WSM

WORKSHOP MANUAL
KUBOTA EXCAVATOR

KX080-3

Kubota

Code No.97899-61622

Record of Revisions

Symbol	Date	Main Revised Points & Corrective Measures	Person-in-charge
△1	Dec.18th 2006	Modification of S/P 1 control system and new travel motor with automatic torque-up control. Correction of hydraulic oil check conditions. Addition of LS pump flow performance test. Correction of motor specifications.	M.Okuda
△2	July 2nd 2007	Addition of Two Piece Boom Chapter	I.Okae
△3			
△4			

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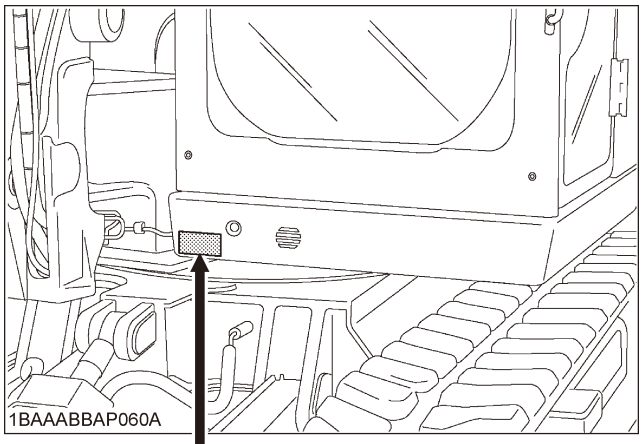
I General

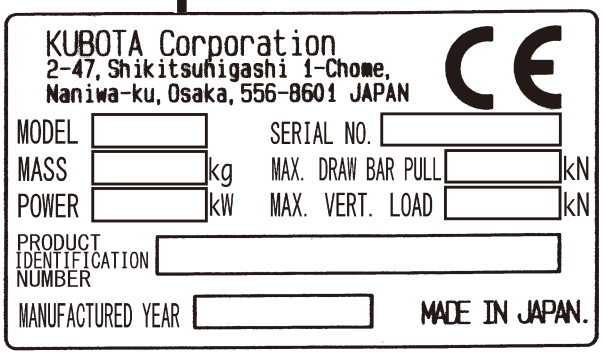
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A.Body and engine identification marks

If trouble should occur during use, or if servicing is necessary, contact the dealer who handles the machine. At that time please inform the machine model and engine type and serial numbers.

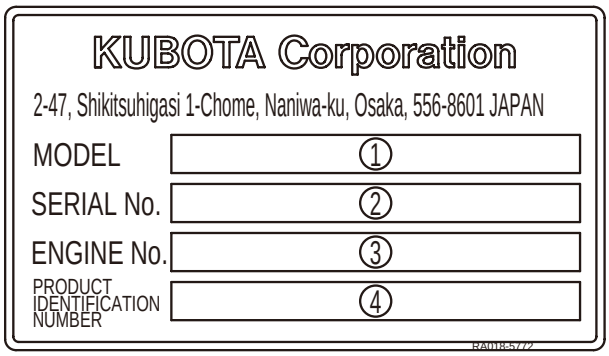
(1)Product number plate





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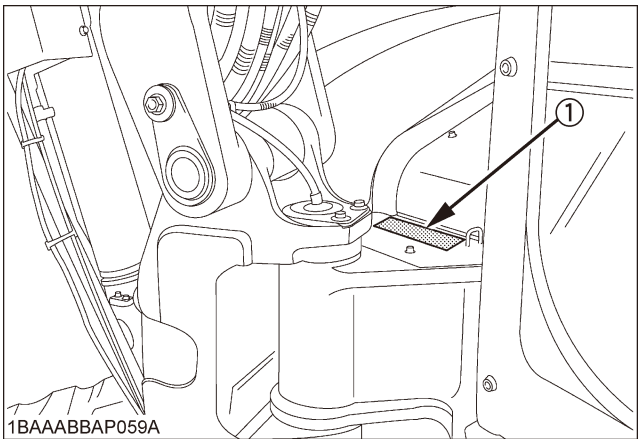
KTC, KCL, KTA-version



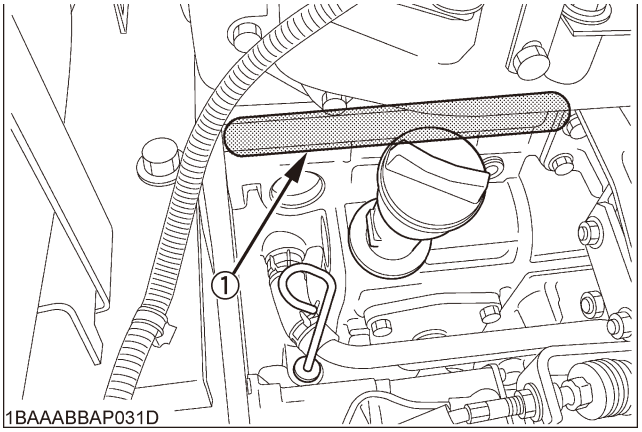
Name plate : Code No. RA018-57721

(3) Engine serial number
e.g. D1105-5L0025
"5" indicates year of 2005 and "L" indicates June. So, 5L indicates that the engine was manufactured in June 2005.

(2)Machine and engine serial number



(1) Machine serial No.



(1) Engine serial No.

(Engine production month code)

Month	Serial No.	
	0001~9999	10001~19999
Jan.	A	B
Feb.	C	D
Mar.	E	F
April	G	H
May	J	K
June	L	M
July	N	P
Aug.	Q	R
Sept.	S	T
Oct.	U	V
Nov.	W	X
Dec.	Y	Z

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 clothed. (Under no circumstances may workers wear undershirts only.)
   Cuffs must be kept buttoned, and any tears must be mended.)
2. Wear safety shoes.
3. Do not wear cotton gloves when working on the internal section of engine, reduction gears or hydrauric units for repair or others, or when using a hammer. Wear leather gloves, however, 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 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. Crane 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 44lb (20kg).
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 batteries, 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) Acceptance inspection

The machine must be checked before it is disassembled to record existing conditions, such as those listed below.

Model, serial number, and hourmeter reading

- Reason for repair and repair history
- Element stains
- Fuel and oil condition
- Parts damage *(Take photographs if necessary.)

(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 assembles only after removing the coating.
3. Separated parts must be correctly reassembled using alignment marks.
4. As a rule, use a press to reassembled bearings, bushing and oil seals. Use pads when using a hammer.

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 panel, seat stand, 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.

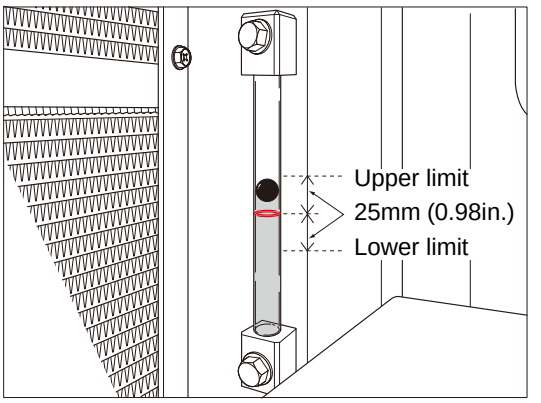
b Make Sure the Safety decals and Wireharness Clamps are in their Specified Positions.

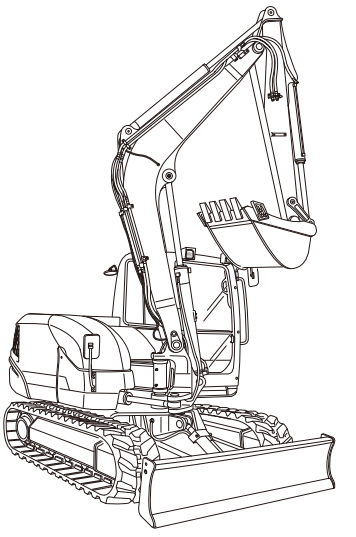
c With the Machine Front in a Specified Posture, Check the Amount of Hydrauric Oil

Checking the oil level (For further details, 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.

Place the front in the left swing position with the arm, boom and bucket cylinders stretched most.

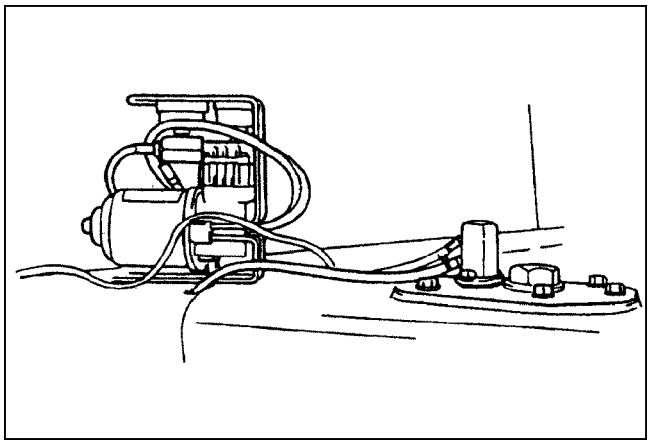


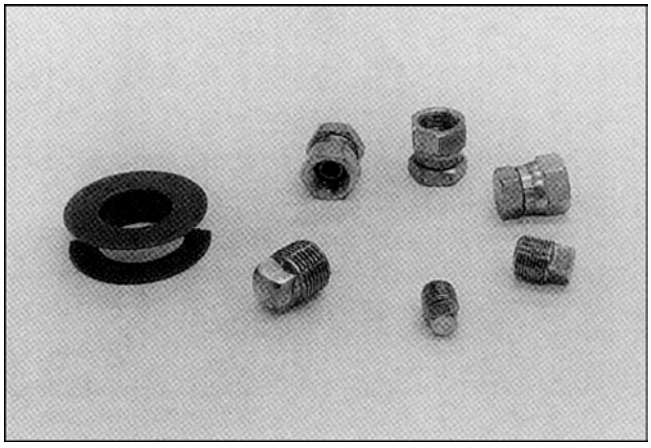


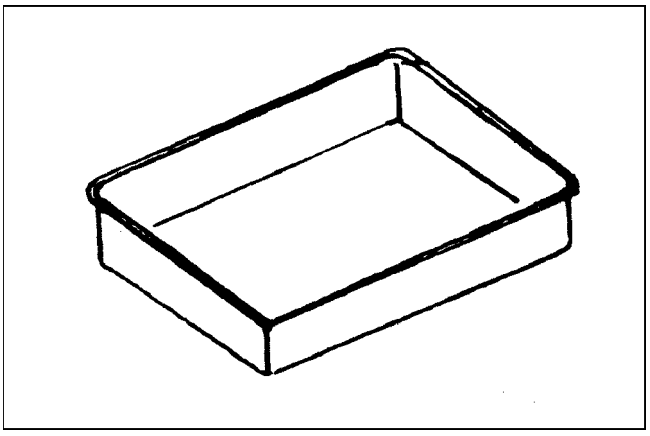
E.SERVICING FUNDAMENTALS

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.

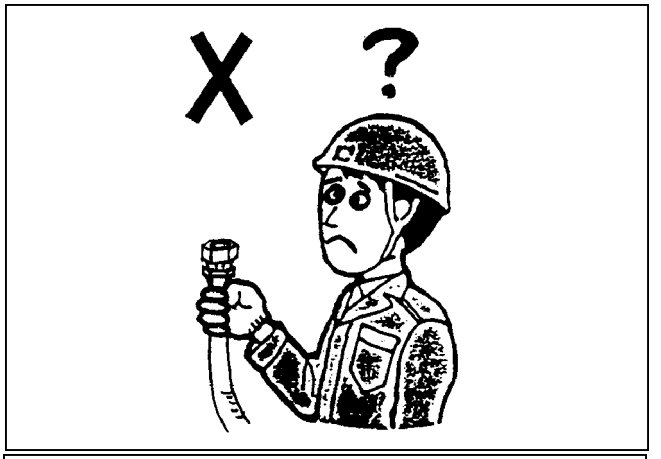
Types of screw adhesive
Equivalent to LOCTITE 271 (Heavy-duty) Equivalent to THREE-BOND 1305P (Heavy-duty) Equivalent to THREE-BOND TB1401B (Light-duty) Unless specified otherwise, use THREE-BOND 1324 (Medium-duty).

Type of instantaneous adhesive
Use THREE-BOND 1733 or 1741E

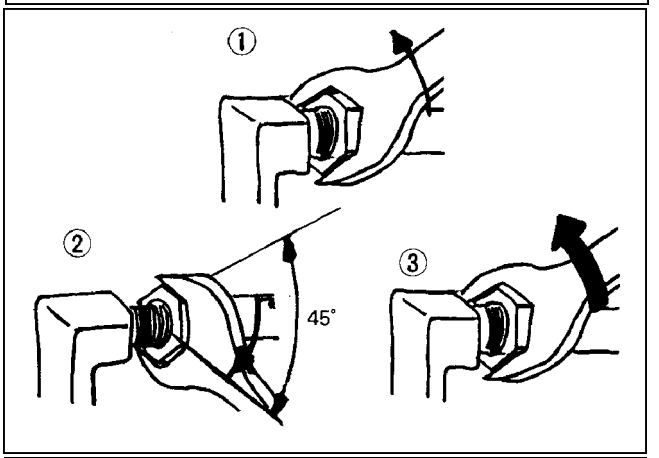
The word “LOCTITE“ in this manual denotes the red-color type.

(3) Precautions in disassembling the hydraulic equipment

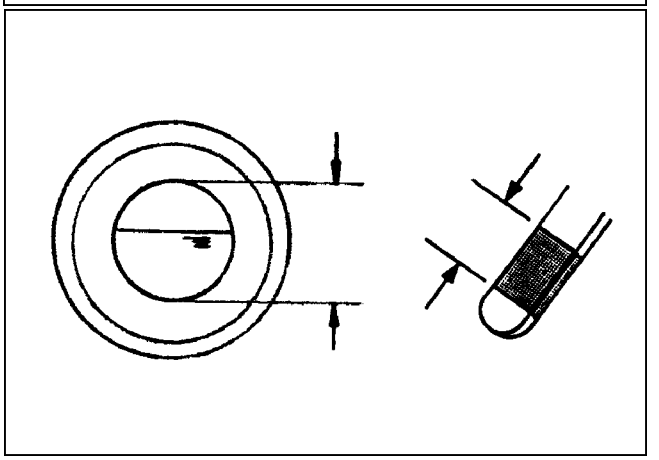
- Use a vacuum pump, plugs, oil pans, waste cloth and the like to prevent oil from running out or splashing.
  Wipe out leaking oil completely first and then add oil as required.
- Protect the openings with plugs, covers or the like to keep off foreign matters. Most of hydraulic system troubles are caused 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.



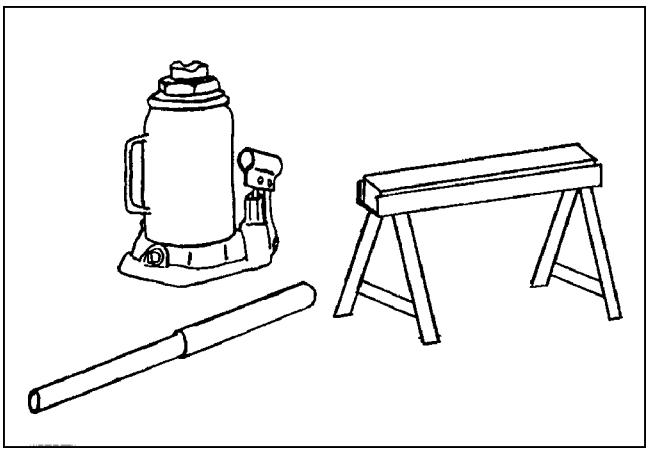
(4) Precautions in tightening hoses and pipes.
- Flexible hoses have a slight natural bend of their own. Utilize the natural bend. Be also careful not to twist them.
- Be careful not to confuse the routes of the hoses.
- Do not hold the hoses in tight contact with their adjacent parts and surfaces.



- 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.

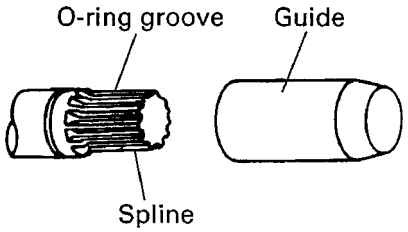


(5) The quantities of oil, fuel, water and others, except for the oil to be filled in the track rollers and idlers, are listed just as reference. Fill up the fluid up to the specified center level of a level gauge if it is provided.

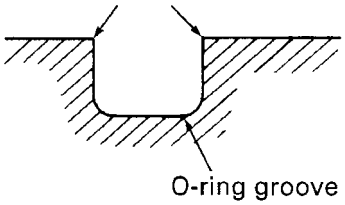


(6) Security support the machine with a jack and a supporting jig when it is jacked up for servicing.
(7) Be sure to use a crane in disassembling and reassembling heavy parts and components (frame, front attachment, crawler, etc.).

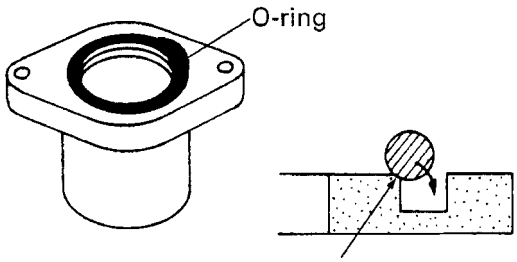
b. O-ring, Oil seal, Circlip and Roll Pin



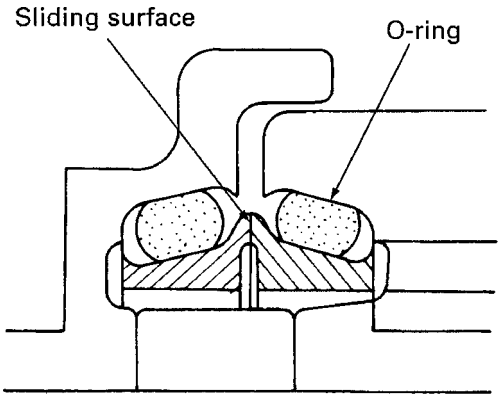
(1) General precautions
- Make sure the O-ring and the oil seal are free of anything unusual (uneven surface, scratches, chipping, etc.).
- Check the O-ring groove for burrs. Correct, if any, using an oil stone or the like.
- When putting a part past a sharp edge into position, protect such edge with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

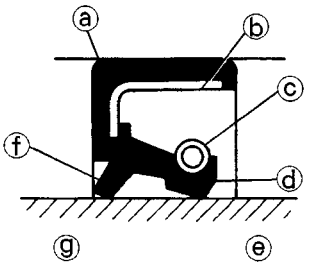


(3) Floating seal
- Be sure to wipe oil off the O-ring and the O-ring contact surface. (Note, however, that oil must be applied thinly over those of the wheel motor.)
- In fitting the O-ring into the floating seal, be careful not to twist the O-ring.
- Before installing the floating seal together with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

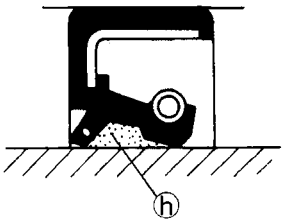


(4) Oil seal

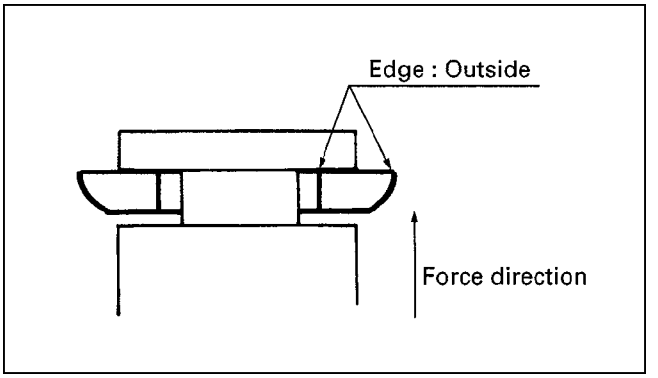
- Do not confuse the orientation of the oil seal lips. Direct the main lip toward the oil chamber; in other word, toward what is to be sealed.



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

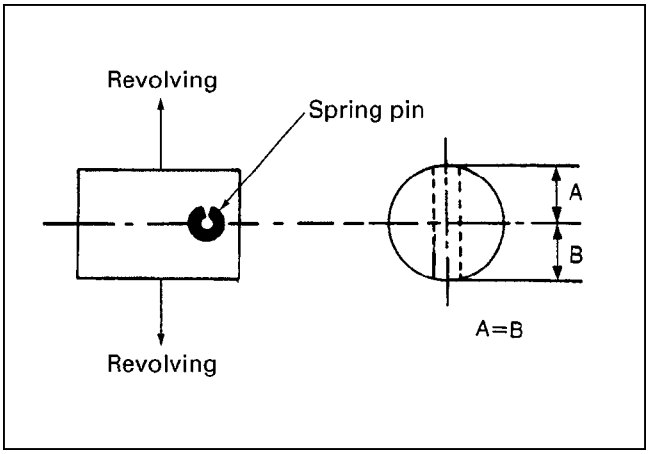


- If in dry state, the oil seal may wear out when running in the machine. To prevent this, be sure to apply lubricant (grease) over the lip sliding surface. If provided also with a dustproof lip, fill the space between this lip and the main lip with grease.
- As a rule, use a press to press-fit the oil 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.



(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.

c. Piping

(1) General precautions

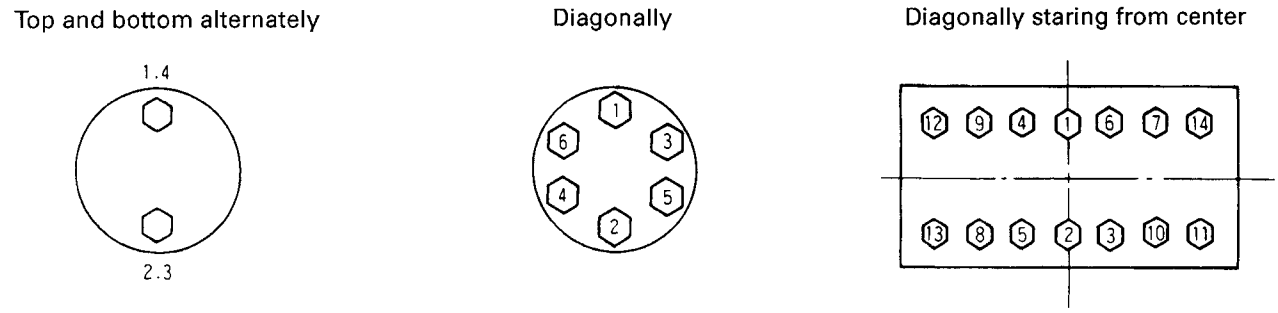
- Tightening the pipe socket to the specified torque. If too tight, the socket itself or a hydraulic component may get damaged. It too loose, an oil leak may result.
- In connecting a new hose or pipe, tighten its nut first to the specified torque and then turn it back (about 45°). Then tighten it again 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 disconnecting 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.

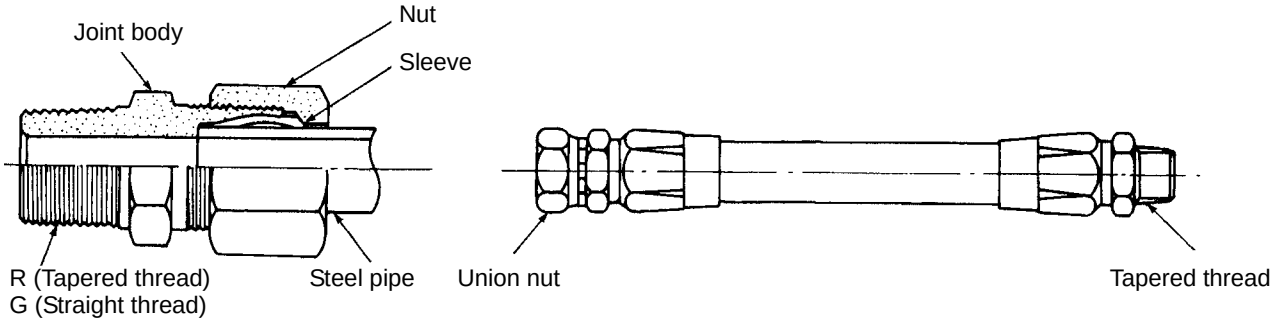
(2) Hydraulic hose

Check the hydraulic hose for too tight a connect or twist.
*Excessively tight contact
Let's suppose that a hose is in contact with another hose or other part. If the hose is 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) Hose clamp (screw-in type) tightening torque chart

Applicable diameter/Part code	Part name.	Tightening torque
(Ø10 ~ 14) 6C040-5872Δ	Hose clamp (screw-in type 14)	2.5~3.4N.m (25~35kgf.cm)1.8~2.5ft.lbs
(Ø12 ~ 16) 09318-81916	Hose clamp (screw-in type)	2.5~3.4N.m (25~35kgf.cm)1.8~2.5ft.lbs
(Ø13 ~ 20) RB101-6363Δ	Hose clamp (13-20)	2.5~3.4N.m (25~35kgf.cm)1.8~2.5ft.lbs
(Ø19 ~ 25) 09318-89024	Hose clamp (screw-in type)	2.5~3.4N.m (25~35kgf.cm)1.8~2.5ft.lbs
(Ø31 ~ 40) 09318-89039	Hose clamp (screw-in type)	2.5~3.4N.m (25~35kgf.cm)1.8~2.5ft.lbs
(Ø36 ~ 46) 09318-89045	Hose clamp (screw-in type)	2.5~3.4N.m (25~35kgf.cm)1.8~2.5ft.lbs
(Ø15 ~ 25) RC101-6458Δ	Hose clamp (15-24)	4.9~5.9N.m (50~60kgf.cm) 3.6~4.4ft.lbs
(Ø26 ~ 38) 68311-7282Δ	Hose clamp (26-38)	4.9~5.9N.m (50~60kgf.cm) 3.6~4.4ft.lbs
(Ø32 ~ 44) RD411-6382Δ	Hose clamp (32-44)	4.9~5.9N.m (50~60kgf.cm) 3.6~4.4ft.lbs
(Ø40 ~ 55) RD411-6318Δ	Hose clamp (40-55)	4.9~5.9N.m (50~60kgf.cm) 3.6~4.4ft.lbs
(Ø44~ 53) 09318-89052	Hose clamp (screw-in type)	4.9~5.9N.m (50~60kgf.cm) 3.6~4.4ft.lbs
(Ø49 ~ 60) 67890-5828Δ	Hose clamp (screw-in type 60)	4.9~5.9N.m (50~60kgf.cm) 3.6~4.4ft.lbs
(Ø50 ~ 60) RC401-6319Δ	Hose clamp (50-60)	4.9~5.9N.m (50~60kgf.cm) 3.6~4.4ft.lbs
(Ø58 ~ 75) 36919-0459Δ	Hose clamp (58-75)	4.9~5.9N.m (50~60kgf.cm) 3.6~4.4ft.lbs
(Ø66 ~ 88) 3F740-0459Δ	Hose clamp (66-88)	4.9~5.9N.m (50~60kgf.cm) 3.6~4.4ft.lbs
(Ø77 ~ 95) 69284-6137Δ	Hose clamp (77-95)	4.9~5.9N.m (50~60kgf.cm) 3.6~4.4ft.lbs

(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

Refer to the tightness 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

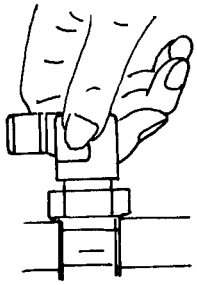
[ex. bolts]

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

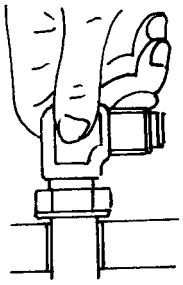
Size	N·m	kgf·m	ft·lbs
G1/8	15.0~16.5	1.5~1.7	11.1~12.2
G1/4	24.5~29.4	2.5~3.0	18.1~21.7
G3/8	49.0~53.9	5.0~5.5	36.1~39.8
G1/2	58.8~63.7	6.0~6.5	43.4~47.0
G3/4,G1	117.6~127.4	12.0~13.0	86.7~94.0
G1,1/4	220.5~230.3	22.5~23.5	162.6~169.9
7/8-14UNF	55.9~60.8	5.7~6.2	41.2~44.8



Tightening procedure

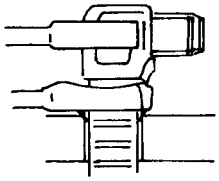
1. Connecting with the valve
   - Screw in the elbow by hand until the washer comes into contact.

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

1.Face sealing (ORS) type

Tighten to the specified torque.

Screw size	Part code of O ring
9/6UNF	RD809-6184Δ
11/16UNF	RD809-6161Δ
13/16UNF	RD809-6162Δ
1-14UNS	RD809-6163Δ

9/16UNF size
35.2~43.1N.m (3.6~4.4kgf.m) 26.0~30.8ft.lbs

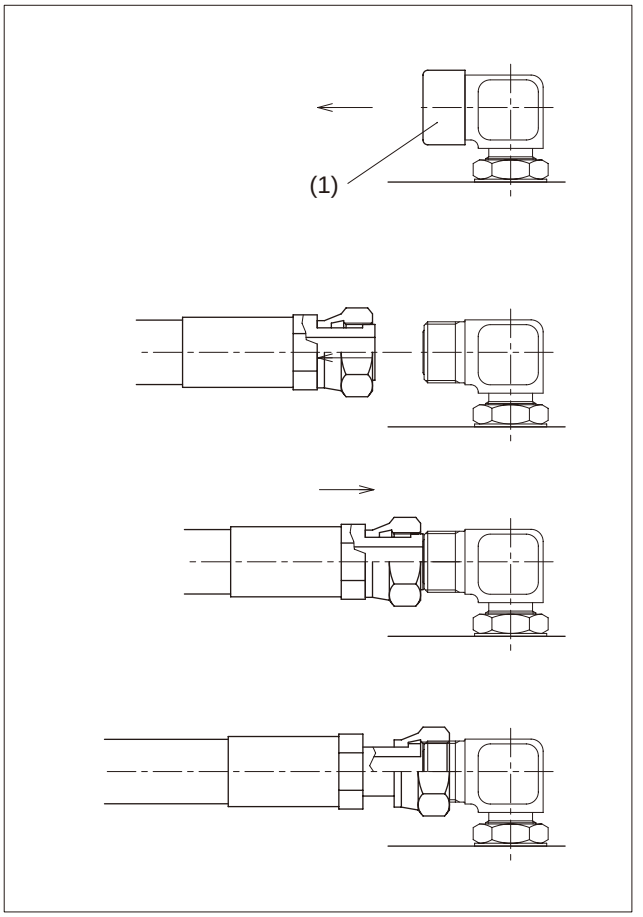
11/16UNF size
60.0~73.5N.m (6.1~7.5kgf.m) 44.3~54.2ft.lbs

13/16UN size
70.6~86.2N.m (7.2~8.8kgf.m) 52.1~63.6ft.lbs

1-14/16UNS size
105.8~129.4N.m (10.8~13.2kgf.m)
78.0~95.4ft.lbs

2.Connecting the face sealing (ORS) type hose

Take the procedure at left.



Connecting the face sealing (ORS) type hose

1)Remove the protective cap from the adaptor and make sure the O ring is installed in its groove. (If the O ring is missing, fit the specified-size one in position.)

(1)Protective cap

2)Shift the hose's cap nut in the direction of arrow until the O ring contact face stretched out of the cap nut.

3) Bring the hose's O ring contact face in close contact with the joint's O ring.
Make sure they do not come off each other.

4) Tighten up the cap nut to the specified torque.

Hose tightening torque chart

N.m (kgf.m) ft.lbs

Size (ORS)	Union nut (metal sealing type)	Union nut (ORS type)
1/8 (-)	7.8~11.8N.m(0.8~1.2kgf.m) 5.8~8.7ft.lbs	-
1/4 (9/16-18)	24.5~29.4N.m(2.5~3.0kgf.m) 18.1~21.7ft.lbs	35.2~43.1N.m(3.6~4.4kgf.m) 26.0~31.8ft.lbs
3/8 (11/16-16)	37.2~42.1N.m(3.8~4.3kgf.m) 27.4~31.1ft.lbs	60.0~73.5N.m(6.1~7.5kgf.m) 44.3~54.2ft.lbs
1/2 (13/16-16)	58.8~63.7N.m(6.0~6.5kgf.m) 43.4~47.0ft.lbs	70.6~86.2N.m(7.2~8.8kgf.m) 52.1~63.6ft.lbs
3/4 (1-14)	117.6~127.4N.m(12.0~13.0kgf.m) 86.7~94.0ft.lbs	105.8~129.4N.m(10.8~13.2kgf.m) 78.0~95.4ft.lbs
1, 1/4 (-)	220.5~230.3N.m(22.5~23.5kgf.m) 162.6~169.9ft.lbs	-

F. Maintenance intervals

a. Maintenance intervals chart : EU-version

	General Maintenance	Elapsed Operating Hours																							
		50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000	Interval	
Operator Services	Check fuel level																					daily	
	Check coolant level																					daily	
	Check engine oil level																					daily	
	Check hydraulic oil level																					daily	
	Check V-belt																					daily	
	Check washer liquid																					daily	
	Check water separator																					daily	
	Check, clean air filter	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	50 h	
	Tracks and chassis: clean, visual inspection and check tension	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	50 h	
	Grease swivel gear	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	50 h	
	Grease front attachments: Bucket and bucket link pin, Boom swing fulcrum		○		○		○		○		○		○		○		○		○		○	100 h	
	Grease front attachments: Others					○					○					○					○	250 h	
	Grease swivel gear bearing				○				○				○				○				○	200 h	
	Clean air conditioner filter				○				○				○				○				○	200 h	
	Check air conditioner drive belt				○				○				○				○				○	200 h	
	Clean air conditioner condenser				○				○				○				○				○	200 h	
	Drain water in fuel tank										○										○	500 h	
	Check battery electrolyte level										○										○	500 h	
	Check air conditioner pipes and hoses																					every 2 years	

Servicing by skilled personnel or KUBOTA dealer	Service	Elapsed Operating Hours																				Interval
		50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000	
	Inspect coolant hoses and clamps					○					○					○					○	250 h
	Check/adjust V-belt tension					○					○					○					○	250 h
	Grease pilot valve linkage					○					○					○					○	250 h
	Change engine oil and oil filter										○										○	500 h
	Change drive unit oil	◉									○										○	500 h
	Change fuel filter cartridge										○										○	500 h
	Change hydraulic return line filter element					◉					○										○	500 h
	Renewing the pilot circuit filter																				○	1000 h
	Change hydraulic oil and suction filter																				○	1000 h
	Change air filter elements																				○	1000 h
	Change air conditioner filter																					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 air conditioner pipes and hoses																					every 2 years
	Change coolant																					every 2 years
	Change hydraulic hoses																Please contact your KUBOTA dealer.					every 6 years
	Check refrigerant (gas)																					Service as required
	Safety inspection																					annually

◉First operation

b. Maintenance interval chart : PP-version

To be announced soon.

c. Water and oil quantity

	Unit			Remarks
Radiator	L gal	8.2 (2.17)		Kubota LLC-N-50F 50%
Reserve tank	L gal	1.3 (0.34)		
Engine oil with filter	L gal	10.7 (2.83)		Engine Oil SAE10W30(CF-4)
Hydraulic oil Full	L gal	146 (38.6)		ISO 46
Hydraulic oil Tank gauge center	L gal	75 (19.8)		ISO 46
Wheel motor	L gal	1.3 (0.34)		Gear Oil SAE90 (API GL-4)
Track roller	cc cu.in.	80 (4.88)		Engine Oil SAE30(CD)
Upper roller	cc cu.in.	60 (3.66)		SAE30(CD)
Front idler	cc cu.in.	80 (4.88)		
Fuel tank	L cu.in.	115 (30.4)		Diesel Fuel JIS #3 (Initial)

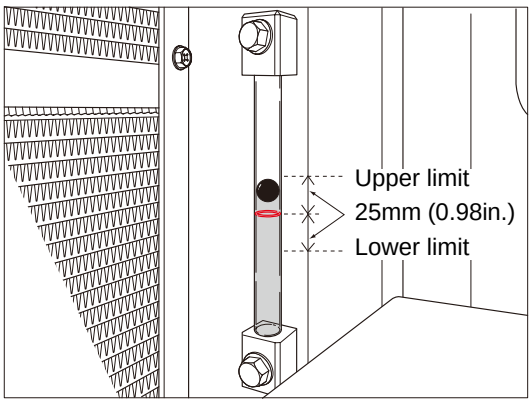
Note : Type of oil, fuel and coolant in the remarks are filled in the Factory.

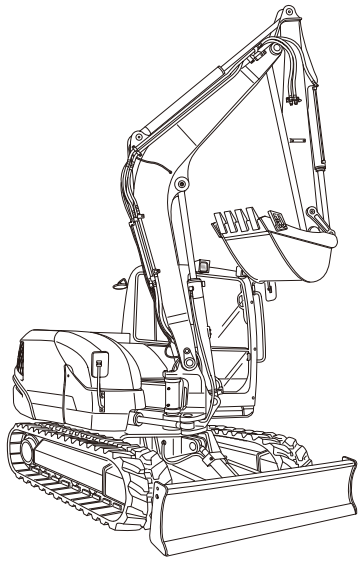
Grease	Supply grease to such amount that it oozes out of periphery of the rotating end.	Ultra -pressure grease : EP2, Beacon Q2
Control levers and links Du-bushing	Assemble after applying grease	

Inspection of hydraulic oil

The hydraulic tank of KX080-3 is pressurized type.
When checking the hydraulic oil level, satisfy the following conditions and make sure the oil level is above the center the oil gauge.

1) Oil temp. should be between 10 ~ 30 °C (50 ~ 86 °F)
2) Stance of front attachment :
   Swing : Left end
   Dozer blade : Down to the ground
   Boom :The highest position
   Arm : Crowd to end
   Bucket : Crowd to end





In this way, large amount of the hydraulic oil in the cylinders when checking and replenishing is supposed to return back into the hydraulic tank in order to keep the tank pressurized.

d. 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 only for EU-version and CD, CE or CF for North America and 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)			

f. 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)	*2	
8	Hydraulic hose (Arm cylinder)	*2+2	
9	Hydraulic hose (Bucket cylinder)	*4	
10	Hydraulic hose (Swing cylinder)	2	
11	Hydraulic hose (Dozer cylinder)	4	
12	Hydraulic hose (Service port)	*2+2	
13	Hydraulic hose (Swivel motor)	2	

Note: The *-marked hydraulic hoses are Kubota's genuine ultra wear-resistant hoses. Be sure to use these parts.

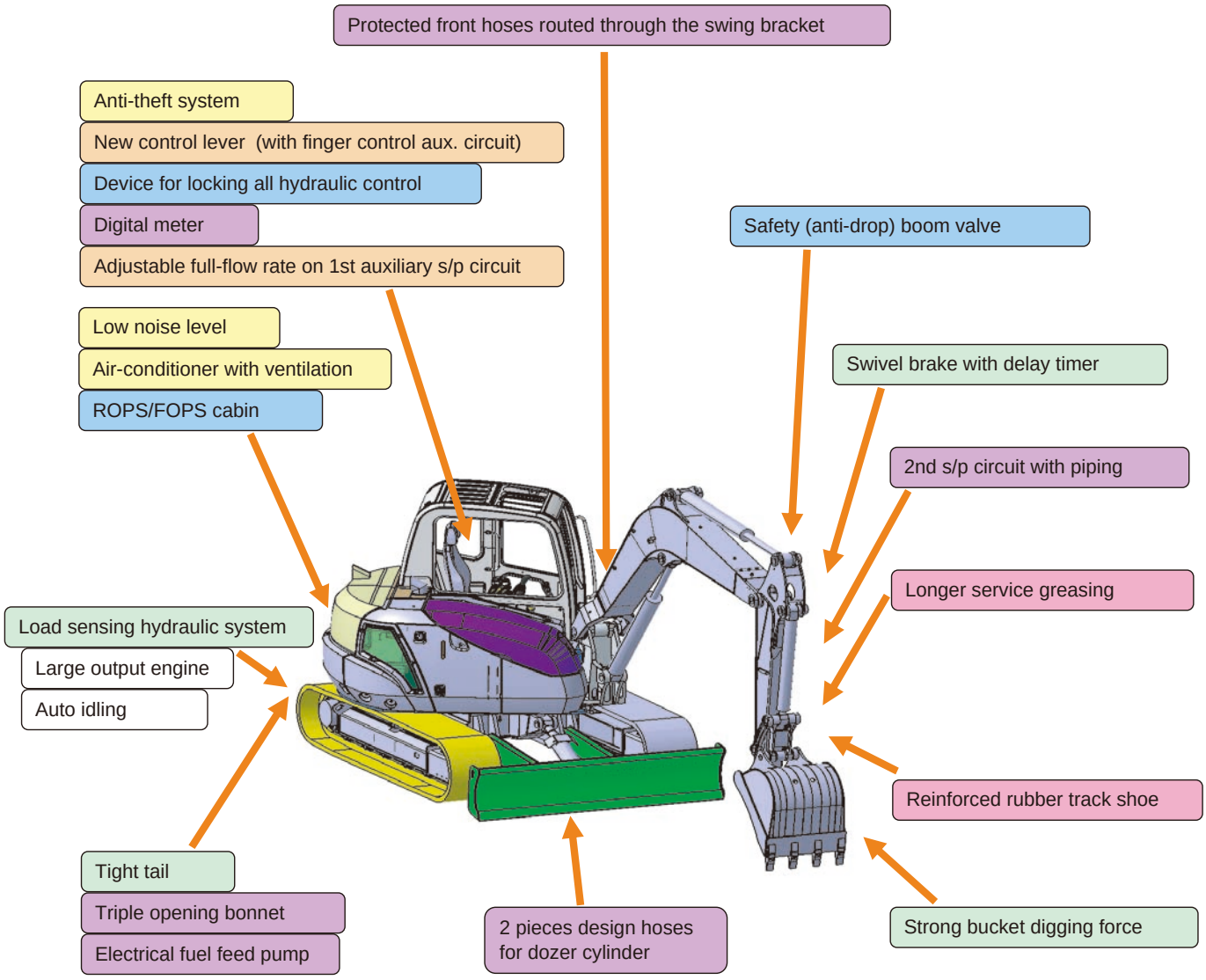
II. Machine Body

Mechanism Section

A. New Product Feature II-M-3
a. Feature, quick chart II-M-3
b. Feature points II-M-4
B. Maintenence components layout II-M-11
C. Rubber track vs Iron track II-M-13
D. Greasing intervals II-M-14

A.New Product Feature

a. Feature, quick chart



1. Performance

1-1. Kubota original engine
1-2. Working range and stability
1-3. Digging force
1-4. Lifting capacity
1-5. Load sensing system
1-6. Auto Idling system
1-7. Max. Hydraulic flow adjustfor auxiliary circuit

2. Durability and service ability

2-1. Rubber crawler
2-2. Fuel refilling pump
2-3. Triple opening bonnet

3. Safety

3-1. ROPS / FOPS cabin
3-2. Anti-fall valve
3-3. Anti-theft system

4. Operator's comfort

Air conditioner
Radio installation kit
Tight tail
Other accessories (Cup holder, etc)

b. Feature points

1. Performance

1-1. Kubota original engine

Kubota original new DI engine contributes for stronger digging force, lower noise level, and lower fuel consumption.

		Kubota KX080-3	Kubota KX251	Takeuchi TB175
Model		V3800DI	V3300-B	4TNE98-TB
Brand		Kubota	Kubota	Yanmar
Output	kW/rpm	47.8/2000	43.4/2300	43.5/2100
	PS/rpm	65/2000	59.0/2300	59.2/2100
Displacement	cc	3769	3318	3318

1-2. Working range and stability

Working range

		Kubota KX080-3	Kubota KX251	Takeuchi TB175	Difference with TB175	
Max. digging reach at ground level	mm	7170	6720	7245	-75mm	-1%
Max. digging depth	mm	4600	4220	4590	10mm	0%
Max. digging height	mm	7300	6665	7290	10mm	0%

Static stability

condition of measurement		long arm w/o QC	std arm w/o QC	long arm w/o QC		
Over side	kgf	734	895	724	10kg	1%
Over front	kgf	1062	1100	942	120kg	13%

QC : Quick coupler

Rear overhang

Track width	mm	2200	2150	2150	50mm	2%
Rear overhang with 90 degree swivel	mm	320	495	645	-325mm	-50%
TTL width	mm	2520	2645	2795	-275mm	-10%

Wide as conventional machine, more stable and compact than conventional machine.

1-3. Digging force

Realized strongest bucket digging force.

		Kubota KX080-3	Kubota KX251	Difference KX251	Takeuchi TB175	Difference
Bucket	kN	65.2	51.5	+27%	52.7	+24%
Arm	kN	38.1	37.2	+2%	36.7	+4%

1-4. Lifting capacity

Keeping better lifting capacity than TB175

Comparison with 1470kg load.



Kubota KX080-3 machine (EU-version)



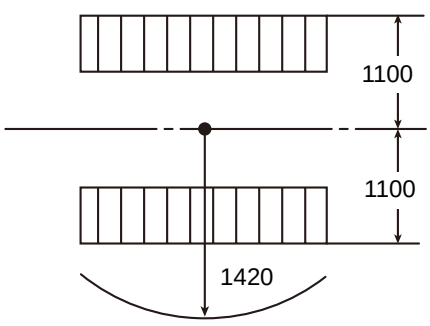
Takeuchi TB175

		Kubota KX080-3	Takeuchi TB175
condition of measurement		long arm w/o QC	long arm w/o QC
Lifting capacity	kgf	1534	1318

Difference with TB175	
216kgf	16%

QC : Quick coupler

(Total width and Overhang)



1) Total width : 2520
2) Over hang : 320

1-5. Load sensing system

Load sensing system enables smoother movement of each actuator. It means pump supplies required oil flow according to the lever stroke.

Especially when leveling or lifting, it lets you smoother operation.

Takeuchi TB175 does not adopt this system.

1-6. Auto Idling system



Engine speed will automatically reduced and Increased, operator doesn, have to push the button every time whey they wish...

Kubota KX080-3 machine



Have to push the AI button every time when increase/decrease the engine RPM.

Less possibility to use ??

Takeuchi TB175

It contributes saving cost for fuel

Fuel consumption of KX080-3 machine

9.73 liter (comes from average data of durability test)

Fuel consumption in idling time (1000 rpm)

6.00 liter/hour

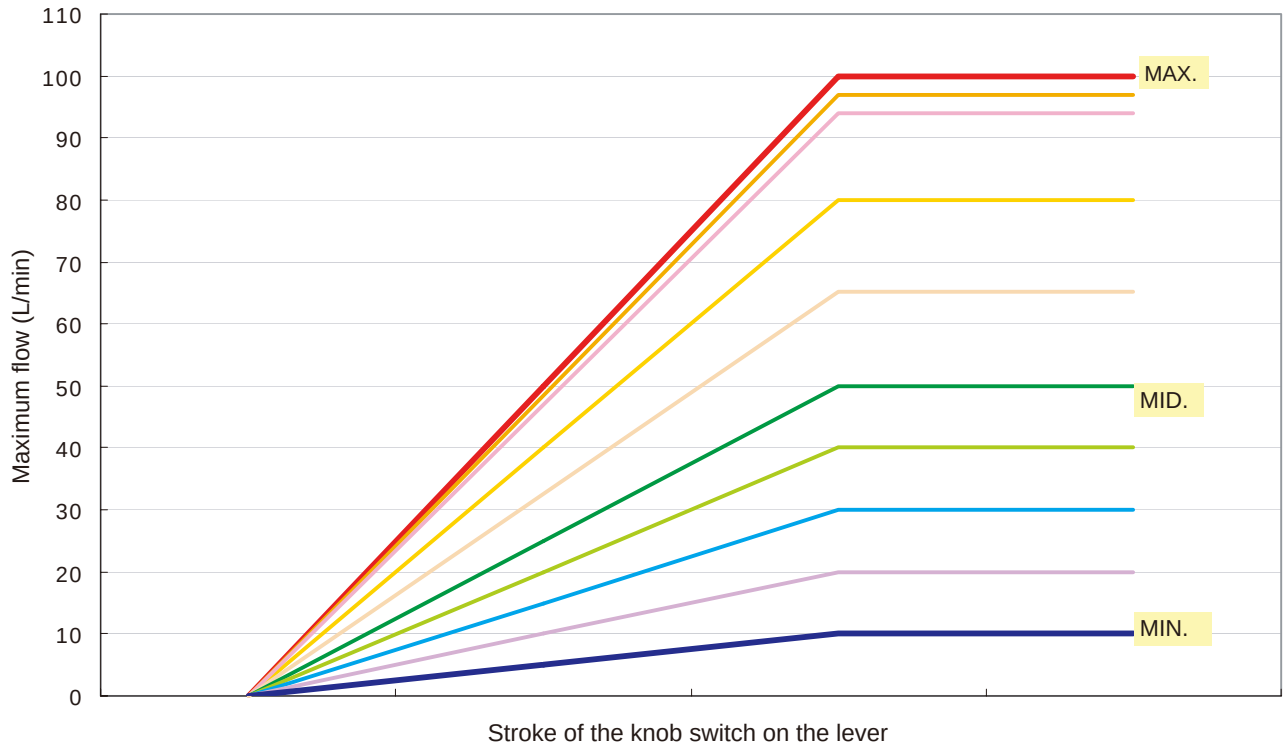
We calculate how AI contributes fuel consumption.
70% with full rpm / 30% with idling (1000rpm)
10 hours per day x 20days.

1-7. Max. Hydraulic flow adjustor auxiliary circuit (SP1)

Combined with Kubota Intelligent Control System, operator can adjust the maximum oil flow of SP1 according to the attachment you use.

Function :
You can adjust the Maximum oil flow of SP1.

Functional image chart



2. Durability and service ability

2-1. Rubber crawler

Kubota newly adopts reinforced rubber crawler, against by cutting edge.

We made a comparison test with TB175 of rubber crawler's durability at our supplier.

Test condition... 100h traveling test (10 times load = condition of after 1000h)

Comparison test results ;



Kubota KX080-3 machine



Takeuchi TB175

2-2. Fuel refilling pump

Fuel refilling pump will be adopted as standard. In addition, we will adopt the auto-stop function.(TB175 does not adopt)



Kubota KX080-3 machine



Takeuchi TB175

2-3. Triple opening bonnet

For the easier access to the components for daily check and maintenance, new 8 ton machine is designed with triplebonnet.



Takeuchi TB175



Kubota KX080-3 machine

3. Safety

3-1. ROPS / FOPS cabin

For the maximum safety for operator, Kubota adopted ROPS/FOPS certified cabin.



Kubota KX080-3 machine



Takeuchi TB175

3-2. Anti-fall valve (Holding valve)

Boom anti-fall valve will be adopted as standard.



3-3. Anti-theft system

Same as -3 series introduced in Europe, Kubota original anti-theft system will be equipped as standard.

★Easy operation

No special procedures needed. Just turn the key and the engine can be started.





Red programming key





Black operational key

★Safety / Security

☆With correct key



Only programmed keys will enable the engine to start.

☆With wrong key



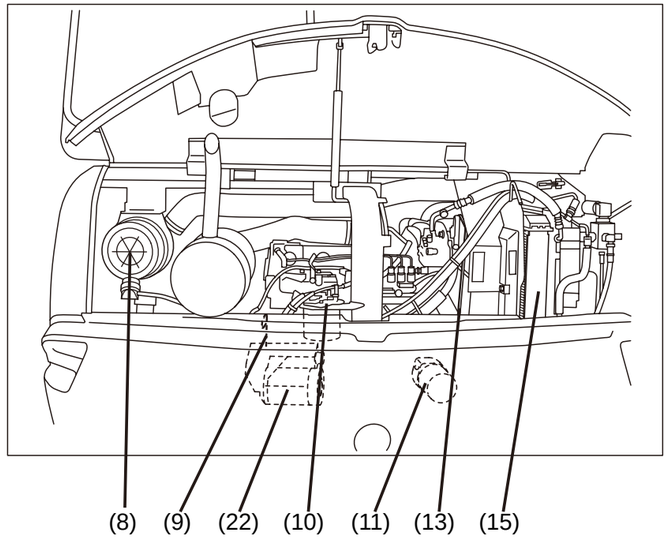
With wrong key, several attempting to start engine will activate the alarm.

★Easy operation

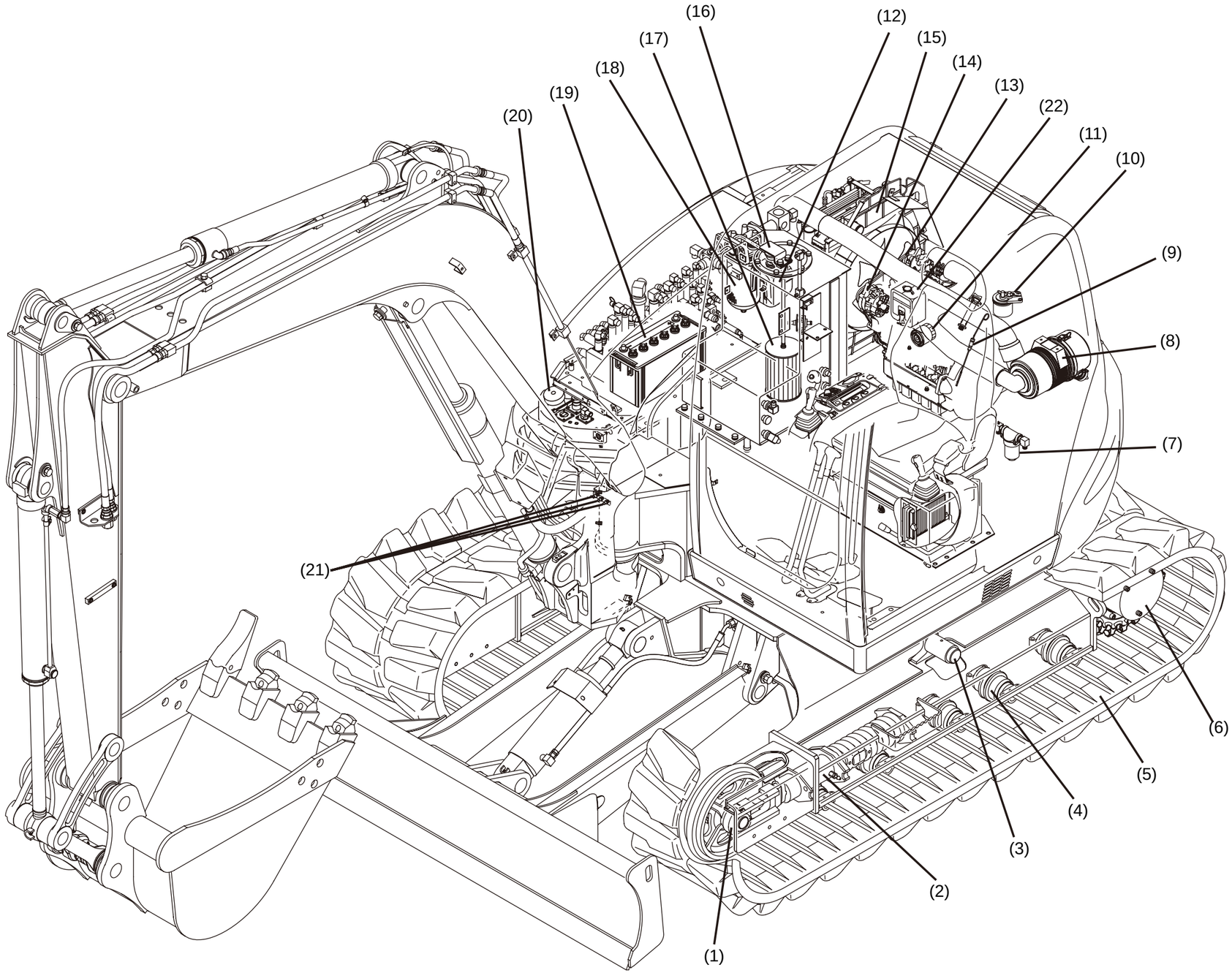
Combined with digital panel, it enables easier programming.



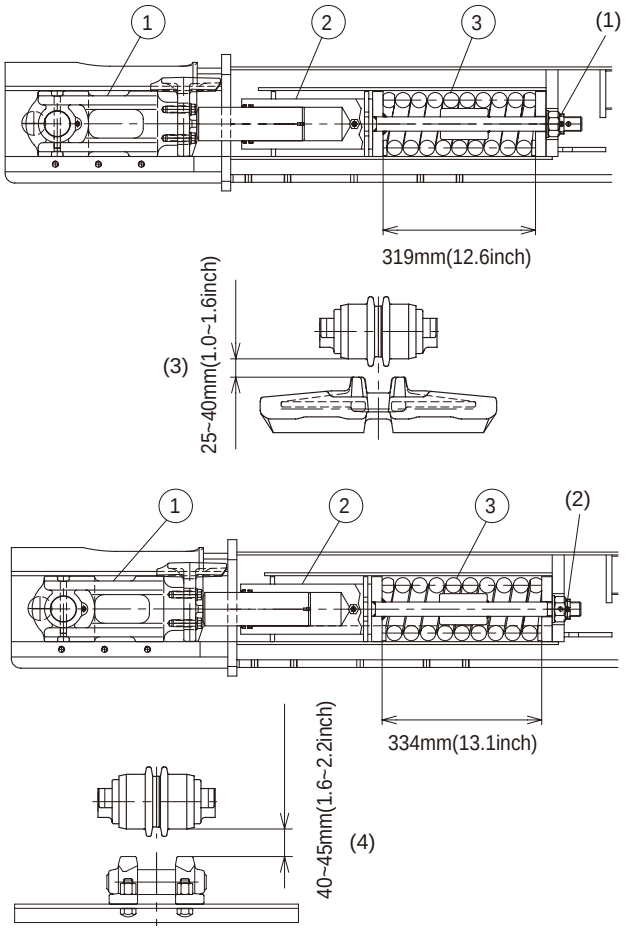
B.Maintenence components layout



(1) Idler
(2) Grease tension cylinder
(3) Upper roller
(4) Track roller
(5) Rubber track
(6) Travel motor
(7) Pilot filter
(8) Air cleaner
(9) Oil gauge
(10) Fuel filter
(11) Engine oil filter
(12) Reserve tank
(13) Fan belt
(14) Alternator
(15) Radiator
(16) Oil tank
(17) Suction filter
(18) Return filter
(19) Battery
(20) Fuel tank
(21) Grease nipples
(22) Washer tank



C.Rubber track vs Iron track



Rubber track type

No.	Part name
1	Idler assembly
2	Cylinder assembly
3	Spring assembly (rubber)

Iron track type

No.	Part name
1	Idler assembly
2	Cylinder assembly
3	Spring assembly (rubber)

(1) Set the cotter pin into the hole inside.
(2) Set the cotter pin into the hole outside.
(3) Rubber track
(4) Iron track

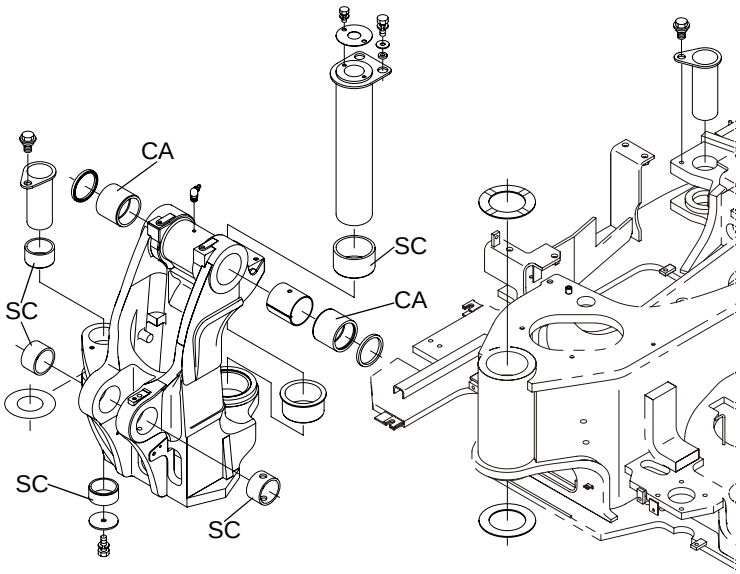
D.Greasing intervals

Greasing intervals are extended.

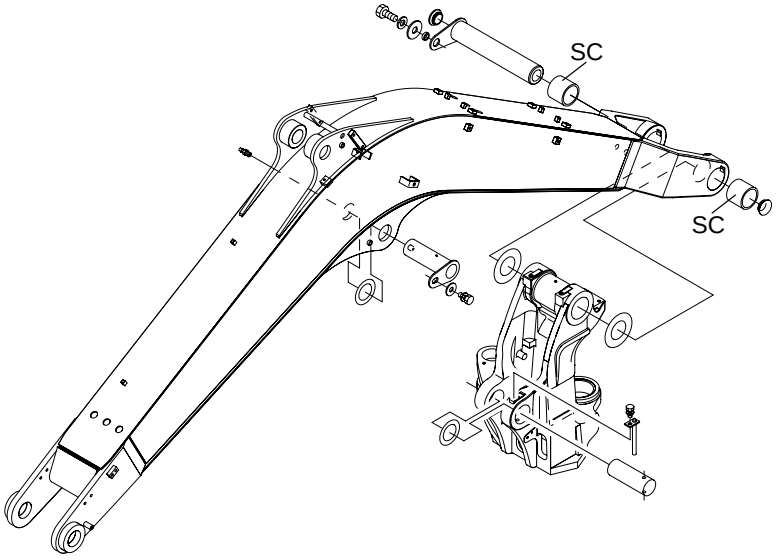
Bushing material has been changed from metal (carbon steel) to copper alloy castings (high strength brass). High-strength brass is excellent in abrasion resistance.

1. Swivel gear : Every 50 hrs
2. Swivel gear bearing : Every 200 hrs
3. Bucket, bucket link pin and boom swing fulcrum : Every 100 hrs
4. Others : 250 hrs

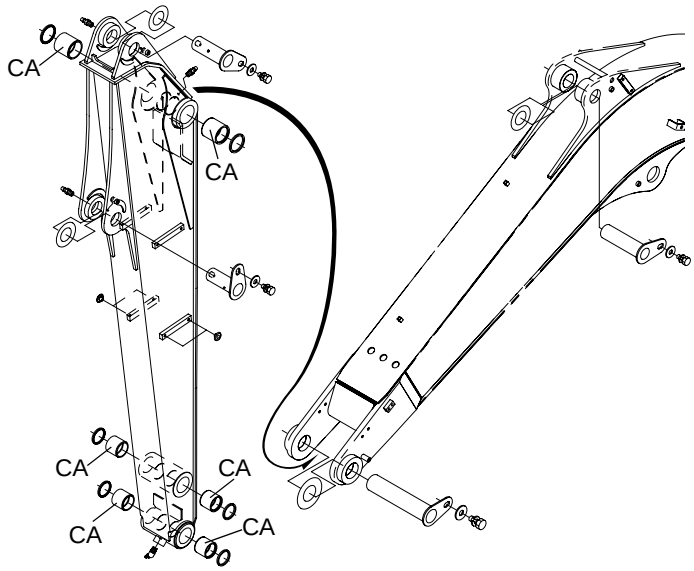
In each rotating area including cylinders, this new material bushing is installed.
In fixed areas, steel bushings are installed. (Materials used for main parts)
CA : Copper alloy casting
SC : Carbon steel



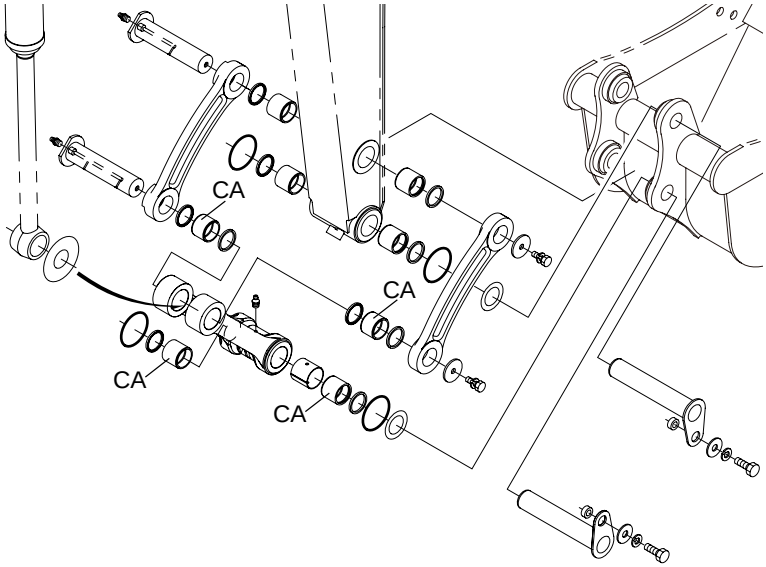
RD809-6645-0	BUSH	CA
RD809-6647-0	BUSH	SC
RD809-6648-0	BUSH	SC
RD809-6642-0	BUSH	SC
RD809-6643-0	BUSH	SC
RD809-6746-0	BUSH	SC
RD809-6747-0	BUSH	SC



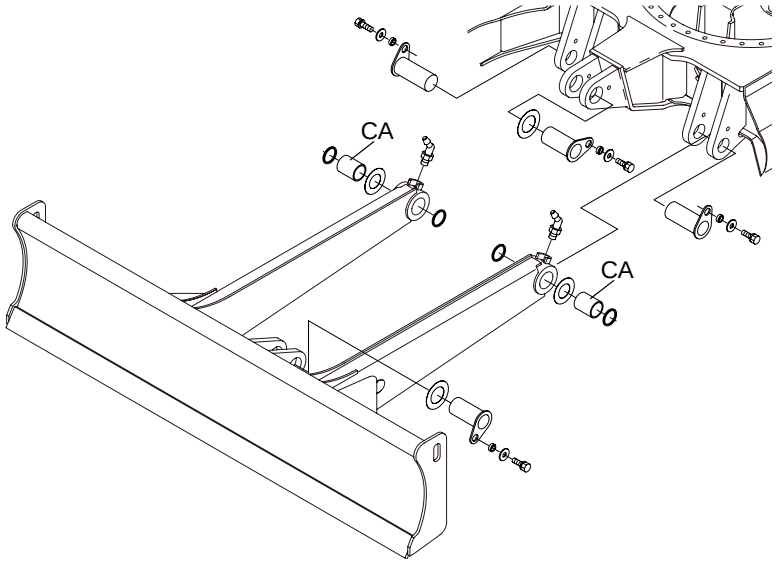
RD809-6659-0	BUSH	CA



RD809-6662-0	BUSH	CA
RD809-6665-0	BUSH	CA



RD809-6665-0	BUSH	CA
RD809-6677-0	BUSH	CA

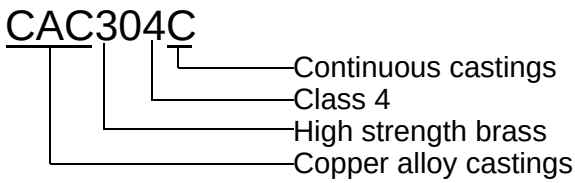


RD809-7442-0	BUSH	CA

FYI (For Your Information)

What is the material of bushing?
Answer : High strength brass

According to JIS, this is high strength brass continuous casting class 4.



High-strength brass castings

This material, commonly called manganese brass, is made by adding iron, manganese, aluminum, nickel and tin to Cu60-Zn40 brass for improved mechanical properties and corrosion resistance. Its chemical components, mechanical properties and applications are listed in Table 1 (JIS H5102-1958).
High-strength brass castings are typically used for marine propellers. Highly anti-corrosive classes in particular are widely applied for mechanical parts.
It is molten in skull crucible furnace, electric furnace or reverberating furnace. The melting temperature is 1050-1100 °C.

Table 1 High-strength brass castings (JIS H5102-1979)

Class	Code	Chemical components (%)					Tensile test		Brinell hardness (HB)		Applications
		Cu	Zn	Mn	Fe	Al	Tensile strength	Elongation	10/1000	10/3000	
Class 4	HBsC4	60.0-65.0	22.0-28.0	2.5-5.0	2.0-4.0	5.0-7.5	Over 755	Over 14	-	Over 250	Stronger, harder and more abrasion-resistant than Class 3, Used for low-speed, high-load sliding parts, bridge bearing members, bearings, bushings, nuts, worm gears, hard-wearing plates, etc.

III. Engine

Mechanism Section

A. Engine III-M-3
a. Engine specifications III-M-3
b. Performance curve III-M-5
c. Different installation from V3800 basic model III-M-7

A.Engine

a. Engine specifications

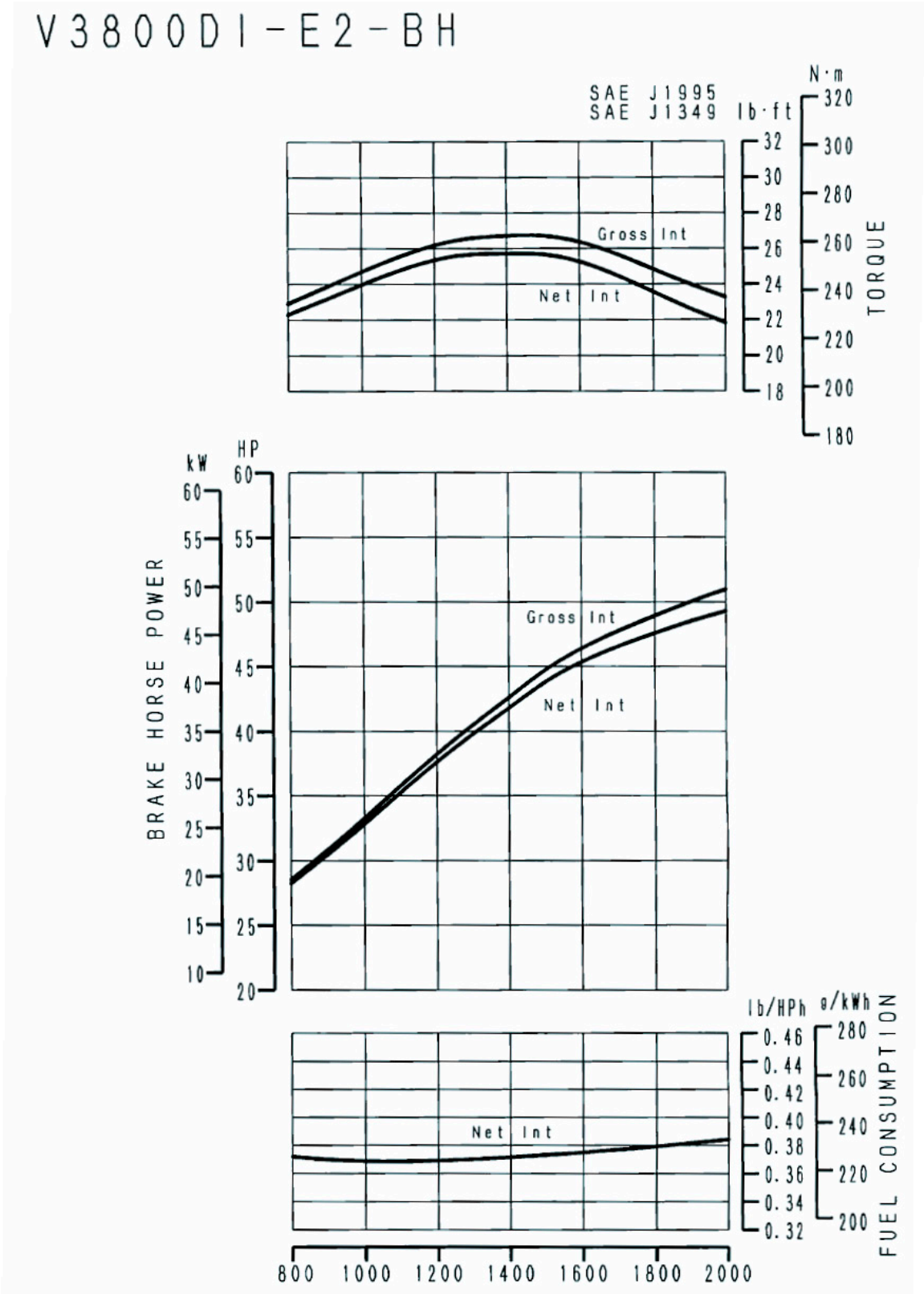
	Unit	KX080-3	Remarks
Model		V3800DI-E2-BH	
Number of cylinder		4	
Bore x Strok	mm	100 x 120	
	in	3.94 x 4.72	
Displacement	cc	3769	
	in^3	230.01	
Max. output/rpm	kW/rpm	47.8 / 2000	New engine's tolerance: 5%
	PS/rpm	65.0 / 2000	
	HP/rpm	64.1 / 2000	
Compression ratio		20	
Max. torque/rpm	N.m	262.7 / 1400	New engine's tolerance: 5%
	kgf.m	26.79 / 1400	
	ft.lbf	193.8 / 1400	
Dimensions: L x W x H	mm	798 x 548 x 789	
	in	31.4 x 21.6 x 31.1	
Dry weight	kg	278	
	lbs	612.9	
Valve clearance	mm	0.23 - 0.27	Cold condition
	in	0.0091 - 0.0106	
Firing sequence		1-3-4-2	
Combustion chamber		(Direct Injection)	
Compression pressure (A)/(B)	MPa	3.73 - 3.92 / 2.90	Ref. value/Service limit
	kgf/cm^2	38 - 40 / 29.6	
	psi	540 - 569 / 421	
Fan belt		Bando RPF3475	
Fuel consumption ratio	g/kWh	232	Net value
	g/PSh	171	
	lbs/HPh	0.382	
Fuel consumption	l/h	13.2	Load factor = 100% Fuel specific gravity = 0.88
	US gal/h	3.49	
Engine speed with idling	rmp	1050 ± 50	On the machine
Engine oil pressure with rated engine rpm	kPa	196 - 392 / 98	
	kgf/cm^2	2.0 - 4.0 / 1.0	
	psi	28 - 57 / 14	
Fuel injection pressure 1st stage/2nd stage	MPa	18.6 / 23.5	
	kgf/cm^2	190 / 240	
	psi	2702 / 3414	
Engine oil consumption ratio	g/kWh	0.48	
	g/PSh	0.35	
	lbs/HPh	0.00078	

Engine electric components

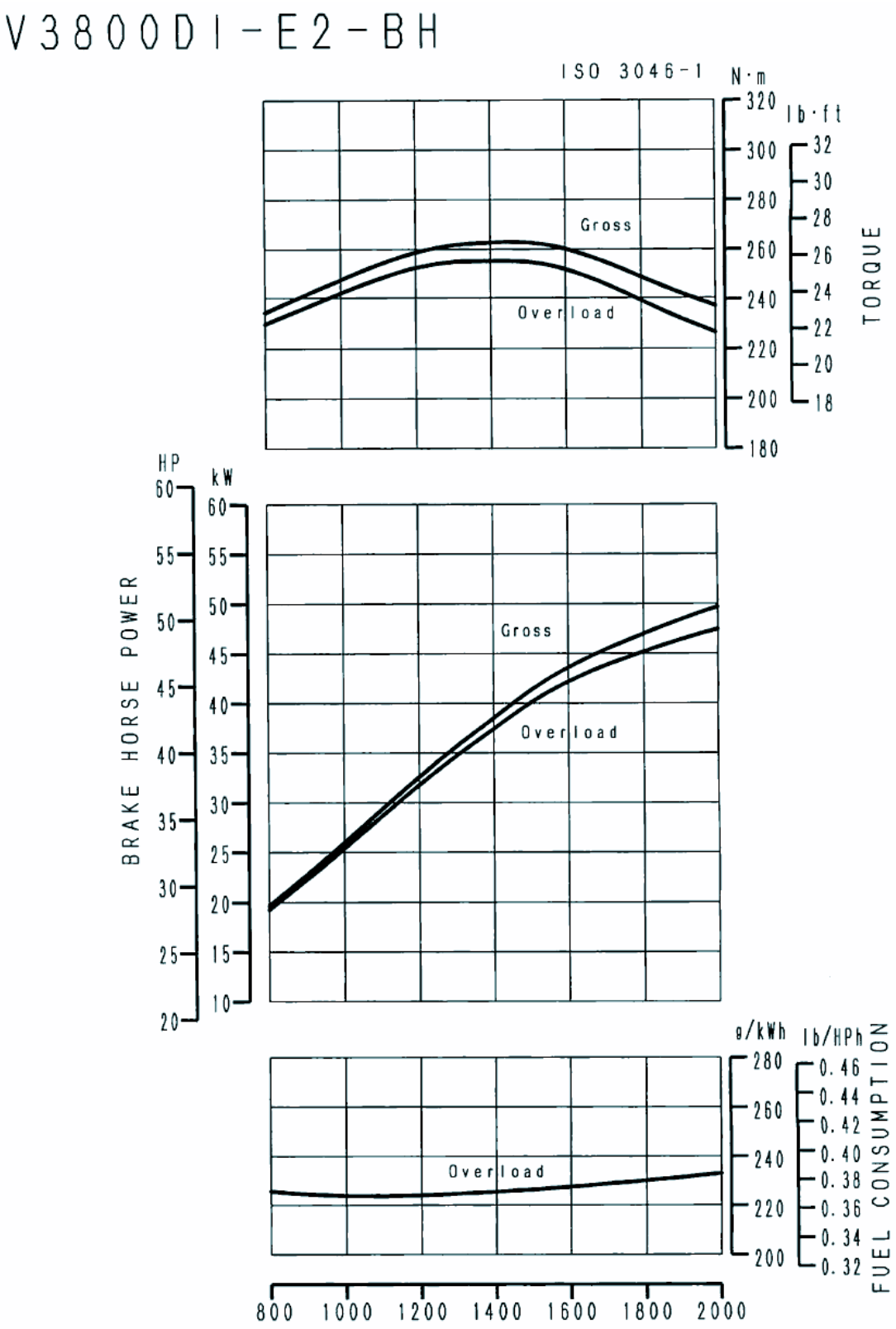
	Unit	KX080-3	Remarks
Engine model		V3800DI-E2-BH	
Fuel injection pump type		Bosch P type mini-pump	
Nozzle type		Bosch P type	
Fuel injection pressure 1st stage/2nd stage	MPa	18.6 / 23.5	
	kgf/cm^2	190 / 240	
	psi	2702 / 3414	
Alternator		12V 720W	
Kubota Part No.		1G524-6401-0	
Regulator adjusting voltage	V	14.4 - 15	at 20°C (68°F)
Battery type (JIS)		130E41R	
Nominal Capacity of 5 hrs rating	Ah	92	
Specific gravity of electrolite		1.28	
Starter motor		12V 2.7kW	
Manufacturer P/N		1G524-6301-0	
Starting support device		Intake air heater in intake manifold	

b. Performance curve

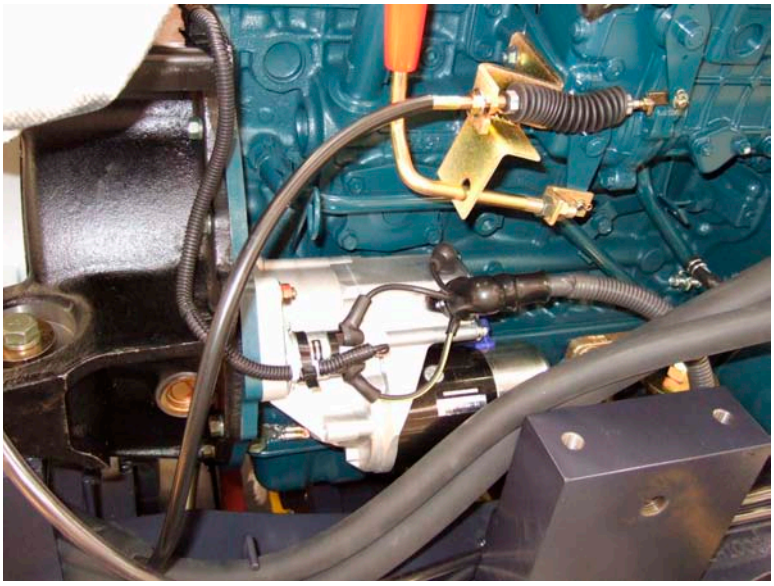
V3800DI-E2-BH (SAE)



V3800DI-E2-BH (ISO)

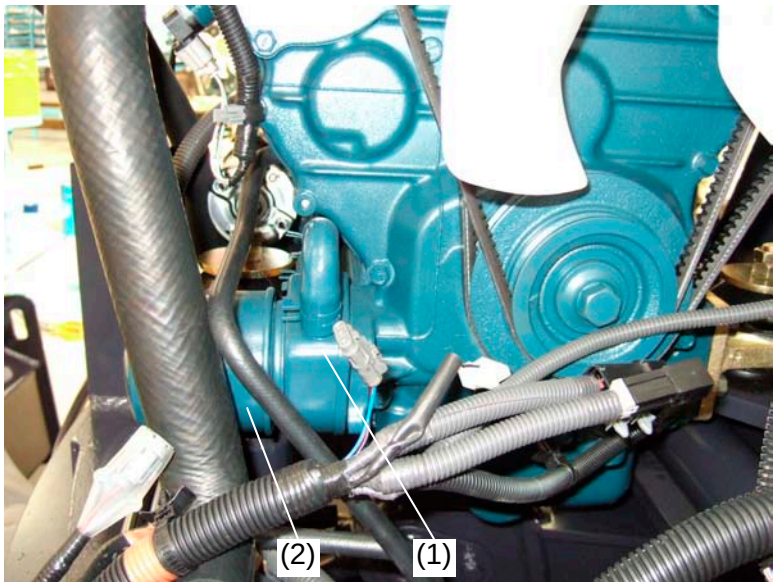


c. Different installation from V3800 basic model.



1. Starter moter

(1) Starter moter
1G524-6301-0



2. Oil filter

(1) Oil cooler
(2) oil filter

D.Engine WSM

TO THE READER

The following engine WSM has been compiled after minor changing of original V3800DI engine WSM by eliminating some pages which doesn't apply to construction machinery model of KX080-3.
Still some pages contain common specifications on V3800DI series engine.
Therefore, some date may differ from the engine mounted on constructinon machinery.
In that case, please come to the specifications in the front pages of KX080-3 WSM engine chapter.

July 2006

****

This Workshop Manual has been prepared to provide servicing personnel with information on the mechanism, service and maintenance of V3800DI-E2B, V3800DI-T-E2B. 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. 97897-01870) 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 2004

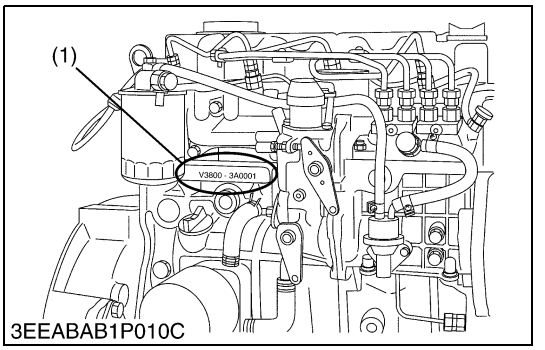
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General

1. ENGINE IDENTIFICATION III-S-32
[1] MODEL NAME AND ENGINE SERIAL NUMBER III-S-32
[2] CYLINDER NUMBER III-S-33
2. GENERAL PRECAUTIONS III-S-34
3. MAINTENANCE CHECK LIST III-S-35
4. CHECK AND MAINTENANCE III-S-37
[1] DAILY CHECK POINTS III-S-37
[2] CHECK POINTS OF INITIAL 50 HOURS III-S-39
[3] CHECK POINT OF EVERY 50 HOURS III-S-40
[4] CHECK POINTS OF EVERY 250 HOURS III-S-41
[5] CHECK POINTS OF EVERY 500 HOURS III-S-43
[6] CHECK POINT OF EVERY 1000 HOURS III-S-46
[7] CHECK POINTS OF EVERY 1 OR 2 MONTHS III-S-47
[8] CHECK POINTS OF EVERY 1500 HOURS III-S-49
[9] CHECK POINTS OF EVERY 3000 HOURS III-S-50
[10]CHECK POINTS OF EVERY 1 YEAR III-S-53
[11]CHECK POINTS OF EVERY 2 YEARS III-S-54
5. SPECIAL TOOLS III-S-57

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 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 ~

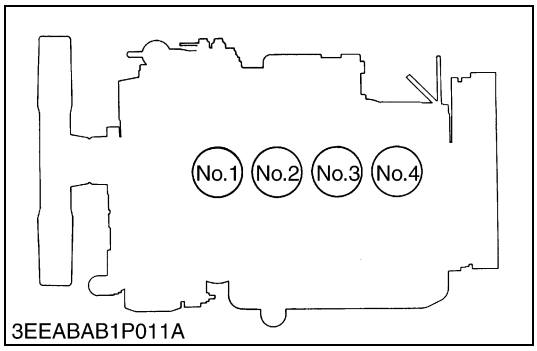
e.g. V3800-3A0001

"3" indicates 2003 and "A" indicates January.

So, 3A indicates that the engine was manufactured in January, 2003.

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[2] CYLINDER NUMBER



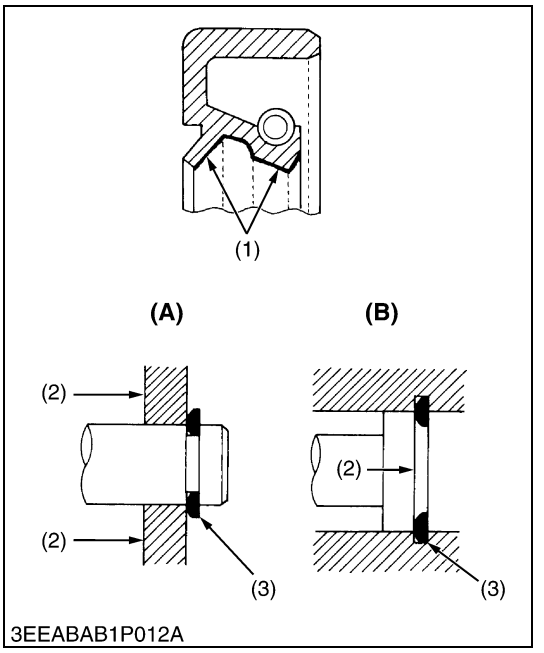
3EEABAB1P011A

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



- 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.

Item	Service Interval									
	Initial 50 hrs	Every 50 hrs	Every 250 hrs	Every 500 hrs	Every 1000 hrs	Every 1 or 2 months	Every 1500 hrs	Every 3000 hrs	Every 1 year	Every 2 years
Changing engine oil	*			*					*	
Replacing oil filter cartridge	*			*						
*Checking fuel hoses and clamps		*								
*Cleaning air filter element (Replace the element after 6 times cleanings)			*							
*Cleaning fuel filter			*							
Checking battery electrolyte level			*							
Checking radiator hoses and clamps			*							
*Checking intake air line			*							
Checking fan belt tension and damage	*		*							
*Replacing fuel filter cartridge				*						
Replacing fan belt				*						*
Cleaning radiator interior				*						
Checking valve clearance					*					
Recharging battery						*				
*Checking injection nozzle condition							*			
*Checking turbocharger								*		
Checking fuel injection pump								*		
*Checking injection timing (spill timing)								*		
*Replacing air filter element									*	
Changing radiator coolant (L.L.C.)										*
Replacing radiator hoses and clamps										*
*Replacing fuel hoses and clamps										*
*Replacing intake air line										*
Replacing battery										*

* 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

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

■ **NOTE**

Lubricating Oil

With the emission control now in effect, the CF-4 and CG-4 lubricating oils have been developed for use of a low-sulfur fuel on-road vehicle engines. When an off-road vehicle engine runs on a high-sulfur fuel, it is advisable to employ the CF, CD or CE lubricating oil with a high total base number. If the CF-4 or CG-4 lubricating oil is used with a high-sulfur fuel, change the lubricating oil at shorter intervals.

- **Lubricating oil recommended when a low-sulfur or high-sulfur fuel is employed.**

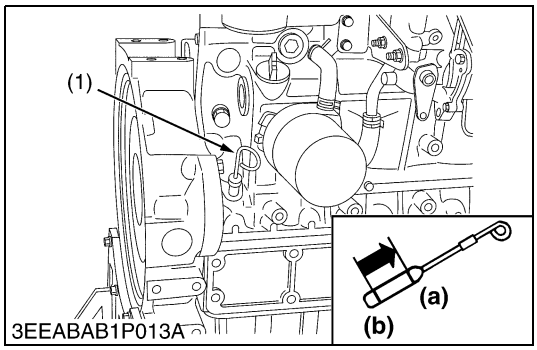
Fuel / Lubricating oil class	Low sulfur (0.5 % ≥)	High sulfur	Remarks
CF	O	O	TBN ≥ 10
CF-4	O	X	
CG-4	O	X	

O : Recommendable X : Not recommendable

W1035555

4. CHECK AND MAINTENANCE

[1] DAILY CHECK POINTS



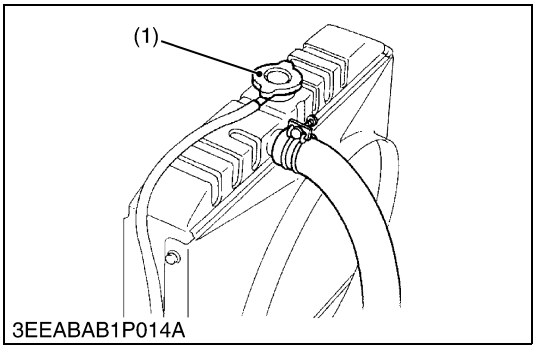
Checking Engine Oil Level

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.

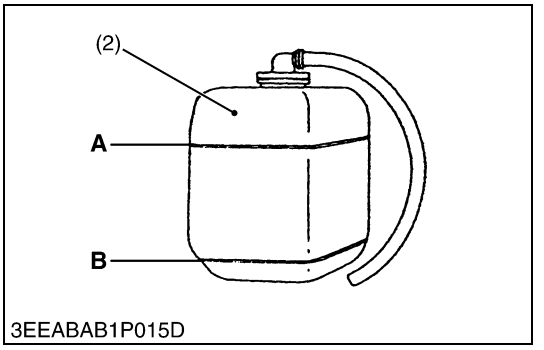
- **When using an oil of different maker or viscosity from the previous one, drain old oil. Never mix two different types of oil.**
- **Be sure to inspect the engine, locating it on a horizontal place. If placed on gradients, accurately, oil quantity may not be measured.**
- **Be sure to keep the oil 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

W1035676



3EEABAB1P014A



3EEABAB1P015D

Checking and Replenish Coolant

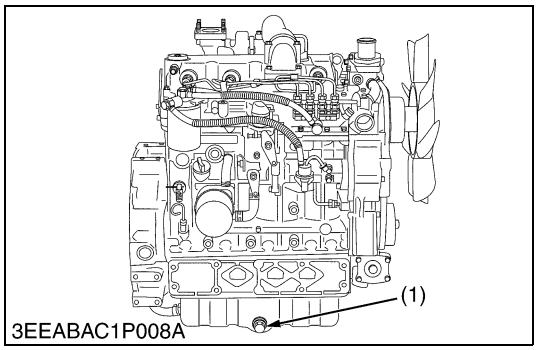
1. Without recovery tank :
   Remove the radiator cap (1) and check to see that the coolant level is just below the port.
   With recovery tank (2) :
   Check to see that the coolant level lies between **FULL** (**A**) and **LOW** (**B**).
2. If coolant level is too low, check the reason for decreasing 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.

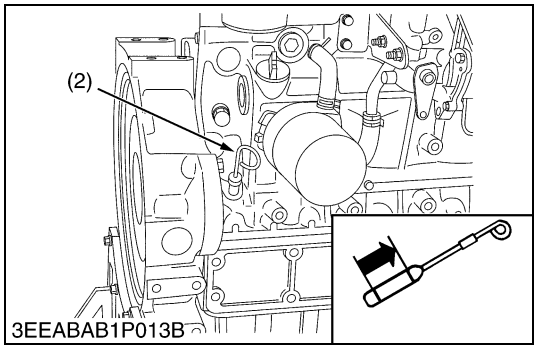
- **Do not remove the radiator cap until coolant temperature is below its boiling point. Then loosen the cap slightly to relieve any excess pressure before removing the cap completely.**
- **During filling the coolant, air must be vented from the engine coolant passages. The air vents by jiggling the 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 **A: FULL**
(2) Recovery Tank **B: LOW**

W1035779

[2] CHECK POINTS OF INITIAL 50 HOURS





Changing Engine Oil

- **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).

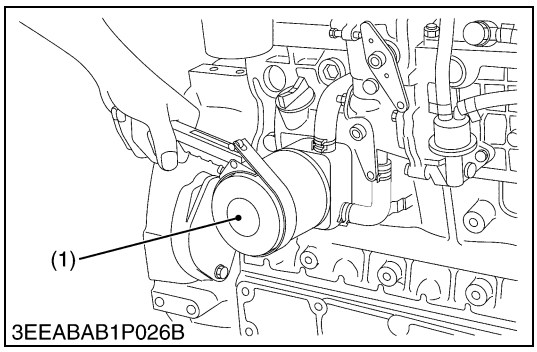
- **When using an oil of different maker or viscosity from the previous one, remove all of the old oil.**
- **Never mix two different types of oil.**
- **Engine oil should have properties of API classification CD/CE/CF/CF-4/CG-4.**
- **Use the proper SAE Engine Oil according to ambient temperature.**

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

Engine oil capacity	13.2 L 3.49 U.S.gals

(1) Drain Plug (2) Dipstick

W1016604



Replacing Oil Filter Cartridge

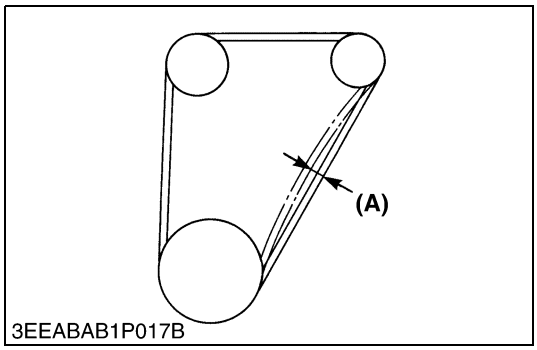
- **Be sure to stop the engine before changing filter cartridge.**

1. Remove the oil filter cartridge (1) with the filter wrench.
2. Apply a slight coart 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.

- **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

W1017137



Fan Belt Tension

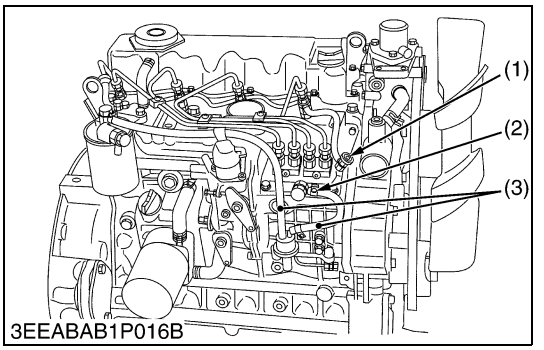
1. Measure the deflection **(A)**, depressing the belt halfway between the fan drive pulley and alternator pulley at specified force 98 N (10 kgf, 22 lbs).
2. If the measurement is not within the factory specifications, loosen the alternator mounting screws and relocate the alternator to adjust.

Deflection **(A)**	Factory spec.	10 to 12 mm 0.394 to 0.472 in.

(A) Deflection

W1208957

[3] CHECK POINT OF EVERY 50 HOURS



Checking Fuel Hose and Clamp Bands

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

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

(When bleeding fuel system)

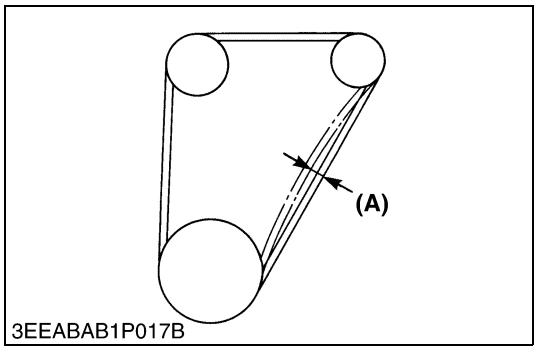
1. Fill the tank with fuel and open the cock.
2. Loosen the air vent coupling bolt of fuel filter a few turns.
3. When there is no more air bubbles in the fuel coming out of this coupling bolt, tighten the coupling bolt.
4. Open the air vent cock (1) on the top of fuel injection pump.
5. If equipped electrical fuel feed pump, turn the key on **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 (1) after air bleeding.

- **Except when venting the air, be sure to keep closed the air vent coupling bolt of the fuel injection pump. Otherwise, the engine may stall.**

(1) Air Vent Cock
(2) Clamp
(3) Fuel Hose

W1035921

[4] CHECK POINTS OF EVERY 250 HOURS



3EEABAB1P017B

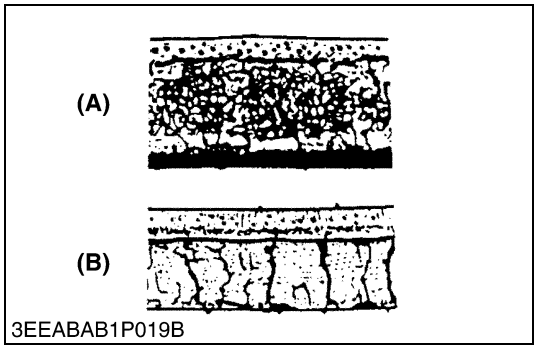
Fan Belt Tension

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 lbs).
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.	10 to 12 mm 0.394 to 0.472 in.

(A) Deflection

W1014131



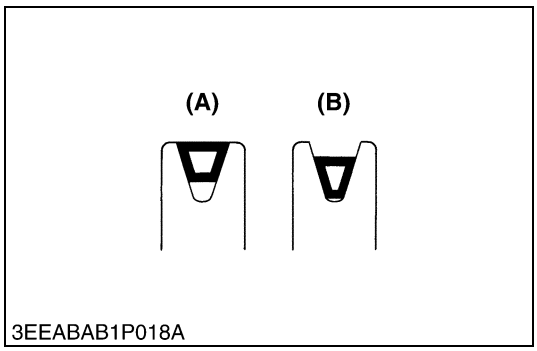
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Fan Belt Damage and Wear

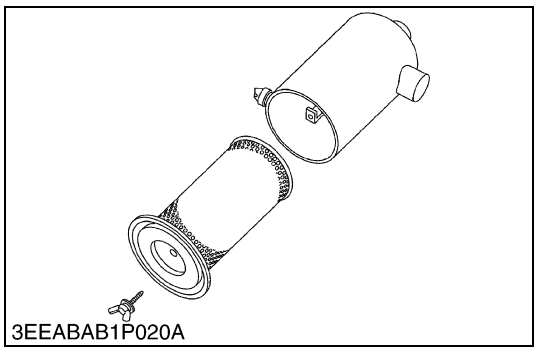
1. Check the fan belt for damage.
2. If the fan belt is damaged, replace it.
3. Check if the fan belt is worn and sunk in the pulley groove.
4. If the fan belt is nearly worn out and deeply sunk in the pulley groove, replace it.

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

W1209480



3EEABAB1P018A

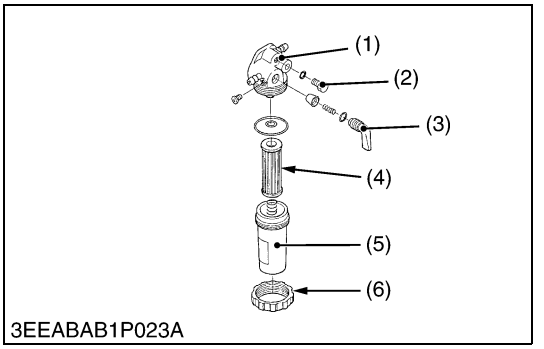

3EEABAB1P020A

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 205 kPa (2.1 kgf/cm^2, 30 psi).
   Maintain reasonable distance between the nozzle and the filter.

- **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

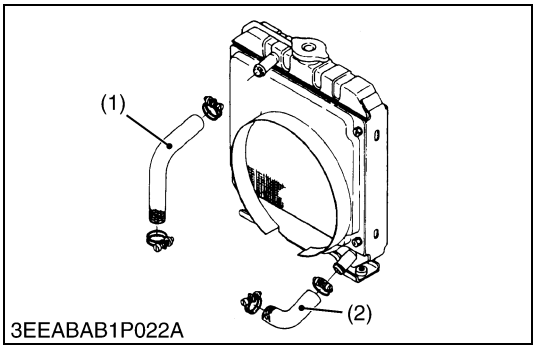
Cleaning Fuel Filter (Element Type only)

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.

- **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 filter cup (5) periodically.**

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

W1046058



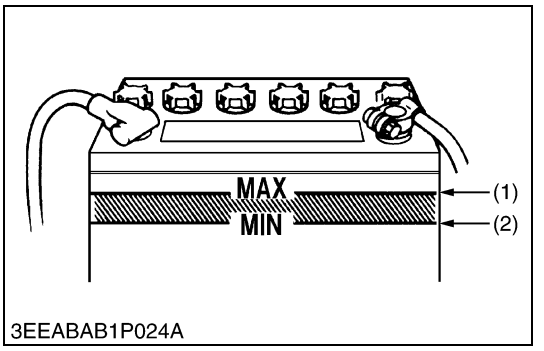
3EEABAB1P022A

Checking Radiator Hoses and Clamp Bands

1. Check to see if the radiator hoses are properly fixed every 250 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



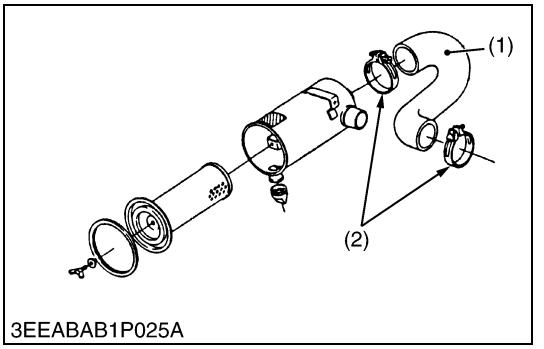
3EEABAB1P024A

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



3EEABAB1P025A

Checking Intake Air Line

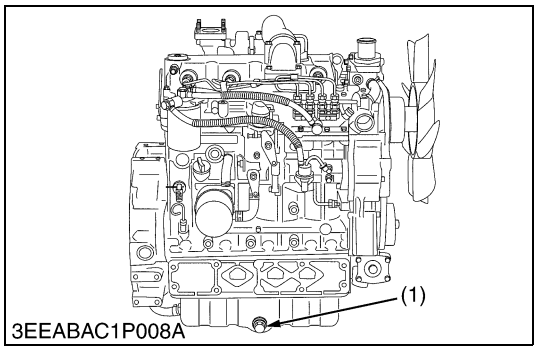
1. Check to see if the intake air hose(s) are properly fixed every 250 hours of operation.
2. If the clamp is loose, apply oil to the threads and retighten it securely.
3. The intake air hose(s) is made of rubber and tends to age. It must be change every two years. Also change the clamp and tighten it securely.

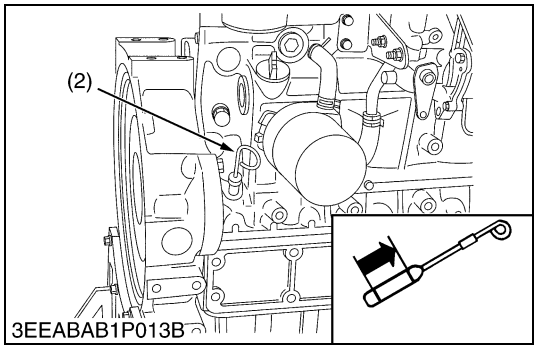
- **To prevent serious damage to the engine, keep out any dust inside the intake air line.**

(1) Intake Air Hose
(2) Clamp

W1029631

[5] CHECK POINTS OF EVERY 500 HOURS





Changing Engine Oil

- **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).

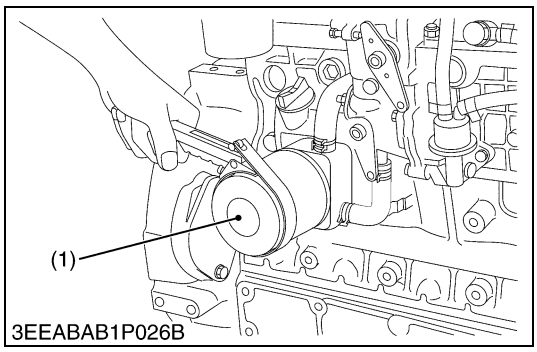
- **When using an oil of different maker or viscosity from the previous one, remove all of the old oil.**
- **Never mix two different types of oil.**
- **Engine oil should have properties of API classification CD/CE/CF/CF-4/CG-4.**
- **Use the proper SAE Engine Oil according to ambient temperature.**

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

Engine oil capacity	13.2 L 3.49 U.S.gals

(1) Drain Plug (2) Dipstick

W1014590



Replacing Oil Filter Cartridge

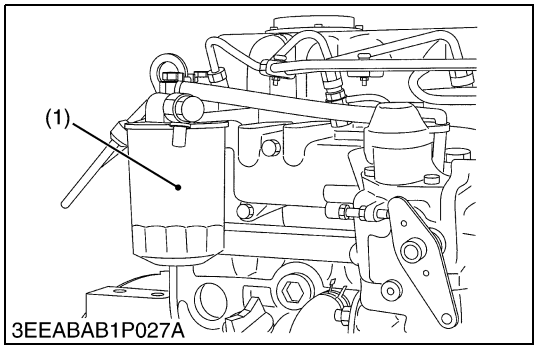
- **Be sure to stop the engine before changing filter cartridge.**

1. Remove the oil filter cartridge (1) with the filter wrench.
2. Apply a slight coart 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.

- **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

W1015117



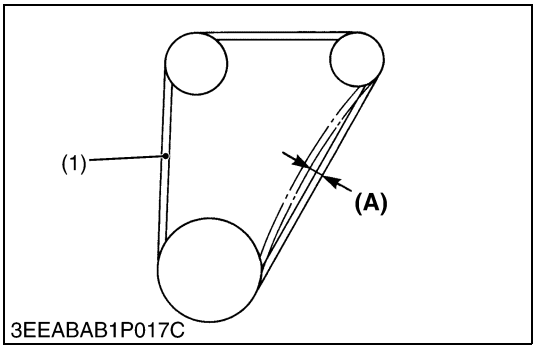
Replacing Fuel Filter Cartridge (Cartridge Type)

Water and dust in fuel are collected in the filter cartridge. So, change the filter cartridge every 500 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

W1037062



3EEABAB1P017C

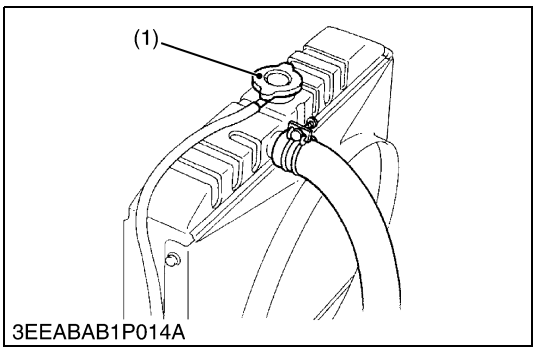
Replacing Fan Belt

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.

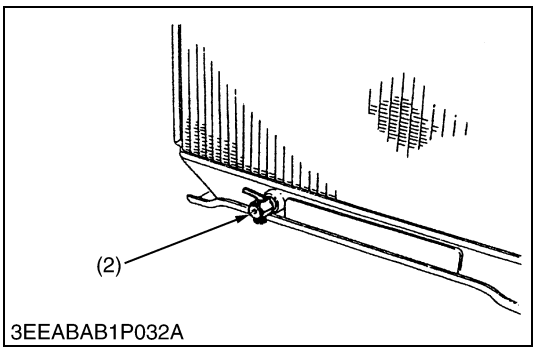
Deflection **(A)**	Factory spec.	10.0 to 12.0 mm / 98 N 0.394 to 0.472 in. / 98 N (10 kgf, 22 lbs)

(1) Fan Belt **(A) Deflection**

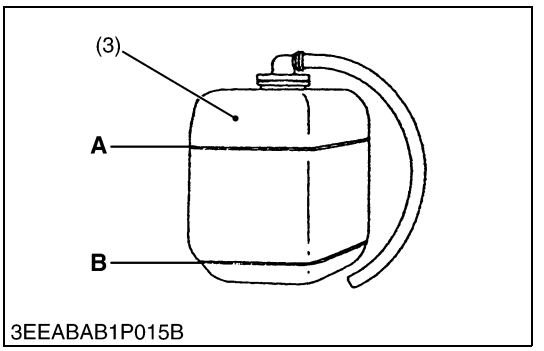
W1052220



3EEABAB1P014A



3EEABAB1P032A



3EEABAB1P015B

Cleaning Water Jacket and Radiator Interior

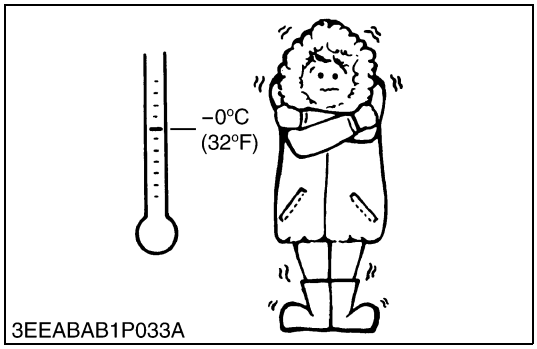
- **Do not remove the radiator cap when the engine is hot. Then loosen cap slightly to the stop to relieve any excess pressure before removing cap completely.**

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.

- **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 **A : Full**
(2) Drain Plug **B : Low**
(3) Recovery Tank

W1038102



3EEABAB1P033A

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.
- **When the anti-freeze is mixed with fresh, soft water, the anti-freeze mixing ratio must be less than 50 %.**

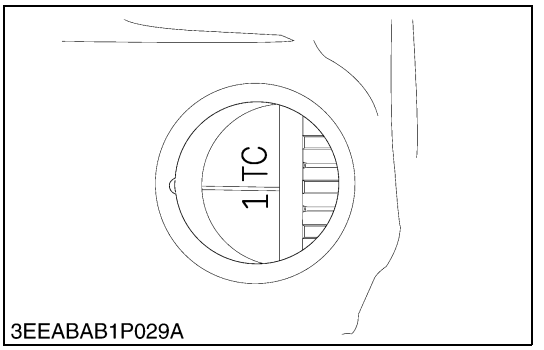
Vol % anti-freeze	Freezing point		Boiling point*	
	°C	°F	°C	°F
40	–24	–11.2	106	222.8
50	–37	–34.6	108	226.4

* At 1.013 × 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.

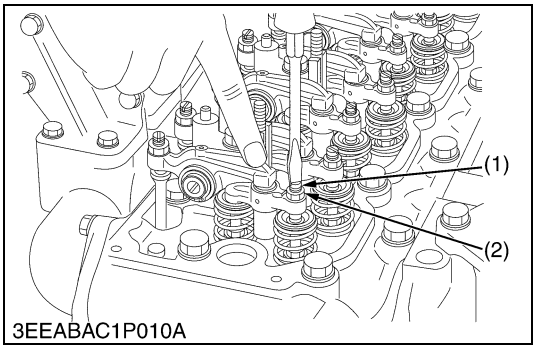
- **The above data represents industrial standards that necessitate a minimum glycol content in the concentrated anti-freeze.**
- **When the coolant level drops due to evaporation, add fresh, soft water only to keep the anti-freeze mixing ratio less than 50 %. In case of leakage, add anti-freeze and 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

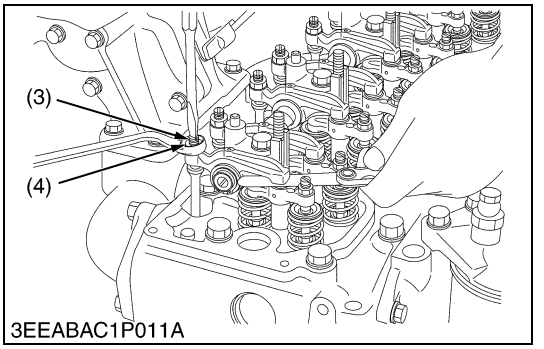
[6] CHECK POINT OF EVERY 1000 HOURS



3EEABAB1P029A



3EEABAC1P010A



3EEABAC1P011A

Checking Valve Clearance

- **Valve clearance must be checked and adjusted when engine is cold.**

1. Remove the high pressure pipes and the head cover.
2. Align the 1TC mark of flywheel and the convex of flywheel housing timing windows so that the first piston (gear case side) comes to the compression top dead center.
3. Before adjusting the valve clearance, adjust the bridge evenly to the valve stem.
4. Loosen the lock nut (2) and adjust with screw (1).
5. Slightly push the rocker arm by your fingers and screw in the adjusting screw slowly until you feel the screw touch the top of valve stem, then tighten the lock nut.
6. Loosen the lock nut (4) of adjusting screw (3) (push rod side) and insert the thickness gauge between the rocker arm and the bridge head. Set the adjusting screw to the specified value, then tighten the lock nut.

Valve clearance	Factory spec.	0.23 to 0.27 mm 0.0091 to 0.0106 in.

- **After adjusting, tighten the lock nut (4) securely.**

Valve arrangement Adjustment cylinder Location of piston		IN.	EX
When No.1 piston is at compression top dead center	1st	*	*
	2nd	*	
	3rd		*
	4th		
When No.1 piston is at overlap position	1st		
	2nd		*
	3rd	*	
	4th	*	*

Tightening torque	Cylinder head cover screw	6.9 to 11.3 N·m 0.7 to 1.15 kgf·m 5.1 to 8.32 ft-lbs
	Injection pipe retaining nut	19.6 to 24.5 N·m 2.0 to 2.5 kgf·m 14.5 to 18.1 ft-lbs

(1) Adjusting Screw
(2) Lock Nut
(3) Adjusting Screw
(4) Lock Nut

W1037215

[7] CHECK POINTS OF EVERY 1 OR 2 MONTHS

Recharging

- **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.

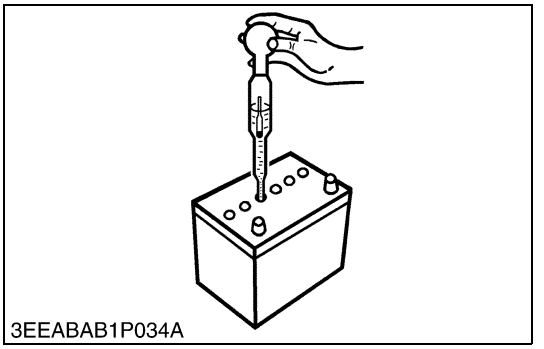
2) Quick Charging

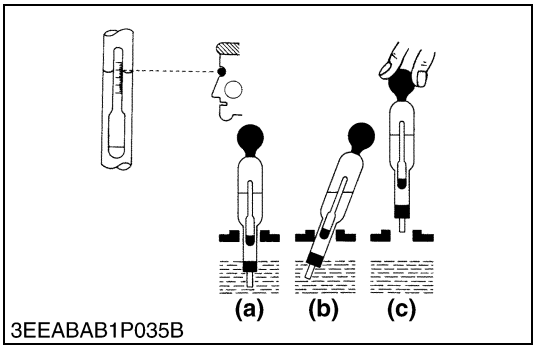
1. Determine the proper charging current and charging time with the tester attached to the quick charger.
2. Determine the proper charging current as 1/1 of the battery capacity. If the battery capacity exceeds 50 Ah, consider 50 A as the maximum.

<Dingbats>n 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.

- **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

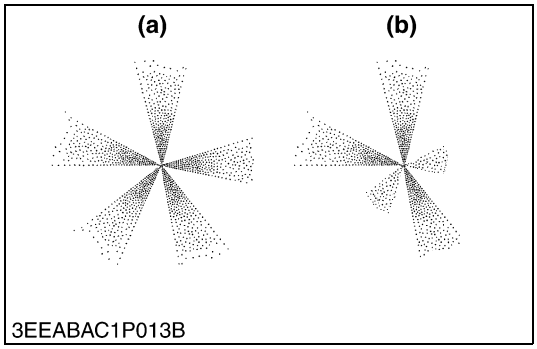
At an electrolyte temperature of 20 °C (68 °F)

(a) Good
(b) Bad
(c) Bad

W1012763

[8] CHECK POINTS OF EVERY 1500 HOURS

- **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.**



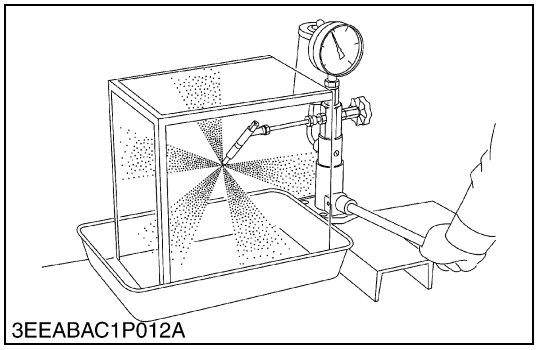
3EEABAC1P013B

Nozzle Spraying Condition

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 or repair at Denso service shop.

(a) Good **(b) Bad**

W10411400


3EEABAC1P012A

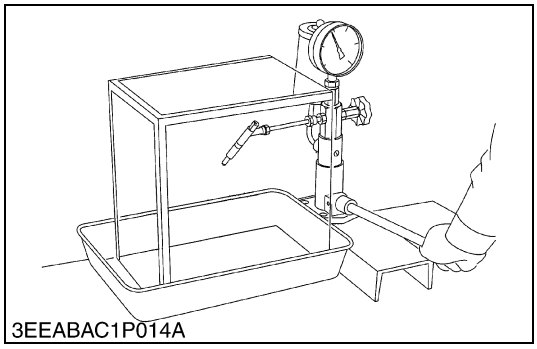
Checking Nozzle Injection Pressure

1. Set the injection nozzle to the 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 or repair at Denso service shop.

- **Injection nozzle gasket must be replaced when the injection nozzle is removed for checking.**

Injection pressure	Factory spec.	1st stage	18.63 to 19.61 MPa 190 to 200 kgf/cm^2 2702 to 2845 psi

W1024942


3EEABAC1P014A

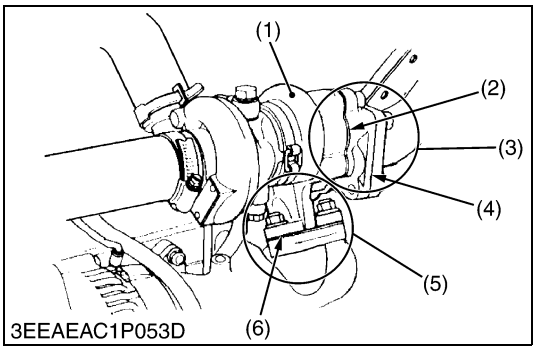
Valve Seat Tightness

1. Set the injection nozzle to a nozzle tester.
2. Raise the fuel pressure, and keep at 16.67 MPa (170 kgf/cm^2, 2418 psi) for 10 seconds.
3. If any fuel leak is found, replace the injection nozzle assembly or repair at Denso service shop.

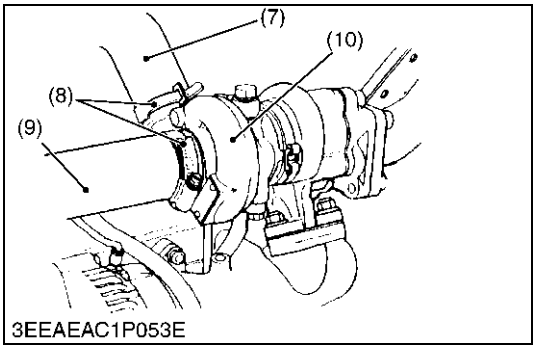
Valve seat tightness	Factory spec.	No fuel leak at 16.67 MPa 170 kgf/cm^2 2418 psi

W10412730

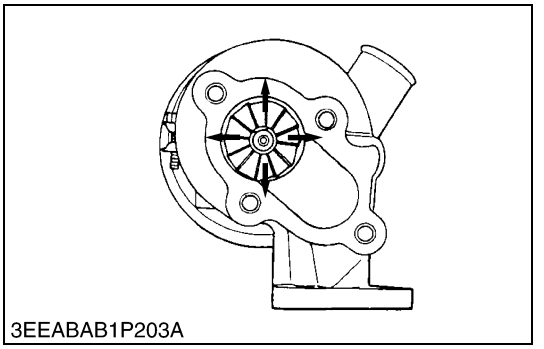
[9] CHECK POINTS OF EVERY 3000 HOURS



3EEAEAC1P053D



3EEAEAC1P053E


3EEABAB1P203A

Checking Turbocharger

(Turbine Side)

1. Check the exhaust port (3) and inlet port (5) 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 (2) / (4) / (6) with new one.

(Compressor Side)

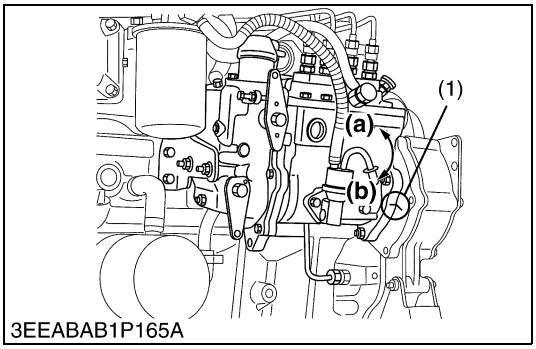
1. Check the inlet hose (9) of the compressor cover (10) to see if there is no air leak.
2. If any air leak is found, change the clamp (8) and / or inlet hoses.
3. Check the intake hose (7) and the clamp to see if there is not loose or crack.
4. If any loose or crack is found, tighten the cramp or change the hose to prevent dust from entry.

(Radial Clearance)

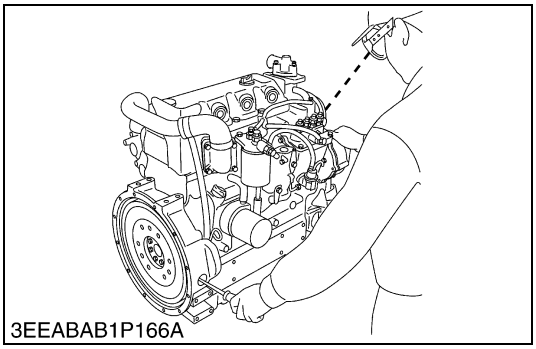
1. If the wheel contact to the housing, replace the turbocharger assembly with new one.

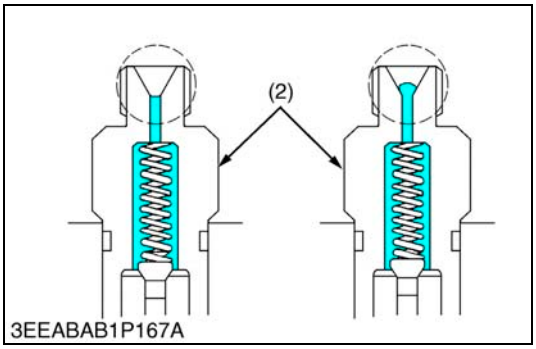
(1) Turbine Housing
(2) Gasket
(3) Exhaust Port
(4) Gasket
(5) Inlet Port
(6) Gasket
(7) Intake Hose
(8) Clamp
(9) Inlet Hose
(10) Compressor Cover

W1022082

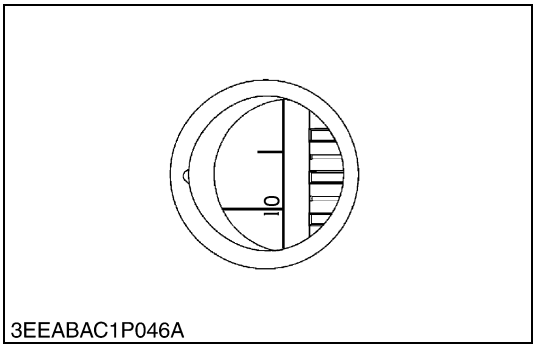


3EEABAB1P165A


3EEABAB1P166A



3EEABAB1P167A



3EEABAC1P046A

Injection Timing

1. Make sure of matching the injection timing align mark (1) of the injection pump unit and the plate (gearcase), as shown in the illustration.
2. Remove the injection pipes.
3. Remove the stop solenoid.
4. Turn the flywheel counterclockwise (viewed from flywheel side) until the fuel fills up to the hole of the delivery valve holder (2) for No.1 cylinder.
5. After the fuel fills up to the hole of the delivery valve holder for No.1 cylinder, turn back (clockwise) the flywheel around 1.57 rad (90 °).
6. Turn the flywheel counterclockwise to set at around 0.35 rad (20 <Symbol>×) before T.D.C..
7. Slowly turn the flywheel counterclockwise and stop turning when the fuel begins to come up, to get the present injection timing.
8. Check to see the degree on flywheel.
   The flywheel has mark “1TC”, “10” and “20” for the crank angle before the top dead center of No.1 piston.
9. If the injection timing is not within the specification, rotate the injection pump unit to adjust the injection timing.

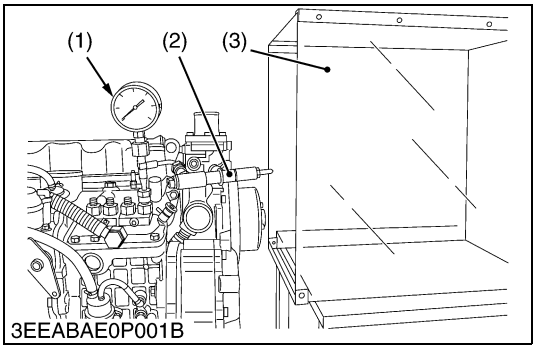
- **When installing the injection pump unit to the engine body, follow the correct procedure.**
  See the “Injection Pump Unit”.

Injection timing	Factory spec.	0.21 to 0.24 rad (12 ° to 14 °) before T.D.C.

Tightening torque	Injection pipe retaining nut	19.6 to 24.5 N·m 2.0 to 2.5 kgf·m 14.5 to 18.1 ft-lbs
	Injection pump unit mounting nut	17.7 to 20.6 N·m 1.8 to 2.1 kgf·m 13.0 to 15.2 ft-lbs

(1) Injection Timing Align Mark
(2) Delivery Valve Holder
(a) Injection Timing Advanced
(b) Injection Timing Retarded

W1072910



Checking Injection Pump

(Fuel Tightness of Pump Element)

1. Remove the engine stop solenoid.
2. Remove the injection pipes.
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 engine stop solenoid.
2. Remove the injection pipes.
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 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 to 180 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 to 180 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.

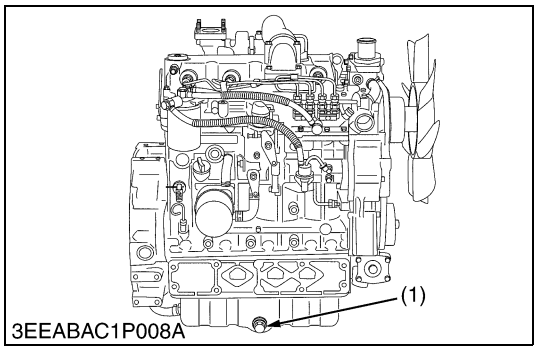
Fuel tightness of pump element	Allowable limit	18.63 MPa 190 kgf/cm^2 2702 psi
Fuel tightness of delivery valve	Factory spec.	10 seconds 18.63 → 17.65 MPa 190 → 180 kgf/cm^2 2702 → 2560 psi
	Allowable limit	5 seconds 18.63 → 17.65 MPa 190 → 180 kgf/cm^2 2702 → 2560 psi

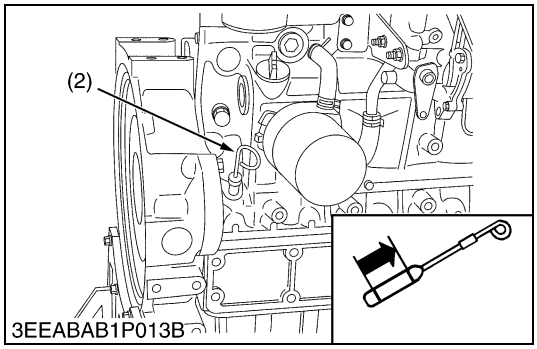
- **Never try to disassemble the injection pump assembly. For repairs, you are strongly requested to contact a Kubota-authorized pump service shop.**

(1) Injection Pump Pressure Tester
(2) Injection Nozzle
(3) Protection Cover for Jetted Fuel

W1022357

[10] CHECK POINTS OF EVERY 1 YEAR





Changing Engine Oil

- **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).

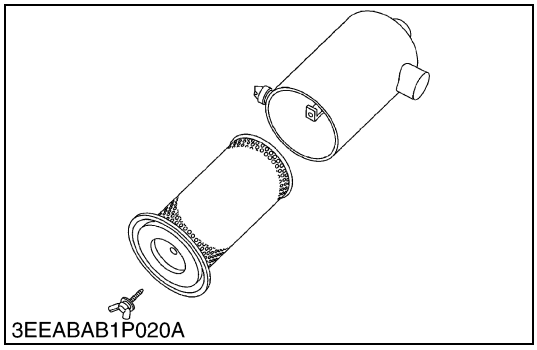
- **When using an oil of different maker or viscosity from the previous one, remove all of the old oil.**
- **Never mix two different types of oil.**
- **Engine oil should have properties of API classification CD/CE/CF/CF-4/CG-4.**
- **Use the proper SAE Engine Oil according to ambient temperature.**

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

Engine oil capacity	13.2 L 3.49 U.S.gals

(1) Drain Plug (2) Dipstick

W1019006



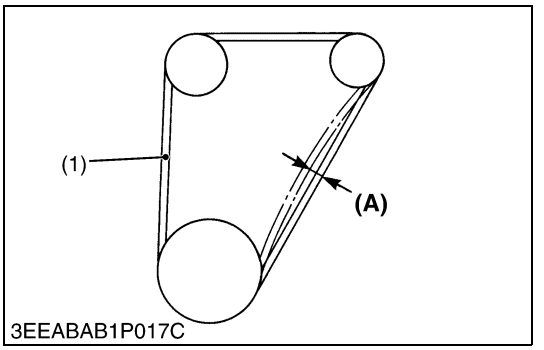
Replacing Air Cleaner Element

1. Remove used air cleaner element.
2. Replace new air cleaner element.

- **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 2 YEARS



3EEABAB1P017C

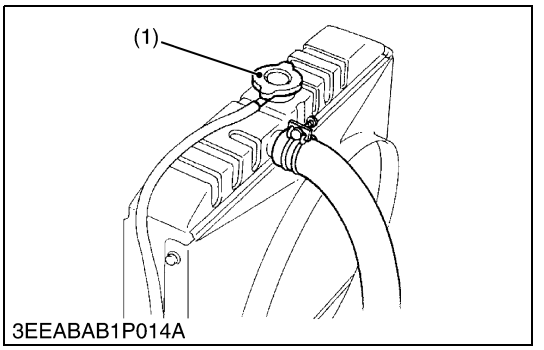
Replacing Fan Belt

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.

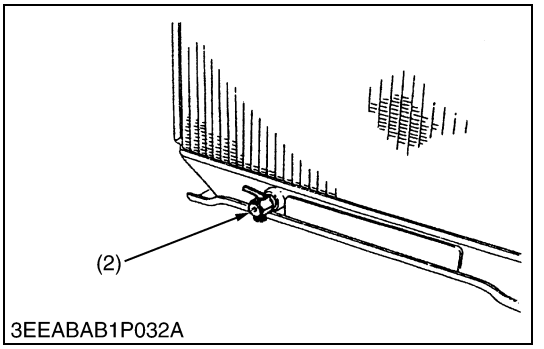
Deflection **(A)**	Factory spec.	10.0 to 12.0 mm / 98 N 0.394 to 0.472 in. / 98 N (10 kgf, 22 lbs)

(1) Fan Belt **(A) Deflection**

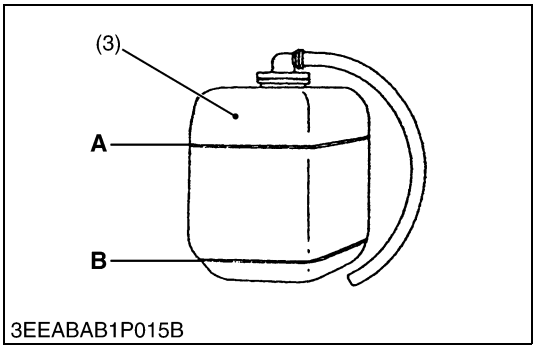
W1019333



3EEABAB1P014A



3EEABAB1P032A



3EEABAB1P015B

Changing Radiator Coolant (L.L.C.)

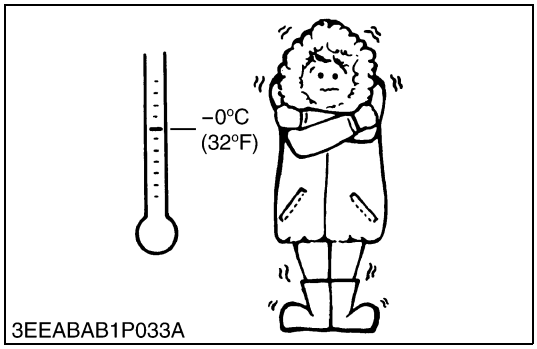
- **Do not remove the radiator cap when the engine is hot. Then loosen cap slightly to the stop to relieve any excess pressure before removing cap completely.**

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.

- **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 **A : Full**
(2) Drain Plug **B : Low**
(3) Recovery Tank

W1024599



3EEABAB1P033A

Changing Radiator Coolant (L.L.C.) (Continued)

(Anti-freeze)

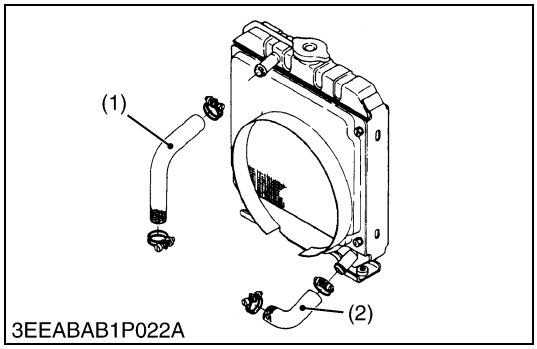
- There are two types of anti-freeze available: use the permanent type (PT) for this engine.
- Before adding anti-freeze for the first time, clean the radiator interior by pouring fresh, soft water and draining it a few times.
- The procedure for mixing water and anti-freeze differs according to the 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.
- **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	–11.2	106	222.8
50	–37	–34.6	108	226.4

* At 1.013 × 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.

- **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



3EEABAB1P022A

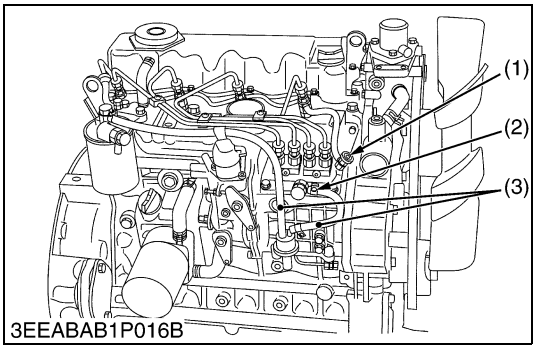
Replacing Radiator Hoses and Clamp Bands

- **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



Replacing Fuel Hose and Clamp Bands

1. Loosen the clamp (2) and remove the fuel hose (3).
2. Replace new fuel hose (3) and new clamp (2).
3. Tighten the clamp (2).

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

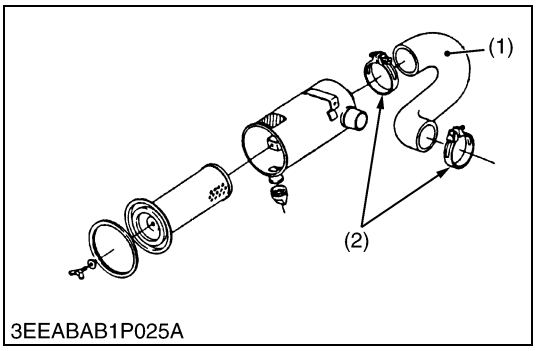
(When bleeding fuel system)

1. Fill the tank with fuel and open the cock.
2. Loosen the air vent coupling bolt of fuel filter a few turns.
3. When there is no more air bubbles in the fuel coming out of this coupling bolt, tighten the coupling bolt.
4. Open the air vent cock (1) on the top of fuel injection pump.
5. If equipped electrical fuel feed pump, turn the key on 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 (1) after air bleeding.

- **Except when venting the air, be sure to keep closed the air vent coupling bolt of the fuel injection pump. Otherwise, the engine may stall.**

(1) Air Vent Cock
(2) Clamp
(3) Fuel Hose

W1020090



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).

- **To prevent serious damage to the engine, keep out any dust inside the intake air line.**

(1) Intake Air Hose
(2) Clamp

W1023867

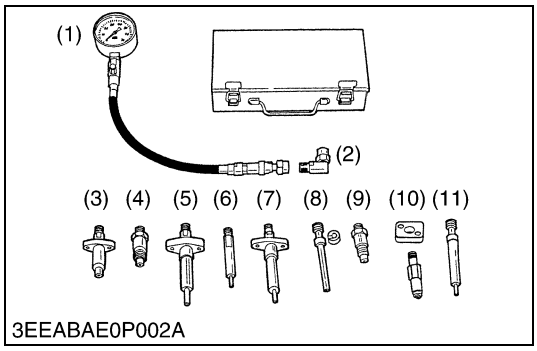
Replacing Battery

- **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

5. SPECIAL TOOLS



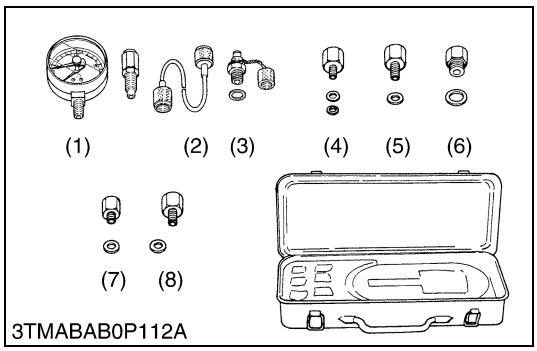
Diesel Engine Compression Tester

Code No: 07909-30208 (Assembly) 07909-31251 (G)
07909-30934 (A to F) 07909-31271 (I)
07909-31211 (E and F) 07909-31281 (J)
07909-31231 (H)

Application: Use to measure diesel engine compression and diagnostics 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



Oil Pressure Tester

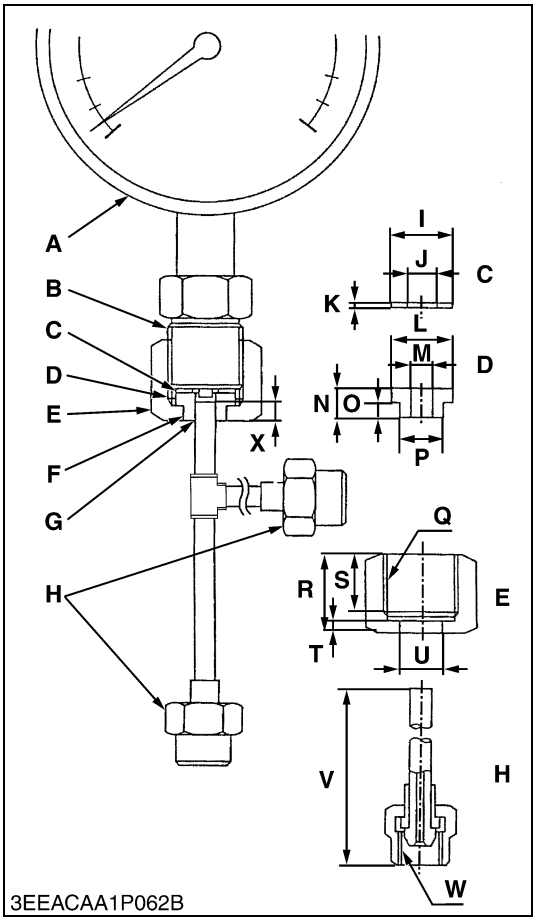
Code No: 07916-32032

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

- **The following special tools are not provided, so make them referring to the figure.**



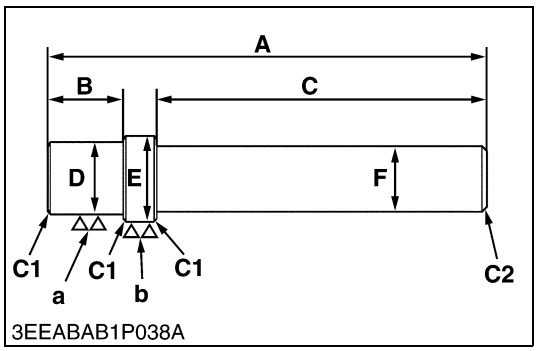
3EEACAA1P062B

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 (1.06 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. (0.31 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. (0.2402 to 0.2441 in. dia.)
N	8 mm (0.31 in.)
O	4 mm (0.16 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 (0.16 in.)
U	12.00 to 12.02 mm dia. (0.4724 to 0.4732 in. dia.)
V	100 mm (3.94 in.)
W	M12 × P1.5
X	5 mm (0.20 in.)

W10252400



3EEABAB1P038A

Small End Bushing Replacing Tool

Application: Use to press out and to press fit the small end bushing.

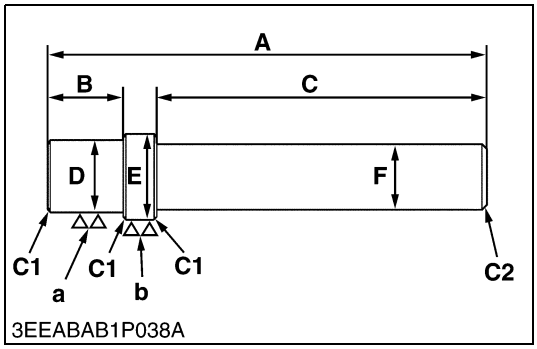
[Press out]

A	157 mm (6.181 in.)
B	14.5 mm (0.571 in.)
C	120 mm (4.7244 in.)
D	30.0 mm dia. (1.1811 in. dia.)
E	32.95 mm dia. (1.2972 in. dia.)
F	20 mm dia. (0.7874 in. dia.)
a	6.3 μm (250 μin.)
b	6.3 μm (250 μin.)
C1	Chamfer 1.0 mm (0.039 in.)
C2	Chamfer 2.0 mm (0.079 in.)

[Press fit]

A	157 mm (6.181 in.)
B	14.5 mm (0.571 in.)
C	120 mm (4.7244 in.)
D	30.0 mm dia. (1.1811 in. dia.)
E	42.000 mm dia. (1.6535 in. dia.)
F	20 mm dia. (0.7874 in. dia.)
a	6.3 μm (250 μin.)
b	6.3 μm (250 μin.)
C1	Chamfer 1.0 mm (0.039 in.)
C2	Chamfer 2.0 mm (0.079 in.)

W1040702



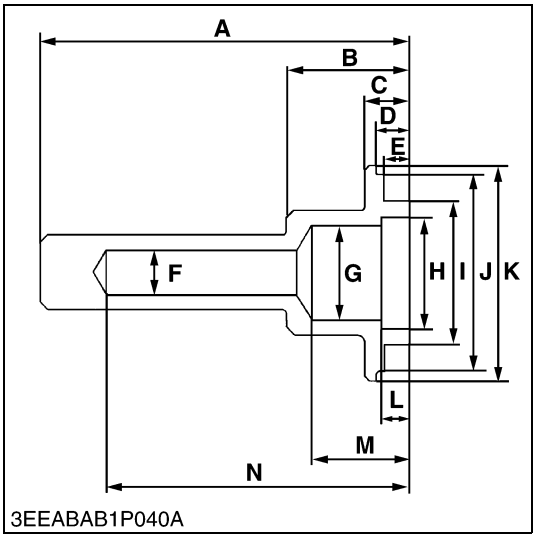
3EEABAB1P038A

Idle Gear Bushing Replacing Tool

Application: Use to press out and to press fit the bushing.

A	196 mm (7.7165 in.)
B	37.5 mm (1.476 in.)
C	150 mm (5.9055 in.)
D	44.95 mm dia. (1.7697 in. dia.)
E	48.075 to 48.100 mm dia. (1.8927 to 1.8937 in. dia.)
F	20 mm dia. (0.7874 in. dia.)
a	6.3 μm (250 μin.)
b	6.3 μm (250 μin.)
C1	Chamfer 1.0 mm (0.039 in.)
C2	Chamfer 2.0 mm (0.079 in.)

W1040289



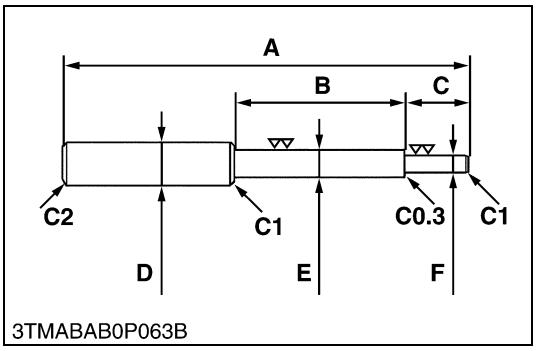
3EEABAB1P040A

Gear Case Oil Seal Replacing Tool

Application: Use to press fit the oil seal.

A	148.8 mm (5.8582 in.)
B	50 mm (1.9685 in.)
C	18.8 mm (0.7401 in.)
D	13.7 to 13.9 mm (0.5394 to 0.5472 in.)
E	11 mm (0.433 in.)
F	18 mm dia. (0.7087 in. dia.)
G	38 mm dia. (1.4961 in. dia.)
H	45 mm dia. (1.7716 in. dia.)
I	57.9 to 58.1 mm dia. (2.2795 to 2.2874 in. dia.)
J	79.5 mm dia. (3.1299 in. dia.)
K	87 mm dia. (3.425 in. dia.)
L	12 mm (0.4724 in.)
M	40 mm (1.5748 in.)
N	120 mm (4.7244 in.)

W1041529



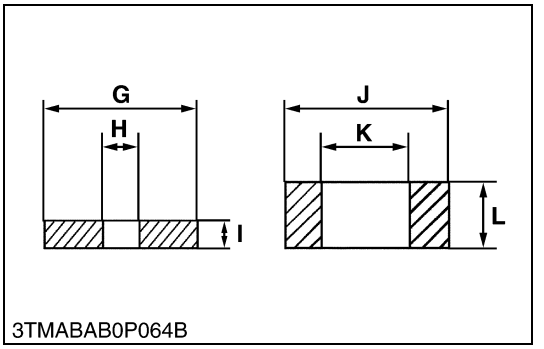
3TMABAB0P063B

Valve Guide Replacing Tool

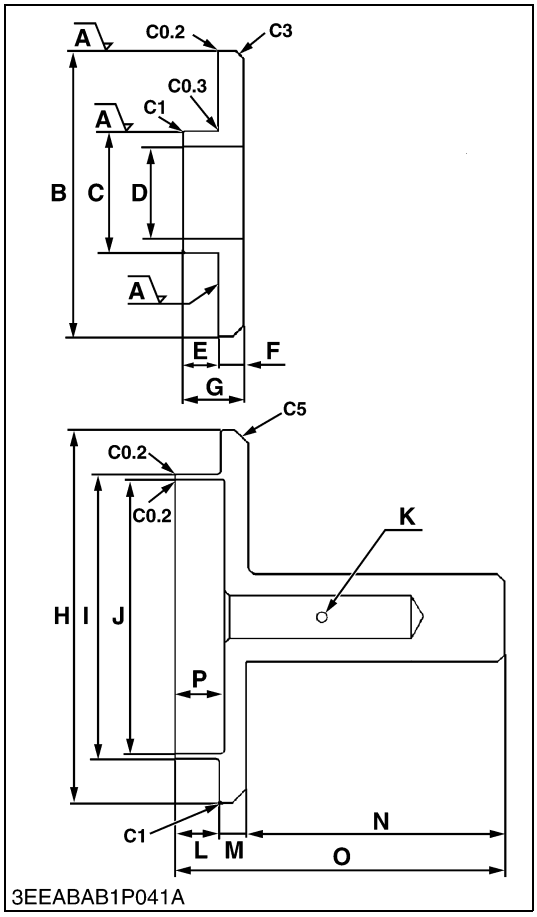
Application: Use to press out and press fit the valve guide.

A	225 mm (8.86 in.)
B	70 mm (2.76 in.)
C	45 mm (1.77 in.)
D	20 mm dia. (0.79 in dia.)
E	11.7 to 11.9 mm dia. (0.460 to 0.468 in. dia.)
F	6.5 to 6.6 mm dia. (0.256 to 0.259 in. dia.)
G	25 mm dia. (0.98 in. dia.)
H	6.7 to 7.0 mm dia. (0.263 to 0.275 in. dia.)
I	5 mm (0.197 in.)
J	20 mm dia. (0.787 in.dia.)
K	12.5 to 12.8 mm dia. (0.492 to 0.504 in. dia.)
L	8.9 to 9.1 mm (0.350 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 (0.012 in.)

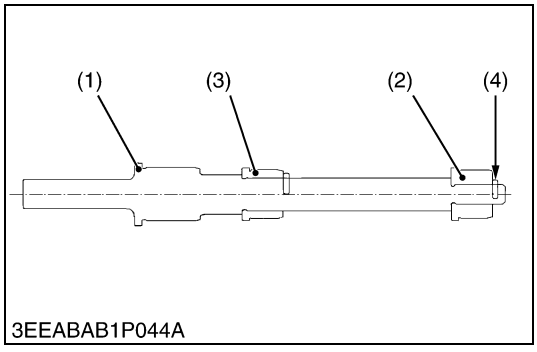
W1038887



3TMABAB0P064B



3EEABAB1P041A



3EEABAB1P044A

Auxiliary Socket for Fixing Crankshaft Sleeve

Application: Use to fix the crankshaft sleeve of the diesel engine.

A	Rmax = 12.5 S
B	94.5 to 95.0 mm dia. (3.7205 to 3.7402 in. dia.)
C	40 mm dia. (1.5748 in. dia.)
D	30 mm dia. (1.1811 in. dia.)
E	12 mm (0.4724 in.)
F	7.9 to 8.1 mm (0.3110 to 0.3189 in.)
G	20 mm (0.7874 in.)
H	130 mm dia. (5.1181 in. dia.)
I	99.4 to 99.6 mm dia. (3.9134 to 3.9213 in. dia.)
J	95.05 to 95.20 mm dia. (3.7421 to 3.7480 in. dia.)
K	3 mm dia. (0.1181 in.dia.)
L	15 mm (0.5905 in.)
M	10 mm (0.3937 in.)
N	90 mm (3.5433 in.)
O	115 mm (4.5275 in.)
P	16.9 to 17.1 mm (0.6654 to 0.6732 in.)
C1	Chamfer 1.0 mm (0.039 in.)
C3	Chamfer 3.0 mm (0.1181 in.)
C5	Chamfer 5.0 mm (0.1969 in.)
C0.2	Chamfer 0.2 mm (0.0079 in.)
C0.3	Chamfer 0.3 mm (0.0118 in.)

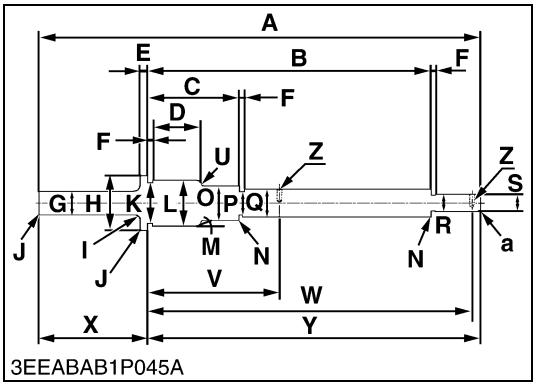
W1041815

Balancer Bushing Replacing Tool 1 Assembly

Application: Use to press fit the bushing.

No.	Name of Part	Q'ty.	Remarks
(1)	Shaft	1	
(2)	Piece 1	1	
(3)	Piece 2	1	
(4)	Bolt	2	M6 × P1.0

W1042867



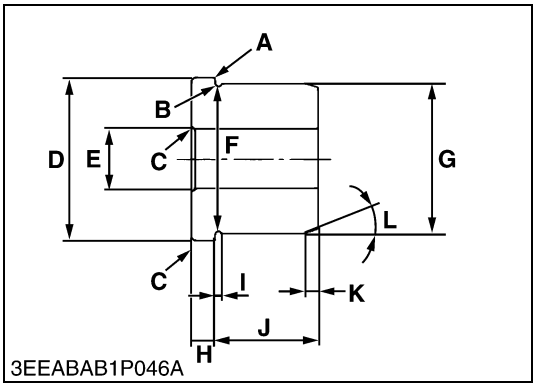
3EEABAB1P045A

Balancer Bushing Replacing Tool 1 Components Parts

1) Shaft

A	498 mm (19.61 in.)
B	318.8 to 319.2 mm (12.5512 to 12.5669 in.)
C	102.8 to 103.2 mm (4.0472 to 4.0630 in.)
D	60 mm (2.36 in.)
E	8 mm (0.31 in.)
F	5 mm (0.20 in.)
G	30 mm dia. (1.18 in. dia.)
H	65 mm dia. (2.56 in. dia.)
I	6 mm (0.24 in.)
J	Chamfer 1 mm (0.04 in.)
K	53 mm dia. (2.09 in. dia.)
L	54.7 to 54.9 mm dia. (2.1535 to 2.1614 in. dia.)
M	0.26 rad (15 °)
N	Chamfer 0.5 mm (0.02 in.)
O	41 mm dia. (1.61 in. dia.)
P	32 mm dia. (1.26 in. dia.)
Q	33.96 to 34.0 mm dia. (1.3370 to 1.3386 in. dia.)
R	18 mm dia. (0.71 in. dia.)
S	19.967 to 20.0 mm dia. (0.7861 to 0.7874 in. dia.)
U	3 mm (0.12 in.)
V	149.1 to 149.4 mm (5.8701 to 5.8819 in.)
W	365.1 to 365.4 mm (14.3740 to 14.3858 in.)
X	123 mm (4.84 in.)
Y	375 mm (14.76 in.)
Z	M6 × P1.0 depth 7 mm (0.28 in.)
a	Chamfer 2 mm (0.08 in.)

W1043162

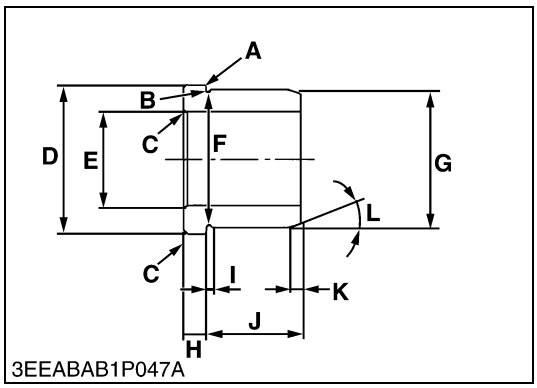


3EEABAB1P046A

2) Piece 1

A	Chamfer 0.1 mm (0.004 in.)
B	1 mm (0.04 in.)
C	Chamfer 1mm (0.04 in.)
D	53.8 to 53.9 mm dia. (2.1181 to 2.1220 in. dia.)
E	20.02 to 20.041 mm dia. (0.7882 to 0.7890 in. dia.)
F	48 mm dia. (1.89 in. dia.)
G	49.934 to 49.94 mm dia. (1.9659 to 1.9661 in. dia.)
H	8 mm (0.31 in.)
I	2 mm (0.08 in.)
J	35 mm dia. (1.38 in. dia.)
K	5 mm (0.20 in.)
L	0.26 rad (15 °)

W1044434

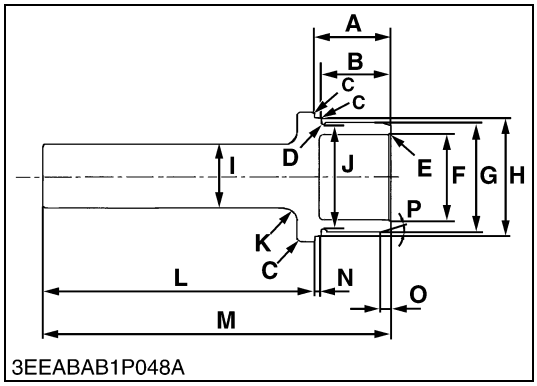


3EEABAB1P047A

3) Piece 2

A	Chamfer 0.1 mm (0.004 in.)
B	1 mm (0.04 in.)
C	Chamfer 1mm (0.04 in.)
D	54.3 to 54.4 mm dia. (2.1378 to 2.1417 in. dia.)
E	34.025 to 34.05 mm dia. (1.3396 to 1.3406 in. dia.)
F	48.5 mm dia. (1.9094 in. dia.)
G	50.421 to 50.44 mm dia. (1.9851 to 1.9858 in. dia.)
H	8 mm (0.31 in.)
I	2 mm (0.08 in.)
J	35 mm dia. (1.38 in. dia.)
K	5 mm (0.20 in.)
L	0.26 rad (15 °)

W1044620



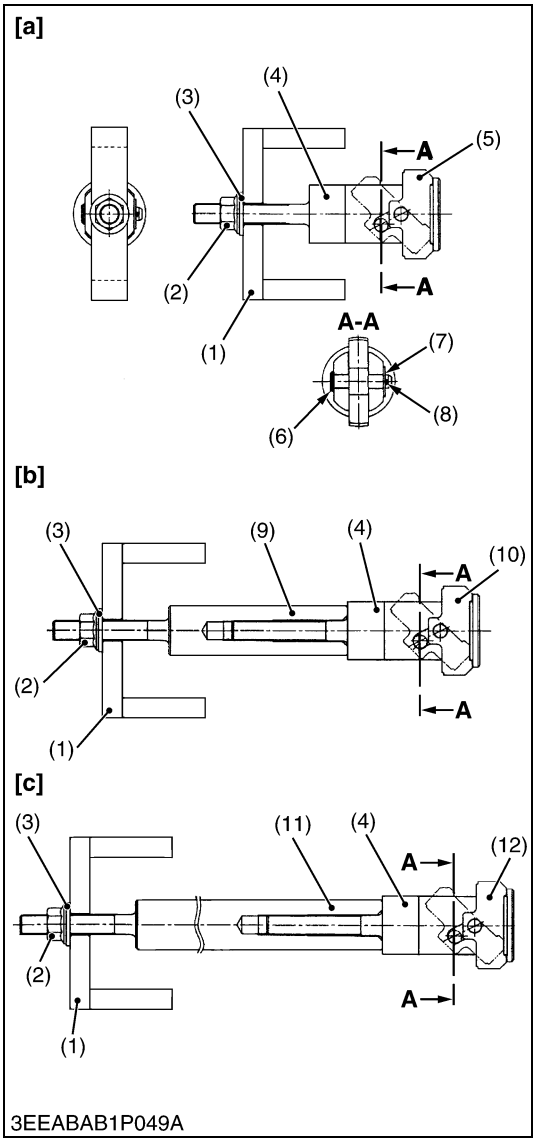
3EEABAB1P048A

Balancer Bushing Replacing Tool 2

Application: Use to press fit the bushing.

A	35 mm (1.38 in.)
B	33 mm (1.30 in.)
C	Chamfer 0.5 mm (0.02 in.)
D	1 mm (0.04 in.)
E	Chamfer 1 mm (0.04 in.)
F	40 mm dia. (1.57 in. dia.)
G	50.921 to 50.94 mm dia. (2.0048 to 2.0055 in. dia.)
H	54.8 to 54.9 mm dia. (2.1575 to 2.1614 in. dia.)
I	30 mm dia. (1.18 in. dia.)
J	49 mm dia. (1.93 in. dia.)
K	6 mm (0.24 in.)
L	125 mm (4.92 in.)
M	160 mm (6.30 in.)
N	3 mm (0.12 in.)
O	5 mm (0.20 in.)
P	0.26 rad (15 °)

W1044794



3EEABAB1P049A

Balancer Replacing Tools 3, 4, 5

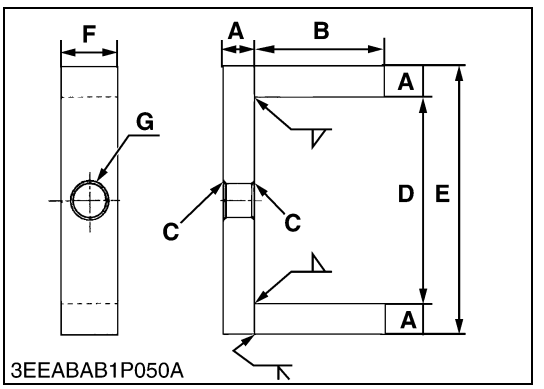
Application: Use to press fit the bushing.

- **This special tool is not provided, so make it referring to the figure.**

No.	Name of Part	Q'ty.
(1)	Bracket	1
(2)	Flange Nut	1
(3)	Washer	1
(4)	Shaft	1
(5)	Piece 1	1
(6)	Clevis	1
(7)	Washer	1
(8)	Cotter Pin	1
(9)	Joint 1	1
(10)	Piece 2	1
(11)	Joint 2	1
(12)	Piece 3	1

[a] :Tool 3
[b] :Tool 4
[c] :Tool 5
A : Section

W1045310



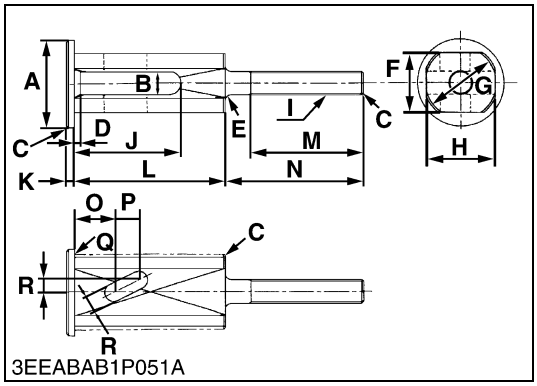
3EEABAB1P050A

Balancer Replacing Tool Components Parts

1) Bracket

A	12 mm (0.47 in.)
B	50 mm (1.97 in.)
C	Chamfer 1 mm (0.04 in.)
D	80 mm (3.15 in.)
E	104 mm (4.09 in.)
F	22 mm (0.87 in.)
G	13 mm dia. (0.51 in. dia.)

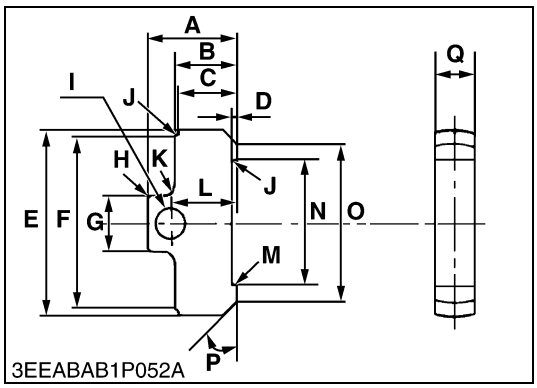
W1167794



2) Shaft

A	44 mm dia. (1.73 in. dia.)
B	12 mm (0.47 in.)
C	Chamfer 1 mm (0.04 in.)
D	3 mm (0.12 in.)
E	3 mm (0.12 in.)
F	30 mm (1.18 in.)
G	38 mm (1.50 in.)
H	35 mm (1.38 in.)
I	M12 × P1.25
J	53 mm (2.09 in.)
K	4 mm (0.16 in.)
L	75 mm (2.95 in.)
M	57 mm (2.24 in.)
N	70 mm (2.76 in.)
O	19.5 mm (0.77 in.)
P	12 mm (0.47 in.)
Q	0.8 mm (0.03 in.)
R	6 mm (0.24 in.)

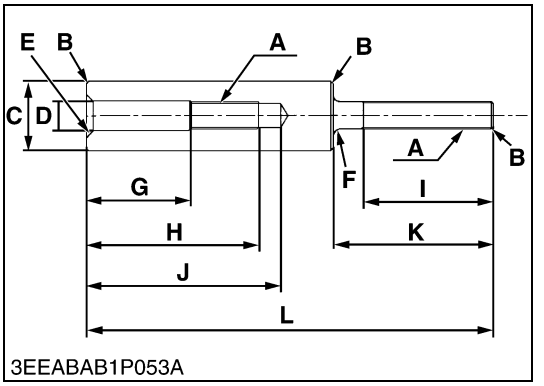
W1046146



3) Piece 1

A	26 mm (1.02 in.)
B	18 mm (0.71 in.)
C	16.5 to 17.0 mm (0.6496 to 0.6693 in.)
D	1.5 mm (0.06 in.)
E	54.0 to 54.2 mm dia. (2.1260 to 2.1339 in dia.)
F	50.55 to 50.75 mm dia. (1.9902 to 1.9980 in dia.)
G	16 mm (0.63 in.)
H	Chamfer 1 mm (0.04 in.)
I	8.5 mm dia. (0.33 in. dia.)
J	0.4 mm (0.0157 in.)
K	3 mm (0.12 in.)
L	19 mm (0.75 in.)
M	Chamfer 0.5 mm (0.02 in.)
N	36 mm (1.42 in.)
O	45 mm dia. (1.77 in. dia.)
P	0.78 rad (45 °)
Q	11.5 mm (0.45 in.)

W1047263

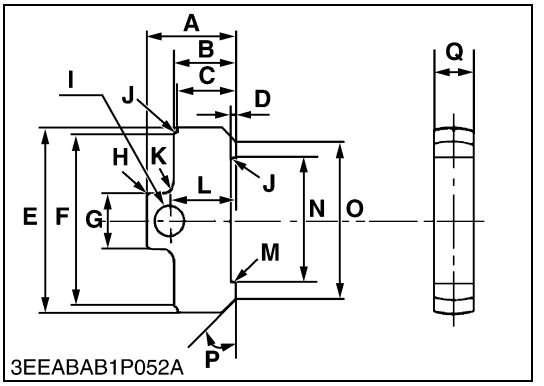


3EEABAB1P053A

4) Joint 1

A	M12 × P1.25
B	Chamfer 1 mm (0.04 in.)
C	30 mm dia. (1.18 in. dia.)
D	13 mm dia. (0.51 in. dia.)
E	Chamfer 3 mm (0.12 in.)
F	3 mm (0.12 in.)
G	45 mm (1.77 in.)
H	75 mm (2.95 in.)
I	57 mm (2.24 in.)
J	85 mm (3.35 in.)
K	70 mm (2.76 in.)
L	178 mm (7.01 in.)

W1047709

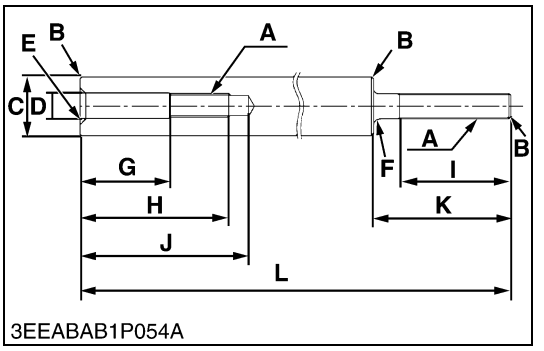


3EEABAB1P052A

5) Piece 2

A	26 mm (1.02 in.)
B	18 mm (0.71 in.)
C	16.5 to 17.0 mm (0.6496 to 0.6693 in.)
D	1.5 mm (0.06 in.)
E	53.5 to 53.7 mm dia. (2.1063 to 2.1142 in dia.)
F	50.05 to 50.25 mm dia. (1.9705 to 1.9783 in dia.)
G	16 mm (0.63 in.)
H	Chamfer 1 mm (0.04 in.)
I	8.5 mm dia. (0.33 in. dia.)
J	0.4 mm (0.0157 in.)
K	3 mm (0.12 in.)
L	19 mm (0.75 in.)
M	Chamfer 0.5 mm (0.02 in.)
N	36 mm (1.42 in.)
O	45 mm dia. (1.77 in. dia.)
P	0.78 rad (45 °)
Q	11.5 mm (0.45 in.)

W1048068

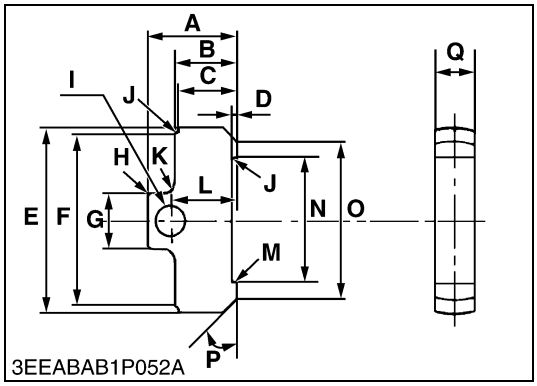


3EEABAB1P054A

6) Joint 2

A	M12 × P1.25
B	Chamfer 1 mm (0.04 in.)
C	30 mm dia. (1.18 in. dia.)
D	13 mm dia. (0.51 in. dia.)
E	Chamfer 3 mm (0.12 in.)
F	3 mm (0.12 in.)
G	45 mm (1.77 in.)
H	75 mm (2.95 in.)
I	57 mm (2.24 in.)
J	85 mm (3.35 in.)
K	70 mm (2.76 in.)
L	394 mm (15.51 in.)

W1048305

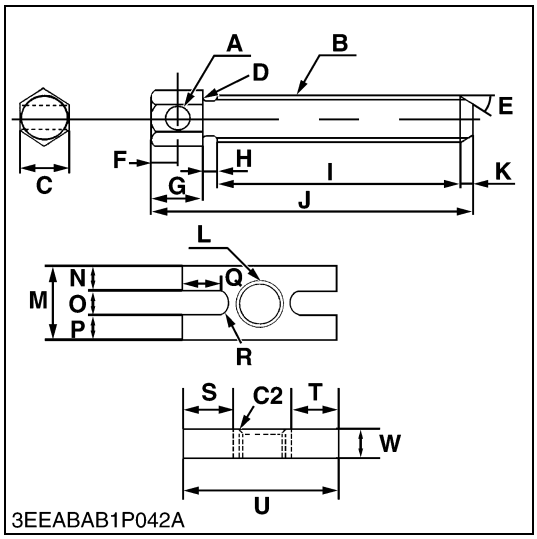


3EEABAB1P052A

7) Piece 3

A	26 mm (1.02 in.)
B	18 mm (0.71 in.)
C	16.5 to 17.0 mm (0.6496 to 0.6693 in.)
D	1.5 mm (0.06 in.)
E	53.0 to 53.2 mm dia. (2.0866 to 2.0945 in dia.)
F	49.55 to 49.75 mm dia. (1.9508 to 1.9587 in dia.)
G	16 mm (0.63 in.)
H	Chamfer 1 mm (0.04 in.)
I	8.5 mm dia. (0.33 in. dia.)
J	0.4 mm (0.0157 in.)
K	3 mm (0.12 in.)
L	19 mm (0.75 in.)
M	Chamfer 0.5 mm (0.02 in.)
N	36 mm (1.42 in.)
O	45 mm dia. (1.77 in. dia.)
P	0.78 rad (45 °)
Q	11.5 mm (0.45 in.)

W1048484



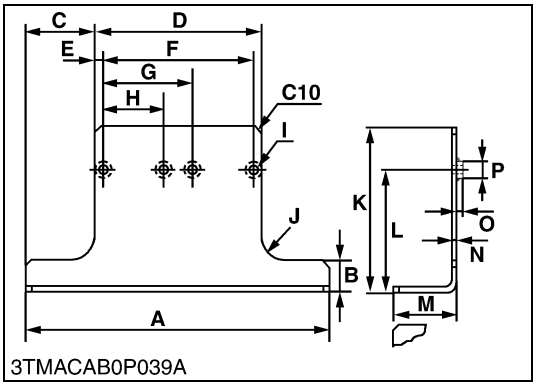
3EEABAB1P042A

Injection Pump Gear Puller

Application: Use for remove the injection pump gear from governor shaft.

A	10 mm dia. (0.39 in.dia.)
B	M16 × Pitch 1.5
C	19 mm (0.75 in.)
D	0.5 mm radius (0.02 in. radius)
E	0.87 rad (50 °)
F	10 mm (0.39 in.)
G	20 mm (0.79 in.)
H	5 mm (0.20 in.)
I	95 mm (3.74 in.)
J	125 mm (4.92 in.)
K	5 mm (0.20 in.)
L	M16 × Pitch 1.5
M	30 mm (1.18 in.)
N	9.5 mm (0.3740 in.)
O	11 mm (0.4331 in.)
P	9.5 mm (0.3740 in.)
Q	14.5 mm (0.57 in.)
R	5.5 mm radius (0.22 in. radius)
S	20 mm (0.79 in.)
T	20 mm (0.79 in.)
U	80 mm (3.1496 in.)
W	12 mm (0.47 in.)
C2	Chamfer 2.0 mm (0.079 in.)

W1042094



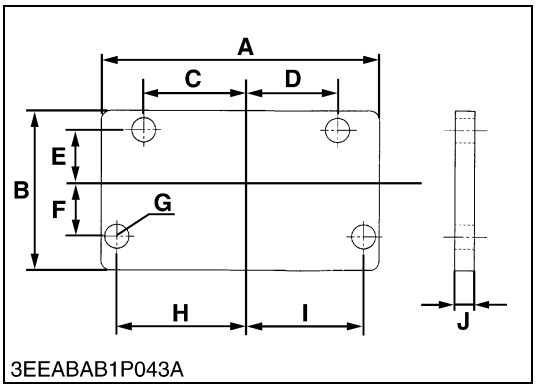
3TMACAB0P039A

Engine Stand

Application: Use to support engine.

A	480 mm (18.90 in.)
B	50 mm (1.97 in.)
C	108.5 mm (4.272 in.)
D	262.5 mm (10.33 in.)
E	12.5 mm (0.492 in.)
F	237.5 mm (9.350 in.)
G	142.5 mm (5.610 in.)
H	95 mm (3.74 in.)
I	14 mm dia. (0.55 in. dia.)
J	40 mm radius (1.57 in. radius)
K	210 mm (8.27 in.)
L	190 mm (7.48 in.)
M	100 mm (3.94 in.)
N	6 mm (0.24 in.)
O	6 mm (0.24 in.)
P	25 mm dia. (0.98 in. dia.)
C10	Chamfer 10 mm (0.394 in.)

W1033645



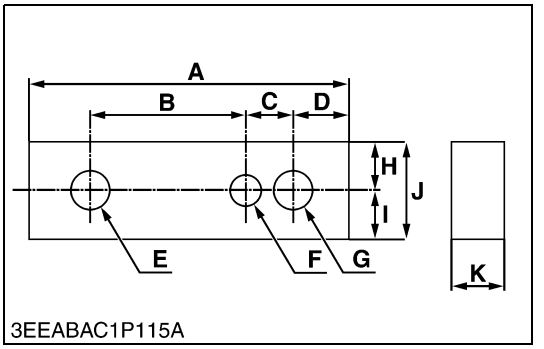
3EEABAB1P043A

Flywheel Stopper (for SAE Flywheel and Housing)

Application: Use to loosen and tighten the flywheel screw.

A	140 mm (5.5 in.)
B	80 mm (3.15 in.)
C	49.3 mm (1.94 in.)
D	49.3 mm (1.94 in.)
E	23.8 mm (0.94 in.)
F	23.8 mm (0.94 in.)
G	11 mm dia. (0.43 in. dia.)
H	56.5 mm (2.22 in.)
I	56.5 mm (2.22 in.)
J	8 mm (0.31 in.)

W1042515



3EEABAC1P115A

Tool for Aligning the Crankcase 1 and 2

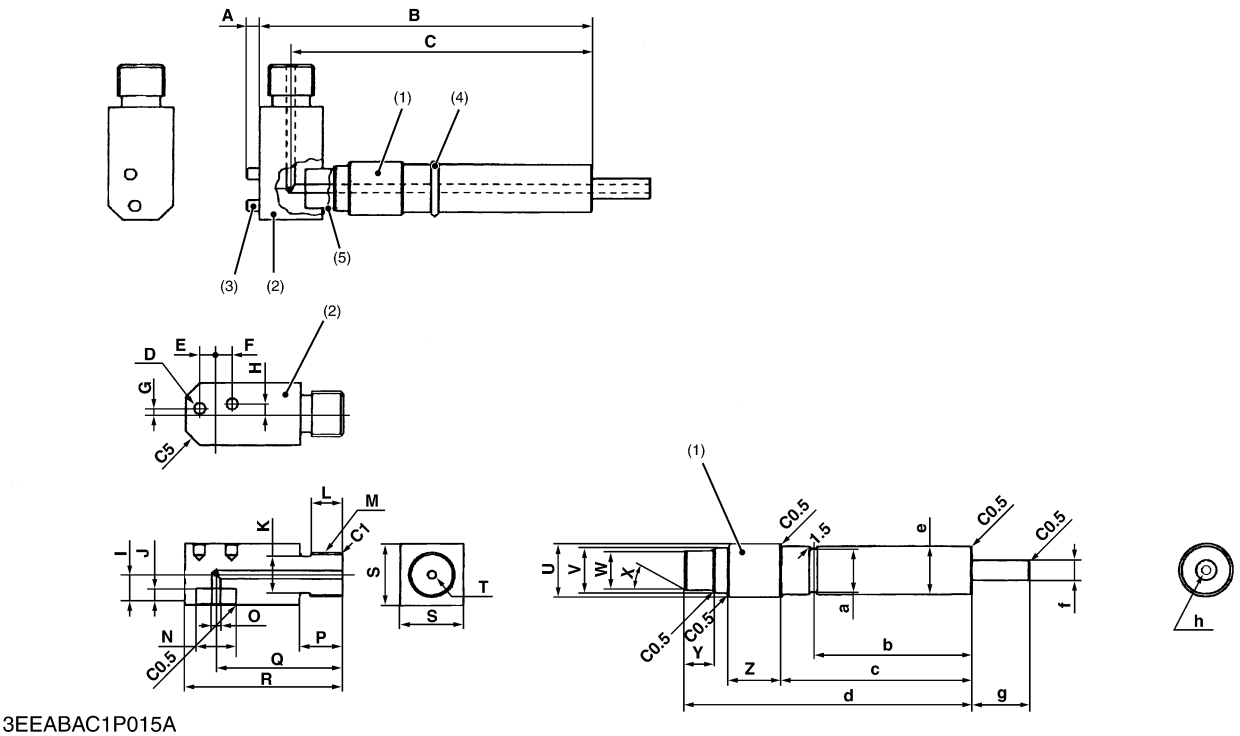
Application: Use for aligning the crankcase 1 and 2.

A	115 mm (4.5276 in.)
B	56 mm (2.2047 in.)
C	17 mm (0.6693 in.)
D	20 mm (0.7874 in.)
E	14 mm dia. (0.5512 in. dia.)
F	11 mm dia. (0.4331 in. dia.)
G	14 mm dia. (0.5512 in. dia.)
H	17.5 mm (0.6890 in.)
I	17.5 mm (0.6890 in.)
J	35 mm (1.3780 in.)
K	19 mm (0.7480 in.)

W1047882

Nozzle Adaptor for Measuring Cylinder Compression Pressure

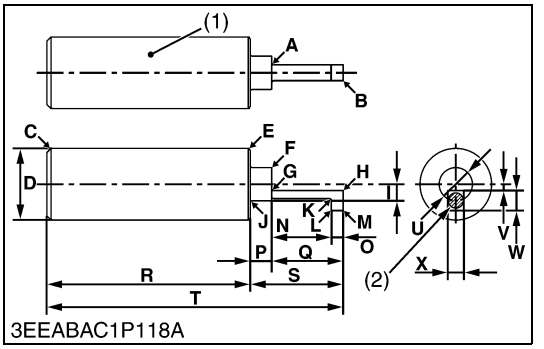
Application: Use for measuring diesel engine compression pressure.



3EEABAC1P015A

A	5 mm (0.1969 in.)	T	3 mm dia., 44.5 to 45 mm depth (0.1181 in. dia., 1.7520 to 1.7717 in. depth)
B	115.9 to 116.1 mm (4.5630 to 4.5709 in.)		
C	105 mm (4.1339 in.)	U	19 mm dia. (0.7480 in. dia.)
D	4 mm dia., 4 mm depth (0.1575 in dia., 0.1575 in. depth)	V	16 mm dia. (0.6299 in. dia.)
E	6 mm (0.2362 in.)	W	14 mm dia. (0.5512 in. dia.)
F	5.3 mm (0.2087 in.)	X	0.524 rad (30°)
G	1.9 mm (0.0748 in.)	Y	10 mm (0.3937 in.)
H	3.5 mm (0.1378 in.)	Z	19 mm (0.7480 in.)
I	11.6 to 12.1 mm (0.4567 to 0.4764 in.)	a	14.94 to 15 mm dia. (0.5882 to 0.5906 in. dia.)
J	6 to 6.1 mm (0.2362 to 0.2402 in.)	b	55 mm (2.1654 in.)
K	13 mm dia. (0.5118 in. dia.)	c	66 mm (2.5984 in.)
L	11 mm (0.4331 in.)	d	100 to 100.1 mm (3.9370 to 3.9409 in.)
M	5/8-18UNF-2B	e	16.89 to 17 mm dia. (0.6650 to 0.6693 in. dia.)
N	14.0 to 14.011 mm dia. (0.5512 to 0.5516 in. dia.)	f	7.1 to 7.2 mm dia. (0.2795 to 0.2835 in. dia.)
O	3 mm dia. (0.1181 in. dia.)	g	20.3 to 20.5 mm (0.7992 to 0.8071 in.)
P	15 mm (0.5906 in.)	h	3 mm dia. (0.1181 in. dia.)
Q	44 mm (1.7323 in.)	C0.5	Chamfer 0.5 mm (Chamfer 0.0197 in.)
R	55 mm (2.1654 in.)	C1	Chamfer 1 mm (Chamfer 0.0394 in.)
S	22 mm (0.8661 in.)	C5	Chamfer 5 mm (Chamfer 0.1969 in.)

(1) Material SS400 (3) Pin 05012-00408 (4) O-ring 04811-00150 (5) Arc welding
(2) Material S43C-D



3EEABAC1P118A

Jig for Governor Connecting Rod

Application: Use for connecting the governor connecting rod to the rack pin of the fuel injection pump assembly.

A	1 mm radius (0.0394 in. radius)
B	Chamfer 0.2 mm (0.0079 in.)
C	Chamfer 2 mm (0.0787 in.)
D	35 mm dia. (1.3780 in. dia.)
E	Chamfer 1 mm (0.0394 in.)
F	Chamfer 0.1 mm (0.0039 in.)
G	1 mm radius (0.0394 in. radius)
H	Chamfer 0.2 mm (0.0079 in.)
I	8 mm radius (0.3150 in. radius)
J	1 mm radius (0.0394 in. radius)
K	1 mm radius (0.0394 in. radius)
L	Chamfer 0.2 mm (0.0079 in.)
M	Chamfer 0.2 mm (0.0079 in.)
N	29 mm (1.1417 in.)
O	6 mm (0.2362 in.)
P	10.7 mm (0.4213 in.)
Q	35 mm (1.3780 in.)
R	99.3 mm (3.9095 in.)
S	45.65 to 45.75 mm (1.7972 to 1.8012 in.)
T	145 mm (5.7087 in.)
U	16.15 to 16.35 mm (0.6358 to 0.6437 in.)
V	3 mm (0.1181 in.)
W	10 mm (0.3937 in.)
X	8 mm (0.3150 in.)

(1) Material: S45C-D

(2) Permanent Magnet: 8 mm dia. (0.3150 in. dia.)
Thickness: 3 mm (0.1181 in.)

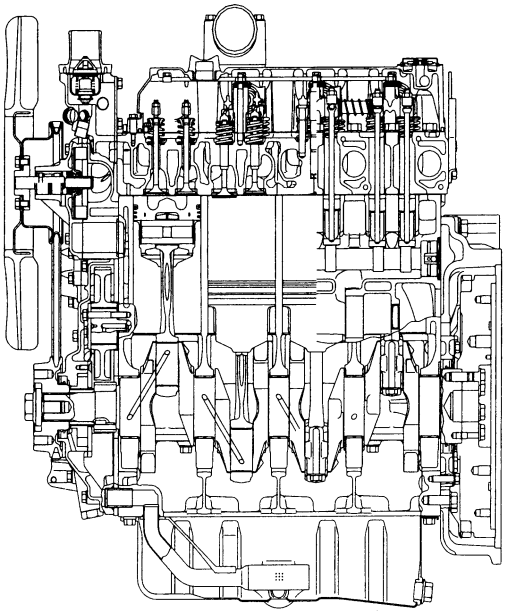
W1115114

Mechanism

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7. INTAKE SYSTEM III-S-86
[1] INTAKE AIR HEATER III-S-86

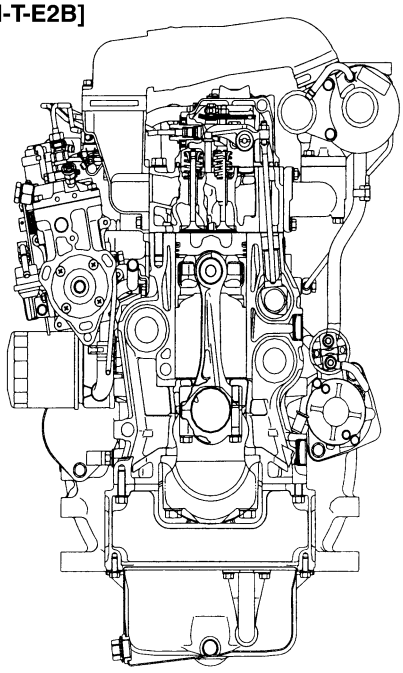
1. FEATURE

[V3800DI-E2B]



3EEABAC1P001C

[V3800DI-T-E2B]



3EEABAC1P002C

The V3 series DI engine are the vertical type 4-cycle diesel engine featuring the advanced performances shown below.

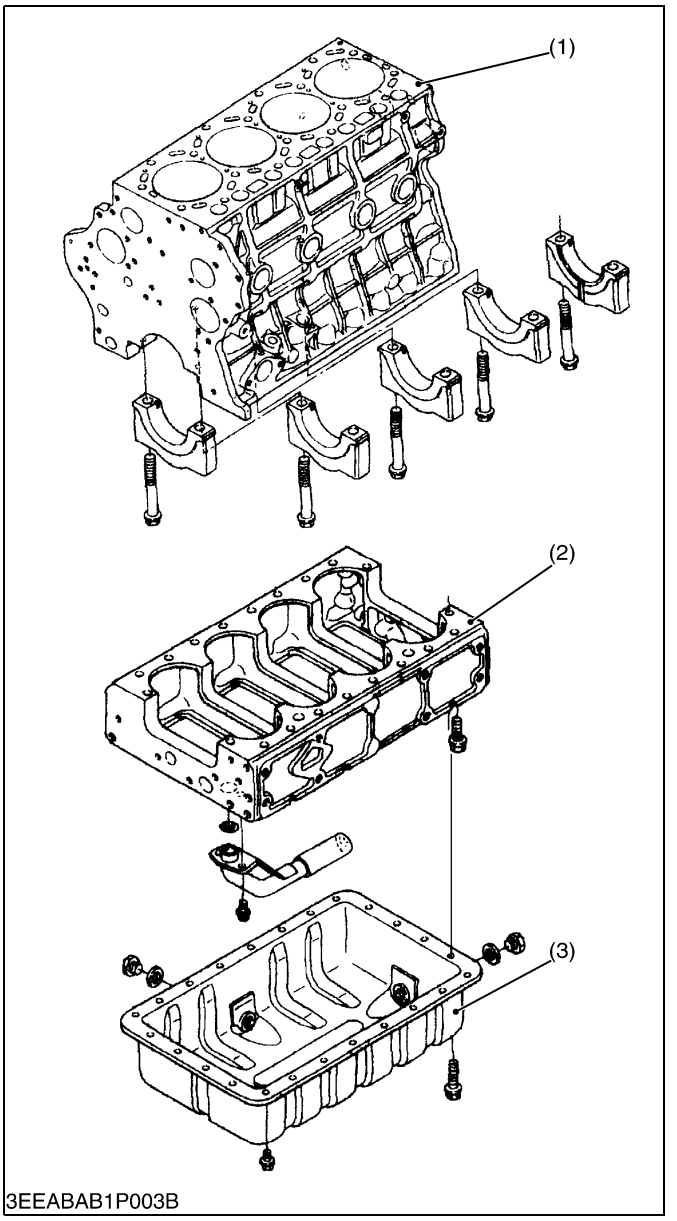
This is a small sized, high power and environment conscious engine, which employs the four valve system, two inlet valves with double ports, and two exhaust valves with the new E-CDIS. Thus, this engine achieves high combustion efficiency and complies with various regulations of exhaust gas.

Based upon the conventional model, Kubota developed a unique governor system and various new mechanisms which reduces exhaust emission, noise and vibration and realize durability and high torque.

W1013043

2. ENGINE BODY

[1] CYLINDER BLOCK



3EEABAB1P003B

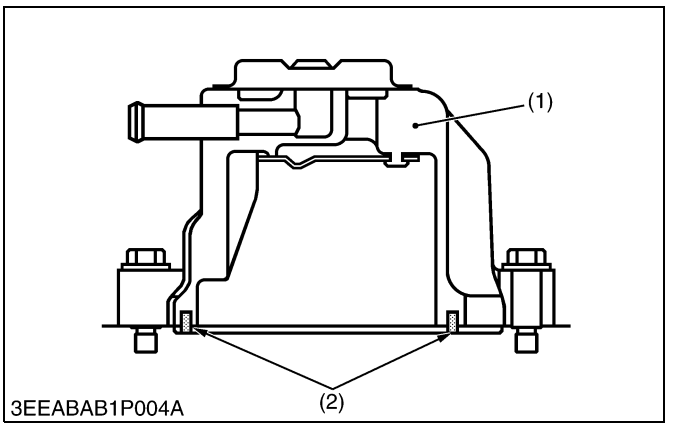
This engine employs separate type crankcases - the crankcase 1 (1) with combustion part and the crankcase 2 (2) which supports the crankcase 1 (1) and reduces noise.

Since it is a hanger type, you can easily assemble / disassemble it. The cylinder is a linerless type which enables good cooling operation, less strain and good abrasion resistance.

(1) Crankcase 1 (3) Oil Pan
(2) Crankcase 2

W1013119

[2] HALF-FLOATING HEAD COVER



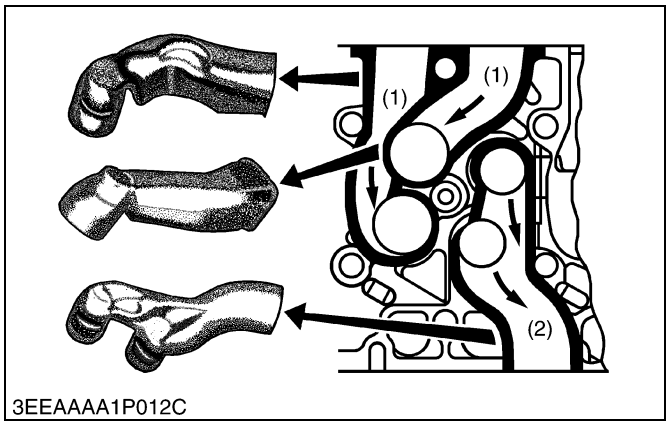
3EEABAB1P004A

The rubber packing is fitted in to maintain the 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

[3] CYLINDER HEAD



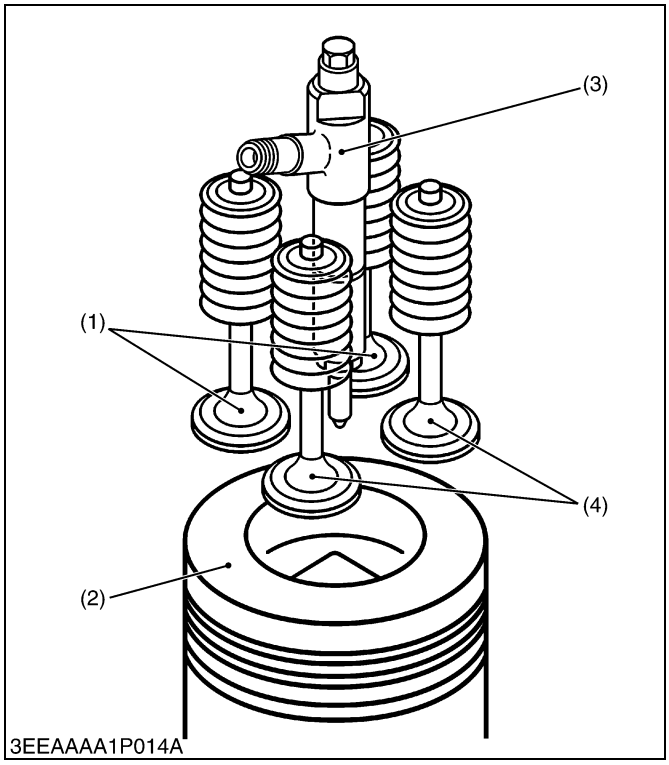
3EEAAAA1P012C

This engine employs four valve system, the cylinder head is provided with double intake passenge in order to ensure appropriate air suction and give an optimum swirl.

(1) Intake (2) Exhaust

W1013336

[4] CENTER DIRECT INJECTION SYSTEM (E-CDIS)



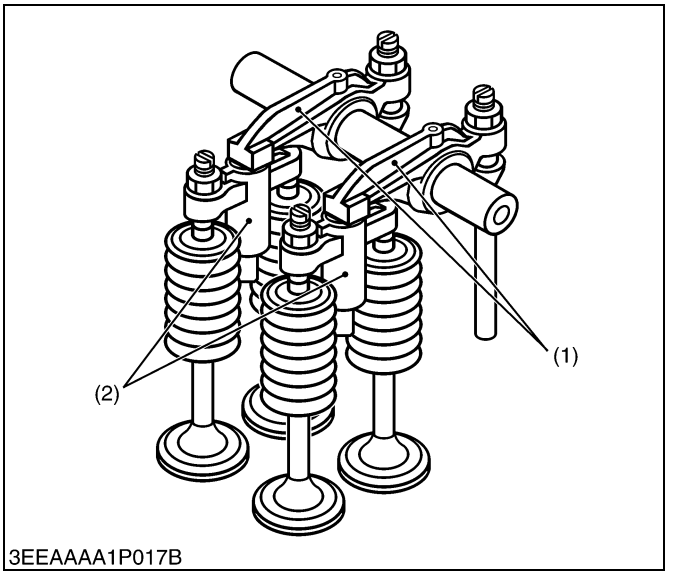
3EEAAAA1P014A

V3 series DI engine adopts the Center Direct Injection System (E-CDIS), in which the injection nozzle is positioned upright at the center of the cylinder.

This system serves to inject fuel directly at the center of the cylinder. By so doing, injected fuel and suction air can be mixed more uniformly, leading to more stable, higher combustion performance. In other words, cleaner emission, higher power output, lower fuel consumption, lower operating noise and higher start-up performance have been achieved.

(1) Exhaust Valves (3) Injection Nozzle
(2) Piston (4) Intake Valves

W11094950



3EEAAAA1P017B

V3 series DI engine has two intake valves and two exhaust valves per each cylinder.

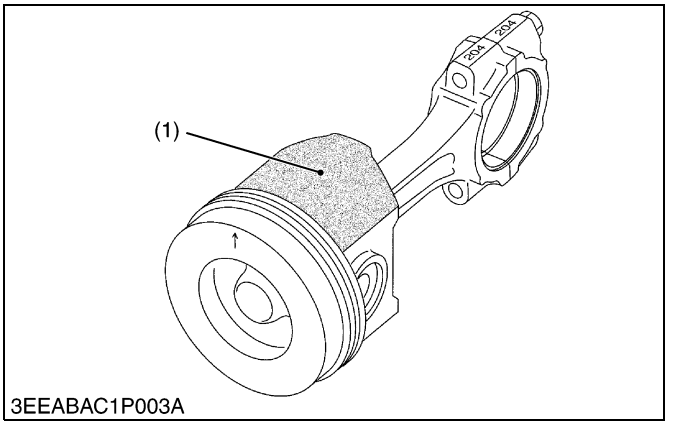
The rocker arm (1) contacts a bridge arm (2) instead of the valves stem tip.

The bridge arm then contacts both intake valves or bath exhaust valves and causes two valves to open simultaneously.

(1) Rocker Arm (2) Bridge Arm

W1014724

[5] PISTON



3EEABAC1P003A

Piston's skirt is coated with molybdenum disulfide<Dingbats>H, which reduces the piston slap noise and thus the entire operating noise.

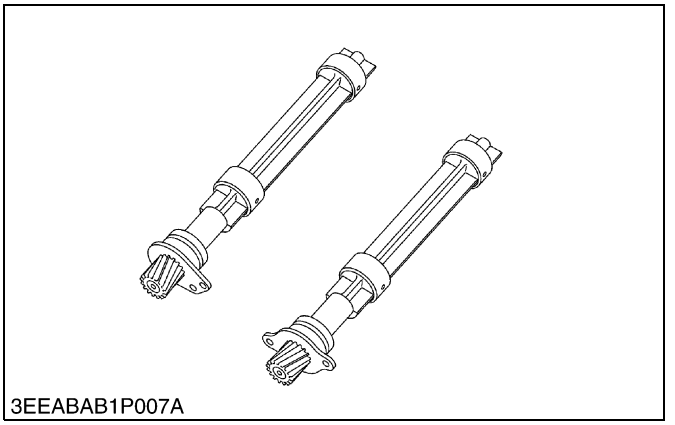
■ **Molybdenum disulfide (MoS_2)**

The molybdenum disulfied serves as a solid lubricant, like a Graphite or Teflon. This material helps resist metal wears even with little lube oil.

(1) Molybdenum Disulfide

W1015665

[6] BUILT-IN DYNAMIC BALANCER (BALANCER MODEL ONLY)


3EEABAB1P007A

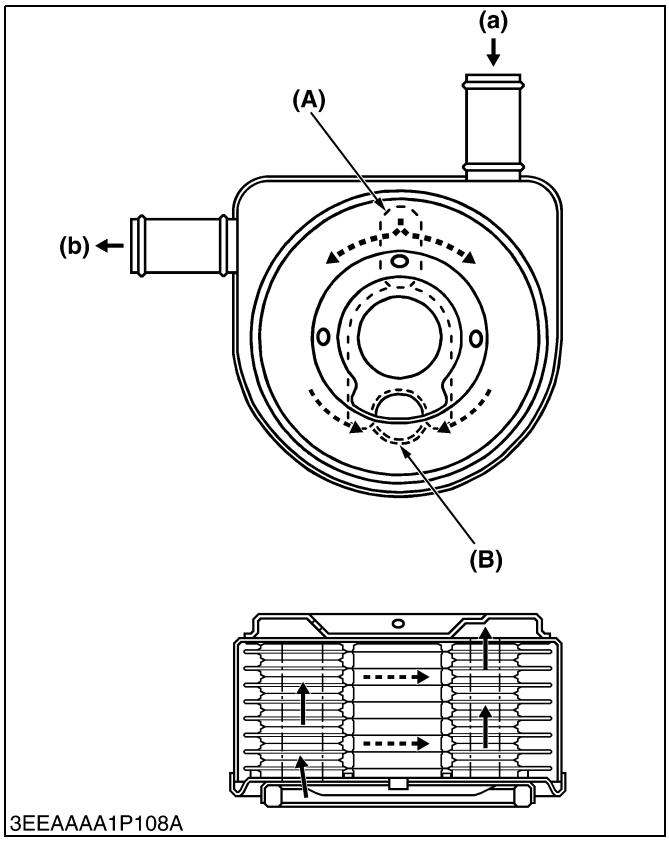
Engine are sure to vibrate by piston's reciprocation. Theoretically, three-cylinder engines are much less prone to cause vibration than four-cylinder ones (second inertia, etc.). However, any engine has many moving parts in addition to its pistons and cannot be completely free from vibration.

The four cylinder engine is fitted with balance weight on crankcase to absorb the second inertia mentioned above and reduce vibration.

W1013617

3. LUBRICATING SYSTEM

[1] OIL COOLER



V3 series engine has a water-cooled oil cooler that not only cools hot oil, but also warms the cool engine oil shoftly after start up.

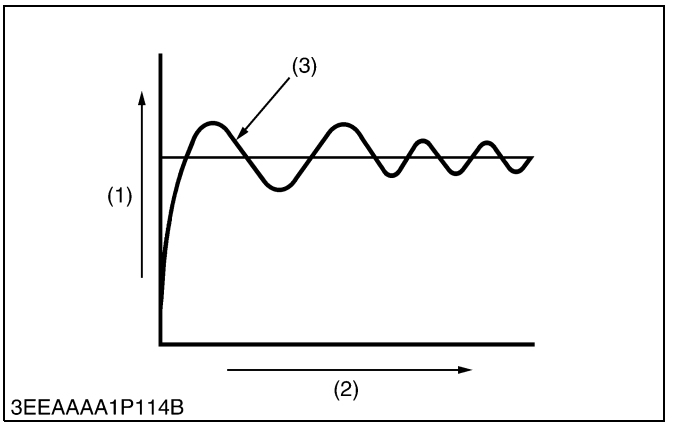
As shown in the figure, the oil flows inside the connected cooler plate, whereas coolant is kept circulating outside the cooler plate, thereby cooling down or warming the oil.

(A) Oil Inlet Port
(B) Oil Outlet Port
(a) Coolant Inlet Port
(b) Coolant Outlet Port

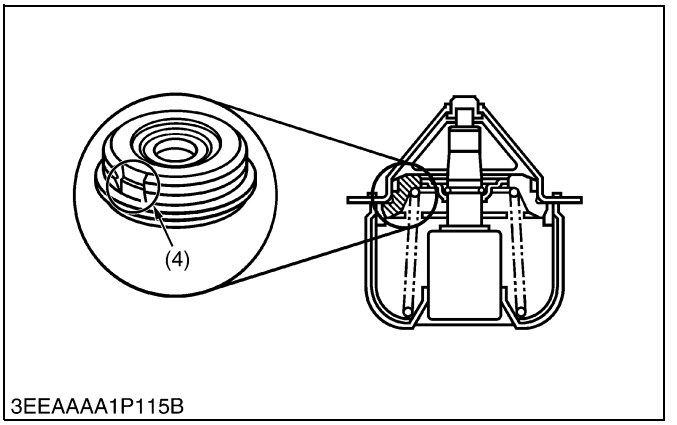
W10344770

4. COOLING SYSTEM

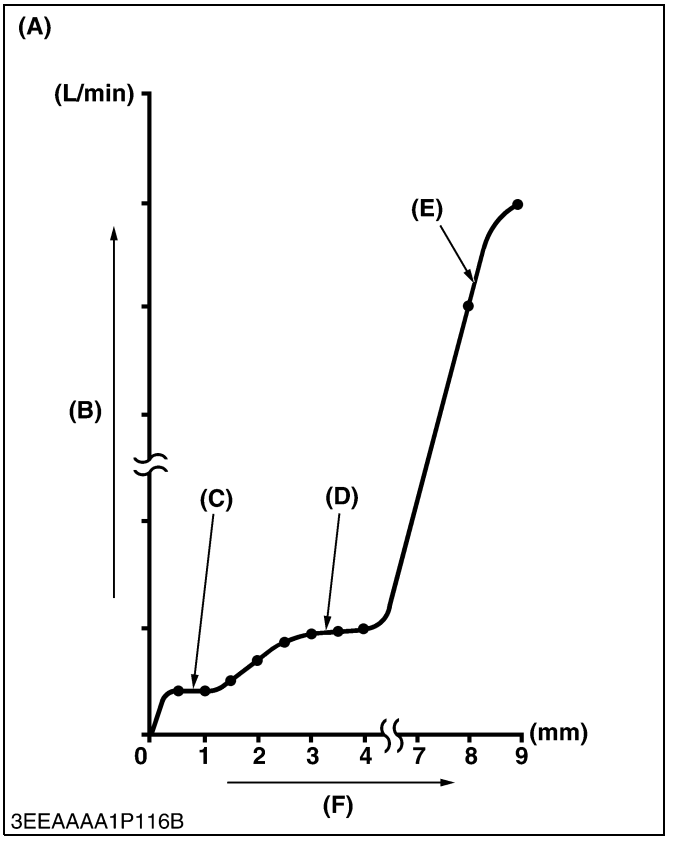
[1] THERMOSTAT



3EEAAAA1P114B



3EEAAAA1P115B



3EEAAAA1P116B

Conventional thermostatically-controlled valves (outlet water temperature control type) open against the flow of coolant. In this design, the pressure (steam pressure + water pump's discharge pressure) affects the open/close performance of such valve. In other words, the valve may be delayed in opening at a preset opening temperature opening suddenly, above the preset temperature. This is called the overshoot phenomenon.

The overshoot problem invites the undershoot phenomenon too. Too much water cooled by the radiator flows through the water passage, which suddenly closes the valve below the thermostat's preset valve closing temperature.

A repeated cycle of such overshoot and undershoot phenomena is called the water temperature hunting. This hunting problem may adversely affects the cooling system parts, and also the engine and its related components.

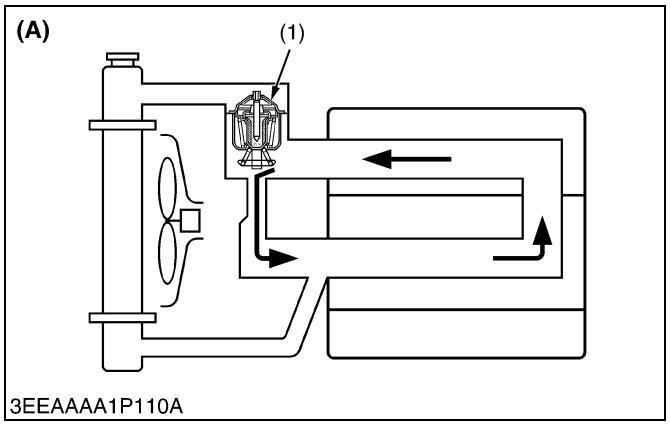
To cope with this trouble, the V3 series engine is equipped with the flow control thermostat. The valve has a notch to control the coolant flowrate smoothly in small steps.

(1) Coolant Temperature
(2) Time
(3) Overshoot
(4) Notch

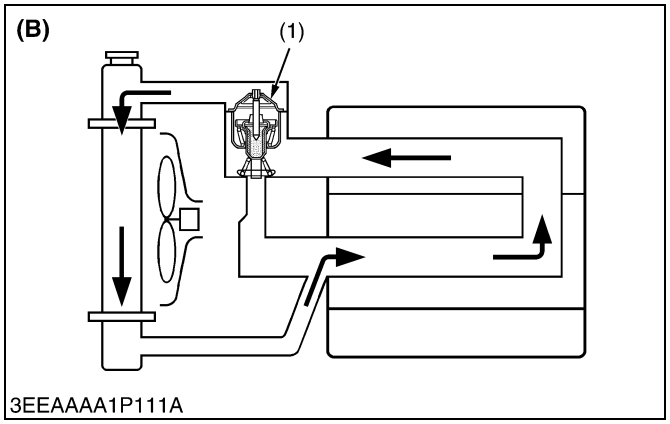
(A) Valve Lift Versus Flowrate
(B) Flowrate
(C) At Short Valve Lift
(D) At Medium Valve Lift
(E) At High Valve Lift
(F) Valve Lift

W1013684

[2] BOTTOM BYPASS SYSTEM



3EEAAAA1P110A



3EEAAAA1P111A

Bottom bypass system is introduced in V3 series for improving the cooling performance of the radiator.

While the temperature of coolant in the engine is low, the thermostat 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 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.

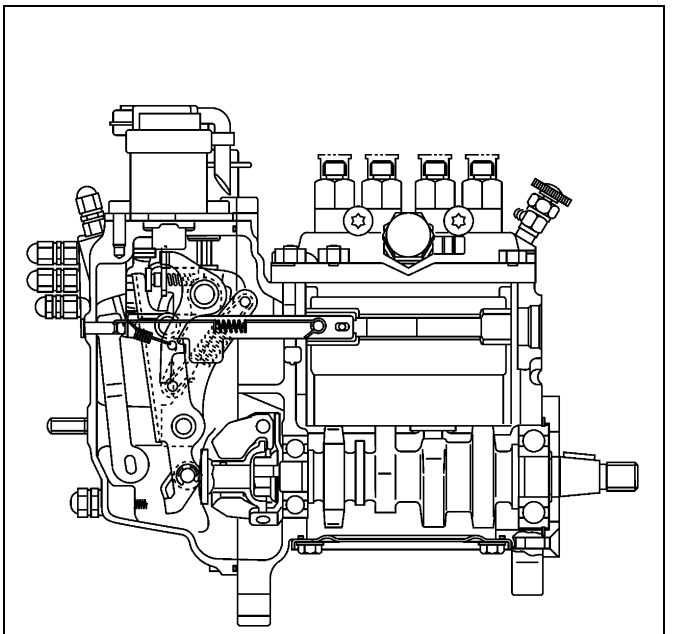
(1) Thermostat

(A) Bypass Opened
(B) Bypass Closed

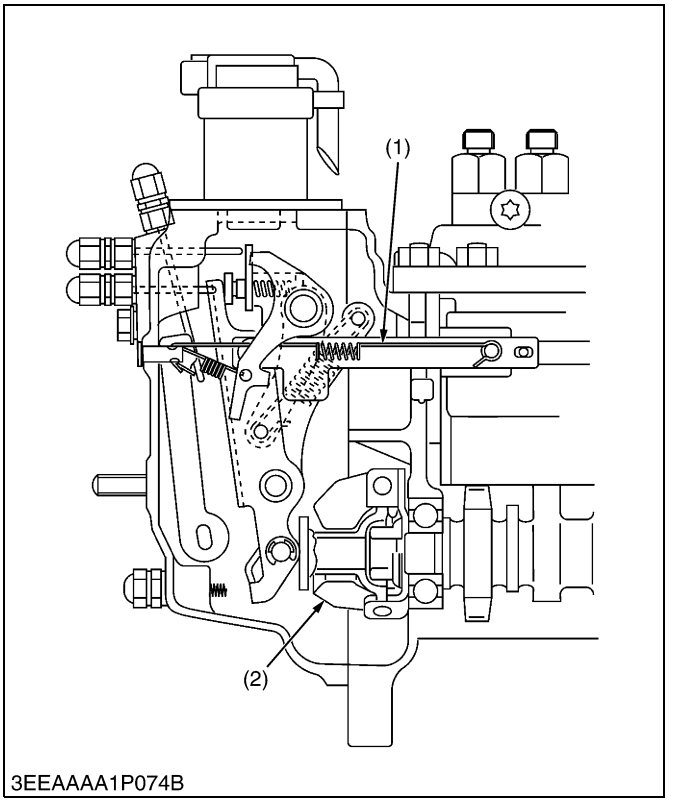
W1013406

5. FUEL SYSTEM

[1] GOVERNOR



3EEAAAA1P064B



3EEAAAA1P074B

The engine employs the separated fuel injection pump in combination with Kubota's own small multi-function mechanical governor, which enable more dependability.

It also employs the torque limiting mechanism to control the maximum peak torque so that it complies with the regulations of exhaust gas.

This mechanism maintains engine speed at a constant level even under fluctuating loads, provides stable idling and regulates maximum engine speed by controlling the fuel injection rate.

This engine uses a mechanical governor that controls the fuel injection rate at all speed ranges (from idling to maximum speed) by utilizing the balance between the flyweight's centrifugal force and spring tension.

A governor shaft for monitoring engine speed is independent of the injection pump shaft and rotates at twice the speed of conventional types, providing better response to load fluctuation and delivering greater engine output.

W1013830

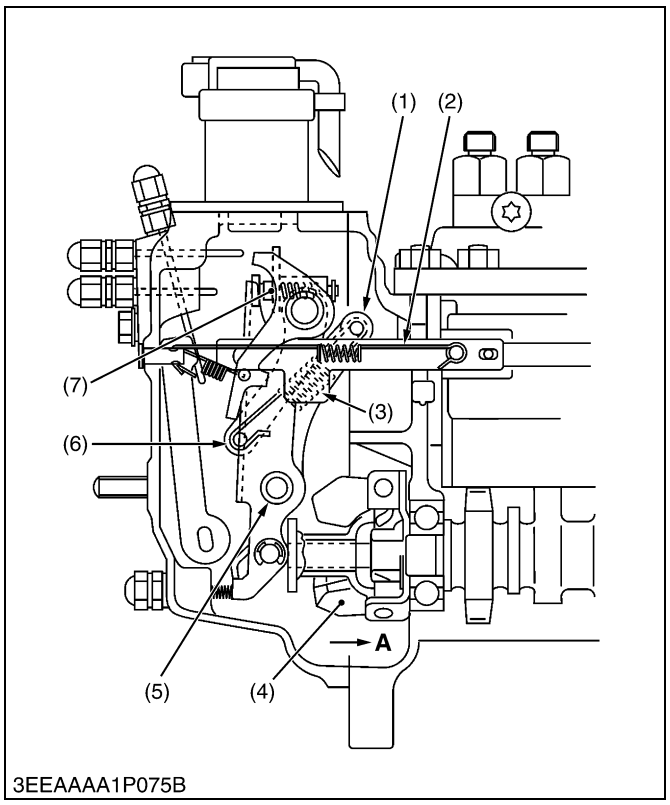
■ At Start

The stop solenoid (energized-to-run type) is powered to release the stop lever.

As no centrifugal force is applied to flyweight (2), low tension of start spring (1) permits control rack to move the starting position, supplying the amount of fuel required to start the engine.

(1) Start Spring (2) Flyweight

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3EEAAAA1P075B

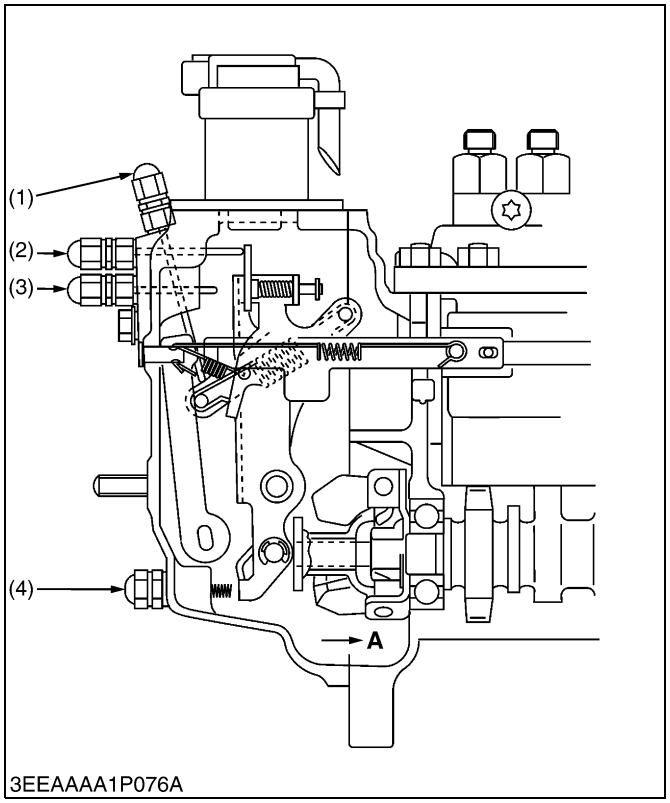
■ At Idling

Turn the speed control lever (6) clockwise to idle the engine. It tensions the governor spring (3) to pull the fork lever 2 (1).

When the fork lever 2 is pulled, it moves the torque spring pin (7) and the fork lever 1 (5) in the direction of the arrow **A** to restrain the weight. In combination with the start spring tension, it is balanced with the centrifugal force of flywheel weight to keep idling.

(1) Fork Lever 2
(2) Start Spring
(3) Governor Spring
(4) Flyweight
(5) Fork Lever 1
(6) Speed Control Lever
(7) Spring Pin

W1014034



3EEAAAA1P076A

■ At rated speed with full load and overload

As the speed control lever is changed from the middle speed to high speed, the governor spring tension increases to compress the torque spring and move the fork lever 1 in the direction of the arrow **A**.

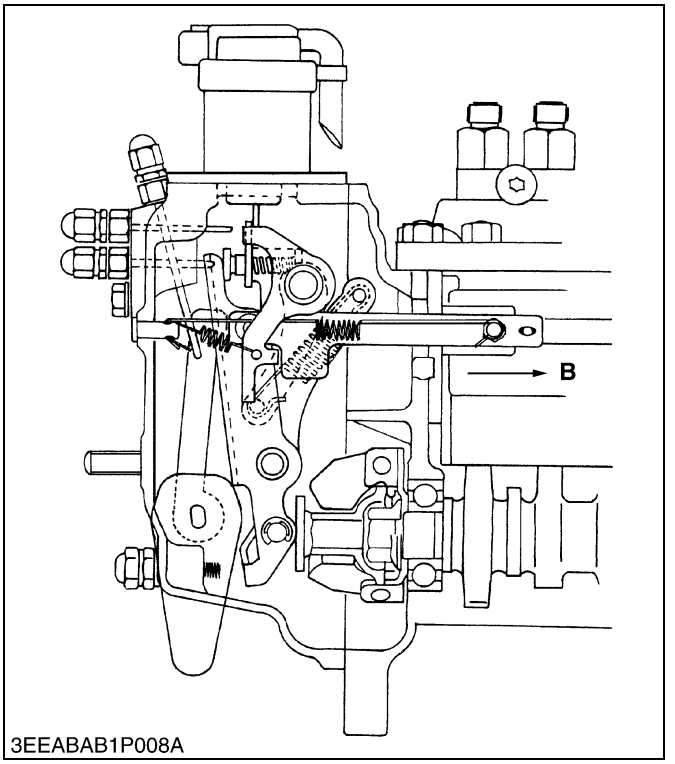
The fork lever 2 moves until it reaches the output limiting bolt to keep rated rotation and rated output.

When the engine is overloaded, the engine rotating speed decreases and the centrifugal force of flywheel weight decreases. Then the torque spring moves the fork lever 1 in the direction of arrow **A**.

The control rack moves in the direction that increases fuel supply to increase the output. It is balanced with the centrifugal force of the flywheel weight to produce low-speed output (torque output).

(1) No-load Maximum Rotation
(2) Output Limiting Bolt
(3) Torque Limiting Bolt
(4) Idling Adjusting Bolt

W1014276



3EEABAB1P008A

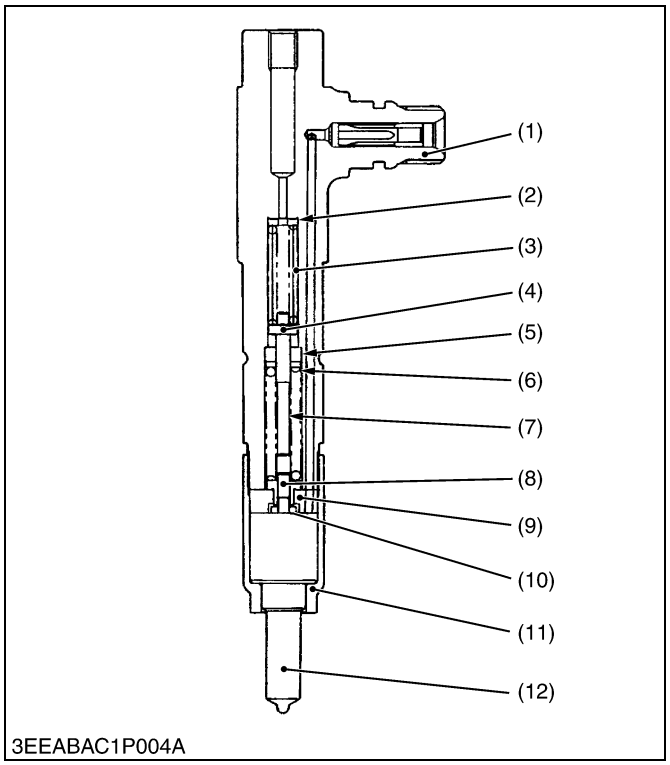
■ **To stop engine**

When the stop solenoid is turned off, the spring tension of the solenoid is released, the rod extrudes and the stop lever moves the control rack in the direction of the arrow **B** which stops the engine.

To stop the engine manually, move the external stop lever to the left.

W1014393

[2] 2 STAGE DI NOZZLE



3EEABAC1P004A

Exhaust and noise regulations are becoming increasingly strict, particularly in regard to the reduction of NOx (nitrogen oxides) and particulates.

The two-spring nozzle holder has been developed to reduce NOx (nitrogen oxides) and particulates from direct injection diesel engine exhaust.

■ **Features**

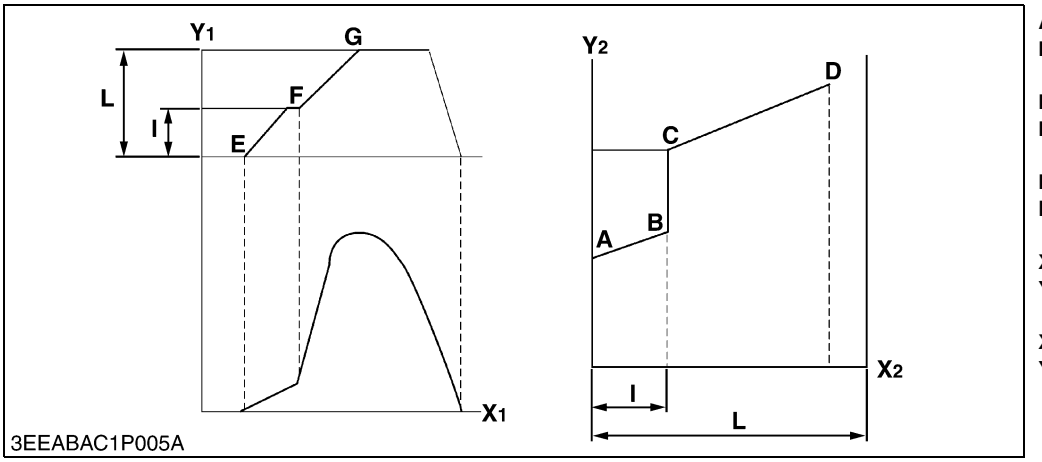
The two-spring nozzle holder limits needle valve lift at initial valve opening to throttle the injection quantity. Main injection occurs when the in-line pressure has increased sufficiently to move the needle valve through its full lift.

This gives the following features.

- Improved engine stability at low and intermediate speeds.
- Decreased engine hunting and surge.
- Decreased noise at idling.
- Decreased idling speed because of improved engine stability.
- Stabilized fuel injection characteristics from the injection pump and nozzle system, and easier matching of governor characteristics to engine demand.

(1) Nozzle Holder Body
(2) 1st Stage Injection Pressure Adjusting Shim
(3) First Spring
(4) Pressure Pin
(5) Spring Seat
(6) 2nd Stage Injection Pressure Adjusting Shim
(7) Second Spring
(8) Pre-lift Adjusting Spring Seat
(9) Chip-packing
(10) Max-lift Adjusting Washer
(11) Retaining Nut
(12) Nozzle

W1014568



3EEABAC1P005A

A-B : First Spring's Set Force
B-C-D : Combined Force of First and Second Springs
P1 : First Opening Pressure
P2 : Second Opening Pressure

L : Full Needle Valve Lift
l : Needle Valve Pre-lift

X1 : Cam Angle (<Symbol>×)
Y1 : Injection Rate (mm3/ <Symbol>×)
X2 : Needle Valve Lift (mm)
Y2 : In-line Pressure

W1014795

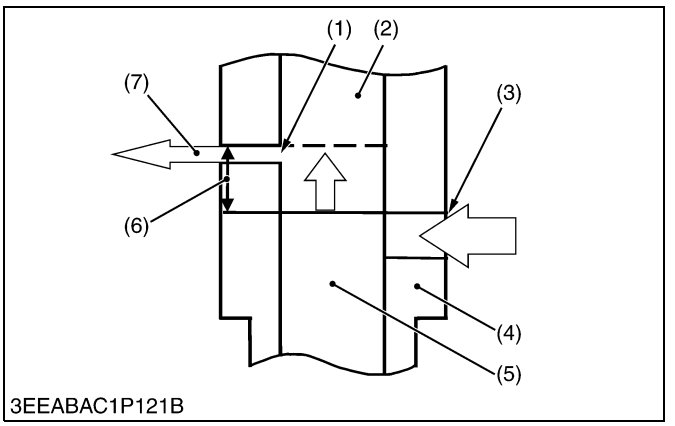
■ **First opening pressure**

The force of the high pressure fuel delivered by the injection pump acts to push the needle valve up. When this force exceeds the set force of the first spring, the nozzle's needle valve pushes the first pushrod up and the valve opens. (First opening pressure is represented by point **E** in the bottom left hand figure, and point **A** in the above figure.)

■ **Second opening pressure**

When the first pushrod has been lifted through the pre-lift, it contacts the second pushrod. As the set force of the second spring is acting on the second pushrod, the combined forces of both the first spring and the second spring then act on the needle valve, which will not lift unless these forces are overcome.

[3] INJECTION PUMP WITH F.S.P.



3EEABAC1P121B

The fuel injection pump with F.S.P. (Fine Spill Port) mechanism is equipped with two functions: speed timer function and injection rate control function.

The former function works like this. As the rpm is low, the injection timing gets delayed. This helps cut down on NOx and operating noise.

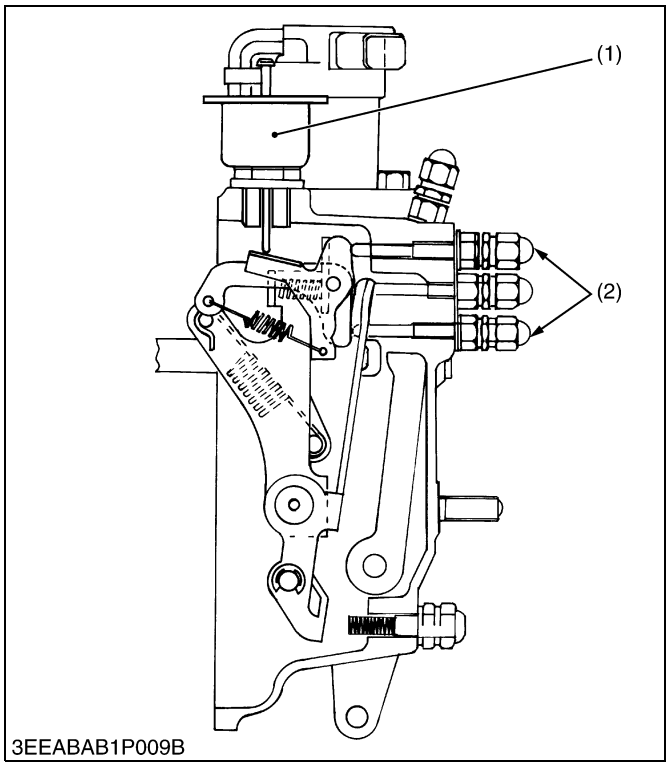
The latter function serves to keep down the initial injection rate and keep up the later injection rate, which cuts down on NOx and PM as well.

(1) Fine Spill Port (F.S.P.)
(2) Plunger Chamber
(3) Main Port
(4) Cylinder
(5) Plunger
(6) F.S.P. Stroke
(7) Leaking Fuel at Initial Fuel Pressure-Feed Stage

W1014969

6. TURBOCHARGER SYSTEM

[1] BOOST COMPENSATOR



The boost compensator is controlled by the boost pressure of the control mechanism which controls transient smoke caused by oversupply of fuel when the engine starts and accelerates.

When the boost pressure is lower than working pressure of the boost actuator (1), it prevents oversupply of fuel to reduce transient smoke.

When the boost pressure is higher than working pressure of the boost actuator (1), it controls the supply of fuel to the equivalent of maximum power / rated speed output.

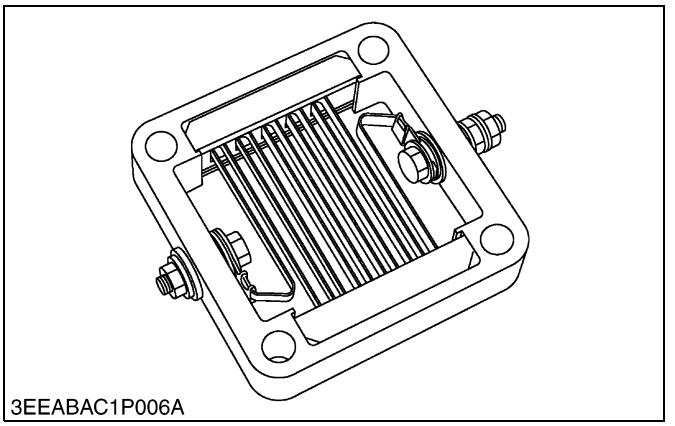
The boost compensator adjusting screws (2) are set and tamper-proof capped in factory, so never take off the tamper-proof cap and readjust the screws.

(1) Boost Actuator
(2) Boost Compensator Adjusting Screw

W1014569

7. INTAKE SYSTEM

[1] INTAKE AIR HEATER


3EEABAC1P006A

The intake air heater is introduced in order to further improve the starting performance and to reduce the white smoke at cold starting.

The intake air heater is mounted on the intake manifold. In this new construction, there is no need to arrange any glow plug on the cylinder head. This means that a multi-valve design can be implemented and that the starting performance and serviceability are enhanced.

W1015544

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      (8) Alternator III-S-165

1. TROUBLESHOOTING

Symptom	Probable Cause	Solution	Reference Page
Engine Does Not Start	No fuel	Replenish fuel	
	Air in the fuel system	Vent air	
	Water in the fuel system	Change fuel and repair or replace fuel system	
	Fuel hose clogged	Clean or replace	
	Fuel filter clogged	Replace	
	Excessively high viscosity of fuel or engine oil at low temperature	Use specified fuel or engine oil	
	Fuel with low cetane number	Use specified fuel	
	Fuel leak due to loose injection pipe retaining nut	Tighten retaining nut	
	Incorrect injection timing	Adjust	
	Fuel camshaft worn	Replace	
	Injection nozzle clogged	Repair or replace	
	Injection pump malfunctioning	Repair or replace	
	Seizure of crankshaft, camshaft, piston, cylinder or bearing	Repair or replace	
	Compression leak from cylinder	Replace head gasket, tighten cylinder head screw and nozzle holder	
	Improper valve timing	Correct or replace timing gear	
	Piston ring and cylinder worn	Replace	
	Excessive valve clearance	Adjust	
	Stop solenoid malfunctioning	Replace	
Starter Does Not Run	Battery discharged	Charge	
	Starter malfunctioning	Repair or replace	
	Key switch malfunctioning	Replace	
	Wiring disconnected	Connect	

W1014322

Symptom	Probable Cause	Solution	Reference Page
Engine Revolution Is Not Smooth	Fuel filter clogged or dirty	Replace	
	Air cleaner clogged	Clean or replace	
	Fuel leak due to loose injection pipe retaining nut	Tighten retaining nut	
	Injection pump malfunctioning	Repair or replace	
	Incorrect nozzle opening pressure	Repair or replace	
	Injection nozzle stuck or clogged	Repair or replace	
	Governor malfunctioning	Repair	
	Turbocharger bearing worn out	Replace the turbocharger assembly	
	Turbocharger shaft bent	Replace the turbocharger assembly	
	Turbocharger fin or other part damaged due to foreign matters	Replace the turbocharger assembly	
Either White or Blue Exhaust Gas Is Observed	Excessive engine oil	Reduce to specified level	
	Piston ring and cylinder worn or stuck	Repair or replace	
	Incorrect injection timing	Adjust	
Oil Leak into Exhaust Pipe or Suction Pipe	Waste oil pipe clogged or deformed	Repair or replace	
	Turbocharger's piston ring seal faulty	Replace the turbocharger assembly	
Either Black or Dark Gray Exhaust Gas Is Observed	Overload	Reduce the load	
	Low grade fuel used	Use specified fuel	
	Fuel filter clogged	Replace	
	Air cleaner clogged	Clean or replace	
	Deficient nozzle injection	Repair or replace nozzle	

W1014322

Symptom	Probable Cause	Solution	Reference Page
Deficient Output	Incorrect injection timing	Adjust	
	Engine's moving parts seem to be seizing	Repair or replace	
	Injection pump malfunctioning	Repair or replace	
	Deficient nozzle injection	Repair or replace nozzle	
	Compression leak	Check the compression pressure and repair	
	Gas leak from exhaust system	Repair or replace	
	Air leak from compressor discharge side	Repair or replace	
	Air cleaner dirty or clogged	Clean or replace	
	Compressor wheel turning heavily	Replace the turbocharger assembly	
Excessive Lubricant Oil Consumption	Piston ring's gap facing the same direction	Shift ring gap direction	
	Oil ring worn or stuck	Replace	
	Piston ring groove worn	Replace piston	
	Valve stem and valve guide worn	Replace	
	Crankshaft bearing and crank pin bearing worn	Replace	
	Oil leaking due to defective seals or packing	Replace	
Fuel Mixed into Lubricant Oil	Injection pump's plunger worn	Repair or replace	
	Deficient nozzle injection	Repair or replace nozzle	
	Injection pump broken	Replace	
Water Mixed into Lubricant Oil	Head gasket defective	Replace	
	Cylinder block or cylinder head flawed	Replace	
Low Oil Pressure	Engine oil insufficient	Replenish	
	Oil strainer clogged	Clean	
	Relief valve stuck with dirt	Clean	
	Relief valve spring weaken or broken	Replace	
	Excessive oil clearance of crankshaft bearing	Replace	
	Excessive oil clearance of crankpin bearing	Replace	
	Excessive oil clearance of rocker arm	Replace	
	Oil passage clogged	Clean	
	Different type of oil	Use specified type of oil	
	Oil pump defective	Replace	

W1014322

Symptom	Probable Cause	Solution	Reference Page
High Oil Pressure	Different type of oil	Use specified type of oil	
	Relief valve defective	Replace	
Engine Overheated	Engine oil insufficient	Replenish	
	Fan belt broken or elongated	Replace or adjust	
	Coolant insufficient	Replenish	
	Radiator net and radiator fin clogged with dust	Clean	
	Inside of radiator corroded	Clean or replace	
	Coolant flow route corroded	Clean or replace	
	Radiator cap defective	Replace	
	Overload running	Reduce the load	
	Head gasket defective	Replace	
	Incorrect injection timing	Adjust	
	Unsuitable fuel used	Use specified fuel	
Battery Quickly Discharged	Battery electrolyte insufficient	Replenish distilled water and charge	
	Fan belt slips	Adjust belt tension or replace	
	Wiring disconnected	Connect	
	Rectifier defective	Replace	
	Alternator defective	Replace	
	Battery defective	Replace	

W1014322

2. SERVICING SPECIFICATIONS

ENGINE BODY

Item		Factory Specification	Allowable Limit
Cylinder Head Surface	Flatness	–	0.05 mm 0.0020 in.
Top Clearance		0.72 to 0.90 mm 0.0283 to 0.0354 in.	–
Compression Pressure	V3800DI-E2B	3.92 MPa / 250 min^{-1} (rpm) 40.0 kgf/cm^2 / 250 min^{-1} (rpm) 569 psi / 250 min^{-1} (rpm)	2.90 MPa / 250 min^{-1} (rpm) 29.6 kgf/cm^2 / 250 min^{-1} (rpm) 421 psi / 250 min^{-1} (rpm)
	V3800DI-T-E2B	3.47 MPa / 250 min^{-1} (rpm) 35.4 kgf/cm^2 / 250 min^{-1} (rpm) 503 psi / 250 min^{-1} (rpm)	2.56 MPa / 250 min^{-1} (rpm) 26.1 kgf/cm^2 / 250 min^{-1} (rpm) 371 psi / 250 min^{-1} (rpm)
Variance Among Cylinders		–	10 % or less
Valve Seat	Angle (Intake)	1.047 rad 60 °	–
	Angle (Exhaust)	0.785 rad 45 °	–
	Width (Intake)	1.6 to 2.0 mm 0.0630 to 0.0790 in.	–
	Width (Exhaust)	2.3 to 2.6 mm 0.0906 to 0.1024 in.	–
Valve Face	Angle (Intake)	1.047 rad 60 °	–
	Angle (Exhaust)	0.785 rad 45 °	–
Valve Recessing	Intake	0.6 to 0.8 mm 0.0236 to 0.0315 in.	1.2 mm 0.0472 in.
	Exhaust	0.85 to 1.05 mm 0.0335 to 0.0413 in.	1.2 mm 0.0472 in.

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ENGINE BODY (Continued)

Item		Factory Specification	Allowable Limit
Valve Stem to Valve Guide	Clearance (Intake)	0.055 to 0.085 mm 0.0022 to 0.0033 in.	0.1 mm 0.0039 in.
Valve Stem	O.D. (Intake)	6.960 to 6.975 mm 0.2740 to 0.2746 in.	–
Valve Guide	I.D. (Intake)	7.030 to 7.045 mm 0.2768 to 0.2774 in.	–
Valve Stem to Valve Guide	Clearance (Exhaust)	0.055 to 0.085 mm 0.0022 to 0.0033 in.	0.1 mm 0.0039 in.
Valve Stem	O.D. (Exhaust)	6.960 to 6.975 mm 0.2740 to 0.2746 in.	–
Valve Guide	I.D. (Exhaust)	7.030 to 7.045 mm 0.2768 to 0.2774 in.	–
Valve Clearance (Cold)		0.23 to 0.27 mm 0.0091 to 0.0106 in.	–
Intake Valve Timing	Open	0.24 rad (14 °) before T.D.C.	–
	Close	0.61 rad (36 °) after B.D.C.	–
Exhaust Valve Timing	Open	0.79 rad (45 °) before B.D.C.	–
	Close	0.29 rad (17 °) after T.D.C.	–
Valve Spring	Free Length (Intake)	35.1 to 35.6 mm 1.3819 to 1.4016 in.	34.6 mm 1.3622 in.
	Free Length (Exhaust)	35.1 to 35.6 mm 1.3819 to 1.4016 in.	34.6 mm 1.3622 in.
	Tilt	–	1.0 mm 0.039 in.
Valve Spring	Setting Load / Setting Length (Intake)	63.547 N / 31.5 mm 6.48 kgf / 31.5 mm 14.256 lbs / 1.2401 in.	45.864 N / 31.5 mm 4.68 kgf / 31.5 mm 10.296 lbs / 1.2401 in.
	Setting Load / Setting Length (Exhaust)	63.547 N / 31.5 mm 6.48 kgf / 31.5 mm 14.256 lbs / 1.2401 in.	45.864 N / 31.5 mm 4.68 kgf / 31.5 mm 10.296 lbs / 1.2401 in.

W1013874

ENGINE BODY (Continued)

Item		Factory Specification	Allowable Limit
Rocker Arm Shaft to Rocker Arm	Clearance	0.016 to 0.045 mm 0.0006 to 0.0018 in.	0.15 mm 0.0059 in.
Rocker Arm Shaft	O.D.	15.973 to 15.984 mm 0.6289 to 0.6293 in.	–
Rocker Arm	I.D.	16.000 to 16.018 mm 0.6299 to 0.6306 in.	–
Valve Arm Bridge and Valve Arm Bridge Shaft	Clearance	0.018 to 0.042 mm 0.0007 to 0.0017 in.	0.15 mm 0.0059 in.
Valve Arm Bridge	I.D.	9.050 to 9.065 mm 0.3563 to 0.3569 in.	–
Valve Arm Bridge Shaft	O.D.	9.023 to 9.032 mm 0.3552 to 0.3556 in.	–
Push Rod	Alignment	–	0.25 mm 0.0098 in.
Tappet to Tappet Guide	Clearance	0.020 to 0.062 mm 0.0008 to 0.0024 in.	0.07 mm 0.0028 in.
Tappet Guide Bore	I.D.	24.000 to 24.021 mm 0.9449 to 0.9457 in.	–
Tappet	O.D.	23.959 to 23.980 mm 0.9433 to 0.9441 in.	–
Camshaft	Side Clearance	0.07 to 0.22 mm 0.0028 to 0.0087 in.	0.30 mm 0.0118 in.
	Alignment	–	0.01 mm 0.00039 in.
Cam Height	Intake	37.63 mm 1.4815 in.	37.13 mm 1.4618 in.
	Exhaust	38.96 mm 1.5338 in.	38.46 mm 1.5141 in.
Camshaft	Oil Clearance	0.050 to 0.091 mm 0.0020 to 0.0036 in.	0.15 mm 0.0059 in.
Camshaft Journal	O.D.	45.934 to 45.950 mm 1.8084 to 1.8091 in.	–
Camshaft Bearing	I.D.	46.000 to 46.025 mm 1.8110 to 1.8120 in.	–

W1013874

ENGINE BODY (Continued)

Item		Factory Specification	Allowable Limit
Timing Gear			
Idle Gear 1 to Crank Gear	Backlash	0.049 to 0.193 mm 0.0019 to 0.0076 in.	0.22 mm 0.0087 in.
Idle Gear 1 to Cam Gear	Backlash	0.049 to 0.189 mm 0.0019 to 0.0074 in.	0.22 mm 0.0087 in.
Idle Gear 1 to Idle Gear 2	Backlash	0.044 to 0.185 mm 0.0017 to 0.0073 in.	0.22 mm 0.0087 in.
Idle Gear 2 to Injection Pump Gear	Backlash	0.044 to 0.177 mm 0.0017 to 0.0070 in.	0.22 mm 0.0087 in.
Cam Gear to Balancer Gear 1 (Balancer Model Only)	Backlash	0.047 to 0.182 mm 0.0018 to 0.0072 in.	0.22 mm 0.0087 in.
Idle Gear 1 to Balancer Gear 2 (Balancer Model Only)	Backlash	0.044 to 0.183 mm 0.0017 to 0.0072 in.	0.22 mm 0.0087 in.
Idle Gear Shaft 1, 2 to Idle Gear 1, 2 Bushing	Oil Clearance	0.050 to 0.091 mm 0.0020 to 0.0036 in.	0.10 mm 0.0039 in.
Idle Gear 1, 2 Bushing	I.D.	45.025 to 45.050 mm 1.7726 to 1.7736 in.	–
Idle Gear 1, 2 Shaft	O.D.	44.959 to 44.975 mm 1.7700 to 1.7707 in.	–
Idle Gear	Side Clearance	0.15 to 0.30 mm 0.0059 to 0.0118 in.	0.9 mm 0.0354 in.
Balancer Shaft (Balancer Model Only)	Side Clearance	0.070 to 0.22 mm 0.0028 to 0.0087 in.	0.3 mm 0.0118 in.
Balancer Shaft (Balancer Model Only)	Alignment	–	0.02 mm 0.0008 in.
Balancer Shaft (Balancer Model Only)	Oil Clearance	0.070 to 0.159 mm 0.0028 to 0.0063 in.	0.2 mm 0.0079 in.
Balancer Shaft Journal	O.D.	50.92 to 50.94 mm 2.0047 to 2.0055 in.	–
Balancer Bearing	I.D.	51.01 to 51.08 mm 2.0083 to 2.0110 in.	–
Piston Pin Bore	I.D.	30.000 to 30.013 mm 1.1811 to 1.1816 in.	30.05 mm 1.1831 in.
Top Ring to Ring Groove	Clearance	0.05 to 0.09 mm 0.0020 to 0.0035 in.	0.15 mm 0.0059 in.
Second Ring to Ring Groove	Clearance	0.093 to 0.120 mm 0.0037 to 0.0047 in.	0.20 mm 0.0079 in.
Oil Ring to Ring Groove	Clearance	0.020 to 0.060 mm 0.0008 to 0.0023 in.	0.15 mm 0.0059 in.

W1013874

ENGINE BODY (Continued)

Item		Factory Specification	Allowable Limit
Piston Ring Gap	Top Ring	0.30 to 0.45 mm 0.0118 to 0.0177 in.	1.25 mm 0.0492 in.
	Second Ring	0.30 to 0.45 mm 0.0118 to 0.0177 in.	1.25 mm 0.0492 in.
	Oil Ring	0.25 to 0.45 mm 0.0098 to 0.0177 in.	1.25 mm 0.0492 in.
Connecting Rod	Alignment	–	0.05 mm 0.0020 in.
Piston Pin to Small End Bushing	Clearance	0.020 to 0.040 mm 0.0008 to 0.0016 in.	0.15 mm 0.0059 in.
Piston Pin	O.D.	30.006 to 30.011 mm 1.1813 to 1.1815 in.	–
Small End Bushing	I.D.	30.031 to 30.046 mm 1.1823 to 1.1829 in.	–
Crankshaft	Side Clearance	0.15 to 0.31 mm 0.0059 to 0.0122 in.	0.50 mm 0.0197 in.
	Alignment	–	0.02 mm 0.00079 in.
Crankshaft Journal to Crankshaft Bearing	Oil Clearance	0.018 to 0.062 mm 0.0007 to 0.0024 in.	0.20 mm 0.0079 in.
Crankshaft Journal	O.D.	74.977 to 74.990 mm 2.9518 to 2.9524 in.	–
Crank Pin to Pin Bearing	Oil Clearance	0.018 to 0.051 mm 0.0007 to 0.0020 in.	0.20 mm 0.0079 in.
Crank Pin	O.D.	52.977 to 52.990 mm 2.0857 to 2.0862 in.	–
Cylinder Bore	I.D.	100.000 to 100.022 mm 3.9370 to 3.9379 in.	100.15 mm 3.9429 in.
Cylinder Bore (Oversize)	I.D.	100.500 to 100.522 mm 3.9567 to 3.9576 in.	100.65 mm 3.9626 in.

W10138740

LUBRICATING SYSTEM

Item		Factory Specification	Allowable Limit
Engine Oil Pressure	At Idle Speed	–	49 kPa 0.5 kgf/cm^2 7 psi
	At Rated Speed	196 to 392 kPa 2.0 to 4.0 kgf/cm^2 28 to 57 psi	147.1 kPa 1.5 kgf/cm^2 21.3 psi
Engine Oil Pressure Switch	Working Pressure	39.2 to 58.8 kPa 0.4 to 0.6 kgf/cm^2 5.6 to 8.4 psi	–
Inner Rotor to Outer Rotor	Clearance	0.04 to 0.16 mm 0.0016 to 0.0063 in.	0.3 mm 0.0118 in.
Outer Rotor to Pump Body	Clearance	0.100 to 0.184 mm 0.0039 to 0.0072 in.	0.3 mm 0.0118 in.
Inner Rotor to Cover	Clearance	0.025 to 0.075 mm 0.0010 to 0.0030 in.	0.225 mm 0.0089 in.
Relief Valve	Working Pressure	885 kPa 9.04 kgf/cm^2 129 psi	–

W10139730

COOLING SYSTEM

Thermostat	Valve Opening Temperature	74.5 to 78.5 °C 166.1 to 173.3 °F	–
	Valve Opening Temperature (Opened Completely)	90 °C 194 °F	–
Radiator	Water Tightness	Water tightness at specified pressure 137 kPa 1.4 kgf/cm^2 20 psi	–
Radiator Cap	Air Leakage	10 seconds or more 88 → 59 kPa 0.9 → 0.6 kgf/cm^2 13 → 9 psi	–
Fan Belt	Tension	10.0 to 12.0 mm / 98 N 0.394 to 0.472 in. / 98 N (10 kgf, 22 lbs)	–

W10135990

FUEL SYSTEM

Item		Factory Specification	Allowable Limit
Injection Timing		0.21 to 0.24 rad (12 to 14 °) before T.D.C.	–
Pump Element	Fuel Tightness	–	18.63 MPa 190 kgf/cm^2 2702 psi
Delivery Valve	Fuel Tightness	10 seconds 18.63 → 17.65 MPa 190 → 180 kgf/cm^2 2702 → 2560 psi	5 seconds 18.63 → 17.65 MPa 190 → 180 kgf/cm^2 2702 → 2560 psi
Fuel Injection Nozzle	Injection Pressure (1st stage)	18.63 to 19.61 MPa 190 to 200 kgf/cm^2 2702 to 2845 psi	–
	Injection Pressure (2nd stage)	23.54 to 24.52 MPa 240 to 250 kgf/cm^2 3414 to 3556 psi	–
	Valve Seat Tightness	When the pressure is 16.67 MPa (170 kgf/cm^2, 2418 psi), the valve seat must be fuel tightness.	–

W10139730

ELECTRICAL SYSTEM

Commutator	O.D.	32 mm 1.2598 in.	31.4 mm 1.2362 in.
Mica	Undercut	0.5 mm 0.0197 in.	0.2 mm 0.0079 in.
Brush (Starter)	Length	18.0 mm 0.7086 in.	11.0 mm 0.4331 in.
Alternator	No-load Voltage	14 V at 4000 min^{-1} (rpm)	–
Rotor Coil	Resistance	2.8 to 3.3 Ω	–
Slip Ring	O.D.	22.7 mm 0.894 in.	22.1 mm 0.870 in.
Brush (Alternator)	Length	18.5 mm 0.728 in.	5.0 mm 0.197 in.
Intake Air Heater	Resistance (at cold occasion)	Approx. 0.3 Ω	–

W1013973

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 Unit Diameter	Standard Screw and Bolt 〈4〉			Special Screw and Bolt 〈7〉		
	N·m	kgf·m	ft-lbs	N·m	kgf·m	ft-lbs
M6	7.9 to 9.3	0.80 to 0.95	5.8 to 6.9	9.8 to 11.3	1.00 to 1.15	7.23 to 8.32
M8	17.7 to 20.6	1.8 to 2.1	13.0 to 15.2	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
M10	39.2 to 45.1	4.0 to 4.6	28.9 to 33.3	48.1 to 55.9	4.9 to 5.7	35.4 to 41.2
M12	62.8 to 72.6	6.4 to 7.4	46.3 to 53.5	77.5 to 90.2	7.9 to 9.2	57.1 to 66.5

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	ft-lbs
Cylinder head cover screw	–	6.9 to 11.3	0.7 to 1.15	5.1 to 8.32
*Cylinder head screw	M12 x 1.25	98.1 to 107.9	10.0 to 11.0	72.3 to 79.6
*Connecting rod screw	M10 x 1.25	78.5 to 83.4	8.0 to 8.5	57.9 to 61.5
*Flywheel screw	M12 x 1.25	98.1 to 107.9	10.0 to 11.0	72.3 to 79.6
*Crankshaft screw	M16 x 1.5	255.0 to 274.6	26.0 to 28.0	188.1 to 202.5
*Main bearing case screw	M14 x 1.5	137.3 to 147.1	14.0 to 15.0	101.3 to 108.5
Rocker arm bracket screw	M10 x 1.25	49.0 to 55.9	5.0 to 5.7	36.2 to 41.2
Nozzle holder clamp nut	M8 x 1.25	17.7 to 20.6	1.8 to 2.1	13.0 to 15.2
Injection pipe retaining nut	M12 x 1.5	19.6 to 24.5	2.0 to 2.5	14.5 to 18.1
Overflow pipe assembly retaining screw	M6 x 1.0	9.8 to 11.3	1.0 to 1.15	7.23 to 8.32
Oil switch taper screw	R 1/8	14.7 to 19.6	1.5 to 2.0	10.8 to 14.5
Oil cooler joint screw	–	39.2 to 44.1	4.0 to 4.5	28.9 to 32.5
Oil pump cover screw	–	7.9 to 9.3	0.80 to 0.95	5.8 to 6.9
Starter's terminal **B** mounting nut	M8 x 1.25	9.8 to 11.8	1.0 to 1.2	7.2 to 8.7
Intake air heater terminal nut	M6 x 1.0	3.4 to 5.4	0.35 to 0.55	2.53 to 3.98
Injection pump gear mounting nut	M14 x 1.5	73.6 to 83.4	7.5 to 8.5	54.2 to 61.5
Injection pump unit mounting nut	M8 x 1.25	17.7 to 20.6	1.8 to 2.1	13.0 to 15.2
Gear case cover	M8 x 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
Relief valve retaining screw	–	68.6 to 78.4	7.0 to 8.0	50.6 to 57.9
Idle gear mounting screw	M8 x 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
Plate mounting screw	M8 x 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
Camshaft set screw	M8 x 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
Flywheel housing mounting screw	M12 x 1.25	77.5 to 90.2	7.9 to 9.2	57.1 to 66.5
Crankcase 2 mounting screw	M10 x 1.25	49.0 to 55.9	5.0 to 5.7	36.2 to 41.2
Injection pump mounting screw	M8 x 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
Injection pump mounting nut	M8 x 1.25	17.7 to 20.6	1.8 to 2.1	13.0 to 15.2
Boost actuator (Boost compensator model only)	–	39.2 to 45.1	4.0 to 4.6	28.9 to 33.3
Governor weight mounting nut	M12 x 1.25	62.8 to 72.6	6.4 to 7.4	46.3 to 53.5
Fuel camshaft stopper mounting screw	–	7.9 to 9.3	0.80 to 0.95	5.8 to 6.9

W1013236

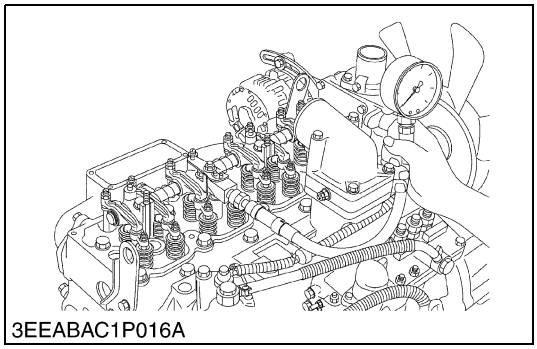
Item	Size x Pitch	N·m	kgf·m	ft-lbs
Governor housing mounting screw	M6 x 1.0	9.8 to 11.3	1.00 to 1.15	7.23 to 8.32
Anti-rotation nut	M5 x 0.8	2.8 to 4.0	0.29 to 0.41	2.1 to 3.0
Balancer shaft set screw (Balancer model only)	M8 x 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
Bearing case cover mounting screw	M8 x 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
Alternator pulley nut	–	58.3 to 78.9	5.95 to 8.05	43.0 to 58.2

W1013236

4. CHECKING, DISASSEMBLING AND SERVICING

[1] CHECKING AND ADJUSTING

(1) Engine Body


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Compression Pressure

1. After warming up the engine, stop it and remove the air cleaner, the muffler, high pressure pipes, cylinder head cover, overflow pipe, all nozzle holders and all nozzle gaskets.
2. Install a compression tester (Code No: 07909-30208) and nozzle adaptor for diesel engines to nozzle holder hole.
3. After making sure that the stop lever is set at the stop position (Non-injection), run the engine at 200 to 300 min^{-1} (rpm) with the starter.
4. Read the maximum pressure. Measure the pressure more than twice.

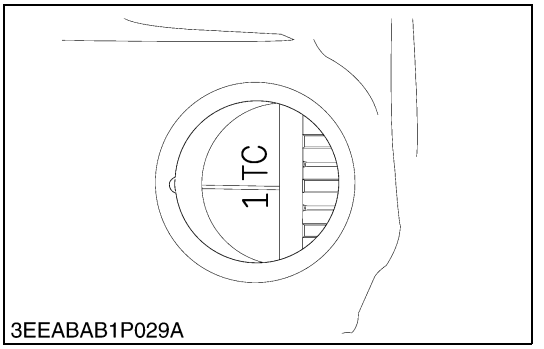
■ **Note**

- **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 %.**

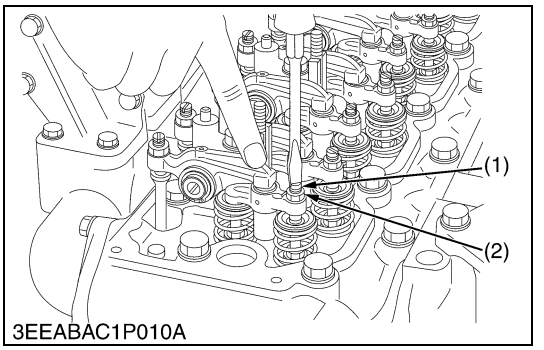
Compression pressure	Factory spec.	V3800DI-E2B	3.92 MPa / 250 min^{-1} (rpm) 40.0 kgf/cm^2 / 250 min^{-1} (rpm) 569 psi / 250 min^{-1} (rpm)
		V3800DI-T-E2B	3.47 MPa / 250 min^{-1} (rpm) 35.4 kgf/cm^2 / 250 min^{-1} (rpm) 503 psi / 250 min^{-1} (rpm)
	Allowable limit	V3800DI-E2B	2.90 MPa / 250 min^{-1} (rpm) 29.6 kgf/cm^2 / 250 min^{-1} (rpm) 421 psi / 250 min^{-1} (rpm)
		V3800DI-T-E2B	2.56 MPa / 250 min^{-1} (rpm) 26.1 kgf/cm^2 / 250 min^{-1} (rpm) 371 psi / 250 min^{-1} (rpm)

Tightening torque	Nozzle holder clamp nut	17.7 to 20.6 N·m 1.8 to 2.1 kgf·m 13.0 to 15.2 ft-lbs
	Overflow pipe assembly retaining screw	9.8 to 11.3 N·m 1.0 to 1.15 kgf·m 7.23 to 8.32 ft-lbs
	Cylinder head cover screw	6.9 to 11.3 N·m 0.7 to 1.15 kgf·m 5.1 to 8.32 ft-lbs
	Injection pipe retaining nut	19.6 to 24.5 N·m 2.0 to 2.5 kgf·m 14.5 to 18.1 ft-lbs

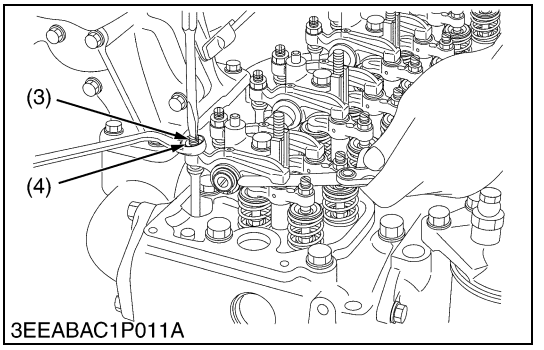
W1048776



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3EEABAC1P011A

Checking Valve Clearance

■ IMPORTANT

- **Valve clearance must be checked and adjusted when engine is cold.**

1. Remove the high pressure pipes and the head cover.
2. Align the 1TC mark of flywheel and the convex of flywheel housing timing windows so that the first piston (gear case side) comes to the compression top dead center.
3. Before adjusting the valve clearance, adjust the bridge evenly to the valve stem.
4. Loosen the lock nut (2) and adjust with screw (1).
5. Slightly push the rocker arm by your fingers and screw in the adjusting screw slowly until you feel the screw touch the top of valve stem, then tighten the lock nut.
6. Loosen the lock nut (4) of adjusting screw (3) (push rod side) and insert the thickness gauge between the rocker arm and the bridge head. Set the adjusting screw to the specified value, then tighten the lock nut.

