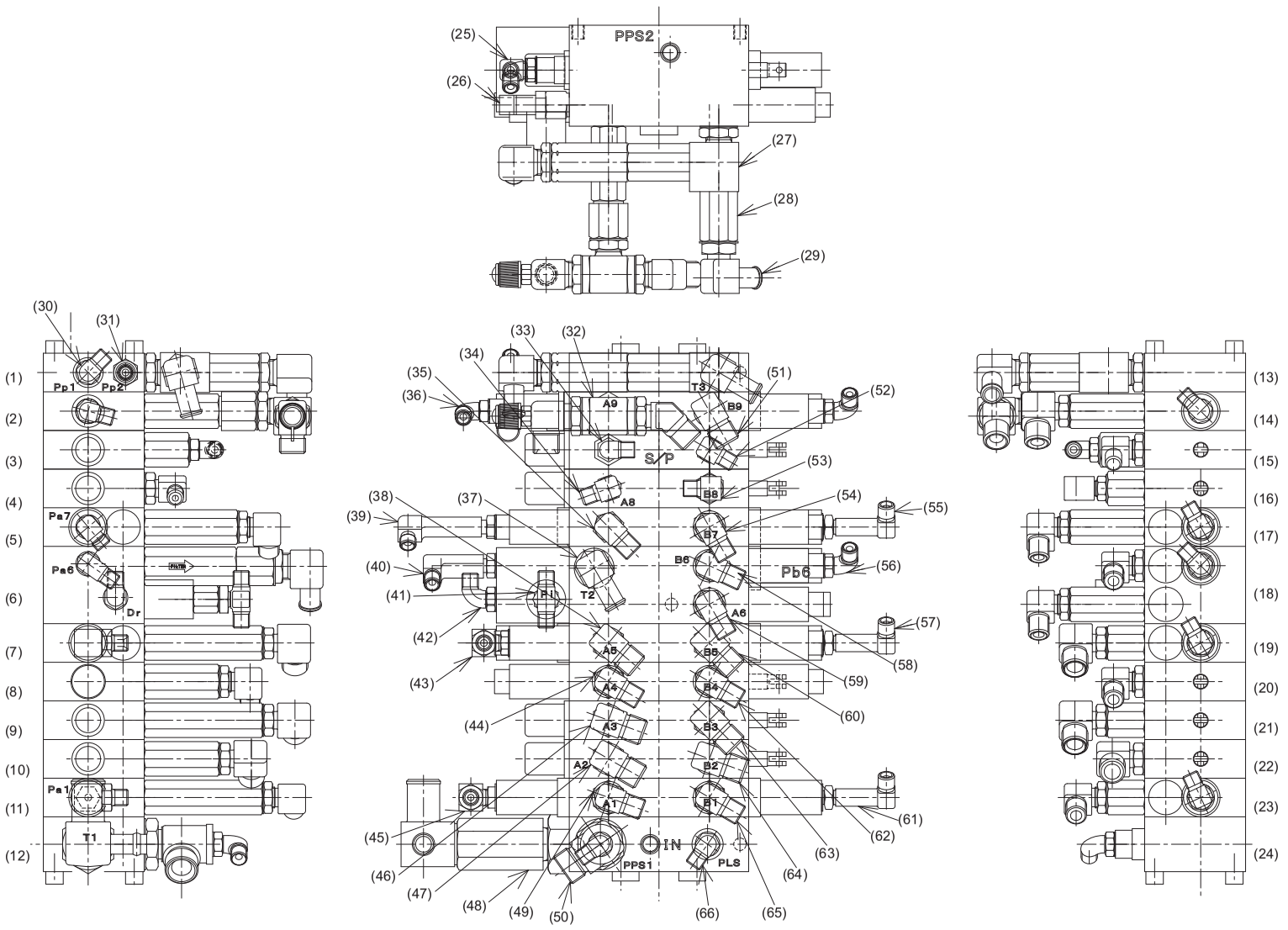
(1) Outlet
(2) Service port
(3) Swing
(4) Bucket
(5) Boom
(6) Arm
(7) Dozer
(8) Travel right
(9) Travel left
(10) Swivel
(11) Inlet
(12) Outlet
(13) Service port
(14) Swing
(15) Bucket
(16) Boom
(17) Arm
(18) Dozer
(19) Travel right
(20) Travel left
(21) Swivel
(22) Inlet
(23) Pipe joint (L, G1/4-G1/4)
O-ring
(24) Pipe joint (S, G1/4-M10)
O-ring
Switch (pressure, 25, OK)
(25) Pipe joint (S, G3/8-G3/8)
Pipe joint (S, G3/8-G1/2)
T pipe joint (G1/2-3)
Elbow pipe joint
Adapter (gauge)
Pipe joint (L, G4-G4, 45)
(26) Elbow pipe joint (G1/2-3)
Pipe joint (S, G1/2-G1/2)
O-ring
Valve assembly (check, 12)
(27) Pipe joint (S, G1/2-G1/2)
O-ring
(28) Pipe joint (L, F1/2-15.9)
O-ring
(29) Pipe joint (L, G1/4-G1/4)
(30) Pipe joint (S, G1/4-M10)
Switch (pressure, 25, OK)
O-ring
(31) Pipe joint (L, F3-F2)
O-ring
(32) Pipe joint (L, G3/8-G3/8)
O-ring
Pipe joint (S, G3/8-G3/8)
O-ring
(33) Pipe joint (L, G1/4-G1/4)
(34) Filter
Pipe joint (L, F1/2-15.9)
O-ring
(35) Pipe joint (L, G3/8-G1/2)
Pipe joint (S, G3/8-G3/8)
(36) Elbow pipe joint (2)
O-ring
(37) Elbow pipe joint (1)
O-ring
(38) Pipe joint (S, G1/4-G1/4)
O-ring
T pipe joint (F2)
O-ring
(39) Pipe joint (L, G1/4-G1/4)
(40) Pipe joint (L, G1/4-G1/4)
(41) Pipe joint (L, G3/8-G3/8)
O-ring
Pipe joint (S, G3/8-G3/8)
(42) Pipe joint (S, G3/8-G1/2)
Pipe joint (S, G3/8-G3/8)
(43) Pipe joint (L, G1/4-G1/4)
O-ring
Straight pipe joint
O-ring
(44) Pipe joint (L, G3/8-G1/2)
Pipe joint (S, G3/8-G3/8)
(45) Valve assembly (check, 15)
(46) Pipe joint (L, G3/8-G3/8)
O-ring
Pipe joint (S, G3/8-G3/8)
(47) T pipe joint (G6-G6-G2)
Pipe joint (L, G1/4-G1/4)
(48) Pipe joint (S, G3/8-G3/8)
Pipe joint (L, G3/8-G1/2)
(49) Pipe joint (S, G3/8-G3/8)
Pipe joint (L, F3-F2)
O-ring
(50) Pipe joint (L, G3/8-G3/8)
O-ring
Pipe joint (S, G3/8-G3/8)
(51) Pipe joint (L, G1/4-G1/4)
O-ring
(52) Pipe joint (L, G1/4-G1/4)
(53) Pipe joint (L, G1/4-G1/4)
O-ring
(54) Pipe joint (L, G3/8-G3/8)
O-ring
(55) Pipe joint (S, G3/8-G3/8)
Pipe joint (L, G3/8-G3/8)
O-ring
(56) Pipe joint (S, G3/8-G3/8)
Pipe joint (L, G3/8-G1/2)
(57) Pipe joint (L, G1/4-G1/4)
O-ring
(58) Pipe joint (L, G3/8-G3/8)
O-ring
(59) Pipe joint (L, G3/8-G1/2)
Pipe joint (S, G3/8-G3/8)
(60) Pipe joint (L, G3/8-G1/2)
(61) Pipe joint (L, G3/8-G3/8)
O-ring
Pipe joint (S, G3/8-G3/8)
(62) Pipe joint (L, G1/4-G1/4)

Model: KX121-3S/ST/α, Angle blade



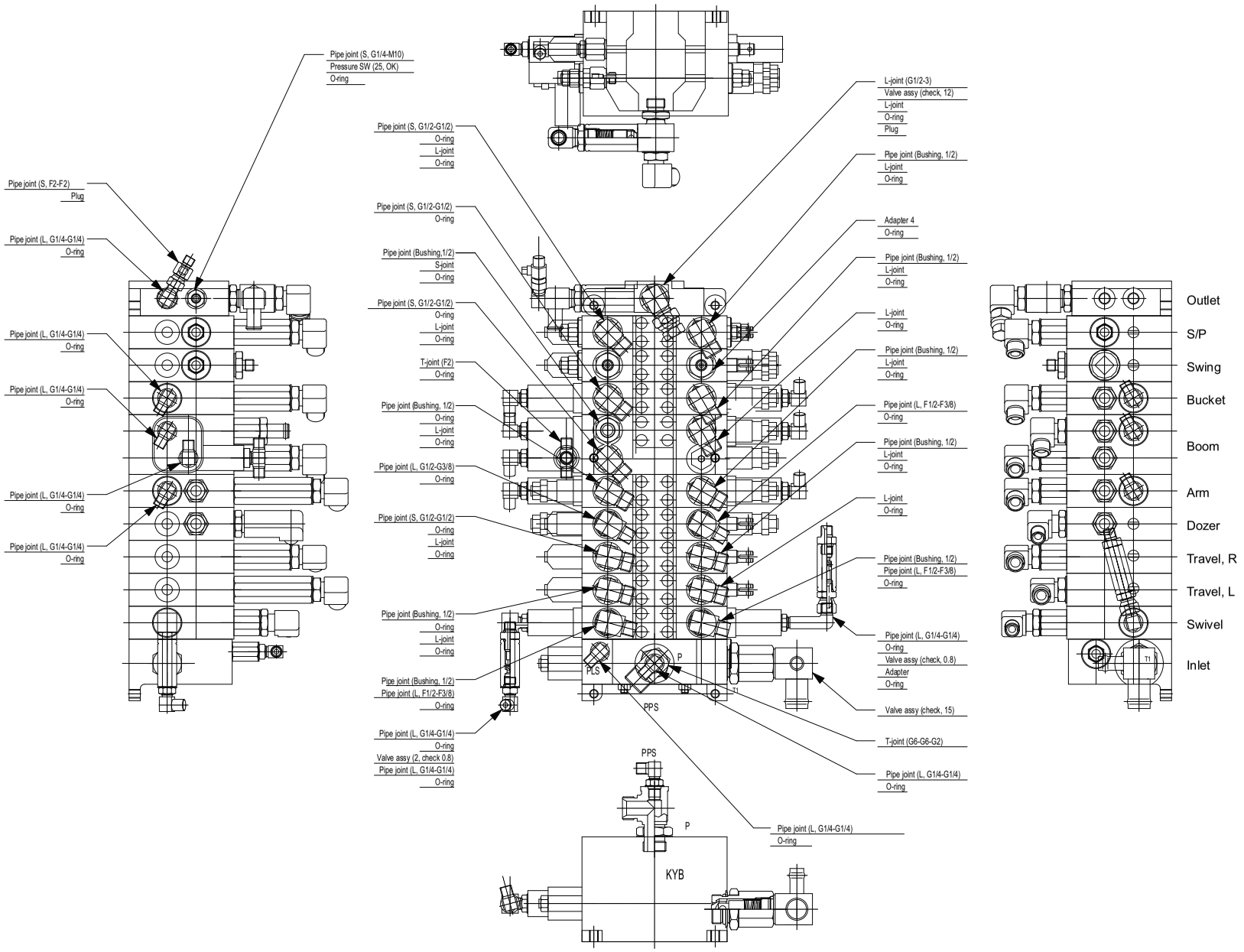
(1) Outlet
(2) Service port
(3) Angle
(4) Swing
(5) Bucket
(6) Boom
(7) Arm
(8) Dozer
(9) Travel right
(10) Travel left
(11) Swivel
(12) Inlet
(13) Outlet
(14) Service port
(15) Angle
(16) Swing
(17) Bucket
(18) Boom
(19) Arm
(20) Dozer
(21) Travel right
(22) Travel left
(23) Swivel
(24) Inlet
(25) Pipe joint (L, G1/4-G1/4)
O-ring
(26) Pipe joint (S, G1/4-M10)
O-ring
Switch (pressure, 25, OK)
(27) Elbow pipe joint (G1/2-3)
Pipe joint (S, G1/2-G1/2)
O-ring
Valve assembly (check, 12)
(28) Pipe joint (S, G1/2-G1/2)
O-ring
(29) Elbow pipe joint
O-ring
Plug
(30) Pipe joint (L, G1/4-G1/4)
(31) Pipe joint (S, G1/4-M10)
Switch (pressure, 25, OK)
O-ring
(32) Pipe joint (S, G3/8-G3/8)
Elbow pipe joint (3-4-25)
Adapter (gauge)
(33) Adapter (gauge)
Pipe joint (L, G1/4-G1/4)
O-ring
(34) Pipe joint (L, F3-F2)
O-ring
(35) Pipe joint (L, G3/8-G3/8)
O-ring
Pipe joint (S, G3/8-G3/8)
O-ring
(36) Filter
Pipe joint (L, F1/2-15.9)
O-ring
(37) Pipe joint (L, G3/8-G1/2)
Pipe joint (S, G3/8-G3/8)
(38) Pipe joint (L, G1/4-G1/4)
(39) Elbow pipe joint (2)
O-ring
(40) Elbow pipe joint (1)
O-ring
(41) Pipe joint (S, G1/4-G1/4)
O-ring
T pipe joint (F2)
O-ring
(42) Pipe joint (L, G1/4-G1/4)
(43) Pipe joint (L, G1/4-G1/4)
O-ring
Adapter
(44) Pipe joint (L, G3/8-G3/8)
O-ring
Pipe joint (S, G3/8-G3/8)
(45) Pipe joint (L, G3/8-G1/2)
Pipe joint (S, G3/8-G3/8)
(46) Pipe joint (L, G1/4-G1/4)
O-ring
Straight pipe joint
O-ring
(47) Pipe joint (L, G3/8-G1/2)
Pipe joint (S, G3/8-G3/8)
(48) Valve assembly (check, 15)
(49) Pipe joint (L, G3/8-G3/8)
O-ring
Pipe joint (S, G3/8-G3/8)
(50) T pipe joint (G6-G6-G2)
Pipe joint (L, G1/4-G1/4)
(51) Pipe joint (S, G3/8-G3/8)
Pipe joint (L, G3/8-G1/2)
(52) Pipe joint (L, F3/8-F1/4)
O-ring
(53) Pipe joint (S, G3/8-G3/8)
Pipe joint (L, F3-F2)
O-ring
(54) Pipe joint (L, G3/8-G3/8)
O-ring
Pipe joint (S, G3/8-G3/8)
(55) Pipe joint (L, G1/4-G1/4)
O-ring
(56) Pipe joint (L, G1/4-G1/4)
(57) Pipe joint (L, G1/4-G1/4)
O-ring
(58) Pipe joint (L, G3/8-G3/8)
O-ring
(59) Pipe joint (S, G3/8-G3/8)
Pipe joint (L, G3/8-G3/8)
O-ring
(60) Pipe joint (S, G3/8-G3/8)
Pipe joint (L, G3/8-G1/2)
(61) Pipe joint (L, G1/4-G1/4)
O-ring
(62) Pipe joint (L, G3/8-G3/8)
O-ring
(63) Pipe joint (L, G3/8-G1/2)
Pipe joint (S, G3/8-G3/8)
(64) Pipe joint (L, G3/8-G1/2)
(65) Pipe joint (L, G3/8-G3/8)
O-ring
Pipe joint (S, G3/8-G3/8)
(66) Pipe joint (L, G1/4-G1/4)

Model: KX121-3S/ST/α, Angle blade and third line

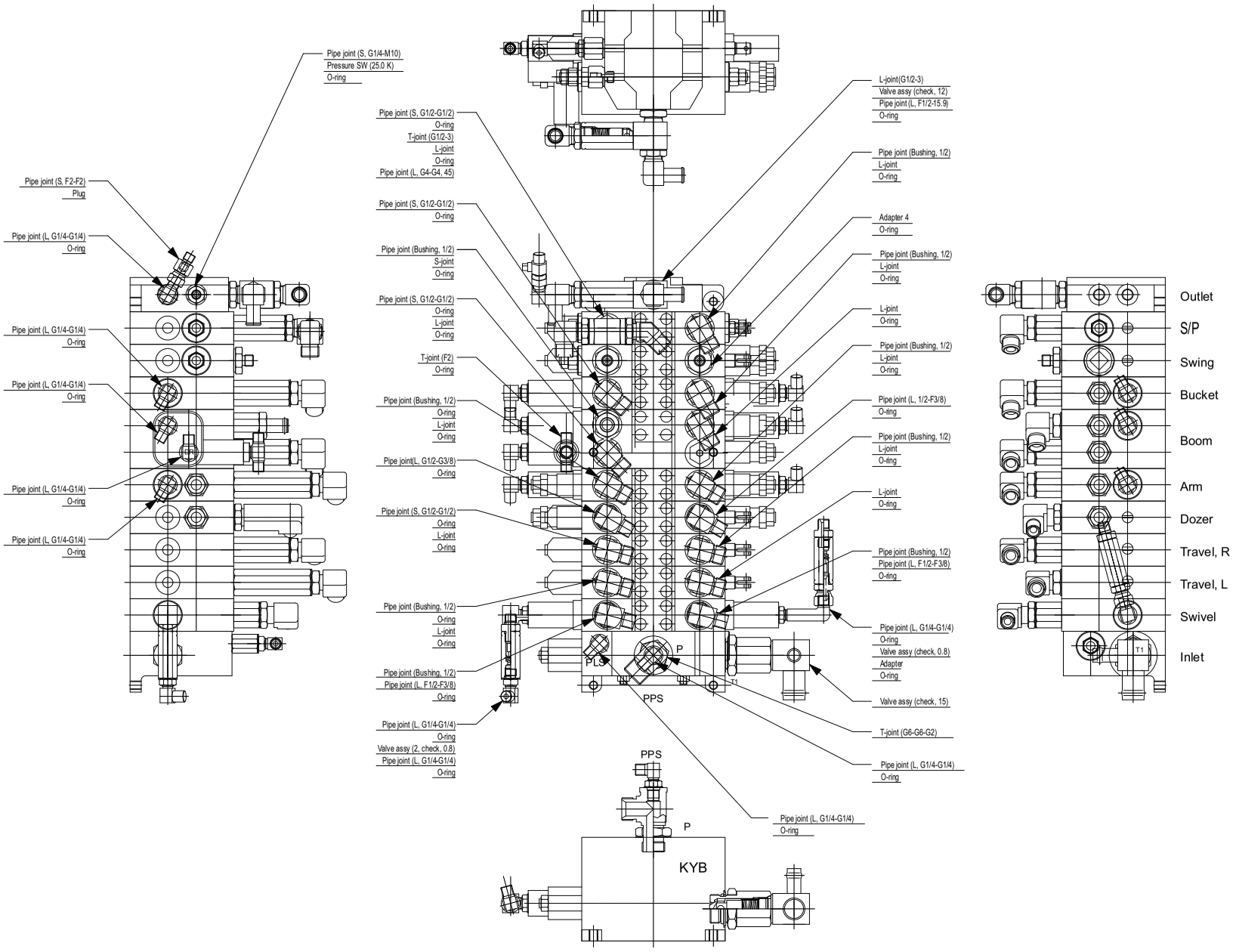


(1) Outlet
(2) Service port
(3) Angle
(4) Swing
(5) Bucket
(6) Boom
(7) Arm
(8) Dozer
(9) Travel right
(10) Travel left
(11) Swivel
(12) Inlet
(13) Outlet
(14) Service port
(15) Angle
(16) Swing
(17) Bucket
(18) Boom
(19) Arm
(20) Dozer
(21) Travel right
(22) Travel left
(23) Swivel
(24) Inlet
(25) Pipe joint (L, G1/4-G1/4)
O-ring
(26) Pipe joint (S, G1/4-M10)
O-ring
Switch (pressure, 25, OK)
(27) Elbow pipe joint (G1/2-3)
Pipe joint (S, G1/2-G1/2)
O-ring
Valve assembly (check, 12)
(28) Pipe joint (S, G1/2-G1/2)
O-ring
(29) Pipe joint (L, F1/2-15.9)
O-ring
(30) Pipe joint (L, G1/4-G1/4)
(31) Pipe joint (S, G1/4-M10)
Switch (pressure, 25, OK)
O-ring
(32) Pipe joint (S, G3/8-G3/8)
Pipe joint (S, G3/8-G1/2)
T pipe joint (G1/2-3)
Elbow pipe joint
Adapter (gauge)
Pipe joint (S, G4-G4, 45)
(33) Adapter
Pipe joint (L, G1/4-G1/4)
O-ring
(34) Pipe joint (L, F3-F2)
O-ring
(35) Pipe joint (L, G3/8-G3/8)
O-ring
Pipe joint (S, G3/8-G3/8)
O-ring
(36) Pipe joint (L, G1/4-G1/4)
(37) Filter
Pipe joint (L, F1/2-15.9)
O-ring
(38) Pipe joint (L, G3/8-G1/2)
Pipe joint (S, G3/8-G3/8)
(39) Elbow pipe joint (2)
O-ring
(40) Elbow pipe joint (1)
O-ring
(41) Pipe joint (S, G1/4-G1/4)
O-ring
T pipe joint (F2)
O-ring
(42) Pipe joint (L, G1/4-G1/4)
(43) Pipe joint (L, G1/4-G1/4)
O-ring
Adapter
(44) Pipe joint (L, G3/8-G3/8)
O-ring
Pipe joint (S, G3/8-G3/8)
(45) Pipe joint (L, G1/4-G1/4)
O-ring
Straight pipe joint
O-ring
(46) Pipe joint (S, G3/8-G1/2)
Pipe joint (S, G3/8-G3/8)
(47) Pipe joint (L, G3/8-G1/2)
Pipe joint (S, G3/8-G3/8)
(48) Valve assembly (check, 15)
(49) Pipe joint (L, G3/8-G3/8)
O-ring
Pipe joint (S, G3/8-G3/8)
(50) T pipe joint (G6-G6-G2)
Pipe joint (L, G1/4-G1/4)
(51) Pipe joint (S, G3/8-G3/8)
Pipe joint (L, G3/8-G1/2)
(52) Pipe joint (L, F3/8-F1/4)
O-ring
(53) Pipe joint (S, G3/8-G3/8)
Pipe joint (L, F3-F2)
O-ring
(54) Pipe joint (L, G3/8-G3/8)
O-ring
Pipe joint (S, G3/8-G3/8)
(55) Pipe joint (L, G1/4-G1/4)
O-ring
(56) Pipe joint (L, G1/4-G1/4)
(57) Pipe joint (L, G1/4-G1/4)
O-ring
(58) Pipe joint (L, G3/8-G3/8)
O-ring
(59) Pipe joint (S, G3/8-G3/8)
Pipe joint (L, G3/8-G3/8)
O-ring
(60) Pipe joint (S, G3/8-G3/8)
Pipe joint (L, G3/8-G1/2)
(61) Pipe joint (L, G1/4-G1/4)
O-ring
(62) Pipe joint (L, G3/8-G3/8)
O-ring
(63) Pipe joint (L, G3/8-G1/2)
Pipe joint (S, G3/8-G3/8)
(64) Pipe joint (L, G3/8-G1/2)
(65) Pipe joint (L, G3/8-G3/8)
O-ring
Pipe joint (S, G3/8-G3/8)
(66) Pipe joint (L, G1/4-G1/4)

Model: KX161-3S/ST, KTC, KCL, KTA-version

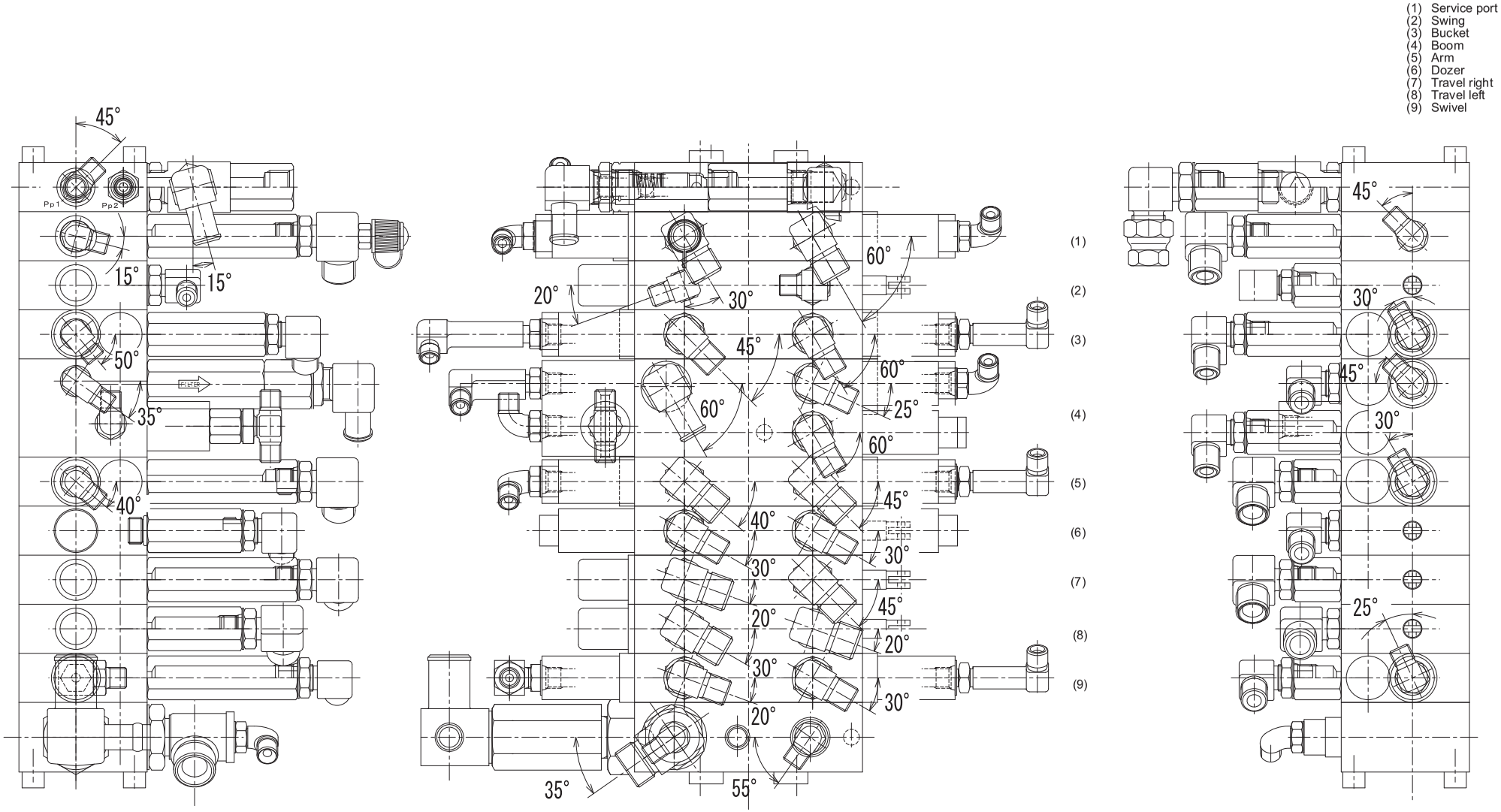


Model: KX161-3/α, EU-version (AI, third line)



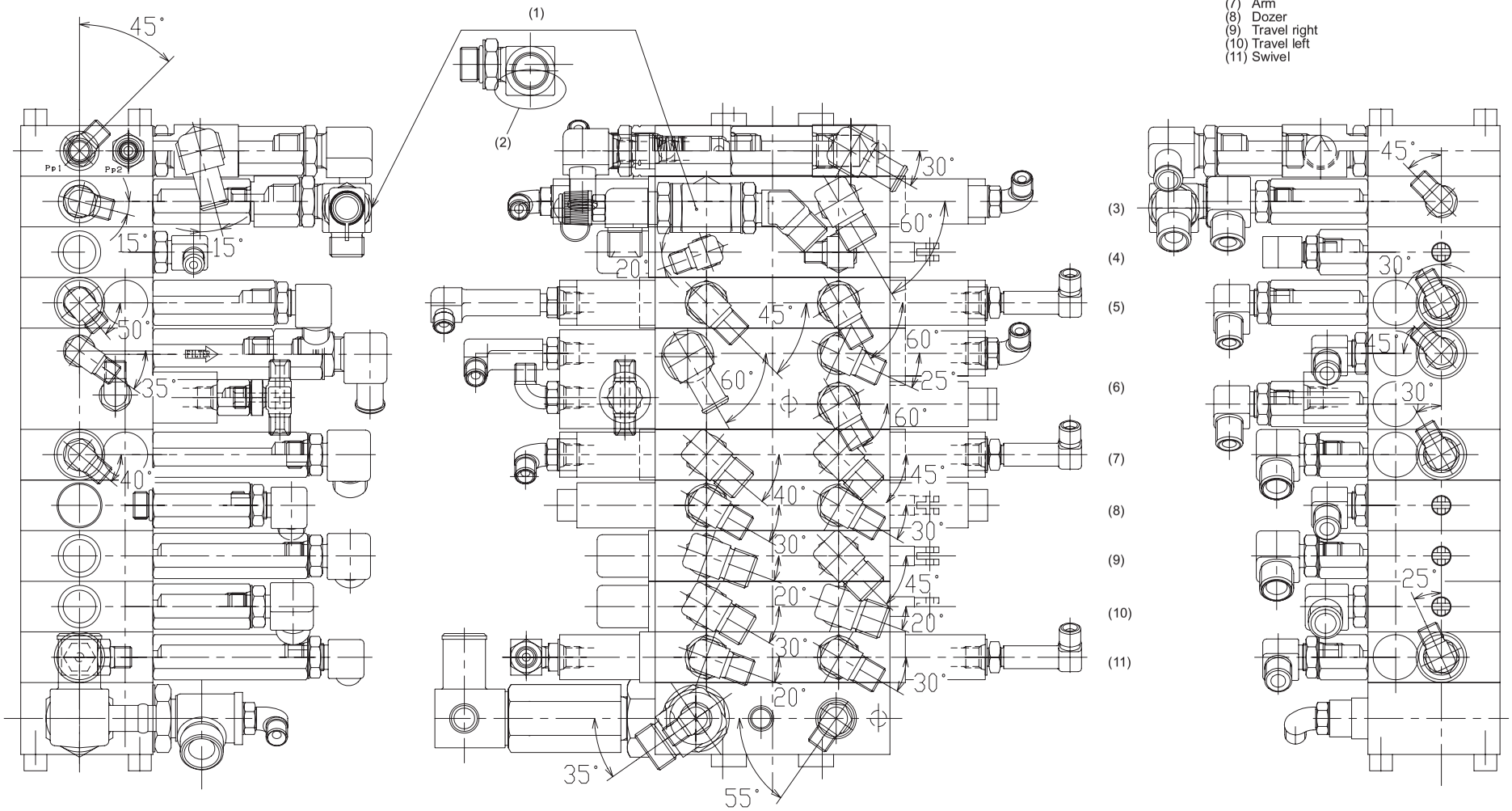
(3)Adapter angle

Model: KX121-3 ST

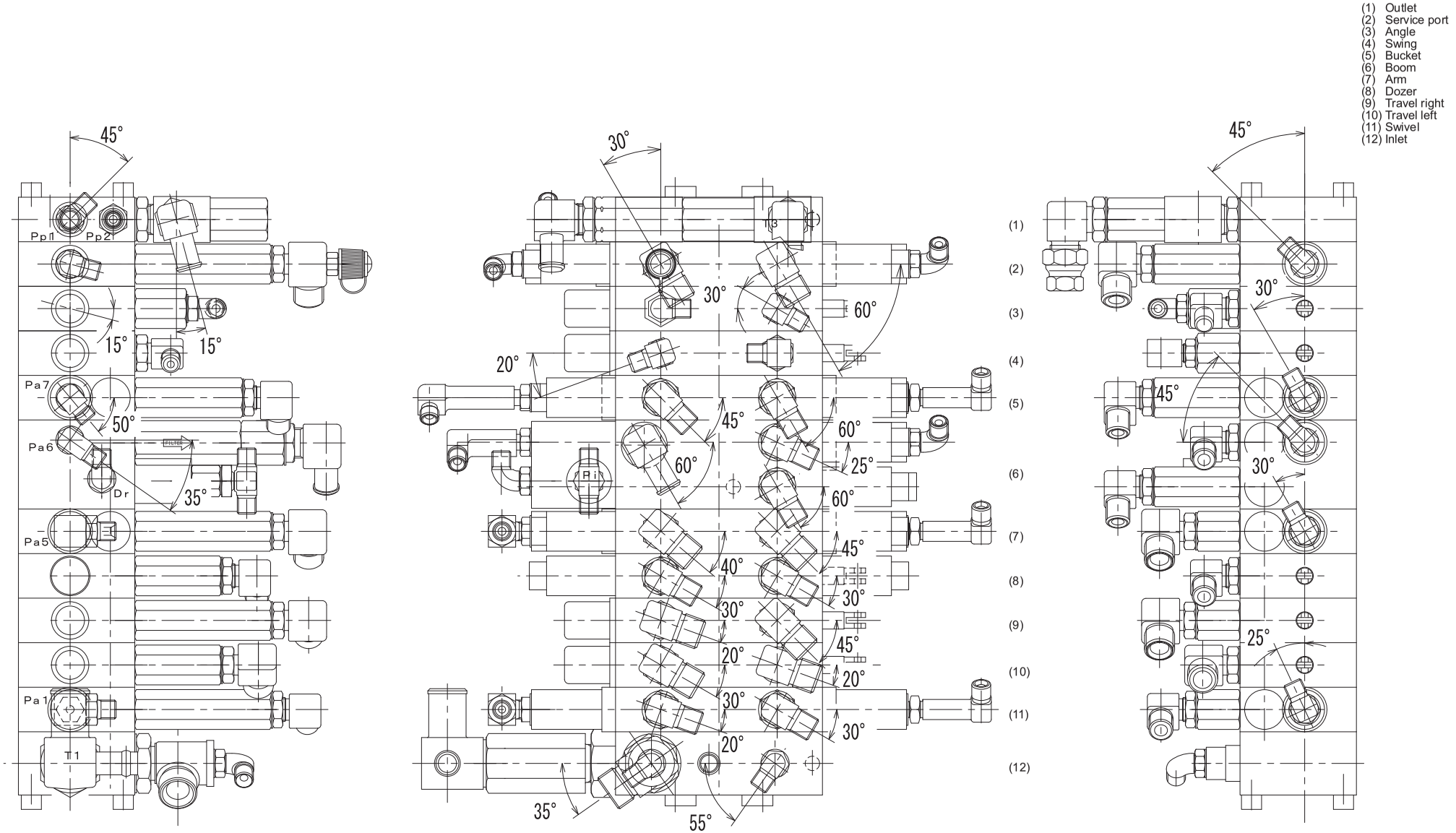


Model: KX121-3 ST, Third line

(1) Attention to the vertical positioning of the T pipe point
(2) Stretching side to be downward
(3) Service port
(4) Swing
(5) Bucket
(6) Boom
(7) Arm
(8) Dozer
(9) Travel right
(10) Travel left
(11) Swivel

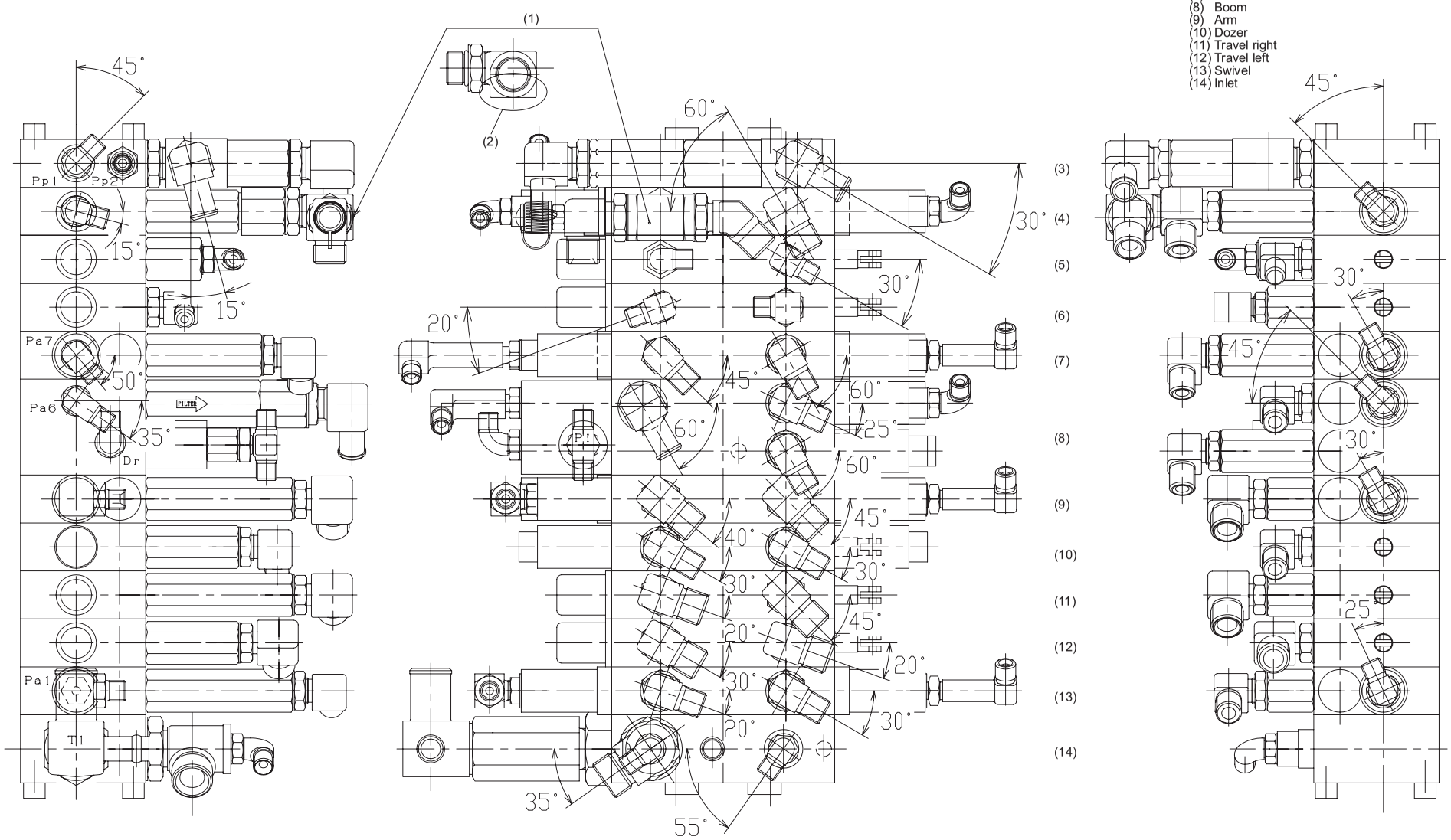


Model: KX121-3 ST, Angle blade

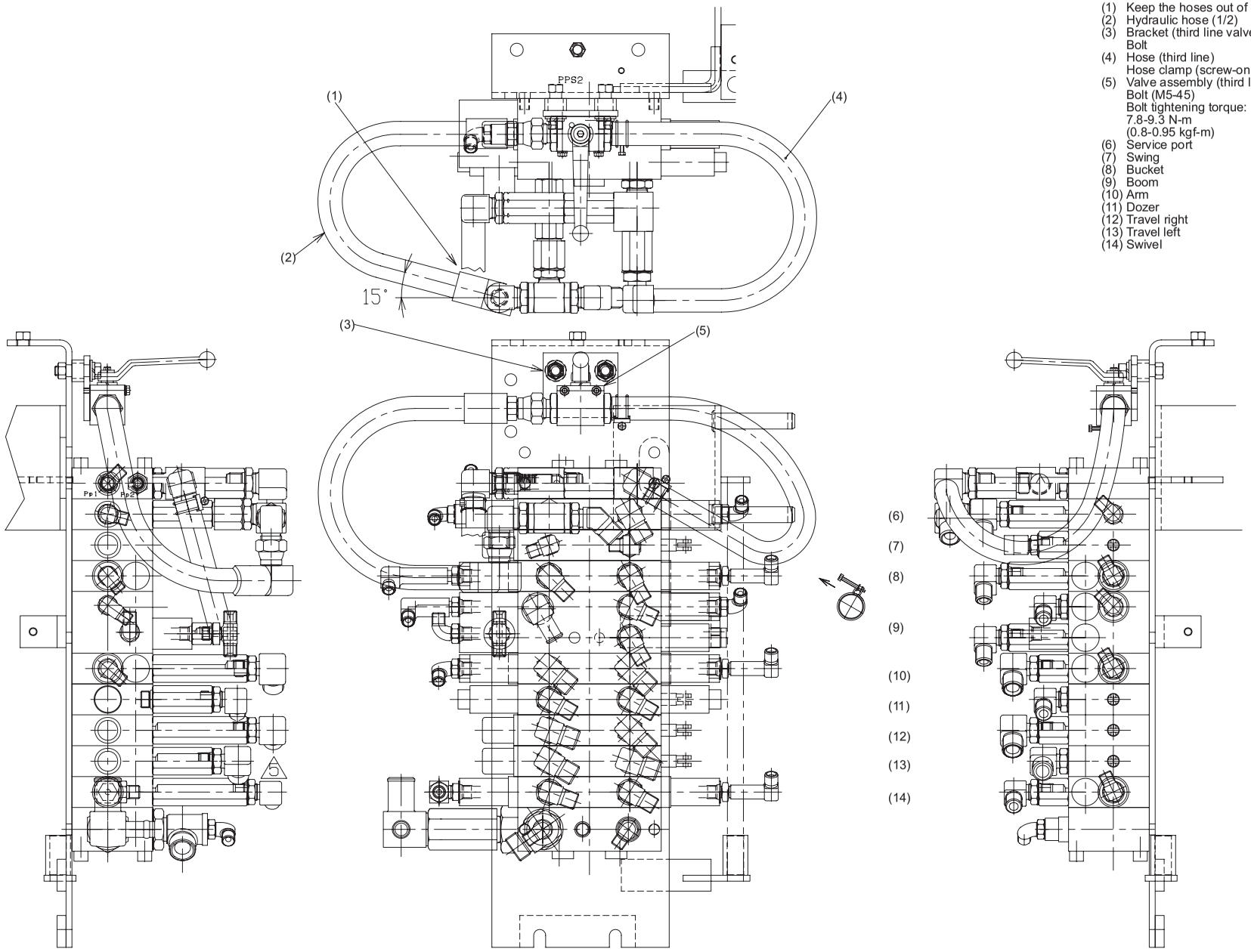


Model: KX121-3 ST, angle blade and third line

(1) Attention to the vertical positioning of the T pipe point
(2) Stretching side to be downward
(3) Outlet
(4) Service port
(5) Angle
(6) Swing
(7) Bucket
(8) Boom
(9) Arm
(10) Dozer
(11) Travel right
(12) Travel left
(13) Swivel
(14) Inlet

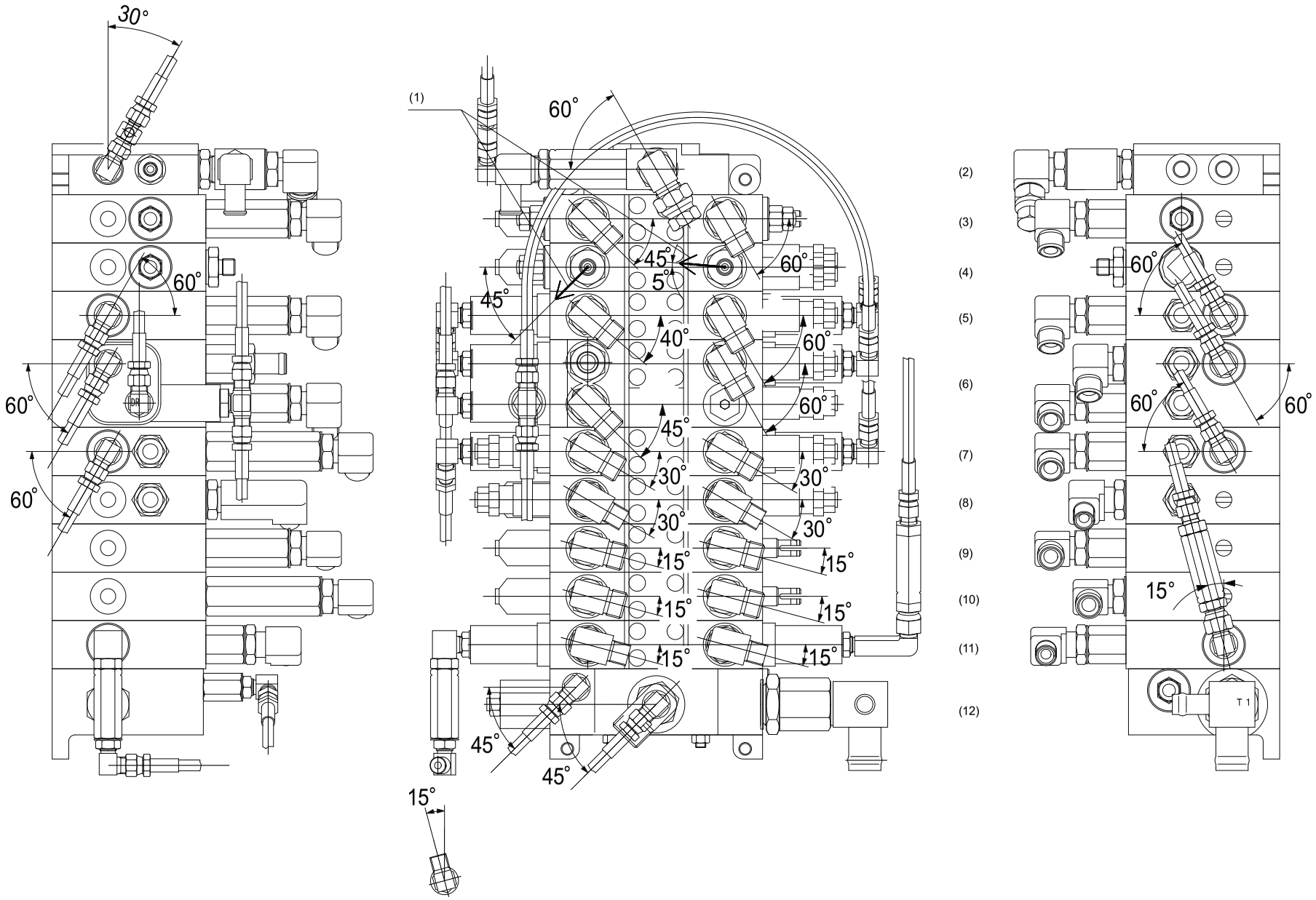


Model: KX121-3 ST, angle blade and third line hoses

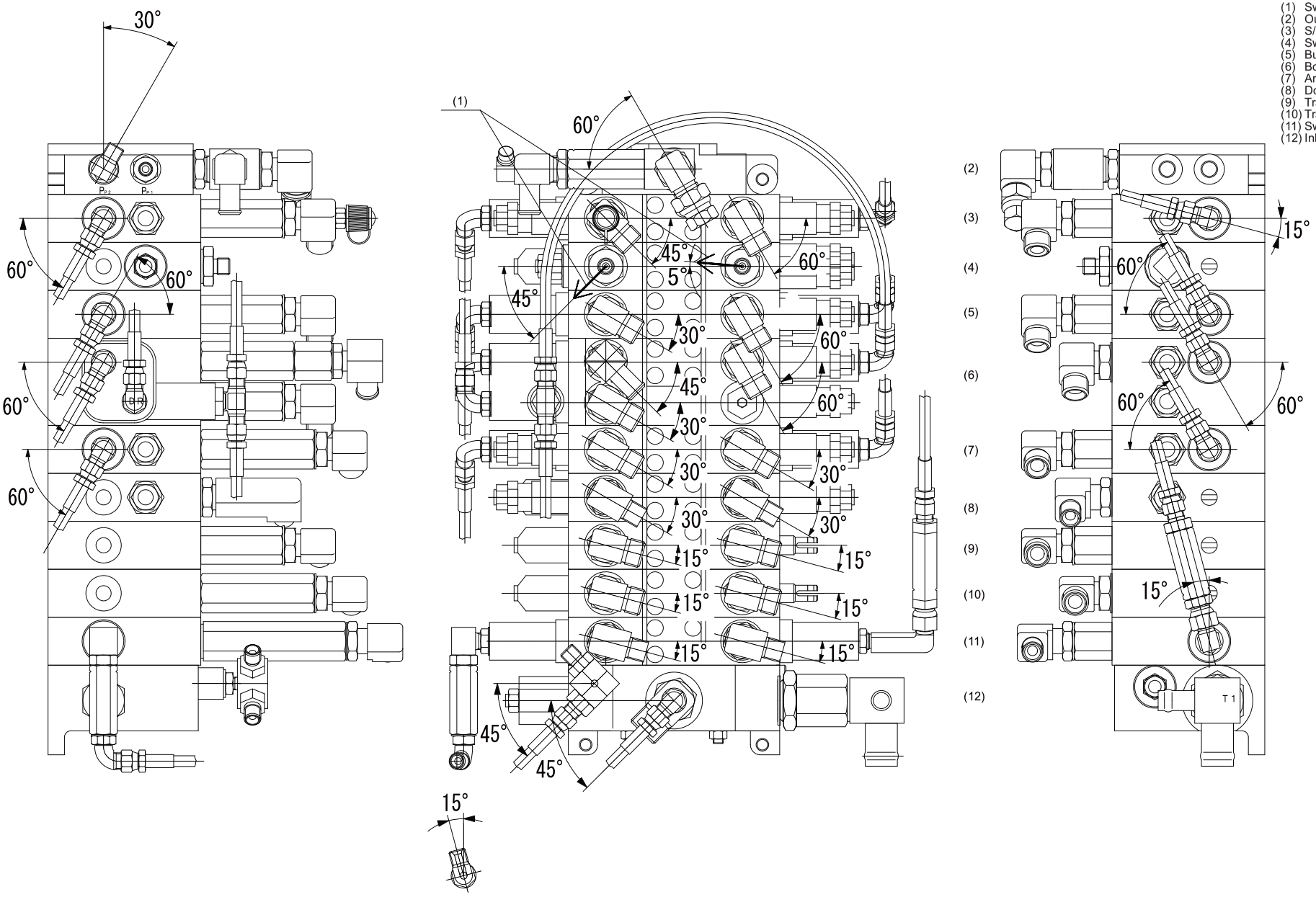


(1) Keep the hoses out of contact with each other.
(2) Hydraulic hose (1/2)
(3) Bracket (third line valve)
Bolt
(4) Hose (third line)
Hose clamp (screw-on type)
(5) Valve assembly (third line)
Bolt (M5-45)
Bolt tightening torque:
7.8-9.3 N-m
(0.8-0.95 kgf-m)
(6) Service port
(7) Swing
(8) Bucket
(9) Boom
(10) Arm
(11) Dozer
(12) Travel right
(13) Travel left
(14) Swivel

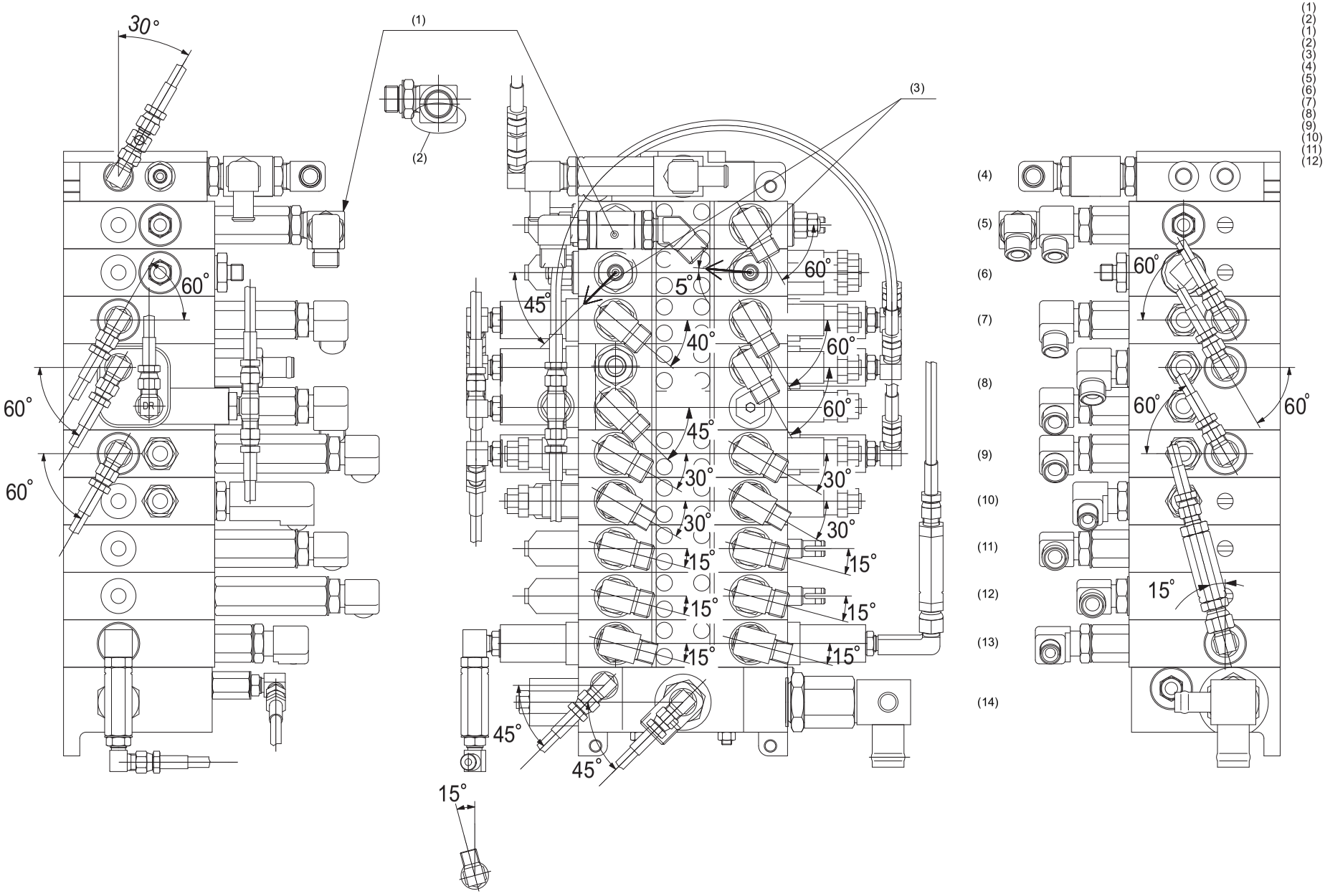
Model: KX161-3, KTC, KCL, KTA-version



Model: KX161-3S/ST, PP-version

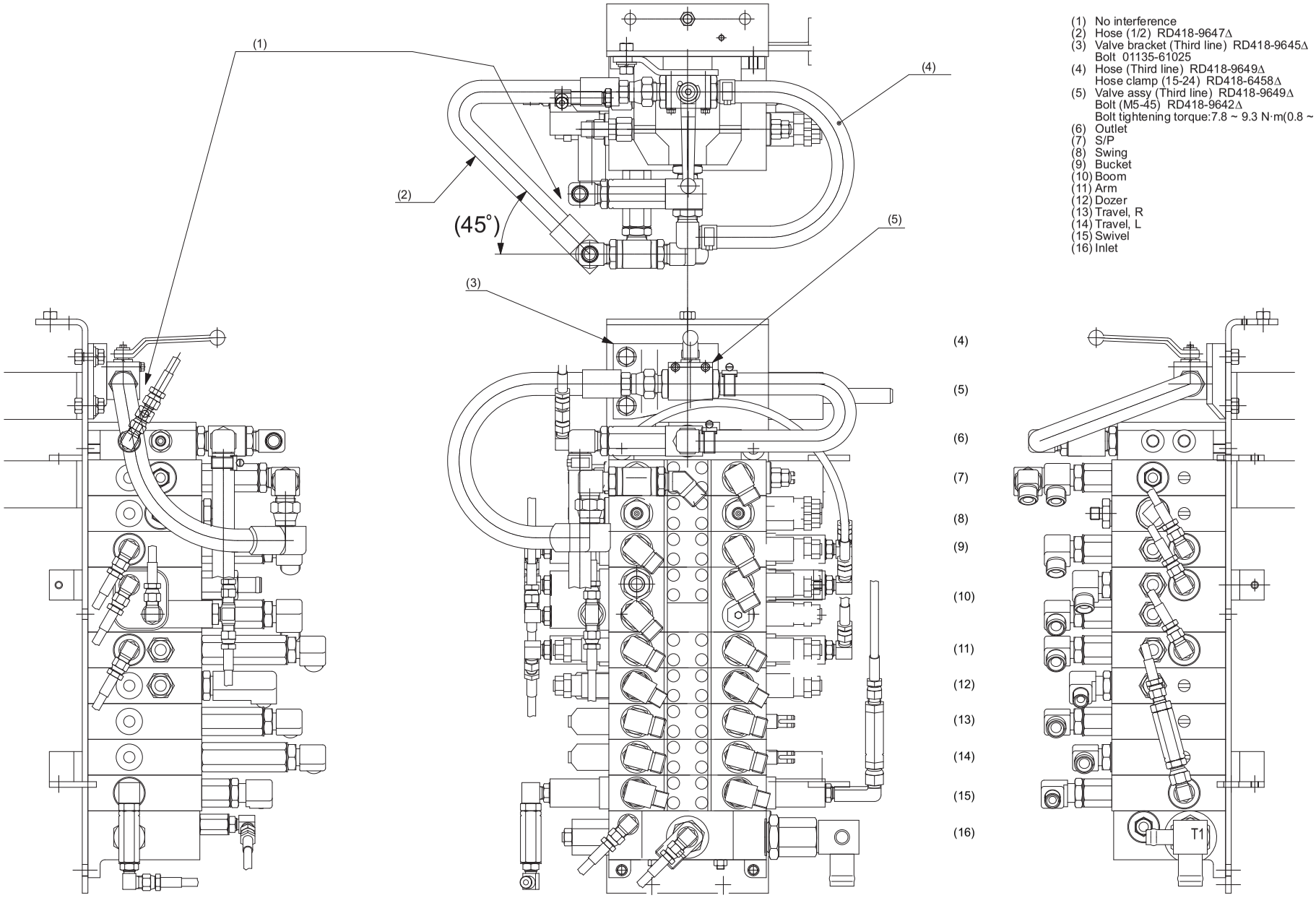


Model: KX161-3/α, EU-version (AI, third line)



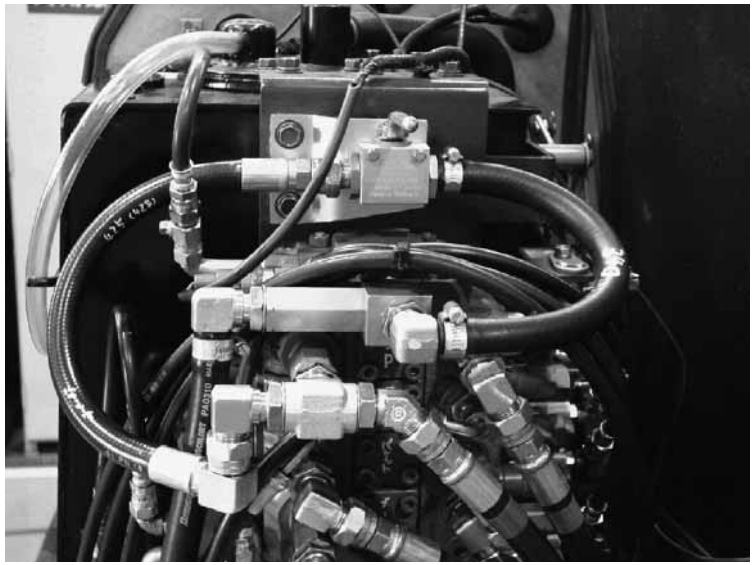
(1) T-joint
(2) Outlet comes lower direction
(1) Swing hose
(2) Outlet
(3) S/P
(4) Swing
(5) Bucket
(6) Boom
(7) Arm
(8) Dozer
(9) Travel, R
(10) Travel, L
(11) Swivel
(12) Inlet

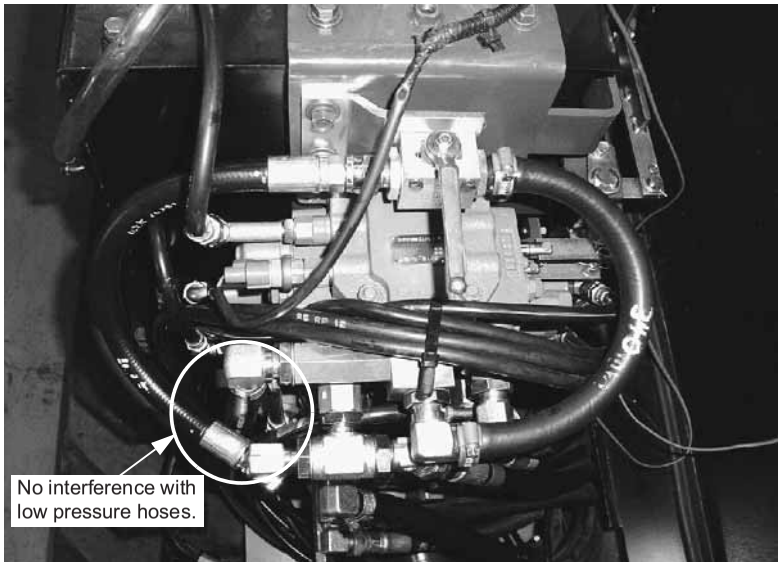
Model: KX161-3/α, EU-version (third line type)



(1) No interference
(2) Hose (1/2) RD418-9647Δ
(3) Valve bracket (Third line) RD418-9645Δ
Bolt 01135-61025
(4) Hose (Third line) RD418-9649Δ
Hose clamp (15-24) RD418-6458Δ
(5) Valve assy (Third line) RD418-9649Δ
Bolt (M5-45) RD418-9642Δ
Bolt tightening torque:7.8 ~ 9.3 N·m(0.8 ~ 0.95)(kgf·m)
(6) Outlet
(7) S/P
(8) Swing
(9) Bucket
(10) Boom
(11) Arm
(12) Dozer
(13) Travel, R
(14) Travel, L
(15) Swivel
(16) Inlet

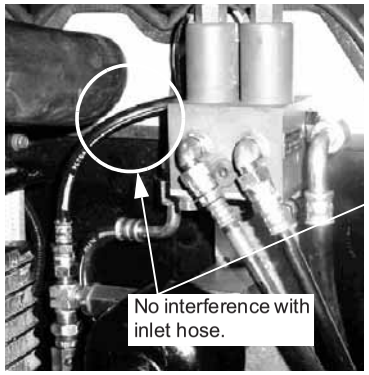
Third line: EU-version only



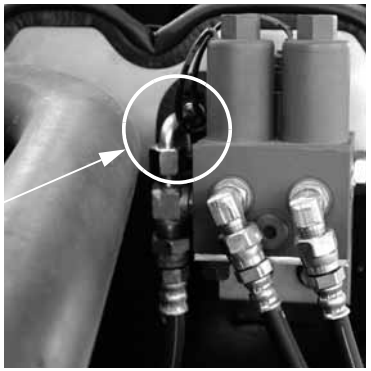


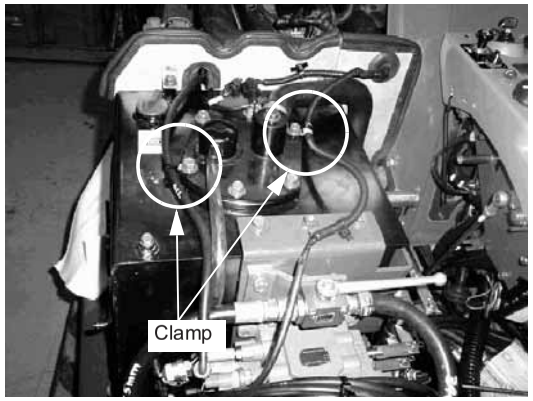
Auto idle signal hose

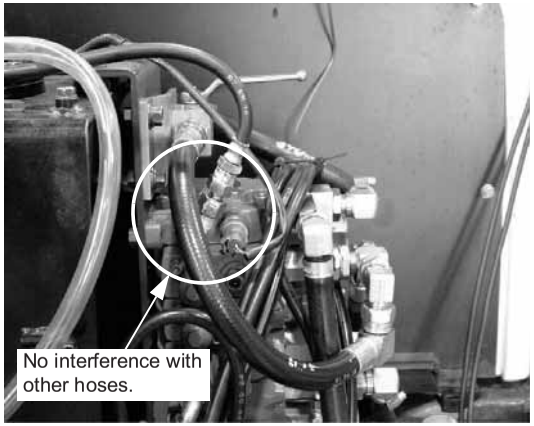
EU-version



KTC, KCL, KTA-version



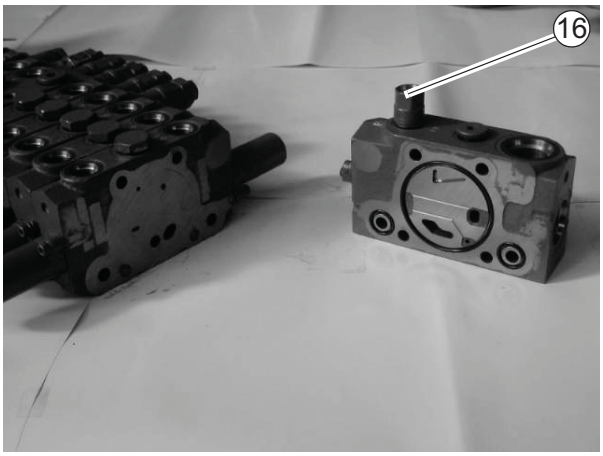


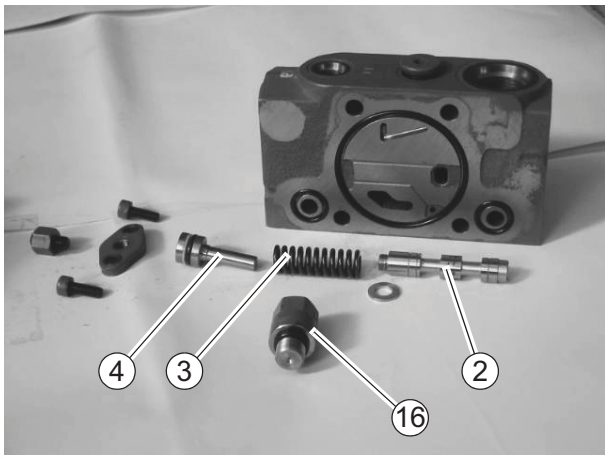


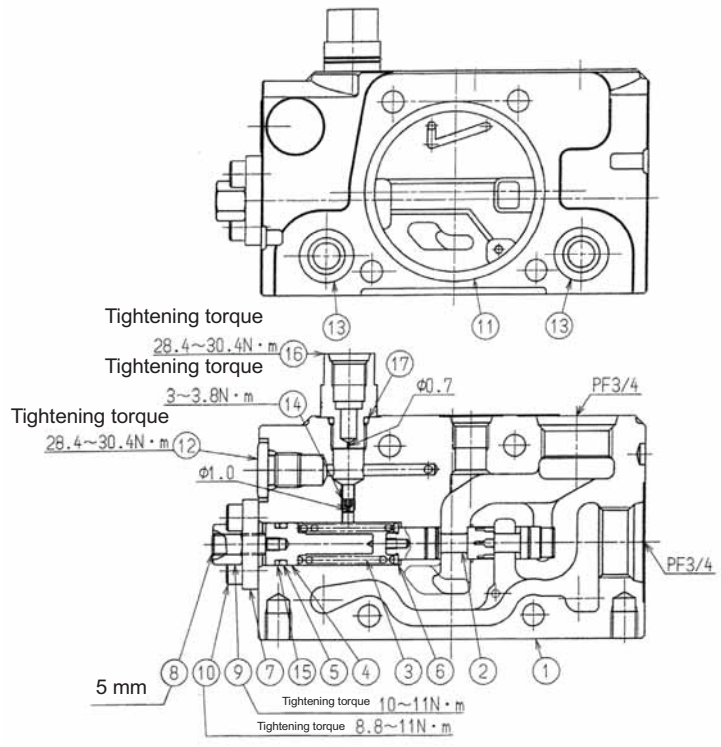
(3) Control valve disassembly and reassembly: KX121-3/S/α/ST

(1) Inlet section
(2) Swivel section
(3) Travel (LH) section
(4) Travel (RH) section
(5) Dozer section
(6) Arm section
(7) Boom section
(8) Bucket section
(9) Swing section
(10) Service port section
(11) Outlet section

[1] Inlet section

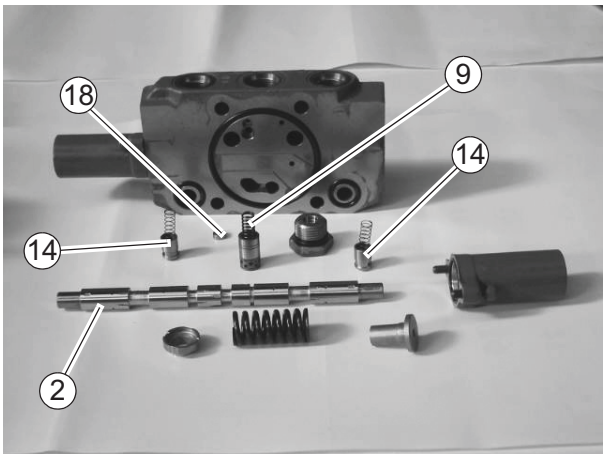


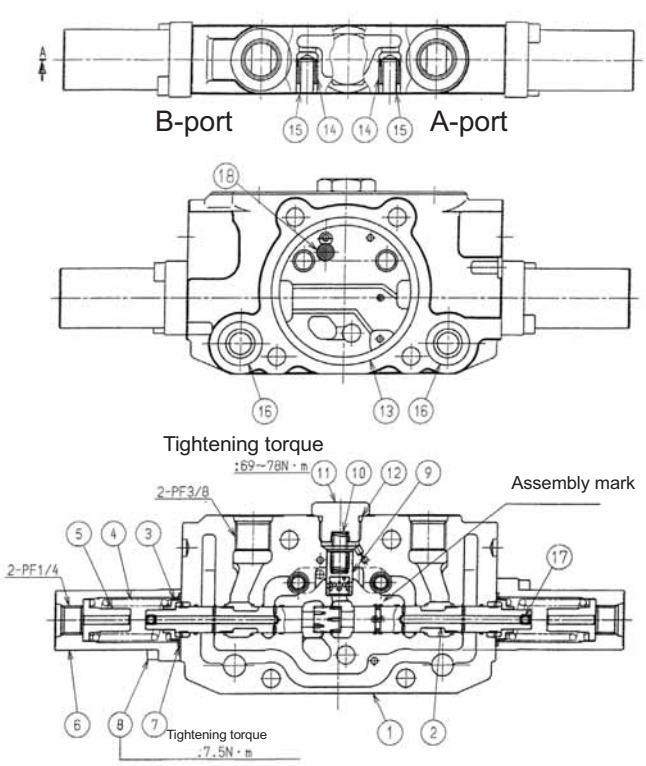




(1) Inlet housing
(2) Unload spool
(3) Spring
(4) Spacer
(5) O-ring: JIS B2401-1-B, P12
(6) Washer
(7) Flange
(8) Set screw: M8 × 1.25 × 20
(9) Nut
(10) Socket head bolt: M6 × 1 × 16 - 12.9
(11) O-ring: AS568-144, HS70
(12) Plug assy: PF1/4
(13) O-ring: JIS B2401-1-A, P16
(14) Orifice: ϕ1.0
(15) Backup ring: JIS B2407 T2 P12
(16) Plug: ϕ 0.7
(17) O-ring: JIS B2401-1-B P11

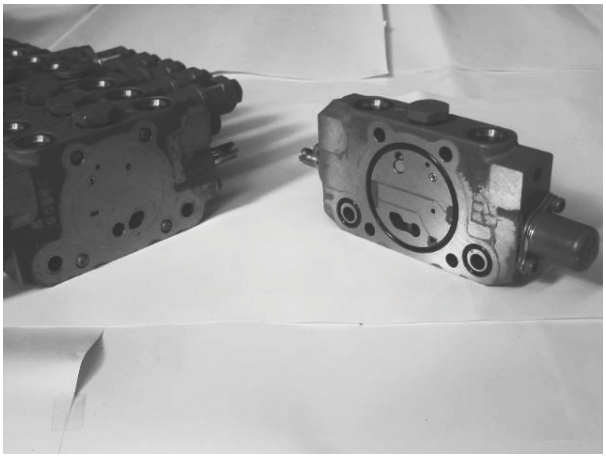
[2] Swivel section

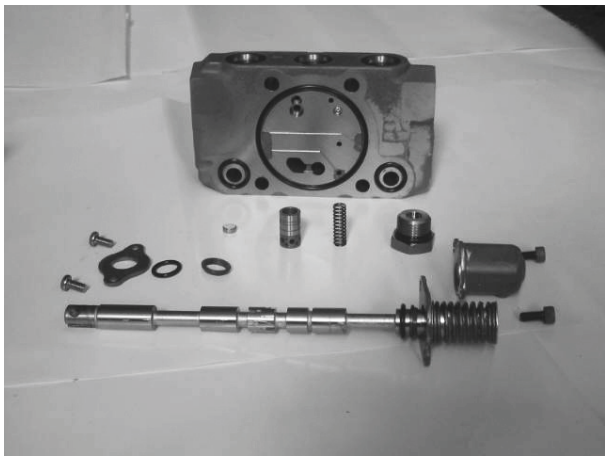


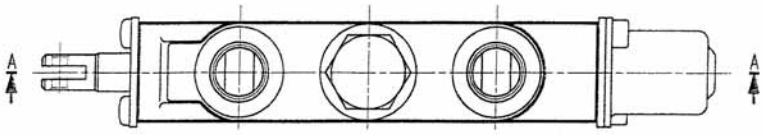


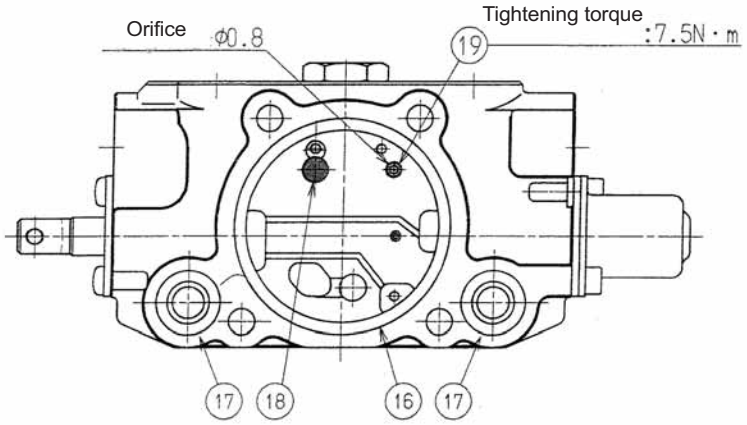
(1) Valve housing
(2) Main spool
(3) Spring seat
(4) Spring: free length=
outer dia.=
(5) Spring seat
(6) Cap
(7) O-ring: NOK S22
(8) Socket head bolt: M5 × 0.8 × 18 - 12.9
(9) Compensation spool: U/R 2.5 mm^2
(10)Spring: 2.0 K
(11)Plug
(12)O-ring
(13)O-ring: AS568-144, HS70
(14)Load check valve
(15)Spring: free length=
outer dia.=
(16)O-ring: JIS B2401-1-A, P16
(17)Plug
(18)Shuttle plate
(High pressure selection valve)

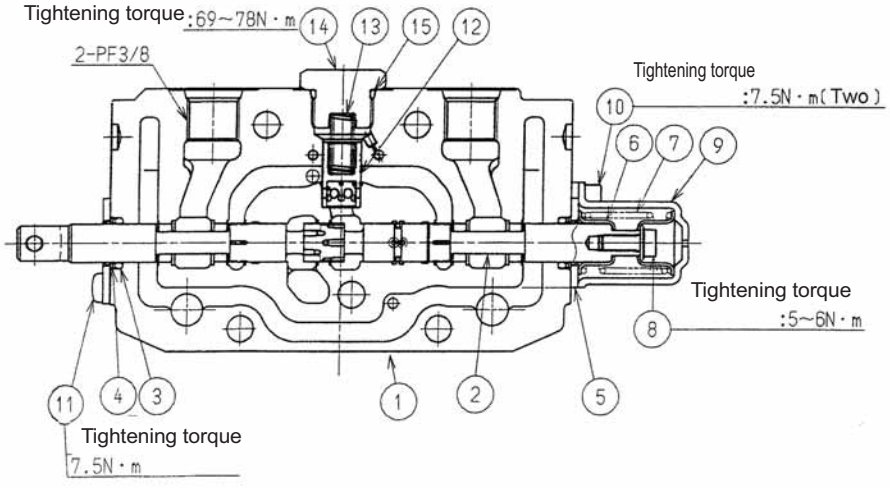
[3] Travel L section





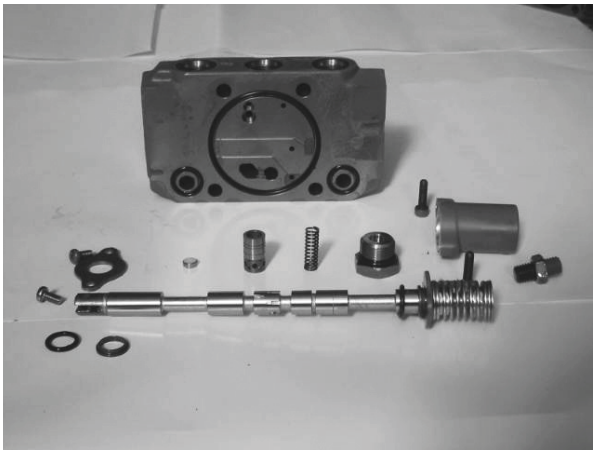




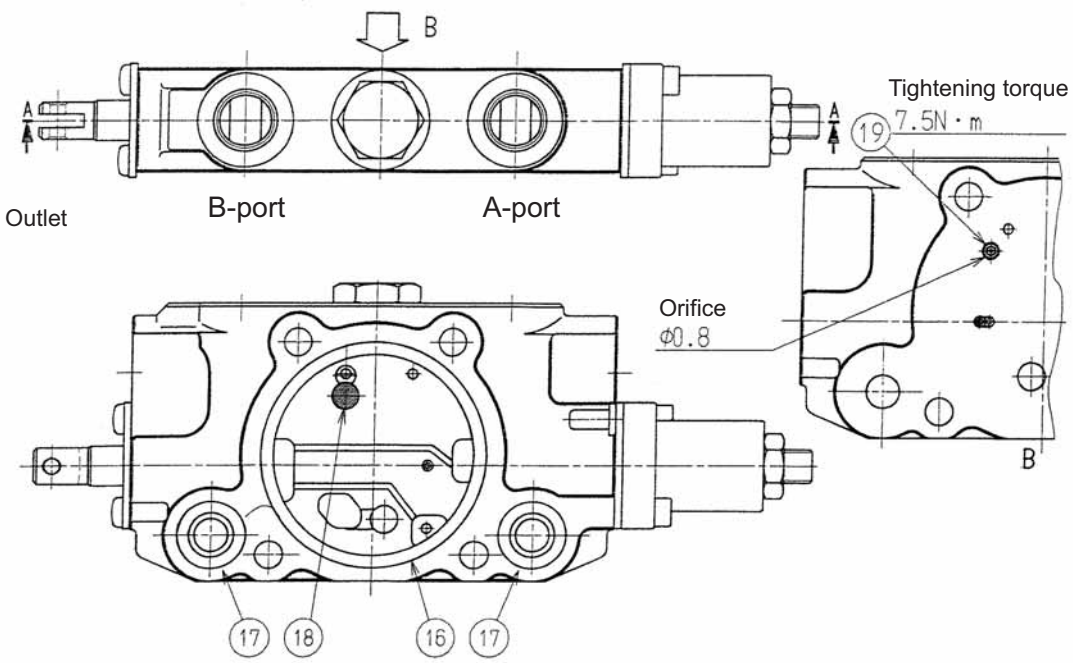


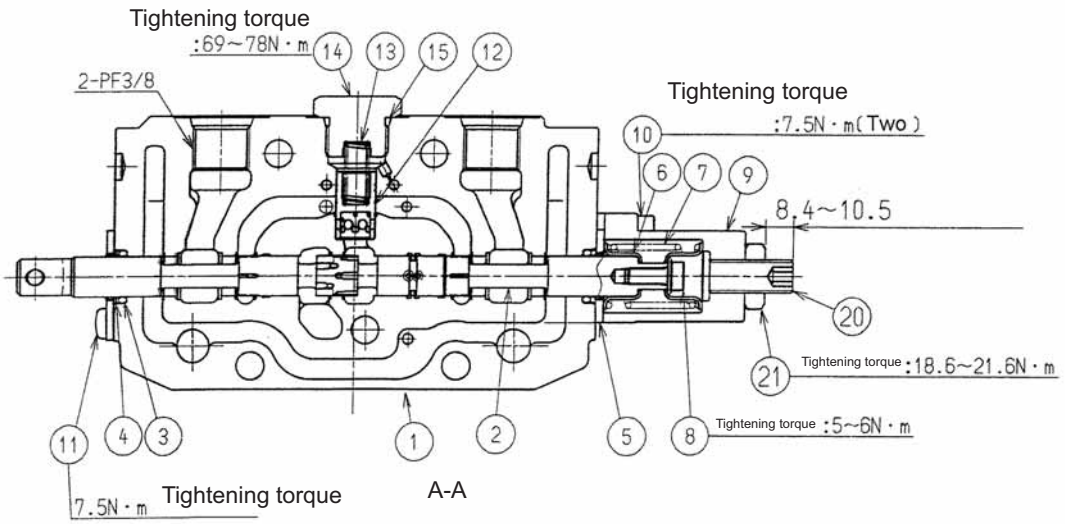
(1) Valve housing
(2) Main spool
(3) O-ring: JIS B2401-1-A, P12
(4) Wiper
(5) Seal plate
(6) Spring seat
(7) Spring: free length=
outer dia.=
(8) Cap screw
(9) Cap
(10) Socket head bolt:
M5 × 0.8 × 12 - 12.9
(11) Screw: M5 × 0.8 × 10
(12) Compensation spool:
U/R=5.0mm^2
(13) Spring: 2.0K
(14) Plug
(15) O-ring
(16) O-ring: AS568-144, HS70
(17) O-ring: JIS B2401-1-A, P16
(18) Shuttle plate
(19) Orifice: ϕ0.8

[4] Travel R section

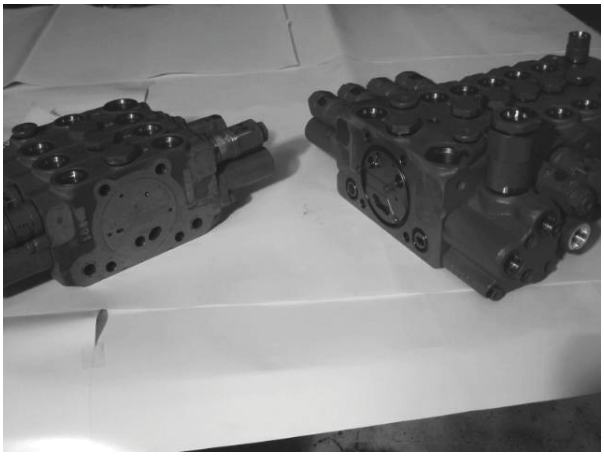


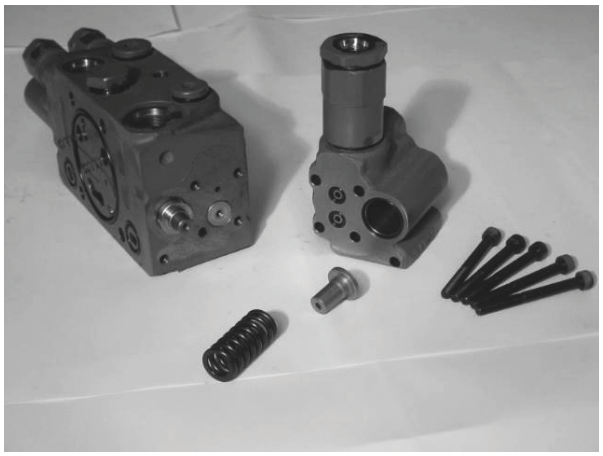
(1) Valve housing
(2) Main spool
(3) O-ring: JIS B2401-1-A, P12
(4) Wiper
(5) Seal plate
(6) Spring seat
(7) Spring: free length=
outer dia.=
(8) Cap screw
(9) Cap
(10)Socket head bolt:
M5 × 0.8 × 18 - 12.9
(11)Screw: M5 × 0.8 × 10
(12)Compensation spool:
U/R=5.0mm^2
(13)Spring: 2.0K
(14)Plug
(15)O-ring
(16)O-ring: AS568-144, HS70
(17)O-ring: JIS B2401-1-A, P16
(18)Shuttle plate
(19)Orifice: ϕ0.8
(20)Set screw: M10 × 1.5 × 25
(21)Nut: M10 × 1.5

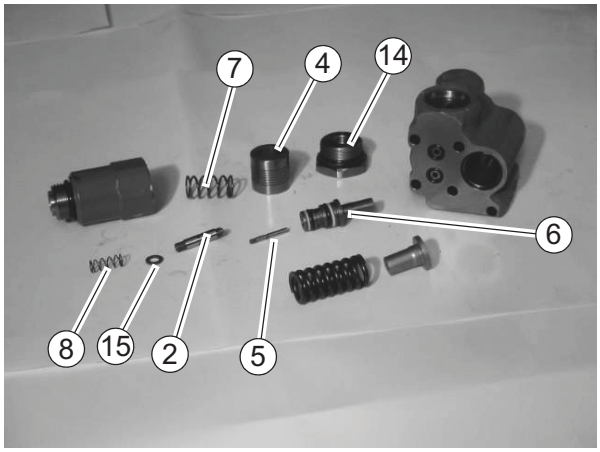


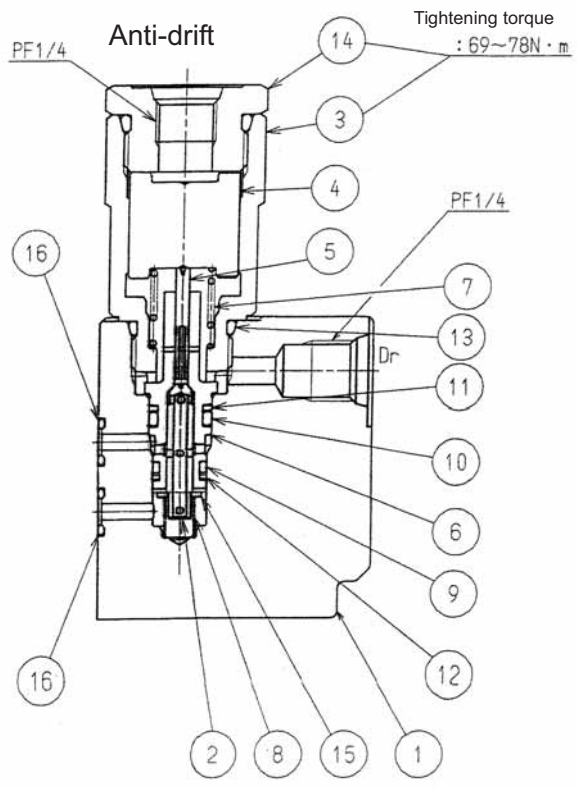


[5] Boom section

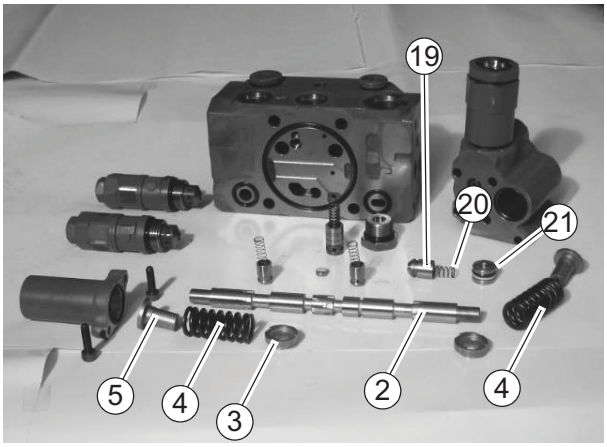




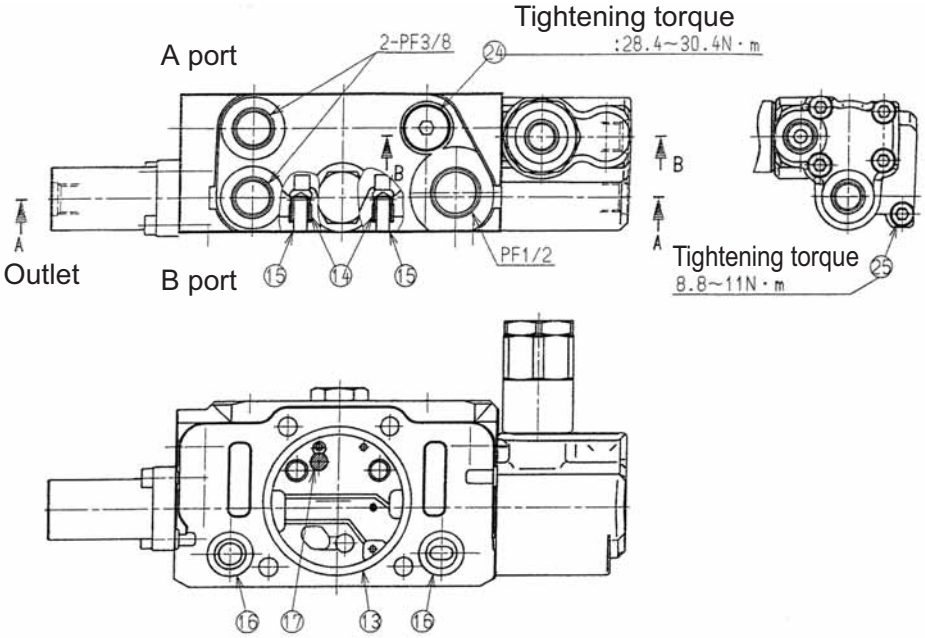


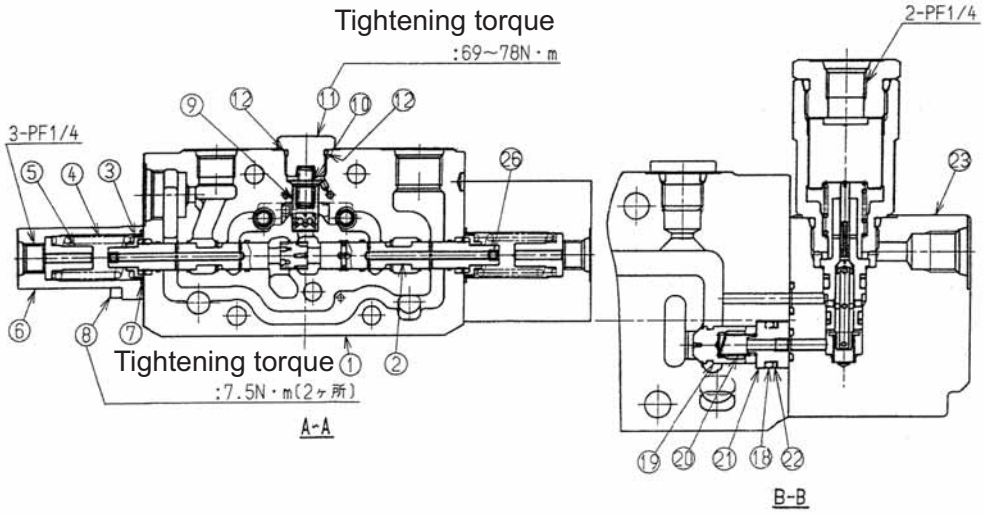


(1) Body
(2) Poppet
(3) Plug
(4) Piston
(5) Spool
(6) Sleeve
(7) Spring
(8) Spring
(9) O-ring: JIS B2401-1-A P9
(10)O-ring: JIS B2401-1-A P10A
(11)Backup ring: JIS B2407 T2 P10A
(12)Backup ring: JIS B2407 T2 P9
(13)O-ring: ARP568-910
(14)Plug assy
(15)Spring seat
(16)O-ring: JIS B2401-1-B P7

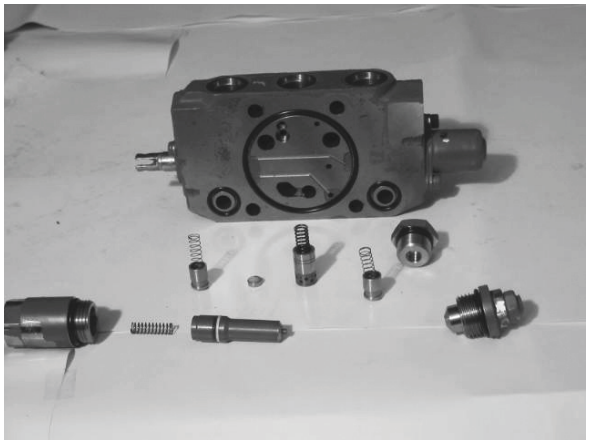


(1) Valve housing
(2) Main spool
(3) Spring seat
(4) Spring
(5) Spring seat
(6) Cap
(7) O-ring: NOK S22
(8) Socket head bolt: M5 × 0.8 × 18 - 12.9
(9) Compensation spool: U/L=5.0mm^2
(10) Spring: 2.0K
(11) Plug
(12) O-ring
(13) O-ring: ARP568-144 HS70
(14) Load check valve
(15) Spring
(16) O-ring: JIS B2401-1-A P16
(17) Shuttle plate
(18) O-ring: JIS B2401-1-B P11
(19) Poppet
(20) Spring
(21) Spacer
(22) Bucket ring
(23) Anti-drift valve assy
(24) Plug assy: PF1/4
(25) Socket head bolt: M6 × 1.0 × 60 - 12.9
(26) Plug

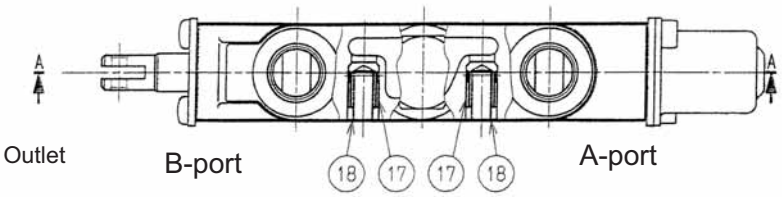


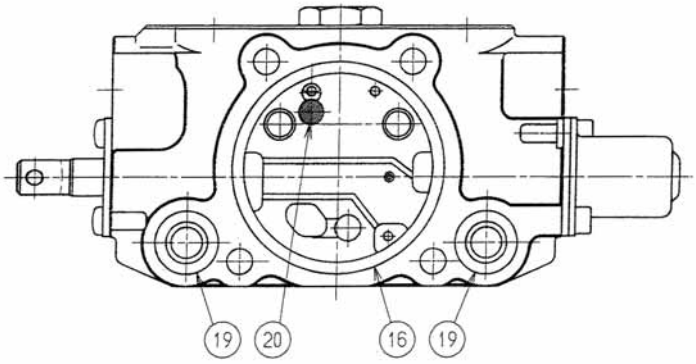


[6] Swing section

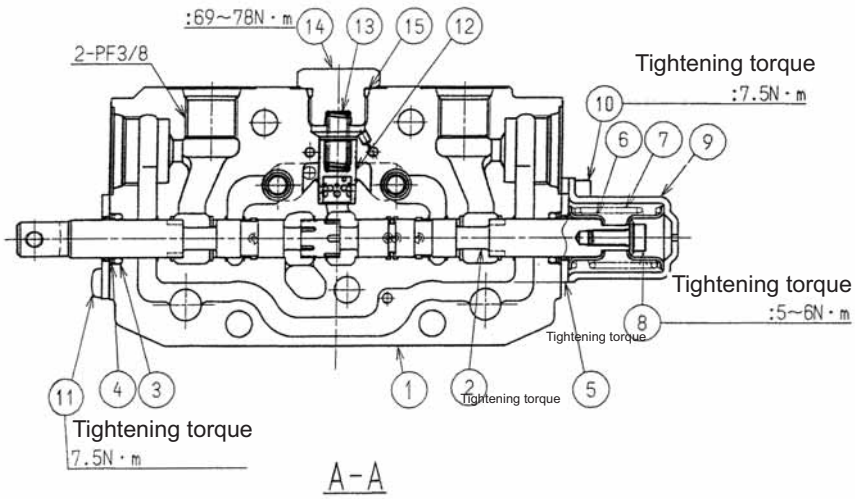


(1) Valve housing
(2) Main spool
(3) O-ring: JIS B2401-1-A, P12
(4) Wiper
(5) Seal plate
(6) Spring seat
(7) Spring
(8) Cap screw
(9) Cap
(10) Socket head bolt: M5 × 0.8 × 18
(11) Screw: M5 × 0.8 × 10
(12) Compensation spool: U/R=2.5 mm^2
(13) Spring: 2.0K
(14) Plug
(15) O-ring
(16) O-ring: AS568-144, HS70
(17) Load check valve
(18) Spring
(19) O-ring: JIS B2401-1-A P16
(20) Shuttle plate



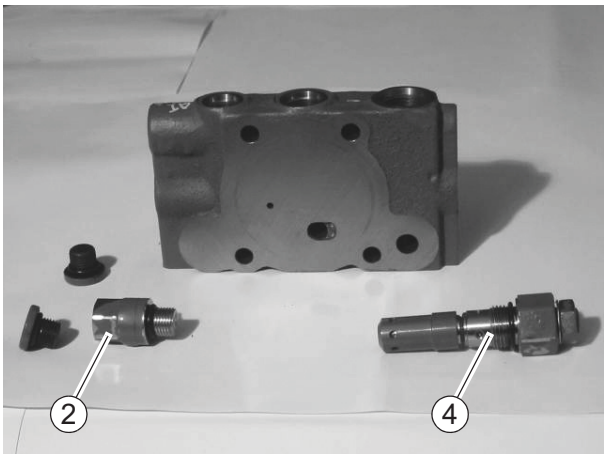


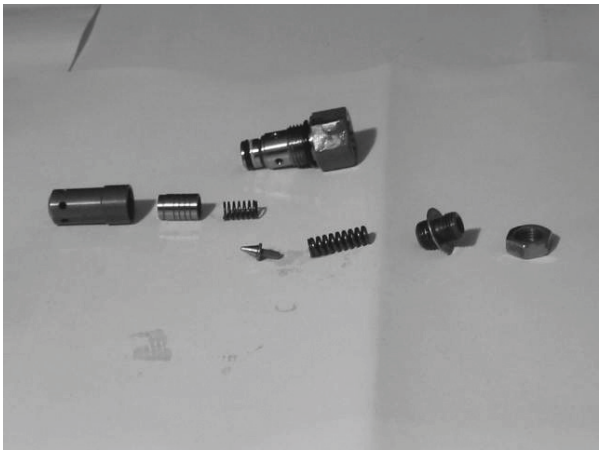
Tightening torque
:69~78N · m

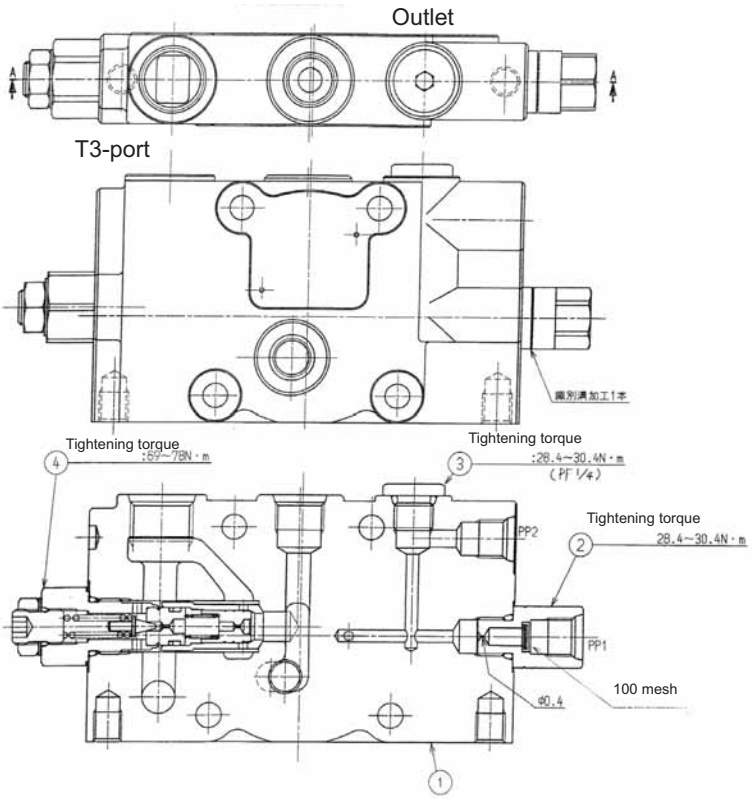


A-A

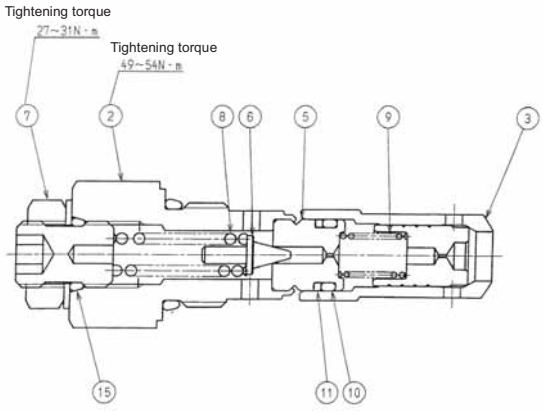
[7] Outlet section







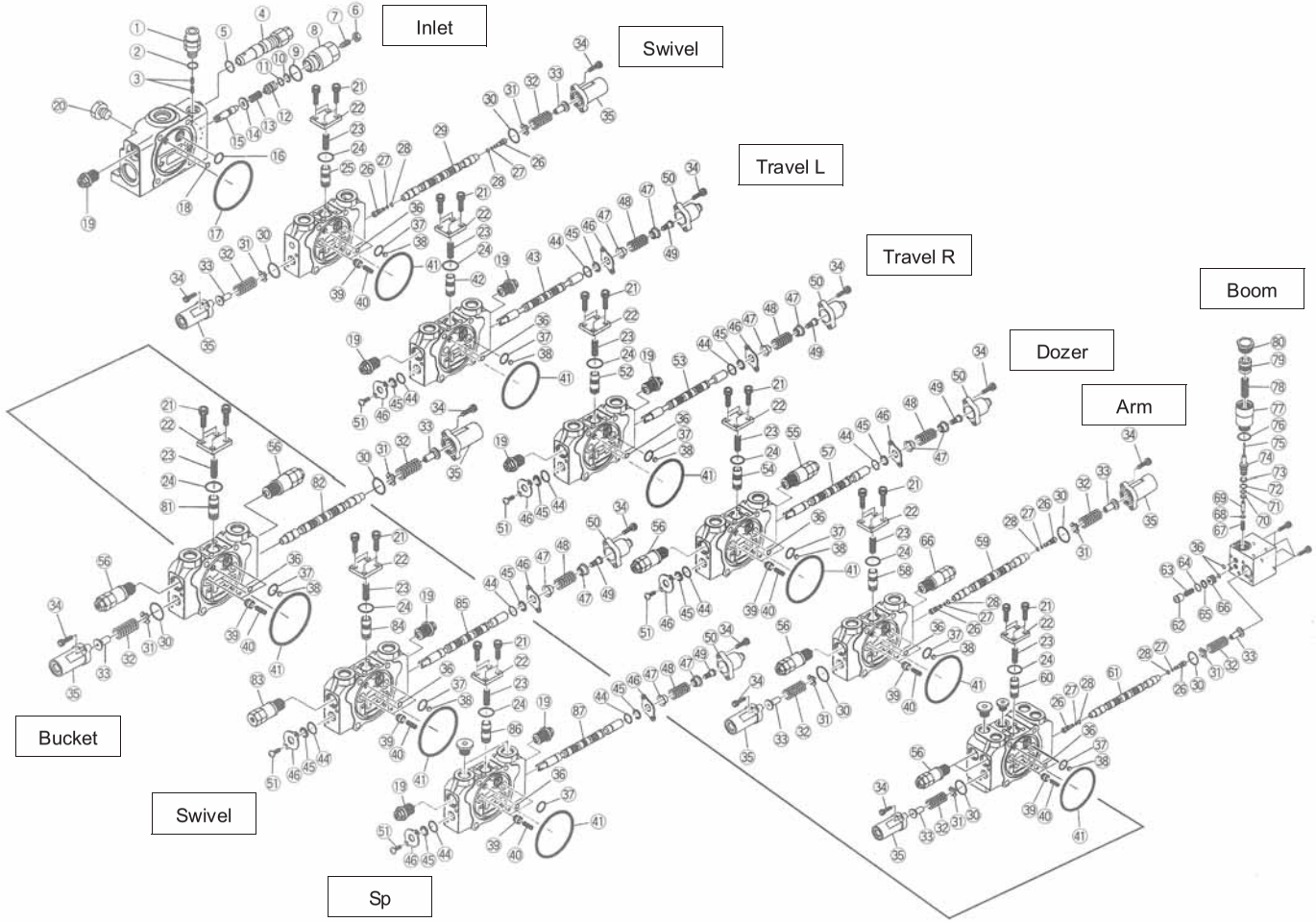
(1) Outlet housing
(2) Plug assy
(3) Plug assy
(4) Relief valve assy



(2) Plug
(3) Poppet assy
(5) Seat
(6) Pilot poppet
(7) adjuster kit
(8) Pilot spring
(9) Spring
(10) O-ring: JIS B2401-1-D P16
(11) Backup ring: JIS B2407 T2 P10
(15) O-ring: JIS B2401-1-B P10
(16) O-ring

Specifications:
1. Pressure adjusting range:
   3.9 ~ 24.5 MPa
   40 ~ 250 kgf/cm^2
   569 ~ 3556 psi
2. Rated flow amount
   80 L/min (21 G/min)
3. Adjusting screw per one turn:
   17.7 MPa, 180 kgf/cm^2, 2567 psi

(4) Inner parts: KX161-3/S/ST/α, U45S/ST, U45-3S/ST/α, U50-3α

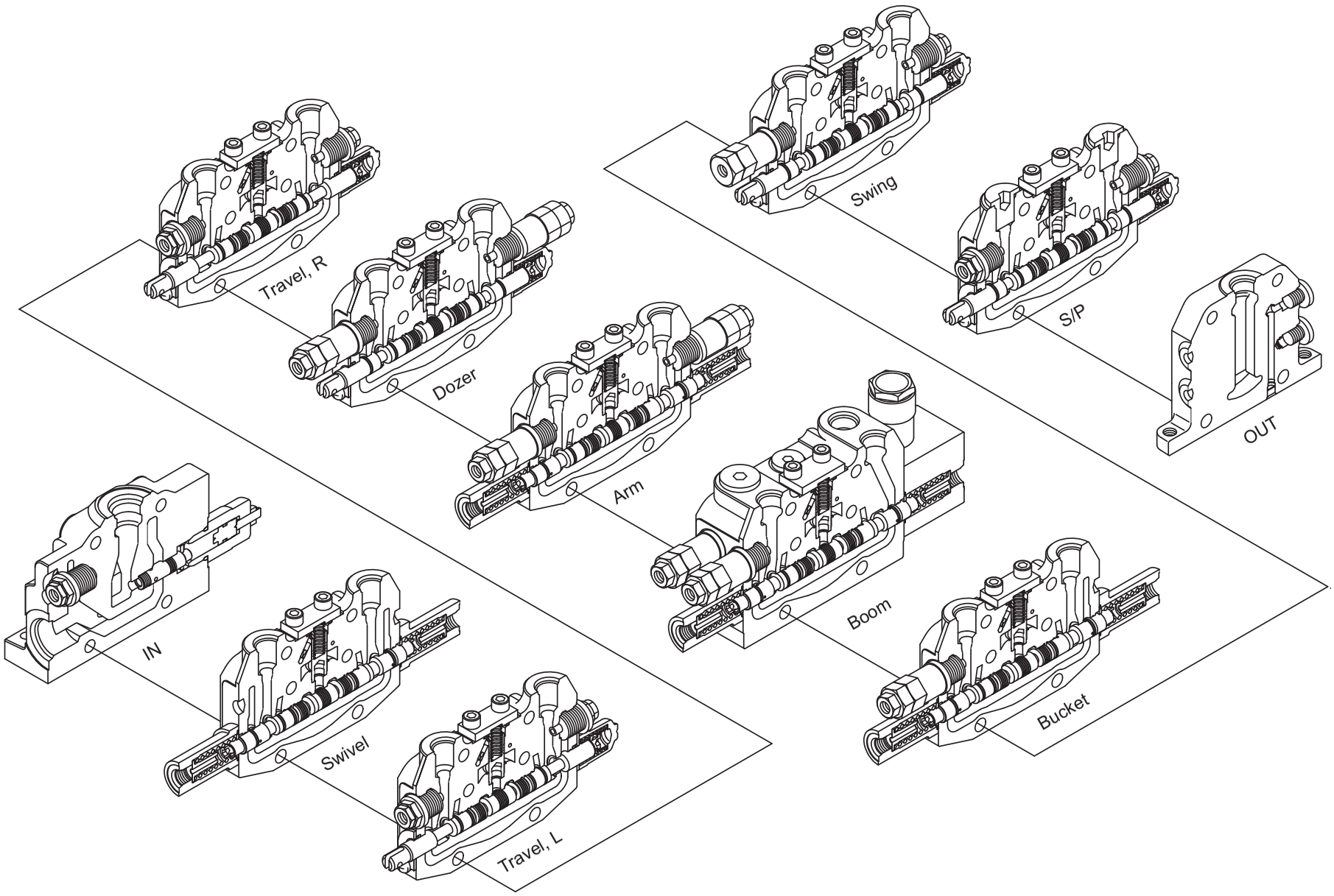


(1) Parts list

No	Name
1	Plug
2	O-ring
3	Orifice
4	Inlet valve assy
5	O-ring
6	Nut
7	set bolt
8	Plug
9	O-ring
10	Backup ring
11	O-ring
12	Poppet
13	Spring
14	Spring seat
15	Poppet
16	O-ring
17	O-ring
18	O-ring
19	Shut-off valve assy
20	Plug assy
21	Hex. bolt
22	Flange
23	Spring
24	O-ring
25	Compe. spool
26	Plug
27	Backup ring
28	O-ring
29	Spool
30	O-ring
31	Spring plate
32	Spring
33	Spring seat
34	Hex. bolt
35	Cap
36	O-ring
37	O-ring
38	Plate
39	Poppet
40	Spring
41	O-ring
42	Compe. spool
43	Spool
44	O-ring

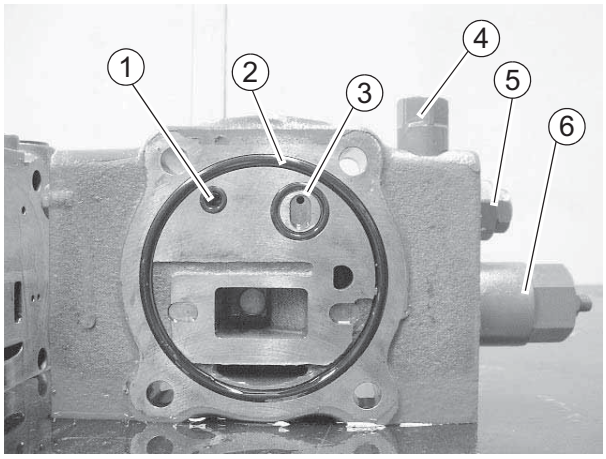
No	Name
45	Wiper
46	Seal plate
47	Spring seat
48	Spring
49	Cap screw
50	Cap
51	Screw
52	Compe. spool
53	Spool
54	Compe. spool
55	Relief valve assy
56	Relief valve assy
57	Spool
58	Compe. spool
59	Spool
60	Compe. spool
61	Spool
62	Poppet
63	Spool
64	O-ring
65	Backup ring
66	Spacer
67	Spring
68	Spring seat
69	Spool
70	Backup ring
71	O-ring
72	O-ring
73	Backup ring
74	Sleeve
75	Poppet
76	O-ring
77	Plug
78	Spring
79	Piston
80	Plug assy
81	Compe. spool
82	Plug assy
83	Spool
84	Compe. spool
85	Anti-void valve assy
86	Compe. spool
87	Spool

Control valve section cutaway



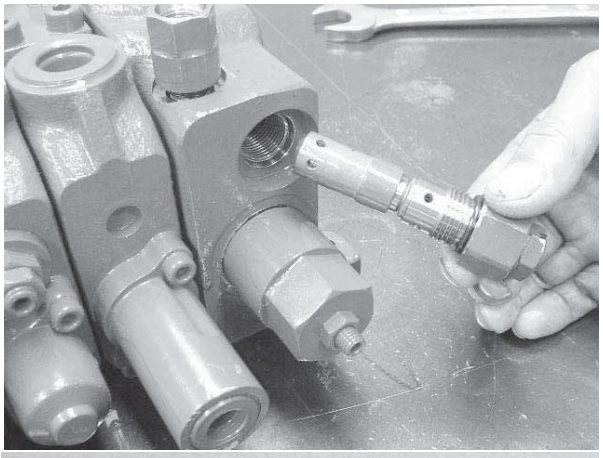
(5) Control valve disassembly and reassembly: KX161-3/S/ST/α, U45S/ST/α

[1] Inlet section disassembling



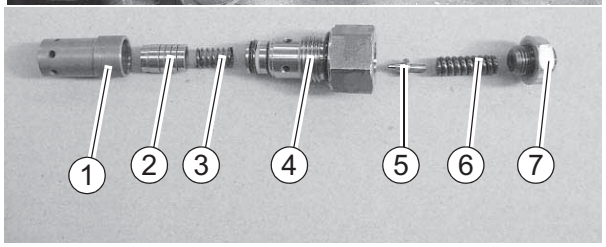
1) Inner parts

(1) O-ring
(2) O-ring
(3) O-ring
(4) Plug
(5) main relief valve
(6) Unload valve



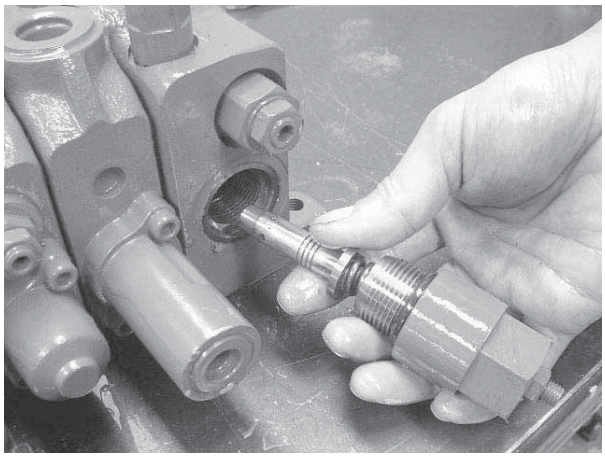
2) Main relief valve disassembling

1. Tightening torque: 49 ~ 54 N·m
   (5.0 ~ 5.5 kgf·m)
   36 ~ 40 ft·lbs



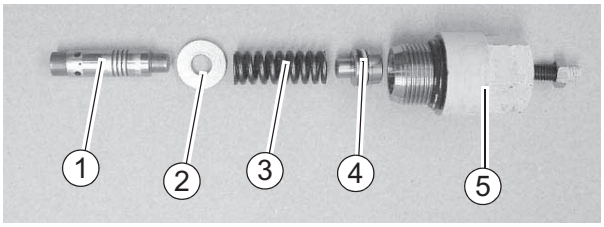
2. Main relief valve inner parts.

(1) Sleeve
(2) Poppet
(3) Spring
(4) Plug
(5) Poppet
(6) Spring
(7) Adjust nut, washer



3) Unload valve disassembling

1. Remove the plug (with lock screw and stopper nut), and draw out the spring, spring seat and unload spool.
   Plug tightening torque: 205 ~ 227 N·m
   (20.9 ~ 23.2 kgf·m)
   151 ~ 168 ft·lbs



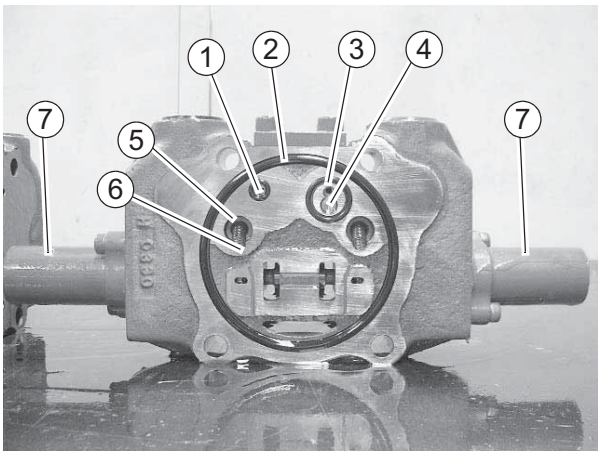
2. Unload valve inner parts.

(1)	Poppet	(4)	Poppet
(2)	Spring seat	(5)	Plug
(3)	Spring		

Precautions

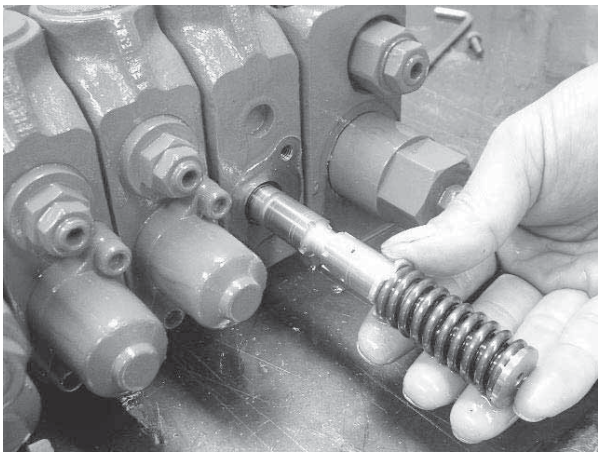
If not necessary, do not detach the lock screw and stopper nut that are at the end of the plug. Otherwise, the unload valve pressure setting must be readjusted.

[2] Swivel section disassembly



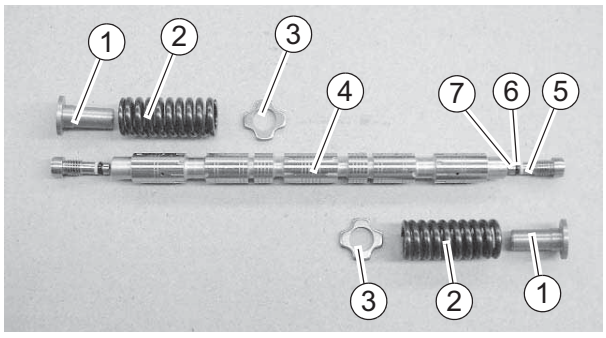
1) Inner parts

(1)	O-ring	(5)	Load check poppet
(2)	O-ring	(6)	Spring
(3)	O-ring	(7)	Cap
(4)	Shuttle plate		



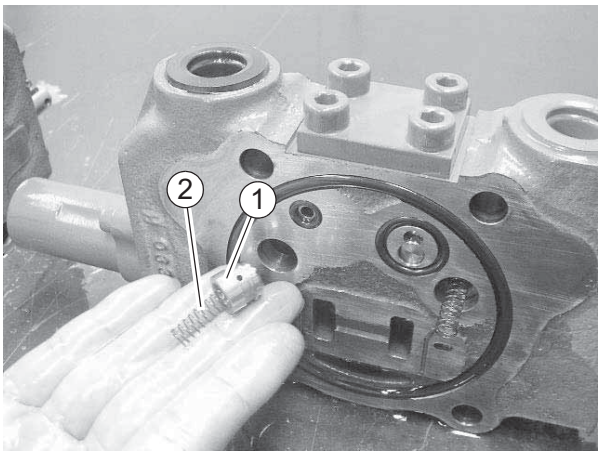
2) Removing spool

1) Remove the hex socket bolt from the cap. Slowly draw out the seat (1), spring (2), plate (3) and spool (4).
   * Bolt tightening torque: 8.8 ~ 10.8 N·m
     (0.9 ~ 1.1 kgf·m)
     6.5 ~ 8.0 ft·lbs
2) Precautions in reassembling
   a) Each spool fits only its specified section. It is not interchangeable with any other spool.
   b) The spool must be positioned in the specified direction. Be careful not to confuse the inserting direction.
   c) Apply fresh hydraulic oil to the spools and gently insert them in their sections.



3. Inner parts

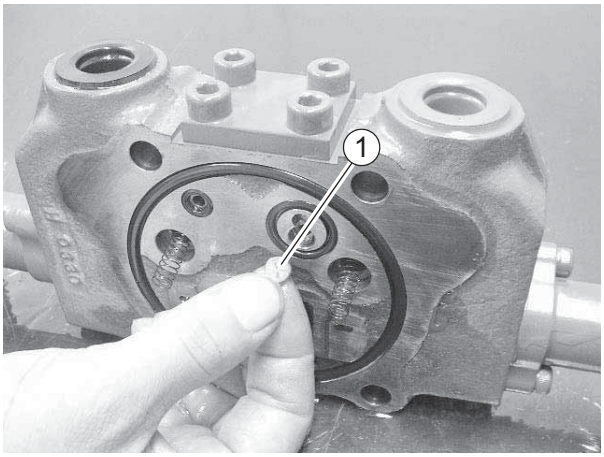
(1)	Spring seat	(5)	Plug
(2)	Spring	(6)	Backup ring
(3)	Spring plate	(7)	O-ring
(4)	Spool		



3) Load check poppet

Remove load check poppet and spring.

(1) Poppet (2) Spring



4) Shuttle plate removing

(1) Shuttle plate

Note:
When detaching the shuttle plate, be careful not to get the shuttle plate and the housing around it scratched.

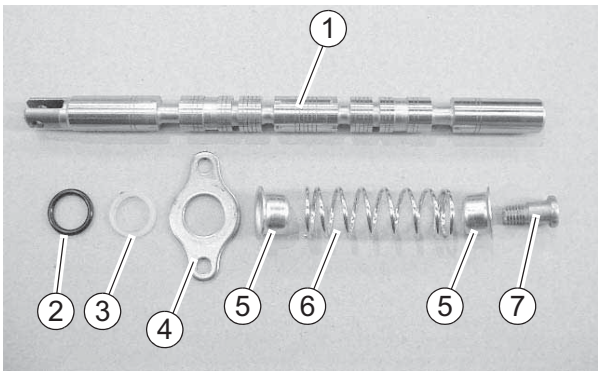
[3] Travel section disassembly

1) Inner parts

(1) O-ring (4) Shuttle plate
(2) O-ring (5) Shut-off valve
(3) O-ring (6) Cap

2) Removing spool

1) Remove the hex socket bolt from the cap. Slowly draw out the seat (5), spring (6), plate (4) and spool (1).
   * Bolt tightening torque: 8.8 ~ 10.8 N·m
     (0.9 ~ 1.1 kgf·m)
     6.5 ~ 8.0 ft·lbs
2) Precautions in reassembling
   a) Each spool fits only its specified section. It is not interchangeable with any other spool.
   b) The spool must be positioned in the specified direction. Be careful not to confuse the inserting direction.
   c) Apply fresh hydraulic oil to the spools and gently insert them in their sections.



3. Spool inner parts

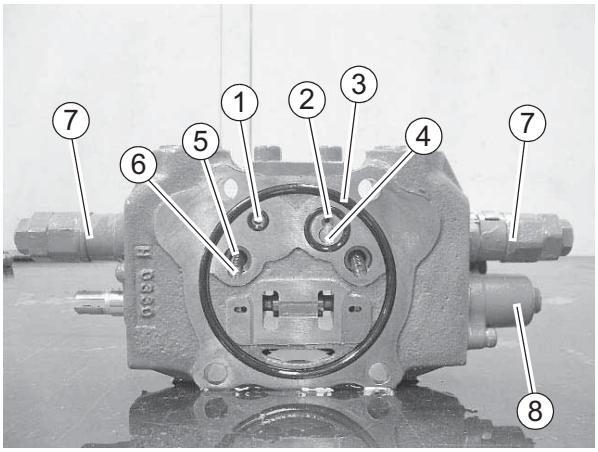
(1)	Spool	(5)	Seat
(2)	O-ring	(6)	Spring
(3)	Wiper	(7)	Cap screw
(4)	Seal plate		

Cap screw tightening torque: 19 ~ 22 N·m
(2.0 ~ 2.2 kgf·m)
15 ~ 16 ft·lbs

3) No load check poppet and spring are installed in travel section.

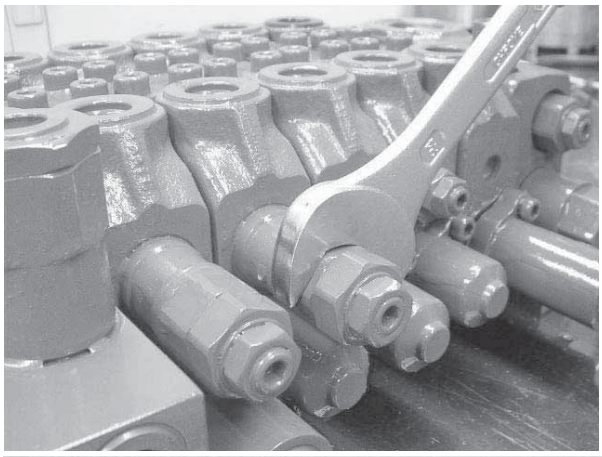
4) Shuttle plate removing
Same as in the swivel section.

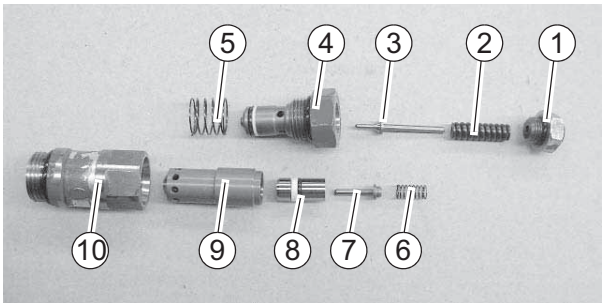
[4] Dozer section disassembly



1) Inner parts

(1)	O-ring	(5)	Spring
(2)	O-ring	(6)	Load check poppet
(3)	O-ring	(7)	Overload relief
(4)	Shuttle plate	(8)	Cap





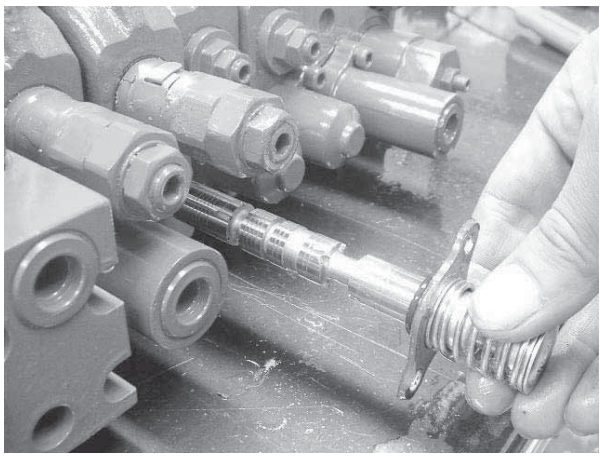
2) Overload relief valve disassembling

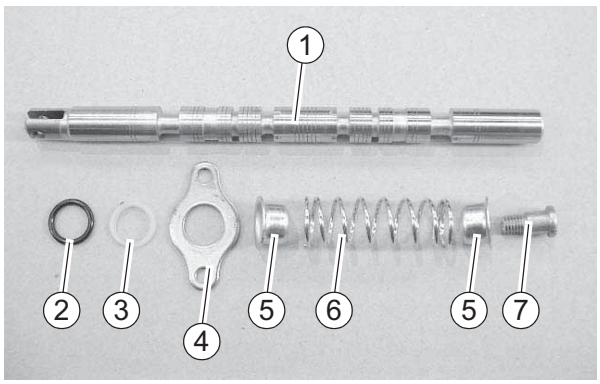
1. Tightening torque: 69 ~ 78 N·m
   (7.0 ~ 8.0 kgf·m)
   50 ~ 58 ft·lbs
2. Pressure setting: 11.8/26.5 MPa (120/270 kgf/cm^2)

   Note:
   Carefully check to see if there is no dust and metallic chippings on the seats of poppets (3) and (8). If they are dented or scratched, correct or replace them.

3. Inner parts

(1)	Adjuster, Nut, washer	(6)	Spring
(2)	Spring	(7)	Piston
(3)	Pilot poppet	(8)	Poppet
(4)	Spool	(9)	Sleeve
(5)	Spring	(10)	Cap





3) Removing spool

1. Remove the hex socket bolt from the cap. Slowly draw out the seat (5), spring (6), plate (4) and spool (1).
   * Bolt tightening torque: 8.8 ~ 10.8 N·m
   (0.9 ~ 1.1 kgf·m)
   6.5 ~ 8.0 ft·lbs
2. Precautions in reassembling
   a) Each spool fits only its specified section. It is not interchangeable with any other spool.
   b) The spool must be positioned in the specified direction. Be careful not to confuse the inserting direction.
   c) Apply fresh hydraulic oil to the spools and gently insert them in their sections.

3. Inner parts

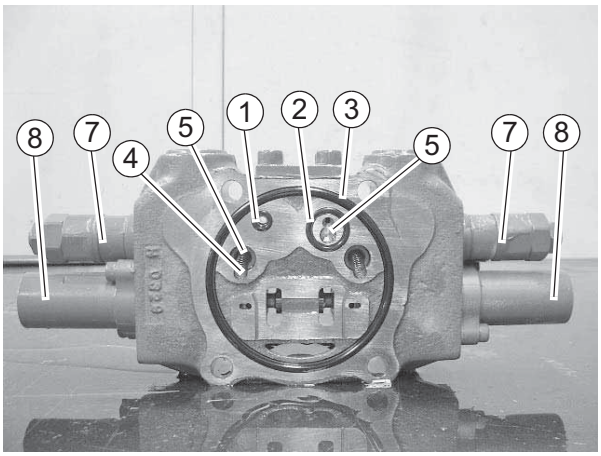
(1)	Spool	(5)	Spring seat
(2)	O-ring	(6)	Spring
(3)	Wiper	(7)	Cap screw
(4)	Seal plate		

   Cap screw tightening torque: 19 ~ 22 N·m
   (2.0 ~ 2.2 kgf·m)
   15 ~ 16 ft·lbs

4. Load check poppet removing
   Refer to the swivel section.

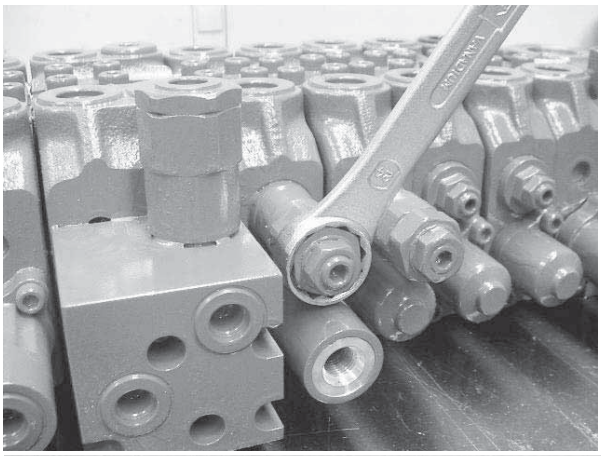
5. Shuttle plate removing

[5] Arm section disassembly



1) Inner parts

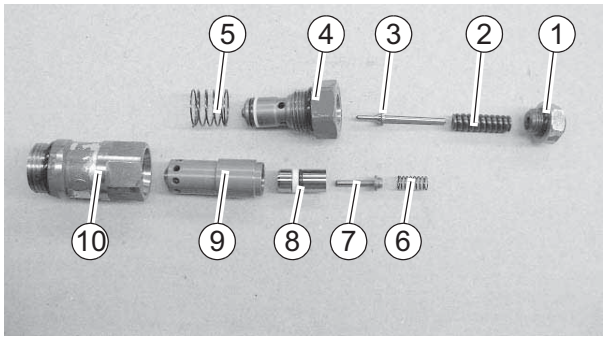
(1)	O-ring	(5)	Load check poppet
(2)	O-ring	(6)	Shuttle plate
(3)	O-ring	(7)	Overload relief
(4)	Spring	(8)	Cap



2) Overload relief valve disassembling

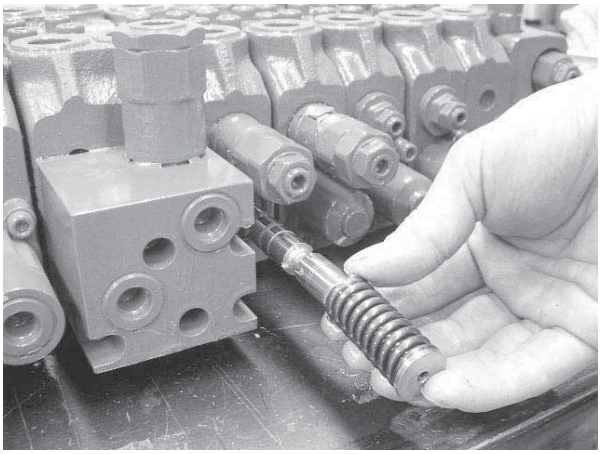
1. Tightening torque: 69 ~ 78 N·m
   (7.0 ~ 8.0 kgf·m)
   50 ~ 58 ft·lbs
2. Pressure setting: 26.5 MPa (270 kgf/cm^2) 3840 psi

Note:
Carefully check to see if there is no dust and metallic chippings on the seats of poppets (3) and (8). If they are dented or scratched, correct or replace them.



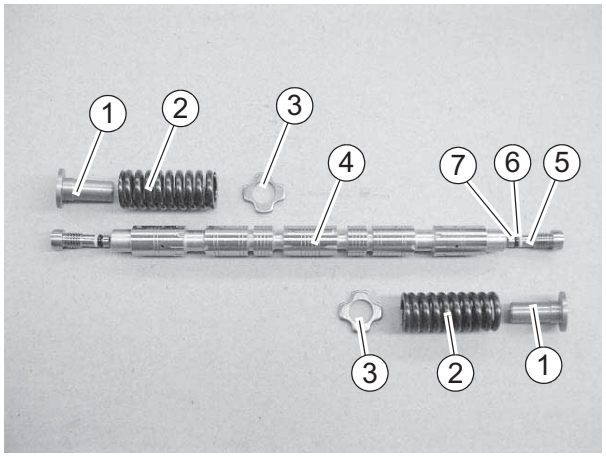
3. Inner parts

(1)	Adjuster, Nut, washer	(6)	Spring
(2)	Spring	(7)	Piston
(3)	Pilot poppet	(8)	Poppet
(4)	Plug	(9)	Sleeve
(5)	Spring	(10)	Cap



3) Removing spool

1. Remove the hex socket bolt from the cap. Slowly draw out the seat (1), spring (2), plate (3) and spool (4).
   * Bolt tightening torque: 8.8 ~ 10.8 N·m
   (0.9 ~ 1.1 kgf·m)
   6.5 ~ 8.0 ft·lbs
2. Precautions in reassembling
   a) Each spool fits only its specified section. It is not interchangeable with any other spool.
   b) The spool must be positioned in the specified direction. Be careful not to confuse the inserting direction.
   c) Apply fresh hydraulic oil to the spools and gently insert them in their sections.



3. Inner parts

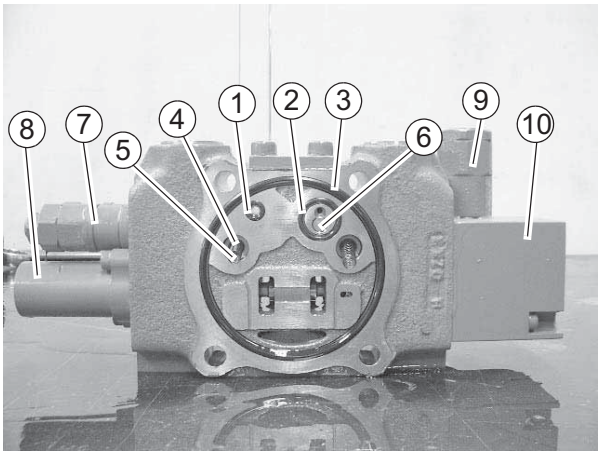
(1)	Spring seat	(5)	Plug
(2)	Spring	(6)	Backup ring
(3)	Plate spring	(7)	O-ring
(4)	Spool		

Cap screw tightening torque: 19 ~ 22 N·m
(2.0 ~ 2.2 kgf·m)
15 ~ 16 ft·lbs

4) Load check poppet removing
Refer to the swivel section.

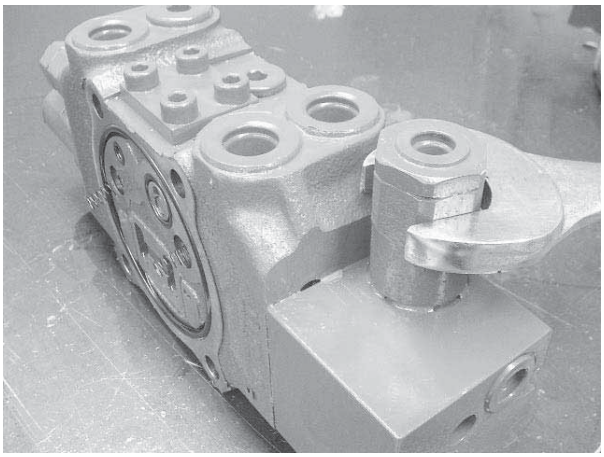
5) Shuttle plate removing

[6] Boom section disassembling

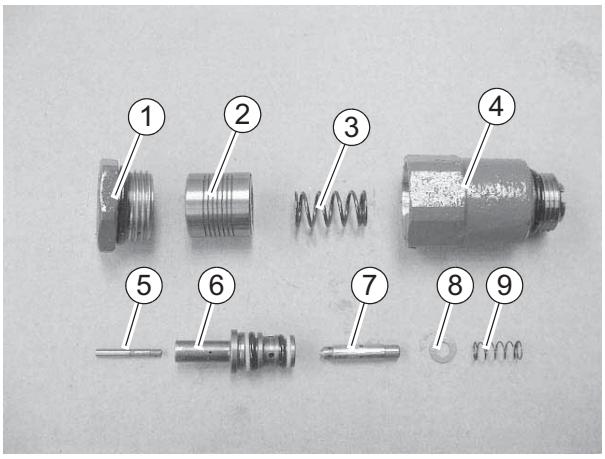


1) Inner parts

(1)	O-ring	(6)	Shuttle plate
(2)	O-ring	(7)	Overload relief
(3)	O-ring	(8)	Cap
(4)	Load check poppet	(9)	Anti-drift valve
(5)	Spring	(10)	Body



2) Anti-drift valve disassembling
1. Anti-drift valve tightening torque: 69 ~ 78 N·m
(7.0 ~ 8.0 kgf·m)
50 ~ 58 ft·lbs

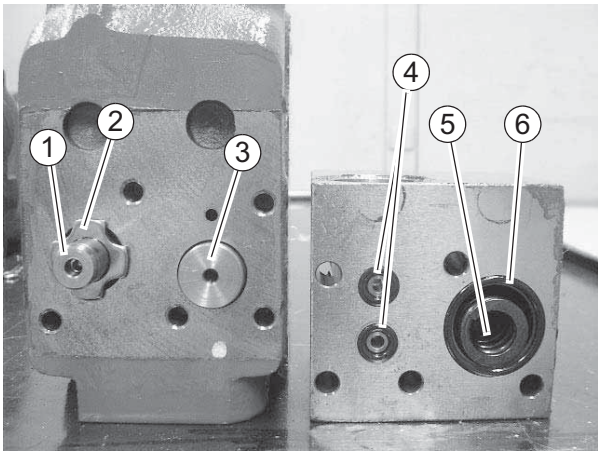


2. Precaution
Security check the direction of spool (5).

3. Inner parts

(1)	Plug assy	(6)	Sleeve
(2)	Piston	(7)	Poppet
(3)	Spring	(8)	Spring seat
(4)	Plug	(9)	Spring
(5)	Spool		

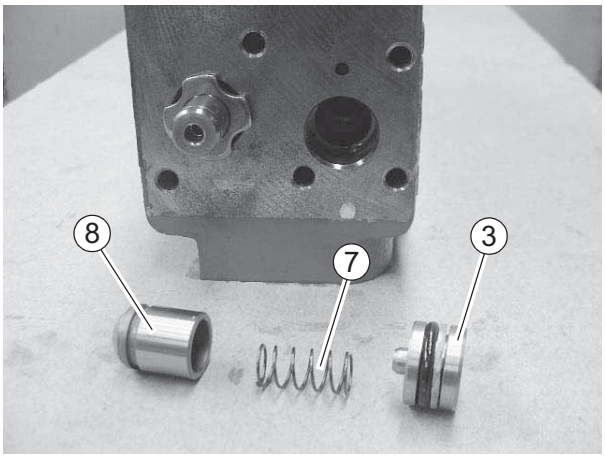
Plug assy tightening torque: 69 ~ 78 N·m
(7.0 ~ 8.0 kgf·m)
50 ~ 58 ft·lbs



3) Body (10) disassembly

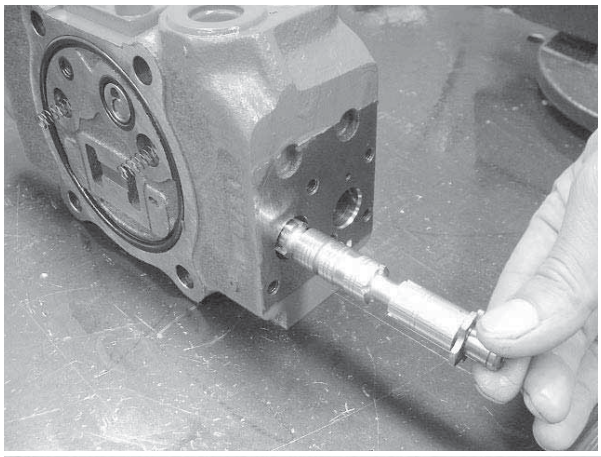
1. Remove hex. bolts, 4 pieces.
Tightening torque: 69 ~ 78 N·m
(7.0 ~ 8.0 kgf·m)
50 ~ 58 ft·lbs

2. Precaution for disassembly
When removing body (10), spring and spring seat may pop out. So case should be taken.

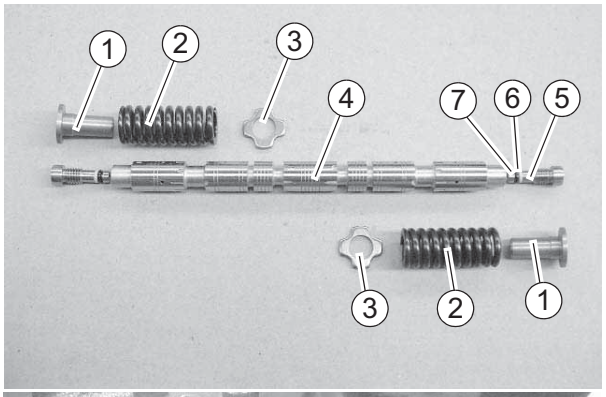


3. Inner parts

(1)	Spool	(5)	Spring
(2)	Spring plate	(6)	O-ring
(3)	Spacer	(7)	Spring
(4)	O-ring	(8)	Spring

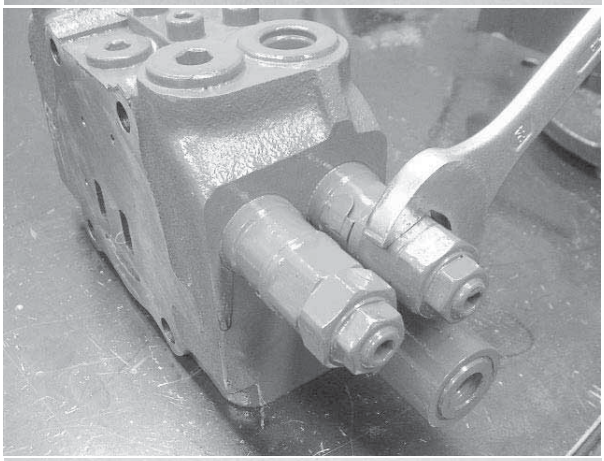


4) Spool removing
1. Remove the spool slowly.
2. Precaution when reassembly
   a) Each spool fits only its specified section. It is not interchangeable with any other spool.
   b) The spool must be positioned in the specified direction. Be careful not to confuse the inserting direction.
   c) Apply fresh hydraulic oil to the spools and gently insert them in their sections.



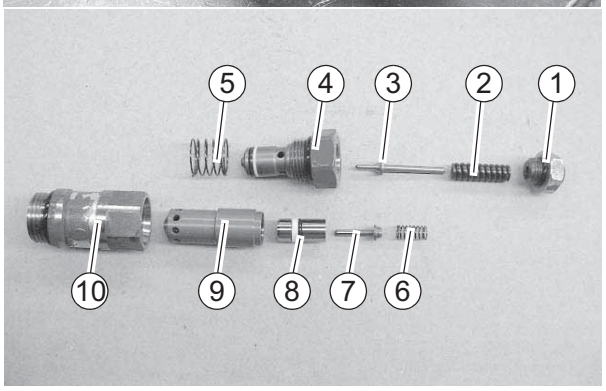
3. Inner parts

(1)	Spring seat	(5)	Plug
(2)	Spring	(6)	Backup ring
(3)	Spring plate	(7)	O-ring
(4)	Spool		



5) Overload relief valve removing
1. Tightening torque: 69 ~ 78 N·m
   (7.0 ~ 8.0 kgf·m)
   50 ~ 58 ft·lbs
2. Pressure setting: 26.5 MPa (270 kgf/cm^2) 3840 psi

Note:
Carefully check to see if there is no dust and metallic chippings on the seats of poppets (3) and (8). If they are dented or scratched, correct or replace them.



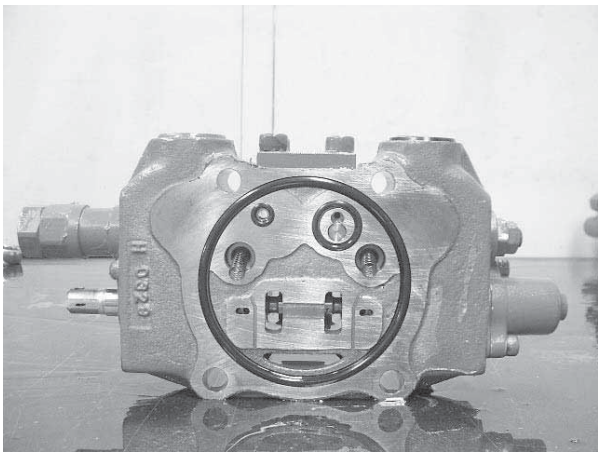
3. Inner parts

(1)	Adjuster, Nut, washer	(6)	Spring
(2)	Spring	(7)	Piston
(3)	Pilot poppet	(8)	Poppet
(4)	Plug	(9)	Sleeve
(5)	Spring	(10)	Cap

6) Load check poppet removing
Refer to the swivel section.

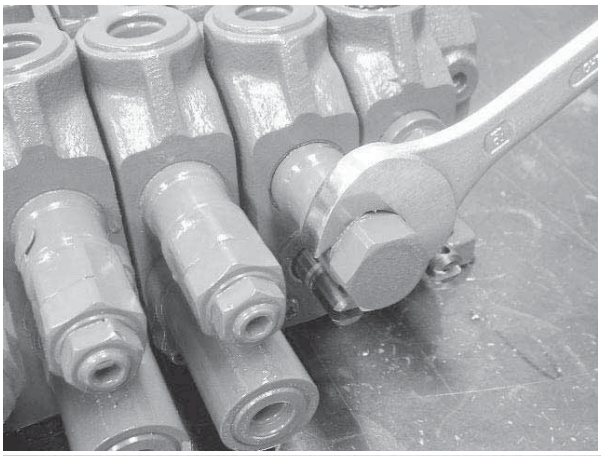
7) Shuttle plate removing

[7] Swing section disassembling



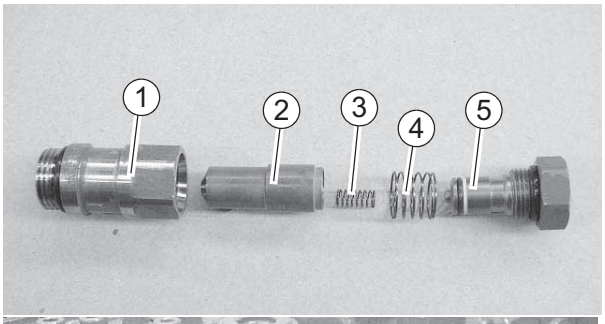
1) Inner parts

(1) O-ring
(2) O-ring
(3) O-ring
(4) Shuttle plate
(5) Spring
(6) Load check poppet
(7) Overload relief
(8) Cap
(9) Shut-off valve assy



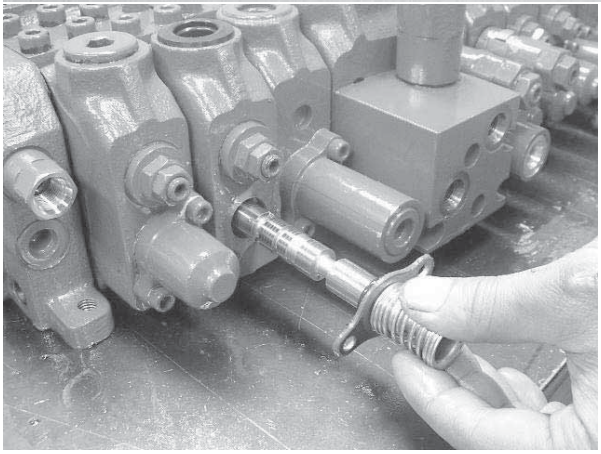
2) Anti-void valve disassembling

1. Anti-void valve tightening torque: 69 ~ 78 N·m
   (7.0 ~ 8.0 kgf·m)
   50 ~ 58 ft·lbs



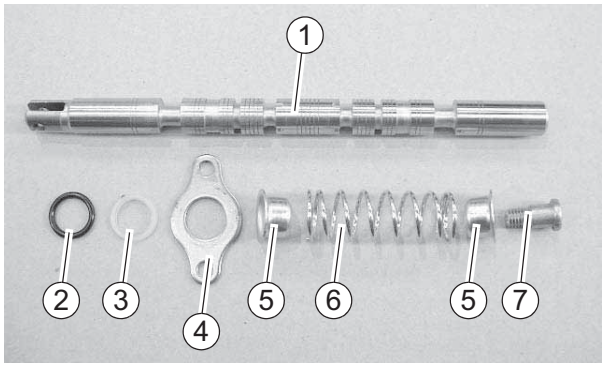
2. Inner parts

(1) Cap
(2) Sleeve
(3) Spring
(4) Spring
(5) Plug



3) Spool removing

1. Remove the spool slowly.
2. Precaution when reassembly
   a) Each spool fits only its specified section. It is not interchangeable with any other spool.
   b) The spool must be positioned in the specified direction. Be careful not to confuse the inserting direction.
   c) Apply fresh hydraulic oil to the spools and gently insert them in their sections.

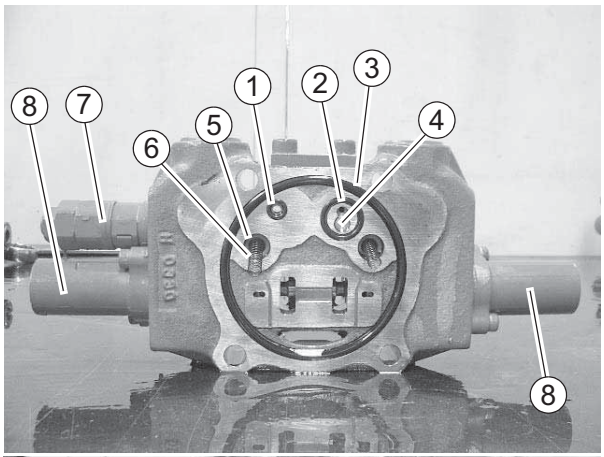


3. Inner parts

(1)	Spool	(5)	Spring seat
(2)	O-ring	(6)	Spring
(3)	Wiper	(7)	Cap screw
(4)	Seal plate		

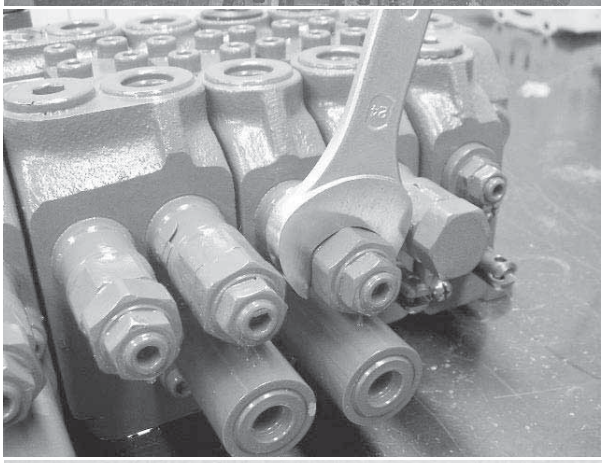
Cap screw tightening torque: 19 ~ 22 N·m
(2.0 ~ 2.2 kgf·m)
15 ~ 16 ft·lbs

[8] Bucket section disassembling



1) Inner parts

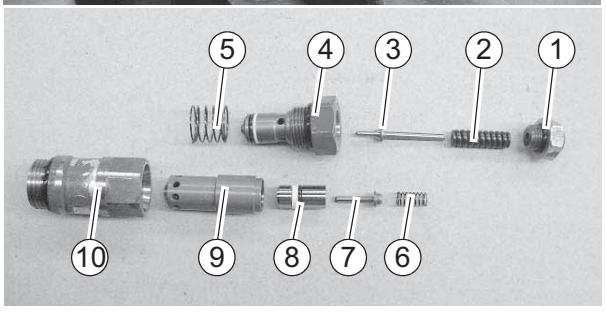
(1)	O-ring	(5)	Spring
(2)	O-ring	(6)	Load check poppet
(3)	O-ring	(7)	Overload relief
(4)	Shuttle plate	(8)	Cap



2) Overload relief valve removing

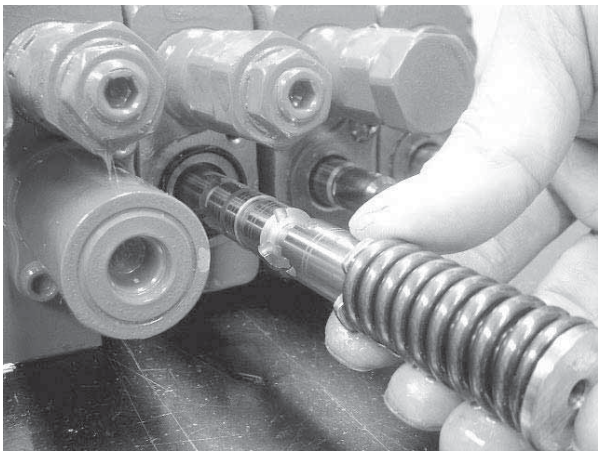
1. Tightening torque: 69 ~ 78 N·m
(7.0 ~ 8.0 kgf·m)
50 ~ 58 ft·lbs
2. Pressure setting: 26.5 MPa (270 kgf/cm^2) 3840 psi

Note:
Carefully check to see if there is no dust and metallic chippings on the seats of poppets (3) and (8). If they are dented or scratched, correct or replace them.



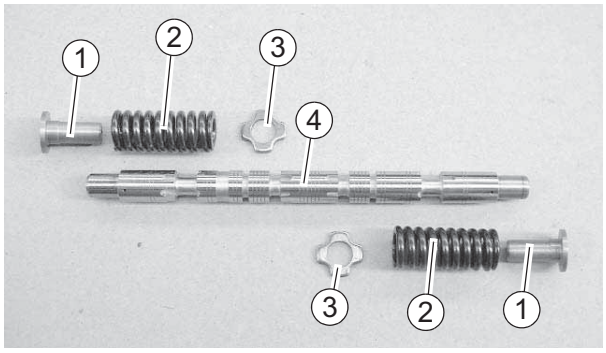
3. Inner parts

(1)	Adjuster, Nut, washer	(6)	Spring
(2)	Spring	(7)	Piston
(3)	Pilot poppet	(8)	Poppet
(4)	Plug	(9)	Sleeve
(5)	Spring	(10)	Cap



3) Spool removing

1. Remove the spool slowly.
2. Precaution when reassembly
   a) Each spool fits only its specified section. It is not interchangeable with any other spool.
   b) The spool must be positioned in the specified direction. Be careful not to confuse the inserting direction.
   c) Apply fresh hydraulic oil to the spools and gently insert them in their sections.



3. Inner parts

(1)	Spring seat	(3)	Spring plate
(2)	Spring	(4)	Spool

4) Load check poppet removing

Refer to the swivel section.

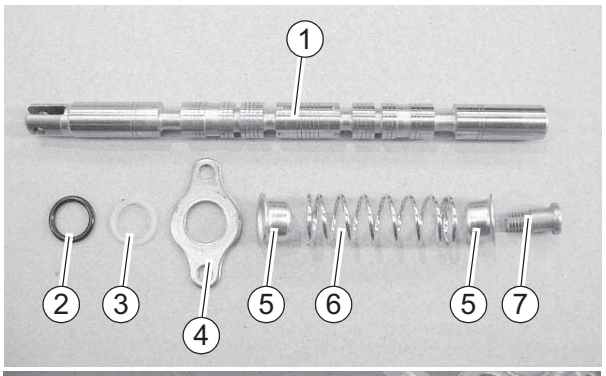
5) Shuttle plate removing

[9] Service port section disassembling

1) Inner parts

(1) O-ring
(2) O-ring
(3) O-ring
(4) Shut-off valve
(5) Spring
(6) Load check poppet
(7) Cap

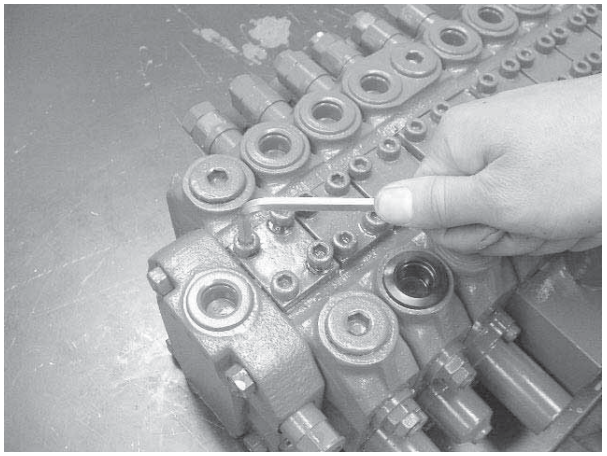
Note:
Shuttle plate isn't incorporated service port.



2) Spool removing

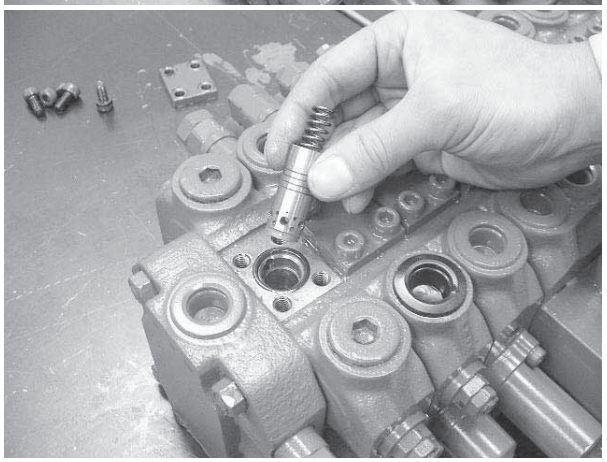
1. Remove the hex socket bolt from the cap. Slowly draw out the seat (1), spring (2), plate (3) and spool (4).
   * Bolt tightening torque: 8.8 ~ 10.8 N·m
     (0.9 ~ 1.1 kgf·m)
     6.5 ~ 8.0 ft·lbs
2. Inner parts

(1) Spring seat
(2) Spring
(3) Spring plate
(4) Spool



3) Removing compensation spool

1. Remove hex bolts, 4 pieces and detach the flange.
   Tightening torque: 35.1 ~ 38.8 N·m
   (3.6 ~ 4.0 kgf·m)
   26 ~ 29 ft·lbs
2. Remove o-ring, spring and compensation spool.

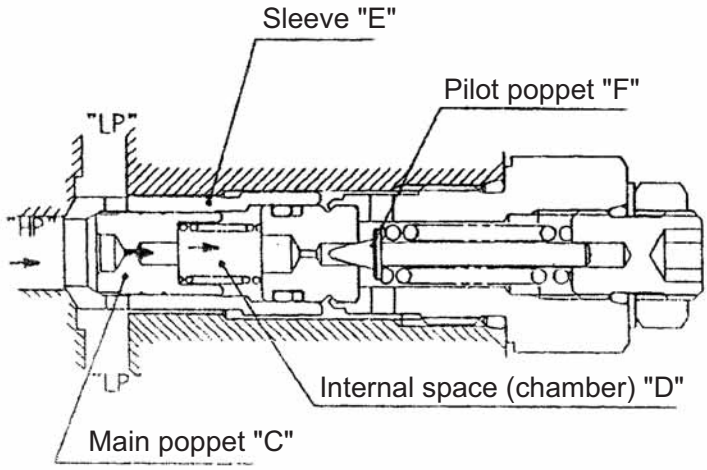


Precaution:
Compensation spools aren't interchangeable.
They should be used selectively to each section.

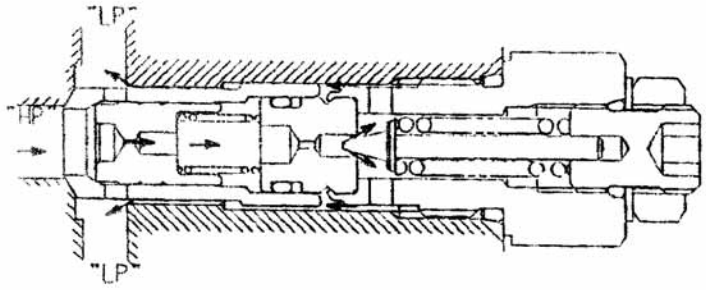
(6) Main relief valve

1. Function

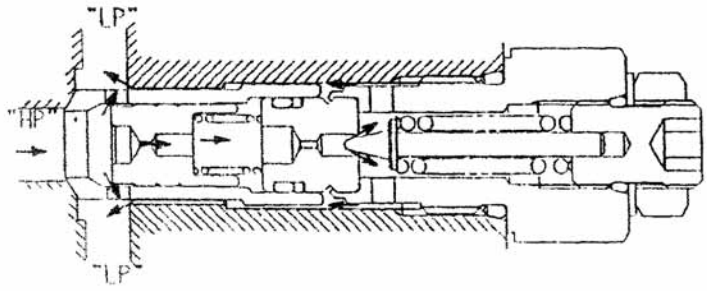
The main relief valve, which is assembled between the neutral passage "HP" and the low-pressure passage "LP", operates as follows:



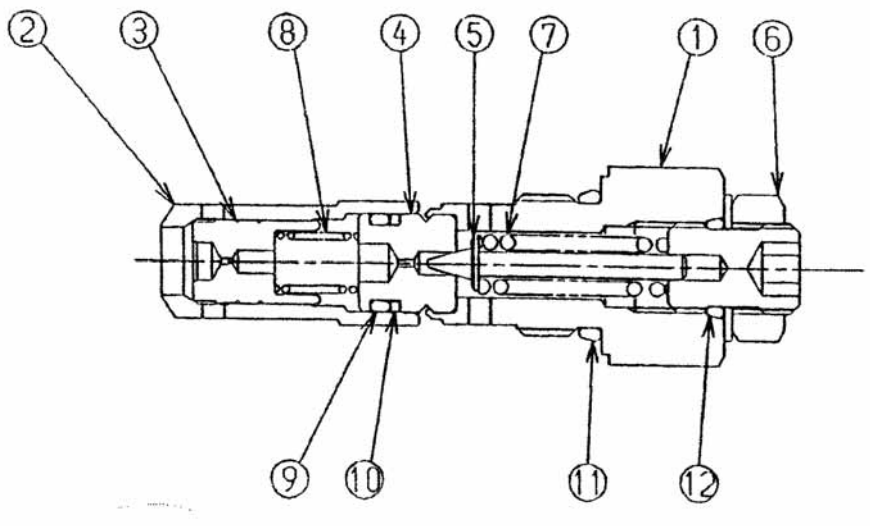
1) Oil passes the throttle hole of the main poppet, fills the internal space (chamber) "D" and the main poppet "C" and sleeve "E" are seated surely by difference in area.



2) When the pressure of the "HP" reaches the preset pilot spring force, the pilot poppet "F" opens. Oil flows around the pilot poppet up to the low-pressure passage "LP" through drilled hole.



3) When the pilot poppet "F" opens, oil begins to flow from the "HP" to the "D" chamber through the throttle hole of the main poppet "C". Thus, a pressure difference is generated between the "HP" and the chamber "D" and the main poppet "C" opens to allow oil to flow from the "HP" directly to the "LP".



2. Disassembly

Remove the plug (1) and disassemble the sleeve (2), main poppet (3) and spring (8).
Loosen the adjuster kit (6) and take out the pilot poppet (5) and spring (7).
Do not disassemble the pilot seat (4), which is caulked by the plug end.

3. Inspection

Wash all the parts with clean mineral oil, and check the parts after drying them by compressed air.

1. The poppet and sleeve end seating surfaces should be free from any defect and uniformed.
2. The main poppet (3) and sleeve (2) should slide lightly and smoothly. There should be no scratch and any other defect on the main poppet outer surface and the sleeve inner surface.
3. The springs should be free from any damage, deformation and abrasion.
4. The orifices of the main poppet and pilot seat should not be clogged with foreign matter.
5. The O-rings and backup rings should be free from any abrasion and deformation.

If a slight flaw is found in the above checks, remove it by lapping.
If a defective part is found, replace the relief valve assembly in whole.

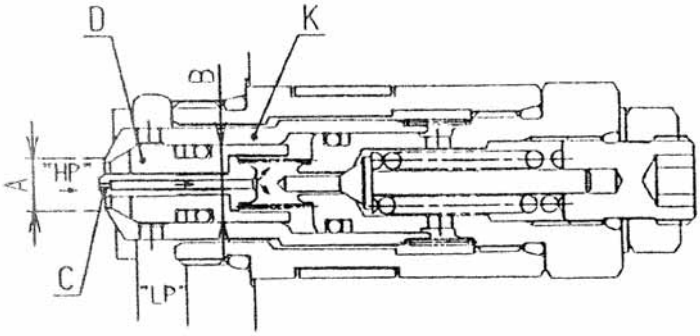
4. Reassembly

Set the main poppet (3) and spring (8) into the sleeve (2), and put them on the pilot seat in which the O-ring (9) and backup ring are assembled.
Fit the O-ring (11) beforehand and tighten the assembly to the inlet housing. (Tightening torque: 49 ~ 54 N·m (5 ~ 5.5 kgf·m) 36.2 ~ 39.8 ft·lbs)
Set the pilot poppet (5) and spring (7) into the plug (1), screw in the adjuster kit (6) to which the O-ring (12) is fitted and assemble them temporarily by lock nuts.
Assemble them in the inlet housing and adjust the pressure.

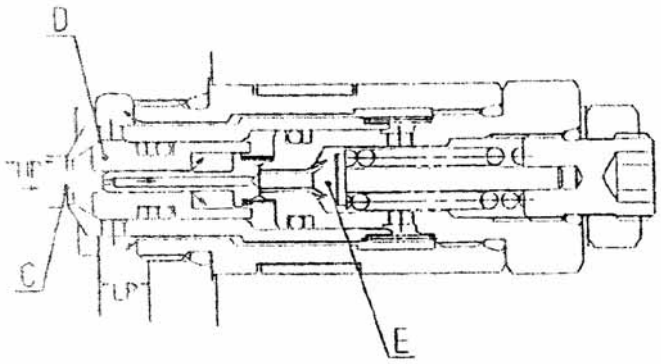
Do not re-use the O-ring and backup ring but replace them with new ones.

(7) Overload relief valve (Port relief valve, secondary relief valve)

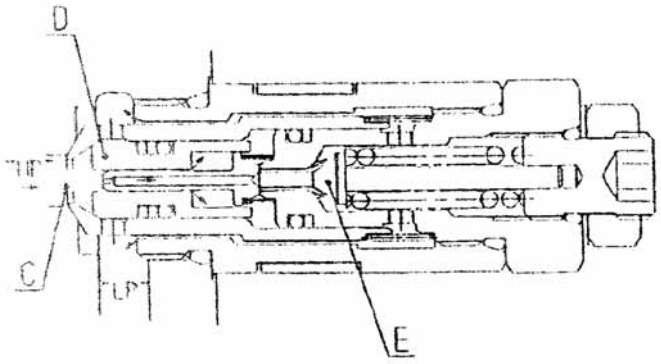
1. Function



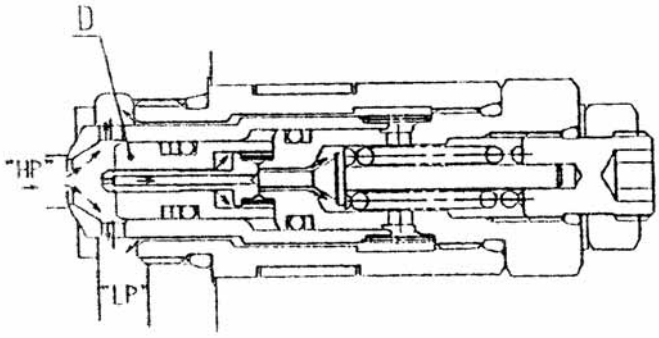
1) This relief valve is assembled between the cylinder port "HP" and the low-pressure passage "LP". Oil passes the orifice of poppet "C", acts on the areas which differ from each other in the diameter between "A" and "B" and the check valve poppet "K" and relief valve poppet "D" are surely seated.



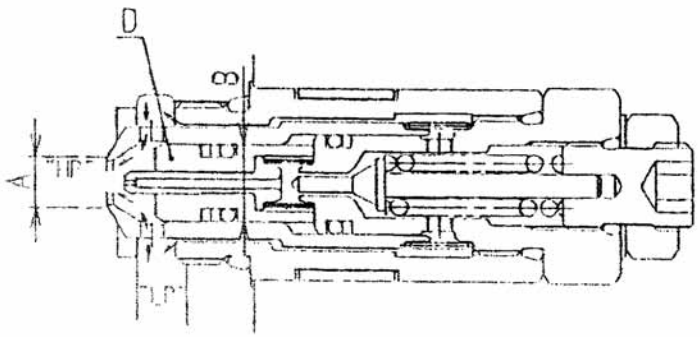
2) When the pressure of the cylinder port reaches the preset pilot valve spring force, the pilot poppet opens. Oil flows around the poppet up to the low-pressure passage "LP" through the drilled hole.



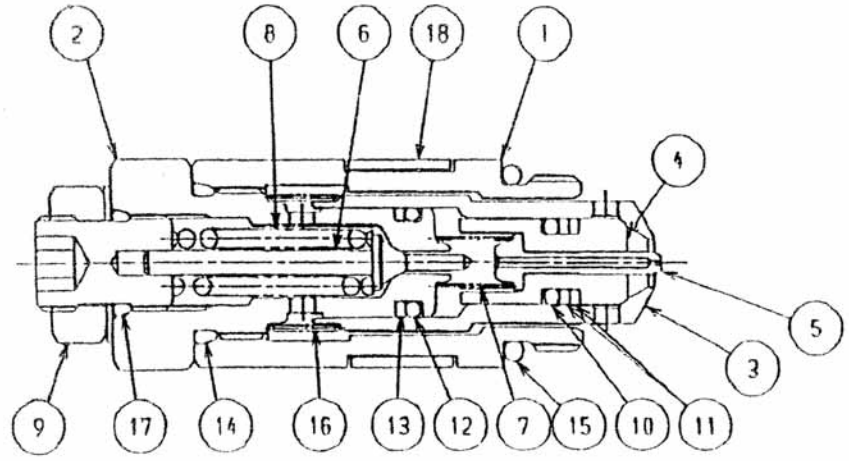
3) When the pilot poppet "E" opens, oil begins to flow through the throttle hole of the poppet "C". Thus, a pressure difference is generated between the "HP" and the back side of the poppet "C" and the poppet "C" moves to be seated to the pilot poppet "E".



4) Oil flowing from the cylinder port "HP" to the back side of the relief valve poppet "D" goes through a clearance between the relief valve poppet "D" and the poppet "C" only, which increase the pressure difference. Thus, the relief valve poppet "D" opens to allow oil to flow directly to the low-pressure passage "LP".



5) This is the anti-void unit to supply oil when cavitation is generated in the cylinder port "HP". When low pressure is transmitted from the low-pressure side to the cylinder port "HP", the relief valve poppet opens due to difference in area between the diameters "A" and "B". Then, adequate amount of oil enters from the low-pressure side to fill the space.



2. Disassembly

Remove the plug (2) and disassemble corrugated washer (16), sleeve (3), poppet (4), piston (5) and spring (7).
Loosen the nut (9-3), remove the adjuster (9-1) and washer (9-2), and then disassemble the spring (8) and pilot poppet (6).

3. Inspection

1) The poppet end seating surfaces should be free from any defect and uniformed.
2) The poppet (1) and sleeve (3) should slide lightly and smoothly. There should be no scratch and any other defect on the poppet outer surface and sleeve inner surface.
3) The springs should be free from any damage, deformation and abrasion.
4) The orifices of the main poppet and pilot seat should not be clogged with foreign matter.
5) The O-rings and backup rings should be free from any abrasion and deformation.

If a slight flaw is found in the above checks, remove it by lapping.
If a defective part is found, replace the relief valve assembly in whole.

4. Reassembly

Fit the poppet (4) in which the O-ring (10) and backup rings (11) (two pcs.) in the sleeve (3). Set the piston (5) and spring (7) into the poppet.
(The parts that have been assembled so far are called "assembly A".)

Set the pilot poppet (6) and pilot spring (8) into the plug (2) in which the O-ring (12) and backup ring (13) are assembled, fit the O-ring (17) and tighten them by screwing the adjuster (9-1) thereon. Tighten the adjuster temporarily by the nut (9-3).
Fit the O-ring into the plug (14). (The parts that have been assembled so far are called "assembly B".) Fit the above-mentioned assembly A into the cap (1) and mount the assembly B.
(Tightening torque: 69 ~ 78 N·m (7.0 ~ 8.0 kgf·m) 50 ~ 58 ft·lbs)
Do not re-use the O-rings and backup rings but replace them with new ones.

5. Final check

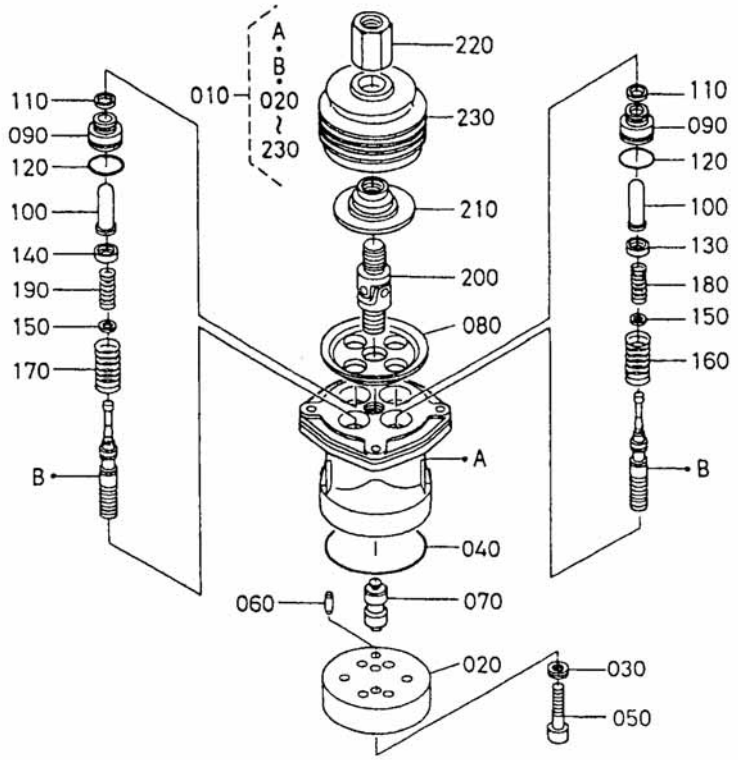
After assembling the relief valve, push the sleeve (3) inside, and make sure in this state that the piston (5) can be rotated lightly by finger. If it cannot be so rotated, replace the whole relief valve assembly.

6. Pressure adjusting procedure

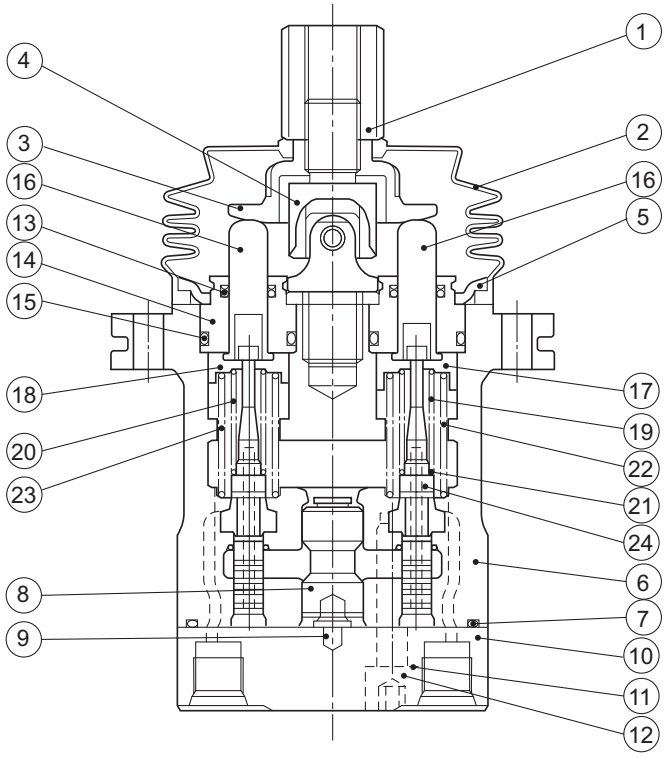
1) Mount an accurate pressure gauge to the inlet circuit (pump port side circuit).
2) Run the pump at the rated rotating speed.
3) Move the cylinder spool of the control valve in full stroke, and read the pressure gauge. (Cylinder stroke end)
4) Turn the adjuster clockwise until necessary pressure is obtained.
   Pressure increased by one turn of the adjuster:
   Main relief valve: Approx. 17.7 Mpa (180.5 kgf/cm^2, 2567 psi)
   Overload relief valve:Low-pressure type :Approx. 17.8 Mpa (181.5 kgf/cm^2, 2582 psi)
   High-pressure type: Approx. 28.4 Mpa (289.6 kgf/cm^2, 4119 psi)
5) When necessary pressure is obtained, tighten the nut while pressing the adjuster to prevent rotation.
   (Tightening torque: 27 ~ 31 N·m, 2.8 ~ 3.2 kgf/cm^2, 20.3 ~ 23.1 ft·lbs)
6) Raise the pressure again and make sure that the specified pressure is obtained.

e) Pilot Valve

(1) Components of the pilot valve



010	Assy valve, Pilot
020	Plate
030	Washer, Seal
040	O-ring
050	Bolt, HEX-SOC-HD
060	Pin, Spring
070	Bush
080	Plate
090	Plug
100	Push rod
110	Seal
120	O-ring
130	Seat, Spring
140	Seat, Spring
150	Washer
160	Spring
170	Spring
180	Spring
190	Spring
200	Joint
210	Nut
220	Nut, Adjusting
230	Boot



When reassembling:

1) Apply grease.
   a) Rotating part of joint (4)
   b) Top of push rod (16)
2) Pilot cut-away

Pilot cut-away

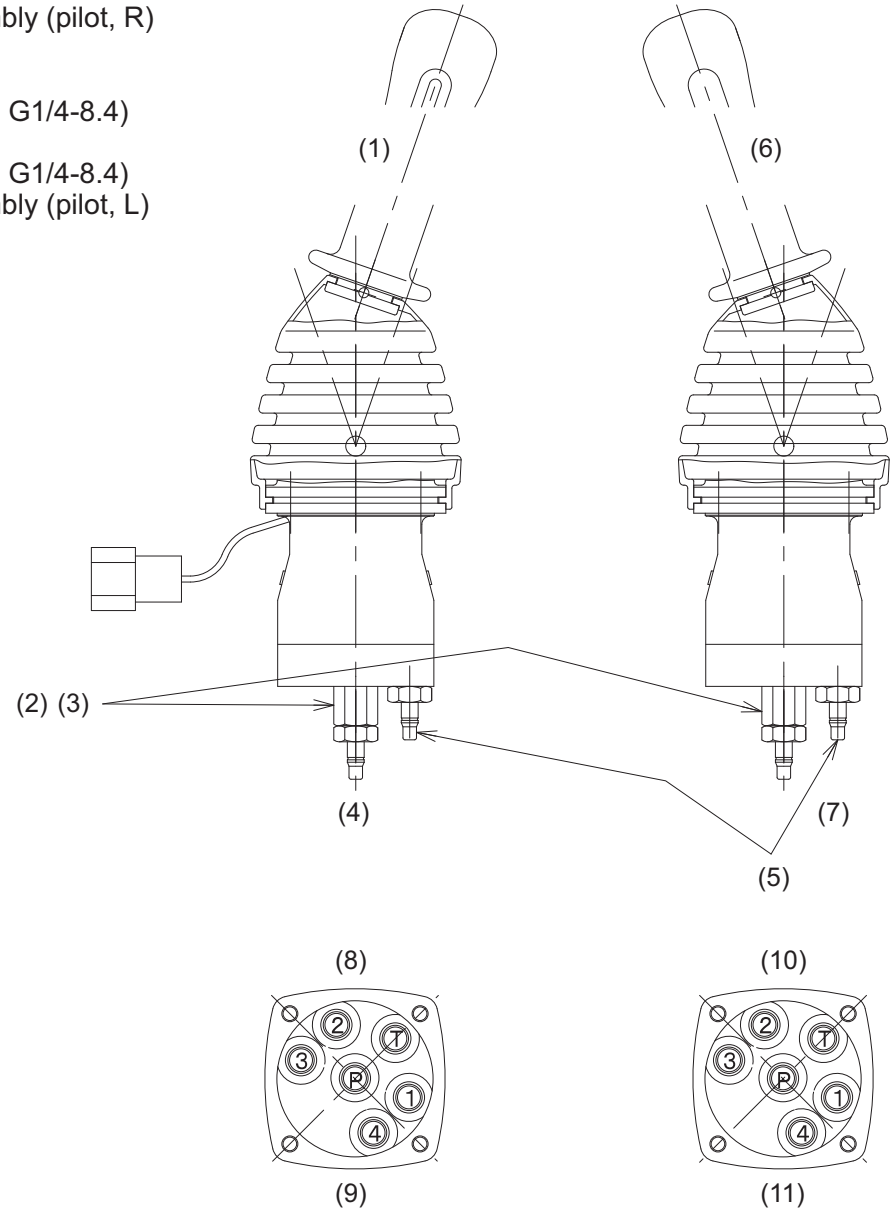
(1) Adapter installation
P port: Filter (68499-8374△)
All ports: Adapter (RD411-6176△)

(2) Adapter tightening torque
G1/4 24.5 ~ 29.4 N·m (2.5 ~ 3.0 kgf·m) 1.8 ~ 2.2 ft·lbs

(3) Pilot valve mounting direction
Port (2) to be toward the machine front (on both sides).

(4) Adapter (S, G1/4-8.4) (RD411-6176△)
Fit-in spots to be free of scratches.

(1) RC448-6172△ Valve assembly (pilot, R)
(2) Port P
(3) 68499-8374△ Filter
RD411-6176△ Pipe joint (S, G1/4-8.4)
(4) Right pilot valve
(5) RD411-6176△ Pipe joint (S, G1/4-8.4)
(6) RC448-6171△ Valve assembly (pilot, L)
(7) Left pilot valve
(8) Front
(9) Back
(10)Front
(11)Back



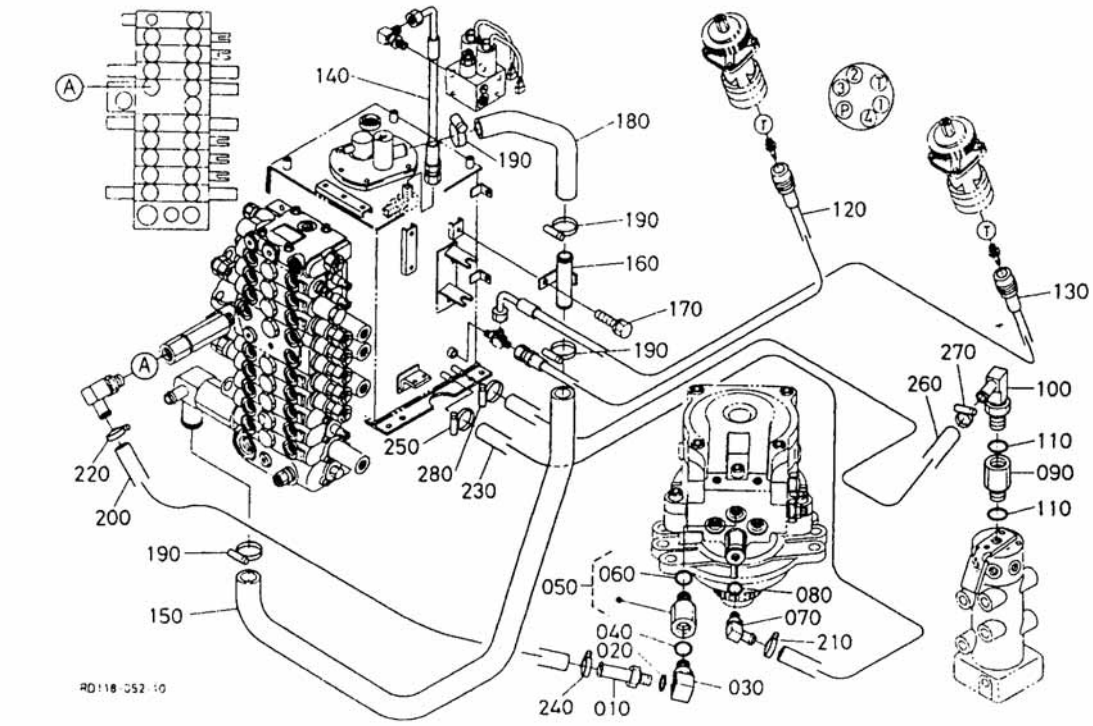
P/V, Right side

1	Bucket crowd	Pink
2	Boom down	Light blue
3	Bucket dump	Brown
4	Boom up	Gray
P	P port	White
T	T port	None

P/V, Left side

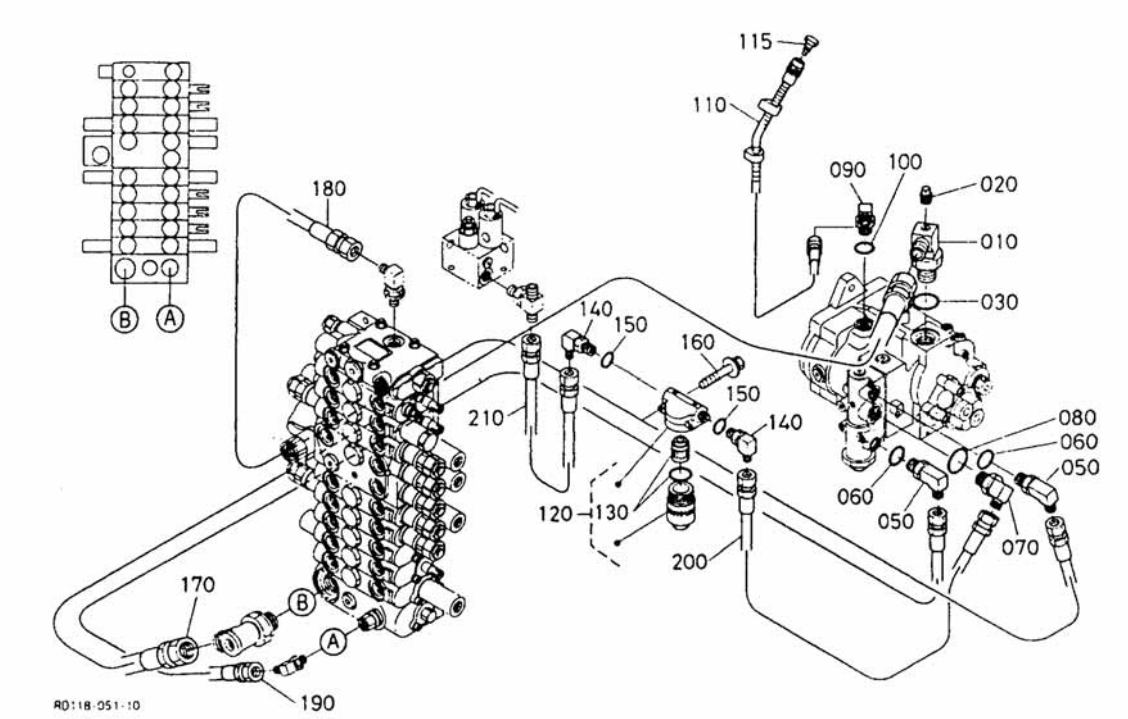
1	Swivel, L	Red
2	Arm dump	Blue
3	Swivel, R	Yellow
4	Arm crowd	Green
P	P port	White
T	T port	None

(2) Pilot hose connection: KTC, KCL, KTA-version



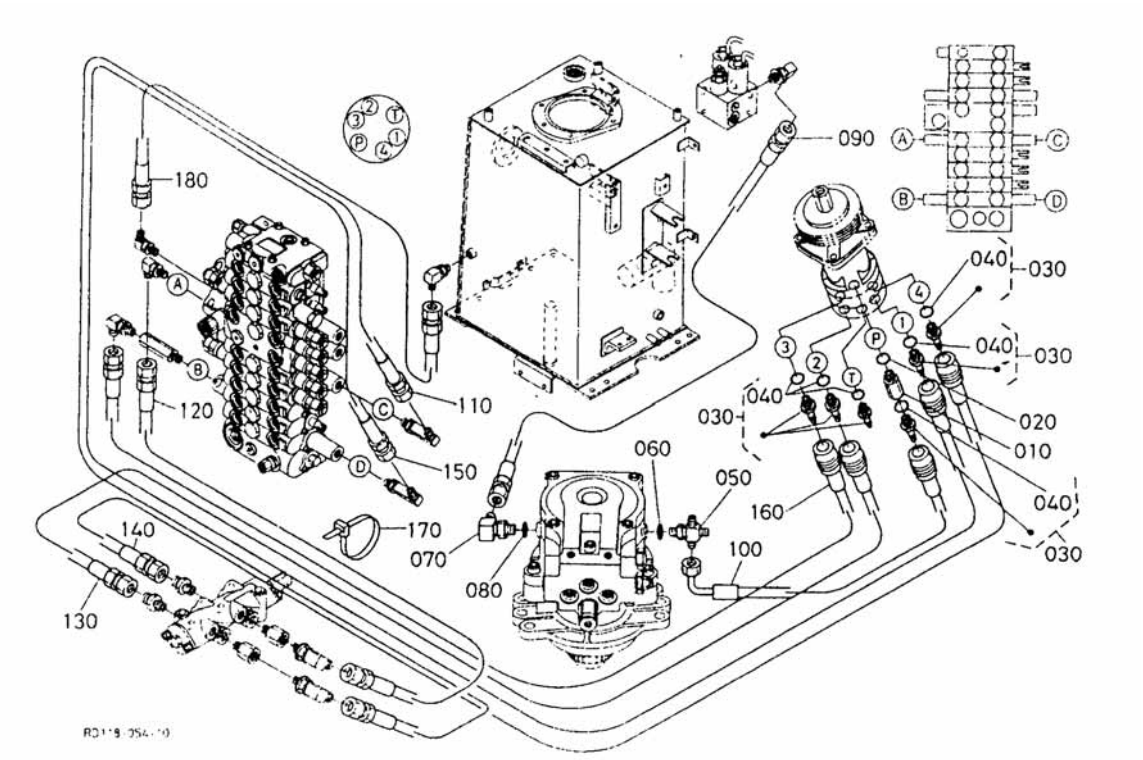
Ref. No	Part No	Part Name
010	RP401-6183-0	Joint, Pipe
020	04810-00140	O-ring
030	RP802-6363-2	Joint
040	04810-00140	O-ring
050	RD118-6194-0	Joint, Pipe
060	04810-00140	O-ring
070	RD401-6395-0	Elbow joint
080	04810-00110	O-ring
090	RC411-6388-0	Joint, Pipe
100	RD401-6395-0	Elbow joint
110	04810-00110	O-ring
120	RD118-6334-0	Hose, Hydraulic
130	RD118-6335-0	Hose, Hydraulic
140	RD411-6358-2	Hose, Hydraulic

Ref. No	Part No	Part Name
150	RD118-6354-0	Hose, Return
160	RD411-6355-0	Pope, Return
170	01135-61020	Bolt
180	RD411-6359-0	Hose, Return
190	RD411-6382-0	Clamp, Hose
200	RD118-6453-0	Hose
210	RC101-6458-0	Clamp, Hose
220	RC101-6458-0	Clamp, Hose
230	RD118-6455-0	Hose, Drain
240	RB101-6363-0	Clamp, Hose
250	RB101-6363-0	Clamp, Hose
260	RD118-6447-0	Hose
270	RB101-6363-0	Clamp, Hose
280	RB101-6363-0	Clamp, Hose



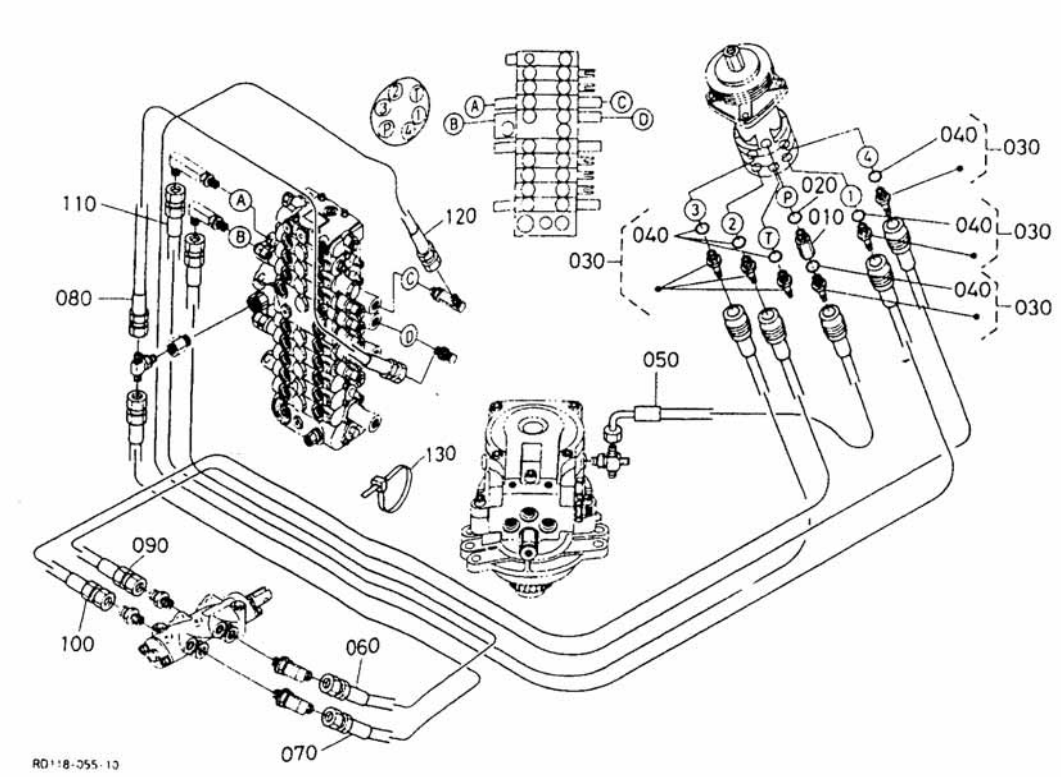
Ref. No	Part No	Part Name
010	R1401-6416-2	Joint
020	06312-10010	Plug
030	04810-00240	O-ring
040	----	Blank
050	69254-7849-0	Joint
060	04810-00110	O-ring
070	RP201-6181-0	Joint
080	04810-00140	O-ring
090	RC601-6372-0	Joint
100	04810-00110	O-ring
110	RD411-6315-3	Hose, Hydraulic

Ref. No	Part No	Part Name
115	RD411-6316-0	Plug
120	RD401-6126-0	Assy, Filter
130	RD401-6127-0	Kit element, Filter
140	69251-6185-0	Joint, Pipe (LF/-F)
150	04810-00180	O-ring
160	01025-60655	Bolt
170	RD118-6321-0	Hose, Hydraulic
180	RD118-6322-0	Hose, Hydraulic
190	RD114-6323-0	Hose, Hydraulic
200	RD118-6324-0	Hose, Hydraulic
210	RD411-6325-0	Hose, Hydraulic



Ref. No	Part No	Part Name
010	68499-8374-0	Filter
020	04810-00110	O-ring
030	RD411-6176-0	Joint, Pipe
040	04810-00110	O-ring
050	RP802-6193-0	Joint, Pipe
060	04810-00110	O-ring
070	RC601-6372-0	Joint
080	04810-00110	O-ring
090	RD118-6327-0	Hose, Hydraulic

Ref. No	Part No	Part Name
100	RD411-6332-0	Hose, Hydraulic
110	RD118-9633-0	Hose, Hydraulic
120	RD118-9634-0	Hose, Hydraulic
130	RD118-9643-0	Hose, Hydraulic
140	RD118-9644-0	Hose, Hydraulic
150	RD118-6348-0	Hose, Hydraulic
160	RD118-6349-0	Hose, Hydraulic
170	55311-4126-0	Band, Code
180	RD118-6356-0	Hose, Hydraulic



Ref. No	Part No	Part Name
010	68499-8374-0	Filter
020	04810-00110	O-ring
030	RD411-6176-0	Joint, Pipe
040	04810-00110	O-ring
050	RD118-6331-0	Hose, Hydraulic
060	RD118-9631-0	Hose, Hydraulic
070	RD118-9632-0	Hose, Hydraulic

Ref. No	Part No	Part Name
080	RD411-6343-0	Hose, Hydraulic
090	RD118-9641-0	Hose, Hydraulic
100	RD118-9642-0	Hose, Hydraulic
110	RD118-6346-0	Hose, Hydraulic
120	RD118-6347-0	Hose, Hydraulic
130	RD401-6127-0	Band, Code

(3) Disassembling and assembling

1) Tools and tightening torque

Tool	Size (mm)	Part No.	Part name	Screw size	Tightening torque N·m (kgf·m) ft·lbs
Hex wrench	6	125	Hex socket bolt	M8	20.6 ± 1.5 (2.1 ± 0.15) 15 ± 11
Money wrench	22	312	Adjusting nut	M14	68.6 ± 4.9 (7.0 ± 0.5) 496 ± 35
	32	302	Disc	M14	
Special tool (Drawing on page 17)	24	301	Joint	M14	47.1 ± 2.9 (4.8 ± 0.3) 341 ± 21

Others
- Vapor phase inhibitor
- Kerosene
- Heat-resistant grease
- Sandpaper (#1000, #2000)
- Oilstone
- Vise

2) Maintenance standard

Checkpoints	Criteria	Remarks
Leak amount	Replace the pilot valve assembly with new one if the oil leak exceeds 1000 cc/min with the steering wheel at neutral or 2000 cc/min while in operation.	Conditions: Primary pressure: 2.95 MPa Oil viscosity: 23 mm^2/s
Spool	If the sliding face is worn over 10 μ more than the non-sliding one, replace the pilot valve assembly with new one.	This amount of wear corresponds to the above leak amount. The same conditions as above are expected.
Push rod	If the tip is worn 1 mm or more, replace the push rod with new one.	
Loose control elements	If the disc (302) or joint (301) is worn out and loose 2 mm or more, replace it with new one.	If the shakiness is caused by a loose fixture, tighten it up.
Stable operation	If unusual noise, hunting, primary pressure drop, etc, occurs and it cannot be corrected according to "Chapter 8 Troubleshooting", replace the pilot valve assembly with new one.	

Note 1: It is advisable to replace the O-rings and other sealing elements at every disassembly. They may be reused when they are found not damaged.
Note 2: When the hex socket bolt (125) has been loosened, be sure to replace the sealing washer (121).

3) Disassembling

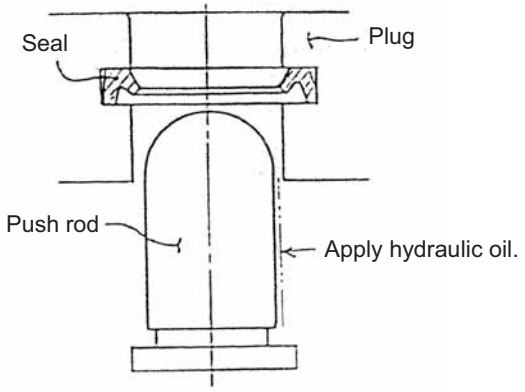
1. Preparations
   (1) Prepare a workbench that is spacious enough for the parts handled and strong and stable enough to keep the parts in place.
   (2) Also have the tools and jigs, discussed in Item 7-1, at hand.
2. General precautions
   (1) The parts are precision-machined. Handle them with enough care not to hit them against each other or drop them.
   (2) Even if any part is hard to remove, do not strike it out or pry out forcibly. Such handling may cause burrs or damages, which may invite oil leak or poor performance later. Try to do the job with patience.
   (3) Do not leave the taken-out or exposed parts unprotected. Moisture or dust may get stuck on them, causing rust. If unavoidably the job is interrupted halfway, be careful to protect such parts against rust and dust.
3. Disassembling procedure

	Procedure	Precautions
1	Clean up the pilot valve with kerosene.	* Apply blind plugs to all the open ports.
2	Fix the pilot valve on a vise using copper (or lead) sheets.	
3	Remove the bellows (501). [Photo 7-1]	* Be careful not to break the bellows (501).
4	Apply a wrench across the adjusting nut (312) and disc (302). Loosen and remove the adjusting nut and disc. [Photos 7-2, 7-3 and 7-4]	
5	With the specified jig, turn the joint (301) counterclockwise to get it loose. [Photos 7-5 and 7-6]	* Photo 7-5 shows the jig in its specified position. **CAUTION:** * When the return spring (221) is strong in force, take care in loosening and drawing out the joint (301). The plate (151), plug (211) and push rod (212) may pop out together when taking out the joint.
6	Remove the plate (151). (When the return spring (221) is strong in force) [Photo 7-7] (When the return spring (221) is weak in force) [Photo 7-8]	
7	When the return spring (221) is weak in force, the sliding resistance of the O-ring holds the plug (211) inside the casing (101). Using a bladed screwdriver, draw out the plug. [Photo 7-9]	* Using its outer groove, draw out the plug (211) with care not to get it damaged by an unbalanced load. **CAUTION:** * Keep in mind that when the plug (211) may pop out by the force of the return spring (221).
8	Pull the push rod (212), plug (211), reducing valve assembly, and return spring (221) out of the casing (101). [Photo 7-10]	* Keep record of the positional relation with the casing hole.
9	Fix the pilot valve, with its port plate (111) upward, in the vise.	
10	Using the specified hex wrench, loosen and remove the hex socket bolt (125). [Photo 7-11]	
11	Detach the port plate (111) and O-ring (122) from the casing (101). [Photos 7-12 and 7-13] Draw the bushing (131) out of the casing (101).	
12	To disassemble the reducing valve, do the following. Press in the spring seat (216) to get the secondary-pressure spring (241) warped. Then slide this spring seat sideways and pass it through the larger hole and out of the spool (201). [Photo 7-14] Next separate the following parts: spool (201), spring seat (216), secondary-pressure spring (241) and washer 2 (217). [Photo 7-15]	* Be careful not to scratch the surface of the spool (201). * Do not allow the spring seat (216) 6 mm or lower than specified. * Handle this group of parts as an assembly.

	Procedure	Precautions
13	Remove the folding-purpose spring (246) and spring seat (218) from the push rod (212). [Photo 7-16]	
14	Draw the push rod (212) out of the plug (211). [Photo 7-17]	
15	Remove the O-ring (214) and seal (213) from the plug (211). Use a small bladed screwdriver or the like to take out the seal (213). [Photos 7-18 and 7-19]	
16	Clean up the parts. 1) Put the parts one by one in a rough-washing container with kerosene. (Rough washing) 2) Put the parts one by one in a finish-washing container with kerosene. Slowly turn them and wipe them clean thoroughly inside and out. (Finish washing) Using clean waste cloth, wipe kerosene away from the parts.	* Do not wipe dirty parts in kerosene from the beginning because otherwise they might get scratched. Keep them dipped until dirt, fat and grease become loose enough off the parts. * Be attentive to keep the kerosene clean enough. Otherwise the parts may get scratched, leading to poor performance when reassembled. * Do not dry up the parts with compressed air. Dust and moisture in the air may damage the parts or get them rusty later.
17	Keep the parts against rust. Apply rust-preventive to the specified parts.	* Do not leave the parts without rust-preventive. Rust may build up, causing malfunction later.

4) Assembling

1. Preparations
   (1) As in the case of disassembling, prepare the specified workbench, tools and materials.
2. General precautions
   (1) Take the same general precautions as in disassembling.
   (2) Before reassembling, remove metal chippings and foreign matters from all the parts. Make sure the parts are free of burrs, hit marks and other problems. If a burr or hit mark is found, get rid of it with an oilstone.
   (3) In principle, replace the O-rings and backup rings with new ones.
   (4) When fitting the O-rings and backup rings, handle them with care not to damage it. (Apply a small amount of grease for smooth fitting.)
   (5) When fitting the parts in place, preferably use grease to avoid accidental drop.
   (6) Tighten the bolts and the like to the their specified torques listed in "7-1 Tightening Torque Chart". Measure the tightening torques with a torque wrench.
   (7) Finally apply blind plugs to all the open ports to avoid entry of dust.
3. Reassembling procedure

	Procedure	Precautions
1	Fit the bushing (131) and O-ring (122) to the casing (101). [Photo 7-20]	
2	Install the port plate (111), with the hex socket bolt (125) and seal washer (121) in between, on the casing (101). [Photos 7-21 and 7-22]	* Carefully position the spring pin (126) in the casing hole. * Replace the seal washer (121) with new one.
3	Tighten the hex socket bolt (125) to the specified torque. [Photo 7-23]	* Alternately tighten the two bolts.
4	Install the washer 2 (217), secondary-pressure spring (241) and spring seat (216) in this order on the spool (201). [Photo 7-24] Then press in the spring seat (216) to get the secondary-pressure spring (241) warped. Now slide this spring seat sideways and pass it through the larger hole and onto the spool (201). [Photo 7-25]	* Do not allow the spring seat (216) 6 mm or lower than specified.
5	Fit the return spring (221) in the casing (101). Also fit the reducing valve assembly to the casing (101). [Photo 7-26]	* Place these parts back in their original positions.
6	Fit the O-ring (214) to the plug (221). [Photo 7-27]	
7	Fit the seal (213) to the plug (211). [Photo 7-28]	* Place the seal (213) with its lip positioned as shown below.
8	Fit the push rod (212) into the plug (211). [Photo 7-29] Fit the folding-purpose spring (246) and spring seat (218) into the push rod (212). [Photo 7-30]	* Apply hydraulic oil over the surface of the push rod. 

	Procedure	Precautions
9	Fit the plug assembly to the casing (101). When the return spring (221) is weak in force, this assembly is kept in place by the sliding resistance of the O-ring. [Photo 7-31] When the return spring (221) is strong in force, fit all the four plugs at once using the plate (151). Apply and temporarily tighten the joint (301). [Photo 7-32]	* Be careful not to pry the spool (201) too hard. Otherwise the casing hole (101) may get damaged. **CAUTION:** * Keep in mind that the plug assembly and plate (151) may pop out.
10	Place the plate (151) in position.	
11	Using the specified jig, tighten the joint (301) to the casing (101) by the specified torque. [Photos 7-33 and 7-34]	* Photo 7-33 shows the jig in its specified position.
12	Fit the disc (302) to the joint (301). [Photo 7-35]	* Screw in the disc until it comes into even contact with the four push rods (212). **WARNING:** * Carefully adjust the final position of the disc (302). If it is screwed in too much, the secondary pressure with the lever at neutral may be wrongly applied, causing the machine to malfunction.
13	Apply the adjusting nut (312) and fix it by applying the specified wrench across the disc (302). Tighten the adjusting nut to the specified torque. [Photo 7-36]	* In tightening the nut, keep the disc (302) in position.
14	Apply grease to the turning portion of the joint (301) and the top of the push rod (212). [Photo 7-37]	
15	Fit the bellows back into position. [Photo 7-38]	* Be careful not to break the bellows (501).
16	Pour vapor phase inhibitor from the ports and apply the blind plugs.	

Photo 7-1

Photo 7-2

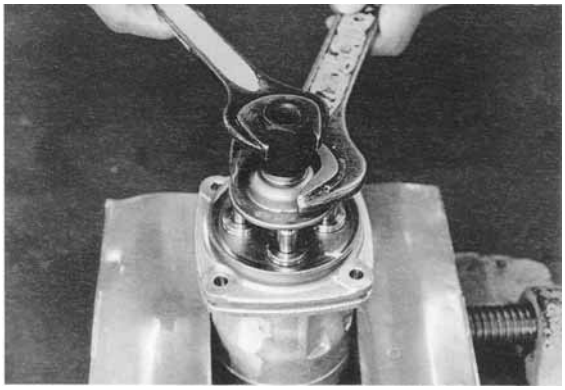


Photo 7-3

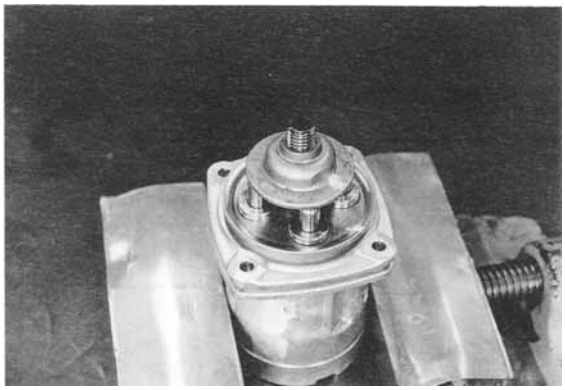


Photo 7-4

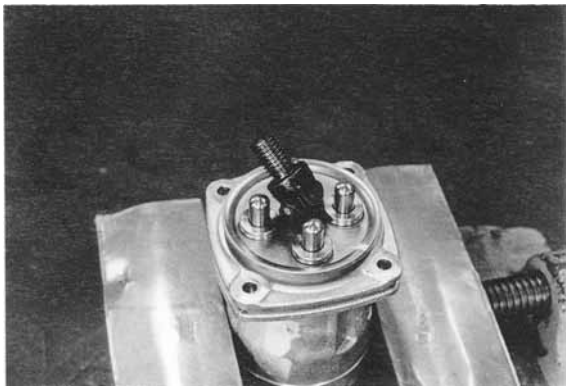


Photo 7-5

Photo 7-6

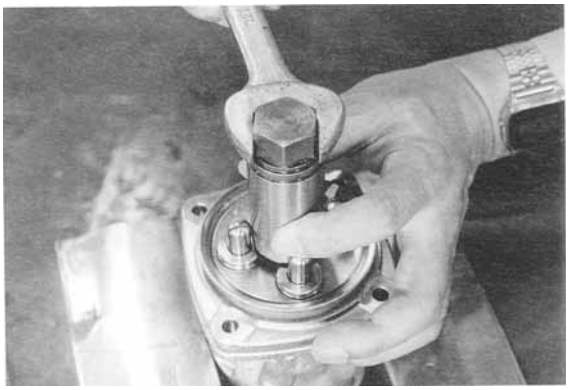


Photo 7-7

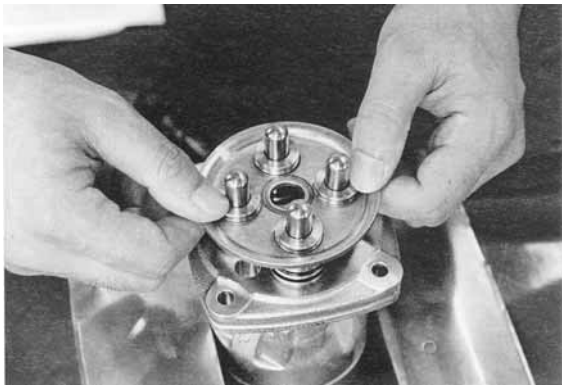


Photo 7-8

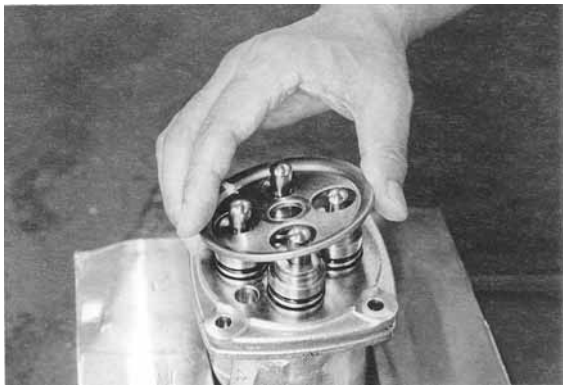


Photo 7-9

Photo 7-10

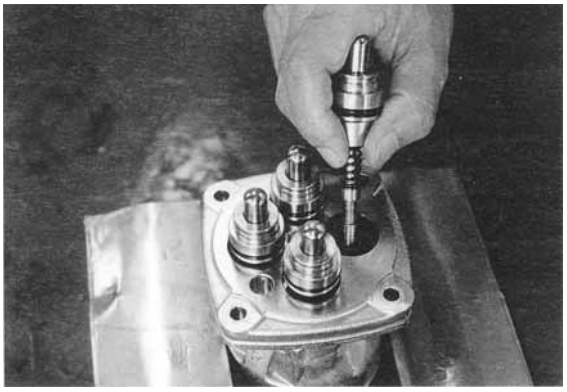


Photo 7-11

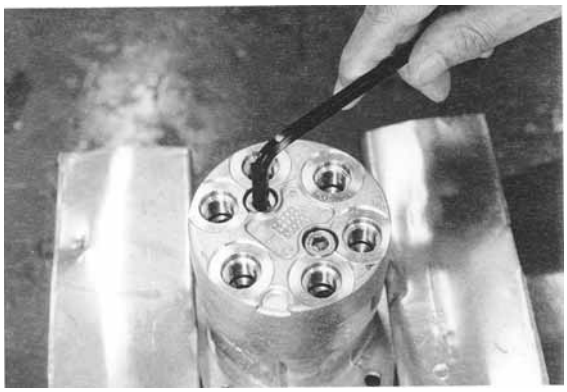


Photo 7-12

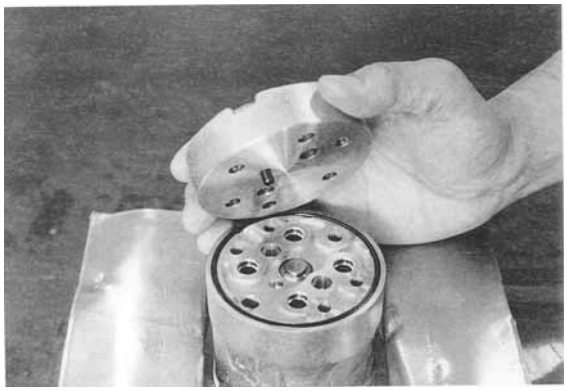


Photo 7-13

Photo 7-14

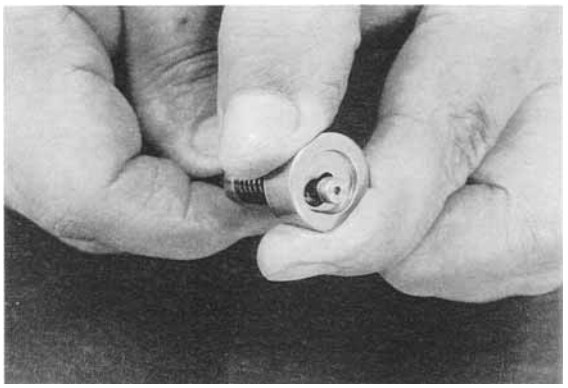


Photo 7-15

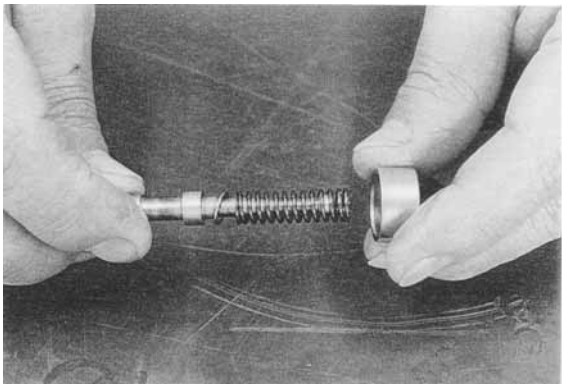


Photo 7-16

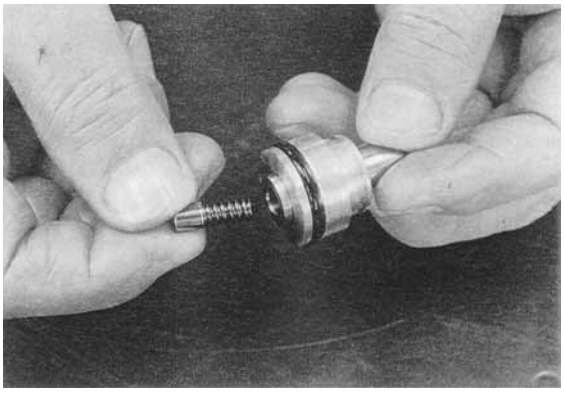


Photo 7-17

Photo 7-18

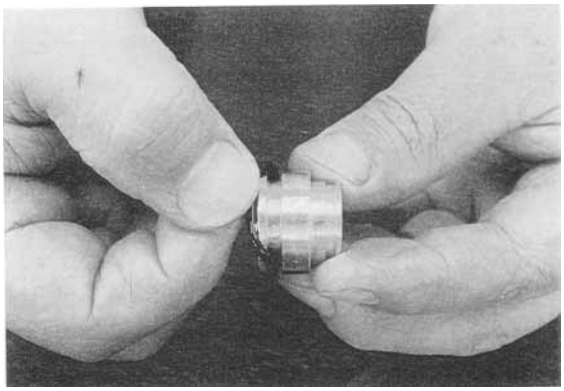


Photo 7-19

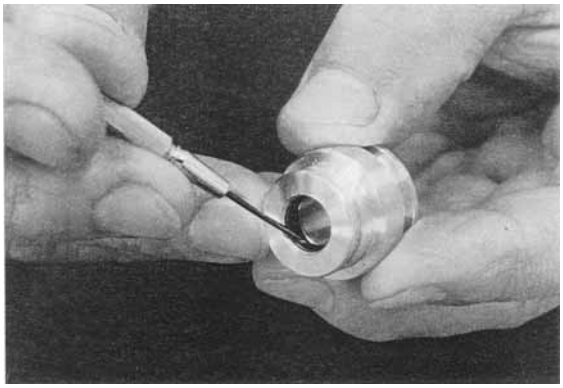


Photo 7-20

Photo 7-21

Photo 7-22

Photo 7-23

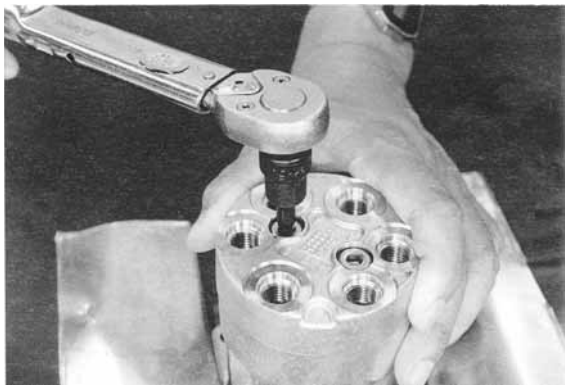


Photo 7-24

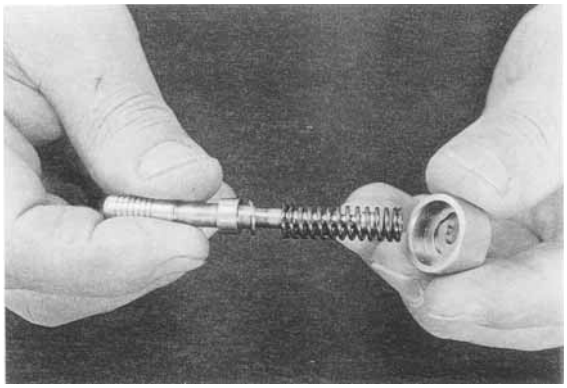


Photo 7-25

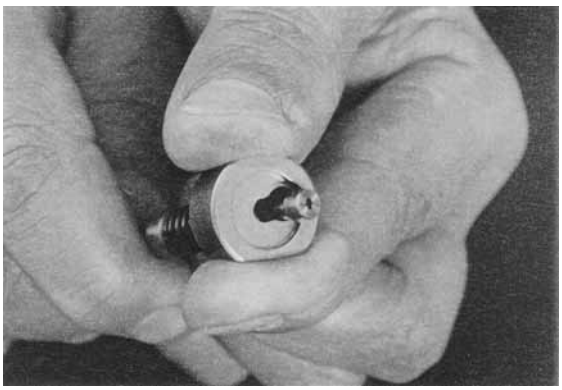


Photo 7-26

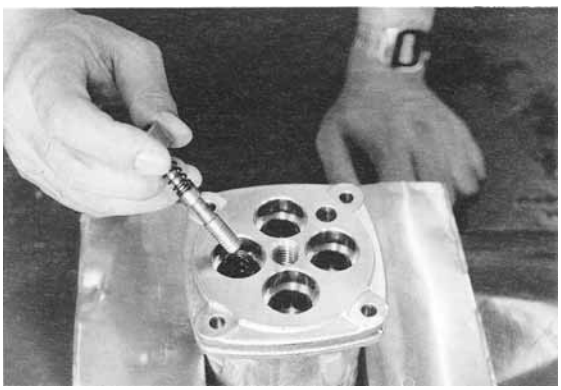


Photo 7-27

Photo 7-28

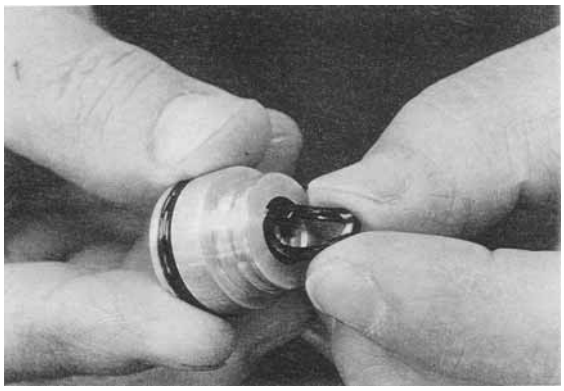


Photo 7-29

Photo 7-30

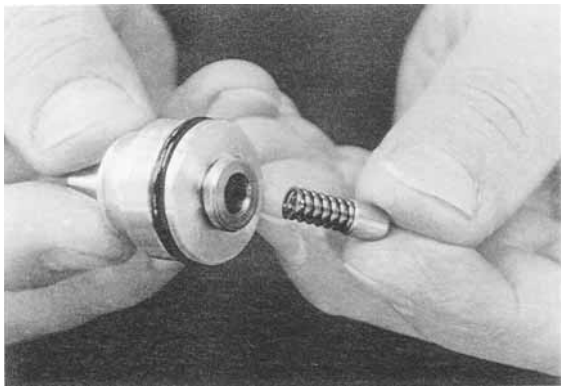


Photo 7-31

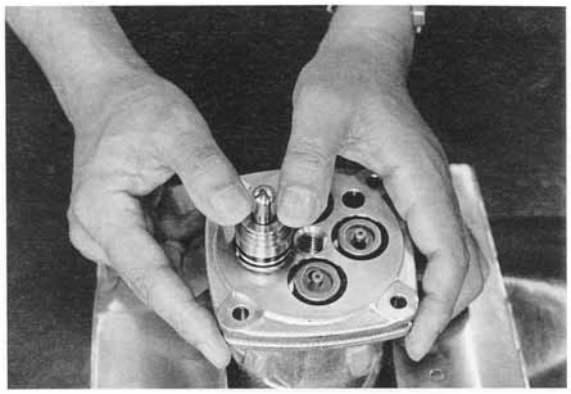


Photo 7-32

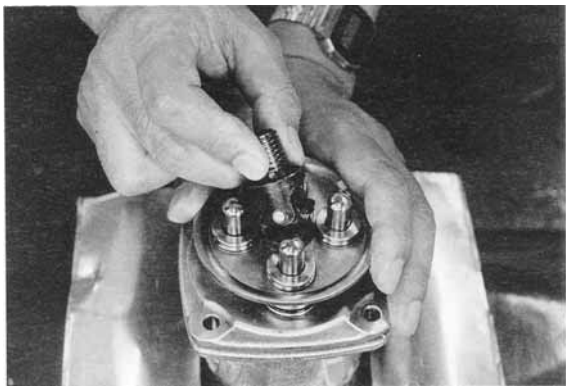


Photo 7-33

Photo 7-34

Photo 7-35

Photo 7-36

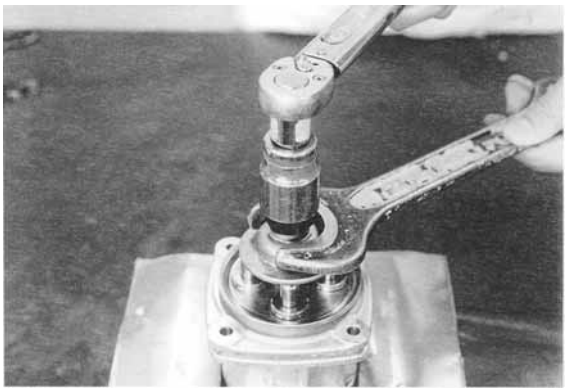


Photo 7-37

Photo 7-38

(4) Troubleshooting

It is not easy to pinpoint trouble spots. The table below lists some typical problems, their possible causes and corrections. Before starting repair jobs, refer to the table below.

A machine trouble is not necessarily caused by just one part, but by come different parts combined. It should be noted that the corrections listed below might not be enough and additional measures might be needed.

This chart does not cover all possible causes and corrections. Whenever necessary, it is therefore essential for the repair supervisor to look further into the problem and cause in question.

Problem	Causes	Corrections
Secondary pressure failure to rise	(1) Primary pressure too low. (2) Secondary-pressure spring (241) broken or worn out. (3) Too large a gap between the spool (201) and casing (101). (4) Steering wheel too loose.	(1) Ensure the specified primary pressure. (2) Replace the spring with new one. (3) Replace the remotely operated valve with new one. (4) Disassemble and reassemble the related section. Or replace the steering wheel as required.
Secondary pressure unstable	(1) Sliding parts stuck. (2) Tank line pressure fluctuating too much. (3) Air sucked in the piping.	(1) Correct the stuck spot. (2) Return the oil direct to the oil tank. (3) Operate the machine to let out the air.
Secondary pressure too high	(1) Tank line pressure too high. (2) Sliding parts stuck.	(1) Correct the stuck spot. (2) Return the oil direct to the oil tank.

f) Swivel Motor

(1) Dismounting and mounting the swivel motor

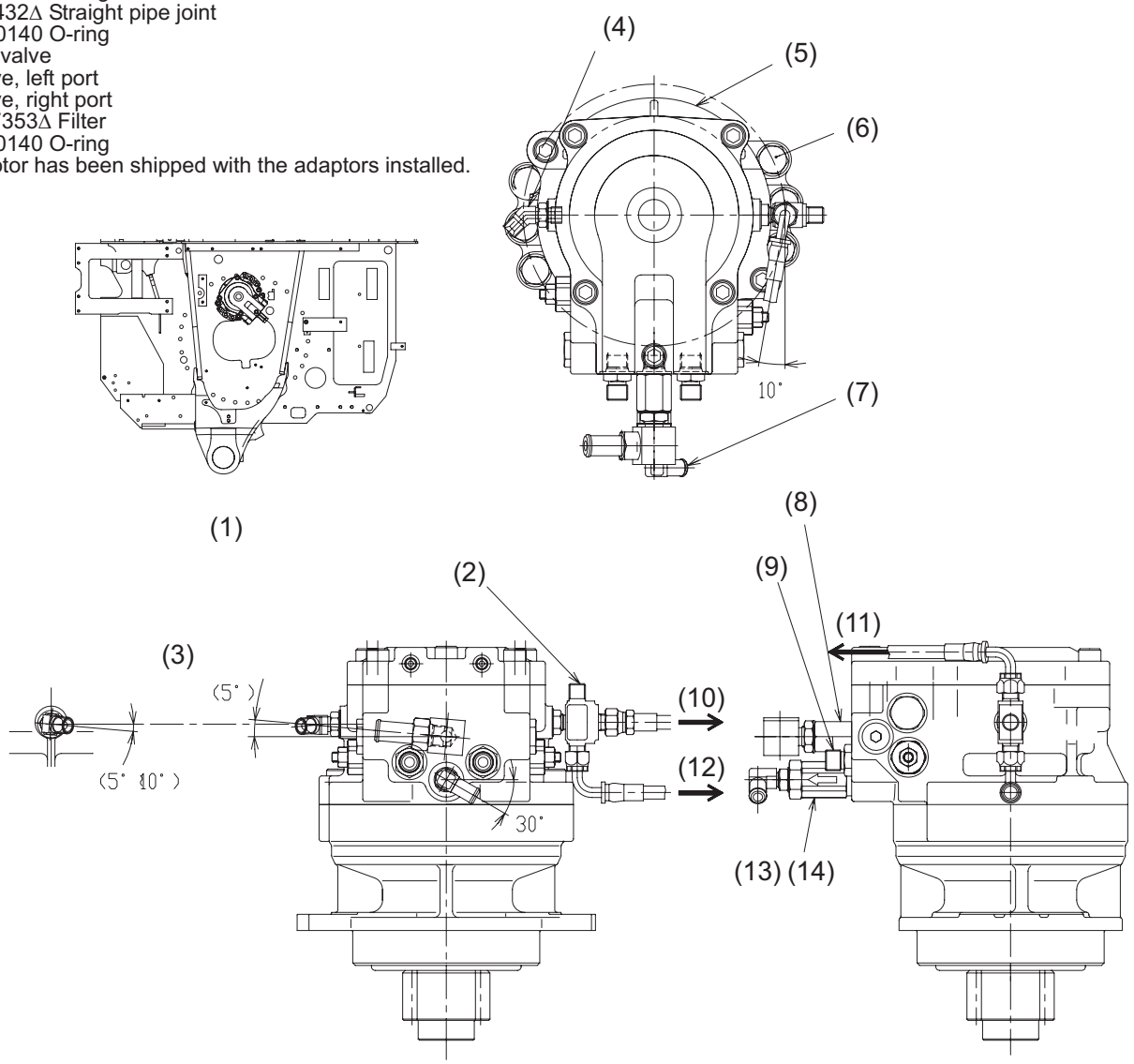
(1) Mounting swivel motor assy
Tightening torque:
259.9 ~ 304.0 N·m (26.5 ~ 31.0 kgf·m) 191.7 ~ 224.2 ft·lbs
Apply screw lock agent (Locktite 271)

(2) Adapter installing angle
Refer to Fig.

(3) Adapter tightening torque
Tightening torque
G1/4:
25.4 ~ 29.4 N·m (2.5 ~ 3.0 kgf·m) 18.1 ~ 21.7 ft·lbs
G3/8:
49.1 ~ 53.9 N·m (5.0 ~ 5.5 kgf·m) 36.2 ~ 39.8 ft·lbs

KX121-3S/α

(1) Motor set-up direction
(2) RP802-6193Δ Pipe joint (cross, G1/4)
04810-00110 O-ring
(3) To be out of contact with the crane-necked hose below
(4) SP proportional valve
(5) RD118-6170Δ Motor assembly (swivel)
(6) 01138-51440 Bolt
(7) RD401-6395Δ Elbow pipe joint (G4-13)
04810-00110 O-ring
(8) RD118-6194Δ Pipe joint (S, G3/8-G3/8)
04810-00140 O-ring
(9) 68311-6432Δ Straight pipe joint
04810-00140 O-ring
(10) Selector valve
(11) Pilot valve, left port
(12) Pilot valve, right port
(13) RC441-7353Δ Filter
04810-00140 O-ring
(14) * The motor has been shipped with the adaptors installed.

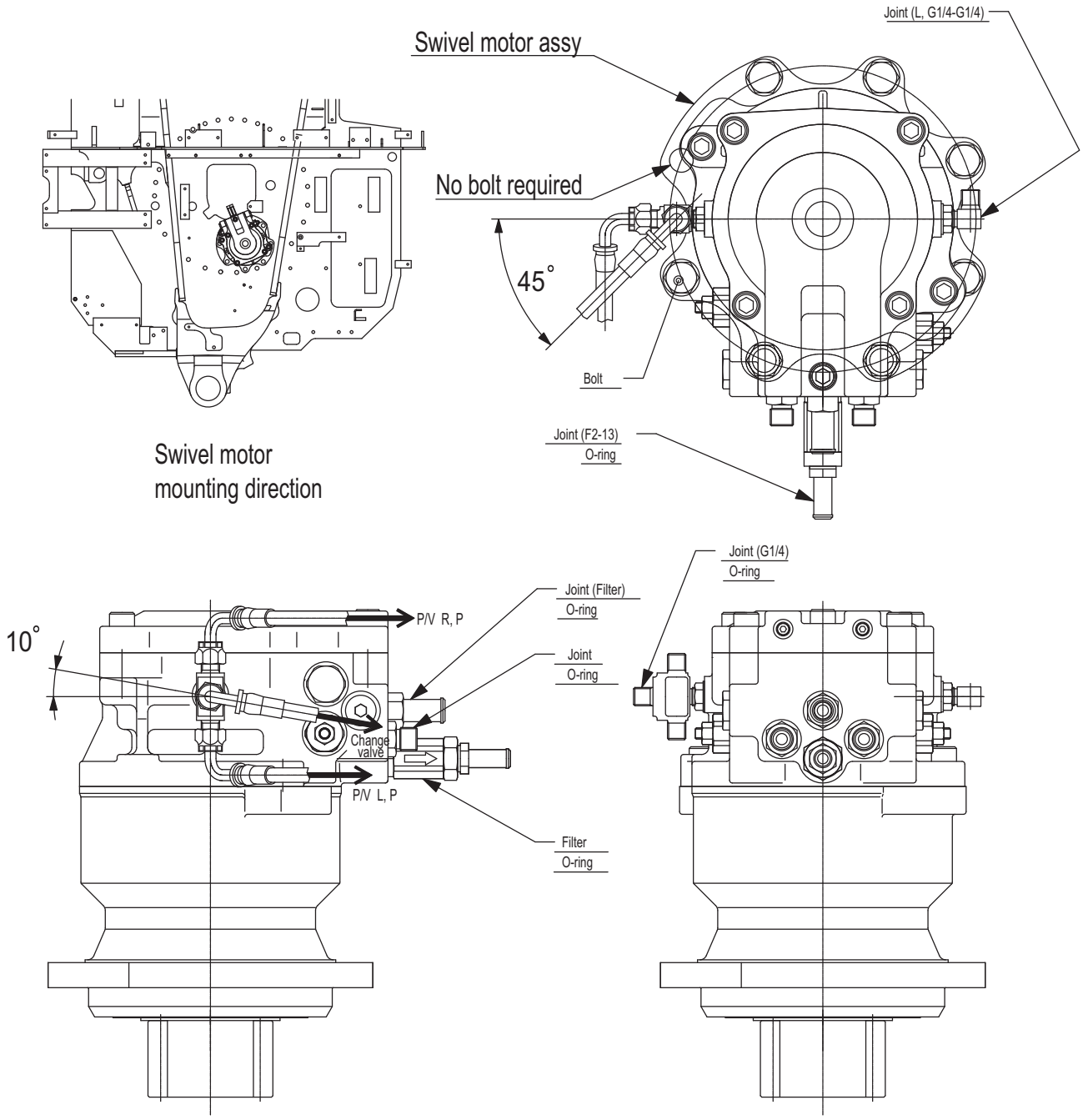


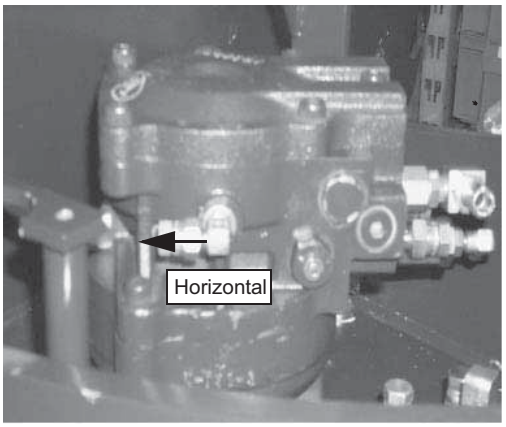
KX161-3α/S/ST

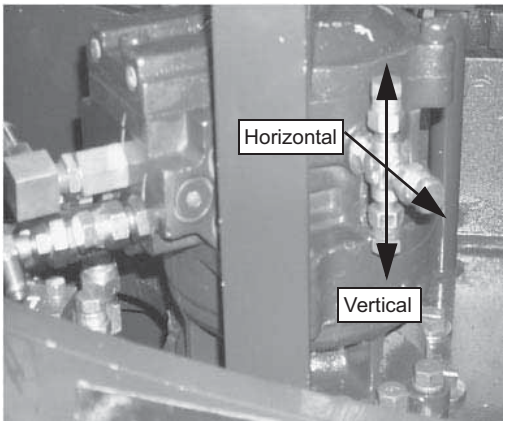
1. **Mount swivel motor assy**
   Tightening torque:
   116.7 ~ 196.1 N·m (17.0 ~ 20.0 kgf·m) 123 ~ 145 ft·lbs
   Apply screw Locktite lock agent.

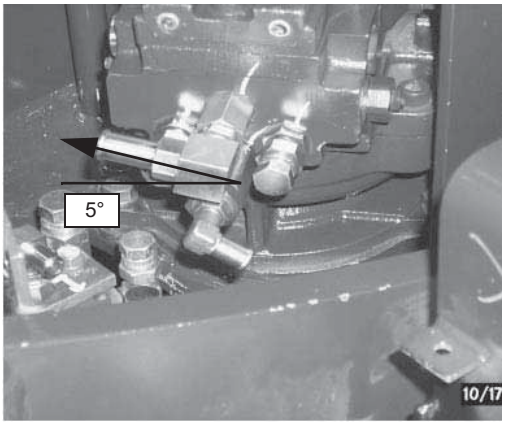
2. **Adapter installing angle**
   Refer to Fig.

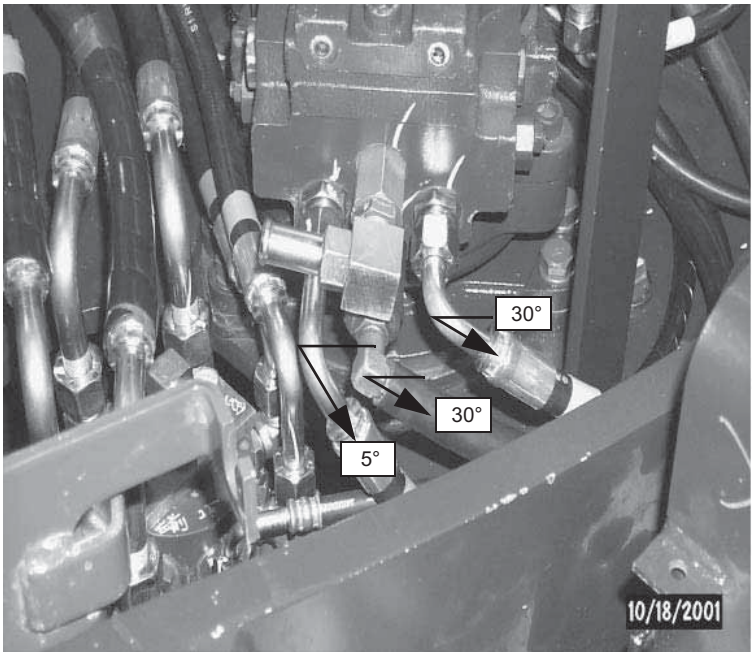
3. **Adapter tightening torque**
   G1/4:
   25.4 ~ 29.4 N·m (2.5 ~ 3.0 kgf·m) 18.1 ~ 21.7 ft·lbs
   G3/8:
   49.1 ~ 53.9 N·m (5.0 ~ 5.5 kgf·m) 36.2 ~ 39.8 ft·lbs

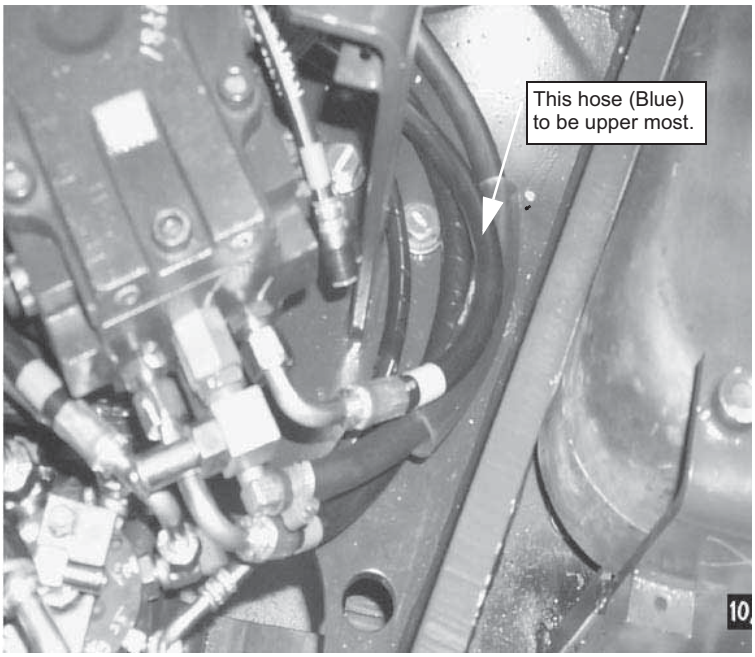



Horizontal


Horizontal
Vertical

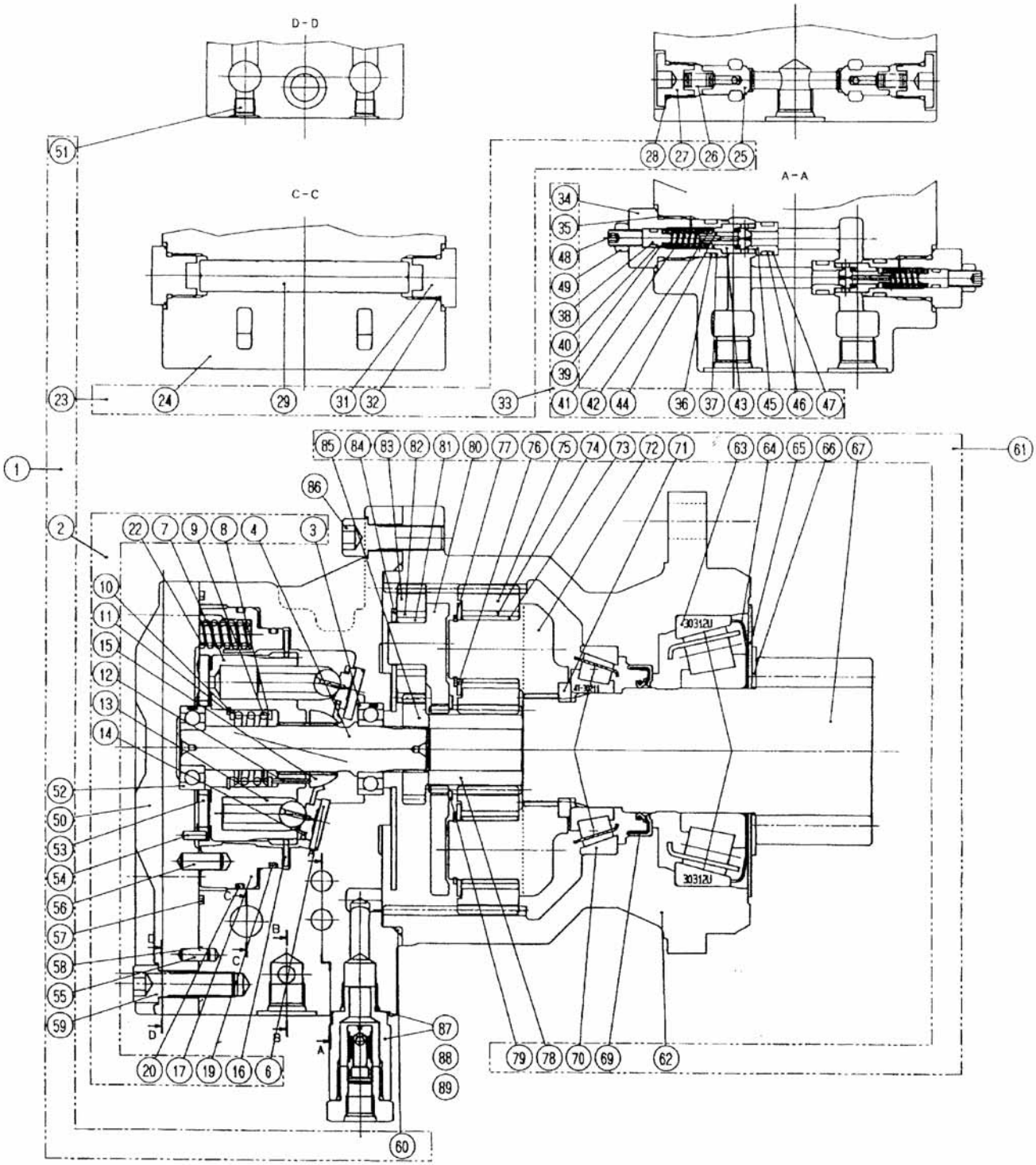

5°
10/17


30°
30°
5°
10/18/2001

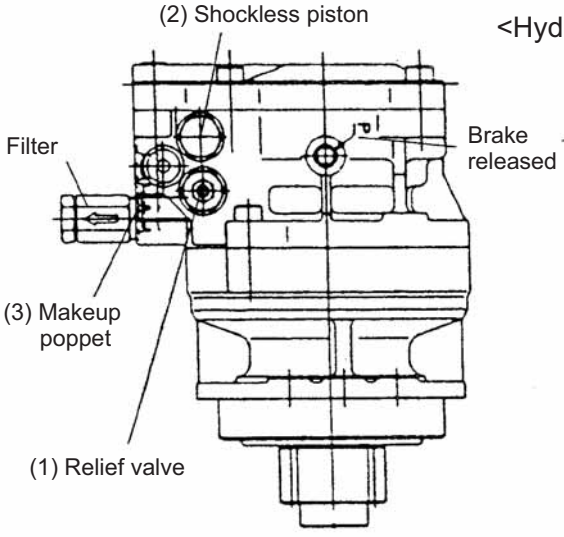

This hose (Blue)
to be upper most.

(2) Components of the swivel motor

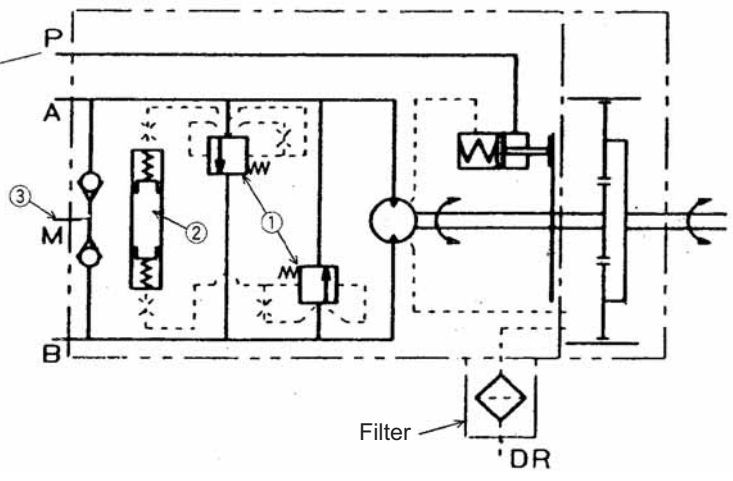
Type: SM29GL
Maker: Kubota seiki



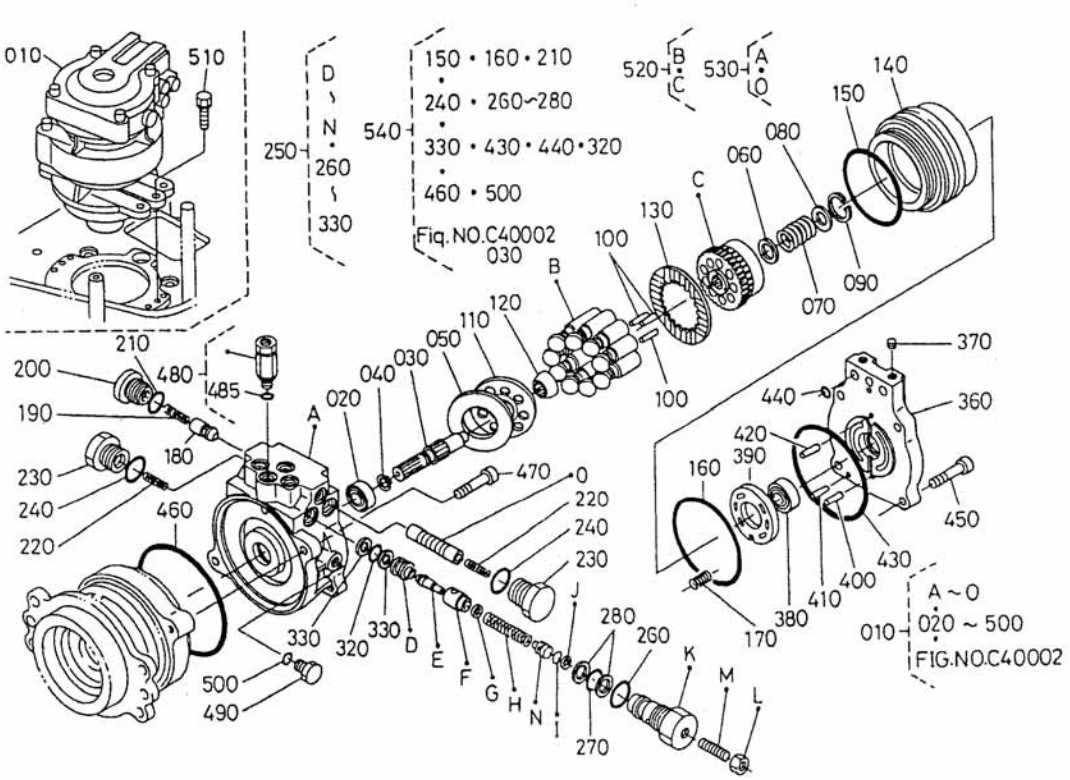
1	Motor, assy, with valve	31	Plug	61	Gear case, assy
2	Motor, assy	32	O-ring	62	Gear case
3	Ball bearing	33	Valve, assy (Relief)	63	Taper roller bearing
4	Shaft	34	Housing (Relief)	64	Seal plate
5	-	35	O-ring	65	Plate, piston
6	Plate thrust	36	O-ring	66	Plate, pinion 2
7	Cylinder Block	37	Ring, backup	67	Shaft, pinion
8	Washer spring	38	Guide (Spring)	68	-
9	Spring	39	O-ring	69	Oil seal
10	Washer, Spring	40	Ring, backup	70	Taper roller bearing
11	Circlip	41	Spring	71	Spacer
12	Pin	42	Ring, Spring seat	72	Holder 2
13	Piston, assy	43	Guide, poppet	73	Color 2
14	Plate, retainer	44	Poppet	74	Needle bearing
15	Holder, retainer	45	Ring, poppet seat	75	Planetary gear 2
16	Plate, friction	46	O-ring	76	Thrust plate 2
17	Piston, brake	47	Ring, backup	77	Circlip
18	-	48	Bolt	78	Sun gear
19	O-ring	49	Nut	79	Circlip
20	O-ring	50	Cover, motor	80	Holder 1
21	-	51	Plug	81	Color 1
22	Spring	52	Ball bearing	82	Needle bearing
23	Valve assy	53	Plate, valve	83	Planetary gear 1
24	Housing	54	Pin	84	Thrust plate
25	Poppet	55	Pin	85	Drive gear
26	Spring	56	Pin	86	Hex. bolt
27	Plug	57	O-ring	87	Filter
28	O-ring	58	O-ring	88	Plug 5
29	Shockless piston	59	Bolt	89	O-ring
30	-	60	O-ring		



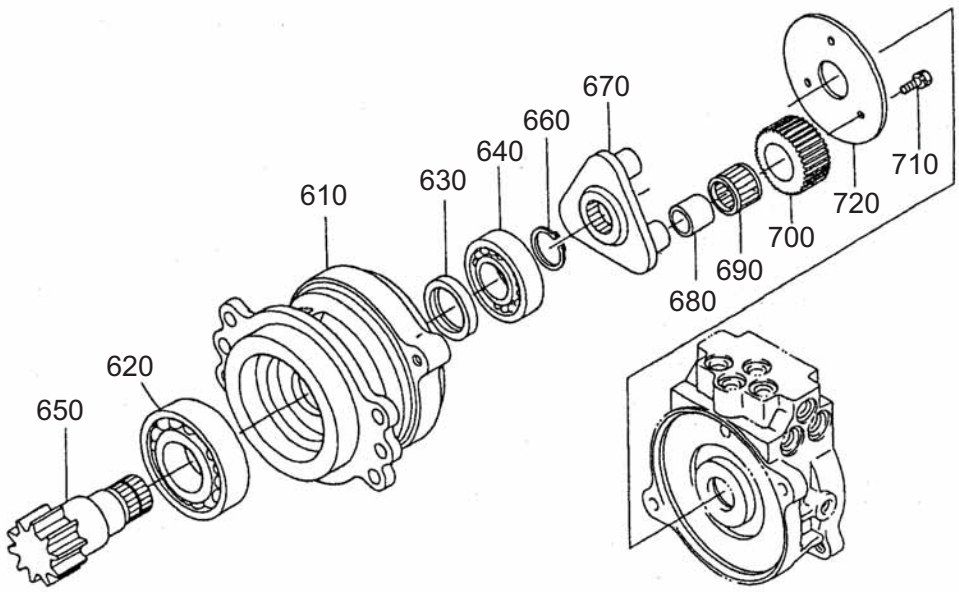
<Hydraulic Circuit Diagram>



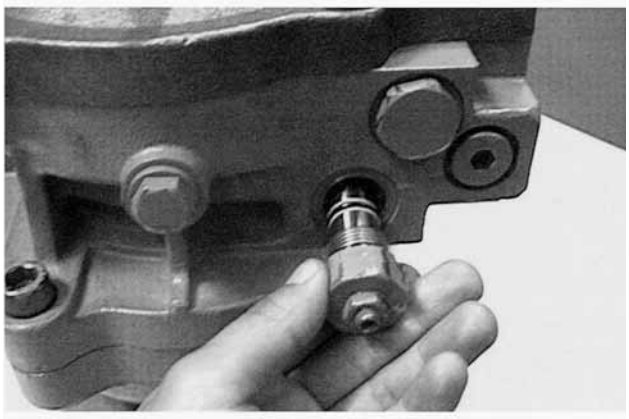
Parts development



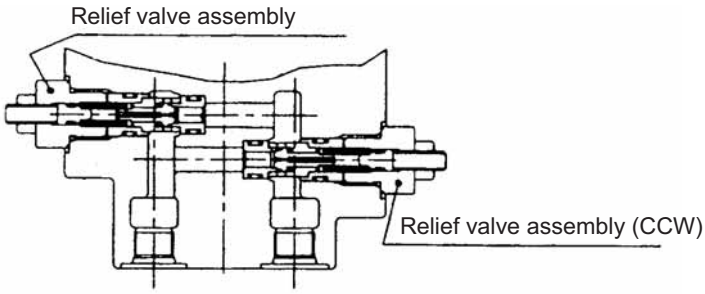
010	Motor, assy (Swivel)	200	Spring	380	Ball bearing
020	Ball bearing	210	O-ring	390	Plate, valve
030	Shaft	220	Spring	400	Pin
040	Circlip	230	Plug	410	Pin
050	Plate, thrust	240	O-ring	420	Pin
060	Washer, spring	250	Valve, assy (Relief)	430	O-ring
070	Spring	260	O-ring	440	O-ring
080	Washer, spring	270	O-ring	450	Bolt
090	Circlip	280	Ring, backup	460	O-ring
100	Pin	290	Blank	470	Bolt
110	Plate, retainer	300	Blank	480	Filter
120	Holder, retainer	310	Blank	485	O-ring
130	Plate, friction	320	O-ring	490	Plug
140	Piston, brake	330	Ring, backup	500	O-ring
150	O-ring	340	Blank	510	Bolt
160	O-ring	350	Blank	520	Cylinder Block, assy
170	Spring	360	Cover, motor	530	Housing, assy
180	Poppet	370	Plug	540	Seal, kit
190	Spring				



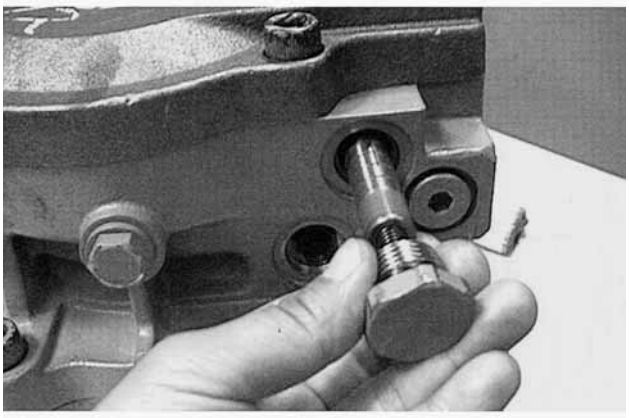
610	Case, gear	650	Shaft, pinion	690	Needle bearing
620	Ball bearing	660	Circlip	700	Gear (Planetary)
630	Seal, oil	670	Holder	710	Bolt
640	Ball bearing	680	Collar	720	Plate, thrust



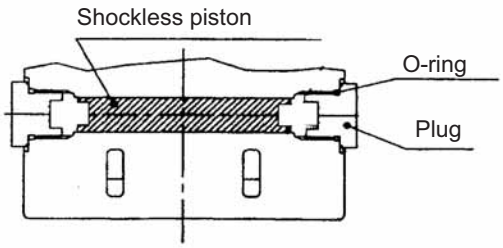
1) Relief valve



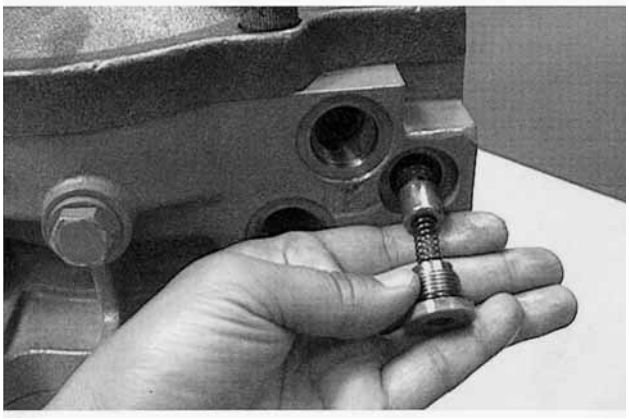
Relief valve assembly tightening torque:
58.8 ~ 68.6 N·m
6.0 ~ 7.0 kg·m
43.4~ 50.6 ft·lbf



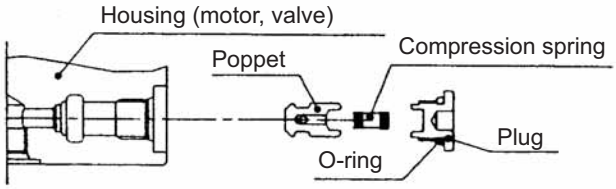
2) Piston (Shockless)



Plug tightening torque:
58.8 ~ 68.6 N·m
6.0 ~ 7.0 kg·m
43.4~ 50.6 ft·lbf

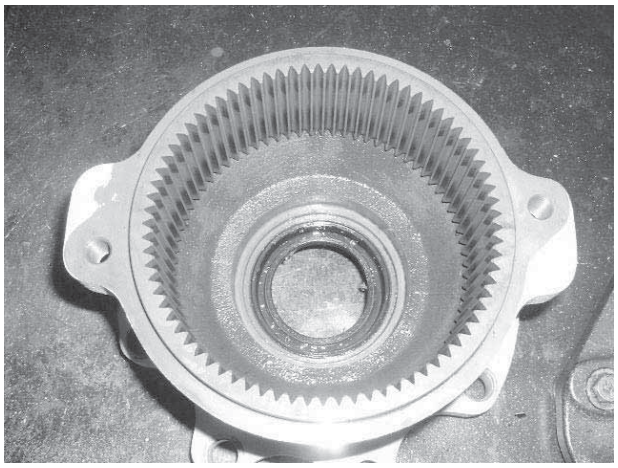


3) Poppet (Makeup)

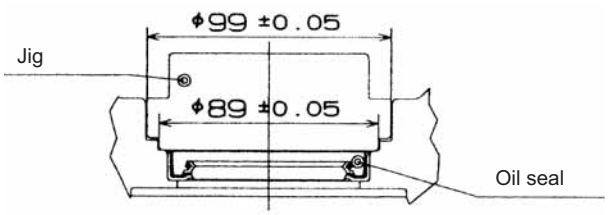


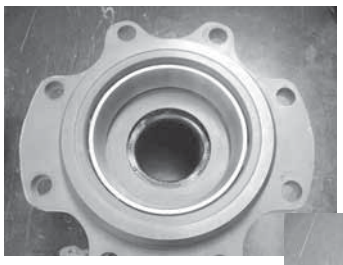
Tightening torque:
49.0 ~ 58.8 N·m
5.0 ~ 6.0 kg·m
36.1~ 43.4 ft·lbf

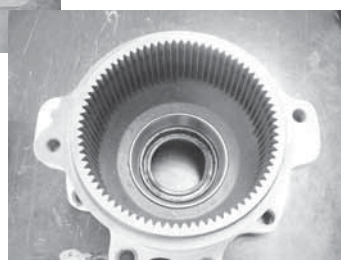
(3) Swivel motor reassembly procedure: KX121-3α/S/ST, 161-3α/S/ST



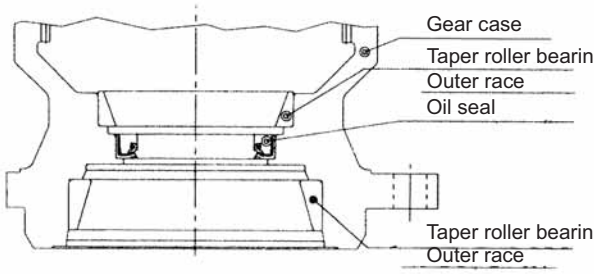
1) Apply grease to the lip and outer surface of the oil seal. Fit it into position using the jig.

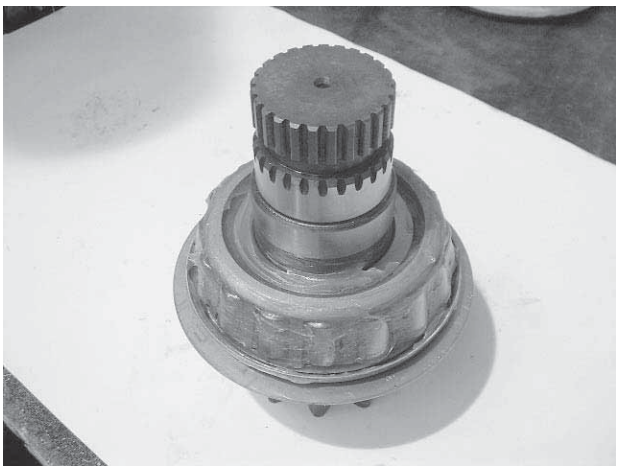




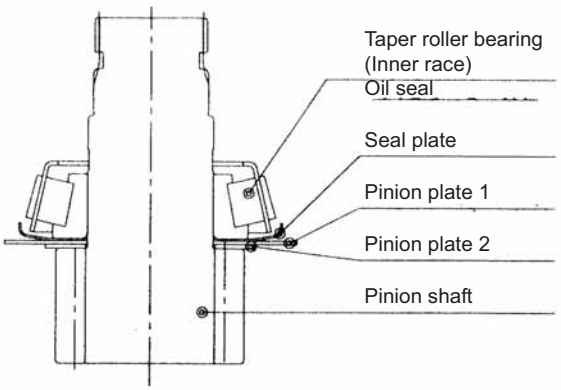


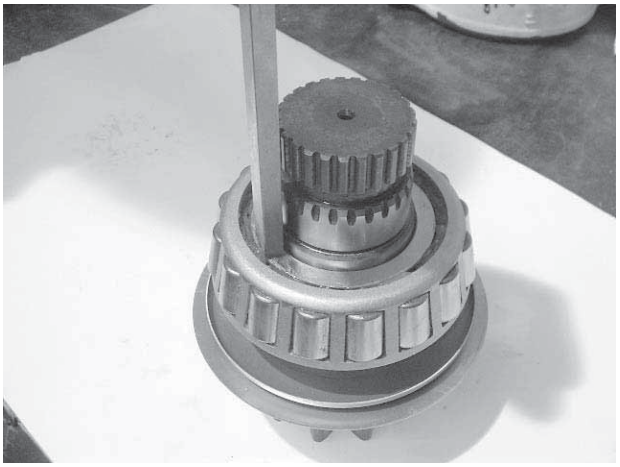
2) Press-fit the outer race of the taper roller bearing fully into the gear case.



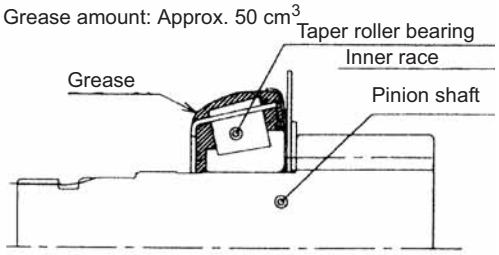


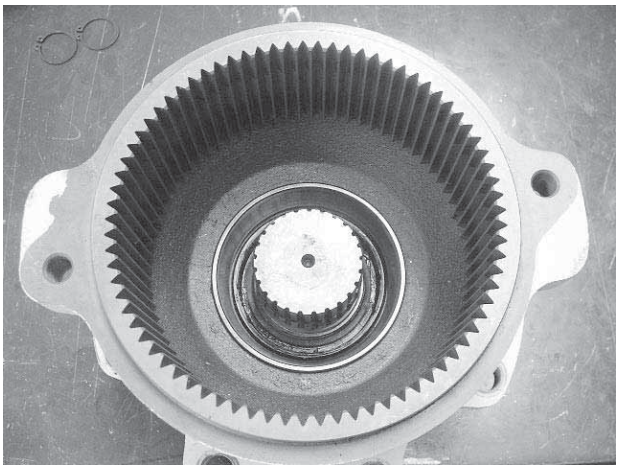
3) Positioning the pinion shaft in the correct direction, install the pinion plate (2), pinion plate and seal plate. Press-fit the inner race of the taper roller bearing into the pinion shaft in the specified direction.



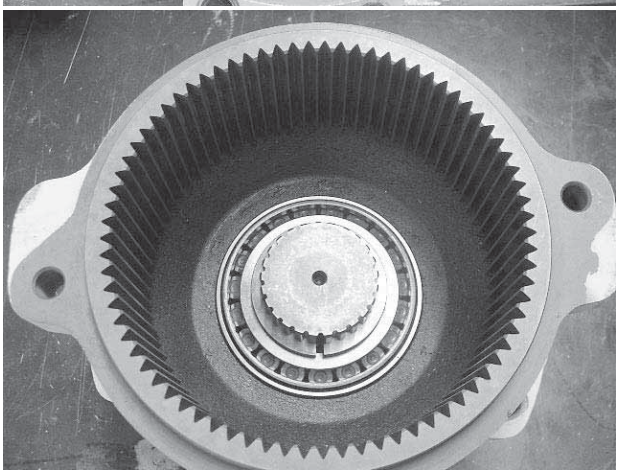


4) Adapter reassembly, full, the grease in the inner race of taper roller bearing.

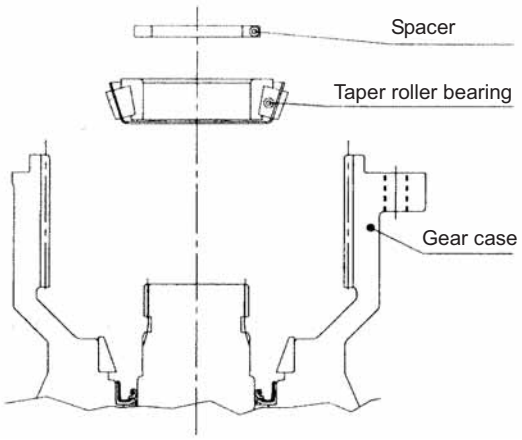


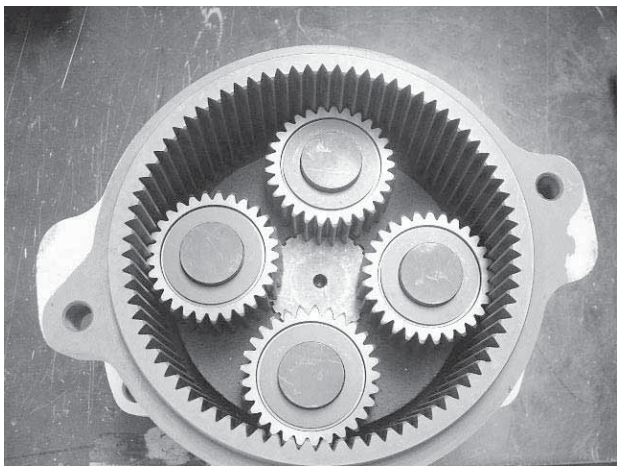


5) Press fit the pinion shaft into the gear case.
<Precaution>
Never get damage the oil seal.

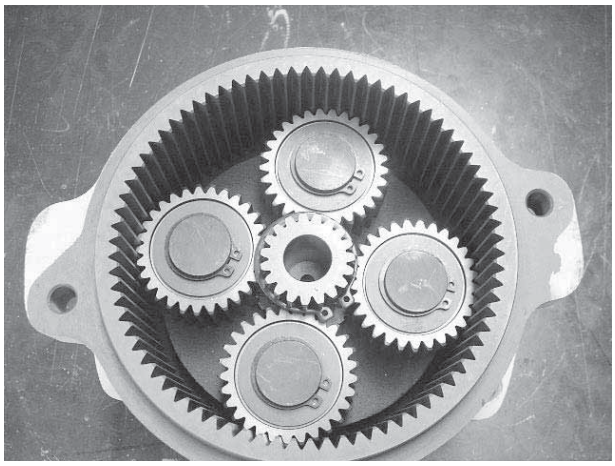


6) Press-fit the inner race of the taper roller bearing into the pinion shaft in the specified direction.
Select a spacer to keep a clearance of 0 ~ 0.15 mm. Fit the spacer in position and turn the shaft to see it rotates smoothly.

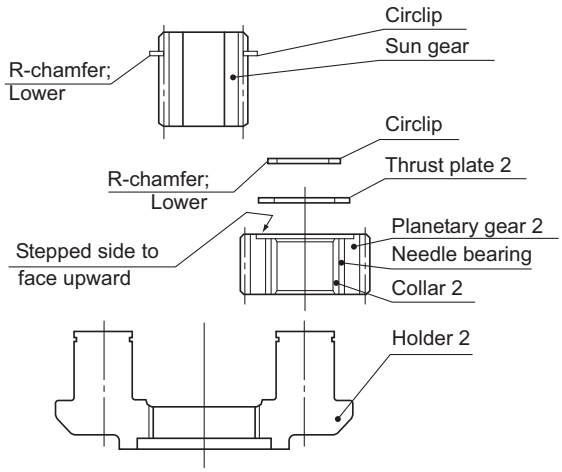


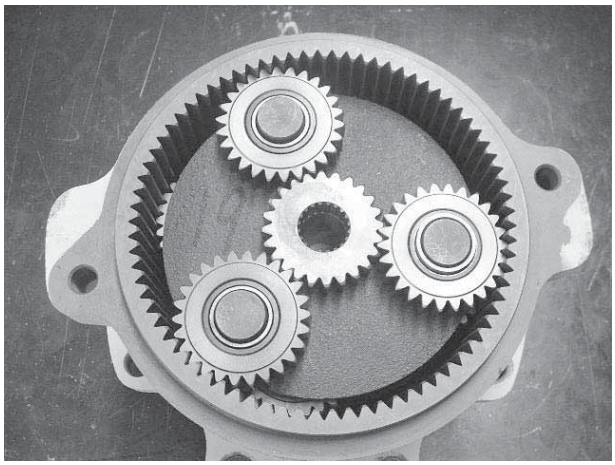


7) Install the collar (2), needle bearing, planetary gear (2)*, thrust plate (2) and circlip* onto the holder (2).
* Pay attention to the fitting direction.

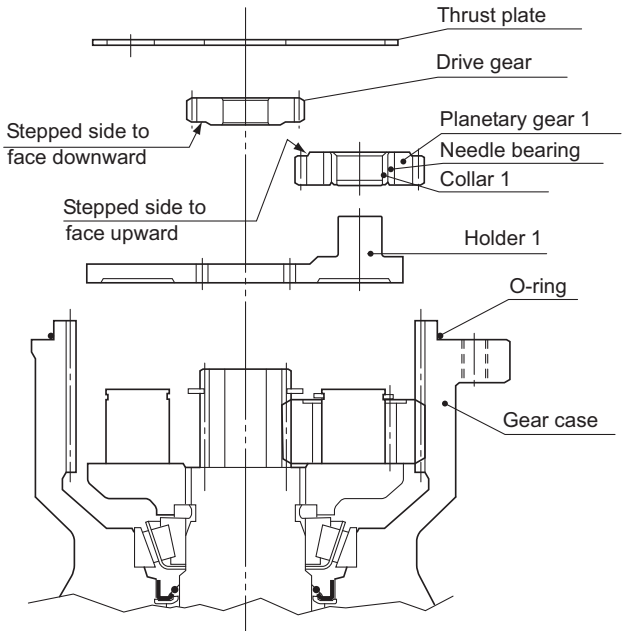


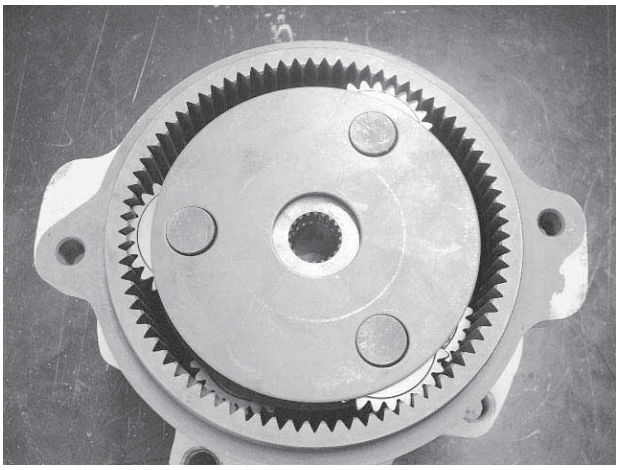
8) Install the sun gear.





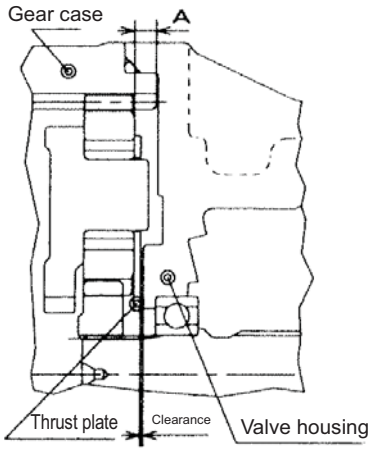
9) Install the collar (1), needle bearing, planetary gear (1)*, drive gear and grease-applied O-ring onto the holder (1).
* Pay attention to the fitting direction.

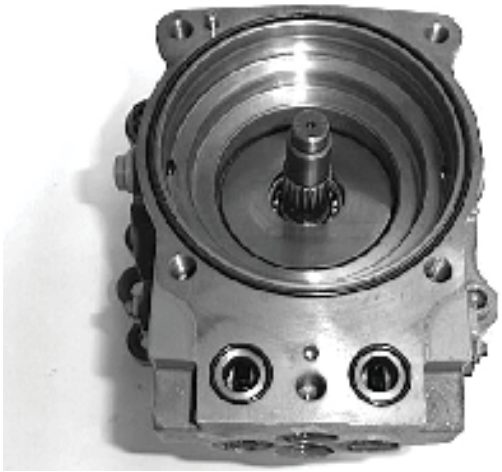




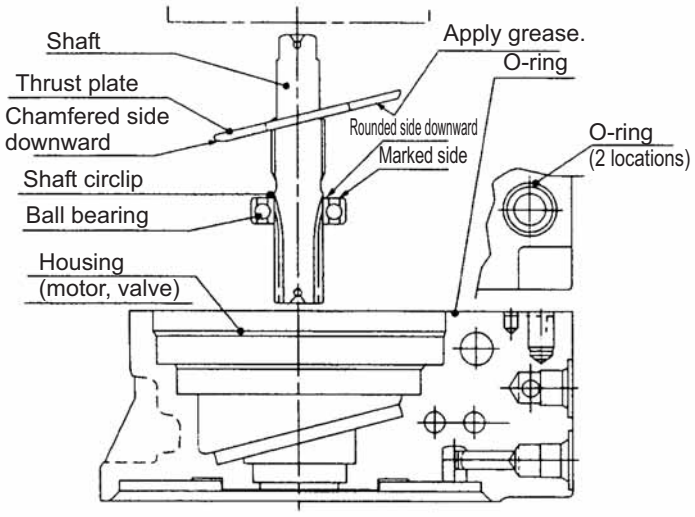
10)Measure the dimension A shown below. Select a plate thickness, referring to the table.
(1) Measure the dimension A between the top of planetary gear (1) and the top of gear case.
(2) With the measurement of dimension A, choose the right thrust plate from the table below and fit it into position.
(Clearance shown at left: 0.08 ~ 1.14 mm)

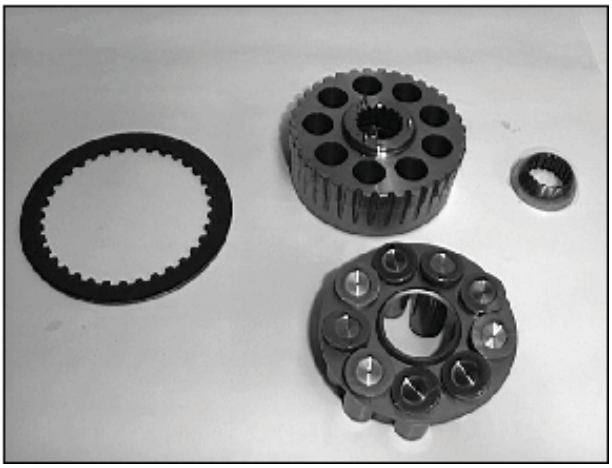
Dimension	Part code No.	Thickness mm (in.)
5.50 ~ 6.00	RD411-1727△	1.8 (0.07)
6.00 ~ 6.60	RD411-1728△	2.3 (0.09)
6.60 ~ 6.90	RD411-1729△	2.9 (0.11)
6.9 ~ 7.40	RD411-1730△	3.2 (0.13)

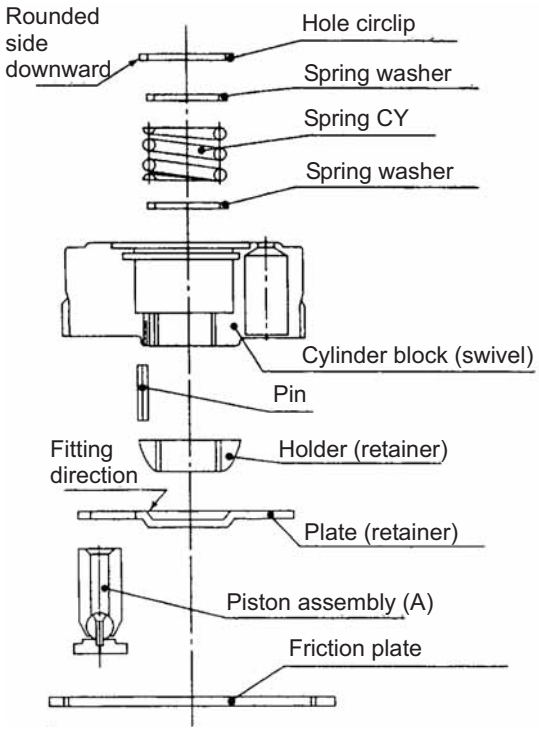


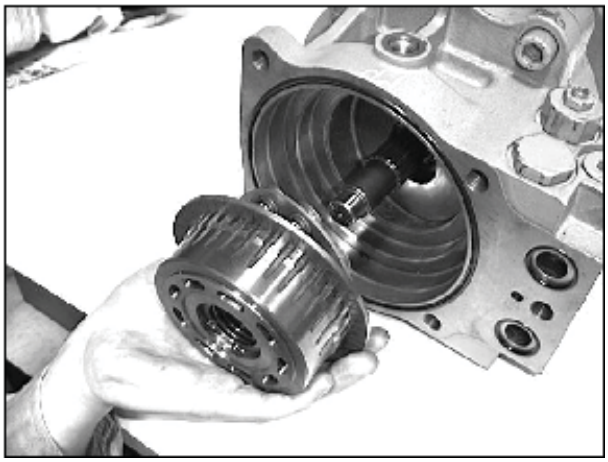


11)Fit the ball bearing* onto the shaft, and install them in the valve housing.
* Using the jig, drive them in position in the specified fitting direction.
Dip the entire thrust plate in hydraulic oil and apply grease. Then install it with the chamfered side toward the housing.





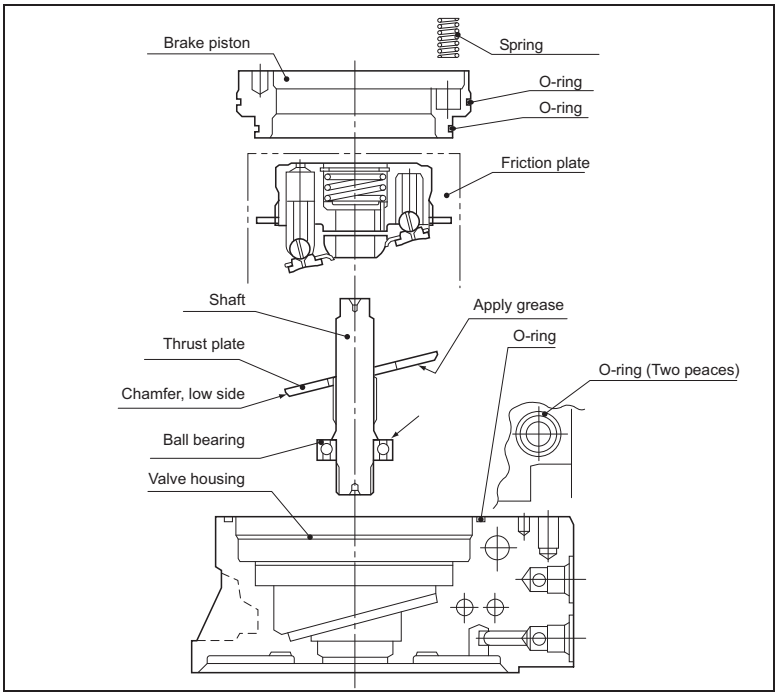


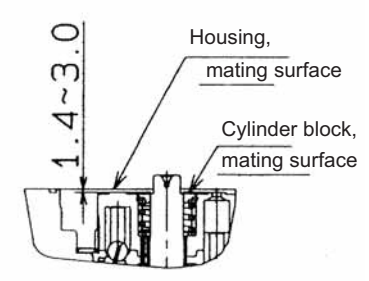


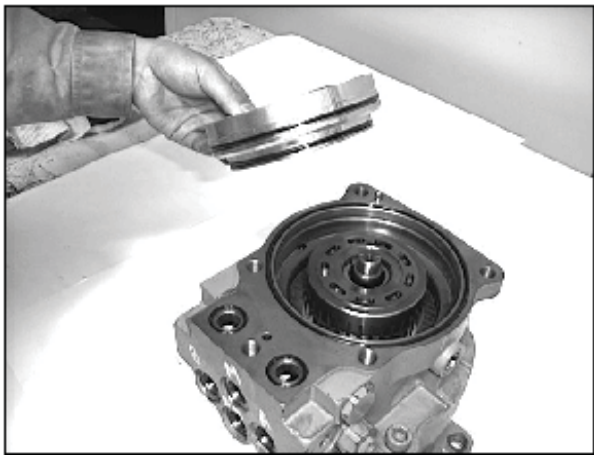
12) Install the spring washer, spring CY and circlip* onto the swivel cylinder block.
Apply grease to the pin and insert it. Then fit the retainer holder and retainer plate* into position.
* Pay attention to the fitting direction.

13) Fit the piston assembly (A)* and the friction plate* into position.
* Dip them fully in hydraulic oil before fitting in place.

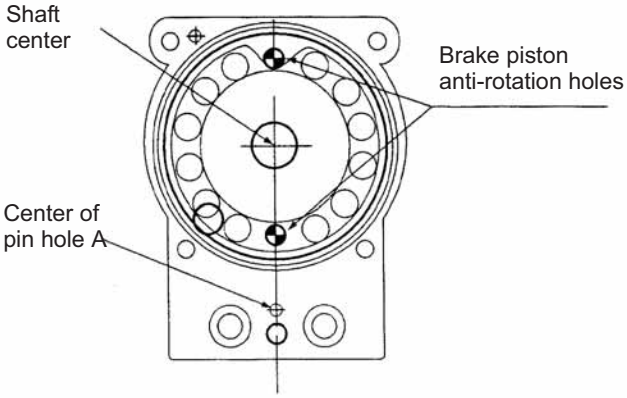
14) Dip the entire cylinder subassembly in hydraulic oil. Then fit this subassembly with care not to let the thrust plate, retainer holder and pin come off position. Cylinder block is 3.9 ~ 5.5 mm below the mating face of the valve housing.
Also be sure that the friction plate is not tilted.

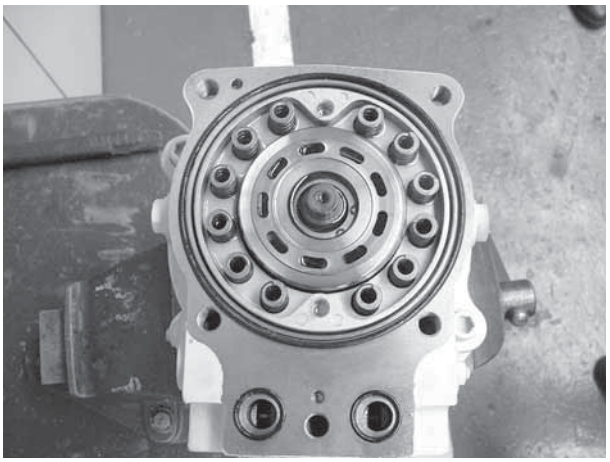




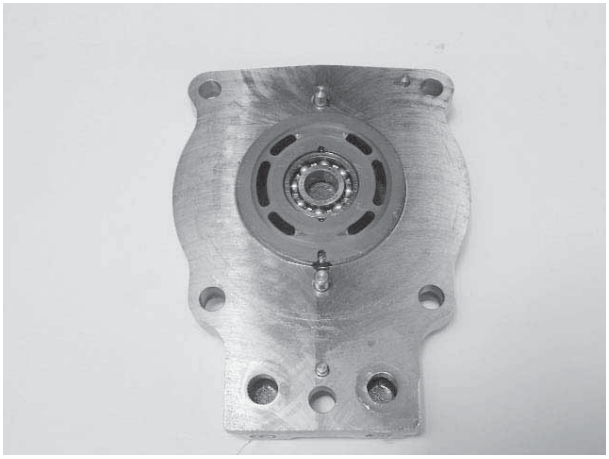


15) Make sure the brake piston is provided with the two grease-applied O-rings. Fit the piston in parallel with the insertion face (valve housing).
Pay attention to the fitting direction as shown below. (The anti-rotation holes must be located as shown below.)

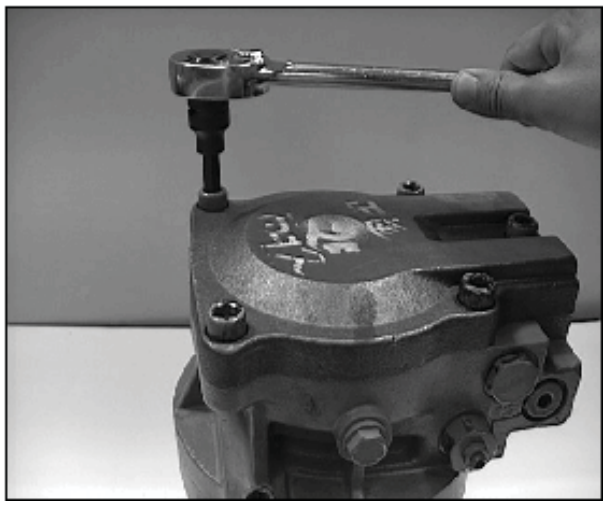




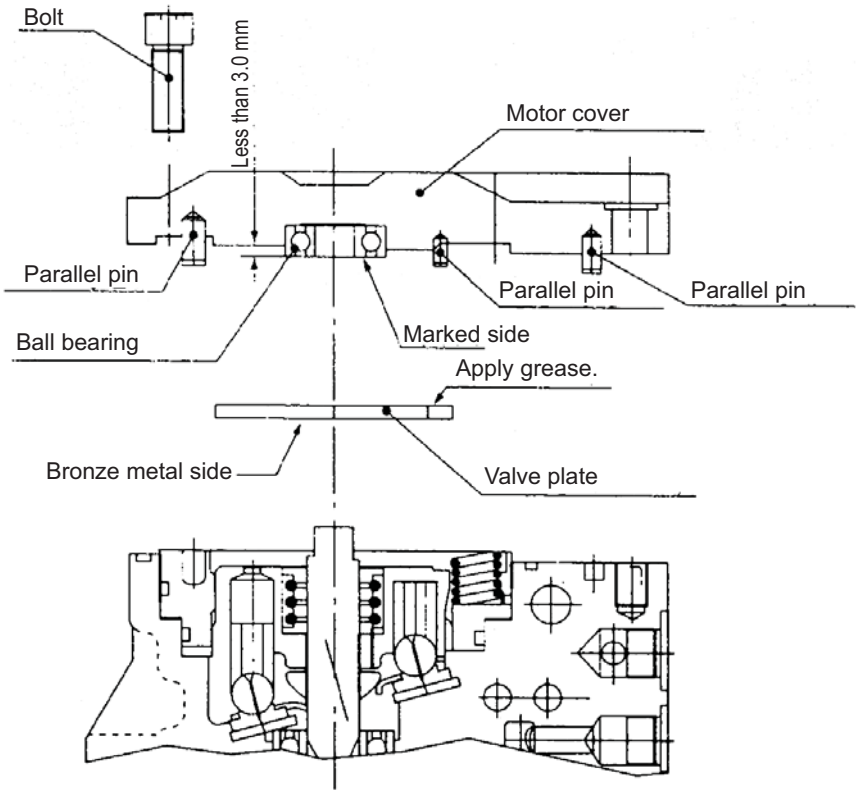
16) Fit the spring (NB) and the two grease-applied O-rings.



17) Fit the ball bearing* to the motor cover. Install the grease-applied valve plate on the motor cover.
* Using the jig, drive the valve plate in the specified fitting direction. Make sure the step difference between the plate and the motor cover is smaller than 3 mm.



18) Place the motor cover on the valve housing with care not to let the valve plate come off position. Finally tighten up the five M12 hex socket bolts.
Tightening torque:
102.9 ~ 117.6 N·m (10.5 ~ 12.0 kgf·m) 76 ~ 87 ft·lbs (9T)



g) Wheel Motor: KX121-3S/α, 161-3S/α

(1) Installation of travel motor

1. KX121-3S, KX121-3α

(1) Fitting direction of the track frame
Place the frame with the ports forward.

<Failure case>
Hose malpositioned

(2) Tightening torque of the travel motor

A Track frame
Sprocket
103.0 ~ 117.7 N·m (10.5 ~ 12.0 kgf·m) 76 ~ 87 ft·lbs
* Apply screw adhesive. (Locktite 271)

<Failure case>
Insufficient tightness
↓
Bolt loose
↓
Come-off

(3) Connecting position of the motor drain hose
Connect the drain hose to the upper drain port.
(Apply the plug to the lower port.)

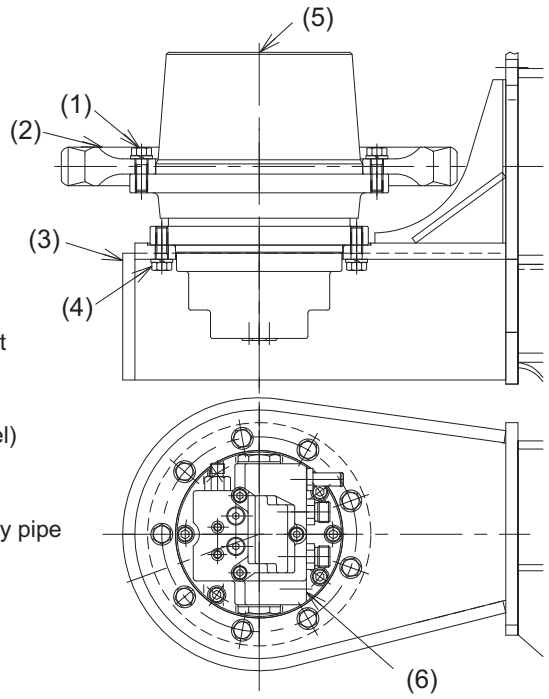
<Failure case>
Connected to the lower port
↓
Air trapped
↓
Unusual noise from the motor

(4) Routing of the hoses
Connect the hoses as shown in Fig. 2.
Make sure no excessive twist, crossover and tight contact inside the track frame.

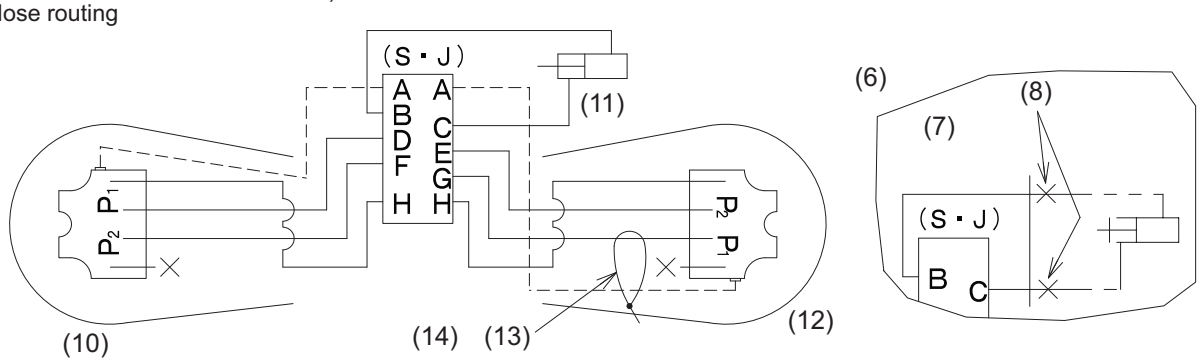
<Failure case>
Wrong routing
↓
Contact and entangled
↓
Hose durability reduced

Route	Part name	Part code	Length
S/J (D/F) ~ Motor left up/down	Hydraulic hose (1/2)	RD118-6371Δ	1200
S/J (E/G) ~ Motor right up/down	Hydraulic hose (1/2)	RD118-6372Δ	1060
S/J (B) ~ Dozer relay	Hydraulic hose (3/8)	RD118-6377Δ	285
S/J (C) ~ Dozer relay	Hydraulic hose (3/8)	RD118-6376Δ	450
Dozer relay ~ Dozer cylinder	Hydraulic hose (3/8)	RD118-6378Δ	450
S/J (A) ~ Motor (right) dual-speed	Hydraulic hose (1/4)	RD118-6370Δ	1260
S/J (A) ~ Motor (left) dual-speed	Hydraulic hose (1/4)	RD118-6370Δ	1260
Drain circuit (motor right)	Hose (1/2)	RD118-6375Δ	1090
Drain circuit (motor left)	Hose (1/2)	RD118-6374Δ	1180

S/J side	Travel motor/cylinder side
A Dual-speed pilot	Left/right travel dual-speed
B Dozer down	Cylinder bottom side
C Dozer up	Cylinder rod side
D Left forward	Left P1
E Right forward	Right P2
F Left backward	Left P2
G Right backward	Right P1
H Drain	Left/right drain port (upper)



(1) Sprocket mounting bolt
(2) Sprocket
(3) Track frame
(4) Motor mounting bolt
(5) Motor assembly (wheel)
(6) Port face
(7) * EU specifications
(8) Plug
To be fitted on the relay pipe
(9) Dozer
(10) Left track
(11) Dozer
(12) Right track
(13) Cord band
Clamp the dual-speed boost signal hose and the P1 hose together.
(Only for right track)
(No contact with the track frame allowed)
(14) Fig. 2 Hose routing



2. KX161-3S, KX161-3α

(1) Fitting direction of the track frame
Place the frame with the ports forward.

<Failure case>
Hose malpositioned

(2) Tightening torque of the travel motor
A Track frame
Sprocket
166.7 ~ 196.1 N·m (17.0 ~ 20.0 kgf·m) 123 ~ 145 ft·lbs
* Apply screw adhesive. (Locktite 271)

<Failure case>
Insufficient tightness
↓
Bolt loose
↓
Come-off

(3) Connecting position of the motor drain hose
Connect the drain hose to the upper drain port.
(Apply the plug to the lower port.)

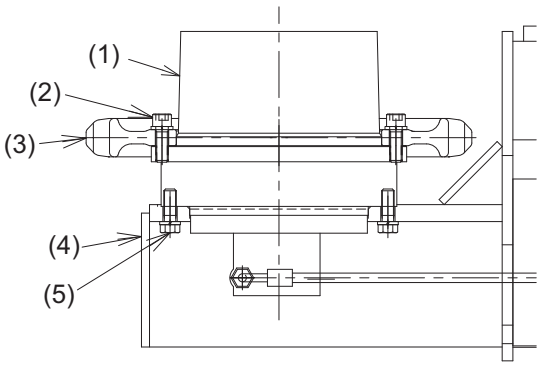
<Failure case>
Connected to the lower port
↓
Air trapped
↓
Unusual noise from the motor

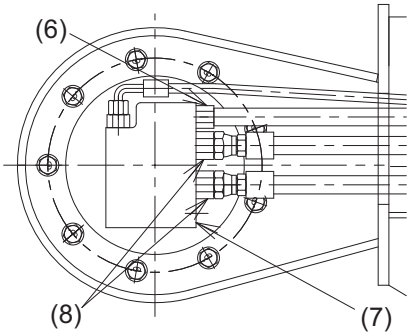
(4) Routing of the hoses
Connect the hoses as shown in Fig. 2.
Make sure no excessive twist, crossover and tight contact inside the track frame.

<Failure case>
Wrong routing
↓
Contact and entangled
↓
Hose durability reduced

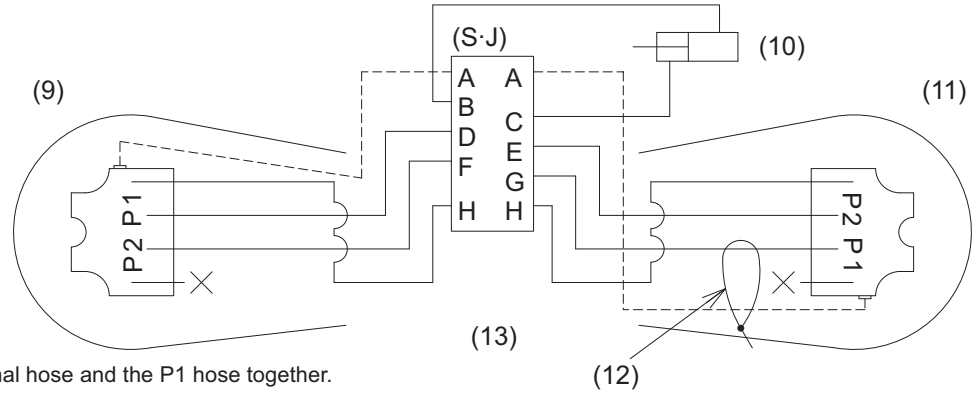
Route	Part name	Part code	Length
S/J (D/F) ~ Motor left up/down	Hydraulic hose (1/2)	RD411-6371Δ	1160
S/J (E/G) ~ Motor right up/down	Hydraulic hose (1/2)	RD411-6371Δ	1160
S/J (B) ~ Dozer relay	Hydraulic hose (3/8)	RD411-6376Δ	300
S/J (C) ~ Dozer relay	Hydraulic hose (3/8)	RD411-6376Δ	300
Dozer relay ~ Dozer cylinder	Hydraulic hose (3/8)	RD411-6378Δ	670
S/J (A) ~ Motor (right) dual-speed	Hydraulic hose (1/4)	RD411-6373Δ	1310
S/J (A) ~ Motor (left) dual-speed	Hydraulic hose (1/4)	RD411-6373Δ	1310
Drain circuit (motor right)	Hose (1/2)	RD411-6374Δ	1200
Drain circuit (motor left)	Hose (1/2)	RD411-6374Δ	1200

	S/J side	Travel motor/cylinder side
A	Dual-speed pilot	Left/right travel dual-speed
B	Dozer down	Cylinder bottom side
C	Dozer up	Cylinder rod side
D	Left forward	Left P1
E	Right forward	Right P2
F	Left backward	Left P2
G	Right backward	Right P1
H	Drain	Left/right drain port (upper)



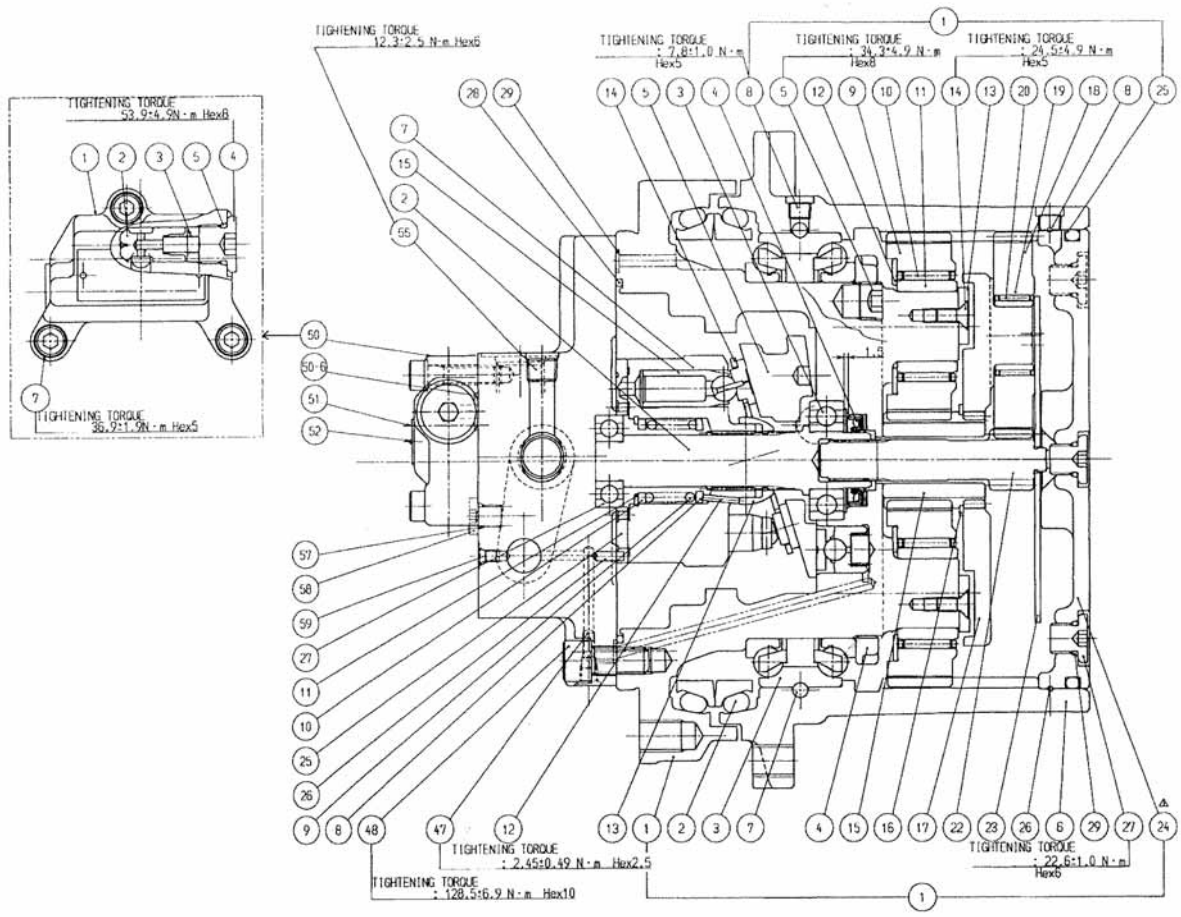


(1) Motor assembly (wheel)
RD431-6129Δ (U45-3ST and A: Arm length 1360)
RD531-6129Δ (KX161-3A)
RD538-6129Δ (KX161-3ST, CHN and U45-3A: Arm length 1650)
(2) Sprocket mounting bolt
68671-1117Δ
(3) Sprocket
RD411-1443Δ
(4) Track frame
(5) Motor mounting bolt
RD411-1117Δ
(6) Straight pipe joint (G3/8-13)
(RD411-6178Δ)
(with O-ring)
(7) Port face
(8) Straight pipe joint (G4-G4)
RD201-6383Δ
(9) Left track
(10) Dozer
(11) Right track
(12) Cord band
55311-41263
Clamp the dual-speed boost signal hose and the P1 hose together.
(Only for right track)
(No contact with the track frame allowed)
(13) Fig. 2 Hose routing

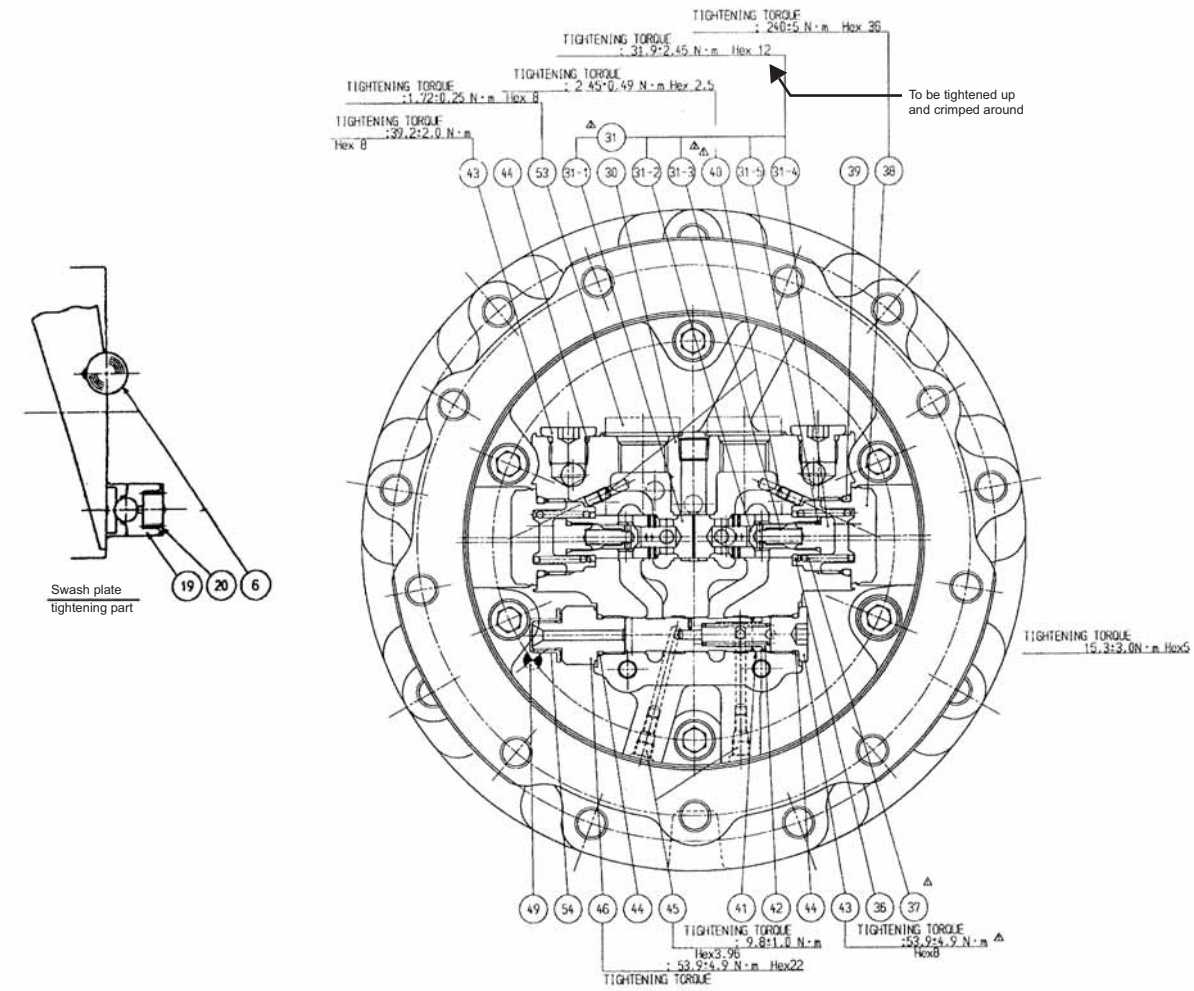


(2) Inner parts

Maker: Kayaba kogyo
Type: MAG-33V

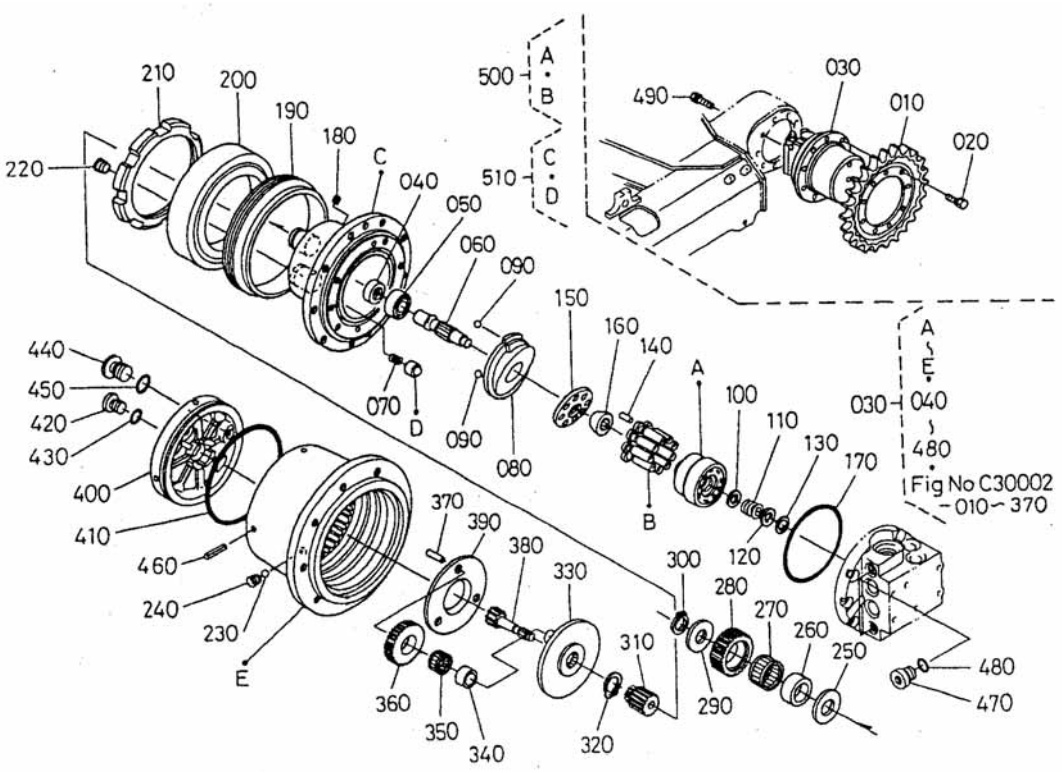


1	Reduction gear case	1-16	Snap ring	4	Oil seal
1-1	Flange holder	1-17	Holder	5	Swash plate
1-2	Floating seal	1-18	Planetary gear A	6	Steel ball
1-3	Angular bearing	1-19	Cage & roller	7	Cylinder block
1-4	Ring nut	1-20	Inner race	8	Collar
1-5	Plug	1-22	Drive gear	9	Spring
1-6	Housing	1-23	Thrust plate	10	Washer
1-7	Steel ball	1-23	Thrust plate	11	Snap ring
1-8	Plug	1-23	Thrust plate	12	Pin
1-9	Planetary gear B	1-24	Cover	13	Retainer holder
1-10	Needle bearing	1-25	O-ring	14	Retainer plate
1-11	Inner race	1-26	Wire	15	Piston assy
1-12	Thrust washer	1-27	Plug	19	Hi - Low piston assy
1-13	Thrust plate	1-29	O-ring	20	Spring
1-14	Screw	2	Shaft		
1-15	Sun gear	3	Ball bearing		

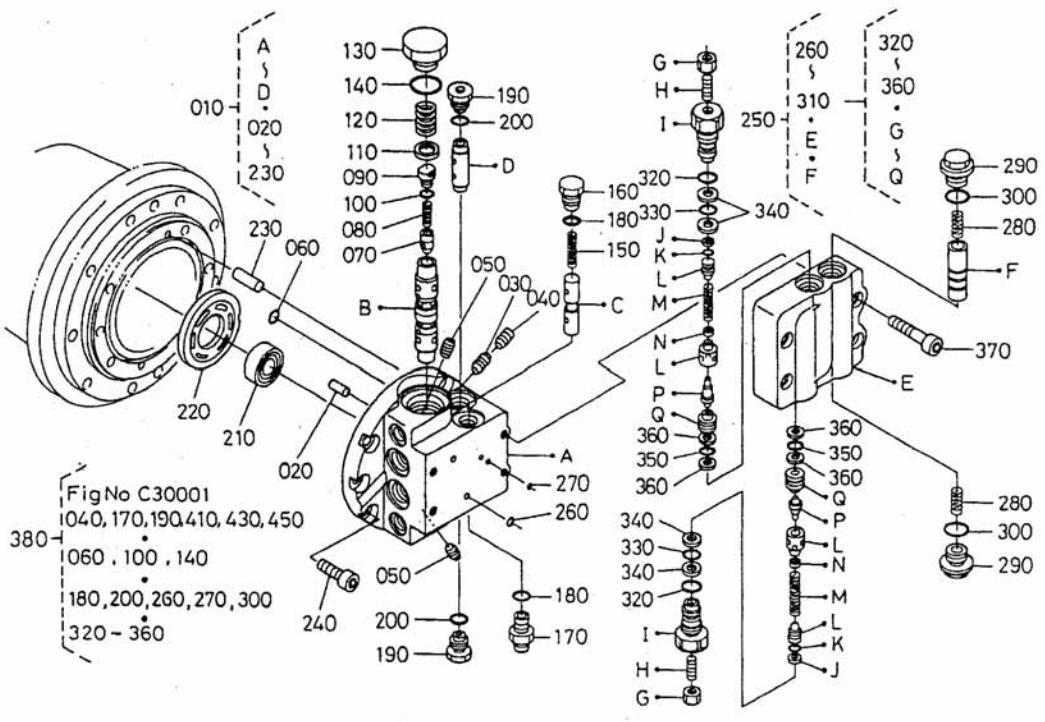


25	Valve plate	39	O-ring	50-4	Plug
26	Pin	40	Orifice	50-5	O-ring
27	Ball bearing	41	Spool	50-6	O-ring
28	O-ring	42	Spring	50-7	Hex. socket bolt
29	O-ring	43	Plug	51	Name plate
30	Base plate	44	O-ring	52	Drive screw
31	Spool assy	45	Plug	53	Shipping plug
31-1	Spool	46	Plug	54	Shipping plug
31-2	Check valve	47	Orifice	55	Plug
31-3	Spring	48	Hex. socket bolt	57	O-ring
31-4	Plug	49	Pin	58	Plug
31-5	O-ring	50	Valve assy	59	Plug
36	Spring seat	50-1	Valve body		
37	Spring	50-2	Check valve		
38	Cap	50-3	Spring		

(3) Parts development

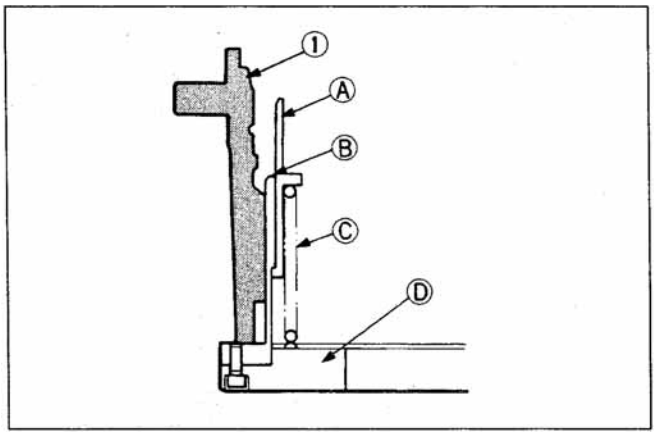


010	Sprocket, Drive	180	Plug	350	Bearing, Needle
020	Bolt	190	Seal	360	Gear
030	Assy motor, Wheel	200	Bearing	370	Pin, Spring
040	Seal, oil	210	Nut, Plug	380	Gear, Drive
050	Bearing, Ball	220	Plug	390	Plate
060	Shaft	230	Ball	400	Cover
070	Spring, Piston	240	Plug	410	O-ring
080	Swash plate	250	Plate, Thrust B	420	Plug
090	Ball	260	Collar	430	O-ring
100	Washer, Spring	270	Bearing, Needle	440	Plug
110	Spring	280	Gear	450	O-ring
120	Washer, Spring	290	Plate	460	Pin, Spring
130	Circlip, Internal	300	Circlip, External	470	Plug
140	Pin	310	Gear	480	O-ring
150	Plate, retainer	320	Circlip, External	490	Bolt
160	Holder, retainer	330	Holder	500	Assy block, Cylinder
170	O-ring	340	Collar	510	Assy holder, Flange



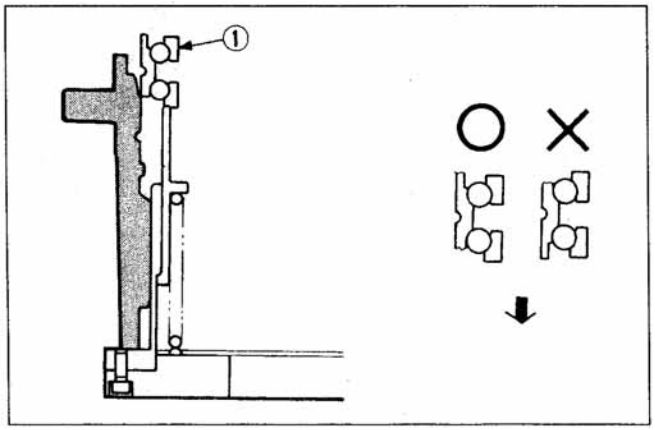
010	Assy valve	140	O-ring	270	O-ring
020	Pin, Straight	150	Spring	280	Spring
030	Orifice	160	Plug	290	Plug
040	Plug	170	Adaptor	300	O-ring
050	Orifice	180	O-ring	310	Assy valve, Relief
060	O-ring	190	Plug	320	O-ring
070	Poppet	200	O-ring	330	O-ring
080	Spring	210	Bearing, Ball	340	Ring, Backup
090	Plug	220	Plate, Valve	350	O-ring
100	O-ring	230	Pin, Straight	360	Ring, Backup
110	Washer, Spring	240	Bolt, HEX-SOC-HD	370	Bolt, HEX-SOC-HD
120	Spring	250	Assy valve	380	Kit seal
130	Plug	260	O-ring		

(4) Assembling of the traveling motor



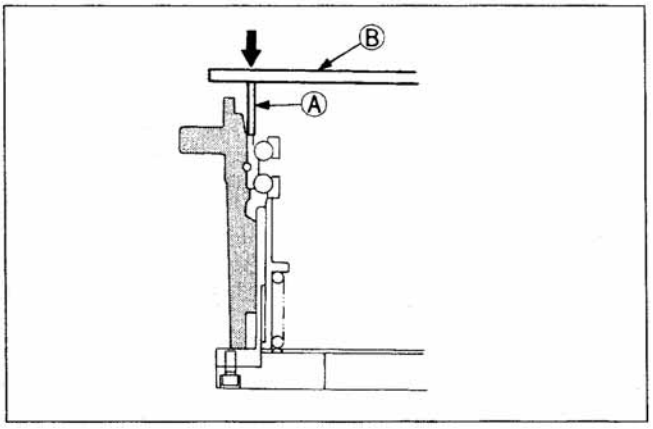
1.Set the angular bearing fitting jigs to the housing.

(1) Housing
A. Spring guide (Jig 4)
B. Housing guide (Jig 5)
C. Spring (Jig 7)
D. Base plate (Jig 6)



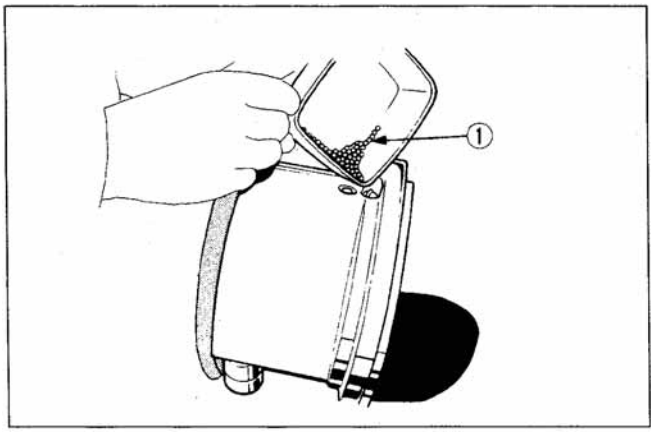
2.Place the angular bearing in its specified direction with care not to let the inner ring fall.

(1) Angular bearing



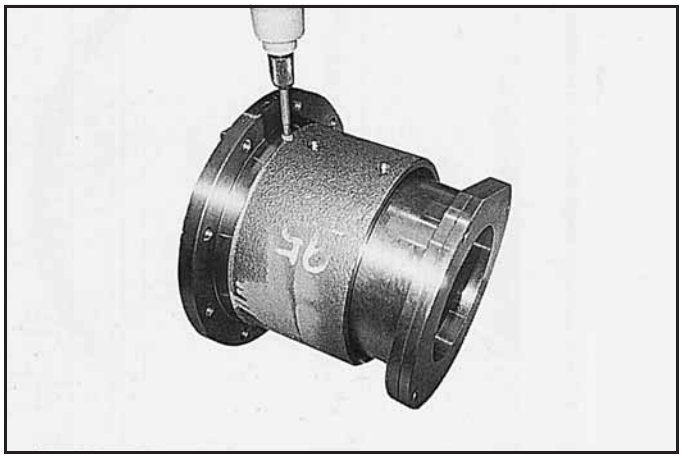
3.Press-fit the angular bearing into position.

A. Pressing jig (Jig 8)
B. Press-fitting plate (Jig 9)



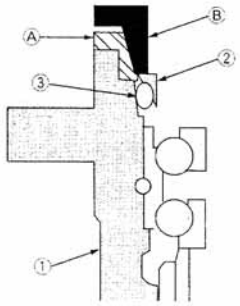
4.Put the 132 steel balls in the outer groove of the bearing.

(1) Steel balls: 132 pcs



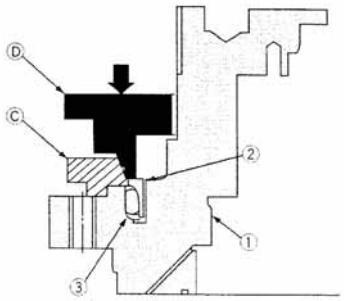
5.Wind sealing tape around the plug with the two end threads exposed. Apply and tighten this plug.
Plug (R1/8) tightening torque:9.8 ~ 14.7 N·m
(1.0 ~ 1.5 kg·m)
7.2 ~ 10.9 ft·lbs

6.Place the guide jig on the housing. Apply grease to the O-ring and temporarily place the floating seal. Using the specified press-fitting jig, evenly press-fit the floating seal with care not to twist or tilt the O-ring.

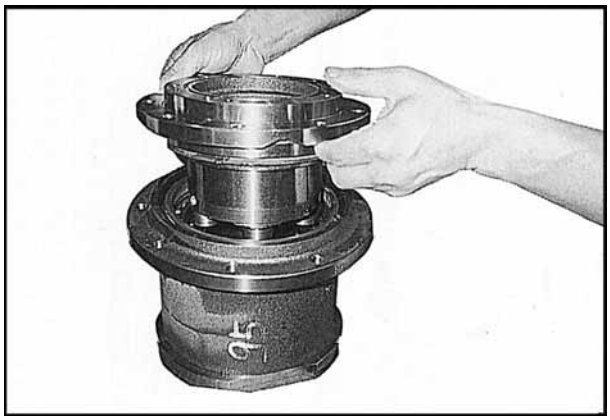


(1) Housing
(2) Floating seal
(3) O-ring
A. Guide (Jig 10)
B. Press-fitting jig (Jig 11)

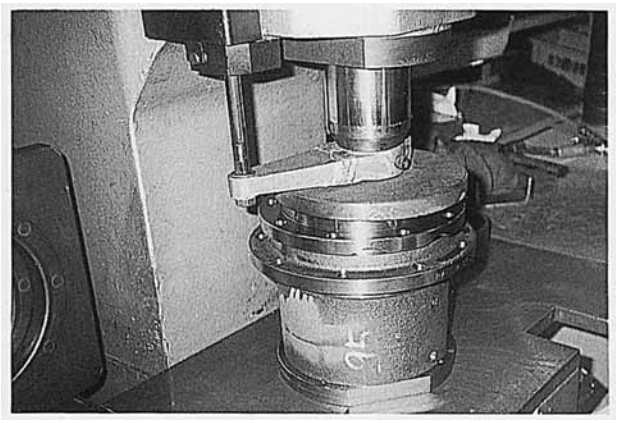
7.Place the guide jig on the flange holder. Apply grease to the O-ring and temporarily place the floating seal. Using the specified press-fitting jig, evenly press-fit the floating seal with care not to twist or tilt the O-ring.



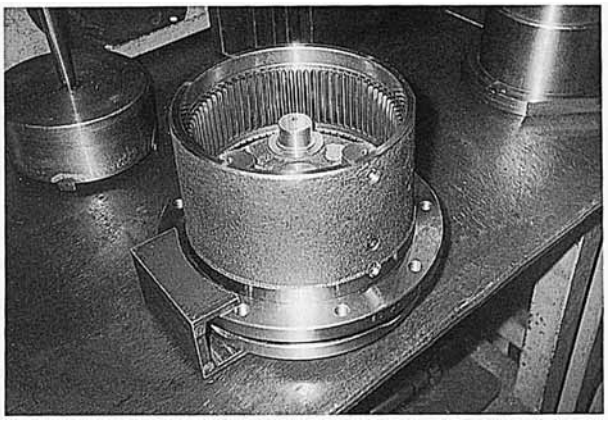
(1) Flange holder
(2) Floating seal
(3) O-ring
A. Guide (Jig 12)
B. Press-fitting jig (Jig 13)



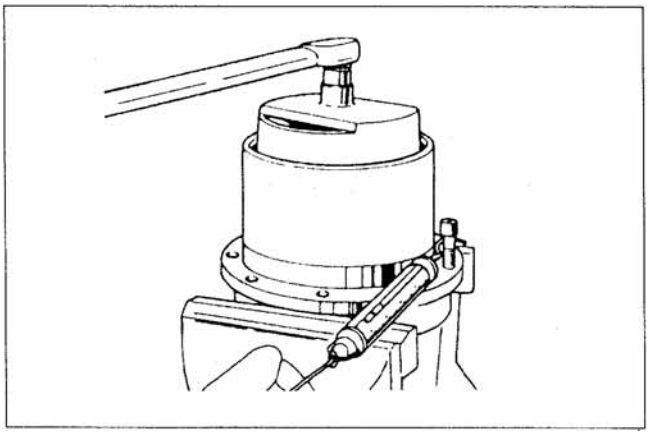
8.Clean the sliding surface of the floating seal. Apply grease over this surface and put the flange holder in the housing.



9.Using the specified press-fitting jig, set the flange holder on the housing.



10.Using the specified clamping jig, clamp the flange holder to the housing.
Detach the press-fitting jig and turn the housing upside down. Leaving the clamping jig in place, remove all the angular bearing fitting jigs.

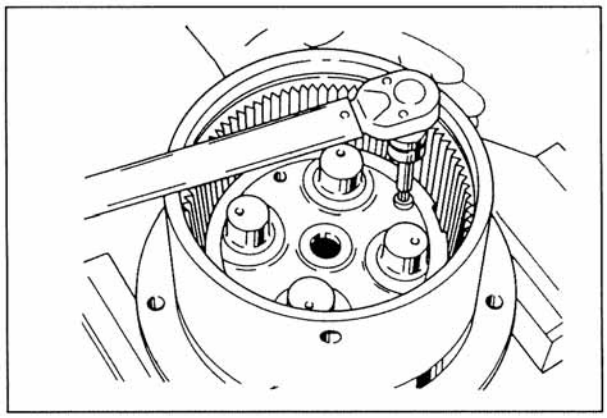


11.Using the specified ring nut fitting jig, tighten the ring nut.

Tightening procedure:

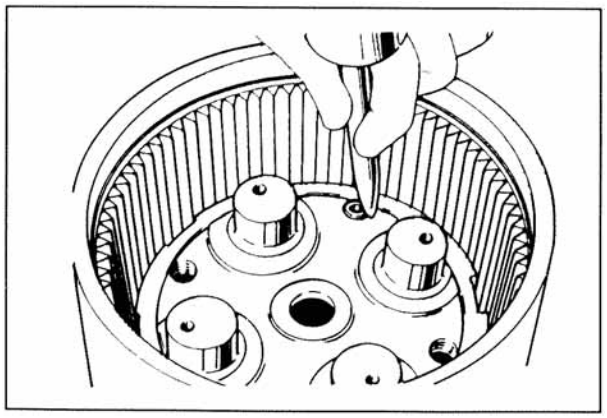
(1)Tighten the ring nut to the torque of 2400 kgf·cm (173.6 ft·lbs) so that there will be no gap between the nut and angular bearing. Turn the housing several times and measure the startup load to make sure it is about 5 kgf.

(2)Tighten the ring nut further until the startup load becomes about 6 ~ 7 kgf (13.2 ~ 15.4 lbs).

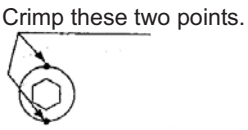


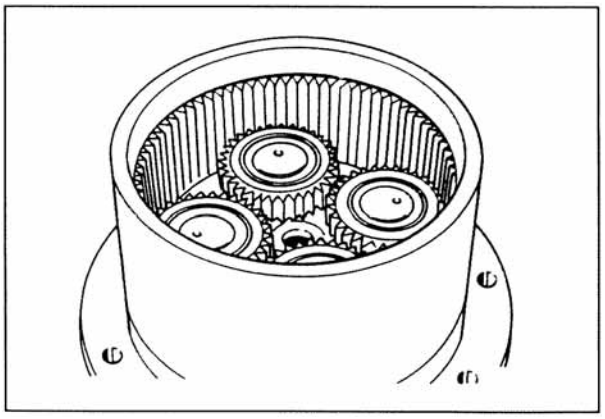
12.Using a hand tap, tap the ring nut locking plug hole R1/4. Remove cuttings and tighten the plug.

Tightening torque:24.5 ~ 34.3 N·m
(2.5 ~ 3.5 kg·m)
18.1 ~ 25.3 ft·lbs

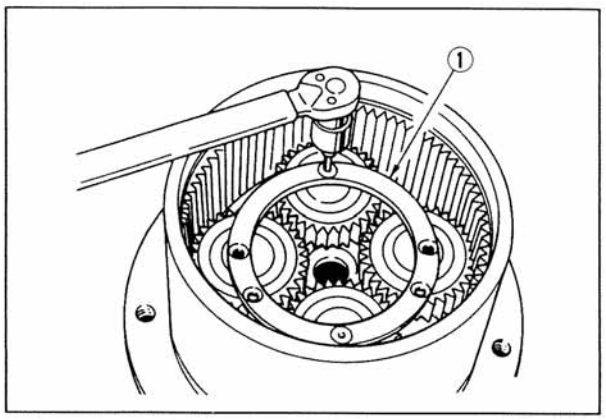


13.Using a punch, crimp the following two points to hold the plug in position.



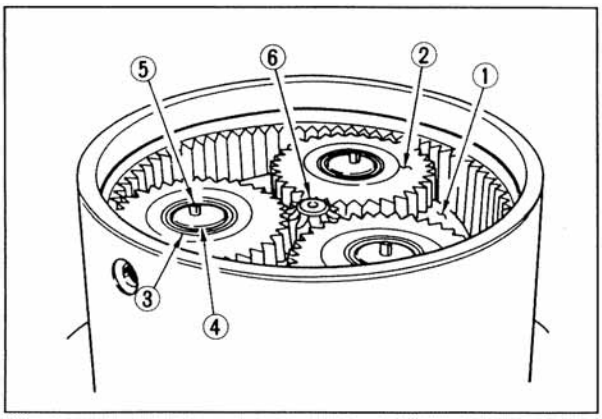


14.Fit the thrust washer, planetary gear B, cage & roller.



15.Fit the thrust plate, apply Locktite #262 to screws, and clamp them.
- When applying Locktite, carry out degreasing of parts sufficiently, and use hardening/curing promotor.
- Screw tightening torque:
  2.97 ~ 6.00 ft·lbs (0.41 ~ 0.83 kgf·m) 4.0 ~ 8.1 N·m

(1) Thrust plate



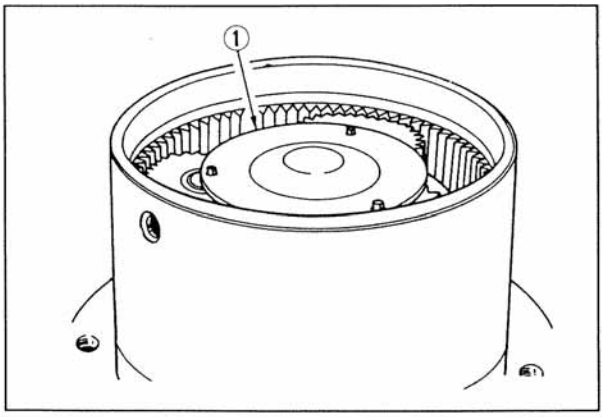
16.Attach a snap ring to the sun gear, and fit it.

17.Attach the spring pin, inner race, cage & roller and planetary gear A to the holder, and fit it.

(1) Holder
(2) Planetary gear A
(3) Cage & roller
(4) Inner race
(5) Spring pin

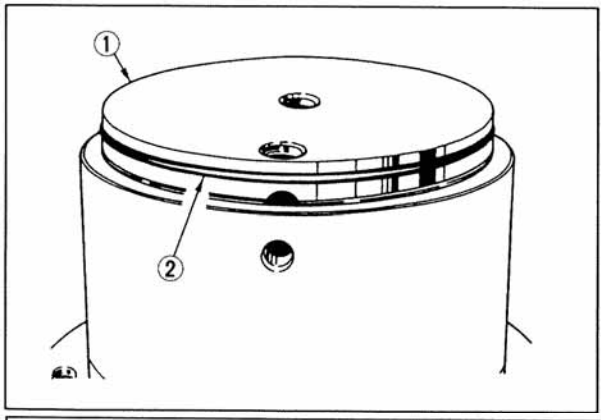
18.Mount the drive gear.

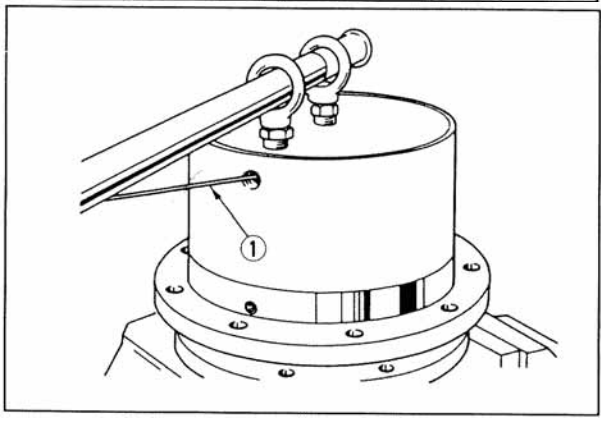
(6) Drive gear



19.Fit the thrust plate

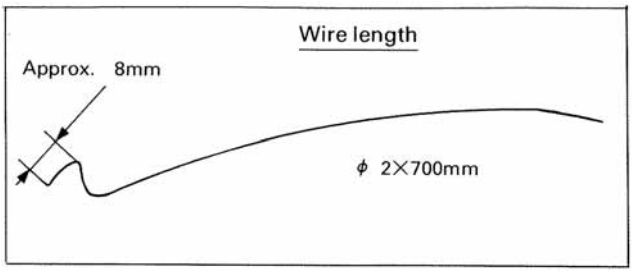
(1) Thrust plate





20.Attach the O-ring to the cover, and fit to the housing.
• Make sure that the U-groove is set with the threaded hole position of plug.

(1) Thrust plate
(2) O-ring

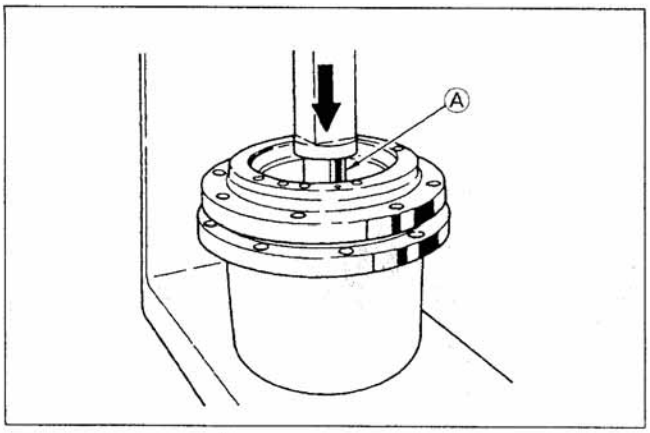


21.Bend the wire at about 0.31 in (8 mm) apart from its tip to 90°, insert in into the threaded hole of the housing, and turn the cover to wind in the wire.
Cut off excess wire if any.

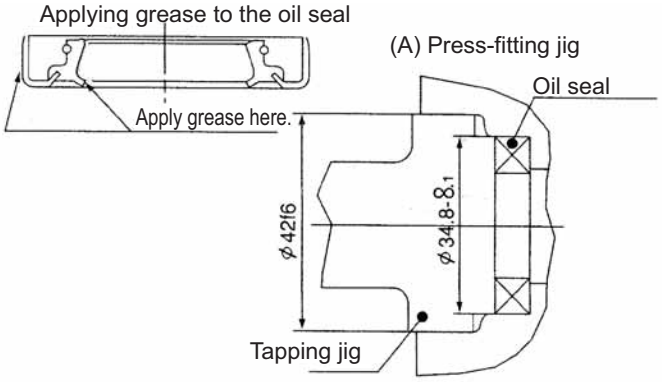
(1) Wire

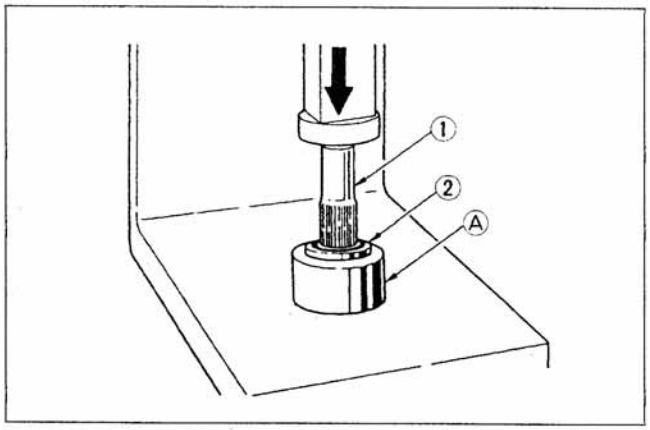
22.With seal tape wound around the plug, fit it.
• Plug tightening torque:6.9 ~ 8.8 N·m
(0.7 ~ 0.9 kgf·m)
5.1 ~ 6.5 ft·lbs

Motor section



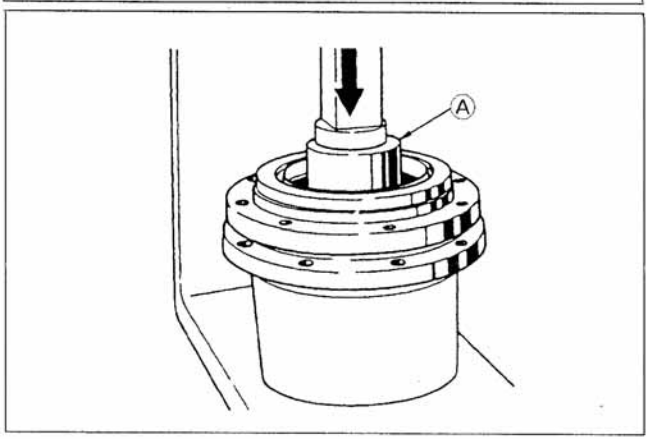
23.Apply grease to the oil seal. Using the specified press-fitting jig, press-fit the oil seal in the flange holder.





24.Using the specified press-fitting jig, press-fit the ball bearing on the shaft.

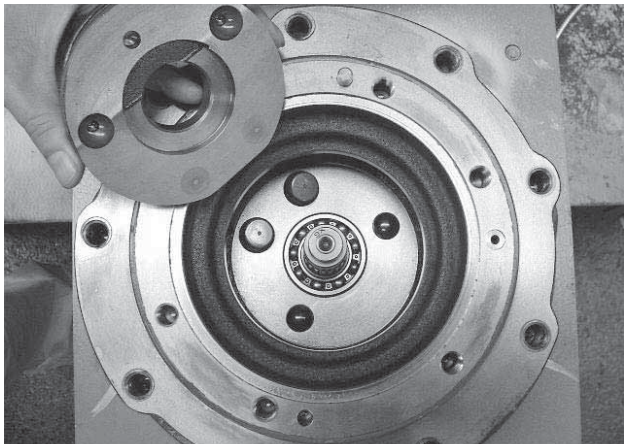
(1) Shaft
(2) Ball bearing
(3) Press-fitting jig



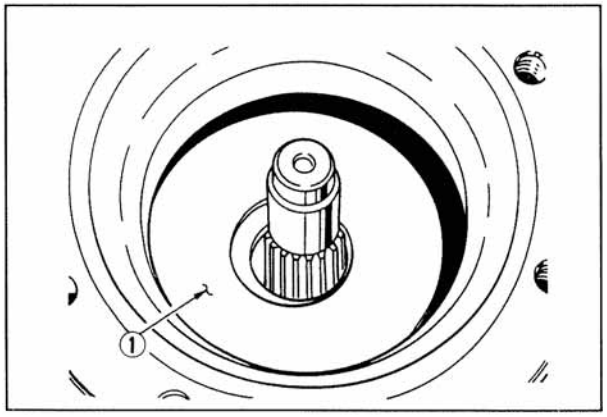
25.Using the specified press-fitting jig, press-fit the shaft sub-assembly in the flange holder.

(A) Press-fitting jig

26.Apply grease to the compression spring. Fit the piston assembly in the flange holder. Apply grease to the balls and put them in the flange holder.

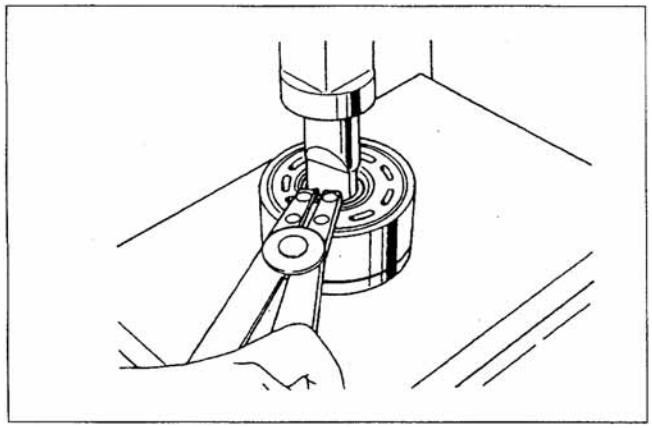


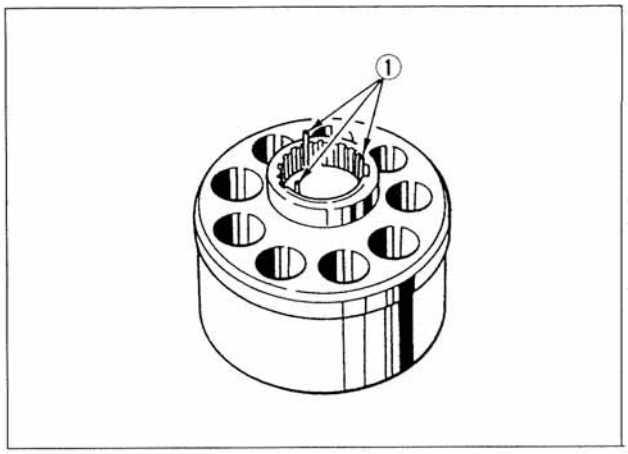
27.Fit the swash plate into position.



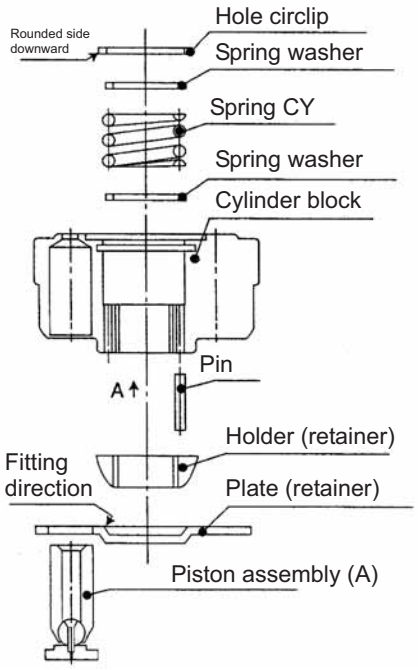
28.Fit Steel balls, spring, piston S/A and swash plate.
- Apply hydraulic oil to the slide way of swash plate.

(1) Swash plate

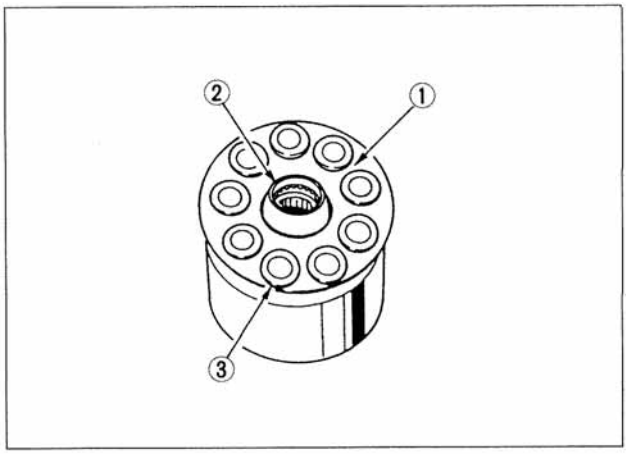




29.Install the spring and two washers in the cylinder block. Using the specified fitting jig, install the snap ring in place.

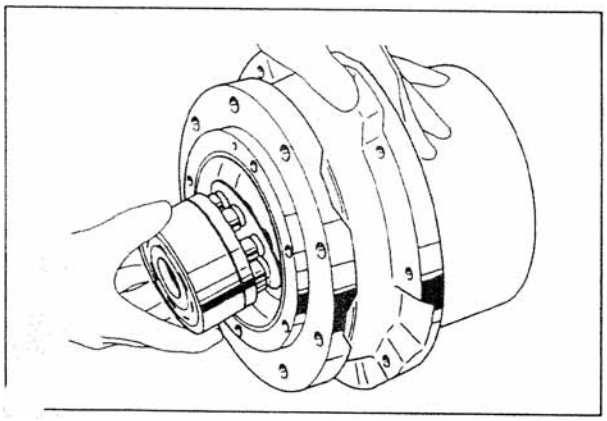


30.Fit the three pins in the cylinder block.
*Apply grease to the pins beforehand to avoid accidental drop.

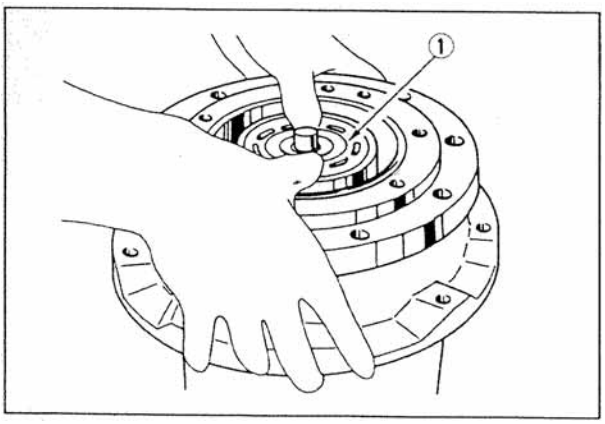


31.Apply hydraulic oil in the nine holes of the cylinder block. Put the holder (retainer), plate (retainer) and piston together into the cylinder block sub-assembly.

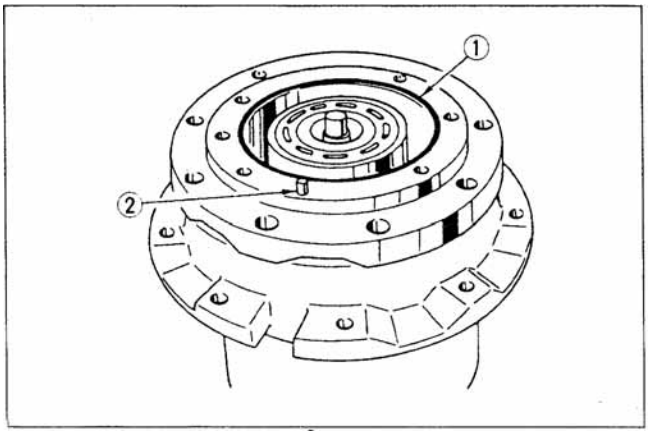
(1) Retainer plate
(2) Retainer holder
(3) Piston assy



32.Place the motor sideways. Fit the cylinder block sub-assembly, along the shaft spline, into the motor.

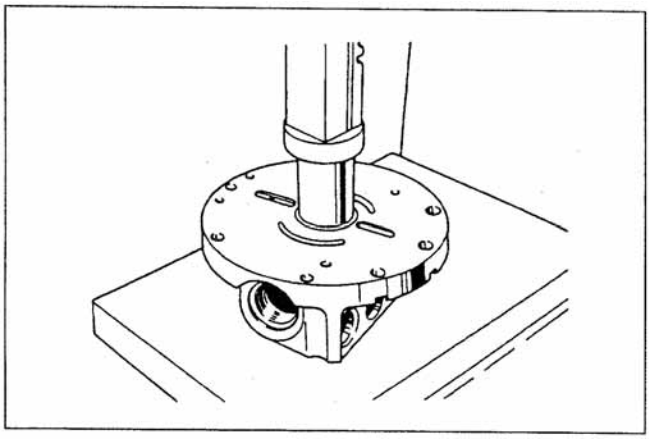


33.Hand-press the cylinder block to make sure the spring reacts. Apply hydraulic oil to the sliding surface of the cylinder block.

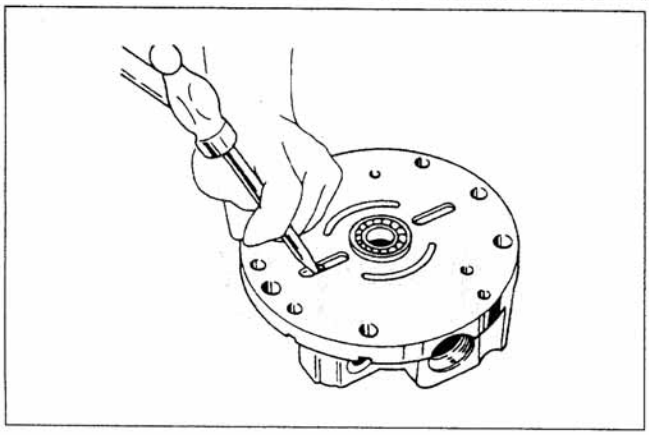


34.Apply grease to the O-ring. Fit the parallel pin and this O-ring in the flange holder.

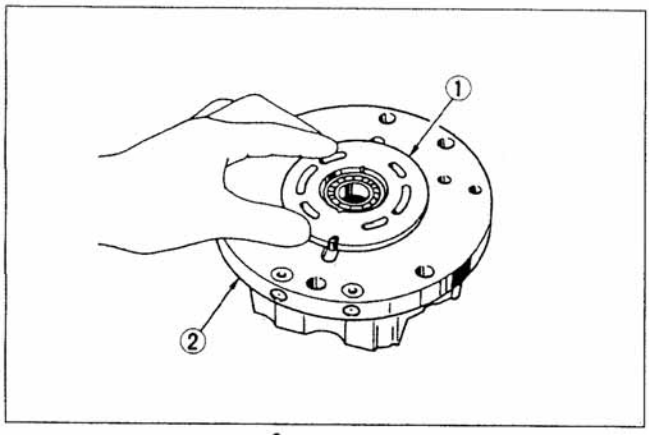
(1) O-ring
(2) Parallel pin



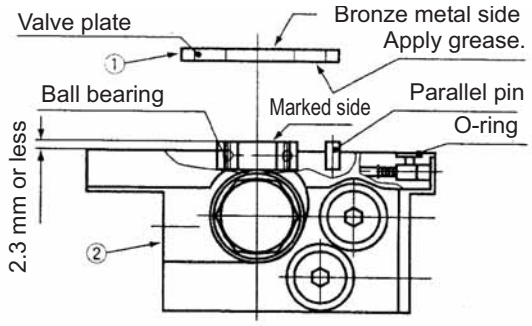
35.Using the specified jig, tap the bearing, with its marked side upward, until there is a step difference of 2.3 mm (0.09 in.) or less with the body.



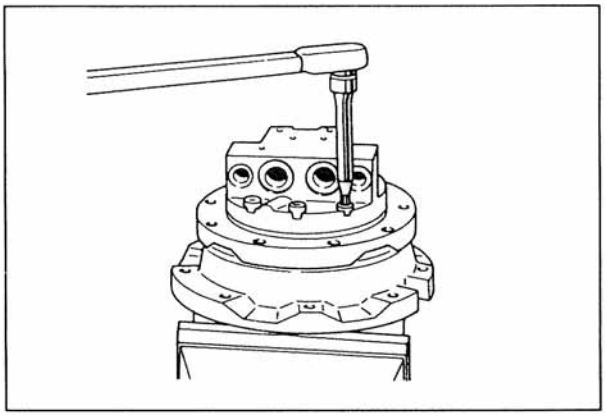
36.Drive the parallel pin all the way into contact.



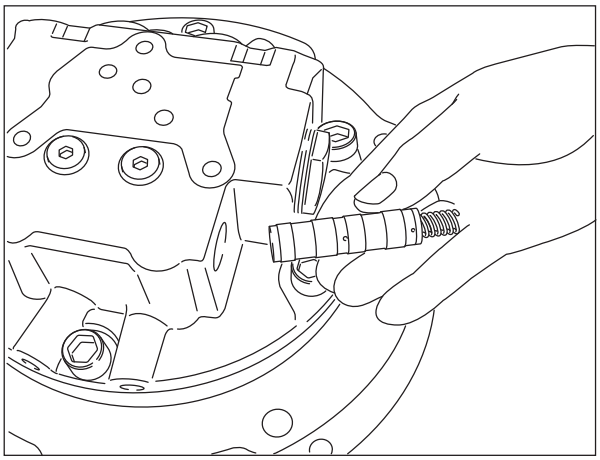
37.Apply grease over the back of the valve plate. Fit the valve plate in the body.



Valve section

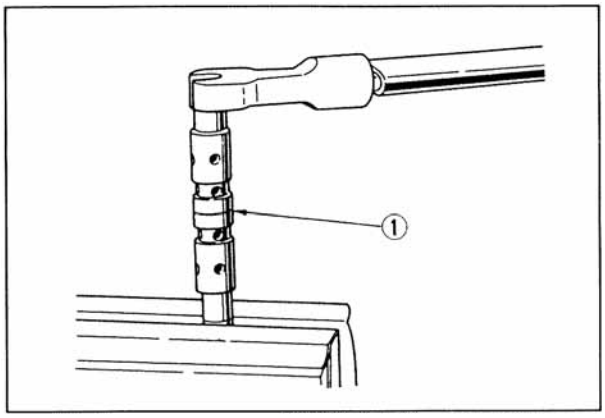


38.Mount the base plate, and tighten socket head bolts.
- Socket head bolt tightening torque:
  58.8 ~ 68.7 N·m
  (6.0 ~ 7.0 kgf·m)
  43.4 ~ 50.6 ft·lbs



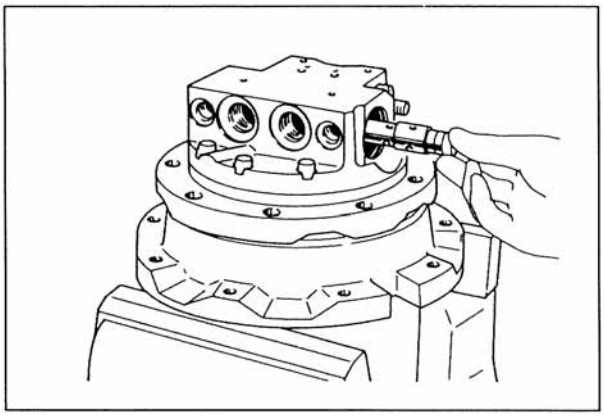
39.Attach a spring to the spool, and fit it to the base plate.
- Insert the spool while turning it.

40.Attach an O-ring to the plug, and fit it to the base plate.
- Plug tightening torque:49.0 ~ 58.8 N·m
  (5.0 ~ 6.0 kgf·m)
  36.2 ~ 43.4 ft·lbs

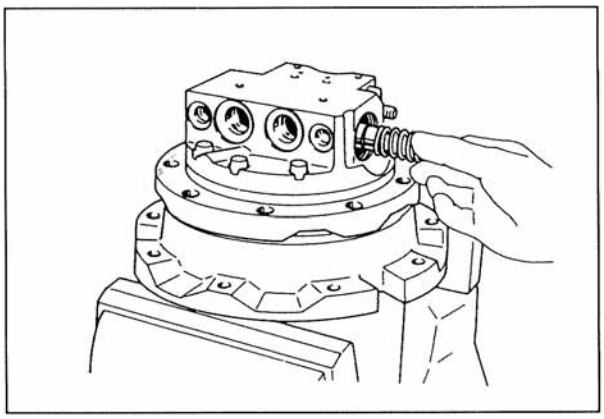


41.Attach the check valve and spring to the plunger.

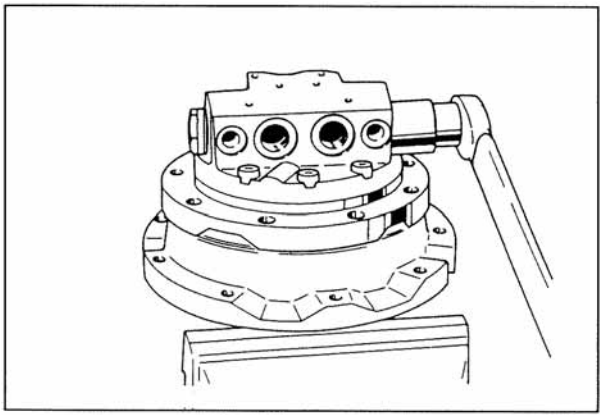
42.Attach an O-ring to the plug, and fit it to the plunger.
- Plug tightening torque:31.9 ± 2.45 N·m
  (3.0 ~ 3.5 kgf·m)
  21.7 ~ 25.3 ft·lbs



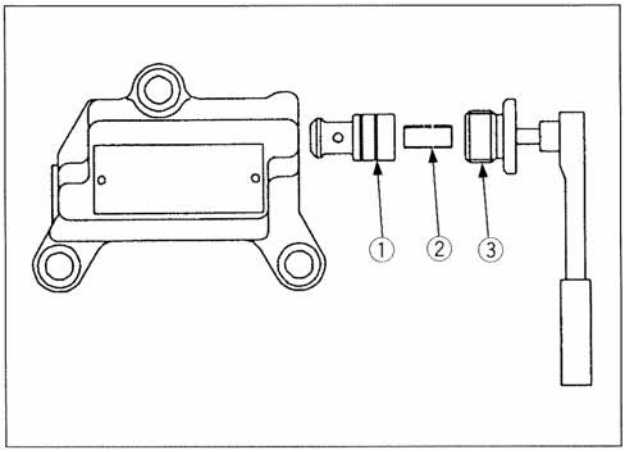
43.Fit the plunger S/A to the base plate.
- Turn the plunger when inserting it so that it does not cling tight in middle of insertion.
- Apply hydraulic oil to the plunger S/A.



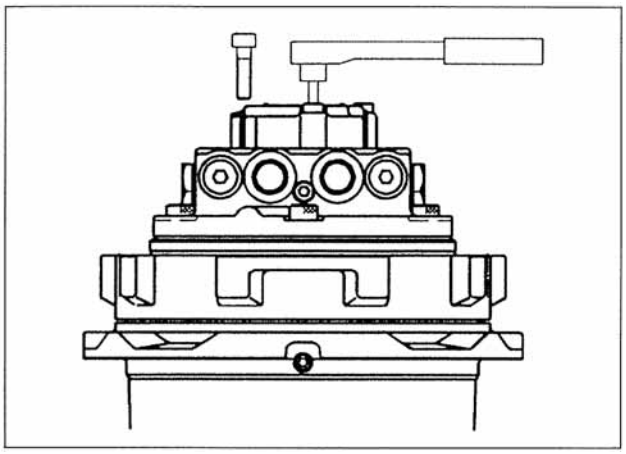
44.Fit the spring seat and spring.



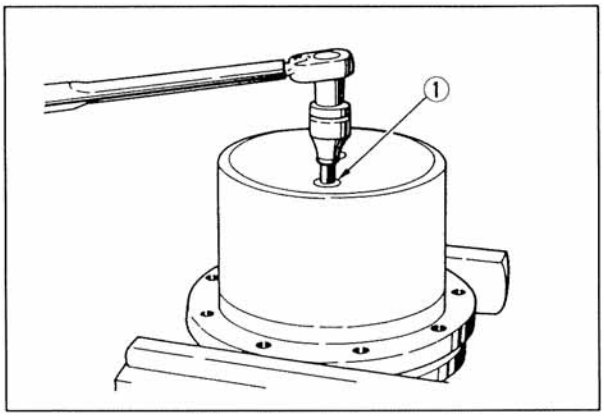
45.Attach an O-ring to the cap, and fit it to the base plate.
- Cap tightening torque:243.2 ~ 245.2 N·m
  (24.8 ~ 25.0 kgf·m)
  179.4 ~ 180.8 ft·lbs



46.Assemble the check valve and spring to the valve body, and tighten up the plug.
- Tightening torque: 53.9 ± 4.9 N·m
  (5.5 ± 0.5 kgf·m)
  40 ± 3.6 ft·lbs

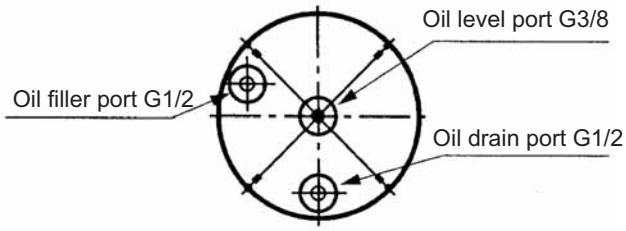


47.Fit the relief valve S/A, and screw socket head bolts. (2nd speed type only)
- Socket head bolt tightening torque:
  36.9 ± 1.9 N·m
  (3.8 ± 0.2 kgf·m)
  27.5 ± 1.5 ft·lbs

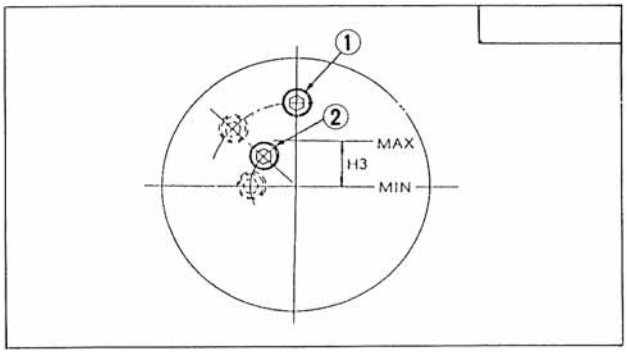


48.Feed gear oil to the plug threaded hole, and then put on the plug.
- Wind seal tape around the plug.

(1) Plug



Gear oil (SAE#90, GL-4): 0.5 l
Plug tightening torque:
G3/8:
49.0 ~ 58.8 N·m (5.0 ~ 6.0 kg·m) 36.2 ~ 43.4 ft·lbs
G1/2:
58.8 ~ 68.6 N·m (6.0 ~ 7.0 kg·m) 43.4 ~ 50.6 ft·lbs



*How to check the oil level.
1. Place the machine on a level floor. Let the inlet/drain port of the traveling motor be at the top position.
2. Remove the gauge port plug.
3. Make sure that gear oil comes out of the gauge port. If not, remove the inlet/drain port and add gear oil until overflows the gauge port.

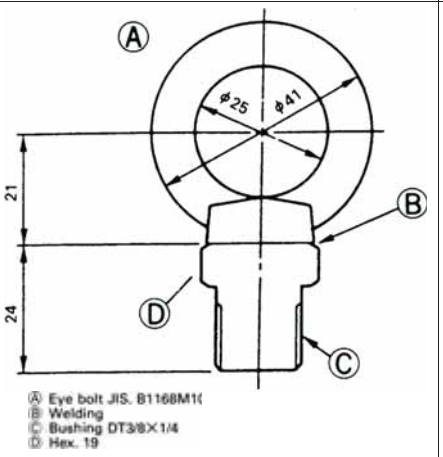
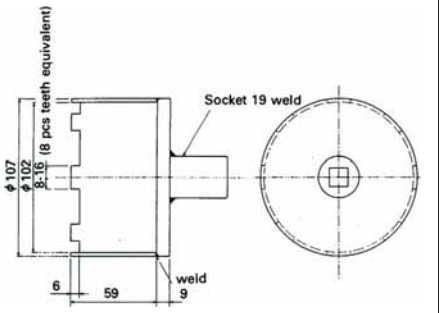
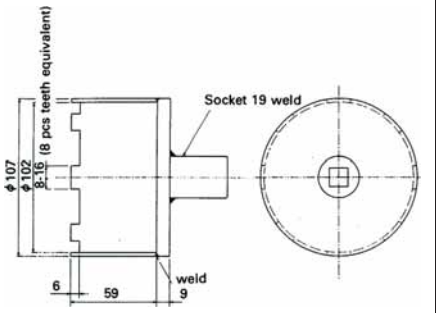
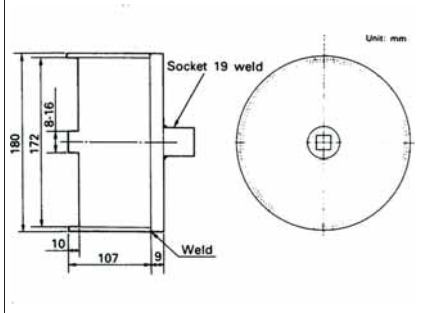
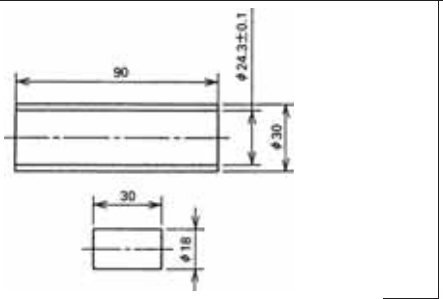
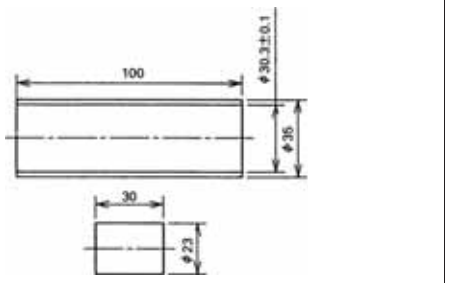
(1) Inlet/drain port
(2) Gauge port

Allowable oil

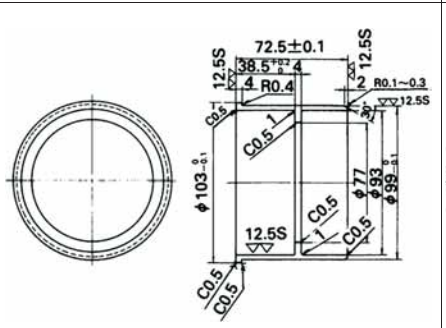
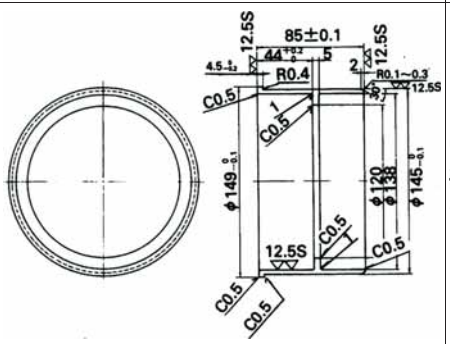
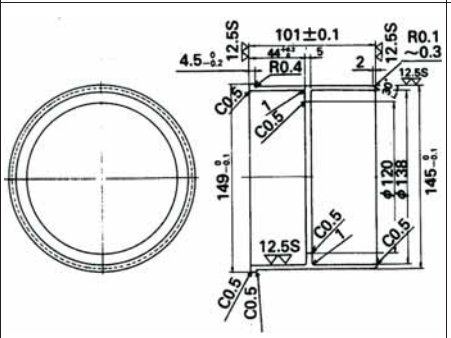
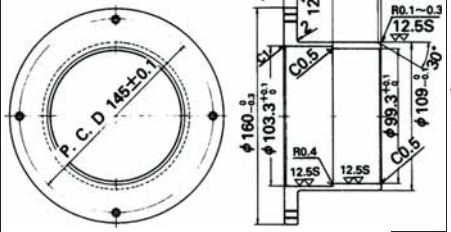
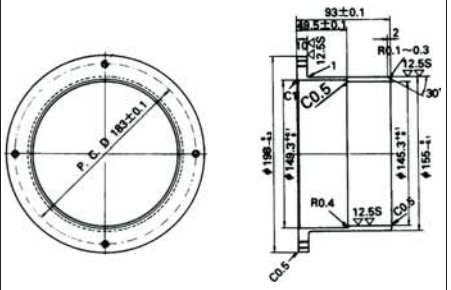
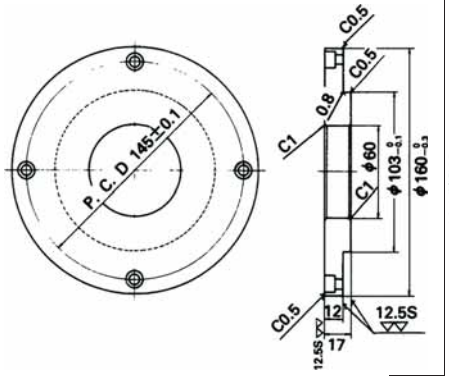
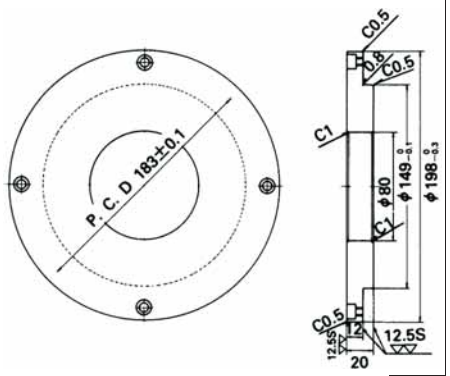
Model	H1	H2	H3
KX121-3α/S/ST	-	-	1.02 (26)

(5) Jig List

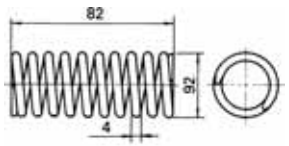
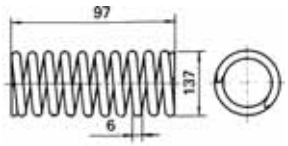
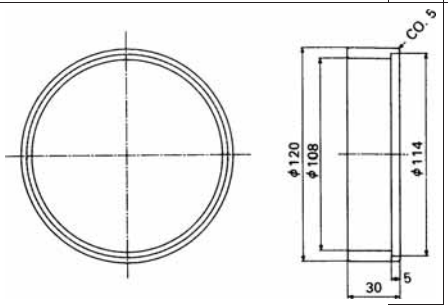
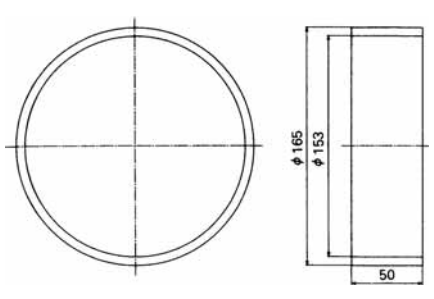
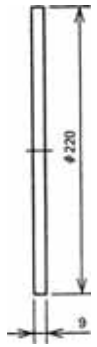
(mm)

Jig No.	Name *Nom* Name	KX41-2/S/V	KX61-2·71-2·91-2 **KX91-3/S/S2/α/α2, KX101-3/α/α2, U35S/S2, U35-3/α/α2, U35-3/S/S2**	KX121-2 **KX121-3/S/α/ST**	KX161-2 **KX161-3/S/α/ST**
1	Eye bolt *Boulon à oeillet* Ringschraube	 Ⓐ Eye bolt JIS. B1168M1(Ⓑ Welding Ⓒ Bushing DT3/8X1/4 Ⓓ Hex. 19	←	←	←
2	Ring nut loosening (tightening) Jig *Outil de desserrage (desserrage) de couronne* Spannvorrichtung zum Lösen oder Festziehen der Ringmutter			←	
3	Ball bearing removing jig *Outil de dépose de roulement à billes* Spannvorrichtung zur Entfernung des Kugellagers	 S35C	 S35C	←	←

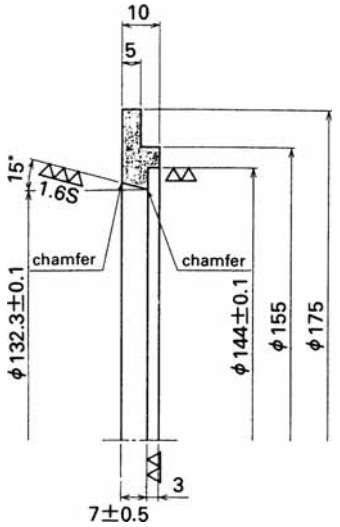
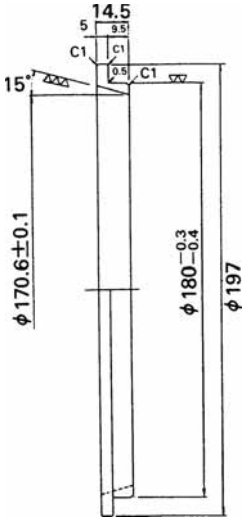
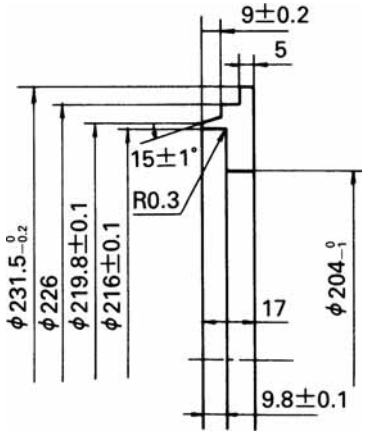
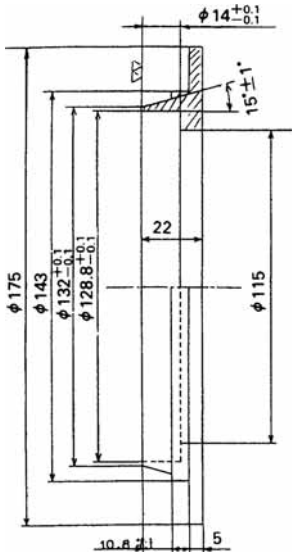
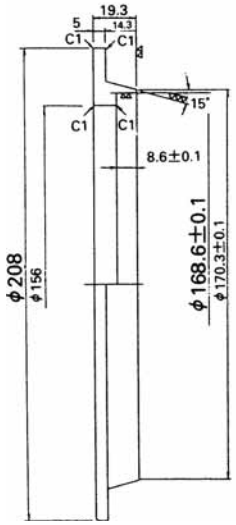
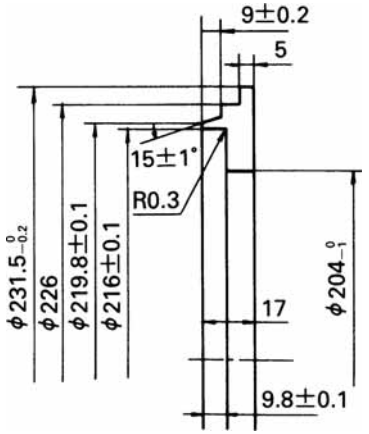
(mm)

Jig No.	Name *Nom* Name	KX41-2/S/V	KX61-2·71-2·91-2 **KX91-3/S/S2/αIα2, KX101-3/αIα2, U35S/S2, U35-3/αIα2, U35-3/S/S2**	KX121-2 **KX121-3/S/α/ST**	KX161-2 **KX161-3/S/α/ST**
4	Angular bearing support jig (Spring guide) *Outil de support de roulement angulaire (guide de ressort)* Spannvorrichtung für Schrägkugellager (Federführung)	 SS40	 SS40	 SS40	←
5	Angular bearing support jig (Base plate) *Outil de support de roulement angulaire (plaque de base)* Spannvorrichtung für Schrägkugellager (Sockelplatte)	 SS40	 SS40	←	←
6	Angular bearing support jig (Base plate) *Outil de support de roulement angulaire (plaque de base)* Spannvorrichtung für Schrägkugellager (Sockelplatte)	 SS40	 SS40	←	←

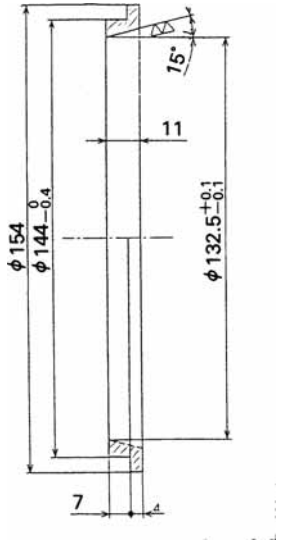
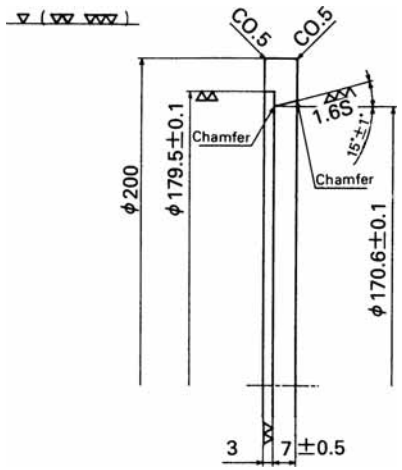
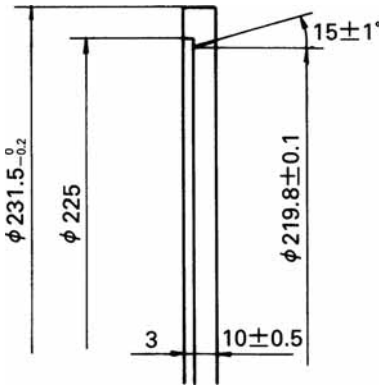
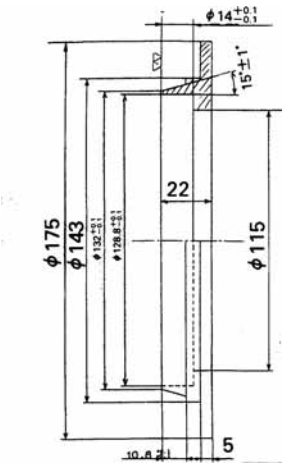
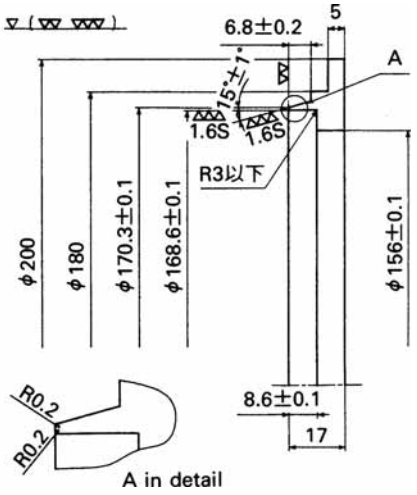
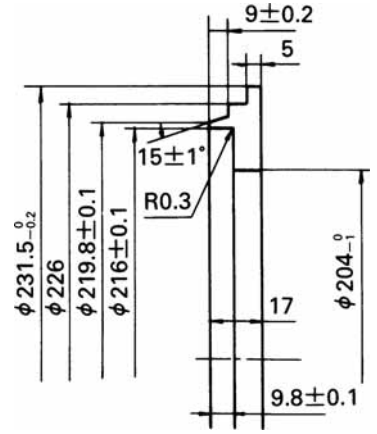
(mm)

Jig No.	Name *Nom* Name	KX41-2/S/V	KX61-2·71-2·91-2 **KX91-3/S/S2/α/α2, KX101-3/α/α2, U35S/S2, U35-3/α/α2, U35-3/S/S2**	KX121-2 **KX121-3/S/α/ST**	KX161-2 **KX161-3/S/α/ST**
7	Angular bearing support jig (Spring) *Outil de support de roulement angulaire (ressort)* Spannvorrichtung für Schräg-kugellager (Feder)	 Total roll No.6 Effective roll No.4 SWB	 Total roll No.6 Effective roll No.4 SWB	←	←
8	Angular bearing pressing jig *Outil de pressage de roulement angulaire* Druck-Spannvorrichtung für Schrägkugellager	 SS41 S43C	 SS41 S43C	←	←
9	Pressing plate *Plaque de pressage* Druckplatte	 S35C	←	←	←

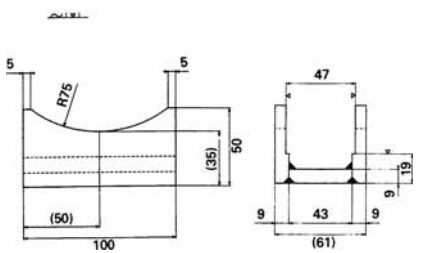
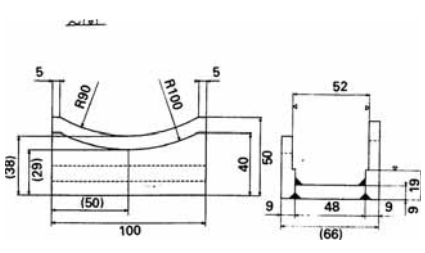
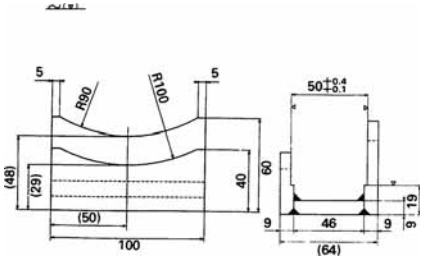
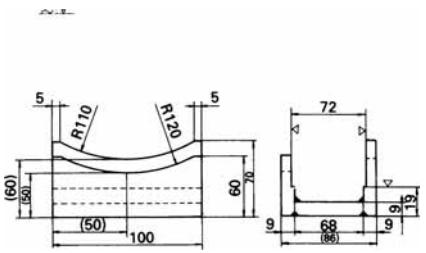
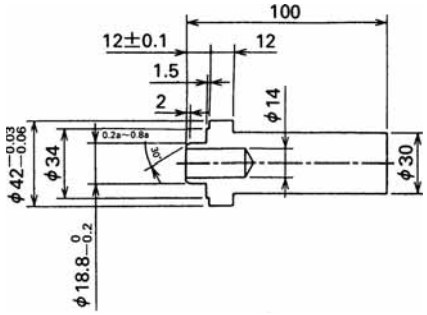
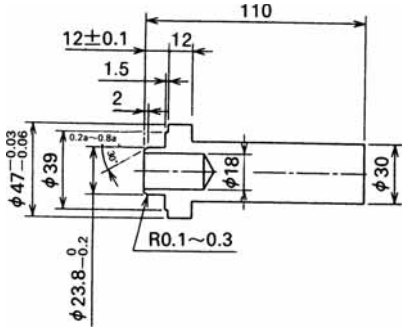
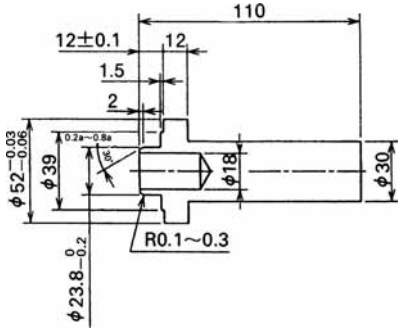
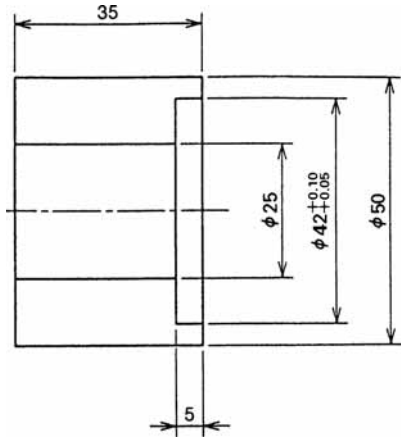
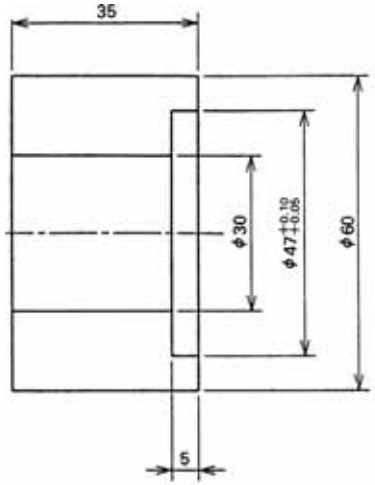
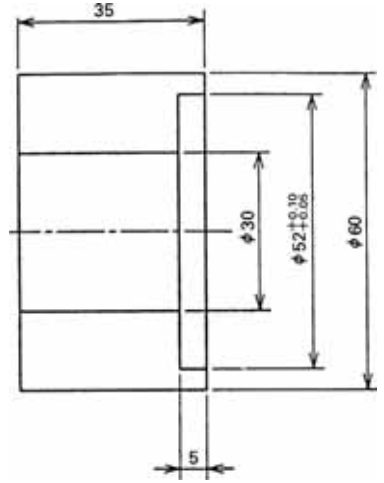
(mm)

Jig No.	Name *Nom* Name	KX41-2/S/V	KX61-2·71-2·91-2 **KX91-3/S/S2/αIα2, KX101-3/αIα2, U35S/S2, U35-3/αIα2, U35-3/S/S2**	KX121-2 **KX121-3/S/α/ST**	KX161-2 **KX161-3/S/α/ST**
10	Floating seal guide jig (Housing) *Outil de guide de joint flottant (carter)* Spannvorrichtung für Schwimmdichtung (Gehäuse)	 SS41 S43C	 SS41 S43C	←	 SS41 S43C
11	Floating seal pressing jig (Housing) *Outil de pressage de joint flottant(carter)* Druck-Spannvorrichtung für Schwimmdichtung (Gehäuse)	 SS41 S43C	 SS41 S43C	←	 SS41 S43C

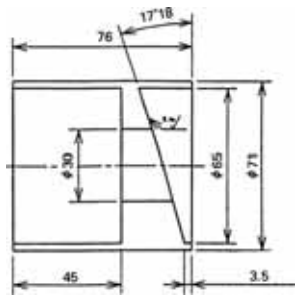
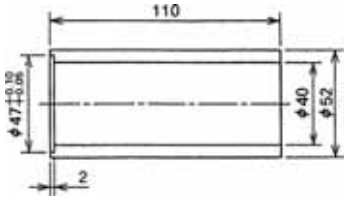
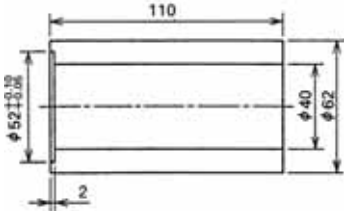
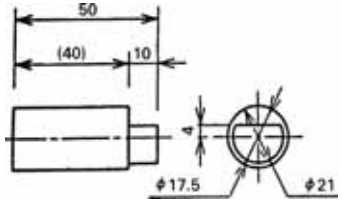
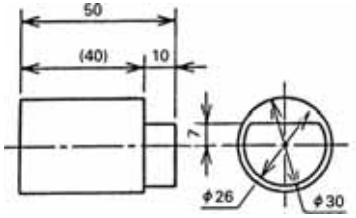
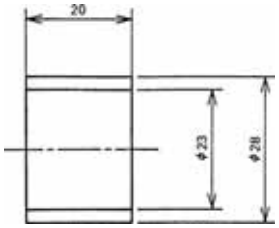
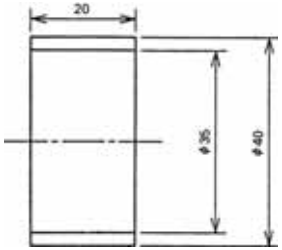
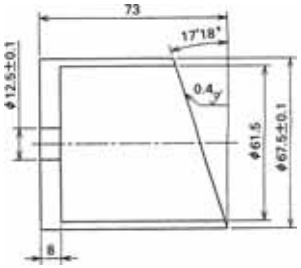
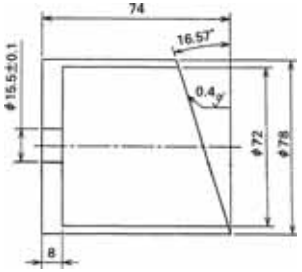
(mm)

Jig No.	Name *Nom* Name	KX41-2/S/V	KX61-2·71-2·91-2 **KX91-3/S/S2/α/α2, KX101-3/α/α2, U35S/S2, U35-3/α/α2, U35-3/S/S2**	KX121-2 **KX121-3/S/α/ST**	KX161-2 **KX161-3/S/α/ST**
12	Floating seal guide jig (Flange holder) *Outil de guide de joint flottant (Support de bride)* Führungs-Spannvorrichtung für Schwimmdichtung (Flanschhalter)	 SS41 S43C	 SS41 S43C	←	 SS41 S43C
13	Floating seal pressing jig (Flange holder) *Outil de pressage de joint flottant(Support de bride)* Druck-Spannvorrichtung für Schwimmdichtung (Flanschhalter)	 SS41 S43C	 SS41 S43C	←	 SS41 S43C

(mm)

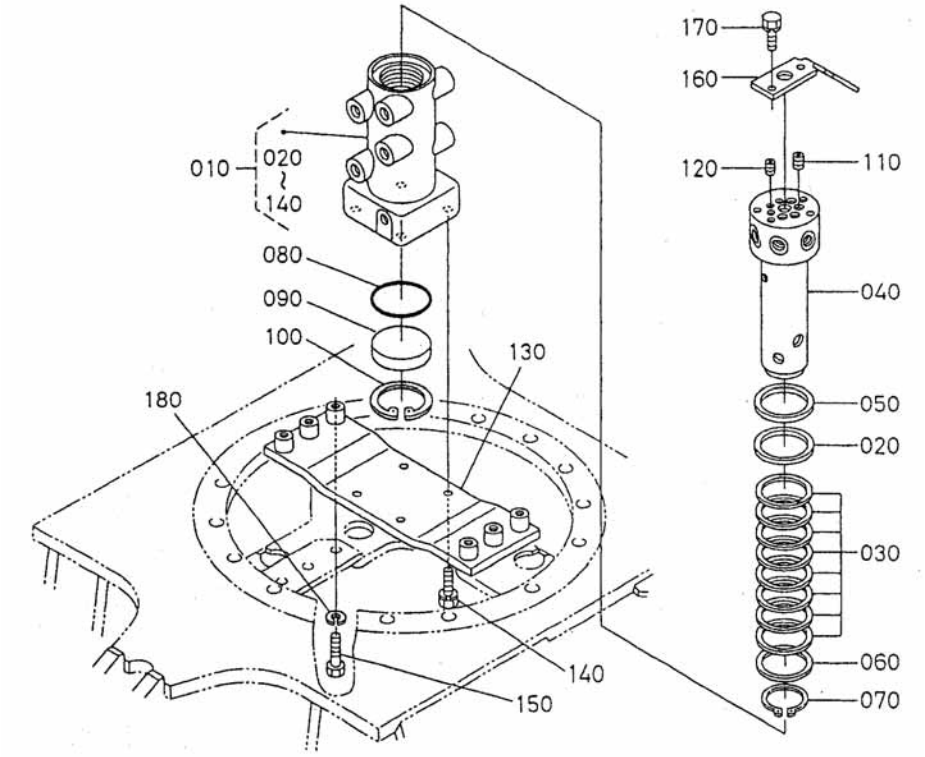
Jig No.	Name *Nom* Name	KX41-2/S/V	KX61-2·71-2·91-2 **KX91-3/S/S2/α/α2, KX101-3/α/α2, U35S/S2, U35-3/α/α2, U35-3/S/S2**	KX121-2 **KX121-3/S/α/ST**	KX161-2 **KX161-3/S/α/ST**
14	Clamping jig *Outil de bridage* Klemm-Spannvorrichtung	 SS41	 SS41	 SS41	 SS41
15	Oil seal fitting jig *Outil de fixation de joint d'étanchéité* Einbau-Spannvorrichtung für Öldichtring	 S35C	 S35C	←	 S35C
16	Ball bearing fitting jig *Outil de fixation de roulement à billes* Einbau-Spannvorrichtung für Kugellager	 S35C	 S35C	←	 S35C

(mm)

Jig No.	Name *Nom* Name	KX41-2/S/V	KX61-2·71-2·91-2 **KX91-3/S/S2/α/α2, KX101-3/α/α2, U35S/S2, U35-3/α/α2, U35-3/S/S2**	KX121-2 **KX121-3/S/α/ST**	KX161-2 **KX161-3/S/α/ST**
17	Shaft S/A fitting jig *Outil de fixation S/A d'arbre* Einbau-Spannvorrichtung für S/A-Welle	 S35C	 S35C	←	
18	Snapring fitting jig *Outil de fixation de jonc d'arrêt* Einbau-Spannvorrichtung für Sicherungsring	 S35C	 S35C	←	←
19	Ball bearing fitting jig *Outil de montage du roulement à billes* Einbau-Spannvorrichtung für Kugellager	 S35C	 S35C	←	←
20	Swash plate fitting jig *Outil de fixation de plateau isolant* Einbau-Spannvorrichtung für Taumelscheibe			←	←

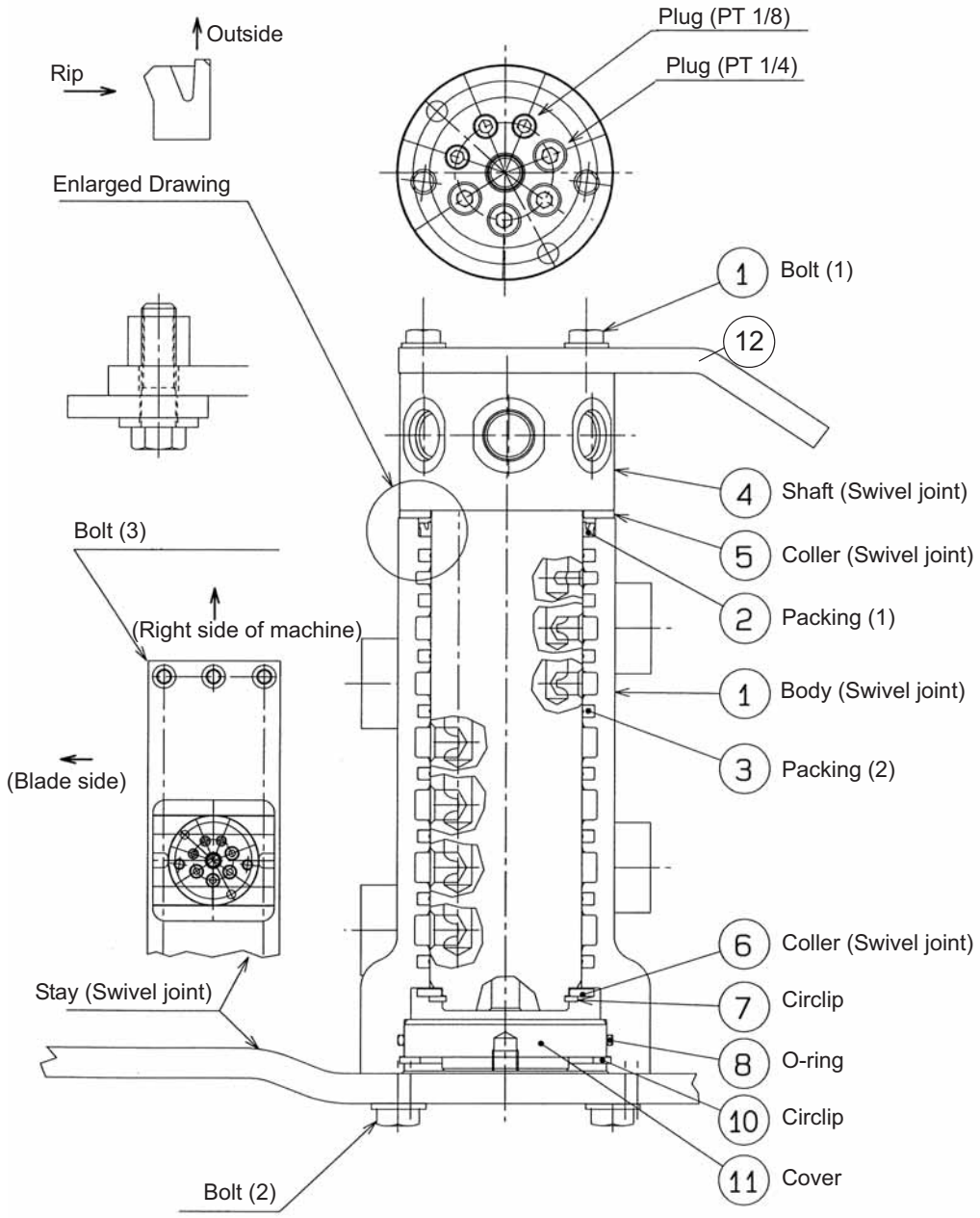
h) Rotary Joint

(1)Inner parts of the rotary joint



010	Assy joint, Swivel	070	Circlip, Internal	130	Stay
020	Gasket	080	O-ring	140	Bolt
030	Gasket	090	Cover	150	Bolt
040	Shaft, Swivel joint	100	Circlip, Internal	160	Stopper
050	Collar	110	Plug	170	Bolt
060	Collar	120	Plug	180	Washer, Spring

(2) Assembling of the rotary joint



1. Place the packing (1) with its lip in the arrow direction, as shown above. Apply grease over the inner and outer surfaces of the packing (1) beforehand.

A 2. Install the swivel joint body with shaft. Apply grease over the inner and outer surfaces of the packing (2) beforehand.

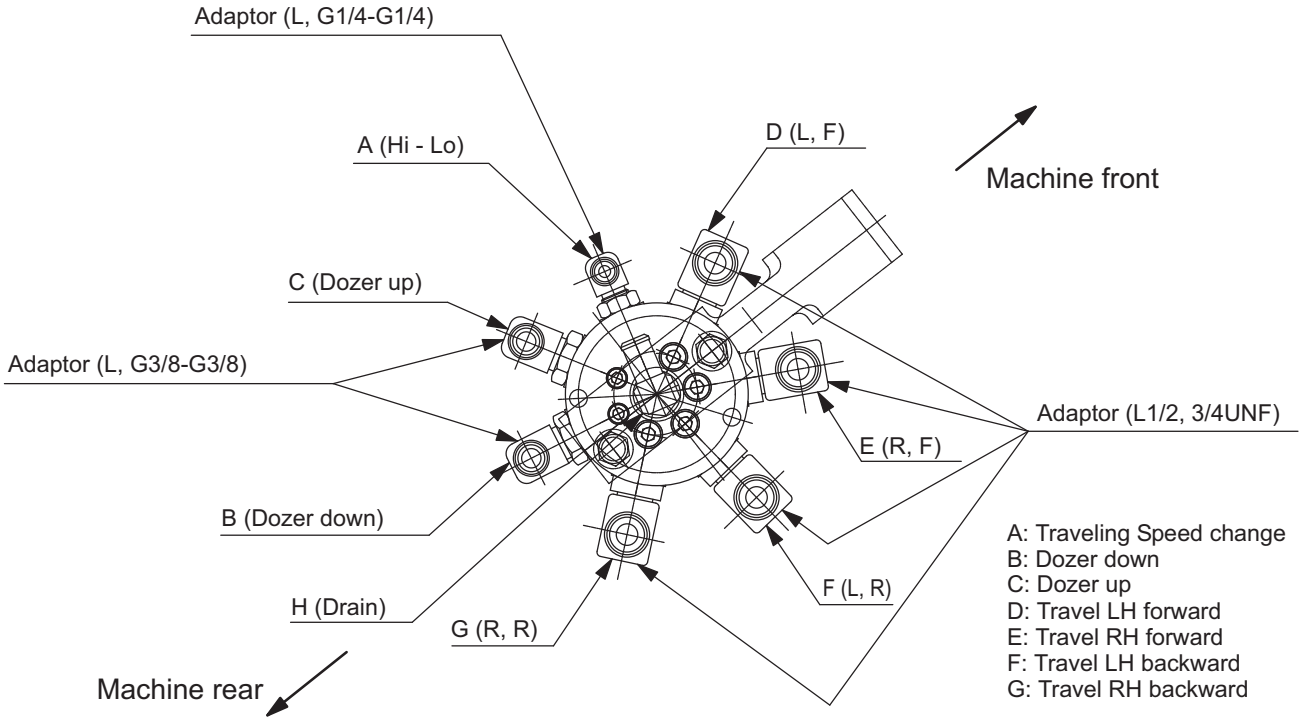
A 3. Install the stopper with the bent part downward. Apply screw adhesive (Three Bond #1324) to the bolt (1).

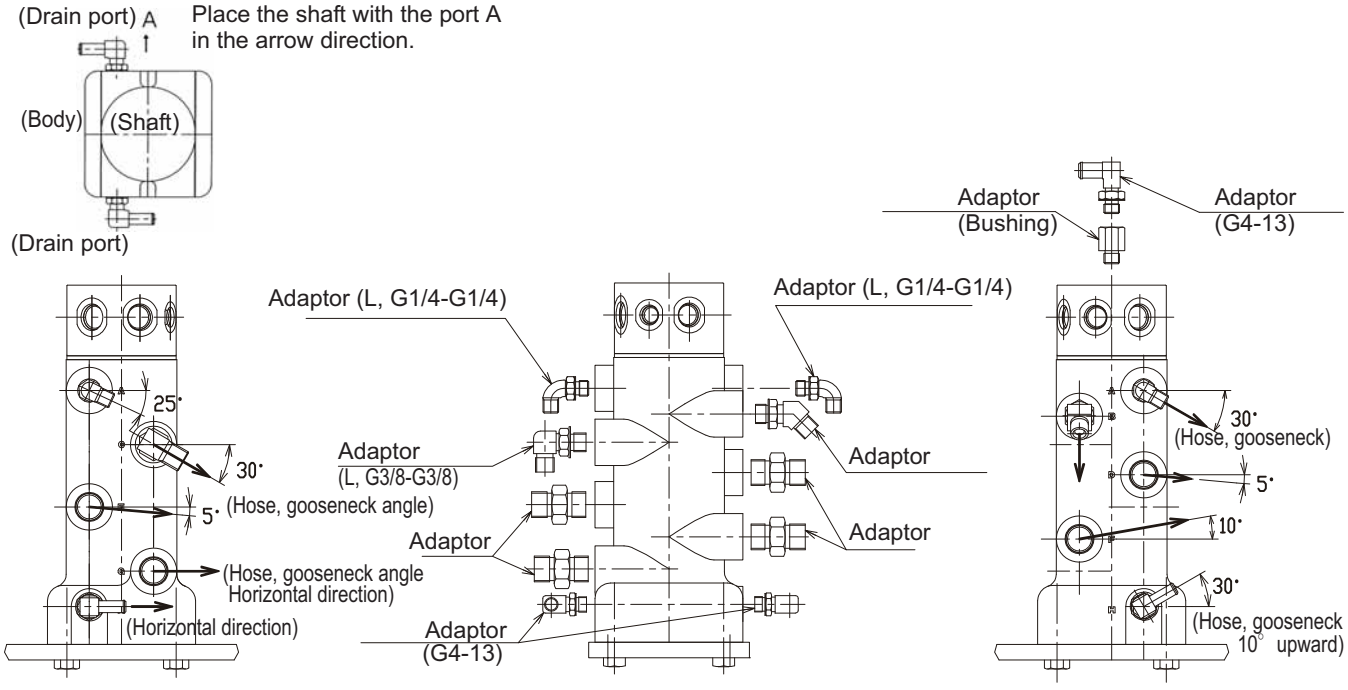
4. Install the stay onto the swivel joint assy. Apply screw adhesive (Three Bond #1324) to the bolt (2).
   Bolt tightening torque: 77.5 ~ 90.2 N·m
   (7.9 ~ 9.2 kg·m)
   57.2 ~ 66.5 ft·lbf

5. Install the stay to the track frame. Apply screw adhesive to the bolt (3). (Locktite 271)
   166.7 ~ 196.1 N·m
   (17.0 ~ 20.0 kg·m)
   123.0 ~ 144.6 ft·lbf

6. Install plugs, PT 1/8, PT 1/4 without protruding from the upper surface.

(3) Adaptor installation on the rotary joint





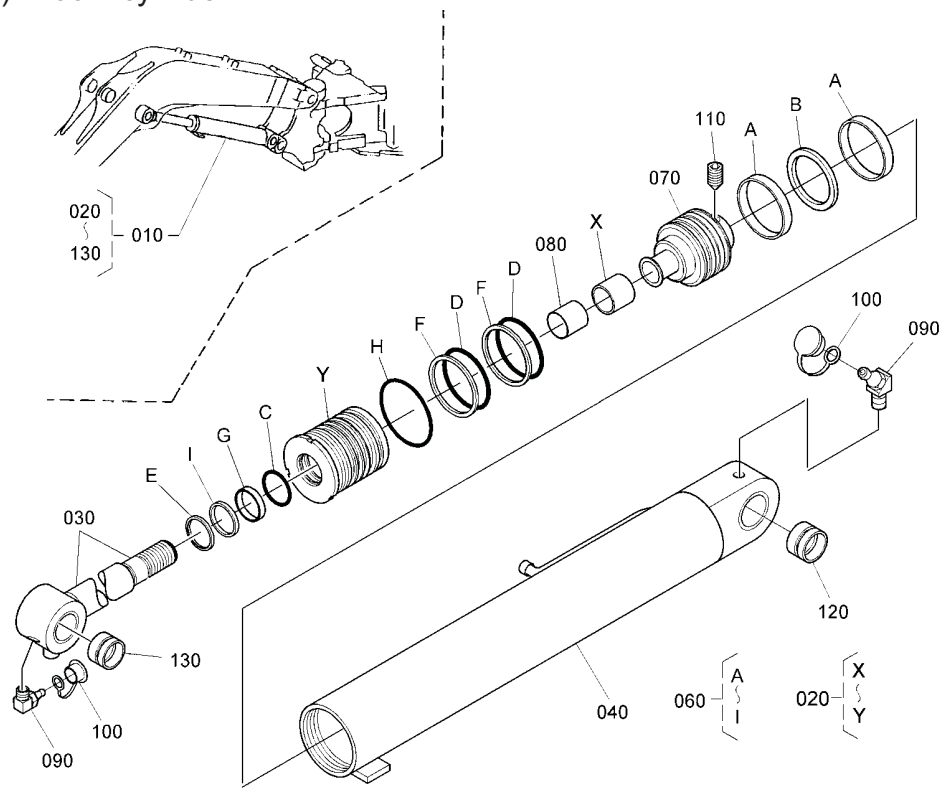
Note: The adaptors at the ports D, E, F and G are unified-threaded. Tighten these adaptors to the torque of 44.1 ~ 53.9 N·m (4.5 ~ 5.5 kgf·m) 32.5 ~ 39.8 ft·lbf.

Adapter's tightening torque: G1/4: 24.5 ~ 29.4 N·m (2.5 ~ 3.0 kgf·m) 18.1 ~ 21.7 ft·lbf
G3/8: 49.0 ~ 53.9 N·m (5.0 ~ 5.5 kgf·m) 36.2 ~ 39.8 ft·lbf
G1/2: 58.8 ~ 63.7 N·m (6.0 ~ 6.5 kgf·m) 43.4 ~ 47.0 ft·lbf

i) Cylinder (KE, KDG, KUK-version)

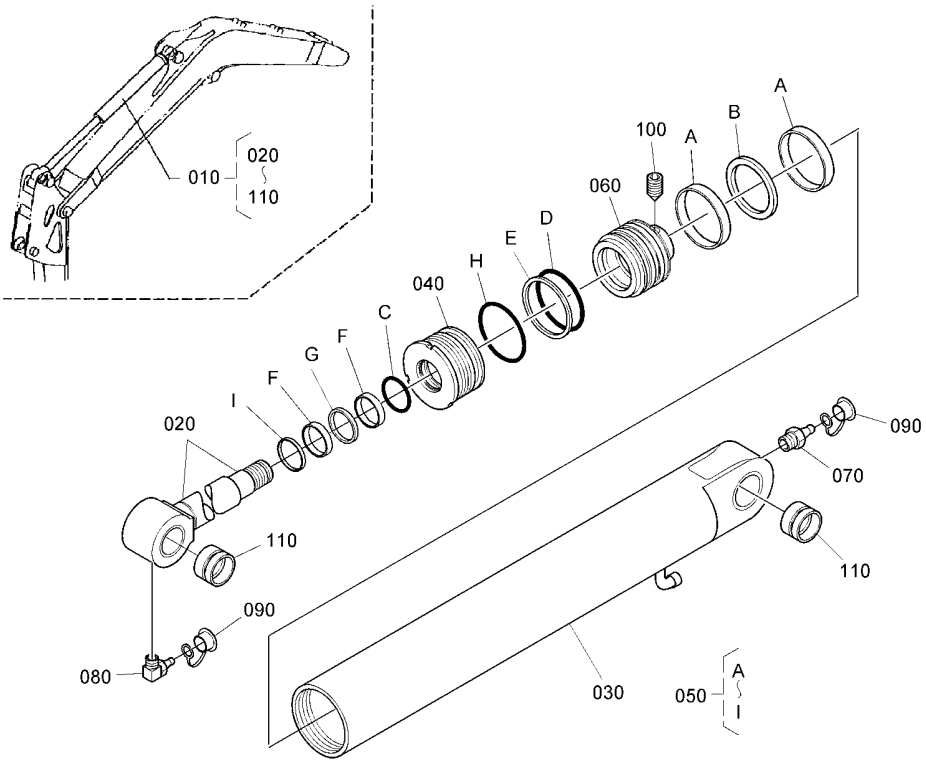
(1) Inner parts of the cylinder

1) Boom cylinder



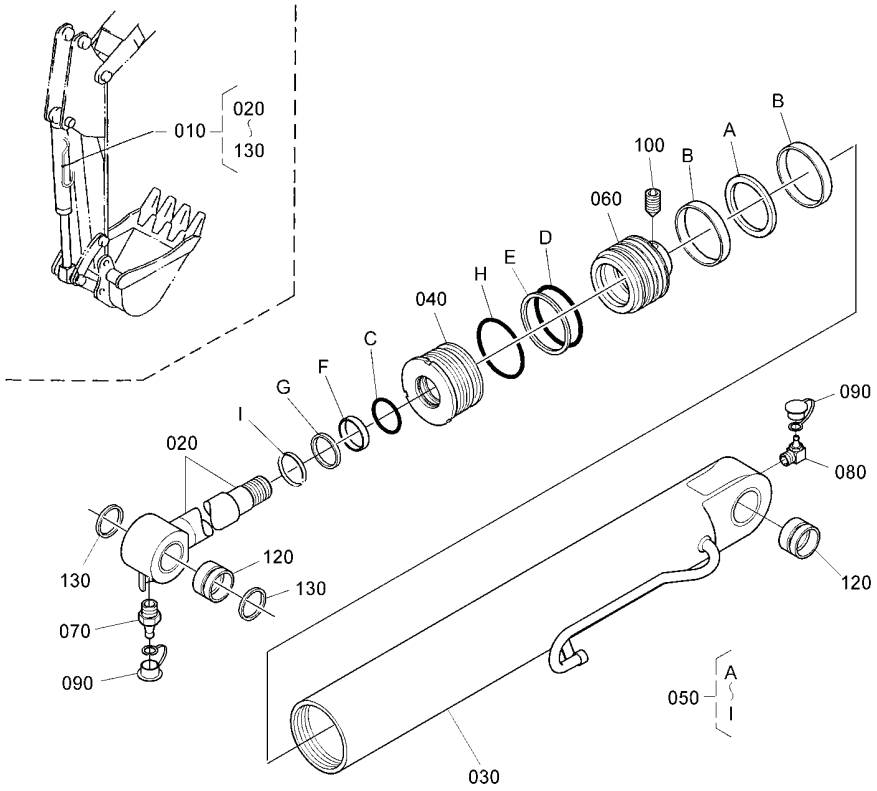
010	Assy cylinder, Boom
020	Kit, Cushion
030	Rod, Piston
040	Tube, Cylinder
050	-
060	Kit, Seal
070	Piston
080	Spacer
090	Grease Nipple
100	Plug
110	Screw, Set
120	Bush
130	Bush

2) Arm cylinder



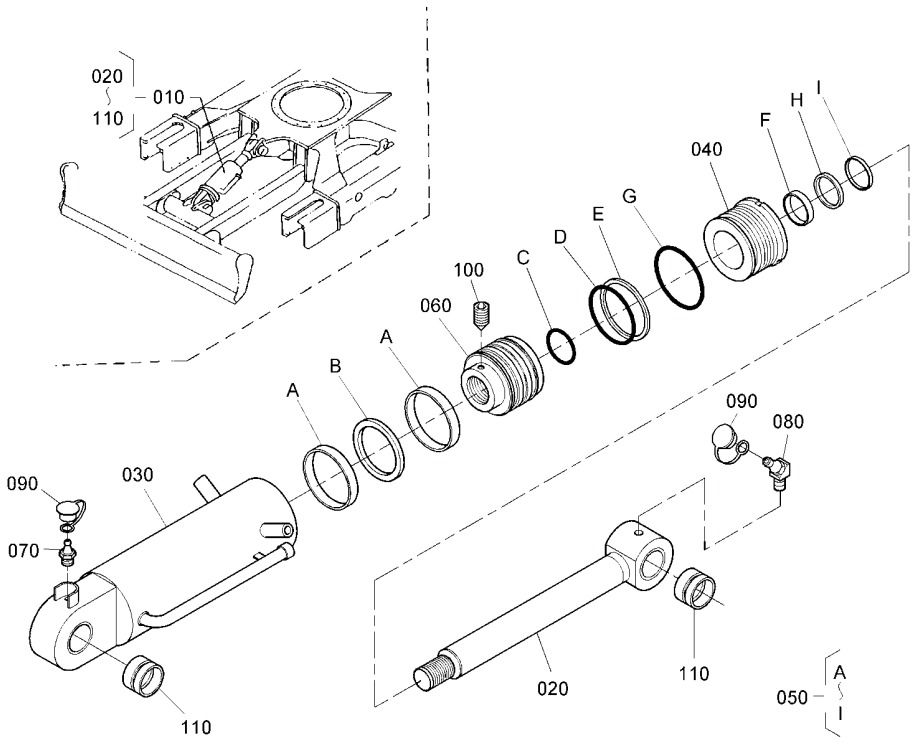
010	Assy cylinder, Arm
020	Rod, Piston
030	Tube, Cylinder
040	Cylinder head
050	Kit, Seal
060	Piston
070	Grease Nipple
080	Grease Nipple
090	Plug
100	Set, Screw
110	Bush

3) Bucket cylinder



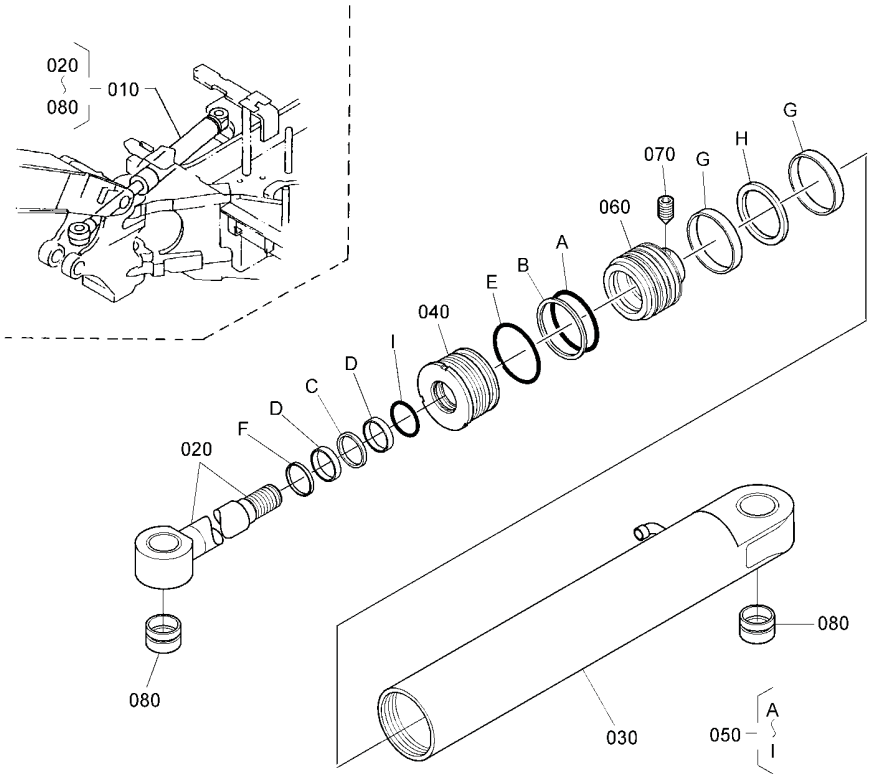
010 Assy cylinder, Bucket
020 Rod, Piston
030 Tube, Cylinder
040 Cylinder head
050 Kit, Seal
060 Piston
070 Grease Nipple
080 Grease Nipple
090 Plug
100 Set, Screw
110 -
120 Bush
130 Seal

4) Dozer cylinder



010 Assy cylinder, Dozer
020 Rod, Piston
030 Tube, Cylinder
040 Cylinder head
050 Kit, Seal
060 Piston
070 Grease Nipple
080 Grease Nipple
090 Plug
100 Set, Seal
110 Bush

5) Swing cylinder



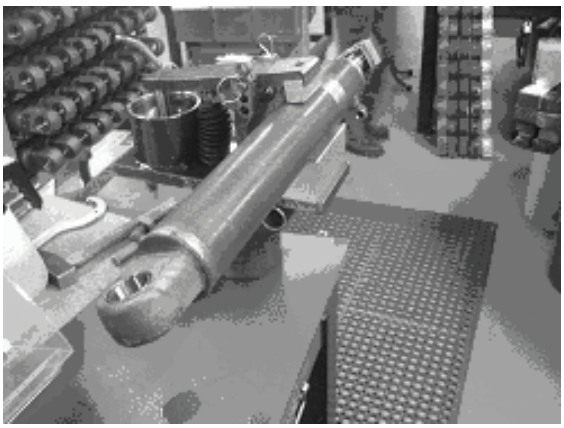
010 Assy cylinder, Swing
020 Rod, Piston
030 Tube, Cylinder
040 Cylinder head
050 Kit, Seal
060 Piston
070 Set, Screw
080 Bush

(2) Disassembling and assembling

1) Proceeding Disassembly and Reassembly of BOOM-Cylinders (EX. Boom Cylinder)

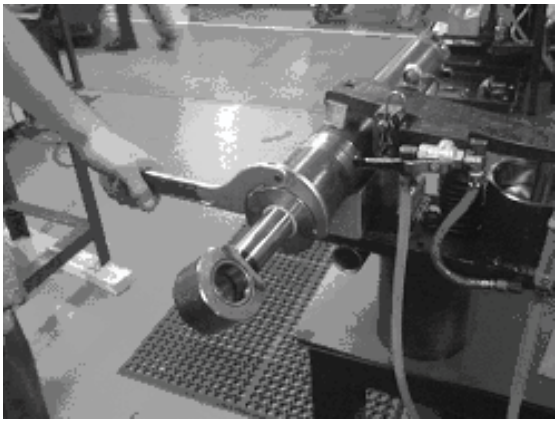
DISASSEMBLY

Place the cylinder into a vice fitted out with soft jaws. Clamp moderately to avoid deformations of the cylinder tube. Buckle out the collar of the notch and unscrew the cylinder head (mark16) with the help of a hook wrench. When the cylinder head is mounted with glue (never on first mounting) and difficult to unscrew, you have to warm up the cylinder head about 250°C. Prefer a pistol pipe oven instead of a blowpipe. Unscrew completely the cylinder head and take out carefully the kit cylinder rod.



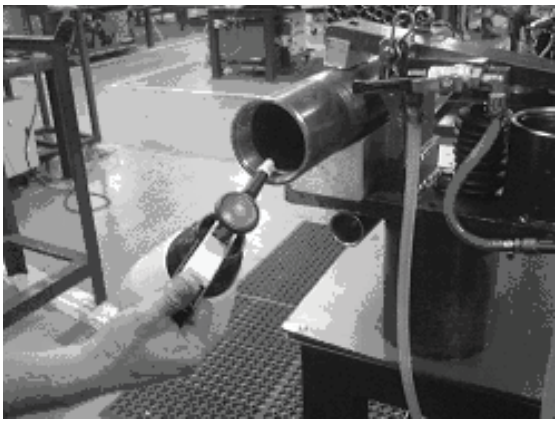
CONTROL

Make a visual control of the whole cylinder. Degrease and clean up the inside of the cylinder tube. Be sure that the inside is free of technical pollution like oxydation or stripes.



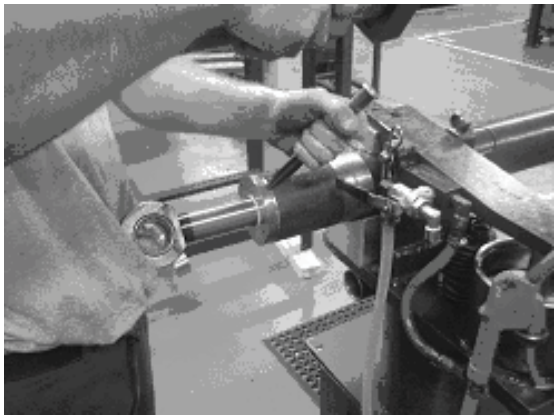
REASSEMBLY

Apply hydraulic oil on the piston seals with a paint brush. Move the kit cylinder rod 2/3 of his length into the cylinder tube (mark 9). ← Assure a well alignment to the axe of the cylinder tube.
Apply hydraulic oil on cylinder head seals and engage the cylinder head. ← Be sure that the seals are not degraded when you engage the cylinder head into the locked zone.
Block it up with the tightening torque mentioned on drawing.
Save the cylinder head by buckling the collar in one notch.
Enter the whole rod to abutment.



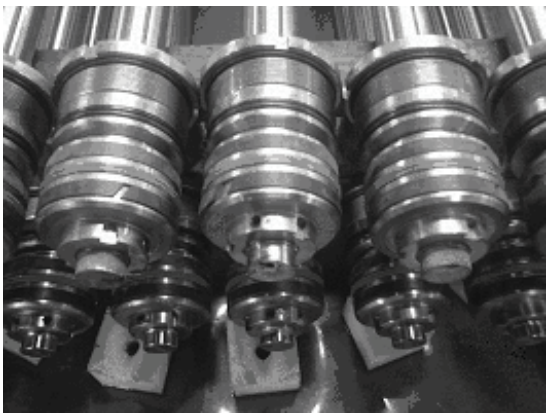
PRECAUTIONS

- Use only non-aggressive solvents like AXETHANE 212, cold degreaser.
- Try to protect all openings and components when not in use.
- If possible, test the cylinder before mounting on machine.



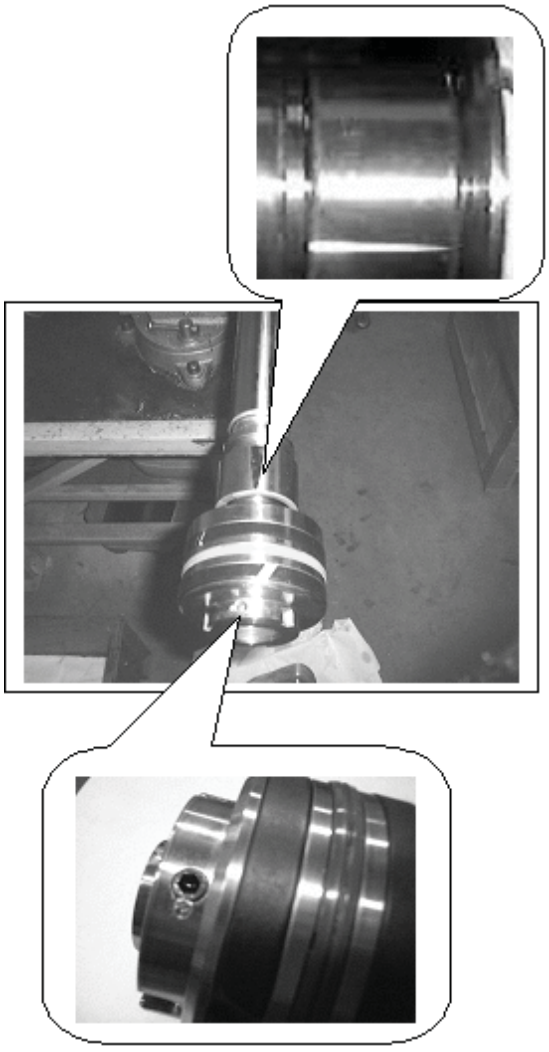
2) Proceeding Disassembly Reassembly Kit Boom-Cylinder Rod (EX. Boom Cylinder)

DISASSEMBLY



Place the kit cylinder rod into a vice fitted out with soft jaws to protect the surface and to avoid turnability. Remove the locking screw (mark 1) and unscrew completely the piston (mark 2) with the help of a hook wrench. Remove the piston seals (mark 3/4/5). Pay attention to the grooves and chamfers. Remove the distance tube (mark 7) and the damping ring (mark 6). Remove the cylinder head (mark 16) ring from the back to avoid seals' damaging. Remove the seals from the cylinder head (mark 10/12/13/14/15).

CONTROL



Degrease and clean up piston and cylinder head. Grooves, chamfers and fronts must be without damages. Be sure that there are no coarse dust particles in the grooves and insides. Control every seal and change if necessary. Control the surface evenness with the help of a comparator. Check the absence of mechanical spalling and pollution.

REASSEMBLY

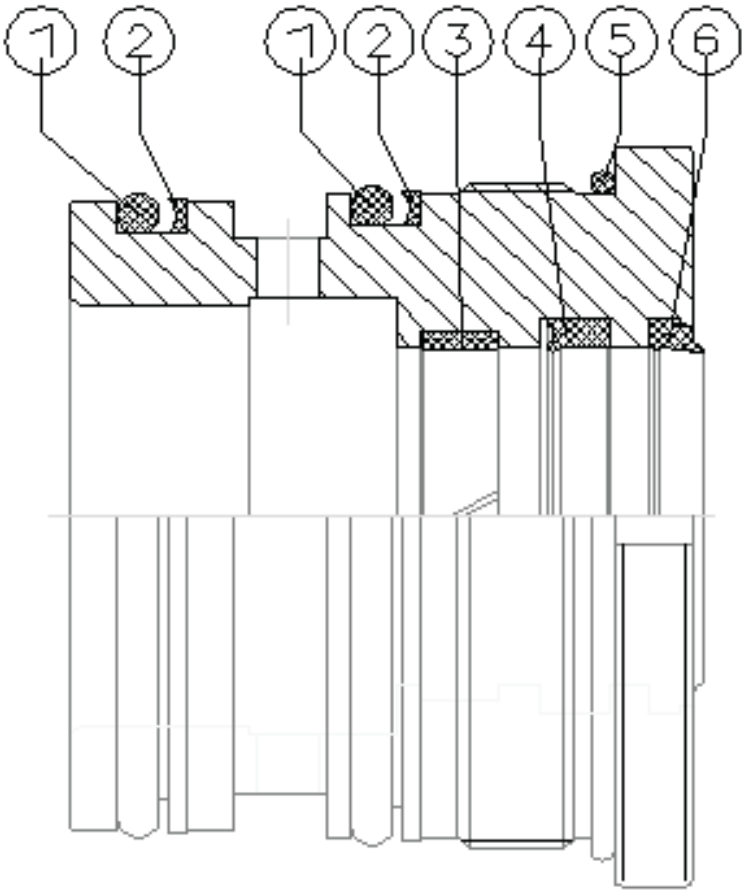
Grease all internal seals with hydraulic oil. The cylinder head must be mounted from the back to the cylinder rod. Assemble the piston on the cylinder rod. Use the tightening torque mentioned on drawing. Place the locking screw (mark 1) with one drop of glue and give a blow of the tap next (2 mm) to the entree of the internal screw thread to lock.

3) SEALS ASSEMBLING OF THE CYLINDER HEAD WITH CUSHIONNING

Make a visual check up of the cleanless of the cylinder head.
Control the absence of stripes, flashes and check the slickness of the grooves.
Included coarse dust particles must be eliminated.

Mount the cylinder head seals like shown in the following scheme:

Mark 1 → O-ring placed manually or with a tool without sharp edges.
Mark 2 → Anti extrusion ring placed manually or with a tool without sharp edges.
Mark 3 → Bearing mounted manually.
Mark 4 → Piston rod seal mounted manually or with a special pliers (3-fingers).
Mark 5 → O-ring placed manually or with a tool without sharp edges.
Mark 6 → Mud scraper ring mounted with a press.



Attention

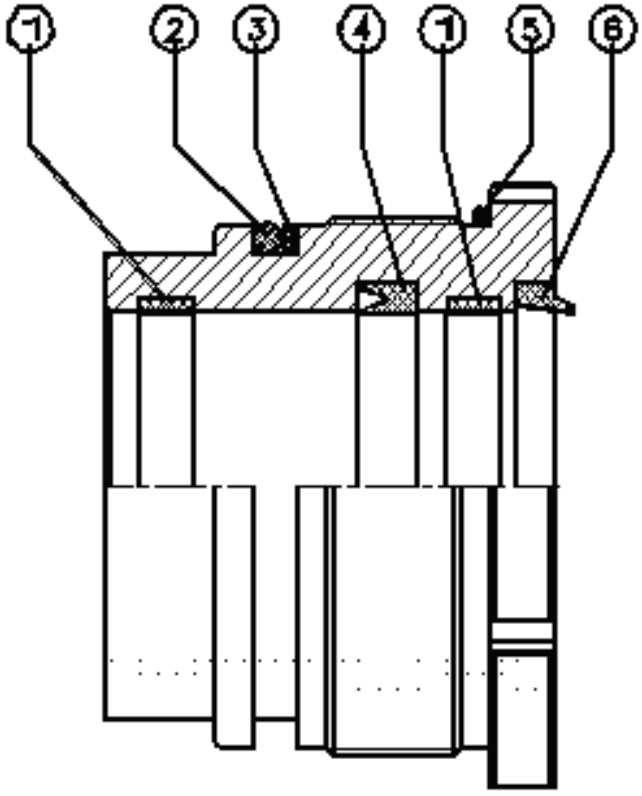
→ The hollow side of the anti-extrusion ring (2) must be directed to the O-ring.
→ The sealing lips of the piston rod seal (4) must be directed to the pressure.