Valve clearance	Factory spec.	0.23 to 0.27 mm 0.0091 to 0.0106 in.

■ Note

- **After adjusting, tighten the lock nut (4) securely.**

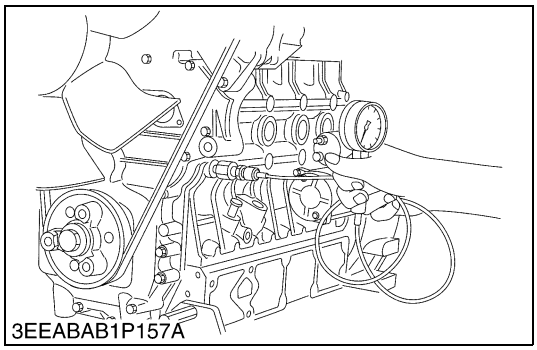
Valve arrangement Adjustment cylinder Location of piston		IN.	EX
When No.1 piston is at compression top dead center	1st	*	*
	2nd	*	
	3rd		*
	4th		
When No.1 piston is at overlap position	1st		
	2nd		*
	3rd	*	
	4th	*	*

Tightening torque	Cylinder head cover screw	6.9 to 11.3 N·m 0.7 to 1.15 kgf·m 5.1 to 8.32 ft-lbs
	Injection pipe retaining nut	19.6 to 24.5 N·m 2.0 to 2.5 kgf·m 14.5 to 18.1 ft-lbs

(1) Adjusting Screw
(2) Lock Nut
(3) Adjusting Screw
(4) Lock Nut

W1047000

(2) Lubricating System


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Engine Oil Pressure

1. Remove the oil switch and set a pressure tester (Code No. 07916-32032).
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

(When reassembling)

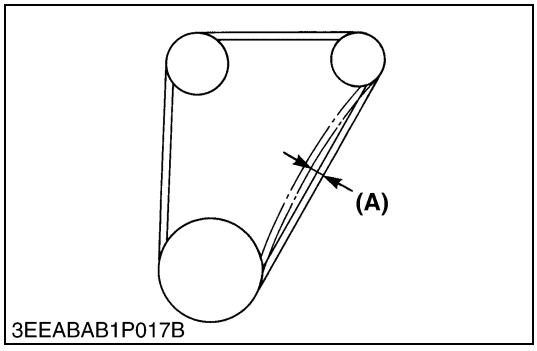
- After checking the engine oil pressure, tighten the engine oil pressure switch to the specified torque.

Engine oil pressure	At idle speed	Allowable limit	49 kPa 0.5 kgf/cm^2 7 psi
	At rated speed	Factory spec.	196 to 392 kPa 2.0 to 4.0 kgf/cm^2 28 to 57 psi
		Allowable limit	147.1 kPa 1.5 kgf/cm^2 21.3 psi

Tightening torque	Oil switch taper screw	14.7 to 19.6 N·m 1.5 to 2.0 kgf·m 10.8 to 14.5 ft-lbs

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(3) Cooling System



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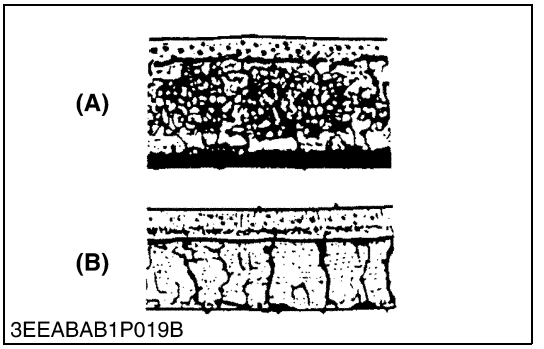
Fan Belt Tension

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 lbs).
2. If the measurement is not within the factory specifications, loosen the alternator mounting screws and relocate the alternator to adjust.

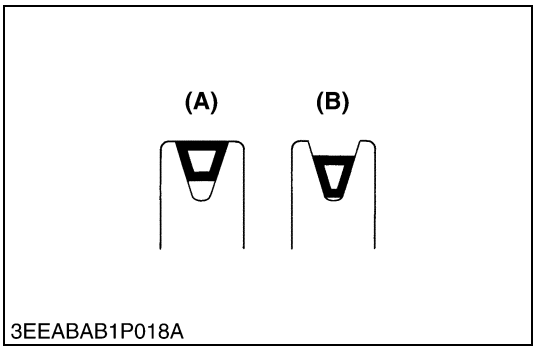
Deflection **(A)**	Factory spec.	10 to 12 mm 0.394 to 0.472 in.

(A) Deflection

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Fan Belt Damage and Wear

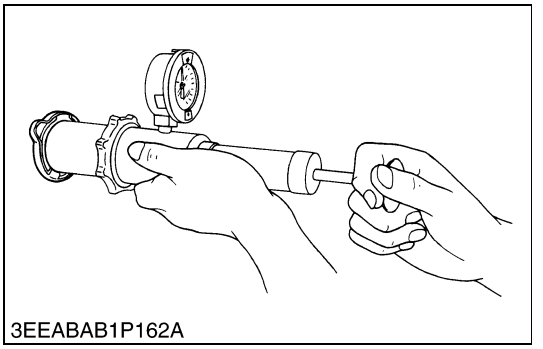
1. Check the fan belt for damage.
2. If the fan belt is damaged, replace it.
3. Check if the fan belt is worn and sunk in the pulley groove.
4. If the fan belt is nearly worn out and deeply sunk in the pulley groove, replace it.

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

W1021108

Caution

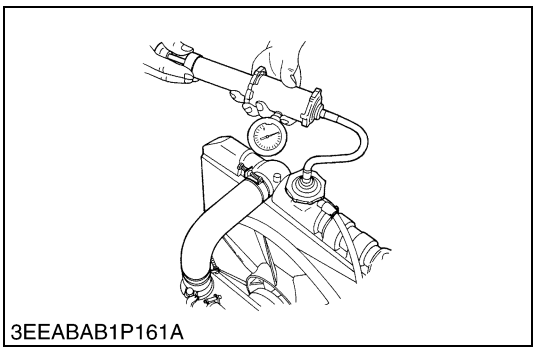
• When removing the radiator cap, wait at least ten minutes after the engine has stopped and cooled down. Otherwise, hot water may gush out, scalding nearby people.


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Radiator Cap Air Leakage

1. Set a radiator tester on the radiator cap.
2. Set a radiator tester.
   Apply the specified pressure of 88 kPa (0.9 kgf/cm^2, 13 psi).
3. Check if the pressure drop to less than 59 kPa (0.6 kgf/cm^2, 9 psi) in 10 seconds.
4. If the pressure is less than the factory specification, replace it.

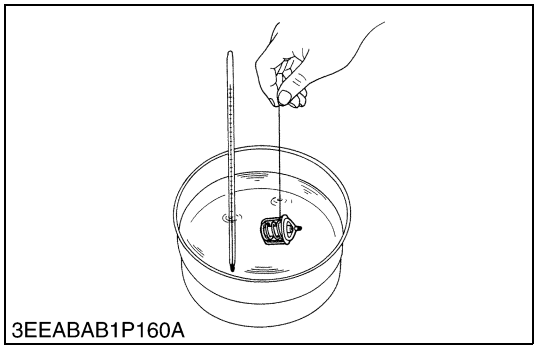
W1021320


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Radiator Water Leakage

1. Pour a specified amount of water into the radiator.
2. Set a radiator tester.
   Increase water pressure to the specified pressure of 137 kPa (1.4 kgf/cm^2, 20 psi).
3. Check the radiator for water leaks.
4. When water leakage is excessive, replace the radiator. If water leakage is caused by a small pinhole, correct the radiator with radiator cement.

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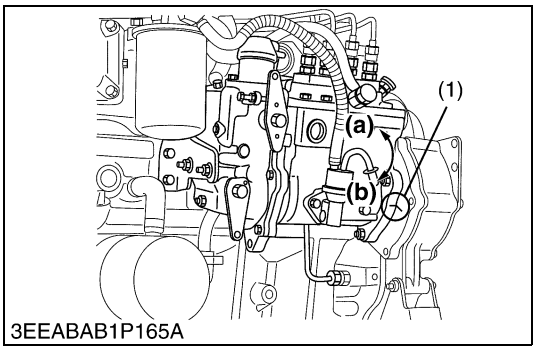
Thermostat Valve Opening Temperature

1. Push down the thermostat valve and insert a string between the valve and the valve seat.
2. Place the thermostat and a thermostat in a container with water and gradually heat the water.
3. Hold the string to suspend the thermostat in the water. When the water temperature rises, the thermostat valve will open, allowing it to fall down from the string.
   Read the temperature at this moment on the thermometer.
4. Continue heating the water and read the temperature when the valve has risen by about 8 mm (0.315 in.).
5. If the measurement is not acceptable, replace the thermostat.

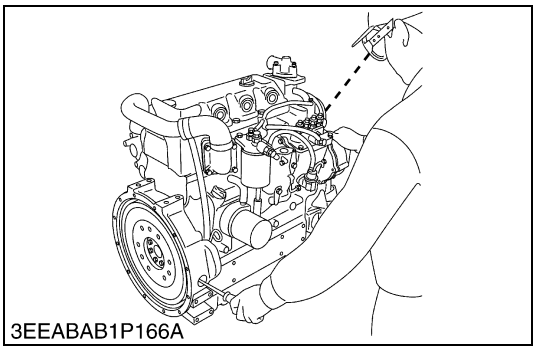
Thermostat's valve opening temperature	Factory spec.	74.5 to 78.5 °C 166.1 to 173.3 °F
Temperature at which thermostat completely opens	Factory spec.	90 °C 194 °F

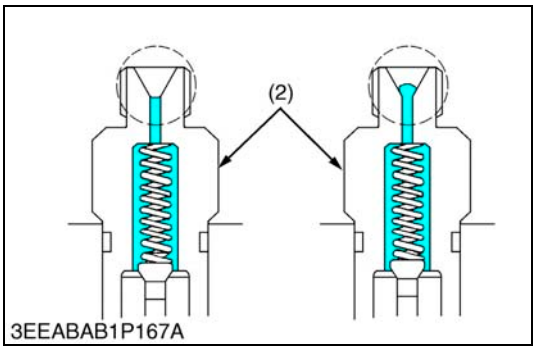
W1071639

(4) Fuel System

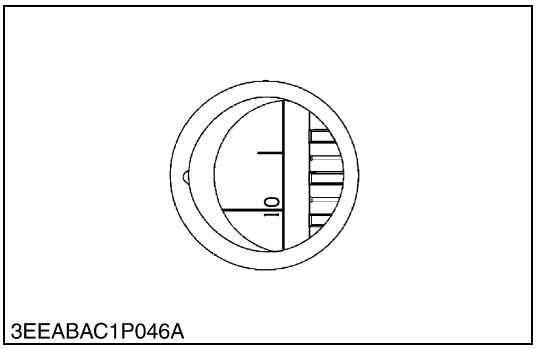


3EEABAB1P165A


3EEABAB1P166A



3EEABAB1P167A



3EEABAC1P046A

Injection Timing

1. Make sure of matching the injection timing align mark (1) of the injection pump unit and the plate (gearcase), as shown in the illustration.
2. Remove the injection pipes.
3. Remove the stop solenoid.
4. Turn the flywheel counterclockwise (viewed from flywheel side) until the fuel fills up to the hole of the delivery valve holder (2) for No.1 cylinder.
5. After the fuel fills up to the hole of the delivery valve holder for No.1 cylinder, turn back (clockwise) the flywheel around 1.57 rad (90 °).
6. Turn the flywheel counterclockwise to set at around 0.35 rad (20 <Symbol>×) before T.D.C..
7. Slowly turn the flywheel counterclockwise and stop turning when the fuel begins to come up, to get the present injection timing.
8. Check to see the degree on flywheel.
   The flywheel has mark “1TC”, “10” and “20” for the crank angle before the top dead center of No.1 piston.
9. If the injection timing is not within the specification, rotate the injection pump unit to adjust the injection timing.

■ **IMPORTANT**

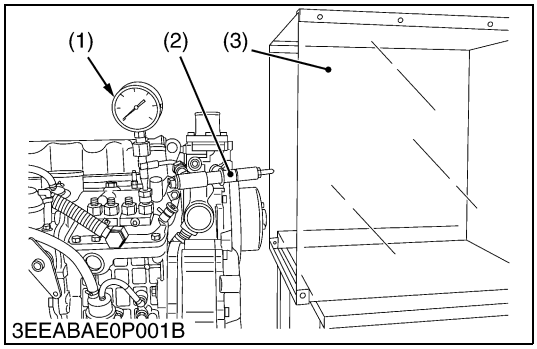
- **When installing the injection pump unit to the engine body, follow the correct procedure.**
  See the “Injection Pump Unit”.

Injection timing	Factory spec.	0.21 to 0.24 rad (12 <Symbol>× to 14 <Symbol>×) before T.D.C.

Tightening torque	Injection pipe retaining nut	19.6 to 24.5 N·m 2.0 to 2.5 kgf·m 14.5 to 18.1 ft-lbs
	Injection pump unit mounting nut	17.7 to 20.6 N·m 1.8 to 2.1 kgf·m 13.0 to 15.2 ft-lbs

(1) Injection Timing Align Mark
(2) Delivery Valve Holder
(a) Injection Timing Advanced
(b) Injection Timing Retarded

W1036105



Fuel Tightness of Pump Element

1. Remove the engine stop solenoid.
2. Remove the injection pipes.
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.

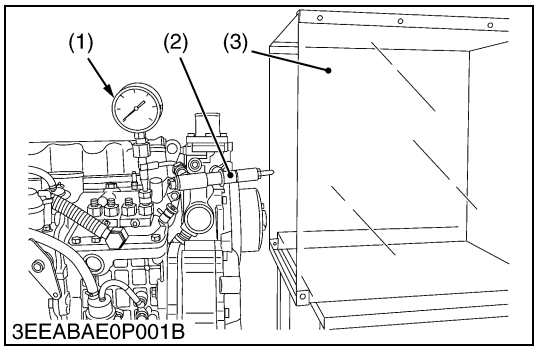
Fuel tightness of pump element	Allowable limit	18.63 MPa 190 kgf/cm^2 2702 psi

■ 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 (3) Protection Cover for Jetted Fuel
(2) Injection Nozzle

W1017430



Fuel Tightness of Delivery Valve

1. Remove the engine stop solenoid.
2. Remove the injection pipes.
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 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 to 180 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 to 180 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 delivery valve	Factory spec.	10 seconds 18.63 → 17.65 MPa 190 → 180 kgf/cm^2 2702 → 2560 psi
	Allowable limit	5 seconds 18.63 → 17.65 MPa 190 → 180 kgf/cm^2 2702 → 2560 psi

■ Note

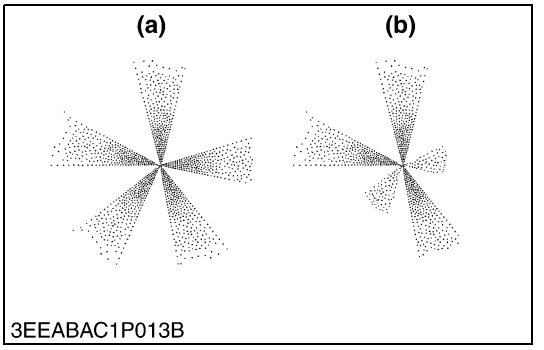
- **Never try to disassemble the injection pump assembly. For repairs, you are strongly requested to contact a Kubota-authorized pump service shop.**

(1) Injection Pump Pressure Tester (3) Protection Cover for Jetted Fuel
(2) Injection Nozzle

W1017786

Caution

- **Check the nozzle 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.**



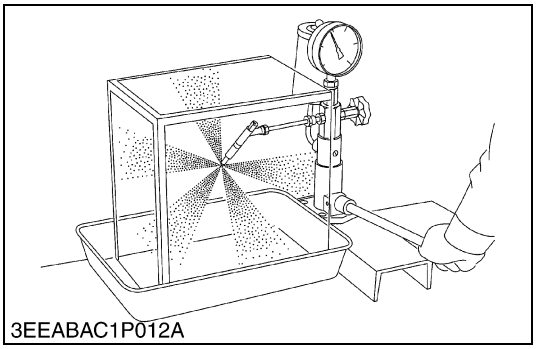
3EEABAC1P013B

Nozzle Spraying Condition

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 or repair at Denso service shop.

(a) Good **(b) Bad**

W10371670


3EEABAC1P012A

Checking Nozzle Injection Pressure

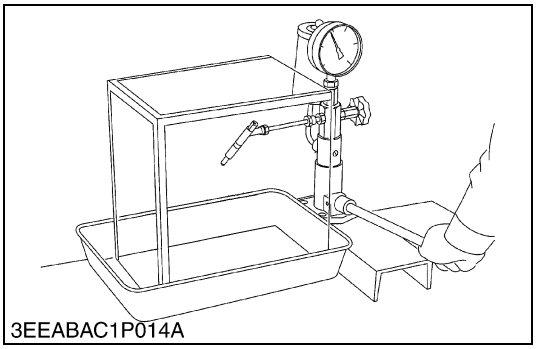
1. Set the injection nozzle to the nozzle tester.
2. Slowly move the tester handle to measure the pressure at which fuel begins jetting out from the nozzle.
3. If the measurement is not within the factory specifications, replace the injection nozzle assembly or repair at Denso service shop.

■ Note

- **Injection nozzle gasket must be replaced when the injection nozzle is removed for checking.**

Injection pressure	Factory spec.	1st stage	18.63 to 19.61 MPa 190 to 200 kgf/cm^2 2702 to 2845 psi

W1037280


3EEABAC1P014A

Valve Seat Tightness

1. Set the injection nozzle to a nozzle tester.
2. Raise the fuel pressure, and keep at 16.67 MPa (170 kgf/cm^2, 2418 psi) for 10 seconds.
3. If any fuel leak is found, replace the injection nozzle assembly or repair at Denso service shop.

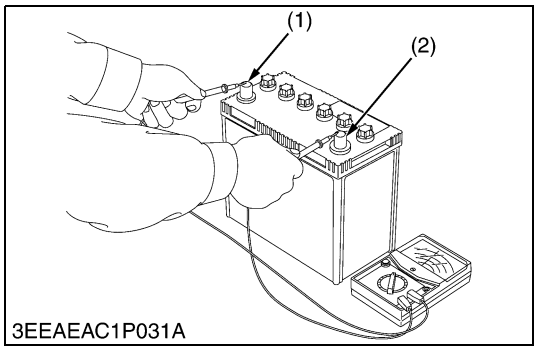
Valve seat tightness	Factory spec.	No fuel leak at 16.67 MPa 170 kgf/cm^2 2418 psi

W10374150

(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.**



3EEAEAC1P031A

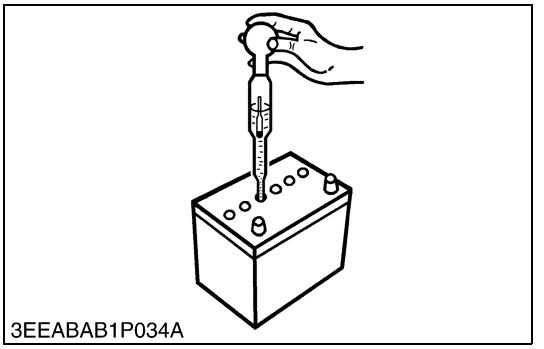
Battery Voltage

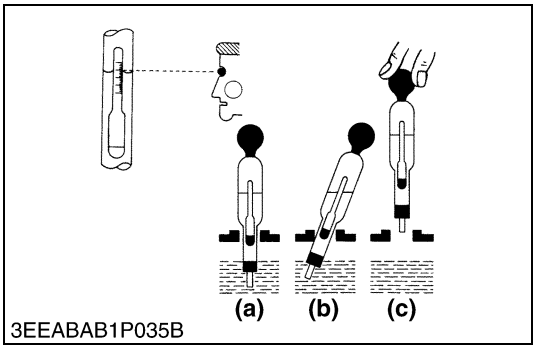
1. Stop the engine.
2. Measure the voltage with a circuit tester between the battery terminals.
3. If the battery voltage is less than the factory specification, check the battery specific gravity and recharge the battery.

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)

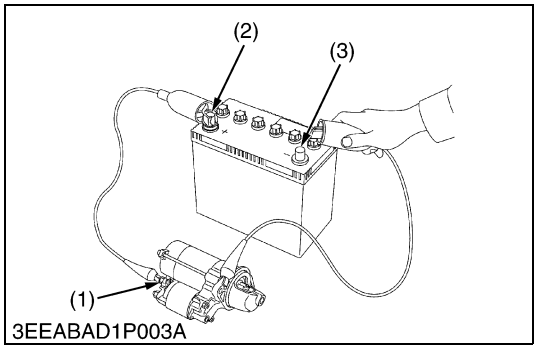
- Specific gravity slightly varies with temperature. To be exact, the specific gravity decreases by 0.0007 with an increase of 1 °C (0.0004 with an increase of 1 °F) in temperature, and increases by 0.0007 with a decreases of 1 °C (0.0004 with a decrease of 1 °F).
  Therefore, using 20 °C (68 °F) as 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



3EEABAD1P003A

Motor Test

Caution

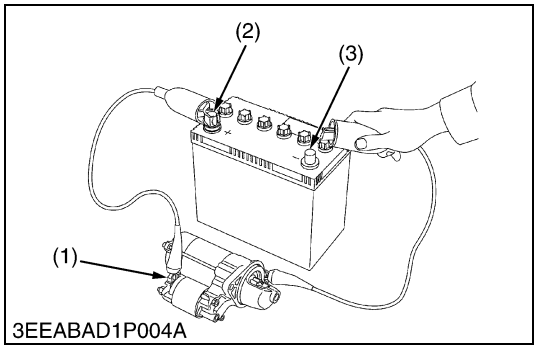
- **Secure the starter to prevent it from jumping up and down while testing the motor.**

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.

- **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



3EEABAD1P004A

Magnetic Switch Test

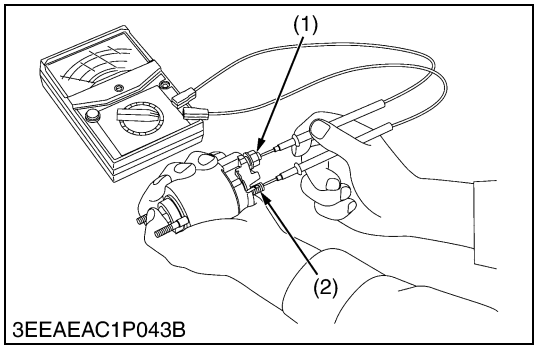
1. Disconnect the battery negative cable from the battery.
2. Disconnect the battery positive cable from the battery.
3. Disconnect the leads from the starter **B** terminal.
4. Remove the starter from the engine.
5. Connect a jumper lead from the starter **S** terminal (1) to the battery positive terminal (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



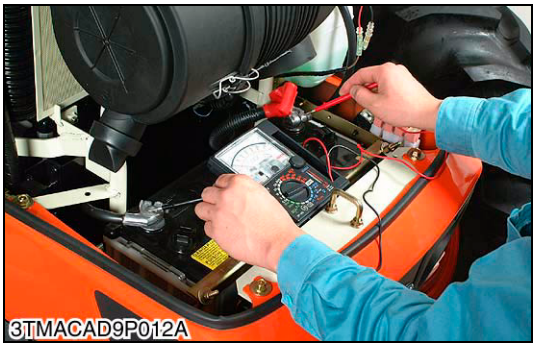
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Magnet Switch Continuity Test

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.

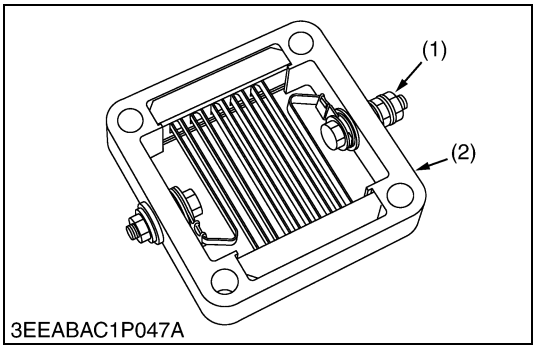
■ NOTE

- **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



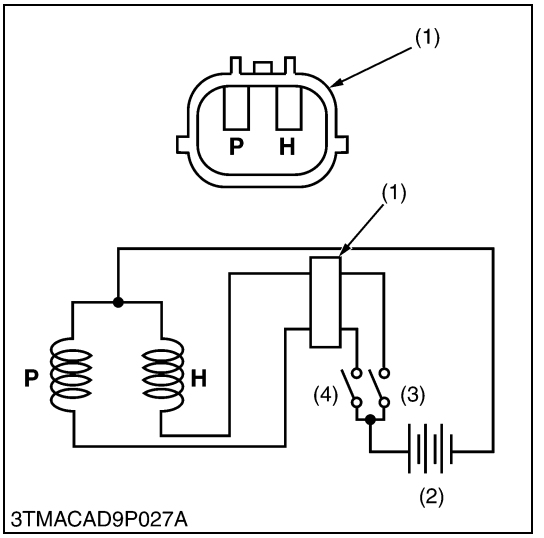
Intake Air Heater

1. Disconnect the lead.
2. Measure the resistance between + terminal (1) and intake air heater body (2).
3. If the resistance is infinity, the intake air heater is faulty.

Intake air heater resistance	Factory spec.	Approx. 0.3 <Symbol>W (At cold occasion)

(1) + Terminal (2) Intake Air Heater Body

W1073774



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

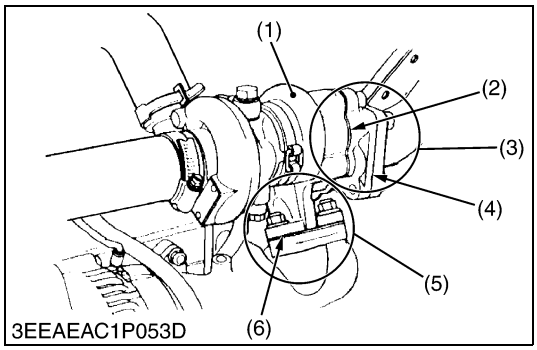
- **Never apply the current for pulling coil more than two seconds when inspecting.**

(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

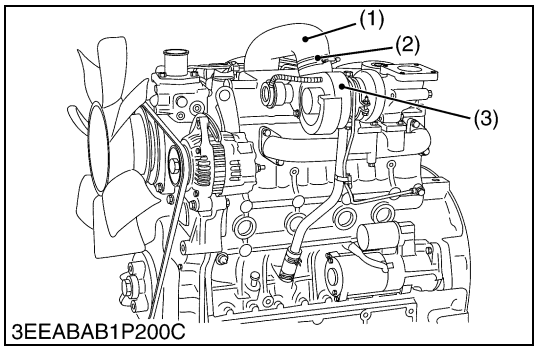


Turbine Side

1. Check the exhaust port (3) and inlet port (5) 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 (2) / (4) / (6) with new one.

(1) Turbine Housing
(2) Gasket
(3) Exhaust Port
(4) Gasket
(5) Inlet Port
(6) Gasket

W1076917

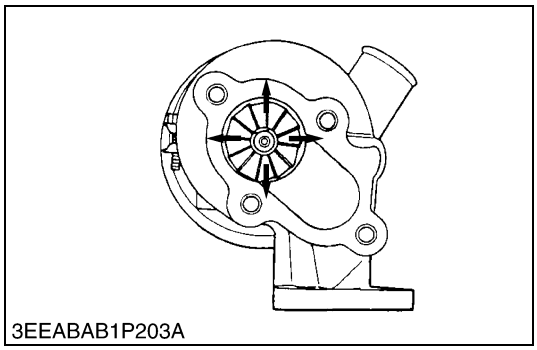


Compressor Side

1. Check the inlet hose (1) of the compressor cover (3) 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 (2) and or inlet hoses.

(1) Inlet Hose
(2) Clamp
(3) Compressor Cover

W1077032



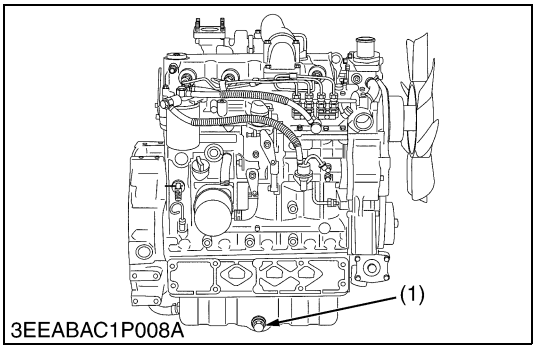
Radial Clearance

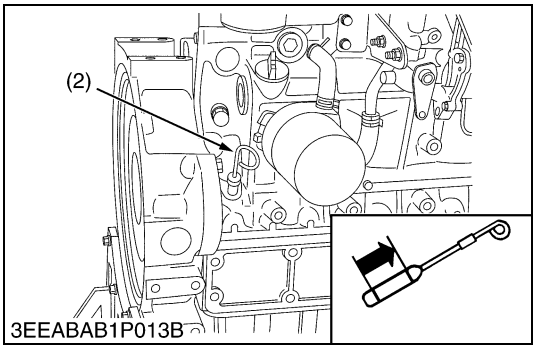
1. If the wheel contact to the housing, replace the turbocharger assembly with new one.

W1077353

[2] DISASSEMBLING AND ASSEMBLING

(1) Draining Oil and Coolant





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)

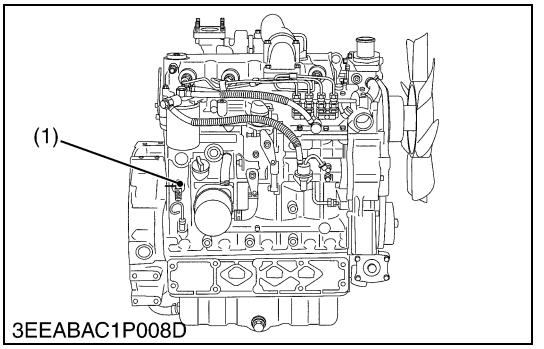
- Fill the engine oil up to the upper line on the dipstick (2).

■ **IMPORTANT**

- **Never mix two different type of oil.**
- **Use the proper SAE Engine Oil according to ambient temperature.**

(1) Drain Plug (2) Dipstick

W1023464



Draining Coolant

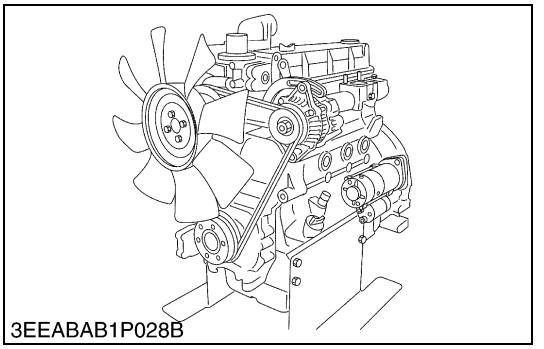
- **Never remove radiator cap while operating or immediately after stopping. Otherwise, hot water will spout out from the radiator. Wait for more than ten minutes to cool the radiator, before opening the cap.**

1. Prepare a bucket. Open the coolant drain cock.

(1) Coolant Drain Cock

W1023496

(2) External Components



Air Cleaner, Muffler and Others

1. Remove the air cleaner and muffler.
2. Remove the fan, fan belt, alternator and starter.

(When reassembling)

- Check to see that there are no cracks on the belt surface.

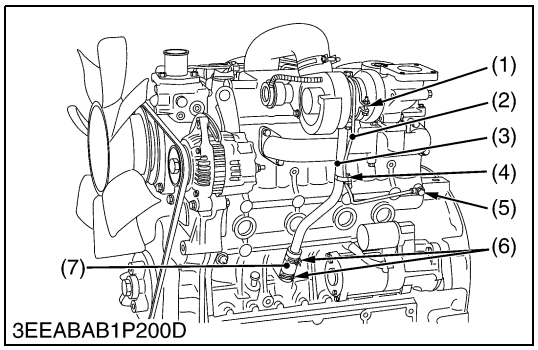
■ **IMPORTANT**

- **After reassembling the fan belt, be sure to adjust the fan belt tension.**
- **Do not confuse the direction of the fan. Attach the fan with its "1C010" marking facing frontward (toward the radiator).**

W1049622

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 matter in the oil pipes.**
- **When the turbocharger assembly has been replace, pour fresh engine oil through the oil filler port of the turbocharger.**
- **Before starting the engine, make sure that air cleaner is in position.**



3EEABAB1P200D

Oil Pipe

1. Remove the joint bolt (5) and clamp (4) and take off the pipe 1 (2).
2. Remove the bolts (1) and release the clamp (6).
3. Disconnect the oil pipe 2 (7) and pipe 4 (3).

(When reassembling)

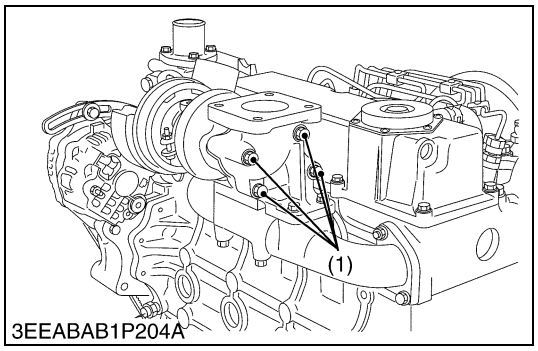
- Pour fresh engine oil through the oil filler port of the turbocharger.
- Replace the gasket with new one.
- Be careful not to allow dust, dirt and other foreign matters in the oil pipes.

■ **NOTE**

- **Tape or plug all openings to prevent foreign matters from damaging the oil cavities in the turbocharger.**

(1) Bolt
(2) Oil Pipe 1
(3) Oil Pipe 4
(4) Clamp
(5) Joint Bolt
(6) Clamp
(7) Oil Pipe 2

W1025983



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Turbocharger

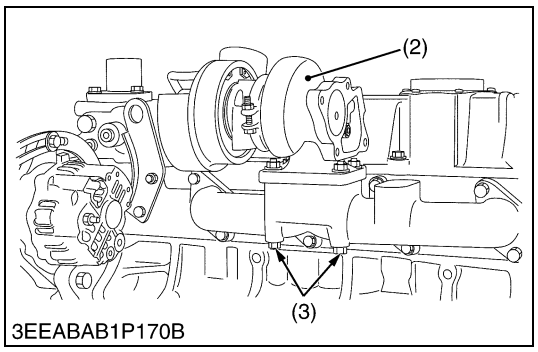
1. Remove the screw (1) and bolt (3).
2. Take off the turbocharger assembly (2).

(When reassembling)

- Replace the gasket with new one.

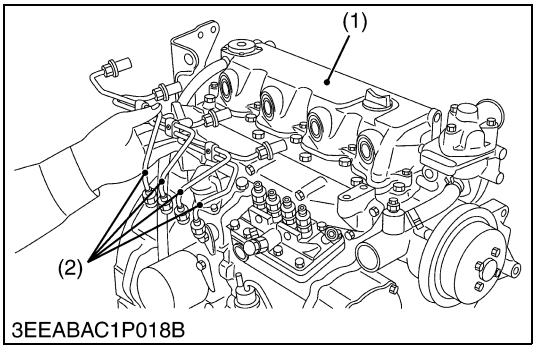
(1) Screw
(2) Turbocharger Assembly
(3) Bolt

W1078106

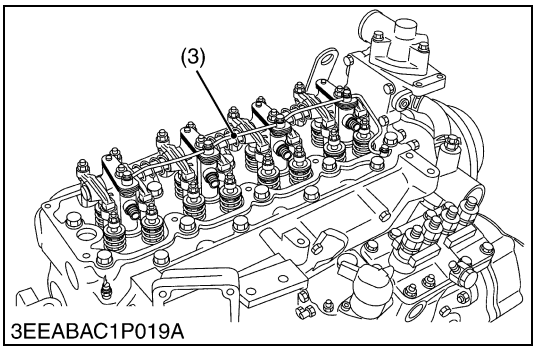


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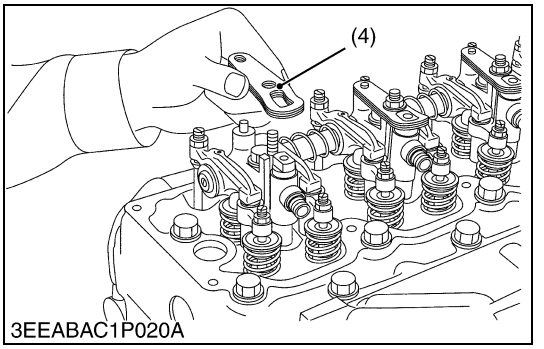
(3) Cylinder Head and Valves



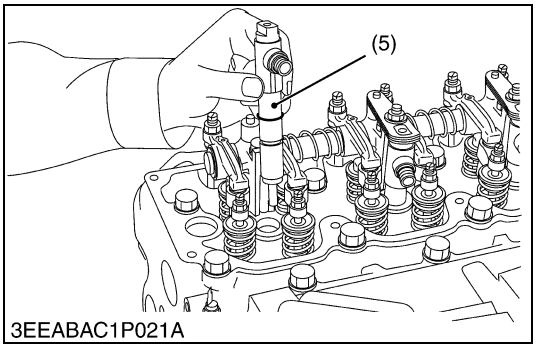
3EEABAC1P018B



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3EEABAC1P020A



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Cylinder Head Cover and Nozzle Holder

1. Remove the injection pipes (2).
2. Remove the cylinder head cover (1).
3. Remove the over flow pipe (3).
4. Remove the nozzle holder clamps (4), nozzle holder assembly (5) and nozzle gaskets.

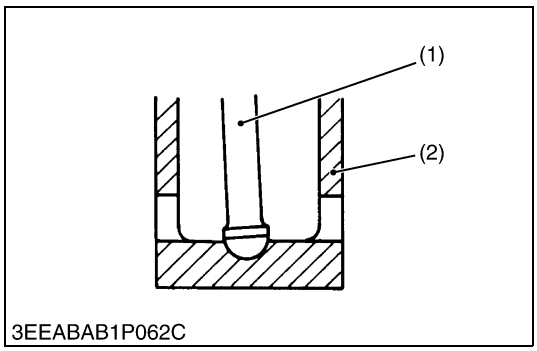
(When reassembling)

- Check to see that the cylinder head cover gasket is not defective.
- Be sure to place the nozzle gaskets.
- Tighten the head cover mounting bolts to specified torque.
- Mount the check valve with the <Symbol>Ø mark toward the tank.

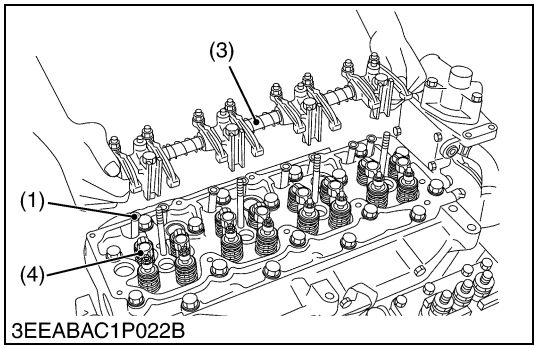
Tightening torque	Nozzle holder clamp nut	17.7 to 20.6 N·m 1.8 to 2.1 kgf·m 13.0 to 15.2 ft-lbs
	Overflow pipe assembly retaining screw	9.8 to 11.3 N·m 1.0 to 1.15 kgf·m 7.23 to 8.32 ft-lbs
	Cylinder head cover screw	6.9 to 11.3 N·m 0.7 to 1.15 kgf·m 5.1 to 8.32 ft-lbs
	Injection pipe retaining nut	19.6 to 24.5 N·m 2.0 to 2.5 kgf·m 14.5 to 18.1 ft-lbs

(1) Head Cover
(2) Injection Pipe
(3) Overflow Pipe
(4) Nozzle Holder Clamps
(5) Nozzle Holder Assembly

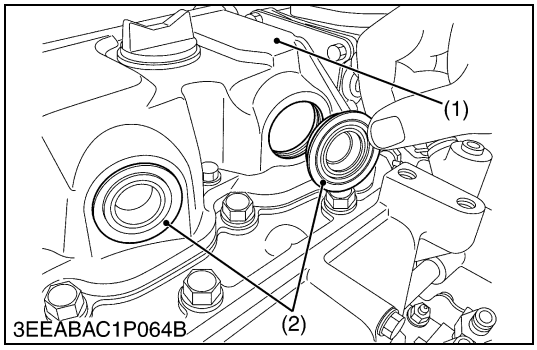
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Rocker Arm and Push Rod

1. Remove the rocker arm (3) as a unit.
2. Remove the push rods (1).
3. Remove the bridge arm (4).

(When reassembling)

- When putting the push rods onto the tappets (2), check to see if their ends are properly engaged with the grooves.

■ **IMPORTANT**

- **After reassembling the rocker arm, be sure to adjust the valve clearance.**

Tightening torque	Rocker arm bracket screw	49.0 to 55.9 N·m 5.0 to 5.7 kgf·m 36.2 to 41.2 ft-lbs

(1) Push Rod
(2) Tappet
(3) Rocker Arm
(4) Bridge Arm

W1050212

Injection Nozzle Oil Seal (if necessary)

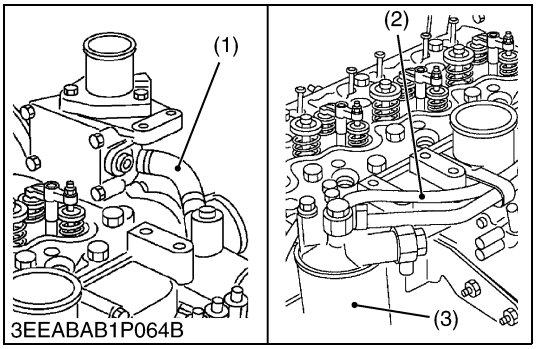
1. Remove the injection nozzle oil seal (2) from cylinder head cover (1).

(When reassembling)

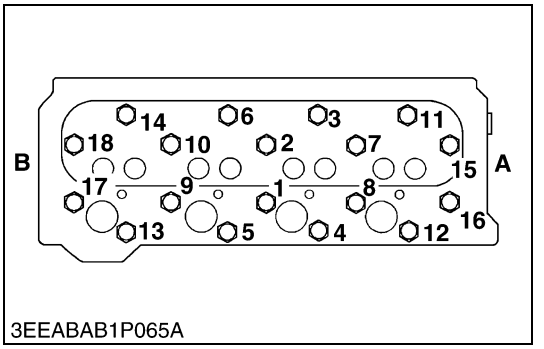
- When install the injection nozzle oil seal, use the new one.

(1) Cylinder Head Cover
(2) Injection Nozzle Oil Seal

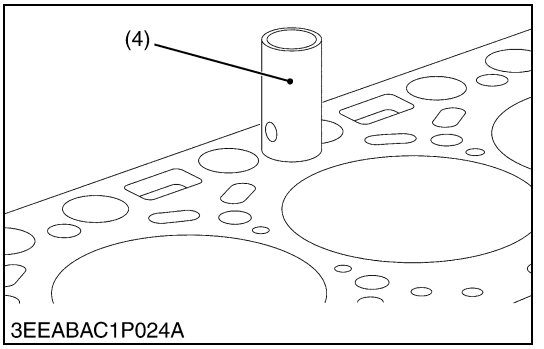
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Cylinder Head and Tappet

1. Loosen the pipe band, and remove the water return pipe (1).
2. Disconnect the fuel pipe (2) first and then the fuel filter (3).
3. Remove the IN. / EX. Manifold.
4. Remove the cylinder head screw in the order of (18) to (1), and remove the cylinder head.
5. Remove the cylinder head gasket.
6. Remove the tappets (4) from the crank case.

(When reassembling)

- Replace the head gasket with a new one.
- Before installing the tappets (4), apply engine oil thinly around them.
- When mounting the gasket, set it to the knock pin hole. Take care not to mount it reversely.
- The cylinder head should be free of scratches and dust.
- Take care for handling the gasket not to damage it.
- Install the cylinder head.
- Tighten the cylinder head screw gradually in the order of (1) to (18) after applying engine oil.
- Be sure to adjust the valve clearance. See the “Valve Clearance”.
- It is not necessary to retighten the cylinder head screw after running the engine for 30 minutes.

■ **IMPORTANT**

- **When replace the piston, piston pin bush, connecting rod or crankpin bearing, select the cylinder head gasket thickness to meet with the top clearance refer to the “Selecting Cylinder Head Gasket”.**

■ **NOTE**

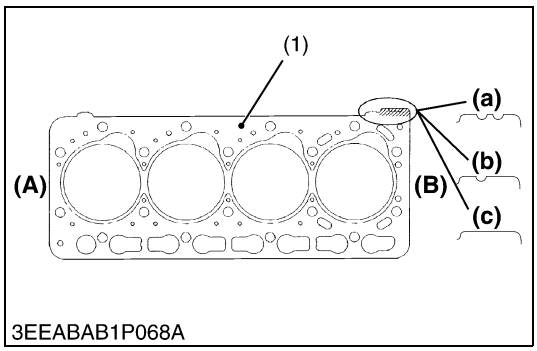
- **Mark the cylinder number to the tappets to prevent interchanging.**

Tightening torque	Cylinder head mounting screw	98.1 to 107.9 N·m 10.0 to 11.0 kgf·m 72.3 to 79.6 ft-lbs

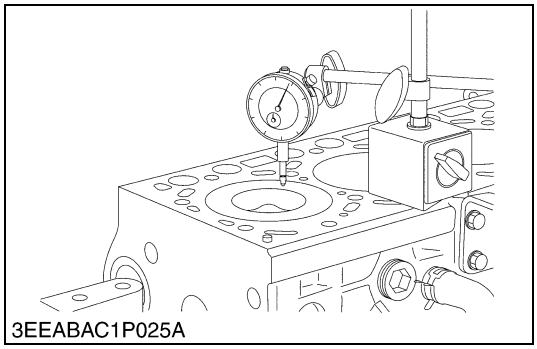
(1) Return Pipe
(2) Fuel Pipe
(3) Fuel Filter
(4) Tappet

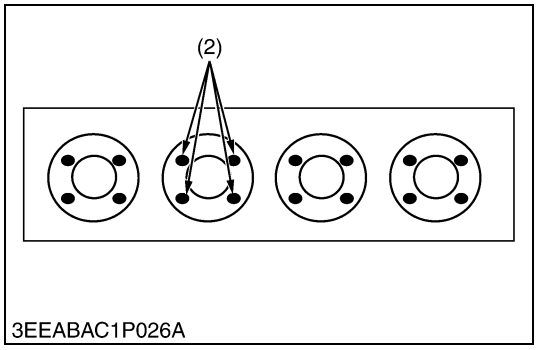
A : Gear Case Side
B : Flywheel Side

W1170923

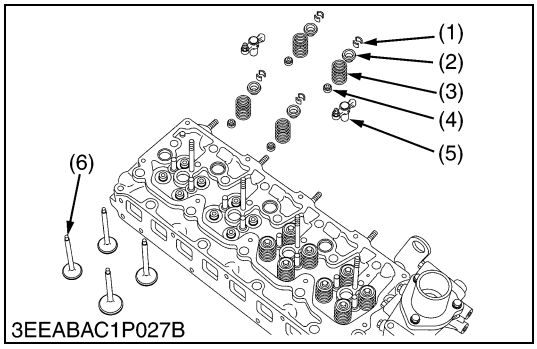


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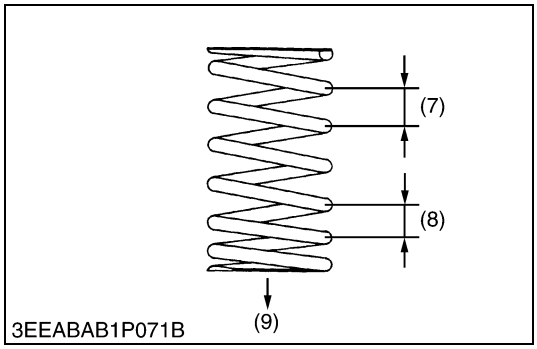

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Selecting Cylinder Head Gasket

■ Replacing the Cylinder Head Gasket

1. Make sure to note the notch **(a)**, **(b)** or **(c)** of cylinder head gasket (1) in advance.
2. Replace the same notch **(a)**, **(b)** or **(c)** as the original cylinder head gasket (1).

■ Selecting the Cylinder Head Gasket

- Select the cylinder head gasket (1) thickness to meet with the top clearance when replacing the piston, piston pin bush, connecting rod or crankpin bearing.

1. Measure the piston head's protrusion or recessing from the crankcase cylinder face 4 spots per each piston and (average of four pistons) using the dial gauge as shown in figure.
2. Select the suitable cylinder head gasket refer to the table below.

Notch of Cylinder Head Gasket	Thickness of cylinder head gasket		Part Code	Piston Head's protrusion or recessing from the level of crankcase cylinder face. (average of 4 pistons)
	Before tightening	After tightening		
2 notches **(a)**	0.90 mm 0.0354 in.	0.80 mm 0.0315 in.	1G514-03310	-0.07 to +0.049 mm -0.0028 to +0.0019 in.
1 notch **(b)**	1.00 mm 0.0394 in.	0.90 mm 0.0354 in.	1G514-03600	+0.050 to +0.149 mm +0.0020 to +0.0058 in.
Without notch **(c)**	1.05 mm 0.0413 in.	0.95 mm 0.0374 in.	1G514-03610	+0.150 to +0.20 mm +0.0059 to +0.0078 in.

(1) Cylinder Head Gasket
(2) Measuring Point
(A) Gear Case Side
(B) Flywheel Side
(a) 2 Notches
(b) 1 Notch
(c) Without Notch

W1022965

Valve

1. Remove the valve spring collets (1) after compressing the valve spring (3) with the valve spring retainer (2).

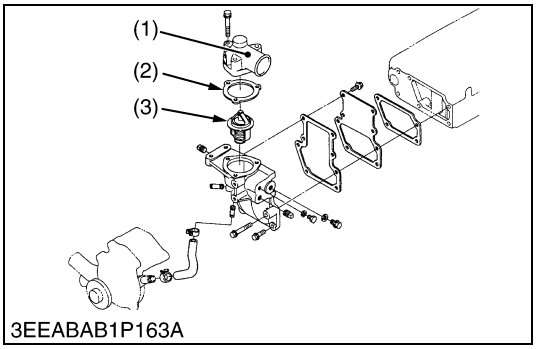
(When reassembling)

- Install the valve spring with its small-pitch end downward (at the head side).
- Wash the valve stem and valve guide hole, and apply engine oil sufficiently.
- After installing the valve spring collets, lightly tap the stem to assure proper fit with a plastic hammer.

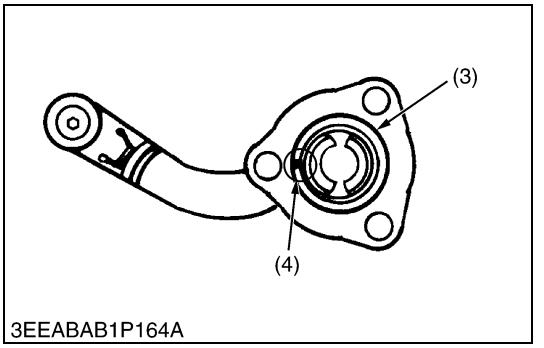
(1) Valve Spring Collet
(2) Valve Spring Retainer
(3) Valve Spring
(4) Valve Stem Seal
(5) Arm Bridge
(6) Valve
(7) Large Pitch
(8) Smaller Pitch
(9) Install the spring with its smaller-pitch end downward (at the head side)

W1053044

(4) Thermostat



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Thermostat Assembly

1. Remove the thermostat cover mounting screws, and remove the thermostat cover (1).
2. Remove the thermostat assembly (3).

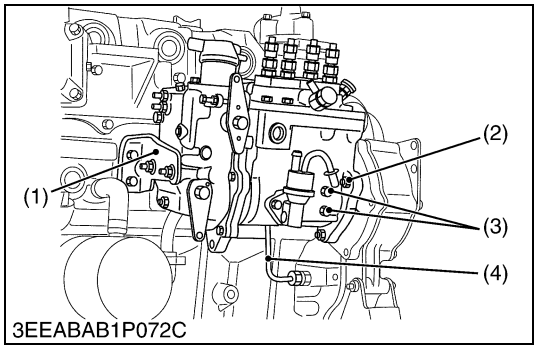
(When reassembling)

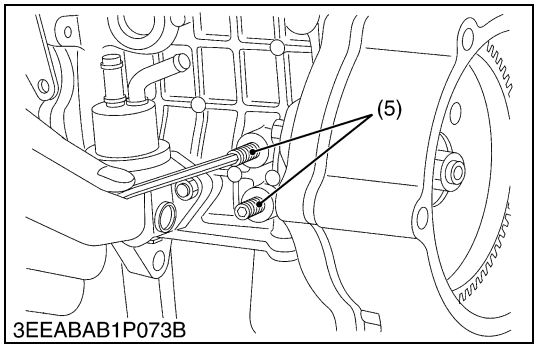
- Apply a liquid gasket (Three Bond 1215 or equivalent) only at the thermostat cover side of the gasket (2).
- Attach the thermostat with its hole facing toward the air suction side.

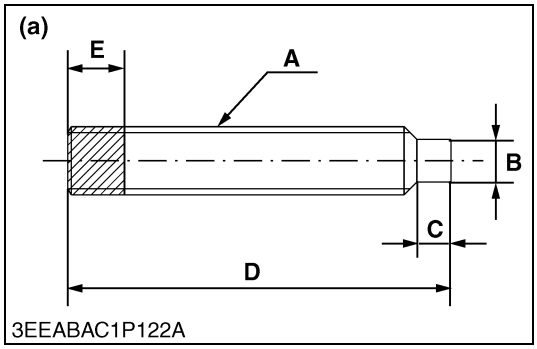
(1) Thermostat Cover
(2) Thermostat Cover Gasket
(3) Thermostat Assembly
(4) Hole

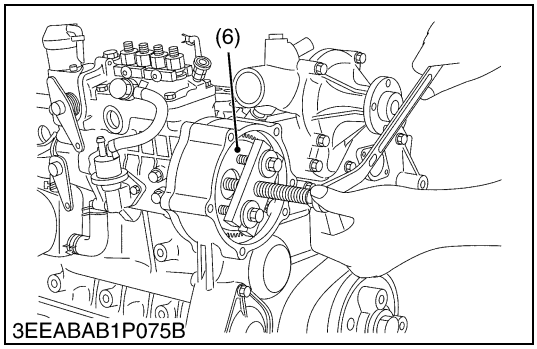
W1072747

(5) Injection Pump Unit









Injection Pump Unit

(Removing the fuel injection pump unit)

1. Detach the gear cover for the fuel injection pump unit from the gearcase.
2. Place the piston of the 4th cylinder at the top dead center in the compression stroke. Fix the flywheel with the flywheel stopper.

■ **IMPORTANT**

- **Look for the align mark on the idle gear 2. Using a white marking pen or the like, put an align mark on the engaged tooth of the idle gear. This helps to reassemble these gears in mesh later.**

■ **NOTE**

- **When the already existing align marks align with each other, there is no need to put another align mark.**

3. Unscrew the two plugs (3) of the injection pump unit.
4. Tighten the upper fuel cam shaft lock screw (5) until it comes into contact with the fuel cam shaft. Make sure the cam shaft does not move any longer.
5. Tighten the lower fuel cam shaft lock screw (5) until it comes into contact with the fuel cam shaft.

■ **NOTE**

- **Never overtighten the lock screws when they have come into contact with the cam shaft. Otherwise the injection pump itself may get damaged.**
- **Use of a socket set screw (dog point type) in recommended for best results. Such screw can be constructed as shown in figure (a).**

6. Loosen the injection pump gear mounting nut. Using the specific gear puller, take out the gear (6).

■ **NOTE**

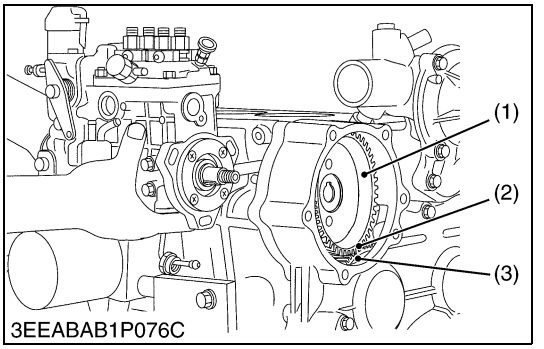
- **Be careful not to drop the key.**

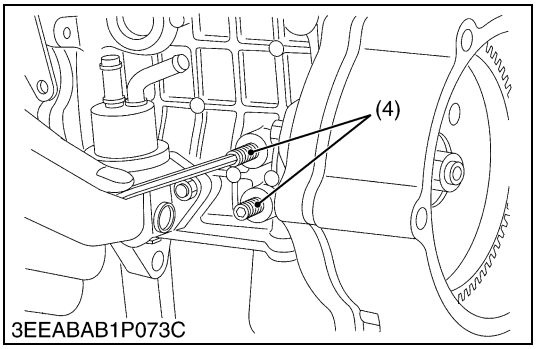
7. Disconnect the lubricating oil pipe (4).
8. Loosen the three injection pump unit mounting nut (2).
9. Remove the injection pump unit support (1) and take out the injection pump unit.

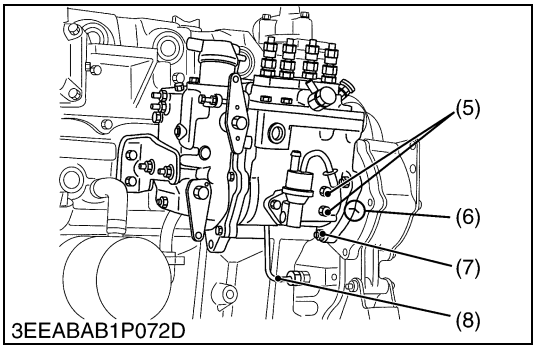
A	M8 × Pitch 1.25
B	5 mm dia. (0.197 in. dia.)
C	4 mm (0.157 in.)
D	45 mm (1.772 in.)
E	10 mm (0.39 in.) : Conspicuously Painted

(1) Injection Pump Unit Support
(2) Injection Pump Unit Mounting Nut
(3) Plug
(4) Lubricating Oil Pipe
(5) Fuel Cam Shaft Lock Screw (Socket Set Screw Dog Point Type)
(6) Injection Pump Gear

W1175054







Injection Pump Unit (Continued)

(Reassembling the fuel injection pump unit)

1. Place the piston of the 4th cylinder at the top dead center in the compression stroke. Fix the flywheel with the flywheel stopper.
2. Place the injection pump gear (1) back into the gear case position. Make sure of aligning the align marks of the injection pump gear (1) and the idle gear 2 (3).
3. Install the injection pump unit to the injection pump gear (1).

■ **NOTE**

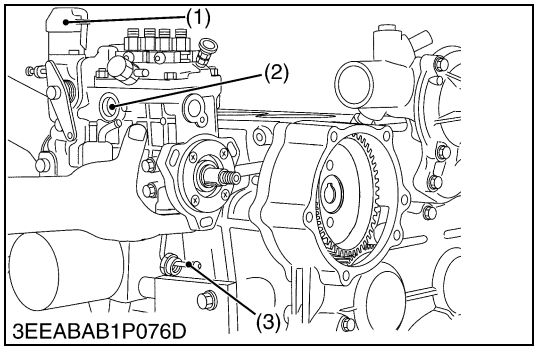
- **When installing the injection pump unit to the injection pump gear, make sure that the key is fit in the keyway of injection pump gear.**

4. Temporarily tighten the injection pump gear mounting nut by hand.
5. Fix the injection pump unit and tighten the injection pump gear mounting nut to the specified torque.
6. Take off the fuel cam shaft lock screws (4) and tighten the plugs (5) for plugging.
7. Loose the injection pump unit mounting nuts (7) for aligning the injection timing.
8. Moving the injection pump unit clockwise (viewed from gear case side), align the injection timing marks (6) on the injection pump unit and on the gear case.
9. Tighten the injection pump unit mounting nut (7) to the specified torque.
10. Reconnect the lubricating oil pipe (8) and place the injection pump unit support and the gear cover of the injection pump unit.
11. Remove the flywheel stopper.
12. Check the injection timing. (See the “Injection Timing”.)
13. If the injection timing is not within the specification, repeat (7) to (12) again.

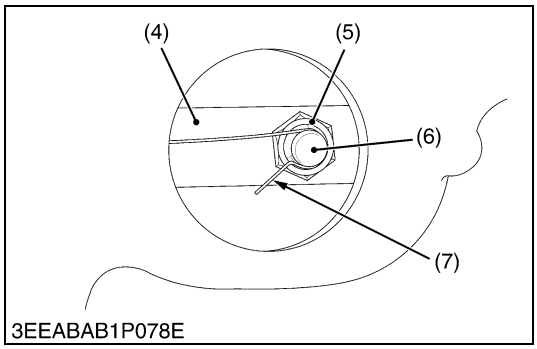
Tightening torque	Injection pump gear mounting nut	73.6 to 83.4 N·m 7.5 to 8.5 kgf·m 54.2 to 61.5 ft-lbs
	Injection pump unit mounting nut	17.7 to 20.6 N·m 1.8 to 2.1 kgf·m 13.0 to 15.2 ft-lbs

(1) Injection Pump Gear
(2) Align mark of the Injection Gear
(3) Idle Gear 2
(4) Fuel Cam Shaft Lock Screw (Socket Set Screw Dog Point Type)
(5) Plug
(6) Align Mark
(7) Injection Pump Unit Mounting Nut
(8) Lubricating Oil Pipe

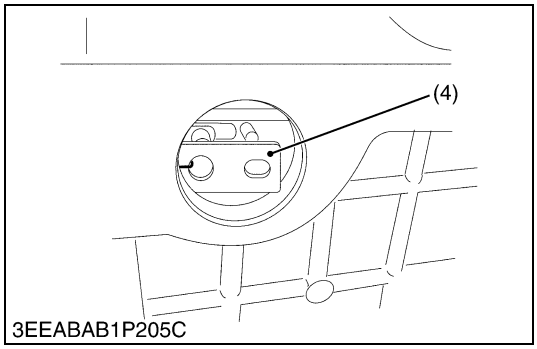
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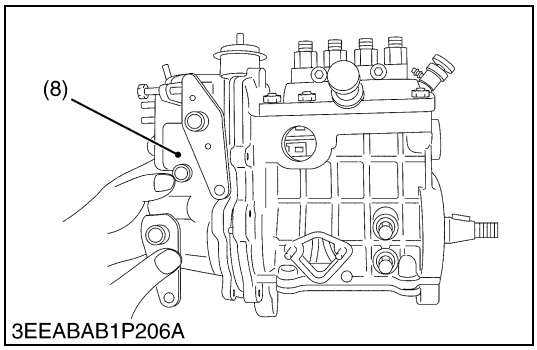
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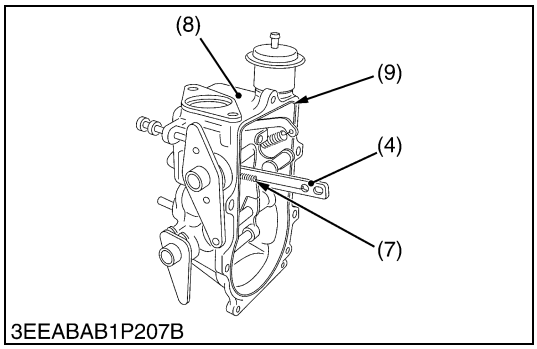
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Governor Housing Assembly

1. Remove the injection pump unit from the engine. (See the "Injection Pump Unit".)
2. Remove the governor lubricating pipe (3).
3. Remove the stop solenoid (1).
4. Detach the sight cover (2) from the injection pump unit.
5. Unhook the start spring (7) from the rack pin (6) of injection pump assembly.
6. Remove the nut (5).

■ **NOTE**

- **Be careful not to drop the nut inside.**

7. Slide off the governor connecting rod (4) from the rack pin of injection pump assembly.
8. For convenient sake, temporarily hook the start spring on the rack pin hole of the governor connecting rod.
9. Remove the governor housing mounting screws.
10. Detach the governor housing assembly (8) from the injection pump unit.

(When reassembling)

- When reassembling the inside parts, put the oil on each inside part slightly.
- After sliding on the governor connecting rod to the rack pin, tighten the nut with the specified torque with using the jig for keeping the governor connecting rod horizontal. (See the Replacing Injection Pump Assembly.)
- After tightening the nut, hook the start spring on the rack pin.
- Check the movement of control rack of injection pump assembly by the stop lever.

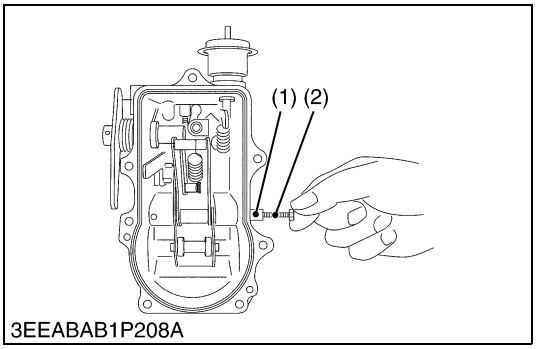
■ **NOTE**

- **When installing the governor housing assembly to the injection pump unit, be careful not to damage O-ring (9).**
- **When linking the governor connecting rod to the rack pin of injection pump, use the jig for keeping the governor connecting rod horizontal. Otherwise the control rack may be stuck, and causes to be difficult to start the engine or hunting of governor. (See the Replacing Injection Pump Assembly.)**

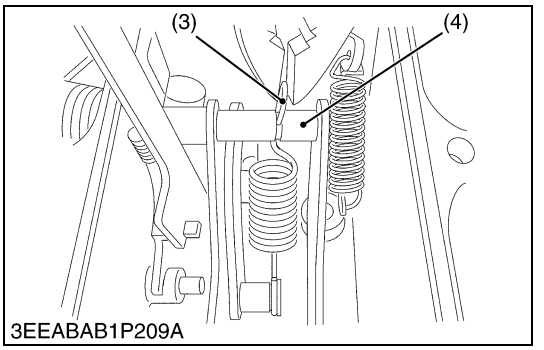
Tightening torque	Governor housing mounting screw	9.8 to 11.3 N·m 1.00 to 1.15 kgf·m 7.23 to 8.32 ft-lbs
	Anti-rotation nut	2.8 to 4.0 N·m 0.29 to 0.41 kgf·m 2.1 to 3.0 ft-lbs

(1) Stop Solenoid
(2) Sight Cover
(3) Governor Lubricating Pipe
(4) Governor Connecting Rod
(5) Anti-Rotation Nut
(6) Rack Pin
(7) Start Spring
(8) Governor Housing Assembly
(9) O-ring

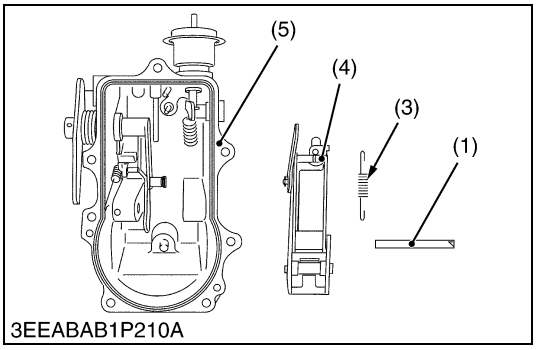
W1137126



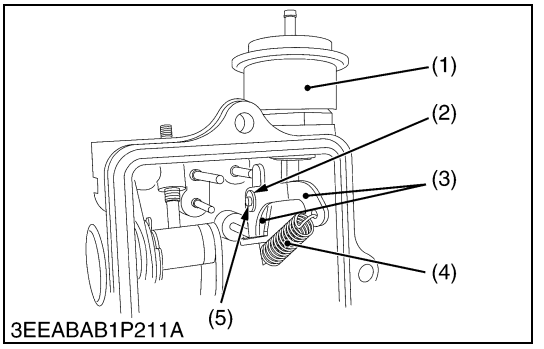
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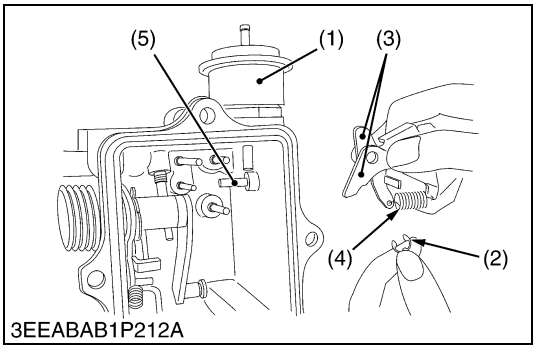
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3EEABAB1P210A



3EEABAB1P211A



3EEABAB1P212A

Governor Fork Lever Assembly

1. Pull off the governor fork lever shaft (1) with the extra bolt (Dia : 4 mm, Pitch : 0.7 mm, Length : more than 25 mm) (2).
2. Unhook the governor spring (3) at the governor fork lever (4) side.
3. Remove the governor fork lever assembly from the governor housing (5).

(When reassembling)

- After reassembling the governor housing assembly, check the movement of the governor fork lever assembly, the speed control lever and the stop lever.

■ **NOTE**

- **When assembling the inside parts, put the oil on each inside part slightly.**
- **Be careful not to deform the start spring.**

(1) Governor Fork Lever Shaft
(2) Extra Bolt (Dia : 4 mm, Pitch : 0.7 mm, Length : more than 25 mm)
(3) Governor Spring
(4) Governor Fork Lever
(5) Governor Housing

W1139749

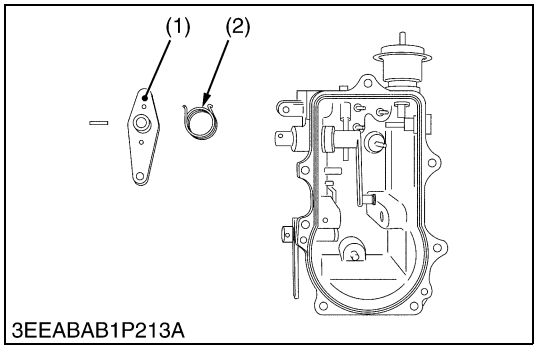
Boost Arms (If equipped Boost Compensator)

1. Remove the boost actuator (1).
2. Remove the cir-clip (2).
3. Remove the boost arms (3) and the boost spring (4) from the pin (5).

Tightening torque	Boost actuator	39.2 to 45.1 N·m 4.0 to 4.6 kgf·m 28.9 to 33.3 ft-lbs

(1) Boost Actuator
(2) Cir-clip
(3) Boost Arm
(4) Boost Spring
(5) Pin

W1141511



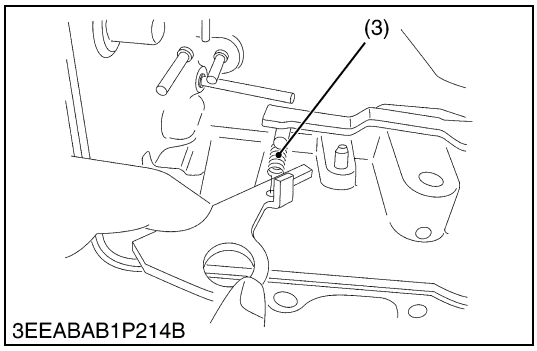
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Governor Lever

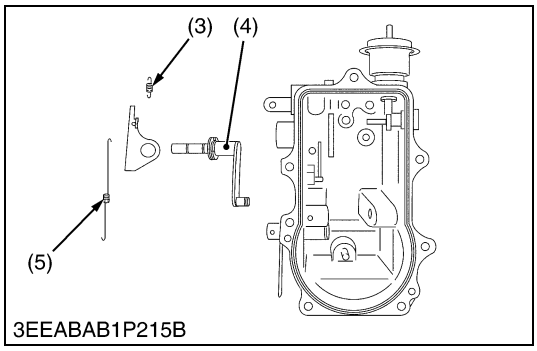
1. Remove the speed control lever (1) and the return spring (2).
2. Remove the governor lever assembly (4) from the governor housing.
3. Remove the start spring (5) and the stop spring (3).

(1) Speed Control Lever
(2) Return Spring
(3) Stop Spring
(4) Governor Lever Assembly
(5) Start Spring

W1142375



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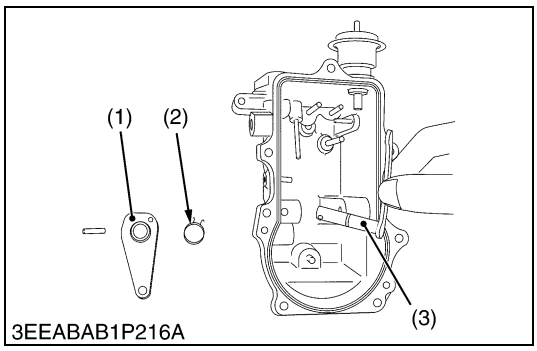
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Stop Lever

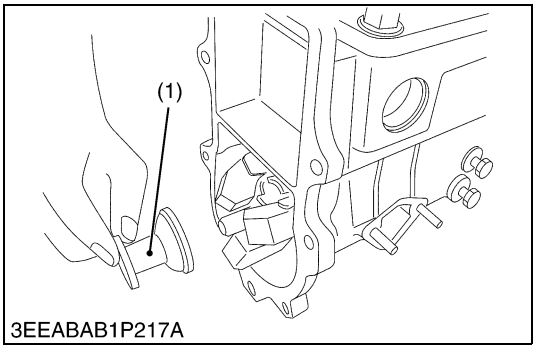
1. Remove the stop lever (1) and the return spring (2).
2. Remove the stop lever shaft (3).

(1) Stop Lever
(2) Return Spring
(3) Stop Lever Shaft

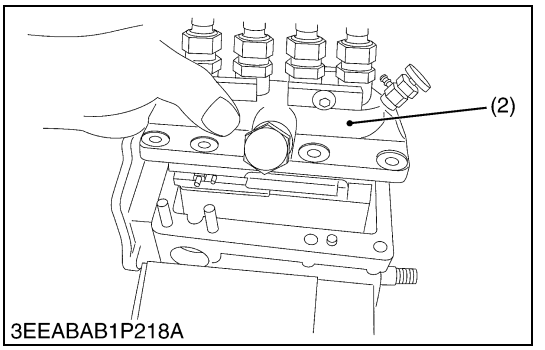
W1143531



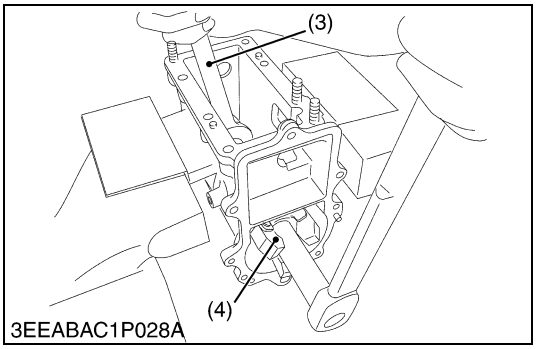
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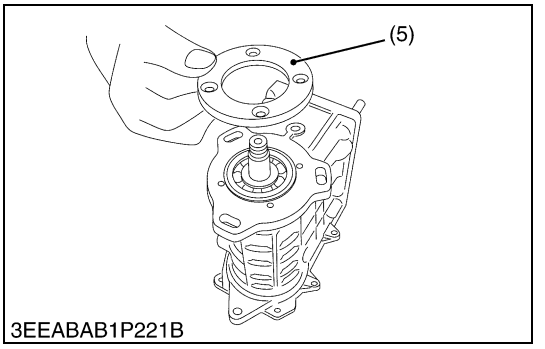
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Fuel Camshaft and Governor Weight

1. Separate the governor housing assembly from the injection pump unit. (See the “Injection Pump Unit”.)
2. Remove the governor sleeve (1).
3. Remove the injection pump assembly (2).
4. Remove the fuel camshaft lock screws.
5. Fix the fuel camshaft with open end wrench (3), and remove the governor weight mounting nut and the governor weight (4).
6. Loosen the fuel camshaft stopper mounting screws and remove the fuel camshaft stopper (5).
7. Pull out the fuel camshaft (8) and bearings (6) together.
8. After removing the bearing’s cir-clip (7), press out the bearings.

■ **NOTE**

- **Do not use the fuel camshaft lock bolts, when removing the governor weight mounting nut. Otherwise, the lock bolts or injection pump housing might get damage.**

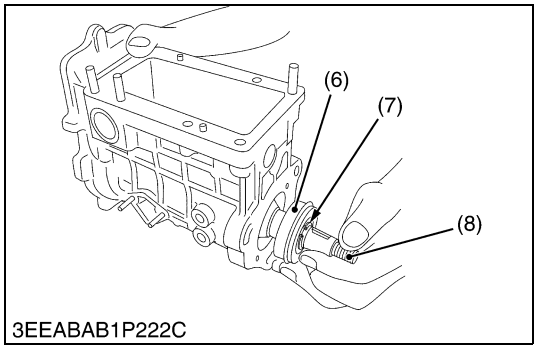
(When reassembling)

- Press the bearings into the fuel camshaft.
- Set the cir-clip at the gear side’s bearing.
- Install the fuel camshaft and bearings to the injection pump housing.
- Attach the fuel camshaft stopper and tighten the fuel camshaft stopper mounting screws with the specified torque.
- Attach the governor weight to the fuel camshaft and tighten the governor weight mounting nut with specified torque.

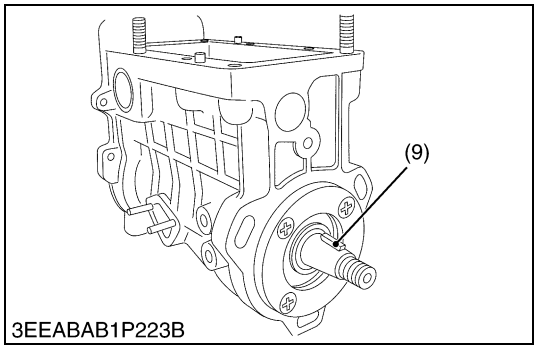
Tightening torque	Injection pump mounting screw	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs
	Injection pump mounting nut	17.7 to 20.6 N·m 1.8 to 2.1 kgf·m 13.0 to 15.2 ft-lbs

(1) Governor Sleeve
(2) Injection Pump Assembly
(3) Open End Wrench (22 mm)
(4) Governor Weight
(5) Fuel Camshaft Stopper
(6) Bearing
(7) Cir-clip
(8) Fuel Camshaft
(9) Key Way of Fuel Camshaft

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Fuel Camshaft and Governor Weight (Continued)

(When reassembling)

- Fix the fuel camshaft with lock bolts as the key way of fuel camshaft (9) is upward.
- Install the injection pump assembly to the injection pump housing.
- Attach the O-ring and the cover and tighten the cover mounting bolts.
- Install the governor sleeve to the fuel camshaft.
- Check the movement of the governor sleeve.

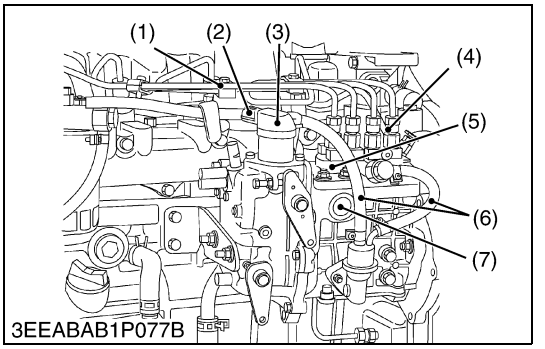
■ **NOTE**

- **Be careful not to damage the O-ring.**
- **Be careful the direction of the governor sleeve.**
- **When reassembling the inside parts, put the oil on each inside part slightly.**

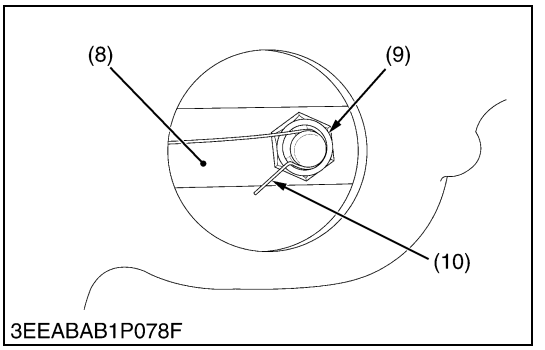
Tightening torque	Fuel camshaft stopper mounting screw	7.9 to 9.3 N·m 0.80 to 0.95 kgf·m 5.8 to 6.9 ft-lbs
	Governor weight mounting nut	62.8 to 72.6 N·m 6.4 to 7.4 kgf·m 46.3 to 53.5 ft-lbs

(1) Governor Sleeve
(2) Injection Pump Assembly
(3) Open End Wrench (22 mm)
(4) Governor Weight
(5) Fuel Camshaft Stopper
(6) Bearing
(7) Cir-clip
(8) Fuel Camshaft
(9) Key Way of Fuel Camshaft

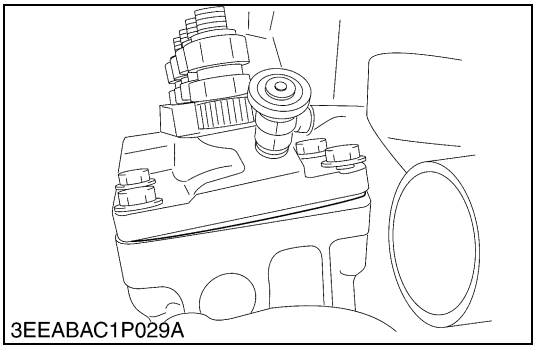
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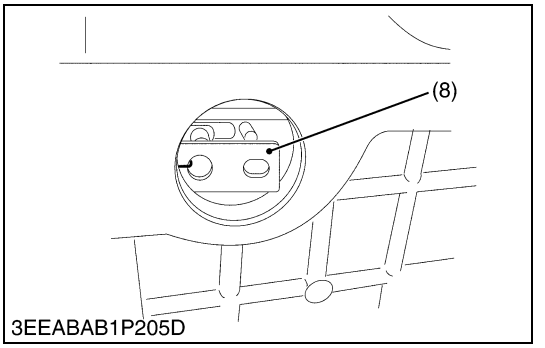


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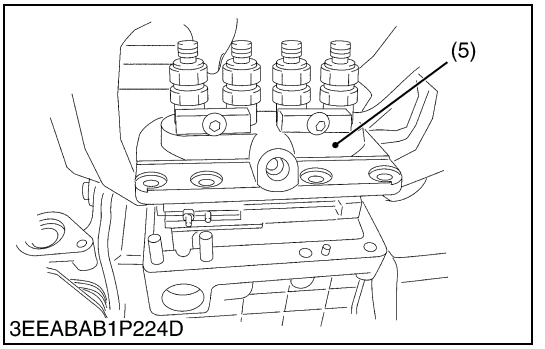


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3EEABAC1P029A



3EEABAB1P205D



3EEABAB1P224D

Replacing Injection Pump Assembly (If necessary)

- **The injection pump can be replaced with the crankshaft in whatever position.**

1. Disconnect all injection pipes (1).
2. Disconnect the fuel pipe (6) and fuel overflow pipe (4).
3. Disconnect the connector (2) from the stop solenoid. Then remove the stop solenoid (3).
4. Detach the sight cover (7) from the injection pump unit.
5. Unhook the start spring (10), and remove the anti-rotation nut (9).
6. Just loosen the injection pump assembly mounting screws and nuts like the figure, which the injection pump assembly keeps tilted.
7. Slide off the governor connecting rod (8) from the rack pin of injection pump assembly.
8. Remove the injection pump mounting screws and nuts, and take out the injection pump assembly (5).

■ **NOTE**

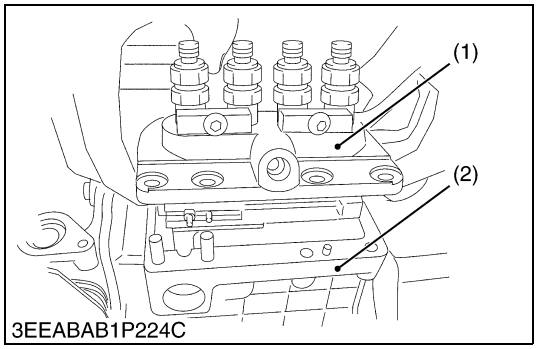
- **Be careful not to drop the anti-rotation nut (9).**
- **Be careful not to deform the start spring.**
- **When taking out the injection pump assembly, be careful not to hit it against the governor connecting rod.**

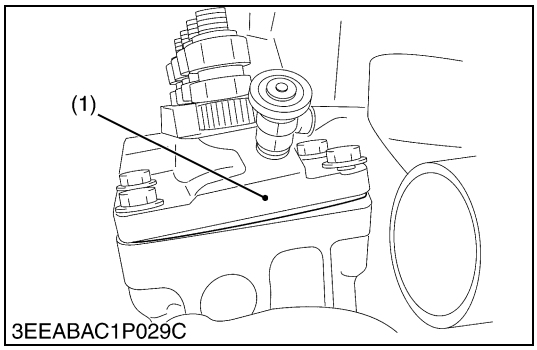
(When reassembling)

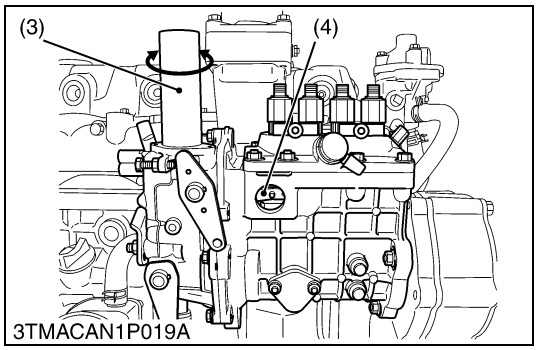
- Install the new injection pump according to the installing procedure.

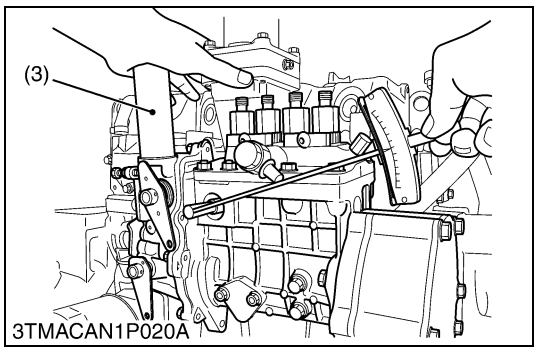
(1) Injection Pipe
(2) Connector
(3) Stop Solenoid
(4) Fuel Overflow Pipe
(5) Injection Pump Assembly
(6) Fuel Pipe
(7) Sight Cover
(8) Governor Connecting Rod
(9) Anti-Rotation Nut
(10) Start Spring

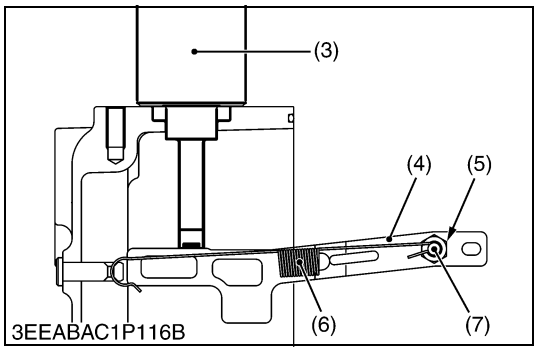
W1182379





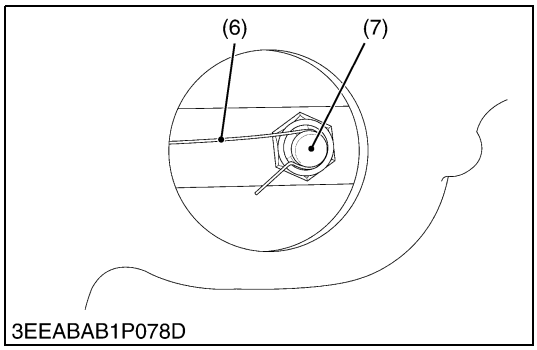






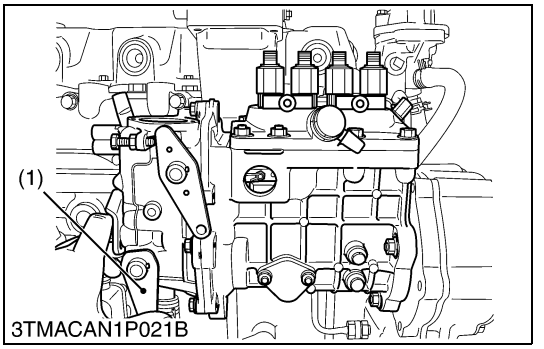
Installing Procedure of Injection Pump Assembly

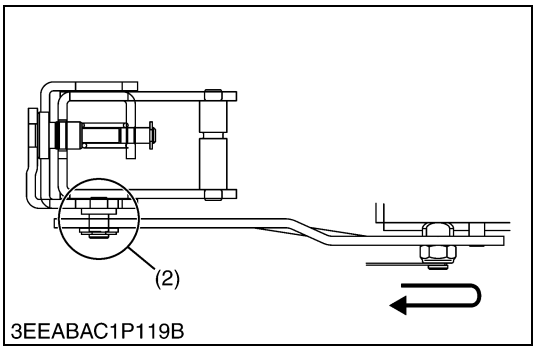
1. Install the fuel injection pump assembly (1) in its unit (2), and tighten the mounting screws and nuts like the figure, which the injection pump assembly (1) keeps tilted.
2. Hook the governor connecting rod (4) to the rack pin of the injection pump assembly (1).
3. Tighten the mounting screws and nuts with the specified torque, not to slide off the governor connecting rod (4) from the rack pin.
4. Place the service jig (3) in the stop solenoid mounting hole of the fuel injection pump unit.
5. Make sure the permanent magnet at the tip of the service jig is attracted to the governor connecting rod (4). To do this, turn the jig a little clockwise and counterclockwise and look into the fuel injection pump unit sight hole to see if the governor connecting rod (4) moves right and left accordingly.
6. Slightly tighten the anti-rotation nut of the governor connecting rod.
7. Holding down the service jig (3) by hand, tighten up the anti-rotation nut (5) to the specified torque.
8. Hook the start spring (6) to the rack pin (7).

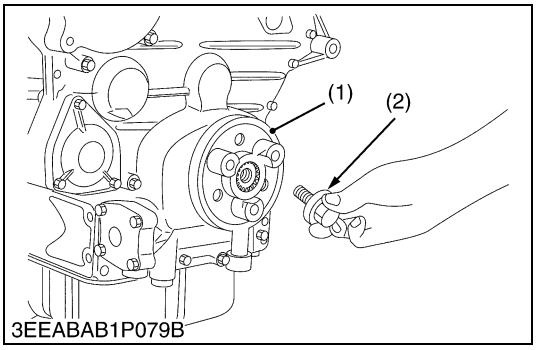


(1) Fuel Injection Pump Assembly
(2) Fuel Injection Pump Unit
(3) Service Jig
(4) Governor Connecting Rod
(5) Anti-rotation Nut
(6) Start Spring
(7) Rack Pin

W1069371







Installing Procedure (Continued)

1. Move the stop lever (1) and visually check to see if the fuel injection pump control rack comes smoothly back to the start position by the counter force of the start spring.
2. If the control rack fails to move back smoothly, remove the start spring and the anti-rotation nut, take the above steps from 2 of the former page again.
3. Finally fit the sight cover and the stop solenoid back into place.

Tightening torque	Anti-rotation nut	2.8 to 4.0 N·m 0.29 to 0.41 kgf·m 2.1 to 3.0 ft-lbs
	Injection pump mounting screw	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs
	Injection pump mounting nut	17.7 to 20.6 N·m 1.8 to 2.1 kgf·m 13.0 to 15.2 ft-lbs

(1) Stop Lever (2) Sliding Point between Governor Fork Lever and Governor Connecting Rod

W1069772

Fan Drive Pulley

1. Set the stopper to the flywheel.
2. Remove the crankshaft screw (2).
3. Draw out the fan drive pulley (1).

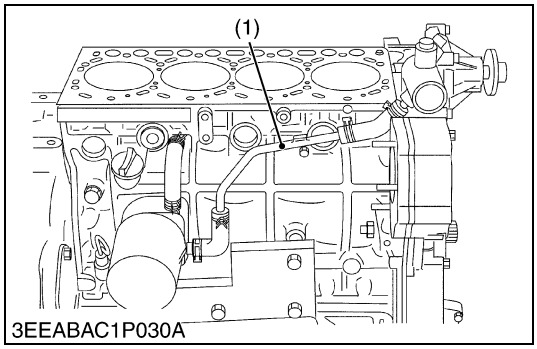
(When reassembling)

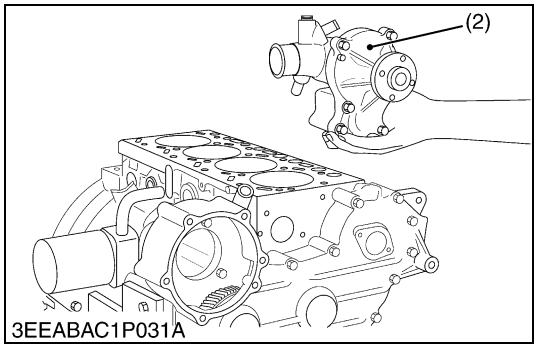
Tightening torque	Crankshaft screw	255.0 to 274.6 N·m 26.0 to 28.0 kgf·m 188.1 to 202.5 ft-lbs

(1) Fan Drive Pulley (2) Crankshaft Screw

W1185033

(6) Water Pump and Oil Cooler





Water Pump

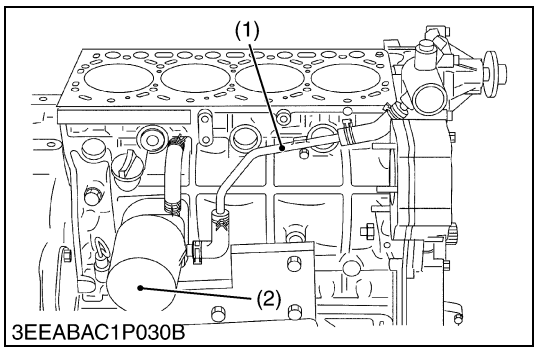
1. Remove the pipe band and the water pipe (1).
2. Remove the water pump (2).

(When reassembling)

- When mounting the water pump, take care not to forget mounting the O-ring and not to let it out of position.

(1) Water Pipe (2) Water Pump

W1187742



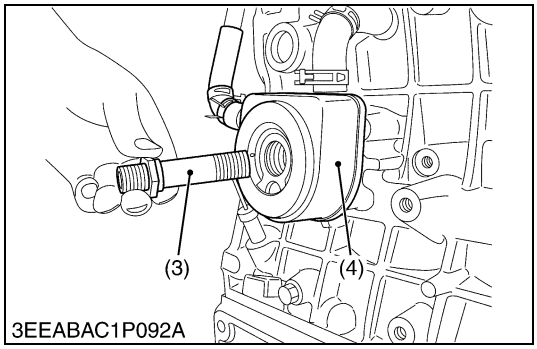
Oil Cooler

1. Remove the water pipe (1).
2. Remove the oil filter cartridge (2) and the oil cooler joint screw (3).
3. Remove the oil cooler (4).

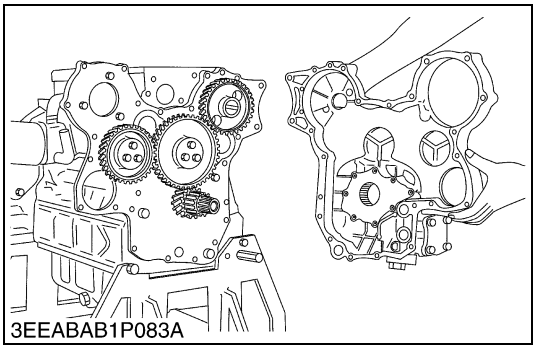
Tightening torque	Oil cooler joint screw	39.2 to 44.1 N·m 4.0 to 4.5 kgf·m 28.9 to 32.5 ft-lbs

(1) Water Pipe (3) Oil Cooler Joint Screw
(2) Oil Filter Cartridge (4) Oil Cooler

W1032266



(7) Gear Case and Timing Gears


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Gear Case Cover

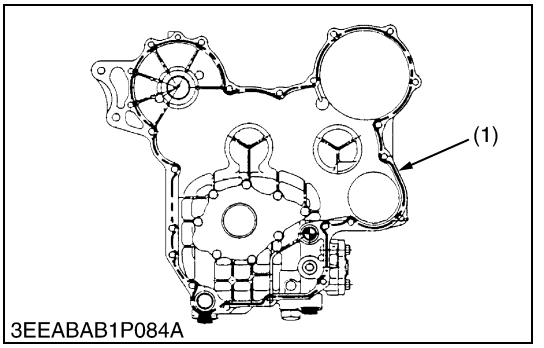
1. Remove the gear case cover.

(When reassembling)

- Confirm that the liquid gasket coating surface is free of water, dust and oil in order to maintain sealing effect.
- Carefully apply the adhesive evenly. (Refer to the figure on the left.)

■ **NOTE**

- **When mounting the adhesive-applied parts, take care to fit them to the mating parts.**
- **Assemble the adhesive-applied parts within ten minutes.**
- **Apply a liquid gasket (Three Bond 1217D) to the gear case cover.**



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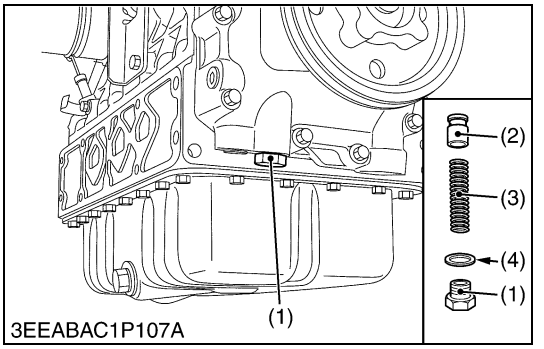
Tightening torque	Gear case cover mounting screw	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs

(1) Liquid Gasket

W1189218

Relief Valve

1. Remove the relief valve retaining screw (1).
2. Remove the relief valve (2), the spring (3) and the packing (4).



3EEABAC1P107A

Tightening torque	Relief valve retaining screw	68.6 to 78.4 N·m 7.0 to 8.0 kgf·m 50.6 to 57.9 ft-lbs

(1) Relief Valve Retaining Screw
(2) Relief Valve
(3) Spring
(4) Packing

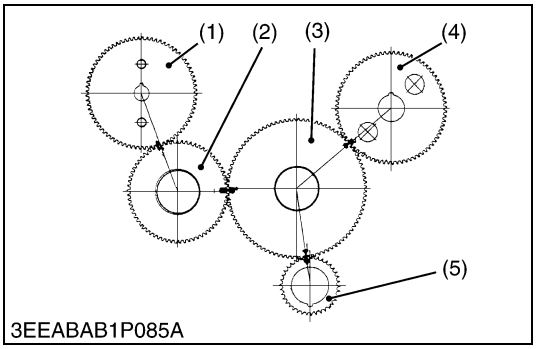
W1081251

Idle Gear and Camshaft

1. Remove three set screws of the idle gear and draw out the idle gear 1, 2.
2. Remove two set screws of the camshaft stopper and draw out the camshaft.

(When reassembling)

- Set the crankshaft at the top dead center of No. 1 and 4 cylinder and the camshaft key to the top position and align the marks of idle gear 1 (3) and idle gear 2 (2) to assemble them. (Refer to the figure on the left.)
- Mount the injection pump gear (1) after installing the gear case.

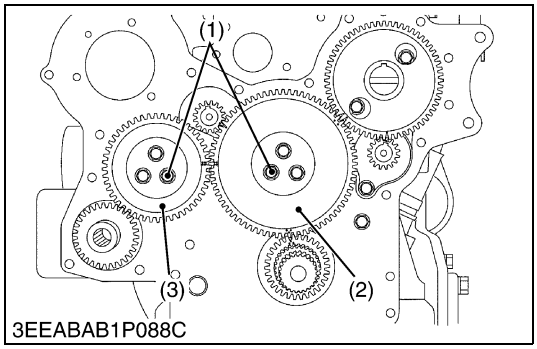


3EEABAB1P085A

Tightening torque	Camshaft set screw	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs
	Idle gear mounting screw	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs

(1) Injection Pump Gear
(2) Idle Gear 2
(3) Idle Gear 1
(4) Cam Gear
(5) Crank Gear

W1189797



Idle Gear 1 and Idle Gear 2 (for Balancer Model)

1. Remove the idle gear mounting screw (1).
2. Draw out the idle gear (2) and (3).

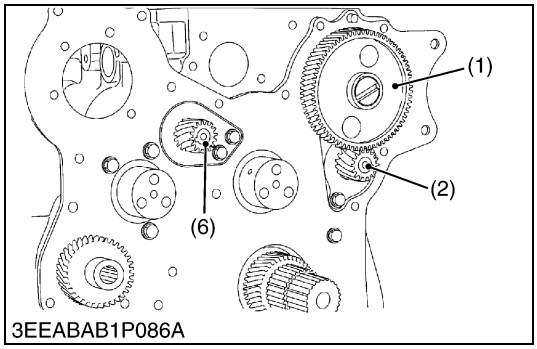
(When reassembling)

- When install the idle gear (2) and (3), be sure to place the 4th cylinder piston at the top dead center in compressio then, align all mating marks on each gear to assemble the timing gears, set the idle gear last.

Tightening torque	Idle gear mounting screw	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs

(1) Idle Gear Mounting Screw
(2) Idle Gear 1
(3) Idle Gear 2

W1032991



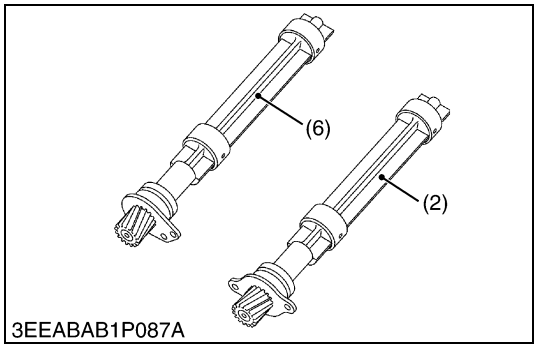
Camshaft and Balancer Shaft (for Balancer Model)

1. Remove the camshaft set screws and draw out the camshaft (1).
2. Remove the balancer shaft 1 set screws and draw out the balancer shaft 1 (2).
3. Remove the balancer shaft 2 set screws and draw out the balancer shaft 2 (6).

(When reassembling)

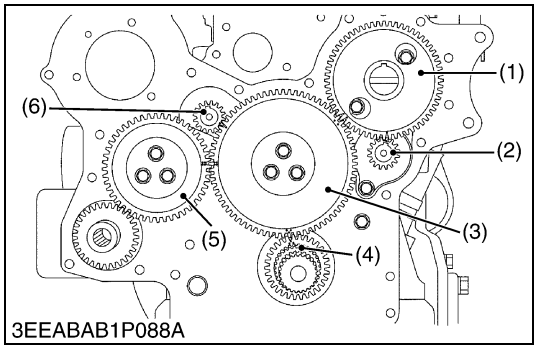
- When install the balancer shaft 1 and 2, be sure to place the 4th cylinders piston at the top dead center in compression then, align all mating marks on each gear to assemble the timing gears, set the idle gear last.

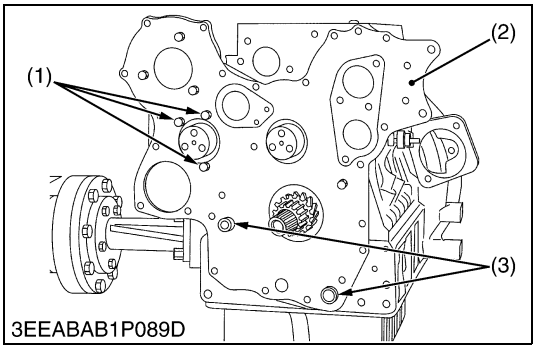
Tightening torque	Camshaft set screw	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs
	Balancer shaft set screw	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs



(1) Camshaft
(2) Balancer Shaft 1
(3) Idle Gear 1
(4) Crank Gear
(5) Idle Gear 2
(6) Balancer Shaft 2

W1191037





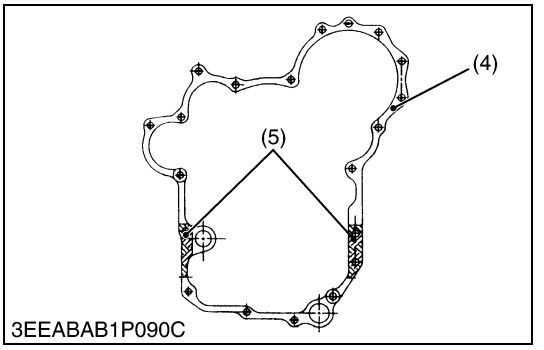


Plate (Gear Case)

1. Remove the three plate mounting screws(1). Detach the plate (2).

(When reassembling)

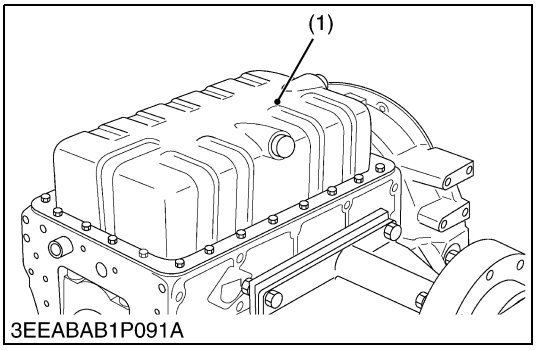
- Apply Three Bond 1217D adhesive or equivalent over the shaded zones on both sides of the gasket that will be sandwiched between the crankcase and plate.
- Be sure to fix the O-rings (3).

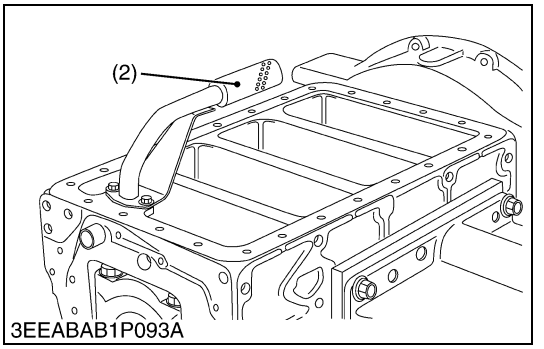
Tightening torque	Plate mounting screw	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs

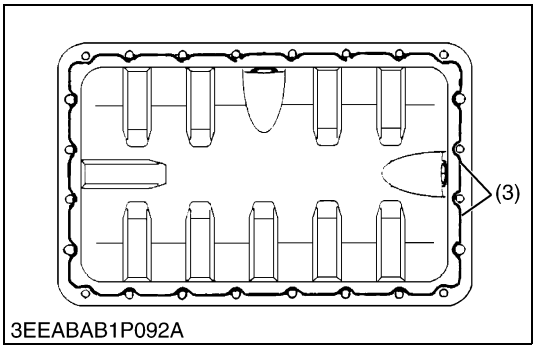
(1) Plate Mounting Screw
(2) Plate
(3) O-ring
(4) Gasket
(5) Liquid Gasket

W1057656

(8) Piston and Connecting Rod







Oil Pan and Oil Strainer

1. Unscrew the oil pan mounting screws and remove the oil pan (1).
2. Unscrew the oil strainer mounting screw, and remove the oil strainer (2).

(When reassembling)

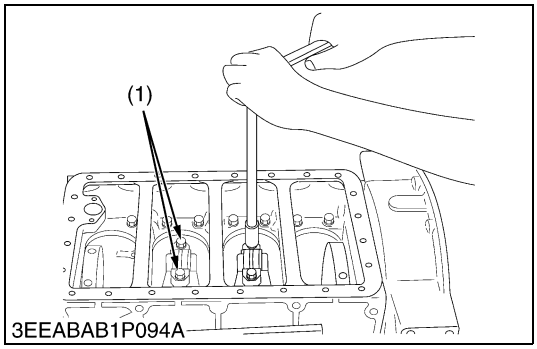
- Install the oil strainer, using care not to damage the O-ring.
- Apply liquid gasket (Three Bond 1217D) to the oil pan as shown in the figure.
- Confirm that the liquid gasket coating surface is free of water, dust and oil in order to maintain sealing effect.
- Carefully apply the adhesive evenly.

■ **NOTE**

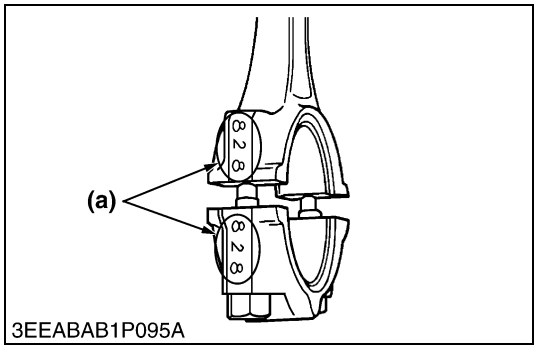
- **When mounting the adhesive-applied parts, take care to fit them to the mating parts.**
- **Assemble the adhesive-applied parts within ten minutes.**
- **To avoid uneven tightening, tighten mounting screws in diagonal order from the center.**
- **After cleaning the oil strainer, install it.**
- **Attach the oil pan with its central drain plug facing toward the air suction side.**

(1) Oil Pan
(2) Oil Strainer
(3) Liquid Gasket

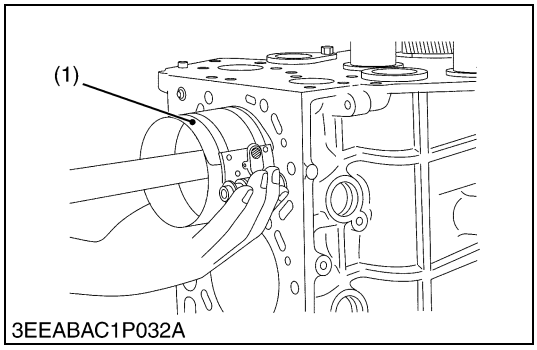
W1057949



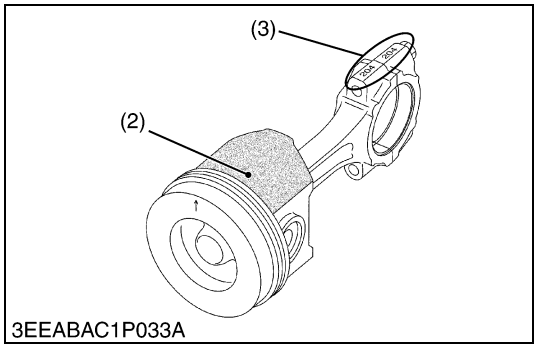
3EEABAB1P094A



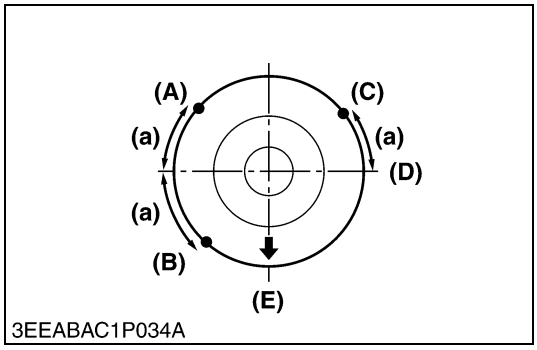
3EEABAB1P095A



3EEABAC1P032A



3EEABAC1P033A



3EEABAC1P034A

Connecting Rod Cap

1. Remove the connecting rod screws (1) from connecting rod cap.
2. Remove the connecting rod caps.

(When reassembling)

- Align the marks **(a)** with each other. (Face the marks toward the injection pump.)
- Apply engine oil to the connecting rod screws and lightly screw it in by hand, then tighten it to the specified torque.
  If the connecting rod screw won't be screwed in smoothly, clean the threads.
  If the connecting rod screw is still hard to screw in, replace it.
- When using the existing crank pin metal again, put tally marks on the crank pin metal and the connecting rod in order to keep their positioning.
- Fit the crank pin metal in place : its centrally groove side toward the connecting rod, and the non-grooved side toward the cap.

Tightening torque	Connecting rod screw	78.5 to 83.4 N·m 8.0 to 8.5 kgf·m 57.9 to 61.5 ft-lbs

(1) Connecting Rod Screw **(a) Mark**

W1058252

Piston

1. Completely clean carbon in the cylinders.
2. Turn the flywheel and set a piston to the top dead center.
3. Pull out the piston upward by lightly tapping it from the bottom of the crankcase with the grip of a hammer.

(When reassembling)

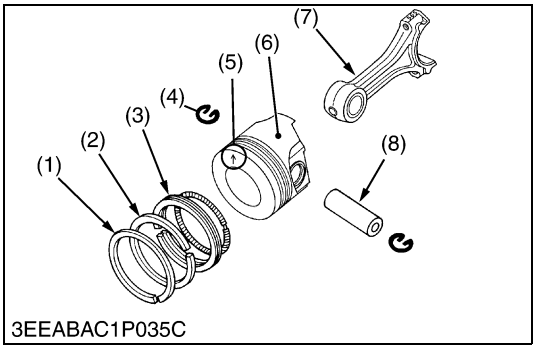
- Before inserting the piston into the cylinder, apply enough engine oil to the cylinder.
- When inserting the piston into the cylinder, face the mark (3) on the connecting rod to the injection pump.

■ IMPORTANT

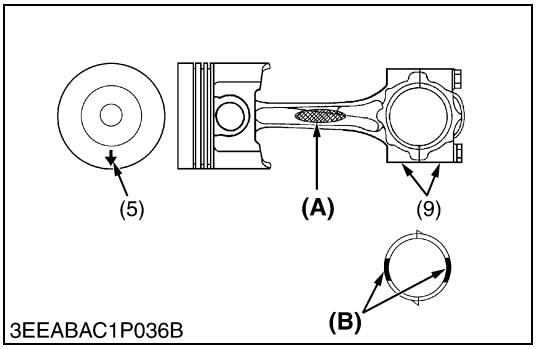
- **Do not change the combination of cylinder and piston. Make sure of the position of each piston by marking. For example, mark "1" on the No. 1 position.**
- **When inserting the piston into the cylinder, place the gap of each pison ring like the figure.**
- **Carefully insert the pistons using a piston ring compressor (1). Otherwise, their chrome-plated section of piston rings may be scratched, causing trouble inside the liner.**
- **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.**

(1) Piston Ring Compressor
(2) Molybdenum Disulfide Coating in piston skirt
(3) Mark
(a) 0.79 rad (45 <Symbol>×)
(A) Top Ring Gap
(B) Second Ring Gap
(C) Oil Ring Gap
(D) Piston Pin Hole
(E) Injection Pump Side

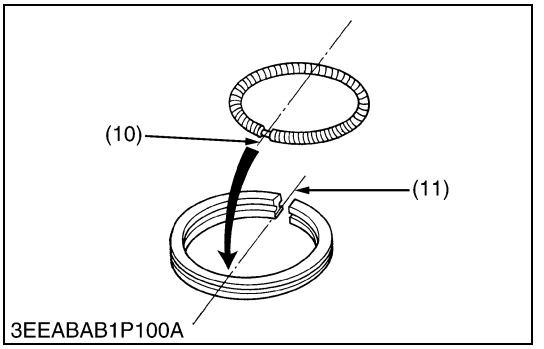
W1058433



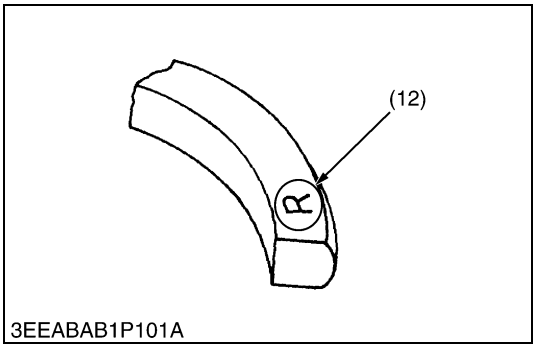
3EEABAC1P035C



3EEABAC1P036B



3EEABAB1P100A



3EEABAB1P101A

Piston Ring and Connecting Rod

1. Remove the piston rings using a piston ring tool.
2. Remove the piston pin (8), and separate the connecting rod (7) from the piston (6).

(When reassembling)

- Be sure to fix the crankpin bearing and the connecting rod are same I.D. colors.
- When installing the ring, assemble the rings so that the manufacture's mark (12) near the gap faces the top of the piston.
- When installing the oil ring onto the piston, place the expander joint (10) on the opposite side of the oil ring gap (11).
- Apply engine oil to the piston pin.
- When installing the piston pin, immerse the piston in 80 <Symbol>×C (176 <Symbol>×F) oil for 10 to 15 minutes and insert the piston pin to the piston.
- Assemble the piston to the connecting rod with the <Symbol>¦ mark (5) and the connecting rod numbering mark (9) facing same side.
- The end faces of the oil ring are plated with hard chrome. In putting the piston into the cylinder, be careful not to get the oil ring scratched by the cylinder. Use the piston ring fitter to tighten up the oil ring. If the ring's planting is scratched, it may get stuck on the cylinder wall, causing a serious trouble.

■ IMPORTANT

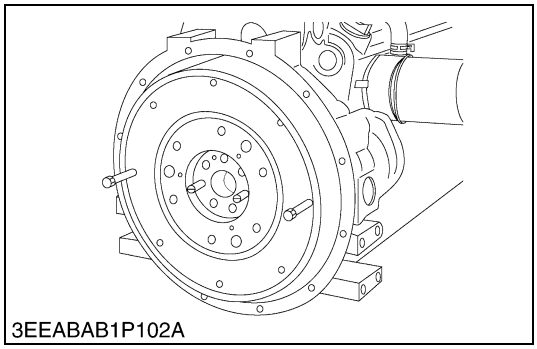
- **Mark the same number on the connecting rod and the piston so as not to change the combination.**

(1) Top Ring
(2) Second Ring
(3) Oil Ring
(4) Piston Pin Snap Pin
(5) Mark (<Symbol>¦)
(6) Piston
(7) Connecting Rod
(8) Piston Pin
(9) Numbering Mark
(10) Expander Joint
(11) Oil Ring Gap
(12) Manufacture's Mark

(A) Connecting Rod ID Color : Blue or without Color
(B) Crankpin Bearing ID Color : Blue or without Color

W1059589

(9) Flywheel and Crankshaft


3EEABAB1P102A

Flywheel

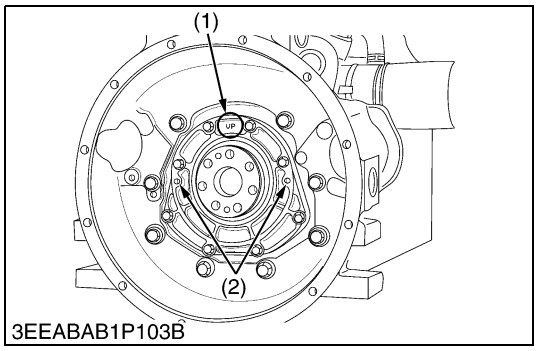
1. Install the stopper to the flywheel so that the flywheel does not turn.
- **NOTE**
- **Do not use an impact wrench. Serious damage will occur.**
2. Detach the flywheel screws.
3. Remove the flywheel.

(When reassembling)

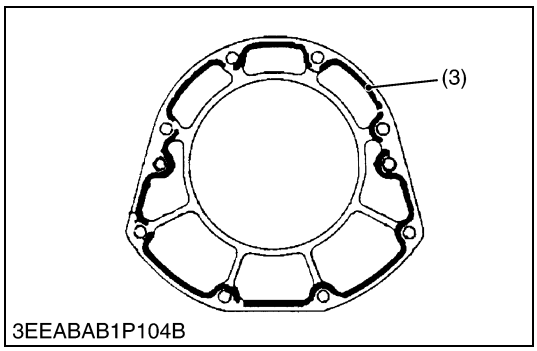
- Apply engine oil to the flywheel screws.
- Before fitting the flywheel and the crankshaft together, wipe oil, dust and other foreign substances off their mating faces.
- The flywheel and the crankshaft are fitting together in just one position. Make sure they are tightly fit and drive the bolts.

Tightening torque	Flywheel screw	98.1 to 107.9 N·m 10.0 to 11.0 kgf·m 72.3 to 79.6 ft-lbs

W1060354



3EEABAB1P103B



3EEABAB1P104B

Bearing Case Cover

■ **NOTE**

- **Before disassembling, check the side clearance of crankshaft. Also check it during reassembly.**

1. Remove the bearing case over mounting screws.
2. Screw two removed screws into the screw hole (2) of bearing case cover to remove it.

(When reassembling)

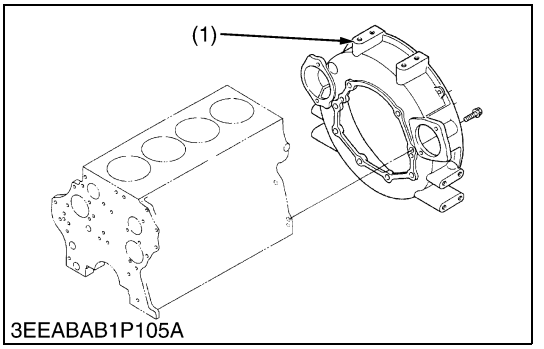
■ **IMPORTANT**

- **In case of replacing the oil seal, use caution when installing the seal in the bearing case cover as not to install it tilted. The seal should be flush with the cover.**
- **Confirm that the liquid gasket coating surface is free of water, dust and oil in order to maintain sealing effect.**
- **Apply liquid gasket (Three Bond 1217D) to the bearing case cover as shown in the figure.**
- **Before installing the bearing case cover / oil seal assembly, lube the seal tna be careful not to damage the seal while installing the assembly.**
  Install the bearing case cover / oil seal assembly to position the casting mark "UP" on it upward.
- **Tighten the bearing case cover mounting screws with even force on the diagonal line.**
- **When mounting the adhesive-applied parts, take care to fit them to the mating parts.**
- **Assemble the adhesive-applied parts within ten minutes.**

Tightening torque	Bearing case cover mounting screw	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs

(1) Top Mark **"UP"**
(2) Screw Hole
(3) Liquid Gasket

W1060482



3EEABAB1P105A

Flywheel Housing

1. Remove the flywheel housing.

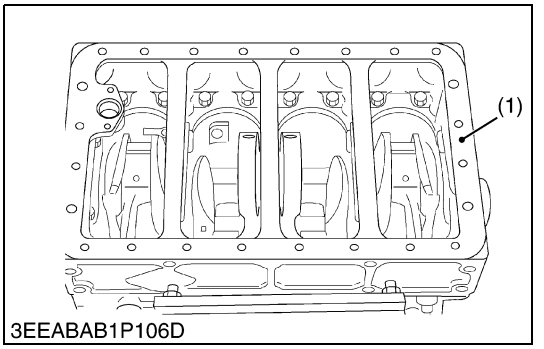
(When reassembling)

- Tighten the flywheel housing mounting screws with even force on the diagonal line.
- Make sure the crank cases 1 and 2 are clean. Install them in position, referring to the flywheel housing's contoured face.

Tightening torque	Flywheel housing mounting screw	77.5 to 90.2 N·m 7.9 to 9.2 kgf·m 57.1 to 66.5 ft-lbs

(1) Flywheel Housing

W1060705



3EEABAB1P106D

Crankcase 2

1. Remove the crankcase 2 (1).

(When reassembling)

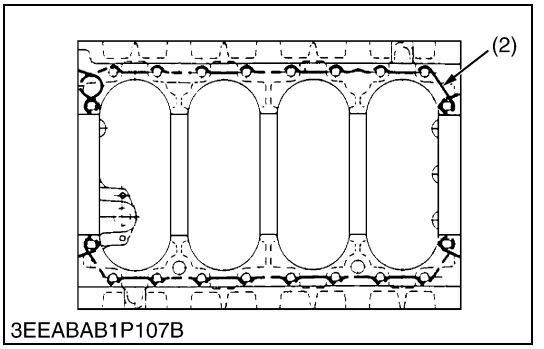
■ IMPORTANT

- **Make sure the crankcase 1 and 2 are clean.**
- **Apply liquid gasket (Three Bond 1217D) to the crankcase 2 as shown in the figure.**
- **Tighten the crankcase 2 mounting screws with even force on the diagonal line.**
- **Confirm that the liquid gasket coating surface is free of water, dust and oil in order to maintain sealing effect.**
- **Carefully apply the adhesive evenly.**

■ NOTE

- **When mounting the adhesive-applied parts, take care to fit them to the mating parts.**
- **Assemble the adhesive-applied parts within ten minutes.**

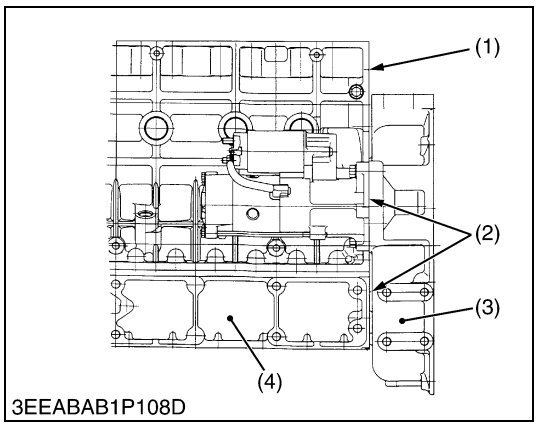
Tightening torque	Crankcase 2 mounting screw	49.0 to 55.9 N·m 5.0 to 5.7 kgf·m 36.2 to 41.2 ft-lbs



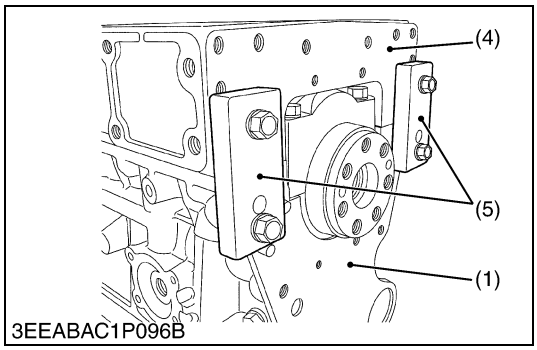
3EEABAB1P107B

(1) Crankcase 2 (2) Liquid Gasket

W1060825



3EEABAB1P108D



3EEABAC1P096B

Crankcase 1 and Crankcase 2

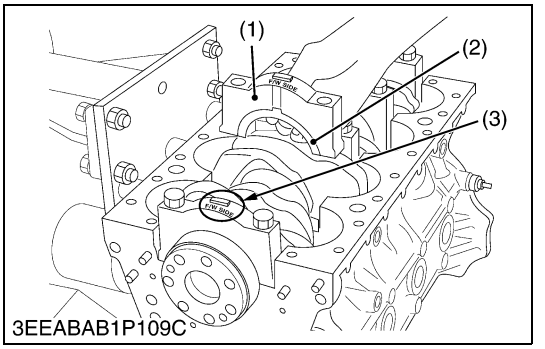
(When reassembling)

- Match the crankcase 1 and 2, referring to the flywheel housing's contoured face.
- Tighten the crankcase 2 mounting screws loosely.
- Tighten up the jig to the specified torque same as the flywheel housing screw. This helps to minimize the level difference between the crankcase 1 and the crankcase 2 (at the flywheel side). Possible gap must be 0.05 mm (0.0020 in.) or smaller.

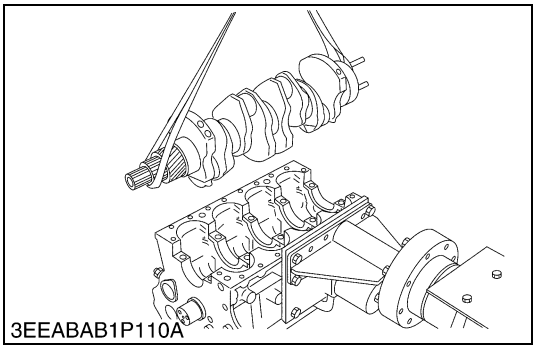
Tightening torque	Crankcase 2 mounting screw	49.0 to 55.9 N·m 5.0 to 5.7 kgf·m 36.2 to 41.2 ft-lbs
	Flywheel housing mounting screw	77.5 to 90.2 N·m 7.9 to 9.2 kgf·m 57.1 to 66.5 ft-lbs

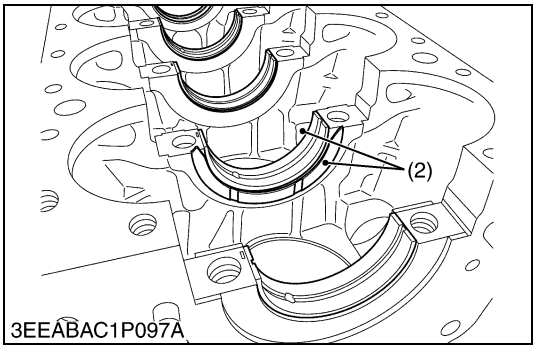
(1) Crankcase 1
(2) Gap to be smaller than 0.05 mm (0.0020 in.)
(3) Flywheel Housing
(4) Crankcase 2
(5) Jig

W1111351

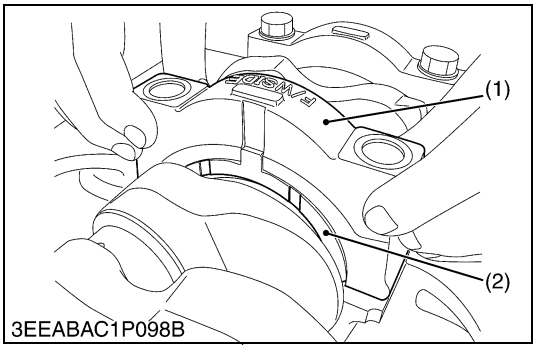


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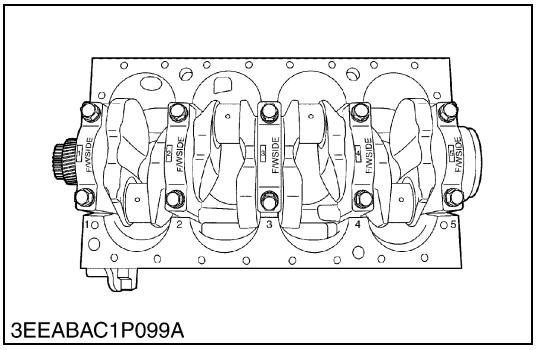

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3EEABAC1P097A



3EEABAC1P098B



3EEABAC1P099A

Crankshaft

1. Remove the main bearing case.
2. Remove the crankshaft.

(When reassembling)

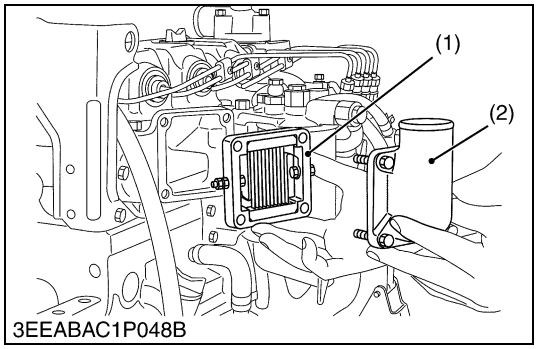
- Reassemble the main bearing case having the same number as the one engraved on the crankcase, and set the casting mark “F / W SIDE” on the main bearing case facing towards the flywheel side.
- Reassemble the thrust bearing (2), with the oil groove facing outside, into both side of the fourth main bearing case (1).
- Apply oil to the bearing case screws and tighten them to the specified torque.

Tightening torque	Main bearing case screw	137.3 to 147.1 N·m 14.0 to 15.0 kgf·m 101.3 to 108.5 ft-lbs

(1) 4th Main Bearing Case
(2) Thrust Bearing
(3) F / W SIDE Mark

W1061157

(10) Intake Air Heater



Intake Air Heater

1. Remove the inlet hose.
2. Disconnect the lead.
3. Remove the flange and the intake air heater.

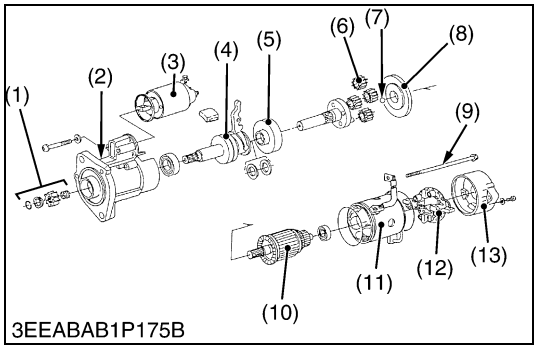
■ **NOTE**

- **When assembling the intake air heater at the side of intake manifold, assemble the intake air heater as the heater lines are vertical. Otherwise, it may be short-circuited.**

(1) Intake air heater (2) Flange

W1043265

(11) Starter



Disassembling Motor

1. Disconnect the solenoid switch (3).
2. Remove the 2 through screws (9) and the 2 brush holder lock screws. Take out the rear end frame (13) and the brush holder (12).
3. Disconnect the armature (10) and the yoke (11). Remove also the ball (7) from the tip of the armature.
4. Remove the set of packings (8), the 4 planetary gears and another packing.
5. Take out the shaft assembly. Take note of the position of the lever.

■ **IMPORTANT**

- **Before disconnecting the yoke, put tally marks on the yoke and the front bracket.**
- **Take note of the positions of the set of packings and the setup bolt.**
- **Apply grease to the gears, bearings, shaft's sliding part and ball.**

■ **NOTE**

- **Do not damage to the brush and commutator.**

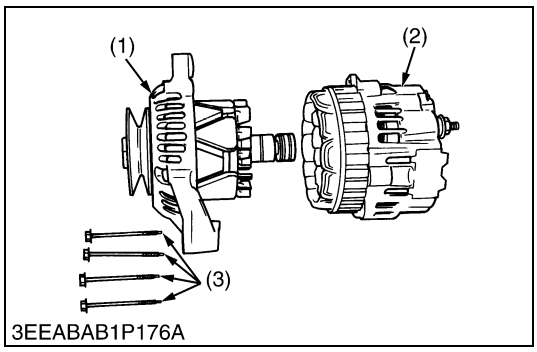
(When reassembling)

- Apply grease (DENSO CO. No.50 or equivalent) to the parts indicated in the figure.

(1) Gear
(2) Front Bracket
(3) Solenoid Switch
(4) Overrunning Clutch
(5) Internal Gear
(6) Planetary Gear
(7) Ball
(8) Set of Packings
(9) Through Bolt
(10) Armature
(11) Yoke
(12) Brush Holder
(13) Rear End Frame

W1074237

(12) Alternator



Front Bracket

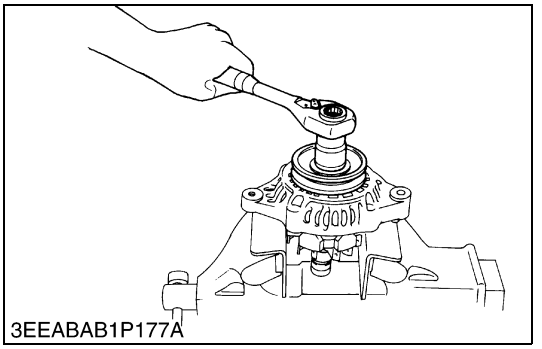
1. Remove the 4 screws (3).
2. Separate the front bracket (1) and the rear bracket (2) from each other.

■ **IMPORTANT**

- **Put a tally line on the front bracket and the rear bracket for reassembling them later.**

(1) Front Bracket
(2) Rear Bracket
(3) Screw

W1074745

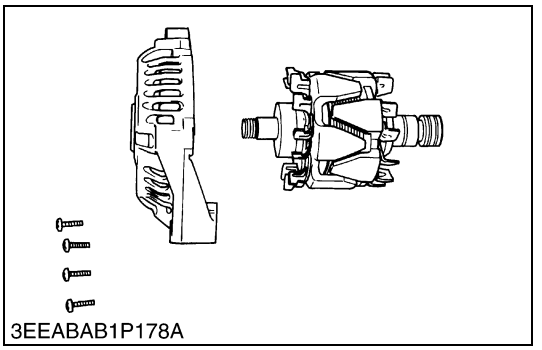

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Pulley

1. Hold the rotor (base of the claw) in a vise. Loosen the lock nut using a M24 box wrench.

Tightening torque	Pulley nut	58.3 to 78.9 N·m 5.95 to 8.05 kgf·m 43.0 to 58.2 ft-lbs

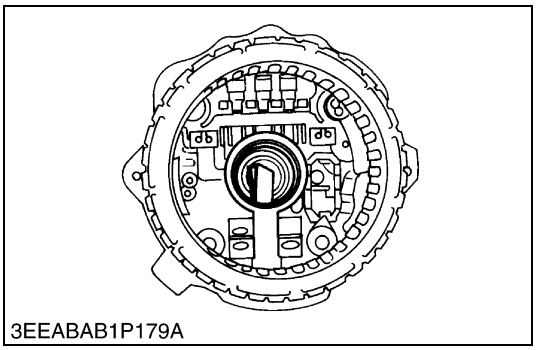
W1074849


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Rotor

1. Remove the 4 screws and detach the bearing retainer.
2. Temporarily install the nut on the pulley screw, and detach the rotor.

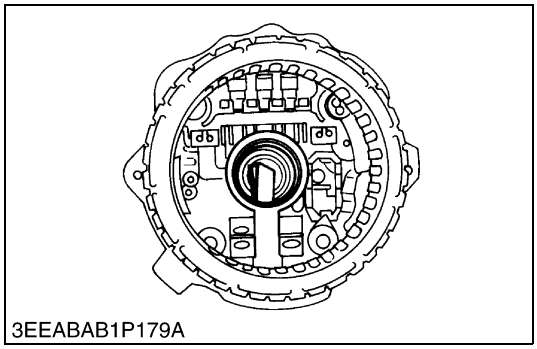
W1074920

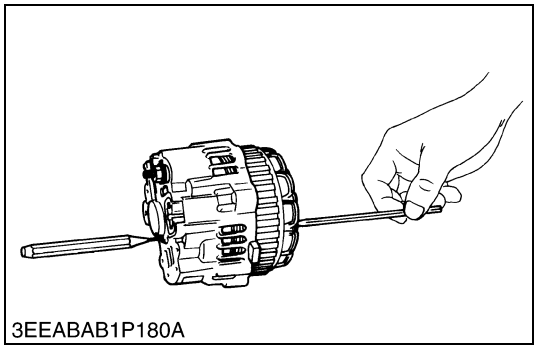

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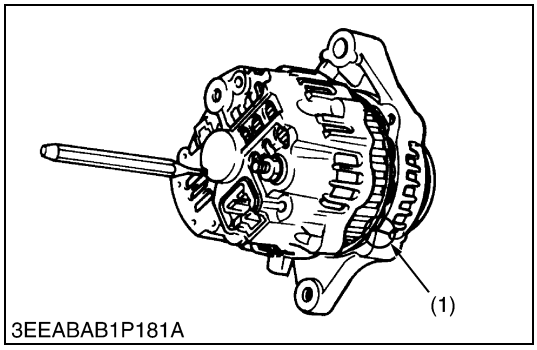
Brush

1. When the rotor is detached, the 2 brushes are found to stretch out of the shaft hole.

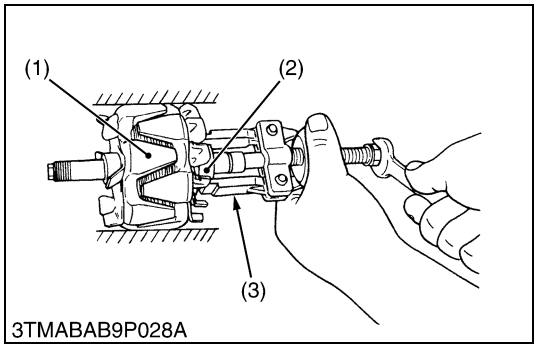
W1075045


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3EEABAB1P180A



3EEABAB1P181A



3TMABAB9P028A

Reassembling the Brush

1. Fit the brush with its sliding face in the clockwise direction when viewed from front.

■ **IMPORTANT**

- **Be sure to keep the 2 brushes deep in the brush holder. Otherwise the rotor and the rear section can not be fitted into the position.**
- **Use a 4 mm hex. wrench to push the brushes into place.**
- **Using a pin-pointed (2 mm) punch, keep the brushes from popping out.**

2. Match the tally line of the front section with that of the rear section.
3. Tighten the 4 screws, and draw out the pin-pointed punch out of the brush holder.

(1) Marking

W1075117

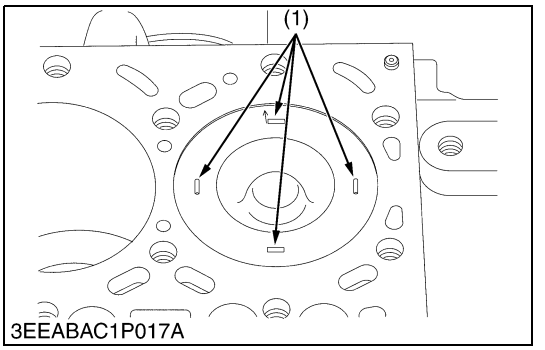
Bearing at Slip Ring Side

1. Lightly secure the rotor (1) with a vise to prevent damage, and remove the bearing (2) with a puller (3).

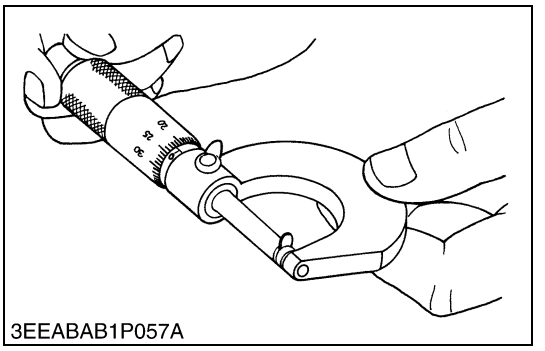
(1) Rotor
(2) Bearing
(3) Puller

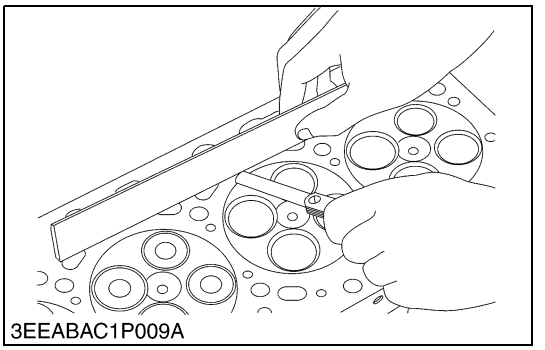
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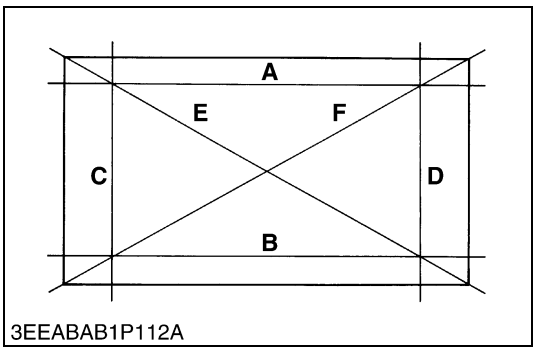
[3]SERVICING
(1) Cylinder Head



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3EEABAB1P057A


3EEABAC1P009A



3EEABAB1P112A

Top Clearance

1. Remove the cylinder head (remove the cylinder head gasket completely).
2. Bring the piston to its top dead center fasten 1.5 mm dia. 5 to 7 mm long fuse wires to 3 to 4 spots on the piston top with grease so as to avoid the intake and exhaust valves and the combustion chamber ports.
3. Bring the piston to its middle position, install the cylinder head, and tighten the cylinder head screws to specification. (Head gasket must be changed to new one).
4. Turn the crank shaft until the piston exceeds its top dead center.
5. Remove the cylinder head, and measure squeezed fuse wires for thickness.
6. If the measurement is not within the specified value, check the oil clearance of the crankpin journal and the piston pin.

Top clearance	Factory spec.	0.72 to 0.90 mm 0.0283 to 0.0354 in.

Tightening torque	Cylinder head mounting screw	98.1 to 107.9 N·m 10.0 to 11.0 kgf·m 72.3 to 79.6 ft-lbs

(1) Fuse

W1049122

Cylinder Head Surface Flatness

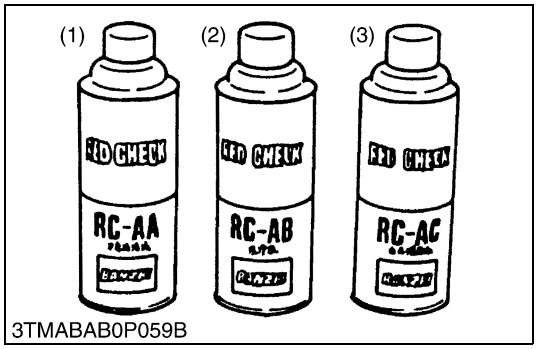
1. Clean the cylinder head surface.
2. Place a straightedge on the cylinder head's four sides (**A**), (**B**), (**C**) and (**D**) and two diagonal (**E**) and (**F**) as shown in the figure. Measure the clearance with a feeler gauge.
3. If the measurement exceeds the allowable limit, correct it with a surface grinder.

■ **IMPORTANT**

- **Be sure to check the valve recessing after correcting.**

Cylinder head surface flatness	Allowable limit	0.05 mm 0.0020 in.

W1061323



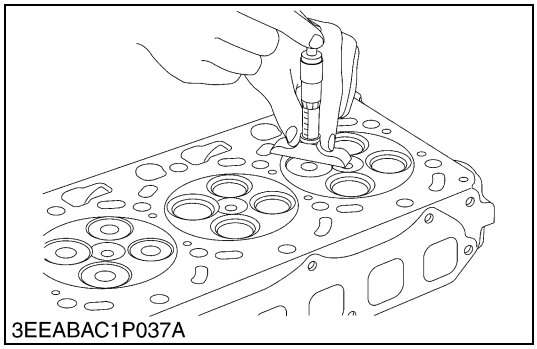
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Cylinder Head Flaw

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

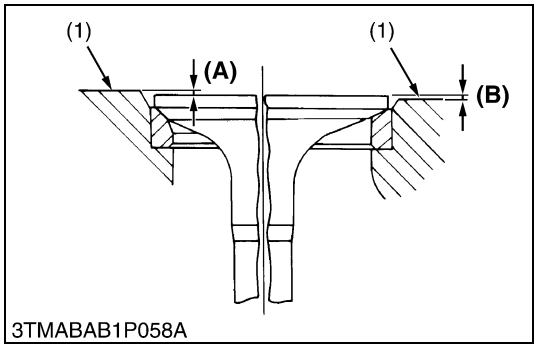
W1076542


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Valve Recessing

1. Clean the cylinder head, the valve face and 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.
   If it still exceeds the allowable limit after replacing the valve, replace the cylinder head.

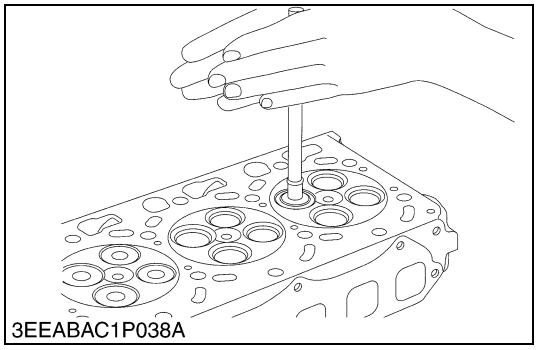
Valve recessing	Factory spec.	Intake valve	(recessing) 0.6 to 0.8 mm 0.0236 to 0.0315 in.
		Exhaust valve	(recessing) 0.85 to 1.05 mm 0.0335 to 0.0413 in.
	Allowable limit	(recessing) 1.2 mm 0.0472 in.	



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(1) Cylinder Head Surface
(A) Recessing
(B) Protrusion

W1061543

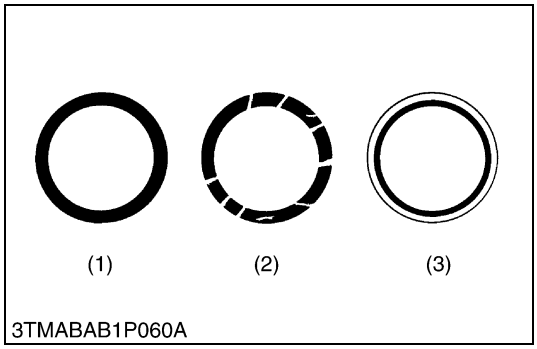

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Valve Lapping

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**

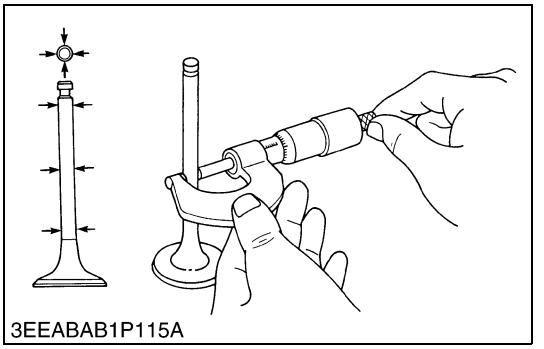
- **When valve lapping is performed, be sure to check the valve recessing and adjust the valve clearance after assembling the valve.**

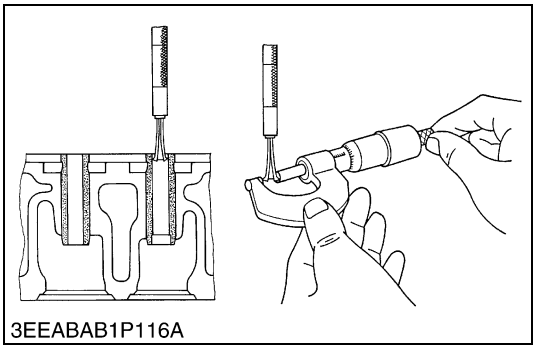


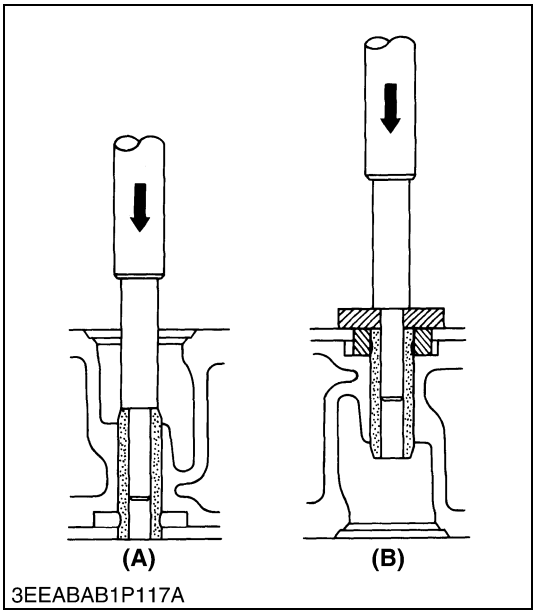
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(1) Correct
(2) Incorrect
(3) Incorrect

W1061709


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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. of the cylinder head at the most wear part as shown in the figure below 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 guide	Factory spec.	Intake valve	0.055 to 0.085 mm 0.0022 to 0.0033 in.
		Exhaust valve	0.055 to 0.085 mm 0.0022 to 0.0033 in.
	Allowable limit		0.1 mm 0.0039 in.

Valve stem O.D.	Factory spec.	Intake valve	6.960 to 6.975 mm 0.2740 to 0.2746 in.
		Exhaust valve	6.960 to 6.975 mm 0.2740 to 0.2746 in.

Valve guide I.D.	Factory spec.	Intake valve	7.030 to 7.045 mm 0.2768 to 0.2774 in.
		Exhaust valve	7.030 to 7.045 mm 0.2768 to 0.2774 in.

W1061883

Replacing Valve Guide

(When removing)

1. Using a valve guide replacing tool, press out the used valve guide.

(When installing)

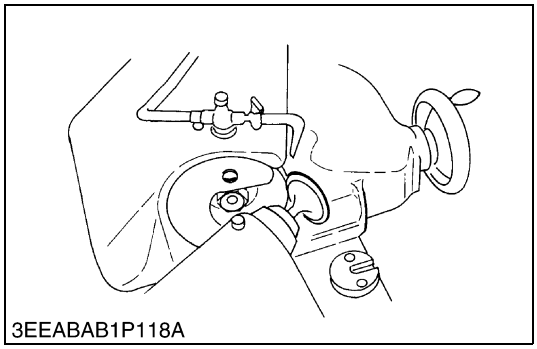
1. Clean a new valve guide, and apply engine oil to it.
2. Using a valve guide replacing tool, press in a new valve guide until it is flush with the cylinder head as shown in the figure.
3. Ream precisely the I.D. of the valve guide to the specified dimension.

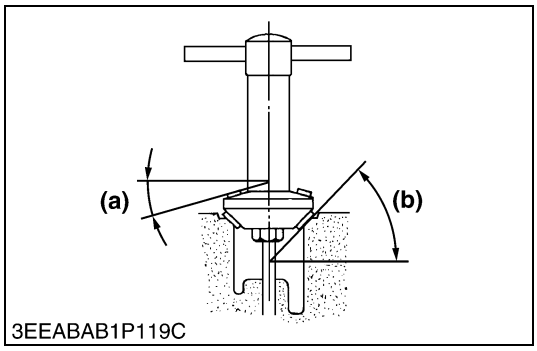
■ **IMPORTANT**

- **Do not hit the valve guide with a hammer, etc. during replacement.**

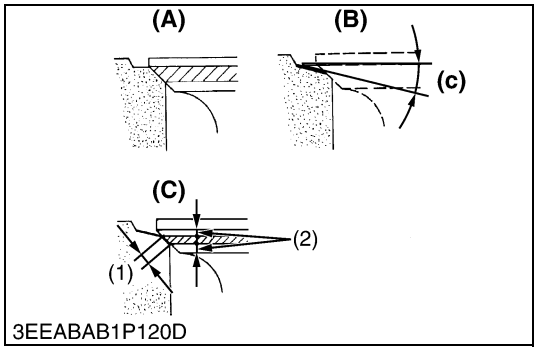
(A) When Removing **(B) When Installing**

W1062212


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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.

Valve face angle	Factory spec.	IN.	1.047 rad 60 °
		EX.	0.785 rad 45 °

2) Correcting Valve Seat

1. Slightly correct the seat surface with a 1.047 rad (60 °) (intake valve) or 0.785 rad (45 °) (exhaust valve) valve seat cutter.
2. Resurface the seat surface with a 0.523 rad (30 °) valve seat cutter to intake valve seat and with a 0.262 rad (15 °) valve seat cutter to exhaust valve seat so that the width is close to specified valve seat width.

Valve seat width	Factory spec.	IN.	1.6 to 2.0 mm 0.0630 to 0.0790 in.
		EX.	2.3 to 2.6 mm 0.0906 to 0.1024 in.

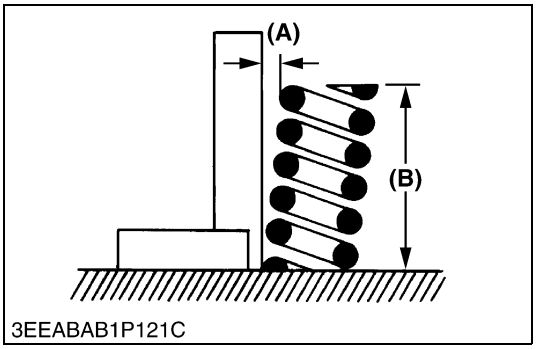
3. After resurfacing the seat, inspect for even valve seating, apply a thin film of compound between the valve face and valve seat, and fit them with valve lapping tool.
4. Check the valve seating with prussian blue. The valve seating surface should show good contact all the way around.

Valve seat angle	Factory spec.	IN.	1.047 rad 60 °
		EX.	0.785 rad 45 °

(1) Valve Seat Width
(2) Identical Dimensions

(A) Check Contact
(B) Correct Seat Width
(C) Check Contact
(a) 0.262 rad (15 °) or 0.523 rad (30 °)
(b) 0.785 rad (45 °) or 1.047 rad (60 °)
(c) 0.523 rad (30 °) or 0.262 rad (15 °)

W10283500



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Free Length and Tilt of Valve Spring

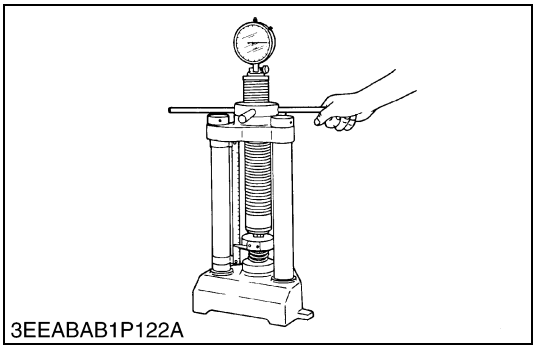
1. Measure the free length (**B**) with vernier calipers. If the measurement is less than the allowable limit, replace it.
2. Put the spring on a surface plate, place a square on the side of the spring, and check to see if the entire side is contact with the square. Rotate the spring and measure the maximum (**A**). If the measurement exceeds the allowable limit, replace.
3. Check the entire surface of the spring for scratches. Replace it, if any.

Tilt (**A**)	Allowable limit	1.0 mm 0.039 in.

Free length (**B**)	Factory spec.	Intake valve	35.1 to 35.6 mm 1.3819 to 1.4016 in.
		Exhaust valve	35.1 to 35.6 mm 1.3819 to 1.4016 in.
	Allowable limit	Intake valve	34.6 mm 1.3622 in.
		Exhaust valve	34.6 mm 1.3622 in.

(A) Tilt **(B) Free length**

W1063303

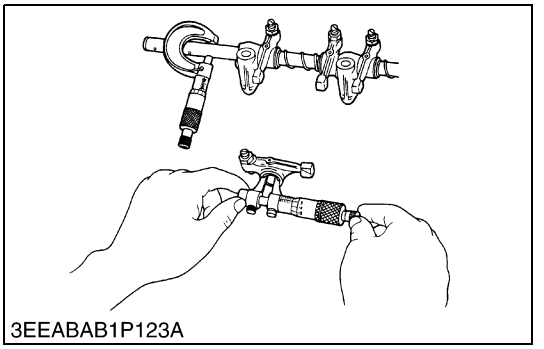

3EEABAB1P122A

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.	Intake valve	63.547 N / 31.5 mm 6.48 kgf / 31.5 mm 14.256 lbs / 1.2401 in.
		Exhaust valve	63.547 N / 31.5 mm 6.48 kgf / 31.5 mm 14.256 lbs / 1.2401 in.
	Allowable limit	Intake valve	45.864 N / 31.5 mm 4.68 kgf / 31.5 mm 10.296 lbs / 1.2401 in.
		Exhaust valve	45.864 N / 31.5 mm 4.68 kgf / 31.5 mm 10.296 lbs / 1.2401 in.

W1063470


3EEABAB1P123A

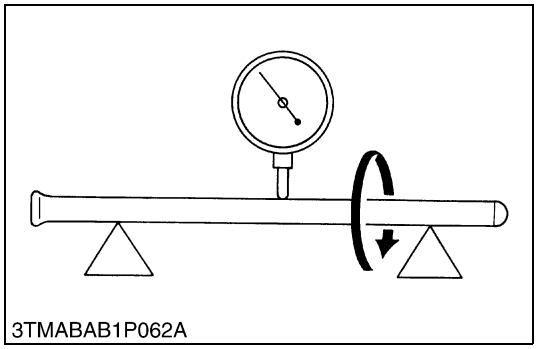
Oil Clearance between Rocker Arm Shaft and Bearing

1. Measure the rocker arm bearing I.D. with an inside micrometer.
2. Measure the rocker arm shaft O.D. with an outside micrometer, and then calculate the oil clearance.
3. If the 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 of rocker arm shaft and bearing	Factory spec.	0.016 to 0.045 mm 0.0006 to 0.0018 in.
	Allowable limit	0.15 mm 0.0059 in.

Rocker arm shaft O.D.	Factory spec.	15.973 to 15.984 mm 0.6289 to 0.6293 in.
Rocker arm I.D. for shaft	Factory spec.	16.000 to 16.018 mm 0.6299 to 0.6306 in.

W1063697

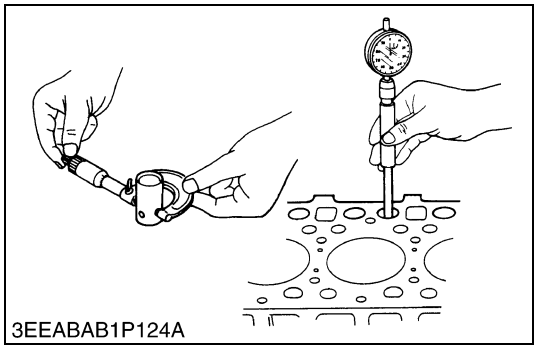

3TMABAB1P062A

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

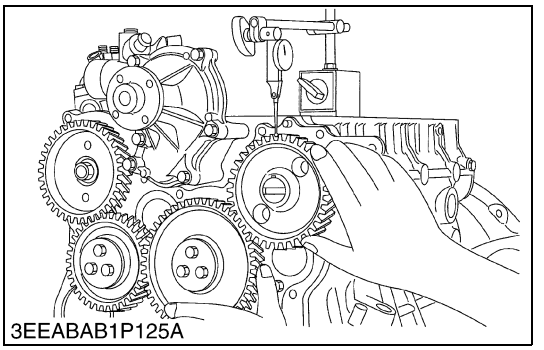
1. Measure the tappet O.D. with an outside micrometer.
2. Measure the I.D. of the tappet guide bore with a cylinder gauge, and calculate the oil clearance.
3. If the oil clearance exceeds the allowable limit or the tappet is damaged, replace the tappet.

Oil clearance between tappet and guide bore	Factory spec.	0.020 to 0.062 mm 0.0008 to 0.0024 in.
	Allowable limit	0.07 mm 0.0028 in.

Tappet O.D.	Factory spec.	23.959 to 23.980 mm 0.9433 to 0.9441 in.
Tappet guide bore I.D.	Factory spec.	24.000 to 24.021 mm 0.9449 to 0.9457 in.

W1063847

(2) Timing Gears

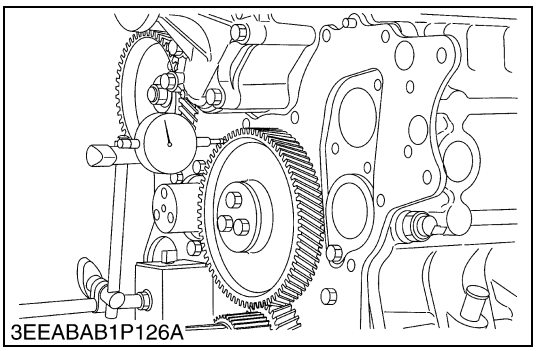

3EEABAB1P125A

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 crank gear and idle gear 1	Factory spec.	0.049 to 0.193 mm 0.0019 to 0.0076 in.
	Allowable limit	0.22 mm 0.0087 in.
Backlash between idle gear 1 and cam gear	Factory spec.	0.049 to 0.189 mm 0.0019 to 0.0074 in.
	Allowable limit	0.22 mm 0.0087 in.
Backlash between idle gear 1 and idle gear 2	Factory spec.	0.044 to 0.185 mm 0.0017 to 0.0073 in.
	Allowable limit	0.22 mm 0.0087 in.
Backlash between idle gear 2 and injection pump gear	Factory spec.	0.044 to 0.177 mm 0.0017 to 0.0070 in.
	Allowable limit	0.22 mm 0.0087 in.
Backlash between cam gear and balancer gear 1	Factory spec.	0.047 to 0.182 mm 0.0018 to 0.0072 in.
	Allowable limit	0.22 mm 0.0087 in.
Backlash between idle gear 1 and balancer gear 2	Factory spec.	0.044 to 0.183 mm 0.0017 to 0.0072 in.
	Allowable limit	0.22 mm 0.0087 in.

W1064048

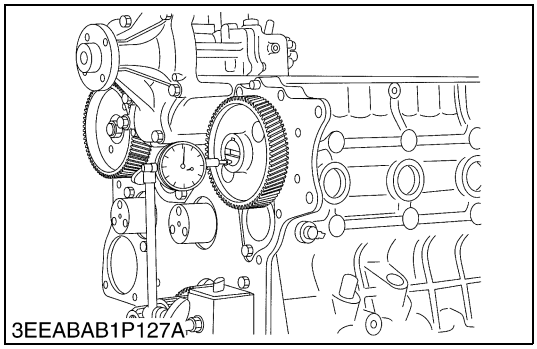

3EEABAB1P126A

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.	0.15 to 0.30 mm 0.0059 to 0.0118 in.
	Allowable limit	0.9 mm 0.0354 in.

W1064208

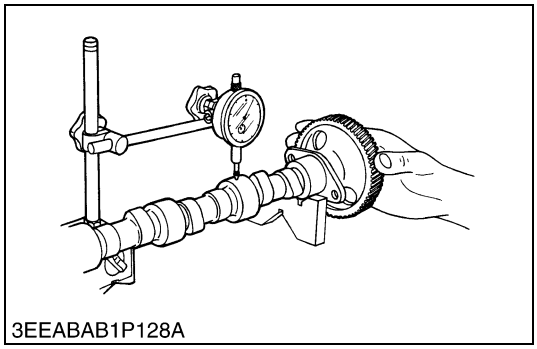

3EEABAB1P127A

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 and rear.
3. If the measurement exceeds the allowable limit, replace the camshaft stopper.

Side clearance	Factory spec.	0.07 to 0.22 mm 0.0028 to 0.0087 in.
	Allowable limit	0.30 mm 0.0118 in.

W1064307

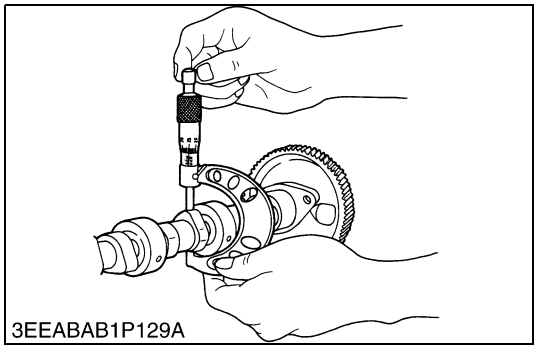

3EEABAB1P128A

Camshaft Alignment

1. Support the camshaft with V block on the surface plate and set a dial indicator with its tip on the intermediate journal at right angle.
2. Rotate the camshaft on the V blocks and get the misalignment (half of the measurement).
3. If the misalignment exceeds the allowable limit, replace the camshaft.

Camshaft alignment	Allowable limit	0.01 mm 0.00039 in.

W1064422

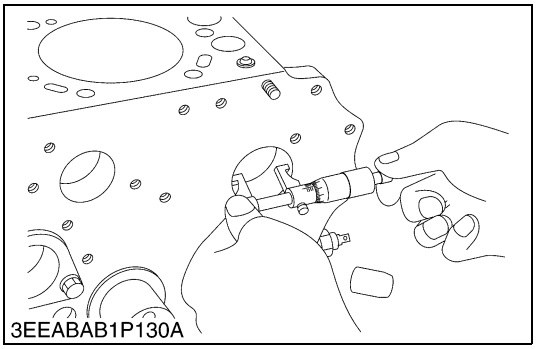

3EEABAB1P129A

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.

Intake and exhaust cam height	Factory spec.	Intake valve	37.63 mm 1.4815 in.
		Exhaust valve	38.96 mm 1.5338 in.
	Allowable limit	Intake valve	37.13 mm 1.4618 in.
		Exhaust valve	38.46 mm 1.5141 in.

W1064551


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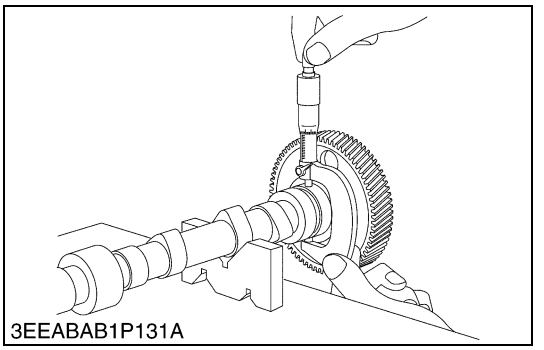
Oil Clearance of Camshaft Journal

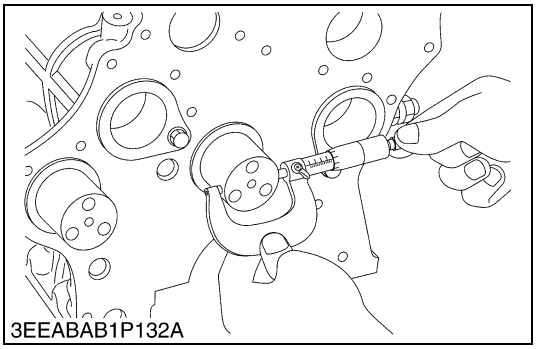
1. Measure the camshaft journal O.D. with an outside micrometer.
2. Measure the cylinder block bore I.D. for camshaft with an inside micrometer.
3. If the clearance exceeds the allowable limit, replace the camshaft.

Oil clearance of camshaft journal	Factory spec.	0.050 to 0.091 mm 0.0020 to 0.0036 in.
	Allowable limit	0.15 mm 0.0059 in.

Camshaft journal O.D.	Factory spec.	45.934 to 45.950 mm 1.8084 to 1.8091 in.
Camshaft bearing I.D.	Factory spec.	46.000 to 46.025 mm 1.8110 to 1.8120 in.

W1064798


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3EEABAB1P132A

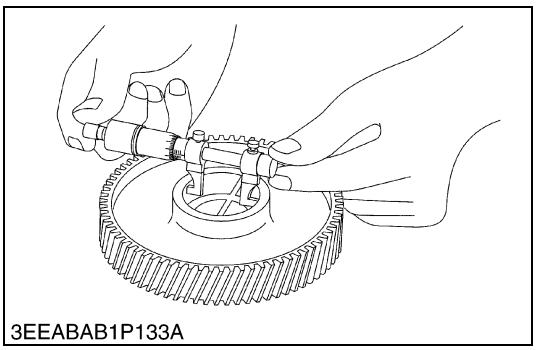
Oil Clearance between Idle Gear Shaft 1, 2 and Idle Gear 1, 2 Bushing

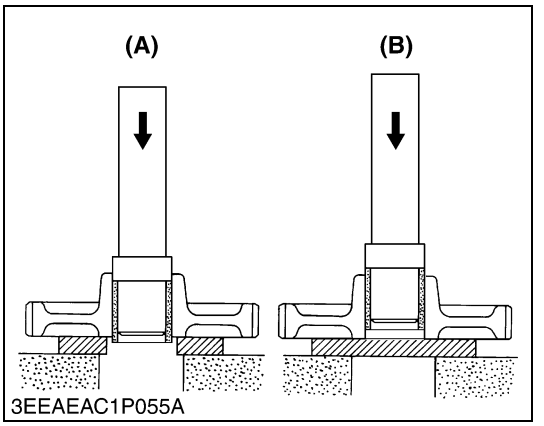
1. Measure the idle gear shaft O.D. with an outside micrometer.
2. Measure the idle gear bushings I.D. with an inside micrometer, and calculate the oil clearance.
3. If the oil clearance exceeds the allowable limit, replace the bushing.

Oil clearance between idle gear 1, 2 shaft and idle gear 1, 2 bushing	Factory spec.	0.050 to 0.091 mm 0.0020 to 0.0036 in.
	Allowable limit	0.10 mm 0.0039 in.

Idle gear 1, 2 bushing I.D.	Factory spec.	45.025 to 45.050 mm 1.7726 to 1.7736 in.
Idle gear 1, 2 shaft O.D.	Factory spec.	44.959 to 44.975 mm 1.7700 to 1.7707 in.

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Replacing Idle Gear Bushing

(When removing)

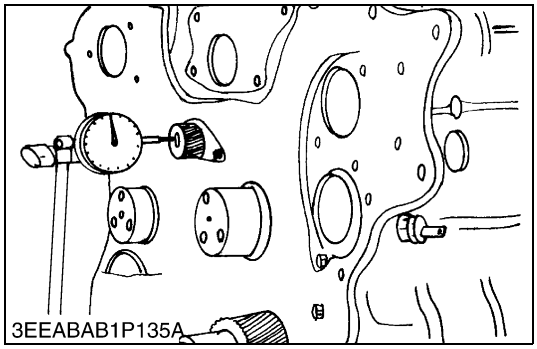
1. Using an idle gear bushing replacing tool, press out the used bushing.

(When installing)

1. Clean a new idle gear bushing and idle gear bore, and apply engine oil to them.
2. Using an idle gear bushing replacing tool, press in a new bushing (service parts) to the specified dimension. (See figure.)

(A) When Removing **(B) When Installing**

W10302410

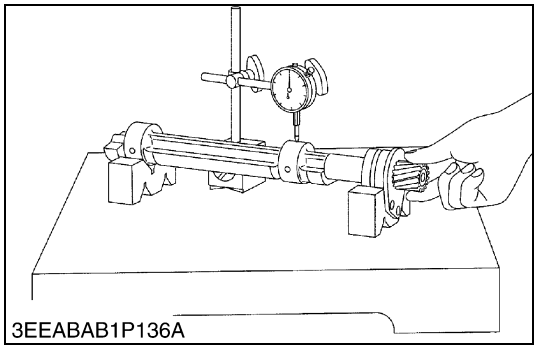

3EEABAB1P135A

Balancer Shaft Side Clearance

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.

Side clearance	Factory spec.	0.070 to 0.22 mm 0.0028 to 0.0087 in.
	Allowable limit	0.3 mm 0.0118 in.

W1065273

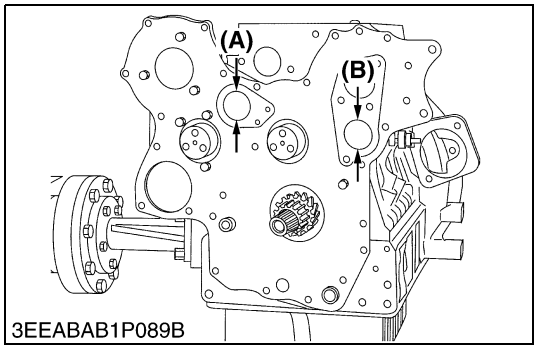

3EEABAB1P136A

Balance Shaft Alignment

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.

W1065448



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Oil Clearance of Balancer Shaft Journal

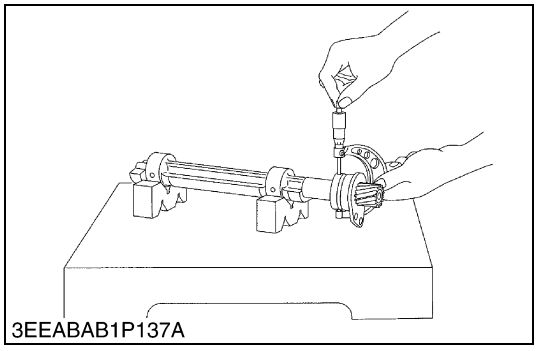
1. Measure the balancer shaft journal O.D. with an outside micrometer.
2. Measure the cylinder block bore I.D. **(A)**, **(B)** for balancer shaft with an inside micrometer.
3. If the clearance exceeds the allowable limit, replace the balancer shaft.

Oil clearance of balancer-shaft journal	Factory spec.	0.070 to 0.159 mm 0.0028 to 0.0063 in.
	Allowable limit	0.2 mm 0.0079 in.

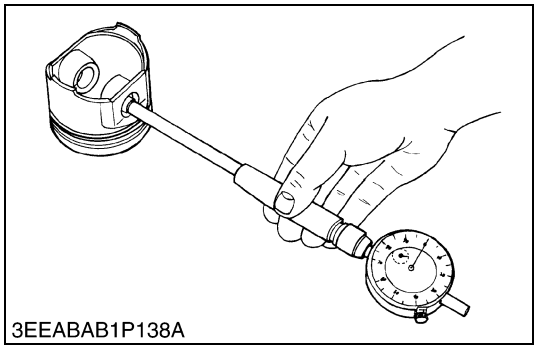
Balancer-shaft journal O.D.	Factory spec.	50.92 to 50.94 mm 2.0047 to 2.0055 in.
Balancer-shaft bearing I.D. **(A), (B)**	Factory spec.	51.01 to 51.08 mm 2.0083 to 2.0110 in.

(A) Balancer-shaft Bearing I.D. **(B) Balancer-shaft Bearing I.D.**

W1065581


3EEABAB1P137A

(3) Piston and Connecting Rod

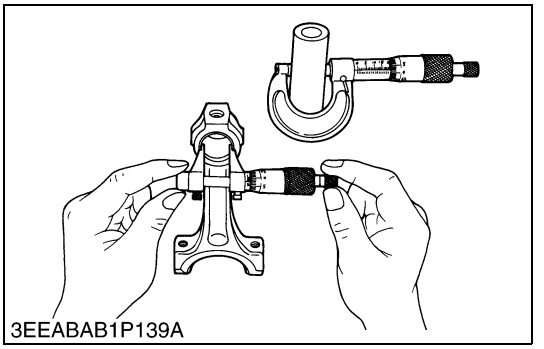

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Piston Pin Bore I.D.

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.	30.000 to 30.013 mm 1.1811 to 1.1816 in.
	Allowable limit	30.05 mm 1.1831 in.

W1065759


3EEABAB1P139A

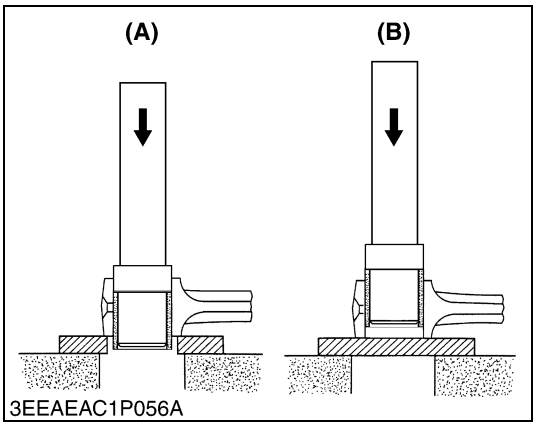
Oil Clearance between Piston Pin and Small End Bushing

1. Measure the O.D. of the piston pin where it contacts the bushing with an outside micrometer.
2. Measure the I.D. of the piston pin bushing at the connecting rod small end with a cylinder gauge.
   Calculate the oil clearance.
3. If the 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.	0.020 to 0.040 mm 0.0008 to 0.0016 in.
	Allowable limit	0.15 mm 0.0059 in.

Piston pin O.D.	Factory spec.	30.006 to 30.011 mm 1.1813 to 1.1815 in.
Small end bushing I.D.	Factory spec.	30.031 to 30.046 mm 1.1823 to 1.1829 in.

W1065897



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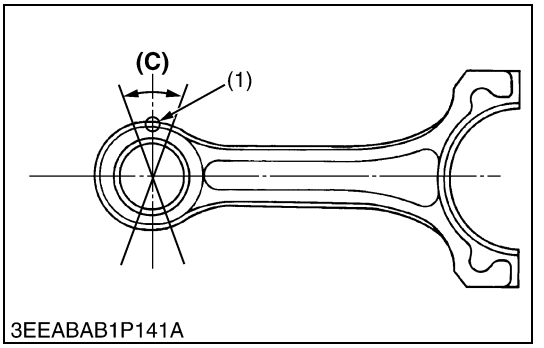
Replacing Small End Bushing

(When removing)

1. Press out the used bushing using a small end bushing replacing tool.

(When installing)

1. Clean a new small end bushing and bore, and apply engine oil to them.
2. Insert a new bushing onto the tool and press-fit it with a press so that the seam (1) of bushing position as shown in the figure, until is flash with the connecting rod.

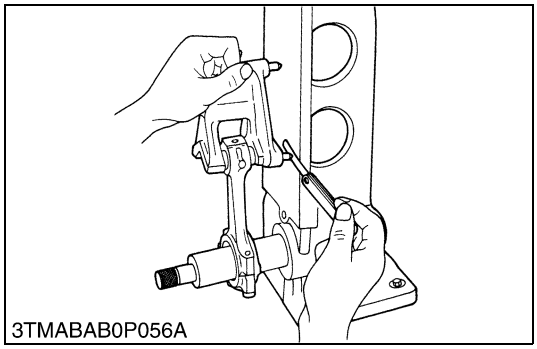


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(1) Seam

(A) When Removing
(B) When Installing
(C) 0.26 rad (15 °)

W1066057


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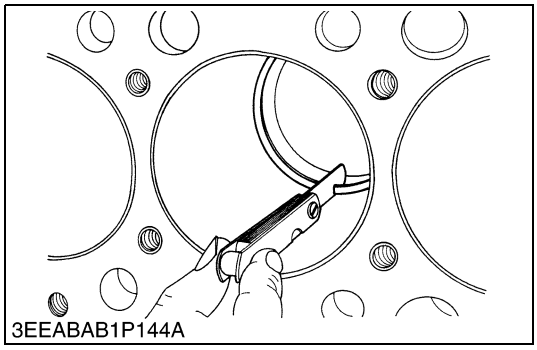
Connecting Rod Alignment

- **NOTE**
- **Since the I.D. of the connecting rod small end bushing is the basis of this check, check the bushing for wear beforehand.**

1. Remove the piston pin from the piston.
2. Install the piston pin in the connecting rod.
3. Install the connecting rod on the connecting rod alignment tool.
4. Put a gauge over the piston pin, and move it against the face plate.
5. If the gauge does not fit squarely against the face plate, measure the space between the pin of the gauge and the face plate.
6. If the measurement exceeds the allowable limit, replace the connecting rod.

Connecting rod alignment	Allowable limit	0.05 mm 0.0020 in.

W1066581


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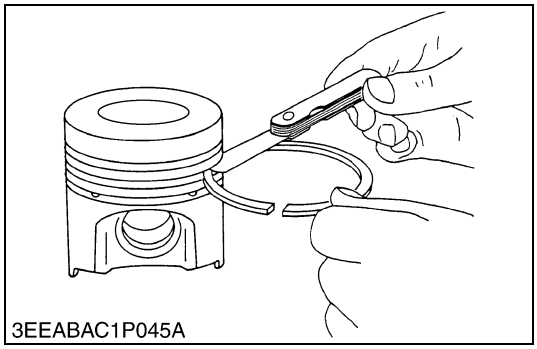
Piston Ring Gap

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 piston ring.

Top ring and second ring	Factory spec.	0.30 to 0.45 mm 0.0118 to 0.0177 in.
	Allowable limit	1.25 mm 0.0492 in.

Oil ring	Factory spec.	0.25 to 0.45 mm 0.0098 to 0.0177 in.
	Allowable limit	1.25 mm 0.0492 in.

W1066430


3EEABAC1P045A

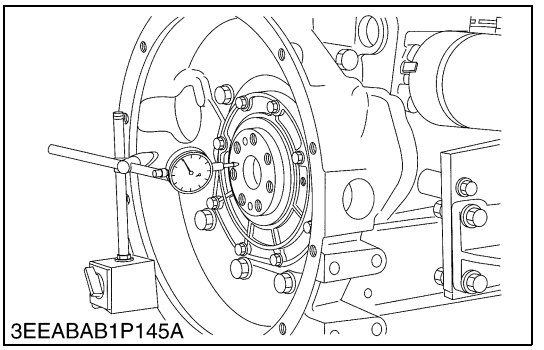
Clearance between Piston Ring and Groove

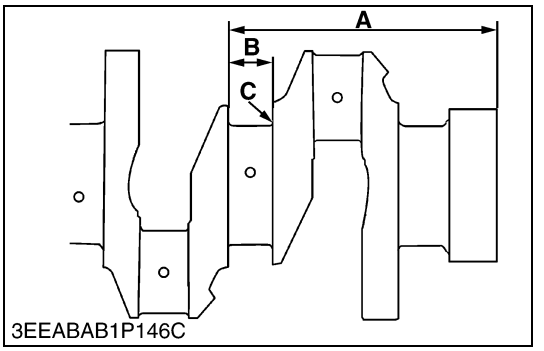
1. Remove carbon from the ring grooves.
2. Measure the clearance between the ring and the groove with a feeler gauge or depth gauge.
3. If the clearance exceeds allowable limit, check the new ring since compression leak and oil shortage result.
4. If clearance still exceeds the allowable limit after replacing the ring, replace the piston.

Factory spec.	Top ring	0.05 to 0.09 mm 0.0020 to 0.0035 in.
	Second ring	0.093 to 0.120 mm 0.0037 to 0.0047 in.
	Oil ring	0.020 to 0.060 mm 0.0008 to 0.0023 in.
Allowable limit	Top ring	0.15 mm 0.0059 in.
	Second ring	0.20 mm 0.0079 in.
	Oil ring	0.15 mm 0.0059 in.

W1066183

(4) Crankshaft


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3EEABAB1P146C

Crankshaft Side Clearance

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.

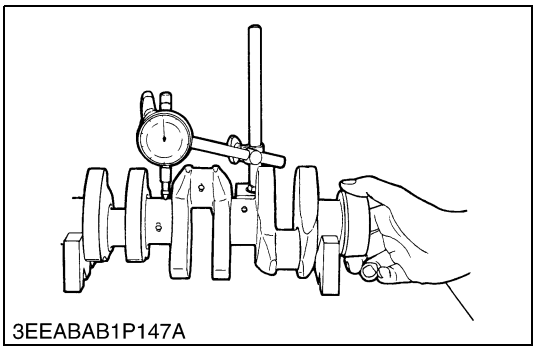
Crankshaft side clearance	Factory spec.	0.15 to 0.31 mm 0.0059 to 0.0122 in.
	Allowable limit	0.50 mm 0.0197 in.

(Reference)

- Oversize dimensions of crankshaft journal.

Oversize	0.2 mm 0.008 in.	0.4 mm 0.016 in.
Dimension **A**	169.1 to 169.15 mm 6.6575 to 6.6594 in.	169.2 to 169.25 mm 6.6614 to 6.6634 in.
Dimension **B**	29.20 to 29.25 mm 1.1496 to 1.1515 in.	29.40 to 29.45 mm 1.1574 to 1.1594 in.
Dimension **C**	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius
The crankshaft journal must be fine-finished to higher than ∇∇∇∇. (0.8S)		

W1066738

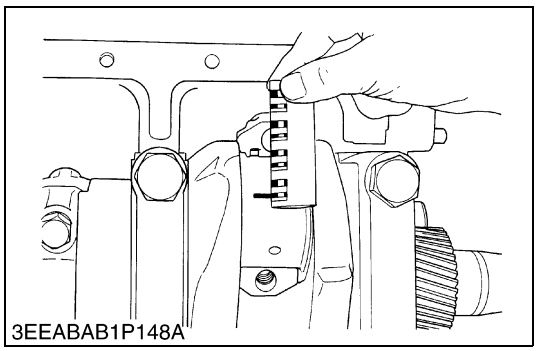

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Crankshaft Alignment

1. Support the crankshaft with V block on the surface plate and set a dial indicator with its tip on the intermediate journal at right angle.
2. Rotate the crankshaft on the V block and get the misalignment (half of the measurement).
3. If the misalignment exceeds the allowable limit, replace the crankshaft.

Crankshaft alignment	Allowable limit	0.02 mm 0.00079 in.

W1067285


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Oil Clearance between Crankpin and Crankpin Bearing

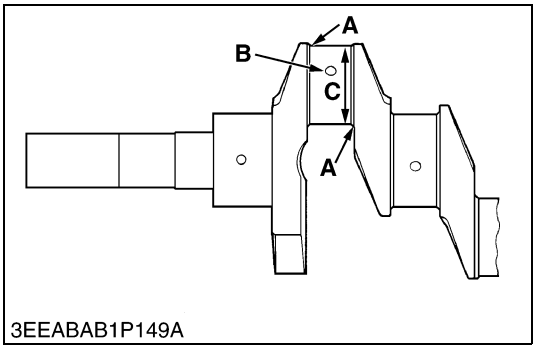
1. Clean the crankpin and crankpin bearing.
2. Put a strip of plastigage on the center of the crankpin.
3. Install the connecting rod cap and tighten the connecting rod screws to the specified torque, and remove the cap again.
4. Measure the amount of the flattening with the scale, and get the oil clearance.
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.**

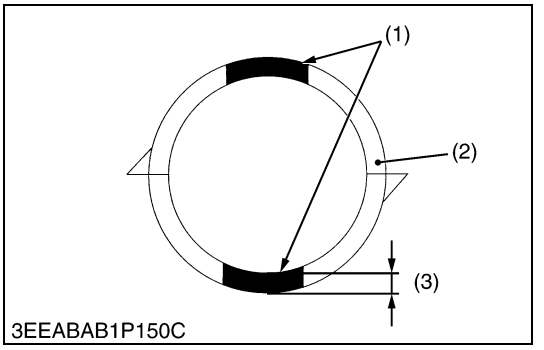
Crankpin O.D.	Factory spec.	52.977 to 52.990 mm 2.0857 to 2.0862 in.

Oil clearance between crankpin and crankpin bearing	Factory spec.	0.018 to 0.051 mm 0.0007 to 0.0020 in.
	Allowable limit	0.20 mm 0.0079 in.

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3EEABAB1P150C

Oil Clearance between Crankpin and Crankpin Bearing (Continued)

■ **IMPORTANT**

- **STD size crankpin bearing.**
  To replace it with a specific STD service part, make sure the crankpin bearing has the same ID color as the connecting rod.

ID Color	Connecting rod	Crankpin bearing		
	Large-end in. dia.	Class	Part code	Center wall thick
Blue	56.01 to 56.02 mm 2.2051 to 2.2055 in.	L	1C020-22311	1.496 to 1.501 mm 0.0589 to 0.0591 in.
Without color	56.00 to 56.01 mm 2.2047 to 2.2051 in.	S	1C020-22331	1.491 to 1.496 mm 0.0587 to 0.0589 in.

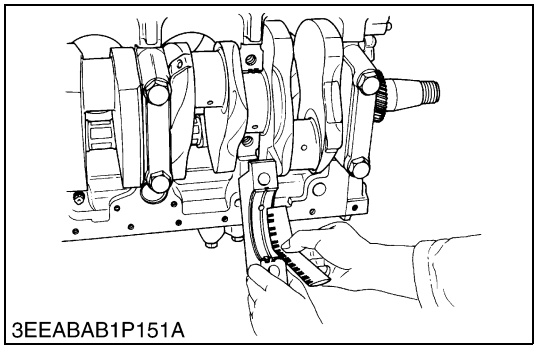
(Reference)

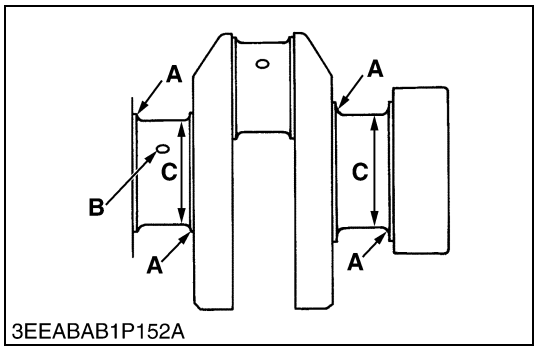
- Undersize dimensions of crankpin

Undersize	0.2 mm 0.008 in.	0.4 mm 0.016 in.
Dimension **A**	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius
*Dimension **B**	1.0 to 1.5 mm relief 0.0394 to 0.0591 in. relief	1.0 to 1.5 mm relief 0.0394 to 0.0591 in. relief
Dimension **C**	52.777 to 52.790 mm dia. 2.0778 to 2.0783 in. dia.	52.577 to 52.590 mm dia. 2.0700 to 2.0705 in. dia.
(0.8S) The crankpin must be fine-finished to higher than ∇∇∇∇. *Holes to be de-burred and edges rounded with 1.0 to 1.5 mm (0.0394 to 0.0591 in.) relief.		

(1) ID Color
(2) Crankpin Bearing
(3) Center Wall Thick

W1067741


3EEABAB1P151A



3EEABAB1P152A

Oil Clearance between Crankshaft Journal and Crankshaft Bearing

1. Clean the crankshaft journal and crankshaft bearing.
2. Put a strip of press gauge on the center of the journal.
- **IMPORTANT**
- **Never insert the press gauge into the oil hole of the journal.**
3. Install the main bearing case and tighten the screws to the specified torque, and remove the cases again.
4. Measure the amount of the flattening with the scale and get the oil clearance.
5. If the clearance exceeds the allowable limit, replace the crankshaft bearing.

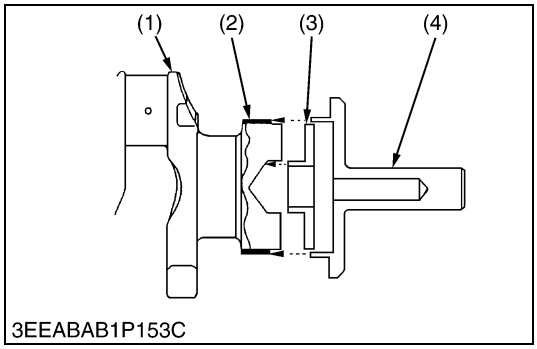
Crankshaft journal O.D.	Factory spec.	74.977 to 74.990 mm 2.9518 to 2.9524 in.

Oil clearance between crankshaft journal and crankshaft bearing	Factory spec.	0.018 to 0.062 mm 0.0007 to 0.0024 in.
	Allowable limit	0.20 mm 0.0079 in.

(Reference)
- Undersize dimensions of crankshaft journal.

Undersize	0.2 mm 0.008 in.	0.4 mm 0.016 in.
Dimension **A**	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius
*Dimension **B**	1.0 to 1.5 mm relief 0.0394 to 0.0591 in. relief	1.0 to 1.5 mm relief 0.0394 to 0.0591 in. relief
Dimension **C**	74.777 to 74.790 mm dia. 2.9440 to 2.9445 in. dia.	74.577 to 74.590 mm dia. 2.9361 to 2.9366 in. dia.
(0.8S) 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 (0.0394 to 0.0591 in.) relief.		

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3EEABAB1P153C

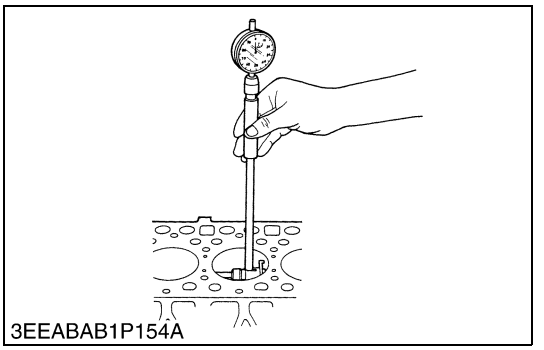
Replacing Crankshaft Sleeve

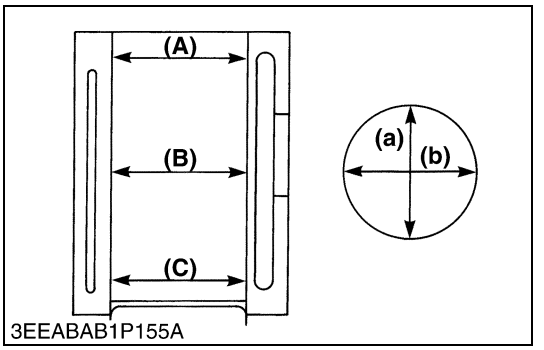
1. Remove the used crankshaft sleeve (2).
2. Set the sleeve guide (3) to the crankshaft (1).
3. Heat a new sleeve to a temperature between 150 to 200 <Symbol>×C (302 to 392 <Symbol>×F), and fix the sleeve to the crankshaft as shown in figure.
4. Press fit the sleeve using the auxiliary socket for pushing (4).
- **NOTE**
- **Mount the sleeve with its largely chamfered surface facing outward.**

(1) Crankshaft
(2) Crankshaft Sleeve
(3) Sleeve Guide
(4) Auxiliary Socket for Pushing

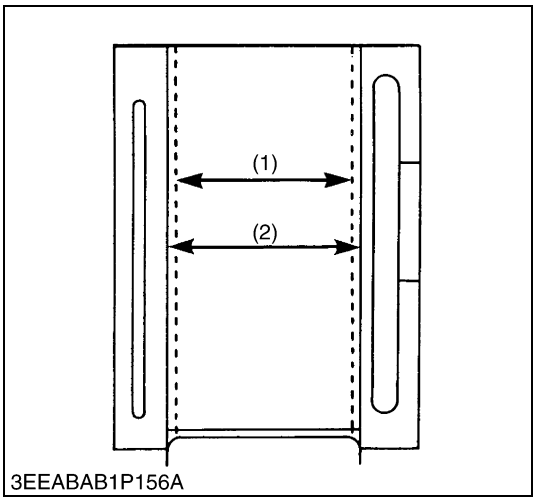
W1069911

(5) Cylinder


3EEABAB1P154A



3EEABAB1P155A



3EEABAB1P156A

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 Bore I.D.	Factory spec.	100.00 to 100.022 mm 3.9370 to 3.9379 in.
	Allowable limit	100.15 mm 3.9429 in.

(A) Top
(B) Middle
(C) Bottom (Skirt)
(a) Right-angled to piston pin
(b) Piston pin direction

W1070089

Correcting Cylinder (Oversize)

1. When the cylinder is worn beyond the allowable limit, bore and hone it to the specified dimension.

Cylinder I.D. (2)	Factory spec.	100.500 to 100.522 mm 3.9567 to 3.9576 in.
Maximum wear	Allowable limit	100.65 mm 3.9626 in.
Finishing	Hone to 1.2 to 3.0 μm Rz (0.000087 to 0.00012 in. Rz) ∇∇∇.	

2. Replace the piston and piston rings with oversize 0.5 mm (0.0197 in.) ones.

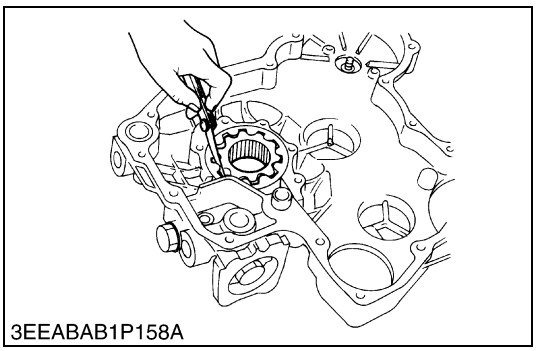
■ **NOTE**

- **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) Oversize Cylinder I.D.

W10344480

(6) Oil Pump

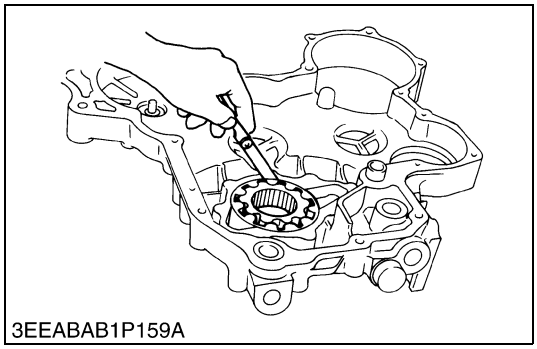

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Rotor Lobe Clearance

1. Measure the clearance between lobes of the inner rotor and the outer rotor with a feeler gauge.
2. If the clearance exceeds the allowable limit, replace the oil pump rotor assembly.

Clearance between inner rotor and outer rotor	Factory spec.	0.04 to 0.16 mm 0.0016 to 0.0063 in.
	Allowable limit	0.3 mm 0.0118 in.

W1071254

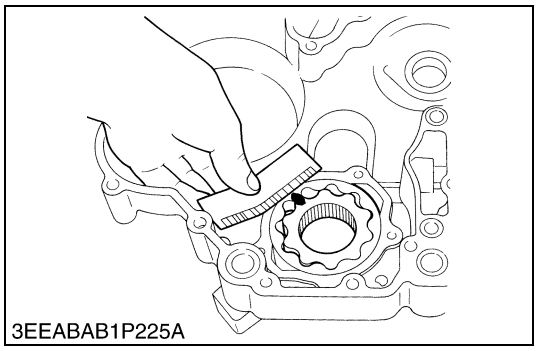

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Clearance between Outer Rotor and Pump Body

1. Measure the clearance between the outer rotor and the pump body with a feeler gauge.
2. If the clearance exceeds the allowable limit, replace the oil pump rotor assembly.

Clearance between outer rotor and pump body	Factory spec.	0.100 to 0.184 mm 0.0039 to 0.0072 in.
	Allowable limit	0.3 mm 0.0118 in.

W1071334


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Clearance between Rotor and Cover

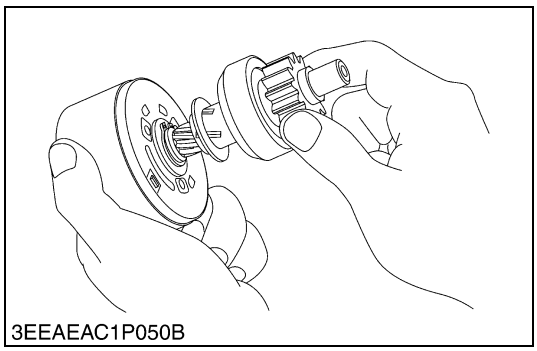
1. Put a strip of plastigage onto the rotor face with grease.
2. Install the cover and tighten the screws with the specified torque.
3. Remove the cover carefully, and measure the amount of the flattening with the scale and get the clearance.
4. If the clearance exceeds the allowable limit, replace oil pump rotor assembly and the cover.

Clearance between rotor and cover	Factory spec.	0.025 to 0.075 mm 0.0010 to 0.0030 in.
	Allowable limit	0.225 mm 0.0089 in.

Tightening torque	Oil pump cover screw	7.9 to 9.3 N·m 0.80 to 0.95 kgf·m 5.8 to 6.9 ft-lbs

W1148218

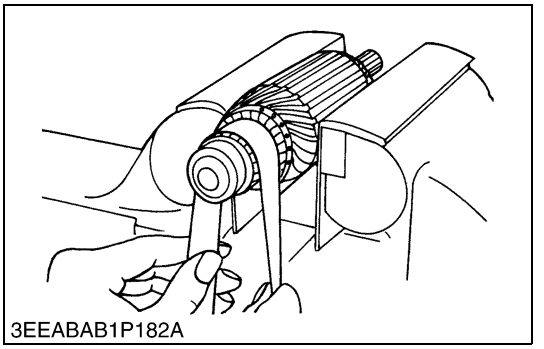
(7) Starter

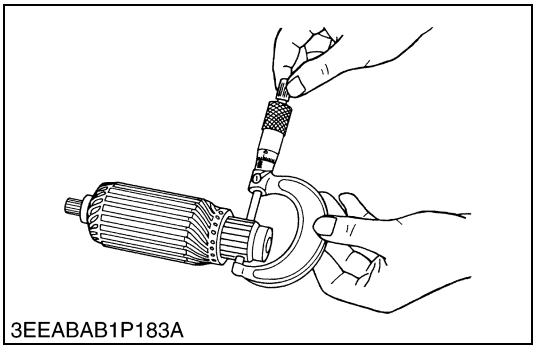

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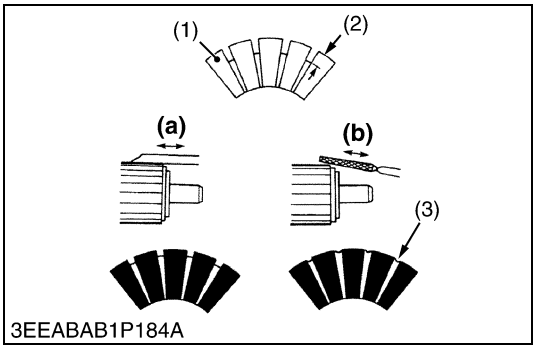
Overrunning Clutch

1. Inspect the pinion for wear or damage.
2. If there is any defect, replace the overrunning clutch assembly.
3. Check that the pinion turns freely and smoothly in the overrunning direction and does not slip in the cranking direction.
4. If the pinion slips or does not rotate in the both directions, replace the overrunning clutch assembly.

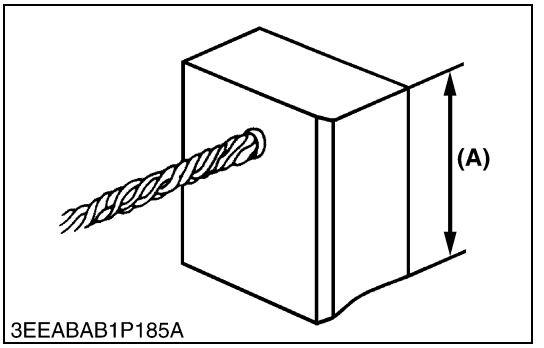
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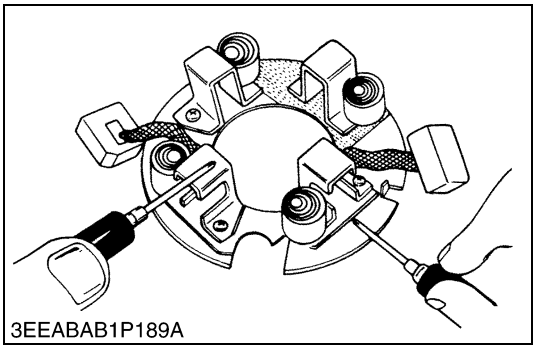

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3EEABAB1P184A



3EEABAB1P185A


3EEABAB1P189A

Commutator and Mica

1. Check the contact face 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 if with a saw blade and chamfer the segment edges.

Commutator O.D.	Factory spec.	32 mm 1.2598 in.
	Allowable limit	31.4 mm 1.2362 in.

Mica under cut	Factory spec.	0.5 mm 0.0197 in.
	Allowable limit	0.20 mm 0.0079 in.

(1) Segment
(2) Depth of Mica
(3) Mica

(a) Good
(b) Bad

W1075277

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 calipers.
3. If the length is less than the allowable limit, replace the yoke assembly and brush holder.

Brush length **(A)**	Factory spec.	18.0 mm 0.7086 in.
	Allowable limit	11.0 mm 0.4331 in.

(A) Brush Length

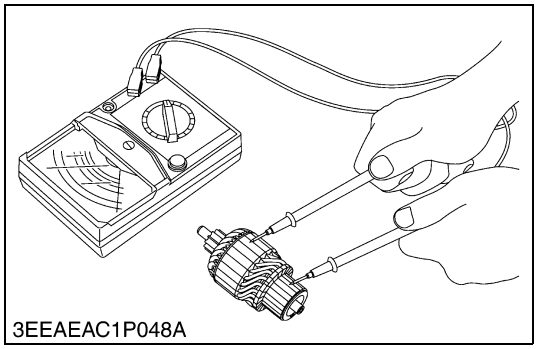
W1075476

Brush Holder

1. Check the continuity across the brush holder and the holder support with an ohmmeter.
2. If it conducts, replace the brush holder.

Resistance	Brush holder – Holder support	Infinity

W1076066

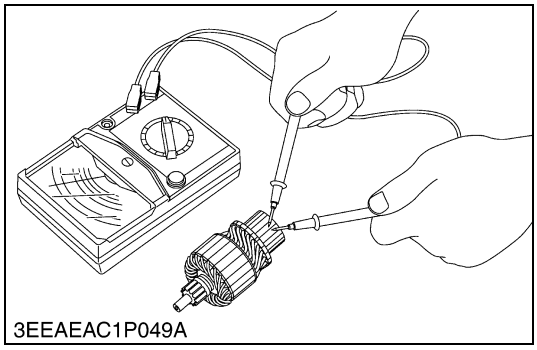

3EEAEAC1P048A

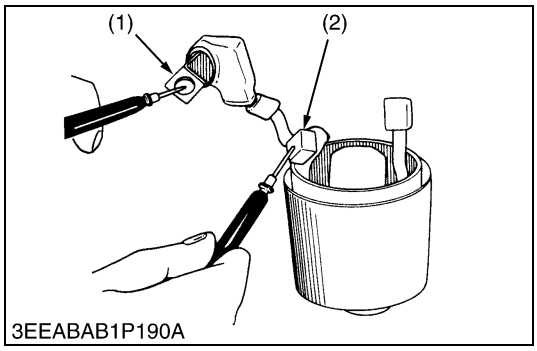
Armature Coil

1. Check the continuity across the commutator and armature coil core with an ohmmeter.
2. If it conducts, replace the armature.
3. Check the continuity across the segments of the commutator with an ohmmeter.
4. If it does not conduct, replace the armature.

Resistance	Commutator – Armature coil core	Infinity
	Commutator segment	0 Ω

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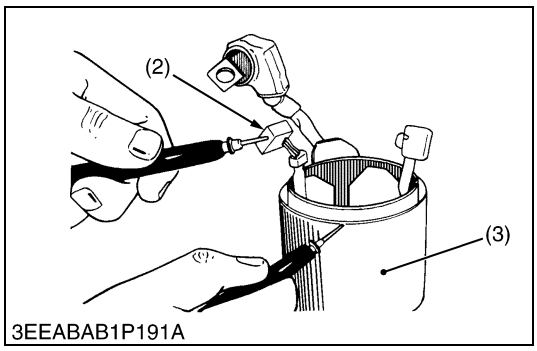
Field Coil

1. Check the continuity across the lead (1) and brush (2) with an ohmmeter.
2. If it does not conduct, replace the yoke assembly.
3. Check the continuity across the brush (2) and yoke (3) with an ohmmeter.
4. If it conducts, replace the yoke assembly.

Resistance	Lead (1) – Brush (2)	0 Ω
	Brush (2) – Yoke (3)	Infinity

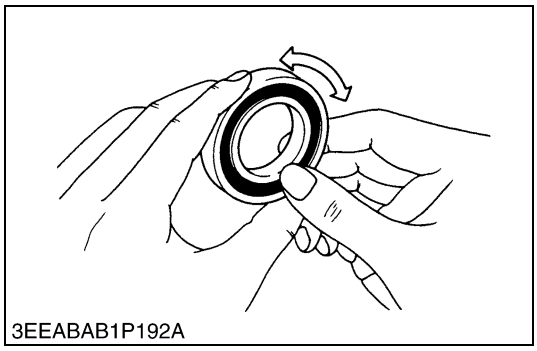
(1) Lead
(2) Brush
(3) Yoke

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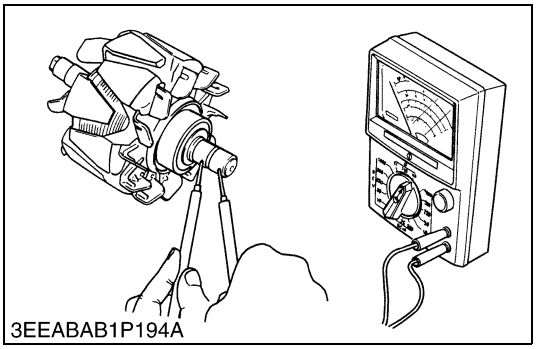
(8) Alternator


3EEABAB1P192A

Bearing

1. Check the bearing for smooth rotation.
2. If it does not rotate smoothly, replace it.

W1076281

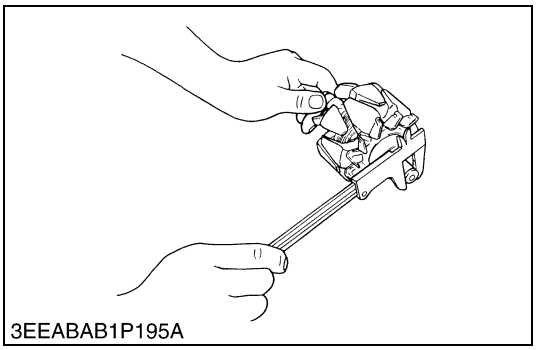

3EEABAB1P194A

Rotor

1. Measure the resistance across the slip rings with an ohmmeter.
2. If the resistance is not the factory specification, replace it.
3. Check the continuity across the slip and core with an ohmmeter.
4. If infinity is not indicated, replace it.

Resistance	Factory spec.	2.8 to 3.3 Ω

W1076422

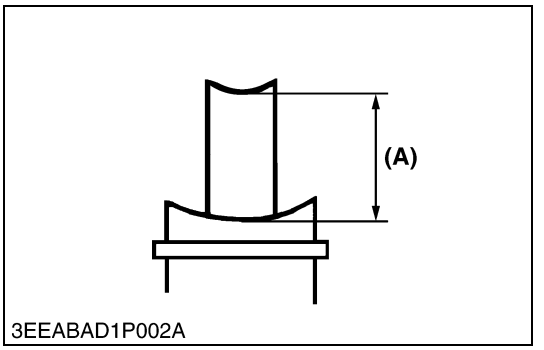

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Slip Ring

1. Check the slip ring for score.
2. If scored, correct with an sand 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.	22.7 mm 0.894 in.
	Allowable limit	22.1 mm 0.870 in.

W1076592



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Brush Wear

1. Measure the brush length **(A)** 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 **(A)**	Factory spec.	18.5 mm 0.728 in.
	Allowable limit	5.0 mm 0.197 in.

(A) Brush Length

W1076714

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I. Boom cylinder holding valve IV-M-112
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b. Specifications IV-M-112
c. Circuit diagram IV-M-112
d. Holding valve installation IV-M-113
e. Main parts function IV-M-114
f. Circuit function IV-M-115
J. Solenoid valve IV-M-121
a. Solenoid proportional control valve IV-M-121

A.General

a. Features of the hydraulic system

No.	Maiin feature points	Feature contents
1	**Three pump system One cylinder block with two delivery ports.**	Travel: P1 right travel, P2 left travel
		Front attachment control: P1 and P2 confluence for LS circuit (Arm, bucket, SP1, boom, swing)
		Travel + front attachment control: P1 right travel, P2 left travel P3: To front attachment LS circuit
		P3 pump: Swivel, dozer, SP2
2	**Control valve Combination valve block**	Monoblock ϕ18 (Arm, bucket, SP1, boom)
		LS ϕ14 (Swing, Option: two-piece boom, angle dozer)
		Open ϕ14 (Travel, SP2, dozer, swivel)
3	**System pressure (Boost pressure for travel)**	Travel: 29.4 MPa, 300 kgf/cm^2, 4267 psi
		LS system front attachment: 27.4 MPa, 280 kgf/cm^2, 3983 psi
		P3: 20.6 MPa, 210 kgf/cm^2, 2987 psi
		Travel + front attachment control: Travel: 29.4 MPa, 300 kgf/cm^2, 4267 psi, front attachment: 20.6 MP, 210 kgf/cm^2, 2987 psi
4	**Auxilliary port (Max flow limit)**	SP1: Electronic control for maximum flow limit
		SP2: CV pilot primary pressure chamber' s mechanical stopper for maximum flow limit
5	**All hydraulic pilot control**	Safety ensured by lever lock in all sections
		(Residual pressure released by accumulator)
6	**Shockless valve for boom cylinder**	To ease shocks in moving up and down the boom Thin-bladed orifice with pressure compensation With spool circuit to release return pressure in switching
7	**Standard equipped with holding valve**	With overload preventive switch Manual control type
8	**Negative swivel (High-pressure selector valve + timer-controlled valve)**	Brake released at left/right swivel and with arm crowded, swivel brake activated otherwise
		Brake activated in 5 seconds
9	**Swivel reverse preventive valve**	To prevent shaking just after swivel
10	**Travel negative brake**	To prevent traveling slipage on slope
11	**Travel pilot valve**	With damper and travel alarm detection port
12	**Pressure regulating hydraulic tank**	Pressure regulated 0.07 MPa, 0.7 kgf/cm^2, 10.2 psi at pressure side, 0.005 MPa, 0.05 kgf/cm^2, 0.73 psi at suction side
		Contamination level reduced (tank breathing reduced)
13	**High pressure hose and hose joint**	ORS (O ring fitting)
		With socket except suction port
14	**Accumulator**	Main aim : Relieve residual pressure in the system.

b. Main specifications of hydraulic components

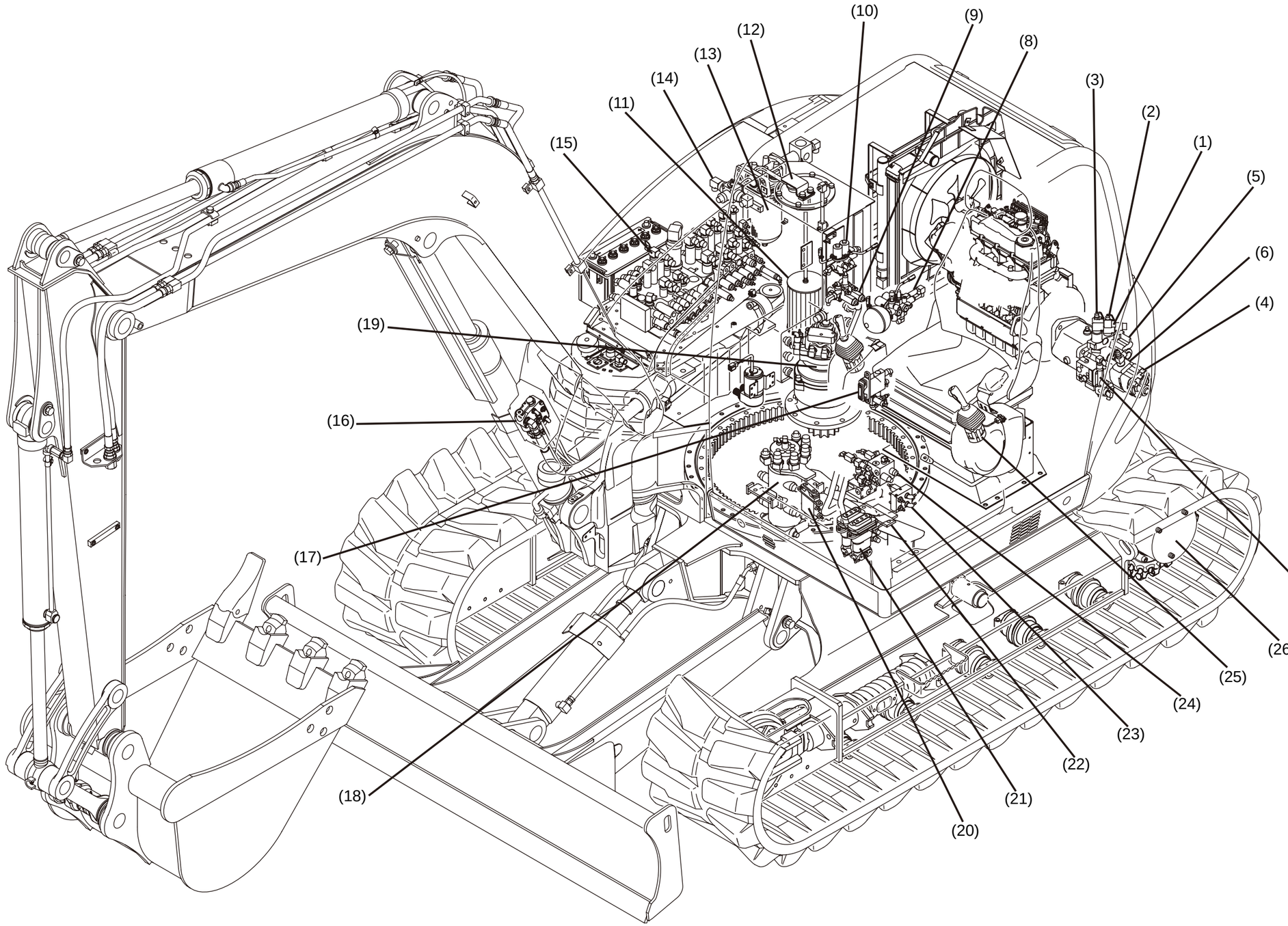
No.	Hydraulic component		Maker	Main specifications
1	Pump	RD809-6111	KYB	36 cc x 2 + 33 + 8.1 cc/rev
				72 x 2 + 67 + 16 L/min (19.0 x + 17.7 + 4.23 GPM)
				LS control valve: Differential pressure 1.5 MPa, 15.3 kgf/cm^2, 218 psi
				PC horsepower control valve: With P3 horsepower shift
				Rated speed: 2000 rpm
2	Control valve	RD809-6113	KYB	LS circuit (ϕ18): 4-valve (monoblock)
				LS circuit (ϕ14): 1-valve
				Open circuit (ϕ14): 3-valve
				P3 confluence valve (ϕ14)
				Travel selector valve (ϕ18)
				Pressure: Travel 29.4 MPa, 300 kgf/cm^2, 4267 psi, front attachment 27.4 MPa, 280 kgf/cm^2, 3983 psi P3: 20.6 MPa, 210 kgf/cm^2, 2987 psi
				Signal detection: AI, travel control detection, LS control detection
3	Travel motor	RD809-6129	Nabtesco	Motor: 36.3/21.3 cc/rev
				Reduction gears: RV reduction gears
				Reduction ratio: 61.6
				Relief: 2-stage shockless relief
				Relief pressure: 30.4 MPs, 310 kgf/cm^2, 4410 psi
				Negative brake
4	Swivel motor	RD809-6128	KYB	Motor: 44.1 cc/rev
				Reduction gears: Planetary reduction gears
				Reduction ratio: 20.615
				Pinion/swivel race: 13/100
				Relief: Shockless relief (0.03 sec)
				Relief pressure: 21.6 MPs, 220 kgf/cm^2, 3129 psi
				Negative brake (with timer, 5 ± 1.5 sec)
				With anti-swivel back valve
5	Boom cylinder	RD809-6750	KYB	ϕ115 x ϕ65 x 878 (cushion at rod side)
6	Arm cylinder	RD809-6760	KYB	ϕ100 x ϕ60 x 914 (cushion at both sides)
7	Bucket cylinder	RD809-6780	KYB	ϕ90 x ϕ55 x 741
8	Swing cylinder	RD809-6740	Koretsune Seiko	ϕ110 x ϕ60 x 715
9	Dozer cylinder	RD809-7510	Koretsune Seiko	ϕ125 x ϕ65 x 250

No.	Hydraulic component		Maker	Main specifications
10	Left-right pilot valve	Right (common) RC448-6172 Left RD809-6140	KPM	Control angle: 19 deg.
				Pilot pressure: 0.83 ~ 2.65 MPa, 8.5 ~ 27.0 kgf/cm^2, 120 ~ 384 psi
				Right: Proportional control switch, left: ON-OFF
11	Travel pilot valve	RD809-9140	KPM	Control angle: 9 deg.
				Pilot pressure: 0.59 ~ 2.65 MPa, 6.0 ~ 27.0 kgf/cm^2, 86 ~ 384 psi
				Hydraulic damper: ϕ0.9 (temporary)
				Left/right high-pressure selector valve (for travel alarm)
12	Unload valve	RD809-6131	Nishina Ind.	Relief pressure: 4 MPa (40.8 kgf/cm^2, 580 psi) at 16 L/min (4.23PM)
				Check valve built-in (Accumulation effect at port B only)
				Accumulator directly connectable
13	Holding valve (boom)	RD809-6405	KPM	With inching spool
14	High-pressure selector valve	RD809-6127	Nishina Ind.	Pressure at left/right swivel with arm crowded → Swivel motor brake released Last chance filter built in at T-side adaptor
15	Hose (high pressure)		BS, THE YOKOHAMA RUBBER CO.,LTD	ORS (O ring seal, flat face)
16	Hose (pilot line)		BS	Metal fitting (conventional), quick type
17	Hose (band) without socket			For suction port only
18	Tank			Pressure regulating type (discharge: 0.07 MPa) (suction: 0.005 MPa) Breather without filter
19	Return filter	RD809-6212	WAKO	External cartridge type
20	Accumulator	RD809-6132	NOK	500 cc: Set pressure 1 MPa, 10.2 kgf/cm^2, 145 psi
21	Line filter	Common R1411-6492	Yamashin	Set pressure 0.25 MPa, 2.55 kgf/cm^2, 36.3 psi
22	SP1 solenoid valve	RD809-6137	KPM	Proportional control
23	SP2 solenoid valve	Common RC601-6191	Nishina Ind.	ON - OFF
24	Pressure switch	RD809-6408	Nagano Kogyo	11.8 MPa, 120 kgf/cm^2, 1712 psi
25	Shockless valve	RD809-6408	Nishina Ind.	Throttle orifice : Up ϕ1.0, down ϕ1.1
26	Back-pressure check valve	RD809-6351	Yamashin	0.4 MPa, 4.08 kgf/cm^2, 58 psi
27	TPSS (North America-version)		Nishina Ind.	Rotary type

*Specifications subject to change

KTB : Kayaba industry Ltd
KPM : Kawasaki Precision Machinery LTD
NOK : Nippon Oil seal Kogyo
BS : Bridgestone Industry Co. Ltd

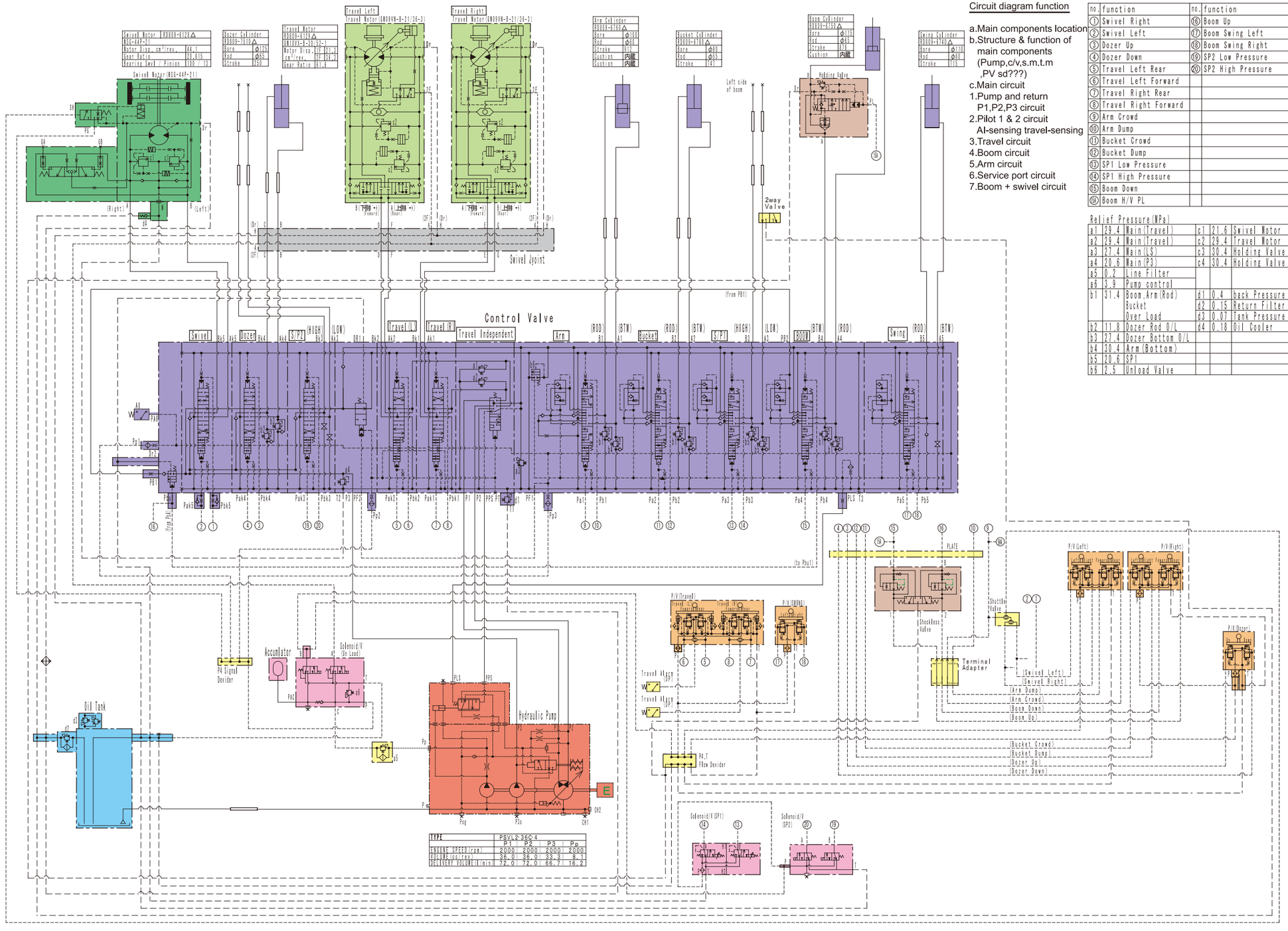
c. Hydraulic components layout



(1) Main pump
(2) P1 delivery port
(3) P2 delivery port
(4) P3 pump
(5) P3 delivery port
(6) Pilot pump
(7) LS valve
(8) Unload valve & accumulator
(9) SP 1 proportional valve
(10) SP 2 solenoid valve
(11) Suction filter
(12) Tank cap(pressure regulator)
(13) Return filter
(14) Third line valve
(15) Control valve assy
(16) Holding valve
(17) Pilot valve, dozer
(18) Swivel joint
(19) Swivel motor
(20) Pilot valve. Swing
(21) Pilot valve, travel
(22) High pressure selector valve
(23) TPSS valve
(24) Shockless valve
(25) Pilot control valve,L
(26) Travel motor

d. Hydraulic Circuit Diagram

1. Main components location



TYPE	PSVL2-36C-4			
	P1	P2	P3	Pp
ENGINE SPEED(rpm)	2000	2000	2000	2000
VOLUME(cc/rev)	36.0	36.0	33.3	8.1
DELIVERY VOLUME(l/min)	72.0	72.0	66.7	16.2

Circuit diagram function

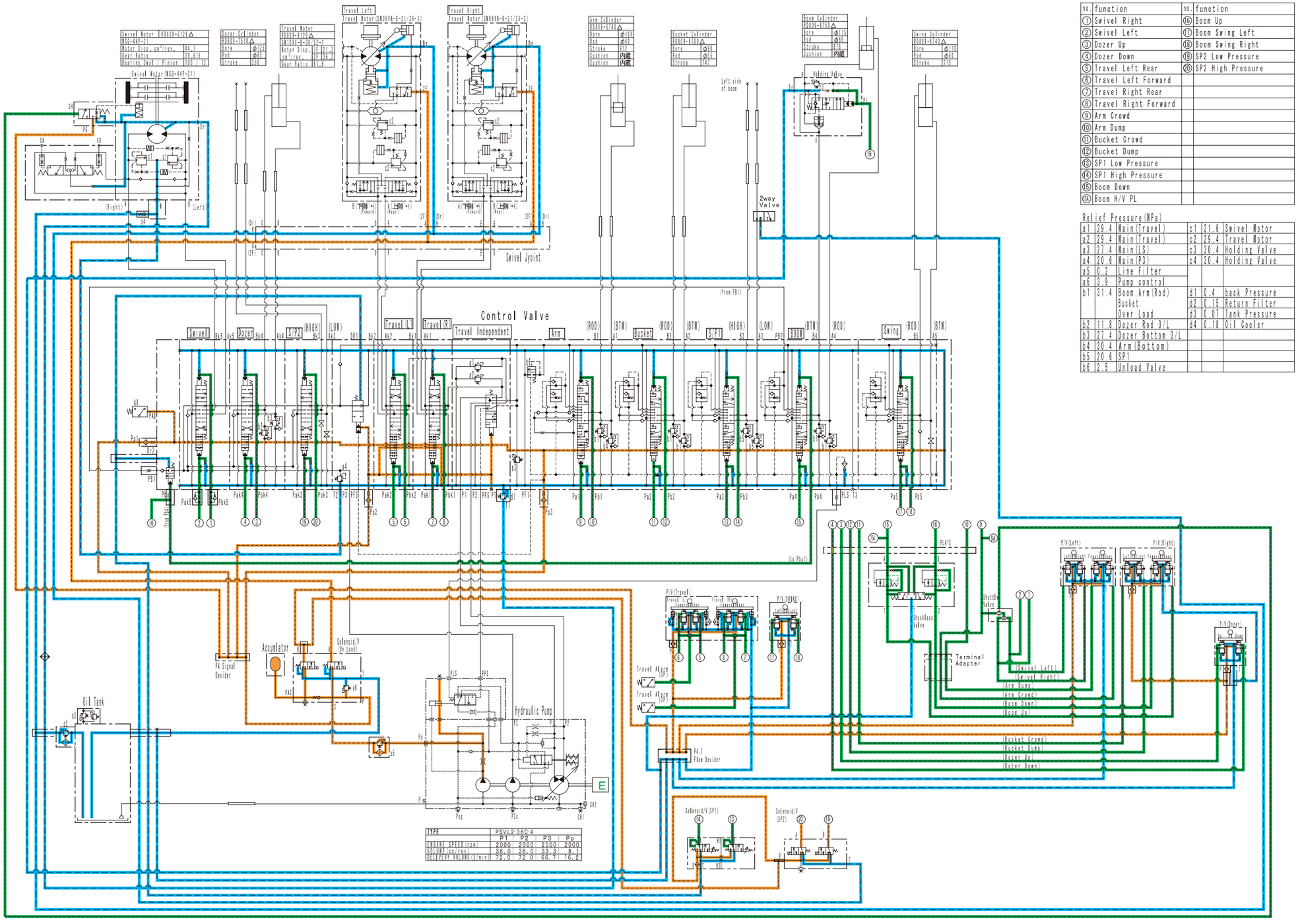
a.Main components location
b.Structure & function of main components (Pump,c/v,s.m.t.m ,PV sd???)
c.Main circuit
1.Pump and return P1,P2,P3 circuit
2.Pilot 1 & 2 circuit AI-sensing travel-sensing
3.Travel circuit
4.Boom circuit
5.Arm circuit
6.Service port circuit
7.Boom + swivel circuit

no.	function	no.	function
①	Swivel Right	⑯	Boom Up
②	Swivel Left	⑰	Boom Swing Left
③	Dozer Up	⑱	Boom Swing Right
④	Dozer Down	⑲	SP2 Low Pressure
⑤	Travel Left Rear	⑳	SP2 High Pressure
⑥	Travel Left Forward		
⑦	Travel Right Rear		
⑧	Travel Right Forward		
⑨	Arm Crowd		
⑩	Arm Dump		
⑪	Bucket Crowd		
⑫	Bucket Dump		
⑬	SP1 Low Pressure		
⑭	SP1 High Pressure		
⑮	Boom Down		
⑭	Boom H/V PL		

Relief Pressure(MPa)

a1	29.4	Main(Travel)	c1	21.6	Swivel Motor
a2	29.4	Main(Travel)	c2	29.4	Travel Motor
a3	27.4	Main(LS)	c3	30.4	Holding Valve
a4	20.6	Main(P3)	c4	30.4	Holding Valve
a5	0.2	Line Filter			
a6	3.9	Pump control			
b1	31.4	Boom,Arm(Rod)	d1	0.4	back Pressure
		Bucket	d2	0.15	Return Filter
		Over Load	d3	0.07	Tank Pressure
b2	11.8	Dozer Rod O/L	d4	0.18	Oil Cooler
b3	27.4	Dozer Bottom O/L			
b4	30.4	Arm(Bottom)			
b5	20.6	SP1			
b6	12.5	Unload Valve			

2. Pilot pump circuit



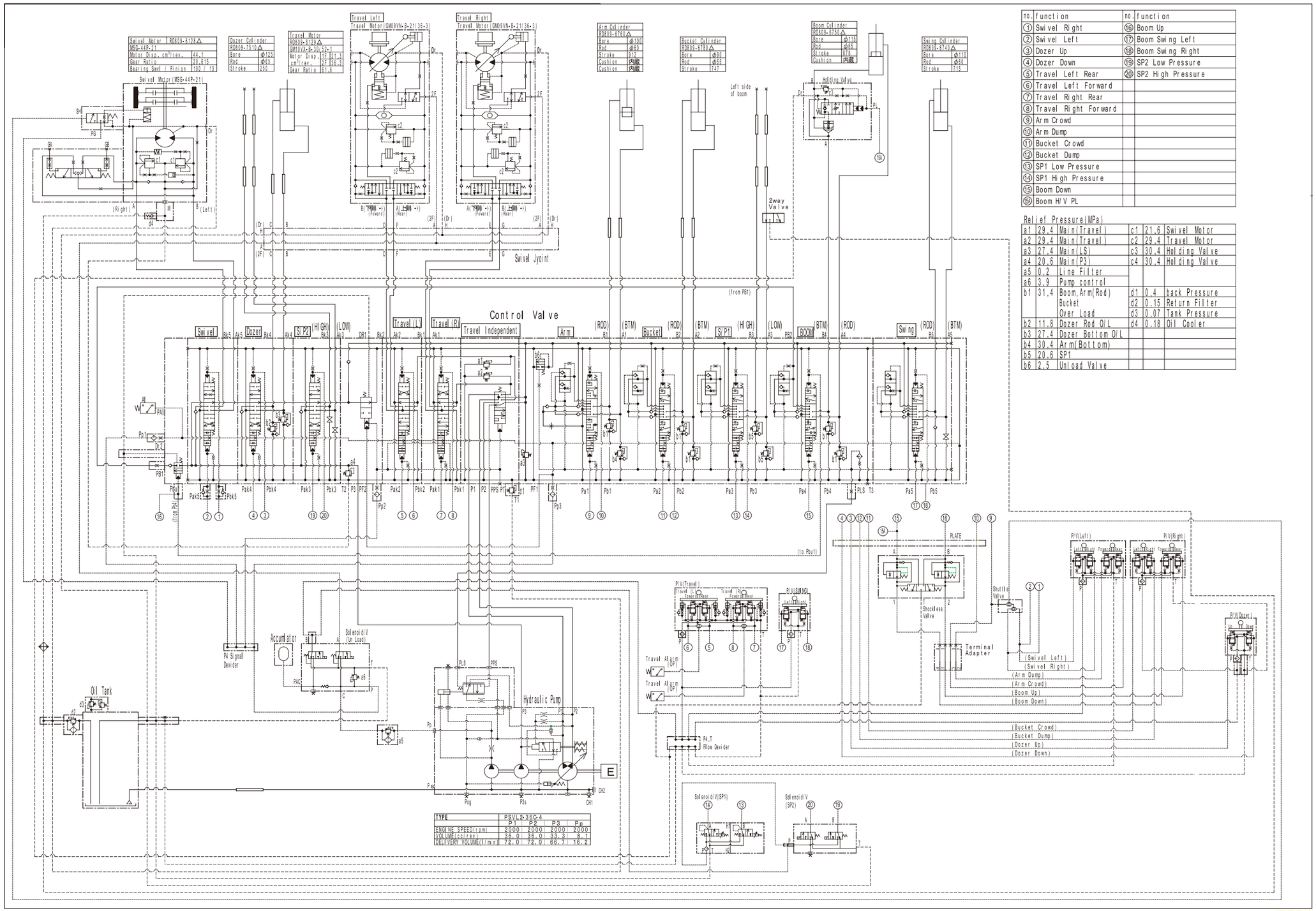
TYPE	PSVL2-36C-4			
	P1	P2	P3	Pp
ENGINE SPEED(rpm)	2000	2000	2000	2000
VOLUME(cc/rev)	36.0	36.0	33.3	8.1
DELIVERY VOLUME(l/min)	72.0	72.0	66.7	16.2

no.	function	no.	function
①	Swivel Right	⑯	Boom Up
②	Swivel Left	⑰	Boom Swing Left
③	Dozer Up	⑱	Boom Swing Right
④	Dozer Down	⑲	SP2 Low Pressure
⑤	Travel Left Rear	⑳	SP2 High Pressure
⑥	Travel Left Forward		
⑦	Travel Right Rear		
⑧	Travel Right Forward		
⑨	Arm Crowd		
⑩	Arm Dump		
⑪	Bucket Crowd		
⑫	Bucket Dump		
⑬	SP1 Low Pressure		
⑭	SP1 High Pressure		
⑮	Boom Down		
㉑	Boom H/V PL		

Relief Pressure (MPa)

a1	29.4	Main(Travel)	c1	21.6	Swivel Motor
a2	29.4	Main(Travel)	c2	29.4	Travel Motor
a3	27.4	Main(LS)	c3	30.4	Holding Valve
a4	20.6	Main(P3)	c4	30.4	Holding Valve
a5	0.2	Line Filter			
a6	3.9	Pump control			
b1	31.4	Boom,Arm(Rod)	d1	0.4	back Pressure
		Bucket	d2	0.15	Return Filter
		Over Load	d3	0.07	Tank Pressure
b2	11.8	Dozer Rod O/L	d4	0.18	Oil Cooler
b3	27.4	Dozer Bottom O/L			
b4	30.4	Arm(Bottom)			
b5	20.6	SP1			
b6	2.5	Unload Valve			

3. Hydraulic Circuit Diagram



no.	function	no.	function
①	Swivel Right	⑯	Boom Up
②	Swivel Left	⑰	Boom Swing Left
③	Dozer Up	⑱	Boom Swing Right
④	Dozer Down	⑲	SP2 Low Pressure
⑤	Travel Left Rear	⑳	SP2 High Pressure
⑥	Travel Left Forward		
⑦	Travel Right Rear		
⑧	Travel Right Forward		
⑨	Arm Crowd		
⑩	Arm Dump		
⑪	Bucket Crowd		
⑫	Bucket Dump		
⑬	SP1 Low Pressure		
⑭	SP1 High Pressure		
⑮	Boom Down		
⑮	Boom H/V PL		

Relief Pressure(MPa)

a1	29.4	Main(Travel)	c1	21.6	Swivel Motor
a2	29.4	Main(Travel)	c2	29.4	Travel Motor
a3	27.4	Main(LS)	c3	30.4	Holding Valve
a4	20.6	Main(P3)	c4	30.4	Holding Valve
a5	0.2	Line Filter			
a6	3.9	Pump control			
b1	31.4	Boom,Arm(Rod)	d1	0.4	back Pressure
		Bucket	d2	0.15	Return Filter
		Over Load	d3	0.07	Tank Pressure
b2	11.8	Dozer Rod O/L	d4	0.18	Oil Cooler
b3	27.4	Dozer Bottom O/L			
b4	30.4	Arm(Bottom)			
b5	20.6	SP1			
b6	2.5	Unload Valve			

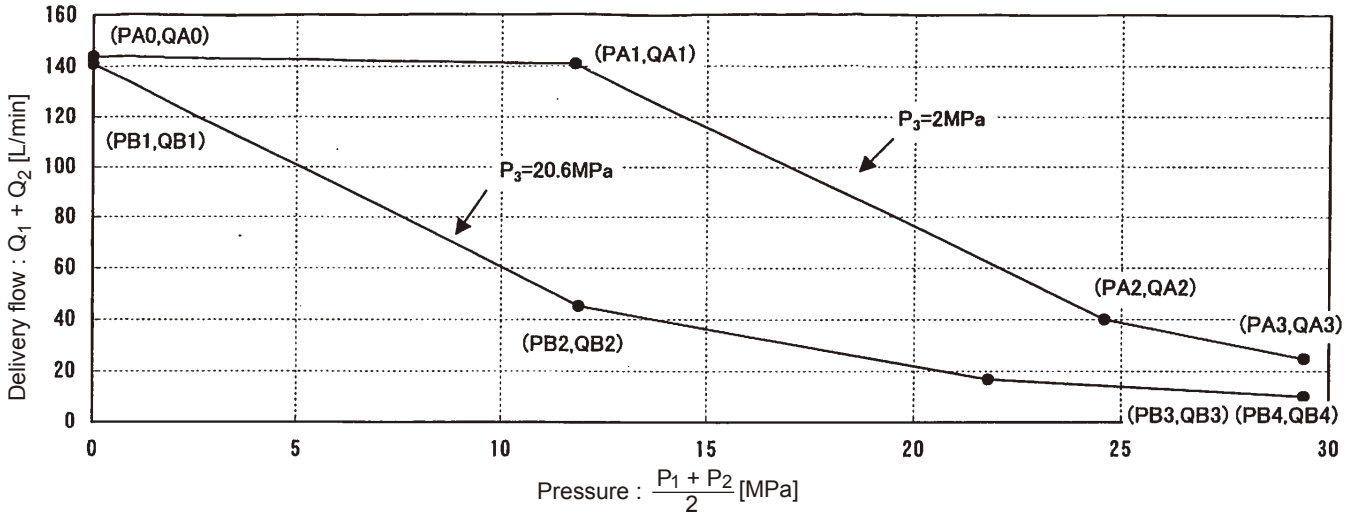
TYPE	PSVL2-36C-4			
	P1	P2	P3	Pp
ENGINE SPEED(rpm)	2000	2000	2000	2000
VOLUME(cc/rev)	36.0	36.0	33.3	8.1
DELIVERY VOLUME(l/min)	72.0	72.0	66.7	16.2

B.Hydraulic pump

a. Main specifications

1	Pump displacement (CC/rev)	36 x 2 + 33 + 8.1
	Pump flow rate (L/min)	72 x 2 + 67 + 16 L/min (19.0 x 2 + 17.7 + 4.23 GPM)
2	Standby flow rate (L/min)	22 L/min (5.81 GPM)
3	Construction	P1, P2 : Split flow of variable displacement piston pump P3 : GP (Gear pump) P4 : GP (Gear pump)
4	Rated speed	2000 rpm
5	LS flow control	LS control valve: Differential pressure 1.5 MPa Engine rpm proportional control at P4 Idling at rated flow rate: About 60 ~ 70%
6	Horsepower control	PC horsepower control valve: With P3 horsepower shift Without small-diameter piston (self-tilting moment) P1 + P2 pressure: Average pressure by aperture
7	Construction	Bearing: Cradle Shoe plate: Spherical Large-diameter piston (with shoe)

Piston pump power constant characteristics

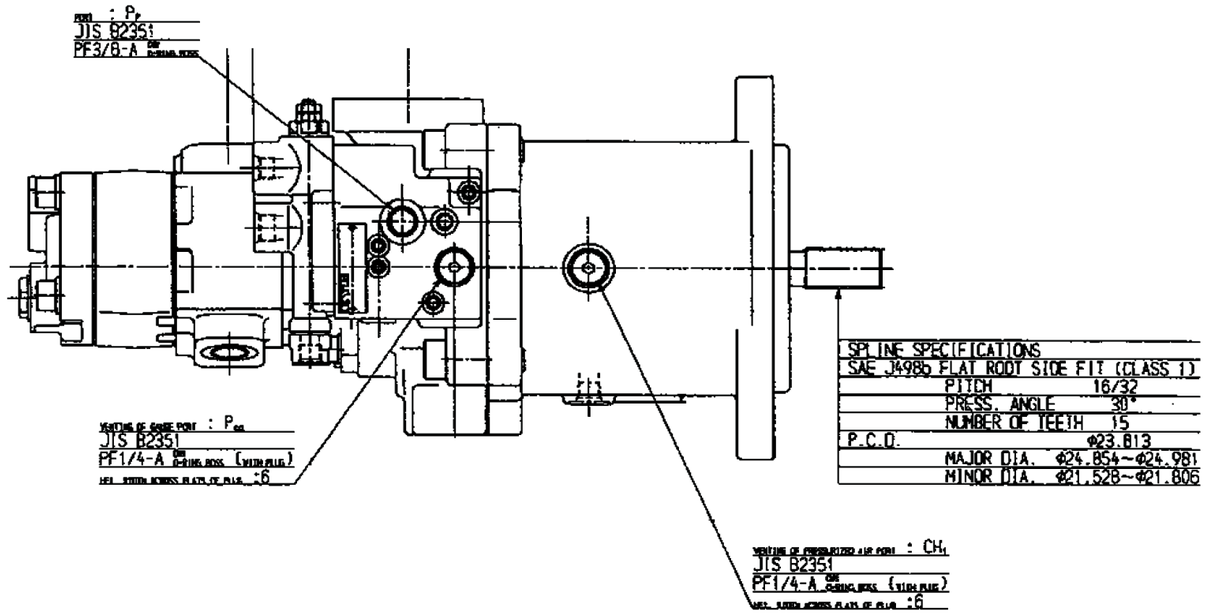


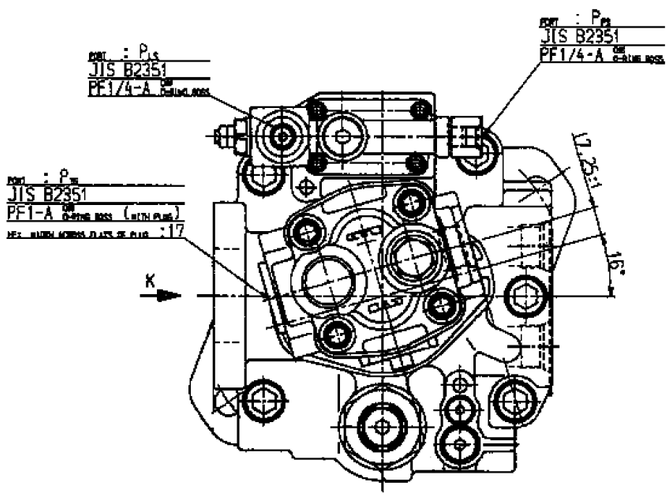
Shaft speed		2000 rpm	
At gear pump pressure	P_3 = 2 MPa	At gear pump pressure	P_3 = 20.6 MPa
Total input torque	192.4 N·m $^{0}_{-2.0}$	Total input torque	193.3 N·m $^{0}_{-2.0}$
Pressure [MPa]	Delivery flow [MPa]	Pressure [MPa]	Delivery flow [MPa]
PA = 0.0	QA0 = 144.0 ± 4.3		
PA1 = 11.8	QA1 = 140.9	PB1 = 0.0	QB1 = 141.0
PA2 = 24.6	QA2 = 40.0	PB2 = 11.9	QB2 = 45.3
PA3 = 29.4	QA3 = 24.8	PB3 = 21.8	QB3 = 16.8
		PB4 = 29.4	QB4 = 10.1 ± 1.8

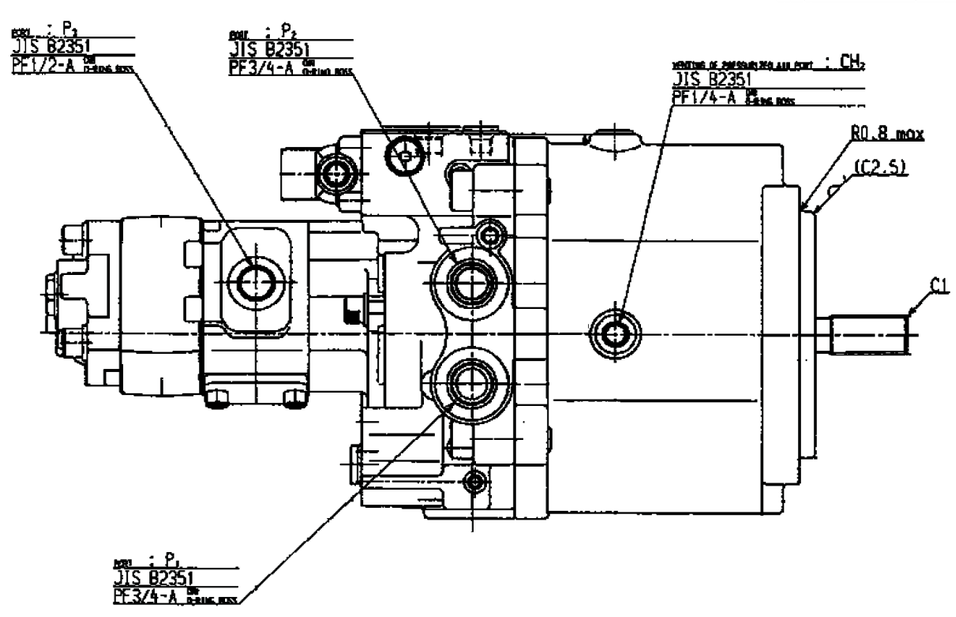
b. Outer view

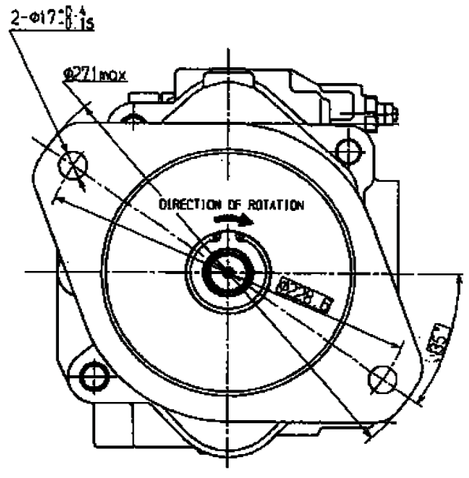
SPECIFICATION

PISTON PUMP	MAX. DISPLACEMENT	cm³/rev	36.0+36.0
	MAX. PRESSURE	MPa	29.4
PILOT PUMP	MAX. DISPLACEMENT	cm³/rev	8.1
	MAX. PRESSURE	MPa	3.9
GEAR PUMP	MAX. DISPLACEMENT	cm³/rev	33.3
	MAX. PRESSURE	MPa	20.6
MAX. SHAFT SPEED		r.p.m.	2000
DIRECTION OF ROTATION (VIEWED FROM SHAFT END)			RIGHT(CLOCKWISE)
WEIGHT		kg	(47)

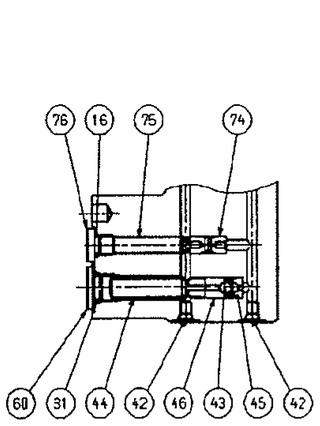


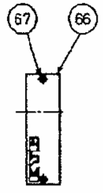




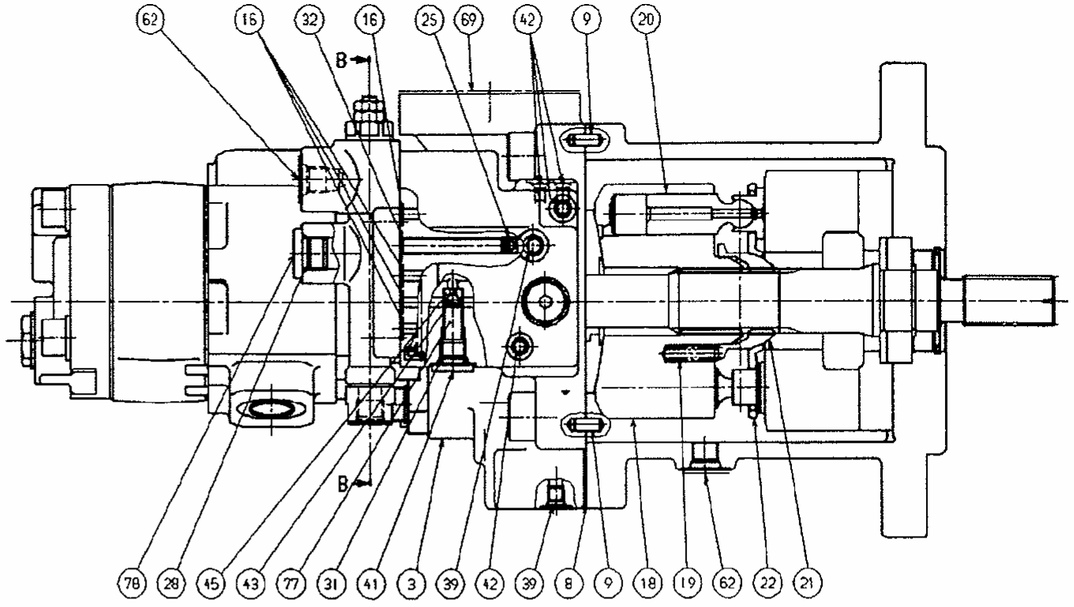


c. Structure

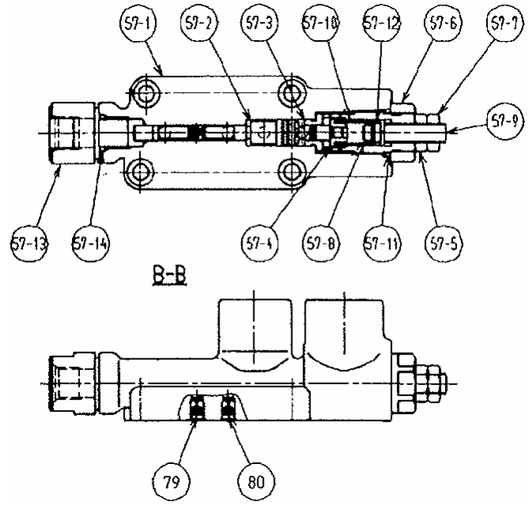


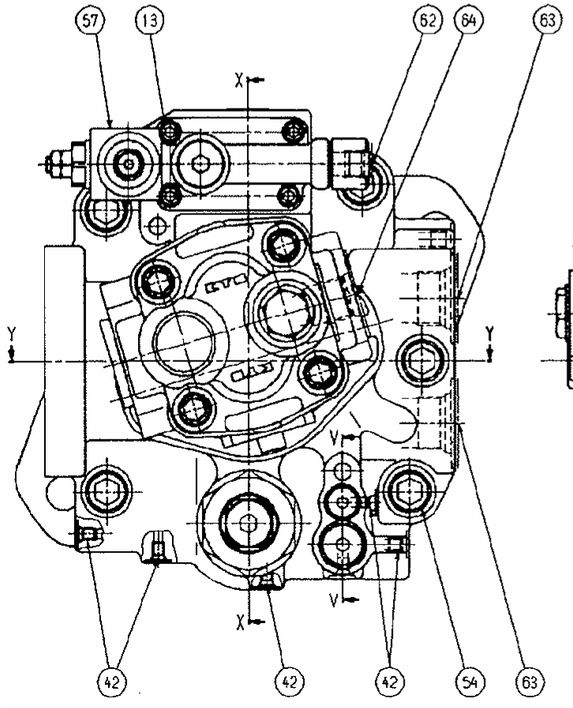


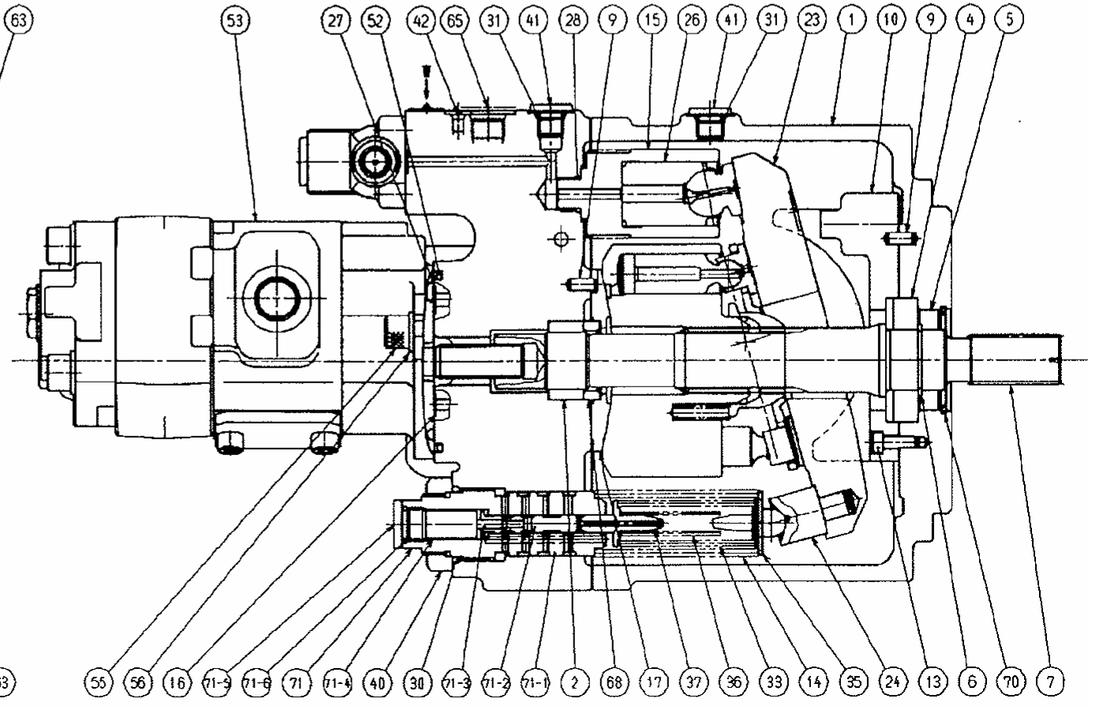
VIEW ON ARROW "N"



Y-Y



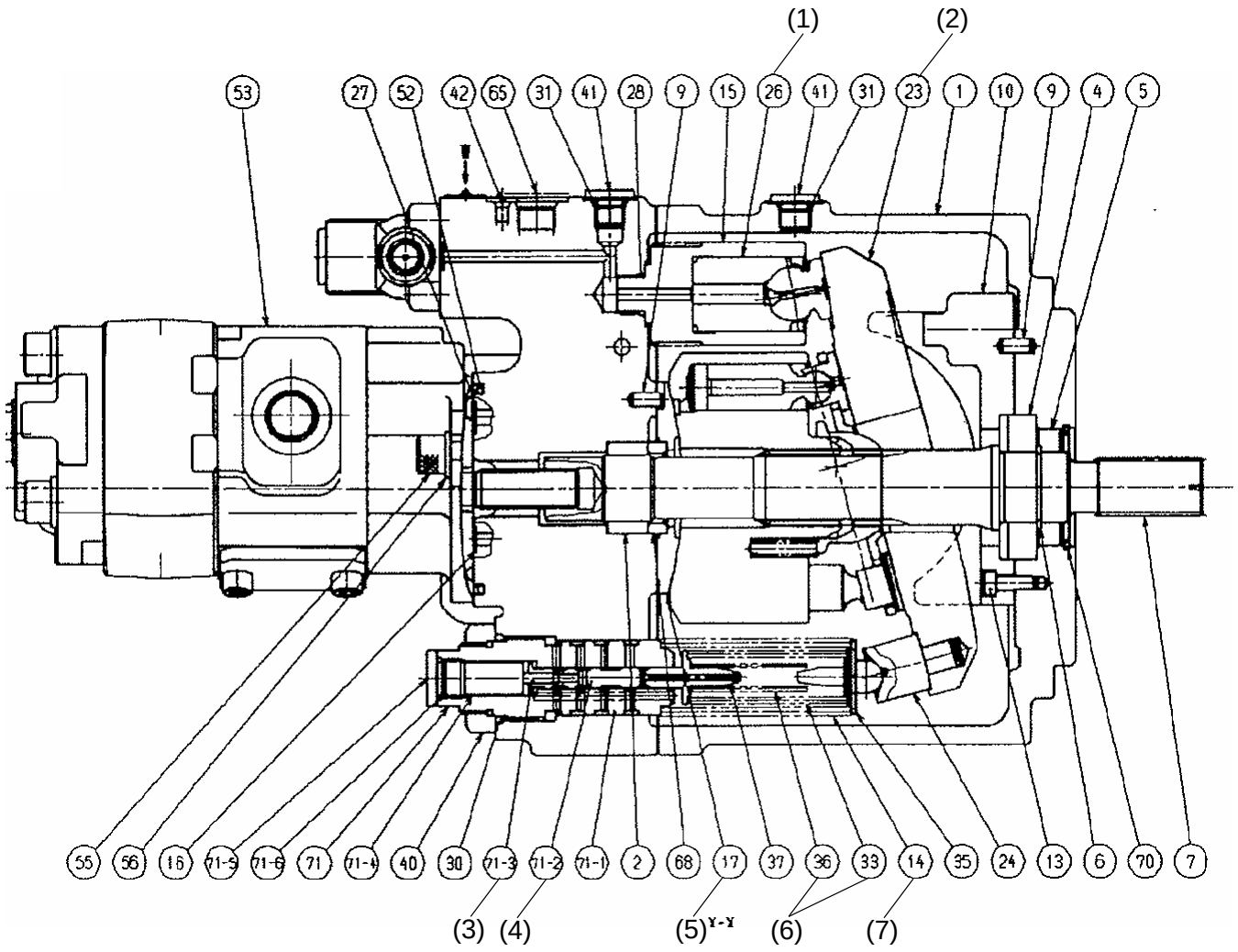


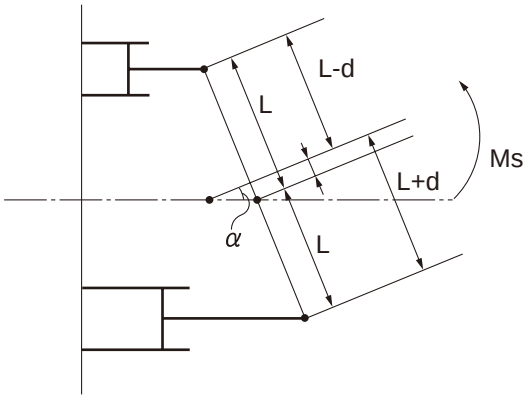


X-X

P1, P2
(Variable displacement pump + Horsepower control + LS control)
P3
Fixed gear pump (Swivel, dozer SP2)
P4 : Pilot pump
(Used also for LS engine rpm proportional control)

d. Functional parts 1

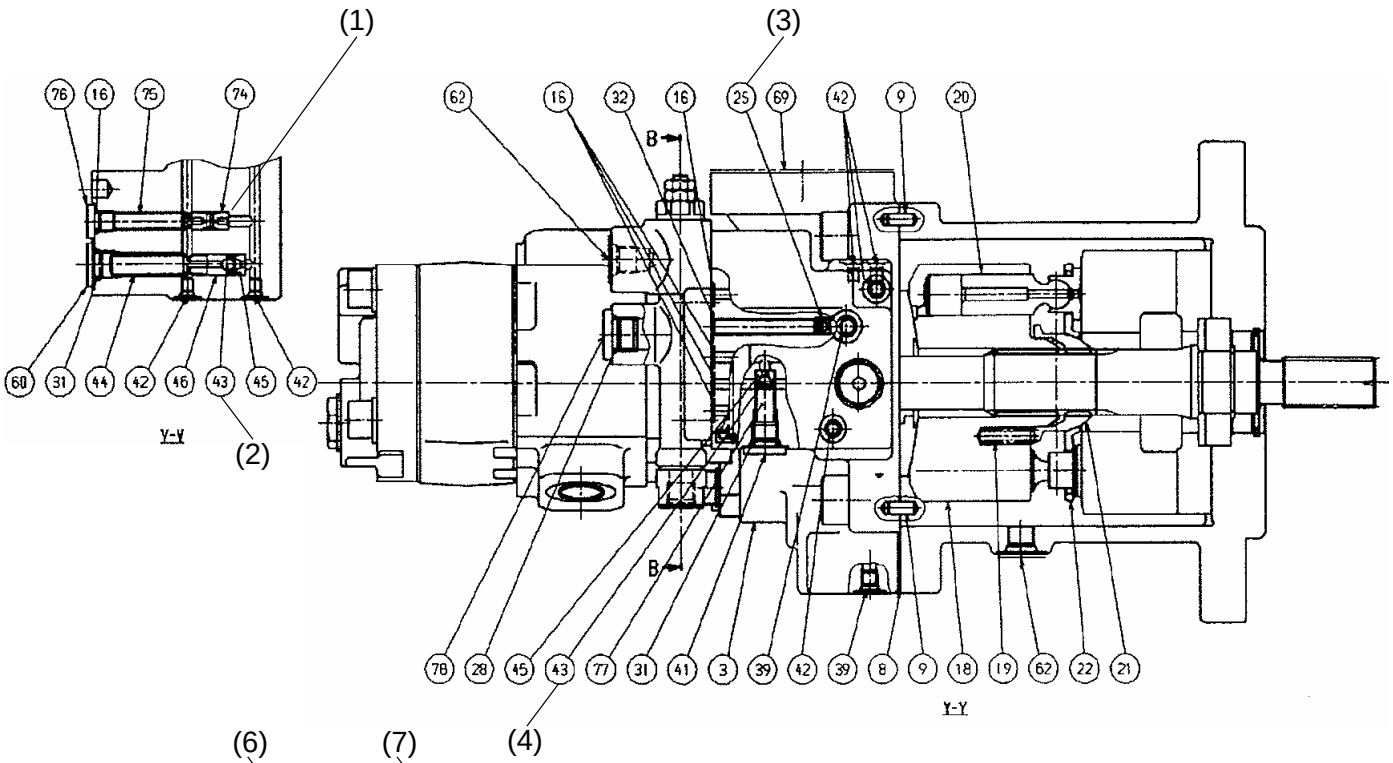


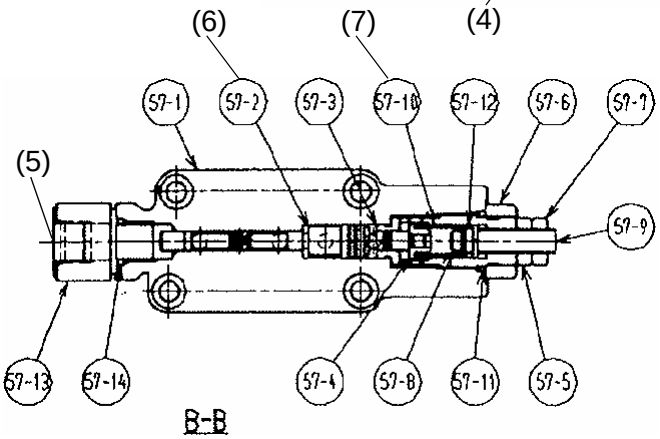


Function :
The force to tilt the tilting swash plate toward the large flow side is produced by repositioning the turning center of the tilting swash plate and generating the self-tilting moment. (The small-diameter piston adopted on KX121-3, KX161-3 is not used here.) The tilt return spring is applied to assist at low pressure.

(1) Large-diameter tilt control piston
(2) Tilting swash plate
(3) P3 pump horsepower shift pin
(4) PC horsepower control spool
(5) Spherical valve plate
(6) PC horsepower control spring
(7) Tilting moment assist spring

e. Functional parts 2



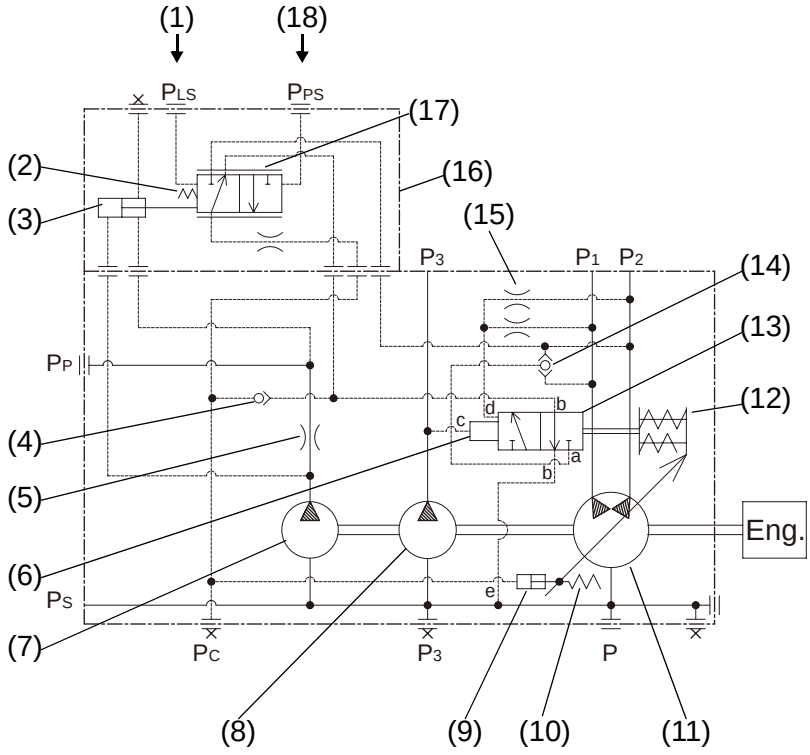


(1) Orifice for P1 + P2 average pressure
(2) High-pressure selector check valve
(3) Engine rpm proportional gain control orifice
(4) Response improvement check valve at P3 under pressure
(5) PPS control pressure from CV (Control valve)
(6) LS flow control spool
(7) LS differential pressure setting spring

LS flow control valve

Basically common with KX121-3, KX161-3
Orifice and control differential pressure setting different, however

f. Pump control circuit



(1) PLS control pressure from CV
(2) LS differential pressure setting spring
(3) Engine rpm proportional gain control piston
(4) Response improvement check valve at P3 under pressure
(5) Engine rpm proportional gain control aperture
(6) P3 pump horsepower shift piston
(7) P4 pilot pump
(8) P3 pump
(9) Large-diameter tilt control piston
(10) Tilting moment assist spring
(11) P1, P2 pump
(12) Horsepower control spring
(13) PC horsepower control spool
(14) High-pressure selector check valve
(15) Aperture for P1 + P2 average pressure
(16) LS control regulator
Basically common with L3
(17) LS flow control spool
(18) PPS control pressure from CV

a : Pmax
b : Tank
c : P_3
d : $P = \frac{P_1+P_2}{2}$
e : PC

(Pump structure)

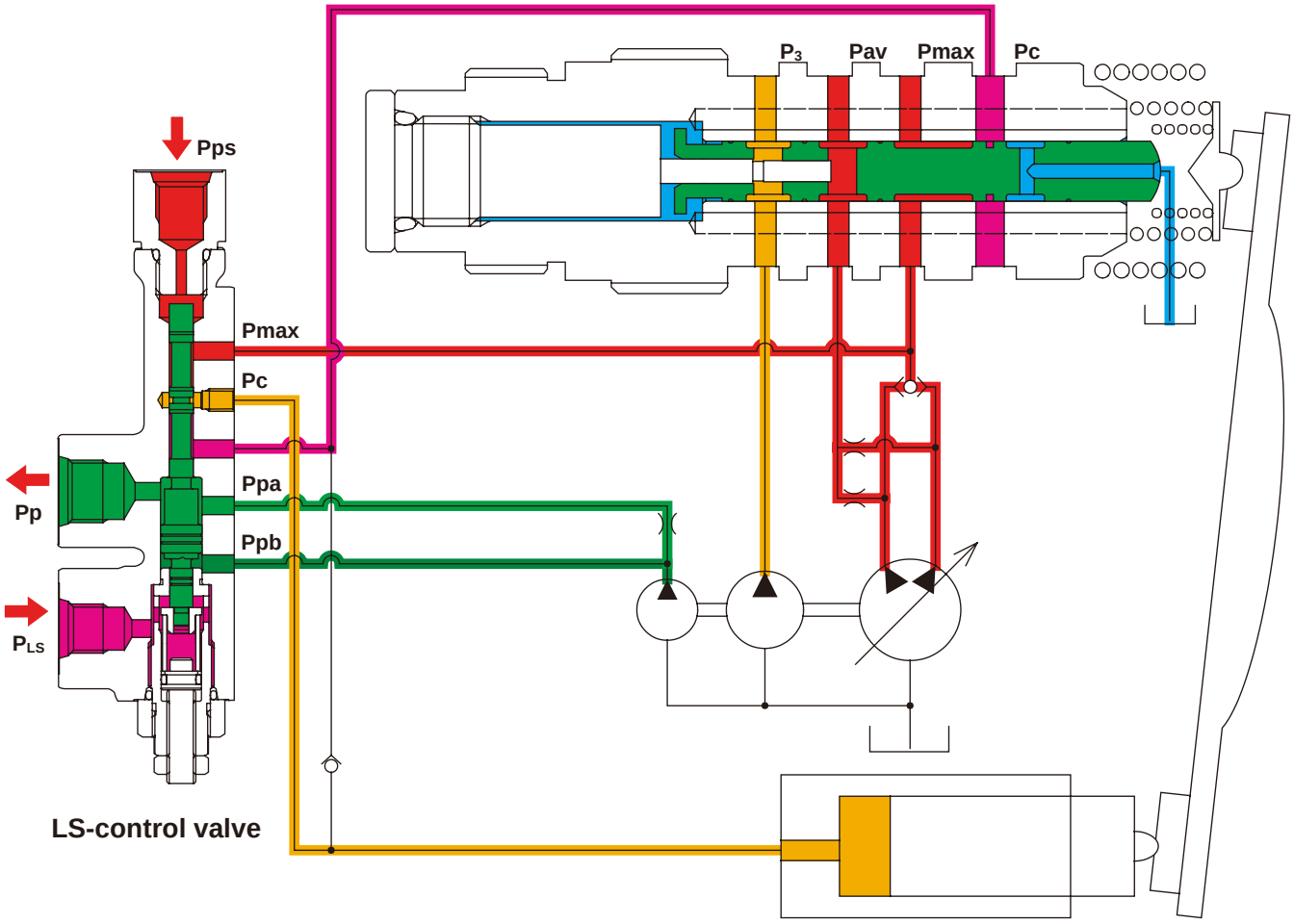
P1, P2 : Variable displacement pump + PC horsepower control + LS flow control (Q1 = Q2) (Travel, arm, bucket, SP1, boom, swing, AUX)
: Split flow
: Spherical valve plate
: Cradle bearing
: No small-diameter piston provided (self-pressing moment used)
P3 : Gear pump (swivel, dozer, SP2) (Used for LS system in using the travel and LS control)
P4 : Gear pump ((Pilot pump) and to use also for LS engine rpm proportional control)

(Pump control)

1. Horsepower: Orifice-controlled P1 + P2 average pressure to make the power double, instead of generating the P1 + P2 horsepower with a stepped piston. P3 also controlled together.
2. Engine rpm gain control: P4 pilot pump' s discharge throttled, resulting in differential pressure. LS differential pressure modified accordingly. (Same mechanism as on KX121-3S/α and KX161-3S/α)
3. Introduction of response improvement check valve (LS flow control valve bypassed) at P3 under pressure. In this way, swivel horsepower control response quicker and engine drop reduced.
4. Tilting swash plate' s moment for larger flow rate controlled by repositioning the turning center of the swash plate and generating the self-tilting moment. (The small-diameter piston on KX121-3S/α and KX161-3S/α is abolished out.) Tilt moment assist spring also adopted to boost the tilting moment at low pressure.

1. LS control 1

$P_{PS} = P_{LS} + P_F + \Delta P_P$



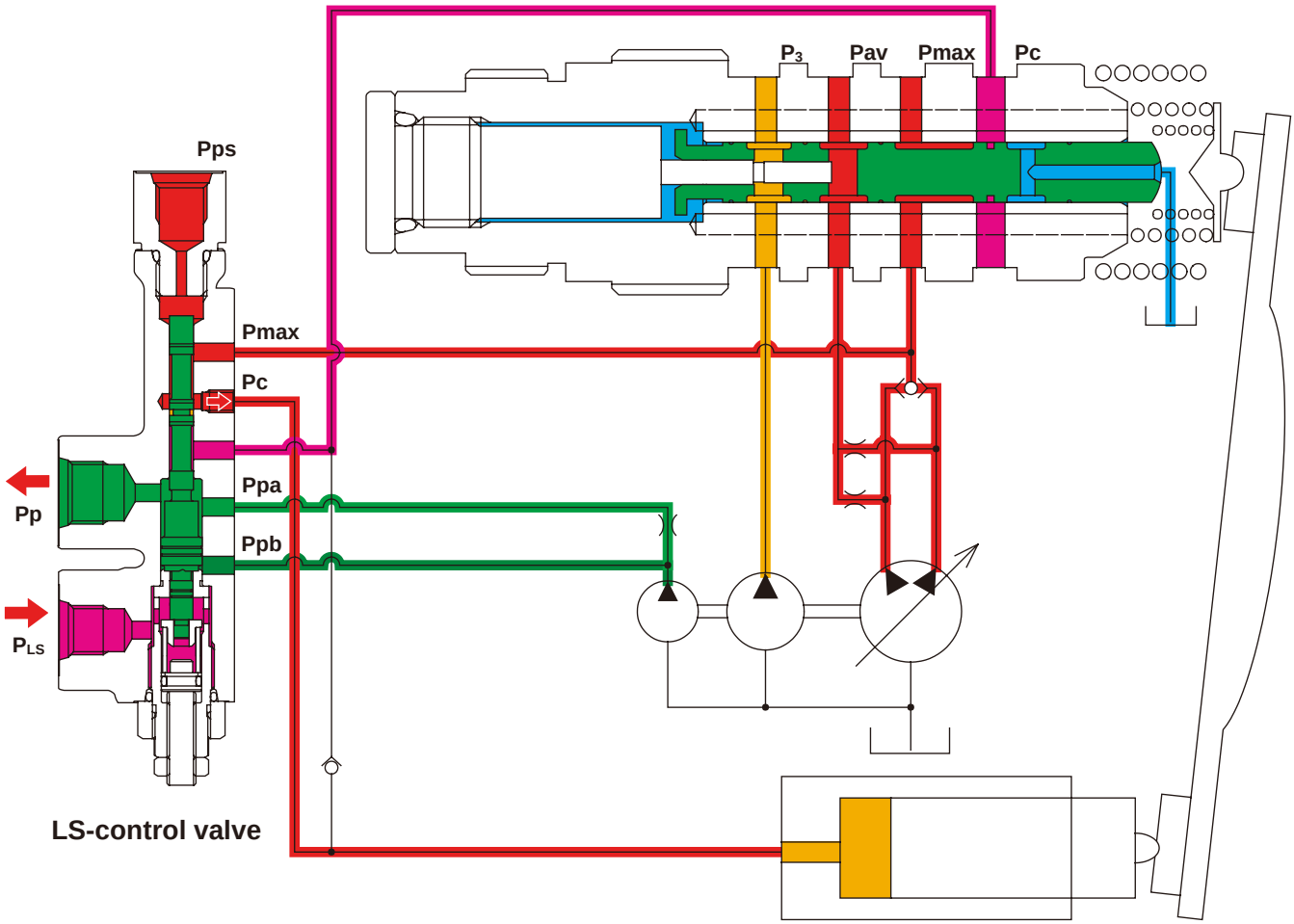
When the machine is working under the stable load condition, load sensing pressure (PLS) and pump swash plate angle are at certain stable values.
Therefore, LS control spool stays balancing according to the following equation.

$P_{PS} = P_{LS} + P_F + \Delta P_P \quad (\Delta P_P = P_{Pb} - P_{Pa})$

Then the control pin stays at the stable position to keep the swash plate for required pump delivery.

2. LS control 2

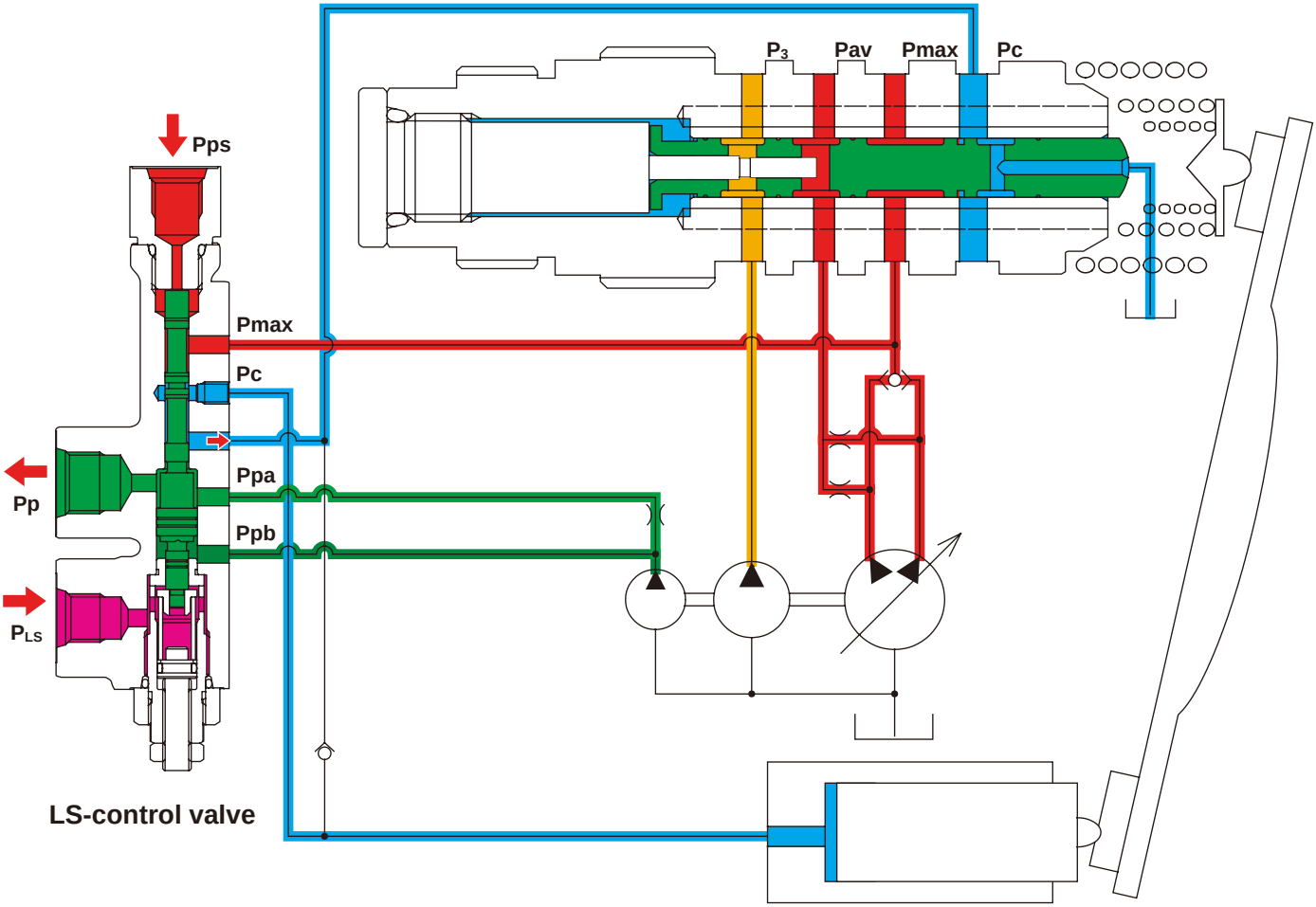
$P_{PS} > P_{LS} + P_F + \Delta P_P$



When an operator shifts the control lever to the inching movement of the front attachment, main spool notch opening area of the control valve is regurated to limit the oil flow through.
Therefore, pressure value before the spool notch (P_{PS}) becomes comparatively higher and the pressure difference between P_{PS} (pressure before the spool notch) and P_{LS} (pressure after the spool notch) increases momentarily.
Thus, pressure balance changes to shift down the LS control spool, which leads the high pressure (P_{max}) to push the control pin and decrease the swash plate angle.

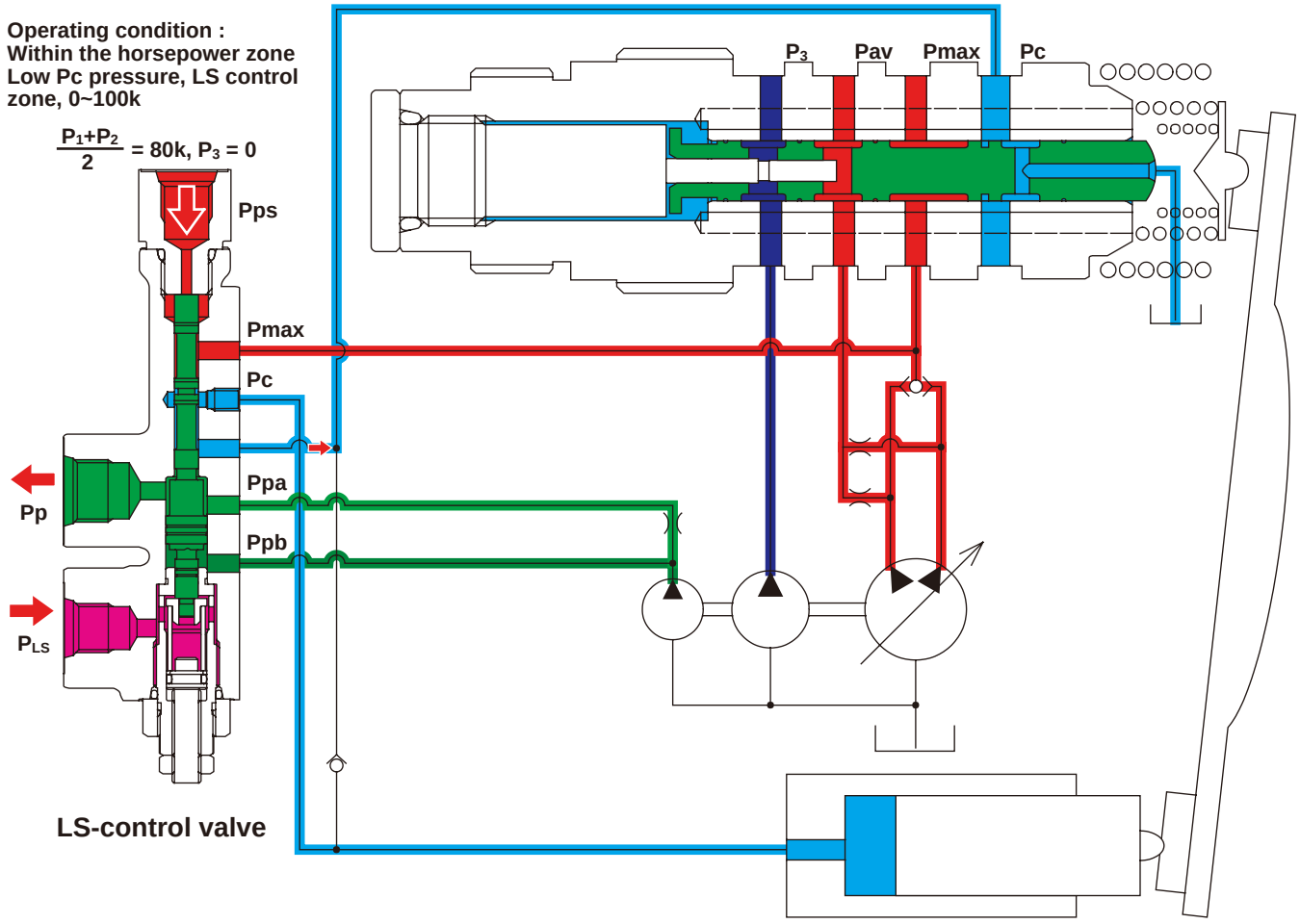
3. LS control 3

$P_{PS} < P_{LS} + P_F + \Delta P_P$



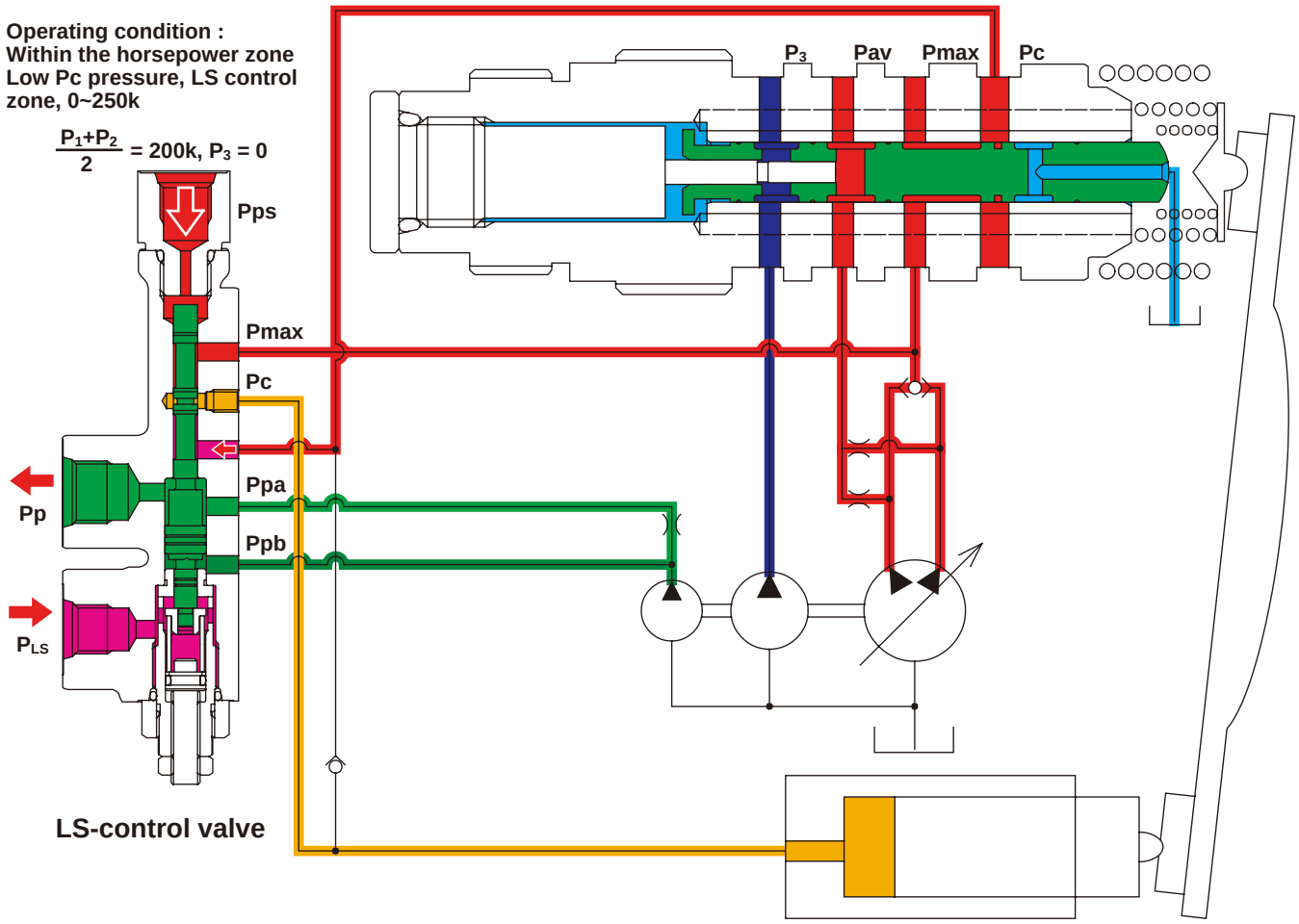
When an operator shifts the control lever to full stroke, main spool notch area of the control valve opens fully. Therefore, pressure value before the spool notch (P_{PS}) becomes comparatively lower and the pressure difference between P_{PS} (pressure before the spool notch) and P_{LS} (pressure after the spool notch) decreases momentarily.
Thus, pressure balance changes to shift up the LS control spool, which leads the control pressure (P_c) from the control pin to dump and increase the swash plate angle.

4. Hose power control 1



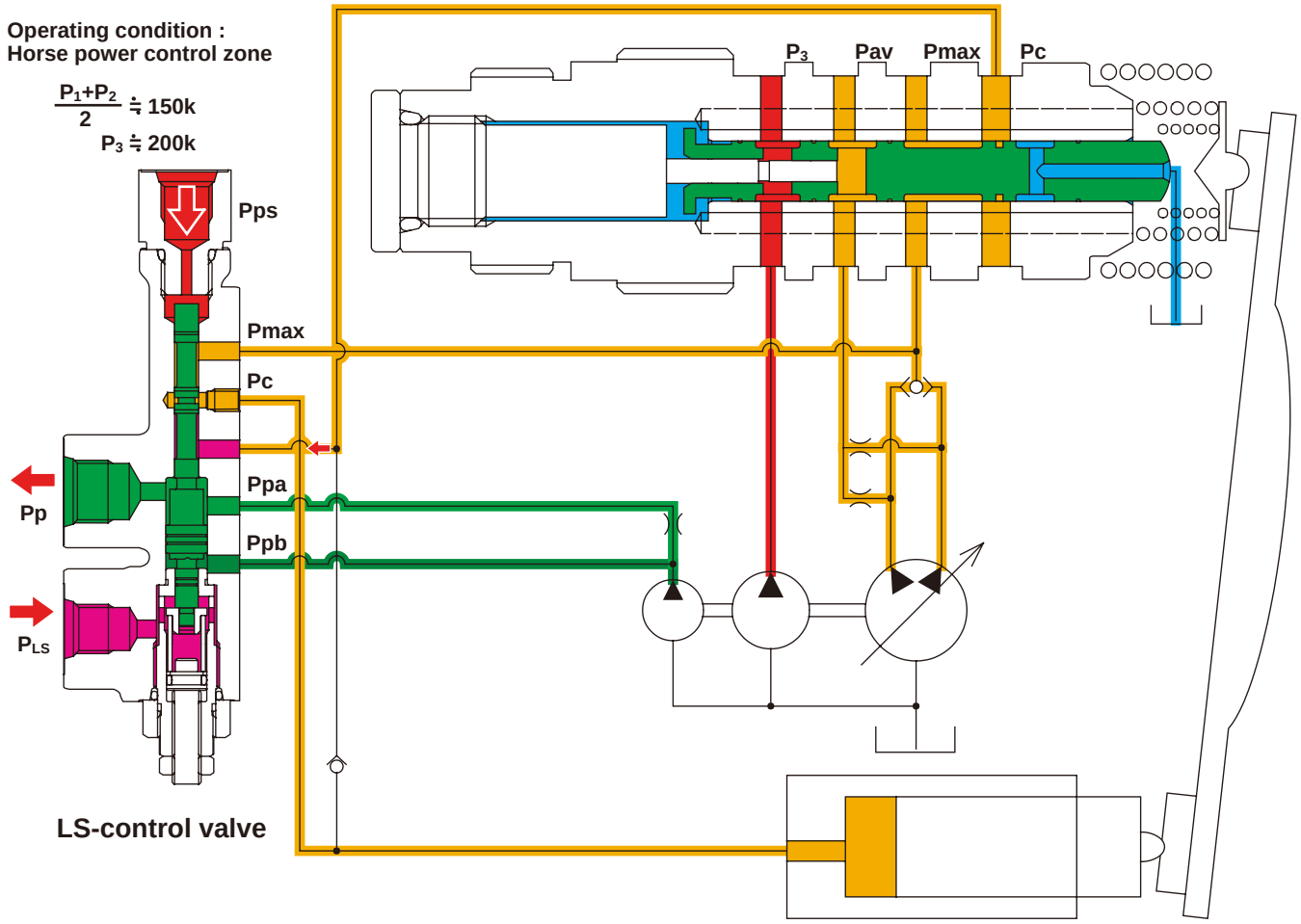
Under this operating condition, average pressure ($\frac{P_1+P_2}{2}$) is being applied the horse power spool to push the spring to increase the swash plate angle.
The control spool notch is opened the P_c port from the control pin chamber to tank.

5. Hose power control 2



Under this operating condition, average pressure ($\frac{P_1+P_2}{2}$) is being applied the horse power spool to push in the right direction and opens the oil passage of P_{max} port to P_c port.
This pressure oil is delivered to the control pin and push the swash plate, balancing against the horse power spool via two springs.

6. Hose power control 3

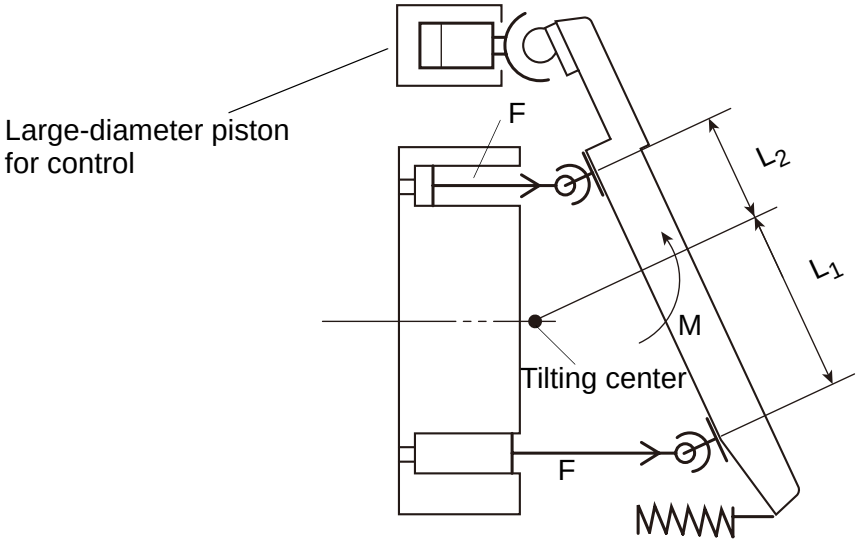


Under this heavy load operating condition, average pressure ($\frac{P_1+P_2}{2}$) and P_3 pressure are being applied the horse power spool to open the oil passage from P_{max} to P_c.
This control pressure is also applied to the control pin to decrease the swash plate angle, preventing the engine stall.

g. FYI (For Your Information)

1. LS pump swash plate control mechanism

KX080-3

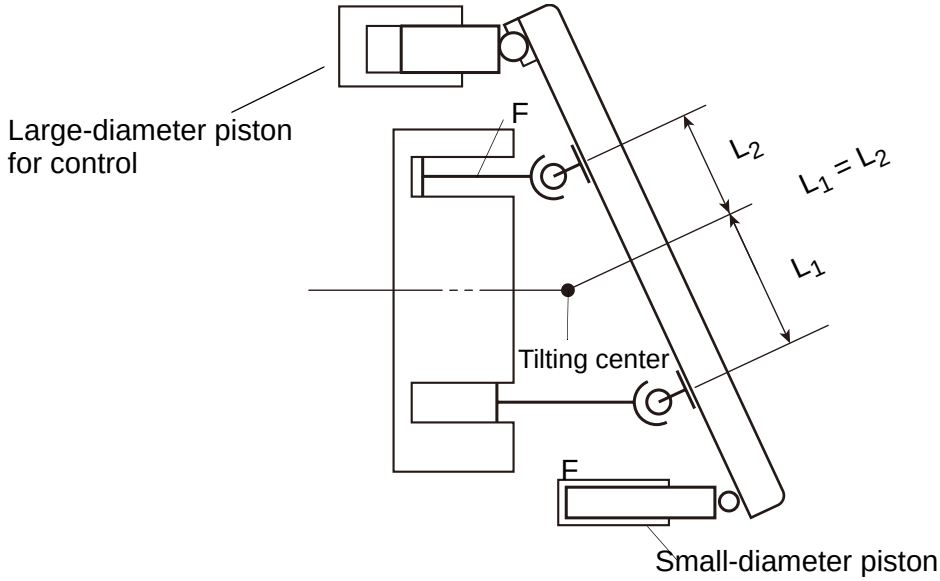


Fa: Assist spring (when F = low pressure)

Clockwise moment of the cylinder block
$= (L_2 \times F - L_1 \times F) \times \cos\vartheta + Fa$

From this equation, the small-diameter piston with a counterclockwise moment has been left out.

Conventional type KX121-3/α, KX161-3/α

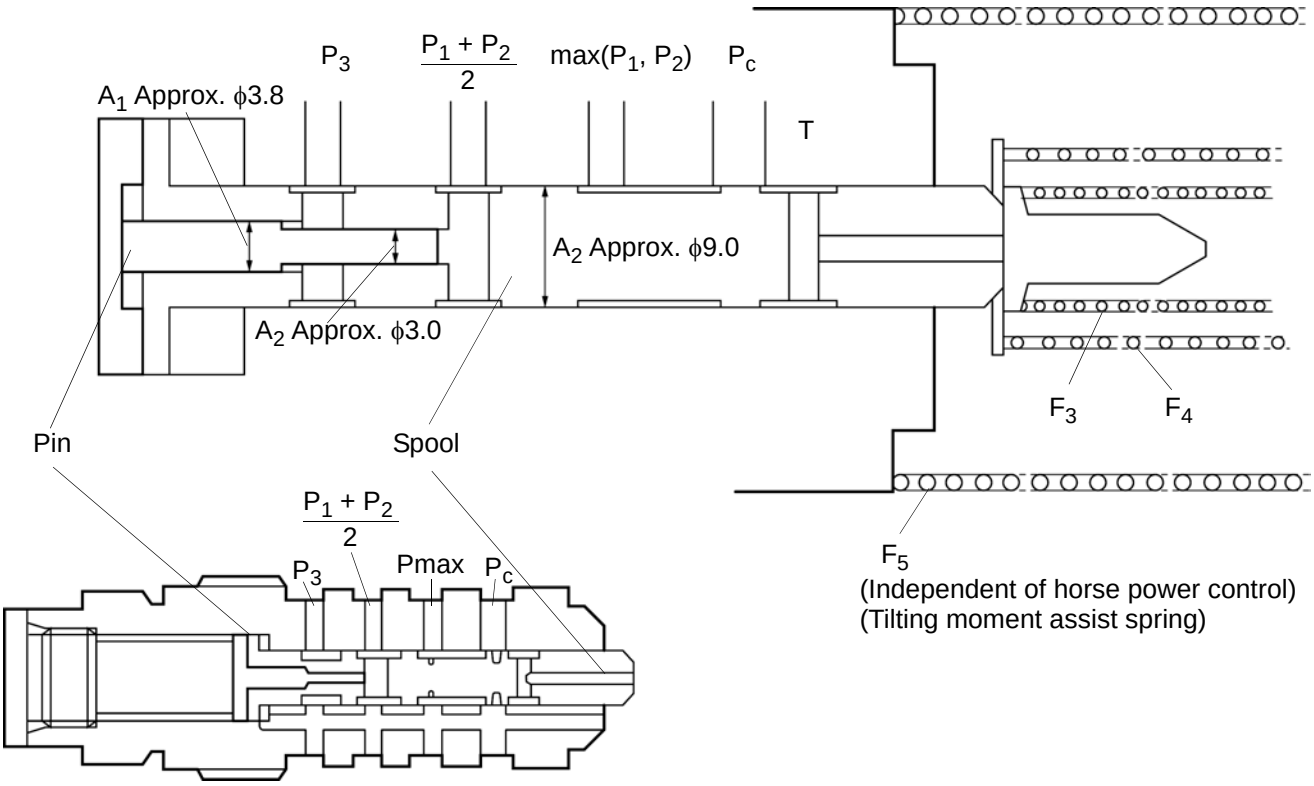


Clockwise moment of the cylinder block
$= (L_2 \times F - L_1 \times F) \times \cos\theta$

Because L1 is equal to L2, the above equation produces 0.

The small-diameter piston has been needed in order to make for greater tilting. (On the variable displacement type except for LS, a large spring has been employed instead of the small-diameter piston.)

2. Horse power control mechanism



$F_1 = P_3 \times (A_1 - A_2)$

$F_2 = \frac{P_1 + P_2}{2} \times A_2$

$F_1 + F_2 = F_3 + F_4$

$F_3 = K_3 \times \chi + \alpha$

$F_3 = K_4 \times (\chi - L_4)$

C.Control Valve

a. Feature

1	Section composition	Center open valve (ϕ14): 3-gang; Swivel, dozer, SP2 P3 confluence valve (ϕ14) Center open valve (ϕ14): 2-gang; Travel left and right Travel selector valve (ϕ18) Center closed valve (LS) (ϕ18): 4-gang monoblock; Arm, bucket, SP1, boom Center closed valve (LS) (ϕ14): 1-gang; Swing Center closed valve (LS) (other spec.) (ϕ14): 2-gang; Future option Angle blade, 2-piece boom
2	Maximum load pressure selection (system change)	High pressure selection => Check valve + LS bleed orifice (ϕ0.5)
3	Spare port	SP1 maximum flow limit: By proportional valve SP1 flow rate: 100 L/min ,26.4 GPM SP2 maximum flow limit: Mechanical stopper SP2 flow rate: 67 L/min, 17.7 GPM
4	Signal circuit	AI signal: PP1 Travel control signal: PP2 (P1 and P2 to the left or right travel section) LS control signal: PP3 P3 pump flow to join the LS system circuit by PP2 + PP3 (travel + LS front system control)
5	Travel speed change when using the dozer	Similar to a variable displacement pump system (speed change by P3 horsepower shift)
6	Traveling	Left/right travel pumps acting independently
7	Others	Boom' s anti-drift valve: None (Leak reduction thanks to the holding valve)

b. Outline

(1) Hydraulic circuit

1	Three-pump LS	Front attachment (Boom, arm, bucket, swing, SP1)	P1 + P2
		Traveling	P1, P2
		Travel + Front attachment	Travel : P1, P2 Front attachment : P3
		Swivel: Dozer, SP2	P3
2	Pressure	Travel	29.4 MPa, 300 kgf/cm^2, 4267 psi
		Front attachment	27.4 MPa, 280 kgf/cm^2, 3983 psi
		Swivel, dozer, SP2 (Service port 2)	20.6 MPa, 210 kgf/cm^2, 2987 psi
		Travel + Front attachment	Travel : 29.4 MPa, 300 kgf/cm^2, 4267 psi Front attachment : 20.6 MPa, 210 kgf/cm^2, 2987 psi
3	Checking the back pressure	Main back-pressure check valve	0.4 MPa, 4.1 kgf/cm^2, 58.0 psi
		Oil cooler back-pressure check valve	0.1 MPa, 1.0 kgf/cm^2, 14.5 psi
4	Overload relief	Arm (bottom)	30.4 MPa, 310 kgf/cm^2, 4410 psi
		Arm (R), boom (B/R), bucket (B/R)	31.4 MPa, 320 kgf/cm^2, 4555 psi
		Dozer (B)	27.5 MPa, 280 kgf/cm^2, 3990 psi
		Dozer (R)	11.8 MPa, 120 kgf/cm^2, 1712 psi
		SP1 (Service port 1)	20.6 Mpa, 210 kgf/cm^2, 2987 psi
5	Others	Swing (R)	Anti-void
		SP2, swing (B)	Stop valve

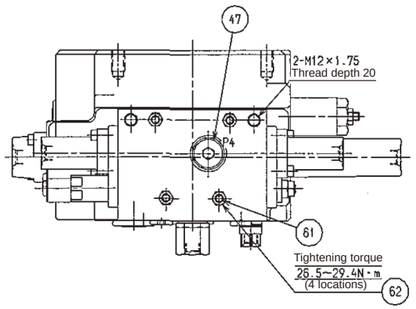
(2) Flow rate

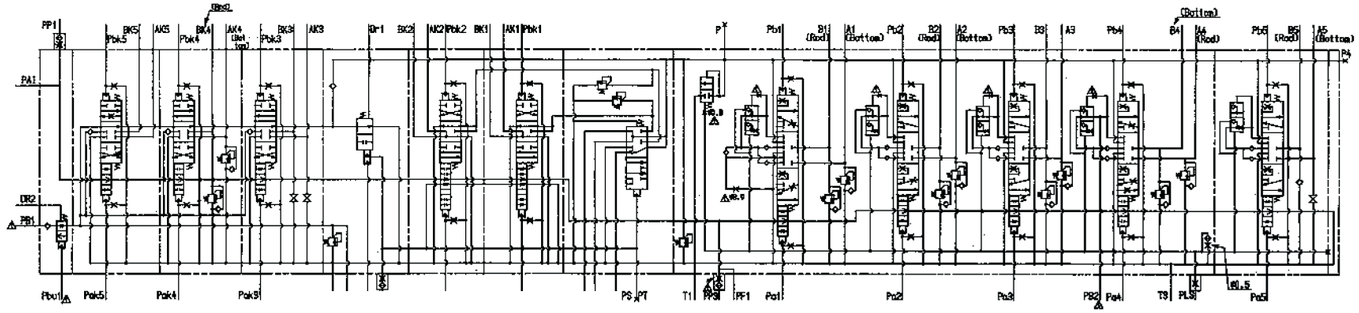
		Approx. flow rate : LPM (GPM)
Boom	Up	110 (29.1)
	Down	68 (18.0)
Arm	Crowded	130 (34.3)
	Dump	95 (25.1)
Bucket	Crowded	90 (23.8)
	Dump	90 (23.8)
SP1		100 (26.4)
Swing	Right	38 (10.0)
	Left	55 (14.5)
Swivel		67 (17.7)
Travel	R & L	72 (19.0) each
Dozer	Up	67 (17.7)
	Down	67 (17.7)
SP2		67 (17.7)

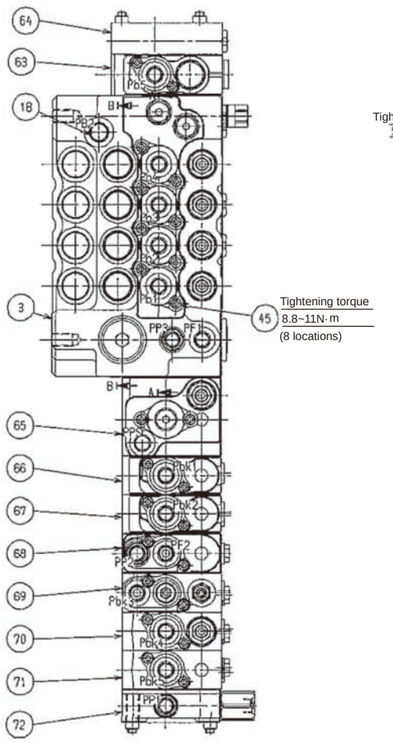
Note : Above flow amount varies according to the load pressure.

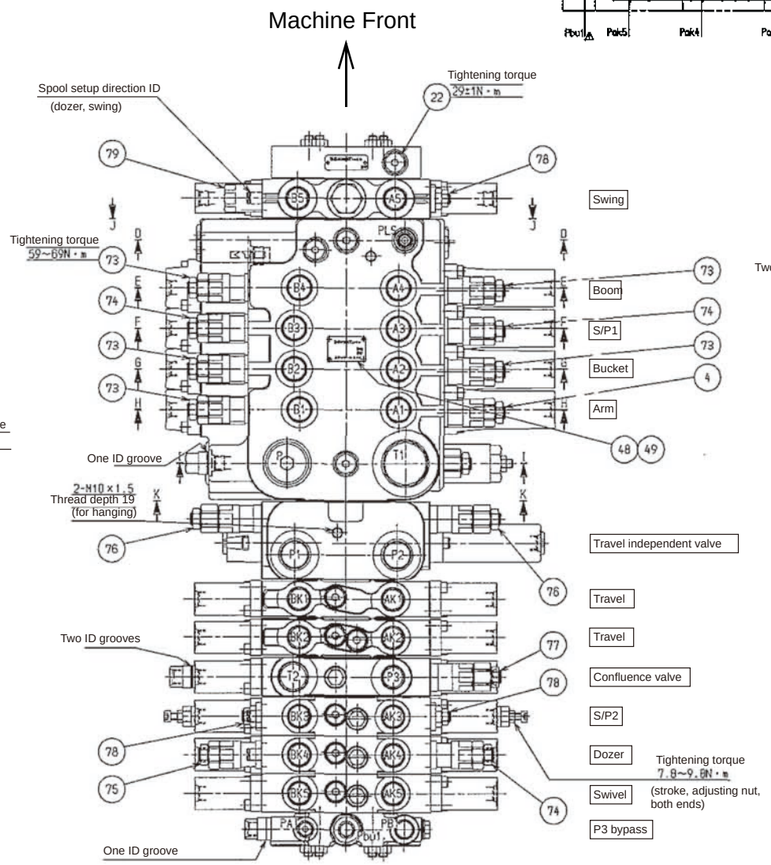
c. Control valve

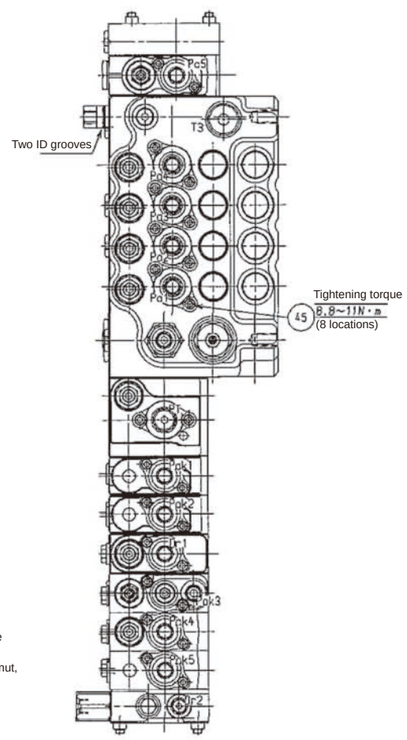
1. Overall view of control valve

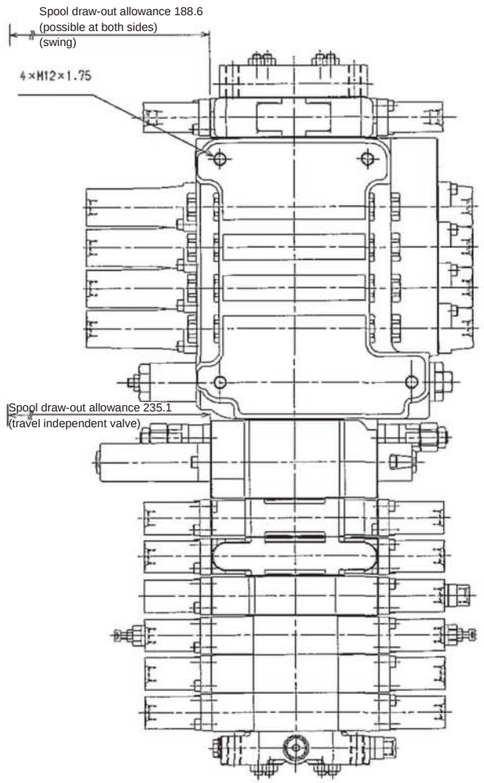


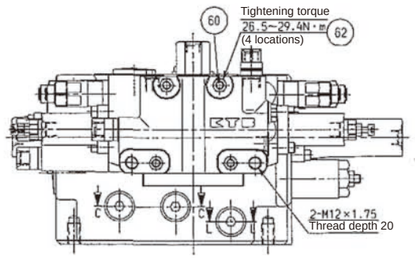












Standard machine

ID No.	Part name	Q'ty	Remarks
1			
2			
3	Valve housing	1	
4	Relief valve kit	1	A1 30.4±0.3MPa at 5L/min
5	Spool	1	
6	Spool	1	
7	Spool	1	
8	Spool	1	
9	Cap	4	
10	Cap	4	
11	Spool end	4	
12	Spring	4	
13	Spring seat	8	
14	Plug	8	
15	Spool	1	
16	Spool	1	
17	Poppet	4	
18	Plug assembly	3	
19	Poppet	1	
20	Spring	1	
21	Plug assembly	1	
22	Plug assembly	6	
23	O-ring	16	
24	Plug	8	
25	Poppet	8	
26	Spring	8	
27	Spool	1	
28	Spool	1	
29	O-ring	8	JISB2401,1A, P26
30	Plug assembly	1	
31	Relief valve kit	1	P(L5) 27.4±0.3MPa at 48L/min
32	Spool	1	
33	Plug	1	
34	Stopper	1	
35	Set-screw	1	JISB1177, M8x25L
36	Nut	1	JISB1181, M8
37	Spring	1	
38	O-ring	1	JISB2401,1B, P12
39	Backup ring	1	JISB2407,P12, T2
40	O-ring	1	JISB2401,1B, P24
41	Sleeve	1	
42	Plug assembly	2	
43	O-ring	1	JISB2401,1B, P16
44	Backup ring	2	JISB2407,P16, T2
45	Socket head bolt	16	JISB1176, M6x20L
46	Plug assembly	1	
47	Plug assembly	2	
48	Nameplate	1	
49	Drive screw	2	
50			

ID No.	Part name	Q'ty	Remarks
51			
52			
53			
54	O-ring	1	JISB2401, 1A, G70
55	O-ring	1	JISB2401, 1A, G75
56	O-ring	1	JISB2401, 1B, P7
57	Spring seat	1	
58			
59			
60	Tie-rod	4	
61	Tie-rod	4	
62	Nut	8	
63	Spool section assembly	1	Swing
64	Outlet housing	1	Outlet
65	Spool section assembly	1	Travel independent valve
66	Spool section assembly	1	Travel
67	Spool section assembly	1	Travel
68	Spool section assembly	1	Confluence valve
69	Spool section assembly	1	S/PS
70	Spool section assembly	1	Dozer
71	Spool section assembly	1	Swivel
72	Outlet section assembly	1	P3 bypass valve
73	Relief valve kit	5	B1,A2,B2,A4,B4 31.4±0.3MPa at 5L/min
74	Relief valve kit	3	A3,B3,AK4 20.6±0.3MPa at 5L/min
75	Relief valve kit	1	BK4 11.8±0.3MPa at 5L/min
76	Relief valve kit	2	P1,P2 29.4±0.3MPa at 43L/min
77	Relief valve kit	1	P3 20.6±0.3MPa at 66L/min
78	Shut-off valve assembly	3	AK3, BK3, A5
79	Anti-void valve assembly	1	B5

2. Control valve specifications

1.	Maximum flow rate:		P1, P2; 72 L/min, P3; 66 L/min
2.	Maximum pressure:		P1, P2; 29.4 MPa, P3; 20.6 MPa
3.	Operating oil temperature range:		253 to 368 °K (-20 to 100°C)
4.	Operating hydraulic oil type:		ISO VG46 or equivalent
5.	Main relief vale pressure setting:	P1, P2 (travel independent valve);	29.4 ± 0.3 MPa at 43 L/min
		P[LS];	27.4 ± 0.3 MPa at 48 L/min
		P3;	20.6 ± 0.3 MPa at 66 L/min
6.	Unload valve pressure setting:		2.45 ± 0.1 MPa at 26 L/min
7.	Overload relief valve pressure setting:	Arm	A1; 30.4 ± 0.3 MPa at 5 L/min
			B1; 31.4 ± 0.3 MPa at 5 L/min
		Bucket	A2; 31.4 ± 0.3 MPa at 5 L/min
			B2; 31.4 ± 0.3 MPa at 5 L/min
		S/P	A3; 20.6 ± 0.3 MPa at 5 L/min
			B3; 20.6 ± 0.3 MPa at 5 L/min
		Boom	A4; 31.4 ± 0.3 MPa at 5 L/min
			B4; 31.4 ± 0.3 MPa at 5 L/min
		Blade	AK4; 27.4 ± 0.3 MPa at 5 L/min
			BK4; 11.8 ± 0.3 MPa at 5 L/min
8.	Pilot air bleeding area		Swivel, dozer, travel, swing, S/P2, arm, S/P1, bucket, boom
9	Equipped with S/P2 spool stroke adjustment mechanism:		Adjustable range; 2 ~ 8 mm
10	Pump LS control pressure difference setting:		1.5 MPa
11.	Genuine Kubota part code:		RO809-61131

Tightening torque for aluminum cap/port joint (pipe)

Port size	PF1/4
Ports applied	pa5, pb5, pak1 ~ 2, pak 4 ~ 5, pbk 1 ~ 2, pbk 4 ~ 5
Recommended tightening torque	34.3 N·m
Maximum torque	39.2 N·m
Thread breaking torque	44.1 N·m
[Conditions]	Standard-size joint (threaded-part length 12)
Remarks	Be careful not to apply any torque over maximum one.

Port name	Port size
T1	PF1-1/4
P1, P2, T2, P	PF3/4
A1 ~ A4, B1 ~ B4	7/8-14UNF
P3, P4, A5, B5, AK1 ~ AK5, BK1 ~ BK5, T3	PF1/2
[PB1], [PB2]	PF3/8
Pa1 ~ Pa5, Pb1 ~ Pb5, Pak1 ~ Pak5, Pbk1 ~ Pbk5, PP1 ~ PP3, PPS, PLS, PAI, PF1, PF2, PT, Dr1, Dr2, Pbu1	PF1/4

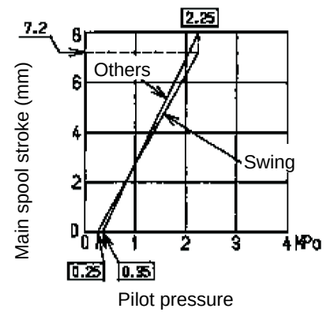


Fig. 1 Pressure receiving characteristic of main spool

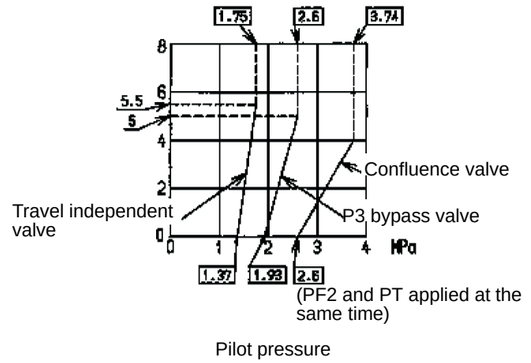
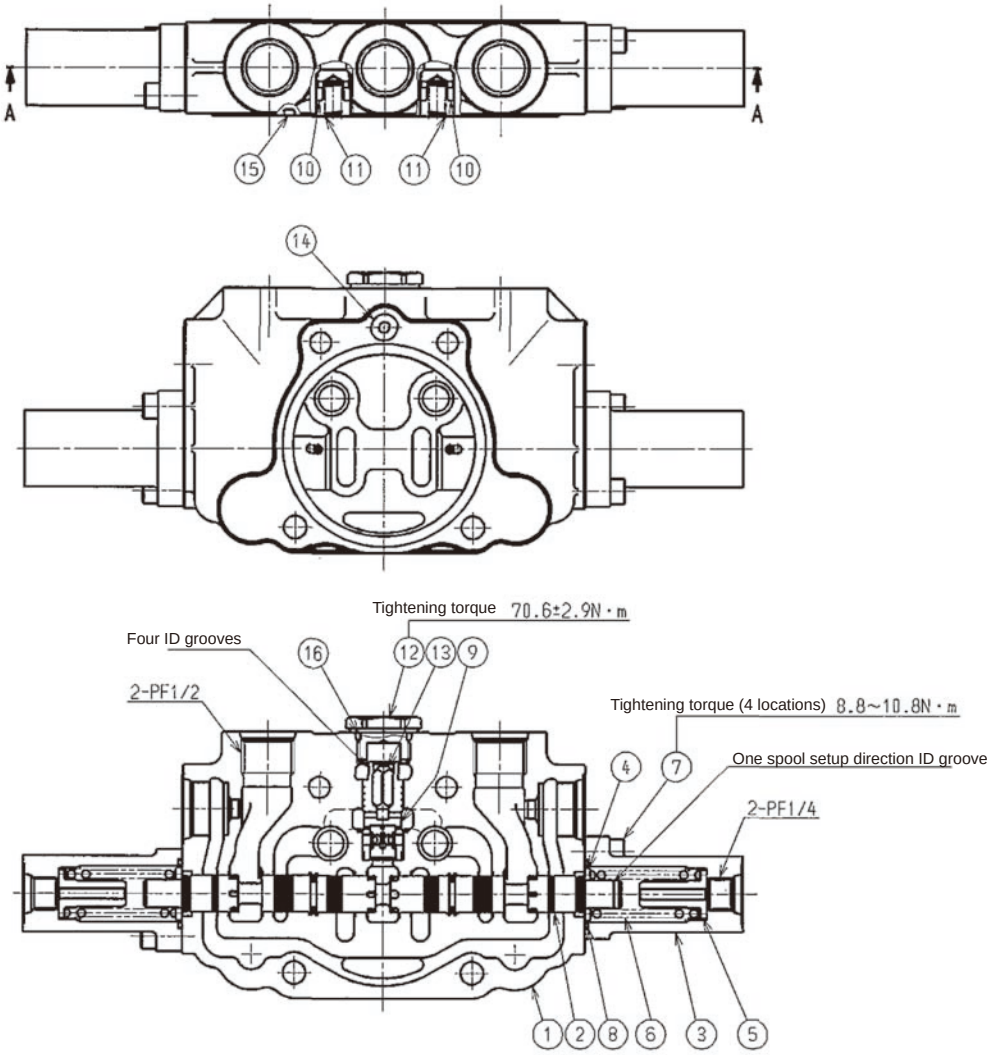


Fig. 2 Pressure receiving characteristic of travel independent and other valves

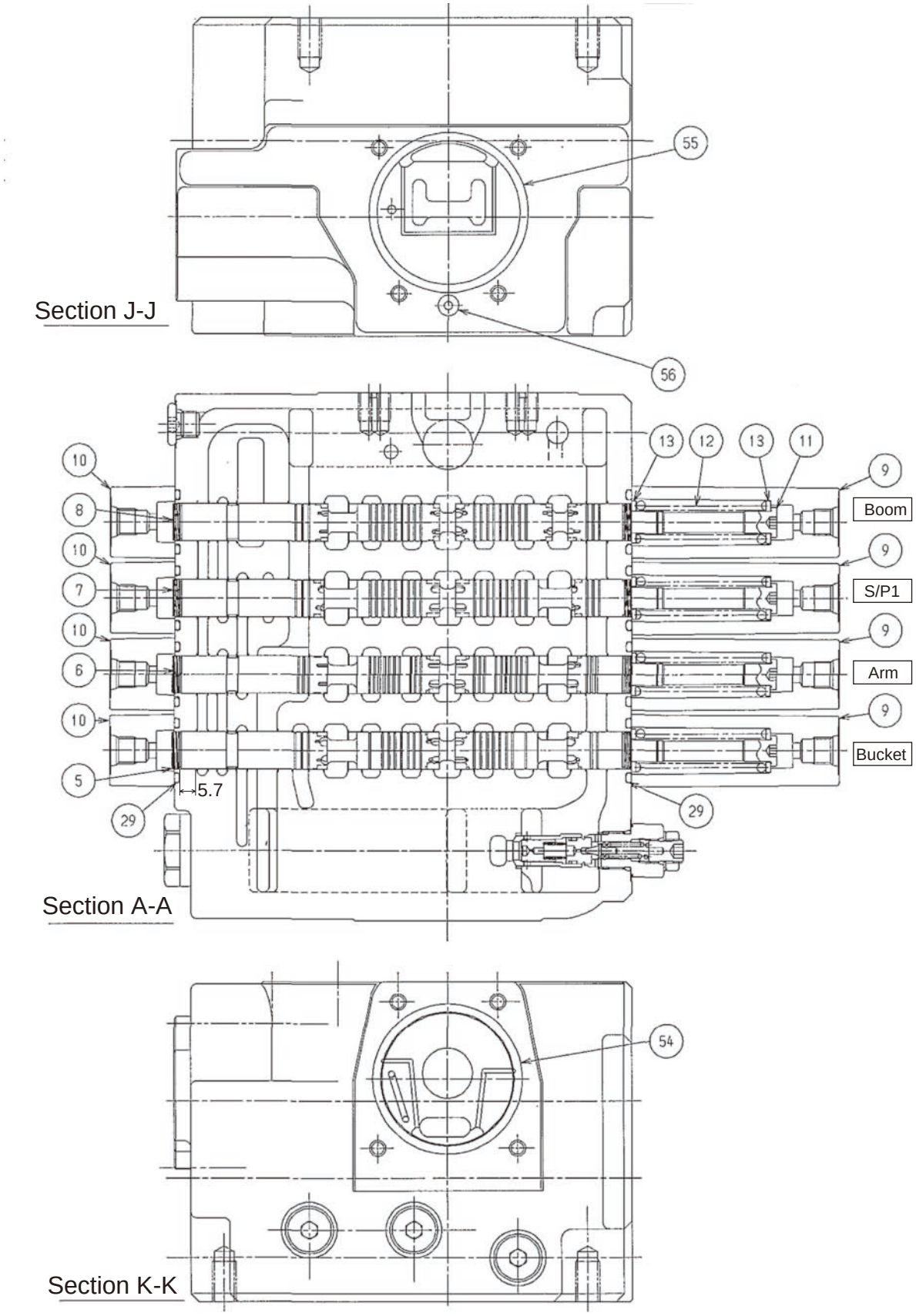
3. Swing section

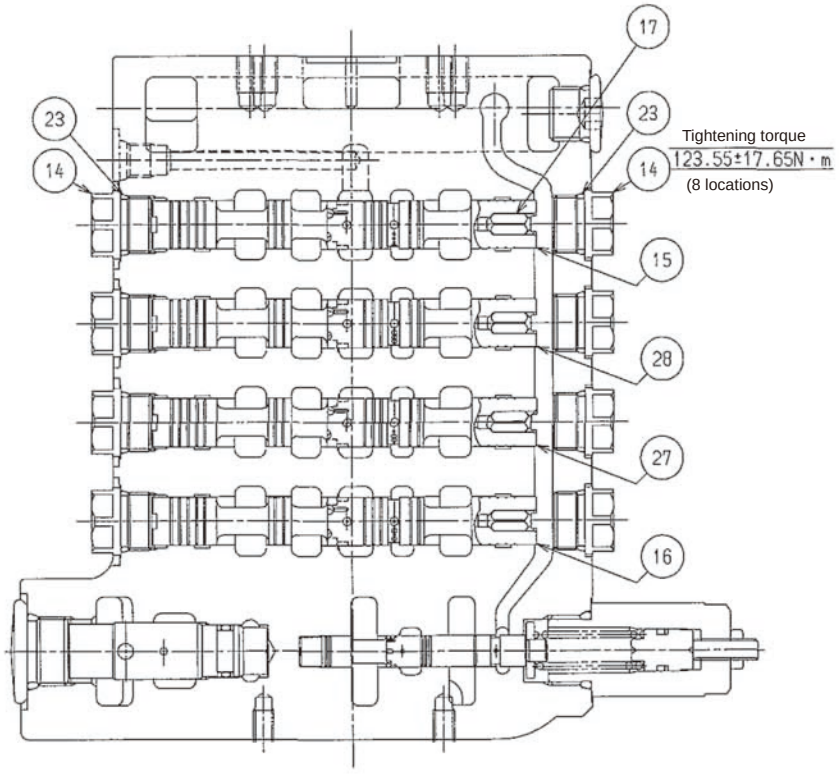


Section A-A

ID No.	Part name	Q'ty	Remarks
1	Valve housing		
2	Spool		
3	Cap	1	
4	Spring seat	1	
5	Spring seat	1	
6	Spring	1	
7	Socket head bolt	1	JISB1176, M6x18L
8	O-ring	1	JISB2401,1A, S24
9	Spool (compensation valve)	4	
10	Poppet (check valve)	4	
11	Spring (check valve)	4	
12	Plug	4	
13	Poppet	8	
14	O-ring	8	JISB2401,18, P7
15	O-ring	1	
16	O-ring	1	JISB2401,1B, P18

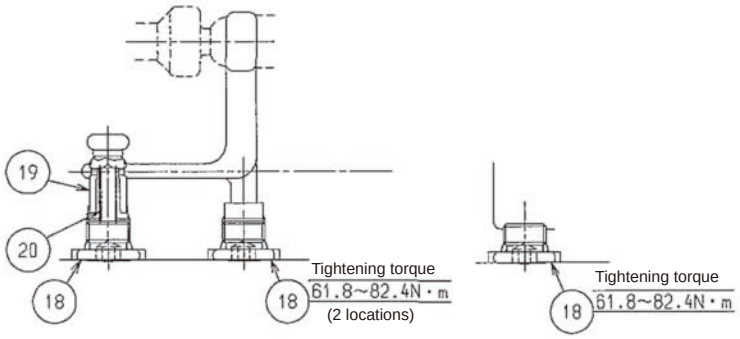
4. Control valve; Uni-block section assy



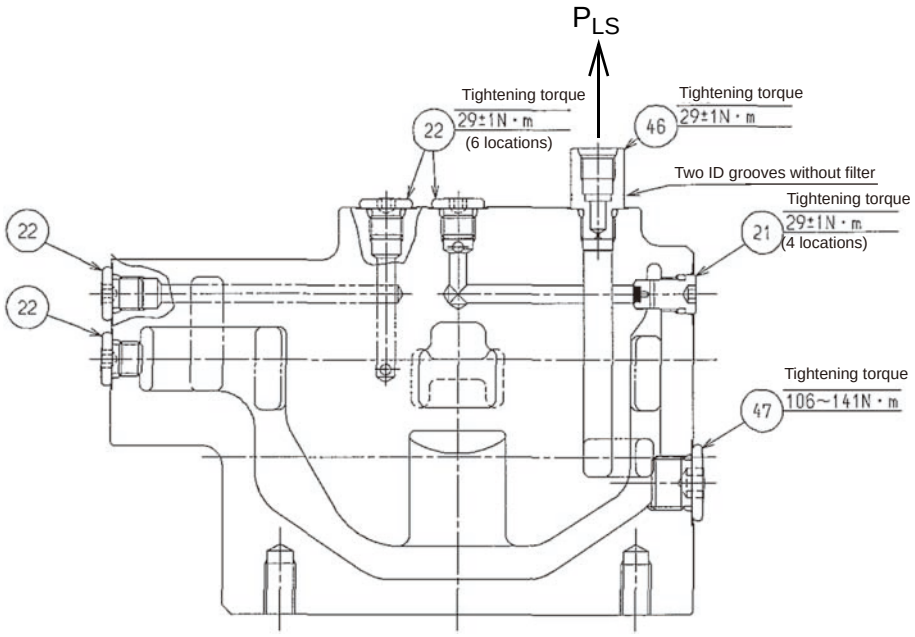


Section B-B

(Check poppet for arm regeneration)

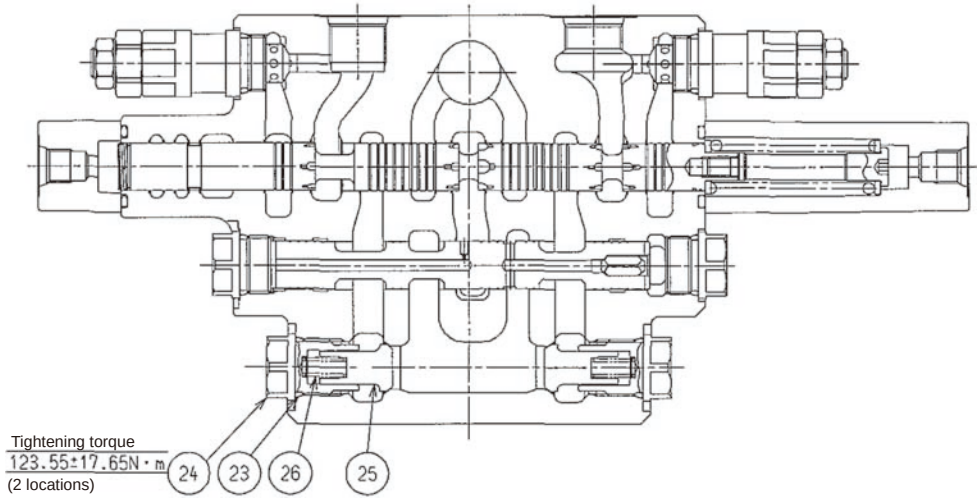


Section C-C Section L-L



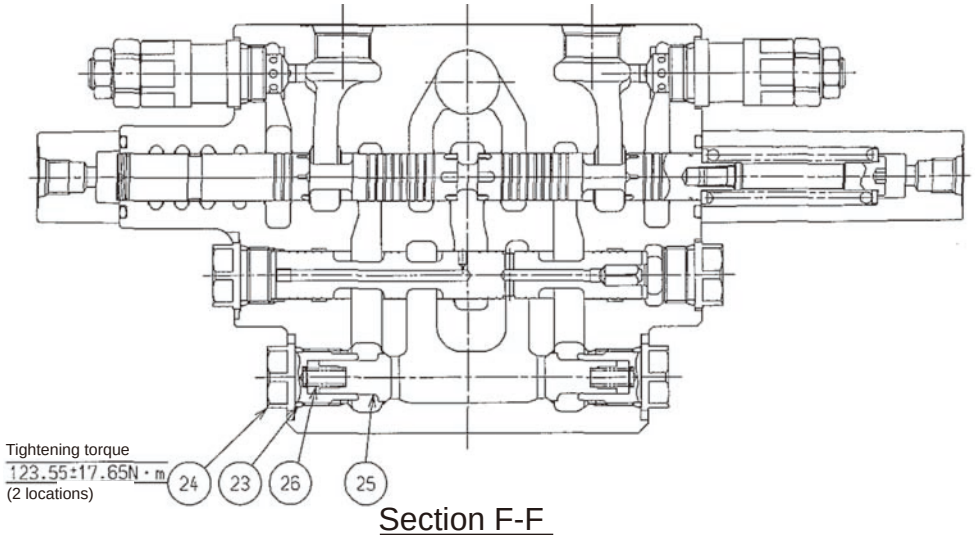
Section D-D

5. Boom



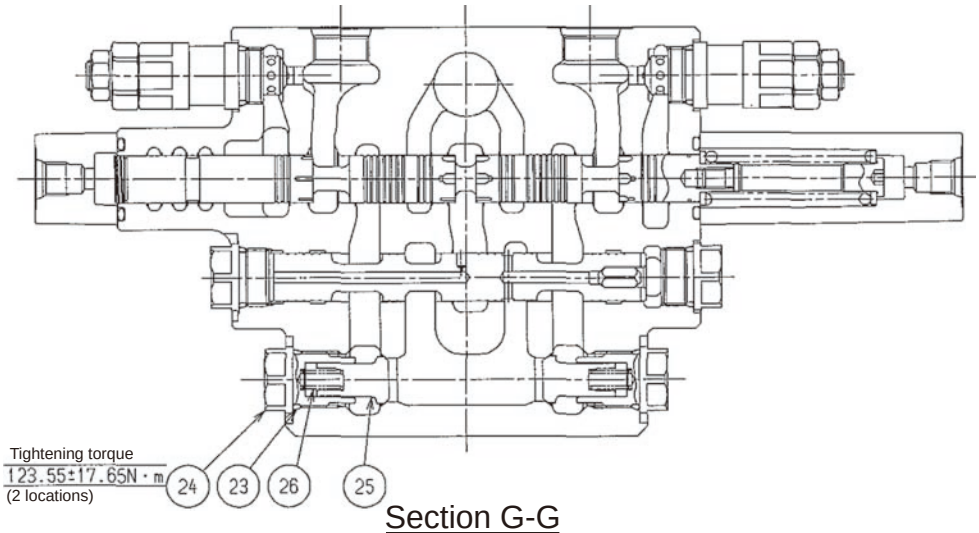
Section E-E

6. S/P1



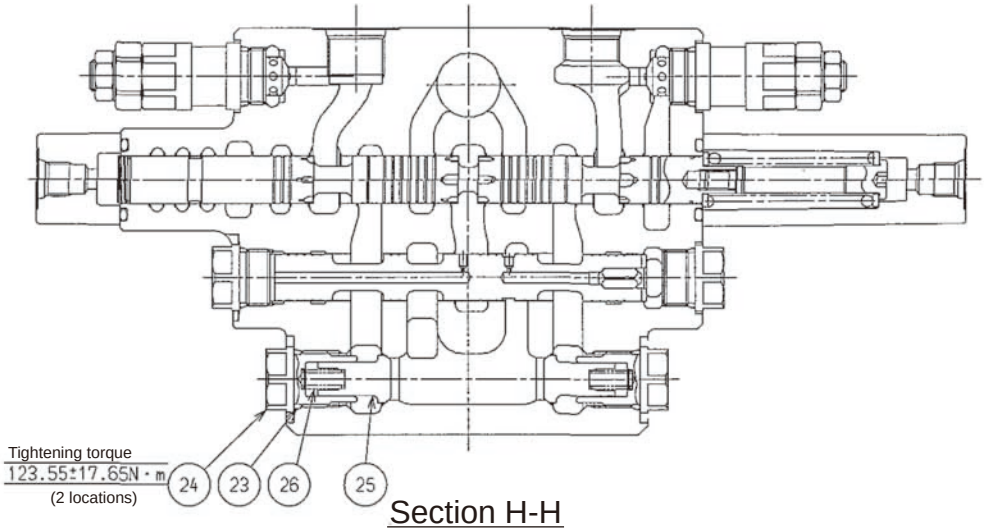
Section F-F

7. Bucket

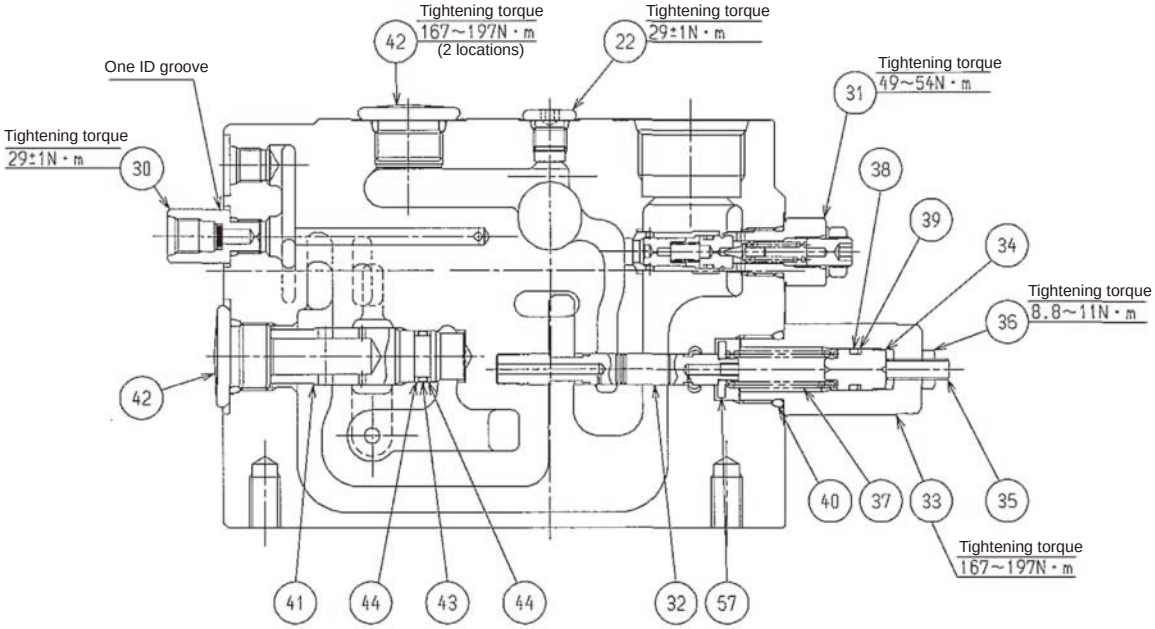


Section G-G

8. Arm

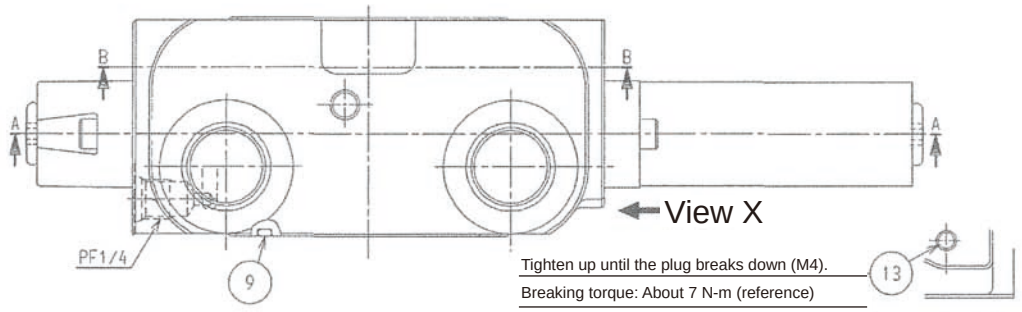


Section H-H

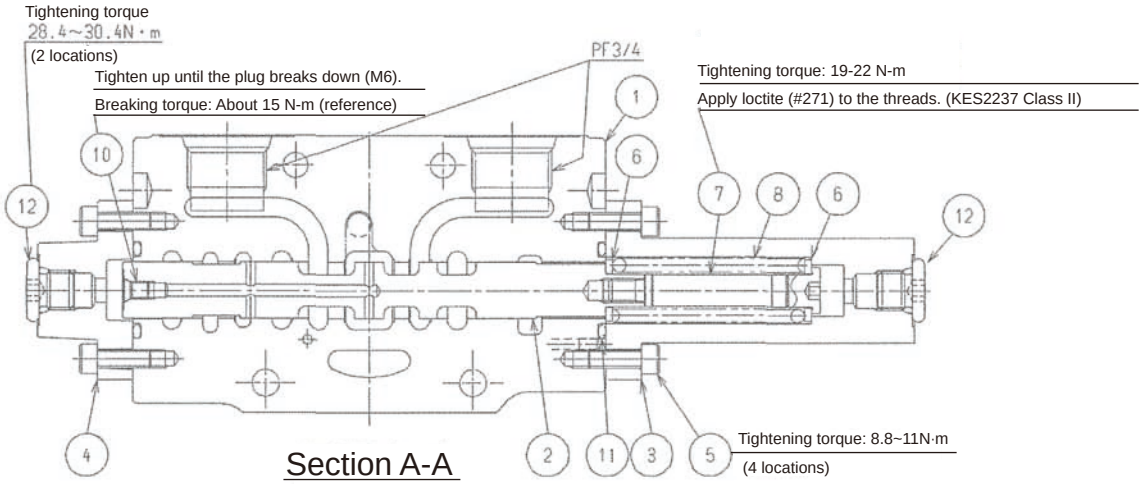


Section I-I

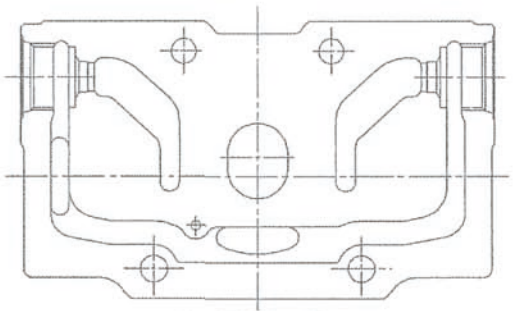
9. Travel independent valve



View X



Section A-A

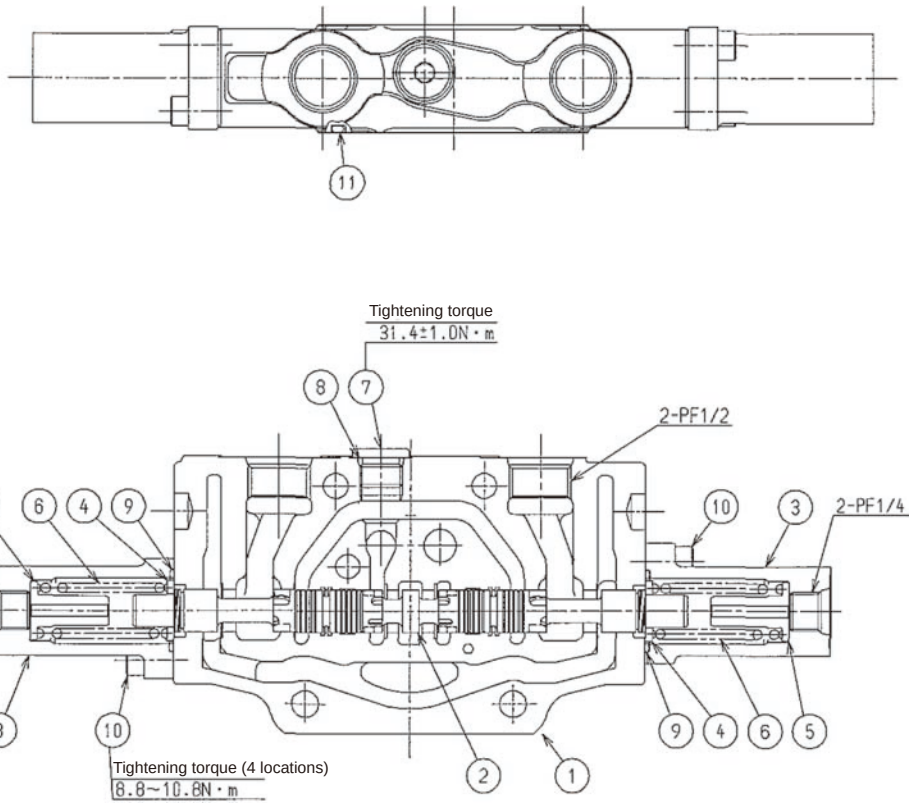


Section B-B

ID No.	Part name	Q'ty	Remarks
1	Valve housing	1	
2	Spool	1	
3	Cap	1	
4	Cap	1	
5	Socket head bolt	4	JISB1176, M6x18L
6	Spring seat	2	
7	Spool end	1	
8	Spring	1	
9	O-ring	1	JISB2401,1A, G70
10	Plug	1	
11	O-ring	2	JISB2401,1A, P26
12	Plug assembly	2	
13	Plug	1	

10.Travel, R section

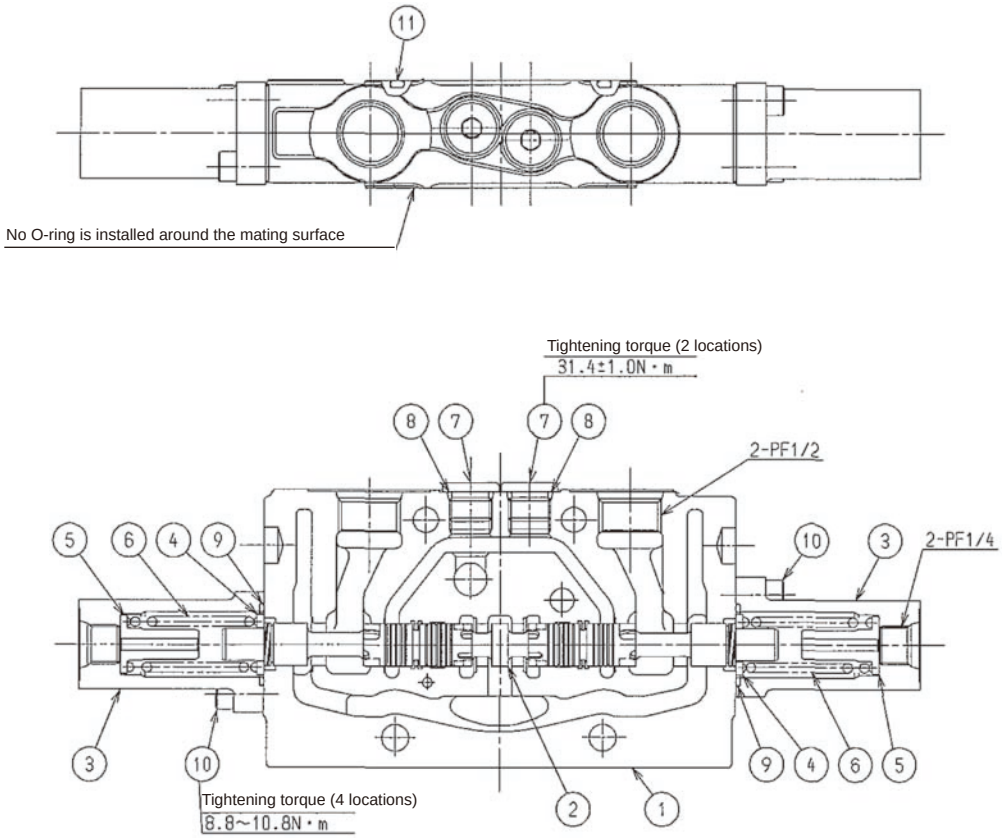
Travel upstream (next to travel independent valve)



ID No.	Part name	Q'ty	Remarks
1	Valve housing	1	
2	Spool	1	
3	Cap	2	
4	Spring seat	2	
5	Spring seat	2	
6	Spring	2	
7	Plug	1	
8	O-ring	1	
9	O-ring	2	JISB2401,1A, G70
10	Socket head bolt	4	JISB1176, M6x18L
11	O-ring	1	JISB2401,1A, G70

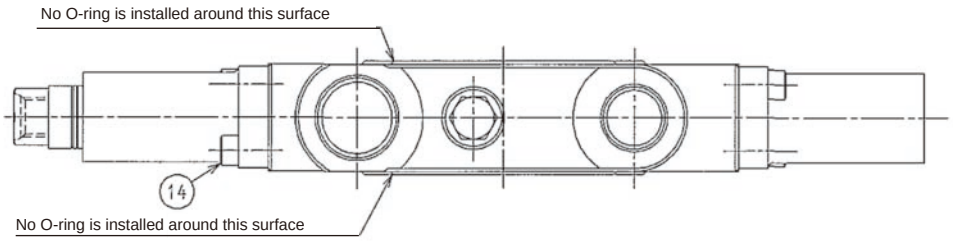
11.Travel, L section

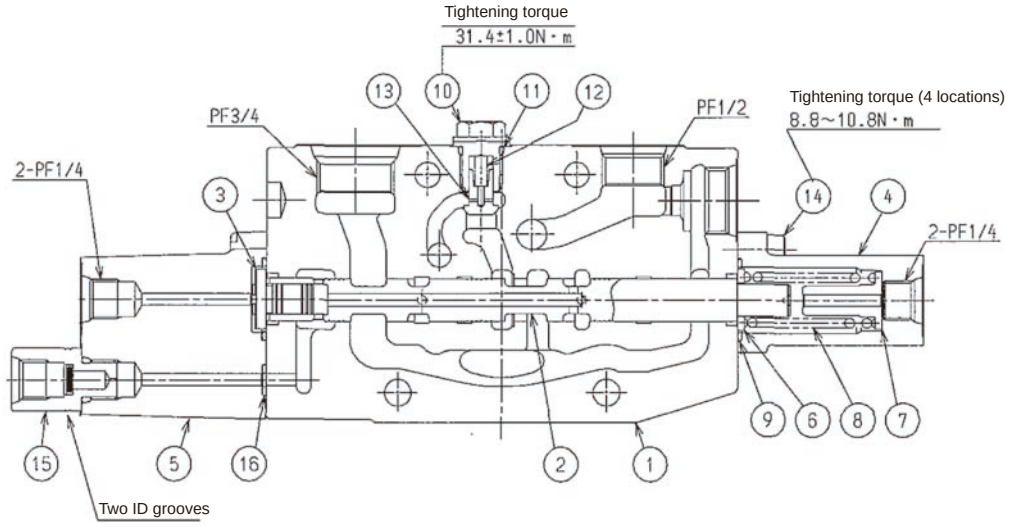
Travel downstream (next to confluence valve)



ID No.	Part name	Q'ty	Remarks
1	Valve housing	1	
2	Spool	1	
3	Cap	2	
4	Spring seat	2	
5	Spring seat	2	
6	Spring	2	
7	Plug	2	
8	O-ring	2	
9	O-ring	2	JISB2401,1A, P24
10	Socket head bolt	4	JISB1176, M6x18L
11	O-ring	1	JISB2401,1A, G70

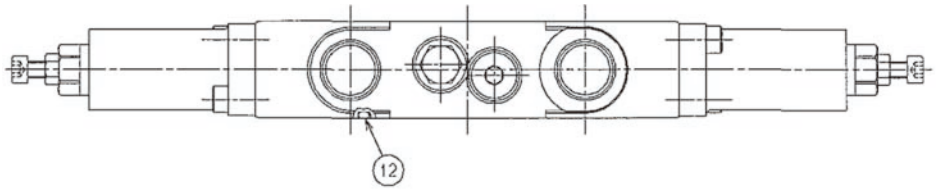
12.Combined valve

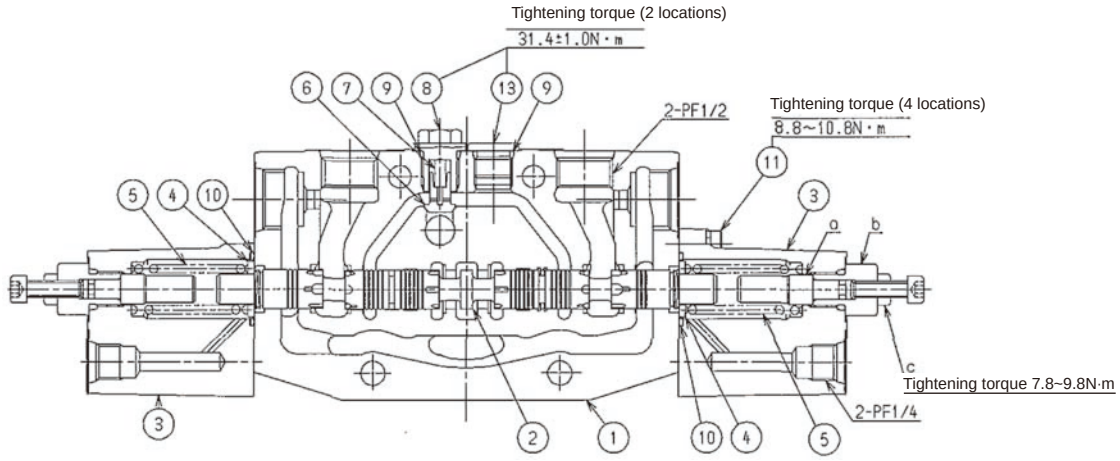




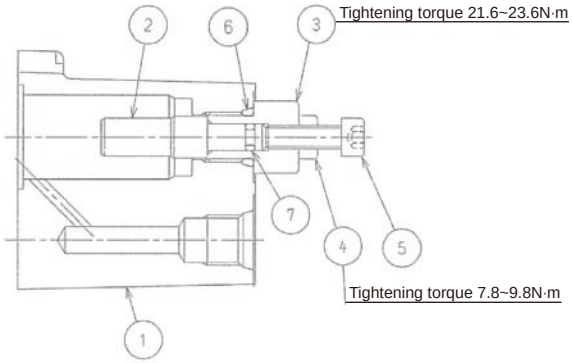
ID No.	Part name	Q'ty	Remarks
1	Valve housing	1	
2	Spool	1	
3	Piston	1	
4	Cap	1	
5	Cap	1	
6	Spring seat	1	
7	Spring seat	1	
8	Spring	1	
9	O-ring	2	JISB2401,1A, P24
10	Plug (check valve)	1	
11	O-ring	1	
12	Spring	1	
13	Poppet (check valve)	1	
14	Socket head bolt	4	JISB1176, M6x18L
15	Plug assembly	1	
16	O-ring	1	JISB2401,1A, G70

13.S/P2 valve





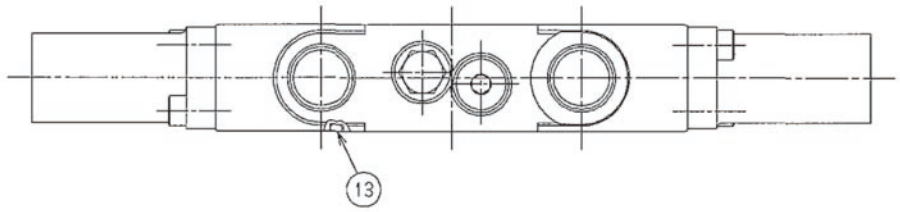
ID No.	Part name	Q'ty	Remarks
1	Valve housing	1	
2	Spool	1	
3	Cap assembly	2	
4	Spring seat	2	
5	Spring	2	
6	Poppet (check valve)	1	
7	Spring (check valve)	1	
8	Plug (check valve)	1	
9	O-ring	2	
10	O-ring	2	JISB2401,1A, P24
11	Socket head bolt	4	JISB1176, M6x18L
12	O-ring	1	JISB2401,1A, G70
13	Plug	1	

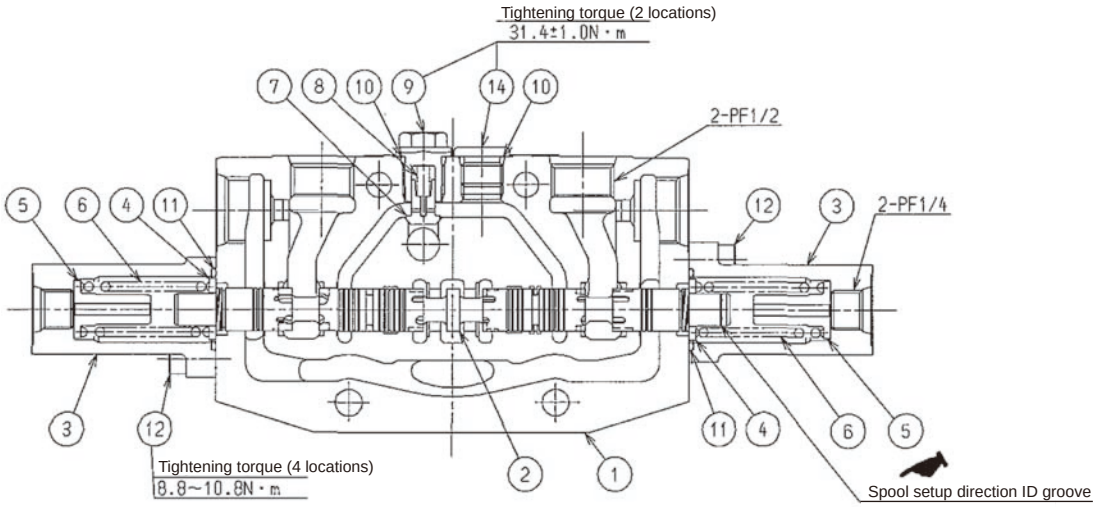


ID No.	Part name	Q'ty	Remarks
1	Cap	1	
2	Piston	1	
3	Plug	1	
4	Nut	1	JISB1181, M16
5	Socket head bolt	1	JISB1176, M6x20L
6	O-ring	1	JISB2401,1B, P11
7	O-ring	1	JISB2401,1A, P4

(Note : This part is compatible with KX161-3S/α)

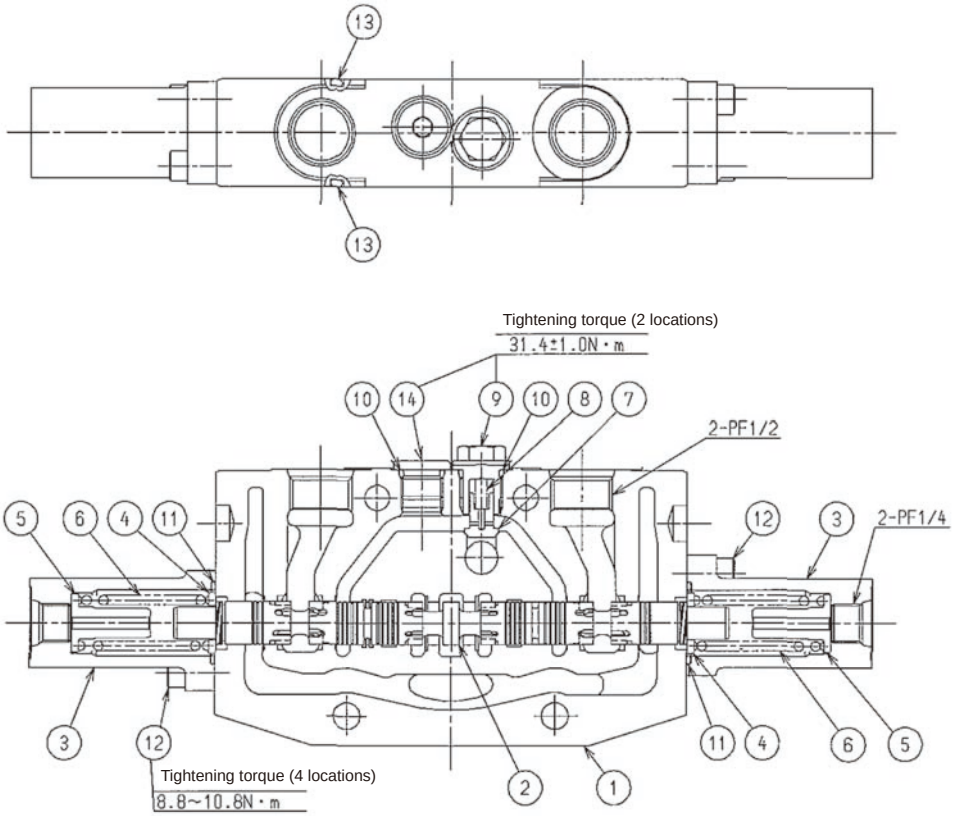
14.Dozer section





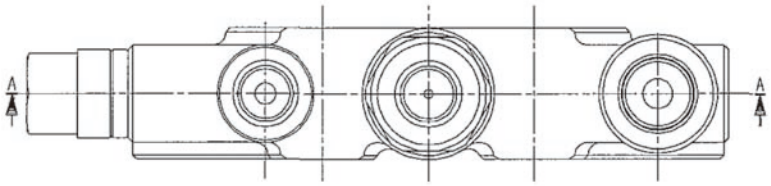
ID No.	Part name	Q'ty	Remarks
1	Valve housing	1	
2	Spool	1	
3	Cap	2	
4	Spring seat	2	
5	Spring seat	2	
6	Spring	2	
7	Poppet (check valve)	1	
8	Spring (check valve)	1	
9	Plug (check valve)	1	
10	O-ring	2	
11	O-ring	2	JISB2401,1A, P24
12	Socket head bolt	4	JISB1176, M6x18L
13	O-ring	1	JISB2401,1A, G70
14	Plug	1	

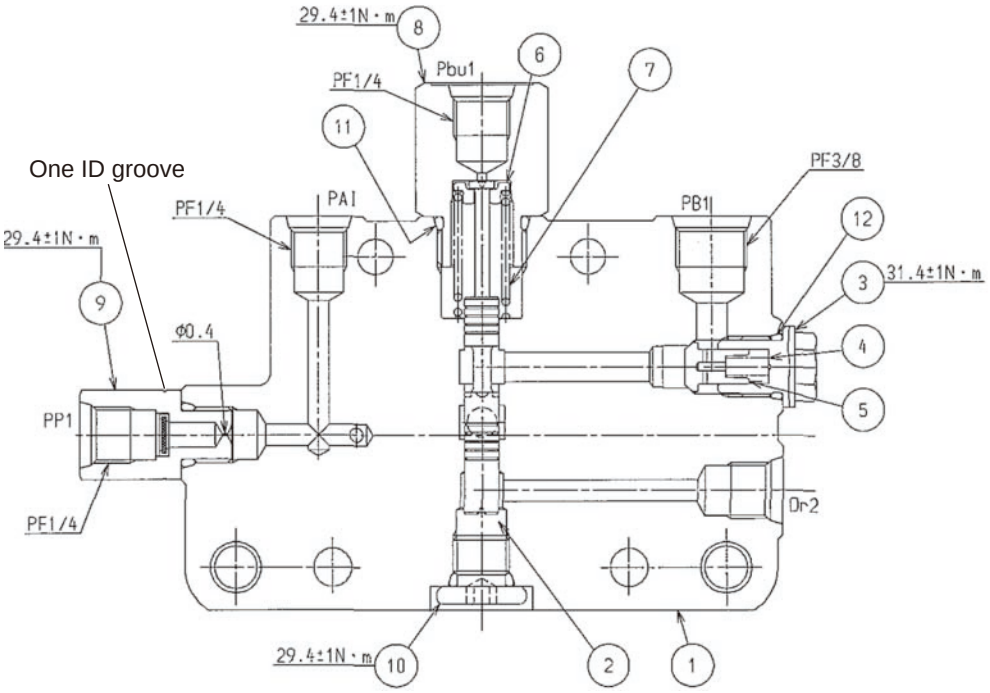
15.Swivel section



ID No.	Part name	Q'ty	Remarks
1	Valve housing	1	
2	Spool	1	
3	Cap	2	
4	Spring seat	2	
5	Spring seat	2	
6	Spring	2	
7	Poppet (check valve)	1	
8	Spring (check valve)	1	
9	Plug (check valve)	1	
10	O-ring	2	
11	O-ring	2	JISB2401,1A, P24
12	Socket head bolt	4	JISB1176, M6x18L
13	O-ring	2	JISB2401,1A, G70
14	Plug	1	

16.Outlet section, P3 bypass valve

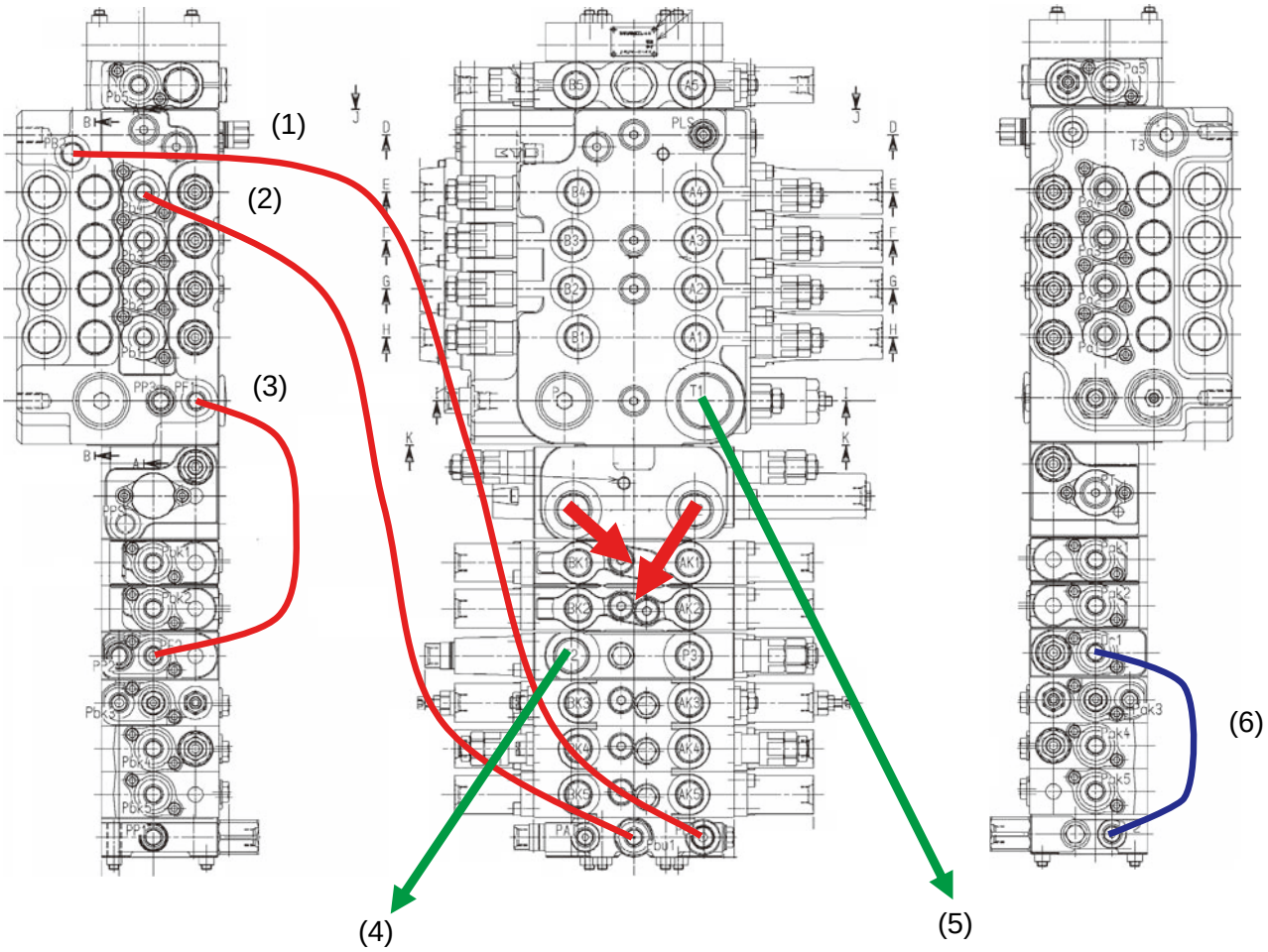




Section A-A

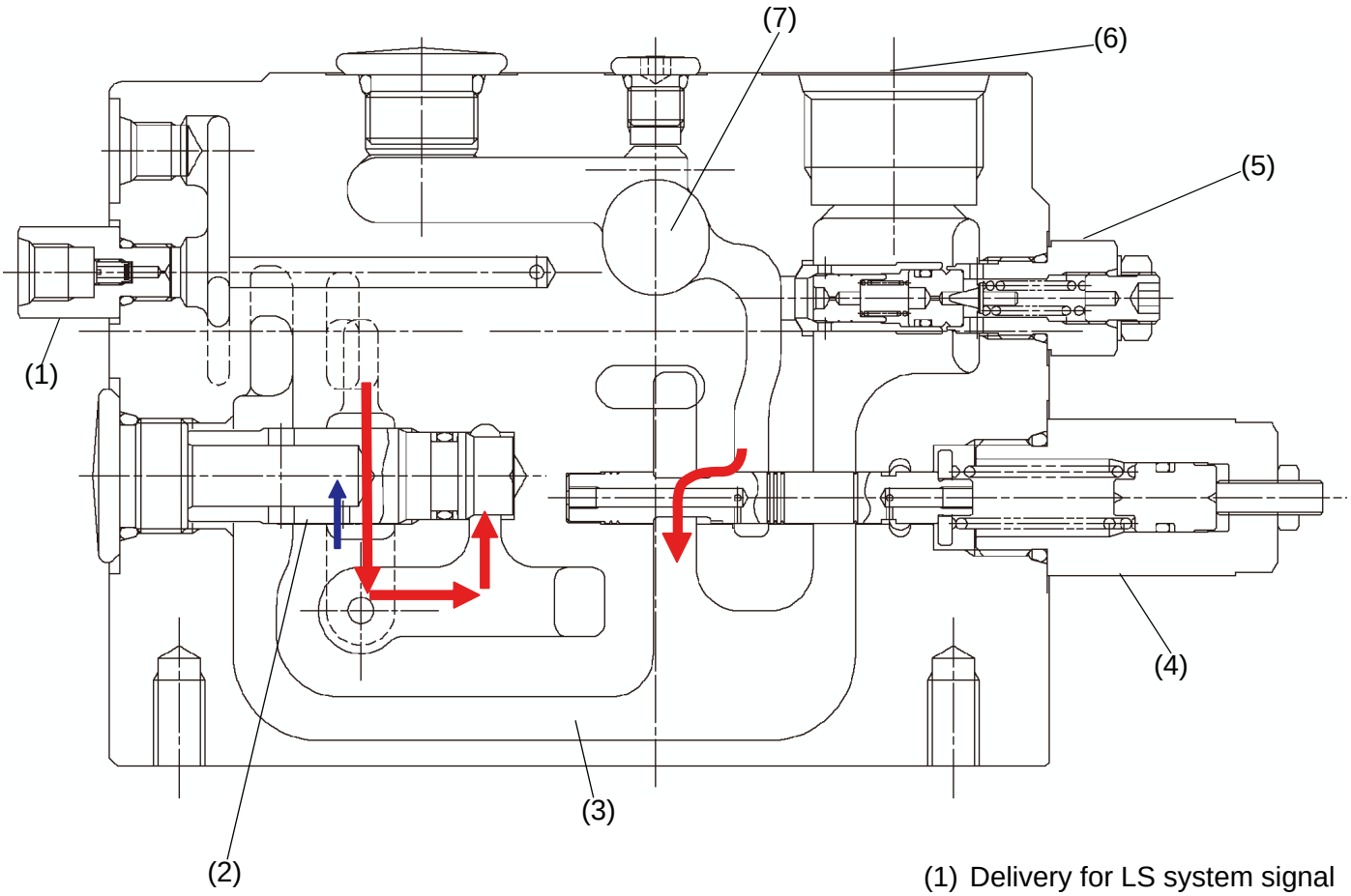
ID No.	Part name	Q'ty	Remarks
1	Valve housing	1	
2	Spool	1	
3	Plug	2	
4	Spring	2	
5	Poppet	2	
6	Spring seat	1	
7	Spring	1	
8	Plug	1	
9	Plug assembly	2	
10	Plug assembly	2	
11	O-ring	4	JISB2401,1B, P18
12	O-ring	1	

d. Layout, delivery circuit and external pipe flow



(1) P3 bypass confluence
(2) P3 bypass signal branch
(3) LS system detection external circuit
(4) To oil cooler via swivel motor and back-pressure check valve
(5) Return filter via back-pressure check valve
(6) Drain

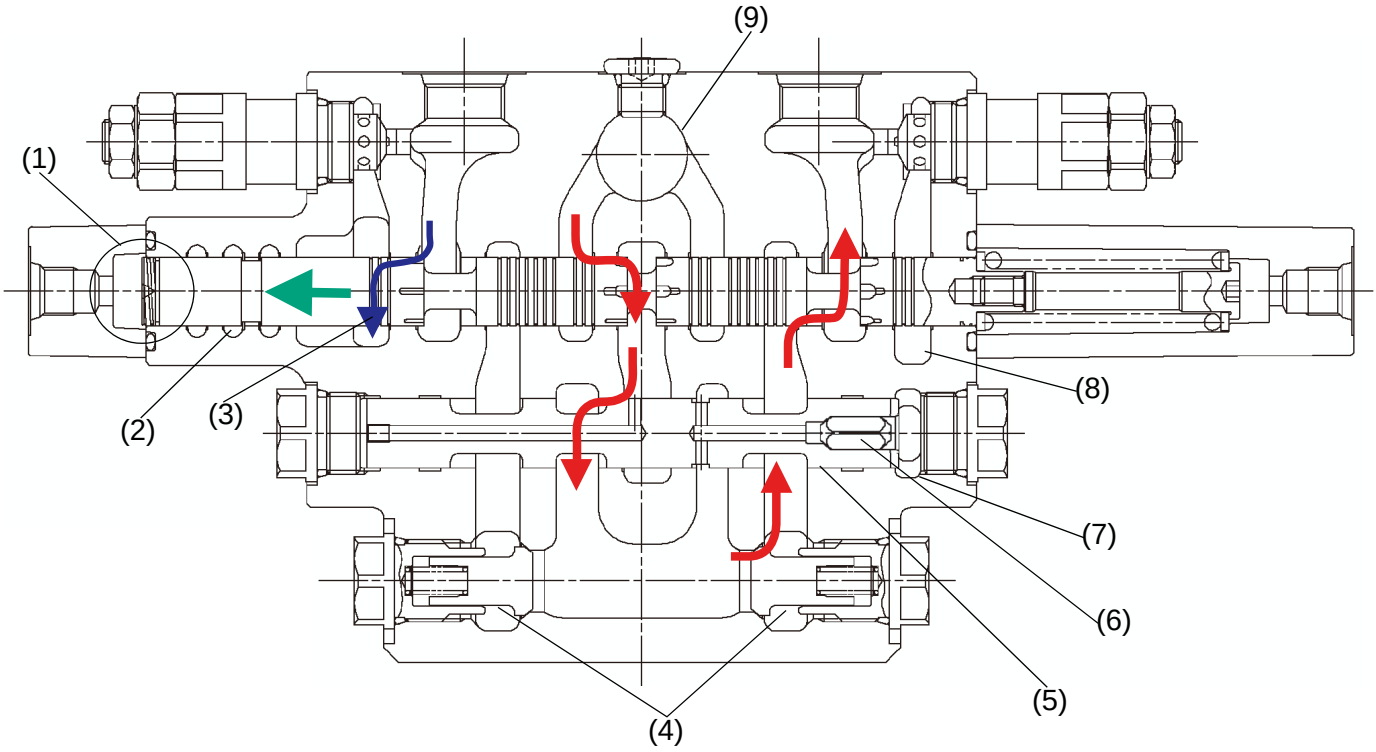
e. Inlet section of mono-block valve



Monoblock inlet
LS relief, unload relief, arm regenerative spool

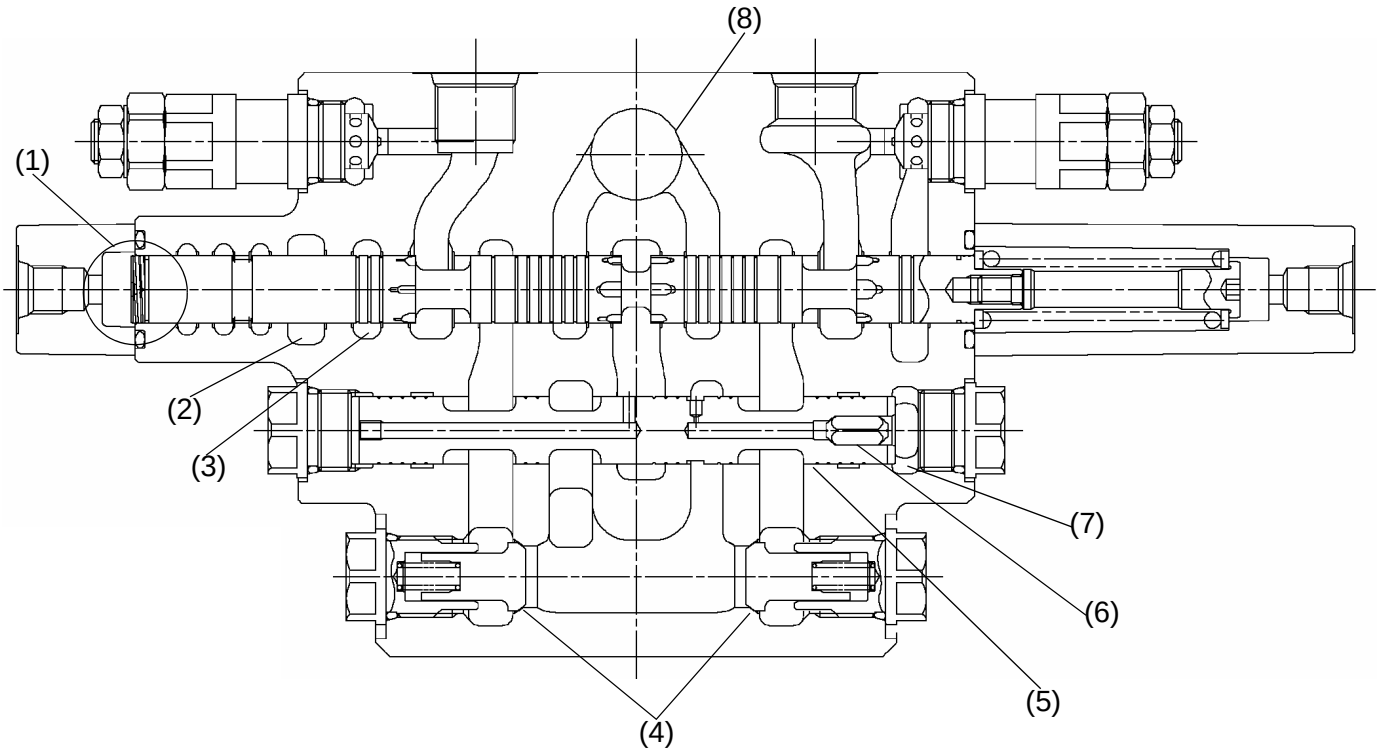
(1) Delivery for LS system signal (PP3)
(LS system control detected)
(2) Arm' s regenerative spool
(3) Tank circuit
(4) LS system unload relief
2.5 MPa
(5) LS system main relief
27.4 MPa
(6) Tank circuit to back-pressure check valve
(7) Pump circuit

f. Center closed valve section (Bucket, S/P 1, Boom)



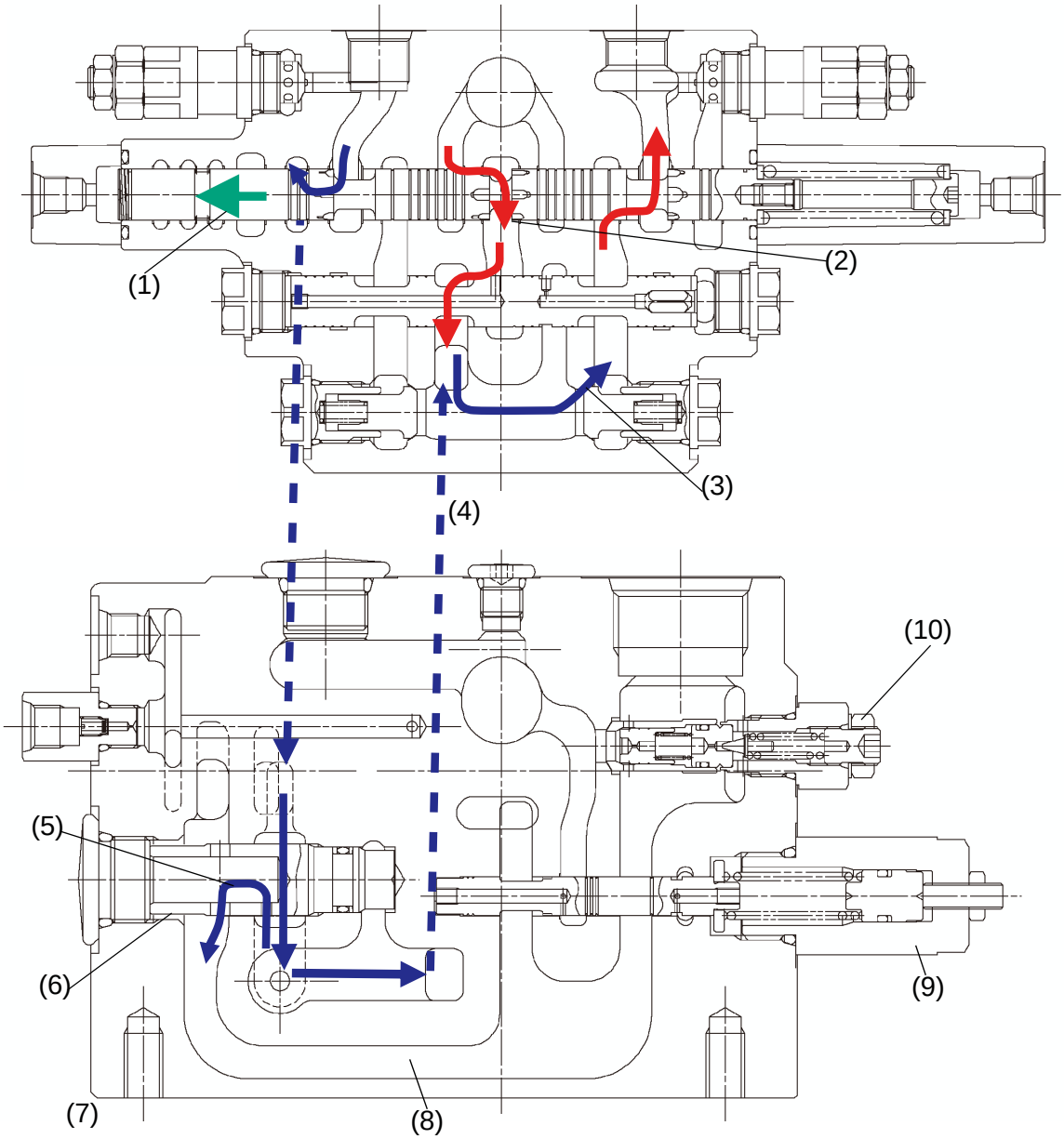
(1) Spiral groove air bleeding circuit
(2) AI signal circuit
(3) Tank circuit
(4) Return check valve
(5) Pressure compensating valve (Compensating spool)
(6) Check valve for PLS signal high-pressure selection
(7) LS signal circuit
(8) Tank circuit
(9) Pump circuit

g. Center closed valve section (Arm)



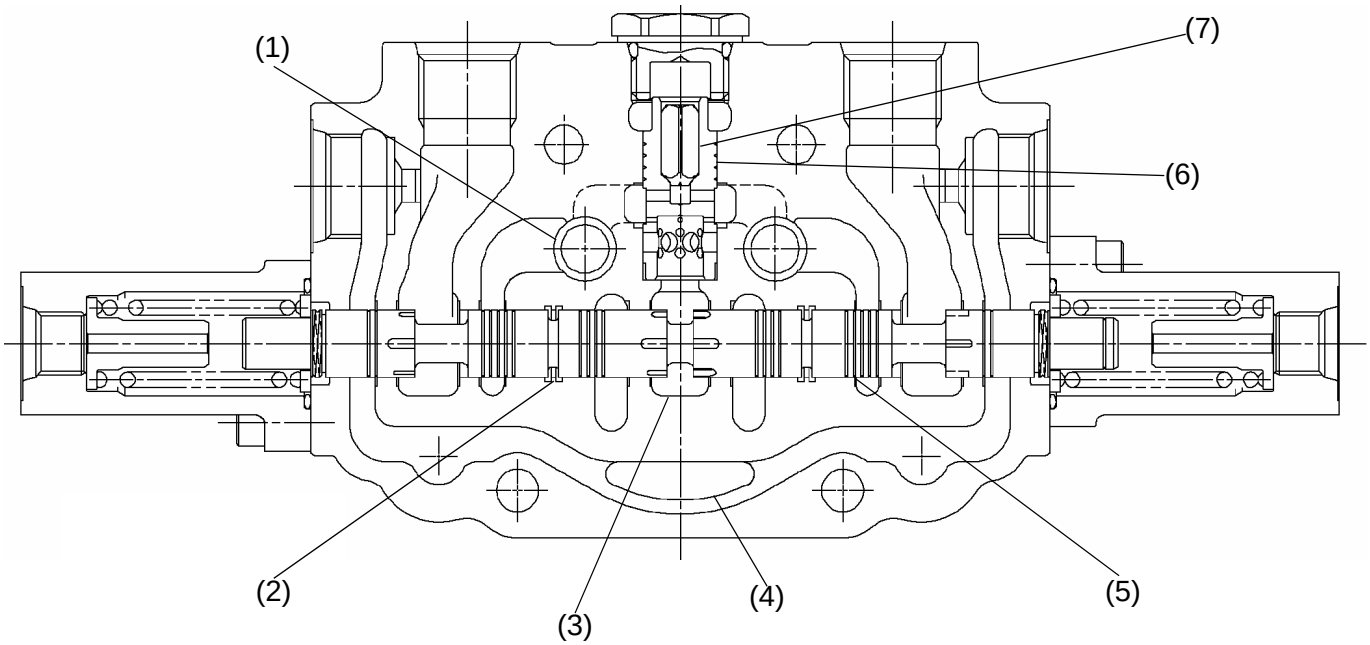
(1) Spiral groove air bleeding circuit
(2) Tank circuit
(3) Main spool with arm regeneration
(4) Return check valve
(Load check valve)
(5) Pressure compensating valve
(Compensating spool)
(6) Check valve for PLS signal high-pressure selection
(7) LS signal circuit
(8) Pump circuit

h. Arm regenerative flow



(1) Spool shift direction at arm crowding regeneration
(2) PC flow
(3) PC flow + Regenerative flow
(4) Regenerative flow
(5) Tank flow
(6) Regenerative spool
(7) Relief, unload section
(8) Tank circuit
(9) Unload valve
(10) LS, main

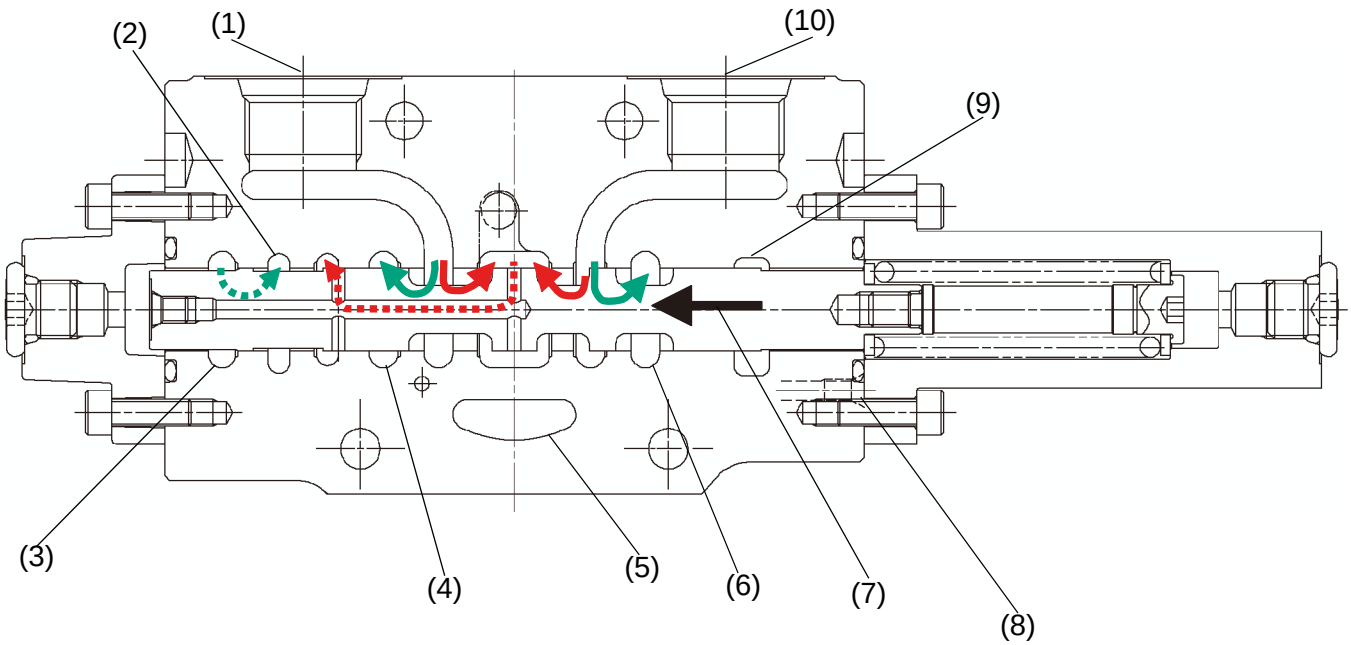
i. Swing section (Center closed valve)



LS : Center closed type section (Spool dia. ϕ14)

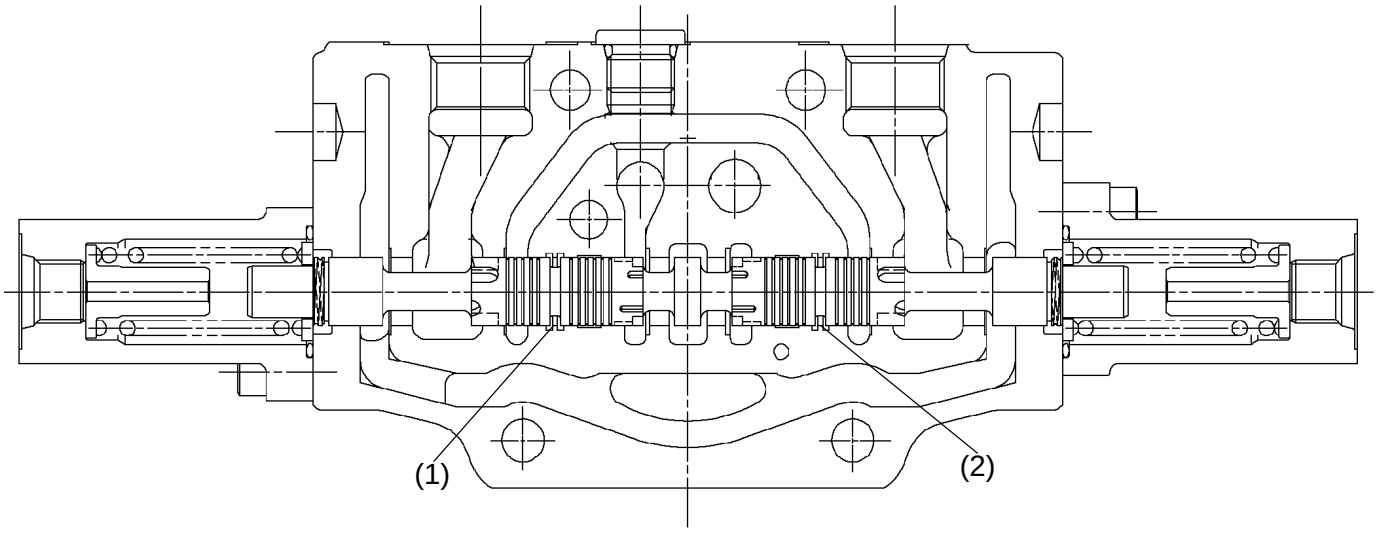
(1) Return check valve
(Load check valve)
(2) AI signal circuit
(3) Pump circuit
(4) Tank circuit
(5) Neutral-position pressure relief land abolished
(unlike conventional LS system)
(6) Pressure compensating valve
(Compensating spool)
(7) Check valve for PLS signal high-pressure selection

j. P1 and P2 inlets and travel selector valve



(1) P2 inlet
(2) Signal circuit to pump PPS
(3) Tank circuit
(4) To left-travel P circuit
(5) Tank circuit
(6) To Travel Right
(7) When traveling
(8)
(9) Travel selector signal circuit
(10) P1 inlet

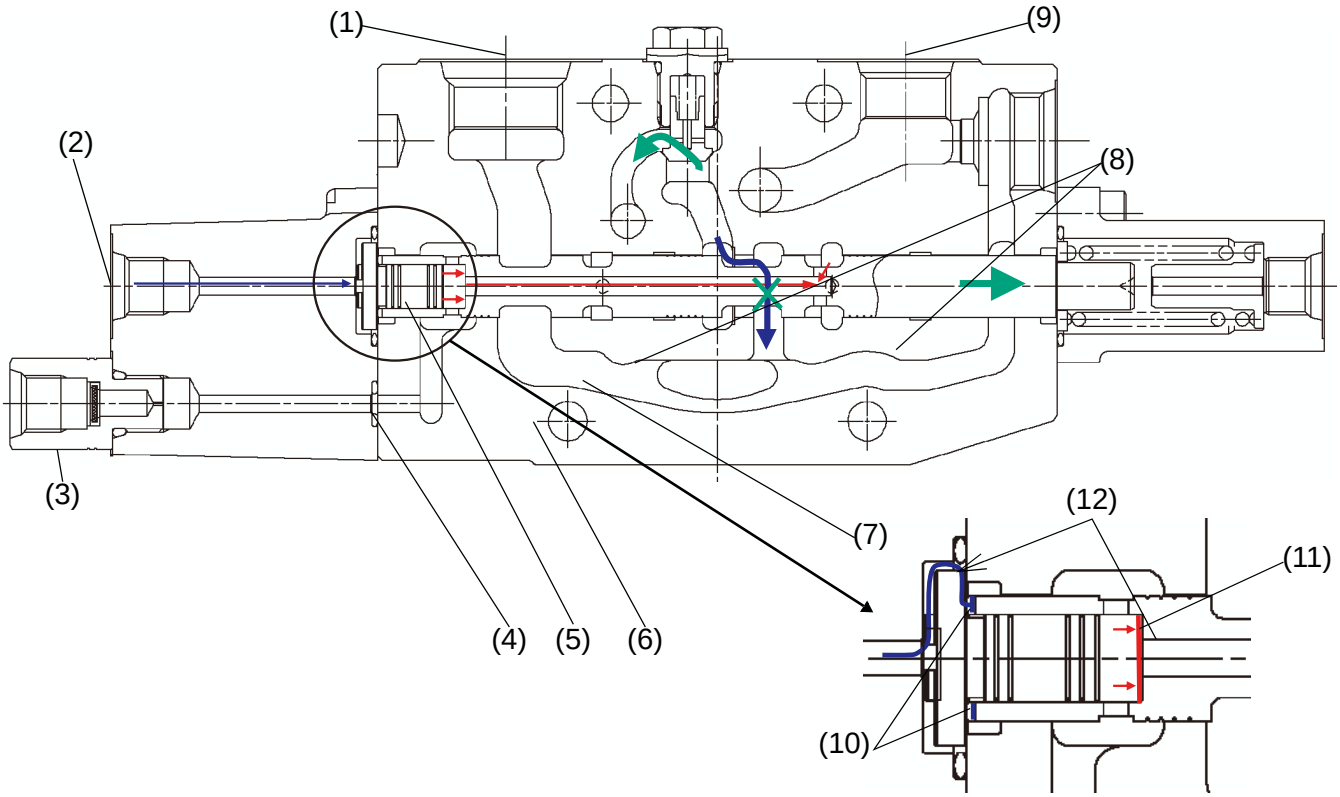
k. Travel section (Center open type)



Open circuit section

(1) AI signal circuit
(2) Travel detection signal circuit

I. P3 inlet and P3 confluence section

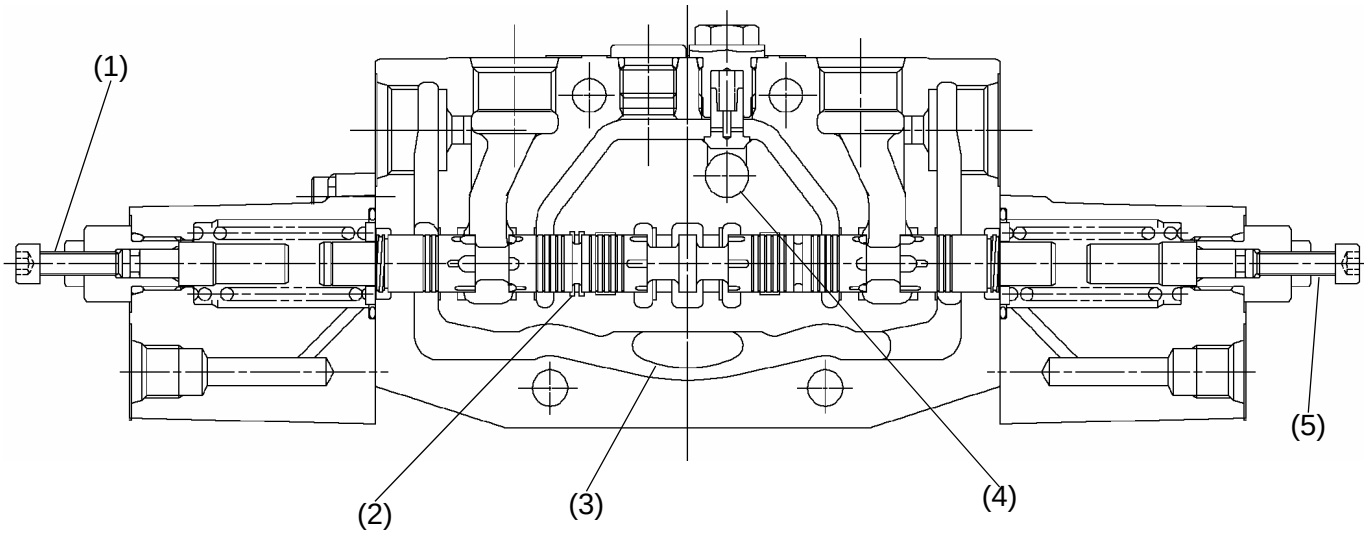


Travel + LS system control to get the spool switched and the P3 center circuit and circuit (A) interconnected.

LS system signal pressure to go to pressure receiver face a2, and travel signal pressure to a1.
Areas a1 and a2 equal to each other.

(1) Tank circuit to swivel motor and oil cooler
(2) LS system action signal inlet port (External pipe)
(3) Delivery port for travel detection (PP2)
(4) AI signal circuit
(5) Circuit (A): LS system delivery circuit
(6) P3 center circuit
(7) Travel detection signal circuit
(8) P3 confluence spool
When not switched: Tank circuit open and no flow to LS system
When switched: Tank circuit closed and flow to LS system
(9) P3 delivery circuit
(10) Pressure receiver a2
(11) Pressure receiver a1
(12) Pilot primary pressure

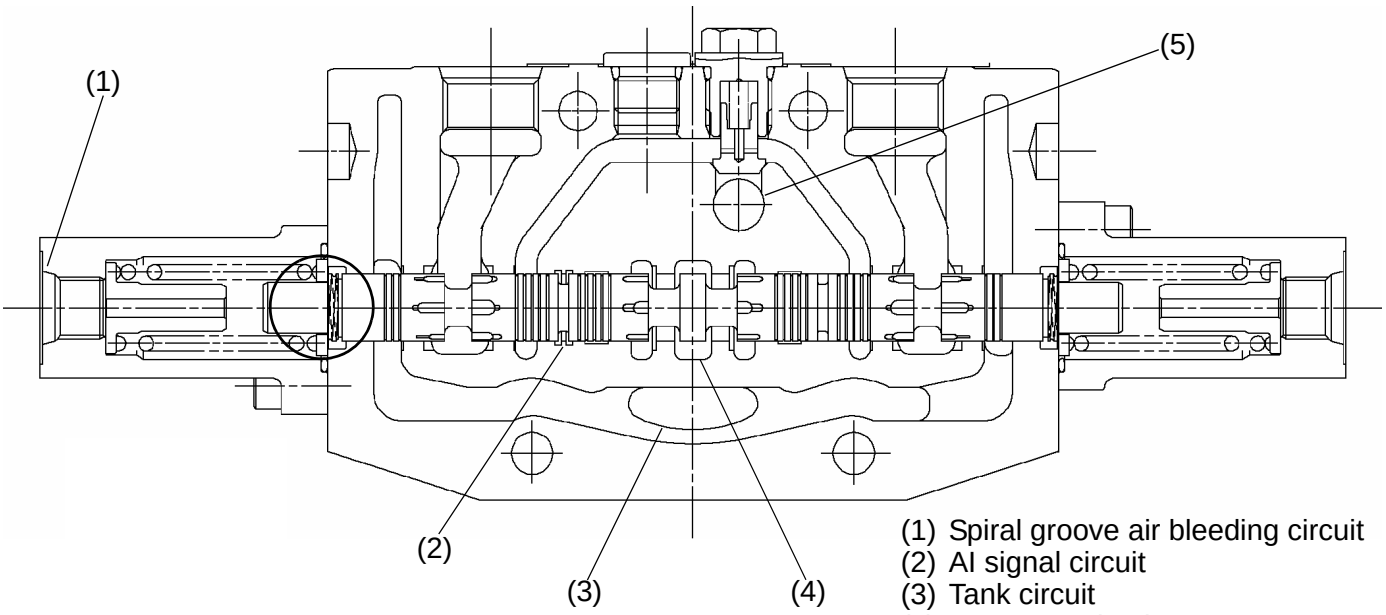
m.SP2 section (Mechanical flow adjustment)



Center open type valve section with mechanical maximum flow adjuster

(1) Mechanical maximum flow adjuster
(2) AI signal circuit
(3) Tank circuit
(4) P3 parallel feeder circuit
(5) Mechanical maximum flow adjuster

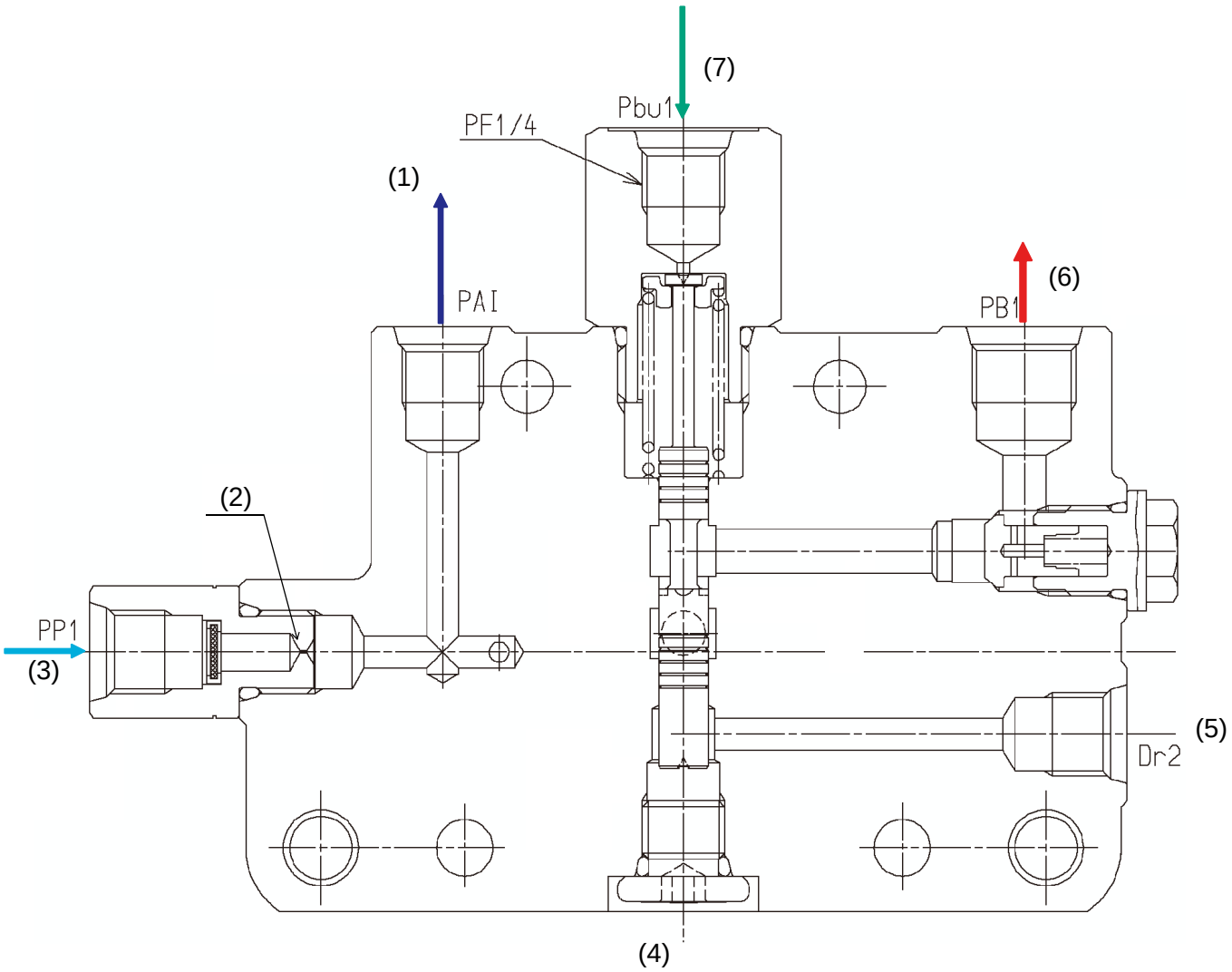
n. Swivel section



Center open type valve section

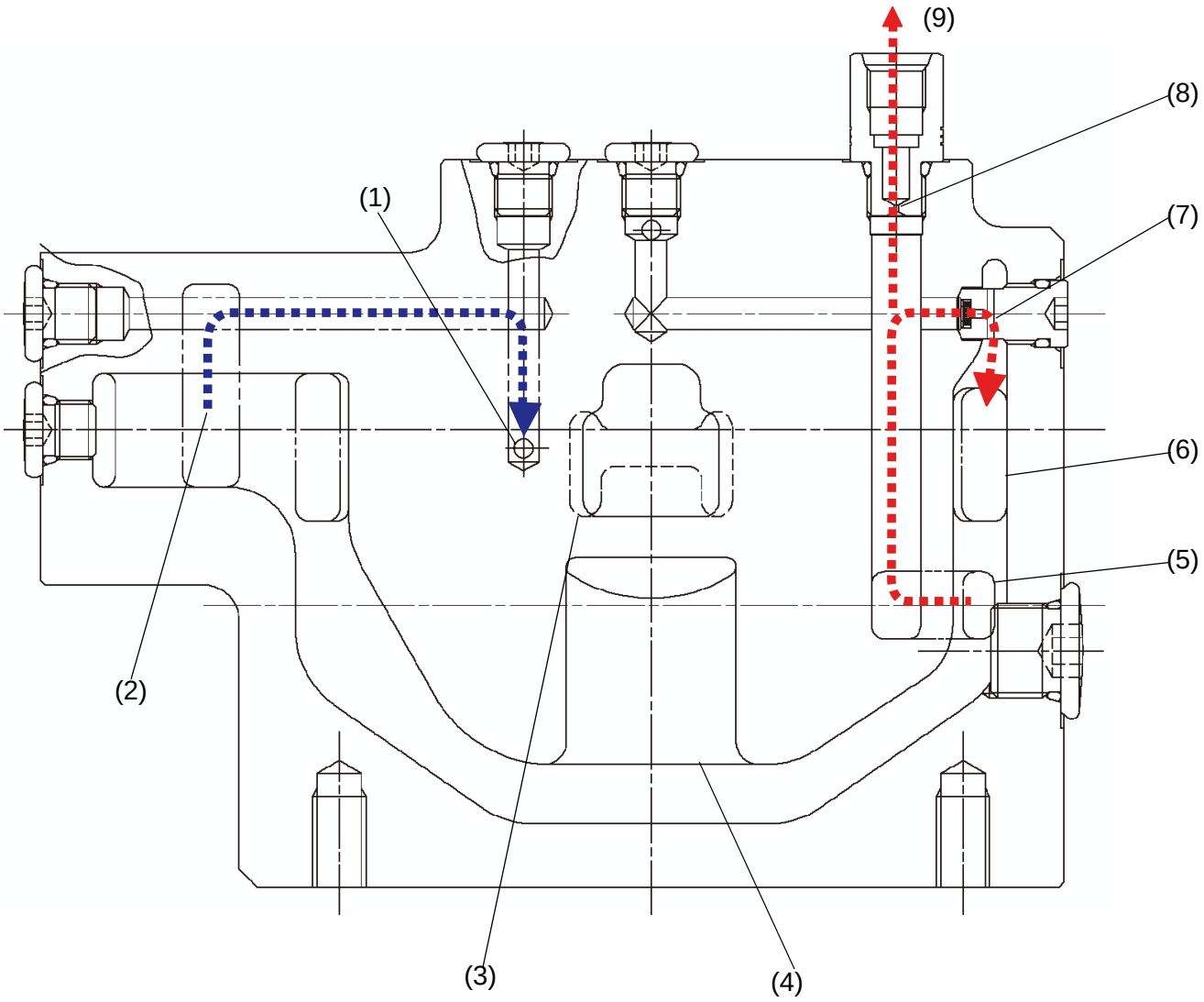
(1) Spiral groove air bleeding circuit
(2) AI signal circuit
(3) Tank circuit
(4) P3 center circuit
(5) P3 parallel feeder circuit

o. P3 bypass confluence valve



(1) To AI pressure switch
(2) AI aperture
(3) AI signal delivery (PP1)
(4) P3 bypass confluence valve
(5) Drain
(6) P3 bypass circuit to monoblock P2
(7) Boom up signal

p. LS bleed



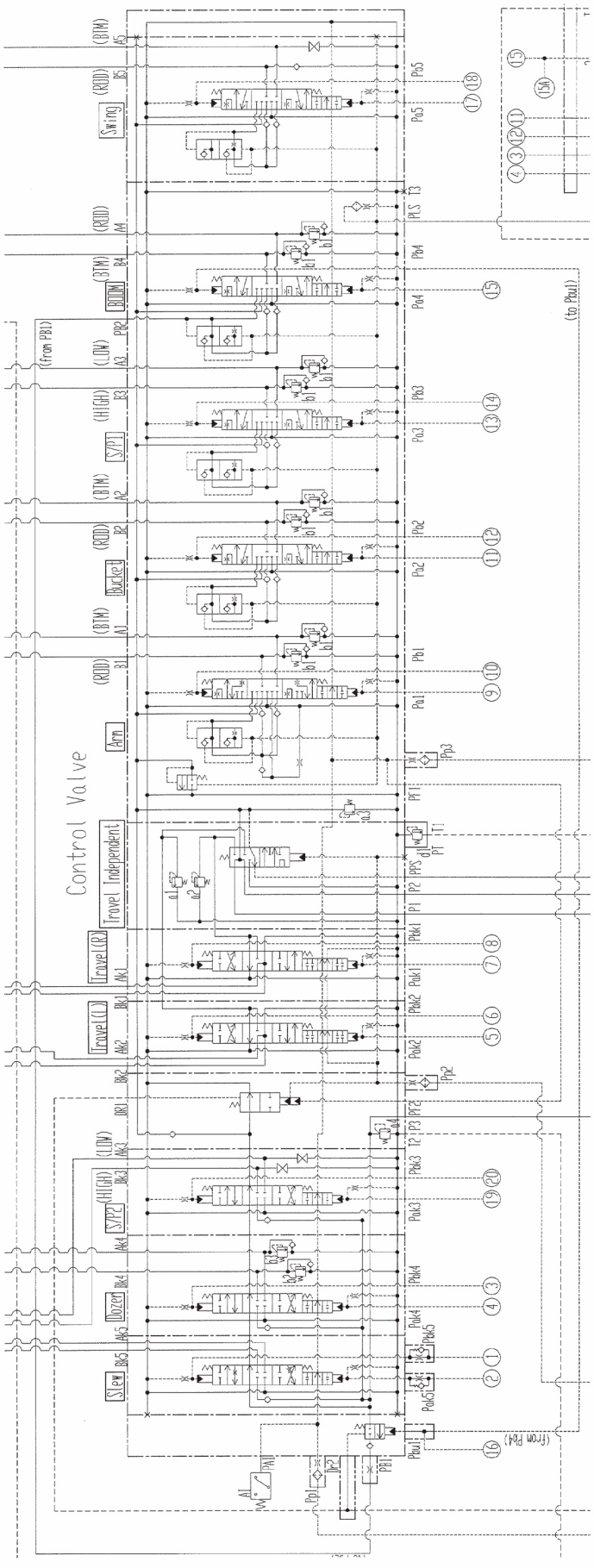
Monoblock end (Circuit between PLS signal processing and ϕ14)

This section is located between boom and swing section.

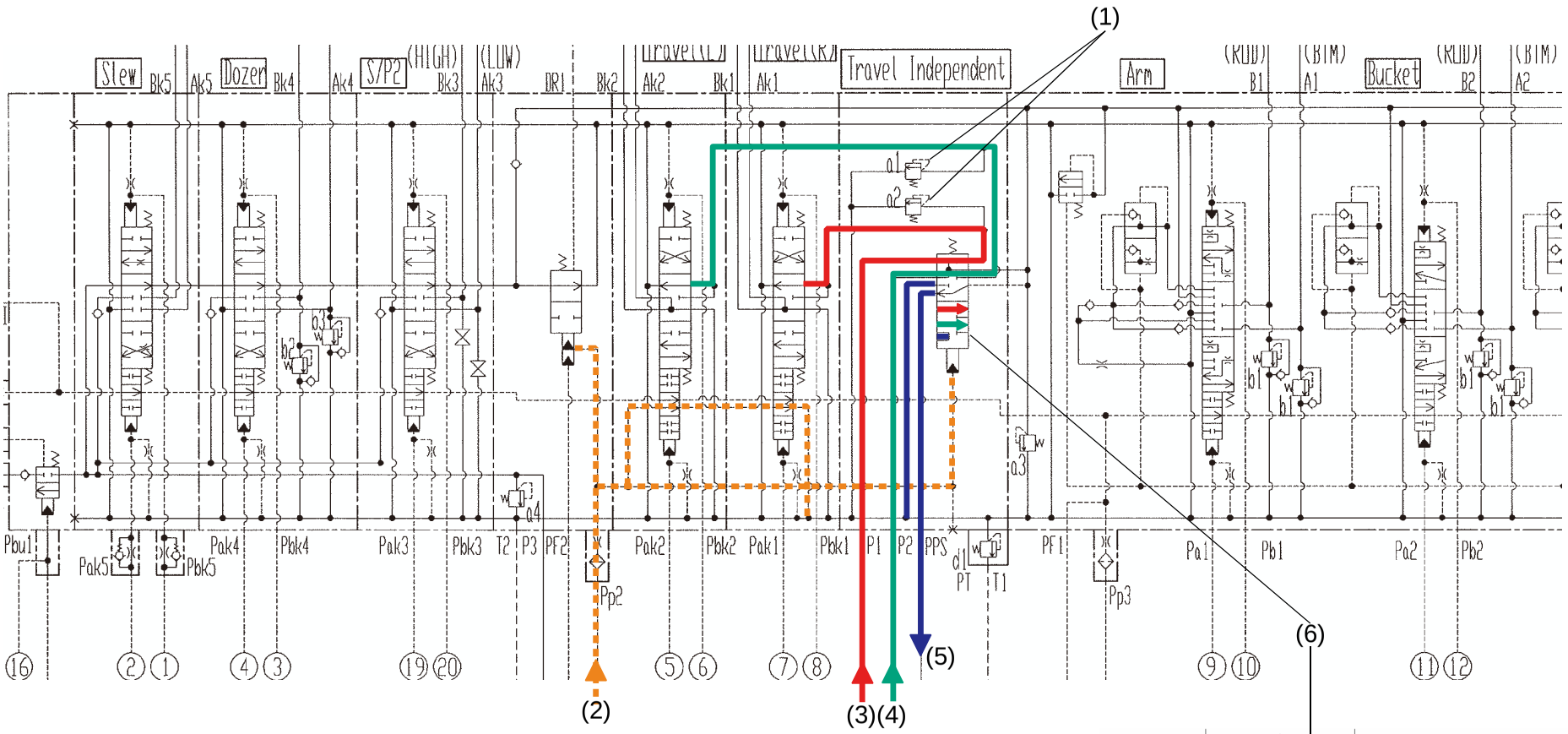
(1) Passage to LS system (ϕ14) AI circuit
(2) AI signal circuit
(3) P circuit
(4) Tank circuit
(5) CV PLS signal circuit
(6) Tank circuit
(7) PLS signal bleed orifice
(8) PLS orifice
(9) PLS signal circuit to pump PLS

D.Control valve circuit

a. Control valve hydraulic circuit diagram

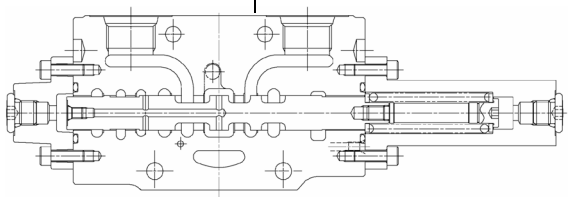


b. Control valve hydraulic circuit in traveling



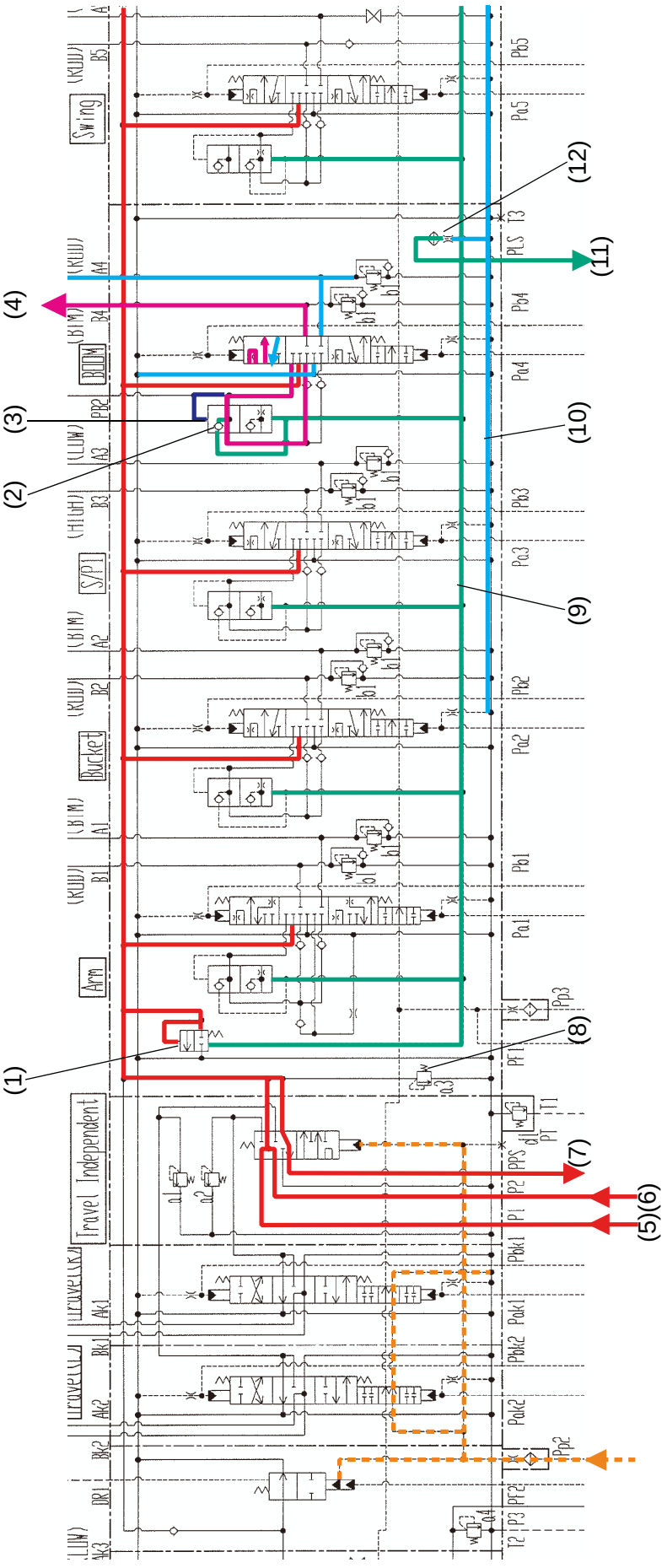
Behavior

When the travel is selected, the travel selector valve switches on to supply oil from the P1 or P2 pump. The PPS signal pressure becomes equal to the tank pressure. When PLS >= PPS = Tank pressure, the pump flow rate gets maximized.



(1) Travel main relief valve (29.4 MPa)
(2) Travel select signal detection pressure from P4 pump
(3) P1 pump
(4) P2 pump
(5) PPS signal (to pump) ≒ 0
(6) Travel selector valve
(7) Travel selector valve

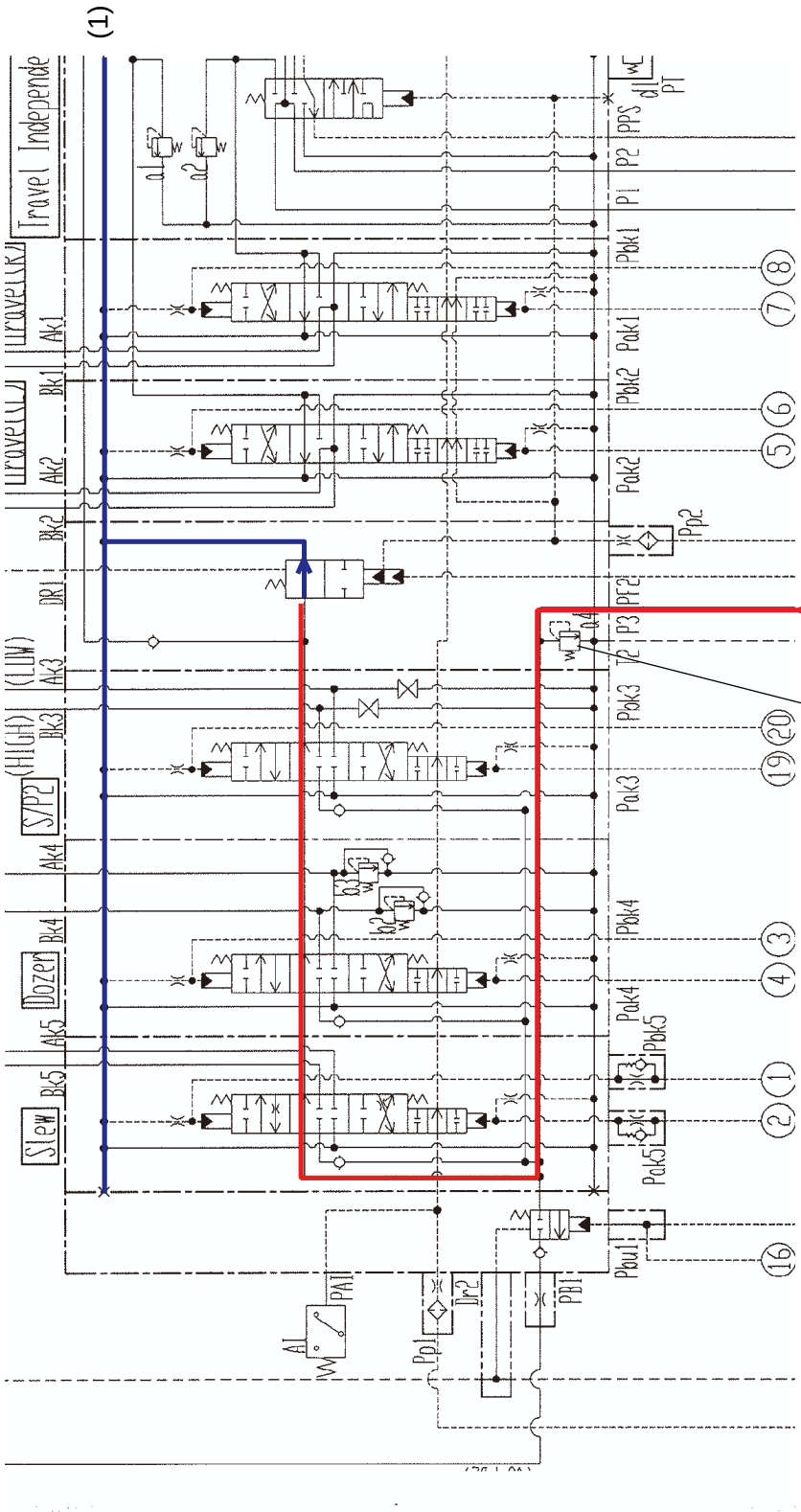
c. Control valve hydraulic circuit under LS system control without traveling



(1) Unload valve
(2) PLS signal high-pressure select check valve
(3) Pressure compensating valve
(4) To cylinder
(5) P1 pump
(6) P2 pump
(7) PPS signal (to pump)
(8) LS system main relief valve
(9) PLS signal
(10) Tank circuit
(11) PPS signal (to pump)
(12) PLS signal bleed aperture

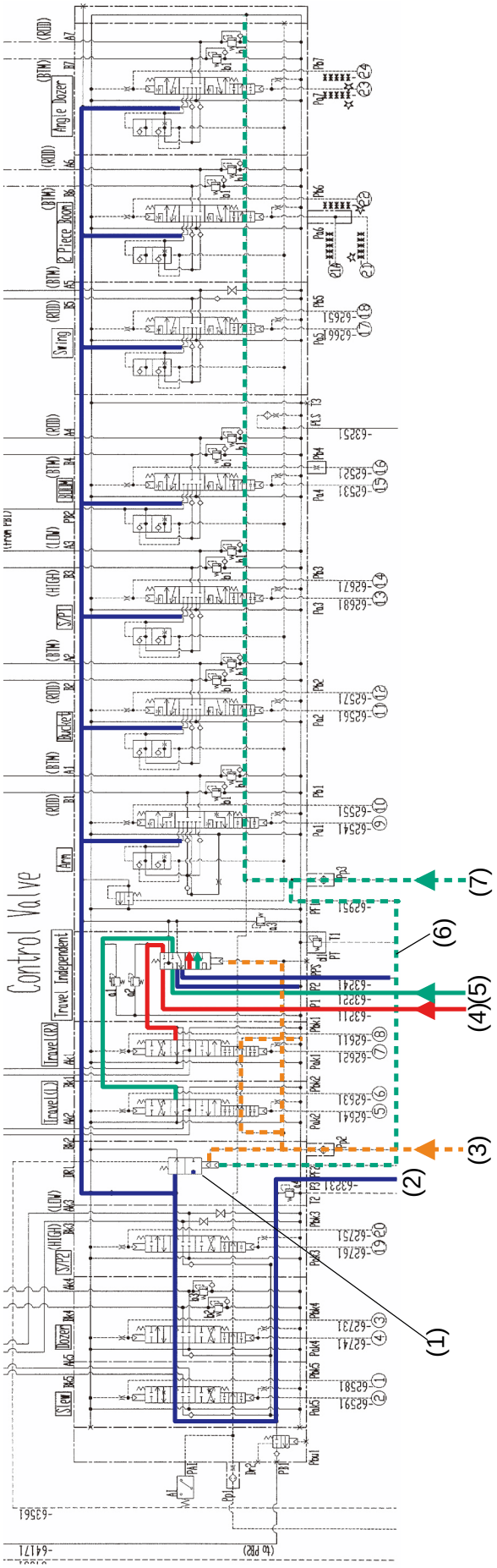
Behavior
When the travel is not selected, the travel selector valve does not switch on with the LS system. The oil is supplied from the P1 and P2 pumps. The PPS signal pressure becomes equal to the delivery pressure and the pumps are controlled at the LS flow rate.

d. Control valve P3 hydraulic circuit



(1) Tank circuit
(2) P3 pump
(3) P3 line main relief vale (20.6 MPa)

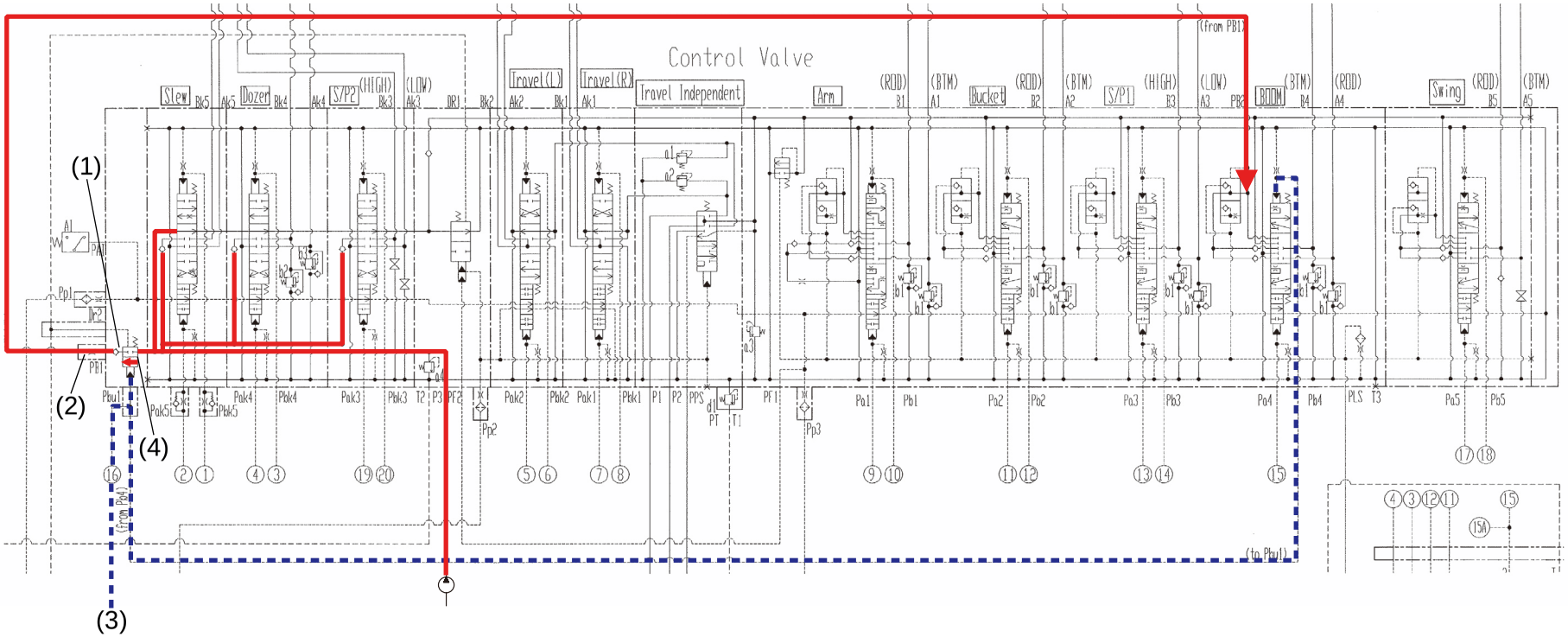
e. Control valve P3 confluence hydraulic circuit



(1) P3 confluence valve
(2) P3 delivery port
(3) Travel select signal detection pressure from P4 pump
(4) P1 pump
(5) P2 pump
(6) CV internal signal detection pressure from P4 pump
(7) LS system control detection signal

Behavior
When the travel is selected and the LS system is operated, the oil is supplied from the P1 or P2 pump for the travel system (The P1 and P2 pumps give their maximum flow rate within the horsepower range.) The P3 selector valve serves for the LS system in order to supply the oil from the P3 pump. (The P3 pump is of fixed displacement type to provide a constant flow rate. Extra oil is let out through the unload valve.)

f. Control valve P3 bypass circuit



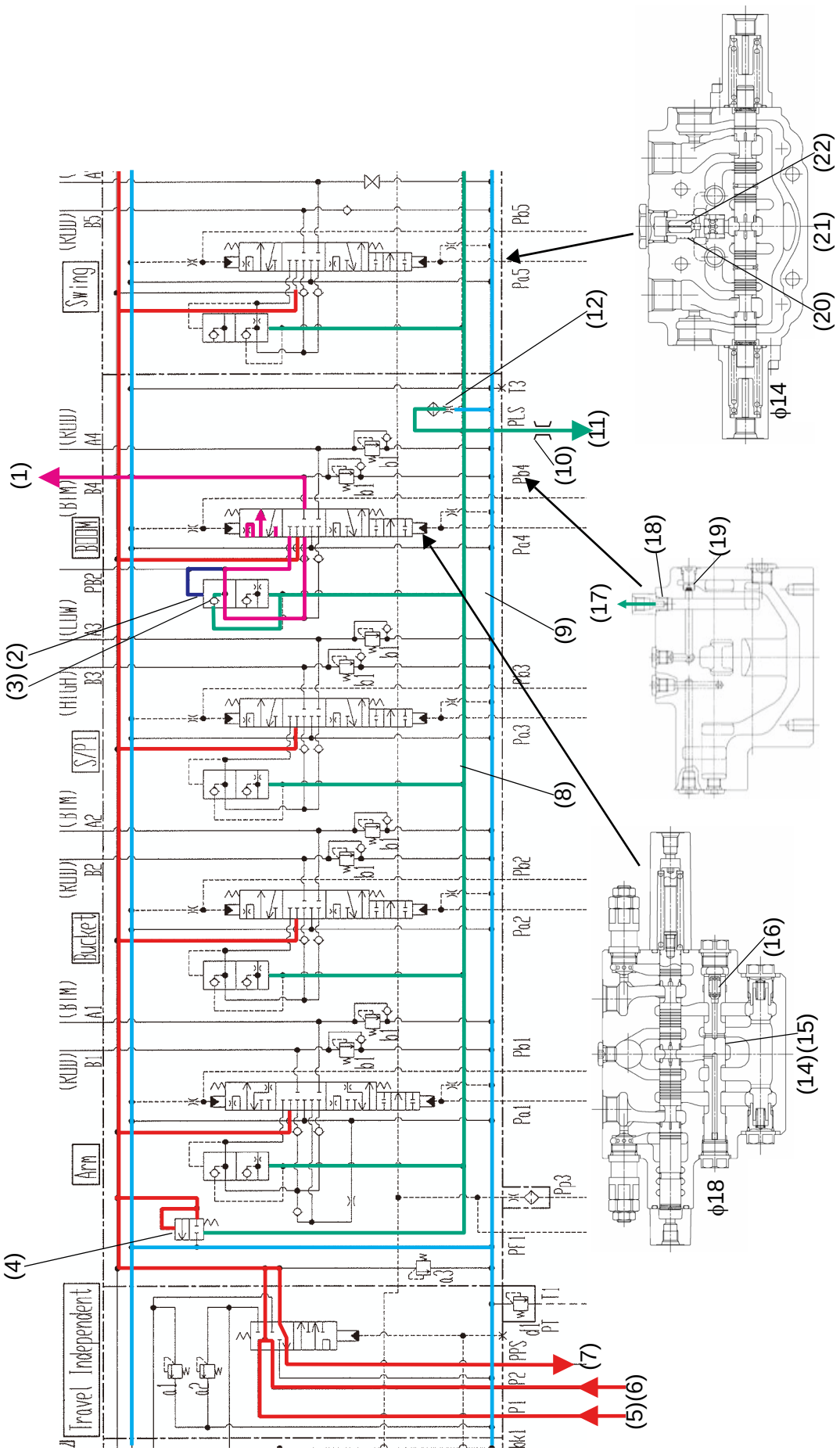
(1) Check valve
(2) P3 bypass confluence valve
(3) Confluence orifice
(4) Boom up signal

Function

When the swivel, boom, (arm) and (bucket) are activated at once, the boom-up pilot pressure works to switch the P3 bypass confluence valve. (The boom pilot pressure joins at 2.2 MPa.) The swivel P3 pump branches the flow for the boom to assist in moving up the boom. When the swivel pressure is greater than the boom operating pressure (at a start of swivel), the confluence occurs.

As the swivel pump pressure drops, the variable displacement pump's horsepower characteristic varies accordingly, which increases the flow rate from this valve. With a drop in the swivel starting pressure, the swivel does not speed up too high. This way, the boom can be moved up speedily compared with the swivel rate.

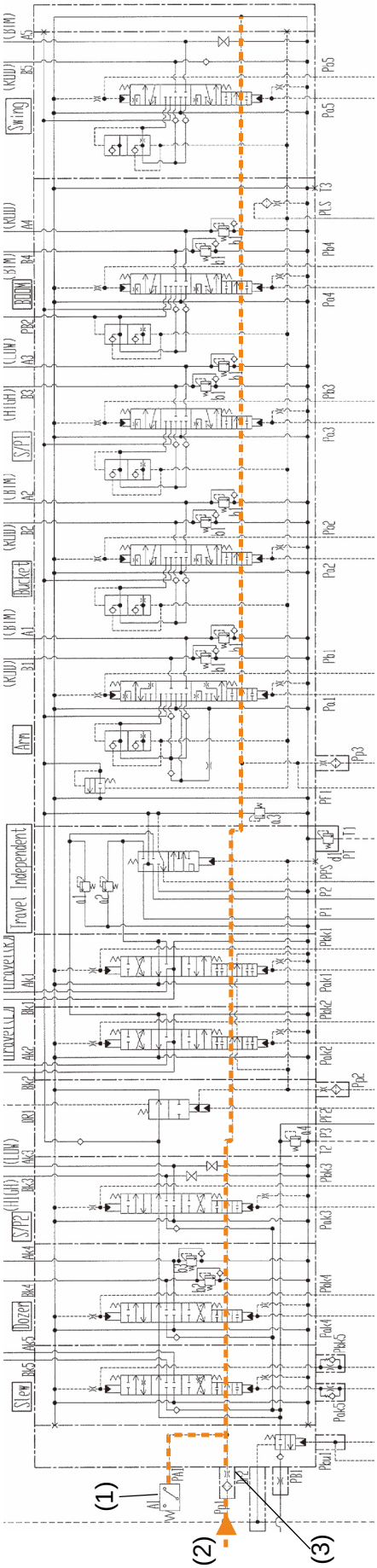
g. Control valve high-pressure selection function



(1) To cylinder
(2) Pressure compensating valve
(3) PLS signal high-pressure select check valve
(4) Unload valve
(5) P1 pump
(6) P2 pump
(7) PPS signal (to pump)
(8) PLS signal
(9) Tank circuit
(10) PLS signal aperture
(11) PLS signal (to pump)
(12) PLS signal bleed aperture
(13) Pressure compensating valve
(14) Boom section
(15) PLS signal high-pressure select check valve
(16) PLS signal (to pump)
(17) PLS signal aperture
(18) PLS signal bleed aperture
(19) Pressure compensating valve
(20) PLS signal high-pressure select check valve
(21) Swing section

Changing the high-pressure select system
Formerly, the high-pressure side was selected by a high-pressure selector valve (≺○≻). On the new system, the high pressure is introduced by the check valve that is incorporated in the pressure compensating valve. The LS bleeder lets the high-pressure oil into the tank.

h. Control valve AI signal hydraulic circuit

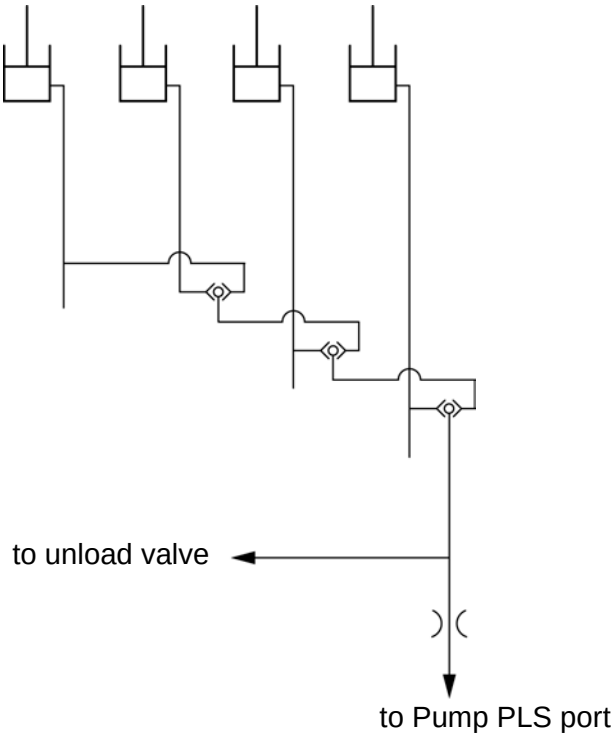


(1) AI pressure switch
(2) AI signal detection aperture
(3) CV internal AI signal detection pressure from P4 pump

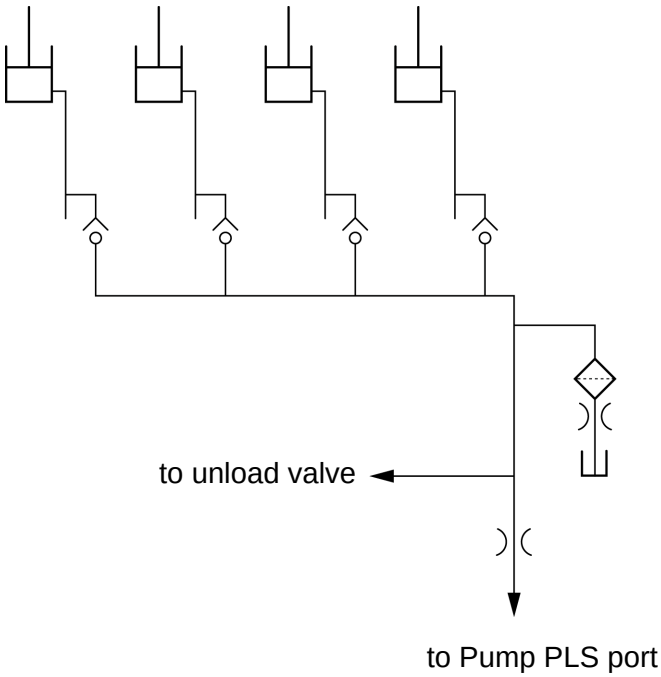
i. FYI (For Your Information)

1. LS load's maximum pressure detection method

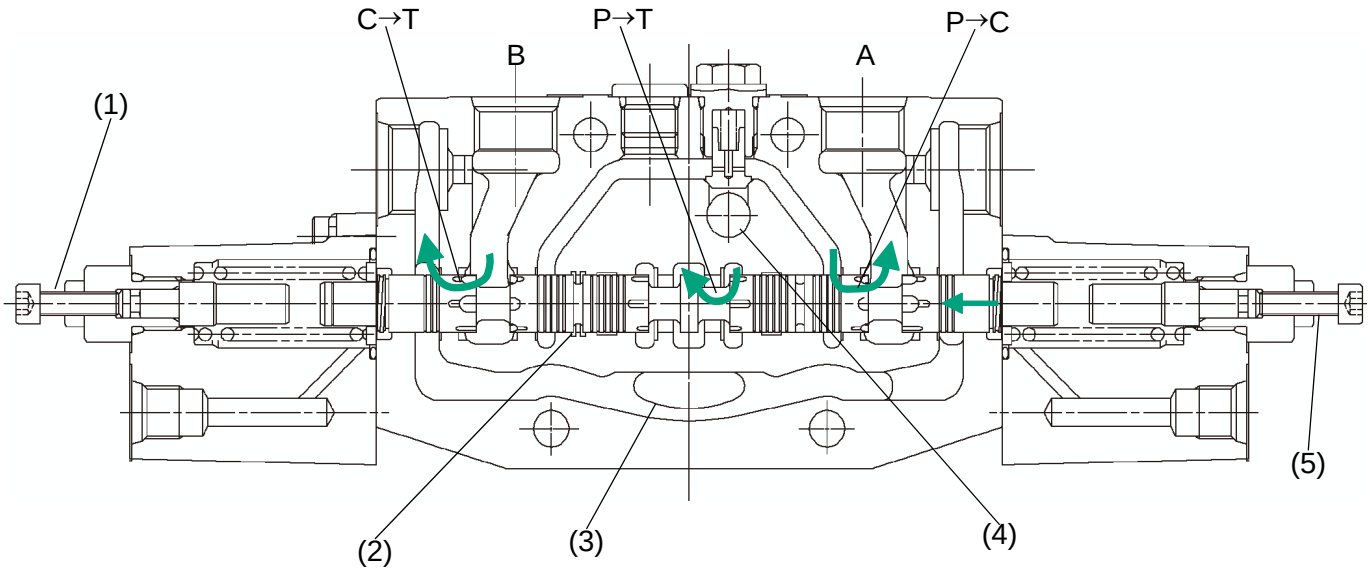
(KX121-3, α/s, KX161-3α/s, U45-3α)



(KX080-3)



2. SP2 flow control : Mechanical oil flow adjustment

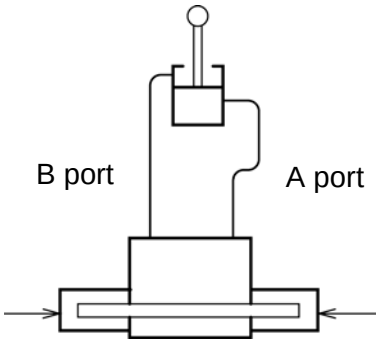


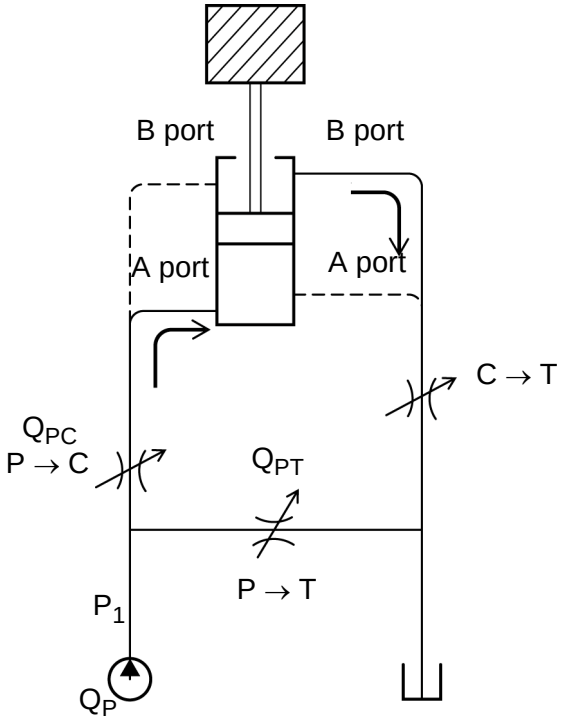
Center open type valve section with mechanical maximum flow adjuster

(1) Mechanical maximum flow adjuster
(2) AI signal circuit
(3) Tank circuit
(4) P3 parallel feeder circuit
(5) Mechanical maximum flow adjuster

3. S/P2 flow control mechanism

depend on load, Pump flow (P3) (∝ rotation) (non linear)





$Q_P = 0.6 \times A_{(P \rightarrow T)} \times \sqrt{P_1}$

$Q_{PC} = Q_P - Q_{P \rightarrow T}$

Motion started when the load becomes higher than P (load < P)

E.Travel pilot valve (with damper)

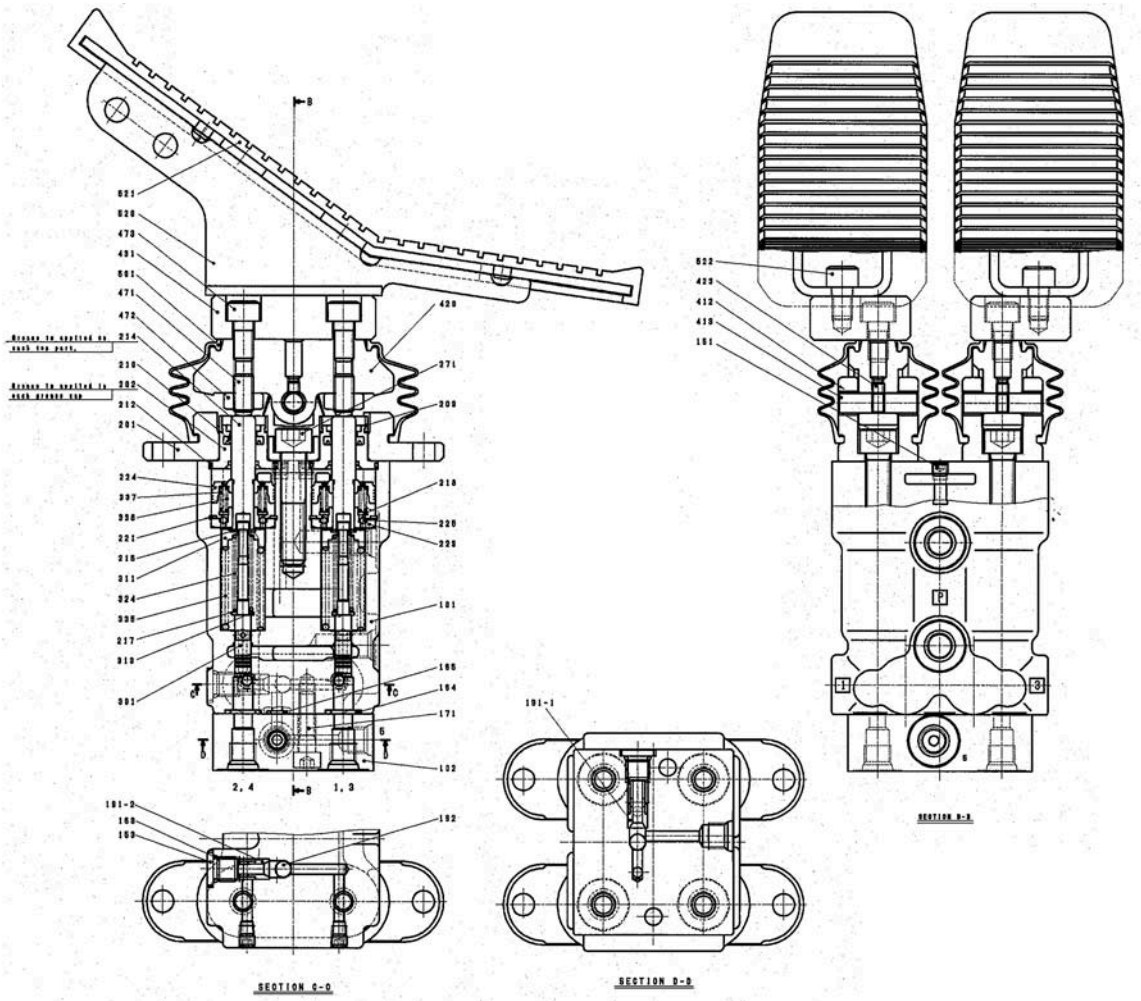
a. Outline

The damper-embedded pilot valve, RCVD8C, is a reducing-type valve using 4 secondary-pressure-controlling reducing valves contained in a single valve casing. The outlet pressure varies according to the angle of the operating section. The RCVD8C also includes a damping mechanism coupled to the valve casing, a mechanism which prevents hunting (lever-hunting) in the man-machine system.
In addition to a damping mechanism, the RCVD8CC also includes shuttle valves which select and output higher pressure from secondary pressures.

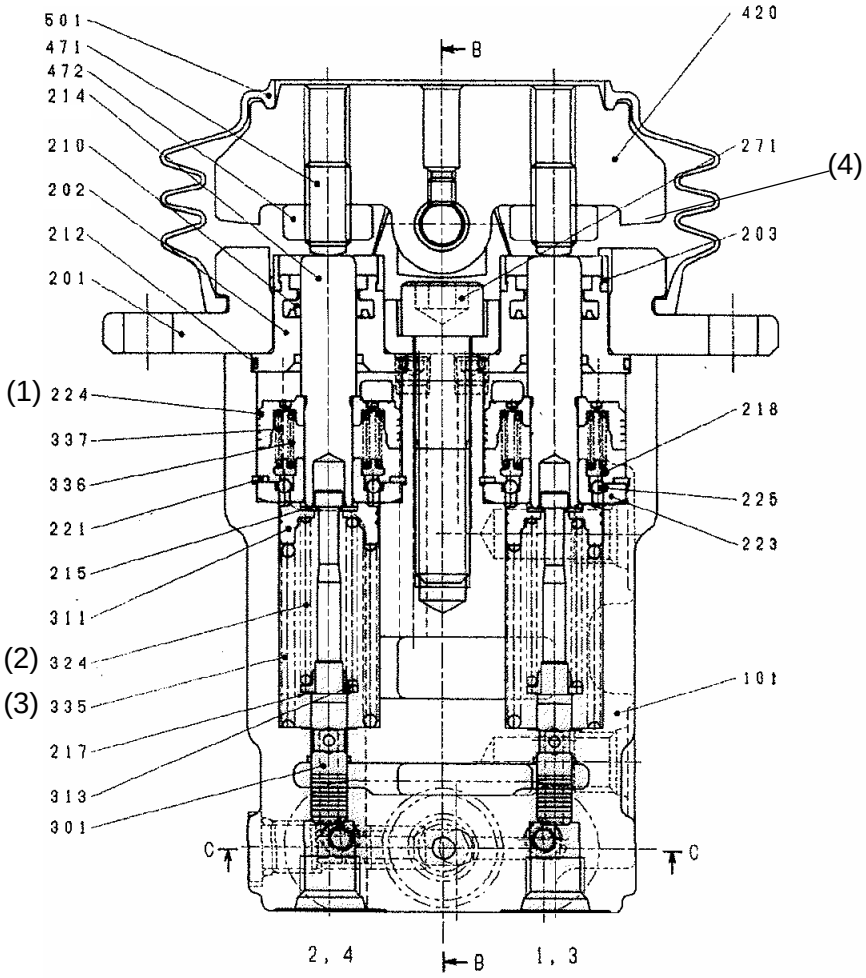
b. Specifications

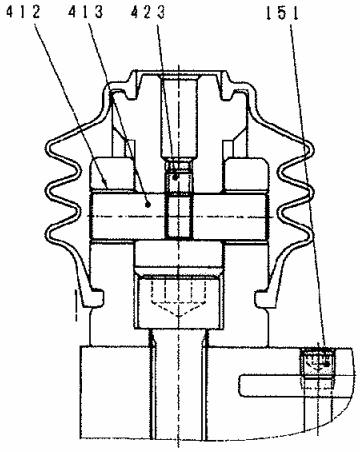
Maximum primary pressure	9.8 MPa {100 kgf/cm^2}
Secondary pressure	0-4.4 (maximum control pressure) MPa {0-45 kgf/cm^2}
Allowable back pressure	At maximum 0.29 MPa {3 kgf/cm^2}
Rated flow volume	10 L/min
Operating angle	±12.4°
Mass	Approx. 7.8 kg per set
Piping	For favorable response, the internal diameter and the length of the pipe should be approx. ϕ8 and 3 mm respectively. To prevent an effect of the back pressure, return the return oil to the tank directly.
Filter	To prevent the spool from being stuck, install a 40-mesh or more filter at the inlet of the P port.

c. Structure

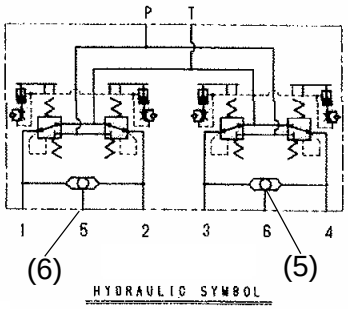


101	Casing	1	212	O-ring	4	336	Spring	4
102	Plate, part	1	214	Rod, push	4	337	Spring	4
151	Plug	2	215	Washer 1	3	412	Bush	4
153	Plug	3	217	Washer 2	4	413	Cam shaft	2
163	O-ring	3	218	Seat, spring	4	420	Cam	2
164	O-ring	4	221	Retaining rings	4	423	Set screw	2
165	O-ring	2	223	Bush	4	431	Block	2
171	Screw, hex. S. H. O.	2	224	Piston	4	471	Set screw	4
191-1	Sheet	1	225	Ball, steel	12	472	Lock nut	4
191-2	Sheet	2	271	Screw, hex. S. H. O.	2	473	Screw, hex. S. H. O.	4
192	Ball, steel	3	301	Spool	4	501	Bellows	2
201	Cover	2	311	Seat, spring	4	520	Pedal	2
202	Plug	4	313	Washer 3	4	521	Cover, pedal	2
203	Grease gap	4	324	Spring	4	522	Screw, hex S. H. O.	4
210	NHU packing	4	335	Spring	4			



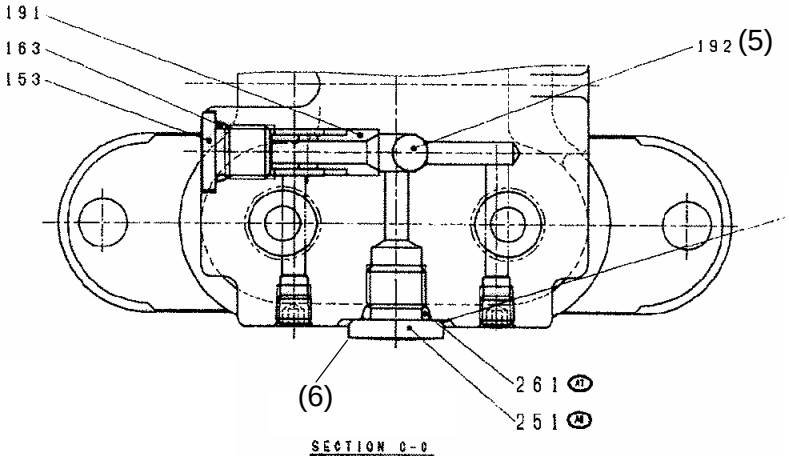


SECTION B-B



HYDRAULIC SYMBOL

NUMBERS IN ( ) ARE FOR REFFERENCE

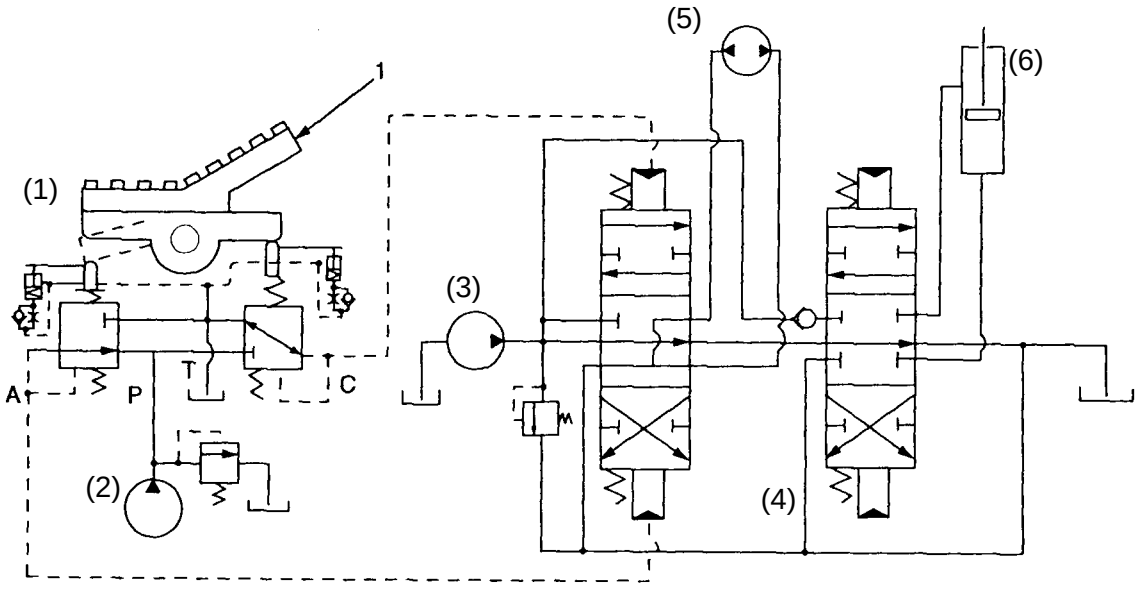


SECTION C-C

(1) Damper narrowed
(2) Secondary pressure spring
(3) Operating force spring
(4) Operating angle control: 9 deg.
(5) Shuttle valve
(6) Travel alarm switching port
2 locations

d. Function

The damper-embedded pilot valve includes in its main body a damping function to prevent hunting (lever hunting) in the man-machine system.
The following explains the operation of the damper-embedded pilot valve, separating it into 2 sections: "a. reducing valve" and "b. operation section damping mechanism" based on the hydraulic circuit diagram below, the assembly cross-section drawing in 31(RCVD8C), 32(RCVD8CC), and the damping operation explanation drawing in 9. The following figure shows a typical usage of the pilot valve.



Hydraulic circuit diagram

(1) Pilot valve
(2) Pilot pump
(3) Main pump
(4) Control valve
(5) Hydraulic motor
(6) Hydraulic cylinder
(7) Shuttle valve(RCVD8CC only)

1. Reducing valve section

1.1 When the pilot valve operating section is at the neutral position

The spool (301), pushed upward by the return spring (335), washer 1(215) through the spring seat (311), is at its neutral position as shown in the assembly cross-section drawing. Since the outlet port is joined only with the tank port T as a result of the spool switching function, the pressure at the outlet ports 1 and 2 is the same as the pressure at the tank port T.

1.2 When the pilot valve operating section is tilted from the neutral position

As shown in the assembly cross-section drawing, when the cam (420) is rotated clockwise, the push rod (214) at the port 1 is pressed downward, which pushed the spool downward with the help of the washer 1, the spring seat, the secondary-pressure-setting spring (324), the washer 2 (217), and the washer 3 (313).
As a result, the port P and the port 1 are joined each other and the oil supplied from the pilot pump starts to flow into the port 1, generating a flow pressure.
When the pressure at the port 1 increases to a pressure equivalent to the force of the secondary-pressure-setting spring, having been set by the tilted operating section, the oil pressure applied to the spool and the spring force are kept in balance, which keeps the port 1 outlet pressure constant.
Since the spool at the port 2 remains neutral, the return oil from the control valve flows out through the tank port T.
Depending on the specifications, the push rod touches the top of the spool directly when the operating section is tilted fully, which forcefully pushes down the spool, joining the port P and the outlet port, resulting in an equal pressure at both ports.

2. Operation section damping mechanism

2.1 When the operating section is at the neutral position

As shown in the assemble cross-section drawing, the push rod is pushed upward by the damping spring (336, 337) through the piston (224).

2.2 When the operating section is tilted from the neutral position (Refer to the damping operation explanation drawing (1))

As you see in the drawing, when the cam is rotated clockwise, the push rod at the port 1 is pressed downward and the piston moves downward.
At this moment, the oil in the damping piston chamber passes out through the orifice in the piston, producing a pressure used for damping.
On the other hand, the push rod at the port 2 is moved upward by the damping spring through the piston.
At this moment, the oil in the tank room is absorbed into the damping piston chamber through the 3 ball check valve portions (using the ball (225) and the bush(223)).
The oil outside the piston chamber flows through the path that joins with the port T at the top of the casing.

2.3 When fully tilted operating section is tilted in reverse direction (Refer to the damping operation explanation drawing (2))

In the operation explanation drawing, if the cam, having been fully tilted clockwise, is tilted anticlockwise, the push rod at the port 2 is pushed downward and the piston moves downward. At this moment, as in the case above, the oil inside the damping piston passes out through the orifice in the piston, producing a pressure used for damping.
On the other hand, the push rod at the port 1 is moved upward by the return spring (335) and the damping spring.
As in the case above, the oil in the tank room is absorbed into the damping piston chamber through the 3 ball check valve portions (using the ball (225) and the bush (223)). The oil outside the piston chamber flows through the path that joins to the tank port from the casing top.
In other words, the damping force is generated in both cases when the operating section is tilted from the neutral position to the fully tilted position and from the fully tilted position to the neutral position.

3. Shuttle valve section

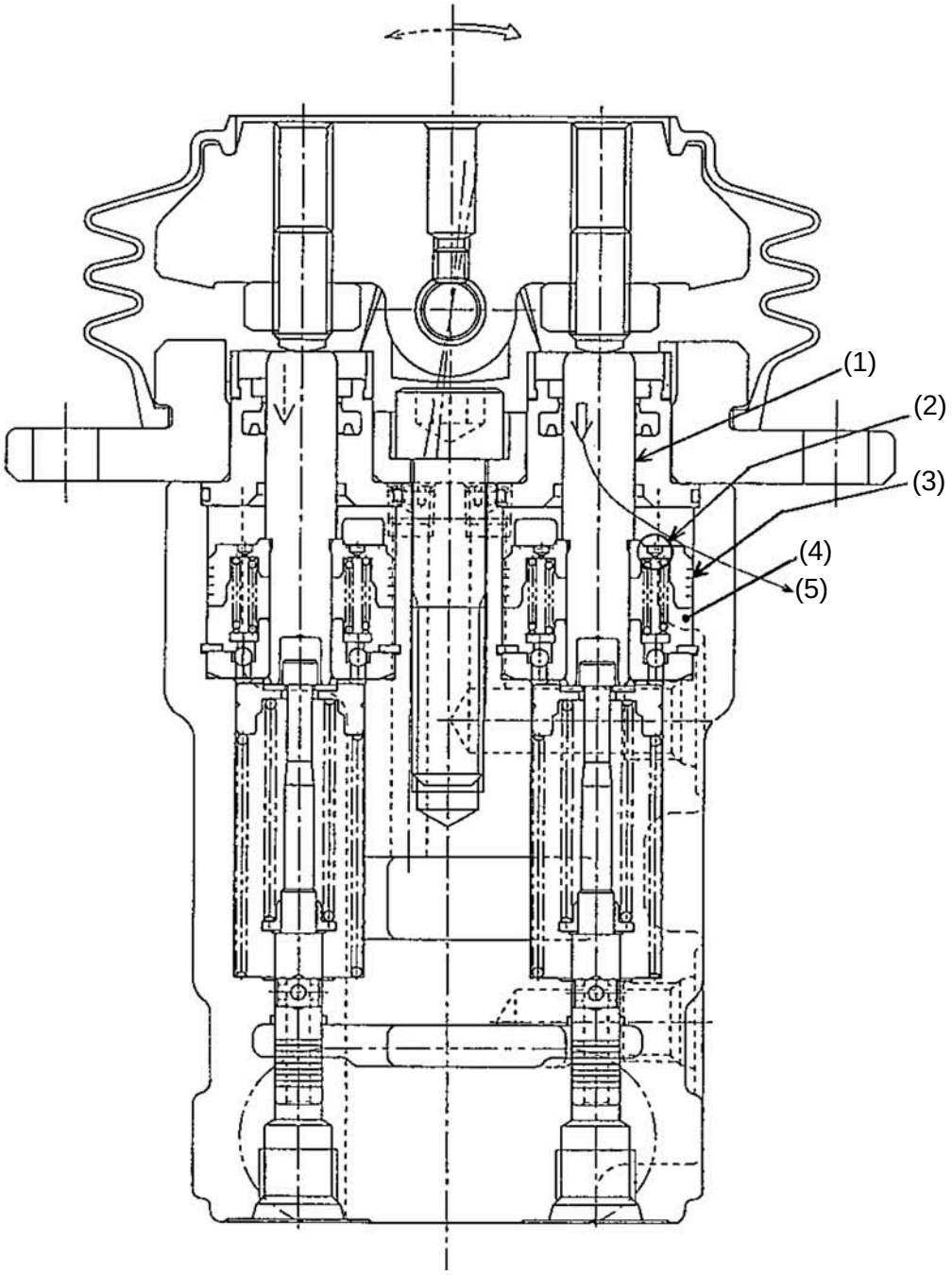
3.1 When the operating section is at the neutral position

The secondary pressure ports are both the same as the tank port T, so the shuttle valve outlet port is also the same as the tank port T.

3.2 When the pilot valve operating section is tilted from the neutral position

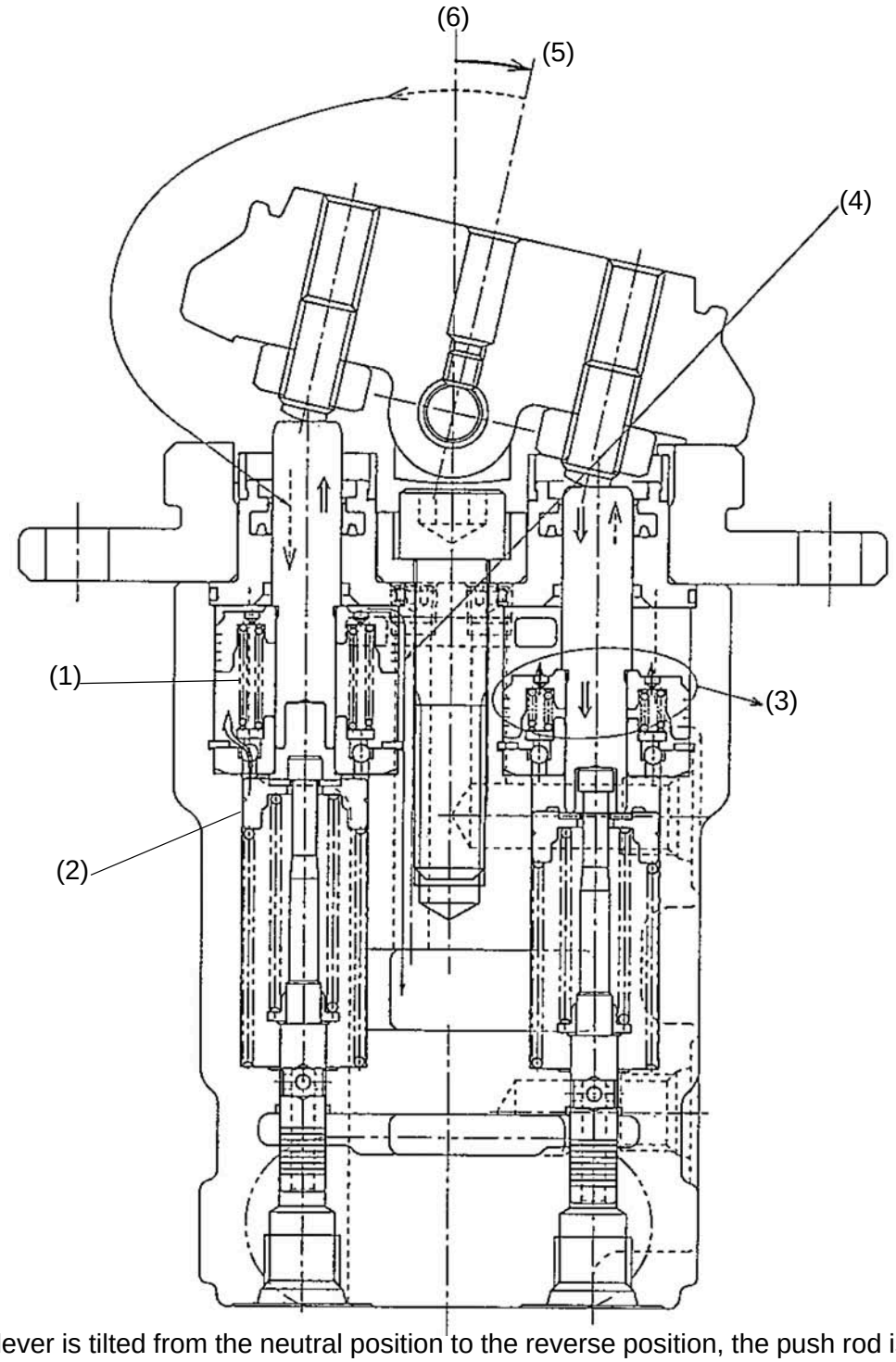
When the one secondary pressure port generate the pressure, the ball(192) is pressed to the other secondary pressure port and closed the port. The shuttle valve outlet port pressure is the same as the one secondary pressure port. In other words, the higher secondary pressure is selected and output from the shuttle valve outlet port.

<Operation when the lever is tilted from the neutral position>



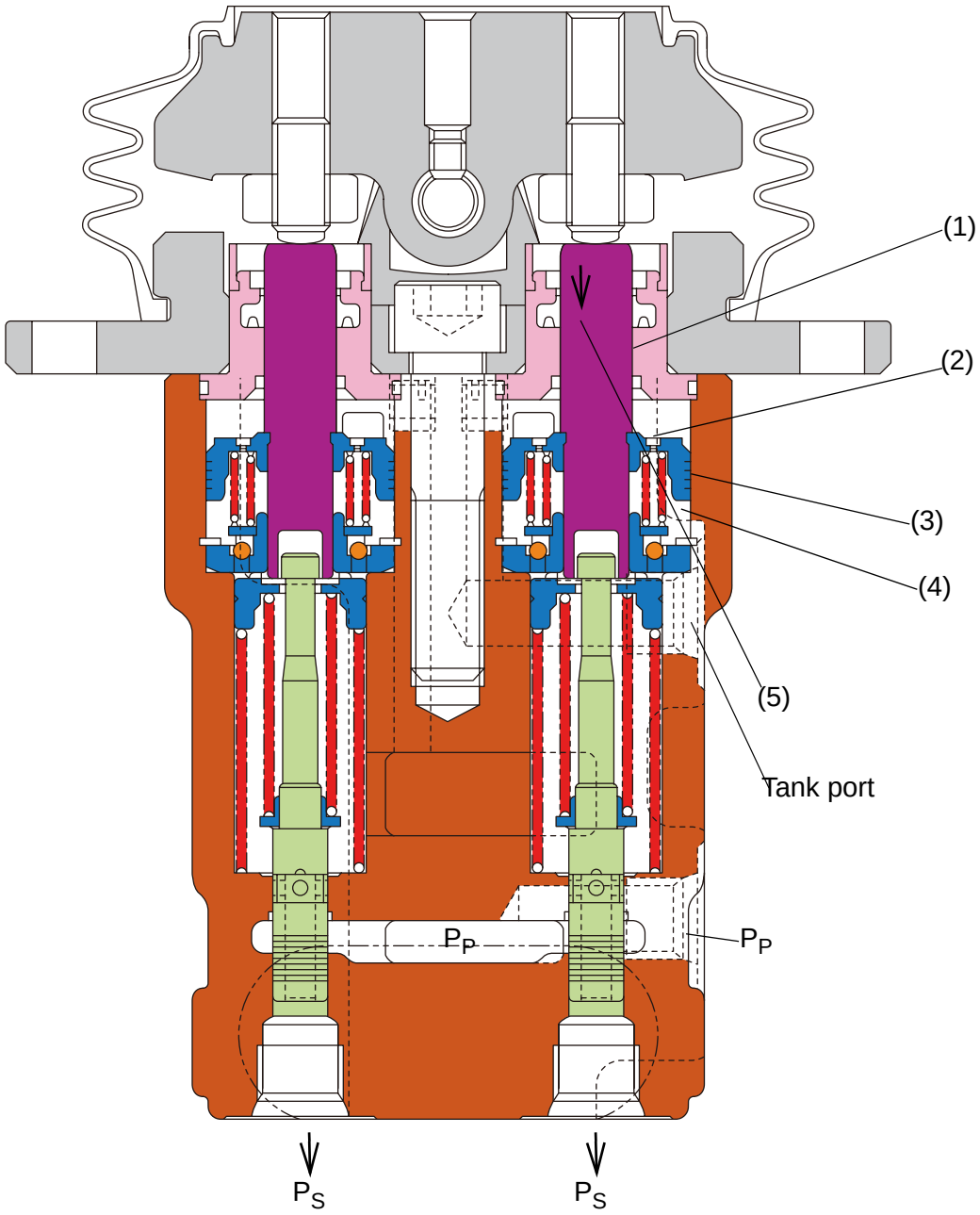
(1) Push rod
(2) Orifice
(3) Piston
(4) Piston chamber
(5) When the lever is tilted from the neutral position toward direction, the oil in the right (left) piston chamber passes out the orifice.

<Lever stroke state and the operation when the lever is tilted in reverse direction>



(1) When the lever is tilted from the neutral position to the reverse position, the push rod is pushed upward by the damping spring (⇒ Operation direction)
(2) The oil in the T line is absorbed into the damper room through the 3 ball check valve portions.
If the lever is tilted in reverse direction from ⇒ to →, the left piston immediately acts as a damper piston
The damping force is generated in both directions
(3) The oil inside the piston chamber passes out through the orifice. The pressure generated at this moment is used for damping pressure (⇒ Operation direction)
(4) The oil outside the piston chamber flows through the pass that joins to the tank port at the top of the casing. (⇒ Operation direction)
(5) Full stroke
(6) Neutral

<Operation when the lever is tilted from the neutral position>

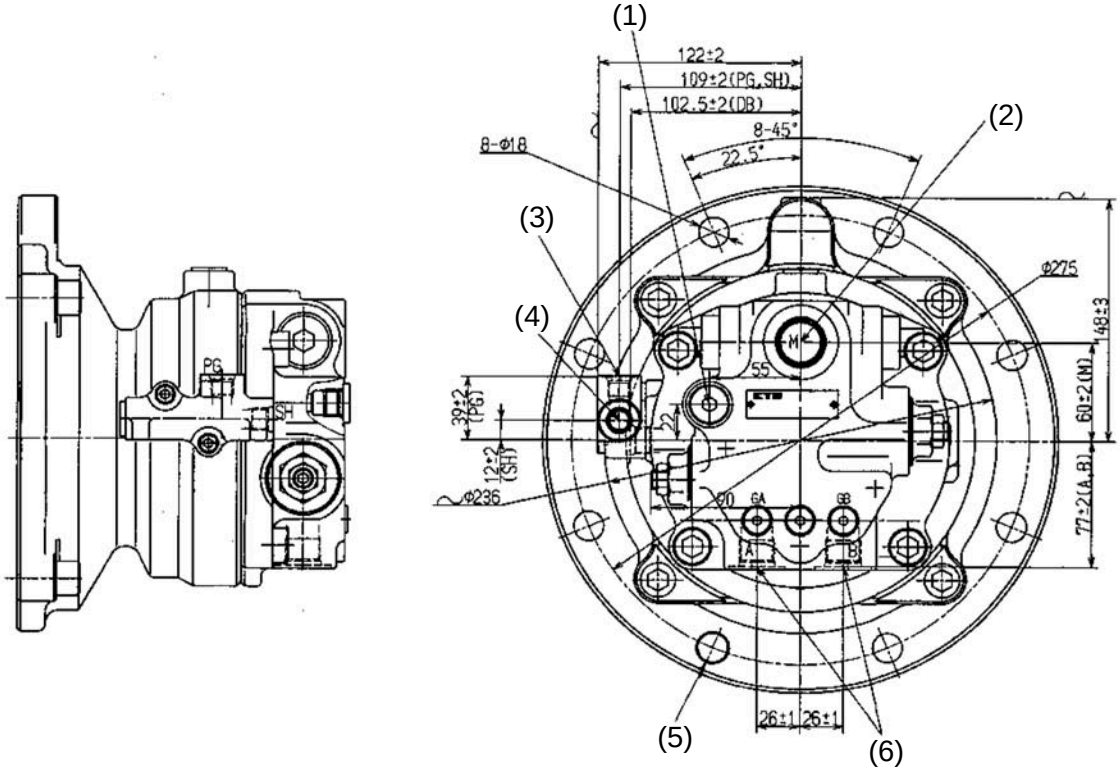


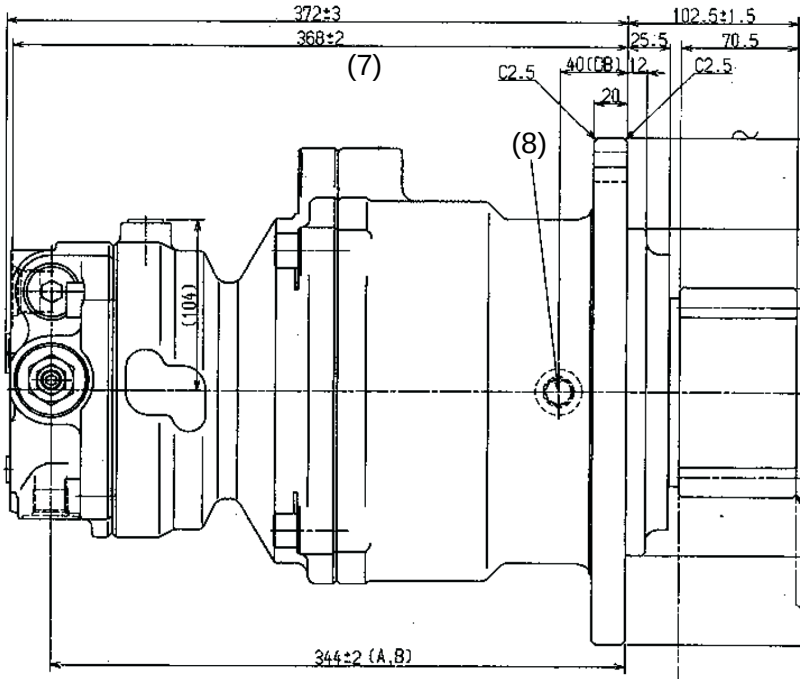
(1) Push rod
(2) Orifice
(3) Piston
(4) Piston chamber
(5) When the lever is tilted from the neutral position toward direction, the oil in the right (left) piston chamber passes out the orifice.

F. Swivel motor

a. General

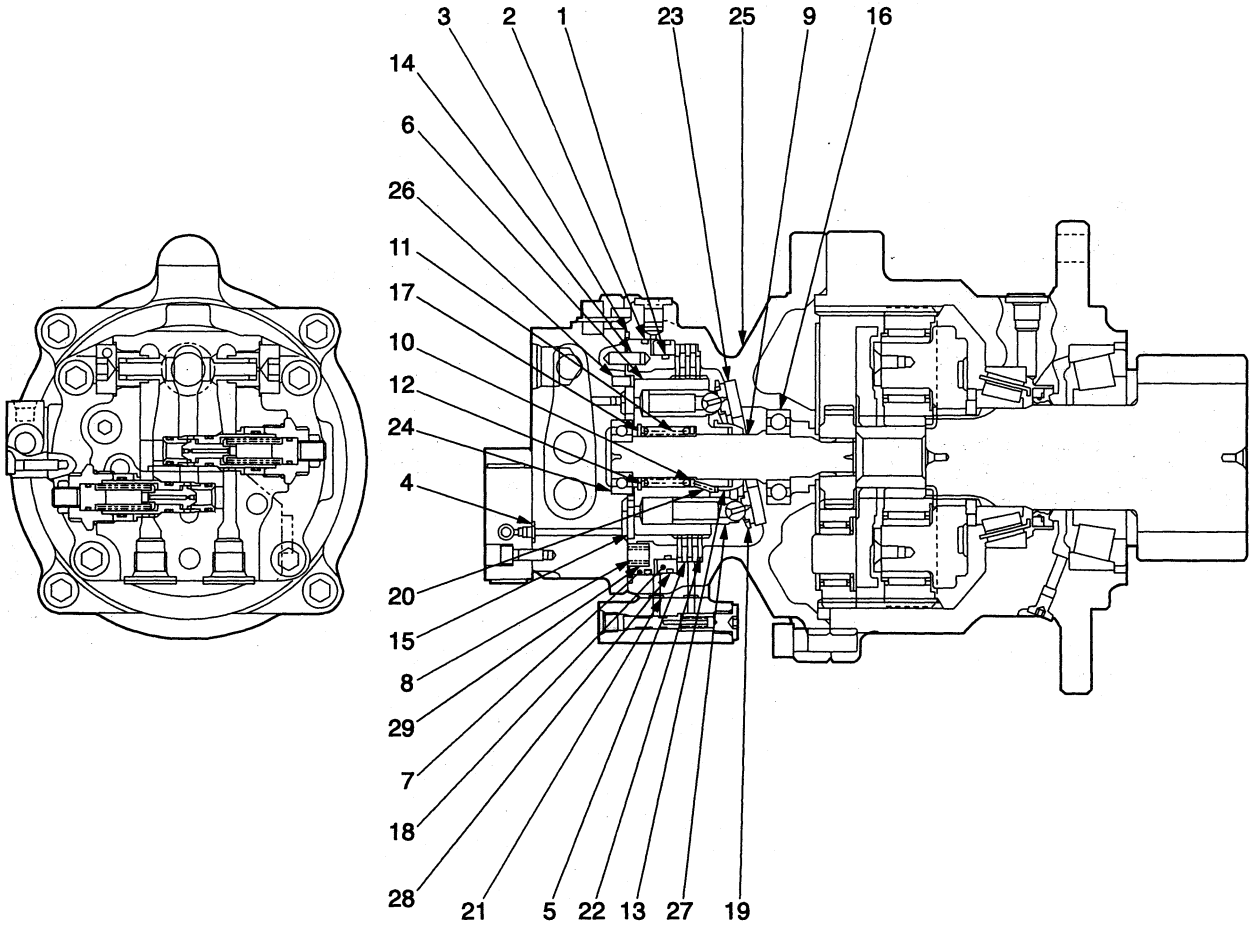
1. Swivel motor outer view





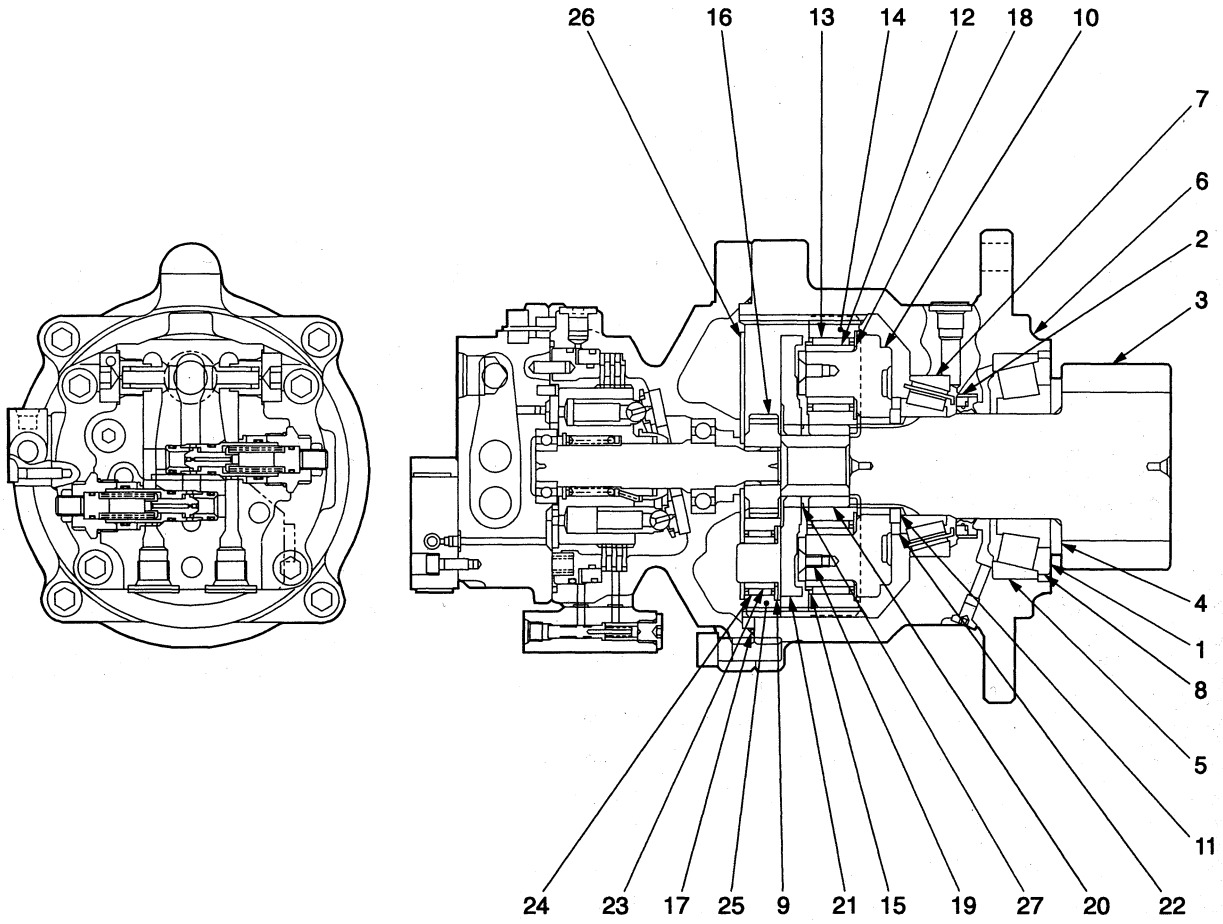
(1) [PF3/8(G3/8)] Vent port
(2) PF3/4-A[G3/4] JIS B2351 O-type
(3) PF1/4-A[G1/4]
(4) PF1/4-A[G1/4]
(5) 1-M20x2.5 [Drilled hole-ϕ18
(6) 2-PF1/2-A[G1/2]
(7) Vent port
(8) PF3/8-A[G3/8]

2. Swivel motor structure

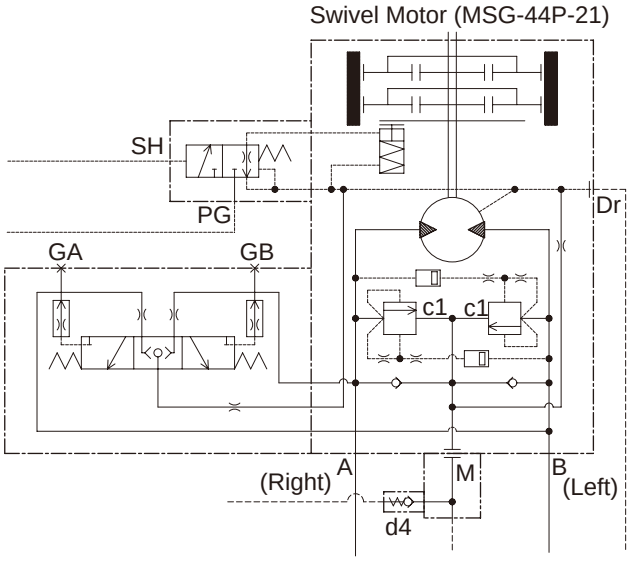


1.	O-ring	11.	Spring	21.	O-ring
2.	O-ring	12.	Holder	22.	Intermediate disc
3.	O-ring	13.	Guide	23.	Swash-plate
4.	O-ring	14.	Pin	24.	Bearing
5.	Friction disc	15.	Valve plate	25.	Housing
6.	Cylinder block	16.	Bearing	26.	Pin
7.	Brake piston	17.	Snap ring	27.	Piston
8.	Spring	18.	Sleeve	28.	O-ring
9.	Shaft	19.	Shoe holder	29.	Spring
10.	Holder	20.	Pin		

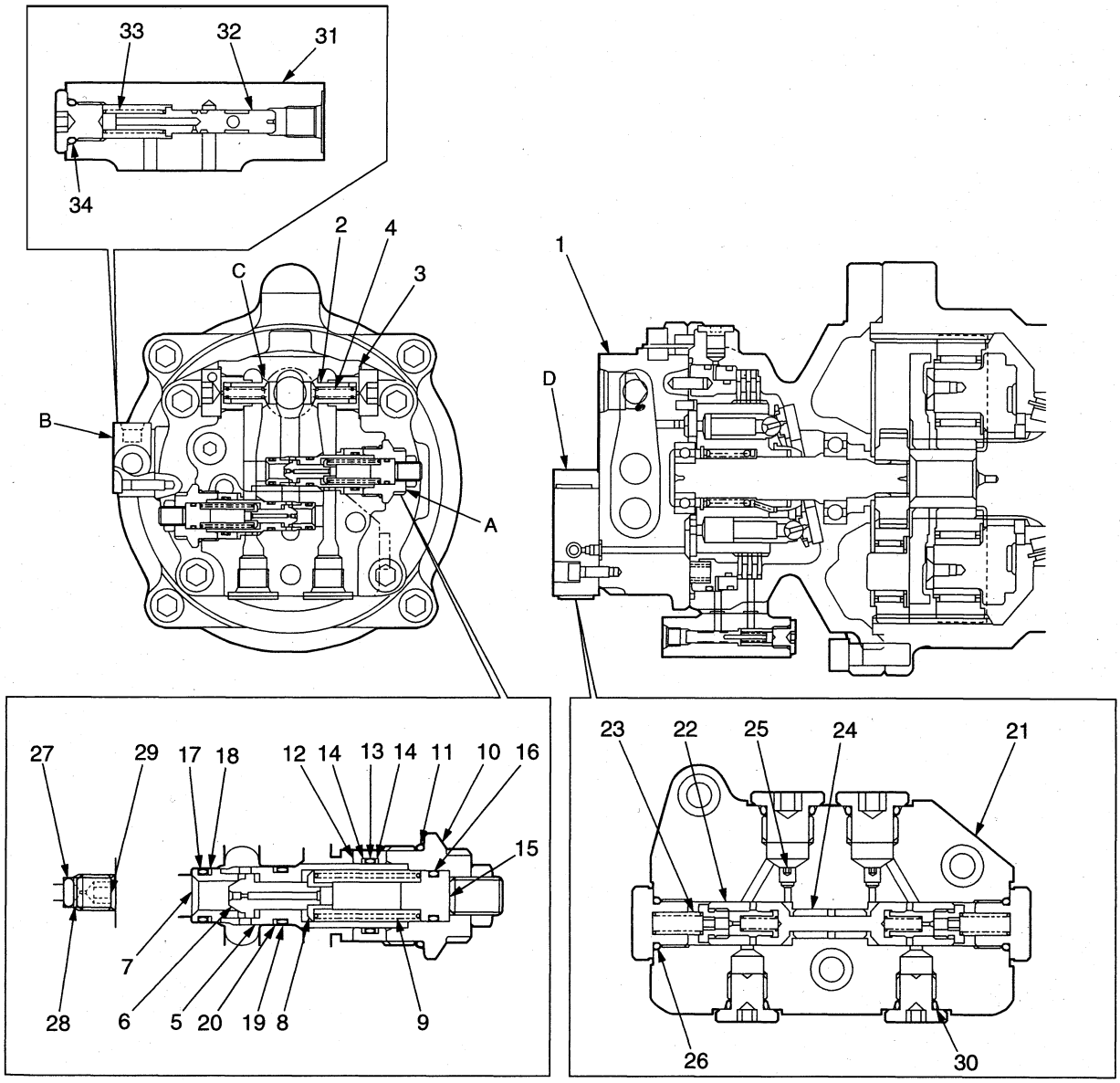
3. Structure of reduction gear case



1.	Plate	15.	Thrust washer
2.	Oil seal	16.	Drive gear
3.	Shaft	17.	O-ring
4.	Sleeve	18.	Thrust washer
5.	Bearing	19.	Screw
6.	Housing	20.	Sun gear
7.	Bearing	21.	Support 1
8.	Plate	22.	Sleeve
9.	Thrust washer	23.	Race
10.	Support 2	24.	Pin
11.	Plate	25.	Planetary gear A
12.	Race	26.	Impact plate
13.	Pin	27.	Snap ring
14.	Planetary gear		



4. Structure of brake valve



A: Counterbalance valve
B: Delay valve
C: Check valve
D: Shock-absorbing valve

1.	Covering	10.	Stopper	19.	O-ring	28.	Washer
2.	Valve cone	11.	O-ring	20.	Retaining ring	29.	Discharge port
3.	O-ring	12.	Piston	21.	Housing	30.	O-ring
4.	Spring	13.	O-ring	22.	Check valve fixture	31.	Housing
5.	Housing	14.	Retaining ring	23.	Spring	32.	Sliding valve
6.	Valve cone	15.	Guide	24.	Sleeve	33.	Spring
7.	Sheet	16.	O-ring	25.	Discharge port	34.	O-ring
8.	Sheet	17.	O-ring	26.	O-ring		
9.	Spring	18.	Retaining ring	27.	Filter		

b. Function of swivel motor

1. Hydraulic motor

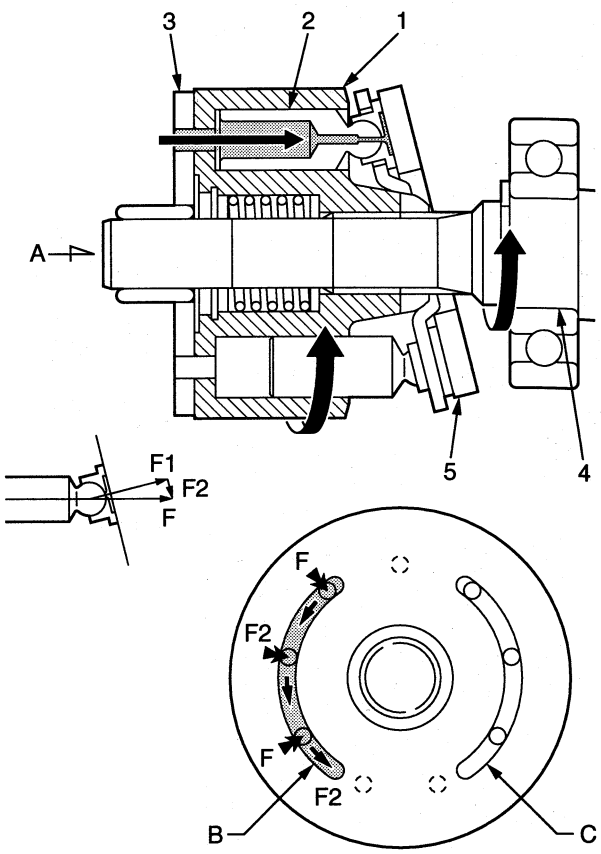
Nine pistons (2) are fitted in the cylinder block (1), and the valve plate (3) is attached at the end with two half-moon-shaped ports B and C. The cylinder block (1) turns itself and is connected by the key with the shaft (4). On the other hand, the swash-plate (5) is secured on the housing.

When pressure oil is introduced through the port B, the swash-late (5) is pushed by each piston (2) with the force F.

F = P x A

P: Pressure, A: Piston cross-sectional area

The force F, which pushes the pistons (2) onto the swash-plate (5), is divided in force F1 and 2: Force F1 pushes against the swash-plate and F2 pushes on the cylinder block (1). The total force of the components in the turning direction of the pistons at the high-pressure side produces a rotational force in the cylinder block (1). This force is transmitted through the key onto the shaft (4), which is turned. When the pressure oil is introduced into the port C, on the other hand, the turning takes place in the opposite direction.



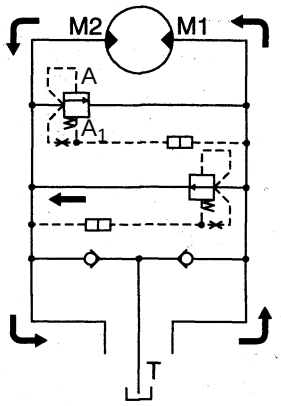
2. Relief valve

Function 1

When the motor gets started:

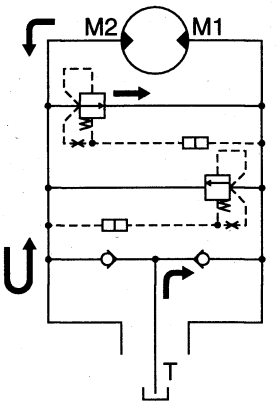
When the motor gets started, the inertial load becomes greater, so that the pressure of the oil required for acceleration rises. If this oil pressure has reached the preset level of the counterbalance valve, the counterbalance valve is activated and the oil returns to the port M2.

In this way, the motor starts running, while the pressure is balanced by the counterbalance valve. With the rpm increasing, the balancing rate decreases until finally the balancing does not take place any longer. In this manner the shock at the startup is absorbed.



When the motor gets stopped:

When the motor gets stopped, the return circuit is interrupted. Because the motor still turns itself by the inertial force, however, the pressure at port M2 rises. If this oil pressure has reached the preset level of the counterbalance valve, the counterbalance valve is activated and the oil starts flowing to the port M1. In this way, the oil flow to the port M1 prevents cavitation that would occur in shock absorbing during stopping.



Function 2

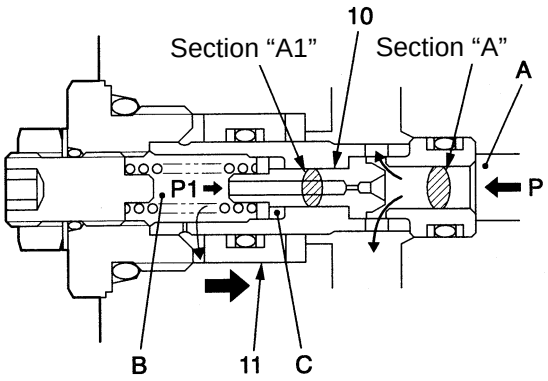
This brake valve has a shock-free mechanism and works in two stages.

First stage

When the brake valve is activated, the pressure in chamber B (P1) is kept lower than that in chamber C. The pressure in chamber A (P), on the other hand, becomes higher than that of the incoming oil.

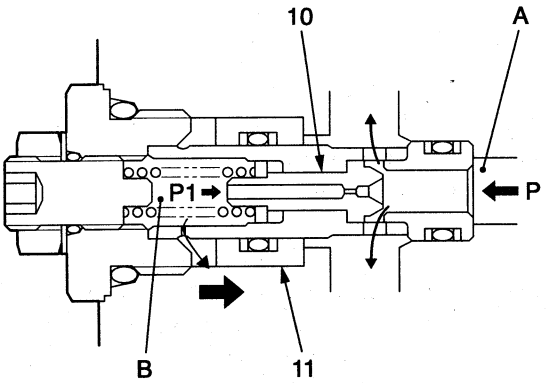
At this time, two forces act on the disc (10). The force F moves the disc (10) to the left, whereas the force F1 pushes against the seat to the right side.

Because F = P x A, F1 = P1 x A1, P > P1 and A >A1, the disc (10) is moved to the left by the force "F - F1". Thereby, the supply-side circuit starting from the chamber A gets open in order to let the pressure escape. That is to say, the brake valve is activated at low pressure (about 1/3 of the preset pressure), while the piston (11) is moved to its stroke end.



Second stage

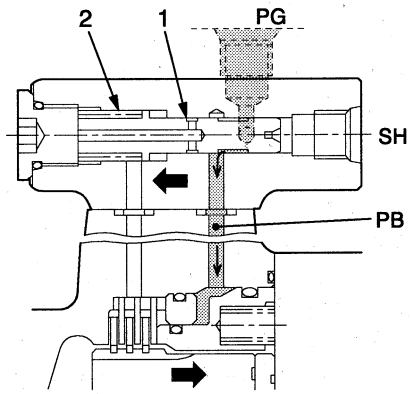
When the piston (11) has reached the stroke end, the pressure in chamber B rises and the pressures in the chambers A and B counterbalance each other. At this time, the force that moves the disc (10) to the left becomes "P = P1", which refers to "A - A1". At the specified pressure setting, the counterbalance valve is then activated.



3. Negative brake release

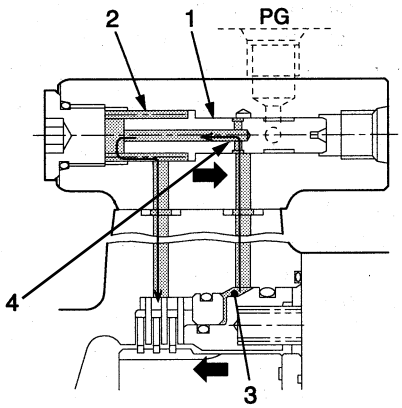
This valve prevents an abrupt movement of the negative brake, when the motor stops.

When the negative brake is applied, oil under pressure is supplied from port P4 to port PG. The sliding valve (1) is pushed to the right by the spring (2), by which the port PG gets closed.



When the pilot pressure is applied at the port for swiveling or arm movement, the sliding valve (1) surpasses the spring (2) and slides itself to the left, by which the port PG gets open. The pressure at port PG is then applied through the hole in the center of the sliding valve (1) to the release port (PB) of the hand brake. In dosing so, the negative brake is now disengaged.

When the pilot pressure is reduced at port SH, the sliding valve (1) is pushed to the right by the spring (2), by which the port PG gets closed. Consequently the hydraulic oil in the brake piston chamber (3) cannot escape any longer. The oil gradually flows from the chamber through the orifice (4) in the range of sliding valve (1) up to the outlet port. In dosing so, the negative brake is now engaged with some delay.