4) SEALS ASSEMBLING OF THE CLINDER HEAD WITHOUT CUSHIONNINIG

Make a visual check up of the cleanless of the cylinder head.
Control the absence of stripes, flashes and check the slickness of the grooves.
Included coarse dust particles must be eliminated.

Mount the cylinder head seals like shown in the following scheme:

Mark 1 → Bearing mounted manually.
Mark 2 → O-ring placed manually or with a tool without sharp edges.
Mark 3 → Anti extrusion ring placed manually or with a tool without sharp edges
Mark 4 → Piston rod seal mounted manually or with a special pliers (3-fingers).
Mark 5 → O-ring placed manually or with a tool without sharp edges.
Mark 6 → Mud scraper ring mounted with a press.



Attention

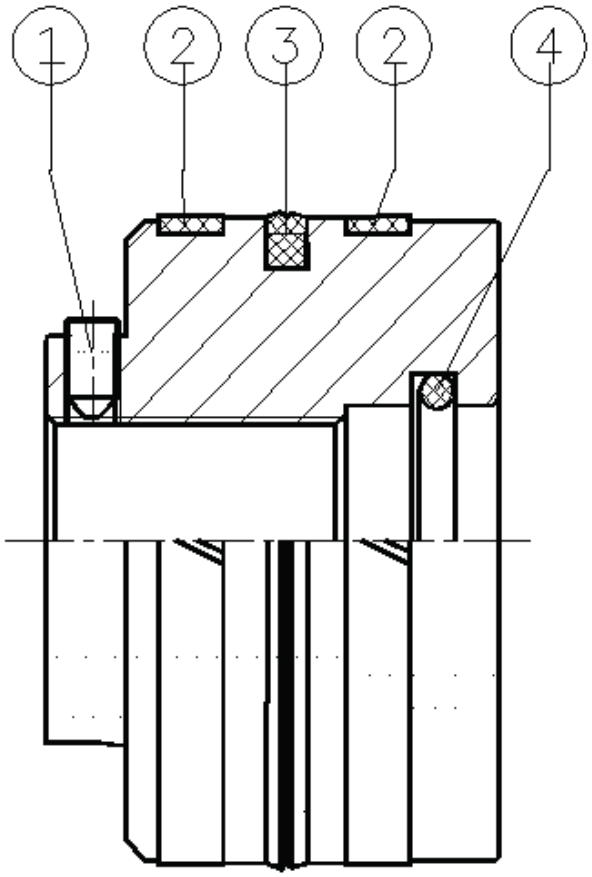
→ The hollow side of the anti-extrusion ring (3) must be directed to the O-ring.
→ The sealing lips of the piston rod seal (4) must be directed to the pressure.

5) SEALS ASSEMBLING OF THE PISTON

Make a visual check up of the cleanless of the piston.
Control the absence of stripes, flashes and check the slickness of the grooves.
Included coarse dust particles must be eliminated.

Mount the cover ring seals like shown in the following scheme.

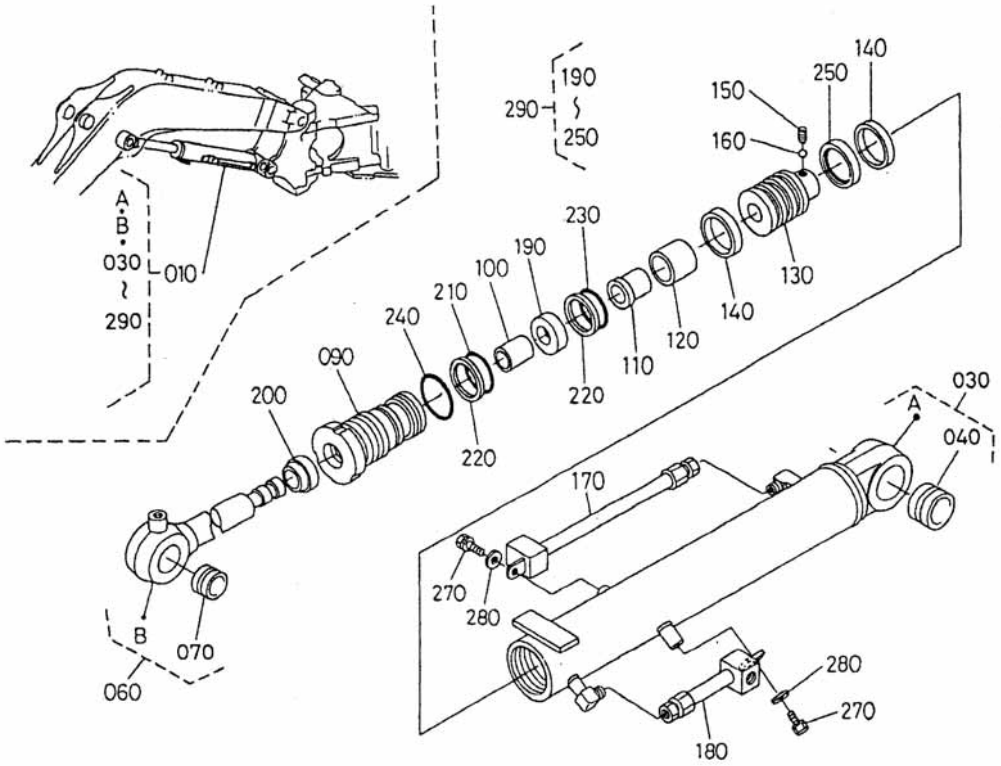
Mark 1 → Locking screw mounted with a drop of "Locktite".
Mark 2 → Piston rings mounted manually.
Mark 3 → Piston seal mounted with a tool free of sharp edges.
Mark 4 → O-ring placed with a tool free of sharp edges or manually.



j) Cylinder (KTC, KCL, KTA-version)

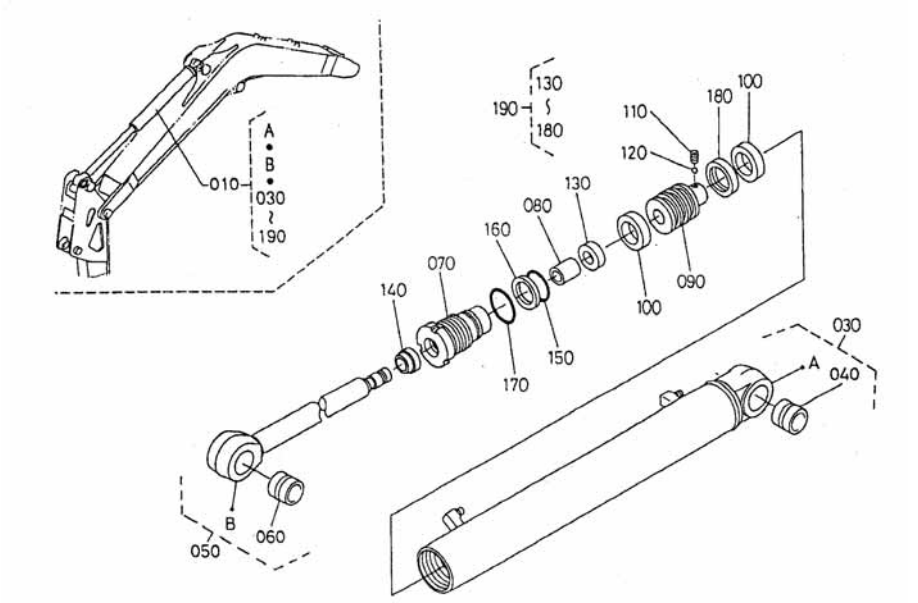
(1) Inner parts of the cylinder

1) Boom cylinder



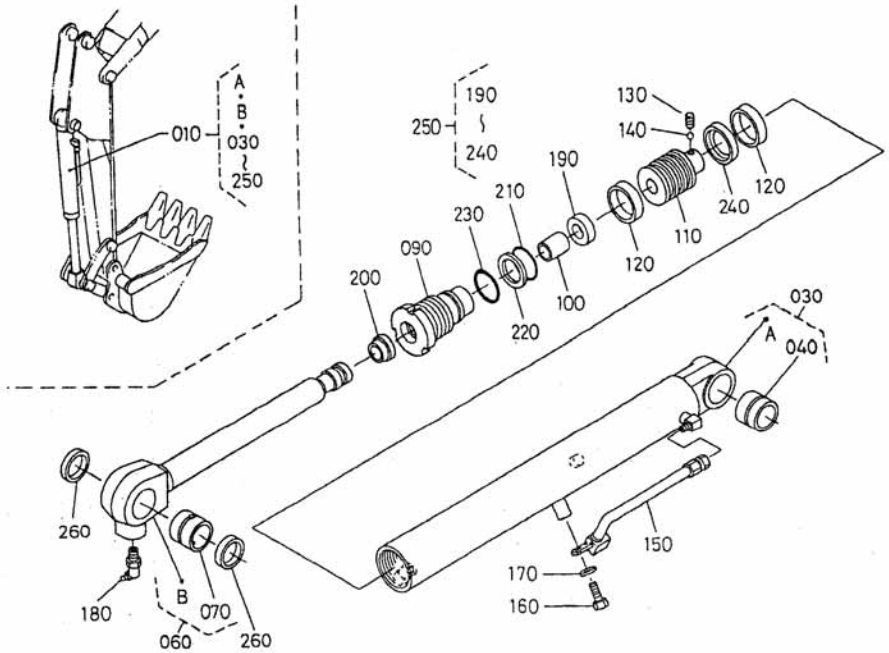
010	Assy cylinder, Boom	110	Spacer	210	O-ring
020	Blank	120	Bearing, Cushion	220	Ring, Backup
030	Assy tube, Cylinder	130	Piston	230	O-ring
040	Bush	140	Ring, Slide	240	O-ring
050	Blank	150	Screw, Set	250	Assy ring, Seal
060	Assy rod, Piston	160	Ball	260	Blank
070	Bush, Pin	170	Pipe	270	Bolt
080	Blank	180	Pipe	280	Washer, Plain
090	Cylinder head	190	U-ring	290	Kit seal
100	Bush	200	Ring, Wiper		

2) Arm cylinder



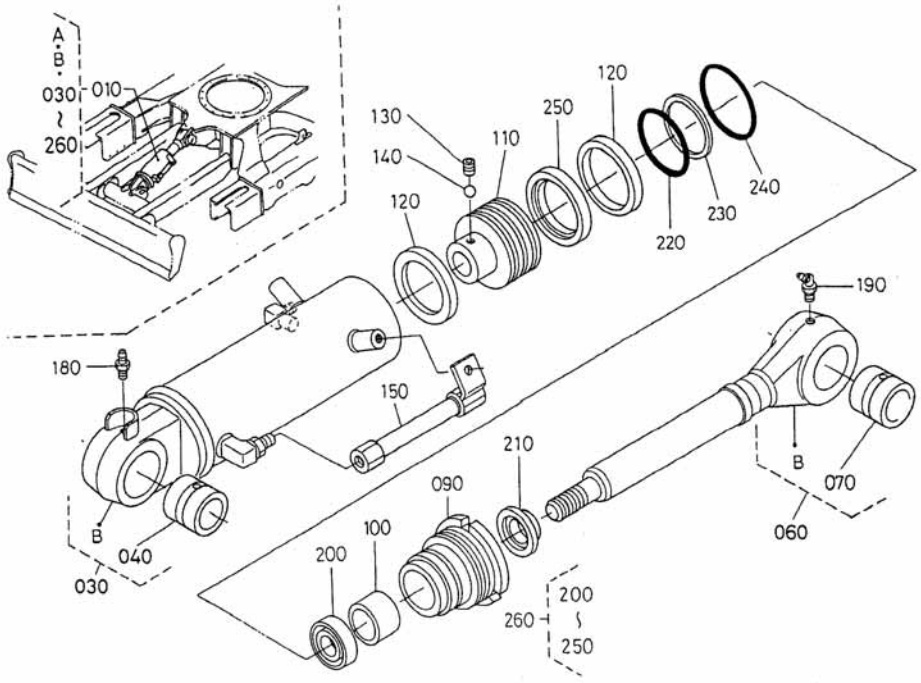
010	Assy cylinder, Arm
020	Blank
030	Assy tube, Cylinder
040	Bush
050	Assy rod, Piston
060	Bush
070	Cylinder head
080	Bush
090	Piston
100	Ring, Slide
110	Screw, Set
120	Ball
130	U-ring
140	Ring, Wiper
150	O-ring
160	Ring, Backup
170	O-ring
180	Assy ring, Seal
190	Kit seal, Bucket

3) Bucket cylinder



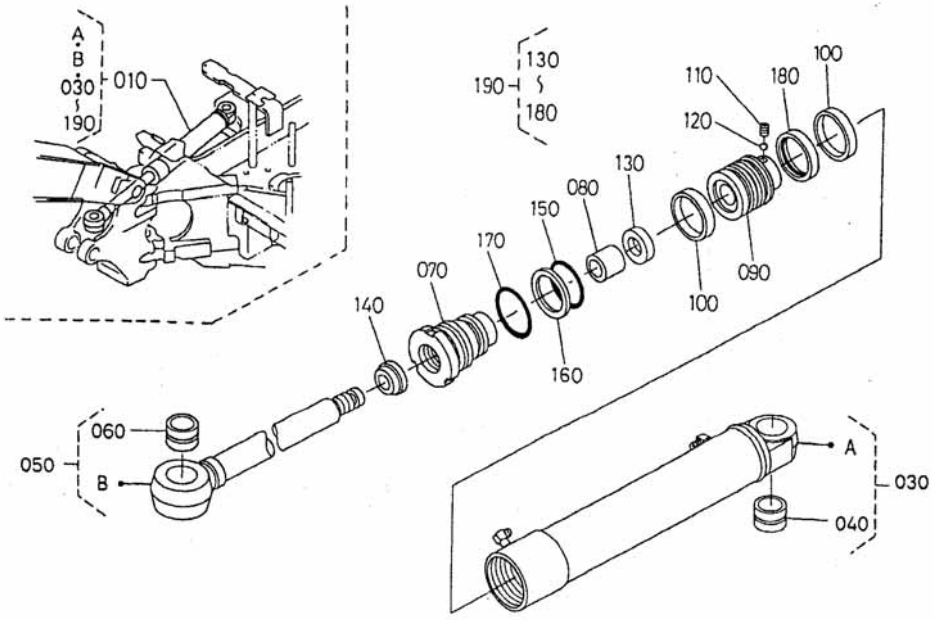
010	Assy cylinder, Bucket
020	Blank
030	Assy tube, Cylinder
040	Bush, Pin
050	Blank
060	Assy rod, Piston
070	Bush, Pin
080	Blank
090	Cylinder head
100	Bush
110	Piston
120	Ring, Slide
130	Screw, Set
140	Ball
150	Pipe
160	Bolt
170	Washer, Plain
180	Nipple, Grease
190	U-ring
200	Ring, Wiper
210	O-ring
220	Ring, Backup
230	O-ring
240	Assy ring, Seal
250	Kit seal
260	Seal, Dust

4) Dozer cylinder



010	Assy cylinder, Blade
020	Blank
030	Assy tube, Cylinder
040	Bush, Pin
050	Blank
060	Assy rod, Piston
070	Bush, Pin
080	Blank
090	Cylinder head
100	Bush
110	Piston
120	Ring, Slide
130	Screw, Set
140	Ball
150	Pipe
180	Nipple, Grease
190	Nipple, Grease
200	U-ring
210	Ring, Wiper
220	O-ring
230	Ring, Backup
240	O-ring
250	Assy ring, Seal
260	Kit seal

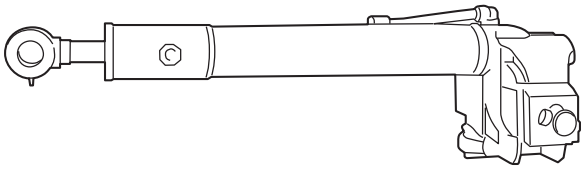
5) Swing cylinder



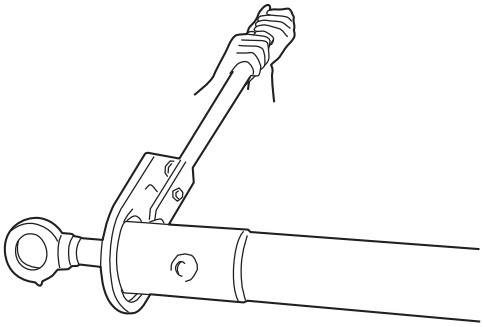
010	Assy cylinder, Swing
020	Blank
030	Assy tube, Cylinder
040	Bush, Pin
050	Assy rod, Piston
060	Bush, Pin
070	Cylinder head
080	Bush
090	Piston
100	Ring, Slide
110	Screw, Set
120	Ball
130	U-ring
140	Ring, Wiper
150	O-ring
160	Ring, Backup
170	O-ring
180	Assy ring, Seal
190	Kit, Cylinder repair

(2) Disassembling and assembling

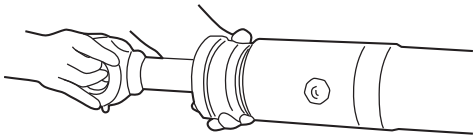
1) Disassembling



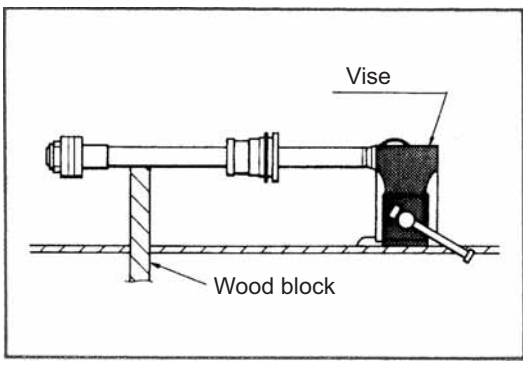
1. Place the cylinder on a vise.
2. Let hydraulic oil out of the cylinder.



3. Straighten the lock washer.
4. Unscrew and remove the cylinder head.
 * If the cylinder head is hard to unscrew, employ the head wrench.

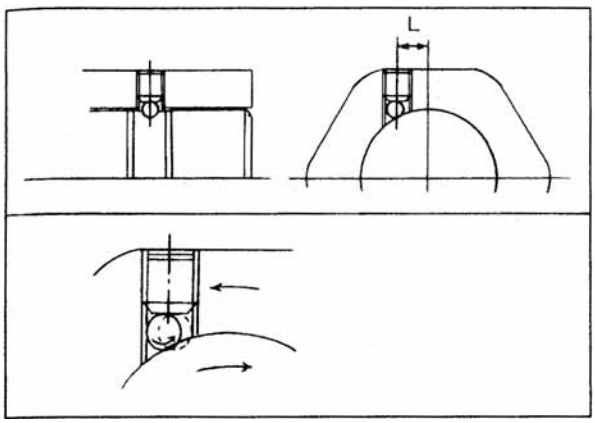


5. Draw out the piston rod together with the cylinder head.
 *If the pipe ports are open, place an oil pan below the port at the retracting-side cylinder head.

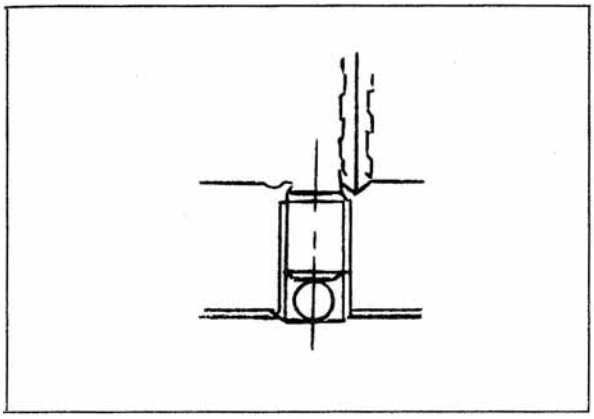


6.Fix the piston rod in the vise.

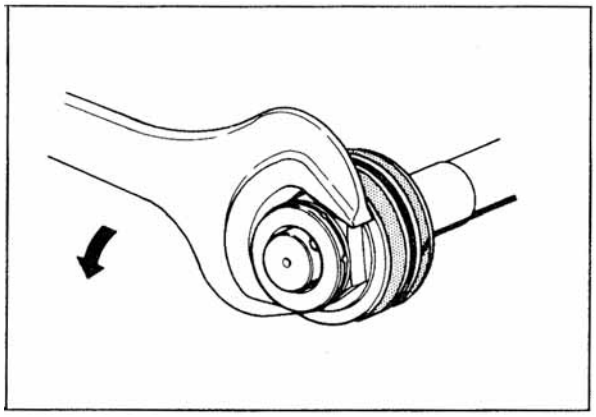
Place a wood block under the rod.



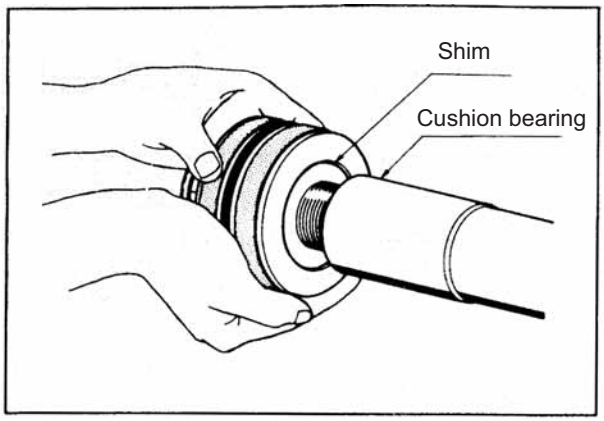
* Anti-rotation measure with steel ball
- Place a steel ball in the position the distance "L" away from the axial center of the nut (rod) and tighten the setscrew. (Fig. 1)
- When the screw gets loose and the nut (rod) starts turning, the ball also rotates and bites to the narrower side of the taper. (Fig. 2)
- Now the steel ball's biting resistance works for keeping the nut from turning.



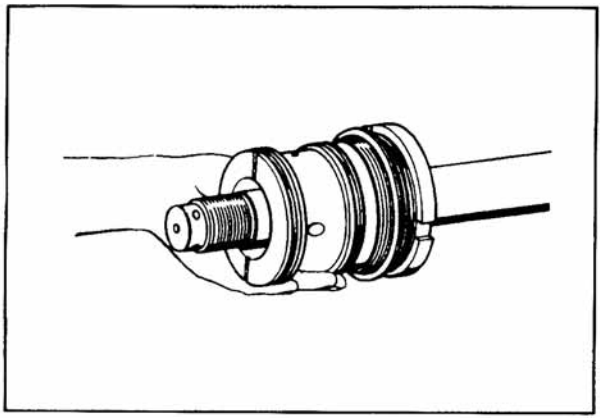
7. Remove the setscrew.
- The setscrew has been crimped at two points using a punch. Scrape the punched spots using a hand drill, loosen the setscrew and take out the steel ball.



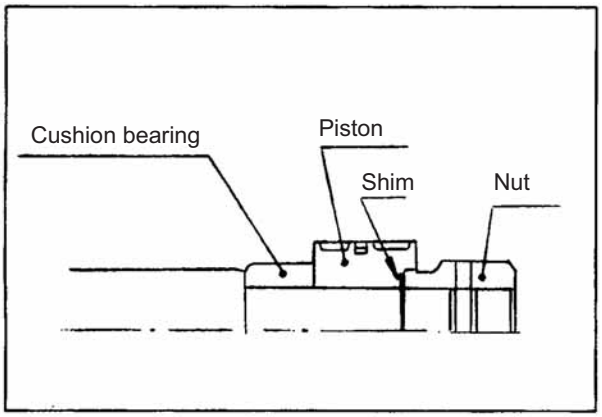
8. Apply a wrench to the hex nut of the piston. Loosen the nut.



9. Draw out the piston and remove the shim
10. Remove the cushion bearing.



11. Draw out the cylinder head.
12. Release the piston rod from the vise.



2) Assembling

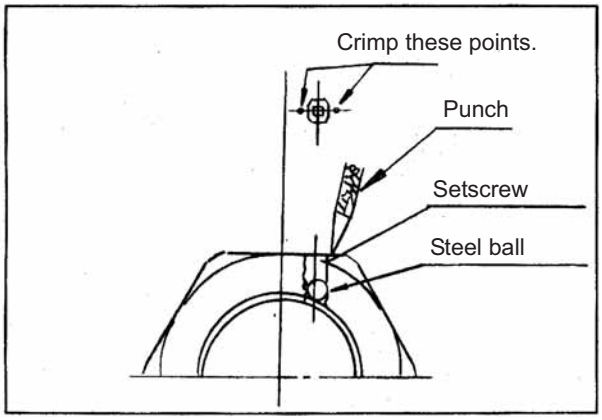
1.Fix the piston rod.

2.Fit the cylinder head into position.

- Be careful not to get the lips of the wiper ring and U ring caught by the step.

3. Install the spacer, cushion bearing and shim in their positions. Fit the piston back into place and tighten the nut.

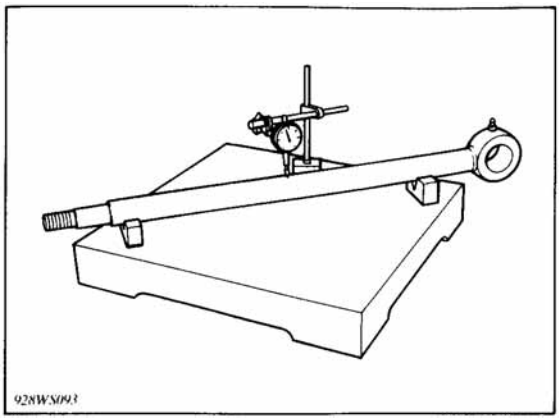
Tightening torque: 853 N·m (87 kgf·m) 629 ft·lbs



4. Put the steel ball, tighten the setscrew, and crimp its two outer points with the punch.

Tightening torque: 16.2 N·m (1.65 kgf·m)11.9 ft·lbs

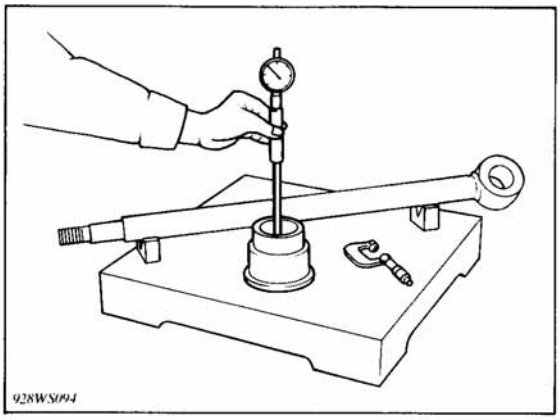
(3) Inspection



1) Piston rod warp

1. Mount the piston rod on a V-block.
2. Set a dial indicator at the center of the rod.
3. Rotate the piston rod and read the indicator. Warp is one-half of the difference between the maximum and the minimum readings.
4. If the valve exceeds the allowable limit, replace the piston rod.

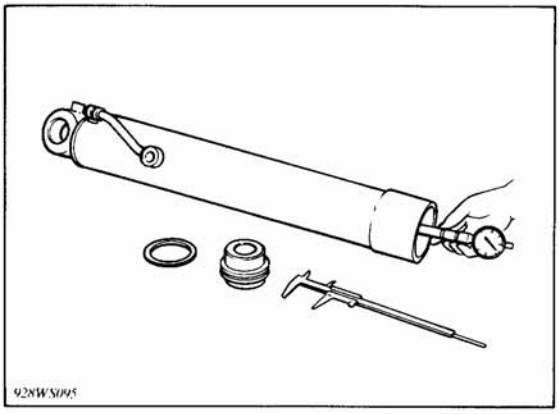
•Reference valuewarp within 0.05 mm (0.002 in.)
•Allowable valuewarp within 0.5 mm (0.0197 in.)



2) Clearance between piston rod and bushing

1. Measure the piston rod O.D. and cylinder head bushing I.D. and determine the clearance.

	Rod size	Clearance
Reference value	ϕ25 to ϕ40 mm	less than 0.25 mm
	ϕ45 to ϕ75 mm	less than 0.30 mm
Allowable limit	ϕ25 to ϕ40 mm	0.4 mm
	ϕ45 to ϕ75 mm	0.5 mm
Reference value	ϕ0.9843 to 1.5748 in	less than 0.010 in
	ϕ1.7717 to 2.9528 in	less than 0.012 in
Allowable limit	ϕ0.9843 to 1.5748 in	0.0158 in
	ϕ1.7717 to 2.9528 in	0.0197 in



3) Clearance between cylinder tube I.D. and Piston ring O.D.

1. Measure the cylinder tube I.D.
2. Calculate the piston ring thickness plus piston ring groove O.D. determine the clearance.

	Rod size	Clearance
Reference value	less than ϕ60 mm	0.05 to 0.30 mm
	ϕ65 to ϕ115 mm	0.05 to 0.35 mm
	more than ϕ120 mm	0.05 to 0.40 mm
Allowable limit	less than ϕ60 mm	0.60 mm
	ϕ65 to ϕ115 mm	0.70 mm
	more than ϕ120 mm	0.80 mm
Reference value	ϕ2.3622 in less	0.0020 to 0.0118 in
	ϕ2.5590 to 4.5276 in	0.0020 to 0.0138 in
	ϕ4.7244 in more	0.0020 to 0.0157 in
Allowable limit	ϕ0.9843 to 1.5748 in	0.0236 in
	ϕ1.7717 to 2.9528 in	0.0276 in
	ϕ4.7244 in more	0.0315 in

k) Proportional Solenoid Valve

(1) Fitting direction of the hydraulic adapters
Fit the adapters as shown at left.

<Failure case>
Contact with hoses and other parts
↓
Rubbing and oil leak

(2) Tightening torque of the hydraulic adapters (For all G1/4)
25.0 ~ 30.0 N·m (2.5 ~ 3.0 kgf·m) 18.1 ~ 21.7 ft·lbs

<Failure case>
Insufficient tightness
↓
Come-off

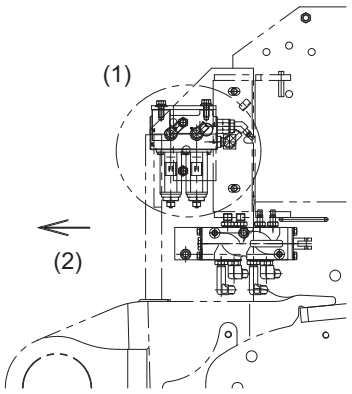
Over-tightness
↓
Damage

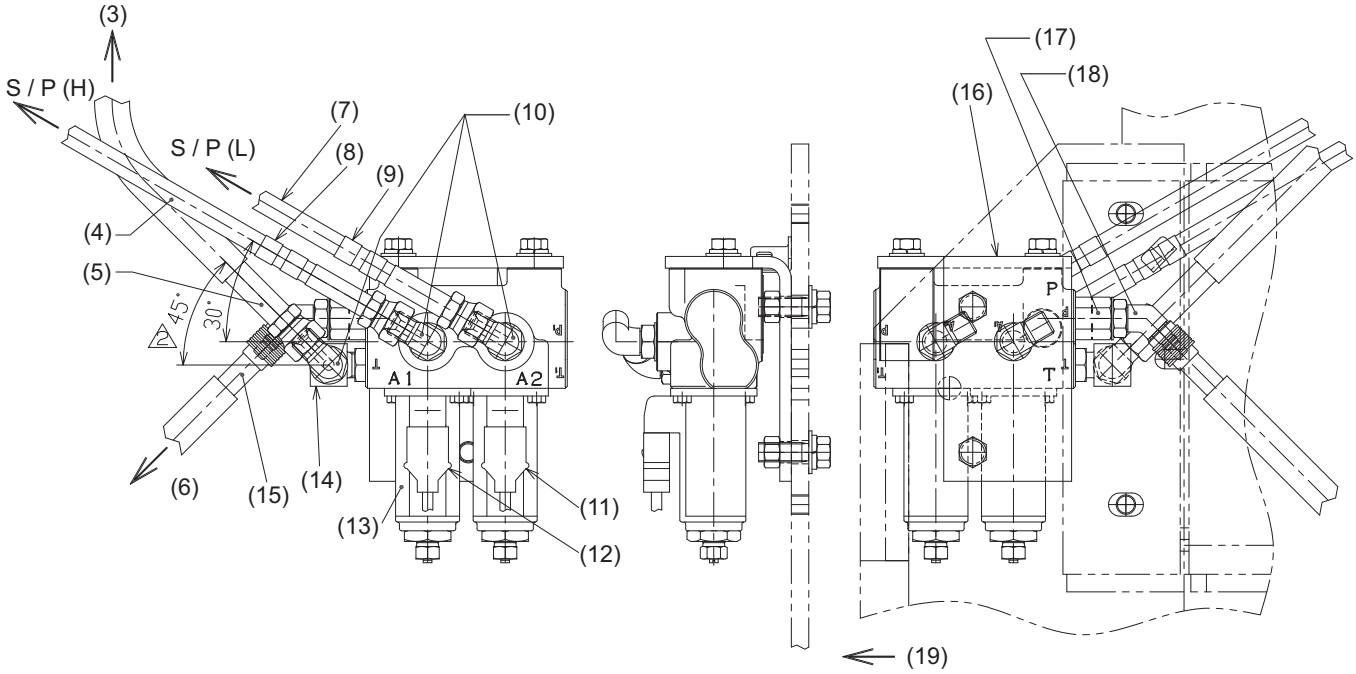
KX121-3S/ST

No.	KX121-3S hose part code	Color	Location	Hose route
1	RD138-6288Δ	Orange	(A1)	SP solenoid (A1) ~ Control valve S/P (H)
2	RD138-6289Δ	Yellowish green	(A2)	SP solenoid (A2) ~ Control valve S/P (L)
3	RD148-6287Δ	-	(T)	SP solenoid (T) ~ Hydraulic oil tank285
4	RD138-6286Δ	White	(P)	SP solenoid (P) ~ Swivel motor450

KX161-3S/ST

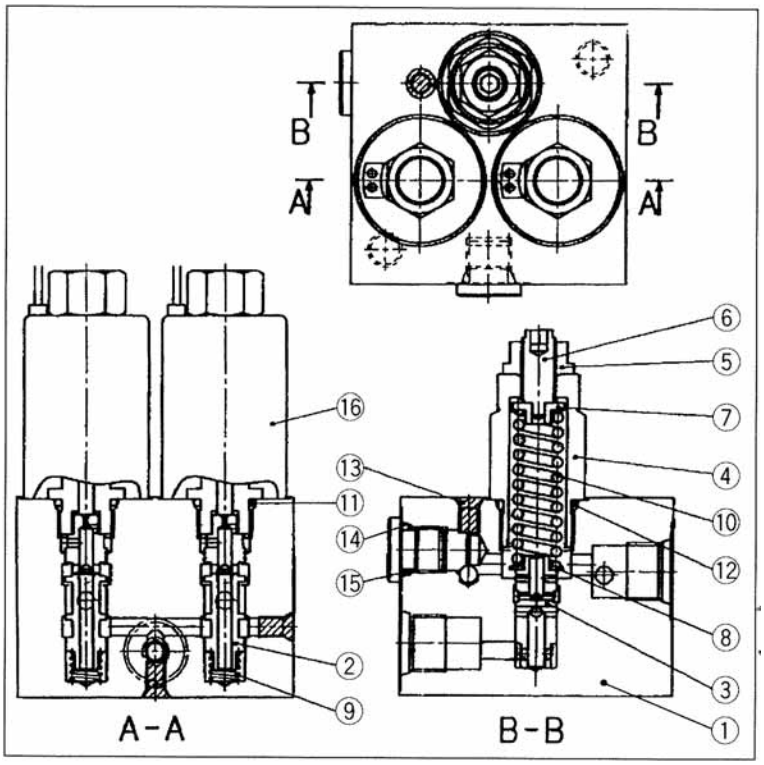
No.	KX161-3S hose part code	Color	Location	Hose route
1	RD538-6288Δ	Orange	(A1)	SP solenoid (A1) ~ Control valve S/P (H)
2	RD538-6289Δ	Yellowish green	(A2)	SP solenoid (A2) ~ Control valve S/P (L)
3	RD148-6287Δ	-	(T)	SP solenoid (T) ~ Hydraulic oil tank285
4	RD538-6286Δ	White	(P)	SP solenoid (P) ~ Swivel motor450





(1) SP proportional valve location
(2) Machine front
(3) To tank
(4) Hydraulic hose (1/4, SLA-SPH) RD138-6288Δ
(5) Hydraulic hose (1/4, SLT-T) RD148-6287Δ
(6) To swivel motor
(7) Hydraulic hose (1/4, SLB-SPL) RD138-6289Δ
(8) Orange tape, 2 winds
(9) Yellowish green tape, 2 winds
(10) Pipe joint (L, G1/4-G1/4) RB411-6376Δ
(11) Red
(12) Blue
(13) Valve assembly (proportional) RC467-6137Δ 01125-60820 Bolt
(14) Pipe joint (L, G1/4-G1/4) RP402-6192Δ
(15) Hydraulic hose (1/4, SM-SLP) RD138-6286Δ
(16) Bracket (proportional valve) RD148-6131Δ 01135-61030 Bolt
(17) Filter 68499-8374Δ
(18) Pipe joint (To Q, G1/4-8.4) RP821-6198Δ
(19) Machine front

I) Other Hydraulic Device

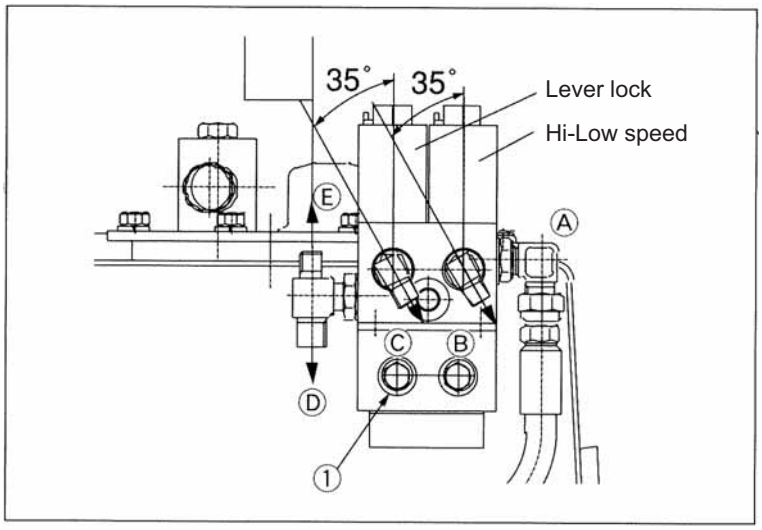


(1) Change valve

1) Part list

(1)	Body	(9)	Spring
(2)	Spool	(10)	Spring
(3)	Spool	(11)	O-ring
(4)	Guide	(12)	O-ring
(5)	Nut	(13)	Plug
(6)	Adjusting screw	(14)	O-ring
(7)	Spring seat	(15)	Plug
(8)	Spring seat	(16)	Solenoid

Solenoid coil resistance: 12.0 ~ 12.5 Ω



2) Assembling step

1.Tightening torque, plug (15):
31 ~ 41 N·m (3.2 ~ 4.2 kgf·m) 23.2 ~ 30.4 ft·lbs

2.Tightening torque, guide (4):
74 ~ 88 N·m (7.6 ~ 9.0 kgf·m) 55.0 ~ 65.1 ft·lbs

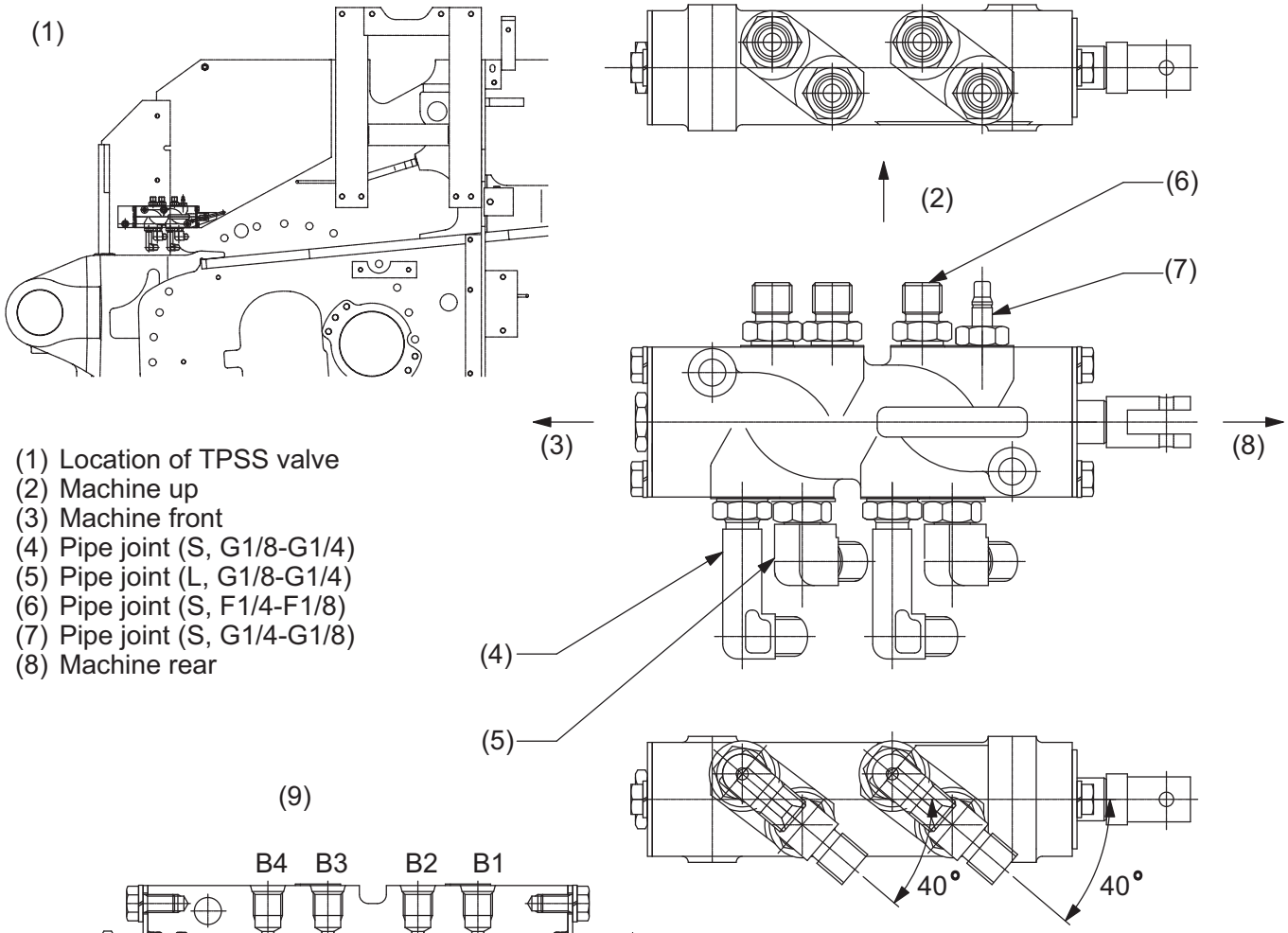
3.Primary pressure setting:
3.92 MPa (40 kgf/cm^2) 569 psi

4.Valve assy mounting bolt tightening torque:
48.1 ~ 55.9 N·m (3.0 ~ 4.9 kgf·m) 21.7 ~ 35.4 ft·lbs

5.Adapter tightening torque:
G1/4 :
24.5 ~ 29.4 N·m (2.5 ~ 3.0 kgf·m) 18.1 ~ 21.7 ft·lbs
G3/8 :
49.1 ~ 53.9 N·m (5.0 ~ 5.5 kgf·m) 36.2 ~ 39.8 ft·lbs

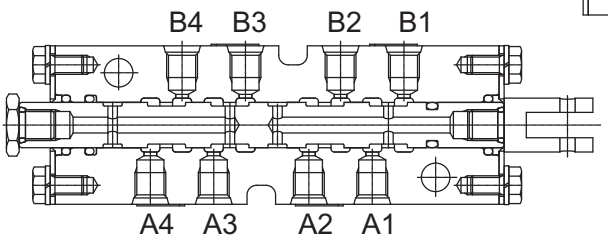
6.Hose route
(A): To oil tank
(B): To swivel joint
(C): To swivel motor
(D): To pilot filter
(E): To control valve

(2) TPSS valve (KTC, KCL, KTA-version only)

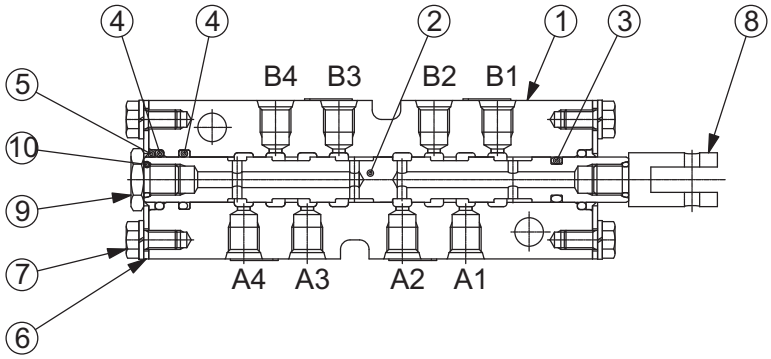


(1) Location of TPSS valve
(2) Machine up
(3) Machine front
(4) Pipe joint (S, G1/8-G1/4)
(5) Pipe joint (L, G1/8-G1/4)
(6) Pipe joint (S, F1/4-F1/8)
(7) Pipe joint (S, G1/4-G1/8)
(8) Machine rear

(9)

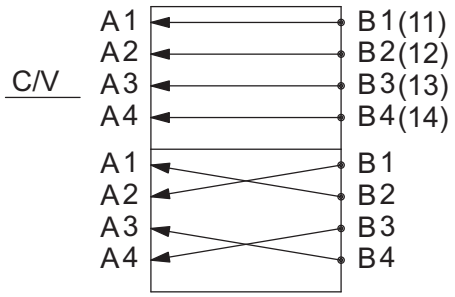


(10)



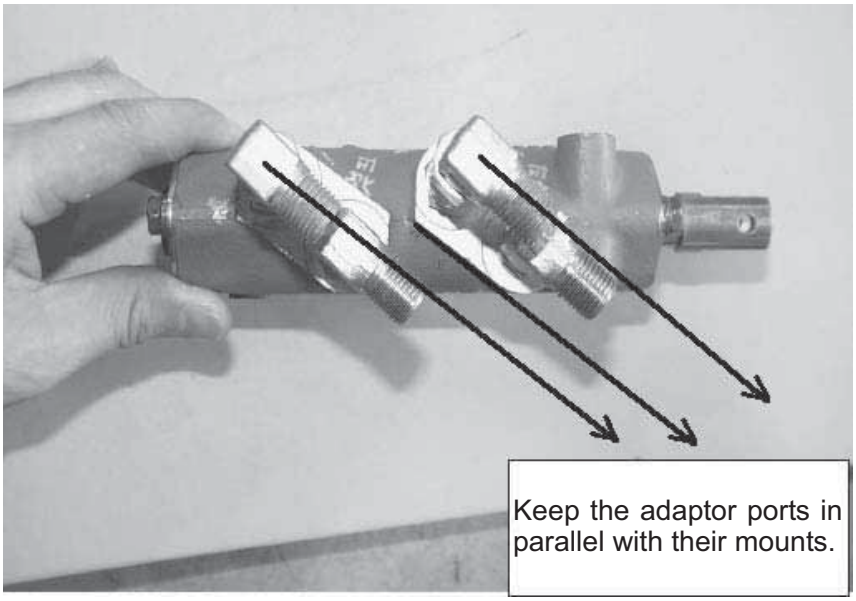
(9) Kubota - pattern
(10) JD - pattern

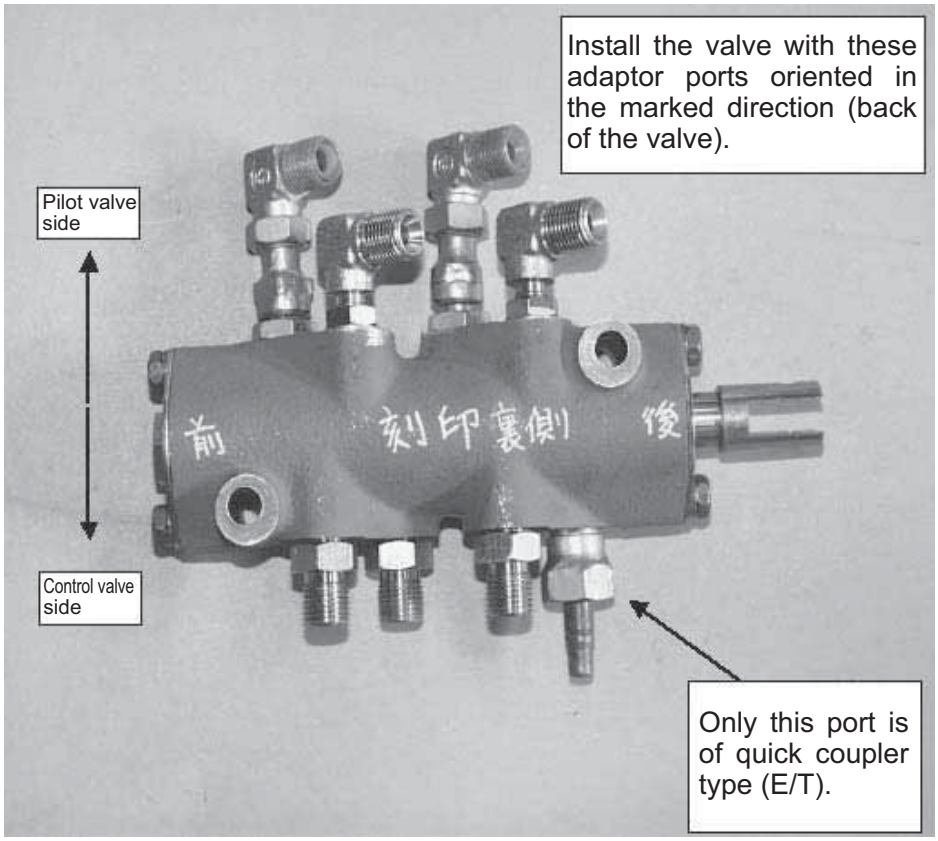
(11) (Gray) Boom up (P/V R(4))
(12) (Green) Arm crowd (P/V R(4))
(13) (L. Blue) Boom down (P/V R(4))
(14) (Blue) Arm dump (P/V R(4))

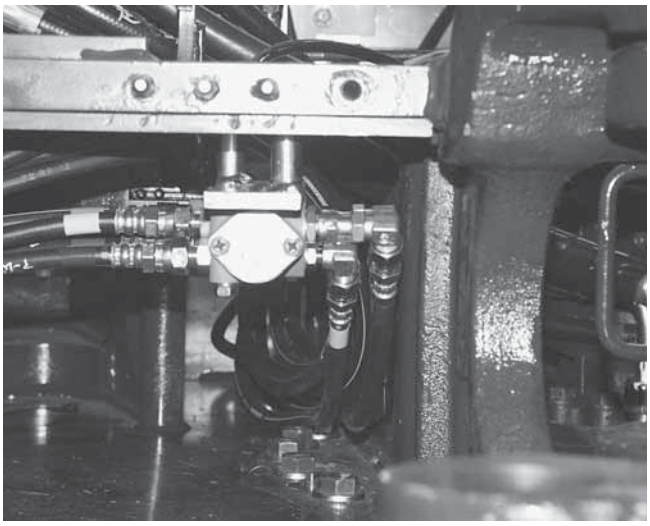


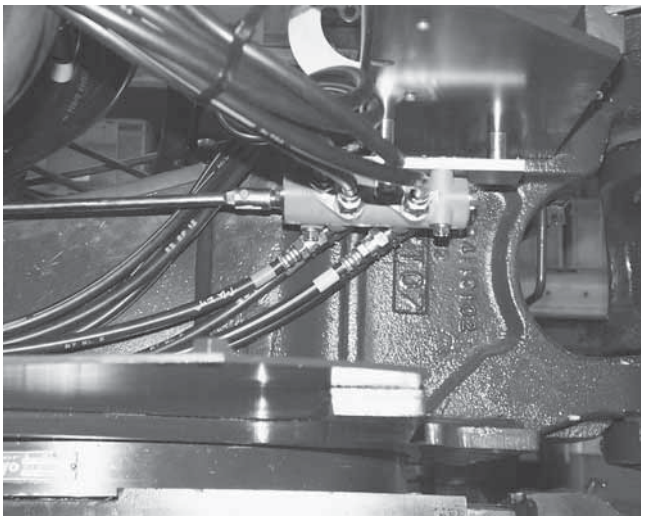
Tightening torque

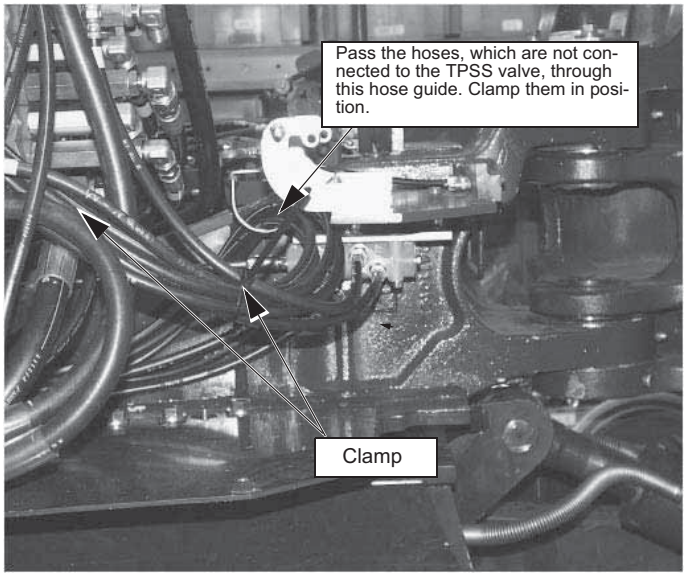
TPSS value mounting bolt	23.5 ~ 27.5 N·m (2.4 ~ 2.8 kgf·m) 17.3 ~ 20.3 ft·lbf
Adaptor	7.8 ~ 11.8 N·m (0.8 ~ 1.2 kgf·m) 5.8 ~ 8.7 ft·lbf
Bracket mounting bolt	48.1 ~ 55.9 N·m (4.9 ~ 5.7 kgf·m) 35.5 ~ 41.2 ft·lbf


Keep the adaptor ports in parallel with their mounts.


Install the valve with these adaptor ports oriented in the marked direction (back of the valve).
Pilot valve side
Control valve side
前
刻印裏側
後
Only this port is of quick coupler type (E/T).



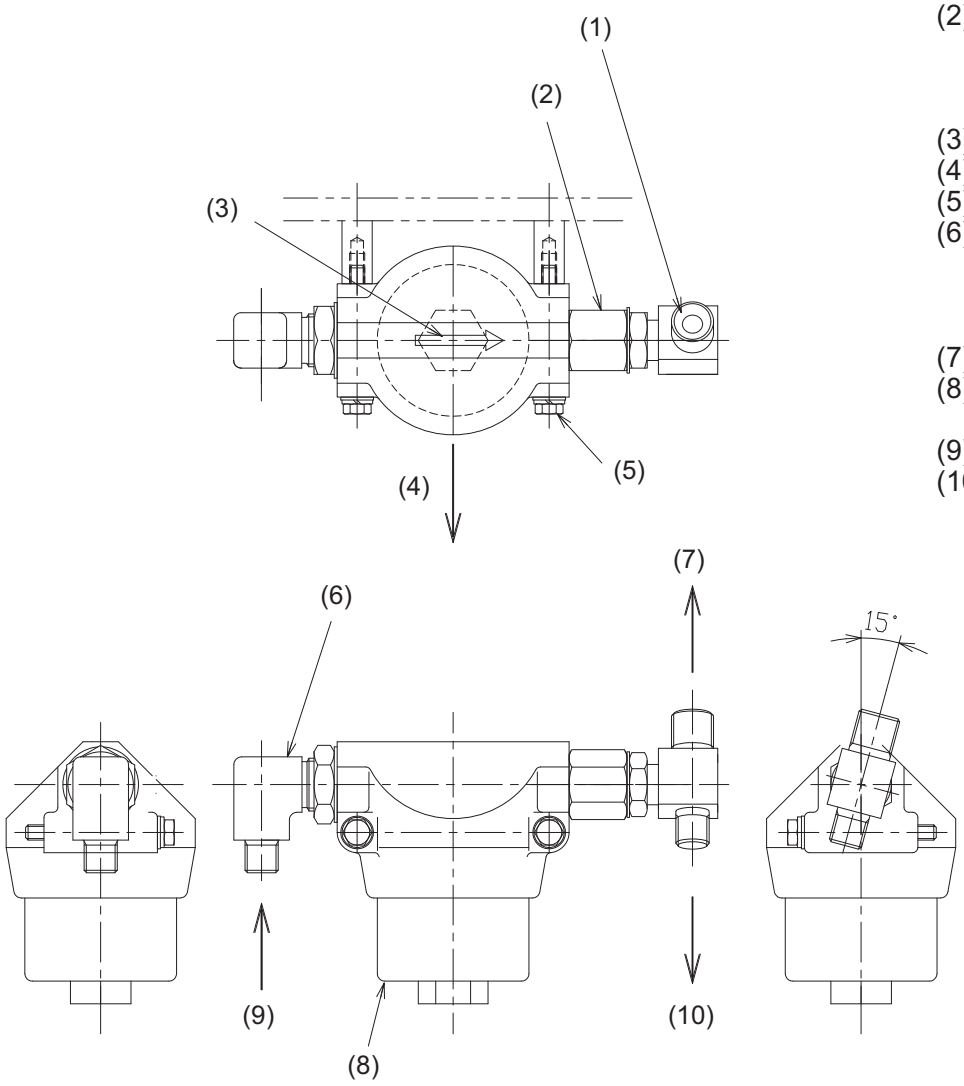



Pass the hoses, which are not connected to the TPSS valve, through this hose guide. Clamp them in position.
Clamp

(3) Pilot filter: 10 micron

(1) Pilot filter assy installation
Bolt tightening torque (01025-60655)
9.8 ~ 11.3 N·m (1.0 ~ 1.15 kgf·m) 7.2 ~ 8.3 ft·lbs

(2) Adapter tightening torque
G1/2: 58.8 ~ 63.7 N·m (6.0 ~ 6.5 kgf·m) 43.4 ~ 47.0 ft·lbs
G3/8: 37.2 ~ 42.1 N·m (3.8 ~ 4.3 kgf·m) 27.5 ~ 31.2 ft·lbs



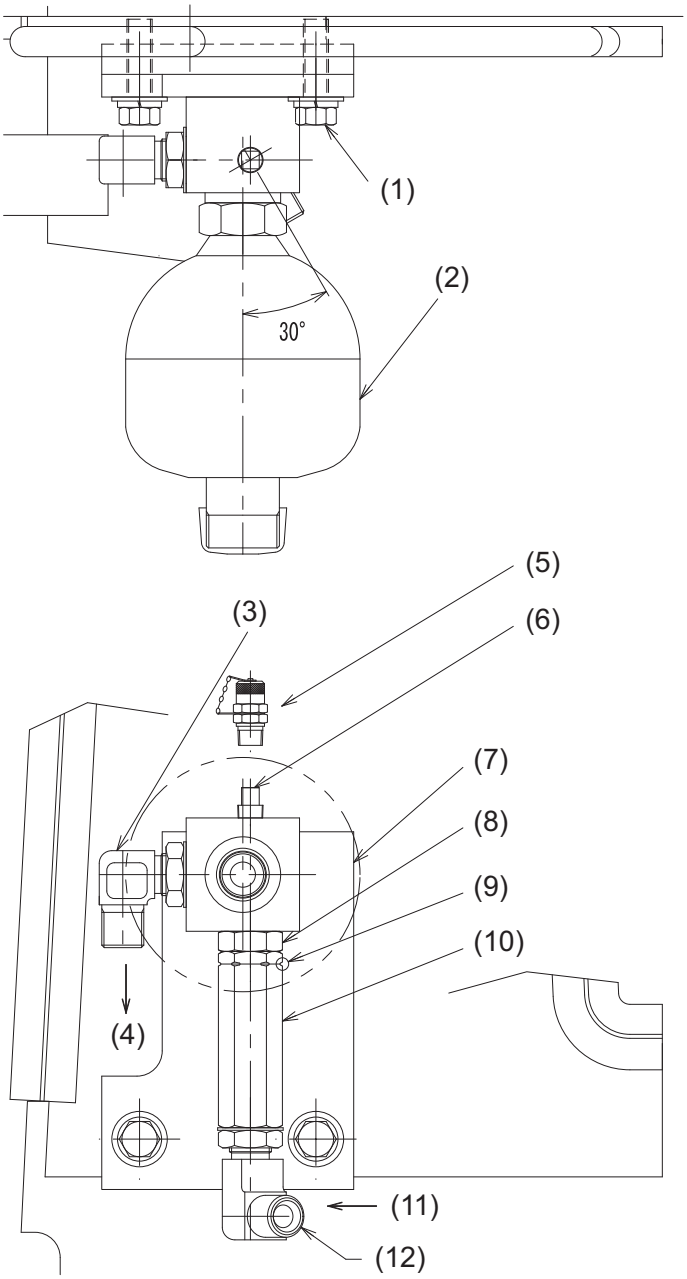
(1) Pipe joint (T, F2-F3)
RC411-6384Δ
O-ring
04810-00140
(2) Pipe joint (S, G3/8-G1/2)
RD519-6374Δ
O-ring
04810-00180
(3) Stamped marking
(4) Machine back
(5) 01025-60655 Bolt
(6) Pipe joint (L, F1/2-F3/8)
69251-6185Δ
O-ring
04810-00180
(7) (To accumulator)
(8) Filter assembly (pilot)
RD401-6126Δ
(9) (From pump)
(10) (To control valve)

(4) Accumulator bracket: KX121-3S/α

(1) Tightening together of the adapter (accumulator, A/C) (RD519-6282Δ) and cover (partition)
Tighten the bolts.(01135-61040)
Tightening torque: 48.1 ~ 55.9 N·m (4.9 ~ 5.7 kgf·m) 35.4 ~ 41.2 ft·lbs

(2) Fitting direction of the hydraulic adapter
Fit the adapter as shown at left.

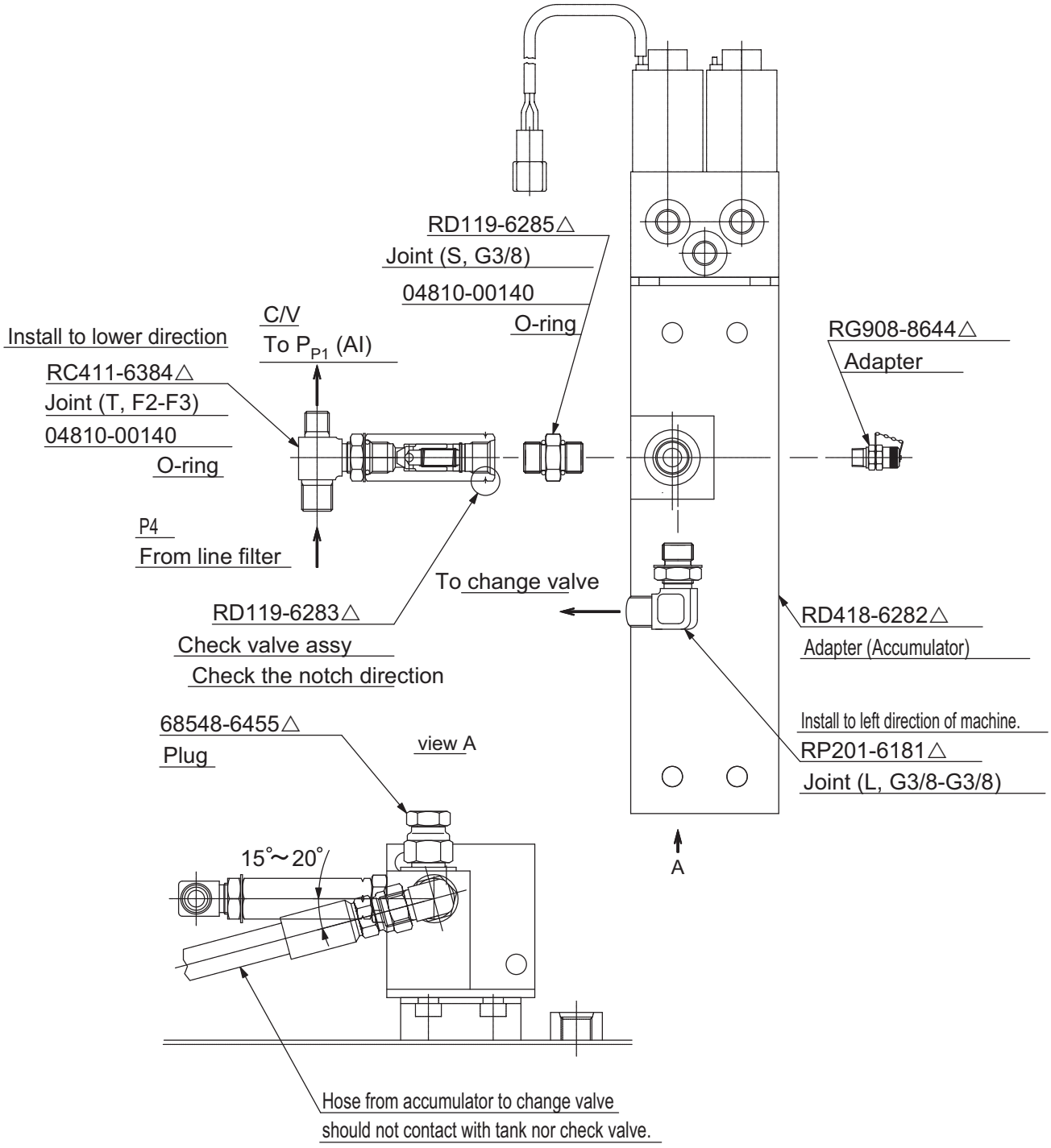
(3) Tightening torque of the hydraulic adapter
Tightening torque
G 3/8: 37.2 ~ 42.1 N·m (3.8 ~ 4.3 kgf·m) 27.5 ~ 31.1 ft·lbs



(1) Bolt
01135-61040Δ
(2) Accumulator
RC448-6281Å¢
(3) Pipe joint (L, G3/8-G3/8)
RP201-6181Δ
(4) (To selector valve)
(5) (Destined for Europe)
Adapter
RG908-8644Δ
(6) (Destined for North America)
Plug
06312-10010
(7) Adapter (accumulator A/C)
RD519-6282Δ
(8) Pipe joint (S, G3/8)
RD119-6285Δ
(9) Be careful not to confuse the notch direction.
(10) Valve assembly (check)
RD119-6283Δ
(11) (From filter)
(12) Pipe joint (L, G3-G3)
RB401-6408Δ

(4) Accumulator bracket: KX161-3α EU-version only

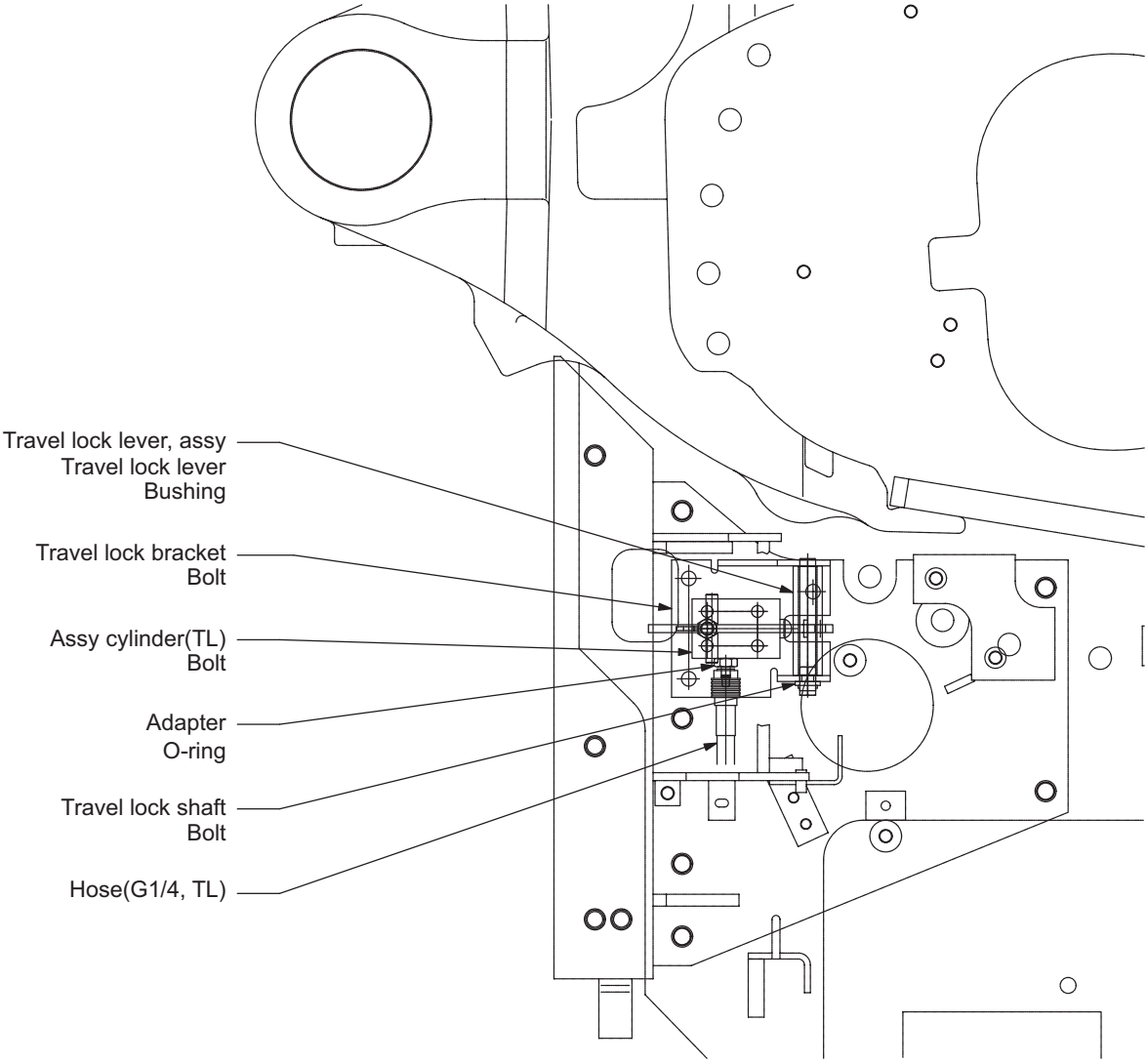
Adapter tightening torque
G3/8: 49.0 ~ 53.9 N·m (5.0 ~ 5.5 kgf·m) 36.2 ~ 39.8 ft·lbs

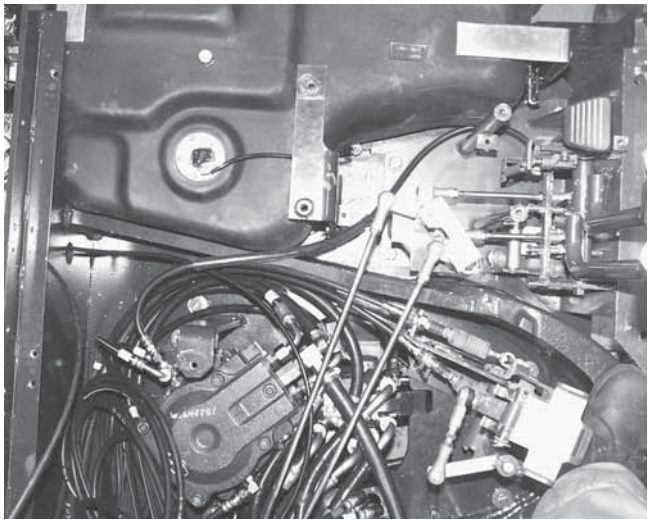


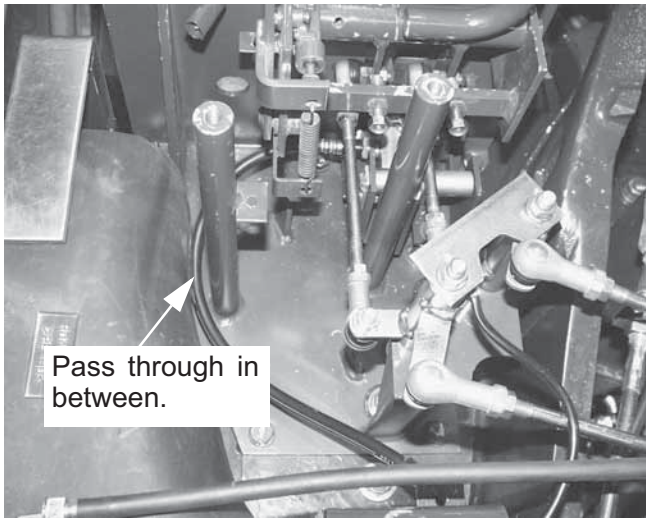
(5) Travel lock valve

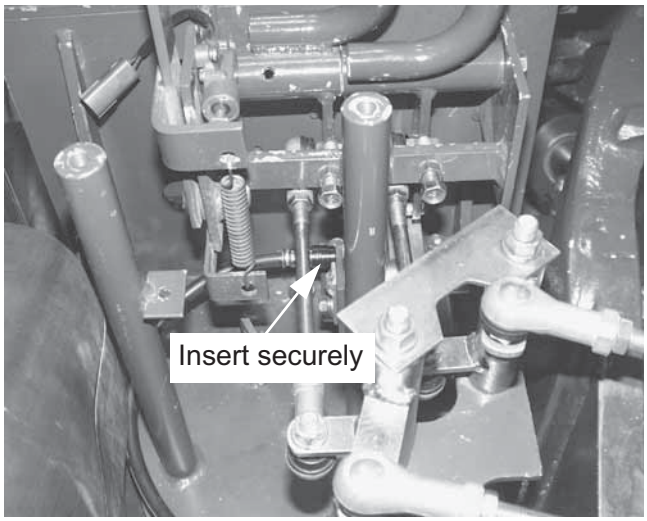
(1) Installing DU bush
Apply grease.

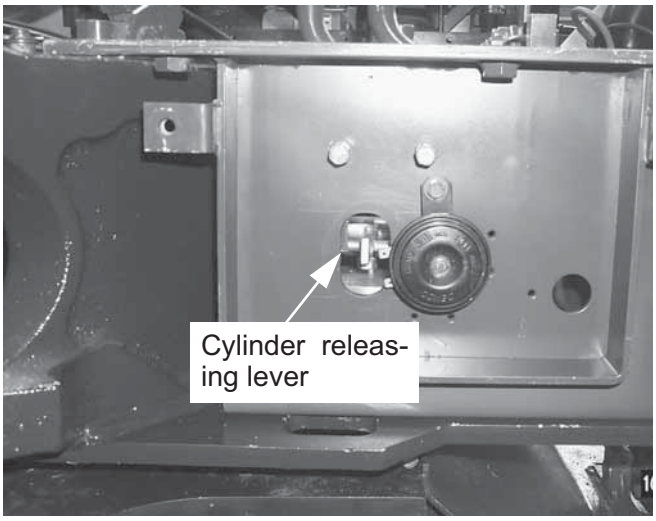
(2) Adapter tightening torque
G1/8
15.0 ~ 16.5 N·m (1.5 ~ 1.7 kgf·m) 10.8 ~ 12.3 ft·lbs






Pass through in between.


Insert securely


Cylinder releasing lever

(6) Oil tank

(1) Tightening torque of return filter (RD411-6212△)
68.6 ~ 78.4 N·m
(7.0 ~ 8.0 kgf·m) 50.6 ~ 57.9 ft·lbs
Return filter support installation

(2) Installing oil gauge

(3) Placing cover tank (RD411-6213△)
Tightening torque
48.1 ~ 55.9 N·m
(4.9 ~ 5.7 kgf·m) 35.4 ~ 41.2 ft·lbs

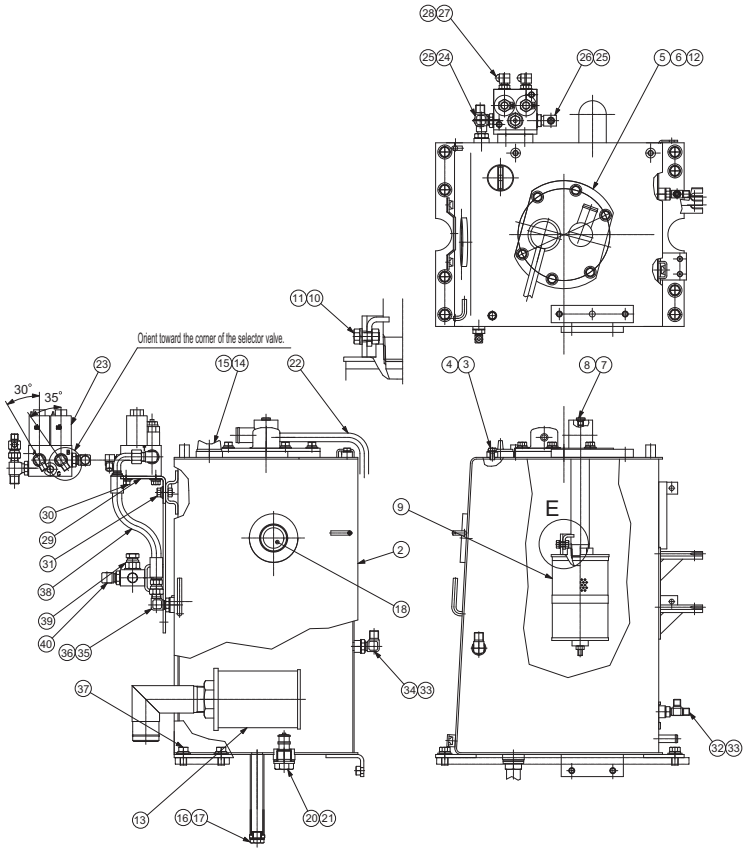
(4) Fitting of adapter
Tightening torque
G1/4
25.4 ~ 29.4 N·m
(2.5 ~ 3.0 kgf·m) 18.1 ~ 21.7 ft·lbs
G3/8
49.1 ~ 53.9 N·m
(5.0 ~ 5.5 kgf·m) 36.2 ~ 39.8 ft·lbs

(5) Mounting of hydraulic oil tank (RD118-6201△)
Tightening torque
77.5 ~ 90.2 N·m
(7.9 ~ 9.2 kgf·m) 57.1 ~ 66.5 ft·lbs
Apply screwlock agent. (Locktite 271)

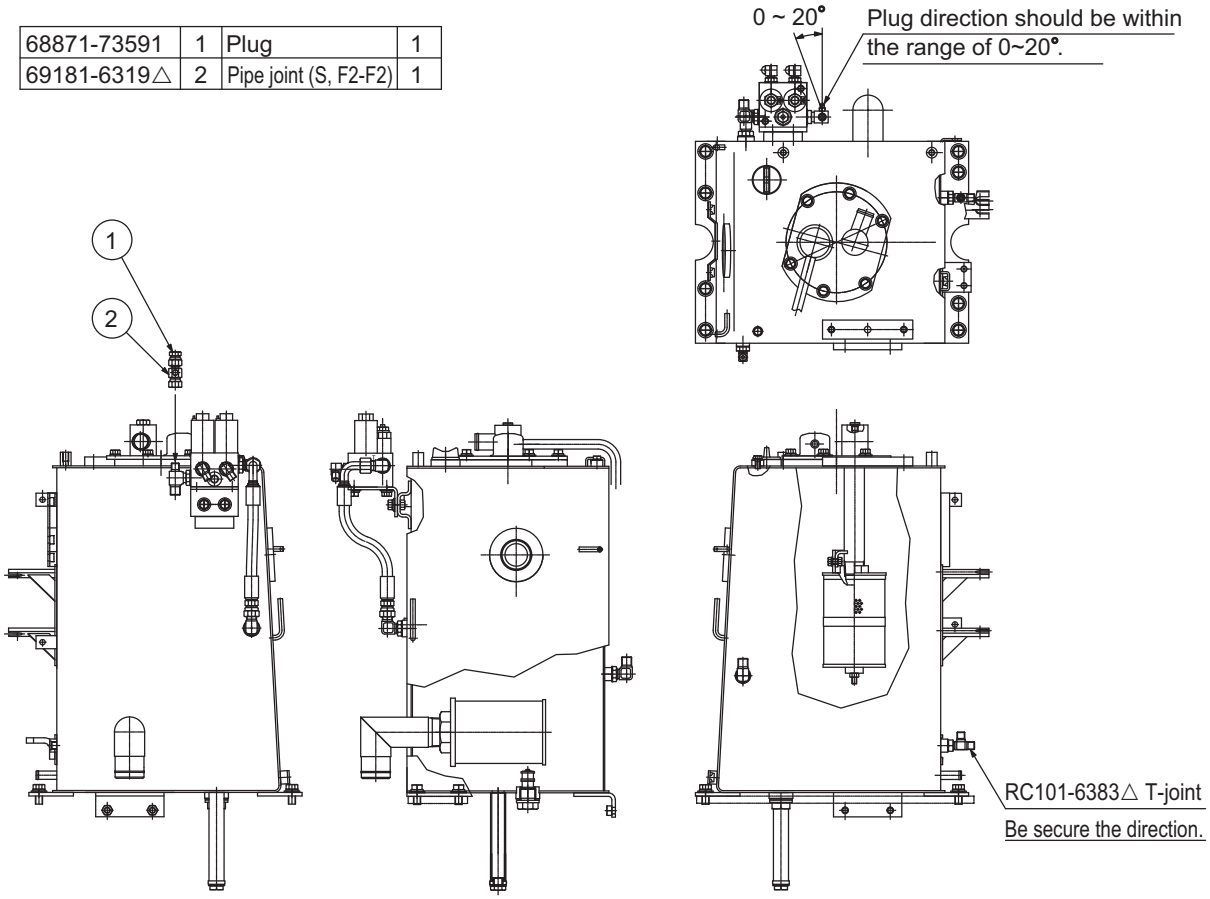
(6) Mounting of change valve (RD411-6125△)
Tightening torque
48.1 ~ 55.9 N·m
(4.9 ~ 5.7 kgf·m) 35.4 ~ 41.2 ft·lbs

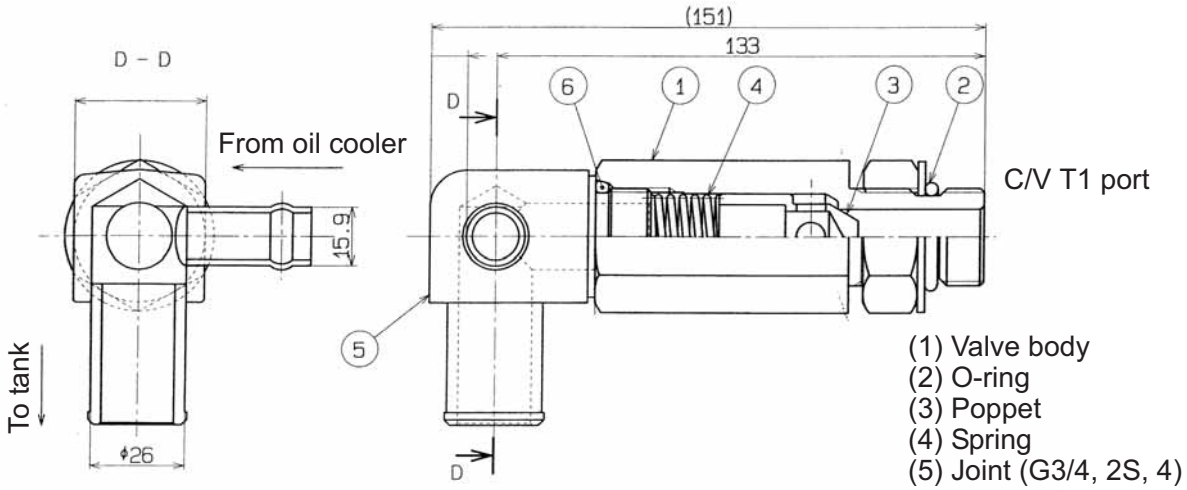
(7) Plug (39) and pipe joint (40) are used only for KTC, KCL, KTA-version machine.

1	Oil tank assy	21	Washer with rubber
2	Oil tank	22	Breather tube
3	Bolt	23	Check valve assy
4	Washer with rubber	24	Pipe joint, G3/8-G3/8
5	Tank cover	25	O-ring
6	O-ring	26	Pipe joint, T, F2-F3
7	Plug G1/4	27	Pipe joint, L, G1/4-G1/4
8	O-ring	28	O-ring
9	Return filter	29	Accumulator adapter
10	Stopper	30	Bolt
11	Bolt	31	Bolt
12	Bolt	32	T joint (F2)
13	Suction filter	33	O-ring
14	Inlet plug	34	Pipe joint, L, G1/4-G1/4
15	O-ring	35	Pipe joint, G, G3/8-G3/8
16	Plug	36	O-ring
17	Washer with rubber	37	Bolt
18	Oil gauge	38	Oil hose, 3/8
19	-	39	Plug
20	Magnet plug	40	Pipe joint, G, G3/8-G3/8



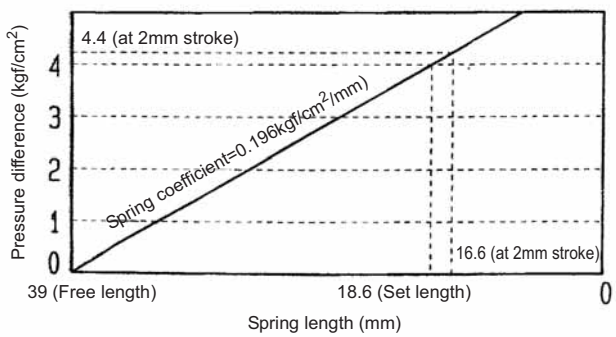
68871-73591	1	Plug	1
69181-6319△	2	Pipe joint (S, F2-F2)	1





(1) Valve body
(2) O-ring
(3) Poppet
(4) Spring
(5) Joint (G3/4, 2S, 4)
(6) O-ring

Check valve

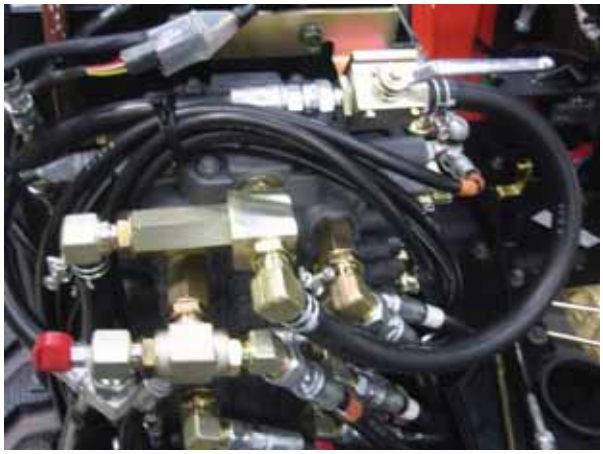


(7) Third line valve

1. KX121-3S
   Angle blade-version
   (1) Third-line valve
   (2) Service port section

2. KX121-3ST
   Non-angle blade
   Third-line opened

3. KX121-3ST
   Non-angle blade
   Third-line closed

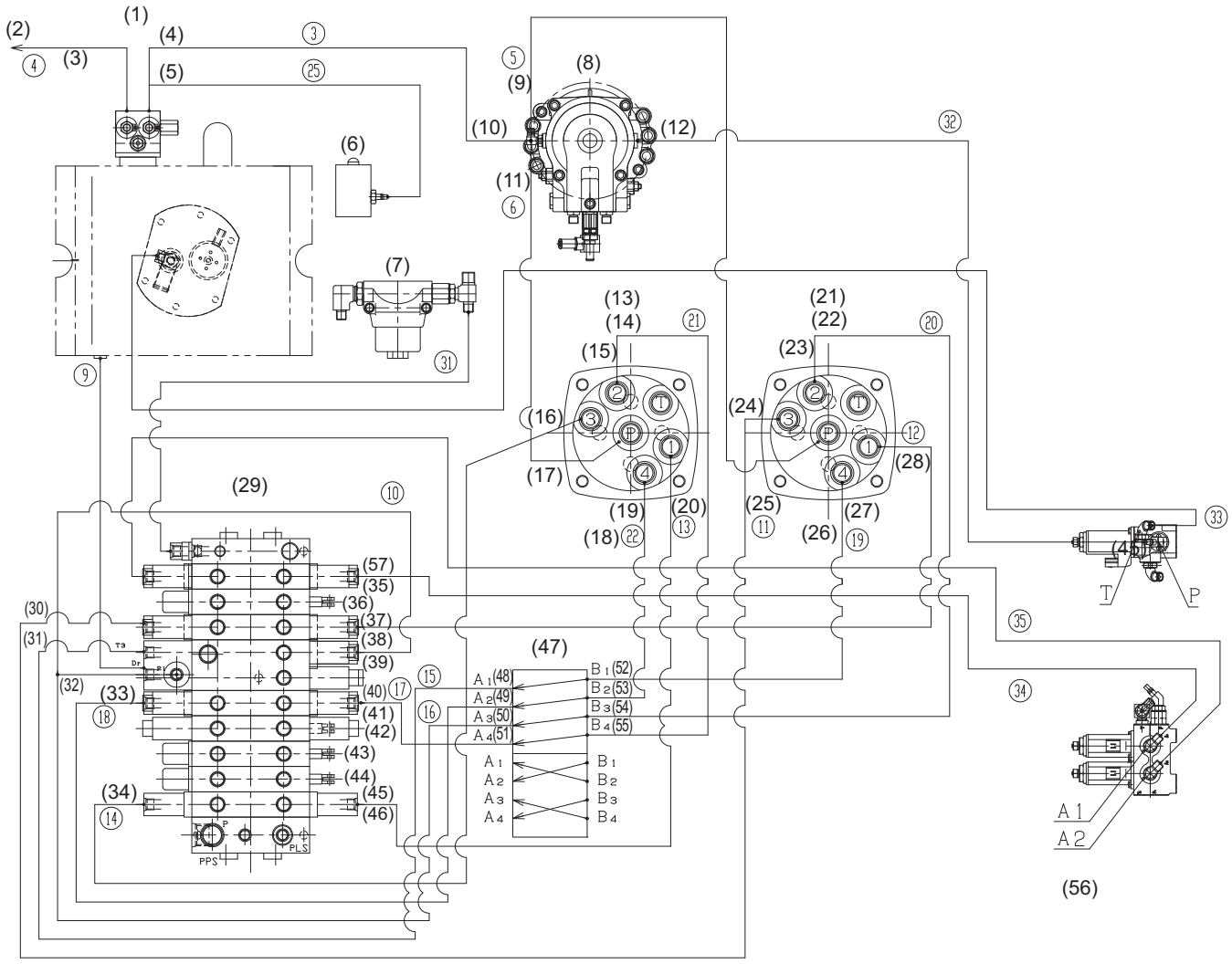


4. KX161-3ST
   (1) Third-line valve
   (2) Service port section

m)Hoses

(1)Pilot hoses

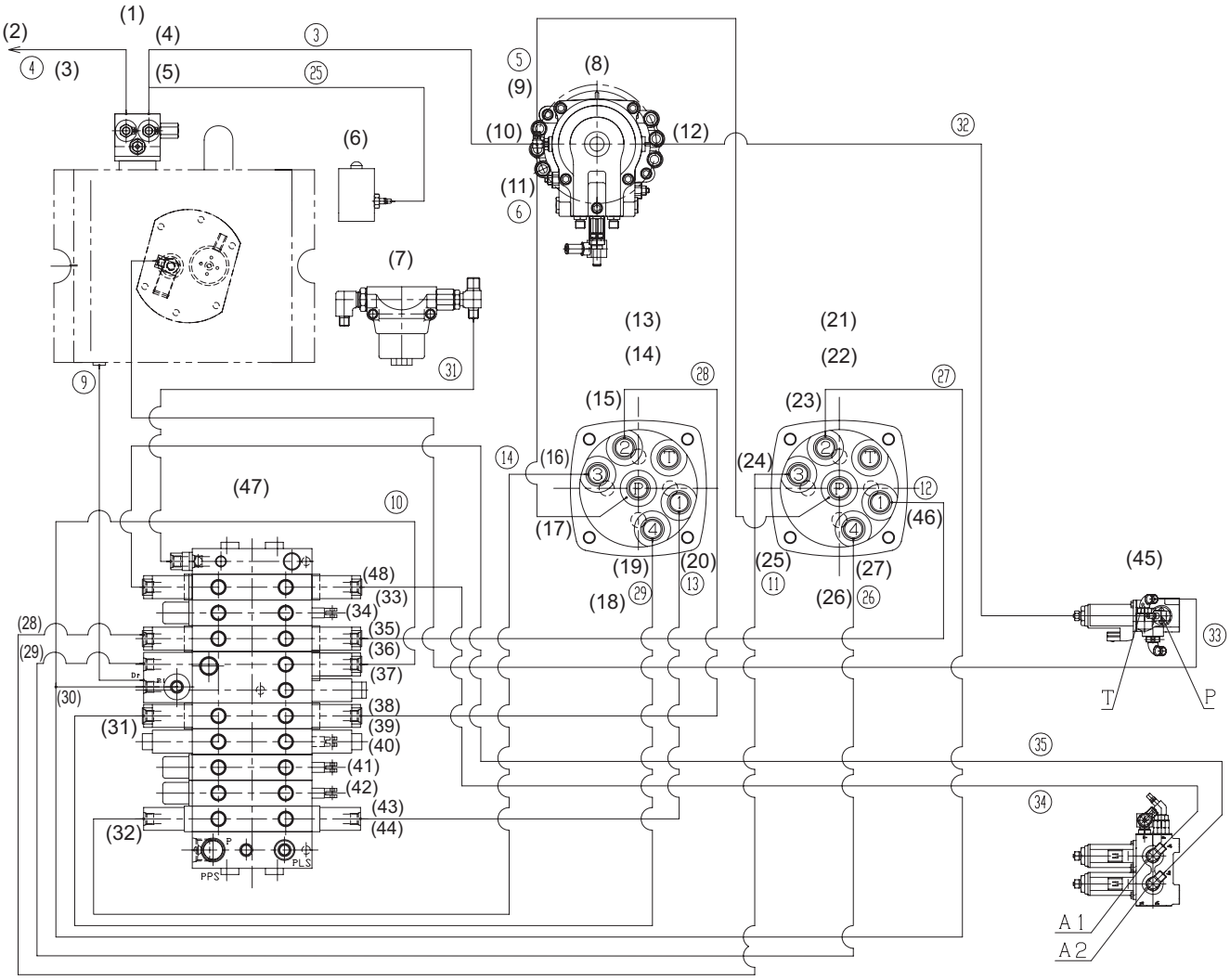
1) Pilot hoses: KX121-3S (KTC, KCL, KTA-version)



(1) Selector valve
(2) To swivel joint
(3) Black
(4) White
(5) White
(6) Travel lock valve
(7) Line filter
(8) Swivel motor
(9) White
(10) White
(11) White
(12) White
(13) Pilot valve, left
(14) Front
(15) Blue
(16) Yellow
(17) White
(18) Back
(19) Green
(20) Red
(21) Pilot valve, right
(22) Front
(23) Light blue
(24) Brown
(25) White
(26) Back
(27) Gray
(28) Violet
(29) Control valve
(30) Brown
(31) Gray
(32) Light blue
(33) Green
(34) Yellow
(35) Orange
(36) Swing
(37) Bucket
(38) Violet
(39) Boom
(40) Blue
(41) Arm
(42) Dozer
(43) Travel right
(44) Travel left
(45) Red
(46) Swivel
(47) TPSS valve
(48) Gray
(49) Green
(50) Light blue
(51) Blue
(52) Gray
(53) Green
(54) Light blue
(55) Blue
(56) S/P solenoid valve

No	Location		Part code	Q'ty
			KX121-3ST	
3	Selector valve ~ Swivel motor, white	Swivel brake release	RD138-6327Δ	1
4	Selector valve ~ Rotary joint	Travel dual-speed boost	RD118-6446Δ	1
5	Pilot valve (right) P ~ Swivel motor Pb, white	P/V boost	RD118-6331Δ	1
6	Pilot valve (left) P ~ Swivel motor Pb, white	P/V boost	RD411-6332Δ	1
9	Control valve ~ Hydraulic tank	Boom lock drain	RD118-6356Δ	1
10	Control valve ~ Control valve	Lock valve release	RD411-6343Δ	1
11	Pilot valve ~ Control valve, brown	Bucket dump	RD118-6346Δ	1
12	Pilot valve ~ Control valve, violet	Bucket crowded	RD118-6347Δ	1
13	Pilot valve ~ Control valve, red	Swivel left	RD118-6348Δ	1
14	Pilot valve ~ Control valve, yellow	Swivel right	RD118-6349Δ	1
15	TPSS ~ Control valve, gray	Boom up	RD118-9631Δ	1
16	TPSS ~ Control valve, light blue	Boom down	RD148-9632Δ	1
17	TPSS ~ Control valve, blue	Arm dump	RD148-9633Δ	1
18	TPSS ~ Control valve, green	Arm crowded	RD138-9634Δ	1
19	TPSS ~ Pilot valve, gray	Boom up	RD118-9641Δ	1
20	TPSS ~ Pilot valve, light blue	Boom down	RD118-9642Δ	1
21	TPSS ~ Pilot valve, blue	Arm dump	RD118-9643Δ	1
22	TPSS ~ Pilot valve, green	Arm crowded	RD118-9644Δ	1
25	Selector valve ~ Travel lock valve, green	Travel unlock	RD431-6616Δ	1
31	Line filter ~ Control valve, red	AI	RD519-6328Δ	1
32	S/P solenoid valve (P) ~ Swivel motor		RD138-6286Δ	1
33	S/P solenoid valve (T) ~ Tank		RD148-6287Δ	1
34	S/P solenoid valve (A1) ~ Control valve, orange	S/P (H)	RD138-6288Δ	1
35	S/P solenoid valve (A2) ~ Control valve, yellowish green	S/P (L)	RD138-6289Δ	1

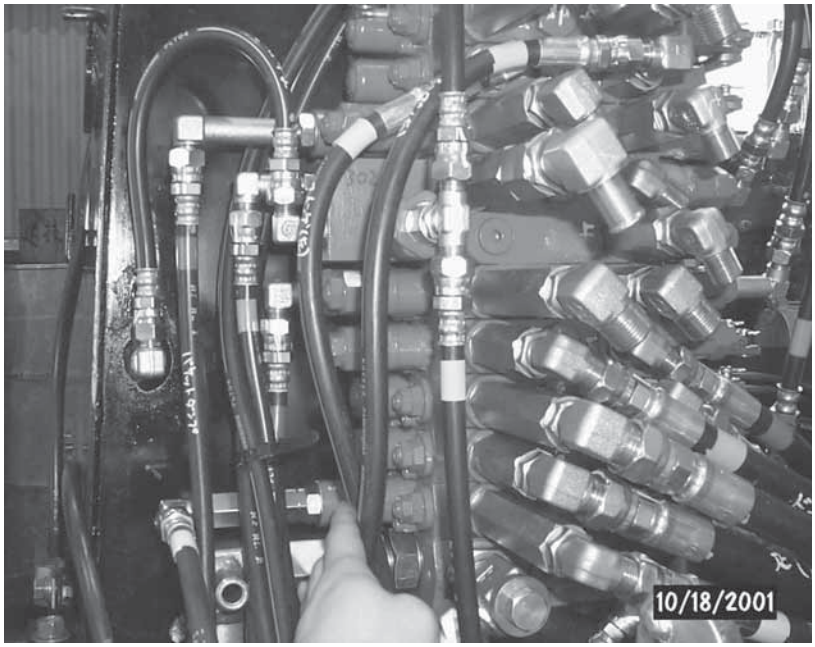
2) Pilot hoses: KX121-3α (EU-version)

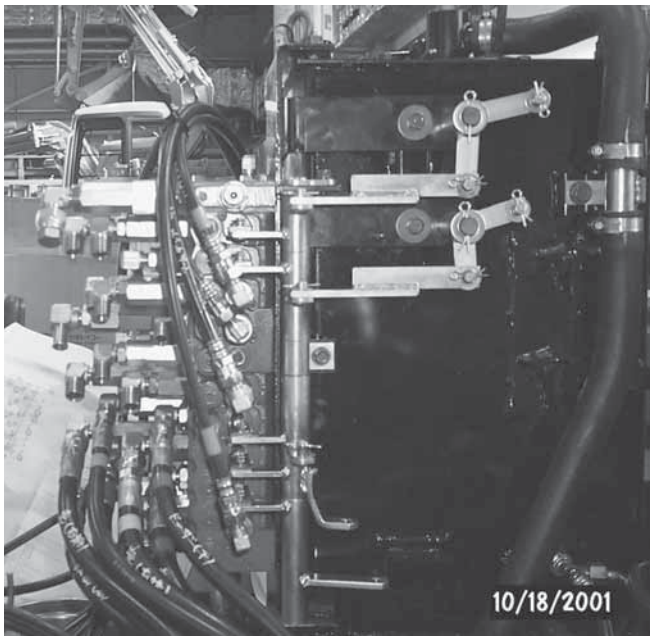


(1) Selector valve
(2) To swivel joint
(3) Black
(4) White
(5) White
(6) Travel lock valve
(7) Line filter
(8) Swivel motor
(9) White
(10) White
(11) White
(12) White
(13) Pilot valve, left
(14) Front
(15) Blue
(16) Yellow
(17) White
(18) Back
(19) Green
(20) Red
(21) Pilot valve, right
(22) Front
(23) Light blue
(24) Brown
(25) White
(26) Back
(27) Gray
(28) Brown
(29) Gray
(30) Light blue
(31) Green
(32) Yellow
(33) Orange
(34) Swing
(35) Bucket
(36) Violet
(37) Boom
(38) Blue
(39) Arm
(40) Dozer
(41) Travel right
(42) Travel left
(43) Red
(44) Swivel
(45) S/P solenoid valve
(46) Violet
(47) Control valve
(48) S/P

No	Location		Part code	Q'ty
			KX121-3A	
3	Selector valve ~ Swivel motor, white	Swivel brake release	RD138-6327Δ	1
4	Selector valve ~ Rotary joint	Travel dual-speed boost	RD118-6446Δ	1
5	Pilot valve (right) P ~ Swivel motor Pb, white	Pilot valve boost	RD118-6331Δ	1
6	Pilot valve (left) P ~ Swivel motor Pb, white	Pilot valve boost	RD411-6332Δ	1
9	Control valve ~ Hydraulic tank	Boom lock drain	RD118-6356Δ	1
10	Control valve ~ Control valve	Lock valve release	RD411-6343Δ	1
11	Pilot valve ~ Control valve, brown	Bucket dump	RD118-6346Δ	1
12	Pilot valve ~ Control valve, violet	Bucket crowded	RD118-6347Δ	1
13	Pilot valve ~ Control valve, red	Swivel left	RD118-6348Δ	1
14	Pilot valve ~ Control valve, yellow	Swivel right	RD118-6349Δ	1
25	Selector valve ~ Travel lock valve, green	Travel unlock	RD431-6616Δ	1
26	Pilot valve ~ Control valve, gray	Boom up	RD119-6341Δ	1
27	Pilot valve ~ Control valve, light blue	Boom down	RD119-6342Δ	1
28	Pilot valve ~ Control valve, blue	Arm dump	RD119-6344Δ	1
29	Pilot valve ~ Service valve, green	Arm crowded	RD119-6345Δ	1
31	Line filter ~ Control valve, red	AI	RD519-6328Δ	1
32	S/P solenoid valve (P) ~ Swivel motor		RD138-6286Δ	1
33	S/P solenoid valve (T) ~ Tank		RD148-6287Δ	1
34	S/P solenoid valve (A1) ~ Control valve, orange	S/P (H)	RD138-6288Δ	1
35	S/P solenoid valve (A2) ~ Control valve, yellowish green	S/P (L)	RD138-6289Δ	

3) Pilot hose route





(2) Delivery hoses

1) Delivery hoses: KX121-3S (KTC, KCL, KTA-version)

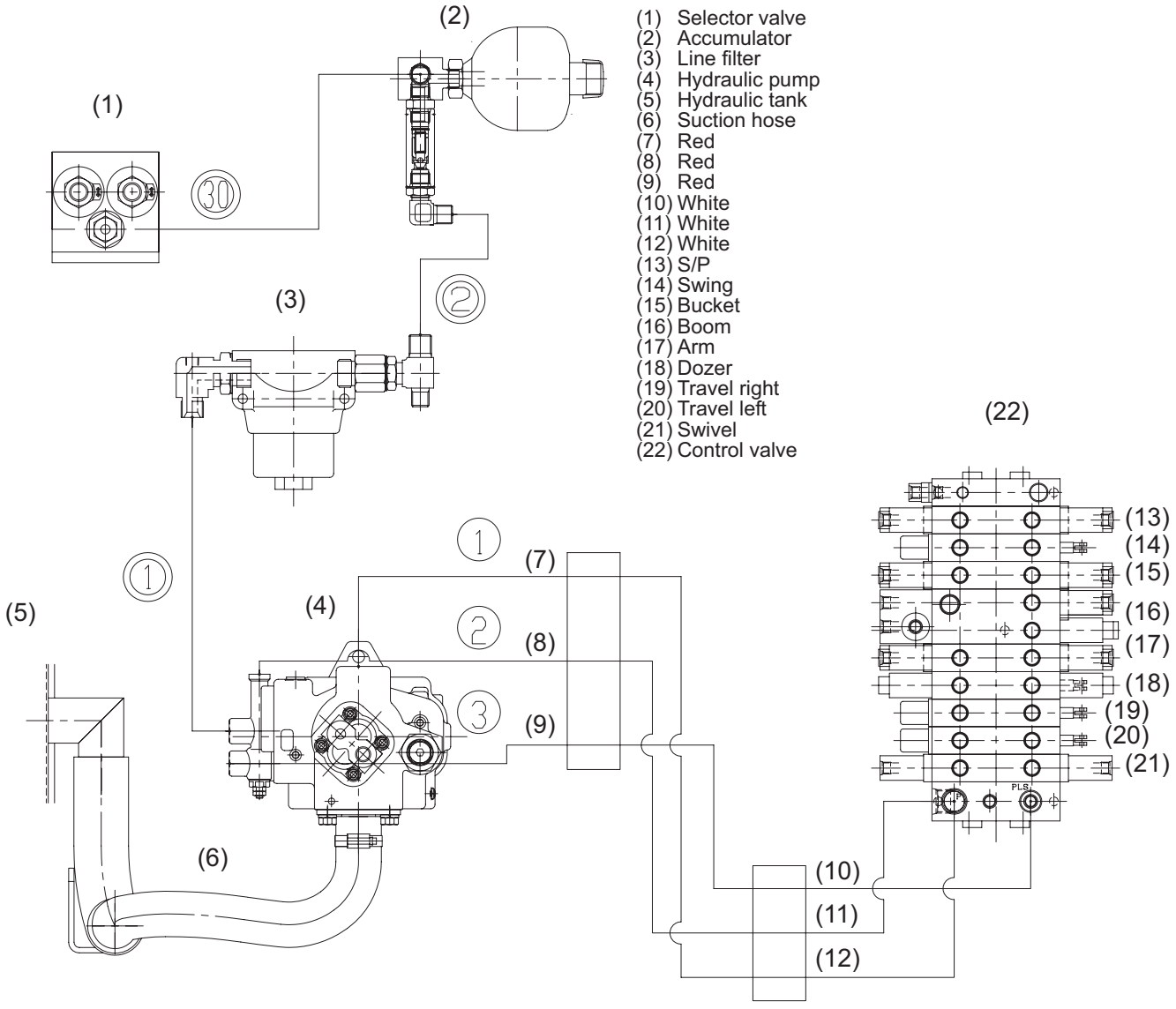
High pressure hose(O)

No.	Location		Code No.		Q'ty
			KX121-3S	L (mm)	
1	Pump ~ C/V Red, White	P (Delivery)	RD118-6321△	2560	1
2	Pump ~ C/V Red, White	PPS	RD118-6322△	2355	1
3	Pump ~ C/V Red, White	PLS	RD118-6323△	2250	1

Pilot hose(◎)

	No.	Location		Code No.		Q'ty
				KX121-3S	L (mm)	
	1	Pump ~ Line filter	P4	RD431-6324Δ	285	1
*	2	Line filter ~ Accumulator (check valve)	P4	RD519-6325Δ	300	1
*	30	Accumulator ~ Selector valve, red	P4	RD519-6286Δ	2130	1

The *-marked hoses are different from those for Europe-destined, air-conditioner-free type.



2) Delivery hoses: EU-version

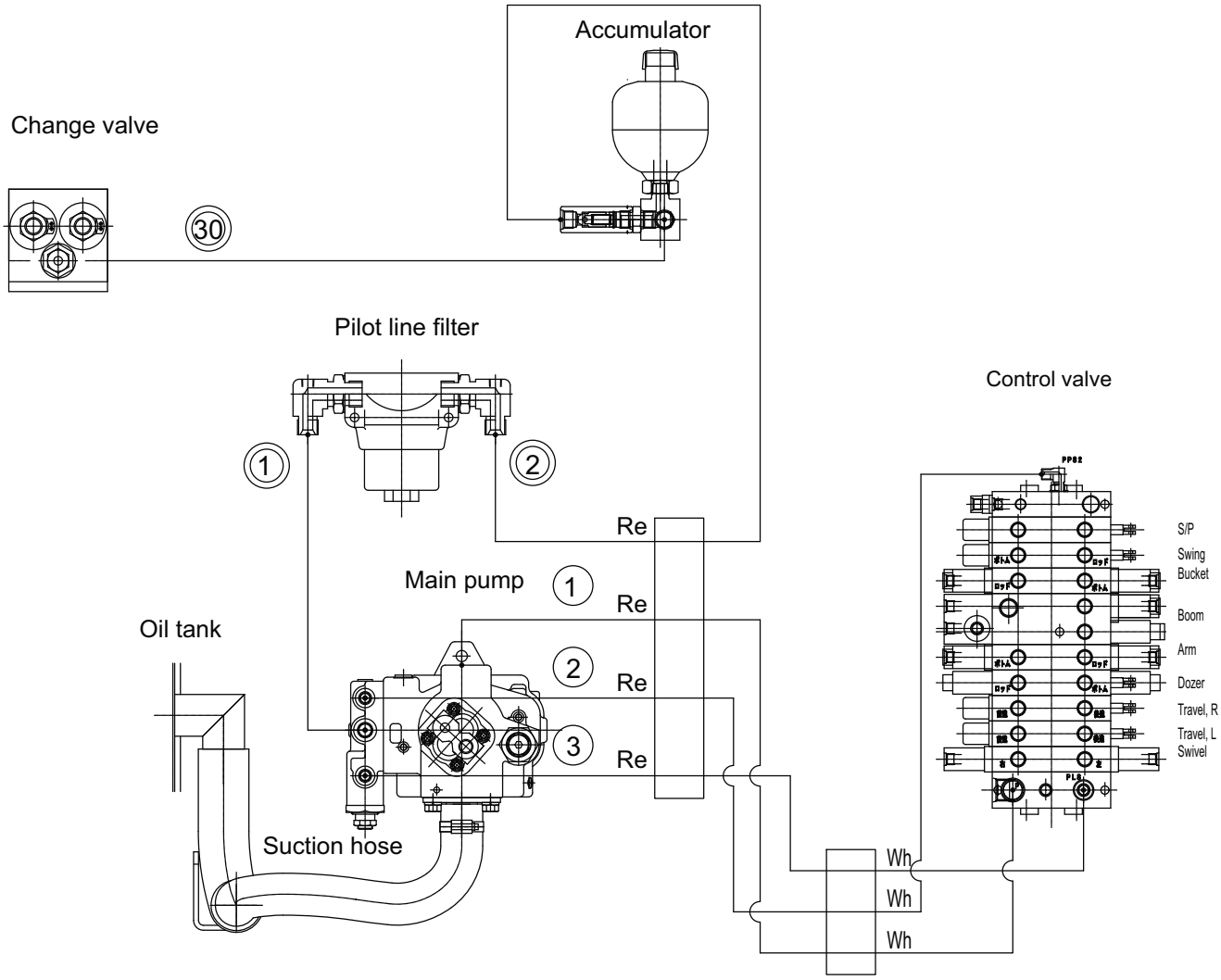
EU - version

High pressure hose (○)

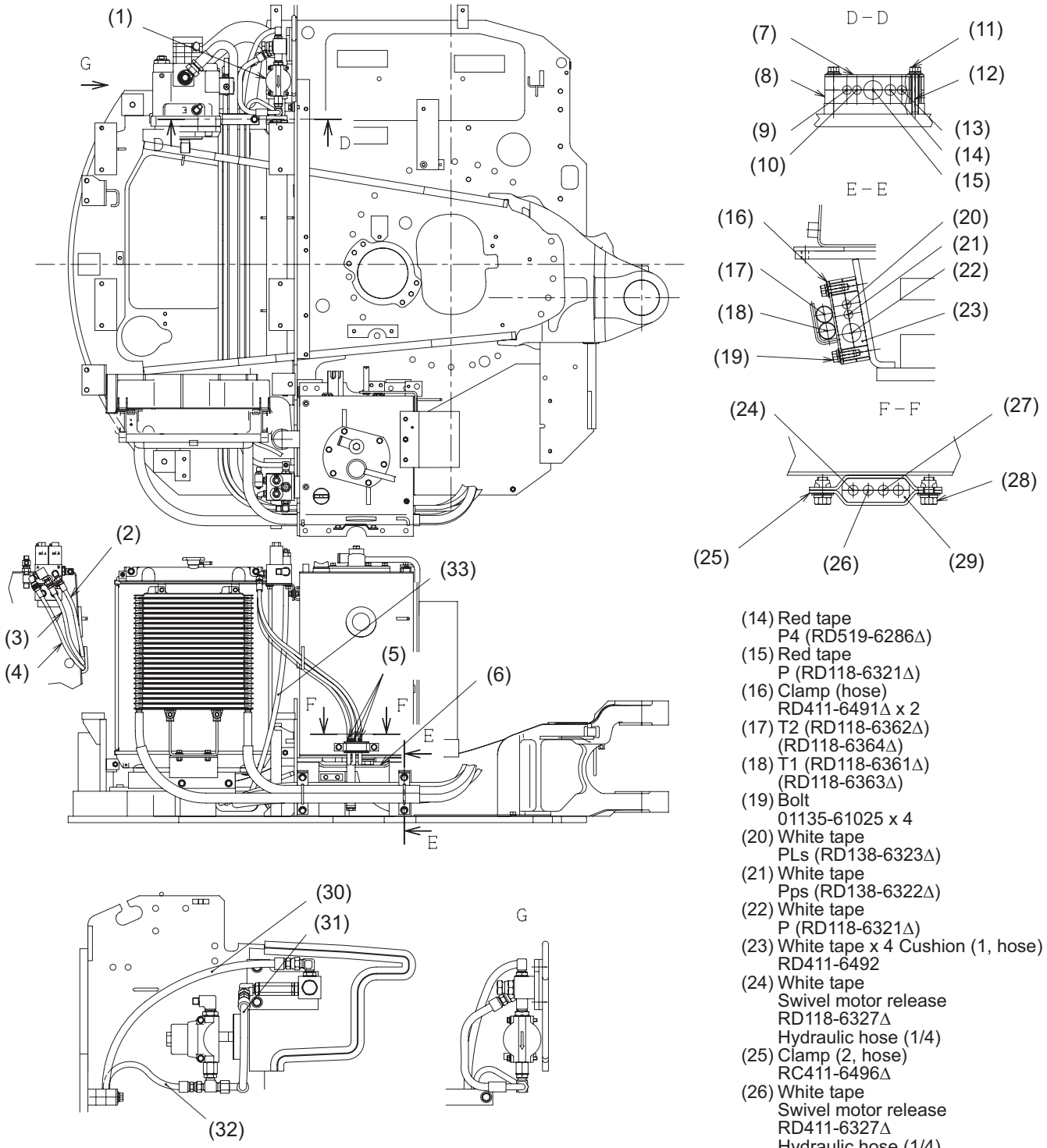
No.	Location		Code No. KX121-3α	Code No. L (mm)	Q'ty
1	Pump ~ C/V Red, White	P (Delivery)	RD118-6321△	2560	1
2	Pump ~ C/V Red, White	PPS	RD118-6322△	2740	1
3	Pump ~ C/V Red, White	PLS	RD118-6323△	2250	1

Pilot hose (◎)

No.	Location		Code No. KX121-3α	Code No. L (mm)	Q'ty
1	Pump ~ Pilot line filter	P4	RD118-6324△	285	1
2	Pilot line filter ~ Accumulator Red	P4	RD119-6325△	1610	1
30	Accumulator ~ Change valve Red	P4	RD119-6286△	230	1



3) Delivery hose: KX121-3S/α



(1) Filter assembly (pilot)
RD401-6126Δ
(2) Travel dual-speed
(3) Swivel motor release
(4) Travel lock release
(5) Taping
(6) Pass the travel lock release, swivel motor release and travel dual-speed hoses above the swivel frame guide.
(7) Clamp (hose)
RC411-6491Δ
(8) x 2 Cushion (2, hose)
RD519-6493Δ
(9) Red tape
Pps (RD138-6322Δ)
(10) Red tape
PLs (RD138-6323Δ)
(11) Bolt
01135-61060 x 2
(12) Collar
RD411-6496Δ x 2
(13) Red tape
P4 (RD519-6328Δ)
(14) Red tape
P4 (RD519-6286Δ)
(15) Red tape
P (RD118-6321Δ)
(16) Clamp (hose)
RD411-6491Δ x 2
(17) T2 (RD118-6362Δ)
(RD118-6364Δ)
(18) T1 (RD118-6361Δ)
(RD118-6363Δ)
(19) Bolt
01135-61025 x 4
(20) White tape
PLs (RD138-6323Δ)
(21) White tape
Pps (RD138-6322Δ)
(22) White tape
P (RD118-6321Δ)
(23) White tape x 4 Cushion (1, hose)
RD411-6492
(24) White tape
Swivel motor release
RD118-6327Δ
Hydraulic hose (1/4)
(25) Clamp (2, hose)
RC411-6496Δ
(26) White tape
Swivel motor release
RD411-6327Δ
Hydraulic hose (1/4)
(27) Black tape
Travel dual-speed
RD118-6446Δ
Hydraulic hose (1/4)
(28) Bolt
01135-61020
(29) Cushion (2, hose)
RD431-6497Δ
(30) P4 (RD519-6286Δ)
(31) P4 (RD519-6325Δ)
(32) P4 (RD519-6328Δ)

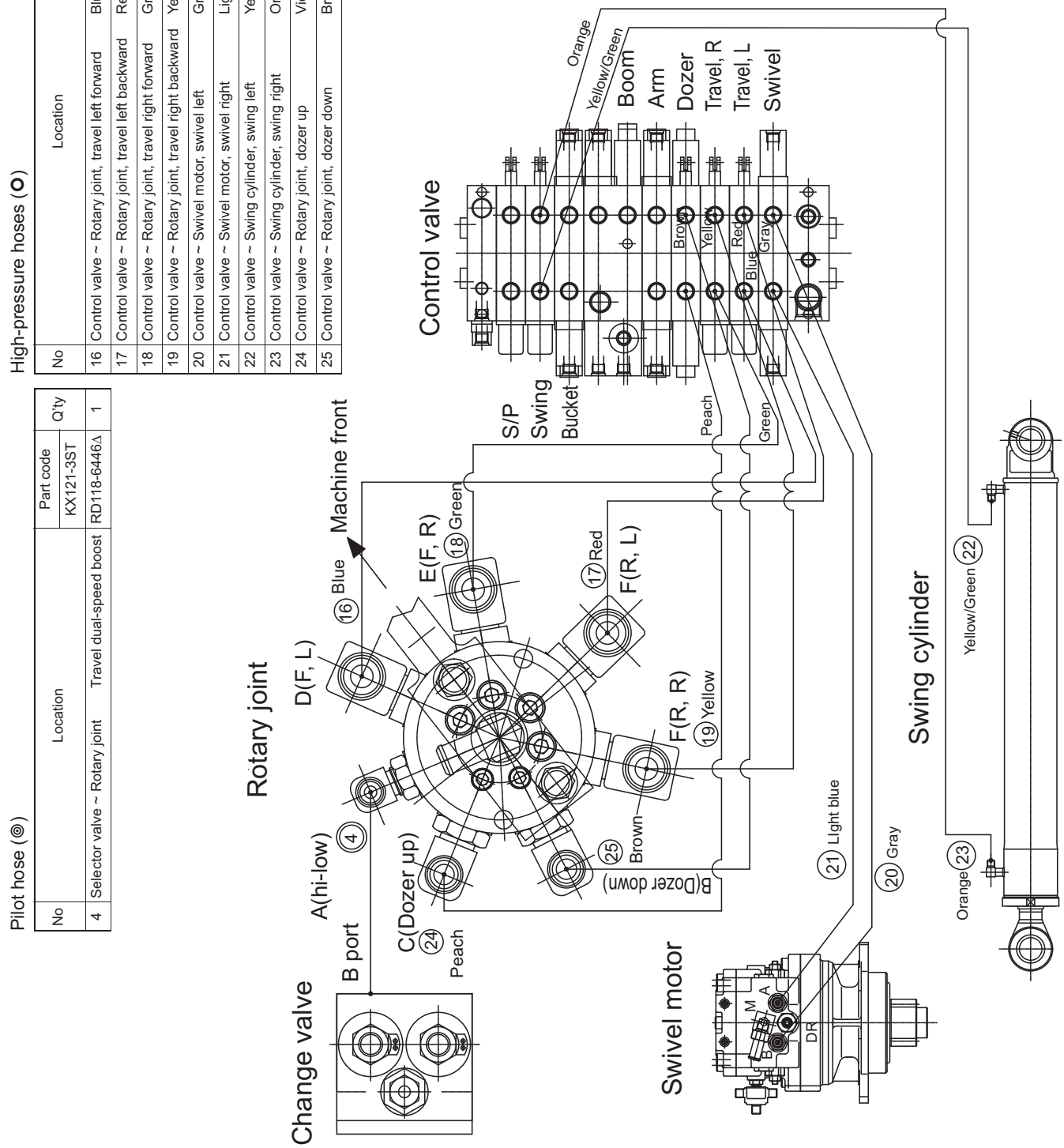
(3) Hose connection around Rotary Joint

Pilot hose (◎)

No	Location	Part code KX121-3ST	Q'ty
4	Selector valve ~ Rotary joint Travel dual-speed boost	RD118-6446Δ	1

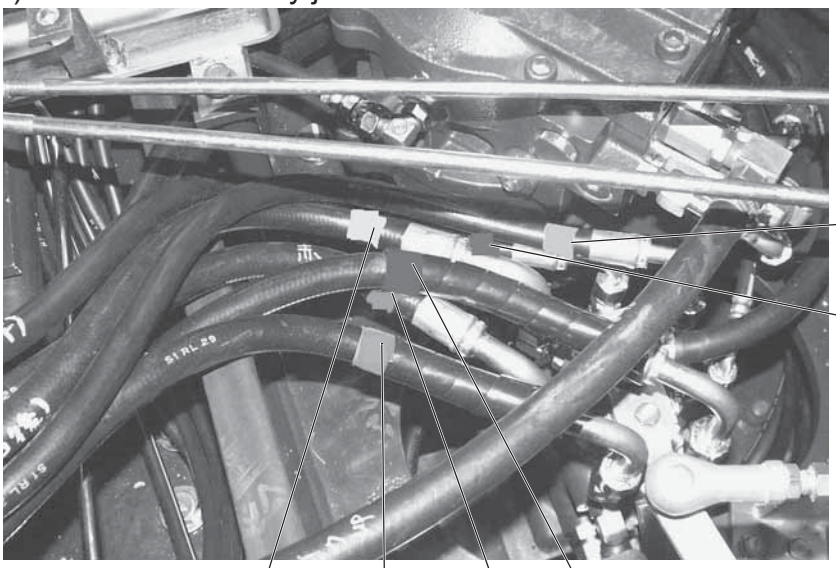
High-pressure hoses (●)

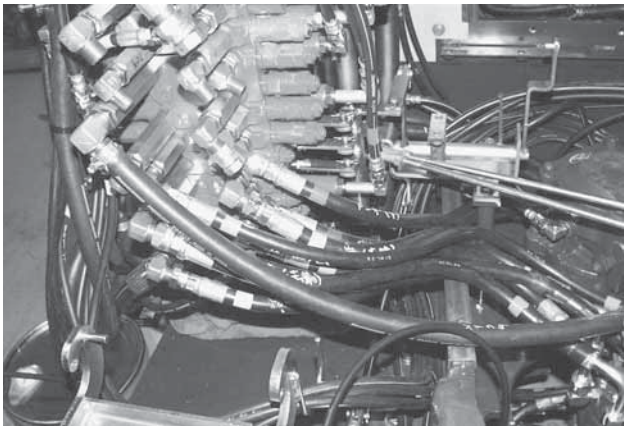
No	Location	Part code KX121-3ST	Q'ty
16	Control valve ~ Rotary joint, travel left forward Blue	RD118-6441Δ	1
17	Control valve ~ Rotary joint, travel left backward Red	RD118-6442Δ	1
18	Control valve ~ Rotary joint, travel right forward Green	RD118-6443Δ	1
19	Control valve ~ Rotary joint, travel right backward Yellow	RD118-6444Δ	1
20	Control valve ~ Swivel motor, swivel left Gray	RD118-6451Δ	1
21	Control valve ~ Swivel motor, swivel right Light blue	RD118-6452Δ	1
22	Control valve ~ Swing cylinder, swing left Yellowish green	RD118-6461Δ	1
23	Control valve ~ Swing cylinder, swing right Orange	RD118-6462Δ	1
24	Control valve ~ Rotary joint, dozer up Violet	RD118-6471Δ	1
25	Control valve ~ Rotary joint, dozer down Brown	RD118-6472Δ	1

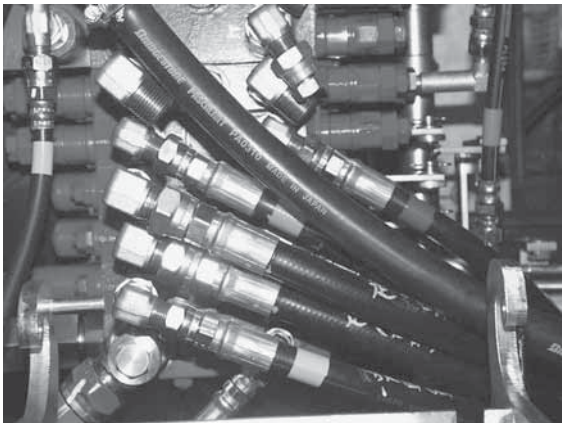


(4) Rotary joint

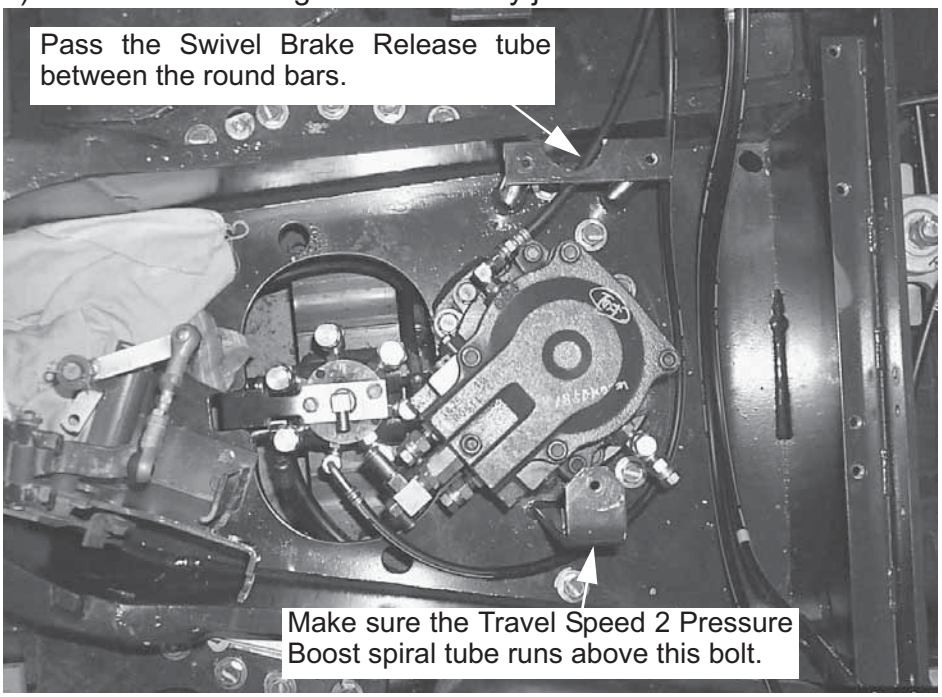
1) Hose route: Rotary joint ~ C/V



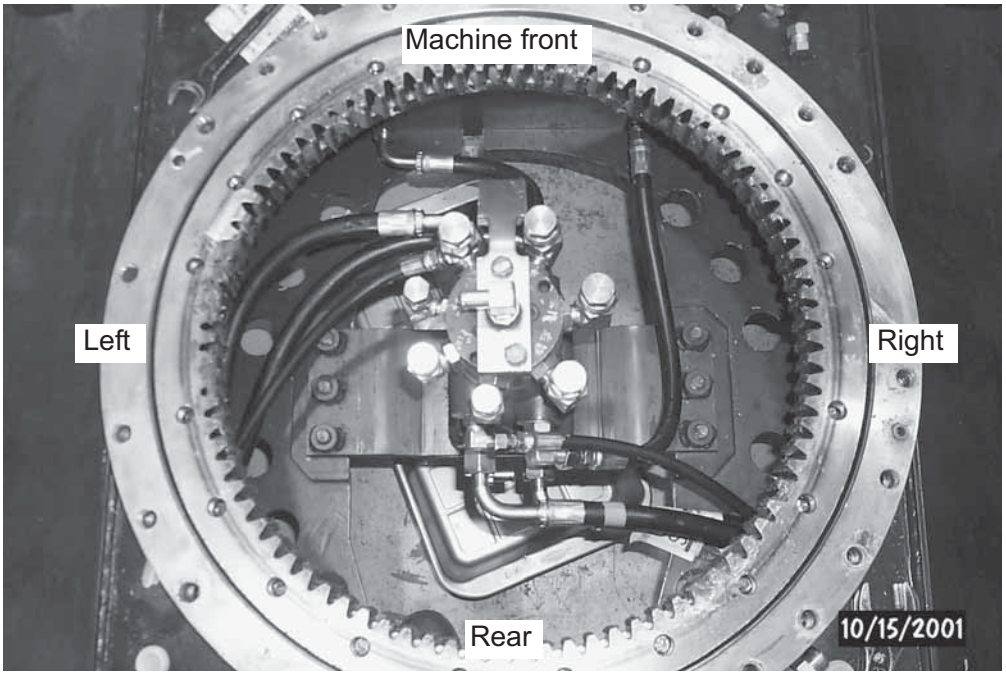


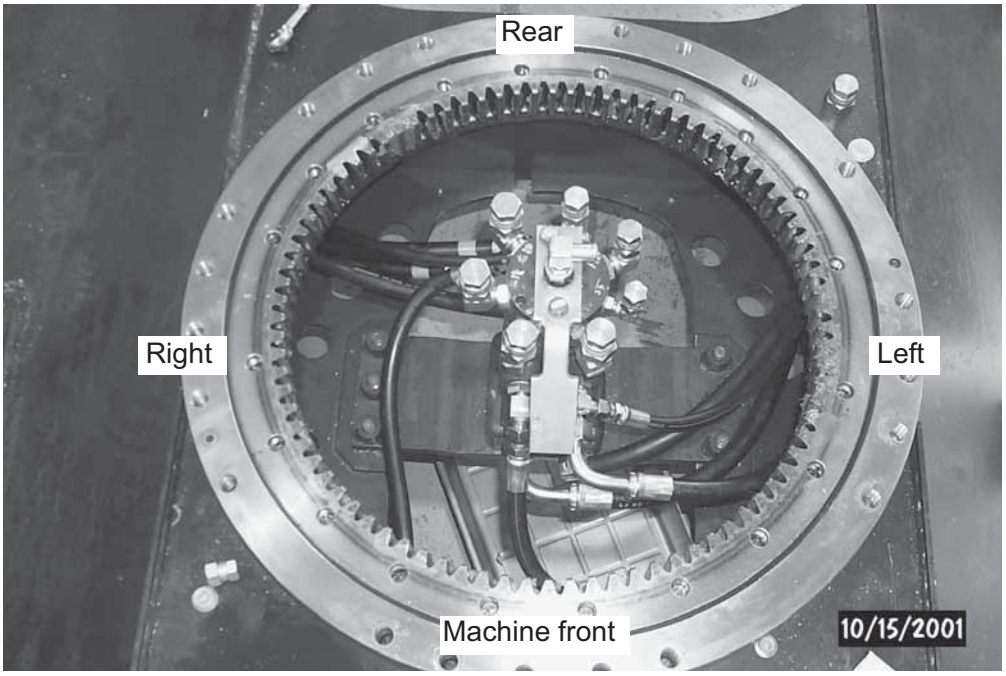


2) Hose route: Change valve ~ rotary joint



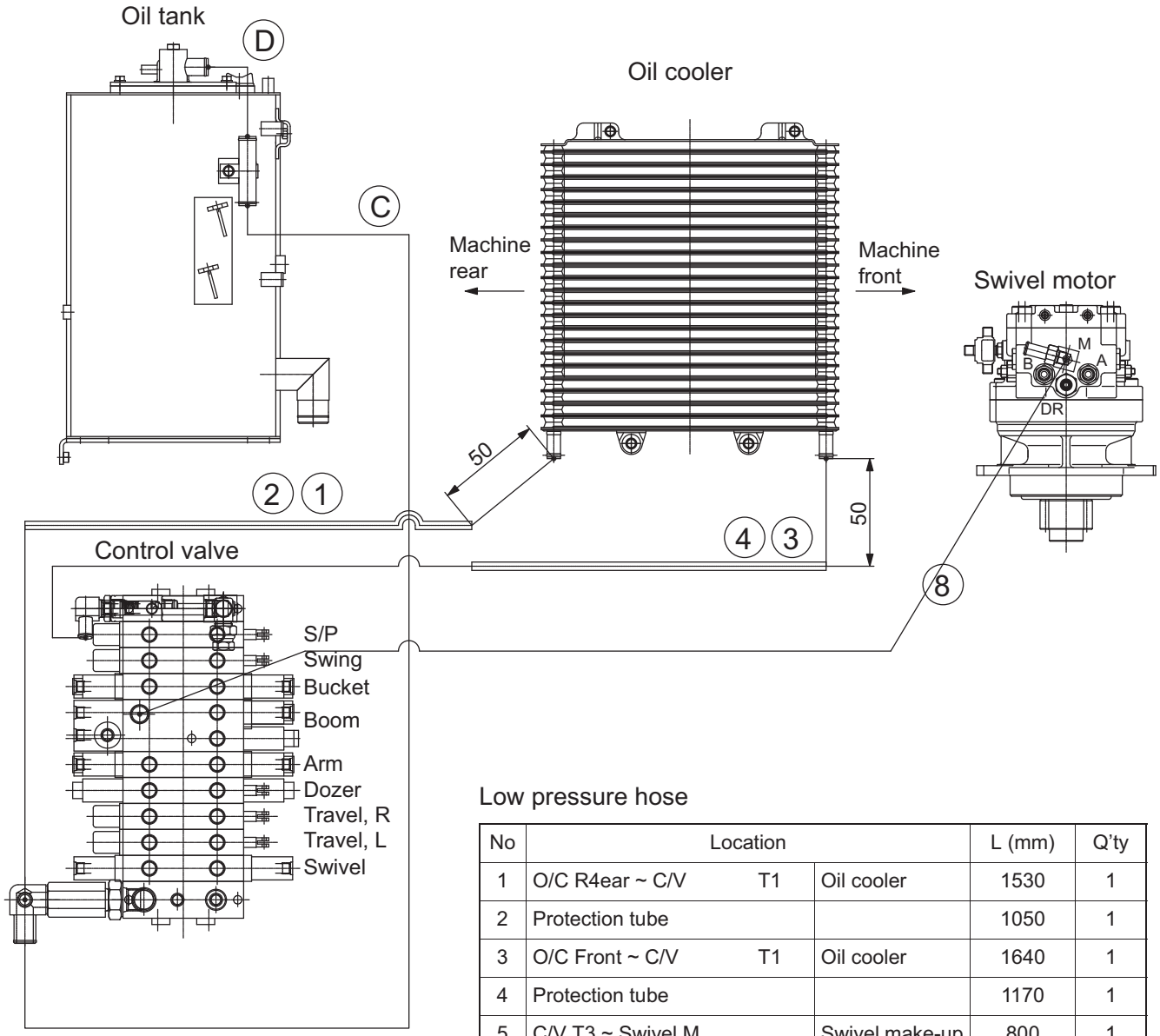
3) Hose route: Under swivel bearing





* Connect the front of the swivel joint to the left leg, and its back to the right leg.

(5) Return hose, drain hose (oil cooler)



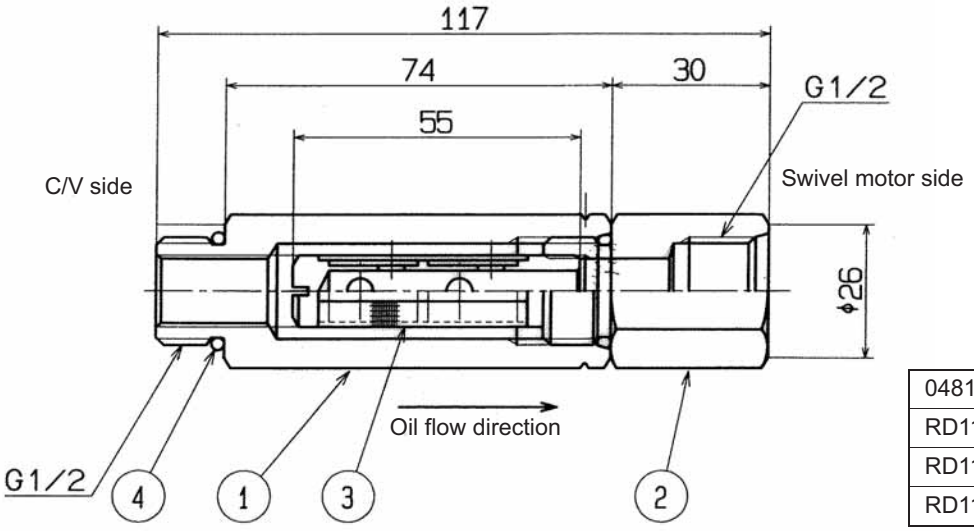
Low pressure hose

No	Location			L (mm)	Q'ty
1	O/C R4ear ~ C/V	T1	Oil cooler	1530	1
2	Protection tube			1050	1
3	O/C Front ~ C/V	T1	Oil cooler	1640	1
4	Protection tube			1170	1
5	C/V T3 ~ Swivel M		Swivel make-up	800	1

Formed hoses

C	C/V T1 ~ Return pipe	Return		1
D	Return pipe ~ Oil tank	Return		1

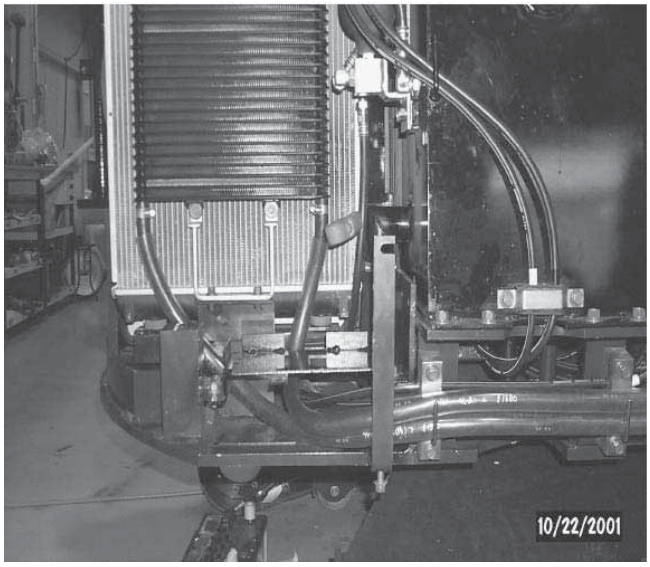
Make-up filter

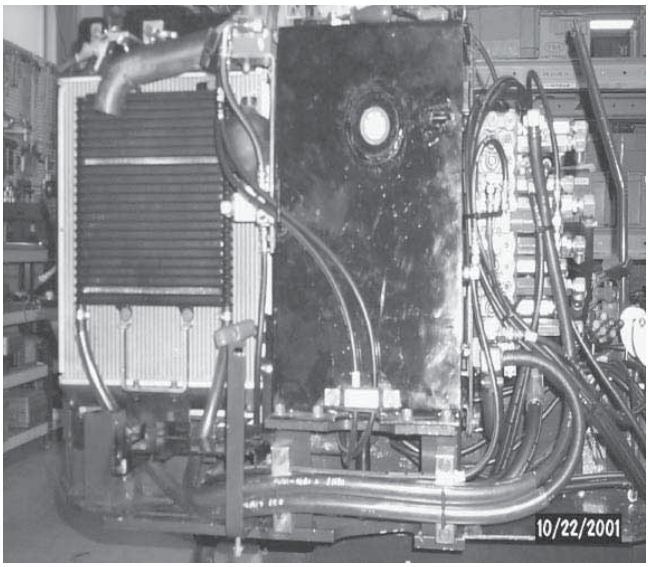


1. Oil:Hydraulic oil
2. Oil flow:20L/min
3. Oil temp.:-30°C ~ 120°C
4. Operating pressure: 21 MPa
5. Percorating grade: 177μm (80mesh)
6. Percorating area: 17.5cm^2
7. Port size:G1/2

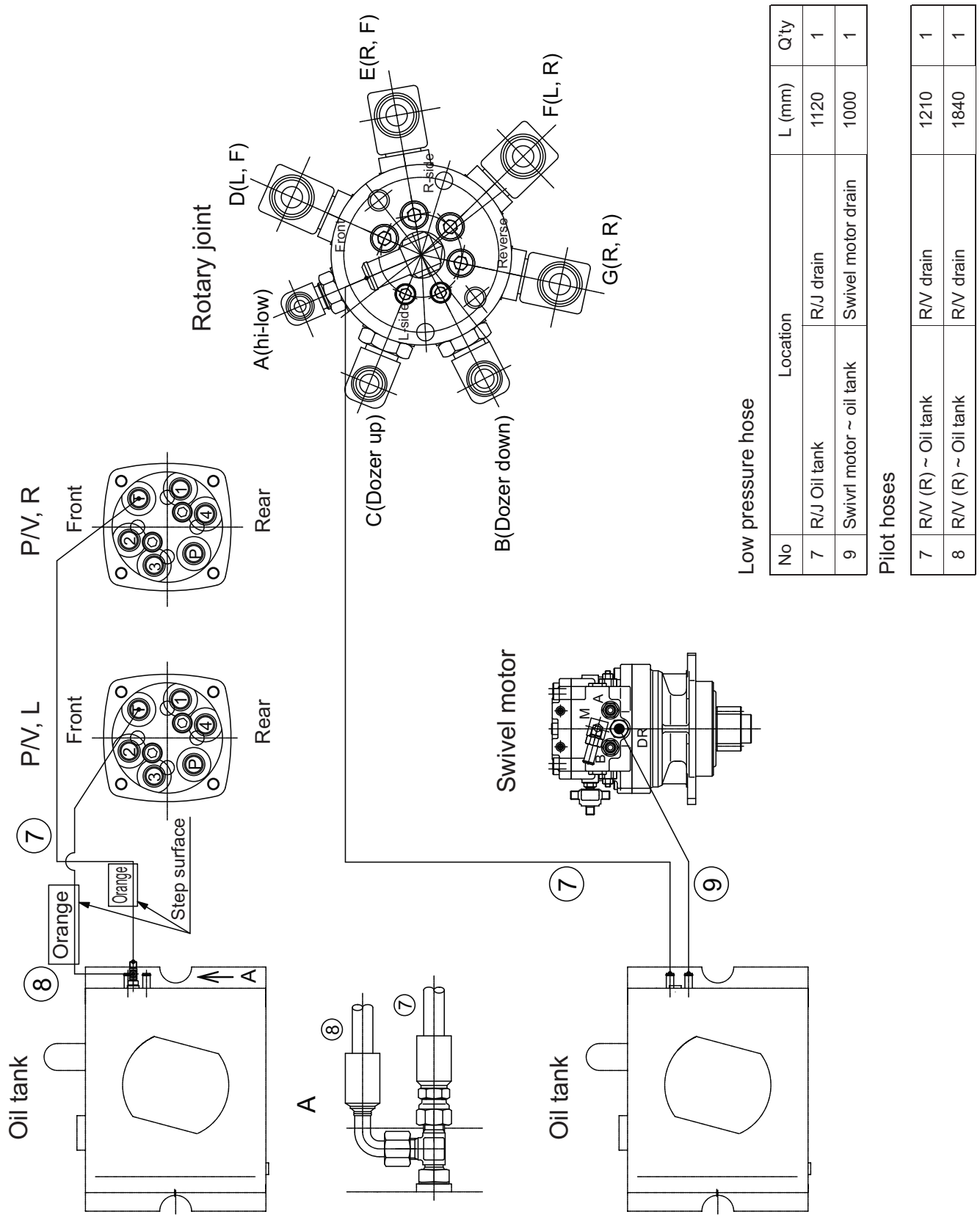
04810-00180	4	O-ring
RD118-9367△	3	Filter
RD118-9366△	2	Filter body 2
RD118-9365△	1	Filter body 1

Oil cooler hose route





(6) Return hose (pilot valve)



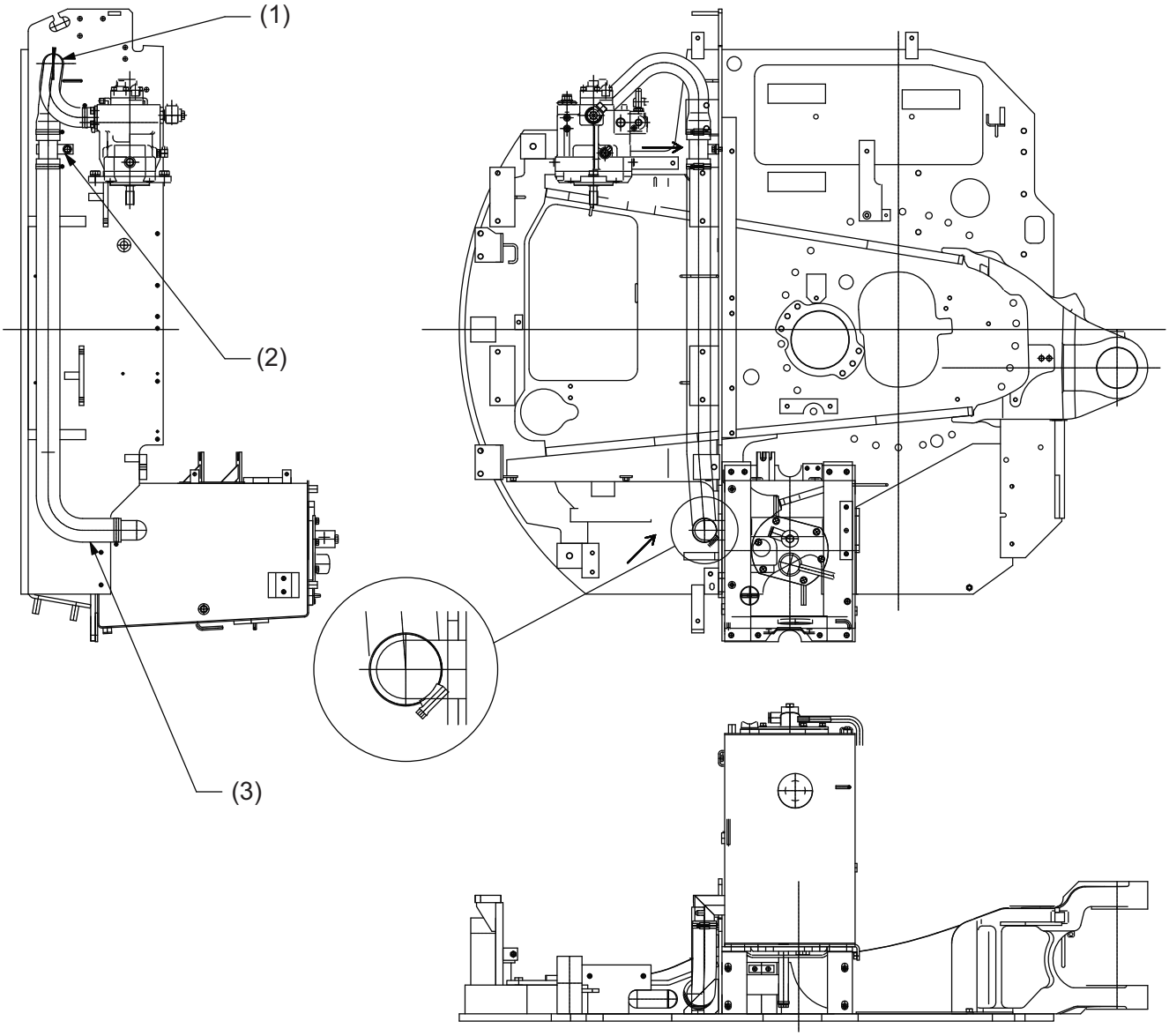
Low pressure hose

No	Location		L (mm)	Q'ty
7	R/J Oil tank	R/J drain	1120	1
9	Swivrl motor ~ oil tank	Swivel motor drain	1000	1

Pilot hoses

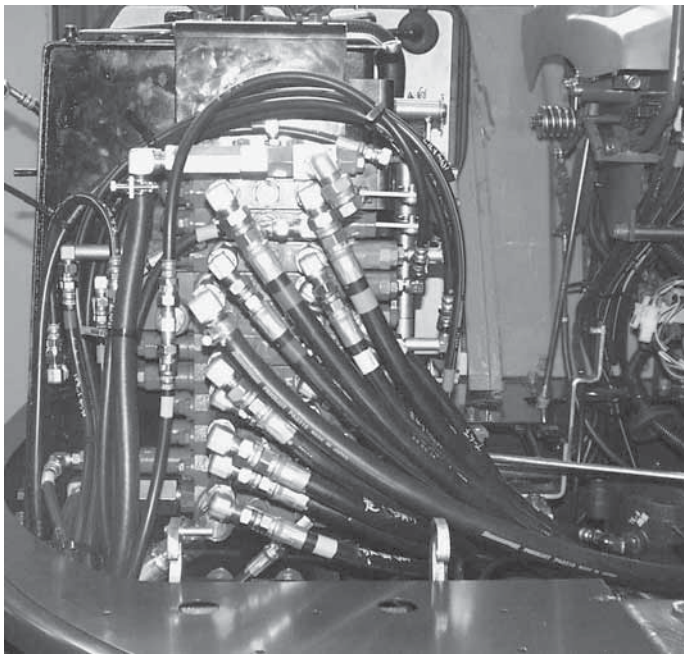
7	R/V (R) ~ Oil tank	R/V drain	1210	1
8	R/V (R) ~ Oil tank	R/V drain	1840	1

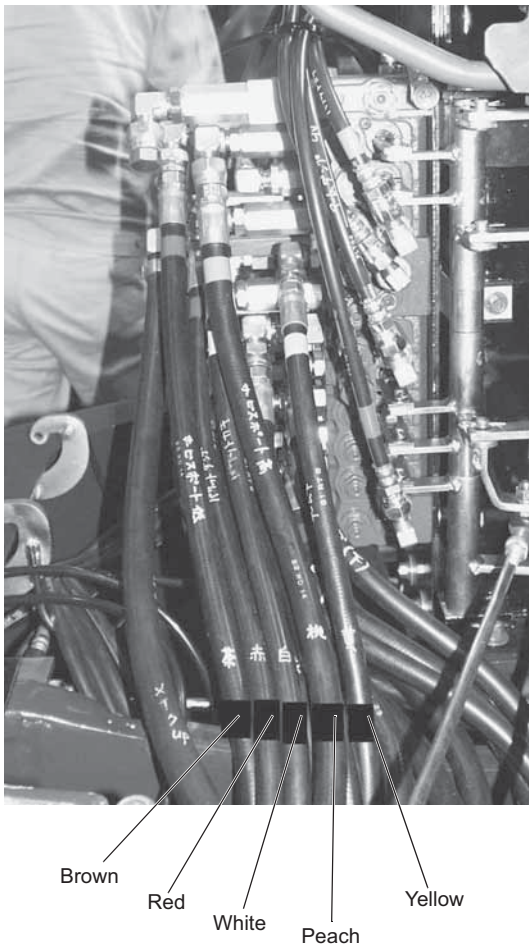
(7) Suction hose



(1) Hose (suction, 1)
RD118-6311Δ
Hose clamp (50-65) ← Pipe side
RC401-6319Δ
Fastening band ← Pump side
35820-1518Δ
(2) Hose (suction)
RD411-6312
Bolt
01135-61020
Pay special attention not to allow contact with the fuel tank.
(3) Hose (suction, 1)
RD411-6313Δ
Hose clamp (50-65)
RC401-6319Δ

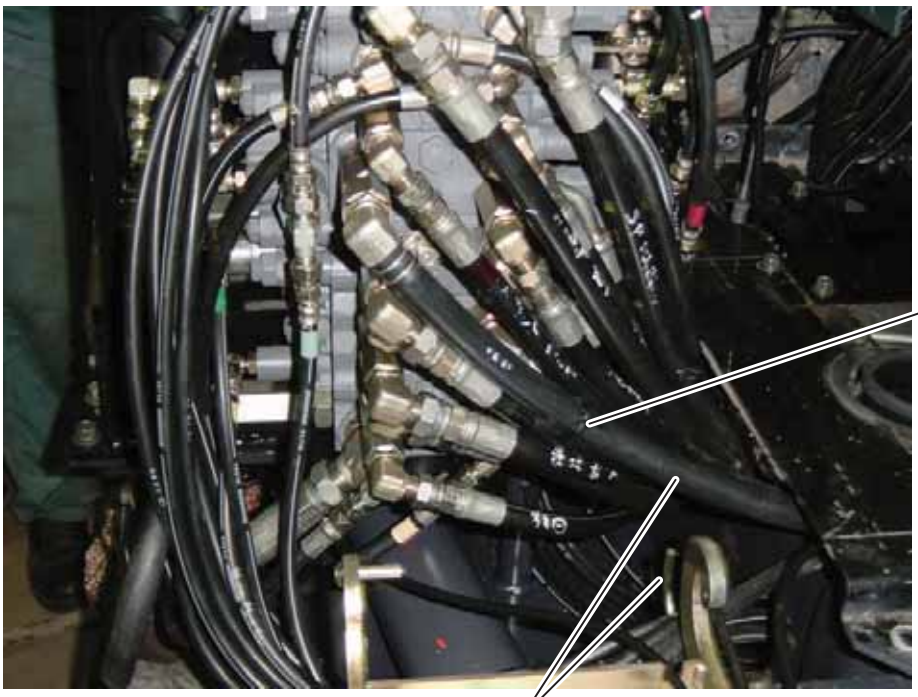
(8) Front hose ~ C/V



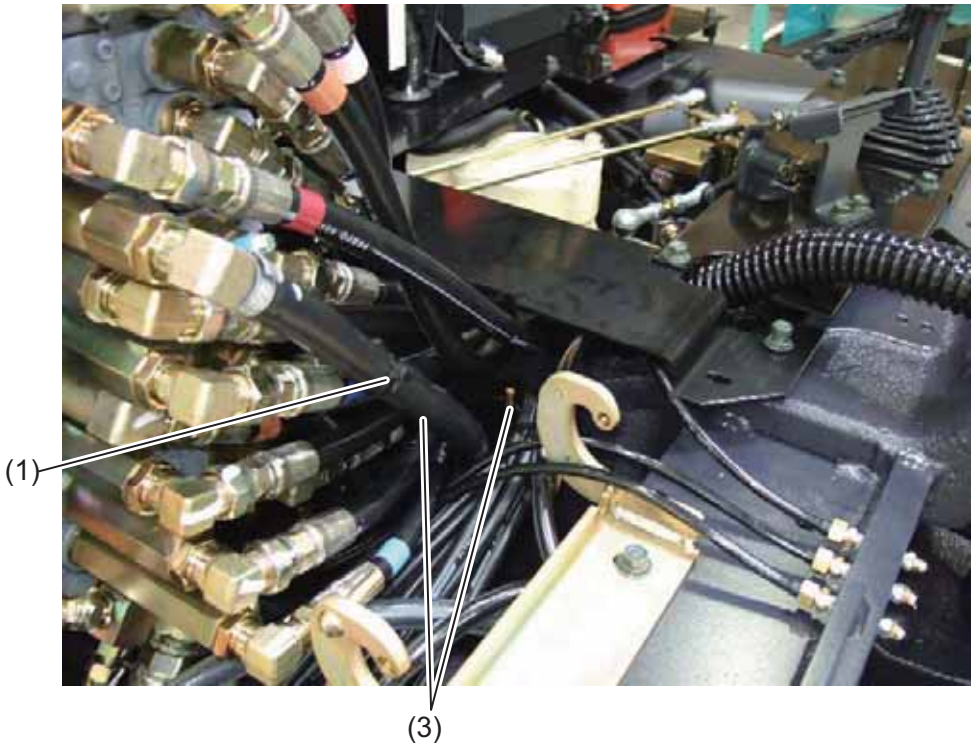


(9) Front hoses (make-up hose): minor change

KX121-3ST



KX161-3ST, U45-3ST

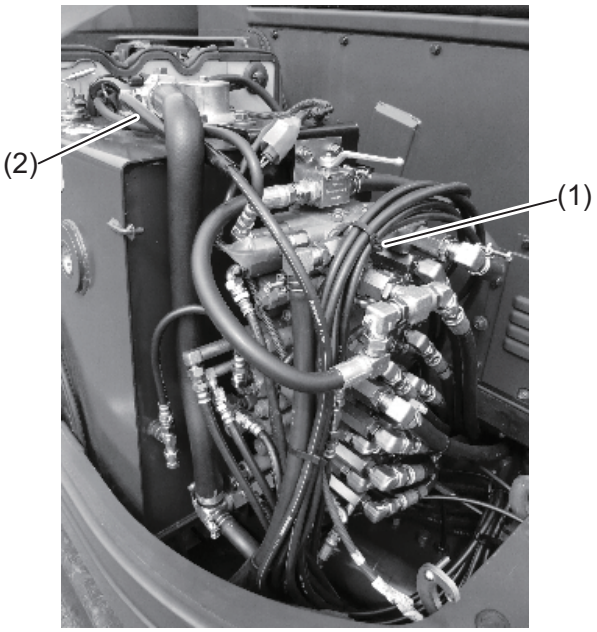


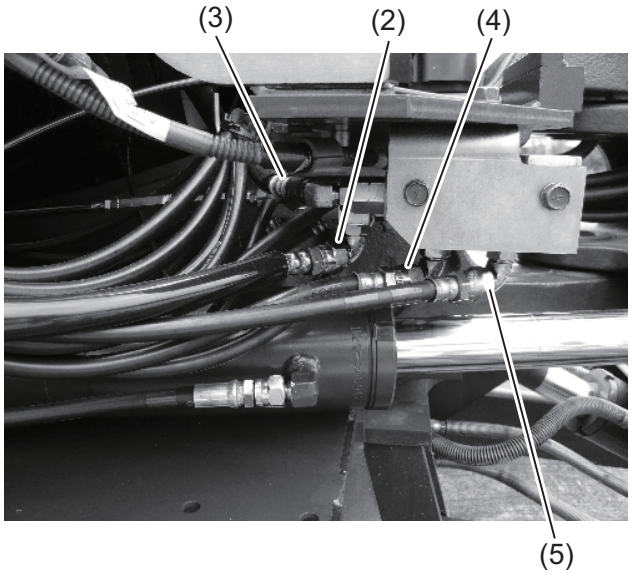
(1) Clamp the make-up hose and arm crowd (blue)
(2) Let the make-up hose run ABOVE the U clevis
(3) Let the make-up hose run UNDER the U clevis

Note: ST means minor change version of -3S series.

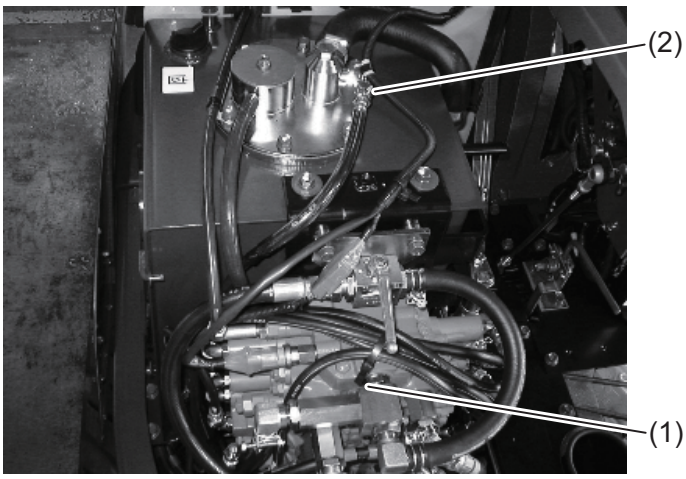
(10) SP proportional valve: minor change

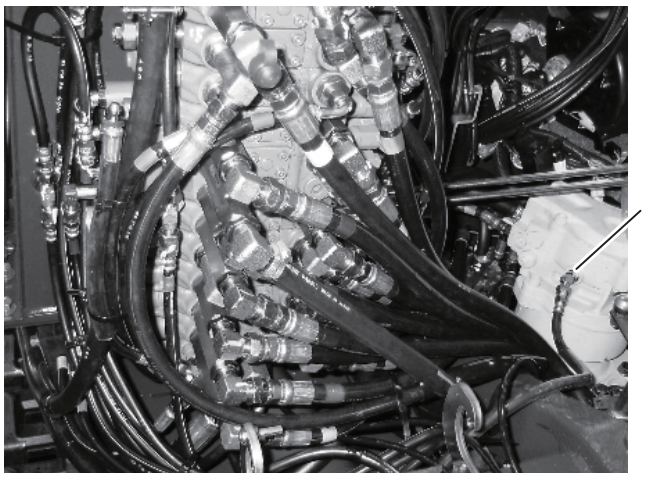
KX121-3S/α

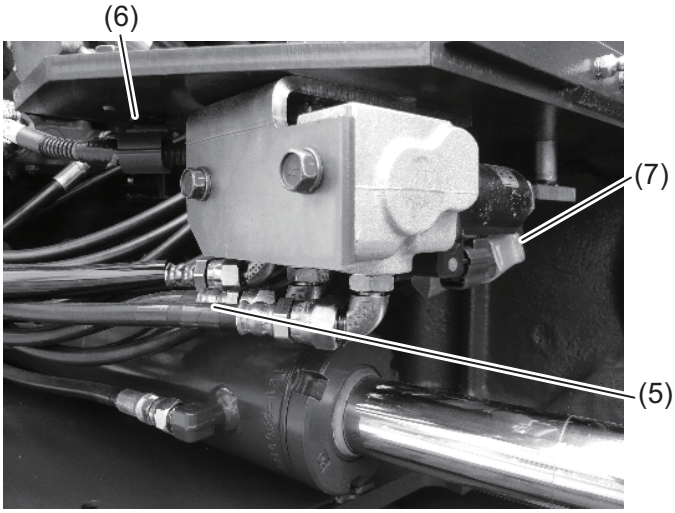




KX161-3S/α, U45S, U45-3S/α, U50-3α



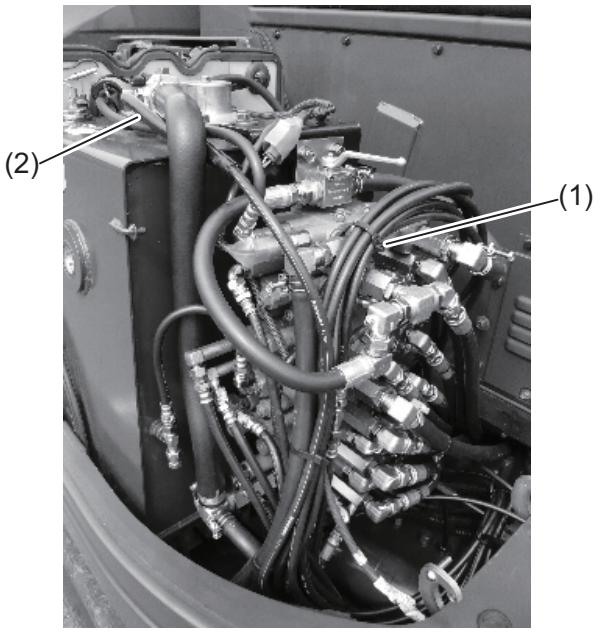


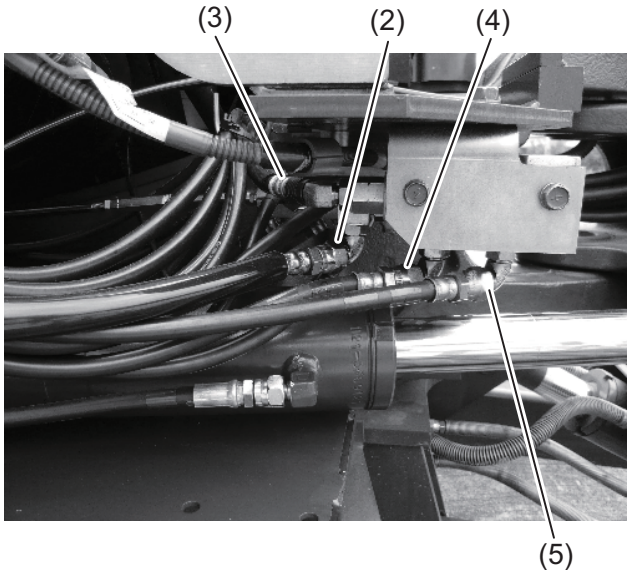


(1) Clamp with the pipe joint
(2) From the SP valve's T port to the hydraulic tank (the protective tube is at the tank side)
(3) Insert the coupler to the swivel motor securely
(4) From the SP valve A1 port to the left side of C/V (the machine rear side, orange tape)
(5) From the SP valve A2 port to the right side of C/V (the machine front side, light green tape)
(6) Insert the harness clamp
(7) Red tape, the harness is at front
(8) Adaptor assembly angle (10° downwards from horizontal line)

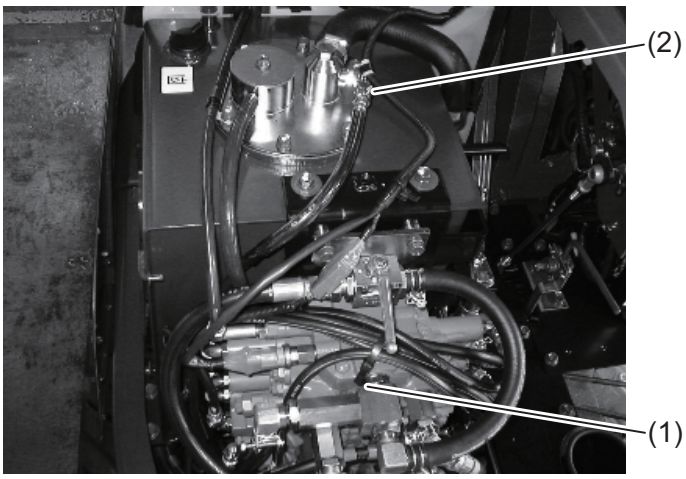
(11) SP proportional valve: minor change

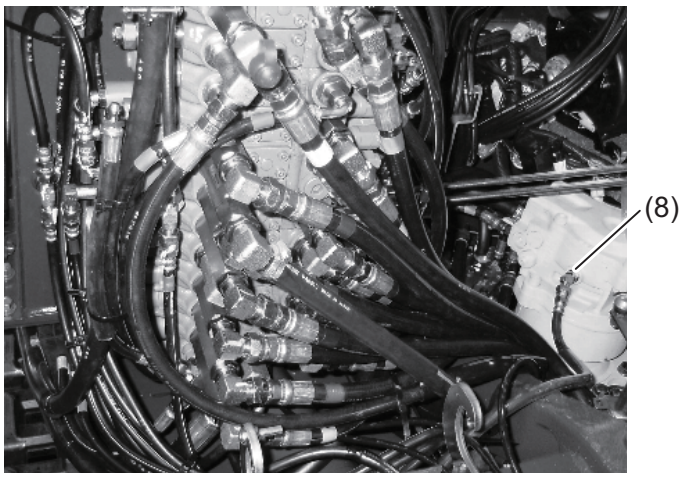
KX121-3ST

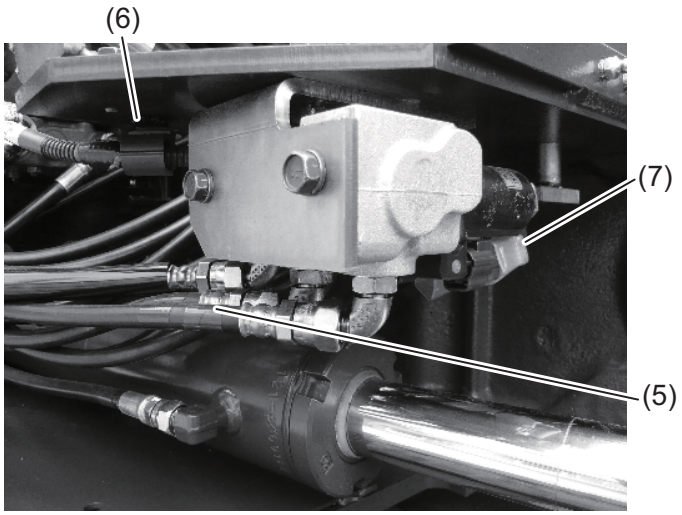




KX161-3ST, U45ST



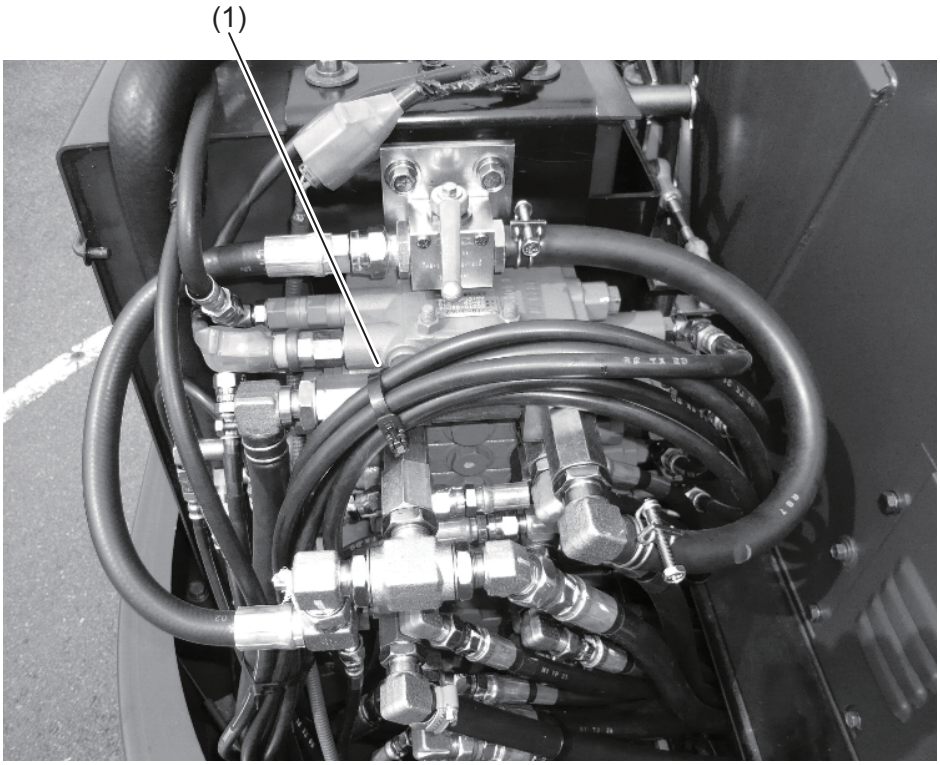




Note: ST means minor change version of -3S series.

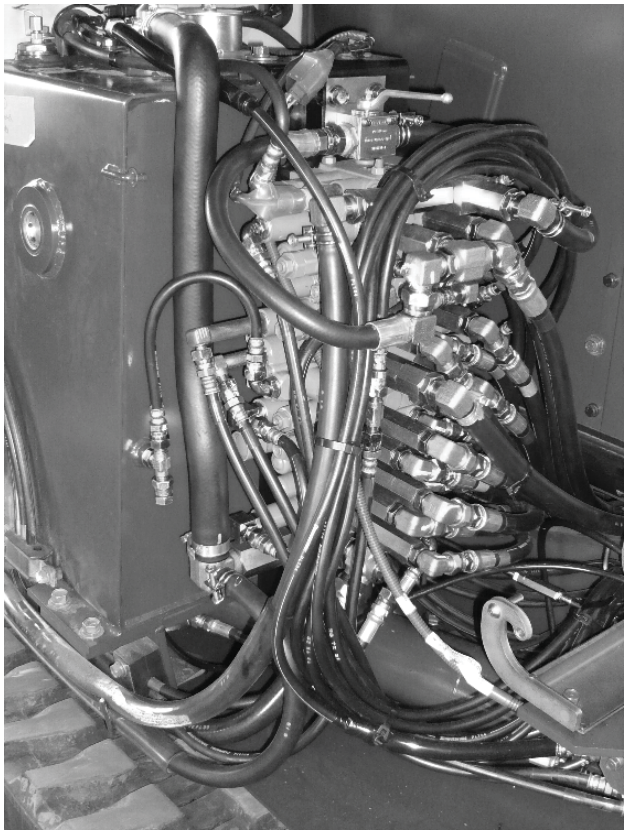
(1) Clamp with the pipe joint
(2) From the SP valve's T port to the hydraulic tank (the protective tube is at the tank side)
(3) Insert the coupler to the swivel motor securely
(4) From SP valve A1 port to the C/V left side (the machine rear side, orange tape)
(5) From SP valve A2 port to the C/V right side (light green tape)
(6) Insert the harness clamp
(7) Red tape, the harness is at front
(8) Adaptor assembly angle (10° downwards from horizontal line)

(12) Control valve: Angle blade and third-line



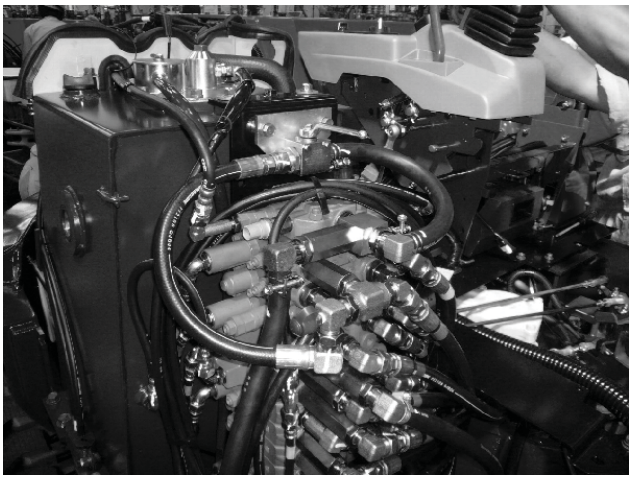
(1) Clamp with the pipe joint

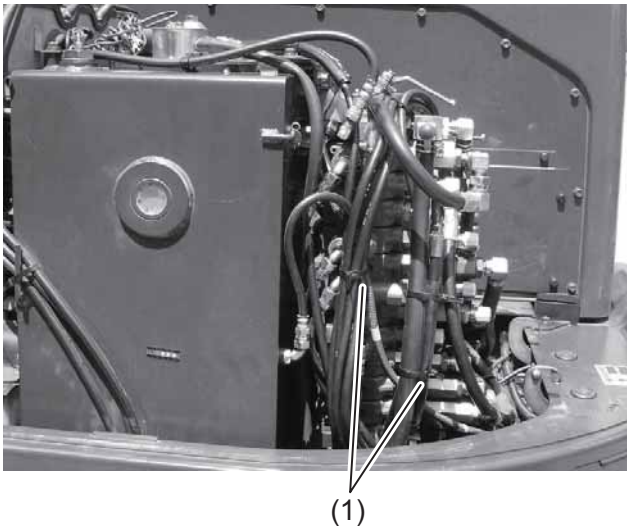
(The angle blade and the third-line version)



(13) Control valve: Angle blade and third-line

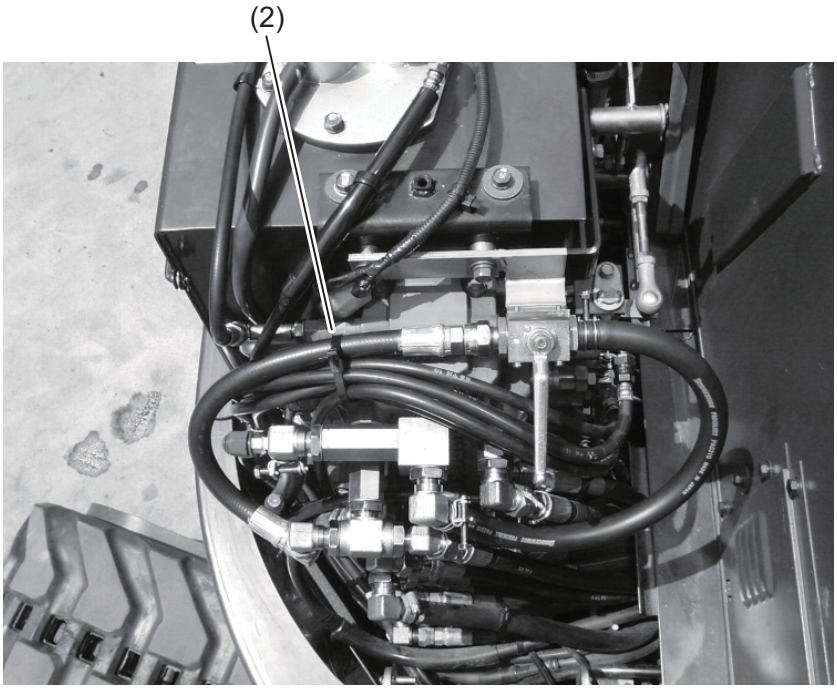
(The third-line specifications)





(1) Clamp with the harness

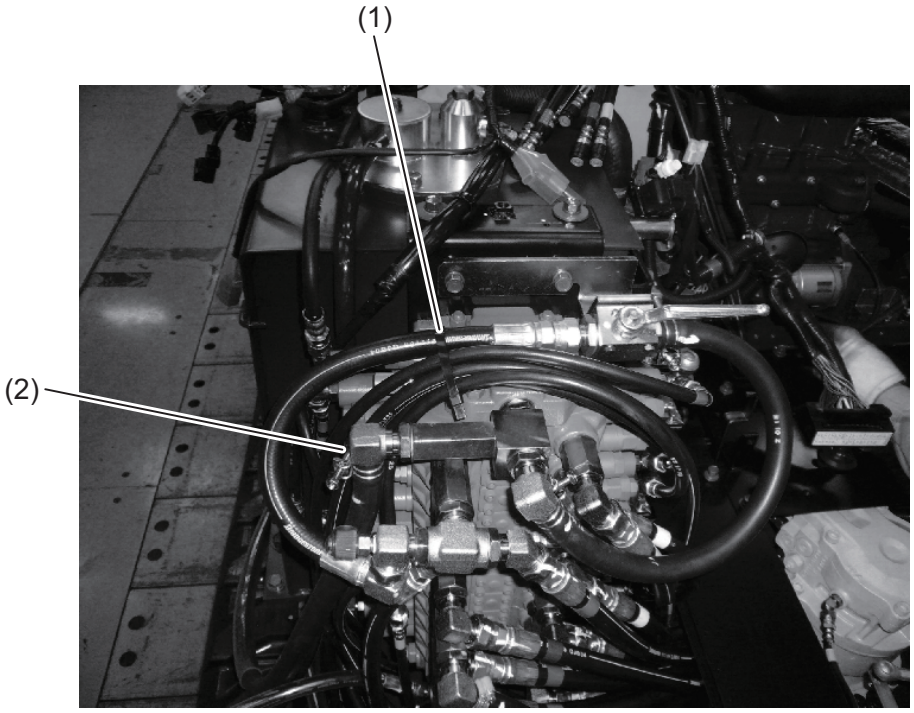
(With the angle blade and the third-line)



(2) Clamp with the third-line hose

(14) Control valve: Angle blade and third-line (KX161-3ST)

(Specifications for the angle blade and the third-line version)



(1) Clamp with the third line hose
(2) The band's screw should not touch the hose

Note: ST means minor change version of -3S series.

(14) Hose list: KX121-3α/S/ST

Pilot hose

No.	Location	Hose size	Q'ty	Length: mm (EU-version)	Tape color	Hose configuration	Remarks
1	Pump ~ Line filter	3/8	1	300		G3/8 PLTO06 G3/8	
2	Line filter ~ Check valve (Accumulator)	3/8	1	300	Red	G3/8 PLTO06 G3/8	
3	Change valve ~ Swivel motor, Brake release P6	1/4	1	1960	White	G1/4 PLTO04 G1/4	
4	Change valve ~ R/J, High-speed	1/4	1	2060	Black	G1/4 PLTO04 G1/4	
5	P/V(R)P ~ Swivel motor Pb	1/4	1	1200	White	Quick PLTO04 G1/4	
6	P/V(L)P ~ Swivel motor Pb	1/4	1	1800	White	Quick PLTO04 G1/4	
7	P/V(R)P ~ Oil tank, P/V drain	1/4	1	1210	Orange	Quick PLTO04 G1/4	
8	P/V(L)P ~ Oil tank, P/V drain	1/4	1	1840	Orange	Quick PLTO04 G1/4	
9	C/V ~ Oil tank, boom lock drain	1/4	1	320		G1/4 PLTO04 G1/4	
10	C/V ~ C/V, lock valve release	1/4	1	570		G1/4 PLTO04 G1/4	
11	P/V ~ C/V, bucket dump	1/4	1	2320	Brown	Quick PLTO04 G1/4	
12	P/V ~ C/V, bucket crowd	1/4	1	2900	Peach	Quick PLTO04 G1/4	
13	P/V ~ C/V, swivel, L	1/4	1	3800	Red	Quick PLTO04 G1/4	
14	P/V ~ C/V, Swivel, R	1/4	1	2900	Yellow	Quick PLTO04 G1/4	
15	TPSS ~ C/V, boom up	1/4	1	710	Gray	Quick PLTO04 G1/4	PP
16	TPSS ~ C/V, boom down	1/4	1	630	L. Blue	Quick PLTO04 G1/4	PP
17	TPSS ~ C/V, arm dump	1/4	1	1430	Blue	Quick PLTO04 G1/4	PP
18	TPSS ~ C/V, arm crowd	1/4	1	660	Green	Quick PLTO04 G1/4	PP
19	TPSS ~ P/V, boom up	1/4	1	1560	Gray	G1/4 PLTO04 Quick	PP
20	TPSS ~ P/V, boom down	1/4	1	1600	L. Blue	G1/4 PLTO04 Quick	PP
21	TPSS ~ P/V, arm dump	1/4	1	2350	Blue	G1/4 PLTO04 Quick	PP
22	TPSS ~ P/V, arm crowd	1/4	1	2250	Green	G1/4 PLTO04 Quick	PP

No.	Location	Hose size	Q'ty	Length: mm (EU-version)	Tape color	Hose configuration	Remarks
23	Change valve ~ Oil tank	3/8	1	300		G3/8 PLTO06 G3/8	
24	Pump drain	3/16	1	650		G1/4 PLTO03 Quick	Corrugate
25	Change valve ~ Travel lock valve	1/4	1	2720	Green	Quick PLTO04 Quick	Vinyl tube
26	P/V ~ C/V, boom up	1/4	1	(2360)	Gray	Quick PLTO04 G1/4	
27	P/V ~ C/V, boom down	1/4	1	(2200)	L. Blue	Quick PLTO04 G1/4	
28	P/V ~ C/V, arm dump	1/4	1	(3780)	Blue	Quick PLTO04 G1/4	
29	P/V ~ C/V, arm crowd	1/4	1	(2900)	Green	Quick PLTO04 G1/4	
30	Accumulator ~ Change valve	3/8	1	2130	Red	G3/8 PLTO06 G3/8	
31	Line filter ~ Control valve (AI)	1/4	1	2400	Red	G1/4 PLTO04 G1/4	
32	S/P solenoid valve (P) ~ Swivel motor	1/4	1	690	White	G1/4 PLTO04 Quick	Vinyl tube
33	S/P solenoid valve (T) ~ Tank	1/4	1	1170		G1/4 PLTO04 G1/4	Vinyl tube
34	S/P solenoid valve (A1) ~ Control valve (S/P, H)	1/4	1	1170	Orange (double)	G1/4 PLTO04 G1/4	
35	S/P solenoid valve (A2) ~ Control valve (S/P, L)	1/4	1	770	Yellowish green (double)	G1/4 PLTO04 G1/4	

High pressure hose (Upper frame)

No.	Location	Hose size	Q'ty	Length: mm (EU-version)	Tape color	Hose configuration	Remarks
1	Pump ~ C/V P (delivery)	3/4	1	2560	Red, White	G3/4 PF2112 G3/4	Pump side: Red
2	Pump ~ C/V P_{PS}	1/4	1	2430	Red, White	G1/4 PF2104 G1/4	Pump side: Red
3	Pump ~ C/V P_{LS}	1/4	1	2330	Red, White	G1/4 PF2104 G1/4	Pump side: Red
4	C/V ~ Boom back (Boom up)	3/8	1	2380	Green	G3/8 PF2106 G3/8	Corrugate
5	C/V ~ Boom back (Boom down)	3/8	1	2380	Yellow	G3/8 PF2106 G3/8	Corrugate
6	C/V ~ Boom back (Arm dump)	1/2	1	2220	Black	G1/2 PF2108 G1/2	Corrugate
7	C/V ~ Boom back (Arm crowd)	1/2	1	2320	Blue	G1/2 PF2108 G1/2	Corrugate
8	C/V ~ Boom back Bucket dump	3/8	1	2290	Red	G3/8 PF2106 G8/8	Corrugate
9	C/V ~ Boom back Bucket crowd	1/2	1	2260	White	G3/8 PF2106 G3/8	Corrugate

No.	Location	Hose size	Q'ty	Length: mm (EU-version)	Tape color	Hose configuration	Remarks
10	Boom back ~ Boom cylinder, (boom up)	1/2	1	930		G1/2 PF2108 G1/2	Corrugate
11	Boom back ~ Boom cylinder, (boom down)	1/2	1	↑		↑	
12	Pipe ~ Bucket cylinder, (Bucket dump)	1/2	1	1550		G1/2 PF2108 G1/2	Super anti-wear hose
13	Pipe ~ Bucket cylinder, (Bucket crowd)	1/2	1	1220		G1/2 PF2108 G1/2	Super anti-wear hose
14	Boom back ~ Arm cylinder, (arm dump)	1/2	1	1415		G1/2 PF2108 G1/2	
15	Boom back ~ Arm cylinder, (arm crowd)	1/2	1	650		G1/2 PF2108 G1/2	
16	C/V ~ R/J, travel, L, F	1/2	1	685	Blue	G1/2 PF2108 G1/2	Spiral protection
17	C/V ~ R/J, travel, L, R	1/2	1	505	Red	G1/2 PF2108 G1/2	
18	C/V ~ R/J, travel, R, F	1/2	1	635	Green	G1/2 PF2108 G1/2	Spiral protection
19	C/V ~ R/J, travel, R, R	1/2	1	565	Yellow	G1/2 PF2108 G1/2	
20	C/V ~ Swivel motor, L	3/8	1	1250	Gray	G3/8 PF1706 G3/8	Spiral protection
21	C/V ~ Swivel motor, R	3/8	1	1250	L. Blue	G3/8 PF1706 G3/8	
22	C/V ~ Swing Cylinder, L	1/4	1	720	Yellow/ Green	G1/4 PF2104 G1/4	
23	C/V ~ Swing Cylinder, R	1/4	1	880	Orange	G1/4 PF2104 G1/4	
24	C/V ~ R/J, dozer up	3/8	1	765	Peach	G3/8 PF2106 G3/8	
25	C/V ~ R/J, dozer down	3/8	1	645	Brown	G3/8 PF2106 G3/8	
26	C/V ~ Pipe, SP delivery	1/2	1	2330 (2270)	Peach	G1/2 PF2108 G1/2	Corrugate
27	C/V ~ Pipe, SP return	1/2	1	2340 (2280)	Brown	G1/2 PF2108 G1/2	Corrugate
28	Boom center ~ SP delivery	5/8	1	500		G1/2 PF2110 G1/2	
29	Boom center ~ SP return	↑	1	↑		↑	
30	Arm tip ~ SP delivery	↑	1	880		G1/2 PF2110 G1/2	Spiral protection
31	Arm tip ~ SP return	↑	1	↑		↑	

High pressure hose (Under carriage)

No.	Location	Hose size	Q'ty	Length: mm (EU-version)	Tape color	Hose configuration	Remarks
1	R/J ~ Travel motor (Left side)	1/2	2	1200		G1/2 PF2108 G1/2	
2	R/J ~ Travel motor (Right side)	1/2	2	1060		G1/2 PF2108 G1/2	
3	R/J ~ Travel motor high speed (Left side)	1/4	1	1260		G1/4 PF2108 G1/4	
4	R/J ~ Travel motor high speed (Right side)	3/8	1	↑		↑	
5	R/J ~ Pipe, dozer up	3/8	1	450		G3/8 PF2106 G3/8	
6	R/J ~ Pipe, dozer down	3/8	1	285		G3/8 PF2106 G3/8	
7	R/J ~ Dozer cylinder, up, down	3/8	2	450		G3/8 PF2106 G3/8	SP Protection

Low pressure hose

No.	Location		Name	Q'ty	Size			Hose clamp	Remarks
					Length	Din	Dout		
1	Oil cooler rear ~ C/V, T1	Oil cooler	Cooler, hose1	1	1530	15.9	2.3.5	Hose clamp (screw type)	PA0310
2	(Protection tube)		Tube(1050)	1	1050	26	30		
3	Oil cooler front ~ C/V, T2	Oil cooler	Cooler, hose2	1	1640	15.9	23.5	Hose clamp (screw type)	PA0310
4	(Protection tube)		Tube(1170)	1	1170	26	30		
5	R/J ~ Travel motor	Travel motor drain, L	Hose(1/2)	1	1180	13	19.8	Hose clamp (13 - 20)	OKE08
6	R/J ~ Travel motor	Travel motor drain, R	Hose(1/2)	1	1090	13	19.8	Hose clamp (13 - 20)	OKE08
7	R/J ~ Oil tank	R/J drain	Drain hose, travel	1	1120	13	19.8	Hose clamp (13 - 20)	OKE08
8	C/V T3 ~ Swivel motor	Swivel make up drain	Make up hose	1	800	15.9	23.5	Hose clamp (15 - 24)	PA0310
9	Swivel motor ~ Oil tank	Swivel motor drain	Drain hose, swivel	1	1000	13	19.8	Hose clamp (13 - 20)	OKE08

Suction & return hose

No.	Location		Name	Q'ty				Hose clamp	Remarks
A	Oil tank ~ Suction hose	Suction	Suction hose 2	1				Hose clamp (50-65)	
B	Pipe (Suction) ~ Pump	Suction	Suction hose 1	1				Hose clamp (50-65)	To pipe
								Hose clamp (50-65)	To pump
C	C/V T1 ~ Pipe (Return)	Return	Return hose 2	1				Hose clamp (26-38)	
D	Pipe (Return) ~ Oil tank	Return	Return hose 1	1				Hose clamp (26-38)	

Pilot hose list: KX161-3α/S/ST

No.	Location	Code No. KX161-3 (US)	Code No. KX161-3 (EU)	Hose size	Q'ty	Length (mm) (EU)	Tape color	Hose configuration			Remarks
1	Pump~Line filter	⟶	RD411-6324△	3/8	1	285		G3/8	PLT06	G3/8	
2	Line filter~ Change valve(Accumulator)	RD411-6325△	RD119-6325△	3/8	1	1800(1610)	Red	G3/8	PLT06	G3/8	
3	Change valve~ Swivel brake release	⟶	RD411-6327△	1/4	1	2050	White	G1/4	PLT04	G1/4	
4	Change valve~ R/J Travel Hi-Low	⟶	RD411-6446△	1/4	1	2050	Black	G1/4	PLT04	G1/4	
5	P/V(R)P~Swivel motor Pb	⟶	RD411-6331△	1/4	1	1200	White	Quick	PLT04	G1/4	
6	P/V(L)P~Swivel motor Pb	⟶	RD411-6332△	1/4	1	1800	White	Quick	PLT04	G1/4	
7	P/V(R)T~Oil tank P/V drain	⟶	RD118-6334△	1/4	1	1210	Orange	Quick	PLT04	G1/4	
8	P/V(L)T~Oil tank P/V drain	⟶	RD118-6335△	1/4	1	1840	Orange	Quick	PLT04	G1/4	
9	C/V~Oil tank Boom lock drain	⟶	RD411-6356△	1/4	1	380		G1/4	PLT04	G1/4	
10	C/V~C/V Boom lock valve release	⟶	RD411-6343△	1/4	1	570		G1/4	PLT04	G1/4	
11	P/V~C/V Bucket dump	⟶	RD411-6343△	1/4	1	2570	Brown	Quick	PLT04	G1/4	
12	P/V~C/V Bucket crowd	⟶	RD411-6347△	1/4	1	3000	Peach	Quick	PLT04	G1/4	
13	P/V~C/V Swivel L	⟶	RD118-6348△	1/4	1	3800	Red	Quick	PLT04	G1/4	
14	P/V~C/V Swivel R	⟶	RD519-6349△	1/4	1	2720	Yellow	Quick	PLT04	G1/4	
15	TPSS~C/V Boom up	RD118-9631△	-	1/4	1	710	Gray	G1/4	PLT04	G1/4	
16	TPSS~C/V Boom down	RD118-9632△	-	1/4	1	630	Light blue	G1/4	PLT04	G1/4	
17	TPSS~C/V Arm dump	RD118-9633△	-	1/4	1	1430	Blue	G1/4	PLT04	G1/4	
18	TPSS~C/V Arm crowd	RD118-9634△	-	1/4	1	660	Green	G1/4	PLT04	G1/4	
19	TPSS~P/V Boom up	RD118-9641△	-	1/4	1	1560	Gray	G1/4	PLT04	Quick	
20	TPSS~P/V Boom down	RD118-9642△	-	1/4	1	1600	Light blue	G1/4	PLT04	Quick	
21	TPSS~P/V Arm dump	RD118-9643△	-	1/4	1	2350	Blue	G1/4	PLT04	Quick	
22	TPSS~P/V Arm crowd	RD118-9644△	-	1/4	1	2250	Green	G1/4	PLT04	Quick	
23	Change valve~Oil tank	⟶	RD411-6358△	3/8	1	275		G3/8	PLT04	G3/8	
24	Pump drain	⟶	RD411-6315△	3/16	1	650		G1/4	PLT04	Quick	Corrugated
25	Swivel motor~Travel lock valve	⟶	RD118-6616△	1/4	1	1000		G1/4	PLT04	Quick	Vinyle tube
26	P/V~C/V Boom up	-	RD119-6341△	1/4	1	2420	Gray	Quick	PLT04	G1/4	
27	P/V~C/V Boom down	-	RD119-6342△	1/4	1	2260	Light blue	Quick	PLT04	G1/4	
28	P/V~C/V Arm dump	-	RD119-6344△	1/4	1	3780	Blue	Quick	PLT04	G1/4	
29	P/V~C/V Arm crowd	-	RD119-6345△	1/4	1	2900	Green	Quick	PLT04	G1/4	
30	Accumulator~Change valve	-	RD119-6286△	3/8	1	230	Red	G3/8	PLT04	G3/8	
31	C/V(AI)~Accumulator(Check valve)	-	RD418-6328△	1/4	1	735		G1/4	PLT04	G1/4	
31	C/V(AI)~Change valve	RD411-6328△	-	1/4	1	620		G1/4	PLT04	G1/4	

V. ELECTRICAL SYSTEM

Mechanism Section

(A) KUBOTA INTELLIGENT CONTROL SYSTEM V-M-3
a) Development Concept of KICS V-M-3
b) Outline of Kubota ICS (Intelligent Control System) V-M-6
c) Operating Mode V-M-9
d) Service Mode Menus V-M-11
(B) NEW AUTO IDLING (AI) CONTROL SYSTEM V-M-29
a) Purpose V-M-29
b) Auto Idle Function Mechanism V-M-29
c) New Auto Idling Modification V-M-30
d) Idle-up Control V-M-37
e) Compressor Control V-M-38
f) Engine Speed Sensor V-M-39
g) Governor Sensor V-M-40
h) Accel. Sensor (Electric Accelerator) V-M-41
i) AI Pressure Switch V-M-42
(C) MAIN COMPONENT'S FUNCTION V-M-43
a) Auto Release Function V-M-43
b) Travel Hi-speed Control Circuit V-M-48
c) Meter Panel (Controller Unit) V-M-49
(D) FAILURE DIAGNOSIS V-M-51
(E) SERVICE MODE FLOW CHART V-M-65
(F) FINGER CONTROL SERVICE PORT SYSTEM V-M-67
a) Feature and Purpose V-M-67
b) Outline of Control System V-M-68
c) Hydraulic Circuit Diagram V-M-70
d) Knob Structure and Function V-M-71
e) Initial Settings of the Knob V-M-77
f) S/P Valve Start Point Setting V-M-79
g) Manual Feeling Setting V-M-85
h) Panel Display Operation Flow Chart V-M-87
i) Proportional Control Solenoid Valve (S/P Valve) V-M-96
j) Other Controls V-M-101
(G) NEW AUXILIARY OIL FLOW CONTROL V-M-103
a) System Overview V-M-103
b) Service Port Operation Method V-M-105
c) Proportional Solenoid Valve V-M-111
d) Amplifier Unit V-M-114
e) Service Mode Flow V-M-115
f) Circuit Wiring Diagram V-M-116
g) Component Layout V-M-119

(A) KUBOTA INTELLIGENT CONTROL SYSTEM

a) Development Concept of KICS

1. About the New Meter

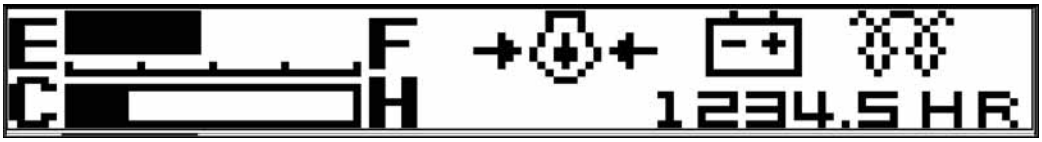
(1) The 3-ton Class Series, released in Japan in 1999 for domestic users, adopted a new meter of LCD type (called YUYU NAVI). This meter has been one of the sales points of the Series since then.
(2) Presently, the new meter is applied to models for domestic users only. (No models for overseas users adopt this meter.)
(3) It has a stable reputation for providing advanced performance, convenience and user-friendliness; this new device should be added the overseas models.
(4) As of 2004, LCD type meter has already been incorporated in KX41-3, KX61-3 and KX71-3. Now this meter is going to be applied to KX91-3S/α to KX161-3S/α and U35 to U45-3S/α all of 3-ton to 5-ton models.

2. Features of the New Meter

(1) Advanced performance:
Digital display (multi-language support for EU-version), alarm sound, and figure showing (see Fig. 2 on the next page.)
(2) Parts integration:
Relays and controllers supporting a variety of functions for conventional models are integrated into the new meter for space saving and high cost performance. (Relays partly need to be installed externally.)
(3) Functions in a wide variety
1. Warning and self-diagnostic functions:
The following items are displayed on the LCD with graphics, failure (warning) numbers, and characters along with an alarm sound.
• Remaining fuel (see Fig. 3 on the next page.)
• Oil pressure (see Fig. 4 on the next page.)
• Charge (see Fig. 5 on the next page.)
• Overvoltage
• Overheating
2. Maintenance time instruction function:
"SERVICE HOURS" appears whenever the time has come for the inspection and replacement of the oil filter as explained in the manual, and prompts the user to make an inspection.
3. Fuel replenishment assist function:
The meter beeps intermittently at the time of fuel replenishment, and the interval between beeps is shortened when the tank is almost filled to prevent the fuel from overflowing.
The beep functions with the key turned OFF, but one of the switch needs to be pressed.
4. Service tester function:
This function allows the monitoring of the operation of electrical devices (e.g., an oil pressure switch) connected to the meter, and provides the history of failures resulted in the past (see Figs. 6 and 7 on the next page).
During harness manipulation mode, it is possible to diagnose and single out harness components that have internal failures (e.g., contact failures).
5. Other functions
• Low travel speed reset at the time of restarting the engine (if the engine is turned OFF with high-low switch set to the high range).
• Engine start check (preventing the engine from starting with the lever unlocked).
• Starter motor automatic disconnection → Auto release
• Auto glow
• Built-in hour meter and display
• Built-in tachometer and display
6. Expansion function for this minor change:
• Monitoring with theft prevention set up (EU-version only)
• Service port (thumb) hand-held proportional control
• Air-conditioner idling control
• Auto idling

(Reference) LCD Display Examples of New Meter

Fig. 1
Normal screen



Key switch ON (Only the glowing moment)

Normal screen (with the tachometer selected)

Normal screen (with the hourmeter selected)

Fig. 2
Language selection screen
(KCL-ver)

Fig. 3

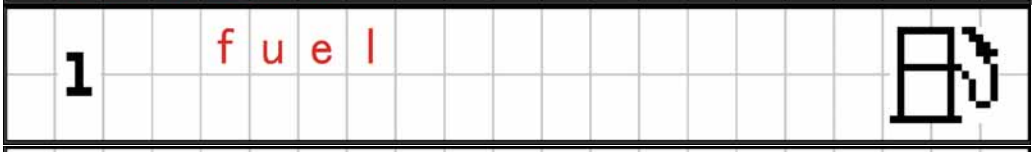


Fig. 4

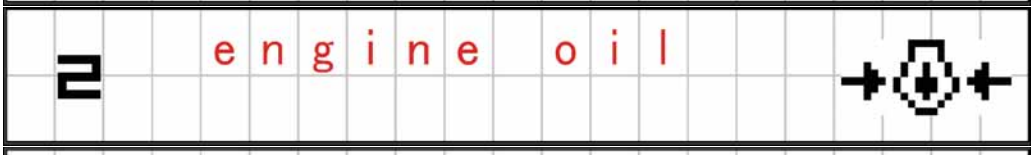


Fig. 5

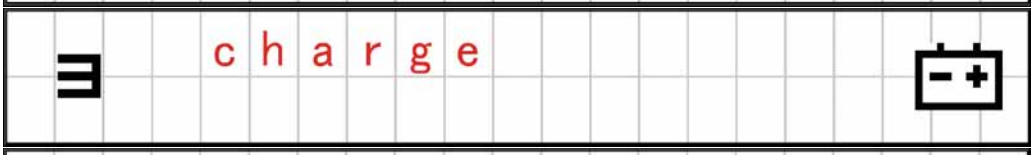


Fig. 6

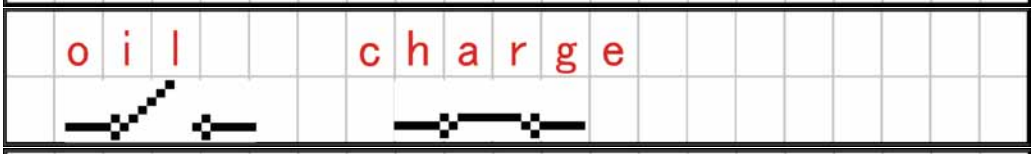
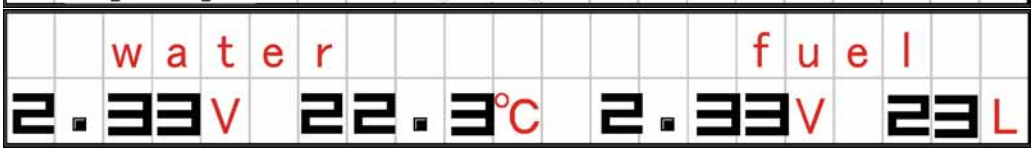


Fig. 7



Functional Comparison:
KX121-3α/S/ST, 161-3α/S/ST, U45S/ST, U45-3α/S/ST, U50-3α

No.	Function	EU-version	North America & Oceania
1	KICS; Kubota Intelligent Control System, LCD (liquid crystal display) with character and illustration	Yes	Yes
2	Maintenance indication upon hour meter	Yes (delete method: manual)	Yes (delete method: auto)
3	Anti-theft system	Yes	No
4	AI (Auto idle) function	Yes	Yes
5	Engine overheat warning	Yes	No
6	Starter motor auto release function	Yes	Yes
7	Glowplug auto glow function	Yes	Yes
8	Travel high-low switch at dozer lever grip	Yes	Yes
9	Fuel feed assist sound	Yes	Yes
10	Heater	Yes (cab version)	Yes (cab version)
11	Rotating lamp	Harness and switch are equipped as standard	Harness is incorporated
12	Service port (thumb) finger-control	Yes	Yes
13	Air-conditioner idling control	Yes	Yes
14	Low temp. idle up control	Yes	Yes
15			

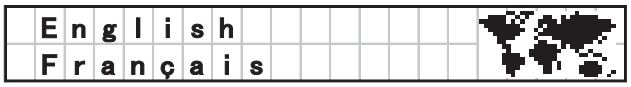
b) Outline of Kubota ICS (Intelligent Control System)

Feature of LCD Navigation System①

(K.I.C.S. : Kubota Intelligent Control System)

①Advanced Feature

・Digital display (Multi language),
Design
Alarm sound



②Integrated function

・Space saving/High Cost performance

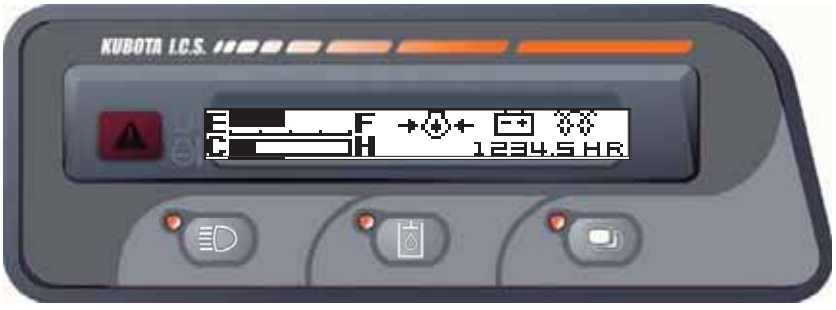
③Additional function

・Convenient function by easy operation.

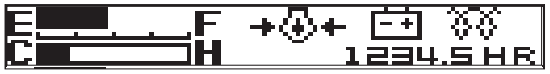
Feature of LCD Navigation System②

Additional function

(1) Normal display



Key sw ON

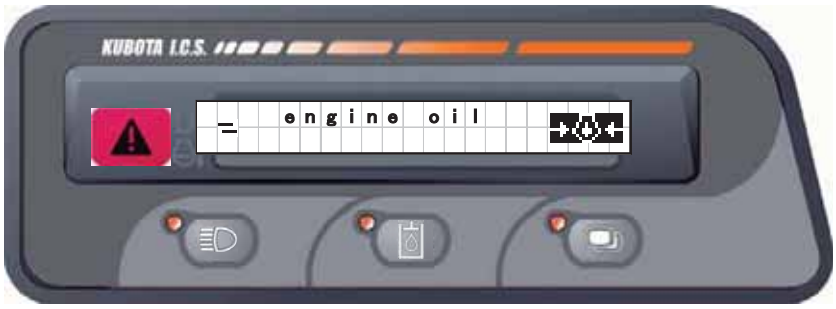


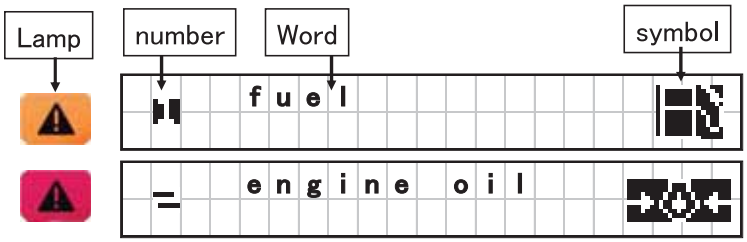
Normal display
・Hour meter
・Tachometer

Feature of LCD Navigation System②

Additional function

(2)Warning & failure





The number is coordinated with the manual.

Feature of LCD Navigation System③

Additional function

(3)display of service maintenance time

[Service Schedule Reminder]

North America & Oceania – version
Message disappears in 10 seconds
Remind operators of the message for 10 times

EU – Version
Push the work lamp switch for 3 seconds and message will disappear.

Feature of LCD Navigation System④

Additional function

(4)Refueling assistance

Prevents Fuel Overflow.

[Specification]

Buzzer sound changes

according to fuel level.

pi___pi___ → pi_pi_pi → pi----------

Push with key off.

And this function starts.

Feature of LCD Navigation System⑤

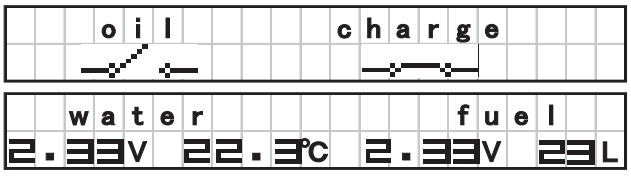
Additional function

(6) The serviceman's support function.

Repairing time becomes shorter.

(for example)

・Tester Function



・Fail record

c) Operating Mode

1. Outline

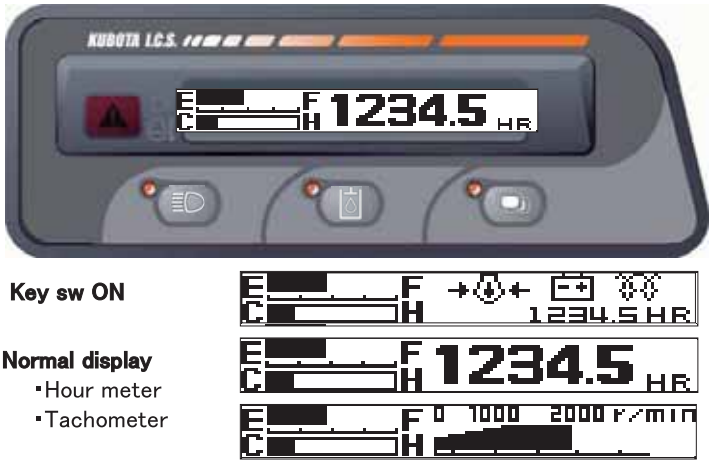
In operating mode, normally LCD shows three types of information.

1) Key switch ON
2) Normal display, hour meter
3) Normal display, tachometer

Feature of LCD Navigation System①

Additional function

(1) Normal display

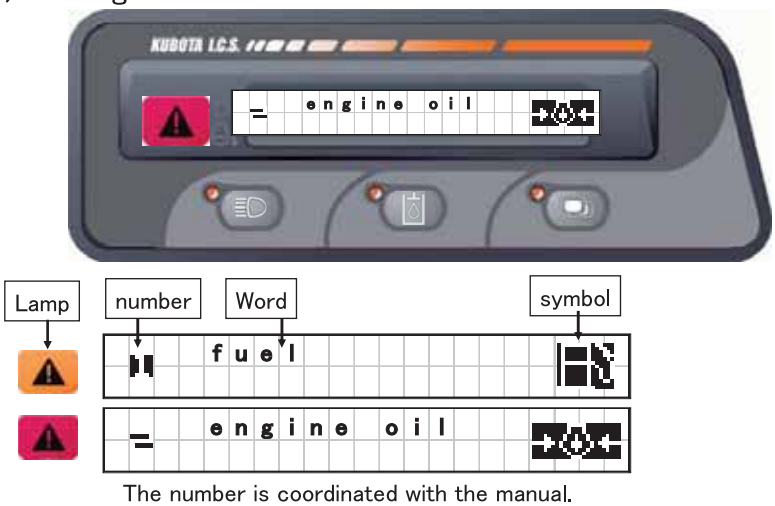


In case of troubles, LCD shows warning and failure indications as shown below.

Feature of LCD Navigation System②

Additional function

(2)Warning & failure



The number is coordinated with the manual.

Caution and warning indications (Sample pictures)

(1) Lift up the lock lever to start engine

(2) Key-on position

(3) If oil sw and charge lines broken

(4) Fuel shortage

(5) Battery charge warning

(6) Engine oil pressure warning

(7) Lift down the lock lever for service port sw function

(8) Maintenance indications

d) Service Mode Menus

1. Outline

Service mode is basically for dealer's service personnel.
This mode is designed to initialize machine's condition, additional attachment and control system, and diagnose machine trouble. Display indication items are listed in page II-140 and II-141, from data number 023 ~ 085.

The following pages include:
1) Service mode flow chart
2) Main menus in detail

2. Service mode flow chart

How to enter the service mode:

Keep pushing the display select or switch and

turn the main key switch to ON position.

Now you are in the service mode.

3. Main menus and functions

3-1 Selection Method of 11 Languages (EU-version only)

When the key is turned ON by pressing the display selector, the names of the model come up on the screen. If a finger is off the display selector, the next language selection screen will appear. The information on the selected model is important. This method enables operators to confirm the machine model. The system is designed to support 11 languages; the language selection screen will appear first. The language selection screen shows each language as shown in figure. When a language is selected, a display corresponding to the language will appear.

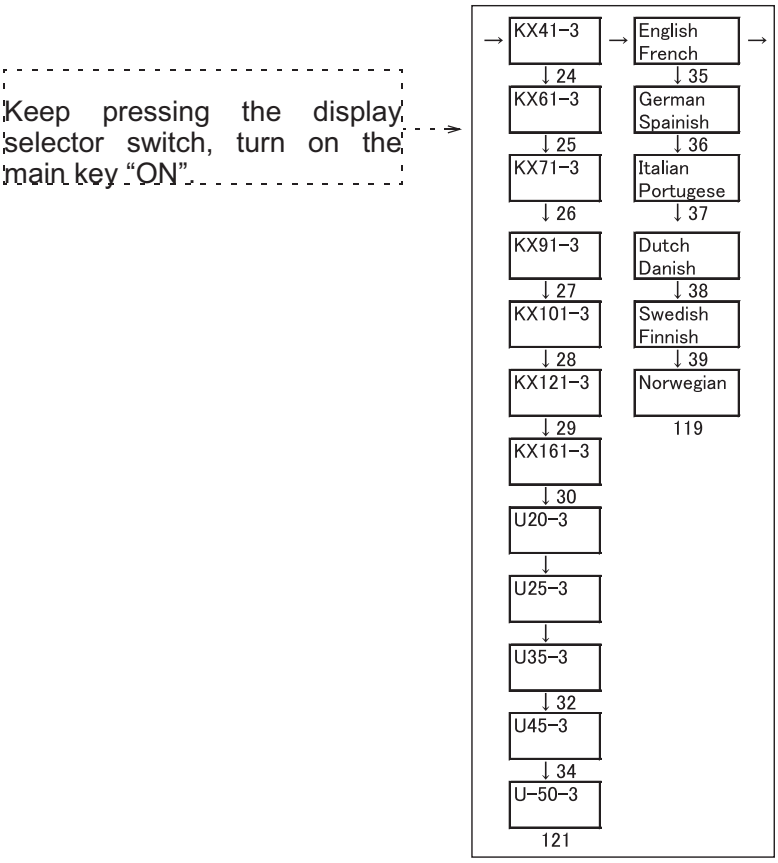


Fig. 1 Service Mode Language Selection Screen (EU-version)

KTC, KTA-version: English only

KCL-version
English and French

3-2 Tester mode

Items such as the present battery voltage can be displayed by selecting Diagnosis and Tester. (See Fig. 2.)