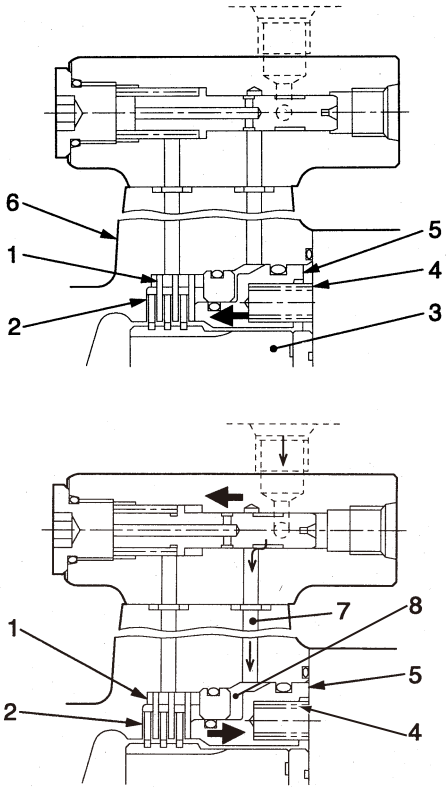


4. Negative brake function

Parking brake

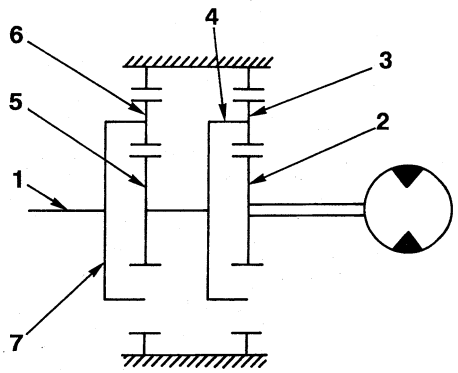
The separator discs (1) are in mesh with the housing, and the friction discs (2) with the cylinder barrel (3). The separator discs (1) and the friction discs (2) are pushed against the housing (6) by the springs (4) and the brake piston (5). The friction between these discs produces a braking moment, preventing the turning of the cylinder barrel (3).

When hydraulic oil is required by the motor, the oil flows from the release port (7) of the parking brake to the brake piston chamber (8). The oil pressure surpasses the spring force and moves the brake piston (5) to the right. By this, free play is produced between the separator discs (1) and friction discs (2), and the parking brake is disengaged. When the motor stops, the sliding valve (9) goes back to the neutral position and closes the release port (7) of the parking brake. Thereby, the pressure oil drains from the brake piston chamber (8) into the motor housing, by which the spring (4) gets the parking brake (4) reengaged.



5. Planetary reduction ratio

The reduction gears consist of a two-stage planetary gear, in order to convert the high speed of the motor to low speed and high torque for the pinion shaft (1). In the figure at right, the motor-generated driving force is transmitted in this way: from the drive shaft of the motor, through the drive gear in the first stage (2), the planetary gear (3) and the support 1 (4), to the sun gear in the second stage (5). The sun gear in the second stage (5) then transmits the driving force through the planetary gear (6) and the support 2 (7) onto the pinion shaft (1), to carry out a swivel motion.



c. Parking brake and hydraulic timer

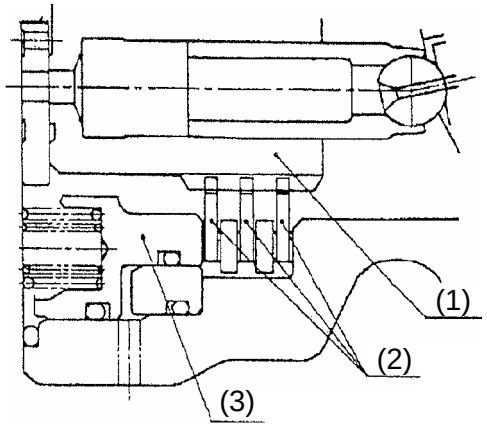
(1) Parking brake (if equipped with parking brake)

The parking brake is of wet multi-disk type and hydraulically released. With shaft-lock mechanism, the brake is engaged and disengaged by switching the external signal pressure.

1. Parking brake ON

Refer to the construction view <Fig. 1>.
When the brake releasing hydraulic pressure is cut off, the discs that are spline-coupled around the cylinder block are pressed on the brake piston (fixed not to turn itself) by a spring force. The frictional force works to retain the cylinder block and the case, which gets the shaft locked.

(1) Cylinder block
(2) Disc plate
(3) Brake piston

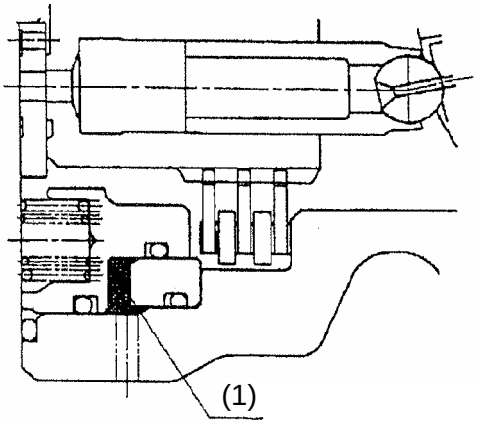


PB (PG) [brake release pressure] OFF
<Fig. 1>

2. Parking brake OFF

Refer to the construction view <Fig. 2>.
When the brake releasing hydraulic pressure is introduced through port PB (port PG if equipped with the parking plate) into the brake cylinder chamber (C), the brake piston acts against the spring force, which gets rid of the frictional force against the discs. Now the shaft can turn itself freely.

(1) Brake cylinder chamber C

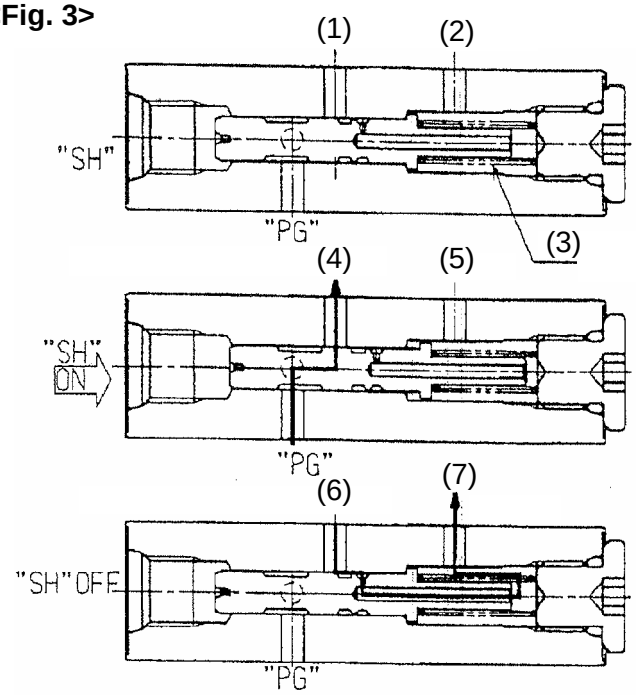


PB (PG) [brake release pressure] ON
<Fig. 2>

3. Hydraulic timer

Refer to the construction view <Fig. 3>.
The hydraulic timer is designed to prevent a drag of the parking brake in braking the swivel motion. While the swivel inertial force is absorbed by the hydraulic dynamic brake, a delay time is ensured to disable the parking brake. The delay time is realized by narrowing the orifice to control the flow of the oil coming out of the brake cylinder chamber.
Keep the motor running and return the control valve to the neutral position. Now the valve switching pressure SH, which is interlocked with the control valve' s switching signal, becomes low. The valve acts by the spring force as shown below. Through this valve, the brake cylinder chamber connects to the drain. (In this state, the upper swivel structure' s energy is converted to thermal energy and absorbed. To do this, the relief valve, as discussed later, provides for hydraulic dynamic braking effect.) On the other hand, the oil in the brake cylinder chamber A tends to flow, by the spring force upon the brake piston, toward the disc-pressing direction. But the flow of the oil out of the brake cylinder chamber is controlled by the orifice of the valve. In a specified time, therefore, the brake piston comes into contact with the discs for braking effect.

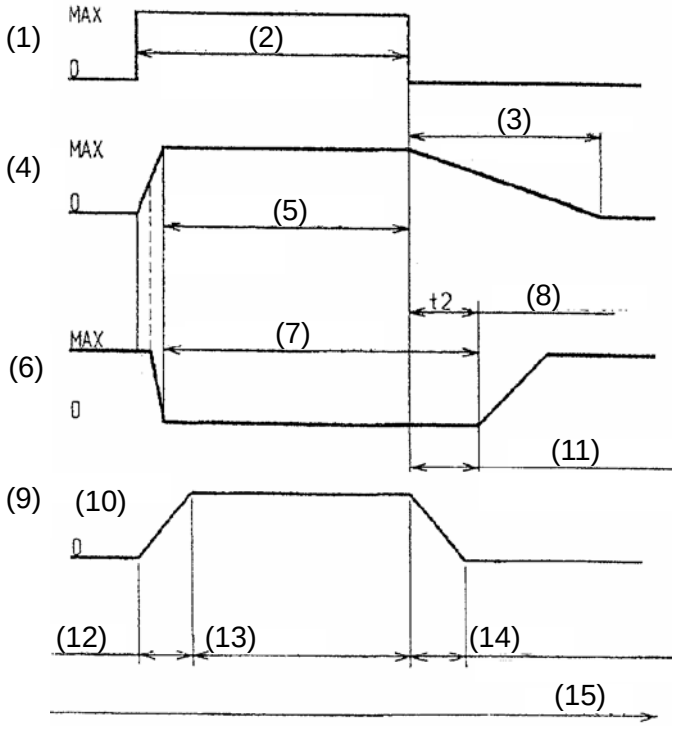
<Fig. 3>



(1) To brake cylinder chamber C
(2) Drain
(3) Spring
(4) To brake cylinder chamber C
(5) Drain
(6) To brake cylinder chamber C
(7) Drain

The above function is explained in a diagram below.

Diagram



(1) Shuttle valve switching external signal pressure SH
(2) Valve switched for main control during this period
(3) Time zone in which the flow is controlled by the orifice
(4) Parking brake cylinder chamber pressure
(5) PG feed pressure acting during this period
(6) Parking brake torque
(7) Parking brake released
(8) Timer setting
(9) Parking brake disabled during this period. No drag allowed.
(10) Swiveling speed
(11) Preset swiveling speed
(12) Acceleration
(13) Constant swiveling speed
(14) Deceleration
(15) Time (t) : 5 ± 1.5 seconds

d. Anti Swivel Back Valve

1. Outline

Anti swivel back valve makes the Main port connect to Drain line in a second in order to prevent Swivel back of upper carriage at swing stop motion.

2. Structure

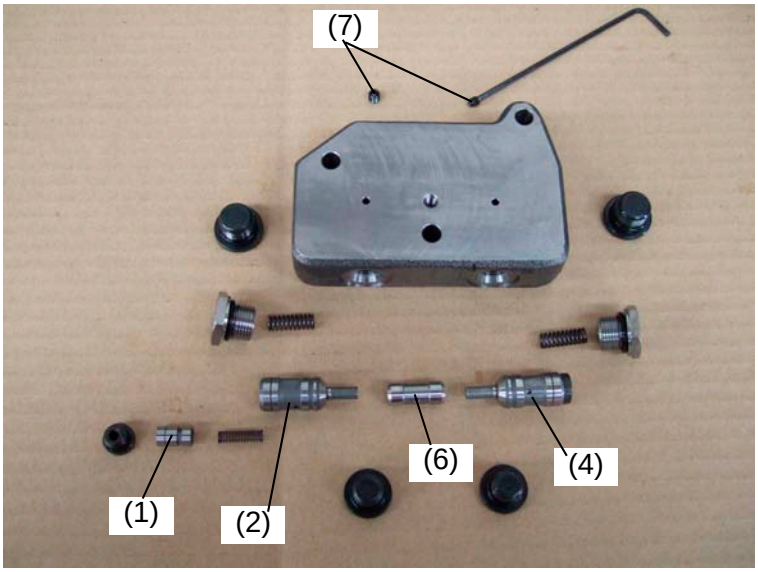
This valve consists of following items.

A) Check valve
B) Flow control valve
C) Sleeve
D) Orifice A (Inside two plugs, ϕ1.0)
E) Orifice B (Inside Cv, ϕ0.6)

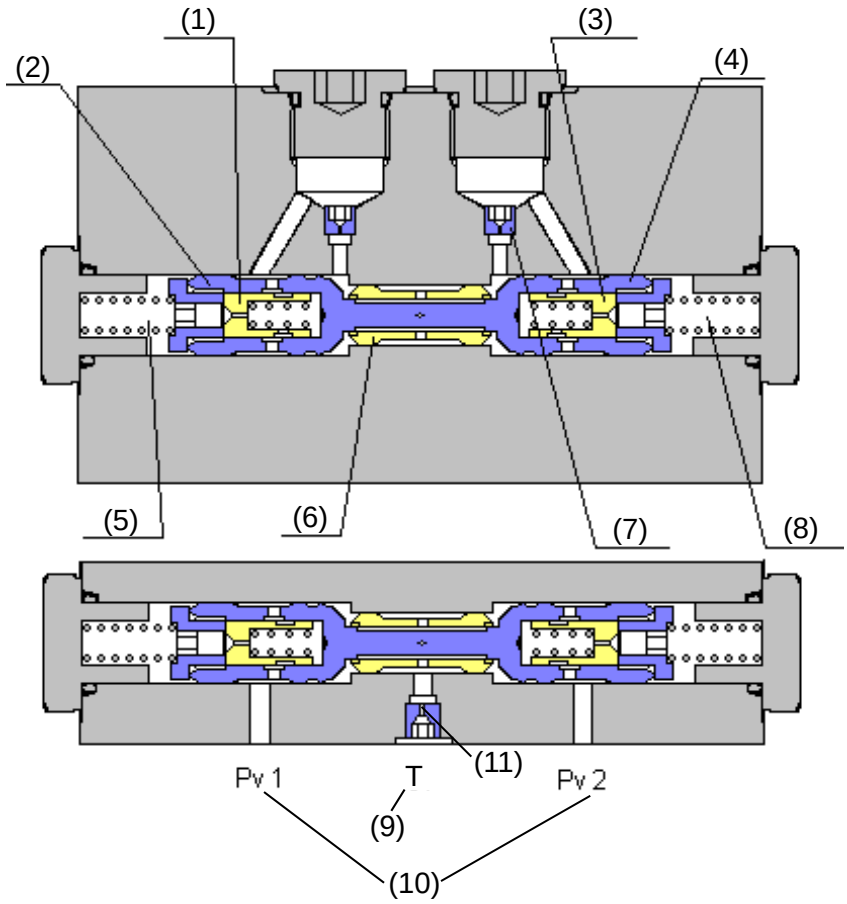




(11)Orifice B



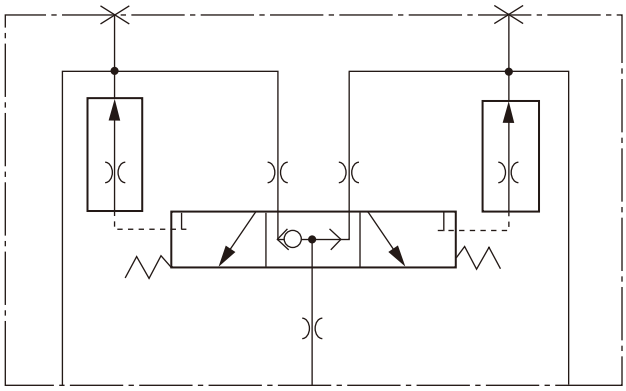
(1) Flow control valve 1
(2) Check valve 1
(4) Check valve 2
(6) Sleeve
(7) Orifice A



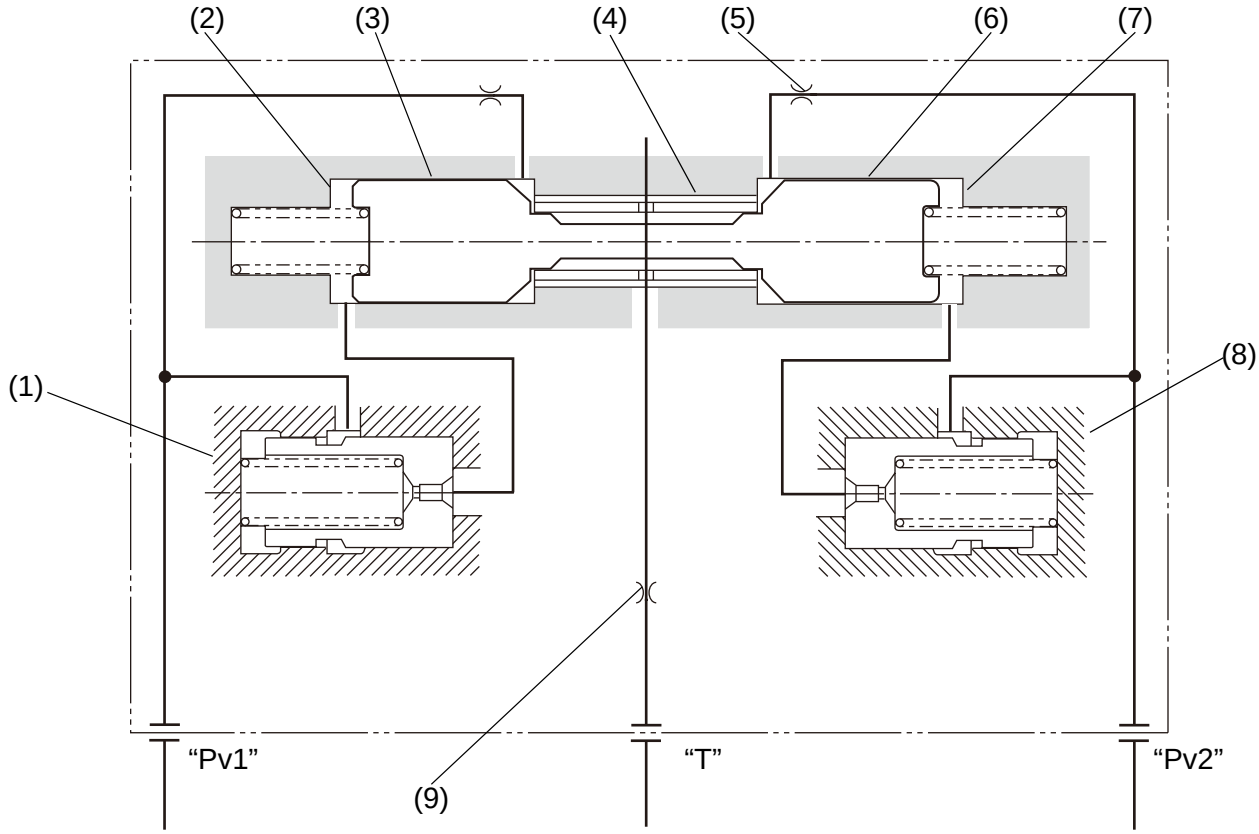
(1) Flow control valve 1
(2) Check valve 1
(3) Flow control valve 2
(4) Check valve 2
(5) Damping chamber 1
(6) Sleeve
(7) Orifice A
(8) Damping chamber 2
(9) To make-up valve (This serves as drain on this motor.)
(10) To main ports
(11) Orifice B

3. Function

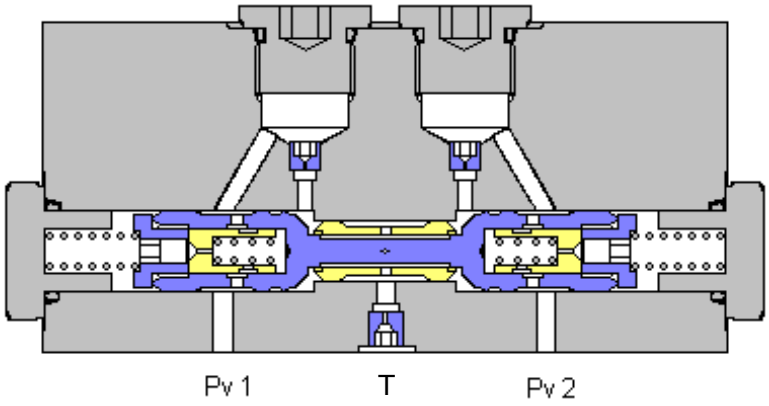
Hydraulic circuit diagram



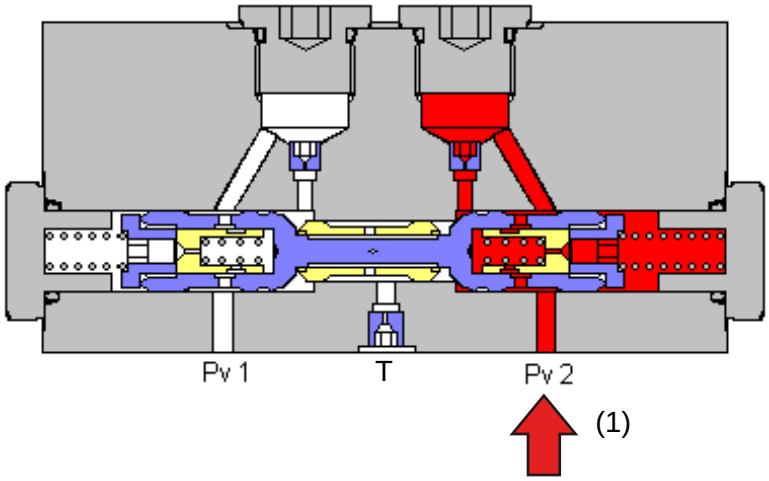
Typical Anti Swivel Back Valve



(1) Flow control valve 1
(2) Damper chamber 1
(3) Check valve 1
(4) Sleeve
(5) Orifice A
(6) Check valve 2
(7) Damper chamber 2
(8) Flow control valve 2
(9) Orifice B



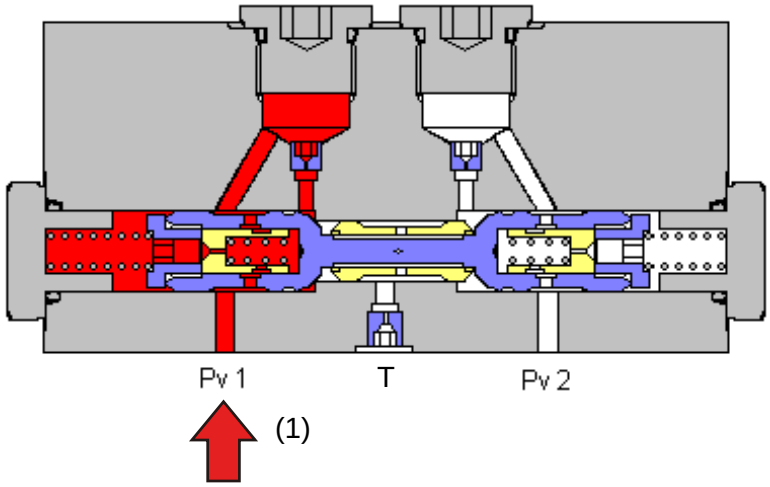
1 (Neutral condition)
Check valve stands in center position by spring force when control valve is not operated.
(P1 and P2 have same pressure.)



2 (Acceleration and operating condition)
Check valve is pushed and block the passage when swivel motor is operated.

(1) Operating pressure

Internal pressure pushes the poppet and seal.

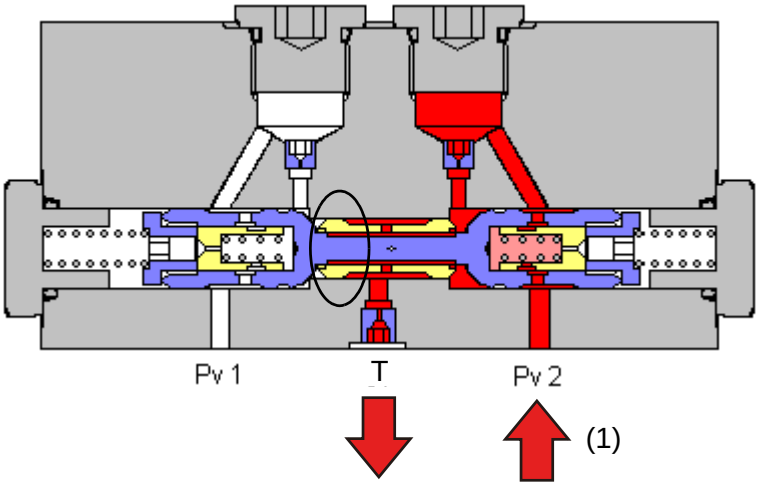


3 (Braking condition)
Check valve is pushed and block the passage by brake pressure.

(1) Brake pressure of motor's pumping function

Note :
This brake pressure is generated by the pumping function of the swivel motor's inertia force when the control lever is returned to neutral position while swiveling.

On this stage, swivel motor is turning a little.

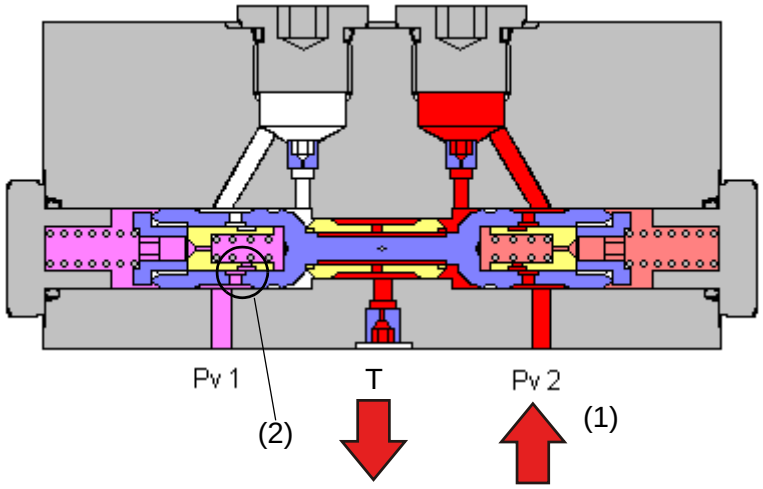


4 (Swivel back condition 1)

After swivel stop, the swivel motor start to swivel back due to the swivel back pressure.
This pressure pushes the sleeve in the direction of the check valve (Low pressure side) and makes sleeve contact with check valve.
At the same time, the passage from Pv2 to T is opened.
The pressure is led to T through this passage.

(1) Swivel back pressure.

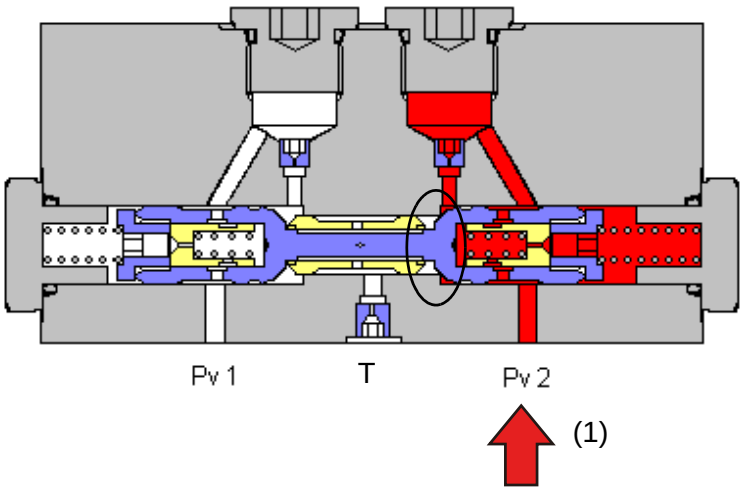
(Instantaneous pressure oil)



5 (Swivel back condition 2)

Swivel back pressure pushes also the check valve in the direction of the arrow. Check valve moves constant speed because flow control valve restricts the flow from damping chamber 1.

(1) Swivel back pressure.
(2) Flow control valve

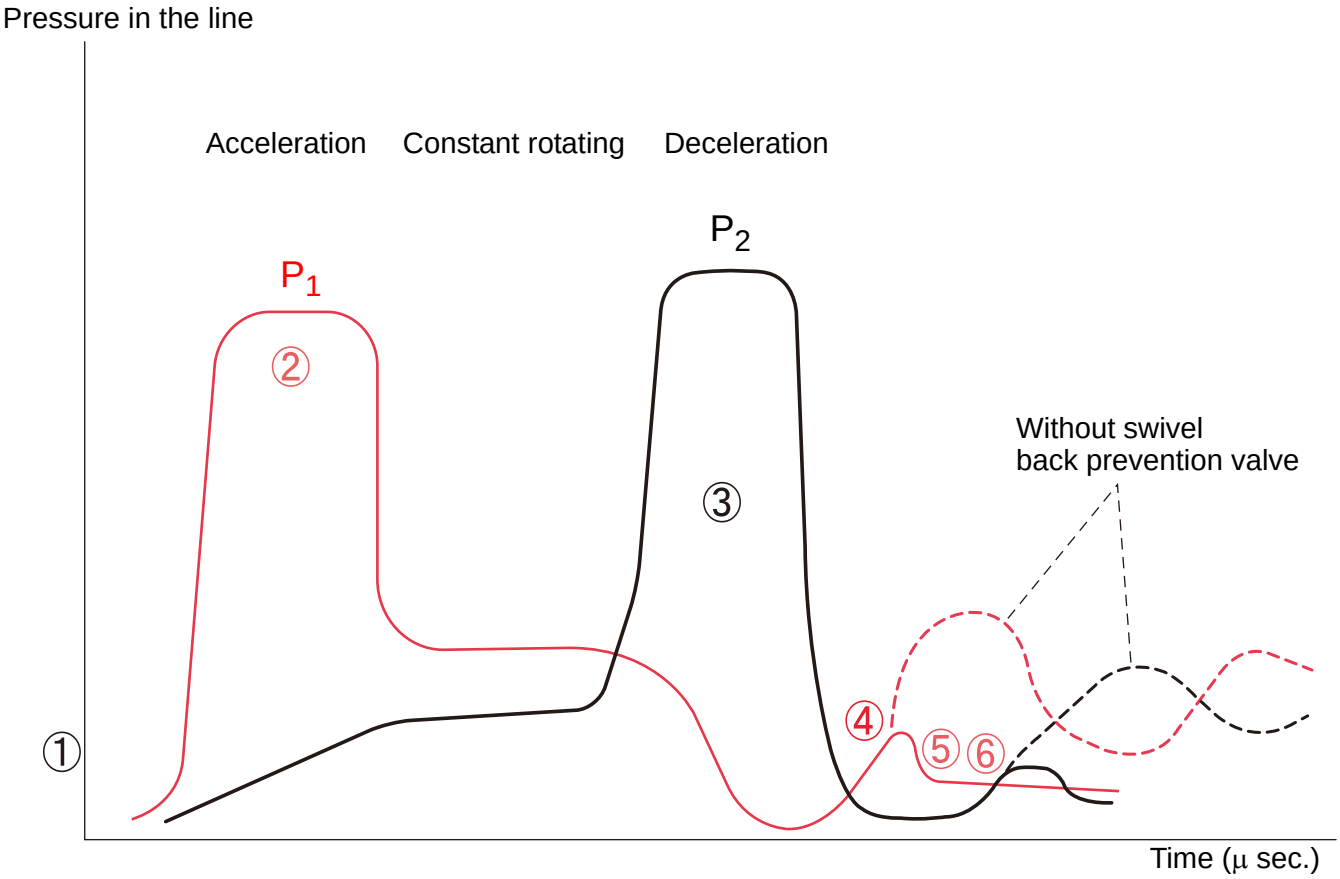


6 (Swivel back condition 3)

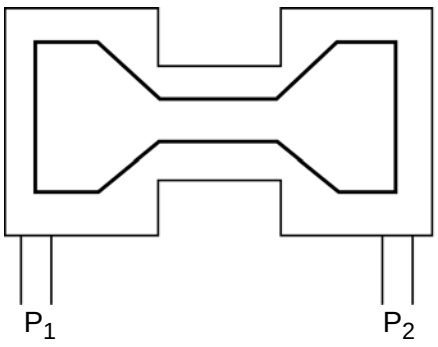
Finally, Check valve shut the passage between Pv2 and T2.

(1) Swivel back pressure.

4. Swivel motor, swivel back prevention mechanism

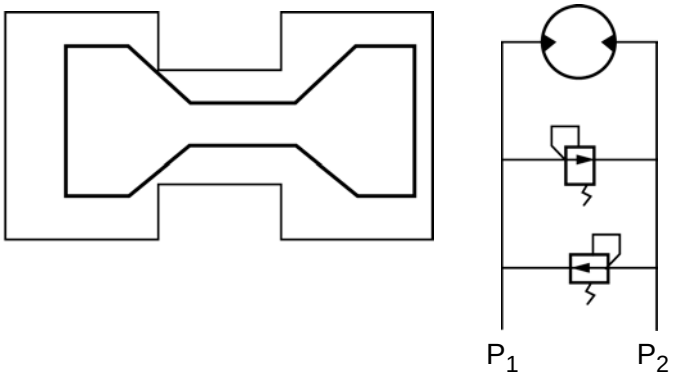


At $P_1 = P_2$



P_1 and P_2 become same pressure and prevent swivel shock.

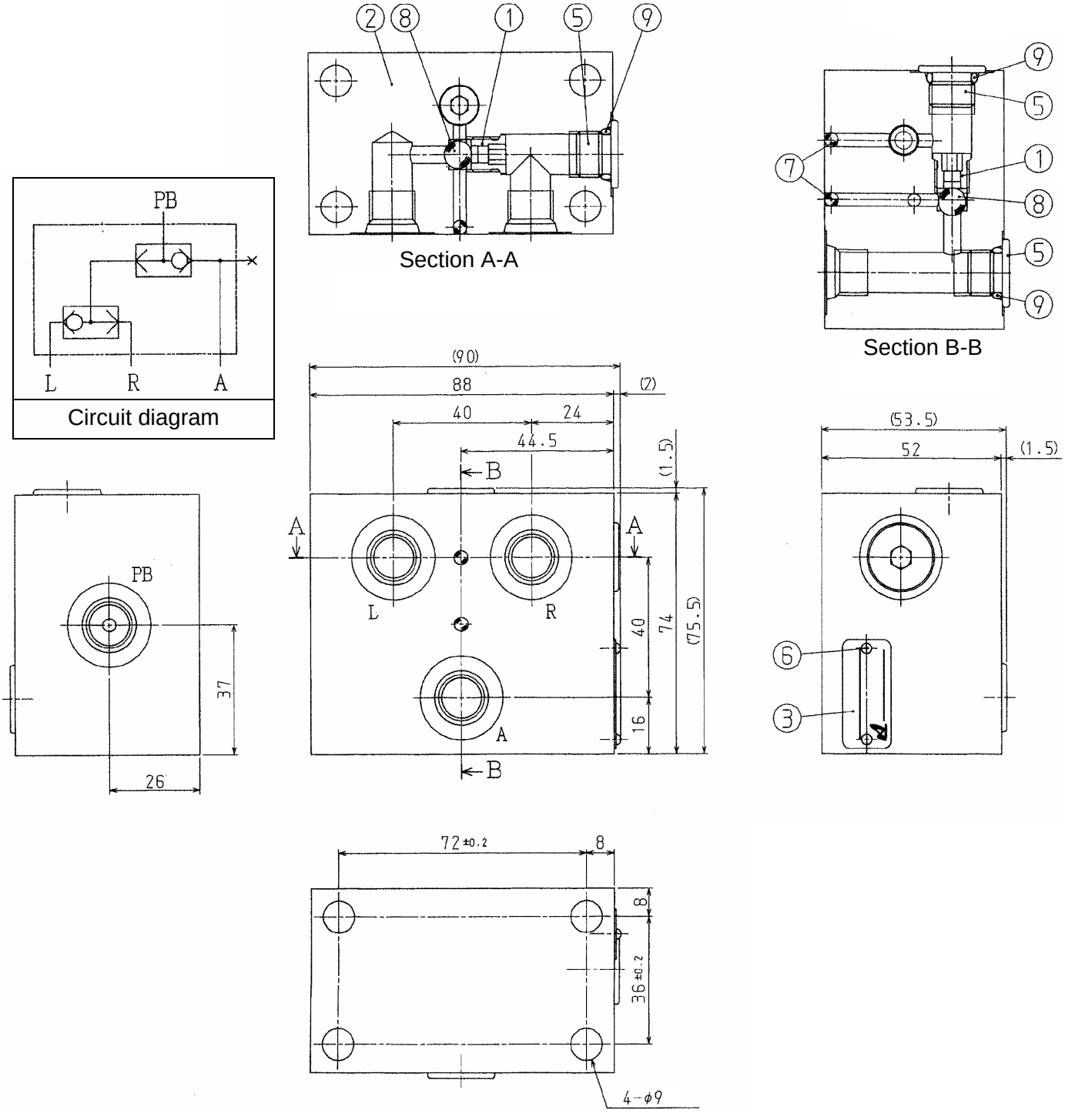
At $P_1 > P_2$



P_1 and P_2 are blocked by the valve seat.

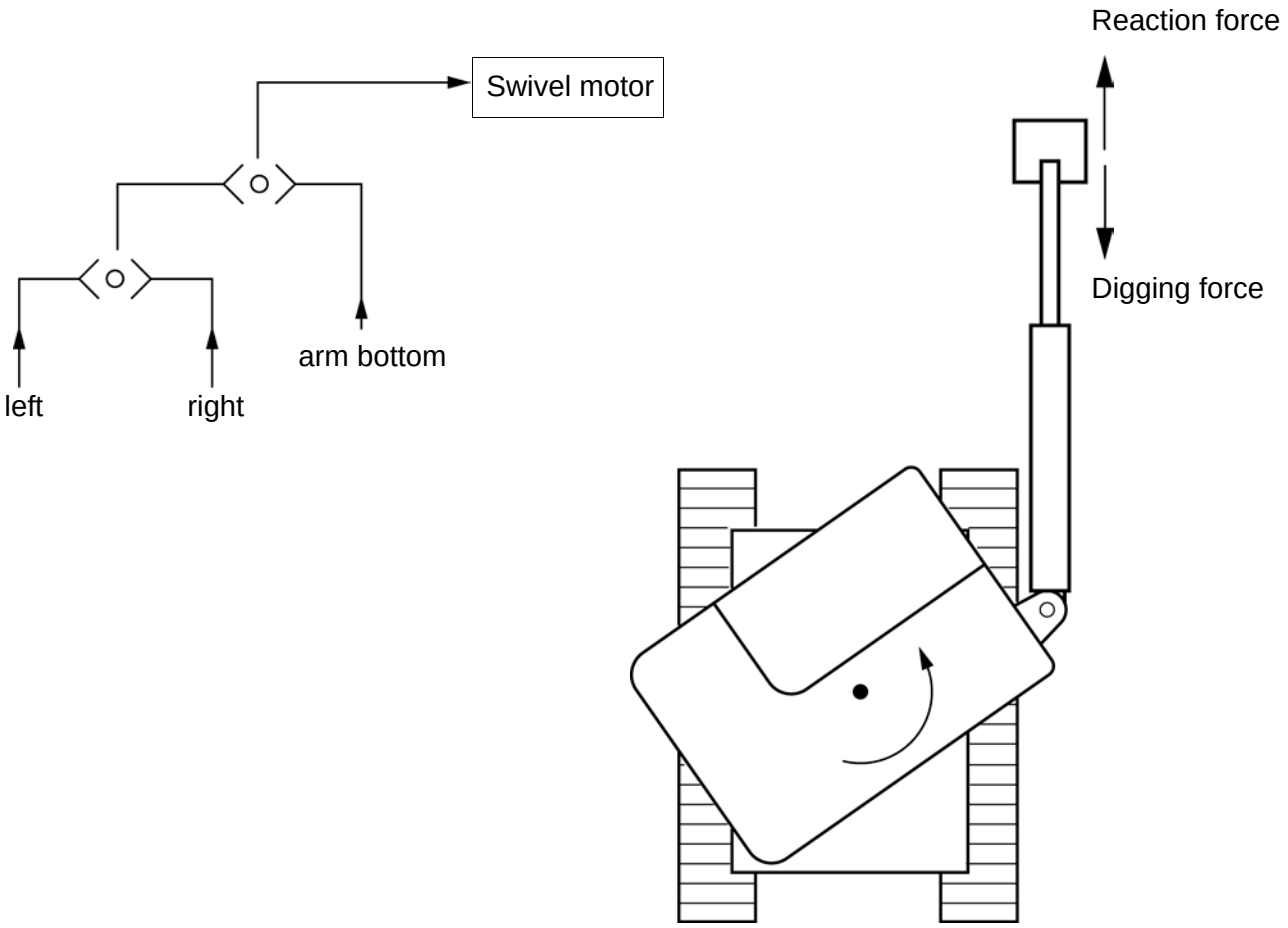
e. High-pressure selector valve (for swivel brake release signal)

1. Outline



- Used to select maximum pressure of the pilot signal for left/right swivel and arm crowd.
- Used to release the swivel motor's negative brake at maximum pressure.
- Used to release the maximum pressure signal on the timer-controlled valve of the swivel motor first and then to get the negative brake activated with a delay (about 5 seconds to allow for enough swivel relief).

2. Release function of negative valve



If, Moment by digging force > Swivel motor negative braking force ; Friction plates might be burned out.

G.Travel motor

a. General

1. GM motor

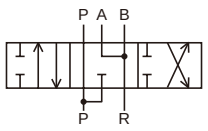
This product is a rotary hydraulic actuator. The reduction gears, hydraulic motor, brake valve and parking brake are compactly integrated in this actuator. It has been developed and manufactured for construction machinery that requires low-speed rotations and high-level torques. This product is called “GM motor” in this manual.

2. Specifications

			Characteristics	Working condition
Motor type			GM09VN-B-21/36-3	
User model			KX080-3	
Reduction gears	Gear ratio		MAX. 75.4	61.6
	Rating torque	N·m (kgf·m)	Rating 8830 (900)	5160/9000 (526/918)
	Output speed	r.p.m.	MAX. 60.0	52.7/31.6
Hyd. motor	MAX. capacity	cm^3/rev.	MAX. 36.3	21.3/36.3
	MAX. working pressure	MPa (kgf/cm^2)	MAX. 31.38 (320)	29.4 (300)
	MAX. speed	r.p.m.	MAX. 3600	3245/1944
	Flow rate	l/min.		72
	2 speed control pressrue	MPa (kgf/cm^2)	1.96 ~ 6.86 (20 ~ 70)	1.96 ~ 6.86 (20 ~ 70)
Parking brake	Braking torque	N·m (kgf·m)	MIN. 97.1 (9.9)	97.1 (9.9)
	Release pressure	MPa (kgf/cm^2)	MIN. 0.47 (4.8)	0.47 (4.8)
System pressure		MPa (kgf/cm^2)		29.4 (300)

Note
1. One side ([D1] or [D2]) of the motor drain ports is plugged. When mounting the GM motor to the excavator, connect the drain piping to the upper drain port.
2. The allowable pressure of the motor case is 0.20 MPa (2 kgf/cm^2) below. The drain piping should be properly sized to keep the inner pressure of the motor case is not over 0.20 MPa (2 kgf/cm^2). {Allowable surge pressure is 0.69 MPa (7 kgf/cm^2).}
3. Motor case should be filled with working oil. Use non-pluged drain port for filling. The volume of the working oil is about 0.5 L.
4. Gear case is filled in advance with oil’s SAE #90 GL4.
5. For mounting GM, use bolts classified JIS B 1501 strength class 12.9. Use of lock compound on bolts threads is recommended.
6. When neutral, the control valve should be the position of following chart.

[Chart]



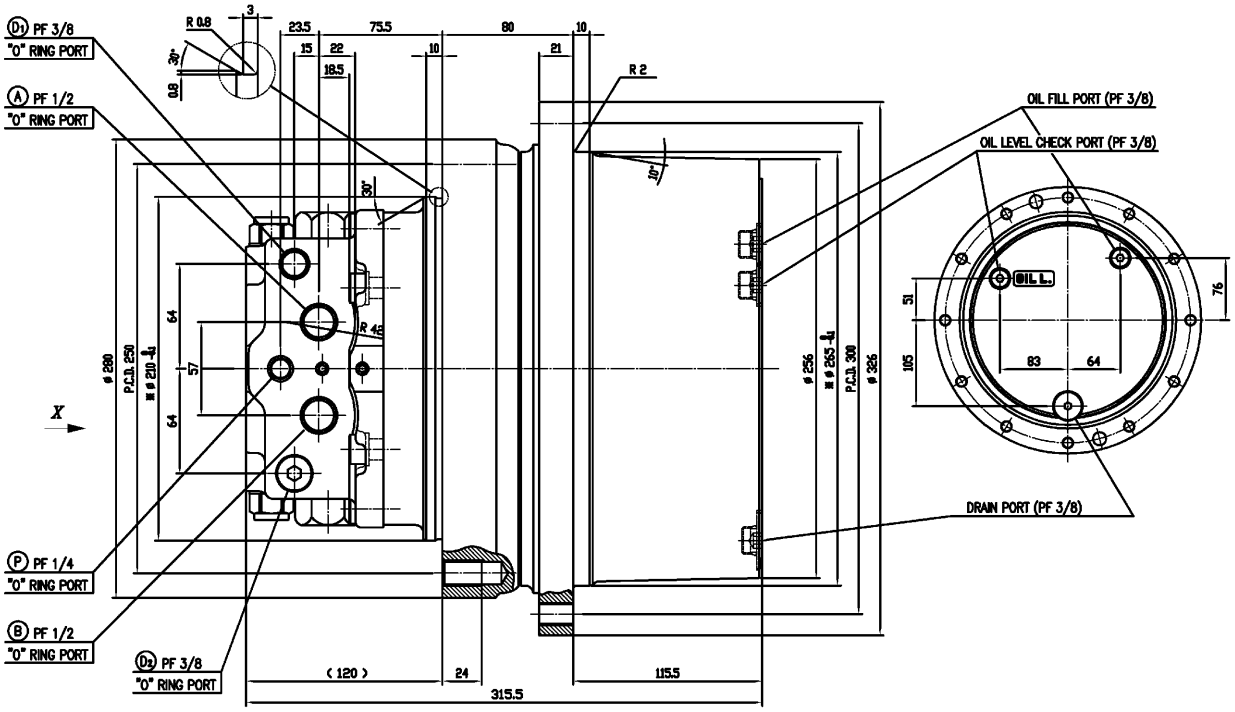
3. Motor type

The type of motor is marked on the product label.

GM (1) **09** (2) **VN** (3) **-** **B** (4) **-** **21 / 36** (5) **-** **3** (6)

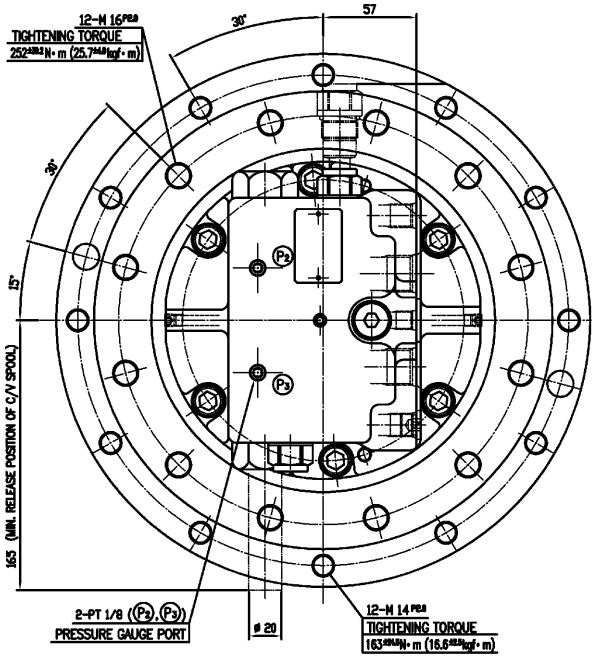
(1) Type code
(2) Size code
(3) Model code
(4) Reduction ratio code
(5) Hydraulic motor displacement rate (cm^3/rev.)
(6) Design number (product classification number)

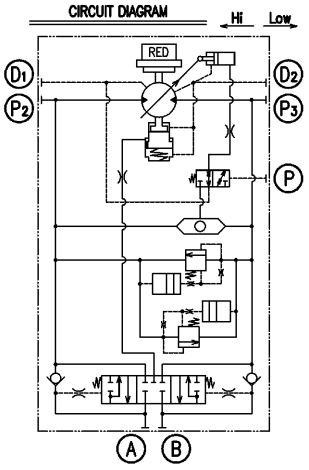
b. Outer view



Direction of rotation

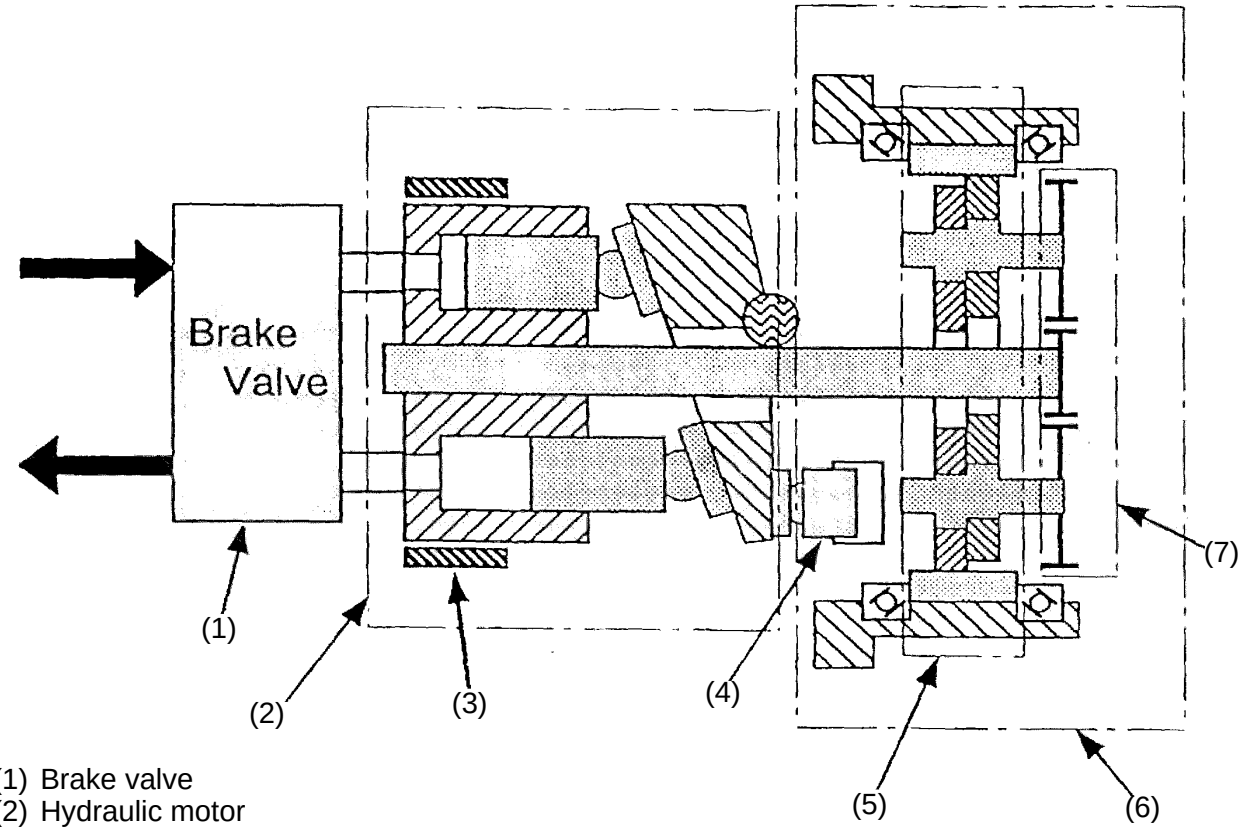
Direction (view X)	Inlet port	Outlet port
Clockwise	B	A
Counter clockwise	A	B





c. Structure

1. Basic structure of GM motor



(1) Brake valve
(2) Hydraulic motor
(3) Parking brake
(4) Two-speed select mechanism
(5) Second reduction section
(6) Reduction gears
(7) First reduction section

1) Reduction gears

The speed reducer consists of two sections: first reduction section with spur gears and second reduction section with pericycloid-toothed differential gears. The high speed of the hydraulic motor is reduced for low-speed, large-torque rotation.

2) Hydraulic motor

The hydraulic motor is of swash-plate axial piston type. The force of pressure oil coming from the pump is converted to rotational movement.

3) Brake valve

This valve is equipped with various component valves. It is designed to bring the hydraulic motor to a smooth stop, to prevent it from running out of control, and to keep off an excessive pressure that would occur in case of a sudden hydraulic motor halt.

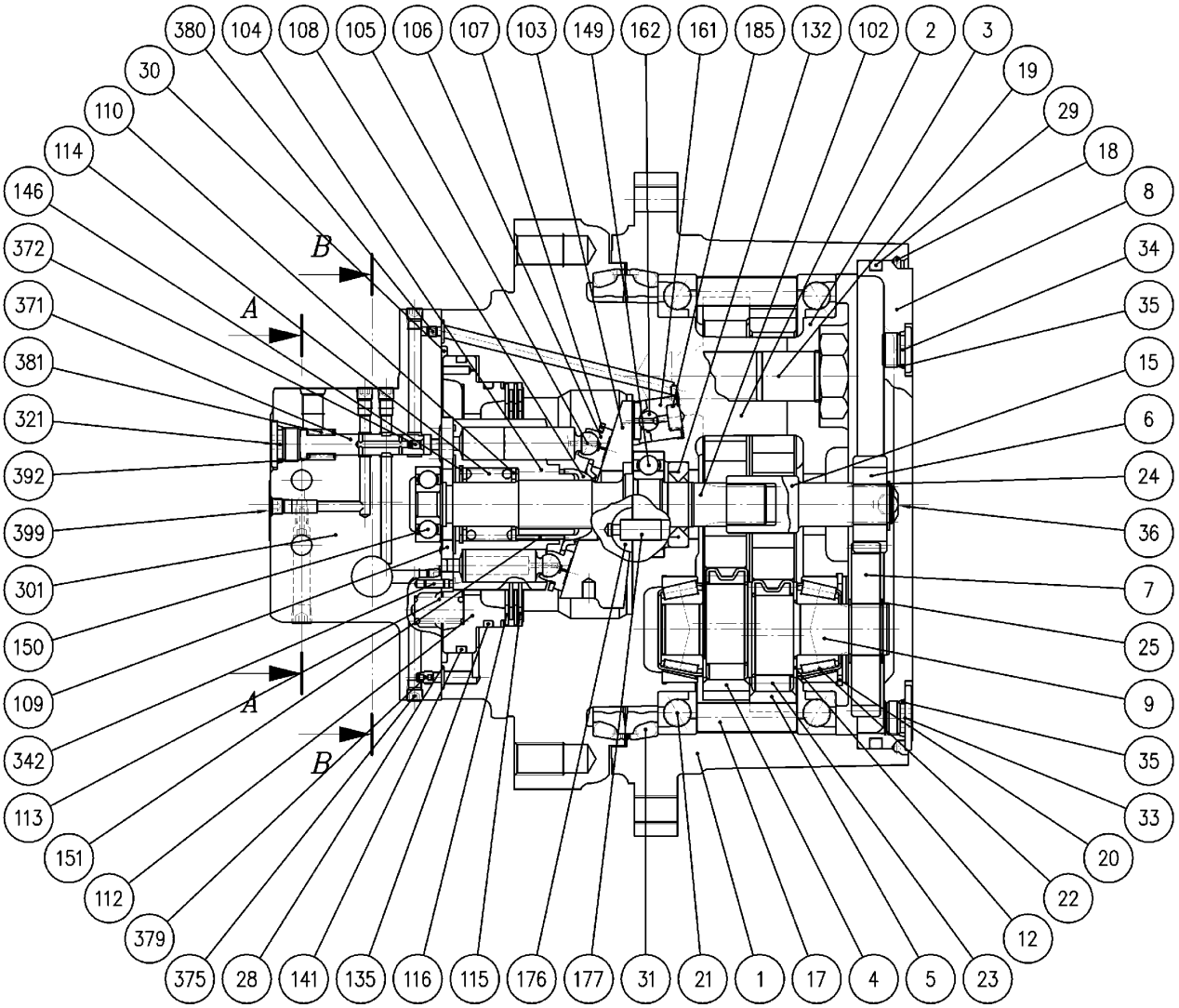
4) Two-speed select mechanism

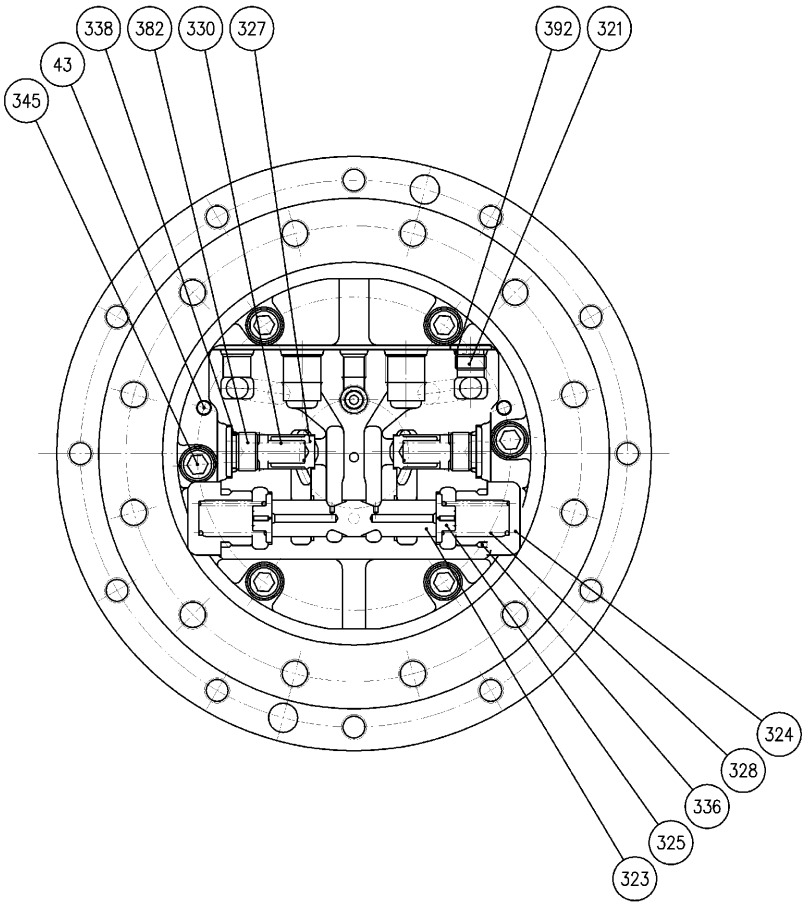
Composed of a selector valve and a piston, this mechanism switches between two different stroke displacements of the hydraulic motor.

5) Parking brake

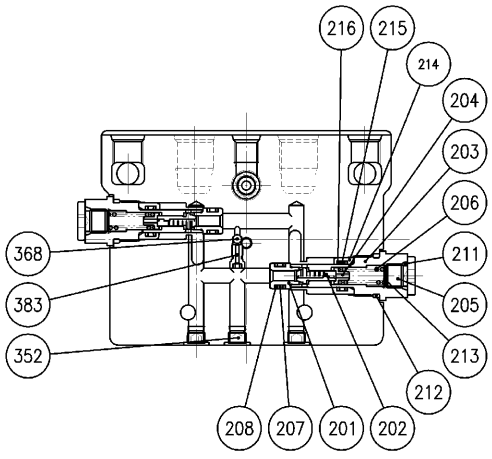
This friction disc type brake is integrated with the hydraulic motor.

2. Sectional view





Section A-A



Section B-B

3. Parts list

No.	Parts name	Q'ty
1	Hub	1
	Spindle kit	
	·Spindle assembly	1
2	··Spindle	1
3	··Hold flange	1
19	·Reamer bolt	3
	RV gear assembly	
	·RV gear kit	1
4	··RV gear A	1
5	··RV gear B	1
9	·Crank shaft	3
12	·Spacer	6
22	·Tapered roller bearing	6
23	·Needle roller bearing	6
6	Input gear	1
	Spur gear kit	1
7	·Spur gear	3
	F-Seal kit	1
31	·Floating seal	2
8	Cover	1
15	Shaft	1
17	Pin	28
18	Ring	1
20	Snap ring	3
21	Ball bearing	2
24		1
25		6
28	O-ring	2
29	O-ring	1
30	O-ring	1
33		1
34	Plug	2
35	O-ring	3
36	Steel ball	1
43	Parallel pin	2
	Piston kit	1
	·Piston assembly	9
105	··Piston	1
	Rear flange assembly	1
	·Rear flange kit	1
301	··Rear flange	1
323	··Spool	1
352	··Hex. socket plug	5
368	··Steel ball	1
375	··Hex. socket plug	5
379	··Filter	1
380	··Orifice	1
383		1
399	··Name plate	1
	·Spool kit	1
371	··Spool	1
372	··Oil stopper	1

No.	Parts name	Q'ty
106	··Shoe	1
	·Piston assembly	1
161	··Piston	1
162	··Shoe	1
102	Shaft	1
103	Swash plate	1
104	Cylinder block	1
107	Retainer plate	1
108	Thrust ball	1
109	Timing plate	1
110	Washer	2
112	Piston	1
113	Spring	8
114	Spring	1
115	Friction plate	2
116	Mating plate	2
132	Oil seal	1
135	O-ring	1
141	O-ring	1
146		2
149		1
150		1
151	Needle roller	3
176	Pivot	2
177	Parallel pin	2
185	Spring	1
		2
201		1
202	·Valve	1
203	·Sleeve	1
204		1
205	·Plug	1
206	·Spring	1
207	·O-ring	1
208	·Back up ring	2
211	·O-ring	1
212	·O-ring	1
213		1
214	·Piston	1
215	·O-ring	1
216	·Back up ring	2
321	·Plug	2
324	·Plug	2
325	·Spring retainer	2
327	·Valve	2
328	·Spring	2
330	·Spring	2
336	·O-ring	2
338	·O-ring	2
381	·Spring	1
382	·Plug	2
392	·O-ring	2
342	Parallel pin	2
345	Hex. socket bolt	6

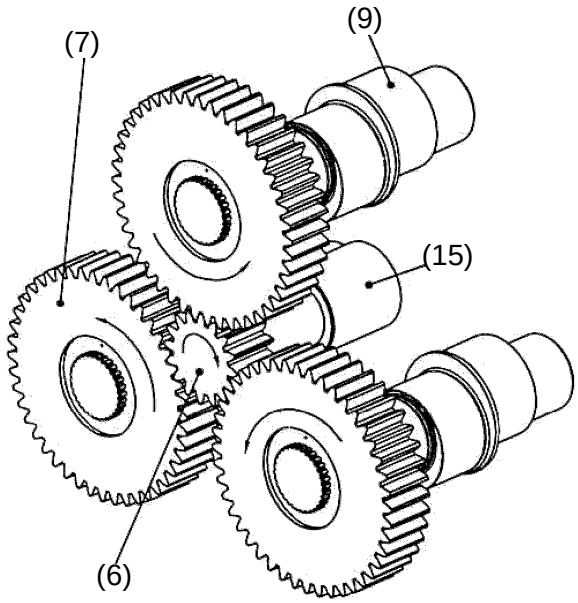
d. Function

1. Reduction gears

1) Function

The speed reducer consists of two sections: first reduction section with spur gears and second reduction section with pericycloid-toothed differential gears. The high speed of the hydraulic motor is reduced for low-speed, large-torque rotation.

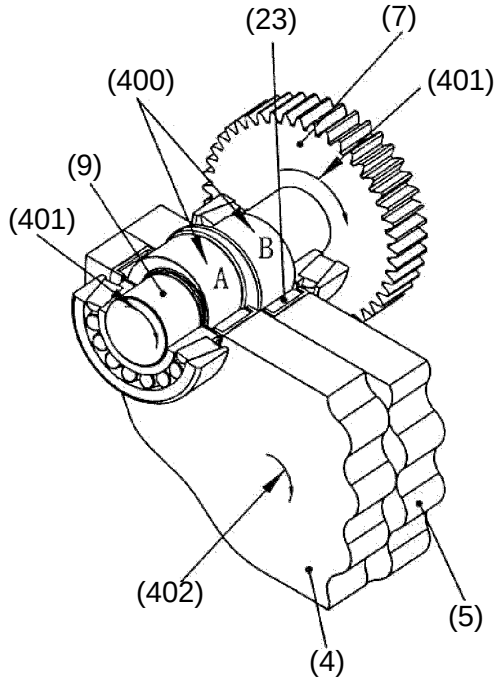
2) Behavior



2.1 First reduction section

1) The hydraulic motor's rotary motion is transmitted through the shaft (102) to the input gear (6) that is coupled with the shaft G (15). The input gear (6) is in mesh with three spur gears (7).
   The spur gears (7) reduce the speed and rotate in the opposite direction. The first reduction section is composed of these input gear (6) and spur gears (7).
   The reduction ratio of this section is calculated as follows.
   $i1 = - Zi / Zs$
   where,i1: First reduction section's reduction ratio
   Zi: Number of teeth of input gear
   Zs: Number of teeth of spur gear

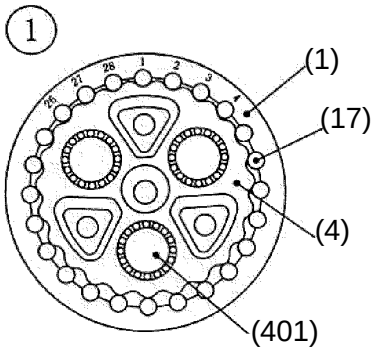
(6) Input gear
(7) Spur gear
(9) Crankshaft
(15)Shaft

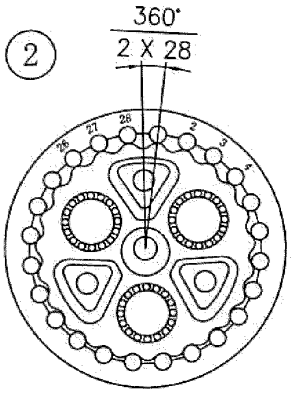


2.2 Second reduction section

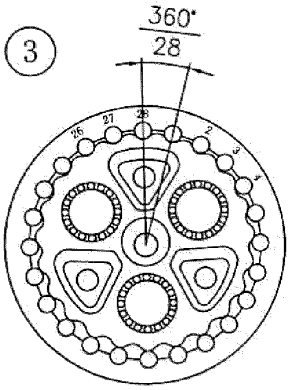
1) Each of the three spur gears (7) is coupled with its crankshaft (9). As the spur gear (7) turns, the crankshaft (9) turns at the same rpm in the same direction. The eccentric elements A and B on the crankshaft (9) produce an eccentric movement (orbital motion), which is transmitted through the needle bearings (23) to the RV gears A (4) and B (5).
   In this way, the RV gears A (4) and B (5) provide for an eccentric movement in the same direction and speed as the spur gear and crankshaft.

(4) RV gear A
(5) RV gear B
(7) Spur gear
(9) Crankshaft
(23)Needle bearing
(400)Eccentric elements
(401)Rotating
(402)Eccentric movement





Movement at half-turn (180°)



Movement at full turn

2) The tooth faces of RV gears A (4) and B (5) are in constant mesh with the pins (17) (number of pins: Zp). During the eccentric movement by the RV gears A and B, their contact points shift sequentially rolling over the faces.
In one eccentric motion, the pins (17) move together with the hub (1) by the number of pins that is the difference [Zp-Zr], where Zr represents the number of teeth of RV gears A and B and Zp the number of pins. The hub (1) turns in the same direction as the eccentric motion of the RV gears. The rotation of this hub (1) gives out an output.
In the second reduction section, the speed is reduced with the crankshaft, RV gears, pins and hub.
The reduction ratio of this section is calculated as follows.
i2 = (Zp-Zr) / Zp
where,i2: Second reduction section's reduction ratio
Zr: Number of teeth of RV gears A and B
Zp: Number of pins

(1) Hub
(17)Pin
(4) RV gear A or B
(403)Eccentric element on crankshaft

2.3 Entire reduction gears

The entire reduction gears behave as the multiplication of the first and second reduction sections. Accordingly, the output rpm (reduction ratio i) of the entire reduction gears, which is generated by one turn of the hydraulic motor shaft, is calculated as follows.

i = i1 x i2
= - Zi / Zs x (Zp-Zr) / Zp
where,i1: First reduction section's reduction ratio
i2: Second reduction section's reduction ratio

2. Hydraulic drive

This chapter describes the hydraulic motor, brake valve, parking brake and the hydraulic motor's two-speed select mechanism, which are all used in the hydraulic drive.

1) Functions

1-1 Hydraulic motor

The hydraulic motor is of swash-plate axial piston type. The force of pressure oil coming from the pump is converted to rotational movement.

1-2 Brake valve

(1) Inertial force is controlled in stopping the hydraulic motor. This helps bring the motor to a smooth halt.
(2) When the hydraulic motor is activated by an external force, this valve keeps the motor from running out of control. In other words, hydraulic cavitation can be avoided.
(3) The valve also keeps off an excessive pressure that would occur in case of a sudden hydraulic motor halt.

1-3 Relief valve

(1) The hydraulic motor gives out some jerk when it gets started and stopped. This valve is intended to ease such shock as well as to avoid cavitation due to the relief action (lower braking noise).
(2) The relief valve suppresses a sudden pressure upon the hydraulic motor below its preset pressure level. In this way, the hydraulic motor is protected against damages.

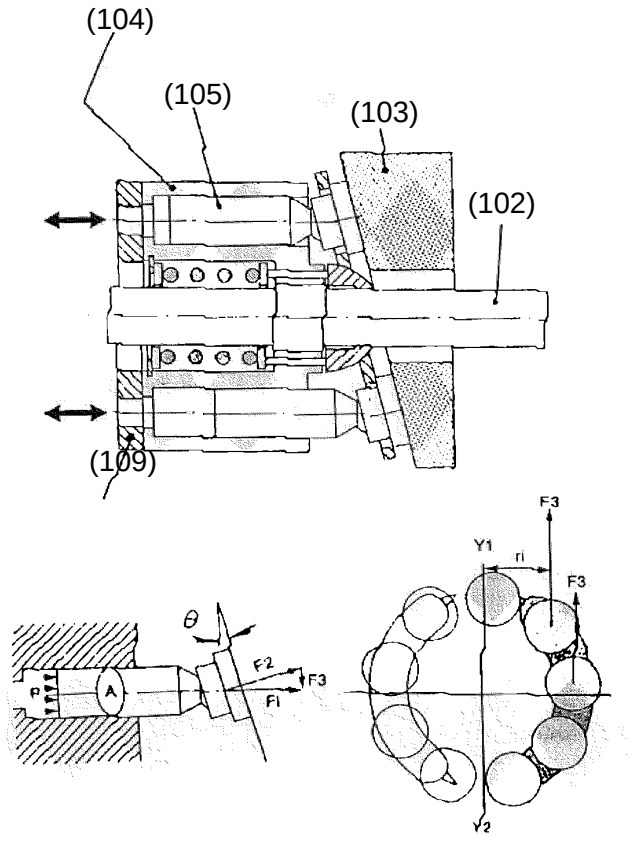
1-4 Two-speed select mechanism

The mechanism is designed to select the hydraulic motor output in two stages: high-speed, low-torque output, and low-speed, high-torque output.

1-5 Parking brake

The parking brake keeps the at-rest hydraulic motor from starting by an external force. This friction disc type brake is integrated with the hydraulic motor.

2) Principle and behavior



2-1 Hydraulic motor

Pressure oil from the hydraulic pump flows into the rear flange (301) of the GM motor. The pressure oil is then introduced through the brake valve and timing plate (109) into the cylinder block (104).

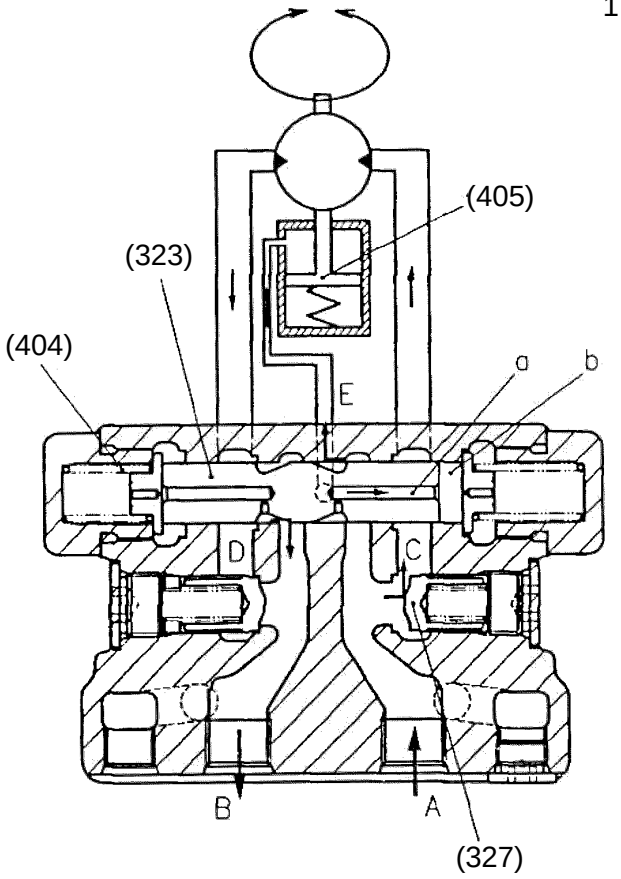
The pressure oil is let into only one side of the Y1-Y2 line that is drawn from the top dead center to the bottom dead center of the stroke of piston (105).

The pressure oil pushes the piston (105) in question, which generates the force F (= P x A). This force then acts on the slant face of swash-plate (103). By the slanting angle θ, the force F is divided into component forces F2 and F3. Among them, the radial component force F3 generates a torque (= F3 x ri). The resultant force T (= Σ × (F3 x ri)) of the torque of each piston (105) becomes the turning force of the hydraulic motor. The latter force is transmitted through the piston (105) to drive the cylinder block (104) and shaft (102).

(102) Shaft
(103) Swash-plate
(104) Cylinder block
(105) Piston
(109) Timing plate

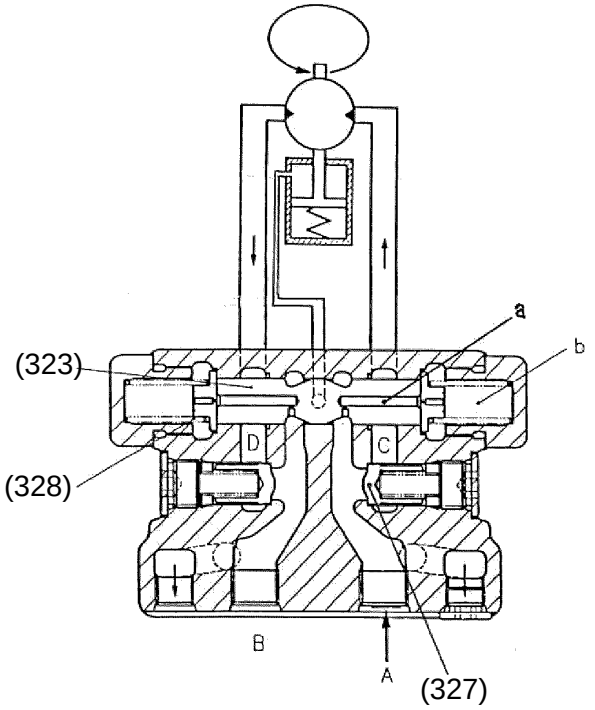
2-2 Brake valve

The ports A and B serve to let in and out hydraulic oil. Discussed here is how the hydraulic oil (pressure oil) is supplied to the port A.
The oil through the port B flows in the opposite direction. The hydraulic motor also runs in the opposite direction.



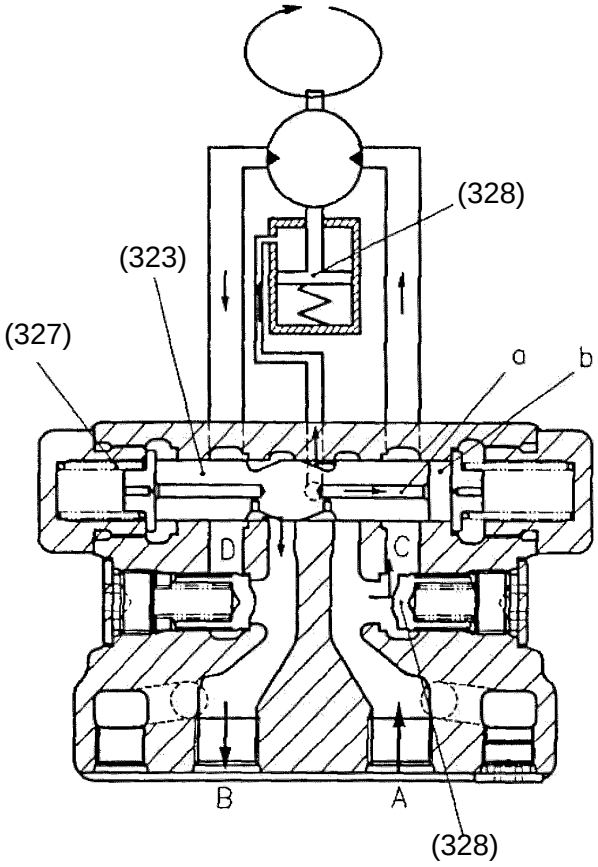
1. Steady running
   When the pressure oil flows from the pump to the port A, the hydraulic motor gets started. Here are the details.
   The pressure oil from the pump flows first through the port A, which opens the valve (327). Passing through this valve, the oil flows then through the port C into the hydraulic motor, which is given a rotational force.
   The pressure oil through the port A also flows through the small opening of spool (323) and the passage “a” into the chamber “b”. By the hydraulic force in the chamber “b”, the spool (323) slides from the neutral position to the left. The groove in the spool (323) forms a passage for the oil to flow between the ports D and B.
   The hydraulic oil out of the hydraulic motor flows through the port D first and then B. In this way, the hydraulic motor starts running and the hydraulic oil returns into the oil tank.
   When the spool (323) slides to the left, on the other hand, the pressure oil flows through the port E. From here, the oil goes to the parking brake and the two-speed selector valve.

(323)Spool
(327)Valve
(404)Spring
(405)Parking brake



(323)Spool
(327)Valve
(328)Spring

2. Stopping (braking)
When the pressure oil is interrupted, the hydraulic motor gets stopped. Here are the details.
When the pressure oil to the port A is blocked, the pressure at the port A and in the chamber “b” drops. Accordingly the spool (323) starts sliding from left to the neutral position by the force of spring (328). Then the oil in the chamber “b” is expected to flow through the passage “a” of spool (323) toward the port A. The throttling effect of passage “a”, however, produces a back pressure and controls the return speed of spool (323).
The hydraulic motor, even after the block of the pressure oil at port A, is expected to keep running by its inertial force. The hydraulic oil from the hydraulic motor is thus expected to pass through the port D, the spool’s groove, the rear flange (301) back to the port B.
When the spool (323) has returned exactly to the neutral position, the return passage of the hydraulic motor is completely blocked and the hydraulic motor stops itself.
In doing so, the brake valve narrows down the return passage of the hydraulic motor under the sliding speed control of spool (323) as well as by the spool groove’s shape. The resulting back pressure brings the hydraulic motor, still under its inertial force, to a smooth halt.
The valve (327) gets activated by a very small negative pressure. The oil passage between the circuit of port A and the motor’s suction port C gets open, which prevents cavitation in the hydraulic motor.



3. Runaway prevention function
If an external force affects the hydraulic motor during its steady run, a runaway trouble may occur. This may happen on the travel motor of a power shovel, for example, which is running down a steep slope. Here is the mechanism to prevent such trouble.
Let’s suppose an external force applies upon the steady-running hydraulic motor. The hydraulic oil (supplied at port A or B) drops in pressure. Before the pressure nears a runaway level, the spool (323) starts sliding to the neutral (center) position. According to the spool’s shift, the hydraulic oil passage from the hydraulic motor’s outlet port D to the port B becomes narrower. The hydraulic oil flow rate from port D to B is thus limited. At the same time, the back pressure at port D rises.
In this manner, the flow rate and pressure at the hydraulic motor’s outlet port are controlled, preventing the runaway problem.

(323)Spool
(327)Valve
(328)Spring
(405)Parking brake

2-3 Relief mechanism behavior

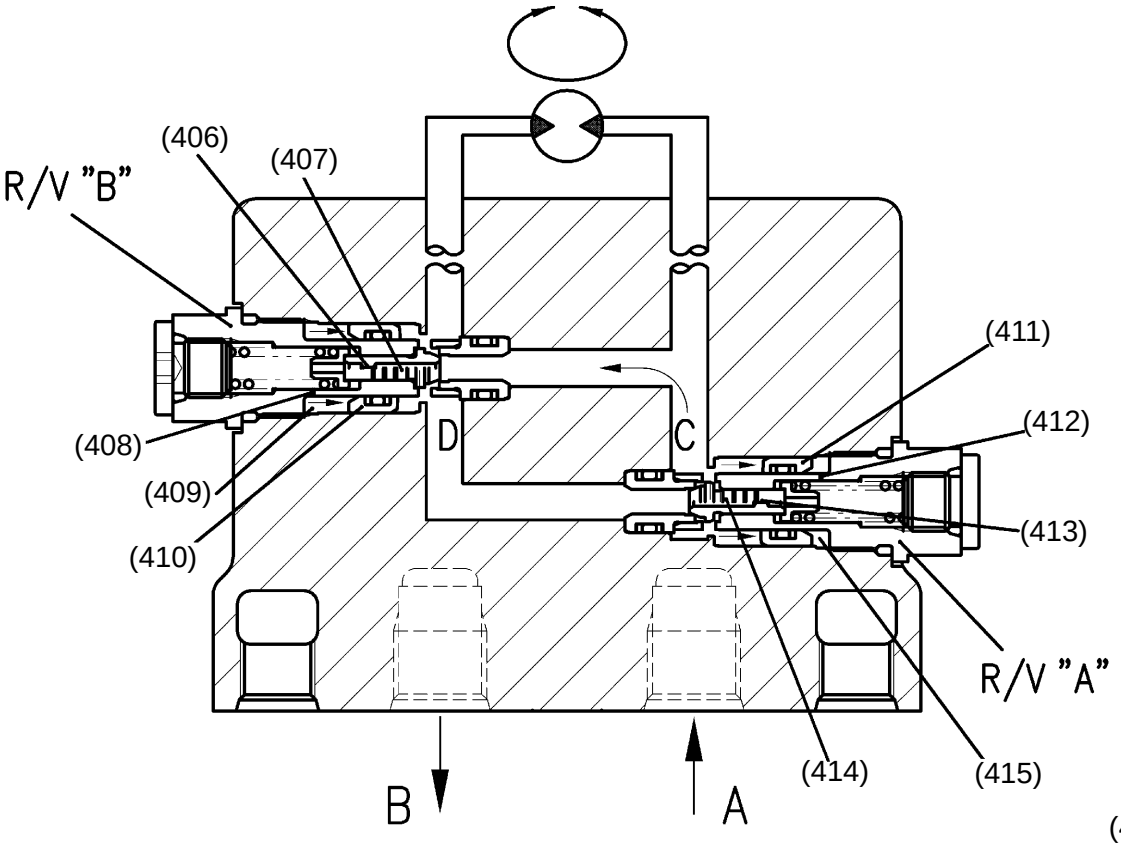
1. Starting

The pressure oil from the pump is introduced from the port A to C. The oil through the port C, connected with the hydraulic motor, gives a rotational force to the motor.

At the relief valve "A", the valve "a" does not open by the pressure oil. The piston "d" is affected by the pressure oil to move in the direction of arrow to its stroke end. During this shift, the oil in the chamber "x" flows through the orifices "c" and "b" to the port D.

At the relief valve "B", on the other hand, the pressure oil from the port C opens the valve "e" at over a preset pressure level, and flows to the port D. This oil passes through the orifices "f" and "g" into the chamber "y". Now the piston "h" is activated by the oil to move in the direction of arrow to its stroke end. With the piston "h" at the stroke end, the pressure between the orifices "f" and "g" rises. The opening pressure of relief valve "B" thus becomes higher than the shovel's system pressure, which closes the valve "e".

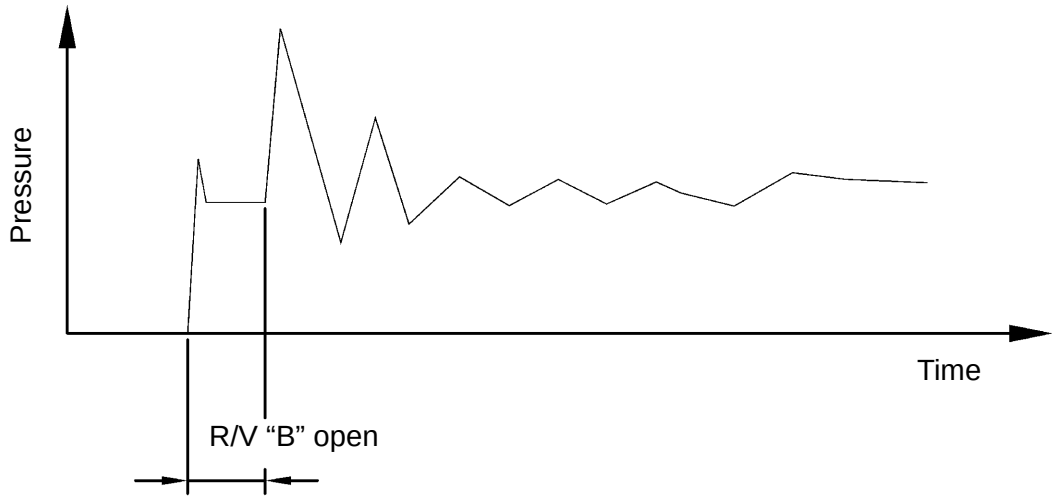
The relief valves "A" and "B" behave in this way to raise the pressure at the port C and boosts the motor.



Pressure oil flow from port A

(406)Orifice "f"
(407)Valve "e"
(408)Orifice "g"
(409)Chamber "y"
(410)Piston "h"
(411)Piston "d"
(412)Orifice "c"
(413)Orifice "b"
(414)Valve "a"
(415)Chamber "x"

Pressure at port C in the above behavior



Let's suppose, however, that the piston "h" is already at its stroke end depending on how the machine stopped immediately before. In such case, the valve "e" of relief valve "B" does not open. The pressure at the port C is thus as shown in the chart below.



As discussed above, the startup pressure at the port C depends on the position of piston "h".

* When the pressure oil from the pump flows from the port B to D, the relief valves "A" and "B" exchange their behaviors according to the above principle.

2. Stopping

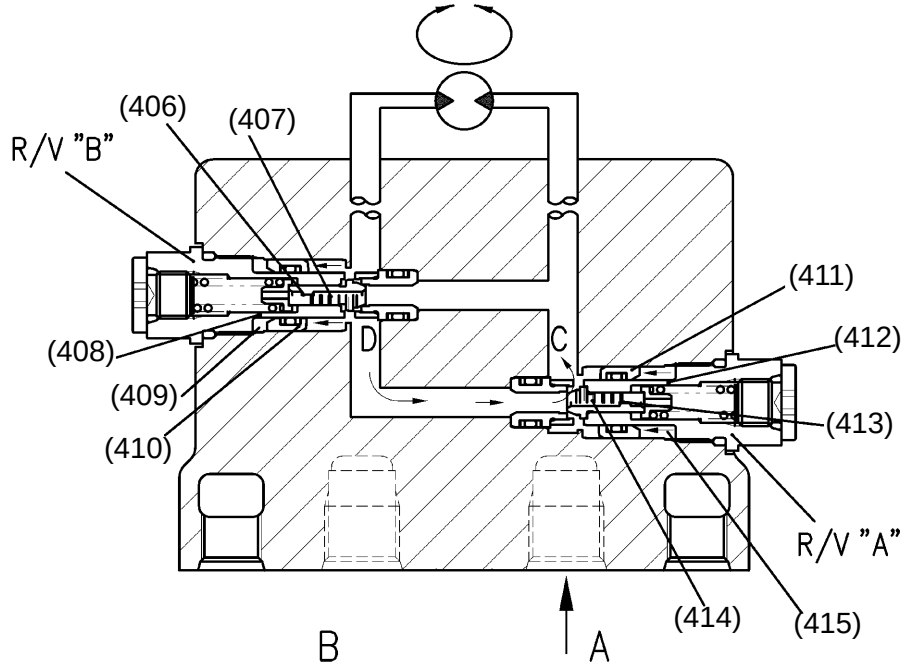
The hydraulic motor runs by the supply of pressure oil from the port A to C. When no pressure oil comes from the port A, the counterbalance valve returns to the neutral position.

With the counterbalance valve in neutral, the outlet port D is blocked and the hydraulic motor keeps running by its inertial force alone. This applies a pressure at the port D. At the relief valve "A", the pressure oil out of the port D flows through the orifices "b" and "c" in the valve "a" into the chamber "x". The pressure oil in the chamber "x" then moves the piston "d" to its stroke end. During this shift, the pressure in the chamber "x" does not rise. So the valve "a" of relief valve "A" is pushed open by the pressure oil at port D. The pressure oil at port D then flows toward the low-pressure port C.

When the relief valve "A" is activated, the pressure at port D is controlled and the oil is supplied to the port C, which prevents cavitation.

When the piston "d" has reached its stroke end, the pressure in the chamber "x" and that between the orifices "b" and "c" rise, getting the valve "a" closed. If the shovel's system pressure is exceeded in this case, the relief valve "A" gets activated to stop the hydraulic motor.

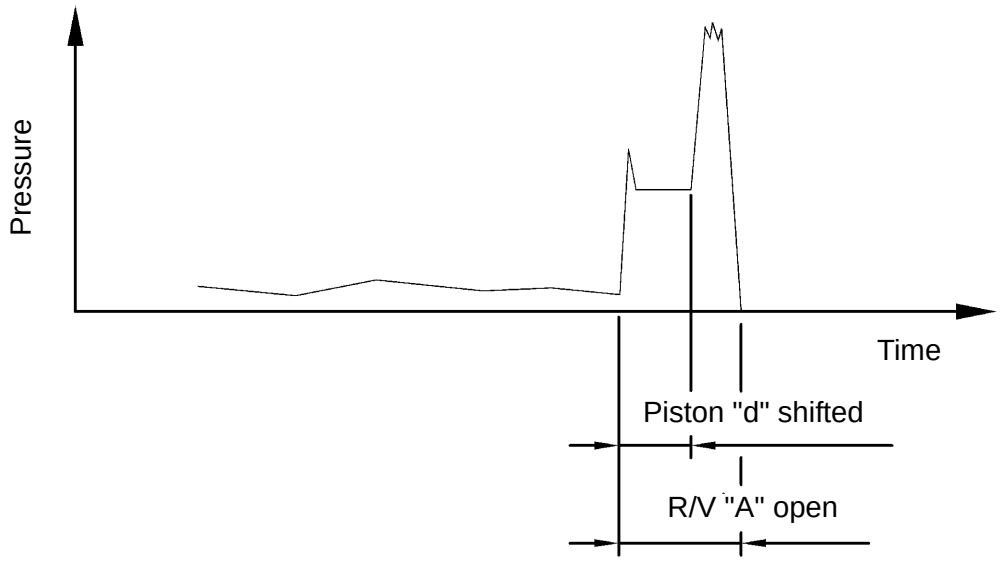
On the other hand, the piston "h" of relief valve "B" moves in the direction of arrow by the pressure oil at port D. The oil in the chamber "y" goes through the orifices "g" and "f" into the port C.



(406)Orifice "f"
(407)Valve "e"
(408)Orifice "g"
(409)Chamber "y"
(410)Piston "h"
(411)Piston "d"
(412)Orifice "c"
(413)Orifice "b"
(414)Valve "a"
(415)Chamber "x"

Pressure oil flow blocked from port A

Pressure at the hydraulic motor (port D) with the pressure oil flow blocked



The pressure with the piston "d" being shifted is commonly called the primary relief pressure (low).
The pressure with the piston "d" already shifted is commonly called the secondary relief pressure (high).

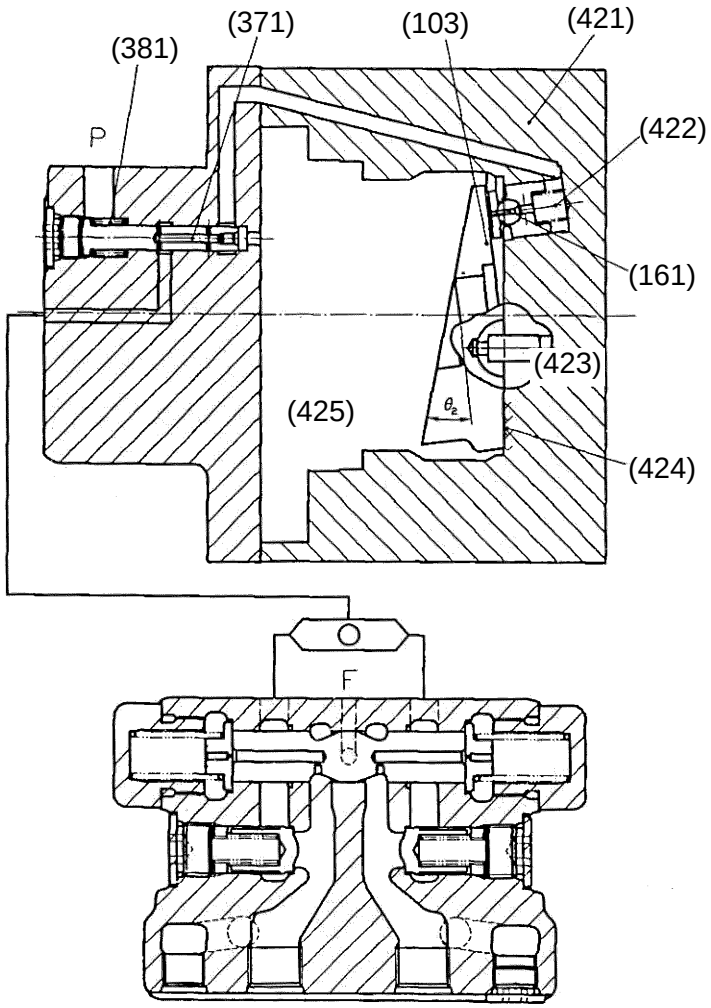
2-4 Two-seed select mechanism (manual two-speed selection)

1. Low-speed stage

At the low-speed stage, the pilot pressure is not supplied from the port P. In such state, the spool (371) is pushed to the left by the force of spring (381). The pressure oil at the port F stays blocked.

The hydraulic oil in the chamber S is let out to the drain (motor case) through the spool (371). The thrust of piston (161) remains low. The swash-plate (103) is positioned along the face Y at the maximum tilt angle of $\theta 1$.

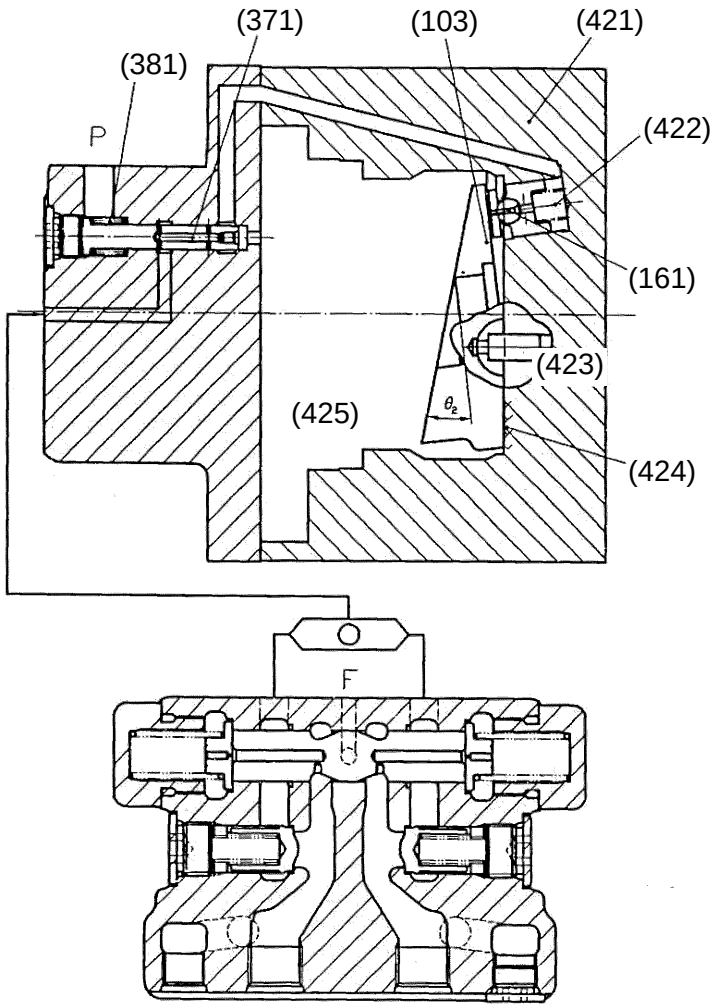
In other words, the hydraulic motor reaches its maximum cylinder capacity and runs at the low speed.



(103)Swash plate
(161)Piston
(371)Spool
(381)Spring
(421)Spindle
(422)Chamber S
(423)Support
(424)Face X
(425)Motor case

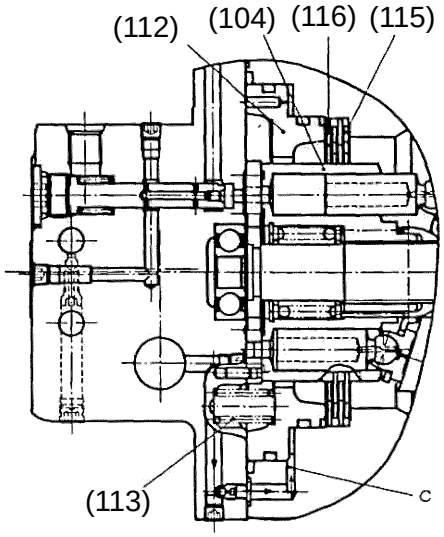
2. High-speed stage

At the high-speed stage, the pilot pressure of over 1.96 MPs (20 kgf/cm^2) is supplied from the port P. In such state, the spool (371) surpasses the force of spring (381) and is pushed to the right. The pressure oil at port F is then introduced through the spool (371) into the chamber S.
The pressure oil in the chamber S makes the thrust of piston (161) high. The piston (161) pushes up the swash-plate (103) until it comes into contact with the face X. The swash-plate (103) stays in this position at the maximum tilt angle of $\theta 2$.
In other words, the hydraulic motor comes to its minimum cylinder capacity and runs at the high speed.



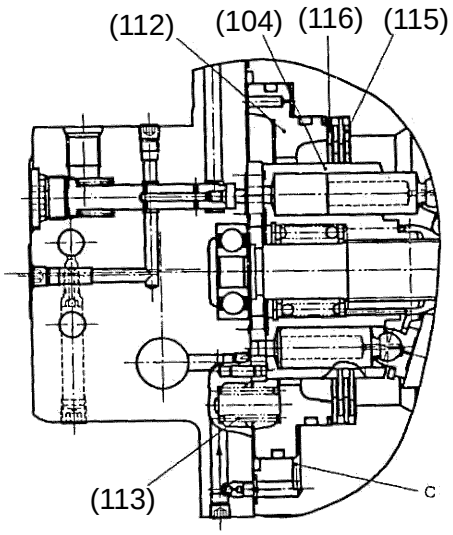
(103)Swash plate
(161)Piston
(371)Spool
(381)Spring
(421)Spindle
(422)Chamber S
(423)Support
(424)Face X
(425)Motor case

2-5 Parking brake



1. Running
   The pressure oil is supplied from the pump to the port A or B. The spool (323) of brake valve shifts to the left or right, which opens the port E. Now the pressure oil flows through the port E into the cylinder “c”. When the hydraulic pressure has risen above 0.47 MPs (4.8 kgf/cm^2), the thrust of piston (112) becomes greater than the force of spring (113). The piston (112) shifts toward the rear flange (301) and frees the mating plate (116) and friction plate (115). The friction plate (115) is now in free rotation.
   The friction plate (115) is also engaged with the cylinder block (104) of hydraulic motor. Accordingly, the cylinder block (104) gets free from the braking force and the hydraulic motor is equally in free run.

   (104)Cylinder block
   (112)Piston
   (113)Spring
   (115)Friction plate
   (116)Mating plate



2. Braking
   The pressure oil is not supplied to the port A or B. The spool (323) of brake valve shifts to the neutral position, which closes the port E. Now the pressure in the cylinder "c" drops. When this pressure has dropped below 0.47 MPs (4.8 kgf/cm^2), the hydraulic pressure of piston (112) becomes less than the force of spring (113). The force of spring (113) activates the piston (112) to press the mating plate (116) and friction plate (115) together. This pressing force turns in the friction force for braking.
   The friction plate (115) is also engaged with the cylinder block (104) of hydraulic motor. The cylinder block (104) is equally coupled with the shaft (102) of hydraulic motor.
   In this way, the hydraulic motor is given a braking torque.

   (104)Cylinder block
   (112)Piston
   (113)Spring
   (115)Friction plate
   (116)Mating plate

G. Travel motor (GM10VA : S/N ~)

a. General

1. Product applications

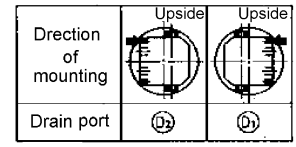
This machine is a rotary hydraulic actuator. The hydraulic motor, reduction gears, brake and brake valve are compactly integrated in this actuator. It has been developed and put to market for construction machinery that requires low-speed rotations and high-level torques.

2. Specifications

			Working condition
Reduction gears	Gear ratio		45.970
	Rating torque	N·m (kgf·m) ft·lbs	5460/9610 (557/980) 4029/7088
	Output speed	r.p.m.	49.8/29.6
Hyd. motor	MAX. capacity	cm^3/rev. (in^3/rev)	30.2/51.9 (1.84/3.17)
	MAX. working pressure	MPa (kgf/cm^2) psi	29.4 (300) 4270
	MAX. speed	r.p.m.	2289/1360
	Flow rate	l/min. (GPM)	72 (19.0)
	2 speed control pressrue	MPa (kgf/cm^2) psi	4.0 (40.8) 580
Parking brake	Braking torque	N·m (kgf·m) ft·lbs	244.4 (249) 2119
	Release pressure	MPa (kgf/cm^2) psi	0.63 (6.42) 91.3
System pressure		MPa (kgf/cm^2) psi	29.4 (300) 42.67

Note

1. One side ([D1] or [D2]) of the motor drain ports is plugged. When mounting the GM motor to the excavator, connect the drain piping to the upper drain port.



Proper drain port selection with the direction of mounting

2. The allowable pressure of the motor case is 0.20 MPa (2 kgf/cm^2) below. The drain piping should be properly sized to keep the inner pressure of the motor case is not over 0.20 MPa (2 kgf/cm^2).
   {Allowable surge pressure is 0.69 MPa (7 kgf/cm^2).}
3. Motor case should be filled with hydraulic oil. Use non-pluged drain port for filling. The volume of the working oil is about 1.2 L. (0.32 us gal)
4. Direction of rotation.

Direction (View X)	Inlet port	Outlet port
Clockwise	(B)	(A)
Counter Clockwise	(A)	(B)

5. Gear case is filled in advance with oil's SAE #90 GL4. (ABT. 1.1L)
6. For mounting GM, use bolts classified JIS B 1501 strength class 10.9 or more. Use of lock compound on bolts threads is recommended.

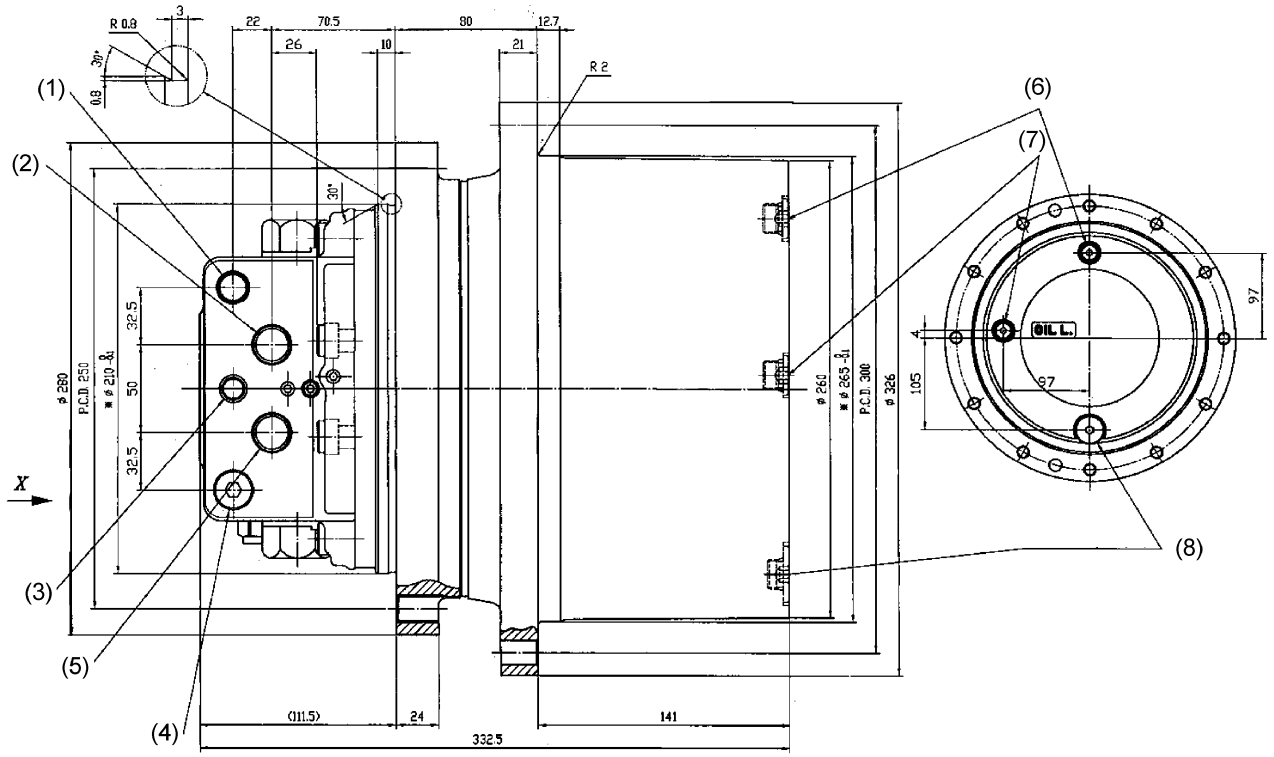
3. Type coding

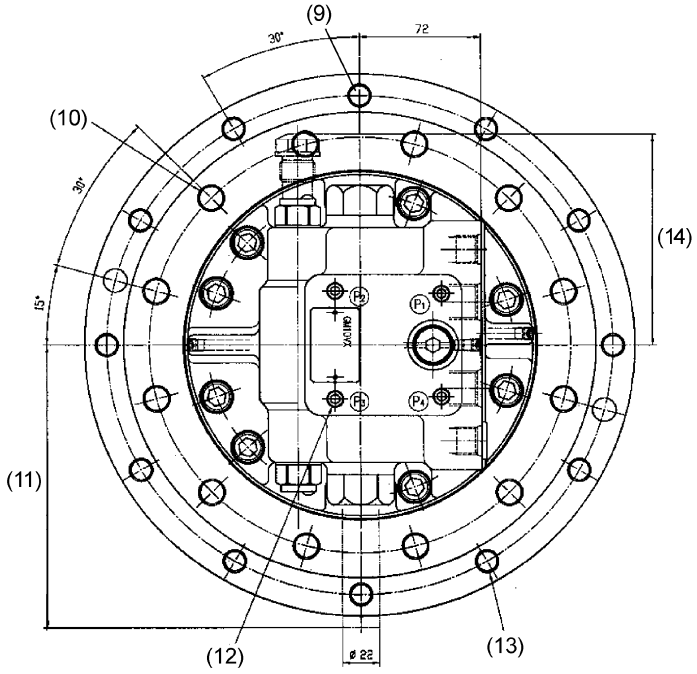
The type code is marked on the product nameplate.

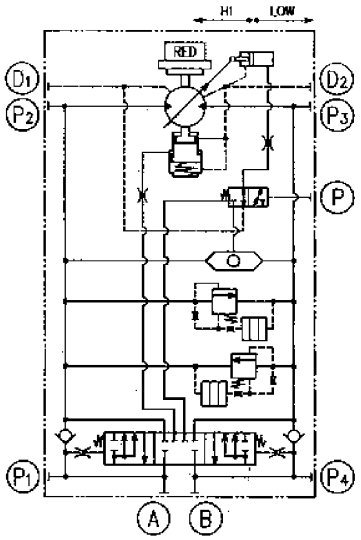
GM (1) **10** (2) **VA** (3) **- B** (4) **- 30 / 52** (5) **- 1** (6)

(1) Series code
(2) Size code
(3) Model code
(4) Reduction ratio code (B →1/45.970)
(5) Hydraulic motor displacement rate (cm^3/rev.)
(6) Design number (product classification number)

b. Outside dimensions







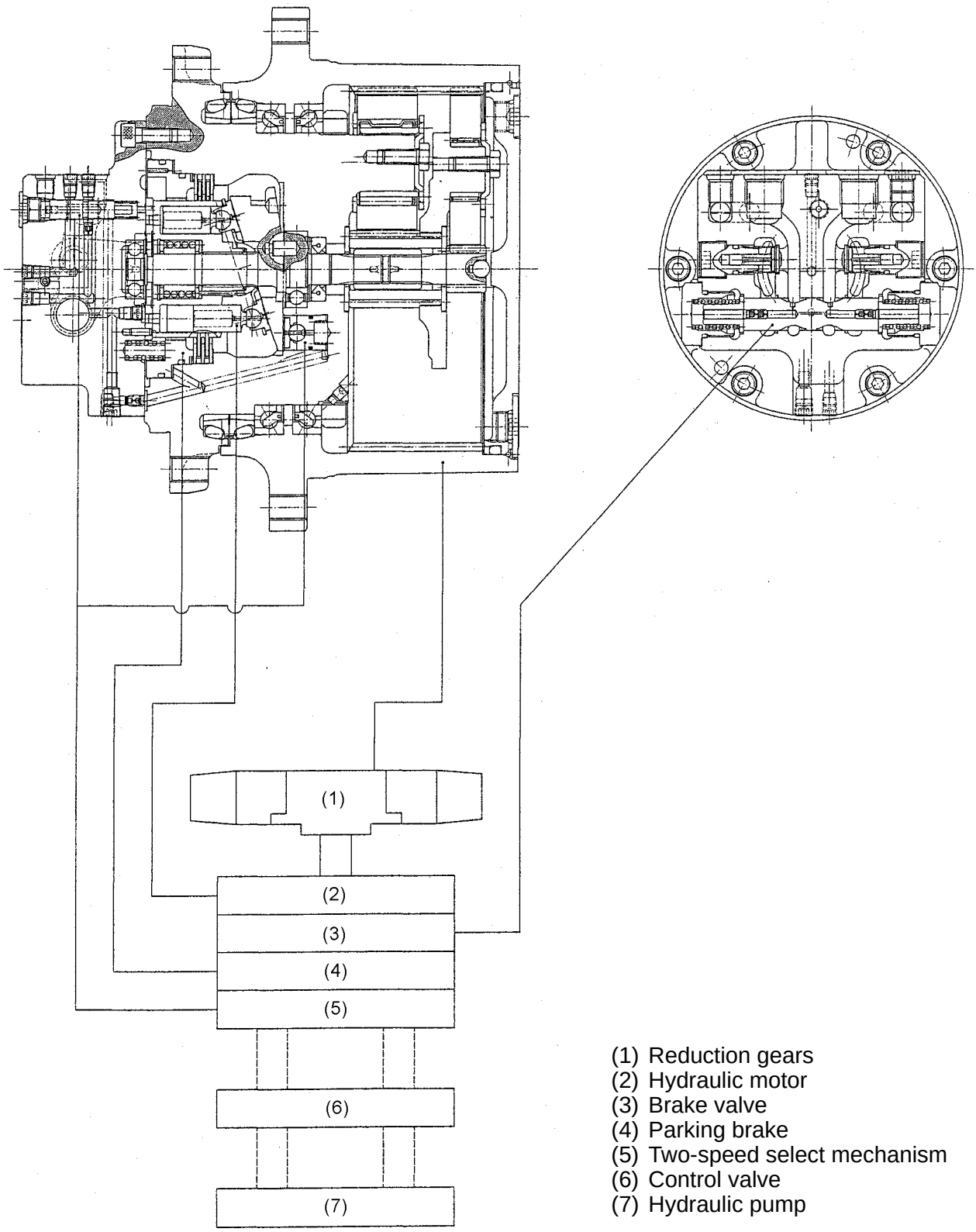
Reduction gears rotation direction vs. oil inlet and outlet

Rotation direction (when viewed from X)	Oil inlet	Oil outlet
Clockwise	A	B
Counter clockwise	B	A

(1) A PF 1/2 O-ring port Tightening torque 108±0.81N·m(11.0±1.0kgf·m)
(2) D1 PF 3/8 O-ring port Tightening torque 73.5±5N·m(7.5±0.5kgf·m)
(3) P PF 1/4 O-ring port Tightening torque 36.3±2N·m(3.7±0.2kgf·m)
(4) D2 PF 3/8 O-ring port Tightening torque 73.5±5N·m(7.5±0.5kgf·m)
(5) B PF 1/2 O-ring port Tightening torque 108±0.81N·m(11.0±1.0kgf·m)
(6) Oil filler port (PF 3/8)
(7) Oil level check port (PF 3/8)
(8) Oil drain port (PF 3/8)
(9) 12-M14P2.0 Tightening torque 163±24.5N·m(16.6±2.5kgf·m)
(10) 12-M16P2.0 Tightening torque 252±39.2N·m(25.7±4.0kgf·m)
(11) About 170 (Control valve spool draw-out allowance)
(12) 4-PT 1/8 (P1~P4) Pressure take-off port
(13) 12-M14P2.0 Tightening torque 163±24.5N·m(16.6±2.5kgf·m)
(14) About 127 (Min. Release position of SRV)

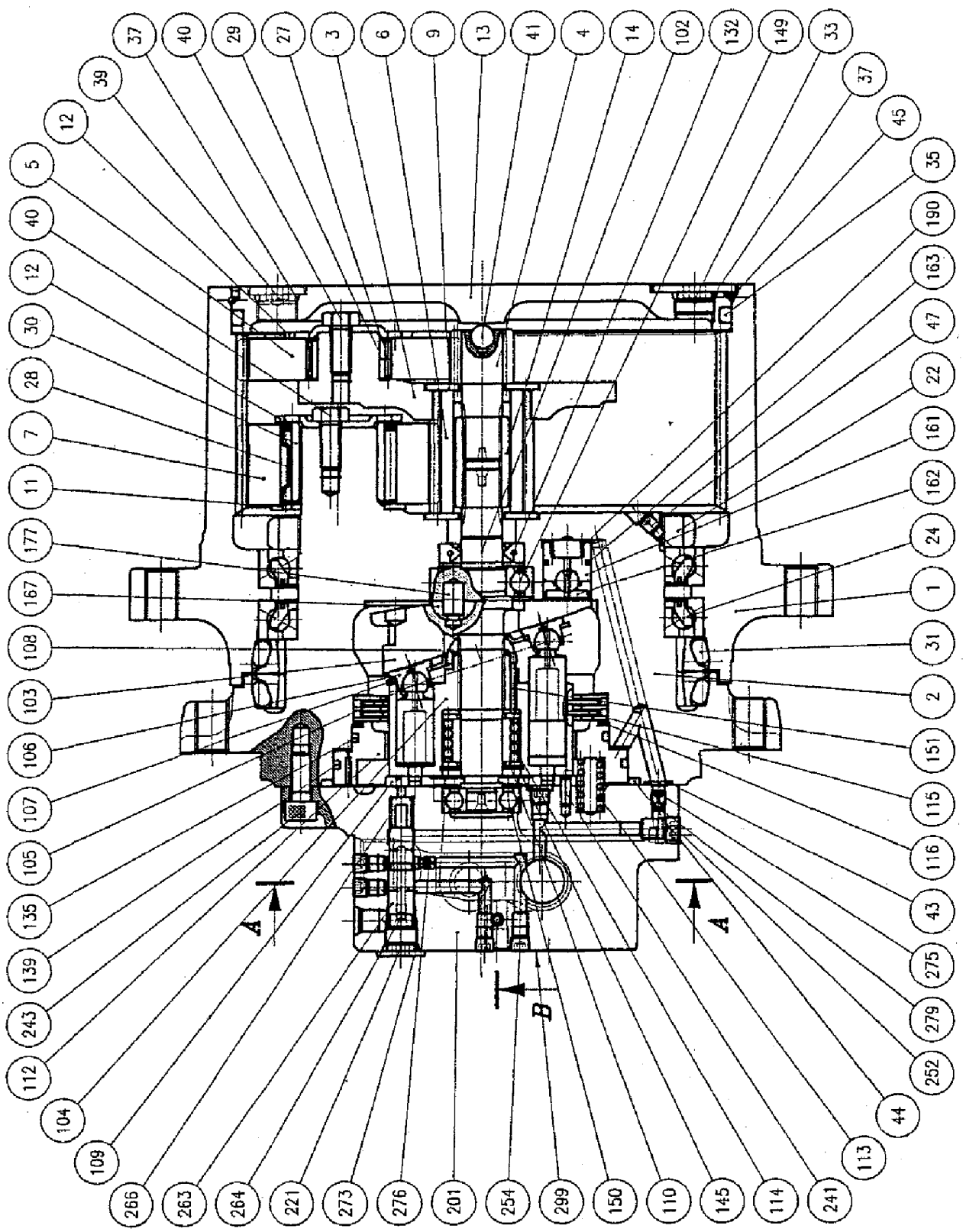
c. Basic structure and drawings

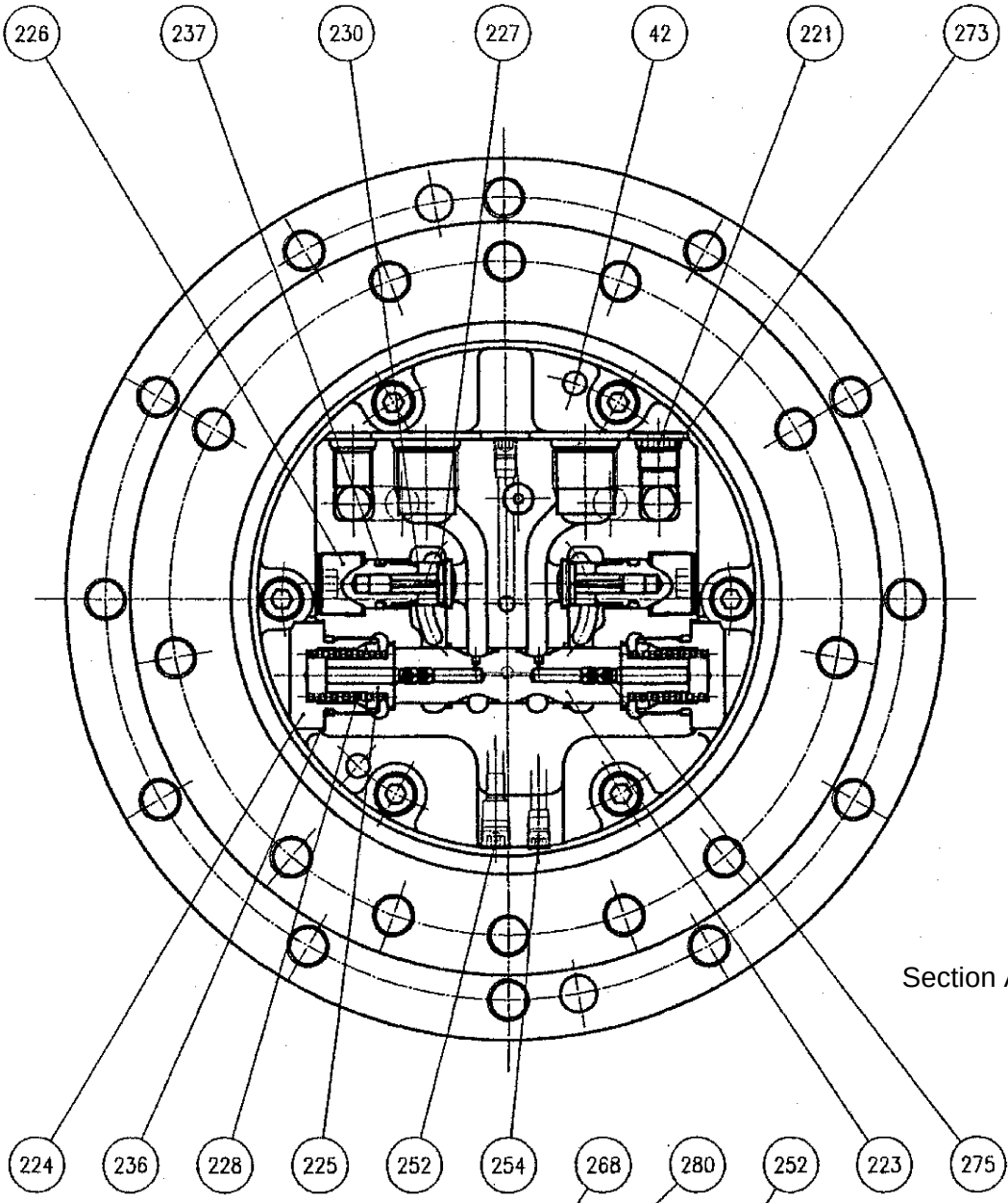
1. Basic structure of GM motor



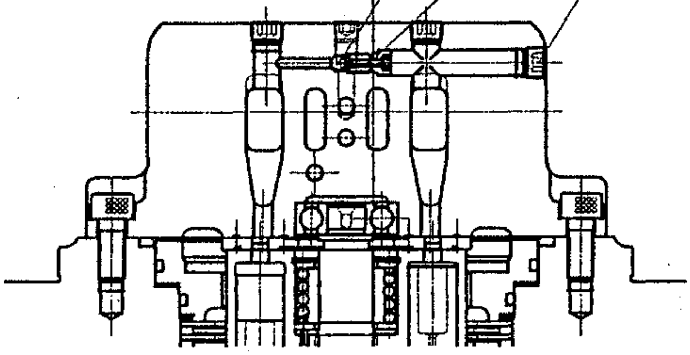
(1) Reduction gears
(2) Hydraulic motor
(3) Brake valve
(4) Parking brake
(5) Two-speed select mechanism
(6) Control valve
(7) Hydraulic pump

2.Assembly cross-sectional view





Section A-A



Section B-B

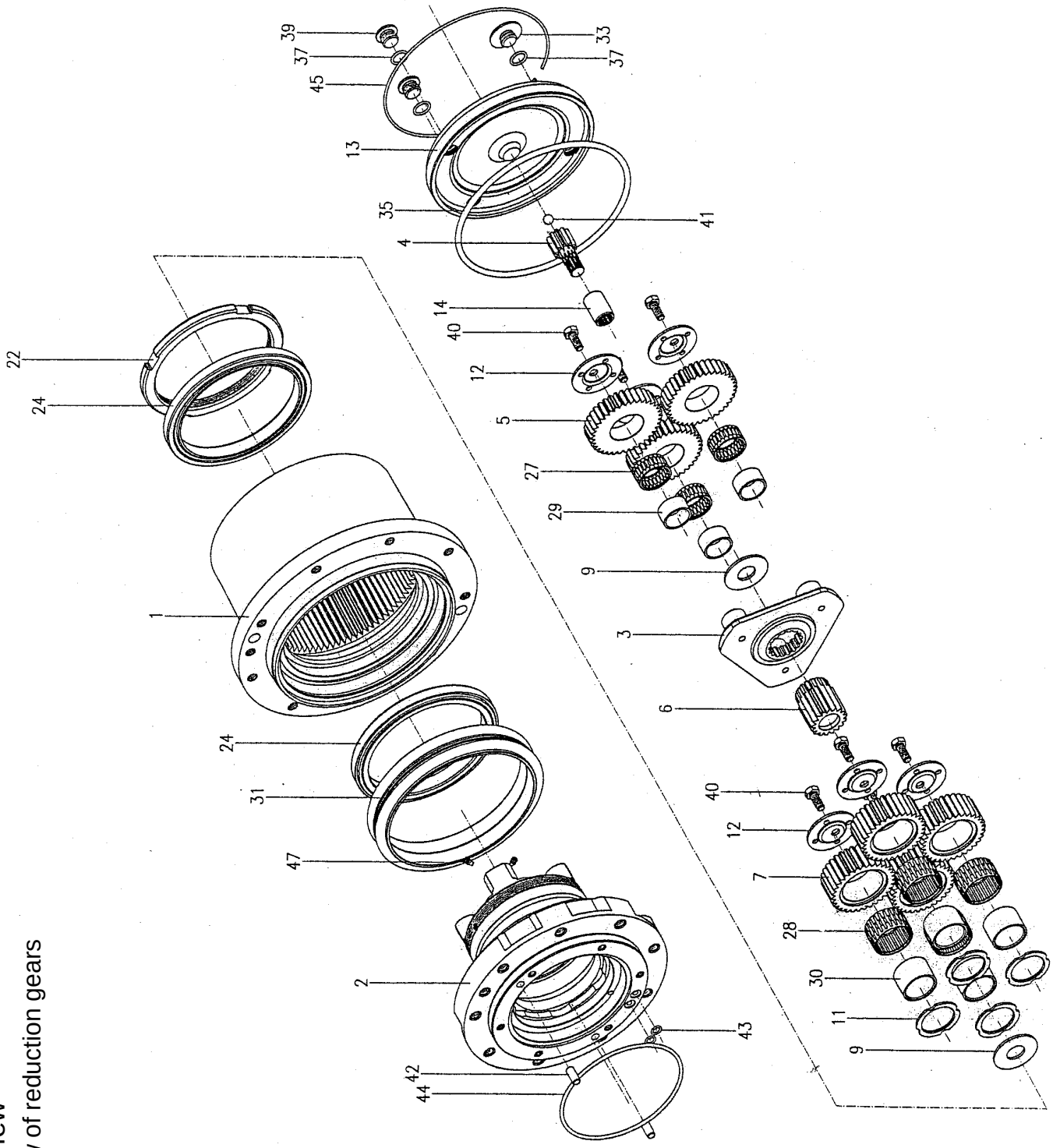
3. Parts List

No.	Parts name	Q'ty
1	Hub	1
2	Spindle	1
3	Carrier	1
4	Sun gear (1)	1
5	Planetary gear (1)	3
6	Sun gear (2)	1
7	Planetary gear (2)	4
9	Thrust washer (1)	2
11	Thrust collar (4)	4
12	Thrust washer (3)	7
13	Cover	1
14	Coupling	1
22	Ring nut	1
24	Ball bearing	2
27	Needle roller bearing with holder	3
28	Needle roller bearing with holder	4
29	Inner race	3
30	Inner race	4
	Floating seal kit	1
31	* Floating seal	2
33	Collared plug	1
35	O-ring	1
37	O-ring	3
39	Plug	2
40	Hex bolt	7
41	Steel ball	1
42	Parallel pin	2
43	O-ring	2
44	O-ring	1
45	Ring	1
47	Hex socket lock screw	2
	Cylinder & piston kit	1
104	* Cylinder block	1
	* Piston kit	1
	** Piston assembly	9
105	*** Piston	1
106	*** Shoe	1
	Piston kit	1
	* Piston assembly	1
161	** Piston	1
162	** Shoe	1
163	* Seal ring	1
102	Shaft	1
103	Swash-plate	1
107	Retainer plate	1
108	Thrust ball	1

No.	Parts name	Q'ty
109	Timing plate	1
110	Washer	2
112	Piston	1
113	Spring	8
114	Spring	1
115	Friction disk	2
116	Mating disk	3
132	Oil seal	1
135	O-ring	1
139	O-ring	1
145	Round R-shaped retaining ring	1
149	Deep-grooved ball bearing	1
150	Deep-grooved ball bearing	1
151	Roller	3
167	Pivot	2
177	Parallel pin	2
190	Spring	1
	Rear flange assembly	1
	* Rear flange kit	1
201	** Rear flange	1
223	** Spool	1
	* Spool kit	1
263	** Spool	1
264	** Oil stopper	1
221	* Plug	2
224	* Plug	2
225	* Stopper	2
226	* Plug	2
227	* Valve	2
228	* Spring	2
230	* Spring	2
236	* O-ring	2
237	* O-ring	2
252	* Hex socket plug	4
254	* Hex socket plug	6
266	* Spring	1
268	* Steel ball	1
273	* O-ring	2
275	* Orifice	5
279	* Filter	1
280	* Collared plug	1
299	* Nameplate	1
241	Parallel pin	2
243	Hex socket bolt	6

4. Exploded view

1)Exploded view of reduction gears



d. Function

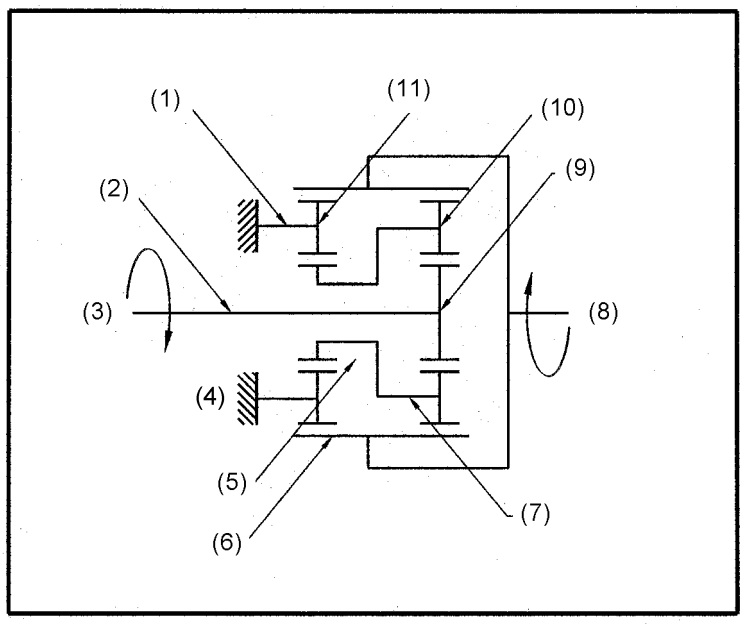
1. Reduction gears

1) Operation

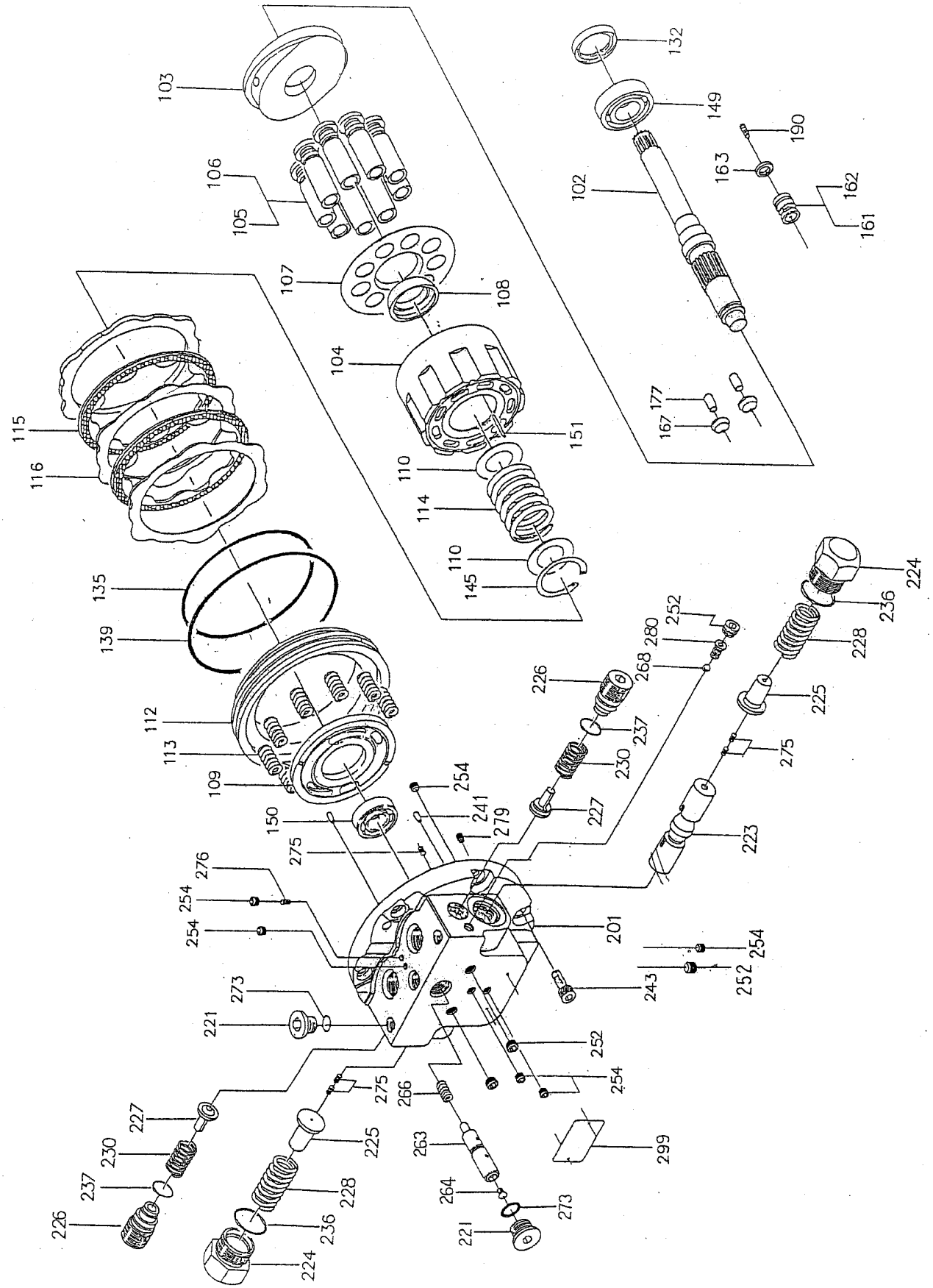
The speed reducer consists of two-stage planetary gear mechanisms. The high-speed rotary motion of the hydraulic motor is reduced for low-speed, large-torque rotation, which gives rotational movement to the hub [1] (case).

2) Function

The rotary motion of the hydraulic motor shaft is transmitted to the first-stage sun gear 1 (9) that is spline-coupled with the shaft (2). The first-stage planetary gear 1 (10), which is in mesh with the sun gear 1 (9), rotates on its axis in mesh with the hub (6) and also moves around the sun gear. This orbital motion enables to turn the carrier (7) that secures the planetary gear 1 (10) as well as the second-stage sun gear 2 (5) that is coupled with the carrier. This rotary motion is then transmitted through the second-stage planetary gear 2 (11), which is fixed on the spindle column (1)(4), to the hub (6) (ring gear), providing for the output of reduction gears, (The rotary motion is also transmitted from the first-stage planetary gear 1 (10).)



(1)Column
(2)Shaft
(3)Input
(4)Spindle
(5)Sun gear 2
(6)Hub (ring gear)
(7)Carrier
(8)Output
(9)Sun gear 1
(10)Planetary gear 1
(11)Planetary gear 2



2.Exploded view of hydraulic motor

2. Hydraulic motor

This chapter describes the hydraulic motor, brake valve, parking brake and the hydraulic motor's two-speed select mechanism, which are all used in the hydraulic motor.

1) Functions

1-1 Hydraulic motor

The hydraulic motor is of swash-plate axial piston type. The force of pressure oil coming from the pump is converted to rotational movement.

1-2 Brake valve

(1) Inertial force is controlled in stopping the hydraulic motor. This helps bring the motor to a smooth halt.
(2) When the hydraulic motor is activated by an external force, this valve keeps the motor from running out of control. In other words, hydraulic cavitation can be avoided.
(3) The valve also keeps off an excessive pressure that would occur in case of a sudden hydraulic motor halt.

1-3 Relief valve

(1) The hydraulic motor gives out some jerk when it gets started and stopped. This valve is intended to ease such shock as well as to avoid cavitation due to the relief action (lower braking noise).
(2) The relief valve suppresses a sudden pressure upon the hydraulic motor below its preset pressure level. In this way, the hydraulic motor is protected against damages.

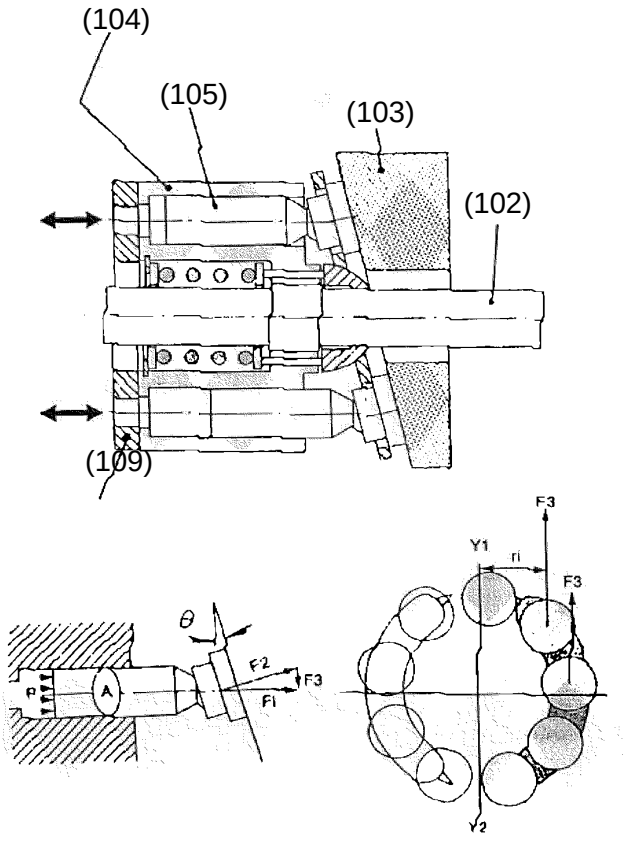
1-4 Two-speed select mechanism

The mechanism is designed to select the hydraulic motor output in two stages of the swash plate angle by the function of the switch valve and control spool : high-speed, low-torque output, and low-speed, high-torque output.

1-5 Parking brake

The parking brake keeps the at-rest hydraulic motor from starting by an external force. This friction disc type brake is integrated with the hydraulic motor.

2) Principle and behavior



2-1 Hydraulic motor

Pressure oil from the hydraulic pump flows into the rear flange (201) of the GM motor. The pressure oil is then introduced through the brake valve and timing plate (109) into the cylinder block (104).

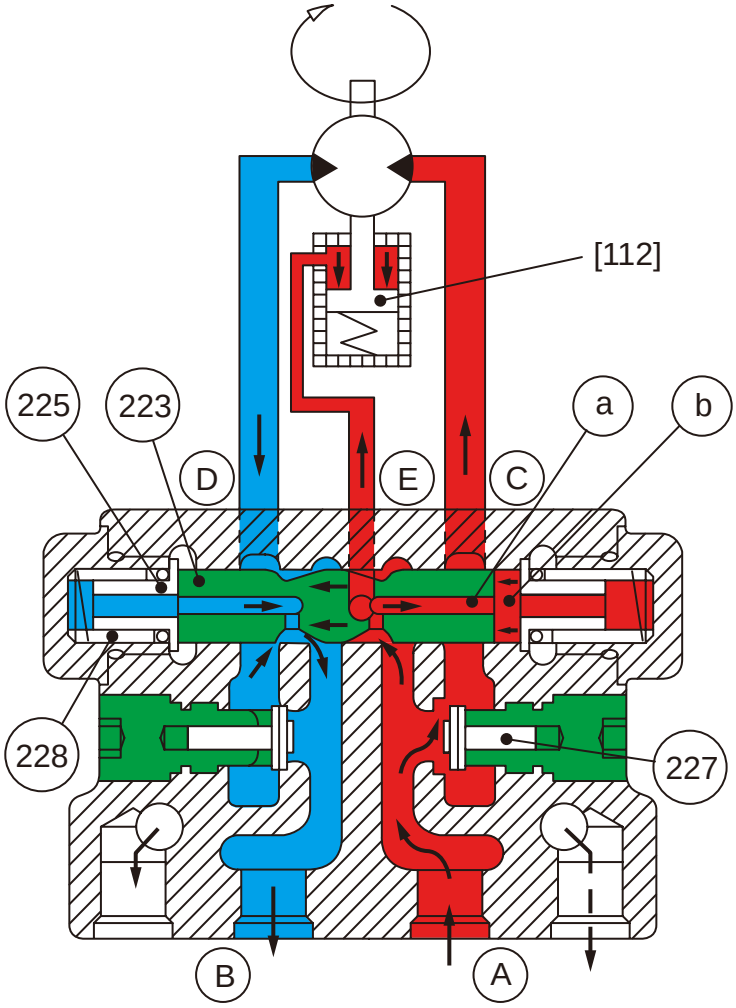
The pressure oil is let into only one side of the Y1-Y2 line that is drawn from the top dead center to the bottom dead center of the stroke of piston (105).

The pressure oil pushes the piston (105) in question, which generates the force F (= P x A). This force then acts on the slant face of swash-plate (103). By the slanting angle θ, the force F is divided into component forces F2 and F3. Among them, the radial component force F3 generates a torque (= F3 x ri). The resultant force T (= Σ × (F3 x ri)) of the torque of each piston (105) becomes the turning force of the hydraulic motor. The latter force is transmitted through the piston (105) to drive the cylinder block (104) and shaft (102).

(102) Shaft
(103) Swash-plate
(104) Cylinder block
(105) Piston
(109) Timing plate

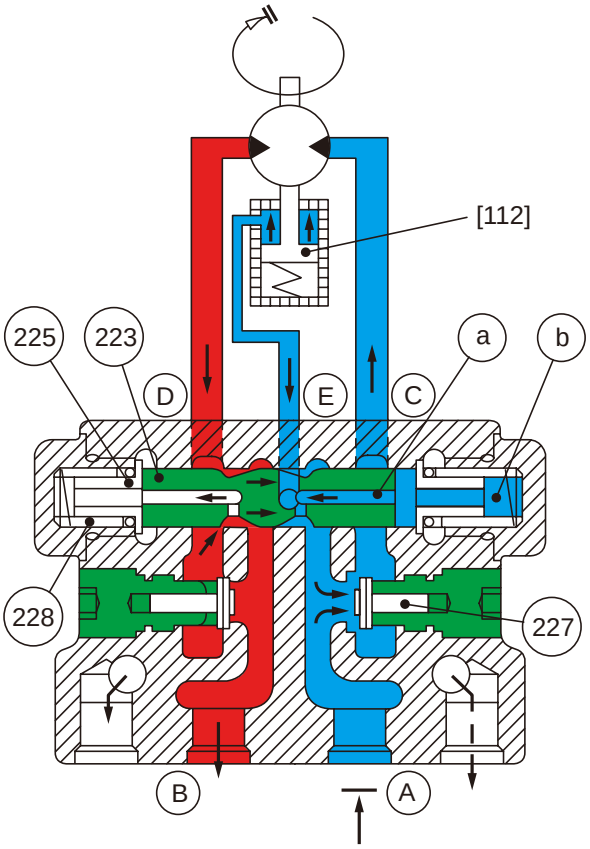
2-2 Brake valve

The ports A and B serve to let in and out hydraulic oil. Discussed here is how the hydraulic oil (pressure oil) is supplied to the port A.
The oil through the port B flows in the opposite direction. The hydraulic motor also runs in the opposite direction.



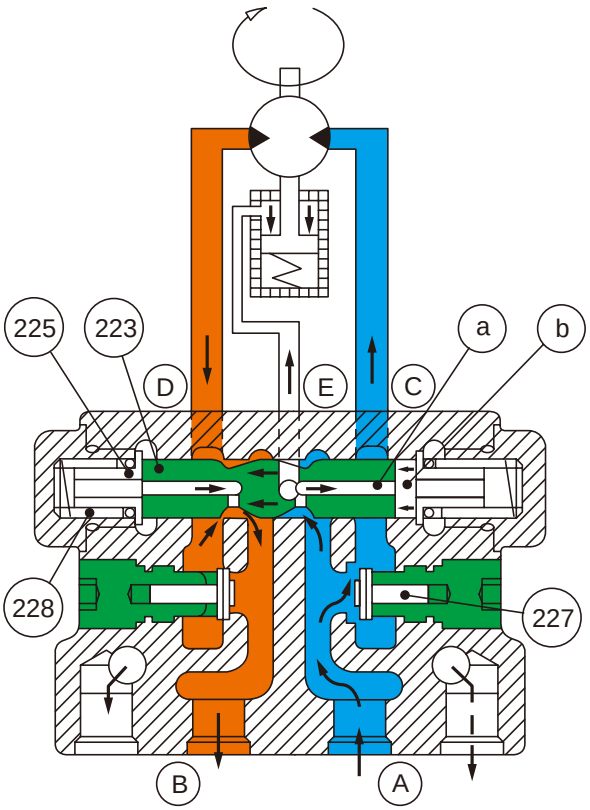
1. Steady running

When the pressure oil flows from the pump to the port A, the hydraulic motor gets started. Here are the details.
The pressure oil from the pump flows first through the port A, which opens the valve (227). Passing through this valve, the oil flows then through the port C into the hydraulic motor, which is given a rotational force.
The pressure oil through the port A also flows through the small opening of spool (223) and the passage “a” into the chamber “b”. By the hydraulic force in the chamber “b”, the spool (223) slides from the neutral position to the left. The groove in the spool (223) forms a passage for the oil to flow between the ports D and B.
The hydraulic oil out of the hydraulic motor flows through the port D first and then B. In this way, the hydraulic motor starts running and the hydraulic oil returns into the oil tank.
When the spool (223) slides to the left, on the other hand, the pressure oil flows through the port E. From here, the oil goes to the parking brake piston and relieve the parking brake.
When the pressure oil flows in to the port B, the hydraulic motor turns to the opsite direction.



(223)Spool
(227)Valve
(228)Spring

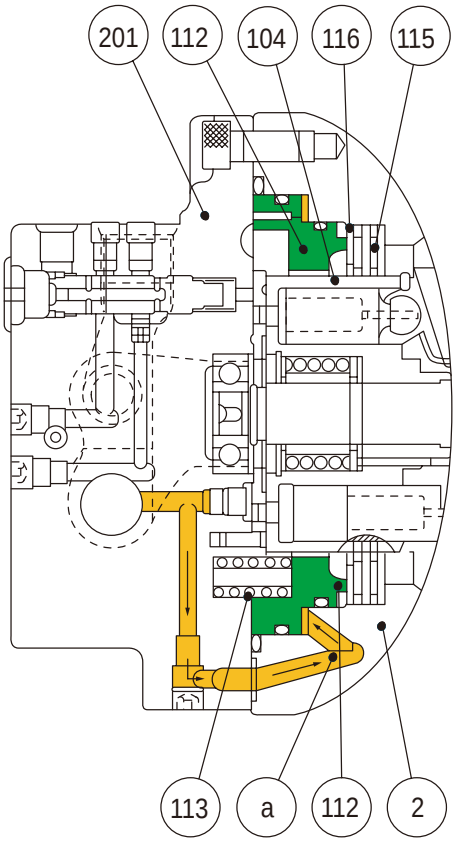
2. Stopping (braking)
When the pressure oil is interrupted, the hydraulic motor gets stopped. Here are the details.
When the pressure oil to the port A is blocked, the pressure at the port A and in the chamber “b” drops. Accordingly the spool (223) starts sliding from left to the neutral position by the force of spring (228). Then the oil in the chamber “b” is expected to flow through the passage “a” of spool (223) toward the port A. The throttling effect of passage “a”, however, produces a back pressure and controls the return speed of spool (223).
The hydraulic motor, even after the block of the pressure oil at port A, is expected to keep running by its inertial force. The hydraulic oil from the hydraulic motor is thus expected to pass through the port D, the spool’s groove, the rear flange (201) back to the port B.
When the spool (223) has returned exactly to the neutral position, the return passage of the hydraulic motor is completely blocked and the hydraulic motor stops itself.
In doing so, the brake valve narrows down the return passage of the hydraulic motor under the sliding speed control of spool (223) as well as by the spool groove’s shape. The resulting back pressure brings the hydraulic motor, still under its inertial force, to a smooth halt.
The valve (227) gets activated by a very small negative pressure. The oil passage between the circuit of port A and the motor’s suction port C gets open, which prevents cavitation in the hydraulic motor.



3. Runaway prevention function
If an external force affects the hydraulic motor during its steady run, a runaway trouble may occur. This may happen on the travel motor of a power shovel, for example, which is running down a steep slope. Here is the mechanism to prevent such trouble.
Let’s suppose an external force applies upon the steady-running hydraulic motor. The hydraulic oil (supplied at port A or B) drops in pressure. Before the pressure nears a runaway level, the spool (223) starts sliding to the neutral (center) position. According to the spool’s shift, the hydraulic oil passage from the hydraulic motor’s outlet port D to the port B becomes narrower. The hydraulic oil flow rate from port D to B is thus limited. At the same time, the back pressure at port D rises.
In this manner, the flow rate and pressure at the hydraulic motor’s outlet port are controlled, preventing the runaway problem.

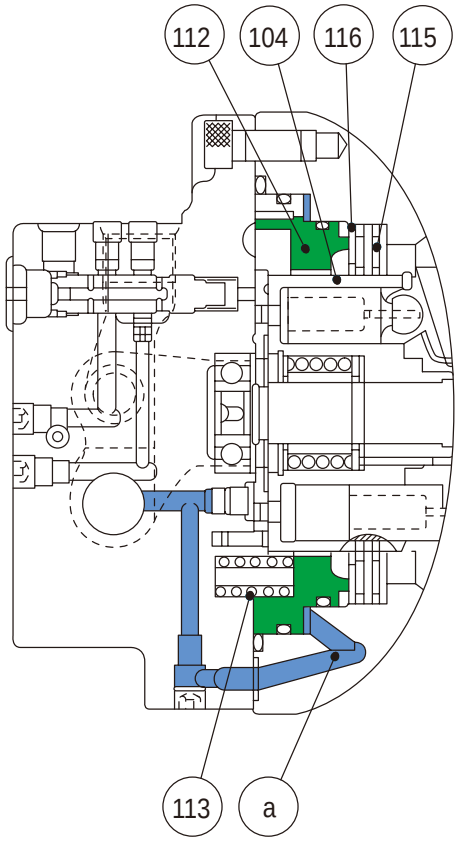
(223)Spool
(227)Valve
(228)Spring

2-3 Parking brake



1. Running
The pressure oil is supplied from the pump to the port A or B. The spool (223) of brake valve shifts to the left or right, which opens the port E. Now the pressure oil flows through the port E into the cylinder “α”. When the hydraulic pressure has risen above 0.89 MPa (9.1 kgf/cm^2,129 psi), the thrust of piston (112) becomes greater than the force of spring (113). The piston (112) shifts toward the rear flange (201) and frees the mating plate (116) and friction plate (115). The friction plate (115) is now in free rotation.
The friction plate (115) is also engaged with the cylinder block (104) of hydraulic motor. Accordingly, the cylinder block (104) gets free from the braking force and the hydraulic motor is equally in free run.

(104)Cylinder block
(112)Piston
(113)Spring
(115)Friction plate
(116)Mating plate



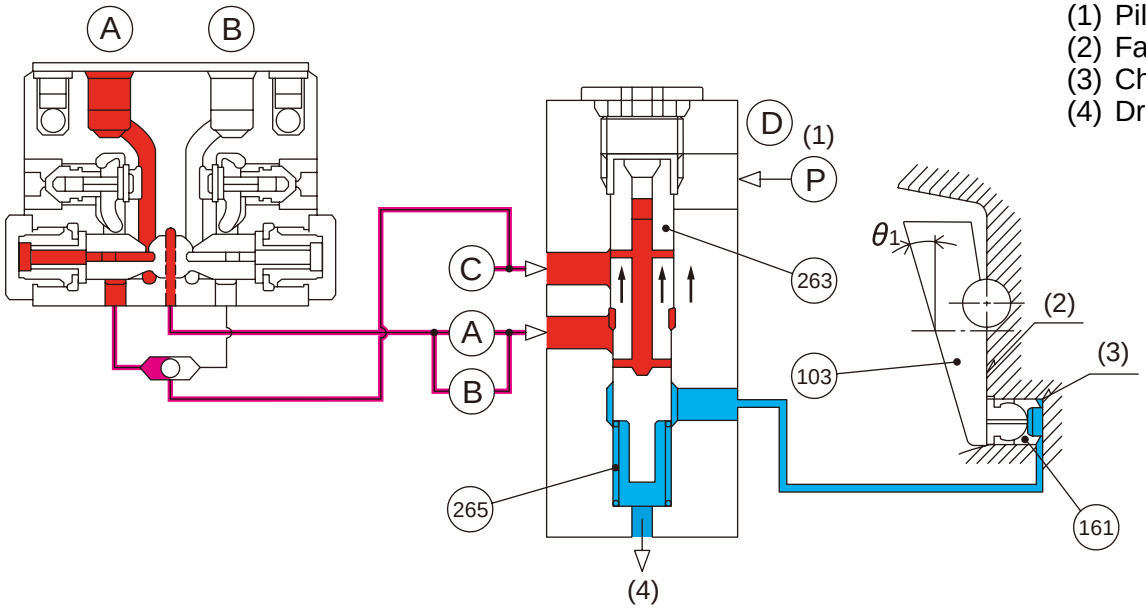
2. Braking
The pressure oil is not supplied to the port A or B. The spool (323) of brake valve shifts to the neutral position, which closes the port E. Now the pressure in the cylinder "α" drops. When this pressure has dropped below 0.89 MPa (9.1 kgf/cm^2,129 psi), the hydraulic pressure of piston (112) becomes less than the force of spring (113). The force of spring (113) activates the piston (112) to press the mating plate (116) and friction plate (115) together. This pressing force turns in the friction force for braking.
The friction plate (115) is also engaged with the cylinder block (104) of hydraulic motor. The cylinder block (104) is equally coupled with the shaft (102) of hydraulic motor.
In this way, the hydraulic motor is given a braking torque, 64.7 N.m (6.6 kgf.m, 47.7 ft.lbs).

(104)Cylinder block
(112)Piston
(113)Spring
(115)Friction plate
(116)Mating plate

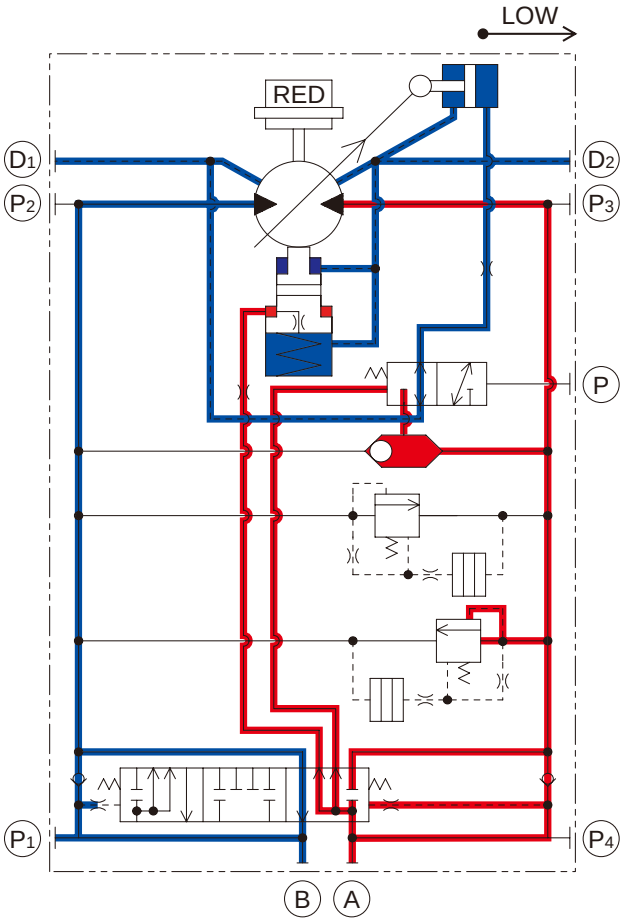
2-4 Automatic two-seed select mechanism

1) Low-speed stage

When no pilot pressure is supplied from the port (D), the valve [263] is pushed up by the force of spring [265] and the pressure oil from port (A) or (B), and the pressure oil at port (C) is cut off. The oil in the chamber (P) is let out to the drain (motor case) through the valve [263]. The swash-plate [103] is therefore positioned at the maximum tilt angle of θ1. In other words, the hydraulic motor reaches its maximum cylinder capacity and runs at the low speed.



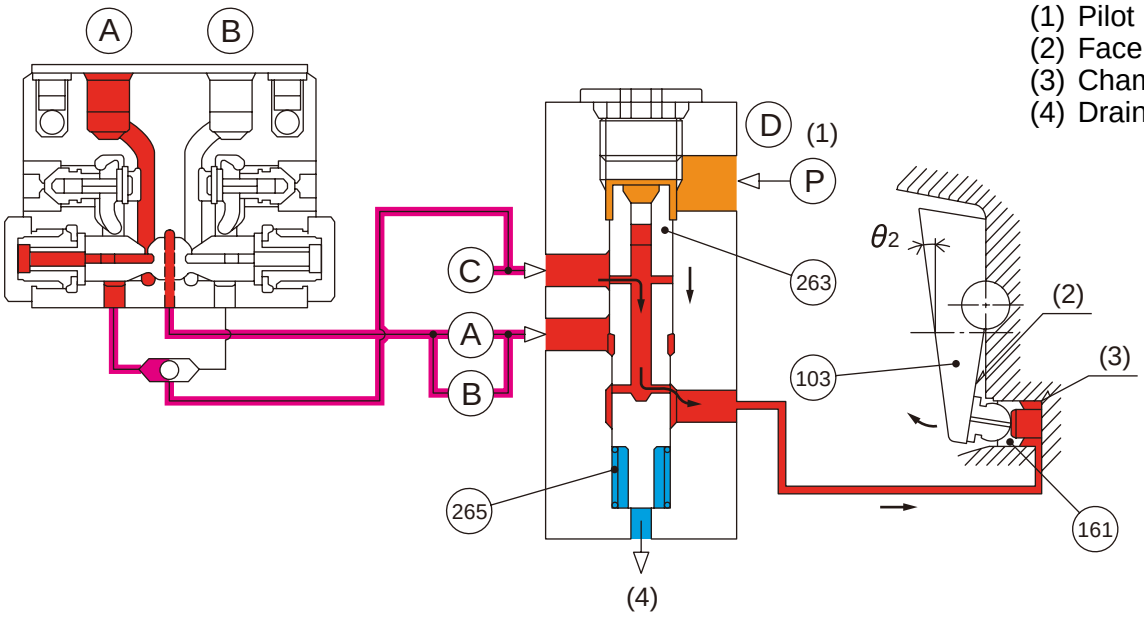
(1) Pilot pressure
(2) Face Y
(3) Chamber P
(4) Drain



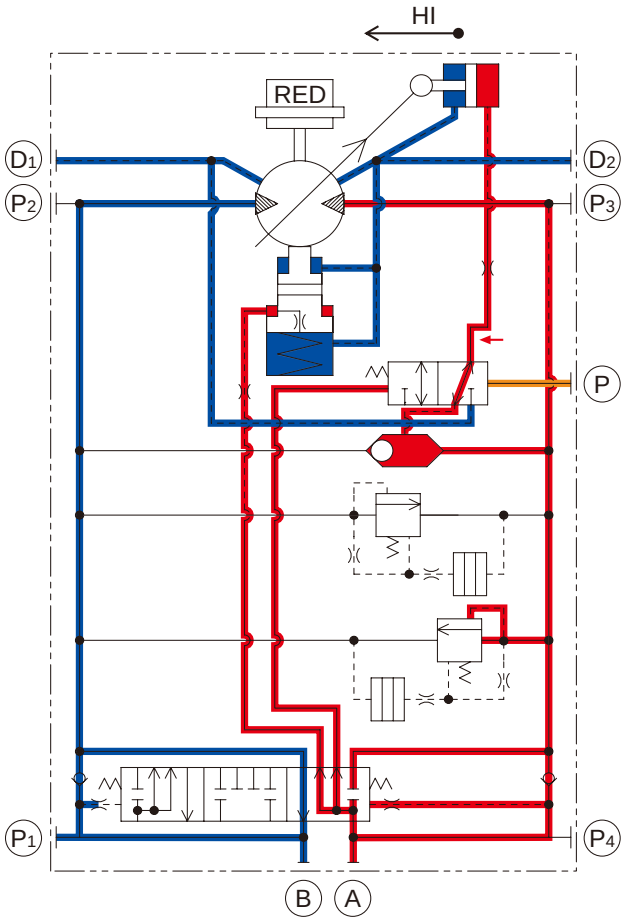
Low speed, high torque

2)High-speed stage

When the pilot pressure of 3.5 MPa (35.7 kgf/cm^2, 508 psi) is supplied from the port (D), the valve [263] is pushed down, surpassing the force of spring [265] and the pressure oil from port (A) or (B). The pressure oil at port (C) is then introduced through the cutoff valve [263] into the chamber (P). The piston [161] pushes up the swash-plate [103] until it comes into contact with the face X. The swash-plate [103] is then positioned at the minimum tilt angle of θ2. In other words, the hydraulic motor comes to its minimum cylinder capacity and runs at the high speed.



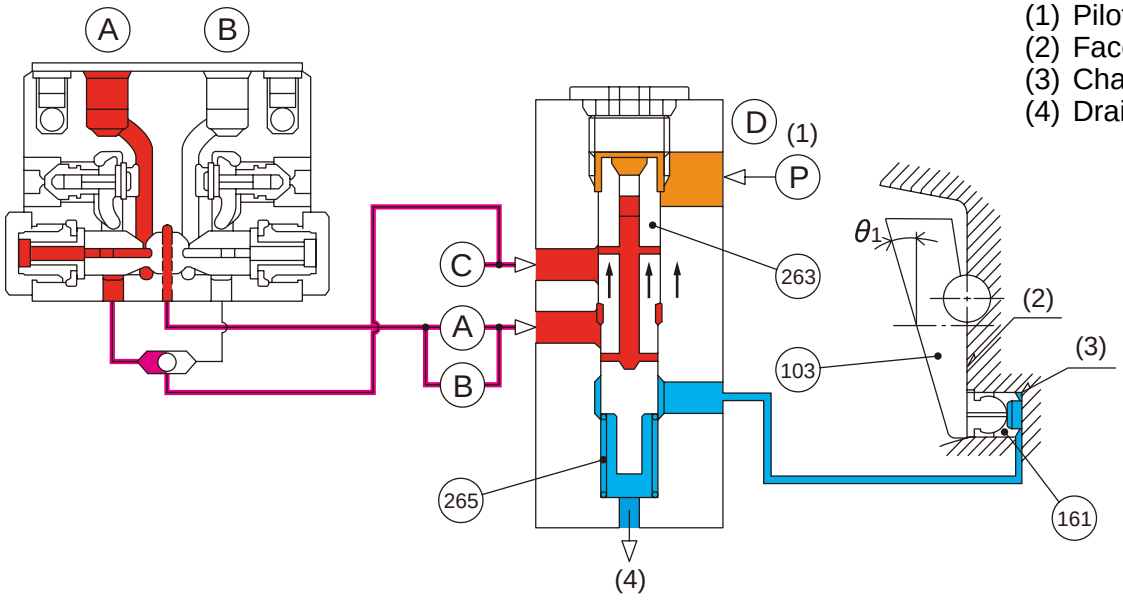
(1) Pilot pressure
(2) Face X
(3) Chamber P
(4) Drain



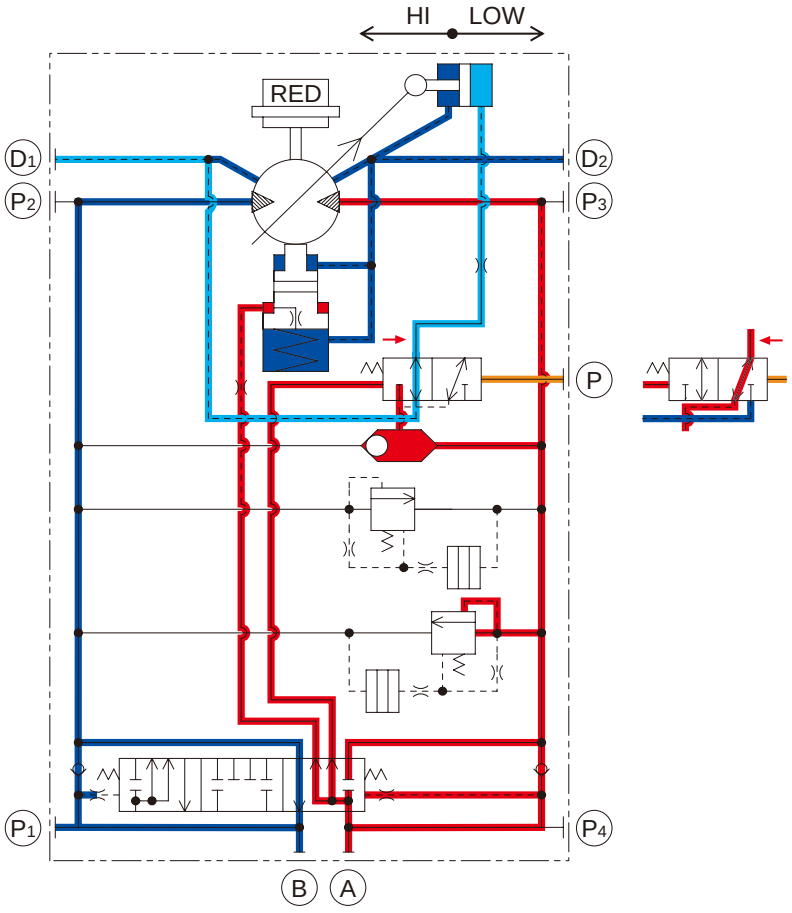
High speed, low torque

3)Automatic switching from high speed to low speed

As the load increases during high-speed run, the oil at port (A) or (B) rises in its pressure level. When the pressure has reached 24.5 MPa (250 kgf/cm^2, 3556 psi), the valve [263] is pushed up, surpassing the pilot pressure of 3.5 MPa (35.7 kgf/cm^2, 508 psi) at port (D). The oil in the chamber (P) is let out to the drain (motor case) through the valve [263]. The swash-plate [103] then comes into contact with the spindle face Y. The swash-plate stays in this position at the maximum tilt angle of θ1, which runs the motor at the low speed.



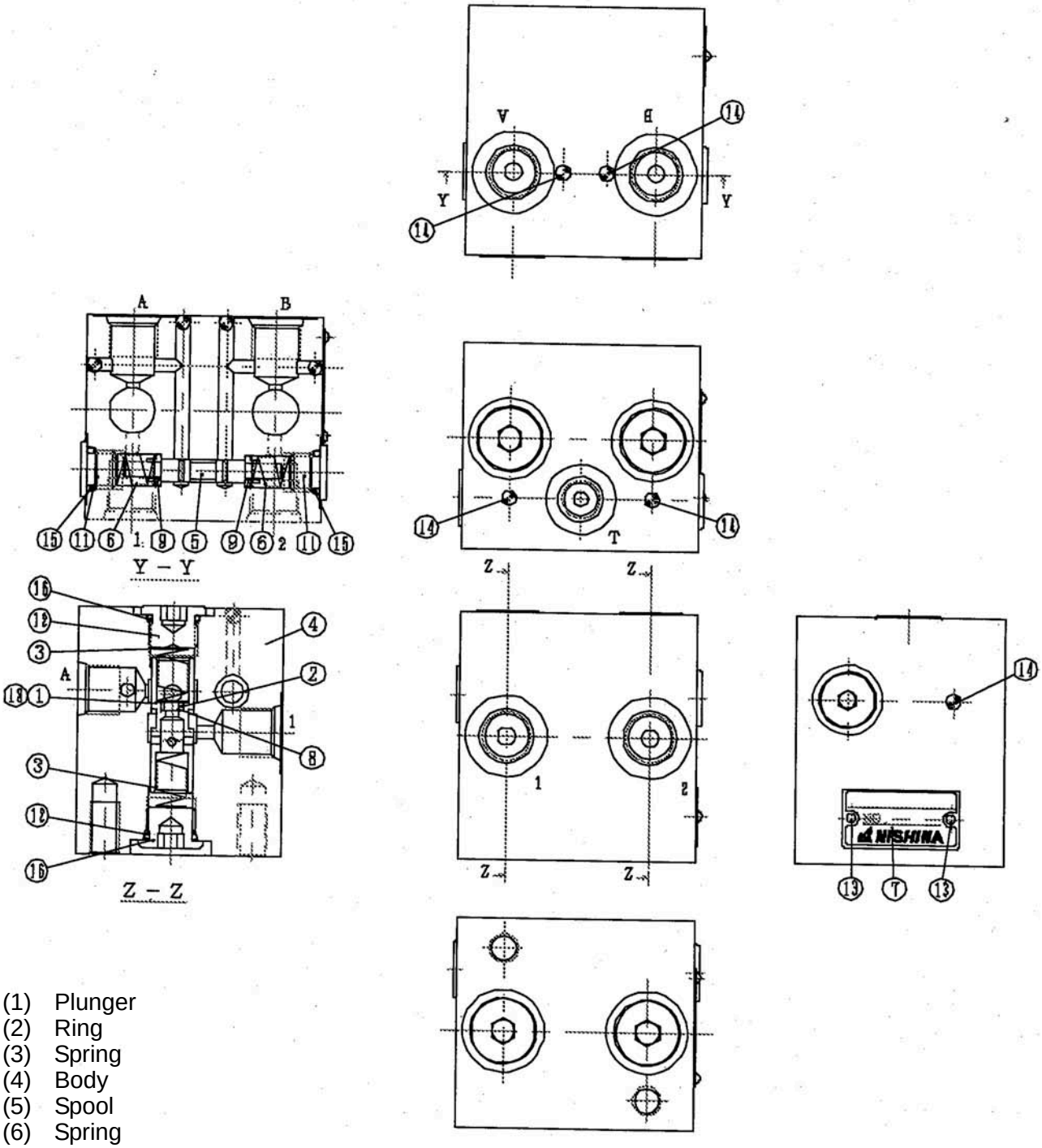
(1) Pilot pressure
(2) Face Y
(3) Chamber P
(4) Drain



H.Cylinder

a. Shockless valve of Boom cylinder pilot line

(1) Structure



(1) Plunger
(2) Ring
(3) Spring
(4) Body
(5) Spool
(6) Spring
(8) Orifice
(9) Retainer
(11) Collared plug
(12) Collared plug
(14) Steel ball
(15) O ring
(16) O ring

[Fig. 1.]

(2) Function

(Let' s discuss the ports A and 1 here. The same is true of the ports B and 2.)

<Port A to Port 1: Flow control> [See Fig. 2.]

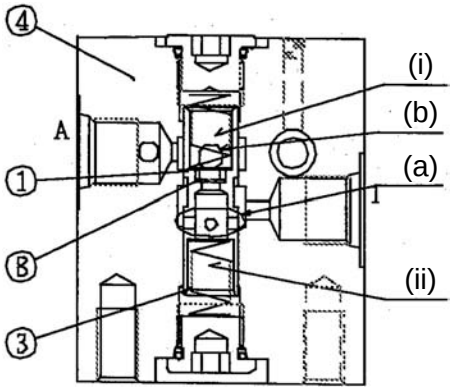
- The pressure oil out of port A flows this way: through the hole (b) of plunger (1), orifice (8), the lateral hole (a) of plunger (1) and into the port 1.
- The resistance in passing through the orifice (8) makes the pressure of chamber (i) higher than that of chamber (ii).
- This pressure difference moves the plunger (1) downward.
- When the plunger (1) has reached down, the hole (a) gets closed and the pressure of chamber (ii) rises.
- When the pressure of chamber (i) and that of chamber (ii) become the same level, the plunger (1) is brought back to the neutral position by the spring force (3).
- These steps are repeated. Finally the plunger (1) reaches the position at which the force of spring (3) and the passing resistance of orifice (8) get balanced each other. This is expressed in the following equation. (The more flow through orifice (8), the higher the resistance at the orifice. The hole (a) gets then closed.)

FS = FA x FB (FA = P1 x a > P2 x b = FB)

Where, FS: Force of spring (3)
FA: Downward force upon plunger (1)
FB: Upward force upon plunger (1)
P1: Pressure in chamber (i)
P2: Pressure in chamber (ii)
a, b: Pressure receiving area on plunger (1) (a = b)

- Accordingly, the flow of pressure oil through the orifice (8) is kept at a level that is required to produce the passing resistance proportional to the force of spring (3). This takes place regardless of the pressure at port A. In this way, the flow rate from port A to port 1 can be controlled at a constant level.

A: Boom C/V section pilot chamber
1: Boom down pilot line to return

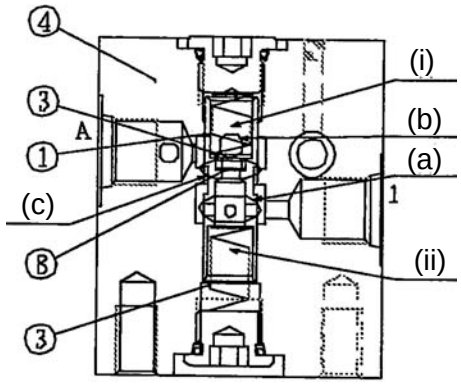


[Fig. 2.]

<Port 1 to Port A: Free flow> [See Fig. 3.]

- The pressure oil supplied out of port 1 flows through the hole (a) and orifice first and then through the hole (b) up to the port A.
- The resistance in passing through the orifice makes the pressure of chamber (i) lower than that of chamber (ii), which moves the plunger upward.
- When the plunger has reached up, the hole (c) gets open and the entire pressure oil flows out to port A.
- With no pressure oil flow, the plunger is brought back to the neutral position by the spring force.

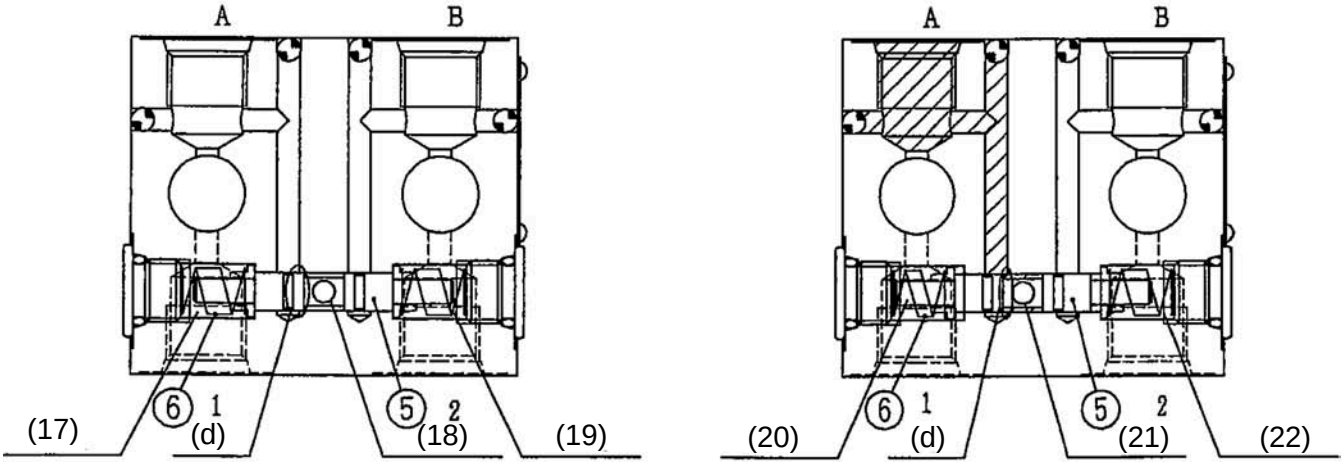
A: Boom C/V section pilot chamber
1 : Boom down pilot line to return



[Fig. 3.]

<Port A to Port 1: Flow control released> [See Fig. 4.]

- Usually the spool (5) is held at the neutral position by the left and right springs (6). The pressure oil from the port A is therefore cut from the port T with the hole (d) in between. As discussed in Fig. 2, the flow through the port A is controlled. (Left layout in Fig. 4)
- When the pressure at port 2 rises above the force of spring (6), the spool moves and allows the ports A and T to connect each other. The pressure oil through the port A therefore flows down directly into the tank, which releases the flow control at port A.



[Fig. 4.]

(17) Port 1 passable
(18) Port T passable
(19) Port 2 passable
(20) Port 1 passable
(21) Port T passable
(22) Port 2 passable

A: Boom C/V section rod side pilot chamber
B: Boom C/V section bottom side pilot chamber
1: Pilot valve port, boom down
2: Pilot valve port, boom up

I. Boom cylinder holding valve

a. Outline

The holding valve has been developed for hydraulic shovels. This control valve prevents the cylinder against gravity fall in the non-operating status and against sudden fall in case of hose burst.

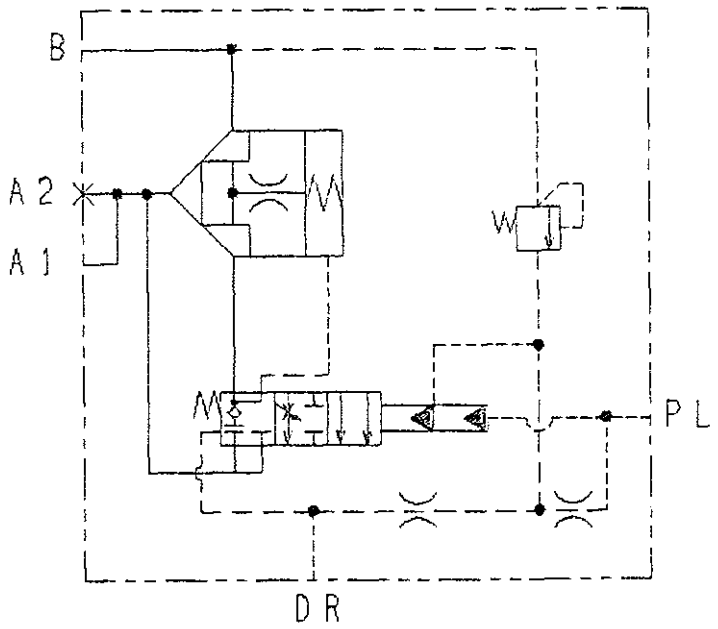
KHCV 15 G - A101 - 3. 0 / 310
(1) (2) (3) (4) (5) (6) (7)

(1) Holding valve
(2) Nominal diameter (size)
(3) B-port configuration (G: Threaded port)
(4) Rotation number
(5) Circuit code
(6) Major revision code
(7) Relief set pressure

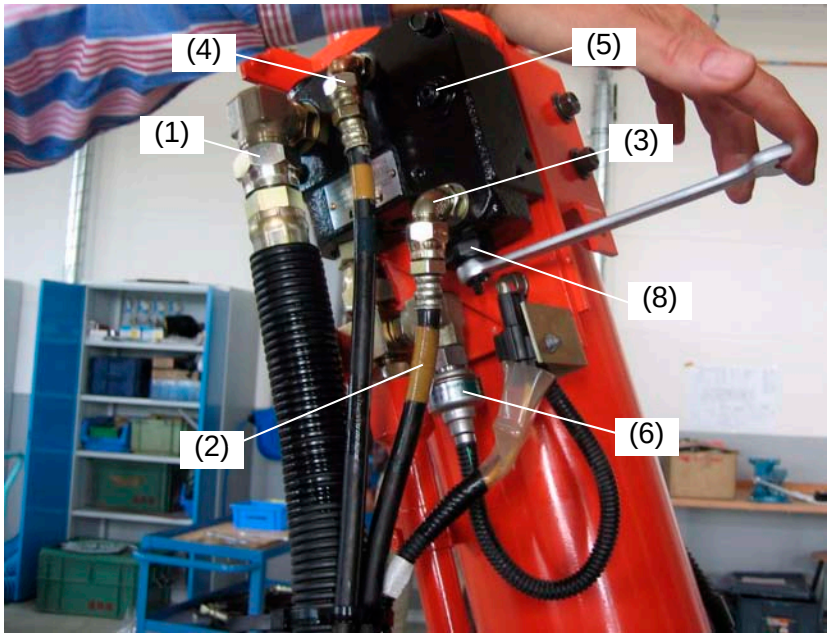
b. Specifications

Maximum operating pressure		31.4 MPa, 320 kgf/cm^2 4551 psi
Maximum allowable flow rate (P-port) A → B		150 L/min, 39.63 GPM
Cracking pressure	B-port pressurized	PB = 30.4 ± 0.5 MPa, 310 ± 5 kgf/cm^2, 4409 ± 71 psi
	A-port pressurized	PA = 0.2 MPa, 2 kgf/cm^2 28 psi
	PL-port pressurized	PPL= 0.5 $^{+0.05}_{-0.10}$ MPa, 5 $^{+0.5}_{-1.0}$ kgf/cm^2 71 $^{+7.0}_{-14.2}$ psi
Leakage	Holding valve internal	0.8 cc/min at B port, 8.3MPa (85 kgf/cm^2)
Hydraulic oil used Allowable hydraulic oil contamination		Mineral hydraulic oil ISO VG3 or VG46 or equivalent Below Class NAS10
Operating temperature range		-20 ~ +95°C

c. Circuit diagram

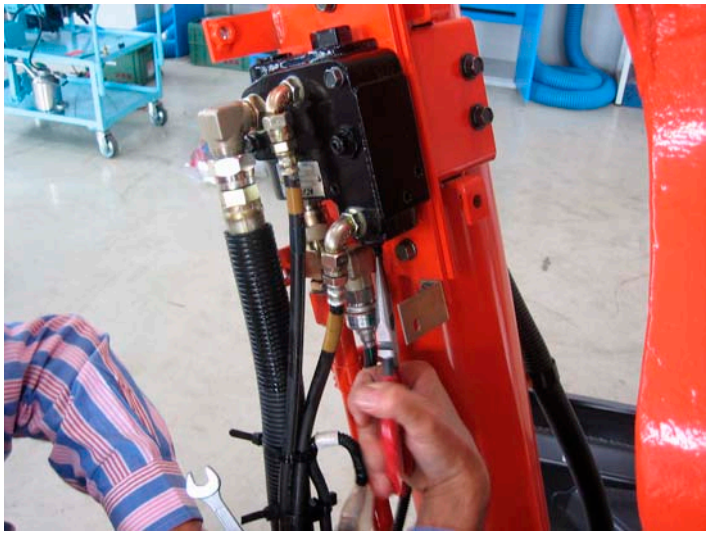


d. Holding valve installation



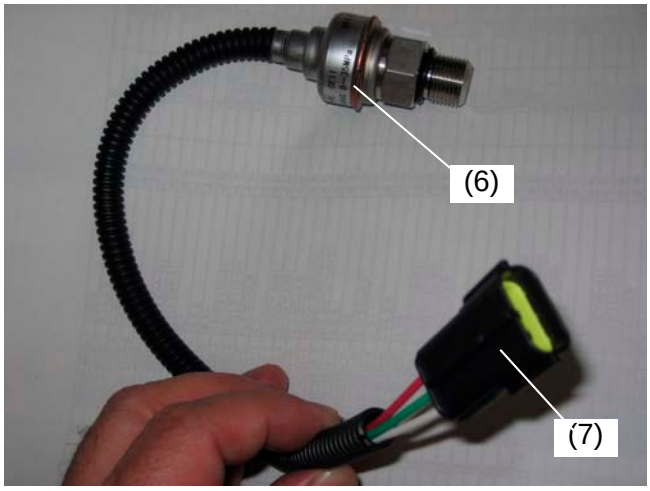
1. Main parts

(1) Main control valve to the holding valve
(2) Holding valve to boom cylinder bottom side
(3) Pilot secondary line
(4) Drain line
(5) Overload relief valve
(6) Load pressure switch
(8) Manual device for boom down





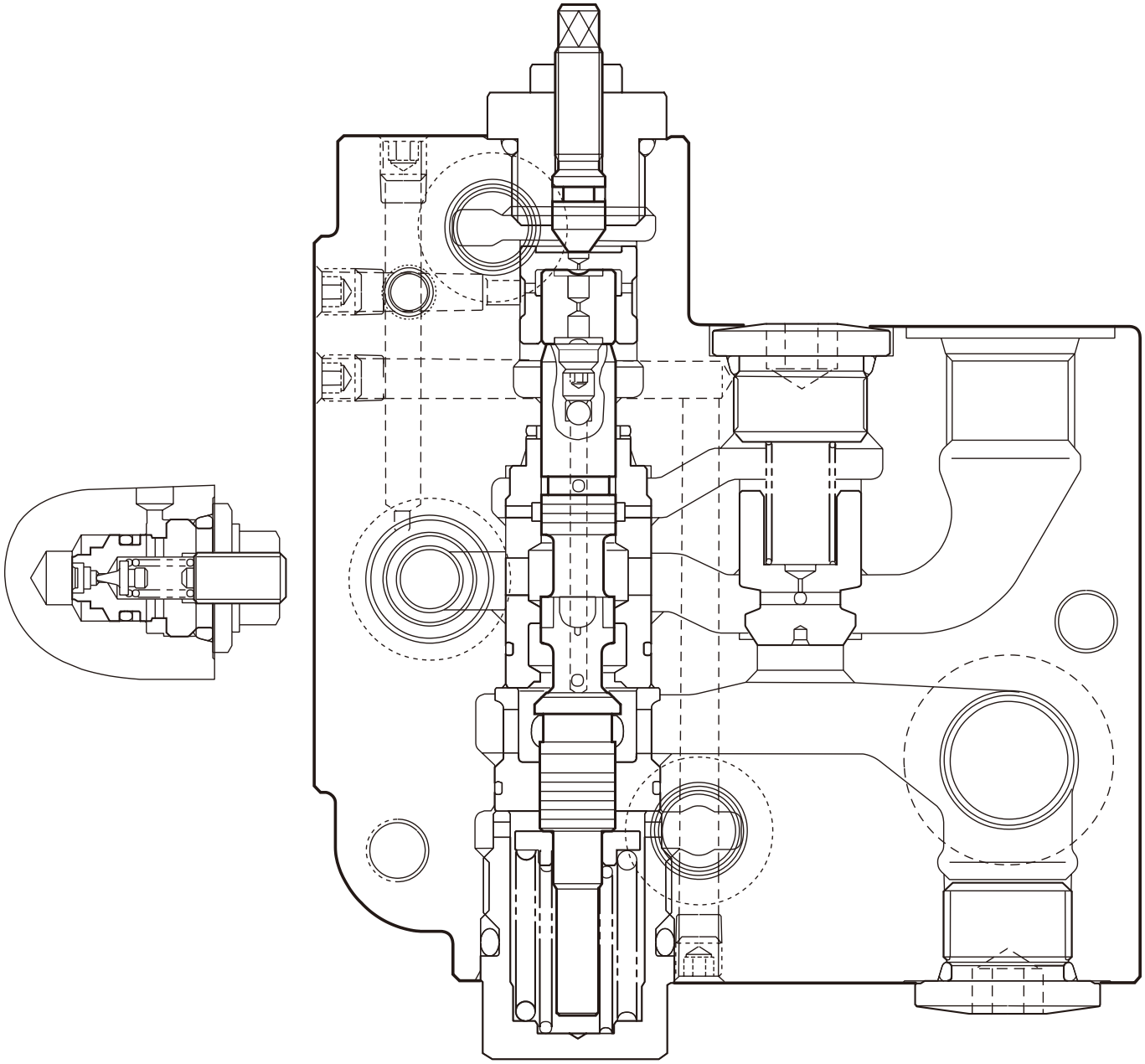
2. In order to get the boom down ;
Disconnect the main hose to drain out the oil



(6) Load pressure switch
(7) Coupler

e. Main parts function

Holding valve (manual open type)



Main part's function

No.	Name	Function
(1)	Poppet	• To stop a leak between main relief valve and cylinder. • Equipped with load check function.
(2)	Spool	• Activated over the stroke by the cylinder-actuated pilot pressure to control the flow rate from cylinder to main relief valve. • To control the poppet openness when the pilot pressure rises too high.
(3)	Piston (1), Piston (2)	• To receive the pilot pressure and to activate the spool over the stroke. • Spool to be activated over the stroke by piston (1) for relief purpose.
(4)	Relief valve	• To regulate maximum pressure at the cylinder port.

A port : From control valve
B port : To boom cylinder bottom side

f. Circuit function

1. Newtral position

When the spool stays neutral (with no pilot pressure applied), the poppet seat (a), spool seat (b), sliding spool seal (c) and relief valve poppet seat (d) all serve to stop a leak from the cylinder. In this way, the cylinder is prevented against gravity fall.

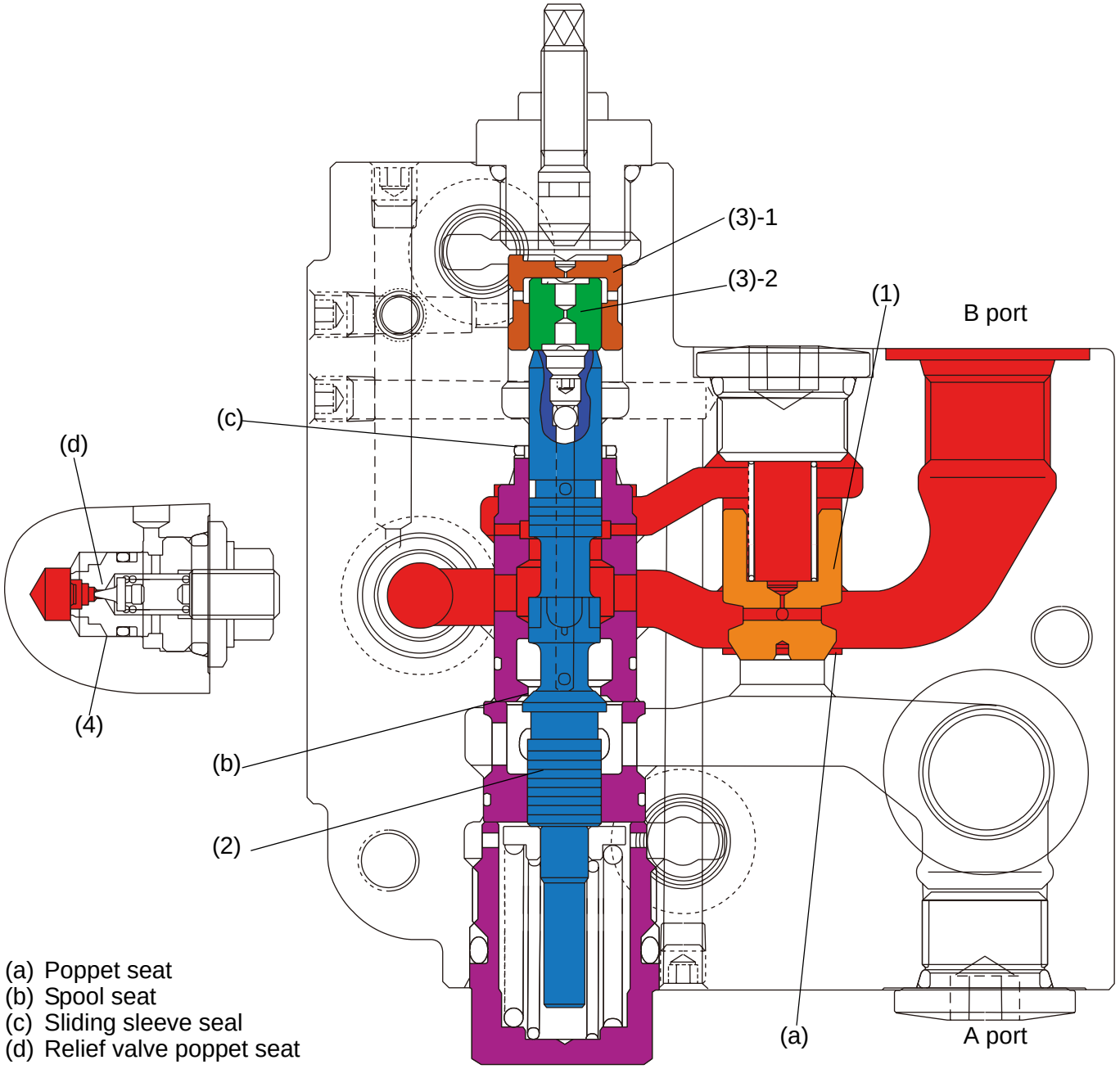
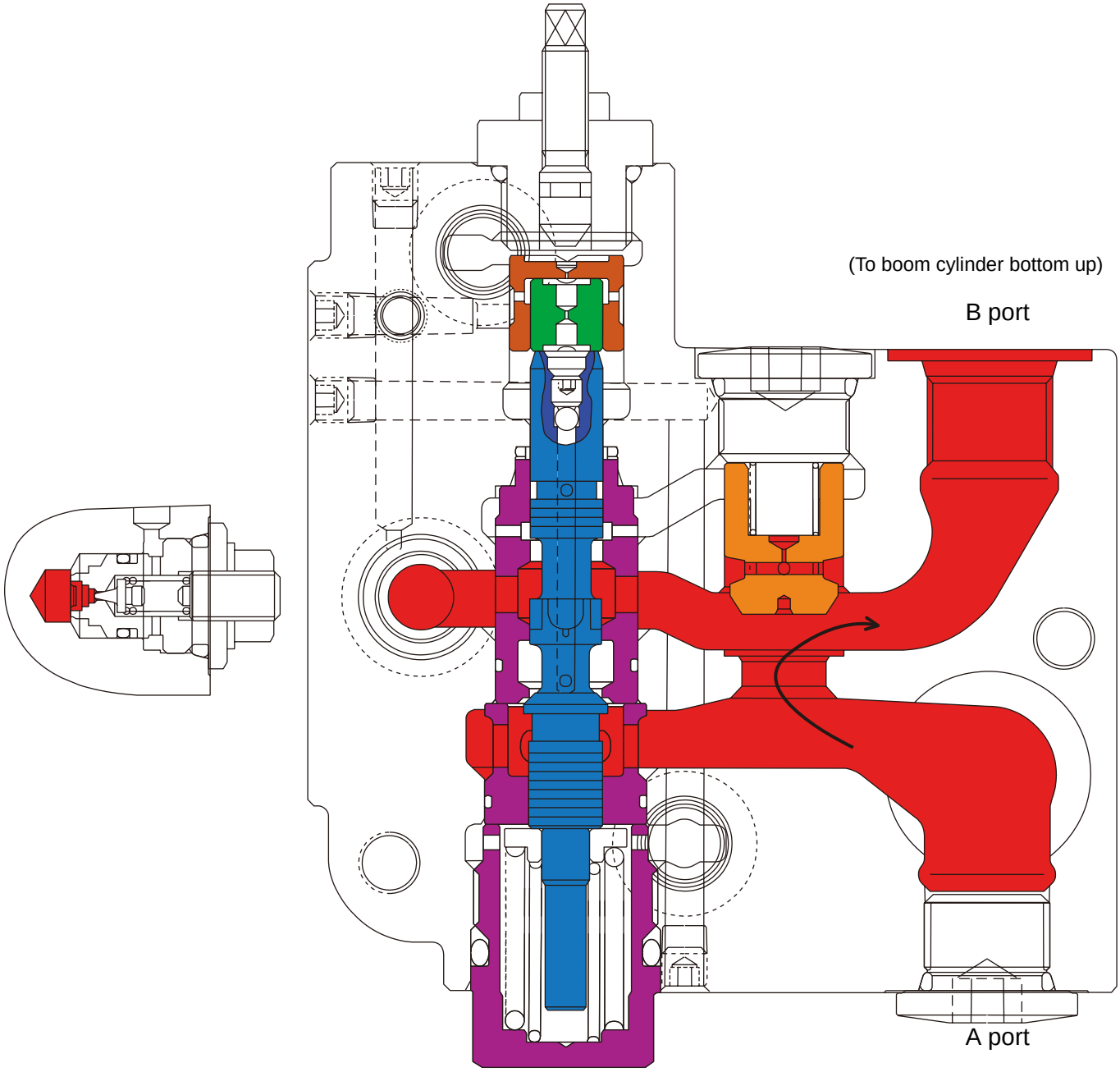


Fig. 1 Spool at neutral position

2. With oil flowing from A-port to B-port (from main control valve to cylinder)

The oil from A-port flows against the cylinder pressure and the poppet's return spring force. It then gets the poppet open and flows on to B-port.



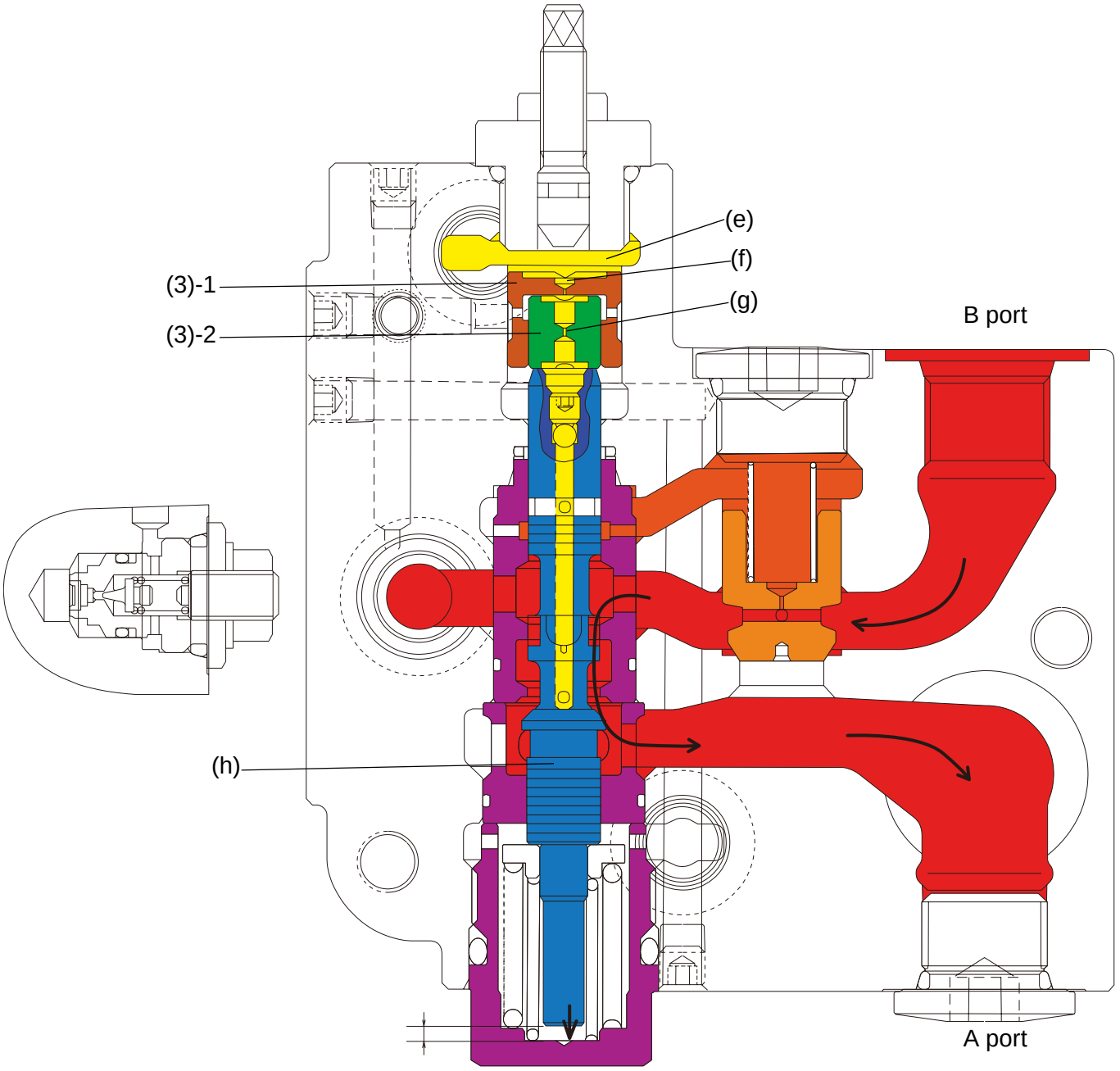
(a) Poppet seat
(b) Spool seat
(c) Sliding sleeve seal
(d) Relief valve poppet seat

Fig. 2 With oil flowing from A-port to B-port

3. With oil flowing from B-port to A-port (from cylinder bottom side to main control valve)

(1) When the pilot pressure is applied, the pressure in the pilot chamber (e) rises. The oil from the pilot chamber flows along the pilot line and through the orifices (f) and (g) into the drain port. Now the air in the pilot pipe is let out automatically.

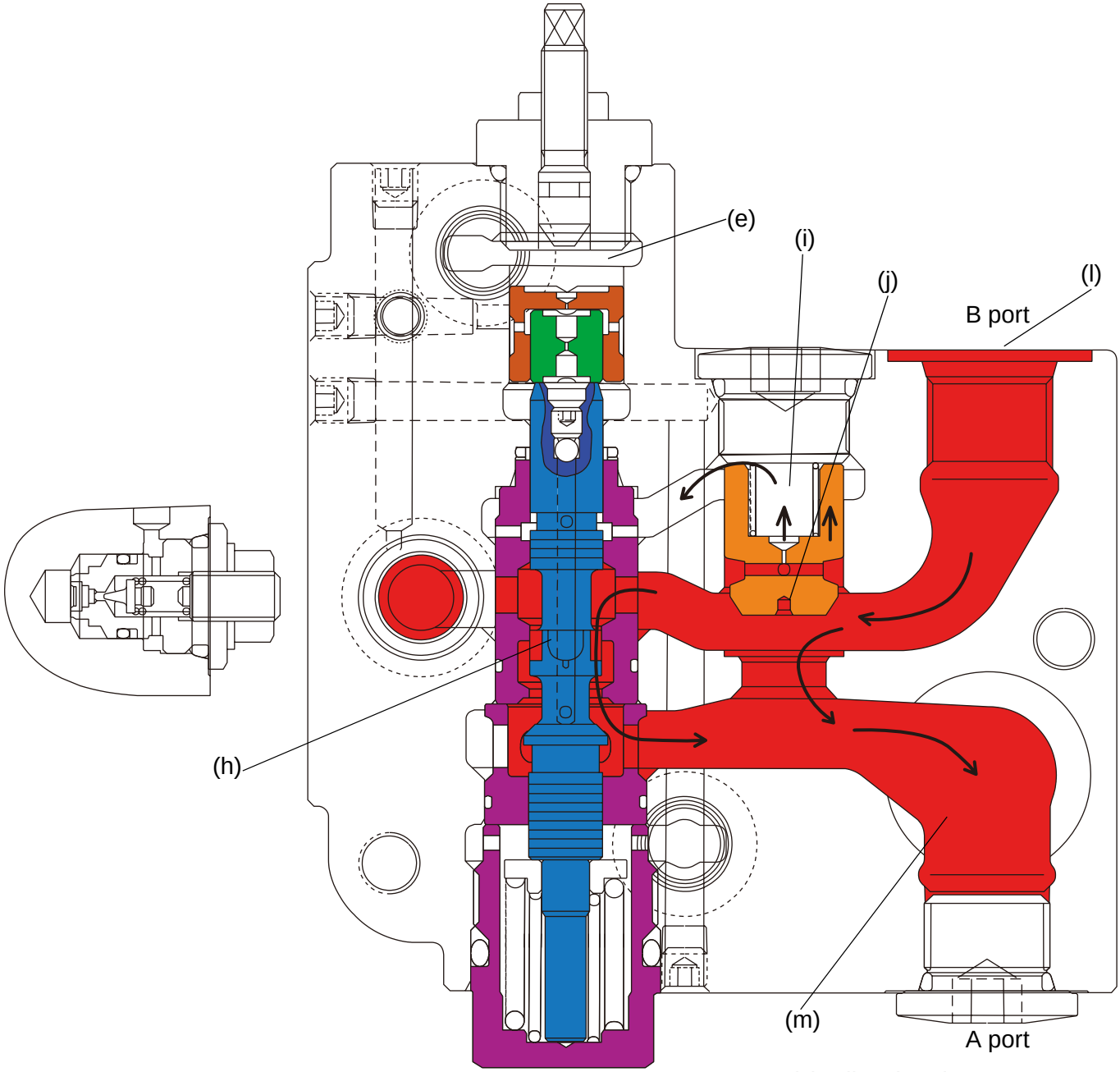
(2) Because of the pilot pressure, the pistons (3)-1 and (3)-2 as well as the spool are activated against the spool's return spring force. The return oil from the actuator flows from B-port (cylinder) through the spool control (h) into A-port (main control valve).



(e) Pilot chamber
(f) Orifice
(g) Orifice
(h) Control spool

Fig. 3 With oil flowing from B-port to A-port (at low pilot pressure)

(3) When the pilot pressure rises higher, the poppet spring chamber (i) gets connected to the A-port side with the spool internal passage in between. The poppet's orifice (j) then causes a pressure difference between B-port and poppet spring chamber, which gets the poppet open.



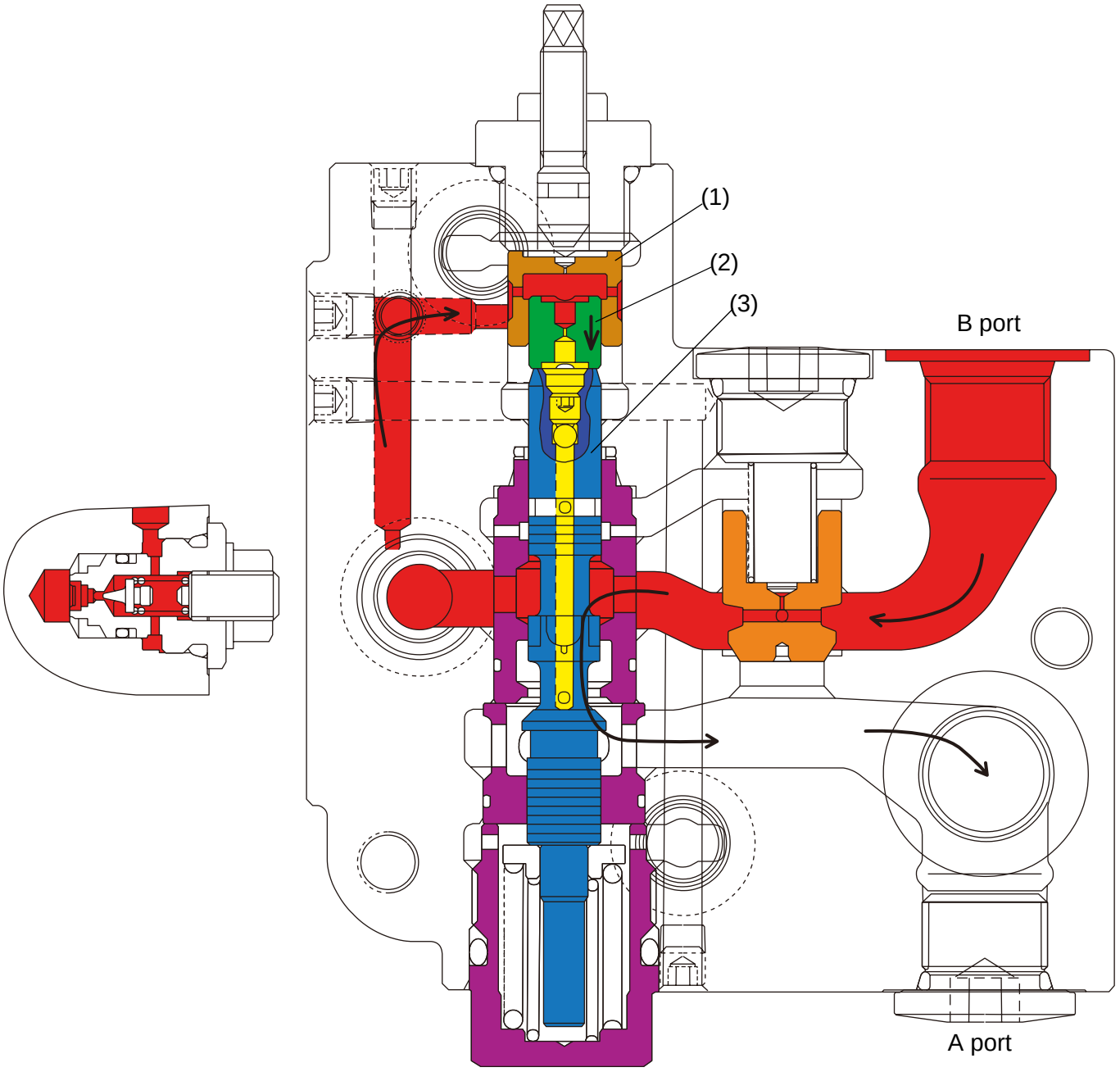
(e) Pilot chamber
(h) Control
(i) Poppet spring chamber
(e) Pilot chamber
(i) Poppet spring chamber
(j) Orifice
(l) From boom cylinder bottom
(m) To main control valve

Fig. 4 With oil flowing from B-pot to A-port (at high pilot pressure)

4. Over-pressure in the cylinder (relief valve activated)

(1) If the cylinder pressure rises above the relief valve's pressure setting, the relief valve opens itself to generate a pressure in the chamber (k).

(2) The pressure in the chamber (k) moves the piston (1) toward the plug and the piston (2) toward the spool. The piston (2) then pushes the spool against the spool's return spring force. Now the spool goes over the stroke to open the passage from B-port to A-port, which lets the oil flow from the cylinder to the main relief valve.



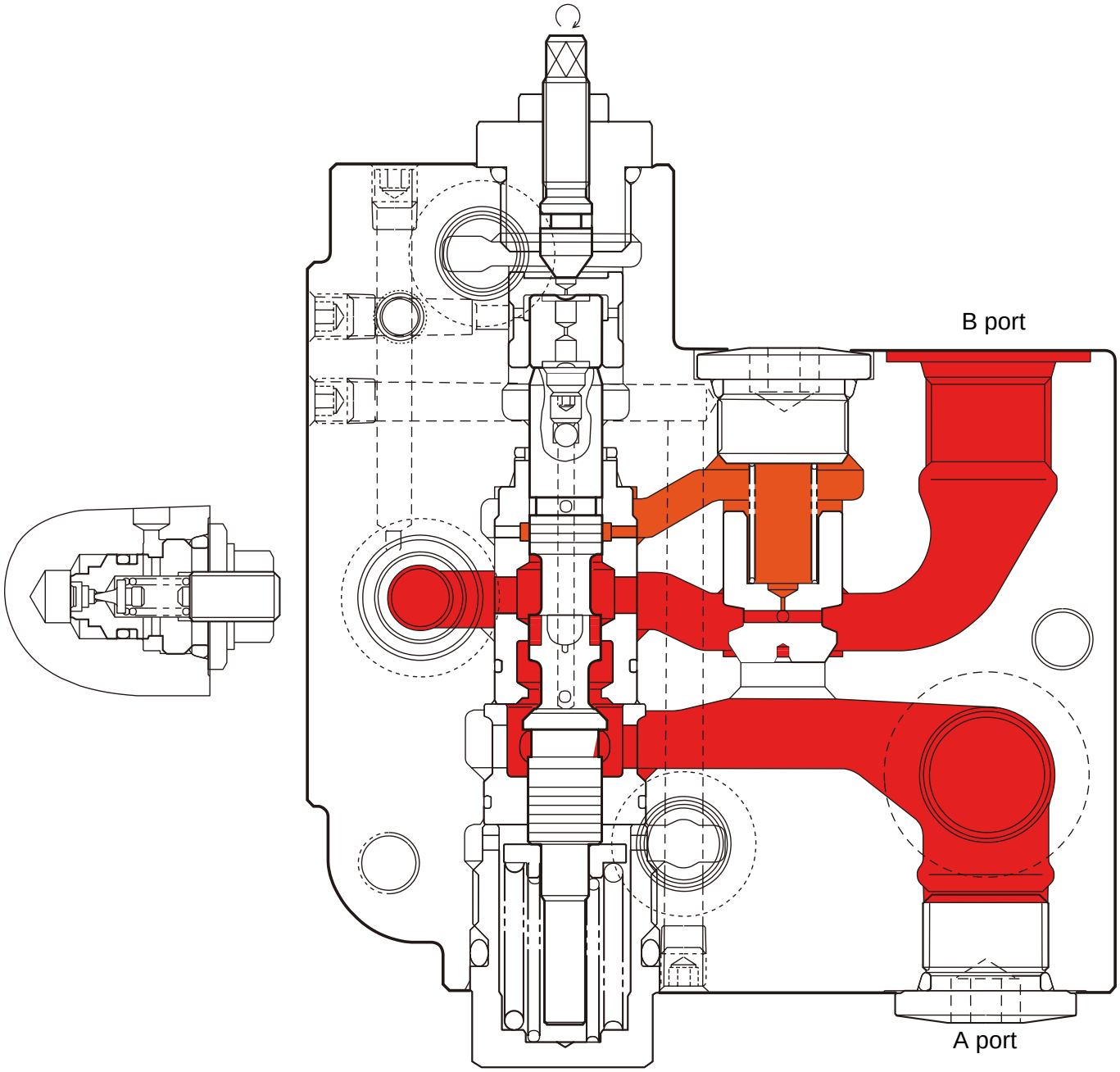
(h) Control
(k) Pilot chamber

(1) Piston 1
(2) Piston 2
(3) Spool

Fig. 5

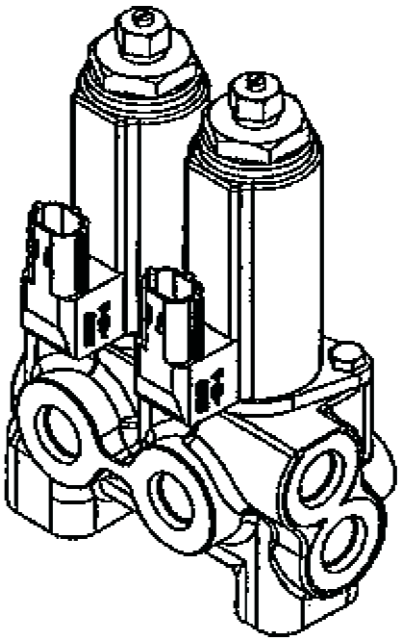
5. Manual release of cylinder bottom oil

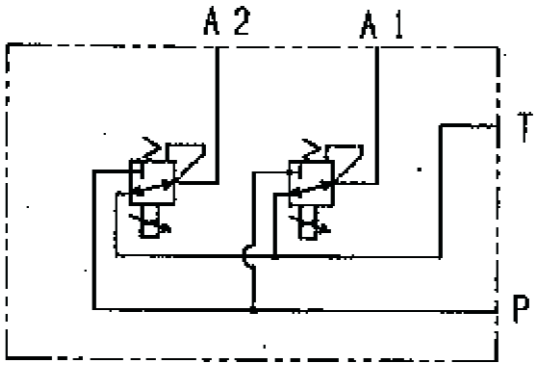
When the boom cylinder is required to get down, screw in the screw plug, which pushes the piston (1) and (2) and results in opening the oil passage of control spool.
As the main cotrol valve is at its neutral position, the hydraulic hose from A port to the main control valve should be removed to drain the oil.



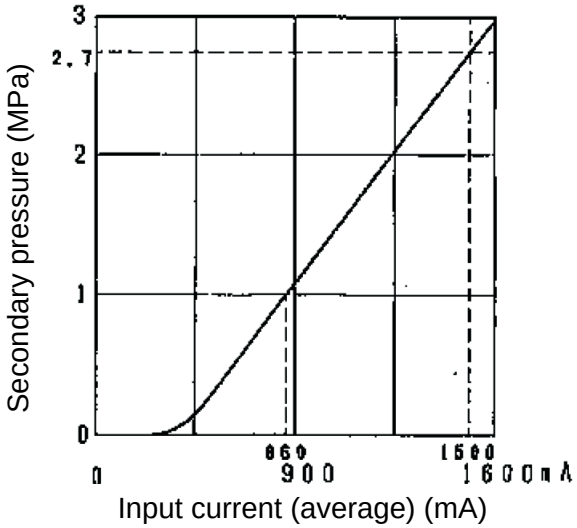
J. Solenoid valve

a. Solenoid proportional control valve



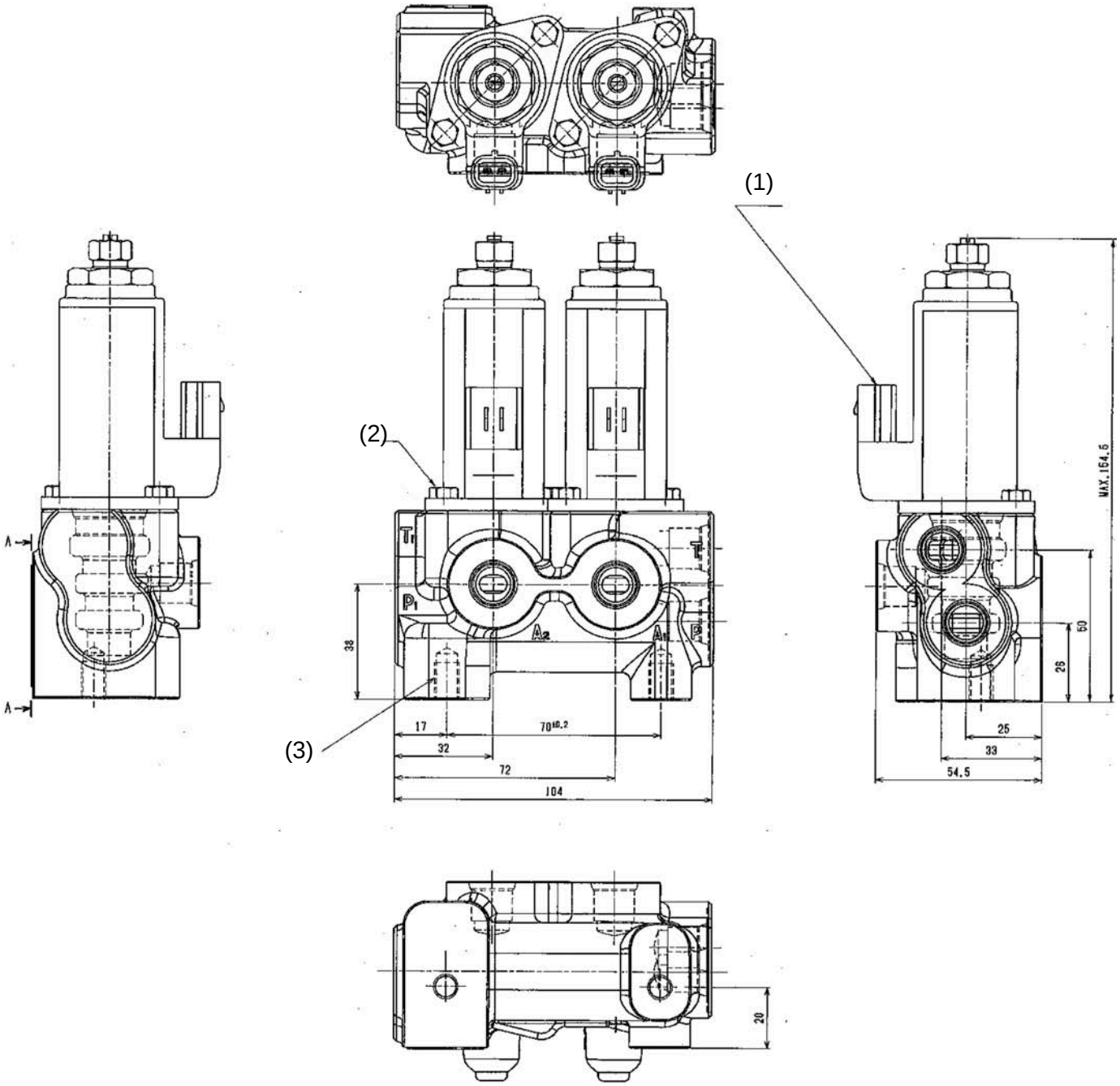


Hydraulic symbol

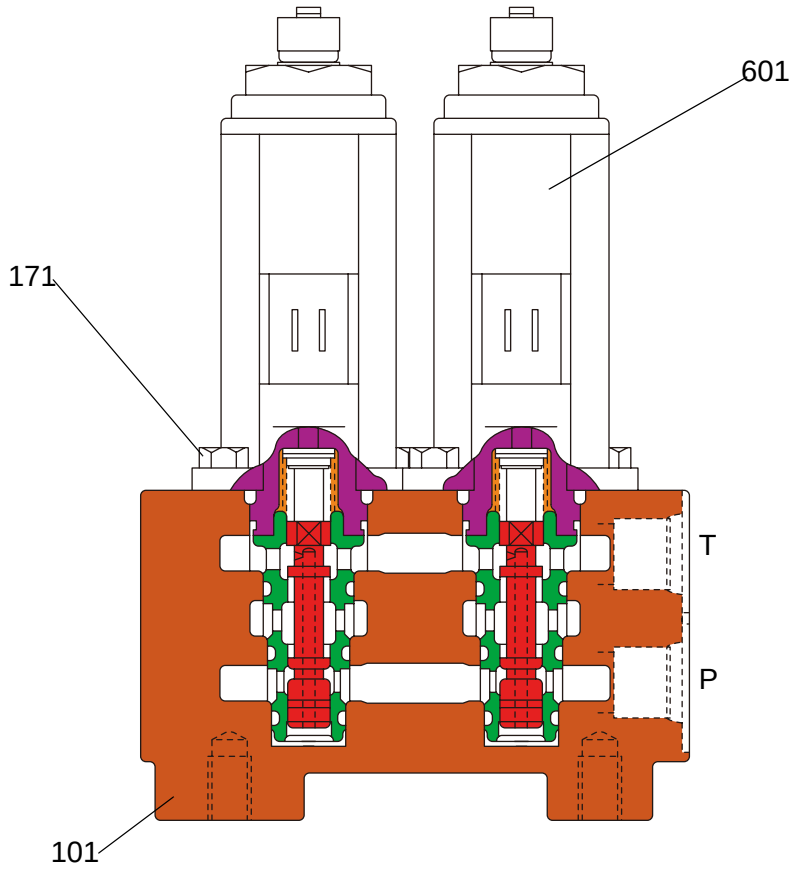


Control diagram

Max. working pressure. (Press. in port P)	7 MPa
Allowable back pressure. (Press. in port T)	1.0 MPa and below
Max flow proportional valve	10 L/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	Accroding to ISO VG 32 ~ 68
Oil temp. range	-20 ~ 90°C
Allowable contanination	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
Propotional valve, secondary press.setting range	0 ~ 2.7 MPa Current pressure profile : 38100 ~ 3408



(1) Type of connection : equivalent to amp econoseal J senies connectors mark II (+) gap hausing
(Gap housing : 174354 -2, Terminal : 173706 - 1)
(2) Tightening torque : 7 ± 1 N·m
(3) 2 - M8 screw depth 12 : Tightening torque



101	Casing	Al alloy
171	Rexabox head bolts	M5 x 0.8 7.0 ± 1
601	Proportional reducing valve	
901	Name plate	

V. Electrical system

Mechanism Section

A. Feature and main function V-M-3
a. Development concept V-M-3
b. Service port speed limit control V-M-5
c. Fuel supply pump V-M-16
d. Intake air heater control V-M-24
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a. Components layout V-M-29
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d. Service mode flow chart V-M-33
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C. Kubota Intelligent Control System Refer to WSM (Minor Change) : Code No. 97899-61260

A.Feature and main function

a. Development concept

1. Features of KX080-3 system

Basic electrical system structure is same as KX-3α and KX-3S series and some new values are added. Newly added features of KX080-3 electrical system are as below.

No.	Feature points	Benefits
1	**Service port (1) delivery flow control (S/P speed control)**	Required max. flow of service port varies according to the attachments. This new S/P flow control enables operators to select optimum flow amount, thus regulate the attachment speed.
2	**Fuel supply pump**	Fuel pump equipped as standard helps operator to supply fuel to the tank. Tank full-sensor is equipped to prevent fuel from overflowing. Four min. timer relay gets the pump function continuously for 4 minutes.
3	**Intake air heater control**	Engine, V3800-DI, has the intake air heater which regulates the intake air temperature for proper combustion and clean exhaust gas. The electrical control system consists of micro-computer unit to work with. (Note: Repeated ON-OFF only of the main key is prohibited, may cause the heater coil damage.)
4	**Travel alarm system**	This system warns the people working around that the machine is travelling nearby. This is the safety oriented device.
5	**Service port (2) is controlled by solenoid valve (ON-OFF control).**	Conventional machines are equipped with mechanical-link pedal-control service port. This one is electrical control device which is easily remote selected ON or OFF position at hand.
6	**Boom overload sensing with pressure switch**	For operator's safety, the pressure switch detects the boom cylinder's internal pressure and alarms the operator.

2. Electrical system : Functional comparison
:KX080-3

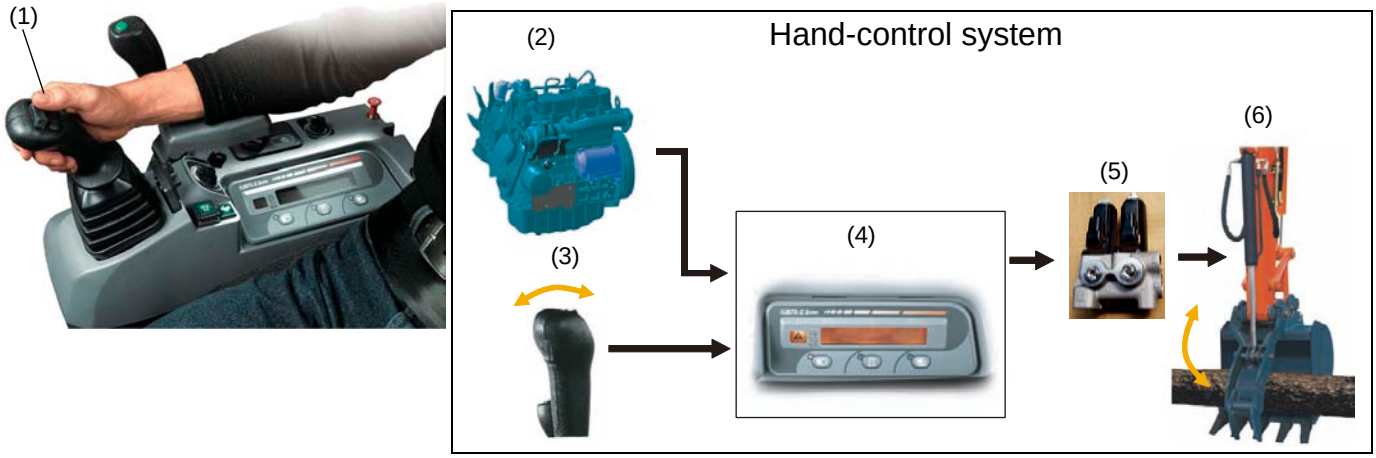
No.	Function	EU-version	North America & Oceanea
1	KICS;Kubota Intelligent Control System, LCD(liquid crystal display) with character and illustration	Yes	Yes
2	Maintenance indication upon hour meter	Yes (delete method:manual)	Yes (delete method:auto)
3	Anti-theft system	Yes	Yes
4	AI(Auto idle) function	Yes	Yes
5	Engine overheat warning	Yes	No
6	Starter motor auto release function	Yes	Yes
7	Travel high-low switch at dozer lever grip	Yes	Yes
8	Fuel feed assist sound	Yes	Yes
9	Heater	Yes	Yes
10	Rotating lamp	Harness and switch are equipped as standard	Harness is incorporated
11	Service port (thumb) finger - control	Yes	Yes
12	Air - conditioner idling control	Yes	Yes
13	Low temp. idle up control	Yes	Yes
14	Service port (1) discharge flow control	Yes	Yes
15	Fuel supply pump	Yes	Yes
16	Intake air heater control	Yes	Yes
17	Travel alarm system	Yes (option)	Yes
18	Boom overload sensor	Yes	Yes
19	Service port (2) solenoid ON-OFF conrol	Yes	Yes

b. Service port1 (S/P1) speed limit control

1. 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.

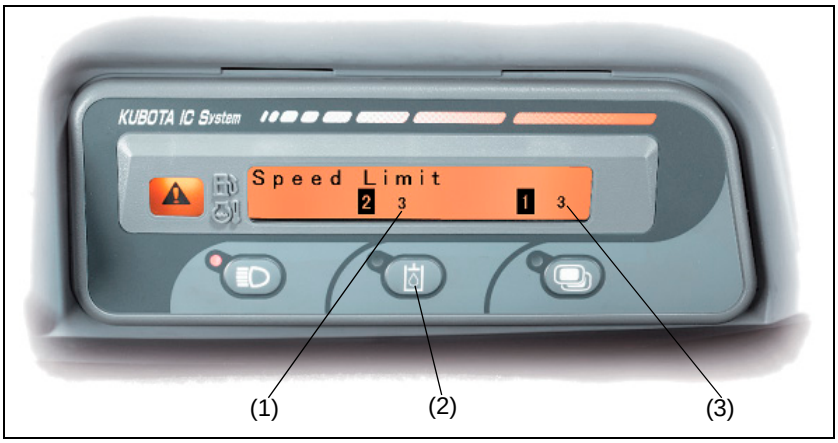
- Hand-control system
  The hydraulic control grip has a small angle sensor built in. Signals from this sensor activate the proportional solenoid valve to control the flow rate at the hydraulic service port stepless.



(1) Control knob (small angle sensor)
(2) Engine rpm
(3) Control angle input
(4) Electronic meter (control unit)
(5) Proportional solenoid valve
(6) Attachment

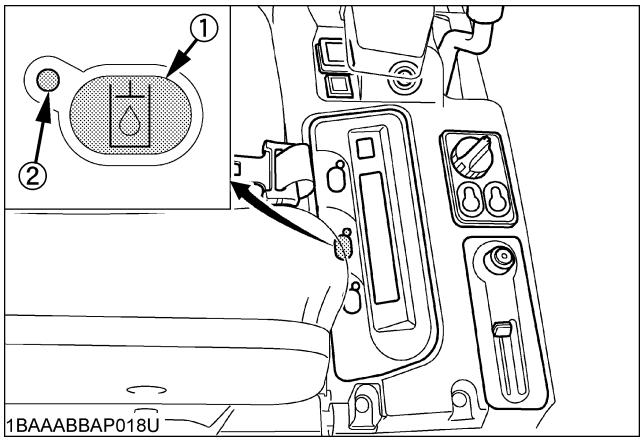
2. Outline of new function

- Speed limit function [New Feature]
  According to maximum necessary flow rate of an attachment, the working speed limit can be preset in multi-steps. Just 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.



(1) Extend
(2) Control button
(3) Retract

3. How to operate servcie port 1



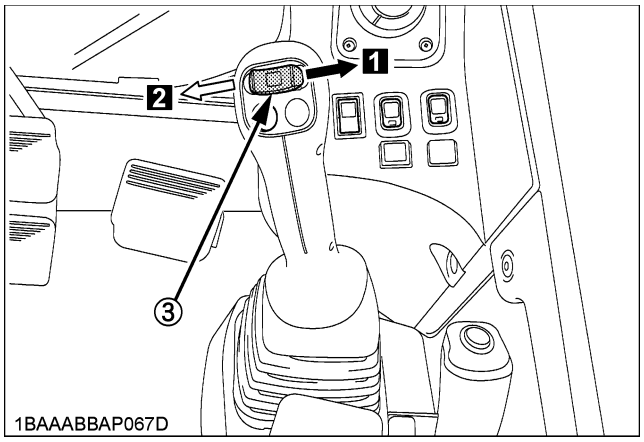
(1) Service port activation switch
(2) Indicator lamp

1. When the lock lever is raised, the service port activation switch is off.
2. Let the engine warm up after start-up for approx. 10 minutes under no load conditions.

3-1 First Service Port Operation

This switch is used to operate hydraulic attachment such as breakers.

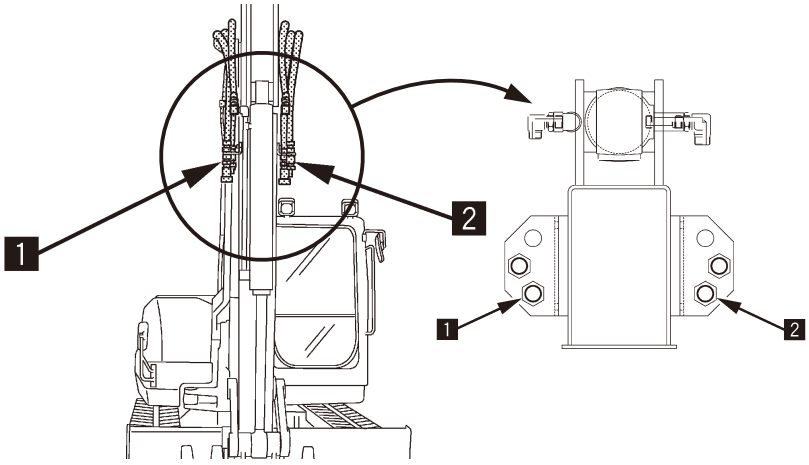
1. Turn the starter key to the "RUN" position.
2. Lower the lock lever.
3. Push the service port activation switch.



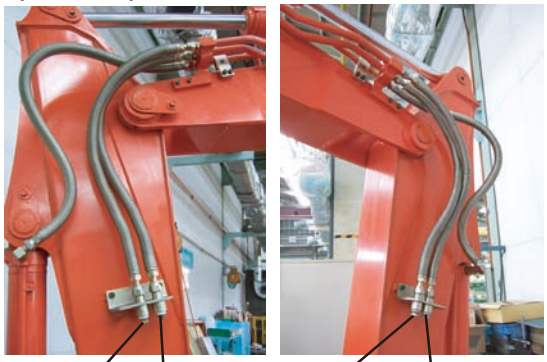
(3) Service port switch

4. Move the service port switch to the right (⬇) **1** to send oil to the port (1).
5. Move the service port switch to the left (⇩) **2** to send oil to the port (2).

- Proportional control allows for slow-to-fast movement of attachment.
  Example: If you move the knob switch half way, the attachment will move at approximately one-half speed.

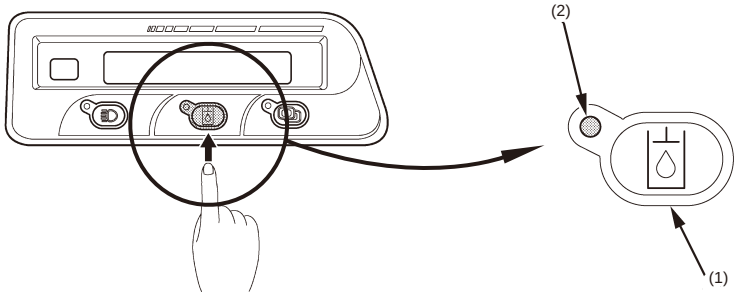


(Left side) View from the cab (Right side)

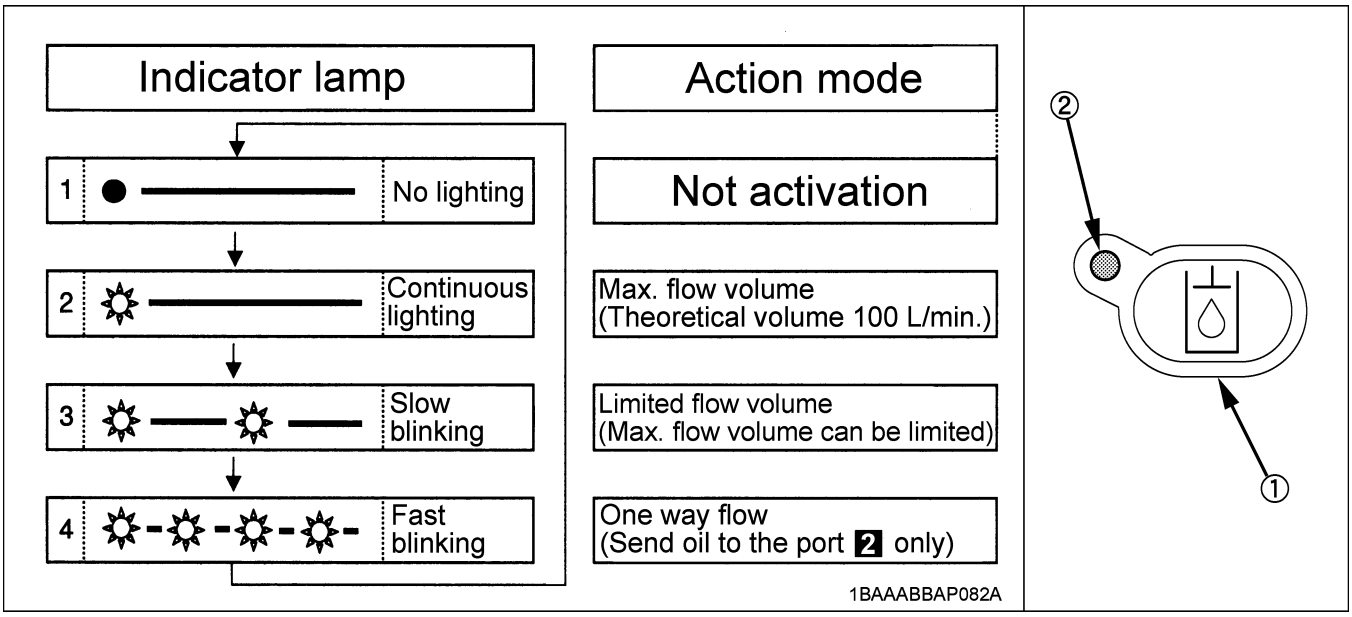


3-2 Action mode of first service port operation

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.



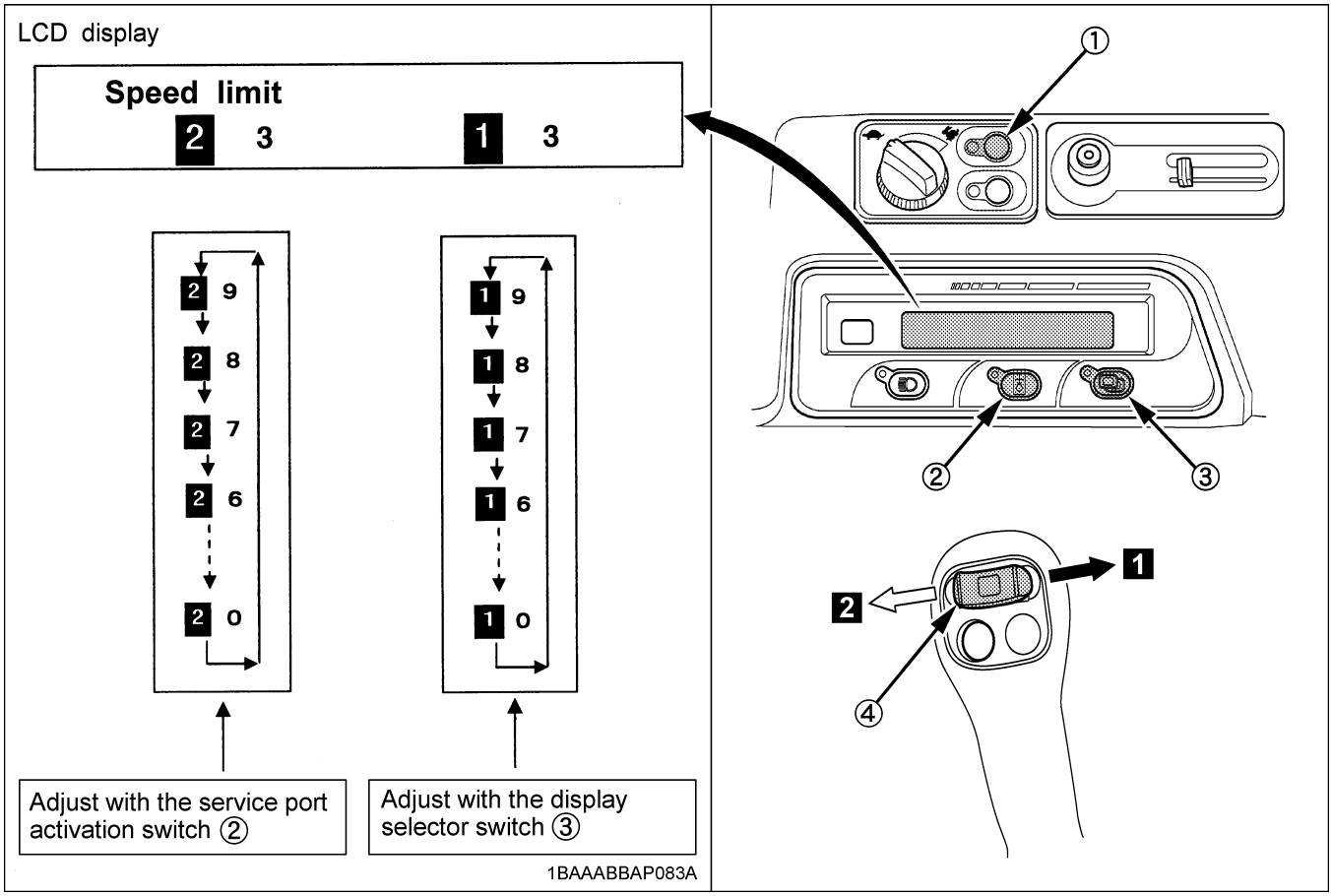
NOTE:
- When turning the starter key to the "RUN" position, the action mode will return to the last action mode used.



(1) Service port activation switch
(2) Indicator lamp

4. Setting of limited flow volume (10 steps)

1. Turn the starter key to the "RUN" position while pushing the flow volume setting switch.
2. Release the hand from the switch after the engine starts.
3. Ten stages can be adjusted for Max. flow volume right (1) and left (2) independently.
4. The oil volume supplied from port (1) is adjusted with the display selector switch (3).
5. The oil volume supplied from port (2) is adjusted with the service port activation switch (2).

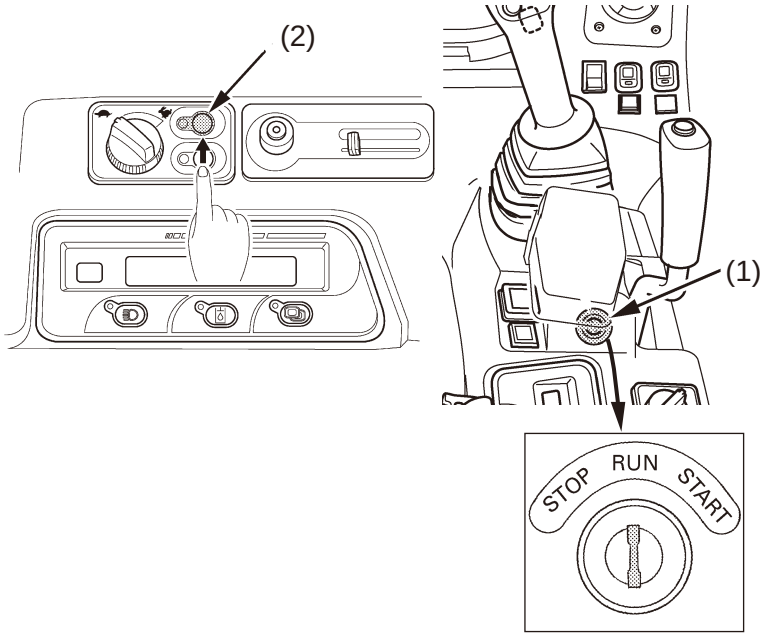


(1) Flow volume setting switch
(2) Service port activation switch
(3) Display selector switch
(4) Service port switch

Note : Above 10 steps speed limit adjustment is for those machines sold only in EU-market up to around November, 2006.
Serial number wise : 10001~

5. Setting of limited flow volume, S/P1 (15 steps)

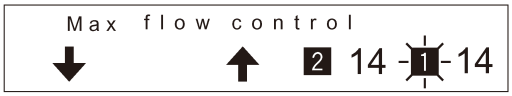
S/N ~



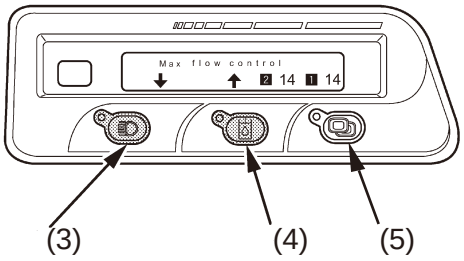
1.Turn the starter key (1) to the "**RUN**" position while pushing the flow volume setting switch. (2) Release the hand from the switch after the enginestarts.

(1) Starter switch
(2) Flow volume setting switch

The following message will appear on the LCD displayand Max. flow volume right **1** can be adjusted.



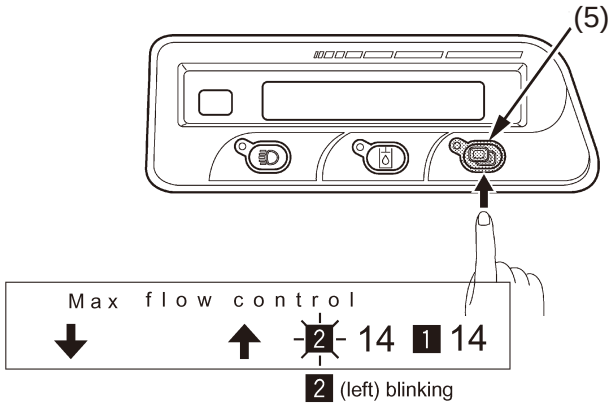
1 (right) blinking



2.The flow volume supplied from port **1** (right) is adjusted properly with the working light switch (3) or the service port activation switch (4) while operating the hydraulic attachment.

- When the working light switch is pushed, the flowvolume is decreased.
- When the service port activation switch is pushed,the flow volume is increased.

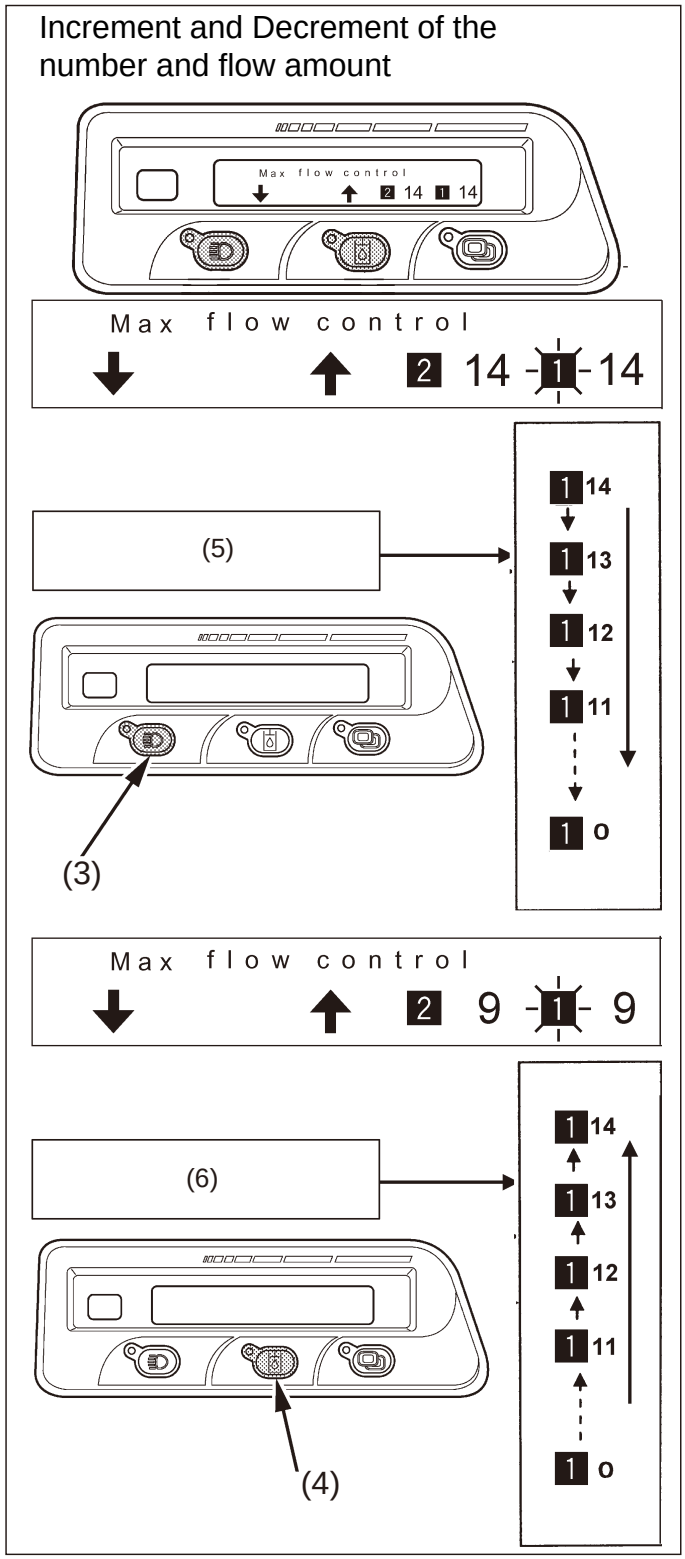
(3) Working light switch
(4) Service port activation switch



2 (left) blinking

3.After Max. flow volume right **1** is set, push the displayselector switch (5).
The following message will appear on the LCD displayand Max. flow volume left **2** can be adjusted.

(5) Display selector switch



4.The flow volume supplied from port **2** (left) is adjusted properly with the working light switch or the serviceport activation switch while operating the hydraulicattachment.

- 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.

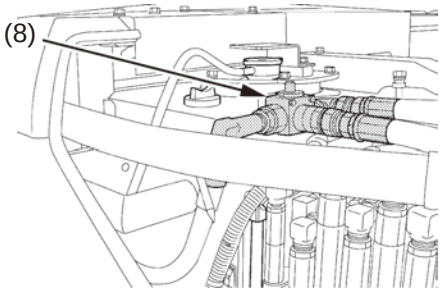
(3) working light switch
(5) Adjust with the working light switch (3)

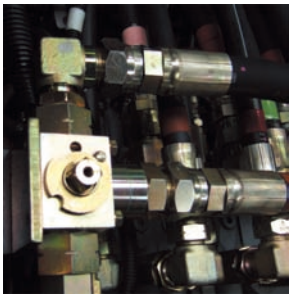
Note :

- When Max. flow volume right **1** is adjusted again, thedisplay selector switch is pushed and the operation of is repeated.

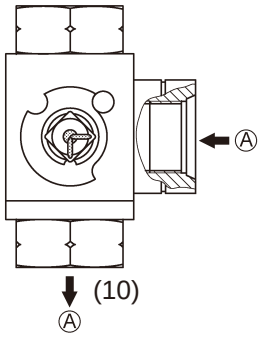
5.After Max. flow volume right **1** and left **2** is set, turn the starter key to the "STOP" position once. Then turn the starter key to the "RUN" position again.

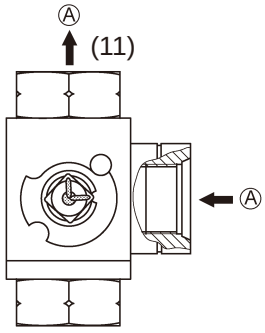
(4) Service port activation switch
(6) Adjust with the service port activation switch (4)





(9)





6.1-way or 2-way CIRCUIT SELECTION VALVE OPERATION

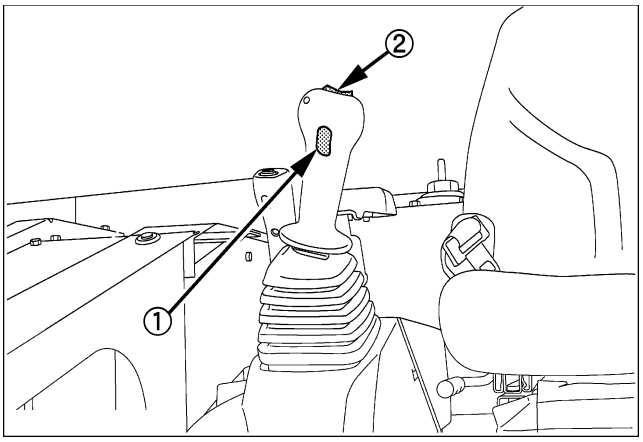
The selection valve which selects 1-way or 2-way circuitof service port has been installed on the hydraulic tank. When the breaker will be used, position the arrow on theaxis of selection valve to the 1-way circuit position toreduce the back pressure with supplied lever.

Note :

- When the equipment (auger, crusher, ...), which needs 2-way circuit will be used, position the arrow on theaxis to the 2-way circuit position.

(8) Selection valve
(9) Two way position
(10) 1-way circuit
(11) 2-way circuit

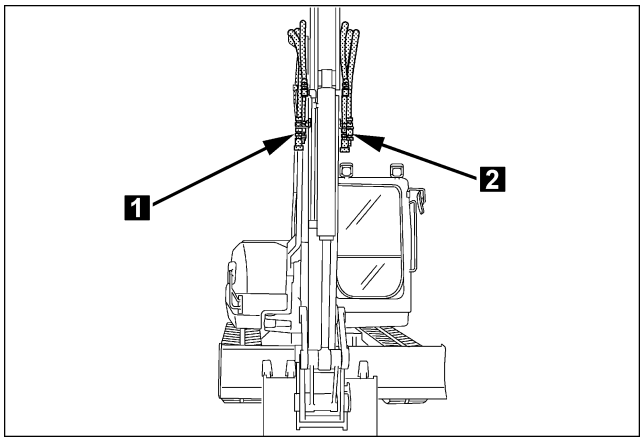
(A) Hydraulic flow



(1) One way hold lock switch
(2) First service port switch

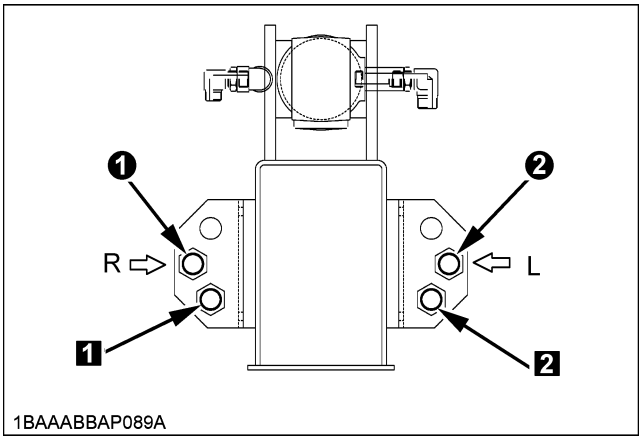
7. One way flow operation

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 first service port switch is pushed.



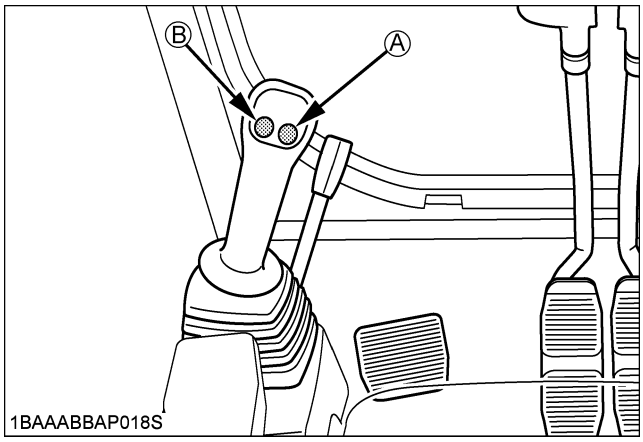
In case of one way flow operation

2 S/P1, L : Pressure port
1 S/P1, R : Return port



L : Left side viewed from cab
R : Right side viewed from cab

1 : Service port1, right side
2 : Service port1, left side
❶ : Service port2, right side
❷ : Service port2, left side

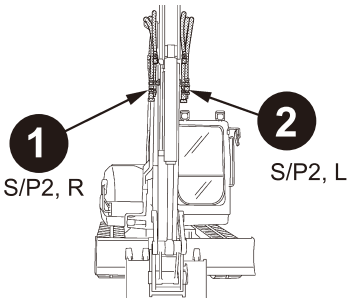


8. Second service port operation

S/N 10001~

1. Turn the starter key to the "RUN" position.
2. Lower the lock lever.
3. Press the right switch (A) to send oil to the port ❶.
4. Press the left switch (B) to send oil to the port ❷.

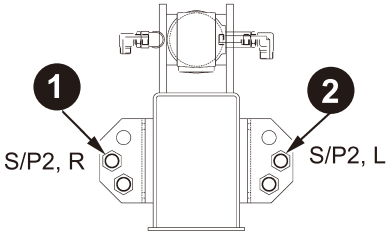
- Proportional control is not possible.

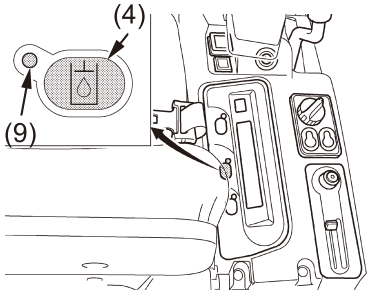


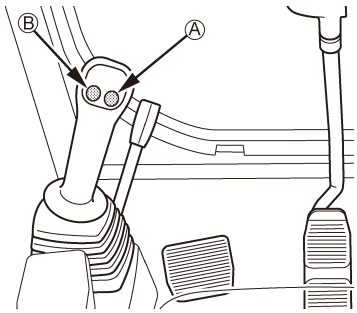
- It is possible to adjust the flow volume of the second service port. Contact your local KUBOTA dealer when necessary.