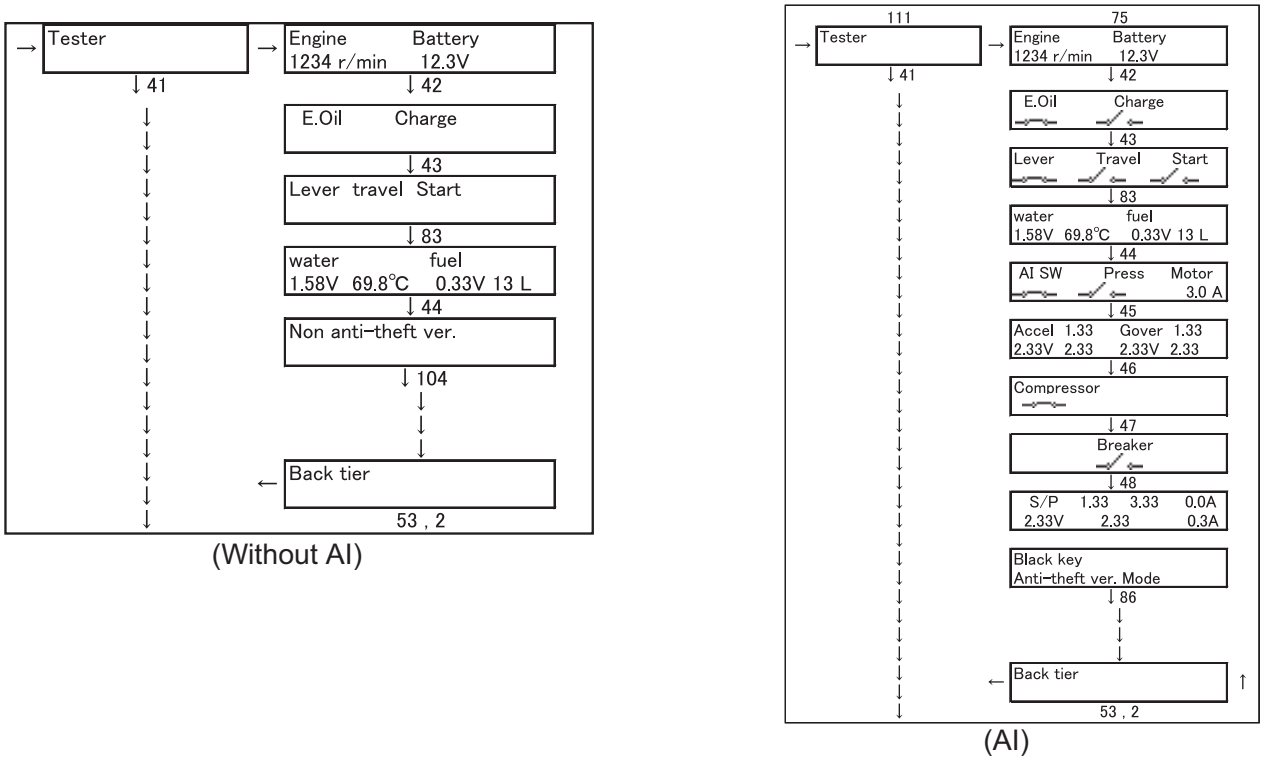


Fig. 2 Tester menu

- Engine -> Engine revolution XXXX rpm
  A revolution sensor is mounted to the injection pump gear.
  The gear ratio varies with the model as described below.
  KX41-3's gear ratio: 46
  KX61-3 and KX71-3's gear ratio: 54
  KX91-3S/α, KX101-3α, KX121-3α/S/ST, and KX161-3α/S/ST gear ratio: 68

Calculation Method

A single rotation of the injection pump corresponds to two engine rotations.
The revolution of the engine is calculated by measuring the passing period of the number of gear tooth specified by the timer and obtaining the revolution under the same condition for 60 seconds.

- Battery: Battery Voltage
  The battery voltage is input into the meter through two diodes. The voltage displayed is added with 1.4 V in consideration of the potential drop caused by the diode.
- E. oil: Engine oil switch ON and OFF.
- Charge: Alternator L terminal ON and OFF.
  These switches are turned ON when the engine stopped and turned OFF when the engine started in normal operation.
- Lever: Lever lock.
- Travel: Running in second gear.
- Start: Start position of key switch.
- Water: Water temperature voltage and water temperature (°C).
- Fuel: Fuel voltage and fuel quantity (in liters).
  The quantity of fuel (in litters) displayed is a reference value.
  The fuel (in liters) is displayed from data measured according to the model.
- Non anti-theft ver.: Not connected to theft prevention ECU (i.e., no communication is possible with the theft prevention ECU).

3-3 Fail record dump

The fail record can be displayed by selecting Diagnosis and Fail record. (See Fig. 3.)

By selecting the Fail record, the system reads the contents of the EEPROM and checks the information on failures.
If failures are found, each failure item and the number of times on the hour meter can be scrolled at 1.5-second intervals.
By pressing the display selector just once, the next failure point can be viewed.
If there is no failure, "No fail record" will be displayed.
(See the Section of Fail Safe for failures in detail.)

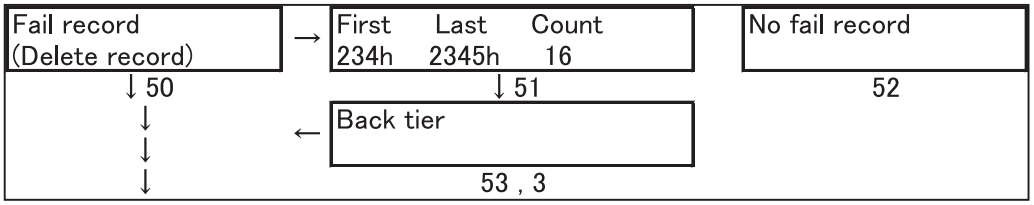


Fig. 3 Fail record dump

3-4 Deletion of Fail Record

The fail record can be deleted by selecting Diagnosis and Delete record. (See Fig. 4.)

The message "Fail record deleted" will be displayed when the record is deleted.
By pressing the display selector while this message is displayed, the message to read the fail record will appear again. The message to read the fail record will, however, appear automatically in 3 seconds without pressing the display selector.

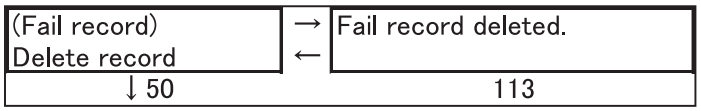


Fig. 4 Fail record delete

3-5 Machine model setup

Model settings can be made by selecting Set up and Set up machine. (See Fig. 6.)

Here, information on the model and the country of manufacturer is selected.
By selecting the country of manufacturer, European/North American specifications are distinguished.
(If AI optional specifications are provided, the selection of AI as an optional item will appear as well.)

Note:
By selecting the country of manufacturer, optional functions attached to the country-version, such as the overheating and service auto manual items can be determined automatically.

(Without AI)

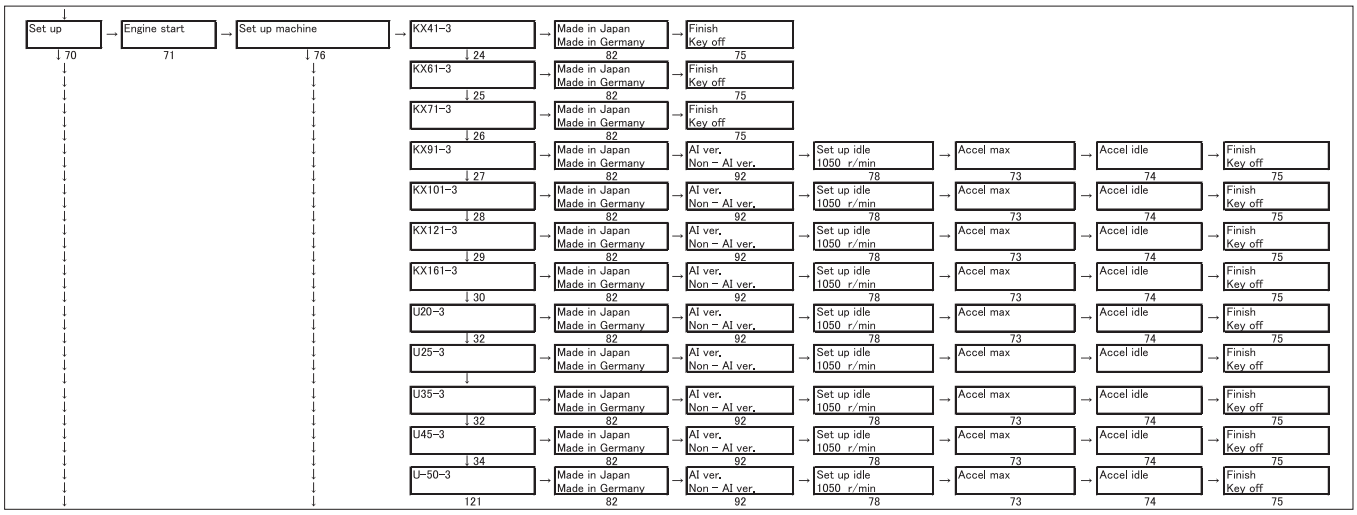


Fig. 5 Machine model set-up

(AI)

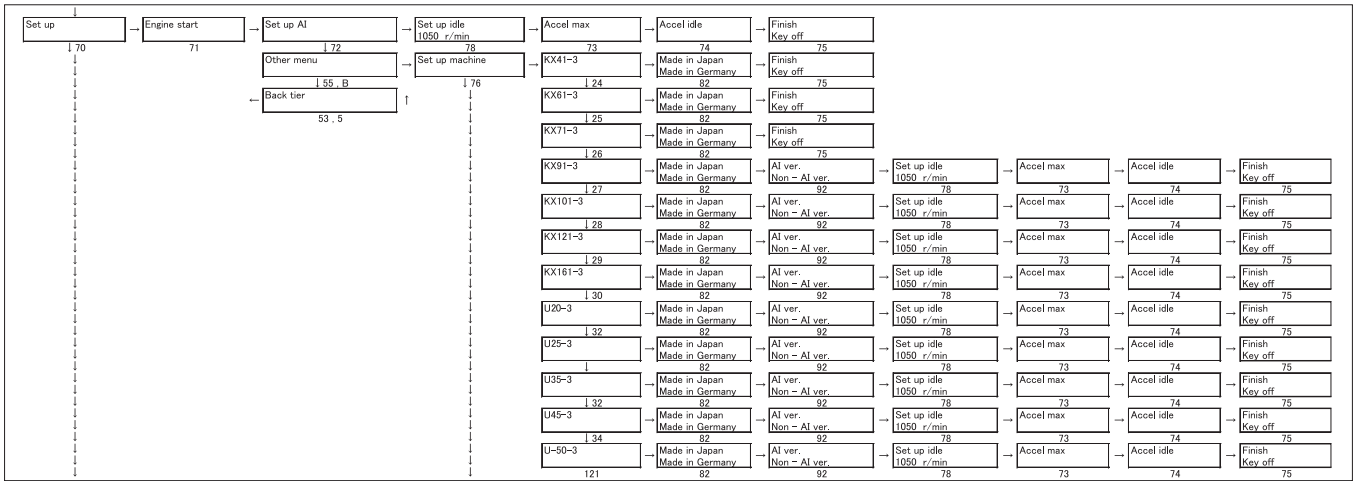


Fig. 6 Machine model set-up

3-6 Overheat set-up

Note:

By selecting Diagnosis, Set up, Engine start, Set up machine, and Set up overheat warning, overheat warning settings can be made.

By turning the overheat warning to the ON position, it enables its function. When the preset temperature is reached, the warning will be output.
The preset temperature can be adjusted in 10 °C increments or decrements.
The value will be negative with the working lamp switch turned ON and positive with the center switch turned ON. The entered value will be determined with the display selector continuously turned ON.

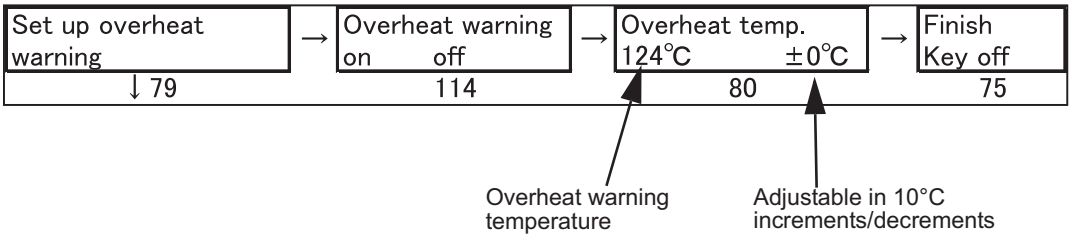


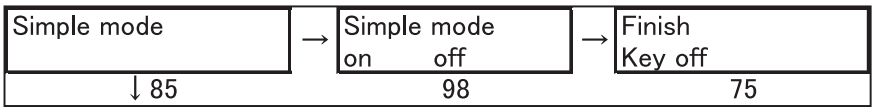
Fig. 7 Overheat Settings

In default condition, Overheat warning is OFF for North America and Oceania-version and ON for EU-version.

3-7 Simple mode set-up --- Chinese-version only

Simple-mode settings can be made by selecting Set up, Engine start, Set up machine, and Simple mode.

In Simple mode, the outputs will be turned OFF with no messages when the fail-safe function is activated. The Fuel replenish mode will not be available. No messages for failures including engine oil failures will be output in Simple mode. In this case, the hour meter cannot be switched over to the tachometer in Normal mode, and only the hour meter will be displayed. This is because the tachometer does not display the engine oil icon. This meter is used for China's U-50-3, shipping with a factory setting mode to Simple mode.



3-8 Harness check Mode

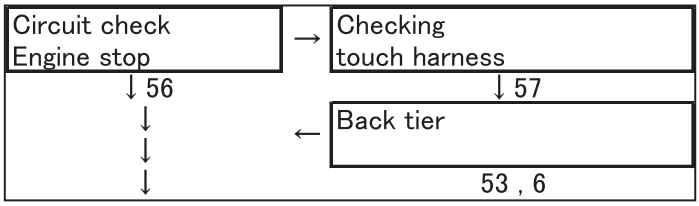
By selecting Other menu and Circuit check Engine stop, the present conditions of the harness connector can be checked. (See fig. below.)

When the Circuit check Engine stop is selected, the message "Checking touch harness" will appear at the moment the engine revolution drops below 800 rpm. This mode is available on the condition that the engine is stopped. The mode cannot be selected when the engine revolution is 800 rpm or over.

In harness check mode, the following items can be checked. Items in parentheses are error criteria.

- Lever lock switch (OFF When lever is down.)
- Fuel sensor (Reading of 2 V or more, or 0.2 V or less.)
- Water temperature (Water temperature of 140 °C or more, or -30 °C or lower.)
- Oil switch (OFF When the engine stops and Key is ON.)
- Charge circuit (OFF)

If there is any error, a message indicating the position of the error will flash automatically and the buzzer will beep at the same time.
When the error is restored, the buzzer will be turned OFF, but the flashing memory will be kept on hold.
If there are a number of errors, the screen will scroll.



3-9 All Fail Record

All the accumulated failure records can be shown by selecting Other menu, and All fail record. (See Fig. 6.)

By selecting All fail record, the first hour meter items generated after shipping through the last one will be shown.
There are 19 types of failure diagnostic items, and the details of each type of item can be checked. The hour meter will, however, remain even after the failure records are deleted.

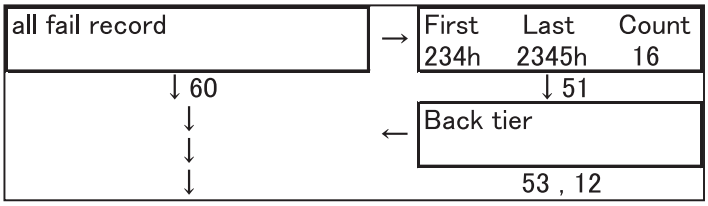


Fig. 6 All Fail Record

3-10 EEPROM read

The data of the EEPROM can be checked by selecting Other menu, Other menu, and EEPROM read. (See Fig. 7.)

Ten items are displayed on each page in hexadecimal, and 13 pages will be used in total.
The EEPROM consists of 128 x 16 bits.

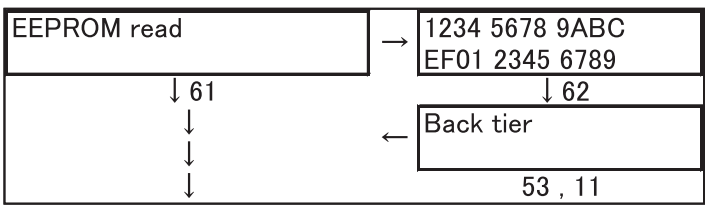


Fig. 7 EEPROM read

3-11 LCD inspection

The dot type of the LCD can be checked by selecting Other menu, Other menu, and LCD check. (See Fig. 8.)

Checkered pattern 1, checkered pattern 2, and the outer frame will be displayed. Checkered pattern 1 and checkered pattern 2 are opposite to each other in dot ON-OFF pattern. Missing dots can be checked by using this function. (See Figs. 9 and 10.)

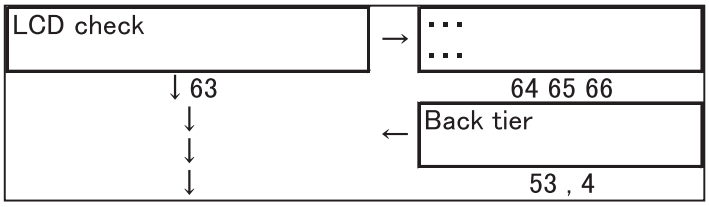


Fig. 8 LCD check

Fig. 9 Frame Display

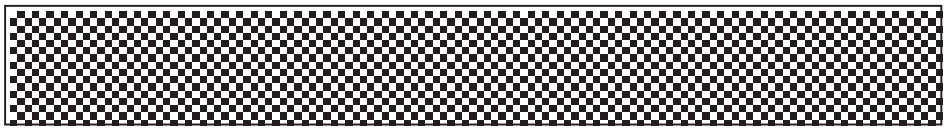


Fig. 10 Checkered Pattern

3-12 Service hour meter

A service maintenance message will appear when the preset hour meter item is activated.
The message will disappear in 10 seconds. Whenever the key is turned ON and OFF, the message will appear for the first 10 seconds.
There are two modes (i.e., auto mode and manual mode) to turn OFF the inspection icon perfectly, either of which is selectable by the user's settings.
While the system is in auto mode, the icon will disappear when the key is turned OFF and ON 10 times in total. Then icon will not appear again with the key further pressed. This is convenient because the icon will disappear only with the key turned OFF and ON, in which case the actual maintenance of the equipment will be up to the user's choice.
In manual mode, the icon will disappear with the working lamp pressed continuously for 3 seconds. In this case, the message will be eliminated after the user's maintenance work. This function is newly incorporated in this series. In the previous models KX121-3 and 161-3, AL motor's position is only controlled by the accel. sensor dial. Suppose an operator turns off the starter key at the accel. sensor dial max. position. Next time the operator turns the main key, the engine will start at max. speed. The new function prevents operators from this type of frightening.
When all the described inspection items in the Operation Manual are considered, a message will be displayed at 50-hour intervals, which is not so meaningful. In view of the foregoing, important items (e.g., items related to the engine oil, operating oil, air filter, and engine oil filter) should be targeted so that a message will appear in the case of maintenance necessity for any of these items. The meter with North American specifications and that with European specifications share the same software, but the timing of maintenance varies with the specifications and the size of the system. The displayed frequency of each item is changed according to the specifications. Fig. 2 shows an example of the display of the KX41-3, KX71-3 and super series models with North American specifications.
Usually, the service hour meter advances in synchronization with the hour meter, thus causing no problems. If the hour meter is replaced, however, the new hour meter will start with zero hour. In that case, the service hour meter will be asynchronous. Due to ethics reasons, the system cannot incorporate functions that allow the alternation of the hour meter. There are, however, no problems in altering the service hour meter. Items that can be input for the service hour meter have been prepared.

Service Hour Meter with North American Specifications

No.	Check points		Intervals	Hour meter indicator									Consequently
				50	100	250	300	500	550	750	800	1000	
1	Engine oil		change	○			○		○		○		every 250 hrs
2	Hydraulic oil											○	every 1000 hrs
3	Air filter element	Outer element	replace									○	every 1000 hrs
		Inner element										○	every 1000 hrs
4	Drive unit oil		change		○			○				○	every 500 hrs
5	Engine oil filter		replace	○			○		○		○		every 250 hrs
6	Hydraulic return filter element					○				○			every 500 hrs
7	Hydraulic suction filter element											○	every 1000 hrs

The message appears. The message shows up as follows.

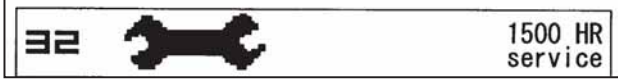


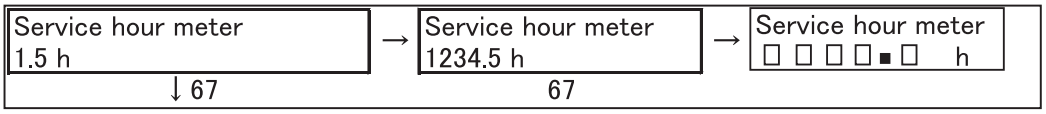
Fig. 2

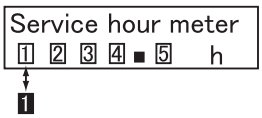
EU-version machine

A message appears initial at 50-hour intervals and 250-hour intervals (i.e., every 250, 500, 750, and 1000 hours).

3-13 Service hour meter check

The service hour meter can be checked and altered by selecting Other menu, Other menu, and Service hour meter.
Only the display selector switch is used to make value changes. The service hour meter will be changed when the meter is replaced, because the service hour meter will not be synchronized with the hour meter, and warnings will not be displayed in a timely manner.





As you reach to this menu, the first box is blinking to ready to change the digit. Push the SW in short, the number will be increased. Push the SW longer, the number will be fixed and shifted to next box. After fixing all boxes, the beep sounds three times and automatically returns to service hour meter with new service hours.

3-14 Service hour meter delete

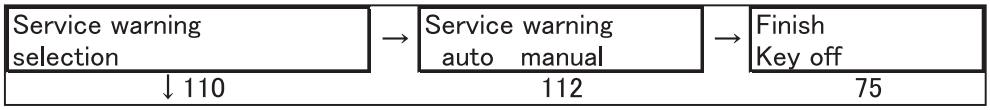
A deletion method of the service hour meter can be set by selecting Other menu, Other menu, and Service warning selection.

Auto: North America & Oceania - version
The service hour meter will be turned off when the key is turned OFF and ON 10 times in total.

Manual: EU - version
The service hour meter will be turned off with the working lamp switch pressed continuously for 3 seconds.

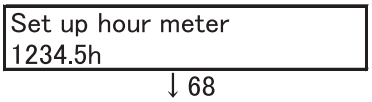
Note:
Change in Service Hour Meter

North American specifications: By default set to auto.
European specifications: By default set to manual.
Turn off the service hour meter with the working lamp switch pressed.



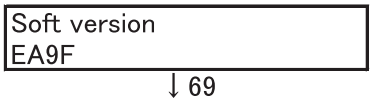
3-15 Set-up time

The hour meter used for model settings can be checked by selecting Other menu, Other menu, and Set up hour meter.



3-16 Software version

The software version can be checked by selecting Other menu, Other menu, and Soft version.



3-17 Auto glow control

The glow will be turned ON for an optimum time according to the temperature of engine cooling water.

3-17-1 Key-ON Processing

Water temperature: The glow-ON time is obtained from the glow time map (see Figs. 1, 2). The glow will not, however, turn ON while the engine is working or the temperature is 81 °C or over. The glow icon will appear with the glow turned ON.

When the user confirms that the glow icon turns OFF and tries starting the engine, a delay in response (usually 0.5 to 1.5 seconds) will result, during which the temperature of the glow plug will drop. The actual glow will be kept turned ON for 2 seconds after the glow icon disappears. This will make a response time lag between the display and glow time, thus making it possible to start the engine smoothly. (See Fig. 3.)

Water temperature (°C)	Glow time (s)	**Glow icon display time (s)**
140	0.0	0.0
100	0.0	0.0
81	0.0	0.0
80	3.0	1.0
60	3.3	1.3
40	3.8	1.8
20	5.3	3.3
10	6.5	4.5
0	9.0	7.0
-10	11.0	9.0
-15	12.0	10.0
-40	12.0	10.0

Fig. 1 Cooling Water Temperature vs. Glow Time

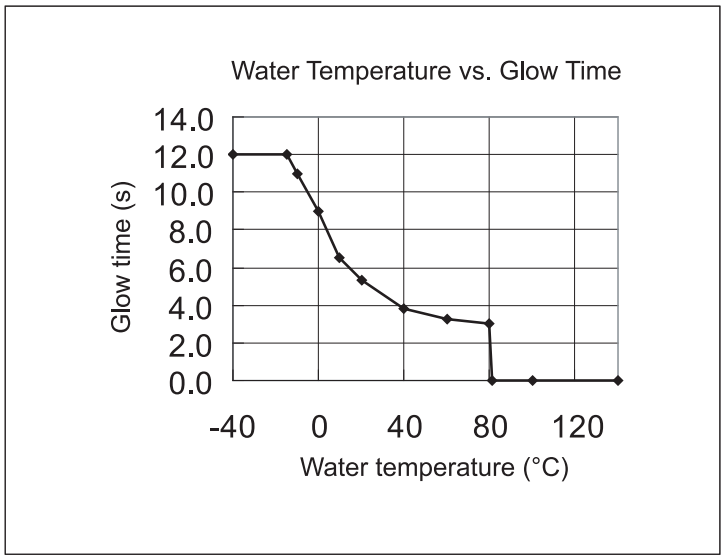


Fig. 2 Graph of Water Temperature vs. Glow Time

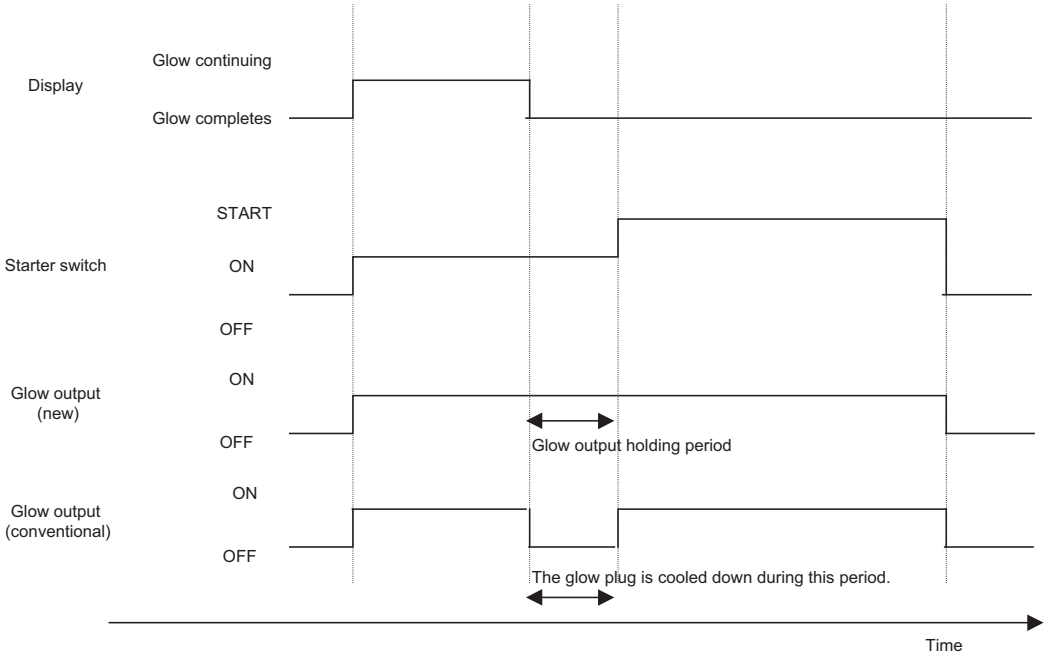


Fig. 3 Transition Diagram of Glow and Starter Key

Glow ON/OFF Conditions

The glow will turn ON under any of the following conditions. The engine revolution is 1,000 rpm or below; the engine oil pressure switch is OFF (the input terminal of the engine oil pressure switch is H); the charge is OFF (the L input terminal is H). If these conditions are not satisfied, the glow will be turned OFF because controller unit judges that the engine has started.

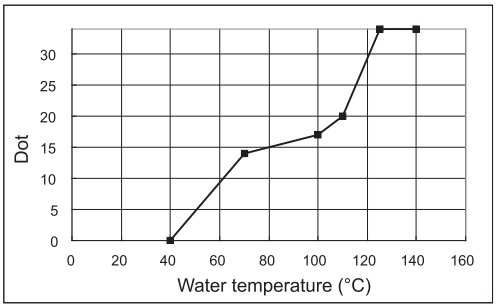
Relationship between Water Temperature and Dots
The gauge of the water temperature uses four dots vertically and 34 dots horizontally.
The relationship between the water temperature and dots is shown below.

Refreshment Cycle of Number of Dots
The average temperature of 721 samples obtained at 6.9344-ms intervals (6.9344 ms x 721 = 5 s) is converted into the number of dots to refresh the display.

Water temperature	Dots
40	0
70	14
100	17
110	20
125	34
140	34

Relationship of Water Temperature and Number of Dots

Enlarged view of water temperature gauge



Relationship of Water Temperature and Number of Dots (Graph)

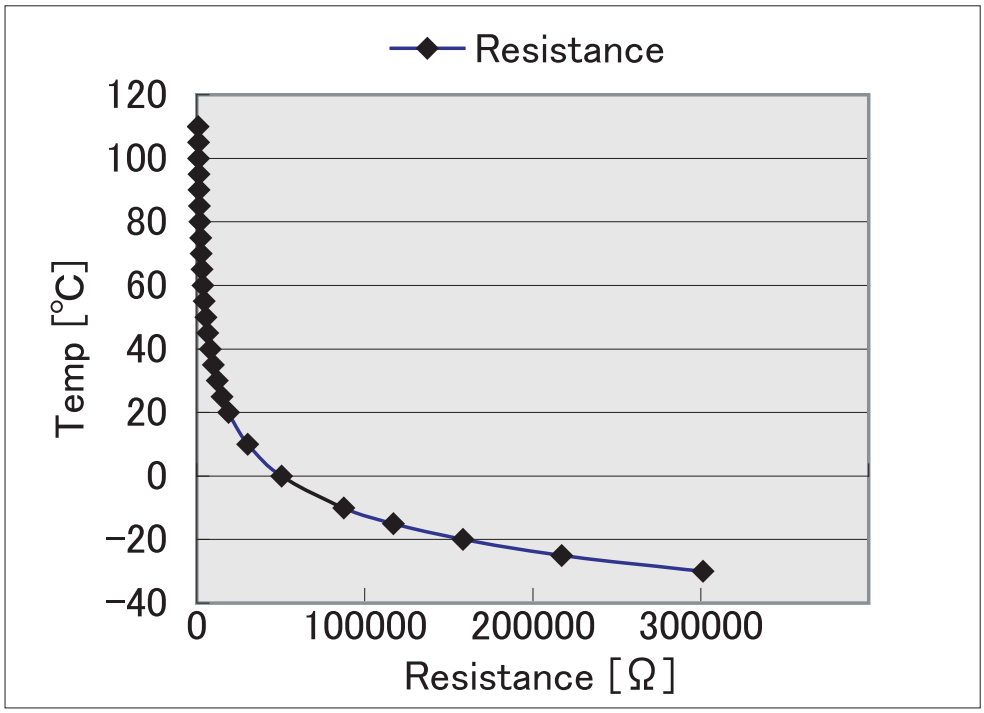
Glow Control (Others)
1. If the grounding of the motor to the engine is improper, the voltage may sneak to the glow relay, thus always turning the glow relay ON. When the key is not at the start position, the glow relay will be turned OFF.
2. If the battery is discharged while the key turned ON (In case operator left the key ON) and when the battery voltage is close to the level of triggering the CPU, the following operation may be repeated.

The microcontroller starts and turns the glow relay ON to perform auto glowing.
↓
The glow current flows and the battery voltage drops because the glow relay is turned ON.
↓
The microcontroller is reset.
↓
The battery voltage rises because the microcontroller is reset and the glow relay is turned OFF, when no current flows.
↓
The microcontroller is triggered and the glow relay is turned ON because the battery voltage rises.
↓
The above sequence is repeated. Then glow relay contact may have chattering and be damaged.

The glow relay will be always turned OFF in order to prevent the chattering of the above glow relay when the voltage is 7.5 V or below. The similar process will be performed for the relay for the working lamp.
This know - how is to protect the relay itself.

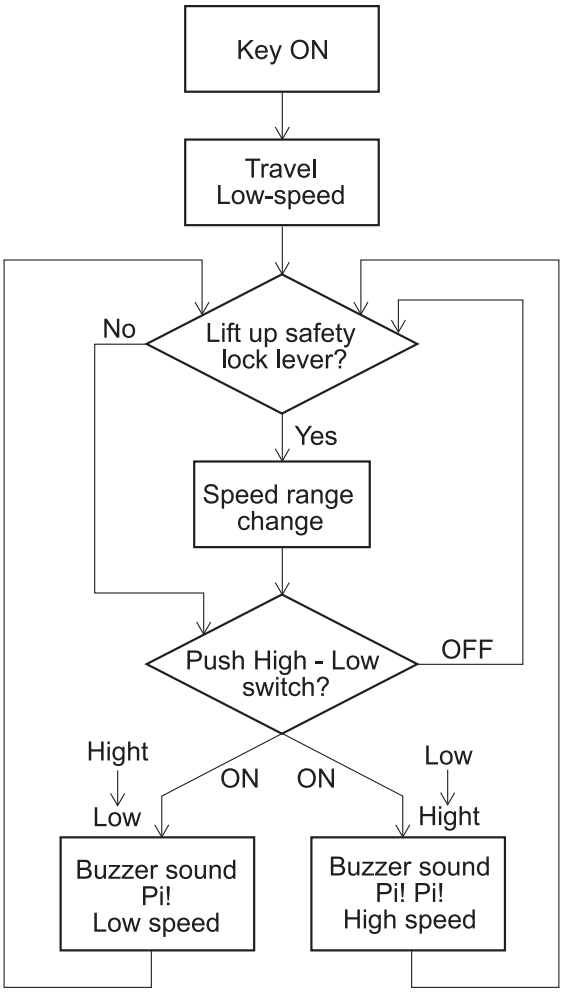
3. FYI (For your information)

water [V]	temp [°C]
0.33	140
0.409	130
0.504	120
0.634	110
0.795	100
1	90
1.26	80
1.58	70
1.96	60
2.4	50
2.86	40
3.36	30
3.77	20
4.15	10
4.44	0
4.66	-10
4.8	-20
4.89	-30
4.94	-40



3-18 Travel high-low switch control

1. Change travel speed by pressing the high-low switch on the dozer control lever. Refer to the control flow.
2. The travel mechanism will start in low gear to ensure safety when the key is turned ON.
3. In consideration of the change of the operator with the key kept turned ON, the frame mechanism will be set into low gear to ensure safety when the lever lock is lifted up.
4. Control flow chart.



Note:
System will always “Reset” to low speed when key is switched “OFF” or safety lock lever is lifted.

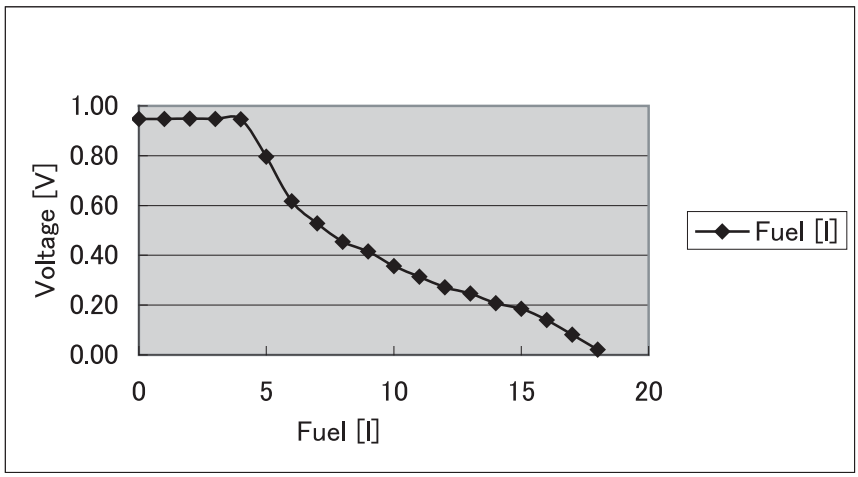
3-19 Fuel amount control

1. Outline

A map indicating the voltage and fuel relationship has been prepared by plotting each determined input voltage based on the float position of the fuel sensor and the remaining fuel.

The power supply voltage (5V) is input into the microcomputer according to the partial voltage varied with the float position. When calculating the actual quantity of remaining fuel, make a map conversion in consideration of the power supply voltage.

The fuel shortage alarm will be displayed when the quantity of remaining fuel is between approximately 5 to 10 liters, the range of which, however, varies with the model. As a rule of thumb, the fuel will last for approximately one hour after the alarm turns ON.

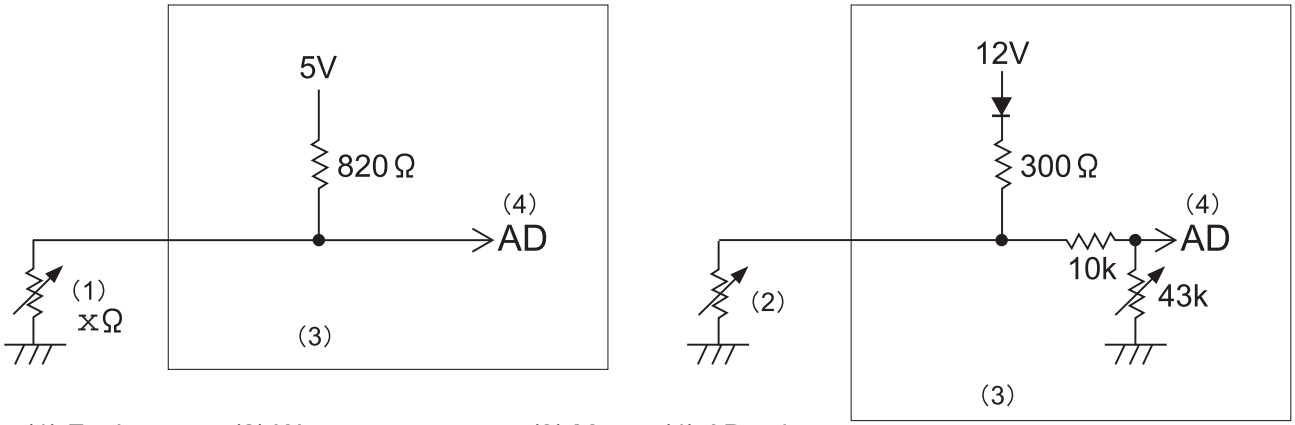


Voltage and fuel map

Fuel shortage alarm

Model	Fuel residual amount L: (US G)
KX41-3	5 ± 3 (1.3 ± 0.8)
KX61-3, U20-3	7 ± 3 (1.9 ± 0.8)
KX71-3, U25-3	7 ± 3 (1.9 ± 0.8)
KX91-3S/α	5 ± 2 (1.3 ± 0.5)
KX101-3α	5 ± 2 (1.3 ± 0.5)
KX121-3S/α	12 ± 2 (3.2 ± 0.5)
KX161-3S/α	12 ± 2 (3.2 ± 0.5)
U35S, U35-3S/α	5 ± 2 (1.3 ± 0.8)
U45S, U45-3S/α	12 ± 2 (3.2 ± 0.5)

Circuit diagram & function (Fuel sensor) (Water temp sensor)



(1) Fuel sensor (2) Water temp sensor (3) Meter (4) AD voltage

(Calculation example) Voltage value is 0.899 for example.

$$\frac{5}{x + 820} \times x = 0.899$$

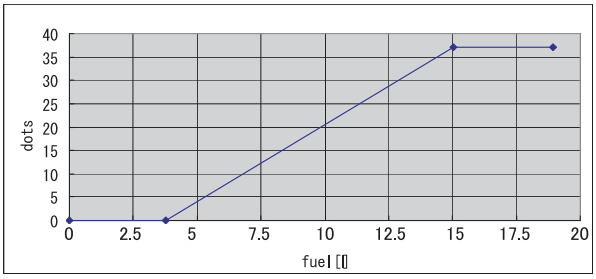
$$5x = 0.899x + 0.899 \times 820$$

$$(5 - 0.899)x = 0.899 \times 820$$

$$x = \frac{0.899 \times 820}{5 - 0.899} = \frac{737.18}{4.101} = 179.76\ \Omega$$

Theoretically, water sensor's resistance is 179.76 Ω

2. Meter display
   1) The LCD with four vertical dots and 37 horizontal dots is used to display the fuel gauge.



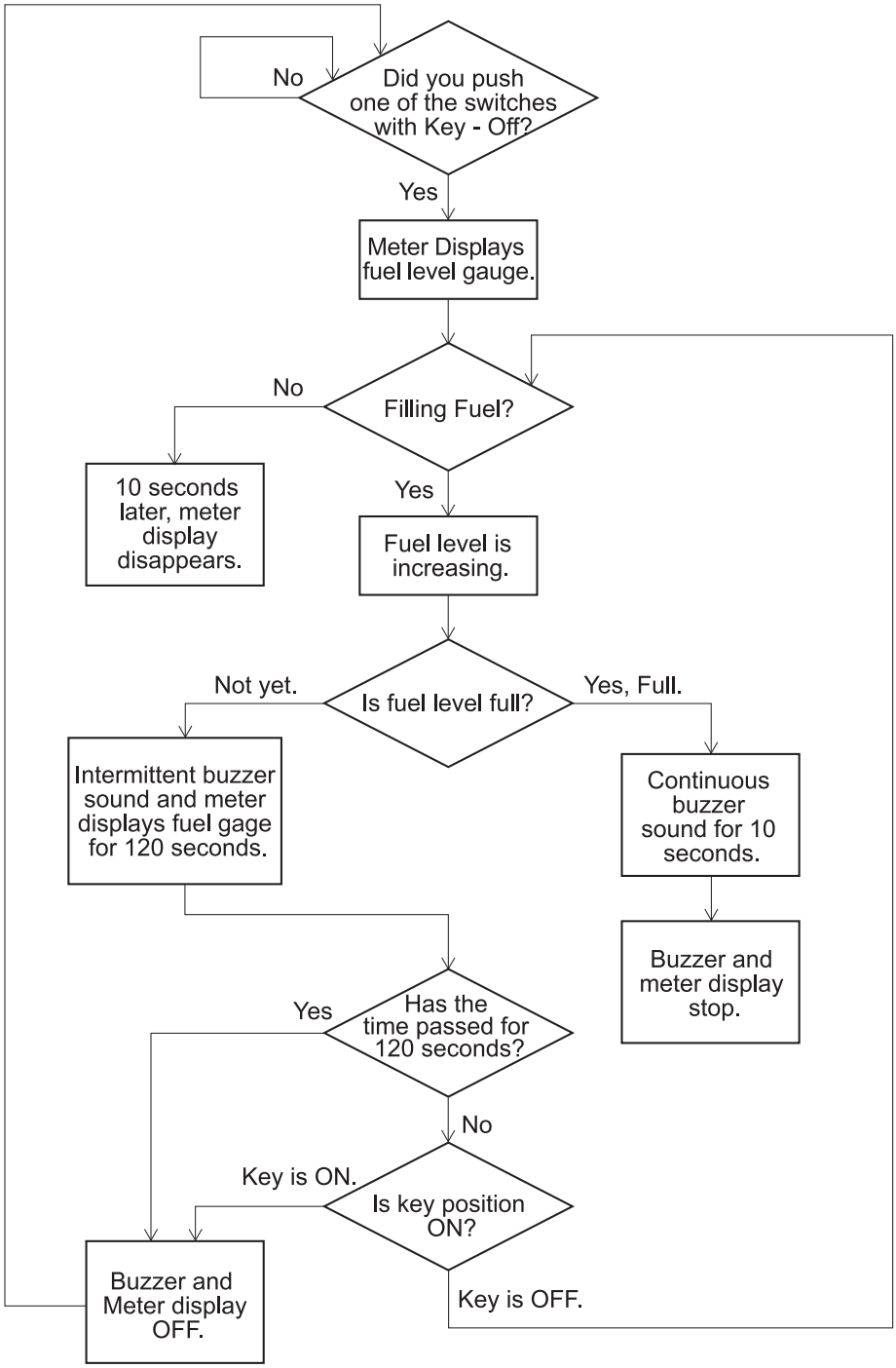
(Sample data: KX41-3)

Fuel level L: (US G)	KX41-3	KX61-3, 71-3 U20-3, U25-3
Full in tank	19 ± 3 (5.0 ± 0.8)	42 ± 3 (11.1 ± 0.8)
Sensor upper limit	17 ± 3 (4.5 ± 0.8)	41 ± 3 (10.8 ± 0.8)
Sensor lower limit	5 ± 3 (1.3 ± 0.8)	7 ± 3 (1.9 ± 0.8)

Fuel level L: (US G)	KX91-3S/α, 101-3α	U35, U35-3S/α	KX121-3S/α, 161-3S/α, U45-3S/α, U45S
Full in tank	48 ± 5 (12.7 ± 1.3)	42 ± 5 (11.1 ± 1.3)	65 ± 5 (17.2 ± 1.3)
Sensor upper limit	40 ± 3 (10.6 ± 0.8)	40 ± 3 (10.6 ± 0.8)	58 ± 5 (15.3 ± 1.3)
Sensor lower limit	5 ± 2 (1.3 ± 0.8)	5 ± 2 (1.3 ± 0.8)	12 ± 2 (3.2 ± 0.5)

   2) A fuel shortage (0.899 V or over) is judged with 8,653 sampling times for 60 seconds. If a fuel shortage is detected 7,780 times or more (i.e., a minimum of 90% of the total), the fuel shortage alarm will be displayed.
   3) If the fuel shortage alarm is displayed when the key is turned OFF, data on the alarm will be saved in the microcomputer. If the voltage on average for 0.2 second indicates a fuel shortage (0.899 V or over) when the key is turned ON again, the alarm will be displayed at once.
   4) The alarm displayed will be canceled if the alarm cancel voltage (0.719 V or below) is detected 649 times or more (i.e., a minimum of 90% of the total) after the sensor signal is sampled 721 times for 5 seconds.
   5) When the engine starts, the sensor float sways greatly, thus resulting in input voltage dispersion. The sampling cycle of the sensor signal is, thus set to 25 seconds.
   6) If fuel sensor disconnection occurs, and the existence of fuel is not detectable, the fuel shortage alarm will not turn ON.

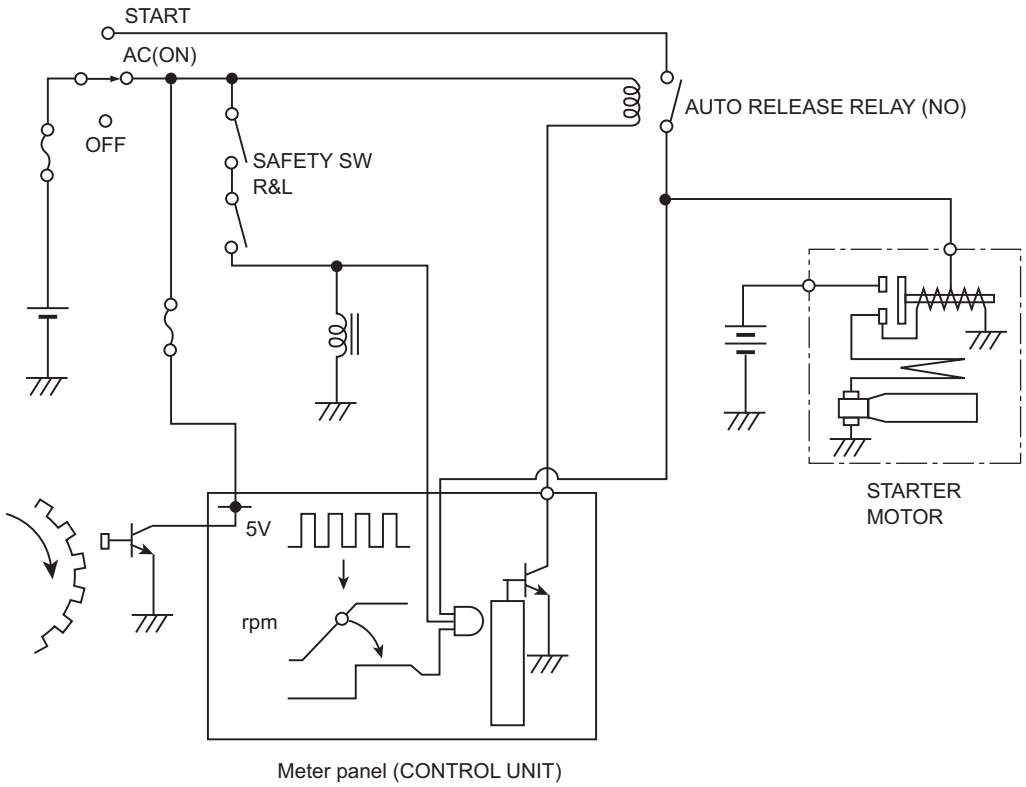
3. Fuel Replenishment Assist Function
While replenishing fuel by pressing any switch after the key is turned OFF, the buzzer interval will change according to the quantity of fuel replenished. When the fuel in the tank is not much, the buzzer will be heard at long intervals. When the quantity approaches the full tank level, the intermittent buzzer continues at shorter intervals. When the tank is full, the buzzer will be heard continuously with no intervals to prevent the fuel from overflowing from the tank.



- Beep sound disappears approx. 10 seconds after reaching the full of fuel.
- If fuel tank isn't full, keep the sound continuing for two minutes to alarm.

3-20 Starter auto release control

1. Outline
   1) If the key freezes in the start position, the auto release relay is turned OFF to prevent damage to the starter motor. At the same time, the glow relay will be turned OFF forcibly to prevent damage to the glow plug. (Prevention of starter motor from key freezing)
   2) The start of the engine is judged from the engine revolution sensor signal to turn OFF the auto release relay. (Starter auto release)
   3) If the key is turned OFF once and reset to the start position immediately while the engine is starting, the pinion gear will engage while the ring gear rotates, which deteriorates the durability of the gears. The mechanism is designed to prevent of the engine from starting in two seconds after the key is turned OFF. (Reentry prevention control)
   4) The engine on the KX41-3 does not start at low temperature unless the revolution rises approximately 800 rpm. The start of the engine is judged at 1,000 rpm.
      (The judgment of the release of the starter has been raised by 200 rpm.)
      As for the other models except KX41-3, the start of the engine is judged at 800 rpm.
   5) If the key freezes while there is a failure in the engine revolution sensor, the auto release relay will be automatically turned OFF in 30 seconds and power supply to the starter will be stopped. (Prevention of starter burnout damage)
      The reason of the above period is set to 30 seconds is that it will be possible to start the engine by energizing the starter three times for 10 seconds after auto glowing even in winter at a temperature as low as -17 °C.
   6) As shown in the diagram, if the meter panel is damaged or the couplers of the meter panel are disconnected, then engine won't start.
      Just because the auto release relay is Normally Open type and so battery current won't be supplied to the starter motor. This is also for the safety.



(B) NEW AUTO IDLING (AI) CONTROL SYSTEM

a) Purpose

When you interrupt a job and set the control lever to neutral, the engine will come to the automatic idling rpm in 4 seconds. This helps save energy and keep quiet.

b) Auto Idle Function Mechanism

1. The auto idle type machines are equipped with the electrical devices that are shown in the accompanying AI function layout.
   (1) Meter panel (AI system lamp)
   (2) AI motor
   (3) Pull cable
   (4) Acceleration sensor
   (5) AI pressure switch
   (6) Governor sensor
   (7) Engine speed sensor
2. To enable the auto idle function, turn on the AI switch first.
3. When you operate the machine, the AI pressure switch detects the primary pressure of the hydraulic pilot system and opens the contact. The signal is then sent to the CPU of the controller.
   The AI pressure switch is attached on the control valve. This switch is of normally closed type (the contact is usually kept closed).
4. The acceleration sensor is attached on the support of the accelerator knob. The knob position is detected in terms of turning angle by a potentiometer, and the signal is sent to the controller CPU.
5. The governor sensor and the engine speed sensor are installed on the engine governor. The governor position signal is sent to the controller CPU.
6. The controller CPU processes the above information and feeds a current command to the AI motor so that the engine governor should run at maximum speed.
7. Receiving the command, the AI motor starts and controls for the engine governor, through the pull cable, to reach maximum rpm. This leads to the maximum engine speed.
8. When all the hydraulic actuators are at neutral, the AI pressure switch gets normally closed and sends the signal to the controller CPU.
9. The CPU of the controller then feeds a current command to the AI motor so that the engine governor should run idle. In this way, the engine will also set itself to the idling speed.
   The CPU will get idling, too, 4 seconds after receiving the pressure switch signal.

☆Trouble cases

Electrical system:

If the AI switch or its coupler is out of position or if the harness is broken, the circuit gets open (contact off). In other words, the microcomputer judges that the hydraulic actuator is running, and the auto idle function fails.

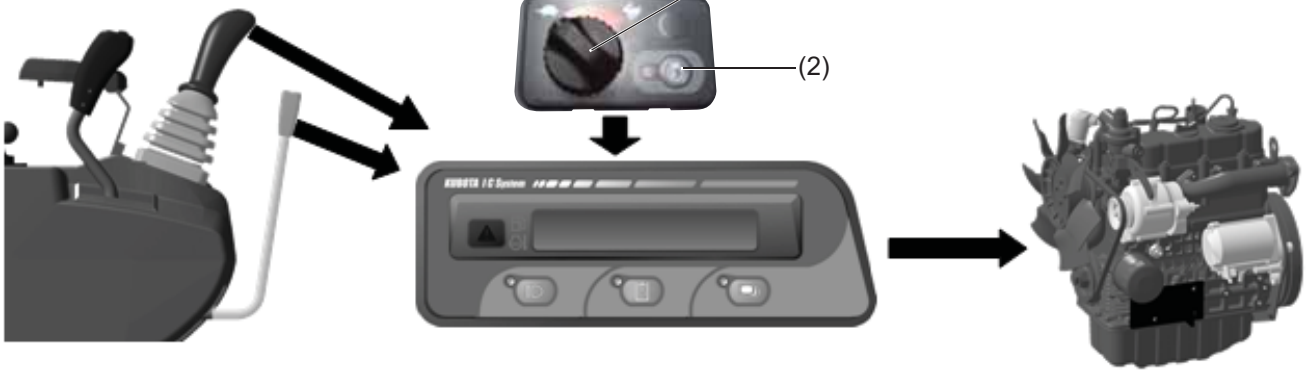
Hydraulic system:

If a trouble occurs in the hydraulic system, there is no pressure rise often. In other words, the AI pressure switch gets normally closed, and the microcomputer judges that the hydraulic system is not running, namely, the control lever is at neutral. (Even by moving the control lever, the initial; engine speed cannot be resumed.)

c) New Auto Idling Modification

1. Interlocked with lever lock.

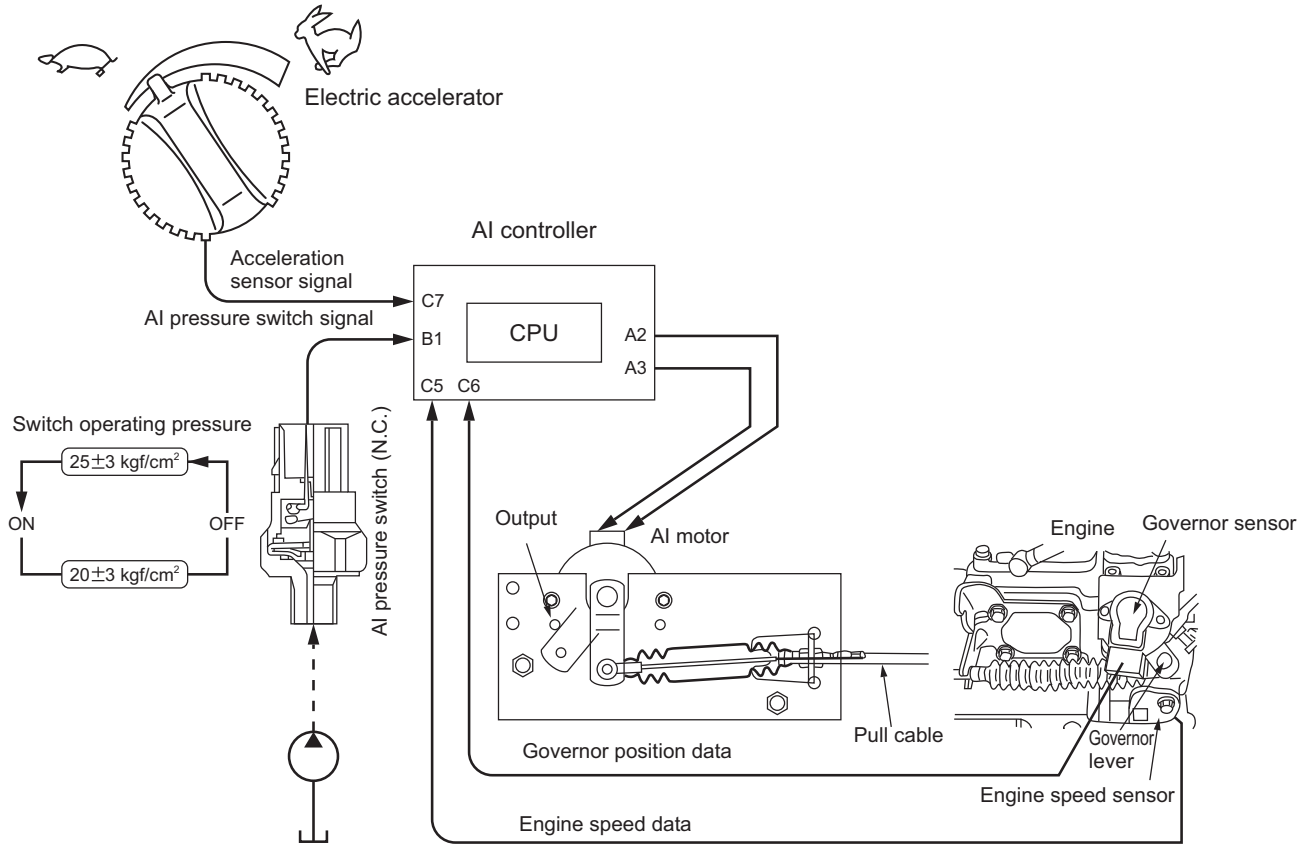
If the lock lever is raised, engine changes to idling rotation immediately (does not wait for 4 seconds.)
(Convenient at the time of getting off a machine.)



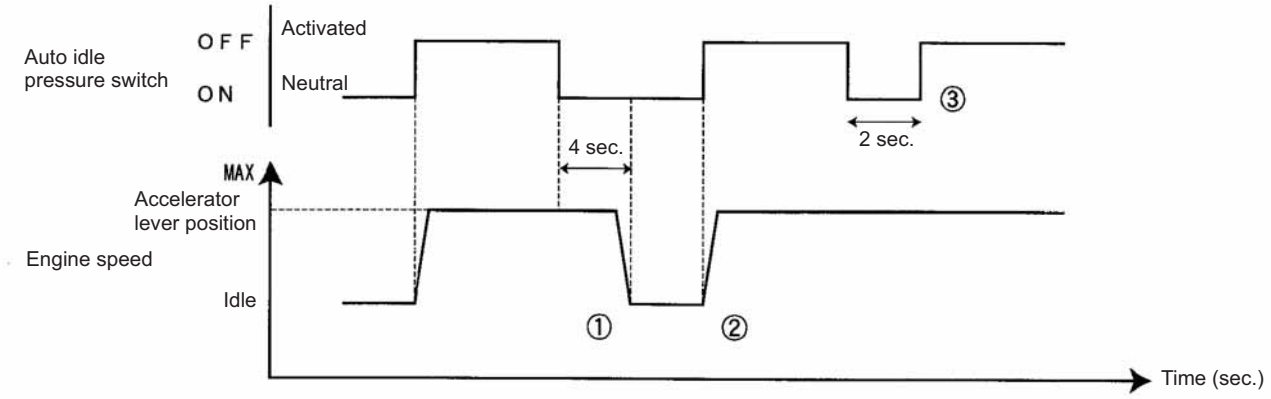
(1) Accel sensor
(2) AI switch

(3) Governor sensor
(4) Engine speed sensor

2. AI function layout

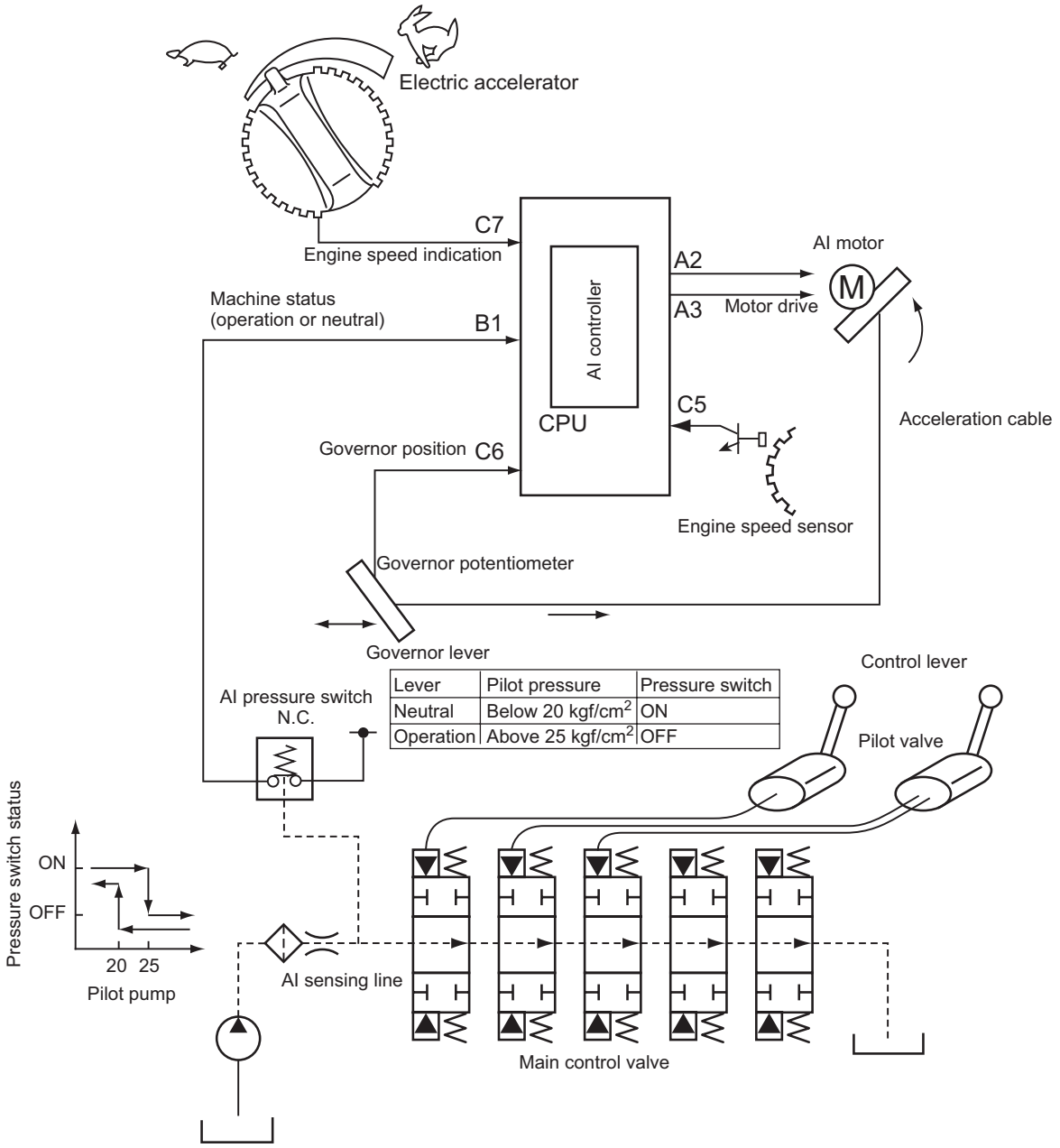


<Operating chart>



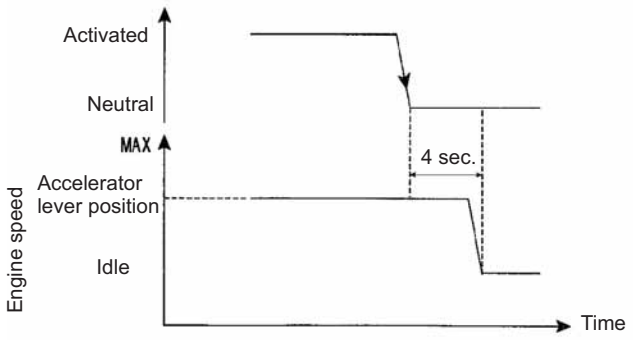
(1) The idling speed can be achieved 4 seconds after the control lever is set to neutral.
(2) The initial speed is resumed just after the control lever is moved.
(3) The speed remains the same if the control lever is kept at neutral for 2 seconds.
(4) When the safety lock laver is lifted up, engine speed goes down to idle rpm.

3. Behavior when the control lever is returned to neutral

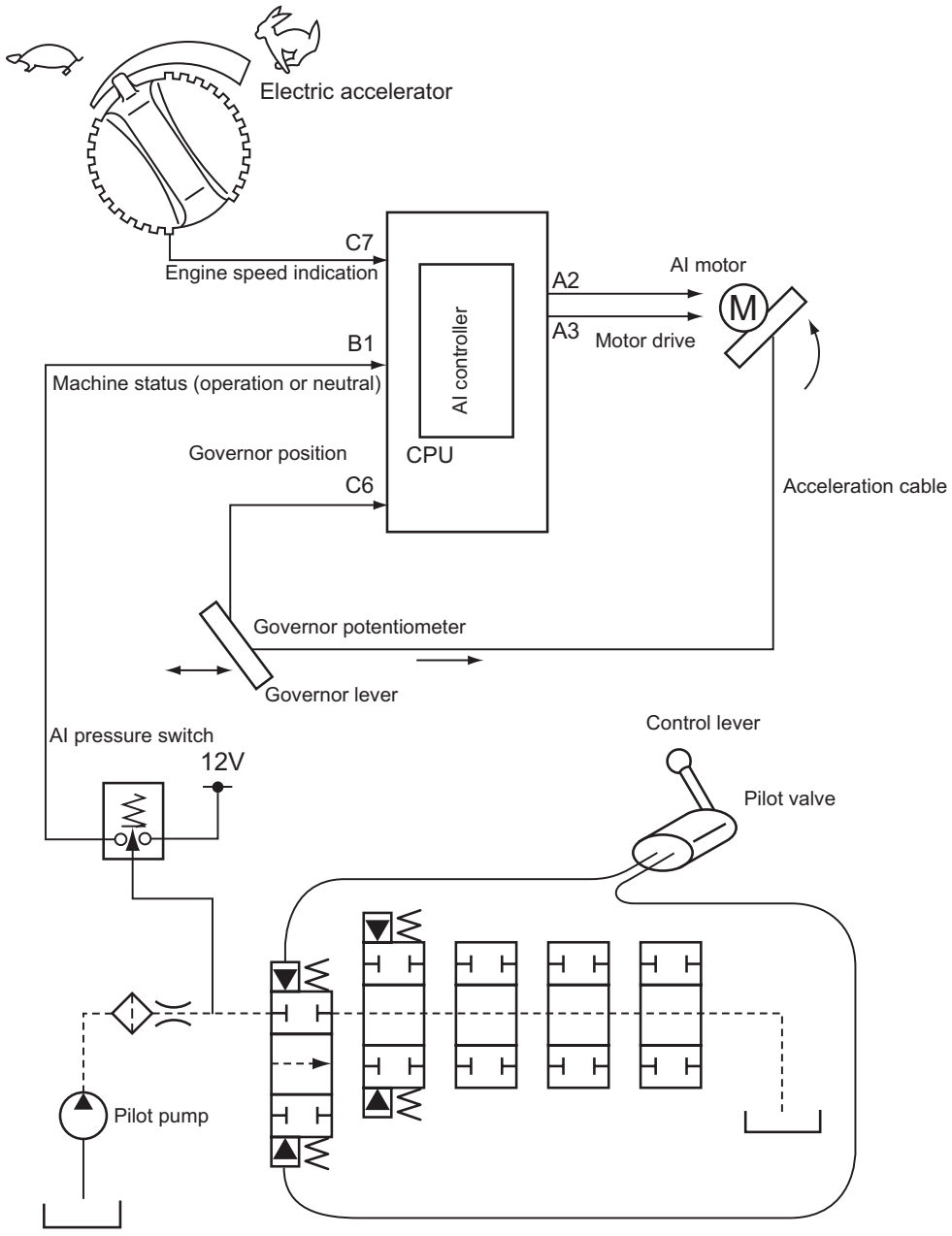


Lever	Pilot pressure	Pressure switch
Neutral	Below 20 kgf/cm^2	ON
Operation	Above 25 kgf/cm^2	OFF

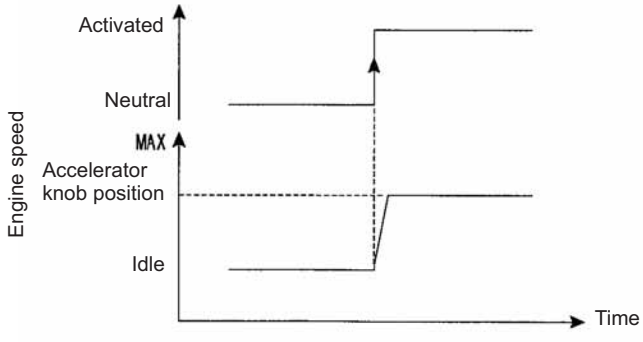
1. When returning the control lever back to neutral:
   - AI pressure switch at ON and accelerator knob at MAX:
     When the control lever has been placed back to neutral, the oil flows from the pilot pump through the neutral passage of the control valve to the tank. The pressure drops, which turns on the pressure switch. In about 4 seconds, the AI motor gets started to reduce the engine speed to the idling level.



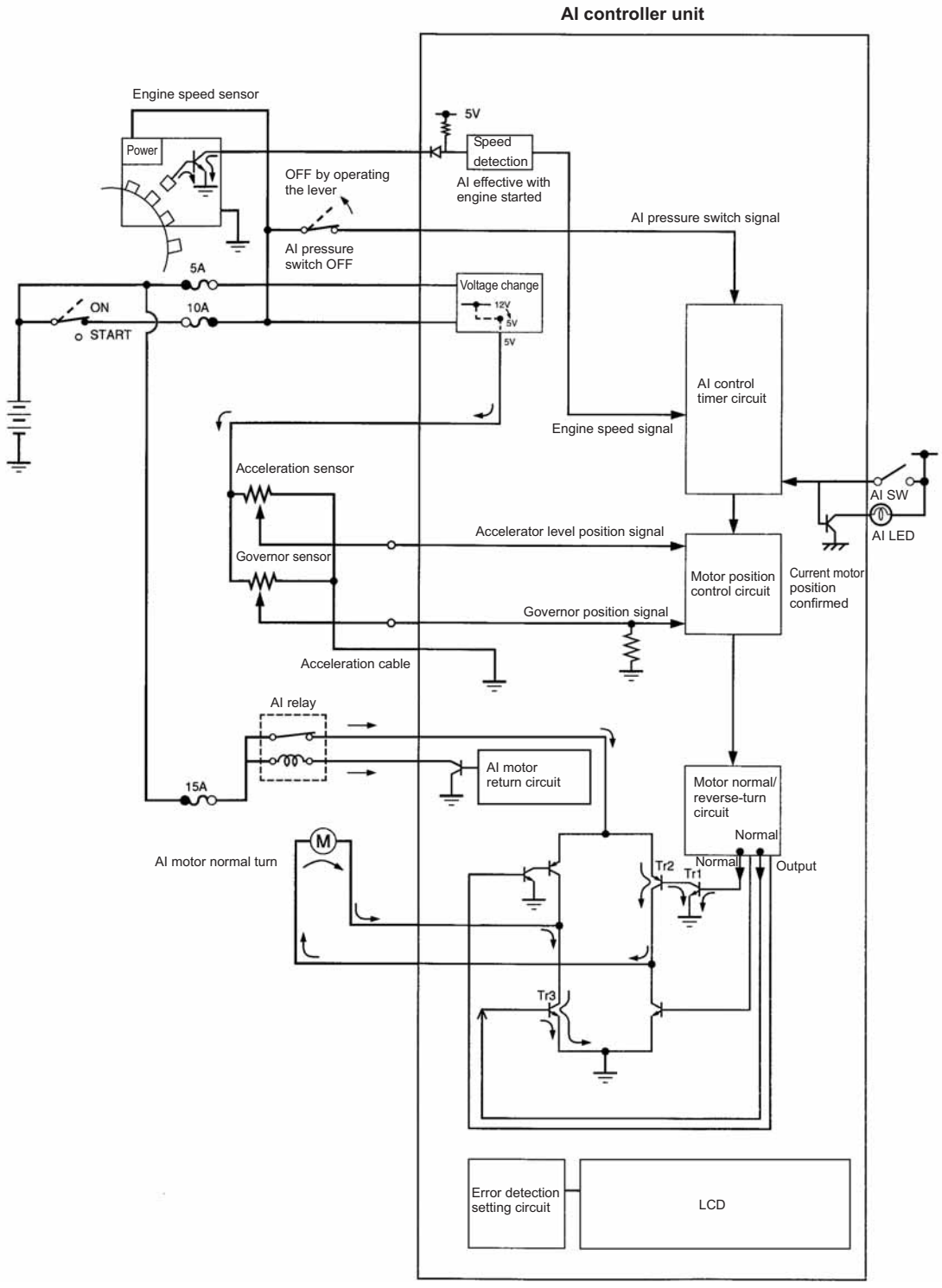
4. Behavior when the control lever is operated:



- AI pressure switch at ON and accelerator knob at MAX:
  When the control lever is operated (left swivel, for example), the control valve is activated to cut off the oil flowing from the pilot pump. The primary pilot pressure is applied to turn off the pressure switch.
  The AI controller functions to run the AI motor so that the engine governor should reach maximum position. The engine speed rises quickly to maximum rpm.



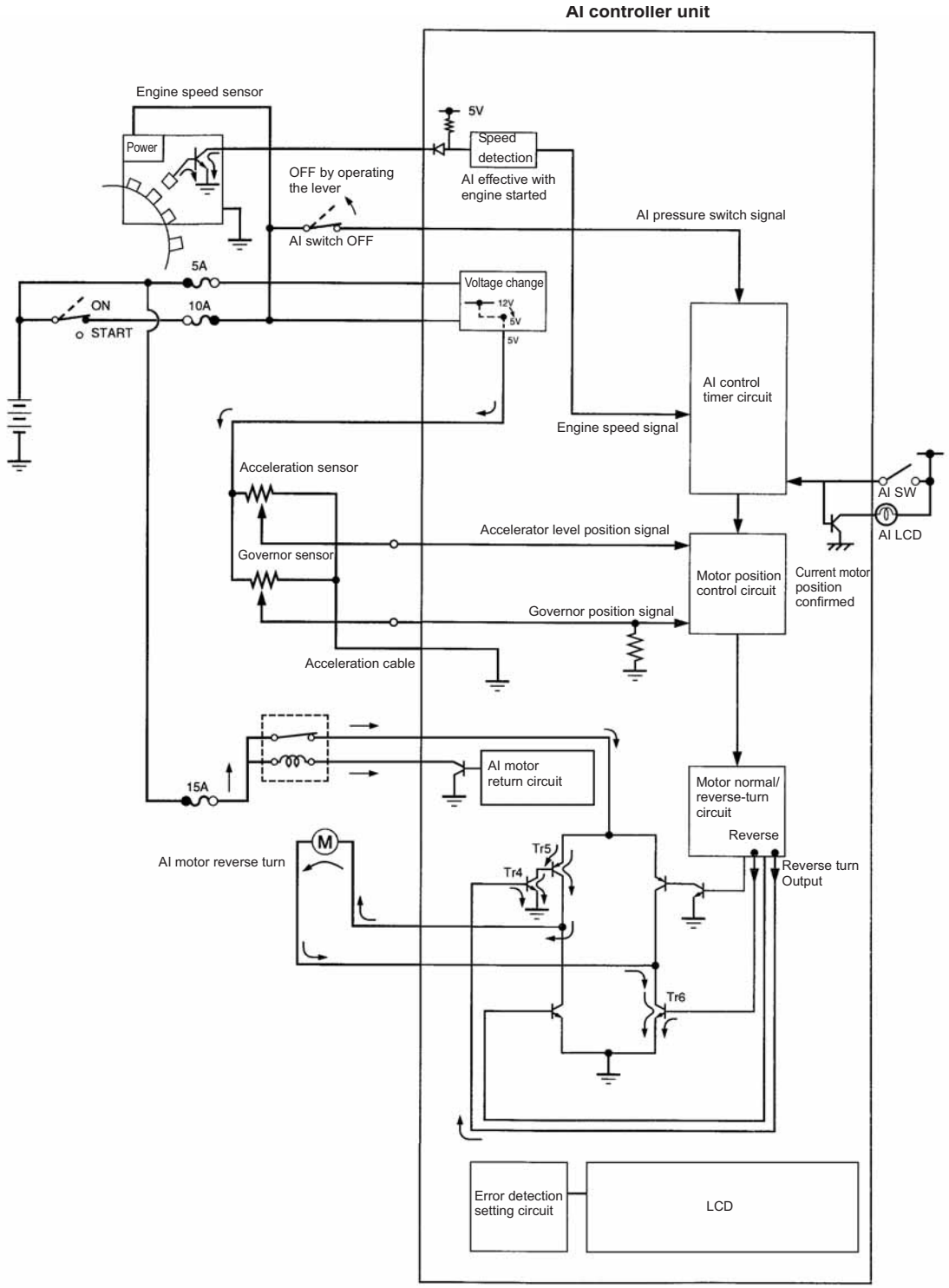
5. AI motor normal-turn circuit



Behavior:

1. The acceleration sensor signal and governor sensor signal are fed to the motor position control circuit.
2. The motor normal/reverse-turn circuit serves to select the AI motor turning direction based on the lever position by the operator.
3. When the normal turn is selected as shown in the figure, the base current flows to the transistor Tr1. Now the battery current flows for running the AI motor in the normal direction.

6. AI motor reverse-turn circuit



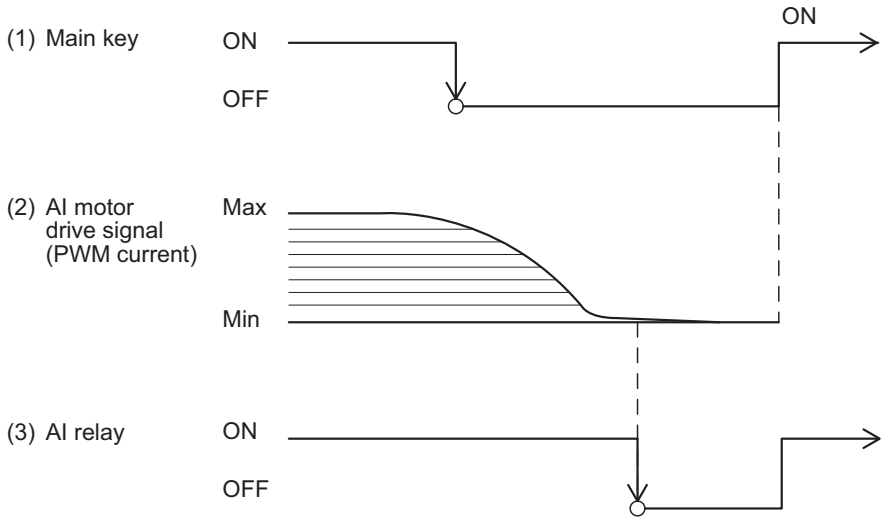
Behavior:

1. When the reverse turn is selected by the motor normal/reverse-turn circuit as shown in the figure, the battery current flows for running the AI motor in the reverse direction.
2. The reverse-turn electrical signal activates the transistors Tr4, Tr5 and Tr6 in this order. Now the battery current flows for running the AI motor in the reverse direction.

7. AI motor returning function

This function is newly incorporated in this new series.
In the previous models, KX121-3, 161-3,
AI motor's position is only controlled by the accel. sensor dial.
If an operator turns off the starter key at the accelerator sensor dial max. position and next turns the main key to start, the engine will start at max. speed. Although this is a frightening case, the new function prevents it.

<Function chart>

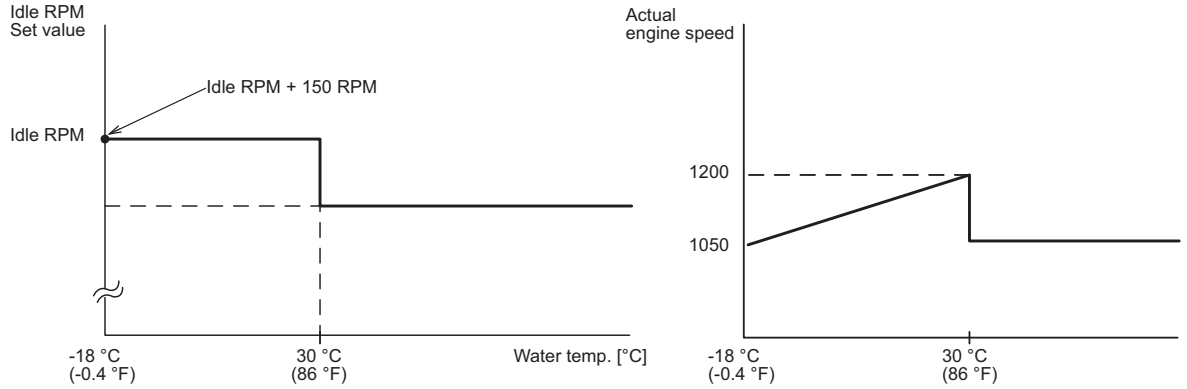


After the main key is off, the controller detects the AI motor drive signal which is set by the accel. sensor and reduces to min. level to return the AI motor position to the idling speed.
In this way, even when the operator turns off the key at max. speed, engine starts at idle speed for the next key turning.

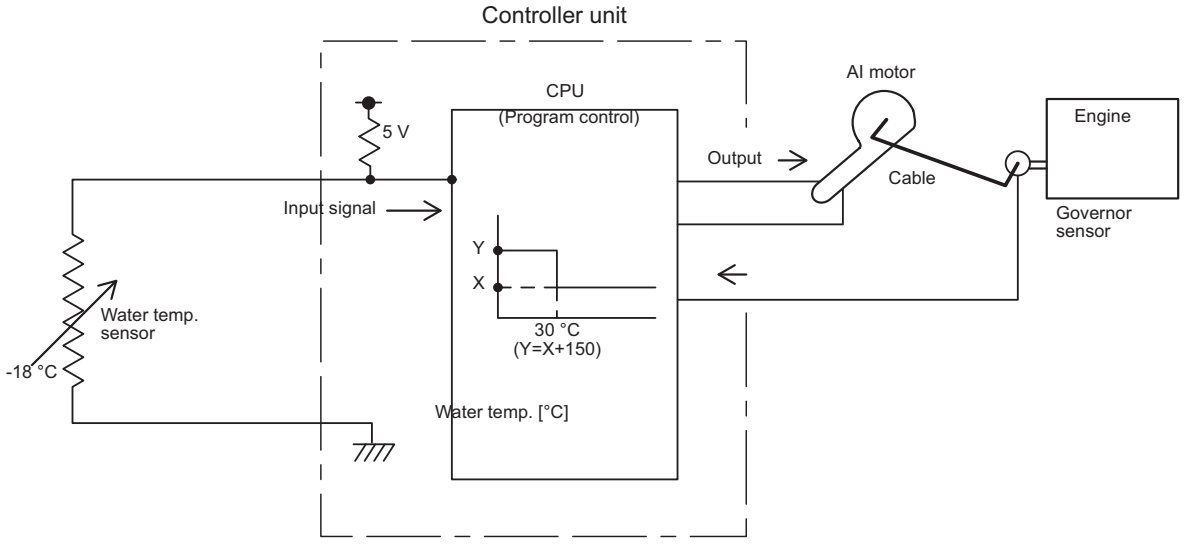
d) Idle-up Control

The idling speed increases by 150 rpm when the water temperature drops below 30 centi-degrees. (Reason: Even at the same governor position, the engine speed drops about 150 rpm at the temperature of -18 centi-degrees.)

<Function chart>



<Function diagram>

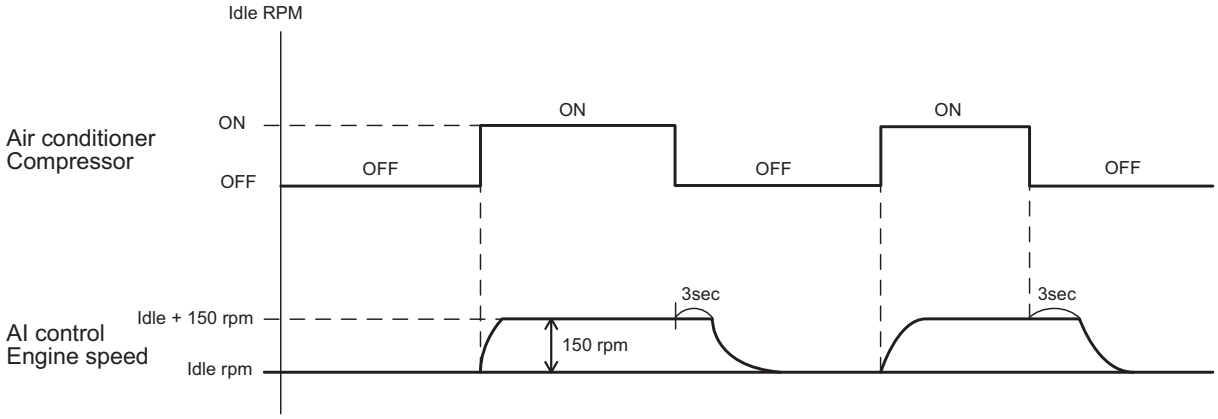


CPU in the controller unit detects the water temp. sensor signal.
Stored program calculates the optimum idle speed according to the water temp. sensor value.
If the temp. value is over 30 °C (86 °F), then CPU commands to output the preset idle PRM.
If the temp. value is below 30 °C (86 °F), then CPU commands to output 150 rpm higher than the preset idle speed.
Actual output from the controller is PWM current to the AI motor. Then AI motor rotates to regulate the engine governor value which is always feed back to the controller.

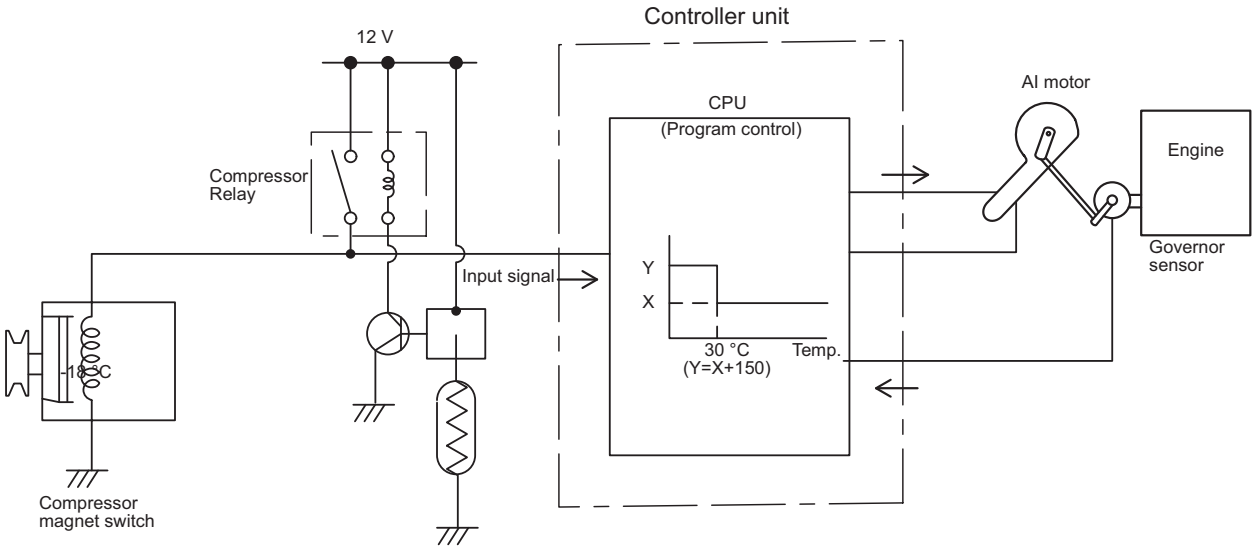
e) Compressor Control

When the compressor is on, the idling speed is raised by 150 rpm.
The idea is as follows.
If the compressor is repeatedly turned on and off kept off for 3 seconds, the idling speed gets back to its original rpm. In this way, the AI motor can be kept from getting activated many times.
(Reason: If the compressor is on and the alternator barely generates power, the battery, if connected to an external load, may fail to work.)

<Function chart>



<Function diagram>



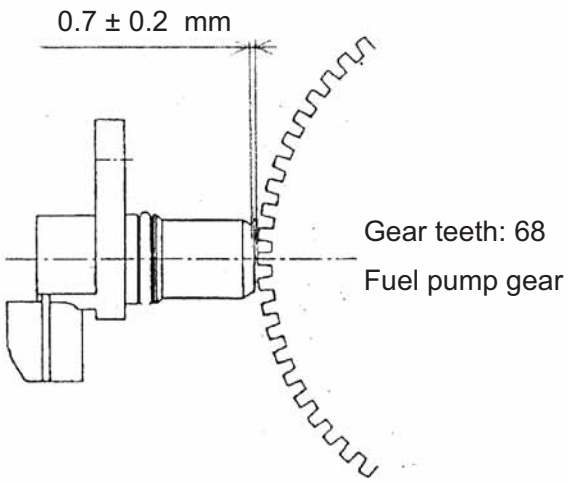
Watching the voltage condition of compressor magnet switch, CPU in the controller commands the AI motor to regulate the engine idle speed.
If the magnet switch is ON, then CPU commands to output 150 rpm higher than the preset idle speed.
If the magnet switch is OFF, then CPU commands to output the preset idle RPM.
Actual output from the controller is PWM current to the AI motor.

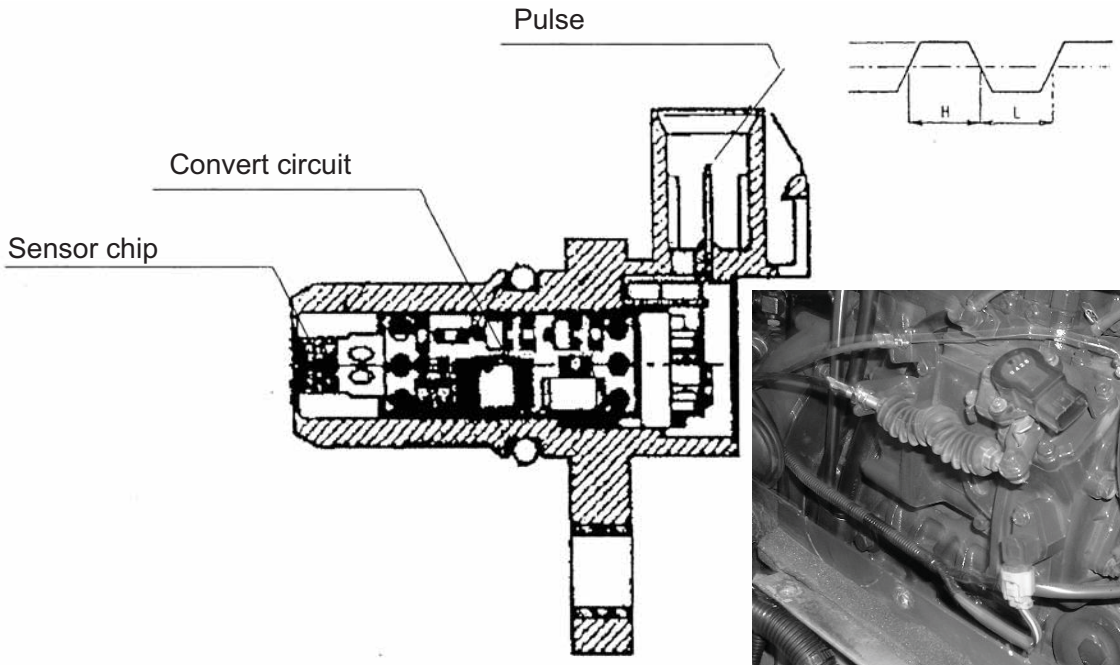
f) Engine Speed Sensor

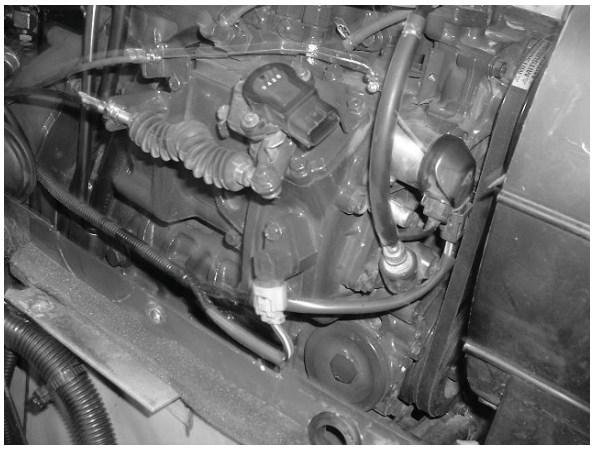
The engine speed sensor is a quick-response proximity switch. When the teeth of a gear pass close, the magnetic field inside the switch changes and the variation is converted to pulses.
The number of pulses for "t" seconds is counted by the microcomputer. The engine speed is then computed in the following equation.

$$\frac{2 \times 60}{68 \times t} \text{ [rpm]}$$

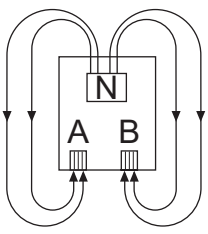
Such speed data is used for the starter's automatic release system.

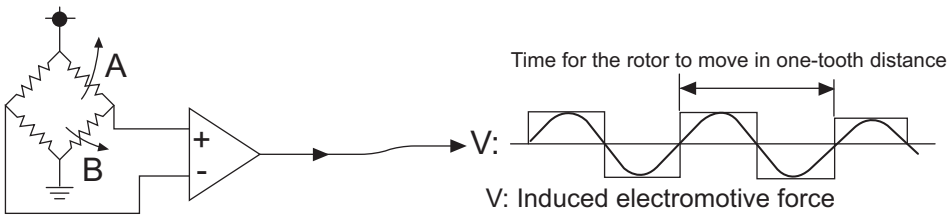






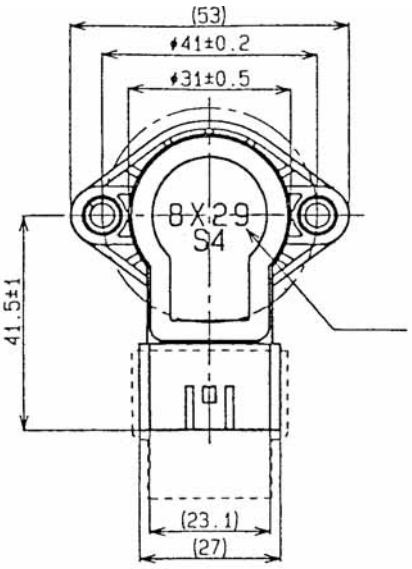
This sensor is composed of a sensor and a rotor. The sensor has a coil wound up around a magnet, and the rotor is of iron with teeth. As the rotor turns, the magnetic flux varies at its peaks and troughs according to the turning speed. Such frequency-dependent change of the magnetic force line generates an induced electromotive force in the coil. The resulting signal is fed to the controller to detect the turning speed.





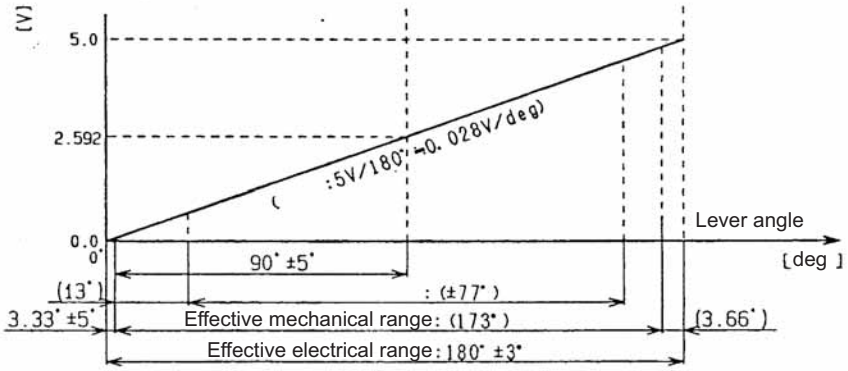
g) Governor Sensor

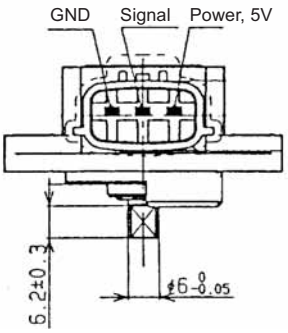
Code No. RP421-5371-1



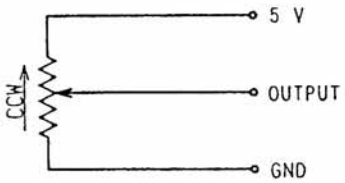
Specifications

1. Rated voltage: DC5V
2. Total resistance: 2 KΩ ± 20%
3. Insulation resistance: 100 MΩ or more
4. Output performance:

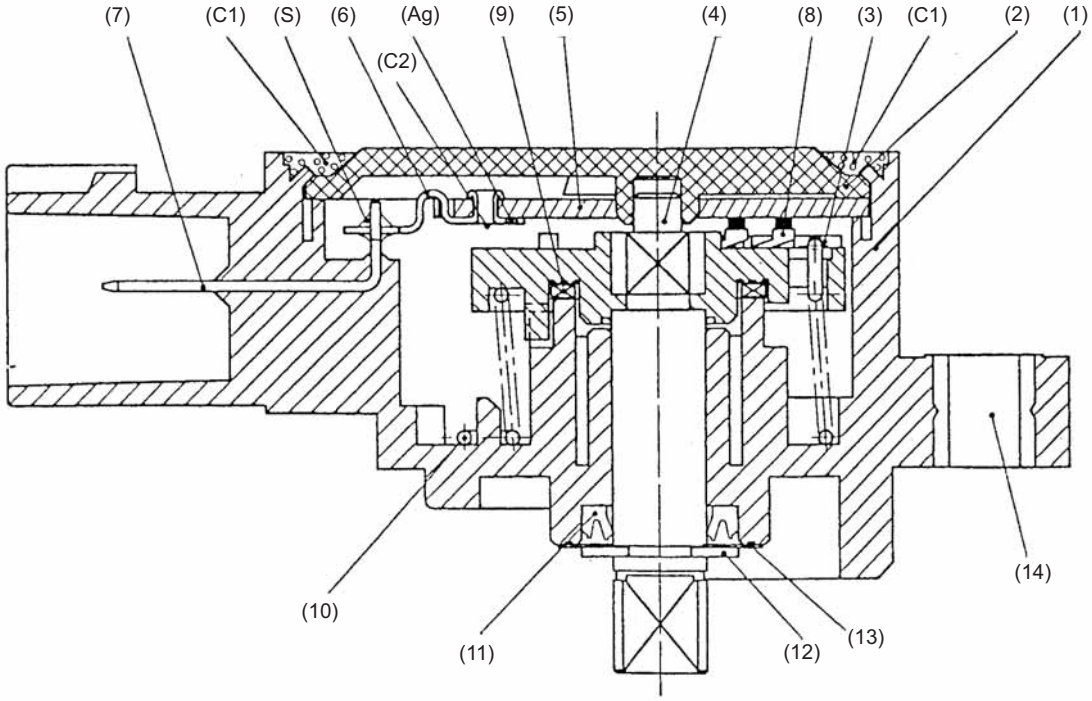




Circuit diagram



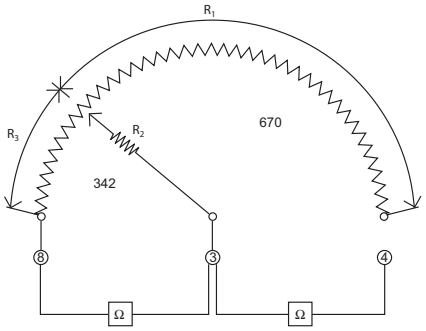
(1) Case
(2) Cover
(3) Rotor
(4) Shaft
(5) Resistance
(6) Element terminal
(7) Connector terminal
(8) Slider
(9) Wave washer
(10) Return spring
(11) Rubber seal
(12) E-ring
(13) Washer
(14) Sleeve
C1, C2: Adhesive

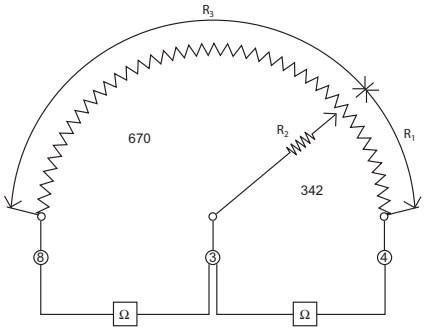


h) Accel. Sensor (Electric Accelerator)

Code No.
AI panel assy: RD809-53731

(1) AI panel assy





(Sample data)[Ω]

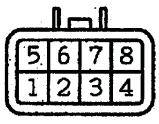
Accel sensor position	Min.	Max.
4-8 R_1-R_2	1000	
4-3 R_1+R_2	670	342
3-8 R_2+R_3	342	670

R_2 is contact resistance.
How to get R_2?

$$R_2 = \frac{670 + 342 - 1000}{2} = 6\ \Omega$$

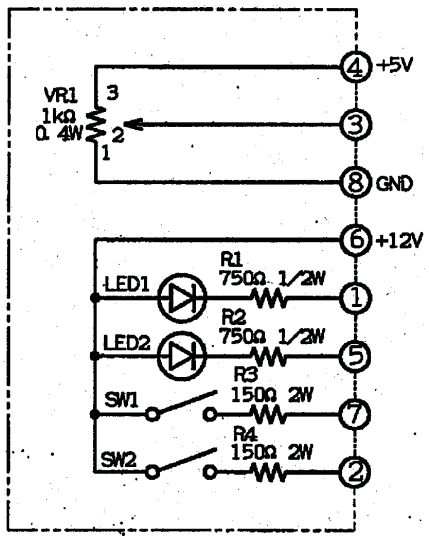
$$R_2 = \frac{342 + 670 - 1000}{2} = 6\ \Omega$$

$R_2 = 6\ \Omega$



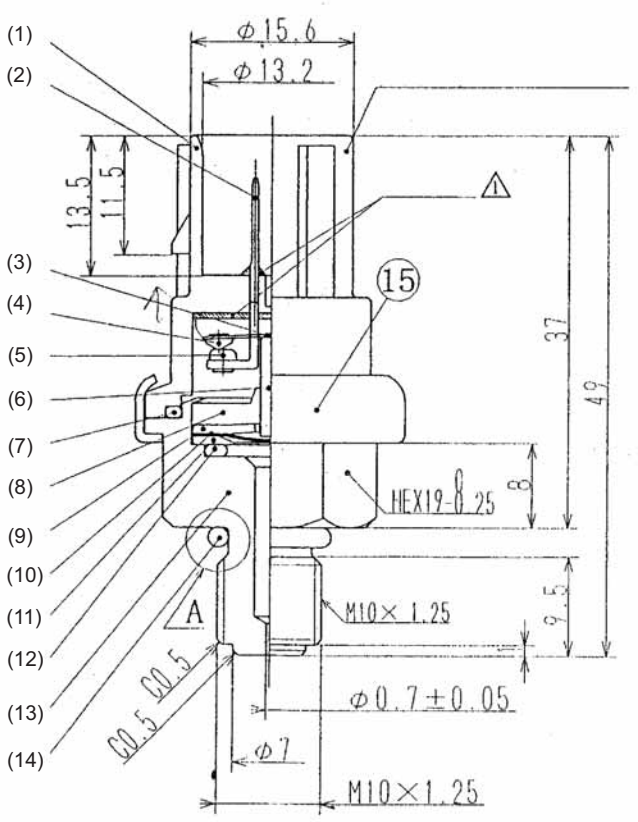
Connector pin numbers

Pin No.	Name
1	LED1
2	SW2
3	ACCEL VR
4	ACCEL VR POWER
5	LED2
6	LED/SW POWER
7	SW1
8	ACCEL VR GND



i) AI Pressure Switch

C/N RC411-53681, 25 kgf/cm^2, Normal close type



1	Terminal block
2	Terminal
3	Movable contact plate
4	Movable contact
5	Fixed contact
6	Shaft
7	O-ring A
8	Guide plate
9	Stopper
10	Flex plate
11	Cap
12	O-ring B
13	Coupling
14	O-ring C
15	Clamp plate

1. Function

When the pressure sensed by the oil pressure detection circuit for auto idle control has dropped below 20 kgf/cm^2, the contact of the AI switch, shown at left, gets closed. The microcomputer picks up the resulting ON signal and sends a command to the AI motor to reach the engine idling speed. The idling speed approach is preset to be 4 seconds after the switch has been turned on by the microcomputer.

When the control lever is moved, on the other hand, the pressure in the hydraulic pilot circuit rises. At 25 kgf/cm^2, the hydraulic pressure pushes the diaphragm as shown at left, which opens the contact. The microcomputer picks up the resulting OFF signal and raises the engine speed up to the accelerator lever rpm setting.

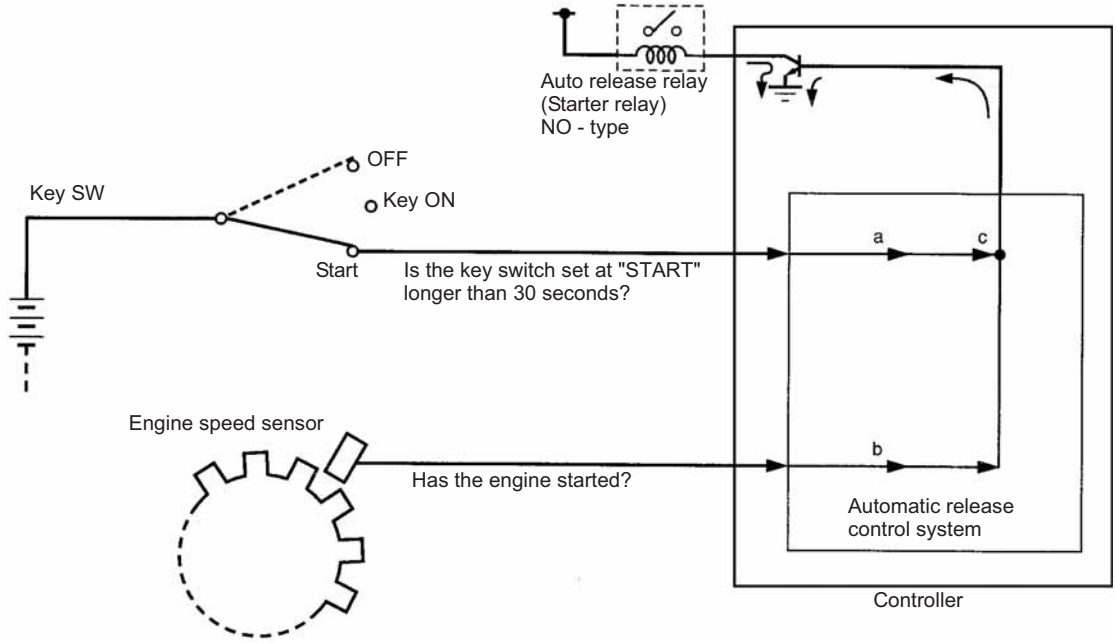
2. Switch specifications

(1) Detection method: Metallic diaphragm
(2) Switching logic: Normally closed (NC)
Continuity resistance = 0.2Ω
(3) Operating pressure:
2.45 ± 0.3 MPa (25 ± 3 kgf/cm^2) 356 ± 43 psi
--> Switch OFF
1.96 ± 0.3 MPa (20 ± 3 kgf/cm^2) 285 ± 43 psi
--> Switch ON
(4) Insulation resistance: Over 100 MΩ
(with DC500V megger)
(5) Code No. RC411-53681

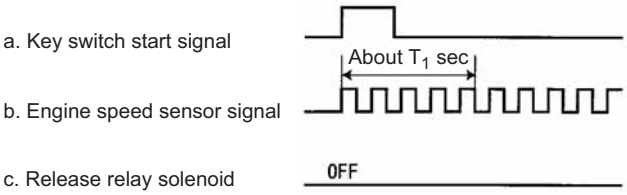
(C) MAIN COMPONENT'S FUNCTION

a) Auto Release Function

1. Auto release circuit diagram & function



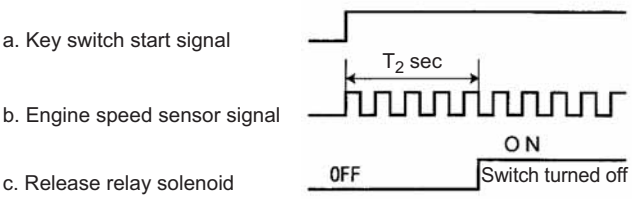
1) Function chart
When in normal operation



When the key switch is returned after the engine got started, the release relay functions as shown below upon engine speed.

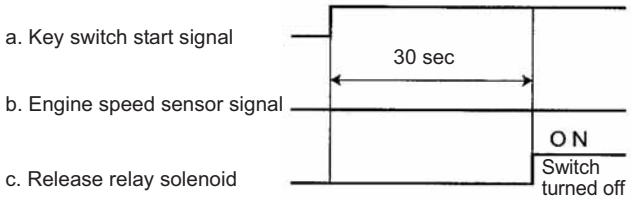
Engine speed		Auto release relay (T_1, T_2)
KX41-3	KX61-3 ~ 161-3S/α, U20-3 ~ U45-3S/α	
1000 ≧ N_x	800 ≧ N_x	ON
1001 ~ 1150	801 ~ 950	ON (Within 6 seconds) OFF (After 6 seconds)
1151 ≦ N_x	951 ≦ N_x	ON (Within 0.5 seconds) OFF (After 0.5 seconds)

2) If the engine has started but the key switch fails to return (key switch failure)



Suppose that the key switch fails to return and the key switch start signal stays on. But if the engine speed sensor signal is fed, the automatic release control system regulates the transistor's base current flow, which turns on the release relay solenoid ON or OFF.

3) If the key switch fails to return and the engine speed sensor is also in trouble



If the key switch start signal is detected to have been on for 30 seconds, the automatic release control system (3) lets the transistor's base current flow, which turns on the release relay solenoid (1) and turns off the relay switch.

	a: Key switch status	b: Engine speed sensor status	c: Release relay solenoid action
(1)	Normal: No particular action	Normal	Normal: No particular action
(2)	Start position → Failure to return	Normal	Relay deactivated 0.5 or 6 seconds according the engine speed.
(3)	Start position → Failure to return	Engine failure to start, or no engine speed sensor signal	Relay deactivated 30 seconds after the key switch turn to "START"

2. Troubleshooting

If the Engine Does Not Start

1) Check if the safety lock lever is lifted.
Make sure that the safety switch is turned OFF.
Take the following steps, set the unit to tester mode, and check the condition of the safety switch.

(Service mode)

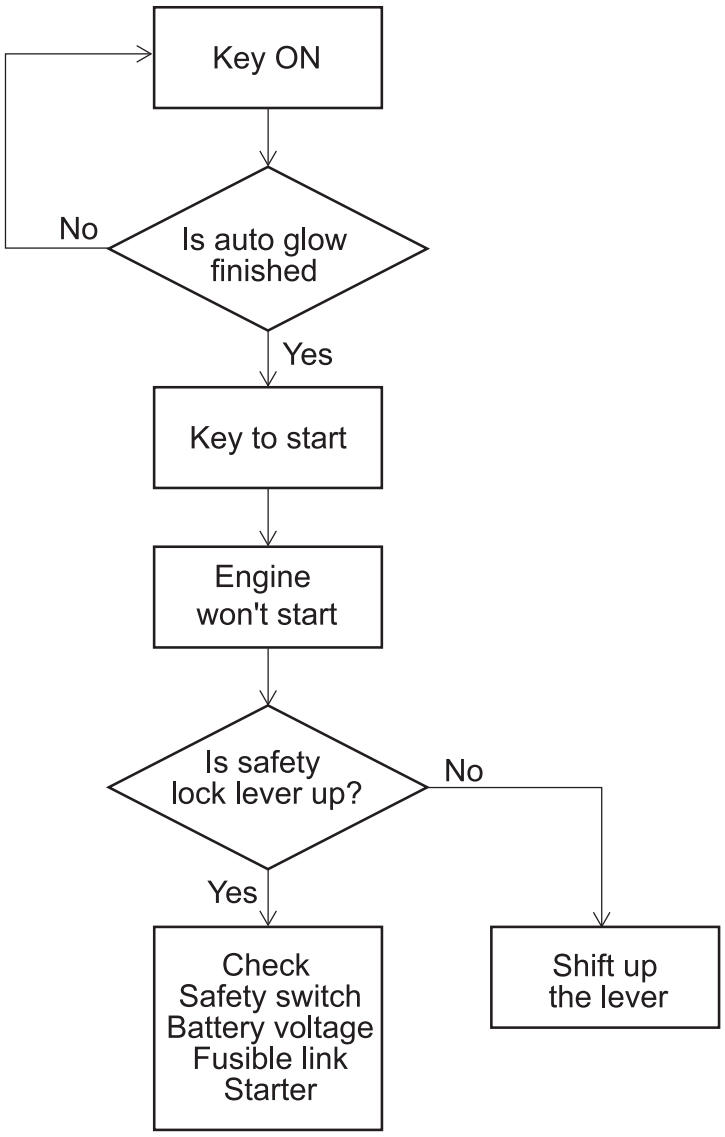
KX121-3 ⟶ English ⟶ Diagnosis ⟶ Tester ⟶ Lever travel start

A manual check with a circuit tester is possible.

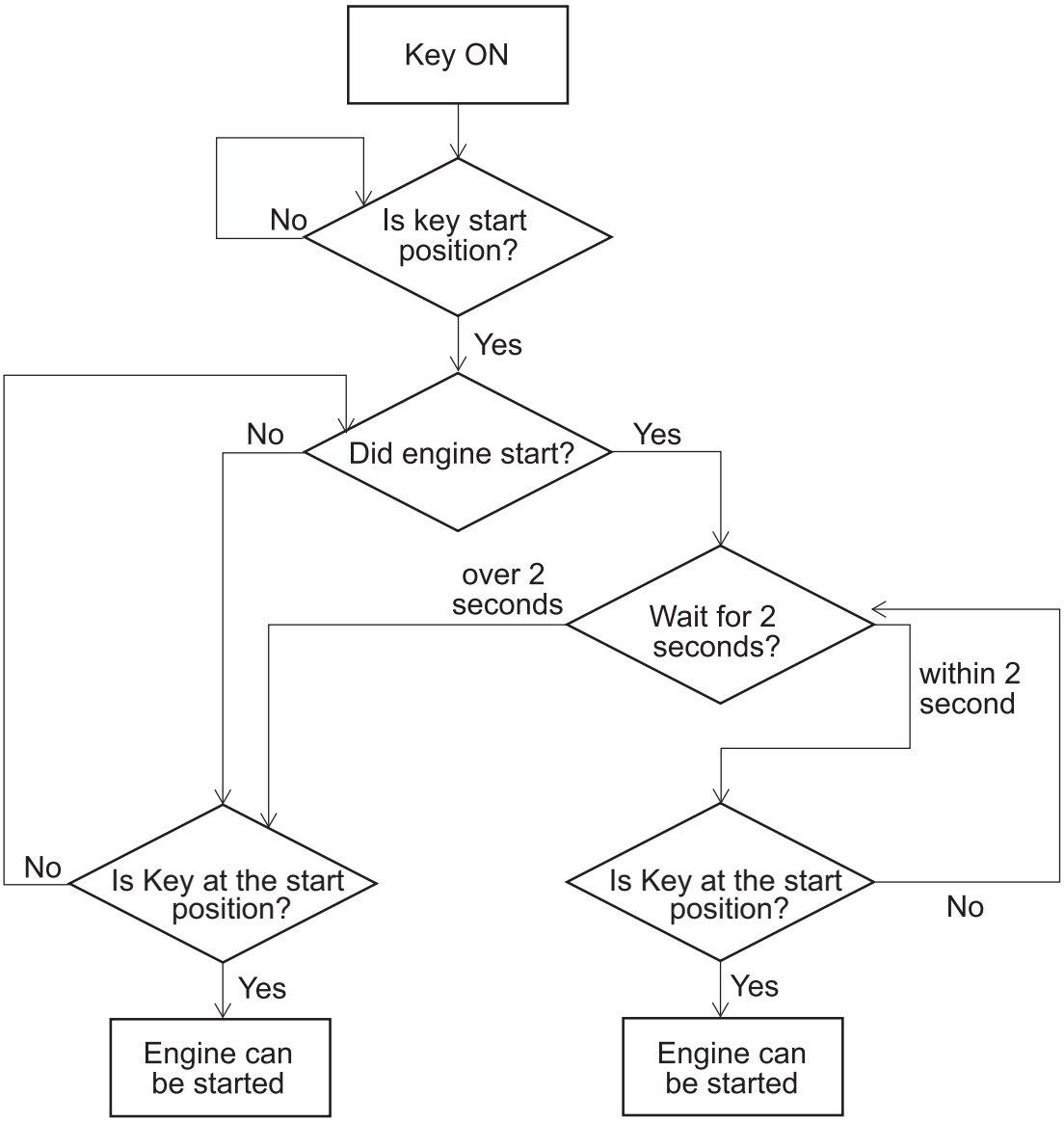
2) Check if the prevention of start mode reentry is working. (Wait two seconds or more.)
3) Check if the auto release relay is turned OFF.
Make a manual check with a circuit tester.
4) Check if the wrong model settings are made.
Depending on the model, the start of the engine is judged at 1,000 rpm or below for KX41-3. The release of the starter motor is judged before the startup revolution of the engine is reached.
5) The reason why detecting engine speed is set at 1,000 rpm;
If 800 rpm is set to detect the engine start-up speed, the controller stops supplying the current to the starter motor.
Under the low ambient temperature, engine may not start up at around 800 rpm.
In order to make sure the actual engine start, sensing engine speed is set higher by 200 rpm.
This varies according to the models. Other than KX41-3, the start of the engine is detected at 800 rpm.

3. Operational flow chart

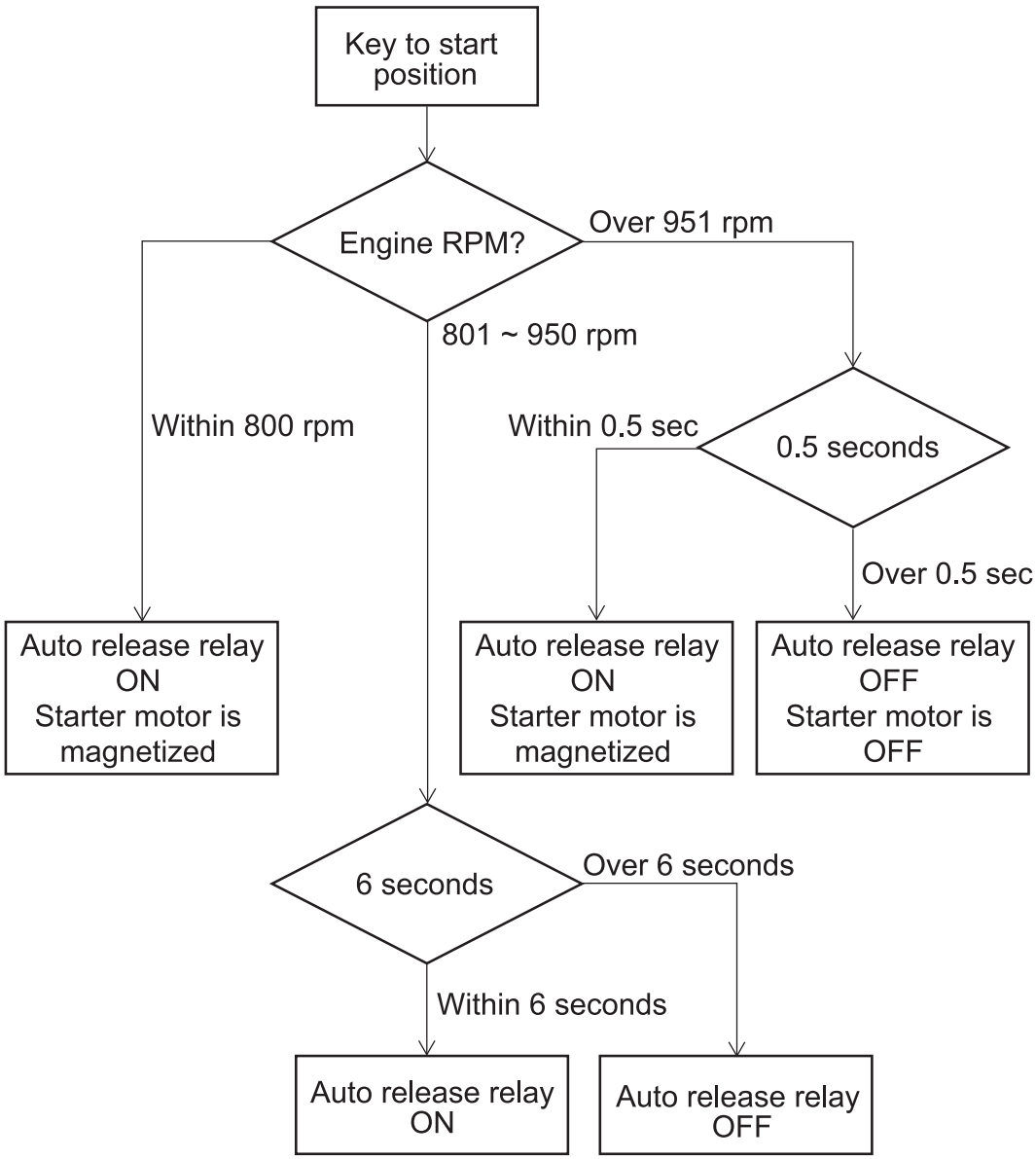
3-1



3-2


Key ON
No
Is key start position?
Yes
No
Did engine start?
Yes
over 2 seconds
Wait for 2 seconds?
within 2 second
No
Is Key at the start position?
Yes
Engine can be started
Is Key at the start position?
No
Yes
Engine can be started

3-3

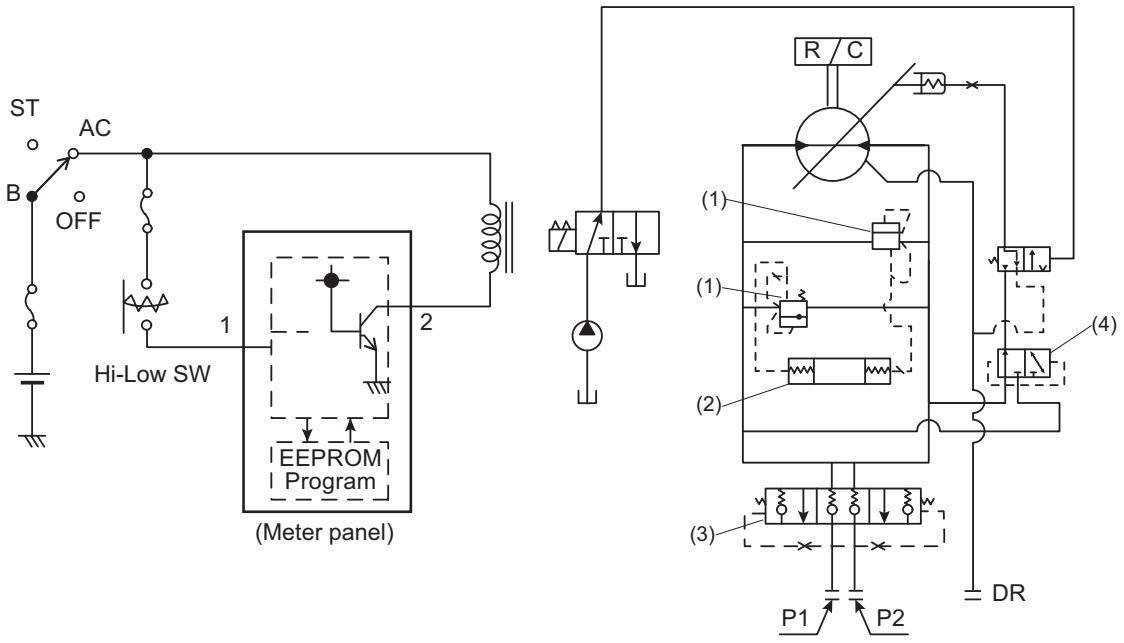


< Engine speed and condition of auto release relay >

Engine speed: N_x		Time: T_1, T_2	Auto release relay
KX61-3 ~ KX161-3α/S/ST U20-3 ~ U45-3α/S/ST, U45S/ST S2/α2 series	KX41-3		
800 ≧ N_x	1000 ≧ N_x		ON
801 ~ 950	1001 ~ 1150	Within 6 seconds	ON
		After 6 seconds	OFF
951 ≦ N_x	1151 ≦ N_x	Within 0.5 seconds	ON
		After 0.5 seconds	OFF

starter relay = Auto release relay

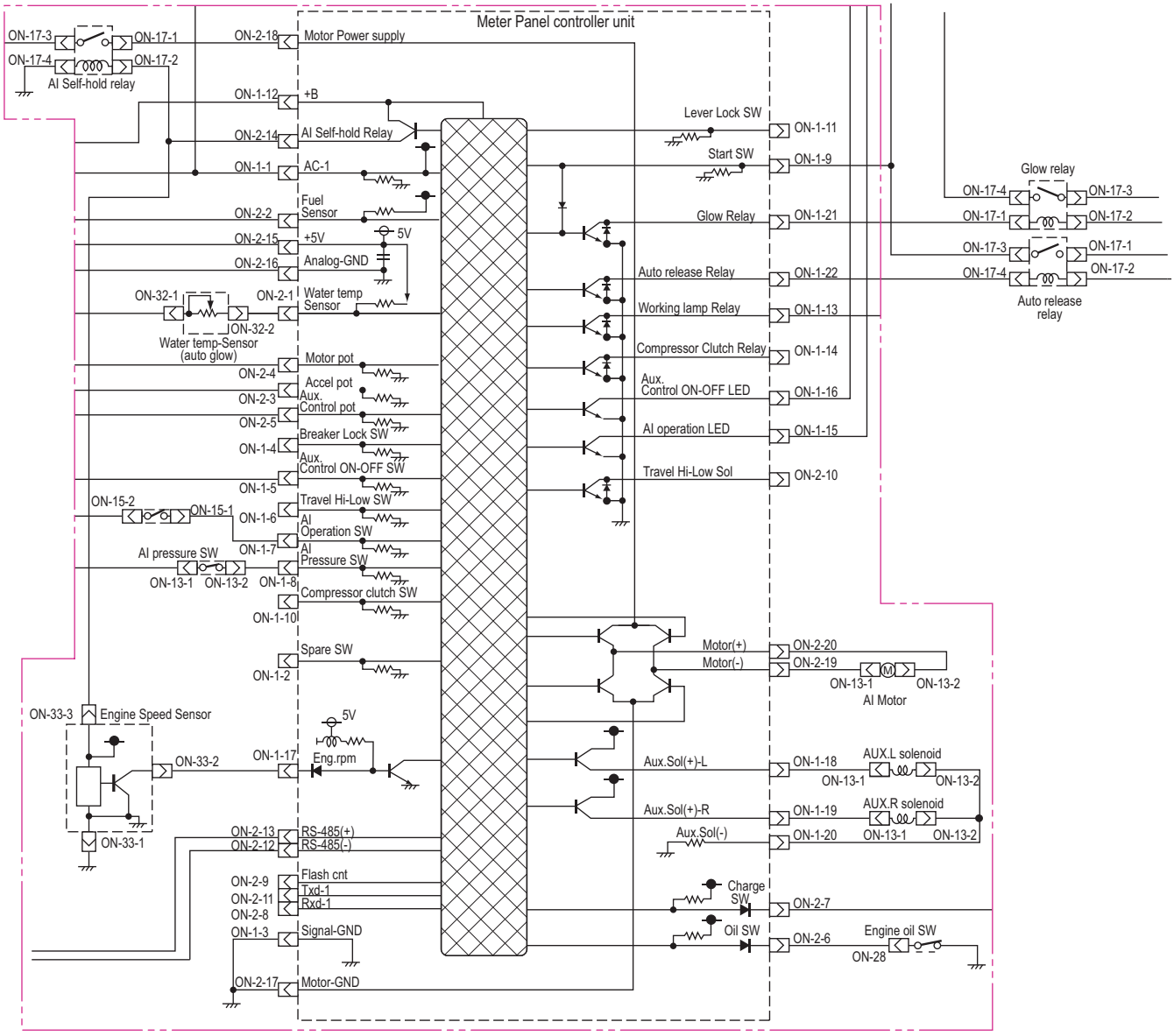
b) Travel Hi-speed Control Circuit



Troubleshooting: Travel hi-speed malfunction

1. Turn the key switch to the ON position to see if 12 V is applied to terminal 2 of the travel hi-speed switch.
2. Press the travel hi-speed switch to see if the 12 V signal comes to terminal 1.
3. Turn on and off the travel hi-speed switch and check the continuity and discontinuity.
4. Check the continuity of the travel hi-speed solenoid coil and measure its resistance.
5. If there is no problem with the above steps, it means the electrical system functions. Now go to the hydraulic system.
6. Possible troubles with the hydraulic system include stuck solenoid spool, poorly performing pilot pump, malfunctioning primary relief valve, stuck Hi-Lo selector spool, etc.

c) Meter Panel (Controller Unit)



(D) FAILURE DIAGNOSIS

1. Failure display and diagnosis criteria

The following table 1 shows data on failure diagnosis, for operating mode and service mode.

Note:
- Display items of the system in service mode can be checked with the fail record.
- In the case of a warning for fuel scarcity, the buzzer will be turned ON for a moment at five-minute intervals.
- No.11 ~ 61 except 31, 32, 51, 52, 53, 54, 55 will be incorporated in future version machine, such as auto idle (AI) model, anxilliary port (AUX) model and anti - theft system model.

Table 1. Failure diagnosis

Display		Buzzer	Lamp	Reset method	Function stop point	EEPROM address	Method of diagnosis
Operating mode	Service mode						
1 Fuel	-	5-minute intervals	Yellow	Replenish fuel or key off	---	---	Fuel scarcity rate is 90% of total sensing times min. after 60-s sampling. Sensing every 10 m. second and total 6000 times
2 Engine oil	2 Engine oil	Continually	Red	Returns to normal or key off	---	66, 86	At 5 V: Normal CPU sensor voltage The following conditions continue 20 s: oil switch level = L and engine speed is less than 800 rpm min.
3 Charge	3 Charge	Momentarily	Red	Returns to normal or key off	---	65, 85	At 5 V: Normal CPU sensor voltage The following conditions continue 10 s: charge switch level = L and engine speed is less than 800 rpm min.
4 High voltage	4 High voltage	Continually	Red	Turn key OFF	AI S/P	67, 87	At 5 V: Normal CPU sensor voltage A power supply voltage of 18 V min. continues 3 s.
5 Overheat	5 Overheat	Continually	Red	112°C ± α max. or key off	AI S/P	77, 97	At 5 V: Normal CPU sensor voltage The following conditions continue: Engine revolution of 800 rpm min. with overheat warning When the water temperature sensor is normal, a water temperature of (124 ± α) °C min. continues 5 s. (α: Adjustable between -10 °C and +10 °C.)
11 Accel sensor	11 Accel sensor	Momentarily	Red	Turn key OFF	AI	68, 88	At 5 V: Normal CPU sensor voltage The accelerator sensor for AI specifications at 0.25 V max. or 4.75 V min. continues for 0.2 s.
12 Governor sensor	12 Governor sensor	Momentarily	Red	Turn key OFF	AI	71, 91	At 5 V: Normal CPU sensor voltage The governor sensor for AI specifications at 0.25 V max. or 4.75 V min. continues for 0.2 s.
13 AI motor short	13 AI motor short	Momentarily	Red	Turn key OFF	AI	69, 89	At 5 V: Normal CPU sensor voltage AI specifications. The specifications are presently under consideration.
14 AI motor short	14 AI motor short	Momentarily	Red	Turn key OFF	AI	70, 90	At 5 V: Normal CPU sensor voltage AI specifications. The specifications are presently under consideration.

Note:1) AI indicates Auto Idling version only.
2) Operating voltage of engine oil pressure and AI motor is 12 V.
3) Normal CPU sensing circuit voltage is 5 V for the following items; 2, 3, 4, 5, 11, 12, 13, 14, 21, 22, 23, 24, 25, 51, 52, 53, 54 and 61.

Display		Buzzer	Lamp	Reset method	Function stop point	EEPROM address	Method of diagnosis
Operating mode	Service mode						
21 S/P volume (S/P knob SW)	21 S/P volume (S/P knob SW)	Momentarily	Red	Cancel S/P or key off	S/P	72, 92	At 5 V: CPU sensor circuit voltage S/P specifications. S/P mode turns ON. The AUX sensor at 0.25 V max. or 4.75 V continues for 0.2 s.
22 S/P Solenoid L short	22 S/P Solenoid L short	Momentarily	Red	Cancel S/P or key off	S/P	73, 93	At 5 V: CPU sensor circuit voltage S/P specifications. S/P mode turns ON. The specifications are presently under consideration.
23 S/P Solenoid L break	23 S/P Solenoid L break	Momentarily	Red	Cancel S/P or key off	S/P	74, 94	At 5 V: CPU sensor circuit voltage S/P specifications. S/P mode turns ON. The specifications are presently under consideration.
24 S/P Solenoid R short	24 S/P Solenoid R short	Momentarily	Red	Cancel S/P or key off	S/P	75, 95	At 5 V: CPU sensor circuit voltage S/P specifications. S/P mode turns ON. The specifications are presently under consideration.
25 S/P Solenoid R short	24 S/P Solenoid R short	Momentarily	Red	Cancel S/P or key off	S/P	76, 96	At 5 V: CPU sensor circuit voltage S/P specifications. S/P mode turns ON. The specifications are presently under consideration.
31 Lift up unload lever	-	Momentarily	Yellow	Wait for 5 s, then disappear	Engine does not start	---	The key is shifted to the start position with the lever lock moved down.
32 Service hour	-	Momentarily	Yellow	Wait for 10 s	---	---	The specified hour meter is set.
33 Key is wrong	-	Momentarily	Yellow	Wait for 3 s	Engine does not start	---	Theft prevention specifications The wrong key is used to start the engine.
34 Different key	-	Momentarily	Yellow	Wait for 3 s	Engine does not start	---	Theft prevention specifications The registered key is used to start the engine.
51 Coolant sensor (EU)	51 Coolant sensor (US)	Momentarily	Red	Turn key OFF	---	82, 102	At 5 V: CPU sensor circuit voltage A water temperature of -30°C max. or 140°C min. continues for 1 s.
-	52 Fuel sensor	Momentarily	Red	Turn key OFF	---	81, 101	At 5 V: CPU sensor circuit voltage The fuel sensor at 2 V min. continues for 10 s.
53 Sensor supply short 12V	53 Sensor supply short 12V	Momentarily	Red	Turn key OFF	LCD turns OFF AI and S/P 5-V output turns OFF	79, 99	12-V short-circuiting detection terminal at H level continues for 0.1 s.
54 Sensor supply short 5V	54 Sensor supply short 5V	Momentarily	Red	Turn key OFF	AI and S/P always 0 rpm	80, 100	At 5 V: CPU sensor circuit voltage The 5-V short-circuiting detection terminal at H level continues for 0.1 s.
55 Meter controller error	-	Momentarily	Red	Turn key OFF	AI and S/P	78, 98	The rightmost 16 bits of the added value of addresses 36 through 50 do not coincide with the value of address 64.
-	61 AI motor restricted	Momentarily	Red	Press accelerator	---	83, 103	At 5 V: CPU sensor circuit voltage AI specifications A motor current of 6 A min. continues for 3 s. AI motor diagnosis: Check continuity of motor coil. Connect to battery and test run.

2. EEPROM address information

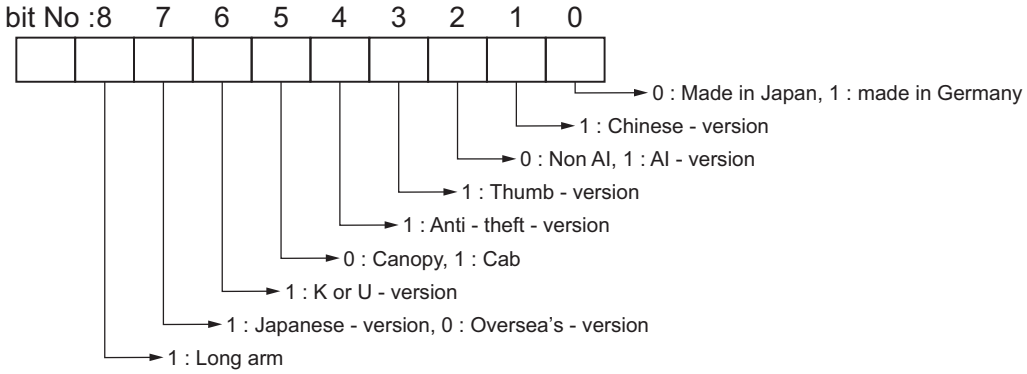
The error log will be deleted by selecting Error Log Delete in Diagnosis Mode. In the software, only the 0th to third bits (the accumulated number of errors) in EEPROM addresses 85 through 103 will be zero cleared, but hour meter data will not be zero cleared. Error Log Delete in Diagnosis Mode judges that there is no error log if the number of errors is zero.
Hour meter data will not be deleted after executing Error Log Delete in Diagnosis Mode. By dumping the EEPROM, hour meter data for errors will be known. This will make troubleshooting possible if the LCD meter is returned to the factory due to a failure after shipping.
The contents of addresses 65 through 103 are zero cleared with the PC before shipping.

Address No.	Contents & purpose to use	
0 ≀ 35	Hour meter	
36	Machine model (Ref. 1)	
37	Optional item (Ref. 2)	
38 ≀ 44	AI control data	38: Accel max. 39: Accel min. 40: Governor min. 41: Governor max. 42: Governor mini. 43: Idle-up governor value, 44: Set speed off-set
45 ≀ 49	Thumb control data	45: S/P right, 46: S/P neutral, 47: S/P left, 48: Start-point gap right, 49: Start-point gap left
50	Language selection	0: EU (11 language), 1: USA and Australia (English only) 2: Canada (English and French)
51 52	Overheat control data	51: Overheat setting (1-EU, 0-NA) 52: Offset value (0)
53	Language (Ref. 3)	
54 ≀ 63	Machine hours & times	
64 ≀ 104	Machine failure warning	
105 ≀ 127	Original manufacturer use Address No. 118: Machine serial No.	

Fig. 2 Address and contents of EEPROM

Ref. 1: 0:KX41-3, 1:KX61-3, 2:KX71-3, KX91-3, 4:KX101-3, 5:KX-121-3, 6:KX161-3, 7:KX080, 8:U35, 9:U45, 10:U50-3, 11:U20, 12:U25, 13:U15 ···

Ref. 2 :



Address No.	Contents of failure	Data bit
64	Check sum, 36 ~ 50	The leftmost 12 bits display the hour meter value of the first error. The rightmost four bits display the accumulated number of errors.
65	3 Charge	
66	2 Engine oil	
67	4 High voltage	
68	11 Accel sensor	
69	13 AI motor short	
70	14 AI motor break	
71	12 Governor sensor	
72	21 S/P volume	
73	22 S/P solenoid L short	
74	23 S/P solenoid L break	
75	24 S/P solenoid R short	
76	25 S/P solenoid R break	
77	5 Overheat	
78	55 Meter controller error	
79	54 Sensor supply short 5V	
80	53 Sensor supply short 12V	
81	52 Fuel sensor	
82	51 Coolant sensor	
83	61 AI motor retricted	
84		Reserve
85	3 Charge	The leftmost 12 bits display the hour meter value of the last error. The rightmost four bits are dummy bits.
86	2 Engine oil	
87	4 High voltage	
88	11 Accel sensor	
89	13 AI motor short	
90	14 AI motor break	
91	12 Governor sensor	
92	21 Aux.volume	
93	22 S/P solenoid L short	
94	23 S/P solenoid L break	
95	24 S/P solenoid R short	
96	25 S/P solenoid R break	
97	5 Overheat	
98	55 Meter controller error	
99	54 Sensor supply short 5V	
100	53 Sensor supply short 12V	
101	52 Fuel sensor	
102	51 Coolant sensor	
103	61 AI motor retricted	

Fig. 3 EEPROM Addresses for Error Log

3. Fail record in EEPROM

If the sensor or actuator line has an error, the output of the actuator will stop and the LCD will display the contents of the error while the error point is written to the EEPROM. Fig. 2 and Fig. 3 show the address allocation of the EEPROM.

3-1 Error Storage Method

If an error result, data in a corresponding EEPROM address will be overwritten. The data in the corresponding address has a capacity of 2 x 16 bits. The first address (1 x 16 bits) has an hour meter record for the latest error. The other address (1 x 16 bits) has an hour meter record of the first error along with the total number of errors in the past. The data will be written to the EEPROM after rounding off all hour meter values for less than one hour (see Fig. 1).

Hour meter data and the number of errors (1) will be written to both addresses if an error occurs for the first time. The last hour meter data will be converted into present hour meter data for errors on and after the second time. The count will remain 15 regardless of whether the actual number of errors exceeds 15, and only data on the last hour meter data will be overwritten.

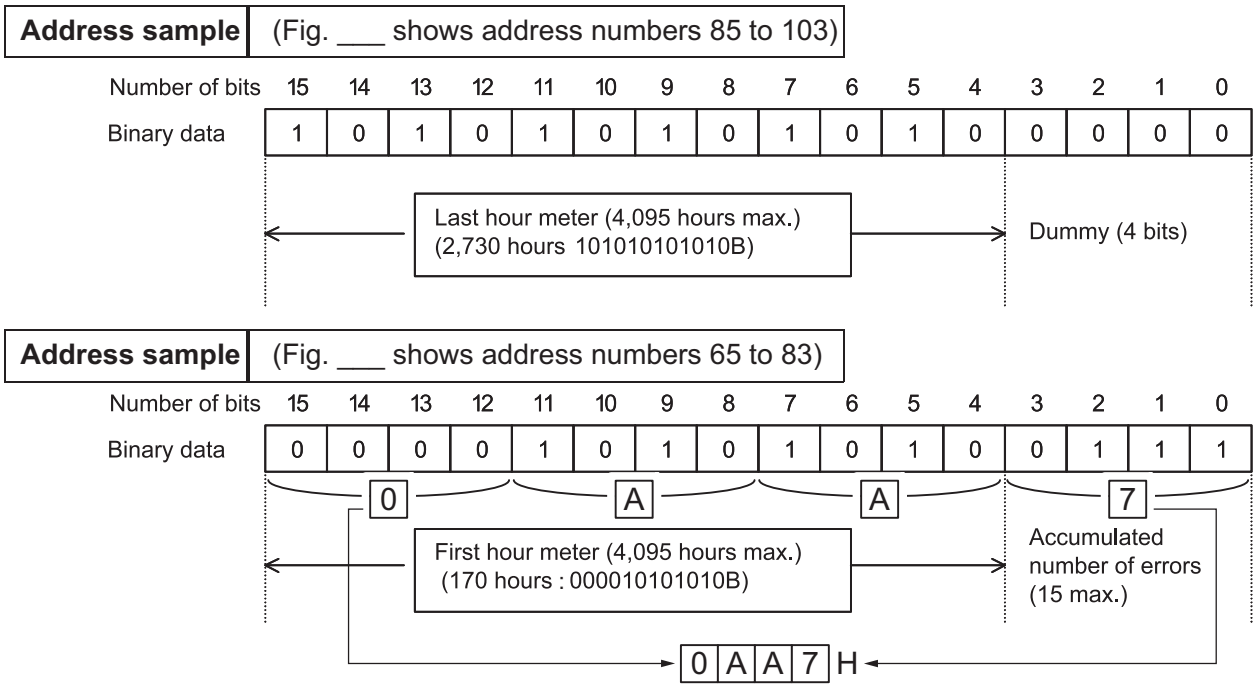
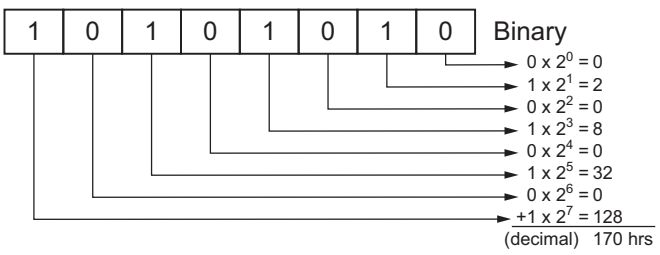


Fig. 1 Error Data Storage Method

3-2 Number of Errors

Because data is stored in four bits, the maximum number of errors is limited to 15. The count increases by one if an error occurs after the key is turned ON. Once the key is turned ON, however, the count increases only by one until the key is turned OFF.

(Example) Binary to decimal



3-3 Erasing Method of Error Log

The error log will be deleted by selecting Error Log Delete in Diagnosis Mode. In the software, only the 0th to third bits (the accumulated number of errors) in EEPROM addresses 85 through 103 will be zero cleared, but hour meter data will not be zero cleared. Error Log Delete in Diagnosis Mode judges that there is no error log if the number of errors is zero.

Hour meter data will not be deleted after executing Error Log Delete in Diagnosis Mode. By dumping the EEPROM, hour meter data for errors will be known. This will make troubleshooting possible if the LCD meter is returned to the factory due to a failure after shipping.

The contents of addresses 65 through 103 are zero cleared with the PC before shipping.

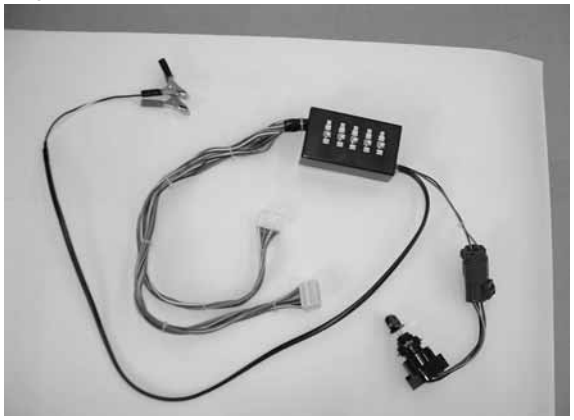
4. Self-diagnosis of controller unit

4-1 Purpose

The error diagnosis of the meter is possible by using the self-diagnostic harness. The self-diagnostic function of a conventional model provided with a microcontroller can detect failures in the microcontroller only after all the failure diagnosis of the electrical devices other than the microcontroller is made. This kind of method requires time. Furthermore, there is a concern for the accuracy of the diagnosis.
By connecting the self-diagnostic harness to the meter and applying voltage from the battery, the self-diagnostic program built into the meter will run, thus making the self-diagnosis of the incorporated hardware of the meter possible with the inputs and outputs of the meter automatically activated and checked.

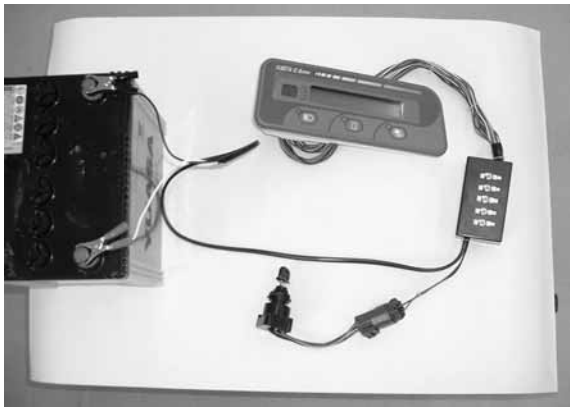
Note:
It is not absolutely possible to make the perfect self-diagnosis of the hardware of the meter, however, because not all hardware components built into the meter are checked.
This self-diagnosis harness kit is owned and managed by Kubota's overseas distributors, (KTC, KCL, KTA, KE, KUK and KBM). If needed, contact them.

4-2 Operation Procedure



(1) Grips for battery terminals
(2) Couplers for the meter
(3) Key switch to ON or OFF
(4) Switch box for testing

1. Dismount the meter from the main harness of the equipment and connect the meter to the self-diagnostic harness.



2. Connect the 12-V terminal and negative terminal of the self-diagnostic harness to the battery.

3. Self-diagnosis starts automatically.

The red and yellow lamps flash alternately.

The LCD of the meter flashes black and white alternately.

The lamp as shown in the illustration on the right-hand side turns ON and OFF repeatedly.

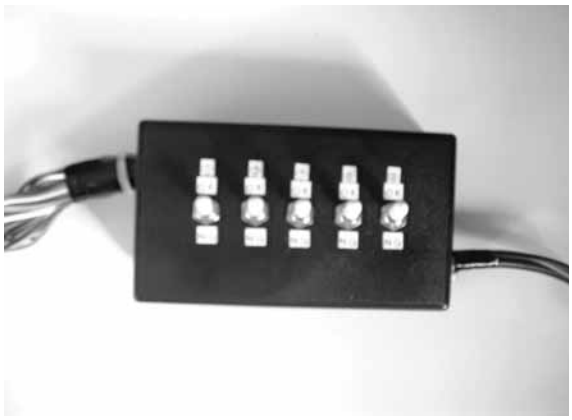
The buzzer beeps.
The backlight of the meter turns ON and OFF repeatedly.

4. If the following message appears in approximately one minute, the hardware in the meter is considered normal.

Finish
Key off

5. If any one out of numbers 0 through number 12 specified in table 2 is displayed, the meter has a failure.

6. If the lamp is kept turned ON, and three LED light up, then the switches, lamp and LED are in normal condition.



7. As for the training purpose, we developed to install the switch box as shown in the photo.
   As a test, push the switch to NG position and let it run the self-diagnosis test.
   Then the pre-set failure number will be displayed on the LCD screen.

Example:No.1 switch is being pushed to NG position.

Note:The self-diagnostic harness will be provided to Kubota Distributors, KTC, KCL, KTA, KE, KUK and KBM only.
When the failure diagnosis of the meter panel is needed, please contact them.

4-3 Failure Display Number of Self-diagnostic Function

Table 2. Self-diagnosis of controller, items and methods

	Check item	Check parts	Check methods	Fail indication No.
2	Check sum	CPU ROM	Implement self-checksum.	0
3	Input & output	Glow relay output RS-485 (negative) (positive) flash TXD, RXD input	Turn OFF the glow relay and make sure that pin 29 (RXD2 power 7.1) is set to low level. Turn OFF the glow relay and make sure that flash RXD TXD input is set to high level.	1
	Input & output	Glow relay output RS-485 (negative) (positive) flash TXD, RXD input	Turn ON the glow relay and make sure that pin 29 (RXD2 port 7.1) is set to low level. Turn ON the glow relay and make sure that the flash RXD TXD input is set to low level.	
4	Input & output	Auto release relay output, lever lock switch input	Turn OFF the auto release relay and make sure that the lever lock switch is set to high level.	2
	Input & output	Auto release relay output, lever lock switch input	Turn ON the auto release relay and make sure that the lever lock switch is set to low level.	
5	Input & output	Working lamp relay output, start switch input	Turn OFF the working lamp relay and make sure that the start switch is set to high level.	3
	Input & output	Working lamp relay output, start switch input	Turn ON the working lamp relay and make sure that the start switch is set to low level.	
6	Input & output	Compressor clutch relay output, engine rpm input	Turn OFF the compressor clutch relay and make sure that the engine rpm is set to low level.	4
	Input & output	Compressor clutch relay output, engine rpm input	Set the compressor clutch relay to high level and make sure that the engine rpm is set to high level.	
7	Input & output	AUX LED output, charge input	Turn OFF the AUX LED and make sure that the aircon switch is set to high level.	5
	Input & output	AUX LED output, charge input	Turn ON the AUX LED and make sure that the air-con switch is set to low level.	
8	Input & output	AI LED output, oil input	Turn OFF the AI LED and make sure that the oil is set to low level.	6
	Input & output	AI LED output, oil input	Turn ON the AI LED and make sure that the oil is set to low high level.	
9	Input & output	Travel sol output, aircon switch input	Turn OFF the travel sol and make sure that the charge is set to low level.	7
	Input & output	Travel sol output, aircon switch input	Turn ON the travel sol and make sure that the charge is set to high level.	

	Check item	Check parts	Check methods	Fail indication No.
10	Input & output	Motor Tr1, Tr2, Tr3, and Tr4 output AI operation switch input, travel switch input	Motor Tr1, Tr2, Tr3, and Tr4 are set to low output level. The AI operation switch is set to low level. The travel switch is set to low level.	8
	Input & output	Motor Tr1, Tr2, Tr3, and Tr4 output AI operation switch input, travel switch input	Motor Tr1 is set to high output level and Tr2, Tr3, and Tr4 are set to low output level. The AI operation switch is set to high level. The travel switch is set to high level.	
	Input & output	Motor Tr1, Tr2, Tr3, and Tr4 output AI operation switch input, travel switch input	Motor Tr1 and Tr4 are set to high output level and Tr2 and Tr3 are set to low output level. The AI operation switch is set to high level. The travel switch is set to low level.	
	Input & output	Motor Tr1, Tr2, Tr3, and Tr4 output AI operation switch input, travel switch input	Motor Tr2 is set to high output level and Tr1, Tr3, and Tr4 are set to low output level. The AI operation switch is set to high level. The travel switch is set to high level.	
	Input & output	Motor Tr1, Tr2, Tr3, and Tr4 output AI operation switch input, travel switch input	Motor Tr2 and Tr3 are set to high output level and Tr1 and Tr4 are set to low output level. The AI operation switch is set to low level. The travel switch is set to high level.	
11	Input & output	AUX sol (positive) (R) output, compressor clutch switch input	Turn OFF the AUX sol (positive) (R) and make sure that the compressor clutch switch is set to low level.	9
	Input & output	AUX sol (positive) (R) output, compressor clutch switch input AN2_7 input	Turn ON the AUX sol (positive) (R) and make sure that the compressor clutch switch is set to high level. The AN2_7 AD value varies more by 25 mV or more from the value with the input turned OFF. From theoretical values, 12 V and 240 Ω: 50 mA Voltage fluctuation corresponding to 50 mA: 50 mV	
12	Input & output	AUX sol (negative) (L) output, AI pressure switch input	Turn OFF the AUX sol (negative) (L) and make sure that the AI pressure switch is set to low level.	10
	Input & output	AUX sol (negative) (L) output, AI pressure switch input	Turn ON the AUX sol (negative) (L) and make sure that the AI pressure switch is set to high level.	
13	Input & output	AI self-hold relay output, breaker switch and AUX switch input	Turn OFF the AI self-hold relay and make sure that the breaker switch and AUX switch are set to low level.	11
	Input & output	AI self-hold relay output, breaker switch and AUX switch input	Turn ON the AI self-hold relay and make sure that the breaker switch and AUX switch are set to high level.	
14	AD (Analog and digital conversion)	fuel sensor	Check with the microcomputer that the AD value is 1.8 V ± 0.15.	12
15	AD (Analog and digital conversion)	water temp sensor	Check with the microcomputer that the AD value is 2.5 V ± 0.15.	
16	AD (Analog and digital conversion)	motor potention sensor	Check with the microcomputer that the AD value is 3.75 V ± 0.15.	
17	AD (Analog and digital conversion)	accel potention sensor	Check with the microcomputer that the AD value is 2.5 V ± 0.15.	
18	AD (Analog and digital conversion)	AUX potention sensor	Check with the microcomputer that the AD value is 1.25 V ± 0.15.	

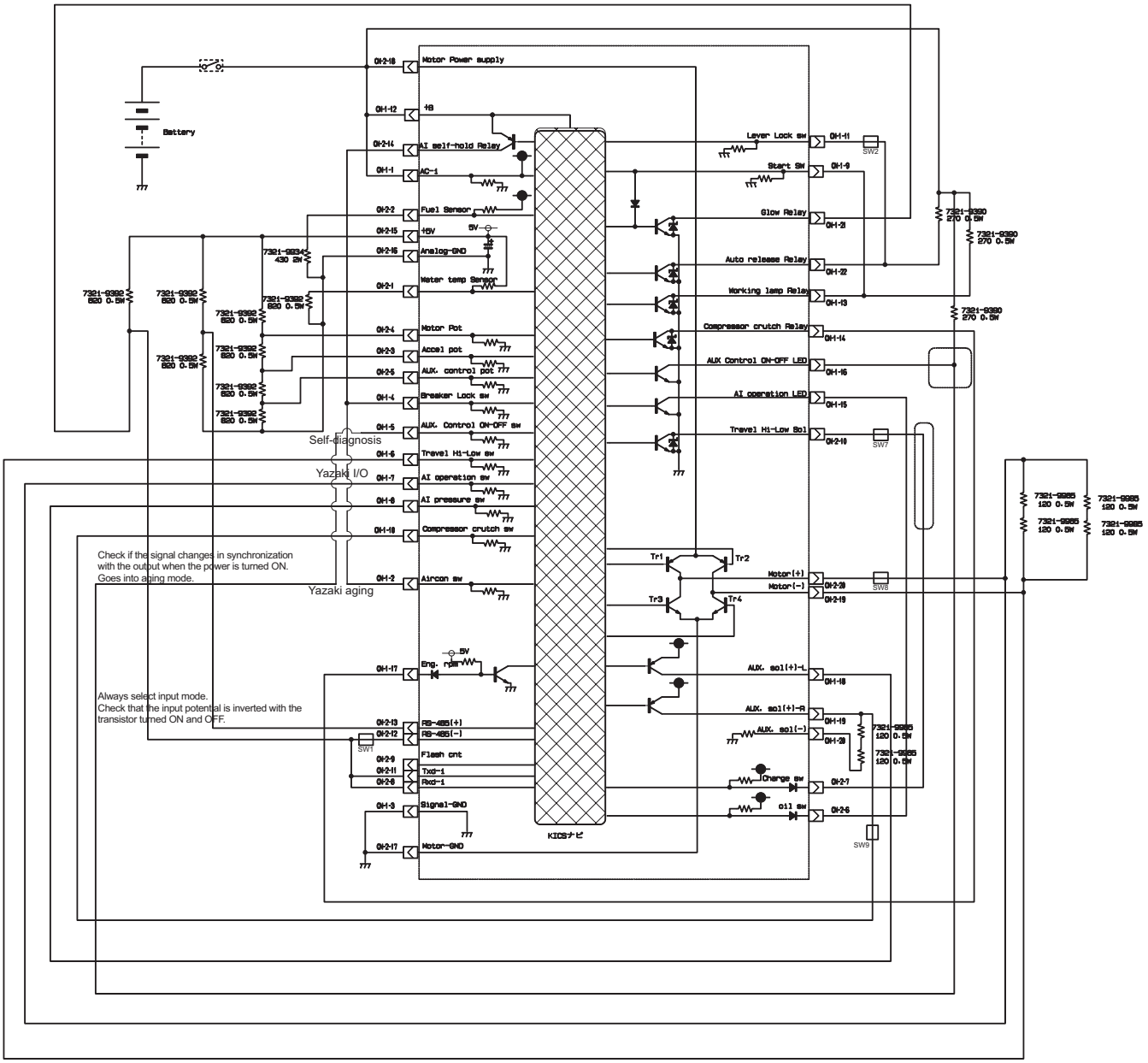
FYI (For your information)

Check Sum Error

1. A check sum error is checked to see if the contents of the program for microcomputer control are corrupted.
2. The control program is saved in the ROM of the CPU. Once data is written to the ROM and shipped to the market, the data cannot be written in the market.
3. The total sum of the data in each address of the control program is obtained in advance and stored as check sum data prepared while in normal operation.
4. When the key is ON, the microcomputer calculates the total sum of the data in each address of the control program in self-control of the microcomputer. The microcomputer checks if the results coincide with the check sum data prepared while in normal operation (i.e., at the time of writing the program). The microcomputer will go to the next step after the microcomputer checks if the results are found normal.
5. If the data does not coincide, the microcontroller judges that the program is illegal. In that case, a check sum data error will result and an error alarm will be output. Error No. = 55
6. The program data can be reversed if the LSI in the controller partly fails to operate due to external environmental factors, such as abnormal temperatures or excessive shock. That is the reason the microcomputer makes this check when the key is turned ON, thus preventing the microcomputer resulting in out-of-control conditions due to program failures.

4-4 Functions of Self-diagnostic Harness

The self-diagnostic harness short-circuits the input and output terminals of the meter, switches the respective inputs of the meter ON and OFF in sequence, and checks if the data on the output side is normal.



Note: Yazaki I/O and Yazaki aging are the exclusive use of Yazaki.

(E) SERVICE MODE FLOW CHART

1. General

1-1 There are several flow charts, depending on the models or machine-versions as below.

1) KX41-3, KX61-3, and KX71-3 have one identical service mode flow chart.
   Refer to the correspondent WSM.
2) KX91-3S, U35S and U35-3S for KTC, KCL and KTA have the flow chart which doesn't include AI-version but includes S/P (Service port)-version.
3) KX121-3S, 161-3S and U45-3S for KTC, KCL and KTA have the flow chart which includes AI-version and S/P (Service port)-version.
4) EU-version models of KX91-3α, 101-3α, 121-3α, 161-3α, U35-3α and U45-3α have AI (Auto idle)- and S/P (Service port)-version.
5) The service mode flow chart of anti-theft version will be added to the EU-version machine in the appropriate future.
   This will be announced later in the manual for the anti-theft-version.

1-2 How to enter the service mode?

While pushing the display-select-switch, turn the main key to ON position. Then you'll be in the service mode.
The model name which was pre-set will come to appear on the LCD screen.

1-3 What do the arrows indicate?

↓	vertial to down:	You're required to push the selector switch for a short time. Push once. Then you'll proceed to the down menu.
↑	vertial to up:	Similar to the above. Push once. Then you'll return to the top menu of the same column.
→	horizonal to right:	Push the selector switch for a long time until you hear a pi-sound. Then You'll proceed to the next right.
←	horizonal to left:	Similar to the above. Push for a long time. This is only attached to the Back tier. This arrow indicates to go back to the top menu of the previous tier.

1-4 This service mode flow chart is divided into two zones.

One is for ordinary service personnel to carry out the troubleshooting of the machine if needed.
The other is for only the authorized personnel to proceed several important machine set-up, adjustment and troubleshooting in detail. These are:

1) Machine model set-up
2) AI - or Non-AI-version selection
3) Engine idle speed set-up
4) Service port system set-up
5) Service warning set-up
6) Circuit check for wire harness disconnection
7) etc.

1-5 What should you do in the following case?

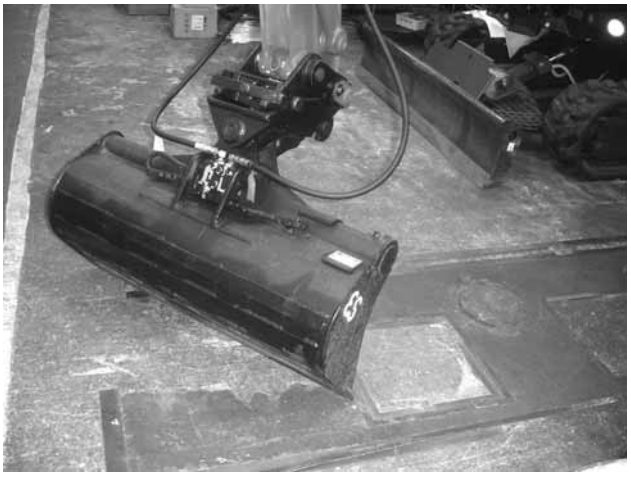
Cases	Action to be taken
(1) Renewal of a meter panel. Customer purchased a new meter panel from the spare part center. Or change the meter panel to another machine model.	1) Machine model set-up 2) AI or Non-AI selection 3) AI set-up (Idle & max.speed) 4) Service warning set-up 5) S/P knob set-up 6) S/P valve set-up 7) Overheat warning set-up
(2) Replace from a canopy to a cab or vice versa.	1) Idle speed set-up
(3) Renew a S/P knob	1) S/P knob initial set-up
(4) Renew a S/P valve	1) S/P valve initial set-up
(5) Change a service port attachment	1) S/P feeling adjustment
(6) Different native language speaking operator or service personnel	1) Selection of language This is EU-version and KCL-version only.

(F) FINGER CONTROL SERVICE PORT SYSTEM

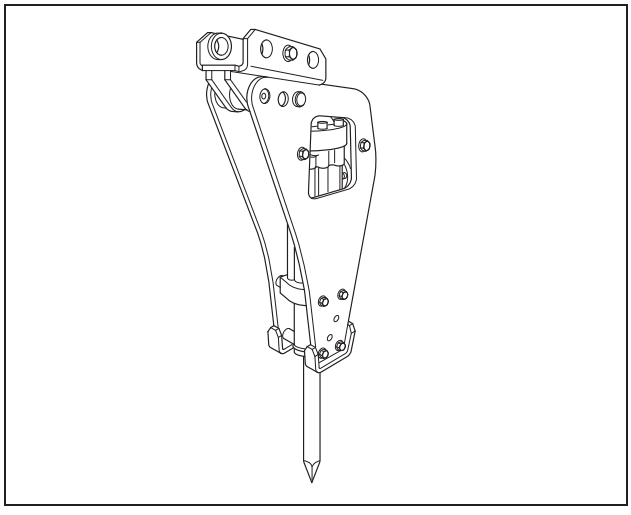
a) Feature and Purpose

1. The service port pedal has been replaced by a lever-top knob switch; feather-touch finger control realized.
2. The breaker can easily be operated with a button switch.
3. Optimum control feeling adjustments can be made for maneuvering various attachments efficiently.
4. Safe attachment handling is ensured through foolproof control.

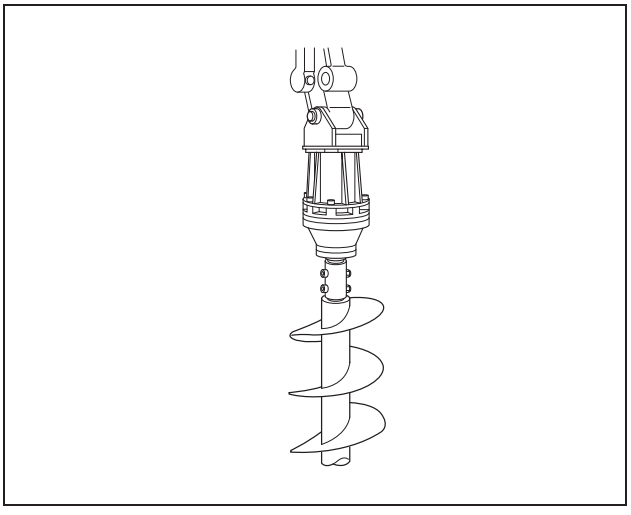
Thumb



Tilt bucket



Breaker



Auger

When a thumb (and tilt bucket) attached, the foot pedal has been used to operate. It has not been easy for fine control in this way. Such operation can now be finely controlled with your hand (thumb) and you can ensure more space around your feet.
Service port functions have been tremendously upgraded.

b) Outline of Control System

1. Aux. port finger operation

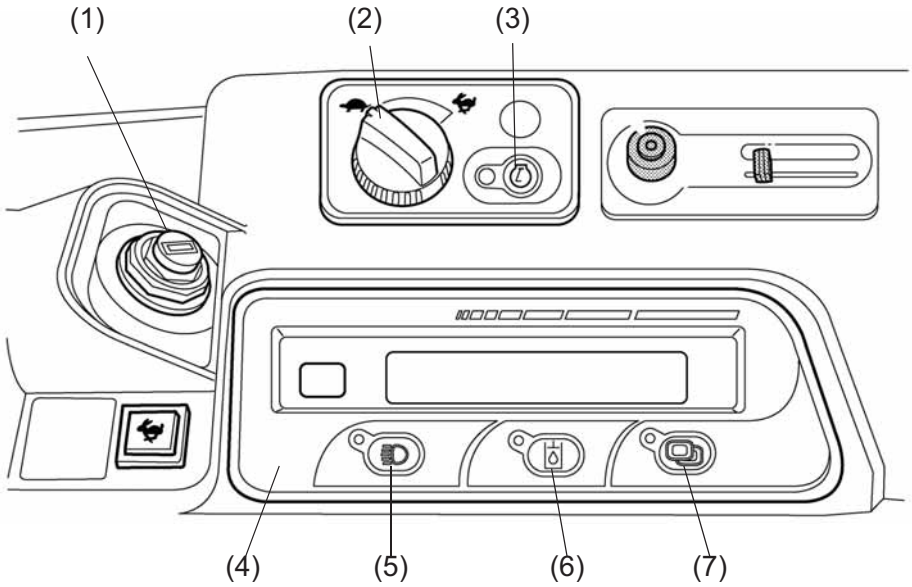
Fine control by finger operation

① Proportional operation of AUX. port.

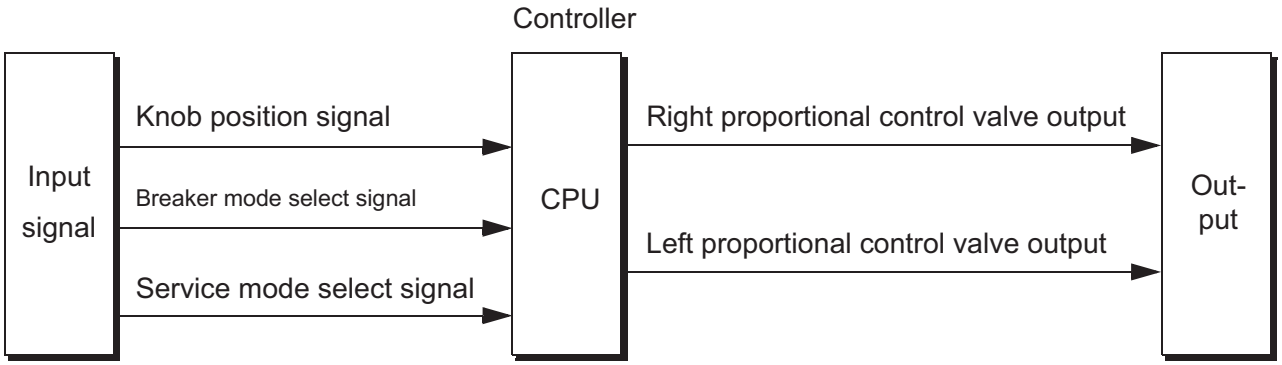
② Full open output hold Switch at the time of breaker operation.

③ Hand operation ON-OFF Switch. (secure 'safety-first')

2. Control layout



(1) Main starter SW
(2) Accel. potentiometer
(3) Auto idle SW
(4) Meter panel
(5) Working light SW
(6) Service port SW
(7) Display selector SW



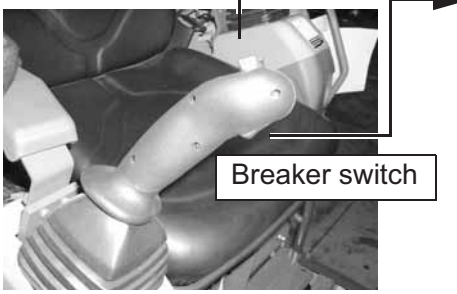
3. Service port system components

Meter panel

(Non-AI-version)

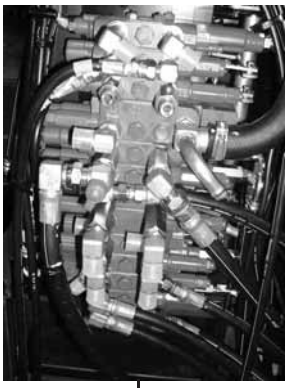
AI accel

(AI-version)



Proportional solenoid valve

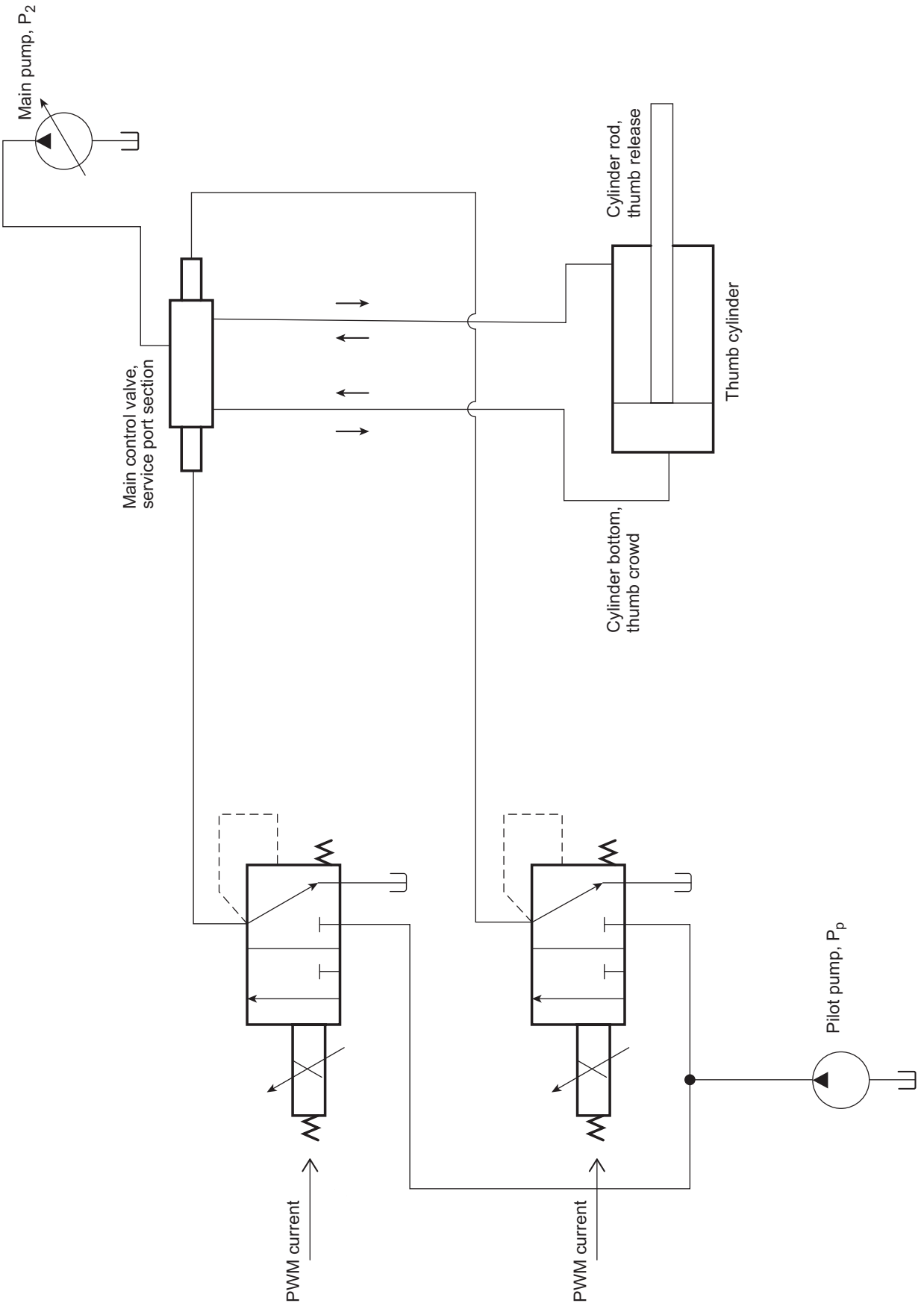
Main control valve



Tilt bucket

Thumb cylinder

c) Hydraulic Circuit Diagram

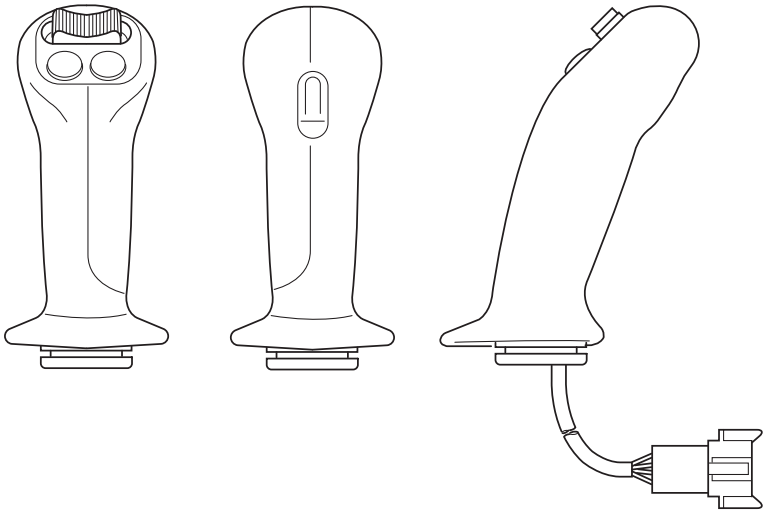


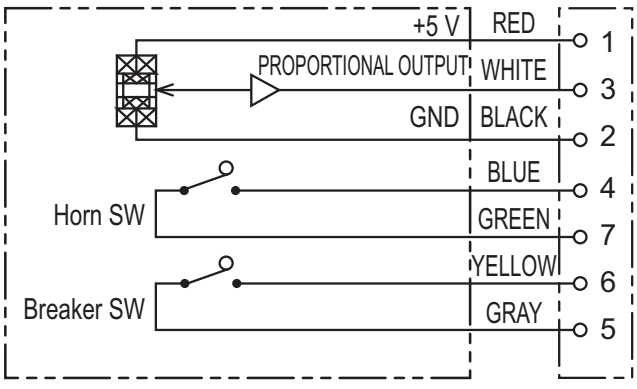
d) Knob Structure and Function

The knob has a built-in IC chip that is different from one for potentiometers.

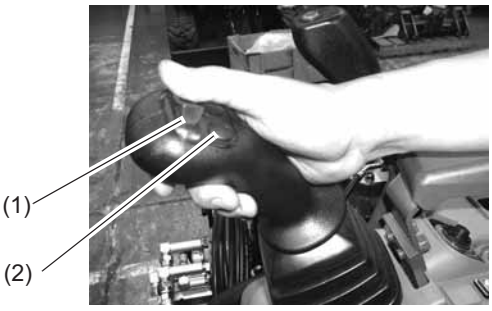
1) Service mode: Press the center switch of the meter panel to call the service mode.
2) Knob control: Shift the knob to L or R direction to call two way PTO operation.
3) Breaker operation: Press the back button of the knob to call the breaker mode.

1. Structure of knob switch

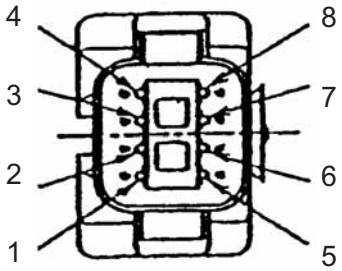


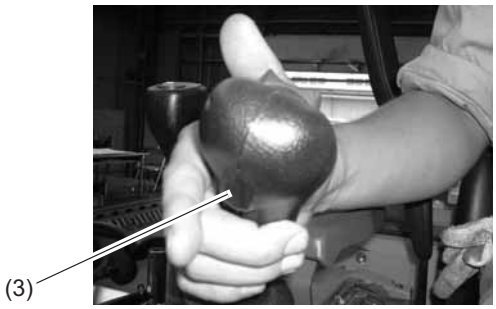


ELECTRIC CIRCUIT



(1) Knob switch (2) Horn switch





(3) Breaker switch

2. Basic operation of the knob

1) With the key on

When the key is on, the system starts from 'out of the service' mode-OFF-position.
In other words, the knob is not operative. (For safety)

2) Service mode

Press the center switch of the meter panel, and the center LED indicator lights up and the system gets in the service mode. Now the knob is operative. Move the knob to the left for the thumb to grasp an object. Move it to the right for the thumb to release it.

3) Breaker mode

The breaker mode is enabled while in the service mode. Press the breaker switch on the back of the knob to activate the breaker. The main pump fully feeds the fluid to the breaker. If the thumb is attached in place, the main pump feeds the full amount of fluid from the service port to the thumb cylinder.

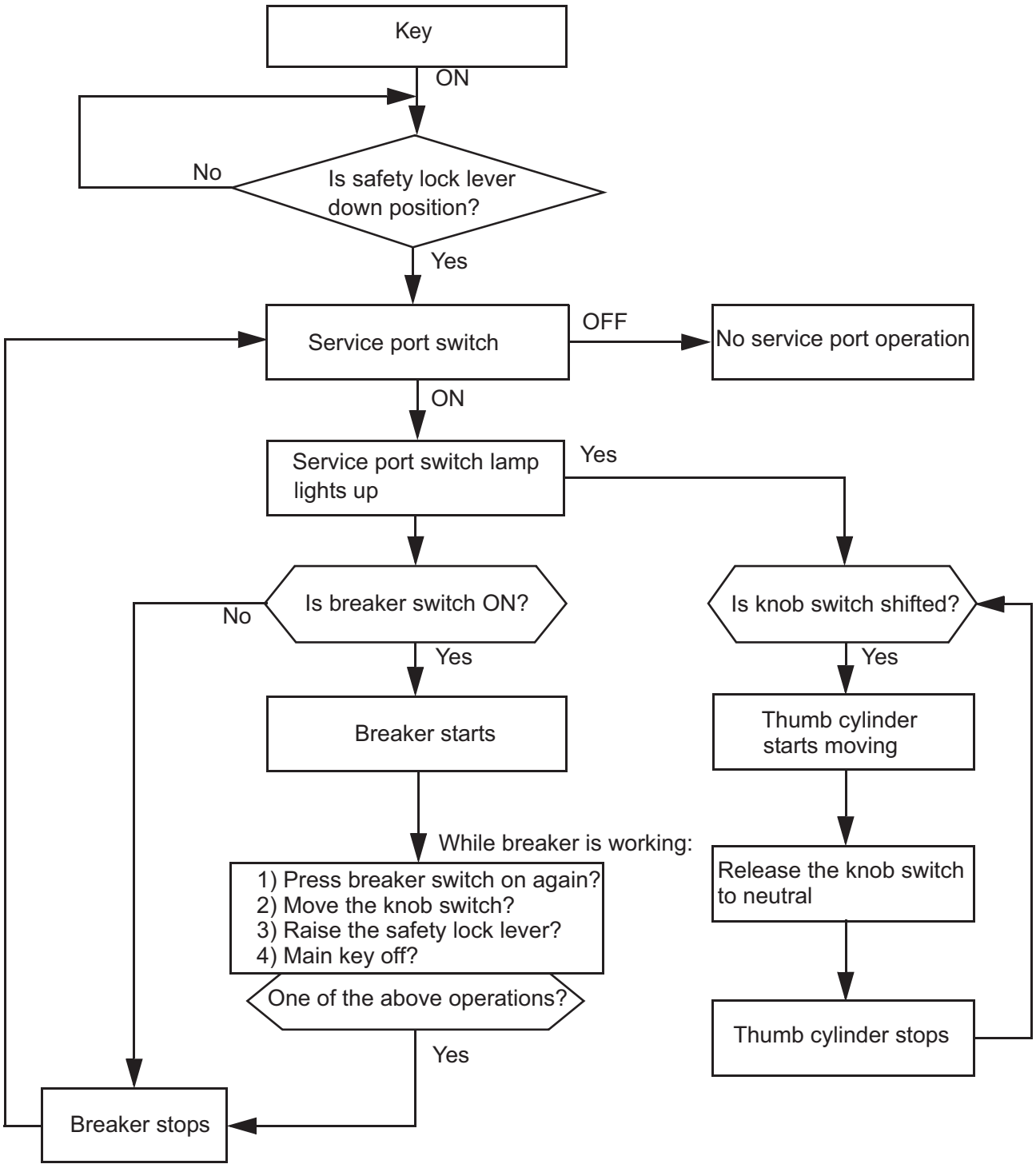
<Breaker switch function>

(1) Push the S/P switch on.
(2) Press the breaker switch.
(3) Breaker starts pounding.
(4) Press the breaker switch again.
(5) Breaker stops.

4) Releasing the breaker

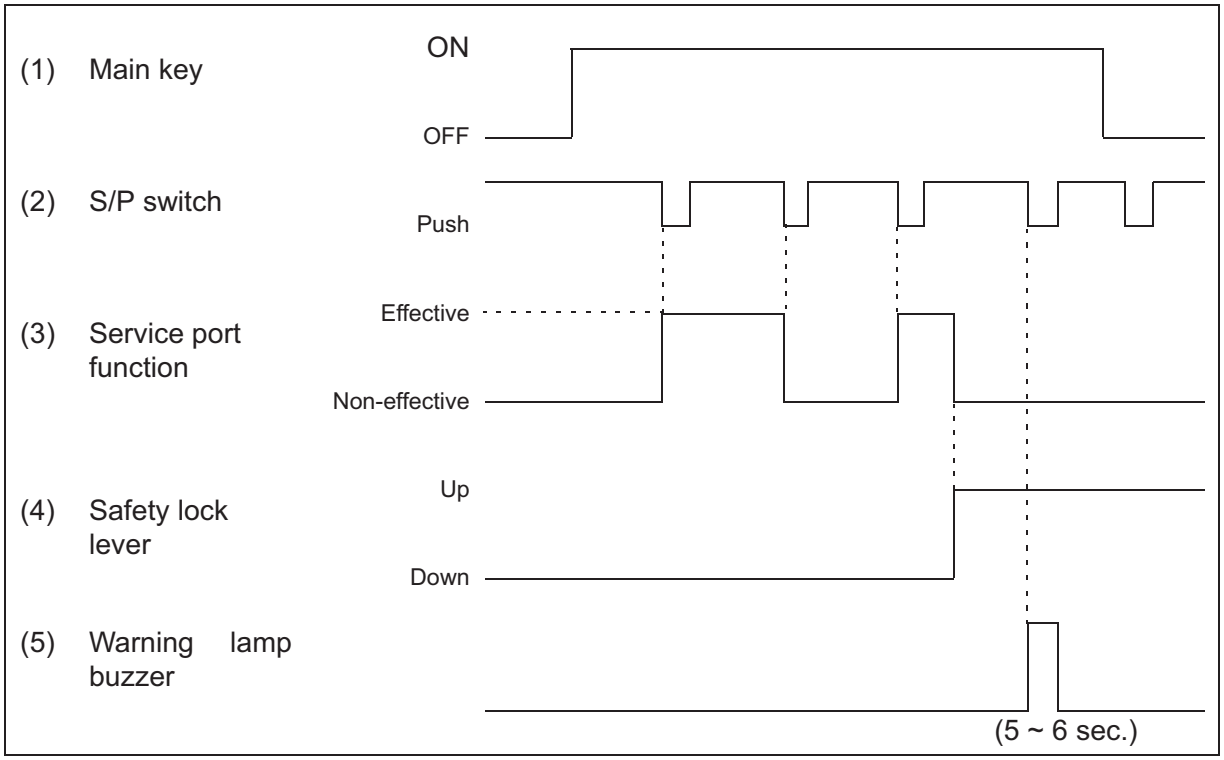
There are three methods to release the breaker operation.
(1) Press the breaker switch again to stop the breaker.
(2) Press the service port switch to off position. (The center LED indication goes off.)
(3) Or, move the knob for over 0.2 second.
(4) Or, lift up the safety lock lever.
(5) Turn the main key to off position.

3. Flow chart: Service port operation



4. S/P switch (service port switch)

<Function chart>



Service port switch (S/P sw) in the middle bottom on the meter panel controls the service port functions, such as thumb switch and breaker switch.

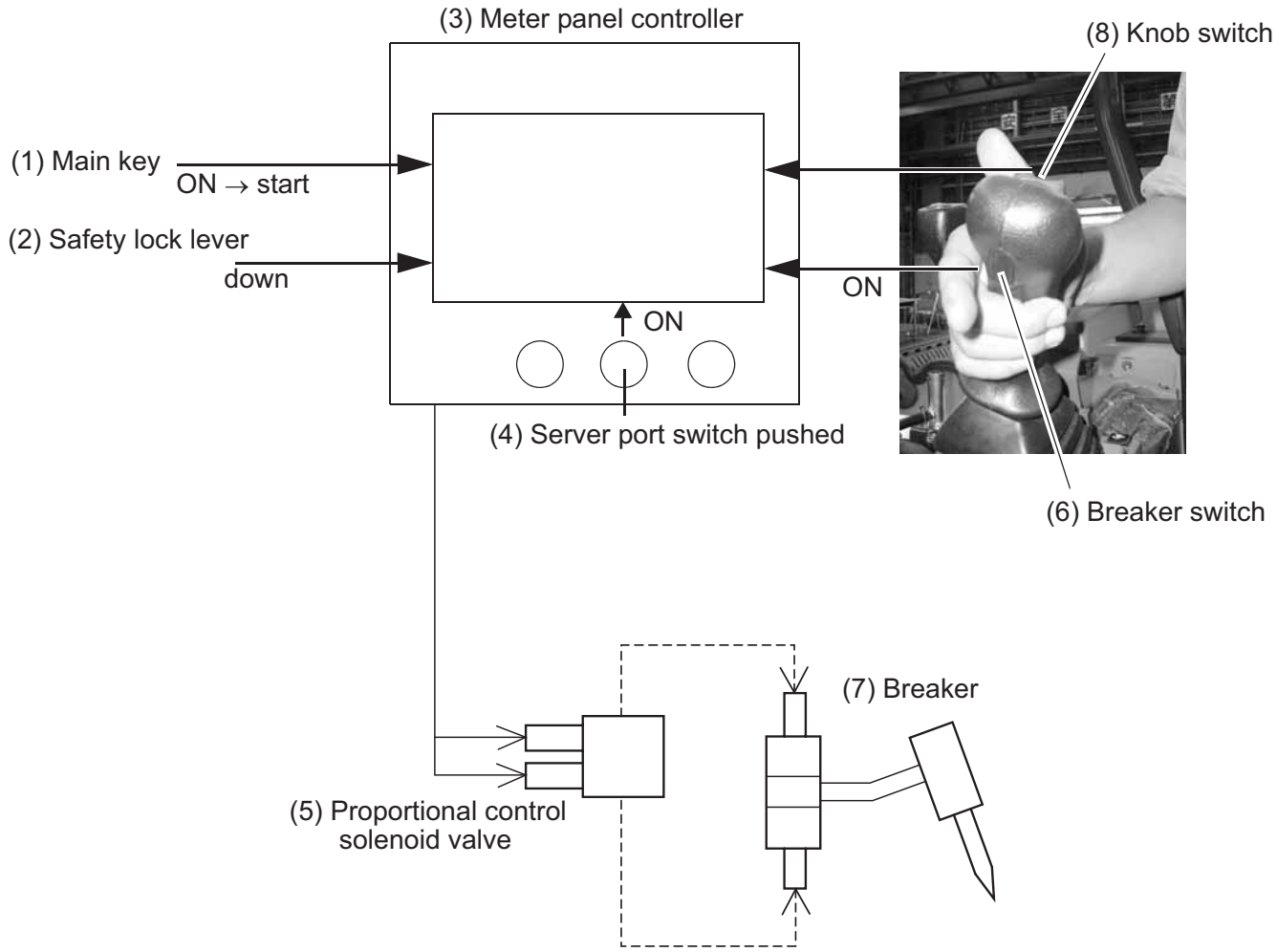
In order to get the service port function, first push this switch and then control the two switches on the knob lever.

(1) Service port switch

5. How the knob switch works

1) If the breaker is released and need to call the breaker mode again, press the back button (breaker switch) of the knob. (For safety)
2) To release the breaker, just move the knob. This is highly convenient.
3) If the lever is forcefully moved to operate the other functions, such as boom up or down, the knob may be momentarily shaken. It causes the voltage fluctuates and the breaker release unnecessarily. To avoid this, the knob must be moved for over 0.2 seconds to release the breaker operation. For reference, the knob does not tilt for over 0.2 seconds under usual level control conditions.

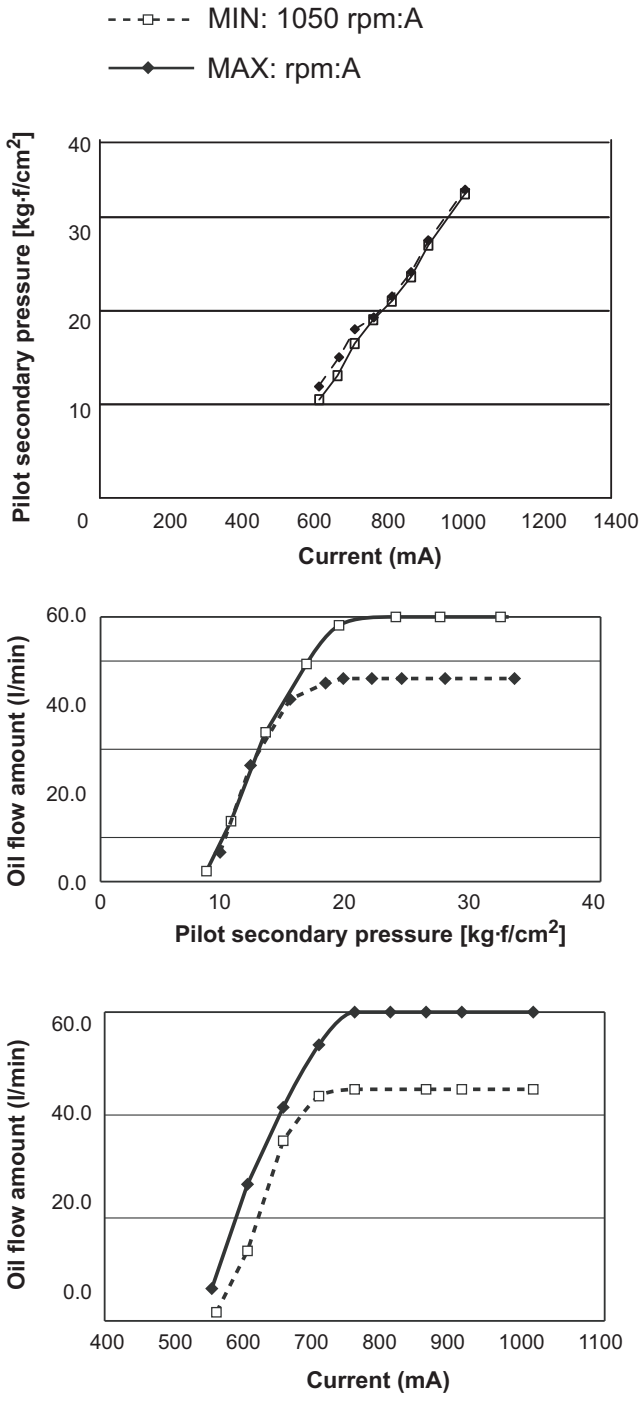
6. Breaker operation



Note: When the safety lock lever is 'UP' position, all the switches - service port switch, breaker switch and knob don't function at all because of safety purposes. Once the safety lock lever is shifted up during service port operation, breaker or thumb cylinder stops.
To start the breaker again, shift down the safety lock lever first and press ON the service port switch and the breaker switch. Safety lock switch has the priority for safety.

7. Interrelation among current, pressure and flow

Sample data: Thumb clamp (Bottom side, A port, left)



Note: Above charts are the sample figures to illustrate the interrelation among the three parameters.
1. Current: PWM current provided from the panel controller.
2. Pressure: Secondary pilot pressure delivered from S/P solenoid valve.
3. Flow: Oil flow amount supplied to the thumb cylinder.

e) Initial Settings of the Knob

1. Set-up and adjustment of service port

This new finger control service port system requires three types of set-up and adjustment procedures.

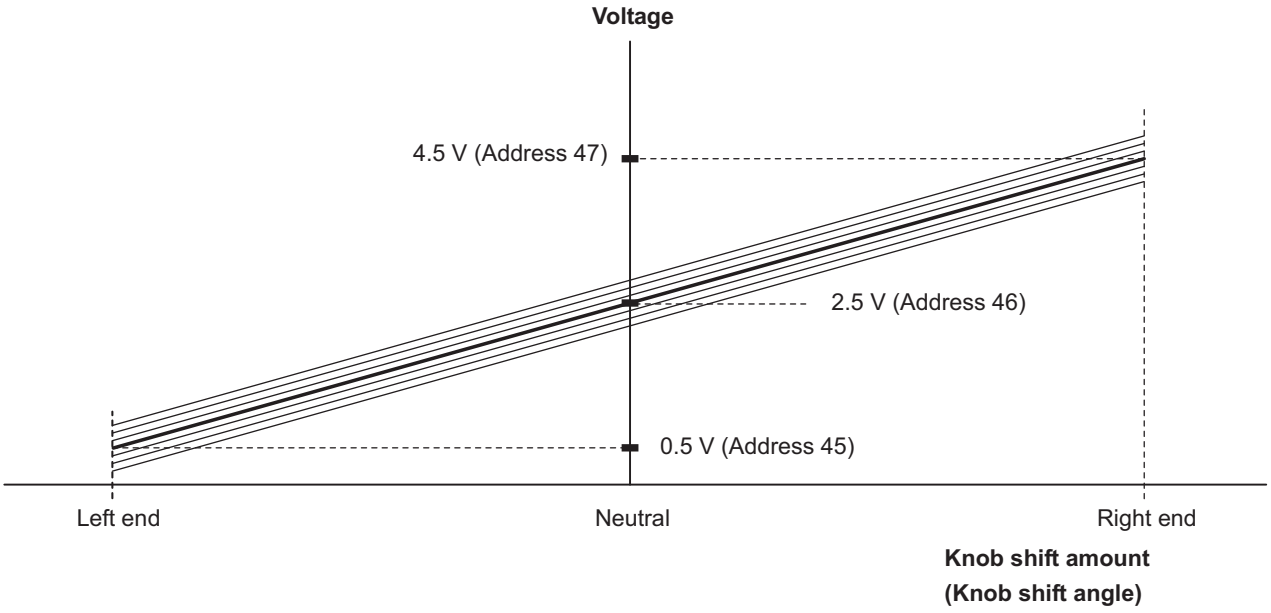
Items to set-up	When
Knob initial set-up	1. Knob change 2. S/P valve change 3. Meter panel change
S/P valve start-point set-up	1. S/P valve change 2. Main control valve change 3. Pilot pump change 4. Hydraulic actuator change
Manual feeling adjustment	1. Hydraulic actuator change 2. Operator change and feeling change

2. Purpose

Three settings (right and left ends, and neutral) of the knob are kept in the meter controller's memory. Note that there are fluctuations from knob to knob.
The knob has been factory-set at Hirakata Factory or KBM. When the meter, the knob or the proportional control solenoid valve is replaced, the knob settings must be manually reprogrammed. If not reprogrammed, the thumb may get activated even in neutral or slowly move even at the right end.
The meter memory keeps the following data in the EEPROM addresses
1023 × 8 = 8184 then 5 V.
But actual data varies as follows.

Address 45:	Left end	→	0.4 ~ 0.8 V
Address 46:	Neutral	→	2.4 ~ 2.8 V
Address 47:	Right end	→	4.40 ~ 4.80 V

<Knob shift amount and output voltage>



3. Background and meaning of knob initial set-up

1) The output voltages at the neutral, rightmost and leftmost positions of a knob are entered as initial settings. Accordingly, correlation between the knob's right-left shift and the output voltage is stored in microcomputer memory.
2) The voltage generated by the knob's movement is converted by the microcomputer to a PWM control current. In this way, usual operations can be carried on under proportional control.
3) Also the voltages at the neutral, rightmost and leftmost positions of a new control knob are entered as initial settings in microcomputer memory. Such data serves to control the output voltage in proportion to the knob's movement.
4) Suppose that you have replaced a control knob but forgotten to make its initial settings. The previous knob's data, still in microcomputer memory, may be slightly different from new entries. This may cause different operating feelings.
5) These settings can be made with the key on. Thanks to the built-in temperature compensation function, there is no problem with ambient temperatures in making the settings.

FYI (For Your Information)

1. Knob switch and Hall element (IC chip)

The knob switch has a temperature-compensated Hall element incorporated. The Hall element consists of a magnet and a coil as shown below. A kind of sensor, this switch has the tilt angle Éý, which changes the quantity of magnetism. This quantity is converted to voltage. The input voltage is set at 5 V maximum. With the knob switch at neutral position, the output is about 2.5 V.

2. Hall effect

Let's suppose, as shown in Fig. 1, that a current is applied to a rectangular solid and a magnetic field is added perpendicular to the direction of current. There will be a voltage that is perpendicular to the direction of current as well as to the direction of magnetic field. This phenomenon is called the Hall effect, and the voltage thus generated is called the Hall voltage.

This effect was discovered by American physicist Edwin H. Hall in 1879. The effect has the nature of taking place very frequently with semiconductors, but rarely with conductors.

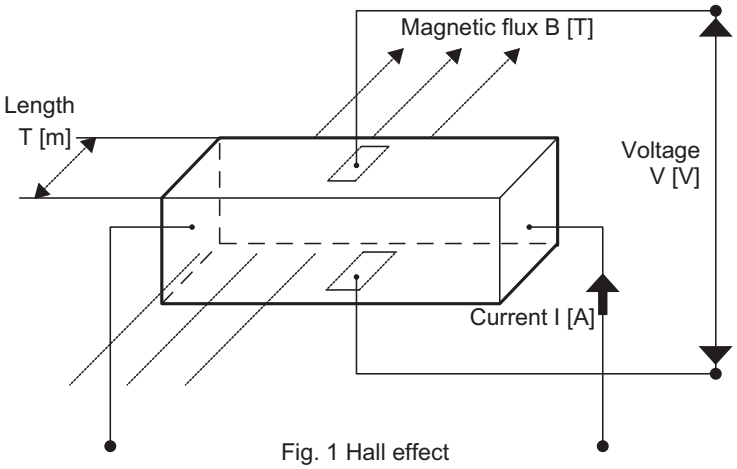


Fig. 1 Hall effect

3. Hall element

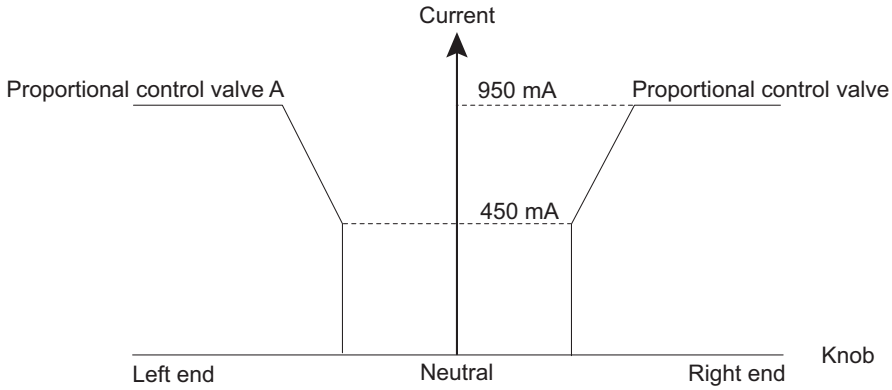
The Hall effect is discussed above. The Hall element includes semiconductors that produce the Hall effect. Given that the effect takes place very frequently with semiconductors, but rarely with conductors, semiconductors are used to make the Hall element.

Here are the materials to make the Hall element.

- Silicon (Si)
- Germanium (Ge)
- Gallium arsenide (GaAs)
- Indium arsenide (InAs)
- Indium antimonide (InSb)

f) S/P Valve Start Point Setting

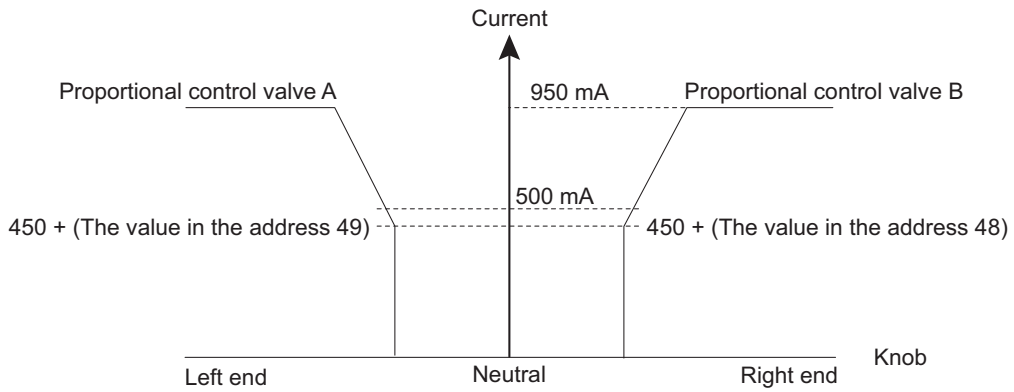
1. Performance characteristics profile: Knob shift amount vs Output current



1) A dead zone is provided to keep the thumb intact in neutral. Some margins are also given to start the thumb at each end.
2) The right-end, neutral, and left-end settings of the knob are presupposed to be in memory.
3) The profile is flexibly modifiable even for maximum engine rpm and idling speed. When the engine runs at middle speed, for example, the average is determined from the idling map and maximum map and finally outputted.
4) Suppose that the thumb starts moving at the current of 500 mA. The knob's operating map must begin with 450 mA because it is necessary to provide an inching zone and give better feeling.
5) At the 500mA level, however, there could be fluctuations due to the control valve, proportional control valve, hoses and other factors. The meter keeps the initial map and performs as well, but the inching zone might be longer or shorter depending on the machine.
6) The starting point setting is made to cope with such problem. In the setting mode, the meter shows the current gradually higher from 450 mA. When the thumb starts moving, the operator is supposed to press and release the button twice for releasing and grasping of the thumb. The meter memorizes the then setting.

   Address 48: → Release R Deviation
   Address 49: → Grasp L Deviation

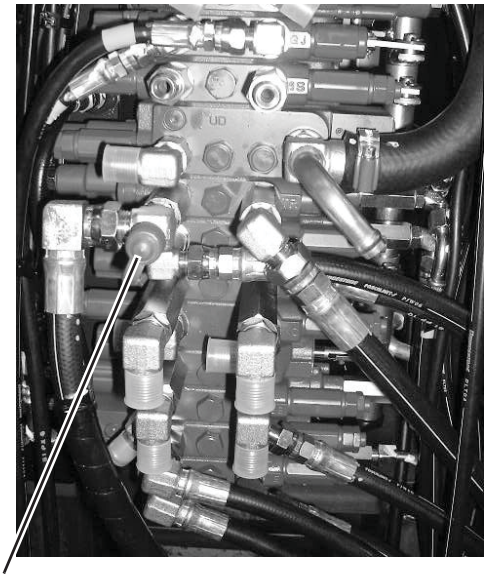
The following correction is made for control.



7) Service engineers do not notice, but at Hirakata Factory and KBM, the starting point has been measured at the service port (red pressure measuring port for North America and Europe) and fluctuations have been put in the meter memory. At the manufacturing plants, however, the machine is not equipped with any thumb attachment. The starting point is expected to be measured locally, however, it would cause troubles for the dealers.

   At the manufacturing level, a pressure take-out plug is prepared. Although a thumb is not attached, a current flows to the proportional control valve and the pressure level changes at a certain point. This pressure level is detected and put into memory.

   Note: 450 mA and 950 mA are default values before setting in the factory.
   Actual value may differ each model and each machine after the factory setting up.



(1) Pressure port

8) Dealers are expected to do the following in the field.

(1) Usually → Just install the attachment (Thumb) and connect the service port hoses.

(2) When the meter is replaced → Make the knob initial setting and the starting point setting.

(3) When the knob is replaced → Make the knob initial setting.

(4) When the proportional control valve replaced → Make the starting point setting, knob initial setting

The above knob initial setting and starting point setting are required. Otherwise the performance may be unstable depending on finish accuracies of the component parts.

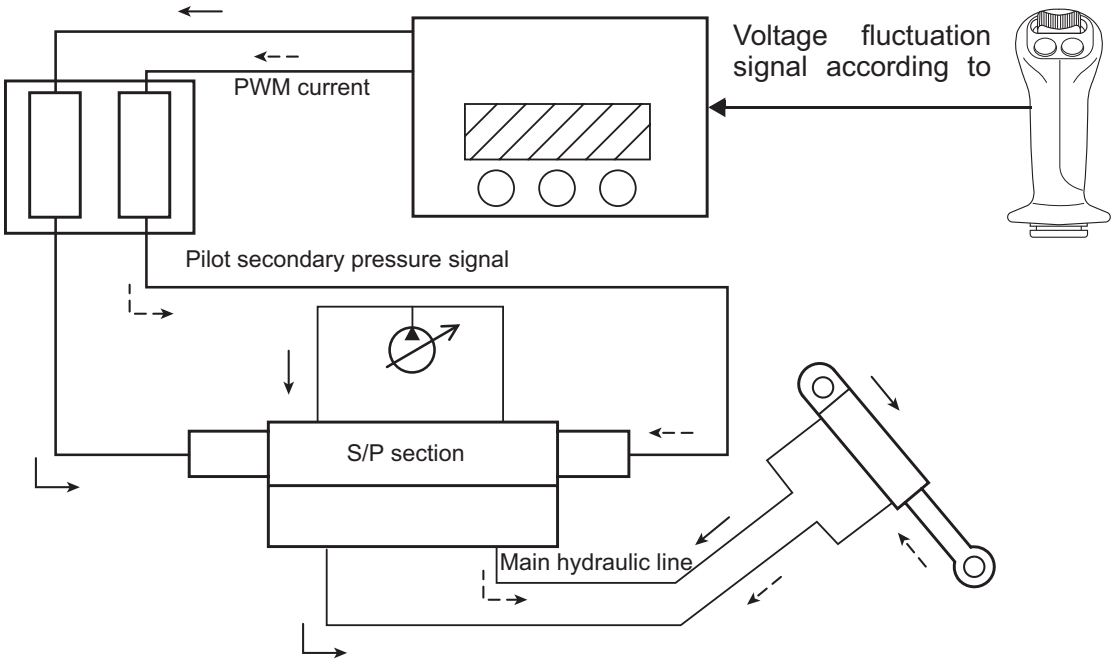
2. Background and meaning of start-point setting

1) The purpose of this setting is to keep the knob's operating force of starting the attachment (thumb cylinder) constant whether the engine runs idle or at maximum speed.
2) The proportional control valve's start-point is activated when you have slowly moved the knob to start the attachment that is connected with the service port circuit.
3) The knob's action point is referred to in some different factors: knob's movement, output voltage, controller's output PWM current, proportional control valve's hydraulic pressure, pilot secondary pressure of service port main control valve, and hydraulic pressure of attachment (thumb cylinder, for example).
4) The start-point setting works as follows. When a component of the service port system line replaced, the component with its slightly different individual behavior pattern may delicately affect the line's final output. To compensate such deviation, the initial setting (start-point setting) must be entered in the controller.
5) The following factors are important in affecting the start-point.
   (1) Oil temperature
   (2) Engine rpm
   (3) Proportional control valve
   (4) Main control valve, service port section
   (5) Service port load fluctuations
6) These factors are considered for the start-point setting.

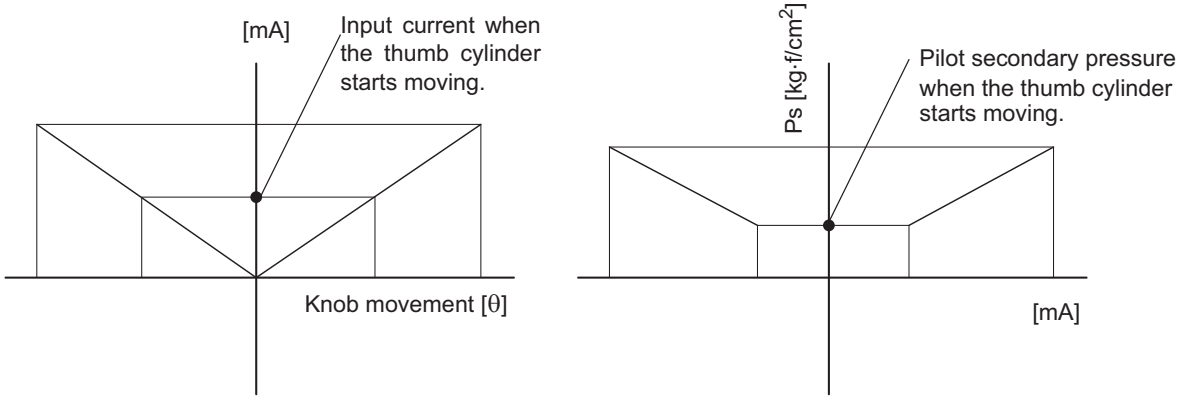
(1)	Oil temperature	→	50 °C (122 °F)
(2)	Engine rpm	→	Idling, Maximum
(3)	Proportional control valve	→	At each replacement
(4)	Main control valve, service port section	→	At each replacement
(5)	Service port load fluctuations	→	Basically, it is preferable to arrange the settings for each attachment. Some adjustment may be needed until the right setting is done.

Note: In the S/P valve start point setting menu, the controller provides the PWM current to the proportional control valve to activate the service port attachment.
When you push the bottom of the attachment-start-moving, the controller detects the point, in other words, detects the start-up PWM current amount by itself.
Then the controller program calculates and makes the appropriate control map of “knob angle vs. output current“.

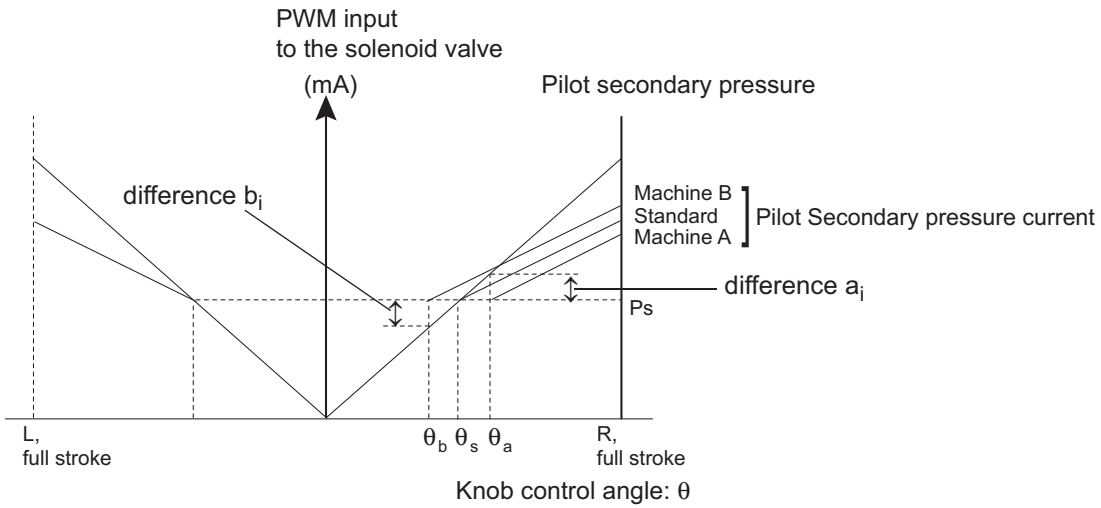
3. Illustration of the start-point setting



Move the knob, and you will find the point where the thumb cylinder starts moving. Just when the cylinder gets activated, press the selector switch. Do this for the right and left movements of the knob. Does control start when the start-point has been reached?



4. Concrete functions at the start-point setting

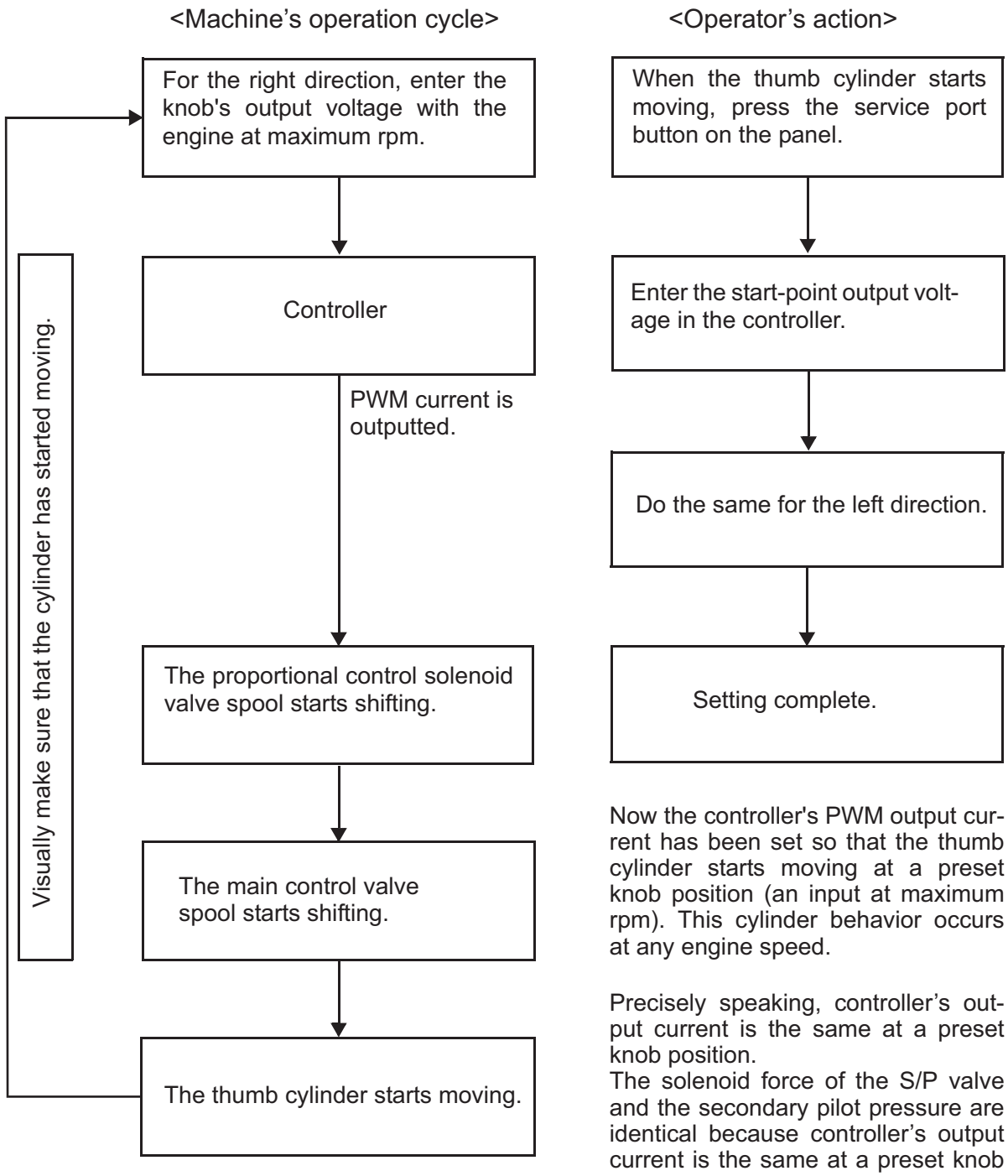


θ_s: standard knob angle to start S/P
θ_a: Machine A knob angle to start S/P before set-up.
θ_b: Machine B knob angle to start S/P before set-up.

The purpose of the start-point setting is to start attachment (thumb cylinder) at the constant same knob control angle, θ_s. As shown in above Fig., machine A starts at θ_a, machine B at θ_b.
In order to get both machines start at θ_s, controller outputs the PWM current by adding the difference a_i or by subtracting the difference b_i to machine A and B respectively.
Start point set-up is to test the difference a_i, b_i and input their data to the controller. So that the controller can calculate and output the required amount PWM current to start the attachment at the same knob control angle θ_s.
Why set-up at engine Max. rpm?
For safety purpose, start-up point is earlier at engine Max. speed than at idle speed.

(In another explanation)
The above chart shows that the service port attachment gets started only after the knob control angle has shifted to θ_a.
In other words, the PWM current corresponding to θ_a flows to the proportional control valve and the pilot secondary pressure reaches the level shown in the above chart. Now the service port attachment starts moving.
Such uneven actions result from individual differences of the proportional control valve, main control valve, cylinder and other components.
In order for the user to maneuver the knob in a stable way, the differences ai and bi are programmed into the controller. Just in doing so, the service port attachment is made to start at the knob's specified angle θ_s. The controller calculates the difference in PWM current (see the chart above) for finely adjusted output.

5. S/P valve initial set-up flow chart



Now the controller's PWM output current has been set so that the thumb cylinder starts moving at a preset knob position (an input at maximum rpm). This cylinder behavior occurs at any engine speed.

Precisely speaking, controller's output current is the same at a preset knob position.
The solenoid force of the S/P valve and the secondary pilot pressure are identical because controller's output current is the same at a preset knob position. Spool shift amount of the main control valve section is the same as well. But as the main pump delivery rate and the thumb cylinder's starting point both varies according to the engine speed to some extent. Then why do the start-up setting at max. engine speed? (For safety)

g) Manual Feeling Setting

1. Outline of manual feeling setting

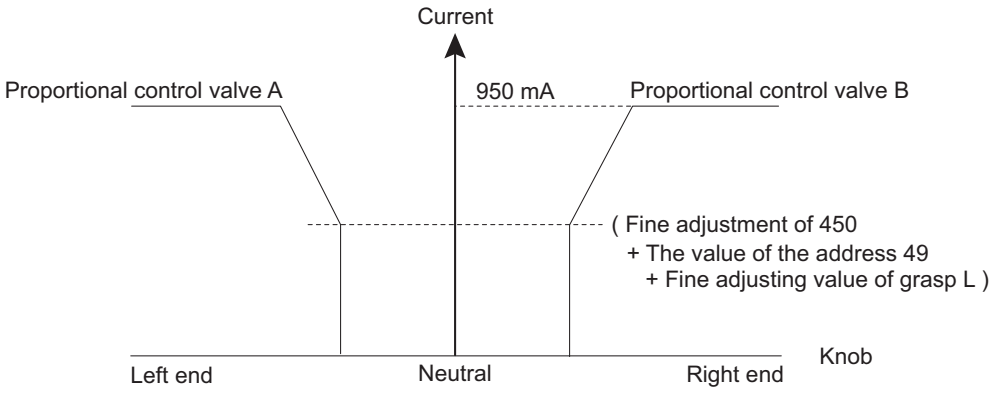
The thumb should move smoothly by the starting point setting, yet this mode is added to ensure its comfortableness for the variety of attachments by different operators.

Setup
Service port feeling adjust

Right		
Slow	-12	Fast

↑

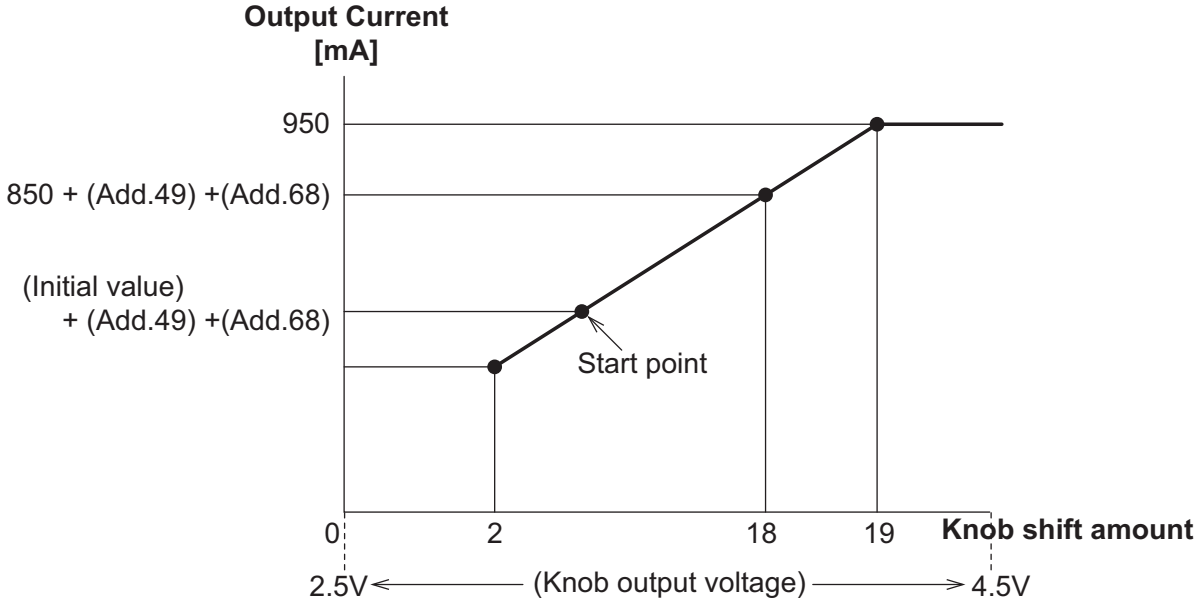
(This value x 5 mA) is added to the map.



The right and left fine adjustment values are put to addresses 62 and 63, respectively, in the memory. These values will become zero when the starting point setting of a model is made.
When address 62 is set at "5", the setoff will be 25 mA: when set at "FFFF", the setoff will be -10 mA.

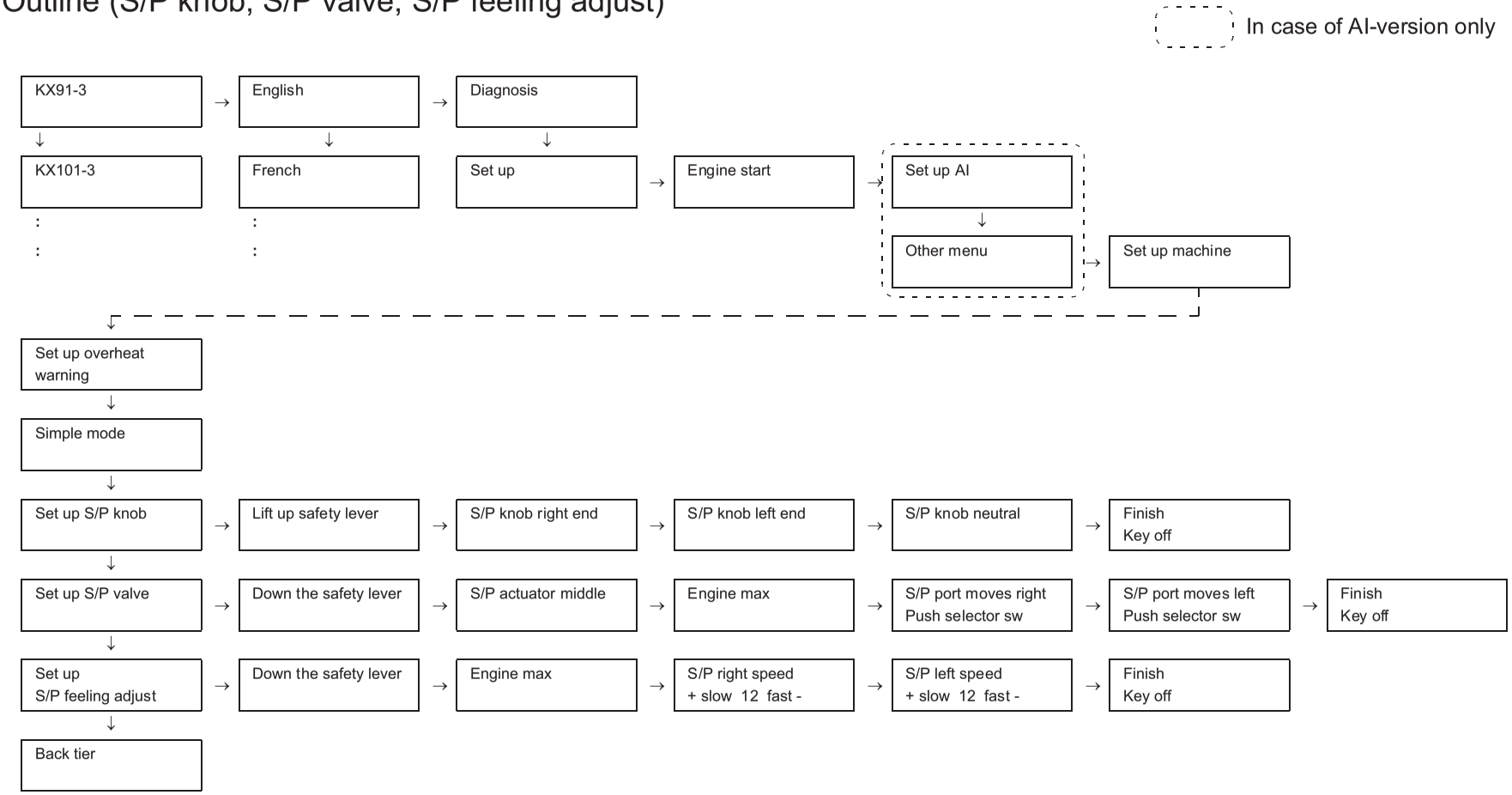
2. Knob shift amount and output current

Move the knob and ensure a good current-duty map at the current of 500 mA and the oil-flowing current.
The proportional control valve, however, is rather unstable in its temperature characteristics (temperature vs. resistance). Such control is still required. (Dark current theory)



h) Panel Display Operation Flow Chart

1. Outline (S/P knob, S/P valve, S/P feeling adjust)



2. Display flow chart with photo

→ KX91-3

1. Turn the starter key to ON (AC position) while pressing the display selector switch on the panel.
   Then the machine model comes on the display.

→ English

2. Push the display selector switch long enough and languages will pop up on the display.
   For KTC and KTA, English ONLY. For KCL, English and French. EU-version has eleven languages to choose.

→ Diagnosis

3. Push the display selector switch long enough, then the display changes to “Diagnosis”.

↓

Set up

4. Push the display selector switch short, then the display changes to “Set up”.

→ Engine start

5. Push the display selector switch long, then the display indicates to “Engine start”.

→ Set up machine

6. Push the display selector switch long, then the display moves to “Set up machine”.

Set up overheat warning

7. Push the display selector switch short, then the display moves to “Set up overheat warning”.
Skip this menu.

↓

Simple mode

8. Push the switch short, then the display shows “Simple mode”.
Skip this also.

↓

Set up S/P knob

9. Push the display selector switch short, the display indicates to “Set up S/P knob”. For the Setting-up of the service port knob initialization, press the display selector switch long. This initialization procedure will be illustrated in another pages.

↓

Set up S/P valve

10. Push the display selector switch short, the display indicates “Set up S/P valve”.

↓

Set up
S/P feeling adjust

11. Push the display selector switch short, the display indicates “Set up S/P feeling adjust”.

↓

Back tier

12. Push the display selector switch short, the display returns to “Set up machine”. Push the display selector switch long, the display returns to “Set up”.

Note: In one of AI-version machine, the display shows “Set up AI” when the display selector switch is pressed long at “Engine start”.

3. Knob initial set-up

↓

Set up S/P Knob

1. The LCD display shows as “Set up S/P knob”.
2. Push the display selector switch short, then the display shows “Lift up safety lever“. This is for safety purpose.

↓

S/P knob right end

3. Lifting up the safety lock lever moves to the display of “S/P knob right end”.

↓

S/P knob left end

4. Push the display selector switch short, then the display shows “S/P knob left end”.

↓

S/P knob neutral

5. Push the display selector switch short, then the display shows “S/P knob neutral”.

↓

Finish
Key off

6. Push the display selector switch short, the display indicates “Finish Key off”. It means knob initialization is completed.

4. S/P valve initial set-up

Set up S/P valve

1. Keep pushing the button until “Set up S/P valve” appears.

Warning!
Engine is running.

↓

Down the safety lever

2. Shift down the safety lock lever down to control the service port attachment.

↓

S/P actuator middle

3. Get the S/P actuator to the middle point of the full stroke by shifting the S/P knob.

↓

Engine max

4. Set the engine at the max. speed.

↓

S/P port moves right
Push selector sw

5. Push the display selector switch at the moment when the actuator cylinder starts moving to extend.

Note: In case of thumb cylinder, “right” indicates the cylinder to extend. “left” indicates to retract.

↓

S/P port moves left
Push selector sw

6. After being pressed in the above, automatically the display moves over “S/P port moves left”.
Push the display selector switch at the moment when the actuator cylinder starts moving to retract.

↓

Finish
Key off

7. Then the display changes to “Finish Key off”.

5. S/P operational feeling adjustment

↓

Set up
S/P feeling adjust

1. As instructed in page ***, you're required to reach the display shows as "Set up S/P feeling adjust".

Caution!
Engine is running.

↓

Down the safety lever

2. Shift down the safety lock lever down to control the service port attachment.

↓

Engine max

3. Set the engine at the max. speed.

↓

S/P right speed
+ slow 12 fast -

↓↑

S/P left speed
+ slow 12 fast -

↓

Finish
Key off

4. Slowly slide the S/P knob switch to right direction and check the actuator's starting points.

   If it starts moving too quick, get it slow by pressing the work lamp switch, left end button.

   If it starts moving too slow, get it fast by pressing the service port switch, middle button.
   Digit number indicates the feeling level of slow or fast.

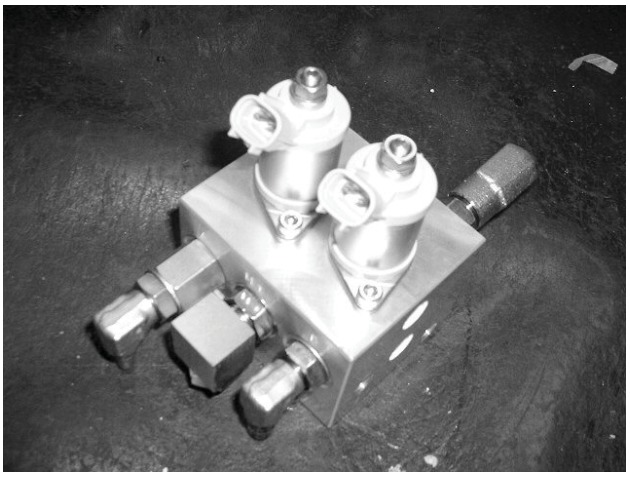
   Pressing the display selector switch short, switches the display to adjust the left or right speed.

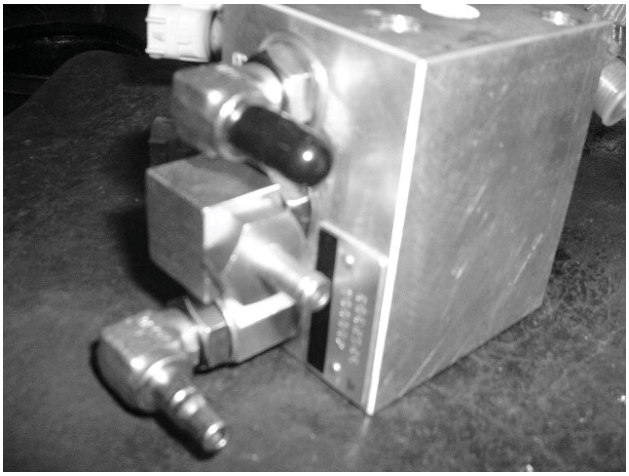
   After completing the feeling adjustment, set the key off.

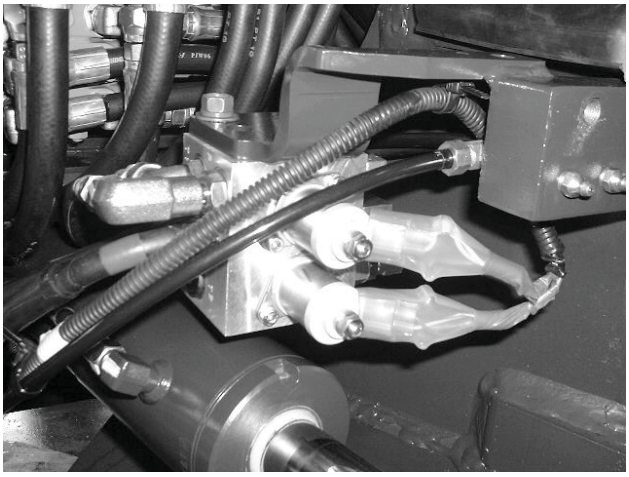
i) Proportional Control Solenoid Valve (S/P Valve)

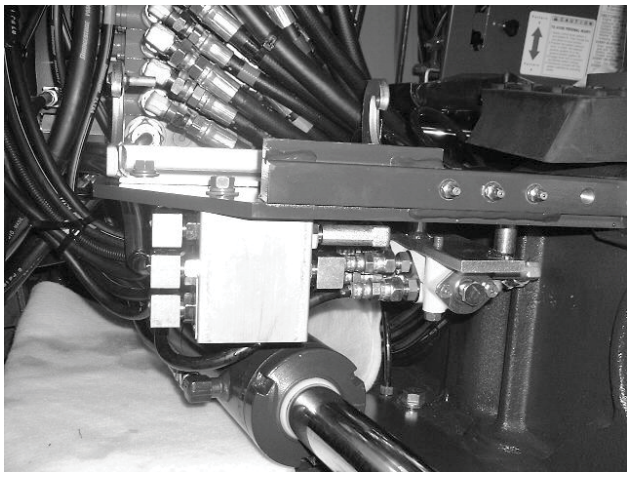
1. Outline

This valve is the combination of electro magnetic solenoid valve and hydraulic reducing valve.
Regular solenoid valve is controlled ON-OFF by battery 12 V direct current. But this valve is controlled by the PWM (pulse width modulation) current supplied from the micro computer controller incorporated in the meter panel.
Valve spool function is basically the reducing valve same as the hydraulic pilot control valve, normally used for the lever control. Difference is as follows.
The hydraulic pilot control valve regulates the pilot pressure, balancing to the operator's manual force. This S/P valve is regulated by the PWM current. In either case, this pilot pressure is so-called the secondary pilot pressure to control the spool stroke of the main control valve.



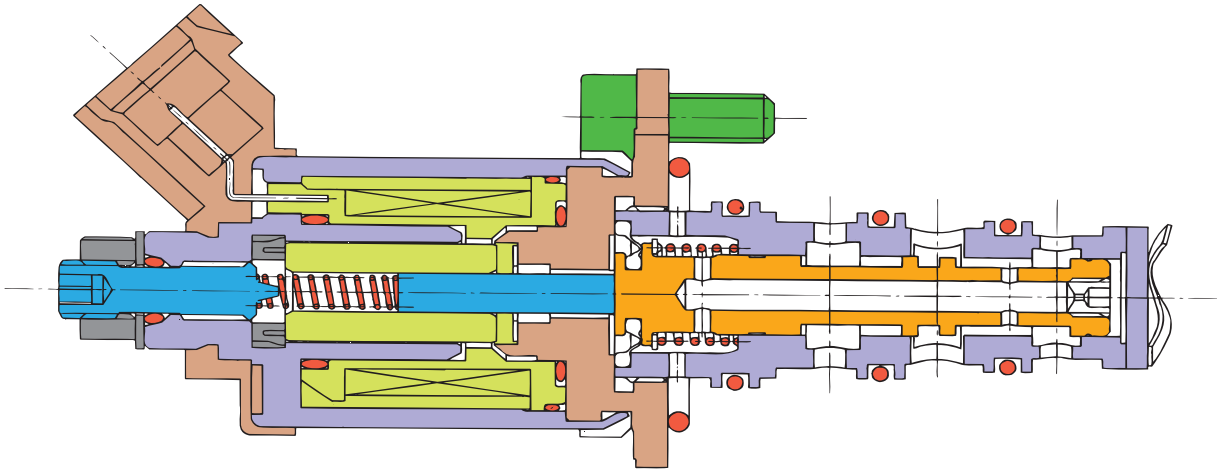




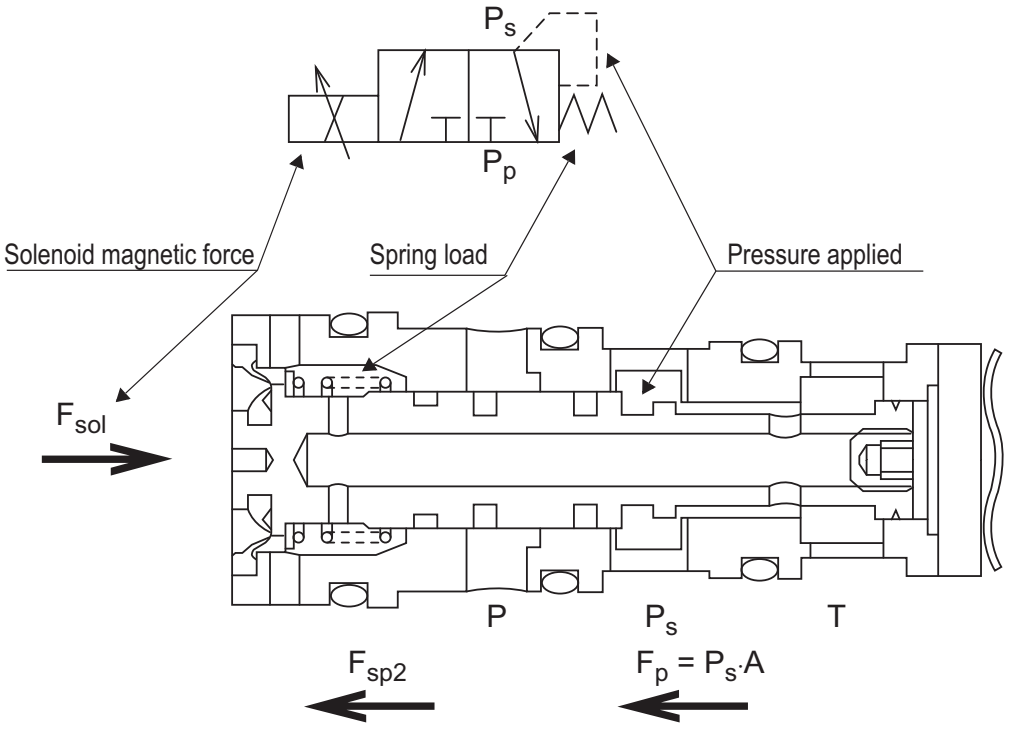


(Photo models: KX91-3S/α, KX101-3α, U35S, U35-3α)

2. Structure and function



(Hydraulic symbols)

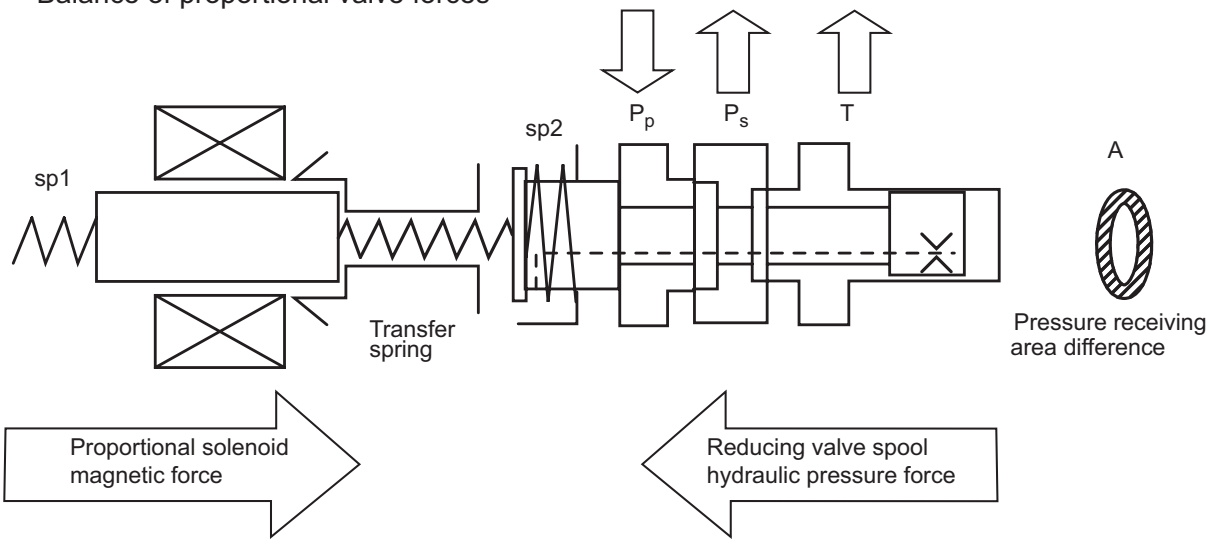


P_p: Primary pilot pressure
P_s: Secondary pilot pressure

3. Function theory

Behavior of proportional valve

Balance of proportional valve forces



Behavior of solenoid proportional valve

Definitions of values

F_{sol}: Solenoid magnetic force generated according to current
F_{sol} = C1 x I (C1 and I are solenoid's constant and current, respectively.)

F_{sp1}: Solenoid's spring load

F_{sp2}: Valve's spring load (constant during pressure control)

F_p: Pressure applied by setup area difference
F_p = A x Pa (A and Pa are setup area difference and pressure at port P_s, respectively.)

P_p: Primary pilot pressure from the pilot pump controlled by the unload relief valve

P_s: Secondary pilot pressure to control the main control valve spool

Balance of forces

The balance of forces for the valve spool (see above) is expressed like this.

$$F_{sol} + F_{sp1} = P_s \cdot A + F_{sp2}$$

When the left term is greater, the spool moves rightward and ports P_p and P_s open one after the other.

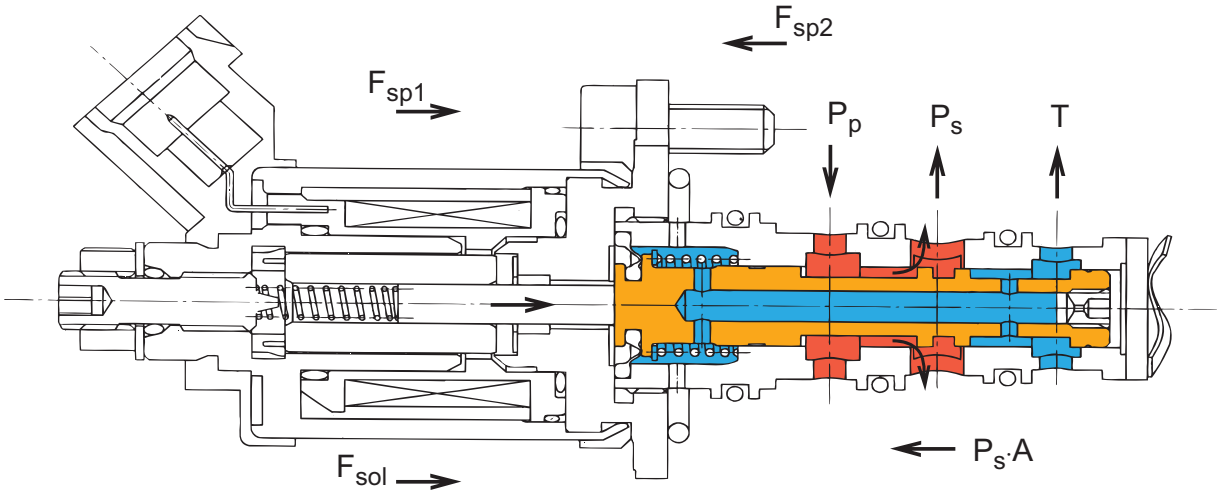
When the right term is greater, the spool moves leftward and ports P_s and P_p open one after the other.

The above expression is rearranged as follows.

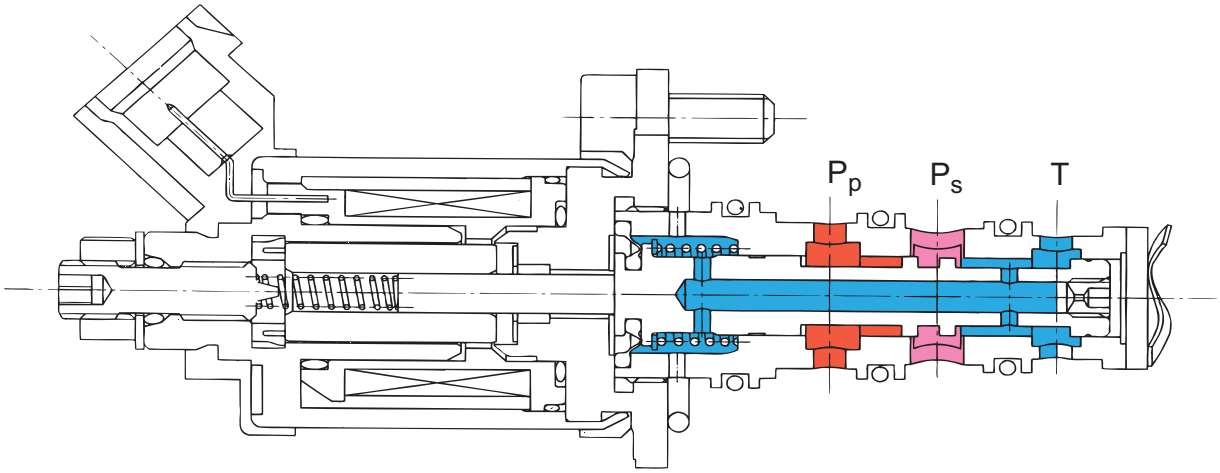
$$F_{sol} + F_{sp1} - F_{sp2} = P_s \cdot A$$

$$P_s = \frac{F_{sol} + F_{sp1} - F_{sp2}}{A}$$

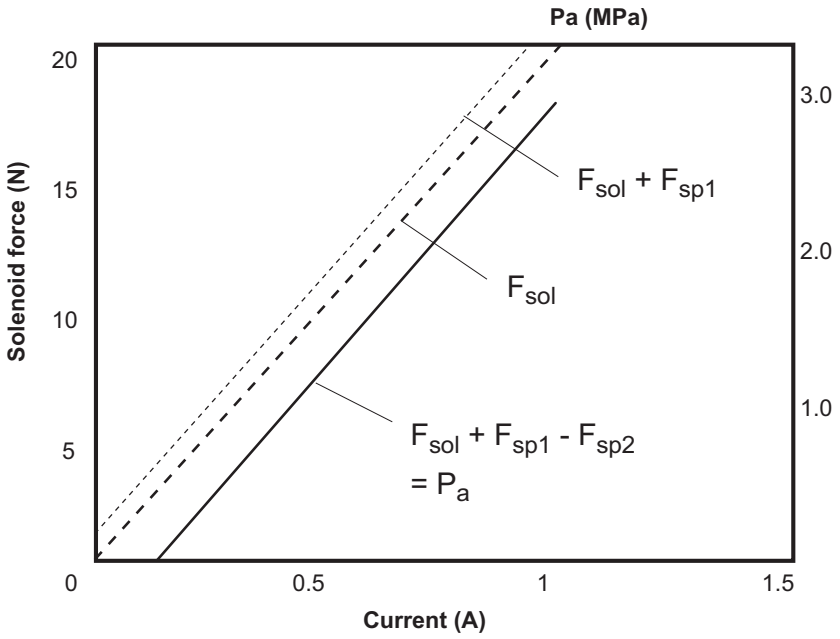
$F_{sol} + F_{sp1} > P_s \cdot A + F_{sp2}$



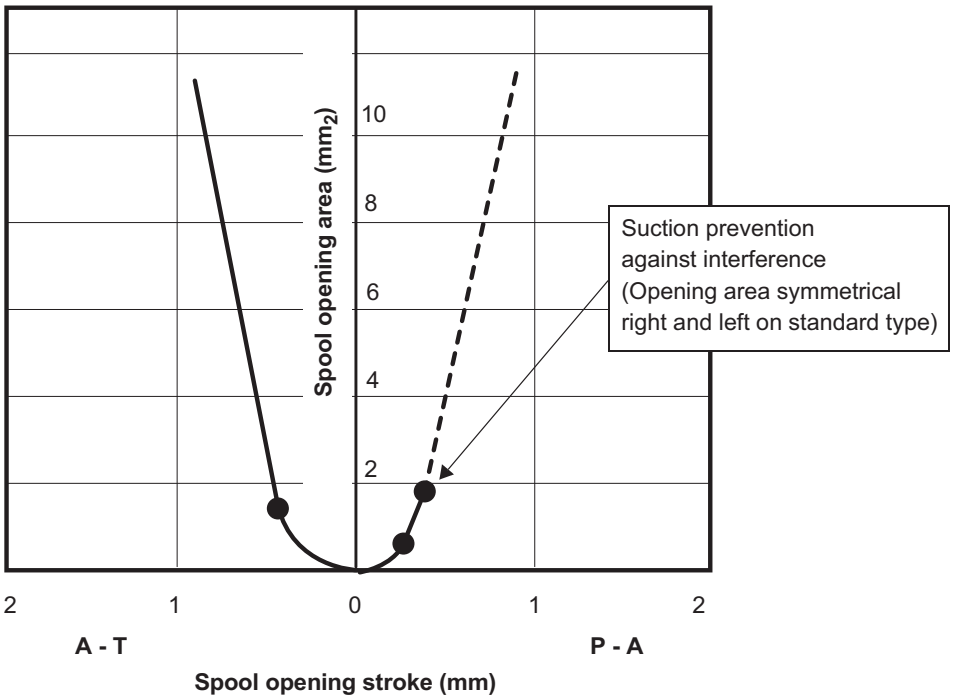
$F_{sol} + F_{sp1} < P_s \cdot A + F_{sp2}$



Spool control performance I-P curve



Spool opening area



A - T: Actuator to tank

P - A: Pump to actuator

j) Other Controls

1. Model number display

Displayed in the case of AI specifications.

2. Automatic service port identification

With the key on, a current of 250 mA or so is made to flow in the service port proportional control valve. When feedback is available, the machine is of service port type. If not, the machine has no service port.
This automatic identification is added because some machines have service port and the others have not. It should be noted that the map profile is different from each model and destination respectively (Europe and North America).

3. Fool-proof control

When the service port sensor reads below 0.25 V or over 4.75 V for 0.2 second; it will be 'Out of Service' without display.

4. Idle-up control

The idling speed increases by 150 rpm when the water temperature drops below 30 centi-degrees (Reason: Even at the same governor position, the engine speed drops about 150 rpm at the temperature of -18 centi-degrees.)

5. Compressor control

When the compressor is on, the idling speed is raised by 150 rpm.
The idea is as follows.
If the compressor is repeatedly turned on and off and kept off for 3 seconds, the idling speed gets back to its original rpm. In this way, the AI motor can be kept from getting activated many times.
(Reason: If the compressor is on and the alternator barely generates power, the battery, if connected to an external load, may fail to work.)

(G) NEW AUXILIARY OIL FLOW CONTROL - Minor Change Version - (Year of 2007)

a) System Overview

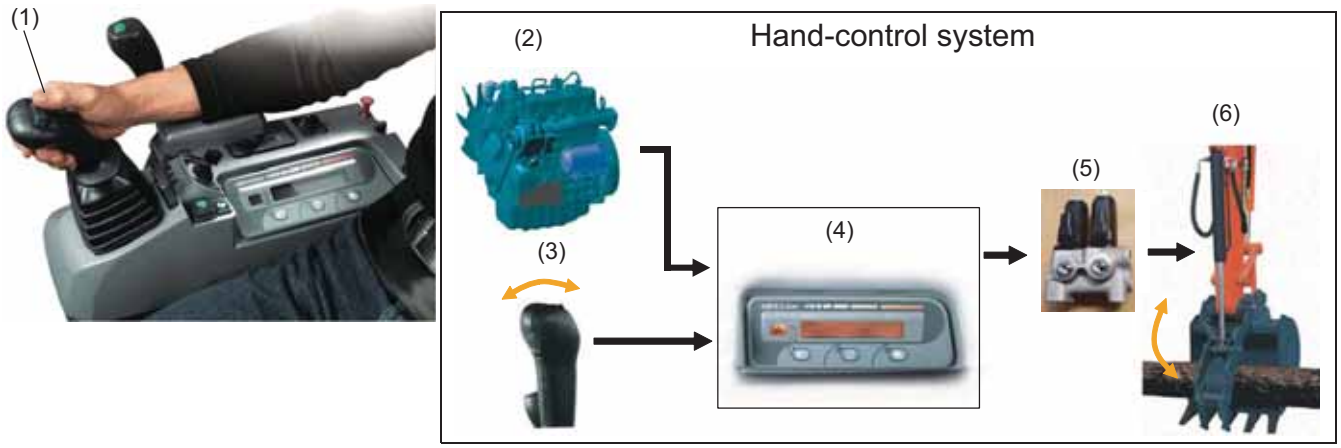
1. Applied models:

KX121-3α/S/ST, KX161-3α/S/ST, U45S/ST, U45-3α/S/ST, U50-3α

2. Background and concept of R&D

The hydraulic service port is provided to move an attachment that is installed on the machine. Such attachment was operated with a foot pedal on conventional machines. For finely maneuvering an attachment and saving the space around the operator's feet, the hand-control system was developed. Kubota's 3-ton and higher-capacity export machines are now standard equipped with this system.
The top-end model KX080-3 is also equipped with the speed limit function (the world's first on mini-backhoes) to differentiate this model from our competition.

- Hand-control system
  The hydraulic control grip has a small angle sensor built in. Signals from this sensor activate the proportional solenoid valve to control the flow rate at the hydraulic service port stepless.



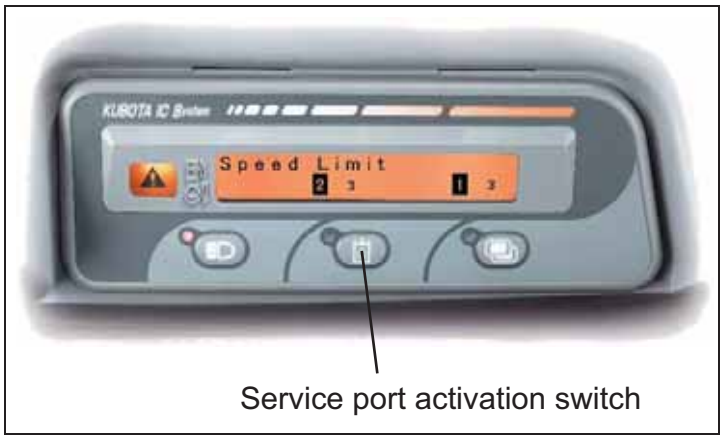
(1) Control knob (small angle sensor)
(2) Engine rpm
(3) Control angle input
(4) Electronic meter (control unit)
(5) Proportional solenoid valve
(6) Attachment

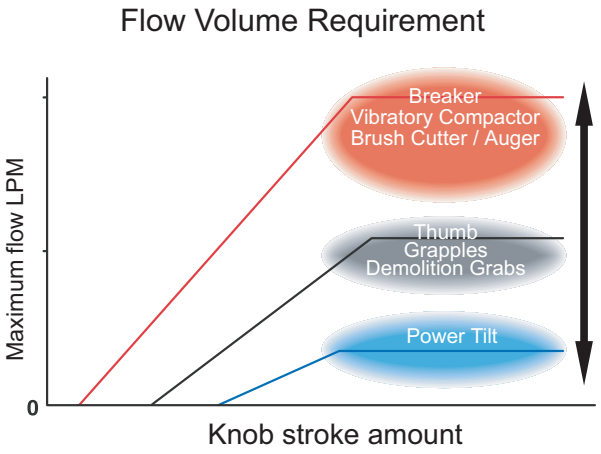
- Setting of limited flow volume, S/P 1

Machine model	Applied S/N (JPN)	Applied S/N (KBM)
KX121-3α/S/ST	56121 ~	75899 ~
KX161-3α/S/ST	58404 ~	77728 ~
U45-3α/S/ST	56834 ~	76703 ~
U50-3α	56834 ~	76628 ~

3. Outline of new function

- Speed limit function [New Feature]
  According to maximum necessary flow rate of an attachment, the working speed limit can be preset in multi-steps. Look at the electronic meter's LCD screen and press the button.
  What's more, the control knob angle and the service port flow rate are in linear response to each other. The attachment can now be easily controlled by moving the control knob over its full stroke.



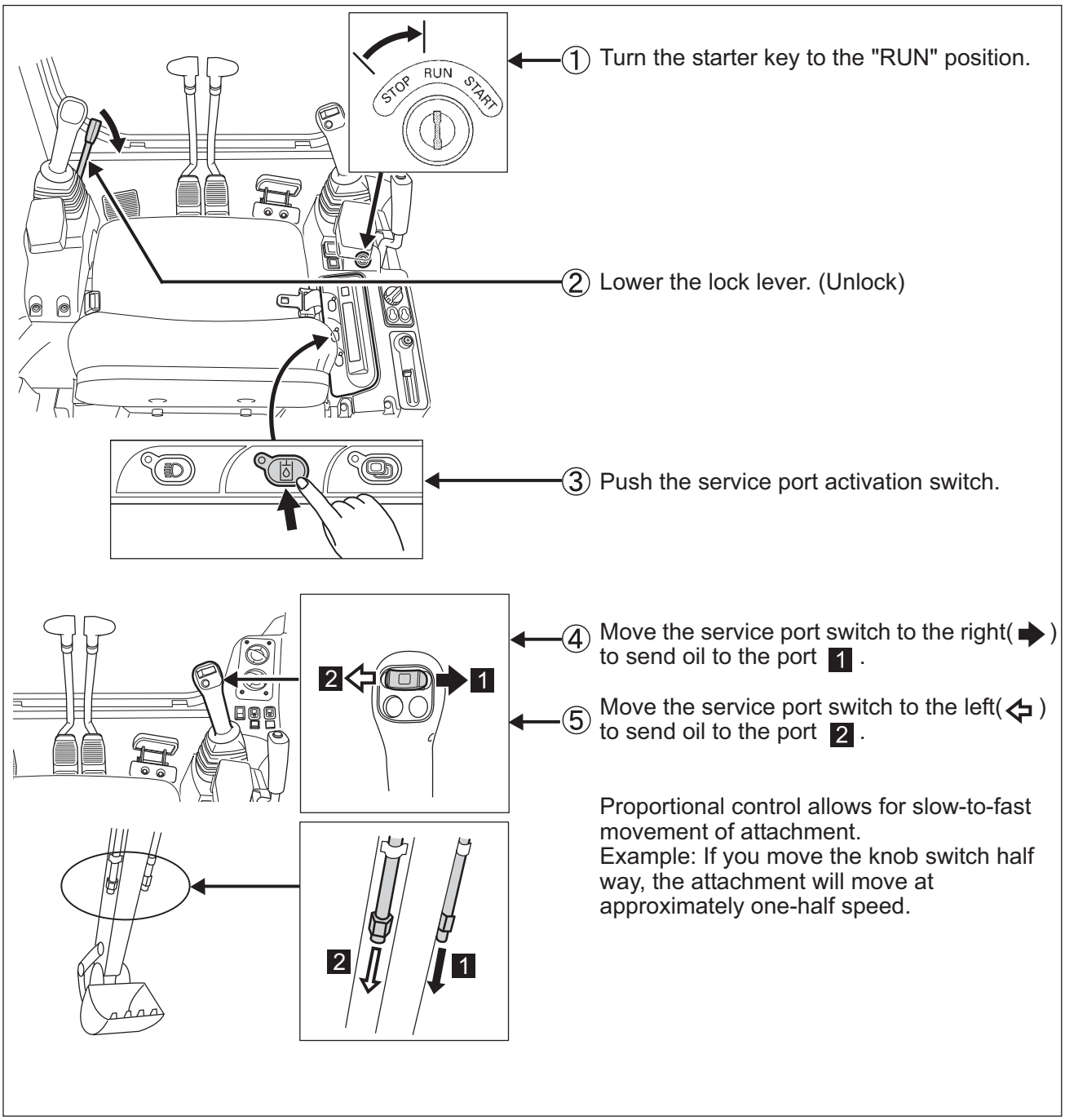


b) Service Port Operation Method

NOTE:
When the lock lever is raised, the service port activation switch goes off.
Let the engine warm up after start-up for approx. 10 minutes under no load conditions.

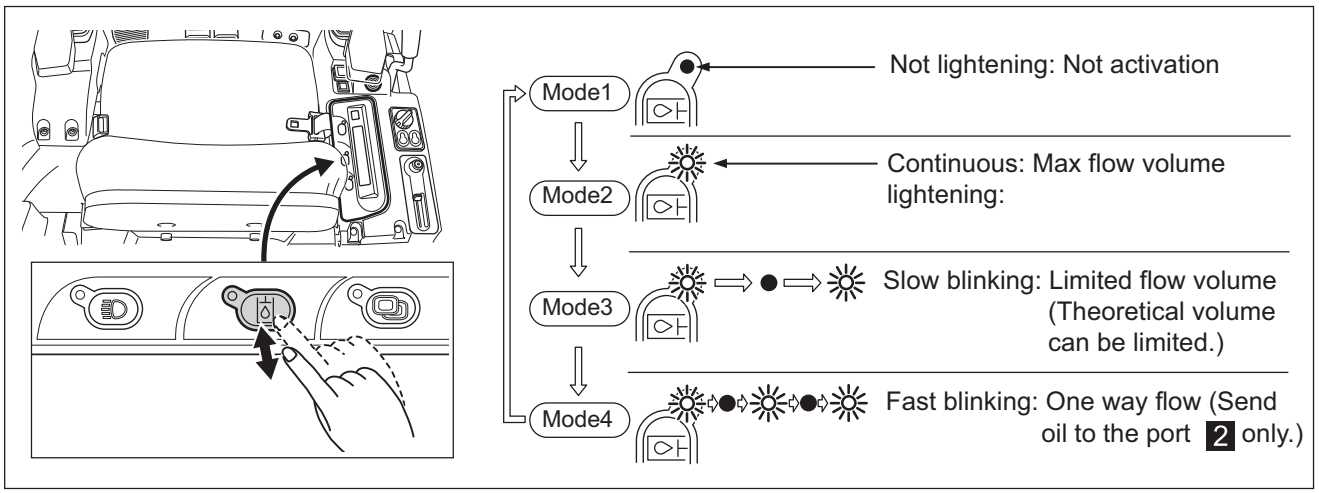
1. Service port operation

This switch is used to operate hydraulic attachment such as breakers, tilt bucket, thumb, etc.



2. Action mode of service port operation

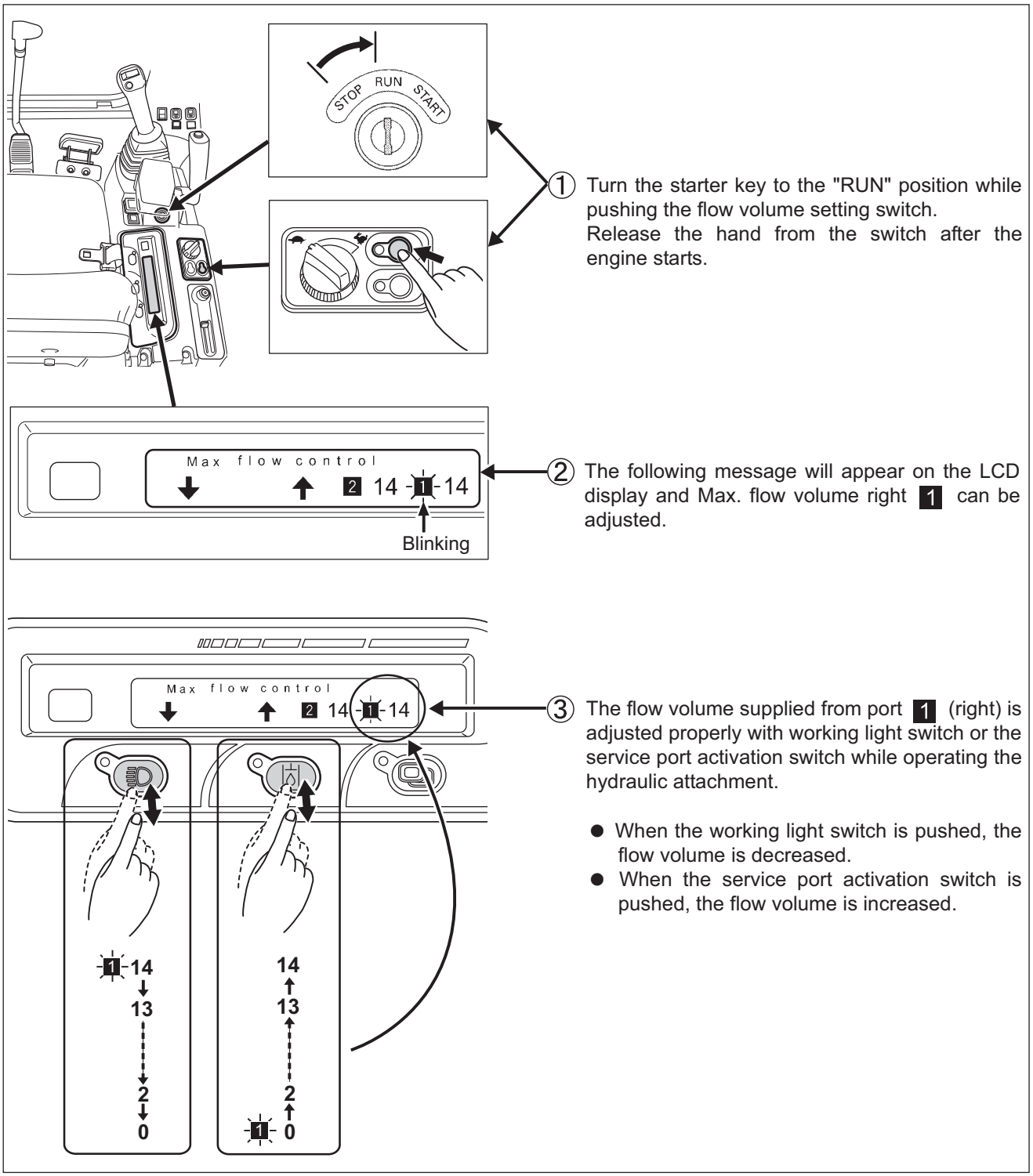
It is possible to select four action mode of the first service port operation by pushing the service port activation switch.
Each time the service port activation switch is pushed, the action mode changes from 1 through 4.



NOTE:
When turning the starter key to the "RUN" position, the action mode will return to the last-used action mode.

3. Setting of limited flow volume

Max. flow volume right 1 and left 2 can be adjusted in 15 stages individually.

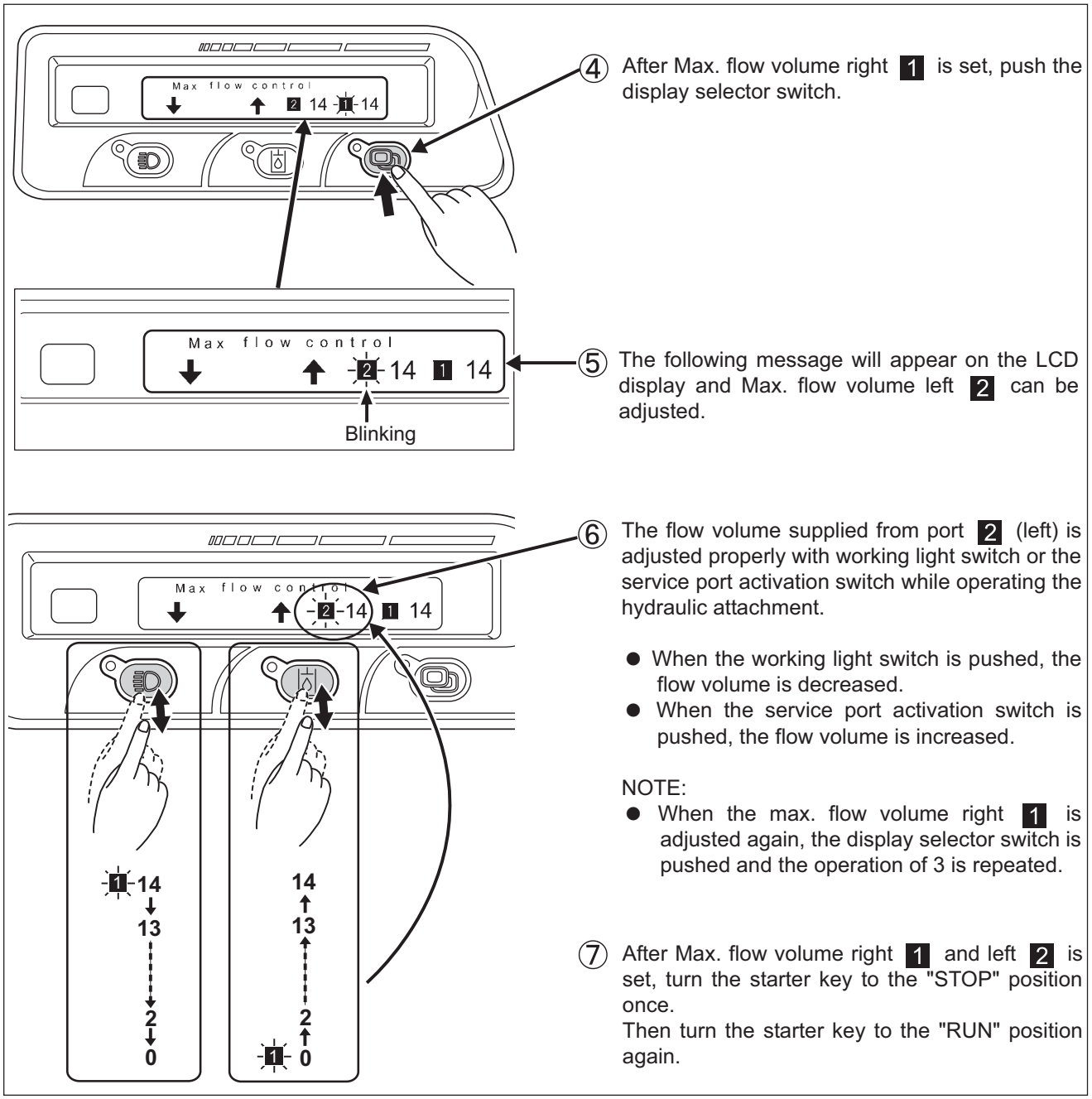


① Turn the starter key to the "RUN" position while pushing the flow volume setting switch.
Release the hand from the switch after the engine starts.

② The following message will appear on the LCD display and Max. flow volume right 1 can be adjusted.

③ The flow volume supplied from port 1 (right) is adjusted properly with working light switch or the service port activation switch while operating the hydraulic attachment.

- When the working light switch is pushed, the flow volume is decreased.
- When the service port activation switch is pushed, the flow volume is increased.



④ After Max. flow volume right 1 is set, push the display selector switch.

⑤ The following message will appear on the LCD display and Max. flow volume left 2 can be adjusted.

⑥ The flow volume supplied from port 2 (left) is adjusted properly with working light switch or the service port activation switch while operating the hydraulic attachment.

- When the working light switch is pushed, the flow volume is decreased.
- When the service port activation switch is pushed, the flow volume is increased.

NOTE:
- When the max. flow volume right 1 is adjusted again, the display selector switch is pushed and the operation of 3 is repeated.

⑦ After Max. flow volume right 1 and left 2 is set, turn the starter key to the "STOP" position once.
Then turn the starter key to the "RUN" position again.

4. Service port max. flow volume

Theoretical Max. Flow Volume L/min (US gal/min)	KX121-3α/S/ST	60.0 (15.9)
	KX161-3α	65.0 (17.2)
	U45-3α, U50-3α	
	KX161-3S/ST, U45-3S/ST, U45S/ST	75.0 (19.8)
Max. pressure at bench MPa (kgf/cm^2) psi	KX121-3α/S/ST	24.5 (250) 3551
	KX161-3α/S/ST, U45-3α/S/ST, U50-3α, U45S/ST	23.5 (240) 3412

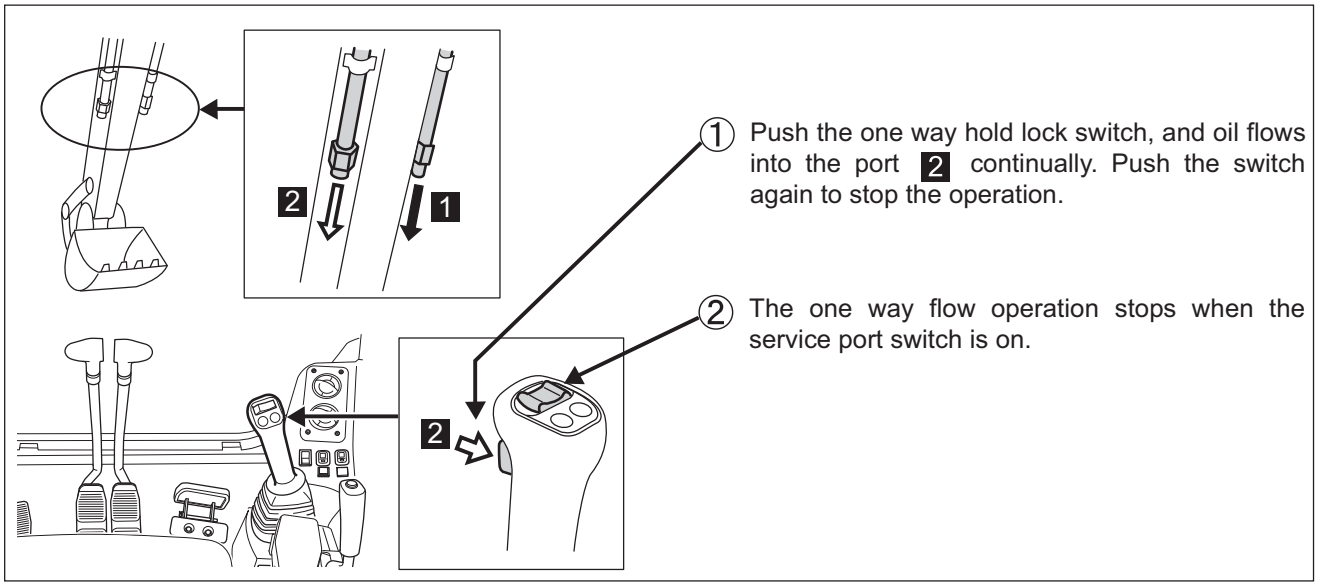
IMPORTANT:
When the service port is not used for a long period, dirt particles can settle in the lower part of the service port lines.
When the plugs on the service port lines are removed to connect attachments, drain approx. 100 cc (3.4 oz) of oil per side before making connections.
For breaker choices, contact your dealer.

NOTE:
- Suppose that the same attachment is mounted on another machine. Even if the same limit setting is made, the same speed cannot be achieved. Make an optimum setting on each machine.

The service port speed fluctuates by getting an attachment relieved at the limited flow volume.

Keep in mind that the limit level with combined operations of attachments.

5. One way flow operation

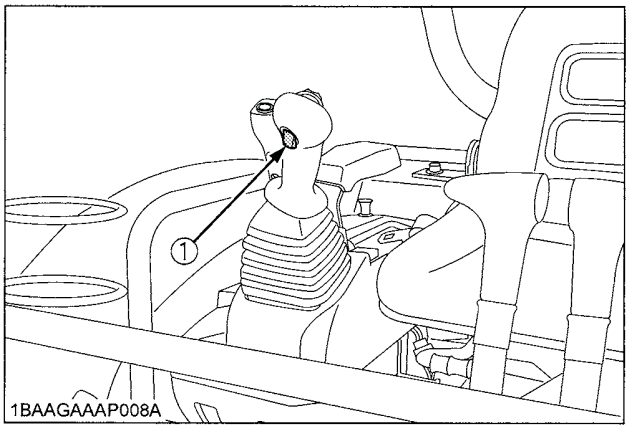


① Push the one way hold lock switch, and oil flows into the port 2 continually. Push the switch again to stop the operation.

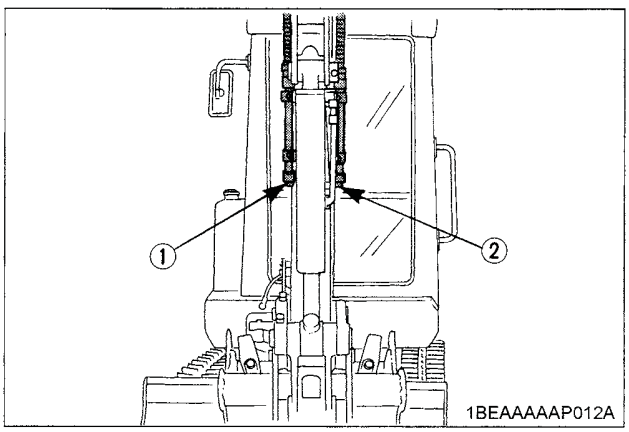
② The one way flow operation stops when the service port switch is on.

6. Breaker operation

1. Push the breaker lock switch, and oil flows into the pipe (2) continually. Push the switch again to stop the operation.



(1) Breaker lock switch

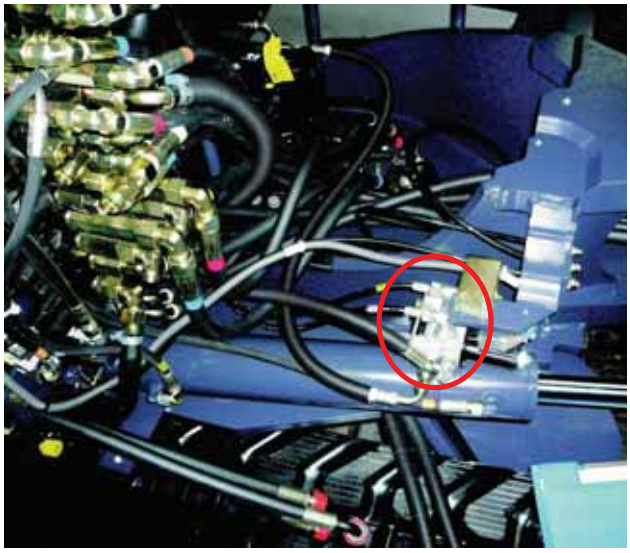


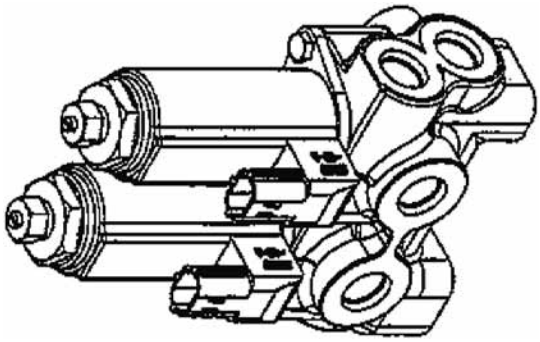
7.Relieving hydraulic pressure

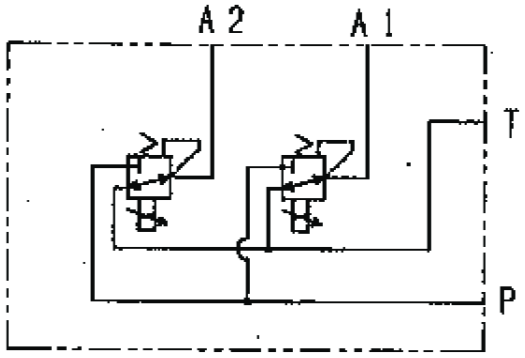
1. Turn the starter key to the “ON” position.
2. Lower the safety lock lever.
3. Turn on the service port activation switch. Move the service port switch to the right and left several times to relieve hydraulic pressure of the service port.

c) Proportional Solenoid Valve

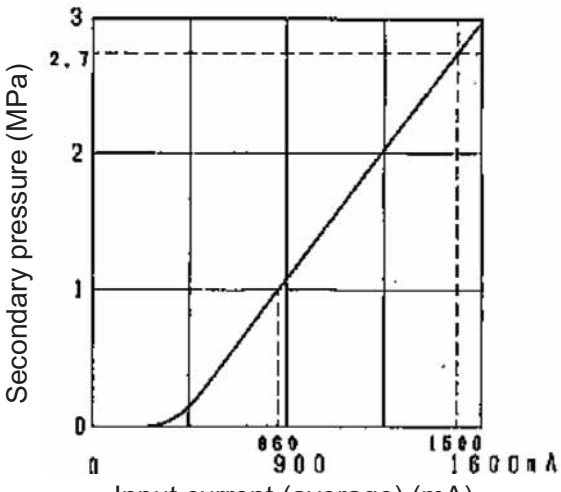
Proportional solenoid valve has been renewed as shown below.
This proportional solenoid valve is exactly the same as KX080-3 S/P 1 solenoid valve.
With this change, the heating water hose can be deleted.
Instead, amplifier unit is added to obtain appropriate constant current from the controller.
This amplifier unit is also same as the one used in KX080-3.





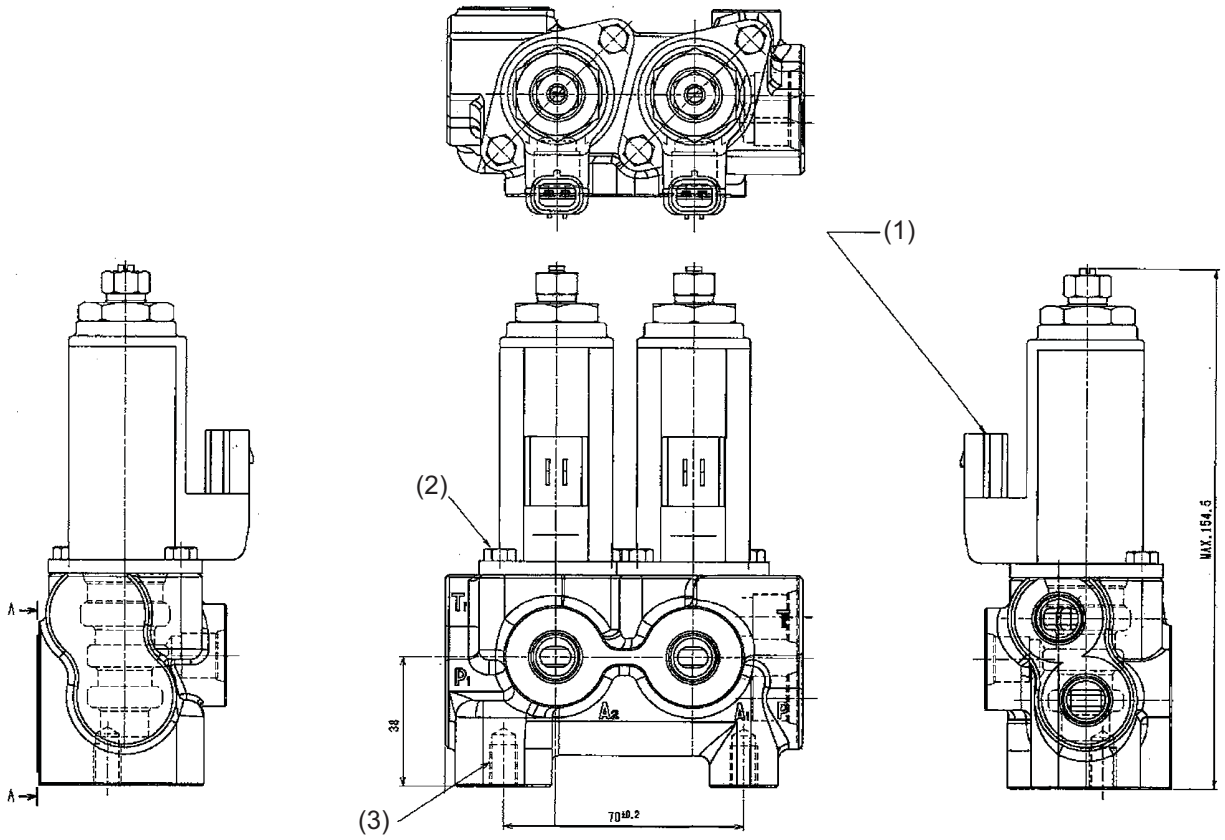


Hydraulic symbol

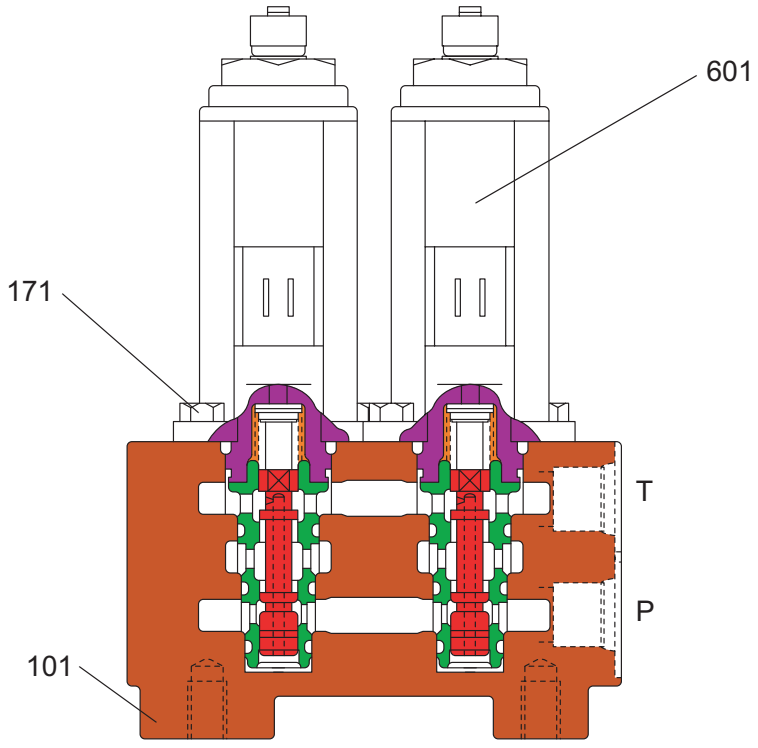


Control diagram

Max. working pressure. (Press. in port P)	7 MPa (71.4 kgf/m^2) (1016 psi)
Allowable back pressure. (Press. in port T)	1.0 MPa (10.2 kgf/m^2) (145 psi) and below
Max flow proportional valve	10 L/min (2.6 gal/min) (1 spool)
Flow in drain line at solenoid/off	400 cm^3/min and below (AT 20 cST, P port press = 4.9 MPa)
Water resistance	According to JIS D 203 S”
Vibration proof	JIS D 1601 b 7
Hydraulic oil	According to ISO VG 32 ~ 68
Oil temp. range	-20 ~ 90°C
Allowable contamination	NAS grade 10 and below
Electrical specifications	Rated current: 1600 mA Coil resistance: 3.2 ~ 0.50 (at 20°C) Power source voltage: 12 V
Proportional valve, secondary press. setting range	0 ~ 2.7 MPa (0 ~ 27.5 kgf/m^2) (0 ~ 391 psi) Current pressure profile: 38100 ~ 3408



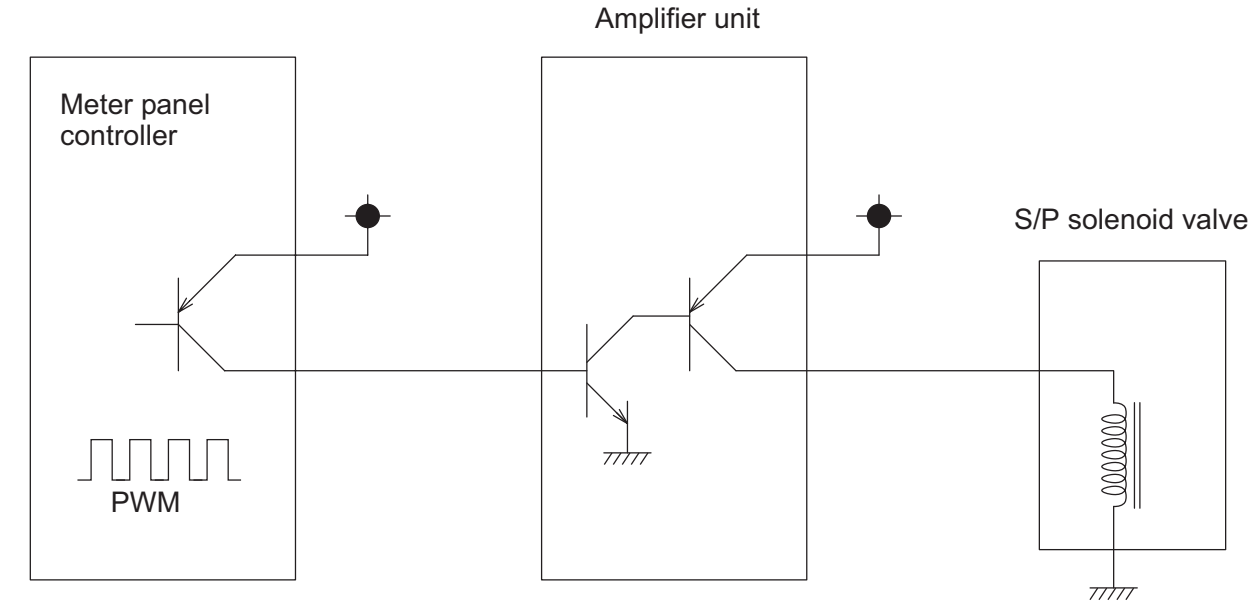
(1) Connector
(2) M5 x 8 Tightening torque: 7 ± 1 N·m (0.7 ± 0.1 kgf·m) 5.2 ± 0.74 ft·lbs
(3) 2 - M8 screw depth 12: Tightening torque



101 Casing Al alloy
171 Hex. box head bolts M5 x 0.8
601 Proportional reducing valve
901 Name plate

d) Amplifier Unit

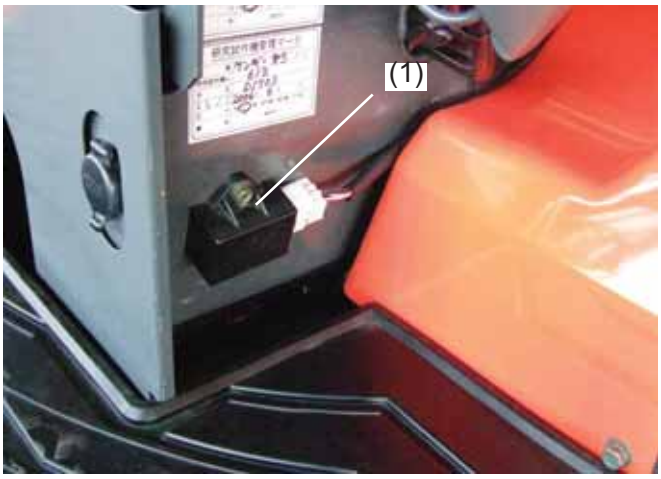
This amplifier unit is incorporated to ensure the control current amount to the S/P solenoid valve.
Simplified function circuit is shown below.



Max. output current capacity = 1.4A

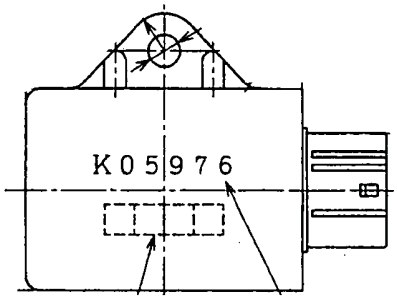
Max. output current capacity = 5A

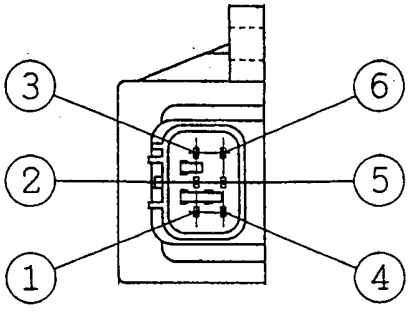
Max. operating current capacity = 1.6A
(Note: KX91-3α..... .....KX161-3α = 0.9A)



(1) Amplifier unit
Code No. RD809-53761

PWM drive: 70 ~ 200 Hz





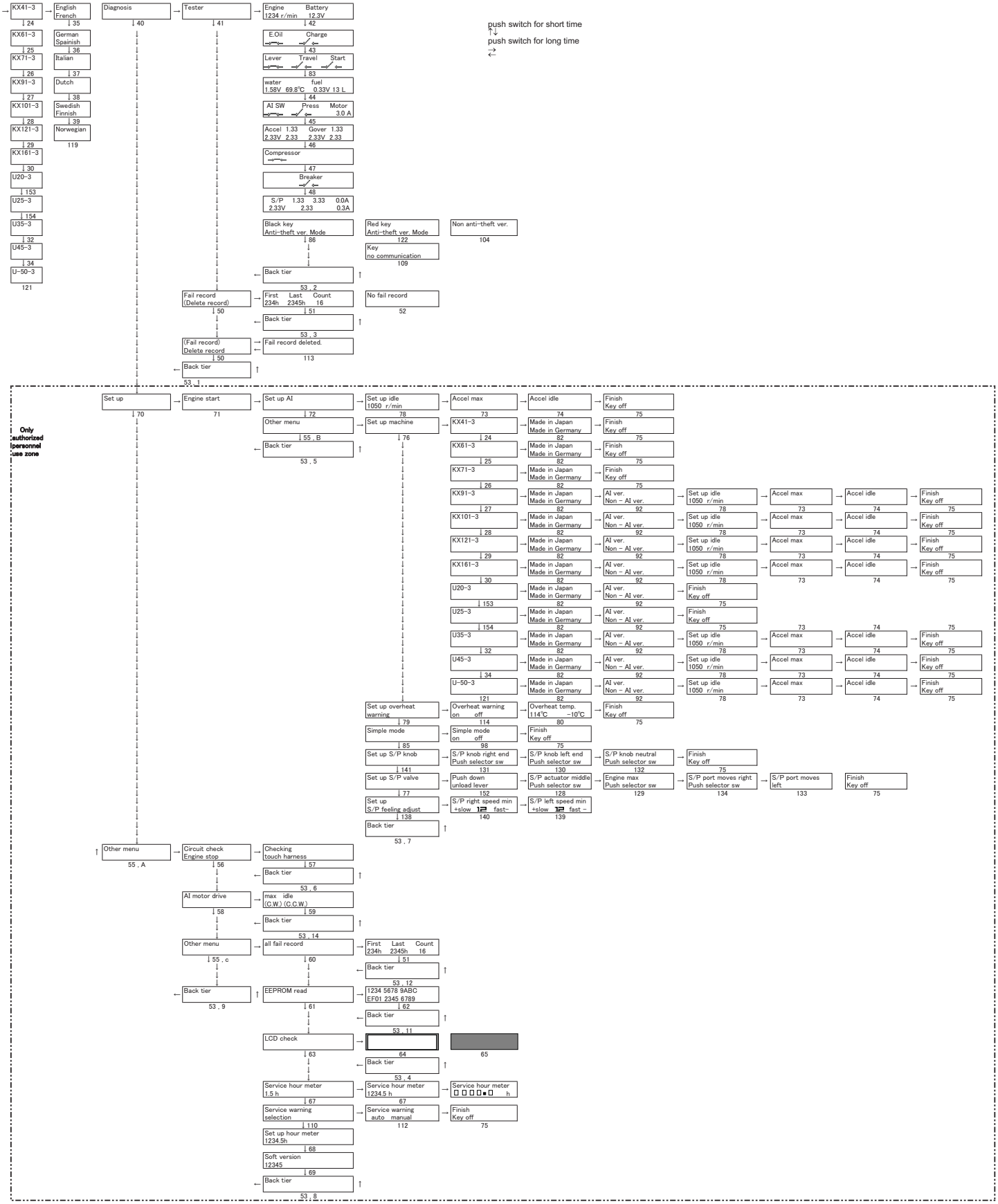
Coupler terminal

(1) PWM input 1
(2) PWM input 2
(3) Battery 12V
(4) Ground (Earth)
(5) Solenoid output 1
(6) Solenoid output 2

e) Service Mode Flow

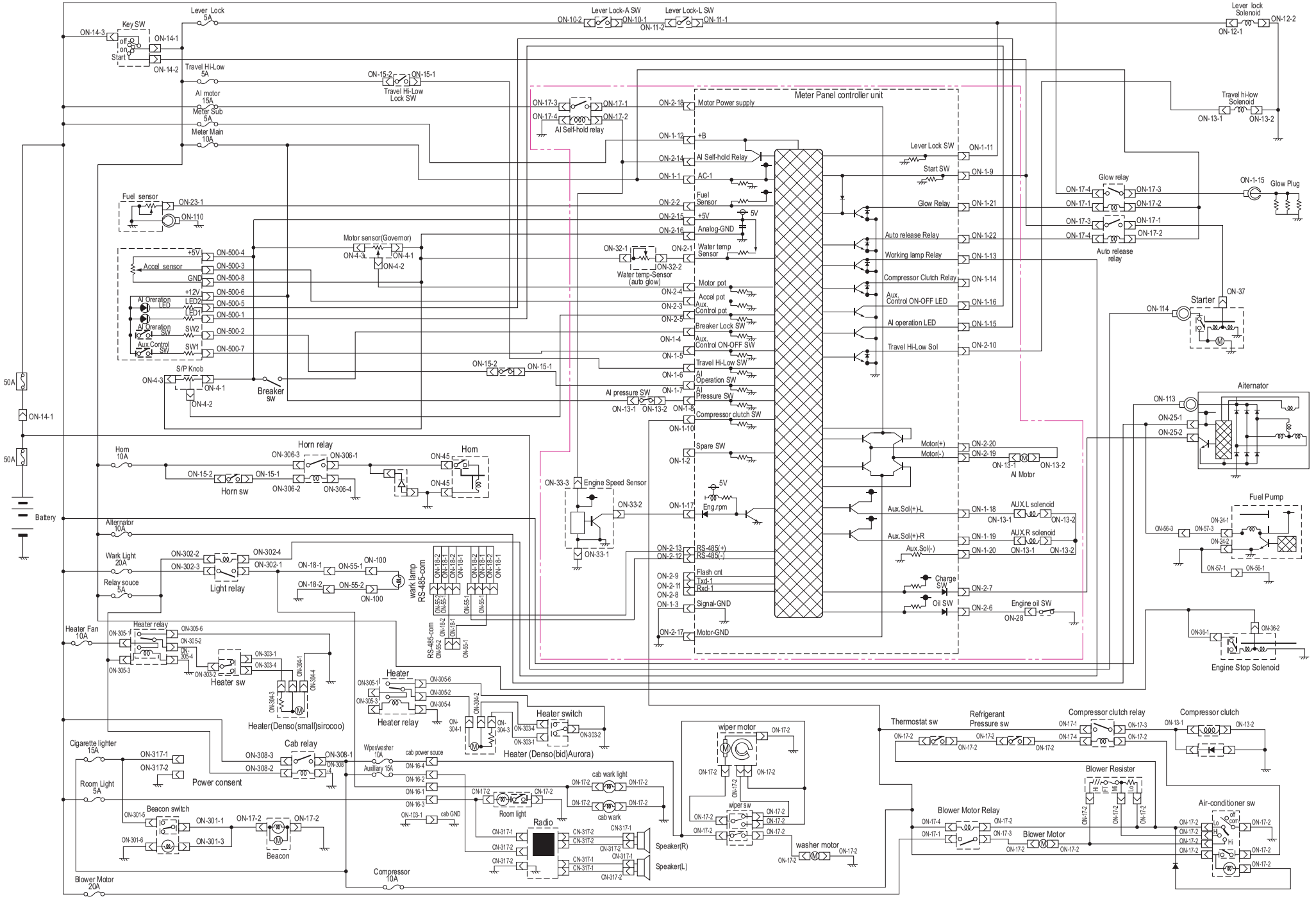
EU service mode **KX91-3α KX101-3α KX121-3α KX161-3α U35-3α U45-3α U50-3α** (AI, S/P) ver 1.21

How to enter the service mode.
While pushing the display-select-switch, turn the main key to ON position.
Then you are in this mode.

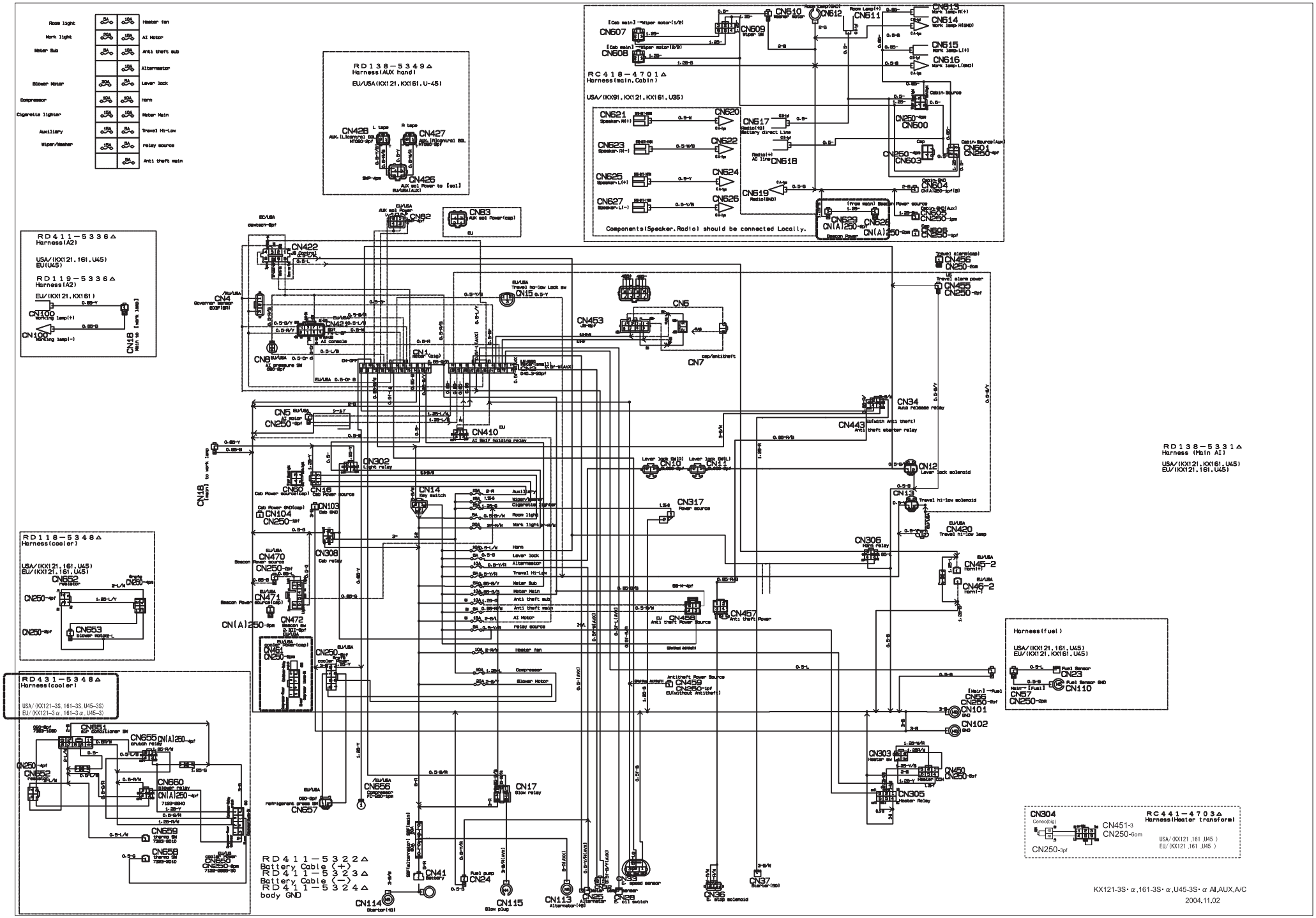


f) Circuit Wiring Diagram

1. **KX91-3α/α2/S/S2,101-3α/α2, 121-3α/S/ST, 161-3α/S/ST, U35S/S2, U35-3α/S/S2, U45S/ST, U45-3α/S/ST, U50-3α** (S/P, AI)

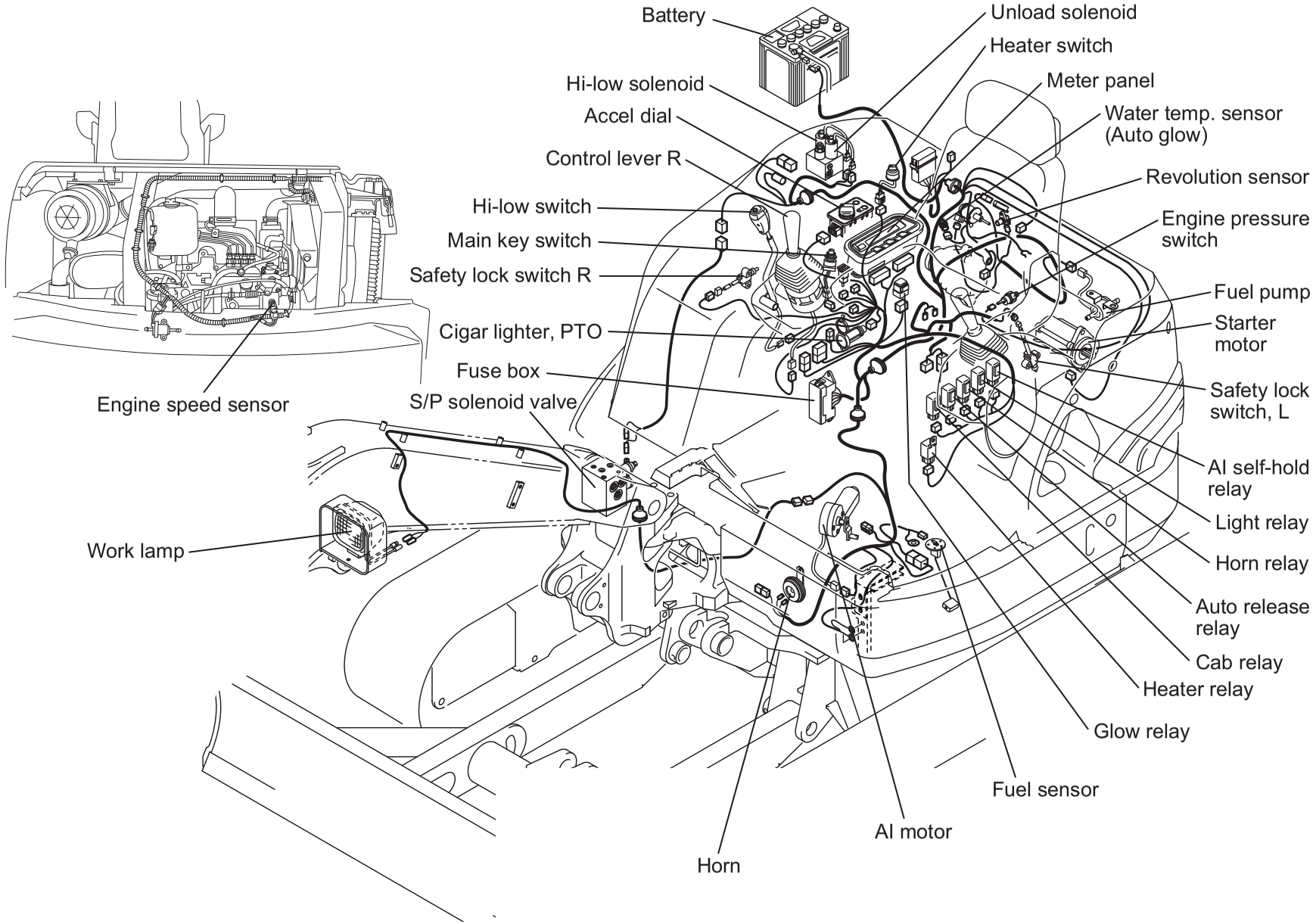


2. **KX121-3α/S/ST, 161-3α/S/ST, U45S/ST, U45-3α/S/ST**: EU and PP-version



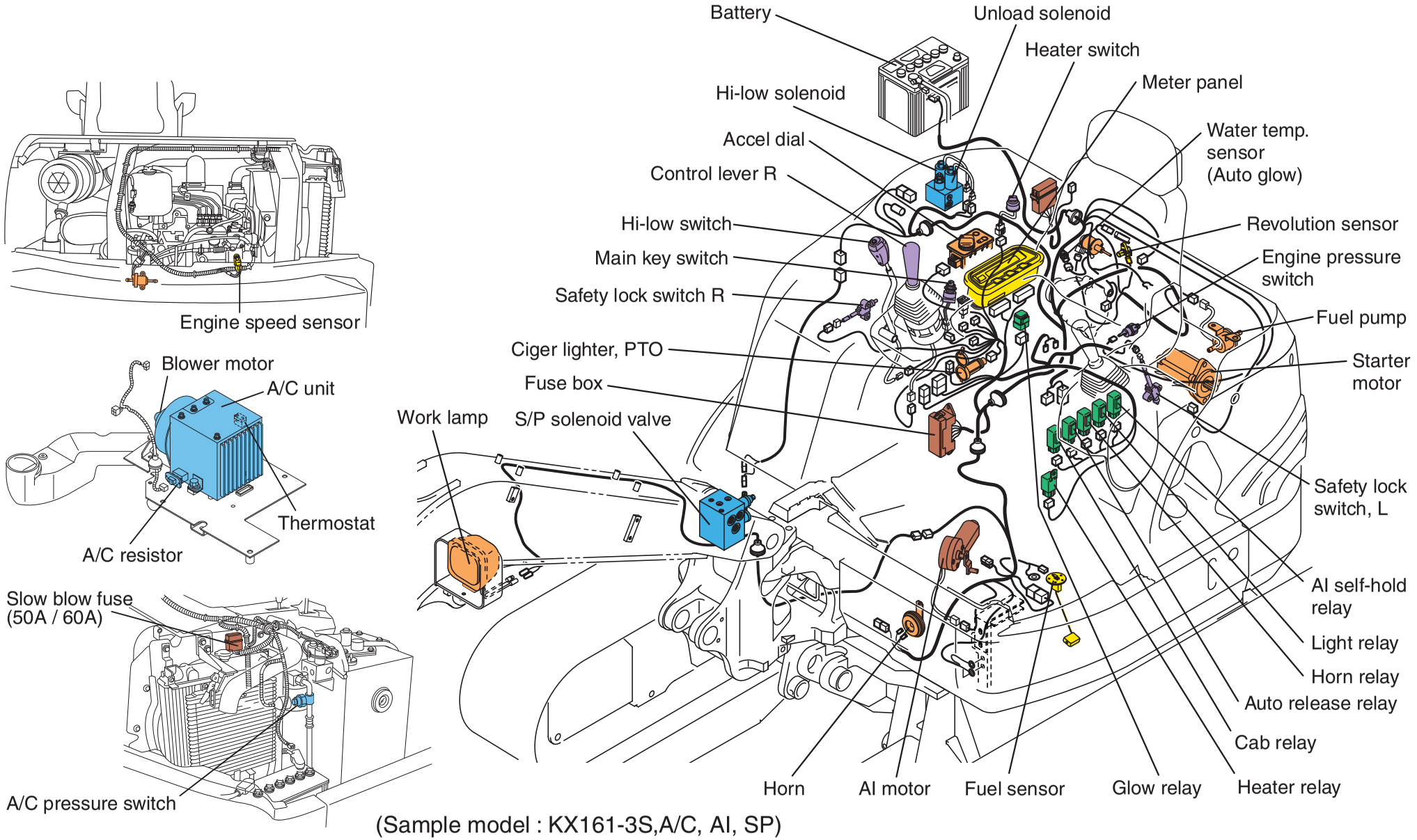
g) Component Layout

1. **KX121-3α/S/ST, KX161-3α/S/ST, U45S/ST** electrical wiring, except A/C



V-M-119

2. **KX121-3α/S/ST, KX161-3α/S/ST, U45S/ST** electrical wiring, A/C



(Sample model : KX161-3S,A/C, AI, SP)

V. ELECTRICAL SYSTEM

Service Section

(A) WIRE HARNESS INSTALLATION. V-S-3
a) Precautions V-S-3
b) Engine Earth, Starter Switch V-S-4
c) Wireharness Routes and Clamps V-S-5
d) Key Modification V-S-11
e) Electrical Equipment Specifications V-S-15

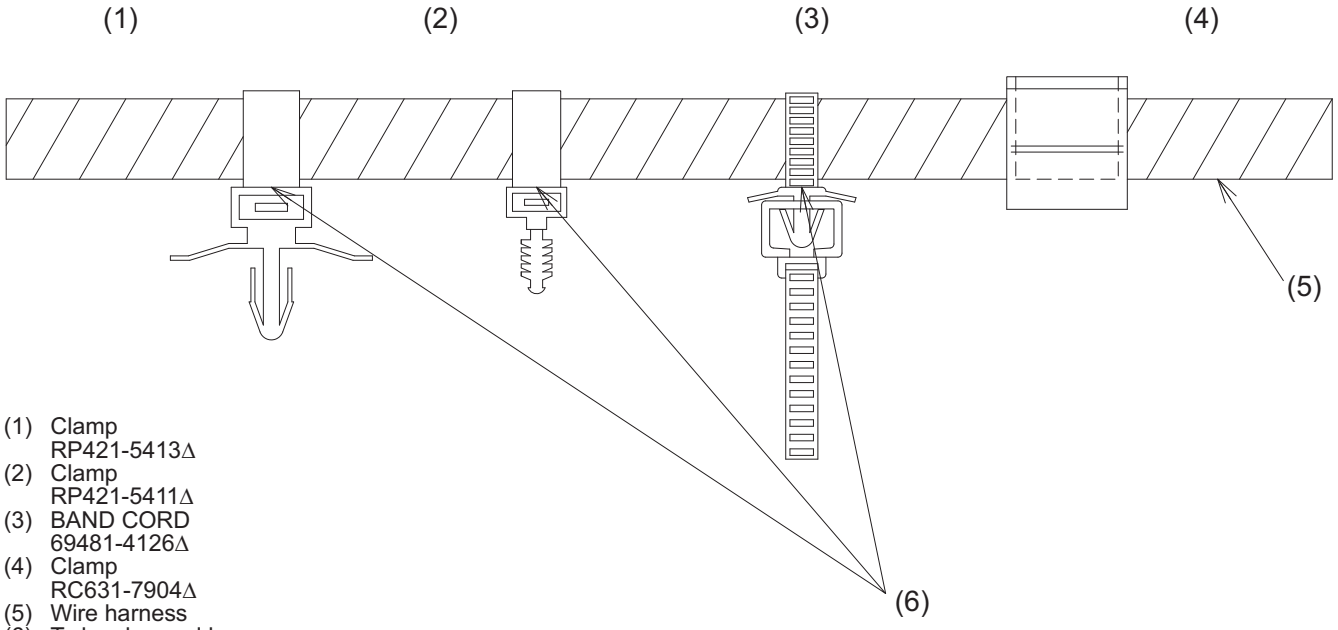
(A) WIRE HARNESS INSTALLATION

a) Precautions

S **(1) No contact with the peripheral parts along the route**
Unprotected members not to be in contact

S **(2) Checking the routes**
1. Fuel hose not to be clamped together
2. Couplers, terminals, etc. to be connected tight enough to withstand usual pulling force
3. Clamps to be surely folded

S **(3) Clamping the harness at the specified points**
1. White-colored tapings to be clamped
2. Clamps to be surely folded
3. Harness-fixed clamps
* Anchor-shaped clamps to be inserted deep to the stoppers
* Threaded clamps to be inserted deep enough



(1) Clamp
RP421-5413Δ
(2) Clamp
RP421-5411Δ
(3) BAND CORD
69481-4126Δ
(4) Clamp
RC631-7904Δ
(5) Wire harness
(6) To be clamped here

1) The harness tapings indicate the clamping positions. Clamp at these specified points.
2) Clamp the harness tight enough not to come off nor get loose.
3) Insert the handgrip-equipped harness deep into their mating holes.
* Do not allow the harness to come out of the corrugated slit.
* Catch the cord clamp at the corrugated winding.

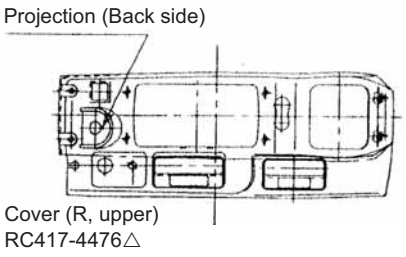
S **(4) Inserting of the couplers and clamps (insertable)**
Make sure the couplers and clamps are tight in position.
Insert them until they click. (Retry them if they do not click.)
Finally pull the wire harnesses lightly to make sure they do not come off.
(Pull them with a 29.7 N (3 kgf, 6.6 lbs) or smaller force.)

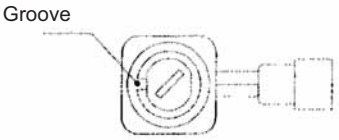
b) Engine Earth, Starter Switch

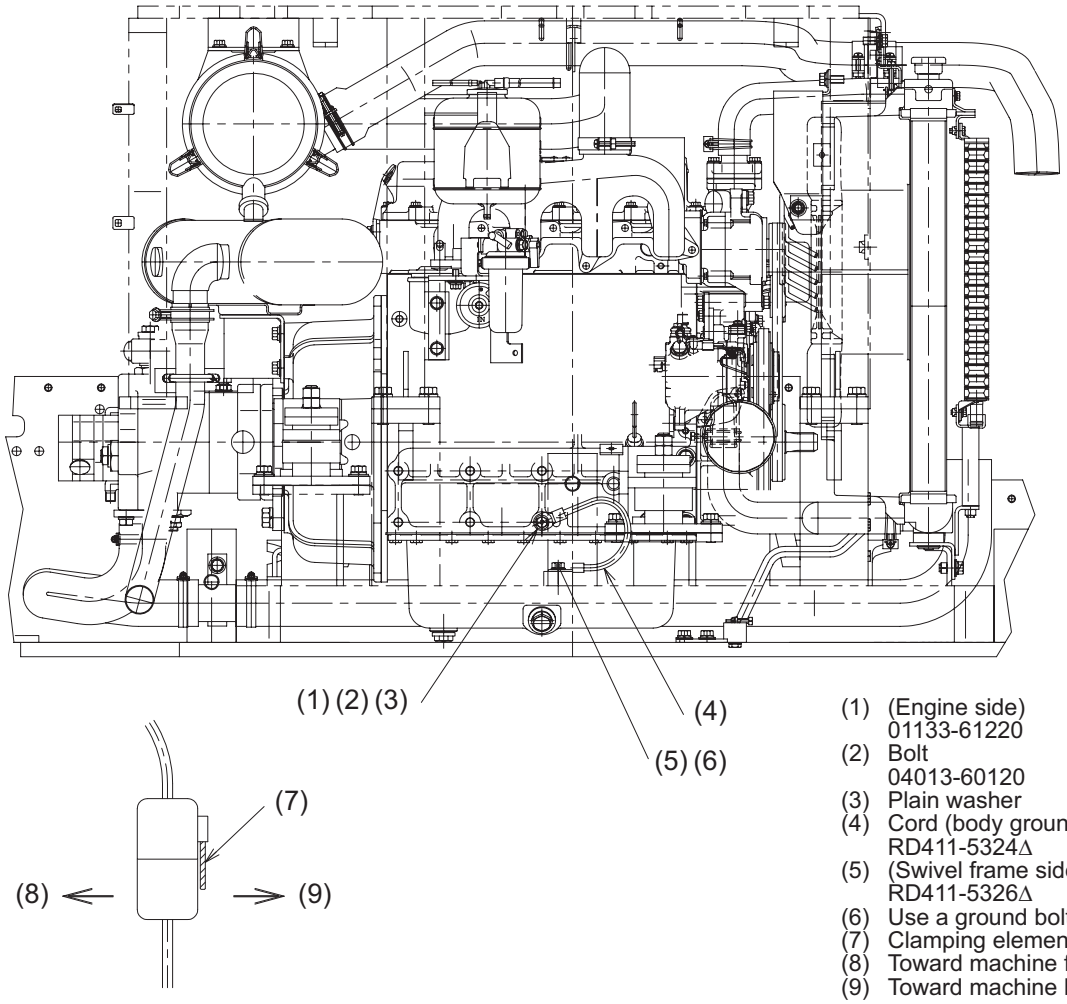
S **(1) Tightening torque of the cable fixing nut to the sel-motor terminal**
Tightening torque 5.9 ~ 11.8 N·m (0.6 ~ 1.2 kgf·m) 4.34 ~ 8.68 ft·lbs

S **(2) Installation of starter switch (RC411-5346△)**
1.Starter switch groove to be fitted to the projection of the cover (top right)
2.Nut tightening torque 4.0 ~ 5.0 N·m (0.4 ~ 0.5 kgf·m) 2.89 ~ 3.62 ft·lbs

S **(3) Checking the automatic starter release function**
Start the engine, place the key switch back to the start position and make sure the starter is not activated.





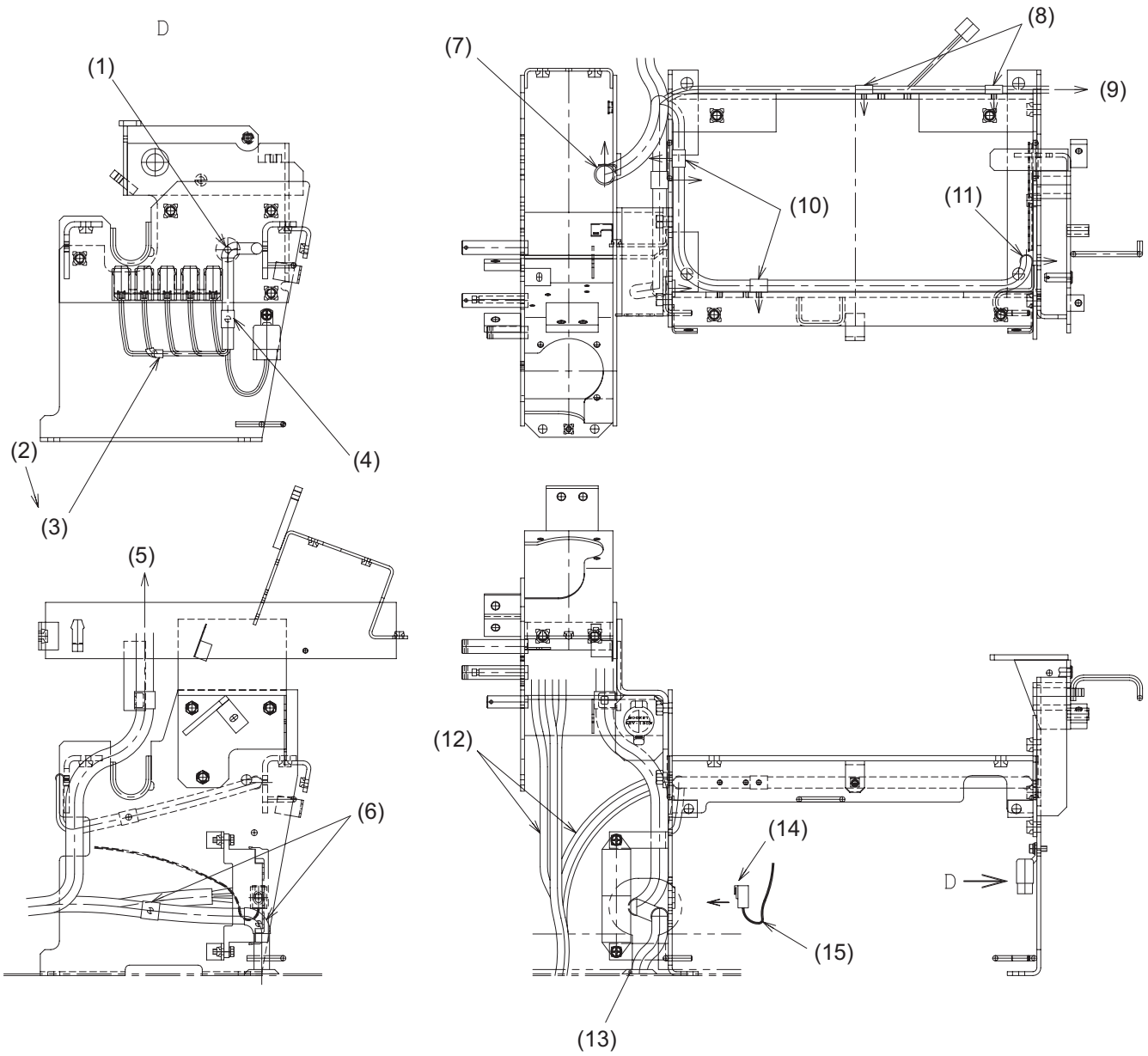


(1) (Engine side) 01133-61220
(2) Bolt 04013-60120
(3) Plain washer
(4) Cord (body ground) RD411-5324Δ
(5) (Swivel frame side) RD411-5326Δ
(6) Use a ground bolt (VT, M10).
(7) Clamping element
(8) Toward machine front
(9) Toward machine back

Note:
Install the starter switch coupler at the front side of the clamping element. If installed at the back, the rubber boot may be pressed against, by which the meter may come off.

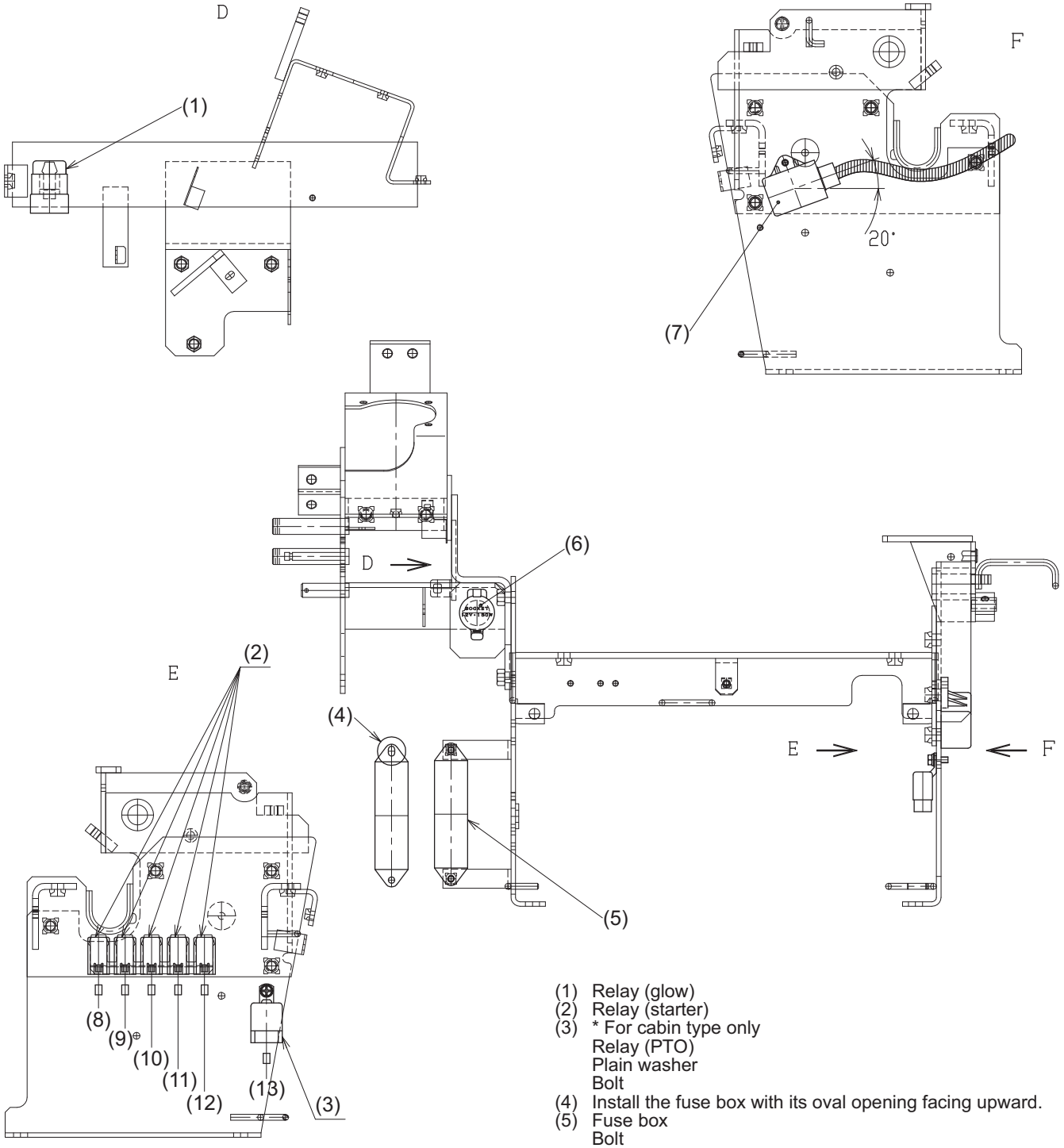
c) Wireharness Routes and Clamps

1. Seat



(1) Clamp
(2) * The heater type requires no clamping here.
(3) Clamp
(4) Clamp
(5) To meter
(6) Clamp
(7) Clamp
(8) Clamp
(9) To left unload switch
(10) Clamp
(11) Clamp
(12) Pilot hose
(13) Fit the rubber boot into the opening of step (4).
(14) Clamp
(15) Communication cable

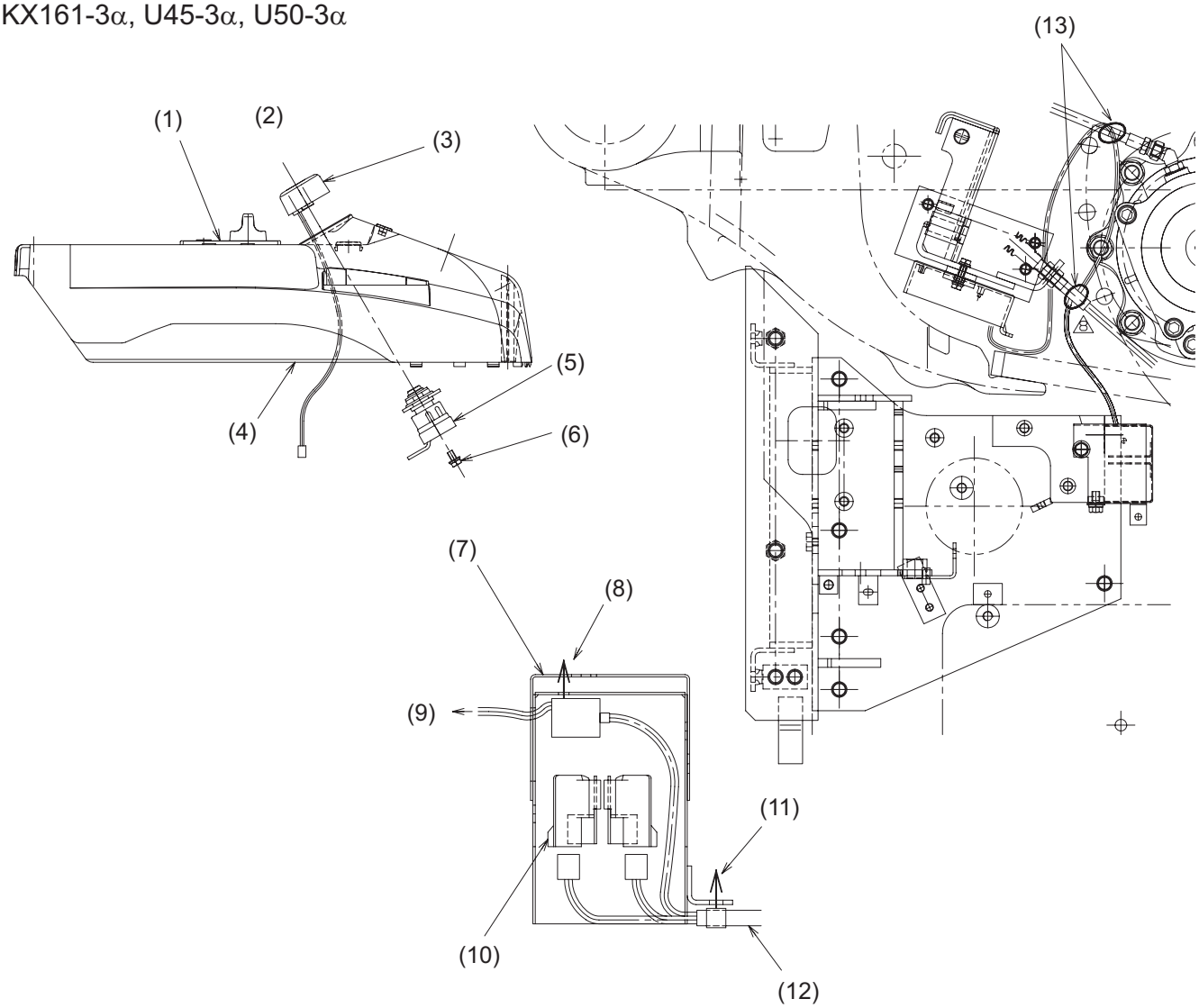
2. Relays & fuse box



(1) Relay (glow)
(2) Relay (starter)
(3) * For cabin type only
Relay (PTO)
Plain washer
Bolt
(4) Install the fuse box with its oval opening facing upward.
(5) Fuse box
Bolt
(6) Socket assembly
(7) ECU (amplifier)
Bolt
(8) AI
(9) Light
(10) Horn
(11) Automatic release
(12) Cabin (power)
(13) Heater

3. Control console

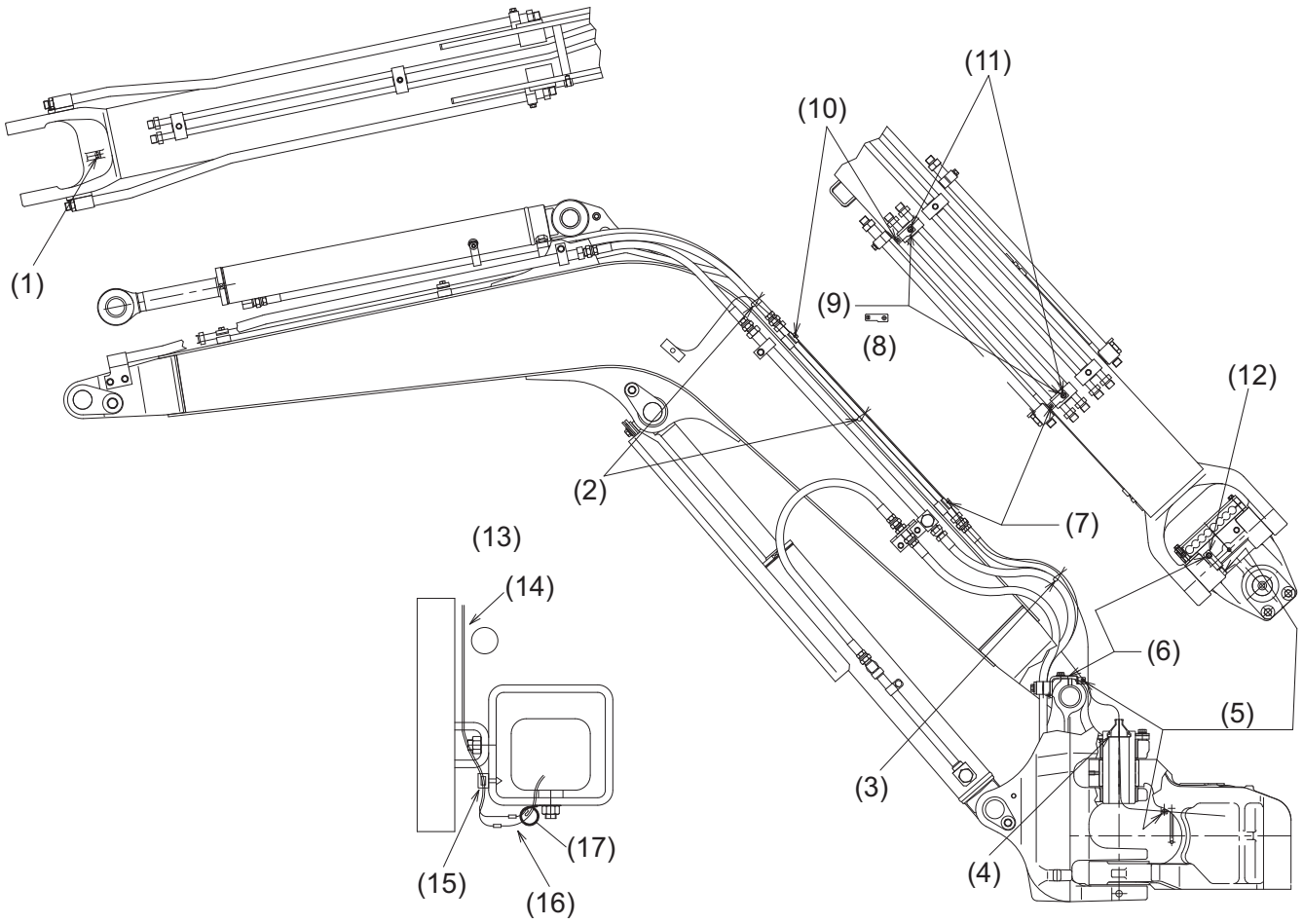
(Anti-theft version)
KX161-3α, U45-3α, U50-3α



(1) Panel assembly (AI)
(2) * Pass the antenna (anti-theft) cable first and then install the starter switch.
(3) Antenna (anti-theft)
(4) Cover assembly (R, C-SW)
(5) Starter switch
(6) Bolt (2 pcs.)
(7) Cover (anti-theft)
Bolt (2 pcs.)
(8) Clamp tightly.
(9) To ECU (anti-theft)
(10) Relay (starter) (4 pcs.)
(11) Clamp tightly.
(12) Main wire harness
(13) Clamp the wire harness to the cable and hydraulic hose.
(Pass the wire harness below the cable.)

4. Front attachment

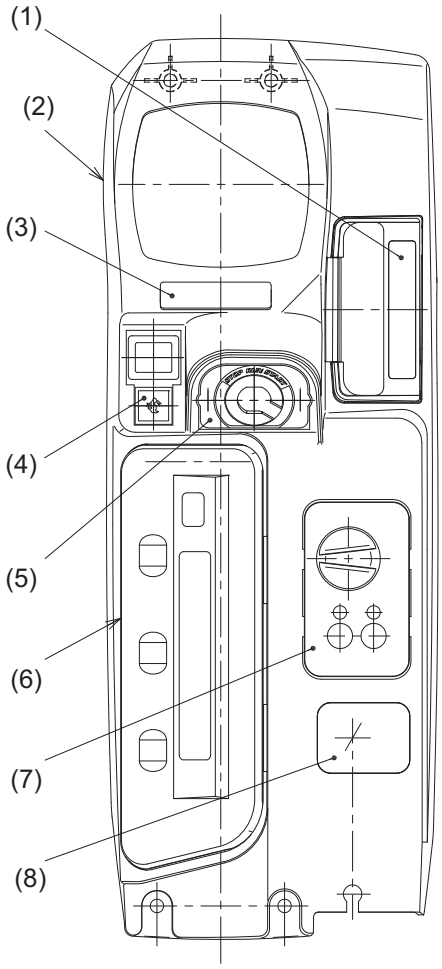
KX161-3ST, U45-3ST, U45-3α



(1) Plug
(2) Cord band
(3) Cord band
(included in the cabling fixture)
(4) Place the rubber boot upright and fit it into the pin groove.
(5) Insert the clamp in position.
(6) Stay (1, wire harness clamp)
(7) Inset the clamp in position.
(8) Stay (2, wire harness clamp)
(9) Clamp
Insertable type
(10) Insert the clamp in position.
(11) Tighten up together with the arm cylinder pipe clamps.
(12) Tighten up together with the bracket (hose guide).
(13) Wire harness clamp at the light
(14) Pass between the SP pipe and boom.
(15) Insert into this opening.
(16) Connect the terminal first and then put it into the corrugated tube.
(17) Cord clamp

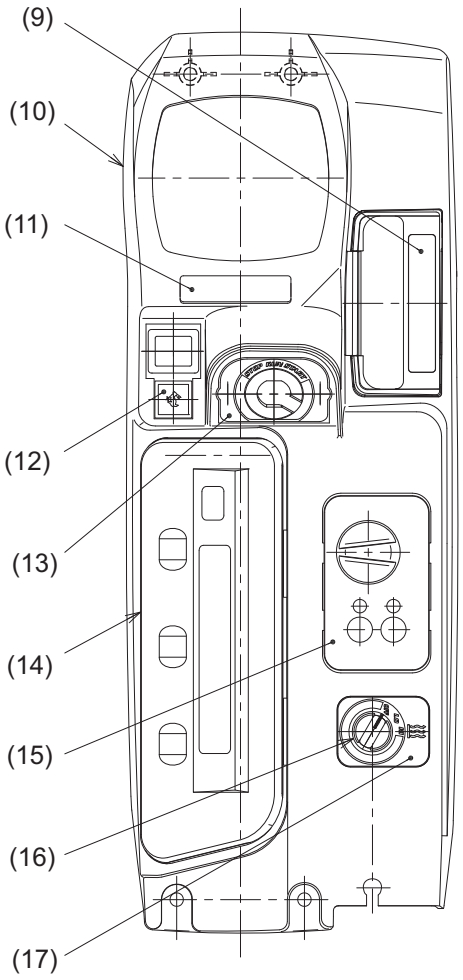
5. Meter panel

KX121-3S, KX161-3S, U45-3S, U45S
Canopy type
(Destined for North America and Australia)



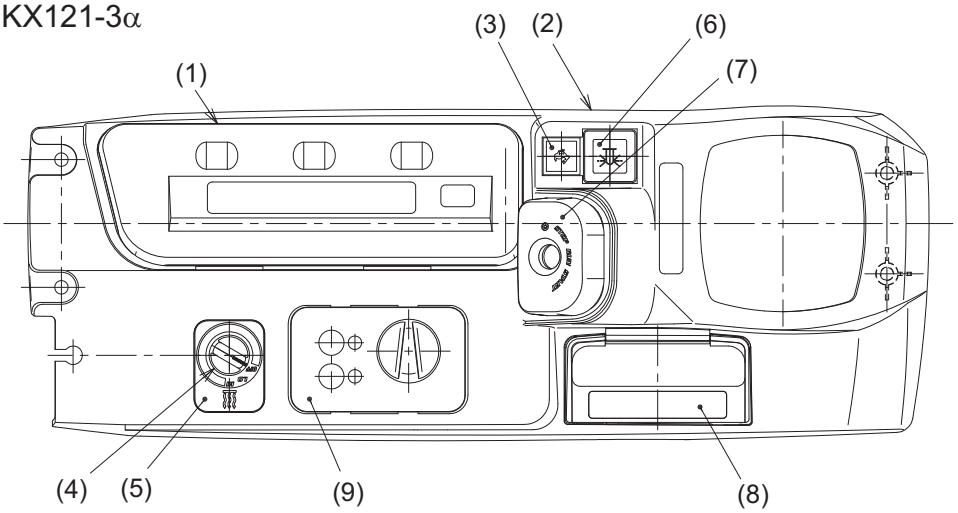
(1) Plate (right, blade)
(2) Cover assembly (R, C-SW)
(3) (For Australia-destined type only)
Cap (wrist rest)
(4) Lamp (HI)
(5) Label (main switch)
(6) RC467-5312Δ meter assembly
(RC468-5312Δ after inspection unit setting)
(7) Panel assembly (AI, SC)
(8) Label (panel)

KX121-3S, KX161-3S, U45-3S, U45S
Cabin type
(Destined for North America and Australia)



(9) Plate (right, blade)
(10) Cover assembly (R, C-SW)
(11) (For Australia-destined type only)
Cap (wrist rest)
(12) Lamp (H)
(13) Label (main switch)
(14) RC467-5312Δ meter assembly
(RC468-5312Δ after inspection unit setting)
(15) Panel assembly (AI, SC)
(16) Switch assembly (heater)
(17) Label (panel)

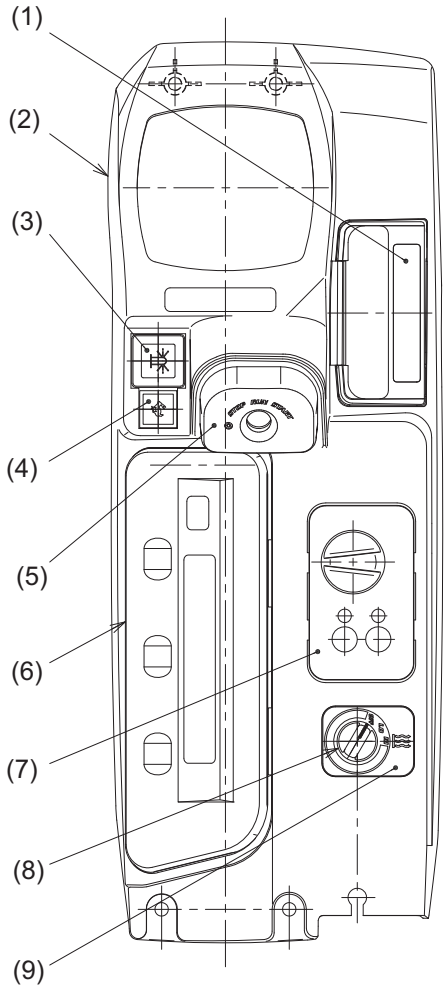
KX121-3α



Destined for Europe
(as from the October 2007 production month)

(1) Meter assembly
(2) Cover (right, upper)
(3) Lamp (HI)
(4) Switch assembly (heater)
(5) Label (heater)
(6) Switch (beacon)
(7) Antenna (anti-theft)
(8) Plate (right, blade)
(9) Panel assembly (AI, SC)

KX161-3α, U45-3α, U50-3α



Destined for Europe
(as from the October 2007 production month)

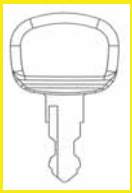
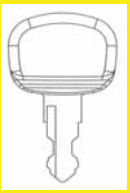
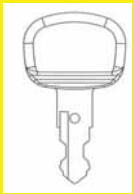
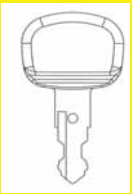
(1) Plate (right, blade)
(2) Cover (right, upper)
(3) Switch (beacon)
(4) Lamp (HI)
(5) Antenna (anti-theft)
(6) Meter assembly
(7) Panel assembly (AI, SC)
(8) Switch assembly (heater)
(9) Label (heater)

d) Key Modification

1. Outline of the starter key modification

The Key and related parts have been changed since March 2008 production for Excavators except K008-3.

The new key is compatible with both old and new key switches but old key is only for old key switches.

		North America		EU	JPN	CHN	Australia	
		Except KX080	KX080				Except KX080	KX080
Old	Key							
	Antenna Cover	No	Yes	Yes	Yes	Yes	No	Yes
New	Key							
	Antenna Cover	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Parts code number

Old		New		Model
Part No	Description	Part No	Description	
RC411-53933	Key (Starter)	RC461-53931	Key (Starter)	Except KX080-3
RC441-93213	Key (B)	RC461-93211	Key (B)	KX080-3
RC441-93203	Key Assy	RC461-93201	Key Assy	↑
RC411-53961	Starter Switch	RC461-53961	Starter Switch	All
RC411-53941	Nut (Starter)	RC461-53941	Nut (Starter)	All
RC441-93154	Antenna	RC461-93151	Antenna	KX080-3
		RC468-93451	Cover (Starter switch)	Except KX080-3
RA221-44764	Cover RH	RA221-44751	Cover RH	U15-3S
RB441-44863	Cover RH upper	RB451-44861	Cover RH upper	U25S
RB237-44763	Cover RH upper	RC661-44761	Cover RH upper	KX41-3, KX71-3, KX91-3S, U35S, U35-3S, KX121-3S, KX161-3S, U45S, U45-3S
RD517-47612	Cover RH upper A/C	RD441-47611	Cover RH upper A/C	KX121-3S, 161-3S (A/C) U45S (A/C) KX080-3
RC348-44761	Cover RH upper	RC348-44771	Cover RH upper	KX71-3 (SP)

2. KTC, KCL, KTA - version

1) MODEL : U15,U25,U35,U45,KX41-3, KX71-3, KX91-3S, KX121-3S, KX161-3S, KX080-3
2) COUNTRY AFFECTED : UNITED STATES, CANADA AND AUSTRALIA
3) SERIAL No. AFFECTED :

	Starter key and key switch redesigned
K008-3	Not redesigned
U15	#46277~
U25	#30796~
U35S	#40163~
U45S	#70092~
KX41-3V	#32129~
KX71-3	#12125~
KX91-3S/S2	#40475~
KX121-3S/ST	#70534~
KX161-3S/ST	#70326~
KX080-3/AB	#20001~

4) REASON FOR ISSUE :

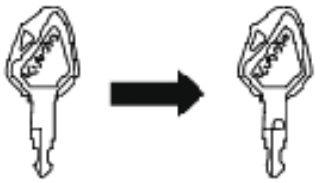
The starter key and key switch have been reconfigured in order to improve their reliability.
Here are the modifications and the machine serial numbers affected.
Please use as reference for your dealers and users.

(1) Non-anti-theft type key:
On all models except KX080-3

RC411-53933 **RC461-53931**

- Longer key plate
- The key plate with detent hole
- The shutter is newly adopted on the key switch for water/dust-proof

(2) Anti-theft type key:
On KX080-3 only



Black: RC441-93213 **RC461-93211**

- Key plate provided with detent hole

<Interchangeability>
The new key works for both old and new machine
The old key does Not work for the new machine

3. EU - version

1) MODEL : U10-3,U15-3,U20-3α,U25-3α,U45-3α,U50-3α,KX121-3α,KX161-3α,KX080-3
2) COUNTRY AFFECTED : FRANCE, GERMANY AND UNITED KINGDOM
3) SERIAL No. AFFECTED :

	Starter key only redesigned	Starter key and key switch redesigned
K008-3	Not redesigned	—
U10-3	Not redesigned	—
U15-3 (Note1)	#46149~ (Note 2)	#46277~
U20-3α	#21014~	#21066~
U25-3α	#22144~	#22247~
U45-3α	#57319~	#57410~
KX121-3α	#56250~	#56287~
KX161-3α	#58866~	#59001~
KX080-3	—	#20001~

*Note 1: Either anti-theft or non-anti-theft system is incorporated in U15-3 in Europe.
New part code for non-anti-theft starter key is RC461-53931.
*Note 2: Old-type starter key and key switch were equipped on machines with serial numbers 46225~46248.

4) REASON FOR ISSUE :

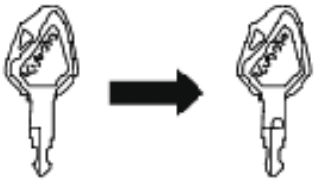
The starter key and key switch have been reconfigured in order to improve their reliability.
Here are the modifications and the machine serial numbers affected.
Please use as reference for your dealers and users.

(1) Non-anti-theft type key:
On U-15-3 only

RC411-53933 **RC461-53931**

- Longer key plate
- The key plate with detent hole
- The shutter is newly adopted on the key switch for water/dust-proof

(2) Anti-theft type key:
On all models except K008-3~U15-3



Black : RC441-93213 **RC461-93211**

- Key plate provided with detent hole

<Interchangeability>
The new key works for both old and new machine
The old key does not work for the new machine

4. Parts description

Item	Old Part No Description	New Part No Description	Interchangeability	Model	Serial Number
Black Key (User)	RC441-93210	RC461-93210	OLD→NEW OLD←NEW [Improved pulling and inserting performance]	U15-3	#46149~ 46224, 46249
				U17-3ALPHA	#10001~
				U20-3ALPHA	#21014~
				U25-3ALPHA	#22144~
				U30-3ALPHA2	#80024~
				U35-3ALPHA2	#80557~
				U45-3ALPHA	#77143~ (KBT #57319~)
				U50-3ALPHA	#77083~ (KBT #57319~)
				KX36-3	#78565~
				KX41-3S	#79819~
				KX41-3V	
				KX61-3	#77433~
				KX71-3	#76768~
				KX91-3ALPHA2	#80489~
				KX101-3ALPHA2	#80534~
				KX121-3ALPHA	#76060~ (KBT #56250~)
				KX161-3ALPHA	#78189~ (KBT #58866~)
				KX080-3ALPHA	#20001~

Item	Old Part No Description	New Part No Description	Interchangeability	Model	Serial Number
Switch (Key)	RC411-53960	RC461-53960 Without rubber cap Additional clamp 24mm longer	※2 OLD—×→NEW OLD←×—NEW [Longer diameter length.]	※1 U15-3	#46277~
				U17-3ALPHA	#10001~
				※1 U20-3ALPHA	#21066~
				※1 U25-3ALPHA	#22247~
				U30-3ALPHA2	#80096~
				U35-3ALPHA2	#80615~
				U45-3ALPHA	#77221~ (KBT #57410~)
				U50-3ALPHA	#77214~ (KBT #57410~)
Antenna	RC441-93150	RC461-93150 Shutter is added Design is changed	2 OLD—×→NEW OLD←×—NEW [New design to increase credibility]	KX36-3	#78603~
				KX41-3S	#80087~
				KX41-3V	
				KX61-3	#77543~
				KX71-3	#76879~
Cover	RA228-44760(U15-3) RB441-44860(U20/U25) RB237-44760 (KX36/41/61/71/91/101 121/161/U35/45/50) RD517-47610 (KX121/161/U45/50--A/C KX080-3ALPHA)	RA228-44750(U15-3) RB451-44860(U20/U25) RC661-44760 (KX36/41/61/71/91/101 121/161/U35/45/50) RD441-47610 (KX121/161/U45/50--A/C KX080-3ALPHA)	※2 OLD—×→NEW OLD←×—NEW	KX91-3ALPHA2	#80529~
				KX101-3ALPHA2	#80597~
				KX121-3ALPHA	#76066~ (KBT #56287~)
				KX161-3ALPHA	#78332~ (KBT #59001~)
				KX080-3ALPHA	#20001~

※1 U15/U20/U25----The old parts are available while the stock lasts. The whole key set must be replaced, afterwards.
※2 Fit the new antenna and switch on the old panel. Modify the cover or replace the assembly.
The key, key switch and antenna have been changed in response to customer's complaints about the key's insecurity at the "ON" position.

e) Electrical Equipment Specifications

Fig.	Item	KX121-3αS/ST, KX161-3αS/ST, U45-3α **/U50-3α**
Battery	Part No.	RB411-5325-0
	Manufacturer	Yuasa Corporation
	Capacity (5 hr)	52 Ah
	Type	JIS 80D26RR
	Dimensions (L x W x H) (mm)	171 x 258 x 223
	Dimensions (L x W x H) (in.)	6.73 x 10.16 x 8.78
	Electrolyte specific gravity (20°C)"	1.28±0.01
	Connection of battery cells	Anode : Φ19.5x17mm (Φ0.77x0.67in.)
		Cathode : Φ17.9x17mm (Φ0.70x0.67in.)
	Amount of electrolyte	4.5L / 1.189US gal
Alternator	Part No.	T1065-1568-0
	Manufacturer	Denso Corporation
	Type	Regulator built-in
	Nominal voltage	12V
	Max. output	45A at 5000 rpm
	Rotating direction	Clockwise
	Polarity	Ground at cathode
Starter motor	Part No.	17123-63016
	Manufacturer	Denso Corporation
	Type	Reduction type
	Nominal voltage	12V
	Nominal output	2.0kW
	Time rating	30 sec.
	Rotating direction	Clockwise (viewed from pinion end)
	Number of pinion gear	9
Glow plug	Part No.	19077+6551-0
	Manufacturer	NGK Spark Plug Co.,Ltd.
	Type	Two materials coil
	Resistance	11.7±0.2Ω
	Voltage / current	DC 11V
	Tightening torque	M8x1.0 : 20.0-25.0N·m (14.8-18.4ft.lbs)
		Nut (M4x0.7) : 1.0-1.8.0N·m (0.7-1.3ft.lbs)
Oil pressure switch	Part No.	1A024-3901-0
	Manufacturer	Tokai Rika Co., Ltd.
	Nominal voltage	DC 12V
	Insulation resistance	>3MΩ

Fig.	Item	KX121-3αS/ST, KX161-3αS/ST, U45-3α **/U50-3α**
Fuel sensor unit	Part No.	RD411-5114-0
	Manufacturer	Yazaki Meter Co.,Ltd.
	Sliding resistance value	Full : 3±1.2Ω
		Half : 32.5±1.5Ω
		Empty : 110±3.5Ω
Horn	Part No.	RD408-5336-0
	Manufacturer	Denso Corporation
	Current ampere	3.0±1.0A
	Sound level	113±5 dB (A) at 2m
	Frequency	420±30Hz
Fuel pump	Part No.	RD411-5135-0
	Manufacturer	U-SHIN
	Operating voltage range	DC 8.5 to 16.5V
	Max. operating ampere	<1.5A
	Full delivery amount at free flow	>0.4L/min (0.11USGPM)
Change valve	Relief pressure setting	3.9MPa (40 kgf/cm^2) (565.6 psi)
	Part No.	RB411-6125-0
	Manufacturer	Bosch Rexroth, Japan (Uchida Hydraulic)
	Unload valve coil resistance	11.1-13.5Ω
	High-Low change valve coil resistance	11.1-13.5Ω
	Rated flow and pressure	10L/min, 4.9MPa (50 kgf/cm^2) (2.6USGPM, 711psi)
Engine stop solenoid	Part No.	1A021-60013
	Manufacturer	Kyosan Electric
	Pull-in coil resistance	1.0-1.5Ω
	Hold coil resistance	16.0-18.0Ω
Engine speed sensor	Part No.	T1060-3227-0
	Manufacturer	Matsushita Electronic Components
	Operating voltage	DC 7 to 16V
	Air gap (mm)	0.5 to 0.9 (0.7)
	Sensing frequency	1Hz to 7kHz
	Output type	Open collector
	Output voltage	V_H = 4.8V, V_L=0.8V
	Gear RPM	600 rpm
Accel. sensor	Part No.	T1060-3228-0
	Manufacturer Electric effective angle	TOCOS (Tokyo Cosmos Electric Co.,Ltd.
	Manufacturer Electric effective angle Operating voltage Total resistance	110°±3°
		120°±5°
		DC 5V
		2kΩ±10%
	Insulation resistance	100MΩ<

Fig.	Item	KX121-3αS/ST, KX161-3αS/ST, U45-3α **/U50-3α**
Thermostat unit	Part No.	T1060-6566-0
	Manufacturer Type	Keihin
	Resistance	-20°C (-4°F): 18.80Ω
		40°C (104°F) : 1.136Ω
		100°C (212°F) : 0.1553Ω
	Tightening torque	180±20kgf.cm (133±15 ft.lbs)
Auto idle motor	Part No.	RC411-5364-0
	Manufacturer Operating voltage range	Denso Corporation
		10-15V
	No load speed	56 rpm
	No load current	3.7A
	Motor seized current	17.7A
	Motor seized torque	4.5N.m (46kgf.cm) (3.3ft.lbs)A
	Reduction ratio	0
Glow relay	Part No.	T1060-3371-0
	Manufacturer	Denso Corporation
	Rated coil voltage and current”	12V, 0.19±0.04A (at 20°C/-4°F)
	Lowest operating voltage	6V
	Return voltage	1 -5V
	Current capacity	0.1 - 40A
Heater relay (Cabin only)	Part No.	PL-503-6859-0
	Manufacturer	Matsushita Electronic Components
	Rated coil voltage and current”	12V, 0.15±0.015A (at 20°C/-4°F)
	Lowest operating voltage	8V
	Return voltage	0.6V
	Current capacity	20A
Relays (Light, Horn, Auto Idle, Cabin)	Part No.	T1060-3372-0
	Manufacturer	Matsushita Electronic Components
	Rated coil voltage and current”	12V, 0.15±0.015A (at 20°C/-4°F)
	Lowest operating voltage	8V
	Return voltage	0.6-6V
	Current capacity	30A
Meter panel	Part No.	RC447-5311-0
	Manufacturer	Yazaki Meter Co.,Ltd.
	Display language	English/French/German/Italian/Spanish/Portuguese/ Dutch/Danish/Swedish/Finnish/Norwegian
Work lamp (Boom)	Part No.	3G710-75911-0
	Manufacturer	Knight Beam (Imasen Electric Industrial Co., Ltd.)
	Capacity	55W
	Type	Halogen lamp

Fig.	Item	KX121-3αS/ST, KX161-3αS/ST, U45-3α **/U50-3α**
Work lamp (Cabin)	Part No.	RG518-4710-0
	Manufacturer	Fritzmeier Systems
	Capacity	27W
	Type	Halogen lamp
Safety lock SW	Part No.	RC411-5347-0
	Manufacturer	Asahi Denso Co.,Ltd.
	Operating voltage, ampere	DC 14V, 1.5A
	Continuity resistance	0.2Ω
	Operating stroke	9±0.5mm (0.35±0.02 in.)
	Insulation resistance	1MΩ<
	Operating force at full stroke	32±4N (7.2±0.9 lbf.)
	Switch type	Normal Open
Wiper motor	Part No.	RG518-4632-0 Fritzmeier Systems
	Manufacturer	
	Operating voltage	DC 12V
	No load current	<2A
	Restricted current	<12A
Heater	Part No.	TA043-7241-0
	Manufacturer	Denso Corporation
	Operating voltage	DC 12V

VI. OPTIONAL UNIT: AIR CONDITIONER

Mechanism Section

(A) AIR CONDITION SYSTEM VI-M-3
a) Introduction of Air Conditioner VI-M-3
b) Components and Location VI-M-7
c) A/C System, Electric Circuit Diagram VI-M-11
(B) FUNCTION AND STRUCTURE VI-M-21
a) Compressor VI-M-22
b) High Pressure Relief Valve VI-M-32
c) Magnetic Clutch VI-M-33
d) Condenser VI-M-34
e) Receiver VI-M-35
f) Dual Pressure Switch VI-M-37
g) Air Conditioner Unit VI-M-38
h) Refrigerant VI-M-45
(C) ELECTRICAL SYSTEM VI-M-49
a) Electrical Circuit VI-M-49
b) Air Conditioner Blower Switch VI-M-51
c) Dual Pressure Switch VI-M-52
d) Thermostat VI-M-54
e) Control Panel VI-M-55
f) Air Flow VI-M-56
(D) TECHNICAL TERMS VI-M-57
a) Heat VI-M-57
b) Temperature VI-M-57
c) Humidity VI-M-59
d) Pressure VI-M-61
e) Change of State VI-M-62
f) What is a Heater? VI-M-64
g) Principle of Cooling VI-M-64
h) Principle of Air Conditioning VI-M-67
i) Refrigeration Cycle VI-M-68
j) Practical Control of Air Conditioner VI-M-69
k) Mollier Diagram VI-M-72
l) Basic Operation of Cooling Cycle VI-M-73
m) Calculation of Refrigeration Capacity and Power from Mollier Diagram VI-M-74
n) Calculation of Flow of Circulating Refrigerant VI-M-74
o) Theoretical Performance (Sample Calculation) VI-M-75

(A) AIR CONDITION SYSTEM

a) Introduction of Air Conditioner

(1) Principle of Air Conditioner

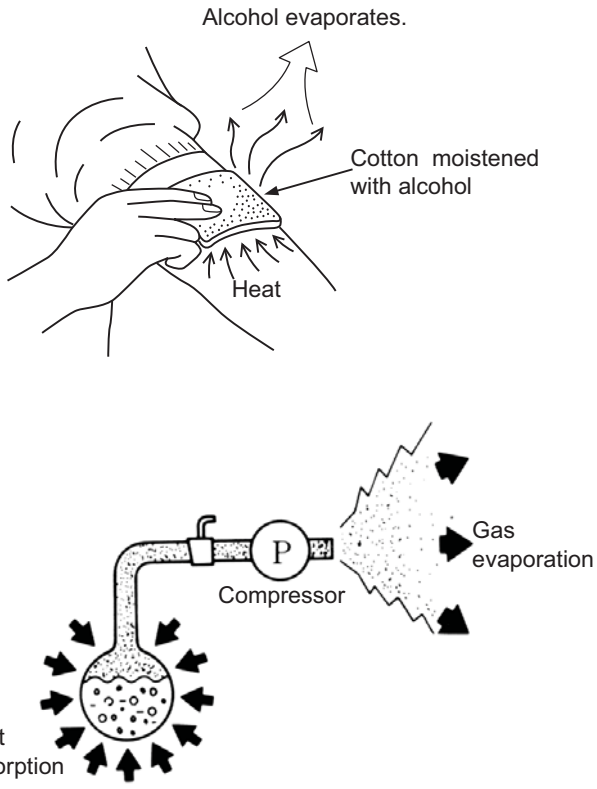
When your hand is wet and exposed to the wind or when you disinfect your hand with alcohol, you should feel your skin being cooled. This is because water or alcohol draws heat from your skin when it evaporates.

Air conditioners operate on this principle, using "Freon" as a refrigerant instead of water and alcohol.

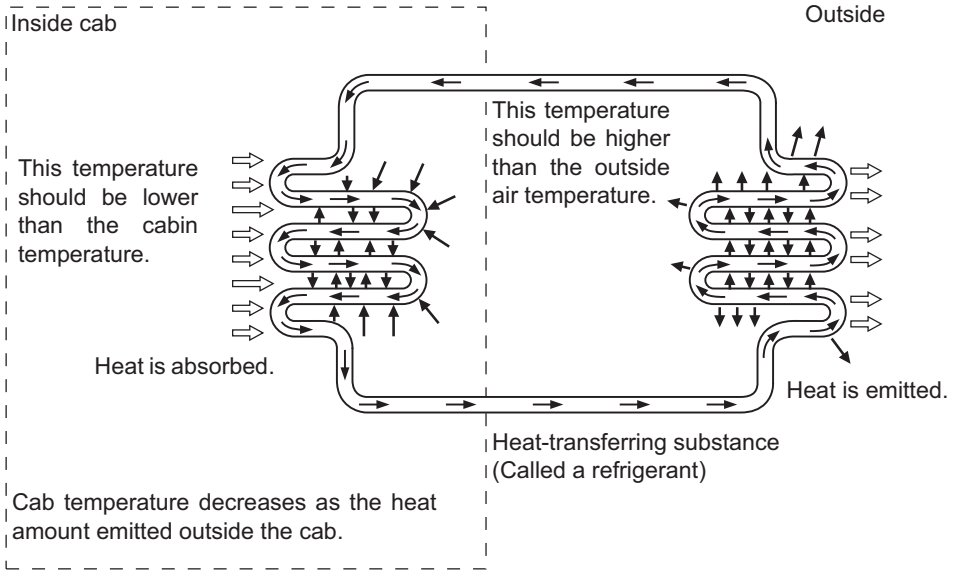
To cool the cabin of a vehicle in hot summer, the air conditioner of a vehicle is a device to absorb heat in the cabin and emit it out of the vehicle. Heat will transfer from high temperatures to low temperatures. In summer, inconveniently the temperature outside the vehicle is higher than the temperature of the cabin from which heat should be transferred. If the temperature outside the vehicle is lower, just opening the windows will emit heat out of the vehicle and cool the cabin immediately.

Trying to emit heat out of the vehicle in hot summer when the temperature outside the vehicle is higher than inside is to fight against the natural phenomenon. It seems that man likes to fight against nature and has been accumulating wisdom and expending enormous efforts to do so.

The air conditioner is the fruit of man's wisdom, which is a device that consumes important energy accordingly.



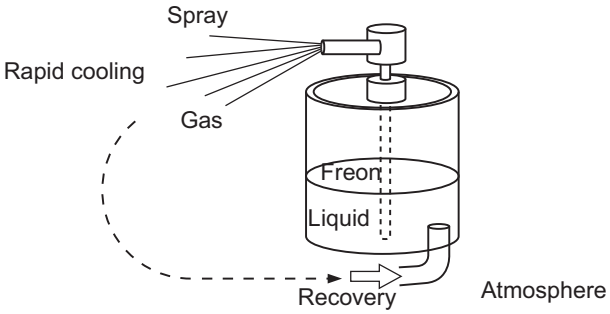
Cooling the cabin of the vehicle means emitting heat out of the vehicle. The air conditioner is a device to absorb heat in the cabin and emit it out of the vehicle.



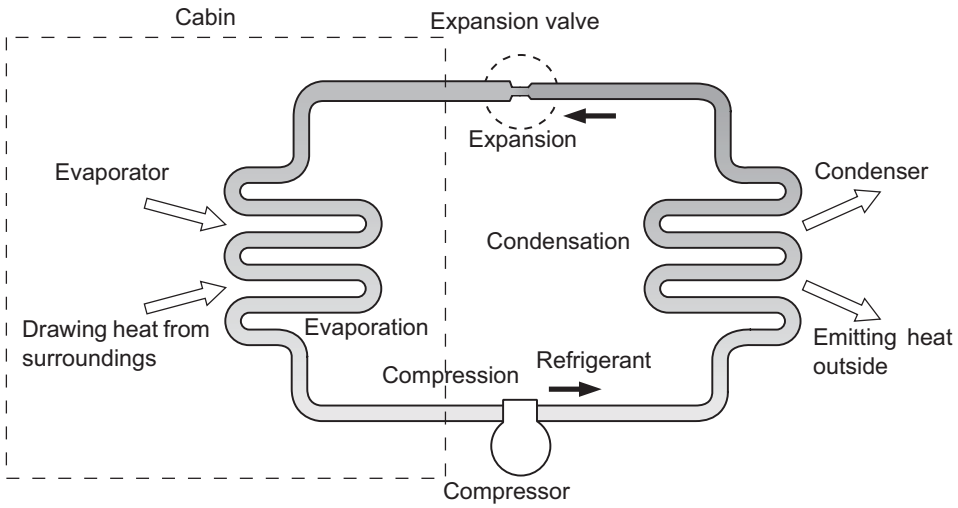
The figure in the left shows the principle of the air conditioning system to lower the temperature of the cabin by emitting heat out of the vehicle. Because heat transfers from high temperatures to low temperatures, the temperature in the piping should be lower than the cabin temperature inside the vehicle and higher than the atmospheric temperature outside the vehicle.

(2) Change of State of Refrigerant

The concept of the air conditioning system is as follows. When liquid Freon is sprayed, it expands and turns into very cold gas. It is so cold that it freezes and looks snow-white (even under atmospheric pressure). If the sprayed Freon is left as it is, it will be lost. It should be therefore recovered and reused. Freon continues to carry out a cooling function while changing its state from liquid to gas and vice versa.

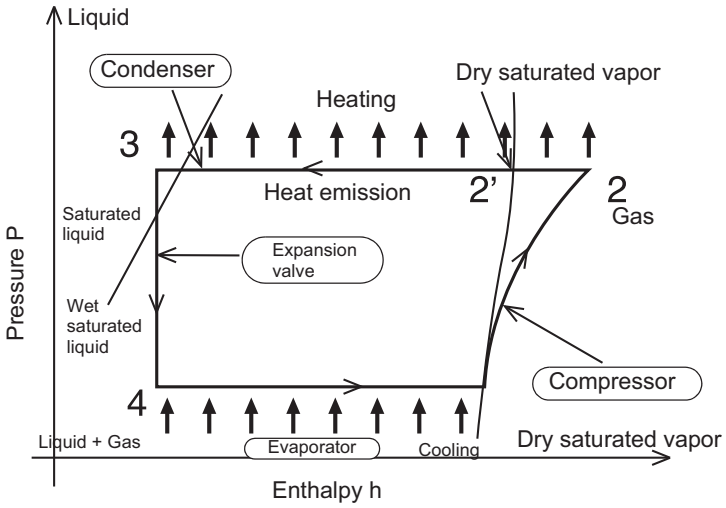


The temperature of the refrigerant should be lower than the cabin temperature inside the vehicle and higher than the atmospheric temperature outside the vehicle. As a refrigerant (heat-exchanging medium), Freon is used which makes it possible to provide such temperature changes relatively easily.



The principle of the air conditioner is as follows. By means of the expansion valve, the refrigerant in liquid form is rapidly expanded and turned into low-temperature gas. This low-temperature gas is passed through the evaporator, which is so designed that heat in the cabin can be absorbed effectively, and the cabin is cooled. Then the refrigerant in gaseous form, which has absorbed heat in the cabin and increased its temperature a little, is compressed by the compressor and becomes high-pressure and high-temperature gas. By means of the condenser, this high-pressure and high-temperature gas is air-cooled and turned back into liquid. At this time, the refrigerant emits into the atmosphere the heat absorbed from the cabin. This circulating system is called "Refrigerant Cycle".

The following p-H diagram describes each state of refrigerant.



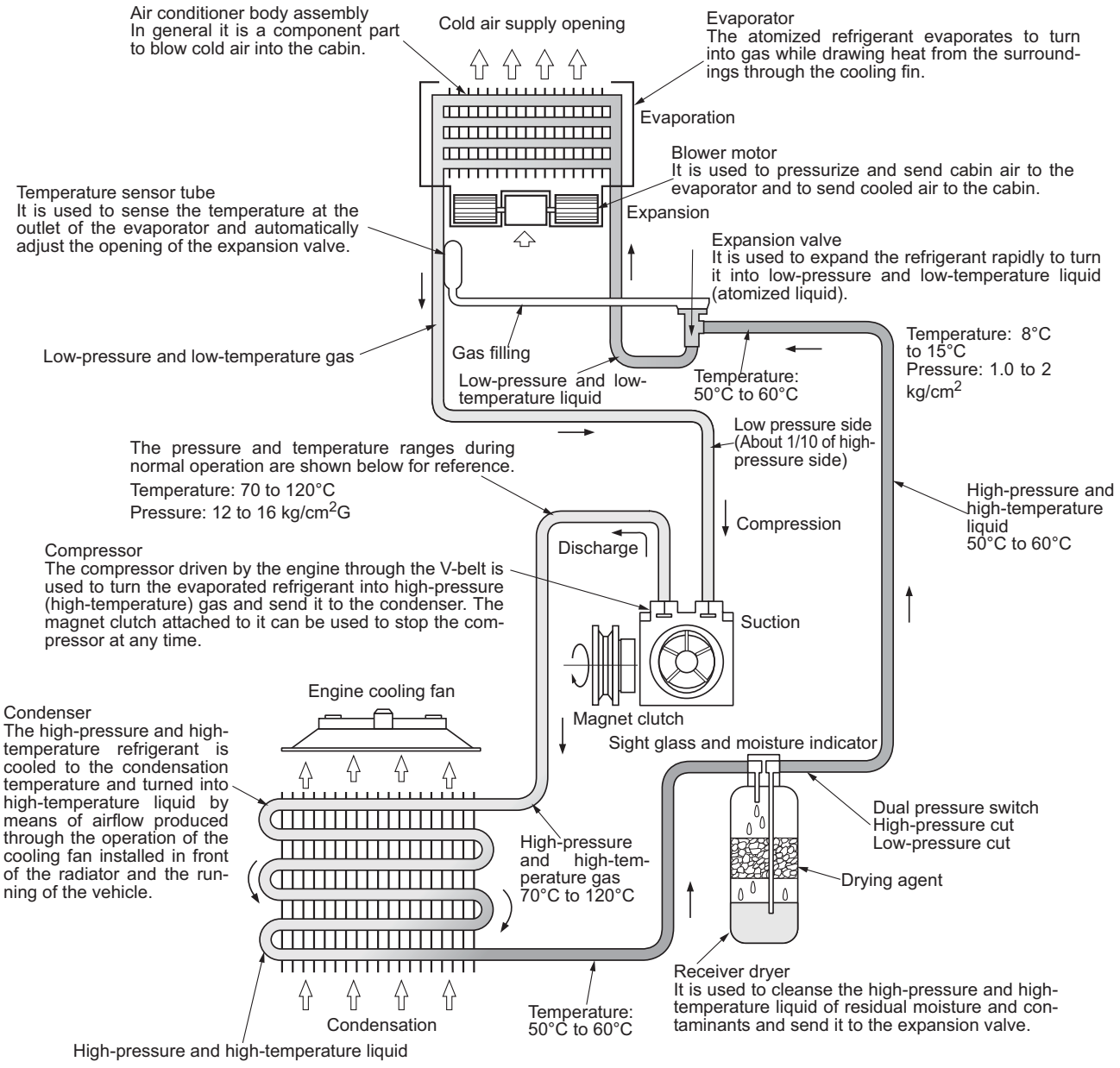
1: Dry vapor
1→2: Adiabatic compression by means of compressor
2: Superheated vapor
2→2'→3: Isobaric change by means of condenser (condensation through heat emission)
3: Saturated liquid
3→4: Isoentropic change by means of expansion valve (restriction phenomenon)
4: Wet vapor
4→1: Isobaric and isothermal change by means of evaporator (evaporation through heat absorption)
The cycle is thus completed.

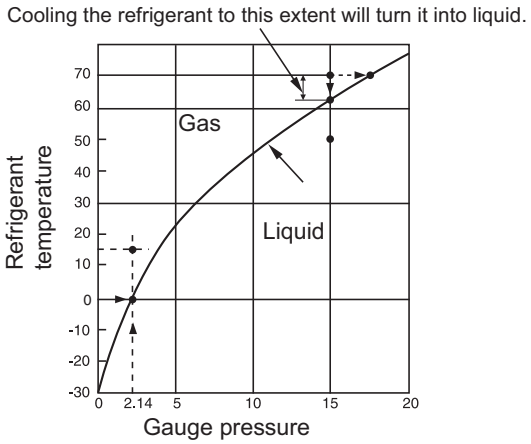
Function of expansion valve

- Sending a proper amount of refrigerant in liquid form from the high-pressure condenser side to the low-pressure evaporator side (flow control)
- Turning high-pressure refrigerant into low-temperature and low-pressure wet vapor

(3) Function and Construction

Note:Values of temperature and pressure in below Fig. are not specifications but just sample data.





The characteristics of the refrigerant used so far are as follows. When the gasified refrigerant is compressed to 15 kg/cm^2, its temperature becomes 70°C. Then, when the refrigerant is cooled to less than 60°C (which means the refrigerant emits 10°C or more of heat), it turns into liquid. When the pressure is reduced to less than 2.14 kg/cm^2, it turns back into gas at 0°C.

(4) Refrigerant Cycle

1. Evaporation

The refrigerant changes from liquid (wet vapor) to gas (superheated vapor) in the evaporator. The atomized refrigerant sent to the evaporator evaporates actively. At this time, the liquid (wet vapor) keeps on evaporating while drawing heat necessary for evaporation (latent heat) from air around the cooling fin (cabin air). The air cooled as a result of losing heat is used to cool the cabin through the operation of the blower.

In the evaporator, the liquid (wet vapor) sent from the expansion valve and the evaporation gas (superheated vapor) coexist and a change of state from liquid to gas is performed. During this change of state, there is a certain relation between the pressure (evaporating pressure) and temperature (evaporating temperature); if the pressure is determined, the temperature is also determined. In other words, this relation is one between saturation pressure and saturation temperature.

In order to allow evaporation at a lower temperature in this change of state from liquid to gas, it is necessary to lower the pressure in the evaporator accordingly. The evaporation gas (superheated vapor) is therefore discharged rapidly from the evaporator with the compressor sucking it.

2. Compression

The compressor compresses the refrigerant to a state in which the refrigerant can be easily liquefied at ordinary temperature (outside air temperature).

The gas generated through evaporation in the evaporator (superheated vapor) is sucked into the compressor. This operation is intended to keep the evaporating pressure in the evaporator at a low level so that the refrigerant in liquid form can evaporate even at low temperatures around 0°C. The gas (superheated vapor) sucked into the compressor is compressed in the vane chamber and becomes such high-pressure and high-temperature gas as can be easily liquefied by being cooled with outside air at ordinary temperature.

3. Condensation

The refrigerant is cooled with outside air in the condenser and changes from gas to liquid.

The high-pressure and high-temperature gas coming out of the compressor is cooled with outside air, liquefied and stored in the receiver. The heat emitted from the high-pressure and high-temperature gas coming out of the compressor is called heat of condensation.

This heat of condensation is equal to the sum of the heat drawn from the cabin (evaporation heat) by the refrigerant in the evaporator and the energy used for compression (converted to heat quantity).

In the case of condensation, like the case of evaporation, there is a certain relation between the pressure (condensing pressure) and temperature (condensing temperature) during a state of change from gas to liquid performed with vapor and liquid coexisting. (Note that the pressure varies depending on the type of refrigerant and the condensing temperature.)

4. Expansion

The expansion valve reduces the pressure of the refrigerant in liquid form to a state in which the refrigerant can be easily evaporated.

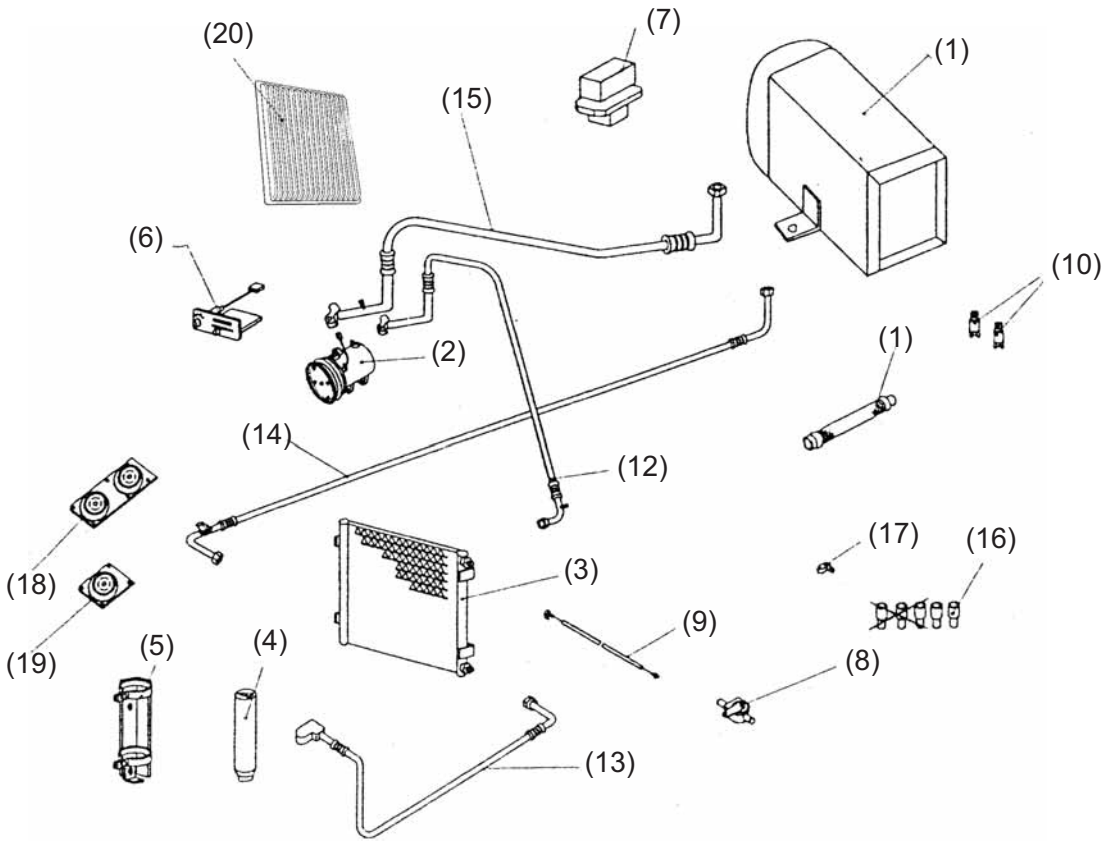
Before the liquefied refrigerant is sent to the evaporator, its pressure is reduced to a state in which it can be easily evaporated, which is called an expansion process. The expansion valve used for this process performs flow control of the refrigerant as well as pressure reduction.

The amount of refrigerant to be evaporated in the evaporator is determined by the heat quantity to be removed (cooling load) at a given evaporating temperature (evaporating pressure). It is important to catch it correctly and feed a proper amount of refrigerant.

The refrigerant circulates through the cooling system while going through the above-mentioned four processes. As a result, it transfers heat from the cabin to the outside air, that is, from low temperatures to high temperatures.

b) Components and Location

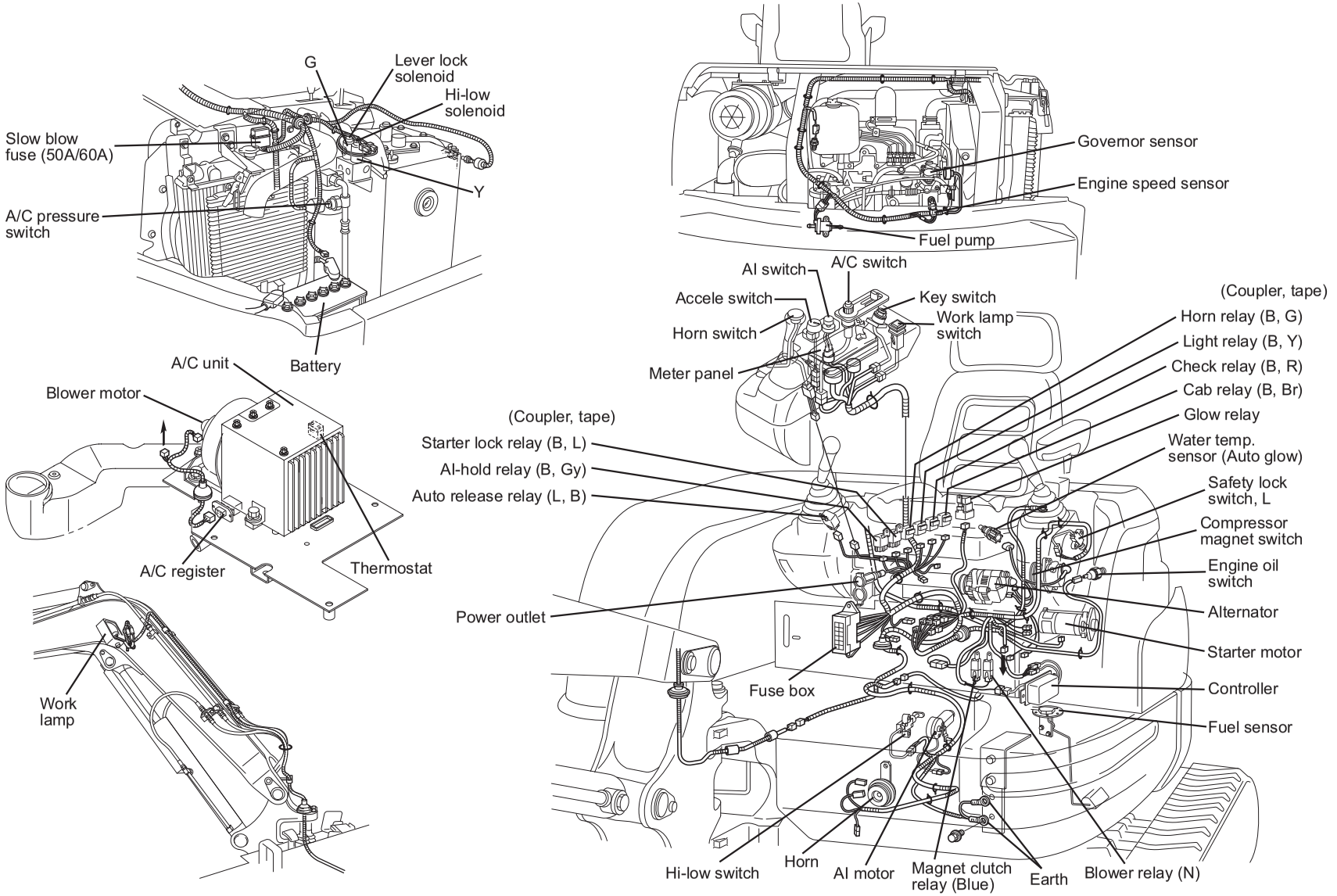
(1) Air conditioner & accessory assy



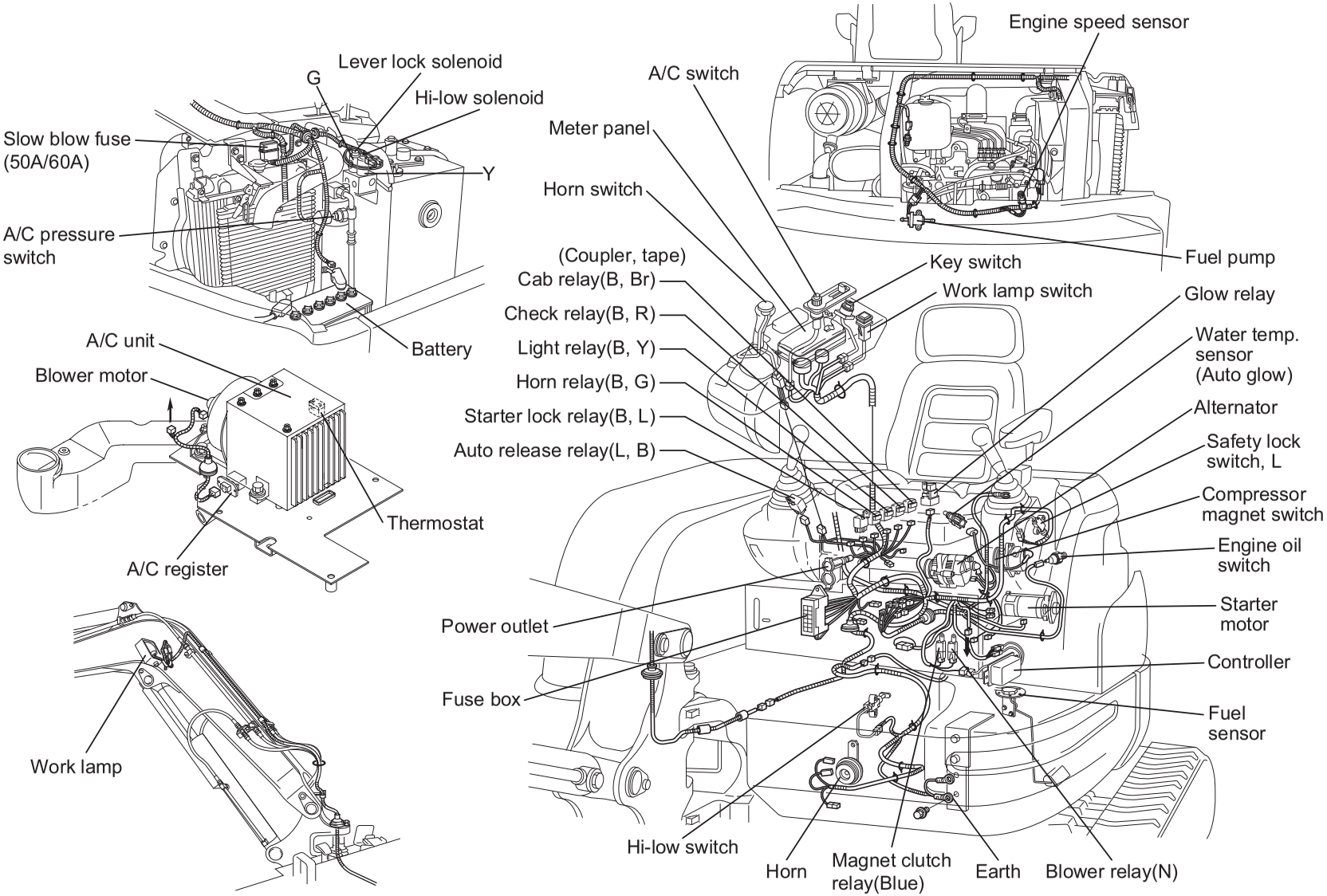
Kit No. RD118-53501

(1)	A/C unit assy:	RD118-53701	(11)	Receiver joint:	T0270-87171
(2)	Compressor assy:	T2055-72252	(12)	Discharge hose:	RD118-47511
(3)	Condenser:	T1065-72221	(13)	Liquid hose:	RD411-47541
(4)	Receiver tank:	T0070-79271	(14)	A/C hose accessory:	RD118-47531
(5)	Receiver holder:	T0070-79281	(15)	Suction hose:	RD118-47621
(6)	A/C control lever assy:	RD118-53611	(16)	Drain connector:	6A671-71691
(7)	Blower resister:	T1065-72181	(17)	Defroster hose:	RB419-49282
(8)	Water valve assy:	T0270-67501	(18)	Grill assy, air outlet:	3G710-50291
(9)	Control cable:	RD118-47451	(19)	Grill assy, air outlet:	RD118-47231
(10)	Relay:	T1155-72151	(20)	Filter subassy:	6A671-75091

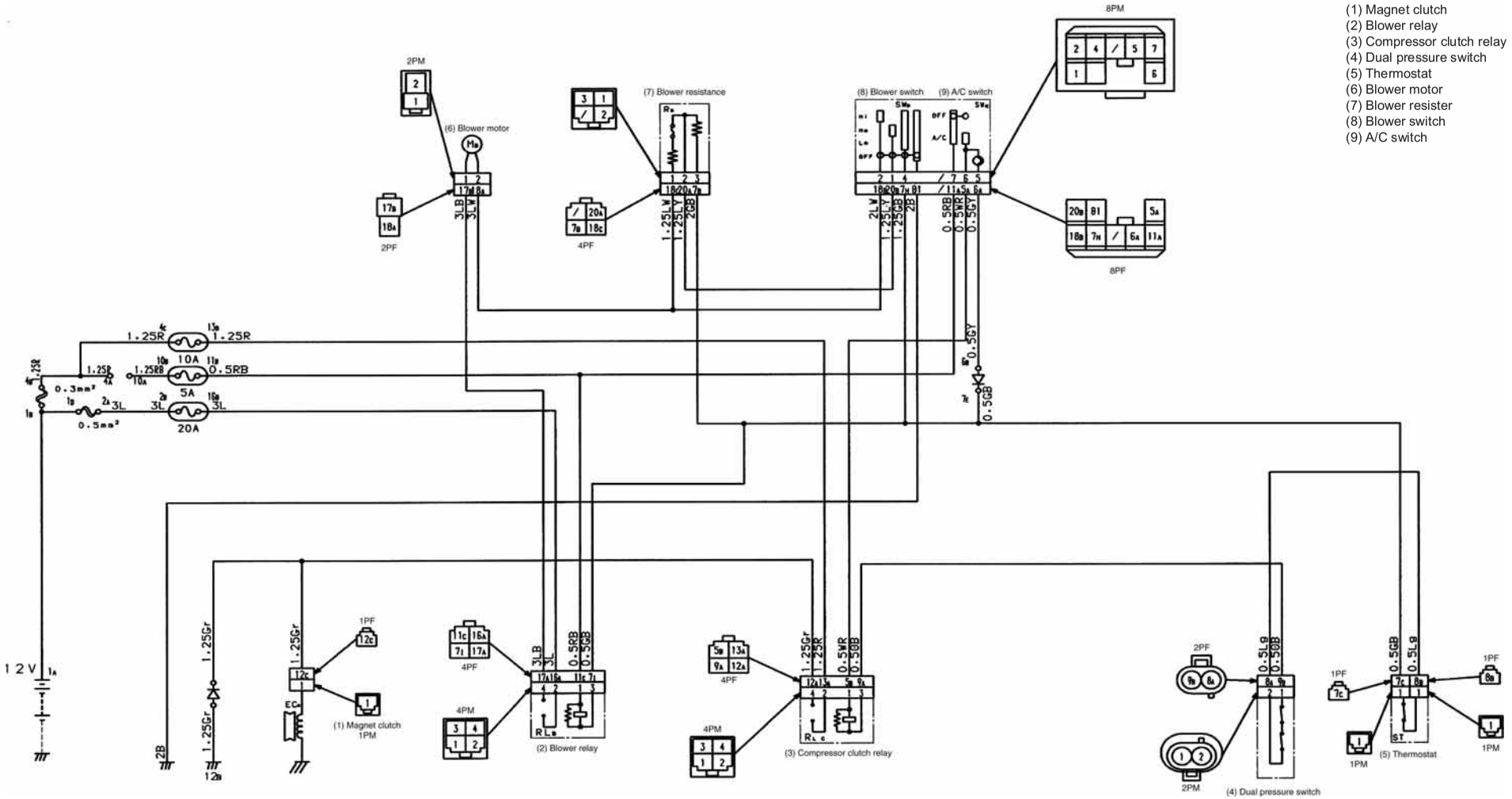
(2) Layout of A/C components: AI-version



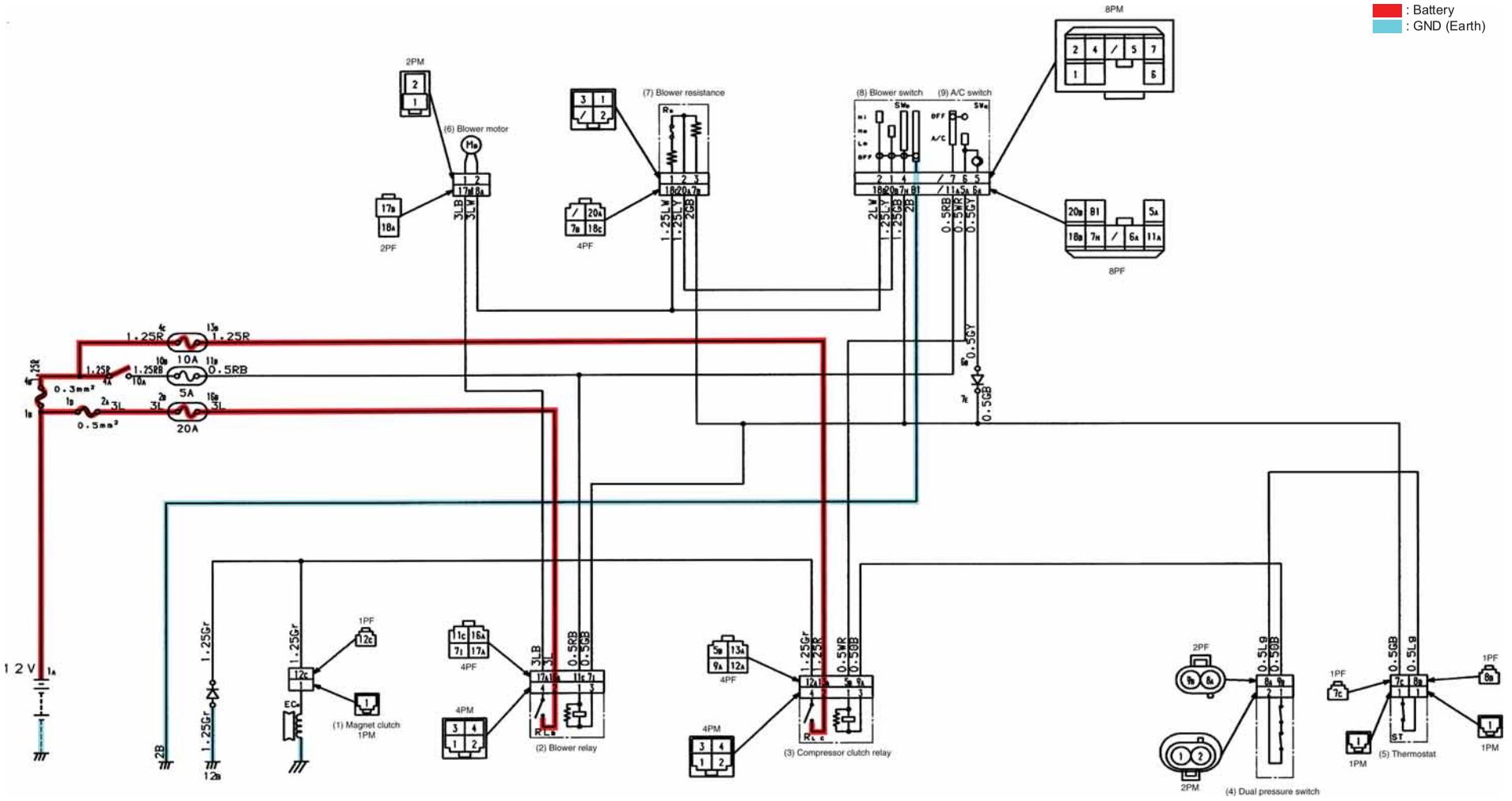
(3)Layout of A/C components: Non AI-version



c) A/C System, Electric Circuit Diagram

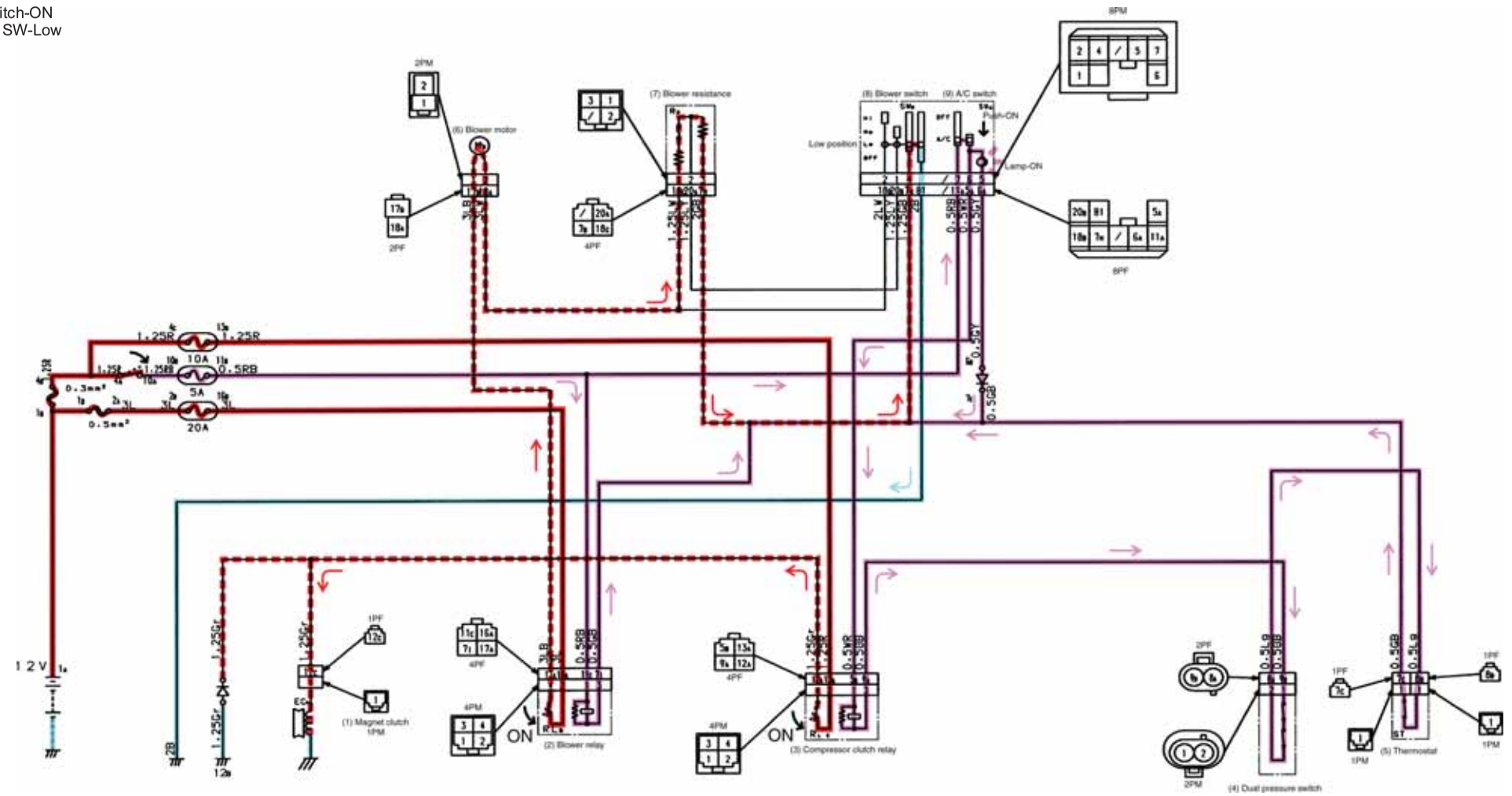


(1)Key-Off condition

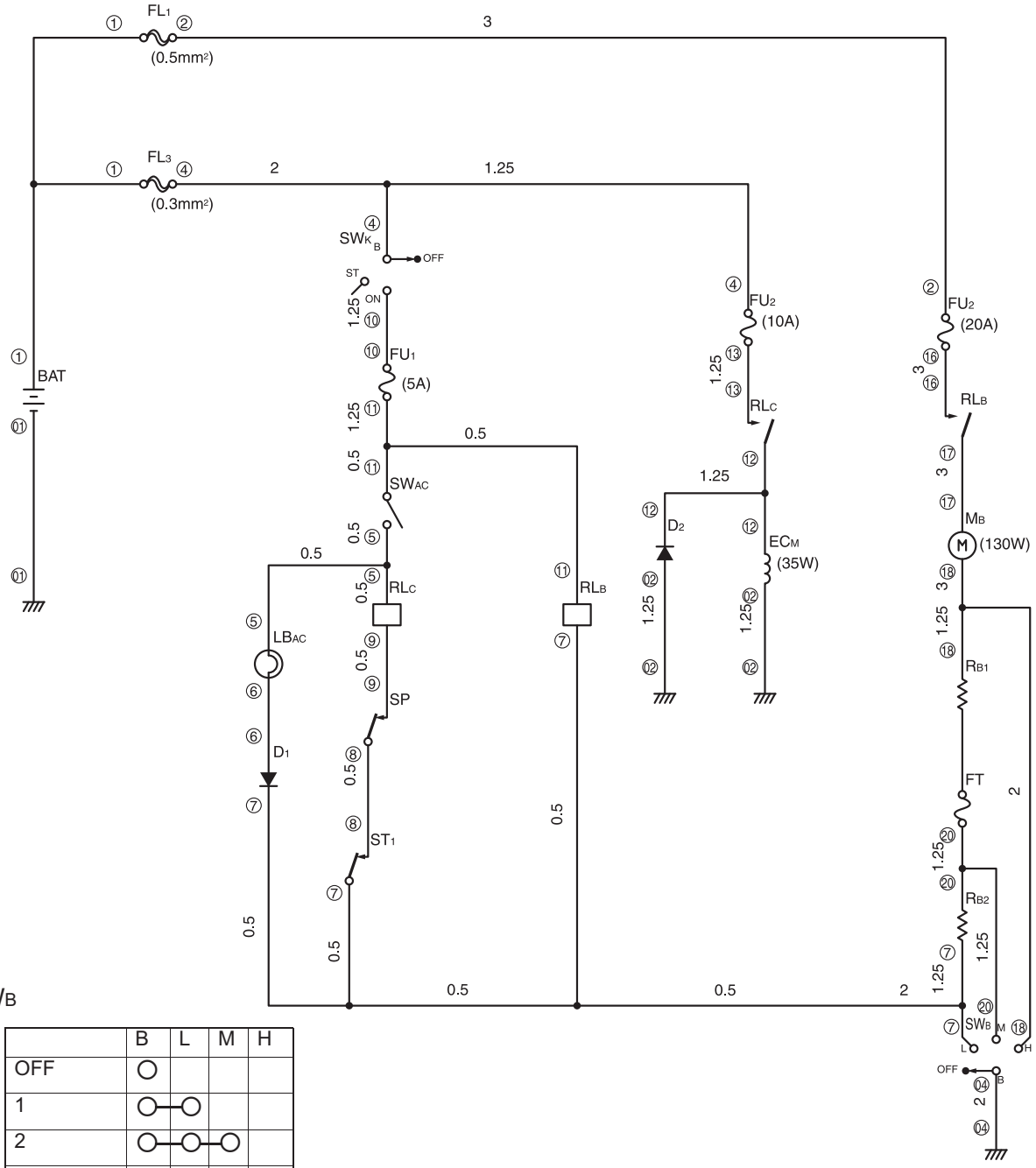


(2)Key-On (AC) condition

A/C switch-ON
Blower SW-Low



(3) A/C electric circuit diagram (DENSO A/C)



SWB

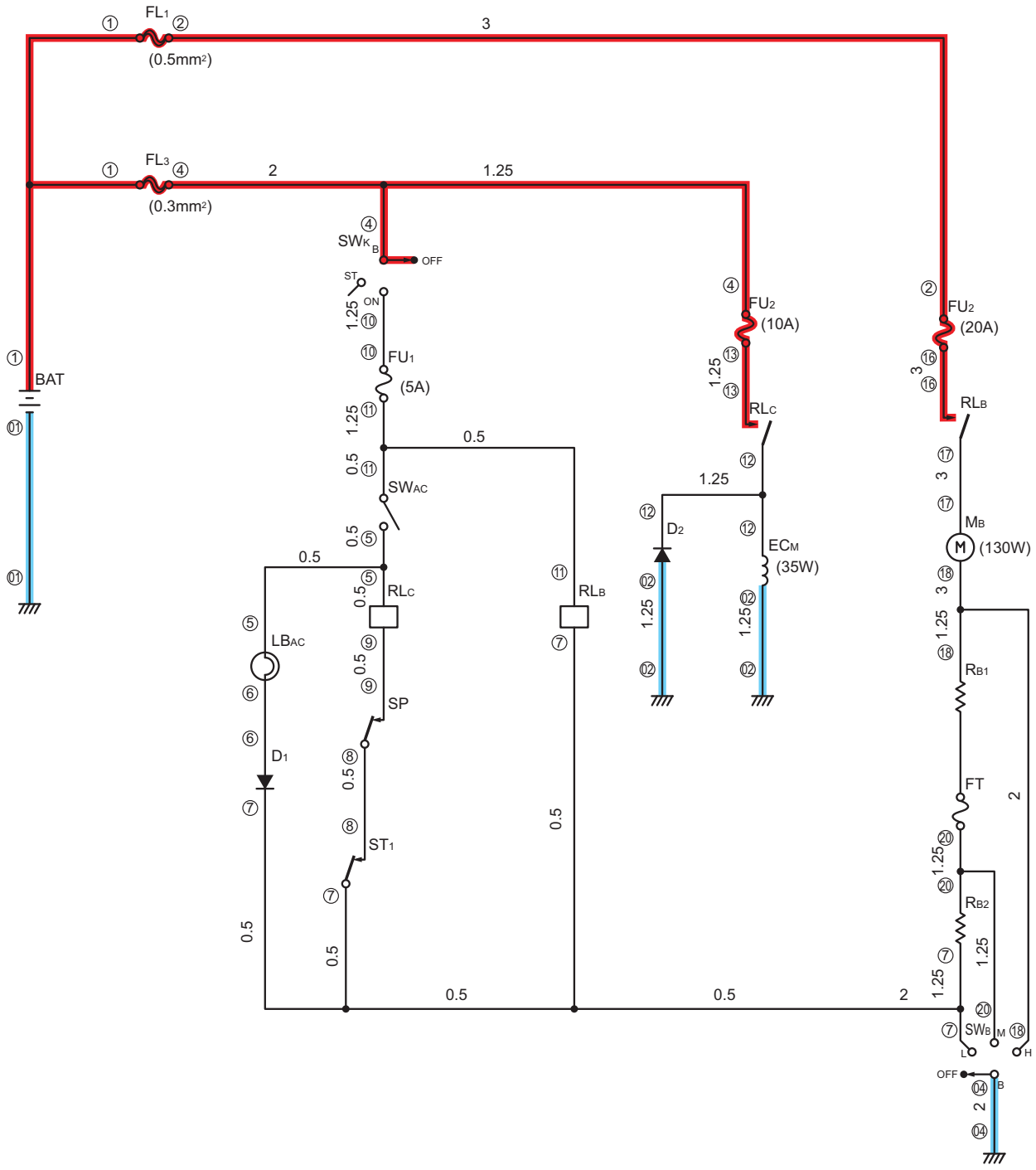
	B	L	M	H
OFF	○			
1	○	○		
2	○	○	○	
3	○	○	○	○

⑫	1.25	⑨	0.5
⑬	1.25	⑩	1.25
⑭	2	⑪	0.5, 1.25
②	3	⑫	1.245
④	2, 1.25	⑬	1.25
⑤	0.5	⑯	3
⑥	0.5	⑰	3
⑦	0.5, 2, 1.25	⑱	2, 1.25
⑧	0.5	⑳	1.25

BAT:Battery
D_1: Diode 1
D_2: Diode 2
EC_M:Magnet clutch
FL_1: Fusible link 1
FL_2: Fusible link 2
FT: Resister, thermo fuse
FV_1:Control Fuse
FV_2:Control Fuse
FV_4:Blower Fuse
LB_{AC}:A/C unit lamp

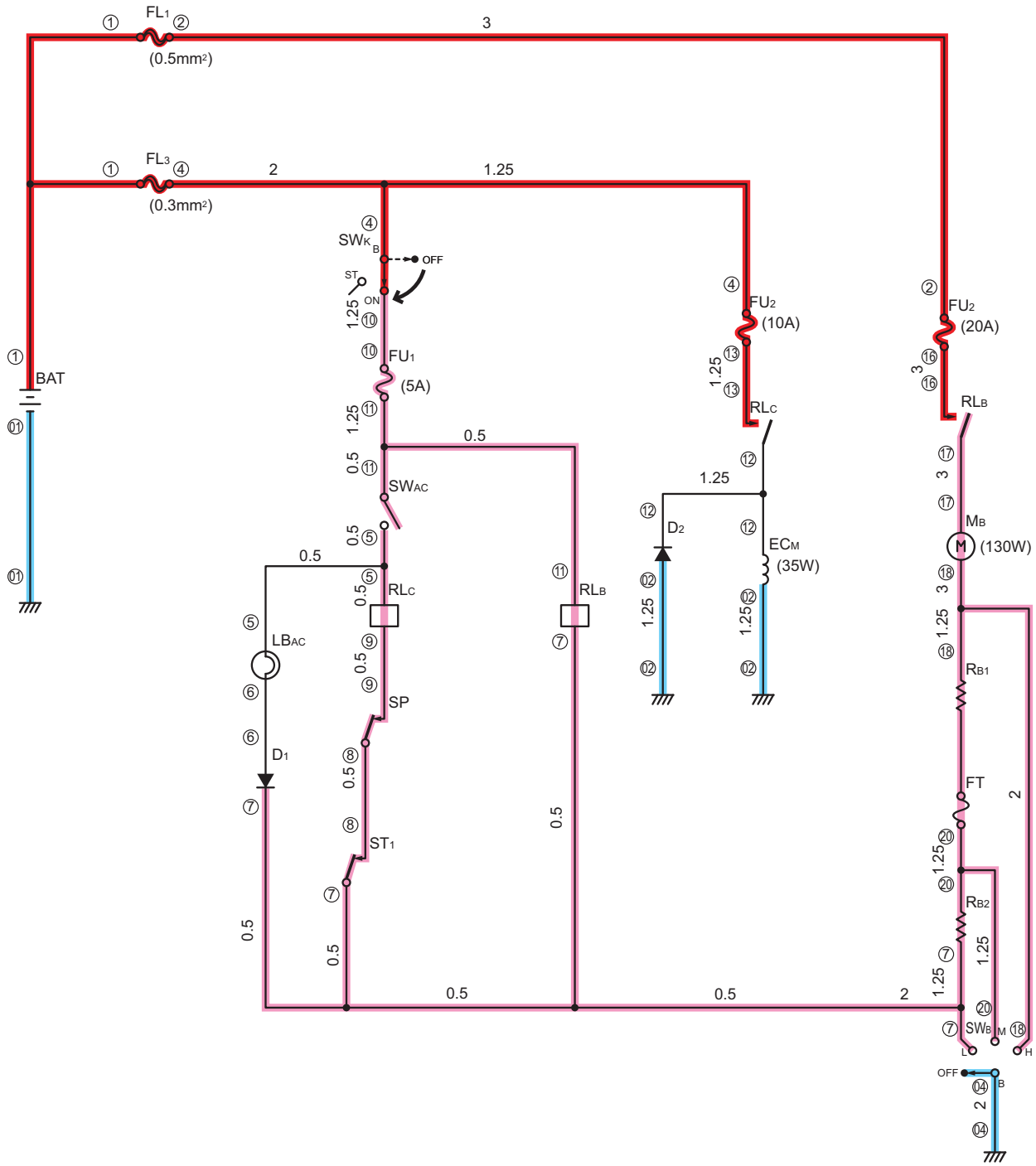
MB: Blower motor
R_{B1}:Blower resister 1
R_{B2}:Blower resister 2
RL_B:Blower relay
RL_C:Compressor clutch relay
SP: Dual pressure switch
ST_1:Thermostat
SW_{AC}:A/C switch
SW_B:Blower switch
SW_K:Main key switch

(4) Key-Off condition



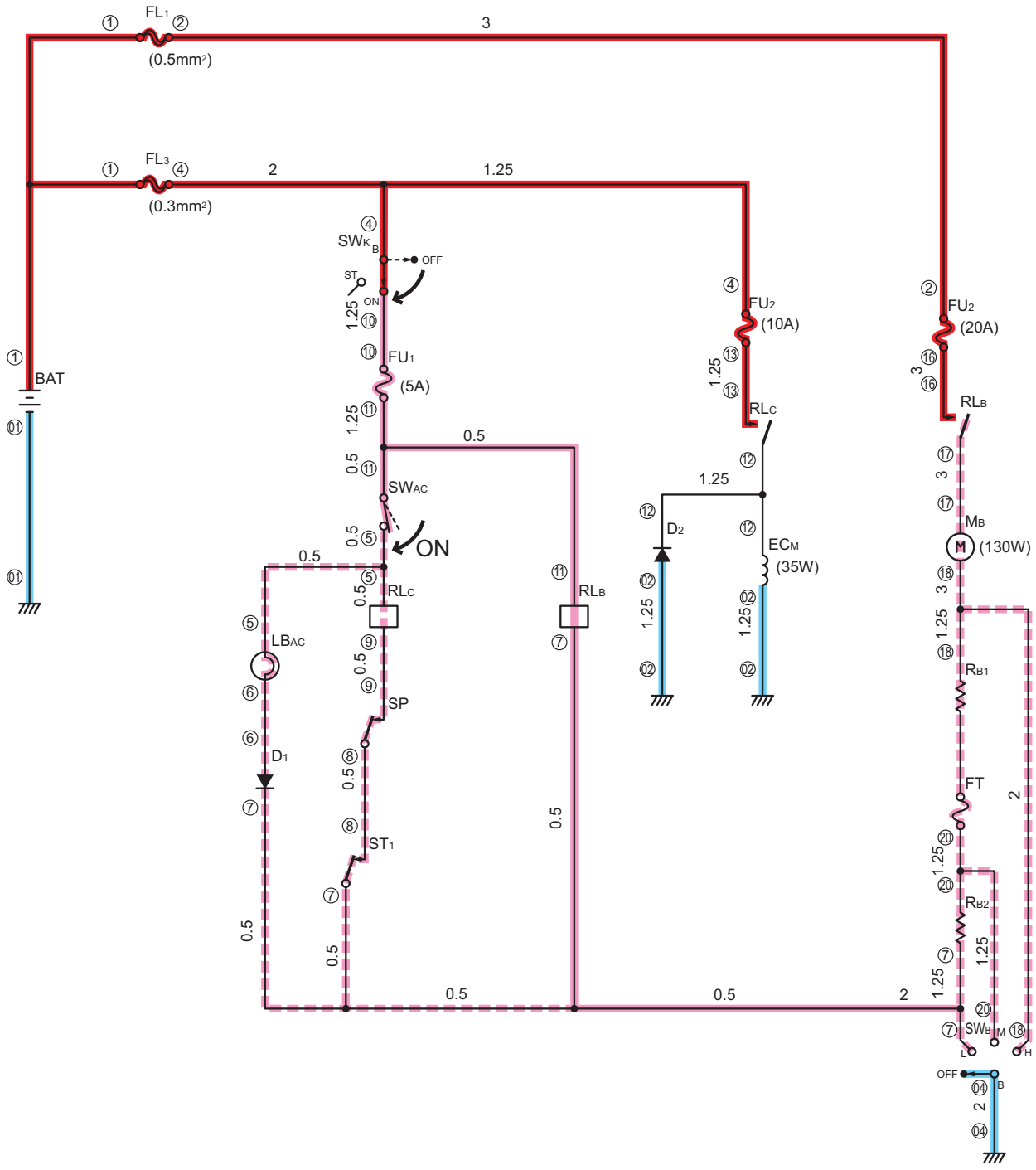
Function: Battery voltage is always reached to magnet clutch relay and blower relay control points.

(5) Key-On (A/C) Conditions



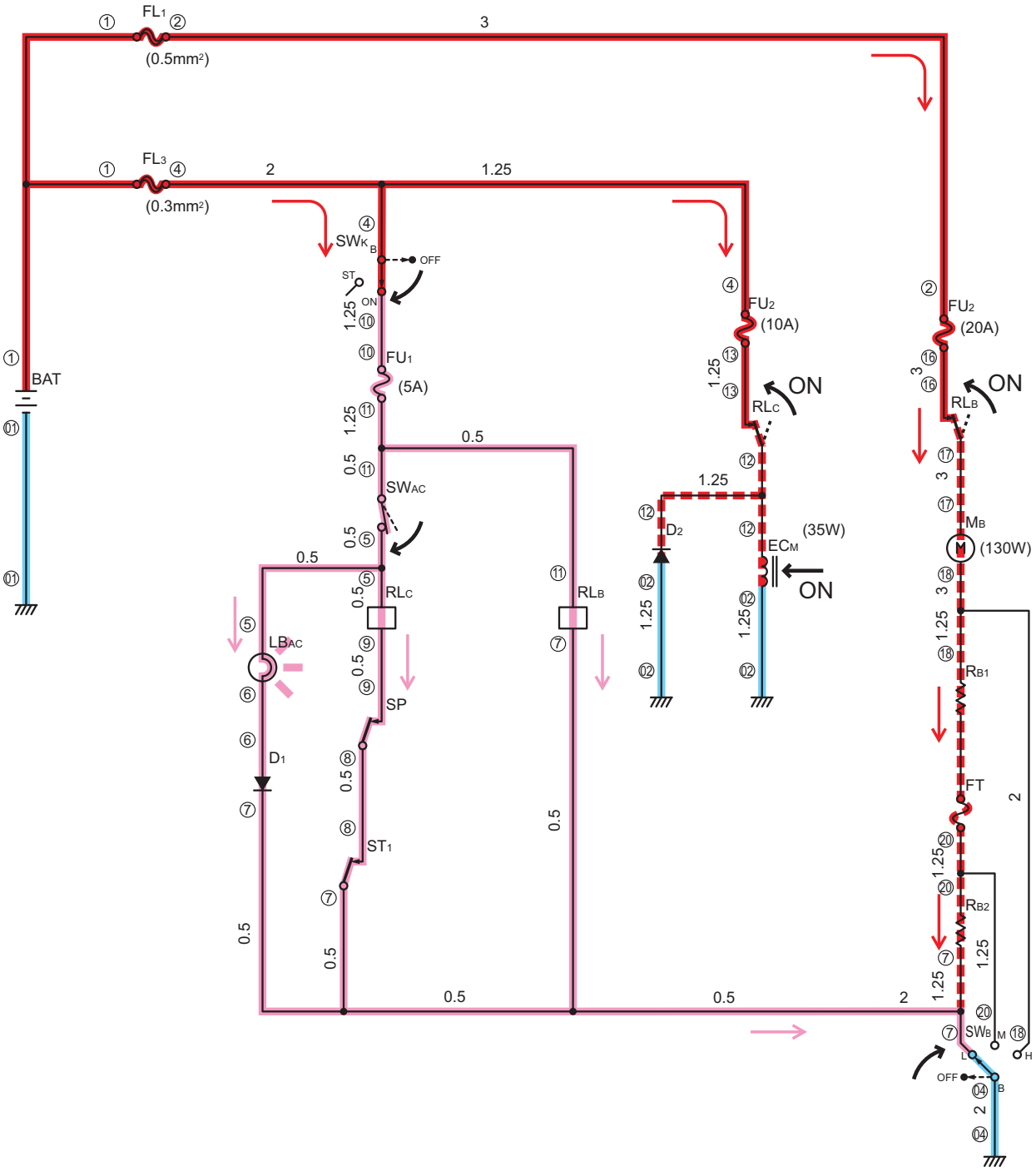
Function: When key switch is turned ON, battery current flows to blower relay coil. But as long as blower switch is off, current doesn't flow. So relay won't be magnetized and stays off. Still battery voltage can be detected on all connecting lines.

(6) Key-On (A/C) + A/C SW-On Condition



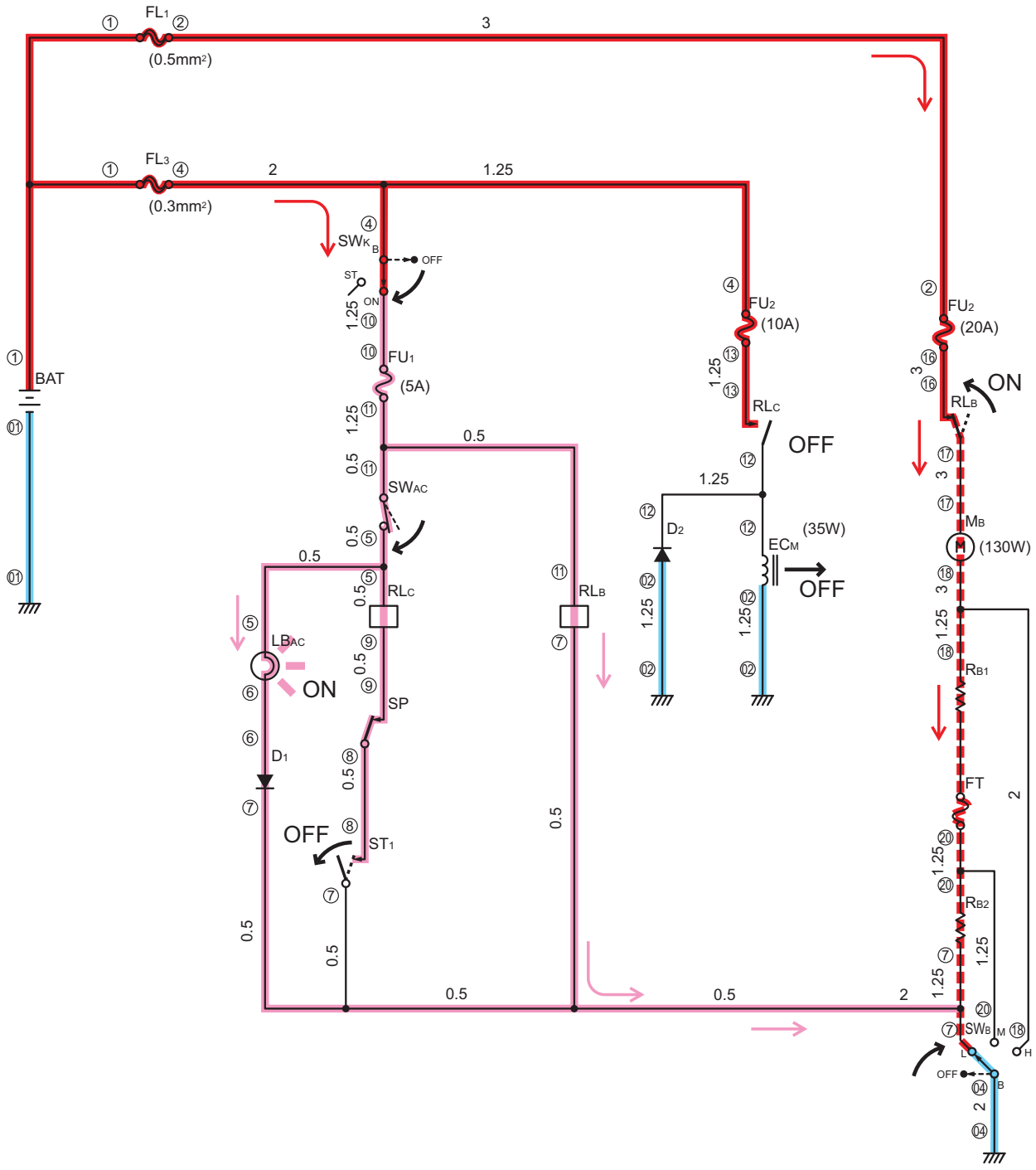
Function: Even when A/C switch is pushed on, as long as blower switch is off, current doesn't flow. So both clutch and blower relays stay off condition.

(7) Key-On (A/C) + A/C SW-On + Blower SW-Low Condition



Function: When blower switch is turned to low position, electric system current flows as shown in Fig. Both magnetic clutch and blower relays are turned on. Then compressor magnetic clutch is engaged. Blower motor current flows from battery through two resisters. In case of medium position, current flows through one resister. In high, it flows in no resister.

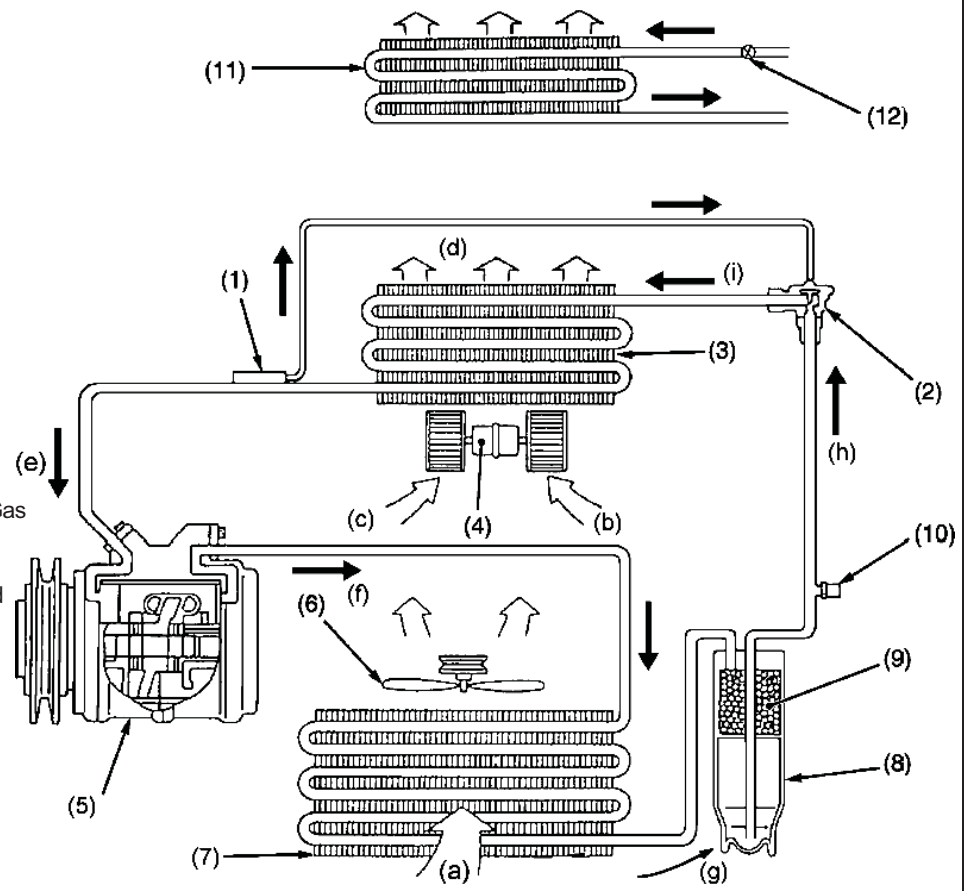
(8) Key-On (A/C) + A/C SW-On + Blower SW-Low + Thermostat-Off Condition



Function: When room temperature is cooled down to pre-set level, thermostat turns off. Then clutch relay turns off and magnet clutch is disengaged. When dual pressure switch is turned off, also magnet clutch is disengaged.