Service Port Max. Flow Volume; No load

Condition : Noload 50°C (122°F)	First service port	Second service port
Max. Flow Volume Theoretical LPM (GPM)	100 (26.4)	67 (17.7)
Max. Pressure at beach MPa (kgf/cm^2)[psi]	20.6 (210)[2987]	20.6 (210)[2987]
machine set pressure MPa (kgf/cm^2)[psi]	20.6 ± 0.3 (210 ± 3) [2988 ± 44]	20.6 ± 0.3 (210 ± 3) [2988 ± 44]



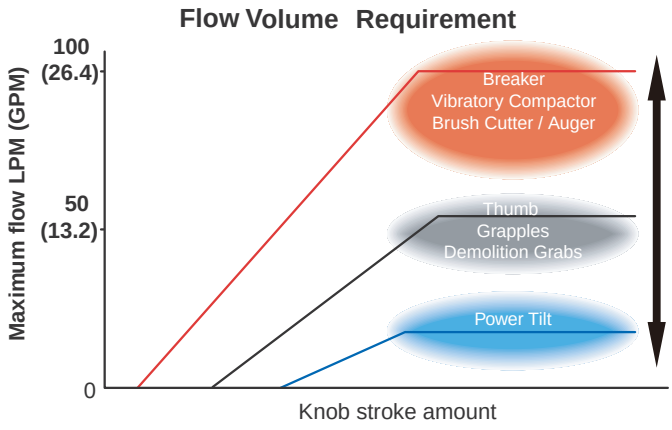




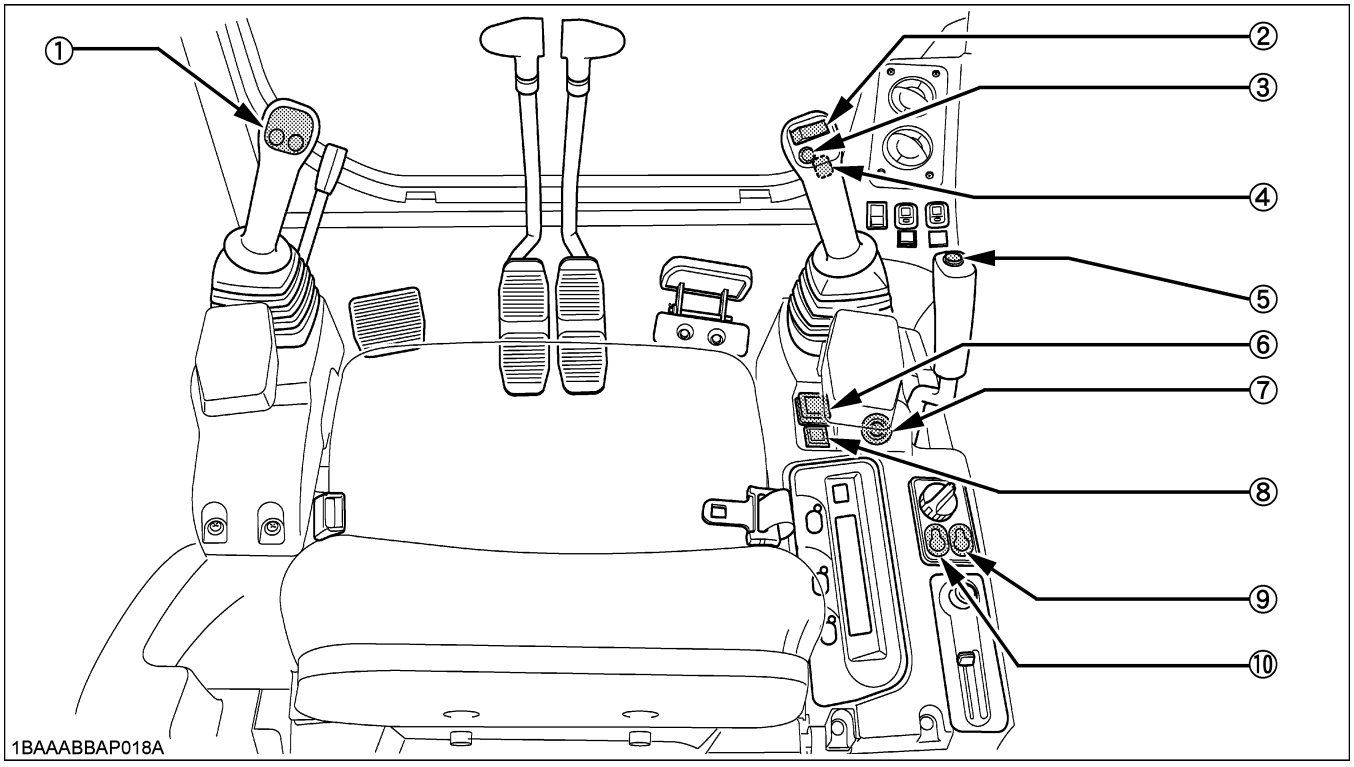
9. Second service port operation

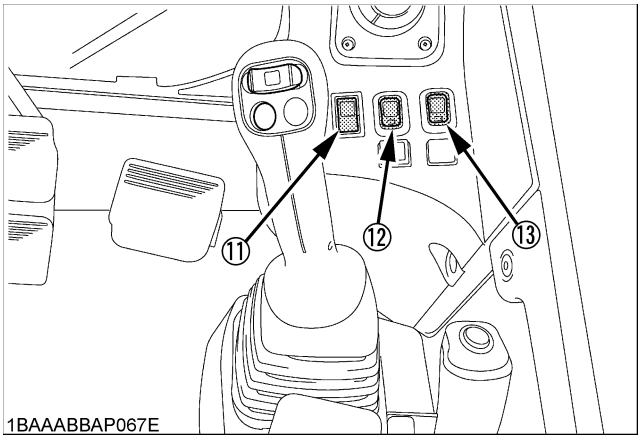
S/N ~

1.Turn the starter key to the "RUN" position.
2.Lower the lock lever.
3.Push the service port activation switch (4).
4.Press the right switch (A) to send oil to the port ❶.
5.Press the left switch (B) to send oil to the port ❷.
- Proportional control is not possible.

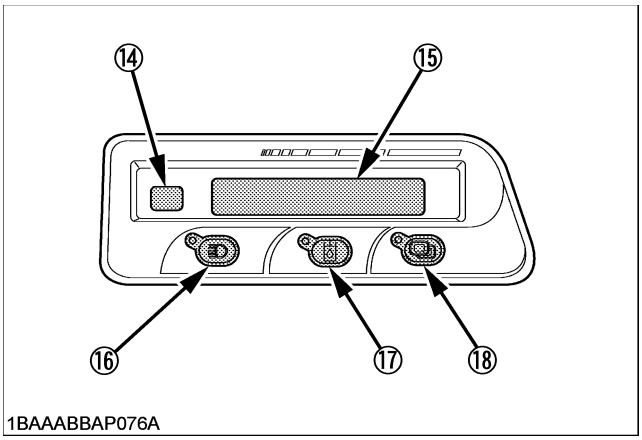


10.Instrument panel, switch





Depicted contents
(1) Second service port switch
(2) First service port switch
(3) Horn switch
(4) One way hold lock switch
(5) Two travel speed switch
(6) Beacon light switch
(7) Starter switch
(8) Two speed indicator light
(9) Flow volume setting switch

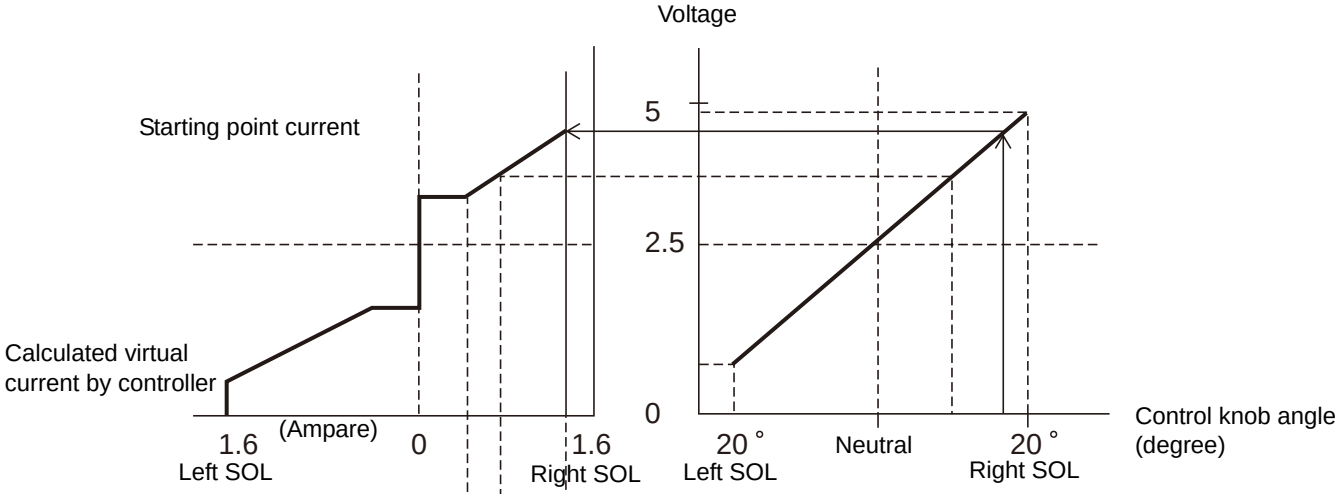


(10)Switch for Auto idle control
(11)Wiper / Washer switch
(12)Cab light switch
(13)Overload warning switch
(14)Warning lamp
(15)LCD display
(16)Working light switch
(17)Service port activation switch
(18)Display selector switch

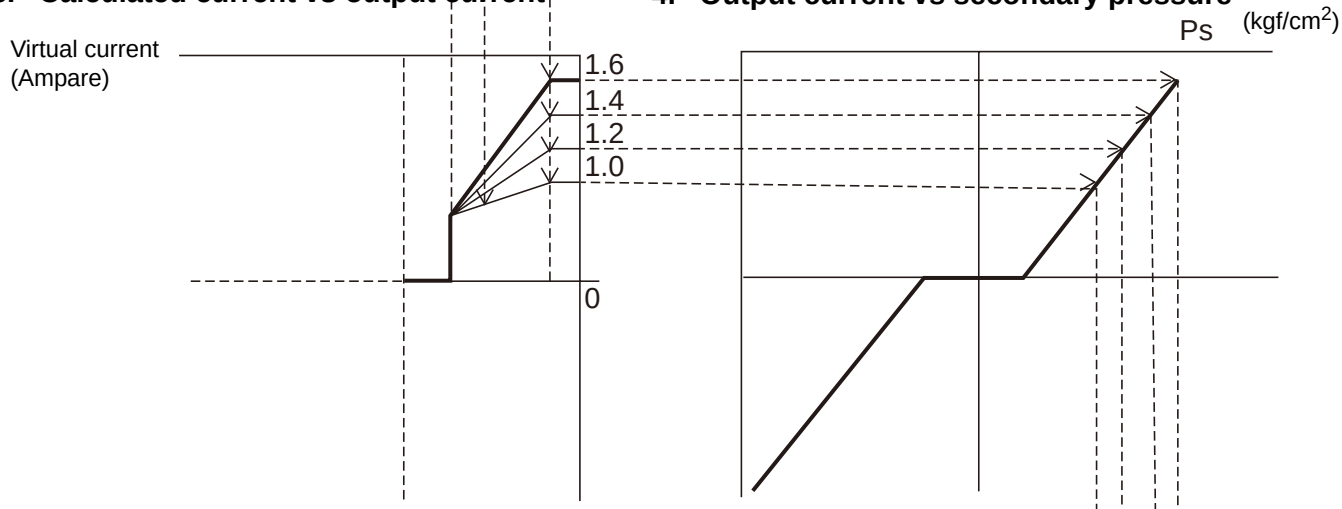
11.FYI (For Your Information)

To those who want to know more about the funetional relationship.
Following charts show the theoretical approach to recognize the principle of 15-stage speed limit control
Basic concept of 10-stage speed limit control is the same..

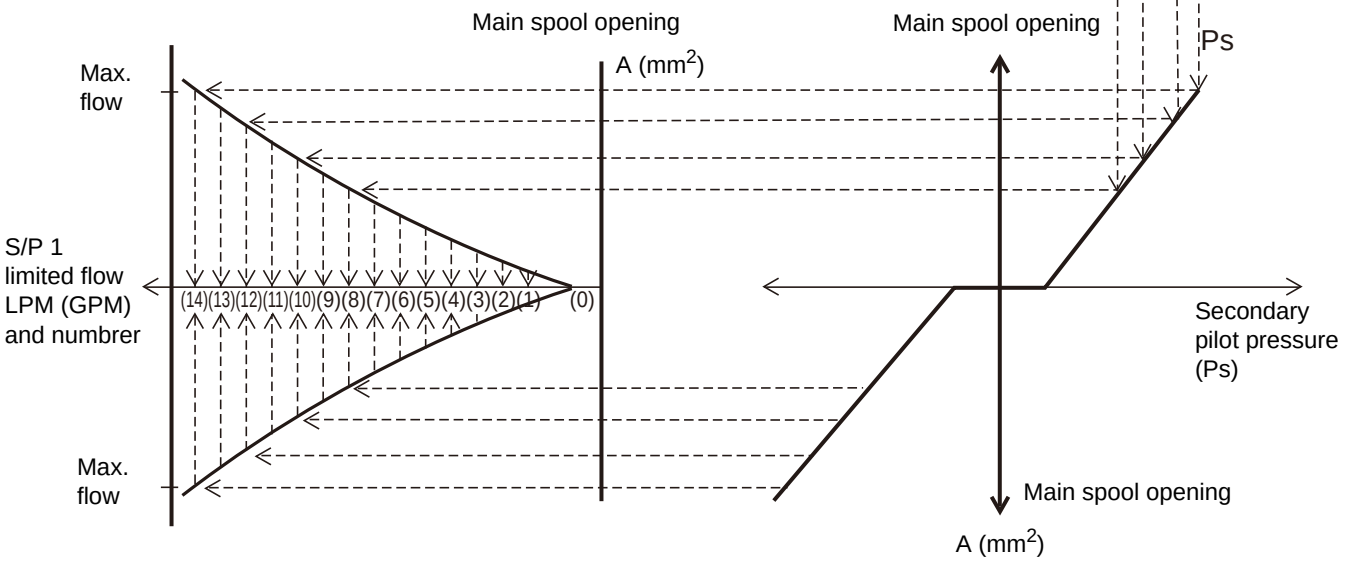
2. Output voltage vs current calculated **1. Control knob vs output voltage**



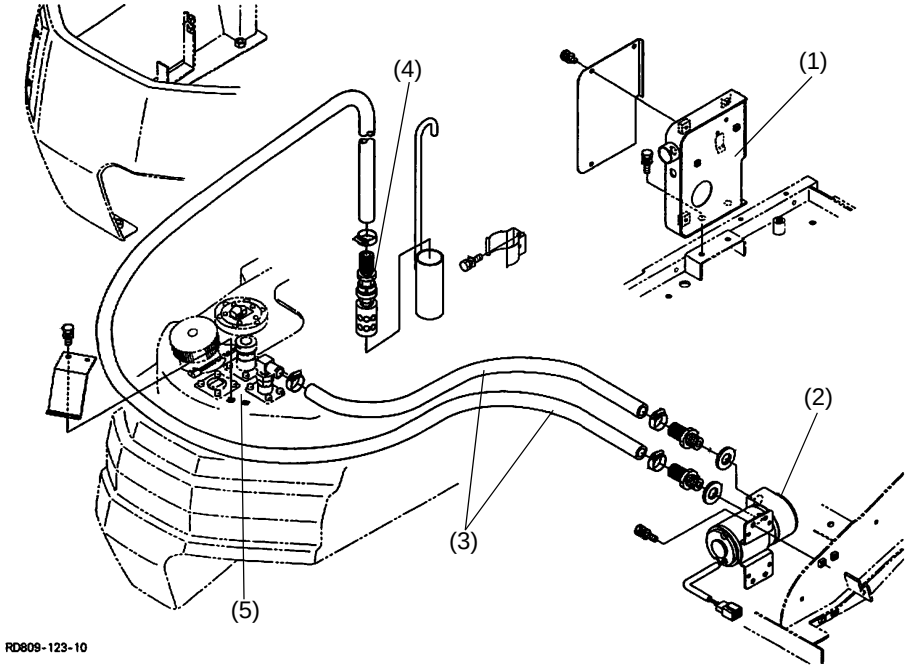
3. Calculated current vs output current **4. Output current vs secondary pressure**



6. Main spool opening vs S/P 1 limited oil flow **5. Secondary pilot pressure vs main spool opening**

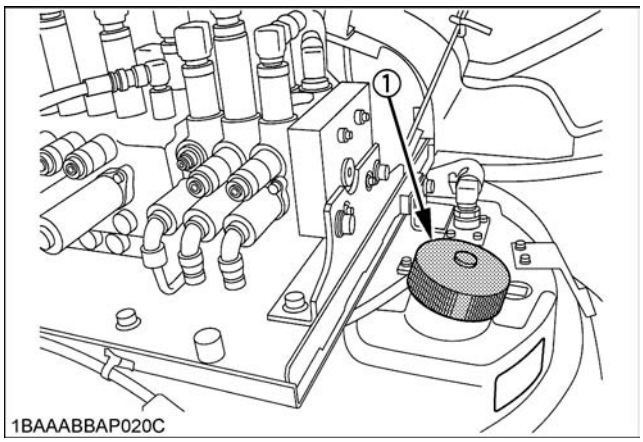


d. Fuel supply pump



1. Main parts

(1) Control box
(2) Fuel supply pump
(3) Hoses
(4) Suction inlet and filter
(5) Fuel tank



(1) Fuel tank cap

2. How to use

DANGER

To avoid serious injury or death:

- Do not use the fuel supply pump for gasoline or hydraulic oil. Doing so could result in explosion or damage. Only use the fuel supply pump for diesel fuel.

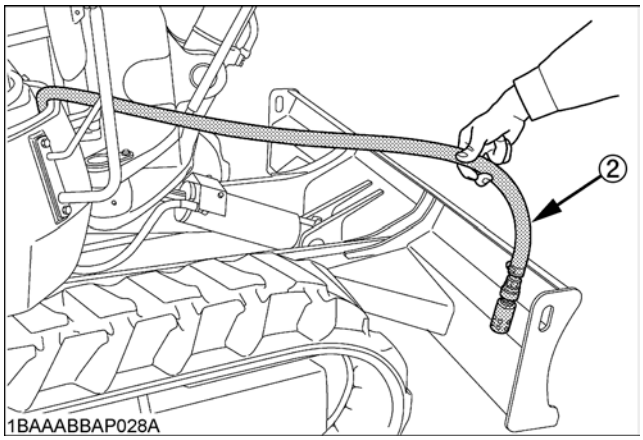
CAUTION

To avoid personal injury:

- When the fuel supply pump is used, be sure to open the fuel tank cap.

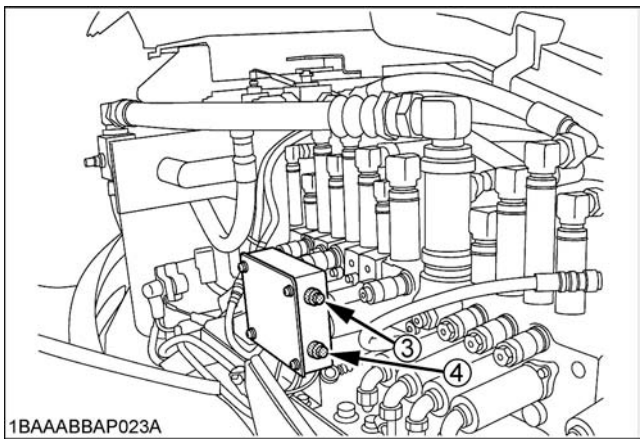
This device automatically supplies fuel to the fuel tank and stops automatically when the fuel tank is full.

1. Open the tank cover.
2. Open the fuel tank cap (1).



(2) Pump’s nozzle

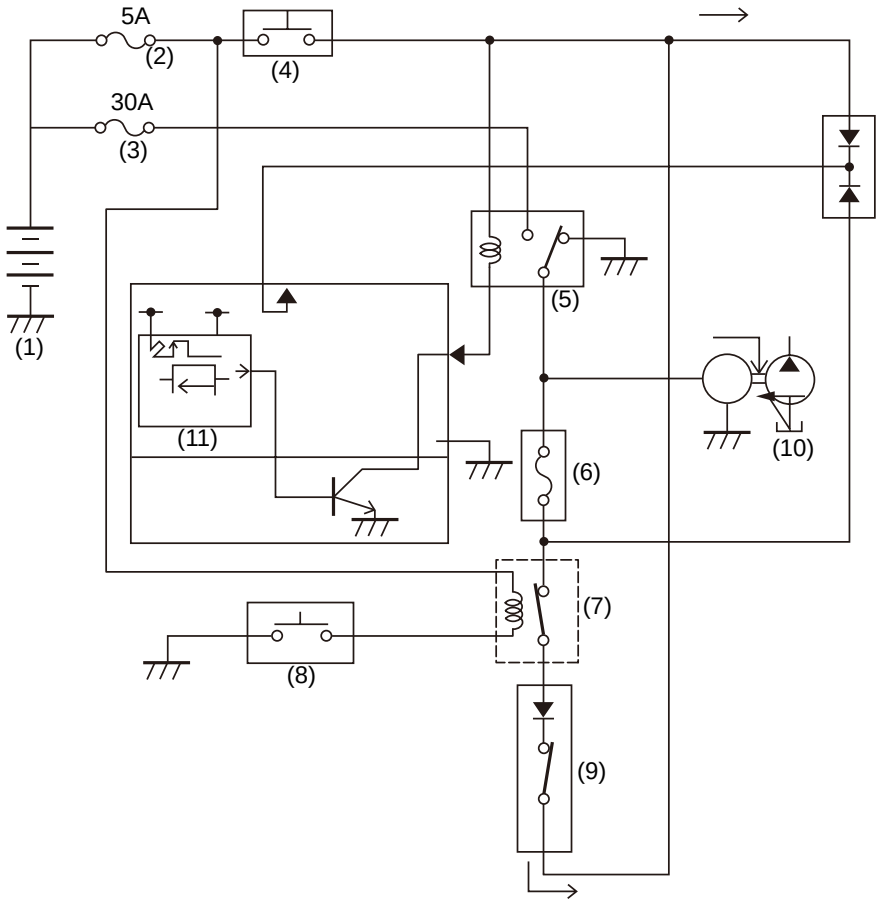
3. Insert the pump's nozzle (2) in the fuel supply tank.



(3) Switch (black button)
(4) Switch (red button)

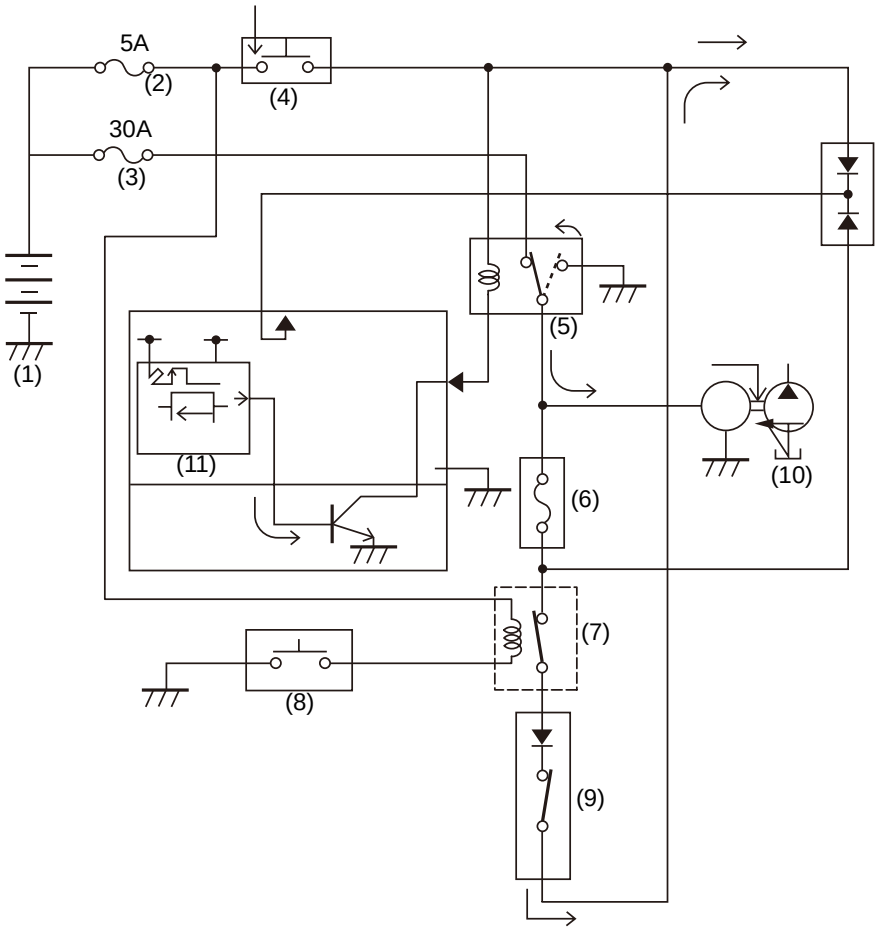
4. Push the switch (black button (3)). The pump stops automatically once the fuel tank is full. To stop the pump on the way, the switch (red button (4)) is pushed.

3. Electrical system function



3-1 Circuit diagram

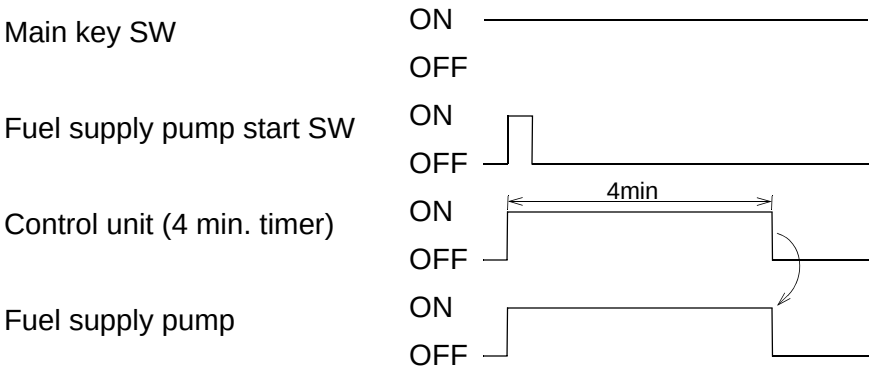
(1) Battery, 12 V
(2) Mini-fuse, 5 A
(3) SBF (slow blow fuse), 30 A
(4) Start switch
(5) Relay 1
(6) Mini-fuse, 5 A
(7) Relay 2
(8) Stop switch
(9) Fuel level sensor
(10) Fuel supply pump
(11) 4 min. timer relay

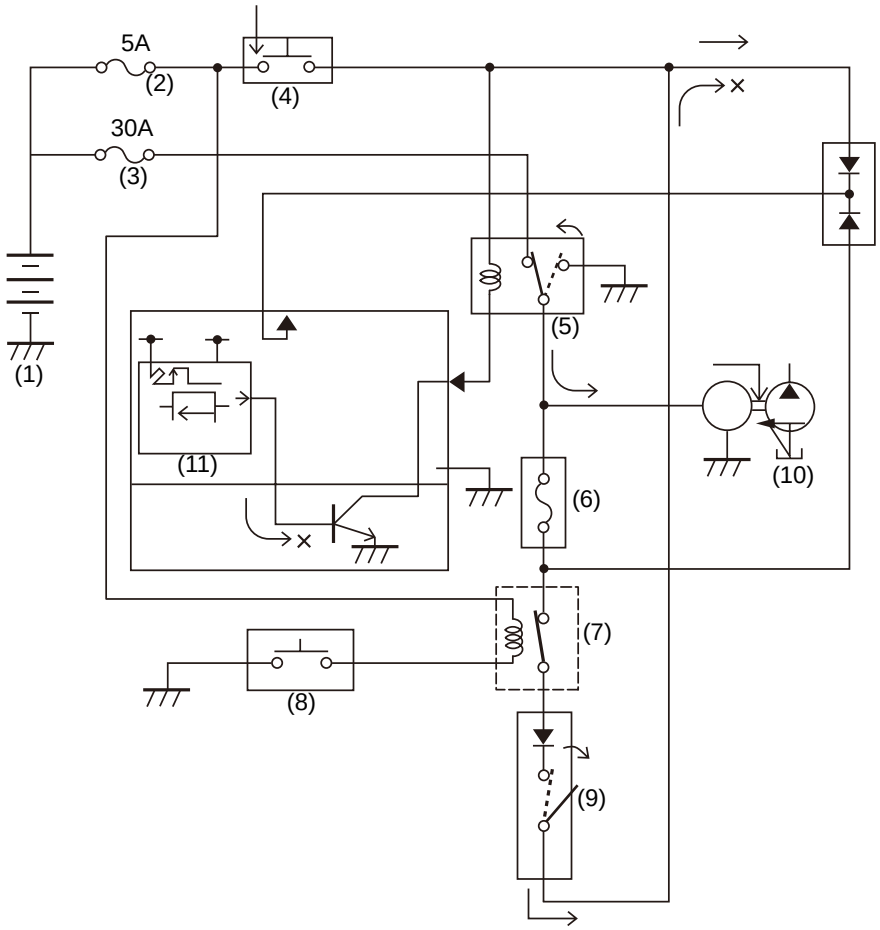


3-2 When the start switch is pushed:

(1) Battery, 12 V
(2) Mini-fuse, 5 A
(3) SBF (slow blow fuse), 30 A
(4) Start switch
(5) Relay 1
(6) Mini-fuse, 5 A
(7) Relay 2
(8) Stop switch
(9) Fuel level sensor
(10) Fuel supply pump

Function chart



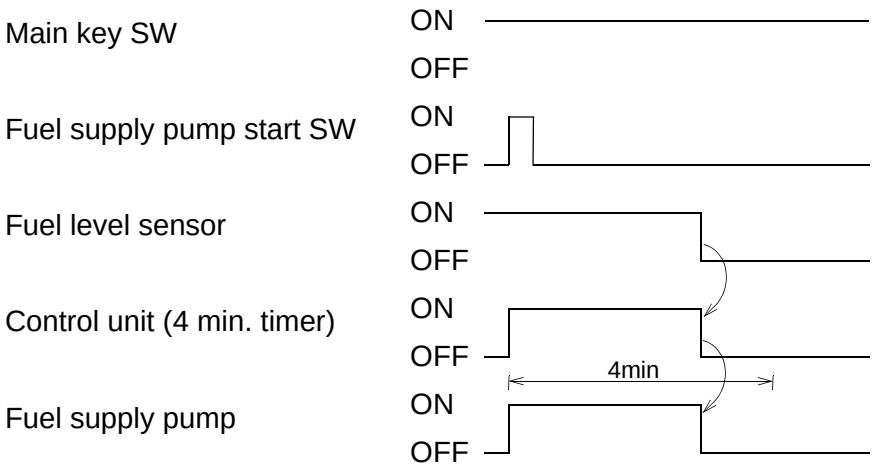


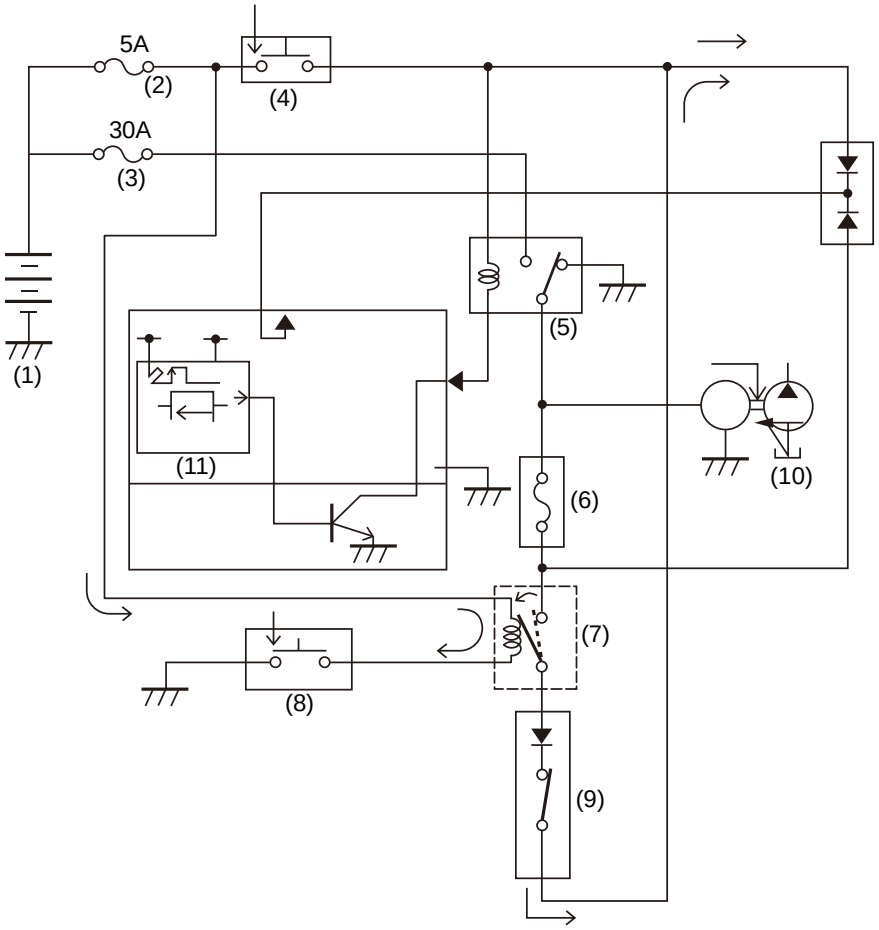
3-3 When fuel level sensor detects the full amount of fuel;

Without the battery voltage, 4 min. timer turns off condition.

(1) Battery, 12 V
(2) Mini-fuse, 5 A
(3) SBF (slow blow fuse), 30 A
(4) Start switch
(5) Relay 1
(6) Mini-fuse, 5 A
(7) Relay 2
(8) Stop switch
(9) Fuel level sensor
(10) Fuel supply pump

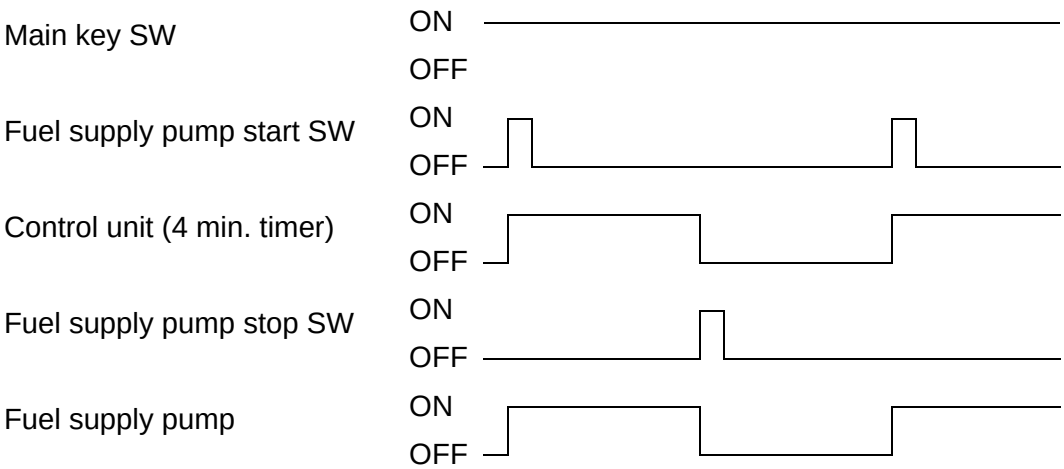
Function chart

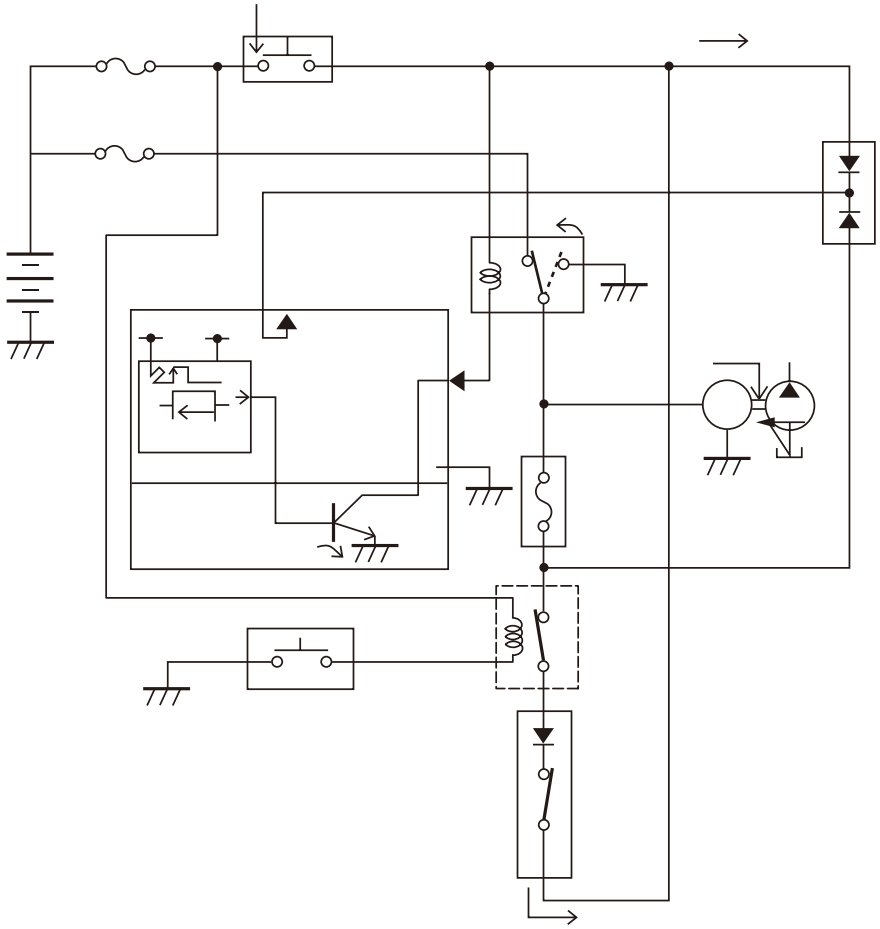




3-4 When pushing the stop switch during supplying the fuel;

Function chart



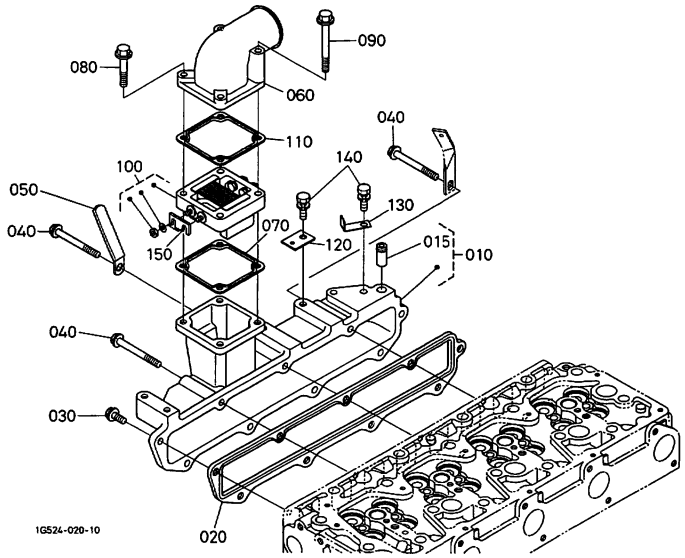


3-5 When pushing the start switch after the full fuel level;

e. Intake air heater control

1. Location of main components





2. Outline of control system

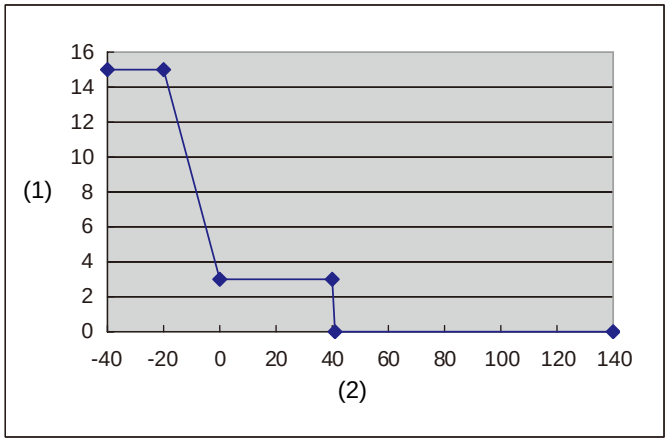
2-1. Control points

Pre-heating is automatically made according to the engine's water temperature at a cold starting. Once the engine has got started, the post-heating is also controlled to prevent bluish-white smoke.

2-2. Control system

- Auto glow : Water temp. vs Glow time

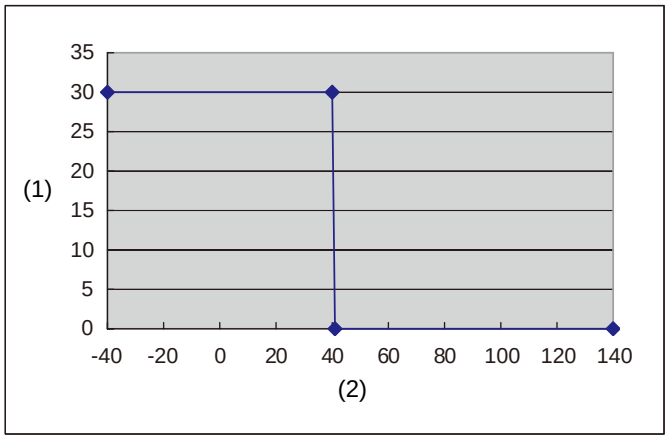
Water temp [°C]	Glow time [s]
-40	15
-20	15
0	3
40	3
41	0
140	0



(1) Water temp [°C]
(2) Glow time [s]

- After glow : Water temp. vs Glow time

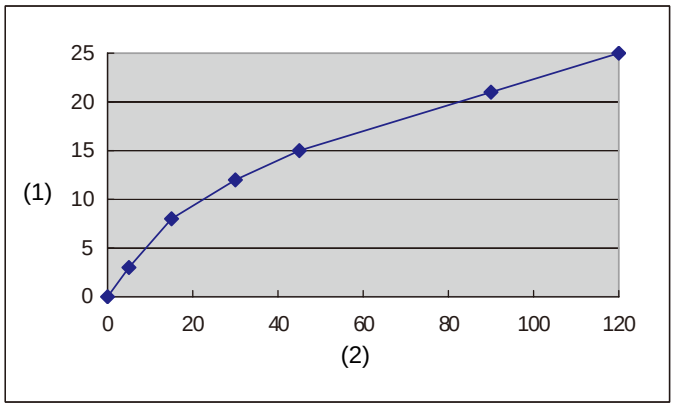
Water temp [°C]	Glow time [s]
-40	30
40	30
41	0
140	0



(1) Water temp [°C]
(2) Glow time [s]

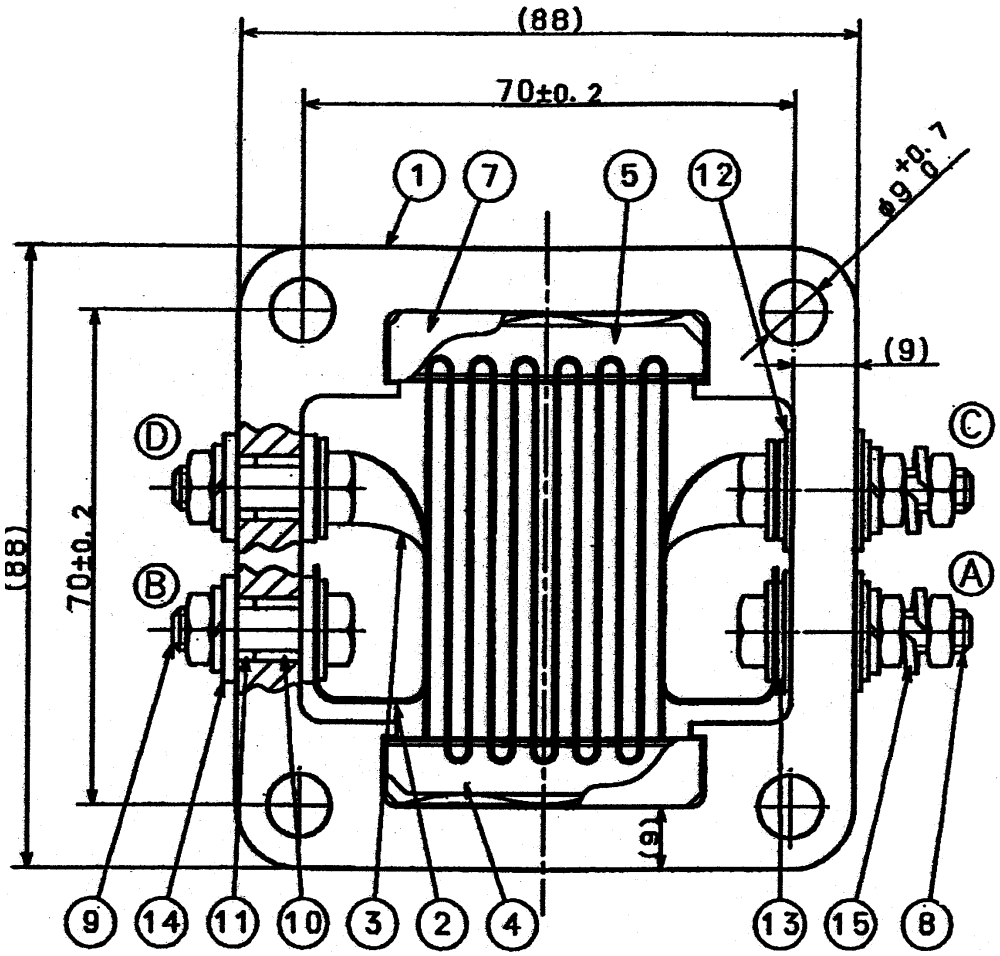
- Key - off : time vs Glow time

Key - off time [s]	Max. Glow time [s]
0	0
5	3
15	8
30	12
45	15
90	21
120	25

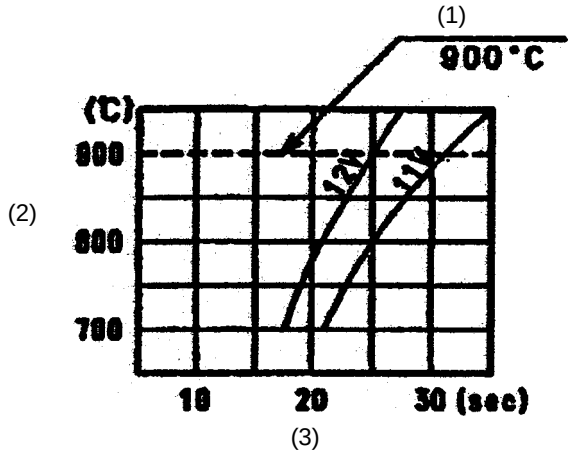


(1) Max. Glow time [s]
(2) Key - off time [s]

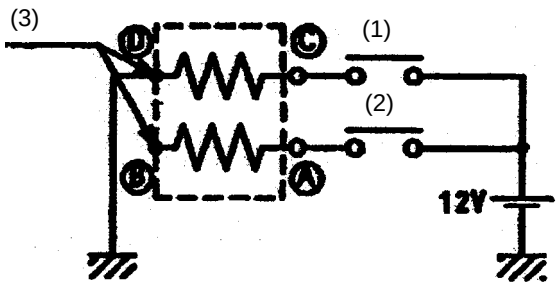
2-3. Air intake heater



(1) Heater body
(2) Heater element
(3) Heater element
(4) Heater element
(5) Insulater



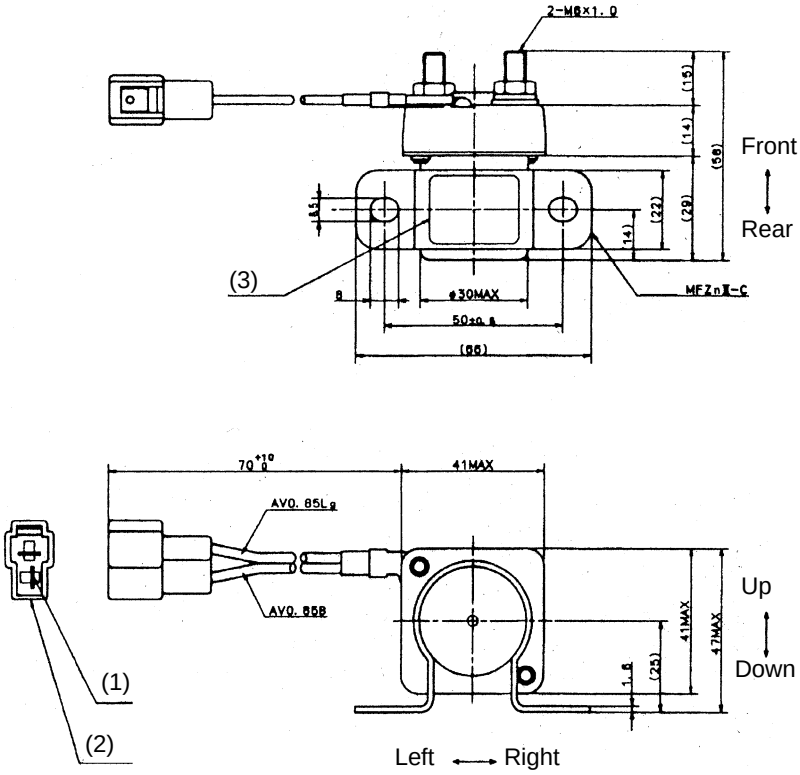
(1) Max. limit temperature
(2) Heater temperature
(3) Time



(1) Relay 1
(2) Relay 2
(3) Body earth

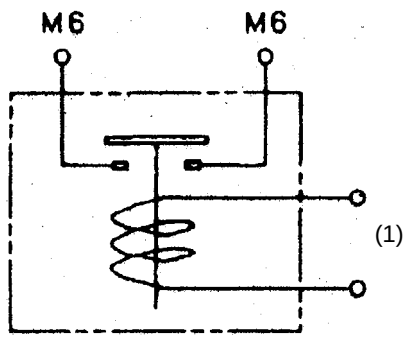
2-4. Air intake heater relay (Code : No. N300-75211)

1) Outer view



2) Drawing

(1) Terminal
(2) Housing
(3) Label : Gray

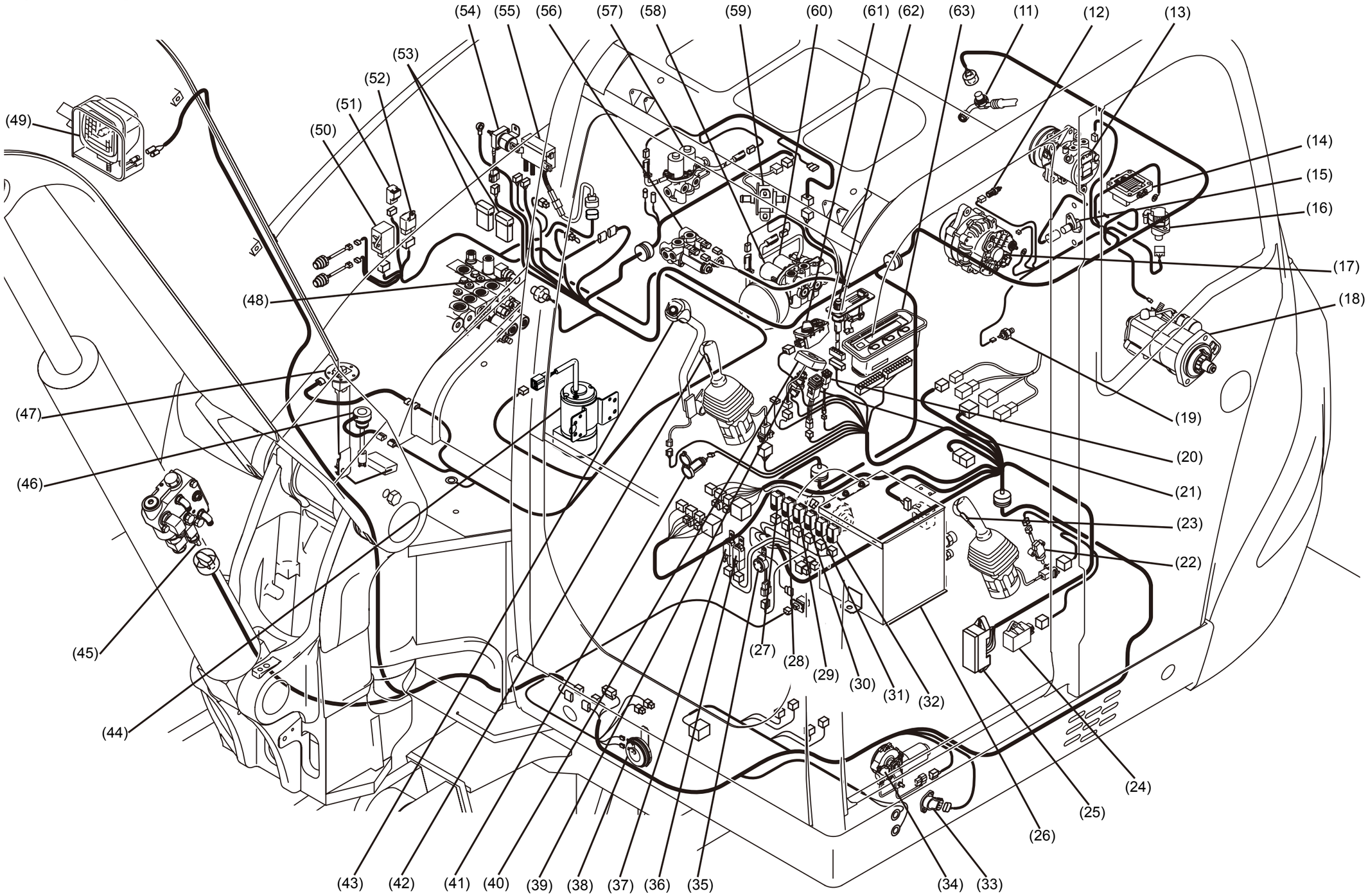


3) Diagram

(1) Connecter

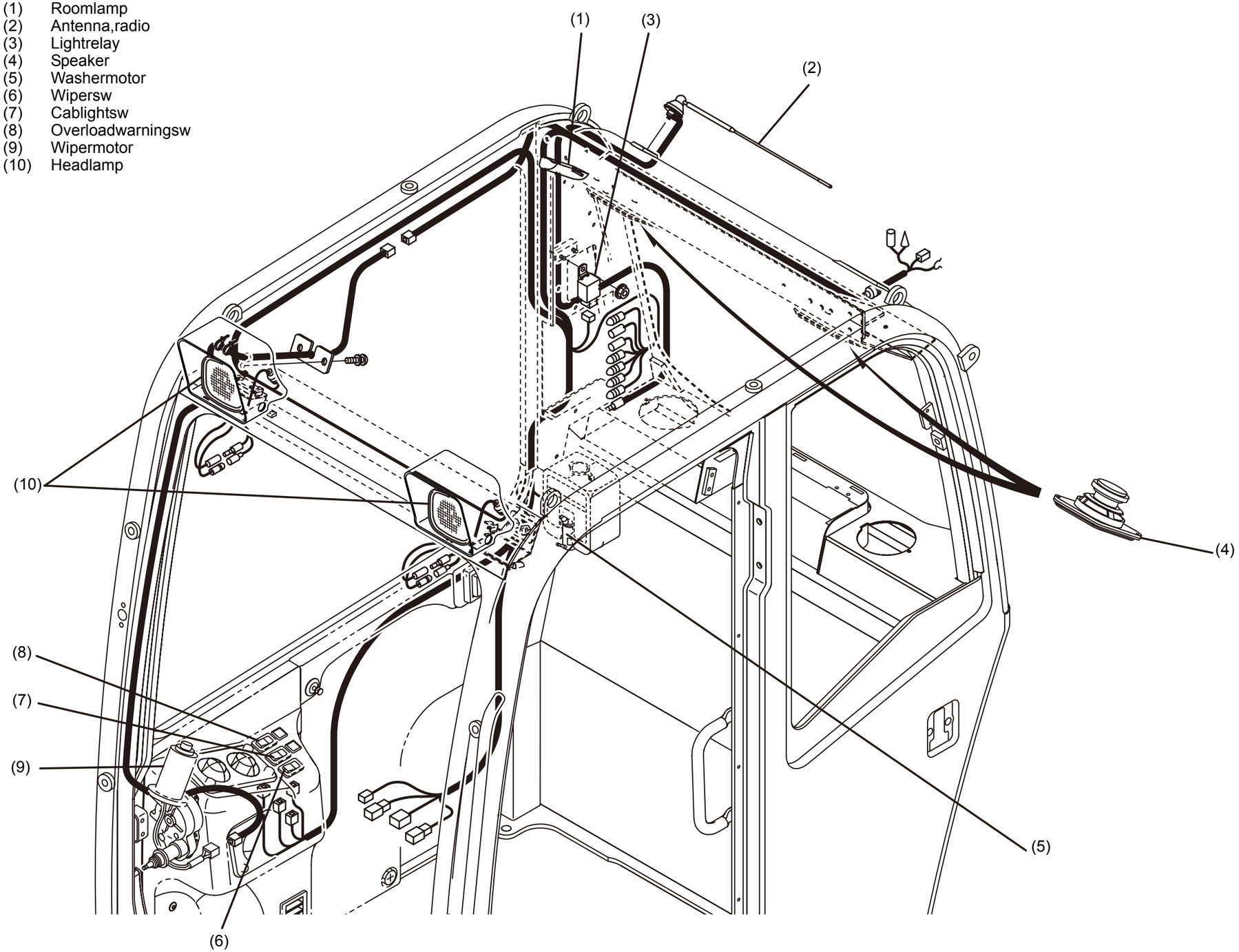
B.Electrical components and circuit diagram

a. Components layout



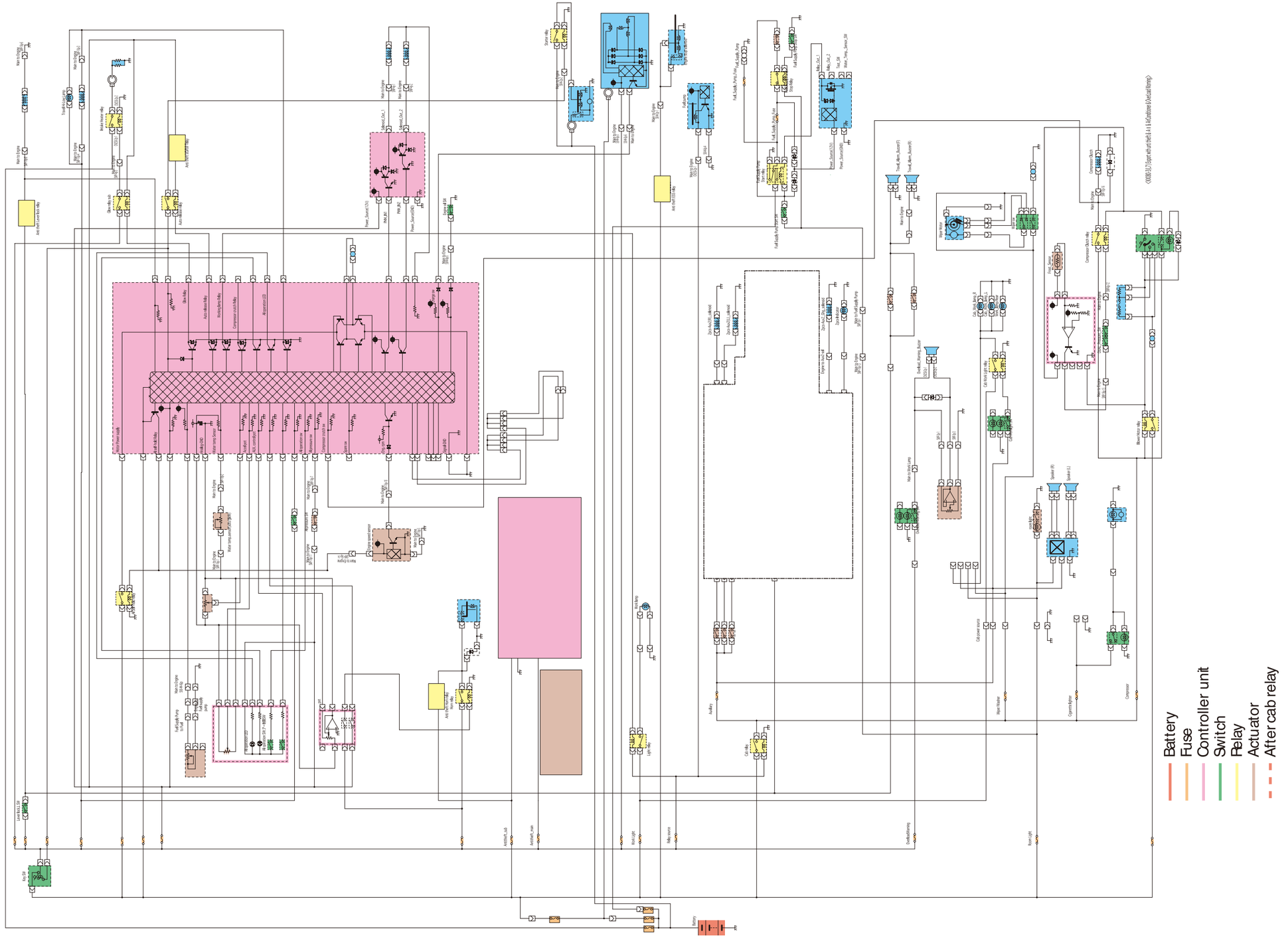
V-M-29

(1) Roomlamp
(2) Antenna,radio
(3) Lightrelay
(4) Speaker
(5) Washermotor
(6) Wipersw
(7) Cablightsw
(8) Overloadwarningsw
(9) Wipermotor
(10) Headlamp

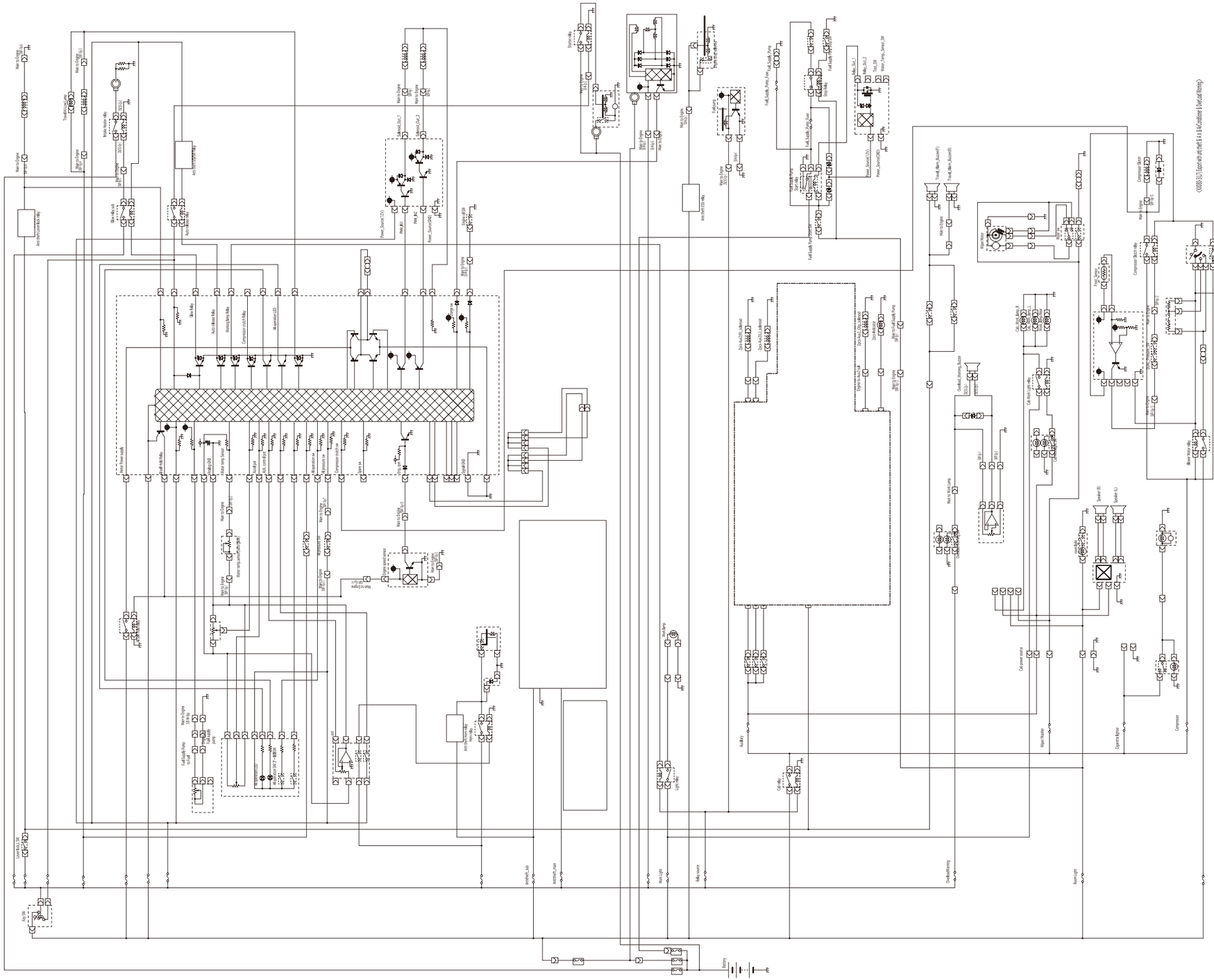


(11) Dualpressuresw
(12) Watertemp.sensor
(13) Compressor,A/C
(14) Intakeairheater
(15) Enginespeedsensor
(16) Enginestopsolenoid
(17) Alternator
(18) Startermotor
(19) Engineoilsw
(20) TravelHi-Lamp
(21) Beaconlightsw
(22) Leverlocksw
(23) S/P2sw
(24) Amp.unit
(25) Fusebox
(26) A/Cunit
(27) Glowrelay
(28) Cabreley
(29) Aotoreleaserelay
(30) Hornrelay
(31) Lightrelay
(32) Alrelay
(33) Governersensor
(34) Almotor
(35) Buzzer
(36) Blowerrelay
(37) Clutchrelay
(38) Horn
(39) Mainkey
(40) Antenna(A/T)
(41) Poweroutlet
(42) S/P1controlsw
(43) TravelHi-lowsw
(44) Fuelsupplypump
(45) Overloadpressuresw
(46) Fuelresidualleadsw
(47) Fuelsensor
(48) Alpressuresw
(49) Workinglamp
(50) ECU(4min.timer)
(51) Fuelpumpstarterrelay
(52) Fuelpumpstoprelay
(53) SBF(slowblowfuse)
(54) Intakeheaterrelay
(55) Fusebox
(56) S/P1solenoid
(57) S/P2solenoid
(58) Unloadsolenoid
(59) Fuelpump
(60) Hi-Lowsolenoid
(61) Accelsensor(Alswitch)
(62) A/Cswitch
(63) Meterpanel

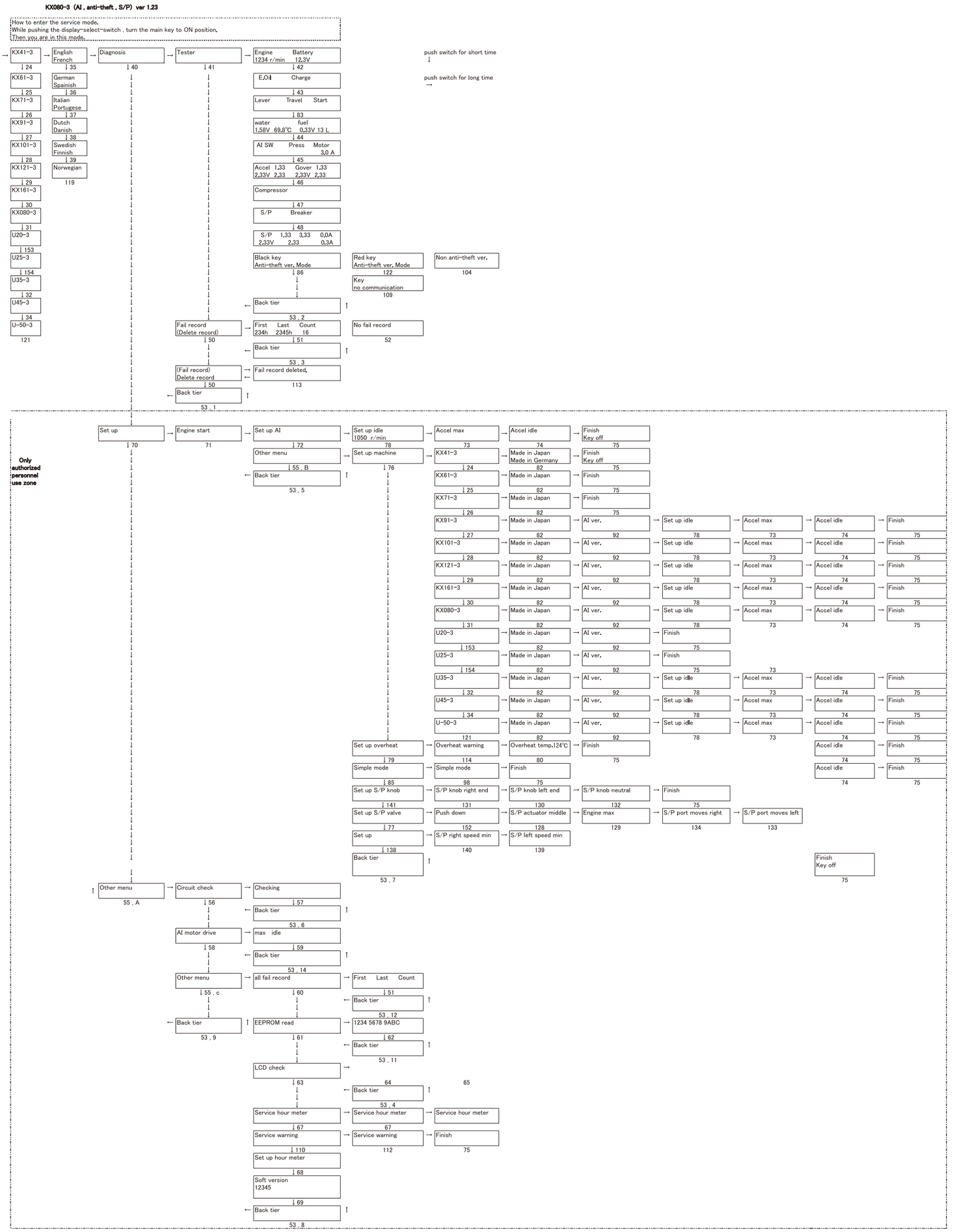
b. Main components diagram



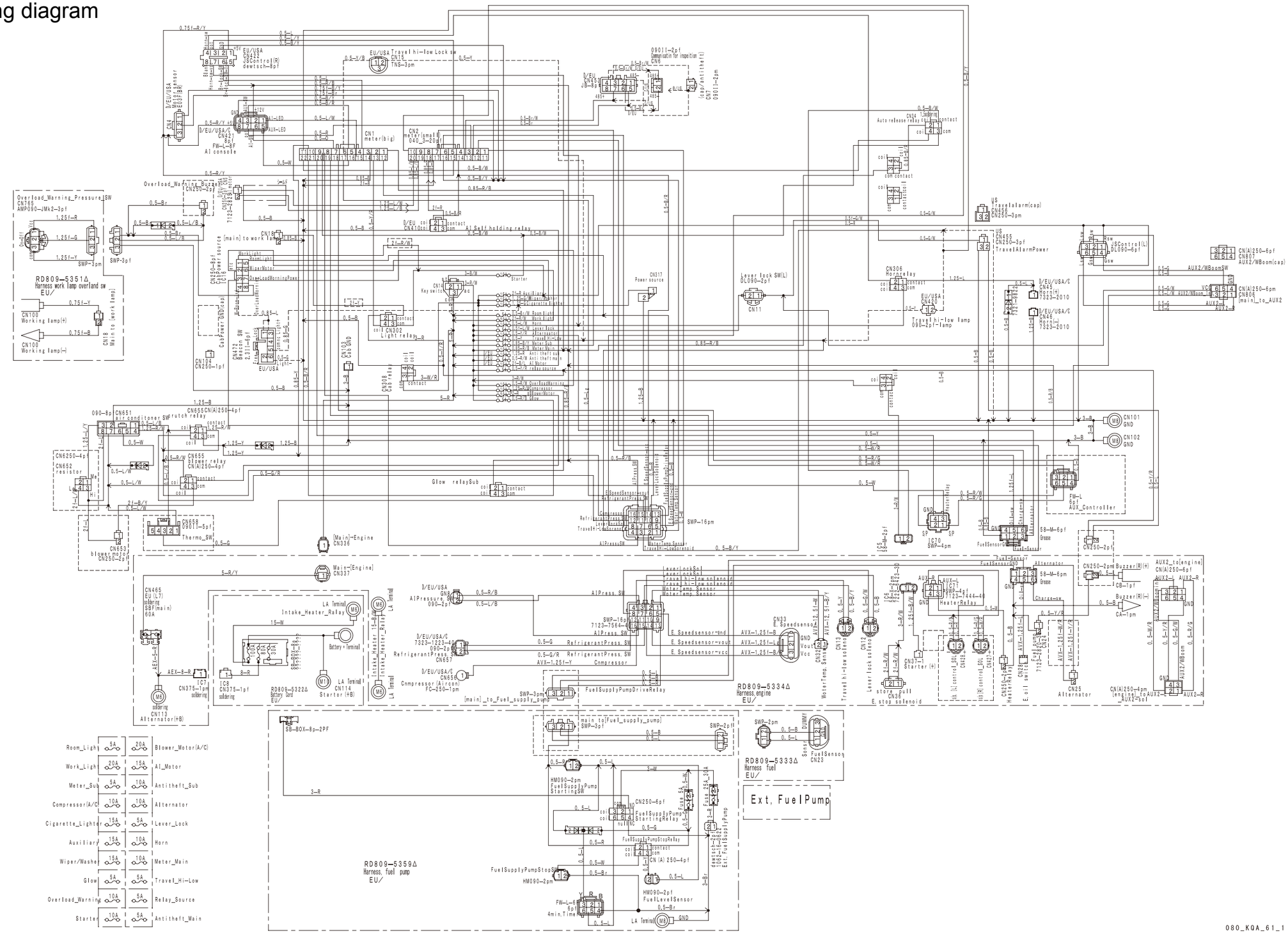
c. Electrical circuit diagram



d. Service mode flow chart



e. Electrical wiring diagram



VI. Air Conditioner

Mechanism Section

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A.Air conditioner system

a. Introduction of air conditioner

(1) Principle of air conditioner

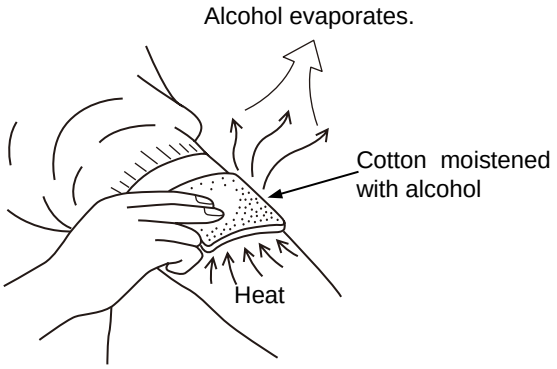
When your hand is wet and exposed to the wind or when you disinfect your hand with alcohol, you should feel your skin being cooled. This is because water or alcohol draws heat from your skin when it evaporates.

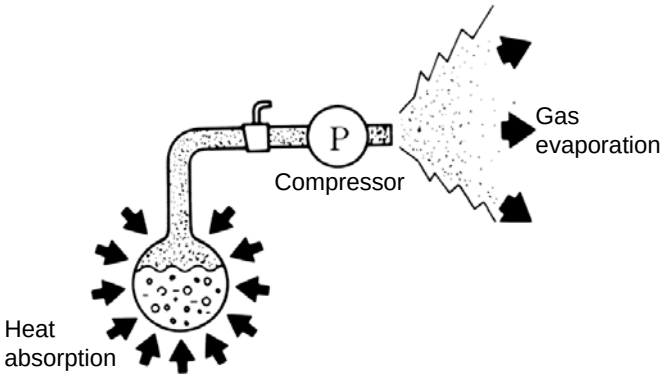
Air conditioners operate on this principle, using "Freon" as a refrigerant instead of water and alcohol.

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.

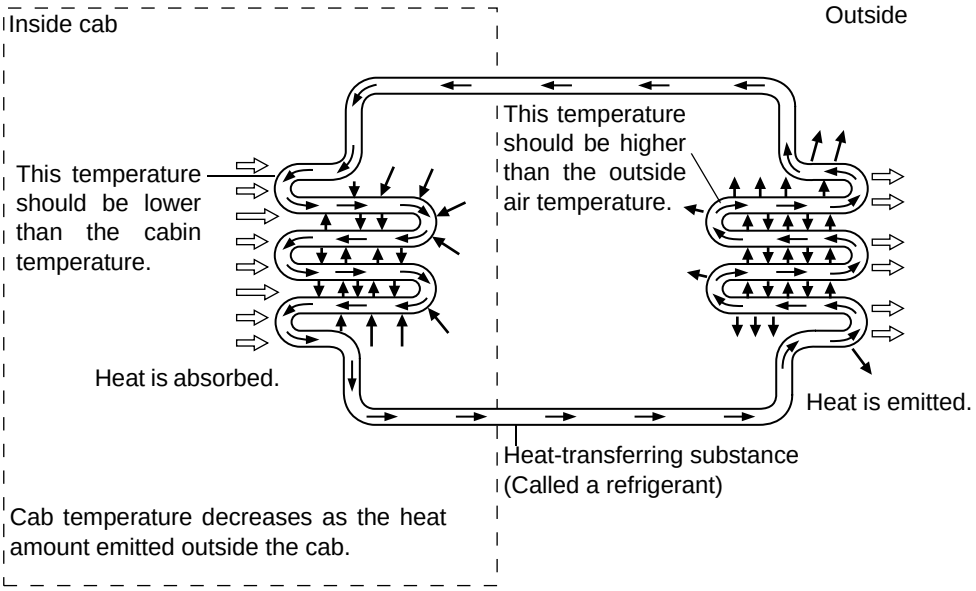
Trying to emit heat out of the vehicle in hot summer when the temperature outside the vehicle is higher than inside is to fight against the natural phenomenon. It seems that man likes to fight against nature and has been accumulating wisdom and expending enormous efforts to do so.

The air conditioner is the fruit of man's wisdom, which is a device that consumes important energy accordingly.





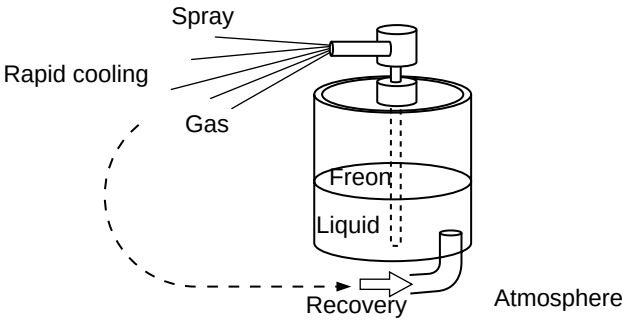
Cooling the cabin of the vehicle means emitting heat out of the vehicle. The air conditioner is a device to absorb heat in the cabin and emit it out of the vehicle.



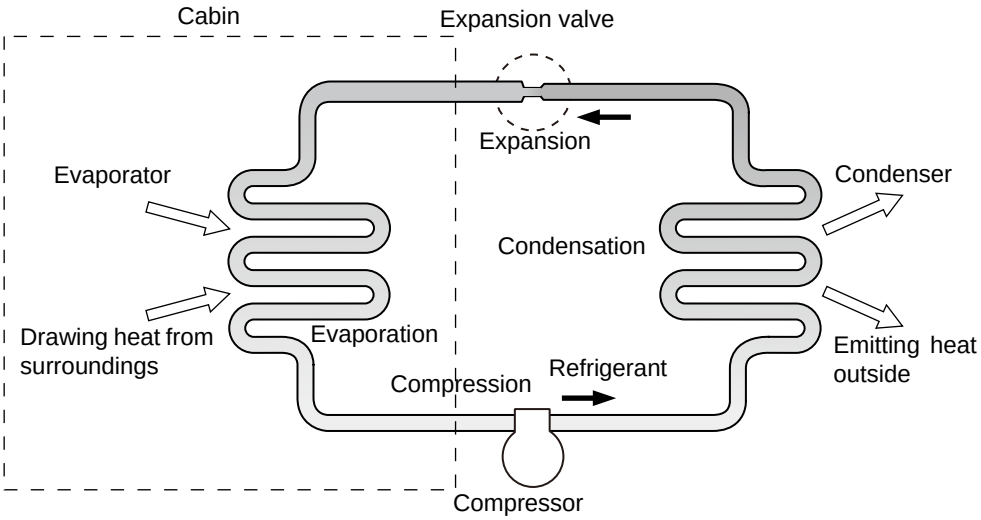
The figure in the left shows the principle of the air conditioning system to lower the temperature of the cabin by emitting heat out of the vehicle. Because heat transfers from high temperatures to low temperatures, the temperature in the piping should be lower than the cabin temperature inside the vehicle 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.

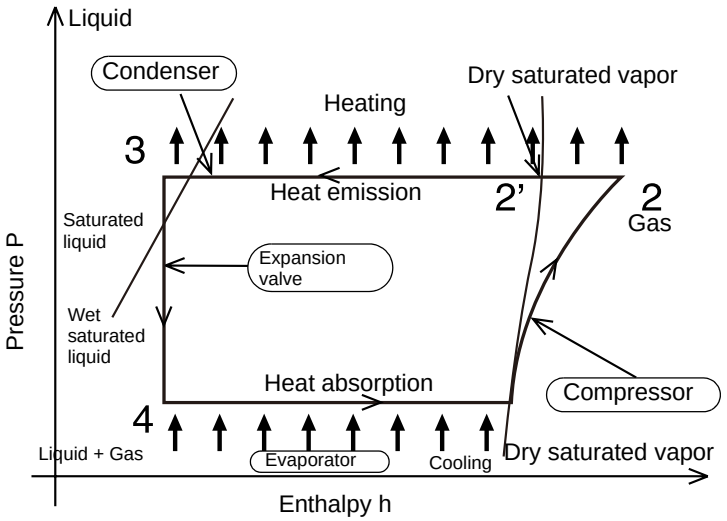


The temperature of the refrigerant should be lower than the cabin temperature inside the vehicle and higher than the atmospheric temperature outside the vehicle. As a refrigerant (heat-exchanging medium), Freon is used which makes it possible to provide such temperature changes relatively easily.



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.



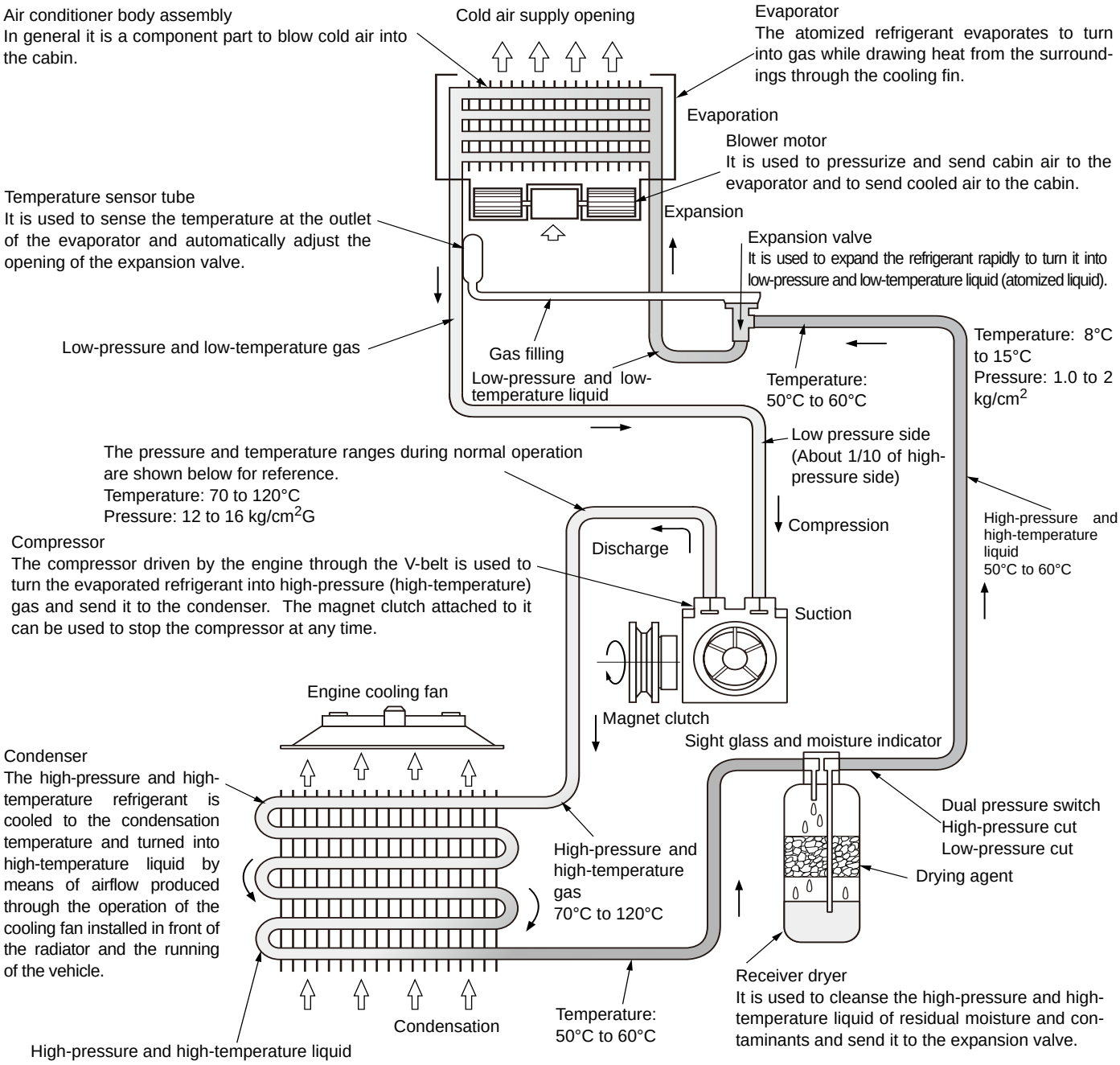
- 1: Dry vapor
  1→2: Adiabatic compression by means of compressor
- 2: Superheated vapor
  2→2'→3: Isobaric change by means of condenser (condensation through heat emission)
- 3: Saturated liquid
  3→4: Isoentropic change by means of expansion valve (restriction phenomenon)
- 4: Wet vapor
  4→1: Isobaric and isothermal change by means of evaporator (evaporation through heat absorption)

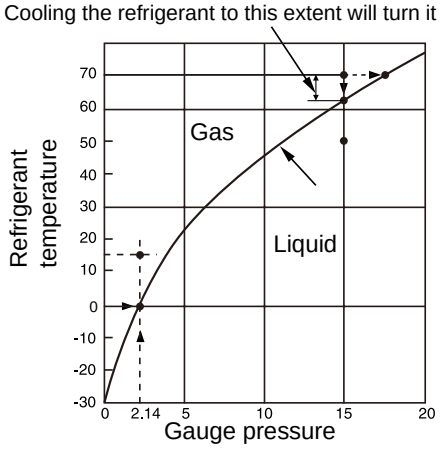
The cycle is thus completed.

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.



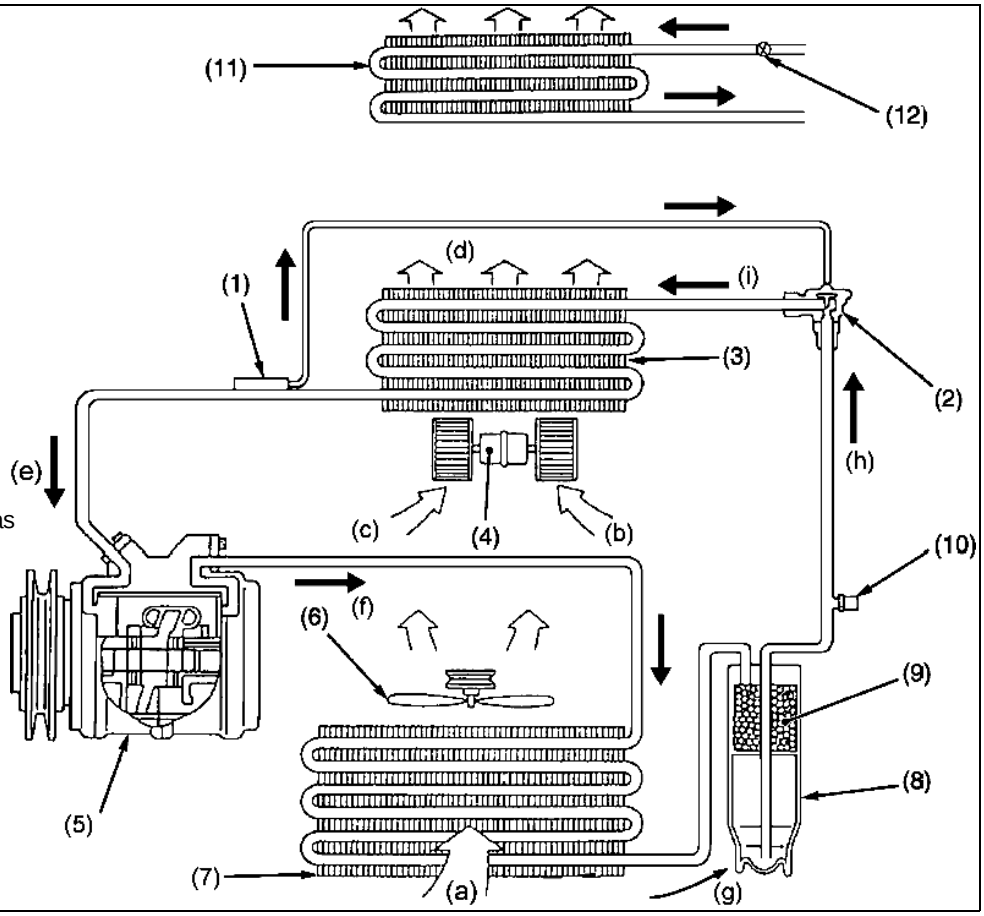


The characteristics of the refrigerant used so far are as follows. When the gasified refrigerant is compressed to 15 kg/cm^2 , its temperature becomes 70ºC. Then, when the refrigerant is cooled to less than 60ºC (which means the refrigerant emits 10ºC or more of heat), it turns into liquid. When the pressure is reduced to less than 2.14 kg/cm^2 , it turns back into gas at 0ºC.

b. Function and structure

(1) System flow

(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. 1.47Mpa (15kgf/cm^2, 213 psi) and is also raised in temperature to approx. 70ºC (158ºF) and delivered to the condenser (7).
2) The gaseous refrigerant is cooled down through the condenser (7) to approx. 50ºC (122ºF) 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 0ºC (32ºF) 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.

(2) 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.

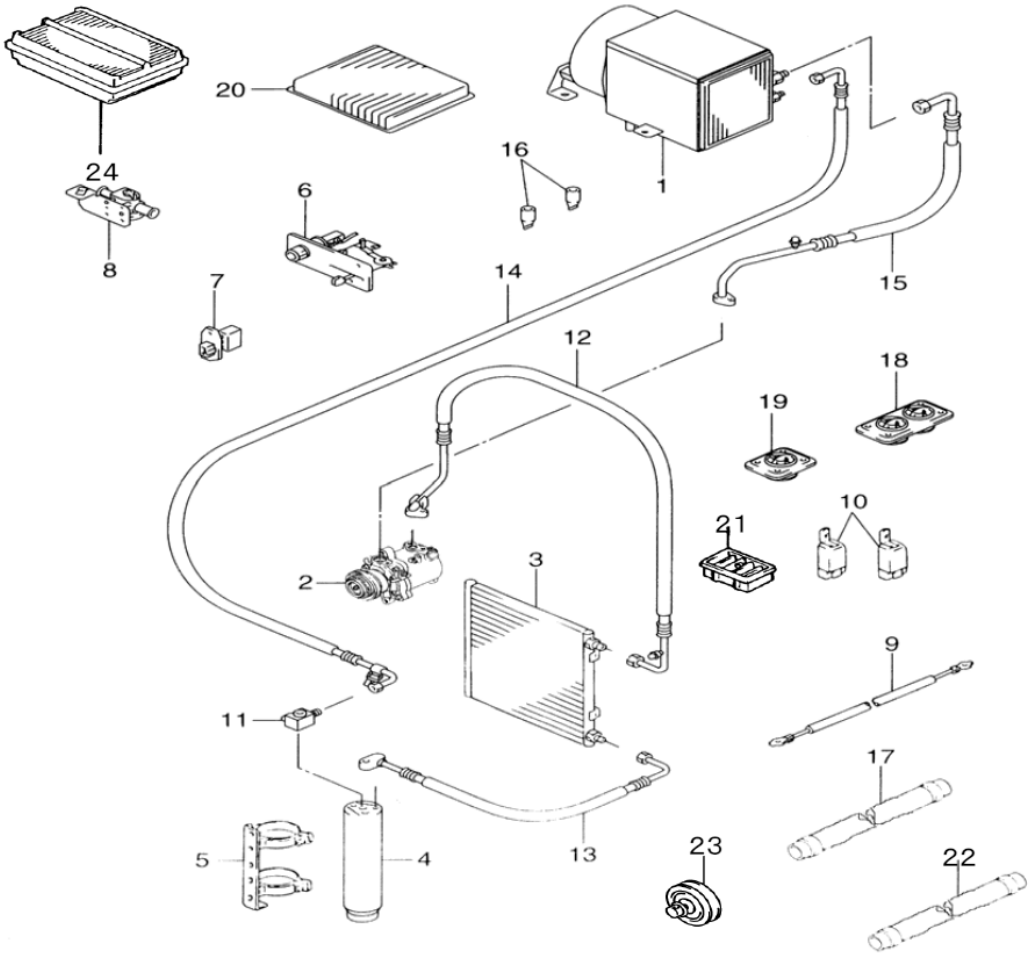
Before the liquefied refrigerant is sent to the evaporator, its pressure is reduced to a state in which it can be easily evaporated, which is called an expansion process. The expansion valve used for this process performs flow control of the refrigerant as well as pressure reduction.

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.

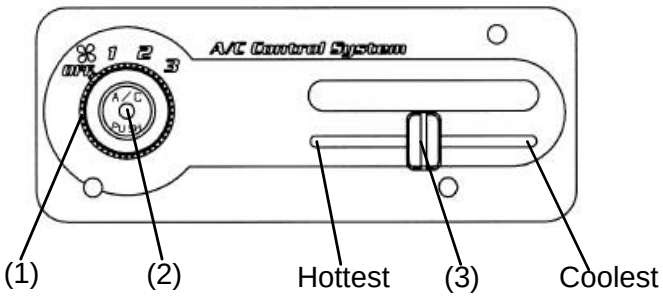
B.System components; KX080-3

a. Components and location



No.	Part name	KX121-3, KX161-3	Qty	KX080-3	Qty	Remarks
1	Unit assembly, air conditioner	RD118-53703	1	RD809-53702	1	Thermostat→ Fin thermistor
2	Compressor assembly, with clutch	T2055-72253	1	←	1	
3	Condenser	T1065-72221	1	←	1	
4	Tank, receiver	T0070-79271	1	←	1	
5	Holder, receiver	T0070-79281	1	←	1	
6	Control assembly, air conditioner	RD118-53611	1	←	1	
7	Resistor, blower	T1065-72181	1	←	1	
8	Valve assembly, water	T0270-67501	1	←	1	
9	Cable, control	RD118-47451	1	RD809-47451	1	
10	Relay assembly	T1155-72151	2	←	2	
11	Joint assembly	T0270-87171	1	←	1	
12	Hose, discharge	RD118-47511	1	RD809-47511	1	
13	Hose, liquid	RD411-47541	1	RD809-47542	1	
14	Hose & accessory assembly	RD118-47531	1	RD809-47531	1	
15	Hose, suction	RD118-47622	1	RD809-47521	1	
16	Connector, drain	6A671-71691	2	←	3	
17	Hose, air	RB419-49282	1	68729-47141	1	For outside air intake
18	Grill assembly (for face)	3G710-50291	1	←	1	
19	Grill assembly (for def.)	RD118-47231	1	←	1	
20	Filter assembly	6A671-75091	1	—	0	
21	Grill assembly (for foot)	RD118-47221	1	←	2	Added for rear blow
22	Hose, air	—	0	RB419-49282	1	For rear blow
23	Pulley assembly	—	0	3C581-50091	1	
24	Filter assembly	—	0	T0270-67061	1	Common for inside and outside air

b. Control panel

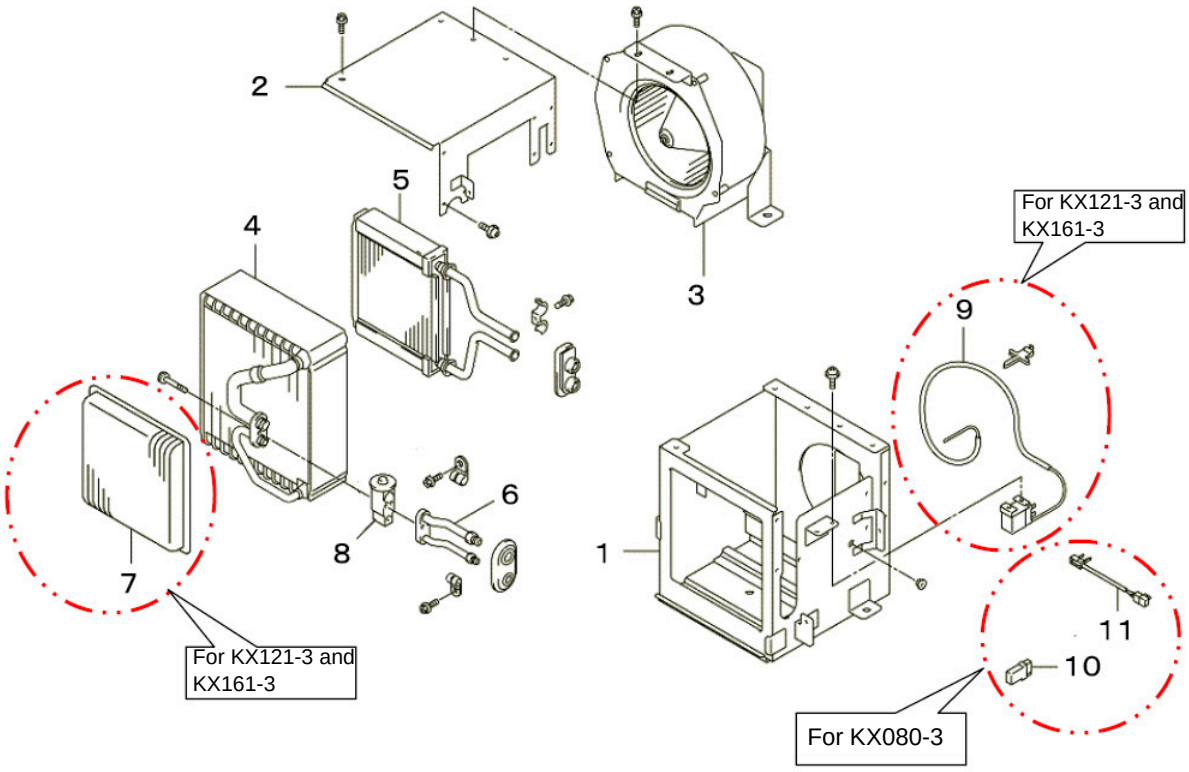


Mounted on actual machine



(1) Fan switch: Used to turn on and off the fan and to select the airflow in 3 steps.
(2) Air conditioner switch: Used to turn on the compressor to start cooling.
(3) Temperature adjusting lever: Used to adjust the blow temperature by opening and closing the hot-water valve via cable.

c. Air conditioner unit



No.	Part name	Remarks
1	Case sub-assembly (bottom case)	
2	Case sub-assembly (top cover)	
3	Blower assembly	
4	Evaporator assembly	
5	Core sub-assembly, heater	
6	Tube & accessory	
7	Filter, air (for inside air)	For KX121-3 and KX161-3
8	Valve, expansion	
9	Thermostat assembly	For KX121-3 and KX161-3 (for frost control)
10	Amplifier assembly (electronic thermo amp.)	For KX080-3 } (for frost control)
11	Thermistor assembly (fin thermistor)	For KX080-3

C.Main components

a. Compressor

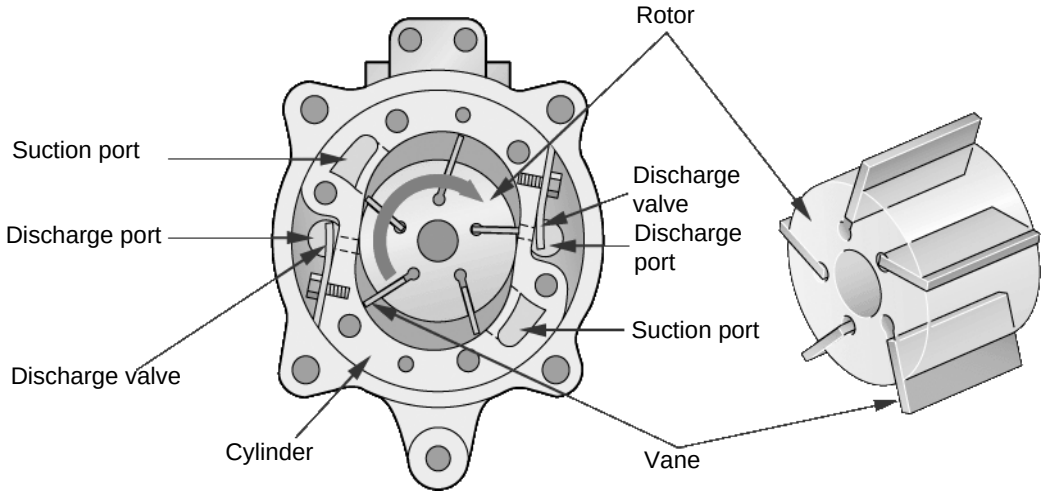
The compressor is installed on the engine and is driven by crank pulley through a belt.
The compressor is a pump designed to raise the pressure of refrigerant. Raising the pressure means raising the temperature. High temperature refrigerant vapor will condense rapidly in the condenser by releasing heat to the surrounding.

Compressors are classified as follows:

- Reciprocationg type
  - Swash plate type(6,10 cylinders) . . . . . 10P,10PA type
  - Wobble plate type(6 sylinders) . . . . . 6C, 6CA type
  - Variable capacity type . . . . . 7SB16 type
  - Crank shaft type(1 to 6 cylinders)
- Rotary type
  - Through vane type . . . . . TV type
  - Sliding vane type . . . . . SV type
  - Scroll type . . . . . SC type

(1) Outline of sliding-vane type compressor (SV07 type) : **KX080-3, KX121-3, 161-3**

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	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

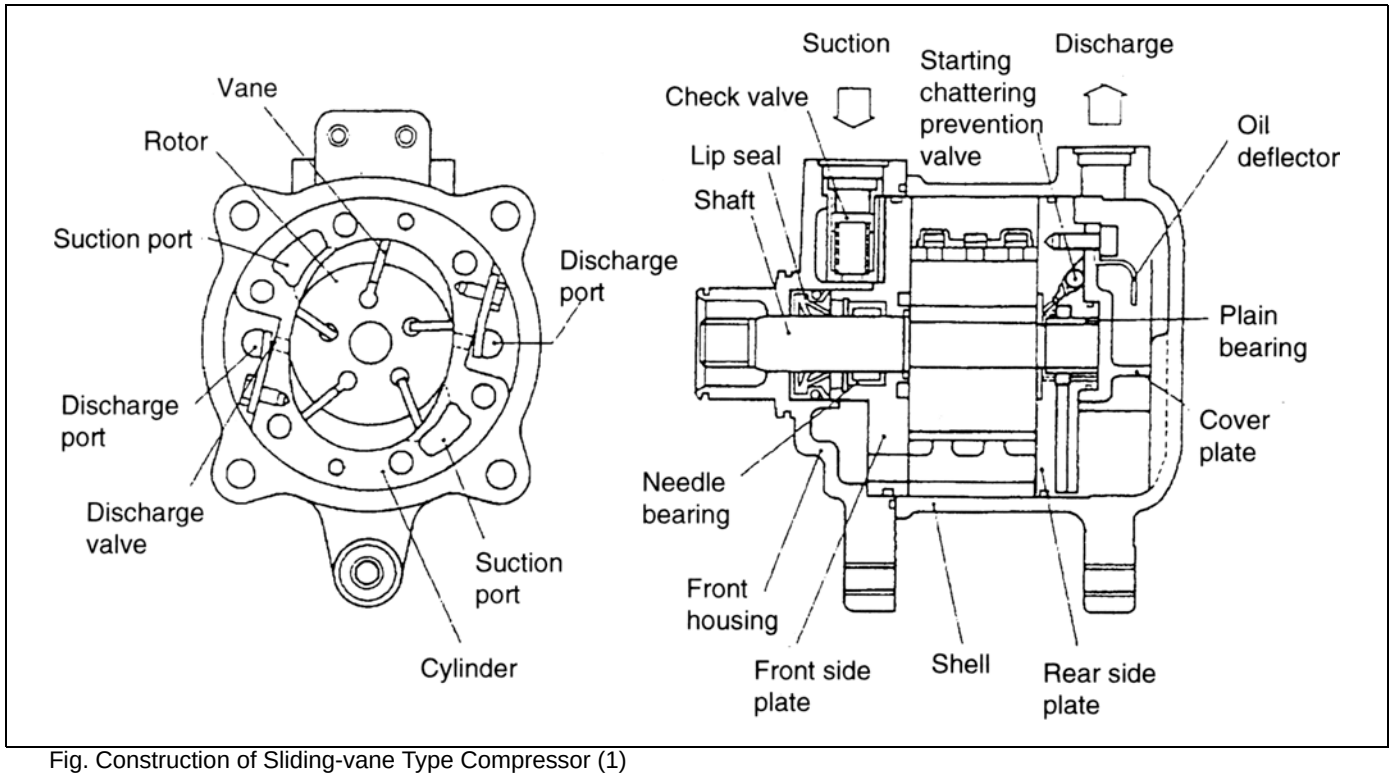


Fig. Construction of Sliding-vane Type Compressor (1)

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.

2 Operation

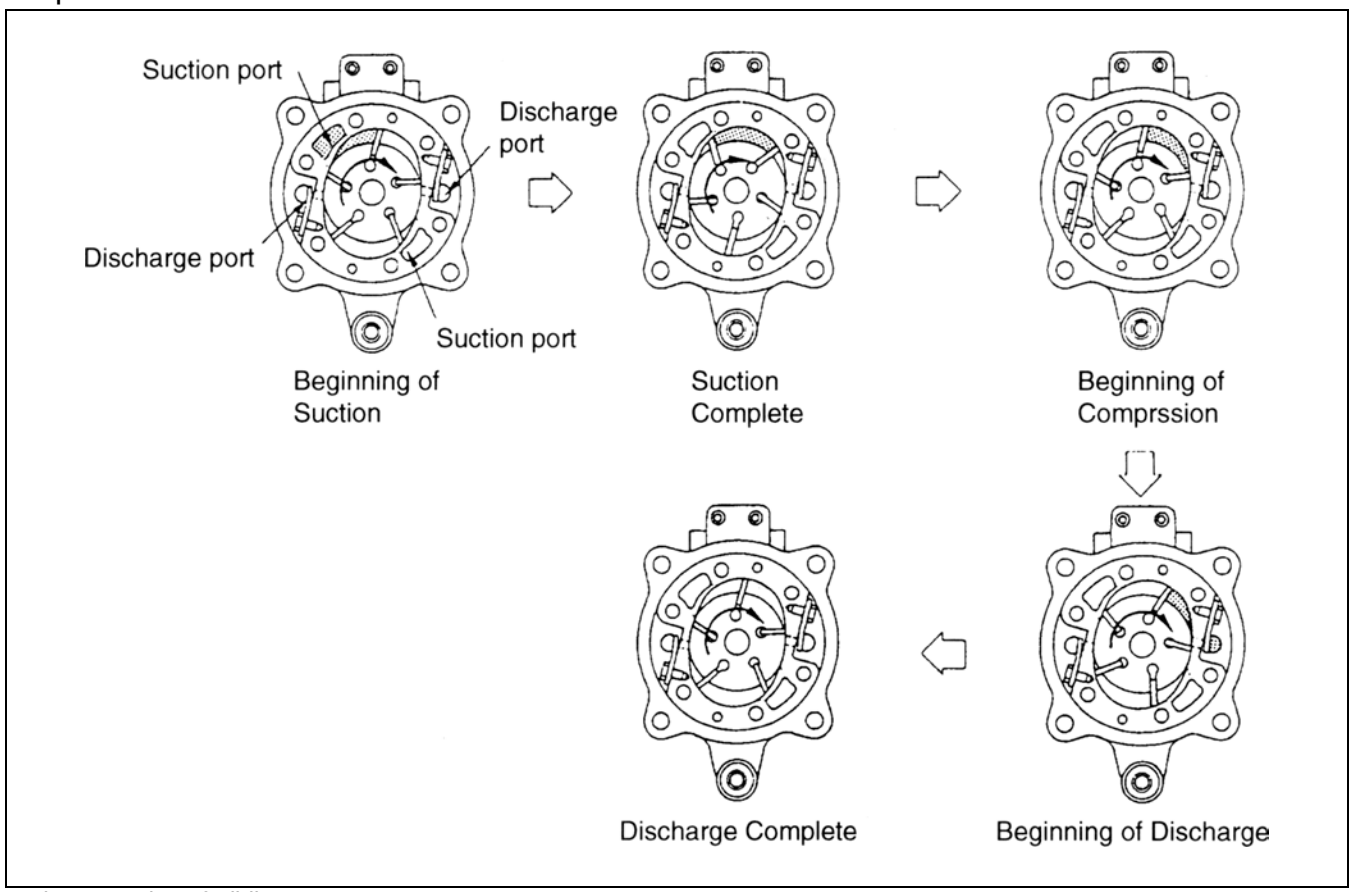


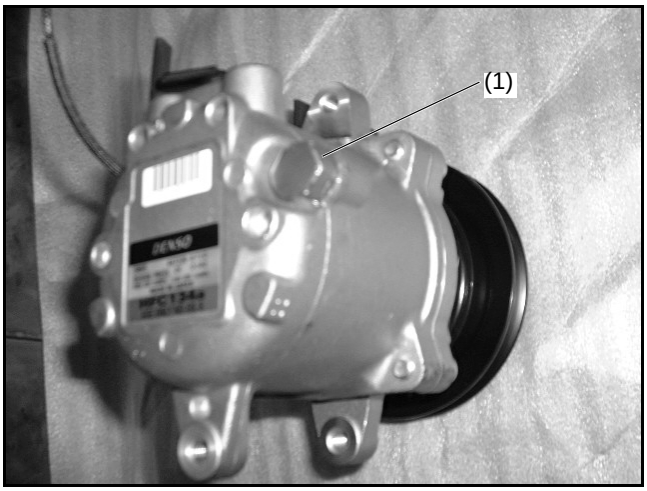
Fig. Operation of Sliding-vane Type Compressor

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.

b. High pressure relief valve

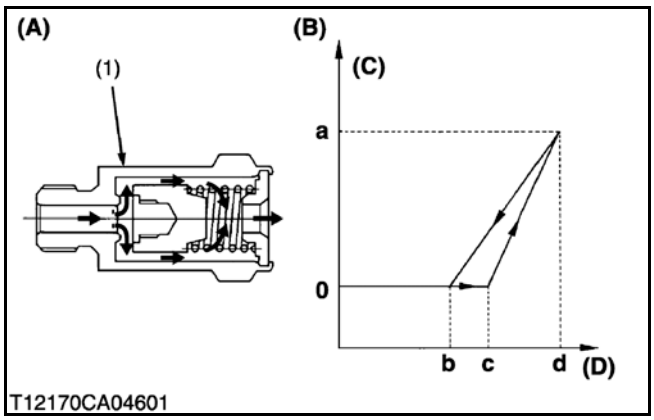


If the high pressure is abnormally high, the pressure relief valve open, and the refrigerant is released into the atmosphere, and the system is maintained. At that time, some of the refrigerant in the system is released into the atmosphere.
Even in the worst case, the outflow of refrigerant is stopped at the minimum limit.

(Reference)

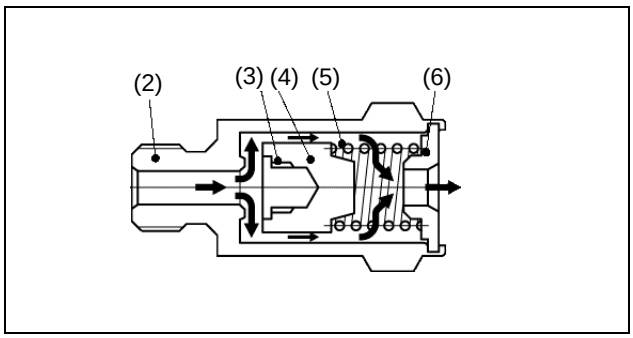
In normal operation, the high pressure switch is triggered first and the compressor stops, so the pressure relief valve is not triggered so easily.

(1) Pressure Relief Valve



(a) 113L/min., 27.2 U.S.gals./min., 24.86 Imp.gals/min.
(b) 2.75 Mpa, 28.1 kgf/cm2, 399.7 psi
(c) 3.43 Mpa, 35.0 kgf/cm2, 497.8 psi
(d) 4.14 Mpa, 42.4 kgf/cm2, 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.

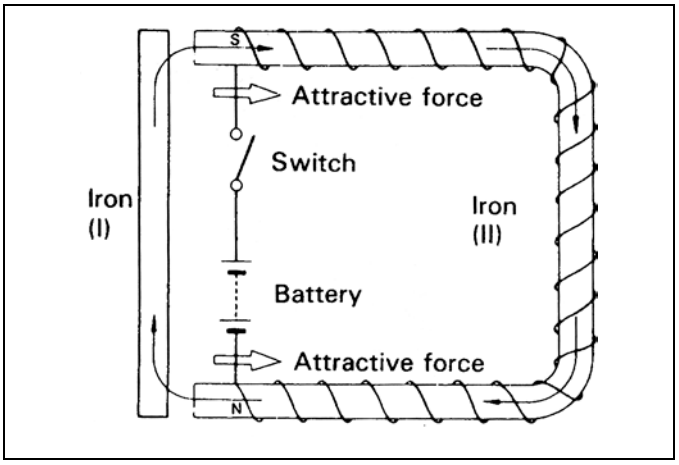


Fig. Magnetic Attractive Force

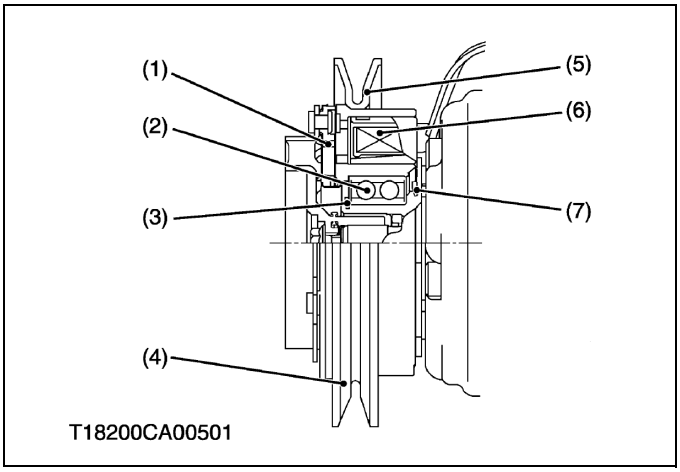
(2) Magnetic Clutch

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.

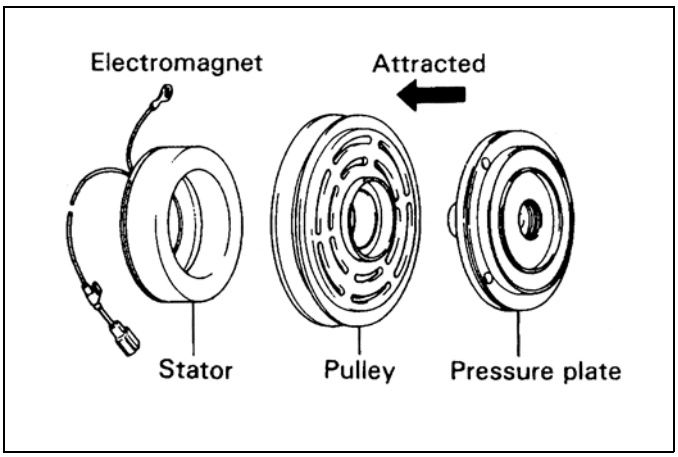


Fig. Operation

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.

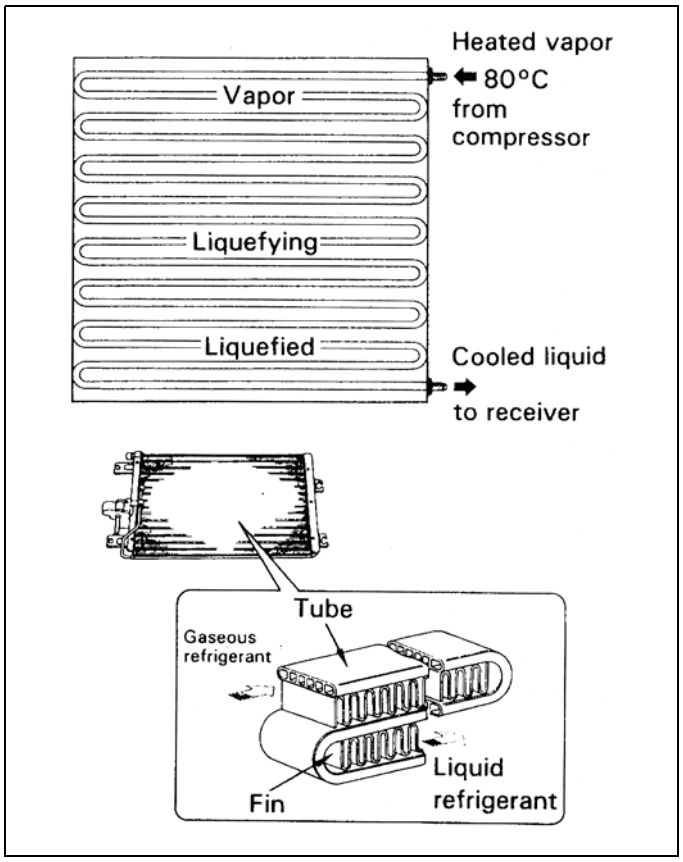


Fig. Single Pass Condenser

(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.

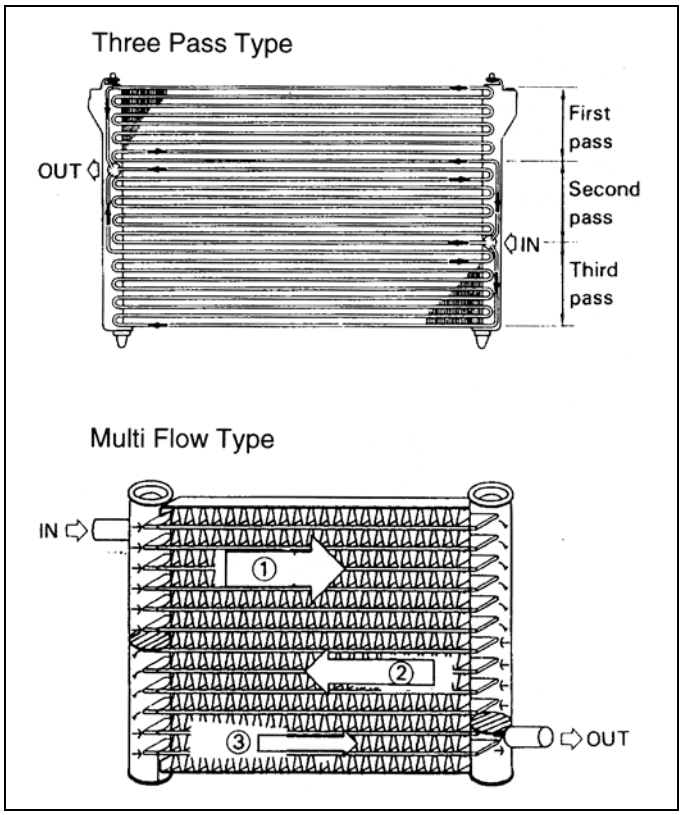
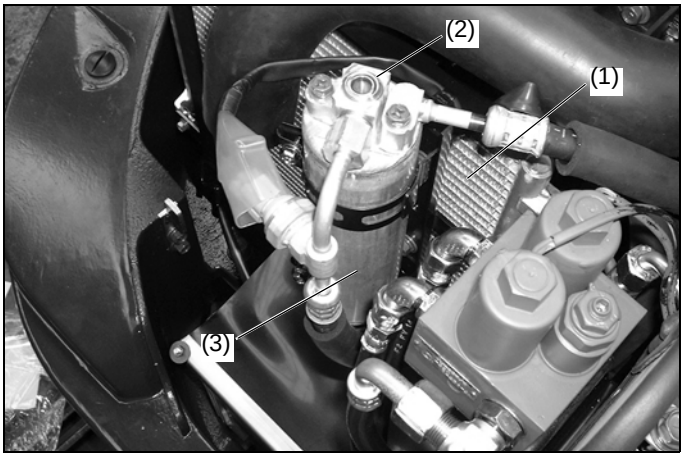
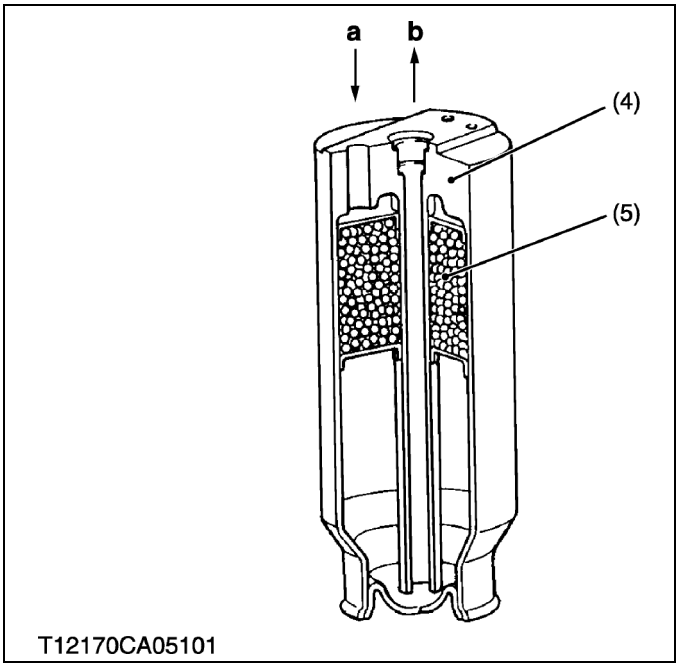


Fig. Three Pass Type and Multi Pass Type Condensers

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 changed from silicagel to zeolite for HFC134a type.

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.

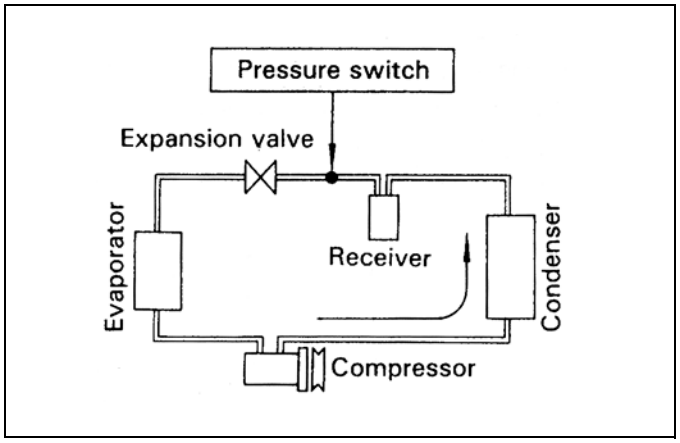


Fig. Location of Dual Pressure Switch



(1) Dual Pressure Switch

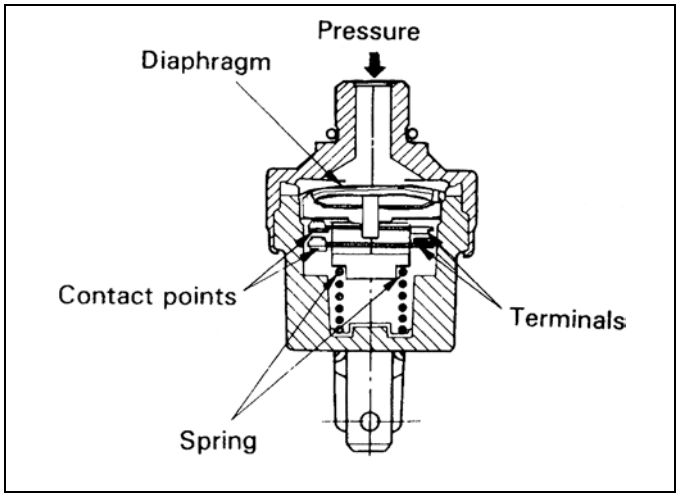


Fig. Dual Pressure Switch

(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.

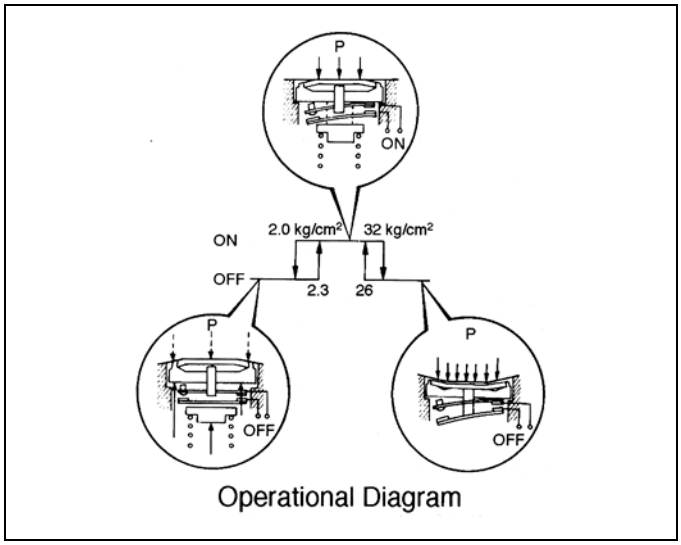
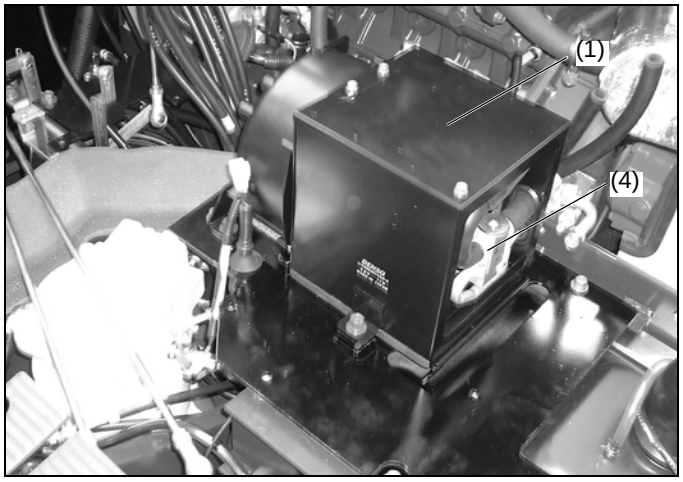


Fig. Operation of Dual Pressure Switch for HFC134a.

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



h. 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.

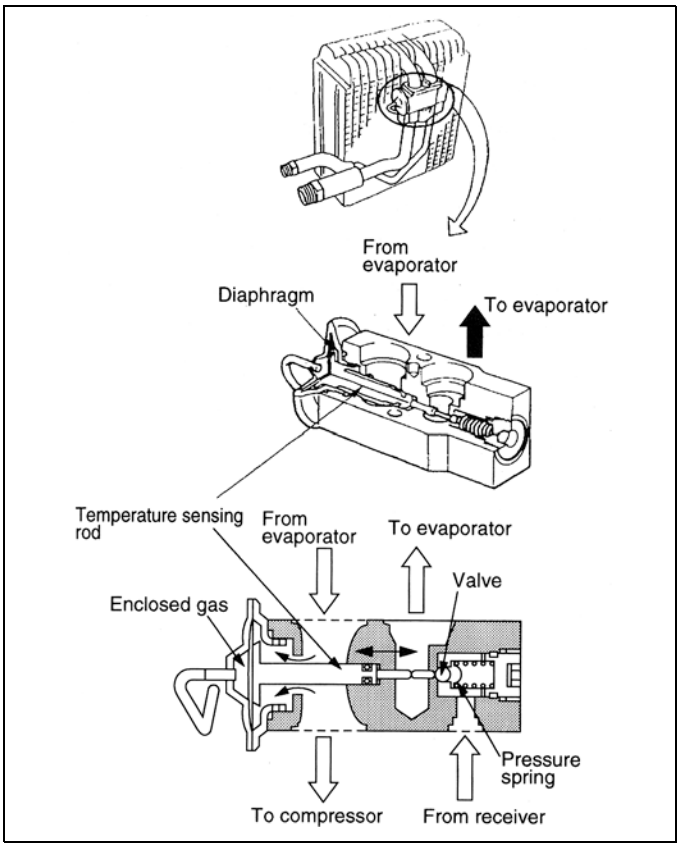


Fig. Box Type Expansion Valve

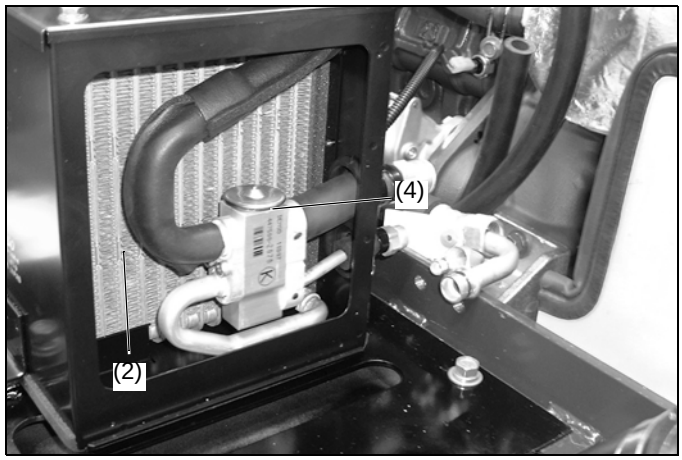
i. Evaporator

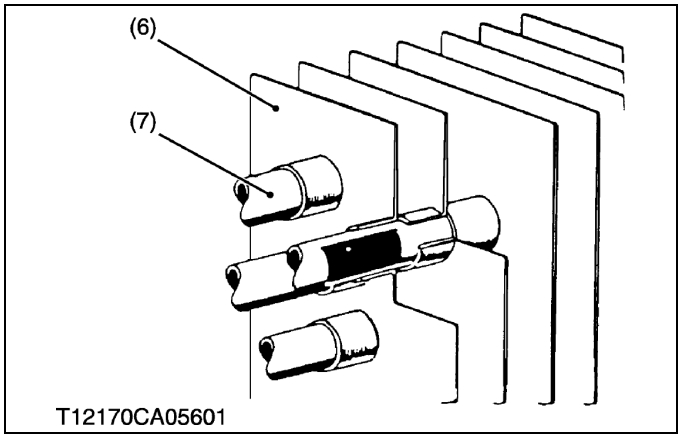
The purpose of evaporator (2) is just opposite to that of the condenser. The state of refrigerant immediately after the expansion valve (4) is 100% liquid. As soon as the liquid pressure drops, it starts to boil, and in doing so, absorbs heat. This heat is removed from the air passing over the cooling 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.

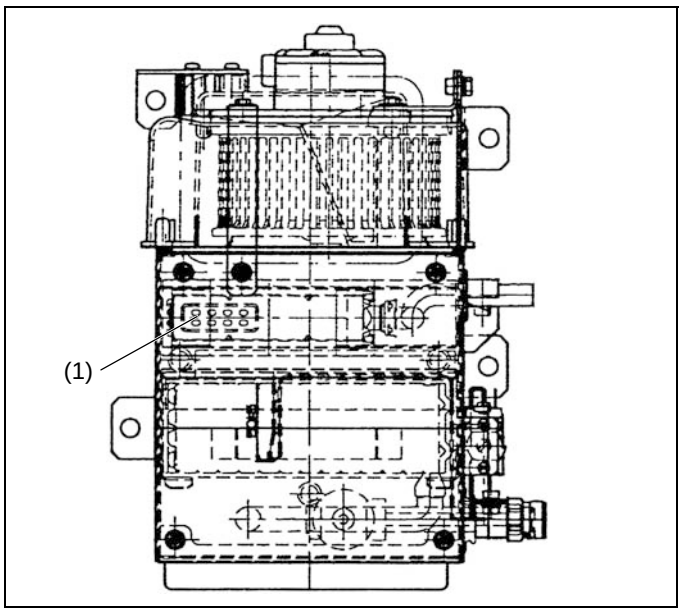
Refrigerant properly metered into the evaporator should allow for 100% liquid just after the expansion valve, and 100% gas at the outlet.





(1) Pressure Switch
(2) Evaporator
(3) Capillary Tube
(4) Expansion Valve
(5) Thermostat
(6) Fin
(7) Tube

j. Heater core



The heater-source of heater utilizes coolant which becomes high temperature by heat of engine.

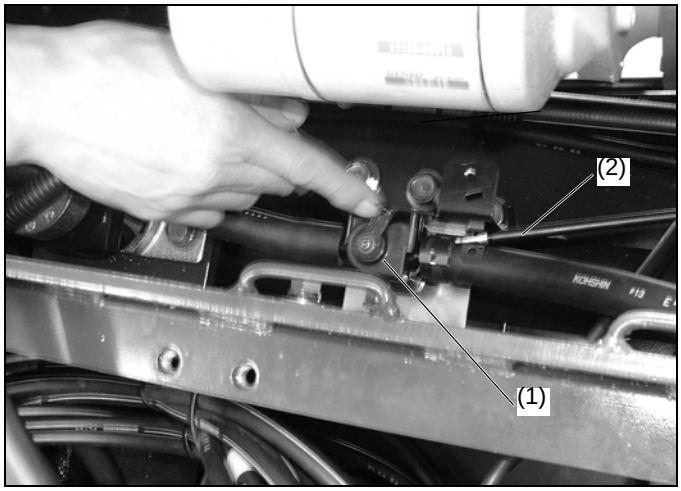
The inlet port heater core is connected to the delivery side of engine water pump by a rubber hose, and the water valve is installed on the inlet port of heater core.

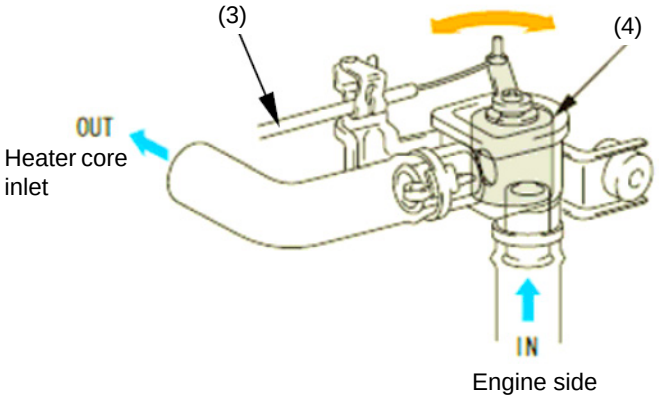
Also, the outlet port of heater core is connected to the engine cylinder block.

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

k. Water valve



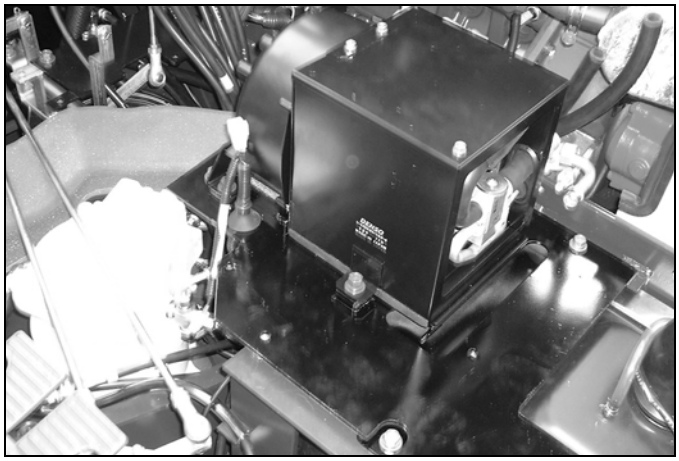


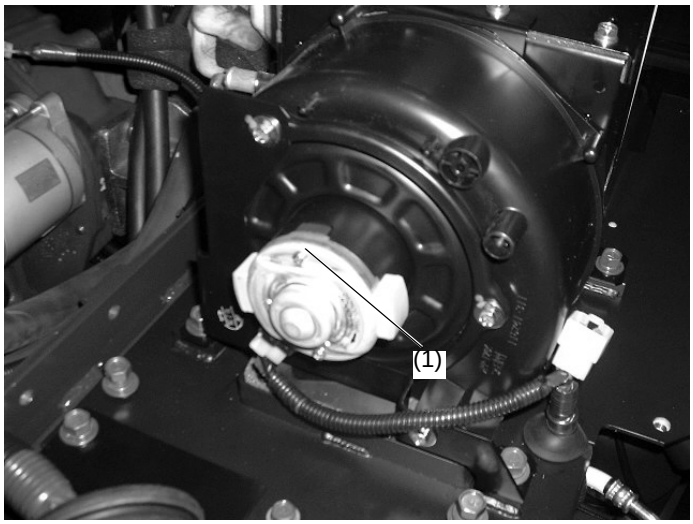
The hot water valve (1) is connected with the got water valve cable (2) and controlled with the temperature control lever on the control panel. This lever is used to adjust the flow rate of hot water going into the heater.
Set the temperature control lever to the COOL position and the hot water valve 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

(3) Cable (control panel side)
(4) Rotary valve

I. 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

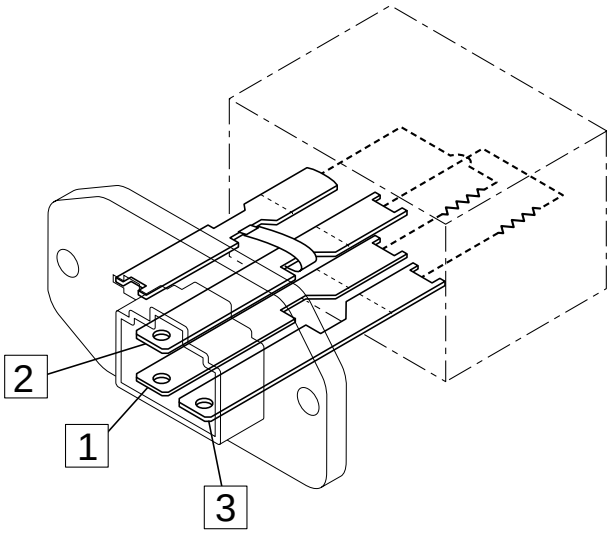
(1) Blower Motor

m.A/C blower resistor

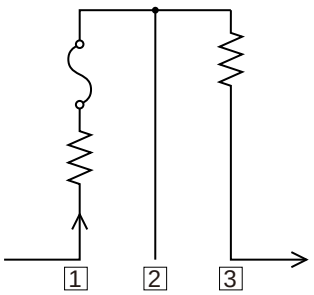
1 Main functions are ;

1. Two resistors regulate the blower speed according to the A/C blower switch speed range.
2. Fuse prevents the blower from burning out.

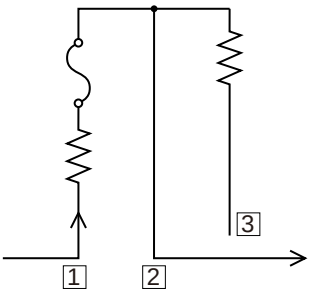
2 Structure



3 Current flow

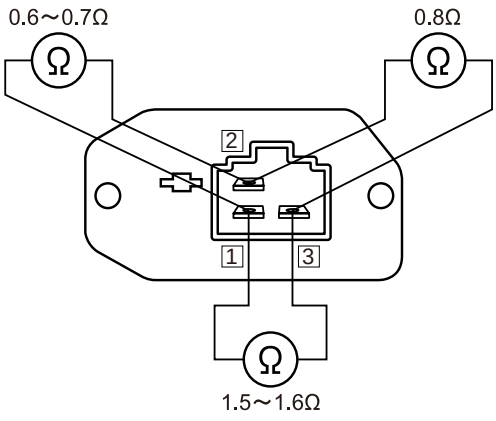


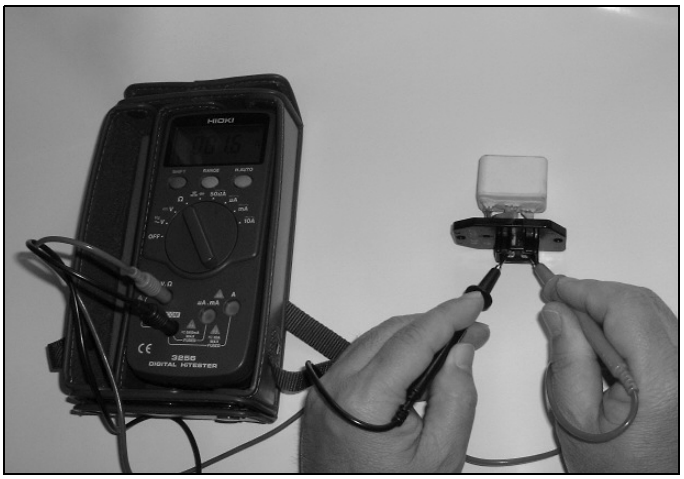
Low position



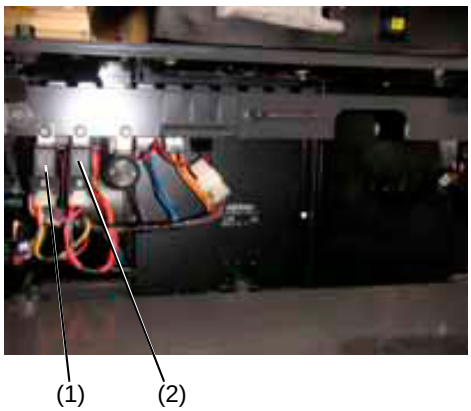
Medium position

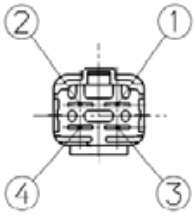
4 Testing

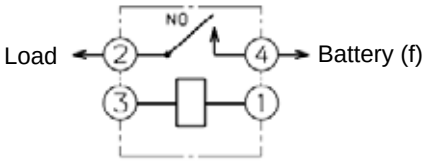




n. Relays







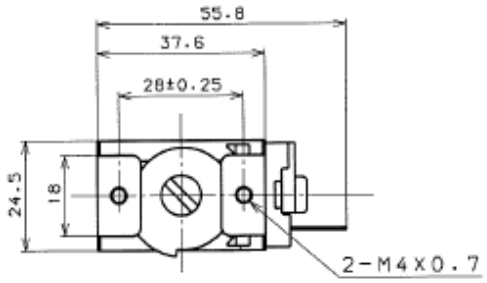
(1) Clutch relay
(2) Blower relay

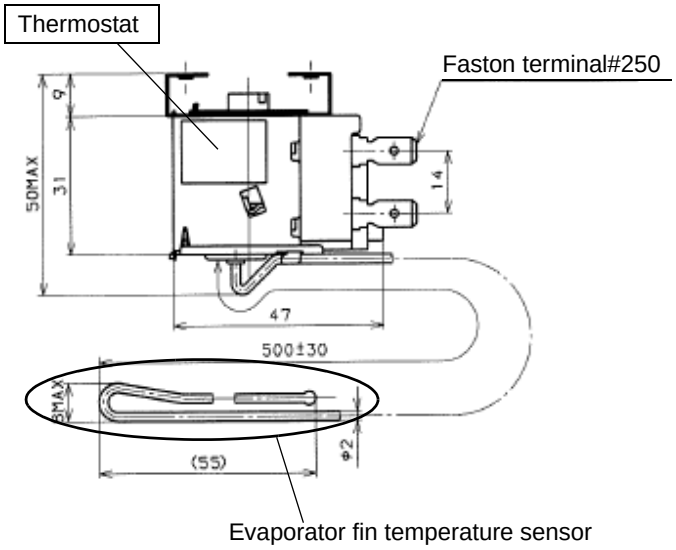
D.Frost control

[Function]

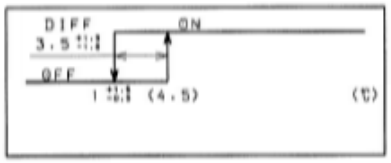
The evaporator fin temperature is sensed. If detected too low, the compressor is interrupted to prevent the evaporator from freezing.

a. KX121-3, 161-3



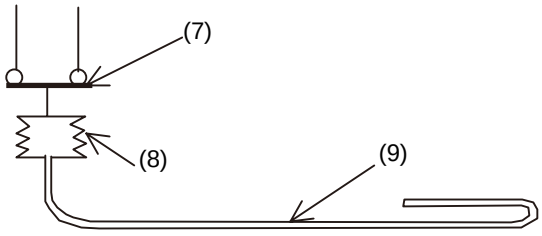


Activating temperature characteristic



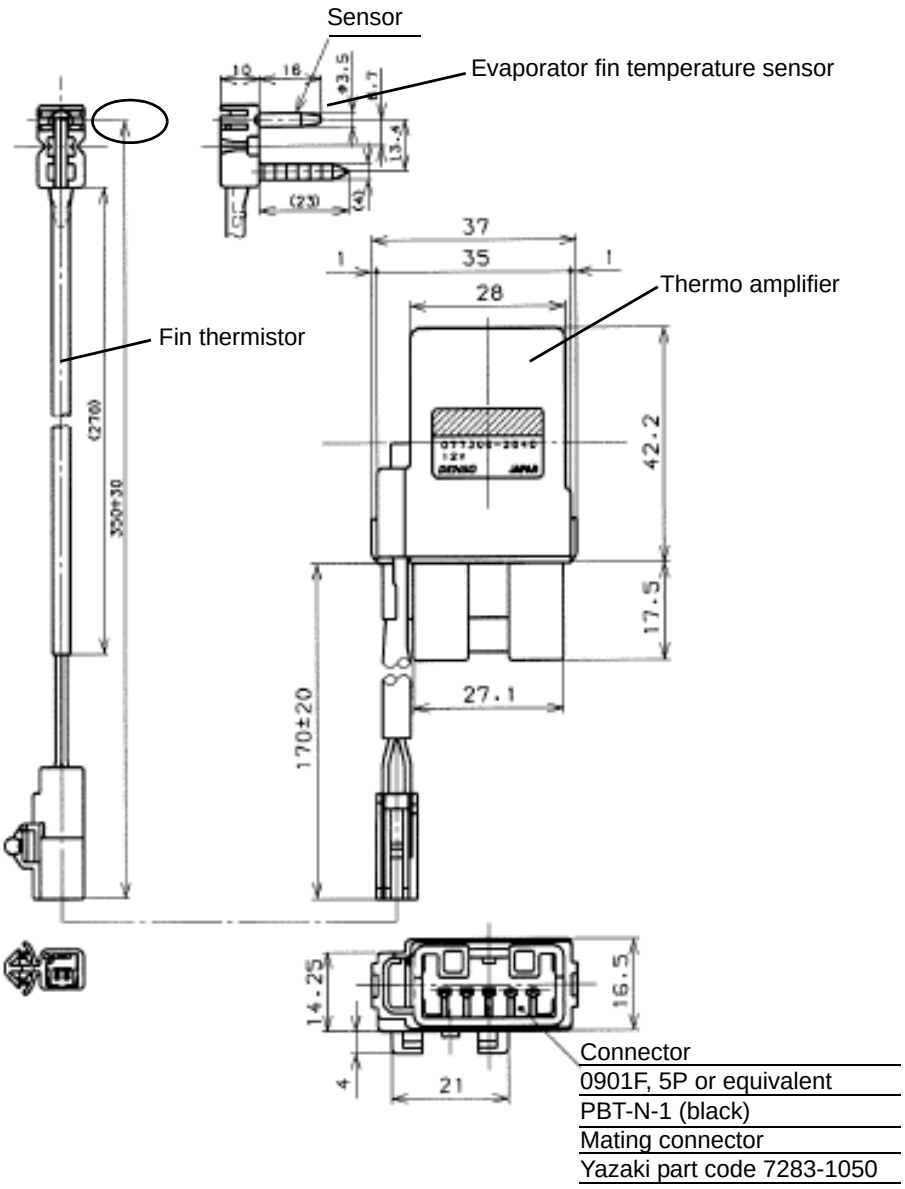
[Function]

The evaporator fin temperature is sensed by a refrigerant-filled capillary tube. If the temperature drops below a specified level, the pressure in the internal bellows drops too. The contact is now broken to turn off the compressor clutch power.



(7) Contact
(8) Bellows
(9) Capillary tube

b. KX080-3



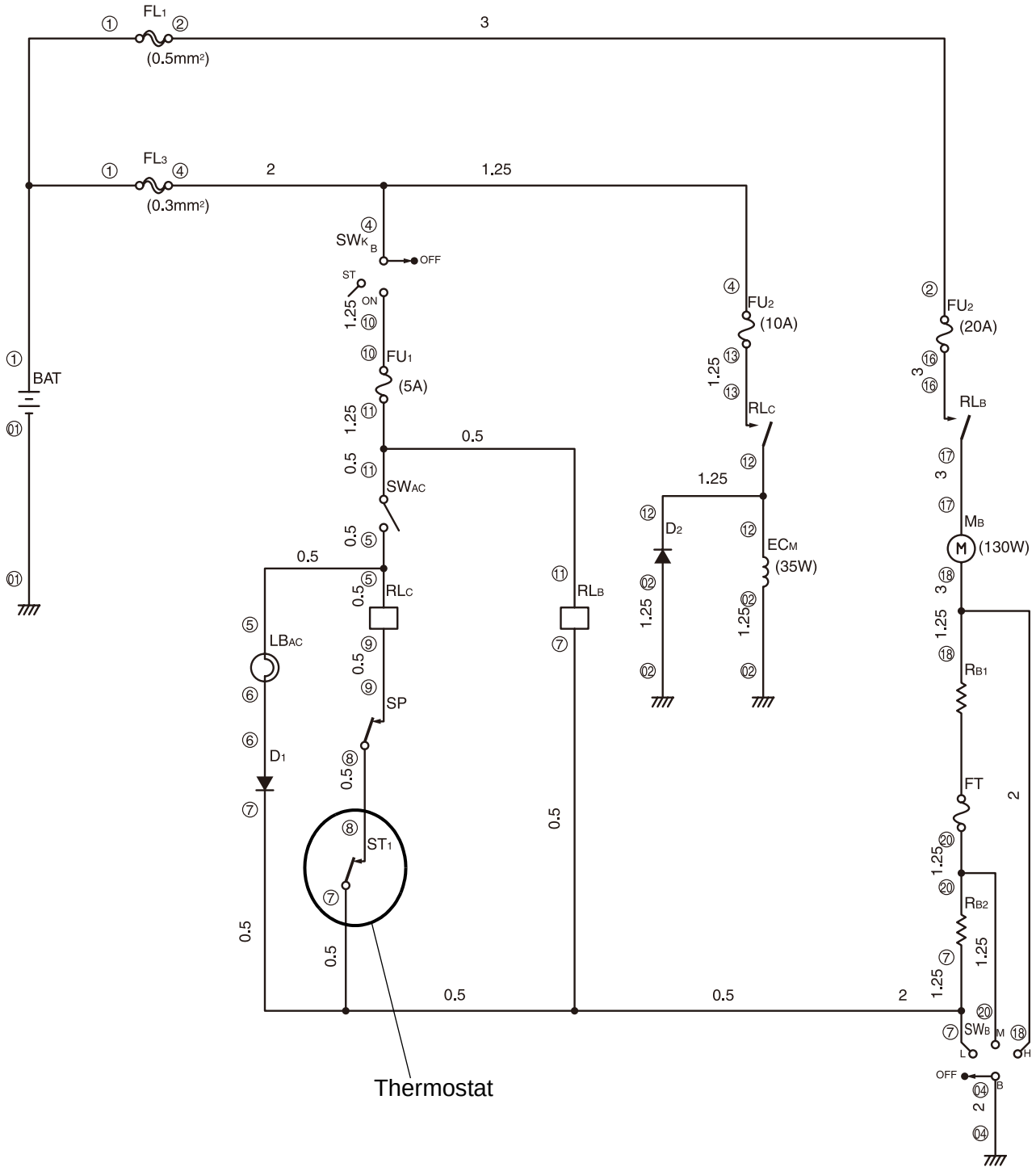
Specifications			
Rated voltage	DC12V		
Measuring conditions	DC13 ± 0.2 V at 25 ± 5°C		
Temperature detection (RTH) (Note 4)	OFF R1	4383 ± 131 Ω	(2°C)
	ON R2	(4095 Ω)	(3.35°C)
	Hysteresis	215^{+145} 0 Ω	(1°C)
Operating conditions			
Operating temperature range	-30 ~ 80°C		
Operating voltage range	DC10 ~ 16V		
Activating voltage range	DC8 ~ 1GV (at 25°C)		

[Function]

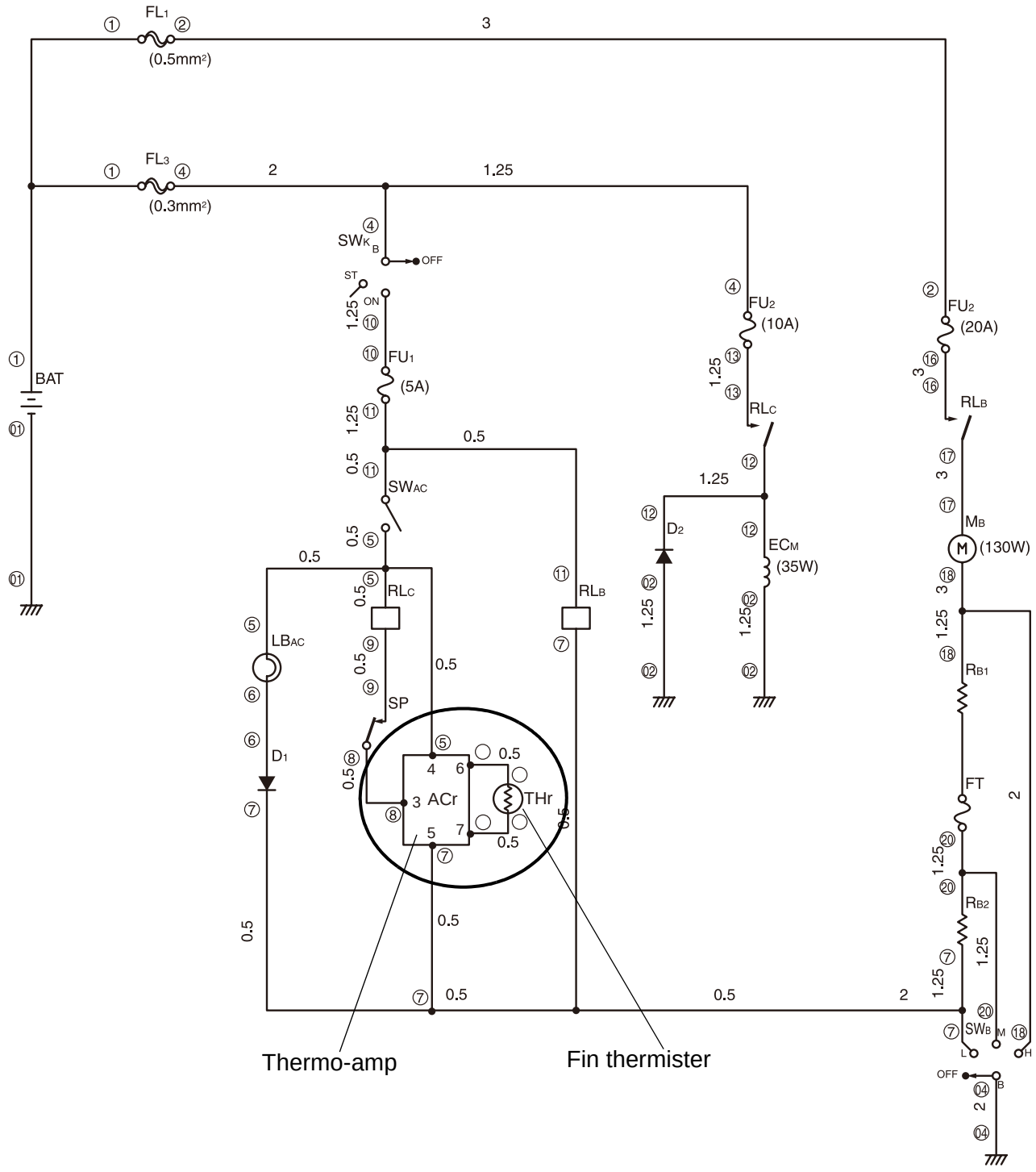
The evaporator fin temperature is sensed by the sensor of fin thermistor. If the sensor's internal resistance rises above the thermo amplifier's set resistance, the internal circuit is activated to turn off the compressor clutch power.

E.Electric circuit diagram

a. KX121-3, 161-3



b. KX080-3


FL1
(0.5mm²)
FL3
(0.3mm²)
BAT
SWKB
OFF
ST
ON
FU1
(5A)
SWAC
RLC
LBAC
D1
SP
ACr
THr
RLB
FU2
(10A)
D2
ECM
(35W)
FU2
(20A)
MB
(130W)
RB1
FT
RB2
SWB
L
M
H
OFF
B
Thermo-amp
Fin thermister

VII Two-Piece Boom

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A. General

a. Main Specifications

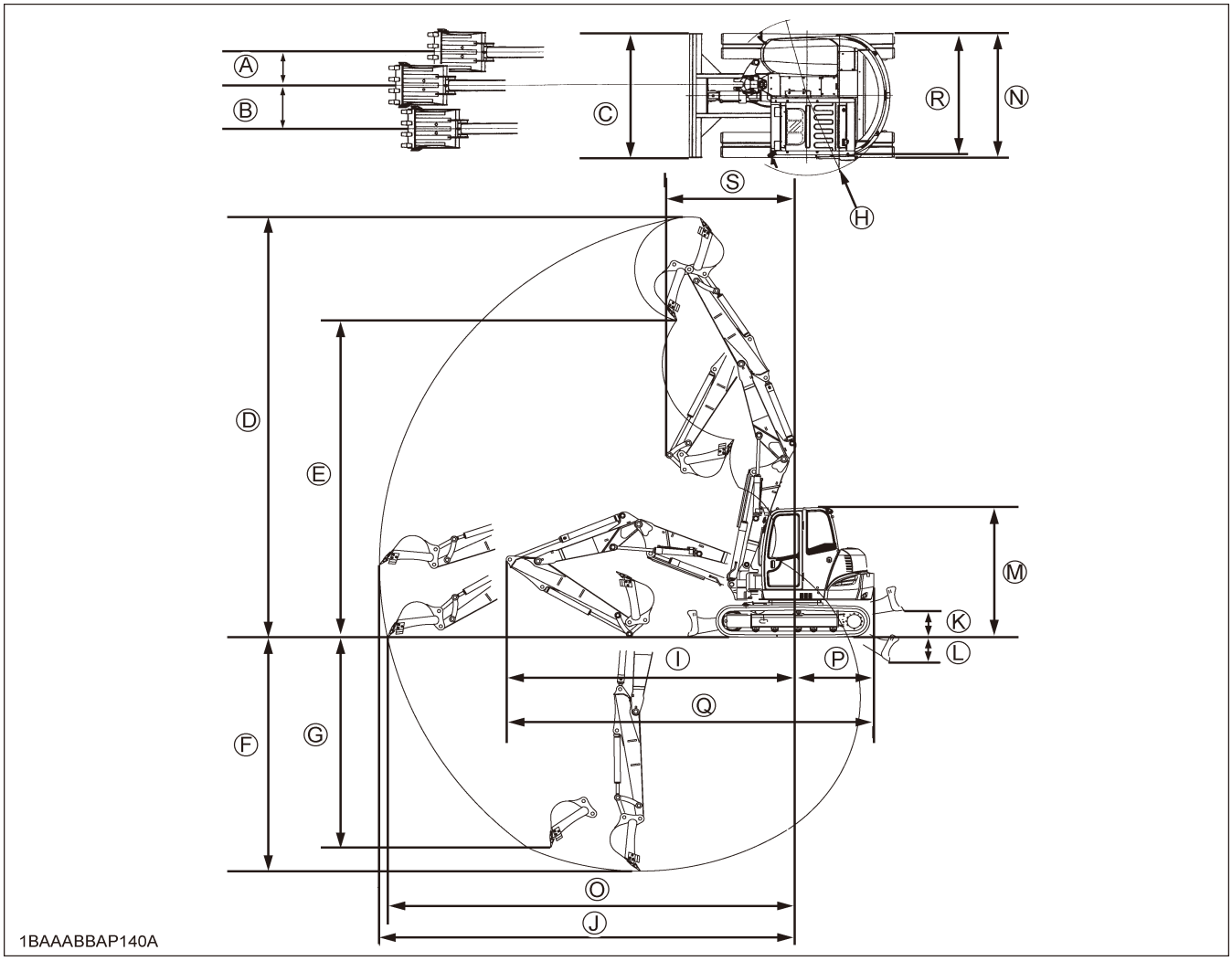
1. Machine Specifications

			KUBOTA EXCAVATOR, KX080-3			
Model name			**Two-piece boom**	Mono-boom		
Type			**Cabin**			
Operating weight (including operator's weight) kg(lbs.)			**Rubber tracks (450 width)**		Steel tracks (450 width)	Steel tracks (600 width)
			8700 (19180)	8280 (18254)	8330 (18364)	8460 (18475)
Engine	Type		**Water cooled 4 cycle diesel engine with 4 cylinder**			
	Model name		**KUBOTA V3800DI**			
	Total displacement cc (cu.in)		**3769 (230)**			
	Engine power SAE gross kW(Hp)		**49.7 (66.6)**			
	Rated speed rpm		**2000**			
Performance	Swivel speed rpm		**9.5**			
	Travel speed	Fast km/h(mph)	**5.1 (3.2)**			
		Slow km/h(mph)	**2.8 (1.7)**			
	Ground contact pressure (With operator) kPa (kgf/cm^2) [psi]		**Rubber tracks (450 width)**		Steel tracks (450 width)	Steel tracks (600 width)
			37.8 (0.386) [5.49]	36.0 (0.367) [5.22]	36.2 (0.369) [5.25]	27.6 (0.281) [4.00]
	Climbing angle %(deg)		***36 (20)**			
	Angle in case of crossing slope %(deg)		***27 (15)**			
Dozer	Width x Height mm(in.)		**2200 x 500 (86.6 x 19.7)**			2400 x 500 (94.5 x 19.7)
Boom swing angle		Left rad(deg)	**1.22 (70)**			
		Right rad(deg)	**1.05 (60)**			
Pressure connection for attachments	Max.displacement (Theoretical) SP1 / SP2 L(US gal)/ min		**100 (26.4) / 67 (17.7)**			
	Max. pressure Mpa (kgf/cm^2) SP1, SP2 [psi]		**20.6 (210) [2987]**			
Fuel tank capacity L(US gal)			**115 (30.4)**			

Note :
· Above dimensions are based on the machine with KUBOTA original bucket and 2100mm (82.7in.) length arm.
· 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.

2. Operating Space

1) 2-piece boom



mm

	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)
1750 Arm	590	770	2200	7930	5900	4240	3780	1490	5430	7490
2100 Arm	590	770	2200	8240	6210	4590	4120	1490	5440	7820

	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	
1750 Arm	500	500	2540	2200	7330	1490	6920	2140	2230	
2100 Arm	500	500	2540	2200	7670	1490	6930	2140	2420	

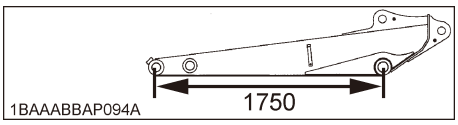
Note :

· Above dimensions are based on the machine with KUBOTA original bucket.
· Above dimensions are based on the machine with rubber crawler.
· Specifications subject to change without notice.

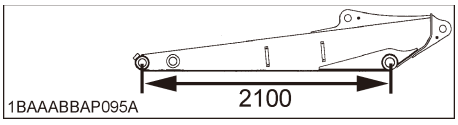
Part No.	Name	Weight, kgf
RD809-66604	Arm assembly (1750)	163
RD809-67104	Arm assembly (2100)	184
RD809-67903	Arm assembly (2100, Thumb)	195

· Arm length

1750 Arm



2100 Arm



b. Feature of Two-piece Boom

1. Operational Feature

1) Better workability in narrow space
   1-1. Near-side works
   * The machine performs better in deep digging at near side than standard machines.
   * The machine can easily do the lifting at near side.
   1-2. Minimum front turning radius
   * The machine can swivel with the second boom folded.

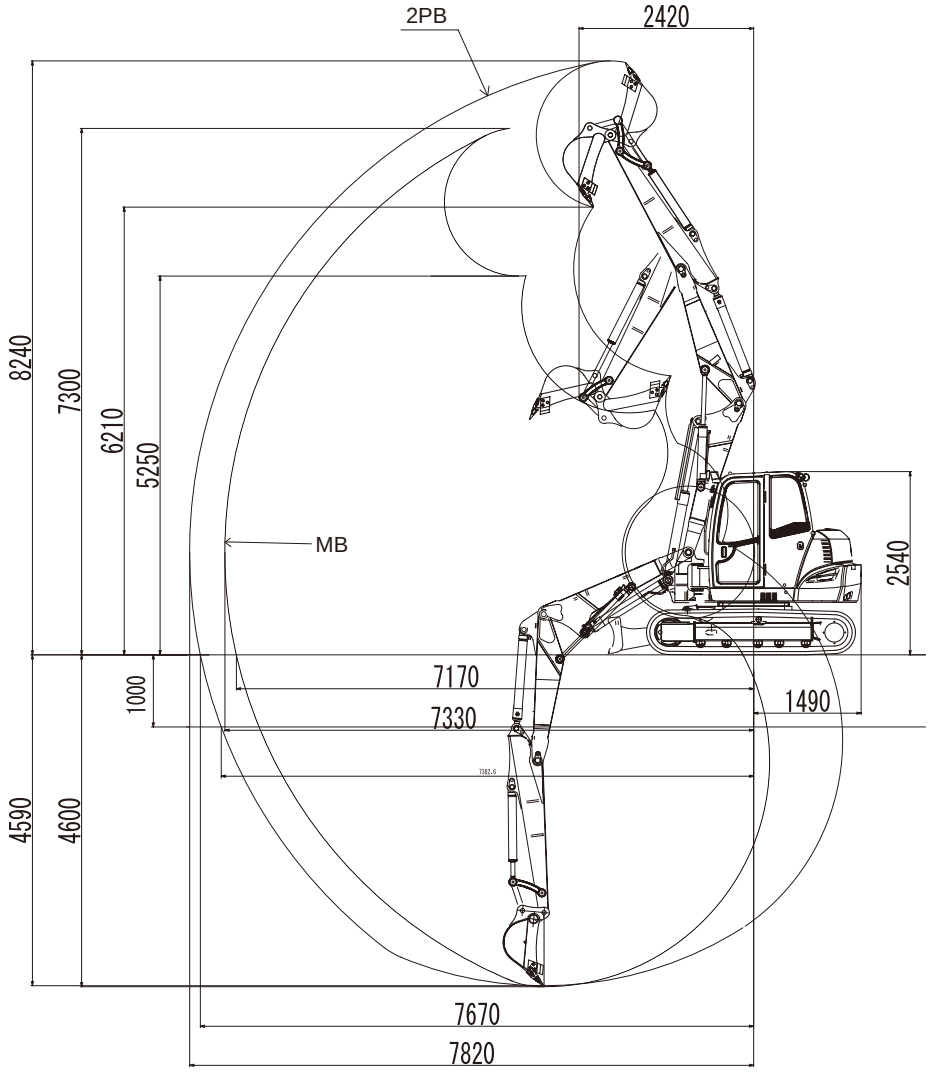
2) Loading onto dump truck
   2-1. Earth can be loaded from a wide area onto a dump truck without running the machine.
   2-2. Earth can be loaded deep onto a dump truck without running the machine.

3) Expanded work zone
   * The machine reaches enough from near side to far side.

4) Horizontal digging and leveling off
   The machine reaches long with the arm and second boom. Earth can be easily horizontally dug and leveled off.

2. Working Space Comparison : Mono-boom vs Two-piece Boom

Arm length = 2100 mm (82.7 inch)



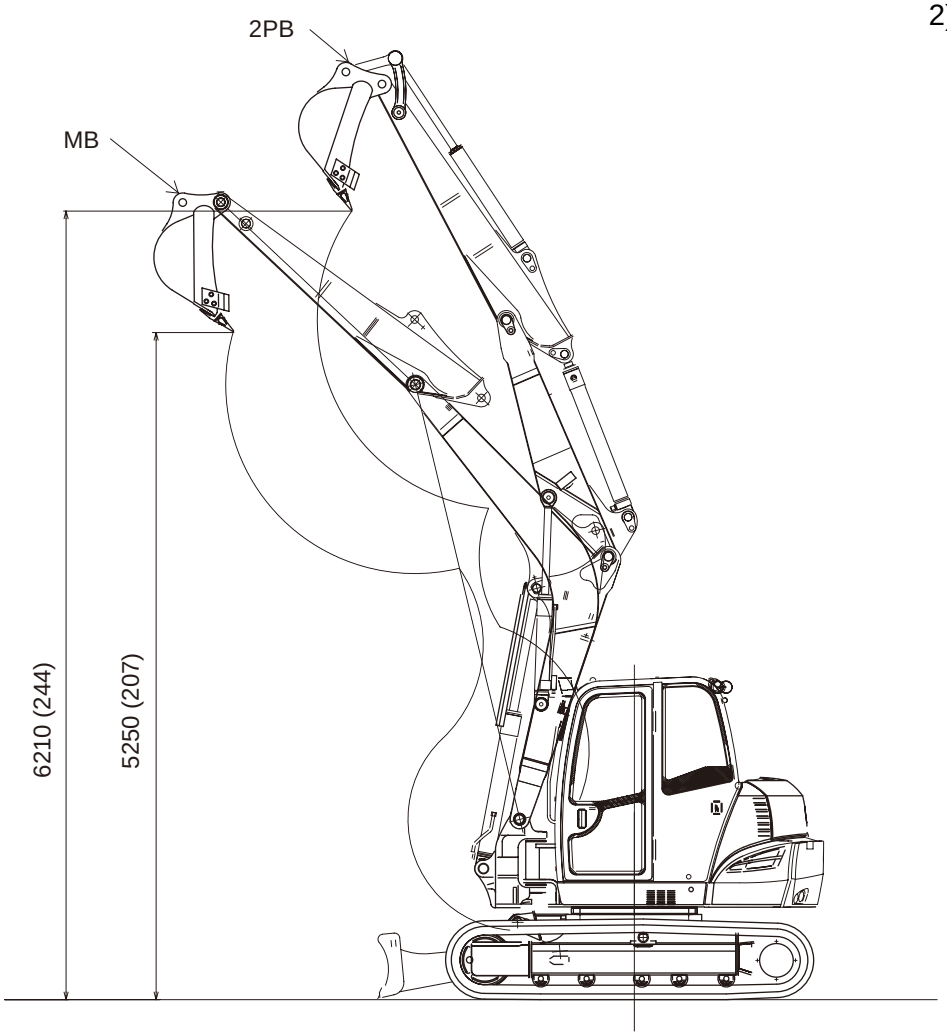
1) Overall working space
   2PB : Two piece boom
   + 2100 (82.7 in.) arm
   MB : Mono-boom
   + 2100 (82.7 in.) arm

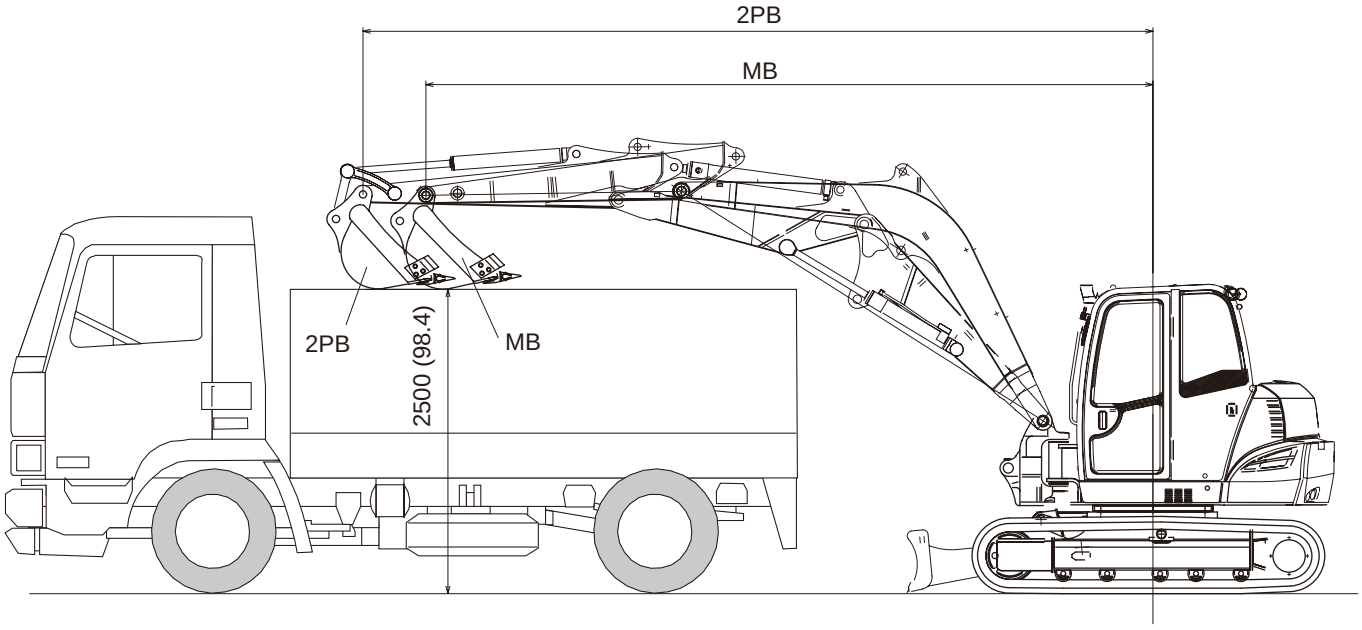
Unit : mm

2) Dumping height and loading-height on to truck

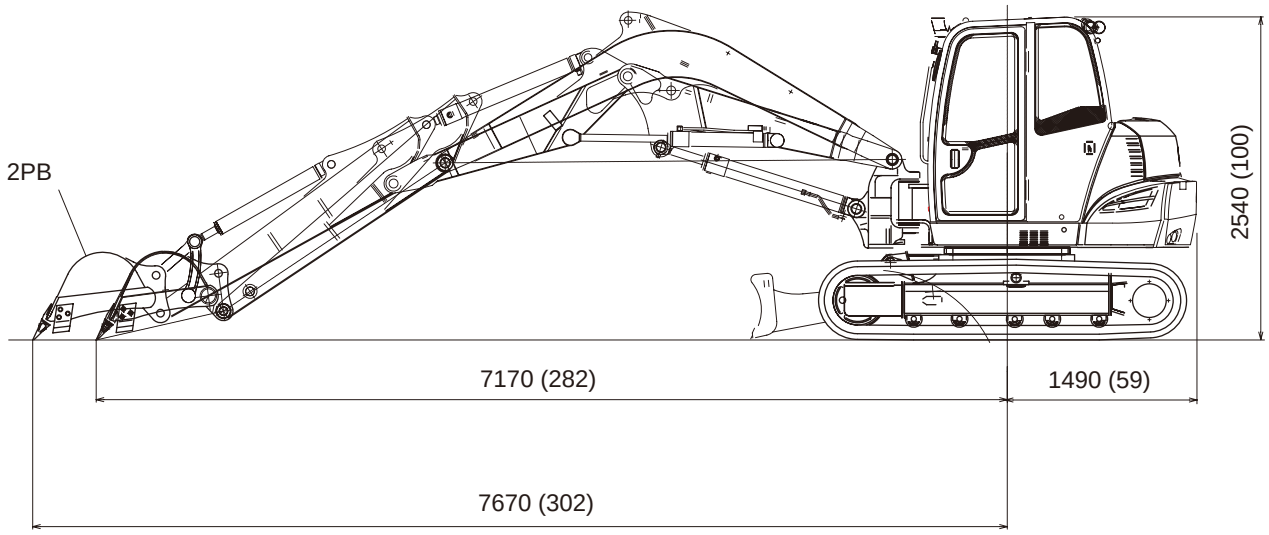
Unit : mm (inch)

2PB : Two piece boom
MB : Mono-boom

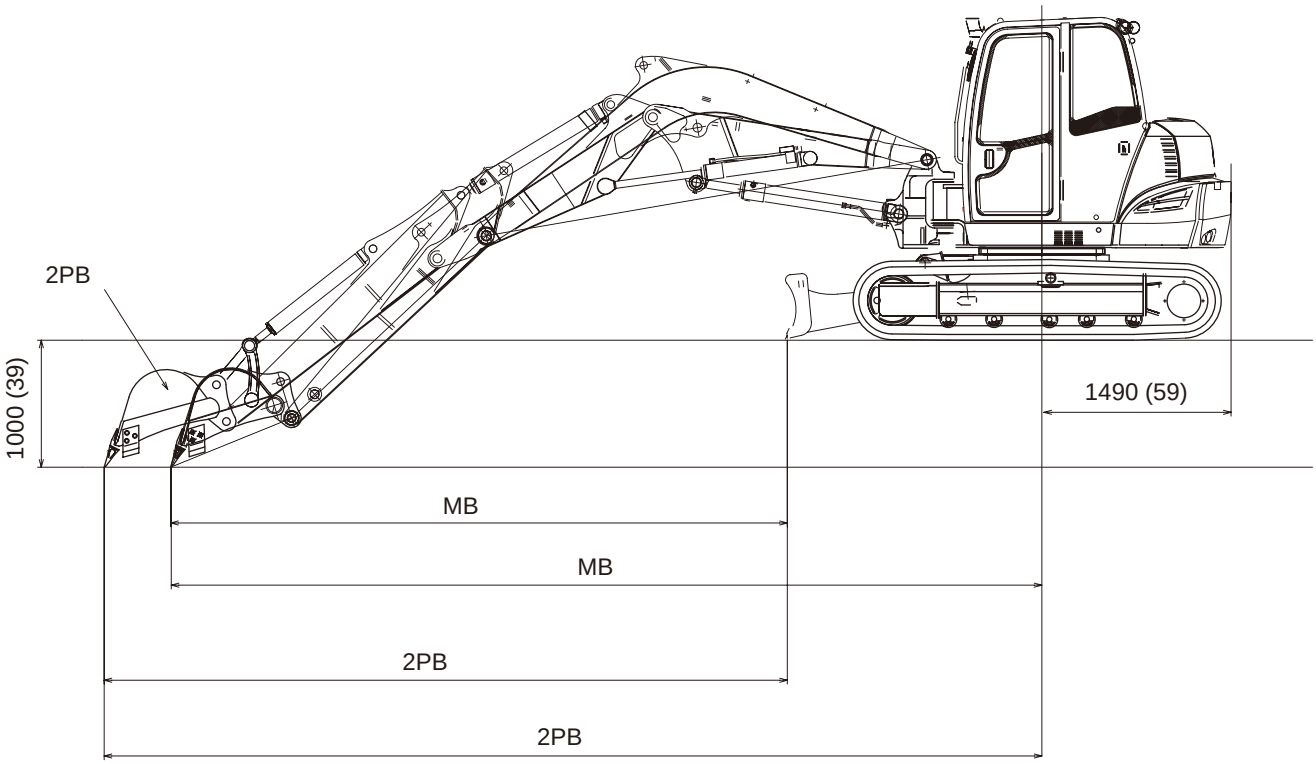




3) Max. digging reach on the ground

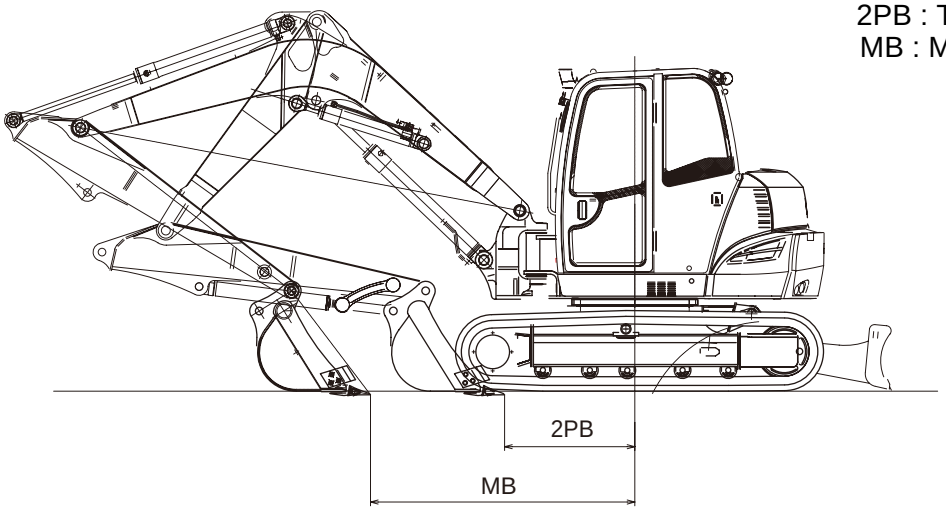


4) Ditch digging length
Ditch depth = 1000 mm (39 inch)



5) Approach digging distance

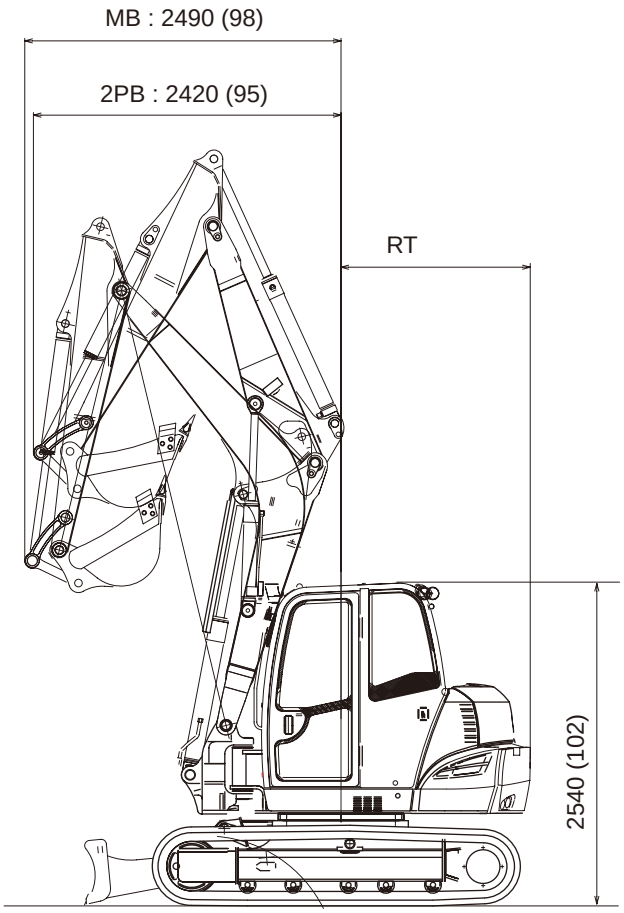
2PB : Two piece boom
MB : Mono-boom



6) Turning radius : front and rear

2PB : Two piece boom
MB : Mono-boom
RT : Rear tail turning radius

MB=1420 mm (55.9 in.)
1460 mm (57.5 in.)
2PB=1490 mm (58.7in.)



3.Main Performance Comparison

1) Working range and stability equal to or better than the competitors

			Kubota	Takeuchi	Komatsu	Neuson	Kubota
			KX080-3	TB175	PC75-2	8003	KX251
Weight		kg	**8700**	7940 *8140	7600 *8180	8000 *8910	7860
Overall width		mm	**2200**	2245	2050	2250	
Rear over hang		mm	**380**	645	475	485	
Maximum dumping height		mm	**6210**	5255	6135	5882	5820
Maximum digging depth		mm	**4590**	4440	4210	4560	4200
Maximum digging radius		mm	**7810**	7650	7770	7778	7410
Static stability	Front	kg	***1058**	*879	*867	*932	850
	Sideways	kg	***736**	*686	*562	*838	*678

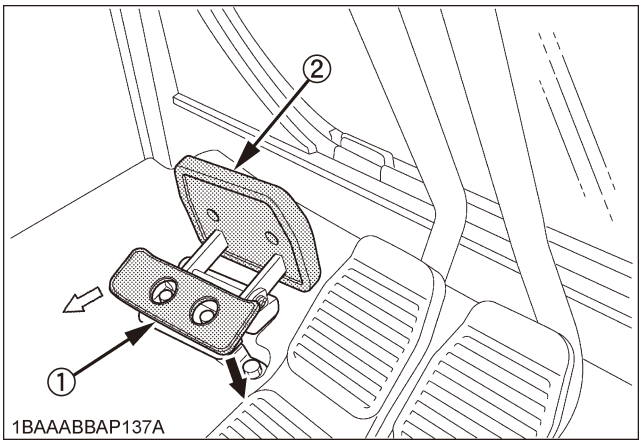
*marked values are actual measurements. The stability values were converted, as with the 191-kg Kubota bucket attached, for the same conditions.

2) Improvements in second boom holding power, simultaneous controllability and swivel angle

		Kubota	Takeuchi	Komatsu	Neuson	Kubota
		KX080-3	TB175	PC75-2	8003	KX251
Second boom cylinder off-set amount (10 diggings)	mm	**8**	167	163	10	-
Second boom speed, crowd / dump	sec	**4.3/5.3**	6.8/8.0	4.7/5.5	4.7/8.4	10.6/11.8
Swivel angle, left/right	degrees	**17.5/19**	15/15.5	14.5/14	17/19	(16.4/15.9)

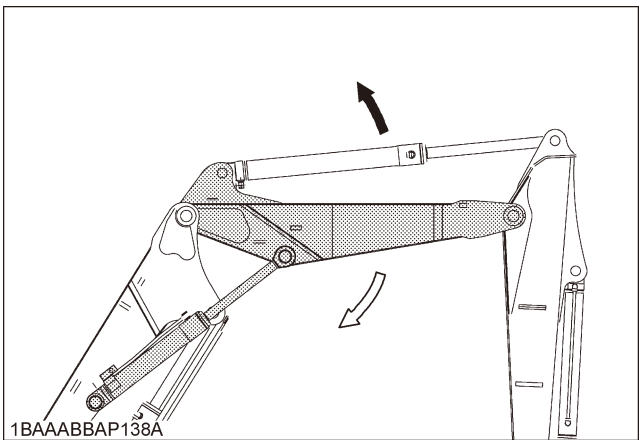
*: The KX251 swivel angle is for the single-boom type.
Some of the above data are the actually measured values from one machine each for the purpose of comparison.
Therefore, these are not machine's specifications.

4.Operation of the Second Boom (2-piece Boom)



1. Flip the left pedal lock up to unlock the pedal.
2. Step on the right side of the pedal (➡) to raise the second boom.
3. Step on the left side of the pedal (⇨) to lower the second boom.

(1) Second boom control pedal
(2) Pedal lock



IMPORTANT :

· Note that the attachment might come in contact with the boom cylinder, the swing bracket or the hydraulic hoses when the arm and the bucket are operated with the second boom crowded.

c. Maintenance Specifications

1. Water and Oil Quantity

	Unit	STD	**2-piece boom**	Remarks
Radiator	L gal	10.5 (2.79)	←	Kubota LLC-N-50F 50%
Reserve tank	L gal	1.3 (0.34)	←	
Engine oil with filter	L gal	10.7 (2.83)	←	Engine Oil SAE10W30(CF-4)
Hydraulic oil Full	L gal	146 (38.6)	159(42.0)	ISO 46
Hydraulic oil Tank gauge center	L gal	75 (19.8)	←	ISO 46
Wheel motor	L gal	1.3 (0.34)	←	Gear Oil SAE90 (API GL-4)
Track roller	cc cu.in.	80 (4.88)	←	Engine Oil SAE30(CD)
Upper roller	cc cu.in.	60 (3.66)	←	SAE30(CD)
Front idler	cc cu.in.	80 (4.88)	←	
Fuel tank	L cu.in.	115 (30.4)	←	Diesel Fuel JIS #3 (Initial)

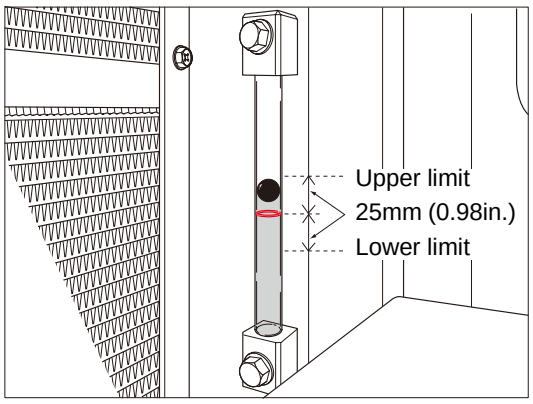
Note : Type of oil, fuel and coolant in the remarks are filled in the factory.

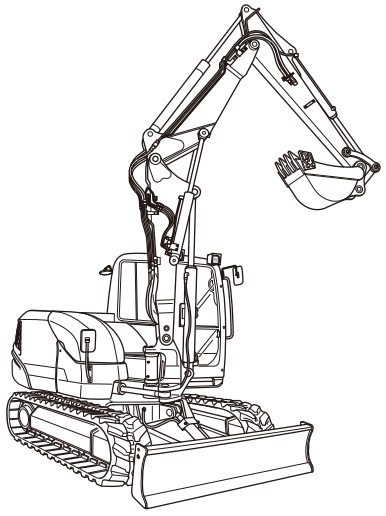
Grease	Supply grease to such amount that it oozes out of periphery of the rotating end.	Ultra -pressure grease : EP2, Beacon Q2
Control levers and links Du-bushing	Assemble after applying grease	

2. Inspection of hydraulic oil

The hydraulic tank of KX080-3 is pressurized type.
When checking the hydraulic oil level, meet the following conditions and make sure the oil level is above the center the oil gauge.

1) Oil temp. should be between 10 ~ 30 °C (50 ~ 86 °F)
2) Stance of front attachment :
   Swing : Left end
   Dozer blade : Down to the ground
   Boom :The highest position
   Arm : Crowd to end
   Bucket : Crowd to end





In this way, large amount of the hydraulic oil in the cylinders is supposed to return back into the hydraulic tank and result in getting the tank pressurized during the normal operation.

3. Maintenance Intervals Chart : EU-version

	General Maintenance		Elapsed Operating Hours																			
			50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000	Interval
Operator Service	Check fuel level																						daily
	Check coolant level																						daily
	Check engine oil level																						daily
	Check hydraulic oil level																						daily
	Check V-belt																						daily
	Check washer liquid																						daily
	Check water separator																						daily
	Check, clean air filter		O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	50 h
	Tracks and chassis: clean, visual inspection and check tension		O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	50 h
	Grease swivel gear		O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	50 h
	Grease front attachments	Bucket and bucket link pin		O		O		O		O		O		O		O		O		O		O	100 h
		Boom swing fulcrum		O		O		O		O		O		O		O		O		O		O	100 h
		Others*					O					O					O					O	250 h
	Grease swivel gear bearing					O				O				O				O				O	200 h
	Clean air conditioner filter					O				O				O				O				O	200 h
	Check air conditioner drive belt					O				O				O				O				O	200 h
	Clean air conditioner condenser					O				O				O				O				O	200 h
	Drain water in fuel tank											O										O	500 h
	Check battery electrolyte level											O										O	500 h
	Check air conditioner pipe and hoses																						every 2 years

* Others includes two piece boom linkage.

	Service	Elapsed Operating Hours																				Interval
		50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000	
Servicing skilled personnel or KUBOTA dealer	Inspect coolant hoses and clamps					O					O					O					O	250 h
	Check/adjust V-belt tension					O					O					O					O	250 h
	Grease pilot valve linkage					O					O					O					O	250 h
	Change engine oil and oil filter										O										O	500 h
	Change drive unit oil	◉									O										O	500 h
	Change fuel filter cartridge										O										O	500 h
	Change hydraulic return line filter element					◉					O										O	500 h
	Renewing the pilot circuit filter																				O	1000 h
	Change hydraulic oil and suction filter																				O	1000 h
	Change air filter elements																				O	1000 h
	Change air conditioner filter																					1000 h
	Change idler and track roller oil																					2000 h
	Change alternator and starter motor	Please contact your KUBOTA dealer.																				2000 h
	Inspect electric cables and connector	Please contact your KUBOTA dealer.																				annually
	Change air conditioner pipe and hoses																					every 2 years
	Change coolant																					every 2 years
	Change hydraulic hoses	Please contact your KUBOTA dealer.																				every 6 years
	Change refrigerant (gas)																					Service as required
	Safety inspection																					annually

◉ First operation

4.Greasing Front Attachments (Without Bucket Pin and Boom Swing Fulcrum)

Every 250 hrs
CAUTION

To avoid personal injury:

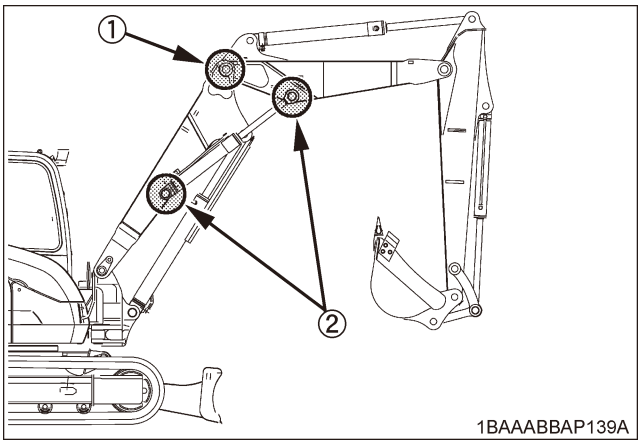
- **First lower all attachments on the ground then stop the engine and remove the key.**
- **While greasing, not to step on the bucket teeth.**

INPORTANT :

- When doing excavating work in water, generously grease the following points. After the job, grease them again.

Grease the marked grease nipples shown by arrows in the illustration below.

2 pieces boom



(1) 2nd boom bottom linkage
(2) 2nd boom cylinder boss

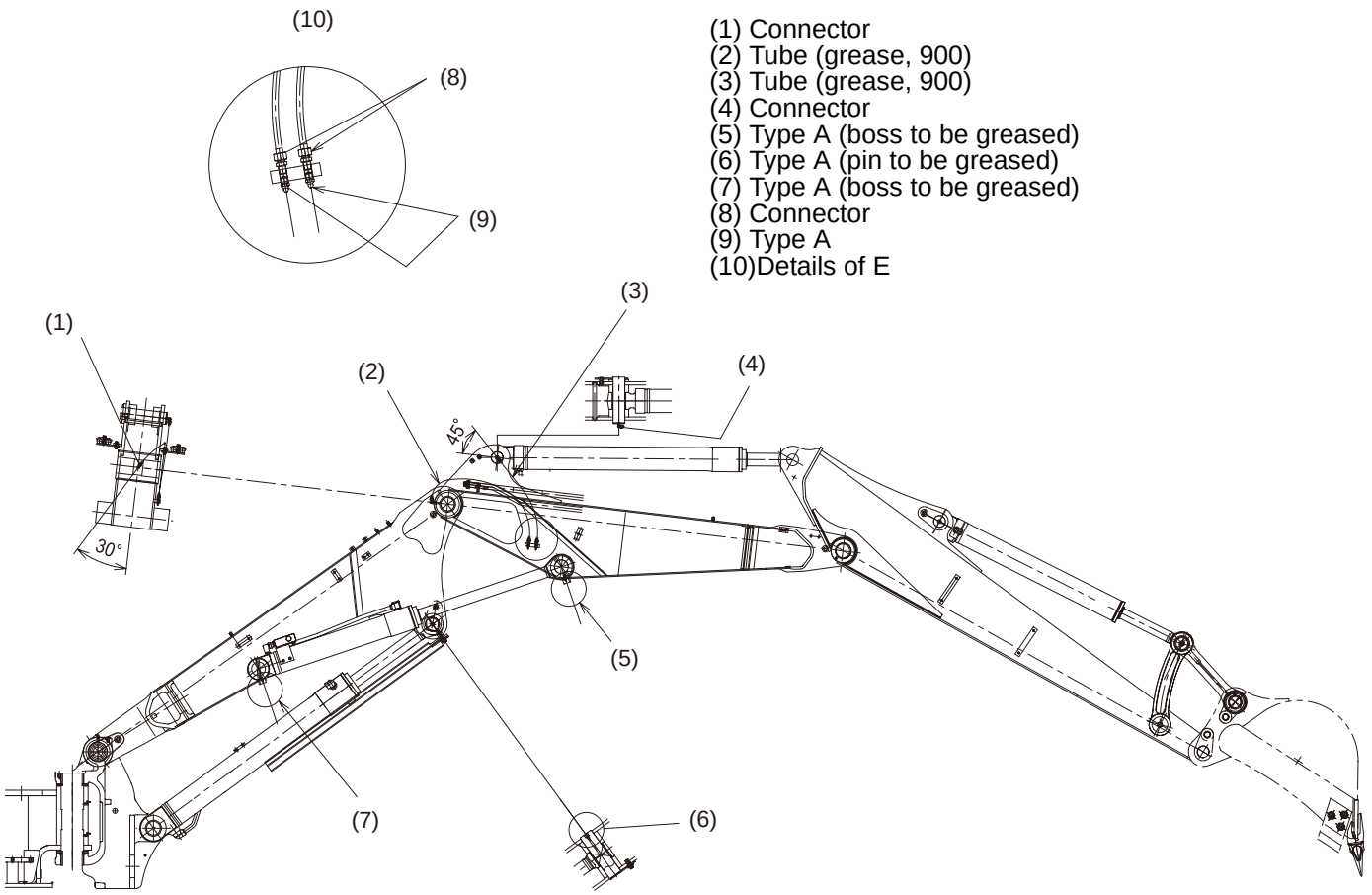
5.Front Attachment (Greasing)

1)Fitting direction of grease nipple

Type A: Straight (06611-15010)
Fit the grease nipple as shown below.

2)Greasing amount

Apply grease until it comes out of the circumference of either turning end face.



(1) Connector
(2) Tube (grease, 900)
(3) Tube (grease, 900)
(4) Connector
(5) Type A (boss to be greased)
(6) Type A (pin to be greased)
(7) Type A (boss to be greased)
(8) Connector
(9) Type A
(10)Details of E

d. Quality Specifications, 2-piece Boom-version

Machine specification : Rubber track, Auxiliary port (SP1, SP2), Wrist rest, 2100mm arm, Japan-cab, bucket, AI
(Data listed below are major different values from standard-version.

No		Specifications Items			Unit	KX080-3	Remarks
Q1		Main Speed JIS A8404					
1	1	Machine size	Total length (Transport)		mm	6930 ± 139	
					inch	272.8 ± 5.47	
	2		Total width		mm	2200 ± 22	
					inch	86.6 ± 0.9	
	4		Total height (Cabin)		mm	2540 ± 25	Include grouser height
					inch	100.0 ± 25	
2	2	Weight	Machine weight (Cabin)		kg	8800 ± 176	Fuel tank:Full Lub oil and hydraulic tank coolant to be specified. Additional weight : 200kgf (441 lbs)
					lbs	19401 ± 388	
4	1	Rear end min. turning radius			mm	1490 ± 30	
					inch	58.7 ± 1.2	
5	8	Front attachment	Max. digging radius		mm	7820 ± 117	Swing angle = 0 degree Second boom = Extended
					inch	307.9 ± 4.6	
	9		Ground level Max. digging radius		mm	7673 ± 115	
					inch	302.1 ± 4.5	
	10		Ground level Min. finish radius		mm	2684 ± 54	Bucket bottom horizontal
					inch	105.7 ± 2.1	
	11		Max. digging depth		mm	4588 ± 10.8	
					inch	180.6 ± 4.3	
	12		Max. vertical digging depth		mm	4122 ± 124	
					inch	162.3 ± 4.9	
	14		Max. digging height	Cabin	mm	8236 ± 165	
					inch	324.3 ± 6.5	
	16		Max. dump height	Cabin	mm	6208 ± 124	
					inch	244.4 ± 4.9	
	18		Max. dump height (Arm vertical)	Cabin	mm	2550 76	
					inch	100.4 3.0	
	20		Mini. turning radius	Cabin	mm	2421 ± 73	
					inch	95.3 ± 2.9	
	22		Mini. turning radius (Left swing)	Cabin	mm	1984 ± 60	
					inch	78.5 ± 22.4	
Q5		Work performance					
2	5	Boom speed	Cabin	up 1st	sec.	4.0 ± 0.3	Oil temp. 50±5°C (122±9°F) Ground to max. height (exclude cushioning)
	6			up 2nd	sec.	-	
	7			down	sec.	4.4 ± 0.3	
	8			down	sec.	-	
2-2	1	Second boom speed		crowd	sec.	4.7 ± 0.3	Arm extended, bucket dump without load.
	2			dump	sec.	5.5 ± 0.3	
7	2	Max. digging height radius	Cabin		mm	1987 ± 199	Second boom extended, Distance from swivel center
					inch	78.2 ± 7.8	
	4	Max. dump height radius	Cabin		mm	2229 ± 134	at bucket pin Second boom extended
					inch	87.9 ± 5.3	
	6	Bucket bottom height at arm vertical	Cabin		mm	3048 ± 91	Bucket horizontal Second boom extended
					inch	120.0 ± 3.6	

No		Specifications Items			Unit	KX080-3	Remarks
Q6		Swivel, swing performance					
2	1	Swivel capable slope angle		L	deg.	14, 12<	Bucket load=JIS heapedx1.8 Second boom extended
	2			R	deg.	14, 12<	
3	1	Swivel block performance	Engine stop	L	deg.	0	Bucket loaded at heaped. Slope angle at 20° 1 min engine stop. Hydraulic oil temp : 50°±5°C
	2			R	deg.	0	
	3		Engine running	L	deg.	0	Bucket loaded at heaped. Slope angle at 20° 1 min engine running. Lever lock released Hydraulic oil temp : 50°±5°C
	4			R	deg.	0	
Q7	Hydraulic performance						
1	1	Relief pressure setting		P1	kgf/cm^2	290 ± 10	At pump delivery port 50±5°C(122±9°F) Engine Max. speed
					MPa	28.4 ± 1.0	
					bar	284 ± 10	
					psi	4125 ± 142	
	2			P2	kgf/cm^2	290 ± 10	
					MPa	28.4 ± 1.0	
					bar	284 ± 10	
					psi	4125 ± 142	
	3			P3	kgf/cm^2	220 ± 10	
					MPa	21.6 ± 1.0	
					bar	216 ± 10	
					psi	3129 ± 142	
	4			P4	kgf/cm^2	40 ± 10	
					MPa	3.9 ± 1.0	
					bar	39 ± 10	
					psi	569 ± 142	
Q7	Hydraulic performance						
2	1	Cylinder oil sealing capacity	Boom	50±5°C (122±9°F)	mm	20	Arm extended, Bucket height 1m, 10 min. Bucket load=JIS heapedx1.8
					inch	0.79	
	2			95±5°C (203±9°F)	mm	20	
					inch	0.79	
	3		Arm	50±5°C (122±9°F)	mm	11	
					inch	0.43	
	4		Bucket	50±5°C (122±°F)	mm	10	
					inch	0.39	
	5		Blade	50±5°C (122±9°F)	mm	20	Arm vertical, blade cylinder extended for 10 min. engine stop."
					inch	0.79	
	6	Second boom			mm	10, 10>	
					inch	0.4, 0.4>	

No		Specifications Items			Unit	KX080-3		Remarks
Q8		Lever operating force & stroke						
1	19	Second boom pedal		R	kgf	5.8	-1.0,+1.0	Pedal edge
					N	56.9	-9.9,+10.1	
					lbf	12.8	-2.2,+2.3	
	20			L	kgf	5.8	-1.0,+1.1	
					N	56.9	-9.9,+10.1	
					lbf	12.8	-2.2,+2.3	
Q9		Stability						
1	5	STD arm, static limited load Arm length = 2100mm (82.7inch)	Bucket load to tip fully	Side	kgf	709		Front horizontal, bucket crowd. Load at arm tip end. Second boom extended. Oil temp.50±5°C (122±9°F)
					N	6953		
					lbf	1563		
	6			Front	kgf	1033		
					N	10131		
					lbf	2277		

e. Lifting Capacity

1. Lifting Capacity Chart

KX080-3 2 piece boom
1750 Arm Rubber crawler

kN (ton)

Lift point radius (m)

Lift point height (m)	MIN.	3	4	5	6	MAX.
+7						
+6	25.5 (2.60)	23.5 (2.40)	20.6 (2.10)			
+5	24.0 (2.45)	22.6 (2.30)	19.1 (1.95)	16.2 (1.65)		
+4	27.5 (2.80)	26.0 (2.65)	20.6 (2.10)	16.2 (1.65)		
+3			22.6 (2.30)	15.7 (1.60)	11.8 (1.20)	10.8 (1.10)
+2			21.1 (2.15)	15.2 (1.55)	11.3 (1.15)	10.3 (1.05)
+1			20.1 (2.05)	14.2 (1.45)	10.8 (1.10)	9.8 (1.00)
0			19.6 (2.00)	14.2 (1.45)	10.8 (1.10)	10.3 (1.05)
-1	20.6 (2.10)	27.5 (2.80)	19.6 (2.00)	13.7 (1.40)		
-2	18.1 (1.85)	19.6 (2.00)	16.7 (1.70)	11.8 (1.20)		
-3			6.9 (0.70)			

Over-front (Blade up)

KX080-3 2 piece boom
2100 Arm Rubber crawler

kN (ton)

Lift point radius (m)

Lift Point Height (m)	MIN.	3	4	5	6	MAX.
+7						
+6			18.6 (1.90)			
+5			17.7 (1.80)	16.2 (1.65)		
+4	23.5 (2.40)	23.0 (2.35)	19.1 (1.95)	16.7 (1.70)	11.8 (1.20)	11.3 (1.15)
+3	32.4 (3.30)	29.9 (3.05)	21.6 (2.20)	16.2 (1.65)	11.8 (1.20)	9.8 (1.00)
+2			21.6 (2.20)	15.2 (1.55)	11.3 (1.15)	9.3 (0.95)
+1			20.1 (2.05)	14.7 (1.50)	10.8 (1.10)	9.3 (0.95)
0	21.6 (2.20)	23.0 (2.35)	19.1 (1.95)	14.2 (1.45)	10.8 (1.10)	9.3 (0.95)
-1	20.1 (2.05)	30.4 (3.10)	19.1 (1.95)	13.7 (1.40)	10.8 (1.10)	10.3 (1.05)
-2	26.0 (2.65)	23.5 (2.40)	18.6 (1.90)	13.7 (1.40)		
-3		13.2 (1.35)	10.8 (1.10)			

Over-front (Blade up)

kN (ton)

Lift point radius (m)

Lift point height (m)	MIN.	3	4	5	6	MAX.
+7						
+6	25.5 (2.60)	23.5 (2.40)	20.6 (2.10)			
+5	24.0 (2.45)	22.6 (2.30)	19.1 (1.95)	17.7 (1.65)		
+4	27.5 (2.80)	26.0 (2.65)	20.6 (2.10)	17.7 (1.65)		
+3			23.0 (2.35)	18.6 (1.90)	15.7 (1.60)	15.2 (1.55)
+2			26.0 (2.65)	19.6 (2.00)	15.7 (1.60)	14.7 (1.50)
+1			27.0 (2.75)	20.1 (2.05)	15.7 (1.60)	13.7 (1.40)
0			25.5 (2.60)	19.1 (1.95)	14.7 (1.50)	13.2 (1.35)
-1	20.6 (2.10)	27.5 (2.80)	22.1 (2.25)	17.2 (1.75)		
-2	18.1 (1.85)	19.6 (2.00)	16.7 (1.70)	11.8 (1.20)		
-3			6.9 (0.70)			

Over-front (Blade up)

kN (ton)

Lift point radius (m)

Lift Point Height (m)	MIN.	3	4	5	6	MAX.
+7						
+6			18.6 (1.90)			
+5			17.7 (1.80)	16.2 (1.65)		
+4	23.5 (2.40)	23.0 (2.35)	19.1 (1.95)	16.7 (1.70)	14.7 (1.50)	14.7 (1.50)
+3	32.4 (3.30)	29.9 (3.05)	21.6 (2.20)	17.7 (1.80)	15.2 (1.55)	14.2 (1.45)
+2			25.0 (2.55)	19.1 (1.95)	15.7 (1.60)	13.7 (1.40)
+1			26.5 (2.70)	19.6 (2.00)	15.7 (1.60)	13.2 (1.35)
0	21.6 (2.20)	23.0 (2.35)	26.0 (2.65)	19.6 (2.00)	15.2 (1.55)	12.3 (1.25)
-1	20.1 (2.05)	30.9 (3.15)	23.5 (2.40)	17.7 (1.80)	13.2 (1.35)	11.8 (1.20)
-2	26.0 (2.65)	23.5 (2.40)	18.6 (1.90)	14.2 (1.45)		
-3		13.2 (1.35)	10.8 (1.10)			

Over-front (Blade up)

kN (ton)

Lift point radius (m)

Lift point height (m)	MIN.	3	4	5	6	MAX.
+7						
+6	25.5 (2.60)	23.5 (2.40)	18.1 (1.85)			
+5	24.0 (2.45)	22.6 (2.30)	18.6 (1.90)	12.3 (1.25)		
+4	27.5 (2.80)	26.0 (2.65)	18.1 (1.85)	12.3 (1.25)		
+3			17.2 (1.75)	11.8 (1.20)	8.8 (0.90)	8.3 (0.85)
+2			15.7 (1.60)	11.3 (1.15)	8.3 (0.85)	7.4 (0.75)
+1			14.7 (1.50)	10.8 (1.10)	8.3 (0.85)	7.4 (0.75)
0			14.2 (1.45)	10.3 (1.05)	7.8 (0.80)	7.4 (0.75)
-1	20.6 (2.10)	21.6 (2.20)	14.2 (1.45)	10.3 (1.05)		
-2	18.1 (1.85)	19.6 (2.00)	14.2 (1.45)	10.3 (1.05)		
-3			6.9 (0.70)			

Over-front (Blade up)

kN (ton)

Lift point radius (m)

Lift Point Height (m)	MIN.	3	4	5	6	MAX.
+7						
+6			18.6 (1.90)			
+5			17.7 (1.80)	12.7 (1.30)		
+4	23.5 (2.40)	23.0 (2.35)	18.6 (1.90)	12.7 (1.30)	9.3 (0.95)	8.3 (0.85)
+3	30.4 (3.10)	27.5 (2.80)	17.2 (1.75)	12.3 (1.25)	8.8 (0.90)	7.4 (0.75)
+2			15.7 (1.60)	11.3 (1.15)	8.3 (0.85)	6.9 (0.70)
+1			14.7 (1.50)	10.8 (1.10)	8.3 (0.85)	6.9 (0.70)
0	21.6 (2.20)	21.1 (2.15)	13.7 (1.40)	10.3 (1.05)	7.8 (0.80)	6.9 (0.70)
-1	20.1 (2.05)	21.1 (2.15)	13.7 (1.40)	10.3 (1.05)	7.8 (0.80)	7.4 (0.75)
-2	26.0 (2.65)	21.6 (2.20)	13.7 (1.40)	10.3 (1.05)		
-3		13.2 (1.35)	10.8 (1.10)			

Over-front (Blade up)

2. Safety Precautions About Object Handling Application

1. Don't use of the excavator to lift loads without suitable load lifting attachments.
   Object handing application is prohibited unless otherwise a hydraulic excavator meet the safety requirements of ISO 8643. 1987, ISO 10567 (1992) and EN474 (2006).

2. If you do the object handling application, the suitable device should be equipped as the followings.
   The lifting device (Example:Hook) which accorded to EN474-1 should be equipped, like the followings.

   2-1. Lifting Device
   - The lifting device has to be safely mounted to the attachment or other parts of the excavator to prevent the rope from unhooking.
   - When mounting the device to an attachment or the equipment, ensure visibility between the operator and the guide [person who attaches the rope to the lifting device].
   - Position the lifting device to make sure that the rope will not be deflected in its vertical direction by other machine parts.
   - The lifting device's shape and position should guarantee that the rope can not be deflected.
   - When positioning the lifting device, make sure that no restrictions (such as jamming) occur during normal operation or when working with objects.
   - Trained personnel may attach load support devices (such as hooks) by welding. For such tasks, contact your authorized KUBOTA dealer.
   - At any attachment or boom part of the lifting device should be firm enough to with hold 250% of the nominal lifting capacity.

3. When lifting loads using the excavator with a lifting capacity (acc.to ISO 10567) of more than 1000kg or tipping moment equal/more than 40000N·m, the excavator should be equipped with additional devices described in EN474-5, like the followings.

   3-1. Load safety device
   - An overload warning device.
     Acoustic or visual warning device for the operator when the rated load or the corresponding tilting moment has been exceeded.
   - A boom lowering control device shall conform to ISO 8643:1997.

4 If you do object handling application ;
- Even with the all above conditions satisfied, do not lift loads exceeding the values given in the lifting capacity tables.

3. Safety Precautions About Lifting Capacity

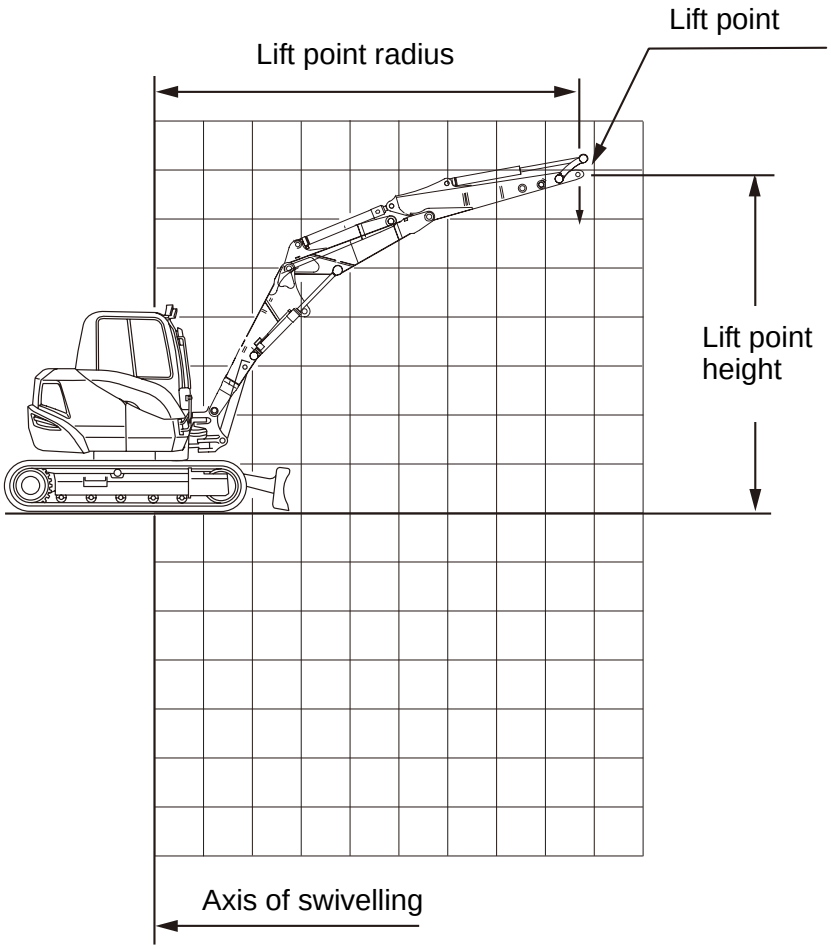
1. The lifting capacities are based on ISO 10567 and do not exceed 75% of the static tilt load of the machine or 87% of the hydraulic lifting capacity of the machine.
2. The conditions are as follows.
   (1) The load point corresponds to the front pin part of the arm that is fully extended.
   (2) The machine positions are; (i) over - front (Blade down), (ii) over - front (Blade up), and (iii) over - side.
   (3) The operating cylinder is the boom cylinder.
3. The bucket of the excavator, the hook, the sling and other lifting accessories should be included for the loads.

Machine conditions:
No bucket, all others according to the standard regulations.

WARNING

To avoid personal injury or death:

- **No loads greater than those values mentioned in the lifting capacity tables are to be lifted.**
- **No loads greater than 1 ton are to be lifted when no safety devices are not attached to boom and dozer blade cylinders.**
- **The values mentioned in the table are valid only on level and hard grounds. When lifting on soft ground, the machine can tip over due to the load being concentrated on only one side of the machine.**
- **The table values are calculated at the end of the arm without the bucket. In order to find the allowable loads for machines with bucket, the bucket weight must be subtracted from the values in the table.**



4. FYI (For Your Information) : Relevant Safety Regulations

EN474-1(2006) - safety, general requirement -

5 Safety requirements and/or measures

5.12 Object handling

5.12.1 Lifting device for object handling

The lifting device may be either fixed or removable.

The device may be located on a bucket, on an arm or any other part of the machine or may be a separate device and shall be;

(1)so located and designed that the risk of being damaged during normal earth moving operations is minimized;

(2)Designed so that hooking device prevents unintentional unhooking of the load.

(3)The lifting device shall meet the requirements of Annex E.

Annex E

Shows strength ,assembly and operation about lifting device test methods. Operator's manual shall be supplied by the manufacturer of the lifting device and shall include the following information for use of the lifting device.

5.12.2 Lowering control device

Machine used in object handling application, which require a boom lowering control device, shall conform with ISO 8643;1997.

7.2 Operator's manual

7.2.3 Instruction and information for use and maintenance of the machine

18)safety instructions for object handling application

EN474-5(2006) - safety requirement for hydraulic excavator -

5 Safety requirements and/or measures

5.6 Stability and safety devices

5.6.4 Object handling application

5.6.4.3 Rated lift capacity table in object handling

The table shall be available at the operator's station for each object-handling configulation specified in OPM. This capacity should be determined according to ISO10567(1992).

5.6.4.3 Load safety devices

In case that either ≧1000kg or ≧40000Nm, shall be equiped with

(1)acoustic or visual warning device.....

(2)boom lowering control device in accordance with ISO8643;1997

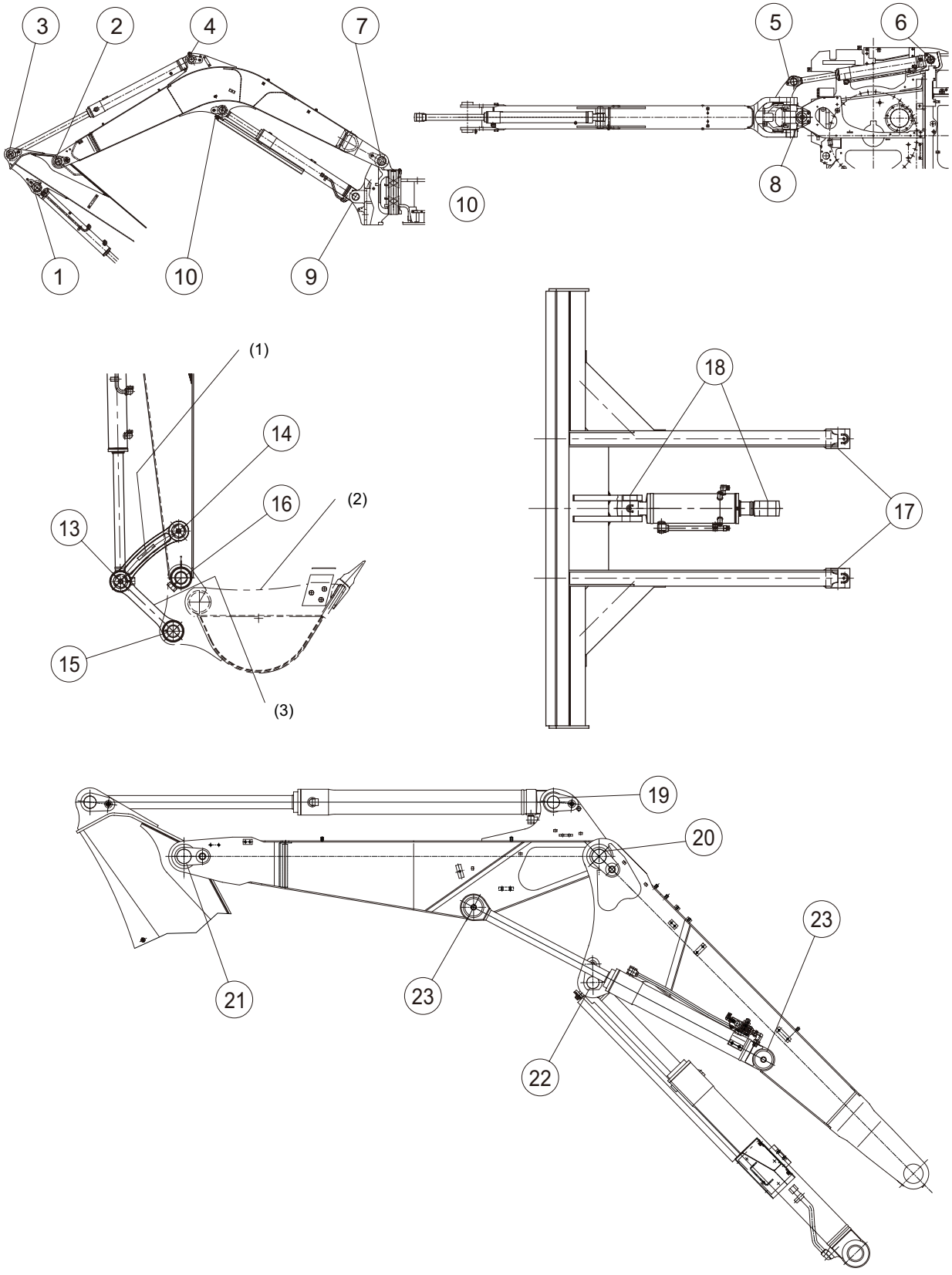
While doing object handling by earth moving machinery, lifting device(hook,etc.) shall be in accordance with EN and safety instruction for object handling shall be noted in OPM.

While doing object handling by hydraulic excavator, preparation of lifting capacity information on operator's space as well as observance the above EN474-1. In case that either lifting capacity is ≧1000kg or tilting momentum is ≧40000Nm, acoustic or visual warning device shall be equipped and boom lowering device(followed ISO8643) shall be equiped.

B. Machine Body

a. Specifications

1. Location and size of front pins and bushing



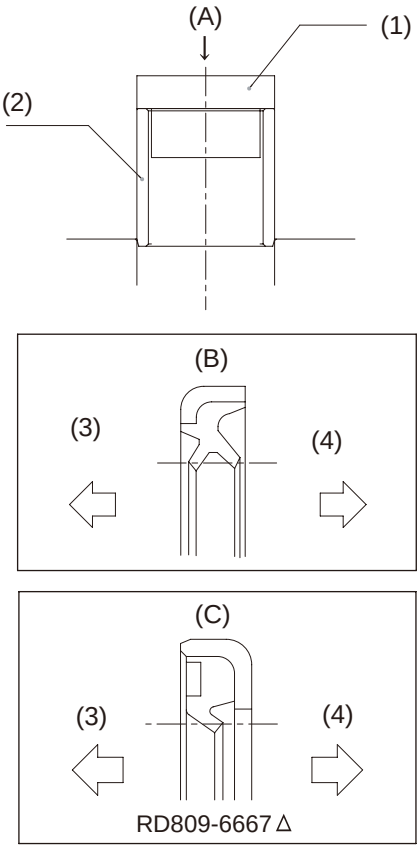
(Unit : mm)

No.	Location	Pin size Dia. x Length	Pin size Inner x Outer x Length	Pin size S.D. x Outer x Width
①	Arm assy-Bucket cylinder bottom	65 x 151		Cylinder
②	Arm assy-boom assy	70 x 332	70 x 82 x 80 (CAC)	70 x 82 x 06
③	Arm assy-arm cylinder rod	60 x 175		Cylinder
④	Boom assy-boom cylinder bottom	60 x 226		Cylinder
⑤	Swing bracket-swing cylinder rod	70 x 168	70 x 82 x 36 (SC) 70 x 82 x 45 (SC)	Cylinder
⑥	Swivel frame-swing cylinder bottom	70 x 183		Cylinder
⑦	Swing bracket-boom assy	80 x 437	80 x 95 x 80 (CAC)	80 x 95 x 08
⑧	Swing bracket-swivel frame	100 x 474	100 x 115 x 64 (SC) 100 x 115 x 61 (SC)	100 x 115 x 08 (2)
⑨	Swing bracket-boom cylinder botton	70 x 200	70 x 82 x 49	Cylinder
⑩	Boom assy-boom cylinder rod	70 x 226		Cylinder
⑬	Bucket link 1, 2, 3-bucket cylinder	60 x 284	60 x 70 x 52 (CAC)	60 x 70 x 04
⑭	Bucket link 2, 3-arm assy	60 x 284	60 x 70 x 60 (CAC)	60 x 70 x 04
⑮	Bucket link 1-bucket	60 x 333	60 x 70 x 60 (CAC)	60 x 70 x 04
⑯	Arm assy-bucket	60 x 333	60 x 70 x 60 (CAC)	60 x 70 x 04
⑰	Blade arm-track frame	60 x 167	-	Cylinder
⑱	Blade cylinder	70 x 147		Cylinder
⑲	Boom 2 assy-arm cylinder bottom	60 x 226		
⑳	Boom 1 assy-boom 2 assy	70 x 232	70 x 82 x 80	70 x 82 x 06 (2)
㉑	Boom 2 assy-arm assy	70 x 332		
㉒	Boom 1 assy-boom cylinder rod	70 x 258		
㉓	Boom 1 assy-boom 2 cylinder bottom	70 x 520	70 x 82 x 52	70 x 82 x 06 (4)
㉓	Boom 2 assy-boom 2 cylimder rod	70x 520	70 x 82 x 52	70 x 82 x 06 (4)

CAC = Copper alloy castings, SC = Carbon steel, SD = Shaft diameter

2.Main Parts Weight

No.	Name	Weight : kgf (lbs)	Code No.	Application
1	Standard weight	870 (1918)	RD890-48118	Standard machine + attachment
2	Heavy weight	1100 (2425)	RD809-48471	
3	Additional weight	200 (441)	RD809-48211	To be added upon attachment
4	Heavy + additional weight	1300 (2866) (1100 + 200)	RD809-48471(1100k) + RD809-48211(200k)	2-piece boom
5	First boom assy	300 (661)	RD809-66111	
6	Second boom assy	205 (452)	RD809-66211	
7	First boom cylinder	100 (220)	RD809-67503	
8	Second boom cylinder	56 (123)	RD809-67201 RD809-67301	
9	Second boom pin	10.6 (23.4)	RD809-66562	
10	Rubber track, 450 mm	440 (882)	RD809-22310	
11	Iron track, 450 mm	428 (945)	RD809-22201	
12	Iron track, 600 mm	941 (1082)	RD809-22401	
13	Arm assy (1750)	163 (359)	RD809-66604	
14	Arm assy (2100)	184 (406)	RD809-67104	
15	Arm assy (2100, thumb)	195 (430)	RD809-67903	
16	STD bucket (KBT)	177 (390)		



b. Front Pins, Bushings and Shims

1. Installation Method

1) Fitting the bushings

Using a block or the like, fit the bushings into position.

* Do not hit the bushings directly.

2) Bushing setup dimensions

(1) Without the dust seals

Make sure the bushings do not stretch out of both sides.

(2) With the dust seals

Ensure the dust seal setup space at both sides.

(It is possible to control the press-fitting dimension instead.)

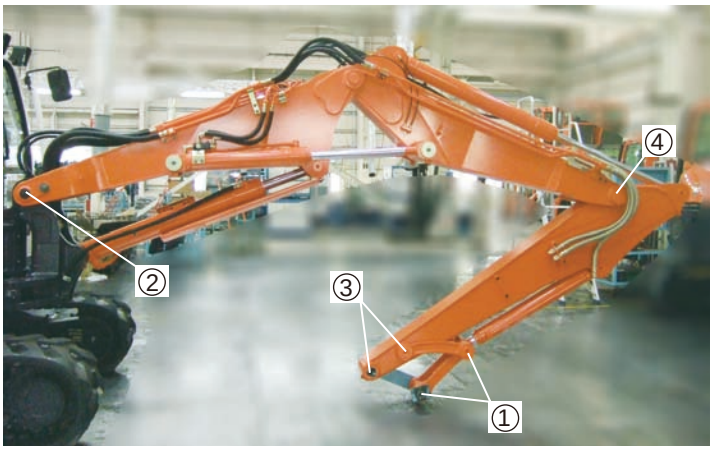
3) Dust seal fitting direction

Fit the dust seals as specified in the figure.

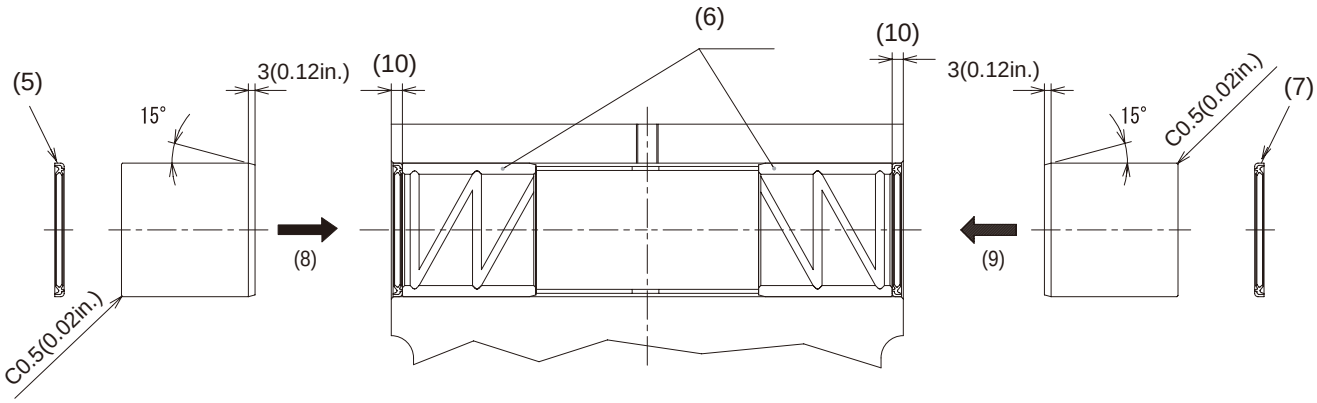
4) Bushing setup direction

Insert the bushings from the 15°-chamfered side.

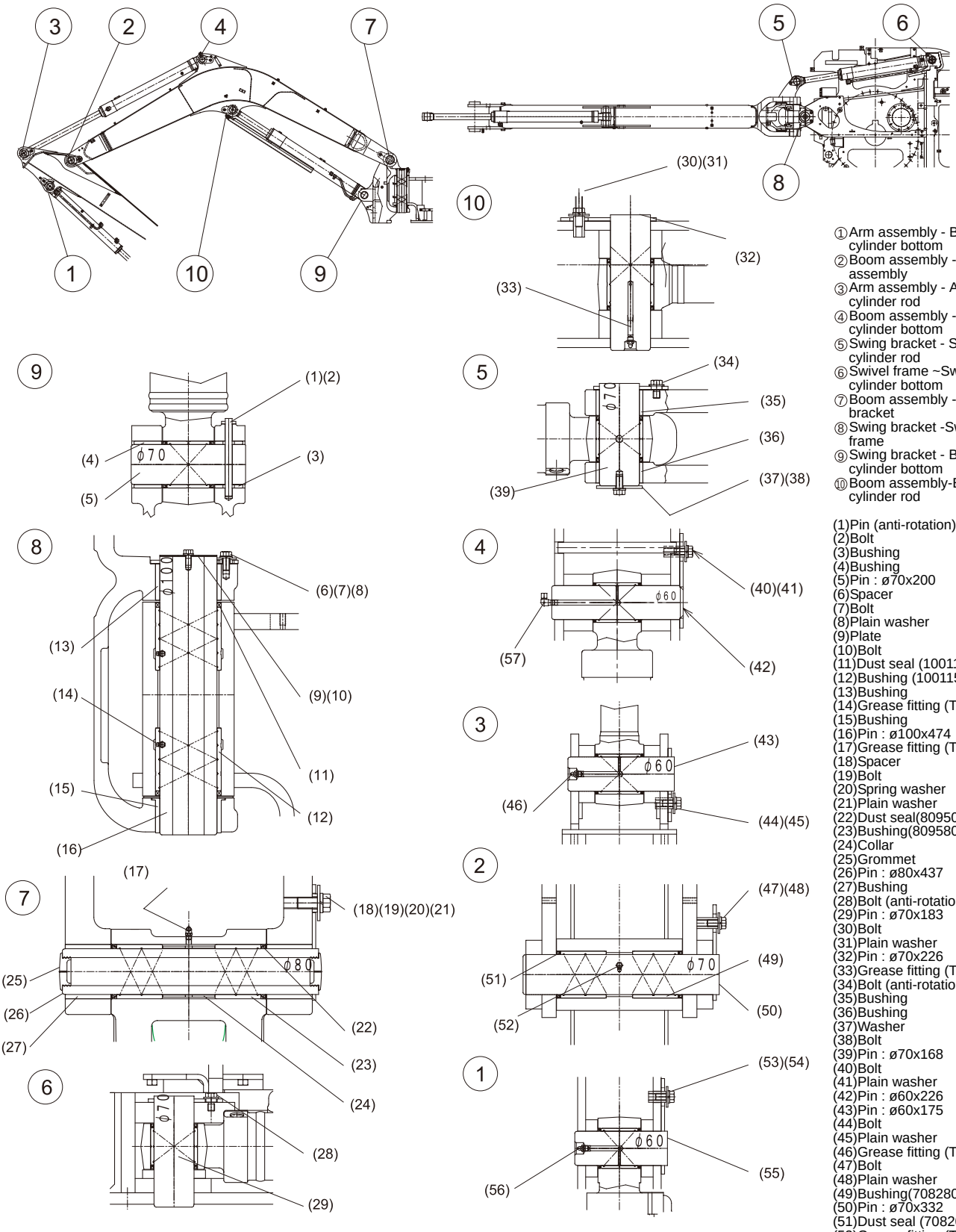
No.	With the dust seals	Seal width, S	Installing direction of dust seal
①	* Bucket link 1, 6 pcs.	5.0mm(0.20in.)	(B)
②	* Swing bracket, 2 pcs. Boom support	10.0mm(0.39in.)	(B)
③	* Arm end, 4 pcs.	4.5mm(0.18in.)	(C)
④	* Arm support, 2 pcs.	6.5mm(0.26in.)	(B)



(A)Insert in this direction.
(B)Enlarged view of dust seal (Most of the front links)
(C)Enlarged view of dust seal (Arm end boss L & R only)
(1)Block
(2)Bushing
(3)Bushing side
(4)Outside
(5)Dust seal
(6)Bushing
(7)Dust seal
(8)Bushing setup direction
(9)Bushing setup direction
(10)More than S



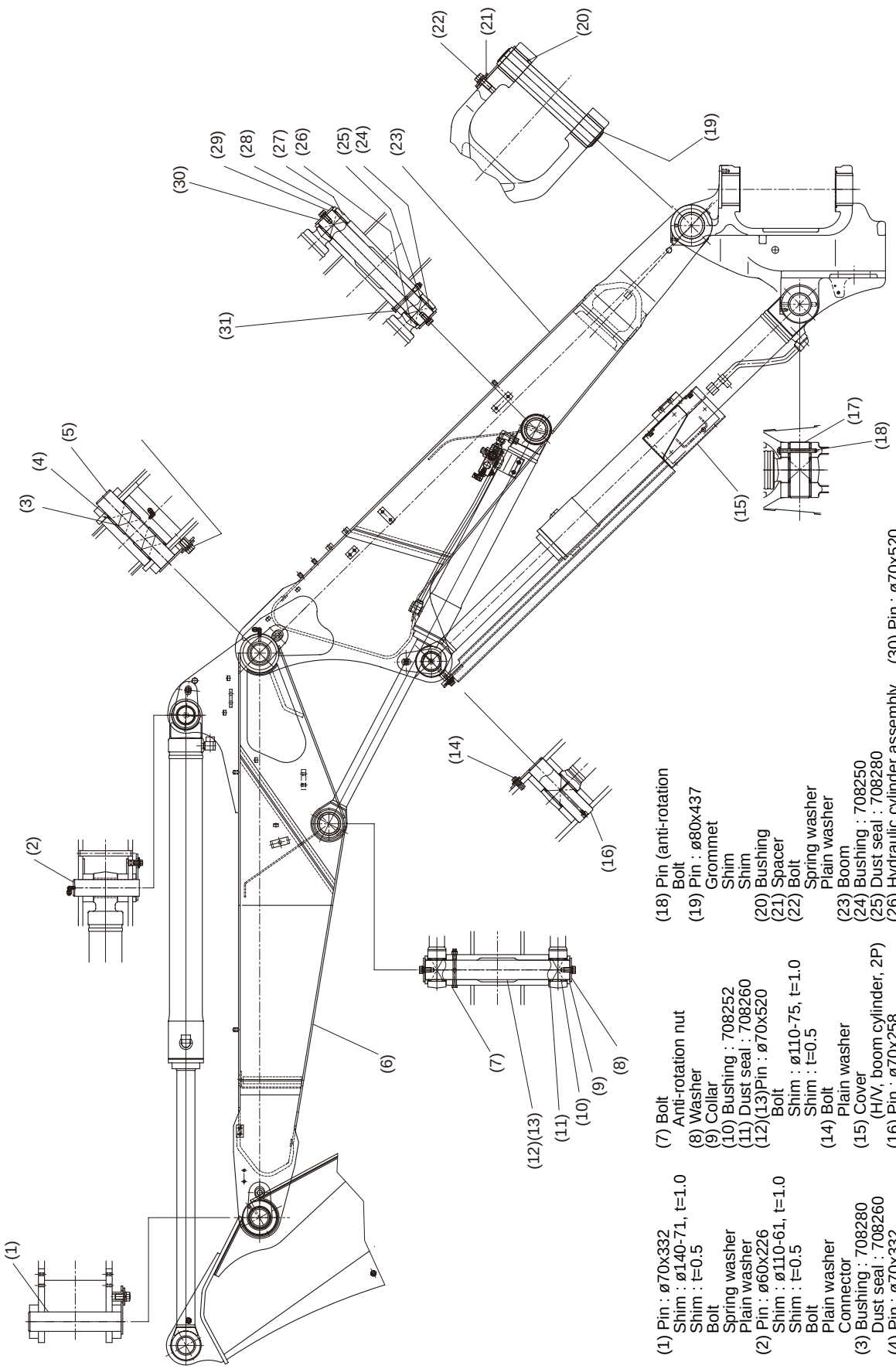
2. Pins and Bushihgs : Mono-boom



① Arm assembly - Bucket cylinder bottom
② Boom assembly - Arm assembly
③ Arm assembly - Arm cylinder rod
④ Boom assembly - Arm cylinder bottom
⑤ Swing bracket - Swing cylinder rod
⑥ Swivel frame ~Swing cylinder bottom
⑦ Boom assembly - Swing bracket
⑧ Swing bracket -Swivel frame
⑨ Swing bracket - Boom cylinder bottom
⑩ Boom assembly-Boom cylinder rod

(1) Pin (anti-rotation)
(2) Bolt
(3) Bushing
(4) Bushing
(5) Pin : ø70x200
(6) Spacer
(7) Bolt
(8) Plain washer
(9) Plate
(10) Bolt
(11) Dust seal (10011508)
(12) Bushing (100115110)
(13) Bushing
(14) Grease fitting (Type C)
(15) Bushing
(16) Pin : ø100x474
(17) Grease fitting (Type B)
(18) Spacer
(19) Bolt
(20) Spring washer
(21) Plain washer
(22) Dust seal(809508)
(23) Bushing(809580)
(24) Collar
(25) Grommet
(26) Pin : ø80x437
(27) Bushing
(28) Bolt (anti-rotation)
(29) Pin : ø70x183
(30) Bolt
(31) Plain washer
(32) Pin : ø70x226
(33) Grease fitting (Type A)
(34) Bolt (anti-rotation)
(35) Bushing
(36) Bushing
(37) Washer
(38) Bolt
(39) Pin : ø70x168
(40) Bolt
(41) Plain washer
(42) Pin : ø60x226
(43) Pin : ø60x175
(44) Bolt
(45) Plain washer
(46) Grease fitting (Type A)
(47) Bolt
(48) Plain washer
(49) Bushing(708280)
(50) Pin : ø70x332
(51) Dust seal (708206)
(52) Grease fitting (Type B)
(53) Bolt
(54) Plain washer
(55) Pin : ø60x151
(56) Grease fitting (Type A)
(57) Connector

3. Pins and Bushings : Two-piece Boom



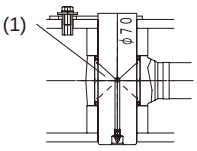
(1) Pin : ø70x332
Shim : ø140-71, t=1.0
Shim : t=0.5
Bolt
Spring washer
Plain washer
(2) Pin : ø60x226
Shim : ø110-61, t=1.0
Shim : t=0.5
Bolt
Plain washer
Connector
(3) Bushing : 708280
Dust seal : 708260
(4) Pin : ø70x332
Shim : ø140-71, t=1.0
Shim : t=0.5
(5) Bolt
Spring washer
Plain washer
(6) Boom

(7) Bolt
Anti-rotation nut
(8) Washer
(9) Collar
(10) Bushing : 708252
(11) Dust seal : 708260
(12)(13)Pin : ø70x520
Bolt
Shim : ø110-75, t=1.0
Shim : t=0.5
(14) Bolt
Plain washer
(15) Cover
(H/V, boom cylinder, 2P)
(16) Pin : ø70x258
Grease nipple
Shim : ø110-75, t=1.0
Shim : t= 0.5
(17) Pin: ø70x200
Shim
Shim

(18) Pin (anti-rotation
Bolt
(19) Pin : ø80x437
Grommet
Shim
Shim
(20) Bushing
(21) Spacer
(22) Bolt
Spring washer
Plain washer
(23) Boom
(24) Bushing : 708250
(25) Dust seal : 708280
(26) Hydraulic cylinder assembly
(boom 2L)
(27) Hydraulic cylinder assembly
(boom 2R)
(28) Collar
(29) Washer

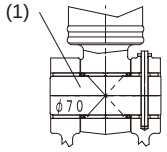
(30) Pin : ø70x520
Bolt
Shim : ø110-75, t=1.0
Shim : t=0.5
(31) Bolt
Anti-rotation nut

⑩ Boom assembly - Boom cylinder



Shim (1.0, 110-75)
Shim (0.5, 110-75)
To be selected

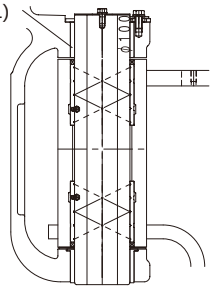
⑨ Swing bracket - Boom cylinder



Shim (1.0, 140-71)
Shim (0.5, 140-71)
To be selected

⑧ Swing bracket - Swivel frame

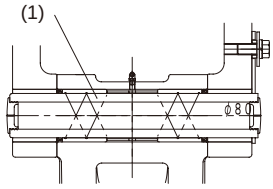
Top
Thrust collar (3,2)
↓
Fit with the groove downward.



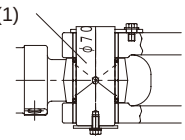
Bottom
Thrust collar (3.5)
Thrust collar (3.2)
To be selected

⑦ Boom assembly - Swing bracket

Shim (1.0, 150-81)
Shim (0.5, 150-81)
To be selected

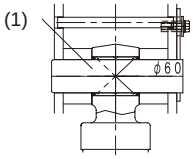


⑤ Swing bracket - Swing cylinder



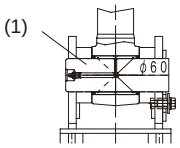
Shim (1.0, 120-71)
Shim (0.5, 120-71)
To be selected

④ Boom assembly - Arm cylinder



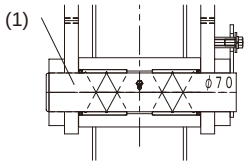
Shim (1.0, 110-61)
Shim (0.5, 110-61)
To be selected

③ Arm assembly - Arm cylinder



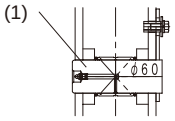
Shim (1.0, 110-61)
Shim (0.5, 110-61)
To be selected

② Boom assembly - Arm assembly



Shim (1.0, 140-71)
Shim (0.5, 140-71)
To be selected

① Arm assembly - Bucket cylinder



Shim (1.0, 110-61)
Shim (0.5, 110-61)
To be selected

4.Shim and Thrust Collar Installation

1.Clearance at the front

*Gap in thrust direction at each support pin : Less than 0.6 mm(0.02inch)
*If over 0.6 mm(0.02inch), add a shim to readjust the gap. (See the figure for proper shims.)

2.Vertical clearance between swivel frame and swing bracket

+0.1~+1.1mm(0.004~0.04inch)

3.Pin lock bolt applying direction

Apply the bolts as shown at left.

4.Direction of the thrust collar on top of the swing support

Face the groove toward the swivel frame.

5.Fitting the thrust collars

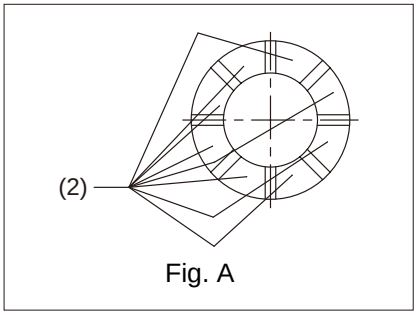


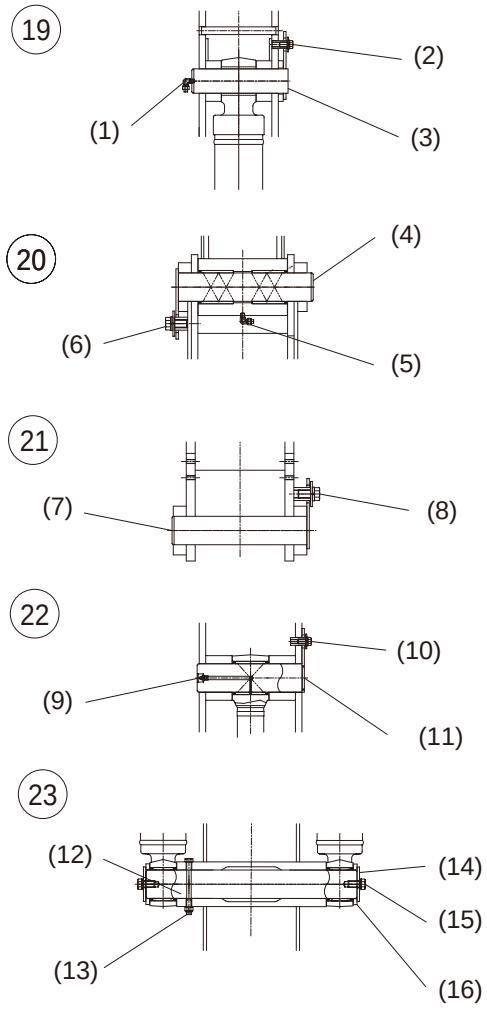
Fig. A

1)Install the grooved thrust collar (with the groove downward) at the top. Apply grease at 8 locations on both sides. (See Fig. A.) (Molybdenum anti-seizure compound may be used instead.)

2)Prepare two different-thickness thrust collars for the bottom. Try the 3.5 mm thick one first to see if it fits on smoothly. If not, use the 3.2 mm thick one.
(Be sure to select a suitable thrust collar.)