(B) FUNCTION AND STRUCTURE

(1) Heat Sensitizing Tube
(2) Expansion Valve
(3) Evaporator
(4) Blower Motor
(5) Compressor
(6) Engine Cooling Fan
(7) Condenser
(8) Receiver
(9) Desiccant
(10) Pressure Switch (Dual type)
(11) Heater Core
(12) Water Valve
(a) Hot air
(b) Cab Interior Air
(c) Cab External Air
(d) Colded Air
(e) Low Press, low-temp. gas
(f) High Pressure, High Temperature Gas
(g) High Pressure, High temp. liquid
(h) Liquid refrigerant
(i) Low Pressure, Low Temperature Liquid



The refrigerant cycle of air conditioning system is as follows.

1) The gaseous refrigerant evaporated through the evaporator (3) is compressed in the compressor (5) to approx. 1.47 Mpa (15 kgf/cm^2, 213 psi) and is also raised in temperature to approx. 70°C (158°F) and delivered to the condenser (7).
2) The gaseous refrigerant is cooled down through the condenser (7) to approx. 50°C (122°F) and delivered to the receiver (8) in the liquid state. At this time, heat removed from the cabin interior is extracted by means of the condenser (7).
3) The liquid refrigerant is collected in the receiver (8) for a certain period. At this time moisture are removed from the refrigerant by desiccant (9).
4) The liquid refrigerant after removing moisture and dust is jetted out of the small hole of the expansion valve (2) into the evaporator (3) as if it were distributed by an atomizer. Thus, the refrigerant is reduced in both pressure and temperature, and becomes easy to evaporate.
5) The refrigerant evaporates at 0°C (32°F) vigorously, taking heat from the surface of the pipes in the evaporator (3).
6) At this time, warm air in a cabin is drawn into the evaporator (3) by the blower motor and is passed over those pipes, transferring its heat to the refrigerant for evaporation. The air thus cooled is distributed to the cabin. (That is, heat in a cabin is taken by the evaporator.)

Reference

Since warm air in a cabin is cooled suddenly, water in the air is liquefied and removed, which means dehumidification is also performed.

7) The gaseous refrigerant from the evaporator (3) after having performed the cooling action is returned to the compressor (5), and is compressed to liquefy it (high pressure and high temperature). This cycle is repeated.

a) Compressor

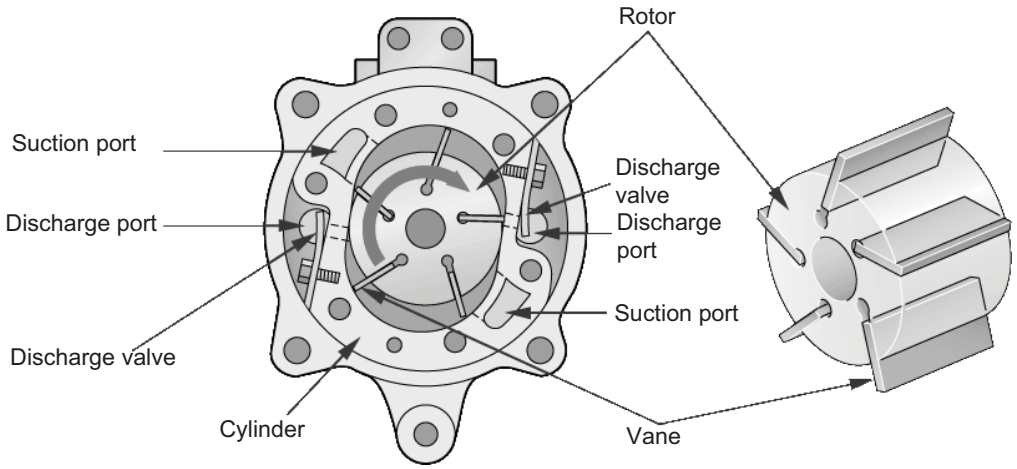
The compressor is installed on the engine and is driven by crank pulley through a belt.
The compressor is a pump designed to raise the pressure of refrigerant. Raising the pressure means raising the temperature. High temperature refrigerant vapor will condense rapidly in the condenser by releasing heat to the surrounding.

Compressors are classified as follows:

- Reciprocation type
  - Swash plate type (6,10 cylinders)10P, 10PA type
  - Wobble plate type (6 cylinders)6C, 6CA type
  - Variable capacity type7SB16 type
  - Crank shaft type (1 to 6 cylinders)
- Rotary type
  - Through vane typeTV type
  - Sliding vane typeSV type
  - Scroll typeSC type

(1) Outline of sliding-vane type compressor (SV07 type)

This compressor consists of the following main parts: rotor with built-in five vanes and cylinder, two discharge valves, side plates on the front and back. As the rotor turns, the five vanes also turn pressed into contact with the inner surface of the cylinder by the centrifugal force and the back pressure of the vanes themselves.



(2) Feature

1) The rotor, cylinder and other major parts are made of aluminum for tremendous drop in weight.
2) The vanes are used to make the compressor compact.
3) Compared to conventional swash-plate compressors, the SV07 is compact with smaller cylinder capacity. Thanks to the better volumetric efficiency, however, the SV07 proves as powerful as the 10P08.

(3) Main specifications

Type	Displacement	Max. RPM	Lib. oil	Type of magnet clutch
SV07	70cm^3 (4.3 cu.in.)	6000rpm	ND OIL8	K-20

(4) Structure & Function

The basic internal construction of sliding-vane type compressor consists of a rotor fitted with five vanes, and a cylinder.
Although its internal construction partially differs from that of the through-vane type compressor, the function is identical. Its basic operation is to effect the suction, the compression, and the discharge of refrigerant gas by rotating the rotor, pushing the vanes to the cylinder inner wall, and allowing the vanes to rotate while sliding along the cylinder wall.
Similar to the through-vane type compressor, the sliding-vane type compressor uses the ND-OIL8 for the compressor oil.

1. Construction

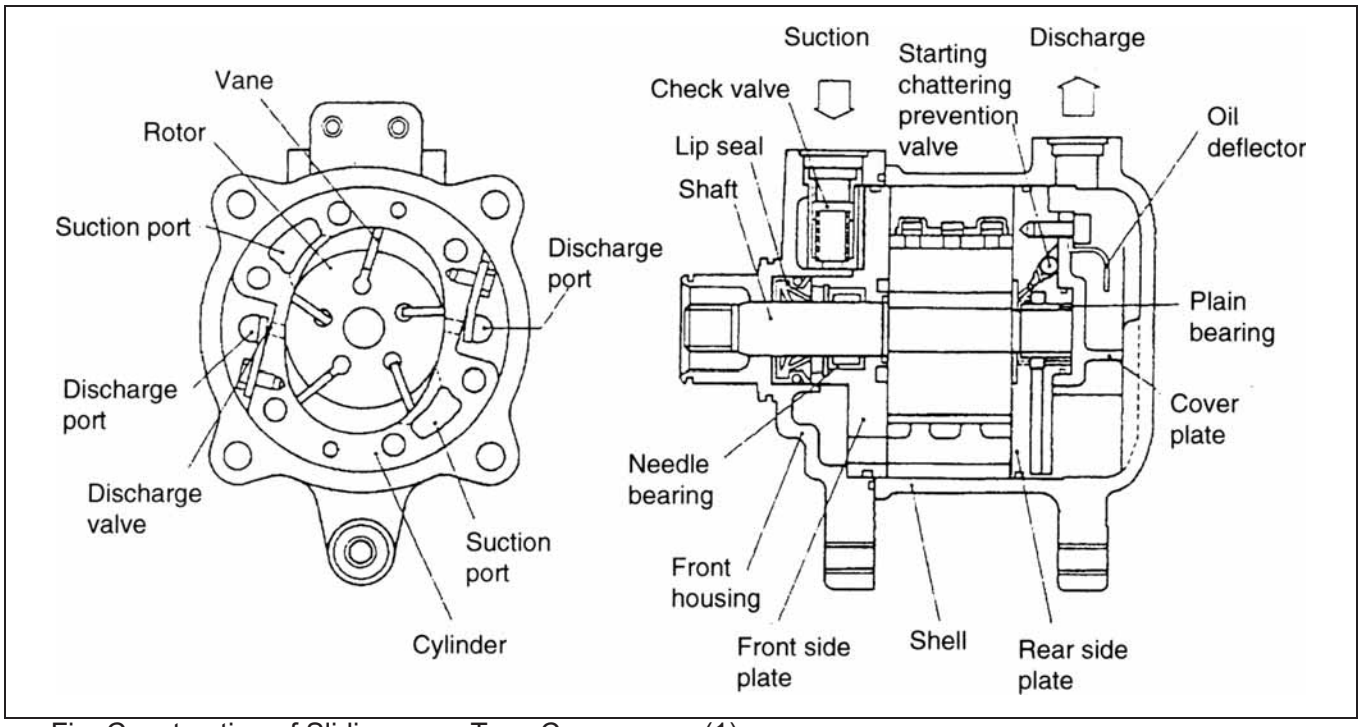


Fig. Construction of Sliding-vane Type Compressor (1)

1) Cylinder Internal Construction
Internally, the cylinder consists of a rotor fitted with five vanes. These vanes slide in contact with the inner cylinder wall to effect the suction, the compression, and the discharge of refrigerant gas.

2) Shaft
The shaft is integrated with the rotor. The front of the shaft is supported by the needle bearing which is fitted in the front side plate. The rear is supported by plain bearing which is fitted in the rear side bearing.
The end of the shaft is provided with splines, and the magnetic clutch (K type) that mates to the spline shaft is secured by a bolt (M6), in the same way as in the through-vane type compressor.

3) Rear Side Plate
The rear side plate is equipped with a valve that prevents the vanes from chattering during starting.

4) Front Side Plate
The front side plate is equipped with a suction port. The vanes pass by the suction port to draw in the refrigerant gas.

5) Front Housing
Internally, the front housing has a low-pressure chamber. In addition, a check valve is provided in the area where the suction hoses is connected.

6) Shaft Seal
A lip seal is used for sealing the shaft.

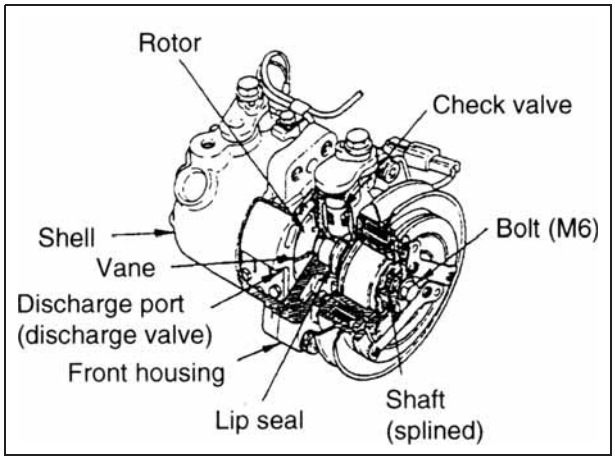
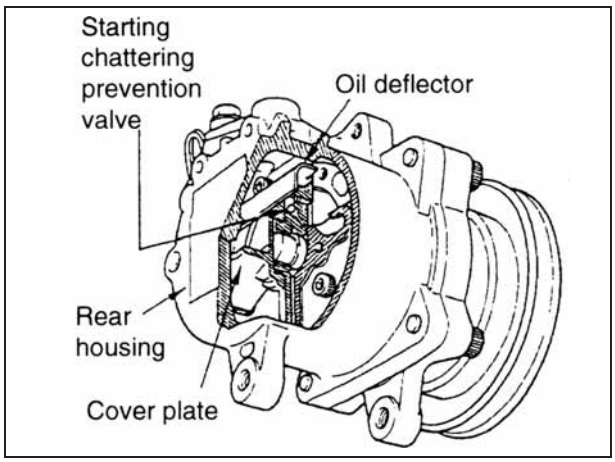


Fig. Construction of Sliding-vane type Compressor

7) **Rear housing (shell)**
The rear housing contains an oil separator chamber.
The discharged high pressure refrigerant gas becomes separated here into refrigerant and oil.



2. Operation

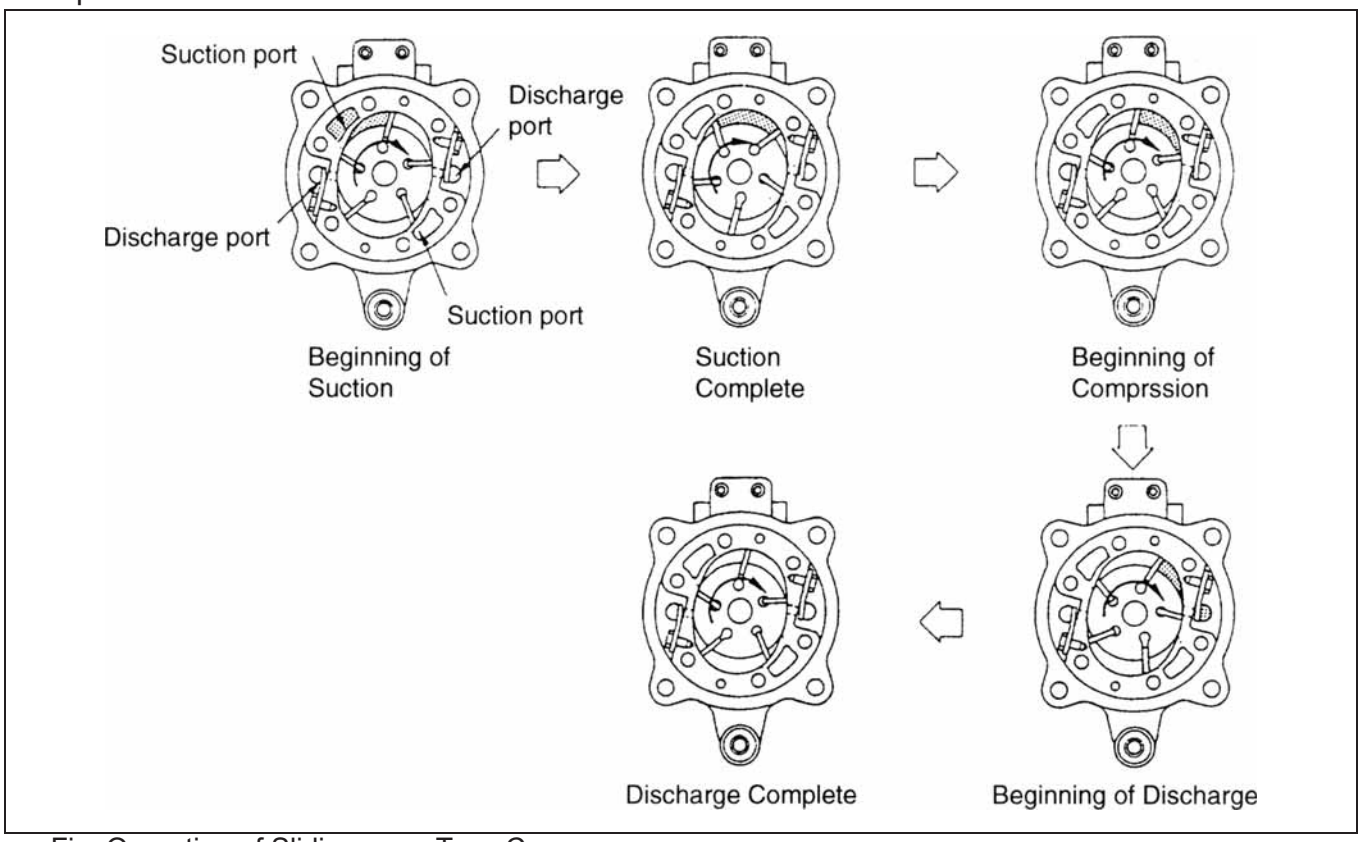


Fig. Operation of Sliding-vane Type Compressor

1) Suction

The refrigerant gas exits from the evaporator by the operation of the compressor, enters the compressor's low-pressure chamber. As the rotor turns together with the vanes, the refrigerant gas is drawn from the suction port into the cylinder.

2) Compression

After completing suction, the refrigerant gas, which is sealed by the vanes in the cylinder, becomes compressed as the vanes rotate. At this time, the sealing between the tip of the vanes and the cylinder wall is ensured by the compressor oil.

3) Discharge

At the compression continues and the refrigerant pressure in the cylinder increases to the point that it becomes higher than that of the high-pressure chamber, the refrigerant gas is discharged.
Even when the pressure in cylinder because the high-pressure chamber pressure maintains the discharge valve closed.
The compressor repeats the cycle described above to enable the five chambers, which are partitioned by the vanes in the cylinder, to perform suction, compression, and discharge twice for each rotation of the rotor.

3. Function of the Compressor

1) Separating the Refrigerant Gas and Oil in the High-Pressure Chamber

The refrigerant gas that is discharged from the cylinder is actually mixed with the compressor oil found in the cycle. Because it is important to minimize the outflow of oil into the cycle in order to achieve efficient refrigeration, the refrigerant gas and the oil are separated in the compressor.The sliding-vane type compressor separates the compressor oil from the discharged refrigerant gas as described below.

(a) The refrigerant gas (which is mixed with oil) that is discharged from the cylinder collides with the oil deflector that is provided on the rear side plate. Because the oil is heavier, the oil flows downward, via the cover plate, and settles in the bottom of the shell.

(b) After the oil thus separated, the refrigerant gas is discharged from the top of the shell.

(c) The cover plate functions as a barrier to prevent the oil (which foams when the compressor is first started) from discharging together with the refrigerant gas.

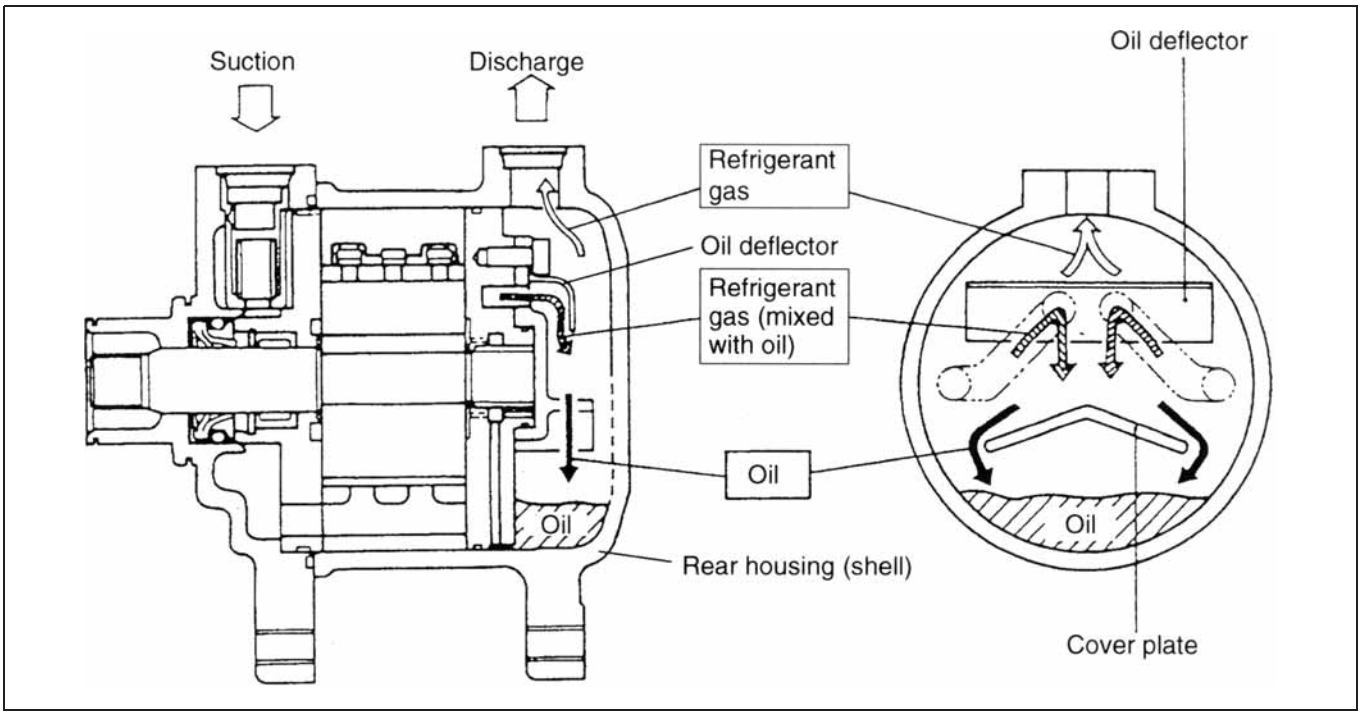
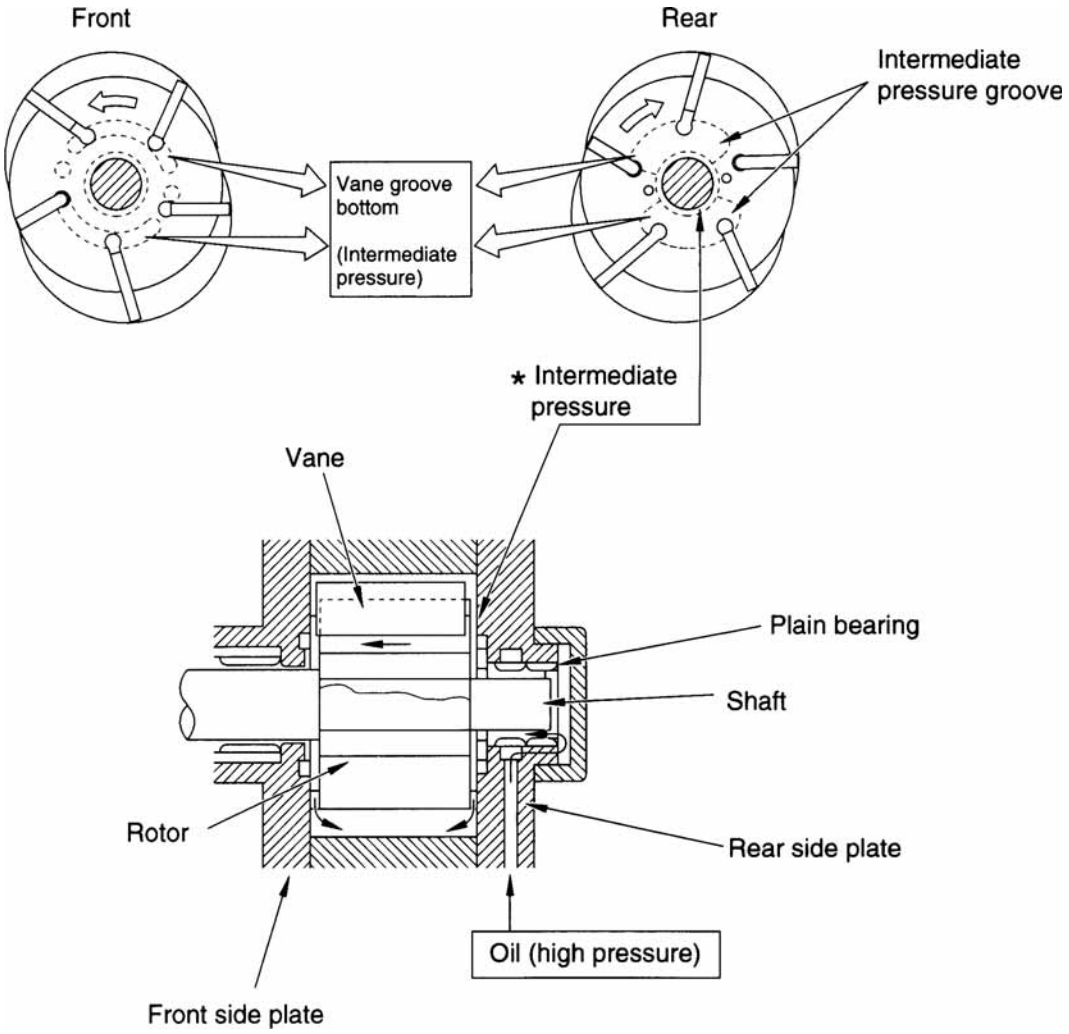


Fig. Separating the Refrigerant Gas and the Compressor Oil in the High-Pressure Chamber

2) Lubricating the Vanes and Plain Bearings

The oil, which settles in the bottom of the shell, is pushed by the pressure from the high-pressure chamber to pass through the passage in the rear side plate and lubricates the plain bearings on the shaft, thus preventing wear.

After passing through the clearance between the shaft and the plain bearings, the decompressed oil passes through the intermediate pressure groove in the rear plate and settles in the vane groove to lubricate the vanes and the rotor.



*Intermediate pressure: The high-pressure oil, which is drawn up from bottom of the shell, travels through the passage in the rear side plate, and becomes decompressed as it passes through the clearance between the shaft and plain bearings. As a result, the pressure of the oil assumes an intermediate pressure between the discharge and suction pressures.

Fig. Vane and Plain Bearing Lubrication

3) Vane Back-Pressure System

To ensure that the vanes of sliding-vane type compressor slide in continuous contact with the cylinder wall, it is necessary to apply a force to push the vanes outward, without relying solely on the centrifugal force that is generated by the rotation of the rotor.

The sliding-vane type compressor uses the oil pressure (under intermediate pressure) that is deposited in the bottom of the rotor's vane grooves, to push the vanes outward.

<Concept of back pressure>

The relationship between the stresses that are applied should ideally be the following:
vane back pressure + vane centrifugal force = vane pushing force
vane outward force = retraction force associated with vane compression

A greater "vane outward force" increases friction at the vane nose, which leads to a loss in consumable horsepower. A small "vane pushing force" causes the vanes to chatter. The sliding-vane type compressor uses plain bearings to reduce the pressure of the high-pressure oil and delivers the oil to the back-pressure chamber so that both forces are in balance.

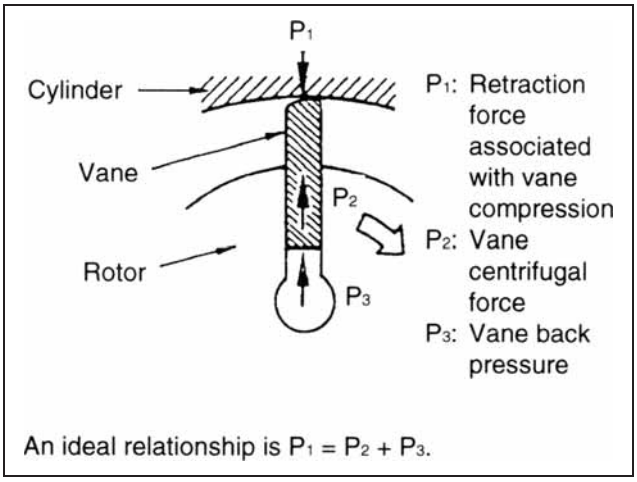


Fig. Vane Back Pressure

4) Chattering Prevention Valve

When the compressor is first started, the vanes are likely to chatter because the back pressure that is applied to the vanes has not reached a prescribed level.

For this reason, a chattering prevention valve is provided in the rear side plate. When the compressor is first started, the chattering prevention valve delivers the refrigerant gas from the high-pressure chamber directly to the back-pressure grooves of the vanes, thus preventing the vanes from chattering.

(a) Stopped compressor

The force of the spring maintains the valve open. (The pressure in the compressor is constant.)

(b) Starting the compressor

Immediately after the compressor begins its rotation, the refrigerant gas from the high-pressure chamber passes through the open valve to apply pressure directly onto the back of the vanes. As a result, the vanes are pushed outward, thus preventing them from chattering.

(c) Normal compressor operation

The discharge pressure rises, overcomes the spring force, and closes the valve (in approximately 3 seconds of operation). After the valves closes, the vanes are pushed outward by the vane back-pressure and the vanes' centrifugal force.

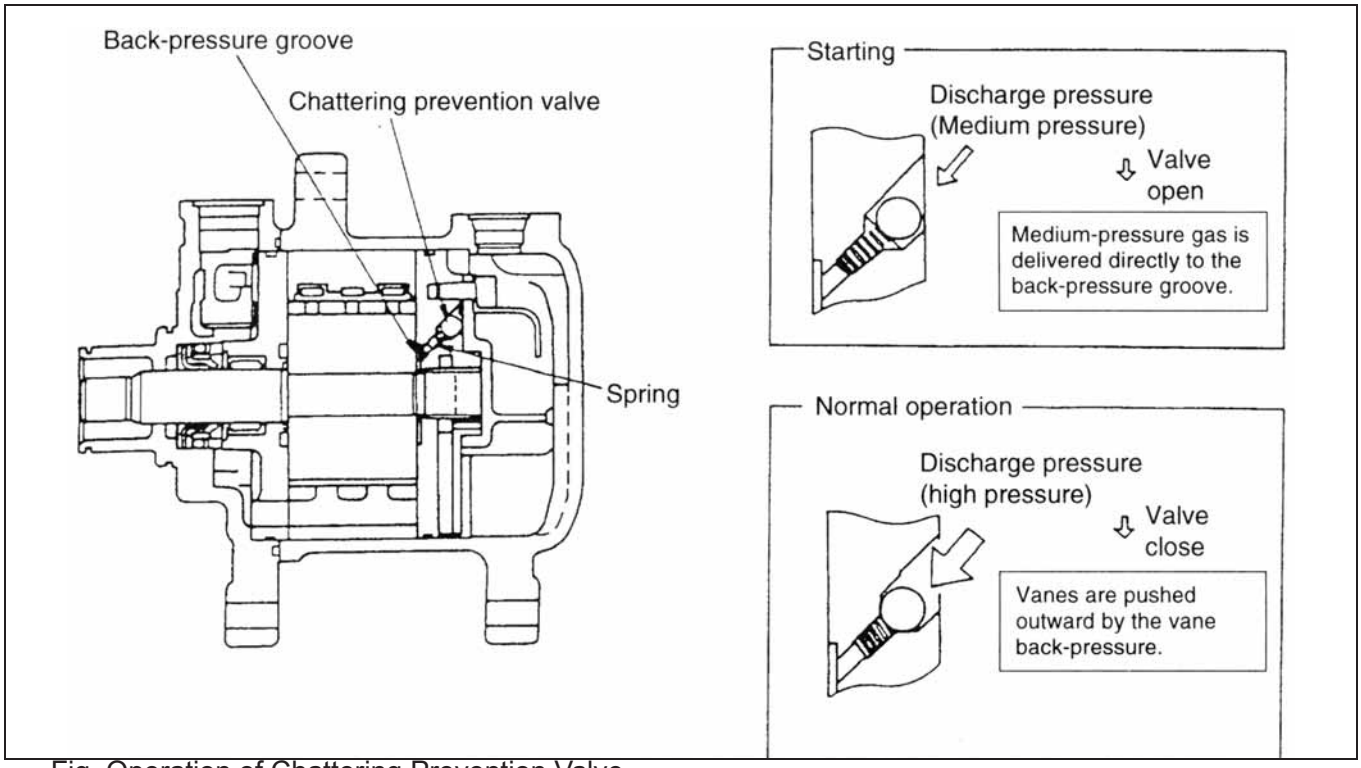


Fig. Operation of Chattering Prevention Valve

5) Check Valve

Immediately after the sliding-vane type compressor stops, if there is a great difference in pressure between the discharge and suction pressure owing to the construction of the compressor, the compressor could rotate backwards and cause the refrigerant gas to flow back into the evaporator.

To prevent the refrigerant gas from flowing back, a check valve is provided at the inlet of the suction valve in the front housing.

Immediately after the compressor stops, the high-pressure gas pushes the spool upward to close the passage to the suction side pipe, thus preventing the refrigerant gas from flowing back.

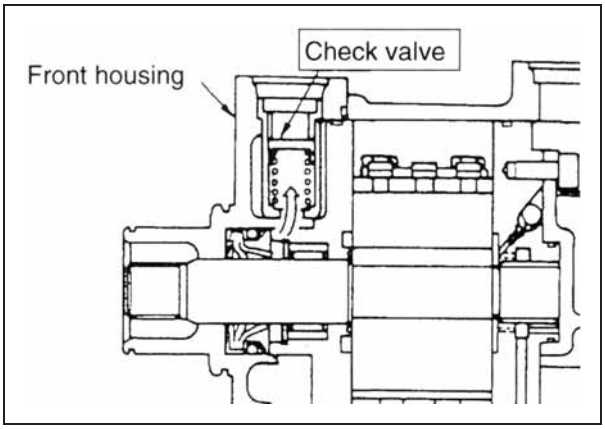


Fig. Check Valve Operation

<Regarding the Check Valve>

Although the check valve is made of nylon (both the spool and the case), it has the strength to withstand the pressure even if it is subjected to liquid compression.

Furthermore, the check valve does not pose any problems in terms of heat resistance because its melting point is 225°C.

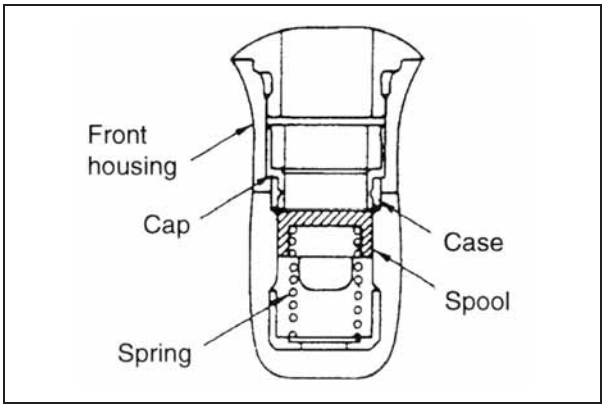


Fig. Check Valve Construction

6) Shaft Seal

A lip seal is used to seal the shaft.

Because the lip seal is located in the low-pressure chamber, it is cooled by the refrigerant gas that is constantly drawn into the chamber. At the same time, the lip seal is lubricated by oil.

In the event that oil leaks through the lip seal, the leaked oil is drained downward and becomes absorbed by the oil felt that is provided in the pool chamber. This prevents the oil from adhering onto the magnetic clutch surface, which could cause the magnetic clutch to slip.

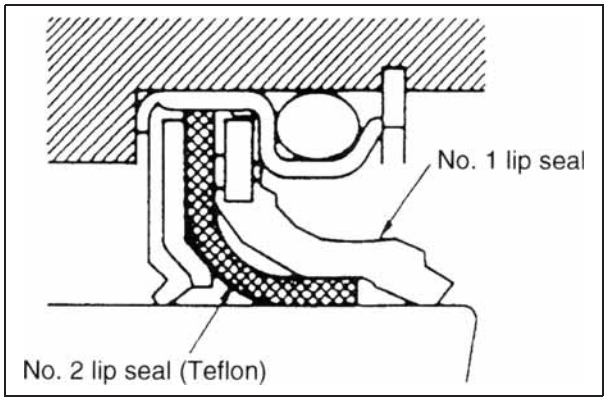


Fig. Shaft Seal Construction

Note: This lip seal is not interchangeable with the lip seal that is used in the swash-plate type or in the through-vane type compressor.

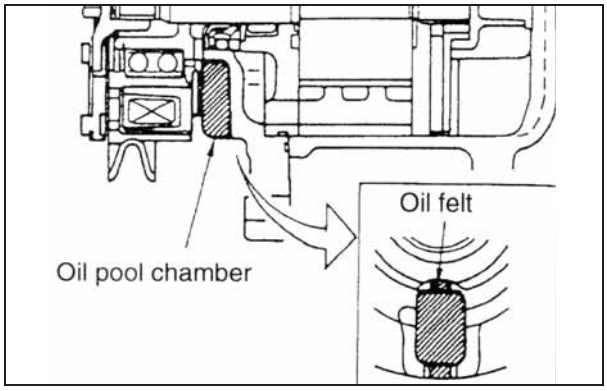


Fig. Oil Felt

(5) Oil Replenishment upon Function Part Replacement (for the HFC134a System)

1. Compressor Oil Quantity
   When the air conditioning system is operating, compressor oil is discharged together with the refrigerant from the compressor and circulates within the refrigeration cycle.
   As a result, an amount of oil is always found inside the condenser, the evaporator, the receiver drier and other parts.
   A specified amount of oil must circulate inside the refrigeration cycle.
   If the amount is larger or smaller than the specified amount, problems will occur in the refrigeration cycle as follows:
   1) If the amount of oil is larger than the specifications;
      A larger amount of oil remains inside the condenser and evaporator, and then prevents proper heat exchange, thus decreasing the cooling capacity.
   2) If the amount of oil is smaller than the specifications;
      A small amount of oil inside the compressor may cause premature wear, overheating and eventually seizure of internal parts.

2. When the evaporator or condenser is replaced;
   Since a certain amount of compressor oil always stays inside the functional part, when the defective evaporator or condenser is replaced with the new one, the following amount of oil needs to be added into the refrigeration cycle.

   <Compressor oil replenishment amounts>

	Replacement part		
	Compressor	Condenser	Evaporator
Compressor oil replenishment amounts	Refer to below explanation	40cc (2.4 cu.in.)	40cc (2.4 cu.in.)
Compressor oil	ND-OIL 8		

3. When the compressor is replaced;
   The amount of oil needed for the cycle is filled in the new compressor. Therefore, when replacing the compressor, remove excess oil as shown in Fig.

   (1) New compressor
   (2) Compressor to be replaced
   (3) Remove the excess oil (A-B)

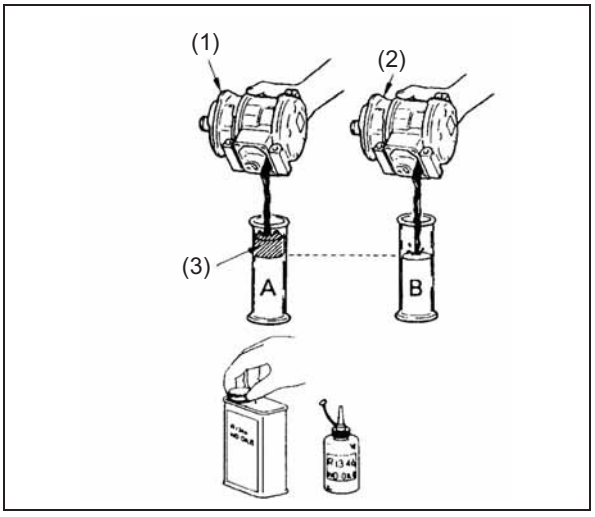


Fig. Oil Replenishment

⚠ Caution

1. **HFC134a oil easily absorbs moisture. Keep the oil container sealed at all times.**
2. **HFC134a oil reacts with some plastics. Keep it stored in metal container. (Plastic bottle should only be used for O-ring lubrication)**
3. **Care should be taken not to spill the HFC134a oil on paint work, and plastics. If this is accidentally done, wipe immediately.**
4. **Clearly identify the oils when transferred to a different container.**

Note: The amount of oil contained ni the new part of compressor is 140 ± 10 cc (0.15 ± 0.011 US qts) 0.12 ± 0.009 Imp. qts.

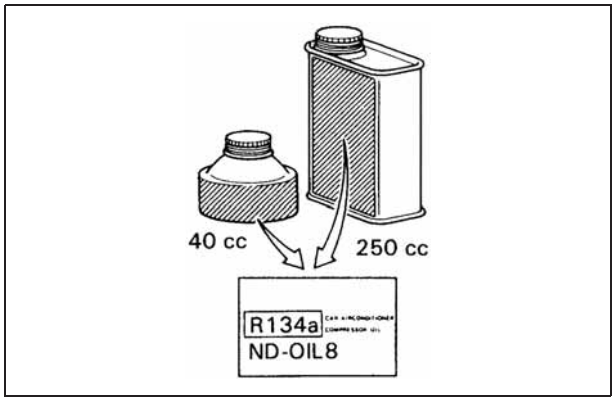
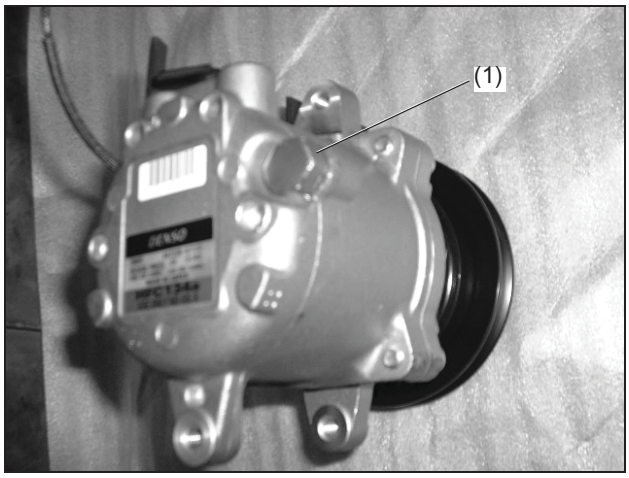


Fig. Compressor Oil Container

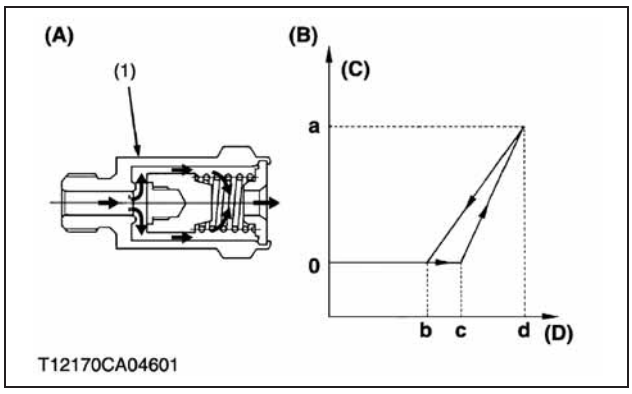
b) High Pressure Relief Valve



If the high pressure is abnormally high, the pressure relief valve open, and the refrigerant is released into the atmosphere, and the system is maintained. At that time, some of the refrigerant in the system is released into the atmosphere.
Even in the worst case, the outflow of refrigerant is stopped at the minimum limit.

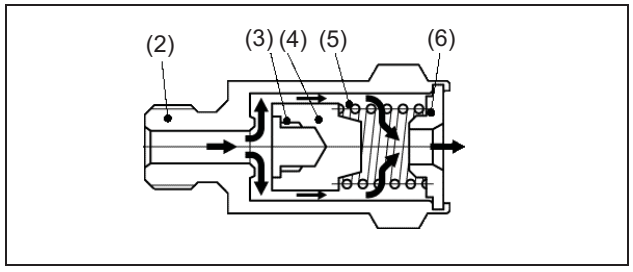
(Reference)
In normal operation, the high pressure switch is triggered first and the compressor stops, so the pressure relief valve is not triggered so easily.

(1) Pressure Relief Valve



(a) 113 L/min., 27.2 U.S. gals./min., 24.86 Imp. gals/min.
(b) 2.75 Mpa, 28.1 kgf/cm^2, 399.7 psi
(c) 3.43 Mpa, 35.0 kgf/cm^2, 497.8 psi
(d) 4.14 Mpa, 42.4 kgf/cm^2, 603.1 psi

(A) Gas Ejection Route When Operating
(B) Operating Characteristic
(C) Leakage Quantity
(D) Pressure



(2) Body
(3) Seal
(4) Poppet
(5) Spring
(6) Stopper

c) Magnetic Clutch

A magnetic clutch is used to connect and disconnect the compressor from the engine.
The main components are the stator, rotor, and pressure plate.

(1) Principle

When the current is supplied to the coil, magnetic forces are generated in the iron II and attracts the iron I.

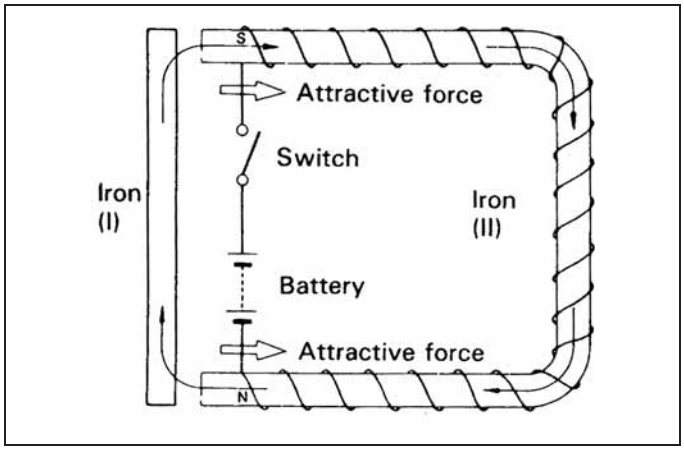
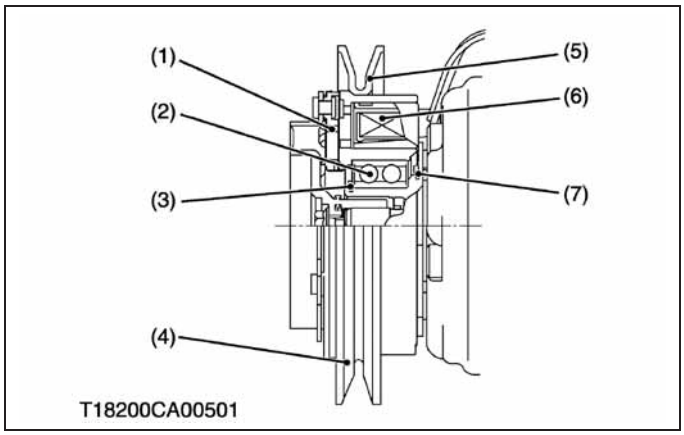


Fig. Magnetic Attractive Force

(2) Magnetic Clutch

A magnetic clutch is used to engage and disengage the compressor from the engine. Main components are stator (6) and rotor with pulley (5), and pressure plate (1) to engage the drive pulley (4) and compressor magnetically.
The stator is fixed on the compressor housing, and pressure plate is attached to the compressor shaft.
Two ball bearings are used between the inner surface of the rotor and the front housing of the compressor.

(1) Pressure Plate
(2) Ball Bearing
(3) Snap Ring
(4) Pulley
(5) Rotor with Pulley
(6) Stator
(7) Snap Ring



(3) Operation

Whenever the engine is operating, the pulley is rotating since it is connected to the crankshaft by a drive belt, but the compressor does not operate until the magnetic clutch is energized. When the air conditioning system is switched on, the system supplies current to the stator coil. Then the electromagnetic field attracts the pressure plate and pulls the plate against the friction facings on the pulley. The friction between the facings on the pulley and pressure plate causes the magnetic clutch assembly to rotate as a unit, and drive the compressor.

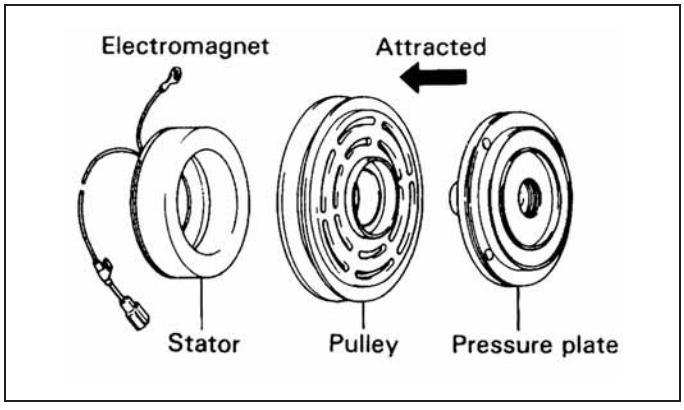


Fig. Operation

d) Condenser

(1) Description

The condenser is used to cool down the high temperature and high pressure gas refrigerant and change it to a liquid refrigerant.
The greater the amount of the heat released off into the air through the condenser, the greater will be the cooling effect obtained by the evaporator.
Therefore, the condenser is installed at the front end of the vehicle to get forcible cooling by the machine when moving.
There are some models which are equipped with a fan exclusively for the condenser.

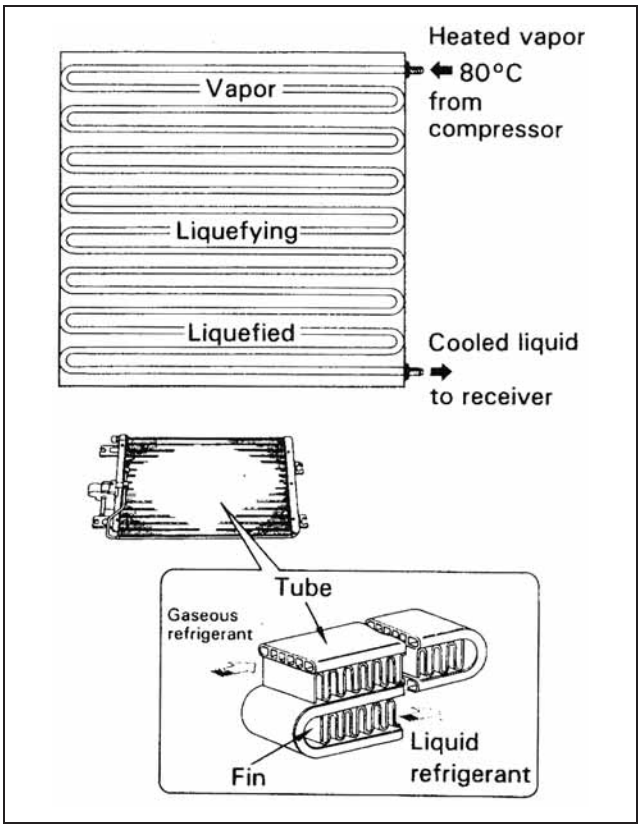


Fig. Single Pass Condenser

(2) Type of Condenser

To improve the cooling performance and decrease the weight and size of condenser, new types of condenser have been developed as follows:

1) Single Pass Type (Conventional type)
   As shown in Fig, the refrigerant gas flows only in one passage.
2) Two Pass (Passage) Type
   This condenser has the refrigerant passages in two directions to improve cooling performance.
3) Three Pass (Passage) Type
   This condenser has the refrigerant passages in three directions to improve cooling performance.
4) Multi Pass (Passage) Type
   This condenser has been developed to decrease its weight and size especially for HFC134a, new refrigeration cycle.

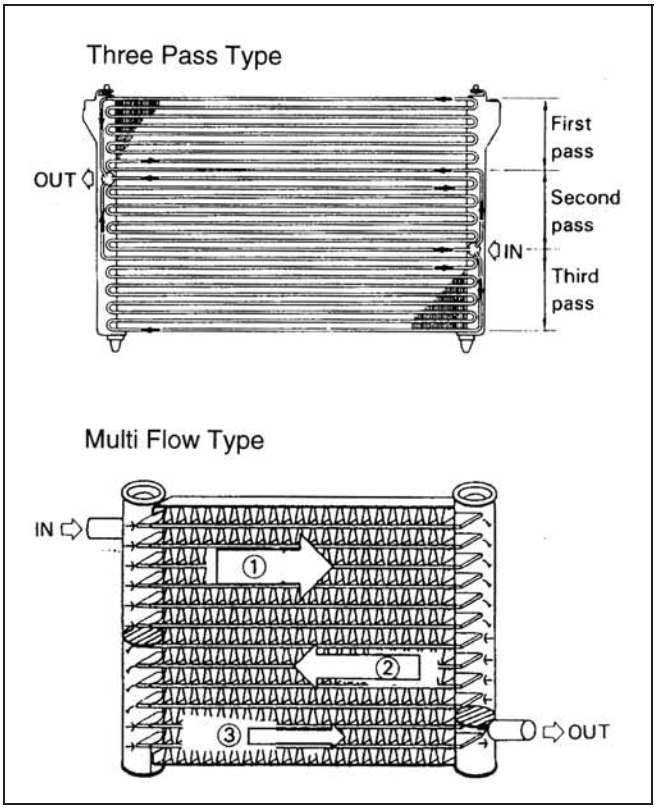
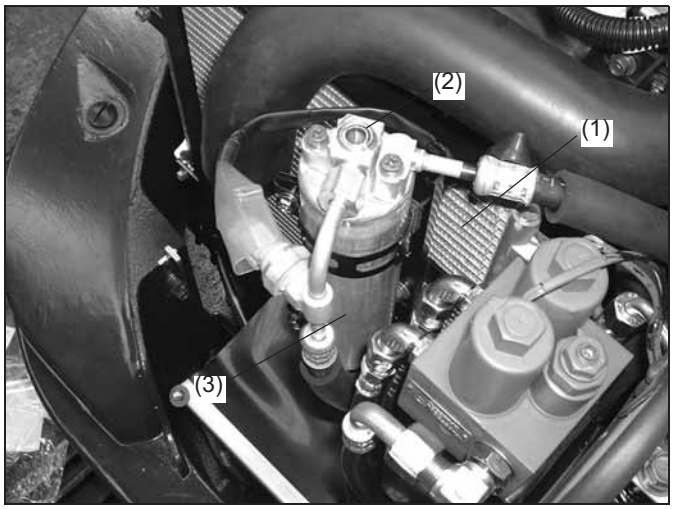
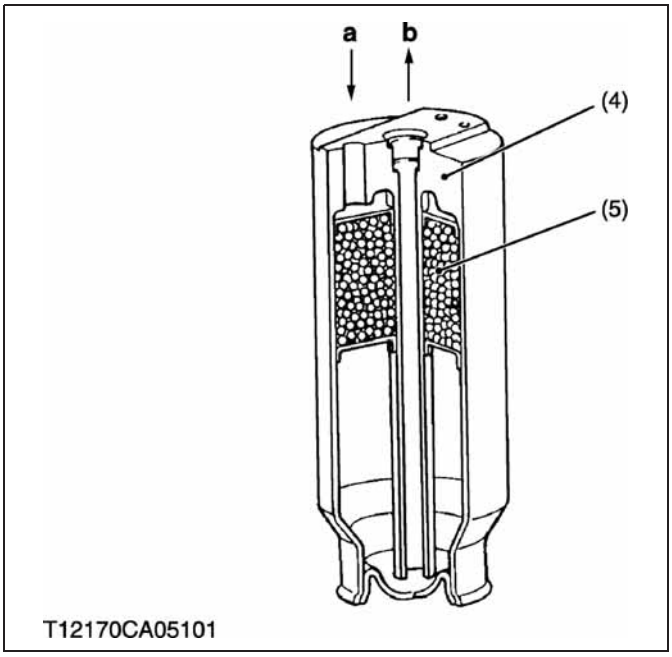


Fig. Three Pass Type and Multi Pass Type Condensers

e) Receiver





The receiver (3) serves the purpose of storing the liquid refrigerant. The amount of the liquid refrigerant flowing through the system varies with the operating condition of the air conditioner. To be accurate, the receiver stores excess amount of refrigerant when the heat load is lowered. It also releases stored refrigerant when additional cooling is needed, thus, maintaining the optimum flow of refrigerant within the system.
The receiver includes a desiccant (5). It has the job of removing moisture as the refrigerant circulates within the system.
The sight glass (2) is installed on the top of receiver. Amount of refrigerant to be charged is very important for the efficiency of air conditioner. The sight glass is used to check the amount of refrigerant. If large flow of bubbles can be seen in the sight glass, there is insufficient refrigerant charged. If so, replenish the refrigerant to the proper level.

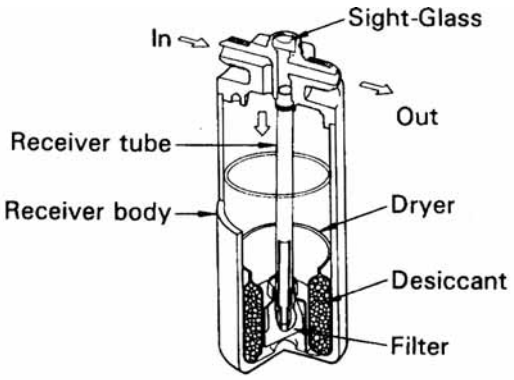
(1) Condenser
(2) Sight Glass
(3) Receiver
(4) Receiver Body
(5) Desiccant (silicagel → zeolite)

a: IN
b: OUT

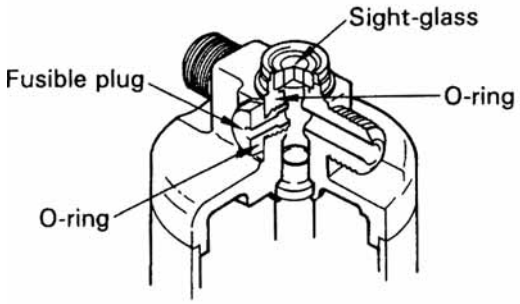
Desiccant change from silicagel to zeolite for HFC134a type.

FYI (For your information)

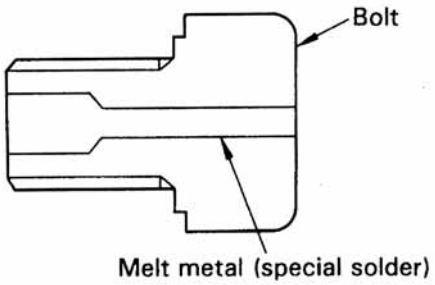
For the receiver/dryer of CFC12 air conditioning, the silicagel is used as a desiccant and its structure is slightly different from HFC134a receiver.
Also, a fusible plug was used to protect the system from abnormally high pressure, which may cause the damage to the other parts in the system.
However, as an environmental concern, the fusible plug has been discontinued.
Instead of this, a pressure relief valve has been employed on the compressor.



Receiver for CFC12



Sight-glass and Fusible Plug for CFC12



Fusible Plug

f) Dual Pressure Switch

(1) Location & structure

The pressure switch is installed on the liquid tube between the receiver and the expansion valve. It detects abnormally high and low pressure of the refrigerant and switches off the magnetic clutch. Then the compressor operation is stopped, preventing potential trouble with the system.

(1) Dual pressure switch

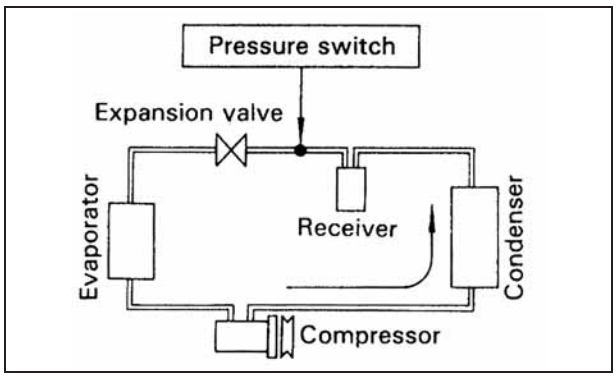


Fig. Location of Dual Pressure Switch

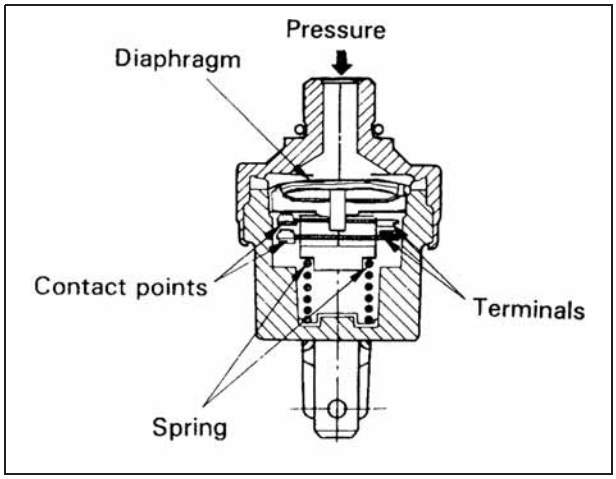


Fig. Dual Pressure Switch

(2) When the Pressure is Abnormally High

When the pressure in the refrigeration cycle becomes abnormally high, it may cause damage to various components.

When it detects abnormally high pressure, generally about 32 kg/cm^2 (3.14 MPa) the switch turns off. This turns the magnetic clutch off and stops the compressor (27 kg/cm^2 for CFC12).

(3) When the Pressure is Abnormally Low

When there is insufficient refrigerant and the pressure drops to 2.0 kg/cm^2 (0.20 MPa) or lower, the pressure switch turns off. This turns the magnetic clutch off and stops the compressor.

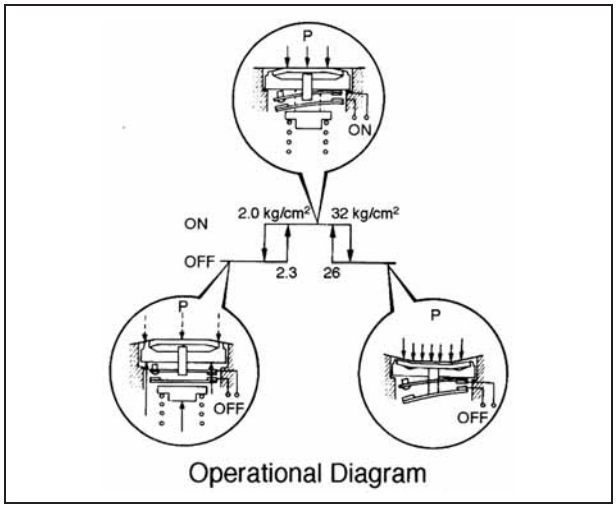


Fig. Operation of Dual Pressure Switch for HFC134a

g) Air Conditioner Unit

Air conditioner unit (1) consists of evaporator (3), expansion valve (4), heater core (2), blower (5), etc.

(1) Air Conditioner Unit
(2) Heater Core
(3) Evaporator
(4) Expansion Valve
(5) Blower

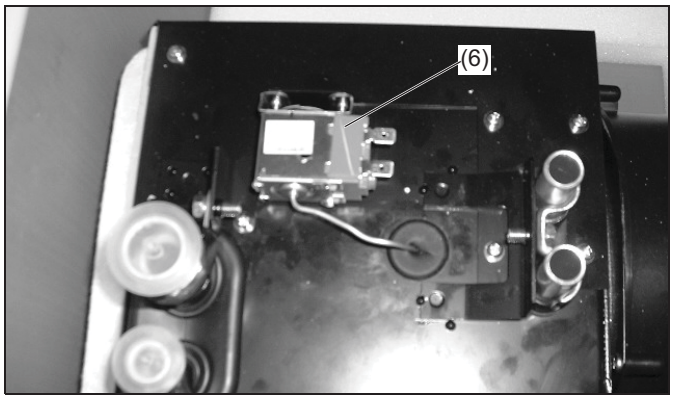
(1) Outline

The cooling unit consists of the following three main parts.

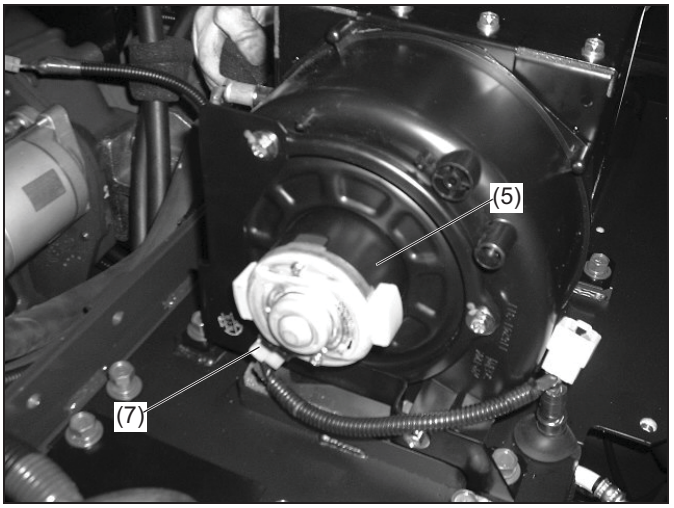
1) Expansion Valve
2) Evaporator
3) Drain Pan

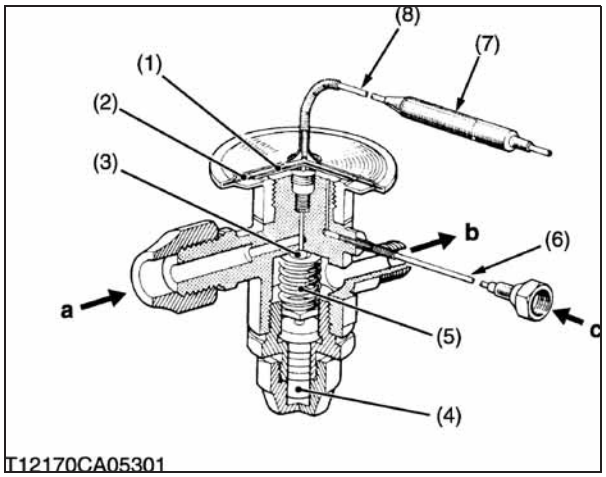
The drain pan collects the water condensed on the evaporator and drains it to the outside of the machine.

(6) Thermostat



(5) Blower
(7) Coupler





T12170CA05301

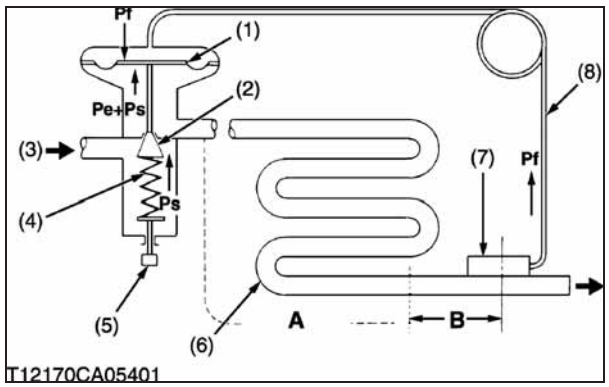
(2)Expansion Valve

The expansion valve restricts the flow of liquid refrigerant as it passes through the expansion valve and delivers sprayed refrigerant to the evaporator for facilitating refrigerant evaporation.
The cabin interior will not be cooled sufficiently if the expansion valve outlet is too small. If it is too wide, frost will be produced on the evaporator, decreasing cooling efficiency. Thus the size of this small spray hole has to be controlled according to various conditions.

(1) Diaphragm Chamber
(2) Diaphragm
(3) Needle
(4) Adjusting screw
(5) Pressure Spring
(6) Tube
(7) Heat Sensitizing Tube
(8) Capillary Tube

a: From Receiver
b: To Evaporator
c: From Evaporator

When the vapor pressure of the operating system is stable, Pf = Pe + Ps condition will prevail. The needle valve opening at this time will be stationary and constant refrigerant flow will be maintained.
In the evaporator installing expansion valve, the refrigerant in the outlet is always in superheated vapor form for certain length (part B in the figure). If the cooling load increases (inlet air temperature of evaporator becomes high), the refrigerant will vaporize faster and cause the length of the superheated vapor part (B) to become longer. Thus, the pressure in the heat sensitizing tube (7) rises and increases needle valve opening, resulting in larger flow of the refrigerant into evaporator. Conversely, if the amount of refrigerant in evaporator becomes greater, the length of the superheated vapor part (B) will become shorter. The pressure in the heat sensitizing tube will drop and decrease the needle valve (2) opening.



T12170CA05401

(1) Diaphragm
(2) Needle Valve
(3) Refrigerant Inlet
(4) Spring
(5) Adjusting Screw
(6) Evaporator Tube
(7) Heat Sensitizing Tube
(8) Capillary Tube

A: Saturated Vapor Part
B: Superheated Vapor Part
Pf: Gas pressure in sensitizing tube
Ps: Spring pressure
Pe: Vapor pressure in evaporator

FYI (For your information)

There are internally equalized and externally equalized types of thermal expansion valves depending on where the refrigerant gas pressure within the evaporator is taken. But both are identical in principle.

1) Internally Equalized Type Thermal Expansion Valve
When the refrigerant gas pressure in the evaporator is stable, pressure Pf is balanced with the sum of the pressure Pe and Ps. The valve opening will be stationary and constant refrigerant in the evaporator outlet is always in super-heated vapor form (completely evaporated) for certain length (part L in diagram). If the amount of the refrigerant in the evaporator becomes less, the refrigerant will vaporize faster and cause the super-heated part L to become longer. Therefore, the temperature of the outlet increases. The pressure in the temperature sensing bulb increases and opens the valve more, resulting in large flow of the refrigerant into the evaporator.
Conversely if the amount of the refrigerant in the evaporator becomes large, the super-heated part L will become shorter. The pressure in the temperature sensing bulb will drop and decrease the valve opening.

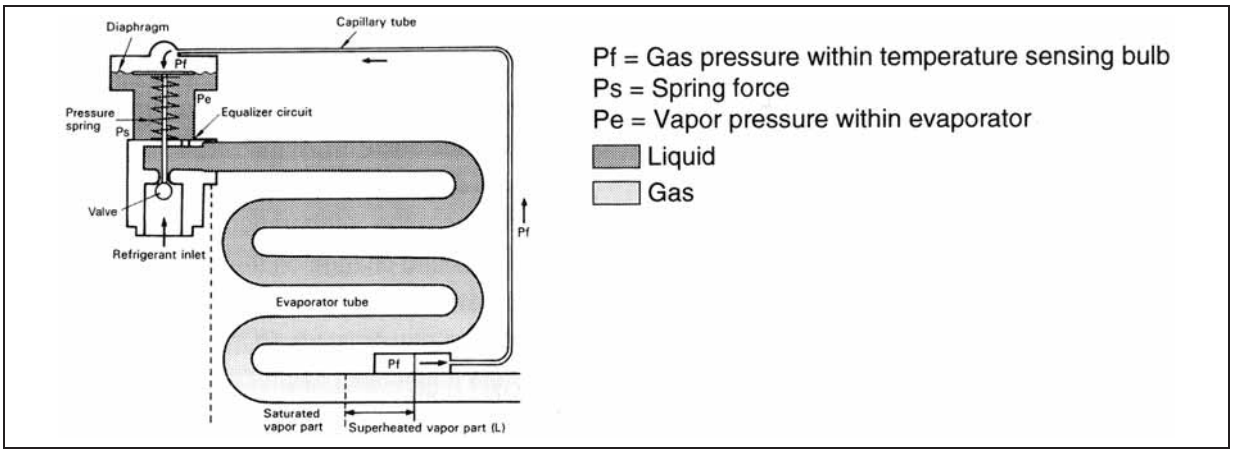


Fig. Operation of Internally Equalized Type Thermal Expansion Valve

2) Externally Equalized Type Thermal Expansion Valve
In the case of an internally equalized type thermal expansion valve, if there is a pressure drop between the evaporator inlet and outlet due to a blockage, a large degree of superheat will be required to open the valve.
In the externally equalized type expansion valve, this problem is overcome by taking the pressure near the end of the evaporator, instead of the evaporator inlet pressure. This pressure is applied to the underside of the diaphragm.

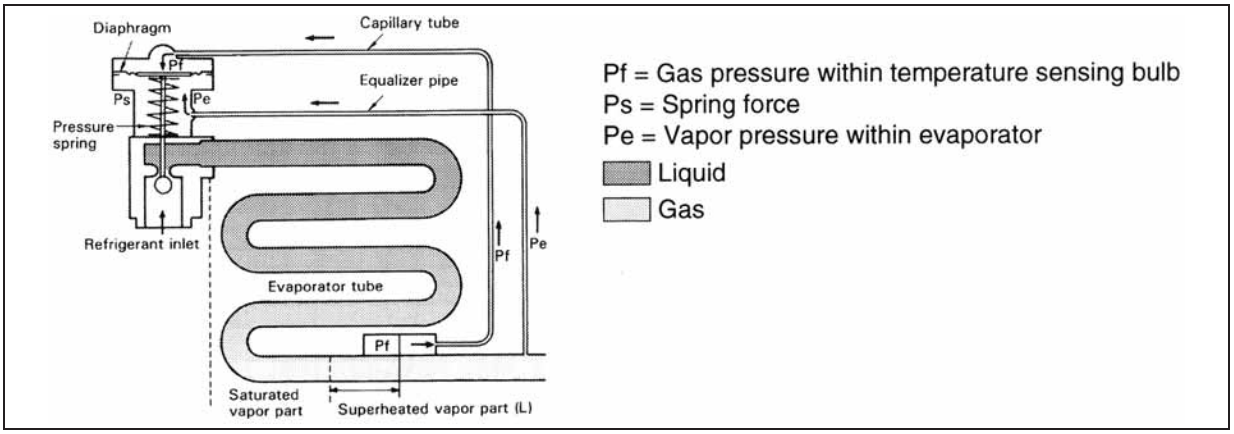


Fig. Operation of Externally Equalized Type Thermal Expansion Valve

3) Box Type Expansion Valve
Some recent vehicle models use a box-type expansion valve. This expansion valve features an internal temperature sensing rod (equivalent to the temperature sensing bulb found in the conventional expansion valve, which makes the use of the conventional capillary tube). This capillary tube is not necessary for the box type. In addition, the box-type construction, in which the refrigerant pressure at the evaporator outlet is applied directly to the temperature sensing rod side of the diaphragm, makes the use of the conventional equalizer pipe unnecessary.
In operation, the temperature sensing rod senses the temperature at the evaporator outlet and transmits to the diaphragm, causing the pressure of the gas that is contained in the diaphragm chamber to vary. As a result, the diaphragm moves, thereby controlling the opening and closing of the valve.

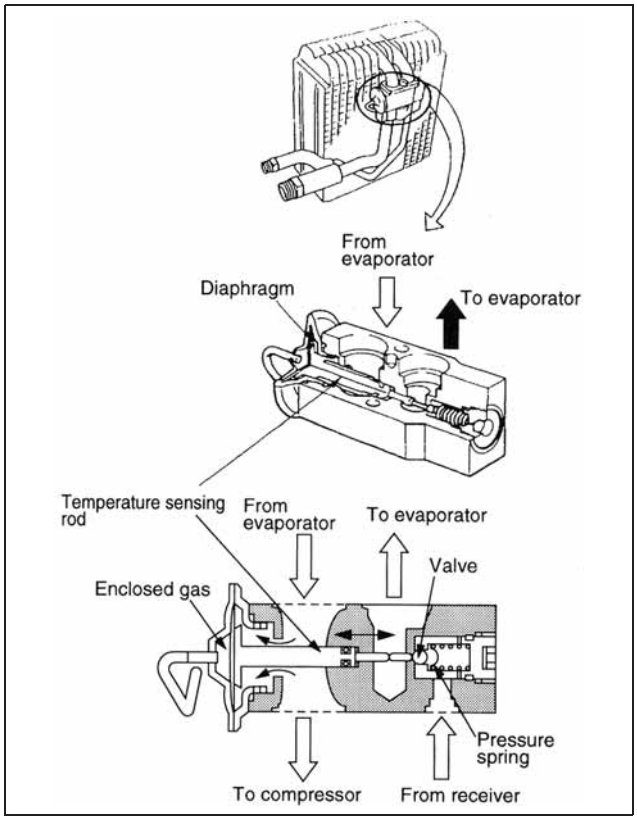
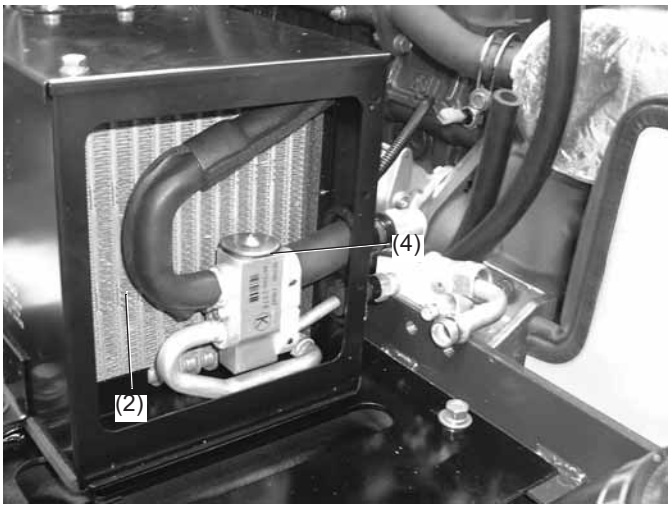


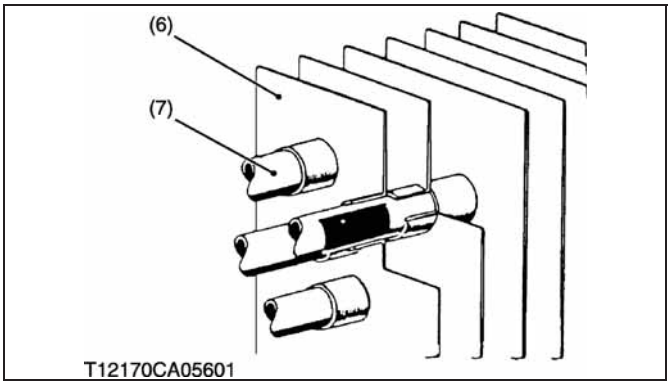
Fig. Box Type Expansion Valve

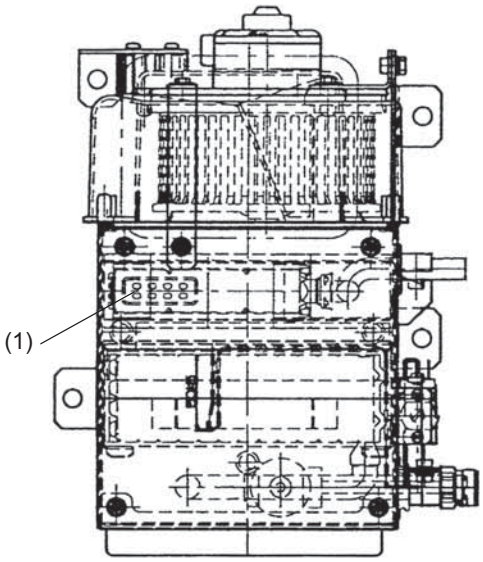
(3) Evaporator

The purpose of evaporator (2) is just opposite to that of the condenser. The state of refrigerant immediately after the expansion valve (4) is 100% liquid. As soon as the liquid pressure drops, it starts to boil, and in doing so, absorbs heat. This heat is removed from the air passing over the cooling fins of the evaporator and causes the air to cool.
If too much refrigerant is sent into the evaporator, it will not boil away so easily. Also, the evaporator filled with liquid refrigerant eliminates a place for the refrigerant to properly vaporize, which is necessary in order to take on heat. A flooding condition of the evaporator will allow an excess of liquid refrigerant to leave the evaporator and may cause serious damage to the compressor.
If too little refrigerant is sent into the evaporator, again the evaporator will not cool because the refrigerant will vaporize, or boil off, long before it passes through the evaporator.
Refrigerant properly metered into the evaporator should allow for 100% liquid just after the expansion valve, and 100% gas at the outlet.

(1) Pressure Switch
(2) Evaporator
(3) Capillary Tube
(4) Expansion Valve
(5) Thermostat
(6) Fin
(7) Tube



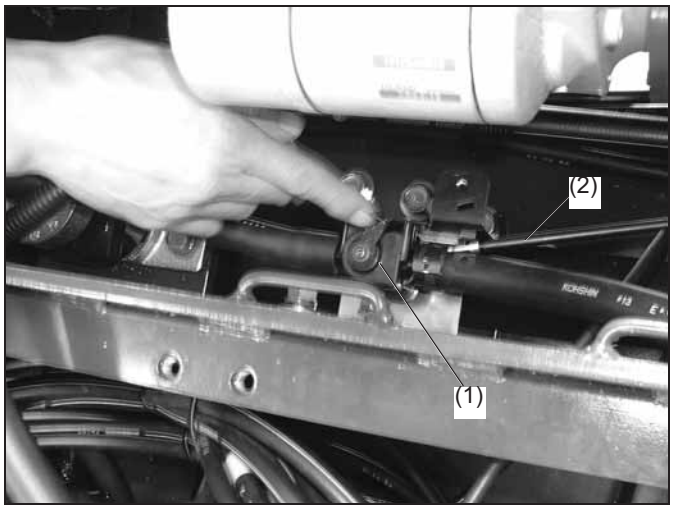




(4)Heater Core

The heater-source of heater utilizes coolant which becomes high temperature by heat of engine.
The inlet port heater core is connected to the delivery side of engine water pump by a rubber hose, and the water valve is installed on the inlet port of heater core.
Also, the outlet port of heater core is connected to the engine cylinder block.
The heater core (1) is one of the heat exchangers like evaporator or condenser, and heat is exchanged between heated coolant passing through the core and air in the cabin or fresh outdoor air. Thus, air is heated.

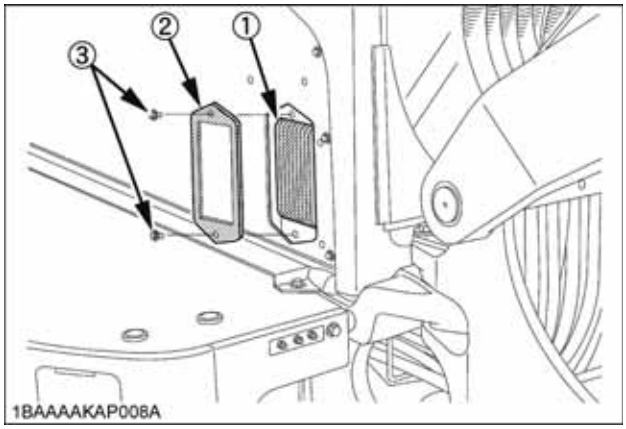
(1) Heater Core



(5)Water Valve

The hot water valve (1) is connected with the got water valve cable (2) and controlled with the temperature control lever on the control panel. This lever is used to adjust the flow rate of hot water going into the heater.
Set the temperature control lever to the COOL position and the hot water valve gets closed, allowing no hot water flow. The hot water valve is built in at the right-hand top of the center pillar.

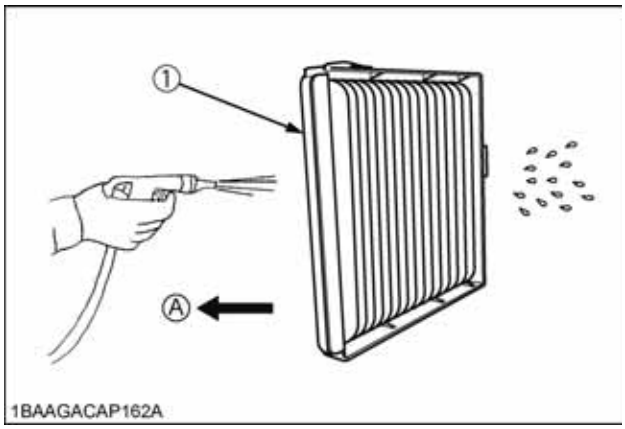
(1) Hot Water Valve
(2) Hot Water Valve Cable

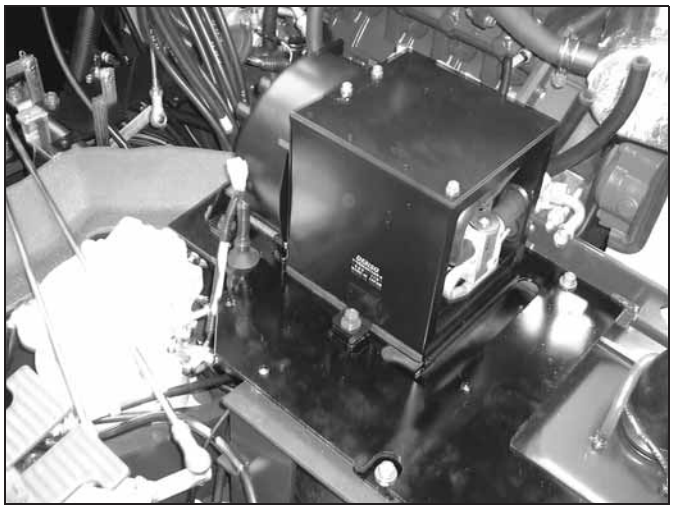


(6)Air filter

1. Percolation area: 0.057 m^2
2. Rated air filter: 300 m^3/h
3. Clearing efficiency:45% or more at 150 m^3/h

(1) Air filter

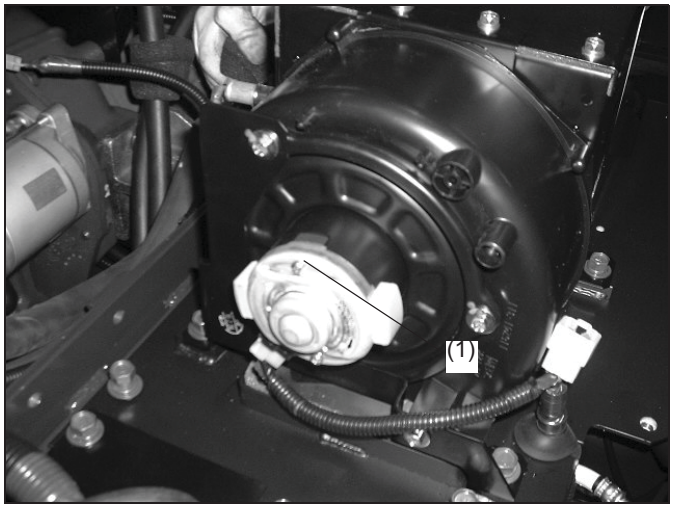




(7)A/C Blower

The blower is incorporated in the right-hand space of the air conditioner unit. It blows cool, warm of fresh air via the front and side blow ports into the cabin.
The speed of the blower motor (1) can be adjusted in 3 steps by the resistor (2).
The blower fan (3) is centrifugal type. The air being sucked in parallel with the rotary shaft is blown in the centrifugal direction; in other words, perpendicular to the rotary shaft.

(1) Blower Motor
(2) Resistor
(3) Blower Fan



(1) Blower Motor

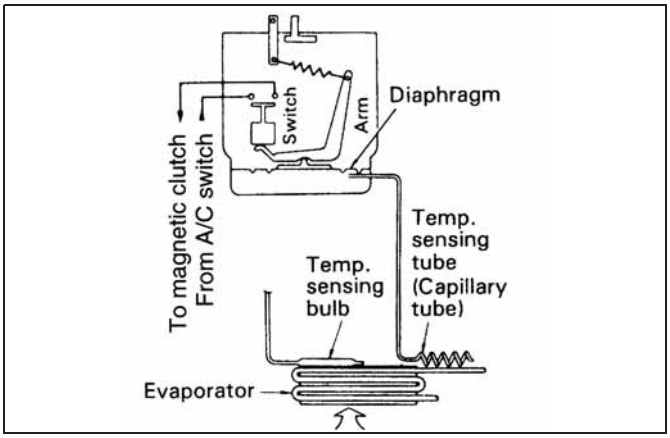


Fig. Temperature Control Circuit

(8)Gas Type Thermostat

The gas type thermostat consists of a capillary tube, diaphragm and microswitch.
The capillary tube is filled with a special gas.
The capillary tube is fitted on the tube of the evaporator outlet. The gas pressure in the capillary tube changes depending on the temperature change of refrigerant gas.
When the temperature of refrigerant at the evaporator outlet increases, the pressure in the capillary tube increases, thus closing the contact point (ON) of the microswitch.
Conversely when the temperature of the refrigerant decreases, the pressure in the capillary tube decreases and opens the contact point (OFF) of the microswitch.
As a result, the magnetic clutch is turned on and off, depending on the temperature of evaporator outlet. This controls the temperature in the cab.

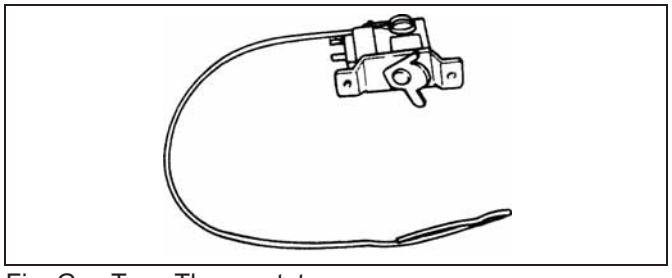
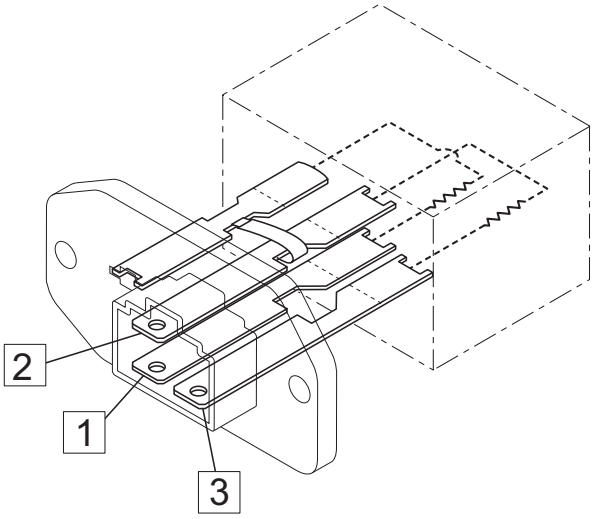


Fig. Gas Type Thermostat

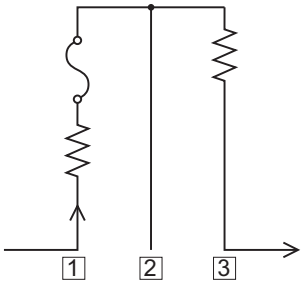
(9) A/C blower resistor

1) Main functions are;
   1. Two resistors regulate the blower speed according to the A/C blower switch speed range.
   2. Fuse prevents the blower from burning out.

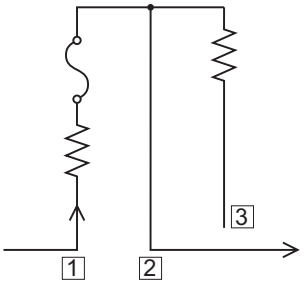
2) Structure



3) Current flow

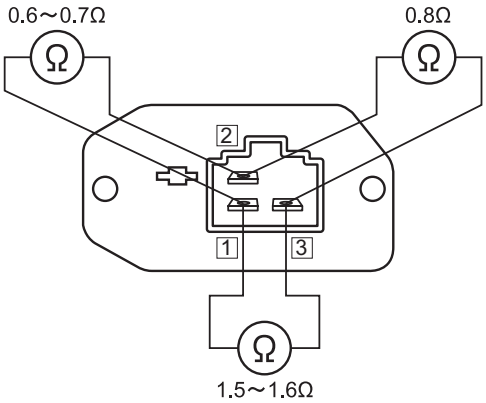


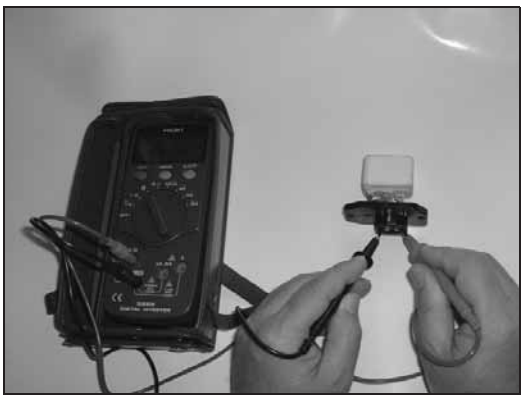
Low position



Medium position

4) Testing





h) Refrigerant

(1) Refrigerant R134a

Important

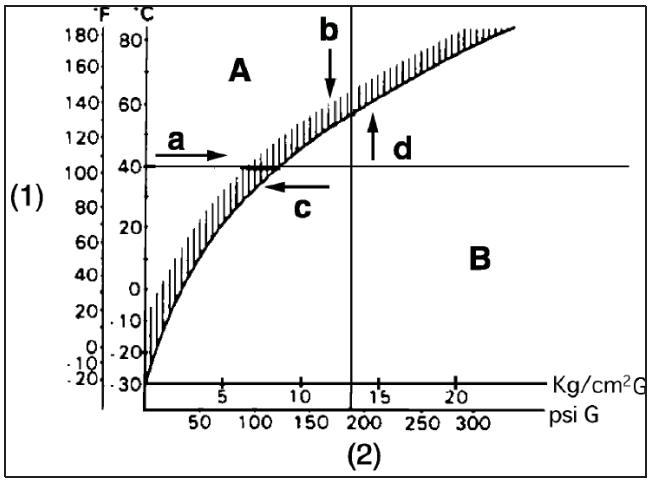
- **The air conditioning system operates using R134a refrigerant. This substance does not contain any chlorine atoms, so it does not have a detrimental effect on the ozone in the Earth's atmosphere.**
- **Even so, the refrigerant must never be discharged straight into the air. It must be trapped in a recycling machine.**
  Refrigerant stored in a recycling unit may be re-used at any time.
- **The recycling machine used to do this must be of a type suitable for handling R134a refrigerant.**
- **R134a has a corrosive effect on copper as well as various seals and components used in the R12 system. For this reason, never use R134a refrigerant in a system that has previously used R12. Before replacing any component, it is vital to check whether it is compatible with the type of refrigerant used.**

(2) Refrigerant Properties

Water boils at 100°C (212°F) under atmospheric pressure, but R134a boils at -26.5°C (-15.7°F) and its freezing points is -101°C (-149.8°F) below zero under atmospheric pressure.

If R134a were exposed and released to the air under normal room temperature and atmospheric pressure, it would absorb the heat from the surrounding air and boil immediately changing into liquid under the pressurized condition by removing heat from it.

The characteristic curve of R134a which expresses the relation between the temperature and pressure is shown in the figure left. The graph itself indicates the boiling point of R134a under each temperature and pressure. On the graph, the upper portion above the curve is gaseous state of R134a and the lower portion below the curves liquid state of R134a. The gaseous refrigerant can be converted into liquid refrigerant by raising the pressure without changing the temperature or decreasing the temperature without changing the pressure. (See (a) and (b) in the figure.) Conversely, the liquid refrigerant by lowering the pressure without changing the temperature, or by raising the temperature without changing the pressure. (See (c) and (d).)



A: GAS
B: LIQUID

(1) Temperature
(2) Gauge Pressure

FYI (For your information)

Type of Refrigerant

The characteristics of representative refrigerants used in vapor compression cooling machines familiar to the public are shown in the table below. Their characteristics stand out as compared with water. Because their boiling point is very low, they boil instantaneously at ordinary temperature, rapidly drawing heat from the surroundings.

The lower the boiling point of a refrigerant used is, the higher the pressure becomes, which allows the use of a low-capacity compressor. HCFC-22 is therefore used in room coolers. In the case of air conditioners for construction machines, because it is absolutely necessary to use a rubber hose as the refrigerant pipe in order to absorb vibration of the compressor attached to the engine, CFC-12 that will not cause rubber to deteriorate has been used. Recently, in order to address the problem of ozone layer destruction, CFC-12 has been replaced with HFC-134a that has almost the same thermal characteristics as CFC-12.

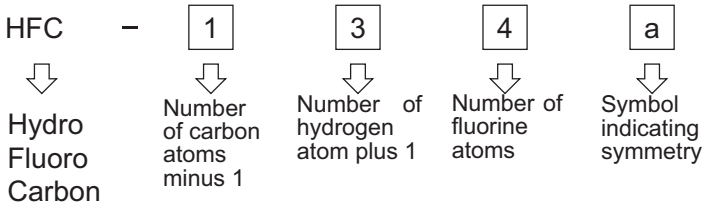
Characteristics of representative refrigerants

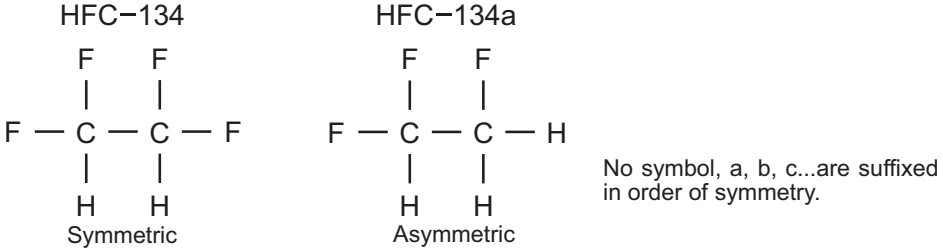
Refrigerant	Chemical formula	Boiling point (1 atm) °C	Pressure (0°C) MPa	Latent heat (0°C) kj/kg	Remarks
HCFC-22	CHC	-40.75	0.50	205.3	Causing rubber to deteriorate
CFC-12	CCF2	-29.65	0.31	151.4	Promoting ozone layer destruction
HFC-134a	CH_2FCF_3	-26.07	0.29	198.7	
<Reference> Water	H_2O	100.0	0.0006	2,502.8	

Freon name

How to understand a Freon name

Example HFC-134a (CH_2FCF_2)





As compared with CFC-12, HFC-134a has the following unfavorable characteristics.
(1) Bad compatibility with the conventional compressor oil (mineral oil)
(2) High water solubility (Absorbing moisture easily)
(3) High swelling-property and permeability for sealing materials and hose materials
It is therefore necessary to select materials suited to HFC-134a. The problems with HFC-134a and the changes to be made to cope with them are summed up in the figure below.

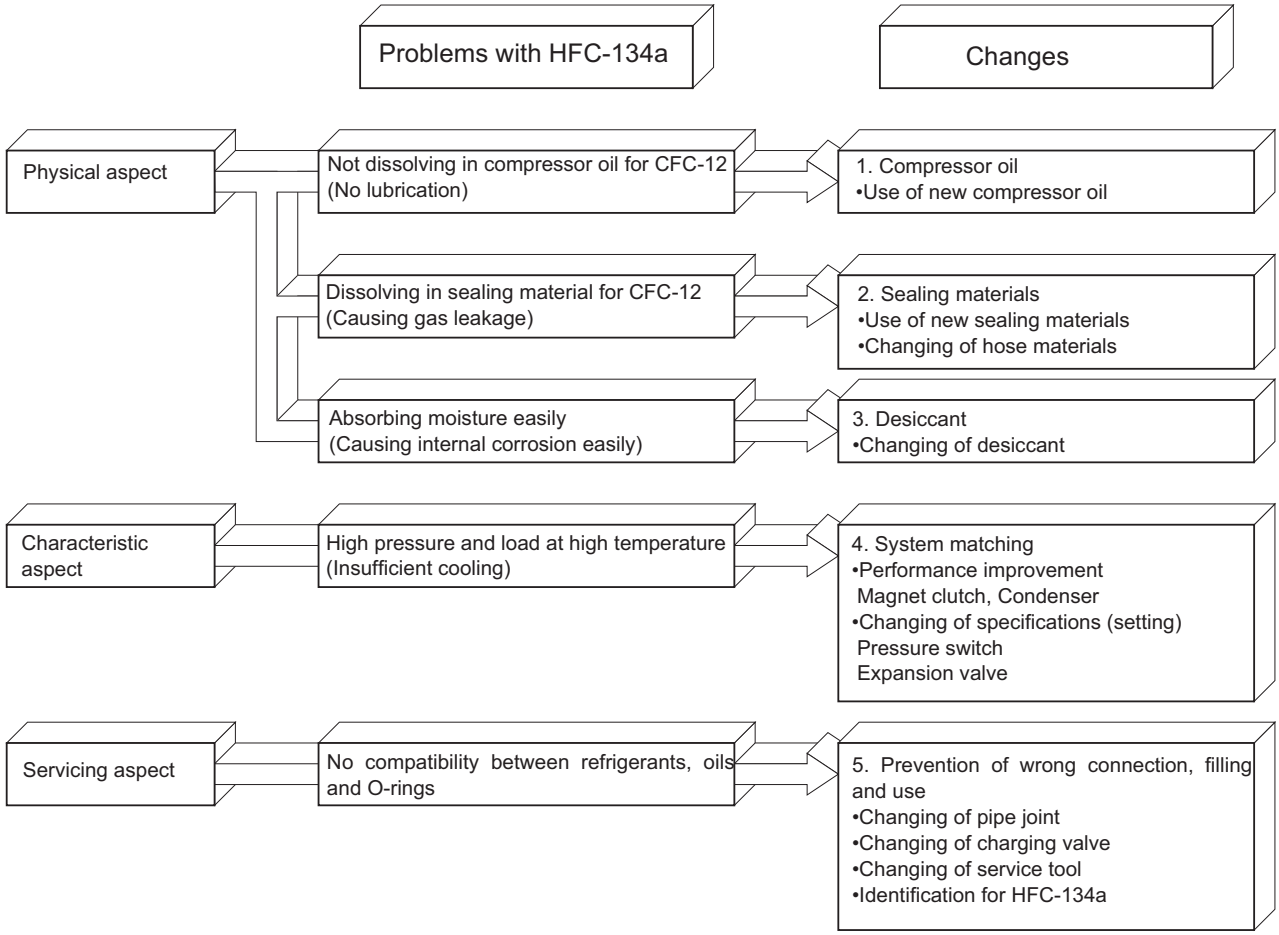
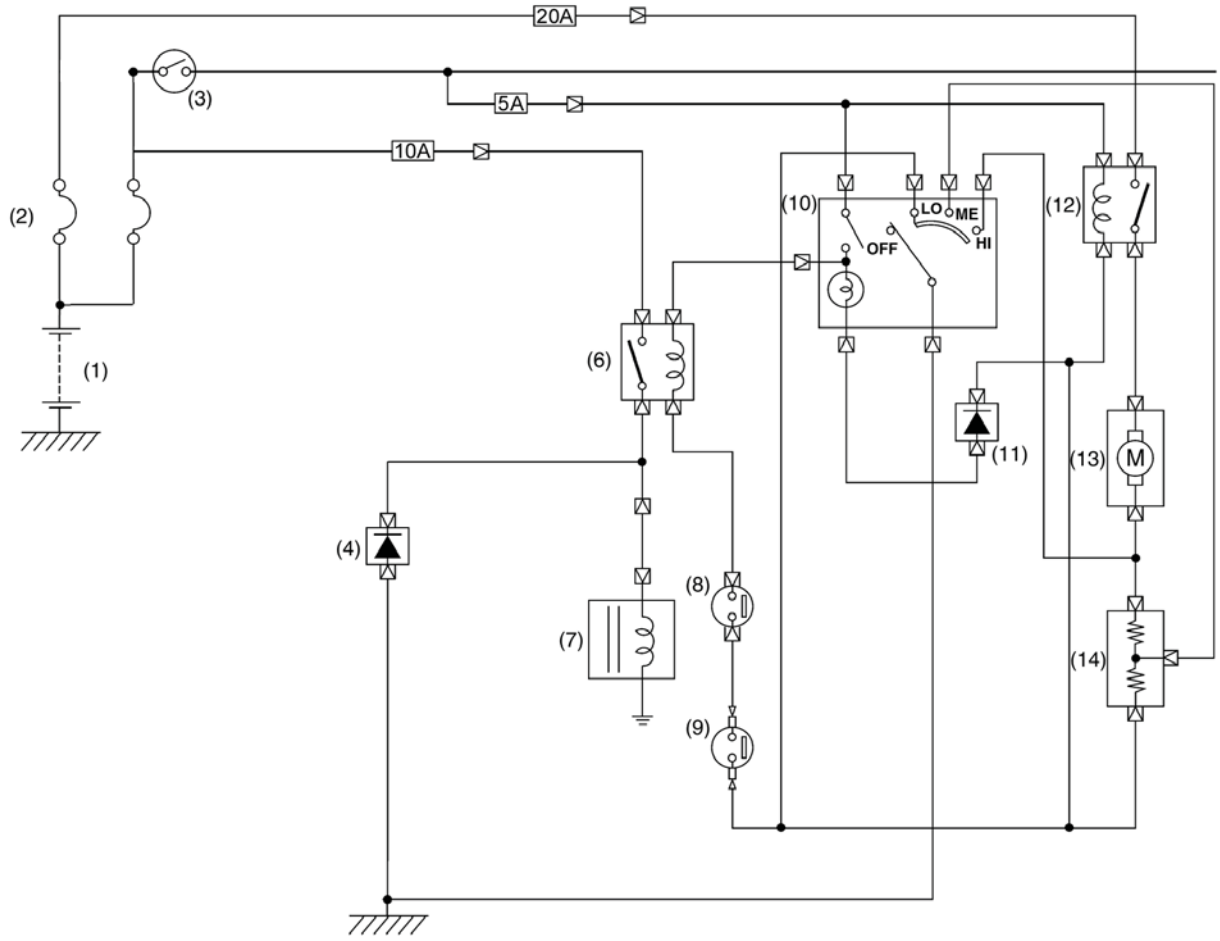


Fig. Problems with HFC-134a and changes to be made to cope with them

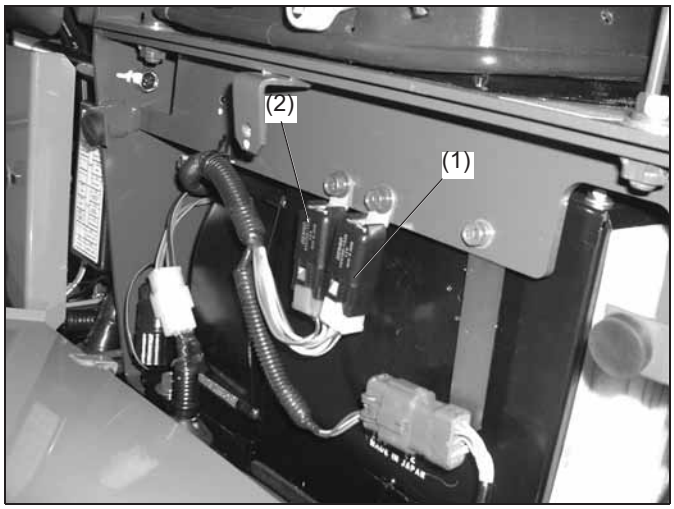
(C) ELECTRICAL SYSTEM

a) Electrical Circuit



(1) Battery
(2) Slow Blow Fuse
(3) Main Switch
(4) Diode
(5) Joint Connector
(6) Compressor Relay
(7) Compressor
(8) Pressure Switch (Dual type)
(9) Thermostat
(10) A/C Blower Switch
(11) Diode
(12) A/C Blower Relay
(13) A/C Blower Motor
(14) A/C Blower Resistor

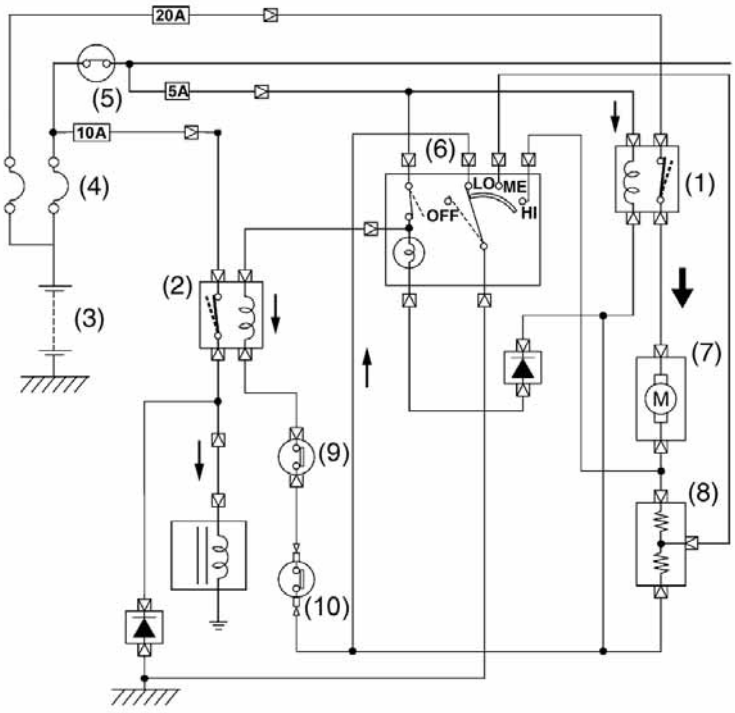
The process of magnetic clutch being engaged is shown below.
Main Switch (3) ON → A/C Switch (10) ON → Compressor Relay Coil (6) → Thermo Switch (9) ON (the thermostat temperature is more than 4°C (39.2°F)) → Pressure Switch (8) ON (if refrigerant pressure is between 0.196 MPa (2.0 kgf/cm^2, 28.4 psi) and 3.14 MPa (32 kgf/cm^2, 445 psi) → Blower Switch (10) ON (Low, Medium or High) → Ground.
Then Compressor Relay Contact (6) → Magnetic Clutch of Compressor (7) engaged.



Open the cover of A/C and the relays are visible at the foot center of the cabin: blower relay (1) and compressor relay (2). When the blower fan is adjusted for the air flow rate, the blower relay (1) is activated by a signal from the fan switch on the control panel.

Among the air conditioner components, current flows to the blower motor (7) and magnetic clutch. If all of these current were to be passed through the main switch (5) and supplied, the current would be too large for the main switch (5) so that there will be danger or burning out the main switch contact. If the current were to be passed directly from the battery (3), forgetting to turn off the blower motor (7) could result in a discharged battery (3).

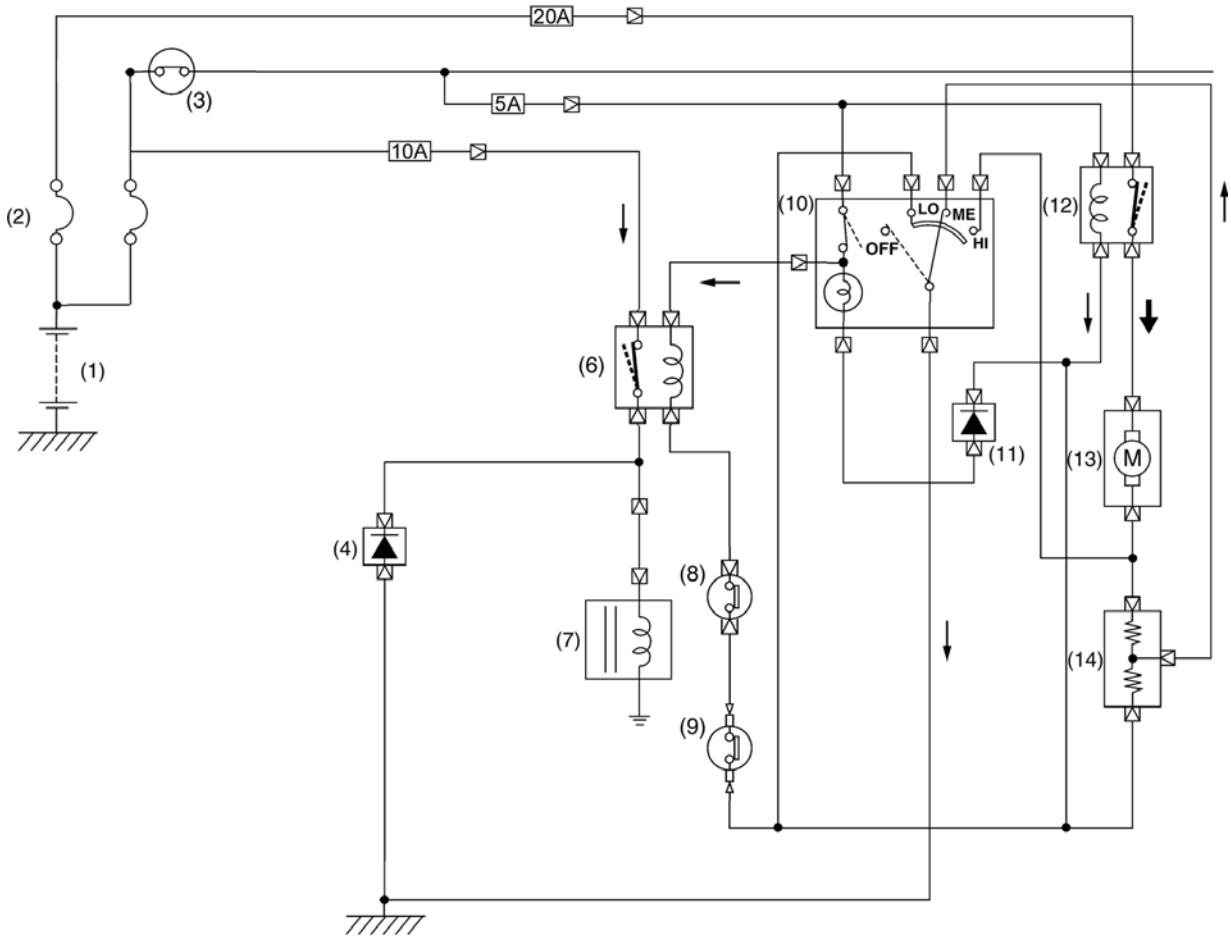
To protect against such trouble, relays have been provided. These relays have been made so that when current flows through its coil, the contact close to supply the power from the battery (3). By employing these relays, the current flowing through the main switch (5) has been decreased as only a small current is required to actuate the relay. Thus there will be no danger of burning out the switch contact, and when the main switch (5) is opened, the relay contact will open at the same time. This action stops the current flow in the air conditioner circuit so that there will also be no chance of the battery discharging.



(1) A/C Blower Relay
(2) Compressor Relay
(3) Battery
(4) Slow Blow Fuse
(5) Main Switch
(6) A/C Blower Switch
(7) A/C Blower Motor
(8) A/C Blower Resistor
(9) Dual pressure switch
(10) Thermostat

b) Air Conditioner Blower Switch

When Blower Switch is in · (Low), • (Medium) or ● (High) Position



(1) Battery	(5) Joint Connector	(8) Pressure Switch	(12) A/C Blower Relay
(2) Slow Blow Fuse	(6) Compressor Relay	(9) Thermostat	(13) A/C Blower Motor
(3) Main Switch	(7) Compressor	(10) A/C Blower Switch	(14) A/C Blower Resistor
(4) Diode	(Magnet clutch)	(11) Diode	

When the Main Switch is turned ON, the current flows from battery to A/C Blower Relay Coil and A/C relay is turned ON. As the A/C relay is turned ON, the current from battery flows to A/C Blower Switch through the A/C Blower Motors as follows.

"·" (Low) Position

Battery (1) → Slow Blow Fuse (2) → Main Switch (3) → Fuse → A/C Blower Relay Coil (12) → A/C Blower Switch LO Position (10) → Ground.

Then, A/C Blower Relay is turned ON and battery current flows to A/C Blower Motor.

Battery (1) → Slow Blow Fuse (2) → Fuse → A/C Blower Relay Contact (12) → Blower Motor (13) → Blower Resister (14) → A/C Blower Switch LO Position (10) → Ground.

"•" (Medium) Position

Battery (1) → Slow Blow Fuse (2) → Main Switch (3) → Fuse → A/C Blower Relay Coil (12) → A/C Blower Switch LO Position (10) → Ground.

Then, A/C Blower Relay is turned ON and battery current flows to A/C Blower Motor (13), A/C Blower Resistor (14), A/C Blower Switch ME Position (10) and ground.

"●" (High) Position

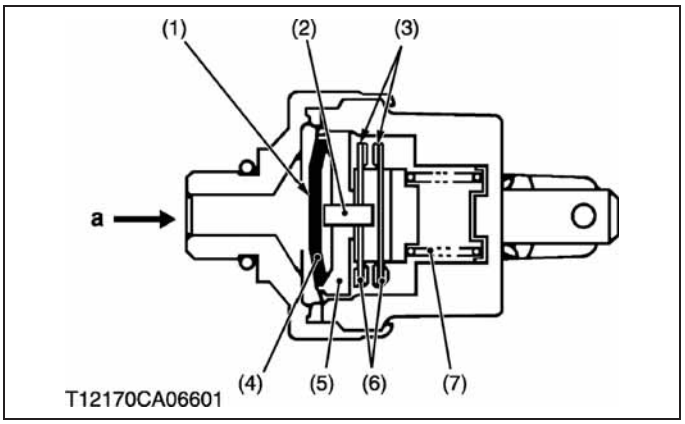
Battery (1) → Slow Blow Fuse (2) → Main Switch (3) → Fuse → A/C Blower Relay Coil (12) → A/C Blower Switch LO Position (10) → Ground.

Then, A/C Blower Relay is turned ON and battery current flows to A/C Blower Motor (13), A/C Blower Switch HI Position (10) and ground.

c) Dual Pressure Switch

The pressure switch detects the pressure in the refrigerant cycle, and when something is wrong, turns off the magnetic clutch to prevent the component from troubling. This system has dual type pressure switch (2), and this switch controls low pressure cut and high pressure cut.

(1) A/C Unit
(2) Pressure Switch

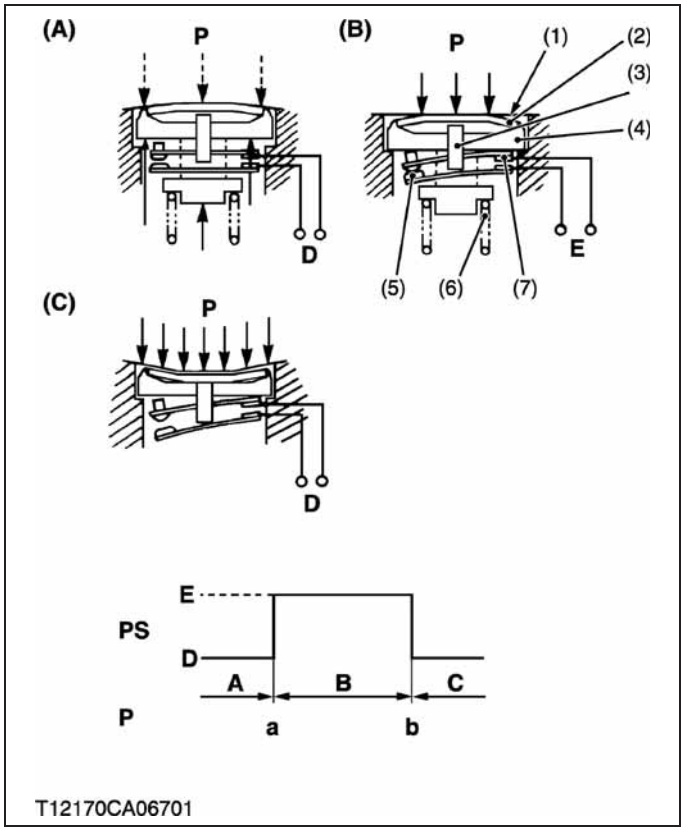


(1)Pressure Switch (Dual Type)

The pressure switch is installed in inlet line (liquid line) between receiver and expansion valve. The contact of pressure switch is normally open type.

(1) Diaphragm
(2) Pin
(3) Terminal
(4) Belleville Spring
(5) Plate
(6) Movable Contact
(7) Spring

a: Pressure



OFF Position

(A: When the Refrigerant Pressure is Low)
The pressure switch detects the pressure drop when the refrigerant leaks from the system causing compressor seizure. When pressure of refrigerant is less than specified pressure, the switch is turned OFF and disengages magnetic clutch.

ON Position

(B: When the Refrigerant Pressure is Normal)
When the pressure in the inlet line is between 0.196 MPa (2.0 kgf/cm^2, 28.4 psi) and 3.14 MPa (32.kgf/cm^2, 455 psi), the switch is turned ON (the pressure is normal condition), and engages magnetic clutch.

OFF Position

(C: When the Refrigerant Pressure is High)
When the pressure in the inlet line is higher than specified pressure, the switch is turned OFF, and disengages magnetic clutch.

Reference

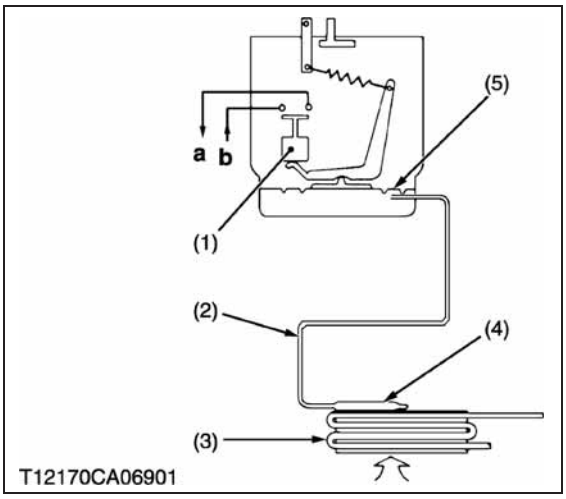
Setting pressure
OFF (Low pressure side):
Less than approx. 0.196 MPa (2.0 kgf/cm^2, 28.4 psi)
ON (Normal pressure):
Between approx. 0.196 MPa (2.0 kgf/cm^2, 28.4 psi), to 3.14 MPa (32 kgf/cm^2, 455 psi)
OFF (High pressure side):
More than approx. 3.14 MPa (32 kgf/cm^2, 455 psi)

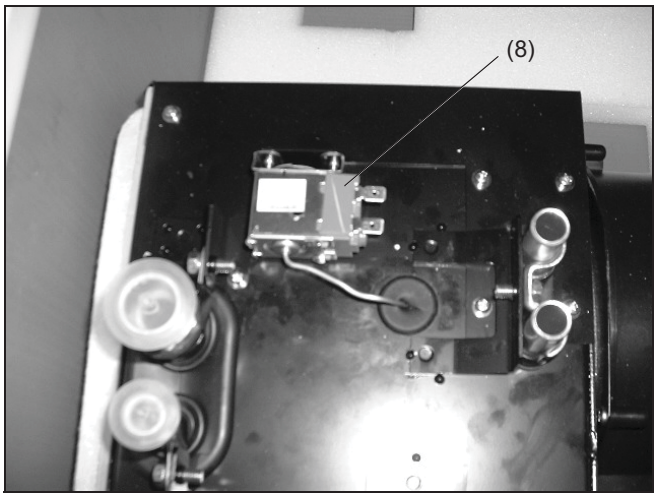
(1) Diaphragm
(2) Bellville Spring
(3) Pin
(4) Plate
(5) Terminal
(6) Spring
(7) Contact

A: Refrigerant Pressure is Low
B: Refrigerant Pressure is Normal
C: Refrigerant Pressure is High
D: OFF
E: ON
P: Pressure
PS: Pressure Switch

a: 0.196 MPa
(2.0 kgf/cm^2, 28.4 psi)
b: 3.14 MPa
(32 kgf/cm^2, 455 psi)

d) Thermostat





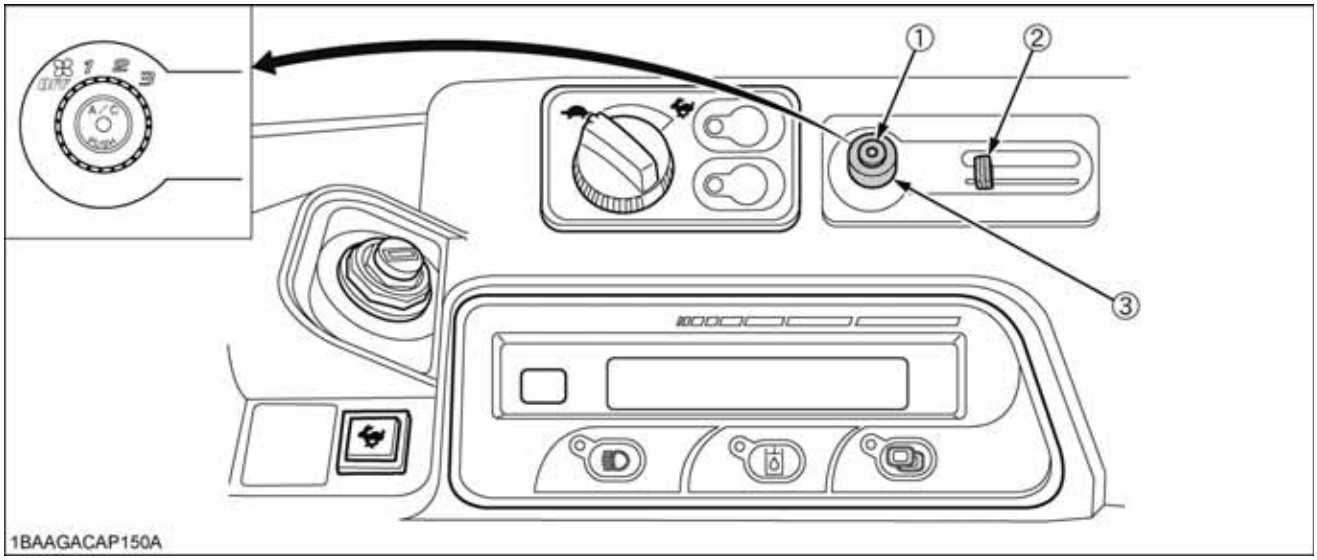
If the evaporator fin temperature, that is, refrigerant vaporizing temperature, drops below 0°C (32°F), frost or ice will form on the fins, causing a decrease in air flow and lowering cooling capacity. To prevent such frosting, and also to allow setting cabin interior to desired temperature, a thermostat has been installed.
In this system, gas type thermostat is used.
The gas type thermostat has a capillary tube which is filled with special gas. The capillary tube is connected to the diaphragm chamber. The tip of the capillary tube is positioned on the evaporator fins.
When the evaporator fins temperature is high, the micro switch in the thermostat is turned **ON** by increasing the pressure in the diaphragm chamber. When the evaporator fins temperature is low, such as in winter season, the micro switch is turned **OFF** because of the pressure in the diaphragm chamber and spring tension drops, thus turning **OFF** the magnetic clutch to prevent the evaporator from frosting.

(Reference)
Thermostat setting temperature
OFF Approx 1°C (34°F)
ON Approx 4.5°C (40.1°F)

(1) Micro Switch
(2) Capillary Tube
(3) Evaporator
(4) Heat Sensitizing Tube
(5) Diaphragm
(6) Thermo Switch
(7) Expansion Valve
(8) Thermo sensor

a: To Magnetic Clutch
b: From A/C Switch

e) Control Panel



(1) Air conditioner switch with indicator light
(2) Temperature control lever
(3) Blower switch

Air Conditioner Switch with Indicator Light
Push this switch to activate the air conditioner. An indicator light will light up when the switch is set "ON". Push switch again to turn air conditioner off, in which case the indicator light will be off.

Temperature Control Lever
Set this lever at the desired position to obtain the desired air temperature. Move the lever to the right to obtain cooler air. Move it to the left to obtain warmer air.

Blower Switch
Air volume can be changed in three steps. At the "3" position, the largest air volume is obtained.

Operation

Heating

1) Adjust the blower (1/2/3) switch and the temperature control lever to achieve the desired temperature level.

Note: In summer when the heater is not used, keep the temperature control lever ar the "COOL" (rightmost) position. Otherwise, hot air will raise the temperature in the CAB.

Dehumidifying-heating

1) Press and turn on the air-conditioner switch.
2) Turn on the blower (1/2/3) switch.
3) Adjust the temperature control lever to "COOL" or an intermediate position to achieve the desired temperature level.

Note: Be sure to close the door while the air conditioner is ON.

Cooling

1) Press and turn the air-conditioner switch.
2) Turn on the blower (1/2/3) switch.
3) Adjust the temperature control lever to the "COOL" or an intermediate position to achieve the desired temperature level.

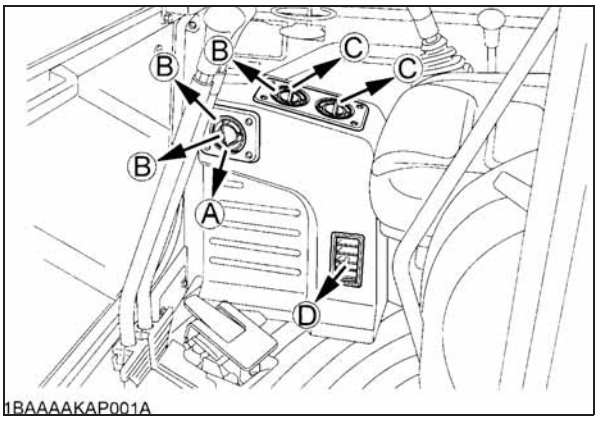
Note: Be sure to close the door while the air conditioner is ON.

Defrosting or demisting
To defrost or demist the windshield, take the following steps.

1) Open the front air outlet and direct it to the windshield.
2) Set the blower switch and the temperature control lever to the "3" and "WARM" (leftmost) positions, respectively.

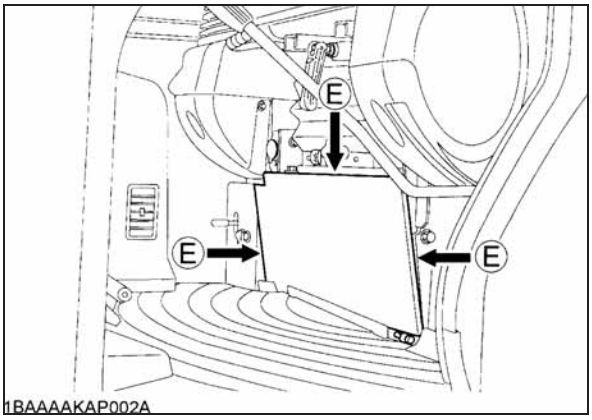
f) Air Flow

Air in the CAB and fresh air introduced into the CAB flow as shown in the figure. Adjust the 4 air outlet ports to obtain the desired condition.



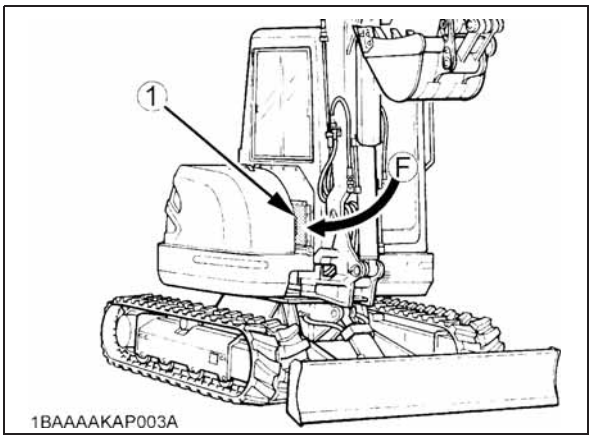
1BAAAAKAP001A

(A) "DOOR WINDOW"
(B) "WIND SHIELD"
(C) "CHEST AREA"
(D) "FOOT AREA"



1BAAAAKAP002A

(E) "INNER AIR RECIRCULATION"



1BAAAAKAP003A

(1) Fresh air filter
(F) "FRESH AIR INLET"

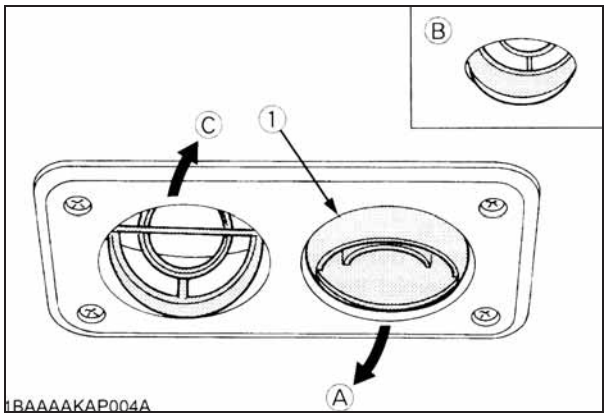
IMPORTANT

Do not allow water to enter the fresh air port while washing the excavator.

Air Control Vent

Front air outlet

The front air outlets can be independently adjusted as required. To defrost the windshield, rotate the outlets toward the windshield.



1BAAAAKAP004A

(1) Front air outlet
(A) "WINDSHIELD"
(B) "CLOSED"
(C) "CHEST AREA"

⚠CAUTION

To avoid personal injury;

- **Replace the water hoses every two years.**
- **Inspect daily.**
- **Have the excavator repaired immediately if any of the following defects are discovered.**
  (Such defects may cause burns or injury. They may also cause engine failure by serious damage.)
  - **Scratches, cracks or swelling in water hoses**
  - **Water leaks at joints or connecting points.**
  - **Missing or damaged water hose protective sleeve or grommet.**
  - **Loose mounting bolt, damaged bracket**
- **Do not touch the water hoses or the heater with your hand. You may get burned.**
- **If the window fails to defrost in extreme conditions or becomes cloudy when dehumidifying the CAB, remove moisture with soft cloth.**
- **Do not block all the air outlets of the air conditioner. A trouble may result.**

(D) TECHNICAL TERMS

a) Heat

Heat is one form of energy.
1 kcal heat quantity changes the temperature of 1 kg of liquid water by 1°C

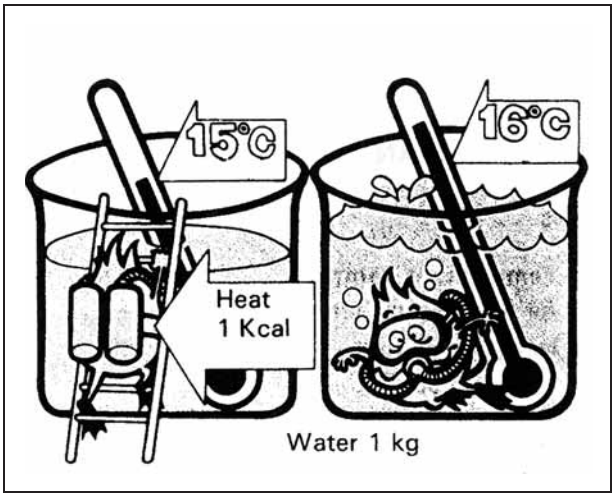


Fig. Heat Quantity

(1) Specific Heat

Specific heat is heat quantity required to CHANGE THE TEMPERATURE of an object 1°C.

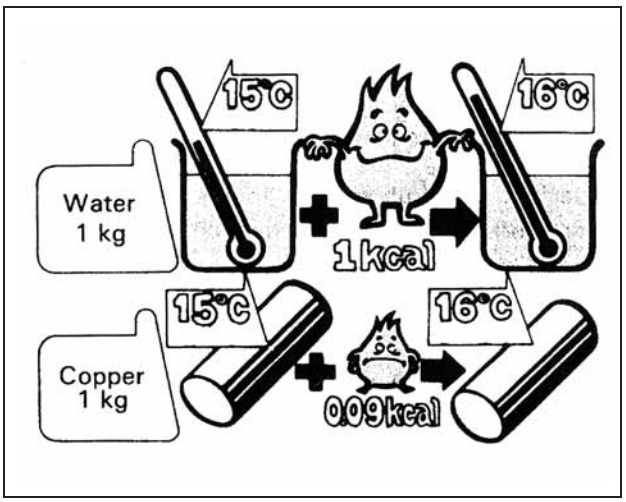


Fig. Specific Heat

b) Temperature

(1) Temperature Scales

Temperature is degree of heat coldness of an object. The unit generally used to express it is "Centigrade degree (°C)" or "Fahrenheit degree (°F)".
In the Celsius scale, the freezing point (solid point) of pure water is taken as 0°C, and the distance between the freezing point and boiling point is divided into 100 parts. And each part designated as 1°C.
In the Fahrenheit scale, the freezing point of pure water is taken as 32°F, and the distance between the freezing point and boiling point is divided into 180 parts, and each part designated as 1°F.

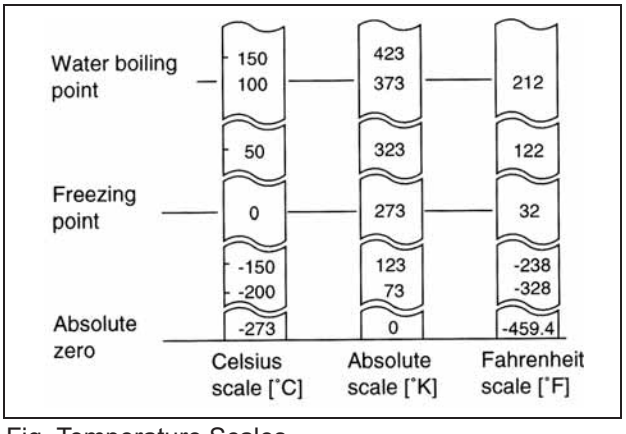


Fig. Temperature Scales

$$°C = \frac{5}{9}(°F - 32)$$

$$°F = \frac{9}{5}(°C + 32)$$

(2) Wet Bulb and Dry Bulb Thermometers

[WET BULB THERMOMETER]

The bulb (heat sensitizing part) of a glass tube thermometer is wrapped with a gauze or other rough mesh cloth. One end of the cloth is immersed in a water container to allow the water to be drawn up by a capillary action and to moisten the heat sensitizing part. The water in the cloth surface near the heat sensitizing part evaporates and robs the latent heat of evaporation from surrounding air, causing the air temperature around the heat sensitizing parts to drop. The temperature registered by the thermometer at this time is called the wet bulb temperature.

This is used to find out humidity in combination with the dry bulb temperature.

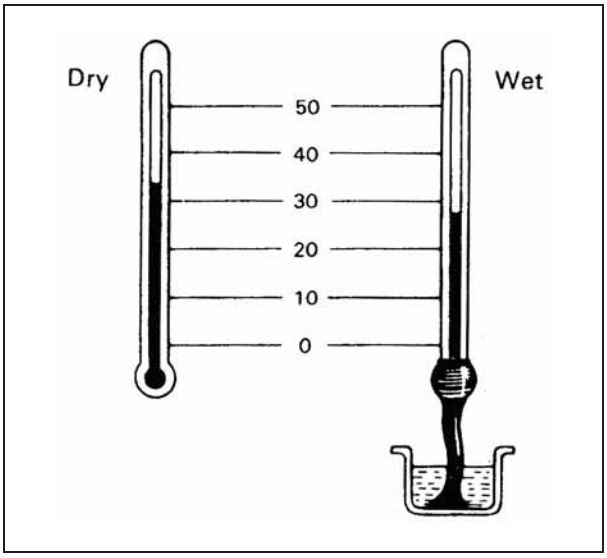


Fig. Thermometer

(3) Dew Point Temperature

When the air surrounding us is cooled, the air temperature drops, and when the humidity becomes 100%, that is, when the dry bulb and wet bulb temperature become the same, the water vapor contained in the air will be in a saturated state.

On further cooling, the water vapor reaches a condition where it cannot remain in a vapor state so that a part condenses and becomes dew. The temperature at which the humidity becomes 100% and dew is formed is called dew point temperature.

c) Humidity

(1) What is Humidity?

Humidity is the term used to express the wetness or dryness of air.
The air around us is composed of air containing no vapor (dry air) and air containing water vapor, all mixed together. The amount of water vapor in the air is called "humidity".
In general, human beings feel uncomfortable when the humidity is high, and comfortable when the humidity is low.

(2) Relative Humidity

There are two ways of measuring humidity: "relative humidity" and "absolute humidity".
The most common measurement of humidity is relative humidity. Relative humidity is the amount (by weight) of water vapor which the air actually contains, compared with the amount (weight) of vapor which the air could hold at a given temperature. Thus, if the relative humidity is 50%, the air could twice as much vapor as it actually does at that temperature.
The amount (weight) of vapor that the air could hold changes according to the temperature of the air. If the temperature of the air rises, the amount of vapor which the air could hold also rises.
So, if the temperature of the air rises, and the amount of vapor that the air contains remains unchanged, the relative humidity will decrease.

(3) Absolute Humidity

Absolute humidity is amount (by weight) of vapor which the air contains, compared with the amount of dry air.

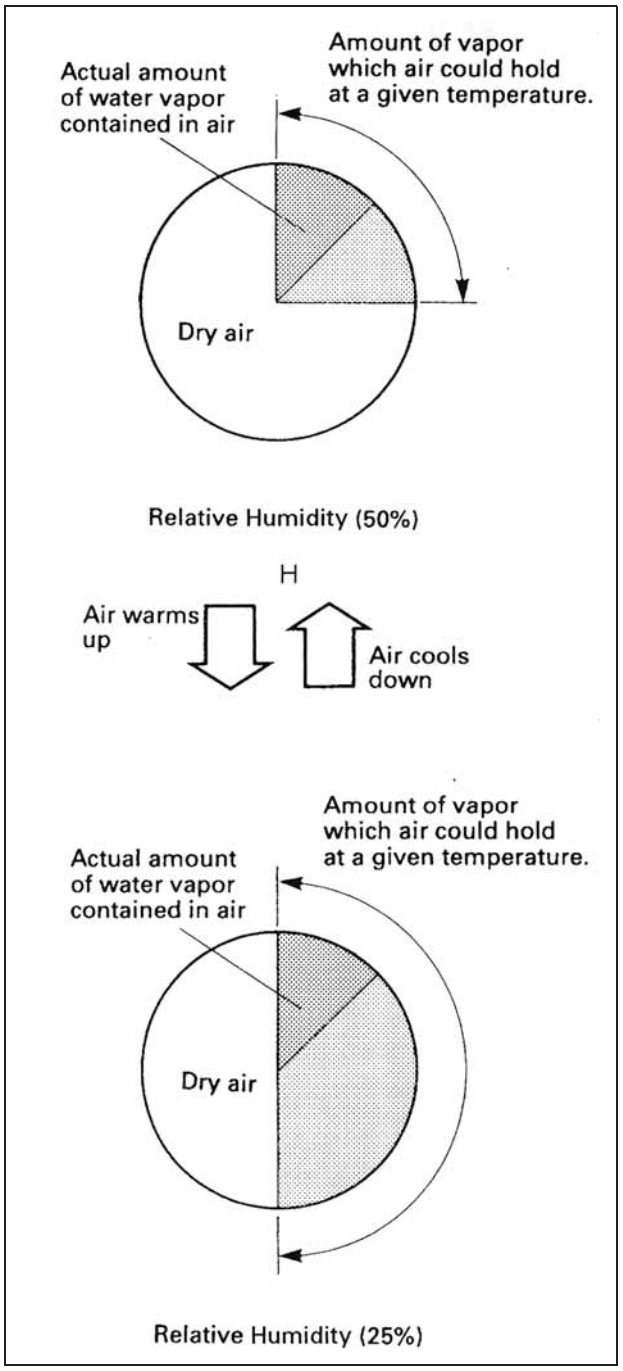


Fig. Relative Humidity

(4) Check Performance of Air Conditioning System

1) Calculate the relative humidity from the psychrometric graph by comparing the wet- and dry-bulb readings of the psychrometer at the air inlet.

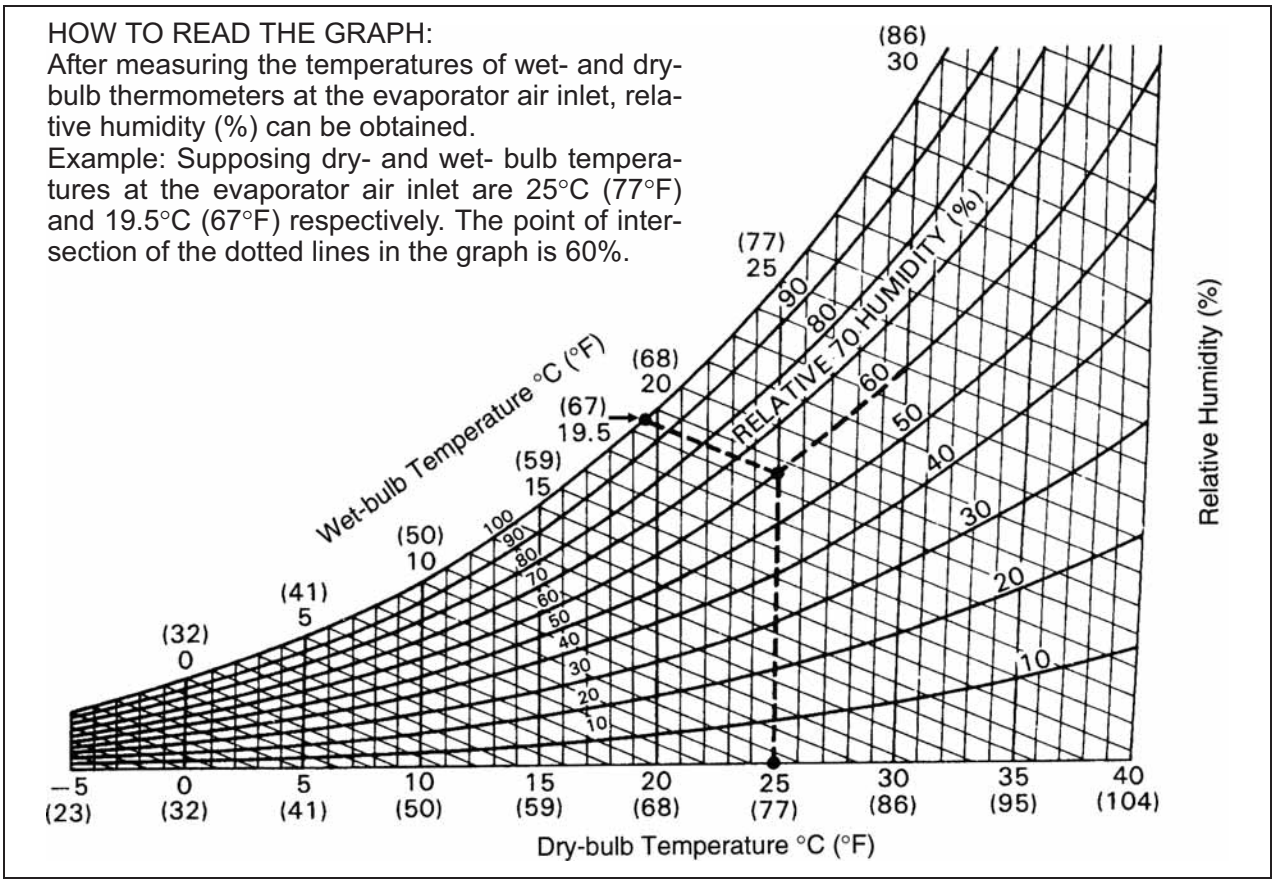


Fig. Psychrometric Graph

2) Measure the dry-bulb temperature at the cool air outlet, and calculate the difference between the inlet dry-bulb and outlet dry-bulb temperatures.
   In this case;
   inlet dry-bulb = 25°C (77 °F)
   outlet dry-bulb = 8°C (46.4 °F)
   Then, temp. difference = 17°C (62.6 °F)
3) Check that the intersection of the relative humidity and temperature difference is above the line.
   If the intersection is within a line A and a line B, cooling performance is satisfactory.

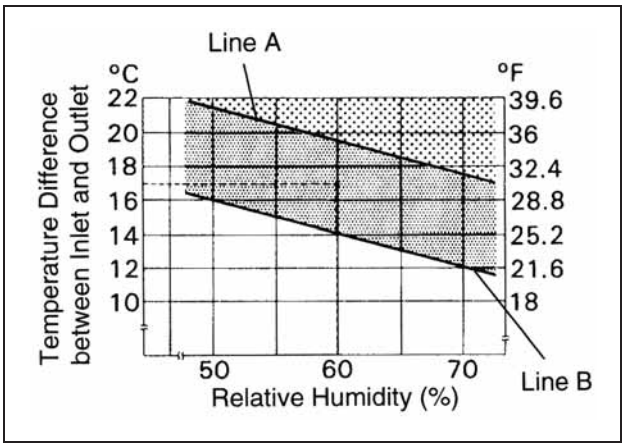


Fig. Relative Humidity Graph

d) Pressure

Pressure is defined as the vertical force applied on an unit area of a solid, liquid or gas. The unit of measurement is "kgf/cm^2".
However, instead of "kgf/cm^2", Pascal is used as a international unit of measurement.

1 kPa (Pascal) = 1.01972 x 10^{-2} kgf/cm^2 = 0.15 psi
1 kgf/cm^2 = 98.06 kPa = 14.2233 psi
1 MPa = 10.1972 kgf/cm^2 = 145 psi

For blower performance, mmAq (Water Column) is generally used.
For pressure below atmospheric (Vacuum), mmHg (Mercury Column) is used.

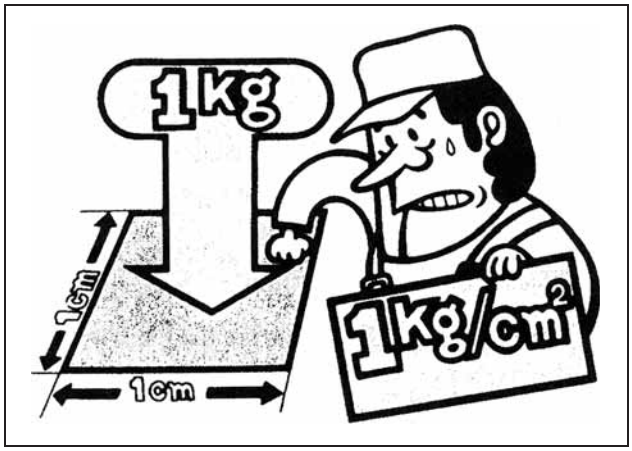


Fig. Pressure

(1) Atmospheric Pressure

This is the pressure acting on all object on earth.
This pressure is the weight of air surrounding everyone and is equal to 1.03 kgf/cm^2 (1 atmosphere).
At this pressure, the mercury column will be 760 mmHg.

1 atm = 1.03 kgf/cm^2 = 760 mmHg = 14.7 psi

Practically all pressure gauges are made to indicate atmospheric pressure as 0.

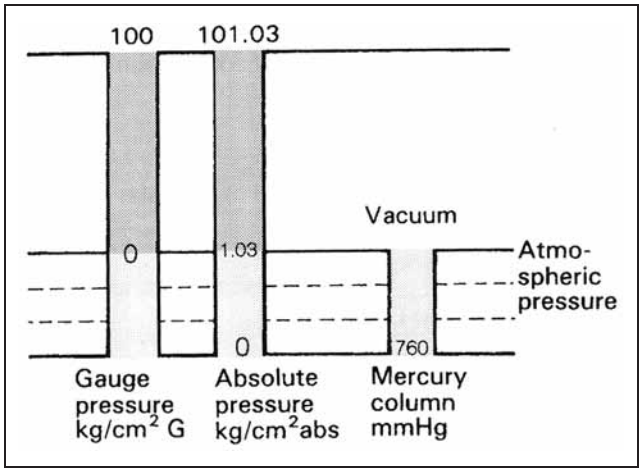


Fig. Pressure Scales

(2) Absolute Pressure

Absolute pressure is when perfect vacuum is taken as 0 kgf/cm^2. Therefore, the atmospheric pressure is 1.03 kgf/cm^2 in terms of absolute pressure.
To distinguish from absolute pressure, the pressure measured with a gauge is called a gauge pressure.
For identification, absolute pressure is indicated by kgf/cm^{2}abs and gauge pressure by kgf/cm^{2}G.
The relationship between absolute pressure and gauge pressure is as fellows:

Absolute press. (kgf/cm^{2}abs) = Gauge press. (kgf/cm^{2}G) + 1.03 kgf/cm^2

e) Change of State

(1) Stage Change of Water

Now, we will consider how ice changes its state when we add heat to it. We will use water as example as it is the easiest matter to understand heat and state change.

It we add heat to ice until the temperature of ice reaches 0 degree centigrade (32°F), ice melts into water, and while the ice is melting, the temperature of ice and water remains at 0 degree centigrade.

After the ice has melted, the temperature of water begins to rise.

When the temperature of water reaches 100°C (212°F), water begins to become steam. Until all the water becomes steam, the temperature of water remains 100°C (212°F).

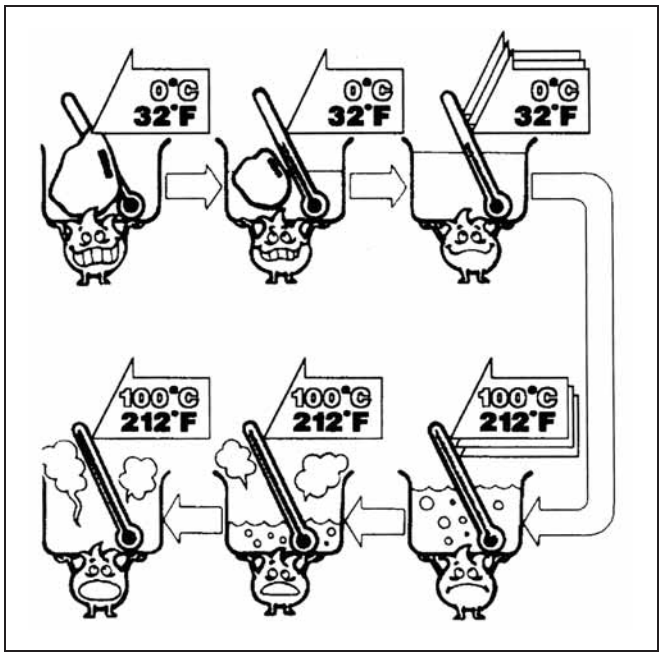


Fig. State Change of Water

(2) Sensible Heat and Latent Heat

Fig. shows the relation between heat and temperature. There are two kinds of heat called sensible heat and latent heat.

THE SENSIBLE HEAT can changes the temperature of water but cannot change the state of water.

Therefore, the sensible heat raises or lowers the temperature of water.

In the case of water, 1 kg of water at 0°C must absorb 100 kcal of sensible heat to change to 1 kg of water at 100°C.

THE LATENT HEAT can change the state of water, but cannot change the temperature of water. Ice melts into water by adding latent heat and water evaporates into steam by adding latent heat. In the case of water, 1 kg of ice at 0 degree must absorb 80 kcal of latent heat to change to 1 kg of water at 0 degree, and 1 kg of water at 100 degrees must absorb 539 kcal of latent heat to change to 1 kg of steam.

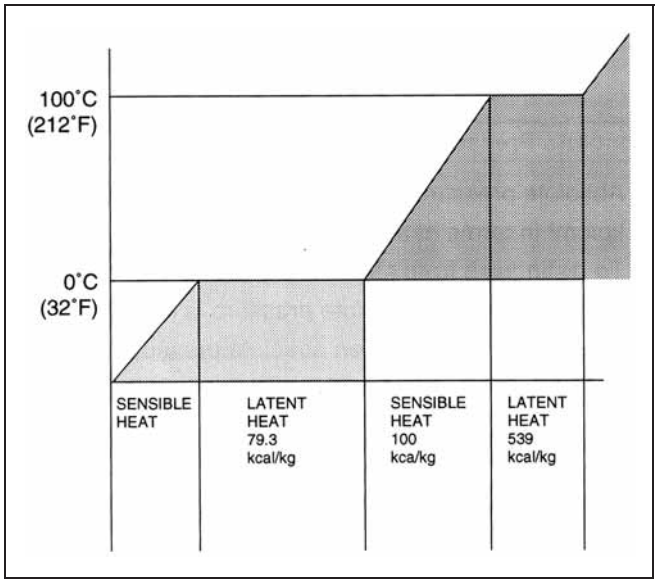


Fig. Sensible Heat and Latent Heat

(3) Three States of Matter

As you know, matter exists in three states; solid, liquid and gas. In the case of water, the solid state is ice, the liquid state is water, and the gas state is steam.

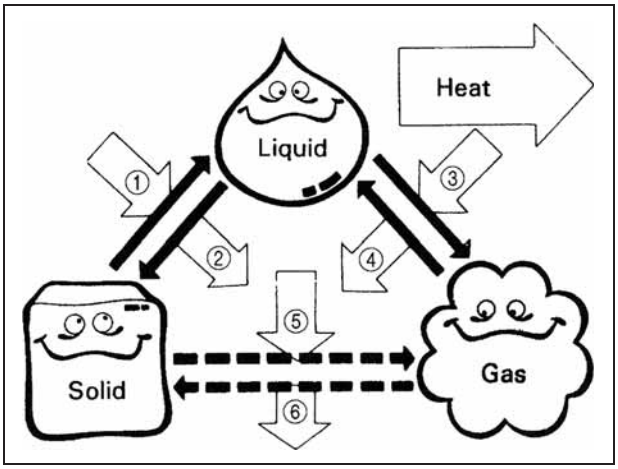


Fig. Three States of Matter

1. Fusion
   When solid melts into liquid, heat is absorbed from the surrounding matter.
   In the case of water, when 1 kg of ice melts into 1 kg of water, under atmospheric pressure, 80 kcal of heat is absorbed from the surrounding.
2. Solidification
   In the opposite situation, when liquid changes into a solid, heat is released to the surrounding matter.
3. Evaporation
   When liquid evaporates into gas, heat is absorbed from the surrounding matter.
4. Condensation
   In the opposite situation, heat is released to the surrounding matter.
   In the case of water, when 1 kg of water evaporates into 1 kg of steam, 539 kcal of heat is absorbed from the surrounding matter.
   In the opposite situation, 539 kcal of heat is released to the surrounding matter.
5. Sublimation
   In rare case such as dry ice (solid carbon dioxide) and naphthalene, heating causes the solid to directly turn into gas.
6. Adhesion
   The reverse process is called adhesion.

f) What is a Heater?

There are various types of heaters, which include a hot water heater, combustion heater and exhaust heater, but generally a hot water heater used in automobiles.

(1) Principle

In a hot water heater system, engine coolant is circulated through the heater core to make it hot. Cold air passes through the hot heater core, being blown by the blower fan. Through heat transfer, the air is warmed up.

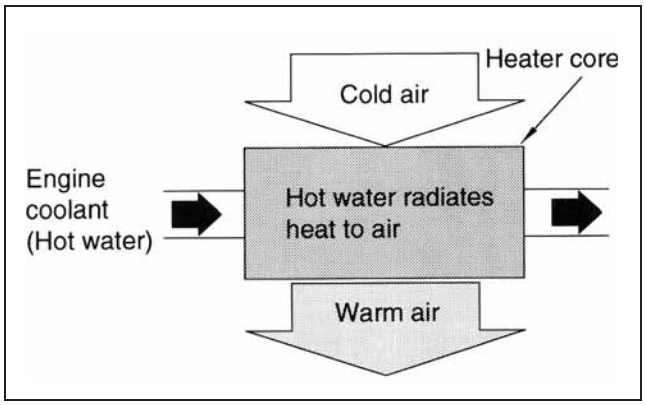


Fig. Principle of Heater

(2) Temperature Control

To control the air temperature, an air mix type control is used. This type uses the air mix control door which changes the air temperature by adjusting the proportion of cold air passing through the hot heater core and the proportion of air not passing through the heater core.

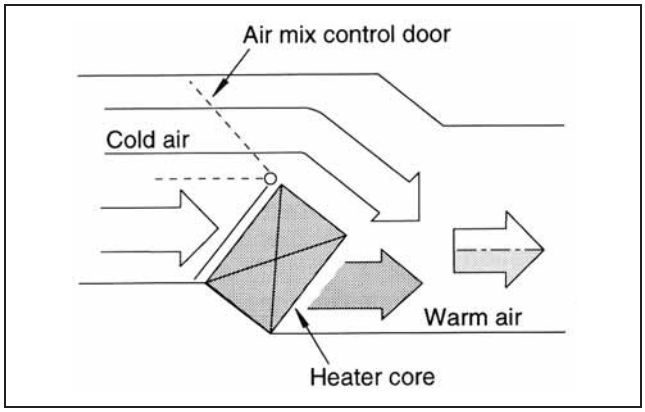


Fig. Temperature Control of Heater

g) Principle of Cooling

A cooler cools and dehumidifies the air inside the car or fresh air from outside the car so as produce comfortable cooling.

(1) Basic Theory of Cooling

After swimming on a hot day we feel a little cold.
This is because the water remaining on our body eventually vaporizes. Whilst vaporizing, this is drawing heat from our body.
For the same reason, we feel cool when we apply alcohol to our skin. The alcohol is placed as a liquid on our skin. After a short time the liquid starts to change into a gas (vaporize).
In this process heat is drawn from our skin (our skin feels cold). Using this principle we can apply it to an air conditioning system. i.e.: Heat being drawn when a liquid vaporizes to a gas.

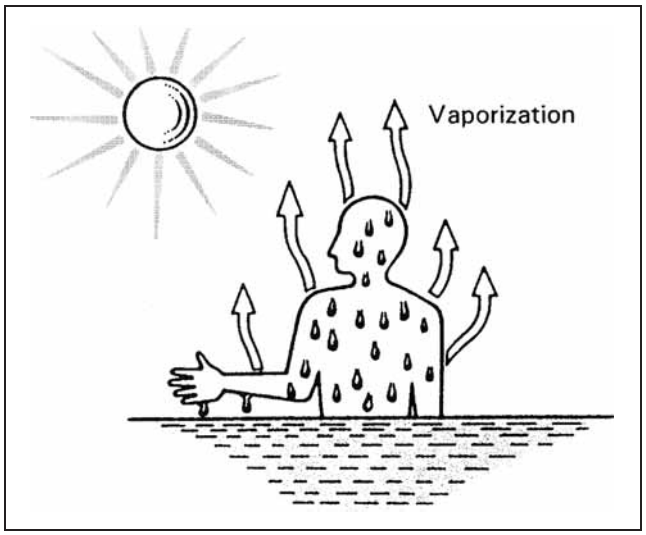


Fig. Vaporization

(2) Refrigerant

Refrigerant is a substance that serves as a moving fluid in a refrigerator and circulates through functional parts to produce the cooling effect by absorbing heat through the expansion valve and evaporator. The refrigerant used in new vehicles today is now HFC134a, which has no-ozone-destroying properties (does not contain chlorine).
HFC stands for Hydro Fluoro Carbon

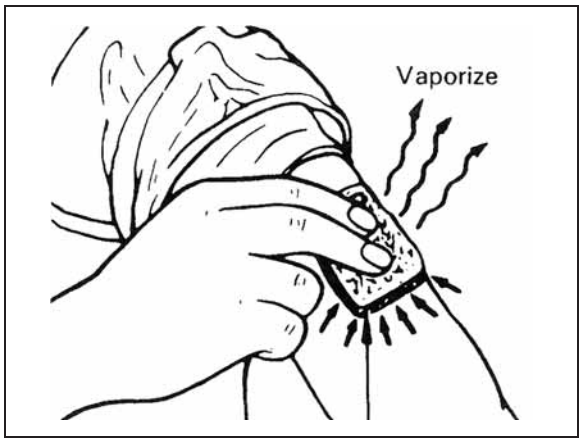


Fig. Basic Theory of Cooling

1. Characteristics of HFC134a
Water boils at 100°C (212°F) under atmospheric pressure, but HFC134a boils at -26.9°C (-16.4°F) under atmospheric pressure.
Water boils at 121°C (250°F) under 1 kg/cm^2 (98 kPa) of pressure, HFC134a boils at -10.6°C (-12.8°F) under 1 kg/cm^2 (98 kPa) of pressure.
If HFC134a were released to air under normal room temperature and atmospheric pressure, it will absorb the heat from the surrounding air and boil immediately, changing into a gas. HFC134a is also easily condensed back into a liquid under a pressurized conditions by removing the heat.

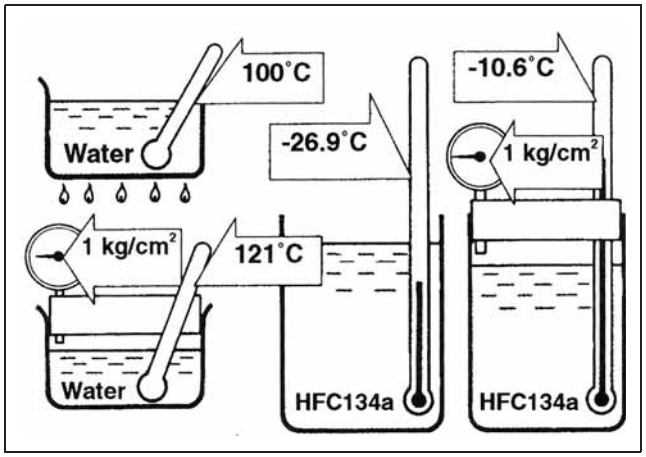


Fig. Characteristics of Refrigerant (HFC134a)

The graph shows the characteristic relationship between the temperature and pressure of HFC134a.
The curve in the graph indicates the boiling point of HFC134a under different temperatures and pressures. The upper portion above the curve is gaseous HFC134a and the lower portion is liquid HFC134a.

Example-1

The gaseous refrigerant can be converted into the liquid refrigerant by increasing the pressure without changing the temperature.

Example-2

The gaseous refrigerant can also be converted into a liquid by decreasing the temperature without changing the pressure.

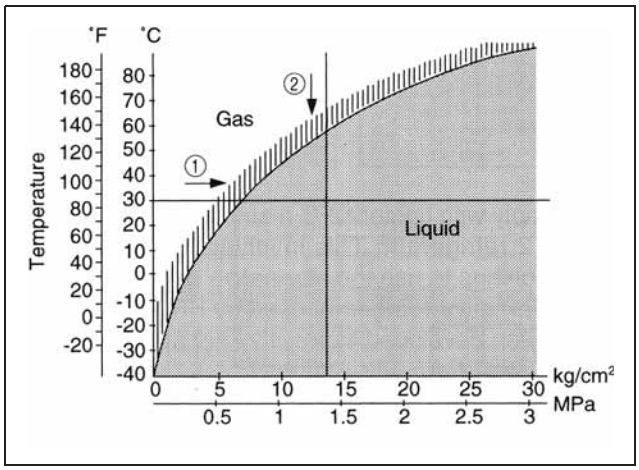


Fig. Refrigerant Saturating Curve

2. Conversely

Example-3
The liquid refrigerant can be converted into gas by decreasing the pressure without changing the temperature.

Example-4
The liquid refrigerant can be converted into a gas by the temperature without changing the pressure.

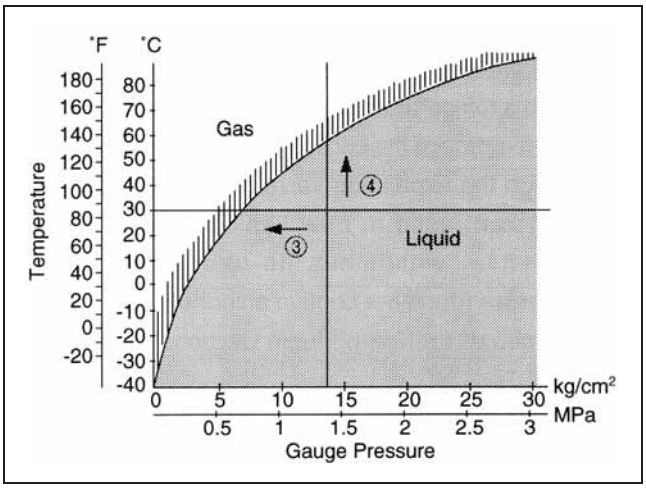


Fig. Refrigerant Saturating Curve

HFC134a has very good characteristics and properties to be used in air conditioning system. It is non-flammable, non-explosive, non-poisonous, non-corrosive, odorless and harmless to clothes and food.

h) Principle of Air Conditioning

(1) Expansion and Evaporation

In a air conditioning the air is cooled by the following method;

- The high temperature and high pressure liquid refrigerant is stored in the receiver.
- Then, the liquid refrigerant is released to the evaporator through a small hole, called the expansion valve. At this time, the temperature and pressure of the liquid refrigerant is decreased, and some of the liquid refrigerant changes to vapor.
- The low temperature and low pressure refrigerant flows into the evaporator.
  In the evaporator, the liquid refrigerant evaporates and takes heat from the surrounding air.

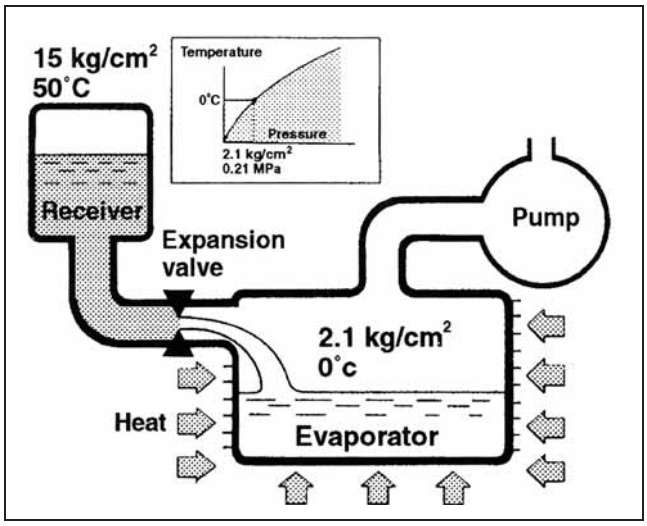


Fig. Expansion and Evaporation

(2) How to Condense Gaseous HFC134a into Liquid

The air conditioning system cannot cool the air when the liquid refrigerant is used up (i.e. changed to the gaseous refrigerant).

To change the gaseous refrigerant into a liquid refrigerant, a compressor is used in the air conditioning.

As you know, when gas is compressed in the compressor, both the temperature and pressure increase.

For example, when the gaseous refrigerant is compressed from 2.1 kg/cm^2 (0.21 Mpa) to 15 kg/cm^2 (1.47 MPa), the temperature also increases from 0°C to 80°C (32°F to 180°F).

The boiling point of refrigerant at 15 kg/cm^2 (1.47 MPa) is 57°C (135°F). The temperature (80°C, 176°F) of compressed gaseous refrigerant is higher than its boiling point (57°C) and also higher than the surrounding air. The refrigerant stays in gaseous state.

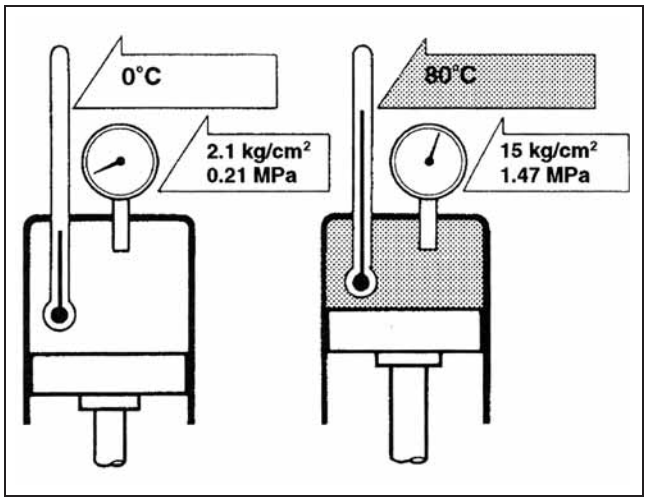


Fig. How to Condense HFC134a

(3) Condensing of the Gaseous HFC134a

In the air conditioning, the high pressure, high temperature gaseous refrigerant is transferred into a liquid by cooling it down at the condenser.

By flowing through the condenser, the compressed gaseous refrigerant releases heat to the surrounding air and is condensed back into a liquid. At this time, the refrigerant temperature becomes lower than the boiling point (around 57°C). The liquid refrigerant then returns to the receiver.

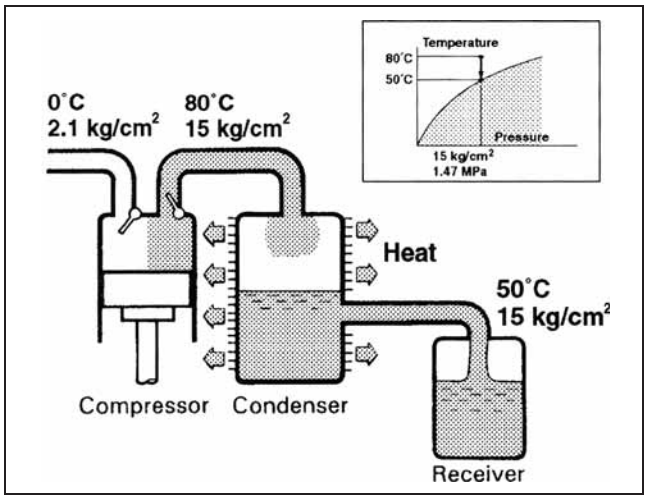
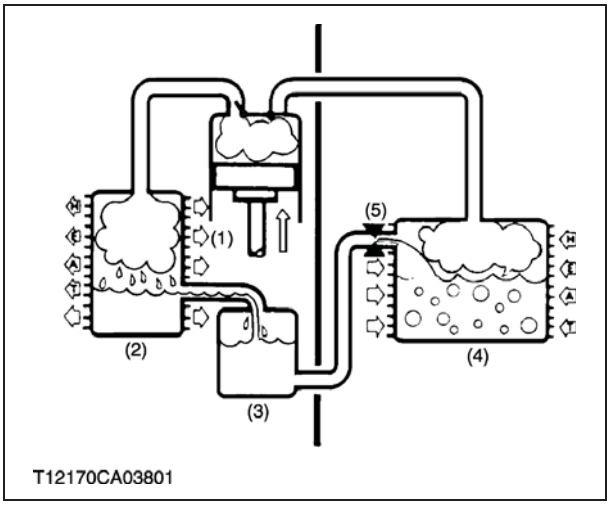


Fig. Condensing the Gaseous HFC134a

i) Refrigeration Cycle



1)The compressor (1) discharges high temperature and high pressure refrigerant that contains the heat absorbed from the evaporator (4) plus the heat created by the compressor in a discharge stroke.
2)This gaseous refrigerant flows into the condenser (2).
In the condenser, the gaseous refrigerant condenses into liquid refrigerant.
3)This liquid refrigerant flows into the receiver (3) which stores and filters the liquid refrigerant changes into low temperature, low pressure liquid and gaseous mixture.
4)By the expansion valve (5), the liquid refrigerant till the evaporator requires the refrigerant.
5)This cold and foggy refrigerant flows to evaporator.
Vaporizing the liquid in the evaporator, the heat from the warm air steam passing through the evaporator core is transferred to the refrigerant.
All the liquid will change into gaseous refrigerant in the evaporator and only heat-laden gaseous refrigerant is drawn into the compressor. Then the process is repeated again.

(1) Compressor
(2) Condenser
(3) Receiver
(4) Evaporator
(5) Expansion Valve

j) Practical Control of Air Conditioner

(1) Concept of control

In order to operate the cooling cycle efficiently, it is necessary to control the heat exchanger outlet optimally. It is desirable to perform control so that the following is realized.

- Evaporation of refrigerant is just completed at the evaporator outlet.
- Condensation of refrigerant is just completed at the condenser outlet.

1. Evaporator outlet control = Temperature-type expansion valve
   As shown in the figure below, the refrigerant flow is controlled by feeding back the outlet temperature (point a') so that evaporation is completed at the evaporator outlet and slightly overheated gas is provided.

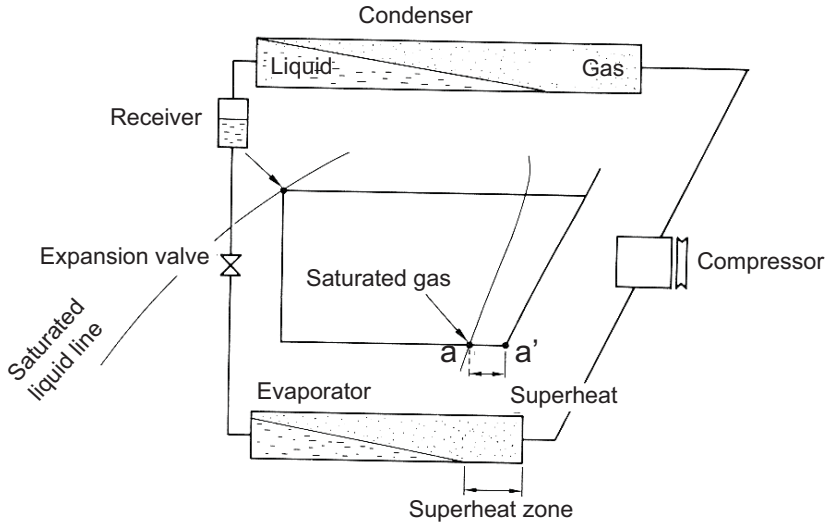


Fig. Control point for receiver and temperature-type expansion valve

Though superheating the refrigerant in gaseous form at this point will increase the refrigerant temperature at the evaporator outlet and therefore may not be the best way, superheat is necessary for feedback.
In view of the characteristics of the temperature-type expansion valve, controlling to 5 to 10°C is usually performed.

2. Condenser outlet control = Receiver
   As shown in the figure above, the receiver provided at the condenser outlet is used for controlling so that condensation is completed at the condenser outlet.

(2) Principle of control

1. Controlling of evaporator outlet superheat by means of temperature-type expansion valve
   The construction of the temperature-type expansion valve is shown in the figure below.

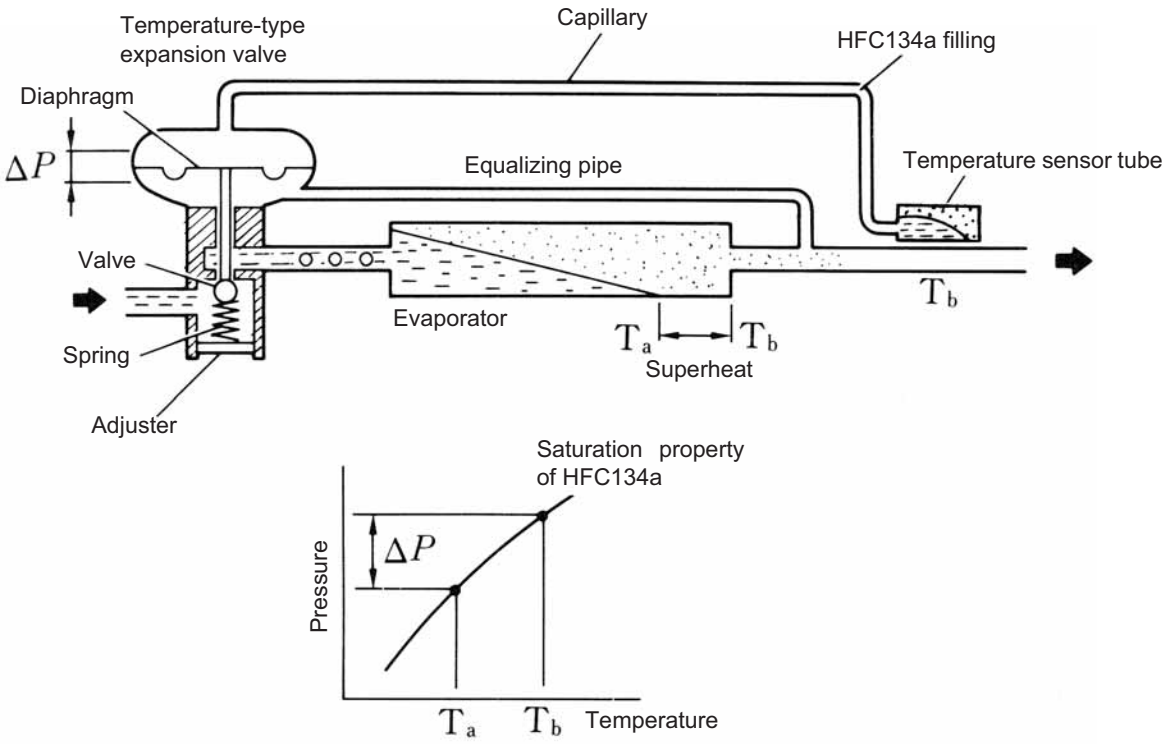


Fig. Principle of control by means of temperature-type expansion valve

The part above the diaphragm is sealed and filled with working medium. Usually this working medium is the same as the refrigerant used in the cooling cycle. In the case of a air-conditioner, this part is filled with HFC-134a.
This part is connected through the capillary tube to the temperature sensor tube attached to the evaporator outlet. In the temperature sensor tube, a saturation state is maintained with liquid and gas coexisting. The pressure in the temperature sensor tube, that is, in the part above the diaphragm is the saturation pressure at temperature T_b. On the other hand, the pressure in the evaporator (saturation pressure at temperature T_a) is directly applied to the part below the diaphragm. Therefore there is pressure difference ΔP corresponding to superheat ($(T_b - T_a)$) between the upper and lower parts. The opening of the valve is determined by the balance between this pressure difference ΔP and the spring force.

The principle of control is instantiated below.

- When the superheat of the evaporator increases (T_b increases), the pressure in the part above the diaphragm increases to displace the diaphragm downward, which further opens the valve to increase the refrigerant flow, thus reducing the superheat.
- When the superheat of the evaporator decreases, the operation described above is reversed.
- When the rotating speed of the compressor increases due to fluctuation in engine revolution, the suction power increases to reduce the pressure in the evaporator. As a result, the pressure in the part below the diaphragm decreases to further open the valve, which immediately increases the refrigerant flow according to the suction power of the compressor. Then the temperature sensor tube feeds back the temperature so that the superheat is optimized with optimum valve opening.

2. Controlling of condenser outlet by means of receiver
The necessary amount of refrigerant changes due to sharp fluctuation in engine revolution and vehicle heat load. To cope with this, excess refrigerant is stored and separate into gas and liquid in the receiver and only refrigerant in liquid form is sent out from the receiver. Normally there is always a liquid level in the receiver in which saturated liquid and saturated gas coexist. The supercooling temperature of the refrigerant in liquid form in the receiver is about 0°C.
The control by means of the receiver can be explained as follows. If, for example, refrigerant in gaseous form is not condensed completely in the condenser due to fluctuation of some kind, lots of refrigerant in gaseous form flows into the receiver. The amount of refrigerant in liquid form flowing into the receiver decreased accordingly and therefore the liquid level moves down, which means a corresponding amount of refrigerant in liquid form shifts to the condenser (Fig. below).
On the other hand, if refrigerant in liquid form collects at the condenser outlet and is cooled further out of the supercooling temperature, bubbles (shown in the figure below) at the condenser outlet disappear and no gas is added to the receiver. As a result, the amount of gas in the receiver decreases and the liquid level moves up (Fig. below), which means excess refrigerant in liquid form in the condenser shifts to the receiver. Thus controlling is performed so that proper gas and liquid flows into the receiver.

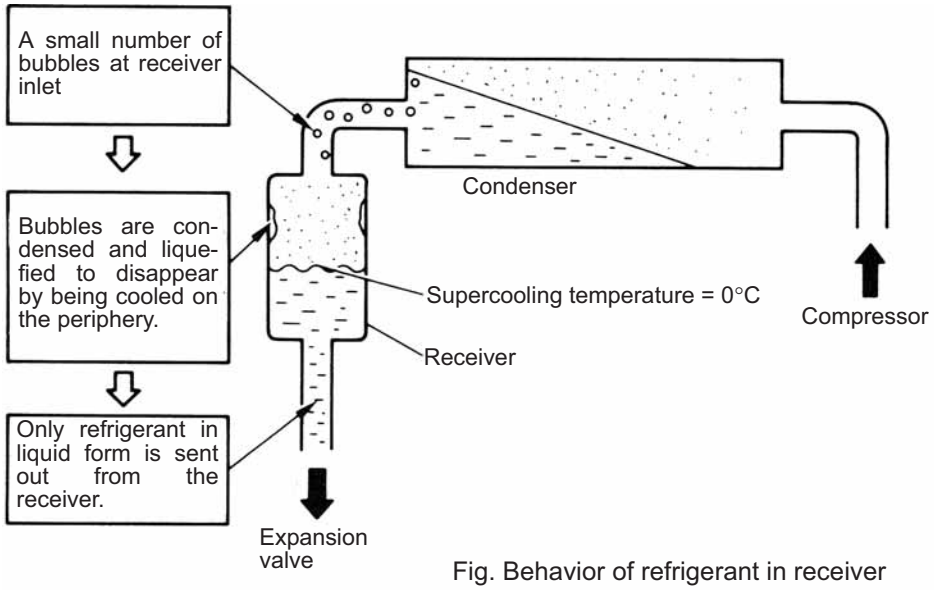


Fig. Behavior of refrigerant in receiver

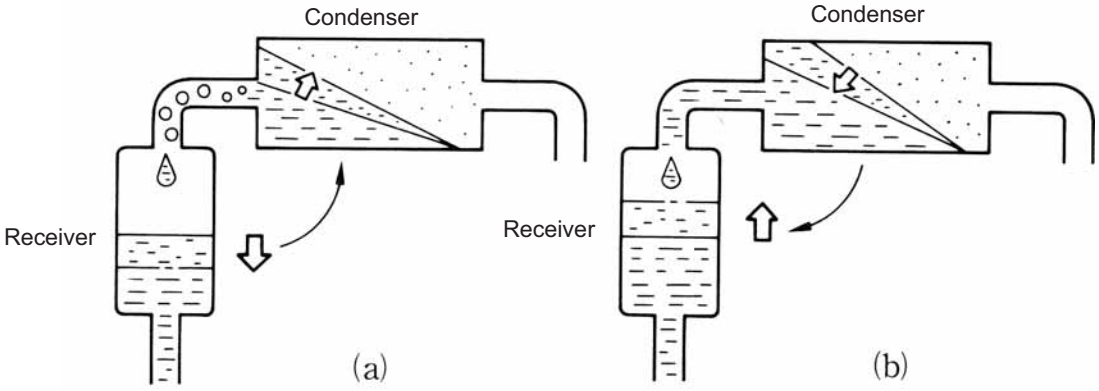


Fig. Behavior of liquid level in receiver

k) Mollier Diagram

The refrigerant in the cooling cycle is subjected to complicated thermodynamic changes such as increase and decrease in temperature, liquefaction and gasification, and changes in pressure. The Mollier diagram devised by Mollier is used to show such thermodynamic changes in a way easy to understand.

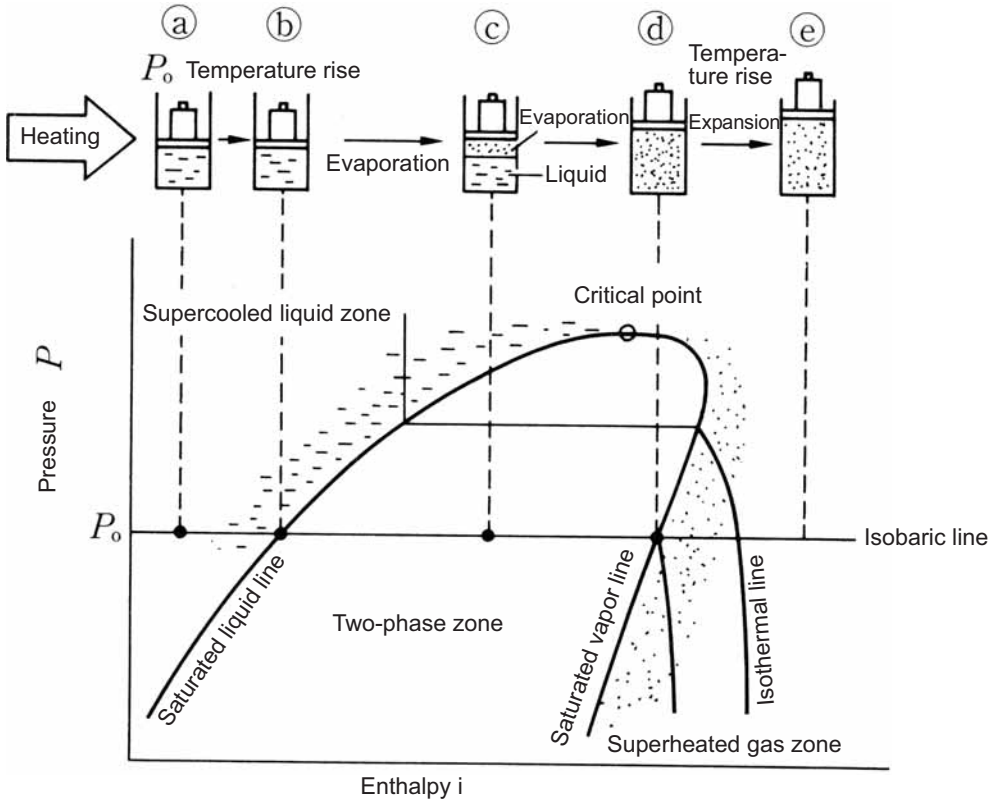


Fig. Fundamentals of Mollier diagram

The configuration of the Mollier diagram is shown in the figure above. The vertical axis indicates the pressure of the refrigerant and the isobaric line is drawn horizontally. The horizontal axis indicates enthalpy i. Enthalpy i represents the total thermal energy of a substance. The quantity of heat and work externally given to the refrigerant is equal to the variation in enthalpy i, which is a very convenient index. For example, if a cylinder filled with liquid is heated at a constant pressure $P0$, the temperature of the liquid increases and the liquid becomes saturated (b). If heated further, the liquid starts to evaporate (c). While the liquid is boiling, the temperature of the liquid is kept constant. If heating is continued, all the liquid is gasified and a state of saturated gas is provided (d). If heated further, the temperature of the gas increases and the gas expands. When W kg of refrigerant is subjected to such enthalpy change Δi, heat quantity Q can be determined as follows:

$$Q = \Delta i \cdot W$$

In the Mollier diagram, the saturated liquid line shows at which stage evaporation is started in heating; the saturated vapor line shows at which stage condensation is started in cooling. The portion to the left of the saturated liquid line is a supercooled liquid zone; the portion to the right of the saturated vapor line is a superheated gas zone. The portion between these lines represents a state of saturation in which liquid and gas coexist. In this zone, the temperature and pressure are uniquely determined by the saturation pressure and temperature characteristics. Degree of dryness ***x*** shown in the figure below indicates the ratio of refrigerant in gaseous form. In the case of saturated liquid, $x = 0$. If 20% (on a weight basis) is gasified, $x = 0.2$.

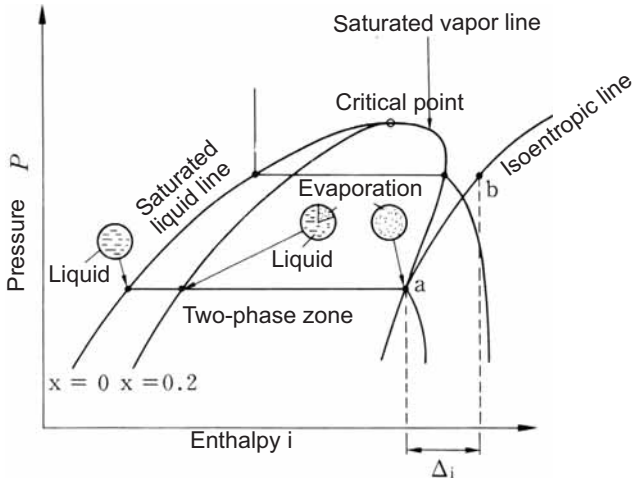


Fig. Fundamentals of Mollier diagram

For compression, it is necessary to explain the isoentropic line. If ideal compression with no heat transfer or friction is realized, a change with constant enthalpy S (a → b in the figure above) occurs. At this time, the quantity of work per unit weight given to the refrigerant in gaseous form is equal to enthalpy difference Δi (kJ/kg) between a and b in the Mollier diagram above.

I) Basic Operation of Cooling Cycle

The basic operation of the cooling cycle is as shown in the figure below (Mollier diagram).

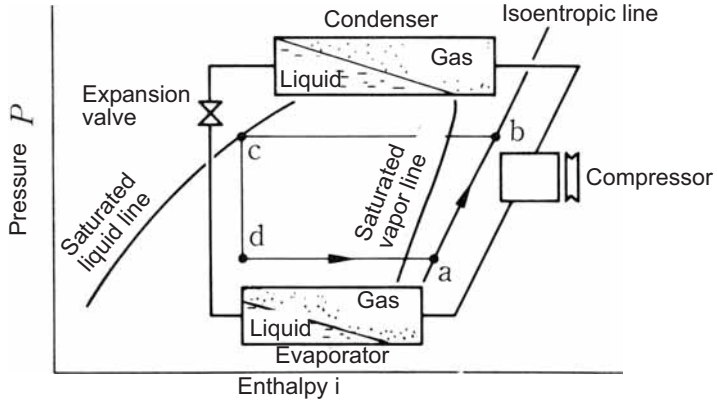


Fig. cooling cycle in Mollier diagram

1. The compressor sucks the gas generated through evaporation in the evaporator and compresses it. In the case of ideal adiabatic compression, as described above, a climbing change (point a → point b) occurs because isoentropic compression is performed. The pressure and enthalpy of the refrigerant in gaseous form increase in accordance with the quantity of work.
2. The refrigerant in gaseous form is cooled at a constant pressure in the condenser. The superheated gas is cooled to be saturated gas and then condensation starts. It is completely liquefied at the outlet.
3. Because no heat transfer is made in the expansion valve, a change from point c to point d occurs at a constant enthalpy. This hot refrigerant in liquid form is rapidly decompressed. Because the saturation temperature is low in the low-pressure side after decompression, it is necessary for the refrigerant to evaporate to lower the liquid temperature. Therefore, at point d at the inlet of the evaporator, a two-phase (gas and liquid) state with degree of dryness χ = 0.3 to 0.4 (refrigerant in gaseous form occupies 30 to 40%) is provided.
4. In the evaporator, the low-temperature and low-pressure refrigerant in liquid form (60 to 70%) draws heat from the surroundings at a constant pressure and evaporates. At the outlet of the evaporator, the refrigerant is completely gasified.

m)Calculation of Refrigeration Capacity and Power from Mollier Diagram

The points shown in the Mollier Diagram are values per unit weight of refrigerant. In order to calculate the refrigeration capacity and power, the flow of refrigerant actually circulating through the cooling system should be determined. Assuming that this flow of refrigerant is Gr (kg/h), refrigeration capacity Q_{er}, which is equal to the change in the enthalpy of the refrigerant achieved by the evaporator drawing heat from the surroundings, is calculated as follows:

$$Q_{er} = (i_a - i_d)G_r \quad \ldots\ldots\ldots\ldots \quad (1)$$

- In the case of the compressor power, because the quantity of externally given work is equal to the increase in the enthalpy of the refrigerant, power L is calculated as follows:

$$Q_{er} = (i_a - i_d)G_r \quad \ldots\ldots\ldots\ldots \quad (2)$$

- The quantity of heat radiation of the condenser, which is opposite to the case of the evaporator, is calculated as follows:

$$Q_{cr} = (i_b - i_c)G_r \quad \ldots\ldots\ldots\ldots \quad (3)$$

Because the sum of the quantity of heat drawn by the evaporator and the quantity of work added by the compressor is equal to the quantity of heat radiation performed by the condenser, the following equation holds.

$$Q_{cr} = (Q_{er} + L) \quad \ldots\ldots\ldots\ldots \quad (4)$$

Shown below is COP (Coefficient of Performance) that is commonly used to indicate the efficiency of work for cooling. It shows a ratio of power L to refrigeration capacity Q_{er}.

$$\mathrm{COP} = \frac{Q_{er}}{L} \quad \ldots\ldots\ldots\ldots \quad (5)$$

n) Calculation of Flow of Circulating Refrigerant

Flow of circulating refrigerant G_r is calculated from compressor suction capacity V_c (m^3/h) and specific volume bulk of gas υ_s (m^3/kg) as shown below.

$$G_r = \frac{V_c}{\upsilon_s} \text{ (kg/h)} \quad \ldots\ldots\ldots\ldots \quad (6)$$

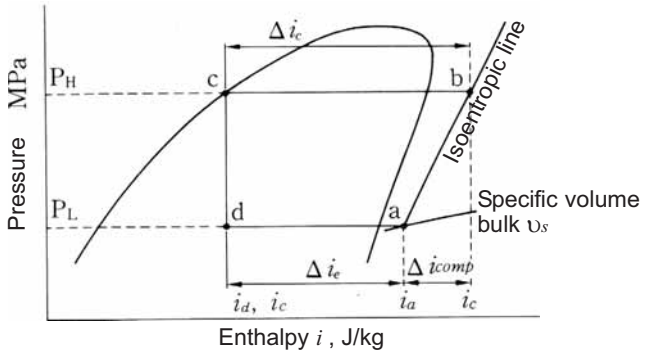


Fig. Cooling cycle in Mollier diagram

Compressor suction capacity V_c is calculated as follows:

$$V_c = \frac{V_1 \times N \times 60}{10^6} \times \eta_v \quad \ldots\ldots\ldots \quad (7)$$

V_1: Volume of compressor cylinder (cc)
N: Rotating speed of compressor (rpm)
η_v: Volumetric efficiency

o) Theoretical Performance (Sample Calculation)

(1) Compressor output: L

Compressor displacement = 70 cm^3/rev
Compressor rotating speed = 1800 rpm
Compressor delivery refrigerant volume V_c;

V_c = 70 cm^3/rev × 1800 rpm × 60 min × 0.65 ÷ 10^6
= 4.914 m^3/h
η_v = volumetric efficiency = 0.65
υ_s = HFC134a specific volume at 10°C, 3 kgf/cm^2abs
= 0.075 m^3/kg

Compressor delivery refrigerant amount G_r;

G_r = 4.914 ÷ 0.075 = 65.52 kg/h

Enthalpy increase by compressor = $i_b - i_a$
= 8 kcal/kg (Example)

L = Compressor output = 8 kcal /kg × 65.52 kg/h
= 524.16 kcal/h

524.16 ÷ 860 = 0.609 kw (1 kwh = 860 kcal/h)

Engine input horse power = 0.609 ÷ 0.7 = 0.871 kw

0.871 kw ÷ 0.7355 = 1.184 ps (1 ps = 0.7355 kw)

Engine torque for compression T_r;

$$T_r = \frac{ps \times 716.2}{N} = \frac{1.184 \times 716.2}{1800} = 0.471\ kgf{\cdot}m$$

(2) Evaporator capacity Q_{er};

Enthalpy change in evaporator = $i_a - i_d$

$Q_{er} = (i_a - i_d) \times G_r$ = 32 kcal/kg × 65.52 kg/h
= 2096.64 kcal/h

(3) Condenser capacity Q_{co};

Enthalpy change in condenser = $i_b - i_c$

$Q_{co} = (i_b - i_c) \times G_r$ = 40 kcal/kg × 65.52 kg/h
= 2620.8 kcal/h

2620.8 ÷ 860 = 3.047 kw

(4) Basically,

$Q_{co} = Q_{er} + L$ = 2096.64 + 524.16
= 2620.8 kcal/h

(5) Coefficient of Performance;

$$COP = \frac{Q_{er}}{L} = \frac{2096.64}{524.16} = 4.0$$

Note: Above data are all for sample calculation purpose only.

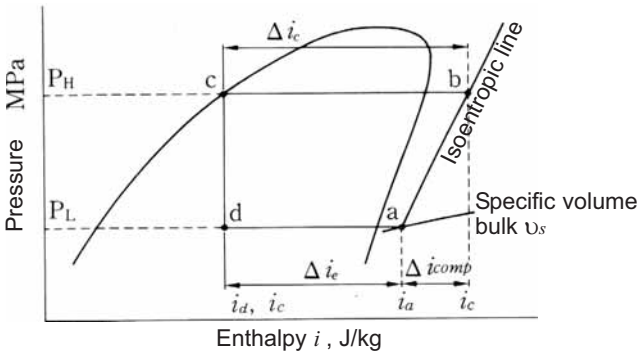
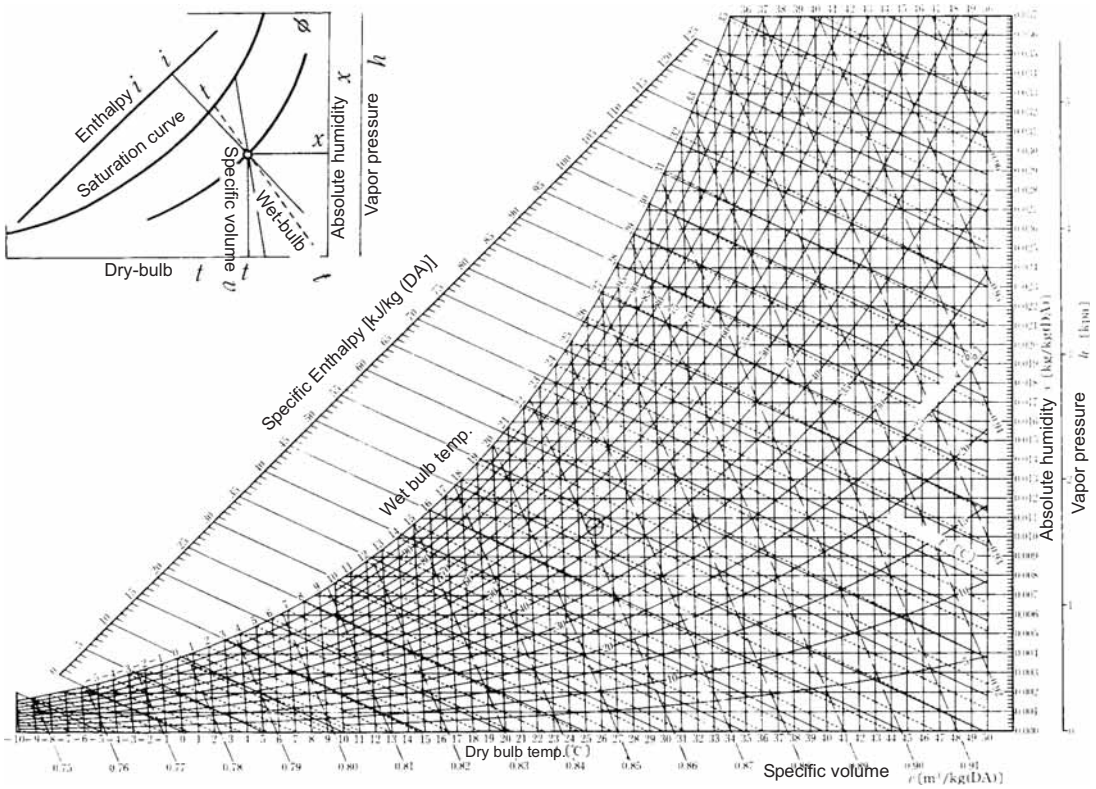


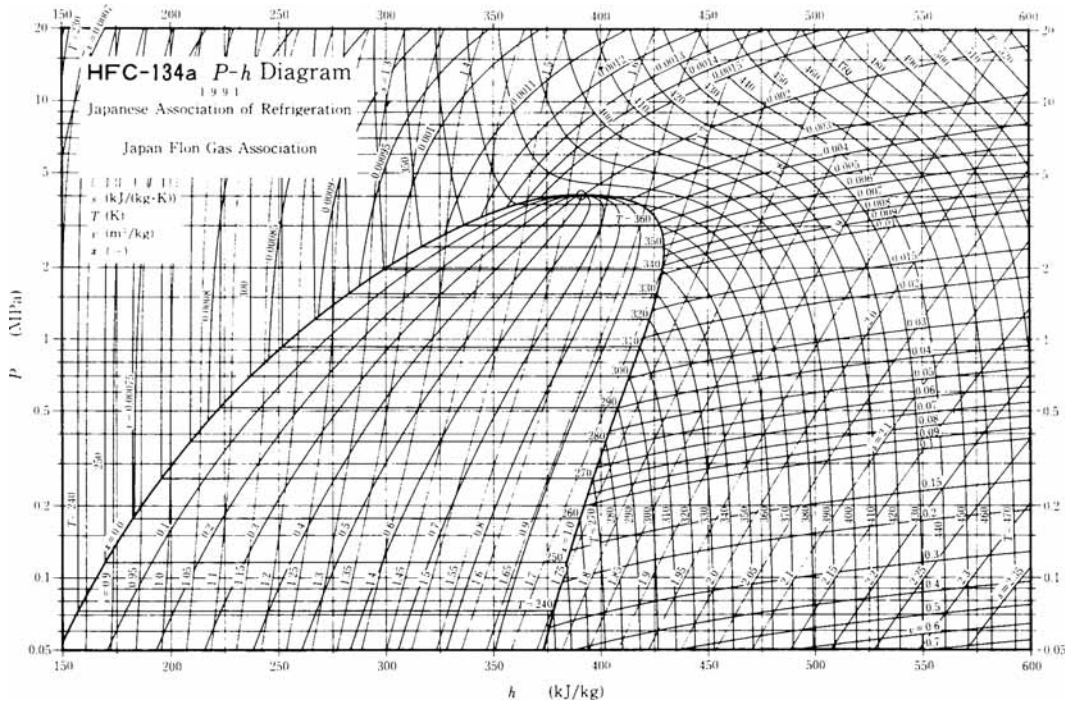
Fig. Cooling cycle in Mollier diagram

(6) Relevant diagram

1. Wet air diagram



2. Mollier diagram: HFC-134a



VI. OPTIONAL UNIT: AIR CONDITIONER

Service Section

(A) TROUBLESHOOTING VI-S-3
a) Visual and Audible Inspection VI-S-4
b) Components VI-S-5
c) Diagnosis Flow Chart VI-S-7
d) Troubleshooting from Problem Symptoms (except Refrigeration Cycle Troubles) VI-S-9
(B) SERVICING SPECIFICATIONS VI-S-11
a) Specifications of A/C System and Components VI-S-11
b) Performance Specifications VI-S-13
c) Adjustment and Testing VI-S-13
d) Ambient Temperature vs Normal High-Low Pressure Range VI-S-14
e) Tightening Torques VI-S-15
(C) REGULAR CHECK AND SERVICE POINTS VI-S-17
a) Maintenance Interval; Air Conditioner VI-S-17
b) Regular Service Points VI-S-18
(D) PRECAUTIONS AT REPAIRING REFRIGERANT CYCLE VI-S-21
(E) PRECAUTION FOR INSTALLATION AND MAINTENANCE VI-S-23
(F) CHECKING AND CHARGING REFRIGERANT CYCLE VI-S-25
a) Handling of Service Tools VI-S-25
b) Checking with Manifold Gauge VI-S-31
c) Discharging, Evacuating and Charging VI-S-35
(G) MAIN COMPONENTS SERVICING VI-S-41
a) Compressor VI-S-41
b) Condenser and Receiver VI-S-56
c) Air Conditioner Unit VI-S-59
d) Electrical System Components VI-S-65
e) Heater Hose and Control Cable VI-S-71
f) Cooler Hoses Installation VI-S-74
g) Duct Cover Installation VI-S-80
h) Noise Absorber and Trims VI-S-81
i) Labels VI-S-83
j) Wire Harness Route VI-S-85
k) Wireharness Clamps for A/C Version VI-S-89
l) Parts Identification of Air Conditioner Version VI-S-93

(A) TROUBLESHOOTING

In order to find the cause of troubles as quickly as possible, it is necessary to conduct troubleshooting using a rational method and procedure. We will explain in the following:

Before starting troubleshooting, first confirm the symptoms as follows:

Start the engine and keep it idling. Then turn the blower switch and A/C switch on, and check the A/C working conditions.

You can check the blower operation, the magnetic clutch operation and A/C outlet air temperature very easily.

After confirmation of symptoms, conduct the following rational method of troubleshooting.

Visual and Audible Inspection
This can detect simple causes of troubles.

See next page VI-S-4 for details.

Preparation: (1) Install the manifold gauge to the refrigerant cycle.
(2) Prepare a multimeter and gas leak detector.

Check Manifold Gauge Pressure
Inspect the refrigeration cycle pressures - Low and High Side
Standards: Low side 1.5 - 2.0 kg/cm^2 (0.15 - 0.20 MPa) 21.3 - 28.5 psi
(at 30 to 35°C) High side 13 - 17 kg/cm^2 (1.27 -1.66 MPa) 185 - 242 psi

See page VI-S-20 for details.

After the pressures to be okay, the remaining causes are on the electrical circuit and components.

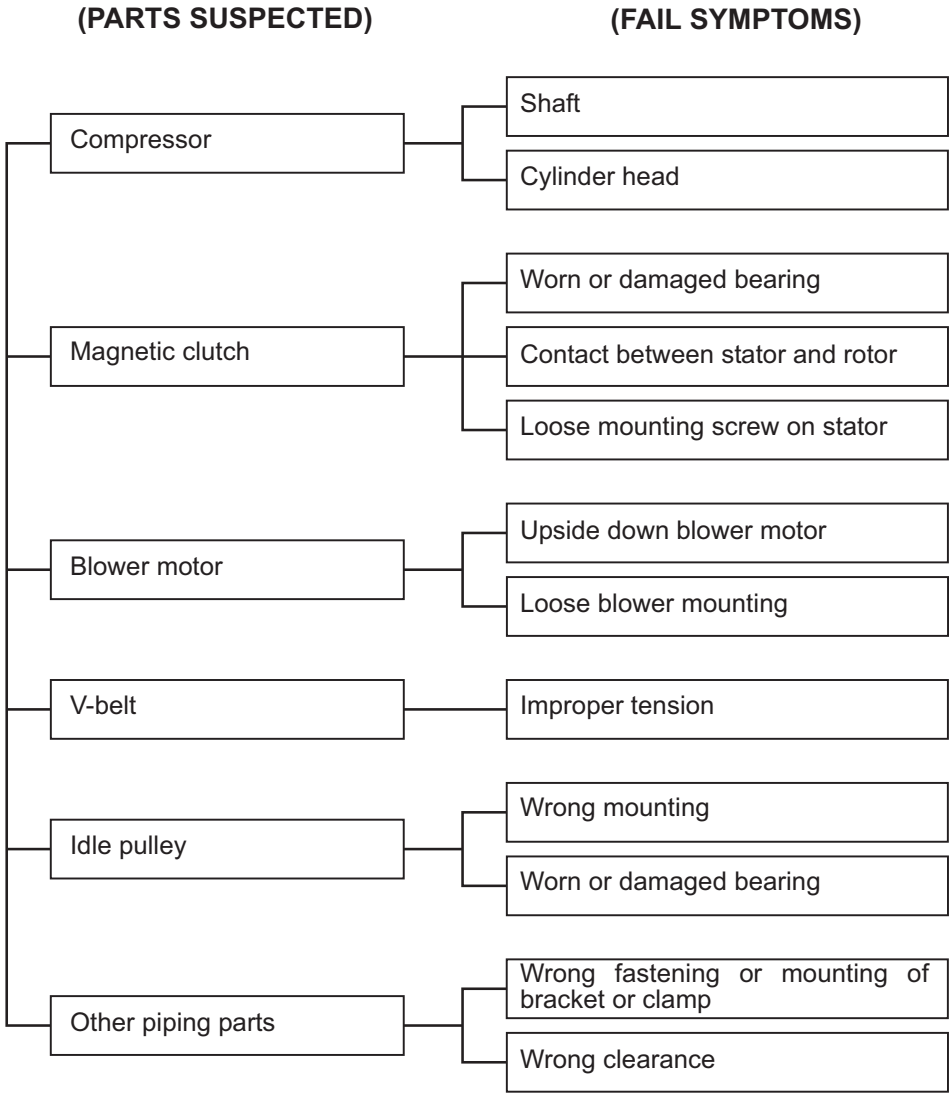
Troubleshooting Electrical Circuit
To make it easy, first start the blower circuit troubleshooting and continue to the cooler circuit troubleshooting.

See page VI-S-45 for details.

a) Visual and Audible Inspection

The simplest way to detect troubles is by looking and listening.

1. Is the drive belt loose?
2. Are the condenser fins covered with dirt and dust?
   In this case, the condenser cooling effect will be greatly reduced. As a result, the cooling capacity also will decrease.
3. Is the air filter clogged?
   A clogged air filter will reduce the air flow and lower the cooling capacity.
4. Can oil stains be seen in the refrigeration cycle connections and joints?
   A place that shows an oil stain indicates that the refrigerant is leaking from that place together with the compressor oil.
5. Check the quantity of refrigerant at the sight glass.
6. Abnormal noise



b) Components

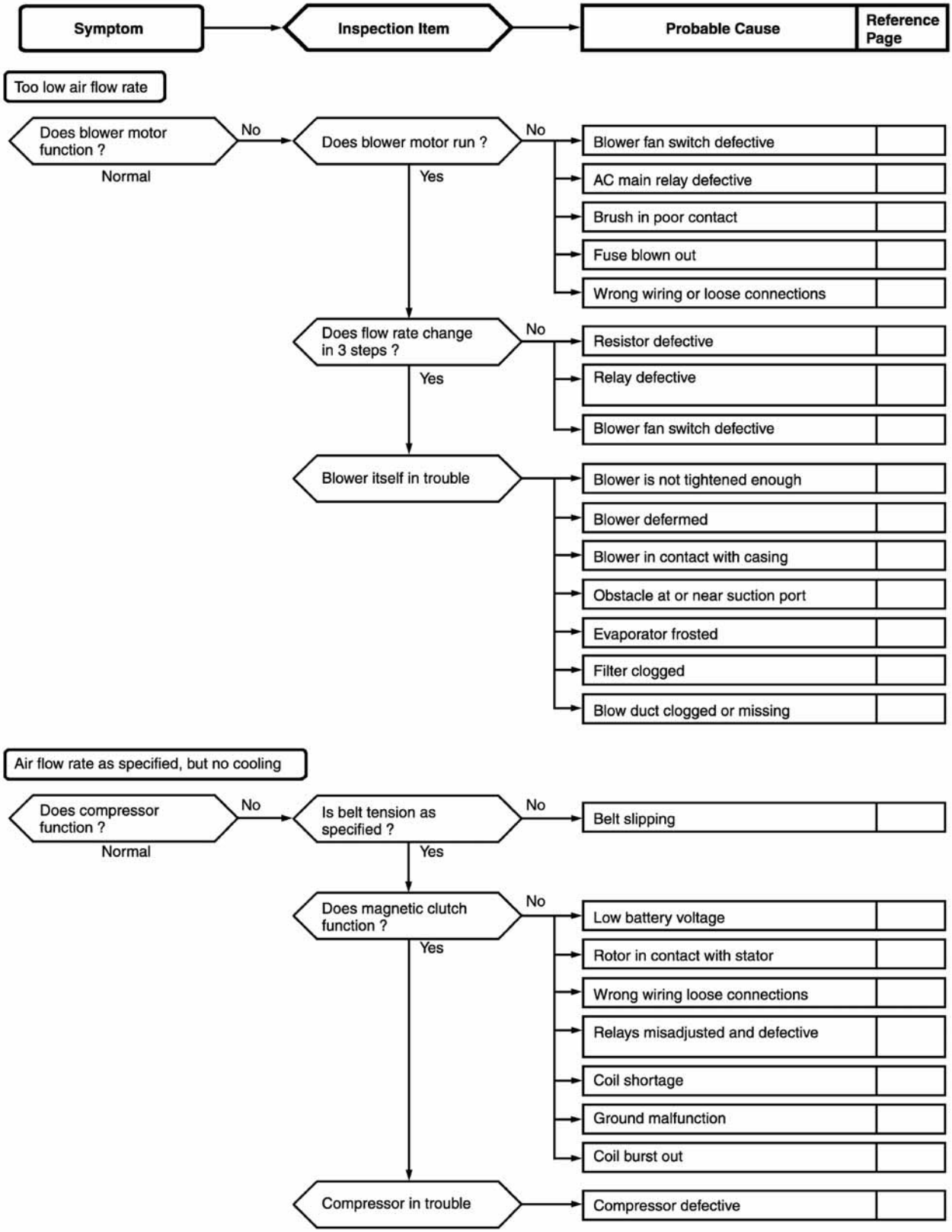
Air Conditioning System

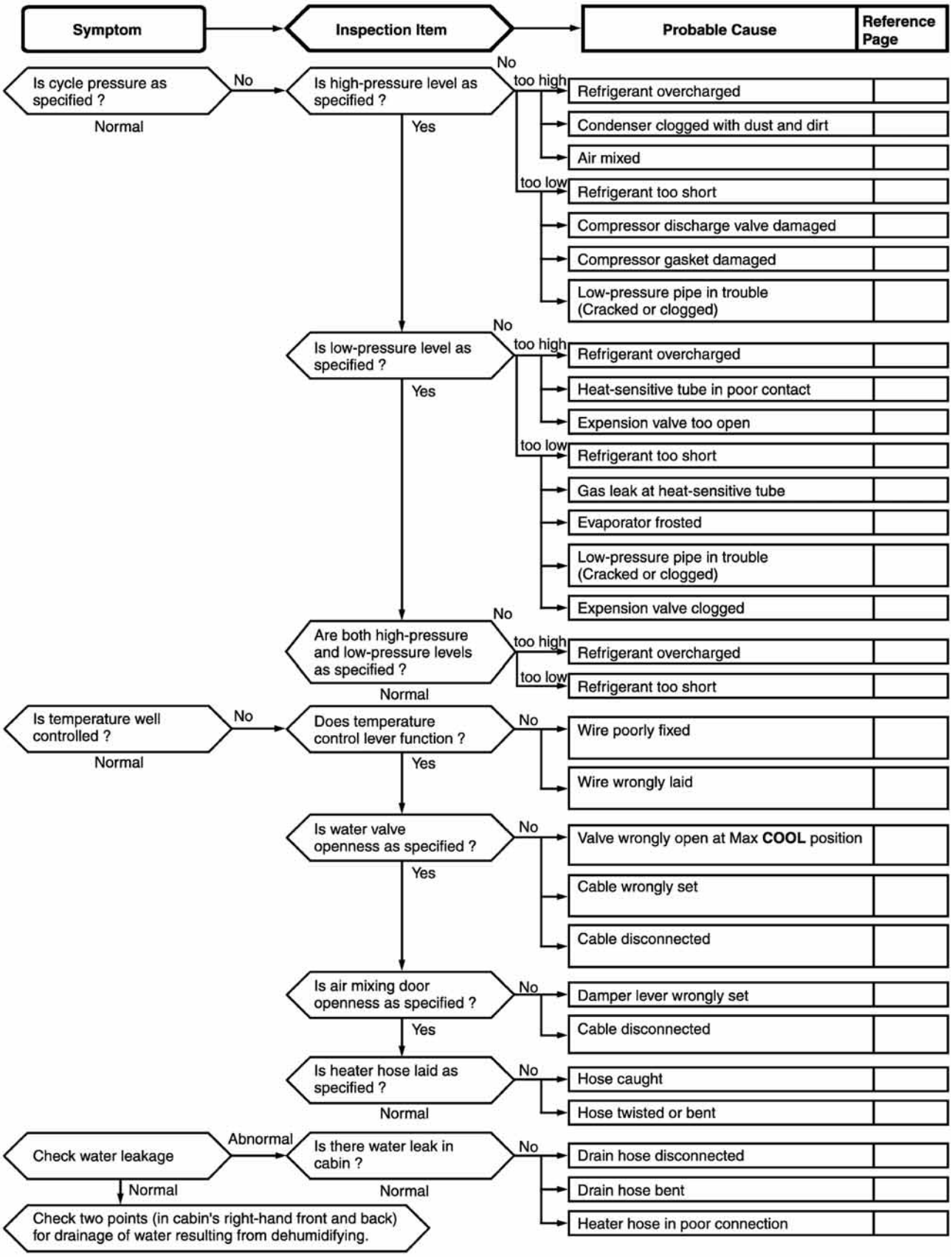
Symptom	Probable Cause	Solution	Reference Page
Does Not Cool (No Air Flow)	• Fuse blown	Replace	
	• A/C main relay defective	Repair or replace	
	• Blower high relay detective	Replace	
	• Blower motor defective	Replace	
	• Blower switch defective	Replace	
	• Wiring harness disconnected or improperly connected	Repair	
(Compressor Does Not Rotate)	• Fuse blown	Replace	
	• Magnetic clutch defective	Repair or replace	
	• A/C switch defective	Replace	
	• Pressure switch defective	Replace	
	• Belt slipping	Adjust or replace	
(Others)	• Insufficient refrigerant	Check with manifold gauge	
	• Expansion valve defective	Replace	
	• Compressor defective	Replace	
Insufficient Cooling (Insufficient Air Flow)	• Air filter clogged	Clean or replace	
	• Evaporator frosted	Clean or replace thermo switch	
	• Blower motor defective	Replace	
	• Blower resistor defective	Replace	
(Many Bubbles in Sight Glass)	• Insufficient refrigerant	Check with manifold gauge Repair and charge refrigerant	
	• Gas leaking from some place in refrigerating cycle	Check with manifold gauge	
	• Air mixed in		
(No Bubbles in Sight Glass)	• Too much refrigerant	Check with manifold gauge	

Compressor

Symptom	Probable Cause	Solution	Reference Page
Insufficient Cooling (Compressor Does Not Rotate Properly)	• Belt slipping • Magnetic clutch defective • Compressor defective	Adjust or replace Repair or replace Replace	
(Others)	• Thermostat defective • Water valve defective • Condenser fin clogged with dust • Expansion valve defective	Replace Replace Clean Replace	
Insufficient Heating	• Water valve defective • Air mix door malfunctioning • Insufficient coolant	Replace Adjust control cable Replenish	
Insufficient Cooling (Compressor Does Not Rotate Properly)	• Belt slipping • Magnetic clutch defective • Compressor defective	Adjust or replace Repair or replace Replace	
(Others)	• Condenser fin clogged with dust • Expansion valve defective	Clean Replace	
Abnormal noise	• Excessive refrigerant • Internal damage	Discharge gas to specified amount. Replace	
Noisy (Compressor ON)	• Bearing of compressor worn or damaged • Valves in compressor damaged • Belt slipping • Compressor bracket mounting screws loosen • Piping resonant	Replace Replace Adjust or replace Tighten Tighten or add clamp	
(Compressor OFF)	• Blower defective • Bearings of magnetic clutch, idle pulley or crank pulley worn or damaged	Repair or replace Replace	

c) Diagnosis Flow Chart




Symptom
Inspection Item
Probable Cause
Reference Page
Is cycle pressure as specified ?
No
Normal
Is high-pressure level as specified ?
No
Yes
too high
Refrigerant overcharged
Condenser clogged with dust and dirt
Air mixed
too low
Refrigerant too short
Compressor discharge valve damaged
Compressor gasket damaged
Low-pressure pipe in trouble (Cracked or clogged)
Is low-pressure level as specified ?
No
Yes
too high
Refrigerant overcharged
Heat-sensitive tube in poor contact
Expension valve too open
too low
Refrigerant too short
Gas leak at heat-sensitive tube
Evaporator frosted
Low-pressure pipe in trouble (Cracked or clogged)
Expension valve clogged
Are both high-pressure and low-pressure levels as specified ?
No
Normal
too high
Refrigerant overcharged
too low
Refrigerant too short
Is temperature well controlled ?
No
Normal
Does temperature control lever function ?
No
Yes
Wire poorly fixed
Wire wrongly laid
Is water valve openness as specified ?
No
Yes
Valve wrongly open at Max COOL position
Cable wrongly set
Cable disconnected
Is air mixing door openness as specified ?
No
Yes
Damper lever wrongly set
Cable disconnected
Is heater hose laid as specified ?
No
Normal
Hose caught
Hose twisted or bent
Check water leakage
Abnormal
Normal
Is there water leak in cabin ?
No
Normal
Drain hose disconnected
Drain hose bent
Heater hose in poor connection
Check two points (in cabin's right-hand front and back) for drainage of water resulting from dehumidifying.

d) Troubleshooting from Problem Symptoms (except Refrigeration Cycle Troubles)

You will find the troubles easily using the table below. For details, refer to each troubleshooting chart.

No.	Problem	Main Inspection Areas						Refer to page
		Fuses	Connectors	Wire harness	Body ground	*1 Sensor circuit	Others	
1	Fuse is blown out easily	○	○	○	○			
2	No blower operation	○	○	○	○		Blower motor, Blower resistor, Blower switch	
3	Blower speed does not change	○	○	○	○		Blower resistor Blower switch	
5	No compressor operation	○	○	○	○		Magnetic clutch & relay Compressor A/C switch	
6	A/C lamp does not light	○	○	○	○		A/C switch	
7	A/C lamp flashes. (only for compressor with lock sensor)	○	○	○		○	Compressor, V-ribbed belt Magnetic clutch	
8	No A/C operation (No cool air comes out)	○	○	○	○			
9	Room temp. does not decrease (insufficient cooling)	○	○	○	○	○		
10	No warm air comes out						Engine coolant volume, A/C temp. control lever Heater radiator	

Note: *1: Sensors are thermistor, pressure switch and water temp. switch.

(B) SERVICING SPECIFICATIONS

a) Specifications of A/C System and Components

	Item			Specifications	Remarks
Performance	Cooler		Capacity	2.8 kW ±10%	Outside air: 35ºC •Inside air: 27ºC, 50% •Rotating speed of Comp: 1800 rpm •Terminal voltage of blower motor: 13.5 V •Vehicle duct resistance: 310 Pa (including air supply grille)
			Airflow	280 m^3/h ±10%	
			Power consumption	150 W ±10%	
	Heater		Capacity	3.6 kW ±10%	•Difference between air and water temperatures: 65ºC •Hot water flow: 6 L/min •Terminal voltage of blower motor: 13.5 V •Vehicle duct resistance: 460 Pa (including air supply grille)
			Air flow	250 m^3/h ±10%	
			Power consumption	140 W ±10%	
Component	Compressor assembly	Compressor	Model	SV07E	
			Piston displacement	70 cm^3 (4.3 cu.in.)	
			Rotating speed	700 ~ 6000 rpm	
			Lubricant	ND-0il 8 140 ±10 cm^3 (8.54 ± 0.61 cu.in.)	
		Magnet clutch	Model	K20	
			Drive belt	Single HM,33.5 inch	Deflection: 12 - 15 mm at 6 ~ 7 kgf
			Pulley efficacy	dia. 108	Nut tightening torque = 19.6 N·m (200 kgf·cm)
			Power consumption	35W or less	
		Weight		2.82 kg (6.22 lbs)	
	Condenser	Specifications of core	Dimensions (mm)	Height 264.2 Width 325 Thickness 16.1	
			Fin type	Corrugated fin, 3.6 mm (with louver)	
		Weight		1.1 kg (2.4 lbs)	
	Cooler unit	Specifications of core (cooler)	Dimensions (mm)	Height 165 Width 163.5 Thickness 58	
			Fin type Pitch	Corrugated fin, 4 mm	
		Specifications of core (heater)	Dimensions (mm)	Height 140 Width 122.5 Thickness 21	
			Fin type Pitch	Corrugated fin, 1.8 mm	
		Motor	Motor type	Dia. 70 ferrite motor	
			Rotating speed	3350 rpm ±10%	12V
			Current	12A or less	
		Weight		6.9 kg (15lbs)	
	Receiver	Actual capacity		370 cm^3	Inner gas = N_2
		Moisture absorption capacity		32 g	60ºC, 90% in air (Desiccant: 290 g)
Refrigerant charge amount				**850 ± 50 g (1.87 ± 0.11lbs)**	

	Item		Specifications		Remarks
Component	Pressure switch	High-pressure relief	Opening pressure	3.43 ~ 4.1 MPa 35.0 ~ 41.8 kgf/cm^2 498 ~ 595 psi	Installed in the compressor
			Closing pressure	2.75 MPa or more 28.0 kgf/cm^2 398 psi	
		High-pressure OFF	3.14 MPa, 32.0 kgf/cm^2, 455 psi (DIFF 0.59 MPa)		High-pressure cut
		Low-pressure OFF	0.196 MPa, 2.0 kgf/cm^2, 28.5 psi (DIFF 0.02 MPa)		Low-pressure cut (prevention of operation without gas)
Refrigerant used			HFC134a		
Engine pulley			ø140		Code No. RD411-55161
Compressor pulley			ø120, w =11.7, θ = 36		

b) Performance Specifications

Item		Specifications	Remarks
Noise level at ear point db (A)		80, 82>	
Duct sealing capacity	Air flow speed out of grille A (m/s)	17.0, 17.0<	Engine: Max., Blower: Max. All outlet except A are closed.
Heater capacity	Air temp. out of grille A (°C)	45.0, 45.0 5 min. later	Engine: Max., Blower: Max. A/C switch: OFF, 4 outlets: Open Measuring point: 20 - 30 mm lower from grille A.
Cooler capacity	Air temp. out of grille A (°C)	10.0> at ambient temp.<=35 °C within 10 min.	Engine: Max., Blower: Max. A/C switch: ON, 4 outlets: Open Measuring point: 20 - 30mm lower from grille A.
		15.0> at ambient temp.> 35 °C within 10 min.	

c) Adjustment and Testing

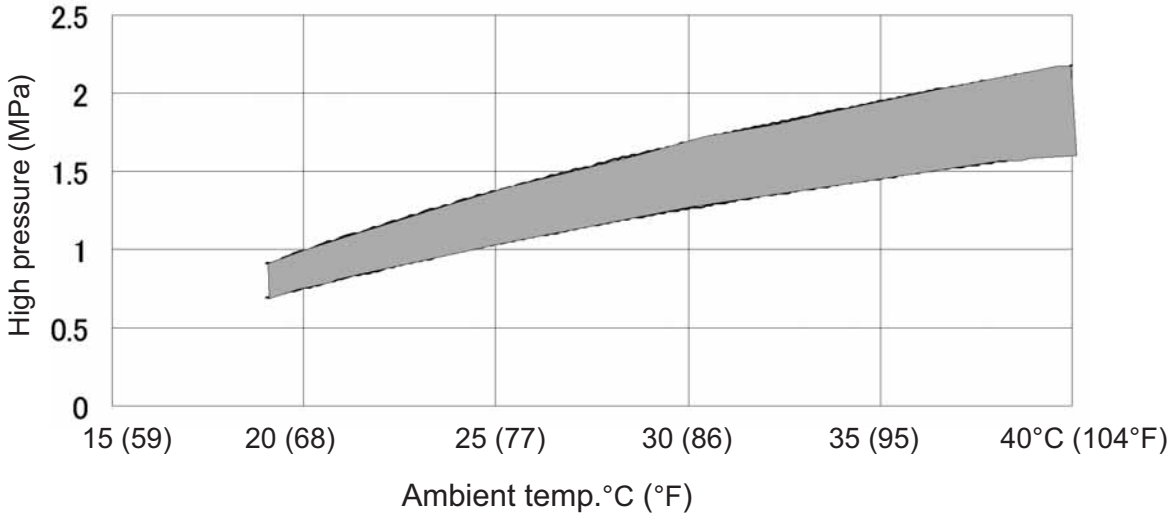
Item		Factory Specification	Allowable Limit
Refrigerant amount	Type: R134a	800 ± 50 g 1.76 ± 0.11 lbs	
Lub. oil amount in total system	Type: ND-Oil 8	140 ± 10 cc 0.037 ± 0.003 us gal	In new compressor
Air-gap of A/C Compressor Magnet Clutch	Swash Plate Type Compressor Scroll Type Compressor	0.25 to 0.50 mm 0.010 to 0.020 in. 0.35 to 0.65 mm 0.014 to 0.022 in.	
Refrigerating Cycle (Refrigerating Cycle is Normal Operating) Condition •Engine Speed: Approx. 1500 min-1 (rpm) •Ambient Temperature: 30 to 35 °C 86 to 95 °F •Blower Switch: High position	Pressure (**LO** Pressure Side) Pressure (**HI** Pressure Side)	0.15 to 0.20 MPa 1.5 to 2.0 kgf/cm^2 21 to 28 psi 1.27 to 1.66 MPa 13 to 17 kgf/cm^2 185 to 242 psi	
Pressure Switch (Dual Type) (When pressure switch is turned **OFF**)	Setting Pressure (**LO** Pressure Side) Setting Pressure (**HI** Pressure Side)	Less than Approx. 0.196 MPa 2.0kgf/cm^2 28.4psi More than approx. 3.14 MPa 32 kgf/cm^2 455 psi	
Air Conditioner Drive Belt	Tension	12 to15 mm (0.47 to 0.59 in.) deflection at 58.8~68.6 N (6~7 kgf, 13.2~15.4 lbs) of force	

d) Ambient Temperature vs Normal High-Low Pressure Range

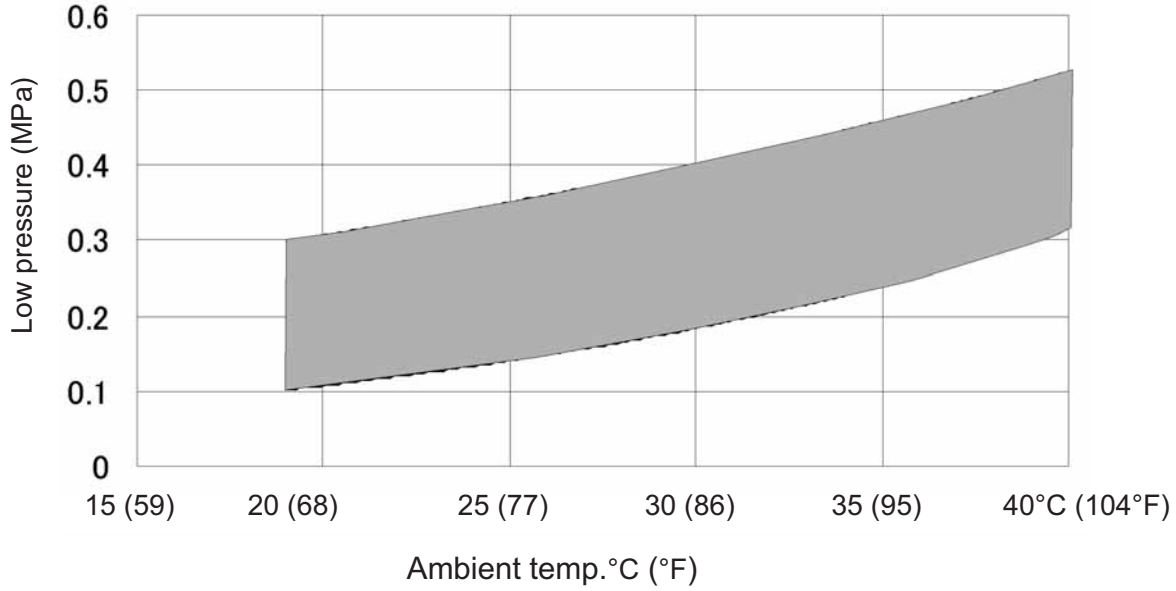
Conditions

Door :open
Blower :High range
Temp. control :Max. cool
Engine speed :1500 rpm

Normal high pressure range



Normal low pressure range



1 MPa = 10.2 kgf/cm^2 = 145 psi

e) Tightening Torques

Tightening torques of screws, bolts and nuts on the table below are especially specified.
(For general use screws, bolts, and nuts: See page G-11.)

Item	N•m	kgf•m	ft-lbs
Cabin mounting nuts			
M14 nut	107.9 to 125.5	11.0 to 12.8	79.6 to 92.6
M16 nut	166.7 to 191.2	17.0 to 19.5	123.0 to 141.0
Compressor mounting screw, M8 bolt	16.7 to 19.9	1.7 to 2.0	12.3 to 14.5
Compressor bracket mounting screws			
Screws M12	77.5 to 90.2	7.9 to 9.2	57.1 to 66.5
Screw M8	16.7 to 19.6	1.7 to 2.0	12.3 to 14.5
Receiver mounting bolt (M6)	3.9 to 6.9	0.4 to 0.7	
Clutch mounting screw (Slide vane type compressor)	10.8 to 16.2	1.10 to 1.65	8.0 to 11.9
High pressure pipe screw and retainer nut			
between compressor and condenser (High pressure pipe 1)			
screw	7.8 to 11.8	0.8 to 1.2	5.8 to 8.7
retaining nut, M22 x 1.5	19.6 to 24.5	2.0 to 2.5	14.5 to 18.1
between condenser and receiver			
screw, M6 bolt	3.9 to 6.9	0.4 to 0.7	2.9 to 5.1
retaining nut, M16 x 1.5	11.8 to 14.7	1.2 to 1.5	8.7 to 10.8
between receiver and A/C unit (High pressure pipe 2)			
retaining nut, M16 x 1.5	11.8 to 14.7	1.2 to 1.5	8.7 to 10.8
Low pressure pipe			
between A/C unit and compressor			
screw, M6 bolt	7.8 to 11.8	0.8 to 1.2	5.8 to 8.7
retaining nut, M24 x 1.5	29.4 to 34.3	3.0 to 3.5	21.7 to 25.3
A/C unit mounting screws (M6)	3.9 to 6.9	0.4 to 0.7	2.9 to 5.1
A/C unit mounting screws (M8)	9.8 to 15.7	1.0 to 1.6	7.23 to 11.6

Reference: Lub.oil

Replacing Parts	Approx Replenish Quantity	Brand Name
Condenser	20 cc 0.021 U.S. qts. 0.018 Imp. qts.	ND-OIL 8 <PAG* oil>
Evaporator	20 cc 0.021 U.S. qts. 0.018 Imp. qts.	
Receiver	10 cc 0.011 U.S. qts. 0.009 Imp. qts.	

* PAG: Polyalkyleneglycol (Synthetic oil)

(C) REGULAR CHECK AND SERVICE POINTS

a) Maintenance Interval; Air Conditioner

No.	Items	Period	Indication on hour meter							Since then	Reference No.	
			50	100	150	200	250	300	350			
1	Inner air filter	clean				○				every 200 hrs	1	*2
		replace								every 1000hrs	1	*2
2	Outer air filter	clean				○				every 200 hrs	1	*2
		replace								every 1000 hrs	1	*2
3	Air conditioner condenser	clean				○				every 200 hrs	2	
4	Air conditioner drive belt	check				○				every 200 hrs	3	
5	Air conditioner pipes and hoses	check								every 1 year		
		replace								every 2 years		
6	Refrigerant (gas)	check								Service as required		

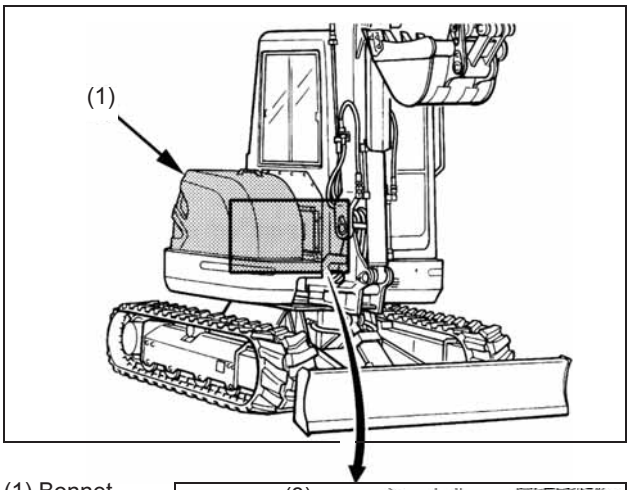
No.	Items	Period	Indication on hour meter							Since then	Reference No.	
			400	450	500	550	600	650	700			
1	Inner air filter	clean	○				○			every 200 hrs	1	*2
		replace								every 1000hrs	1	*2
2	Outer air filter	clean	○				○			every 200 hrs	1	*2
		replace								every 1000 hrs	1	*2
3	Air conditioner condenser	clean	○				○			every 200 hrs	2	
4	Air conditioner drive belt	check	○				○			every 200 hrs	3	
5	Air conditioner pipes and hoses	check								every 1 year		
		replace								every 2 years		
6	Refrigerant (gas)	check								Service as required		

Important

*2 Clean and replace the air filter more frequently if used under dusty conditions. By heavy soiling, replace the filter.

b) Regular Service Points

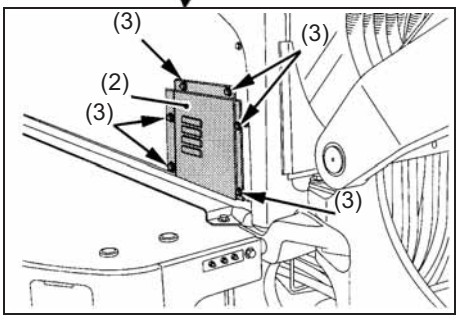
1. Cleaning Air Filter
   Remove the bonnet, and then remove the bolts and pull out filter.



Note:

- Attach the filter, plate and cover as illustration.
- ♦ **Cleaning the air filter**
- Normal use
  Blow air from the opposite direction to the filter's normal air flow.

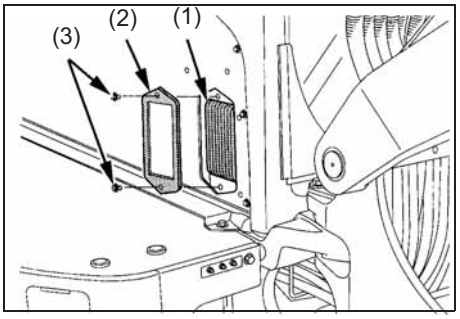
(1) Bonnet
(2) Cover
(3) Bolt



IMPORTANT:

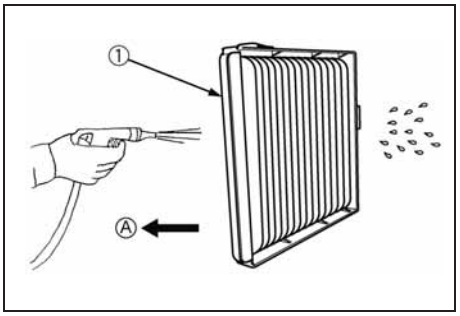
- Do not hit the filter. If the filter becomes deformed, dust may enter into the air-conditioner, which may cause damage and malfunction.

(1) Outer air filter
(2) Plate
(3) Bolt



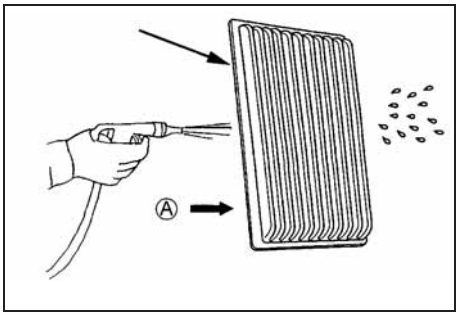
(1) Inner filter

Ⓐ "AIR CONDITIONER AIR FLOW"



(2) Outer filter

Ⓐ "AIR CONDITIONER AIR FLOW"



Note:

- If the filter is very dirty, replace the air filter.

2. Checking Air-Conditioner Condenser
   Check air conditioner condenser to be sure it is clean from debris.

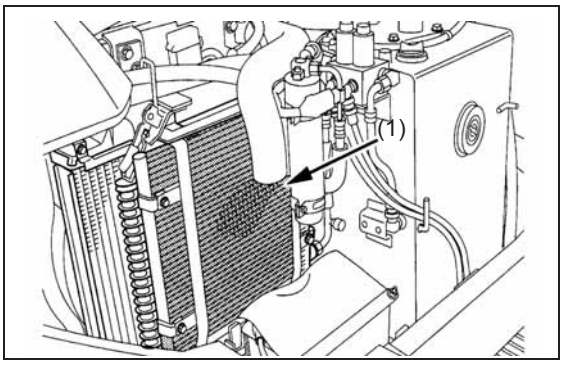
3. Checking Air-Conditioner Belt Tension

⚠ Caution
To avoid personal injury:
- **First stop the engine and remove the key.**
- **After servicing, make sure to replace the belt cover in its original position.**

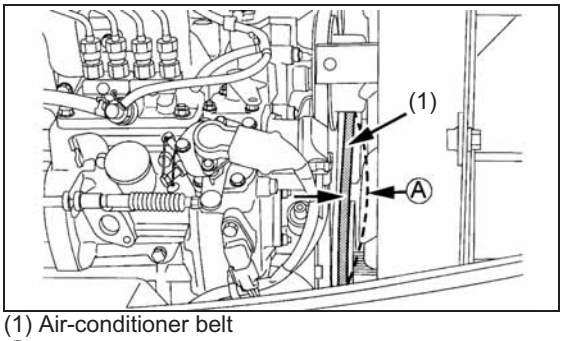
Push on the belt between the pulleys with a finger. A deflection of 12 to 15 mm (0.5 to 0.6 in.) under a 7 kgf (15 lbs) load is appropriate.

Note:
- If the air-conditioner belt is too loose, consult your local KUBOTA Dealer for this service

Important:
- **Charge only with R134a not R12 refrigerant (gas).**



(1) Air conditioner condenser



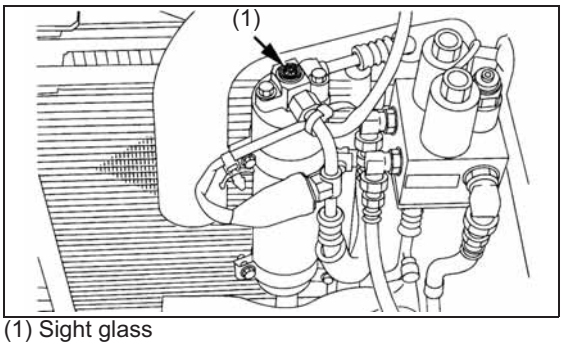
(1) Air-conditioner belt
Ⓐ 10 to 15 mm

Servicing As Required
[Air conditioner type]

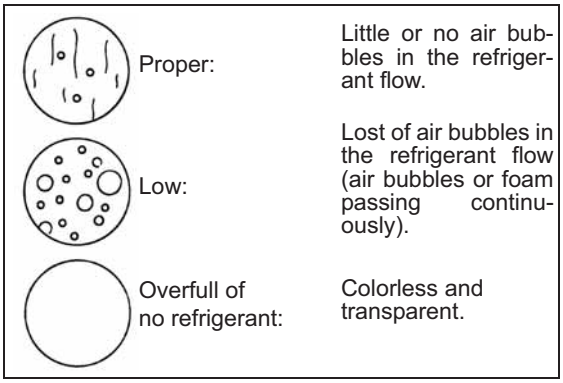
4. Checking Amount of Refrigerant (gas)

⚠ Warning
To avoid personal injury:
- **Liquid contact with eyes or skin may cause frostbite.**
- **In the event of a leakage, wear safety goggles. Escaping refrigerant can cause severe injuries to eyes.**
- **In contact with a flame, R134a refrigerant gives a toxic gas.**
- **Do not disconnect any part of the refrigeration circuit of air conditioning system. Consult your local KUBOTA Dealer for assistance and service.**

A shortage of refrigerant impairs the air-conditioner performance. Check the following points. If it is indicated that the amount of refrigerant is extremely low, ask your dealer to inspect and charge.



(1) Sight glass



Checking procedure
1. Run the air-conditioner in the following conditions.
   - Engine speed: About 1500 rpm
   - Temperature control lever: Maximum cooling position (rightmost)
   - Fan switch: Highest blow (3)
   - Air-conditioner switch: ON
2. Look into the sight glass to see if the refrigerant is flowing through its circuit.

(D) PRECAUTIONS AT REPAIRING REFRIGERANT CYCLE

When checking or repairing the air conditioning system, the following precautions and rules must be observed. And it is of first importance that no other personnel than a well-trained serviceman should be allowed to handle the refrigerant.

⚠ CAUTION

- **Since direct contact of the liquid refrigerant with your skin will cause frostbite, always be careful when handling the refrigerant. Always wear goggles to protect your eyes when working around the system.**
- **The refrigerant service container has a safe strength. However, if handled incorrectly, it will explode.**
- **Therefore, always follow the instructions on the label. In particular, never heat the refrigerant container above 40°C (104°F) or drop it from a high height.**
- **Do not steam clean on the system, especially condenser since excessively high pressure will build up in the system, resulting in explosion of the system.**
- **If you improperly connect the hose or handling the valve, be sure to check the high pressure side or low pressure side.**
- **In case the refrigerant is charged while the compressor is operated, do open the high pressure valve of the gauge manifold.**
- **Beware of the toxicity of the gas. The gas is harmless and nontoxic in its original state, however it produces a toxic substance when it comes in contact with high temperature parts and decomposes.**
- **Do not heat the service can unless necessary. When it has to be heated, use warm water of 40°C (104°F) or lower. Do not heat using boiling water.**

IMPORTANT

- **If the refrigerant, O-rings, etc. for R12 are used in the R134a air conditioner system, problems such as refrigerant leakage or cloudiness in the sight glass may occur. Therefore, in order to prevent charging of refrigerant or erroneous connections, the shapes of the piping joint as well as the shapes of the service valve and the service tools have been changed.**
- **Always keep the working place clean and dry and free from dirt and dust. Wipe off water from the line fittings with a clean cloth before disconnecting.**
- **Use only for R134a refrigerant service tool.**
- **Use for R134a refrigerant recovery and recycling machine when discharging the refrigerant.**
- **Before attaching the charging hose to the can tap valve of the refrigerant container, check each packing for clogging.**
- **When disconnecting the charging hose from the charging valve of compressor and receiver, remove it as quick as possible so that gas leakage can be minimized.**
- **Be sure to charge the specified amount of refrigerant, but not excessively, Over-charging of the refrigerant in particular may cause insufficient cooling, etc.**
- **Since the charging hose can be connected to can tap valve by hand, do not use a pliers for tightening it.**
- **Keep refrigerant containers in a cool and dark place avoiding such place which are subject to strong sunlight or high temperature.**
- **R134a compressor oil absorbs moisture easily, so that be sure to seal after disconnecting the each parts.**
- **Do not use old-type refrigerant R12a or compressor oil for old-type refrigerant.**
- **When replacing the condenser, evaporator and receiver, etc., replenish the compressor oil to compressor according to the table below.**

Observance of laws and regulations

- **Refrigerant is the subject of global environmental protection issue.**
  Therefore, when handling the refrigerant cycle, we are subjected to abide the laws and regulations.

(E) PRECAUTION FOR INSTALLATION AND MAINTENANCE

Important service points for high quality and long life.

<table>
<tr><th>Item</th><th>Description</th><th>Possible problem in case of control failure</th></tr>
<tr><td>1. Storage place of A/C parts (all)</td><td>Store them in an indoor place not exposed to rain water.</td><td>Water or dust entry into circuit
↓
Circuit clogged</td></tr>
<tr><td>2. Plugs</td><td>• Do not remove them until connecting.
Limit the receiver's open time to shorter than 3 minutes (because of the desiccant inside).
• Be sure to put in the plugs if you have to leave the spot during connecting.</td><td>↑</td></tr>
<tr><td rowspan="3">3. Pipe connections</td><td>Tightening torque of pipe fixture nuts and bolts
<table>
<tr><th>Connection</th><th>Tube size or bolt size</th><th>Tightening torque
N•m (kgf•m) ft•lbs</th></tr>
<tr><td rowspan="3">Nut type</td><td>+B pipe (liquid pipe)</td><td>11.8 ~ 14.7 (1.2 ~ 1.5) 8.7 ~ 10.9</td></tr>
<tr><td>D1/2 pipe (discharger pipe)</td><td>19.6 ~ 24.5 (2.0 ~ 2.5) 14.5 ~ 18.1</td></tr>
<tr><td>D5/6 pipe (suction pipe)</td><td>29.4 ~ 34.3 (3.0 ~ 3.5) 21.7 ~ 25.3</td></tr>
<tr><td rowspan="2">Block joint</td><td>Receiver's M6 bolt (4T)</td><td>3.92 ~ 6.86 (0.4 ~ 0.7) 2.9 ~ 5.1</td></tr>
<tr><td>Other M6 bolts (6T)</td><td>7.65 ~ 11.8 (0.8 ~ 1.2) 5.8 ~ 8.7</td></tr>
</table></td><td>Gas leak</td></tr>
<tr><td>Pipe connections
Tighten up the pipe unions and nuts by applying two wrenches at once.</td><td>Cracks in brazed spot
↓
Gas leak</td></tr>
<tr><td>Oil application on O rings
Apply the ND-OIL8 new refrigerant compressor oil to the O rings. Be sure to use the ND-OIL8 oil, not any other such as ND-OIL6, 7, and Suniso.</td><td>Refrigerant cloudiness</td></tr>
<tr><td>4. Pipe clamps</td><td>Use clamps that match the diameters of hoses and tubes. Make sure the pipe connections withstand possible vibrations.</td><td>Pipe damage, hose wear-out
↓
Gas leak</td></tr>
<tr><td>5. Vacuum buildup</td><td>• Use the high-/low-pressure service valve.
• Continue for 10 minutes or longer at -101 kPa, (- 1.03 kgf/cm^2), - 14.6 psi</td><td>Poor removal of water and air from circuit
↓
Poor cooling, circuit clogged</td></tr>
<tr><td>6. Drain hose connection</td><td>Connect the drain hose below the unit drain pan. Make sure there is no air trap.</td><td>Drain water leak</td></tr>
<tr><td rowspan="2">7. Refrigerant charging</td><td>(1) Gas charging (during cycle operation)
1) Feed through the high-pressure side without cycle operation. (Never feed through the low-pressure side, nor keep on the cycle operation.)
2) Then add through the low-pressure side during cycle operation.</td><td>Liquid compression
↓
Compressor failure</td></tr>
<tr><td>(2) Liquid charging (without cycle operation)
Be sure to feed through the high-pressure side (never through the low-pressure side).</td><td>↑</td></tr>
</table>

<table>
<tr><th>Item</th><th>Description</th><th>Possible problem in case of control failure</th></tr>
<tr><td>8. Refrigerant charge amount</td><td>Maintain the refrigerant amount of 850 ± 50 g (1.87 ± 0.11 lbs). (Refrigerant amount with no more bubble sight glass + 150 g)
Determine with the following factors in mind.
(Engine rpm, idling, temperature regulator, cooling power, blower, Lo - Hi)</td><td><Too much refrigerant>
Pressure switch activated, resulting in poor cooling
↓
<Too short refrigerant>
Poor cooling, compressor failure</td></tr>
<tr><td>9. Oil control</td><td>(1) Immediately wipe oil off the metallic parts, as required.
(2) Do not use if the acrylic and ABS resin parts (amorphous thermoplastic resin) get stained with oil.</td><td>Preventing the other parts from rust and degrading due to the ND-OIL8.</td></tr>
<tr><td>10. Tightening torque of A/C unit mounting bolts and nuts</td><td>M8 parts: 9.8 ~ 15.68 N•m (1.0 ~ 1.6 kgf•m) 7.2 ~ 11.6 ft•lbs</td><td>Loose mounting nut, damaged mounting bolt</td></tr>
<tr><td>11. A/C running-in</td><td>Keep the A/C running in for 10 minutes or longer (under the following conditions).
<table><tr><th>Engine run</th><th>Idling</th></tr><tr><td>Key switch</td><td>ON</td></tr><tr><td>Blower switch</td><td>ON, High position</td></tr><tr><td>A/C switch</td><td>ON</td></tr></table>Preferably run at temperatures higher than 20°C.</td><td>Short compressor service life</td></tr>
<tr><td>12. A/C run after long-term shutdown</td><td>When the vehicle has not been used for a long time (1 week or longer) and the A/C gets restarted, be sure to idle-run the engine and turn on the A/C switch to protect the compressor.</td><td>↑</td></tr>
</table>

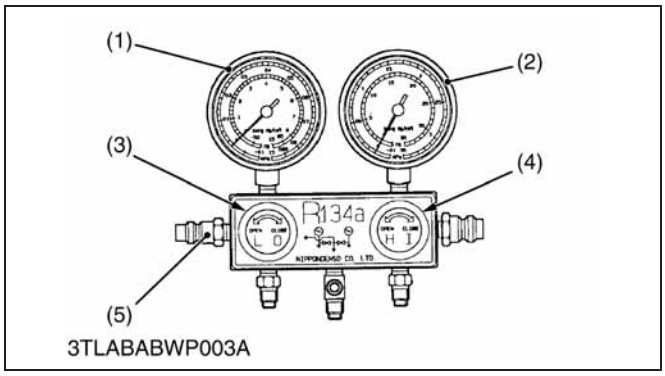
(F) CHECKING AND CHARGING REFRIGERANT CYCLE

a) Handling of Service Tools

(1) Manifold Gauge Set

The hand valves on the manifold gauge set are used to open and close the valve. The hand valve inscribed **LO** is for the low pressure side valve (3) and **HI** is for the high pressure side valve (4). By opening or closing the high and low pressure hand valves, the following circuits are established.

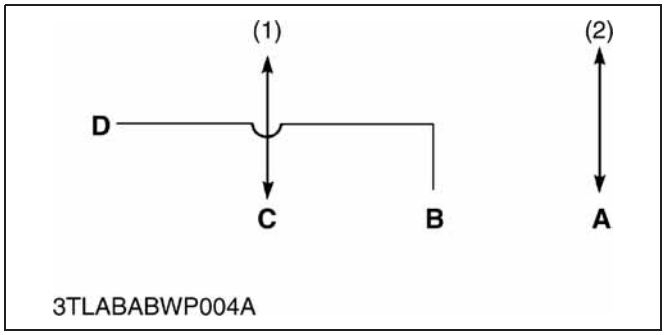
(1) LO Pressure Gauge(4) HI Pressure Side Valve
(2) HI Pressure Gauge(5) Schrader Valve
(3) LO Pressure Side Valve



3TLABABWP003A

When LO Pressure Side Valve and HI Pressure Side Valve are Closed
Two circuits are established.
Port (**C**) → **LO** pressure gauge (1)
Port (**A**) → **HI** pressure gauge (2)

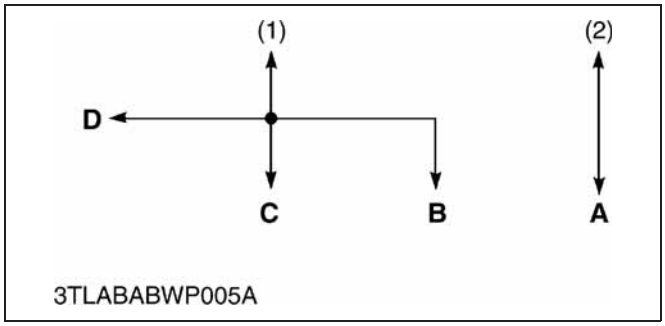
Note: Schrader valve (D) must be opened.



3TLABABWP004A

When LO Valve is Opened and HI Valve is Closed
Two circuits are established.
Port (**C**) → **LO** pressure gauge (1)
→ Port (**B**)
→ Port (**D**)
Port (**A**) → HI pressure gauge (2)

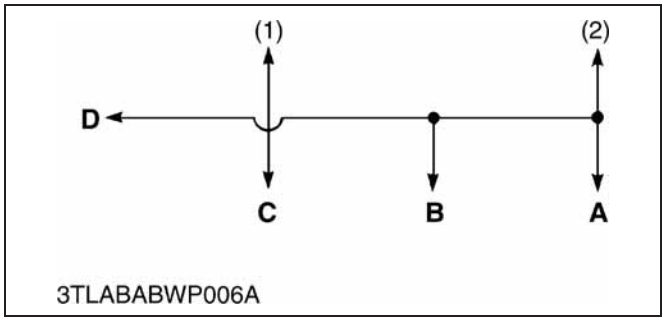
Note: Schrader valve (D) must be opened.



3TLABABWP005A

When LO Valve is Closed and HI Valve is Opened
Two circuits are established.
Port (**C**) → **HI** pressure gauge (2)
→ Port (**B**)
→ Port (**D**) (Schrader valve must be opened)
Port (**A**) → **LO** pressure gauge (1)

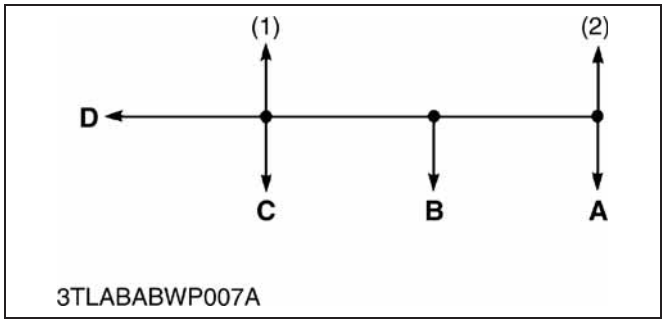
Note: Schrader valve (D) must be opened.



3TLABABWP006A

When LO and HI Valve are Opened
Circuits are established.
Port (**A**) → **HI** pressure gauge (2)
→ **LO** pressure gauge (1)
→ Port (**B**)
→ Port (**C**)
→ Port (**D**) (Schrader valve must be opened)

Note: Schrader valve (D) must be opened.



3TLABABWP007A

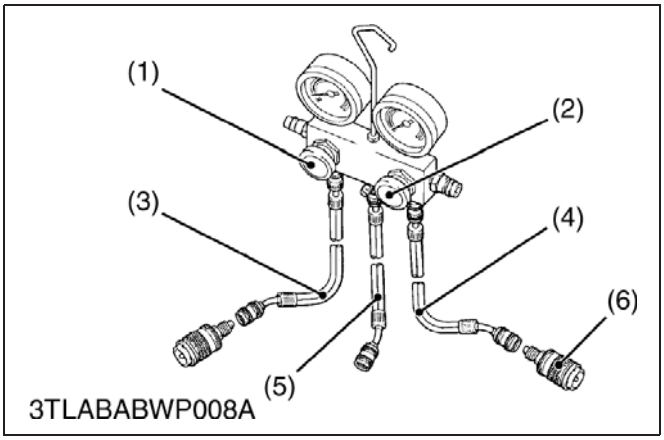
(2) Refrigerant Charging Hose

The charging hoses are classified into three colors. Each charging hose must be handled as follows :

- The air conditioner manufacture recommends that the blue hose (3) is used for the **LO** pressure side (suction side), the green hose (5) for refrigeration side (center connecting port) and the red hose (4) for **HI** pressure side (discharged side).

(When connecting)

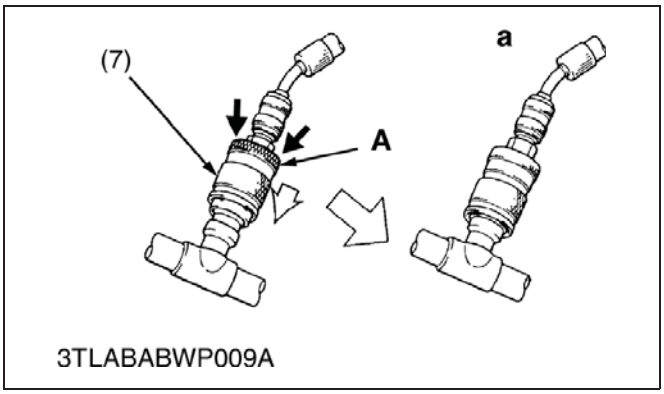
- Push the quick disconnect adaptor (6) into the charging valve, and push on part **A** until a click is heard.



3TLABABWP008A

Note:

- **When connecting, push carefully so the pipe doesn't bend.**
- **When connecting the quick disconnect connector, should the sleeve (7) move before the quick link connector can be connected to the charging valve, move the quick sleeve to its original position and try again.**
- **When some refrigerant remains in the charging hose at the time of connections, it may be difficult to connect the quick link connector. In this case, perform the operation after removing any residual pressure in the hose. (Remove the residual pressure by pushing the pusher (8).)**

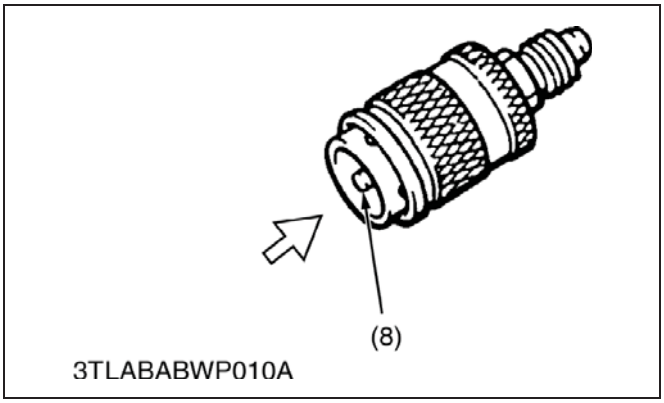


3TLABABWP009A

(When reassembling)

- While holding on to part **A** of the quick disconnect adaptor, slide part **B** up.

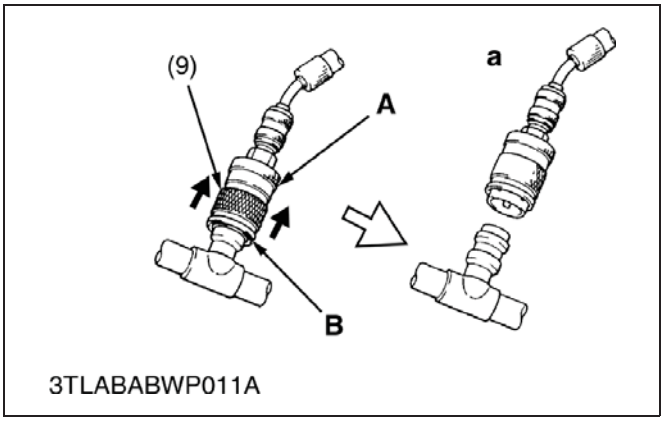
Note: After removing the adaptor, ensure to cap the quick disconnect adaptor service valve.



3TLABABWP010A

(1) LO Pressure Side Valve
(2) HI Pressure Side Valve
(3) Blue Hose
(4) Red Hose
(5) Green Hose
(6) Quick Disconnect Adaptor
(7) Sleeve
(8) Pusher
(9) Sleeve

a: CLICK



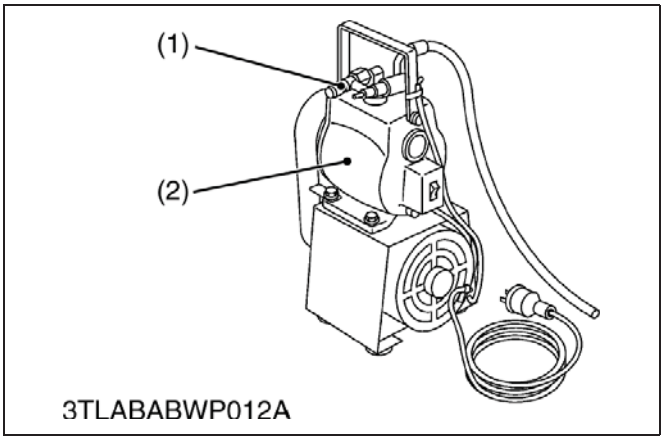
3TLABABWP011A

(3) Vacuum Pump Adaptor

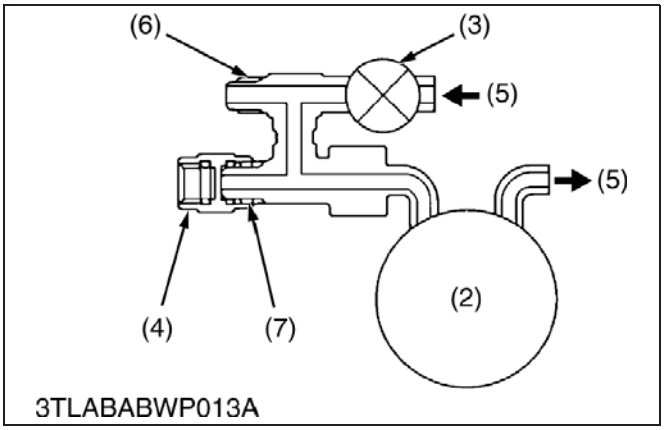
Objective of the Vacuum Pump Adaptor

1) After vacuum has been created in the air conditioning cycle, when the vacuum pump is stopped, since there is vacuum in hoses within the gauge manifold, the vacuum pump oil flows back into the charging hose. If the refrigerant is refilled with the system still in this state, the vacuum pump oil left in the charging hose enters the air conditioner cycle together with the refrigerant. Vacuum pump adaptor with a solenoid valve is used to prevent this back-flow of oil from the vacuum pump. The role of the solenoid valve is that when the current passes through the solenoid valve, the valve closes to keep out the outside air and allow the vacuum to build up, but when the current stops, the valve opens to allow in air and end the vacuum.
2) Attaching this adaptor to the R12 vacuum pump currently being used allows the pump to be used with both R134a and R12.

(1) Vacuum Pump Adaptor
(2) Vacuum Pump
(3) Magnetic Valve
(4) Blind Cap
(5) Air
(6) For R134a
(7) For R12



3TLABABWP012A



3TLABABWP013A

(4) Electric Gas Leak Tester

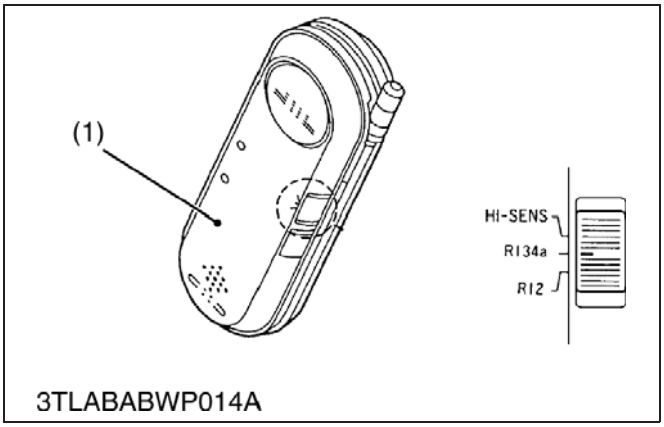
The current R12 gas leak tester has poor sensitivity for R134a and cannot be used. Therefore, a new electric gas leak tester with greater sensitivity has been designed and can be used with both R134a and R12.

Reference

Leak tester with halide torch

- Since the reaction with chlorine within the refrigerant is used to detect gas leaks, R134a, which contains no chlorine, cannot be detected.

(1) Electric Gas Leak Tester



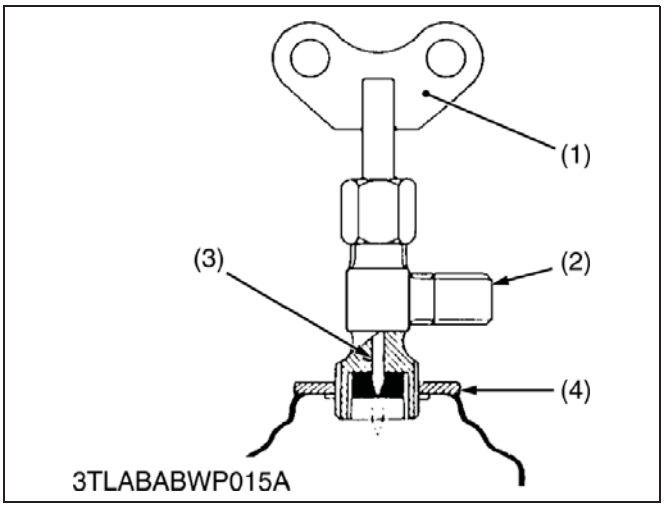
3TLABABWP014A

(5) Can Tap Valve

The can tap valve that is used to charge the refrigerant into the air conditioning system, should be used as follows :

1) Before putting the can tap valve on the refrigerant container, turn the handle (1) counterclockwise till the valve needle is fully retracted.
2) Turn the plate nut (disc) (4) counterclockwise till it reaches its highest position, then screw down the can tap valve into the sealed tap.
3) Turn the place nut clockwise fully, and fix the center charging hose to the valve.
4) Tighten the place nut firmly by hand.
5) Turn the handle (1) clockwise, thus making a hole in the sealed tap.
6) To charge the refrigerant into the system, turn the handle (1) counterclockwise. To stop charging, turn it clockwise.

(1) Butterfly Handle
(2) Connection
(3) Needle
(4) Disc



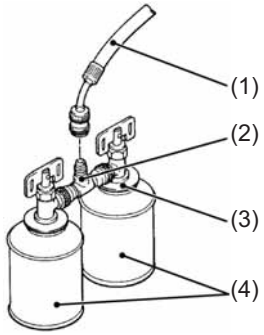
3TLABABWP015A

(6) T-joint

T-joint (2) is used to increase efficiency of gas charging using two refrigerant containers (4) at a time.

1) Install two refrigerant container service valves to T-joint (2) sides and connect the charging hose (1) to it.

(1) Charging Hose (Green)
(2) T-joint
(3) Can Tap Valve
(4) Refrigerant Container



(7) R134a Refrigerant Recovery and Recycling Machine

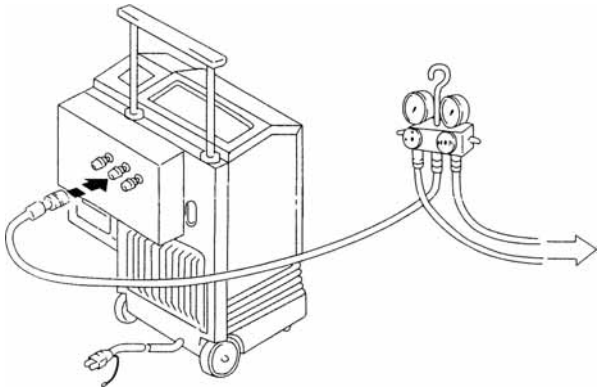
When there is necessity of discharging the refrigerant on repairing the air conditioning system, it should use recovery and recycling machine. (Don't release the refrigerant into the atmosphere.)

IMPORTANT

- **Use only R134a refrigerant recovery and recycling machine, eliminate mixing R134a equipment, refrigerant and refrigerant oils with R12 systems to prevent compressor damage.**

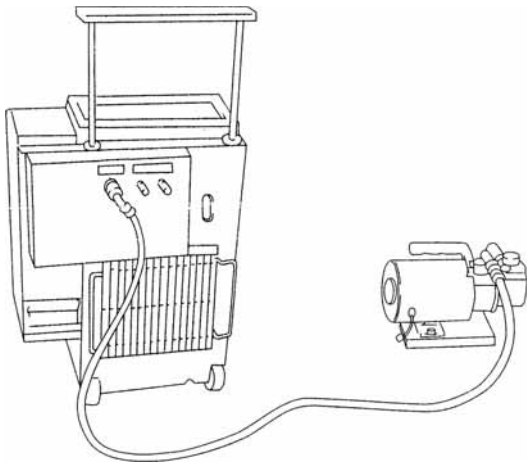
When recovering the refrigerant

(1) Refrigerant recovery port
(2) Charging hose (center)
(3) For HFC134a
(4) Vehicle



When vacuuming the system

(5) Vacuum buildup port
(6) Vacuum pump
(7) Charging hose



Machine unit

Type:	ESR-20ACR
Rated:	AC 100V 50/60Hz 400/460W
Tank type:	HFC134a - ESR-20T
Size:	450 (W) I399(D) I672(H) mm
Weight:	43 kgf
Maker:	DENSO

(8) Special tools

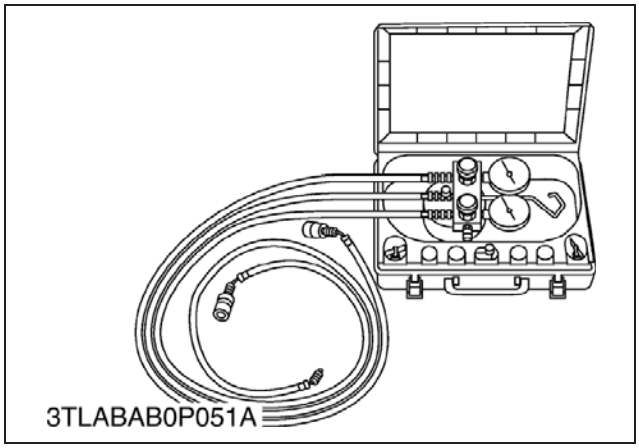
Special tools for R134a refrigerant air conditioning system introduced below are available from NIPPONDENSO CO. LTD.

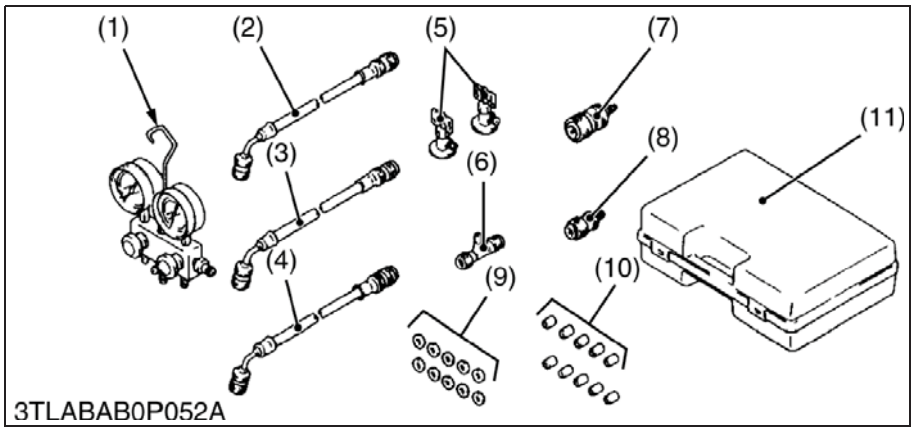
Air Conditioner Service Tool

Code No: NIPPONDENSO 95048-00061

Application: Use for charging, testing or discharging the air conditioning system.

(1) Manifold Gauge Assembly	95048-10090
(2) Charging Hose (Red: HI)	95948-10270
(3) Charging Hose (Blue: LO)	95948-10280
(4) Charging Hose (Green)	95048-10260
(5) Can Tap Valve	95048-10150
(6) T-Joint	95048-10160
(7) Quick Coupler (HI)	95048-10130
(8) Quick Coupler (LO)	95906-10140
(9) Service Valve Packing	95906-10310
(10)Charging Hose Packing	95949-10300
(11)Tool Case	95949-10610

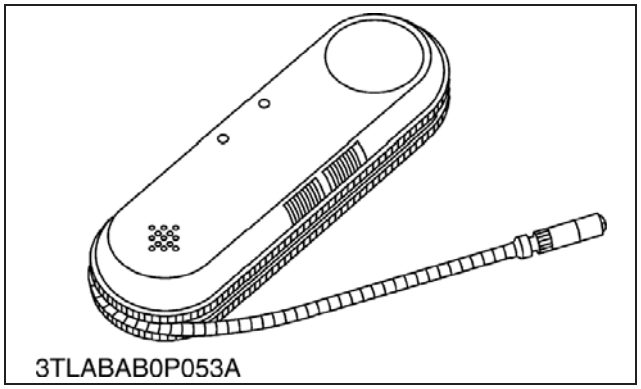




Electric Gas Leak Tester

Code No: NIPPONDENSO 95146-00060

Application: Use for gas leak testing the air conditioning system.

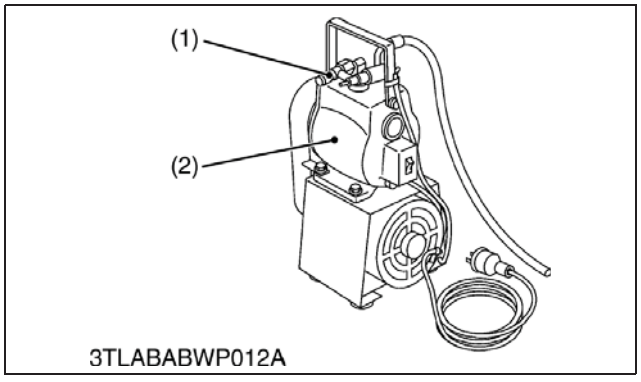


Vacuum Pump

Code No: NIPPONDENSO 95046-00040 (AC220V)
95046-00050 (AC240V)

Application: Use for gas leak testing the air conditioning system.

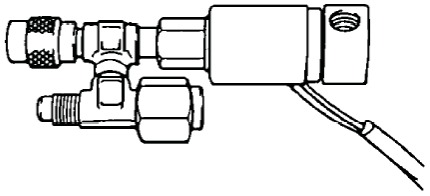
(1) Adaptor (For 134a) (2) Vacuum Pump



Adaptor (For R134a)

Code No: NIPPONDENSO 95048-10190 (AC220V)
95048-10200 (AC240V)

Application: Use for evacuating the air conditioning system.



3TLABAB0P054A

b) Checking with Manifold Gauge

IMPORTANT

The gauge indications described in the following testing are those taken under the same condition, so it should be noted that the gauge readings will differs somewhat with the ambient conditions.

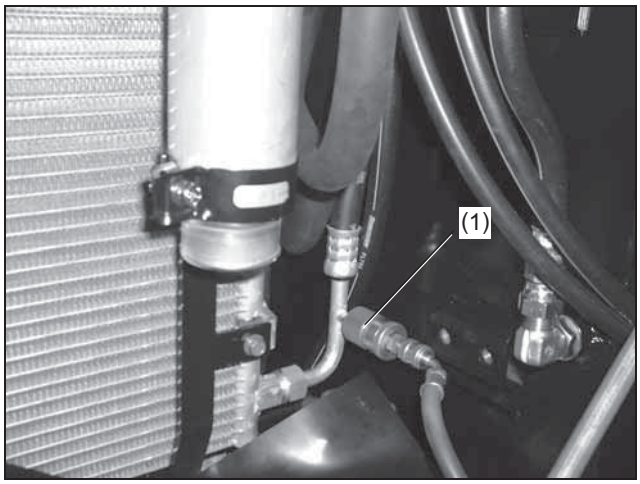
Condition
- Ambient temperature: **30 to 35 °C (86 to 95 °F)**
- Engine speed: Approx. **1500 min^{-1} (rpm)**
- Temperature control lever: **Maximum cooling position**
- Air-Conditioner switch: **ON**
- Blower switch: **HI** position

Manifold Gauge Connecting and Test Preparation

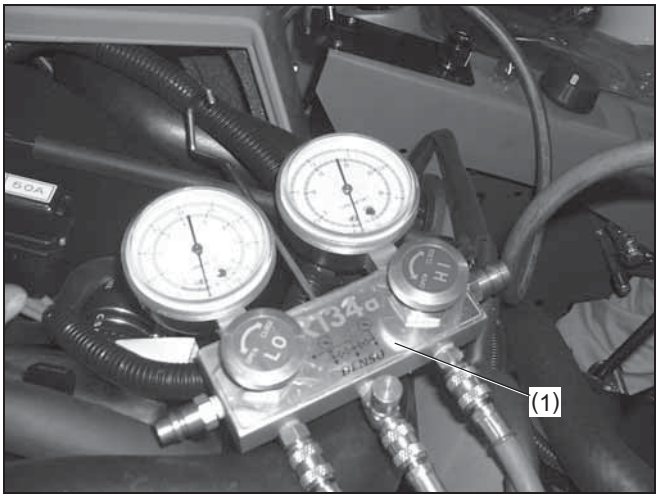
1) Close the manifold gauge **HI** and **LO** pressure side valve (7), (6) tightly.
2) Connect the charging hose (1) (red) to the **HI** pressure side charging valve (2) and connect the charging hose (4) (blue) to the **LO** pressure side charging valve (3).

Note: Be sure to drive out the air in the charging hoses at the manifold gauge connection end by utilizing the refrigerant pressure in the refrigerating cycle.

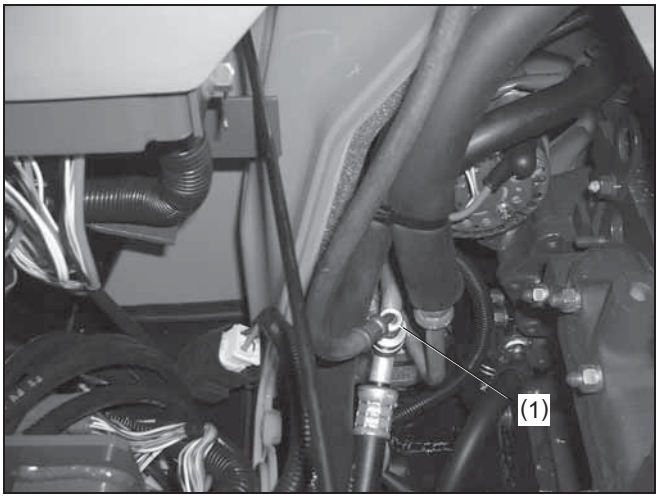
3) Start the engine and set at approx. 1500 min^{-1} (rpm).
4) Turn on the A/C switch and set the temperature control lever to **maximum cooling** position.
5) Set the blower switch to **HI** position.



(1) High pressure port



(1) Manifold gauge

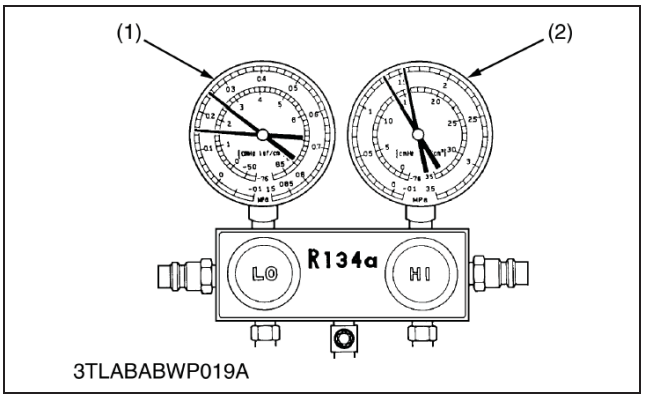


(1) Low pressure port

Normal Operating

If the refrigerating cycle is operating normally, the reading at the **LO** pressure side (1) should be generally by around 0.15 to 0.2 MPa (1.5 to 2.0 kgf/cm^2, 21 to 28 psi) and that at the **HI** pressure side (2) around 1.27 to 1.66 MPa (13 to 17 kgf/cm^2, 185 to 242 psi).

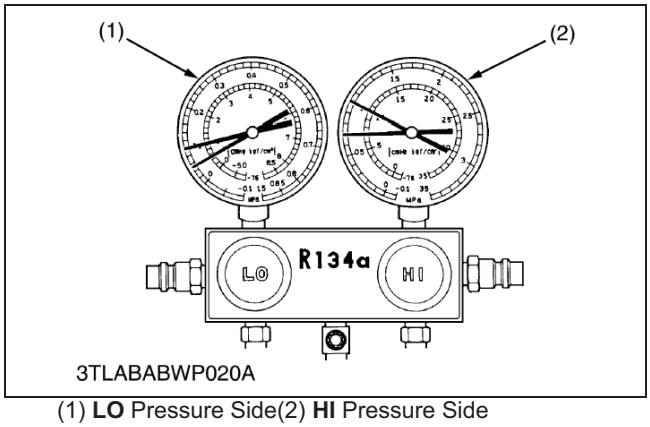
Gas pressure	Factory spec.	Low pressure side	0.15 to 0.20 MPa 1.5 to 2.0 kgf/cm^2 21 to 28 psi
		High pressure side	1.27 to 1.66 MPa 13 to 17 kgf/cm^2 185 to 242 psi



(1) **LO** Pressure Side(2) **HI** Pressure Side

Insufficient Refrigerant

1) Symptoms seen in refrigerating cycle
   Both **LO** and **HI** pressure side (1), (2) pressures too low.
   LO pressure side (1):0.05 to 0.1 MPa
   (0.5 to 1.0 kgf/cm^2, 7.1 to 14.2 psi)
   HI pressure side (2): 0.69 to 0.98 MPa
   (7 to 10 kgf/cm^2, 99.6 to 142.2 psi)
   Bubbles seen in sight glass.
   Air discharged from air conditioner slightly cold.
2) Probable cause
   Gas leaking from some place in refrigerant cycle.
3) Solution
   Check for leakage with electric gas leak tester and repair.
   Recharge refrigerant to the proper level.

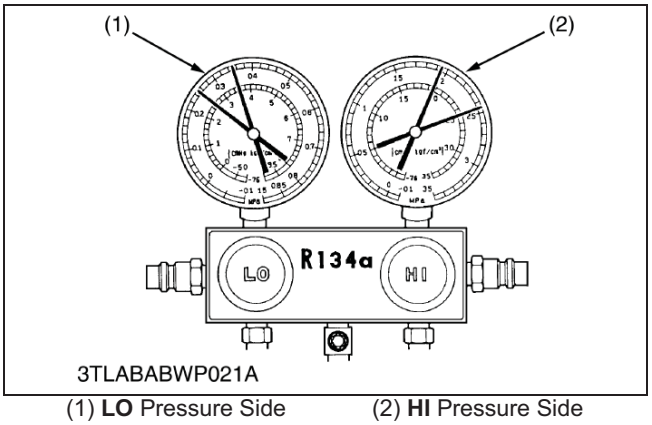


(1) **LO** Pressure Side(2) **HI** Pressure Side

Excessive Refrigerant or Insufficient Condenser Cooling

1) Symptoms seen in refrigerating cycle
   Both **LO** and **HI** pressure side (1), (2) pressures too high.
   LO pressure side (1): 0.2 to 0.35 MPa
   (2.0 to 3.5 kgf/cm^2, 28 to 49.8 psi)
   HI pressure side (2):1.96 to 2.45 MPa
   (20 to 25 kgf/cm^2, 284.5 to 355.6 psi)
2) Probable cause
   Overcharging refrigerant into cycle.
   Condenser cooling faulty.
3) Solution
   Clean condenser.
   Adjust air conditioner belt to proper tension.
   If the above two items are in normal condition, check refrigerant quantity.

Note: If excessive refrigerant is to be discharged, loosen manifold gauge LO pressure side valve and vent out slowly.

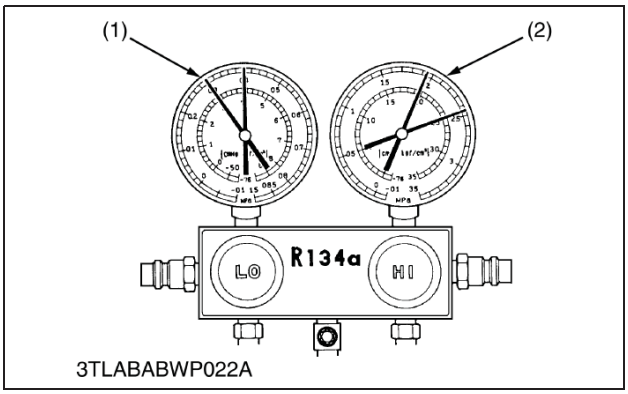


(1) **LO** Pressure Side (2) **HI** Pressure Side

Air Entered in the Cycle

1) Symptoms seen in refrigerating cycle
   Both **LO** and **HI** pressure side (1), (2) pressures too high.
   LO pressure side (1):0.2 to 0.35 MPa
   (2.0 to 3.5 kgf/cm^2, 28 to 49.8 psi)
   HI pressure side (2): 1.96 to 2.45 MPa
   (20 to 25 kgf/cm^2, 284.5 to 355.6 psi)
   LO pressure side (1) piping not cold when touched.
2) Probable cause
   Air entered in refrigerating cycle.
3) Solution
   Replace receiver.
   Check compressor oil contamination and quantity.
   Evacuate and recharge new refrigerant.

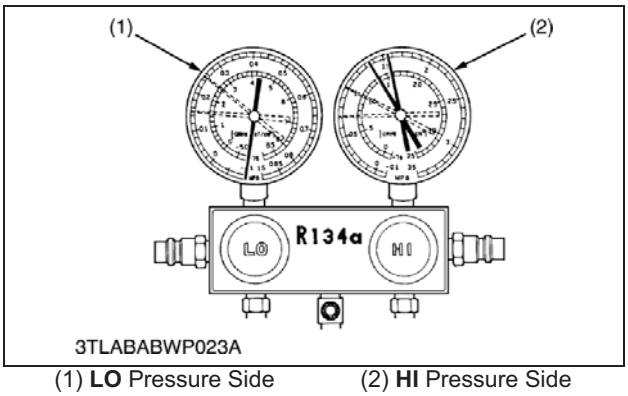
Note: The above cycle can be seen when the cycle is charged without evacuation.



(1) **LO** Pressure Side (2) **HI** Pressure Side

Moisture Entered in the Cycle

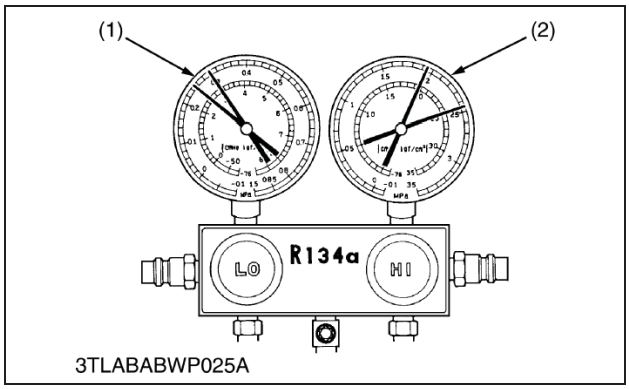
1) Symptoms seen in refrigerating cycle
   The air conditioner operates normally at the beginning, but over time, **LO** pressure side (1) pressure is vacuum and **HI** pressure side (2) is low pressure.
   LO pressure side (1):Vacuum
   HI pressure side (2): 0.69 to 0.98 MPa
   (7 to 10 kgf/cm^2, 99.6 to 142.2 psi)
2) Probable cause
   The moisture in the refrigerating cycle freezes in the expansion valve orifice and causes temporary blocking. After a time, the ice melts and condition returns to normal.
3) Solution
   Replace receiver.
   Remove moisture in cycle by means of repeated evacuation.
   Recharge new refrigerant to the proper level.



(1) **LO** Pressure Side (2) **HI** Pressure Side

Refrigerant Fails to Circulate

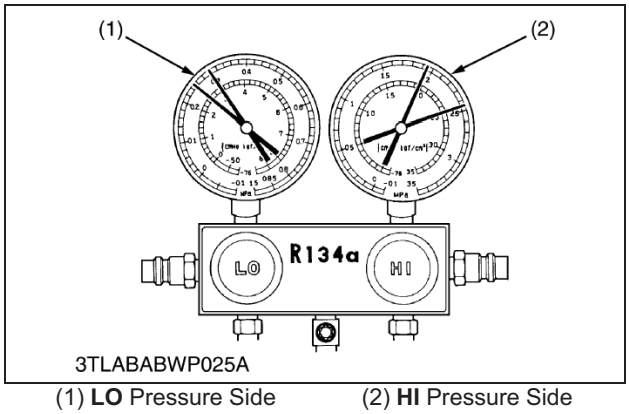
1) Symptoms seen in refrigerating cycle
   LO pressure side (1) pressure is vacuum and, **HI** pressure side (2) is low pressure.
   LO pressure side (1):Vacuum
   HI pressure side (2): 0.49 to 0.59 MPa
   (5 to 6 kgf/cm^2, 71.2 to 85.3 psi)
   Frost or dew formed on piping at front and rear sides of expansion valve or receiver.
2) Probable cause
   Refrigerant flow obstructed by moisture or dirt in the refrigerating cycle freezing or sticking on the expansion valve orifice.
3) Solution
   Allow to stand for same time and then resume operation to decide whether the plugging is due to moisture or dirt.
   If caused by moisture, correct by referring to instructions in previous.
   If caused by dirt, remove the expansion valve and blow out the dirt with compressed air.
   If unable to remove the dirt, replace the expansion valve. Replace the receiver. Evacuate and charge in proper amount of new refrigerant.
   If caused by gas leakage in heat sensitizing tube, replace the expansion valve.



(1) **LO** Pressure Side (2) **HI** Pressure Side

Expansion Valve Opens Too Far or Improper Installation of Heat Sensitizing Tube

1) Symptoms seen in refrigerating cycle
   Both **LO** and **HI** pressure side (1), (2) pressures too high.
   LO pressure side (1):0.29 to 0.39 MPa
   (3.0 to 4.0 kgf/cm^2, 42.71 to 56.9 psi)
   HI pressure side (2): 1.96 to 2.45 MPa
   (20 to 25 kgf/cm^2, 284.5 to 355.6 psi)
2) Probable cause
   Expansion valve trouble or heat sensitizing tube improperly installed.
   Flow adjustment not properly done.
3) Solution
   Check installed condition of heat sensitizing tube.
   If installation of heat sensitizing tube is correct, replace the expansion valve.

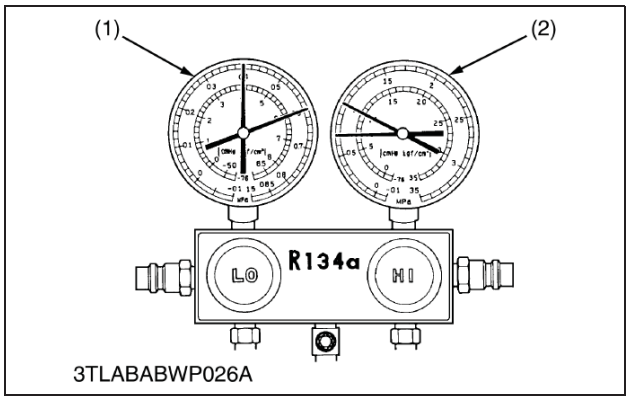


(1) **LO** Pressure Side (2) **HI** Pressure Side

Faulty Compression of Compressor

1) Symptoms seen in refrigerating cycle
   Both **LO** and **HI** pressure side (1), (2) pressures too high.
   LO pressure side (1): pressure too high:
   0.39 to 0.59 MPa (4 to 6 kgf/cm^2, 56.9 to 85.3 psi)
   HI pressure side (2): pressure too low:
   0.69 to 0.98 MPa (7 to 10 kgf/cm^2, 99.6 to 142.2 psi)
2) Probable cause
   Leak in compressor.
3) Solution
   Replace compressor. (See page 10-S39.)

Note: Manifold gauge indications (left side figure) at faulty compressing by compressor.



(1) **LO** Pressure Side (2) **HI** Pressure Side

c) Discharging, Evacuating and Charging

IMPORTANT

When discharging, evacuating or charging the refrigerating system, be sure to observe the "Precaution at Repairing Refrigerant Cycle".

(1) Discharging the System

Prepare for the R134a refrigerant recovery and recycling machine.

1) Connect low pressure side hose (blue) from the recovery and recycling machine to **LO** pressure side charging valve (3) on the compressor (1). Connect high pressure side hose (red) to **HI** pressure side charging valve (2) on the compressor (1).
2) Follow the manufacturers instructions and discharge the system.

IMPORTANT

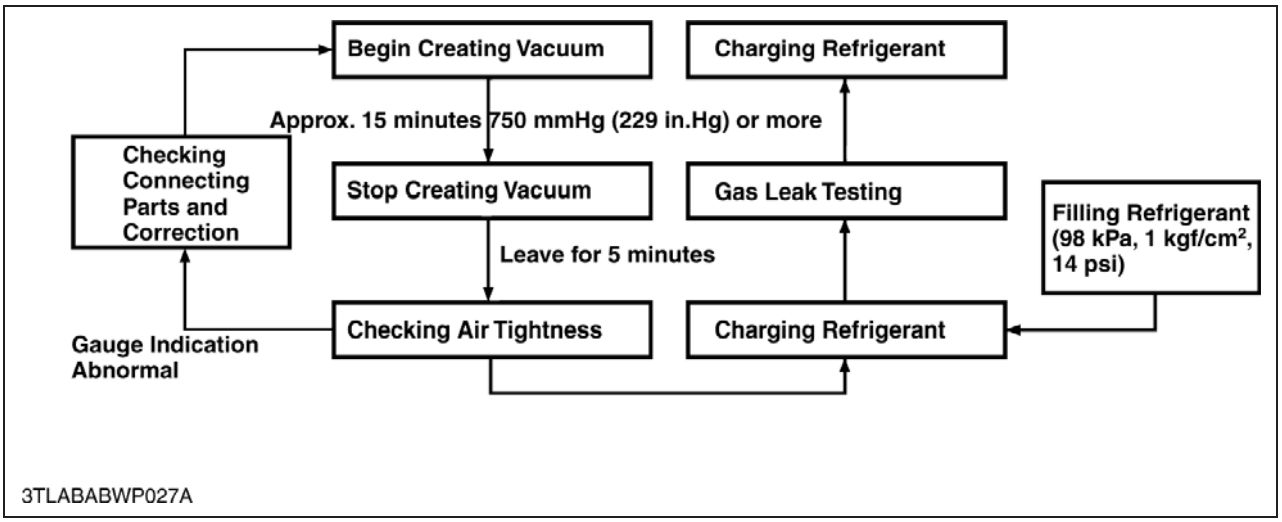
Use only R134a refrigerant recovery and recycling machine. Eliminate mixing R134a equipment, refrigerant, and refrigerant oils with R12 systems to prevent compressor damage.

CAUTION

Protect fingers with cloth against frostbite by refrigerant when disconnecting the hose to the charging valve.

Vacuum and charging unit in the Hirakata Factory Assembly Line.

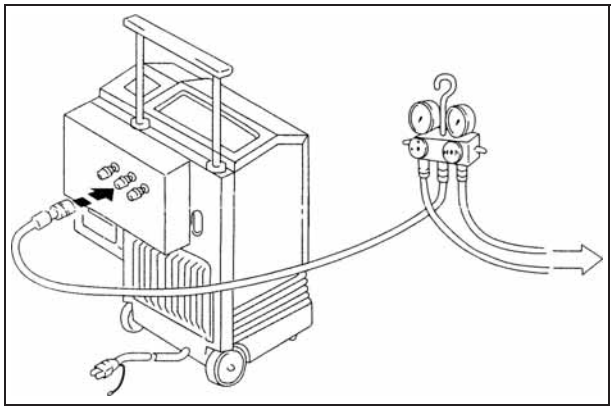
(2) Evacuating the System

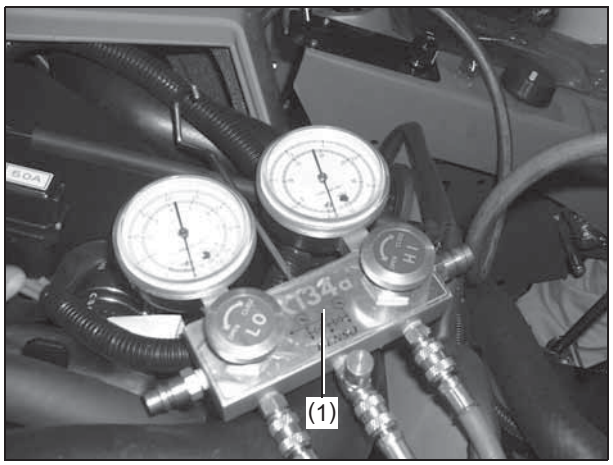


Evacuating the System

1) Discharge refrigerant from the system by R134a refrigerant recovery and recycling machine. (Refer to **"Discharging the system"**.)
2) Connect the charging hose (7) (red) to the **HI** pressure side charging valve and connect the charging hose (9) (blue) to the **LO** pressure side charging valve.
3) Connect the center charging hose (8) (green) to a vacuum pump inlet.
4) Open both valves (6), (10) of manifold gauge fully. Then run the vacuum pump (1) to evacuate the refrigerant cycle. (For approx. **15 minutes**.)
5) When **LO** pressure gauge (10) reading is more than **750 mmHg (299 in.Hg)**, stop the vacuum pump (8) and close both valves (6), (10) of manifold gauge fully.
6) Wait for over 5 minutes with the **HI** and **LO** pressure side valves (6), (10) of gauge manifold closed, and then check that gauge indicator does not return to 0.
7) If the gauge indicator is going to approach to 0, check whether there is a leaking point and repair if it is, and then evacuate it again.

(1) Vacuum Pump (Running)
(2) Vacuum Pump Adaptor
(3) LO Pressure Gauge
(4) HI Pressure Gauge
(5) Compressor
(6) HI Pressure Side Valve (Open)
(7) Red Hose
(8) Green Hose
(9) Blue Hose
(10) LO Pressure Side Valve (Close)





(1) Manifold gauge

(3) Charging the System

Charging an Empty System (Liquid)

This procedure is for charging an empty system through the HI pressure side with the refrigerant in the liquid state.

CAUTION

- **Never run the engine when charging the system through the HI pressure side.**
- **Do not open the LO pressure valve when refrigerant R134a is being charged in the liquid state (refrigerant container is placed upside-down).**

IMPORTANT

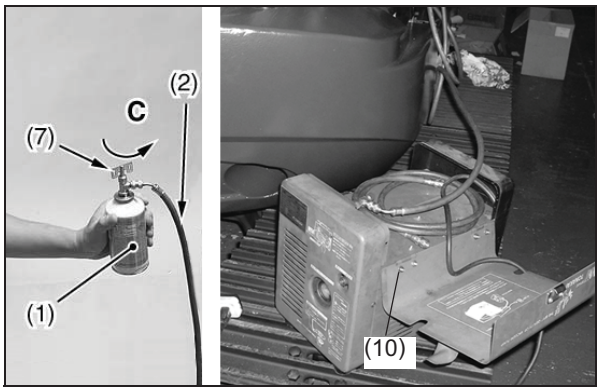
After charging the refrigerant in the liquid state with approx. 850 ± 50 g (1.1 lbs) through the HI pressure side, be sure to recharge the refrigerant in the vapor state to specified amount through the LO pressure side.

1) Close the HI and LO pressure side valves (5), (6) of manifold gauge after the system is evacuated completely.
2) Connect the center charging hose (2) to the can tap valve (7) fitting, and then loosen the center charging hose at the center fitting of manifold gauge until hiss can be heard.
   Allow the air to escape for few seconds and tighten the nut.
3) Open the HI pressure side valve (5) fully, and keep the container upside-down to charge the refrigerant in the liquid state from the HI pressure side.
4) Charge the refrigerant in the liquid state with approx. 850 ± 50 g (1.1 lbs) from the HI pressure side.

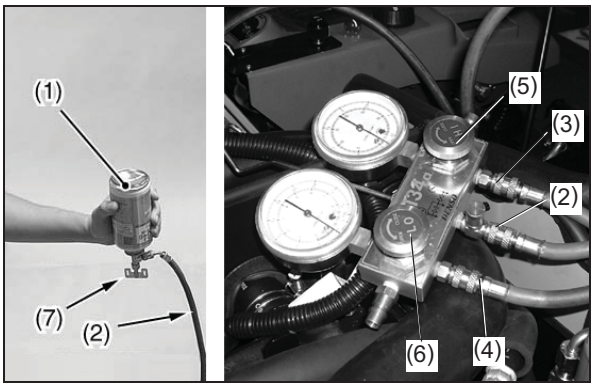
Note: If LO pressure gauge does not show a reading, the system is clogged and must be repaired.

5) Close the HI pressure side valve (5) of manifold gauge and can tap valve of refrigerant container.

(1) Refrigerant Container (R134a)
(2) Green Hose
(3) Red Hose
(4) Blue Hose
(5) HI Pressure Side Valve (Open)
(6) LO Pressure Side Valve (Close)
(7) Can Tap Valve (Open)
(8) Compressor
A: Air Purge
B: Loosen the Nut
C: Open the Can Tap Valve

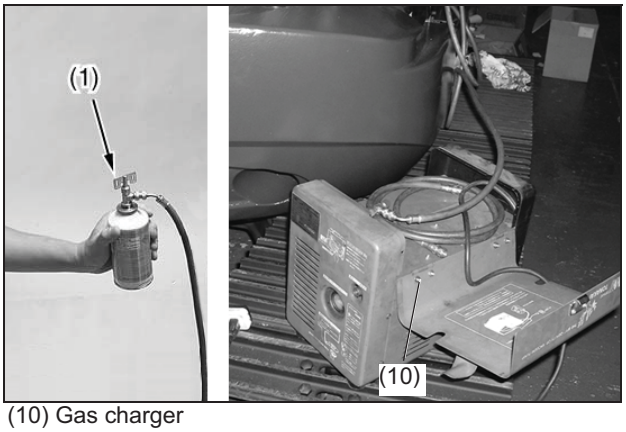


(10) Gas charger



Charging an Empty or Partially Charged System (Vapor)

This procedure is to charge the system through the **LO** pressure side with refrigerant in the vapor state. When the refrigerant container is placed right side up, refrigerant will enter the system as a vapor.



(10) Gas charger

CAUTION

Never open the HI pressure valve of manifold gauge while the engine is running.

Note:

- **Do not turn the refrigerant container upside-down when charging the system by running the engine.**
- **Put refrigerant container into a pan of warm water (maximum temperature 40°C (104°F)) to keep the vapor pressure in the container slightly higher than vapor pressure in the system.**

1) Check that the HI pressure valve (5) is closed.
2) Start the engine and set an approx. **1500 min^{-1} (rpm)**.
3) Turn on the A/C switch.
   Set the temperature control lever to maximum cooling position and the blower switch to **HI** position.
4) Open the **LO** pressure valve (6) of manifold gauge and the can tap valve (1) on refrigerant container and charge the refrigerant until air bubbles in the sight glass of the receiver vanish.
5) After charging the specified amount of refrigerant into the system, close the **LO** pressure valve (6) of manifold gauge and can tap valve (1), then stop the engine.
6) Check for gas leak with an electric gas leak tester.

Reference

- Specified amount of refrigerant (total):
  800 ± 50 g (1.76 to 1.98 lbs) [Refrigerant R134a]
- Manifold gauge indication at fully charged system (at ambient temperature: 30°C (86°F))
  HI pressure side: 1.27 to 1.66 MPa
  13 to 17 kgf/cm^2
  185 to 242 psi
  LO pressure side: 0.15 to 0.20 MPa
  1.5 to 2.0 kgf/cm^2
  21 to 28 psi

(1) Can Tap Valve
(2) LO Pressure Gauge
(3) HI Pressure Gauge
(4) Compressor (Running)
(5) HI Pressure Valve (Close)
(6) LO Pressure Valve (Open)

(4) Checking Charge Refrigerant Amount

After charging the refrigerant, check for amount of charging refrigerant as follows.

Note: The pressure on the following checking are the gauge indications at ambient temperature 30°C (86°F), so it should be noted that the pressure will differ some what with the ambient temperature.

1) Disconnect the **2P** connector (4) of magnetic clutch.
2) Start the engine and set a approx. **1500 min^{-1} (rpm)**.
3) Connect the **2P** connector (4) of magnetic clutch to battery directly, and then set the blower switch to **HI** position.
4) Leave the system for approx. **5 minutes** until the refrigerant cycle becomes stable, keeping pressure on the **HI** pressure side from 1.27 to 1.66 MPa (13 to 17 kgf/cm^2, 185 to 242 psi).
5) When the refrigerant cycle is stabilizer, turn off the blower switch and let the compressor alone to run. Then pressure on the **LO** pressure side gradually drops. At this time, if pressure on the HI pressure side is maintained from 1.27 to 1.66 MPa (13 to 17 kgf/ cm^2, 185 to 242 psi), air bubbles which pass through the sight glass becomes as stated below depending on refrigerant charged amount.

A: Insufficient refrigerant charge

Air bubbles pass continuously the sight glass when pressure on the **LO** pressure side is over 99.0 kPa (1.01 kgf/cm^2, 14.4 psi). In this case, charge the refrigerant from the **LO** pressure side.

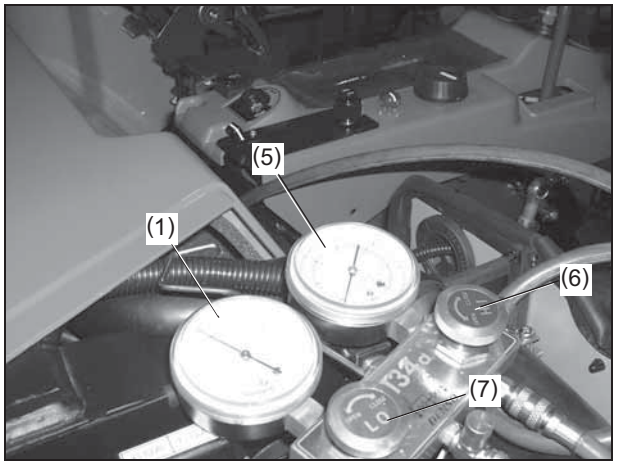
B: Properly refrigerant charge

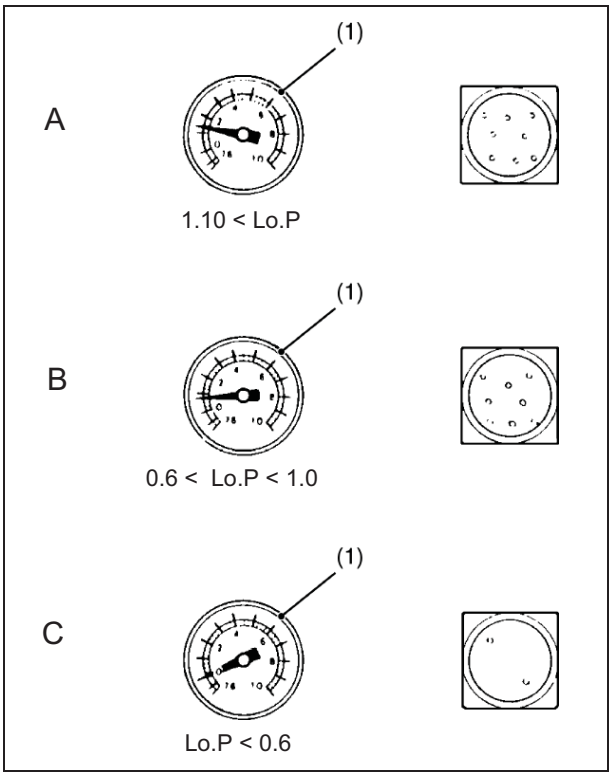
Air bubbles pass through the sight glass continuously when pressure on the **LO** pressure side is within 59 to 98 kPa (0.6 to 1.0 kgf/cm^2, 9 to 14 psi). If the charge refrigerant amount is proper, no air bubble is observed on the sight glass at pressure on the **LO** pressure side over 99.0 kPa (1.01 kgf/cm^2, 14.4 psi) when the blower switch is turned on. When the blower switch is turned off, bubbles pass through the sight glass in case pressure on the **LO** pressure side is within 59 to 98 kPa (0.6 to 1.0 kgf/cm^2, 9 to 14 psi).

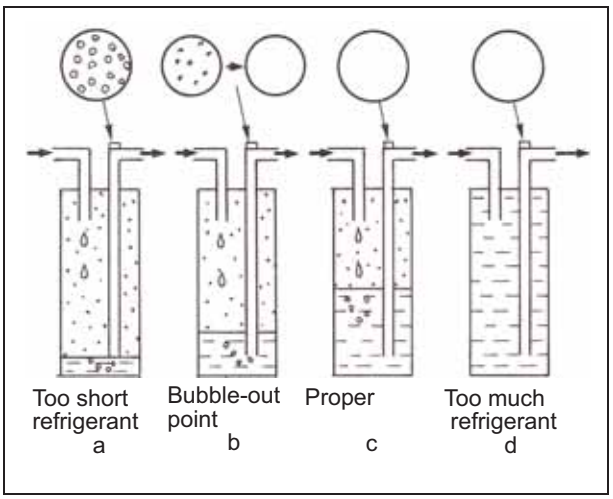
C: Excessive refrigerant charge

Air bubbles pass through the sight glass time to time or no air bubble is observed when pressure on the **LO** pressure side is under 59 kPa (0.6 kgf/cm^2, 9 psi). In this case, discharge excessive refrigerant gradually from the **LO** pressure side.

(1) **LO** Pressure Gauge
(2) To Battery
(3) Compressor (Running)
(4) **2P** Connector
(5) **HI** Pressure Gauge
(6) **HI** Pressure Valve (Close)
(7) **LO** Pressure Valve (Close)







(5) Charging procedure of refrigerant (Summary)

Arging preparations

1) Connect the gauge manifold.
2) Hoses to be connected
   Red hose: High-pressure side (H)
   Blue hose: Low-pressure side (L)
   Green hose: Vacuum pump, service canister gas
3) Be careful not to confuse the high- and low-pressure sides.

Vacuum buildup

1) For about 10 minutes.
2) Gauge pressure at -750 mm^2/Hg.
3) Close the valve and turn off the pump.

Checking air-tightness

1) After the vacuum buildup, leave the system as it is for about 5 minutes.
2) Make sure the gauge pointer does not swing back.
3) If the pointer swings back, check the pipe connections for looseness and correct as required.
4) Start from the vacuum buildup again.

Charging through high-pressure side

1) Reconnect the charging hose to the gas canister. Using a valve, let air out of the hose.
2) Feed the refrigerant through the high-pressure side until the low-pressure gauge reads 1 kgf/cm^2.
   (1) Keep the engine off.
   (2) Feed all the gas from a service canister.
   (3) Do not place the service canister upside down.
3) Using a gas detector, carefully check for gas leak.

Charging through low-pressure side

1) Be sure to close the high-pressure valve.
2) Engine at idling speed (up to 1500 rpm), air-conditioner with Hi switch on.
3) When replacing the service canister, carry out air-bleeding from the hose (using a valve).
4) Never open the high-pressure valve.

Checking the charging amount

1) Refrigerant amount: 850 ± 50 g (1.76 ± 0.11 lbs)
2) Gauge pressure
   High pressure: 1/2 of ambient pressure (kgf/cm^2)
   Low pressure: 1/10 of high pressure (kgf/cm^2)
3) Check through the sight glass.

Too much | Proper | Too short

Checking for gas leak

1) Do this job in a well-ventilated place.
2) An electric gas leak tester may respond to gasoline, light oil, exhaust gas and the like, misleading you.
3) For each check spot, check it not in one direction, but all around it.

(G) MAIN COMPONENTS SERVICING

a) Compressor

(1) Checking

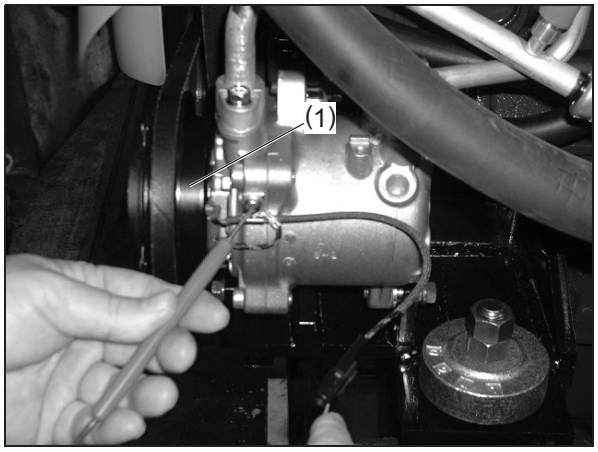
Operation of Magnetic Clutch

1) Start the engine.
2) Check whether abrasion or abnormal noise is heard when only the magnetic clutch pulley is running while the A/C switch is pushed **OFF.**
3) Check that the magnetic clutch (1) does not slip when the A/C switch and blower switch are turned **ON** (when the air conditioner is in operation).
4) If anything abnormal is found, repair or replace.

Stator Coil

1) Measure the resistance of the stator coil with an ohmmeter across the **2P** connector.
2) If the measurement is not within the factory specifications, replace the stator coil.

Stator coil resistance	Factory spec.	3.5 to 4.0Ω



(1) Magnetic Clutch

Construction

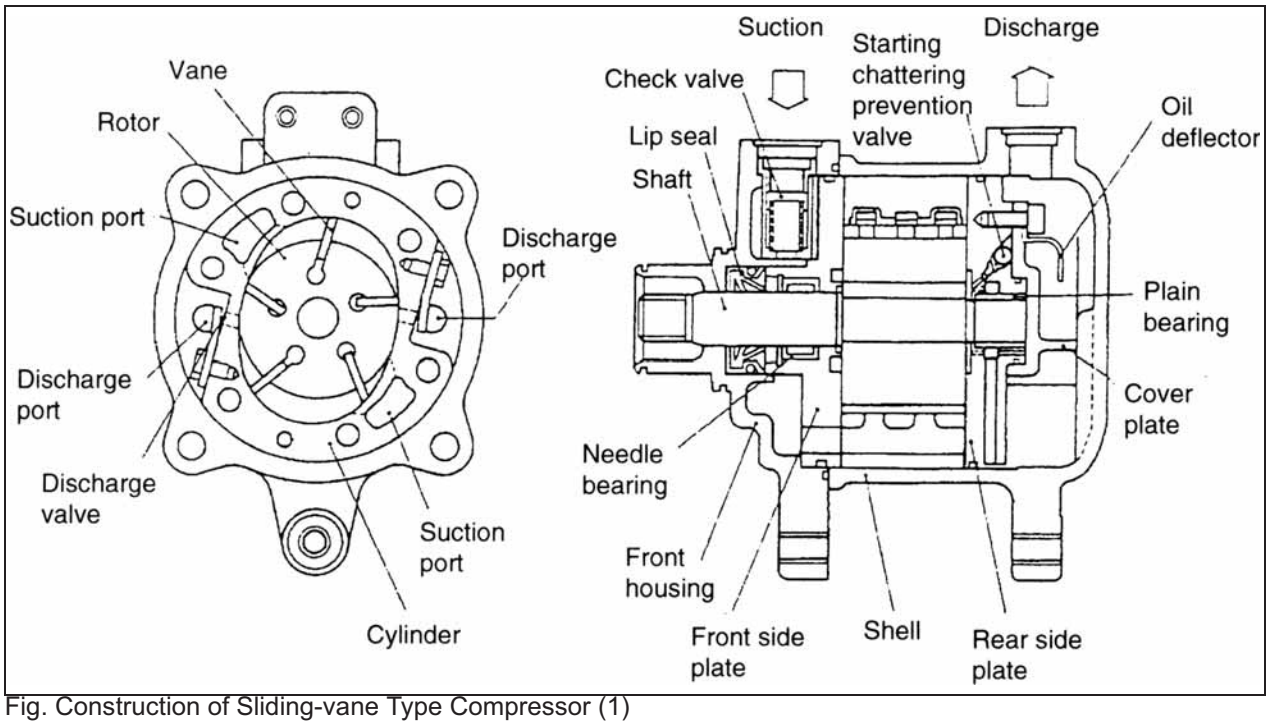
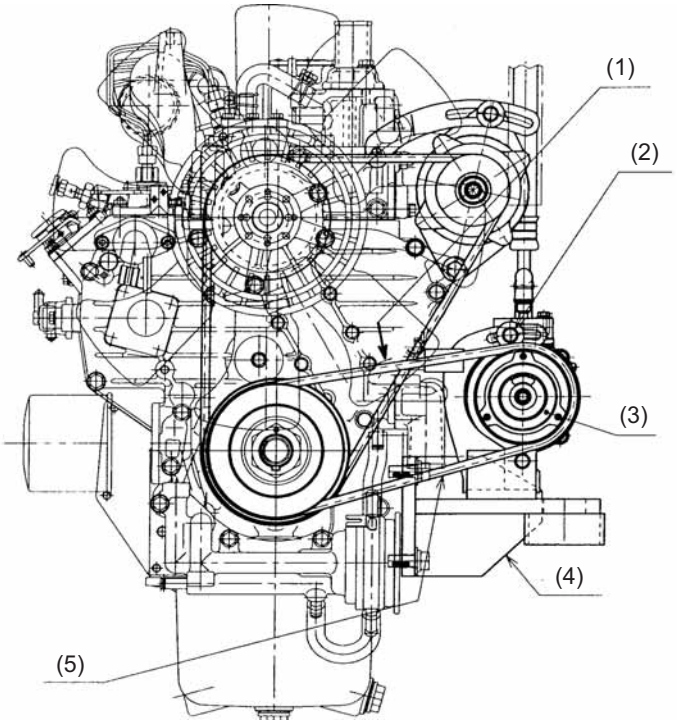
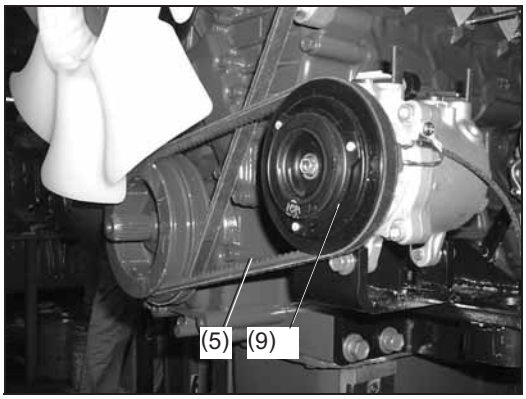


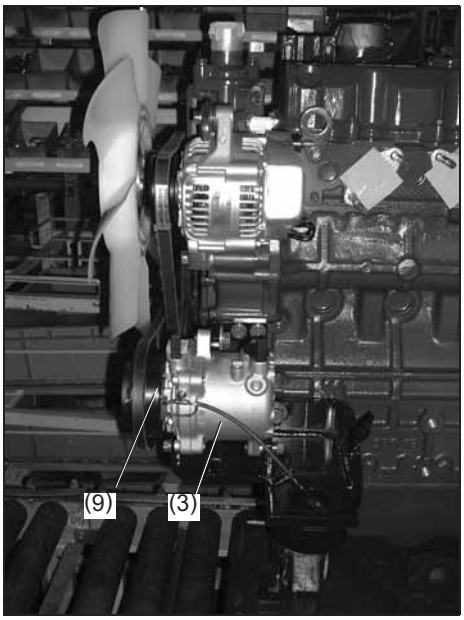
Fig. Construction of Sliding-vane Type Compressor (1)

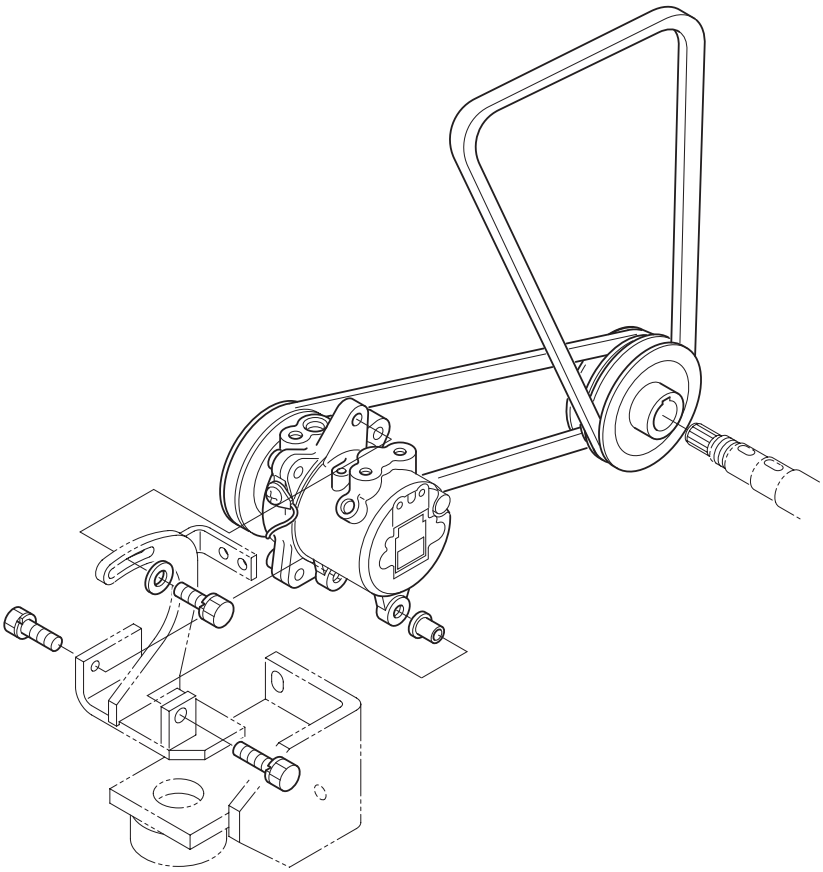
(2) Disassembling and reassembling

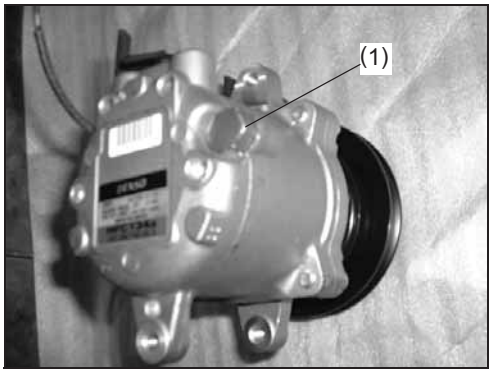


(1) Belt tension check position
(2) Bolt: 01123-60830
Plain washer: 04015-60080
(3) Compressor: T2055-7255 △
(4) Engine bracket 1, A/C: RD118-4757△
(5) V-belt (33.5): RD118-4912△
(6) Bolt: 01123-60820
(7) Pulley
(8) Bush
(9) Magnet clutch

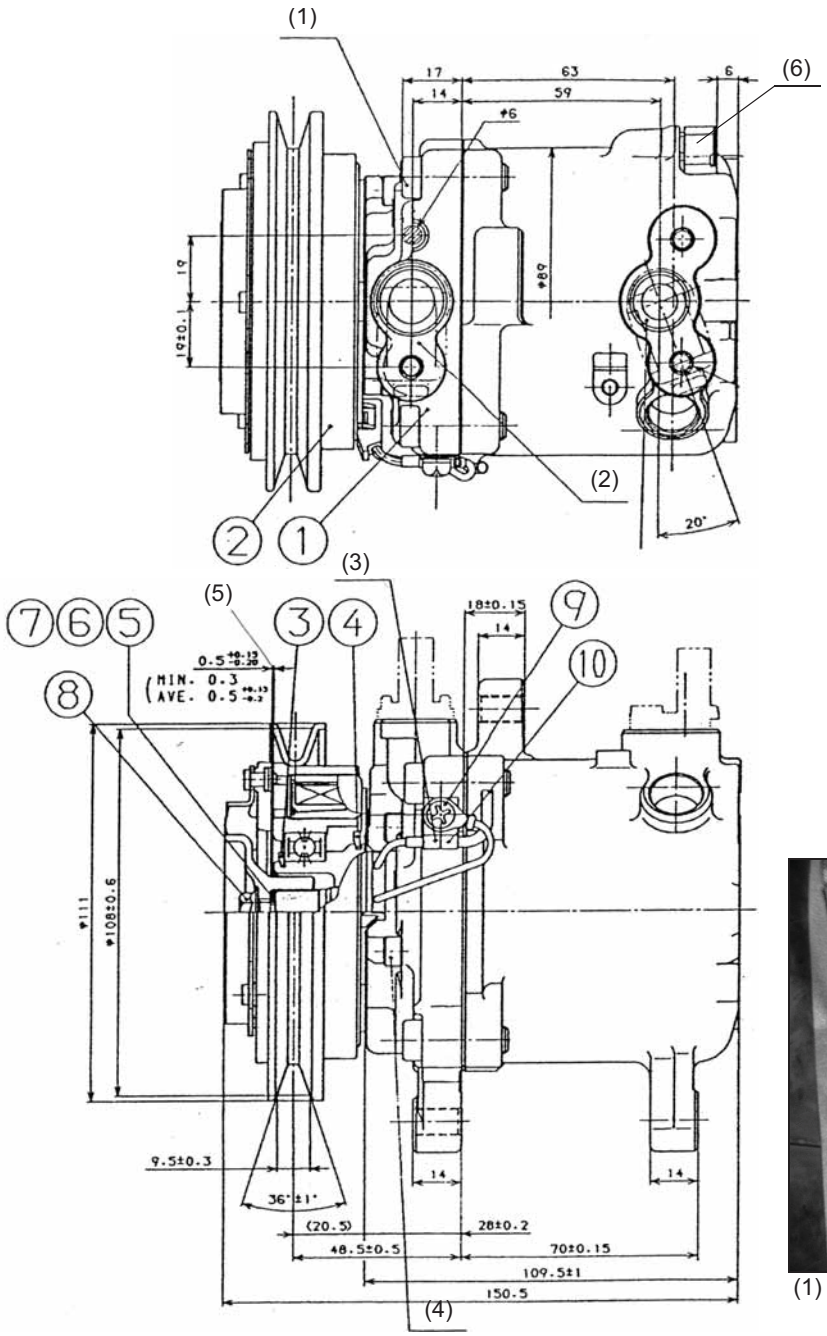




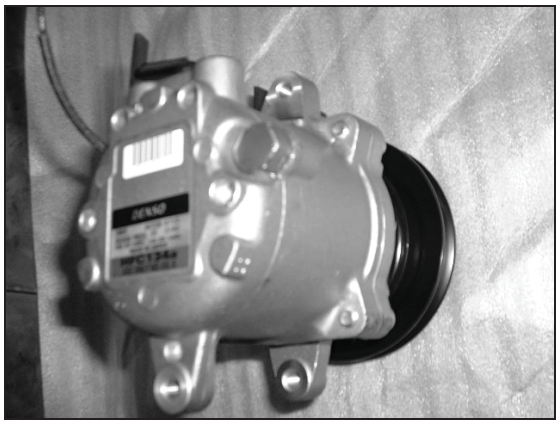




(1) Relief valve



① Compressor assy
② Magnet clutch assy
③ Snap ring
④ Snap ring
⑤ Plate washer, t = 0.1
⑥ Plate washer, t = 0.3
⑦ Plate washer, t = 0.5
⑧ Head bolt
⑨ Screw
⑩ Lead wire clamp



(1) Relief valve

Note:1. When handling the compressor, be careful not to let out the charged gas.
2. The turning direction must be clockwise when viewed from the clutch side.
3. The compressor's internal pressure must be 0 - 0.03 MPa (gauge) for part delivery.

(1) M8 bolt, 4 pcs
(2) Rubber cap
(3) Clamp
(4) M5 bolt, 4pcs
(5) Clearance

Average: $0.5\ ^{+0.15}_{-0.20}$ mm ($0.02\ ^{+0.006}_{-0.008}$ inch)Min: 0.3 mm (0.012 inch)

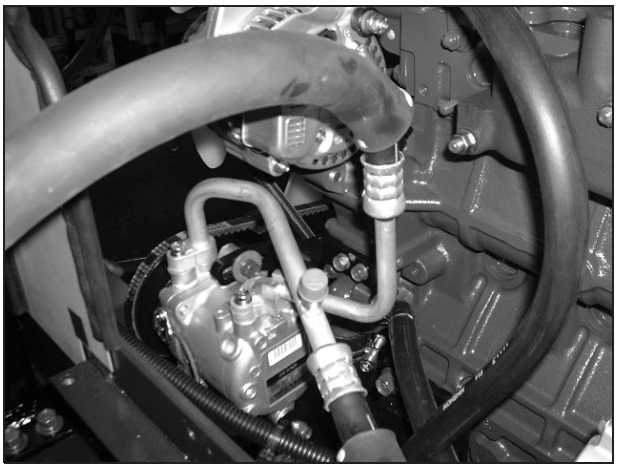
(6) Relief valve pressure setting;

Opening pressure (Gauge)	3.43 - 4.14 MPa	(35 - 42.2 kgf/cm^2)	(498 - 597 psi)
Closing pressure (Gauge)	2.75 Mpa	(28.1 kgf/cm^2)	(399 psi)
Tightening torque	13.2 ±1.49 N•m	(135 ±15 kgf•cm)	9.76 ±1.08 ft-lbs

(3) Compressor dismounting

1) Discharge the refrigerant from the system. (Refer to **"Discharging the System"**: See page VI-S-24.)
2) Disconnect the low pressure pipe (suction) and high pressure pipe (discharge) from the compressor, then cap the open fittings immediately to keep moisture out of the system.
3) Disconnect the 2P connector of magnetic clutch.
4) Remove the air conditioner belt and remove the compressor.

(1) Compressor (2) Alternator
(3) V-pulley



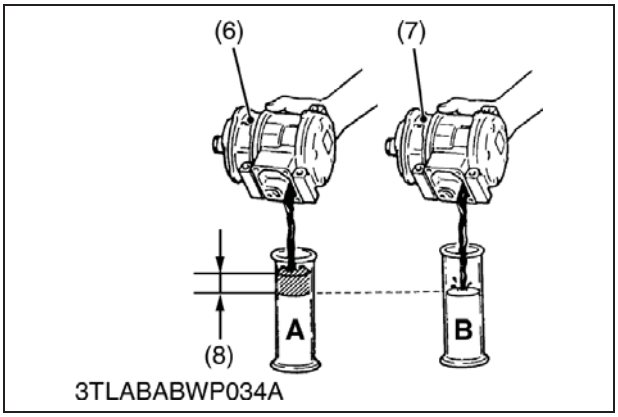
When reassembling

- After reassembling the compressor, be sure to adjust the air conditioner belt tension (see page G-28) and recharge the refrigerant to the system. (Refer to **"Charging the System"**: See page 10-S19.)
- Apply compressor oil (**NIPPONDENSO ND-OIL8** or equivalent) to the O-rings and take care not to damage them.

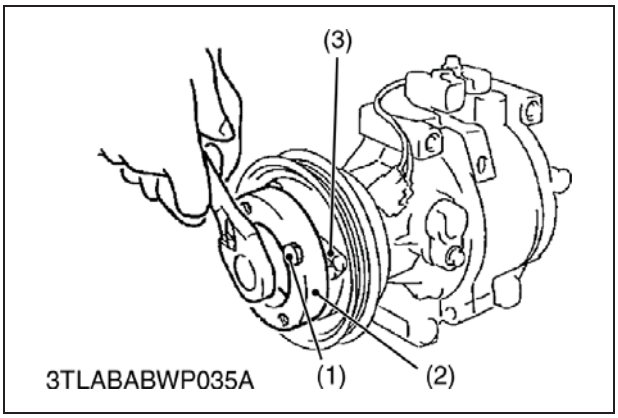
When replacing compressor

- When replacing the compressor with a new one, meet the oil amount with old one.

Tightening torque	High pressure pipe and low pressure pipe mounting screw	7.9 to 11.8 N•m 0.81 to 1.20 kgf•m 5.8 to 8.7 ft-lbs
	Compressor mounting screws M8 bolt	16.7 to 19.6 N•m 1.7 to 2.0 kgf•m 12.3 to 14.5 ft-lbs

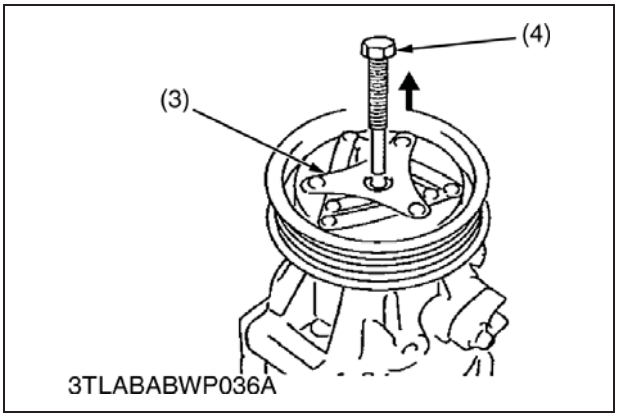


(1) High Pressure Pipe (5) Compressor
(2) Low Pressure Pipe (6) New Compressor
(3) 2P Connector (7) Old Compressor
(4) Air-conditioner Belt (8) Remove the Excess Oil (**A-B**)



(4) Hub Plate

1) Three stopper bolts (1) are set in stopper magnet clutch (2) at the position corresponding to the shape of compressor.
2) The stopper magnet clutch (2) is hung on hub plate (3) and it is fixed that the compressor rotates.
3) Remove the magnet clutch mounting screw or nut.
4) Remove the hub plate (3).
   Compressor is used remover magnet clutch (4).
5) Remove the shims.



When reassembling

- Do not apply grease or oil on the hub plate facing.
- Do not use the screw or nut again.
- It is confirmed to turn rotor by hand after assembling and not contact with stator.
- Check and adjust the air gap before tight the magnet clutch mounting screw or nut to the specified torque.

(5) Magnet clutch

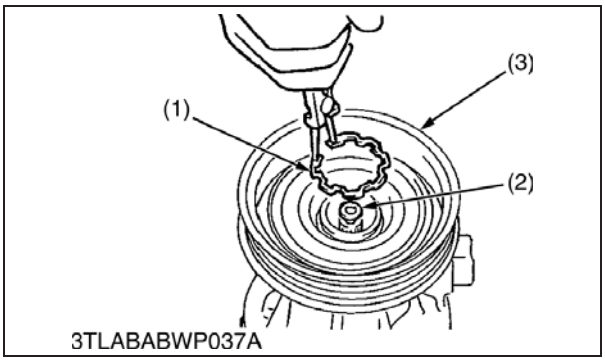
Remove the clutch mounting screw.

M

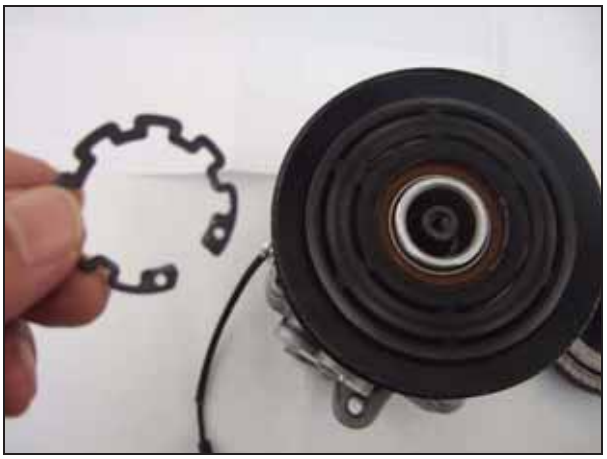
Tightening torque:

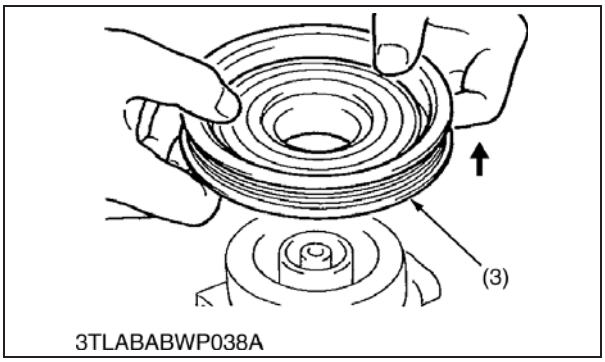
Remove the magnet clutch.

(6) V-pulley



3TLABABWP037A





3TLABABWP038A

1) Remove the cir-clip (1).
2) Remove the rotor (3).

When reassembling

- Do not use the cir-clip again.
- Assemble the cir-clip for the tapered side to become outside of rotor.
- The width of expanding of cir-clip is set in boss of shaft as a minimum.

Type of compressor	Code No. for circlip
Slide vane type	

(1) Cir-Clip
(2) Shim
(3) Rotor

(7) Vane and rotor

Note: Disassembling the compressor is not suggested by the original manufacture, DENSO.

FYI: The following procedure of trouble diagnosis is for your information only - for those who would not mind taking any risk in disassembling and reassembling at your own expense.

1. Remove the front housing mount bolts.

Socket head bolt

M

L-wrench:
Tightening torque:

2. Remove the front side plate bolts.

Star-shape socket head bolts.

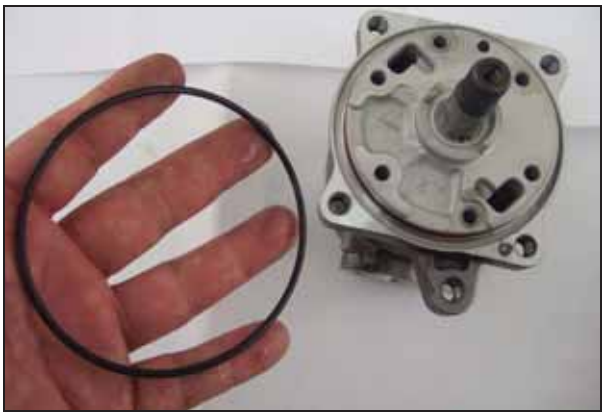
M

L-wrench

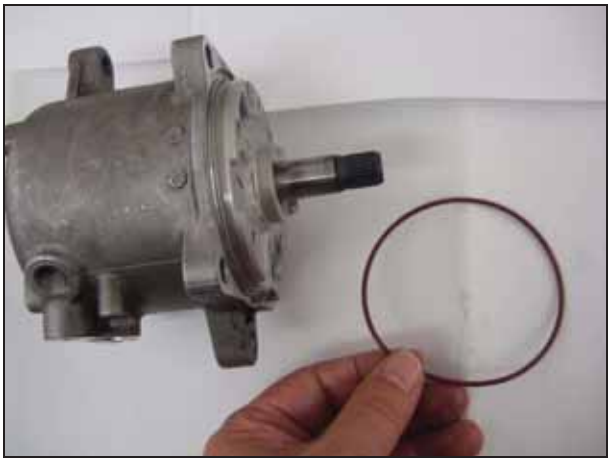
3. Remove the front side plate.

(When reassembling)
Align the knock pin position.
Check the oil seal for any damage.

4. Remove the rotor mounting bolts.



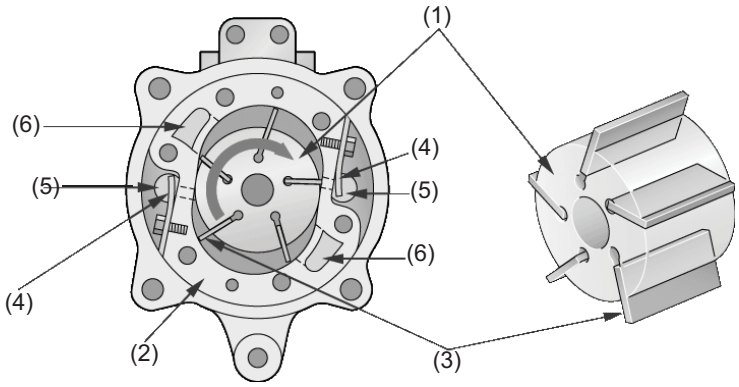
5. Remove the O-ring.



6. Remove the O-ring.

7. Remove the front side plate.

(When reassembling)
Align the bolt holes.



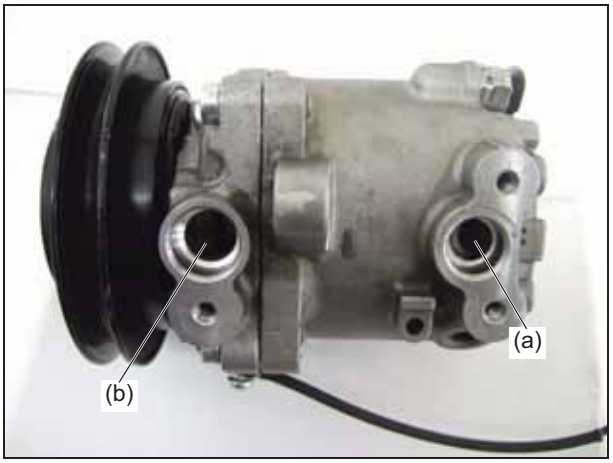
(1) Rotor
(2) Cylinder
(3) Vane
(4) Discharge valve
(5) Discharge port
(6) Suction port

8. Remove the rotor assy.

9. Check the vane.

10. Inside view of the housing case.

11. Removing the relief valve.



12. Overview of the compressor assy.

(a) Suction port
(b) Discharge port

Tightening torque	Clutch mounting screws	10.8 to 16.2 N•m 1.10 to 1.65 kgf•m 8.0 to 11.9 ft-lbs

(1) Stopper Bolt
(2) Stopper Magnet Clutch
(3) Hub Plate
(4) Remover Magnet Clutch

(8) Rotor

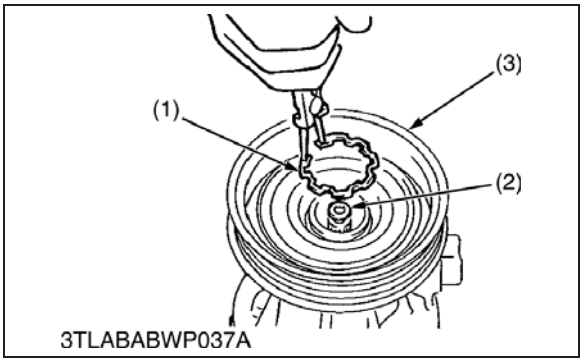
1) Remove the circlip (1)
2) Remove the rotor (3)

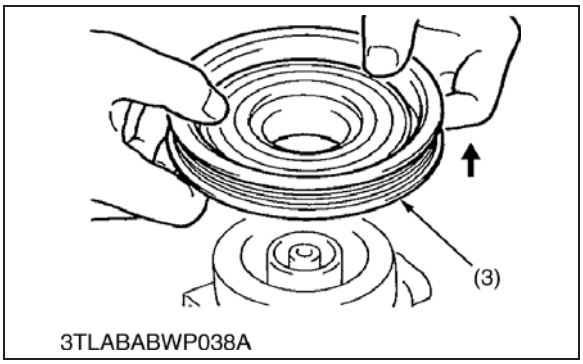
When reassembling

- Do not use the circlip again.
- Assemble the circlip for the tapered side to become outside of rotor.
- The width of expanding for circlip is set in boss of shaft as a mininum.

Type of compressor	Code No. for circlip
Slide vane type	

(1) Circlip
(2) Shim
(3) Rotor





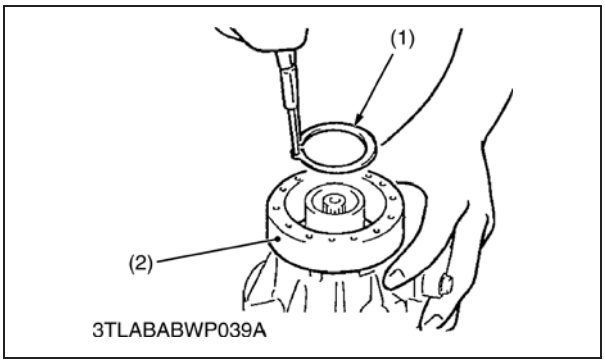
(9) Stator

1) Remove the lead wire from compressor body.
2) Remove the external circlip (1).
3) Remove the stator (2).

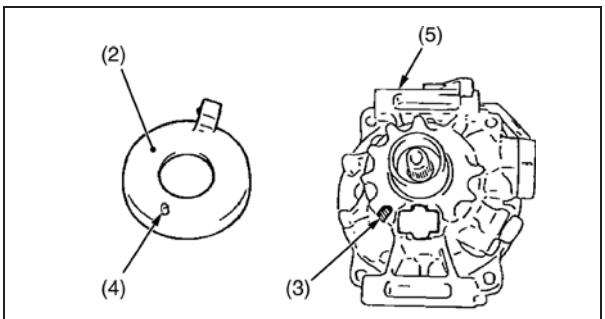
When reassembling

- Do not use the cir-clip again.
- Assemble the cir-clip for the tapered side to become outside of front housing.
- The width of expanding of cir-clip is set is boss of shaft as a minimum.
- Match and assemble the concave part (3) of the front housing (5) and the pin (4) of stator.

(1) External Circlip
(2) Stator
(3) Concave Part
(4) Pin
(5) Front Housing



3TLABABWP039A



3TLABABWP040A

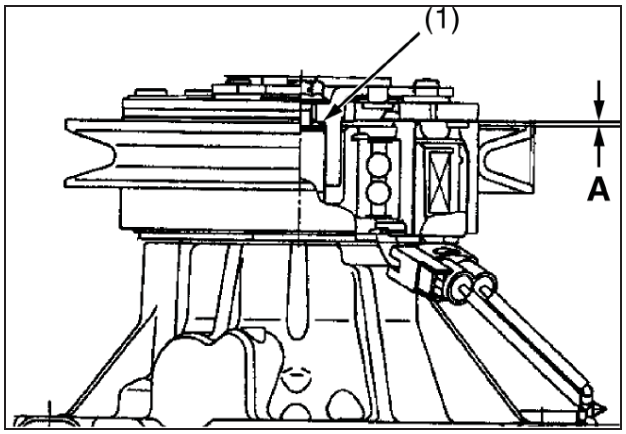
(10) Adjustment of Air-gap

1) Measure the air-gap with a feeler gauge.
2) When the measurement value comes off from factory specification, adjustment shim is added or deleted.

Air-gap	Factory spec.	0.30 to 0.65 mm 0.012 to 0.024 in.

Reference

	Adjustment shim
0.10 mm (0.0039 in.)	
0.30 mm (0.0118 in.)	
0.50 mm (0.0197 in.)	



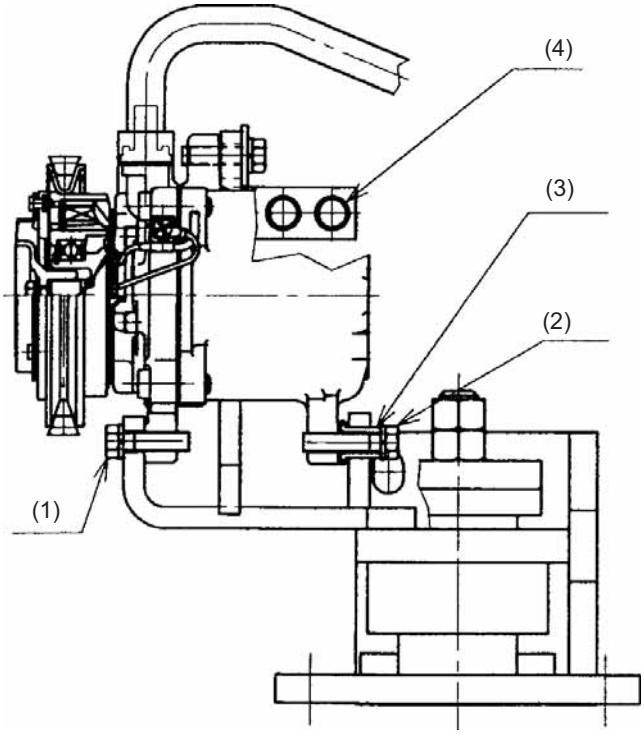
(1) Shim A: Air-Gap

(11) Compressor installation

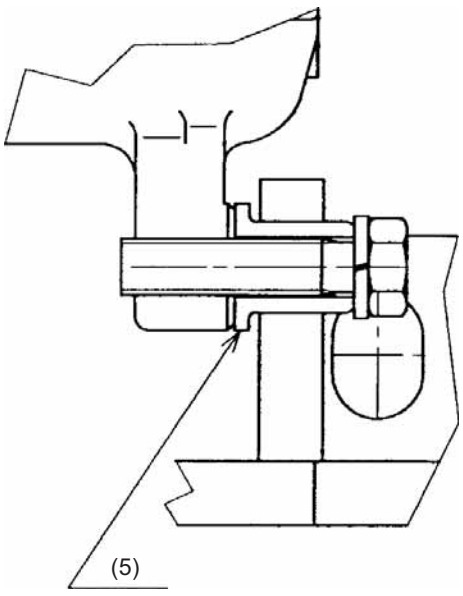
1) Insert (3) bush (compressor) as shown in the left.

Note: Surely check the direction of bush insertion.

2) Temporarily tighten the three M8 bolts and adjust the belt tension. Tighten up the two bolts at the pulley first and then the bolt at the bush.
3) Tightening torque
   M8 bolt: 16.7 - 19.6 N•m
   (1.7 - 2.0 kgf•m)
   12.3 - 14.5 ft•lbs

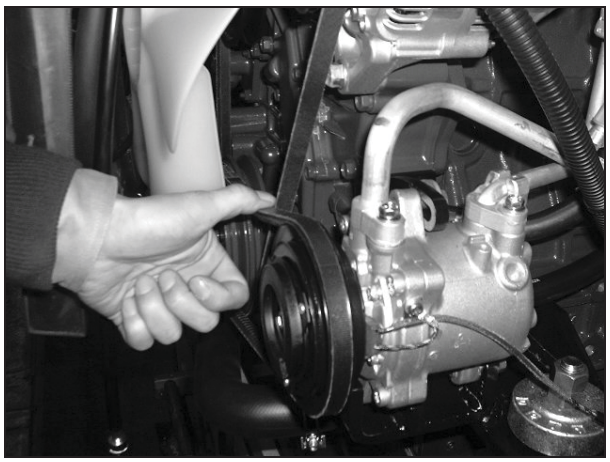


(1) Bolt: 01123-60830
(2) Bolt: 01123-60835
(3) Bush (Compressor): T0270-7232 r
(4) Bolt: 01123-60820
(5) Flange part of bush



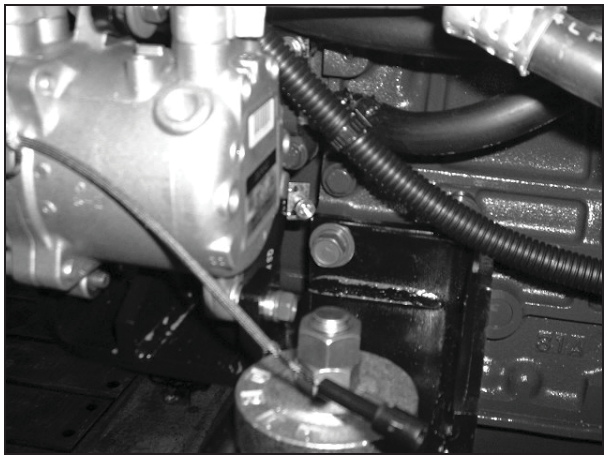
(12) V-belt tension

V-belt: BANDO RPF 2335 9.5 x 850 La
l = 33.5, RD118-4912B, cog belt
Belt deflection amount
12 - 15 mm (0.47 - 0.59 in.)
at pressing force
58.8 - 68.6 N (6 - 7 kgf)
13.2 - 15.4 lbw



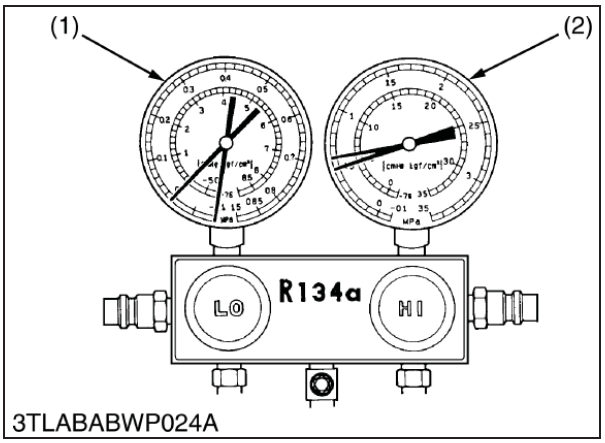
(13) Engine bracket 1, A/C

1) Tightening torque
M12: 77.5 - 90.2 N•m
(7.9 - 9.2 kgf•m)
57.1 - 66.5 ft•lbs
M8: 16.7 - 19.6 N•m
(1.7 - 2.0 kgf•m)
12.3 - 14.5 ft•lbs



(14) Relief valve

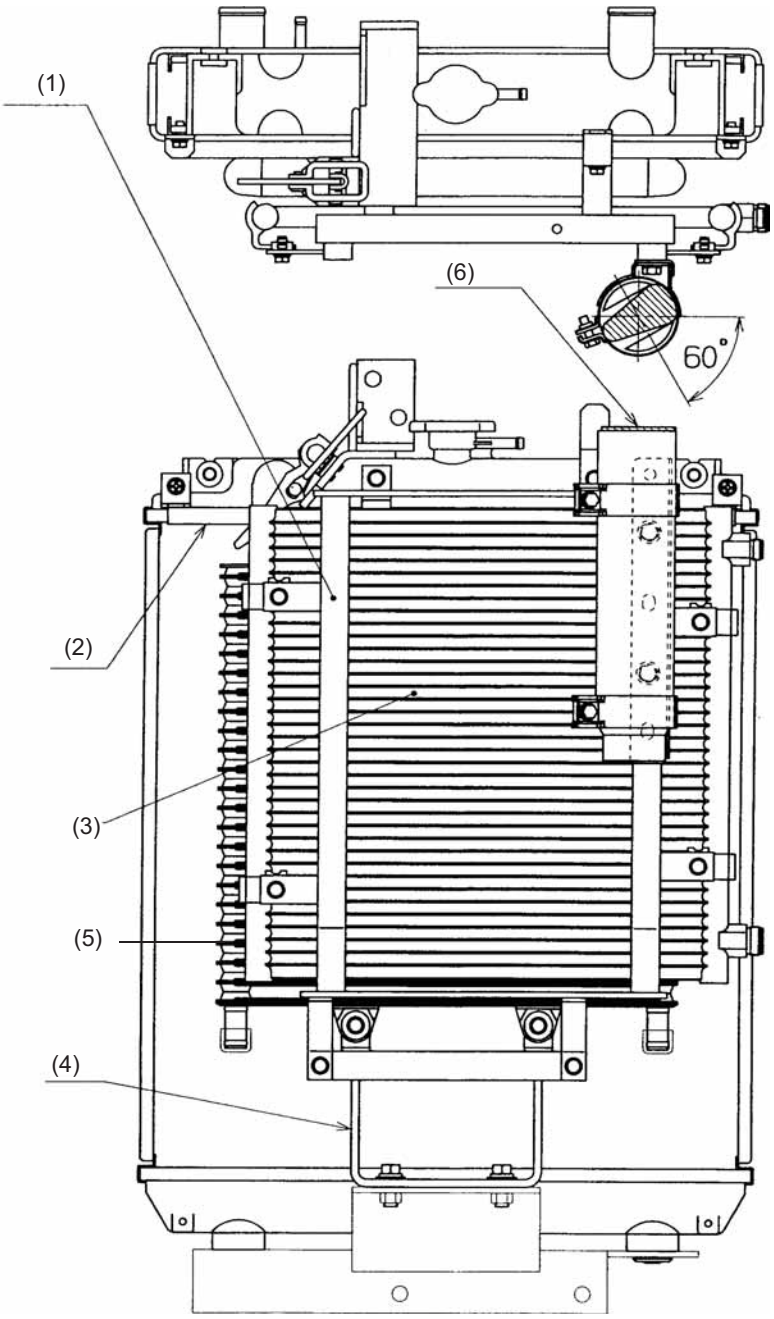
1) Relief opening pressure:
3.4 - 4.14 MPa (35 - 42.4 kgf/cm^2) 498 - 603 psi
2) Valve closing pressure:
2.76 Mpa (28.1 kgf/cm^2) 400 psi



3TLABABWP024A

b) Condenser and Receiver

(1) Parts location



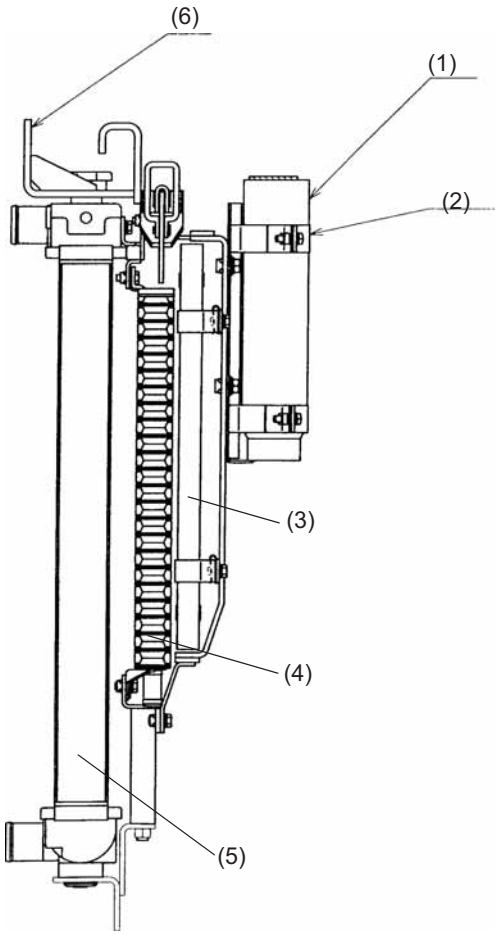
(1) Condenser support: RD411-4766△
Mounting bolt: 01025-60616, 4 pcs
(2) Radiator bracket 2: Rd411-4762△
(3) Condenser: T1065-7222△
Mounting bolt: 01025-60616, 4 pcs
Nut: T1065-7229△
(4) Radiator support 1: RD0411-4768△
(5) Oil cooler
(6) Receiver

Note: Receiver contains desiccant inside.
Do not remove the rubber cap until when connecting the hoses.

Condenser specifications

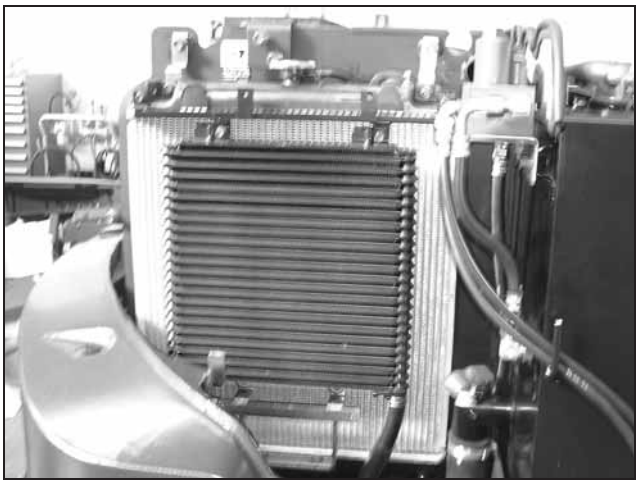
Core dimension mm (inch)	H	364.2 (44.3)
	W	325.0 (12.8)
	T	16.1 (0.63)
	Fin pitch	3.8 (0.15)
Radiation area m^2 (sq.ft)		0.1199 (1.29)
Max allowable pressure MPa (kgf/cm^2) psi		3.53 (36) 512

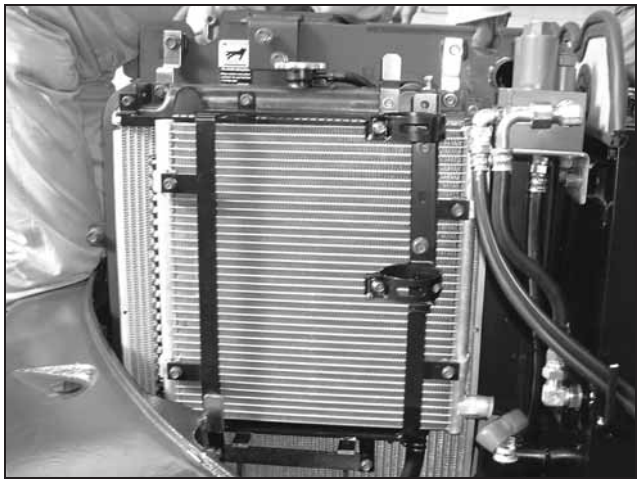
(1) Receiver: T0070-7927△
(2) Receiver holder: T0070-7928△
Mounting bolt: 01125-60816, 2 pcs
(3) Condenser
(4) Oil color
(5) Radiator
(6) Cooler bracket: RD411-4765△



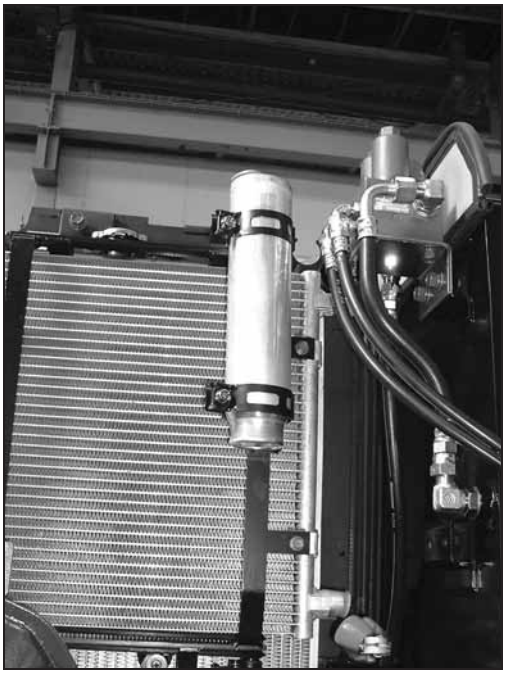
(2) Installation of condenser and receiver

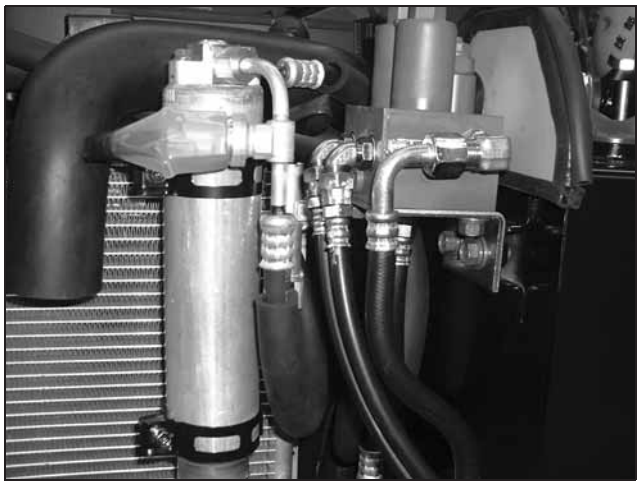
1) Install radiator bracket 2 onto the radiator.
2) Install radiator support 1 at the bottom of the radiator.
3) Install the oil cooler.
4) Install the condenser onto the condenser support.
5) Mount the condenser support onto the radiator bracket.
6) Install the receiver holder.
7) Install the receiver.

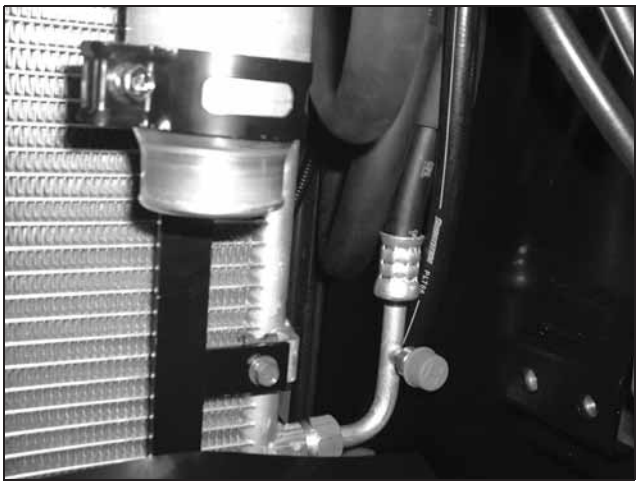




(2) Receiver holder
(3) Condensor
(5) Radiator







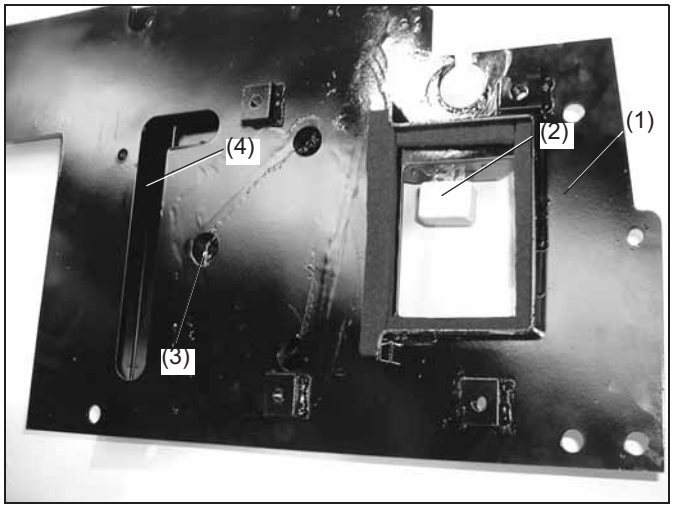
(4) High pressure port

(6) Sight glass
(7) Dual pressure switch

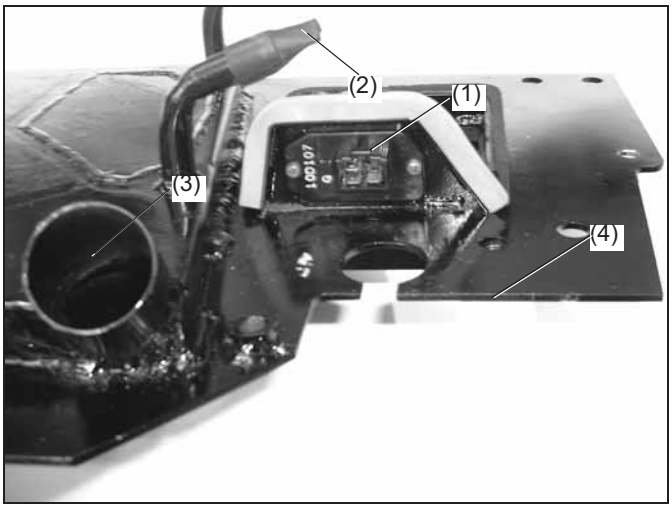
c) Air Conditioner Unit

1. Mounting procedure

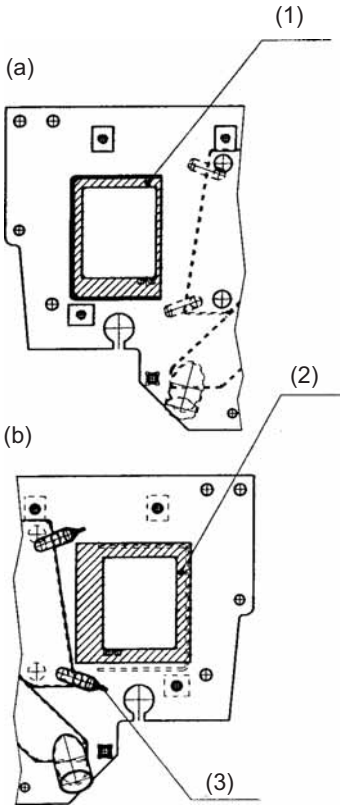
1) Put the sealing parts on the step 3.
2) Install drain boot.
3) Install the resister.
4) Install the duct assy with step 3. Connect the wire harness.
5) Place the step 3 on the swivel frames.
6) Install A/C unit on step 3.
7) Parts location



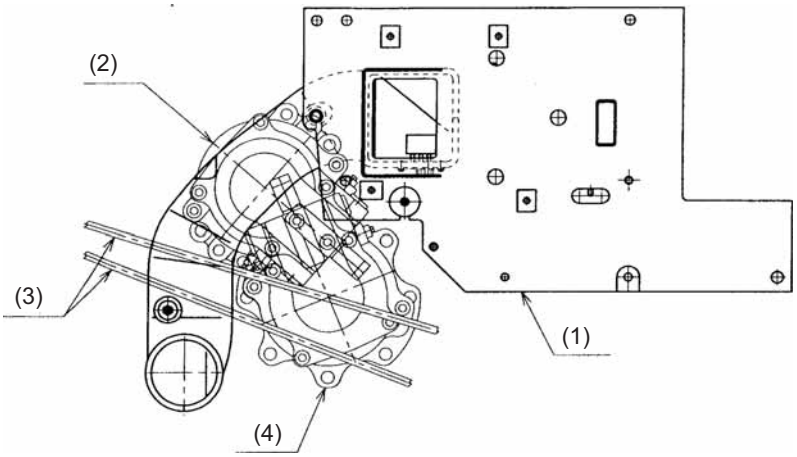
(1) A/C step (3): RD118-4783△
(2) Resister
(3) Water drain
(4) Air suction inlet



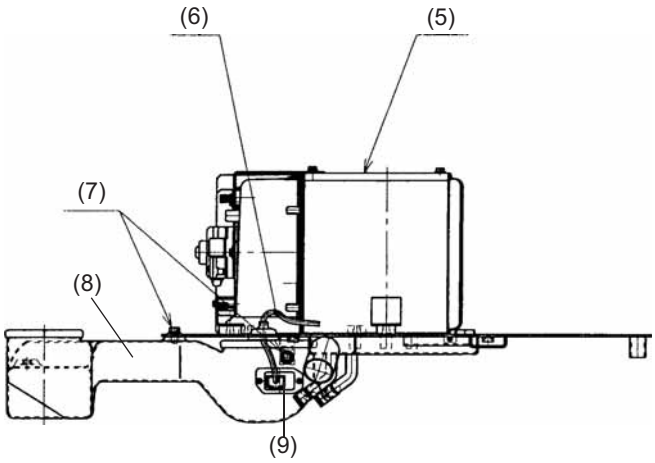
(1) Resister
(2) Water drain boot
(3) Air inlet from outside
(4) A/C step (3), bottom side

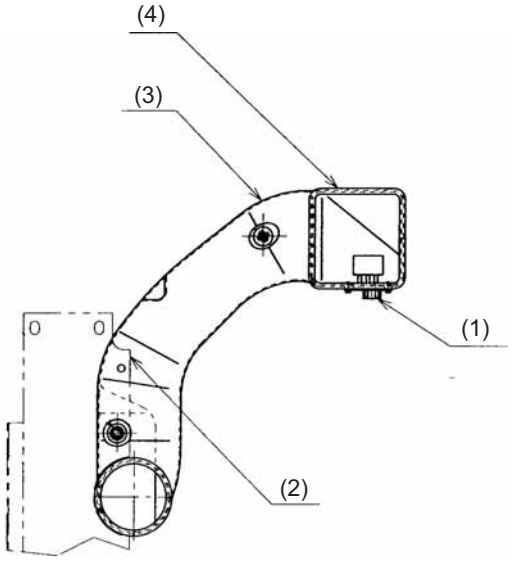


(a) Upper surface of A/C step (3)
(b) Bottom surface of A/C step (3)
(1) Seal 2: RD118-4792△
(2) Seal 1: RD118-4791△
(3) Drain boot: 6A671-71690△



(1) A/C step (3)
(2) Swivel motor, KX121-3
(3) Travel control rod
(4) Swivel motor, KX161-3
(5) A/C unit: RD118-5370△
(6) Blower wire harness: RD118-5348△
(7) Bolt: 01125-60816, 2 pcs
(8) Duct assy
(9) Resister

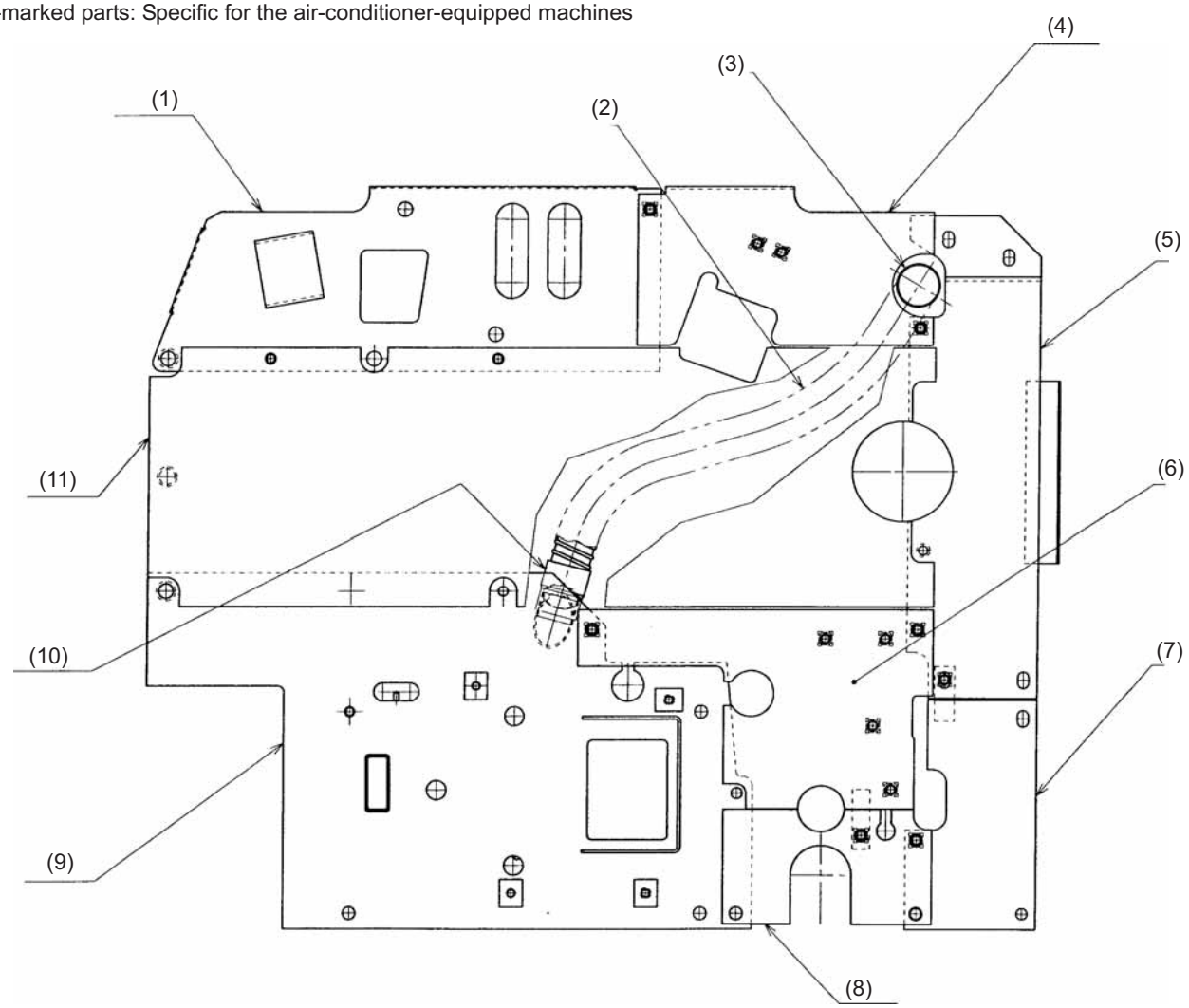




(1) Resister: T1065-7218△
Mounting screw: 03024-60412, 2 pcs
(2) Step support
(3) Trim (3): Rp821-4237△
(4) Duct assy: RD118-4740△

2. Location of steps

*-marked parts: Specific for the air-conditioner-equipped machines



(1) Step 1, L: RD118-4411△
(2) Defroster hose, 700: RB419-4928△
(3) Insert to filter cover, A/C.
(4) Step assy (1, R, A/C): RD118-4777△
Step (1, R, A/C): RD-118-4778△
(5) Step support, A/C: RD118-4167△
(6) Step (4, A/C): RD118-4782△
(7) Step support 2: RD118-4119△
(8) Step assy (5): RD118-4403△
Step (5): RD118-4421△
(9) Step 3, A/C: RD118-4783△
(10) Insert to pipe of step 3, A/C.
(11) Step 2, A/C: RD118-4779△

3. Dismounting steps

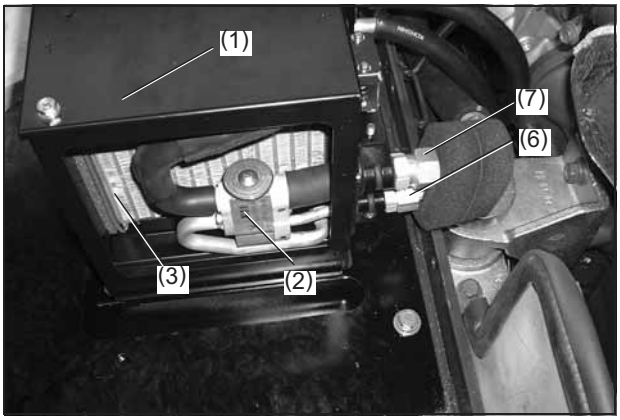
1) Remove the cab and seat.
2) Disconnect the heater hoses (5).
3) Disconnect the cooler pipe (liquid) (6) and cooler pipe (suction side) (7).
4) Remove the screws and take off the unit.
5) Remove the duct hoses.

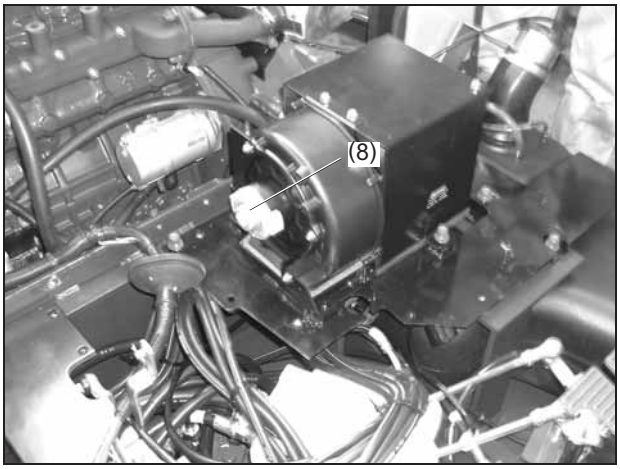
When reassembling

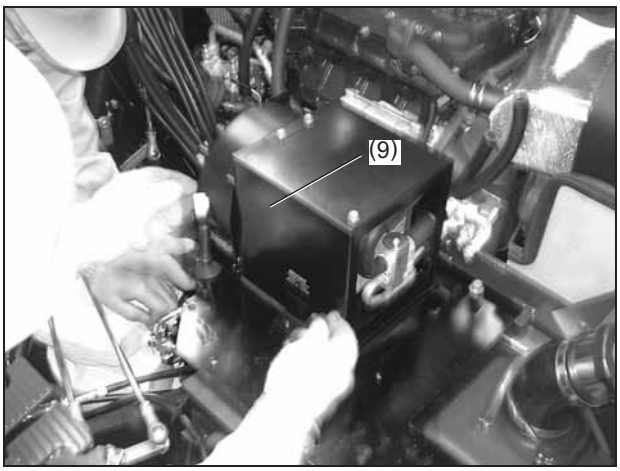
- When reconnecting the cooler pipes with the unit, apply compressor oil (NIPPONDENSO OIL8 or equivalent) to O-rings.
- When remounting the unit, tighten five screws by hand and finally retighten them after aligning the inner roof duct with the unit duct.
- When connecting the heater hose with A/C unit, hose should be put into the A/C unit pipe more than 30 mm (1.2 in.)

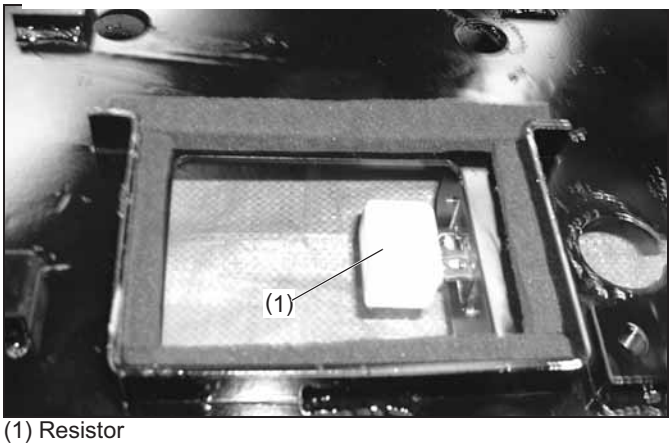
Tightening torque	A/C unit mounting screw (M6)	3.92 to 6.86 N•m 0.40 to 0.70 kgf•m 2.89 to 5.06 ft-lbs
	A/C unit mounting screw (M8)	9.8 to 11.68 N•m 1.00 to 1.19 kgf•m 7.23 to 8.6 ft-lbs
	Low pressure pipe (Cooler pipe (suction)) retaining nut	29.4 to 34.3 N•m 3.0 to 3.5 kgf•m 21.7 to 25.3 ft-lbs
	High pressure pipe (Cooler pipe (liquid)) retaining nut	11.8 to 14.7 N•m 1.2 to 1.5 kgf•m 8.7 to 10.8 ft-lbs

(1) Unit Cover
(2) Expansion Valve
(3) Evaporator
(4) Heater Core
(5) Heater Hoses
(6) High Pressure Pipe (Cooler Pipe (Liquid))
(7) Low Pressure Pipe (Cooler Pipe (Suction Side))
(8) A/C blower
(9) A/C unit

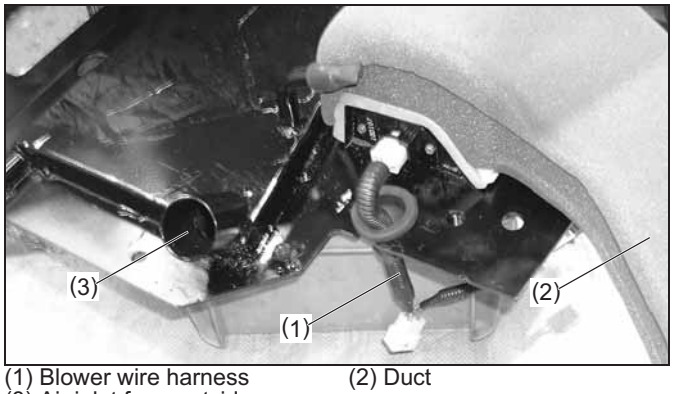




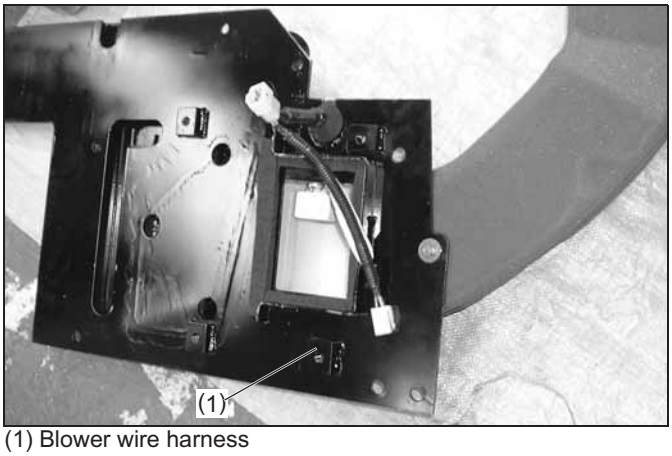




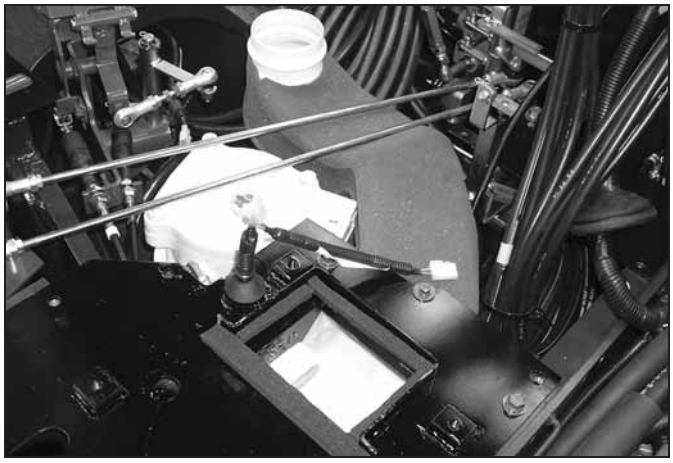
(1) Resistor



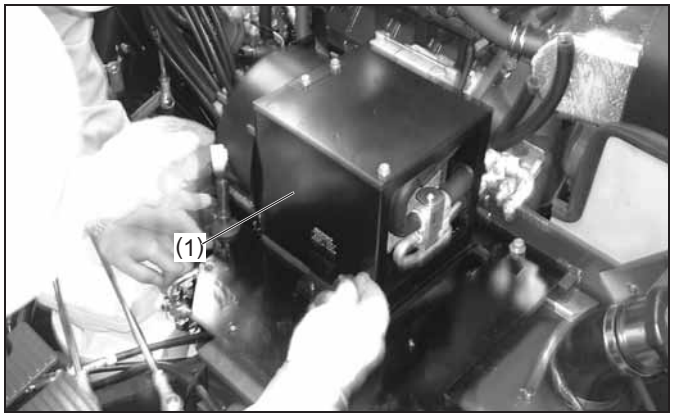
(1) Blower wire harness (2) Duct
(3) Air inlet from outside



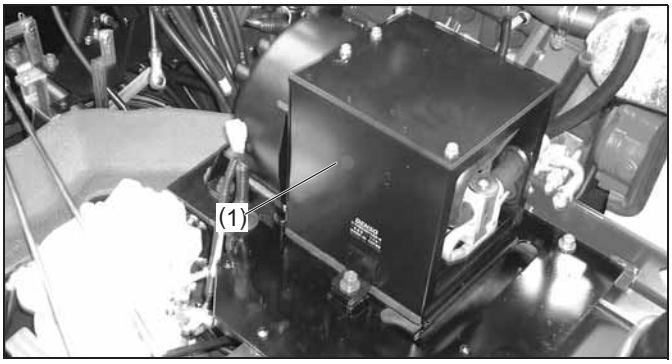
(1) Blower wire harness



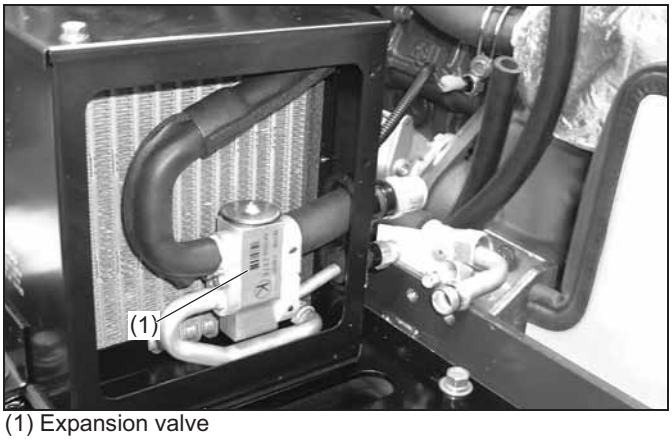
(1) Resistor



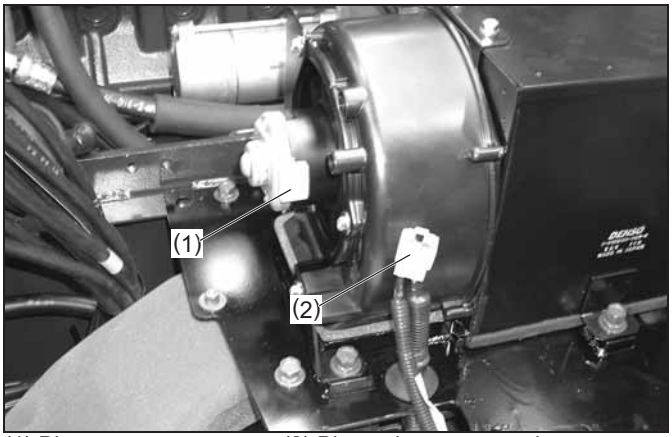
(1) A/C unit



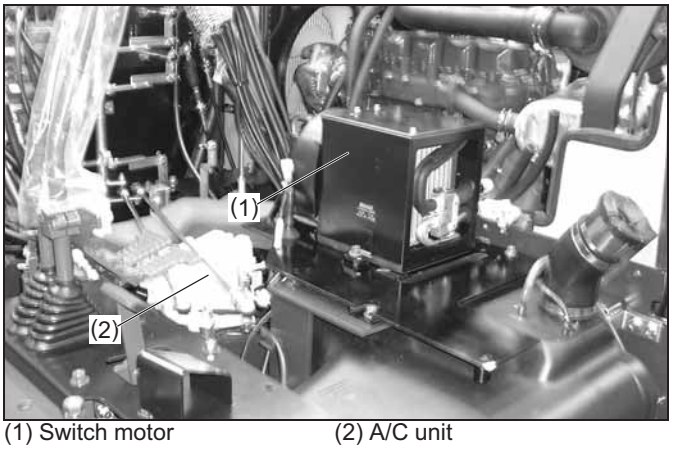
(1) A/C unit



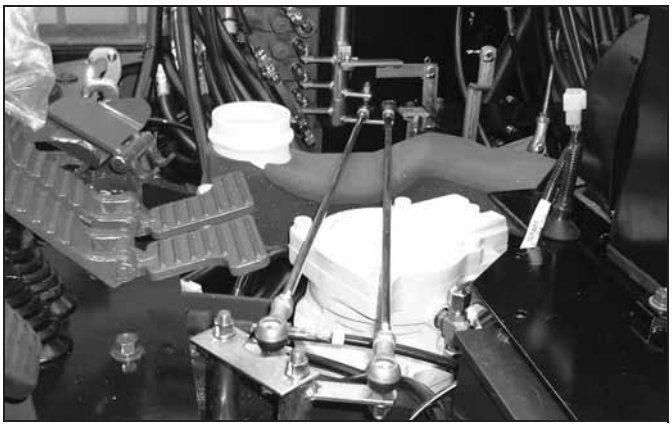
(1) Expansion valve

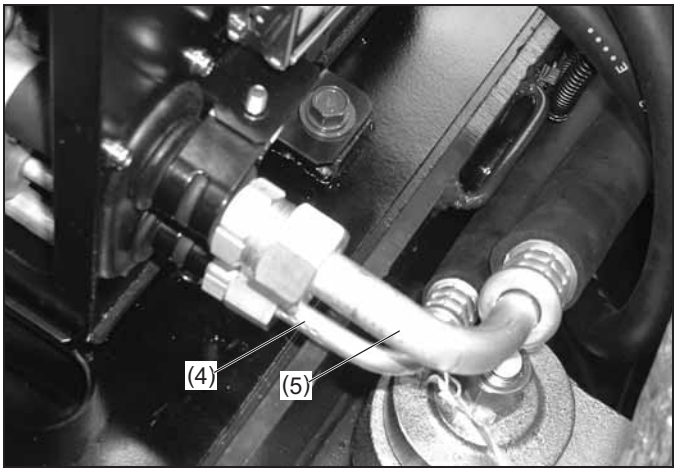


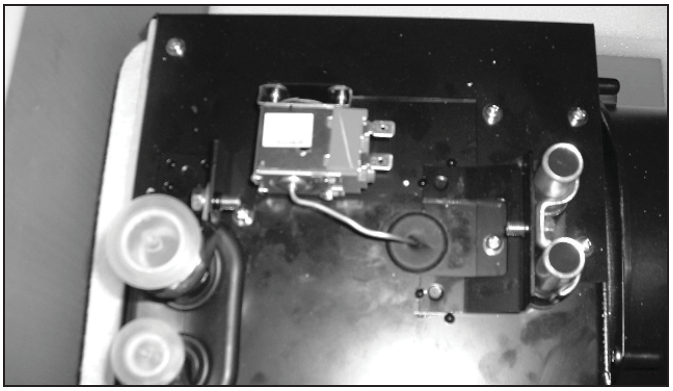
(1) Blower (2) Blower harness coupler

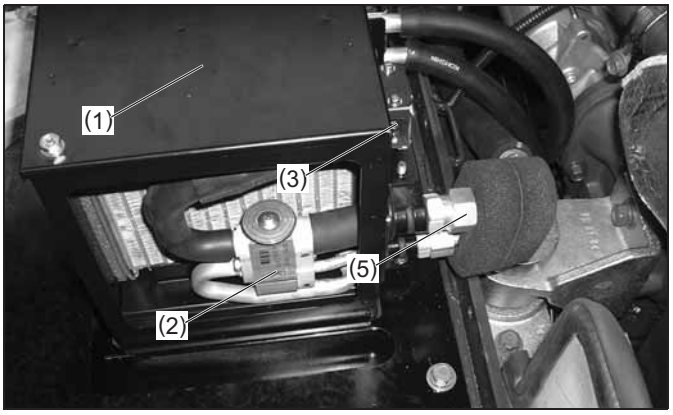


(1) Switch motor (2) A/C unit









(1) A/C unit (2) Expansion valve
(3) Thermostat (4) High (5) Low

d) Electrical System Components

(1) A/C Blower Relay and Compressor Relay

1) Remove the front cover, and disconnect the relay connectors.
2) Perform the following checkings **1)** and **2)**.

(1) A/C Blower Relay
(2) Compressor magnet clutch Relay, (Blue coupler)

1. Connector Voltage

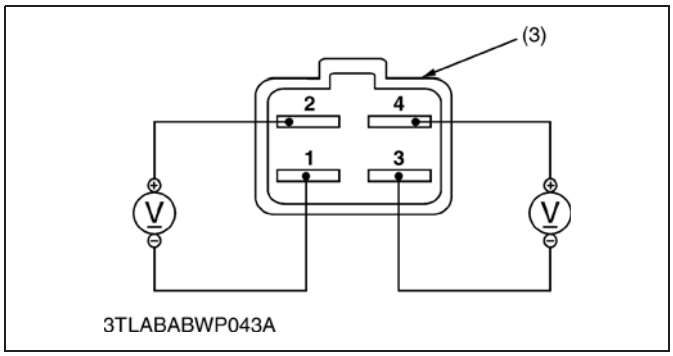
a) A/C Blower Relay

1) The voltage across the **4** terminal and chassis should be approx. battery voltage.
2) When turning the main switch **ON** and A/C blower switch to **LO** position, the voltage across the **2** terminal and chassis should be approx. battery voltage.

b) Compressor Relay

1) The voltage across the **4** terminal and chassis should be approx. battery voltage.
2) When turning the main switch **ON**, A/C blower switch to **LO** and A/C switch **ON**, the voltage across the terminal **2** and chassis should be approx. battery voltage.

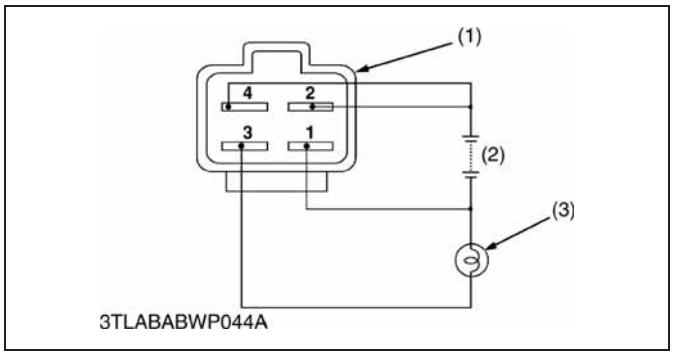
(1) A/C Blower Relay
(2) Compressor Relay(Magnet clutch relay)
(3) Connector Side



2. Relay Test

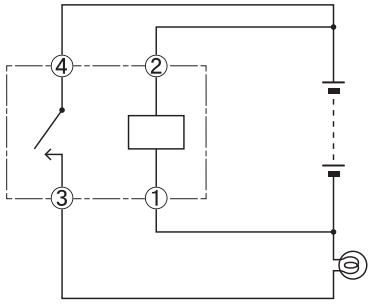
1) Remove the relay (1).
2) Connect the battery (2) and bulb (3) with the relay (1) as shown in the left figure.
3) In this condition, the bulb should light on if the relay is proper.
4) If the bulb light off when disconnecting the jumper lead from the relay **4** terminal, the relay is proper.

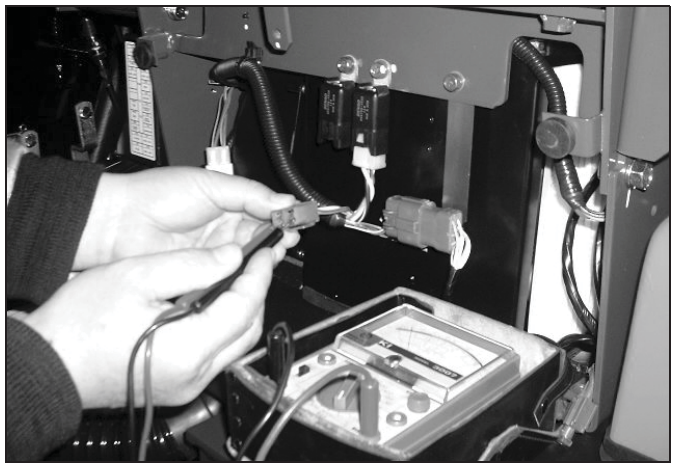
(1) Relay (2) Battery (3) Bulb



(2) Relay specs (at 20°C)

Rated voltage	: 12 V DC
Rated coil current	: 0.12 ±0.2 A
Max. current	: 20 A
Voltage drop	: 0.2 V or less
Min. operating voltage	: 8 V or less
Operating voltage range	: 10 - 16 V

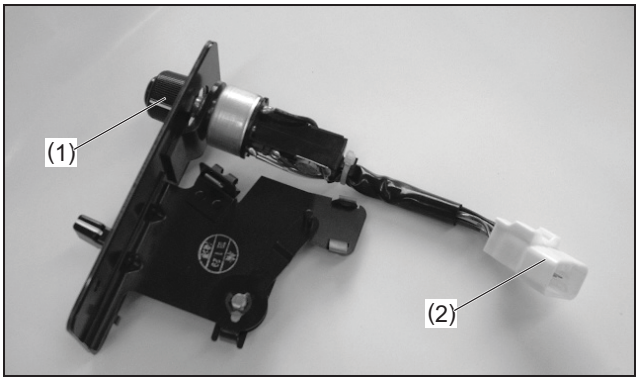




(3) A/C Blower Switch

1) Remove the A/C switch assy and disconnect the A/C blower switch connector (1).
2) Perform the following checkings **1)** and **2)**.

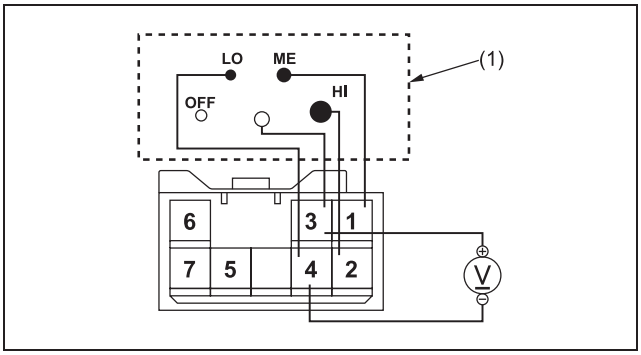
(1) A/C blower switch (2) A/C Blower Switch Connector



1. Connector Voltage

1) Turn the main switch **ON**.
2) Measure the voltage with a voltmeter across the connector **4** terminal and **3** terminal.
3) If the voltage differs from the battery voltage, the wiring harness, A/C relay, fuse or main switch is faulty.

Voltage	4 terminal - 3 terminal	Approx. battery voltage

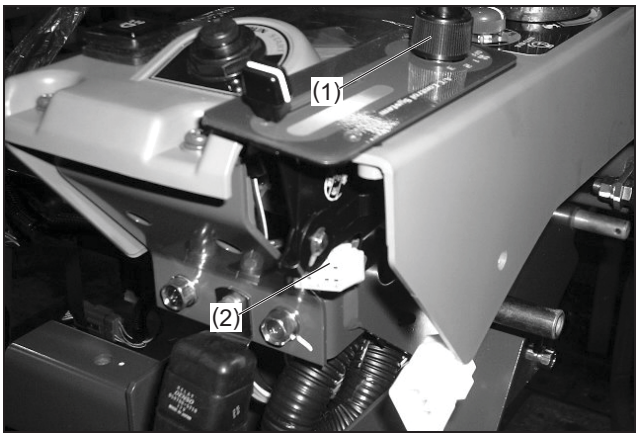


2. A/C Blower Switch

1) Check the continuity through the switch with an ohmmeter.
2) If the continuity specified below are not indicated, the switch is faulty.

Position \ Terminal		3	4	1	2
A/C Blower Switch	OFF	●			
	●(Low)	●	●		
	●(Medium)	●	●	●	
	●(High)	●	●		●

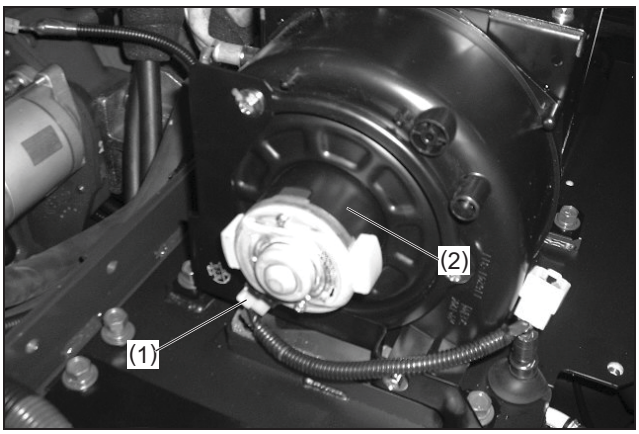
(1) A/C switch coupler (2) A/C Blower Switch Connector



(4) A/C Blower Motor Test

1) Remove the wire harness coupler.
2) Turn the blower motor (2) by hand and check whether it turns smoothly.
3) Disconnect the connector (1) of blower motor (2).
4) Connect a jumper lead from battery positive terminal to connector **B** terminal.
5) Connect a jumper lead from battery negative terminal to connector **E** terminal momentarily.
6) If the blower motor does not run, check the motor.

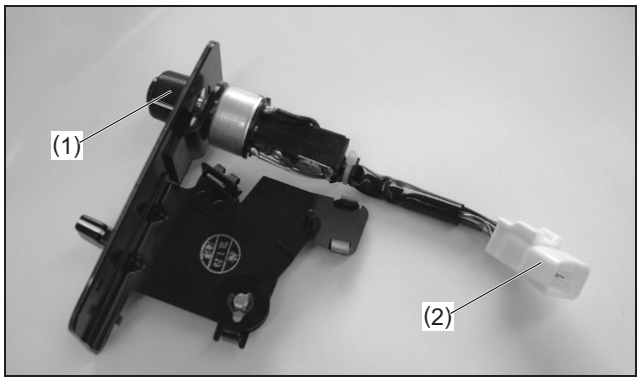
(1) Blower Motor Connector (2) Blower Motor



(5) A/C cooler switch

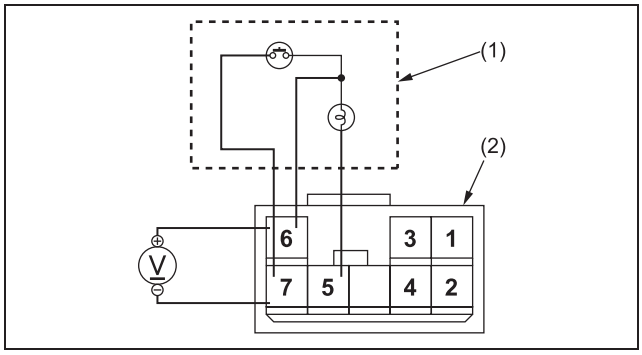
1) Remove, and disconnect the A/C switch connector (2).
2) Perform the following checkings **1)** and **2)**.

(1) A/C Switch (2) A/C Switch Connector



1. Connector Voltage

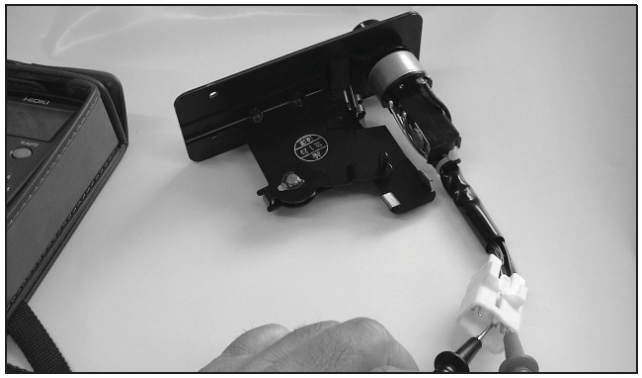
1) Turn the main switch ON.
2) Measure the voltage with a voltmeter across the connector 7 terminal and 6 terminal.
3) If the voltage differs from the battery voltage, the wiring harness, A/C relay or fuse is faulty.



2. A/C cooler switch

1) Check the continuity through the switch with an ohmmeter.
2) If the continuity specified below is not indicated, the switch is faulty.

Position \ Terminal		7	6	5
A/C Cooler Switch	OFF*2	●		
	ON*1	●	●	



*1: Push the A/C cooler switch button to ON position.
Approx. resistanse: 0.1 Ω
*2: Push again the A/C cooler switch button to OFF position.
Lamp resistance: 12 - 13.5 Ω
When lamp is damaged; ∞ Ω

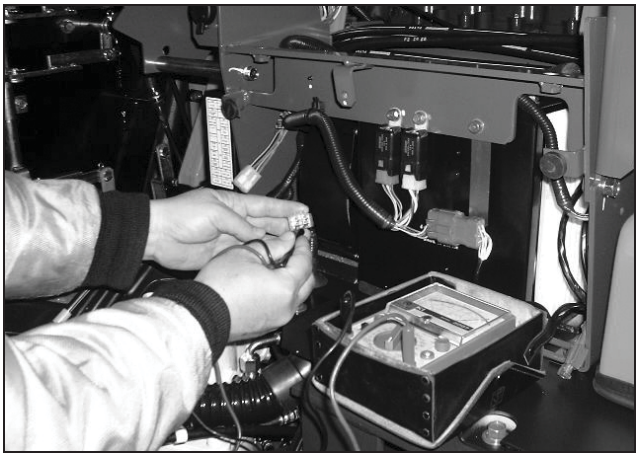
(1) A/C Switch (2) A/C Switch Connector

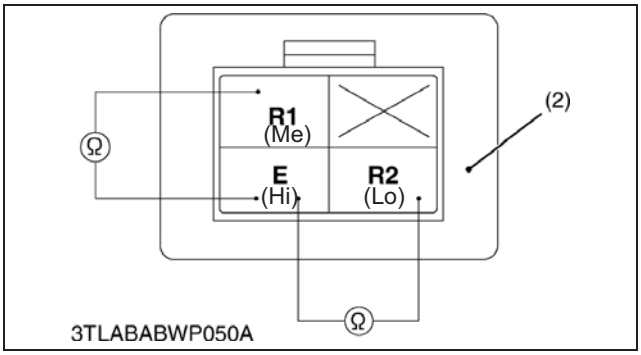
(6) A/C Blower Resistor

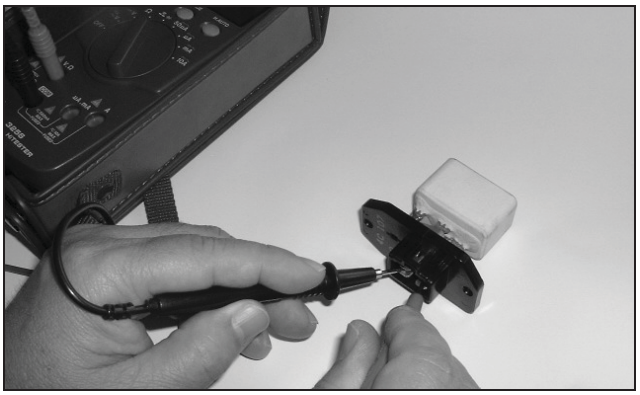
1) Remove the A/C unit and duct.
2) Disconnect the 4P connector (1) for A/C blower resistor (2).
3) Measure the resistance with an ohmmeter across the R1 terminal and E terminal, and across the R2 terminal and E terminal.
4) If the factory specifications are not indicated, A/C blower resistor is faulty.

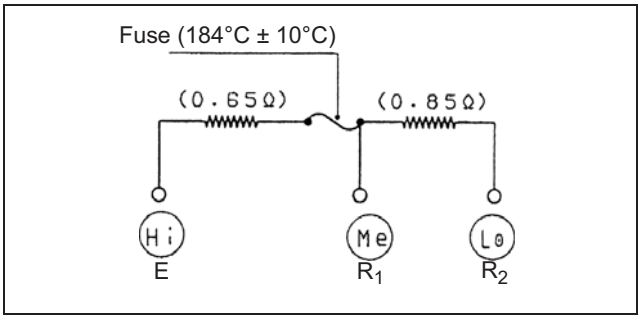
Voltage	R1 terminal - E terminal	Approx. 0.65 Ω
	R2 terminal - E terminal	Approx. 1.5 Ω

(1) A/C Blower Resistor Connector (2) A/C Blower Resistor









(7) Dual pressure switch

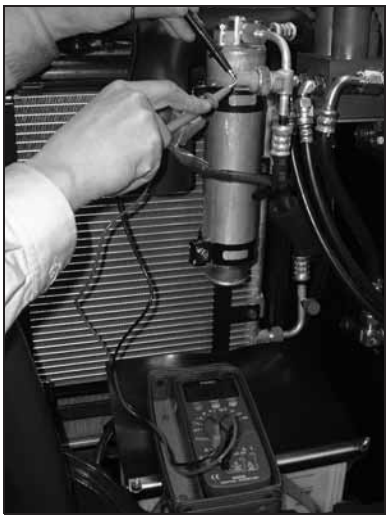
1. Location

(1) Dual pressure switch

2. Continuity test

Before charging the refrigerant: No continuity
After charging the refrigerant: Continuity
(When A/C switch off or even Engine key switch is off.)
(Approx. 0.1 Ω)

Troubleshooting: No continuity indicates no charging of refrigerant or gas leakage out of the system. So check and recharge.



3. Operating pressure

Low pressure side:

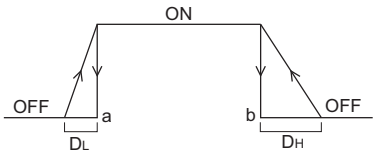
a: OFF pressure valve: 0.196 ± 0.02 MPa
(2.0 ± 0.2 kgf/cm^2)
28.4 ± 3.0 psi

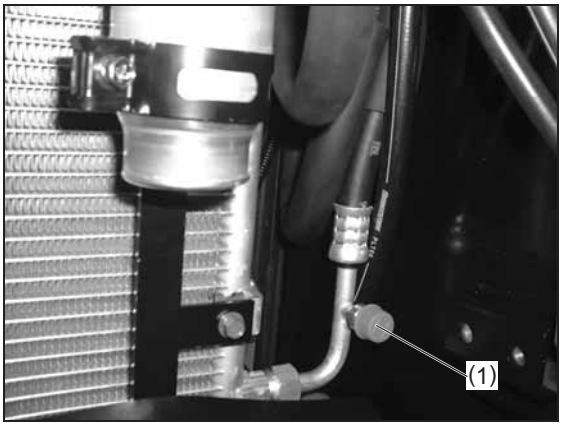
D_L: Differential: 0.02 MPa or lower
(0.2 kgf/cm^2)
2.8 psi

High pressure side:

b: OFF pressure valve: 3.14 ± 0.2 MPa
(32.0 ± 2.0 kgf/cm^2)
455.4 ± 28.4 psi

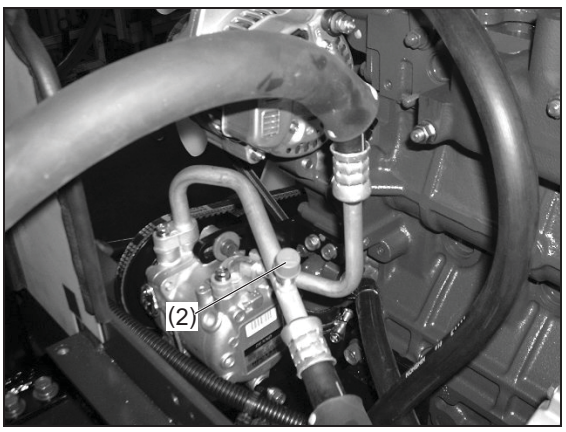
D_H: Differential: 0.59 ± 0.2 MPa
(6.0 ± 3.0 kgf/cm^2)
85.64 ± 42.7 psi





Sealing pressure: 3.53 MPa
(36.0 kgf/cm^2)
512.0 psi

Durable pressure: 5.30 MPa
(54.0 kgf/cm^2)
768.7 psi



(1) High pressure gauge port
(2) Low pressure gauge port

4. HI Pressure Side
   1) Connect the manifold gauge (6) to compressor as following procedure.
      Close the **HI** and **LO** pressure valves (5), (7) of manifold gauge tightly, and connect the charging hoses (red and blue) (1), (4) to the respective compressor service valves. (Refer to **HANDLING OF SERVICE TOOLS**: See page VI-S-15.)

   Note: Be sure to drive out the air in the charging hoses at the manifold gauge connection end by utilizing the refrigerant pressure in the refrigerant cycle.

   2) Start the engine and set at approx. 1500 min^{-1} (rpm). Turn on the A/C switch, then set the blower switch to **HI** position.
   3) Raise pressure on the **HI** pressure side of the refrigerant cycle by covering the condenser front with a corrugated carboard, and the pressure switch (9) is activated and the compressor magnetic clutch is turned off. At this time, read the **HI** pressure gauge of the manifold gauge. If this pressure reading differs largely with the setting pressure, replace the pressure switch with a new one.

Setting pressure	Factory spec.	Pressure switch **OFF**	More than approx. 3.14 MPa 32 kgf/cm^2 455 psi

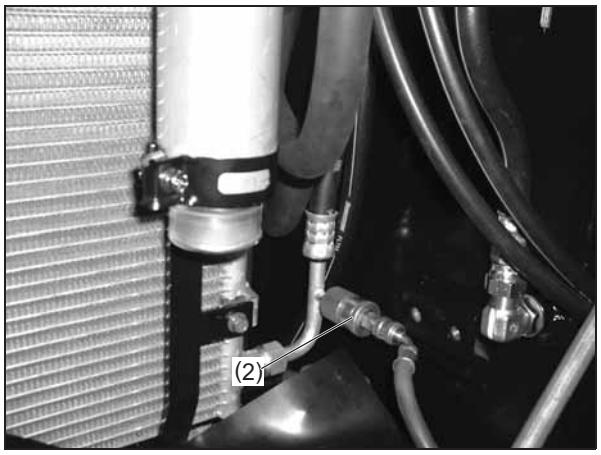
5. LO Pressure Side testing
   1) Disconnect **2P** connector of pressure switch.
   2) Measure the resistance with an ohmmeter across the connector terminals.
   3) If 0 ohm is not indicated at normal condition, there is no refrigerant in the refrigerating cycle because gas leaks or pressure switch is defective.

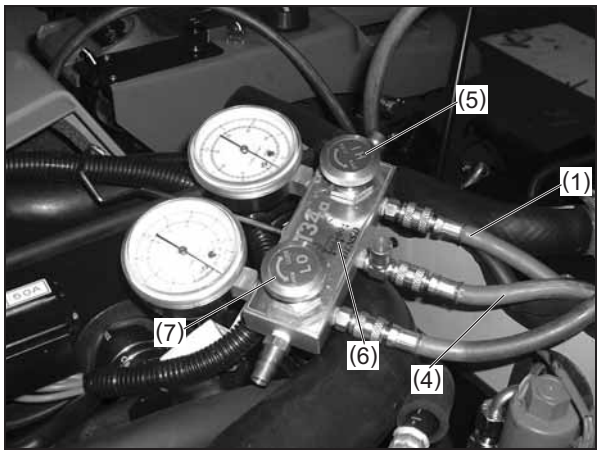
   Reference

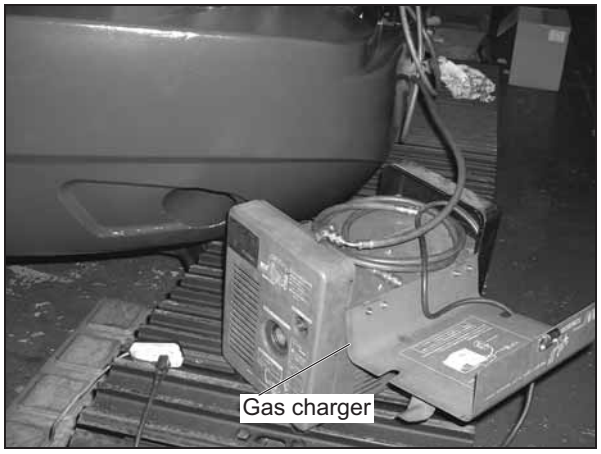
Setting pressure	Factory spec.	Pressure switch **OFF**	More than approx. 0.196 MPa 2.0 kgf/cm^2 28.4 psi

   • The resistance of pressure switch is 0 ~ 0.1 ohm in normal running, but is becomes infinity if the pressure is abnormal (out of factory spec.). Because the pressure switch starts to work.

(1) Charging Hose (Red)
(2) HI (High Pressure Side) Charging
(3) LO (Low Pressure Side)
(4) Charging Hose (Blue)
(5) HI Pressure Valve
(6) Manifold Gauge Valve
(7) LO Pressure Valve Charging
(8) Gas charger

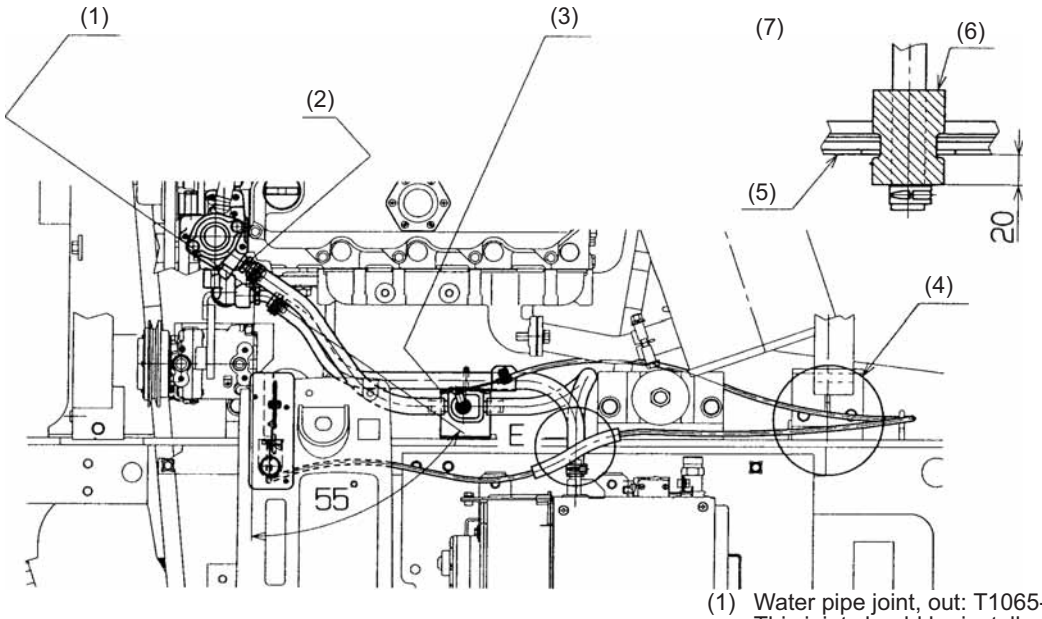




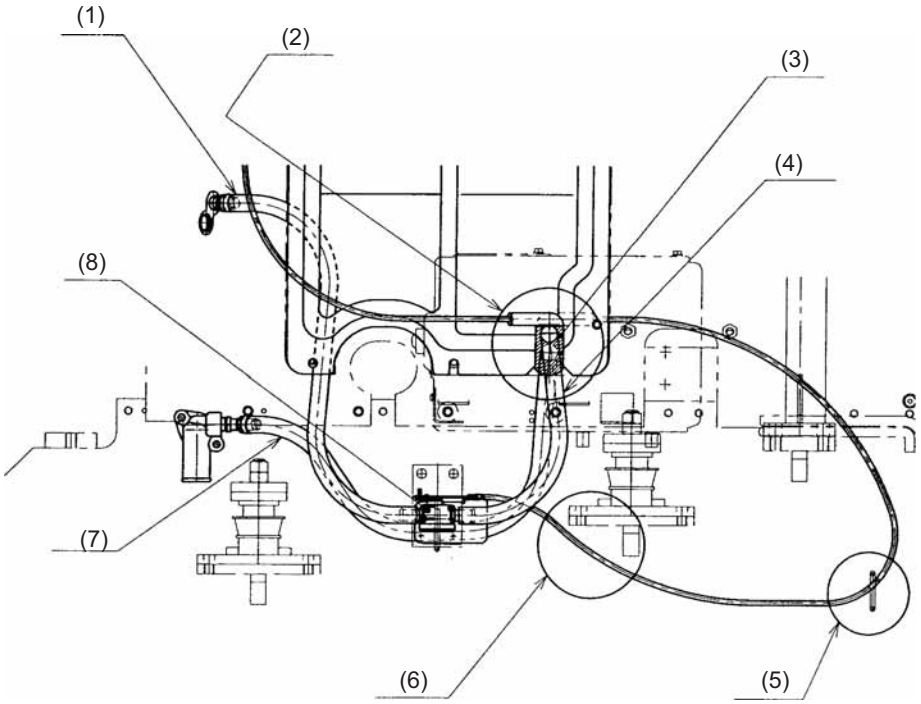


e) Heater Hose and Control Cable

(1) Parts location



(1) Water pipe joint, out: T1065-7282△
This joint should be installed horizontally.
(2) Water pipe joint: T1065-7281△
(3) Hot water valve bracket: RD118-4744△
Bolt: 01135-61020, 2 pcs
(4) Go through the front side of arch.
(5) Bonnet cover 1
(6) Cushion 1
(7) E-detail



(1) Heater hose 1: RD118-4741△
L = 690 mm
Hose clamp: 09318-88185, 6 pcs
(2) When placing the cover assembly (bonnet, A/C), make sure the sealant of cable (valve, A/C) runs on the cushion (1).
(3) Cushion (1)
(4) Heater hose 2: RD118-4742△
L = 405 mm
(5) Go through the rod ring of swivel frame.
(6) Go under engine bracket.
(7) Heater hose 3: RD118-4743△
L = 795 mm
(8) Hot water valve: T0270-6750△
Screw: 03024-50408, 2 pcs

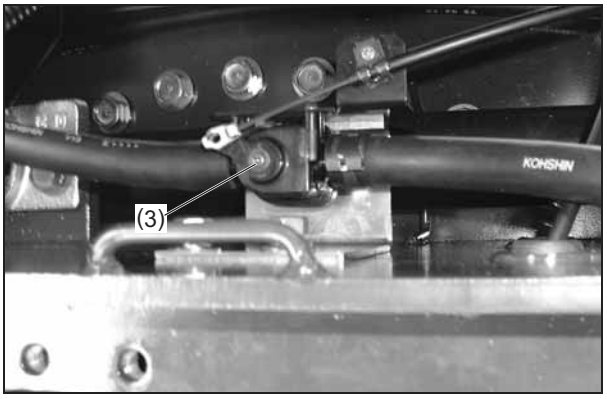
(2) Water Valve Control Cable (White Tape)

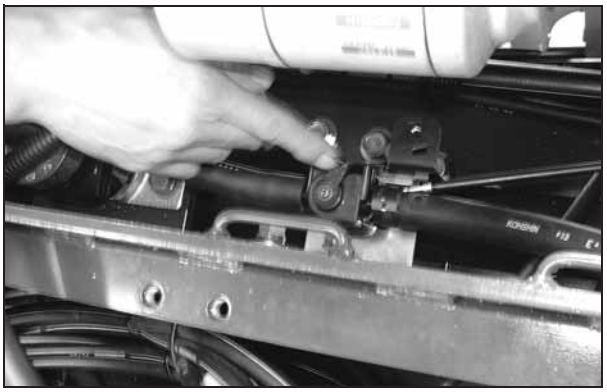
1. When disconnecting the water valve cable (1), follow the next reassembly procedure.

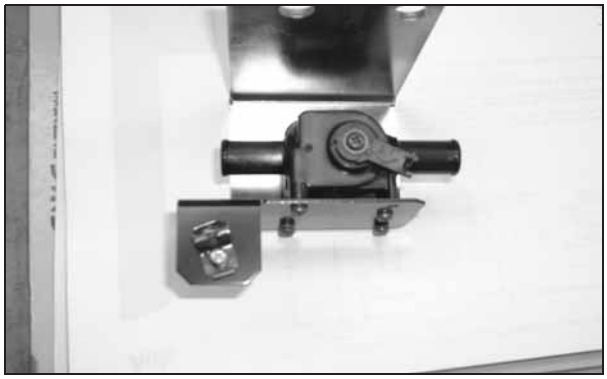
When reassembling

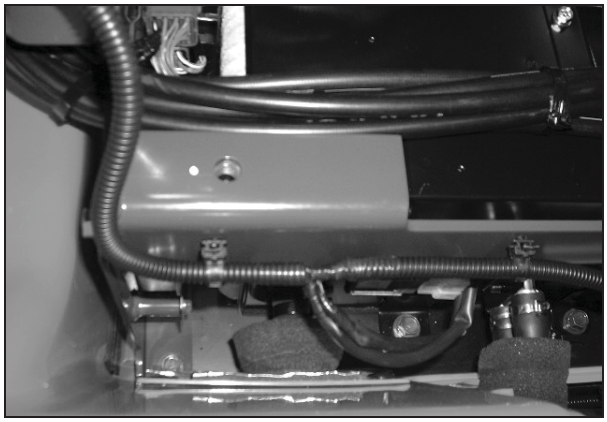
- •Fully close the water valve (3) and reconnect the cable (1).
- •Set the control at MAX COOL position. Fit the inner cable in position, and press and fix the outer cable by the cable clip (2) in the direction of arrow (A) as shown at left.
- •Move the temperature control lever several times to make sure the water valve is fully closed at MAX COOL position.
- •Do no allow the water valve cable to bend just away from the control, nor to get caught by the covers or the like.

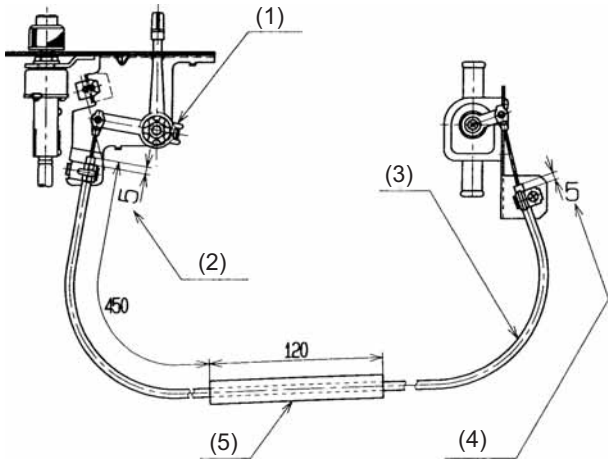
(1) Water Valve Control Cable a: 5 to 10 mm (0.20 to 0.40 in.)
(2) Cable Clip
(3) Water Valve A: Direction of Pulling Outer Cable





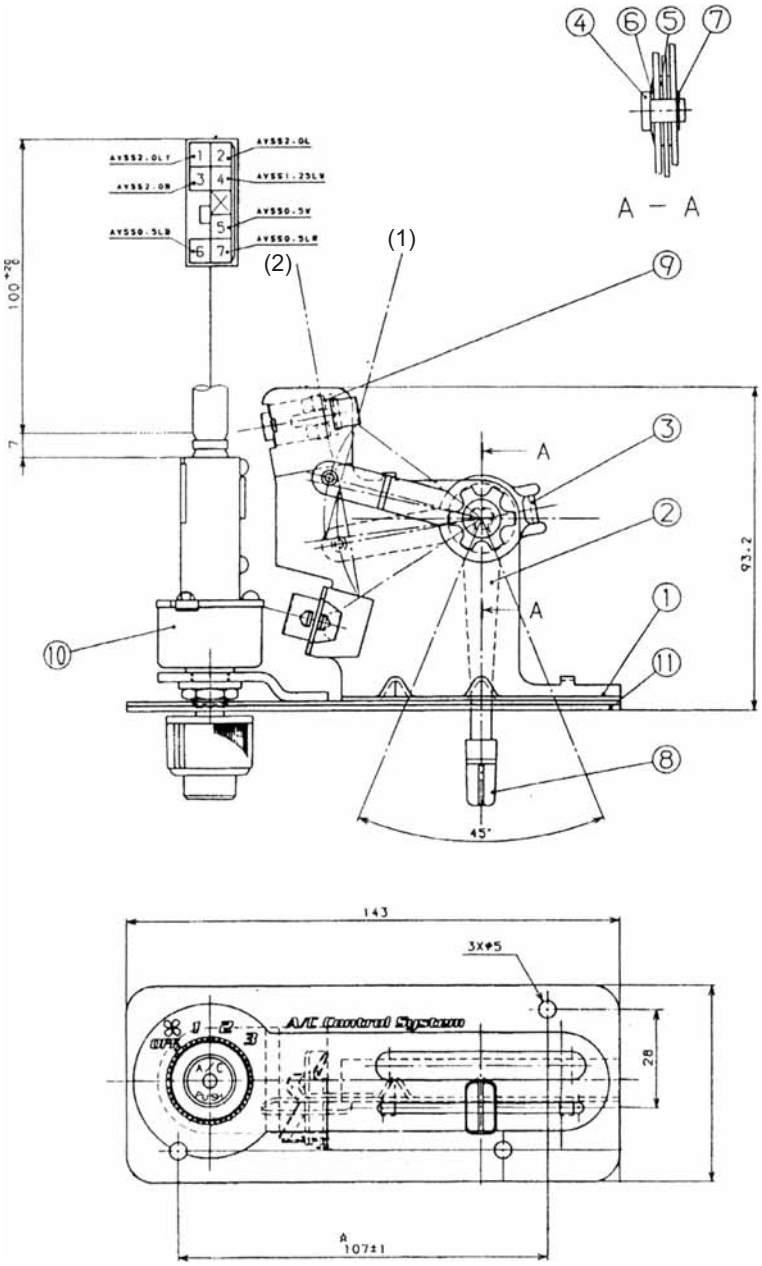






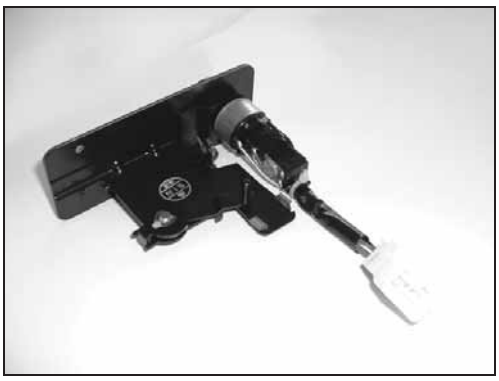
(1) A/C switch assy: RD118-5361△
Screw: 3F760-5333△ , M4 - 10
(2) Let the outer cable 5 mm (0.2") come long from clamp end.
(3) A/C valve cable: RD118-4745△
(4) Let the outer cable 5 mm (0.2") come long from clamp end.
(5) Sealing material
(6) Hoses and cables should not rink itself.