(1)Pin
(2)Apply grease

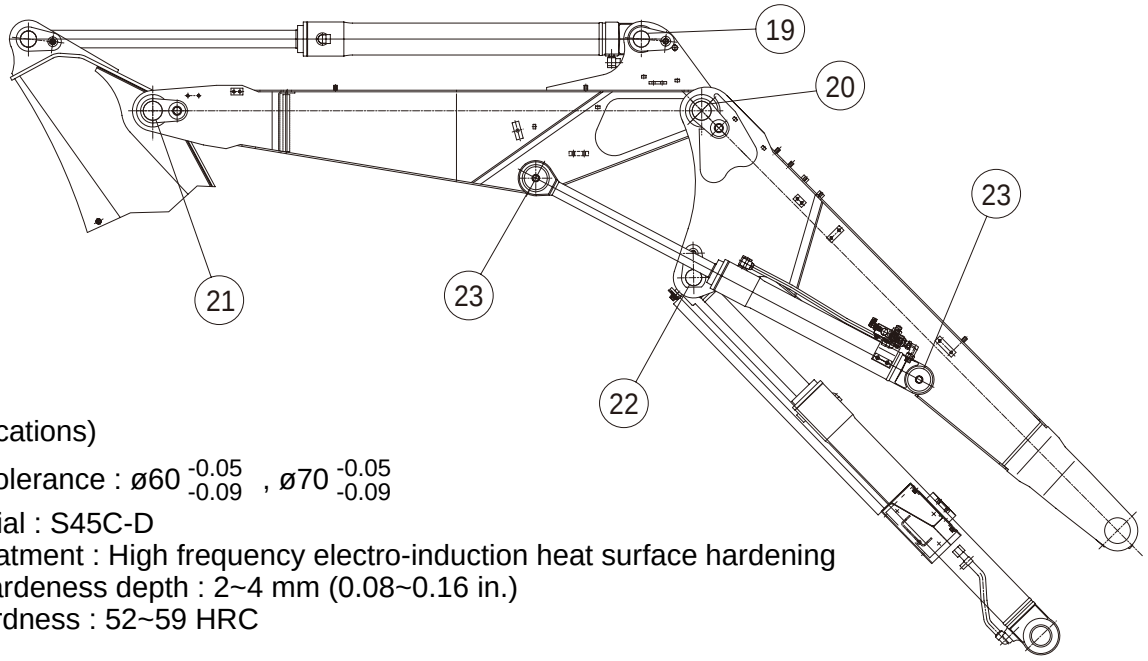
5. Front Attachment : Two-piece Boom (Bushing, Pin and Shim)



⑲ Boom 2 assembly - Arm cylinder bottom
⑳ Boom 1 assembly - Boom 2 assembly
㉑ Boom 2 assembly - Arm assembly
㉒ Boom 1 assembly - Boom cylinder rod
㉓ Boom 1 & 2 assemblies - 2P boom cylinder

(1) Connector
(2) Bolt
Plain washer
(3) Pin : ø60 x L266
Shim : t=1.0, 0.5 ø110-ø61
(4) Pin : ø70 x L332
(5) Connector
(6) Bolt
Spring washer
Plain washer
Shim : t=1.0, 0.5 ø140-ø71
(7) Pin : ø70 x L332
(8) Bolt
Spring washer
Plain washer
Shim : t=1.0, 0.5 ø140-ø71
(9) Grease nipple (type A)
(10) Bolt
Plain washer
(11) Pin : ø70 x L258
Shim : t=1.0, 0.5 ø110-ø75
(12) Pin : ø70 x L520
(13) Bolt
Anti-rotation nut
(14) Washer
(15) Bolt
(16) Collar : t=9.0, ø70-110
Shim : t=1.0, 0.5 ø110-ø75

Note:Shims are to be inserted selectively to readjust the gap less then 0.6 mm (0.02 inch)

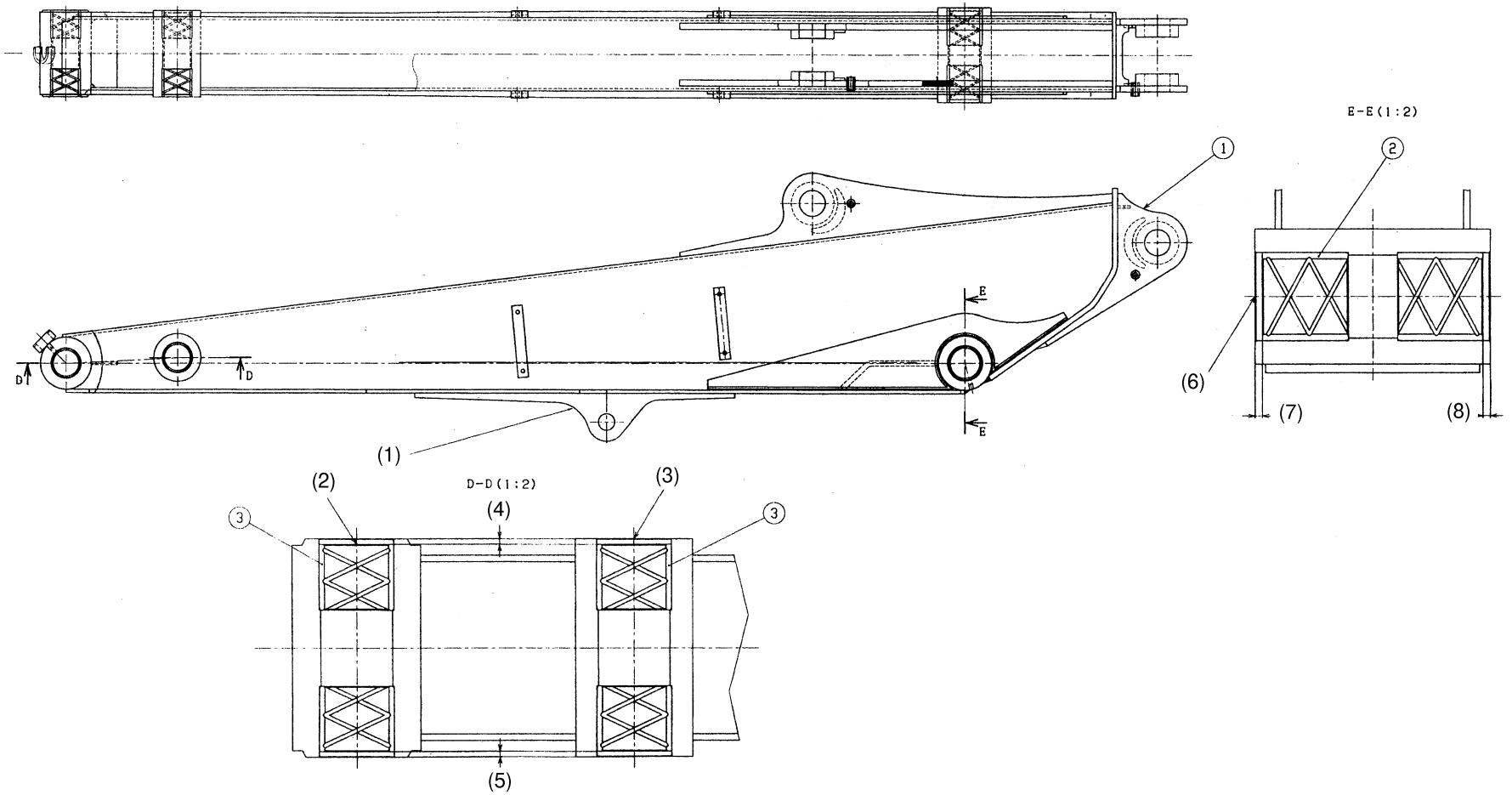


(Pin specifications)

New pin's tolerance : ø60 $^{-0.05}_{-0.09}$, ø70 $^{-0.05}_{-0.09}$

Pin's material : S45C-D
Surface treatment : High frequency electro-induction heat surface hardening
Effective hardeness depth : 2~4 mm (0.08~0.16 in.)
Surface hardness : 52~59 HRC

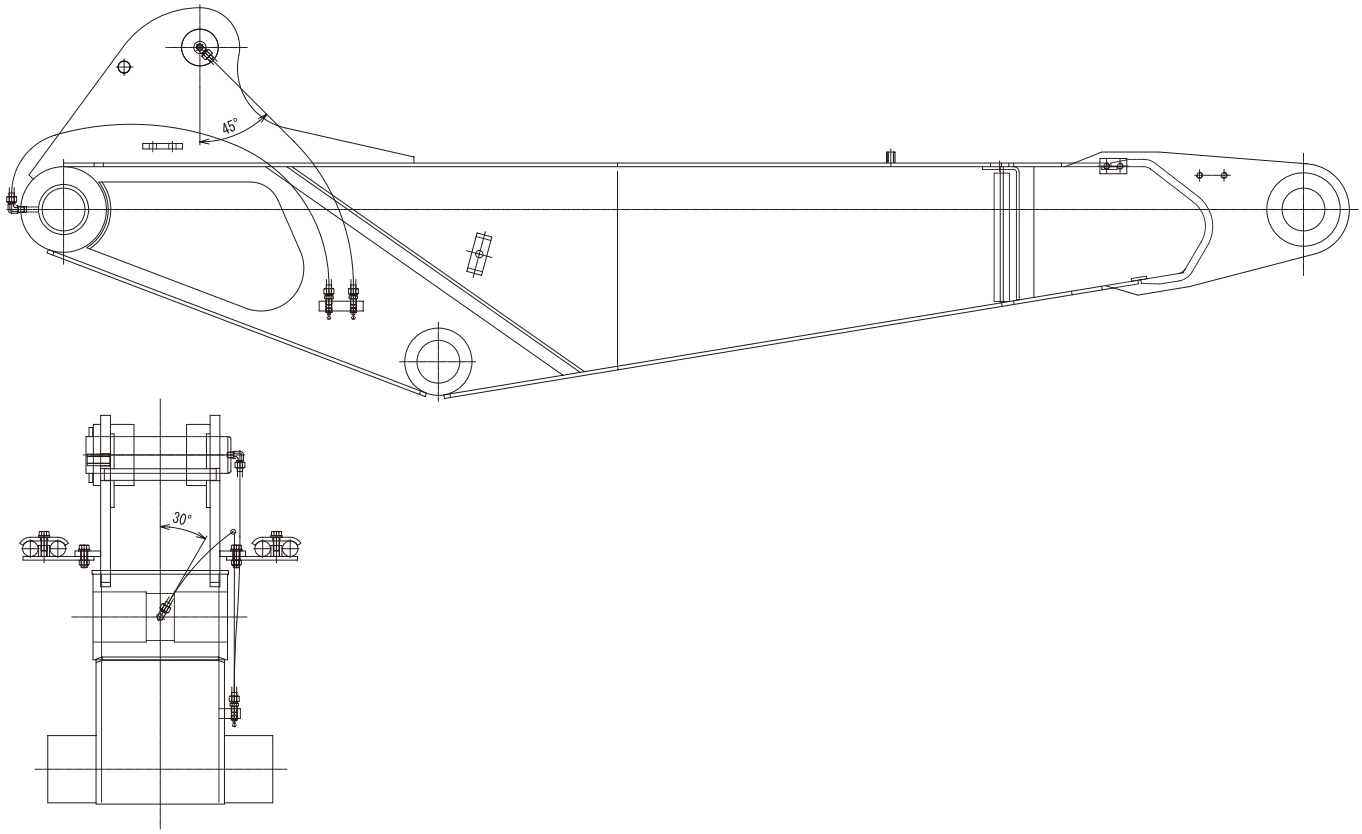
6.Arm Assy



Arm assembly (2100, Thumb)	Arm assembly (2100)	Arm assembly (1750)	Part No.	No.	Name of parts	Material	Q'ty	Weight (kgf)
O	O	O	RD809-66651	3	Bush (607060)	CAC304C	4	0.378
O	O	O	RD809-66621	2	Bush (708280)	CAC304C	2	0.716
O			RD809-67913	1	Arm (2100, Thumb)	SM570*ETC	1	192.5
	O		RD809-66614	1	Arm (2100)	SM570*ETC	1	161.1
		O	RD809-67114	1	Arm (1750)	SM570*ETC	1	182.7

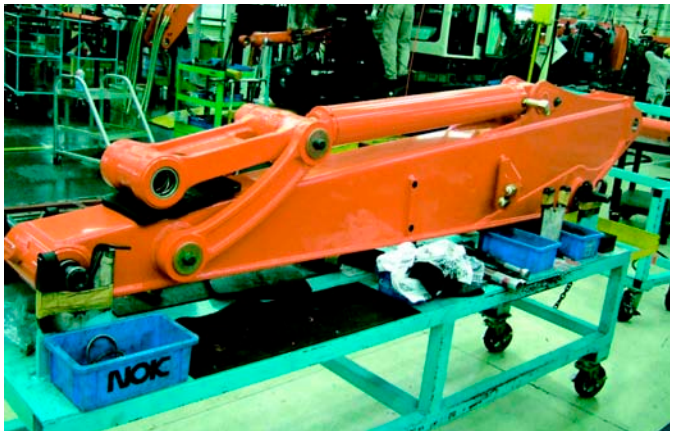
(1)Thumb bracket provided on RD809-6791(3) only
(2)59.95 dia. shaft to be smoothly passed
(3)59.95 dia. shaft to be smoothly passed
(4)Over 4.5
(5)Over 4.5
(6)59.95 dia. shaft to be smoothly passed
(7)Over 6.5
(8)Over 6.5

7. Grease Nipple Installation



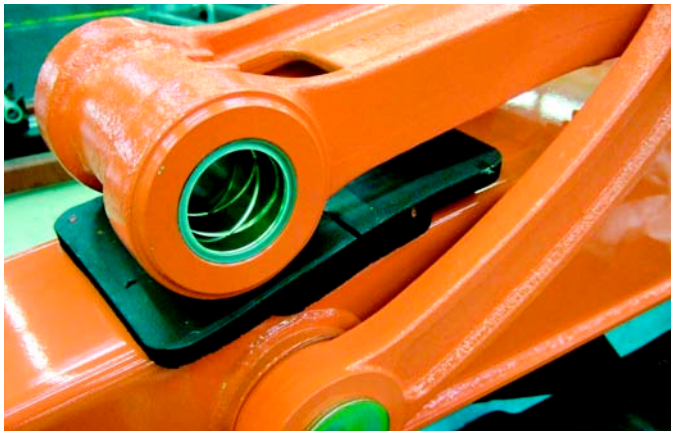




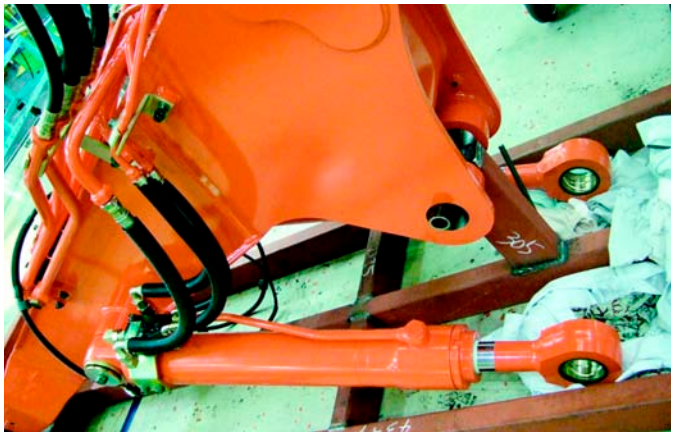


8. 2-piece Boom Mounting Procedure

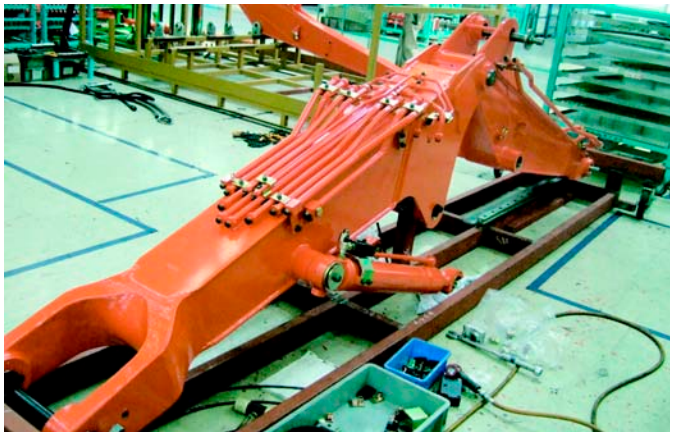
1) Arm assy



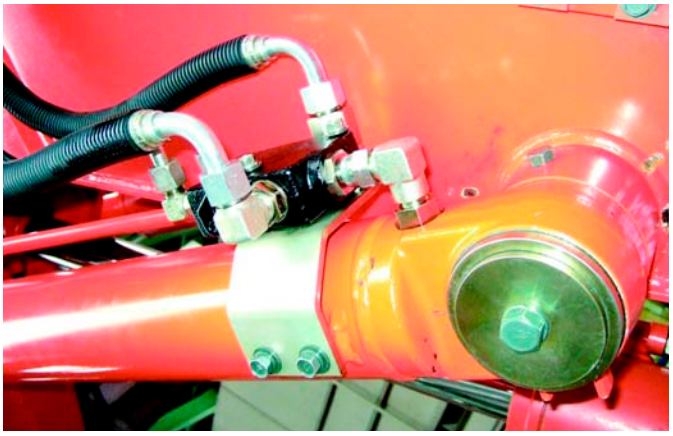
2) Bucket link and dust seal



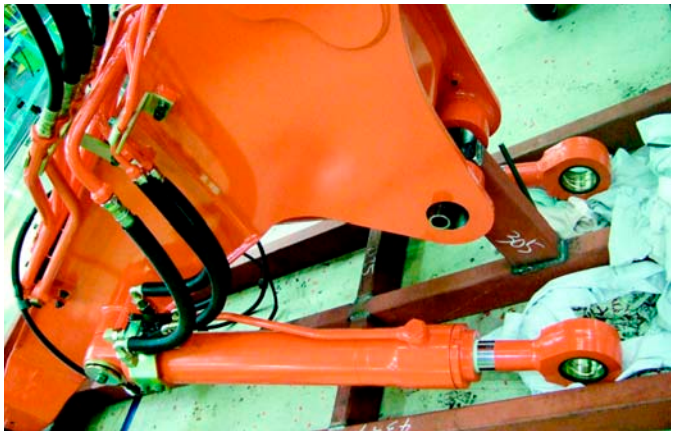
3) Second boom (Boom 2)



4) Boom 1 and Boom 2



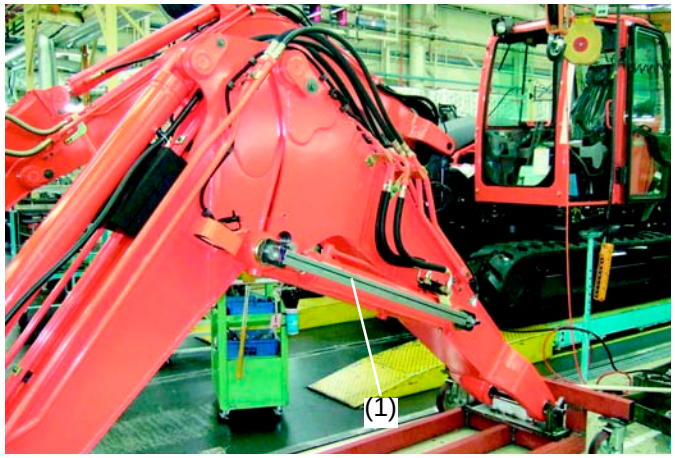
5) Holding valve



6) Boom 2 cylinder



7) Pin and dust seal



8) Boom 1 and 2 assy
Mount the support bar for safety.

(1)Support bar



9) Install the boom 1 cylinder



10) Connect the hoses of boom 1 cylinder and holding valve

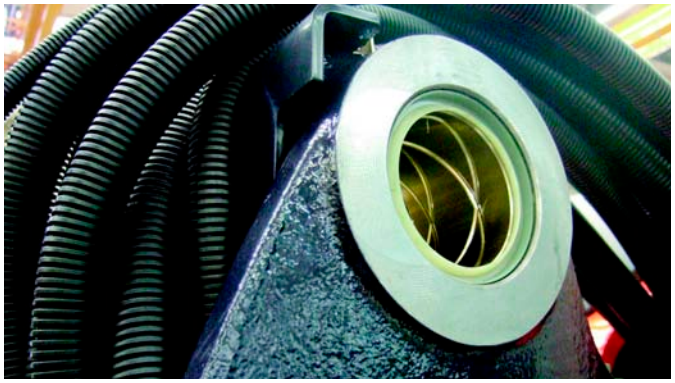


11) Boom 1 cylinder assembled.



12) Lifting 2-piece boom assy.





13) Bushing and dust seal in the swing bracket.



14) Install boom pin and shim.



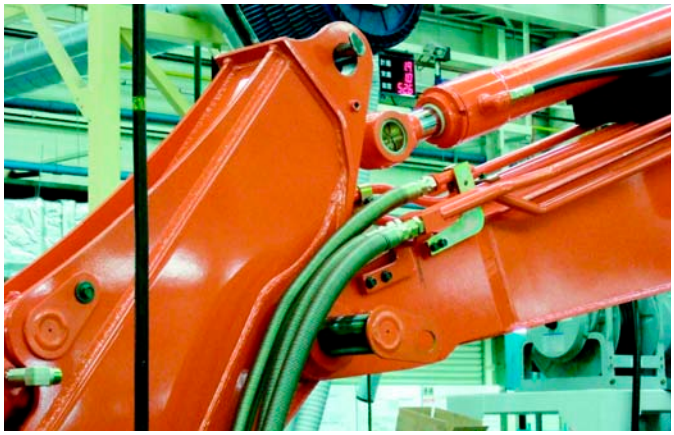
15) Install boom 2 cylinder.



16) Lifting arm assy.



17) Mount arm assy to boom 2.



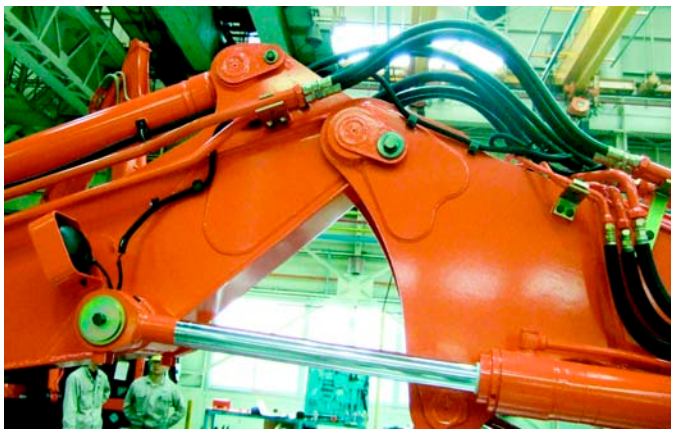
18) Install the pin and shim between arm and boom 2.



19) Install arm cylinder.



20) Two piece boom assy is being crowded.



21) Two piece boom assy extended.



22) Two piece boom machine stance for hydranlic oil level check.

(1) Boom 1 cylinder extended
(2) Boom 2 cylinder extended
(3) Arm cylinder extended
(4) Bucket cylinder extended
(5) Swing cylinder extended



23) Boom 1 cylinder seal leak test.

Standard bucket = 177 kgf (390 lbs)
Weight added = 430 kgf (948 lbs)

· Arm tip end load = 607 kgf (1338 lbs)
· Arm tip end hight =1 m (39.4 in.)
· Boom cylinder rod dislocation
for 10 min. ≦ 20 mm (0.78 in.)
· Oil temp. = 50°C (122°F)

Note : Above machine condition is the one tested in the factory's inspection section.

c. Counterweight

Type of weight	STD-version	2-piece boom version
EU	870 or 1100	1100 and 200
NA	1100	-

870 = 870kgf (1918lbs)
1100 = 1100kgf (2425bs)
200 = 200kgf (441lbs)
EU = European-version
NA = North American-version

(1)Stay (hood lock)
(2)Shim (T2)
(3)Bolt
(4)Plug (M24)
(5)Weight (870) or (5') weight (1100)
(6)Bolt
(7)Washer
(8)Spring washer
(9)Cover (weight)
(10)Bolt
(11)Plain washer
(12)Plug
(13)Bracket (left cover)
(14)Bolt
(15)Weight

1.Attaching the Weight

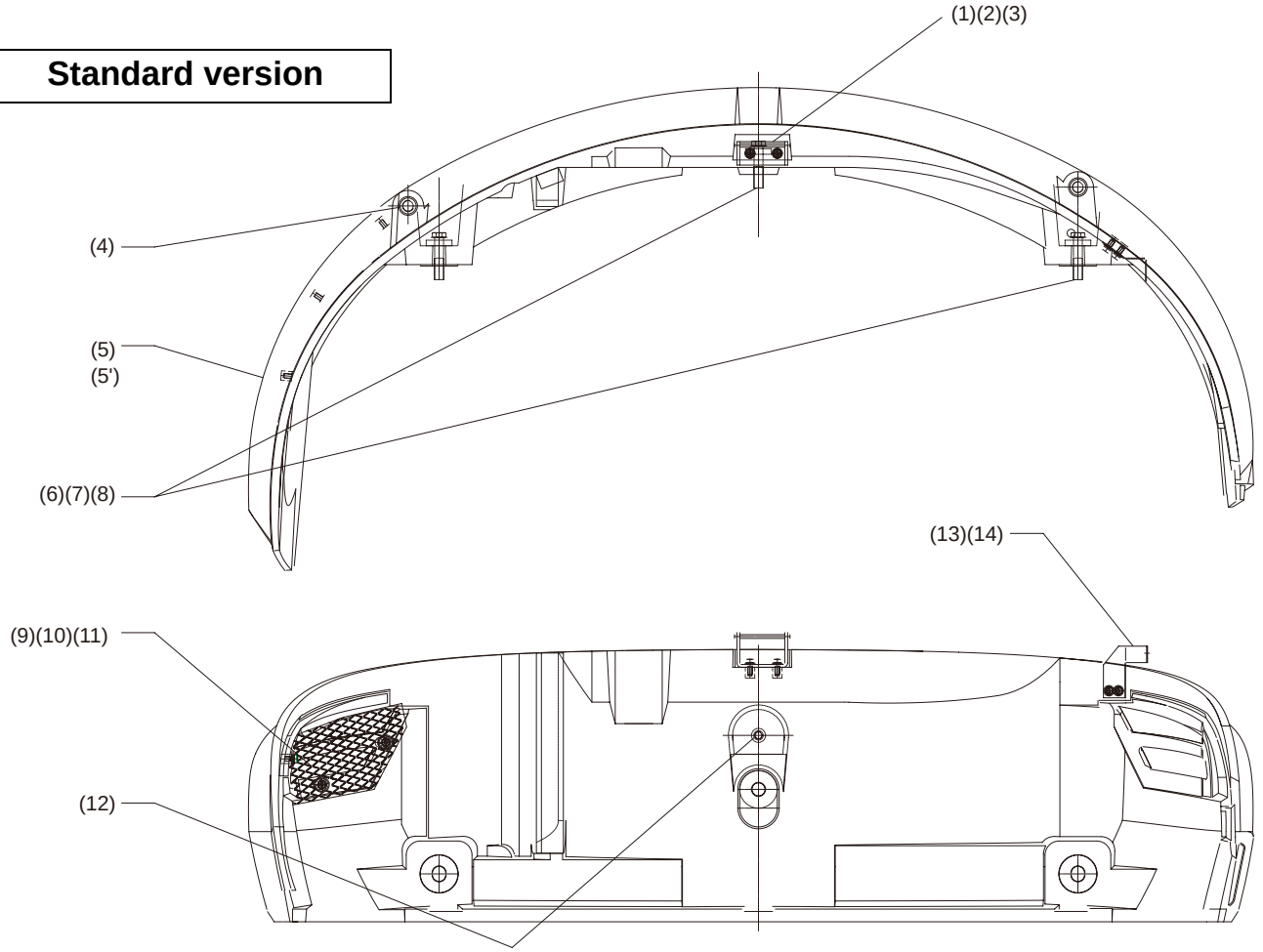
Tightening torque
Three M20 bolts at the back
367.7~431.5N.m (37.5~44.0kgf.m)
271.2~318.3ft.lbs

Apply screw adhesive (Loctite 271).

2.Fitting the Stay (Hook Lock), Cover (Weight) and Bracket (Left Cover)

Tightening torque
48.1~55.9N.m (4.9~5.7kgf.m) 35.5~41.2ft.lbs

Standard version



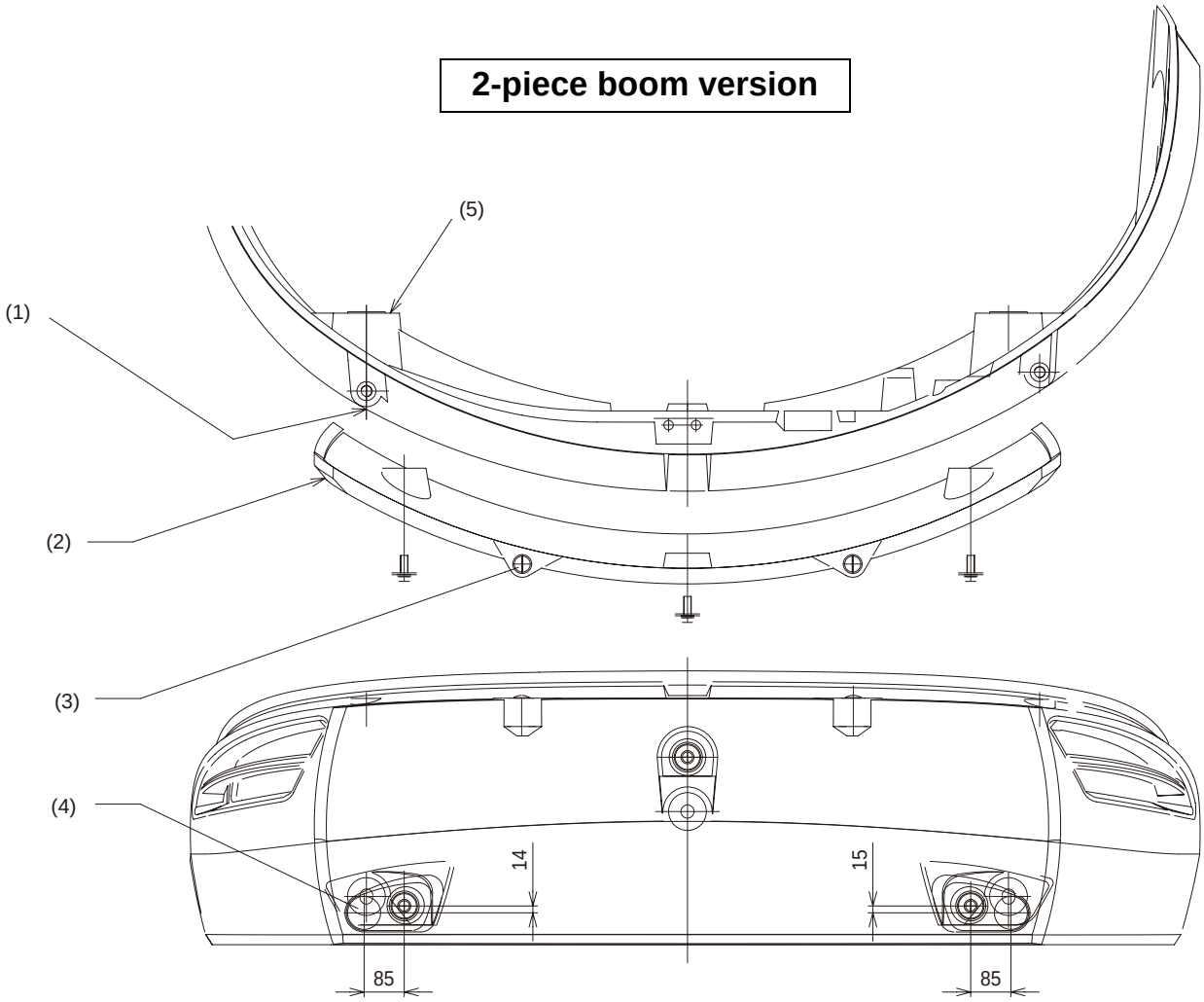


3.Attaching the Additional Weight

Tightening torque
Three M16 bolts
259.5~304.0N.m(26.5~31.0kgf.m)
191.4~224.2ft.lbs

Apply screw adhesive (Loctite 271).

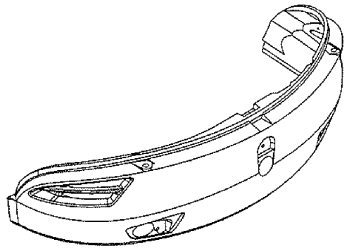
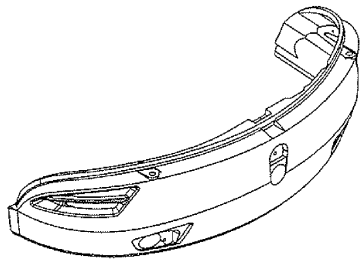
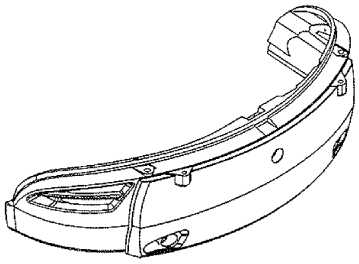
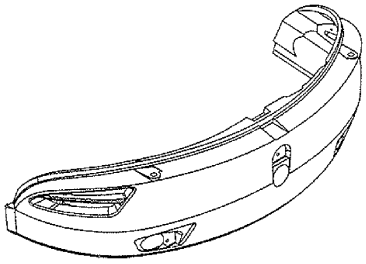
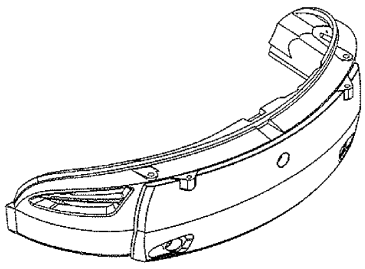
2-piece boom version



(1)Before attaching the weight (200, additional), peel the label (reflector, red, EU) off the weight (870).
(2)Weight (200, additional)
Bolt
Plain washer
(3)Plug (M24)
(4)Label (reflector, red, EU)
(5)Weight (1100)

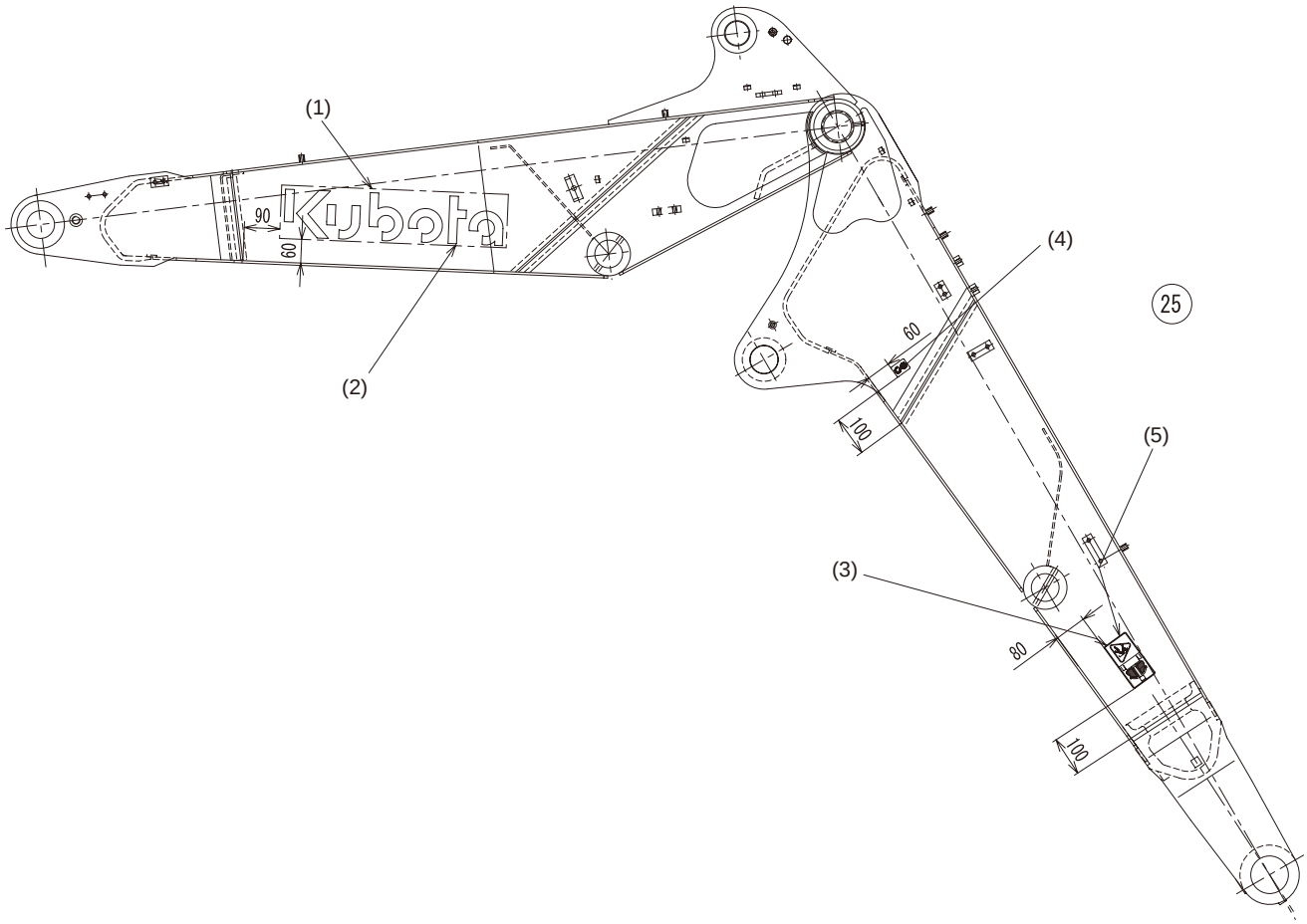
4.Modification of Counterweight

Following the introduction of 2-piece boom type, the counterweight combinations on standard-version machine has also been modified as below.

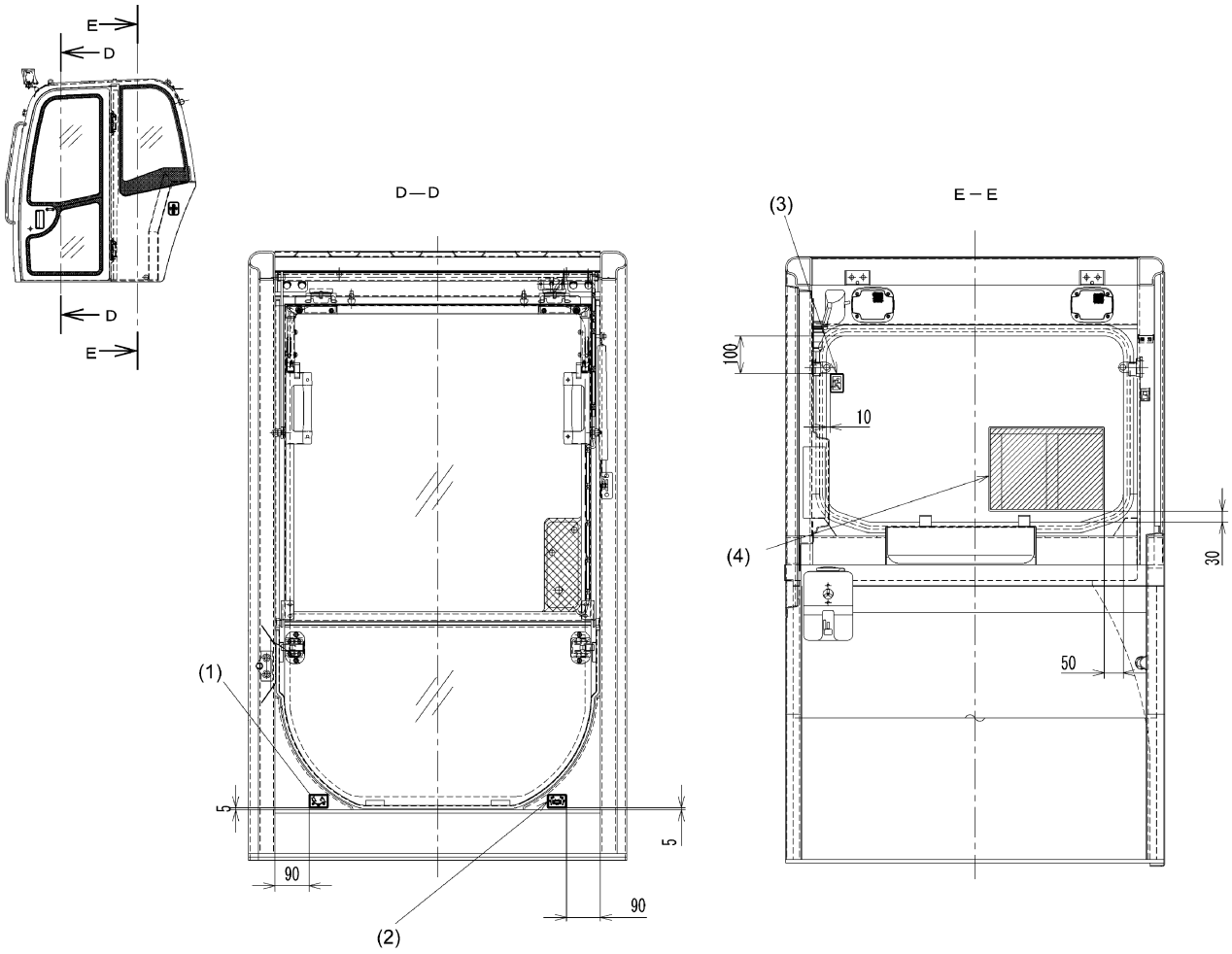
	~2007/05	2007/05~	Modification	Main market
Standard-version	RD809-4811Δ Weight (870) Turning radius : 1420 mm (55.9 in.) 	RD809-4811Δ Weight (870) Turning radius : 1420 mm (55.9 in.) 	Not modified	EU-nations, rnainly Germany and Italy
	RD809-4811Δ Weight (870) + RD809-4821Δ Weight (200, added) Turning radius : 1460 mm (57.5 in.) 	New-type part (integrated) RD809-4847Δ Weight (1100) Turning radius : 1460mm (57.5 in.) 	Modified (integrated)	World-wide except Germany and Itary North Amerian version is this one.
Two-piece boom-version	—	New-type part (integrated) RD809-4847Δ Weight (1100) + RD809-4821Δ Weight (200, added) Turning radius : 1490 mm (58.7 in.) 	New type	EU-nations

* The counterweight lock bolts and other related parts remain the same.

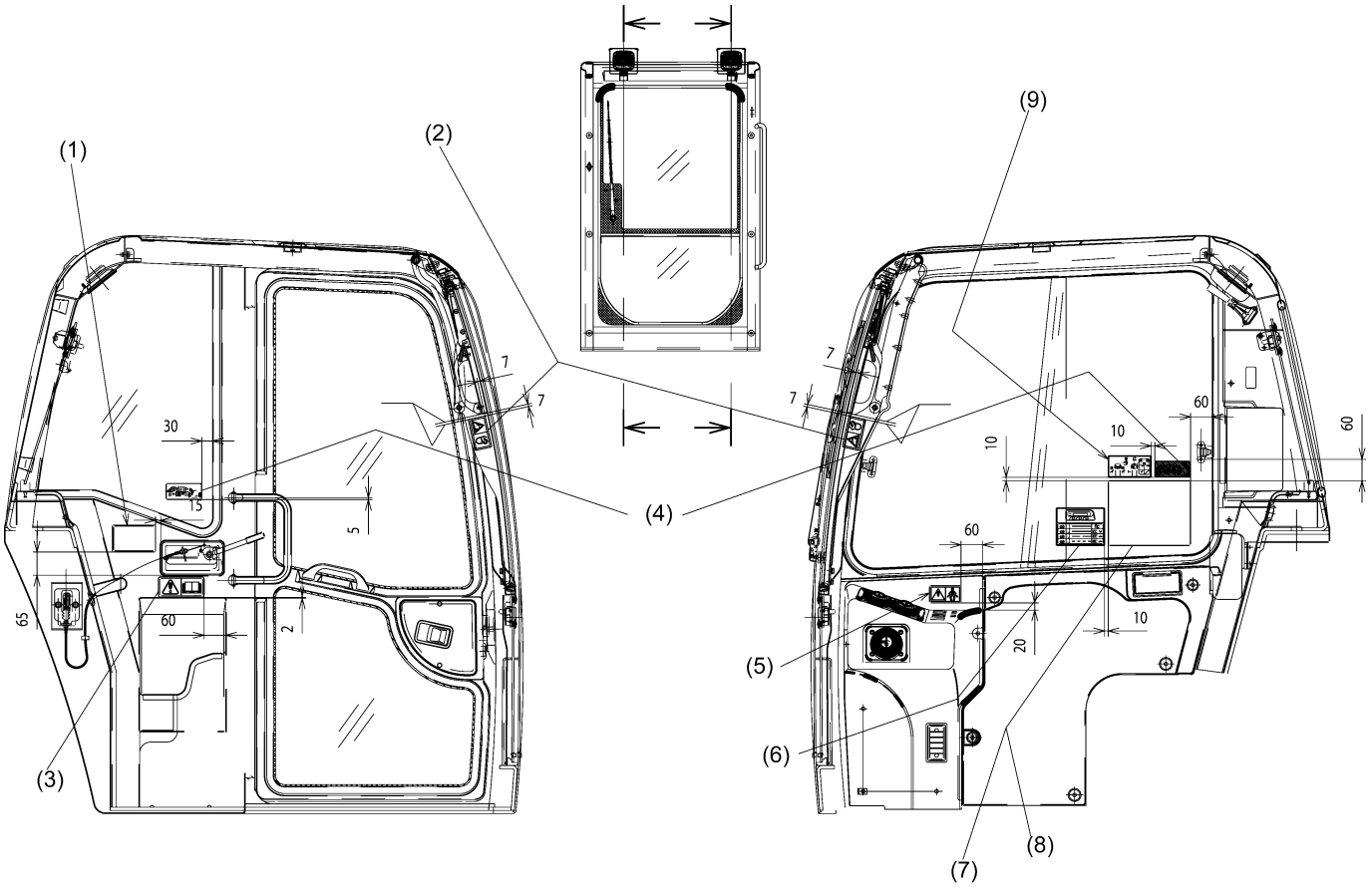
d. Labels



(1)To be applied in the same way.
(2)Marking (Kubota 1)
(2 pcs., on both sides)
(3)Label (attention to swing)
(2 pcs., on both sides)
(4)Label (lifting)
(2 pcs., on both sides)
(5)To be applied in the same way.



(1)For two-boom type
Label (2P boom operation)
RD809-5767Δ
(2)Label (swing, EU)
RD809-5757Δ
(3)Label (emergency exit)
(to be applied on the inner face of window pane)
RD809-5714Δ
(4)Label (inspection)
(to be applied on the inner face of window pane)
RD809-5746Δ



(1)Label (ROPS, cabin)
(Data marked on RC448-5855Δ)
RD809-5802Δ
(2)Label (windshield lock, EU)
(2 pcs.)
RB419-5793Δ
(3)Label (manual)
69198-5784Δ
(4)Label (anti-theft)
(2 pcs.)
(to be applied on the outer face of window pane)
RA228-9338Δ
(5)Label (seat belt)
RD809-5743Δ
(6)Label (adjustment, SP)
RD809-5748Δ
(7)For two-boom type
Label (lifting load, 2P)
RD809-5761Δ
(8)Label (lifting load, EU)
(to be applied on the inner face of window pane)
RD809-5747Δ
(9)Label (operation, SP)
(to be applied on the inner face of window pane)
RD809-5744Δ

C. Hydraulic System

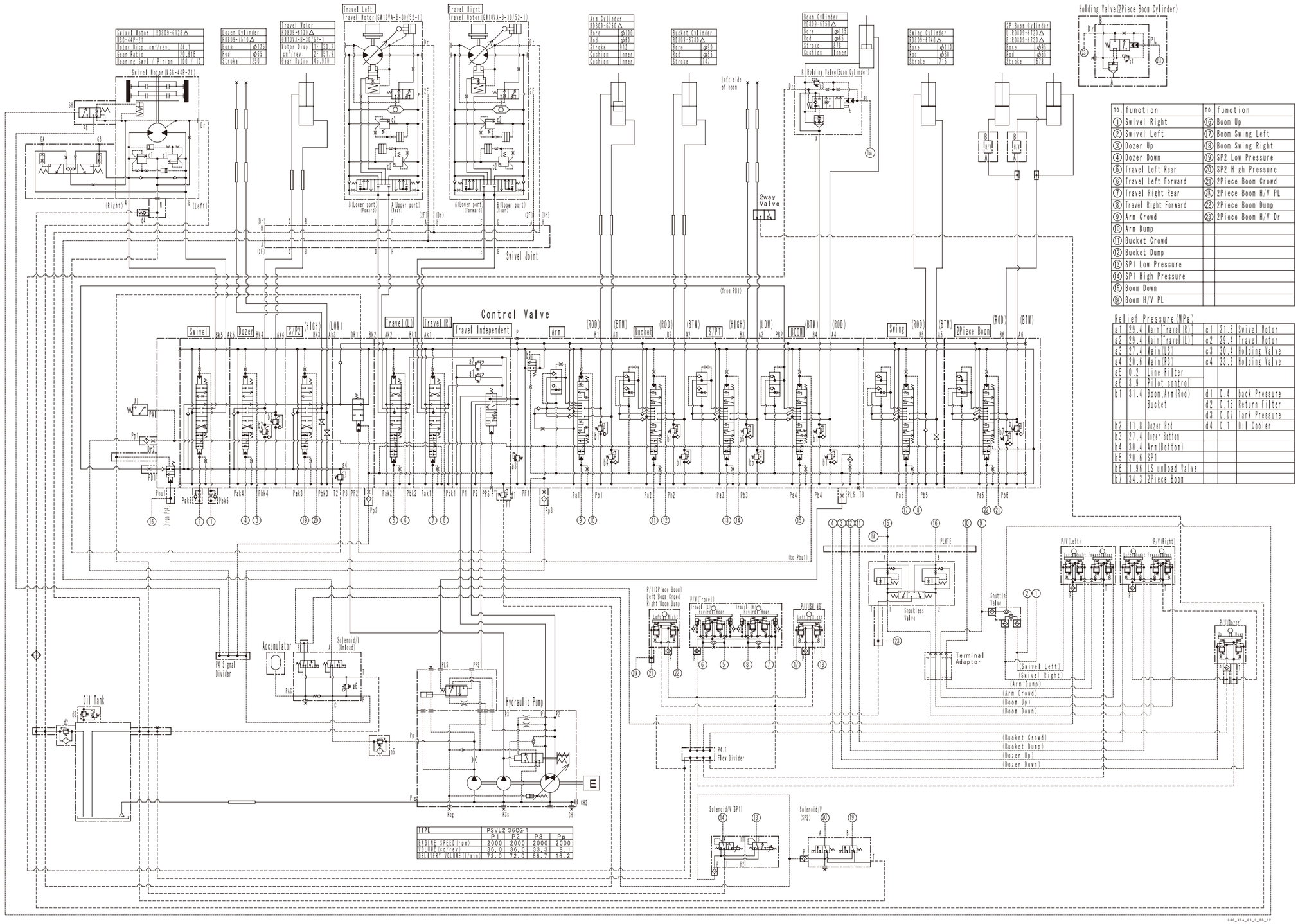
a. Specifications

No.	Specifications items	Unit	Specifications value
1	Second boom cylinder size	mm (inch)	ø95 x ø55 x ø578 (ø3.74 x ø2.17 x ø22.96)
2	Second boom cylinder speed : crowd / dump	sec.	4.7 ± 0.3 / 5.5 ± 0.3
3	Second boom cylinder oil sealing capacity	mm (inch)	10> (0.4>)
4	Main relief pressure, a_3 (LS main) at bench	MPa (kgf/cm^2) psi	27.4 ± 0.3 (280 ± 3) 3983 ± 44
5	Main relief pressure, a_3 (LS main) on machine at Max. speed.	MPa (kgf/cm^2) psi	27.9 ± 1.0 (285 ± 10) 4047 ± 145
6	Overload relief pressure : b_7 (2-P boom cylinder) at bench	MPa (kgf/cm^2) psi	34.3 ± 0.3 (350 ± 3) 4978 ± 44
7	Overload relief pressure : b_7 (2-P boom cylinder) on machine at 1500 rpm	MPa (kgf/cm^2) psi	34.8 ± 1.5 (355 ± 15) 5050 ± 213
8	Second boom holding valve overload relief pressure at bench	MPa (kgf/cm^2) psi	33.3 (340) 4836
9	First boom overload warning pressure at bench	MPa (kgf/cm^2) psi	12.9 (132) 1872
10	Second boom pedal operating force	N (kgf) lbs	56.9 ± 10 (5.8 ± 1.0) 12.8 ± 2.2
11			
12			

b. Troubleshooting

No.	Trouble symptom	Suspected causes	Remedies to be taken
a.	Second boom does not move to both directions.	1.Not enough pilot secondary pressure.	1.Check pilot secondary pressure.
		2.Main control valve spool is stuck.	2.Check main control valve spool.
		3.Pressure compensation spool is stuck.	3.Check the P.C spool.
		4.Second boom pilot valve malfunction	4.Check the pilot valve.
b.	Second boom does not move either one direction.	1.Overload relief valve malfunction.	1.Check O.R. valve.
		2.Main control valve spool is stuck.	2.Check main control valve spool.
c.	Second boom does not move to crowd direction.	1.Not enough pilot secondary pressure at main control valve and holding valve.	1.Check pilot secondary pressure.
		2.Second boom holding valve malfunction. (Poppet, spool, sleeve)	2.Check the second boom holding valve.
d.	Second boom speed is slow.	1.Not enough pilot secondary pressure.	1.Check pilot secondary pressure.
		2.Second boom cylinder inner leakage.	2.Check the pilot second boom cylinder.
		3.Main control valve spool doesn't shift fully.	3.Check the control valve spool.
e.	A natural-fall of the second boom cylinder is excessive.	1.Cylinder piston seal is defective.	1.Check the piston seal.
		2.Oil leaks through main spool.	2.Check main spool sealing capacity.

c. Hydraulic Circuit Diagram : 2-piece Boom



Swivel Motor	RB809-61780
MSG-44P-21	
Motor Disp. cm³/rev.	44.1
Gear Ratio	10.815
Bearing Swivel / Pinion	100 / 13

Dozer Cylinder	RB809-15110
Bore	φ125
Rod	φ55
Stroke	250

Travel Motor	RB809-61730
GM10VA-B-30/52-1	
Motor Disp. 1st	30.2 cm³/rev.
Gear Ratio	2nd 52.3 46.970

Arm Cylinder	RB809-67610
Bore	φ100
Rod	φ60
Stroke	970
Cushion	Inner
Cushion	Inner

Bucket Cylinder	RB809-67110
Bore	φ95
Rod	φ55
Stroke	747

Boom Cylinder	RB809-67500
Bore	φ115
Rod	φ65
Stroke	1215
Cushion	Inner

Swing Cylinder	RB809-67400
Bore	φ110
Rod	φ60
Stroke	715

2P Boom Cylinder	L RB809-67200
	R RB809-67300
Bore	φ95
Rod	φ55
Stroke	570

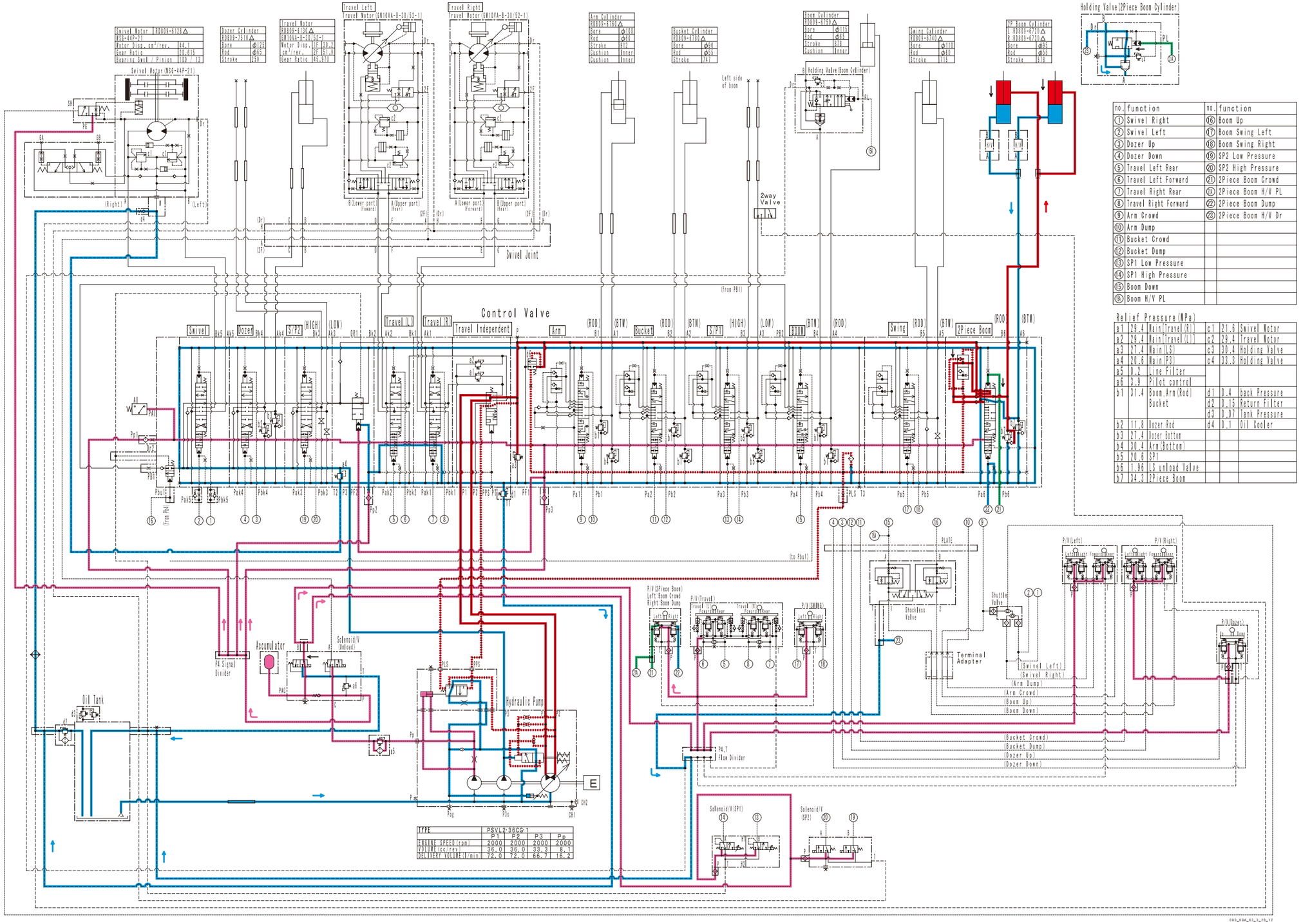
TYPE	PSVL2-36CG-1			
	P1	P2	P3	Pp
ENGINE SPEED (rpm)	2000	2000	2000	2000
VOLUME (cc/rev)	36.0	36.0	33.3	8.1
DELIVERY VOLUME (l/min)	72.0	72.0	66.7	16.2

no.	function	no.	function
①	Swivel Right	⑯	Boom Up
②	Swivel Left	⑰	Boom Swing Left
③	Dozer Up	⑱	Boom Swing Right
④	Dozer Down	⑲	SP2 Low Pressure
⑤	Travel Left Rear	⑳	SP2 High Pressure
⑥	Travel Left Forward	㉑	2Piece Boom Crowd
⑦	Travel Right Rear	㉒	2Piece Boom H/V PL
⑧	Travel Right Forward	㉓	2Piece Boom Dump
⑨	Arm Crowd	㉔	2Piece Boom H/V Dr
⑩	Arm Dump		
⑪	Bucket Crowd		
⑫	Bucket Dump		
⑬	SP1 Low Pressure		
⑭	SP1 High Pressure		
⑮	Boom Down		
⑭	Boom H/V PL		

Relief Pressure (MPa)

a1	29.4	Main Travel (R)	c1	21.6	Swivel Motor
a2	29.4	Main Travel (L)	c2	29.4	Travel Motor
a3	27.4	Main (LS)	c3	30.4	Holding Valve
a4	20.6	Main (P3)	c4	33.3	Holding Valve
a5	0.2	Line Filter			
a6	3.9	Pilot control			
b1	31.4	Boom,Arm (Rod) Bucket	d1	0.4	back Pressure
			d2	0.15	Return Filter
			d3	0.07	Tank Pressure
b2	11.8	Dozer Rod	d4	0.1	Oil Cooler
b3	27.4	Dozer Botton			
b4	30.4	Arm (Buttom)			
b5	20.6	SP1			
b6	1.96	LS unload Valve			
b7	34.3	2Piece Boom			

d. Two-piece Boom Crowding



no.	function	no.	function
①	Swivel Right	⑯	Boom Up
②	Swivel Left	⑰	Boom Swing Left
③	Dozer Up	⑱	Boom Swing Right
④	Dozer Down	⑲	SP2 Low Pressure
⑤	Travel Left Rear	⑳	SP2 High Pressure
⑥	Travel Left Forward	㉑	2Piece Boom Crowd
⑦	Travel Right Rear	㉒	2Piece Boom H/V PL
⑧	Travel Right Forward	㉓	2Piece Boom Dump
⑨	Arm Crowd	㉔	2Piece Boom H/V Dr
⑩	Arm Dump		
⑪	Bucket Crowd		
⑫	Bucket Dump		
⑬	SP1 Low Pressure		
⑭	SP1 High Pressure		
⑮	Boom Down		
⑨	Boom H/V PL		

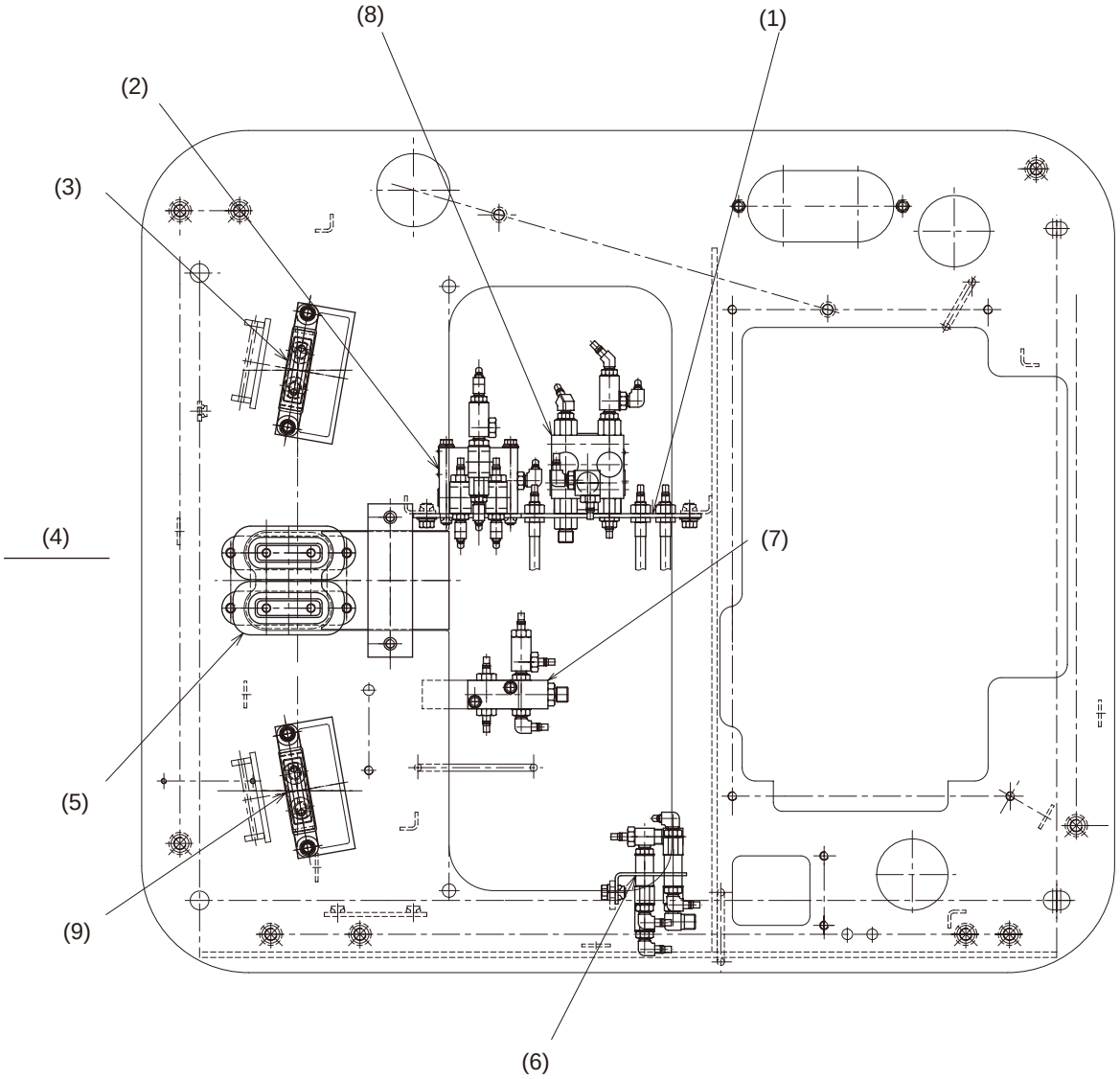
Relief Pressure (MPa)

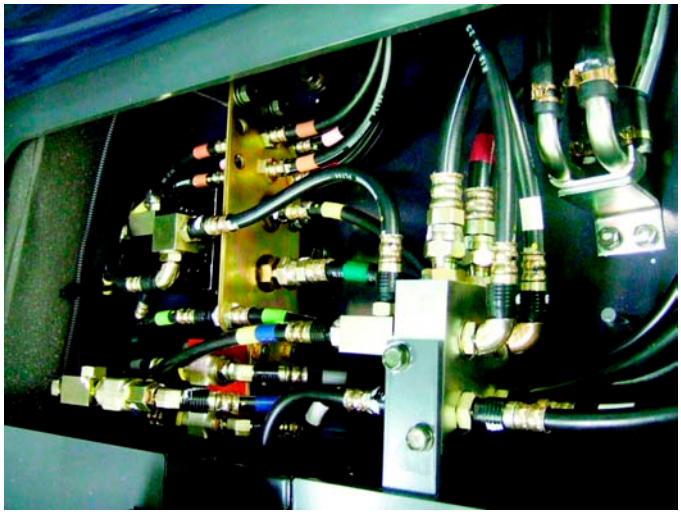
a1	29.4	Main(Travel(R))	c1	21.6	Swivel Motor
a2	29.4	Main(Travel(L))	c2	29.4	Travel Motor
a3	27.4	Main(LS)	c3	30.4	Holding Valve
a4	20.6	Main(PS)	c4	33.3	Holding Valve
a5	0.2	Line Filter			
a6	3.9	Pilot control			
b1	31.4	Boom,Arm(Rod) Bucket	d1	0.4	back Pressure
			d2	0.15	Return Filter
			d3	0.07	Tank Pressure
b2	11.3	Dozer Rod	d4	0.1	Oil Cooler
b3	27.4	Dozer Bottom			
b4	30.4	Arm(Bottom)			
b5	20.6	SP1			
b6	1.96	LS unload Valve			
b7	34.3	2Piece Boom			

TYPE	PSVL2-36CG-1			
	P1	P2	P3	Pp
ENGINE SPEED (rpm)	2000	2000	2000	2000
VOLUME (cc/rev)	36.0	36.0	33.3	8.1
DELIVERY VOLUME (l/min)	72.0	72.0	66.7	16.2

P1,P2 high pressure
Pilot primary presuure
Pilot secondary presuure
Return oil

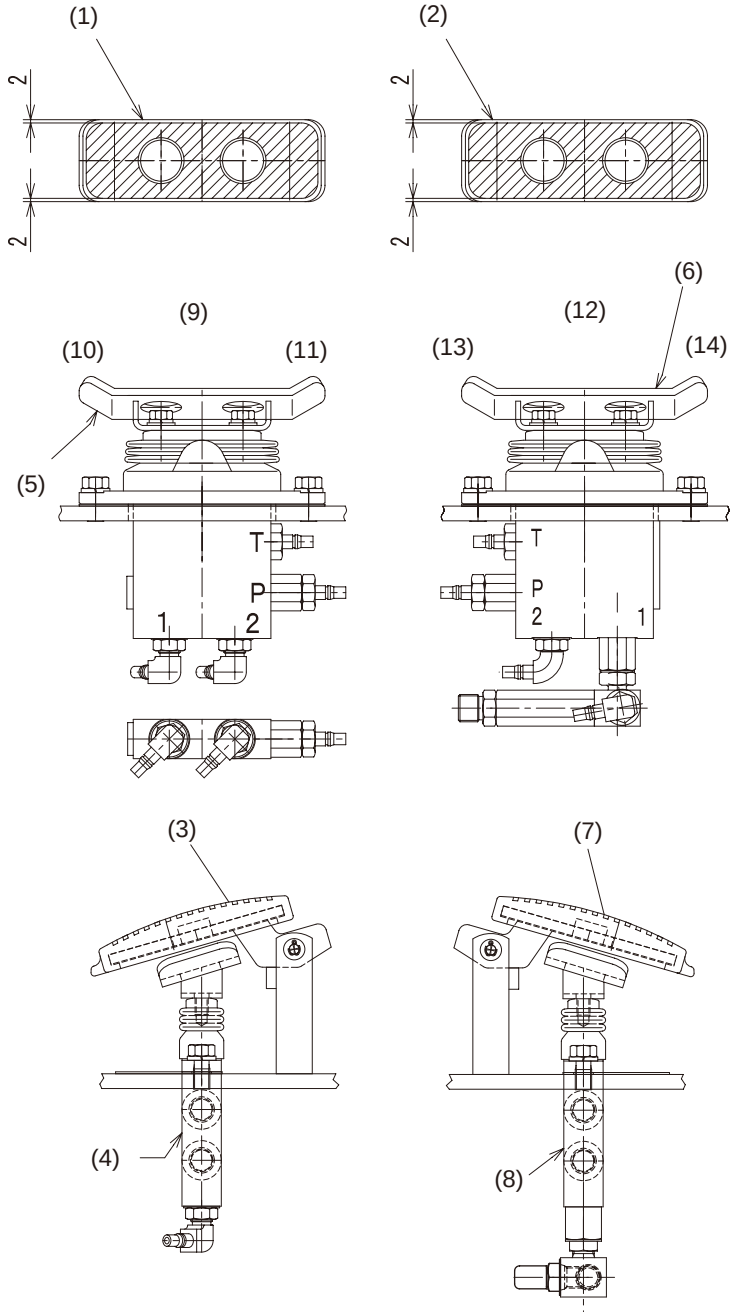
e. Hydraulic Components on the Platform





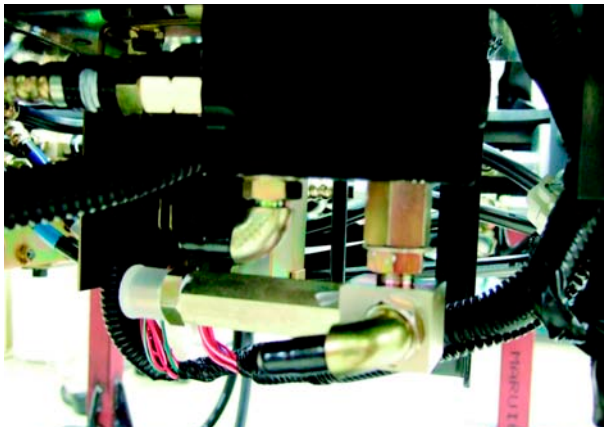
(1)Bracket (pilot hose)
(relay plate)
(2)Valve assembly (swivel shuttle)
(shuttle valve)
(3)Valve assembly (pilot, swing)
(swing P/V)
(4)Machine front
(5)Valve assembly (PV, travel)
(travel P/V)
(6)Adaptor (pilot hose, 2)
(relay adaptor)
(7)Adaptor (pilot hose, 1)
(P4, T collective block)
(8)Valve assy (Shockless valve)
(9)Valve assy (Boom 2, PV)

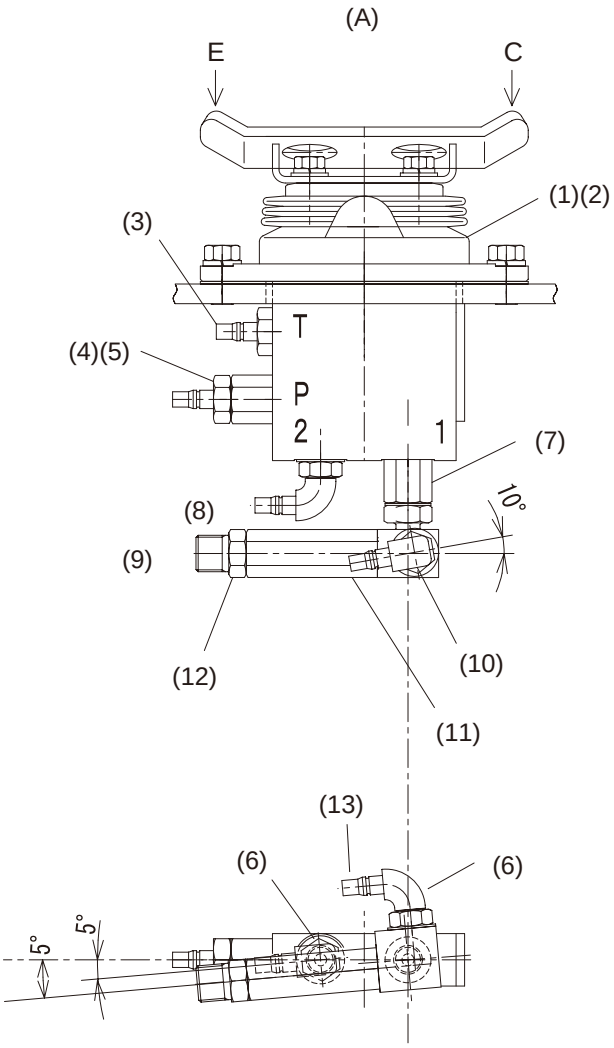
f. Second Boom Pilot Valve



(1) Fitting the valve assembly (pilot OFF) (RD809-6551Δ)
Tightening torque
(2) Applying the anti-slip sheet (swing pedal) (RD809-6552Δ)
Apply the sheets as shown at left.

(1) Anti-slip sheet (swing pedal)
(2) Anti-slip sheet (Boom 2 pedal)
(3) Cover (swing pedal)
Cover (rubber, swing cover)
Pin (rubber, swing cover)
Plain washer
Cotter pin
(4) Valve assembly (pilot, boom 2)
Bolt
(5) Pedal (swing)
Bolt
Anti-slip sheet (swing pedal)
(6) Pedal (Boom 2)
Bolt
Anti-slip sheet (Boom 2 pedal)
(7) Cover (Boom 2 pedal)
Cover (rubber, Boom 2)
Pin (rubber, Boom 2)
Plain washer
Cotter pin
(8) Valve assembly (pilot, boom 2)
Bolt
(9) (View from machine front)
(10) (Right swing)
(11) (Left swing)
(12) (View from machine front)
(13) (Boom 2 dump)
(14) (Boom 2 crowded)





1. Fitting the Adaptor

Port P
(3) Pipe joint (S, G1/4-8, 4)
Ports 1 and 2
(4) Filter
(5) Pipe joint (S, G1/4-8, 4)
Port T
(7) Pipe joint

2. Adaptor Tightening Torque

G1/4 size
24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs

3. Fitting Direction of the Valve

Position the valve with ports P and T facing the machine's left side.

4. Quick-coupling Adaptor

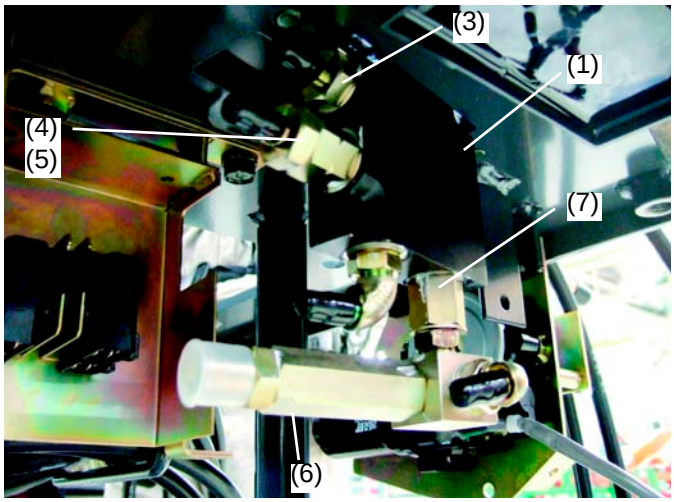
Pipe joint (S, G1/4-8, 4), (QL, G1/4-8, 4)
Make sure the hose connection is free from any scratches.

5. Fitting the Valve Assembly (Pilot, Boom2) (RD809-6551Δ)

Tightening torque
48.1~55.9N.m (4.9~5.7kgf.m) 35.5~41.2ft.lbs

2-piece boom : Boom 2 P/V

	Location	Hose tape color
1	Boom 2 extend (right)	Blue, double
2	Boom 2 crowd (left)	Green, double
P	Port P	White
T	Port T	None

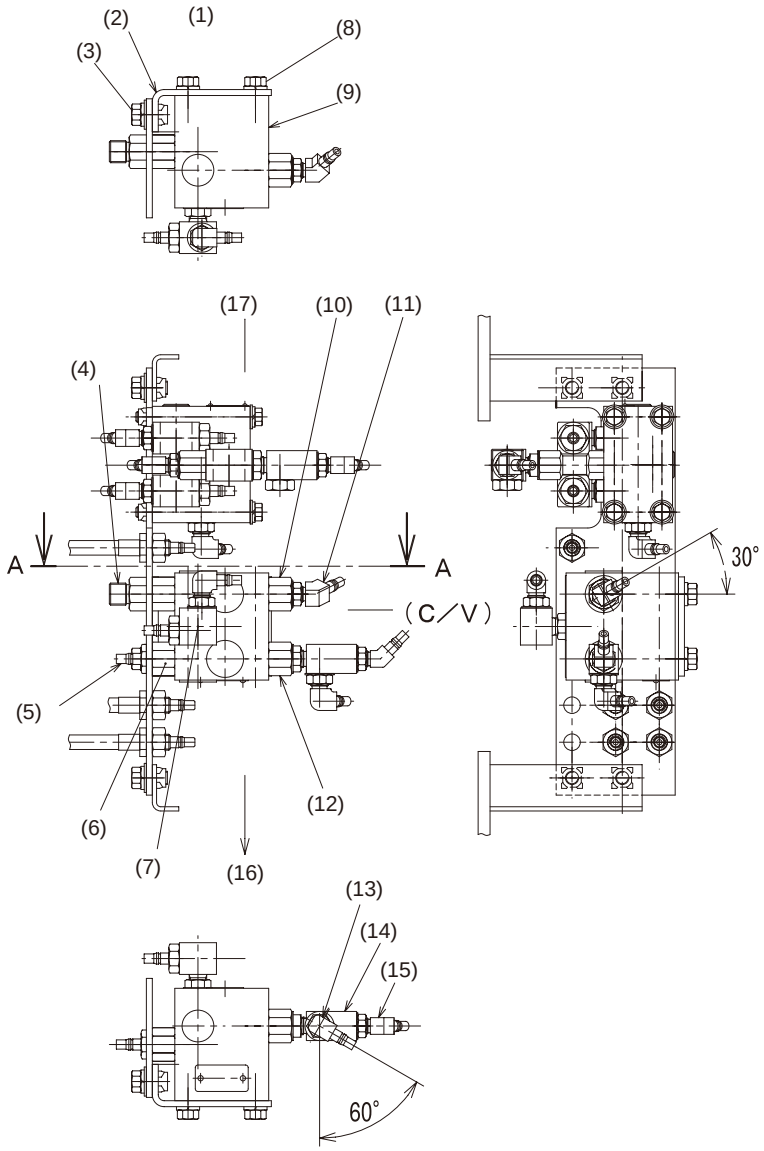


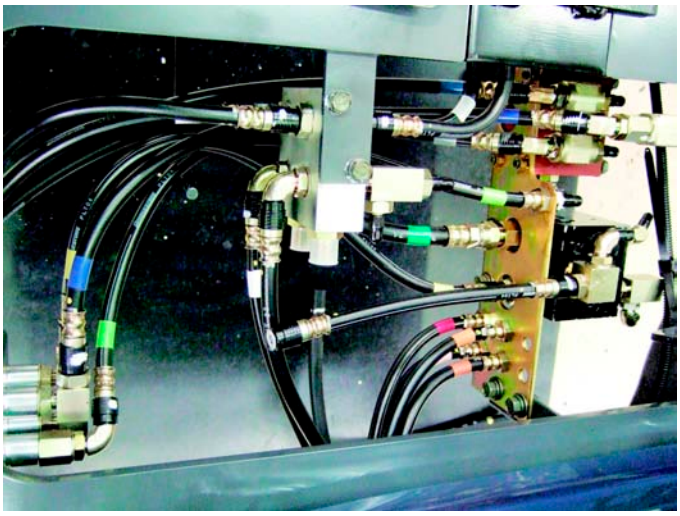
(A)(Viewed from the machine front)

E : Boom 2 extend
C : Boom 2 crowd

(1) Valve assembly (pilot, boom 2)
(2) Bolt
(3) Pipe joint (S, G1/4-8.4)
(4) Filter, O-ring
(5) Pipe joint (S, G1/4-8.4)
(6) Pipe joint (QL, G1/4-8.4)
(7) Pipe joint (S, G1/4-G1/4)
(8) To C/V bottom side
(9) Back side of the boom
(10)Pipe joint (L, G1/4-G1/4), O-ring
(11)Pipe joint (S, G2-G2)
(12)Pipe joint (G2-G3), O-ring
(13)To C/V rod side

g. Shockless Valve





1) Fitting the adaptor
Fit the adaptor as shown on the left.

2) Adaptor tightening torque
G1/4 size : 24.5~29.4N.m (2.5~3.0kgf.m)
18.1~21.7ft.lbs
G3/8 size : 37.2~42.1N.m (3.8~4.3kgf.m)
27.5~31.1ft.lbs

3) Quick coupler adaptor
Pipe joint (QL, G1/4-8.4) (RP821-6197Δ)
Pipe joint (Q , G1/4-8.4) (RP821-6198Δ)
No scratches on the fitting with the hose.

4) Valve assembly (shock-less) installation direction
Set up the valve with nameplate facing the machine's back. (RD809-6135Δ)

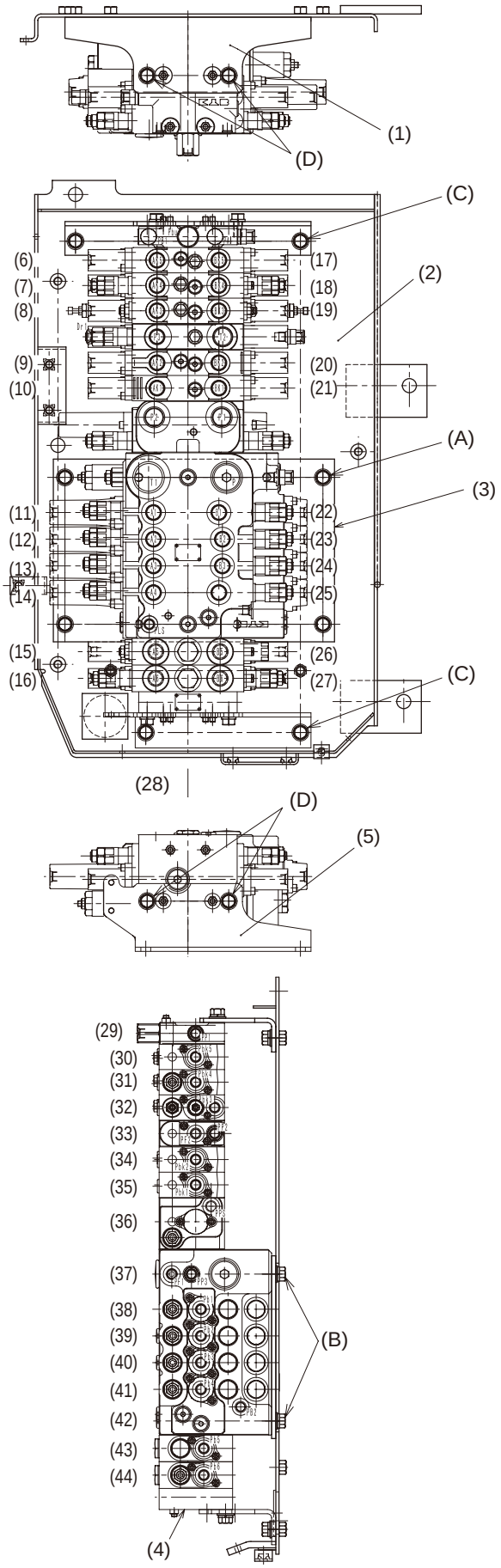
5) Valve assembly (shock-less) bolt tightening torque. (RD809-6135Δ)
M10x1.5
48.1~55.9N.m (4.9~5.7kgf.m)
35.4~41.2ft.lbs

6) Fitting the bracket (pilot hose, 2)
Fit the bracket as shown on the left.
(RD809-4413Δ)

7) Bracket (pilot hose, 2) bolt tightening torque. (RD809-4413Δ)
M10x1.25
48.1~55.9N.m (4.9~5.7kgf.m)
35.4~41.2ft.lbs

(1)Section A-A
(2)Bracket (pilot hose, 2)
(3)Bolt
(4)Pip joint
O-ring
(5)Pip joint
(6)Straight pipe joint
(7)Pipe joint
O-ring
Pipe joint
Pipe joint
(8)Bolt
(9)Valve assembly (shock-less)
(10)Straight pipe joint
(11)Pipe joint
(12)Straight pipe joint
(13)Pipe joint
(14)Pipe joint
(15)Pipe joint

h. Control Valve



1. Fitting the Control Valve Assembly (2P) (RD809-6133Δ),

Bracket (1, valve) (RD809-6115Δ),
Bracket (2, valve, 2P) (RD809-6136Δ)
Bracket (3, valve) (RD809-6117Δ)

Fit the assembly and parts in the following procedure.

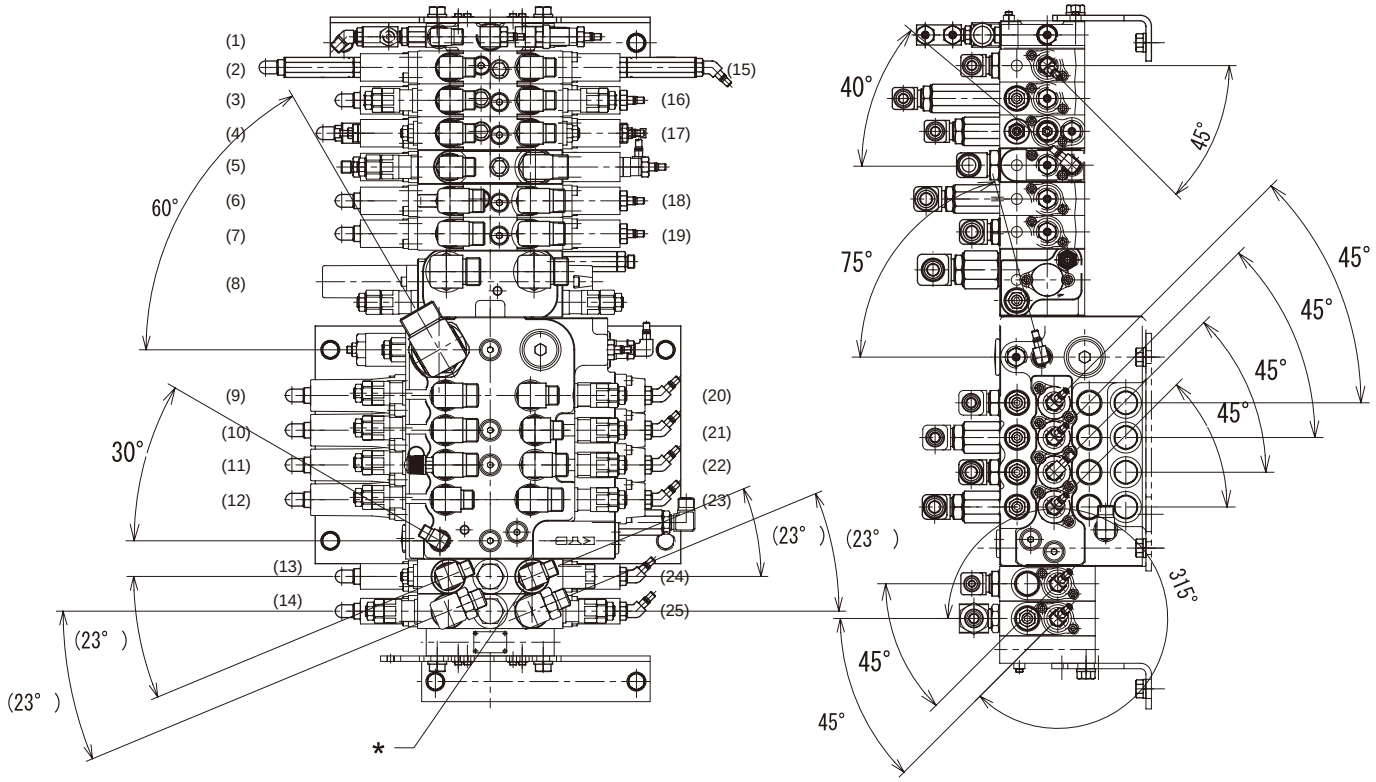
1) Install the bracket (1, valve), bracket (2, valve, 2P) and bracket (3, valve) on the control valve assembly (2P). Keep the bolts temporarily tight.
2) Set the control valve assembly (2P) to the base (valve).
3) Tighten up the bolts (A), as shown on the left, to fix the bracket (3, valve) to the base (valve).
4) Tighten up the bolts (B), as shown on the left, to fix the control valve assembly (2P) to the bracket (3, valve).
5) Tighten up the bolts (C), as shown on the left, to fix the bracket (1, valve) and bracket (2, valve, 2P) to the base (valve).
6) Finally tighten up the bolts (D), as shown at right, to fix the control valve assembly (2P).

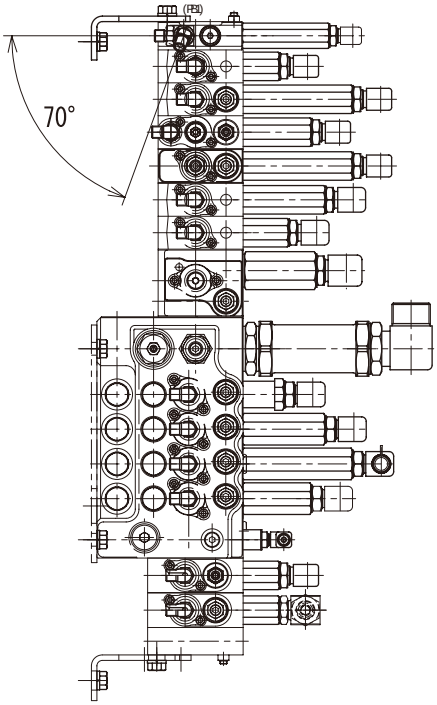
2. Bolt Tightening Torque

(A) (C) M12x1.25
(B) (D) M12x1.75
77.5~90.2N.m (7.9~9.2kgf.m) 57.1~66.5ft.lbs

(1)Bracket (1, valve)
Bolt (C)
(2)Base (valve)
(3)Bracket (3, valve)
Bolt (A)
(4)Control valve assembly (2P)
Bolts (B & D)
(6)Swivel left
(7)Blade down
(8)S/P 2 low
(9)Travel L back
(10)Travel R back
(11)Arm crowd
(12)Bucket crowd
(13)S/P 1 low
(14)Boom down
(15)Swing left
(16)2P boom dump
(17)Swivel right
(18)Blade up
(19)S/P 2 high
(20)Travel forward
(21)Travel R forward
(22)Arm dump
(23)Bucket dump
(24)S/P 1 high
(25)Boom up
(26)Swing right
(27)2P boom crowd
(28)Machine front
(29)P_3 confluence
(30)Swivel
(31)Blade
(32)S/P 2
(33)P_3 , T_2
(34)Travel L
(35)Travel R
(36)P_1, P_2
(37)T_1
(38)Arm
(39)Bucket
(40)S/P 1
(41)Boom
(42)P_{LS}
(43)Swing
(44)2P boom

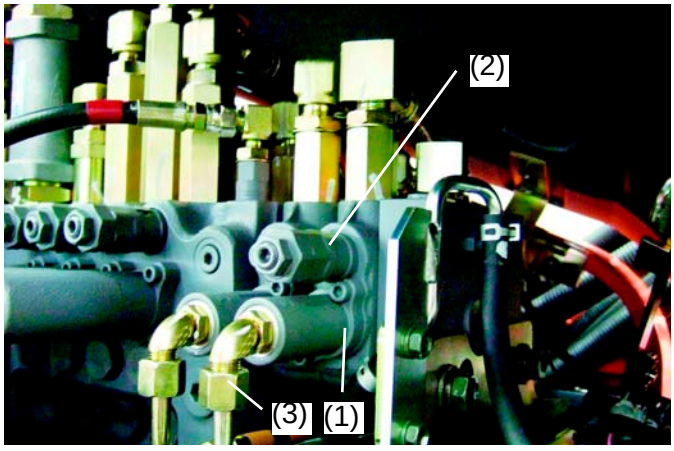
3. Install the Control Valve Adaptors



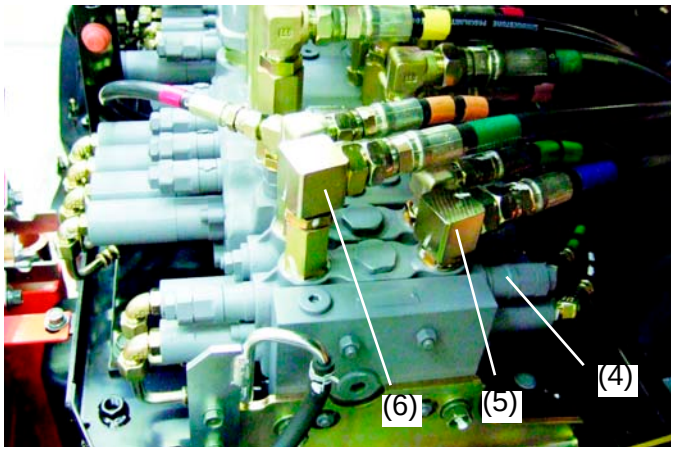


(1)P3 bypass
(2)Swivel (left)
(3)Dozer (bottom)
(4)S/P2 (low)
(5)Confluence valve
(6)Travel (left backward)
(7)Travel (right backward)
(8)Travel independent valve
(9)Arm (bottom)
(10)Bucket (bottom)
(11)S/P1 (low)
(12)Boom (rod)
(13)Swing (left)
(14)2-piece boom, dump
(15)Swivel (right)
(16)Dozer (rod)
(17)S/P 2 (high)
(18)Travel (left forward)
(19)Travel (right forward)
(20)Arm (rod)
(21)Bucket (rod)
(22)S/P 1 (high)
(23)Boom (bottom)
(24)Swing (right)
(25)2-piece boom, crowd

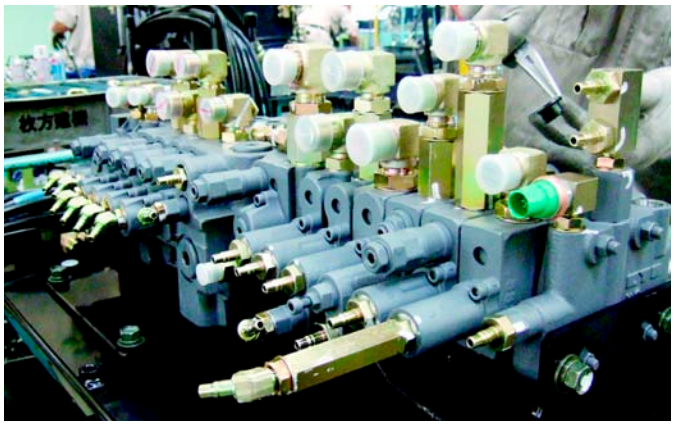
4.How to adjust the swing and 2-piece boom adaptors
First set the 2-piece boom (dump) adaptor in alignment with the center of the swing (right) port (marked * in the above figure).
Then set all the adaptors in parallel with the 2-piece boom (dump) adaptor.

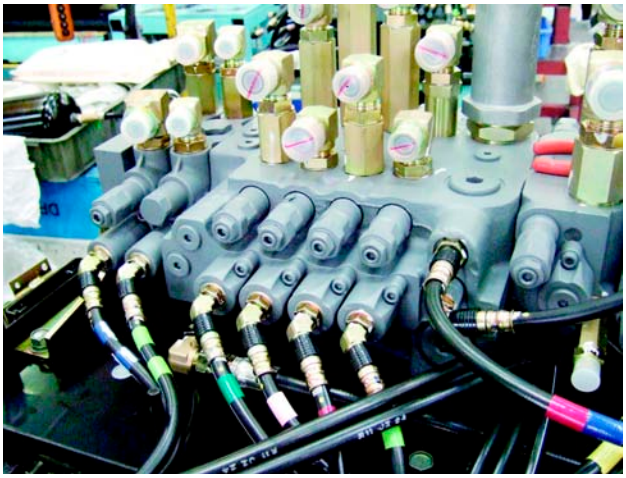


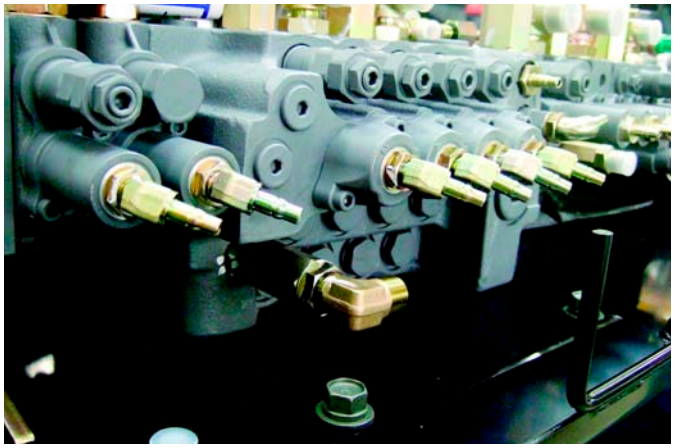
(1) Control valve section, 2 piece boom.
(2) Overload relief valve, dump.
(3) Pilot secondary pressure port, Pa6.

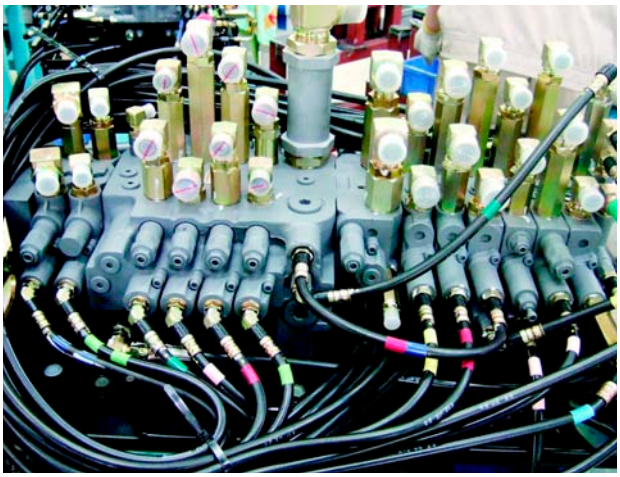


(4) Overload relief valve, crowd, Pb6.
(5) B6 port : Boom 2, crowd.
(6) A6 port : Boom 2, dump.

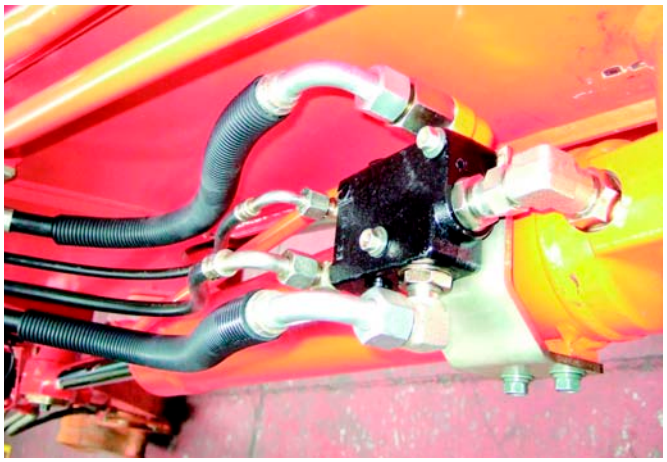








i. Second Boom Holding Valve

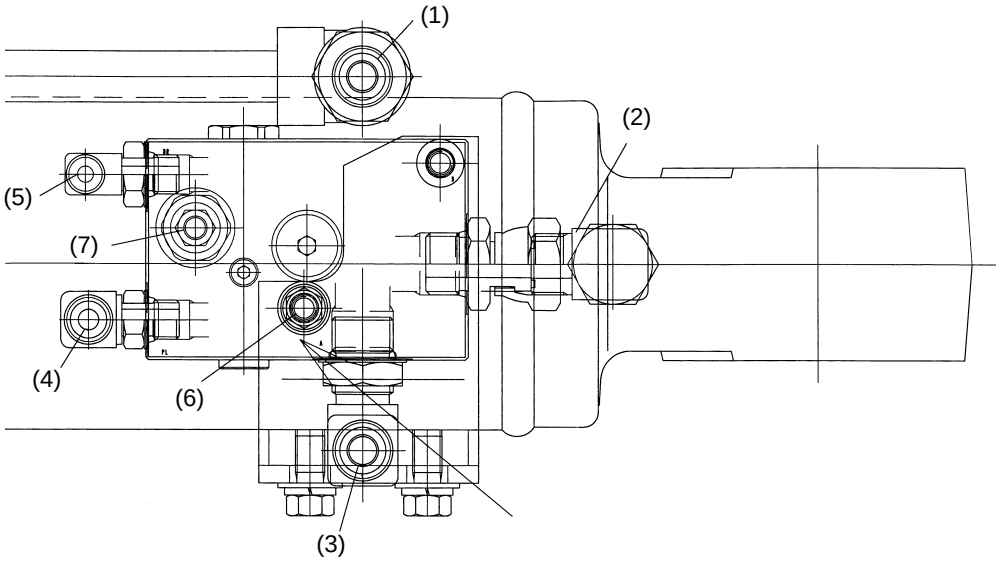


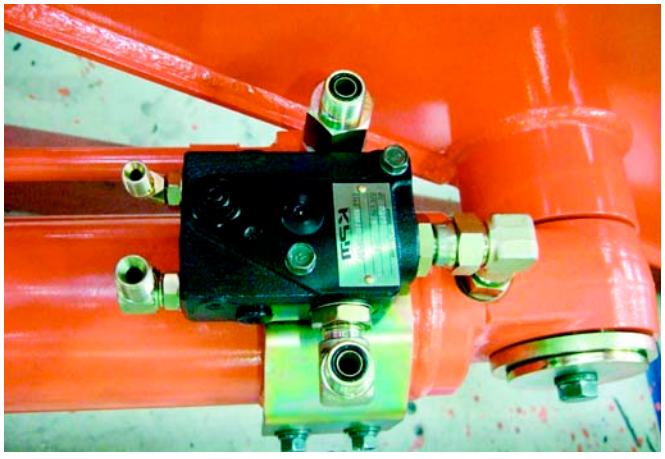
1. Outline

This valve is installed between the hydraulic second boom cylinder and the control valve. The gravity fall of the cylinder due to leak from the control valve can be minimized.

KHV 10 N 30 / *

- Own pressure relief valve pressure setting
- Series No.
- Size
- Holding valve

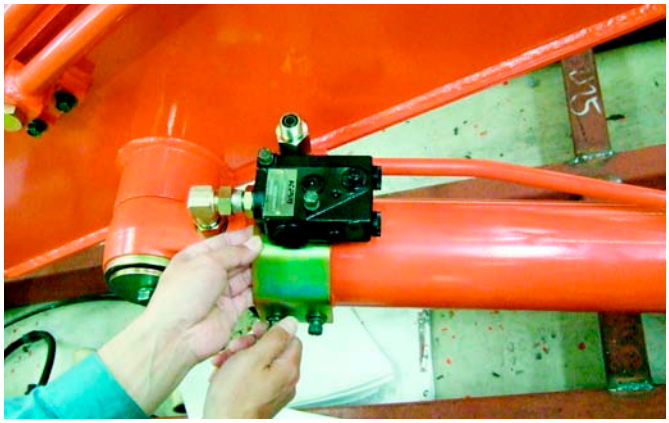


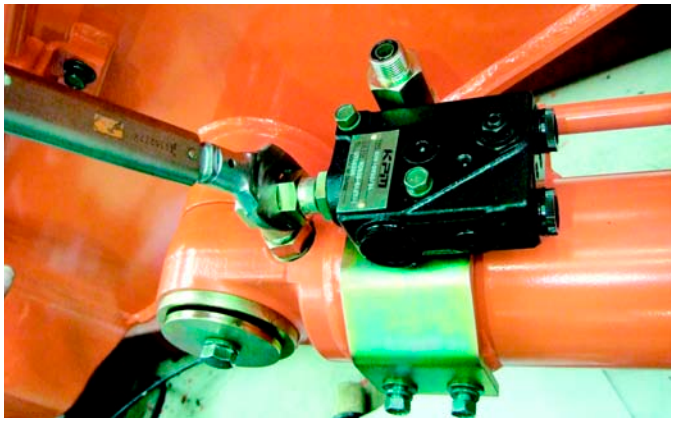


2. Installation

1) Adaptors

(1)Pipe joint (FG4, 13/16V)
(2)Pipe joint (FG4, 13/16V)
(3)Pipe joint (LG4,13/16 U)
(4)Pipe joint (L, G1/4 - G3/8)
(5)Pipe joint (L, G1/4 - G1/4)
(6)Mounting bolt





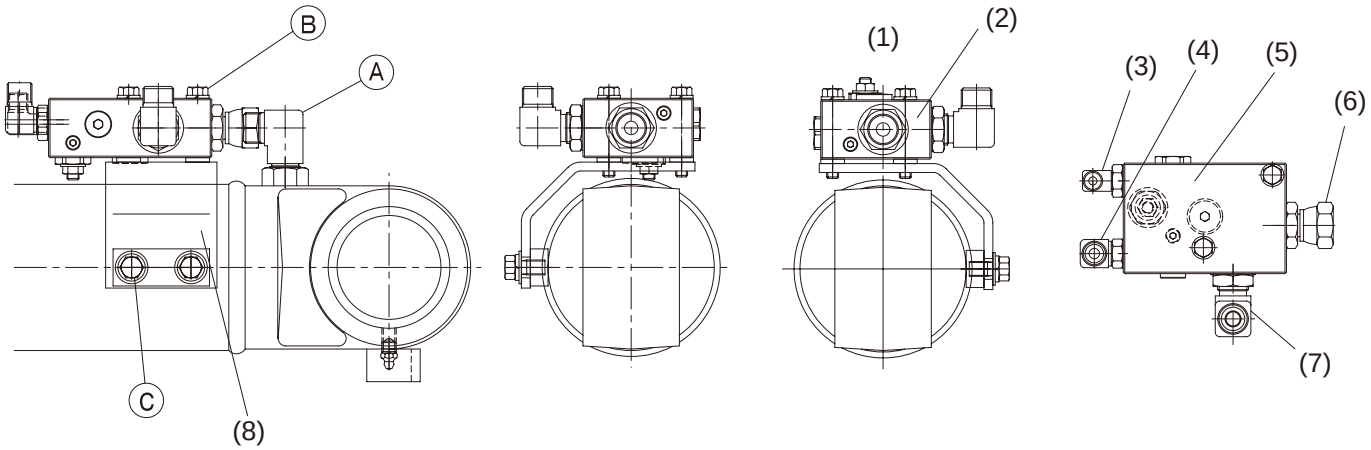
3) Adaptor tightening torque
G1/4 size
24.5~29.4N·m (2.5~3.0kgf·m) 18.1~21.7ft·lbs
G1/2 size
58.8~63.7N·m (6.0~6.5kgf·m) 43.4~47.0ft·lbs

4) Fitting procedure (explained here for the left-side cylinder)
(1) Temporarily fix the valve assembly (holding) to the bracket (left, holding valve).
(2) Screw the pipe joint (6) (FG4, 13/16U) to the pipe joint (A). Temporarily fix the bracket (8) (left, holding valve) to the cylinder.
(3) Tighten up the joint unit for the pipe joint (6) (FG4, 13/16U).
(4) Tighten up the bolts (B and C).

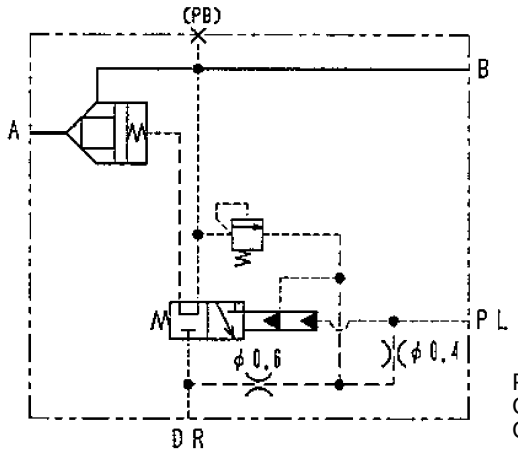
* The valve assembly (holding) is fitted in a different direction on the right-side cylinder. Refer to the figure.

5) Bolt tightening torque
70.6~86.2 N·m (7.2~8.8 kgf.m) 52.1~63.7 ft·lbs
(B) M8 x 55
23.5~27.5 N·m (2.4~2.8 kgf.m) 17.4~20.3 ft·lbs
(C) M10 x 20
48.1~55.9 N·m (4.9~5.7 kgf.m) 35.4~41.2 ft·lbs

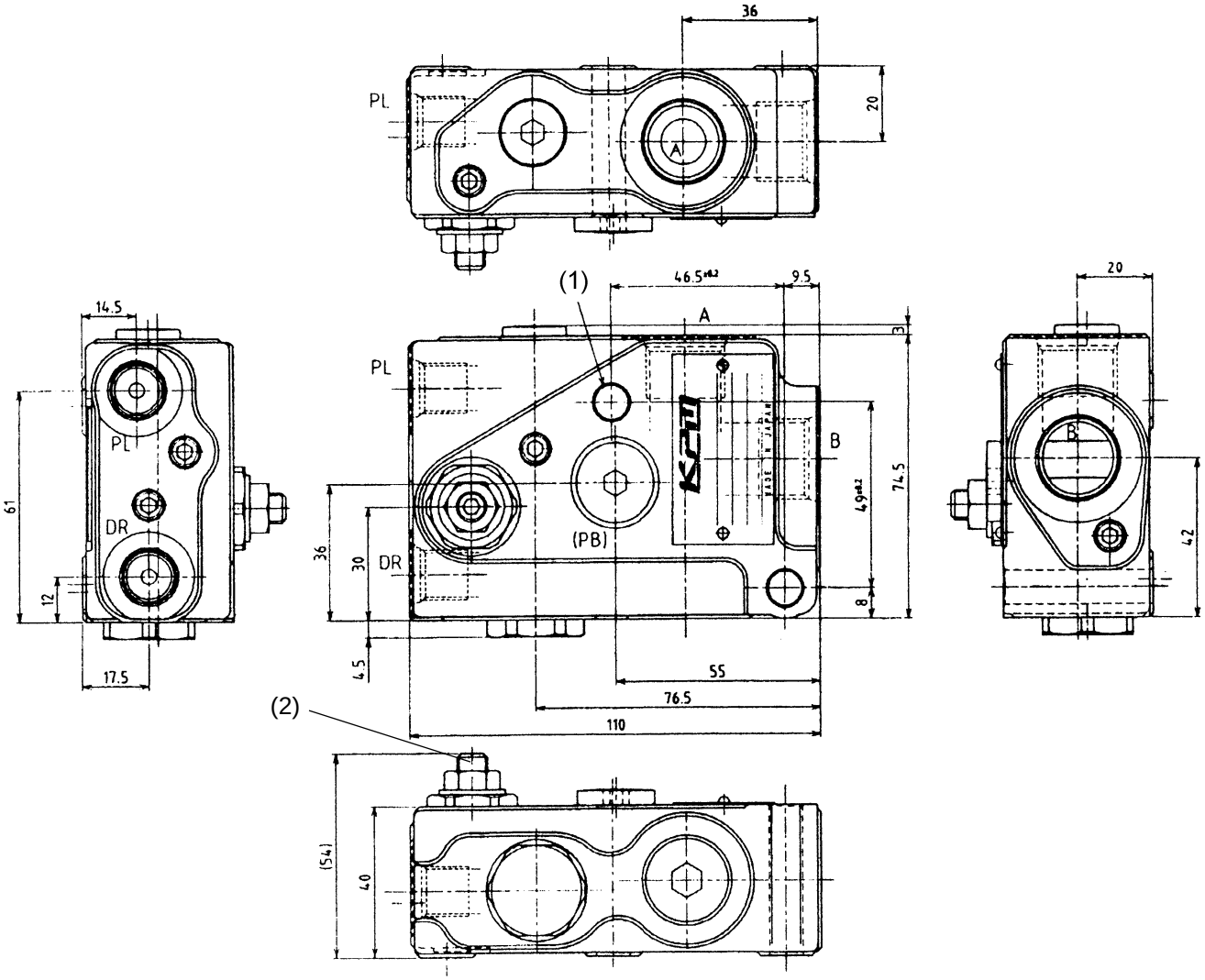
(1) (Fitting onto the right-side cylinder)
(2) The valve assembly (holding) is attached upside down at the left-side cylinder.
The L-shaped pipe joint port of this valve should face upward.
(3) Pipe joint (L, G1/4-G1/4)
(4) Pipe joint (L, G1/4-G3/8)
(5) Valve assembly (holding)
Bolt
(6) Pipe joint (FG4, 13/16U)
(7) Pipe joint (LG4, 13/16U)
(8) Bracket (left, holding valve)
Bolt



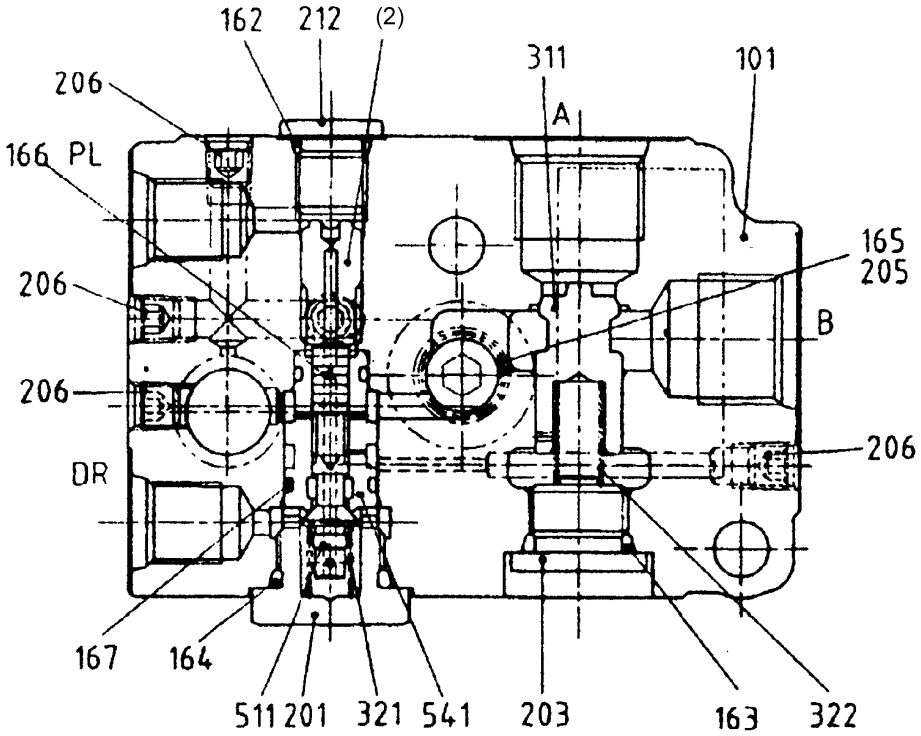
4. Circuit Diagram



Port size
G1/2 : A, B
G1/4 : PL, DR



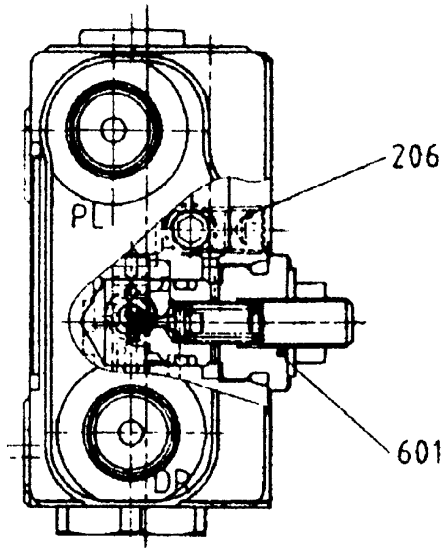
(1) 2-ø9 Through
Tightening torque : 27~31 N·m (2.75~3.16 kgf·m) 19.9~22.9 ft·lbs
(2) Overload relief valve



5. Main Parts

Tighting torgue
A, B port :
98~120 N·m (10.0~12.2kgf·m)
72.3~88.2ft·lbs
P_L, D_r, (PB) port :
34~39 N·m (3.47~3.98kgf·m)
25.1~28.8ft·lbs

101 Casing	311 poppet
162 O-ring	321 spring
163 O-ring	322 spring
164 O-ring	511 spool
165 O-ring	541 sleeve
166 O-ring	601 relief valve
167 O-ring	631 piston
201 plug	901 name plate
203 plug	902 pin
205 plug	
206 plug	
212 plug	



6. Specifications

1.Max pressure : 34.3 MPa (350 kgf/cm^2) 4798 psi
2.Rated flow : 100 L/min. (A→B)
3.Cracking pressure
Opening pressure is action at A port : P_A = 0.1 MPa (1.0kgf/cm^2) 14.2 psi
Opening pressure is action at P_L port : P_{PL} = 0.35~0.5 Mpa (3.6~5.1kgf/cm^2) 51~73 psi
4.Leakage flow rate : 1.5cc/min or less
ISO VG 46, Temp : 50°C
Rated pressure is activated at B port.
5.Overload relief pressure 33.3 MPa (340 kgf/cm^2) 4830 psi

7. Structure

The structure of the KHV10N30/* holding valve is shown in Fig. 1.

The holding valve and the relief valve are housed in the casing (101) that also has the control valve, cylinder and connection ports (PF threaded type).
Inside the casing (101), the relief valve is connected upstream with the port that leads to the cylinder and is connected downstream with the DR port through the orifice of spool (511).
In the holding valve, the poppet (311) that controls the hydraulic oil flow is kept pressed by the spring (322) against the seat of casing (101).
On the other hand, the spool (511) is incorporated in the sleeve (541). The circular conical surface of spool (511) is kept pushed by the spring (321) against the seat of sleeve (541). The sleeve (541) is provided with a cylinder hold pressure lead-in opening.

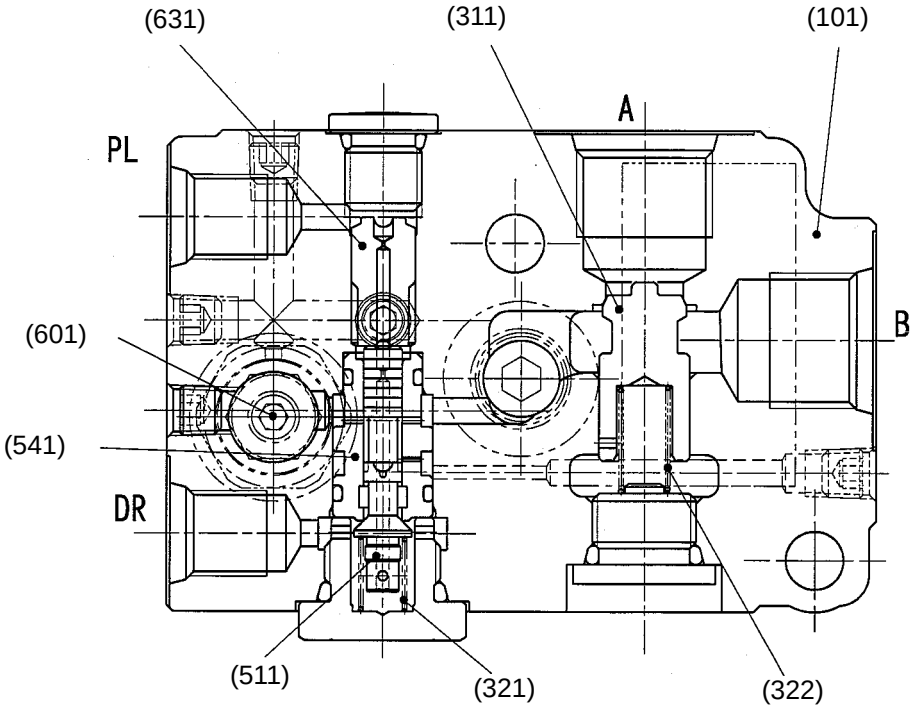


Fig. 1

101 : Casing
311 : Poppet
321 : Spring
322 : Spring
511 : Spool
541 : Sleeve
601 : Relief valve
631 : Piston

A : Port to control valve
B : Port to boom 2 cylinder bottom side
P_L : Pilot secondary pressure from boom 2 pilot valve
Dr : Drain line to tank

8. Function

8-1. With the cylinder being held

In Fig. 2, the cylinder's hold pressure is fed through the B port and around the spool (511) into the spring chamber (a) of poppet (311). This hold pressure pushes the poppet (311) against the casing (101), which closes the return oil passage at the head and prevents the cylinder from falling by gravity.

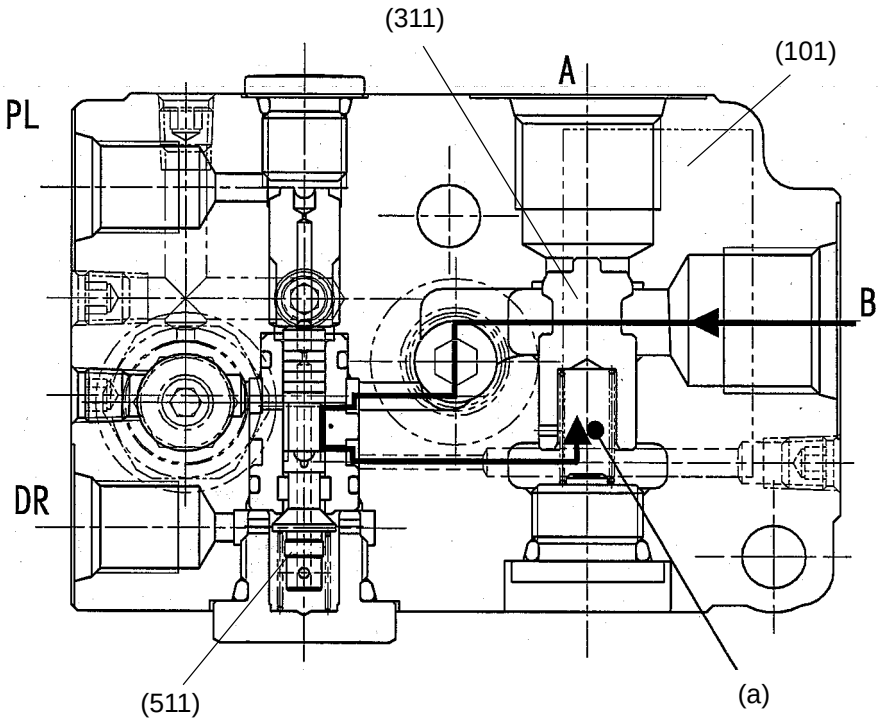
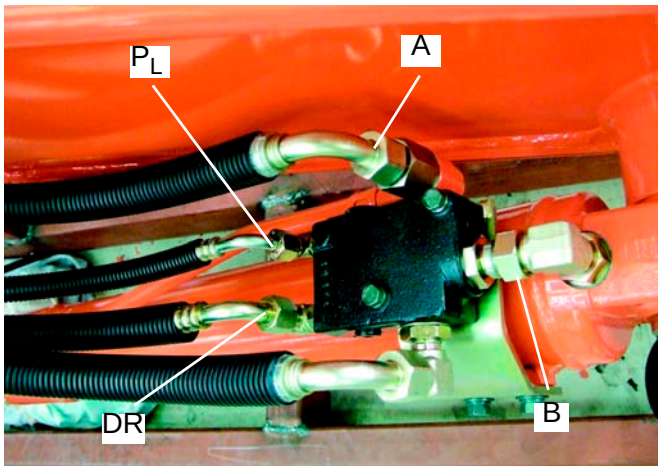


Fig. 2



a : Spring chamber

A : Port to control valve
B : Port to boom 2 cylinder bottom side
P_L : Pilot secondary pressure from boom 2 pilot valve
Dr : Drain line to tank

101 : Casing
311 : Poppet
511 : Spool

8-2. Oil flow from A to B (From control valve to cylinder: Free flow)

Boom 2 cylinder extending :
In Fig. 3, the control valve is activated for hydraulic oil to flow toward side A.
The poppet (311) gets activated at 0.1 MPa (1 kgf/cm^2) 14.2psi and lifted to let hydraulic oil flow from A to B.

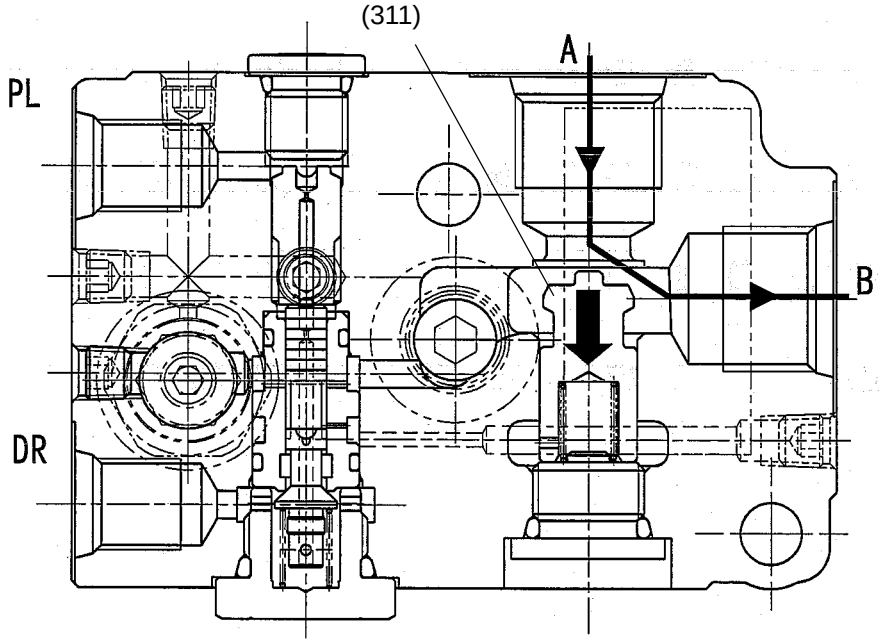


Fig. 3

311 : Poppet

A : Port to control valve
B : Port to boom 2 cylinder bottom side
P_L : Pilot secondary pressure from boom 2 pilot valve
Dr : Drain line to tank

8-3. Oil flow from B to A (From cylinder to control valve: with the cylinder released)

In Fig. 4, the cylinder is still held (in the state 6-1) and the PL pilot port gets pressurized.
When a pressure of over 0.33 MPa (about 3.4 kgf/cm^2) 48.4psi is applied to the PL port, the piston (631) gets activated to move the spool (511) over its stroke against the preset load of spring (321).
As the spool (511) starts over its stroke, the land of spool (511) closes the B opening of sleeve (541), which shuts off the cylinder hold pressure as well as the pressure in the spring chamber of poppet (311).
As the spool (511) moves further full-stroke, the notch of spool (511) opens. The pressure in the spring chamber of poppet (311) is fed through the C opening of sleeve (541) and the notch of spool (511) to the DR drain port.
As a result, the pressure in the spring chamber of poppet (311) becomes equal to the drain pressure. The poppet (311) receives the cylinder hold pressure upon a ring-shaped area that is formed from the difference in diameter at the seat of casing (101). The poppet then overcomes the spring (322) and lifts itself, which lets hydraulic oil flow from B to A.
When the pressure at the PL pilot port comes back to 0 MPa, the spool (511) returns to the neutral position by the force of spring (321).
Therefore, the spring chamber of poppet (311) and the DR drain port are shut off from each other, and the cylinder pressure is led in again. The poppet (311) is then pushed against the seat of casing (101), which holds hydraulic oil from the cylinder.

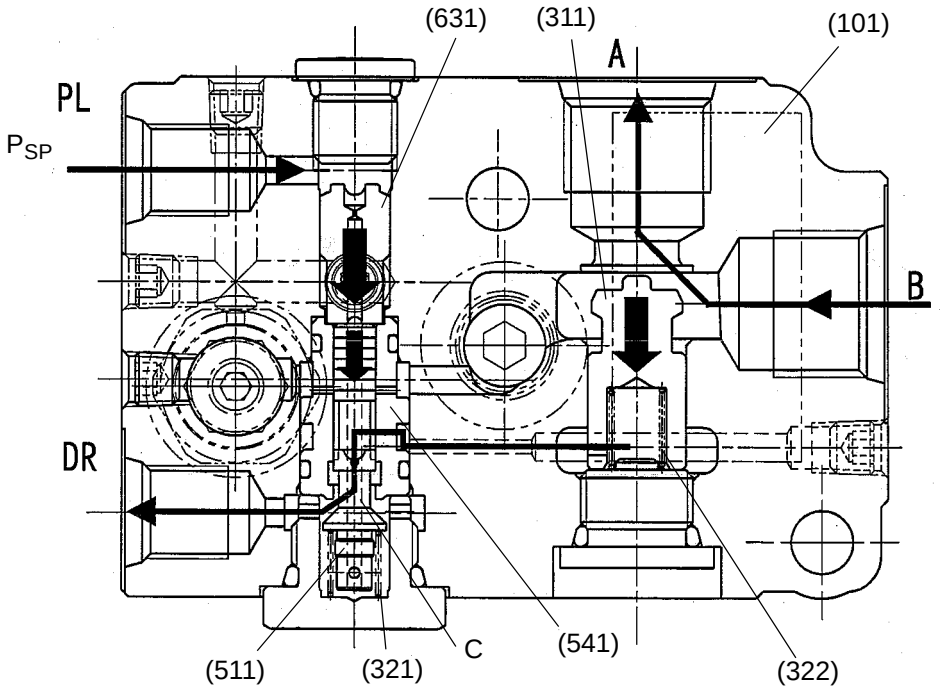


Fig. 4

101 : Casing
311 : Poppet
321 : Spring
322 : Spring
511 : Spool
541 : Sleeve
631 : Piston

A : Port to control valve
B : Port to boom 2 cylinder bottom side
P_L : Pilot secondary pressure from boom 2 pilot valve
Dr : Drain line to tank
P_{SP} : Pilot secondary pressure

8-4. In case of overload

As shown in Fig. 5, the relief valve is built in to protect the machine if the cylinder gets held and overloaded. The hold pressure from the cylinder bottom side is introduced into the D chamber. If this pressure exceeds the relief valve's pressure setting, the relief valve's poppet lifts itself and the hold pressure from the cylinder bottom side is applied via the relief valve into the E chamber. The oil in the E chamber passes through the orifice of spool (511) to the DR drain port. Now the pressure in the E chamber rises because of a pressure difference of the oil passing through the orifice of spool (511). The spool (511) then acts against the spring (321) and shifts downward. The F section is connected with the spring chamber (a) of poppet (311). A downward shift in the spool (511) makes for a passage to the DR drain port and reduces the pressure in the spring chamber (a). In this way, the poppet (311) gets released from the casing (101) and moves down. The return oil at the cylinder bottom side now flows toward the A port, preventing an unusual rise in the hold pressure.

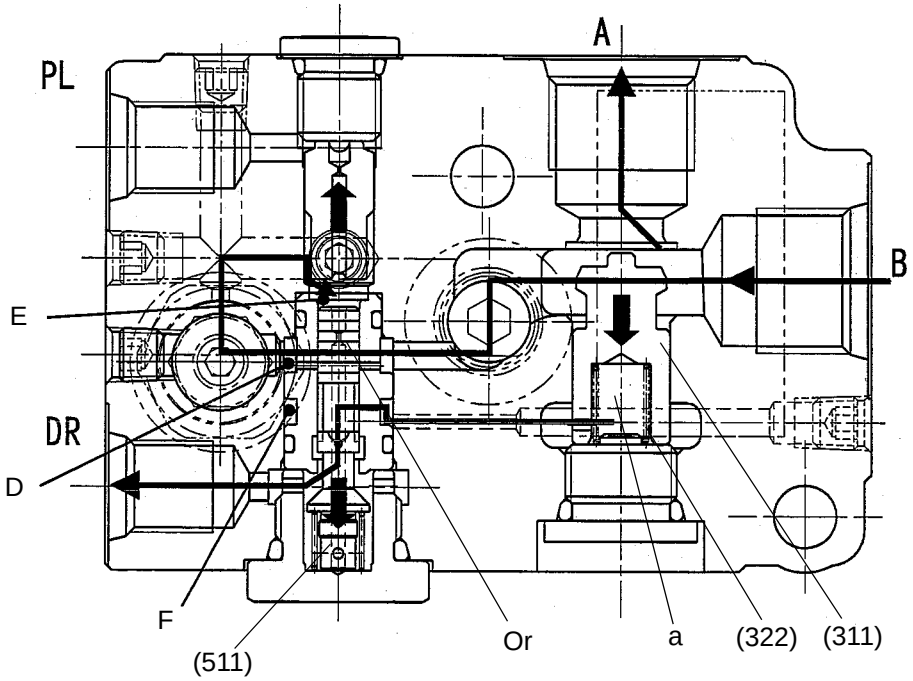
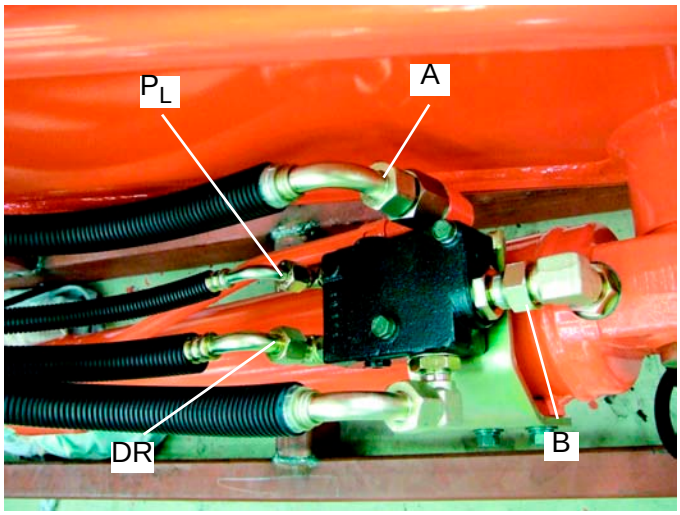


Fig. 5

a : Spring chamber of poppet
Or : Orifice

A : Port to control valve
B : Port to boom 2 cylinder bottom side
P_L : Pilot secondary pressure from boom 2 pilot valve
Dr : Drain line to tank
D : Chamber D
E : Chamber E
F : Section F

311 : Poppet
322 : Spring
511 : Spool



9. Maintenance Procedures

9-1. Tools required and tightening torques

Tool	Size	Fig No.	Part name	Screw size	Tightening torque : N·m (kgf·m) ft·lbs
Allen wrench	4mm	206	Plug	NPTF 1/16	7.8~9.8 (0.8~1.0) 5.8~7.2
	6mm	205	Plug	PF 1/4	34~39 (3.5~4.0) 25.3~29.0
		212	Plug	M12	25~29 (2.6~3.0) 18.8~21.7
	8mm	203	Plug	M16	39~49 (4.0~5.0) 29.0~36.2
Wrench	24mm	201	Plug	M18	49~59 (5.0~6.0) 36.2~43.5
Torque wrench	7.8~59.0 N·m (0.8~6.0 kgf·m) 5.8~43.5 ft·lbs				

Others: Grease, vapor-phase inhibitor

9-2. Relief valve adjustment

The relief valve pressure setting is made using the adjusting screw. In this adjustment, be sure to connect a pressure gauge to the pressure port and monitor the pressure.

One turn of the adjusting screw: About 24.1 MPa (about 245.7 kgf/cm^2) 3495psi

9-3. Disassembling procedure

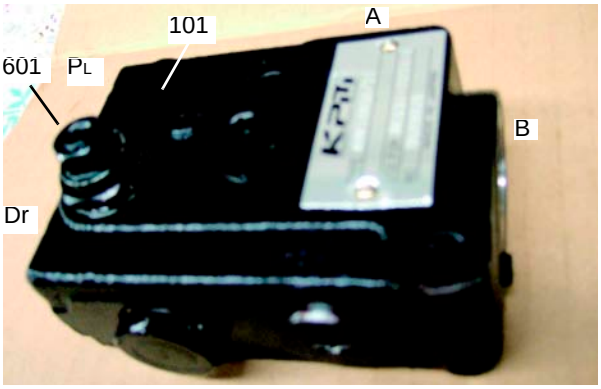
1) Preparations

* Prepare a workbench that is large enough to place removed parts, as well as stable and solid enough to keep them during the job.
* Prepare the tools and materials.

2) General precautions for disassembling

* All the parts are of high precision. Handle them with enough care. Be very careful not to hit or drop them.
* Even if any of the parts is tough to remove, be very careful not to hit it hard or twist it. Otherwise, the part may get burred or damaged, resulting in fitting failure, oil leak or poor performance.
* Do not leave the removed parts or stop the disassembling halfway. Wetness and dust cause rust. During and after the work, take measures to avoid rust and dust.

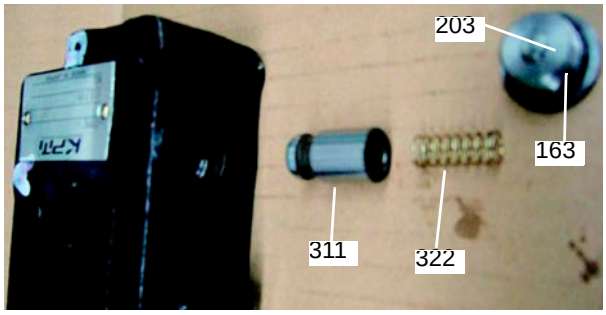
3) Disassembling procedure



1. Clean the holding valve with white kerosene. Before cleaning, cover the ports to avoid dust by applying blank caps and sealings.

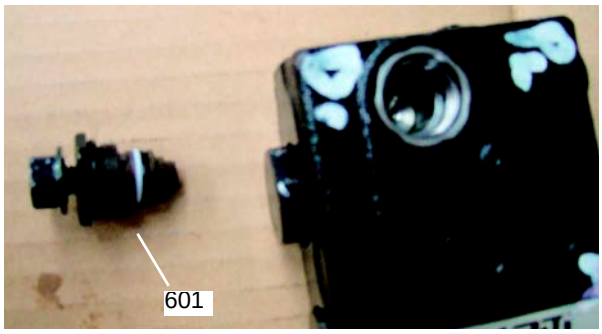
   101 : Holding valve assy
   601 : Overload relief valve

   A : A-port, to or from the control valve
   B : B-port, to or from the second boom cylinder bottom side
   P_L : P_L-port, to or from the boom 2 pilot valve
   Dr : Drain port



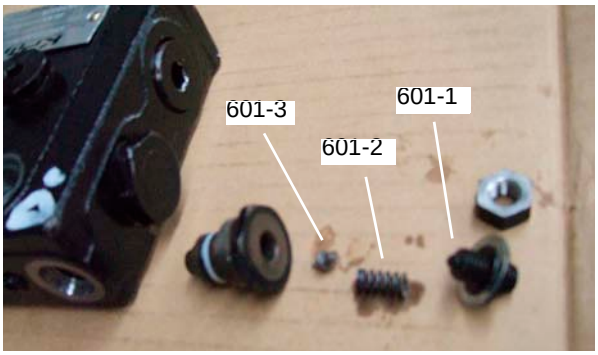
2. Take out the relief poppet.
   1) Secure the casing (101) in a vise or the like. Preferably fix the casing (101) upward for easier disassembling.
   2) Using a wrench, loosen the plug (203) and take it out of the poppet (311) and spring (322).

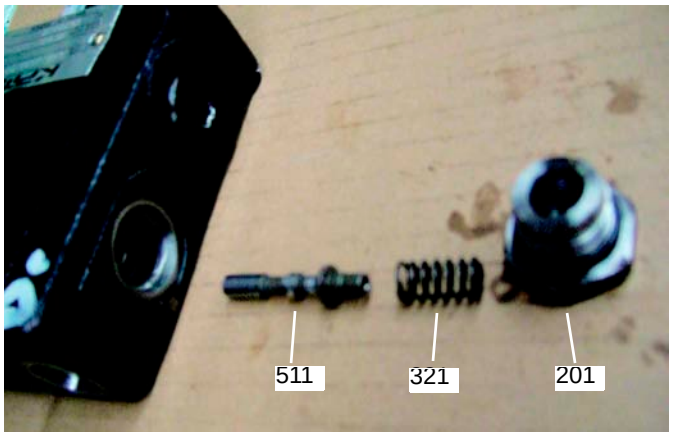
   163 : O-ring
   203 : Plug
   322 : Spring
   311 : Poppet

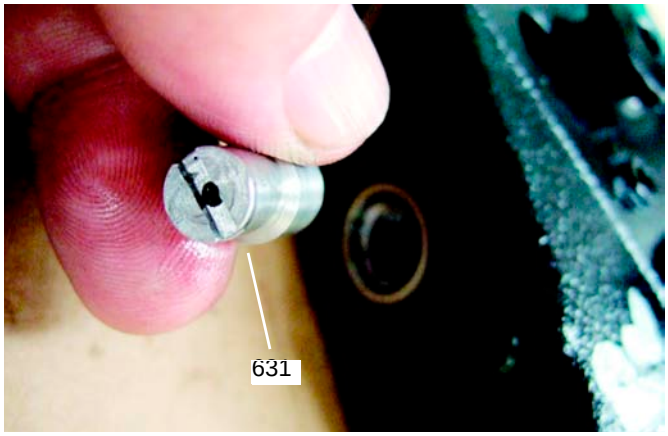


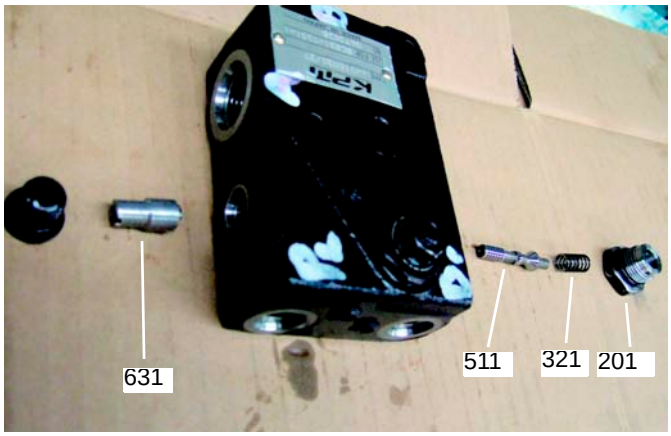
3. Remove the overload relief valve.
   1) Loosen the lick nut
   2) Using an Allen wrench, loosen the adjusting screw.
   3) Remove the valve assy.

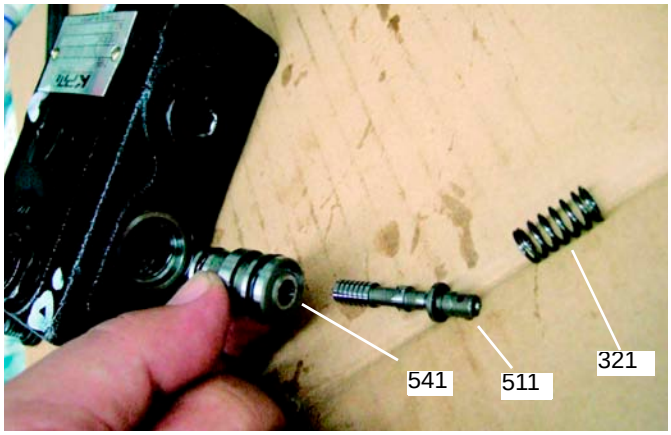
   601 : Relief valve assy
   601-1 : Adjust screw
   601-2 : Spring
   601-3 : Needle poppet











4. Removing the piston (631), sleeve (541) and spool (511)
(Taking out the piston (631))

1) Loosen the plug (201) and take it out of the casing (101).
2) Take the spring (321) out of the casing (101).
3) Take the spool (511) and sleeve (541) out of the casing (101).
4) Remove the O-ring (164) from the plug (201).

201 : Plug
321 : Spring
511 : Spool

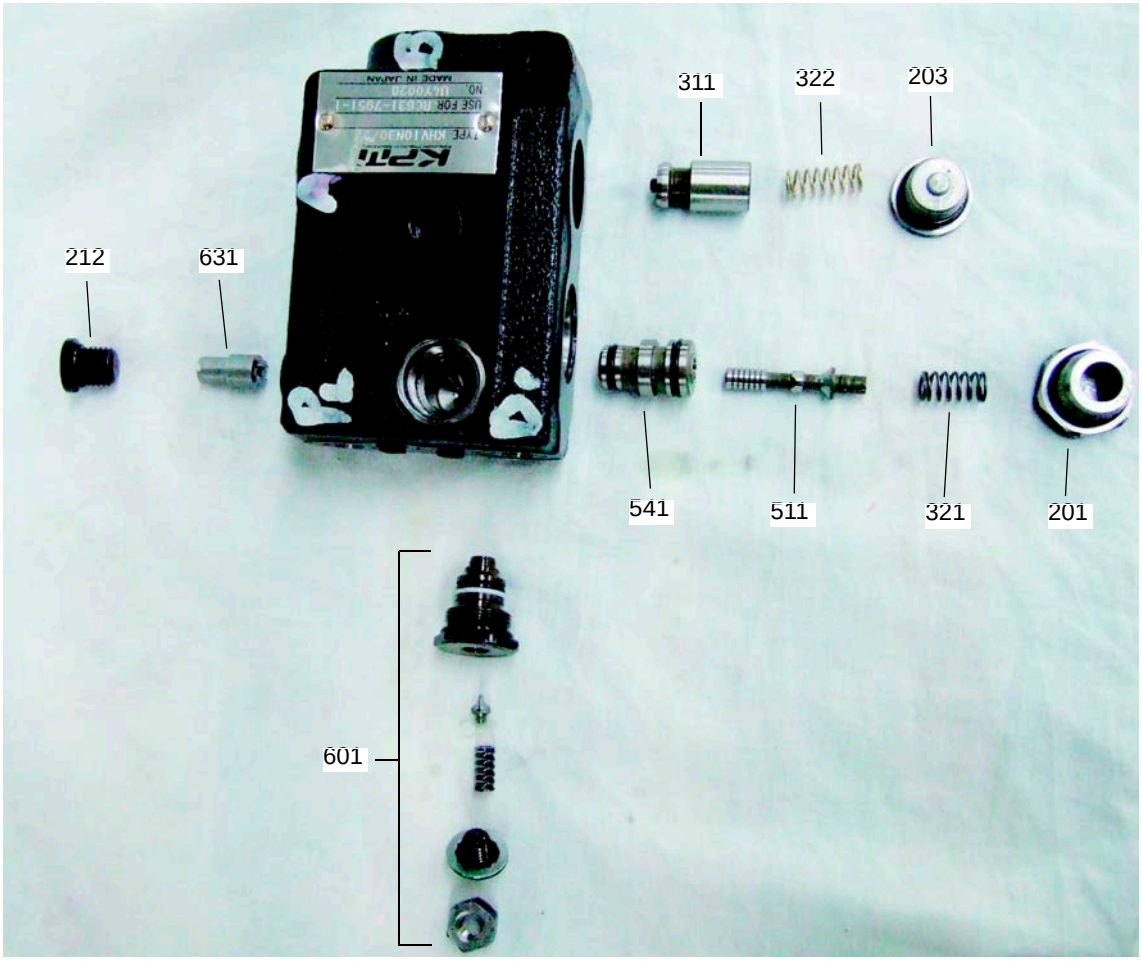
631 : Piston
Securely check the fitting direction

541 : Sleeve

5. Cleaning the parts
1) Put the parts in a rough-washing container with white kerosene and wash them lightly.
2) Then put the parts in a finish-washing container with white kerosene. Slowly turn around the container to wash the inside of the parts as well. (Finish cleaning)
Using clean waste cloth, wipe white kerosene off the parts.

* Do not wash dirty parts in kerosene just after soaking them. They may get scratched. Keep them in kerosene until dust, fat and oil become loose and floating.
* Carefully maintain the cleanliness of white kerosene. Unclean white kerosene may cause damage on the parts, resulting in poor performance after reassembling.
* Do not compressed air to dry up the parts. Dust and moisture in the air may damage the parts or gather dust.

6. Rust-preventing method
Spray vapor-phase inhibitor over the parts.
Do not leave the cleaned parts as they are. They may get rusty and function poorly after reassembling.



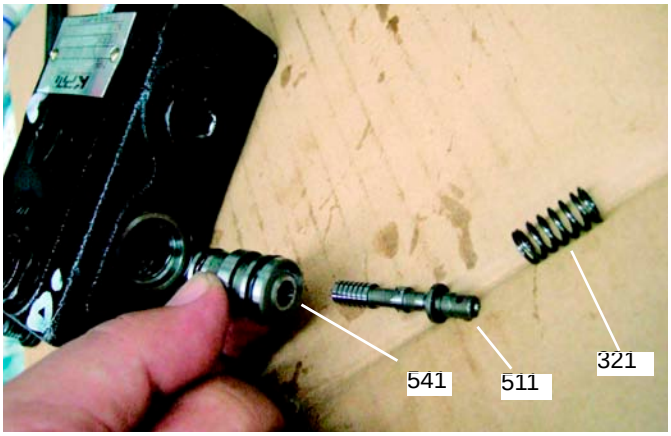
201, 203, 212	: Plug	511 : Spool	601 : Relief valve
321, 322	: Spring	541 : Sleeve	
311	: Poppet	631 : Piston	

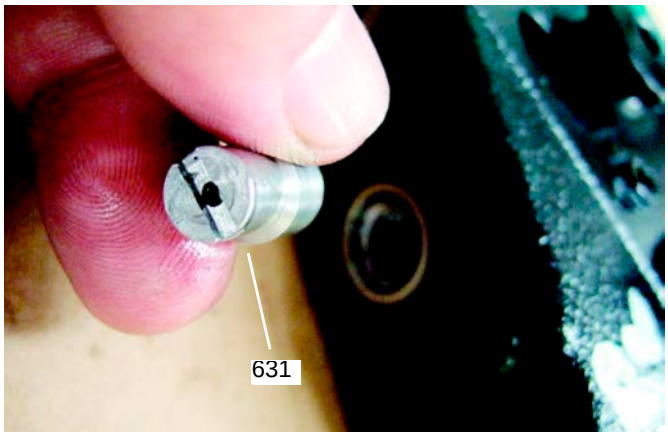
9-4. Reassembling procedure

1) Preparations
   (1)Prepare the workbench, tools and materials in the same way when disassembling.

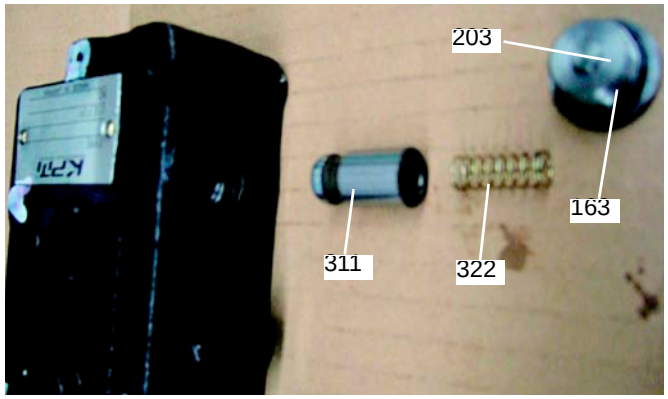
2) General precautions for reassembling
   (1)Take the same general precautions when disassembling.
   (2)In reassembling, remove metallic chips and foreign substance off the parts. Make sure the parts are free of burr, hit marks and the like. Remove such defects, if any, with an oil stone.
   (3)As a rule, replace all the existing O-rings with new ones.
   (4)When installing the O-rings, be careful not to damage them. (Preferably apply a small amount of grease on them for smooth fitting.)
   (5)When fitting the parts, preferably apply grease on them to avoid dropping.
   (6)Tighten the plugs and other threaded parts to their respective torques listed in “6-1 Tightening Torque Table”. Use a torque wrench to monitor the tightening torque.
   (7)With all the parts in place, apply plugs to all the ports to keep off dust.

3) Reassembling procedure





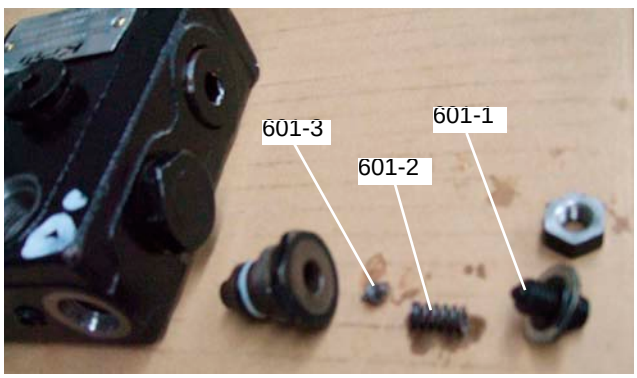
1. Reassemble the sleeve (541), spool (511) and piston (631)
   1) Secure the casing (101) in a vise or the like.
   2) Install the O-ring (164) on the sleeve (541).
   3) Fit the sleeve (541) to the casing (101).
      In fitting the sleeve (541), be careful not to scratch its seat.
   4) Place the spool (511) in the sleeve (541).
      Make sure the spool (511) moves smoothly inside the sleeve (541).
   5) Install the O-ring (161) on the plug (201).
   6) Place the spring (321) in the spool (511), fit the plug (201) to the casing (101), and tighten them up to the specified torque with a wrench.
   7) Fit the piston (631) in the casing (101).
   8) Finally install the O-ring (164) on the plug (204), fit them to the casing (101), and tighten them up to the specified torque with an Allen wrench.



2. Reassemble the poppet.
   1) Fit the poppet (311) and spring (322) to the casing (101).
   2) Install the O-ring (163) on the plug (203), fit them to the casing (101), and tighten them up to the specified torque with an Allen wrench.

3. Reassemble the relief valve
   1) Fit the relief valve (601) to the casing (101), and tighten them up to the specified torque with a wrench.

4. Fit the O-ring (165) to the blind plug (205).
   Tighten them in position, specified in the Assembly Sectional View, to the specified torque.



5. Rust-preventing the inside
   To prevent rust due to dew condensation, fill the casing (101) with vapor-phase inhibitor and seal all the ports with blind plugs.

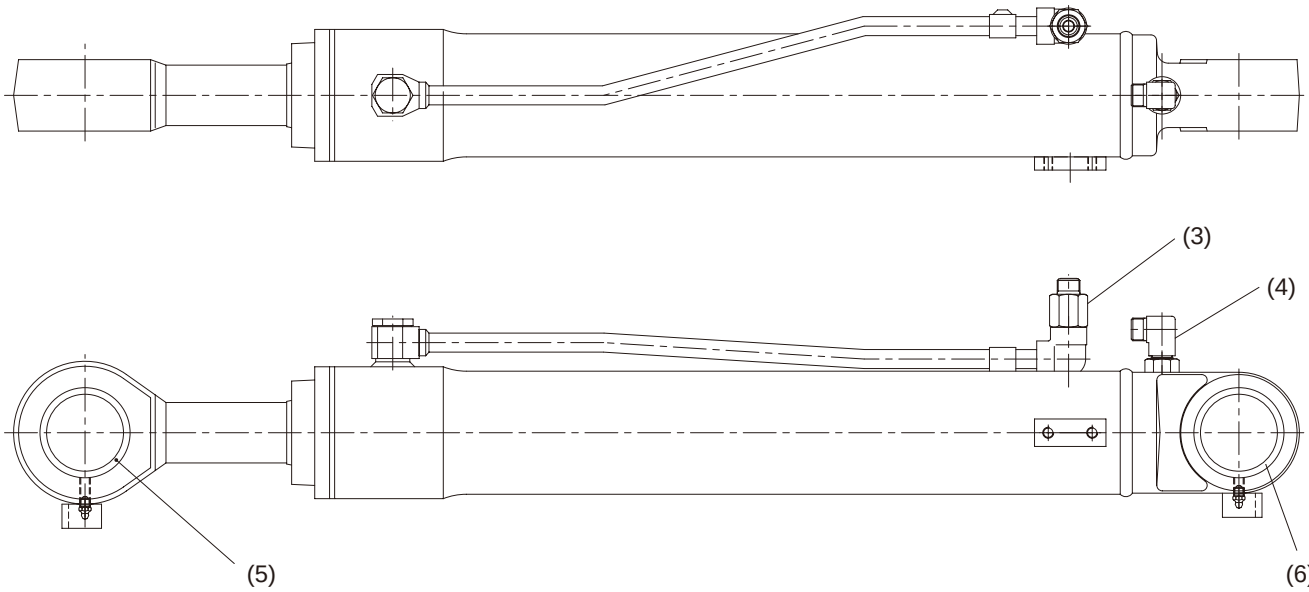
j. Second Boom Cylinder

1. Adaptors

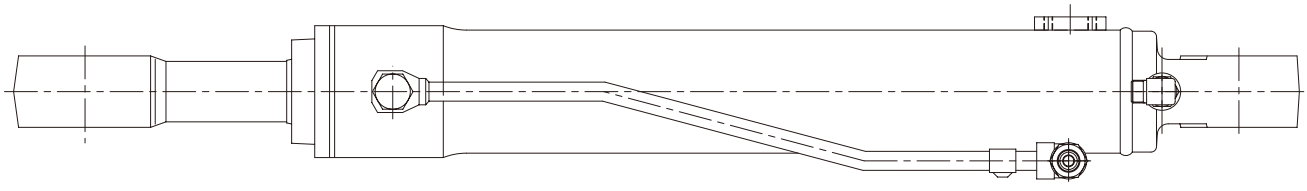
Adaptor tightening torque
RD809-6823
RD809-68771

G1/2 size
58.8~63.7 N·m (6.0~6.5kgf·m) 43.4~47.0 ft·lbs

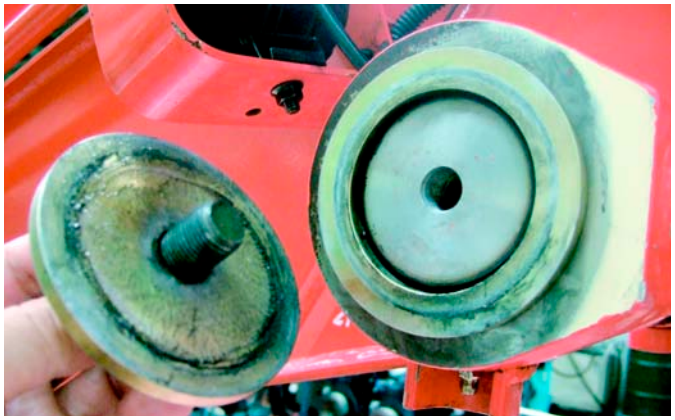
(1)



(2)

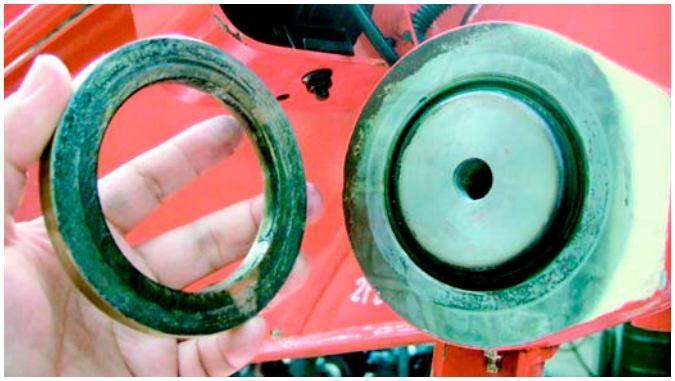


(1)(Boom 2 cylinder L) RD809-6720Δ
(2)(Boom 2 cylinder R) RD809-6730Δ
Different from RD809-6720Δ for left- and right hand setup, but with same adaptor
(3)Pipe joint
(4)Pipe joint
(5)Dust seal
(6)Dust seal

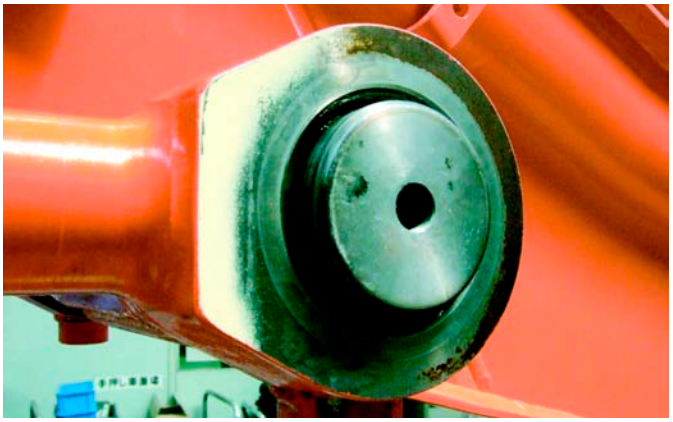


2. Boom 2 Cylinder Dismounting.

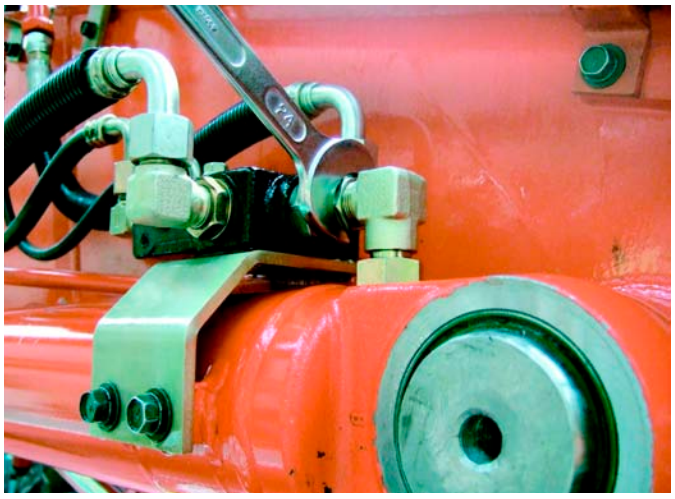
1) Remove the stopper bolt and cover plate.



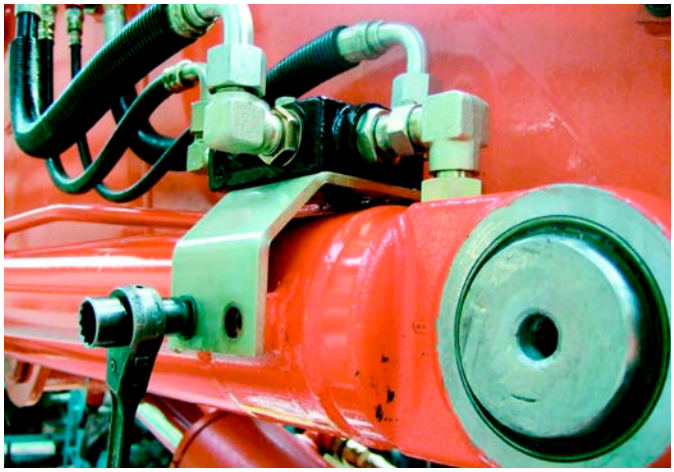
2) Take out the spacer.



3) Check the dust seal.



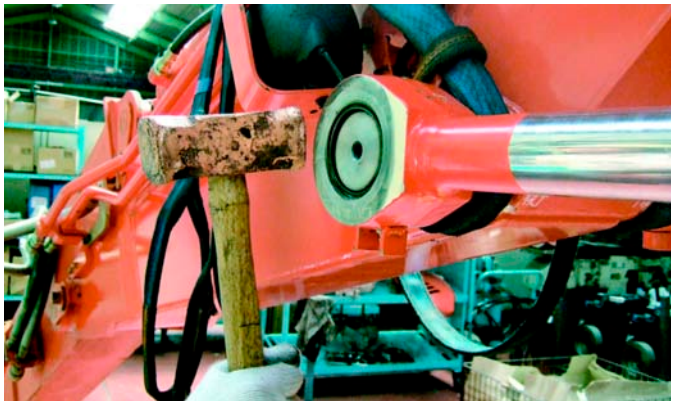
4) Loosen the adapter of the L-joint.



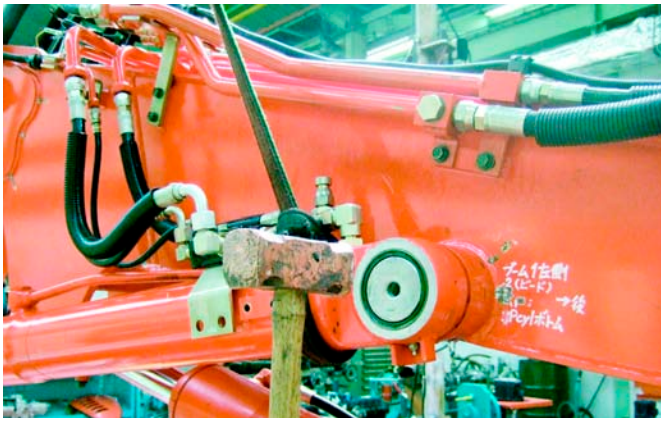
5) Remove the mounting bolts.



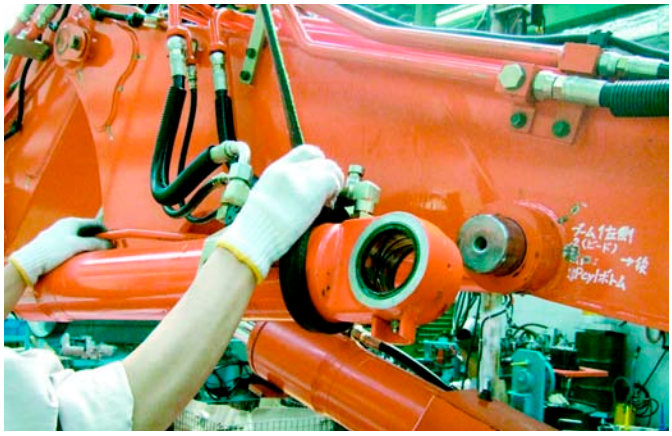
6) Disconnect the adapter and plug them.



7) Remove the stopper bolt and cover plate in the cylinder rod side.



8) Tap in the pin with copper hammer.



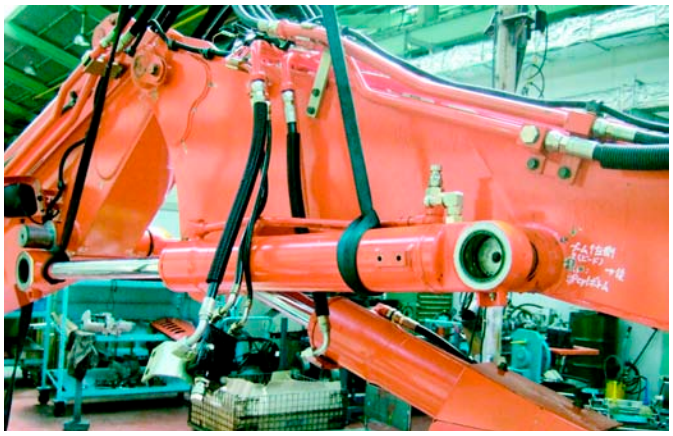
9) Hang the cylinder assy with nylon sling and pull it out.



10) Dismount the other side of cylinder assy.

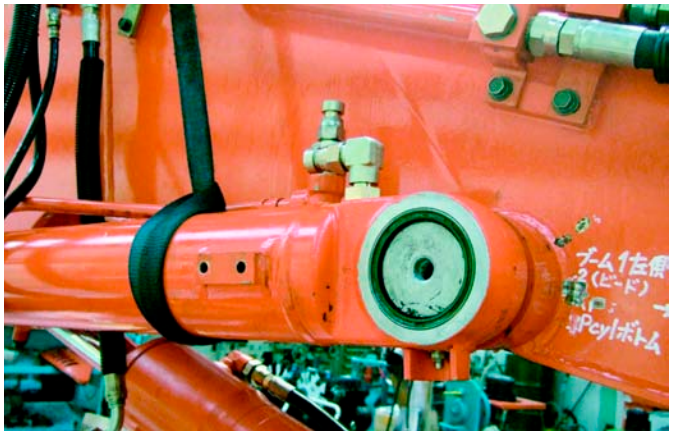


11) Pull out the pin.
Pin weight is approx. 20 kgf (44 lbs).

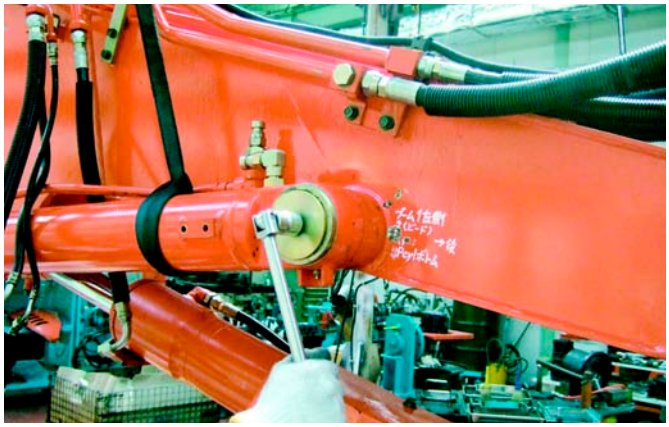


3. Boom 2 Cylinder Remounting

1) Lift up the cylinder assy with nylon sling.



2) Insert the cylinder botton side first.



3) Place the spacer and cover and tighten the stopper bolt.



4) Tighten the mounting bolts by hand.
Tighten all the hose adaptors to torque.



5) Tighten the mounting bolts to torque.

M10 x 20
Tightening torque : 48.1~55.9 N·m (4.9~5.7 kgf·m) 35.4~41.2 ft·lbs



6) Start engine and operate the cylinder.



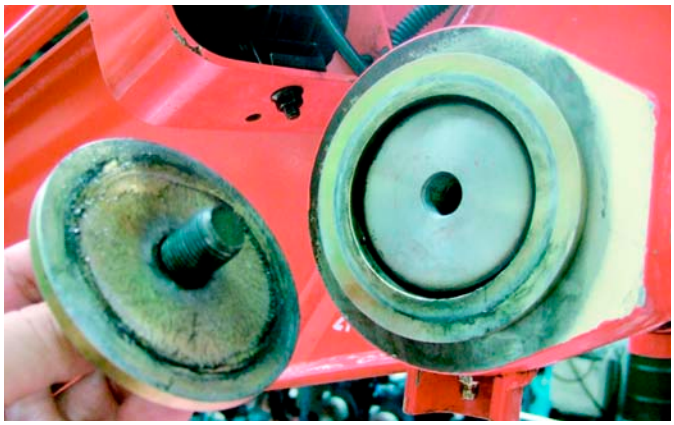
7) Align the pin and the cylinder boss at rod side.



8) Tap in the pin with a copper hammer.



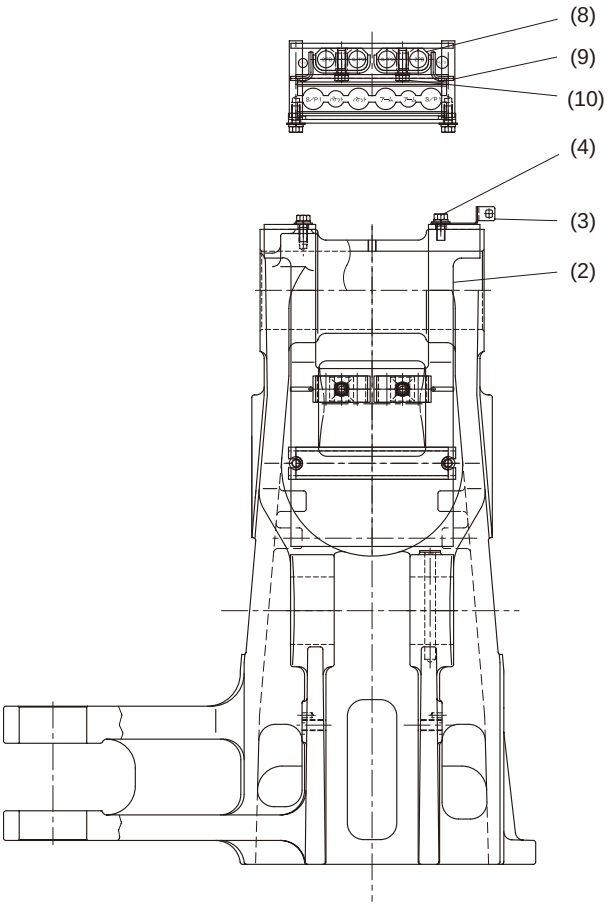
9) Install the dust seal.
Be sure of the direction.

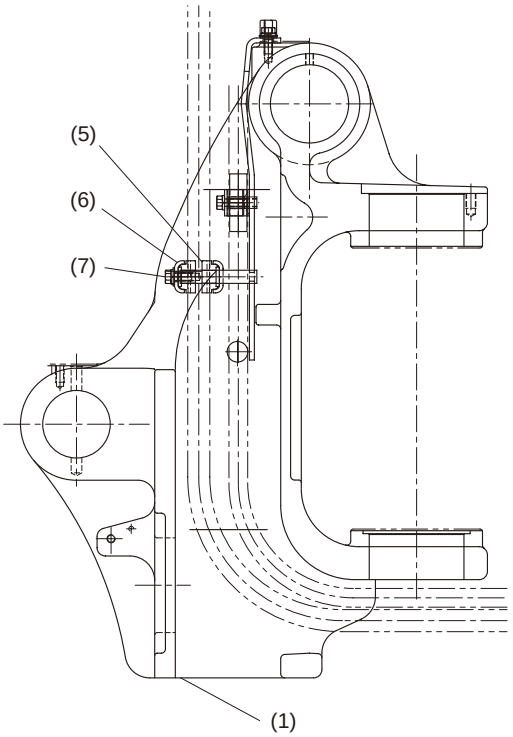


10) Place the spacer and cover and tighten the stopper bolt.

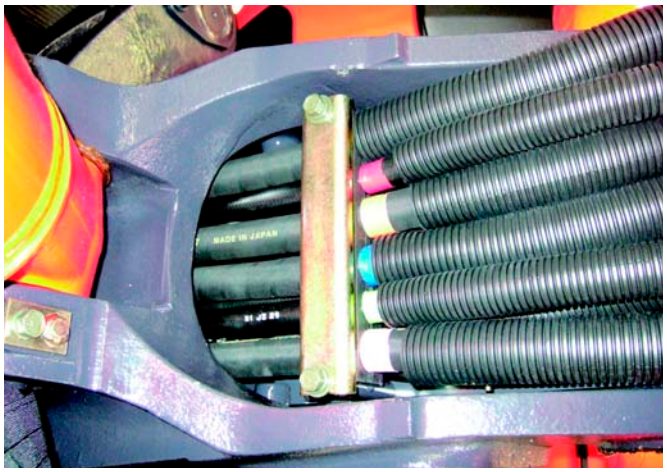
k. Hose and Pipes

1. Hoses in the Swing Bracket

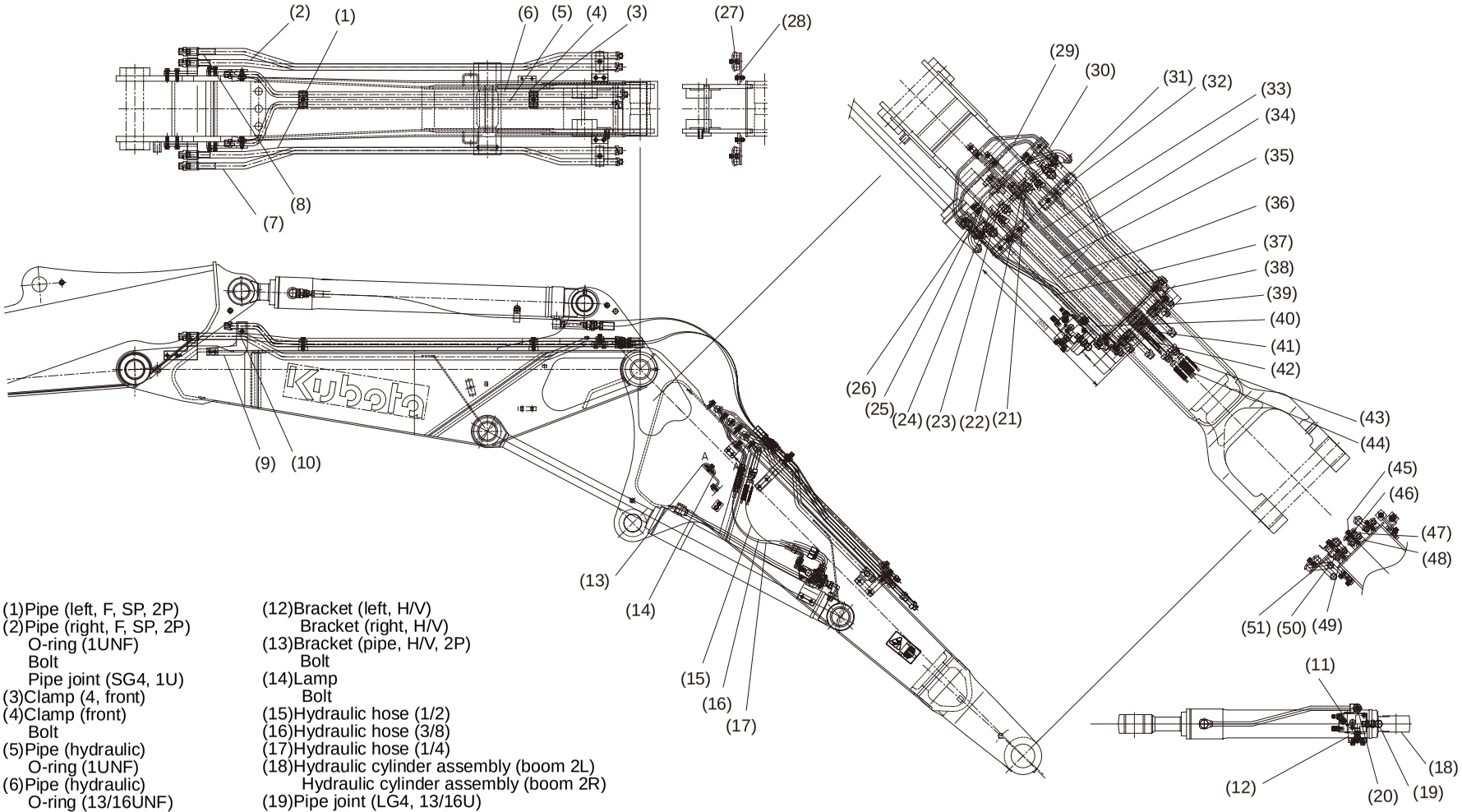




(1) Bracket (swing)
(2) Bracket (hose guide)
(3) Stay (1, harness clamp)
(4) Bolt
(5) Cushion
(6) Plate
(7) Bolt
(8) Cushion (hose, front)
(9) Clamp (2P, front)
(10) Bolt



2. Hoses and Pipes of the 2-piece Boom



(1)Pipe (left, F, SP, 2P)
(2)Pipe (right, F, SP, 2P)
O-ring (1UNF)
Bolt
Pipe joint (SG4, 1U)
(3)Clamp (4, front)
(4)Clamp (front)
Bolt
(5)Pipe (hydraulic)
O-ring (1UNF)
(6)Pipe (hydraulic)
O-ring (13/16UNF)
O-ring (1UNF)
(7)Pipe (left, F, SP, 2P)
(8)Pipe (right, F, SP, 2P)
O-ring (1UNF)
Bolt
Pipe joint (SG4, 1U)
(9)Bracket (clamp)
Clamp (pipe, front)
(10)Bolt
(11)Valve assembly (holding)
Pipe joint (LG4, 13/16U)
Pipe joint (L, G1/4-G1/4)
Pipe joint (L, G1/4-G3/8)
Pipe joint (FG4, 13/16U)
Bolt

(12)Bracket (left, H/V)
Bracket (right, H/V)
(13)Bracket (pipe, H/V, 2P)
Bolt
(14)Lamp
Bolt
(15)Hydraulic hose (1/2)
(16)Hydraulic hose (3/8)
(17)Hydraulic hose (1/4)
(18)Hydraulic cylinder assembly (boom 2L)
Hydraulic cylinder assembly (boom 2R)
(19)Pipe joint (LG4, 13/16U)
(20)Pipe joint (SG4, 13/16U)
(21)Hydraulic hose (5/8)
(22)Hydraulic hose (1/2)
(23)Hydraulic hose (5/8)
(24)Hydraulic hose (1/2)
(25)Hydraulic hose (5/8)
(26)Hydraulic hose (1/2)
(27)Clamp
Bolt
(28)Bracket (SP)
Bolt
(29)Pipe (T, H/V, 2P)
Bolt
(30)Pipe (P, H/V, 2P)
Bolt

(31)Clamp (T)
Bolt
(32)Clamp)
Bolt
(33)Pipe (hydraulic)
(34)Pipe (hydraulic)
O-ring (13/16UNF)
(35)Pipe (hydraulic)
O-ring (1UNF)
(36)Pipe (hydraulic)
O-ring (13/16UNF)
(37)Pipe (left, R, SP, 2P)

(38)Pipe (right, R, SP, 2P)
O-ring (1UNF)
Plug
O-ring
Bolt
(39)Pipe (right, R, SP2, 2P)
(40)Pipe (left, R, SP2, 2P)
O-ring (1/16UNF)
Bolt
(41)Hydraulic hose (1/4)
(42)Hydraulic hose (3/8)
(43)Hydraulic hose (1/2)

(44)Hydraulic hose (1/2)
(45)Bracket (pipe, H/V, 2P)
(46)Clamp (front)
Bolt
(47)Clamp (front)
(48)Clamp (4, front)
Stay (harness clamp)
Bolt
(49)Clamp (4, front)
(50)Clamp (front)
Stay (harness clamp)
Bolt

3. Hoses List

List of pilot hoses (upper) (platform, control system)

No.	Location	Part code KX080-3 (EU)	Part name	Q'ty	Size (mm)	Tape color	Hose configuration	Remarks
1	Travel P/V (P) ~ 2P boom P/V (P)	RD809-6336Δ	Hydraulic hose (1/4P, swing PV)	1	190	White	Quick PLT04 G1/4	Common with Travel P/V ~ Swing P/V, 90° long-neck type at travel P/V side

List of pilot hoses (drain) (upper) (platform, control system)

2	2P boom P/V (T) ~ Travel P/V (T)	RD809-6346Δ	Hydraulic hose (1/4P, swing PV)	1	210		Quick PLT04 G1/4	Common with Travel P/V ~ Swing P/V, 90° long-neck type at travel P/V side

List of pilot hoses (upper) (control valve, front attachment)

3	2P boom P/V (crowded) ~ C/V (2P crowded)	RD809-6896Δ	Hydraulic hose (1/4, boom 2, P)	1	1950	Green, double	Quick PLT04 Quick	With corrugated tube
4	2P boom P/V (dump) ~ C/V (dump)	RD809-6897Δ	Hydraulic hose (1/4, boom 2, T)	1	2350	Blue, double	Quick PLT04 G1/4	With corrugated tube, 90° long-neck type at travel P/V side
5	2P boom P/V (crowded) ~ Boom back pipe (unlock)	RD809-6813Δ	Hydraulic hose (3/8)	1	3310		G3/8 PLT06 G3/8	With corrugated tube
6	Boom back pipe (drain) ~ Shockless valve (T)	RD809-6814Δ	Hydraulic hose (1/4)	1	3000		G1/4 PLT04 Quick	With corrugated tube, quick type at shockless valve side
7	Boom back pipe (unlock) ~ 2-piece boom H/V (PL)	RD809-6833Δ	Hydraulic hose (3/8)	2	540		G3/8 PLT06 G3/8	Overall with corrugated tube
8	2-piece boom H/V (Dr) ~ Boom back pipe (drain)	RD809-6834Δ	Hydraulic hose (1/4)	2	520		G1/4 PLT04 G1/4	Overall with corrugated tube

List of high-pressure hoses (upper) (control valve, front)

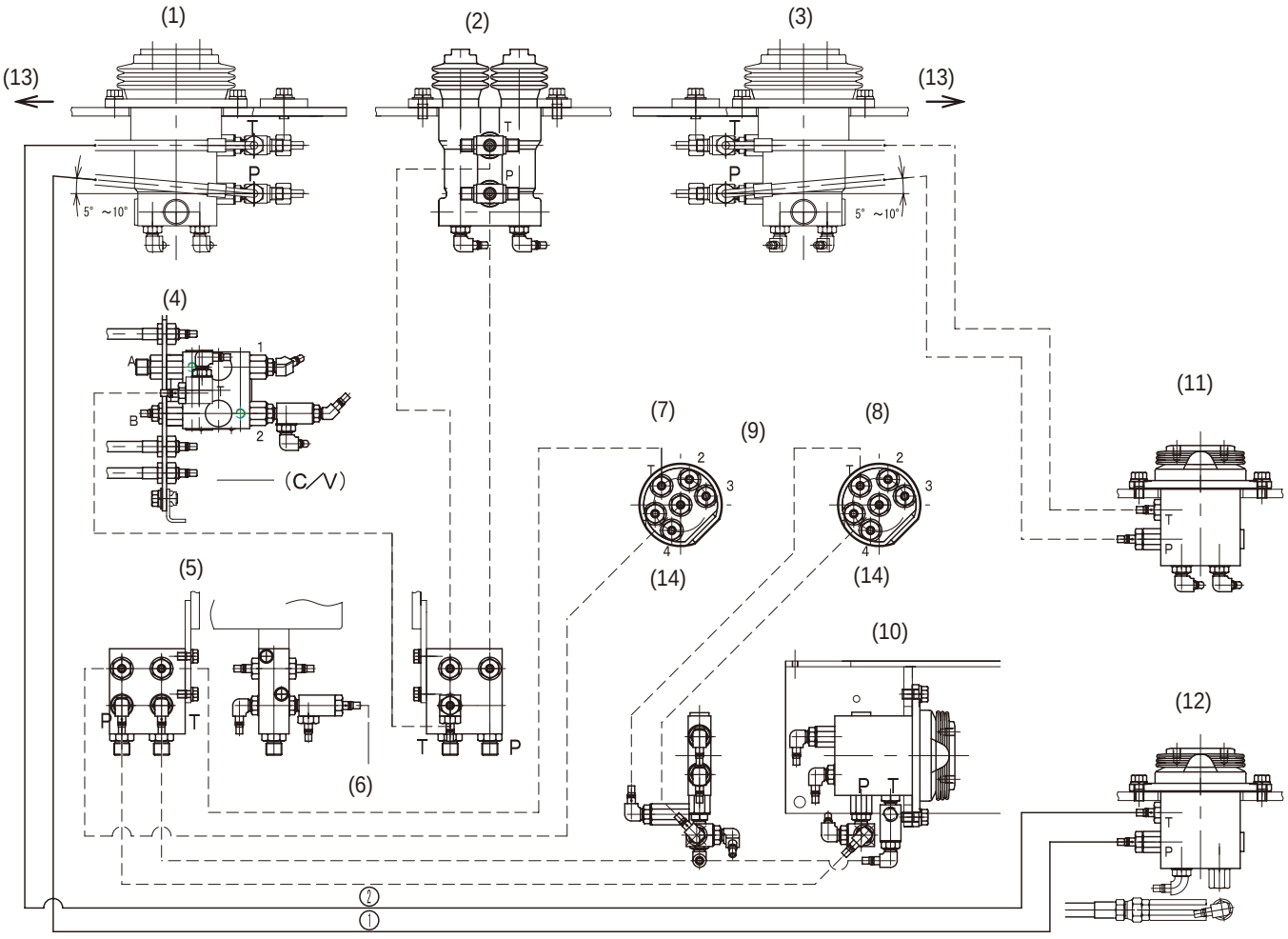
No.	Location	Part code KX080-3 (EU)	–	Part name	Q'ty	Size (mm)	Tape color	Hose configuration	Remarks
9	C/V (2P crowded) ~ Boom back pipe	RD809-6811Δ	–	Hydraulic hose (1/2)	1	3040	Green, double	13/16UN PF2108 13/16UN	With corrugated tube
10	C/V (2P dump) ~ Boom back pipe	RD809-6812Δ	–	Hydraulic hose (1/2)	1	3020	Blue, double	13/16UN PF2108 13/16UN	With corrugated tube
11	Boom back pipe ~ 2P boom H/V (A) (bottom)	RD809-6819Δ	–	Hydraulic hose (1/2)	2	560		13/16UN PF2108 13/16UN	With corrugated tube
12	Boom back pipe ~ 2P boom CYL port (rod)	RD809-6819Δ	–	Hydraulic hose (1/2)	2	560		13/16UN PF2108 13/16UN	With corrugated tube
13	Boom back pipe (crowded) ~ Arm CYL (bottom)	RD809-6835Δ	–	Hydraulic hose (5/8)	1	1010	Blue	1-14UNS PA2810 1-14UNS	(Yokohama-made)
14	Boom back pipe (dump) ~ Arm CYL (rod)	RD809-6836Δ	–	Hydraulic hose (1/2)	1	2195		13/16UN PF2108 13/16UN	(Yokohama-made)
15	Boom back pipe (crowded) ~ Bucket CYL (bottom)	RD809-6844Δ	–	Hydraulic hose (5/8)	1	890		1-14UNS PA2810 1-14UNS	(Yokohama-made)
16	Boom back pipe (dump) ~ Bucket CYL (rod)	RD809-6846Δ	–	Hydraulic hose (1/2)	1	890		13/16UN PF2108 13/16UN	(Yokohama-made)
17	S/P intermediate (SP1)	RD809-6844Δ	–	Hydraulic hose (5/8)	2	890		1-14UNS PA2810 1-14UNS	(Yokohama-made)
18	S/P intermediate (SP2)	RD809-6846Δ	–	Hydraulic hose (1/2)	2	890		13/16UN PFH08 13/16UN	(Yokohama-made)

4. Hose Connection

Pilot hoses

No.	Location		Tape color	Part code	Q'ty
1	Travel P/V (P) ~ 2P boom P/V (P)	2P boom P/V boost	White	RD809-6336Δ	1
2	2P boom P/V (T) ~ Travel P/V (T)	Drain		RD809-6346Δ	1

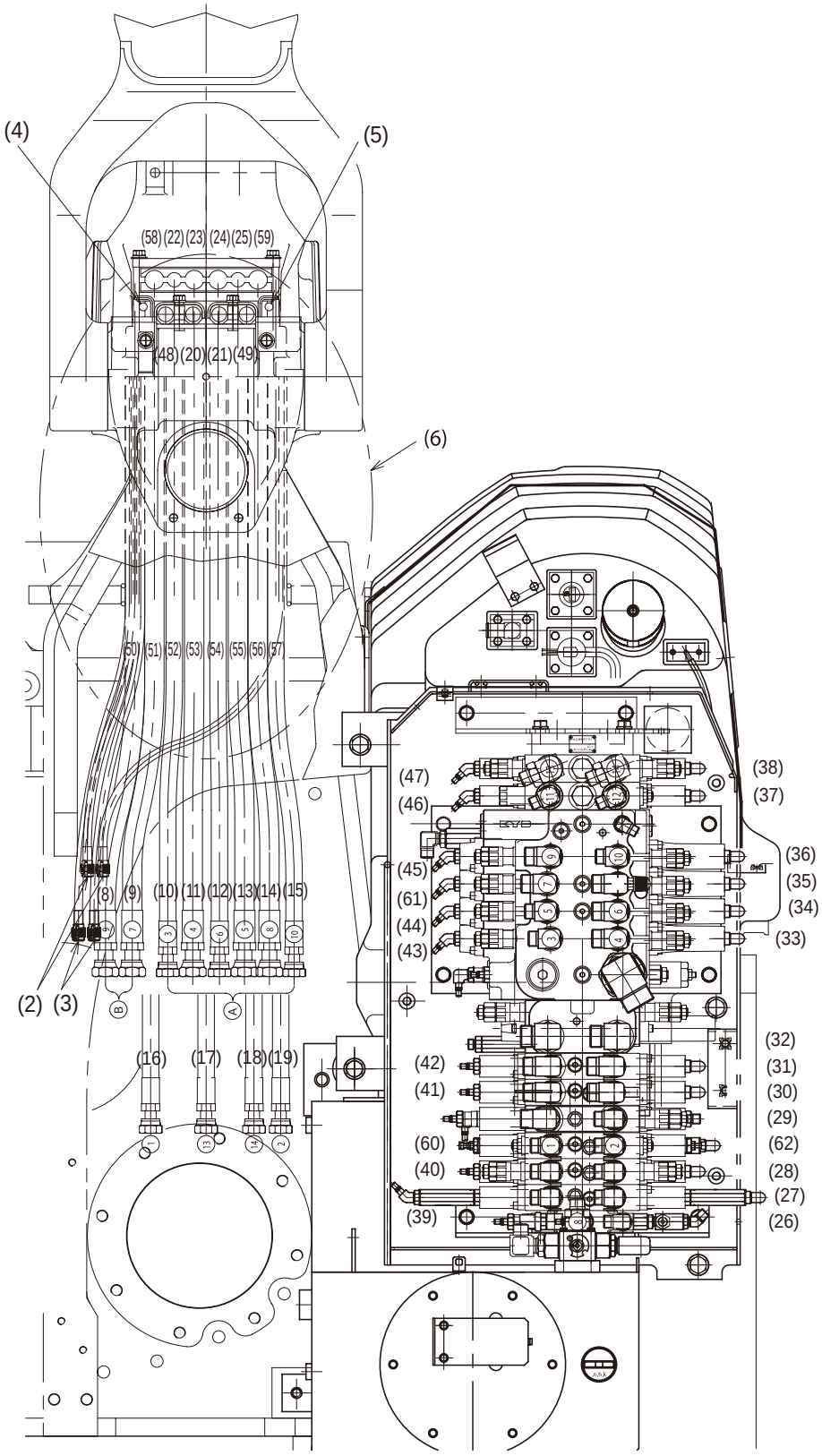
The dashed circuit lines are the same as for the standard machine.



(1) Attention to the fitting angle of long-neck hose at port P
(2) Valve assembly (PV, travel)
(3) Attention to the fitting angle of long-neck hose at port P
(4) Valve assembly (shockless)
(5) Adaptor (pilot hose, 1)
(6) Boom H/V (Dr)
(7) Valve assembly (pilot, L)
(8) Valve assembly (pilot, R)
(9) (Port locations when viewed from valve top)
(Front)
(10) (Used for dozer lever)
Valve assembly (pilot, valve)
(11) (Used for swing pedal)
Valve assembly (pilot, valve)
(12) (Used for 2-piece boom pedal)
Valve assembly (pilot, valve)
(13) Machine front
(14) (Back)

5. Hose Connection 2

Connecting the front hoses (high-pressure hoses) and holding valve hoses (low-pressure hoses)
Connect these hoses to the control valve according to the procedural instructions in the figure. Pay special attention in connecting the holding valve hoses (signal and drain) of the booms (bottom and rod).



(1)Connecting the front hoses
1) Pass the hoses from the swing bracket. Clamp them at the swing bracket.
2) Arrange the hoses as shown below. (Pass the boom holding valve hoses above the boom (up) and S/P1 (high) hoses.) Check the hoses from the clamp to their sockets to make sure that the hoses are not twisted and do not cross each other.
3) Connect the hoses to the control valve in the numerical order shown below. Note that the six hoses (marked A) should be passed above the S/P2 (low) hose and the two hoses (marked B) above the S/P2 (high) hose.

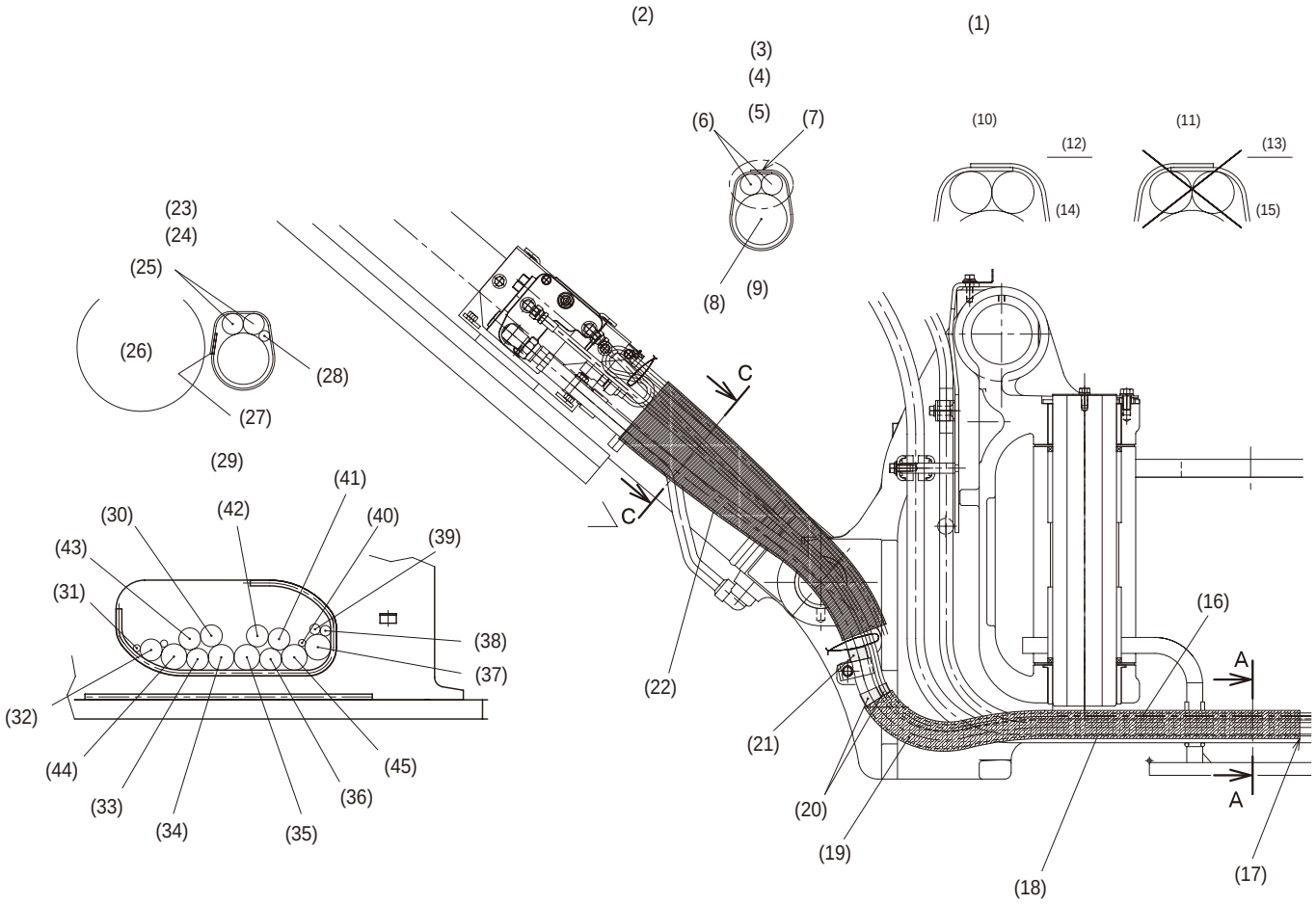
(2)2-piece boom holding valve hose
(3)Boom holding valve hose
(4)2-piece boom holding valve unlock (signal) hose
(5)2-piece boom holding valve drain hose
(6)In this dashed-line-circled zone, arrange the hoses not twisted or crossed each other. Pass the two boom holding valve hoses above the boom (up) and S/P1 (high) hoses.
(7)Connecting the front hoses for the 2-piece boom type
1) Connect all the standard-type hoses in the same way.
2) The additional hoses for the 2-piece boom type should be connected in the procedure below.
Pass the two high-pressure hoses, between the control valve and the cylinder, above all the other high-pressure hoses. Pass the lock valve unlock (signal) hose of the two holding valve pilot hoses along the boom holding valve hoses.
The drain hose crosses the 2-piece boom high-pressure hose in the frame. Pass the drain hose above the high-pressure hose and along the boom holding valve hoses.

(8)(blue)
(9)(violet)
(10)(yellowish green)
(11)(blue)
(12)(orange)
(13)(red)
(14)(brown)
(15)(blue)
(16)(blue)
(17)(blue, double)
2-piece boom (dump)
(18)(blue, double),
2-piece boom (crowd)
(19)(blue)
(20)2P boom (dump)
(21)2P boom (crowd)
(22)Arm (dump)
(23)Arm (crowd)
(24)Bucket (crowd)
(25)Bucket (dump)
(26)P3 bypass
(27)Swivel (left)
(28)Dozer (down)
(29)Confluence valve
(30)Travel (backward)
(31)Travel (backward)
(32)Travel independent valve
(33)Arm (crowd)
(34)Bucket (crowd)
(35)S/P1 (low)
(36)Boom (down)
(37)Swing (left)
(38)2-piece boom (bottom)
(39)(right)
(40)(down)
(41)(forward)
(42)(forward)
(43)(dump)
(44)(dump)
(45)(down)
(46)(right)
(47)(rod)
(48)
(49)
(50)Boom (up)
(51)S/P1 (high)
(52)Arm (dump)
(53)Arm (crowd)
(54)Bucket (crowd)
(55)Bucket (dump)
(56)S/P1 (low)
(57)Boom (down)
(58)
(59)
(60)(high)
(61)(high)
(62)S/P2 (low)

6. Hose Connection 3

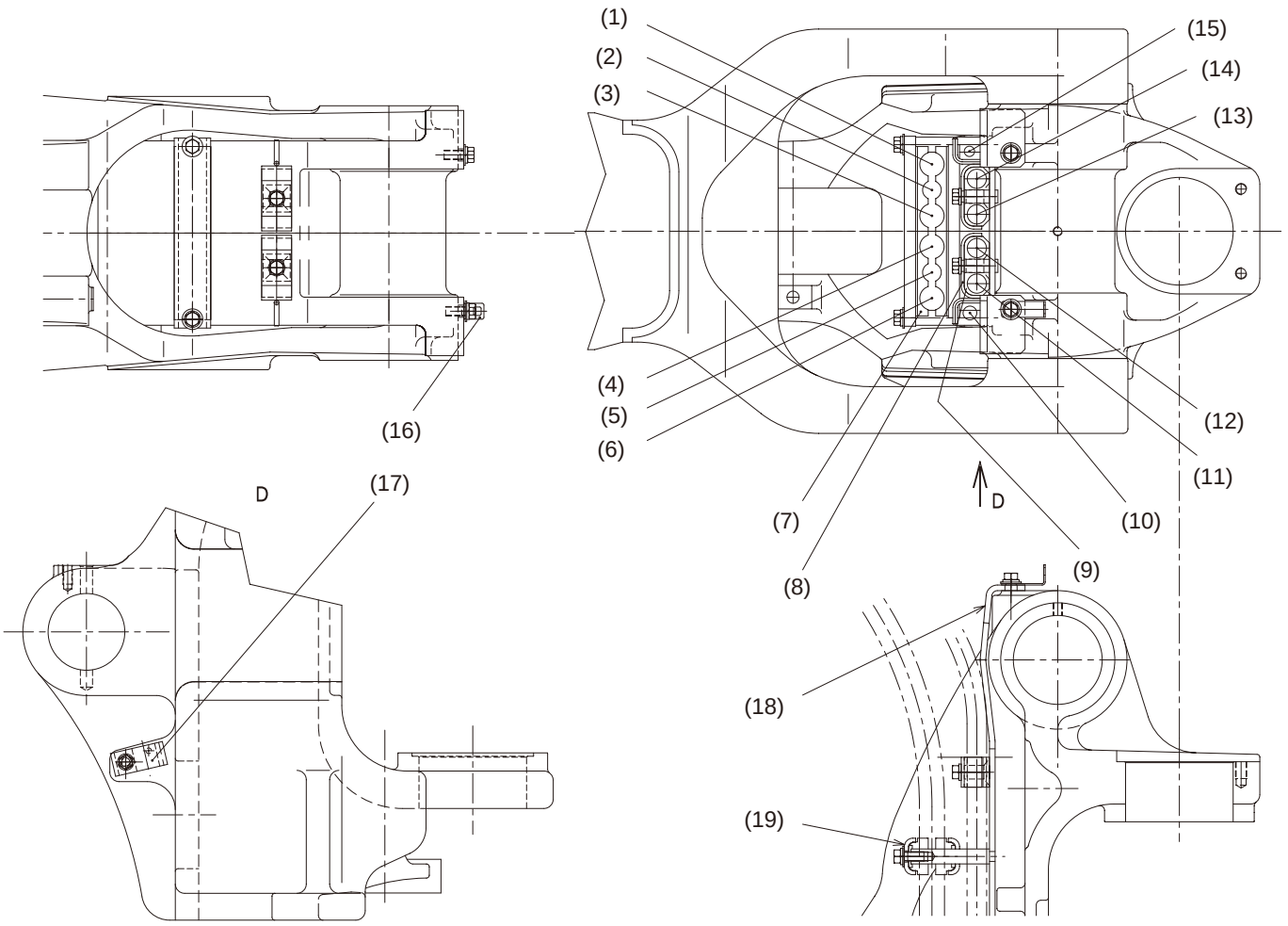
Fitting the cover (hose, 2-600) (RD809-6466Δ)

Put the white-taped parts of the hoses together as shown below. Install the cover from the tape ends as shown below.



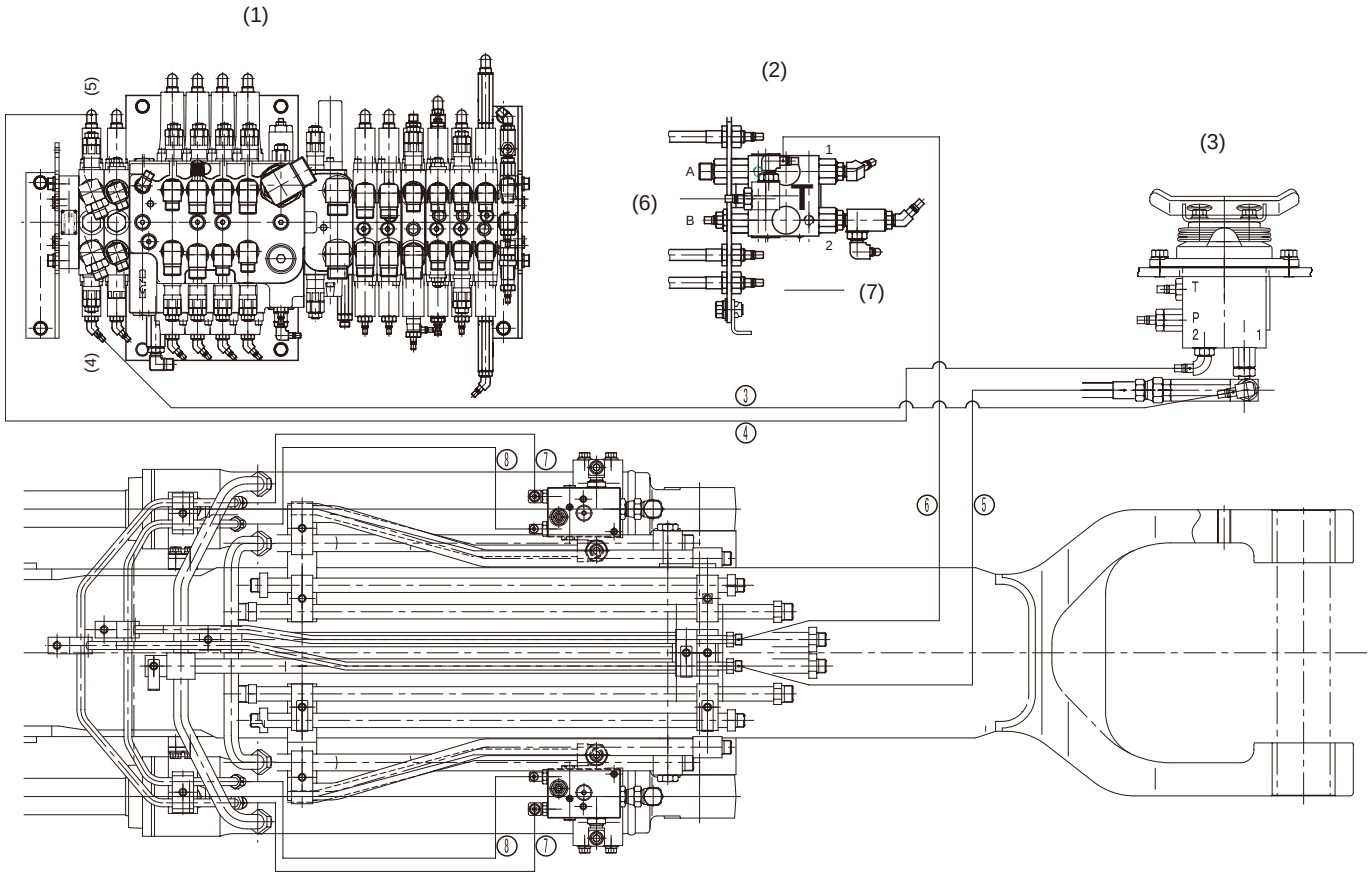
(1) Place the thin hoses over the thick hose as shown at left (Section A-A). Wind them with the cover. Make sure the cover's Velcro faces upward (on the thin hoses).
This Velcro should be invisible when viewed from the side of the swing bracket. (See below.)
(2) Details of boom H/V hoses (signal and drain) at the clamp
(3) Section A-A
(4) (View from machine front)
(5) (Top)
(6) Boom H/V hoses (signal and drain)
(7) Velcro
(8) Boom (up) hose
(9) (Bottom)
(10) (Correct winding)
(11) (Wrong winding)
(12) (View from arrow direction)
(13) (View from arrow direction)
(14) (Operator's side)
(15) (Operator's side)
(16) Boom H/V hoses (signal and drain)
(17) The cover's end must be inside the swivel frame.
(18) Cover (hose, 2-600)
This cover must be placed with its urethane-coated (smooth) face inward (at the hoses).
(19) Boom (up) hose
(20) White tape
(21) Green tape
(22) Cover (hose, 3-670)
This cover must be placed with its urethane-coated (smooth) face inward (at the hoses).
(23) Section C-C
(24) (View from machine front)
(25) Boom H/V hoses (signal and drain)
(26) Boom cylinder
(27) Velcro
To be applied at the boom cylinder side
(28) Wire harness
(29) Hoses arranged near the front hose outlet of the swivel frame
(30) 2-piece boom (crowded) / 2-piece boom (dump)
(31) 2-piece H/V (drain)
(32) Boom (down)
(33) Bucket (crowded)
(34) Bucket (dump)
(35) Arm (crowded)
(36) Arm (dump)
(37) Boom (up)
(38) Boom H/V (drain)
(39) Boom H/V (signal)
(40) 2-piece boom H/V (signal)

7. Hose Connection 4



(1) S/P1 (brown)
(2) Bucket (red)
(3) Bucket (orange)
(4) Arm (blue)
(5) Arm (yellowish green)
(6) S/P1 (violet)
(7) Cushion
(8) Clamp (2P, front)
01135-61025 x 2 pcs.
Bolt
(9) RC411-6421Δ x 2 pcs.
Cushion (hose, front)
(10) 2P boom H/V (unlock)
(11) S/P2 (violet)
(12) 2-piece boom (green, double)
(13) 2-piece boom (blue, double)
(14) S/P2 (brown)
(15) 2P boom H/V (Dr)
(16) Stay (harness clamp)
(17) Clamp assembly
01133-61060
Bolt
(Behind)
Clamp assembly
Cushion
01133-61060
Bolt
18) Bracket (hose guide)
01135-61025 x 2 pcs.
Bolt
19) Plate
01135-61025 x 2 pcs.
Bolt

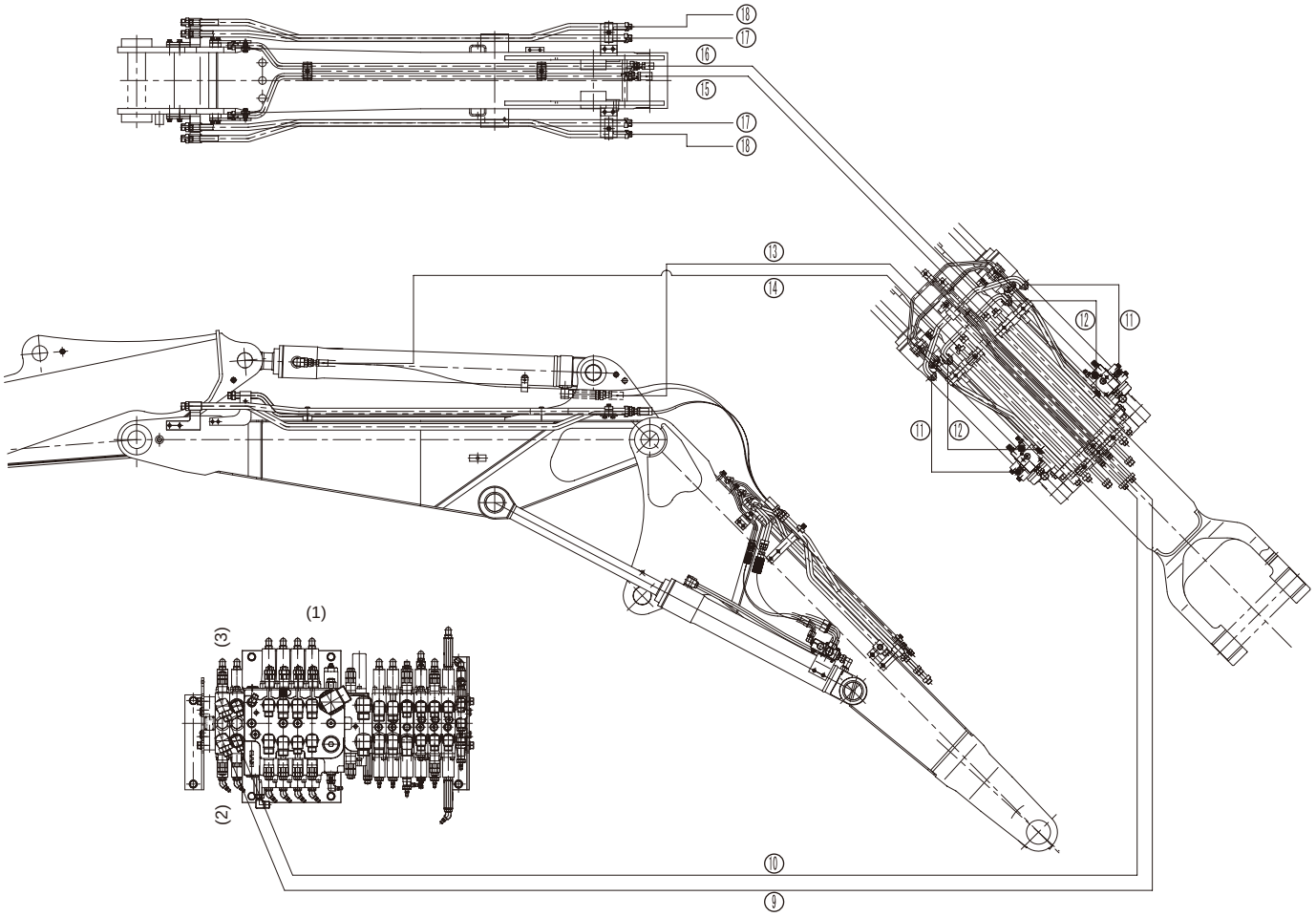
8. Pipe Installation 1



(1)Control valve assembly (2P)
(2)Valve assembly (shockless)
(3)Valve assembly (pilot, OFF)
(4)(crowded)
(5)(dump) 2-piece boom
(6)P/T collective block

No.	Location		Tape colo
③	2P boom P/V (crowded) ~ C/V (2P crowded)	2nd boom (crowded)	Green, double
④	2P boom P/V (dump) ~ C/V (2P dump)	2nd boom (dump)	Blue, double
⑤	2P boom P/V (crowded) ~ Boom back pipe (unlock)	Anti-fall valve unlock	
⑥	Boom back pipe (drain) ~ Shockless valve (T)	Drain	
⑦	Boom back pipe (unlock) ~ 2-piece boom H/V (PL)	Anti-fall valve unlock	
⑧	2-piece boom H/V (Dr) ~ Boom back pipe (drain)	Drain	

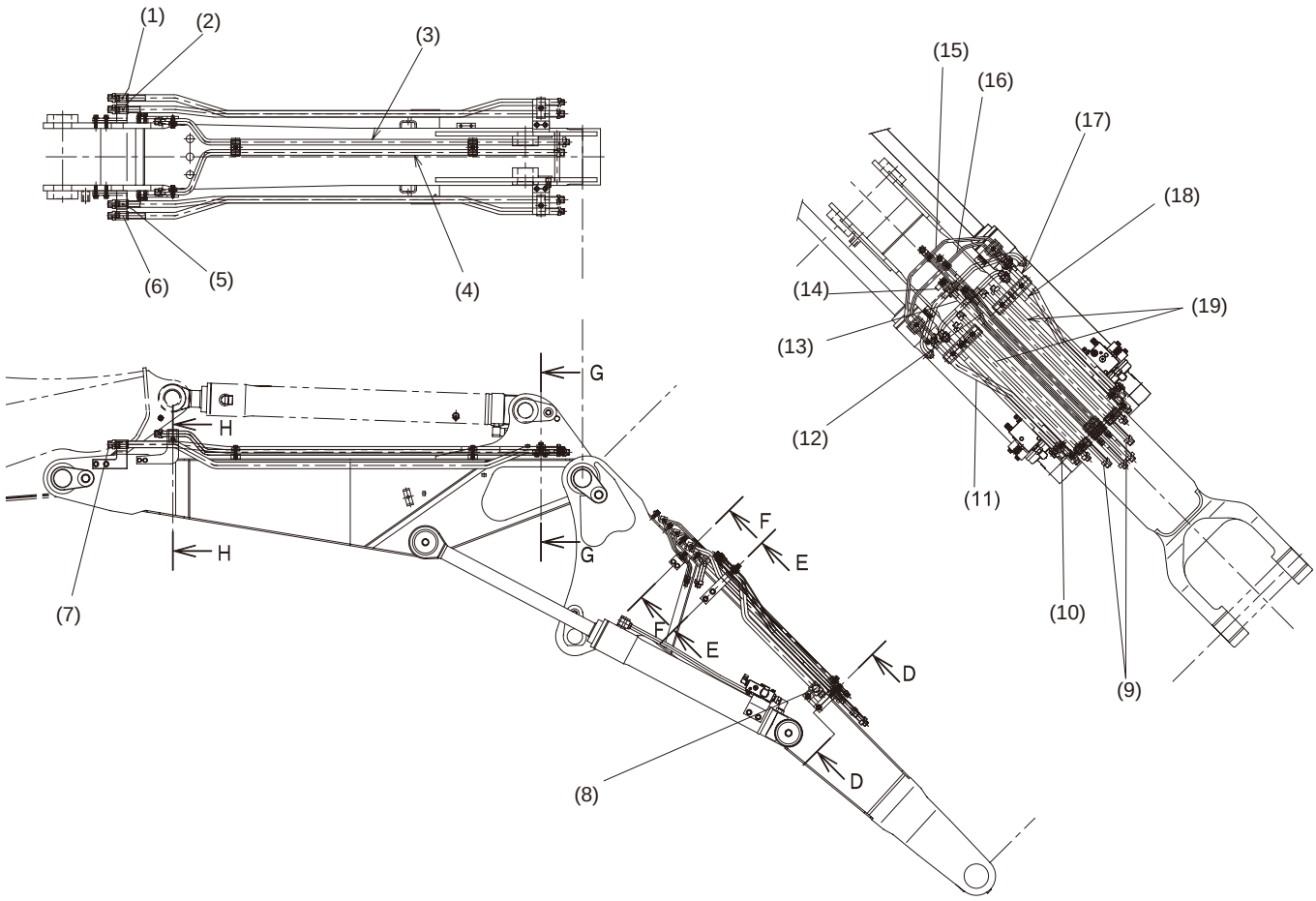
9. Pipe Installation 2



(1)Control valve assembly (2P)
(2)(crowded)
(3)(dump) 2-piece boom

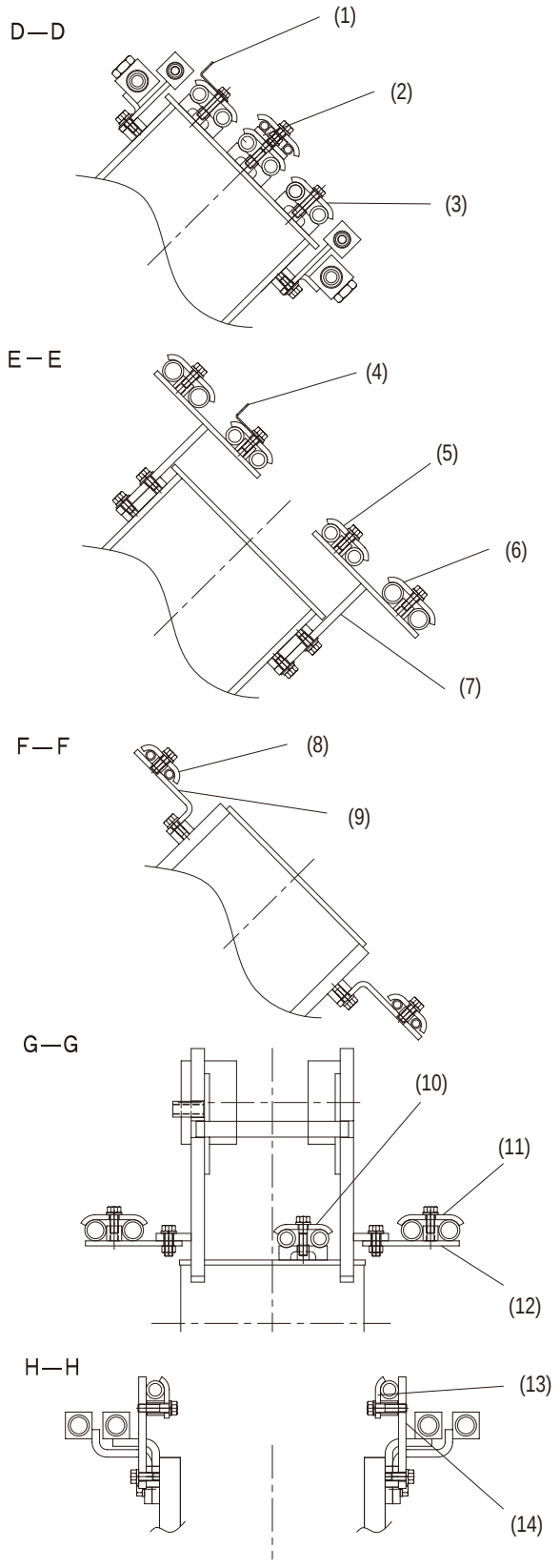
No.	Location		Tape colo
⑨	C/V (2P crowded) ~ Boom back pipe	2nd boom (crowded)	Green, double
⑩	C/V (2P dump) ~ Boom back pipe	2nd boom (dump)	Blue, double
⑪	Boom back pipe ~ H/V (A) (bottom)	2nd boom (dump)	
⑫	Boom back pipe ~ 2P boom cylinder port (rod)	2nd boom (crowded)	
⑬	Boom back pipe (crowded) ~ Arm cylinder (bottom	Arm (crowded)	Blue
⑭	Boom back pipe (dump) ~ Arm cylinder (rod)	Arm (dump)	
⑮	Boom back pipe (crowded) ~ Bucket cylinder (bottom)	Bucket (crowded)	
⑯	Boom back pipe (dump) ~ Bucket cylinder (rod)	Bucket (dump)	
⑰	S/P intermediate (SP1)	SP1	
⑱	S/P intermediate (SP2)	SP2	

10. Pipe Installation 3



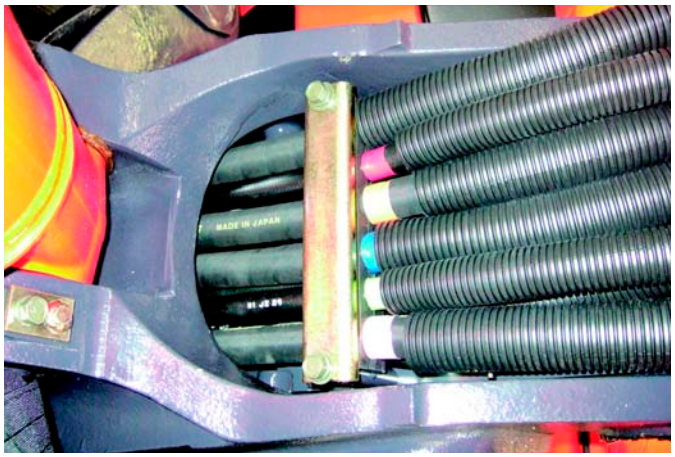
(1)Pipe (right, F, SP2, 2P)
O-ring (13/16UNF)
(2)Pipe (right, F, SP, 2P)
O-ring (1UNF)
Bolt
(3)Pipe (hydraulic)
O-ring (13/16UNF)
O-ring (1UNF)
(4)Pipe (hydraulic)
O-ring (1UNF)
(5)Pipe (left, F, SP, 2P)
O-ring (1UNF)
Bolt
(6)Pipe (left, F, SP2, 2P)
O-ring (13/16UNF)
(7)Pipe joint (SG4, 1U)
(8)Plug
O-ring
(9)Pipe (hydraulic)
O-ring (1UNF)
(10)Pipe (left, R, SP, 2P)
O-ring (1UNF)
Bolt
(11)Pipe (left, R, SP2, 2P)
O-ring (13/16UNF)
Bolt
(12)Pipe (hydraulic)
O-ring (13/16UNF)
(13)Pipe (hydraulic)
O-ring (13/16UNF)
(14)Stay (harness clamp)
(15)Pipe (P, H/V, 2P)
Bolt
(16)Pipe (T, H/V, 2P)
Bolt
(17)Pipe (right, R, SP2, 2P)
O-ring (13/16UNF)
Bolt
(18)Pipe (right, R, SP, 2P)
O-ring (1UNF)
Bolt
(19)Pipe (hydraulic)
O-ring (13/16UNF)

11. Clamp

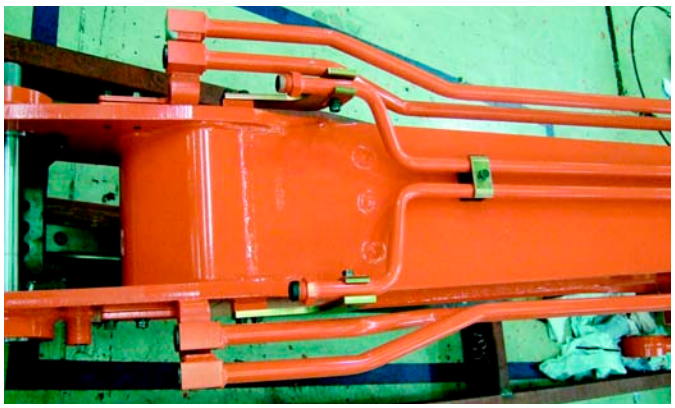


(1)Stay (harness clamp)
(2)Bracket (pipe, H/V, 2P)
Clamp (front)
Bolt
(3)Clamp (4, front)
Clamp (front)
Bolt
Bolt
(4)Stay (harness clamp)
(5)Clamp (front)
Bolt
(6)Clamp
Bolt
(7)Clamp (T)
Bolt
(8)Clamp
Bolt
(9)Bracket (pipe, H/V, 2P)
Bolt
(10)Clamp (4, front)
Clamp (front)
Bolt
(11)Clamp
Bolt
(12)Bracket (SP)
Bolt
(13)Clamp (pipe, front)
Bolt
(14)Bracket (clamp)
Bolt

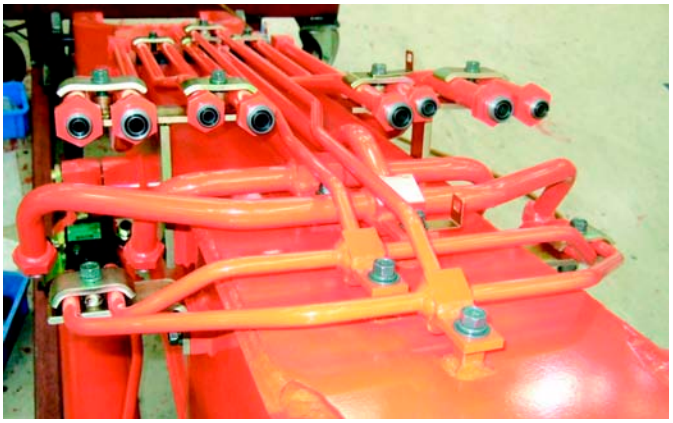
12. Reference Photo; Pipes and Hoses



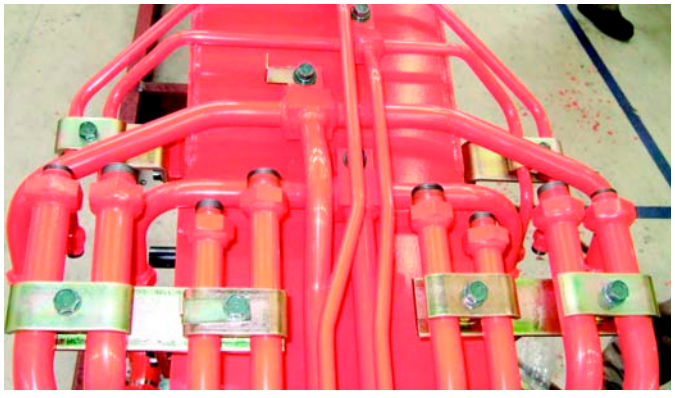


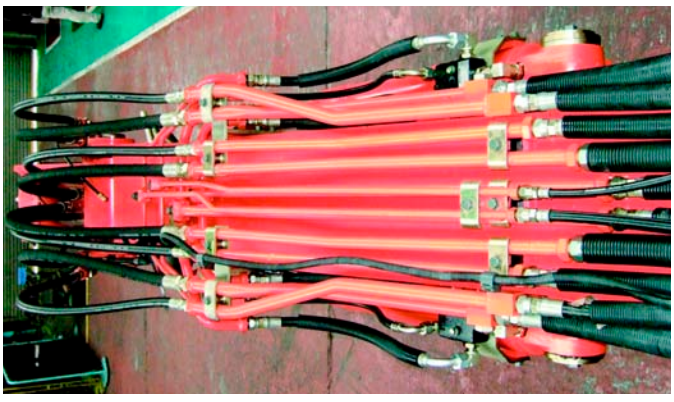


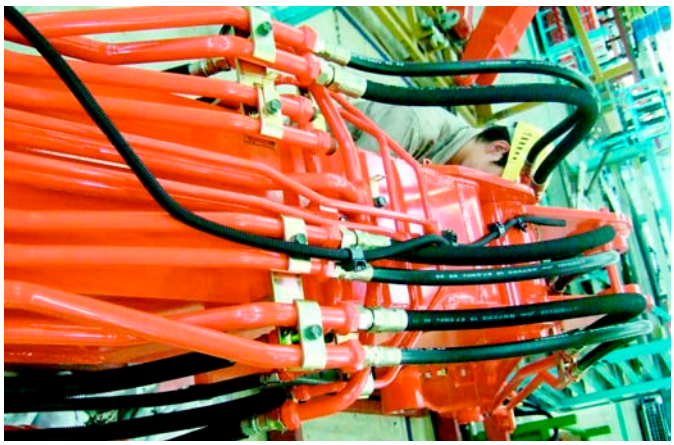
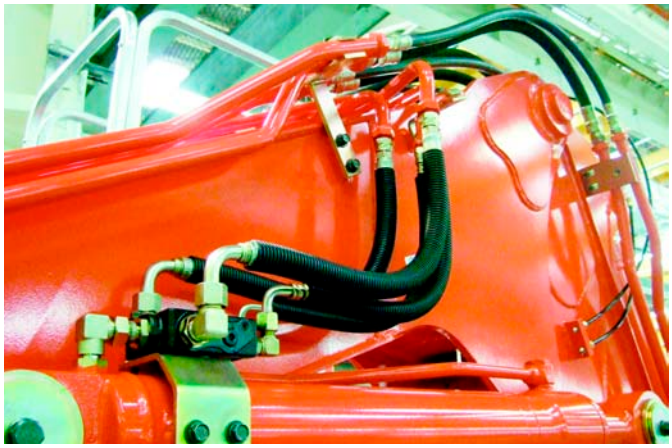
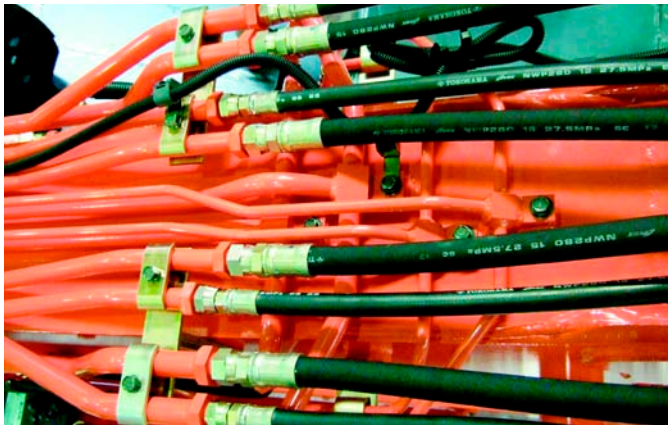
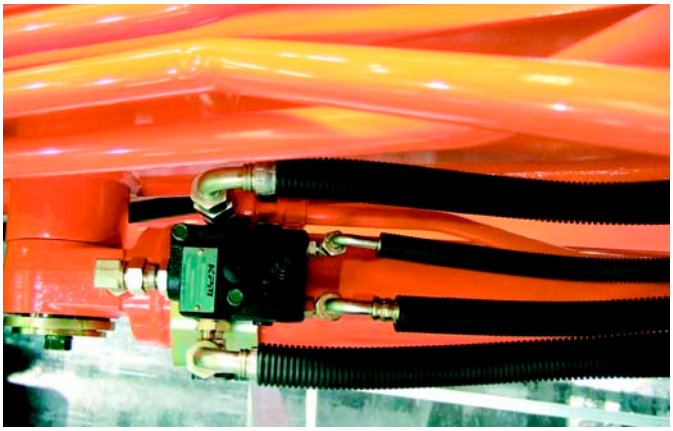
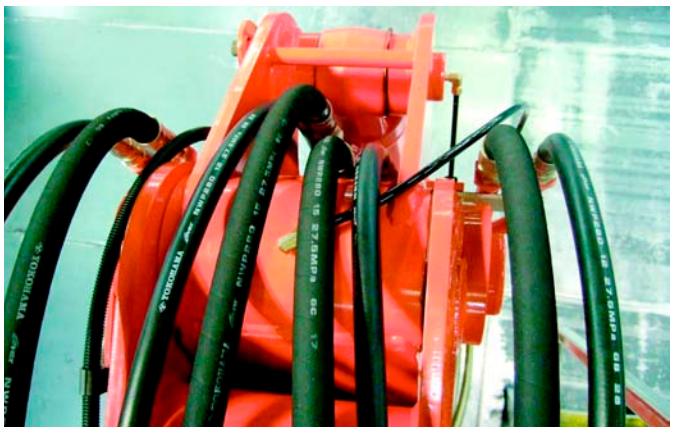
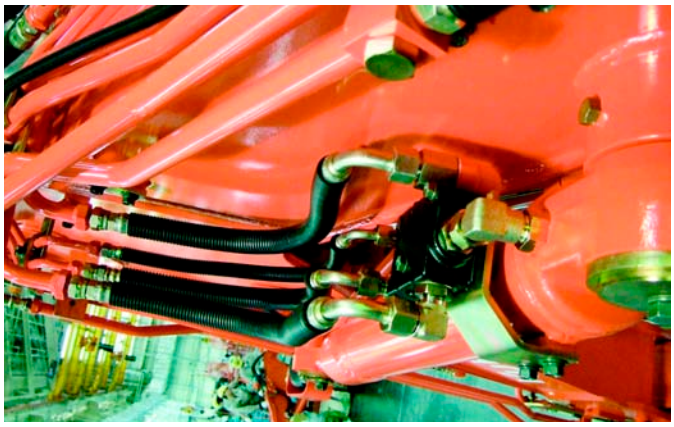


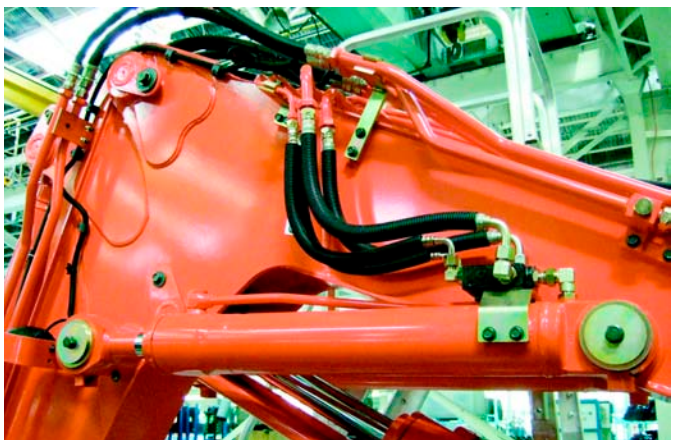






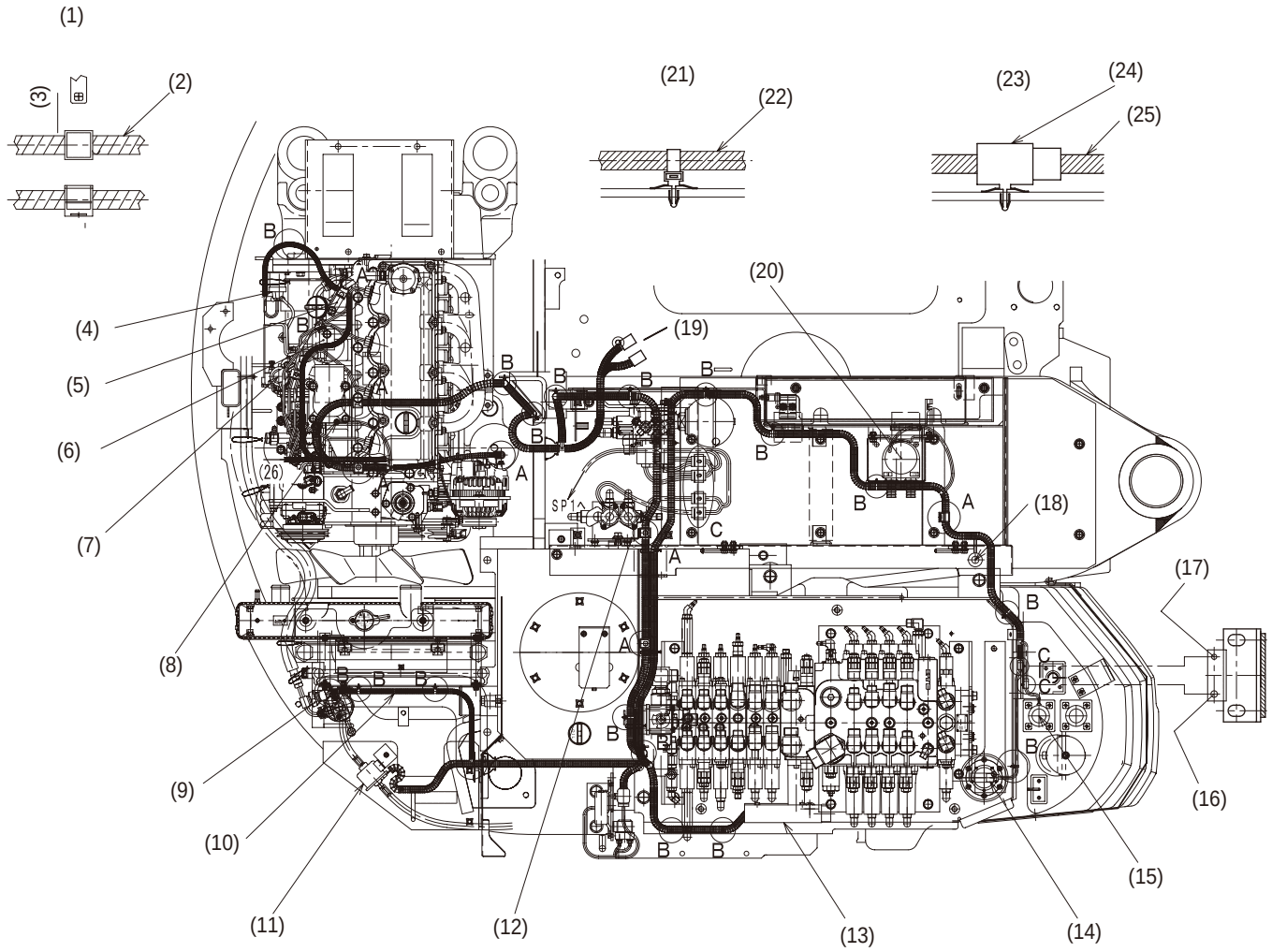


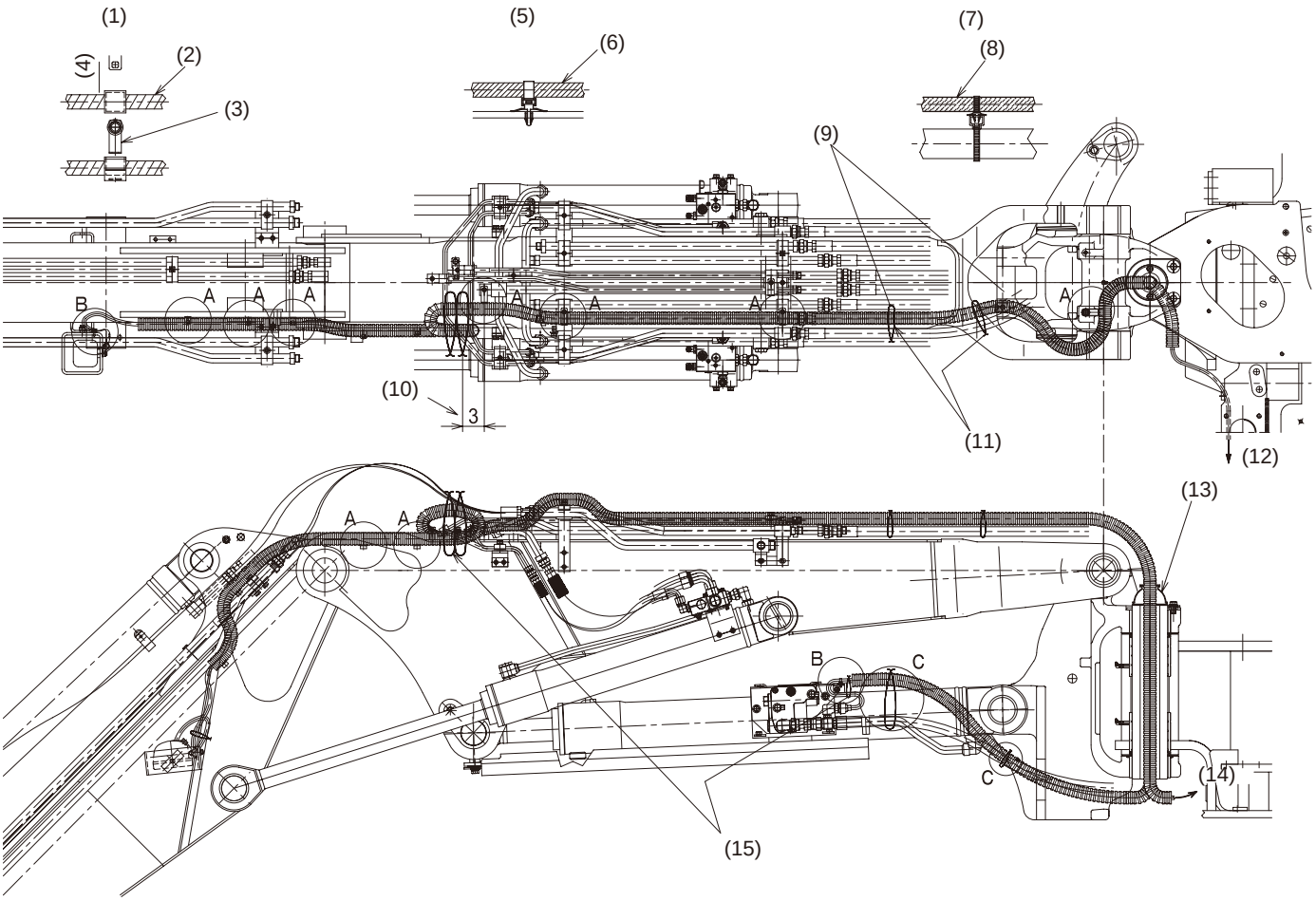


D. Electrical System

a. Wire Harness Route

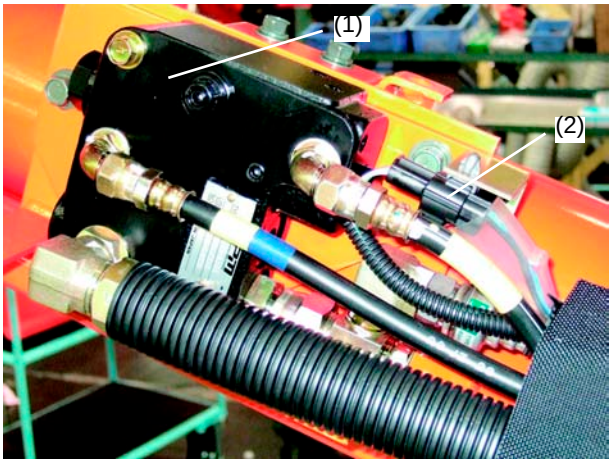


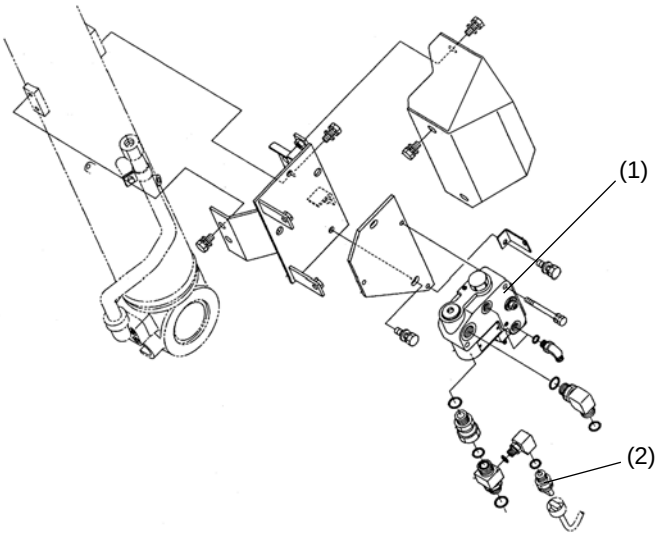
(1)Details of Location A (7 locations)
(2)Wire harness
(3)Insert.
(4)Stator relay
(5)Stay (harness clamp)
(6)Plate (clamp, 1)
(7)Engine stop solenoid
(8)Air intake heater
(9)A/C sensor
(10)A/C compressor switch wire harness rerouted
(11)Fuel pump
(12)Stay (1, wire harness)
(13)Fuel feed switch box
(14)Fuel level gauge
(15)Feed sensor
(16)Feed sensor
(17)Fuel level gauge
(18)Ground cable
(19)To main wire harness
(20)Fuel feed pump
(21)Details of Location B (19 locations)
(22)Wire harness
(23)Location C (6 locations)
(24)Coupler
(25)Wire harness

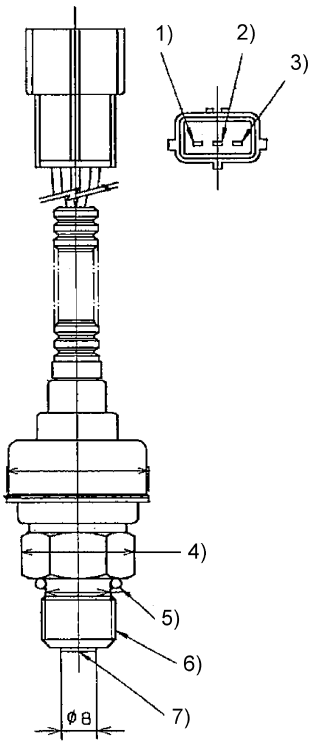


(1)Details of Location A (8 locations)
(2)Wire harness
(3)Stay (harness clamp)
(4)Insert.
(5)Details of Location B (1 location)
(6)Wire harness
(7)Location C (2 locations)
(8)Wire harness
(9)S/P2 (high) hose and clamp
(10)Bundle the wire harnesses with 2 speed clamps 30 mm from the wire harness clamp center.
(11)Cord band (2 pcs.)
(12)To main wire harness
(13)Grommet
(accompanying the wire harness)
(14)To main wire harness
(15)Cord band (3 pcs.)

b. Boom Cylinder Overload Sensor







1. Location

(1) Boom 1 cylinder holding valve : RD 809-64052
(2) Pressure switch : RD 809-64091

2. Specifications

1. Code. No : RD809-64091
2. Screw size : G 3/8 A (PF)
3. Pressure range : 0~35 MPa (~357 kgf/cm^2) 0~5078 psi
4. Output : Open collector type (30V, 150mA)
5. Source : 12V DC
6. Sensing pessure : 12.9 MPa ON (132 kgf/cm^2) 1872 psi

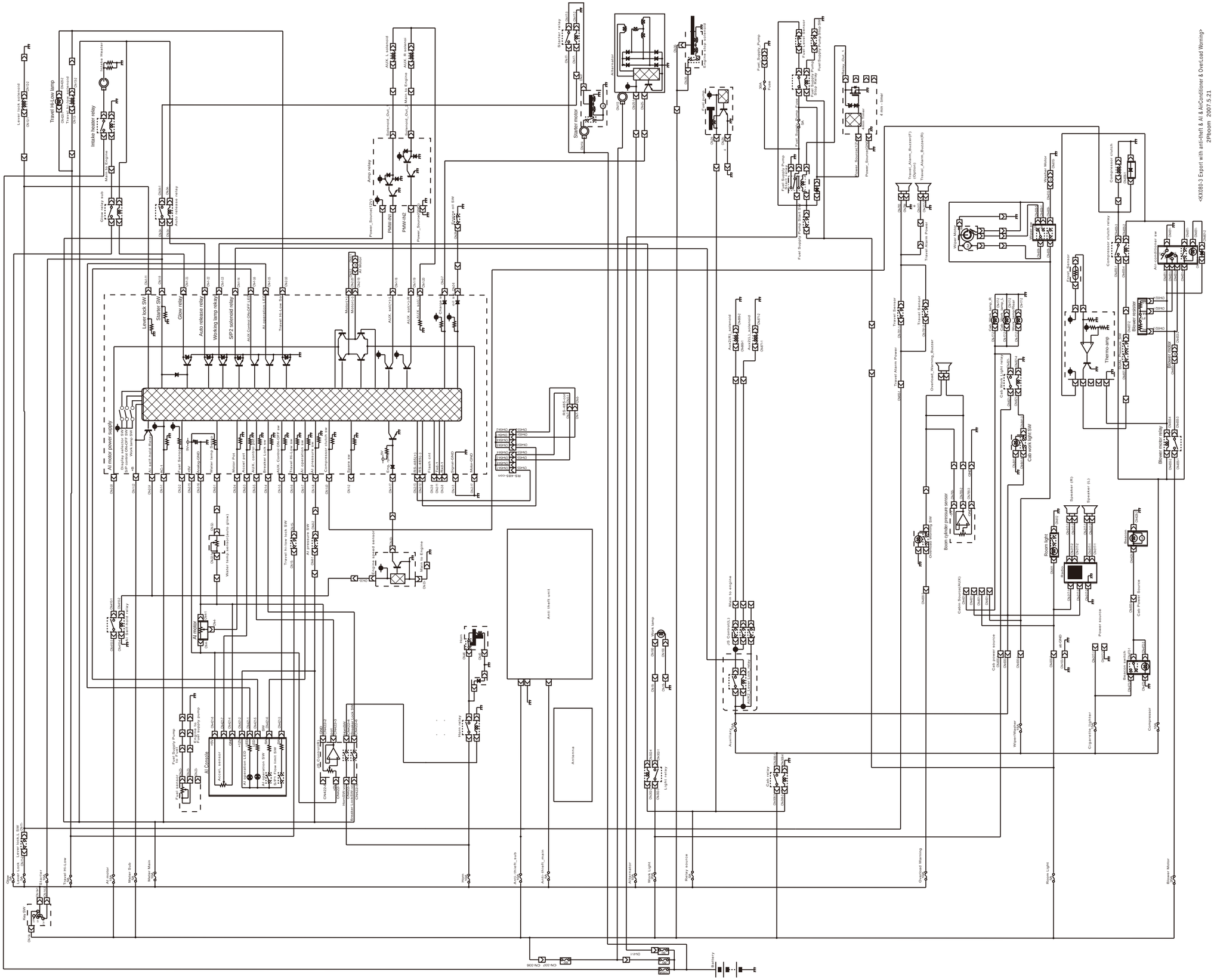
3. Comparison

Boom Boom 1	Mono-boom : boom cylinder	2-piece boom : boom 1 cylinder
Holding valve assy	RD 809-64052	←
Pressure switch	RD 809-64081	RD 809-64091
Sensing pressure	11.8 MPa (120 kgf / cm^2) 1712 ps	12.9MPa (132 kgf / cm^2) 1872 psi
Overload relief pressure, c3	30.4 MPa (310 kgf / cm^2) 4409 psi	←
Arm tip end load		

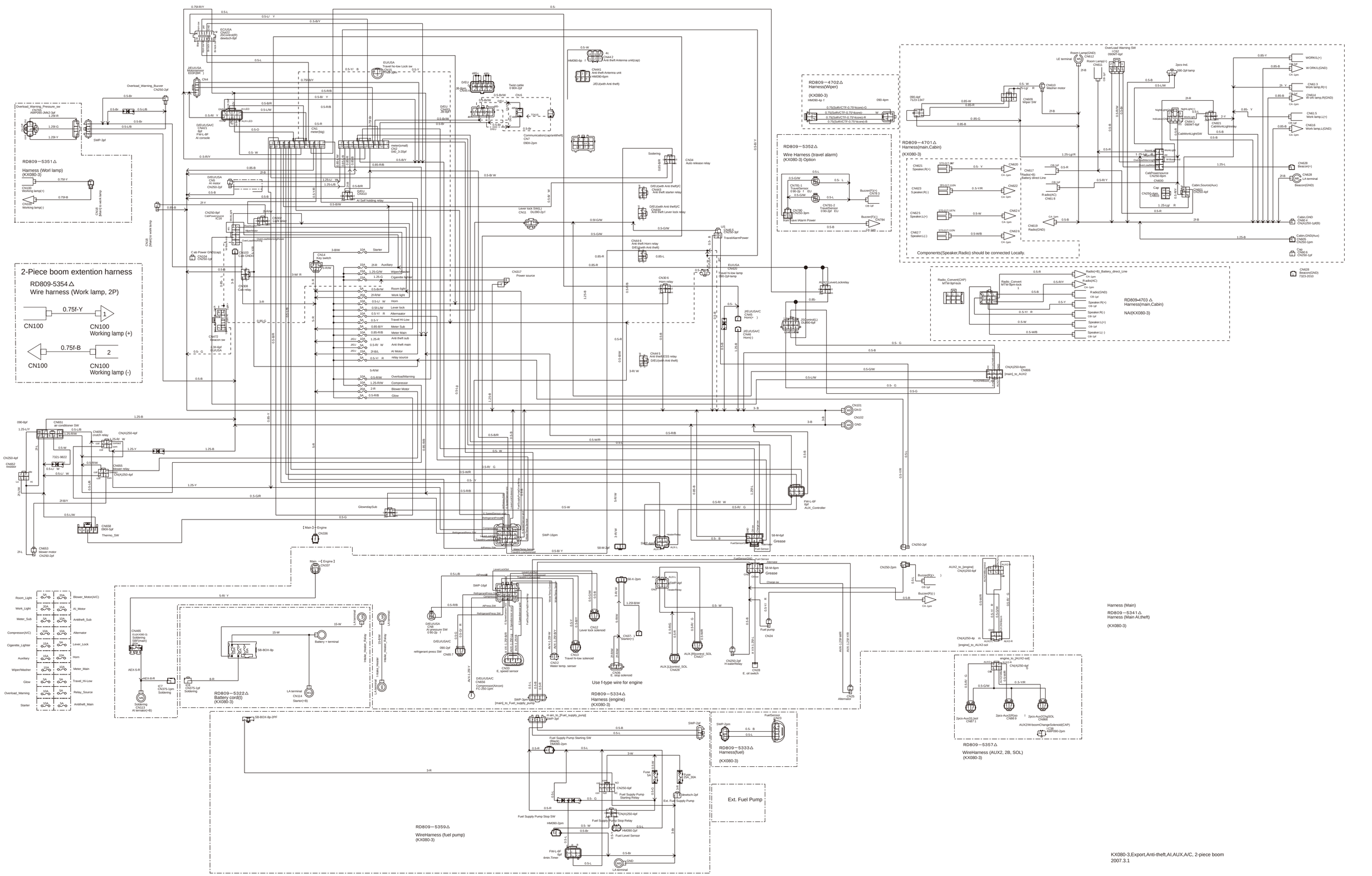
4. Parts Name

1) Power (+)
2) Output (+)
3) Common
4) Wreach size : 22 x 25.4
5) O-ring P14 (JIS 1-B,NBR)
6) G 3/8 A (PF)
7) Orifice ø0.7

c. Electrical Circuit Diagram : 2-piece Boom



d. Electrical Wiring Diagram : 2-piece Boom



Conversion Tables

Conversion Tables, *Tableaux Conversions,* Umrechnungstabelle

a. Length *Longueur* Loenge

mm	cm	m	ınch	ft	yd
1	0.1	0.001	0.03937	0.0032808	0.001094
10	1	0.01	0.39370	0.0328080	0.010940
1000	100	1	39.370	3.2808	1.0936
25.400	2.540	0.02540	1	0.083333	0.02778
304.800	30.480	0.30480	12	1	0.3333
914.4	91 44	0.9144	36	3	1

Ex. 1㎜=0.03937in 120㎜=120×0.03937=4.7244in 1mile = 1.609km

b. Area *Aire* Areal

cm^2	m^2	sq.ın	sq.ft	sq.yd
1	0.0001	0.15500	0.0010764	0.0001196
10000	1	1550.0	10.764	1 1960
6.4516	0.00064516	1	0.006944	0.0007716
929.03	0.092903	144	1	0.11111
8361.0	0.8361	1296	9	1

Ex. 1㎡=1.1960 sq.yd 1.2㎡=1.2×1.1960=1.4352 sq.yd

c. Volume *Volume* Volume

dm^3(l)	m^3	cu.ın	cu.ft	cu.yd	Imperıal gal	US gal
1	0.001	61.027	0.035317	0.0013	0.21998	0.26418
1000	1	61027	35.317	1.3079	219.98	264.18
0.016387	0.00001639	1	0.578697	0.0000214	0.003605	0.00433
28.3153	0.028315	0.000464	1	0.037026	6.22786	7 4006
764.584	0.764584	46656	27	1	168.152	199.816
4.5465	0.0045465	277 4207	0.16057	0.0059	1	1.20114
3.7852	0.0037852	231.005	0.13368	0.0050	0.83254	1

Ex. 0.04㎥=0.04×1.3097=0.052316 cu.yd 1liter=1000cc=1000㎤

d. Flow amount *Decharge internes* Entladung

L/sec	m^3/mın	m^3/h	Inp.gal/mın	US gal/mın	cu.yd/mın	L/mın
1	0.060	3.6	13.197	15.8514	21 192	60
16.666	1	60.0	219.98	264.1833	35.3165	999.96
0.2778	0.016668	1	3.6658	4.4032	0.58806	16.668
0.075775	0.0045465	0.27279	1	1.2011	0.16065	4.5465
0.06309	0.0037824	0.2271	0.8325	1	0.17768	3.7854
0.47192	1.6989	0.02832	6.22787	7 4855	1	28.3152
0.016667	0.001	0.06	0.21995	0.264173	0.035317	1

Ex. 25.6l/sec=25.6×0.06=1.53㎥/mın=25.6×15.8514=405.79584Usgal/mın

e. Force(Weıght) *Foece(Contrepoids)* Kraft(Gewıcht)

N	dyn	kgf	lbw
1	1×10^5	1.01972×10^{-1}	2.24809×10^{-1}
1×10^{-5}	1	1.01972×10^{-6}	2.24809×10^{-6}
9.80665	9.80665×10^5	1	2.20462
4.44822	4.44822×10^5	4.53592×10^{-1}	1

Ex 1.2kgf=1.2×9.80665=11.76798N=11.76798×2.24809×10^{-1}=2.64555lbw

f. Stress ***Emphase*** **Betonen**

Pa	MPa or N/mm²	kgf/mm²	kgf/cm²
1	1×10^{-6}	1.01972×10^{-7}	1.01972×10^{-5}
1×10^{6}	1	1.01972×10^{-1}	1.01972×10
9.80665×10^{6}	9.80665	1	1×10^{2}
9.80665×10^{4}	9.80665×10^{-2}	1×10^{-2}	1

Ex. 1.2kgf/cm²=1.2×9.80665×10⁻²=0.1176798 MPa

g. Pressure ***Pression*** **Pruefdruck**

MPa	Pa	Bar	kgf/cm²	atm	mmH²O	psi(lbw/in²)
1×10^{-6}	1	1×10^{-5}	1.01972×10^{-5}	9.86923×10^{-6}	1.01972×10^{-1}	$1\ 45038\times10^{-4}$
1	1×10^{6}	10	10.1972	9.86923	1.01972×10^{5}	$1\ 45038\times10^{2}$
0.0980665	9.80665×10^{4}	9.80665×10^{-1}	1	9.67841×10^{-1}	1.0×10^{4}	$1\ 42233\times10$
1.01325×10^{-1}	1.01325×10^{5}	1.01325	1.03323	1	1.03324×10^{4}	$1\ 46959\times10$
9.80665×10^{-6}	9.80665	9.80665×10^{-5}	1.0×10^{-4}	9.67841×10^{-5}	1	1.42233×10^{-3}
1.33322×10^{-4}	1.33322×10^{2}	1.33322×10^{-3}	1.35951×10^{-3}	1.31579×10^{-3}	1.35951×10	1.93368×10^{-2}
6.89474×10^{-3}	6.89474×10^{3}	6.89474×10^{-2}	7.03070×10^{-2}	6.80460×10^{-2}	7.03070×10^{2}	1

Ex. 120 kgf/cm²=120×9.80665×10⁴=11767980Pa=11.76798MPa 1Pa=1N/m², 1MPa=1×10⁶Pa

h. Work energy amount ***Equivalent travail mecanique de lachaleur*** **Leistung**

J	kW.h	kgf.m	kcal	ft.lb
1	2.77778×10^{-7}	1.01972×10^{-1}	2.38889×10^{-4}	7.37555×10^{-1}
3.6×10^{5}	1	3.67098×10^{5}	8.6×10^{2}	2.65519×10^{5}
9.80665	2.72407×10^{-6}	1	2.34270×10^{-3}	7.23292
4.18605×10^{3}	$1\ 16279\times10^{-3}$	4.26858×10^{2}	1	3.08743×10^{3}
1.35583	3.76621×10^{-4}	1.38257×10^{-1}	3.23899×10^{-4}	1

Ex. 12kgf.m=12×9.80665=117.6798J, 1J=1W·S, 1W·h=3600W·S, 1cal=4.1865J

ı.Work efficıency ***Puıssance*** **Wirkungsgrad**

kW	kgf.m/s	PS	HP	kcal/h
1	1.01922×10^{2}	1.35962	1.34048	8.6000×10^{2}
9.80665×10^{-3}	1	1.33333×10^{-2}	1.31456×10^{-2}	8.43371
7.355×10^{-1}	7.5×10	1	9.85925×10^{-1}	6.32529×10^{2}
$7\ 46\times10^{-1}$	7.60707×10	1.01428	1	6.41564×10^{2}
$1\ 16279\times10^{-3}$	$1\ 18572\times10^{-1}$	1.58095×10^{-3}	1.55869×10^{-3}	1

Ex. 10.2PS=10.2×7.355×10⁻¹=7.5021kW

ȷ.Torque ***Couple*** **Drehmoment**

kgf.m	ft.lbs	N.m
1	7.233	9.80665
0.1383	1	1.35582
0.1020	0.7376	1

Ex. 12kgf.m=12×9.80665=117.6798N.m

k.Velocity ***Vitesse*** **Geschwındigkeit**

m/sec	km/h	ft/mın	mile/h
1	3.6	3.2808	2.2370
0.2778	1	54.68	0.6214
0.00508	18.288	1	11.639
0.447	1.6093	0.19398	1

l. Temperature
Temperature
Temperatur

°F	°C
0	-17.8
10	-12.2
20	-6.7
30	-1 1
32	0
40	4.4
50	10.0
60	15.6
70	21.1
80	26.7
90	32.2
100	37.8
110	43.3
120	48.9
130	54.4
140	60.0
150	65.6
160	71.1
170	76.7
180	82.2
190	87.8
200	93.3
210	98.9
212	100.0
220	104.4
230	110.0
240	115.6

F=32+9/5×C
C=5/9×(F−32)

KUBOTA Corporation
CONSTRUCTION MACHINERY DIVISION
1-1-1 NAKAMIYA-OHIKE, HIRAKATA, OSAKA, JAPAN
EDITOR:
CONSTRUCTION MACHINERY MANUFACTURING DEPT.
SERVICE ENGINEERING SECTION
HIRAKATA PLANT
1-1-1 NAKAMIYA-OHIKE, HIRAKATA, OSAKA, JAPAN
PHONE :+81-72-840-2888
FAX :+81-72-840-2886

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WSM

WORKSHOP MANUAL
KUBOTA EXCAVATOR

KX080-3

Kubota

Code No.97899-61622

Record of Revisions

Symbol	Date	Main Revised Points & Corrective Measures	Person-in-charge
△1	Dec.18th 2006	Modification of S/P 1 control system and new travel motor with automatic torque-up control. Correction of hydraulic oil check conditions. Addition of LS pump flow performance test. Correction of motor specifications.	M.Okuda
△2	July 2nd 2007	Addition of Two Piece Boom Chapter	I.Okae
△3			
△4			

II Machine Body

Service Section

A. Specifications II-S-3
B. Removing and reassembling II-S-22
a.Front attachment removing II-S-22
b.Grease nipple set up II-S-25
c.Pin and bushing installation II-S-27
d.Shim installation II-S-29
e.Fitting the control lever II-S-31
f. Travel levers II-S-33
g.Dozer lever II-S-34
h.Cab II-S-35
i .Bonnet II-S-36
j .Sound absorber and insulator II-S-41
k.Counterweight II-S-48
l. Clearance of cover II-S-50
m.Labels II-S-51
n.Swivel bearing II-S-60
o.Undercarriage II-S-61
p.Track adjustment II-S-64
q.Swivel frame and track frame II-S-65

A. Specifications

a. Machine weight

	Truck	Arm	Unit	KX080-3
Cabin	Rubber	STD.	kgf (lbs)	7960 (17549)
		Long	kgf (lbs)	8020 (17681)
	Steel	STD.	kgf (lbs)	8060 (17769)
		Long	kgf (lbs)	8080 (17813)

b. Major specifications

		Unit	KX080-3	
Engine				
Type			Vertical, water-cooled 4 cycle, 4 cylinders diesel	
Model			V3800DI-E2-BH	
Rated engine output	ISO 3046 Net	kW/rpm	49.7/2000	
		PS/rpm	67.6/2000	
	SAE J1349 Net	HP/rpm		
	SAE J1995 Gross	HP/rpm		
Displacement		cc in^3	3769	230.0
Dimensions				
Overall length		mm in	6410	252.4
Overall width		mm in	2200	86.6
Overall crawler width		mm in	2200	86.6
Overall height	Canopy	mm in	-	-
	Cabin	mm in	2540	100.0
Min. ground clearance		mm in	386	15.2
Max. digging depth	Canopy	mm in	-	-
	Cabin	mm in	4602	181.2
Max. digging height	Canopy	mm in	-	-
	Cabin	mm in	7300	287.4
Max. digging radius	Canopy	mm in	-	-
	Cabin	mm in	7332	288.7
Max. dumping height	Canopy	mm in	-	-
	Cabin	mm in	5252	206.8
Swing angle (left/right)		deg.	67/60	
Travel speed	Low speed	km/h mph	3.1	1.9
	High speed	km/h mph	4.6	2.9
Swivel speed		rpm	9.5	
Max. traction force	Low speed	kN lbf	55.2	12.4
		kgf	5633	
	High speed	kN lbf	34.3	7.7
		kgf	3500	
Performance				
Tumbler distance		mm in	2296	90.4
Tread		mm in	2200	86.6
Crawler width x No. of shoe x pitch (Rubber crawler)		mm	450 x 80 x 154	
		in	17.7 x 86 x 6.1	
Bucket				
Capacity CECE Heaped		m^3 yd^3	0.25	0.327
Width		mm in	800	31.5
Blade				
Width x height		mm in	2200 x 500	86.6 x 19.7
Life above GL / below GL		mm in	491 / 502	19.3 / 19.8

c. Lever stroke and operating force

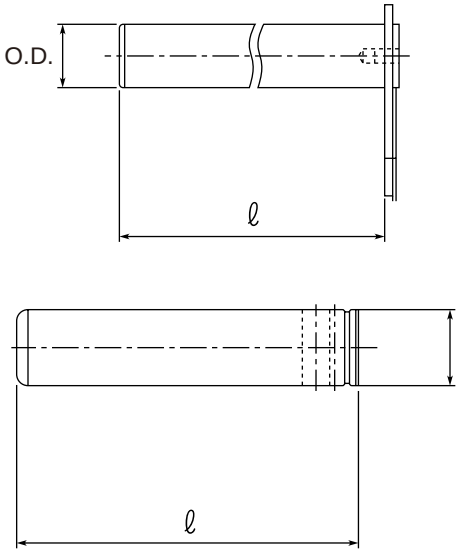
		Unit	KX080-3		Remarks
Boom	Stroke	mm	100	100	Up/Down
		in.	3.9	3.9	
	Force	N	14.7	14.7	
		kgf	1.5	1.5	
		lbf	3.3	3.3	
Arm	Stroke	mm	100	100	Crowd/Dump
		in.	3.9	3.9	
	Force	N	15.7	16.7	
		kgf	1.6	1.7	
		lbf	3.5	3.7	
Bucket	Stroke	mm	80	80	Crowd/Dump
		in.	3.1	3.1	
	Force	N	12.7	12.7	
		kgf	1.3	1.3	
		lbf	2.9	2.9	
Swivel	Stroke	mm	80	80	Left/Right
		in.	3.1	3.1	
	Force	N	12.7	12.7	
		kgf	1.3	1.3	
		lbf	2.9	2.9	
Travel(Left/Right)	Stroke	mm	80	80	F/R
		in.	3.1	3.1	
	Force	N	18.6	18.6	
		kgf	1.9	1.9	
		lbf	4.2	4.2	
Blade	Stroke	mm	73	72	Up/Down
		in.	2.9	2.8	
	Force	N	14.7	24.5	
		kgf	1.5	2.5	
		lbf	3.3	5.5	
Acceleration	Force	N	-	-	This machine has acceleration dial, not lever
		kgf	-	-	
		lbf	-	-	
Swing pedal	Force	N	56.9	56.9	Left/Right
		kgf	5.8	5.8	
		lbf	12.8	12.8	
Safety lock lever (Left)	Force	N	-	-	Up/Down
		kgf	-	-	
		lbf	-	-	

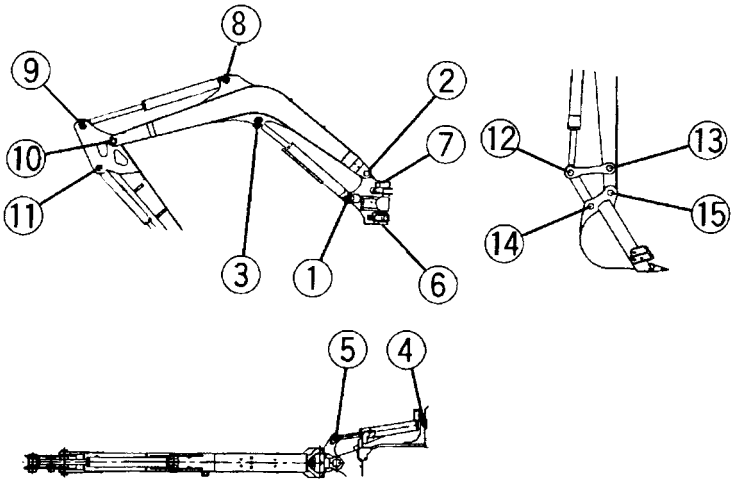
d. Dimensions of parts :

(1) Front pins

No.		Unit	KX080-3α	Position
1	Pin diameter x length	mm in.	Φ70 x 200 Φ2.76 x 7.87	Swing bracket -Boom cylinder
2	Pin diameter x length	mm in.	Φ80 x 437 Φ3.15 x 17.20	Swing bracket - Boom
3	Pin diameter x length	mm in.	Φ70 x 226 Φ2.76 x 8.90	Boom - Boom cylinder
4	Pin diameter x length	mm in.	Φ70 x 183 Φ2.76 x 7.20	Swivel frame -Swing cylinder
5	Pin diameter x length	mm in.	Φ70 x 168 Φ2.76 x 6.61	Swing bracket - Swing cylinder
6	Pin diameter x length	mm in.	Φ100 x 474 Φ3.94 x 18.66	Swing bracket - Swivel frame(Lower)
8	Pin diameter x length	mm in.	Φ60 x 226 Φ2.36 x 8.90	Boom - Arm cylinder
9	Pin diameter x length	mm in.	Φ60 x 175 Φ2.36 x 6.89	Arm - Arm cylinder
10	Pin diameter x length	mm in.	Φ70 x 332 Φ2.76 x 13.07	Boom - Arm
11	Pin diameter x length	mm in.	Φ60 x 151 Φ2.36 x 5.94	Arm - Bucket cylinder
12	Pin diameter x length	mm in.	Φ60 x 284 Φ2.36 x 11.18	Bucket links 1, 2, 3 - Bucket cylinder"
13	Pin diameter x length	mm in.	Φ60 x 284 Φ2.36 x 11.18	Arm - Bucket links 2, 3
14	Pin diameter x length	mm in.	Φ60 x 333 Φ2.36 x 13.11	Bucket - Bucket link 1
15	Pin diameter x length	mm in.	Φ60 x 333 Φ2.36 x 13.11	Arm - Bucket

Note : Service limit of pin and bushing is 1.0mm less and more than original diameter respectively.