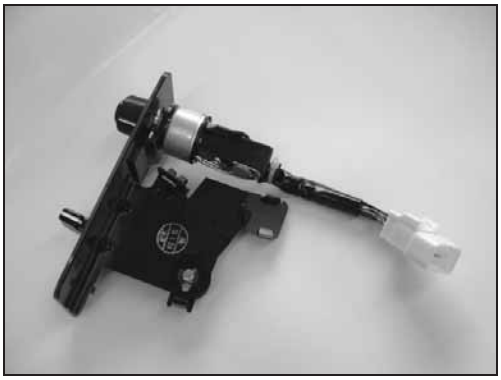
(3) A/C switch



(1) W/V cable, stroke 35 mm
(2) A/M door cable, stroke 32 mm

1 Control base sub assy
2 Control lever sub assy
3 Control lever sub assy
4 Pin
5 Washer
6 Wave washer
7 E-ring
8 Control knob
9 Lock clamp
10 Cooler switch assy
11 Ornament sub assy A/C switch





f) Cooler Hoses Installation

(1) Handling the air-conditioner parts

Do not remove the cooler hose caps until connecting the hose. Do not keep the receiver's cap, in particular, open longer than 3 minutes (because of the desiccant inside).

Water or dust entry into circuit
↓
Circuit clogged

(2) Cooler hose

Cooler hose tightening torque

M24×1.5 Nut Suction hose Ⓓ	29.4 ~ 34.3 N·m (3.0 ~ 3.5 kgf·m)	21.7 ~ 25.3 ft·lbs
M22×1.5 Nut Discharge hose Ⓐ	19.6 ~ 24.5 N·m (2.0 ~ 2.5 kgf·m)	14.5 ~ 18.1 ft·lbs
M16×1.5 Nut Liquid hose Ⓒ	11.8 ~ 14.7 N·m (1.2 ~ 1.5 kgf·m)	8.7 ~ 10.9 ft·lbs
Compressor M6 bolt Ⓓ	7.9 ~ 11.8 N·m (0.8 ~ 1.2 kgf·m)	5.8 ~ 8.7 ft·lbs
Receiver M6 bolt Ⓒ	3.9 ~ 6.9 N·m (0.4 ~ 0.7 kgf·m)	2.9 ~ 5.1 ft·lbs

Low torque
↓
Gas leak
High torque
↓
Thread damage

Pipe connection

Apply compressor oil (ND-OIL8) to the O rings.
Install up to the step at the pipe end. Then tighten up the nut.

O-ring damage
↓
Gas leak
Poor fitting
↓
Thread damage, gas leak

Tightening the hoses

Note that their mating parts are easy to get damaged
Apply another wrench to the mating part to keep it from turning.

Pipe distortion and damage
↓
Gas leak

(3) Gas charging

With a gas charger

Keep the engine off. Be sure to feed the gas through the high-pressure side (H).

Without a gas charger

1) Keep the engine off. Feed the gas through the high-pressure side (H).
2) Then run the engine at below 1500 rpm and feed the gas through the low-pressure side (L).

Wrong gas charging
↓
Liquid compression
↓
Compressor failure

Charging amount (Refrigerant: HFC134a)
850 ± 50 g (1.87 ± 0.11 lbs)

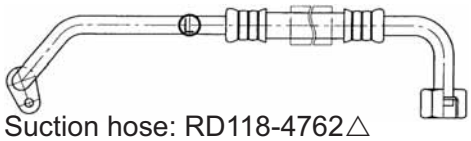
Too much or short gas
↓
Poor cooling

Compressor side

Condenser side
M22×1.5

Ⓐ Discharge hose: RD118-4751△

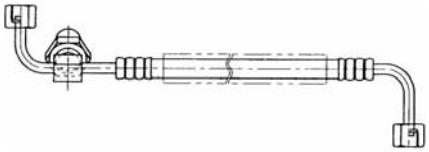
Compressor side



A/C unit side
M24×1.5

Ⓓ Suction hose: RD118-4762△

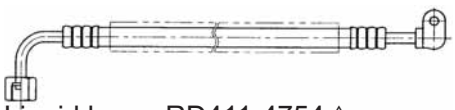
Receiver side
M16×1.5



A/C unit side
M16×1.5

Ⓒ Liquid, pressure hose: RD118-4753△

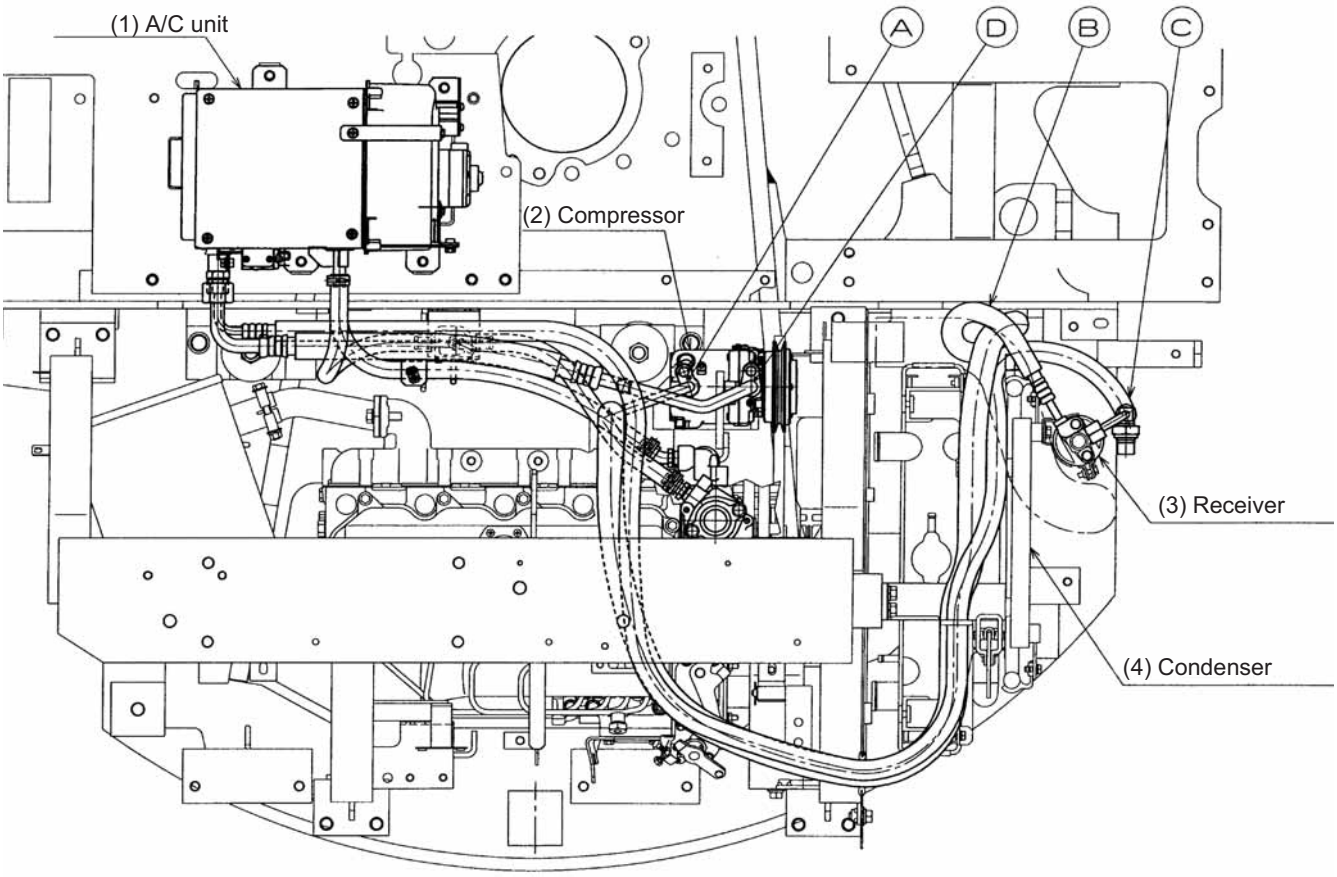
Condenser side
M16×1.5



Receiver side

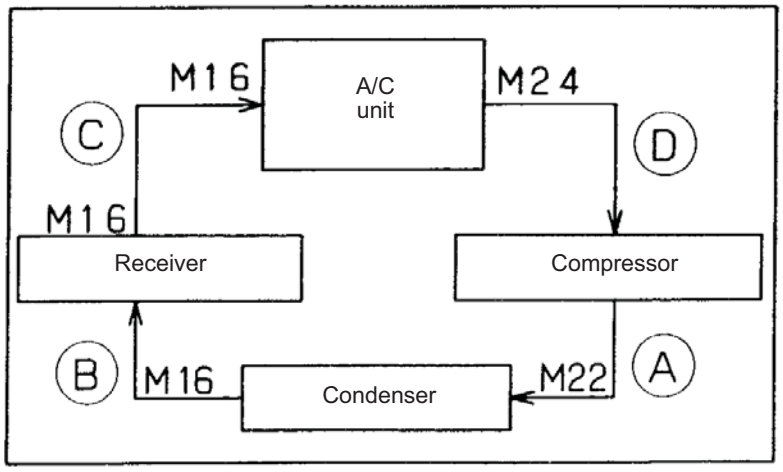
Ⓑ Liquid hose: RD411-4754△

(4) Cooler hoses layout 1



Sample: KX161-3ST

Connection of cooler hoses



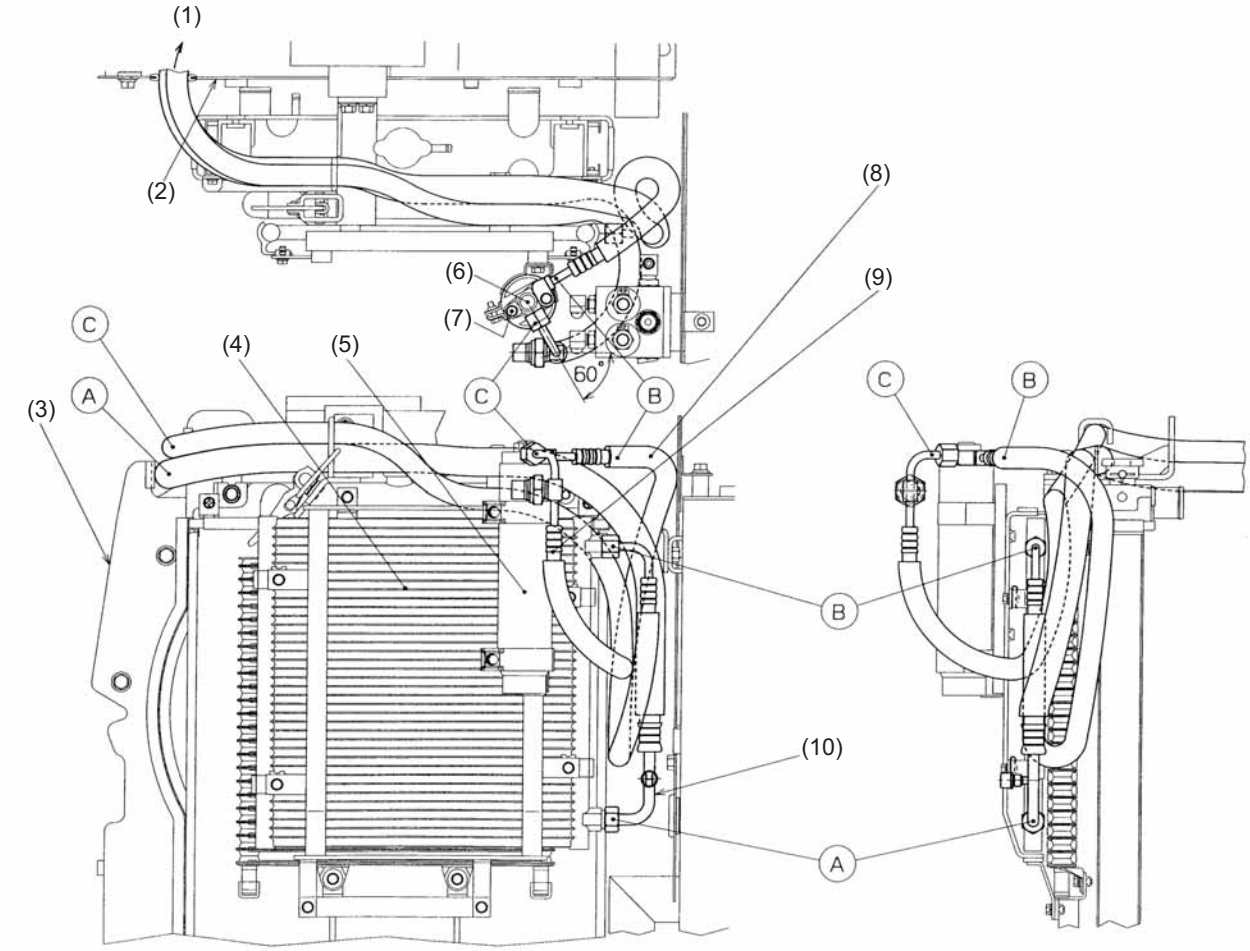
Ⓐ Discharge hose: RD118-4751△

Ⓑ Liquid hose: RD411-4754△

Ⓒ Liquid pressure hose: RD118-4753△

Ⓓ Suction hose: RD118-4762△

(5) Cooler hoses layout 2

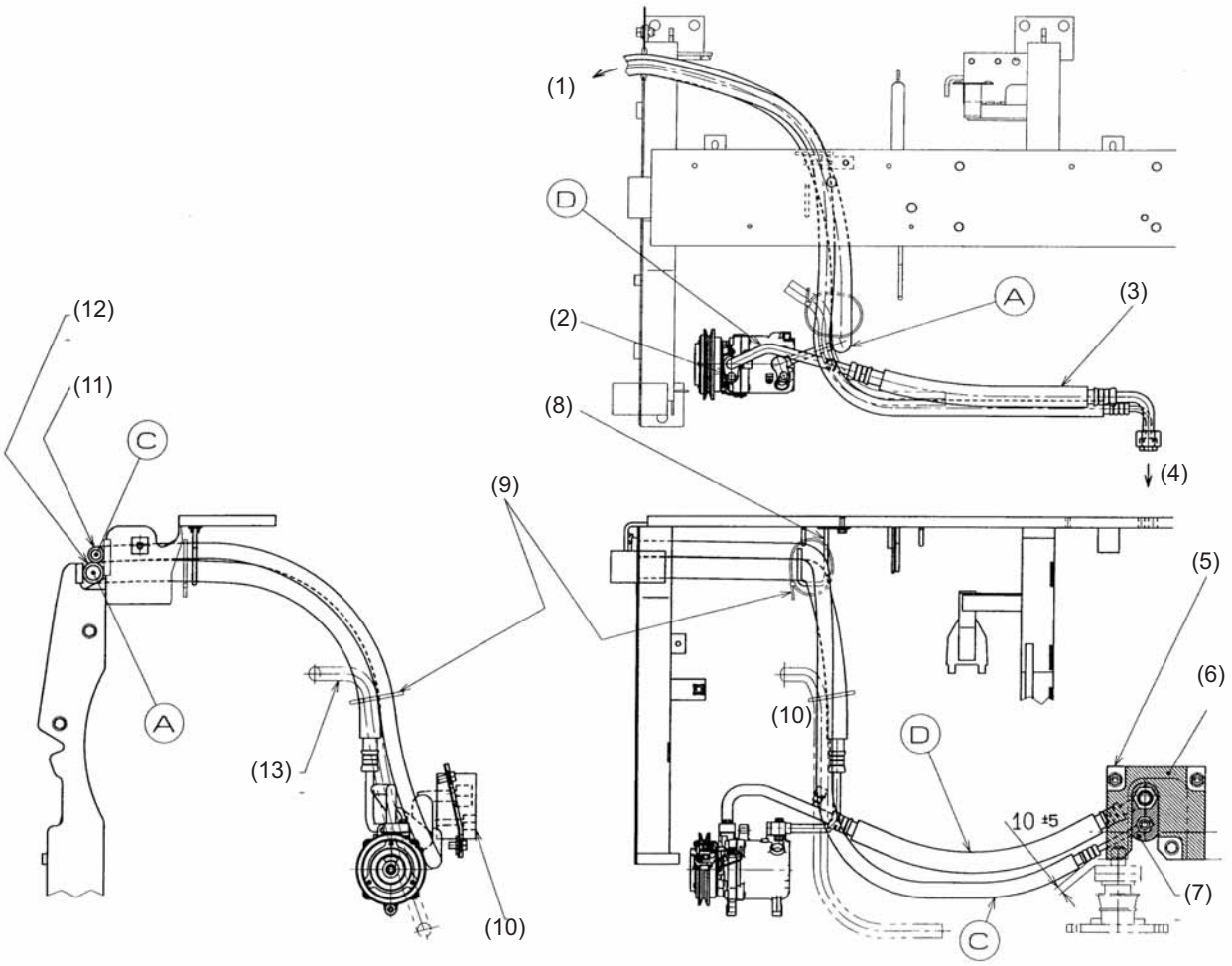


Sample: KX161-3ST

(1) To A/C unit, compressor△
(2) Arch from aasy: RD118-4760△
(3) Arch plate assy: RD118-4770△
(4) Condenser
(5) Receiver
(6) Receiver joint: T0270-8717△
(7) Bolt: 01025-50625
(8) Liquid hose: RD411-4754△
(9) Liquid pressure hose: RD118-4753△
(10) Discharge hose: RD118-4751△

Ⓐ Discharge hose: RD118-4751△
Ⓑ Liquid hose: RD411-4754△
Ⓒ Liquid pressure hose: RD118-4753△
Ⓓ Suction hose: RD118-4762△

(6) Cooler hoses layout 3

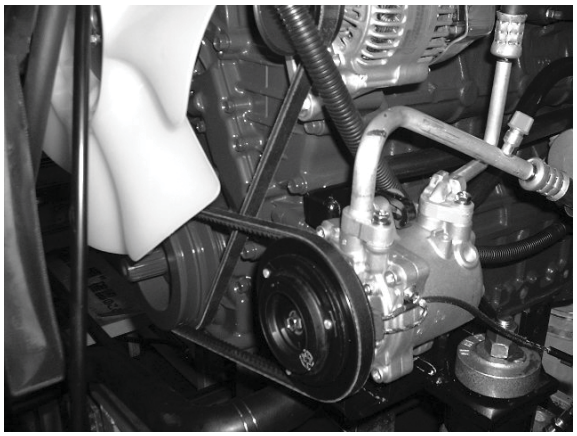


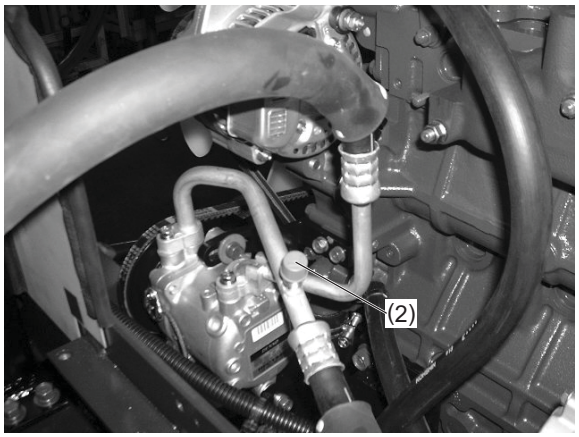
Sample: KX161-3ST

(1) To condenser, receiver
(2) Flange bolt: 01754-50625, 2 pcs
(3) Suction hose: RD118-47620
(4) To A/C unit
(5) Bonnet cover 2: RD118-4789△
(6) Heat insulator: RD118-4789△
(7) Cushion (2): RD118-4715△
(8) Hose guide: RD411-47580△
Flange bolt: 01754-50816
(9) Cord band: 55311-4126△
(10) With the hose in place, install the cushion (2) up to this position to seal the hose.
(11) Liquid pressure hose: RD118-4753△
(12) Discharge hose: RD118-47510△
(13) Heater hose 1: RD118-4741△

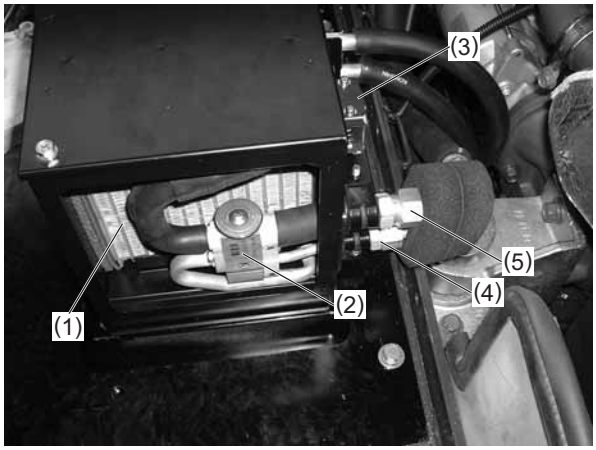
Ⓐ Discharge hose: RD118-4751△
Ⓑ Liquid hose: RD411-4754△
Ⓒ Liquid pressure hose: RD118-4753△
Ⓓ Suction hose: RD118-4762△

(7) Hoses layout photos

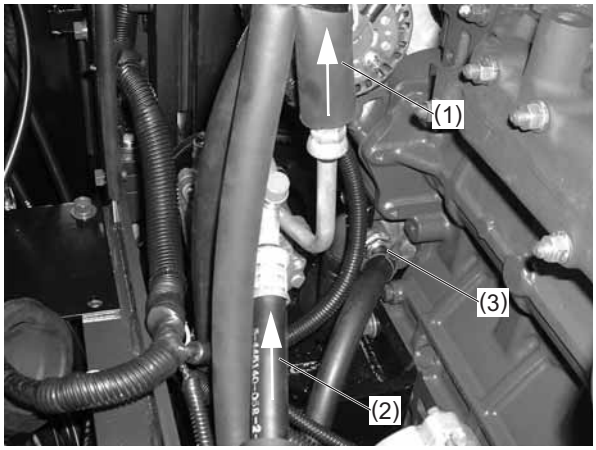




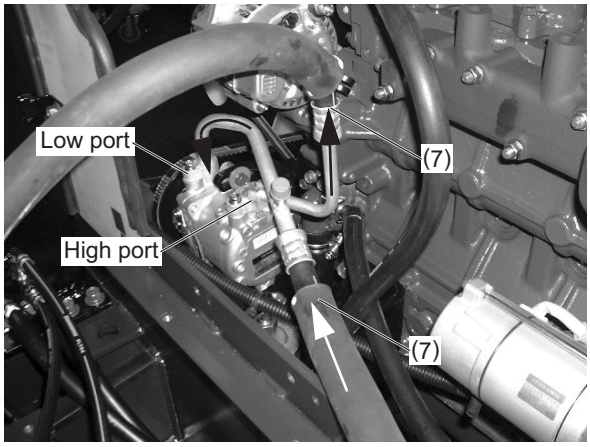
(2) Low pressure port



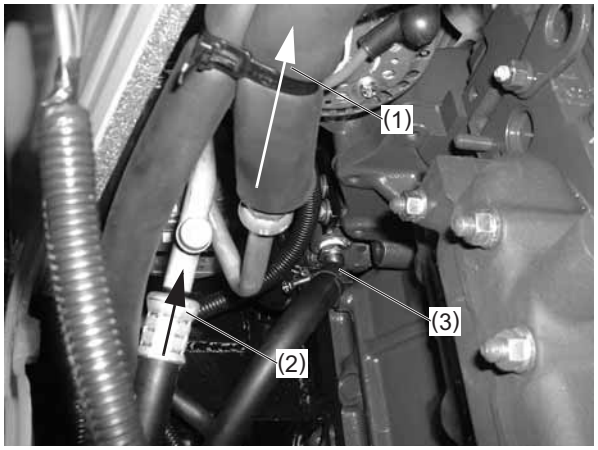
(1) Evaporator
(2) Expansion valve
(3) Thermostat
(4) High pressure hose
(5) Low pressure hose



(1) Compressor H port to condenser lower port (H)
(2) Compressor L port from A/C unit upper port
(3) Engine lower port

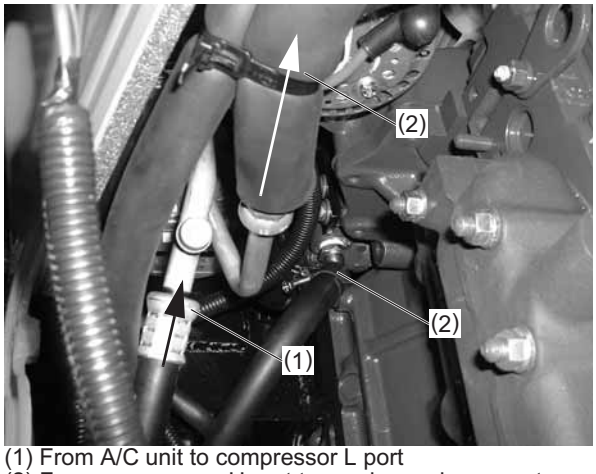


(1) A/C unit outlet port to compressor L port
(2) Compressor H port to condenser lower port (H)

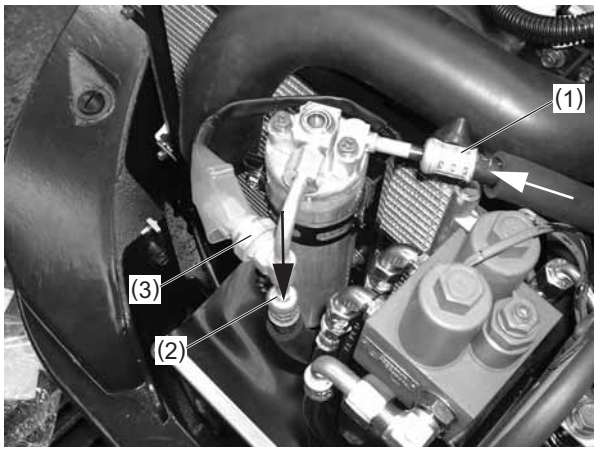


(1) To condenser
(2) From A/C unit
(3) Engine heater hose

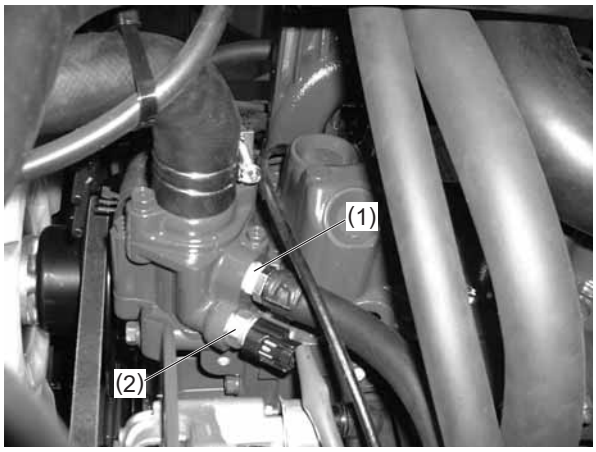
(1) From compressor H port
(2) High pressure port



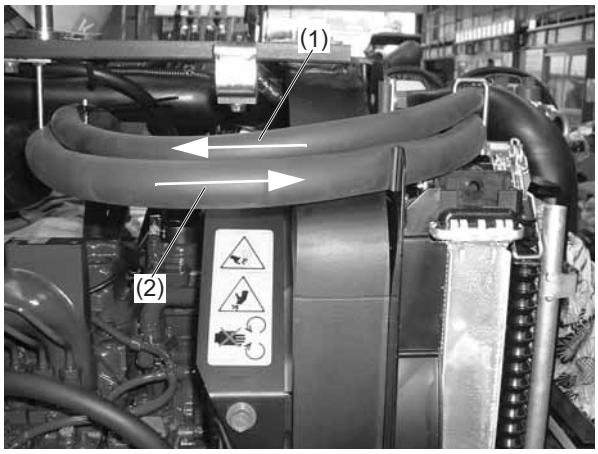
(1) From A/C unit to compressor L port
(2) From compressor H port to condenser lower port (High pressure)



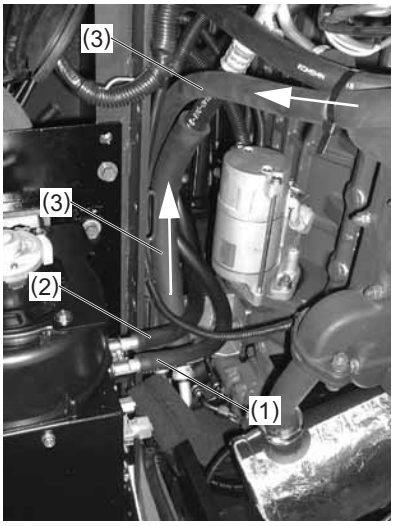
(1) To condenser
(2) From A/C unit
(3) Engine heater hose



(1) Engine upper port
(2) Temp. sensor



(1) To A/C unit
(2) From compressor to condenser lower port

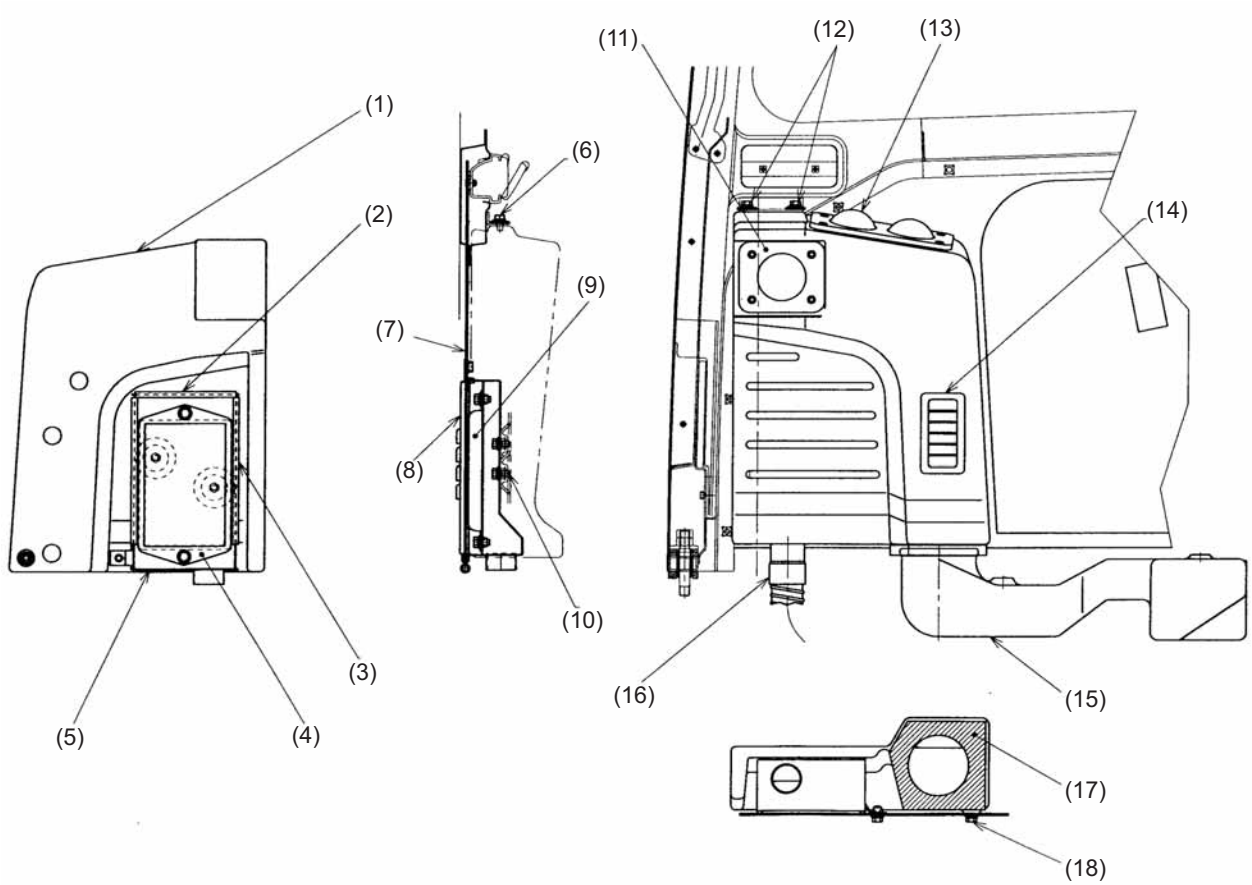


(1) Heater upper inlet from engine upperport
(2) Heater lower inlet from engine lower port
(3) A/C unit to compressor suction port (L)
(4) Receiver to A/C unit

g) Duct Cover Installation

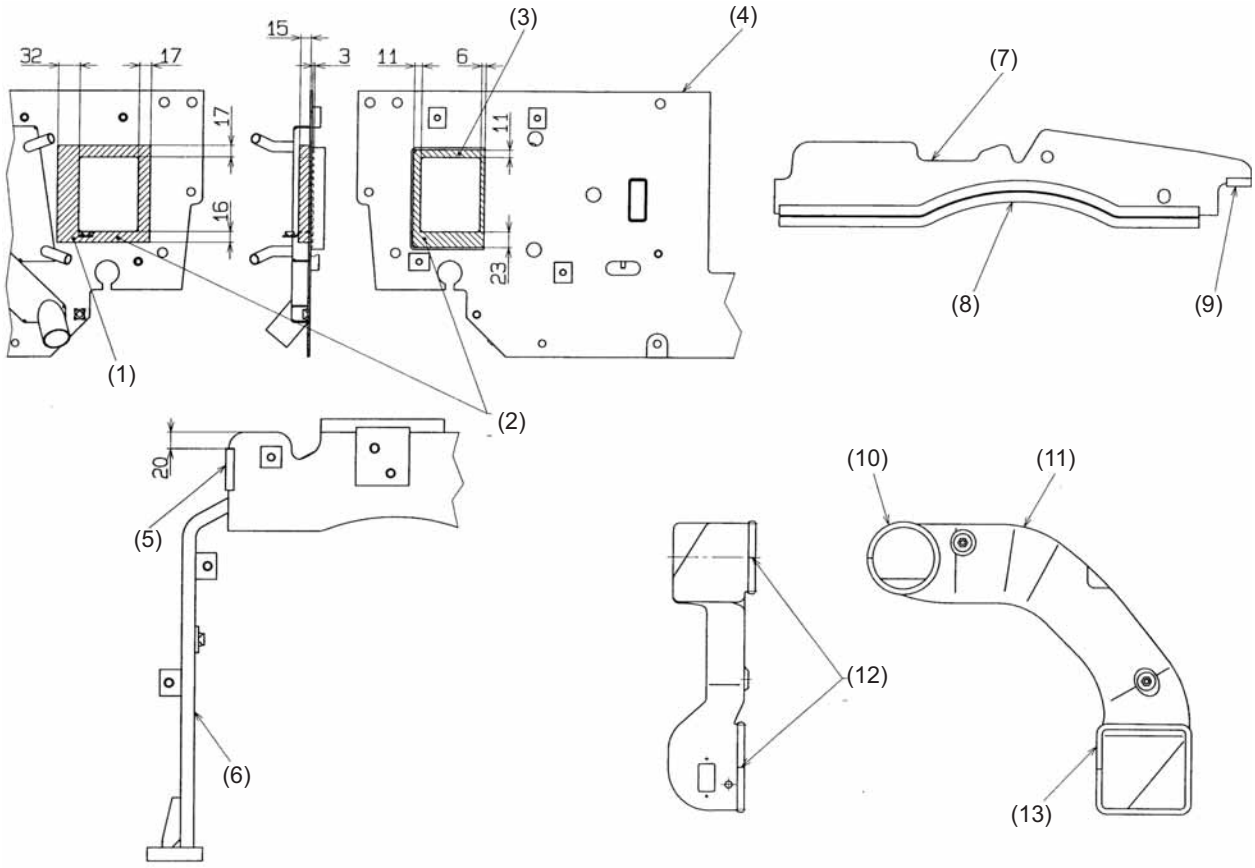
Installing the duct cover

1) Attach the filter cover on the duct cover.
2) Attach the inner filter on the above parts.
3) Connect the defroster hose (700) and temporarily fix the duct cover at the cap A.
4) Attach the outer cover (1) to the cover assembly (R).
5) Attach the duct cover onto the above parts.
   Finally fit all the parts and tighten up the bolts from point A.

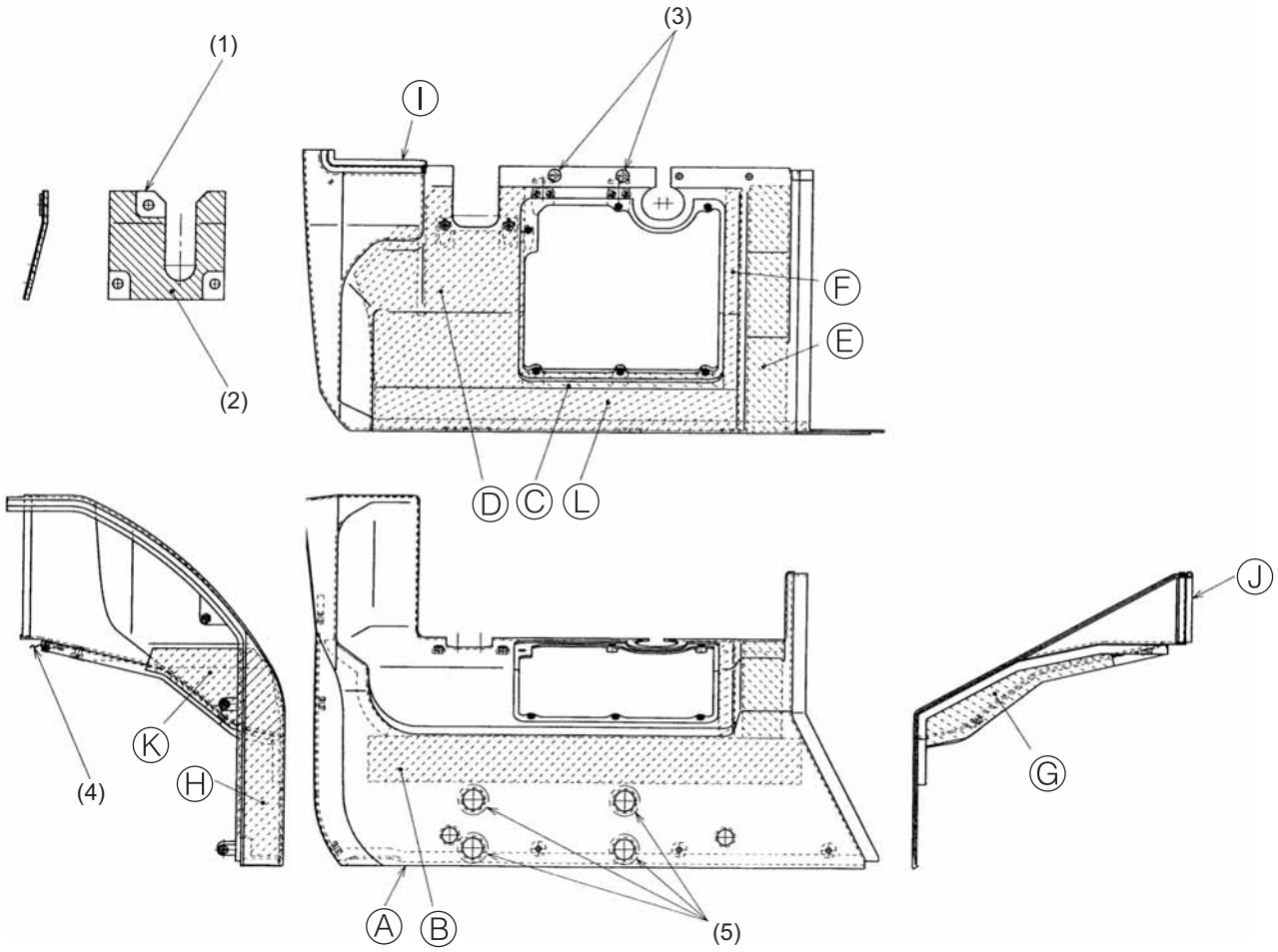


(1) Duct cover: RD118-4721△
(2) Trim: 68311-4238△
(3) Trim, 2 pcs: RC101-5336△
(4) Filter plate, A/C: RD118-4704△
    Bolt: 01125-60816, 2 pcs
(5) Filter cover, A/C: RD118-4707△
(6) Bolt: 01125-60816, 2 pcs
(7) Cover assy, R, A/C: RD118-4705
    Bolt: 01125-60816, 8 pcs
(8) Cover 1: RD118-4731△
    Bolt: 01125-60816, 6 pcs
(10) Bolt: 01125-60816, 2 pcs
(11) Grill 2: RD118-4723△
     Rivet, 4 pcs: RD118-4754△
(12) A-part
(13) Front grill: 3G710-5029△
     Rivet, 4 pcs : RD118-4754△
(14) Grill assy, A/C: 3F760-5605△
(15) Duct assy, A/C: RD118-4740△
(16) Defroster hose, 700: RB419-4928△
(17) Seal: RD118-4725△
(18) Bolt, 2 pcs: 01125-60816

h) Noise Absorber and Trims



(1) Seal 1: RD118-4791△
(2) Align the holes of the sealants with those of the steps.
Be careful not to confuse the applying direction.
(3) Seal 2: RD118-4792△
(4) Step 3, A/C: RD118-4783△
(5) Grommet (50): 68191-4236△
(6) Arch plate: RD118-4121△
(7) Arch plate assy, A/C: RD118-4770△
(8) Trim (515): RD411-4132△
(9) Grommet (30): RP301-4234△
(10) Trim 2-310: RD118-4794△
(11) Duct, A/C: RP118-4749△
(12) Bond together the ends of the trims securely.
(13) Trim (3): Rp821-4237△

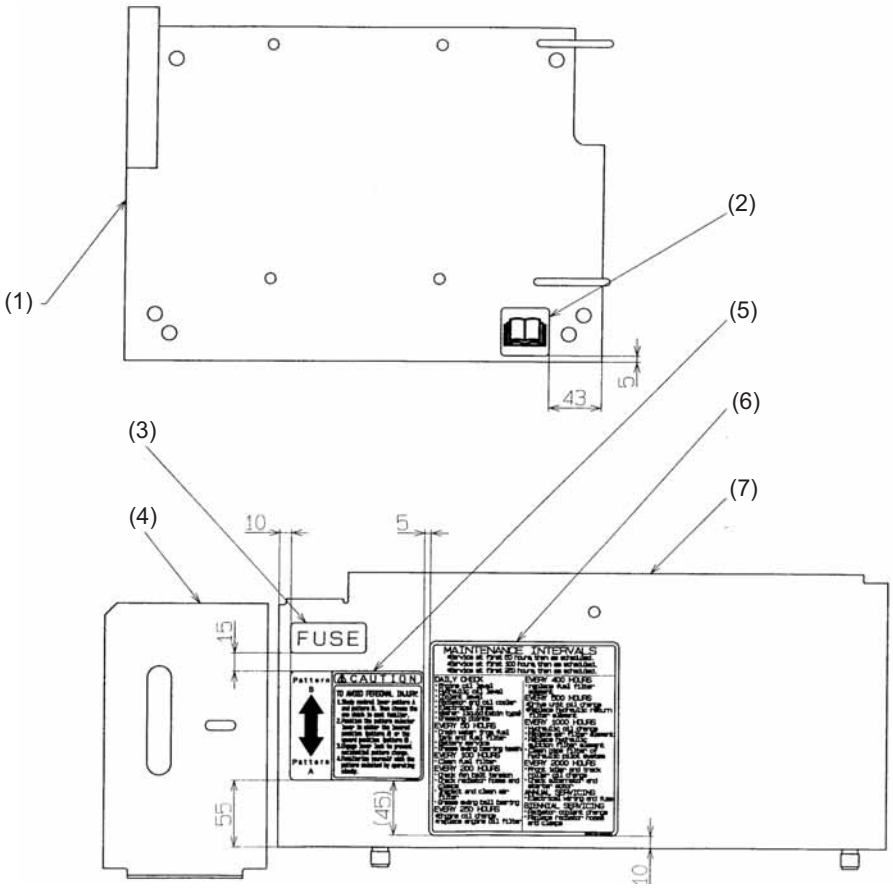


(1) Bonnet cover 2, A/C: RD118-4789△
(2) Heat insulator cover, A/C: RD118-4797△
(3) Label, canopy, 2 pcs: R2401-4525△
(4) Plate spring, A/C, 2 pcs: RD118-4376△
Bolt, 4 pcs: 01125-60816
(5) Label, 4 pcs: RD118-4519△

Ⓐ Bonnet 1, L
Ⓑ Noise absorber 1, Bonnet L
Ⓒ Noise absorber 2, Bonnet L
Ⓓ Noise absorber 3, Bonnet L
Ⓔ Noise absorber 4, Bonnet L
Ⓕ Noise absorber 5, Bonnet L
Ⓖ Noise absorber 6, Bonnet L
Ⓗ Noise absorber 7, Bonnet L
Ⓘ Trim (5)
Ⓙ Trim (6)
Ⓚ Noise absorber 8, Bonnet L
Ⓛ Noise absorber 9, Bonnet L

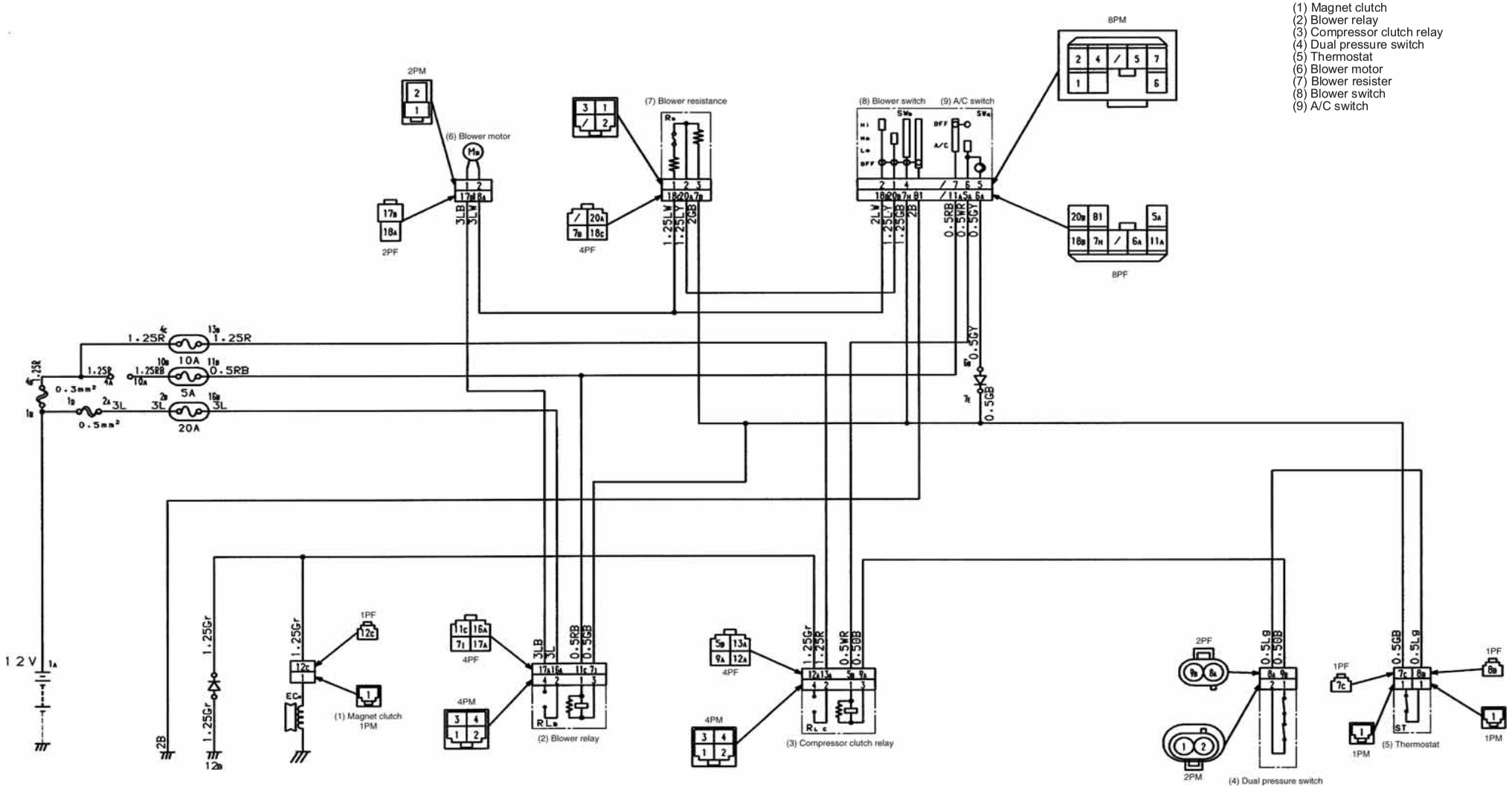
i) Labels

The seat support cover has been redesigned. The name-plate position, accordingly, has also been changed.

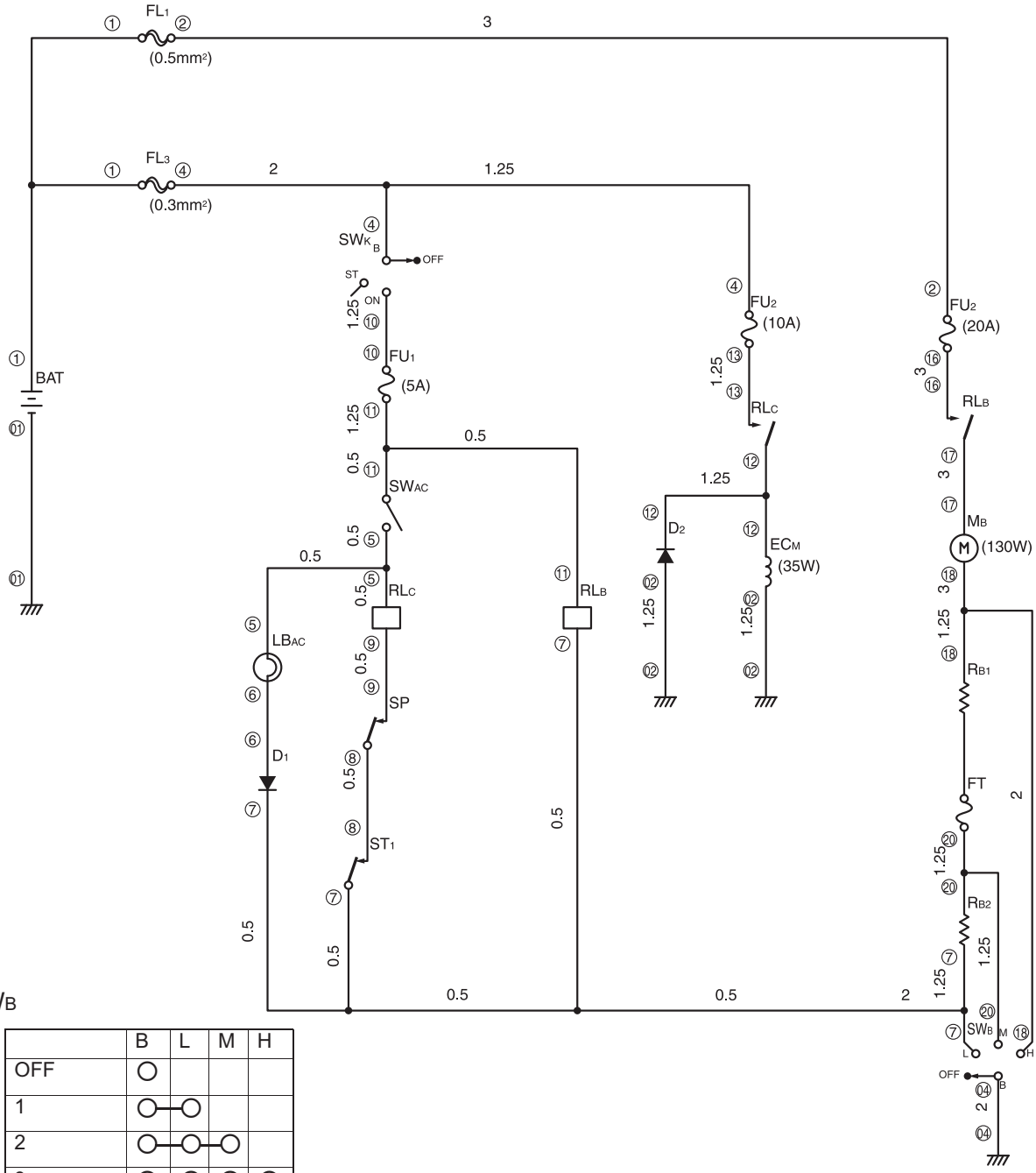


(1) Seat bracket, A/C: RD118-4786△
(2) Label, book: RC418-5783△
(3) Label, fuse: RC418-5781△
(4) TPSS lever bracket: RD118-4796△
(5) Label, caution, control pattern: RC418-5732△
(6) Label, maintenance: RC418-5746△
(7) Seat support cover: RD118-4788△

j) Wire Harness Route



A/C electric circuit diagram (DENSO A/C)



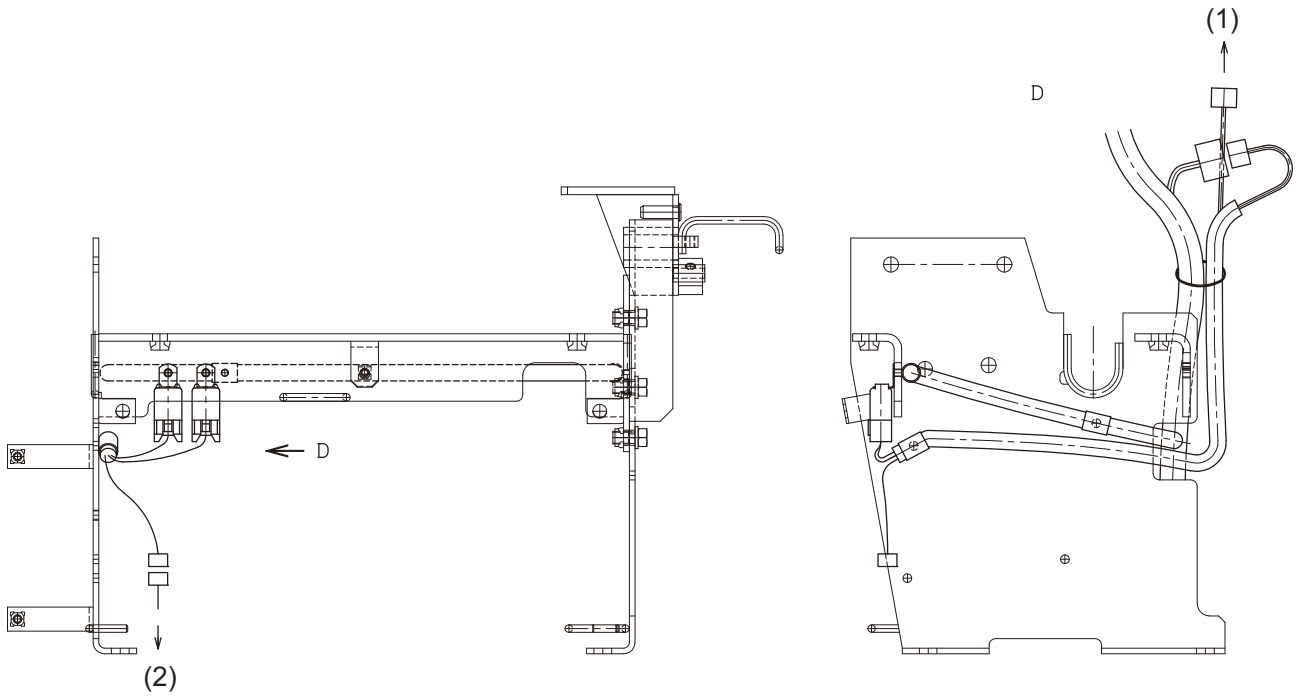
SWB

	B	L	M	H
OFF	○			
1	○	○		
2	○	○	○	
3	○	○	○	○

⑫	1.25	⑨	0.5
⑬	1.25	⑩	1.25
⑭	2	⑪	0.5, 1.25
②	3	⑫	1.245
④	2, 1.25	⑬	1.25
⑤	0.5	⑯	3
⑥	0.5	⑰	3
⑦	0.5, 2, 1.25	⑱	2, 1.25
⑧	0.5	⑳	1.25

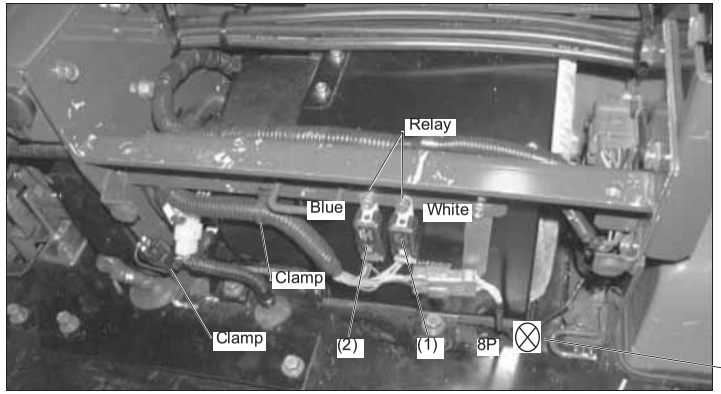
BAT: Battery
D_1: Diode 1
D_2: Diode 2
EC_M: Magnet clutch
FL_1: Fusible link 1
FL_2: Fusible link 2
FT: Resister, thermo fuse
FV_1: Control Fuse
FV_2: Control Fuse
FV_4: Blower Fuse
LB_{AC}: A/C unit lamp

MB: Blower motor
R_{B1}: Blower resister 1
R_{B2}: Blower resister 2
RL_B: Blower relay
RL_C: Compressor clutch relay
SP: Dual pressure switch
ST_1: Thermostat
SW_{AC}: A/C switch
SW_B: Blower switch
SW_K: Main key switch

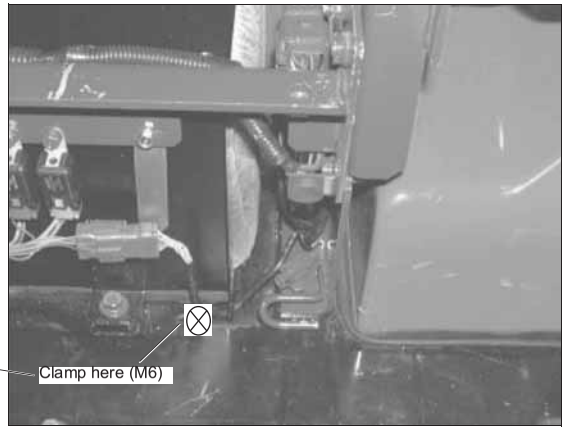


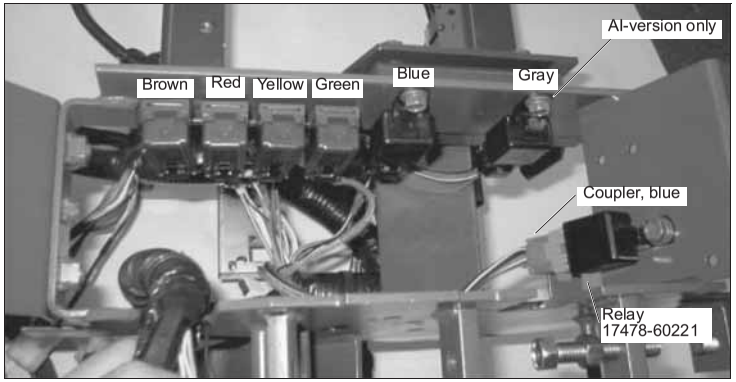
(1) To register
(2) Air-conditioner switch

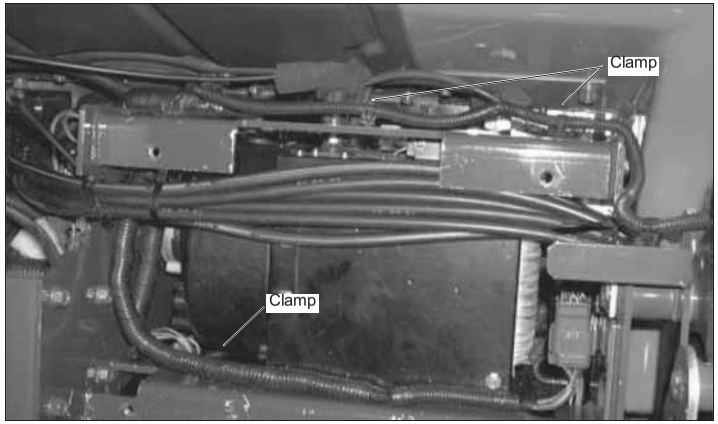
k) Wireharness Clamps for A/C Version

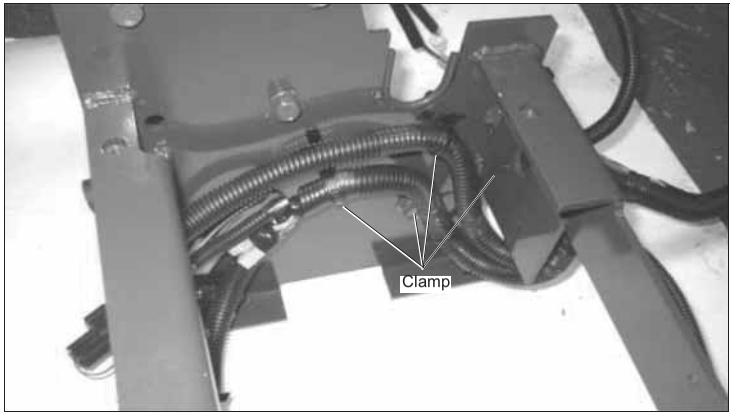


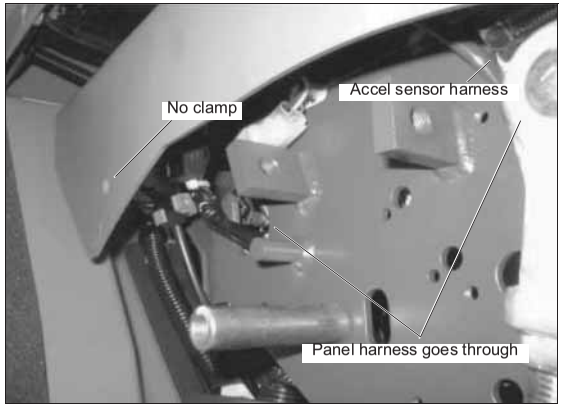
(1) A/C blower relay
(2) Compressor magnet clutch relay (Blue coupler)

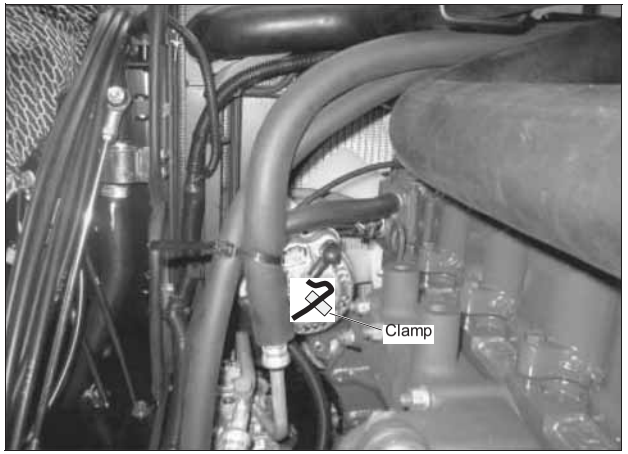


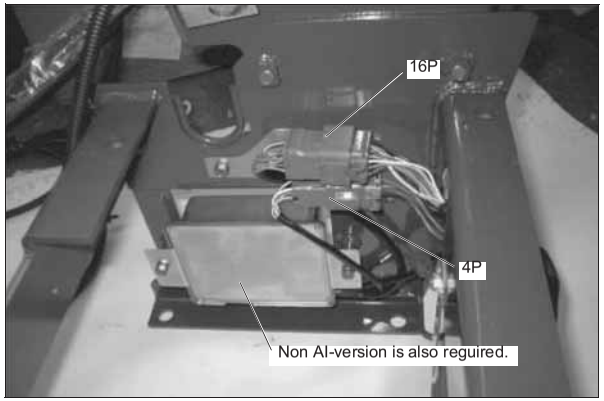


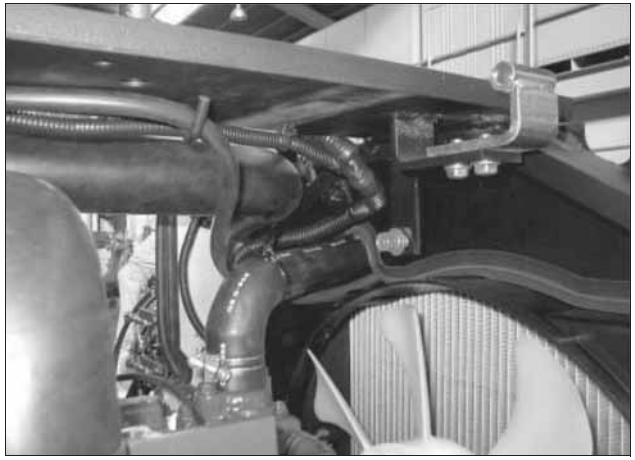


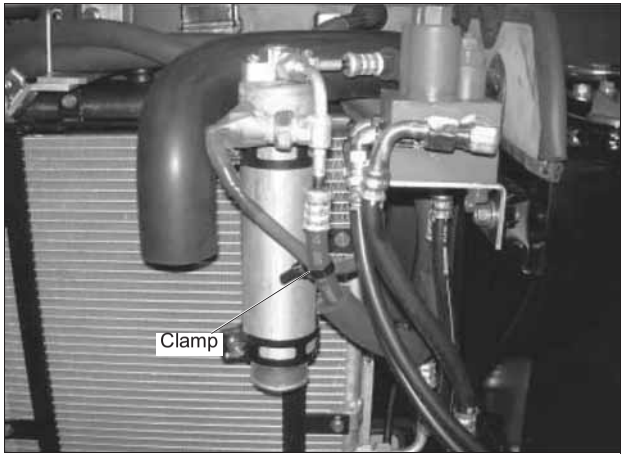



No clamp
Accel sensor harness
Panel harness goes through


Clamp

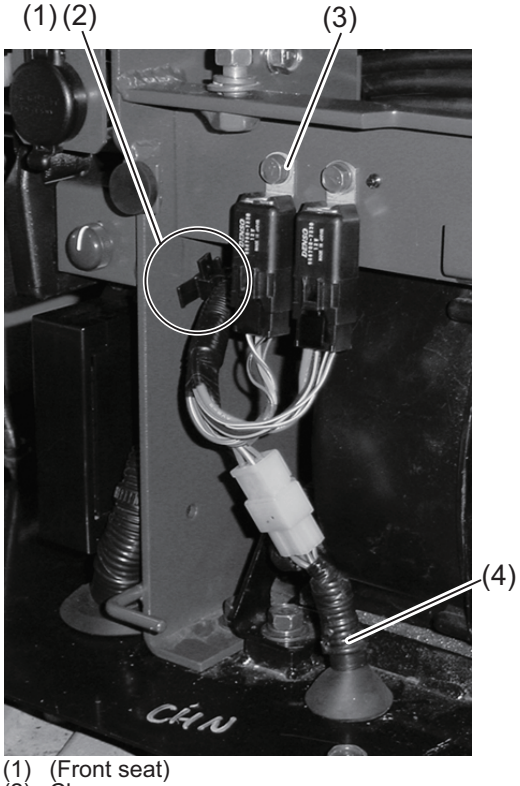

16P
4P
Non AI-version is also reguired.




Clamp

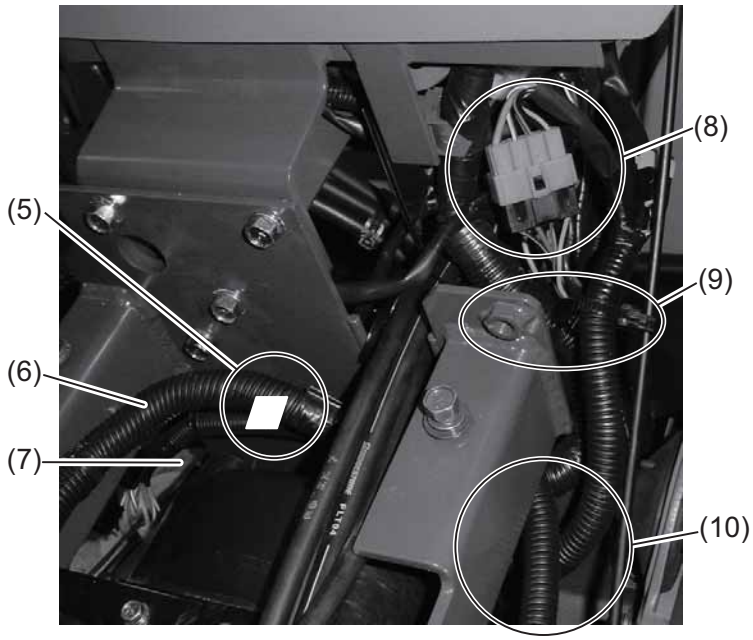
Wireharness route (KX121-3ST)

For the machine with an air conditioner, add the dedicated harness for the air conditioner



(1) (Front seat)
(2) Clamp
(3) Relay T1155-7215Δ*2
Volt 01202-60616
(M6 two spots at the left of screw -the right edge is for back clamp)
(4) Harness (blower)
(RD118-5348Δ)

Instrument panel bottom part

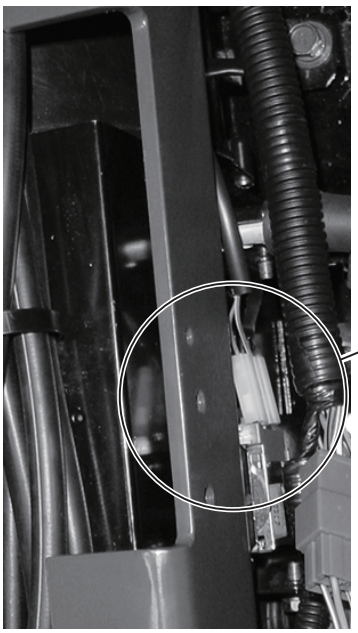


(5) Clamp to the main harness with the cord clamp (white tape part)
(6) Main harness
(7) Harness for the air conditioner (RD431-5348Δ)
(8) Connect the air conditioner harness and the main harness (eight pole coupler)
(9) Clamp the air conditioner harness to the main harness (The clamp is attached on the air conditioner)
(10) Let the additional harness for the air conditioner run under the main harness

Instrument panel bottom part

(11) Connecting spot for the air conditioner and the harness should be inside the right panel

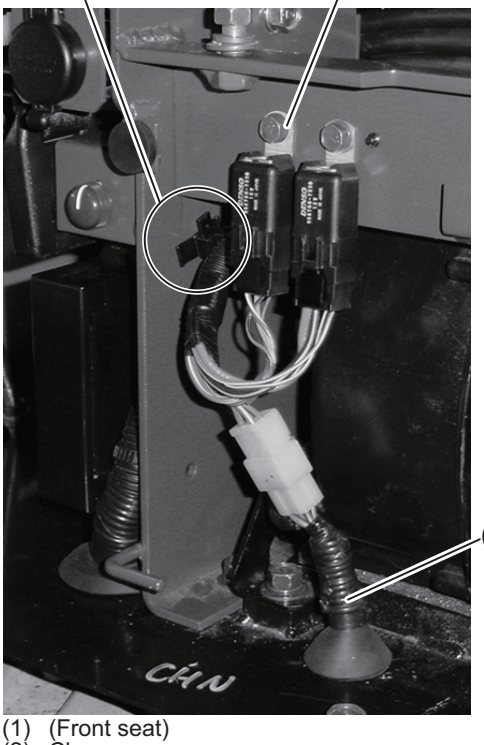
Bottom seat, rear air conditioner



(12) Connect the air conditioner harness and the air conditioner

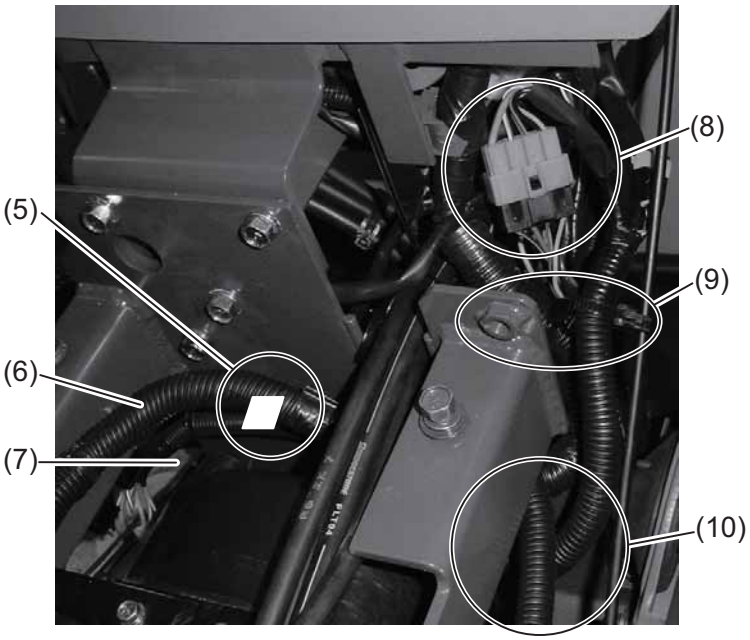
Wireharness route (KX161-3ST)

For the machine with an air conditioner, add the dedicated harness for the air conditioner



(1) (Front seat)
(2) Clamp
(3) Relay T1155-7215Δ*2
Volt 01202-60616
(M6 two spots at the left of screw -the right edge is for back clamp)
(4) Harness (Blower)
(RD118-5348Δ)

Bottom part of instrument panel

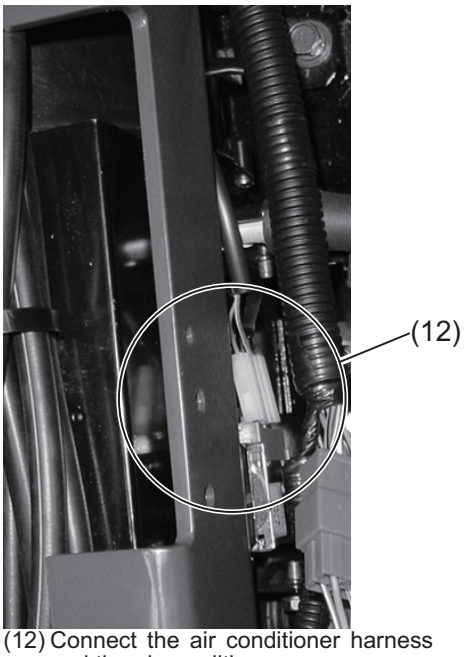


(5) Clamp to the main harness with the cord clamp (white tape part)
(6) Main harness
(7) Harness for the air conditioner (RD431-5348Δ)
(8) Connect the air conditioner harness and the main harness (eight pole coupler)
(9) Clamp the air conditioner harness to the main harness (The clamp is attached on the air conditioner)
(10) Let the additional harness for the air conditioner run under the main harness

Bottom part of instrument panel

(11) Connecting spot for the air conditioner and the harness should be inside the right panel

Bottom seat, rear air conditioner



(12) Connect the air conditioner harness and the air conditioner

I) Parts Identification of Air Conditioner Version

(1) Changes in the engine

Mounting the air-conditioner-specified engine (different types of drive pulley, alternator, etc.)
Engine bracket (1) changed
Heart hose outlet section redesigned

(2) Changes in the radiator and oil cooler

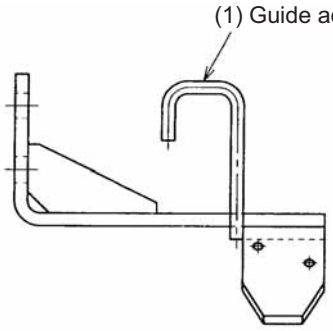
Bracket and support to be replaced . . . . . Condenser impossible to set up

(3) Changes in the frame (arch)

Lock bracket to be replaced . . . . . Condenser impossible to set up

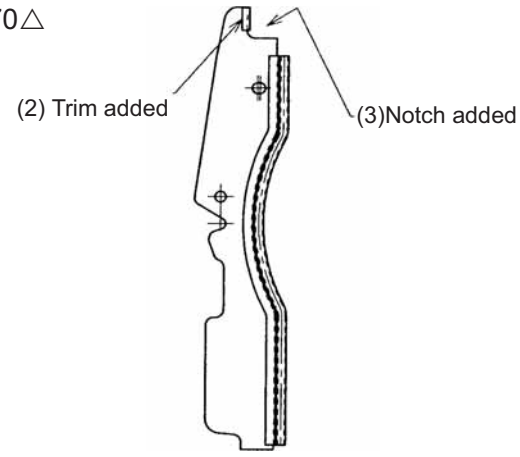
3-1 Lock bracket: RD411-4765△

* The parts shown below will be attached in the same positions as before.



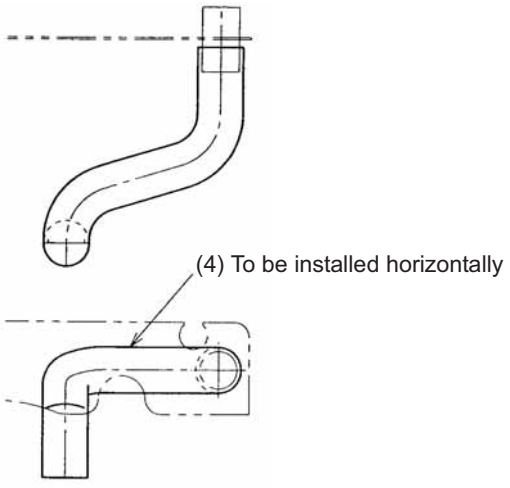
Arch plate assembly to be replaced . . . . . Cooler pipes impossible to connect

3-2 Arch plate assy: RD118-4770△



Inlet hose to be replaced . . . . . Condenser, receiver, etc. impossible to set up

3-3 Inlet hose 3: RD411-4761△



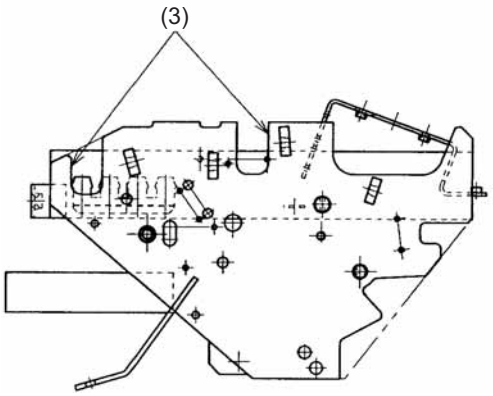
(4) Changes in the steps

Floor parts, except the left step (1)and step support (2), to be replaced
. . . . . A/C unit, duct, duct cover, etc. impossible to set up

(5) Changes in the right-side control

Right control bracket (1) to be replaced. Harness impossible to clamp

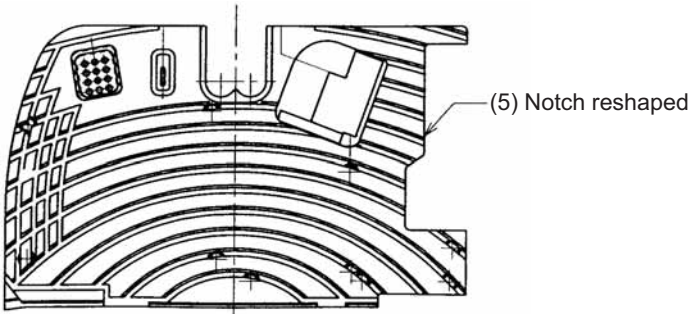
Ⓐ Control bracket 1, R: RD518-4456△



(6) Replacing the rubber mat

To be replaced by the air-conditioner-specific one
. . . . . Duct cover impossible to set up

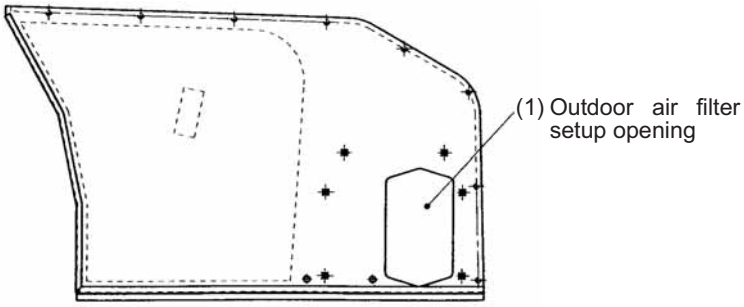
Ⓑ Rubber mat 1: RD118-4973△



(7) Changes in the cabin

Cover assembly (R) to be replaced . . . . . Duct cover impossible to fix

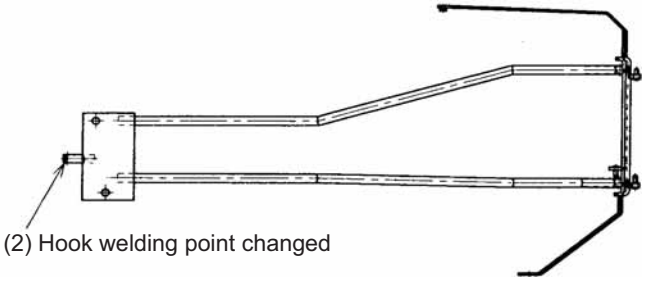
Ⓒ Cover assy, R: RD118-4705△



(8) Replacing the bonnet frame (R)

To be replaced by the air-conditioner-specific one.Right bonnet impossible to lock

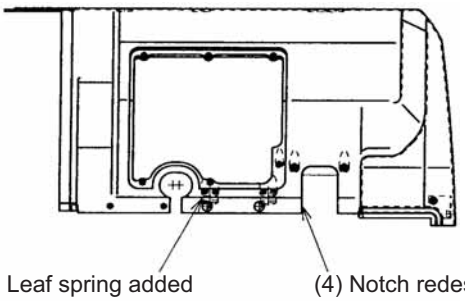
Ⓓ Bonnet frame, R: RD118-4764△



(9) Replacing the left bonnet (1)

To be replaced by the air-conditioner-specific one.Cooler pipes impossible to connect

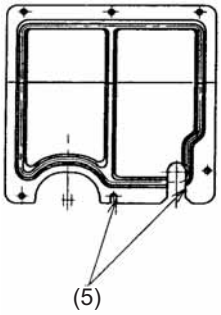
Ⓔ Bonnet assy 1, L: RD118-4780△



(10) Replacing the bonnet cover assembly (1)

To be replaced by the air-conditioner-specific one.Heater hose impossible to connect

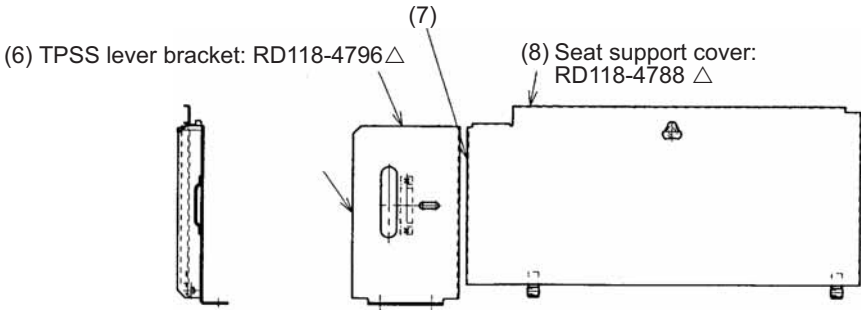
Ⓕ Bonnet cover assy 1: RD118-4771△



(11) Replacing the seat support cover

To be replaced by the air-conditioner-specific one.Cover impossible to open and close

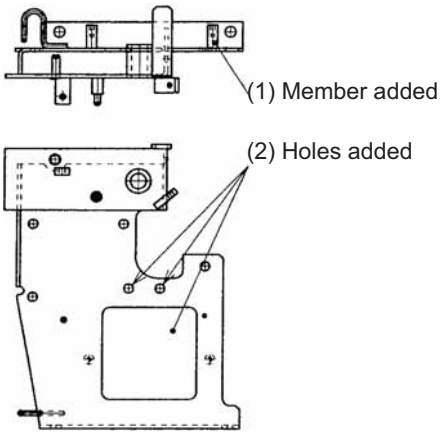
Ⓖ



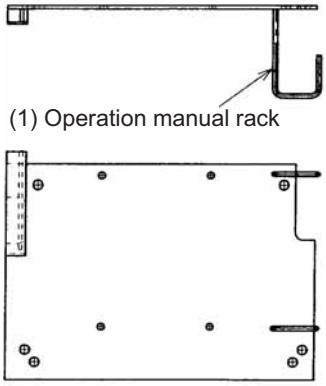
(12) Replacing the seat mount parts

Seat support (L), seat support (R) and seat bracket to be replaced
. . . . . A/C unit impossible to set up
Operation manual impossible to put in

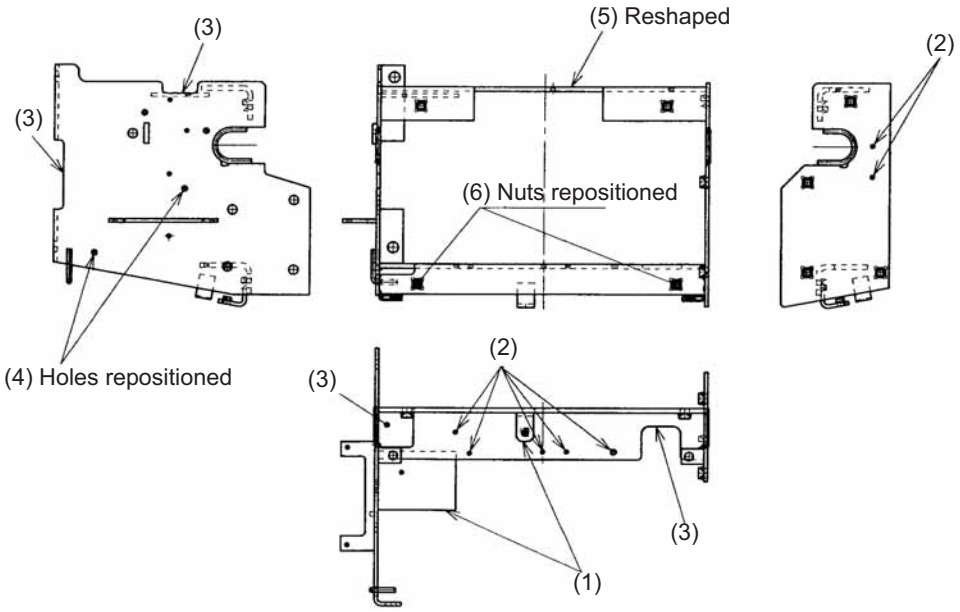
Ⓗ Seat support, L: RD118-4784△



Ⓗ Seat bracket: RD118-4786△



Ⓗ Seat support, R: RD118-4785△



(13) Replacing the wire harness

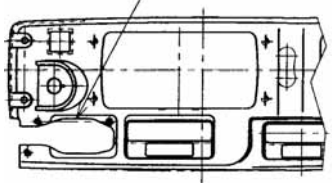
Main wire harness (engine) to be replaced . A/C and related components impossible to start

(14) Replacing the upper cover (R)

Upper cover (R) to be replaced . . . . . A/C-related switches impossible to set up

Ⓘ Upper cover, R: RD118-4761△

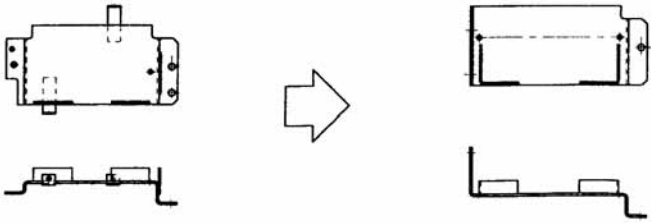
(7) Notch, hole, etc. added



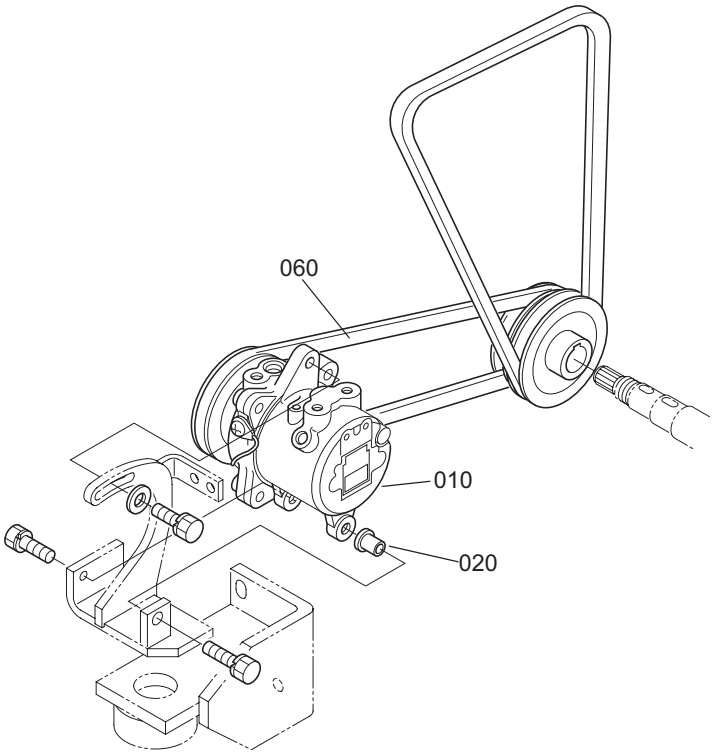
(15) Replacing the battery-related parts (Only for the KX121-3US without AI (Type: 95D31R --> 80D26R))

Battery bracket to be replaced. . . . . Battery impossible to set up

Ⓙ Battery bracket: Rd118-5329△:RD411-5329△

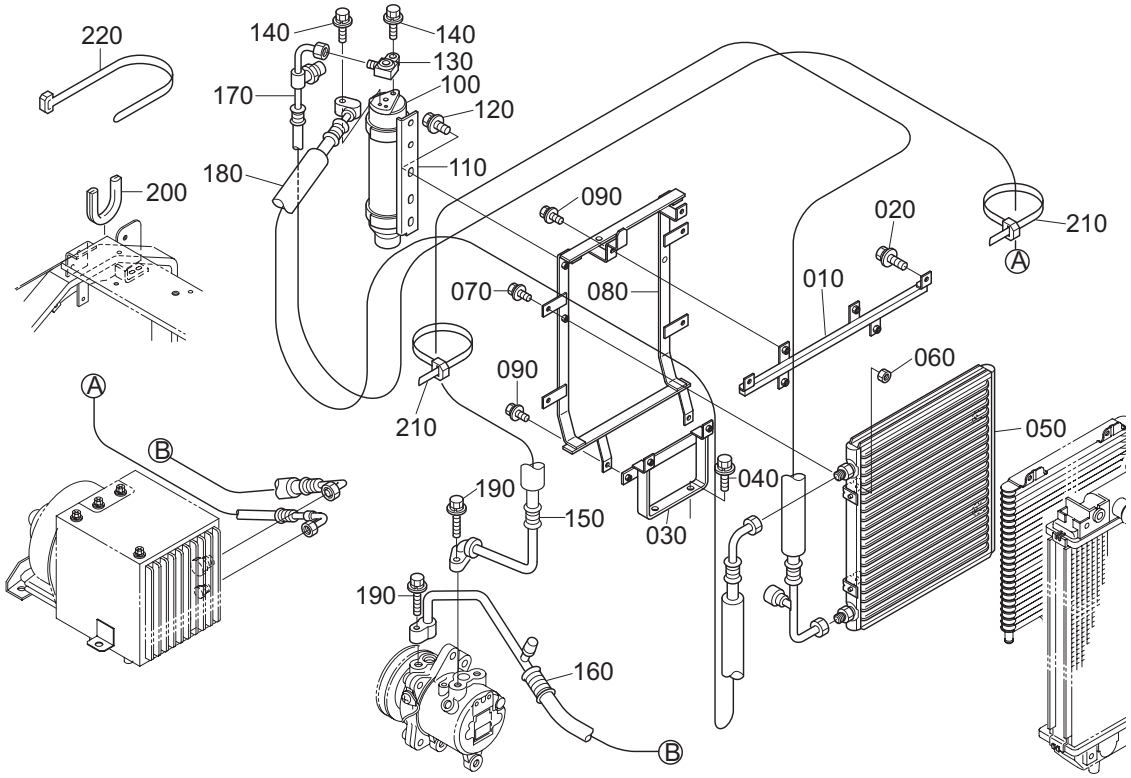


(16) Compressor



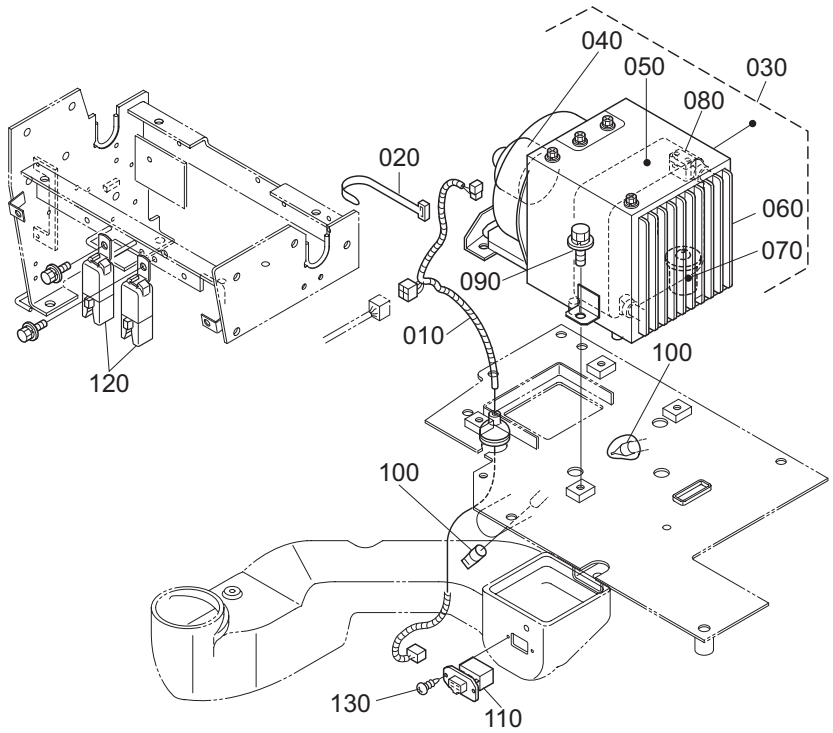
010: Compressor 020: Bush 060: V-belt

(17) Receiver and condenser



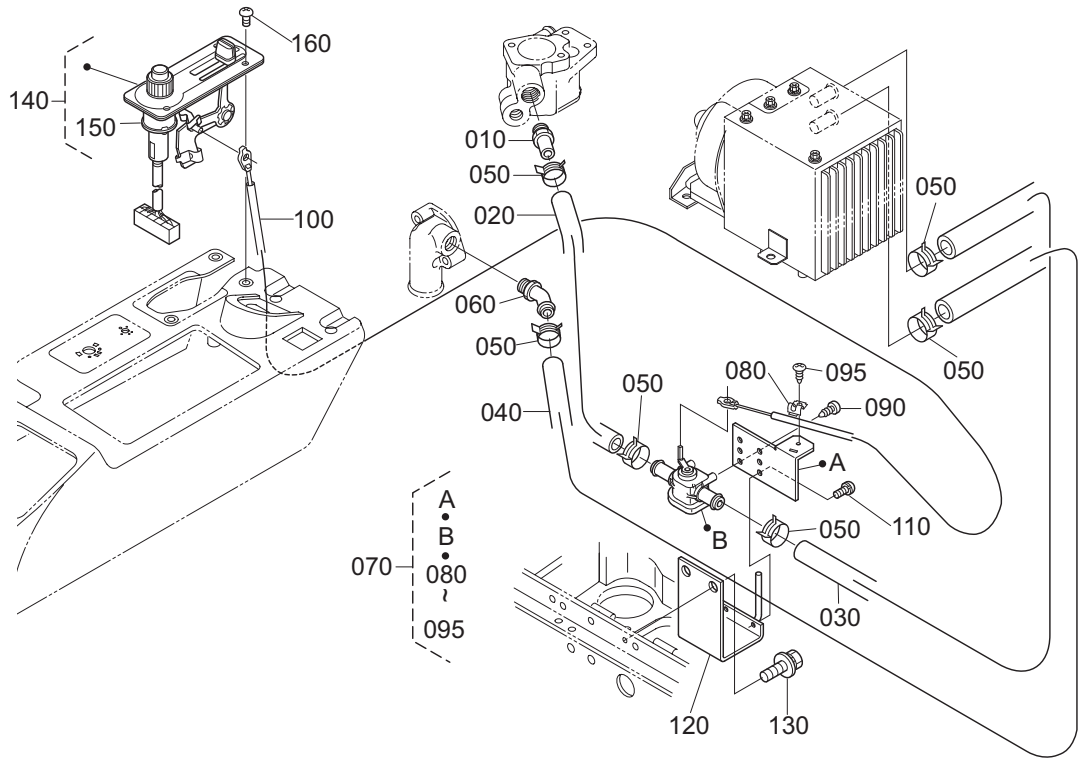
050: Condenser
100: Receiver
130: Sight glass

(18) Air conditioner unit



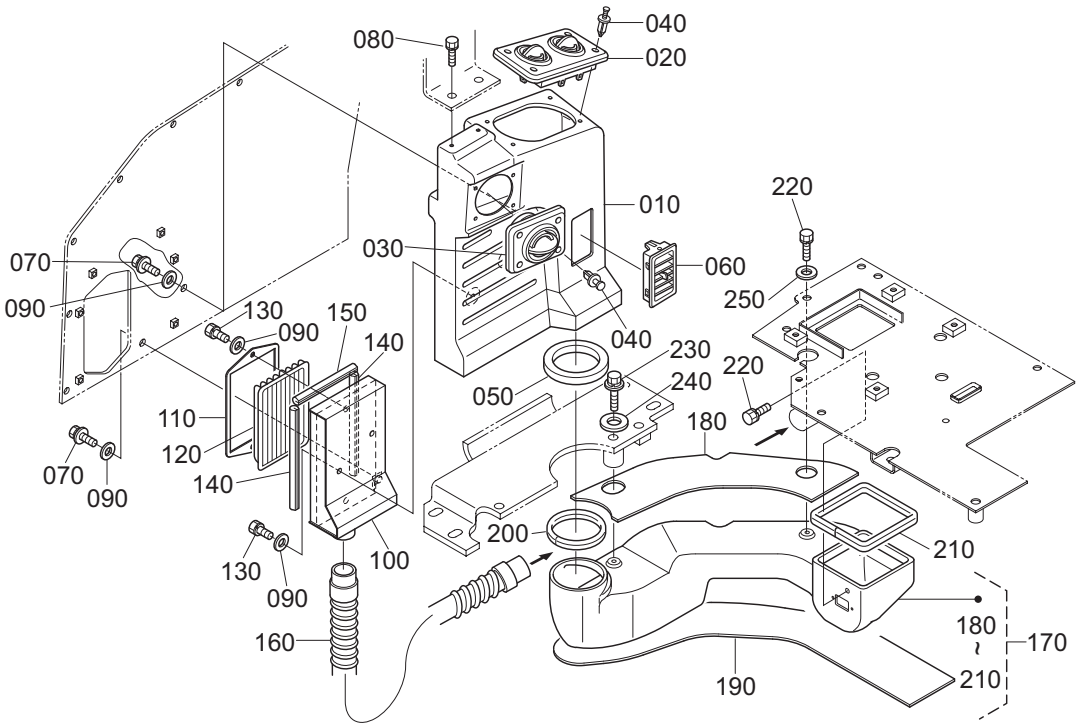
010: Wire harness
030: A/C unit assy
040: Blower
070: Expansion valve
080: Thermostat
110: Blower resistor
120: Relay

(19) A/C switch and heater valve

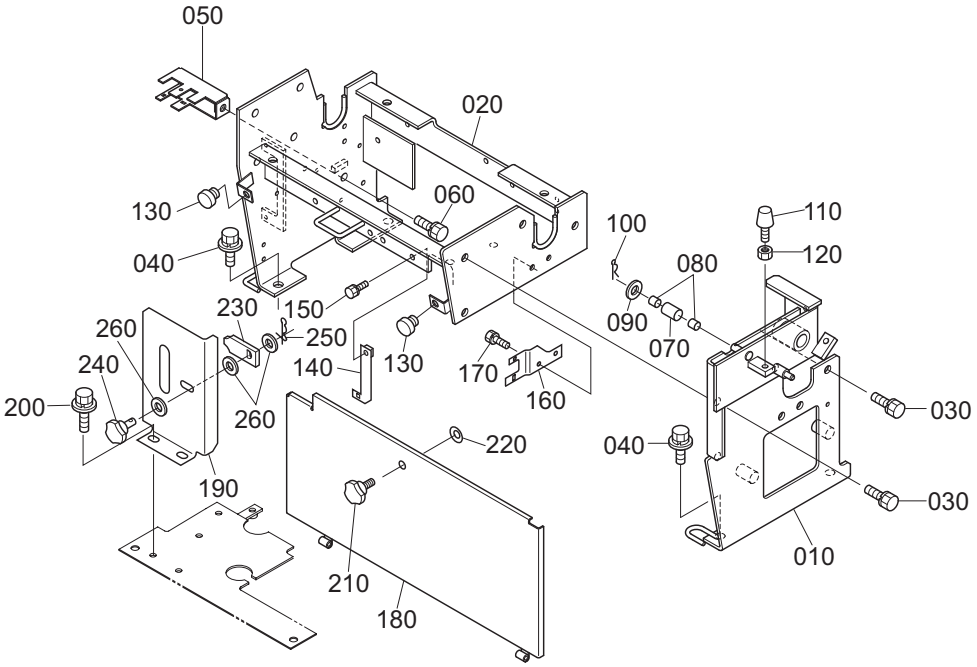


100: Cable
140: A/C switch assy
B: Hot water valve

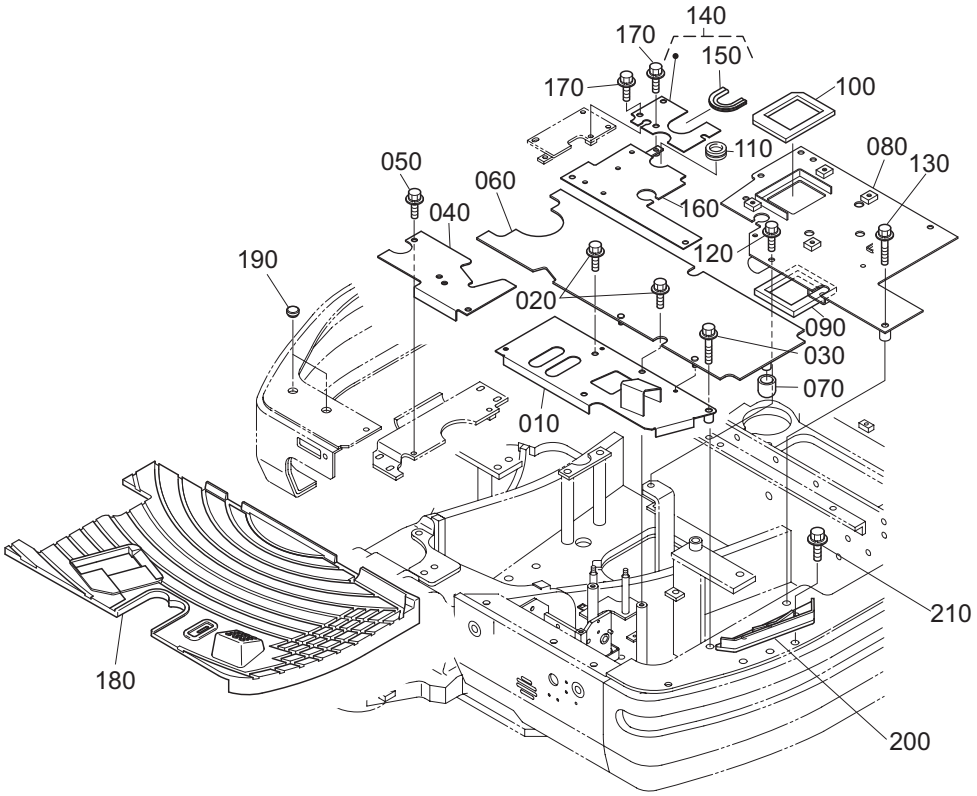
(20) Duct



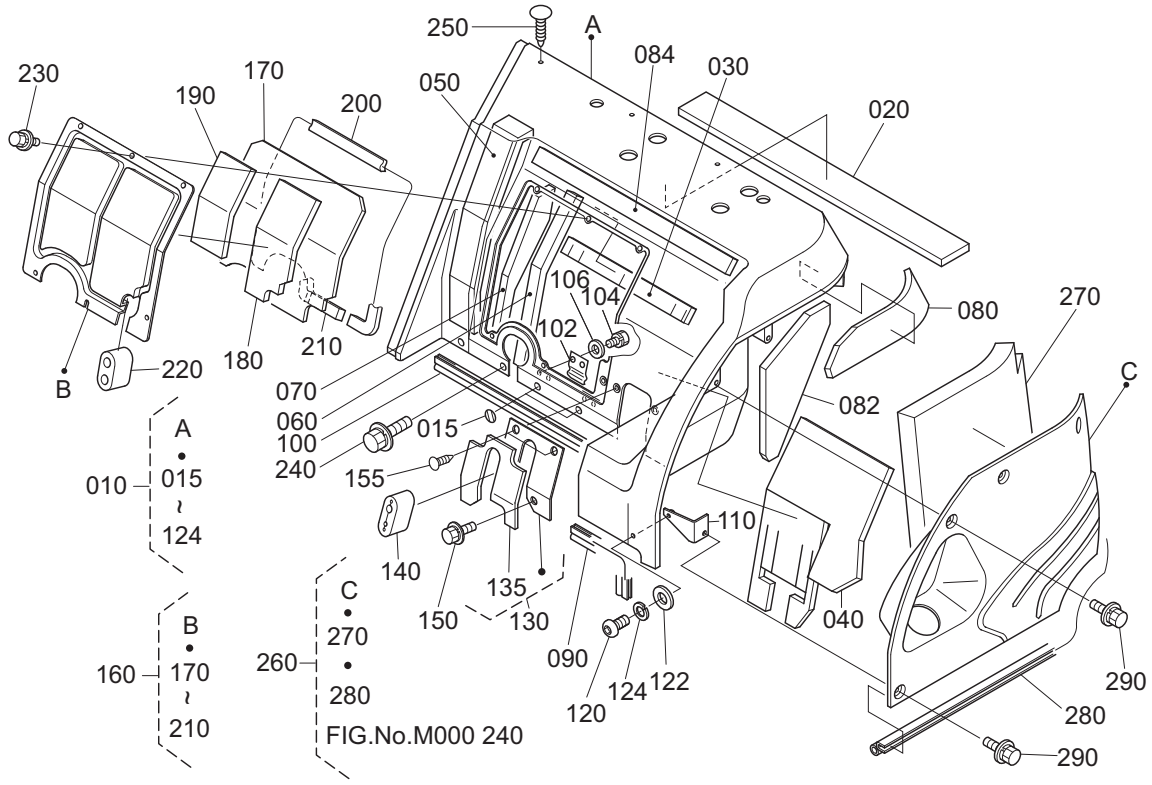
(21) Seat support



(22) Step plate



(23) Bonnet, left



VII. OPTIONAL UNIT: ANGLE BLADE

(A) EXTERIOR VIEW VII-S-3
(B) MACHINE SPECIFICATIONS VII-S-5
(C) QUALITY SPECIFICATIONS. VII-S-7
a) KX121-3ST, 161-3ST, U45ST: KTC Version (Angle Blade) VII-S-7
(D) LUBRICATION POINT OF ANGLE BLADE. VII-S-9
(E) DOZER LEVER VII-S-11
a) Angle Blade Operation VII-S-11
b) Grease Lubrication VII-S-12
c) Control Linkage VII-S-13
d) Label VII-S-16
(F) CONTROL VALVE. VII-S-17
a) Angle Section VII-S-17
b) Dozer section VII-S-18
c) Dozer Float Function VII-S-19
d) General View of Control Valve VII-S-21
e) Control Valve Circuit Diagram VII-S-22
f) Adaptor Installation VII-S-24
(G) ROTARY JOINT. VII-S-25
(H) UNDER CARRIAGE VII-S-29
(I) HYDRAULIC CIRCUIT DIAGRAM. VII-S-31
a) KX121-3S/ST Hydraulic Circuit Diagram (Angle blade) VII-S-31
b) KX161-3S/ST Hydraulic Circuit Diagram (Angle blade) VII-S-32
c) U45S/ST Hydraulic Circuit Diagram (Angle blade) VII-S-33

(A) EXTERIOR VIEW

(B) MACHINE SPECIFICATIONS

				KUBOTA EXCAVATOR									
Model name				KX121-3S				KX161-3S				U45S	
Type				Canopy	CAB	Angle Blade Type		Canopy	CAB	Angle Blade Type		Angle Blade Type	
						Canopy	CAB			Canopy	CAB	Canopy	CAB
Operating weight (including operator's)			kg (lbs.)	4110 (9063)	4200 (9261)	4280 (9437)	4370 (9636)	5230 (11530)	5305 (11695)	5425 (11960)	5500 (12125)	5200 (11464)	5275 (11629)
Engine	Type			Water cooled 4 cycle diesel engine with 4 cylinder									
	Model name			V2203-M-E3-BH-US1 (No air conditioner type) V2203-M-E3-BH-US2 (Air conditioner type)				V2403-M-E3-BH-US1 (No air conditioner type) V2403-M-E3-BH-US2 (Air conditioner type)				V2203-M-E3-BH-US1 (No air conditioner type) V2203-M-E3-BH-US3 (Air conditioner type)	
	Total displacement		cc (cu.in)	2197 (134.1)				2434 (148.5)				2197 (134.1)	
	Engine power SAE J1955 gross		kW (Hp)	30.2 (40.5)				34.3 (46.0)				30.2 (40.5)	
	Rated speed		rpm	2250				2300				2250	
Performance	Unit swing speed		rpm	9.4				9.3				9.1	
	Travel speed	Fast	km/h (mph)	5.0 (3.1)				4.6 (2.9)				4.5 (2.8)	
		Slow	km/h (mph)	2.7 (1.7)				2.5 (1.6)				2.4 (1.5)	
	Ground pressure (With operator)		kPa (kgf/cm²) [psi]	30.8 (0.31) [4.46]	31.4 (0.32) [4.55]	32 (0.33) [4.64]	32.7 (0.33) [4.74]	29.3 (0.30) [4.25]	29.8 (0.30) [4.32]	30.7 (0.31) [4.45]	31.1 (0.32) [4.51]	29.3 (0.30) [4.25]	30.7 (0.31) [4.45]
	Climbing angle		% (deg)	*36 (20)									
	Angle in case of crossing slope		% (deg)	*27 (15)									
Dozer	Width x Height		mm (in.)	1700 x 350 (66.9 x 13.8)		1700 x 385 (66.9 x 15.2)		1960 x 390 (77.2 x 15.4)				1960 x 390 (77.2 x 15.4)	
	Max swing	Left	deg	---		25	25	---		25	25	25	
		Righ	deg	---		25	25	---		25	25	25	
Boom swing angle		Left	rad (deg)	1.40 (80)									
		Righ	rad (deg)	0.87 (50)									
Pressure connection for attachments	Max. displacement (Theoretical)		L (US gal) / min	60.0 (15.9)				73 (19.3)				73 (19.3)	
	Max. pressure		Mpa (kgf/cm²) [psi]	24.5 (250) [3550]				23.5 (240) [3410]				23.5 (240) [3410]	
Fuel tank capacity			L (US gal)	64 (16.9)				70 (18.5)				70 (18.5)	

NOTE :

- Above dimensions are based on the machine with rubber trucks.
- Specifications subject to change without notice.

* With unloaded digging bucket.
* Firm compacted soil.
* Operators must exercise extra caution and follow instructions in the operator's manual.
* Worse condition or heavier attachment to the above will decrease climbing angle.

(C) QUALITY SPECIFICATIONS

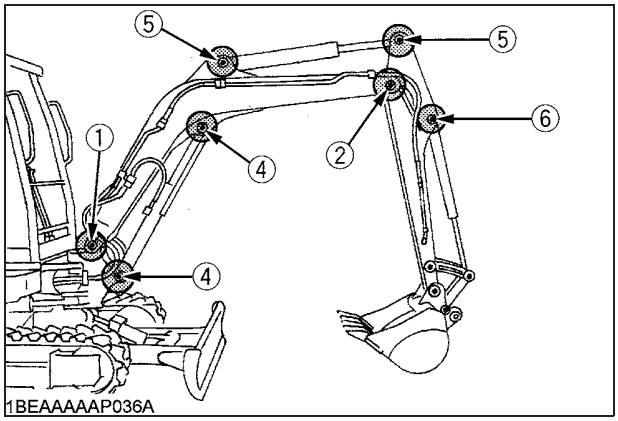
a) KX121-3ST, 161-3ST, U45ST: KTC Version (Angle Blade)

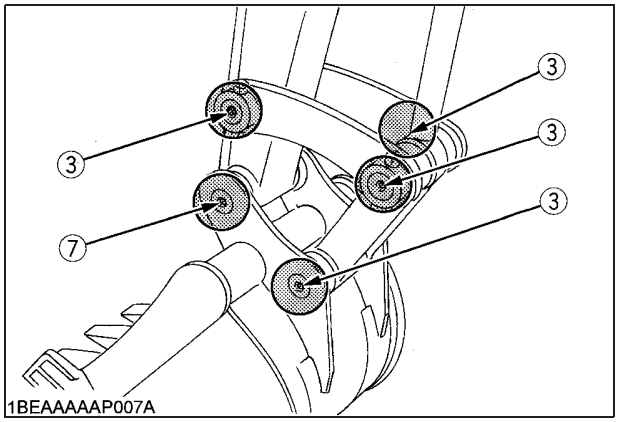
Machine specification: Service port, TPSS, Arm rest, Long arm, 4-Post canopy, KTC-bucket

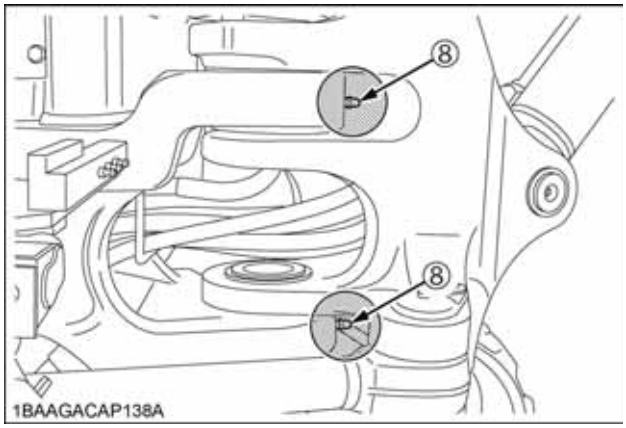
No		Specifications Items			Unit	KX121-3ST	KX161-3ST	U45ST	KX080-3 AB	Remarks
Q1		Main Speed JIS A8404								
2	1	Weight	Machine weight (Canopy)		kg	4200 ± 84	5340 ± 107	5200 ± 107	8550 ± 171	Fuel tank: full, lub, oil, coolant
					lbs	9259 ± 185	11773 ± 236	11464 ± 236	18849 ± 377	
	2		Machine weight (Cabin)		kg	4265 ± 85	5415 ± 108	5275 ± 107	8600 ± 172	
					lbs	9403 ± 187	11938 ± 238	11629 ± 236	18960 ± 379	
6	1	Blade	Width		mm	1700 ± 5	1960 ± 5	1960 ± 5	2200 ± 5	
					inch	66.9 ± 0.2	77.2 ± 0.2	77.2 ± 0.2	86.6 ± 0.2	
	2		Height		mm	385 ± 10	385 ± 10	385 ± 10	510 ± 10	
					inch	15.2 ± 0.4	15.2 ± 0.4	15.2 ± 0.4	20.1 ± 0.4	
	3		Max. lift above GL		mm	425 ± 50	460 ± 50	460 ± 50	580 ± 50	
					inch	16.7 ± 2.0	18.1 ± 2.0	18.1 ± 2.0	22.8 ± 2.0	
	4		Max. below GL		mm	500 ± 50	480 ± 50	480 ± 50	620 ± 50	
					inch	19.7 ± 2.0	18.9 ± 2.0	18.9 ± 2.0	24.4 ± 2.0	
	5	Blade swing angle	Left		deg.	25 ± 5	25 ± 5	25 ± 5	25 ± 5	
	6		Right		deg.	25 ± 5	25 ± 5	25 ± 5	25 ± 5	
Q2		Main Specs JIS A8404								
1	3	Declination of blade			mm	10 ,≦ 10	←	←	←	
					inch	0.39 ,≦ 0.39	←	←	←	
3	1	Blade approach angle			deg.	26 ± 3	←	←	28 ± 3	
Q5		Work performance								
5	1	Blade speed		up (G→T)	sec.	1.3 ± 0.3	1.5 ± 0.3	1.5 ± 0.3		Ground to max. up
	2			up (L→T)	sec.	2.6 ± 0.3	3.1 ± 0.3	3.1 ± 0.3	2.3 ± 0.3	Max. down to max. up
	3			down (T→G)	sec.	1.5 ± 0.3	1.3 ± 0.3	1.3 ± 0.3		Max. up to ground
	4			down (T→L)	sec.	3.4 ± 0.3	2.8 ± 0.3	2.8 ± 0.3	3.0 ± 0.3	Max. up to max. down
8	1	Angle speed		Left	sec.	1.6 ± 0.3	2.0 ± 0.3	2.0 ± 0.3	2.2 ± 0.3	Side end to side end
				Right	sec.	1.8 ± 0.3	2.1 ± 0.3	2.1 ± 0.3	2.2 ± 0.3	
Q7		Hydraulic performance								
2	5	Cylinder oil sealing capacity	Blade	50±5°C (122±9°F)	mm	20 ,≦ 20				Arm: vertical to GL, Blade: Max.down, Eng. stop: 10min.
					inch	0.79 ,≦ 0.79				

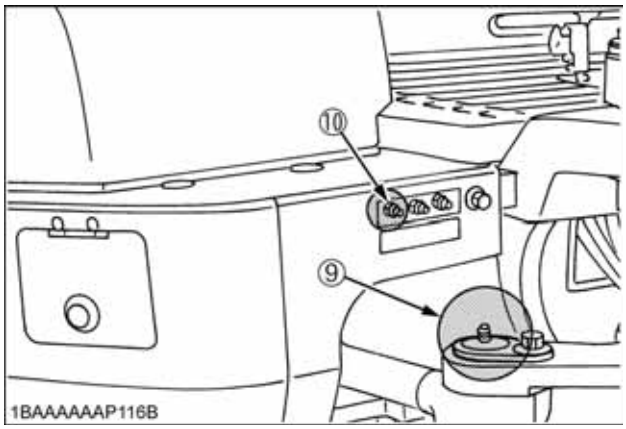
No		Specifications Items		Unit	KX121-3ST	KX161-3ST	U45ST	KX080-3 AB	Remarks
Q8		Lever operating force & stroke							
1	9	Blade lever operating force	up	kgf	2.5 ± 0.5	2.9 ± 0.5	2.9 ± 0.5	2.2 ± 0.5	Measurement point: Below 15mm(0.6in.) from top of lever grip
				N	24.5 ± 4.9	28.4 ± 4.9	28.4 ± 4.9	22.0 ± 5	
				lbf	5.5 ± 1.1	6.4 ± 1.1	6.4 ± 1.1	4.9 ± 1.1	
	10		down	kgf	2.5 ± 0.5	2.9 ± 0.5	2.9 ± 0.5	2.9 ± 0.5	
				N	24.5 ± 4.9	28.4 ± 4.9	28.4 ± 4.9	28.0 ± 5	
				lbf	5.5 ± 1.1	6.4 ± 1.1	6.4 ± 1.1	6.4 ± 1.1	
	11		Float on	kgf	10.0 ± 0.5	10.0 ± 0.5	10.0 ± 0.5	10.0 ± 0.5	
				N	98.1 ± 4.9	98.1 ± 4.9	98.1 ± 4.9	98.0 ± 5	
				lbf	22.0 ± 1.1	22.0 ± 1.1	22.0 ± 1.1	22.0 ± 1.1	
			Float off	kgf	4.0 ± 1.0	4.0 ± 1.0	4.0 ± 1.0	2.1 ± 0.5	
				N	39.2 ± 9.8	39.2 ± 9.8	39.2 ± 9.8	21.0 ± 5	
				lbf	8.8 ± 2.2	8.8 ± 2.2	8.8 ± 2.2	4.6 ± 1.1	
	24	Blade angle lever operating force	Left	kgf	4.5 ± 0.5	4.8 ± 0.5	4.8 ± 0.5	2.6 ± 0.5	
				N	44.1 ± 4.9	47.1 ± 4.9	47.1 ± 4.9	25.0 ± 5	
				lbf	9.9 ± 1.1	10.6 ± 1.1	10.6 ± 1.1	5.7 ± 1.1	
	25		Right	kgf	4.5 ± 0.5	4.8 ± 0.5	4.8 ± 0.5	2.6 ± 0.5	
				N	44.1 ± 4.9	47.1 ± 4.9	47.1 ± 4.9	25.0 ± 5	
				lbf	9.9 ± 1.1	10.6 ± 1.1	10.6 ± 1.1	5.7 ± 1.1	
2	9	Blade lever stroke	up	mm	50 ± 15	70 ± 15	70 ± 15	60 ± 10	Measurement point: top of lever grip Exclude lever idle
				inch	2.0 ± 0.6	2.8 ± 0.6	2.8 ± 0.6	2.4 ± 0.4	
	10		down	mm	50 ± 15	65 ± 15	65 ± 15	60 ± 10	
				inch	2.0 ± 0.6	2.6 ± 0.6	2.6 ± 0.6	2.4 ± 0.4	
	11		Float	mm	100 ± 15	120 ± 15	120 ± 15	95 ± 15	
				inch	3.9 ± 0.6	4.7 ± 0.6	4.7 ± 0.6	3.7 ± 0.6	
	15	Angle lever stroke	Left	mm	35 ± 10	35 ± 10	35 ± 10	35 ± 10	
				inch	1.4 ± 0.4	1.4 ± 0.4	1.4 ± 0.4	1.4 ± 0.4	
	16		Right	mm	35 ± 10	35 ± 10	35 ± 10	35 ± 10	
				inch	1.4 ± 0.4	1.4 ± 0.4	1.4 ± 0.4	1.4 ± 0.4	

(D) LUBRICATION POINT OF ANGLE BLADE









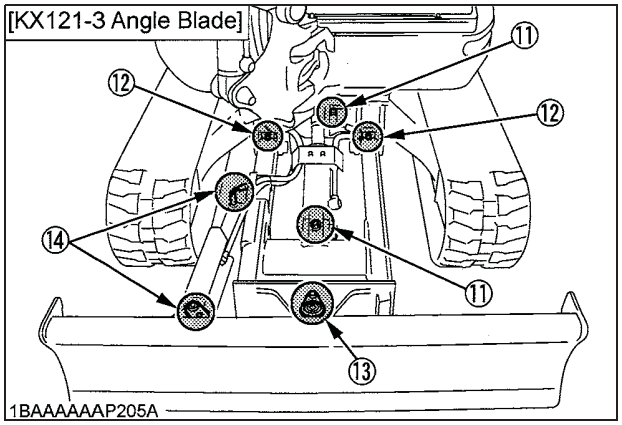
⚠ CAUTION

To avoid personal injury:

- **First lower all attachments to the ground then stop the engine and remove the key.**
- **While greasing, take caution not to step on the bucket teeth.**
- **When doing excavation work in water, generously grease the following points. After ending work, grease again.**

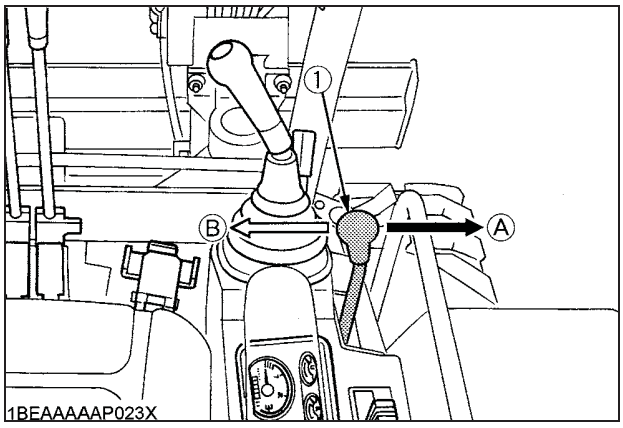
Grease the marked grease nipples shown by arrows in the illustration below.

1. Boom bottom linkage . . . . . 1 place
2. Arm bottom linkage . . . . . 1 place
3. Bucket link pin . . . . . 4 place
4. Boom cylinder boss . . . . . 2 place
5. Arm cylinder boss . . . . . 2 place
6. Bucket cylinder boss . . . . . 1 place
7. Fixing pin between arm and bucket . . . . . 1 place
8. Boom swing fulcrum . . . . . 2 place
9. Swing cylinder boss . . . . . 1 place
10. Swing cylinder pin . . . . . 1 place
11. Dozer cylinder boss . . . . . 2 place
12. Dozer linkage pin . . . . . 2 place
13. Angle pin . . . . . 1 place
14. Angle cylinder boss . . . . . 2 place

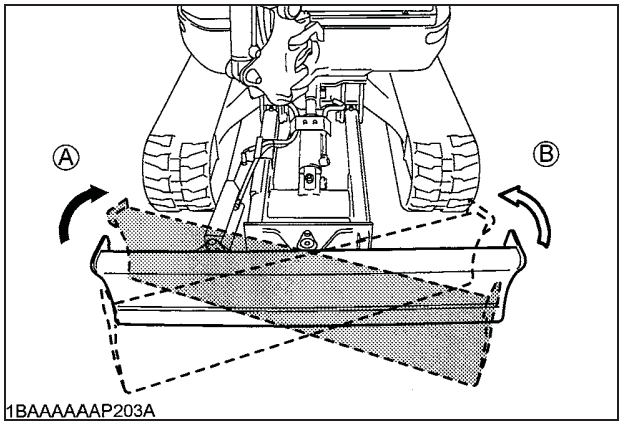


(E) DOZER LEVER

a) Angle Blade Operation



(1) Control lever for dozer
(A) Turn the left
(B) Turn the right

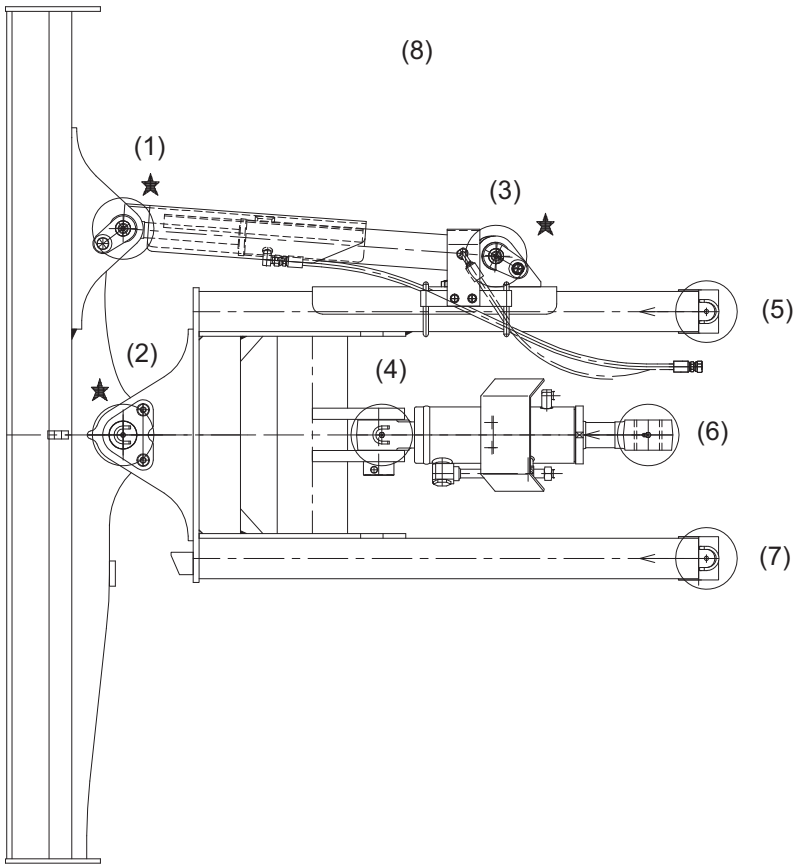


1. The dozer control lever doubles as the angle blade control lever. Move it to the right or left, and the angle dozer is placed at an angle.
2. For the right-hand angle setting, move the control lever in direction (A). The angle blade will be placed at an angle toward (A).
3. For the left-hand angle setting, move the control lever in direction (B). The angle blade will be placed at an angle toward (B).

b) Grease Lubrication

(1) Fitting direction of the grease fittings
Type A: Straight (06611-15010)
Type B: 67° (06616-25010)
Fit the fittings as shown below.

(2) Greasing amount
Apply grease until it flows out of the other side of the turning end.



(1) Type A
(2) Type A
(3) Type A
(4) Type A
(5) Type B
(6) Type B
(7) Type AB
(8) The *-marked grease fittings have been additionally introduced for the angle dozer type.

c) Control Linkage

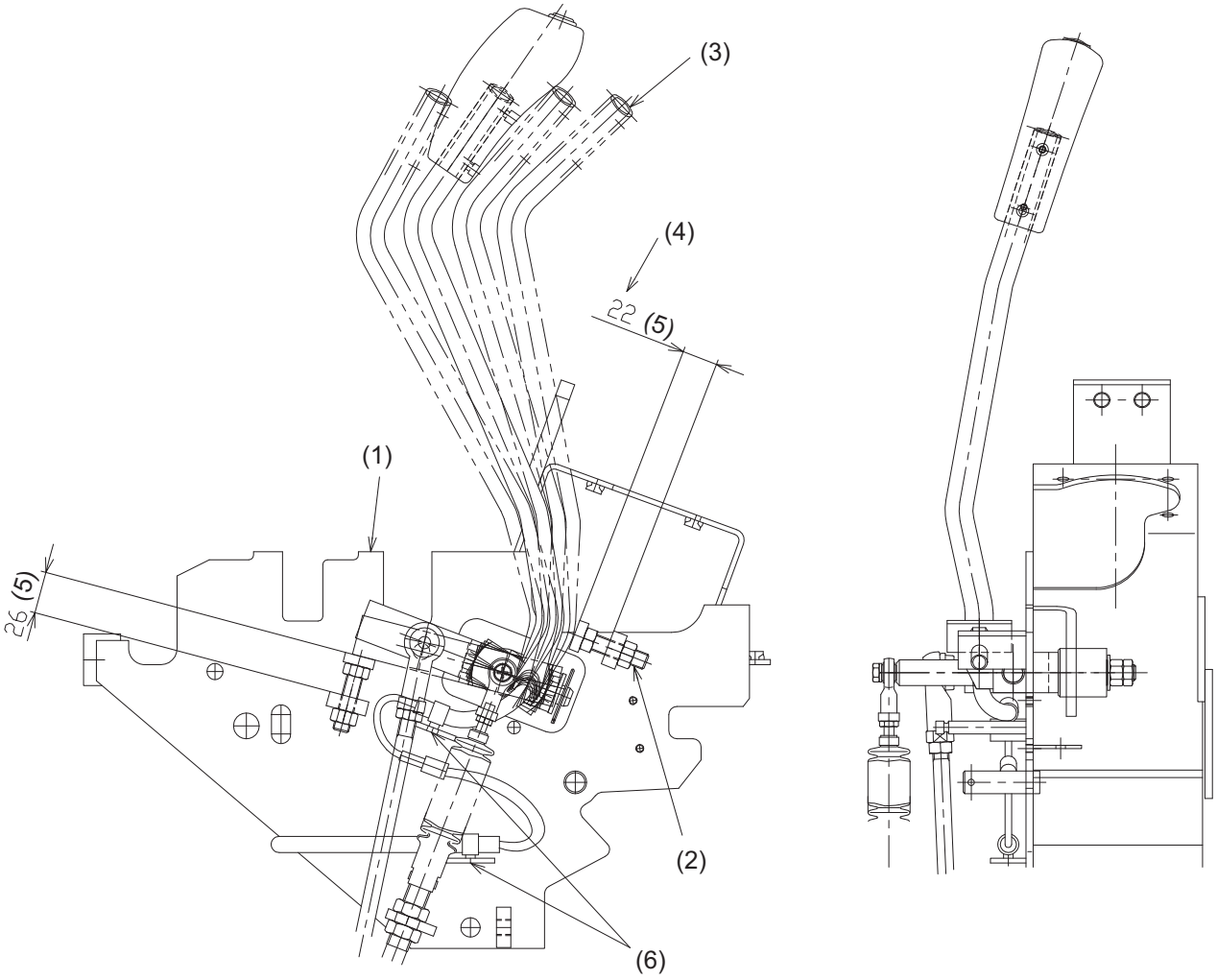
1. KX121-3S

(1) Adjusting of the dozer lever lock

With the lever at its stroke end, apply the rod and return it by half a turn.

<Failure case>

Malpositioned
↓
Poor control

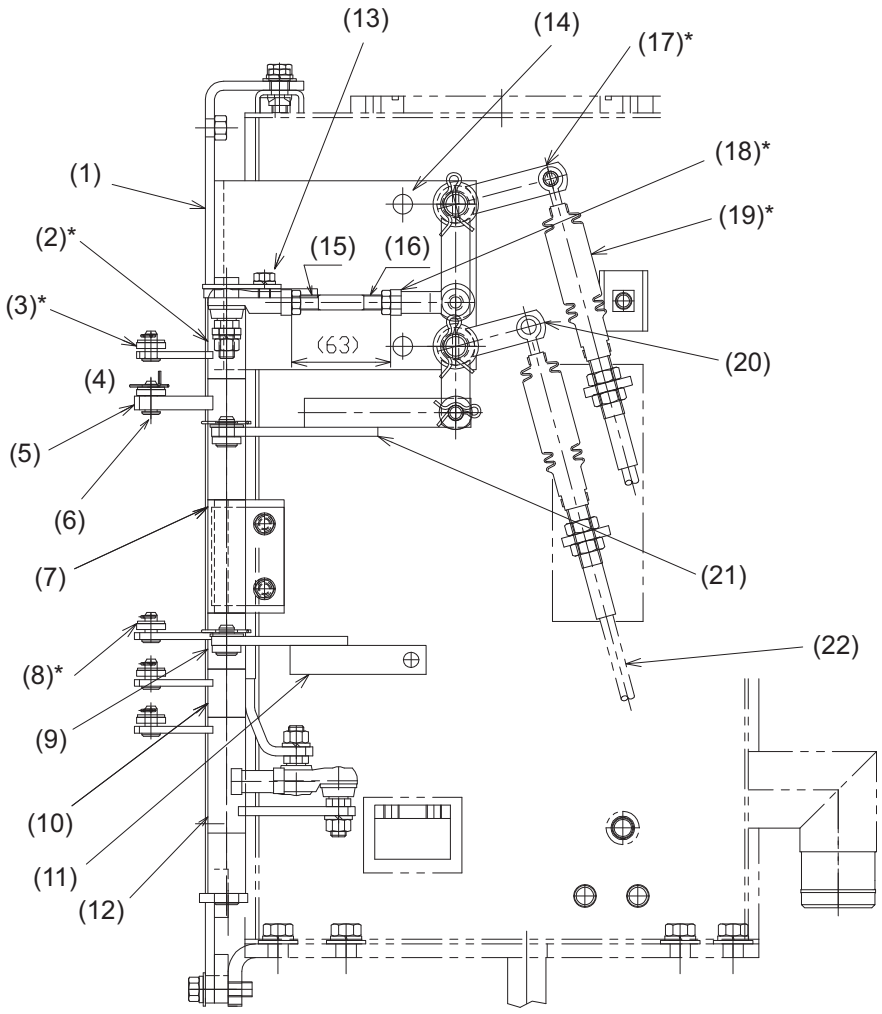


(1) Bracket assembly (control R1, ANG)
Bracket (control, R, 1, ANG)
Bushing
(2) Rod (stopper, angle)
Nut
(3) Float position
(4) Adjusting the rod (stopper, angle)
Move the lever to the float position first and then to the bottom end. Apply the rod (stopper, angle) at this position and return it by half a turn. Now get the rod locked.
(5) 22 (reference)
(6) Wire harness clamping positions

(1) Fitting of the links
Make sure all the links turn smoothly.

(2) Driving of the DU bushings and fitting of the shaft
Apply grease.

(3) Tightening torque of the bracket (control valve) mounting bolts
48.1 ~ 55.9 N·m (4.9 ~ 5.7 kgf·m)



The *-marked parts have been modified for the angle dozer type machines.

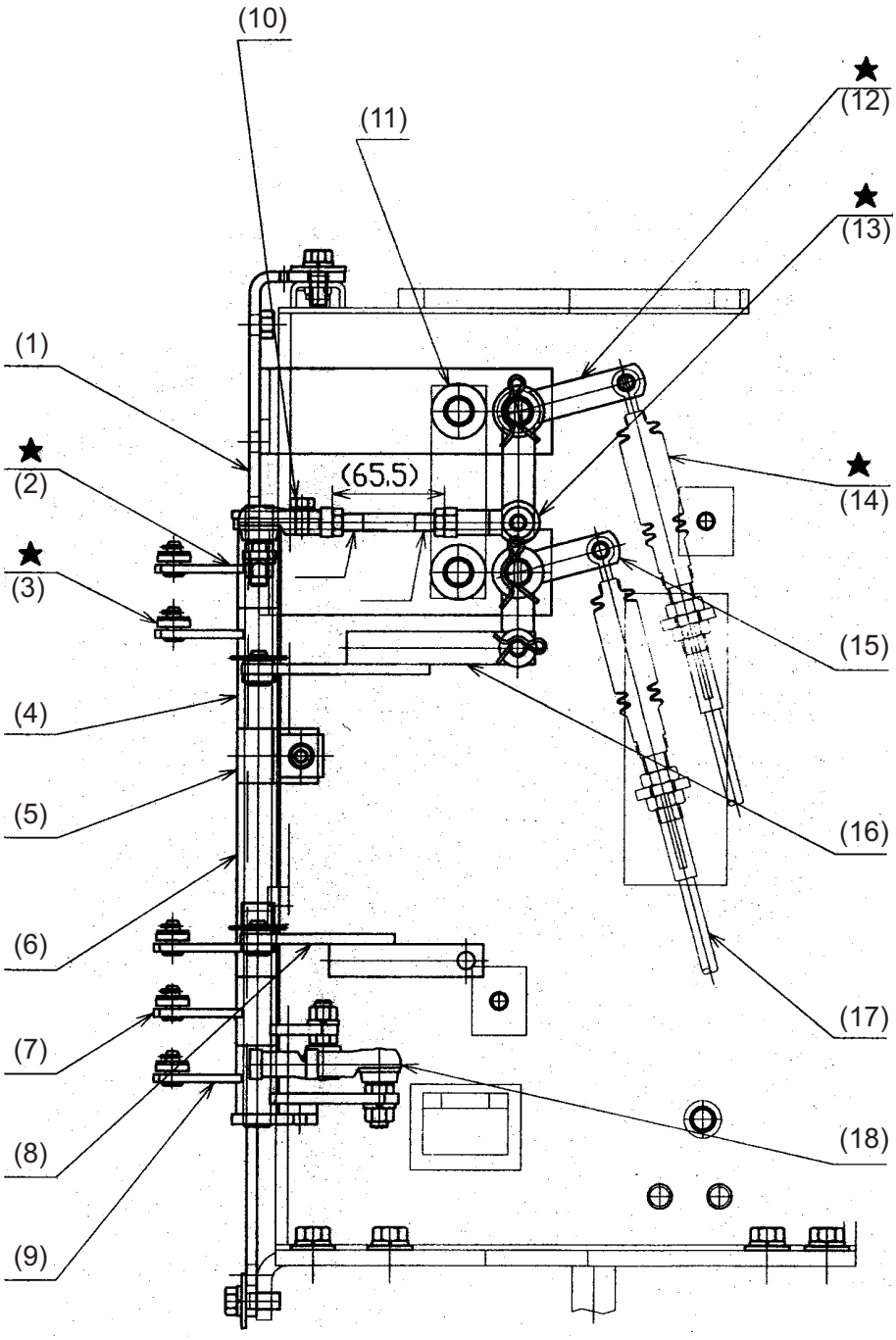
(1) Bracket (control valve)
(2) Link assembly (ANG)
Link (ANG)
Bushing
(3) Plate (50)
Plain washer
Snap pin
Headed pin (4.75)
Snap pin
(4) Insert the headed pin from below and fold the snap pin tightly into position.
(5) Link assembly (swing)
Link (swing)
Bushing
(6) Headed pin
(7) Stay assembly (shaft)
Stay (shaft)
Bushing
Bolt
(8) Plate (37)
(9) Link assembly (dozer)
Link (dozer)
Bushing
(10) Link assembly (travel, R)
Link (travel, R)
Bushing
(11) Rod (CV, dozer)
(12) Link assembly (travel, L)
Link (travel, L)
Bushing
(13) Shaft (link)
Bolt
(14) Bolt
(15) Right-hand threaded
(16) Left-hand threaded
(17) Link assembly (CV, 1, ANG)
Link (CV, 1, ANG)
Bushing
(18) Rod assembly (10-100)
Rod (10-100)
Link ball 1
Link ball 2
Nut
Left-hand lock nut
(19) Cable (1200, ANG)
Plain washer
Snap pin
Rod end 1 (hydraulic control)
Bolt
(20) Link assembly (CV, 2)
Link (CV, 2)
Bushing
Plain washer
Snap pin
Plain washer
Snap pin
(21) Rod (CV, swing)
(22) Cable (swing)
Plain washer
Snap pin

2. KX161-3S, U45S

(1) Fitting of the links
Make sure all the links turn smoothly.

(2) Driving of the DU bushings and fitting of the shaft
Apply grease.

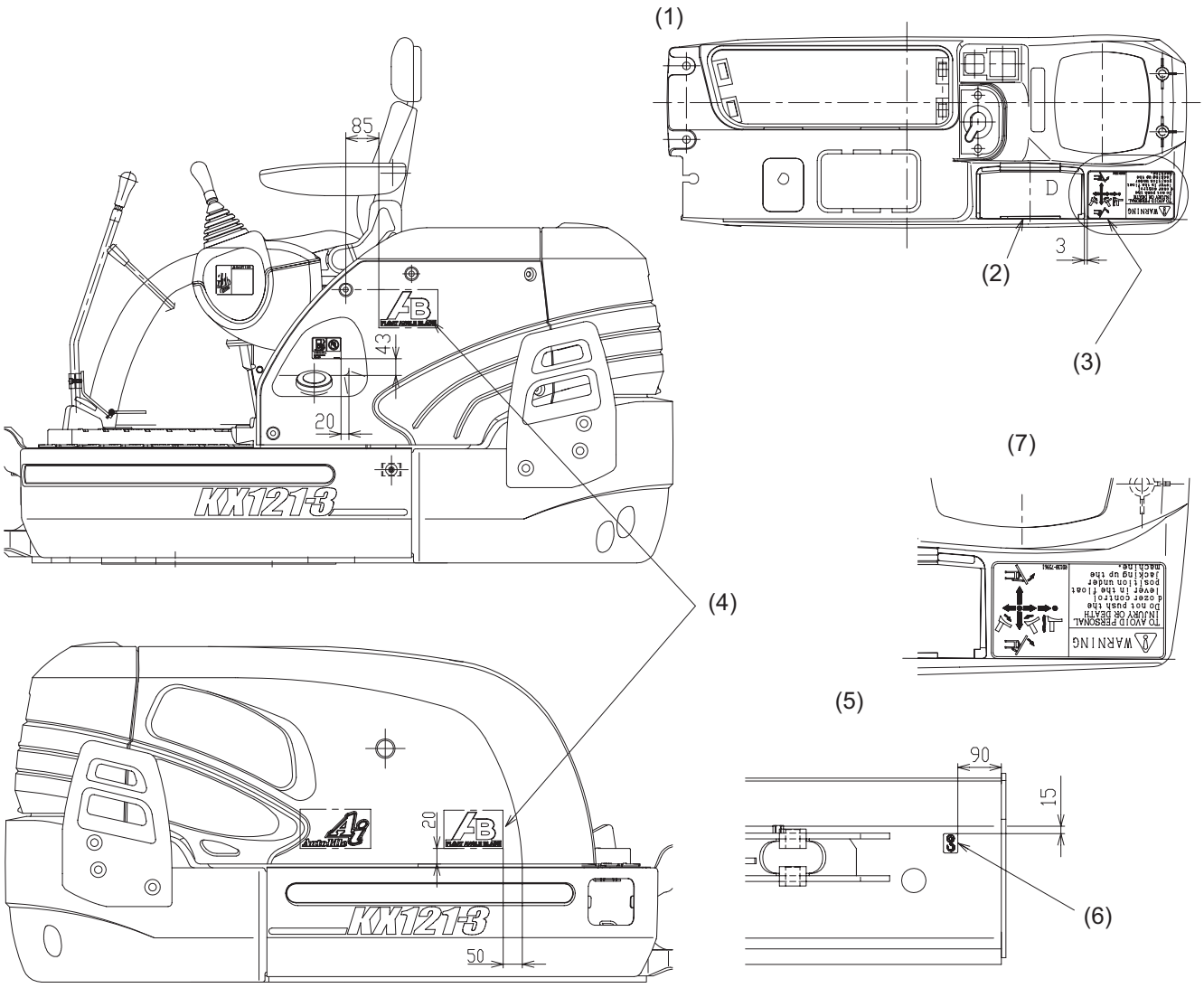
(3) Tightening torque of the bracket (control valve) mounting bolts
48.1 ~ 55.9 N·m (4.9 ~ 5.7 kgf·m)
35.4 ~ 41.2 ft·lbs



(1) Bracket (control valve)
Bolt
Plain washer
(2) Link assembly (ANG)
Link (ANG)
Bushing
(3) Plate (50)
Plain washer
Snap pin
Pin
Snap pin
(4) Link assembly (swing)
Link (swing)
Bushing
(5) Stay assembly (shaft)
Stay (shaft)
Bushing
Bolt
(6) Link assembly (dozer)
Link (dozer)
Bushing
(7) Link assembly (travel, R)
Link (travel, R)
Bushing
(8) Rod (CV, dozer)
Plain washer
Snap pin
(9) Link assembly (travel, L)
Link (travel, L)
Bushing
(10) Shaft (link)
Bolt
(11) Bolt
Plain washer
(12) Right-hand threaded
(13) Left-hand threaded
(14) Link assembly (CV, 1, ANG)
Link (CV, 1, ANG)
Bushing
(15) Rod assembly (10-100)
Rod (10-100)
Link ball 1
Link ball 2
Nut
Left-hand lock nut
Spring washer
Nut
(16) Cable (1200, ANG)
Plain washer
Snap pin
Rod end 1 (hydraulic control)
Bolt
(17) Link assembly (CV, 2)
Link (CV, 2)
Bushing
Plain washer
Snap pin
(18) Rod (CV, swing)
Plain washer
Snap pin
Plain washer
Snap pin
(19) Cable (swing)
Plain washer
Snap pin
(20) Link ball 1
Spring washer
Nut

The *-marked parts have been modified for the angle dozer type machines.

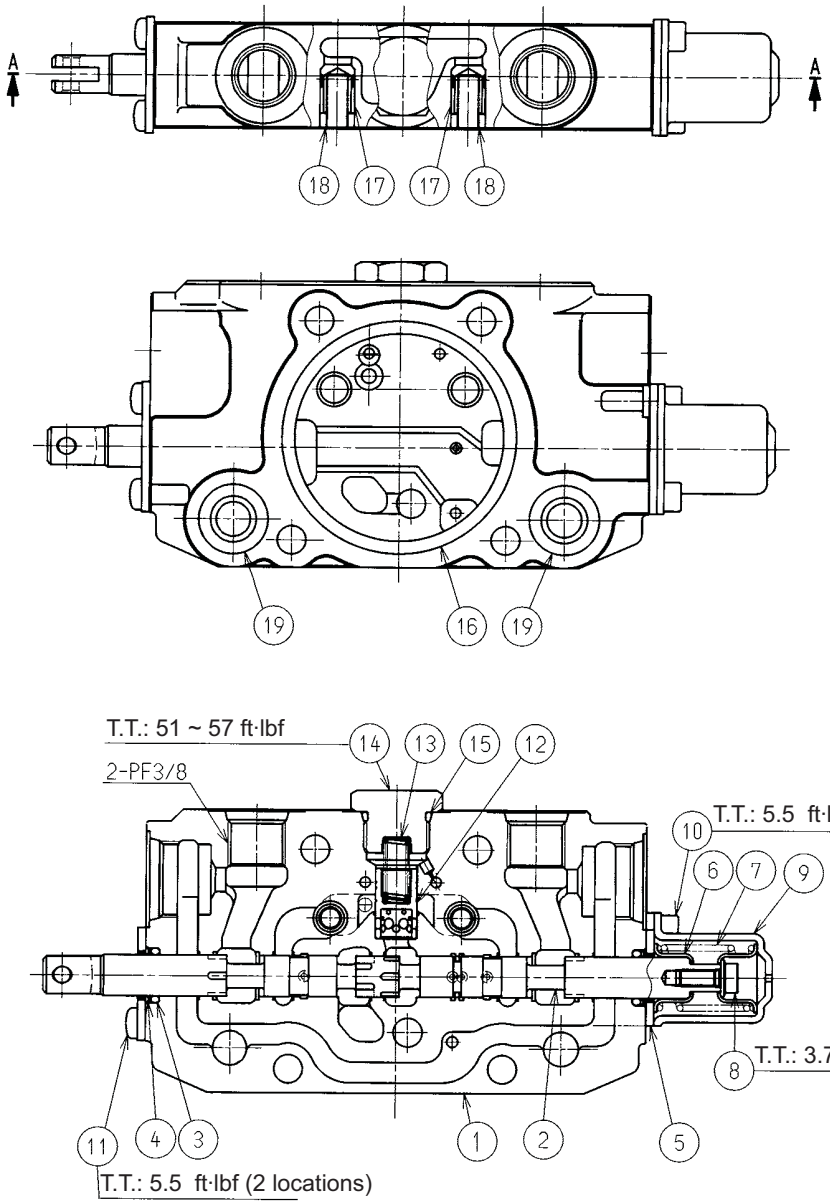
d) Label



(1) Right-hand control box and angle dozer control lever
(2) Align with this line.
(3) Label (dozer, caution)
RD138-7596Δ
(4) Marking (float angle blade)
RD138-7595Δ
Determine the sticking position referring to the surface protective sheet corner.
(5) Back of dozer blade
(6) Label (lifting)
RC108-5796Δ
* Apply the label on the other side.
(7) Details of D

(F) CONTROL VALVE

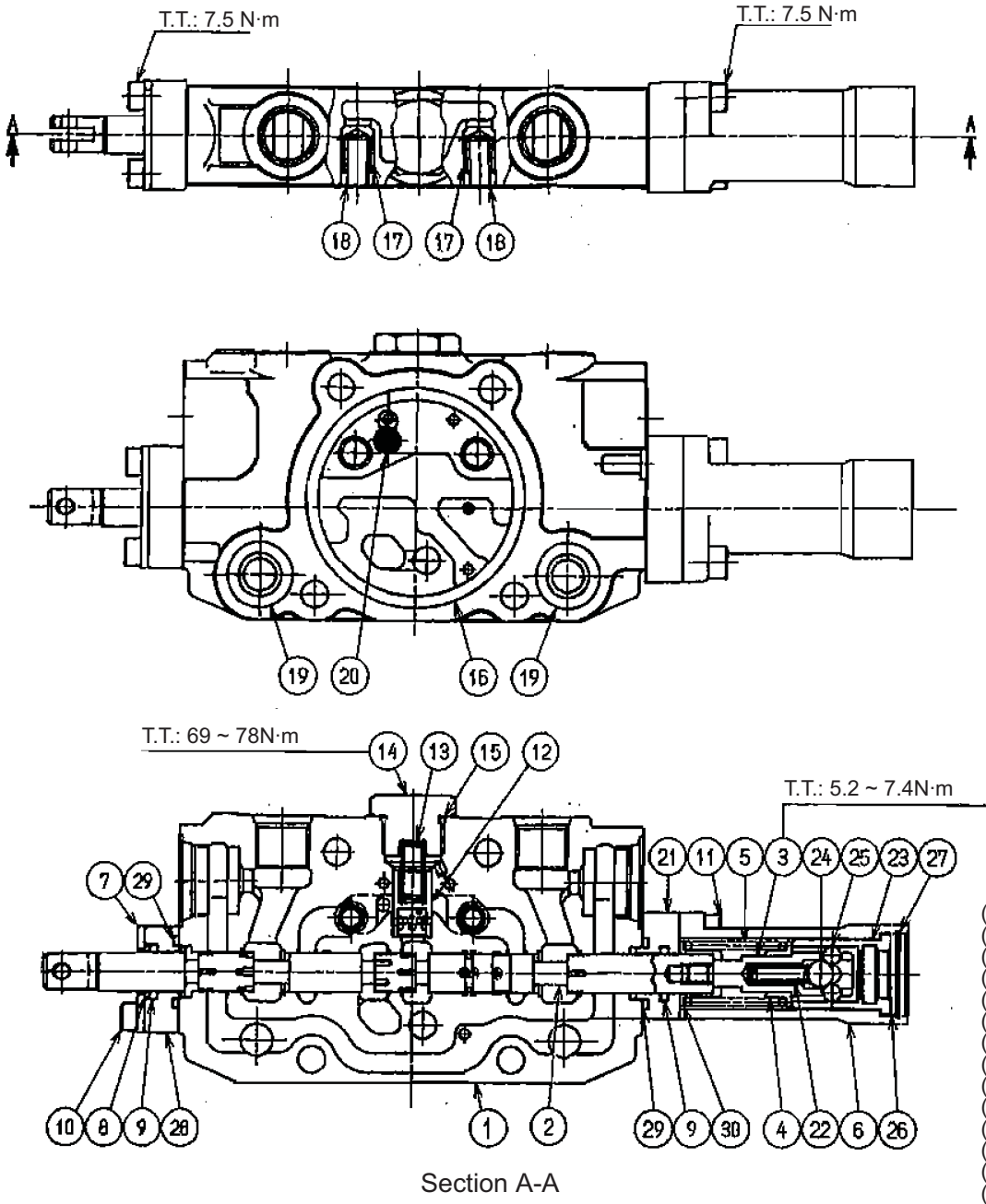
a) Angle Section



No.	Part name	Q'ty	Remarks
1	Valve housing	1	
2	Spool	1	
3	O ring	2	
4	Wipper	2	
5	Seal plate	2	
6	Spring sheet	2	
7	Spring	1	60 ~ 76 N
8	Cap screw	1	
9	Cap	1	
10	Socked head bolt	2	M5 x 0.8 x 12 - 12.9

No.	Part name	Q'ty	Remarks
11	Screw	2	M5 x 0.8 x 10
12	Spool	1	
13	Spring	1	2.0 K
14	Plug	1	3/4 - 16UNF
15	O ring	1	
16	O ring	1	
17	Load check valve	2	
18	Spring	2	
19	O ring	2	

b) Dozer section

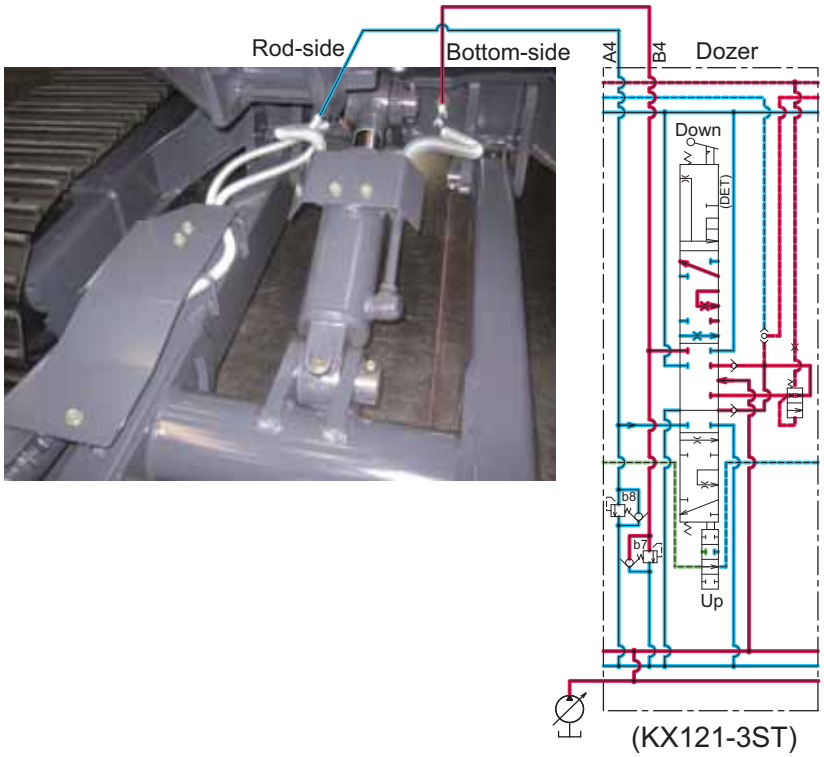


Section A-A

(1) Valve housing
(2) Spool
(3) Pin
(4) Spring seat
(5) Spring
(6) Cap
(7) Seal plate
(8) Wiper
(9) O-ring
(10) Socket head bolt
(11) Socket head bolt
(12) Spool
(13) Spring
(14) Plug
(15) O-ring
(16) O-ring
(17) Load check valve
(18) Spring
(19) O-ring
(20) Plate
(21) Spacer
(22) Spring
(23) Sleeve
(24) Stainless steel ball
(25) Stainless steel ball
(26) Spacer
(27) Snap ring
(28) Spacer
(29) O-ring
(30) Spring seat

c) Dozer Float Function

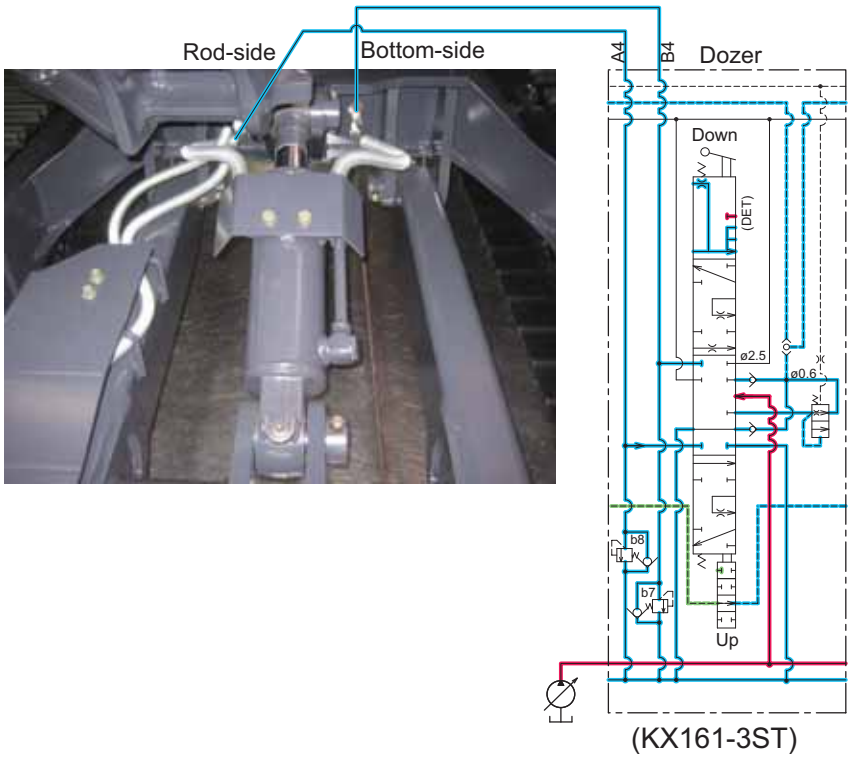
Oil flow of dozer cylinder down



(KX121-3ST)

The left figure shows oil flows to get down the dozer blade.

Oil flow of dozer cylinder floating

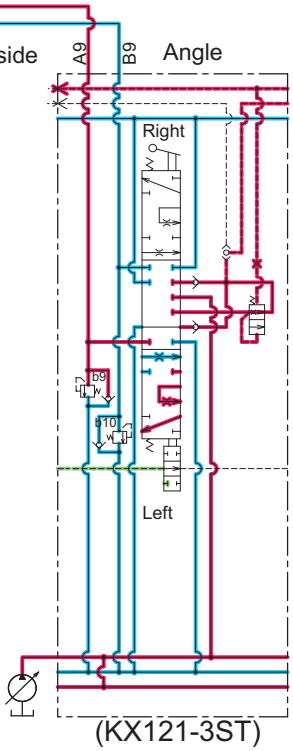


(KX161-3ST)

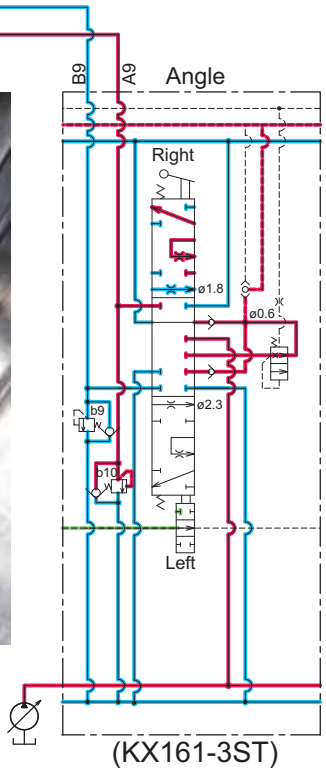
The left figure shows oil flow of the floating function of the dozer blade. When the dozer control lever is shifted to forward-end, then the pump pressure line is closed and dozer cylinder's both ports are connected to the return line in the control valve spool, called ABR connection.

Dozer cylinder moves along the ground's ups and downs so that ground leveling with a dozer blade has become a lot easier.

Oil flow of angle cylinder



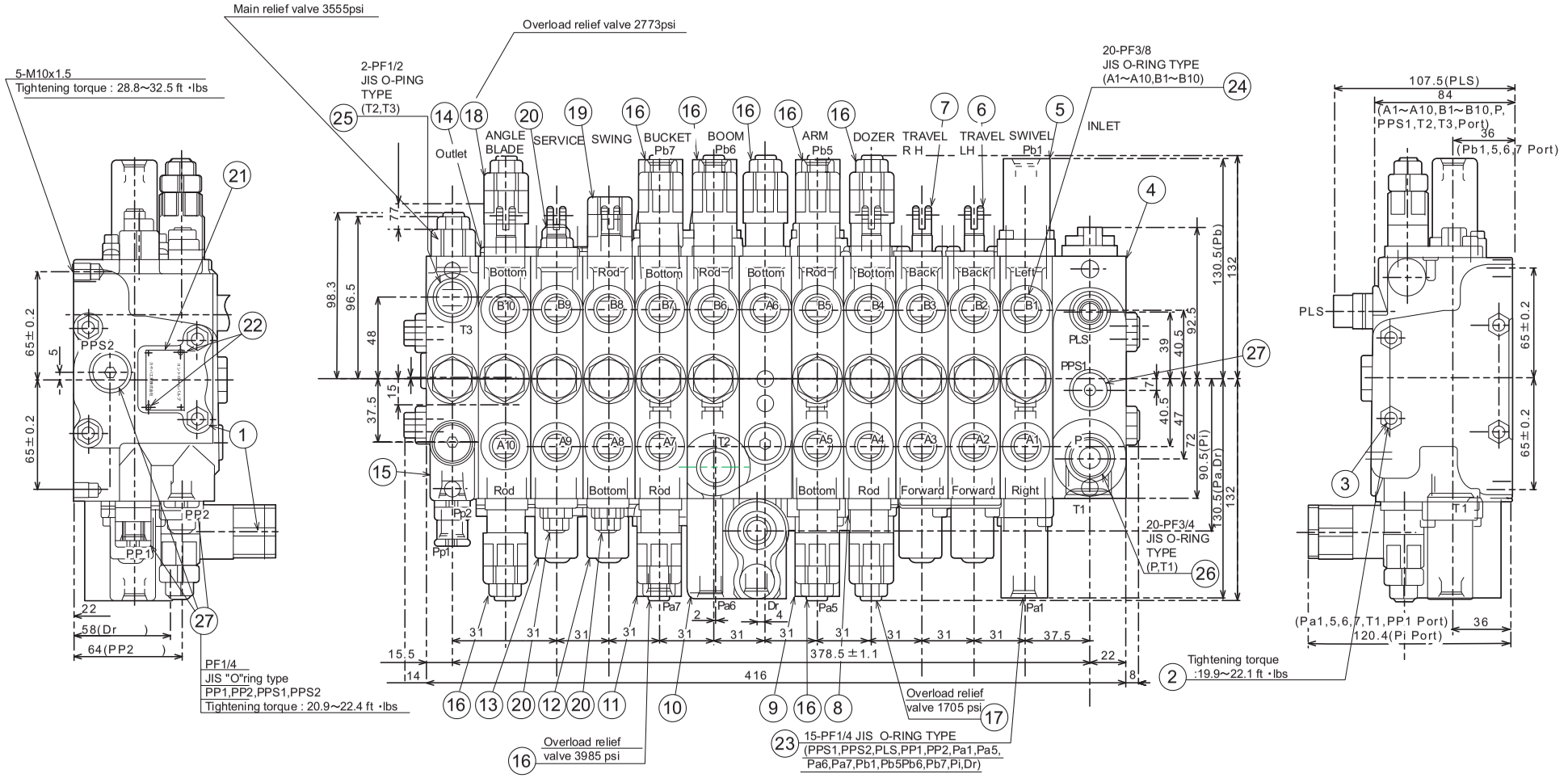
(KX121-3ST)



(KX161-3ST)

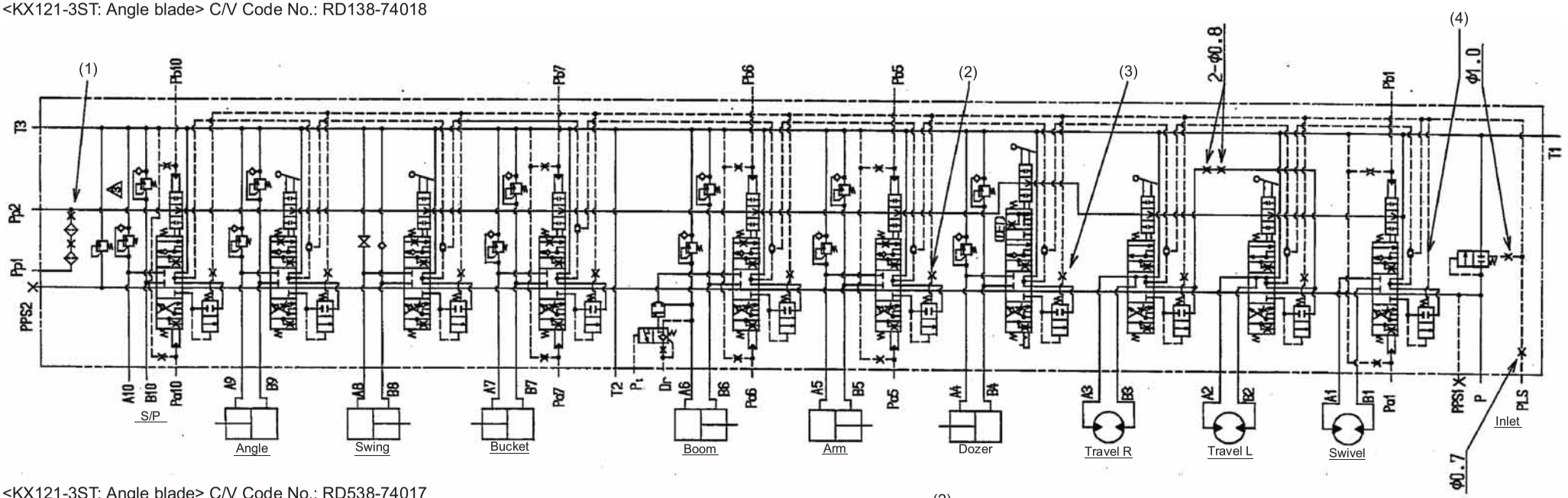
d) General View of Control Valve

(1)KX121-3S, KX121-3ST

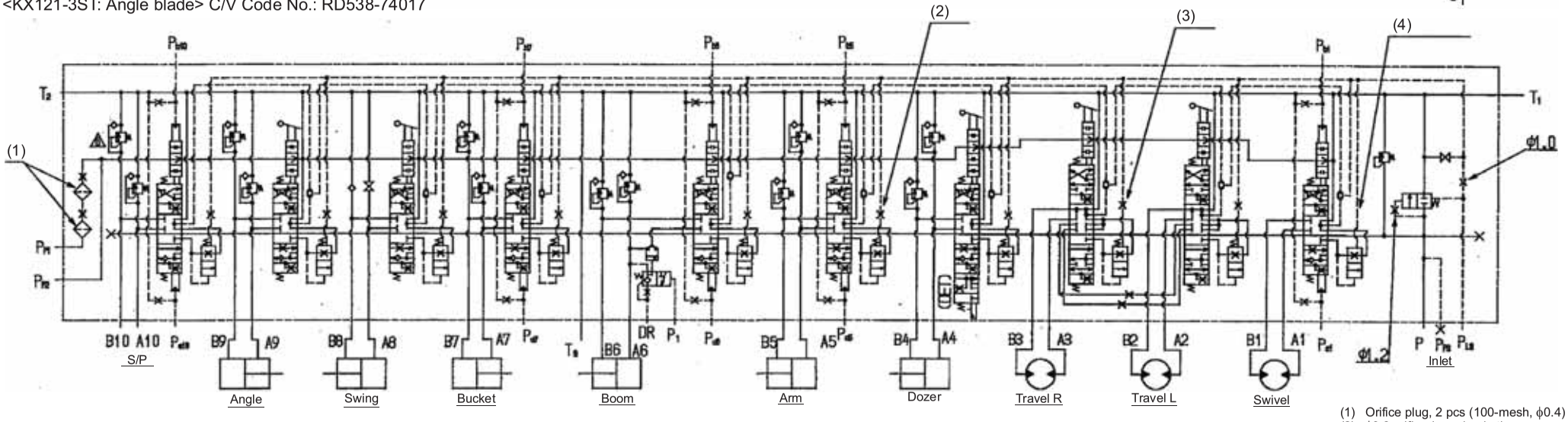


e) Control Valve Circuit Diagram

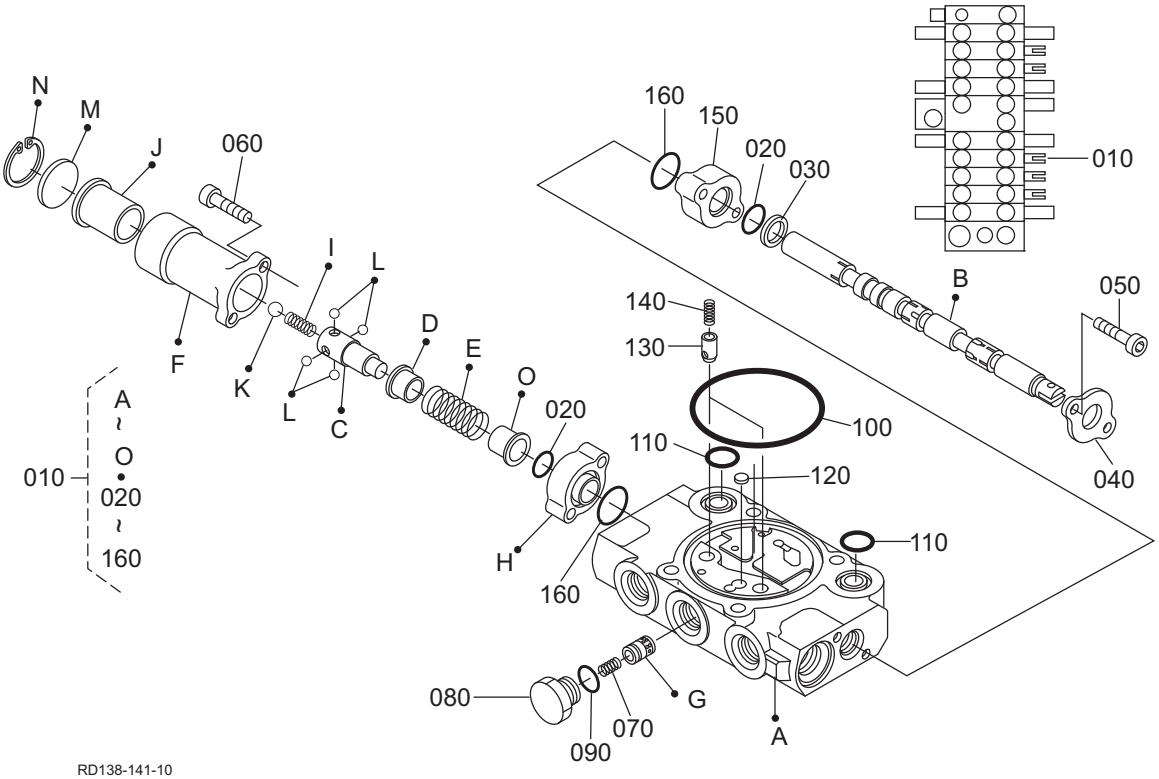
<KX121-3ST: Angle blade> C/V Code No.: RD138-74018



<KX121-3ST: Angle blade> C/V Code No.: RD538-74017

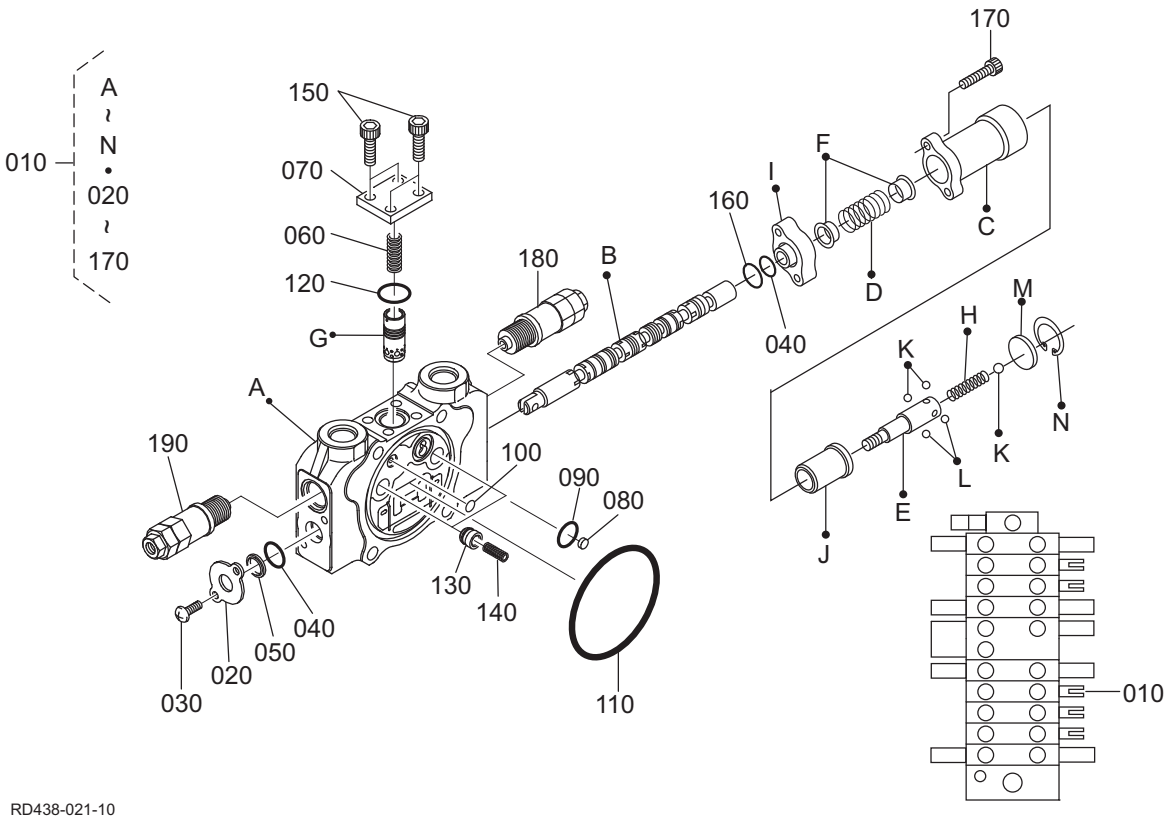


(1) Orifice plug, 2 pcs (100-mesh, ϕ0.4)
(2) ϕ0.8 orifice (arm, bucket)
(3) ϕ0.6 (7 locations)
(4) No orifice (swivel)



RD138-141-10

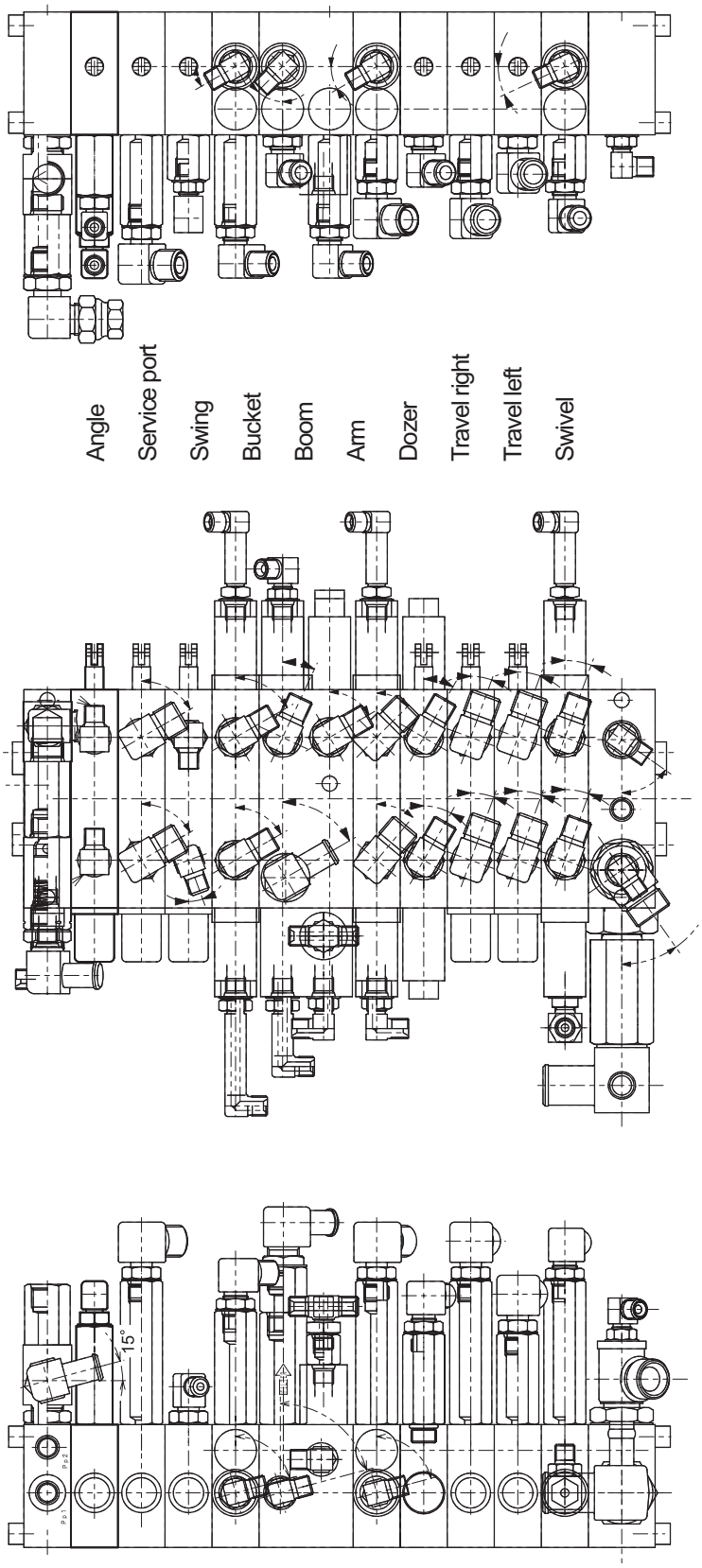
(KX121-3S/ST)
Spool diagram of dozer (float) section



RD438-021-10

(KX161-3S/ST, U45S/ST)
Spool diagram of dozer (float) section

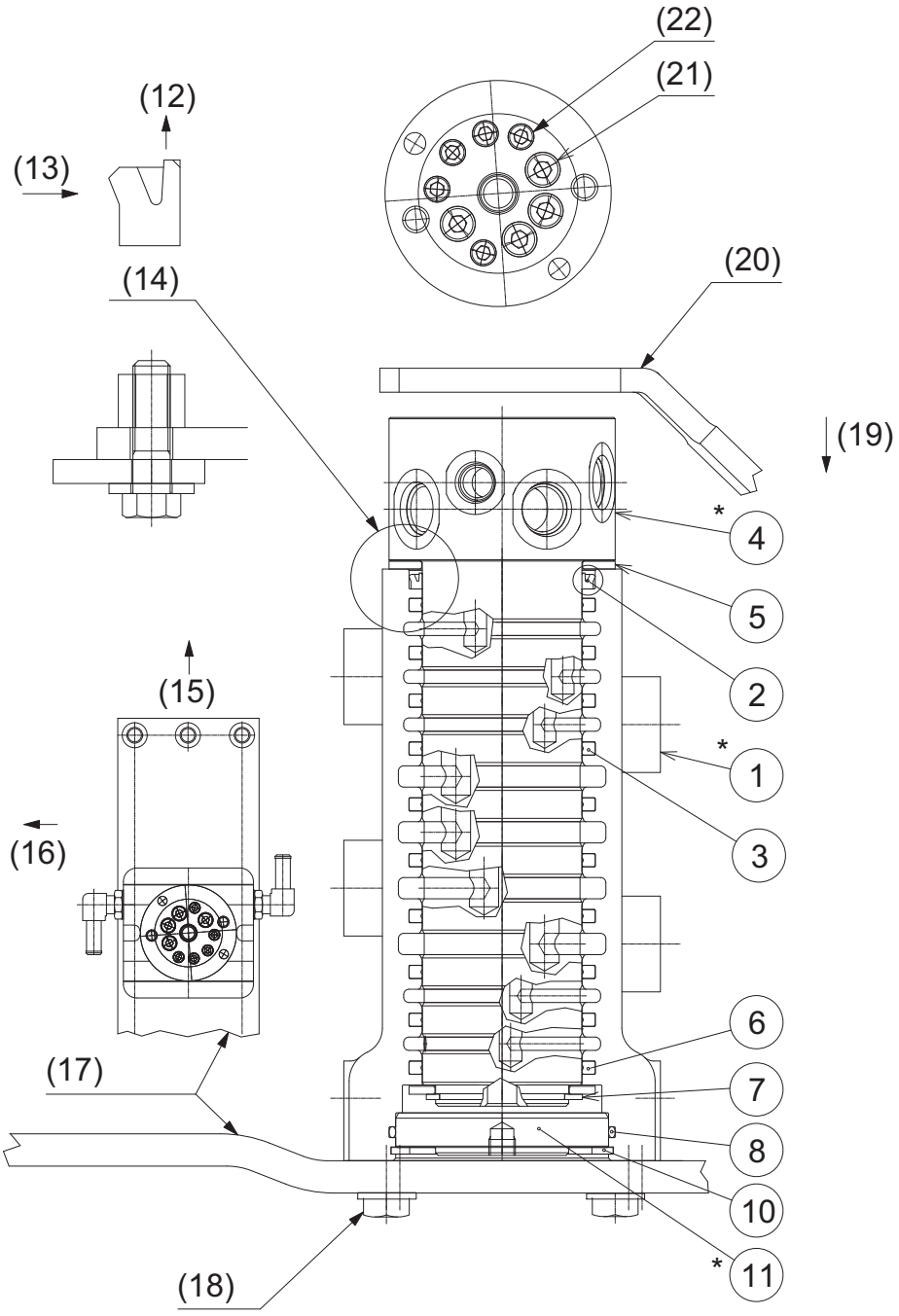
f) Adaptor Installation



Note: For other sections than the angle section, refer to pages of the WSM.

(G) ROTARY JOINT

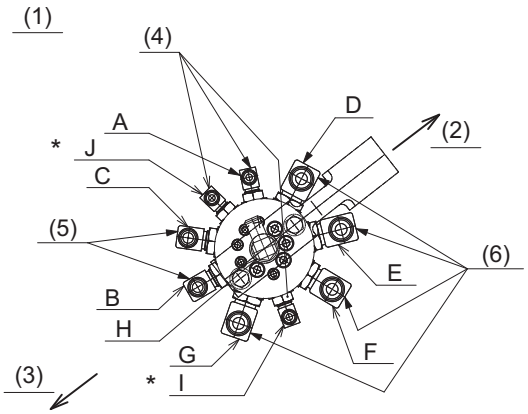
a) Assembling of the Rotary Joint



1	Body (Swivel joint, ANG)
2	Packing
3	Packing (Swivel joint)
4	Shaft (Swivel joint, ANG)
5	Collar (Swivel joint)
6	Collar (Swivel joint)
7	Snap ring, Shaft
8	O-ring
9	blank
10	Snap ring, hole
11	Cover (angle)
12	Outside
13	Lip
14	Enlarged view of packing
15	(Machine right side)
16	(Dozer side)
17	Stay (Swivel joint)
18	Bolt
19	(Downward)
20	Stopper (Swivel joint)
21	Plug (PT1/4)
22	Plug (PT1/8)

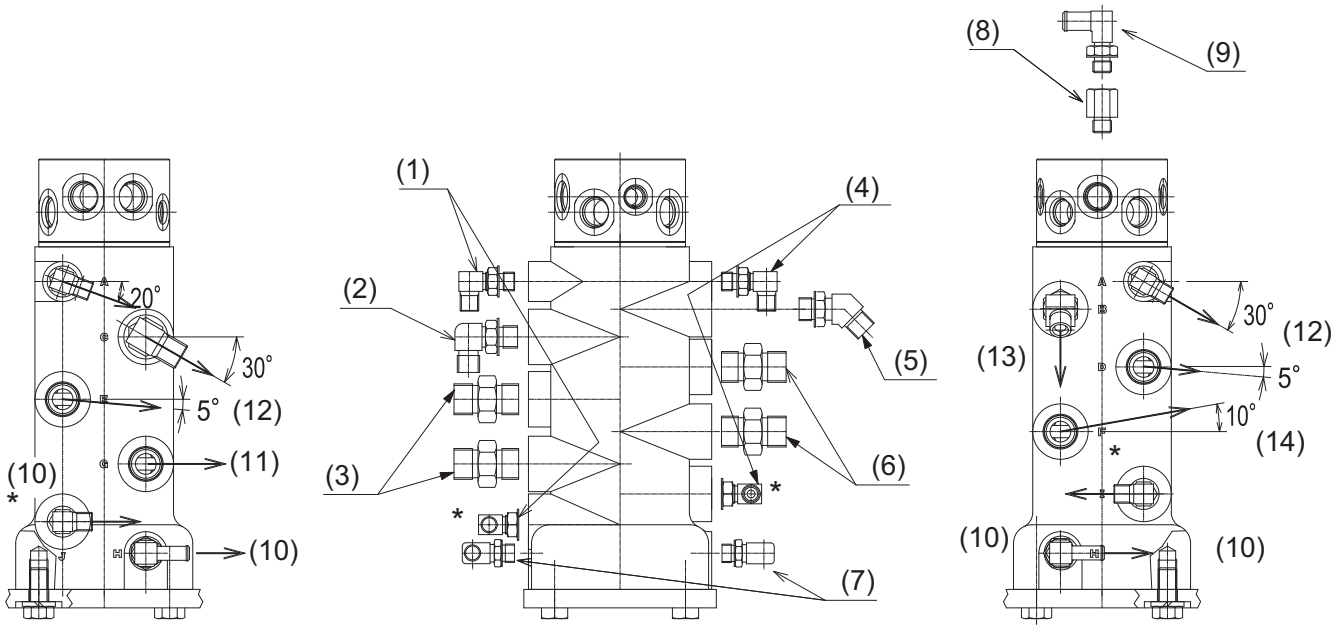
Notes:
- The *-marked parts are different from those for the standard dozer type machine.
- The bolt tightening torques and other requirements are referred to the appropriate pages of the KX121-3S/ST, KX161-3S/ST WSM.

b) Adaptor Installation



A	Bi-speed
B	Dozer, down
C	Dozer, up
D	Front, left
E	Front, right
F	Rear, left
G	Rear, right
H	Drain
I	Angle, left
J	Angle, right

(1)	Control valve (shaft) side
(2)	Machine front
(3)	Machine back
(4)	Pipe joint (L, G1/4-G1/4) O-ring A, I, J port
(5)	Pipe joint (L, G3/8-G3/8) O-ring B, C port
(6)	Pipe joint (L1/2-3/4 UNF) O-ring D, E, F and G ports



(1)	Pipe joint (L, G1/4-G1/4) O-ring
(2)	Pipe joint (L, G3/8-G3/8) O-ring
(3)	Adaptor 7 O-ring
(4)	Pipe joint (L, G1/4-G1/4) O-ring
(5)	Elbow O-ring
(6)	Adaptor 7 O-ring
(7)	Elbow pipe joint (G4-13)

(8)	Pipe joint (Bushing G1/4) O-ring
(9)	Elbow pipe joint (G4-13) O-ring
(10)	Horizontal
(11)	Hose, goose-neck, horizontal
(12)	Hose, goose-neck angle
(13)	Straight downward
(14)	Hose, goose-neck, 10° upward

Adaptor tightening torque

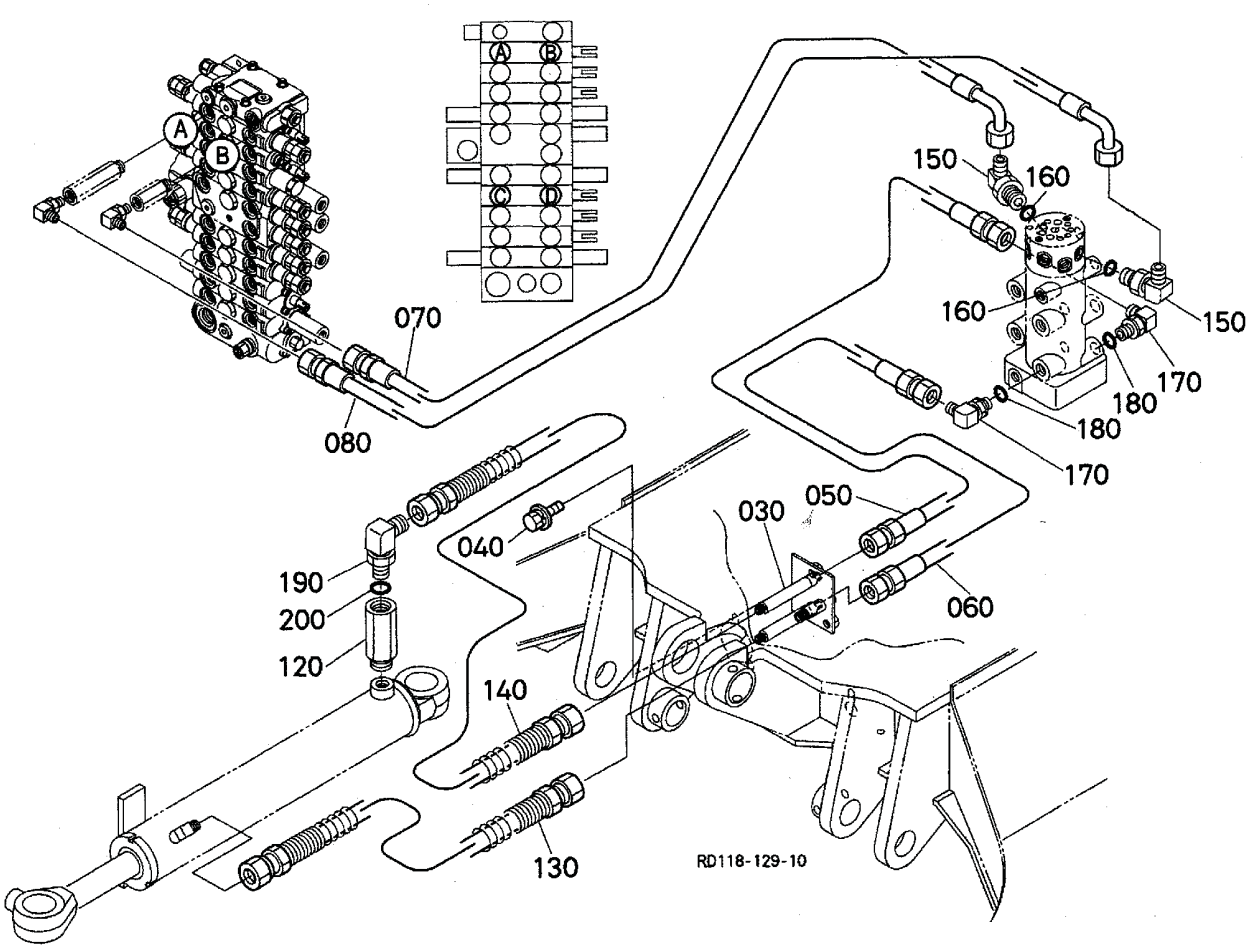
G1/4
24.5 ~ 29.4 N·m
(2.5 ~ 3.0 kgf·m)
18.1 ~ 21.7 ft·lbs

G3/8
49.0 ~ 53.9 N·m
(5.0 ~ 5.5 kgf·m)
36.2 ~ 39.8 ft·lbs

G1/2
58.8 ~ 63.7 N·m
(6.0 ~ 6.5 kgf·m)
43.4 ~ 49.0 ft·lbs

Notes:
- The *-marked parts are different from those for the standard dozer type machine.
- The bolt tightening torques and other requirements are referred to the pages of the KX121-3S/ST, KX161-3S/ST WSM

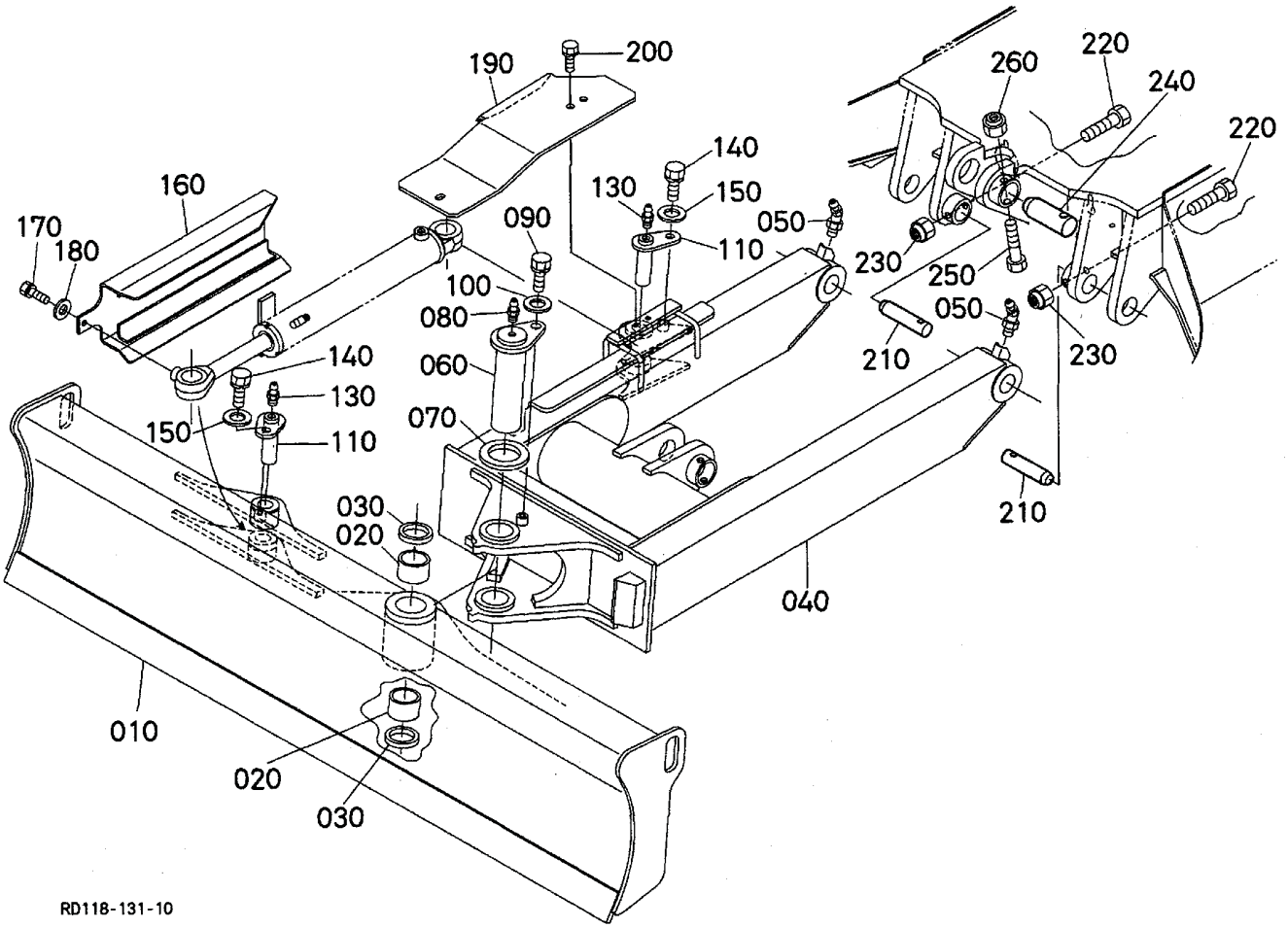
c) Hose Connection



No.	Part name	Hose tape color	Length	Cap size
030	Bracket			
040	Bolt			
050	Hose, hydraulic	-	460 mm	G1/4 - G1/4
060	Hose, hydraulic	-	300 mm	G1/4 - G1/4
070	Hose, hydraulic	White	1100 mm	G1/4 - G1/4
080	Hose, hydraulic	Black	1600 mm	G1/4 - G1/4
	Blank			
120	Joint, pipe			
130	Hose, hydraulic	-	940 mm	G1/4 - G1/4
140	Hose, hydraulic	-	610 mm	G1/4 - G1/4
150	Joint, pipe			
160	O-ring			
170	Joint, pipe			
180	O-ring			
190	Joint, pipe			
200	O-ring			

(H) UNDER CARRIAGE

a) Angle Dozer



No.	Part name
010	Assy blade, angle
020	Bush
030	Seal, dust
040	Reame
050	Nipple, grease
060	Pin
070	Shim
080	Nipple, grease
090	Bolt
100	Washer, plain
110	Pin, angle cylinder
120	Blank
130	Nipple, grease

No.	Part name
140	Bolt
150	Washer, plain
160	Cover, angle cylinder
170	Bolt
180	Washer, plain
190	Cover angle
200	Bolt
210	Pin
220	Bolt
230	Nut, lock
240	Pin
250	Bolt
260	Nut, lock

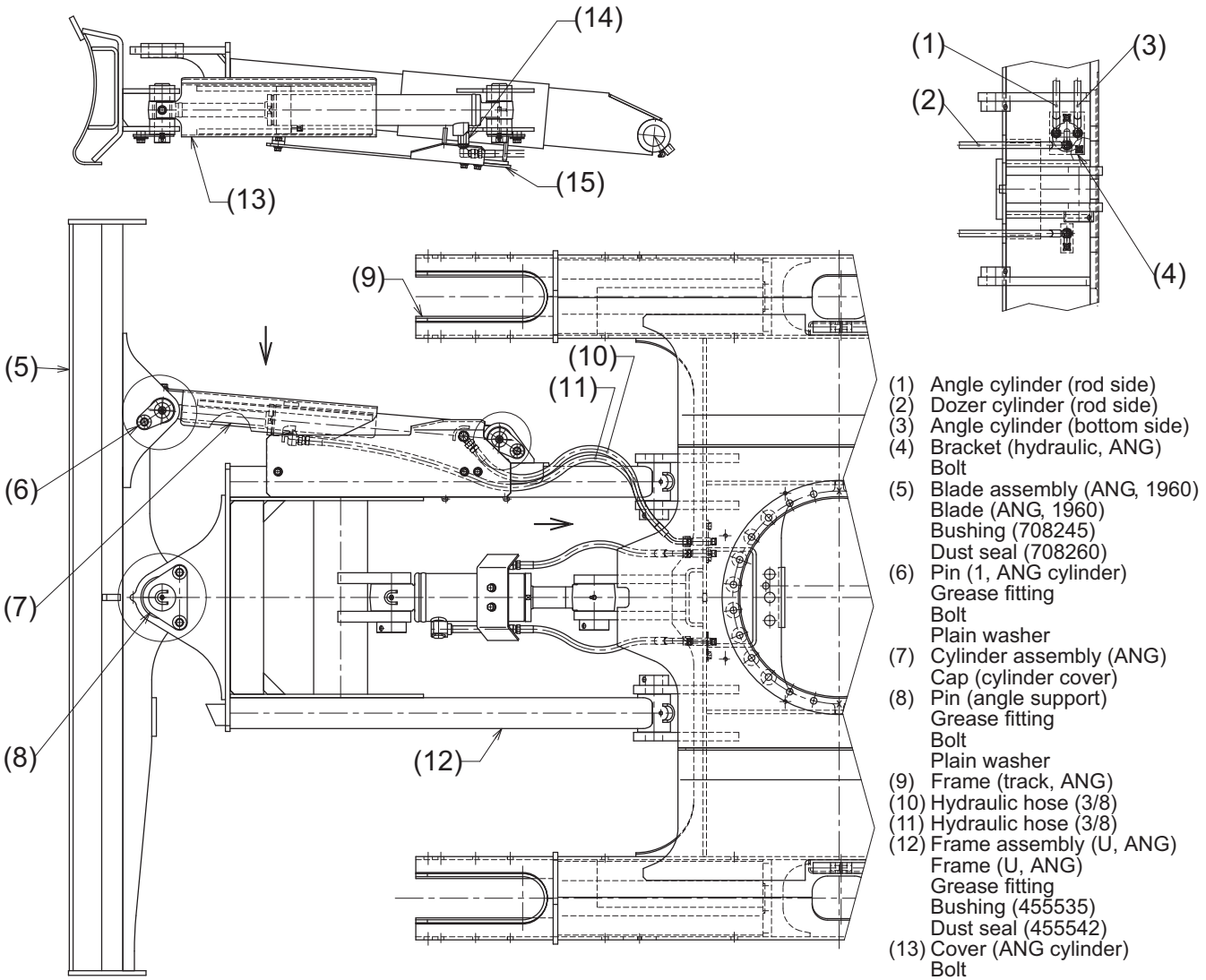
(1) Tilting of the blade
Below 10 mm

<Failure case>
Poor appearance

(2) Movement of the angle
Check for unusual noise.
Apply molybdenum disulfide grease to the top and bottom end faces of each support.
(The locations are marked with * in the figure.)
Keep the backlash at each support below 1.5 mm.
(Tolerable gap at Point F: 0.3 ~ 1.3 mm(0.02 ~ 0.05 in.))

(3) Angle cylinder hose
Hose routing at the dozer cylinder rod
To be out of contact

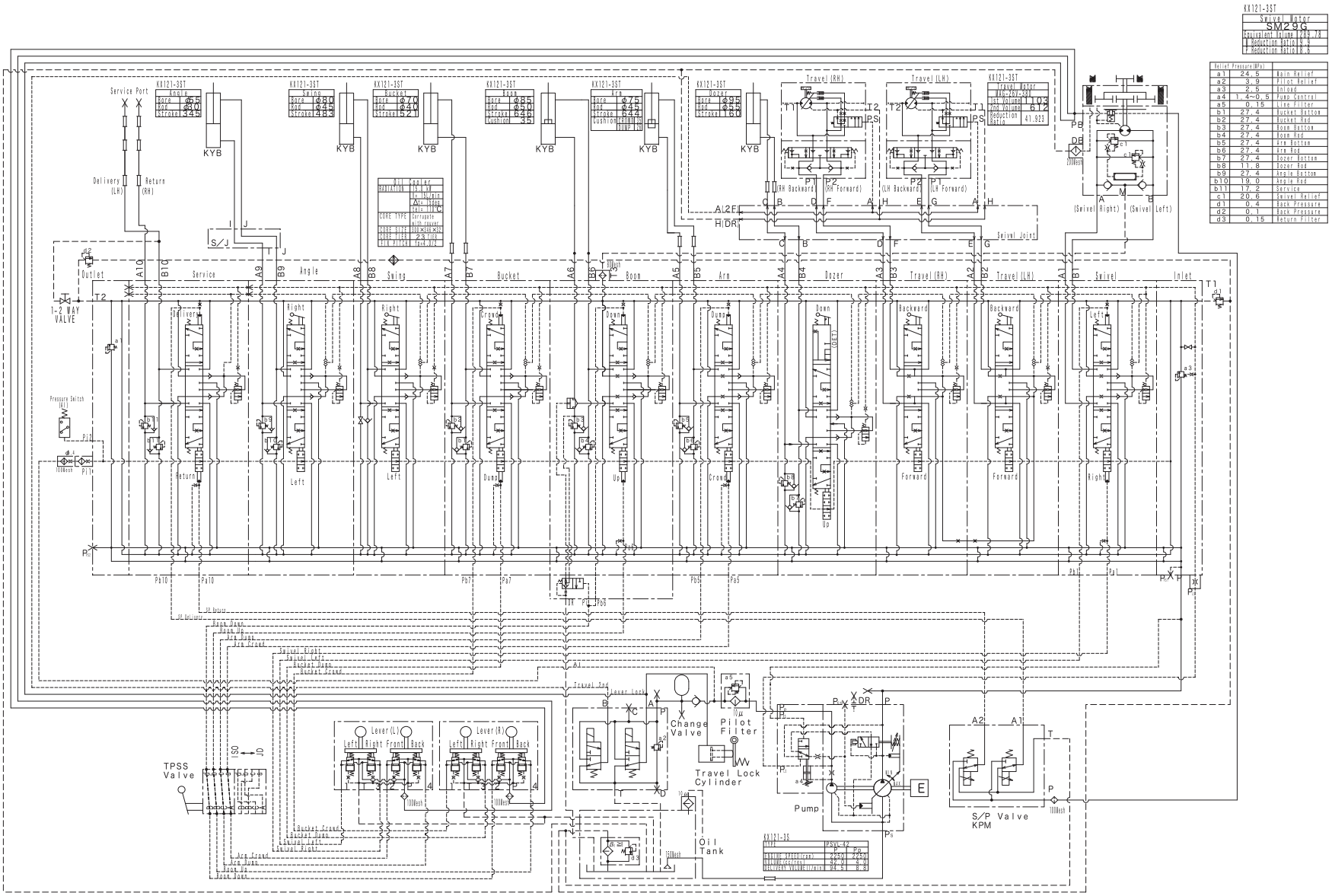
<Failure case>
Contact
↓
Hose damaged
↓
Oil leak



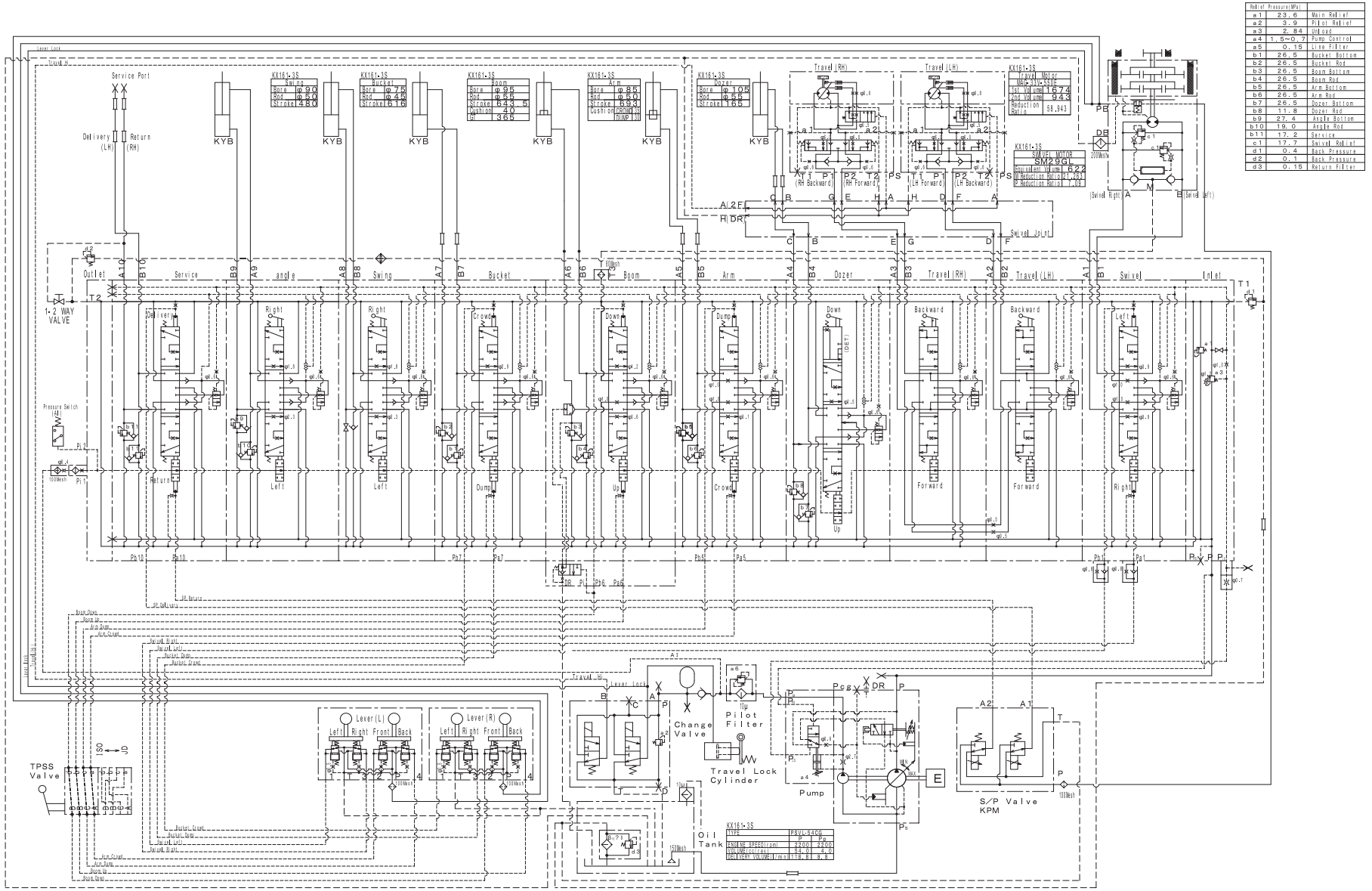
(1) Angle cylinder (rod side)
(2) Dozer cylinder (rod side)
(3) Angle cylinder (bottom side)
(4) Bracket (hydraulic, ANG)
Bolt
(5) Blade assembly (ANG, 1960)
Blade (ANG, 1960)
Bushing (708245)
Dust seal (708260)
(6) Pin (1, ANG cylinder)
Grease fitting
Bolt
Plain washer
(7) Cylinder assembly (ANG)
Cap (cylinder cover)
(8) Pin (angle support)
Grease fitting
Bolt
Plain washer
(9) Frame (track, ANG)
(10) Hydraulic hose (3/8)
(11) Hydraulic hose (3/8)
(12) Frame assembly (U, ANG)
Frame (U, ANG)
Grease fitting
Bushing (455535)
Dust seal (455542)
(13) Cover (ANG cylinder)
Bolt
Plain washer
(14) Pipe joint (S, G3/8-F3/8)
O-ring
Pipe joint (L, G3/8-F3/8)
O-ring
(15) Cover (1, ANG)
Bolt

(I) HYDRAULIC CIRCUIT DIAGRAM

a) KX121-3S/ST Hydraulic Circuit Diagram (Angle blade)

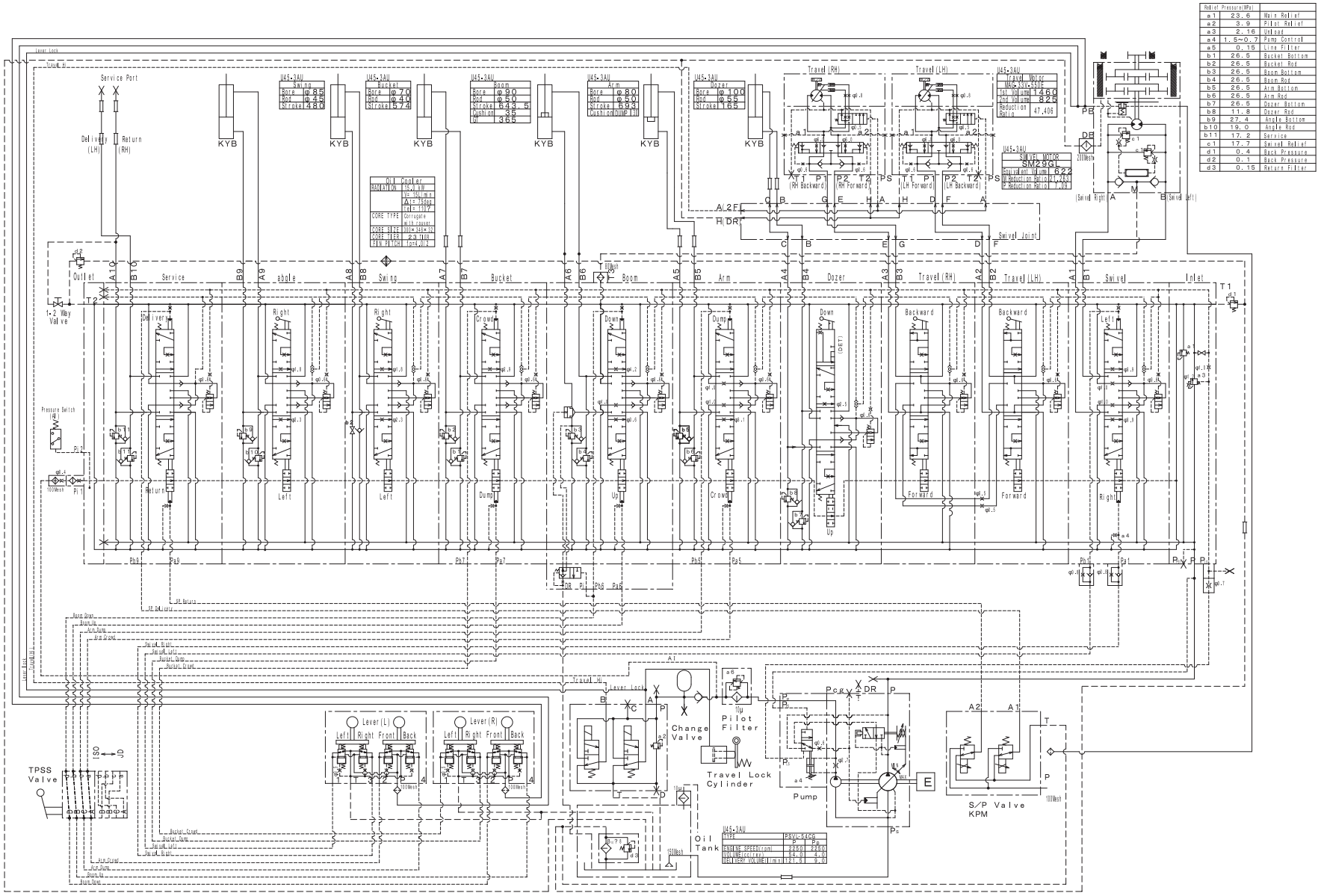


b) KX161-3S/ST Hydraulic Circuit Diagram (Angle blade)



Relief Pressure(MPa)		
a1	23.6	Main Relief
a2	3.9	Pilot Relief
a3	2.84	Unload
a4	1.5~0.7	Pump Control
a5	0.15	Line Filter
b1	26.5	Bucket Bottom
b2	26.5	Bucket Rod
b3	26.5	Boom Bottom
b4	26.5	Boom Rod
b5	26.5	Arm Bottom
b6	26.5	Arm Rod
b7	26.5	Dozer Bottom
b8	11.8	Dozer Rod
b9	27.4	Angle Bottom
b10	19.0	Angle Rod
b11	17.2	Service
c1	17.7	Swivel Relief
d1	0.4	Back Pressure
d2	0.1	Back Pressure
d3	0.15	Return Filter

c) U45S/ST Hydraulic Circuit Diagram (Angle blade)



KUBOTA Corporation
CONSTRUCTION MACHINERY DIVISION
1-1-1 NAKAMIYA-OHIKE, HIRAKATA, OSAKA, JAPAN

EDITOR:
CONSTRUCTION MACHINERY DIVISION
CUSTOMER TECHNICAL SUPPORT DEPT.
HIRAKATA PLANT
1-1-1 NAKAMIYA-OHIKE, HIRAKATA, OSAKA, JAPAN
PHONE: +81-72-890-2888
FAX: +81-72-890-2886