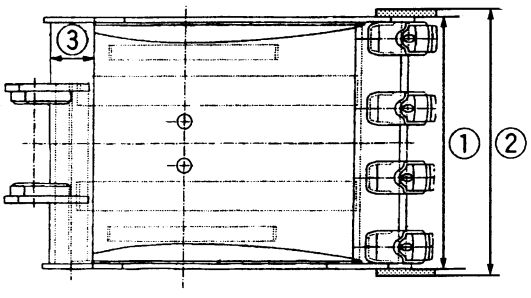
ℓ : length

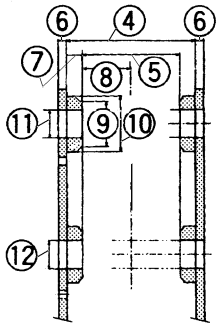
(2) Bucket

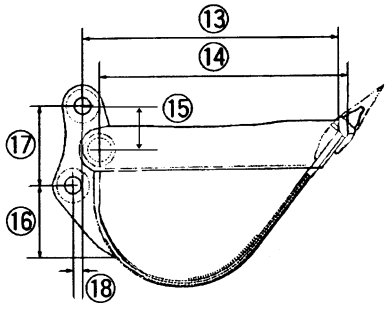
1) Bucket dimensions

No.	Unit		KX080-3
1	mm	676	
	in.	26.61	
2	mm	700	
	in.	27.56	
3	mm	Φ130 x t10	
	in.	Φ5.12 x t0.39	
4	mm	290	
	in.	11.42	
5	mm	200	
	in.	7.87	
6	mm	19	
	in.	0.75	
7	mm	45	
	in.	1.77	
8	mm	100	
	in.	3.94	
9	mm	Φ105	
	in.	Φ4.13	
10	mm	Φ120	
	in.	Φ4.72	
11	mm	Φ60	+0.10 +0.05
	in.	Φ2.36	+0.004 +0.002
12	mm	Φ60	+0.10 +0.05
	in.	Φ2.36	+0.004 +0.002
13	mm	890.5	
	in.	35.06	
14	mm	783	
	in.	30.83	
15	mm	135	
	in.	5.31	
16	mm	165	
	in.	6.50	
17	mm	297	
	in.	11.69	
18	mm	44	
	in.	1.73	

NOTE : BUCKET FOR STANDARD ARM,



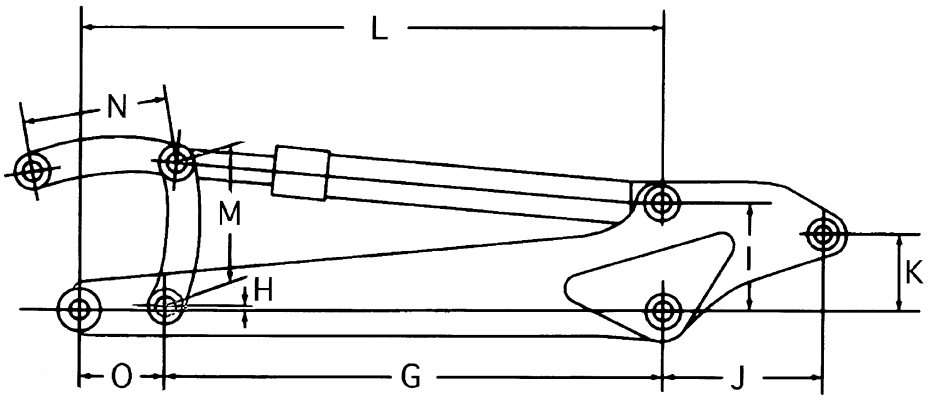


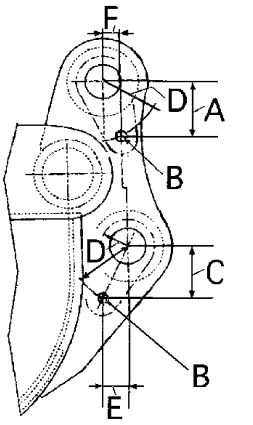


2) Bucket installation relevant dimensions

No.	Unit	KX080-3 Standard arm	KX080-3 Lomg arm
A	mm	-	-
	in.	-	-
B	mm	M20 x 1.5	←
	in.		
C	mm	90	←
	in.	3.54	←
D	mm	90	←
	in.	3.54	←
E	mm	0.0	←
	in.	0.00	←
F	mm	30.0	←
	in.	1.18	←
G	mm	1490	1840
	in.	58.66	72.44
H	mm	13	←
	in.	0.51	←
I	mm	370	←
	in.	14.57	←
J	mm	451	←
	in.	17.76	←
K	mm	279	←
	in.	10.98	←
L	mm	1745	←
	in.	68.70	←
M	mm	428	←
	in.	16.85	←
N	mm	403	←
	in.	15.87	←
O	mm	260	←
	in.	10.24	←

NOTE : KUBOTA JAPAN BUCKET, STANDARD ARM





(3) Rubber crawler

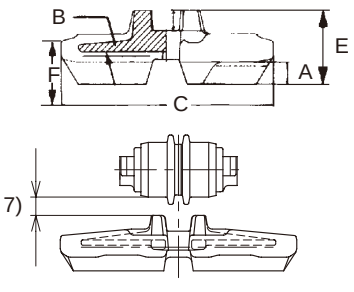
	Unit	KX080-3
Crawler ass'y code No.		RD809-2231-0
Identification mark (Core metal rapping position)		∞
A : Lug height	mm in.	30 1.18
B : Link height	mm in.	52 2.05
C : Crawler width	mm in.	450 17.72
D : Crawler sag distance	mm in.	25 to 40 0.98 to 1.57
E : Crawler height	mm in.	105.5 4.15
Number of core metal		76
Circumference	mm in.	6194 243.9
Core metal pitch	mm in.	81.5 3.21
Steel coad strength	N/piece kgf/piece lbf/piece	16000 1632 3597
Number of steel cord		20
Rubber thickness (Regular / Joint part)	mm in.	52 2.05

(4) Steel crawler

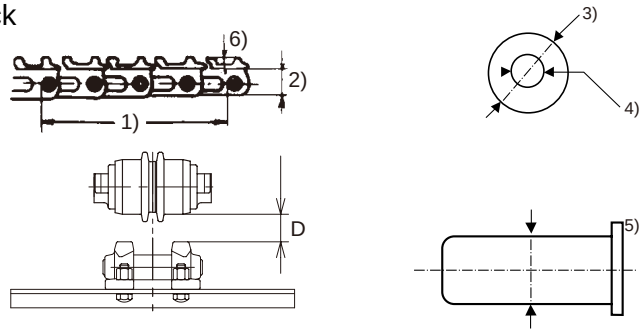
	Unit	KX080-3(STD)	KX080-3(Wide)
Crawler ass'y code No.		RD809-2220-0	RD809-2240-0
Crawler width	mm in.	450 17.72	600 23.62
1) 4 links length	mm in.	616.0 24.25	← ←
2) Height	mm in.	74.0 2.91	← ←
3) Bushing O. D. (A)/(B)	mm in.	Φ41.26 / Φ40.26 Φ1.62 / Φ1.59	← ←
4) Bushing I. D. (A)/(B)	mm in.	Φ24.0 / Φ25.0 Φ0.94 / Φ0.98	← ←
5) Master pin O. D. (A)/(B)	mm in.	Φ24.0 / Φ23.0 Φ0.94 / Φ0.91	← ←
6) Grouser height	mm in.	20.0 0.79	← ←
7) Crawler sag distance	mm in.	40 to 45 1.57 to 1.77	← ←
Number of links		80	←

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

Rubber track



Iron track

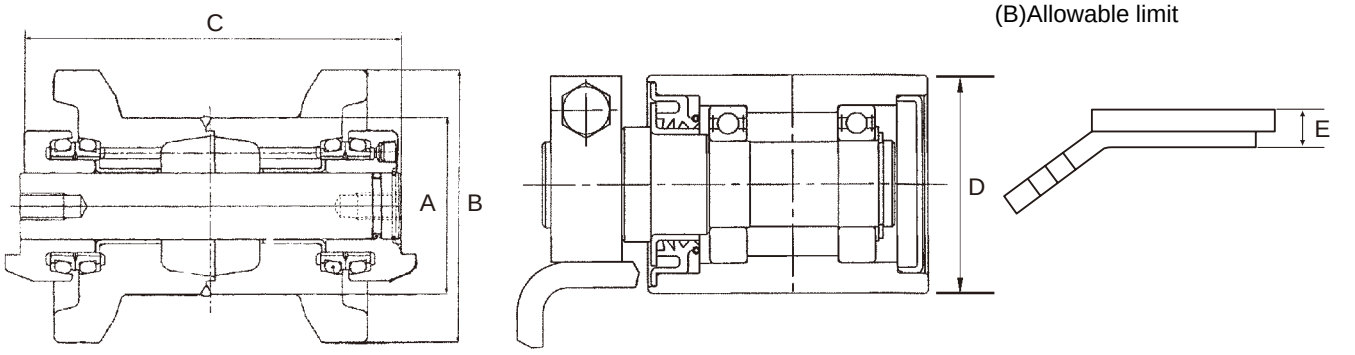


(5) Track roller, idler, sprocket

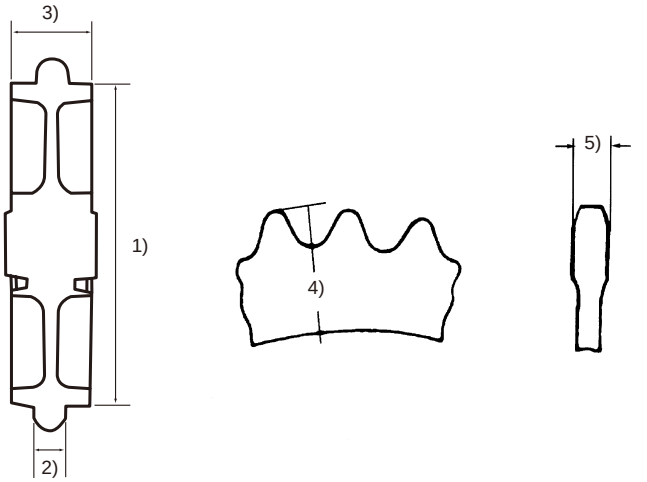
		Unit	KX080-3	Remark
A : Guide width	(A)/(B)	mm in.	Φ104 / Φ99 Φ4.09 / Φ3.89	
B : Outer diameter	(A)/(B)	mm in.	Φ132 / Φ128 Φ5.20 / Φ5.04	
C : Roller width		mm in.	228.5 / 220.5 9.00 / 8.68	
D : Upper roller diameter	(A)/(B)	mm in.	Φ80 / Φ76 Φ3.15 / Φ2.99	
E : Sliding plate thickness	(A)/(B)	mm in.		

		Unit	KX080-3	Remark
1) Idler O.D.	(A)/(B)	mm in.	Φ390 / Φ382 Φ15.35 / Φ15.05	
2) Guide width	(A)/(B)	mm in.	38 / 36 1.50 / 1.42	
3) Idler width	(A)/(B)	mm in.	98 / 93 3.86 / 3.67	
4) Sprocket wheel O.D.	(A)/(B)	mm in.	Φ493 / Φ468 Φ19.41 / Φ18.44	
5) Sprocket wheel width	(A)/(B)	mm in.	39 / 37 1.54 / 1.46	

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

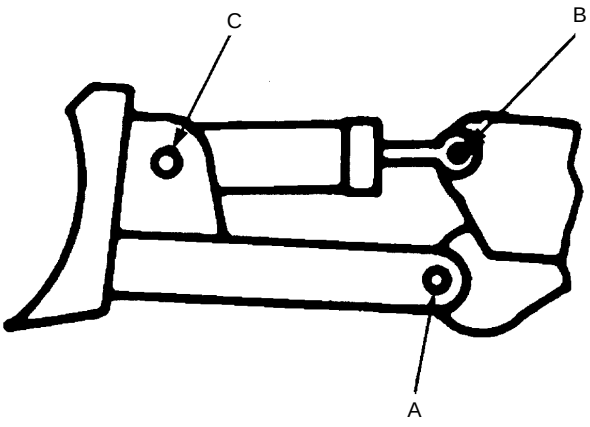


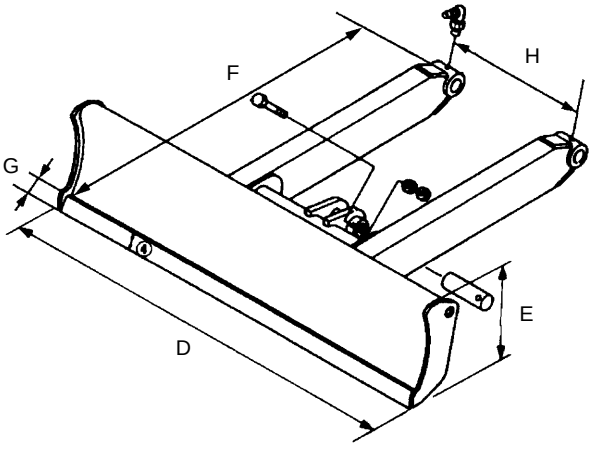
(A)New machine reference value
(B)Allowable limit



(6) Blade

	Unit	KX080-3 STD	Remark
Blade ass'y code No.		RD809-7441-0	
A : Pin diameter x length	mm in.	Φ60 x 167 Φ2.36 x 6.57	Blade am -Track frame
B : Pin diameter x length	mm in.	Φ70 x 147 Φ2.76 x 5.79	Blade cylinder -Track frame
C : Pin diameter x length	mm in.	Φ70 x 147 Φ2.76 x 5.79	Blade cylinder -Blade
D : Blade width	mm in.	2200 86.61	
E : Blade height	mm in.	500.0 19.69	
F : Blade length	mm in.	1448 57.01	
G : Blade tip plate height x thickness	mm in.	90 x 16 3.54 x 0.63	
H : Length between blade arms	mm in.	600 23.62	





(7) Parts weight

		Unit	KX080-3	Remarks
Truck frame		kgf	867	
		(lbs)	(1911.4)	
Swivel frame		kgf	970	
		(lbs)	(2137.4)	
Swing bracket		kgf	176	
		(lbs)	(388.0)	
Boom		kgf	362	
		(lbs)	(798.1)	
Arm	STD.	kgf	161	
		(lbs)	(354.9)	
	Long	kgf	182	
		(lbs)	(401.2)	
Bucket	For STD. arm	kgf		Japan STD.Bucket
		(lbs)		
	For Long arm	kgf		
		(lbs)		
Blade		kgf	295	
		(lbs)	(650.4)	
Weight (left)		kgf	-	
		(lbs)	-	
Weight (right)		kgf	-	
		(lbs)	-	
Weight (rear)		kgf	870	
		(lbs)	(1918.0)	
Rubber crawler		kgf		
		(lbs)		
Steel crawler (STD)		kgf		
		(lbs)		
Steel crawler (Wide)		kgf	-	
		(lbs)	-	
Arch frame 1		kgf	79	
		(lbs)	(174.2)	
Arch frame 2		kgf	8	
		(lbs)	(17.0)	
Engine		kgf		Dry weight
		(lbs)		
Hydraulic tank		kgf	52	With filter
		(lbs)	(114.4)	
Fuel tank		kgf	8	
		(lbs)	(17.6)	
Swivel bearing		kgf	113	
		(lbs)	(249.1)	
Battery		kgf	30	
		(lbs)	(66.1)	
Truck roller		kgf	12.0	
		(lbs)	(26.5)	
Upper roller		kgf		
		(lbs)		
ROPS/FOPS canopy		kgf	-	
		(lbs)	-	
ROPS/FOPS cabin		kgf	308	
		(lbs)	(679.0)	
Hydraulic pump		kgf	47	
		(lbs)	(103.6)	
Traveling motor		kgf	81	
		(lbs)	(178.6)	
Swivel motor		kgf	80	
		(lbs)	(176.4)	

	Unit	KX080-3	Remarks
Sprocket	kgf	22.0	
	(lbs)	(48.5)	
Idler ass'y	kgf	67	
	(lbs)	(147.7)	
Control valve	kgf	94	Without adaptors
	(lbs)	(207.2)	
Boom cylinder	kgf		Canopy / Cabin
	(lbs)		
Arm cylinder	kgf		
	(lbs)		
Bucket cylinder	kgf		
	(lbs)		
Swing cylinder	kgf	76	
	(lbs)	(168.4)	
Blade cylinder	kgf	56	
	(lbs)	(122.6)	
Rotary joint	kgf	42	
	(lbs)	(92.6)	

The above weight list is based on calculation and slightly different from actual ones.

e. Quality specification

KX080-3: KE, KUK, KBM Version

Machine specification : Auxiliary port,Wrist rest,STD-arm,japan-cab,KBM-bucket

No		Specificatios Items			Unit	KX080-3	Remarks
Q1		Main Speed JIS A8404					
1	1	Machine size	Total length (Transport)		mm	6410 ± 128	
					inch	252.4 ± 5.0	
	2		Total width		mm	2200 ± 22	
					inch	86.6 ± 0.9	
	3		Total height (Canopy)		mm	-	Include grouser height
					inch	-	
	4		Total height (Cabin)		mm	2540 ± 25	
					inch	100.0 ± 25	
2	1	Weight	Machine weight (Canopy)		kg	-	Fuel tank:Full
					lbs	-	
	2		Machine weight (Cabin)		kg	7960 ± 159	
					lbs	17548.6 ± 350.5	
3	1	Performance	Swivel speed	L	rpm	9.5 ± 1.0	
	2			R	rpm	9.5 ± 1.0	
	3		Travel speed	Rubber F1	km/h	3.1 ± 0.3	Traveling stance: Engine Max.speed Oil temp. : 50±5°C (122±9°F)
					mph	1.93 ± 0.19	
	4			Rubber F2	km/h	4.6 ± 0.5	
					mph	2.86 ± 0.31	
	5			Steel F1	km/h	±	
					mph	±	
	6			Steel F2	km/h	±	
					mph	±	
	7		Gradeability		deg	30	
4	1	Rear end min. turning radius			mm	1420 ± 28	
					inch	55.9 ± 1.1	
	2	Swivel frame rear ground clearance			mm	728 ± 15	
					inch	28.7 ± 0.6	
	3	Tumbler center distance			mm	2296 ± 69	
					inch	90.4 ± 2.7	
	4	Crawler total length			mm	2898 ± 87	
					inch	114.1 ± 3.4	
	5	Crawler total width			mm	2200 ± 44	
					inch	86.6 ± 1.7	
	6	Min. ground clearance			mm	386 ± 12	
					inch	15.2 ± 0.5	

No		Specificatios Items			Unit	KX080-3	Remarks
5	1	Front attachment	Bucket heaped capacity	CECE	m^3	±	
					yd^3	±	
	2			SAE, JIS	m^3	0.162 ± 0.009	Slope angle: 1x1
					yd^3	0.212 ± 0.012	
	2		Bucket struck capacity		m^3	0.162 ± 0.006	
					yd^3	0.212 ± 0.008	
	3		Bucket width		mm	700 ± 14	Without side cutter
					inch	27.6 ± 0.6	
	4		Swing angle	Canopy L	deg	-	
	5			Canopy R	deg	-	
	6			Cabin L	deg	67 ± 2	
	7			Cabin R	deg	60 ± 2	
	8		Max. digging radius		mm	7332 ± 110	
					inch	288.7 ± 4.3	
	9		Ground level Max. digging radius		mm	7173 ± 108	
					inch	282.4 ± 4.3	
	10		Ground level Min. finish radius		mm	2091 ± 42	Bucket bottom horizontal
					inch	82.3 ± 1.7	
	11		Max. digging depth		mm	4602 ± 92	
					inch	181.2 ± 3.6	
	12		Max. vertical digging depth		mm	3674 ± 110	
					inch	144.6 ± 4.3	
	13		Max. digging height	Canopy	mm	-	
					inch	-	
	14			Cabin	mm	7300 ± 146	
					inch	287.4 ± 5.7	
	15		Max. dump height	Canopy	mm	-	
					inch	-	
	16			Cabin	mm	5252 ± 105	
					inch	206.8 ± 4.1	
	17		Max. dump height (Arm vertical)	Canopy	mm	-	
					inch	-	
	18			Cabin	mm	1774 47	
					inch	69.8 1.9	
5	19	Front attachment	Mini. turning radius	Canopy	mm	-	
					inch	-	
	20			Cabin	mm	2490 ± 75	
					inch	98.0 ± 3.0	
	21		Mini. turning radius (Left swing)	Canopy	mm	-	
					inch	-	
	22			Cabin	mm	1997 ± 60	
					inch	78.6 ± 2.4	
6	1	Blade	Width		mm	2200 ± 5	
					inch	86.6 ± 0.2	
	2		Height		mm	500 ± 10	
					inch	19.7 ± 0.4	
	3		Max. lift above GL		mm	491 ± 50	
					inch	19.3 ± 2.0	
	4		Max. below GL		mm	502 ± 50	
					inch	19.8 ± 2.0	

No		Specificatios Items		Unit	KX080-3	Remarks
Q2		Main Specs JIS A8404				
1	1	Bucket tooth slaggish		mm		Without shockless F=30 kgf (66 lbf)
				inch		
	2	Front boom lateral declination		mm	10	
				inch	0.39	
	3	Blade's lateral declination		mm	10	
				inch	0.39	
2	1	Clearance between bucket crow and boom cylinder cover		mm	76 ± 19	From swivel center
				inch	3.0 ± 0.7	
	2	(Min.value; reference)		mm		
				inch		
3	1	Approach angle		deg	32 ± 3	
4	1	Crawler height		mm	602 ± 12	Include grouser on the spocket
				inch	23.70 ± 0.47	
	2	Max. crawler height		mm	634 ± 13	
				inch	24.96 ± 0.51	
Q3		Engine performance				
1	1	Max, engine rpm	no load	rpm	2000	
	2		1 pump relief	rpm	-	
	3		2 pump relief	rpm	-	
	4		3 pump relief	rpm	-	Boom, arm, swivel
	5		2 pump relief	rpm		
	6		Blade+2 pump relief	rpm		
2	1	Idling RPM	Canopy	rpm		
	2		Cabin	rpm	1050 ± 50	
Q4		Travelling performance				
1	1	Travel motor block performance	L	mm	0	20 deg. slope, 10min engine stop. Hydraulic oil tempt : 50°±5°C
				inch	0	
	2	Travel motor block performance	R	mm	0	
				inch	0	
2	1	Max, Traction force	F1	kgf.m	5633	Slip. This value is 70% of absolute traction force.
				kN.m	55.2	
				ft.lbf	40742	
	2		F2	kgf.m	3500	Relief. This value is 60% of absolute traction force.
				kN.m	34.30	
				ft.lbf	25314	
3	1	Travel straightness	F1	mm	600	10m distance Engine Max. speed
				inch	23.62	
	2		F2	mm	600	
				inch	23.62	
	3		Blade F1	mm	600	Blade up & down 10m distance
				inch	23.62	
	4		Blade R1	mm	600	
				inch	23.62	
4	1	Track shoe sag distance	Steel	mm	40 - 55	
				inch	1.57 - 2.17	
	2		Rubber	mm	25 - 40	
				inch	0.98 - 1.57	

No		Specificatios Items			Unit	KX080-3	Remarks
Q5		Work performance					
1	1	Boom lifting capacity			kgf	1529.6	Front end, Arm extend bucket crowd, at tooth
					kN	15.0	
					lbf	3372.1	
1	2	Arm digging force			kgf	3885.1	Bucket tooth root
					kN	38.1	
					lbf	8565.2	
	3	Bucket digging force			kgf	6648.6	Machine stance to JIS bucket tooth root
					kN	65.2	
					lbf	14657.5	
	4	Blade force		down	kgf		Cutting edge down force at ground level
					kN		
					lbf		
2	1	Boom speed	Canopy	up 1st	sec.	-	Oil temp. 50±5°C (122±9°F) Ground to max. height (exclude cushioning)
	2			up 2nd	sec.	-	
	3			down	sec.	-	
	4			down	sec.	-	
	5		Cabin	up 1st	sec.	3.4 ± 0.3	
	6			up 2nd	sec.	-	
	7			down	sec.	3.4 ± 0.3	
	8			down	sec.	-	
3	1	Arm speed		crowd	sec.	3.7 ± 0.3	
	2			dump	sec.	3.5 ± 0.3	
4	1	Bucket speed		crowd	sec.	3.5 ± 0.3	Oil temp. 50±5°C (122±9°F)
	2			dump	sec.	2.2 ± 0.3	
5	1	Blade speed		up 1st	sec.	±	Ground to max. up
	2			up 2nd	sec.	2.2 ± 0.3	Max. down to max. up
	3			down	sec.	±	Max. up to ground
	4			down	sec.	2.9 ± 0.3	Max. up to max. down
6	1	Arm cylinder cavitation			mm	5	Oil temp. 95±5°C(203±9°F) Engine speed : 1300 rpm
					inch	0.20	
7	1	Max. digging height radius	Canopy		mm	-	
					inch	-	
	2		Cabin		mm	3388 ± 339	
					inch	133.39 ± 13.35	
	3	Max. dump height radius	Canopy		mm	-	at bucket pin
					inch	-	
	4		Cabin		mm	3260 ± 196	
					inch	128.35 ± 7.72	
7	5	Bucket bottom height at arm vertical	Canopy		mm	-	Bucket horizontal
					inch	-	
	6		Cabin		mm	2271 ± 68	
					inch	89.41 ± 2.68	
	7	Bucket wrist angle			deg.	178.6 +3.4,-2.6	
Q6		Swivel, swing performance					
1	1	Swivel torque		L	kgf.m	2104	Arm extend, Slow/Quick operation
					kN.m	20.6	
					ft.lbf	15218	
	2			R	kgf.m	2104	
					kN.m	20.6	
					ft.lbf	15218	
2	1	Swivel capable slope angle		L	deg.	17	Bucket load=JIS heapedx1.8
	2			R	deg.	17	

No		Specificatios Items			Unit	KX080-3	Remarks
3	1	Swivel block performance	Engine stop	L	deg.	0	Bucket loaded at heaped. Slope angle at 20° 1 min engine stop. Hydraulic oil tempt : 50°±5°C
	2			R	deg.	0	
	3		Engine running	L	deg.	0	Bucket loaded at heaped. Slope angle at 20° 1 min engine running. Lever lock released Hydraulic oil tempt : 50°±5°C
	4			R	deg.	0	
4	1	Swivel start-up speed		L	sec.	2.9 ± 0.3	0~90 deg. swivel
	2			R	sec.	2.9 ± 0.3	
5	1	Swing speed	Canopy	L	sec.	-	
	2			R	sec.	-	
	3		Cabin	L	sec.	6.9 ± 0.3	
	4			R	sec.	8.1 ± 0.3	
6	1	Swing Lock		Swivel R&L	mm	10	90 deg-swivel, 100 times actual digging cylinder dislocation
					inch	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	280 ± 5.0	At pump delivery 50±5°C(122±9°F)
					MPa	27.5 ± 0.5	
					bar	275 ± 5.0	
					psi	3983 ± 71	
	2			P2	kgf/cm^2	280 ± 5.0	
					MPa	27.5 ± 0.5	
					bar	275 ± 5.0	
					psi	3983 ± 71	
	3			P3	kgf/cm^2	210 ± 5.0	
					MPa	20.6 ± 0.5	
					bar	206 ± 5.0	
					psi	2987 ± 71	
	4			P4	kgf/cm^2	40 ± 5.0	
					MPa	3.9 ± 0.5	
					bar	39.2 ± 5.0	
					psi	569 ± 71	
2	1	Cylinder oil sealing capacity	Boom	50±5°C (122±9°F)	mm	20	Arm extend, Bucket height 1m, 10 min. Bucket load=JIS heapedx1.8
					inch	0.79	
	2			95±5°C (203±9°F)	mm	20	
					inch	0.79	
	3		Arm	50±5°C (122±9°F)	mm	11	
					inch	0.43	
	4		Bucket	50±5°C (122±°F)	mm	10	
					inch	0.39	
	5		Blade	50±5°C (122±9°F)	mm	20	Arm vertical, blade cylinder extended for 10 min. engine stop."
					inch	0.79	
3	1	Boom cushioning performance		30°C (86°F)	sec.	3	Arm extended, bucket crowd with no road. Engine Max. speed."
	2			50°C (122°F)	sec.	0.4 - 1.3	
	3			80°C (176°F)	sec.	0.3	
Q8		Lever operating force & stroke					

No		Specificatios Items			Unit	KX080-3		Remarks
1	1	Boom lever operating force		UP	kgf	1.5	-0.5,+0.5	Measuring point : 20 mm lower from the lever top. Pilot lever with engine Max. speed.
					N	14.7	-4.7,+5.3	
					lbf	3.3	-1.1,+1.2	
	2			down	kgf	1.5	-0.5,+0.5	
					N	14.7	-4.7,+5.3	
					lbf	3.3	-1.1,+1.2	
1	3	Arm lever		crowd	kgf	1.6	-1.1,+2.1	Dump & crowd
					N	15.7	-4.7,+5.3	
					lbf	3.5	-1.1,+1.2	
	4			dump	kgf	1.7	-1.1,+2.1	
					N	16.7	-4.7,+5.3	
					lbf	3.8	-1.1,+1.2	
	5	Bucket lever		crowd	kgf	1.3	-1.1,+2.1	Dump & crowd
					N	12.7	-4.7,+5.3	
					lbf	2.9	-1.1,+1.2	
	6			dump	kgf	1.3	-1.1,+2.1	
					N	12.7	-4.7,+5.3	
					lbf	2.9	-1.1,+1.2	
	7	Swivel lever		R	kgf	1.3	-1.1,+2.1	Left & right
					N	12.7	-4.7,+5.3	
					lbf	2.9	-1.1,+1.2	
	8			L	kgf	1.3	-1.1,+2.1	
					N	12.7	-4.7,+5.3	
					lbf	2.9	-1.1,+1.2	
	9	Blade lever		up	kgf	1.5	-0.5,+0.5	Up & down Measuring point : 15 mm lower from the lever top
					N	14.7	-4.7,+5.3	
					lbf	3.3	-1.1,+1.2	
	10			down	kgf	2.5	-0.5,+0.6	
					N	24.5	-4.5,+5.5	
					lbf	5.5	-1.0,+1.2	
	11	Travel lever	L	Forward	kgf	1.9	-0.5,+0.6	Measuring point : 20 mm lower from the lever top.
					N	18.6	-4.6,+5.4	
					lbf	4.2	-1.0,+1.2	
	12			Back	kgf	1.9	-0.5,+0.6	
					N	18.6	-4.6,+5.4	
					lbf	4.2	-1.0,+1.2	
	13		R	Forward	kgf	1.9	-0.5,+0.6	
					N	18.6	-4.6,+5.4	
					lbf	4.2	-1.0,+1.2	
	14			Back	kgf	1.9	-0.5,+0.6	
					N	18.6	-4.6,+5.4	
					lbf	4.2	-1.0,+1.2	

No		Specificatios Items			Unit	KX080-3	Remarks
1	15	Accelerator lever		up	kgf	-	This machine has accel dial not a lever.
					N	-	
					lbf	-	
	16			down	kgf	-	
					N	-	
					lbf	-	
	17	Swing pedal		R	kgf	5.8 ± -1.0,+1.0	Pedal edge. 45 degree inward
					N	56.9 ± -9.9,+10.1	
					lbf	12.8 ± -2.2,+2.3	
	18			L	kgf	5.8 ± -1.0,+1.1	
					N	56.9 ± -9.9,+10.1	
					lbf	12.8 ± -2.2,+2.3	
	19	Safety lock lever	R	up	kgf	-	Up & down
					N	-	
					lbf	-	
	20			down	kgf	-	
					N	-	
					lbf	-	
	21	Safety lock lever	L	up	kgf	±	Up & down
					N	±	
					lbf	±	
	22			down	kgf	±	
					N	±	
					lbf	±	
	23	Travel Hi-Lo change			kgf	-	This machine has a switch
					N	-	
					lbf	-	

No		Specificatios Items			Unit	KX080-3	Remarks
2	1	Boom lever stroke		up	mm	100 ± 10	
					inch	3.94 ± 0.39	
	2			down	mm	100 ± 10	
					inch	3.94 ± 0.39	
	3	Arm lever stroke		crowd	mm	100 ± 10	
					inch	3.94 ± 0.39	
	4			dump	mm	100 ± 10	
					inch	3.94 ± 0.39	
	5	Bucket lever stroke		crowd	mm	80 ± 10	
					inch	3.15 ± 0.39	
	6			dump	mm	80 ± 10	
					inch	3.15 ± 0.39	
	7	Swivel lever stroke		R	mm	80 ± 10	
					inch	3.15 ± 0.39	
	8			L	mm	80 ± 10	
					inch	3.15 ± 0.39	
	9	Blade lever stroke		up	mm	73 ± 10	
					inch	2.87 ± 0.39	
	10			down	mm	72 ± 10	
					inch	2.83 ± 0.39	
	11	Travel lever stroke	L	Forward	mm	80 ± 10	
					inch	3.15 ± 0.39	
	12			Back	mm	80 ± 10	
					inch	3.15 ± 0.39	
	13		R	Forward	mm	80 ± 10	
					inch	3.15 ± 0.39	
	14			Back	mm	80 ± 10	
					inch	3.15 ± 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, bucket crowd 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	489	
					N.m	4795	
					ft.lbf	3537	
	4			Front, blade up	kgf.m	749	
					N.m	7345	
					ft.lbf	5417	
	5	Standard arm, static limited load	Bucket load to tip fully	Side	kgf.m	734	Front horizontal bucket crowd, load at arm tip end.
					N.m	7198	
					ft.lbf	5309	
	6			Front	kgf.m	1060	
					N.m	10395	
					ft.lbf	7667	
Q10		Comfortability					
1	1	Noise level	At operator's ear LPA	Canopy	dB(A)	-	
	2			Cabin	dB(A)	76	Cabin door close
	3		Noise source;LWA	7m	dB(A)	96.7 >	
	4		Sonic power level (JIS)		dB(A)		

B: Removing and reassembling

a. Front attachment removing



1. Dismount bracket and bracket link.



2. Disconnect bracket cylinder hose. Lifting the arm assy, tap out the pins and dismount arm assy.





3. Remove the pipe and hose connections.

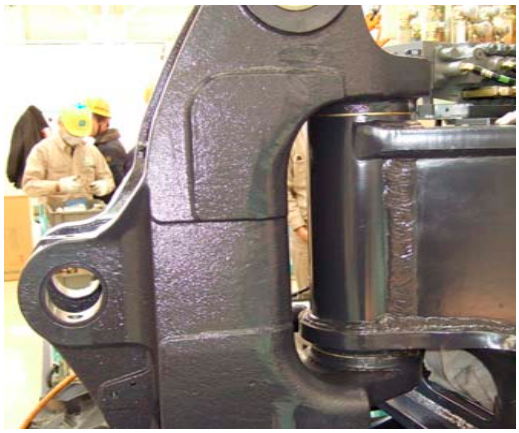




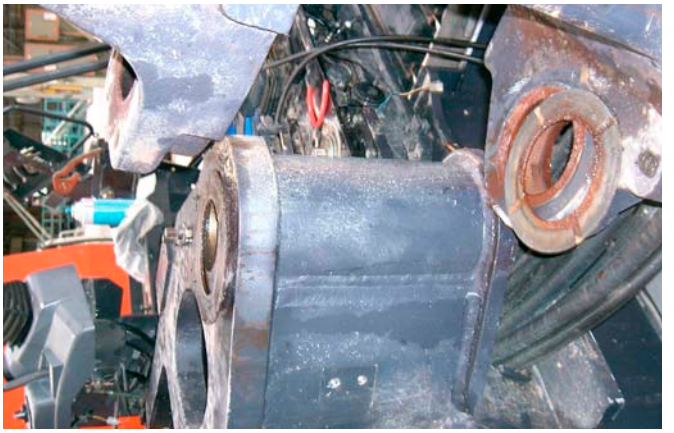
4. While lifting the boom assy, remove the boom pin.



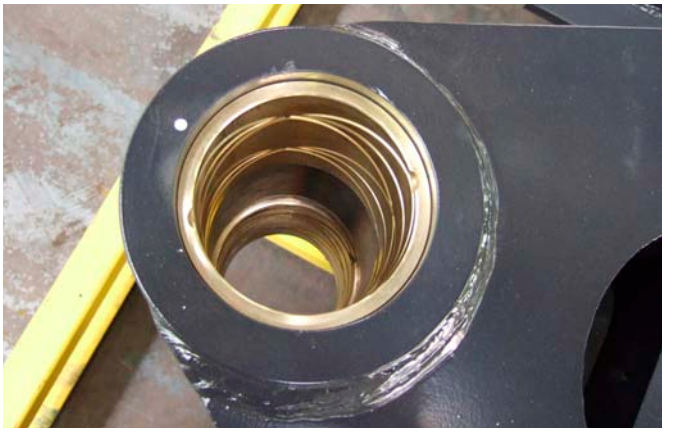
5. While lifting the swing bracket assy, remove the pin.







Shims





Bushings

b. Grease nipple set up

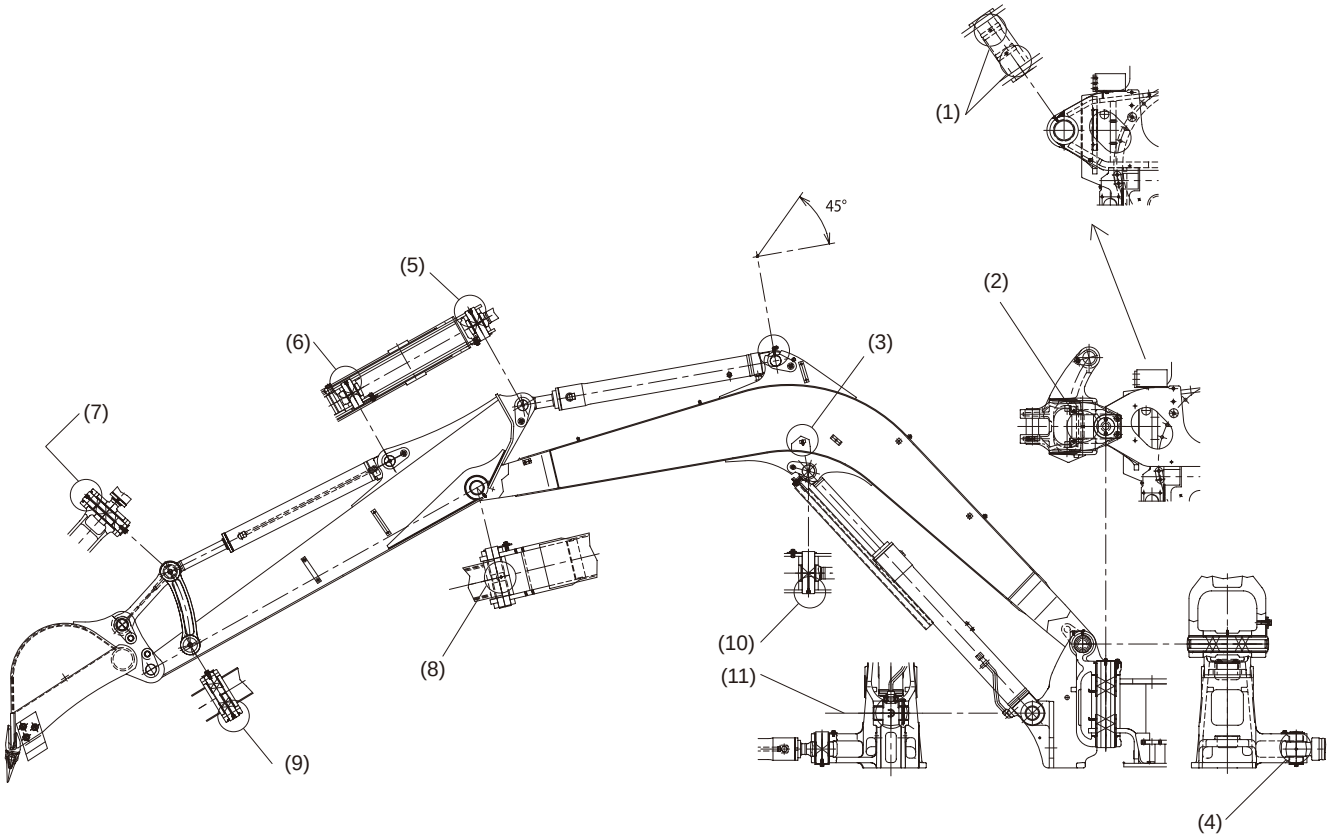
1.Grease nipple setup direction

Type A: Straight (06611-15010)
Type B: 67 degree (06616-25010)
Type C: 90 degree (06616-35010)

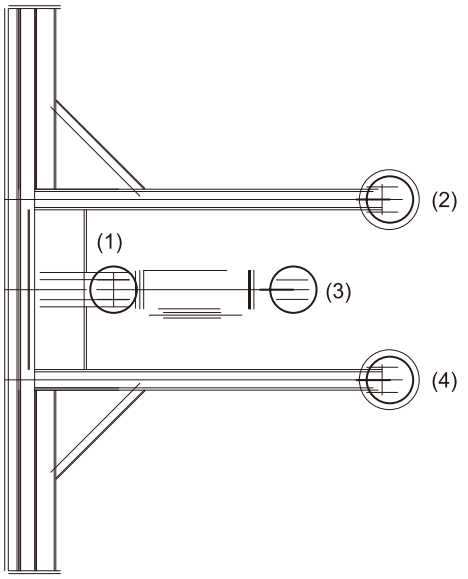
Mount the fittings as shown at left.

2.Greasing quantity

Apply grease until it comes out of the other end of the moving section.



(1)Type A (boss greasing)
(2)Type A (boss greasing)
(3)Type A
(4)Type A (boss greasing)
(5)Type A (pin greasing)
(6)Type A (pin greasing)
(7)Type A (pin greasing)
(8)Type A (boss greasing)
(9)Type A (pin greasing)
(10)Type A (pin greasing)
(11)Type A (boss greasing)



3.Grease nipple setup direction

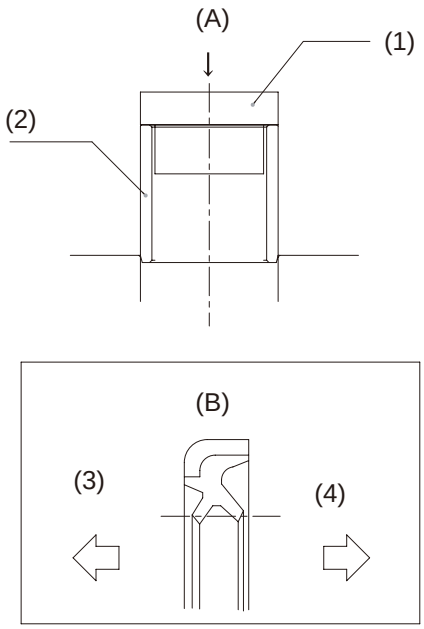
Type A: Straight (06611-15010)
Type B: 67°(06616-25010)

Mount the fittings as shown at left.

4.Greasing quantity

Apply grease until it comes out of the other end of the moving section.

(1)Type A
(2)Type B
(3)Type B
(4)Type B



C. Pin and bushing installation

1.Fitting the bushings

Using a block or the like, fit the bushings into position.

* Do not hit directly against the bushings.

2.Bushing setup dimensions

1) Without the dust seals

Make sure the bushings do not stretch out of both sides.

2) With the dust seals

Ensure the dust seal setup space at both sides.

(It is possible to control the press-fitting dimension instead.)

3.Dust seal fitting direction

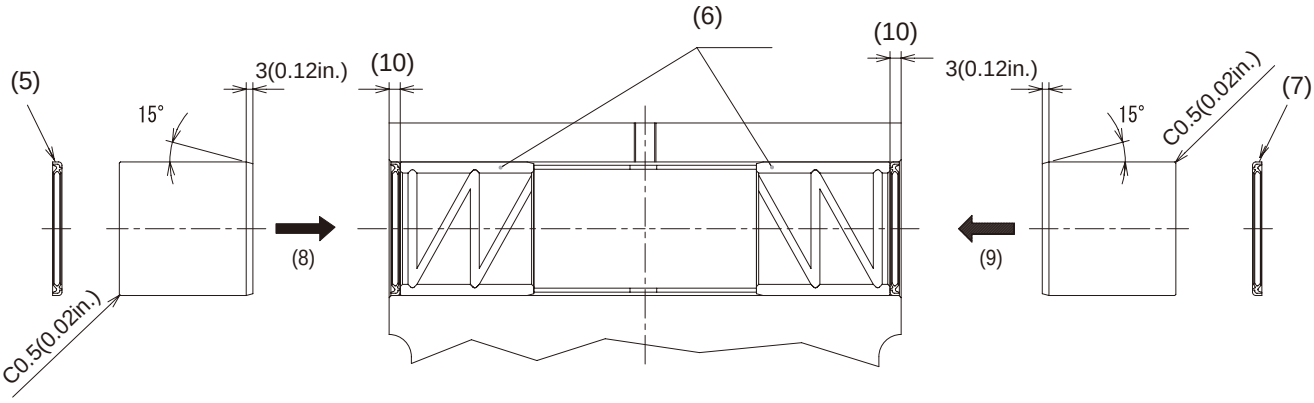
Fit the dust seals as specified in the figure.

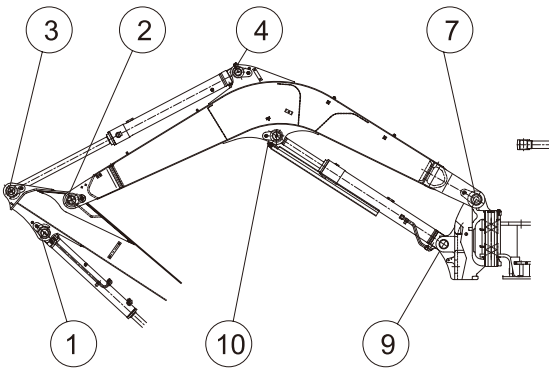
4.Bushing setup direction

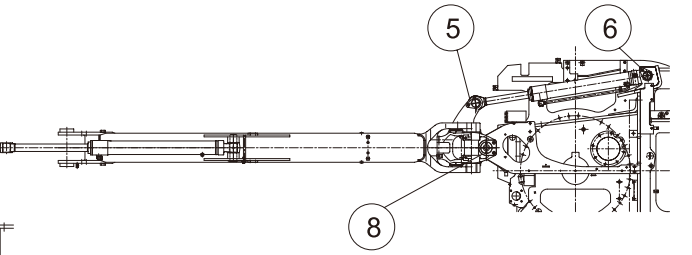
Insert the bushings from the 15×-chamfered side.

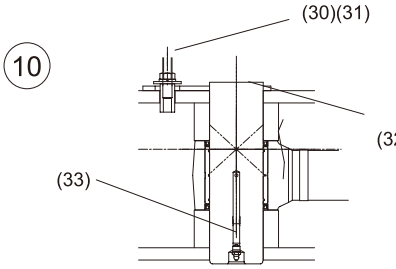
With the dust seals	S
* Bucket link 1, 6 pcs.	5.0mm(0.20in.)
* Swing bracket, 2 pcs. Boom support	10.0mm(0.39in.)
* Arm end, 4 pcs.	4.5mm(0.18in.)
* Arm support, 2 pcs.	6.5mm(0.26in.)

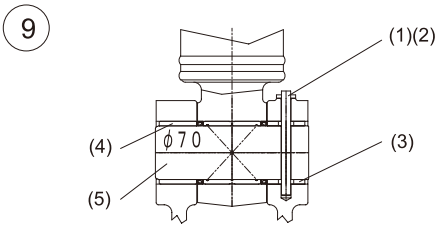
(A)Insert in this direction.
(B)Enlarged view of dust seal
(1)Block
(2)Bushing
(3)Bushing side
(4)Outside
(5)Dust seal
(6)Bushing
(7)Dust seal
(8)Bushing setup direction
(9)Bushing setup direction
(10)More than S

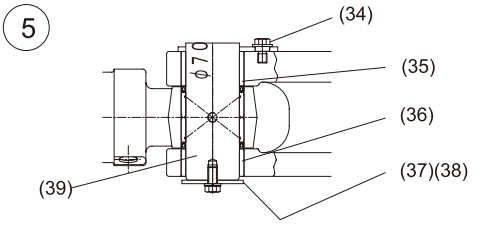


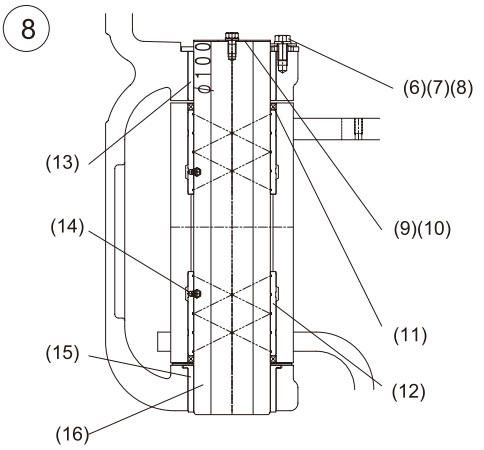


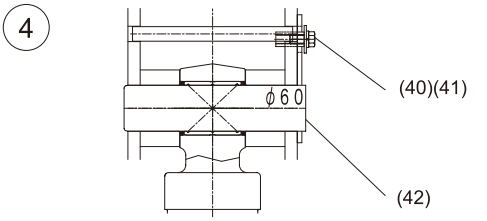


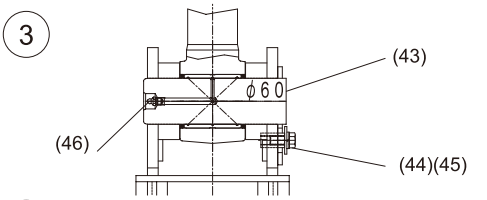


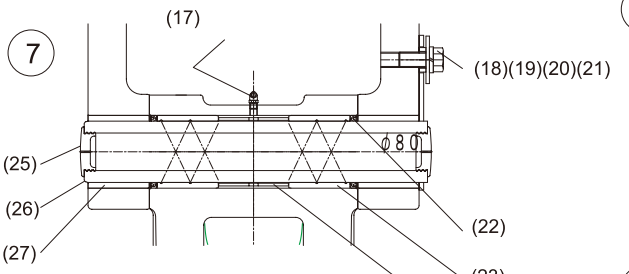


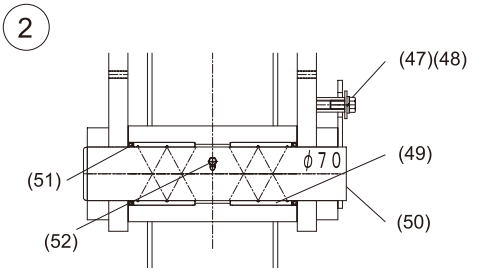


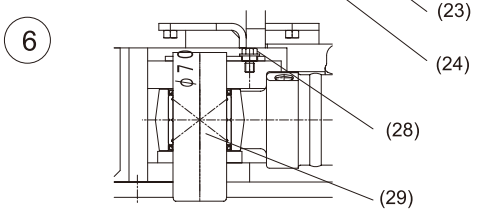


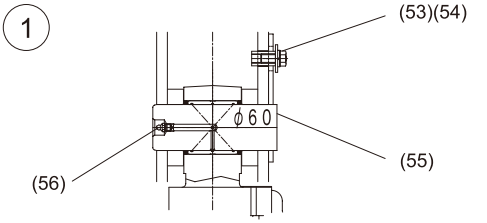








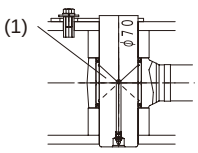




1.Arm assembly - Bucket cylinder
2.Boom assembly - Arm assembly
3.Arm assembly - Arm cylinder
4.Boom assembly - Arm cylinder
5.Swing bracket - Swing cylinder
6.Swivel frame ~Swing cylinder
7.Boom assembly - Swing bracket
8.Swing bracket -Swivel frame
9.Swing bracket - Boom cylinder
10.Boom assembly-Boom cylinder

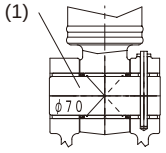
(1)Pin (anti-rotation)
(2)Bolt
(3)Bushing
(4)Bushing
(5)Pin
(6)Spacer
(7)Bolt
(8)Plain washer
(9)Plate
(10)Bolt
(11)Dust seal (10011508)
(12)Bushing (100115110)
(13)Bushing
(14)Grease fitting (Type C)
(15)Bushing
(16)Pin
(17)Grease fitting (Type B)
(18)Spacer
(19)Bolt
(20)Spring washer
(21)Plain washer
(22)Dust seal(809508)
(23)Bushing(809580)
(24)Collar
(25)Grommet
(26)Pin
(27)Bushing
(28)Bolt (anti-rotation)
(29)Pin
(30)Bolt
(31)Plain washer
(32)Pin
(33)Grease fitting (Type A)
(34)Bolt (anti-rotation)
(35)Bushing
(36)Bushing
(37)Washer
(38)Bolt
(39)Pin
(40)Bolt
(41)Plain washer
(42)Pin
(43)Pin
(44)Bolt
(45)Plain washer
(46)Grease fitting (Type A)
(47)Bolt
(48)Plain washer
(49)Bushing(708280)
(50)Pin
(51)Dust seal (708260)
(52)Grease fitting (Type B)
(53)Bolt
(54)Plain washer
(55)Pin
(56)Grease fitting (Type A)

⑩ Boom assembly - Boom cylinder



Shim (1.0, 140-71)
Shim (0.5, 140-71)
To be selected

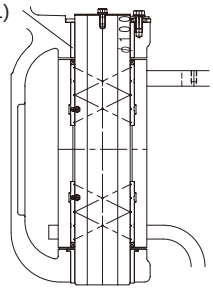
⑨ Swing bracket - Boom cylinder



Shim (1.0, 140-71)
Shim (0.5, 140-71)
To be selected

⑧ Swing bracket - Swivel frame

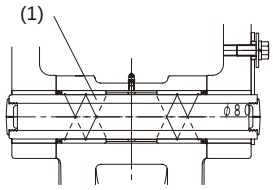
Top
Thrust collar (3,2)
↓
Fit with the groove downward.



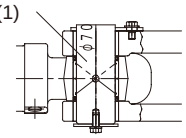
Bottom
Shim (3.5)
Shim (3.2)
To be selected

⑦ Boom assembly - Swing bracket

Shim (1.0, 150-81)
Shim (0.5, 150-81)
To be selected

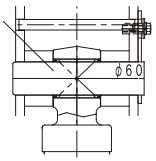


⑤ Swing bracket - Swing cylinder



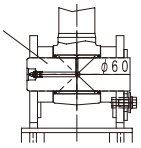
Shim (1.0, 140-71)
Shim (0.5, 140-71)
To be selected

④ Boom assembly - Arm cylinder



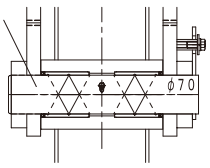
Shim (1.0, 110-61)
Shim (0.5, 110-61)
To be selected

③ Arm assembly - Arm cylinder



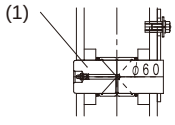
Shim (1.0, 110-61)
Shim (0.5, 110-61)
To be selected

② Boom assembly - Arm assembly



Shim (1.0, 140-71)
Shim (0.5, 140-71)
To be selected

① Arm assembly - Bucket cylinder



Shim (1.0, 110-61)
Shim (0.5, 110-61)
To be selected

d.Shim installation

1.Clearance at the front

* Gap in thrust direction at each support pin Less than 0.6 mm(0.02inch)
*If over 0.6 mm(0.02inch), add a shim to readjust the gap. (See the figure for proper shims.)

2.Vertical clearance between swivel frame and swing bracket

+0.1~+1.1mm(0.004~0.04inch)

3.Pin lock bolt applying direction

Apply the bolts as shown at left.

4.Direction of the thrust collar on top of the swing support

Face the groove toward the swivel frame.

5.Fitting the thrust collars

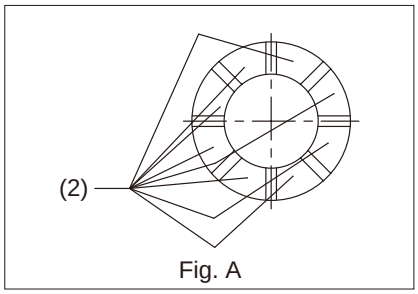
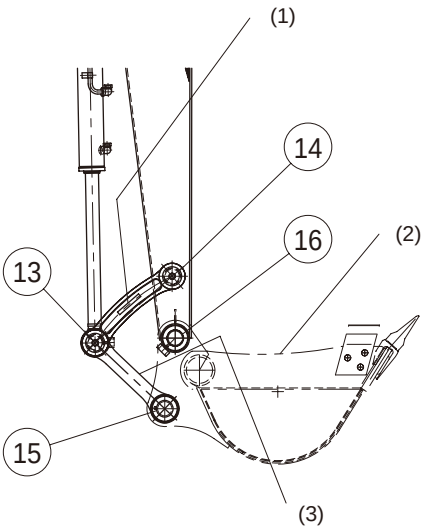


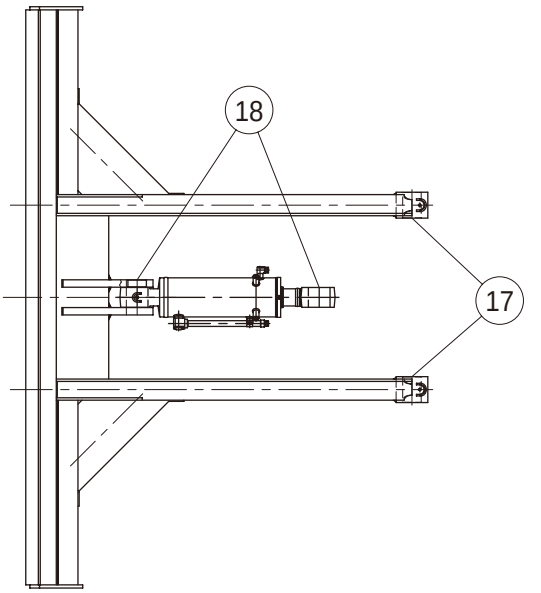
Fig. A

1)Install the grooved thrust collar (with the groove downward) at the top. Apply grease at 8 locations on both sides. (See Fig. A.) (Molybdenum anti-seizure compound may be used instead.)

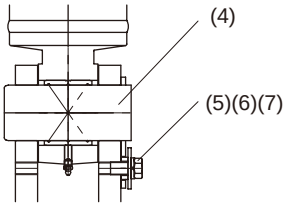
2)Prepare two different-thickness thrust collars for the bottom. Try the 3.5 mm thick one first to see if it fits on smoothly. If not, introduce the 3.2 mm thick one.
(Be sure to select a suitable thrust collar.)

(1)Pin
(2)Apply grease



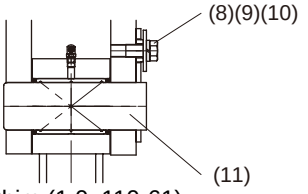


18 Cylinder (blade) - Blade



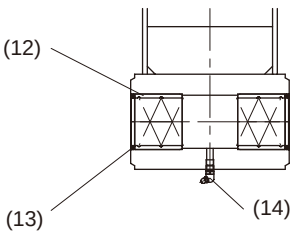
Shim (1.0, 120-71)
Shim (0.5, 120-71)
To be selected

17 Track frame - Blade

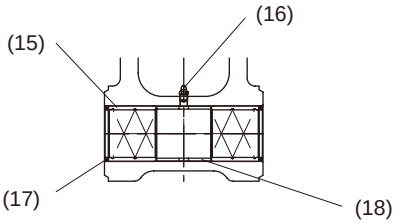


Shim (1.0, 110-61)
Shim (0.5, 110-61)
To be selected

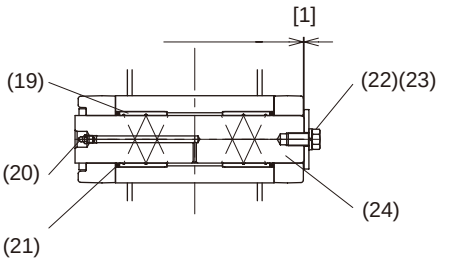
16 Arm assembly
Bucket support



15 Bucket link (1)
Bucket link support 1 (at the bucket)

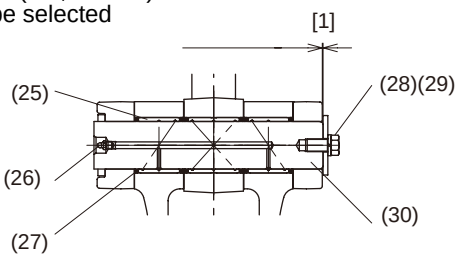


14 Bucket links (2) and (3) - Arm assembly
Bucket link support 2 (at the arm)



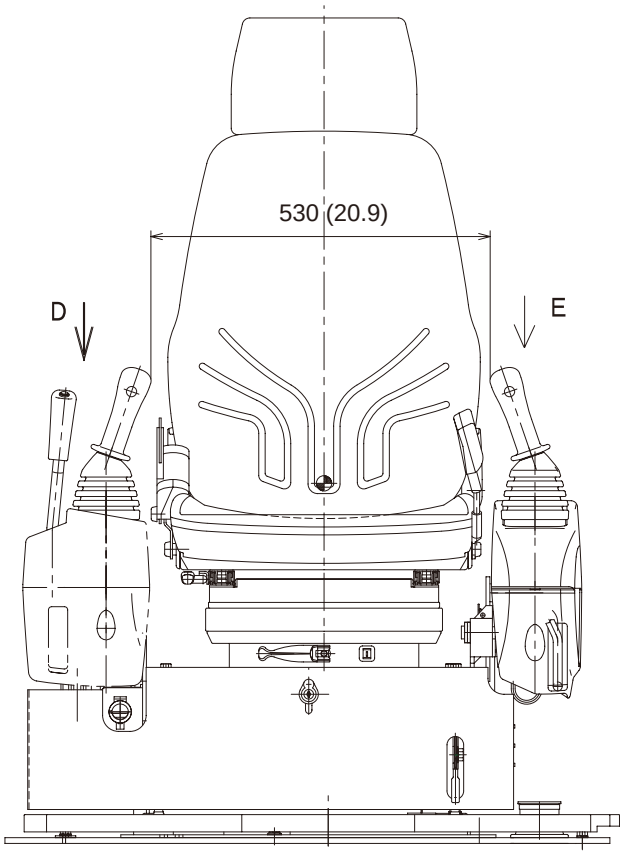
13 Bucket links 1, 2 and 3 - Bucket cylinder
Bucket link support 1 (at the bucket cylinder)

Shim (1.0, 110-61)
Shim (0.5, 110-61)
To be selected



(1)Connect the bucket links 2 and 3 with their markings inside.
(4)Pin
(5)Spacer
(6)Bolt
(7)Plain washer
(8)Spacer
(9)Bolt
(10)Plain washer
(11)Pin
(12)Bushing (607060)
(13)Dust seal (607040)
(14)Grease fitting (Type B)
(15)Bushing (607060)
(16)Grease fitting (Type A)
(17)Dust seal (607040)
(18)Collar
(19)Bushing (607060)
(20)Grease fitting(Type A)
(21)Dust seal (607040)
(22)Bolt
(23)Washer
(24)Pin
(25)Bushing (607052
(26)Grease fitting(Type A)
(27)Dust seal (607040)
(28)Bolt
(29)Washer
(30)Pin

[1]Clearance enough for smooth turning



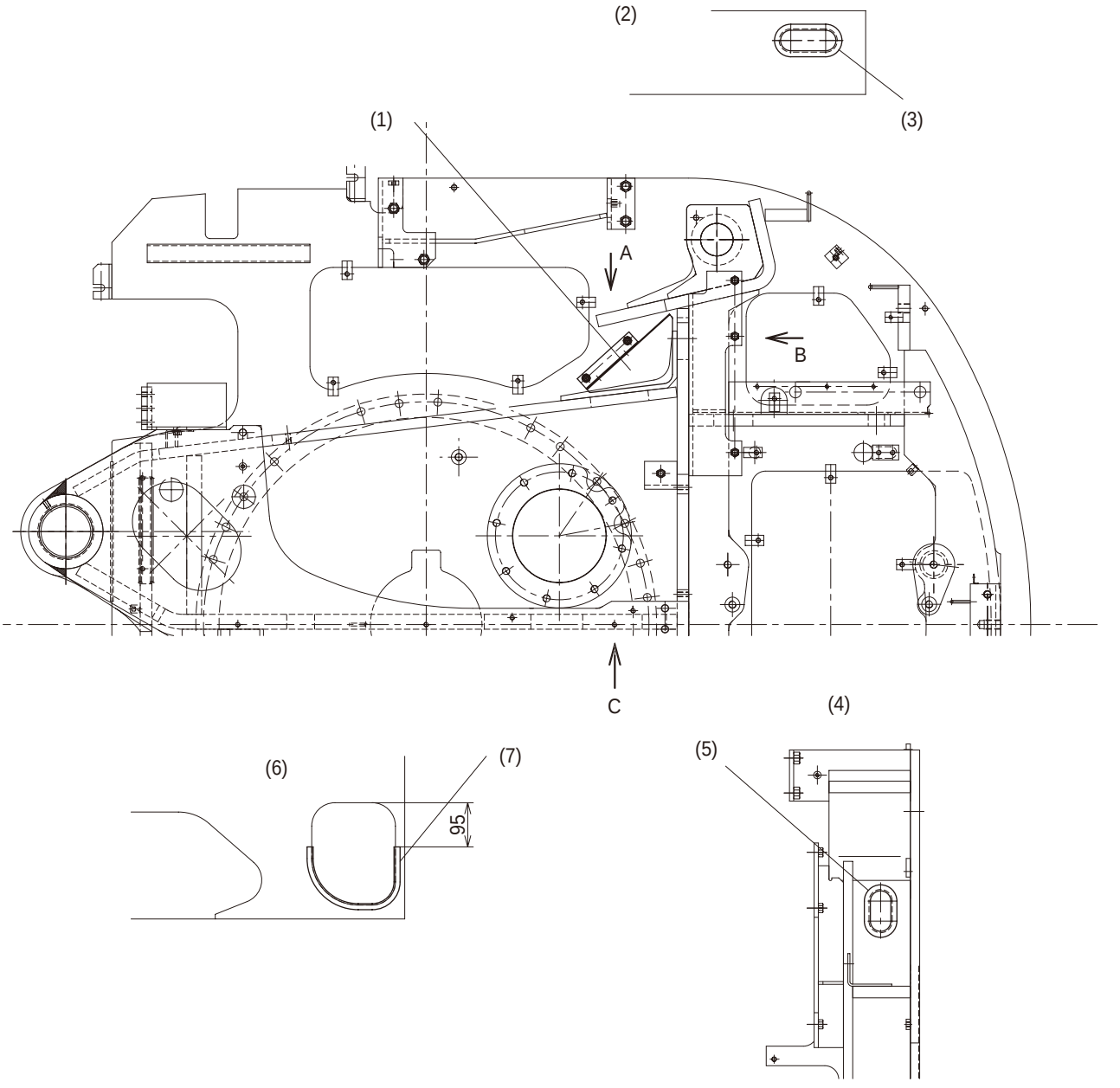
e.Fitting the control lever

With the control levers in place, make sure the distance between them is as specified at left.
Reference: 530 mm(20.9inch)

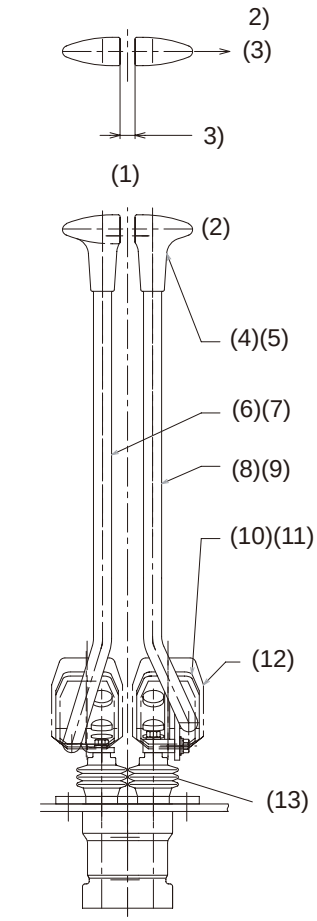
1.Fitting the grommets

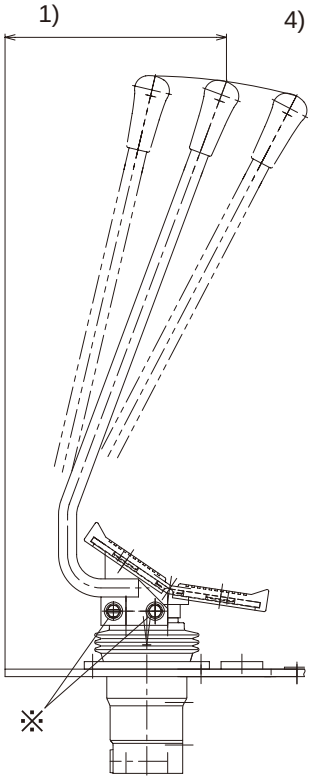
(RD809-4143Δ)
(RD809-4144Δ)
(RD809-4145Δ)

Fit the grommets in position as shown at left.
Apply an instant adhesive.



(1)Guide (hose, swing)
Bolt
(2)View of A
(3)Grommet (2, swivel)
(4)View of B
(5)Grommet (3, swivel)
(6)View of C
(7)Grommet (1, swivel)





unit:mm (inch)

f.Travel levers

1.Adjusting the lever neutral position

Fit the levers in position as shown at left.

2.Adjusting the travel levers

Keep them at the neutral position.
(1)Dimension from the step end
→ 265mm (10.4inch) (reference)

(2)To-and-fro difference between left and right levers → Less than 2 mm (0.08inch)

(Finely adjust the left lever with the *-marked bolts.)

(3)Clearance between left and right levers
15~21mm (0.59~0.83inch)

3.Checking the setup condition

Make sure the valve spool moves over its full stroke.
Make sure the valve spool moves smoothly.

4.Tightening torque for the pilot valve

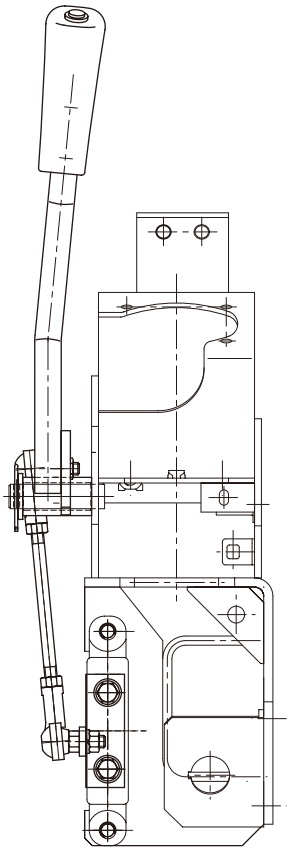
RD809-6536Δ, RD809-6534Δ To be installed

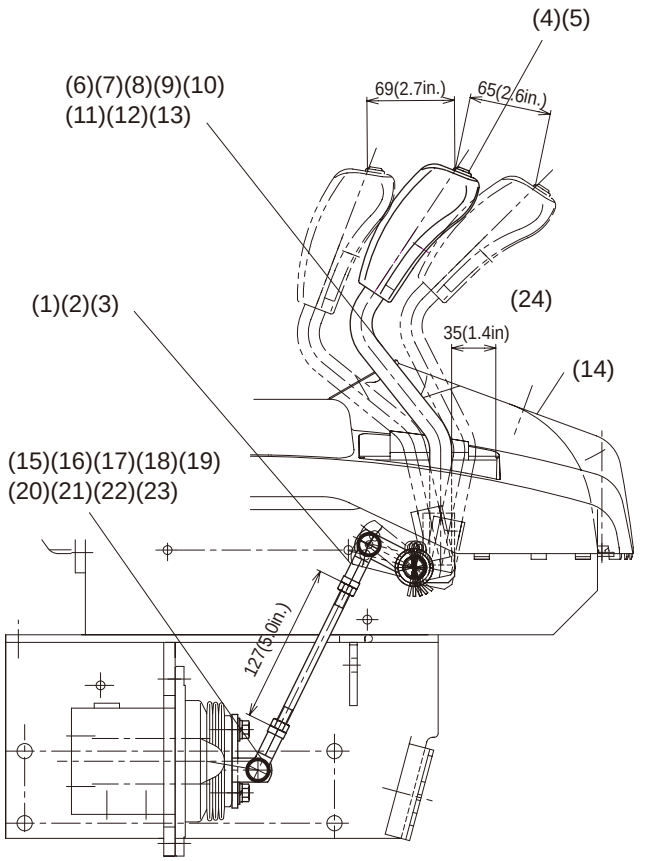
Tightening torque of *-marked bolts
RD809-6536D To be installed

Tightening torque
48.4~55.9N.m (4.9~5.7kgf.m) 35.7~41.2ft.lbs

(1)Right lever
(2)Left lever
(3)To-and-fro difference between left and right levers: Less than 2 mm(0.08inch)
(4)Grip (travel)
(5)Washer-fitted machine screw
(6)Lever (travel, right)
(7)Bolt
(8)Lever (travel, left)
(9)Bolt
(10)Pedal (travel, left)
(11)Bolt
(12)Cover (rubber,travel pedal)
(13)PV valve

1)265±5(10.4±0.20)
2)To-and-fro difference between left and right levers: Less than 2 mm(0.08inch)
3)15~21(0.59~0.83)
4)Neutral position





g.Dozer lever

1.Adjusting the dozer lever neutral position

Fit the lever in position as shown at left.

2.Checking the setup condition

Make sure the valve spool moves over its full stroke.
Make sure the valve spool moves smoothly.

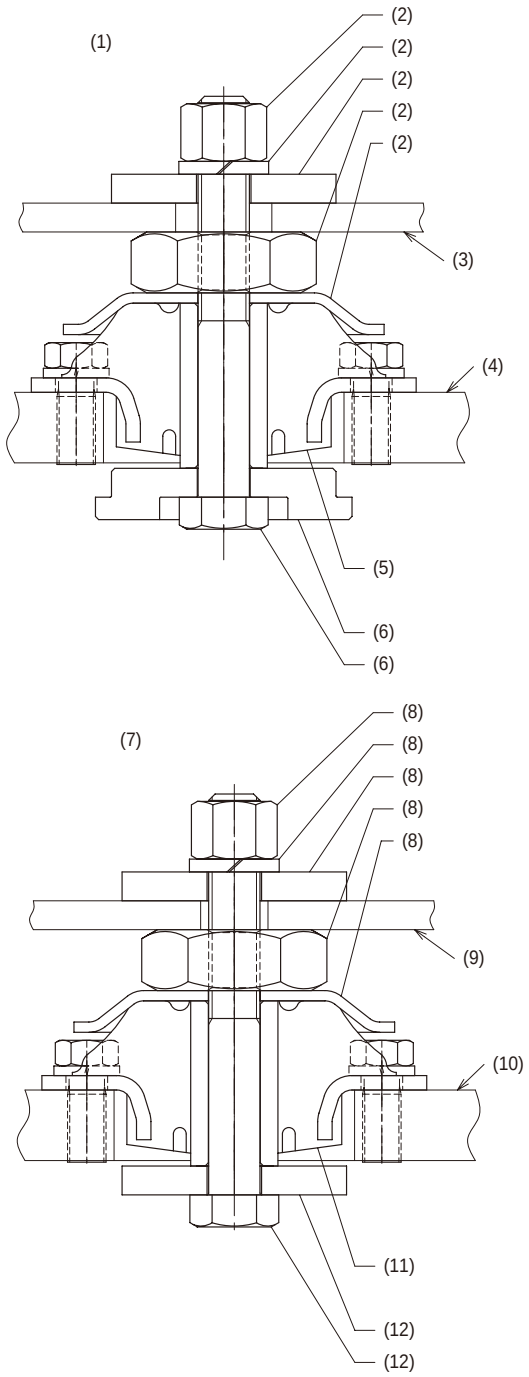
3.DU bushing bearing

Apply grease.

4.Tightening torque of bracket (dozer pilot valve)

Tightening torque of rod end
Tightening torque =
23.5~27.5N.m(2.4~2.8kgf/m)17.3~20.3ft.lbs

(1)Rod end right-hand screw
(2)Nut
(3)Spring washer
(4)Grip (bi-speed)
(5)Pan-head machine screw
(6)Lever assembly (blade)
(7)Lever (blade)
(8)Bushing
(9)Plain washer
(10)Snap pin
(11)69mm(2.7inch)
(12)65mm(2.6inch)
(13)127mm(5.0inch)
(14)Cover (right, upper, A/C)
(15)Bracket (dozer PV)
(16)Bolt
(17)Rod end left-hand screw
(18)Nut
(19)Spring washer
(20)Rod assembly (blade)
(21)Rod (M8-150)
(22)Nut
(23)Left-hand screw 8
(24)Neutral position





h.Cab

1.Anti-vibration rubber (Cab)

Tightening torque of mounting bolt
To be installed

Tightening torque
103.0~117.7N.m (10.5~12.0kgf.m)
75.9~86.8ft.lbs

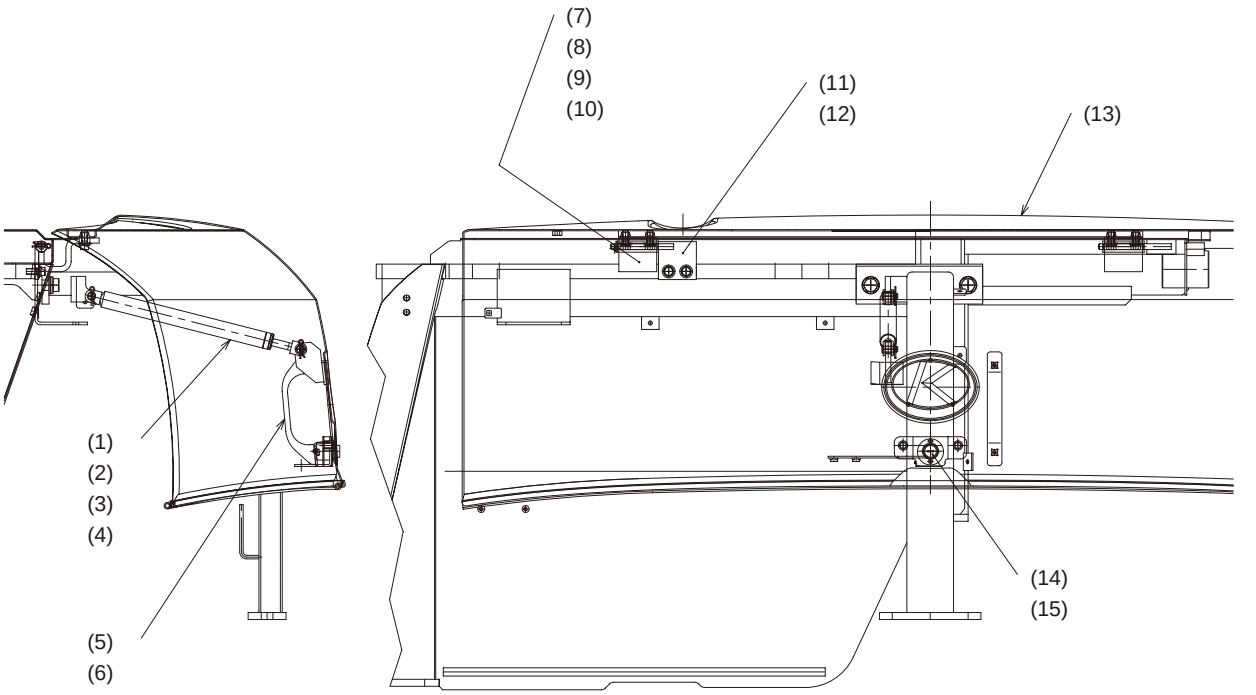
2.Nut (M16-6T, cab)

Rear rim lock nut Tightening torque
To be installed

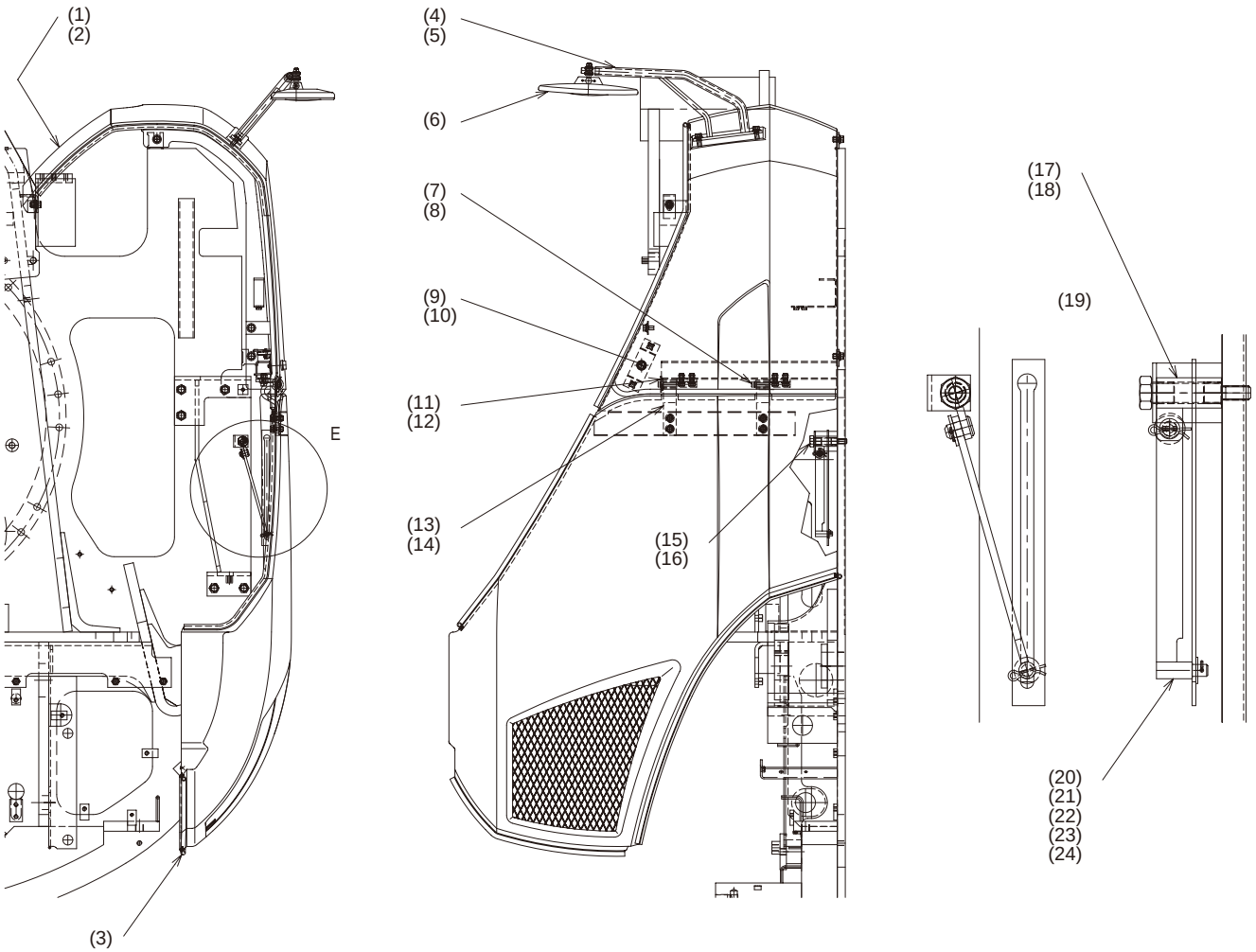
Tightening torque
107.9~127.4N.m (11.0~13.0kgf.m)
79.6~94.0ft.lbs

(1)Details of A and D (2 locations)
(2)Rear rim lock nut
Spring washer
Washer (fender)
Nut (M16-6T, cab)
Cup (mount rubber)
(3)Step (1)
(4)Frame (swivel)
(5)Anti-vibration rubber (Cab)
Bolt
(6)Washer (anti-vibration runner, ROPS)
Bolt (M16x125L-9T)
(7)Details of B and E (3 locations)
(8)Rear rim lock nut
Spring washer
Washer (fender)
Nut (M16-6T, cab)
Cup (mount rubber)
(9)Step (1)
(10)Frame (swivel)
(11)Anti-vibration rubber (Cab-70)
Bolt
(12)Washer (fender)
Bolt (M16x125L-9T)

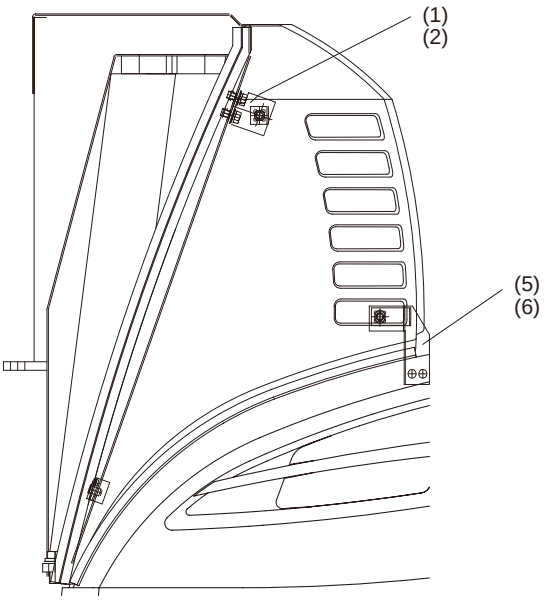
i.Bonnet

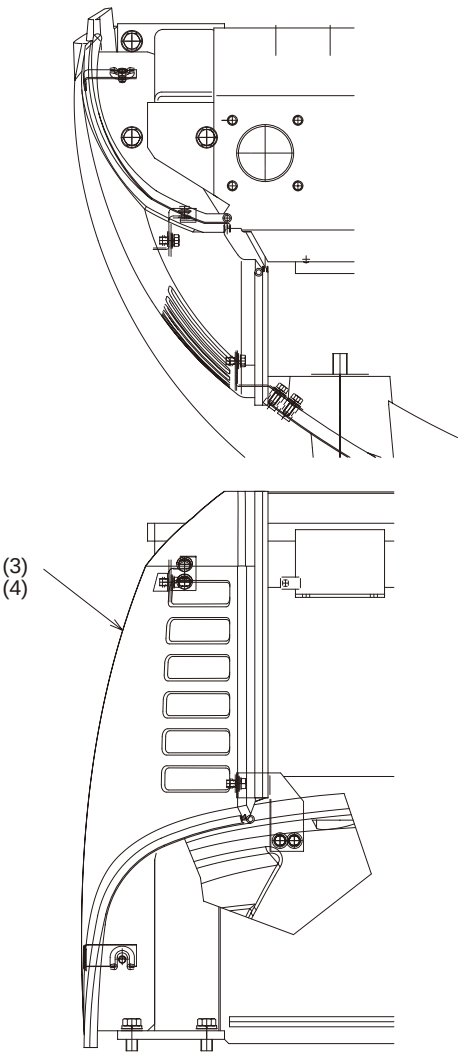


(1)Damper (gas)
(2)Headed pin
(3)Plain washer
(4)Snap pin
(5)Grip
(6)Bolt
(7)Hinge (1, hood back)
(8)Bolt
(9)Plain washer
(10)Snap pin
(11/)Hinge (2, hood back)
(12)Bolt
(13)Hood (back)
(14)Lock assembly (hood)
(15)Bolt

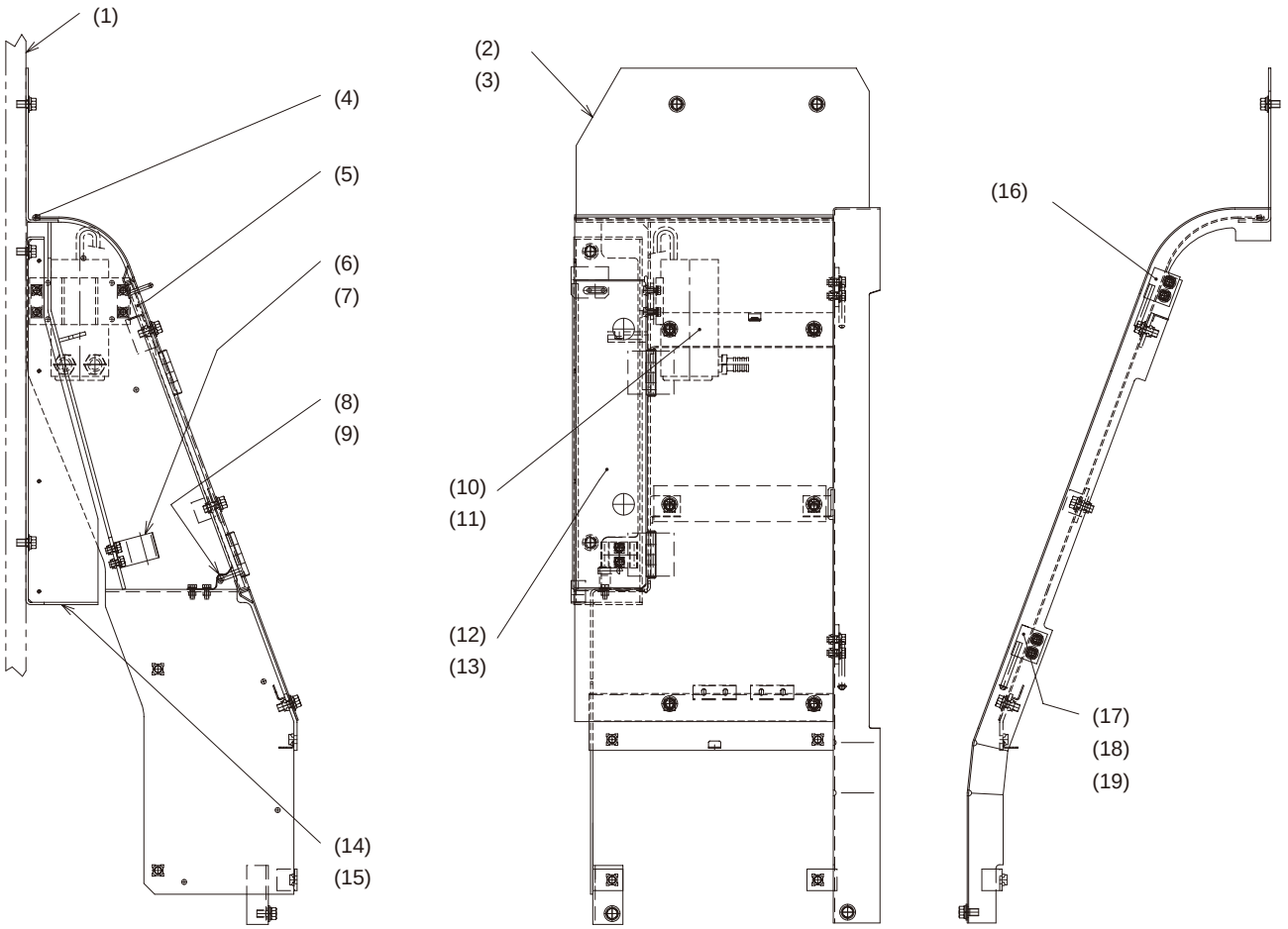


(1)Cover assembly (front)
(2)Bolt
(3)Cover assembly (right)
(4)Stay (rearview mirror)
(5)Bolt
(6)Rearview mirror assembly
(7)Hinge (1, right cover)
(8)Bolt
(9)Lock assembly
(10)Bolt
(11)Plain washer
(12)Snap pin
(13)Hinge (2, right cover)
(14)Bolt
(15)Stopper assembly (right cover)
(16)Reamer bolt
(17)Stopper assembly (right cover)
(18)Reamer bolt
(19)Details of E
(20)Stopper (2, right cover)
(21)Plain washer
(22)Snap pin
(23)Plain washer
(24)Snap pin

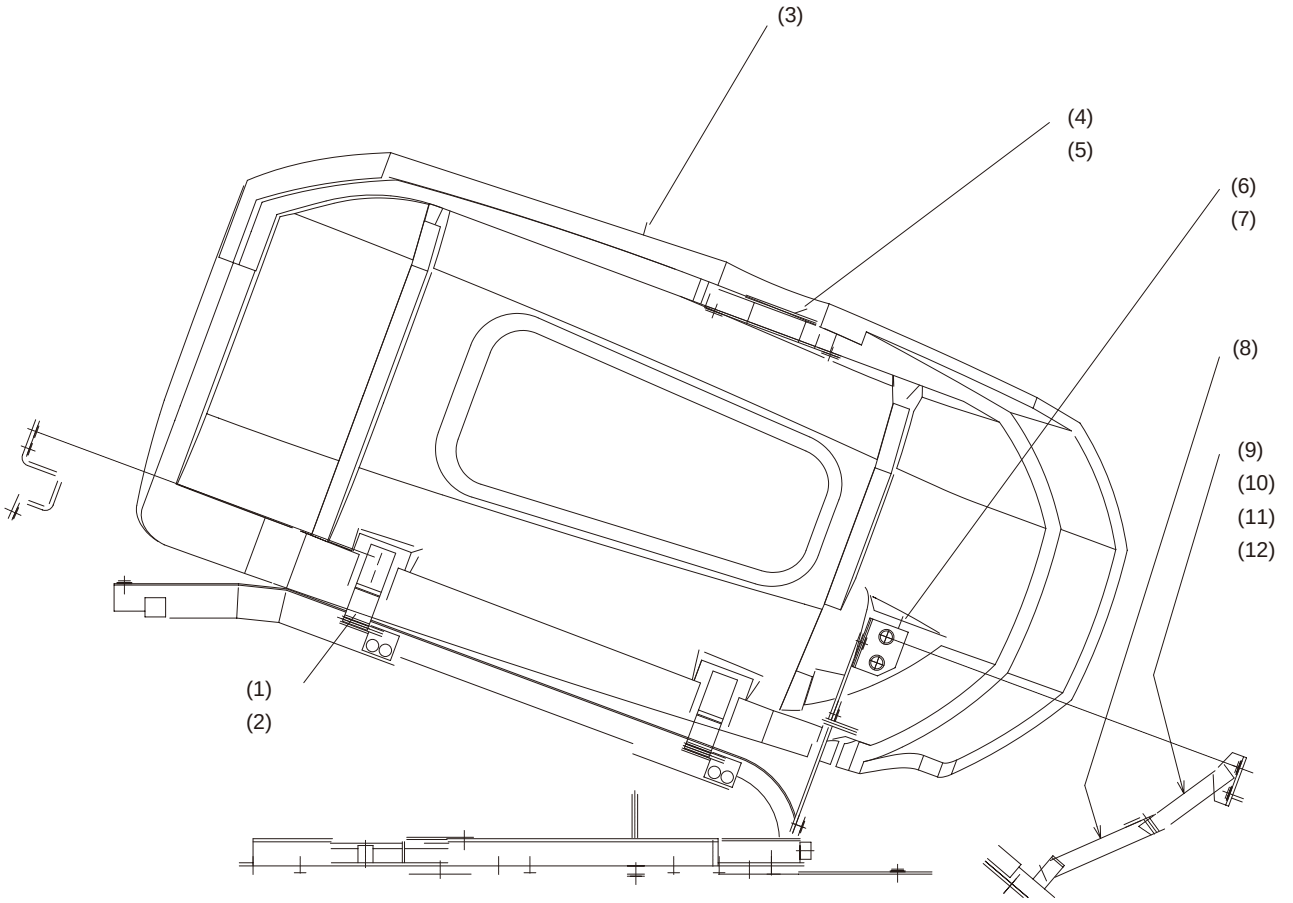




(1)Bracket (2, left cover)
(2)Bolt
(3)Cover (arch, left)
(4)Bolt
(5)Bracket (left cover)
(6)Bolt



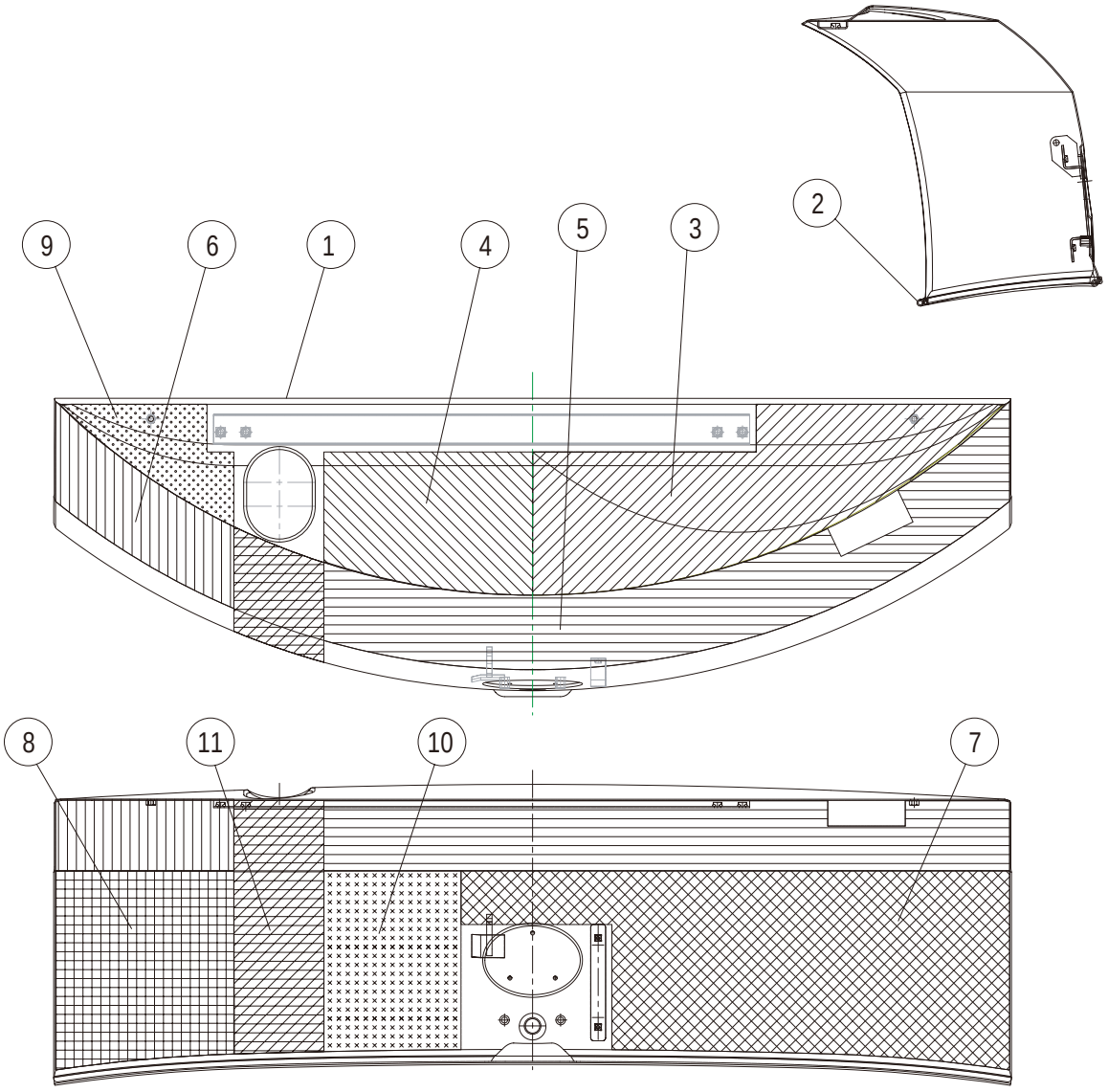
(1)Swivel frame
(2)Frame (center)
(3)Bolt
(4)Grommet (360)
(5)Grommet (450)
(6)Clamp
(7)Bolt
(8)Leaf spring
(9)Bolt
(10)Pump assembly (fuel, filler)
(11)Bolt
(12)Cover (center)
(13)Bolt
(14)Tool box (2)
(15)Bolt
(16)Hinge (1, center cover)
(17)Hinge (2, center cover)
(18)Shaft circlip
(19)Bolt

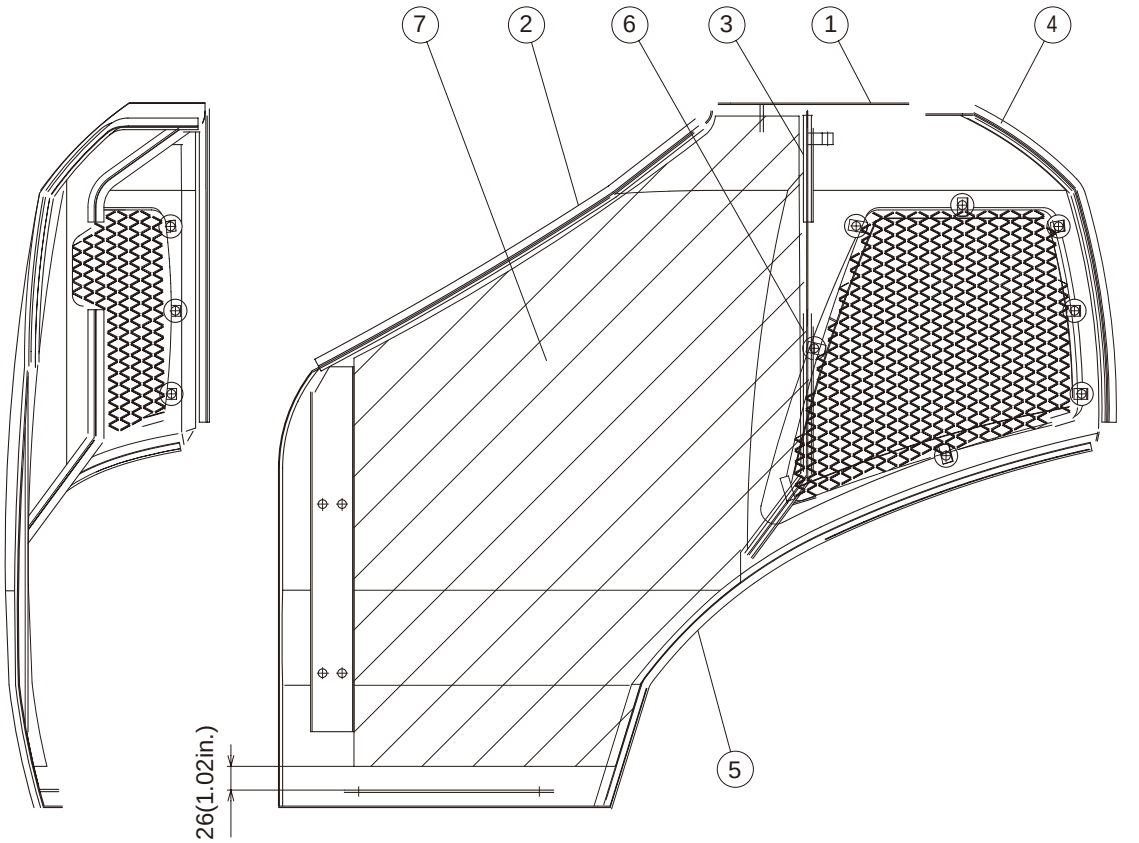


(1)Hinge (tank cover)
(2)Bolt
(3)Cover (tank)
(4)Guide (tank cover)
(5)Bolt
(6)Bracket (tank cover)
(7)Bolt
(8)Link (2, tank cover)
(9)Link (1, tank cover)
(10)Fuel tube
(11)Plain washer
(12)Snap pin

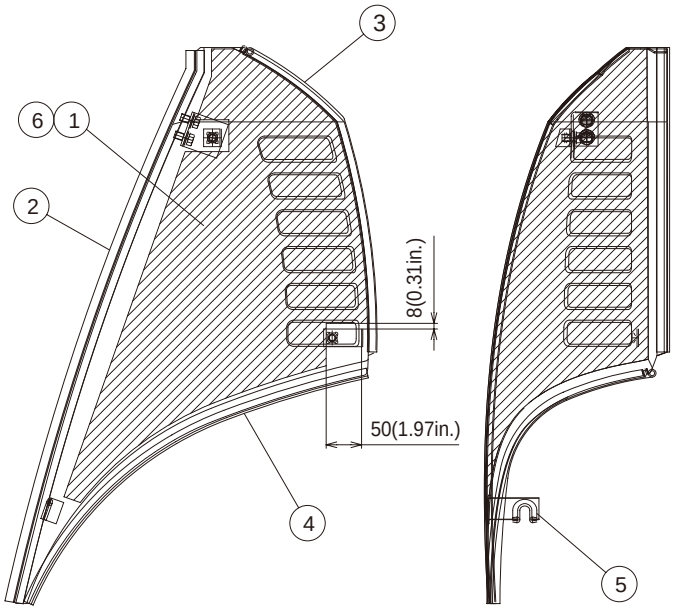
J.Sound absorber and insulator

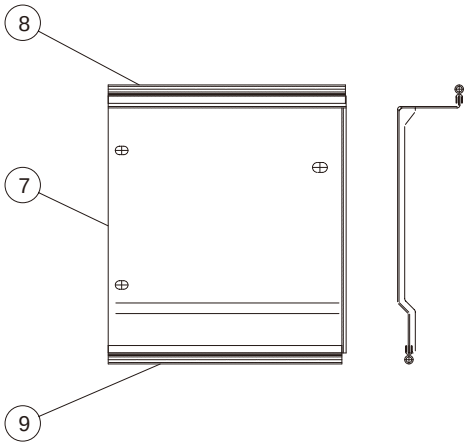
Part name	Q'ty	Location
Hood (back)	1	1
Trim (hood)	1	2
Sound absorber (1, hood)	1	3
Sound absorber (2 hood)	1	4
Sound absorber (3, hood)	1	5
Sound absorber (4, hood)	1	6
Sound absorber (5, hood)	1	7
Sound absorber (6, hood)	1	8
Sound absorber (7, hood)	1	9
Sound absorber (8, hood)	1	10
Thermal insulation (hood)	1	11





Part name	Q'ty	Location
Cover (right)	1	1
Trim (1, right cover)	1	2
Trim (2, right cover)	1	3
Trim (3, right cover)	1	4
Trim (4, right cover)	1	5
Trim (5, right cover)	1	6
Sound absorber (1, right cover)	1	7
Sound absorber (2, right cover)	1	8



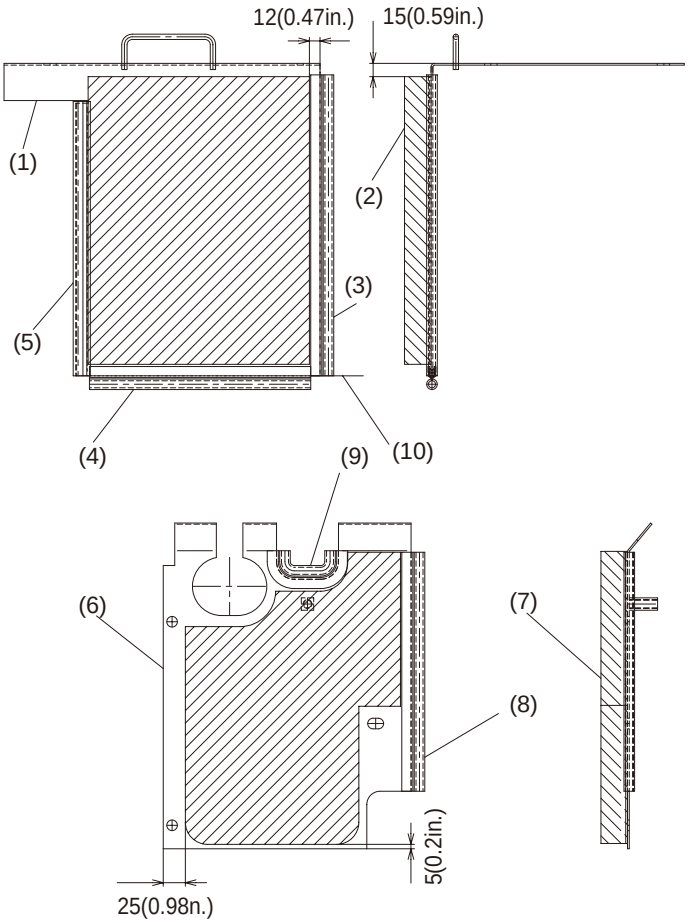


Cover (arch, left)

Part name	Q'ty	Location
Cover (arch, left)	1	1
Trim (1, arch cover L)	1	2
Trim (2, arch cover L)	1	3
Trim (3, arch cover L)	1	4
Grommet (50)	1	5
Sound absorber (left cover)	1	6

Cover (arch, top)

Part name	Q'ty	Location
Trim (1, arch top cover)	1	7
Trim (2, arch top cover)	1	8
Sound absorber (arch top cover)	1	9



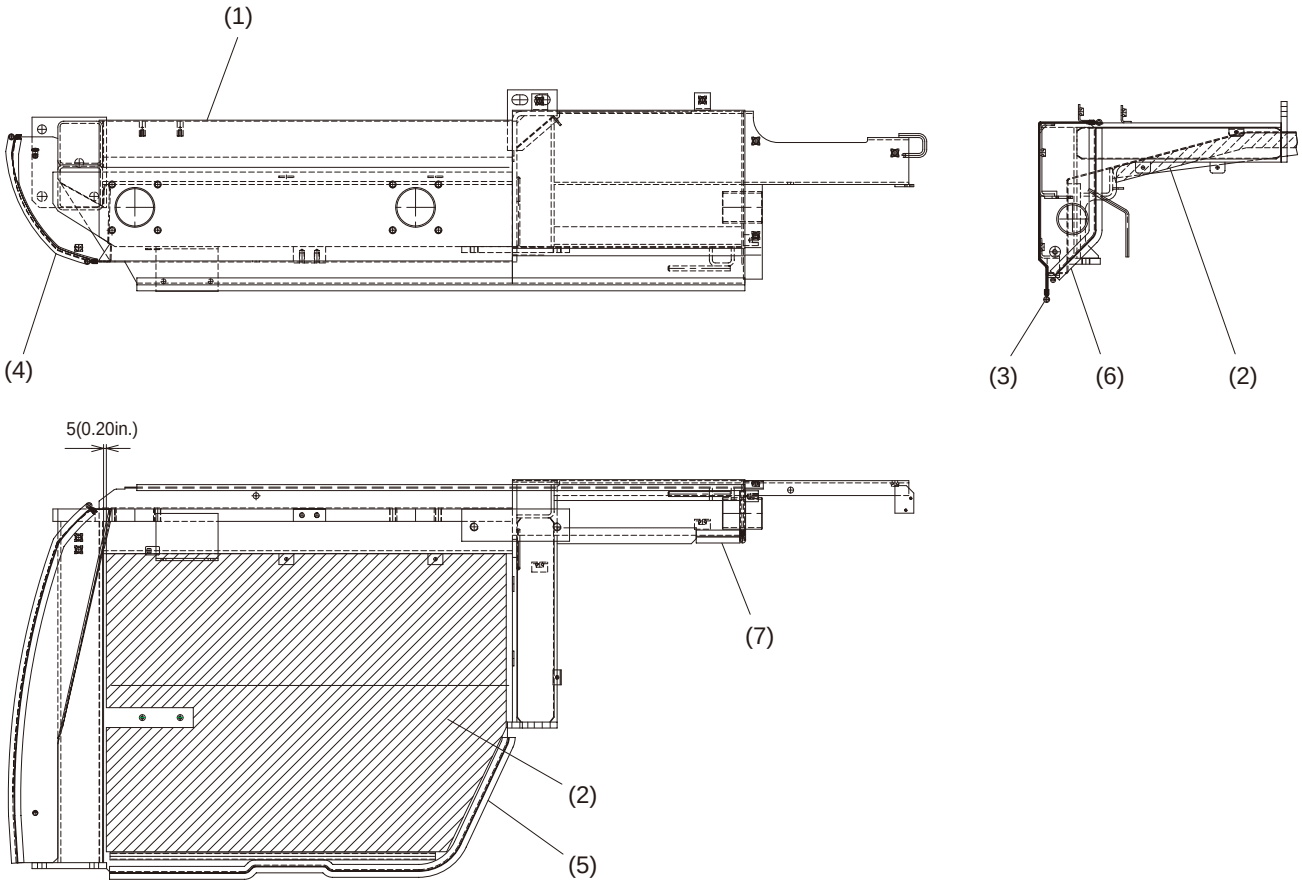
Cover (1, arch)

Part name	Q'ty	Location
Cover (1, arch)	1	(1)
Sound absorber (arch cover 1)	1	(2)
Trim (1, arch cover 1)	1	(3)
Trim (2, arch cover 1)	1	(4)
Trim (3, arch cover 1)	1	(5)

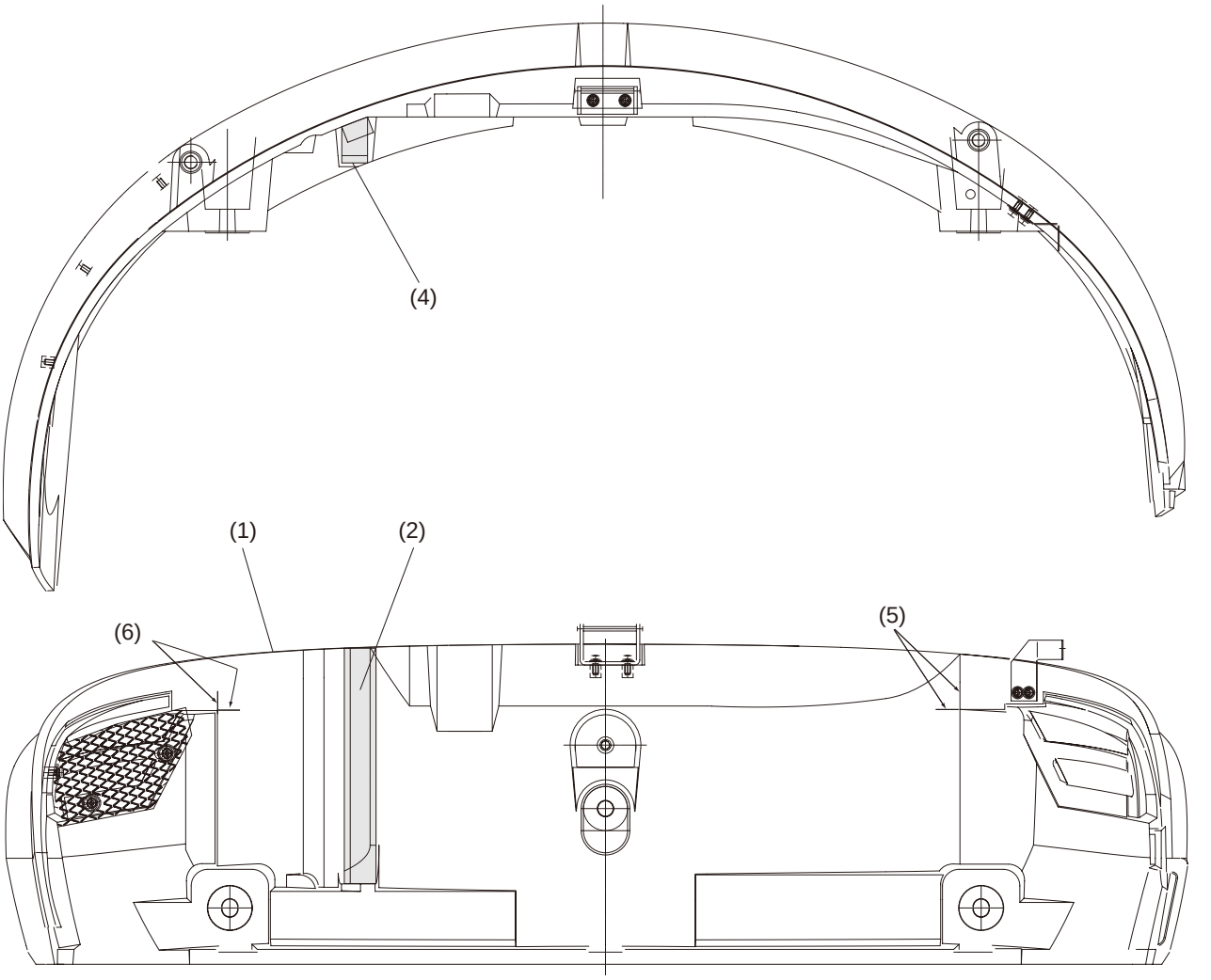
Cover (2, arch)

Part name	Q'ty	Location
Cover (2, arch)	1	(6)
Sound absorber (arch cover 2)	1	(7)
Trim (1, arch cover 2)	1	(8)
Trim (2, arch cover 2)	1	(9)

(10)To be aligned with this line

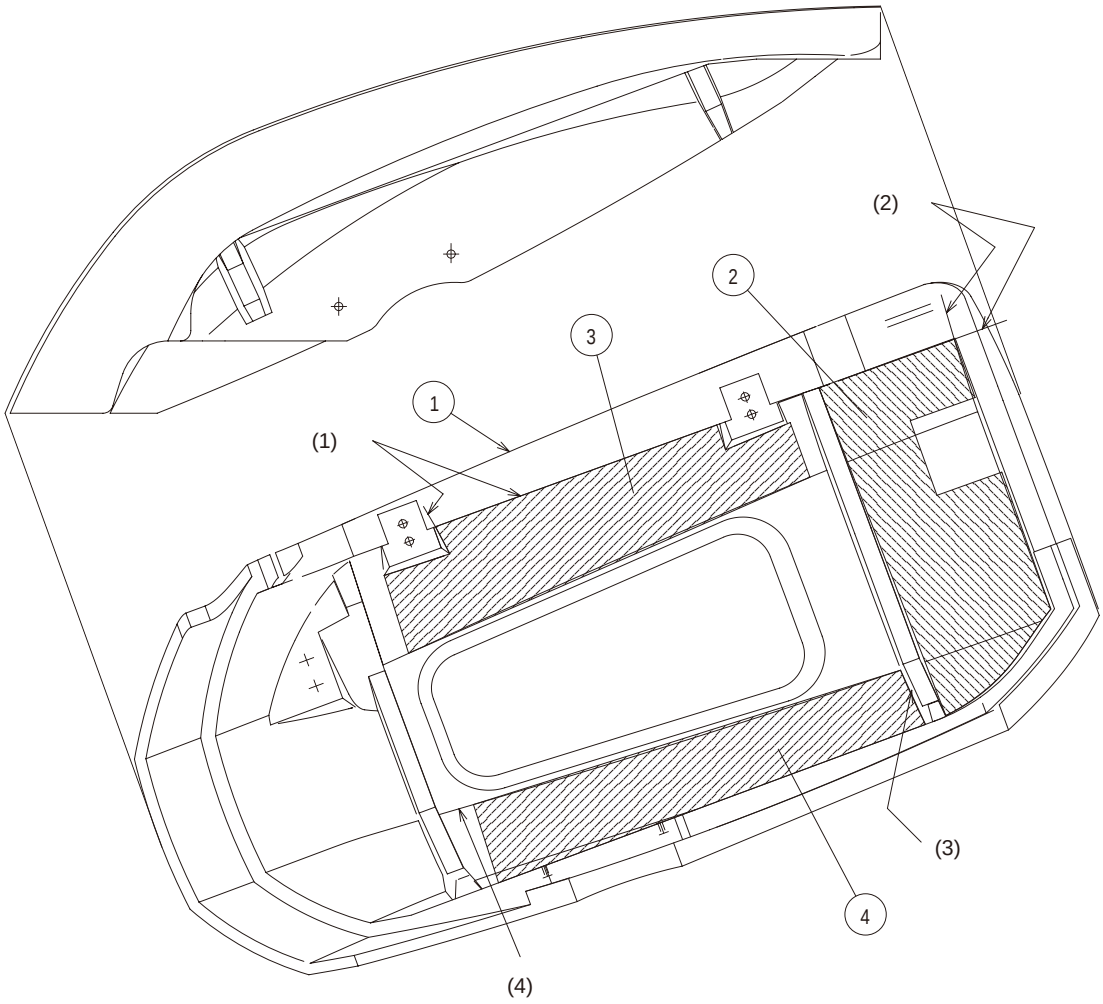


Part name	Q'ty	Location
Frame (1, arch)	1	(1)
Sound absorber (1, arch)	1	(2)
Trim (arch, top)	1	(3)
Trim (arch, left)	1	(4)
Trim (arch, bottom)	1	(5)
Trim (arch, shroud)	1	(6)
Trim (arch, hydraulic tank)	1	(7)



Part name	Q'ty	Location
Weight (870)	1	(1)
Sound absorber (weight)	1	(2)
Sound absorber (R, weight)	1	(3)
Sound absorber (L, weight)	1	(4)

(4)To be applied in the weight groove
(5)To be applied along these lines
(6)To be applied along these lines



(1)Part code
(2)Part name
(3)Q'ty
(4)Location
(5)Cover (tank)
Sound absorber (1, tank cover)
Sound absorber (2, tank cover)
Sound absorber (3, tank cover)
(6)To be applied along these lines
(7)To be applied along these lines
(8)To be applied along this line
(9)To be applied along this line

k. Counterweigt

1.Attaching the weight

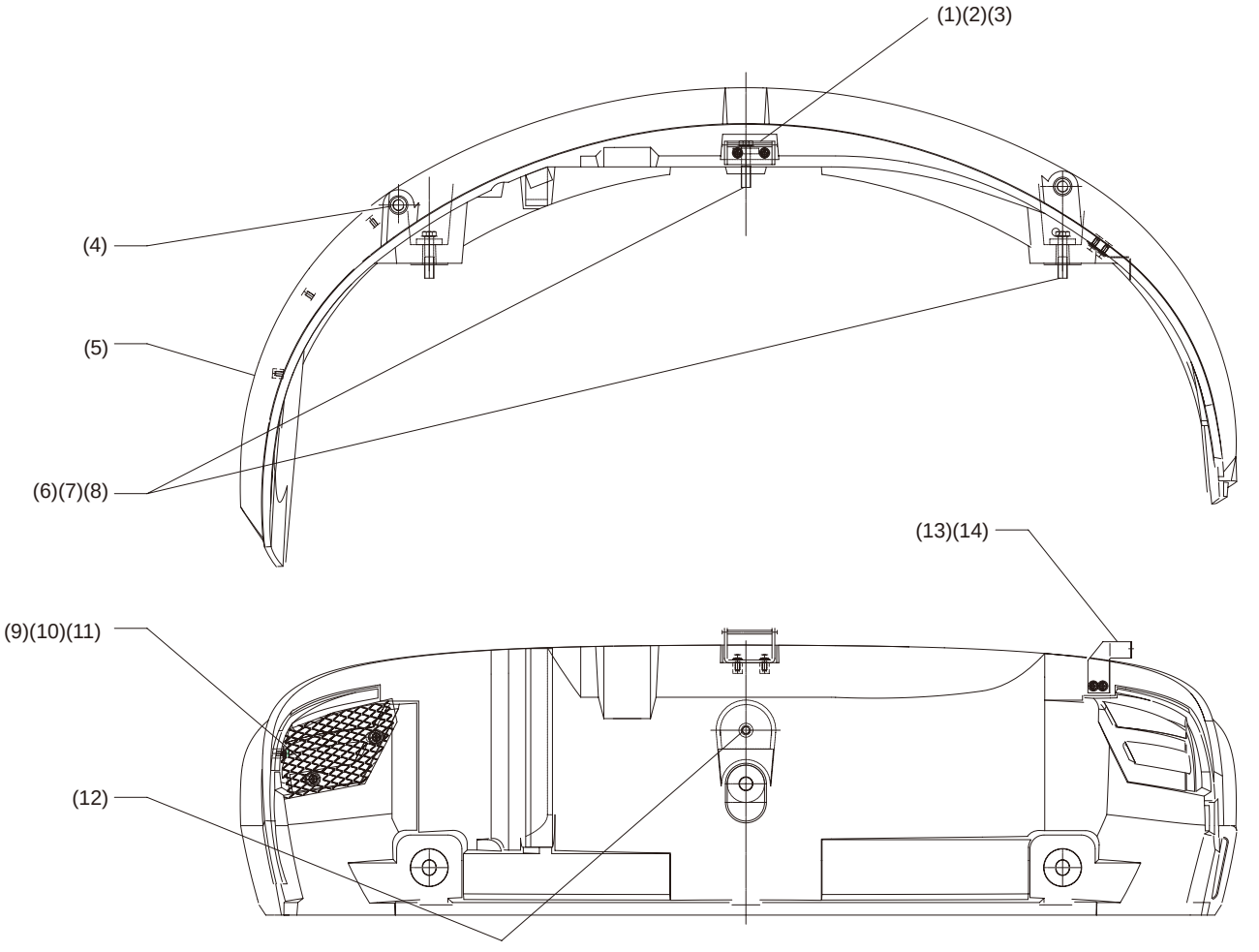
Tightening torque
Three M20 bolts at the back
367.7~431.5N.m (37.5~44.0kgf.m)
271.2~318.3ft.lbs

Apply screw adhesive (Loctite 271).

2.Fitting the stay (hook lock), cover (weight) and bracket (left cover)

Tightening torque
48.1~55.9N.m (4.9~5.7kgf.m) 35.5~41.2ft.lbs

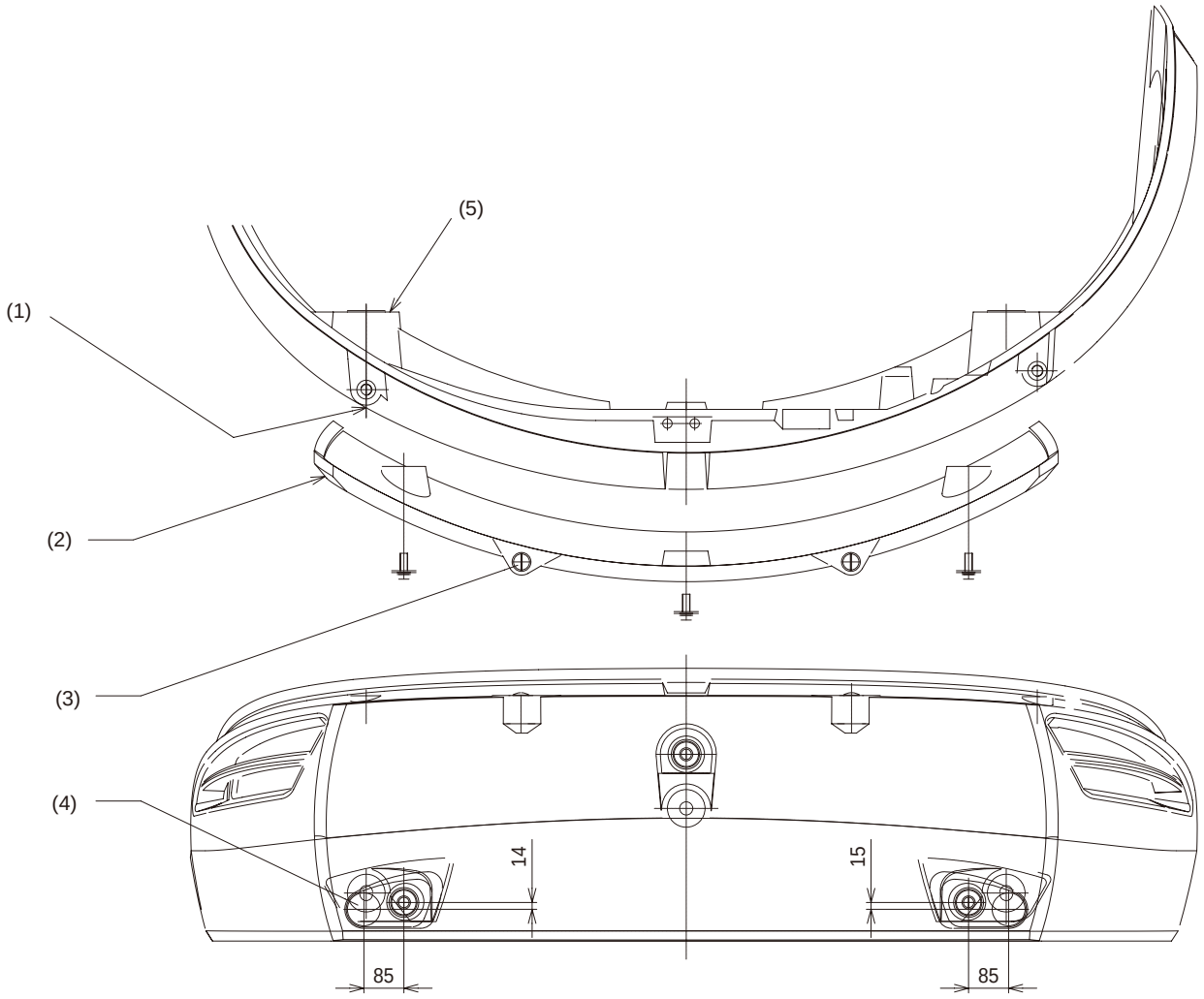
(1)Stay (hood lock)
(2)Shim (T2)
(3)Bolt
(4)Plug (M24)
(5)Weight (870)
(6)Bolt
(7)Washer
(8)Spring washer
(9)Cover (weight)
(10)Bolt
(11)Plain washer
(12)Plug
(13)Bracket (left cover)
(14)Bolt



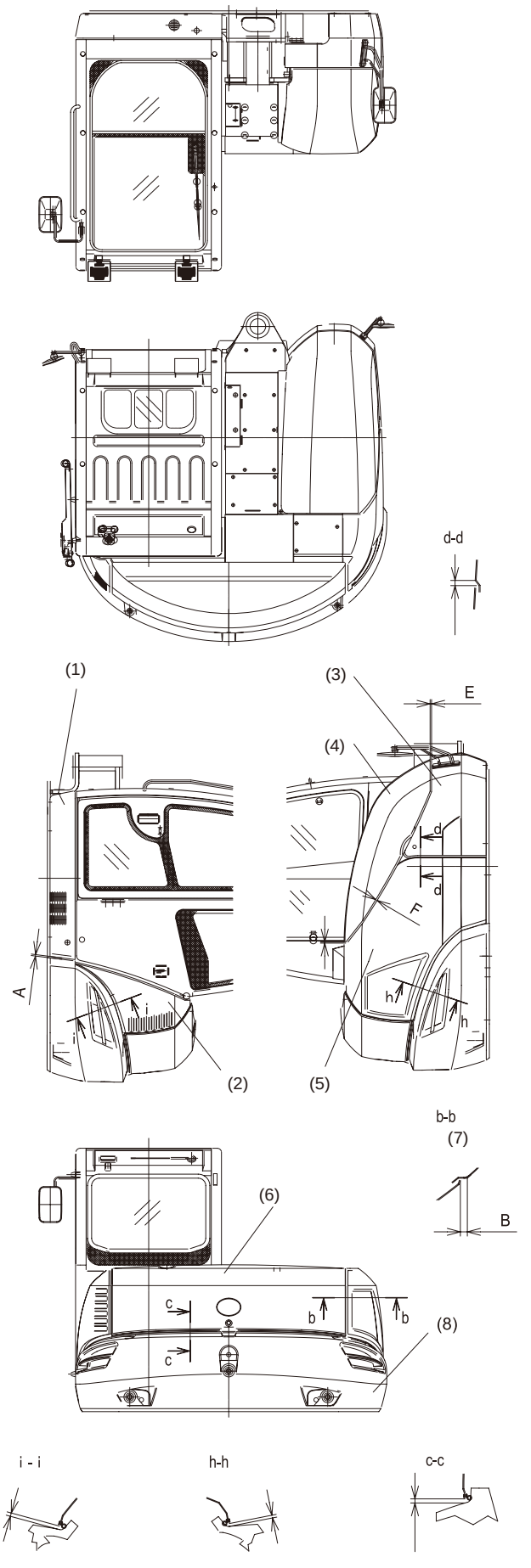
3.Attaching the additional weight

Tightening torque
Three M16 bolts
259.5~304.0N.m(26.5~31.0kgf.m)
191.4~224.2ft.lbs

Apply screw adhesive (Loctite 271).



(1)Before attaching the weight (200, additional), peel the label (reflector, red, EU) off the weight (870).
(2)Weight (200, additional)
Bolt
Plain washer
(3)Plug (M24)
(4)Label (reflector, red, EU)
(5)Weight (870)



I. Clearances of cover

1.Clearance between cover (left) and weight (870)
Clearance A shown at left
8~12mm(0.31~0.47inch)

2.Clearance between hood (back) and each side
Clearance B shown at left
16~20mm(0.63~0.79inch)

3.Clearance between hood (back) and weight
Clearance C shown at left
8~12mm(0.31~0.47inch)

4.Clearance between cover (front) and cover (right)
Clearance D shown at left
10~14mm(0.39~0.55inch)

5.Clearance between cover (front) and cover (tank)
Clearance E shown at left
8~12mm(0.31~0.47inch)

6.Clearance between cover (right) and cover (tank)
Clearance F shown at left
10~14mm(0.39~0.55inch)

7.Clearance between cover (right) and weight (870)
Clearance G shown at left
4~8mm(0.16~0.31inch)

8.Clearance between cover (arch, left) and weight (870)
Clearance H shown at left
5~9mm(0.20~0.35inch)

9.Level difference between corners
Clearance I shown at left
6~10mm(0.24~0.39inch)

10.Dimensional difference at clearances
Less than 3 mm
(0.12inch) 2mm(0.08inch)

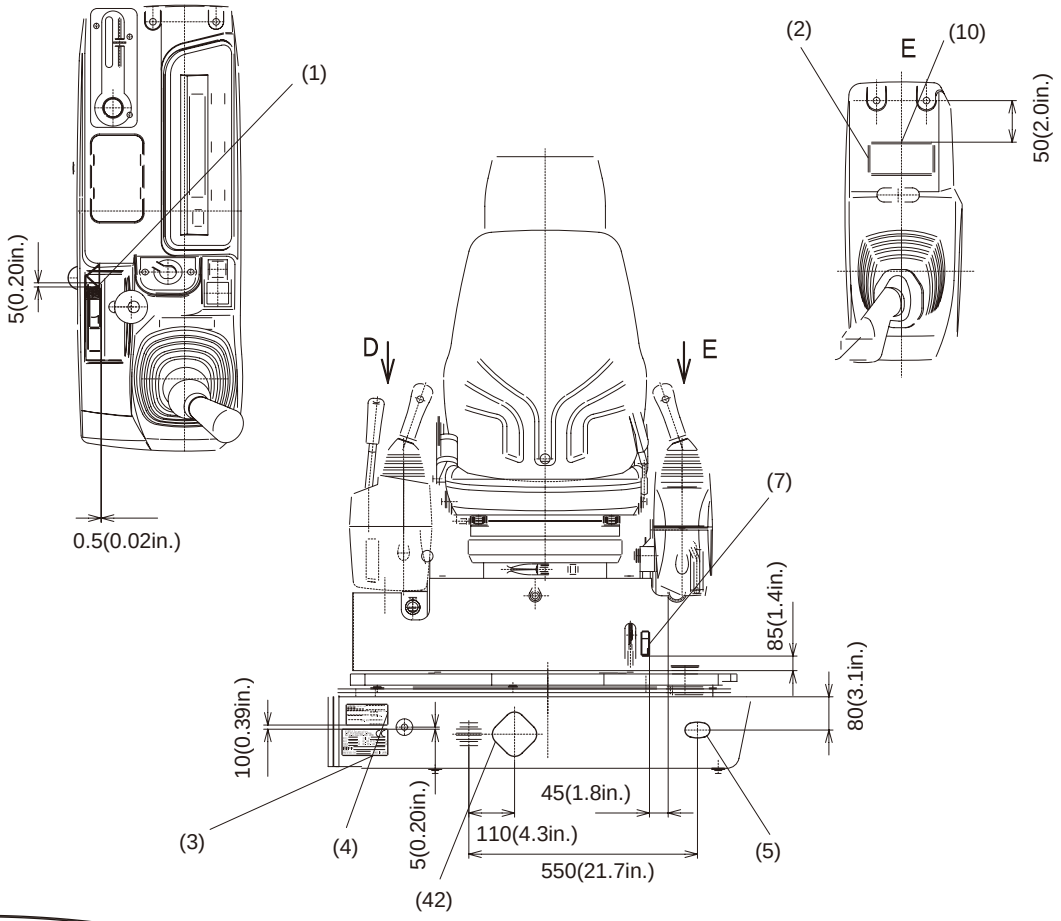
(1)Cover (left)
(2)Cover (arch, left)
(3)Cover (front)
(4)Cover (tank)
(5)Cover (right)
(6)Cover (back)
(7)(Same on the other side)
(8)Weight (870)

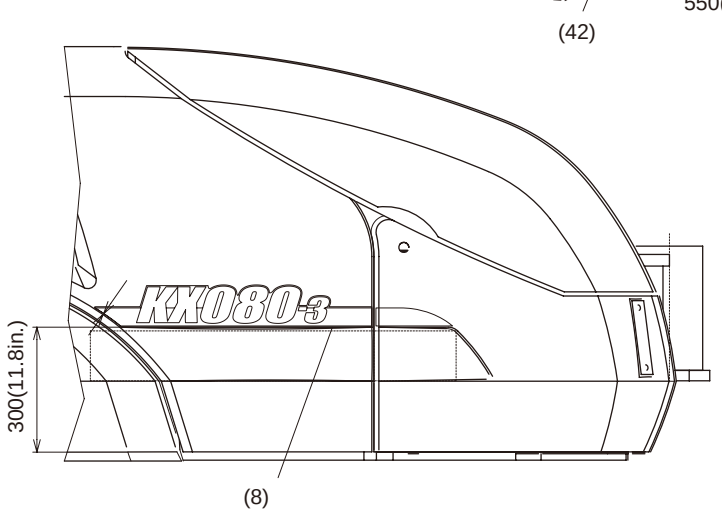
m. Labels

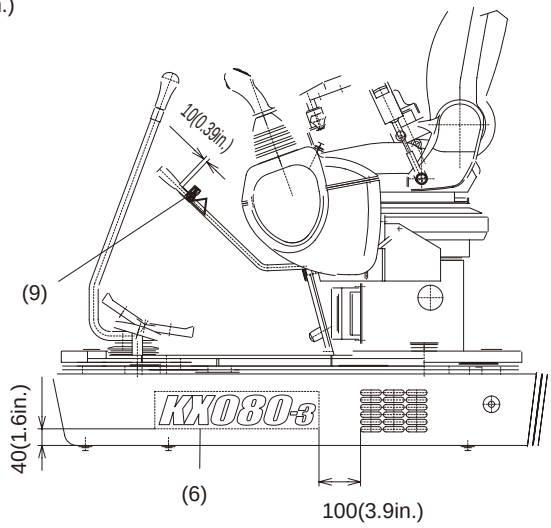
List of labels

No.	Location	Part name	Q'ty	Remarks
1	Control cover (right, top)	Label (blade)	1	
2	Control cover (left, top)	Label (control pattern A)	1	
3	↑	Nameplate (PC board, CE)	1	
4	Frame cover (left)	Label (bar code)	1	
5	↑	Label (reflector, white, EU)	1	
6	↑	Marking (model number, left)	1	
7	Cover (seat support)	Label (attachment switching)	1	
8	Hood cover (right)	Marking (model number, right)	1	
9	Lever (lock)	Label (lever lock)	1	
10	Frame cover (front)	Label (greasing)	1	
11	↑	Label (reflector, white, EU)	1	
12	Fuel tank	Label (fuel filler)	1	
13	Cover (switch, fuel filler)	Label (fuel pump)	1	
14	Hydraulic tank	Label (third line, EU)	1	
15	↑	Label (hydraulic 2)	1	
16	Frame (1, arch)	Label (muffler, warning)	1	
17	Shroud (fan)	Label (fan, warning)	1	
18	↑	Label (burn caution)	1	
19	Hood (back)	Label (muffler, warning)	1	
20	↑	Label (access prohibited)	2	
21	↑	Marking (K, emblem)	1	
22	↑	Label (control caution)	1	
23	Weight	Label (reflector, red, EU)	2	
24	Boom	Marking (Kubota 1)	2	
25	↑	Label (hoisting)	2	
26	↑	Label (swing caution)	2	
27	Blade	Label (hoisting)	2	
28	Frame (track)	Label (plug)	2	
29	Cabin	Label (windshield lock, EU)	1	
30	↑	Label (emergency exit)	1	
31	↑	Label (inspection)	1	
32	↑	Label (swing)	1	
33	↑	Nameplate (ROPS, cabin)	1	
34	↑	Label (anti-theft)	2	
35	↑	Label (seat belt)	1	
36	↑	Label (hoisting load, EU)	1	
37	↑	Label (manual)	1	
38	↑	Label (control, SP)	1	
39	↑	Label (hoisting prohibited, EU)	4	
40	↑	Marking (LPA)	1	

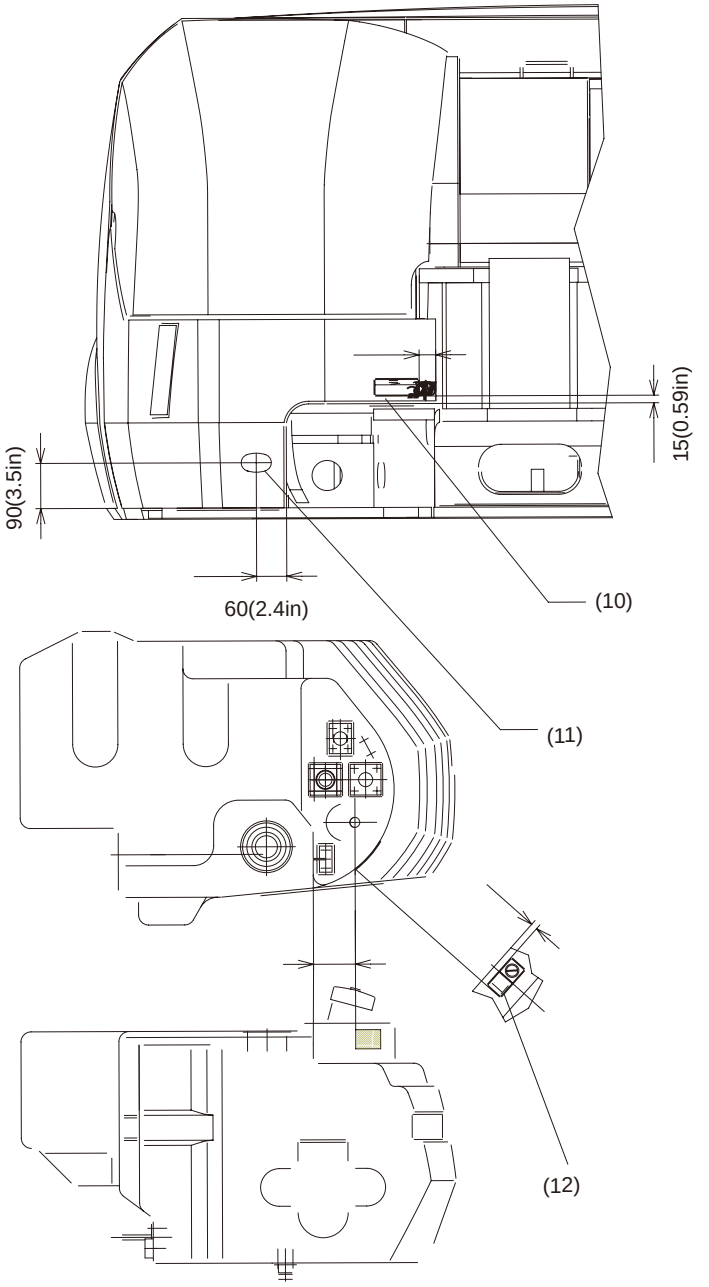
No.	Location	Part name	Q'ty	Remarks
41	↑	Marking (LWA)	1	
42	Frame cover (left)	Label (new-vehicle sticker)	1	

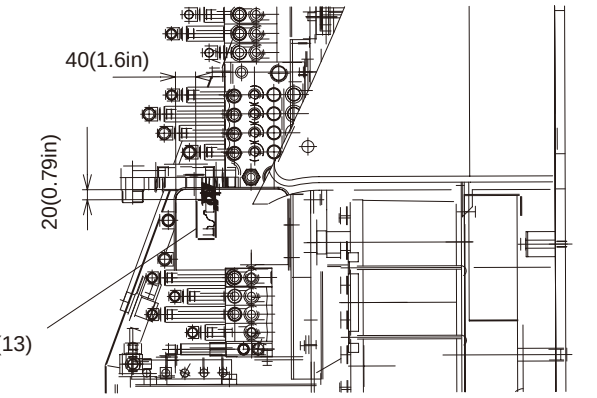


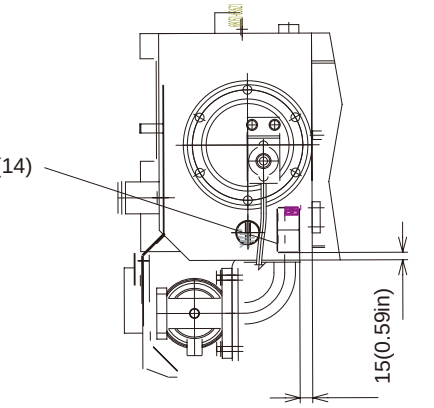


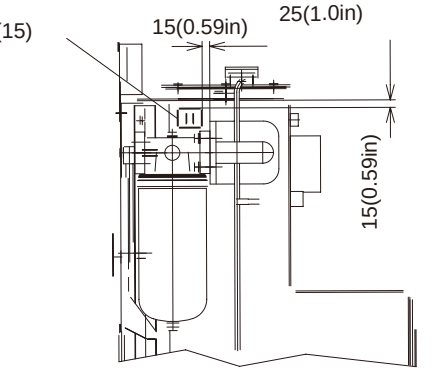


(1)Label (blade)
(2)Label (control pattern A)
(3)Nameplate (PC board, CE)
(4)Label (bar code)
(5)Label (reflector, white, EU)
(6)Marking (model number, left)
(7)Label (attachment switching)
(8)Marking(model number, right)
(9)Label (lever lock)
(10)To be applied at the center
(42)Label (new-vehicle sticker)

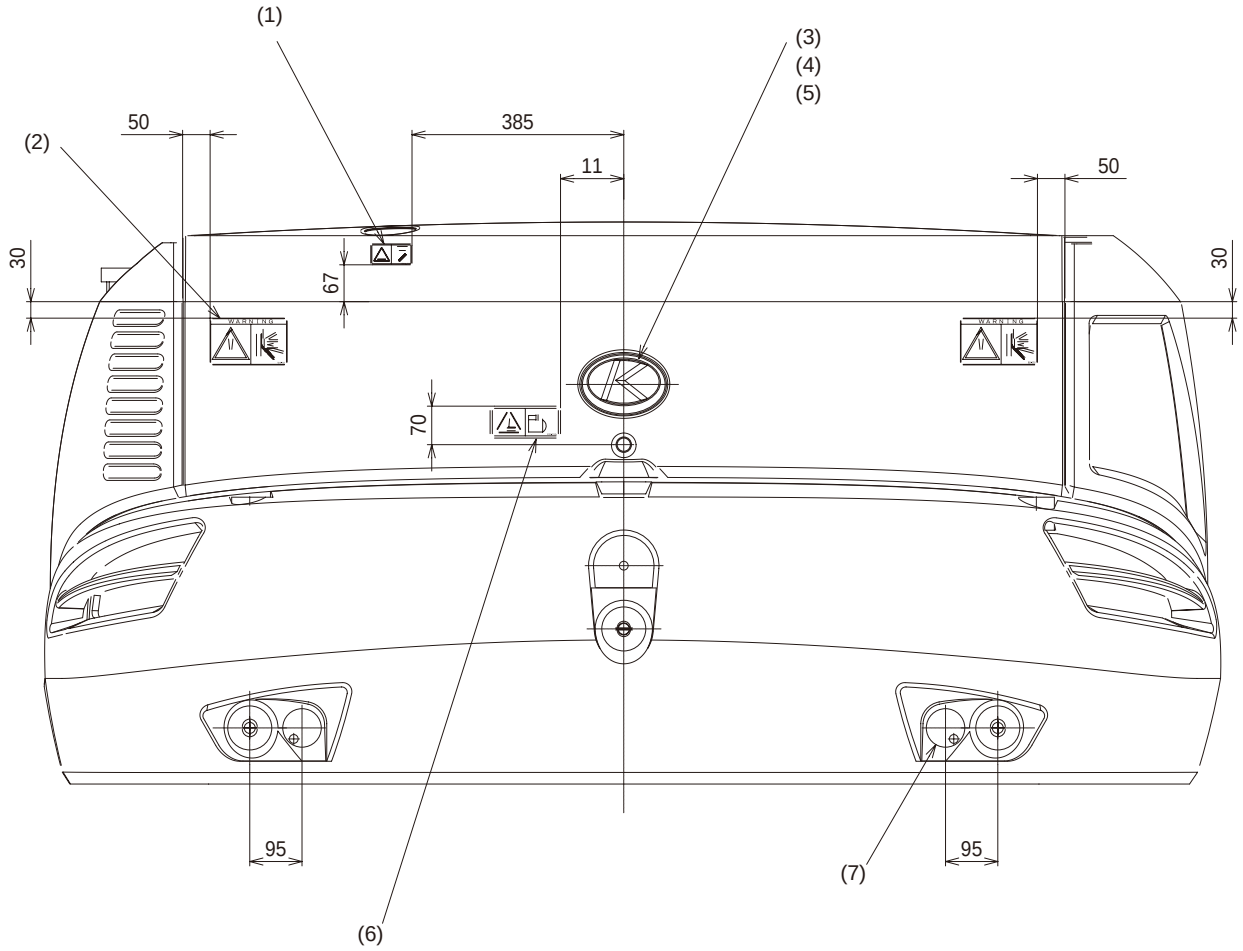




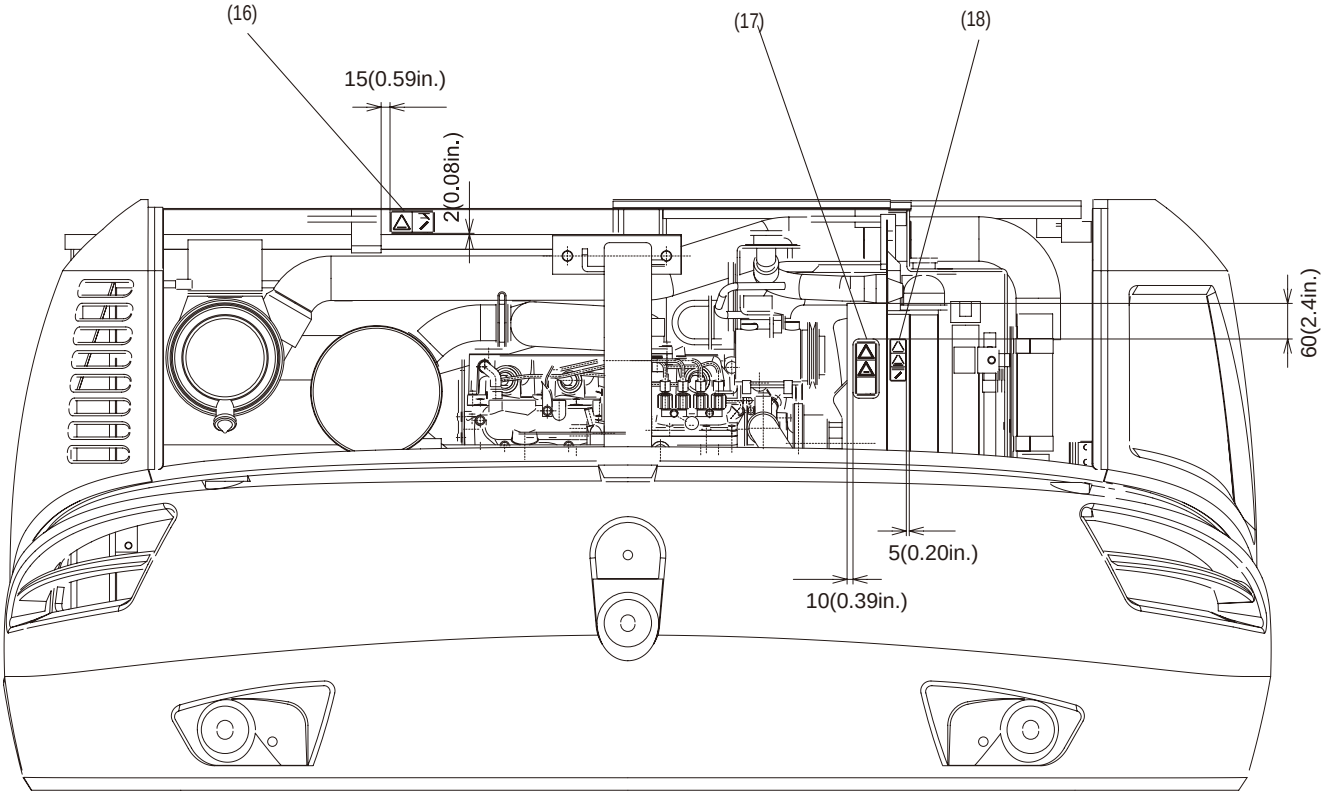




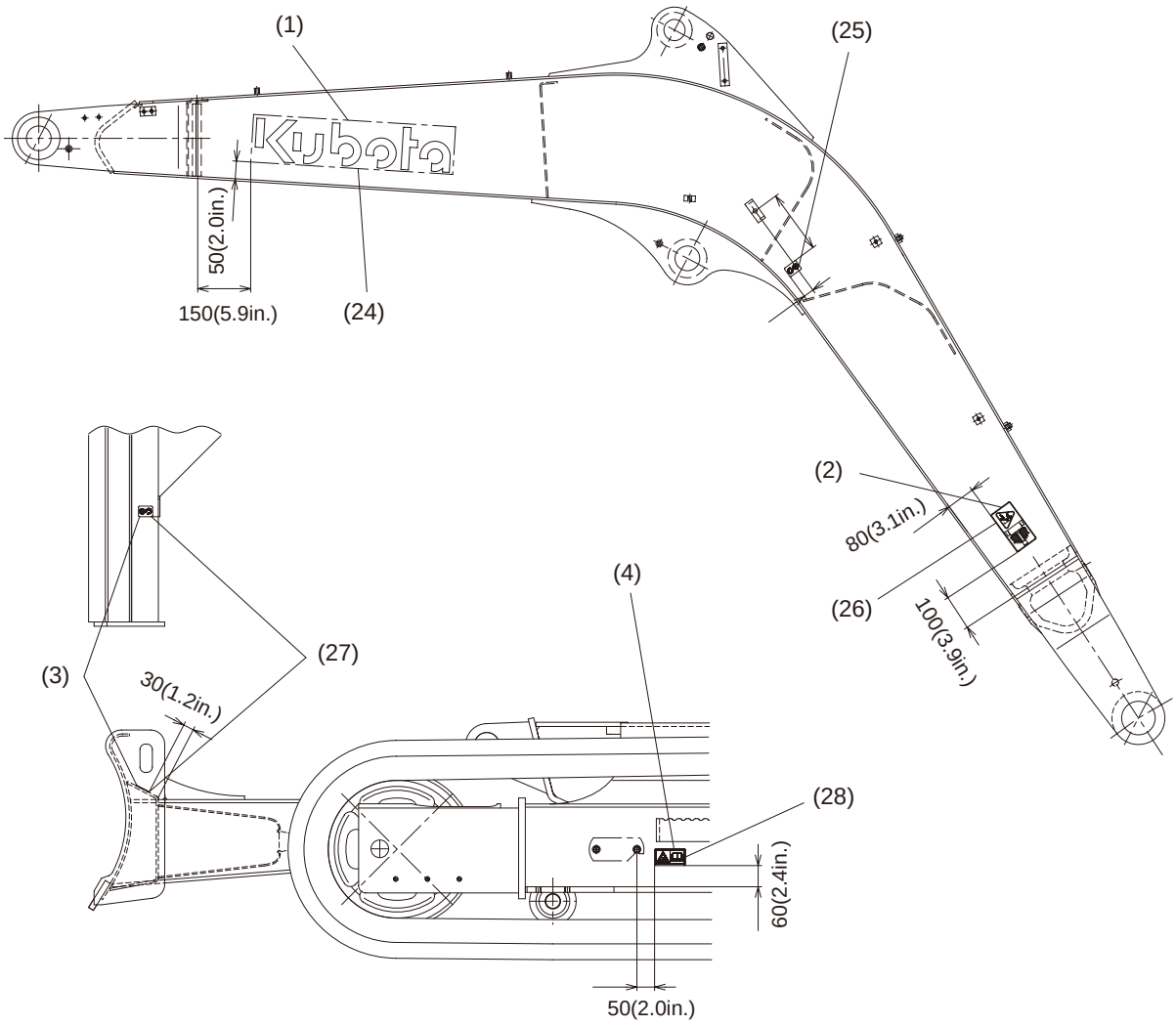
(10)Label (greasing)
(11)Label (reflector, white, EU)
(12)Label (fuel filler)
(13)Label (fuel pump)
(14)Label (third line, EU)
(15)Label (hydraulic 2)



(1)Label (muffler, warning)
(2)Label (access prohibited)
(2 locations: left and right)
(3)Marking (K, emblem)
(4)Nut (speed) (3 pcs.)
(5)Washer (plate) (3 pcs.)
(6)Label (control caution)
(7)Label (reflector, red, EU)
(2 locations: left and right)

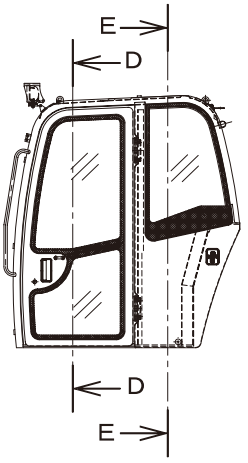


(16)Label (muffler, warning)
(17)Label (fan, warning)
(18)Label (burn caution)

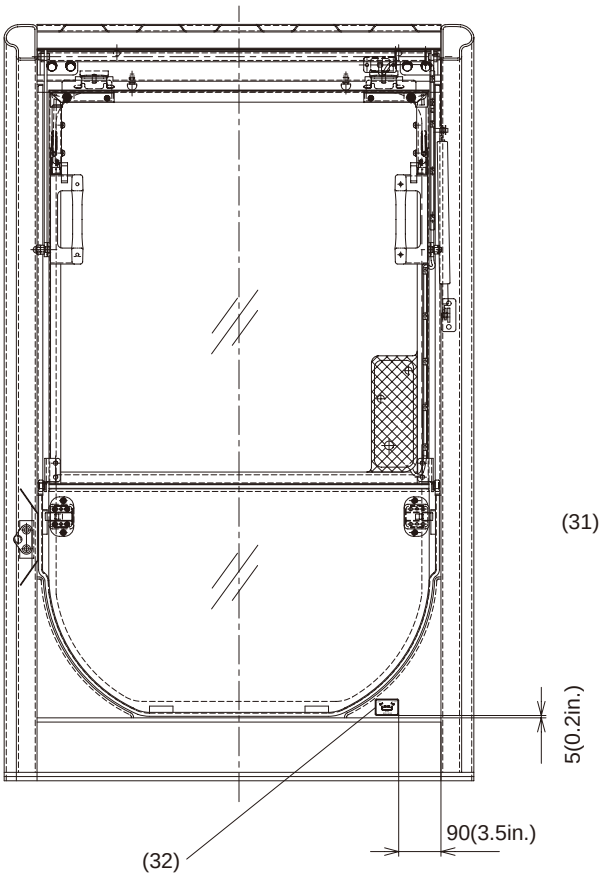


(24)Marking (Kubota 1)
(2 locations: on both sides)
(25)Label (hoisting)
(2 locations: on both sides)
(26)Label (swing caution)
(2 locations: on both sides)
(27)Label (hoisting)
(2 locations: on both sides)
(28)Label (plug)
(2 locations: on both sides)

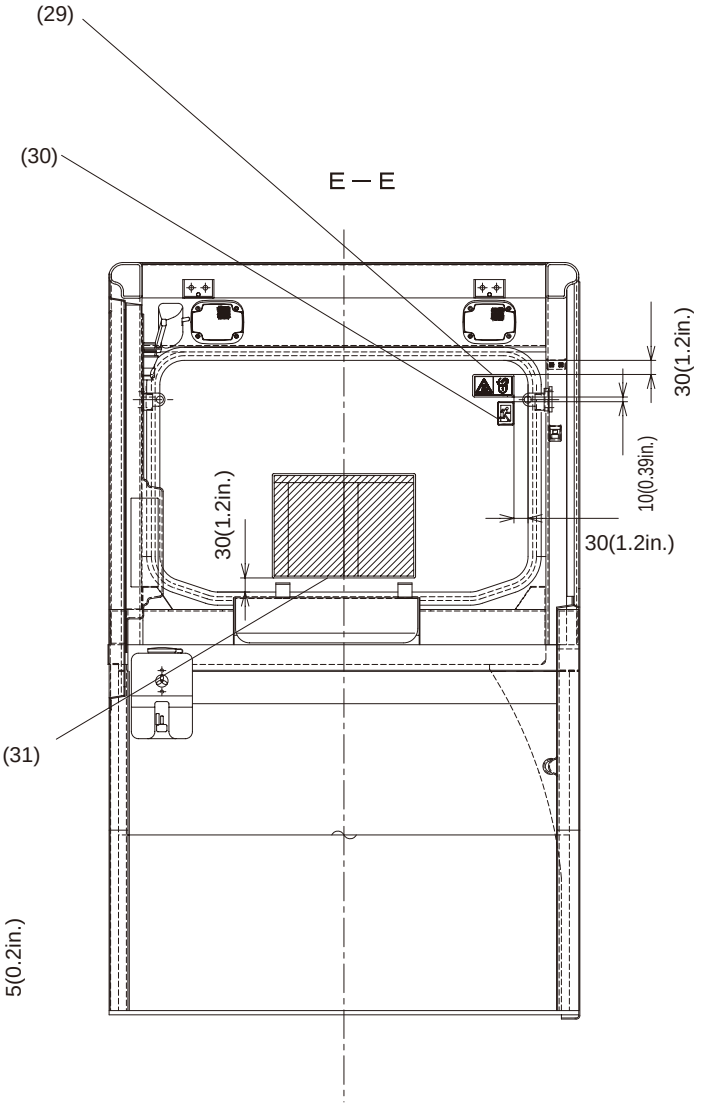
(1)Apply the same way on the other side too.
(2)Apply the same way on the other side too.
(3)Apply the same way on the other side too.
(4)Apply the same way on the other side too.



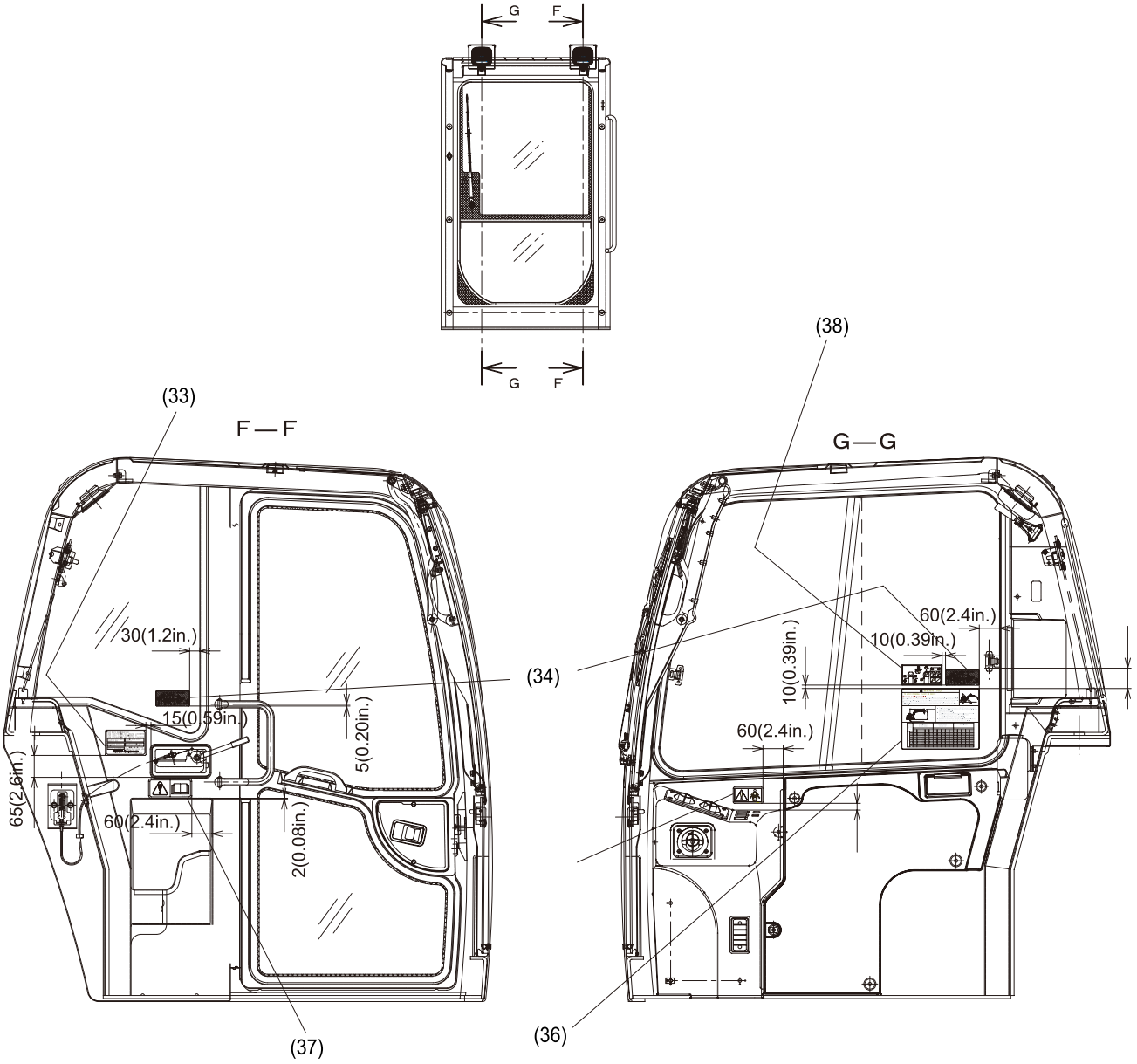
D—D



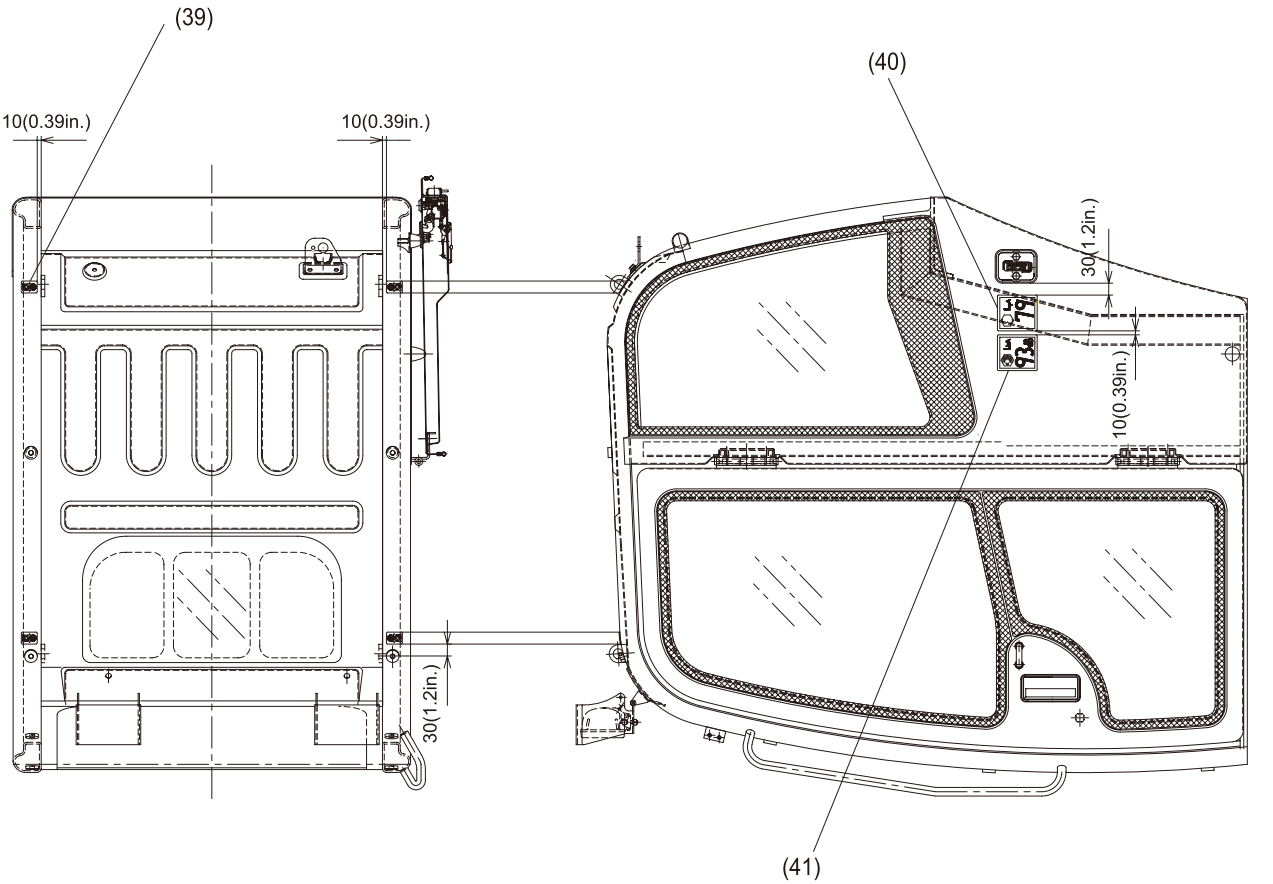
E—E



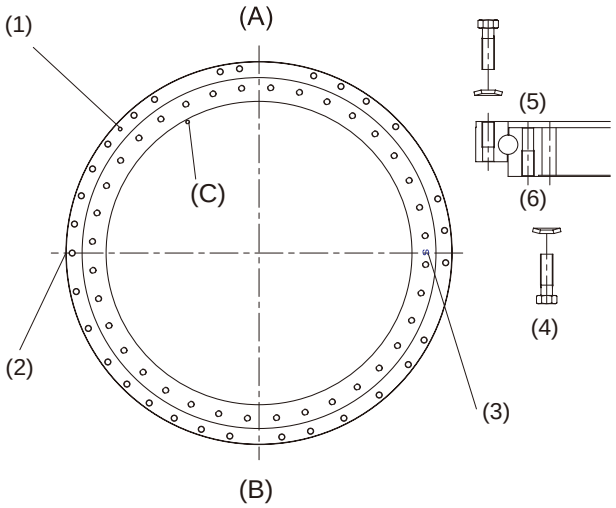
(29)Label (windshield lock, EU) (to be applied on the window pane's inner face)
(30)Label (emergency exit) (to be applied on the window pane's inner face)
(31)Label (inspection) (to be applied on the window pane's inner face)
(32)Label (swing) too.

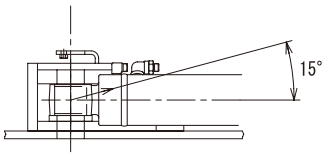


(33)Nameplate (ROPS, cabin)
(34)Label (anti-theft) (2 locations)
(to be applied on the window pane's inner face)
(35)Label (seat belt)
(36)Label (hoisting load, EU) (to be applied on the window pane's inner face)
(37)Label (manual)
(38)Label (control, SP)
(to be applied on the windshield's inner face)



(39)Label (hoisting prohibited, EU)
(4 locations)
(40)Marking (LPA)
(41)Marking (LWA)





Swing cylinder connector direction

(A)Machine front
(B)Machine back
(C)Tooth surface to be greased

(1)Ball greasing port
(to be aligned with swivel frame holes)
(2)Ball insertion hole
(Specific inner race zone)
(3)"S" mark
(Specific inner race zone)
(4)Pay attention to the disc spring direction.
(5)(Swivel frame side)
(6)(Track frame side)
(7)(Swivel bearing tooth surface)
(8)(Swivel bearing ball)
(9)(Swing cylinder bottom)
(10)(Point A)

n. Swivel bearing

(Pass through the left and right vertical rib holes and connect into position.)

1.Fitting the bearing (swivel)

Set the bearing with its specific inner race zone ("S" mark) at the right side of the machine.

2.Tightening torque

259.5~304.0N.m (26.5~31.0kgf.m)
191.4~224.2ft.lbs
Tighten temporarily first and then retighten diagonally.
Apply screw adhesive (Loctite 271).

3.Greasing the tooth surface

Apply grease evenly all over the bearing tooth surface.

Swivel bearing mounting bolt

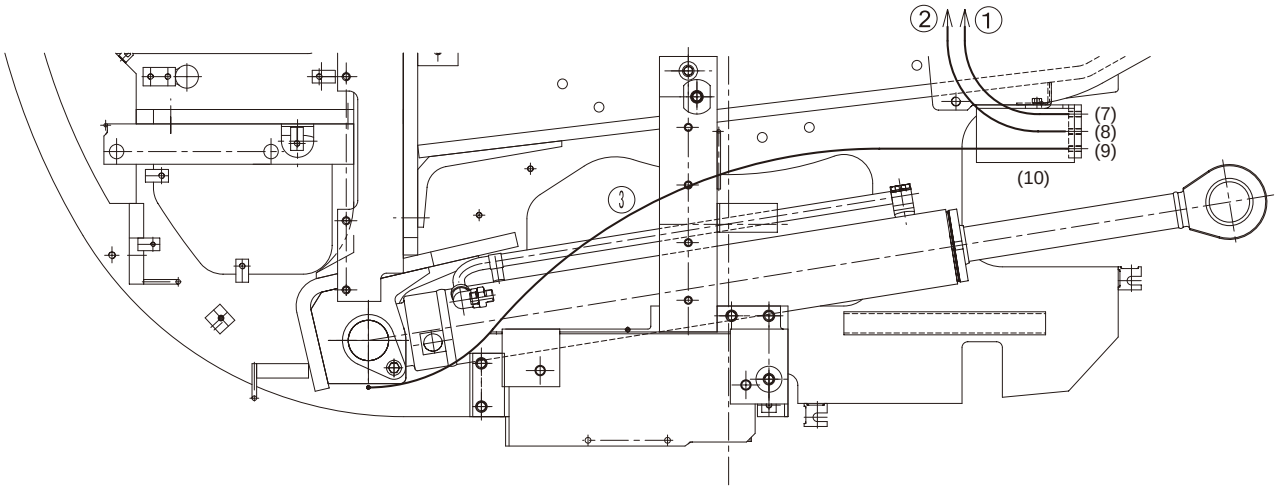
	Bolt	Washer
Track frame (lower)	01176-61660	36500-4941Δ
Swivel frame (upper)		

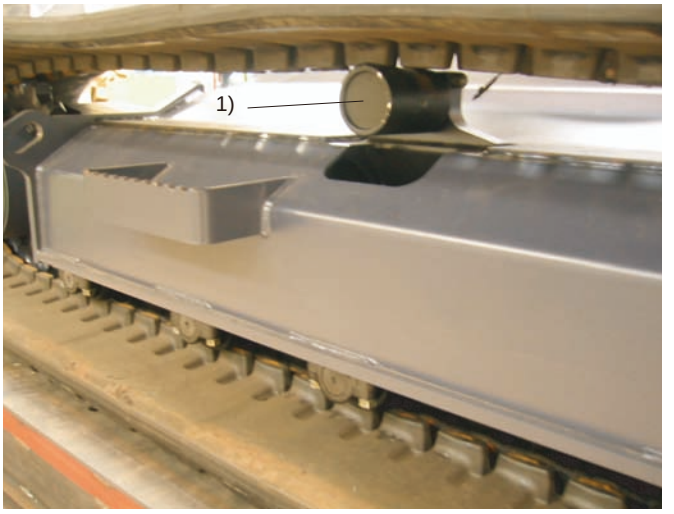
4.Routing the grease tubes up to the swivel bearing and swing cylinder, and connector tightening angle

Connect the tube as shown in the figure

Swivel bearing mounting bolt

No.	Grease tube length	Greasing adaptor
1	RD-809-1921Δ (L=900)	68721-6748Δ
2	RD-809-1922Δ (L=1150)	68721-6748Δ
3	RD-801-6743Δ (L=1300)	68721-6748Δ





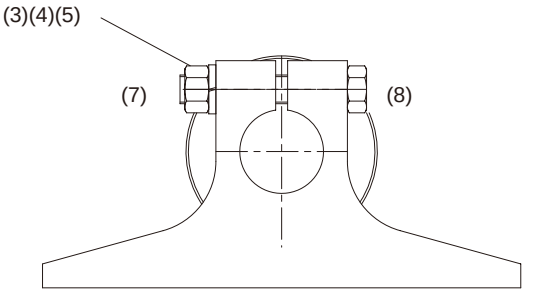
o. Undercarriage

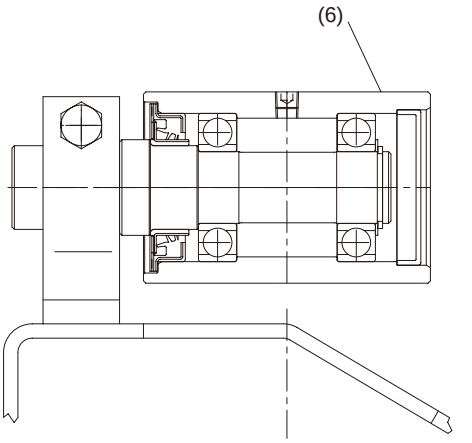
1.Upper roller

1)Upper roller

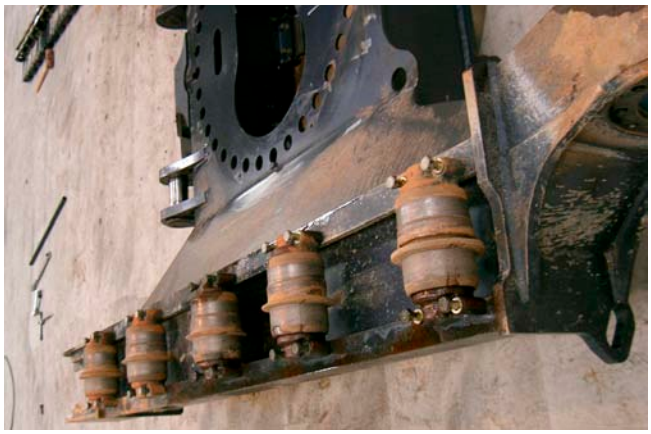


2)Bolt
Bolt tightening torque
77.5~90.2N.m (7.9~9.2kgf.m)
57.2~66.5ft.lbs
Apply screw adhesive (Loctite 271).





(3)Bolt
(4)Nut
(5)Spring washer
(6)Carrier roller
(7)Machine back
(8)Machine front



2.Track roller

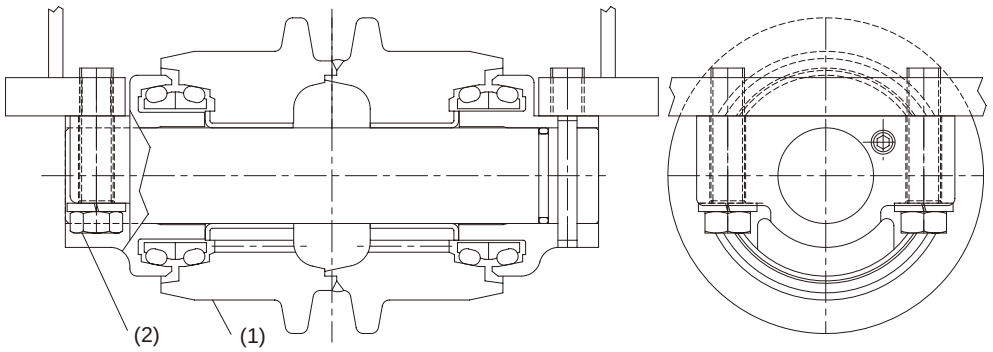
Sprocket and track roller out of alignment
(Idler to be loosely in center)
Within ± 2 mm (0.08in.) (reference)





Bolt tightening torque
166.7~196.1N.m (17.0~20.0kgf.m)
123.0~144.6ft.lbs

* Apply screw adhesive (Loctite 271).
  Carefully remove oil, fat and paint.



(1)Track roller assembly
(2)Bolt



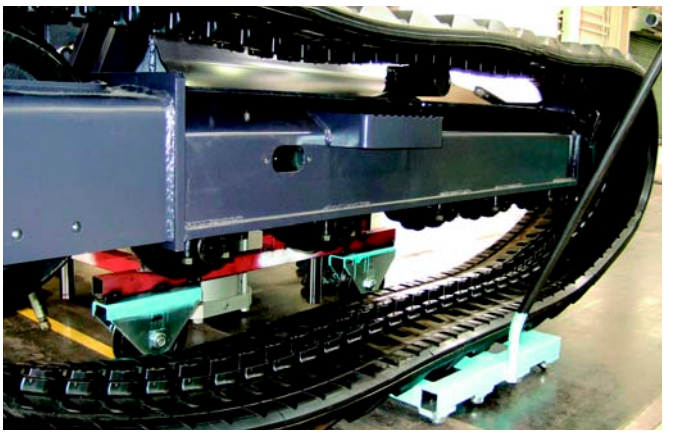
3. Front idler



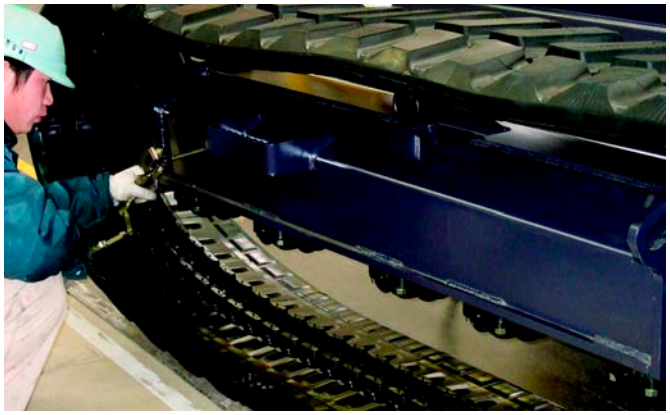
4.Grease tension cylinder



5.Grease tension spring



6.Rubber track removing



p. Track adjustment

1.Grease management

No grease leak is allowed.
* Wipe off grease deposits around.

2.Fitting to the track frame

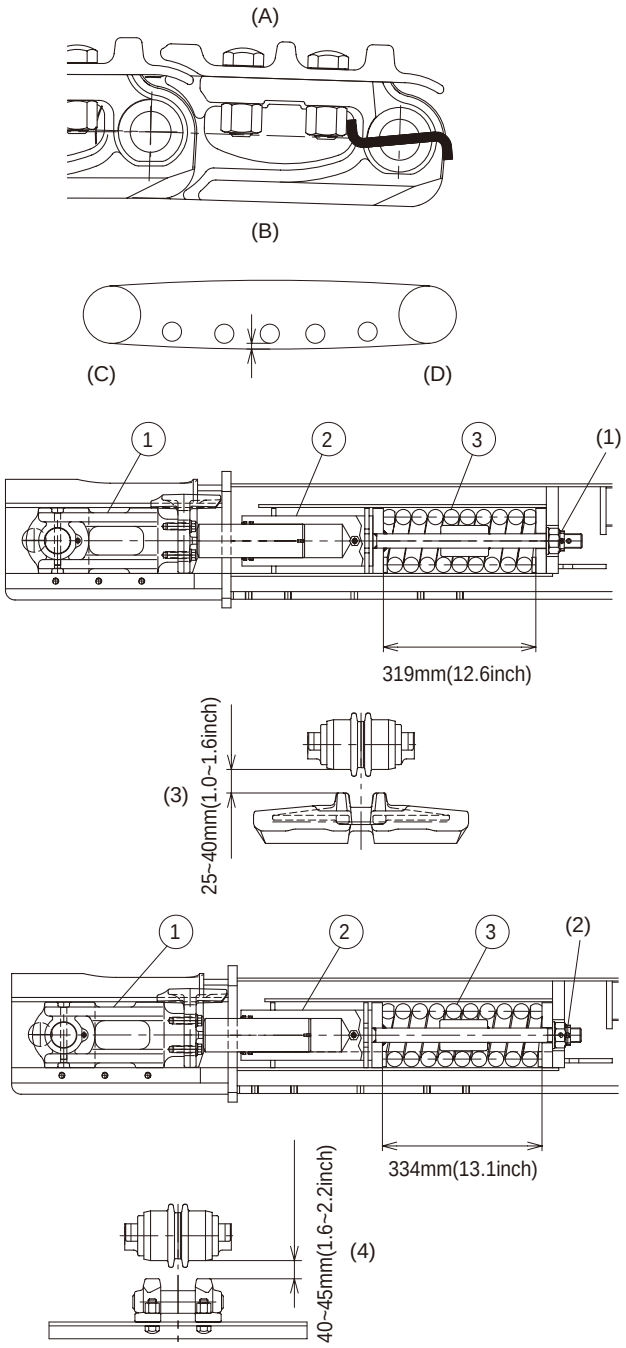
Make sure the crawler slides smoothly.
* Do not force it into position.

3.Spring preset length

*Set the cotter pin into the hole closest to the dimension specified at left.
(Rubber crawler type) 319mm(12.6inch)
(Iron crawler type) 334mm(13.1inch)

4.Adjusting the crawler tension

Measure at the third roller.
(Rubber crawler type) 25~40mm(1.0~1.6inch)
(Iron crawler type) 40~55mm(1.6~2.2inch)



(A)Master pin insertion position: View from the lock pin side
(B)Be careful not to confuse the lock pin bending direction. Bend the lock pin as parallel as possible to avoid turning.
(C)Sprocket side
(D)Idler side

Rubber track type

No.	Part name
1	Idler assembly
2	Cylinder assembly
3	Spring assembly (rubber)

Iron track type

No.	Part name
1	Idler assembly
2	Cylinder assembly
3	Spring assembly (rubber)

(1)Set the cotter pin into the hole inside.
(2)Set the cotter pin into the hole outside.
(3)Rubber track
(4)Iron track

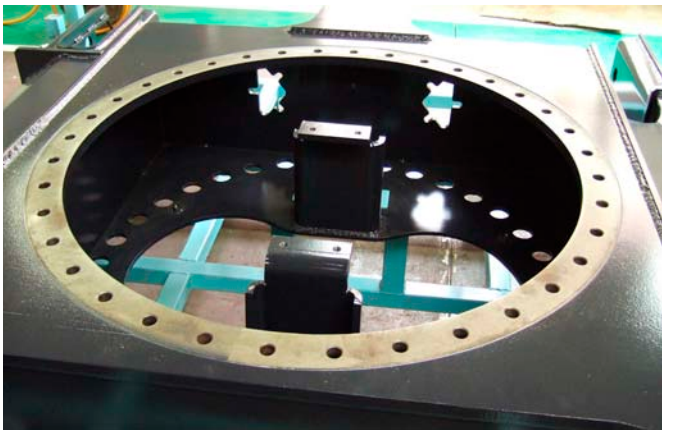


q. Swivel frame and track frame

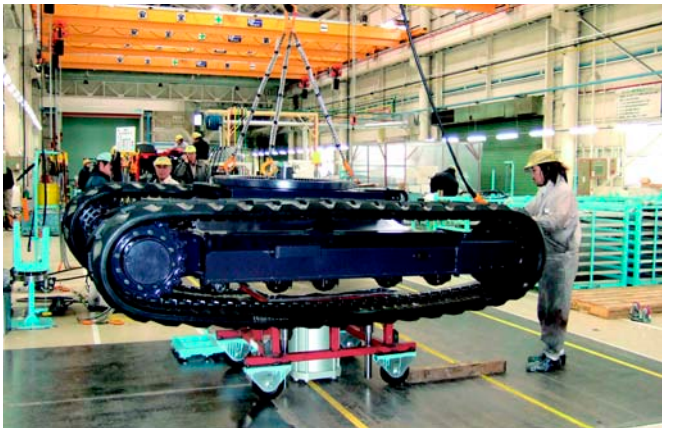
1.Swivel frame assy



2.Swivel bearing



3.Track frame



III Engine

Service Section

A. Troubleshooting III-S-3
B. Serviceing specifications III-S-4
C. Disassemble and Reassmble III-S-5
a.Pump coupling III-S-5
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c.Air cleaner III-S-10
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e.Fuel tank III-S-14
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k.Engine bracket III-S-25
l .Engine assy III-S-27
D. Engine WSM (V3800DI-E2B) III-S-29

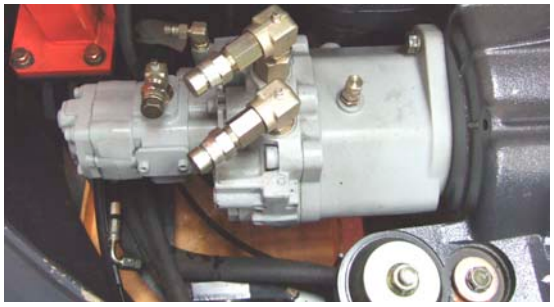
A. Troubleshooting

Refer to the following Engine WSM

B. Serviceing specifications

Refer to the following Engine WSM

C. Disassemble and Reassmble

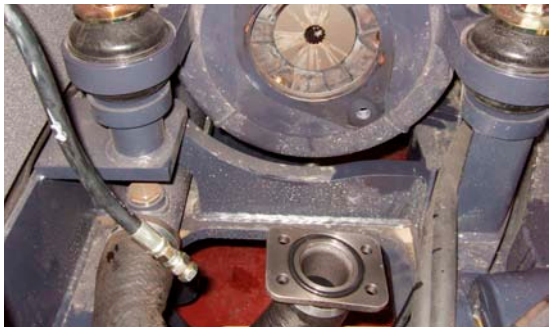


a. Pump coupling

1.Disconnect the hoses and fit the plugs.



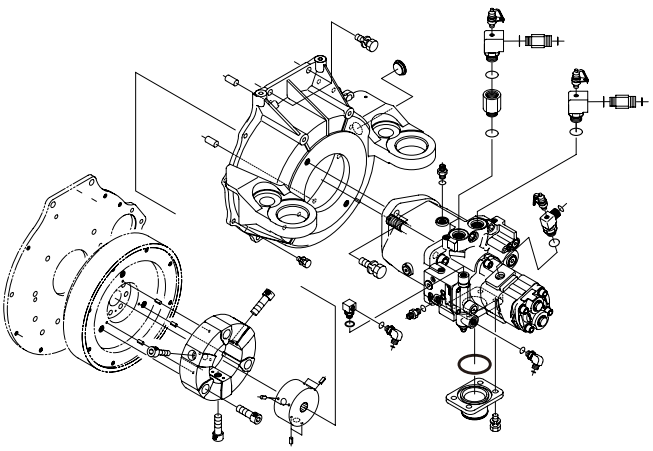
2.Hang the hydraulic pump with nylon sling.



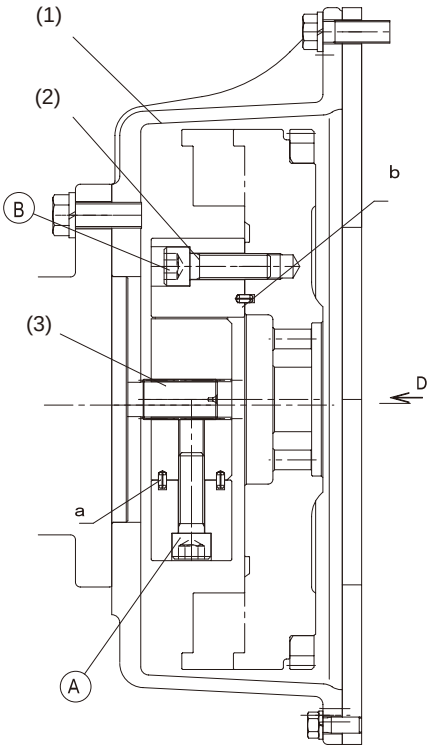
3.Dismount the pump assy.



4.Pump housing.



5.Pump coupling.



6.When reassembling

1) Applying grease to the spline
Apply a proper amount of grease.
(Be careful not to allow it overflow.)

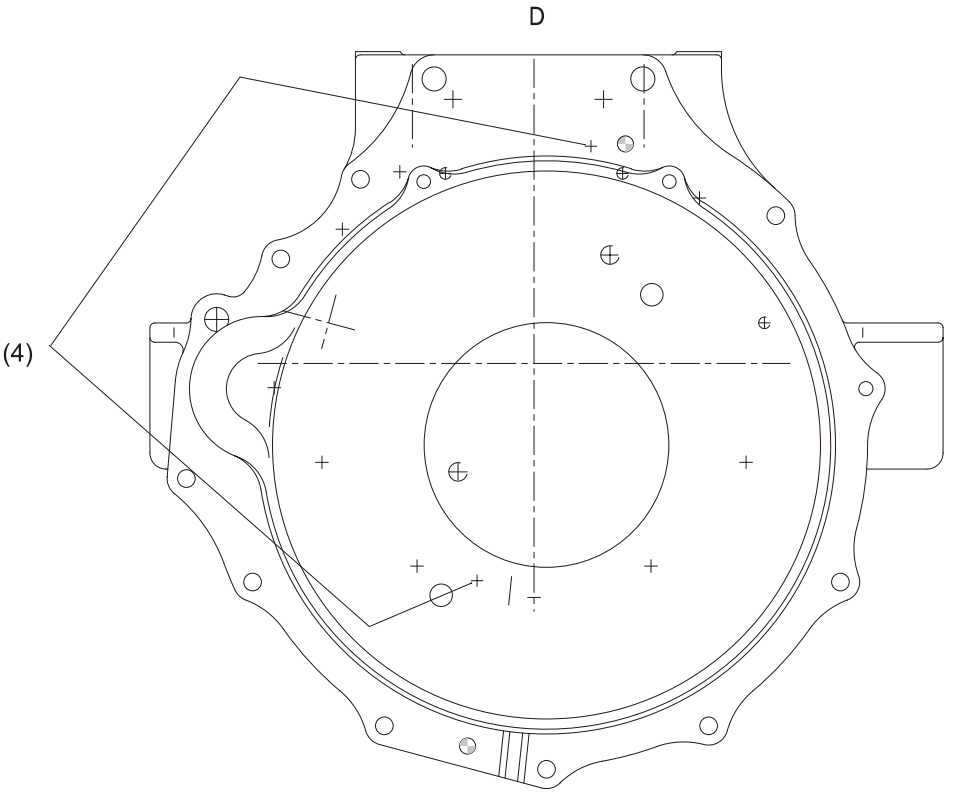
Be careful to keep the rubber free of grease.
Wipe off grease, if on the rubber, immediately.

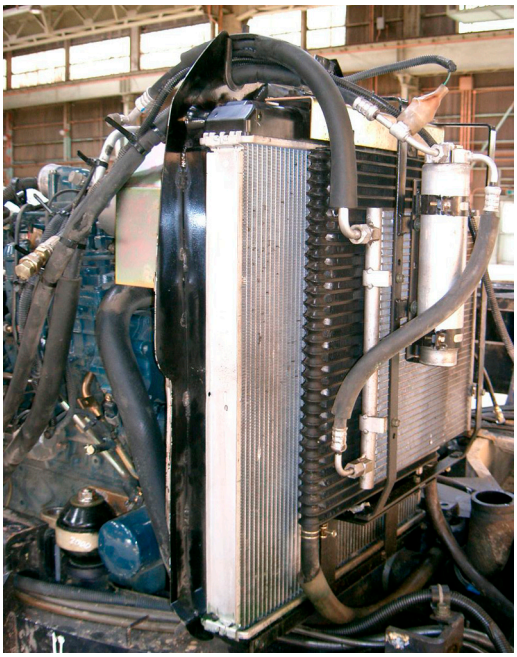
2) Fitting sequence of the coupling **A**
(A): Tighten up first.
*Set the coupling to the spring pin (a) and tighten up.

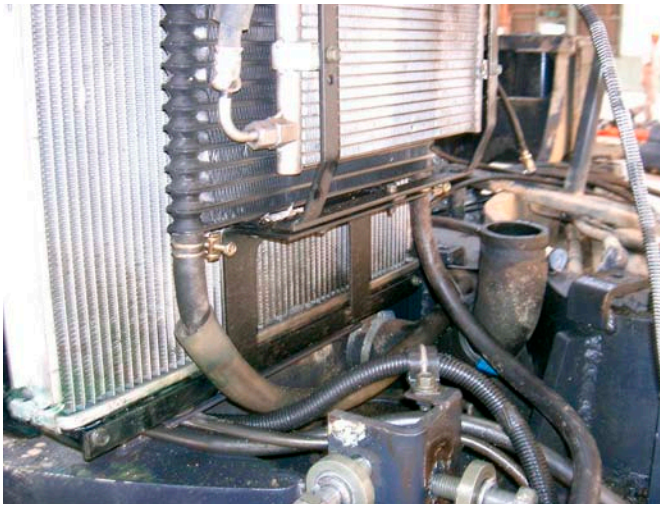
(B): Tighten up second.
*Set the coupling to the spring pin (b) and tighten up.

Tightening torque
210~230N.m(21.4~23.5kgf.m)154.9~169.6ft.lbs
* Do not apply screw adhesive.

(1)Housing (pump)
(2)Coupling
(3)Apply grease to the spline.
(4)Parallel pin







b. Radiator

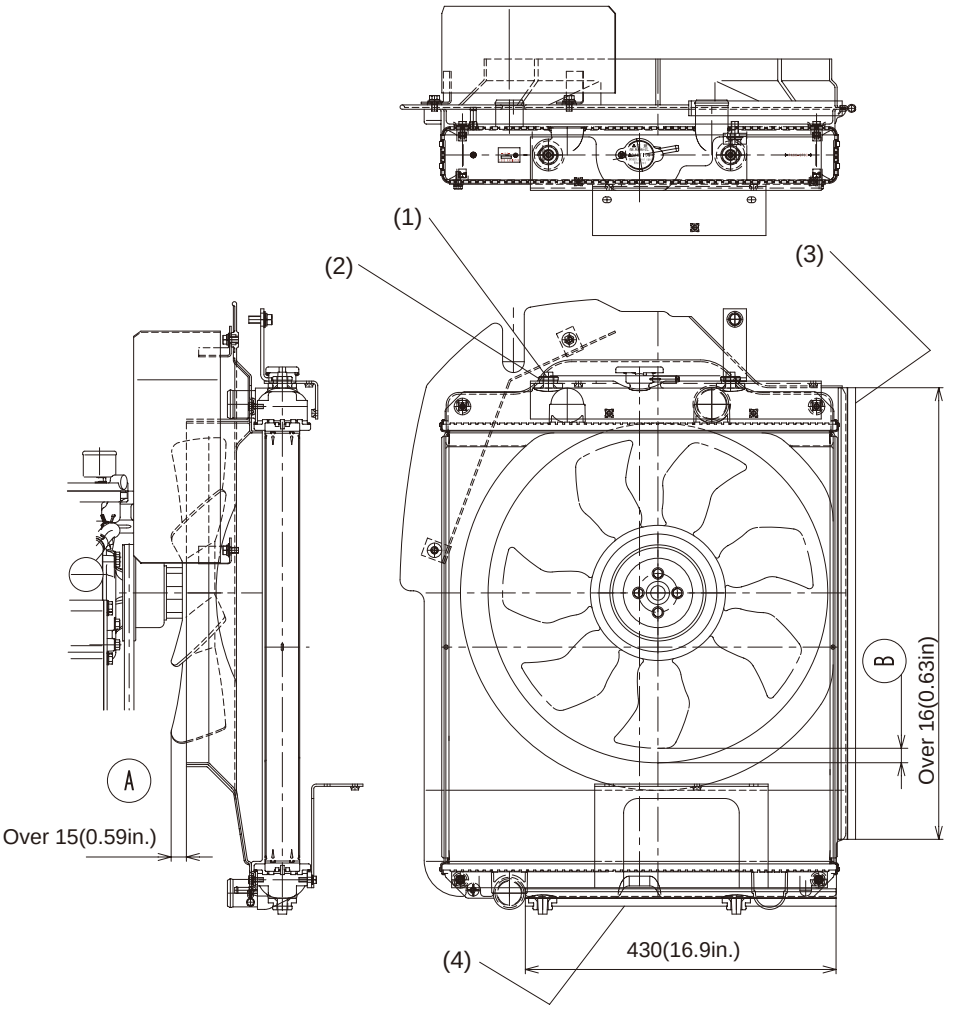
1. Overall view

(1) Receiver
(2) Condenser
(3) Oil cooler
(4) Radiator

3.Stretch (A) of the fan out of the shroud (fan)
Around the fan
Reference dimension: 21 mm(0.83inch)
Minimum stretch: Over 15 mm(0.59inch)
Keep the entire stretch as small as possible.

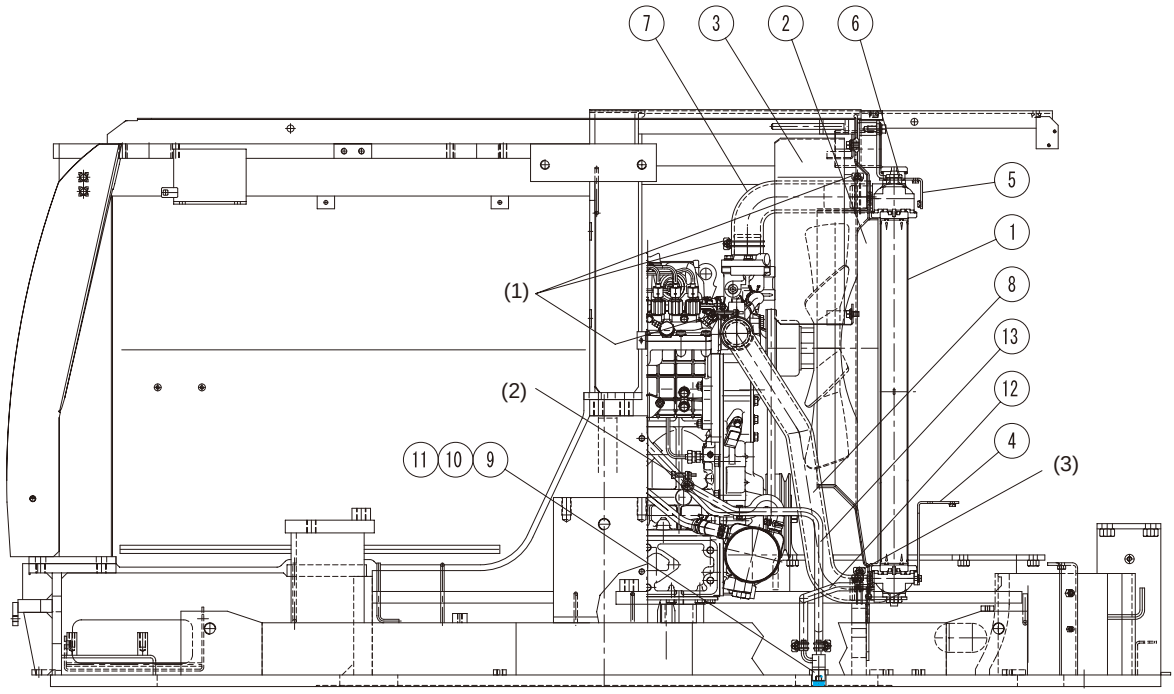
4.Clearance (B) between fan and shroud (fan)
Around the fan
Reference dimension: 20 mm(0.79inch)
Minimum clearance: Over 16 mm(0.63inch)
Keep the entire clearance as small as possible.

5.Install the rubber (radiator mount) to the bracket.
Place the rubber's claws tight into position
.



(1)Rubber (radiator mount)
(2)Make sure the claws are tight in their mating parts.
(3)Trim (625)
(4)Trim (430)

No.	Part name	Q'ty
1	Radiator assembly	1
2	Shroud (fan)	1
3	Cover (fan)	1
4	Bracket (1, oil cooler)	1
5	Bracket (2, oil cooler)	1
6	Rubber (radiator mount)	4
7	Hose (upper, WP)	1
8	Hose (lower, WP)	1
9	Base (drain)	1
10	Plug	1
11	Rubber-fitted washer	1
12	Hose (drain, 1)	1
13	Hose (drain, 2)	1



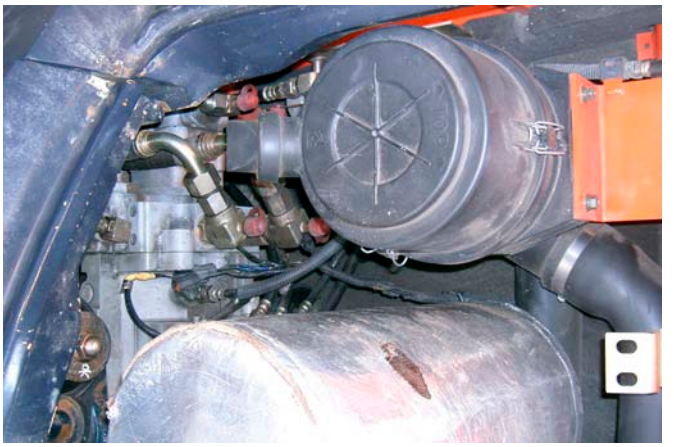
(1)Hose clamp (screw-in type 60)
(2)Hose clamp (screw-in type 14)
(3)Hose clamp (screw-in type)



c. Air cleaner

1.Overall view, engine room.

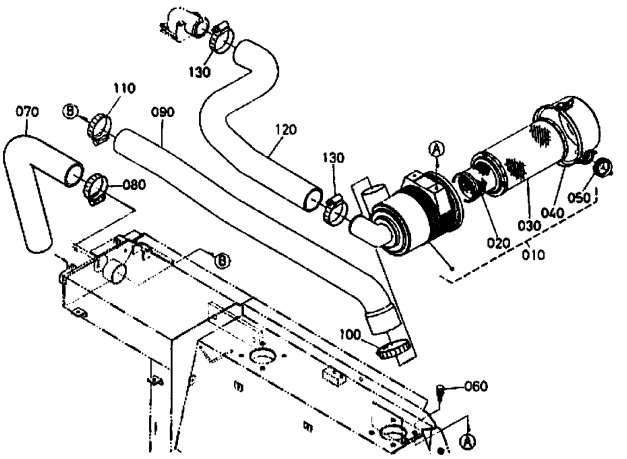
(1)Air cleaner assy.



2.Air cleaner assy



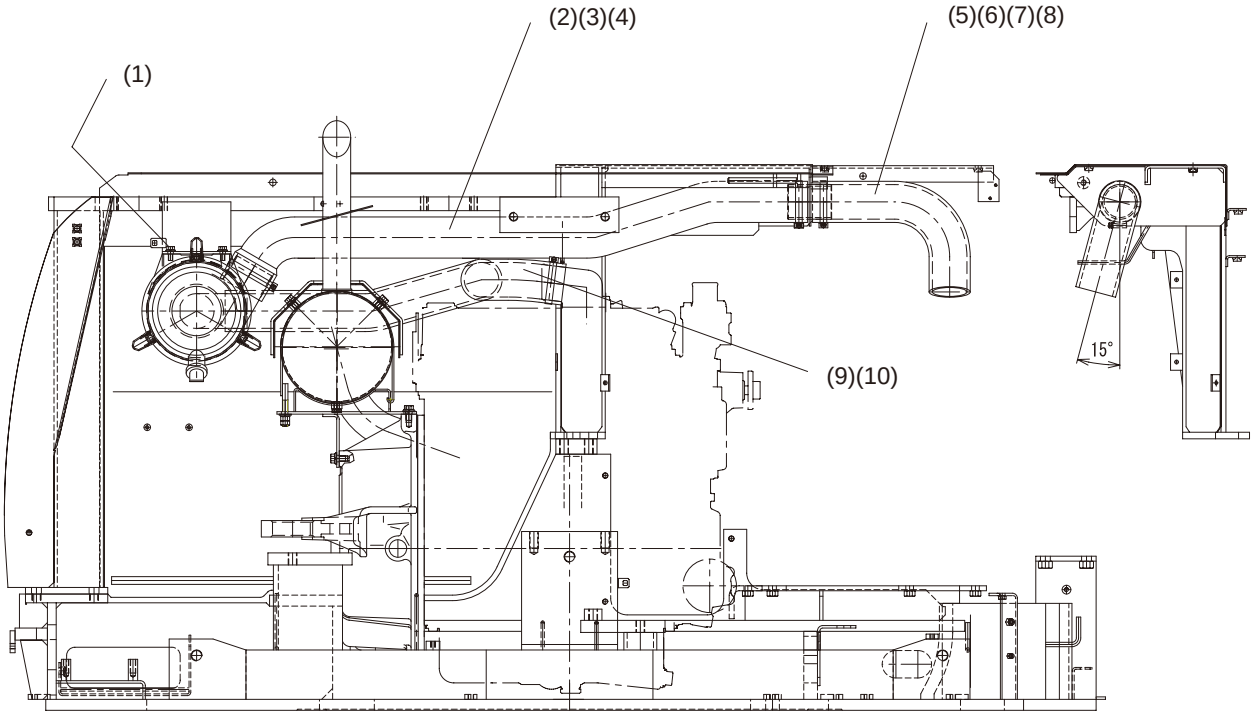
3.Inlet hoses



4.Double elements

5.Laying the hose (1, inlet)

See the figure.



(1)Bolt
(2)Hose (2, inlet)
(3)Hose clamp (66-88)
(4)Hose clip (58-75)
(5)Hose (1, inlet)
(6)Hose clip (58-75)
(7)Hose (3, inlet)
(8)Hose clip (58-75)
(9)Hose (3, inlet)
(10)Hose clip (58-75)

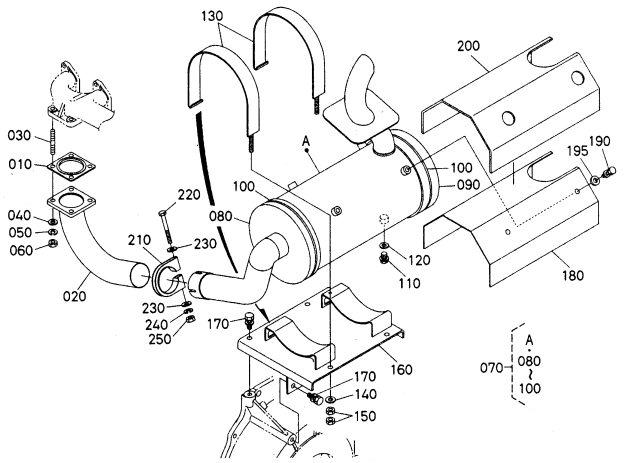






d. Muffler

1.Overall view.



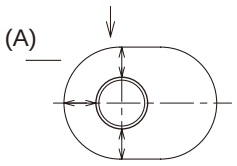
Note : After mounting the new muffler and starting engine, some smoke may wme out from the engine room.
This smoke is resulted from the initial burning of bandage around the muffler pipe.

2.Tightening the flange (muffler) clamp

Tightening torque
3.9~5.9N.m(0.4~0.6kgf.m)28.2~42.7ft.lbs

3.Ensuring the clearance at the pipe (muffler) outlet

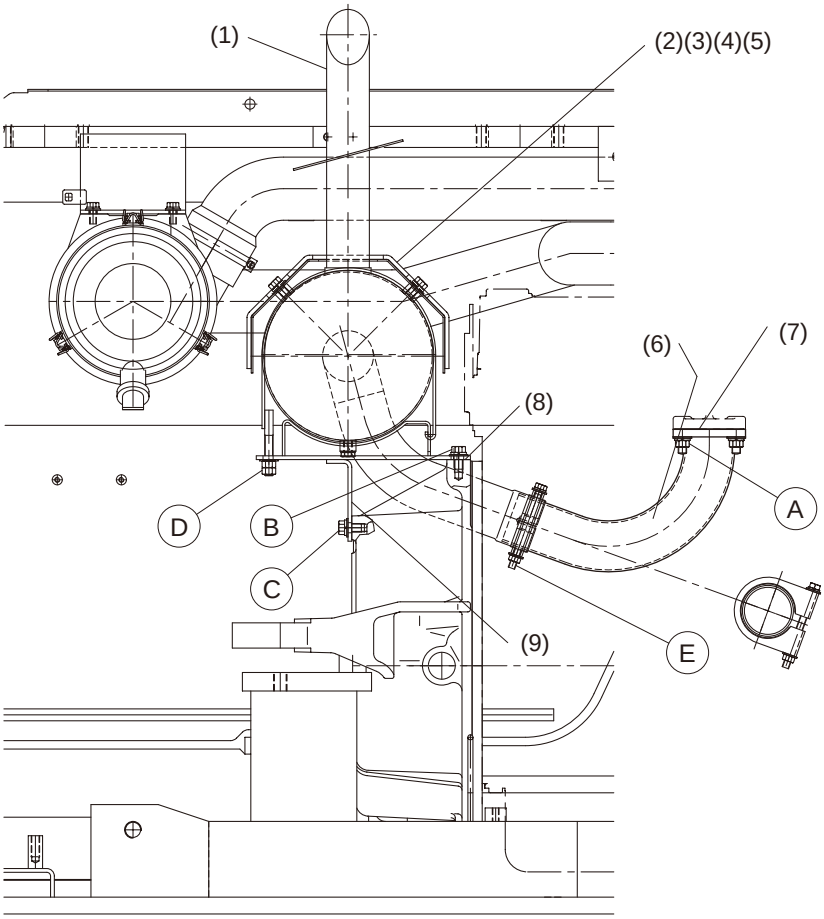
Clearance: Over 25 mm(1.0inch)



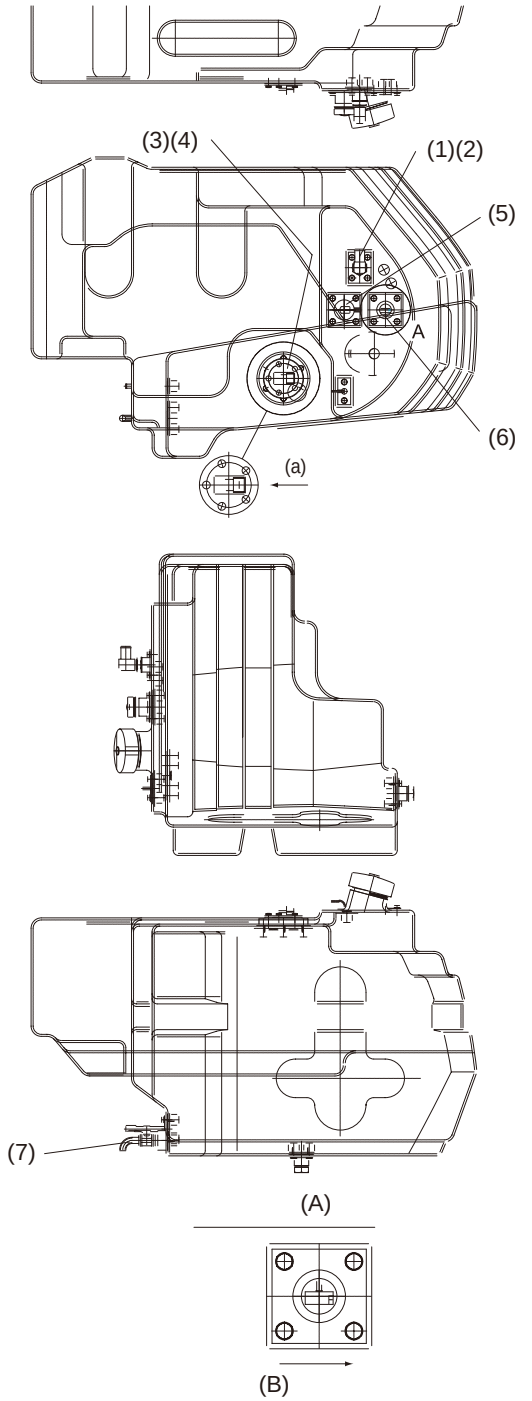
(A) Front

4.Tightening sequence

* (A): Tighten up first.
Tightening torque
39.2~45.1N.m(4.0~4.6kgf.m)28.9~33.3ft.lbs
* (B): Tighten up second.
* (C): Tighten up second.
Tightening torque
48.1~55.9N.m(4.9~5.7kgf.m)35.5~41.2ft.lbs
* (D): Tighten up third.
* (E): Tighten up fourth.



(1)Muffler assembly
(2)Cover (muffler)
(3)Bolt
(4)Plain washer
(5)Thermal insulation (muffler cover)
(6)Flange (muffler)
(7)Face b
(8)Face c
(9)Face d

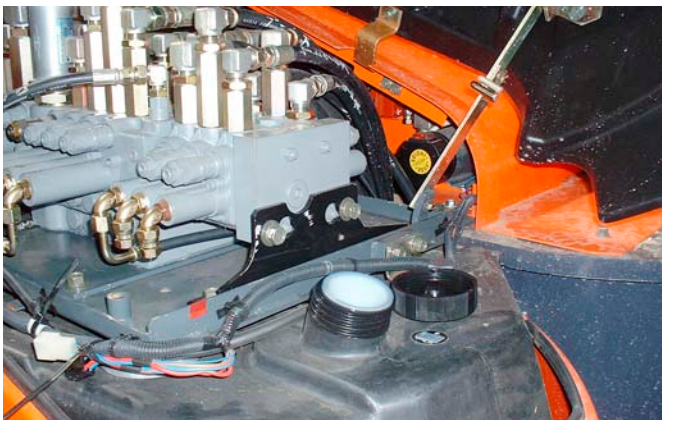


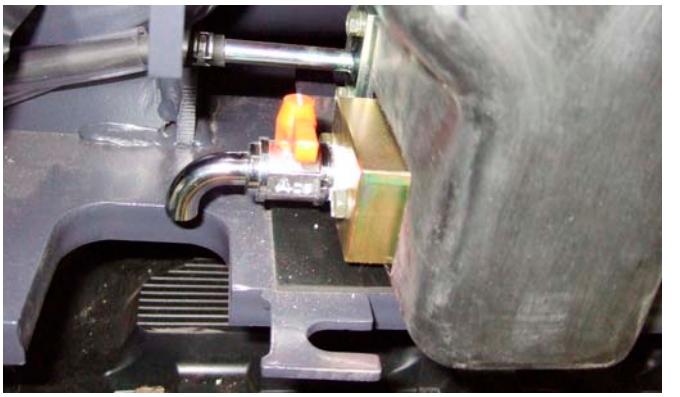
(1)Washer-fitted elbow
(2)O ring (P18)
(3)Sensor assembly (fuel)
(4)Washer-fitted machine screw
(5)Sensor assembly (fuel filler)
(No specified fitting direction)
(6)Gauge (fuel)
(7)Cock (drain)

(a)Connector socket direction(to face the machine front)

(A)View A: Gauge (fuel) fitting direction
(B)Machine front

e.Fuel tank





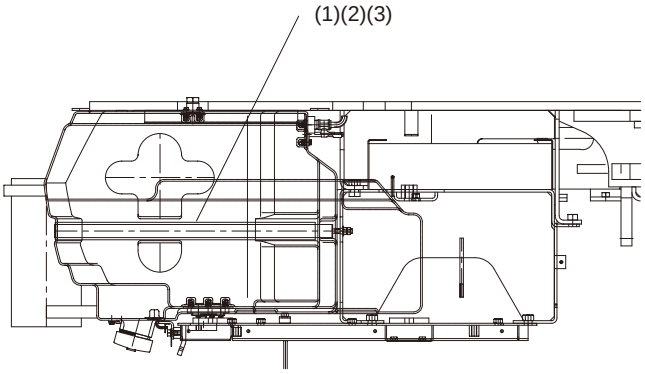
1.Fitting the sensor assembly (fuel) (RD809-5114Δ)
Tightening torque
3~4N.m(0.3~0.4kgf.m)2.2~3.0ft.lbs

Position the assembly so that the connector socket faces the machine front.

2.Fitting the sensor assembly (fuel filler) (RD809-5138Δ) and gauge (fuel) (RD809-5112Δ)
Do not force them into position. Apply some cleaning agent for smooth fitting.

3.Fitting direction of the gauge (fuel) (RD809-5112Δ)
Position the gauge as shown at left. (F mark to face the machine front)

4.Fitting the cock (drain) (RD809-5125Δ)
Position the cock as shown at left. (Drain port to face downward)
After being fitted, close the cock.



5.Fitting the washer-fitted elbow (68881-6446∆)

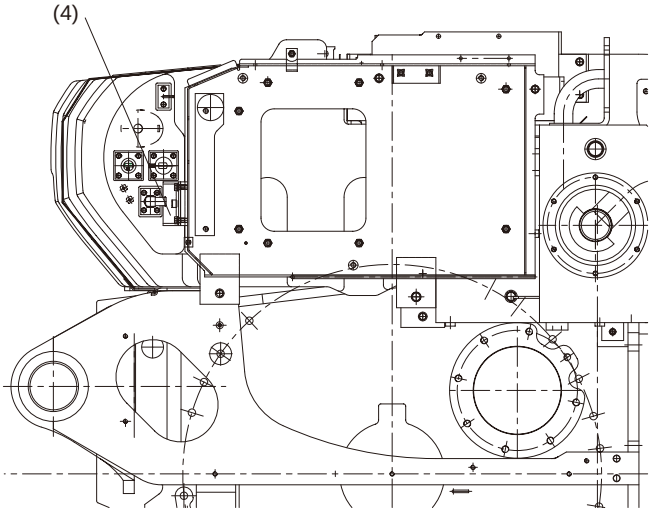
Position the elbow as shown at left.
Note: Be careful not to confuse the O ring (fuel) setup.
(Part code of O ring)
RD809-5128∆
O ring (P18)

6.Adaptor tightening torque

G1/2 size
58.8~63.7N.m(6.0~6.5kgf.m)43.4~47.0ft.lbs

7.Tightening the band assembly (fuel tank)

Shake the tank by hand and make sure it does not wobble.



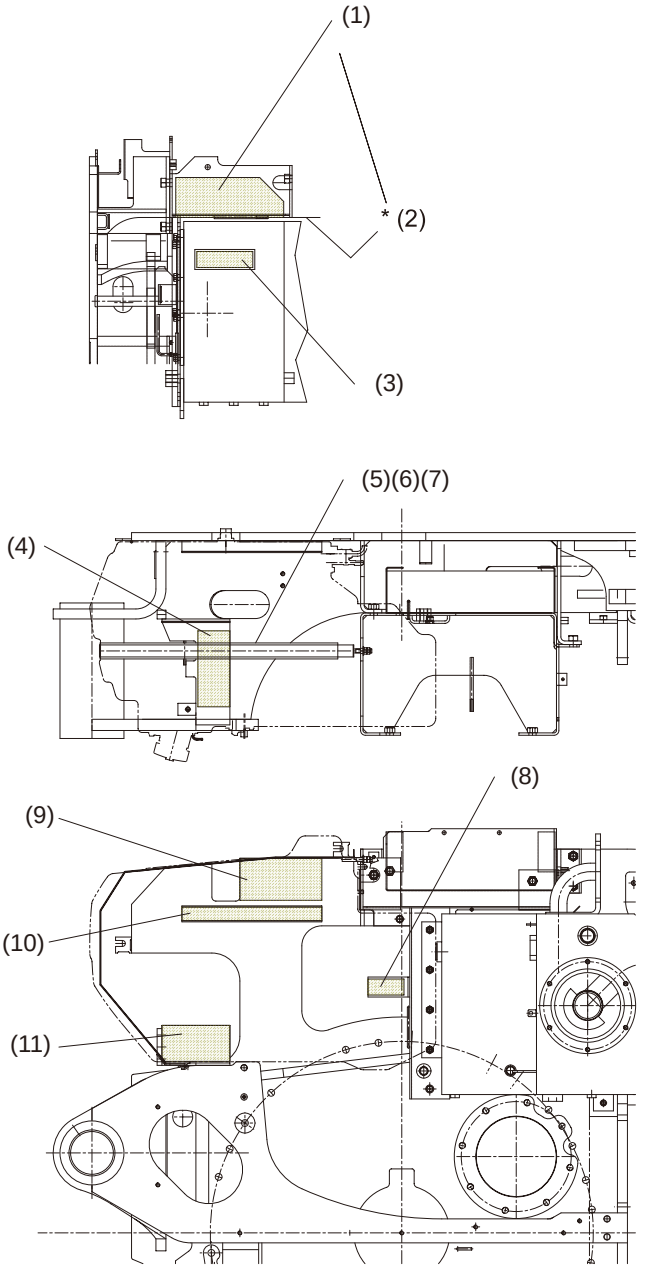
8.Fitting the plate assembly (fuel)

Tighten the assembly while holding the tank in position.
Tightening torque
48.1~55.9N.m(4.9~5.7kgf.m)35.5~41.2ft.lbs

(1)Band assembly (fuel tank)
(2)Plain washer
(3)Nut
(4)Plate assembly (fuel)

9.Attaching the cushions

Attach the cushions as shown in the figure.
* Wipe clean the cushions beforehand.



(1)Cushion (9, fuel tank)
* (2)To be attached along this line
(3)Cushion (3, fuel tank)
(4)Cushion (7, fuel tank)
(5)Band assembly (fuel tank)
(6)Plain washer
(7)Bolt
(8)Cushion (8, fuel tank)
(9)Cushion (2, fuel tank)
(10)Cushion (1, fuel tank)
(11)Cushion (6, fuel tank)

Fuel tube	Fuel tube length	Protective tube length
A	800mm(31.5in.)	705mm(27.8in.)
B	400mm(15.7in.)	300mm(11.8in.)
C	1700mm(66.9in.)	1650mm(65.0in.)
D	200mm(7.9in.)	150mm(5.9in.)
E	440mm(17.3in.)	350mm(13.8in.)
F	3800mm(149.6in.)	1450mm(57.1in.)
		2100mm(82.7in.)

f. Fuel hose

1.Routing condition

Make sure the hoses are out of contact with sharp edges, hot zones and moving parts.
Do not clamp the fuel hose and electrical cable together.
See if the hoses are not too tight or locally sagging.
Be careful not to affect the hose diameter.

2.Installing the protective tubes

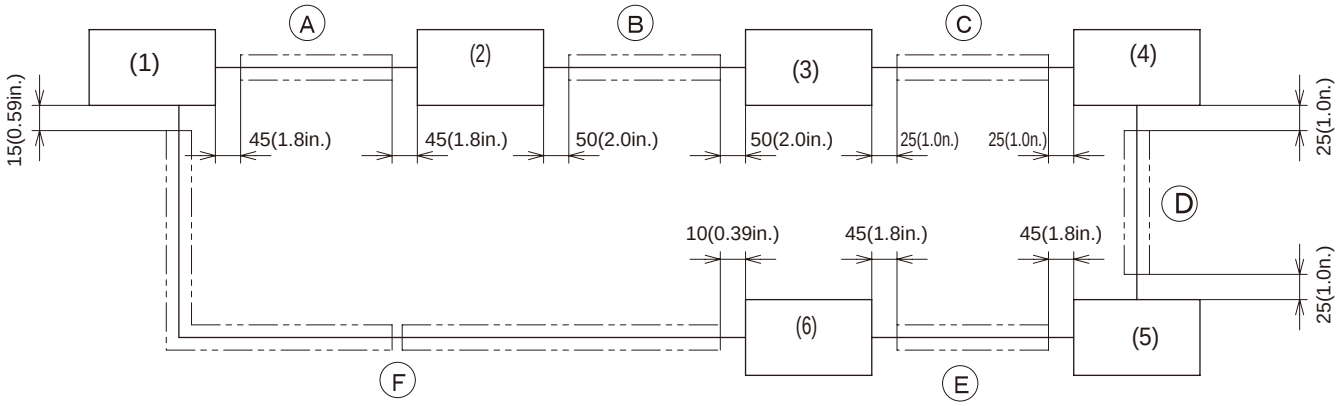
Strictly observe the dimensions specified in the figure.

(1)Fuel tank
(2)Fuel assembly separator
(3)Fuel pump
(4)Fuel filter assembly
(5)Engine
(6)T joint (fuel filter assembly)

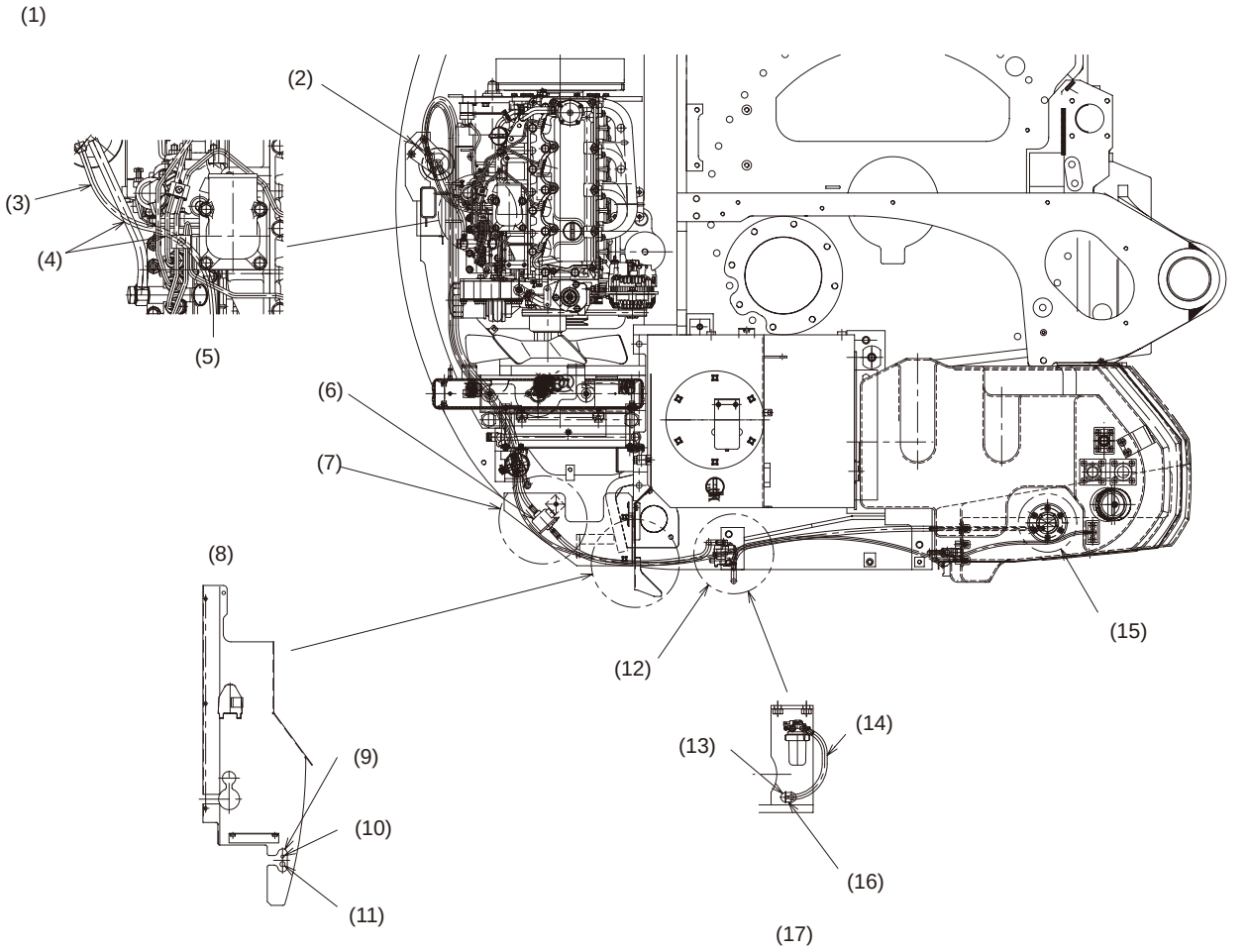
Hose clamp

(A)(B)(C)(D) → 14911-4275Δ Pipe clip

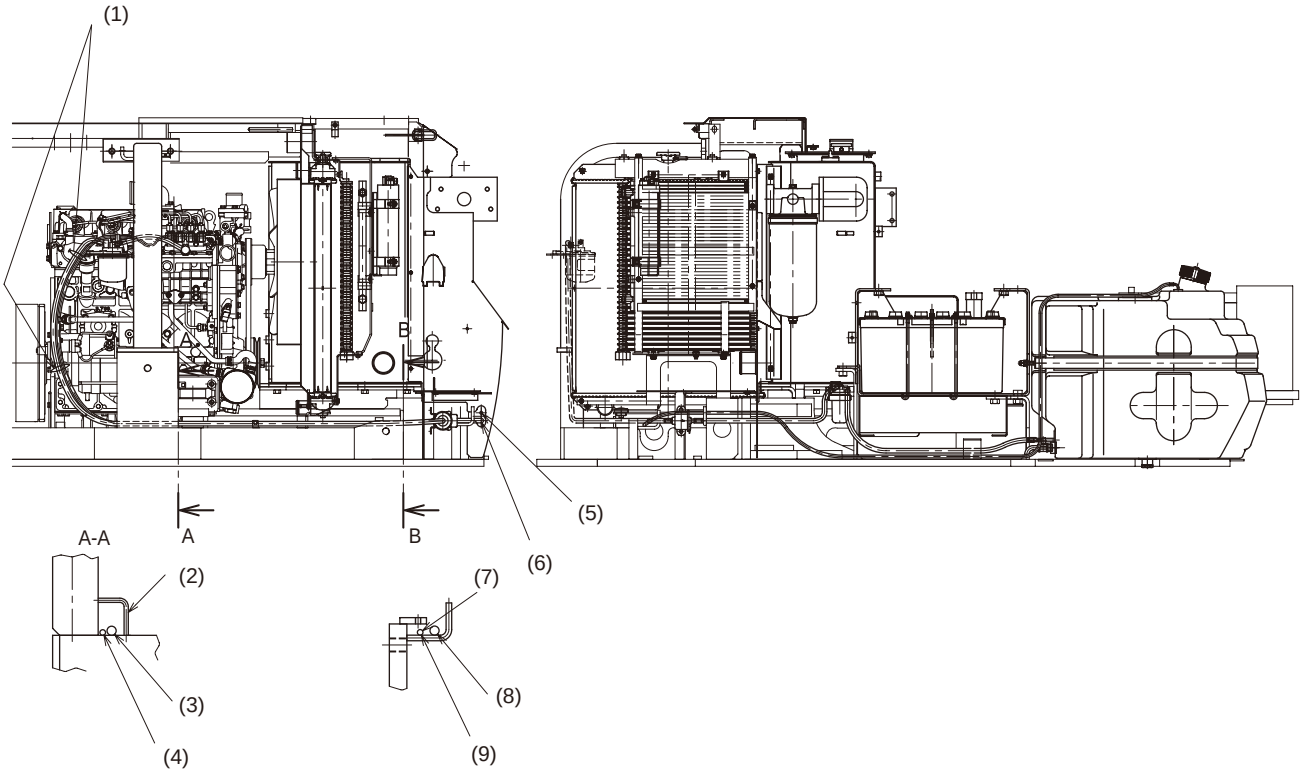
(E)(F) → 14971-4275Δ Pipe clip



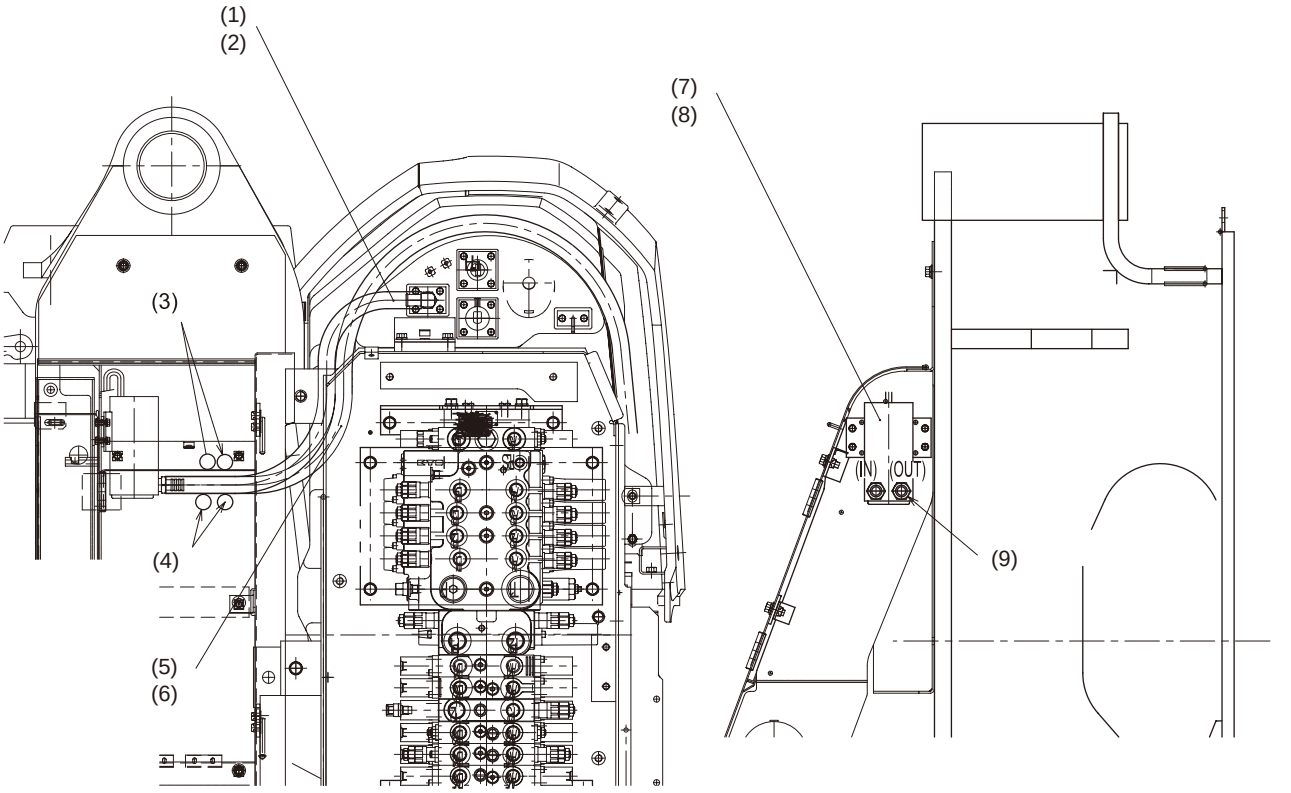
3.Routes of the fuel feed and return hoses



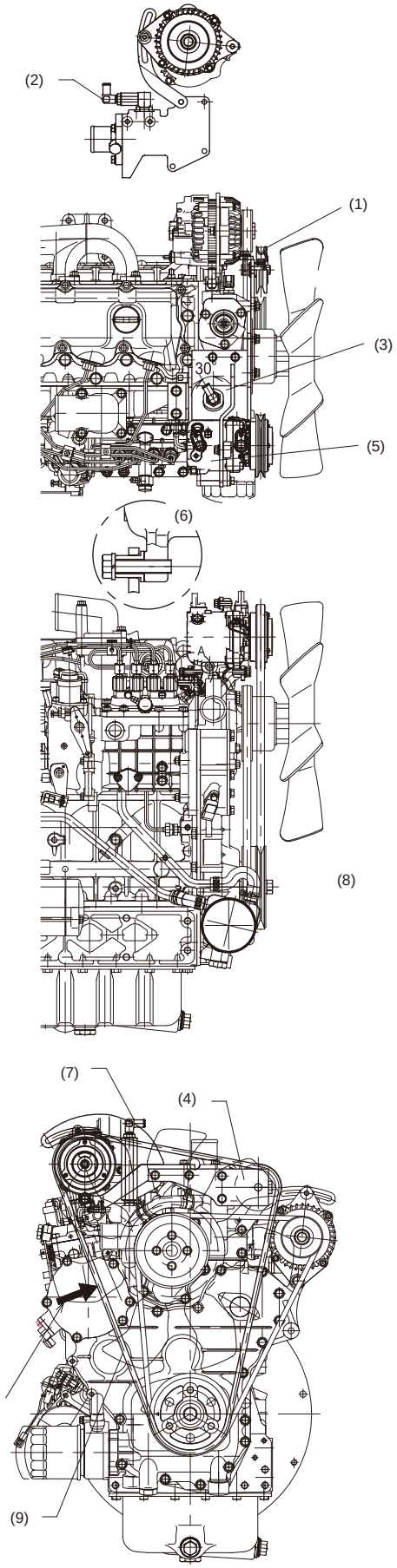
(1)
(2)Filter assembly (fuel)
(3)Fuel return hose
(4)Pass the fuel return hose below the fuel feed hose and the engine's injection pipe.
Then connect it to the engine.
(5)(Engine)
(6)Pump assembly (fuel)
(7)Pass the fuel return hose outside of the pump assembly (fuel) (RD411-5135Δ), as shown in the figure.
Note: Lay the fuel return hose out of contact with the pump.
(8)(Partition board)
(9)Pass through this notch of the partition board (RD809-4153Δ).
(10)Fuel return hose
(11)Fuel feed hose
(12)Filter assembly (separator)
(13)Fuel return hose
(14)Fuel feed hose
(15)Lay the fuel return hose out of contact with the sensor (fuel) connector.
(16)Pass through the oval hole of the swivel frame.
(17)(Battery mount of the swivel frame)



(1)Cord band
(2)Pass both the fuel feed and return hoses through the guide.
(3)Fuel feed hose
(4)Fuel return hose
(5)Fuel return hose
(6)Fuel feed hose
(7)Pass both the fuel feed and return hoses through the guide.
(8)Fuel feed hose
(9)Fuel return hose



(1)Hose (1, fuel, filler)
(2)Hose clamp (22-32)
(3)Swing hose
(4)Boom hose
(5)Hose (1, fuel, filler)
(6)Hose clamp (22-32)
(7)Pump assembly (fuel, filler)
(8)Bolt
(9)Connect to the fuel tank.



g. Compressor

1.Fitting the bracket (compressor) and bracket (pulley)

Fit the brackets in position as shown at left.
Tightening torque
17.7~20.6N.m(1.8~2.1kgf.m)13.1~15.2ft.lbs
M10
48.1~55.9N.m(4.9~5.7kgf.m)35.5~41.2ft.lbs

2.Fitting the compressor

Fitting the bushing (compressor)
Fit the parts in position as shown at left.
Tighten the bolts from the pulley side first.
Set the bushing with its collar inside.

3.Tightening the bolts

Tightening torque
17.7~20.6N.m(1.8~2.1kgf.m)13.1~15.2ft.lbs

4.Adjusting the tension of V belt (FM59)
Adjust the tension at the arrow-marked position as shown at left.
Belt deflection 12~15mm(0.47~0.59in.)
Pressing force
58.8~68.6N.m(6.0~7.0kgf.m)43.4~50.6ft.lbs

5.Fitting the joint (heat takeout), pipe joint (S, G1/4-G1/4) , elbow joint (G4-13) and joint (water return) for the heater hoses

Fit the joints as shown at left.
Adaptor tightening torque
R3/8
68.6~73.5N.m(7.0~7.5kgf.m)50.6~54.2ft.lbs
G1/4
24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs

(1)Tension pulley
Bolt
Bolt
(2)Joint (heat takeout)
Pipe joint (S, G1/4-G1/4)
O ring
Elbow joint (G4-13)
O ring
(3)Bracket (compressor)
Bolt
Bolt
(4)Bracket (pulley)
Bolt
Bolt
(5)Compressor
Bushing (compressor)
Bolt
Plain washer
(6)Details of A
(7)Joint (water return)
Elbow joint (G4-13)
O ring
(8)Check the compressor V belt tension here.
(9)V belt (FM59)

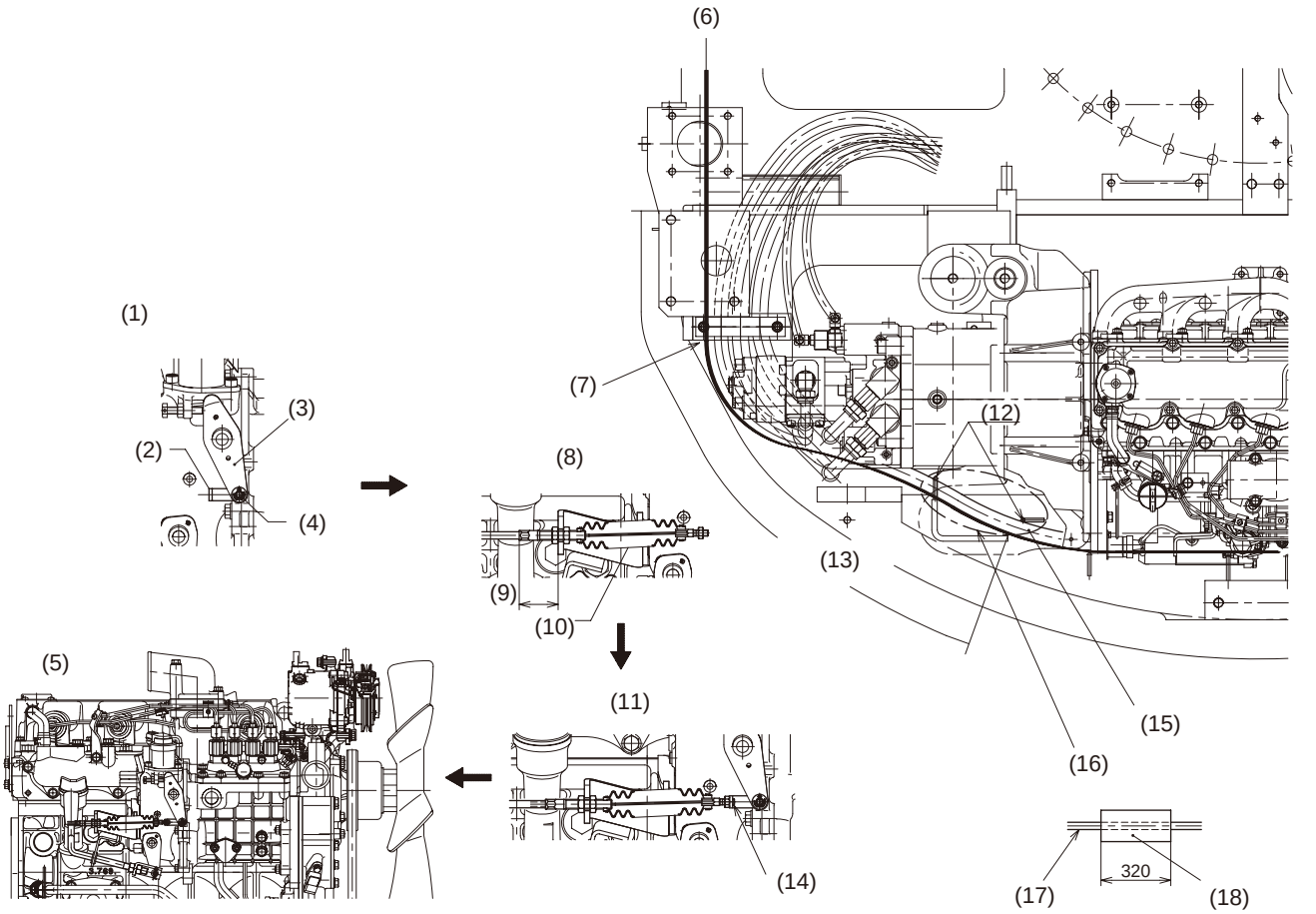
h.Control cable

1.Connecting the cable (acceleration)

Connect the cable in the order as shown in the figure.

2.Routing the cable (acceleration)

Lay the cable in the route as shown at left.



(1)Connecting the cable (acceleration)
1) Install the wire fixture (36919-1033Δ) on the engine-side acceleration lever.
(2)Wire fixture
(3)Engine-side acceleration lever
(4)Plain washer
Cotter pin
(5) 4) Connections and routing complete
(6)To AI motor
(7)Pass outside of the A/C hose.
(8) 2) Connect the cableÅfs outer adjuster along the near center of the bracket (acceleration cable).
(9)32 (reference)
(10)Cable (acceleration)
(11) 3) Join the wire fixture and the cable together and tighten up the nut.
(12)Guide bar
(13)Take the same route along the A/C hose in this arrow-marked zone.
(14)Screw in until two threads or so (about 1 mm) stretch out.
(15)A/C hose
(16)Pass the cable so that the sponge (EPDM material) around the cable comes to these two guides (6 mm dia. round bars).
(17)A/C hose
(18)EPDM material (sponge)

i. Fan belt

1.Fitting the oil switch

Tightening the oil switch

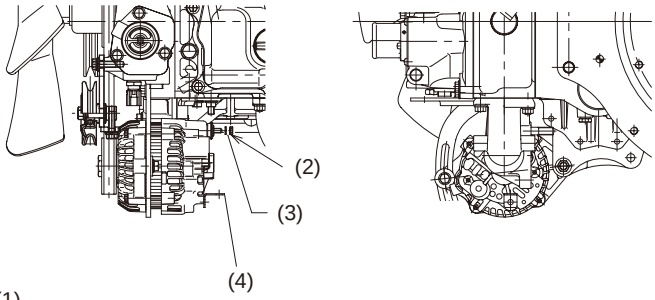
Fit the oil switch in position as shown at left.
PT1/8 size
7.8~9.3N.m(0.8~0.95kgf.m)5.8~6.9ft.lbs

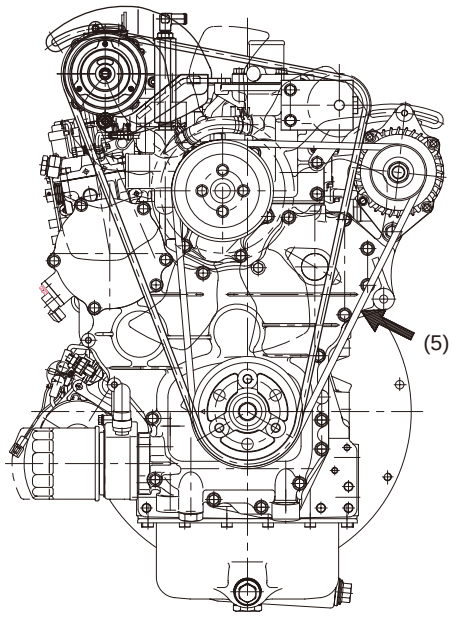
2.Fitting the plate (clamp,2)

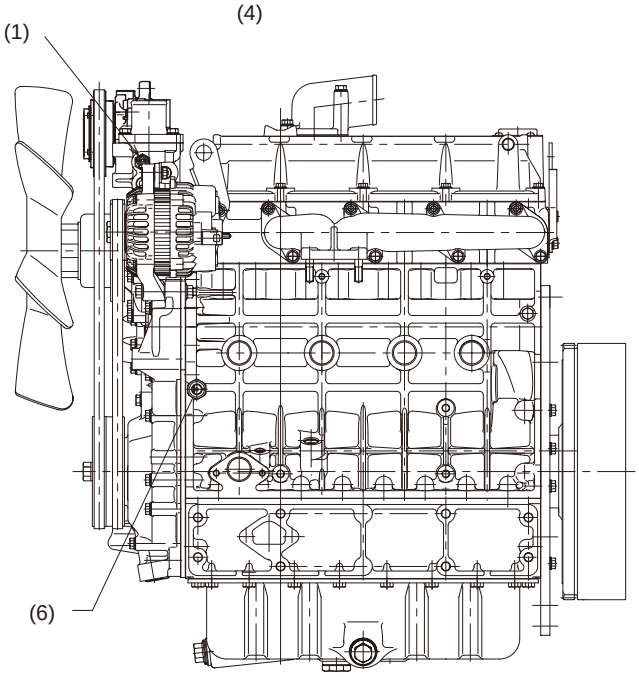
Fit the plate in position as shown at left.

3.Fan belt tension

Before mounting the engine, press on the arrow-marked position in the figure to see if the tension is proper.







(1)Water temperature switch
(to be installed at Engineering staff before shipping)
(2)Used in connecting the alternator wire harness
(3)Spring washer
Nut
(4)Plate (clamp, 2)
Plain washer
Washer-fitted machine screw
(5)Press with a force of 10 kgf to make sure the deflection is 6-8 mm.
(6)Oil switch

j. Engine stop lever

1.Fitting the sensor (rpm)

Tightening the flange bolt

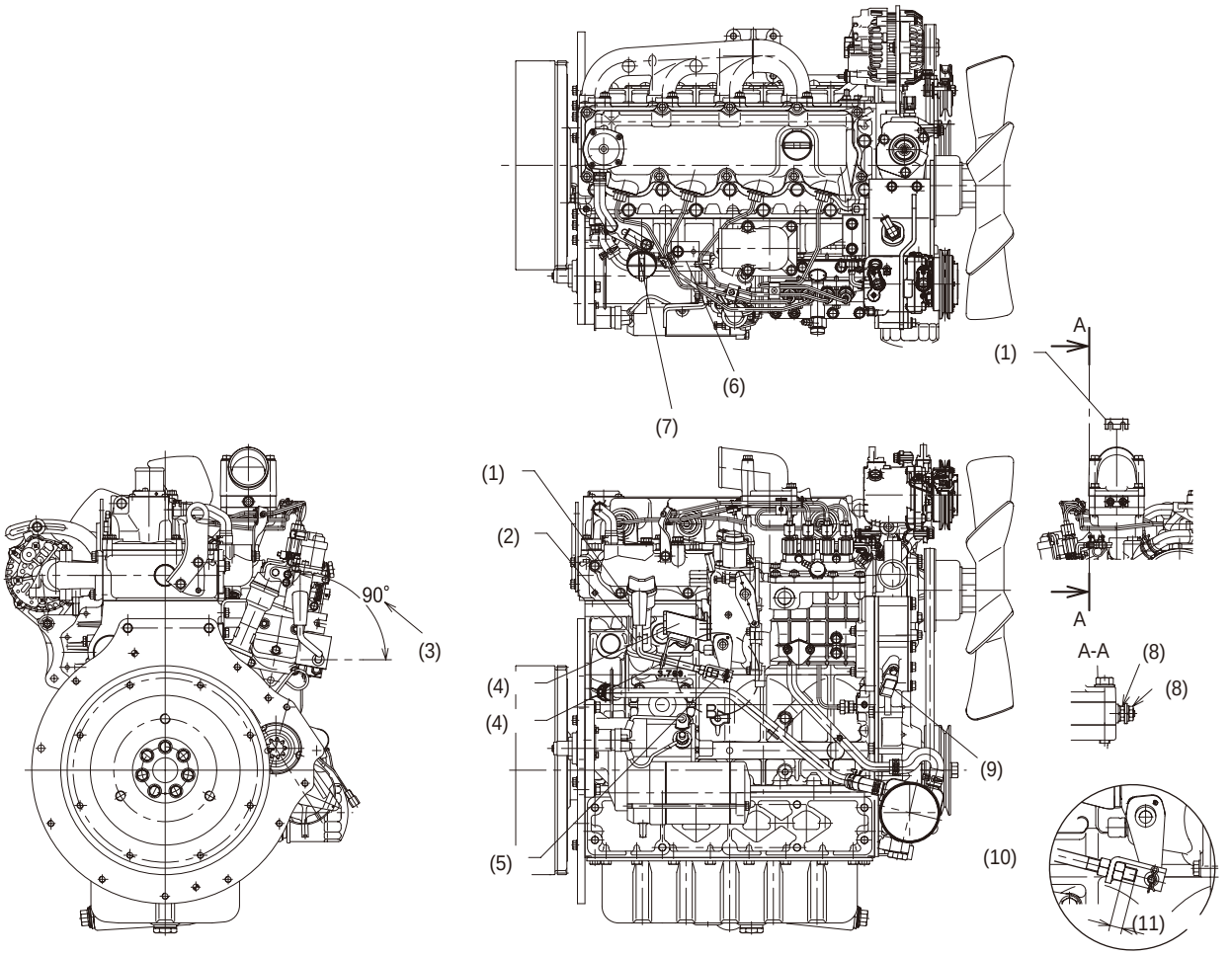
Fit the sensor in position as shown at left.
Tightening torque
7.8~9.3N.m(0.8~0.95kgf.m)5.8~6.9ft.lbs

2.Fitting the plate (bus bar)

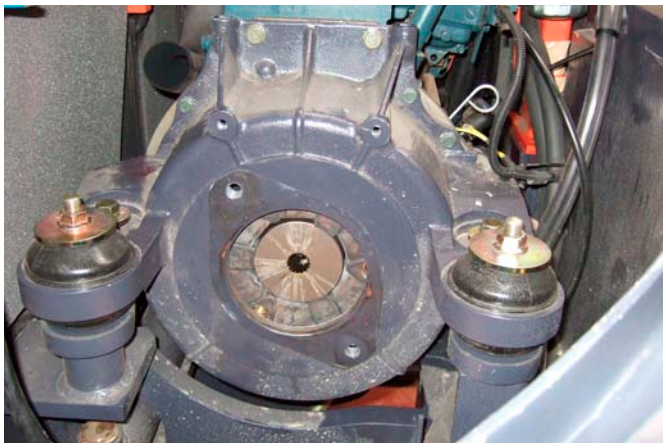
Install the plate between No. 1 and No. 2 nuts at the air intake of the engine inlet, as shown at left.
Tightening torque

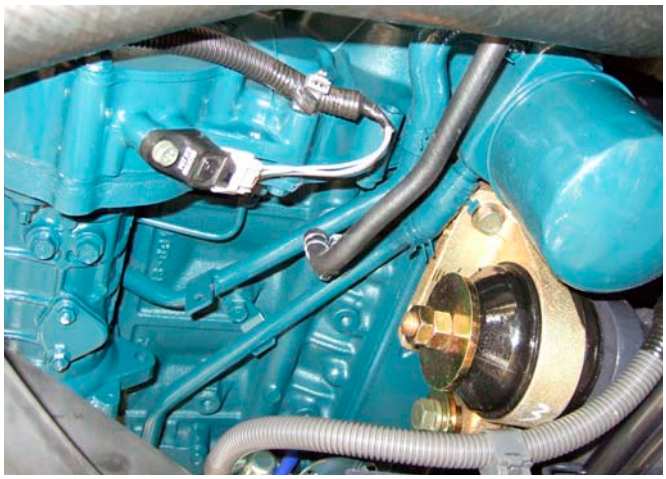
3.Fitting the engine stop lever

Fit the lever in position as shown at left.

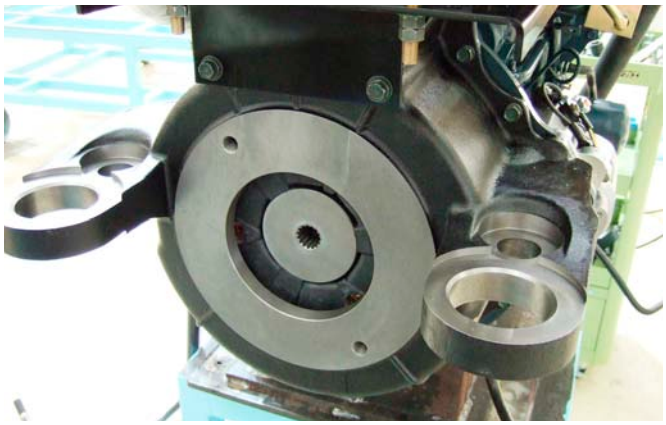


(1)Lever grip
(2)Lever (engine stop)
Nut
(3)Engine stop lever angle
10/Bracket (acceleration cable)
Grommet (engine stop)
(4)Link (engine stop)
Headed pin
Plain washer
Snap pin
(5)Plate (bus bar)
(6)Plate (clamp, 1)
Bolt
(7)Stay (wire harness clamp)
Bolt
(8)No. 1 nut
No. 2 nut
(9)Sensor (rpm)
Flange bolt
(10)Details of B
(11)10 (leverÅfs screw setting length)



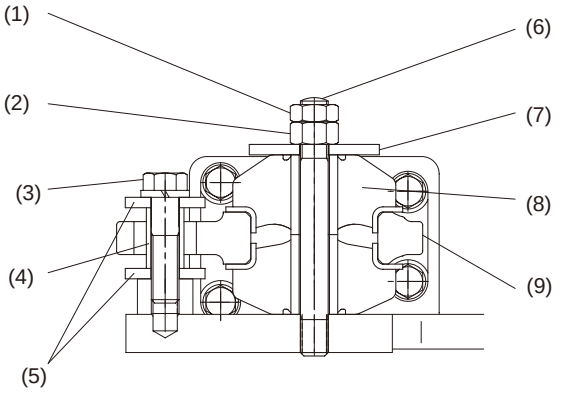


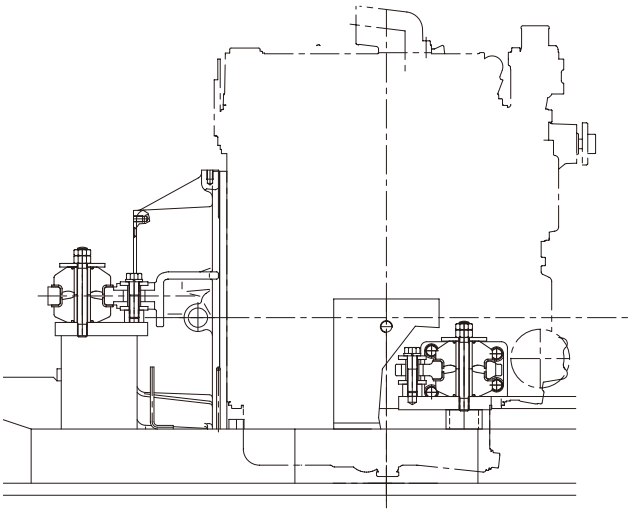




k. Engine bracket

1. Overall view.





2.Fitting the engine bracket

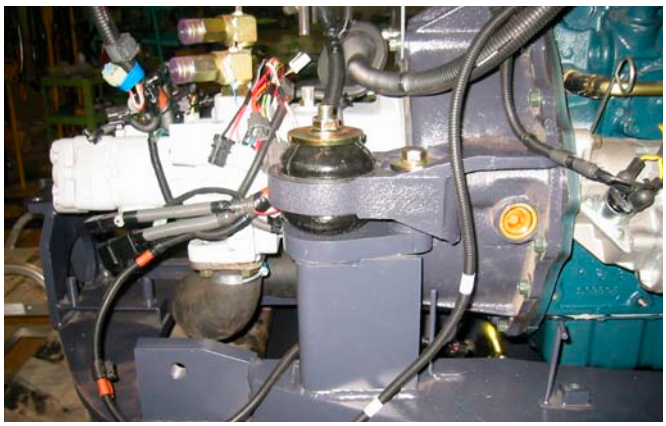
Tightening torque
M12
77.5~90.2N.m(7.9~9.2kgf.m)57.2~66.5ft.lbs
M16
196.1~225.6N.m(20.0~23.0kgf.m)
144.6~166.4ft.lbs
Apply screw adhesive (Loctite 271).

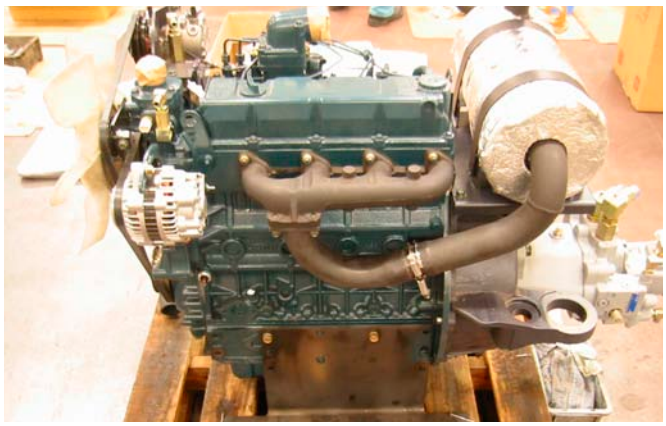
3.Fitting the anti-vibration rubber

Fit the rubber as shown in the figure.
Double nut tightening torque
No. 1 nut
88.2~107.8N.m(9.0~11.0kgf.m)65.1~79.5ft.lbs
No. 2 nut
166~191N.m(17.0~19.5kgf.m)122.4~140.9ft.lbs
Apply screw adhesive (Loctite 271).

(1)(No. 2 nut)
(2)(No. 1 nut)
(3)Bolt
(4)Collar
(5)Washer
(6)Stud
(7)Washer
(8)Anti-vibration rubber
(9)(Right back)Bracket (1, engine)
(Right front)Bracket (2, engine)
Bolt









I. Engine assy

1. Remove and dismount the following parts.
   1)Radiator assy
   2)Air cleaner assy
   3)Bonnet and arch
   4)Wireharness
   5)Fuel hoses
   6)Mount bracket

D.Engine WSM

TO THE READER

The following engine WSM has been compiled after minor changing of original V3800DI engine WSM by eliminating some pages which doesn't apply to construction machinery model of KX080-3.
Still some pages contain common specifications on V3800DI series engine.
Therefore, some date may differ from the engine mounted on constructinon machinery.
In that case, please come to the specifications in the front pages of KX080-3 WSM engine chapter.

July 2006

****

This Workshop Manual has been prepared to provide servicing personnel with information on the mechanism, service and maintenance of V3800DI-E2B, V3800DI-T-E2B. 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. 97897-01870) 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 2004

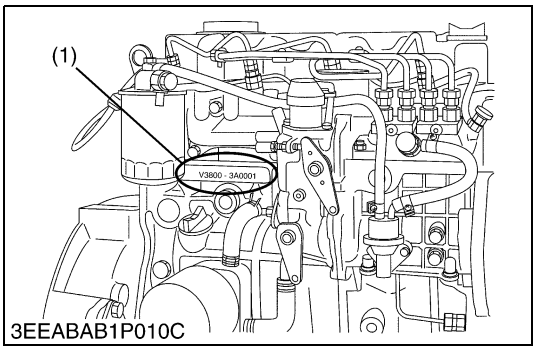
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General

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[2] CYLINDER NUMBER III-S-33
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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 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 ~

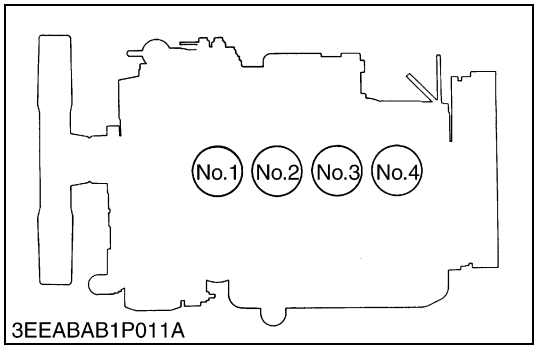
e.g. V3800-3A0001

"3" indicates 2003 and "A" indicates January.

So, 3A indicates that the engine was manufactured in January, 2003.

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[2] CYLINDER NUMBER



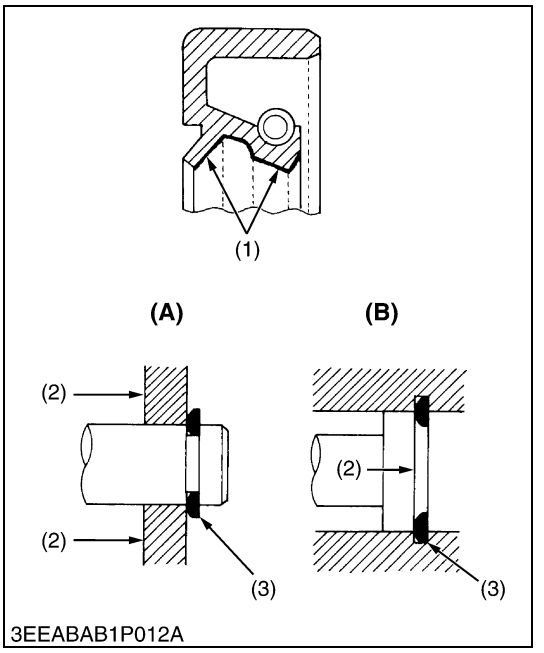
3EEABAB1P011A

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



- 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.

Item	Service Interval									
	Initial 50 hrs	Every 50 hrs	Every 250 hrs	Every 500 hrs	Every 1000 hrs	Every 1 or 2 months	Every 1500 hrs	Every 3000 hrs	Every 1 year	Every 2 years
Changing engine oil	*			*					*	
Replacing oil filter cartridge	*			*						
*Checking fuel hoses and clamps		*								
*Cleaning air filter element (Replace the element after 6 times cleanings)			*							
*Cleaning fuel filter			*							
Checking battery electrolyte level			*							
Checking radiator hoses and clamps			*							
*Checking intake air line			*							
Checking fan belt tension and damage	*		*							
*Replacing fuel filter cartridge				*						
Replacing fan belt				*						*
Cleaning radiator interior				*						
Checking valve clearance					*					
Recharging battery						*				
*Checking injection nozzle condition							*			
*Checking turbocharger								*		
Checking fuel injection pump								*		
*Checking injection timing (spill timing)								*		
*Replacing air filter element									*	
Changing radiator coolant (L.L.C.)										*
Replacing radiator hoses and clamps										*
*Replacing fuel hoses and clamps										*
*Replacing intake air line										*
Replacing battery										*

* 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

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

■ **NOTE**

Lubricating Oil

With the emission control now in effect, the CF-4 and CG-4 lubricating oils have been developed for use of a low-sulfur fuel on-road vehicle engines. When an off-road vehicle engine runs on a high-sulfur fuel, it is advisable to employ the CF, CD or CE lubricating oil with a high total base number. If the CF-4 or CG-4 lubricating oil is used with a high-sulfur fuel, change the lubricating oil at shorter intervals.

- **Lubricating oil recommended when a low-sulfur or high-sulfur fuel is employed.**

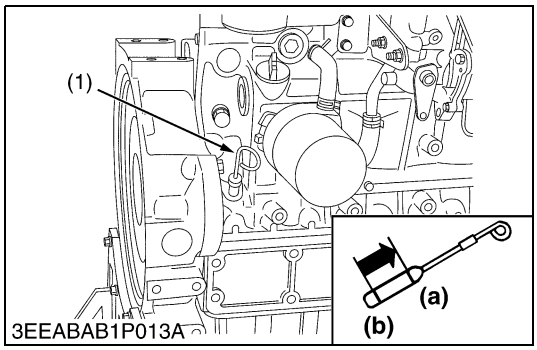
Fuel / Lubricating oil class	Low sulfur (0.5 % ≥)	High sulfur	Remarks
CF	O	O	TBN ≥ 10
CF-4	O	X	
CG-4	O	X	

O : Recommendable X : Not recommendable

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4. CHECK AND MAINTENANCE

[1] DAILY CHECK POINTS



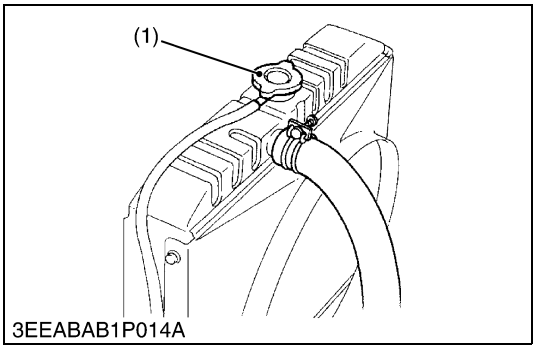
Checking Engine Oil Level

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.

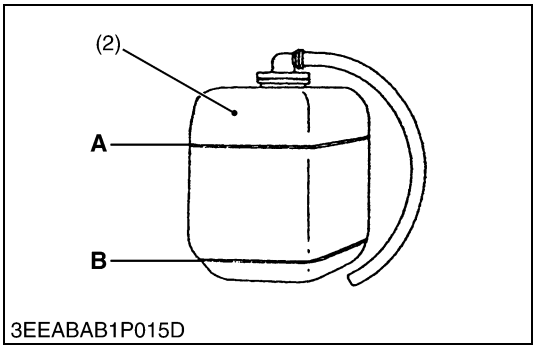
- **When using an oil of different maker or viscosity from the previous one, drain old oil. Never mix two different types of oil.**
- **Be sure to inspect the engine, locating it on a horizontal place. If placed on gradients, accurately, oil quantity may not be measured.**
- **Be sure to keep the oil 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

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3EEABAB1P015D

Checking and Replenish Coolant

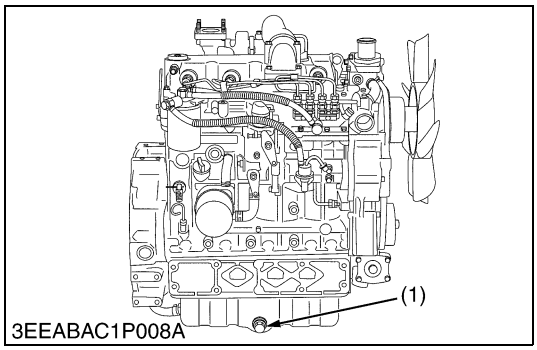
1. Without recovery tank :
   Remove the radiator cap (1) and check to see that the coolant level is just below the port.
   With recovery tank (2) :
   Check to see that the coolant level lies between **FULL** (**A**) and **LOW** (**B**).
2. If coolant level is too low, check the reason for decreasing 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.

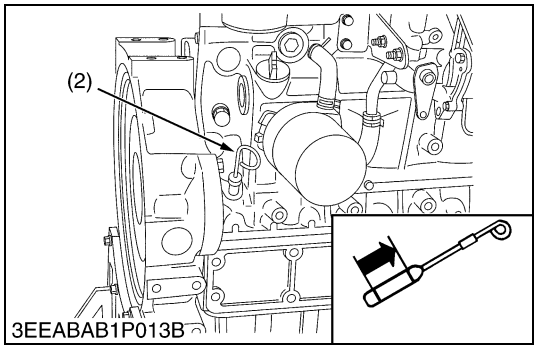
- **Do not remove the radiator cap until coolant temperature is below its boiling point. Then loosen the cap slightly to relieve any excess pressure before removing the cap completely.**
- **During filling the coolant, air must be vented from the engine coolant passages. The air vents by jiggling the 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





Changing Engine Oil

- **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).

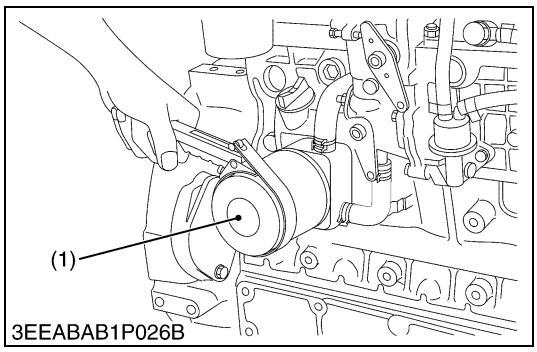
- **When using an oil of different maker or viscosity from the previous one, remove all of the old oil.**
- **Never mix two different types of oil.**
- **Engine oil should have properties of API classification CD/CE/CF/CF-4/CG-4.**
- **Use the proper SAE Engine Oil according to ambient temperature.**

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

Engine oil capacity	13.2 L 3.49 U.S.gals

(1) Drain Plug (2) Dipstick

W1016604



Replacing Oil Filter Cartridge

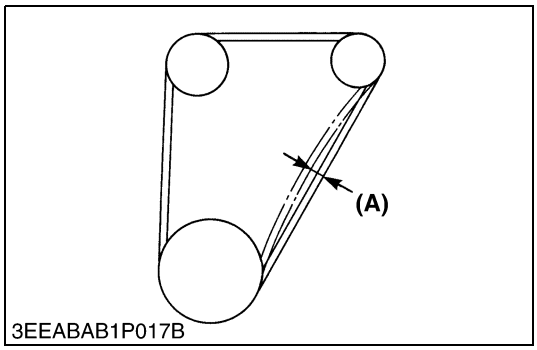
- **Be sure to stop the engine before changing filter cartridge.**

1. Remove the oil filter cartridge (1) with the filter wrench.
2. Apply a slight coart 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.

- **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

W1017137



Fan Belt Tension

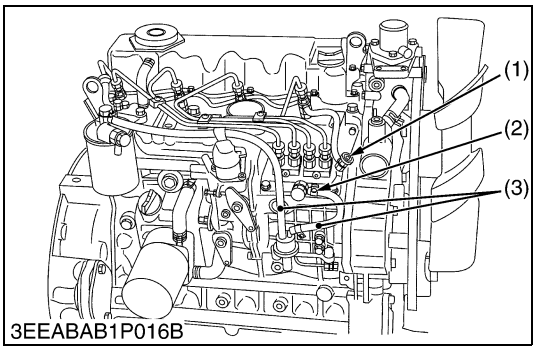
1. Measure the deflection **(A)**, depressing the belt halfway between the fan drive pulley and alternator pulley at specified force 98 N (10 kgf, 22 lbs).
2. If the measurement is not within the factory specifications, loosen the alternator mounting screws and relocate the alternator to adjust.

Deflection **(A)**	Factory spec.	10 to 12 mm 0.394 to 0.472 in.

(A) Deflection

W1208957

[3] CHECK POINT OF EVERY 50 HOURS



Checking Fuel Hose and Clamp Bands

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

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

(When bleeding fuel system)

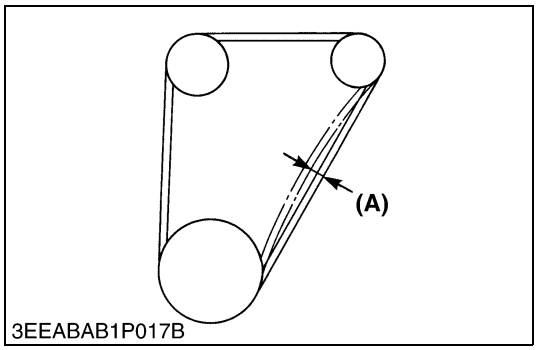
1. Fill the tank with fuel and open the cock.
2. Loosen the air vent coupling bolt of fuel filter a few turns.
3. When there is no more air bubbles in the fuel coming out of this coupling bolt, tighten the coupling bolt.
4. Open the air vent cock (1) on the top of fuel injection pump.
5. If equipped electrical fuel feed pump, turn the key on **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 (1) after air bleeding.

- **Except when venting the air, be sure to keep closed the air vent coupling bolt of the fuel injection pump. Otherwise, the engine may stall.**

(1) Air Vent Cock
(2) Clamp
(3) Fuel Hose

W1035921

[4] CHECK POINTS OF EVERY 250 HOURS



3EEABAB1P017B

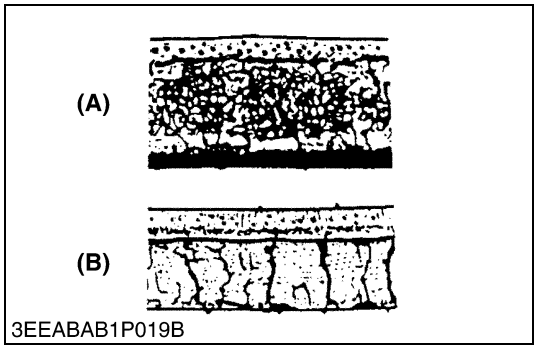
Fan Belt Tension

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 lbs).
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.	10 to 12 mm 0.394 to 0.472 in.

(A) Deflection

W1014131



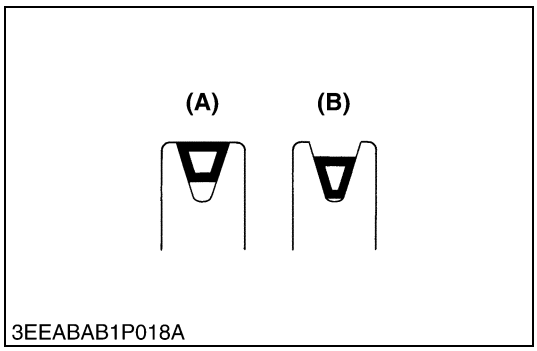
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Fan Belt Damage and Wear

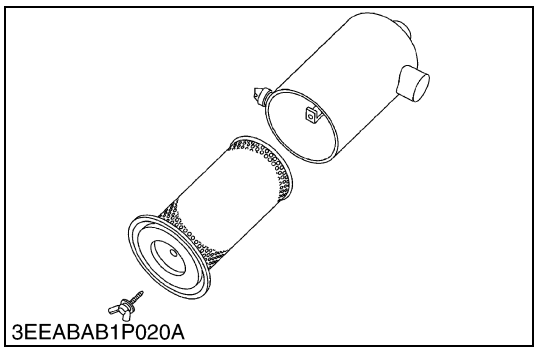
1. Check the fan belt for damage.
2. If the fan belt is damaged, replace it.
3. Check if the fan belt is worn and sunk in the pulley groove.
4. If the fan belt is nearly worn out and deeply sunk in the pulley groove, replace it.

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

W1209480



3EEABAB1P018A

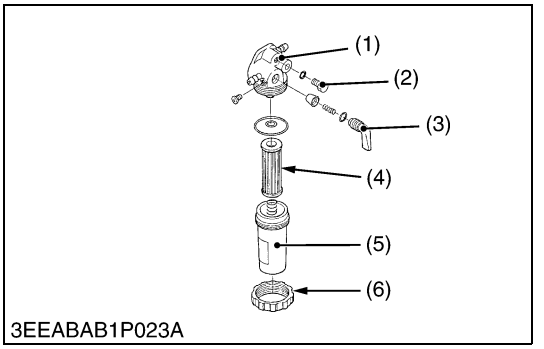

3EEABAB1P020A

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 205 kPa (2.1 kgf/cm^2, 30 psi).
   Maintain reasonable distance between the nozzle and the filter.

- **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

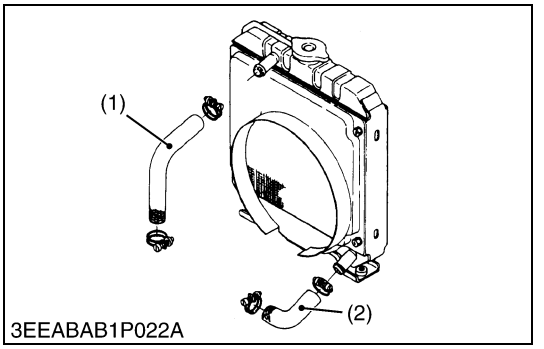
Cleaning Fuel Filter (Element Type only)

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.

- **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 filter cup (5) periodically.**

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

W1046058



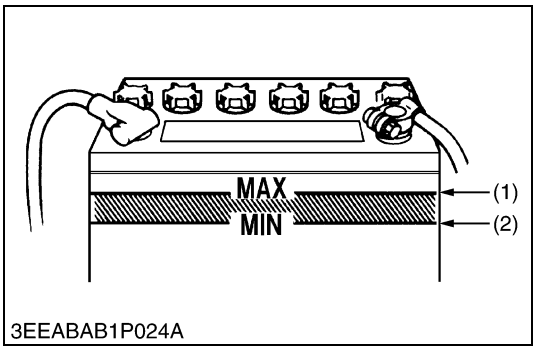
3EEABAB1P022A

Checking Radiator Hoses and Clamp Bands

1. Check to see if the radiator hoses are properly fixed every 250 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



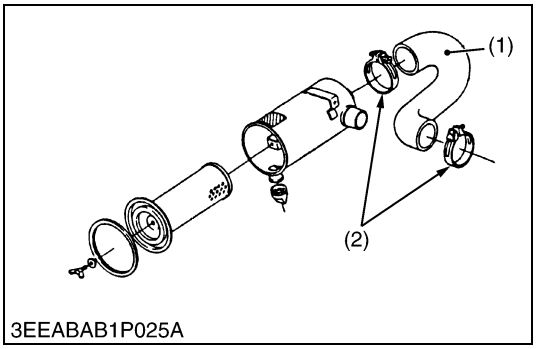
3EEABAB1P024A

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



3EEABAB1P025A

Checking Intake Air Line

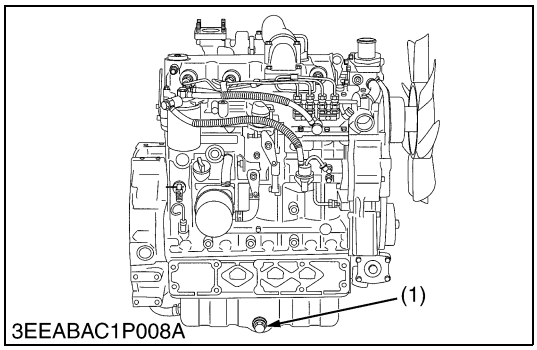
1. Check to see if the intake air hose(s) are properly fixed every 250 hours of operation.
2. If the clamp is loose, apply oil to the threads and retighten it securely.
3. The intake air hose(s) is made of rubber and tends to age. It must be change every two years. Also change the clamp and tighten it securely.

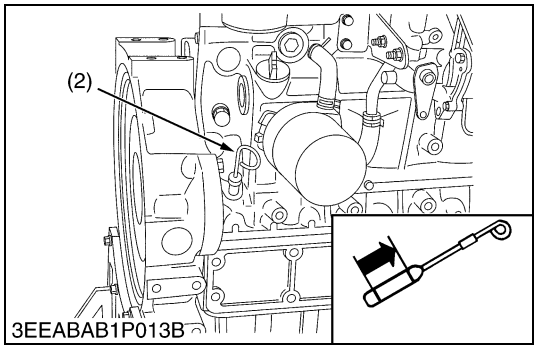
- **To prevent serious damage to the engine, keep out any dust inside the intake air line.**

(1) Intake Air Hose
(2) Clamp

W1029631

[5] CHECK POINTS OF EVERY 500 HOURS





Changing Engine Oil

- **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).

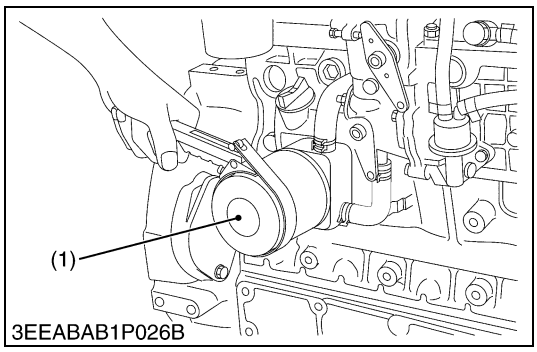
- **When using an oil of different maker or viscosity from the previous one, remove all of the old oil.**
- **Never mix two different types of oil.**
- **Engine oil should have properties of API classification CD/CE/CF/CF-4/CG-4.**
- **Use the proper SAE Engine Oil according to ambient temperature.**

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

Engine oil capacity	13.2 L 3.49 U.S.gals

(1) Drain Plug (2) Dipstick

W1014590



Replacing Oil Filter Cartridge

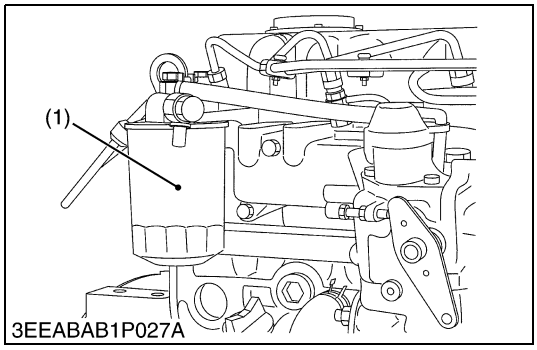
- **Be sure to stop the engine before changing filter cartridge.**

1. Remove the oil filter cartridge (1) with the filter wrench.
2. Apply a slight coart 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.

- **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

W1015117



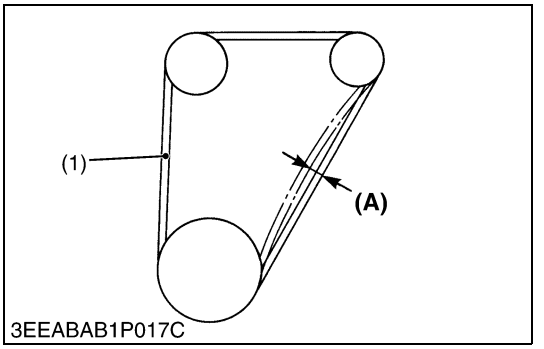
Replacing Fuel Filter Cartridge (Cartridge Type)

Water and dust in fuel are collected in the filter cartridge. So, change the filter cartridge every 500 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

W1037062



3EEABAB1P017C

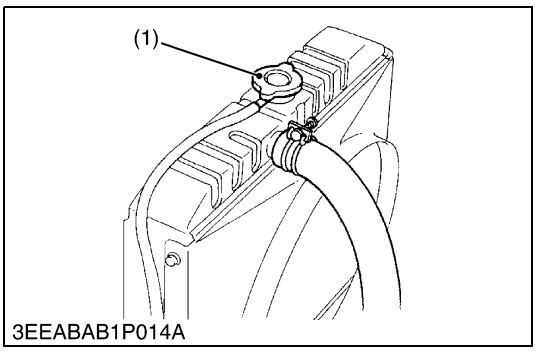
Replacing Fan Belt

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.

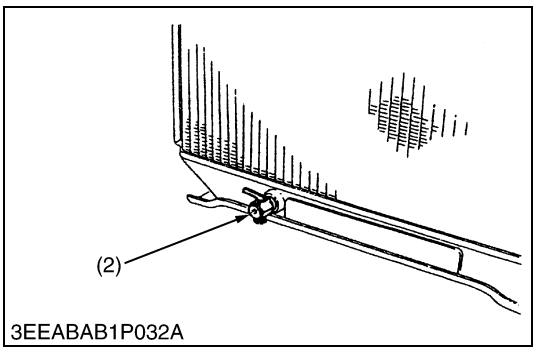
Deflection **(A)**	Factory spec.	10.0 to 12.0 mm / 98 N 0.394 to 0.472 in. / 98 N (10 kgf, 22 lbs)

(1) Fan Belt **(A) Deflection**

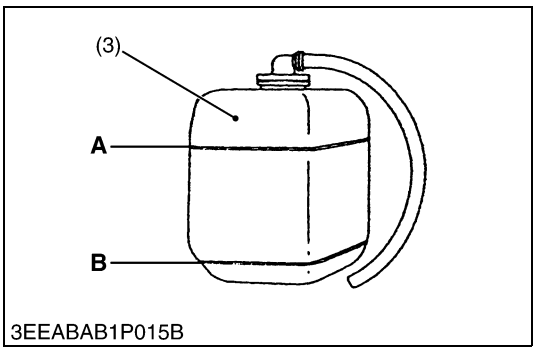
W1052220



3EEABAB1P014A



3EEABAB1P032A



3EEABAB1P015B

Cleaning Water Jacket and Radiator Interior

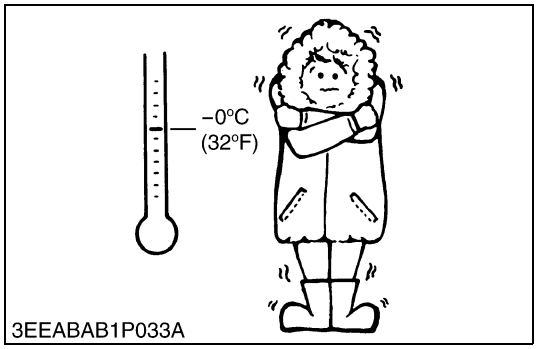
- **Do not remove the radiator cap when the engine is hot. Then loosen cap slightly to the stop to relieve any excess pressure before removing cap completely.**

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.

- **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 **A : Full**
(2) Drain Plug **B : Low**
(3) Recovery Tank

W1038102



3EEABAB1P033A

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.
- **When the anti-freeze is mixed with fresh, soft water, the anti-freeze mixing ratio must be less than 50 %.**

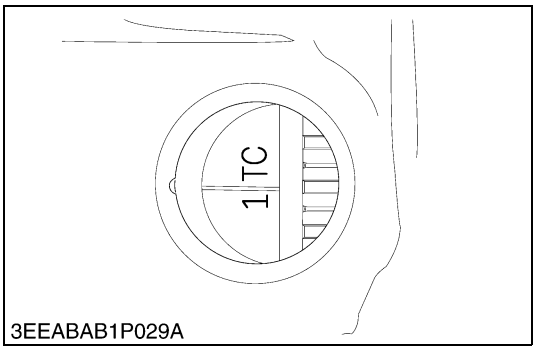
Vol % anti-freeze	Freezing point		Boiling point*	
	°C	°F	°C	°F
40	–24	–11.2	106	222.8
50	–37	–34.6	108	226.4

* At 1.013 × 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.

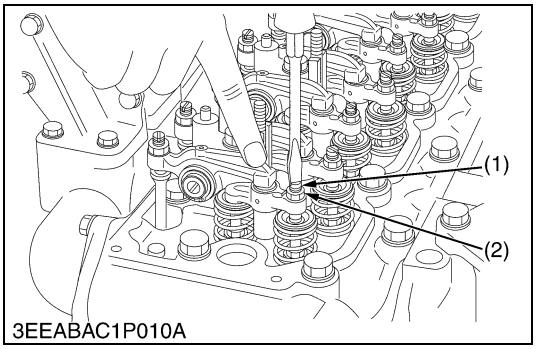
- **The above data represents industrial standards that necessitate a minimum glycol content in the concentrated anti-freeze.**
- **When the coolant level drops due to evaporation, add fresh, soft water only to keep the anti-freeze mixing ratio less than 50 %. In case of leakage, add anti-freeze and 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

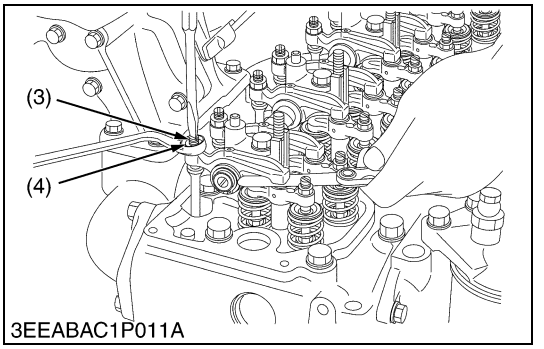
[6] CHECK POINT OF EVERY 1000 HOURS



3EEABAB1P029A



3EEABAC1P010A



3EEABAC1P011A

Checking Valve Clearance

- **Valve clearance must be checked and adjusted when engine is cold.**

1. Remove the high pressure pipes and the head cover.
2. Align the 1TC mark of flywheel and the convex of flywheel housing timing windows so that the first piston (gear case side) comes to the compression top dead center.
3. Before adjusting the valve clearance, adjust the bridge evenly to the valve stem.
4. Loosen the lock nut (2) and adjust with screw (1).
5. Slightly push the rocker arm by your fingers and screw in the adjusting screw slowly until you feel the screw touch the top of valve stem, then tighten the lock nut.
6. Loosen the lock nut (4) of adjusting screw (3) (push rod side) and insert the thickness gauge between the rocker arm and the bridge head. Set the adjusting screw to the specified value, then tighten the lock nut.

Valve clearance	Factory spec.	0.23 to 0.27 mm 0.0091 to 0.0106 in.

- **After adjusting, tighten the lock nut (4) securely.**

Valve arrangement Adjustment cylinder Location of piston		IN.	EX
When No.1 piston is at compression top dead center	1st	*	*
	2nd	*	
	3rd		*
	4th		
When No.1 piston is at overlap position	1st		
	2nd		*
	3rd	*	
	4th	*	*

Tightening torque	Cylinder head cover screw	6.9 to 11.3 N·m 0.7 to 1.15 kgf·m 5.1 to 8.32 ft-lbs
	Injection pipe retaining nut	19.6 to 24.5 N·m 2.0 to 2.5 kgf·m 14.5 to 18.1 ft-lbs

(1) Adjusting Screw
(2) Lock Nut
(3) Adjusting Screw
(4) Lock Nut

W1037215

[7] CHECK POINTS OF EVERY 1 OR 2 MONTHS

Recharging

- **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.

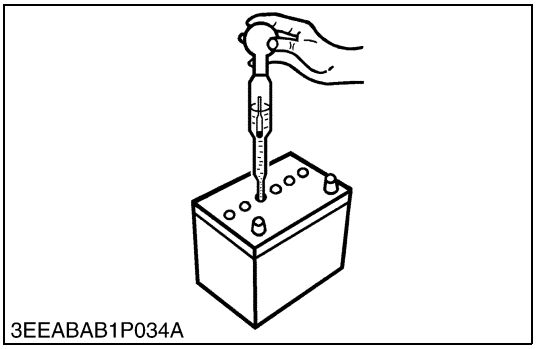
2) Quick Charging

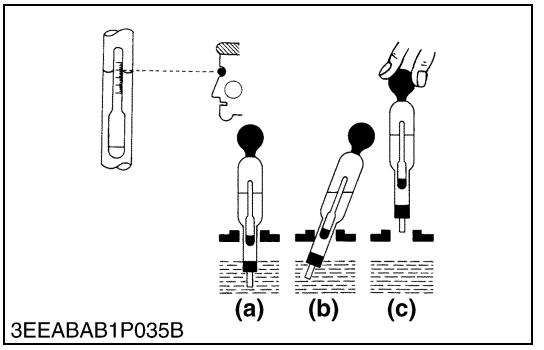
1. Determine the proper charging current and charging time with the tester attached to the quick charger.
2. Determine the proper charging current as 1/1 of the battery capacity. If the battery capacity exceeds 50 Ah, consider 50 A as the maximum.

<Dingbats>n 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.

- **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

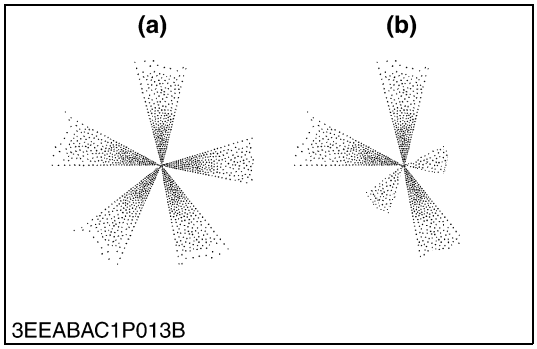
At an electrolyte temperature of 20 °C (68 °F)

(a) Good
(b) Bad
(c) Bad

W1012763

[8] CHECK POINTS OF EVERY 1500 HOURS

- **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.**



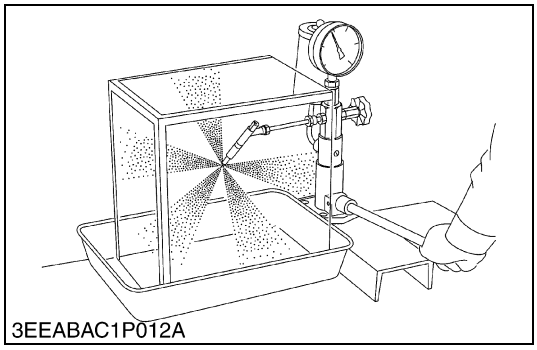
3EEABAC1P013B

Nozzle Spraying Condition

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 or repair at Denso service shop.

(a) Good **(b) Bad**

W10411400


3EEABAC1P012A

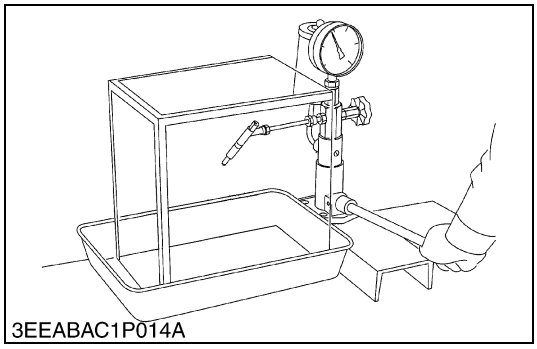
Checking Nozzle Injection Pressure

1. Set the injection nozzle to the 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 or repair at Denso service shop.

- **Injection nozzle gasket must be replaced when the injection nozzle is removed for checking.**

Injection pressure	Factory spec.	1st stage	18.63 to 19.61 MPa 190 to 200 kgf/cm^2 2702 to 2845 psi

W1024942


3EEABAC1P014A

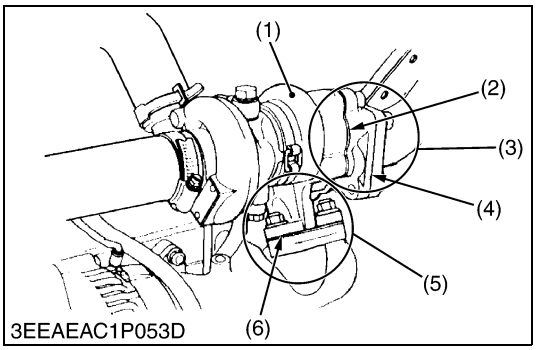
Valve Seat Tightness

1. Set the injection nozzle to a nozzle tester.
2. Raise the fuel pressure, and keep at 16.67 MPa (170 kgf/cm^2, 2418 psi) for 10 seconds.
3. If any fuel leak is found, replace the injection nozzle assembly or repair at Denso service shop.

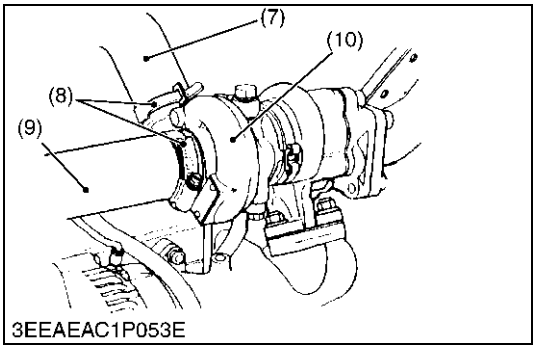
Valve seat tightness	Factory spec.	No fuel leak at 16.67 MPa 170 kgf/cm^2 2418 psi

W10412730

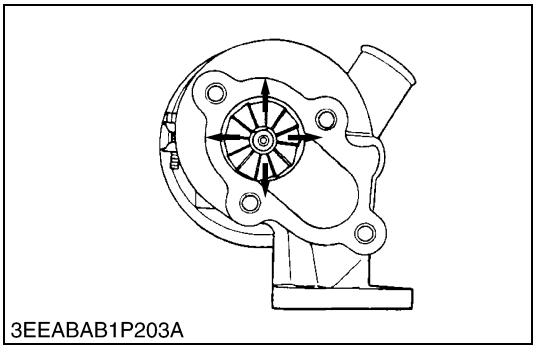
[9] CHECK POINTS OF EVERY 3000 HOURS



3EEAEAC1P053D



3EEAEAC1P053E


3EEABAB1P203A

Checking Turbocharger

(Turbine Side)

1. Check the exhaust port (3) and inlet port (5) 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 (2) / (4) / (6) with new one.

(Compressor Side)

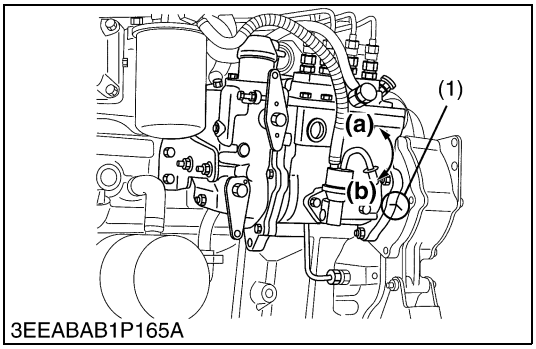
1. Check the inlet hose (9) of the compressor cover (10) to see if there is no air leak.
2. If any air leak is found, change the clamp (8) and / or inlet hoses.
3. Check the intake hose (7) and the clamp to see if there is not loose or crack.
4. If any loose or crack is found, tighten the cramp or change the hose to prevent dust from entry.

(Radial Clearance)

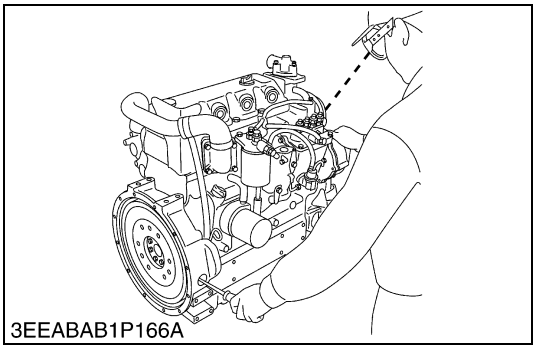
1. If the wheel contact to the housing, replace the turbocharger assembly with new one.

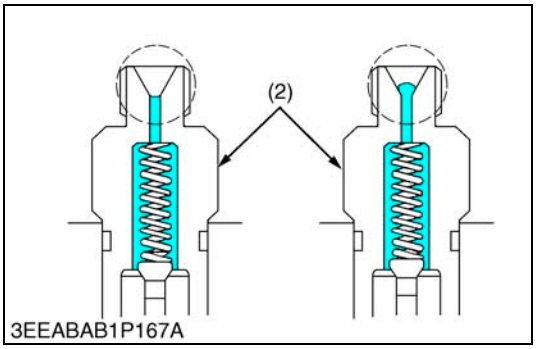
(1) Turbine Housing
(2) Gasket
(3) Exhaust Port
(4) Gasket
(5) Inlet Port
(6) Gasket
(7) Intake Hose
(8) Clamp
(9) Inlet Hose
(10) Compressor Cover

W1022082

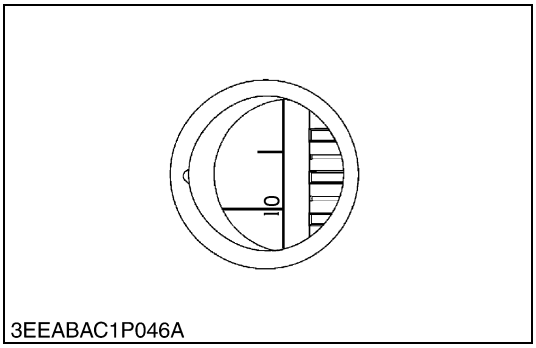


3EEABAB1P165A


3EEABAB1P166A



3EEABAB1P167A



3EEABAC1P046A

Injection Timing

1. Make sure of matching the injection timing align mark (1) of the injection pump unit and the plate (gearcase), as shown in the illustration.
2. Remove the injection pipes.
3. Remove the stop solenoid.
4. Turn the flywheel counterclockwise (viewed from flywheel side) until the fuel fills up to the hole of the delivery valve holder (2) for No.1 cylinder.
5. After the fuel fills up to the hole of the delivery valve holder for No.1 cylinder, turn back (clockwise) the flywheel around 1.57 rad (90 °).
6. Turn the flywheel counterclockwise to set at around 0.35 rad (20 <Symbol>×) before T.D.C..
7. Slowly turn the flywheel counterclockwise and stop turning when the fuel begins to come up, to get the present injection timing.
8. Check to see the degree on flywheel.
   The flywheel has mark “1TC”, “10” and “20” for the crank angle before the top dead center of No.1 piston.
9. If the injection timing is not within the specification, rotate the injection pump unit to adjust the injection timing.

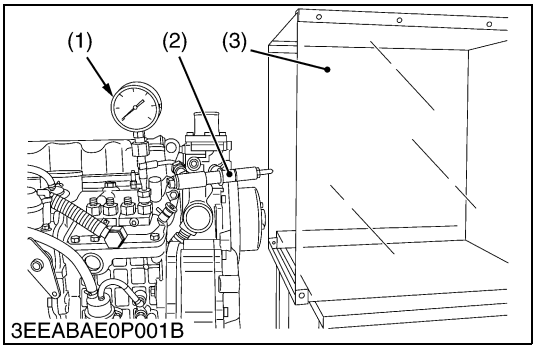
- **When installing the injection pump unit to the engine body, follow the correct procedure.**
  See the “Injection Pump Unit”.

Injection timing	Factory spec.	0.21 to 0.24 rad (12 ° to 14 °) before T.D.C.

Tightening torque	Injection pipe retaining nut	19.6 to 24.5 N·m 2.0 to 2.5 kgf·m 14.5 to 18.1 ft-lbs
	Injection pump unit mounting nut	17.7 to 20.6 N·m 1.8 to 2.1 kgf·m 13.0 to 15.2 ft-lbs

(1) Injection Timing Align Mark
(2) Delivery Valve Holder
(a) Injection Timing Advanced
(b) Injection Timing Retarded

W1072910



Checking Injection Pump

(Fuel Tightness of Pump Element)

1. Remove the engine stop solenoid.
2. Remove the injection pipes.
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 engine stop solenoid.
2. Remove the injection pipes.
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 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 to 180 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 to 180 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.

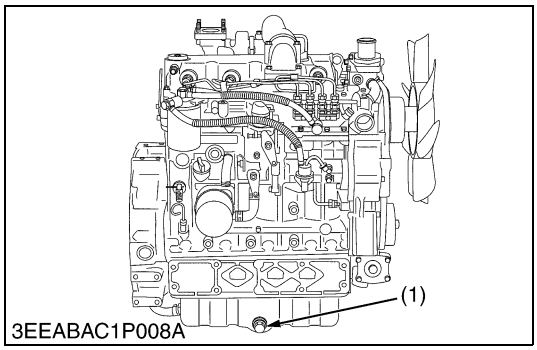
Fuel tightness of pump element	Allowable limit	18.63 MPa 190 kgf/cm^2 2702 psi
Fuel tightness of delivery valve	Factory spec.	10 seconds 18.63 → 17.65 MPa 190 → 180 kgf/cm^2 2702 → 2560 psi
	Allowable limit	5 seconds 18.63 → 17.65 MPa 190 → 180 kgf/cm^2 2702 → 2560 psi

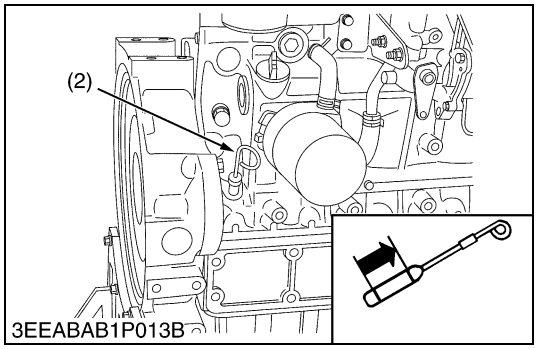
- **Never try to disassemble the injection pump assembly. For repairs, you are strongly requested to contact a Kubota-authorized pump service shop.**

(1) Injection Pump Pressure Tester
(2) Injection Nozzle
(3) Protection Cover for Jetted Fuel

W1022357

[10] CHECK POINTS OF EVERY 1 YEAR





Changing Engine Oil

- **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).

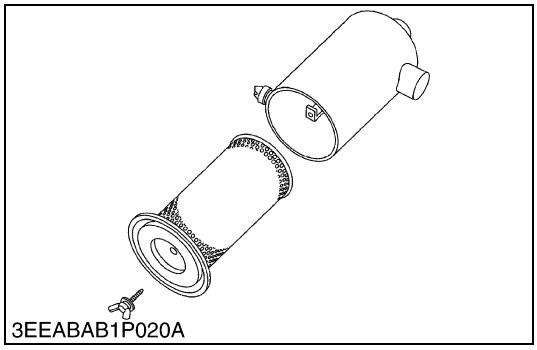
- **When using an oil of different maker or viscosity from the previous one, remove all of the old oil.**
- **Never mix two different types of oil.**
- **Engine oil should have properties of API classification CD/CE/CF/CF-4/CG-4.**
- **Use the proper SAE Engine Oil according to ambient temperature.**

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

Engine oil capacity	13.2 L 3.49 U.S.gals

(1) Drain Plug (2) Dipstick

W1019006



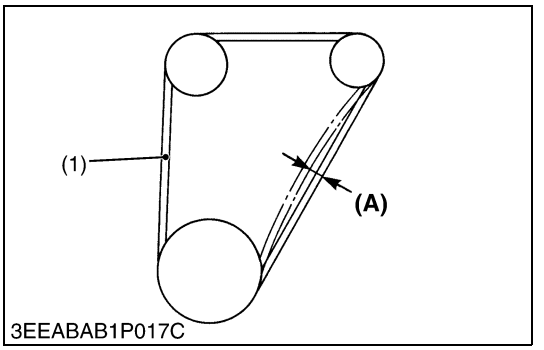
Replacing Air Cleaner Element

1. Remove used air cleaner element.
2. Replace new air cleaner element.

- **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 2 YEARS



3EEABAB1P017C

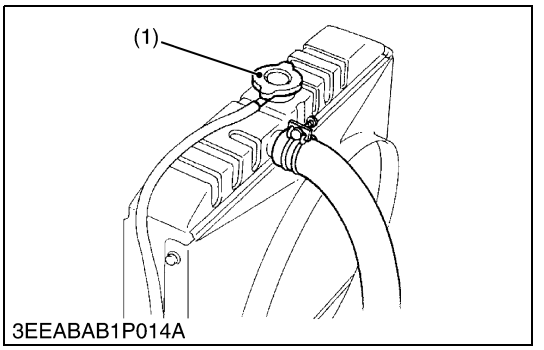
Replacing Fan Belt

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.

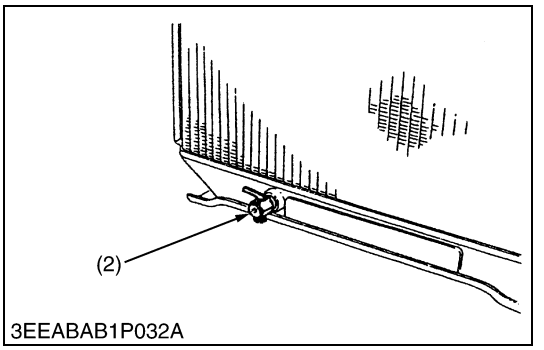
Deflection **(A)**	Factory spec.	10.0 to 12.0 mm / 98 N 0.394 to 0.472 in. / 98 N (10 kgf, 22 lbs)

(1) Fan Belt **(A) Deflection**

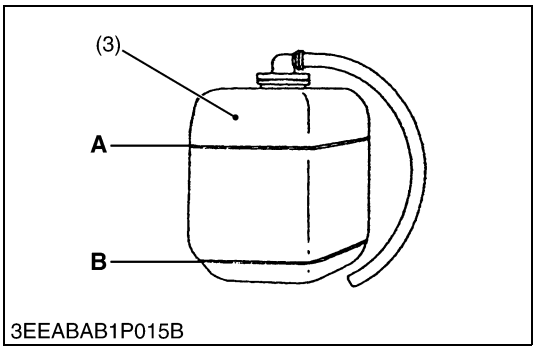
W1019333



3EEABAB1P014A



3EEABAB1P032A



3EEABAB1P015B

Changing Radiator Coolant (L.L.C.)

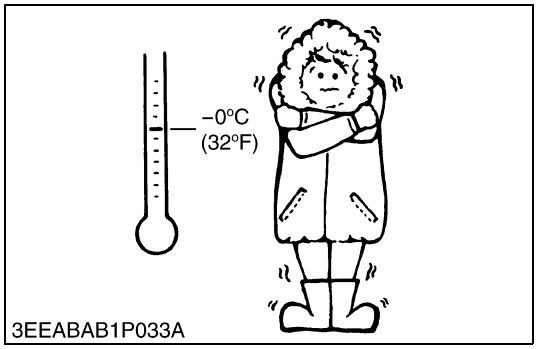
- **Do not remove the radiator cap when the engine is hot. Then loosen cap slightly to the stop to relieve any excess pressure before removing cap completely.**

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.

- **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 **A : Full**
(2) Drain Plug **B : Low**
(3) Recovery Tank

W1024599



3EEABAB1P033A

Changing Radiator Coolant (L.L.C.) (Continued)

(Anti-freeze)

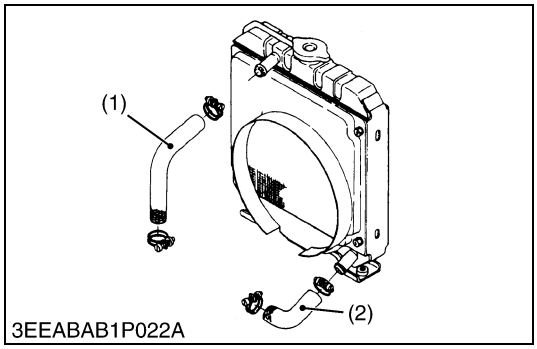
- There are two types of anti-freeze available: use the permanent type (PT) for this engine.
- Before adding anti-freeze for the first time, clean the radiator interior by pouring fresh, soft water and draining it a few times.
- The procedure for mixing water and anti-freeze differs according to the 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.
- **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	–11.2	106	222.8
50	–37	–34.6	108	226.4

* At 1.013 × 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.

- **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



3EEABAB1P022A

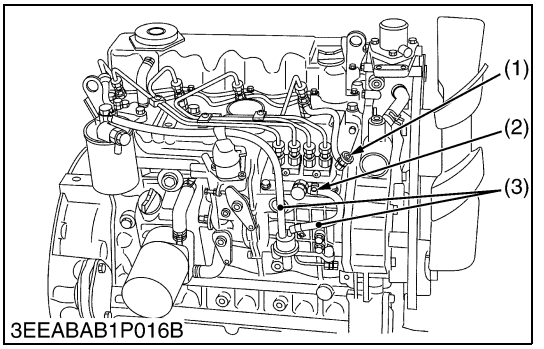
Replacing Radiator Hoses and Clamp Bands

- **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



Replacing Fuel Hose and Clamp Bands

1. Loosen the clamp (2) and remove the fuel hose (3).
2. Replace new fuel hose (3) and new clamp (2).
3. Tighten the clamp (2).

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

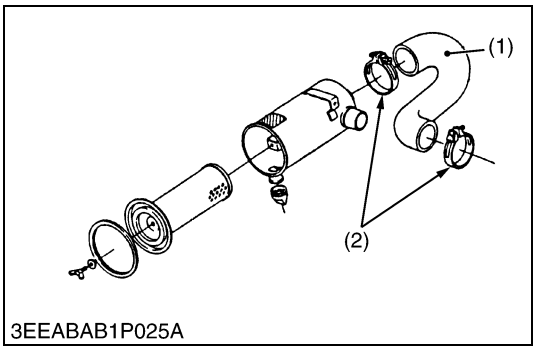
(When bleeding fuel system)

1. Fill the tank with fuel and open the cock.
2. Loosen the air vent coupling bolt of fuel filter a few turns.
3. When there is no more air bubbles in the fuel coming out of this coupling bolt, tighten the coupling bolt.
4. Open the air vent cock (1) on the top of fuel injection pump.
5. If equipped electrical fuel feed pump, turn the key on 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 (1) after air bleeding.

- **Except when venting the air, be sure to keep closed the air vent coupling bolt of the fuel injection pump. Otherwise, the engine may stall.**

(1) Air Vent Cock (3) Fuel Hose
(2) Clamp

W1020090



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).

- **To prevent serious damage to the engine, keep out any dust inside the intake air line.**

(1) Intake Air Hose (2) Clamp

W1023867

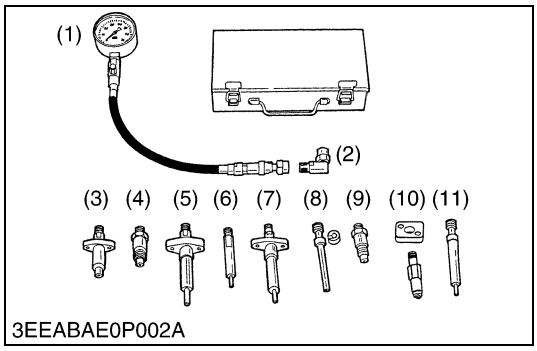
Replacing Battery

- **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

5. SPECIAL TOOLS



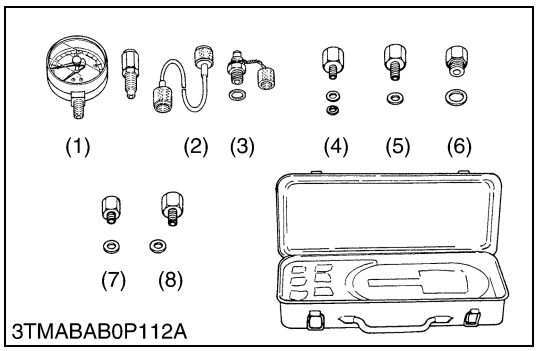
Diesel Engine Compression Tester

Code No: 07909-30208 (Assembly) 07909-31251 (G)
07909-30934 (A to F) 07909-31271 (I)
07909-31211 (E and F) 07909-31281 (J)
07909-31231 (H)

Application: Use to measure diesel engine compression and diagnostics 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



Oil Pressure Tester

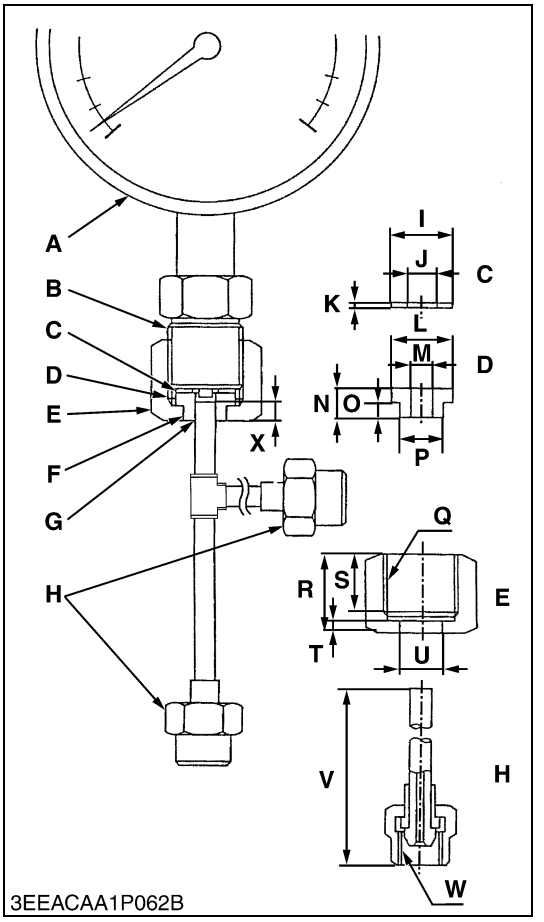
Code No: 07916-32032

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

- **The following special tools are not provided, so make them referring to the figure.**

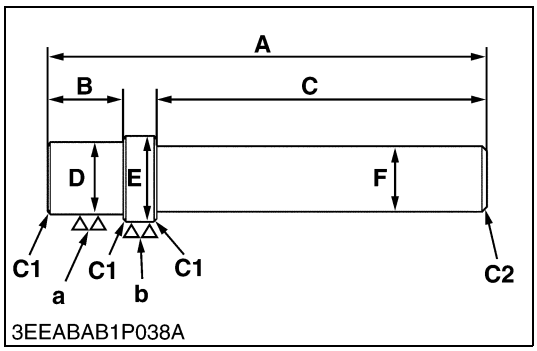


Injection Pump Pressure Tester

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 (1.06 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. (0.31 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. (0.2402 to 0.2441 in. dia.)
N	8 mm (0.31 in.)
O	4 mm (0.16 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 (0.16 in.)
U	12.00 to 12.02 mm dia. (0.4724 to 0.4732 in. dia.)
V	100 mm (3.94 in.)
W	M12 × P1.5
X	5 mm (0.20 in.)

W10252400



3EEABAB1P038A

Small End Bushing Replacing Tool

Application: Use to press out and to press fit the small end bushing.

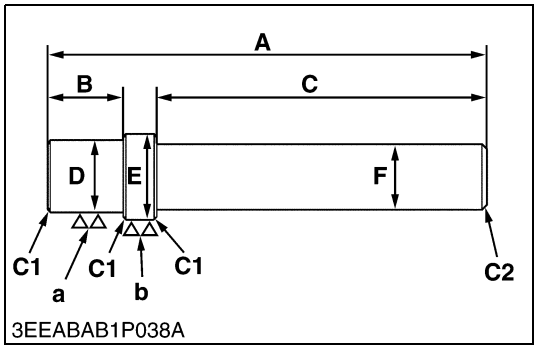
[Press out]

A	157 mm (6.181 in.)
B	14.5 mm (0.571 in.)
C	120 mm (4.7244 in.)
D	30.0 mm dia. (1.1811 in. dia.)
E	32.95 mm dia. (1.2972 in. dia.)
F	20 mm dia. (0.7874 in. dia.)
a	6.3 μm (250 μin.)
b	6.3 μm (250 μin.)
C1	Chamfer 1.0 mm (0.039 in.)
C2	Chamfer 2.0 mm (0.079 in.)

[Press fit]

A	157 mm (6.181 in.)
B	14.5 mm (0.571 in.)
C	120 mm (4.7244 in.)
D	30.0 mm dia. (1.1811 in. dia.)
E	42.000 mm dia. (1.6535 in. dia.)
F	20 mm dia. (0.7874 in. dia.)
a	6.3 μm (250 μin.)
b	6.3 μm (250 μin.)
C1	Chamfer 1.0 mm (0.039 in.)
C2	Chamfer 2.0 mm (0.079 in.)

W1040702



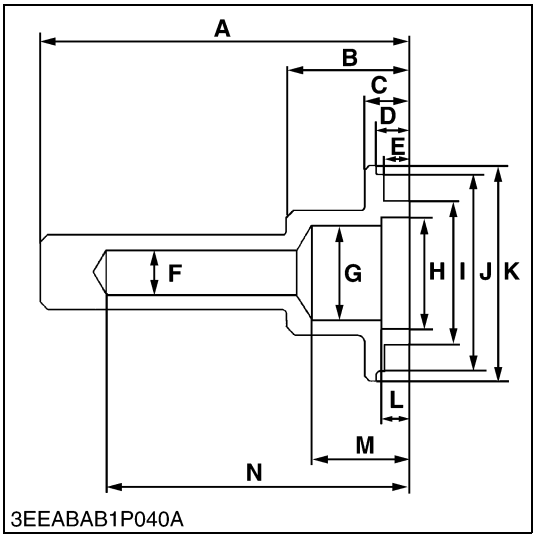
3EEABAB1P038A

Idle Gear Bushing Replacing Tool

Application: Use to press out and to press fit the bushing.

A	196 mm (7.7165 in.)
B	37.5 mm (1.476 in.)
C	150 mm (5.9055 in.)
D	44.95 mm dia. (1.7697 in. dia.)
E	48.075 to 48.100 mm dia. (1.8927 to 1.8937 in. dia.)
F	20 mm dia. (0.7874 in. dia.)
a	6.3 μm (250 μin.)
b	6.3 μm (250 μin.)
C1	Chamfer 1.0 mm (0.039 in.)
C2	Chamfer 2.0 mm (0.079 in.)

W1040289



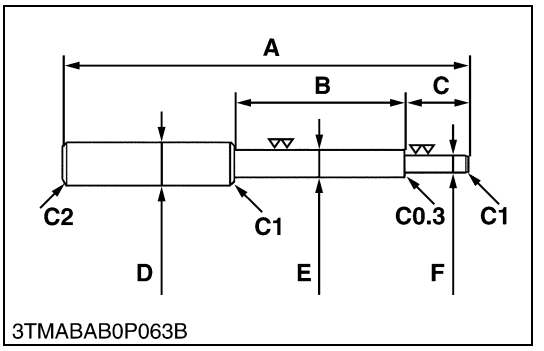
3EEABAB1P040A

Gear Case Oil Seal Replacing Tool

Application: Use to press fit the oil seal.

A	148.8 mm (5.8582 in.)
B	50 mm (1.9685 in.)
C	18.8 mm (0.7401 in.)
D	13.7 to 13.9 mm (0.5394 to 0.5472 in.)
E	11 mm (0.433 in.)
F	18 mm dia. (0.7087 in. dia.)
G	38 mm dia. (1.4961 in. dia.)
H	45 mm dia. (1.7716 in. dia.)
I	57.9 to 58.1 mm dia. (2.2795 to 2.2874 in. dia.)
J	79.5 mm dia. (3.1299 in. dia.)
K	87 mm dia. (3.425 in. dia.)
L	12 mm (0.4724 in.)
M	40 mm (1.5748 in.)
N	120 mm (4.7244 in.)

W1041529



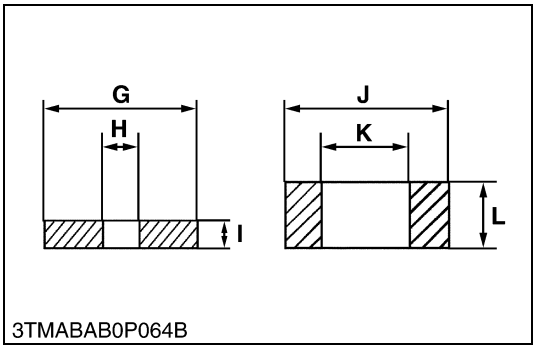
3TMABAB0P063B

Valve Guide Replacing Tool

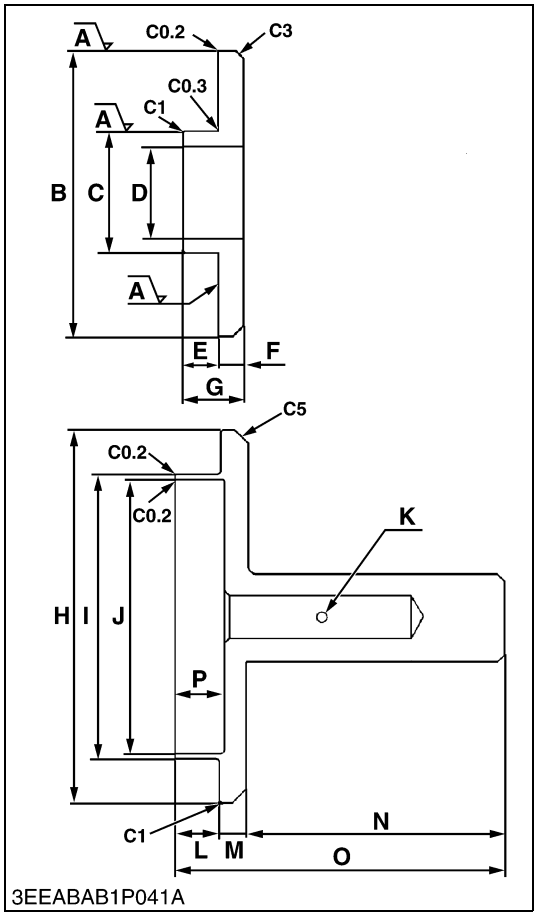
Application: Use to press out and press fit the valve guide.

A	225 mm (8.86 in.)
B	70 mm (2.76 in.)
C	45 mm (1.77 in.)
D	20 mm dia. (0.79 in dia.)
E	11.7 to 11.9 mm dia. (0.460 to 0.468 in. dia.)
F	6.5 to 6.6 mm dia. (0.256 to 0.259 in. dia.)
G	25 mm dia. (0.98 in. dia.)
H	6.7 to 7.0 mm dia. (0.263 to 0.275 in. dia.)
I	5 mm (0.197 in.)
J	20 mm dia. (0.787 in.dia.)
K	12.5 to 12.8 mm dia. (0.492 to 0.504 in. dia.)
L	8.9 to 9.1 mm (0.350 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 (0.012 in.)

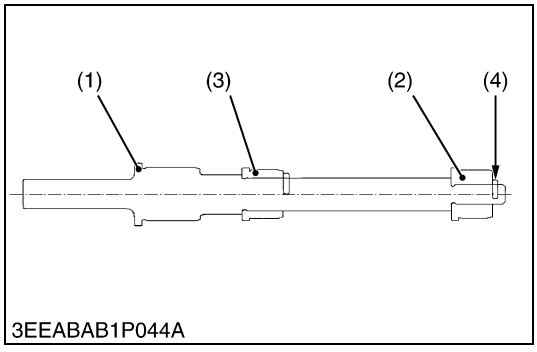
W1038887



3TMABAB0P064B



3EEABAB1P041A



3EEABAB1P044A

Auxiliary Socket for Fixing Crankshaft Sleeve

Application: Use to fix the crankshaft sleeve of the diesel engine.

A	Rmax = 12.5 S
B	94.5 to 95.0 mm dia. (3.7205 to 3.7402 in. dia.)
C	40 mm dia. (1.5748 in. dia.)
D	30 mm dia. (1.1811 in. dia.)
E	12 mm (0.4724 in.)
F	7.9 to 8.1 mm (0.3110 to 0.3189 in.)
G	20 mm (0.7874 in.)
H	130 mm dia. (5.1181 in. dia.)
I	99.4 to 99.6 mm dia. (3.9134 to 3.9213 in. dia.)
J	95.05 to 95.20 mm dia. (3.7421 to 3.7480 in. dia.)
K	3 mm dia. (0.1181 in.dia.)
L	15 mm (0.5905 in.)
M	10 mm (0.3937 in.)
N	90 mm (3.5433 in.)
O	115 mm (4.5275 in.)
P	16.9 to 17.1 mm (0.6654 to 0.6732 in.)
C1	Chamfer 1.0 mm (0.039 in.)
C3	Chamfer 3.0 mm (0.1181 in.)
C5	Chamfer 5.0 mm (0.1969 in.)
C0.2	Chamfer 0.2 mm (0.0079 in.)
C0.3	Chamfer 0.3 mm (0.0118 in.)

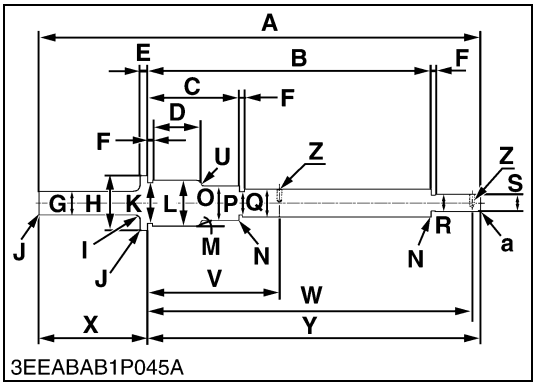
W1041815

Balancer Bushing Replacing Tool 1 Assembly

Application: Use to press fit the bushing.

No.	Name of Part	Q'ty.	Remarks
(1)	Shaft	1	
(2)	Piece 1	1	
(3)	Piece 2	1	
(4)	Bolt	2	M6 × P1.0

W1042867



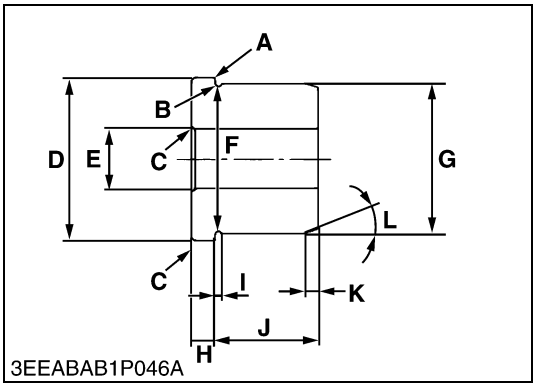
3EEABAB1P045A

Balancer Bushing Replacing Tool 1 Components Parts

1) Shaft

A	498 mm (19.61 in.)
B	318.8 to 319.2 mm (12.5512 to 12.5669 in.)
C	102.8 to 103.2 mm (4.0472 to 4.0630 in.)
D	60 mm (2.36 in.)
E	8 mm (0.31 in.)
F	5 mm (0.20 in.)
G	30 mm dia. (1.18 in. dia.)
H	65 mm dia. (2.56 in. dia.)
I	6 mm (0.24 in.)
J	Chamfer 1 mm (0.04 in.)
K	53 mm dia. (2.09 in. dia.)
L	54.7 to 54.9 mm dia. (2.1535 to 2.1614 in. dia.)
M	0.26 rad (15 °)
N	Chamfer 0.5 mm (0.02 in.)
O	41 mm dia. (1.61 in. dia.)
P	32 mm dia. (1.26 in. dia.)
Q	33.96 to 34.0 mm dia. (1.3370 to 1.3386 in. dia.)
R	18 mm dia. (0.71 in. dia.)
S	19.967 to 20.0 mm dia. (0.7861 to 0.7874 in. dia.)
U	3 mm (0.12 in.)
V	149.1 to 149.4 mm (5.8701 to 5.8819 in.)
W	365.1 to 365.4 mm (14.3740 to 14.3858 in.)
X	123 mm (4.84 in.)
Y	375 mm (14.76 in.)
Z	M6 × P1.0 depth 7 mm (0.28 in.)
a	Chamfer 2 mm (0.08 in.)

W1043162

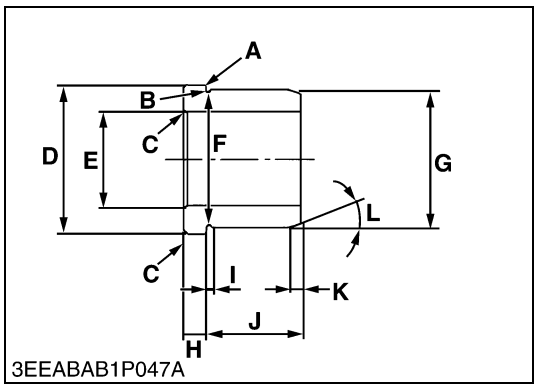


3EEABAB1P046A

2) Piece 1

A	Chamfer 0.1 mm (0.004 in.)
B	1 mm (0.04 in.)
C	Chamfer 1mm (0.04 in.)
D	53.8 to 53.9 mm dia. (2.1181 to 2.1220 in. dia.)
E	20.02 to 20.041 mm dia. (0.7882 to 0.7890 in. dia.)
F	48 mm dia. (1.89 in. dia.)
G	49.934 to 49.94 mm dia. (1.9659 to 1.9661 in. dia.)
H	8 mm (0.31 in.)
I	2 mm (0.08 in.)
J	35 mm dia. (1.38 in. dia.)
K	5 mm (0.20 in.)
L	0.26 rad (15 °)

W1044434

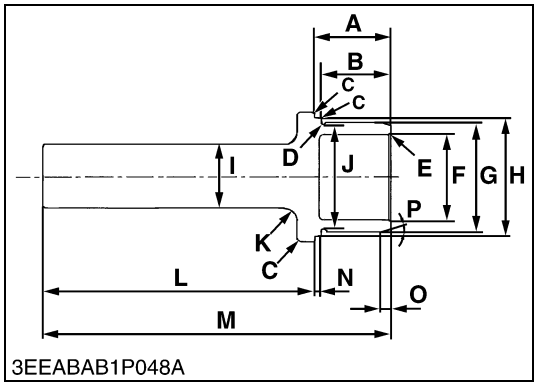


3EEABAB1P047A

3) Piece 2

A	Chamfer 0.1 mm (0.004 in.)
B	1 mm (0.04 in.)
C	Chamfer 1mm (0.04 in.)
D	54.3 to 54.4 mm dia. (2.1378 to 2.1417 in. dia.)
E	34.025 to 34.05 mm dia. (1.3396 to 1.3406 in. dia.)
F	48.5 mm dia. (1.9094 in. dia.)
G	50.421 to 50.44 mm dia. (1.9851 to 1.9858 in. dia.)
H	8 mm (0.31 in.)
I	2 mm (0.08 in.)
J	35 mm dia. (1.38 in. dia.)
K	5 mm (0.20 in.)
L	0.26 rad (15 °)

W1044620



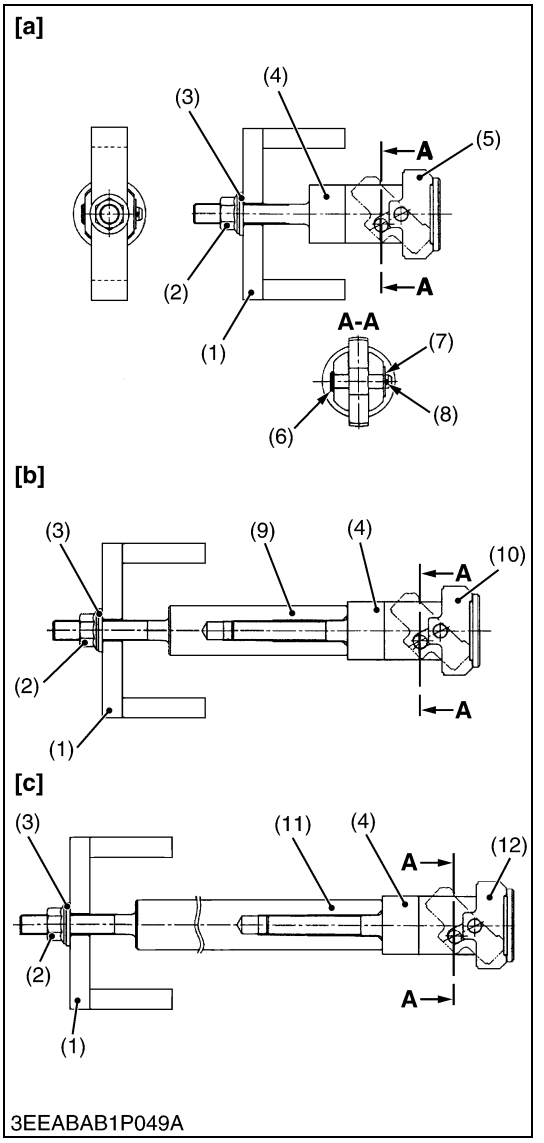
3EEABAB1P048A

Balancer Bushing Replacing Tool 2

Application: Use to press fit the bushing.

A	35 mm (1.38 in.)
B	33 mm (1.30 in.)
C	Chamfer 0.5 mm (0.02 in.)
D	1 mm (0.04 in.)
E	Chamfer 1 mm (0.04 in.)
F	40 mm dia. (1.57 in. dia.)
G	50.921 to 50.94 mm dia. (2.0048 to 2.0055 in. dia.)
H	54.8 to 54.9 mm dia. (2.1575 to 2.1614 in. dia.)
I	30 mm dia. (1.18 in. dia.)
J	49 mm dia. (1.93 in. dia.)
K	6 mm (0.24 in.)
L	125 mm (4.92 in.)
M	160 mm (6.30 in.)
N	3 mm (0.12 in.)
O	5 mm (0.20 in.)
P	0.26 rad (15 °)

W1044794



3EEABAB1P049A

Balancer Replacing Tools 3, 4, 5

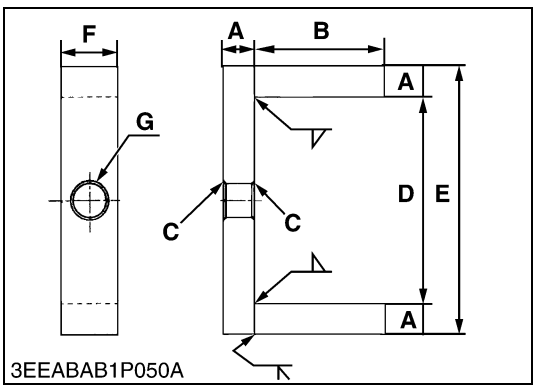
Application: Use to press fit the bushing.

- **This special tool is not provided, so make it referring to the figure.**

No.	Name of Part	Q'ty.
(1)	Bracket	1
(2)	Flange Nut	1
(3)	Washer	1
(4)	Shaft	1
(5)	Piece 1	1
(6)	Clevis	1
(7)	Washer	1
(8)	Cotter Pin	1
(9)	Joint 1	1
(10)	Piece 2	1
(11)	Joint 2	1
(12)	Piece 3	1

[a] :Tool 3
[b] :Tool 4
[c] :Tool 5
A : Section

W1045310



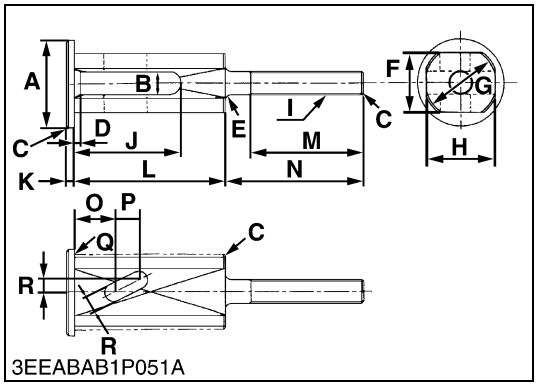
3EEABAB1P050A

Balancer Replacing Tool Components Parts

1) Bracket

A	12 mm (0.47 in.)
B	50 mm (1.97 in.)
C	Chamfer 1 mm (0.04 in.)
D	80 mm (3.15 in.)
E	104 mm (4.09 in.)
F	22 mm (0.87 in.)
G	13 mm dia. (0.51 in. dia.)

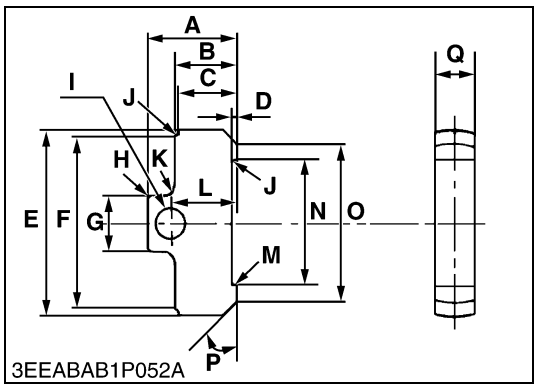
W1167794



2) Shaft

A	44 mm dia. (1.73 in. dia.)
B	12 mm (0.47 in.)
C	Chamfer 1 mm (0.04 in.)
D	3 mm (0.12 in.)
E	3 mm (0.12 in.)
F	30 mm (1.18 in.)
G	38 mm (1.50 in.)
H	35 mm (1.38 in.)
I	M12 × P1.25
J	53 mm (2.09 in.)
K	4 mm (0.16 in.)
L	75 mm (2.95 in.)
M	57 mm (2.24 in.)
N	70 mm (2.76 in.)
O	19.5 mm (0.77 in.)
P	12 mm (0.47 in.)
Q	0.8 mm (0.03 in.)
R	6 mm (0.24 in.)

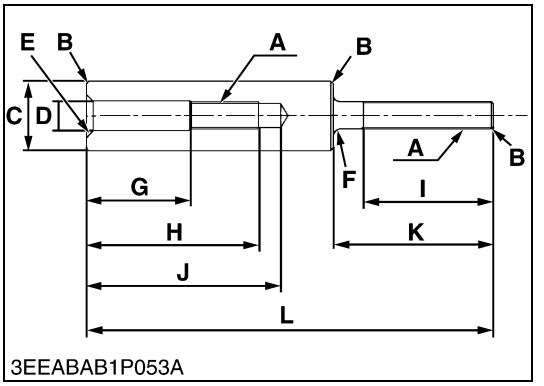
W1046146



3) Piece 1

A	26 mm (1.02 in.)
B	18 mm (0.71 in.)
C	16.5 to 17.0 mm (0.6496 to 0.6693 in.)
D	1.5 mm (0.06 in.)
E	54.0 to 54.2 mm dia. (2.1260 to 2.1339 in dia.)
F	50.55 to 50.75 mm dia. (1.9902 to 1.9980 in dia.)
G	16 mm (0.63 in.)
H	Chamfer 1 mm (0.04 in.)
I	8.5 mm dia. (0.33 in. dia.)
J	0.4 mm (0.0157 in.)
K	3 mm (0.12 in.)
L	19 mm (0.75 in.)
M	Chamfer 0.5 mm (0.02 in.)
N	36 mm (1.42 in.)
O	45 mm dia. (1.77 in. dia.)
P	0.78 rad (45 °)
Q	11.5 mm (0.45 in.)

W1047263

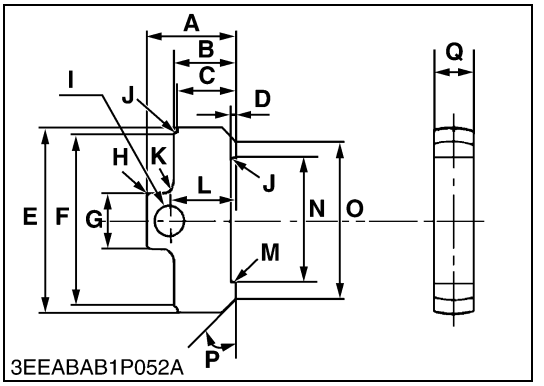


3EEABAB1P053A

4) Joint 1

A	M12 × P1.25
B	Chamfer 1 mm (0.04 in.)
C	30 mm dia. (1.18 in. dia.)
D	13 mm dia. (0.51 in. dia.)
E	Chamfer 3 mm (0.12 in.)
F	3 mm (0.12 in.)
G	45 mm (1.77 in.)
H	75 mm (2.95 in.)
I	57 mm (2.24 in.)
J	85 mm (3.35 in.)
K	70 mm (2.76 in.)
L	178 mm (7.01 in.)

W1047709

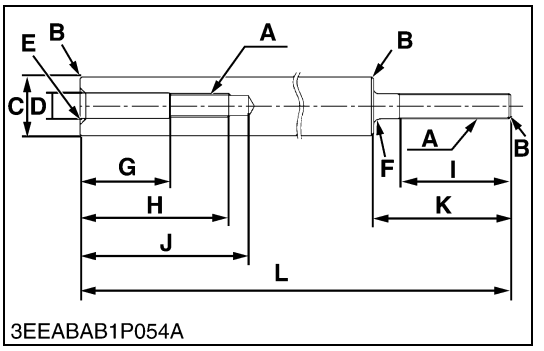


3EEABAB1P052A

5) Piece 2

A	26 mm (1.02 in.)
B	18 mm (0.71 in.)
C	16.5 to 17.0 mm (0.6496 to 0.6693 in.)
D	1.5 mm (0.06 in.)
E	53.5 to 53.7 mm dia. (2.1063 to 2.1142 in dia.)
F	50.05 to 50.25 mm dia. (1.9705 to 1.9783 in dia.)
G	16 mm (0.63 in.)
H	Chamfer 1 mm (0.04 in.)
I	8.5 mm dia. (0.33 in. dia.)
J	0.4 mm (0.0157 in.)
K	3 mm (0.12 in.)
L	19 mm (0.75 in.)
M	Chamfer 0.5 mm (0.02 in.)
N	36 mm (1.42 in.)
O	45 mm dia. (1.77 in. dia.)
P	0.78 rad (45 °)
Q	11.5 mm (0.45 in.)

W1048068

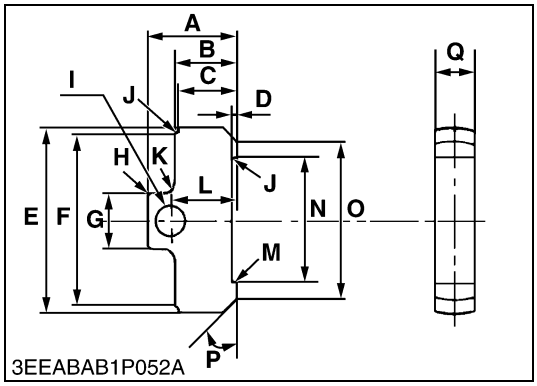


3EEABAB1P054A

6) Joint 2

A	M12 × P1.25
B	Chamfer 1 mm (0.04 in.)
C	30 mm dia. (1.18 in. dia.)
D	13 mm dia. (0.51 in. dia.)
E	Chamfer 3 mm (0.12 in.)
F	3 mm (0.12 in.)
G	45 mm (1.77 in.)
H	75 mm (2.95 in.)
I	57 mm (2.24 in.)
J	85 mm (3.35 in.)
K	70 mm (2.76 in.)
L	394 mm (15.51 in.)

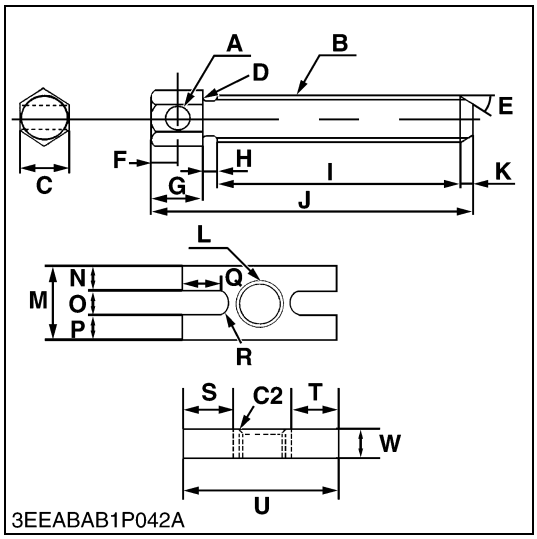
W1048305



7) Piece 3

A	26 mm (1.02 in.)
B	18 mm (0.71 in.)
C	16.5 to 17.0 mm (0.6496 to 0.6693 in.)
D	1.5 mm (0.06 in.)
E	53.0 to 53.2 mm dia. (2.0866 to 2.0945 in dia.)
F	49.55 to 49.75 mm dia. (1.9508 to 1.9587 in dia.)
G	16 mm (0.63 in.)
H	Chamfer 1 mm (0.04 in.)
I	8.5 mm dia. (0.33 in. dia.)
J	0.4 mm (0.0157 in.)
K	3 mm (0.12 in.)
L	19 mm (0.75 in.)
M	Chamfer 0.5 mm (0.02 in.)
N	36 mm (1.42 in.)
O	45 mm dia. (1.77 in. dia.)
P	0.78 rad (45 °)
Q	11.5 mm (0.45 in.)

W1048484

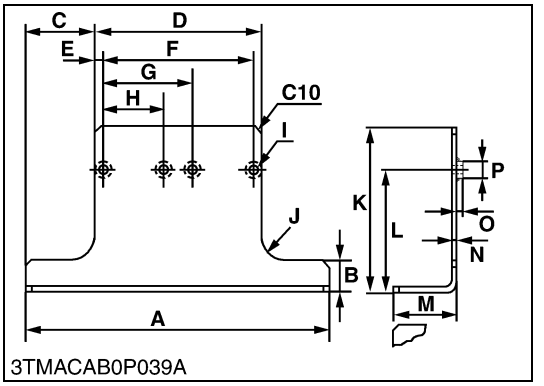


Injection Pump Gear Puller

Application: Use for remove the injection pump gear from governor shaft.

A	10 mm dia. (0.39 in.dia.)
B	M16 × Pitch 1.5
C	19 mm (0.75 in.)
D	0.5 mm radius (0.02 in. radius)
E	0.87 rad (50 °)
F	10 mm (0.39 in.)
G	20 mm (0.79 in.)
H	5 mm (0.20 in.)
I	95 mm (3.74 in.)
J	125 mm (4.92 in.)
K	5 mm (0.20 in.)
L	M16 × Pitch 1.5
M	30 mm (1.18 in.)
N	9.5 mm (0.3740 in.)
O	11 mm (0.4331 in.)
P	9.5 mm (0.3740 in.)
Q	14.5 mm (0.57 in.)
R	5.5 mm radius (0.22 in. radius)
S	20 mm (0.79 in.)
T	20 mm (0.79 in.)
U	80 mm (3.1496 in.)
W	12 mm (0.47 in.)
C2	Chamfer 2.0 mm (0.079 in.)

W1042094



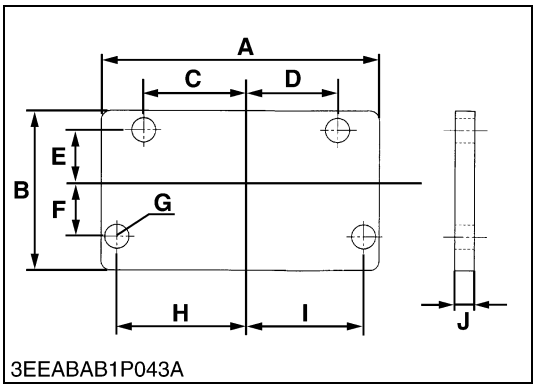
3TMACAB0P039A

Engine Stand

Application: Use to support engine.

A	480 mm (18.90 in.)
B	50 mm (1.97 in.)
C	108.5 mm (4.272 in.)
D	262.5 mm (10.33 in.)
E	12.5 mm (0.492 in.)
F	237.5 mm (9.350 in.)
G	142.5 mm (5.610 in.)
H	95 mm (3.74 in.)
I	14 mm dia. (0.55 in. dia.)
J	40 mm radius (1.57 in. radius)
K	210 mm (8.27 in.)
L	190 mm (7.48 in.)
M	100 mm (3.94 in.)
N	6 mm (0.24 in.)
O	6 mm (0.24 in.)
P	25 mm dia. (0.98 in. dia.)
C10	Chamfer 10 mm (0.394 in.)

W1033645



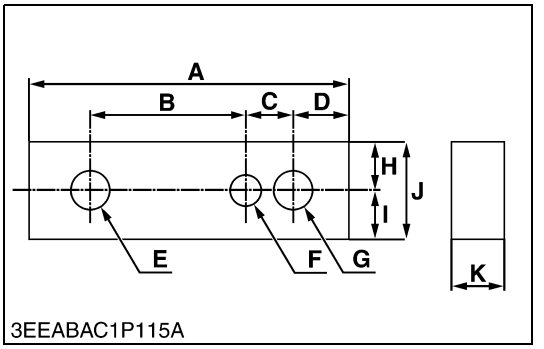
3EEABAB1P043A

Flywheel Stopper (for SAE Flywheel and Housing)

Application: Use to loosen and tighten the flywheel screw.

A	140 mm (5.5 in.)
B	80 mm (3.15 in.)
C	49.3 mm (1.94 in.)
D	49.3 mm (1.94 in.)
E	23.8 mm (0.94 in.)
F	23.8 mm (0.94 in.)
G	11 mm dia. (0.43 in. dia.)
H	56.5 mm (2.22 in.)
I	56.5 mm (2.22 in.)
J	8 mm (0.31 in.)

W1042515



3EEABAC1P115A

Tool for Aligning the Crankcase 1 and 2

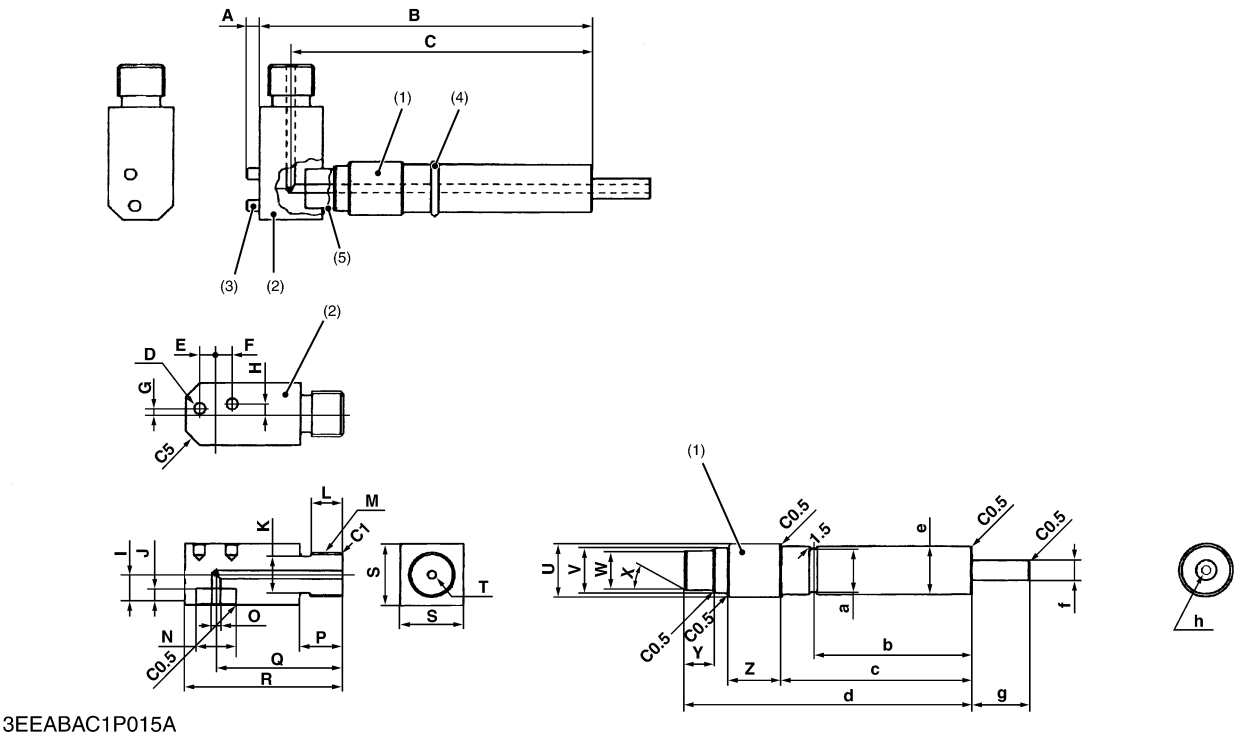
Application: Use for aligning the crankcase 1 and 2.

A	115 mm (4.5276 in.)
B	56 mm (2.2047 in.)
C	17 mm (0.6693 in.)
D	20 mm (0.7874 in.)
E	14 mm dia. (0.5512 in. dia.)
F	11 mm dia. (0.4331 in. dia.)
G	14 mm dia. (0.5512 in. dia.)
H	17.5 mm (0.6890 in.)
I	17.5 mm (0.6890 in.)
J	35 mm (1.3780 in.)
K	19 mm (0.7480 in.)

W1047882

Nozzle Adaptor for Measuring Cylinder Compression Pressure

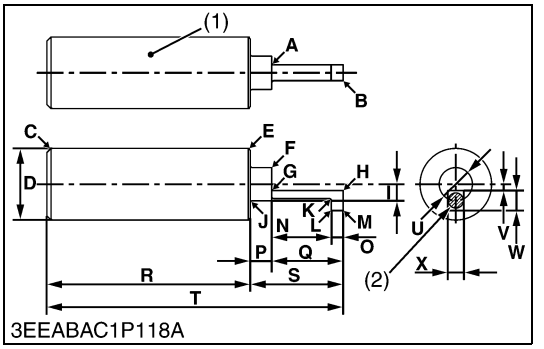
Application: Use for measuring diesel engine compression pressure.



3EEABAC1P015A

A	5 mm (0.1969 in.)	T	3 mm dia., 44.5 to 45 mm depth (0.1181 in. dia., 1.7520 to 1.7717 in. depth)
B	115.9 to 116.1 mm (4.5630 to 4.5709 in.)		
C	105 mm (4.1339 in.)	U	19 mm dia. (0.7480 in. dia.)
D	4 mm dia., 4 mm depth (0.1575 in dia., 0.1575 in. depth)	V	16 mm dia. (0.6299 in. dia.)
E	6 mm (0.2362 in.)	W	14 mm dia. (0.5512 in. dia.)
F	5.3 mm (0.2087 in.)	X	0.524 rad (30°)
G	1.9 mm (0.0748 in.)	Y	10 mm (0.3937 in.)
H	3.5 mm (0.1378 in.)	Z	19 mm (0.7480 in.)
I	11.6 to 12.1 mm (0.4567 to 0.4764 in.)	a	14.94 to 15 mm dia. (0.5882 to 0.5906 in. dia.)
J	6 to 6.1 mm (0.2362 to 0.2402 in.)	b	55 mm (2.1654 in.)
K	13 mm dia. (0.5118 in. dia.)	c	66 mm (2.5984 in.)
L	11 mm (0.4331 in.)	d	100 to 100.1 mm (3.9370 to 3.9409 in.)
M	5/8-18UNF-2B	e	16.89 to 17 mm dia. (0.6650 to 0.6693 in. dia.)
N	14.0 to 14.011 mm dia. (0.5512 to 0.5516 in. dia.)	f	7.1 to 7.2 mm dia. (0.2795 to 0.2835 in. dia.)
O	3 mm dia. (0.1181 in. dia.)	g	20.3 to 20.5 mm (0.7992 to 0.8071 in.)
P	15 mm (0.5906 in.)	h	3 mm dia. (0.1181 in. dia.)
Q	44 mm (1.7323 in.)	C0.5	Chamfer 0.5 mm (Chamfer 0.0197 in.)
R	55 mm (2.1654 in.)	C1	Chamfer 1 mm (Chamfer 0.0394 in.)
S	22 mm (0.8661 in.)	C5	Chamfer 5 mm (Chamfer 0.1969 in.)

(1) Material SS400 (3) Pin 05012-00408 (4) O-ring 04811-00150 (5) Arc welding
(2) Material S43C-D



3EEABAC1P118A

Jig for Governor Connecting Rod

Application: Use for connecting the governor connecting rod to the rack pin of the fuel injection pump assembly.

A	1 mm radius (0.0394 in. radius)
B	Chamfer 0.2 mm (0.0079 in.)
C	Chamfer 2 mm (0.0787 in.)
D	35 mm dia. (1.3780 in. dia.)
E	Chamfer 1 mm (0.0394 in.)
F	Chamfer 0.1 mm (0.0039 in.)
G	1 mm radius (0.0394 in. radius)
H	Chamfer 0.2 mm (0.0079 in.)
I	8 mm radius (0.3150 in. radius)
J	1 mm radius (0.0394 in. radius)
K	1 mm radius (0.0394 in. radius)
L	Chamfer 0.2 mm (0.0079 in.)
M	Chamfer 0.2 mm (0.0079 in.)
N	29 mm (1.1417 in.)
O	6 mm (0.2362 in.)
P	10.7 mm (0.4213 in.)
Q	35 mm (1.3780 in.)
R	99.3 mm (3.9095 in.)
S	45.65 to 45.75 mm (1.7972 to 1.8012 in.)
T	145 mm (5.7087 in.)
U	16.15 to 16.35 mm (0.6358 to 0.6437 in.)
V	3 mm (0.1181 in.)
W	10 mm (0.3937 in.)
X	8 mm (0.3150 in.)

(1) Material: S45C-D

(2) Permanent Magnet: 8 mm dia. (0.3150 in. dia.)
Thickness: 3 mm (0.1181 in.)

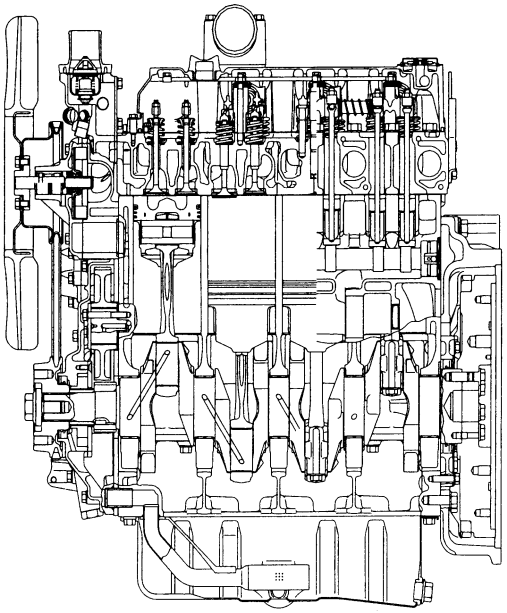
W1115114

Mechanism

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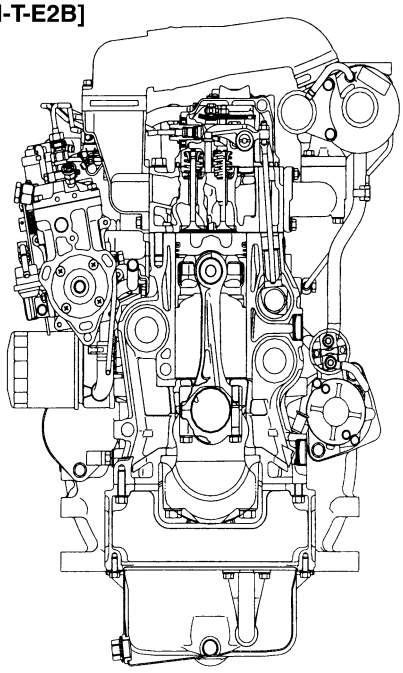
1. FEATURE

[V3800DI-E2B]



3EEABAC1P001C

[V3800DI-T-E2B]



3EEABAC1P002C

The V3 series DI engine are the vertical type 4-cycle diesel engine featuring the advanced performances shown below.

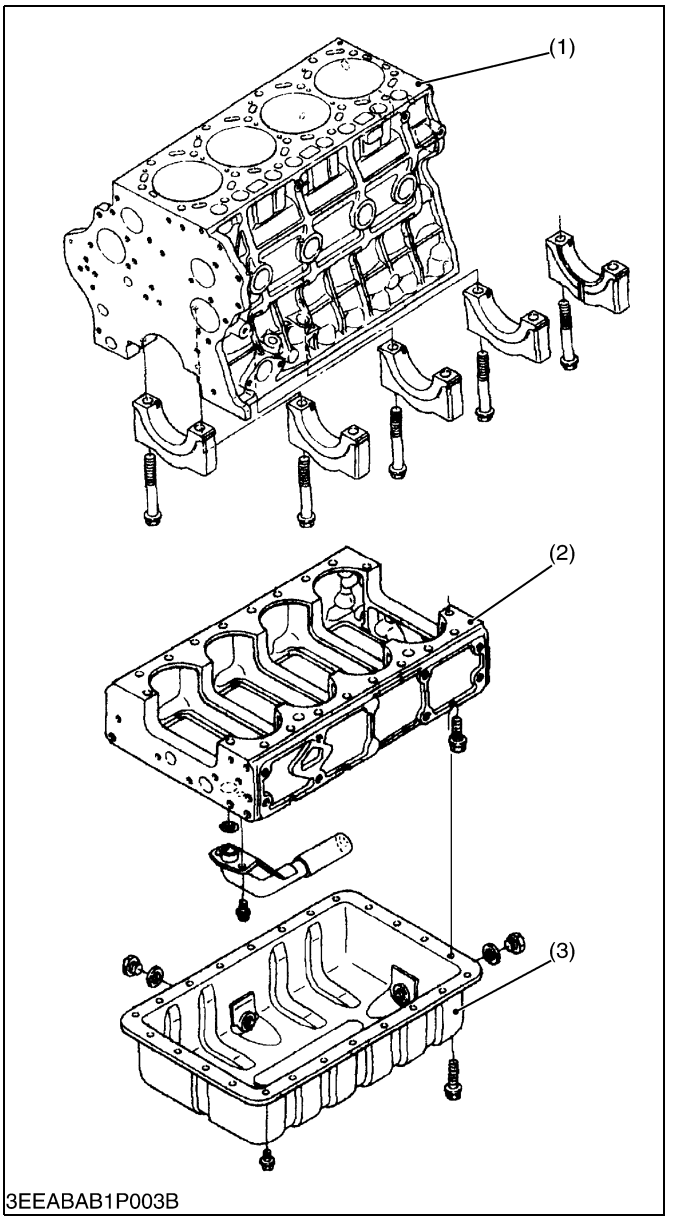
This is a small sized, high power and environment conscious engine, which employs the four valve system, two inlet valves with double ports, and two exhaust valves with the new E-CDIS. Thus, this engine achieves high combustion efficiency and complies with various regulations of exhaust gas.

Based upon the conventional model, Kubota developed a unique governor system and various new mechanisms which reduces exhaust emission, noise and vibration and realize durability and high torque.

W1013043

2. ENGINE BODY

[1] CYLINDER BLOCK



3EEABAB1P003B

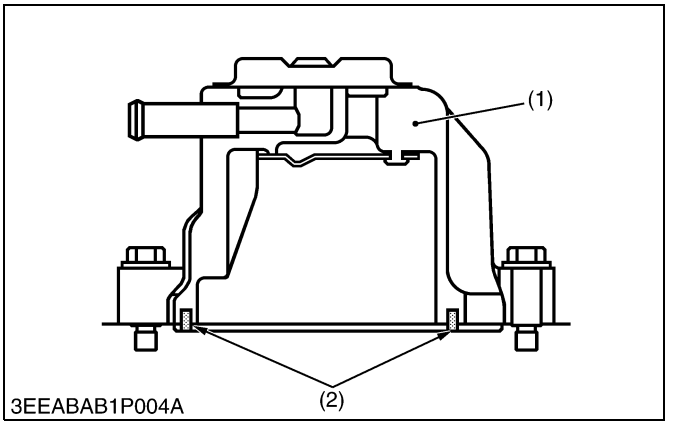
This engine employs separate type crankcases - the crankcase 1 (1) with combustion part and the crankcase 2 (2) which supports the crankcase 1 (1) and reduces noise.

Since it is a hanger type, you can easily assemble / disassemble it. The cylinder is a linerless type which enables good cooling operation, less strain and good abrasion resistance.

(1) Crankcase 1 (3) Oil Pan
(2) Crankcase 2

W1013119

[2] HALF-FLOATING HEAD COVER



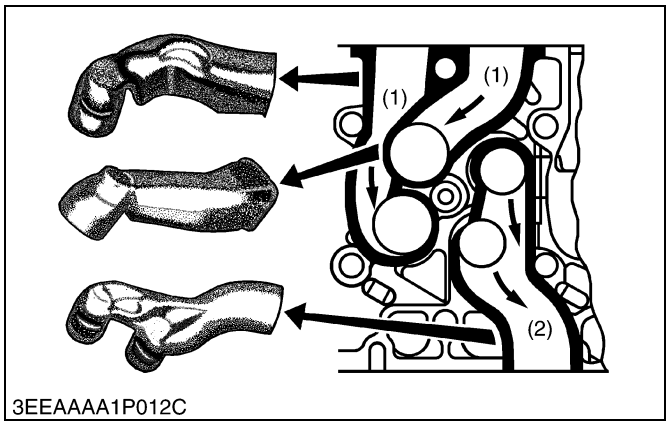
3EEABAB1P004A

The rubber packing is fitted in to maintain the 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

[3] CYLINDER HEAD



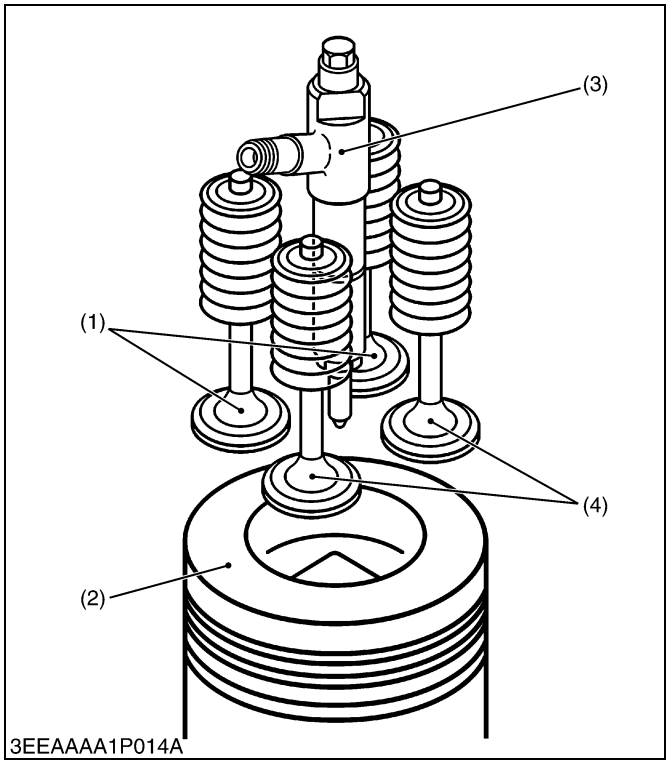
3EEAAAA1P012C

This engine employs four valve system, the cylinder head is provided with double intake passenge in order to ensure appropriate air suction and give an optimum swirl.

(1) Intake (2) Exhaust

W1013336

[4] CENTER DIRECT INJECTION SYSTEM (E-CDIS)



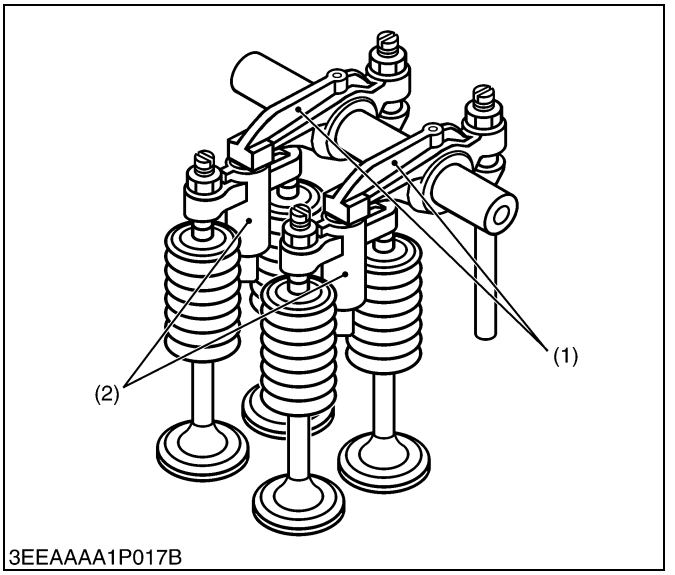
3EEAAAA1P014A

V3 series DI engine adopts the Center Direct Injection System (E-CDIS), in which the injection nozzle is positioned upright at the center of the cylinder.

This system serves to inject fuel directly at the center of the cylinder. By so doing, injected fuel and suction air can be mixed more uniformly, leading to more stable, higher combustion performance. In other words, cleaner emission, higher power output, lower fuel consumption, lower operating noise and higher start-up performance have been achieved.

(1) Exhaust Valves (3) Injection Nozzle
(2) Piston (4) Intake Valves

W11094950



3EEAAAA1P017B

V3 series DI engine has two intake valves and two exhaust valves per each cylinder.

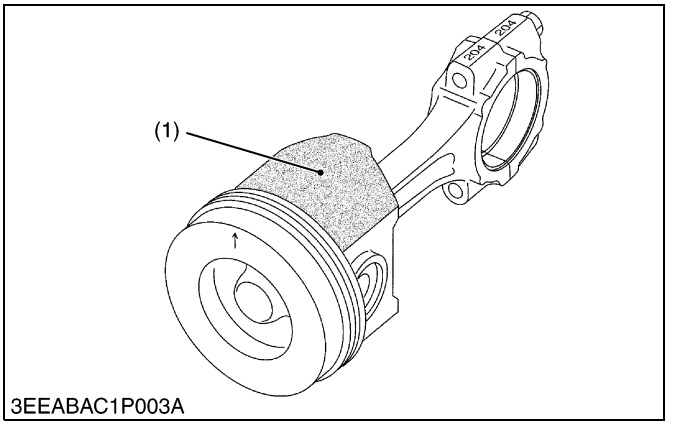
The rocker arm (1) contacts a bridge arm (2) instead of the valves stem tip.

The bridge arm then contacts both intake valves or bath exhaust valves and causes two valves to open simultaneously.

(1) Rocker Arm (2) Bridge Arm

W1014724

[5] PISTON



3EEABAC1P003A

Piston's skirt is coated with molybdenum disulfide<Dingbats>H, which reduces the piston slap noise and thus the entire operating noise.

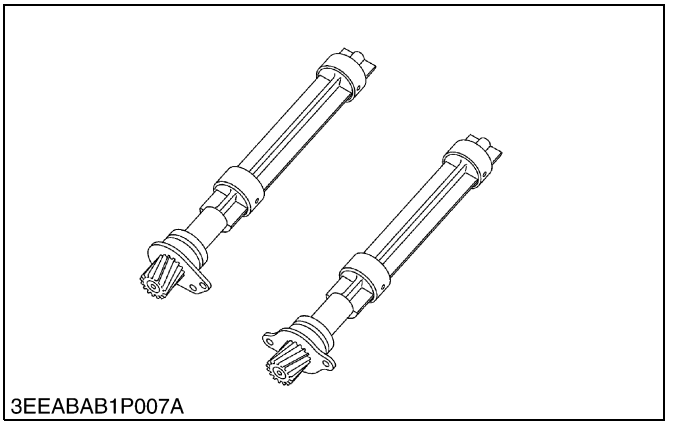
■ **Molybdenum disulfide (MoS_2)**

The molybdenum disulfied serves as a solid lubricant, like a Graphite or Teflon. This material helps resist metal wears even with little lube oil.

(1) Molybdenum Disulfide

W1015665

[6] BUILT-IN DYNAMIC BALANCER (BALANCER MODEL ONLY)


3EEABAB1P007A

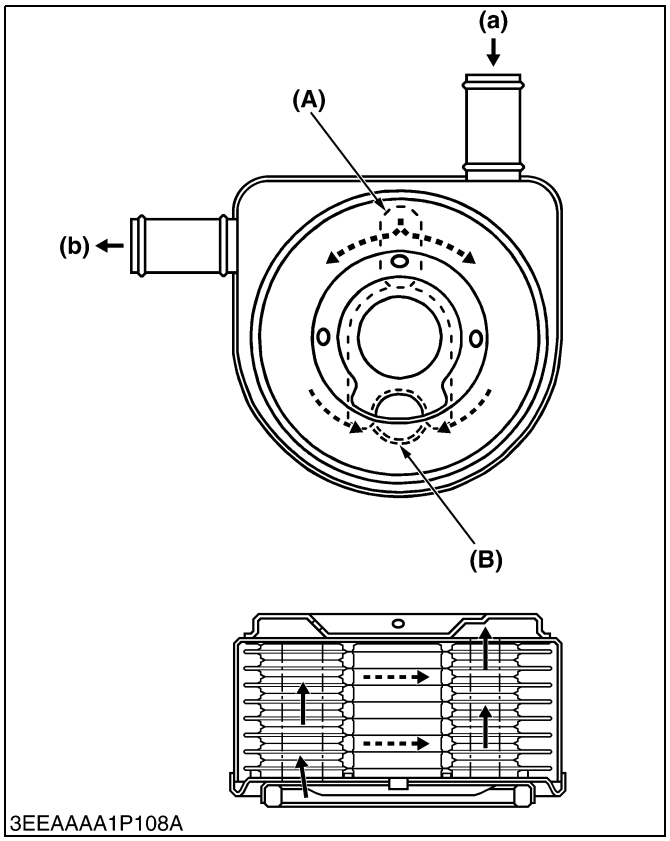
Engine are sure to vibrate by piston's reciprocation. Theoretically, three-cylinder engines are much less prone to cause vibration than four-cylinder ones (second inertia, etc.). However, any engine has many moving parts in addition to its pistons and cannot be completely free from vibration.

The four cylinder engine is fitted with balance weight on crankcase to absorb the second inertia mentioned above and reduce vibration.

W1013617

3. LUBRICATING SYSTEM

[1] OIL COOLER



V3 series engine has a water-cooled oil cooler that not only cools hot oil, but also warms the cool engine oil shoftly after start up.

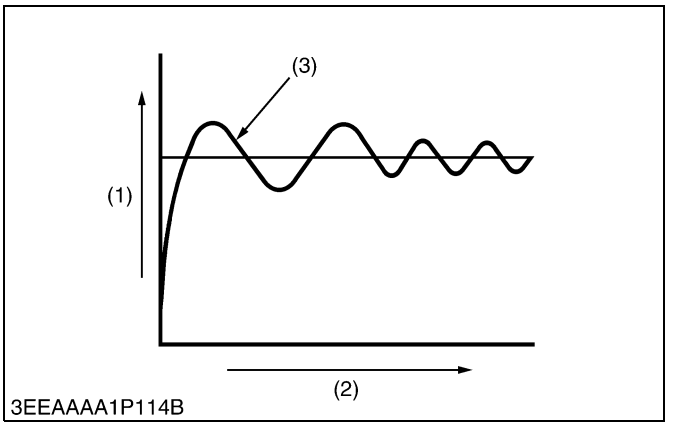
As shown in the figure, the oil flows inside the connected cooler plate, whereas coolant is kept circulating outside the cooler plate, thereby cooling down or warming the oil.

(A) Oil Inlet Port
(B) Oil Outlet Port
(a) Coolant Inlet Port
(b) Coolant Outlet Port

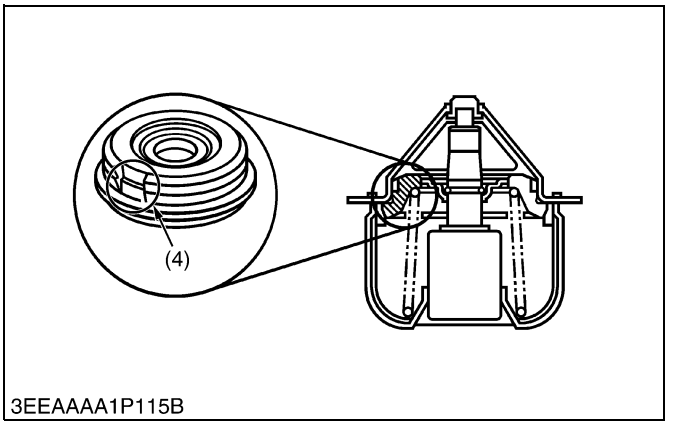
W10344770

4. COOLING SYSTEM

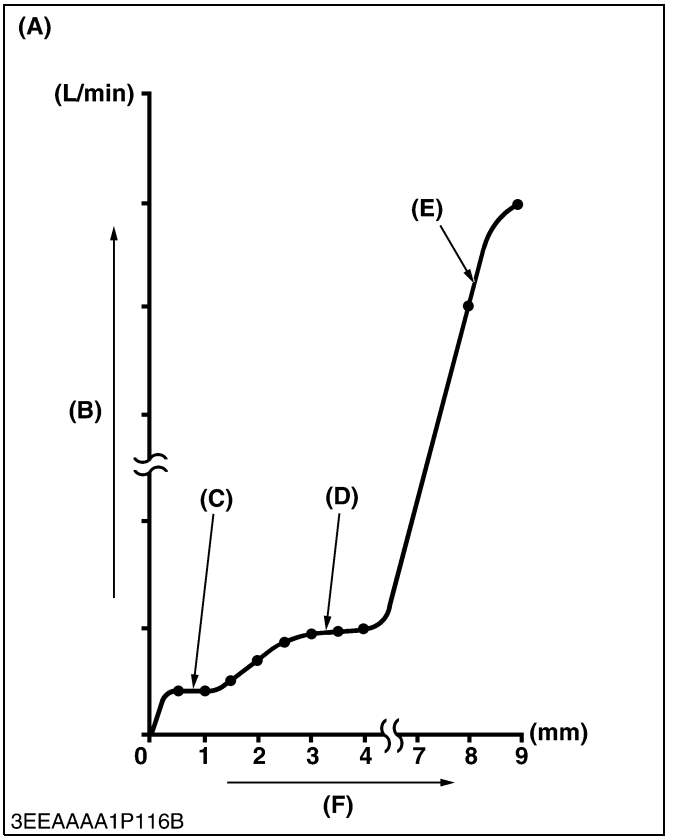
[1] THERMOSTAT



3EEAAAA1P114B



3EEAAAA1P115B



3EEAAAA1P116B

Conventional thermostatically-controlled valves (outlet water temperature control type) open against the flow of coolant. In this design, the pressure (steam pressure + water pump's discharge pressure) affects the open/close performance of such valve. In other words, the valve may be delayed in opening at a preset opening temperature opening suddenly, above the preset temperature. This is called the overshoot phenomenon.

The overshoot problem invites the undershoot phenomenon too. Too much water cooled by the radiator flows through the water passage, which suddenly closes the valve below the thermostat's preset valve closing temperature.

A repeated cycle of such overshoot and undershoot phenomena is called the water temperature hunting. This hunting problem may adversely affects the cooling system parts, and also the engine and its related components.

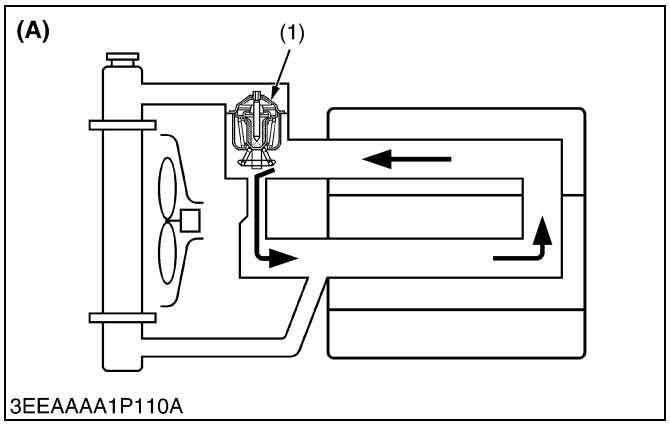
To cope with this trouble, the V3 series engine is equipped with the flow control thermostat. The valve has a notch to control the coolant flowrate smoothly in small steps.

(1) Coolant Temperature
(2) Time
(3) Overshoot
(4) Notch

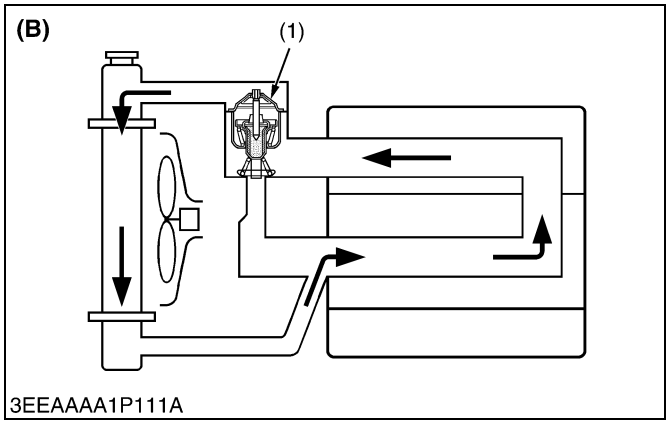
(A) Valve Lift Versus Flowrate
(B) Flowrate
(C) At Short Valve Lift
(D) At Medium Valve Lift
(E) At High Valve Lift
(F) Valve Lift

W1013684

[2] BOTTOM BYPASS SYSTEM



3EEAAAA1P110A



3EEAAAA1P111A

Bottom bypass system is introduced in V3 series for improving the cooling performance of the radiator.

While the temperature of coolant in the engine is low, the thermostat 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 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.

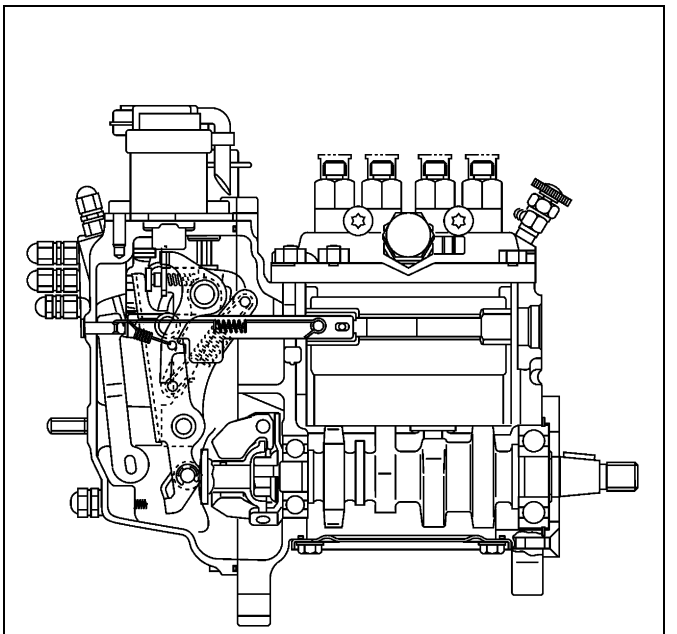
(1) Thermostat

(A) Bypass Opened
(B) Bypass Closed

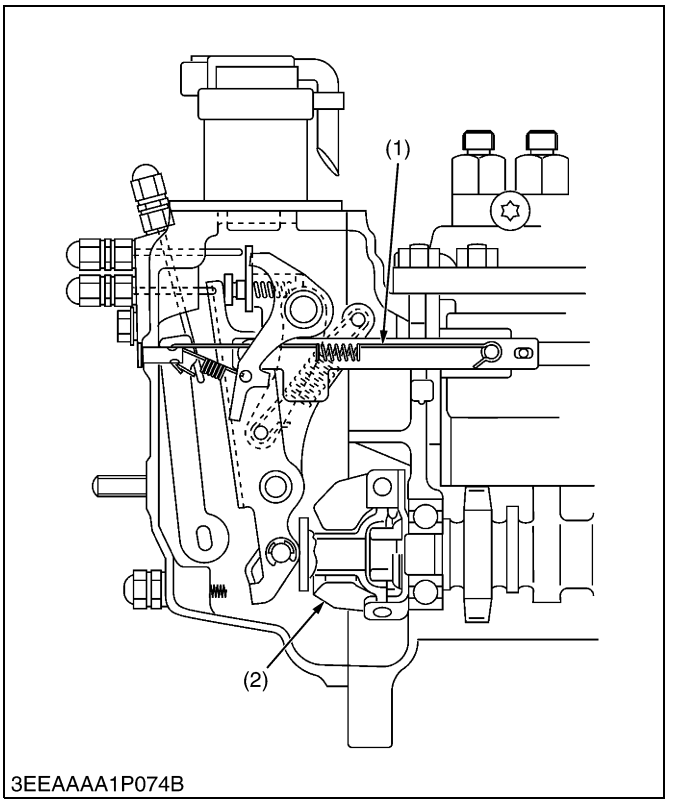
W1013406

5. FUEL SYSTEM

[1] GOVERNOR



3EEAAAA1P064B



3EEAAAA1P074B

The engine employs the separated fuel injection pump in combination with Kubota's own small multi-function mechanical governor, which enable more dependability.

It also employs the torque limiting mechanism to control the maximum peak torque so that it complies with the regulations of exhaust gas.

This mechanism maintains engine speed at a constant level even under fluctuating loads, provides stable idling and regulates maximum engine speed by controlling the fuel injection rate.

This engine uses a mechanical governor that controls the fuel injection rate at all speed ranges (from idling to maximum speed) by utilizing the balance between the flyweight's centrifugal force and spring tension.

A governor shaft for monitoring engine speed is independent of the injection pump shaft and rotates at twice the speed of conventional types, providing better response to load fluctuation and delivering greater engine output.

W1013830

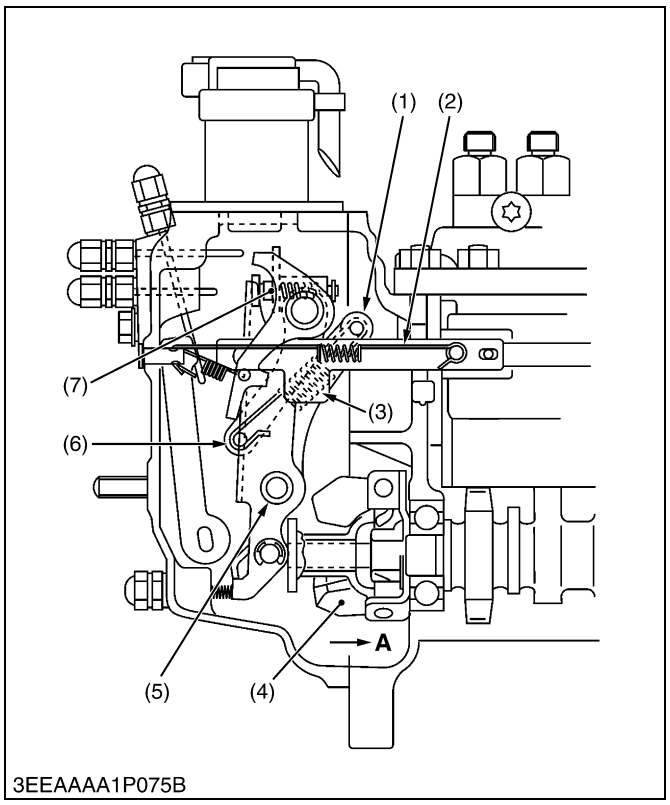
■ At Start

The stop solenoid (energized-to-run type) is powered to release the stop lever.

As no centrifugal force is applied to flyweight (2), low tension of start spring (1) permits control rack to move the starting position, supplying the amount of fuel required to start the engine.

(1) Start Spring (2) Flyweight

W1013967



3EEAAAA1P075B

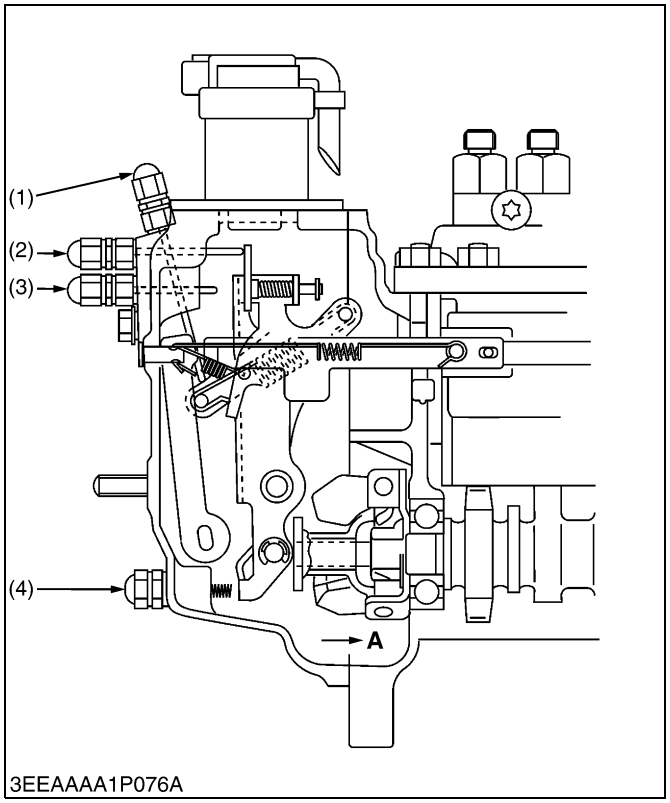
■ At Idling

Turn the speed control lever (6) clockwise to idle the engine. It tensions the governor spring (3) to pull the fork lever 2 (1).

When the fork lever 2 is pulled, it moves the torque spring pin (7) and the fork lever 1 (5) in the direction of the arrow **A** to restrain the weight. In combination with the start spring tension, it is balanced with the centrifugal force of flywheel weight to keep idling.

(1) Fork Lever 2
(2) Start Spring
(3) Governor Spring
(4) Flyweight
(5) Fork Lever 1
(6) Speed Control Lever
(7) Spring Pin

W1014034



3EEAAAA1P076A

■ At rated speed with full load and overload

As the speed control lever is changed from the middle speed to high speed, the governor spring tension increases to compress the torque spring and move the fork lever 1 in the direction of the arrow **A**.

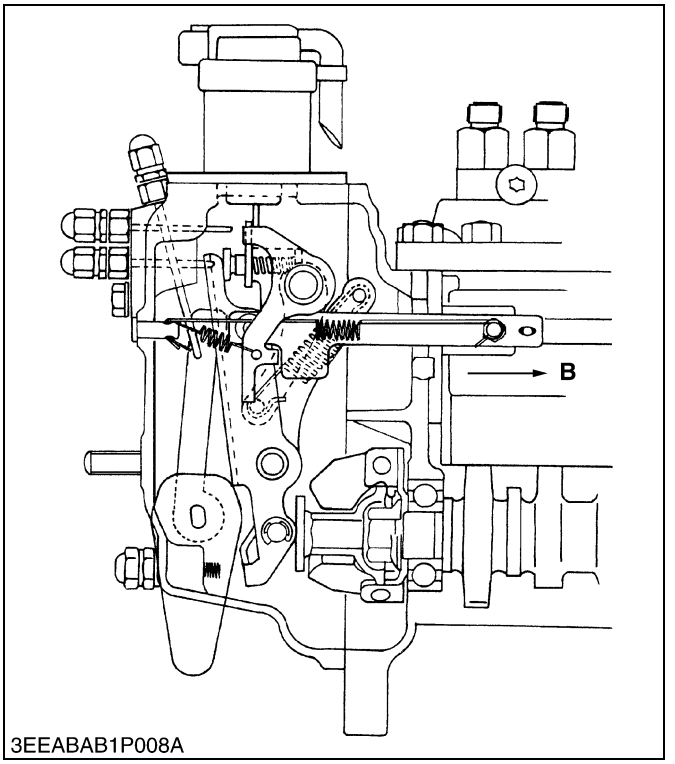
The fork lever 2 moves until it reaches the output limiting bolt to keep rated rotation and rated output.

When the engine is overloaded, the engine rotating speed decreases and the centrifugal force of flywheel weight decreases. Then the torque spring moves the fork lever 1 in the direction of arrow **A**.

The control rack moves in the direction that increases fuel supply to increase the output. It is balanced with the centrifugal force of the flywheel weight to produce low-speed output (torque output).

(1) No-load Maximum Rotation
(2) Output Limiting Bolt
(3) Torque Limiting Bolt
(4) Idling Adjusting Bolt

W1014276



3EEABAB1P008A

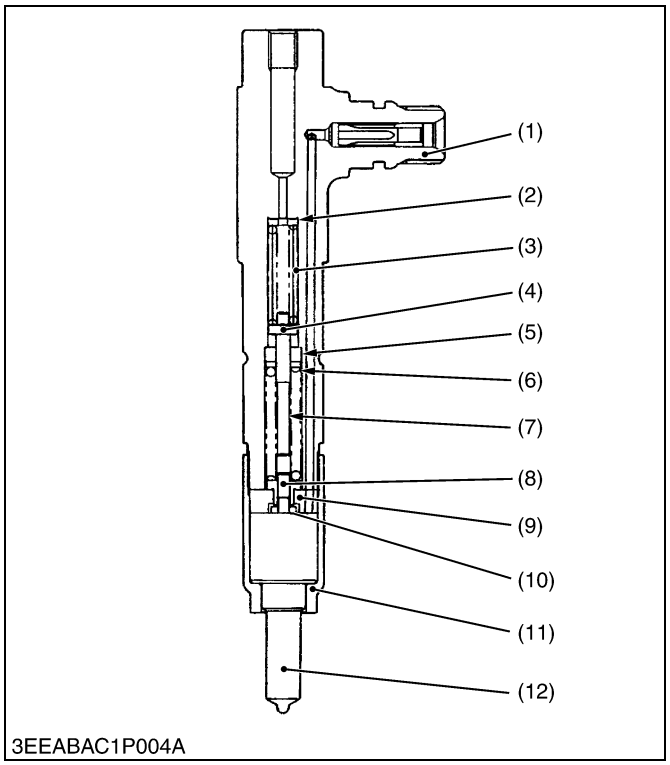
■ **To stop engine**

When the stop solenoid is turned off, the spring tension of the solenoid is released, the rod extrudes and the stop lever moves the control rack in the direction of the arrow **B** which stops the engine.

To stop the engine manually, move the external stop lever to the left.

W1014393

[2] 2 STAGE DI NOZZLE



3EEABAC1P004A

Exhaust and noise regulations are becoming increasingly strict, particularly in regard to the reduction of NOx (nitrogen oxides) and particulates.

The two-spring nozzle holder has been developed to reduce NOx (nitrogen oxides) and particulates from direct injection diesel engine exhaust.

■ **Features**

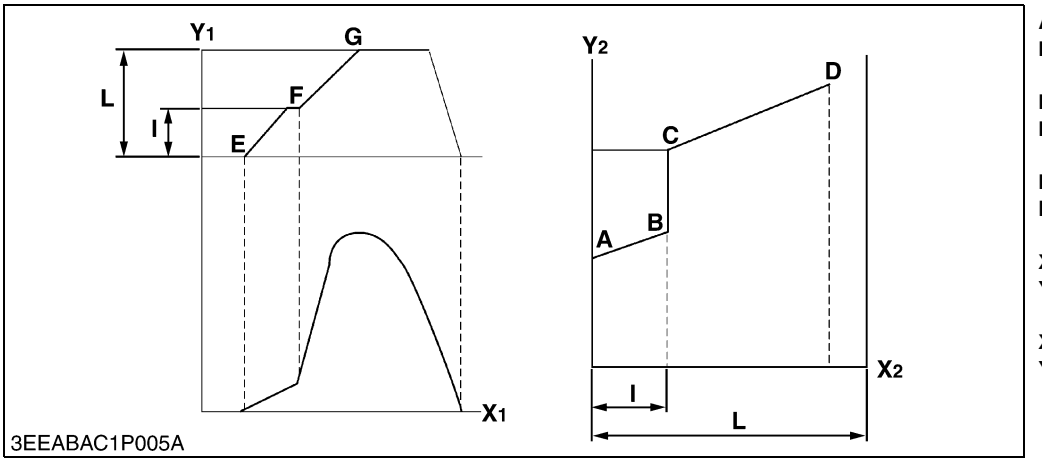
The two-spring nozzle holder limits needle valve lift at initial valve opening to throttle the injection quantity. Main injection occurs when the in-line pressure has increased sufficiently to move the needle valve through its full lift.

This gives the following features.

- Improved engine stability at low and intermediate speeds.
- Decreased engine hunting and surge.
- Decreased noise at idling.
- Decreased idling speed because of improved engine stability.
- Stabilized fuel injection characteristics from the injection pump and nozzle system, and easier matching of governor characteristics to engine demand.

(1) Nozzle Holder Body
(2) 1st Stage Injection Pressure Adjusting Shim
(3) First Spring
(4) Pressure Pin
(5) Spring Seat
(6) 2nd Stage Injection Pressure Adjusting Shim
(7) Second Spring
(8) Pre-lift Adjusting Spring Seat
(9) Chip-packing
(10) Max-lift Adjusting Washer
(11) Retaining Nut
(12) Nozzle

W1014568



3EEABAC1P005A

A-B : First Spring's Set Force
B-C-D : Combined Force of First and Second Springs
P1 : First Opening Pressure
P2 : Second Opening Pressure

L : Full Needle Valve Lift
l : Needle Valve Pre-lift

X1 : Cam Angle (<Symbol>×)
Y1 : Injection Rate (mm3/ <Symbol>×)
X2 : Needle Valve Lift (mm)
Y2 : In-line Pressure

W1014795

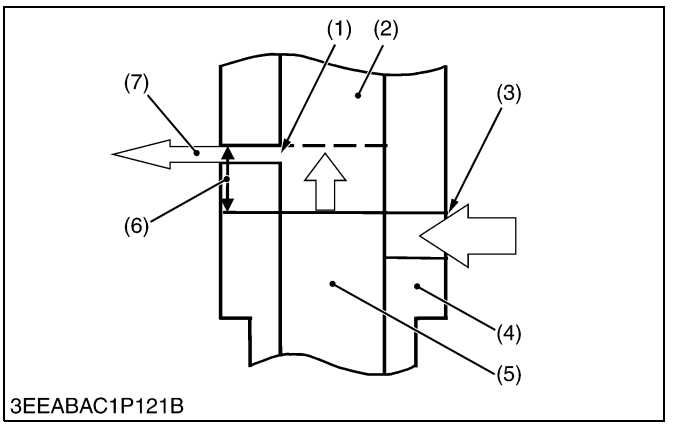
■ **First opening pressure**

The force of the high pressure fuel delivered by the injection pump acts to push the needle valve up. When this force exceeds the set force of the first spring, the nozzle's needle valve pushes the first pushrod up and the valve opens. (First opening pressure is represented by point **E** in the bottom left hand figure, and point **A** in the above figure.)

■ **Second opening pressure**

When the first pushrod has been lifted through the pre-lift, it contacts the second pushrod. As the set force of the second spring is acting on the second pushrod, the combined forces of both the first spring and the second spring then act on the needle valve, which will not lift unless these forces are overcome.

[3] INJECTION PUMP WITH F.S.P.



3EEABAC1P121B

The fuel injection pump with F.S.P. (Fine Spill Port) mechanism is equipped with two functions: speed timer function and injection rate control function.

The former function works like this. As the rpm is low, the injection timing gets delayed. This helps cut down on NOx and operating noise.

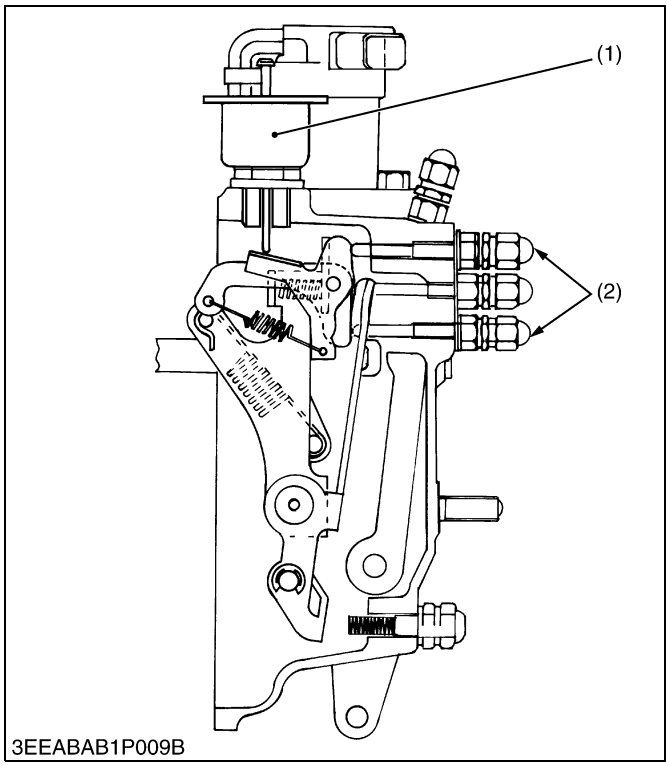
The latter function serves to keep down the initial injection rate and keep up the later injection rate, which cuts down on NOx and PM as well.

(1) Fine Spill Port (F.S.P.)
(2) Plunger Chamber
(3) Main Port
(4) Cylinder
(5) Plunger
(6) F.S.P. Stroke
(7) Leaking Fuel at Initial Fuel Pressure-Feed Stage

W1014969

6. TURBOCHARGER SYSTEM

[1] BOOST COMPENSATOR



The boost compensator is controlled by the boost pressure of the control mechanism which controls transient smoke caused by oversupply of fuel when the engine starts and accelerates.

When the boost pressure is lower than working pressure of the boost actuator (1), it prevents oversupply of fuel to reduce transient smoke.

When the boost pressure is higher than working pressure of the boost actuator (1), it controls the supply of fuel to the equivalent of maximum power / rated speed output.

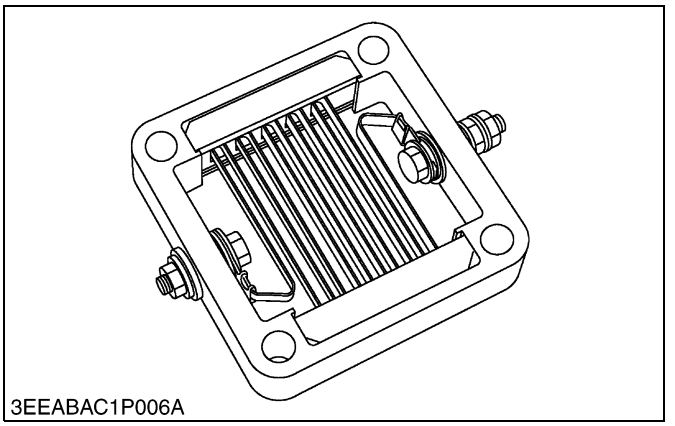
The boost compensator adjusting screws (2) are set and tamper-proof capped in factory, so never take off the tamper-proof cap and readjust the screws.

(1) Boost Actuator
(2) Boost Compensator Adjusting Screw

W1014569

7. INTAKE SYSTEM

[1] INTAKE AIR HEATER


3EEABAC1P006A

The intake air heater is introduced in order to further improve the starting performance and to reduce the white smoke at cold starting.

The intake air heater is mounted on the intake manifold. In this new construction, there is no need to arrange any glow plug on the cylinder head. This means that a multi-valve design can be implemented and that the starting performance and serviceability are enhanced.

W1015544

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      (8) Alternator III-S-165

1. TROUBLESHOOTING

Symptom	Probable Cause	Solution	Reference Page
Engine Does Not Start	No fuel	Replenish fuel	
	Air in the fuel system	Vent air	
	Water in the fuel system	Change fuel and repair or replace fuel system	
	Fuel hose clogged	Clean or replace	
	Fuel filter clogged	Replace	
	Excessively high viscosity of fuel or engine oil at low temperature	Use specified fuel or engine oil	
	Fuel with low cetane number	Use specified fuel	
	Fuel leak due to loose injection pipe retaining nut	Tighten retaining nut	
	Incorrect injection timing	Adjust	
	Fuel camshaft worn	Replace	
	Injection nozzle clogged	Repair or replace	
	Injection pump malfunctioning	Repair or replace	
	Seizure of crankshaft, camshaft, piston, cylinder or bearing	Repair or replace	
	Compression leak from cylinder	Replace head gasket, tighten cylinder head screw and nozzle holder	
	Improper valve timing	Correct or replace timing gear	
	Piston ring and cylinder worn	Replace	
	Excessive valve clearance	Adjust	
	Stop solenoid malfunctioning	Replace	
Starter Does Not Run	Battery discharged	Charge	
	Starter malfunctioning	Repair or replace	
	Key switch malfunctioning	Replace	
	Wiring disconnected	Connect	

W1014322

Symptom	Probable Cause	Solution	Reference Page
Engine Revolution Is Not Smooth	Fuel filter clogged or dirty	Replace	
	Air cleaner clogged	Clean or replace	
	Fuel leak due to loose injection pipe retaining nut	Tighten retaining nut	
	Injection pump malfunctioning	Repair or replace	
	Incorrect nozzle opening pressure	Repair or replace	
	Injection nozzle stuck or clogged	Repair or replace	
	Governor malfunctioning	Repair	
	Turbocharger bearing worn out	Replace the turbocharger assembly	
	Turbocharger shaft bent	Replace the turbocharger assembly	
	Turbocharger fin or other part damaged due to foreign matters	Replace the turbocharger assembly	
Either White or Blue Exhaust Gas Is Observed	Excessive engine oil	Reduce to specified level	
	Piston ring and cylinder worn or stuck	Repair or replace	
	Incorrect injection timing	Adjust	
Oil Leak into Exhaust Pipe or Suction Pipe	Waste oil pipe clogged or deformed	Repair or replace	
	Turbocharger's piston ring seal faulty	Replace the turbocharger assembly	
Either Black or Dark Gray Exhaust Gas Is Observed	Overload	Reduce the load	
	Low grade fuel used	Use specified fuel	
	Fuel filter clogged	Replace	
	Air cleaner clogged	Clean or replace	
	Deficient nozzle injection	Repair or replace nozzle	

W1014322

Symptom	Probable Cause	Solution	Reference Page
Deficient Output	Incorrect injection timing	Adjust	
	Engine's moving parts seem to be seizing	Repair or replace	
	Injection pump malfunctioning	Repair or replace	
	Deficient nozzle injection	Repair or replace nozzle	
	Compression leak	Check the compression pressure and repair	
	Gas leak from exhaust system	Repair or replace	
	Air leak from compressor discharge side	Repair or replace	
	Air cleaner dirty or clogged	Clean or replace	
	Compressor wheel turning heavily	Replace the turbocharger assembly	
Excessive Lubricant Oil Consumption	Piston ring's gap facing the same direction	Shift ring gap direction	
	Oil ring worn or stuck	Replace	
	Piston ring groove worn	Replace piston	
	Valve stem and valve guide worn	Replace	
	Crankshaft bearing and crank pin bearing worn	Replace	
	Oil leaking due to defective seals or packing	Replace	
Fuel Mixed into Lubricant Oil	Injection pump's plunger worn	Repair or replace	
	Deficient nozzle injection	Repair or replace nozzle	
	Injection pump broken	Replace	
Water Mixed into Lubricant Oil	Head gasket defective	Replace	
	Cylinder block or cylinder head flawed	Replace	
Low Oil Pressure	Engine oil insufficient	Replenish	
	Oil strainer clogged	Clean	
	Relief valve stuck with dirt	Clean	
	Relief valve spring weaken or broken	Replace	
	Excessive oil clearance of crankshaft bearing	Replace	
	Excessive oil clearance of crankpin bearing	Replace	
	Excessive oil clearance of rocker arm	Replace	
	Oil passage clogged	Clean	
	Different type of oil	Use specified type of oil	
	Oil pump defective	Replace	

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Symptom	Probable Cause	Solution	Reference Page
High Oil Pressure	Different type of oil	Use specified type of oil	
	Relief valve defective	Replace	
Engine Overheated	Engine oil insufficient	Replenish	
	Fan belt broken or elongated	Replace or adjust	
	Coolant insufficient	Replenish	
	Radiator net and radiator fin clogged with dust	Clean	
	Inside of radiator corroded	Clean or replace	
	Coolant flow route corroded	Clean or replace	
	Radiator cap defective	Replace	
	Overload running	Reduce the load	
	Head gasket defective	Replace	
	Incorrect injection timing	Adjust	
	Unsuitable fuel used	Use specified fuel	
Battery Quickly Discharged	Battery electrolyte insufficient	Replenish distilled water and charge	
	Fan belt slips	Adjust belt tension or replace	
	Wiring disconnected	Connect	
	Rectifier defective	Replace	
	Alternator defective	Replace	
	Battery defective	Replace	

W1014322

2. SERVICING SPECIFICATIONS

ENGINE BODY

Item		Factory Specification	Allowable Limit
Cylinder Head Surface	Flatness	–	0.05 mm 0.0020 in.
Top Clearance		0.72 to 0.90 mm 0.0283 to 0.0354 in.	–
Compression Pressure	V3800DI-E2B	3.92 MPa / 250 min^{-1} (rpm) 40.0 kgf/cm^2 / 250 min^{-1} (rpm) 569 psi / 250 min^{-1} (rpm)	2.90 MPa / 250 min^{-1} (rpm) 29.6 kgf/cm^2 / 250 min^{-1} (rpm) 421 psi / 250 min^{-1} (rpm)
	V3800DI-T-E2B	3.47 MPa / 250 min^{-1} (rpm) 35.4 kgf/cm^2 / 250 min^{-1} (rpm) 503 psi / 250 min^{-1} (rpm)	2.56 MPa / 250 min^{-1} (rpm) 26.1 kgf/cm^2 / 250 min^{-1} (rpm) 371 psi / 250 min^{-1} (rpm)
Variance Among Cylinders		–	10 % or less
Valve Seat	Angle (Intake)	1.047 rad 60 °	–
	Angle (Exhaust)	0.785 rad 45 °	–
	Width (Intake)	1.6 to 2.0 mm 0.0630 to 0.0790 in.	–
	Width (Exhaust)	2.3 to 2.6 mm 0.0906 to 0.1024 in.	–
Valve Face	Angle (Intake)	1.047 rad 60 °	–
	Angle (Exhaust)	0.785 rad 45 °	–
Valve Recessing	Intake	0.6 to 0.8 mm 0.0236 to 0.0315 in.	1.2 mm 0.0472 in.
	Exhaust	0.85 to 1.05 mm 0.0335 to 0.0413 in.	1.2 mm 0.0472 in.

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ENGINE BODY (Continued)

Item		Factory Specification	Allowable Limit
Valve Stem to Valve Guide	Clearance (Intake)	0.055 to 0.085 mm 0.0022 to 0.0033 in.	0.1 mm 0.0039 in.
Valve Stem	O.D. (Intake)	6.960 to 6.975 mm 0.2740 to 0.2746 in.	–
Valve Guide	I.D. (Intake)	7.030 to 7.045 mm 0.2768 to 0.2774 in.	–
Valve Stem to Valve Guide	Clearance (Exhaust)	0.055 to 0.085 mm 0.0022 to 0.0033 in.	0.1 mm 0.0039 in.
Valve Stem	O.D. (Exhaust)	6.960 to 6.975 mm 0.2740 to 0.2746 in.	–
Valve Guide	I.D. (Exhaust)	7.030 to 7.045 mm 0.2768 to 0.2774 in.	–
Valve Clearance (Cold)		0.23 to 0.27 mm 0.0091 to 0.0106 in.	–
Intake Valve Timing	Open	0.24 rad (14 °) before T.D.C.	–
	Close	0.61 rad (36 °) after B.D.C.	–
Exhaust Valve Timing	Open	0.79 rad (45 °) before B.D.C.	–
	Close	0.29 rad (17 °) after T.D.C.	–
Valve Spring	Free Length (Intake)	35.1 to 35.6 mm 1.3819 to 1.4016 in.	34.6 mm 1.3622 in.
	Free Length (Exhaust)	35.1 to 35.6 mm 1.3819 to 1.4016 in.	34.6 mm 1.3622 in.
	Tilt	–	1.0 mm 0.039 in.
Valve Spring	Setting Load / Setting Length (Intake)	63.547 N / 31.5 mm 6.48 kgf / 31.5 mm 14.256 lbs / 1.2401 in.	45.864 N / 31.5 mm 4.68 kgf / 31.5 mm 10.296 lbs / 1.2401 in.
	Setting Load / Setting Length (Exhaust)	63.547 N / 31.5 mm 6.48 kgf / 31.5 mm 14.256 lbs / 1.2401 in.	45.864 N / 31.5 mm 4.68 kgf / 31.5 mm 10.296 lbs / 1.2401 in.

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ENGINE BODY (Continued)

Item		Factory Specification	Allowable Limit
Rocker Arm Shaft to Rocker Arm	Clearance	0.016 to 0.045 mm 0.0006 to 0.0018 in.	0.15 mm 0.0059 in.
Rocker Arm Shaft	O.D.	15.973 to 15.984 mm 0.6289 to 0.6293 in.	–
Rocker Arm	I.D.	16.000 to 16.018 mm 0.6299 to 0.6306 in.	–
Valve Arm Bridge and Valve Arm Bridge Shaft	Clearance	0.018 to 0.042 mm 0.0007 to 0.0017 in.	0.15 mm 0.0059 in.
Valve Arm Bridge	I.D.	9.050 to 9.065 mm 0.3563 to 0.3569 in.	–
Valve Arm Bridge Shaft	O.D.	9.023 to 9.032 mm 0.3552 to 0.3556 in.	–
Push Rod	Alignment	–	0.25 mm 0.0098 in.
Tappet to Tappet Guide	Clearance	0.020 to 0.062 mm 0.0008 to 0.0024 in.	0.07 mm 0.0028 in.
Tappet Guide Bore	I.D.	24.000 to 24.021 mm 0.9449 to 0.9457 in.	–
Tappet	O.D.	23.959 to 23.980 mm 0.9433 to 0.9441 in.	–
Camshaft	Side Clearance	0.07 to 0.22 mm 0.0028 to 0.0087 in.	0.30 mm 0.0118 in.
	Alignment	–	0.01 mm 0.00039 in.
Cam Height	Intake	37.63 mm 1.4815 in.	37.13 mm 1.4618 in.
	Exhaust	38.96 mm 1.5338 in.	38.46 mm 1.5141 in.
Camshaft	Oil Clearance	0.050 to 0.091 mm 0.0020 to 0.0036 in.	0.15 mm 0.0059 in.
Camshaft Journal	O.D.	45.934 to 45.950 mm 1.8084 to 1.8091 in.	–
Camshaft Bearing	I.D.	46.000 to 46.025 mm 1.8110 to 1.8120 in.	–

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ENGINE BODY (Continued)

Item		Factory Specification	Allowable Limit
Timing Gear			
Idle Gear 1 to Crank Gear	Backlash	0.049 to 0.193 mm 0.0019 to 0.0076 in.	0.22 mm 0.0087 in.
Idle Gear 1 to Cam Gear	Backlash	0.049 to 0.189 mm 0.0019 to 0.0074 in.	0.22 mm 0.0087 in.
Idle Gear 1 to Idle Gear 2	Backlash	0.044 to 0.185 mm 0.0017 to 0.0073 in.	0.22 mm 0.0087 in.
Idle Gear 2 to Injection Pump Gear	Backlash	0.044 to 0.177 mm 0.0017 to 0.0070 in.	0.22 mm 0.0087 in.
Cam Gear to Balancer Gear 1 (Balancer Model Only)	Backlash	0.047 to 0.182 mm 0.0018 to 0.0072 in.	0.22 mm 0.0087 in.
Idle Gear 1 to Balancer Gear 2 (Balancer Model Only)	Backlash	0.044 to 0.183 mm 0.0017 to 0.0072 in.	0.22 mm 0.0087 in.
Idle Gear Shaft 1, 2 to Idle Gear 1, 2 Bushing	Oil Clearance	0.050 to 0.091 mm 0.0020 to 0.0036 in.	0.10 mm 0.0039 in.
Idle Gear 1, 2 Bushing	I.D.	45.025 to 45.050 mm 1.7726 to 1.7736 in.	–
Idle Gear 1, 2 Shaft	O.D.	44.959 to 44.975 mm 1.7700 to 1.7707 in.	–
Idle Gear	Side Clearance	0.15 to 0.30 mm 0.0059 to 0.0118 in.	0.9 mm 0.0354 in.
Balancer Shaft (Balancer Model Only)	Side Clearance	0.070 to 0.22 mm 0.0028 to 0.0087 in.	0.3 mm 0.0118 in.
Balancer Shaft (Balancer Model Only)	Alignment	–	0.02 mm 0.0008 in.
Balancer Shaft (Balancer Model Only)	Oil Clearance	0.070 to 0.159 mm 0.0028 to 0.0063 in.	0.2 mm 0.0079 in.
Balancer Shaft Journal	O.D.	50.92 to 50.94 mm 2.0047 to 2.0055 in.	–
Balancer Bearing	I.D.	51.01 to 51.08 mm 2.0083 to 2.0110 in.	–
Piston Pin Bore	I.D.	30.000 to 30.013 mm 1.1811 to 1.1816 in.	30.05 mm 1.1831 in.
Top Ring to Ring Groove	Clearance	0.05 to 0.09 mm 0.0020 to 0.0035 in.	0.15 mm 0.0059 in.
Second Ring to Ring Groove	Clearance	0.093 to 0.120 mm 0.0037 to 0.0047 in.	0.20 mm 0.0079 in.
Oil Ring to Ring Groove	Clearance	0.020 to 0.060 mm 0.0008 to 0.0023 in.	0.15 mm 0.0059 in.

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ENGINE BODY (Continued)

Item		Factory Specification	Allowable Limit
Piston Ring Gap	Top Ring	0.30 to 0.45 mm 0.0118 to 0.0177 in.	1.25 mm 0.0492 in.
	Second Ring	0.30 to 0.45 mm 0.0118 to 0.0177 in.	1.25 mm 0.0492 in.
	Oil Ring	0.25 to 0.45 mm 0.0098 to 0.0177 in.	1.25 mm 0.0492 in.
Connecting Rod	Alignment	–	0.05 mm 0.0020 in.
Piston Pin to Small End Bushing	Clearance	0.020 to 0.040 mm 0.0008 to 0.0016 in.	0.15 mm 0.0059 in.
Piston Pin	O.D.	30.006 to 30.011 mm 1.1813 to 1.1815 in.	–
Small End Bushing	I.D.	30.031 to 30.046 mm 1.1823 to 1.1829 in.	–
Crankshaft	Side Clearance	0.15 to 0.31 mm 0.0059 to 0.0122 in.	0.50 mm 0.0197 in.
	Alignment	–	0.02 mm 0.00079 in.
Crankshaft Journal to Crankshaft Bearing	Oil Clearance	0.018 to 0.062 mm 0.0007 to 0.0024 in.	0.20 mm 0.0079 in.
Crankshaft Journal	O.D.	74.977 to 74.990 mm 2.9518 to 2.9524 in.	–
Crank Pin to Pin Bearing	Oil Clearance	0.018 to 0.051 mm 0.0007 to 0.0020 in.	0.20 mm 0.0079 in.
Crank Pin	O.D.	52.977 to 52.990 mm 2.0857 to 2.0862 in.	–
Cylinder Bore	I.D.	100.000 to 100.022 mm 3.9370 to 3.9379 in.	100.15 mm 3.9429 in.
Cylinder Bore (Oversize)	I.D.	100.500 to 100.522 mm 3.9567 to 3.9576 in.	100.65 mm 3.9626 in.

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LUBRICATING SYSTEM

Item		Factory Specification	Allowable Limit
Engine Oil Pressure	At Idle Speed	–	49 kPa 0.5 kgf/cm^2 7 psi
	At Rated Speed	196 to 392 kPa 2.0 to 4.0 kgf/cm^2 28 to 57 psi	147.1 kPa 1.5 kgf/cm^2 21.3 psi
Engine Oil Pressure Switch	Working Pressure	39.2 to 58.8 kPa 0.4 to 0.6 kgf/cm^2 5.6 to 8.4 psi	–
Inner Rotor to Outer Rotor	Clearance	0.04 to 0.16 mm 0.0016 to 0.0063 in.	0.3 mm 0.0118 in.
Outer Rotor to Pump Body	Clearance	0.100 to 0.184 mm 0.0039 to 0.0072 in.	0.3 mm 0.0118 in.
Inner Rotor to Cover	Clearance	0.025 to 0.075 mm 0.0010 to 0.0030 in.	0.225 mm 0.0089 in.
Relief Valve	Working Pressure	885 kPa 9.04 kgf/cm^2 129 psi	–

W10139730

COOLING SYSTEM

Thermostat	Valve Opening Temperature	74.5 to 78.5 °C 166.1 to 173.3 °F	–
	Valve Opening Temperature (Opened Completely)	90 °C 194 °F	–
Radiator	Water Tightness	Water tightness at specified pressure 137 kPa 1.4 kgf/cm^2 20 psi	–
Radiator Cap	Air Leakage	10 seconds or more 88 → 59 kPa 0.9 → 0.6 kgf/cm^2 13 → 9 psi	–
Fan Belt	Tension	10.0 to 12.0 mm / 98 N 0.394 to 0.472 in. / 98 N (10 kgf, 22 lbs)	–

W10135990

FUEL SYSTEM

Item		Factory Specification	Allowable Limit
Injection Timing		0.21 to 0.24 rad (12 to 14 °) before T.D.C.	–
Pump Element	Fuel Tightness	–	18.63 MPa 190 kgf/cm^2 2702 psi
Delivery Valve	Fuel Tightness	10 seconds 18.63 → 17.65 MPa 190 → 180 kgf/cm^2 2702 → 2560 psi	5 seconds 18.63 → 17.65 MPa 190 → 180 kgf/cm^2 2702 → 2560 psi
Fuel Injection Nozzle	Injection Pressure (1st stage)	18.63 to 19.61 MPa 190 to 200 kgf/cm^2 2702 to 2845 psi	–
	Injection Pressure (2nd stage)	23.54 to 24.52 MPa 240 to 250 kgf/cm^2 3414 to 3556 psi	–
	Valve Seat Tightness	When the pressure is 16.67 MPa (170 kgf/cm^2, 2418 psi), the valve seat must be fuel tightness.	–

W10139730

ELECTRICAL SYSTEM

Commutator	O.D.	32 mm 1.2598 in.	31.4 mm 1.2362 in.
Mica	Undercut	0.5 mm 0.0197 in.	0.2 mm 0.0079 in.
Brush (Starter)	Length	18.0 mm 0.7086 in.	11.0 mm 0.4331 in.
Alternator	No-load Voltage	14 V at 4000 min^{-1} (rpm)	–
Rotor Coil	Resistance	2.8 to 3.3 Ω	–
Slip Ring	O.D.	22.7 mm 0.894 in.	22.1 mm 0.870 in.
Brush (Alternator)	Length	18.5 mm 0.728 in.	5.0 mm 0.197 in.
Intake Air Heater	Resistance (at cold occasion)	Approx. 0.3 Ω	–

W1013973

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 Unit Diameter	Standard Screw and Bolt 〈4〉			Special Screw and Bolt 〈7〉		
	N·m	kgf·m	ft-lbs	N·m	kgf·m	ft-lbs
M6	7.9 to 9.3	0.80 to 0.95	5.8 to 6.9	9.8 to 11.3	1.00 to 1.15	7.23 to 8.32
M8	17.7 to 20.6	1.8 to 2.1	13.0 to 15.2	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
M10	39.2 to 45.1	4.0 to 4.6	28.9 to 33.3	48.1 to 55.9	4.9 to 5.7	35.4 to 41.2
M12	62.8 to 72.6	6.4 to 7.4	46.3 to 53.5	77.5 to 90.2	7.9 to 9.2	57.1 to 66.5

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	ft-lbs
Cylinder head cover screw	–	6.9 to 11.3	0.7 to 1.15	5.1 to 8.32
*Cylinder head screw	M12 x 1.25	98.1 to 107.9	10.0 to 11.0	72.3 to 79.6
*Connecting rod screw	M10 x 1.25	78.5 to 83.4	8.0 to 8.5	57.9 to 61.5
*Flywheel screw	M12 x 1.25	98.1 to 107.9	10.0 to 11.0	72.3 to 79.6
*Crankshaft screw	M16 x 1.5	255.0 to 274.6	26.0 to 28.0	188.1 to 202.5
*Main bearing case screw	M14 x 1.5	137.3 to 147.1	14.0 to 15.0	101.3 to 108.5
Rocker arm bracket screw	M10 x 1.25	49.0 to 55.9	5.0 to 5.7	36.2 to 41.2
Nozzle holder clamp nut	M8 x 1.25	17.7 to 20.6	1.8 to 2.1	13.0 to 15.2
Injection pipe retaining nut	M12 x 1.5	19.6 to 24.5	2.0 to 2.5	14.5 to 18.1
Overflow pipe assembly retaining screw	M6 x 1.0	9.8 to 11.3	1.0 to 1.15	7.23 to 8.32
Oil switch taper screw	R 1/8	14.7 to 19.6	1.5 to 2.0	10.8 to 14.5
Oil cooler joint screw	–	39.2 to 44.1	4.0 to 4.5	28.9 to 32.5
Oil pump cover screw	–	7.9 to 9.3	0.80 to 0.95	5.8 to 6.9
Starter's terminal **B** mounting nut	M8 x 1.25	9.8 to 11.8	1.0 to 1.2	7.2 to 8.7
Intake air heater terminal nut	M6 x 1.0	3.4 to 5.4	0.35 to 0.55	2.53 to 3.98
Injection pump gear mounting nut	M14 x 1.5	73.6 to 83.4	7.5 to 8.5	54.2 to 61.5
Injection pump unit mounting nut	M8 x 1.25	17.7 to 20.6	1.8 to 2.1	13.0 to 15.2
Gear case cover	M8 x 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
Relief valve retaining screw	–	68.6 to 78.4	7.0 to 8.0	50.6 to 57.9
Idle gear mounting screw	M8 x 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
Plate mounting screw	M8 x 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
Camshaft set screw	M8 x 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
Flywheel housing mounting screw	M12 x 1.25	77.5 to 90.2	7.9 to 9.2	57.1 to 66.5
Crankcase 2 mounting screw	M10 x 1.25	49.0 to 55.9	5.0 to 5.7	36.2 to 41.2
Injection pump mounting screw	M8 x 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
Injection pump mounting nut	M8 x 1.25	17.7 to 20.6	1.8 to 2.1	13.0 to 15.2
Boost actuator (Boost compensator model only)	–	39.2 to 45.1	4.0 to 4.6	28.9 to 33.3
Governor weight mounting nut	M12 x 1.25	62.8 to 72.6	6.4 to 7.4	46.3 to 53.5
Fuel camshaft stopper mounting screw	–	7.9 to 9.3	0.80 to 0.95	5.8 to 6.9

W1013236

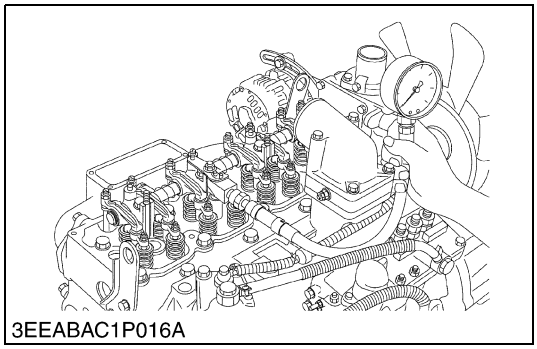
Item	Size x Pitch	N·m	kgf·m	ft-lbs
Governor housing mounting screw	M6 x 1.0	9.8 to 11.3	1.00 to 1.15	7.23 to 8.32
Anti-rotation nut	M5 x 0.8	2.8 to 4.0	0.29 to 0.41	2.1 to 3.0
Balancer shaft set screw (Balancer model only)	M8 x 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
Bearing case cover mounting screw	M8 x 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
Alternator pulley nut	–	58.3 to 78.9	5.95 to 8.05	43.0 to 58.2

W1013236

4. CHECKING, DISASSEMBLING AND SERVICING

[1] CHECKING AND ADJUSTING

(1) Engine Body


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Compression Pressure

1. After warming up the engine, stop it and remove the air cleaner, the muffler, high pressure pipes, cylinder head cover, overflow pipe, all nozzle holders and all nozzle gaskets.
2. Install a compression tester (Code No: 07909-30208) and nozzle adaptor for diesel engines to nozzle holder hole.
3. After making sure that the stop lever is set at the stop position (Non-injection), run the engine at 200 to 300 min^{-1} (rpm) with the starter.
4. Read the maximum pressure. Measure the pressure more than twice.

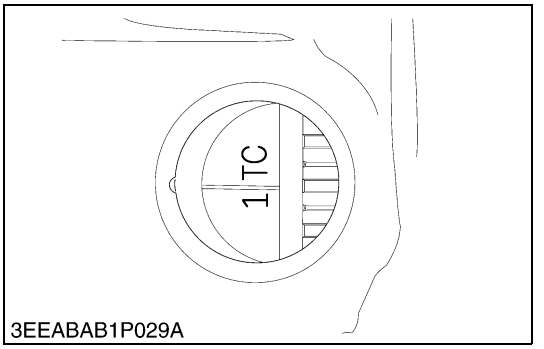
■ **Note**

- **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 %.**

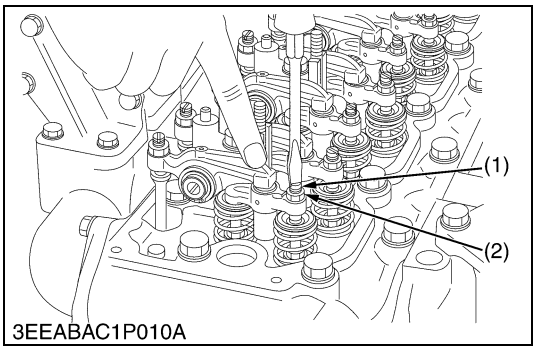
Compression pressure	Factory spec.	V3800DI-E2B	3.92 MPa / 250 min^{-1} (rpm) 40.0 kgf/cm^2 / 250 min^{-1} (rpm) 569 psi / 250 min^{-1} (rpm)
		V3800DI-T-E2B	3.47 MPa / 250 min^{-1} (rpm) 35.4 kgf/cm^2 / 250 min^{-1} (rpm) 503 psi / 250 min^{-1} (rpm)
	Allowable limit	V3800DI-E2B	2.90 MPa / 250 min^{-1} (rpm) 29.6 kgf/cm^2 / 250 min^{-1} (rpm) 421 psi / 250 min^{-1} (rpm)
		V3800DI-T-E2B	2.56 MPa / 250 min^{-1} (rpm) 26.1 kgf/cm^2 / 250 min^{-1} (rpm) 371 psi / 250 min^{-1} (rpm)

Tightening torque	Nozzle holder clamp nut	17.7 to 20.6 N·m 1.8 to 2.1 kgf·m 13.0 to 15.2 ft-lbs
	Overflow pipe assembly retaining screw	9.8 to 11.3 N·m 1.0 to 1.15 kgf·m 7.23 to 8.32 ft-lbs
	Cylinder head cover screw	6.9 to 11.3 N·m 0.7 to 1.15 kgf·m 5.1 to 8.32 ft-lbs
	Injection pipe retaining nut	19.6 to 24.5 N·m 2.0 to 2.5 kgf·m 14.5 to 18.1 ft-lbs

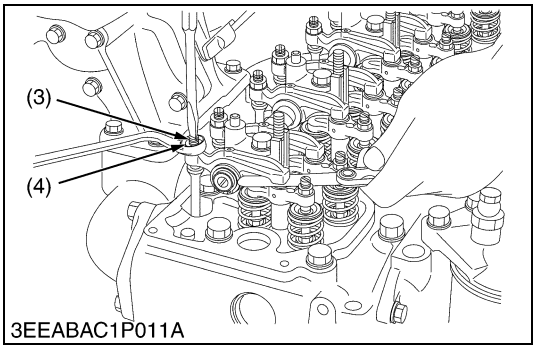
W1048776



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Checking Valve Clearance

■ IMPORTANT

- **Valve clearance must be checked and adjusted when engine is cold.**

1. Remove the high pressure pipes and the head cover.
2. Align the 1TC mark of flywheel and the convex of flywheel housing timing windows so that the first piston (gear case side) comes to the compression top dead center.
3. Before adjusting the valve clearance, adjust the bridge evenly to the valve stem.
4. Loosen the lock nut (2) and adjust with screw (1).
5. Slightly push the rocker arm by your fingers and screw in the adjusting screw slowly until you feel the screw touch the top of valve stem, then tighten the lock nut.
6. Loosen the lock nut (4) of adjusting screw (3) (push rod side) and insert the thickness gauge between the rocker arm and the bridge head. Set the adjusting screw to the specified value, then tighten the lock nut.

Valve clearance	Factory spec.	0.23 to 0.27 mm 0.0091 to 0.0106 in.

■ Note

- **After adjusting, tighten the lock nut (4) securely.**

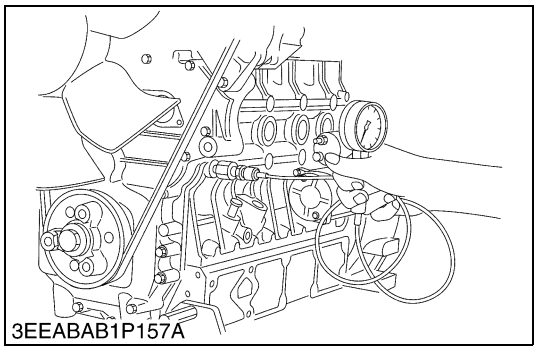
Valve arrangement Adjustment cylinder Location of piston		IN.	EX
When No.1 piston is at compression top dead center	1st	*	*
	2nd	*	
	3rd		*
	4th		
When No.1 piston is at overlap position	1st		
	2nd		*
	3rd	*	
	4th	*	*

Tightening torque	Cylinder head cover screw	6.9 to 11.3 N·m 0.7 to 1.15 kgf·m 5.1 to 8.32 ft-lbs
	Injection pipe retaining nut	19.6 to 24.5 N·m 2.0 to 2.5 kgf·m 14.5 to 18.1 ft-lbs

(1) Adjusting Screw
(2) Lock Nut
(3) Adjusting Screw
(4) Lock Nut

W1047000

(2) Lubricating System


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Engine Oil Pressure

1. Remove the oil switch and set a pressure tester (Code No. 07916-32032).
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

(When reassembling)

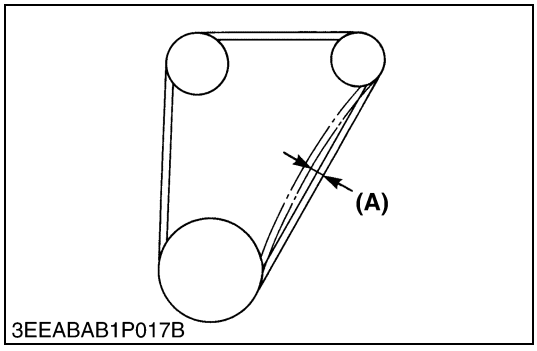
- After checking the engine oil pressure, tighten the engine oil pressure switch to the specified torque.

Engine oil pressure	At idle speed	Allowable limit	49 kPa 0.5 kgf/cm^2 7 psi
	At rated speed	Factory spec.	196 to 392 kPa 2.0 to 4.0 kgf/cm^2 28 to 57 psi
		Allowable limit	147.1 kPa 1.5 kgf/cm^2 21.3 psi

Tightening torque	Oil switch taper screw	14.7 to 19.6 N·m 1.5 to 2.0 kgf·m 10.8 to 14.5 ft-lbs

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(3) Cooling System



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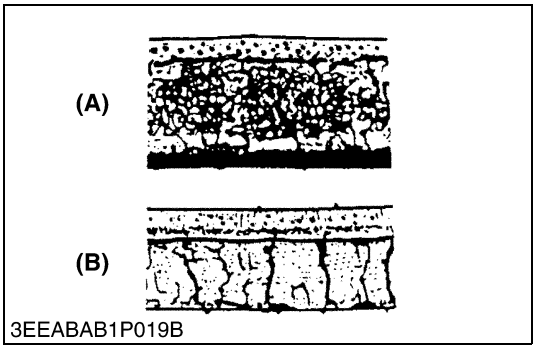
Fan Belt Tension

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 lbs).
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.	10 to 12 mm 0.394 to 0.472 in.

(A) Deflection

W1021011



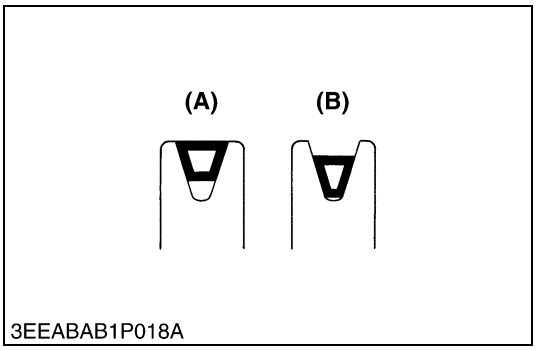
3EEABAB1P019B

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**

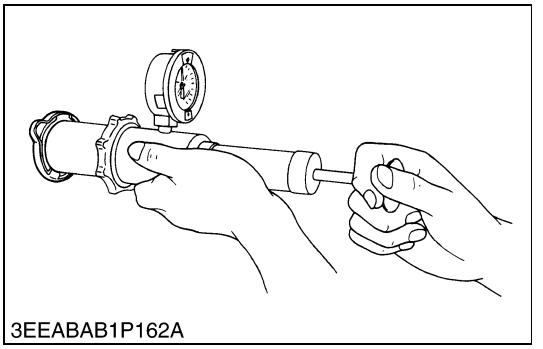
W1021108



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Caution

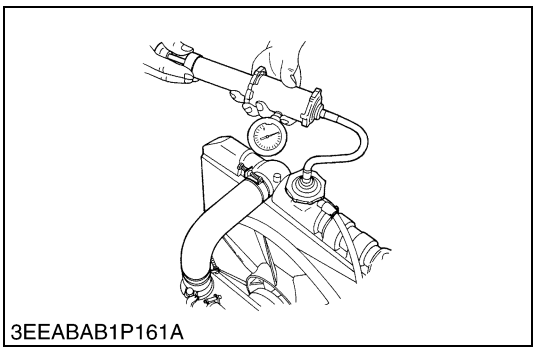
• When removing the radiator cap, wait at least ten minutes after the engine has stopped and cooled down. Otherwise, hot water may gush out, scalding nearby people.


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Radiator Cap Air Leakage

1. Set a radiator tester on the radiator cap.
2. Set a radiator tester.
   Apply the specified pressure of 88 kPa (0.9 kgf/cm^2, 13 psi).
3. Check if the pressure drop to less than 59 kPa (0.6 kgf/cm^2, 9 psi) in 10 seconds.
4. If the pressure is less than the factory specification, replace it.

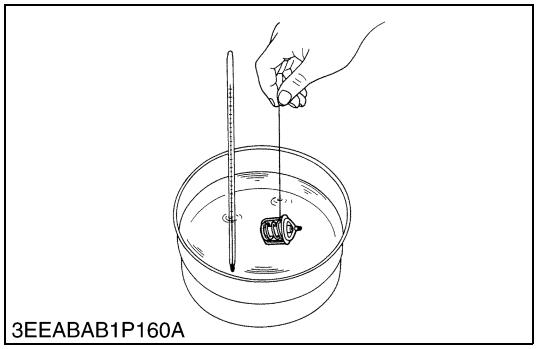
W1021320


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Radiator Water Leakage

1. Pour a specified amount of water into the radiator.
2. Set a radiator tester.
   Increase water pressure to the specified pressure of 137 kPa (1.4 kgf/cm^2, 20 psi).
3. Check the radiator for water leaks.
4. When water leakage is excessive, replace the radiator. If water leakage is caused by a small pinhole, correct the radiator with radiator cement.

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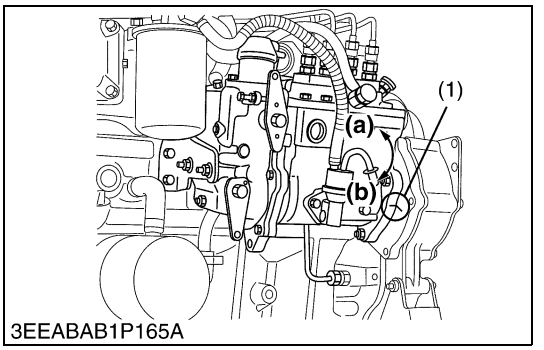
Thermostat Valve Opening Temperature

1. Push down the thermostat valve and insert a string between the valve and the valve seat.
2. Place the thermostat and a thermostat in a container with water and gradually heat the water.
3. Hold the string to suspend the thermostat in the water. When the water temperature rises, the thermostat valve will open, allowing it to fall down from the string.
   Read the temperature at this moment on the thermometer.
4. Continue heating the water and read the temperature when the valve has risen by about 8 mm (0.315 in.).
5. If the measurement is not acceptable, replace the thermostat.

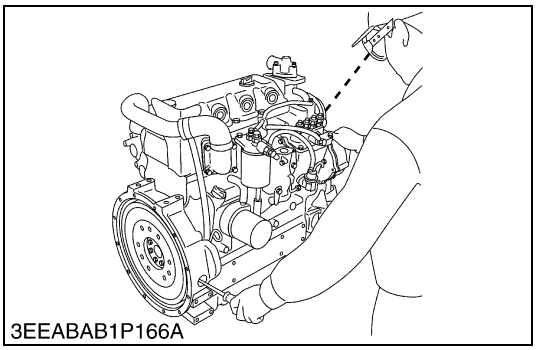
Thermostat's valve opening temperature	Factory spec.	74.5 to 78.5 °C 166.1 to 173.3 °F
Temperature at which thermostat completely opens	Factory spec.	90 °C 194 °F

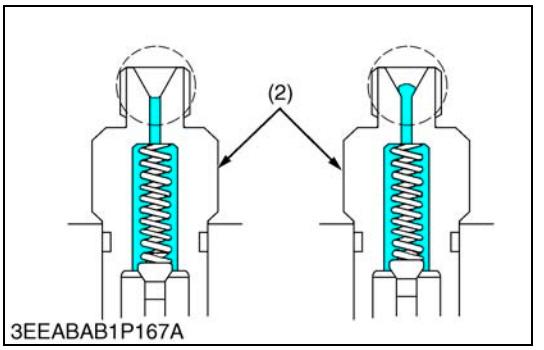
W1071639

(4) Fuel System

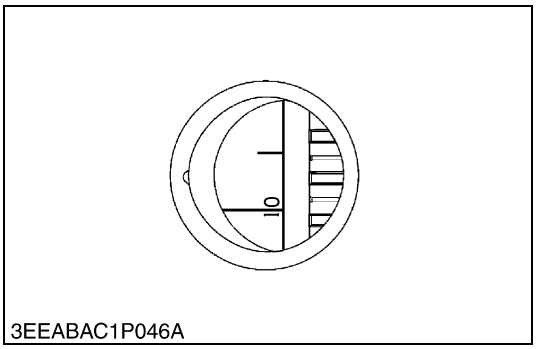


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3EEABAB1P166A



3EEABAB1P167A



3EEABAC1P046A

Injection Timing

1. Make sure of matching the injection timing align mark (1) of the injection pump unit and the plate (gearcase), as shown in the illustration.
2. Remove the injection pipes.
3. Remove the stop solenoid.
4. Turn the flywheel counterclockwise (viewed from flywheel side) until the fuel fills up to the hole of the delivery valve holder (2) for No.1 cylinder.
5. After the fuel fills up to the hole of the delivery valve holder for No.1 cylinder, turn back (clockwise) the flywheel around 1.57 rad (90 °).
6. Turn the flywheel counterclockwise to set at around 0.35 rad (20 <Symbol>×) before T.D.C..
7. Slowly turn the flywheel counterclockwise and stop turning when the fuel begins to come up, to get the present injection timing.
8. Check to see the degree on flywheel.
   The flywheel has mark “1TC”, “10” and “20” for the crank angle before the top dead center of No.1 piston.
9. If the injection timing is not within the specification, rotate the injection pump unit to adjust the injection timing.

■ IMPORTANT

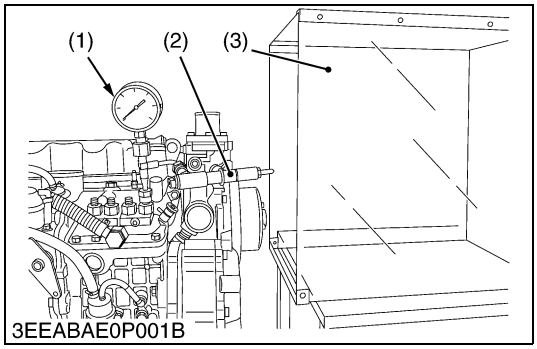
- **When installing the injection pump unit to the engine body, follow the correct procedure.**
  See the “Injection Pump Unit”.

Injection timing	Factory spec.	0.21 to 0.24 rad (12 <Symbol>× to 14 <Symbol>×) before T.D.C.

Tightening torque	Injection pipe retaining nut	19.6 to 24.5 N·m 2.0 to 2.5 kgf·m 14.5 to 18.1 ft-lbs
	Injection pump unit mounting nut	17.7 to 20.6 N·m 1.8 to 2.1 kgf·m 13.0 to 15.2 ft-lbs

(1) Injection Timing Align Mark
(2) Delivery Valve Holder
(a) Injection Timing Advanced
(b) Injection Timing Retarded

W1036105



Fuel Tightness of Pump Element

1. Remove the engine stop solenoid.
2. Remove the injection pipes.
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.

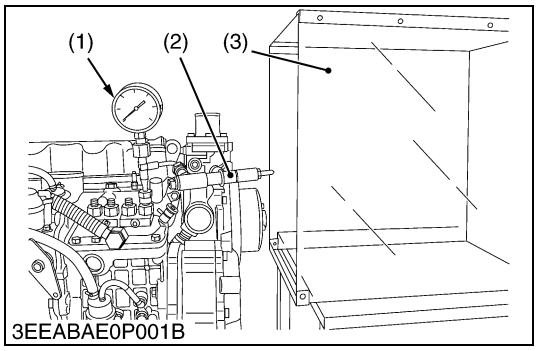
Fuel tightness of pump element	Allowable limit	18.63 MPa 190 kgf/cm^2 2702 psi

■ 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 (3) Protection Cover for Jetted Fuel
(2) Injection Nozzle

W1017430



Fuel Tightness of Delivery Valve

1. Remove the engine stop solenoid.
2. Remove the injection pipes.
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 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 to 180 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 to 180 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 delivery valve	Factory spec.	10 seconds 18.63 → 17.65 MPa 190 → 180 kgf/cm^2 2702 → 2560 psi
	Allowable limit	5 seconds 18.63 → 17.65 MPa 190 → 180 kgf/cm^2 2702 → 2560 psi

■ Note

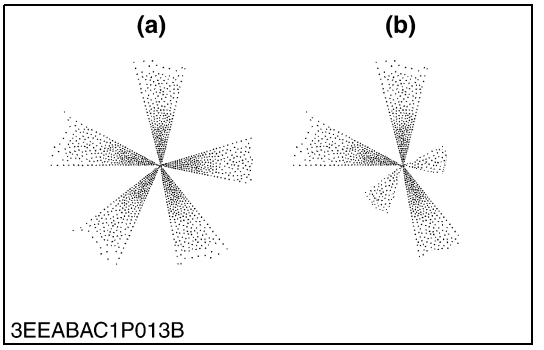
- **Never try to disassemble the injection pump assembly. For repairs, you are strongly requested to contact a Kubota-authorized pump service shop.**

(1) Injection Pump Pressure Tester (3) Protection Cover for Jetted Fuel
(2) Injection Nozzle

W1017786

Caution

- **Check the nozzle 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.**



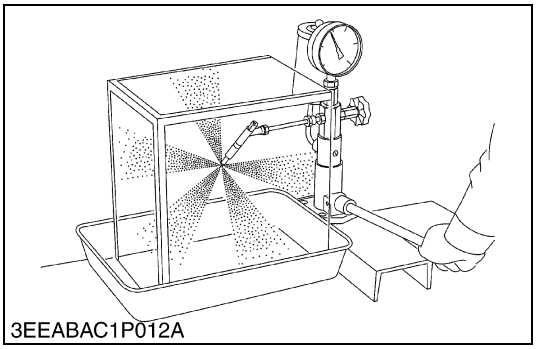
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Nozzle Spraying Condition

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 or repair at Denso service shop.

(a) Good **(b) Bad**

W10371670


3EEABAC1P012A

Checking Nozzle Injection Pressure

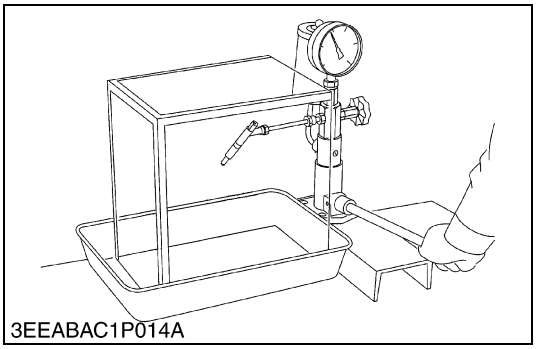
1. Set the injection nozzle to the nozzle tester.
2. Slowly move the tester handle to measure the pressure at which fuel begins jetting out from the nozzle.
3. If the measurement is not within the factory specifications, replace the injection nozzle assembly or repair at Denso service shop.

■ **Note**

- **Injection nozzle gasket must be replaced when the injection nozzle is removed for checking.**

Injection pressure	Factory spec.	1st stage	18.63 to 19.61 MPa 190 to 200 kgf/cm^2 2702 to 2845 psi

W1037280


3EEABAC1P014A

Valve Seat Tightness

1. Set the injection nozzle to a nozzle tester.
2. Raise the fuel pressure, and keep at 16.67 MPa (170 kgf/cm^2, 2418 psi) for 10 seconds.
3. If any fuel leak is found, replace the injection nozzle assembly or repair at Denso service shop.

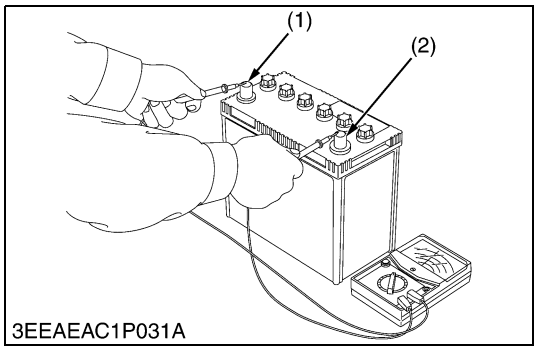
Valve seat tightness	Factory spec.	No fuel leak at 16.67 MPa 170 kgf/cm^2 2418 psi

W10374150

(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.**



3EEAEAC1P031A

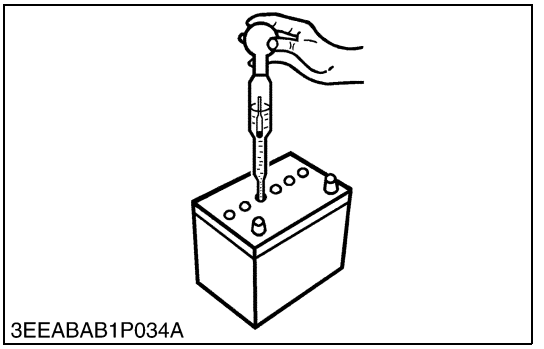
Battery Voltage

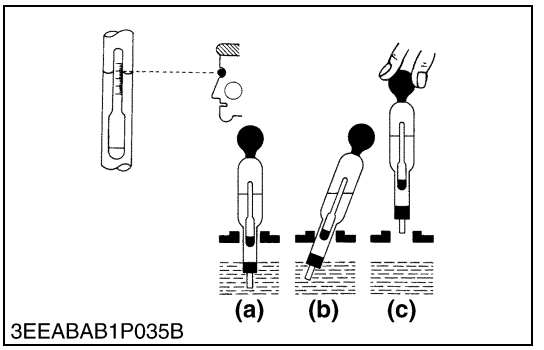
1. Stop the engine.
2. Measure the voltage with a circuit tester between the battery terminals.
3. If the battery voltage is less than the factory specification, check the battery specific gravity and recharge the battery.

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).

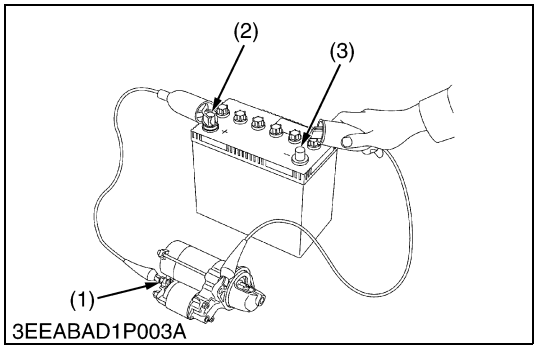
  Therefore, using 20 °C (68 °F) as a reference, the specific gravity reading must be corrected by the following formula :
  - Specific gravity at 20 °C = Measured value + 0.0007 × (electrolyte temperature : 20 °C)
  - Specific gravity at 68 °F = Measured value + 0.0004 × (electrolyte temperature : 68 °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



3EEABAD1P003A

Motor Test

Caution

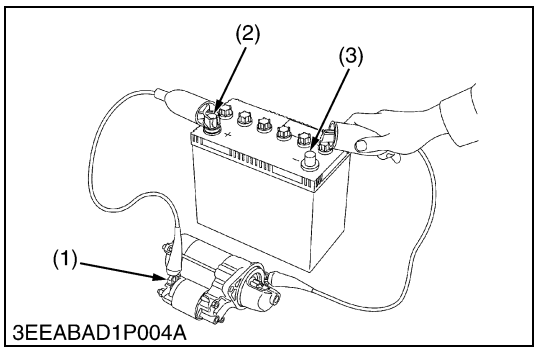
- **Secure the starter to prevent it from jumping up and down while testing the motor.**

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.

- **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



3EEABAD1P004A

Magnetic Switch Test

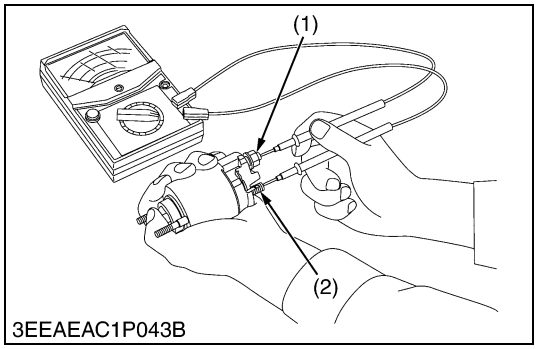
1. Disconnect the battery negative cable from the battery.
2. Disconnect the battery positive cable from the battery.
3. Disconnect the leads from the starter **B** terminal.
4. Remove the starter from the engine.
5. Connect a jumper lead from the starter **S** terminal (1) to the battery positive terminal (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



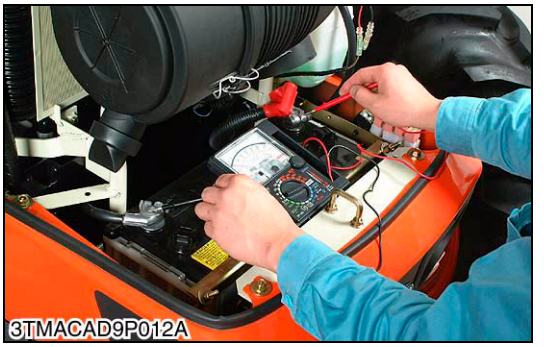
3EEAEAC1P043B

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.

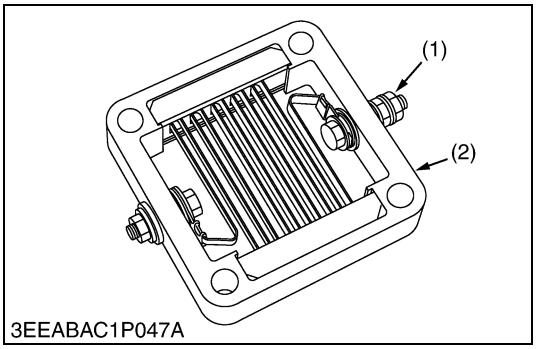
■ NOTE

- **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



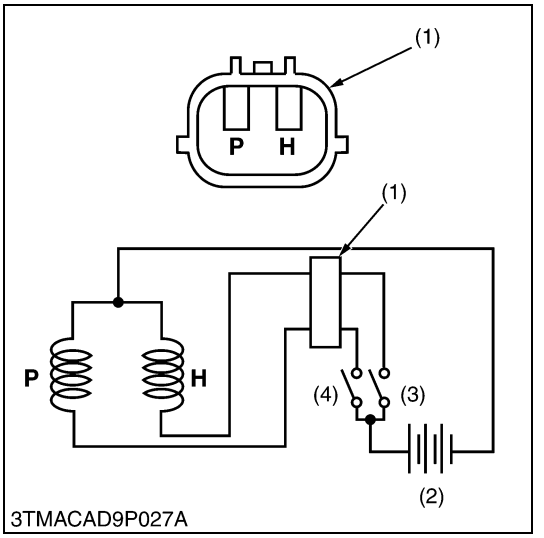
Intake Air Heater

1. Disconnect the lead.
2. Measure the resistance between + terminal (1) and intake air heater body (2).
3. If the resistance is infinity, the intake air heater is faulty.

Intake air heater resistance	Factory spec.	Approx. 0.3 <Symbol>W (At cold occasion)

(1) + Terminal (2) Intake Air Heater Body

W1073774



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

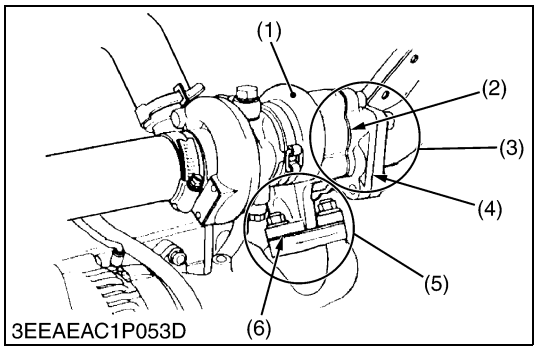
- **Never apply the current for pulling coil more than two seconds when inspecting.**

(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



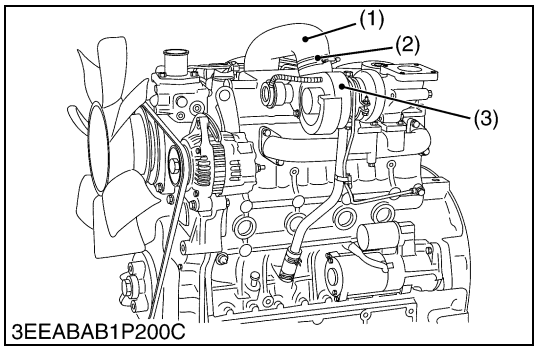
3EEAEAC1P053D

Turbine Side

1. Check the exhaust port (3) and inlet port (5) 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 (2) / (4) / (6) with new one.

(1) Turbine Housing
(2) Gasket
(3) Exhaust Port
(4) Gasket
(5) Inlet Port
(6) Gasket

W1076917



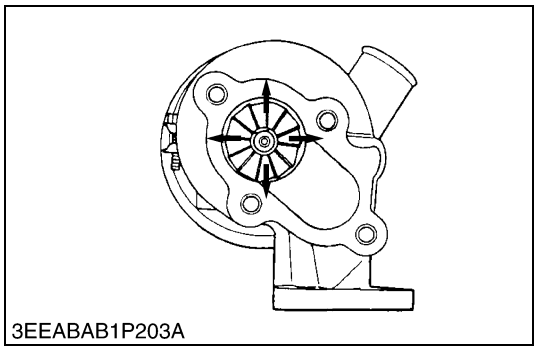
3EEABAB1P200C

Compressor Side

1. Check the inlet hose (1) of the compressor cover (3) 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 (2) and or inlet hoses.

(1) Inlet Hose
(2) Clamp
(3) Compressor Cover

W1077032


3EEABAB1P203A

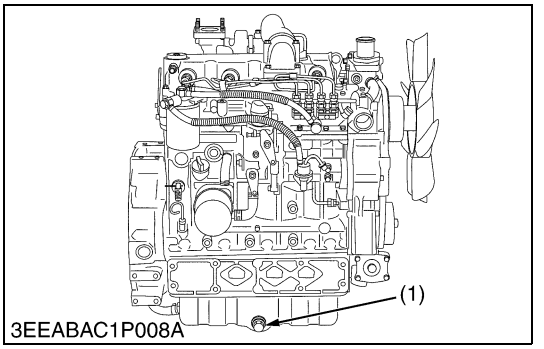
Radial Clearance

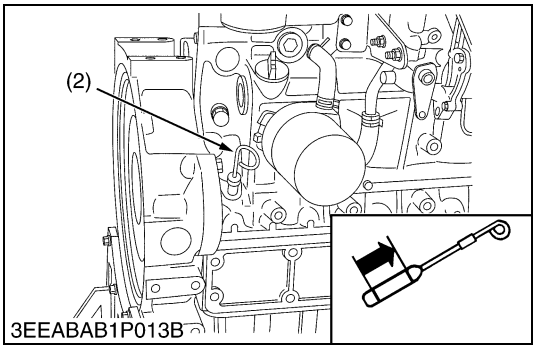
1. If the wheel contact to the housing, replace the turbocharger assembly with new one.

W1077353

[2] DISASSEMBLING AND ASSEMBLING

(1) Draining Oil and Coolant





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)

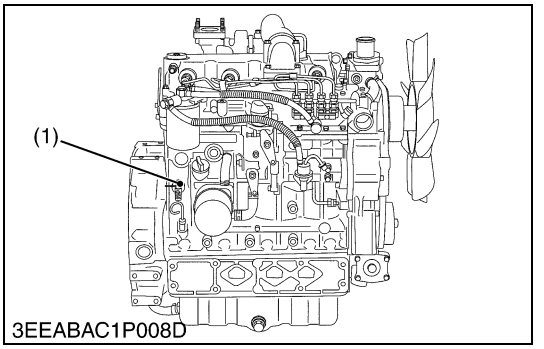
- Fill the engine oil up to the upper line on the dipstick (2).

■ **IMPORTANT**

- **Never mix two different type of oil.**
- **Use the proper SAE Engine Oil according to ambient temperature.**

(1) Drain Plug (2) Dipstick

W1023464



Draining Coolant

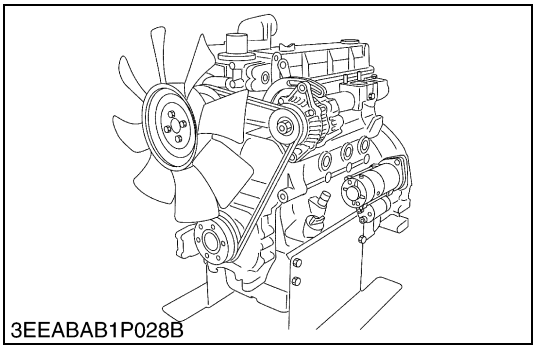
- **Never remove radiator cap while operating or immediately after stopping. Otherwise, hot water will spout out from the radiator. Wait for more than ten minutes to cool the radiator, before opening the cap.**

1. Prepare a bucket. Open the coolant drain cock.

(1) Coolant Drain Cock

W1023496

(2) External Components



Air Cleaner, Muffler and Others

1. Remove the air cleaner and muffler.
2. Remove the fan, fan belt, alternator and starter.

(When reassembling)

- Check to see that there are no cracks on the belt surface.

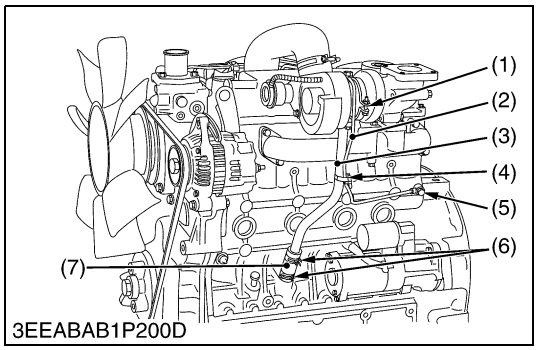
■ **IMPORTANT**

- **After reassembling the fan belt, be sure to adjust the fan belt tension.**
- **Do not confuse the direction of the fan. Attach the fan with its "1C010" marking facing frontward (toward the radiator).**

W1049622

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 matter in the oil pipes.**
- **When the turbocharger assembly has been replace, pour fresh engine oil through the oil filler port of the turbocharger.**
- **Before starting the engine, make sure that air cleaner is in position.**



3EEABAB1P200D

Oil Pipe

1. Remove the joint bolt (5) and clamp (4) and take off the pipe 1 (2).
2. Remove the bolts (1) and release the clamp (6).
3. Disconnect the oil pipe 2 (7) and pipe 4 (3).

(When reassembling)

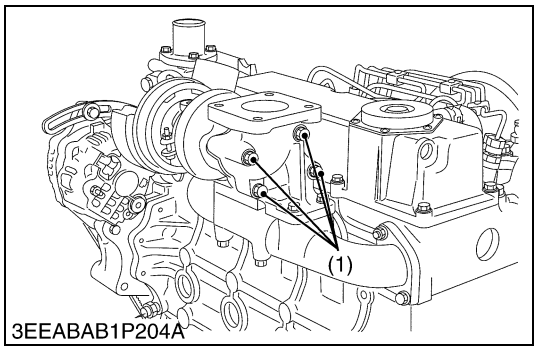
- Pour fresh engine oil through the oil filler port of the turbocharger.
- Replace the gasket with new one.
- Be careful not to allow dust, dirt and other foreign matters in the oil pipes.

■ **NOTE**

- **Tape or plug all openings to prevent foreign matters from damaging the oil cavities in the turbocharger.**

(1) Bolt
(2) Oil Pipe 1
(3) Oil Pipe 4
(4) Clamp
(5) Joint Bolt
(6) Clamp
(7) Oil Pipe 2

W1025983



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Turbocharger

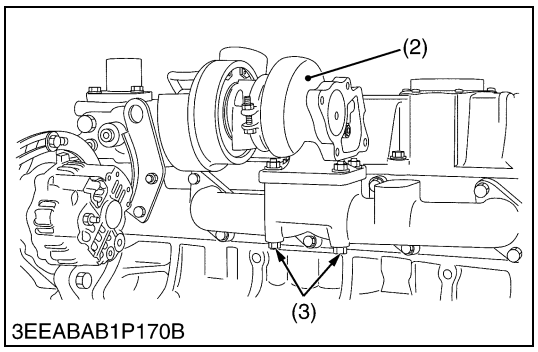
1. Remove the screw (1) and bolt (3).
2. Take off the turbocharger assembly (2).

(When reassembling)

- Replace the gasket with new one.

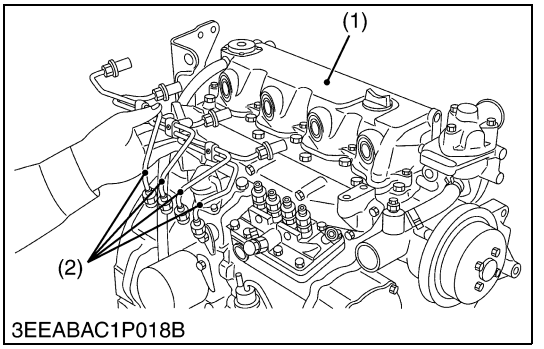
(1) Screw
(2) Turbocharger Assembly
(3) Bolt

W1078106

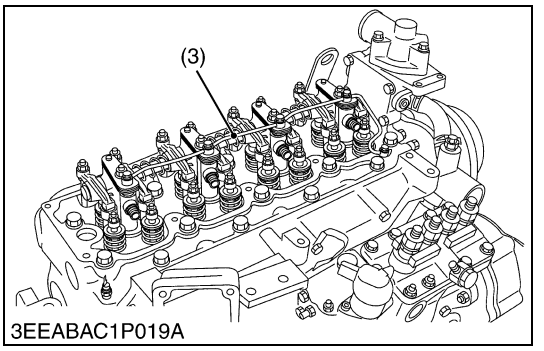


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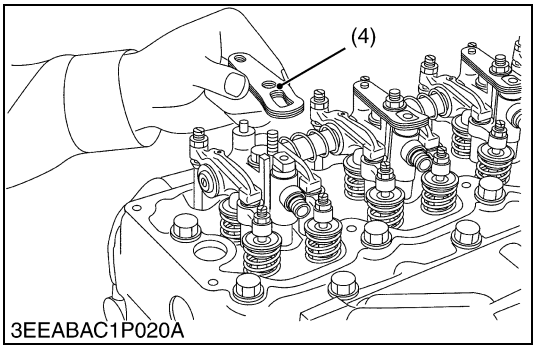
(3) Cylinder Head and Valves



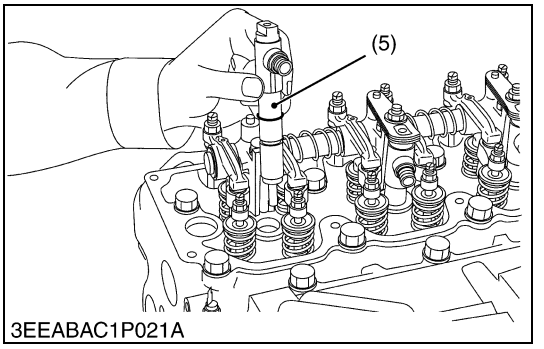
3EEABAC1P018B



3EEABAC1P019A



3EEABAC1P020A



3EEABAC1P021A

Cylinder Head Cover and Nozzle Holder

1. Remove the injection pipes (2).
2. Remove the cylinder head cover (1).
3. Remove the over flow pipe (3).
4. Remove the nozzle holder clamps (4), nozzle holder assembly (5) and nozzle gaskets.

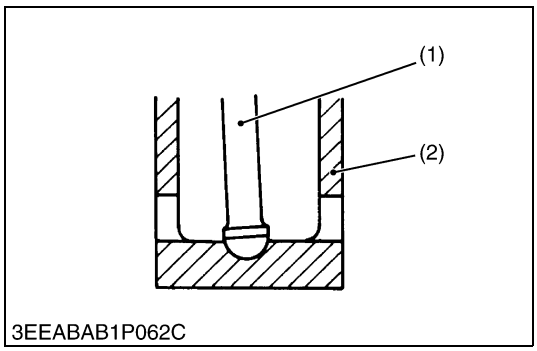
(When reassembling)

- Check to see that the cylinder head cover gasket is not defective.
- Be sure to place the nozzle gaskets.
- Tighten the head cover mounting bolts to specified torque.
- Mount the check valve with the <Symbol>Ø mark toward the tank.

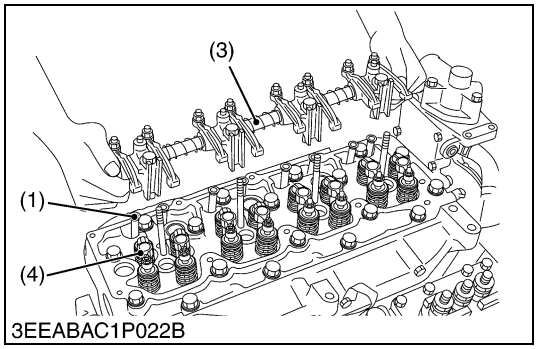
Tightening torque	Nozzle holder clamp nut	17.7 to 20.6 N·m 1.8 to 2.1 kgf·m 13.0 to 15.2 ft-lbs
	Overflow pipe assembly retaining screw	9.8 to 11.3 N·m 1.0 to 1.15 kgf·m 7.23 to 8.32 ft-lbs
	Cylinder head cover screw	6.9 to 11.3 N·m 0.7 to 1.15 kgf·m 5.1 to 8.32 ft-lbs
	Injection pipe retaining nut	19.6 to 24.5 N·m 2.0 to 2.5 kgf·m 14.5 to 18.1 ft-lbs

(1) Head Cover
(2) Injection Pipe
(3) Overflow Pipe
(4) Nozzle Holder Clamps
(5) Nozzle Holder Assembly

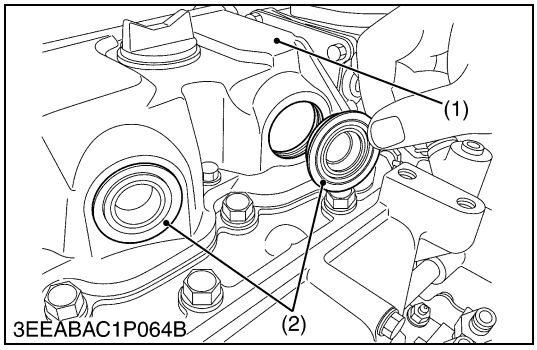
W1049737



3EEABAB1P062C



3EEABAC1P022B



3EEABAC1P064B

Rocker Arm and Push Rod

1. Remove the rocker arm (3) as a unit.
2. Remove the push rods (1).
3. Remove the bridge arm (4).

(When reassembling)

- When putting the push rods onto the tappets (2), check to see if their ends are properly engaged with the grooves.

■ **IMPORTANT**

- **After reassembling the rocker arm, be sure to adjust the valve clearance.**

Tightening torque	Rocker arm bracket screw	49.0 to 55.9 N·m 5.0 to 5.7 kgf·m 36.2 to 41.2 ft-lbs

(1) Push Rod
(2) Tappet
(3) Rocker Arm
(4) Bridge Arm

W1050212

Injection Nozzle Oil Seal (if necessary)

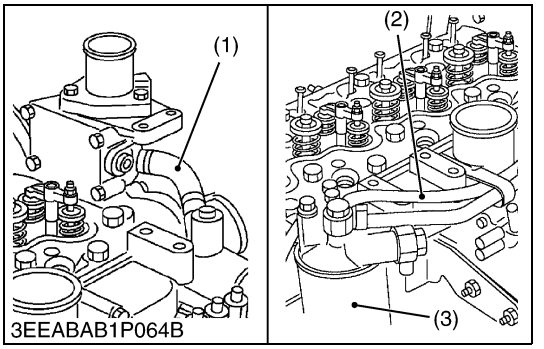
1. Remove the injection nozzle oil seal (2) from cylinder head cover (1).

(When reassembling)

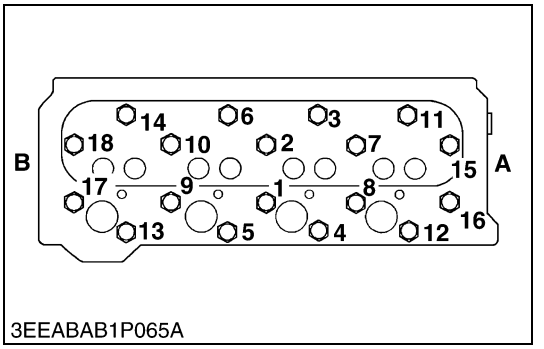
- When install the injection nozzle oil seal, use the new one.

(1) Cylinder Head Cover
(2) Injection Nozzle Oil Seal

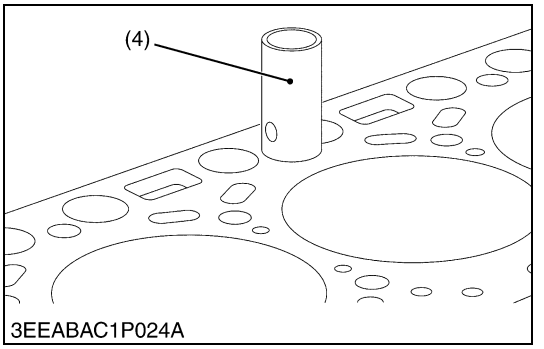
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Cylinder Head and Tappet

1. Loosen the pipe band, and remove the water return pipe (1).
2. Disconnect the fuel pipe (2) first and then the fuel filter (3).
3. Remove the IN. / EX. Manifold.
4. Remove the cylinder head screw in the order of (18) to (1), and remove the cylinder head.
5. Remove the cylinder head gasket.
6. Remove the tappets (4) from the crank case.

(When reassembling)

- Replace the head gasket with a new one.
- Before installing the tappets (4), apply engine oil thinly around them.
- When mounting the gasket, set it to the knock pin hole. Take care not to mount it reversely.
- The cylinder head should be free of scratches and dust.
- Take care for handling the gasket not to damage it.
- Install the cylinder head.
- Tighten the cylinder head screw gradually in the order of (1) to (18) after applying engine oil.
- Be sure to adjust the valve clearance. See the “Valve Clearance”.
- It is not necessary to retighten the cylinder head screw after running the engine for 30 minutes.

■ **IMPORTANT**

- **When replace the piston, piston pin bush, connecting rod or crankpin bearing, select the cylinder head gasket thickness to meet with the top clearance refer to the “Selecting Cylinder Head Gasket”.**

■ **NOTE**

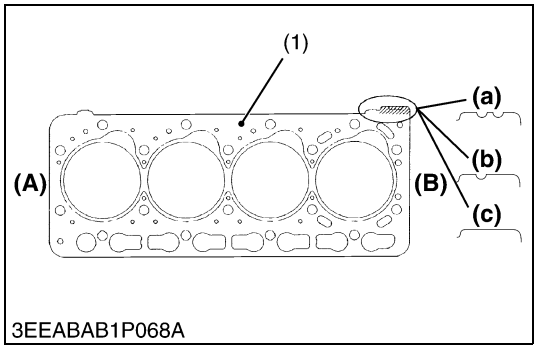
- **Mark the cylinder number to the tappets to prevent interchanging.**

Tightening torque	Cylinder head mounting screw	98.1 to 107.9 N·m 10.0 to 11.0 kgf·m 72.3 to 79.6 ft-lbs

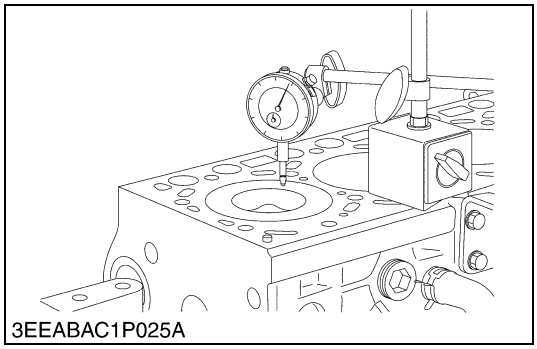
(1) Return Pipe
(2) Fuel Pipe
(3) Fuel Filter
(4) Tappet

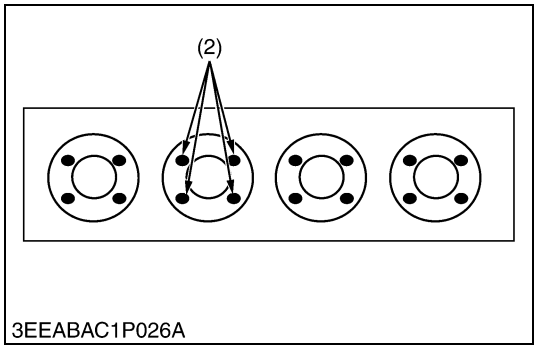
A : Gear Case Side
B : Flywheel Side

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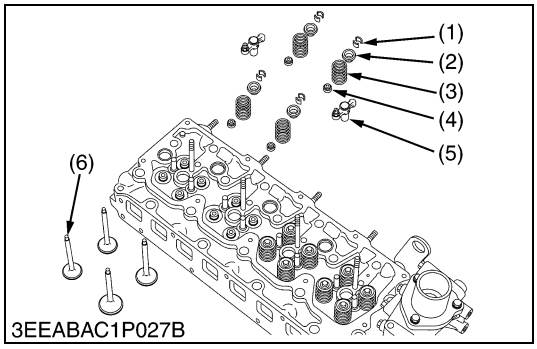


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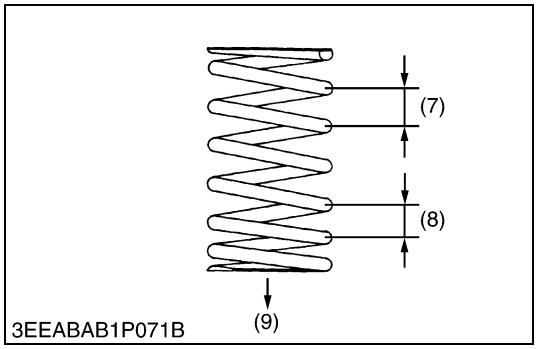

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Selecting Cylinder Head Gasket

■ Replacing the Cylinder Head Gasket

1. Make sure to note the notch **(a)**, **(b)** or **(c)** of cylinder head gasket (1) in advance.
2. Replace the same notch **(a)**, **(b)** or **(c)** as the original cylinder head gasket (1).

■ Selecting the Cylinder Head Gasket

- Select the cylinder head gasket (1) thickness to meet with the top clearance when replacing the piston, piston pin bush, connecting rod or crankpin bearing.

1. Measure the piston head's protrusion or recessing from the crankcase cylinder face 4 spots per each piston and (average of four pistons) using the dial gauge as shown in figure.
2. Select the suitable cylinder head gasket refer to the table below.

Notch of Cylinder Head Gasket	Thickness of cylinder head gasket		Part Code	Piston Head's protrusion or recessing from the level of crankcase cylinder face. (average of 4 pistons)
	Before tightening	After tightening		
2 notches **(a)**	0.90 mm 0.0354 in.	0.80 mm 0.0315 in.	1G514-03310	-0.07 to +0.049 mm -0.0028 to +0.0019 in.
1 notch **(b)**	1.00 mm 0.0394 in.	0.90 mm 0.0354 in.	1G514-03600	+0.050 to +0.149 mm +0.0020 to +0.0058 in.
Without notch **(c)**	1.05 mm 0.0413 in.	0.95 mm 0.0374 in.	1G514-03610	+0.150 to +0.20 mm +0.0059 to +0.0078 in.

(1) Cylinder Head Gasket
(2) Measuring Point
(A) Gear Case Side
(B) Flywheel Side
(a) 2 Notches
(b) 1 Notch
(c) Without Notch

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Valve

1. Remove the valve spring collets (1) after compressing the valve spring (3) with the valve spring retainer (2).

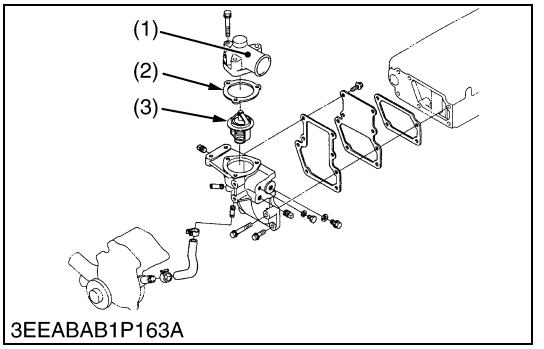
(When reassembling)

- Install the valve spring with its small-pitch end downward (at the head side).
- Wash the valve stem and valve guide hole, and apply engine oil sufficiently.
- After installing the valve spring collets, lightly tap the stem to assure proper fit with a plastic hammer.

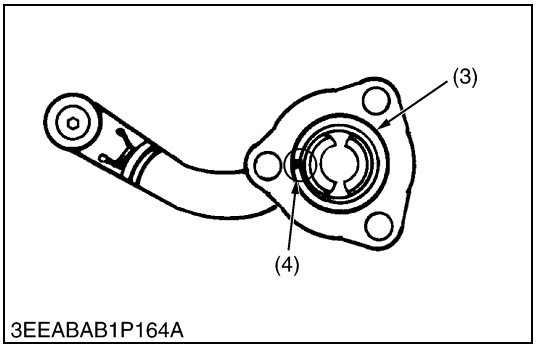
(1) Valve Spring Collet
(2) Valve Spring Retainer
(3) Valve Spring
(4) Valve Stem Seal
(5) Arm Bridge
(6) Valve
(7) Large Pitch
(8) Smaller Pitch
(9) Install the spring with its smaller-pitch end downward (at the head side)

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(4) Thermostat



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Thermostat Assembly

1. Remove the thermostat cover mounting screws, and remove the thermostat cover (1).
2. Remove the thermostat assembly (3).

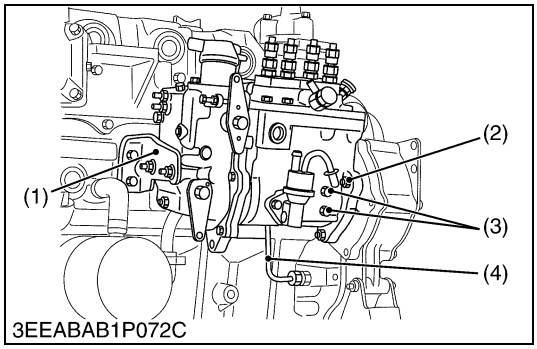
(When reassembling)

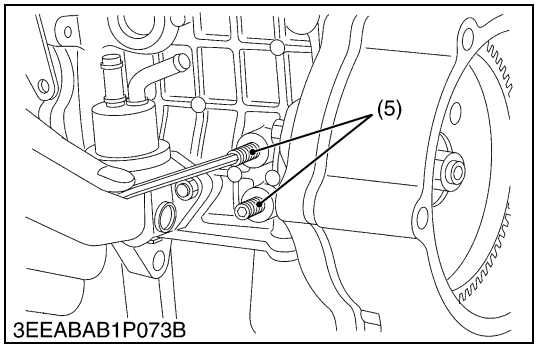
- Apply a liquid gasket (Three Bond 1215 or equivalent) only at the thermostat cover side of the gasket (2).
- Attach the thermostat with its hole facing toward the air suction side.

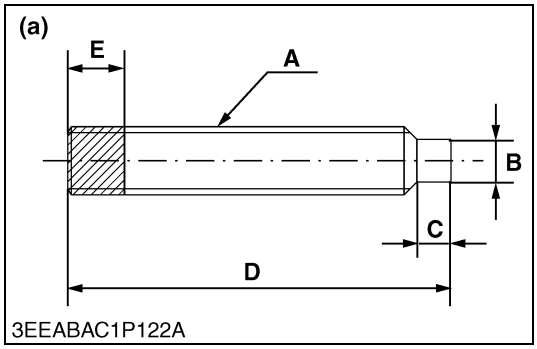
(1) Thermostat Cover
(2) Thermostat Cover Gasket
(3) Thermostat Assembly
(4) Hole

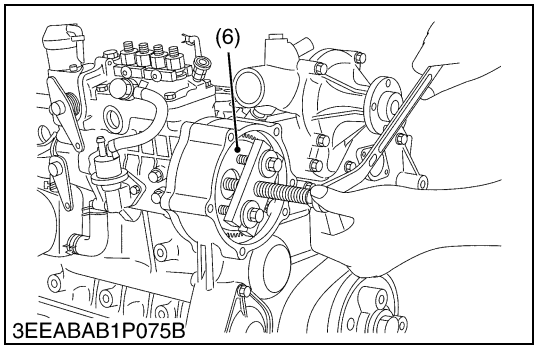
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(5) Injection Pump Unit









Injection Pump Unit

(Removing the fuel injection pump unit)

1. Detach the gear cover for the fuel injection pump unit from the gearcase.
2. Place the piston of the 4th cylinder at the top dead center in the compression stroke. Fix the flywheel with the flywheel stopper.

■ **IMPORTANT**

- **Look for the align mark on the idle gear 2. Using a white marking pen or the like, put an align mark on the engaged tooth of the idle gear. This helps to reassemble these gears in mesh later.**

■ **NOTE**

- **When the already existing align marks align with each other, there is no need to put another align mark.**

3. Unscrew the two plugs (3) of the injection pump unit.
4. Tighten the upper fuel cam shaft lock screw (5) until it comes into contact with the fuel cam shaft. Make sure the cam shaft does not move any longer.
5. Tighten the lower fuel cam shaft lock screw (5) until it comes into contact with the fuel cam shaft.

■ **NOTE**

- **Never overtighten the lock screws when they have come into contact with the cam shaft. Otherwise the injection pump itself may get damaged.**
- **Use of a socket set screw (dog point type) in recommended for best results. Such screw can be constructed as shown in figure (a).**

6. Loosen the injection pump gear mounting nut. Using the specific gear puller, take out the gear (6).

■ **NOTE**

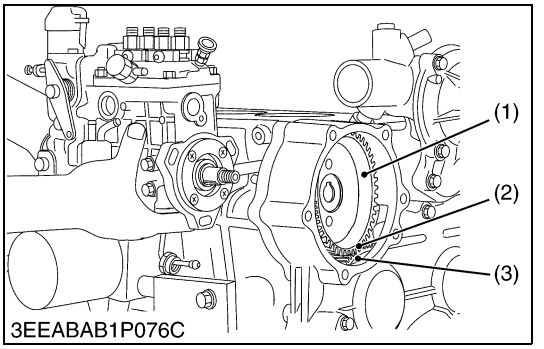
- **Be careful not to drop the key.**

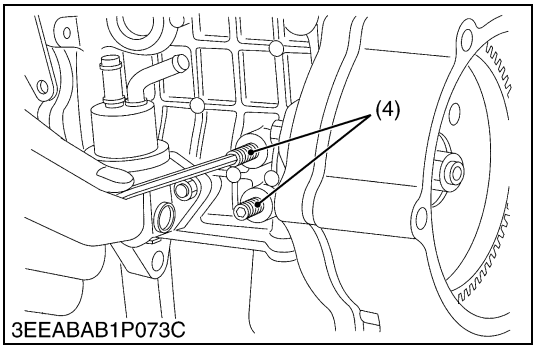
7. Disconnect the lubricating oil pipe (4).
8. Loosen the three injection pump unit mounting nut (2).
9. Remove the injection pump unit support (1) and take out the injection pump unit.

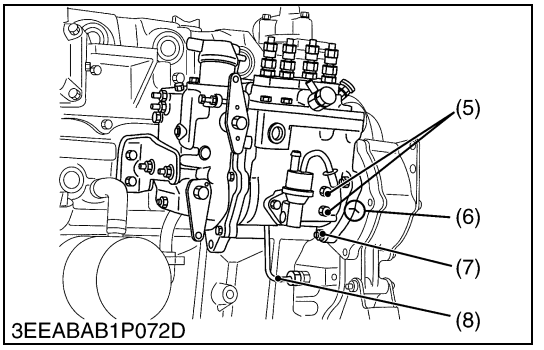
A	M8 × Pitch 1.25
B	5 mm dia. (0.197 in. dia.)
C	4 mm (0.157 in.)
D	45 mm (1.772 in.)
E	10 mm (0.39 in.) : Conspicuously Painted

(1) Injection Pump Unit Support
(2) Injection Pump Unit Mounting Nut
(3) Plug
(4) Lubricating Oil Pipe
(5) Fuel Cam Shaft Lock Screw (Socket Set Screw Dog Point Type)
(6) Injection Pump Gear

W1175054







Injection Pump Unit (Continued)

(Reassembling the fuel injection pump unit)

1. Place the piston of the 4th cylinder at the top dead center in the compression stroke. Fix the flywheel with the flywheel stopper.
2. Place the injection pump gear (1) back into the gear case position. Make sure of aligning the align marks of the injection pump gear (1) and the idle gear 2 (3).
3. Install the injection pump unit to the injection pump gear (1).

■ **NOTE**

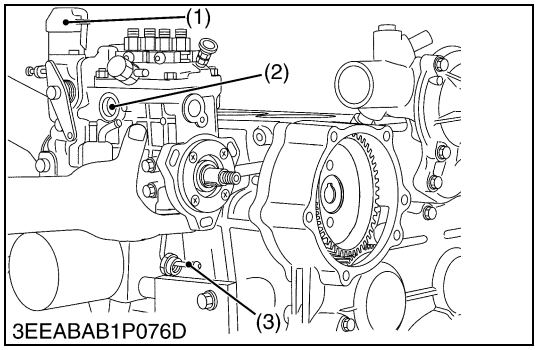
- **When installing the injection pump unit to the injection pump gear, make sure that the key is fit in the keyway of injection pump gear.**

4. Temporarily tighten the injection pump gear mounting nut by hand.
5. Fix the injection pump unit and tighten the injection pump gear mounting nut to the specified torque.
6. Take off the fuel cam shaft lock screws (4) and tighten the plugs (5) for plugging.
7. Loose the injection pump unit mounting nuts (7) for aligning the injection timing.
8. Moving the injection pump unit clockwise (viewed from gear case side), align the injection timing marks (6) on the injection pump unit and on the gear case.
9. Tighten the injection pump unit mounting nut (7) to the specified torque.
10. Reconnect the lubricating oil pipe (8) and place the injection pump unit support and the gear cover of the injection pump unit.
11. Remove the flywheel stopper.
12. Check the injection timing. (See the “Injection Timing”.)
13. If the injection timing is not within the specification, repeat (7) to (12) again.

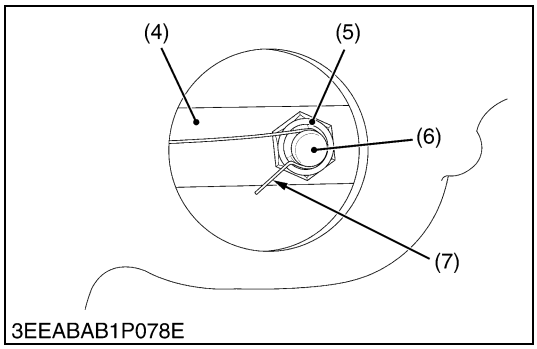
Tightening torque	Injection pump gear mounting nut	73.6 to 83.4 N·m 7.5 to 8.5 kgf·m 54.2 to 61.5 ft-lbs
	Injection pump unit mounting nut	17.7 to 20.6 N·m 1.8 to 2.1 kgf·m 13.0 to 15.2 ft-lbs

(1) Injection Pump Gear
(2) Align mark of the Injection Gear
(3) Idle Gear 2
(4) Fuel Cam Shaft Lock Screw (Socket Set Screw Dog Point Type)
(5) Plug
(6) Align Mark
(7) Injection Pump Unit Mounting Nut
(8) Lubricating Oil Pipe

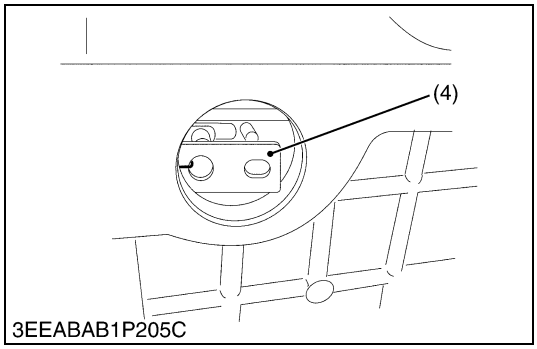
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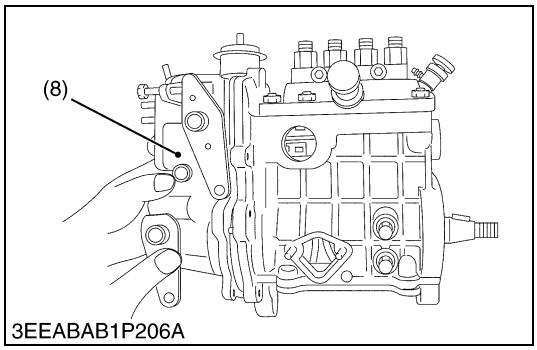
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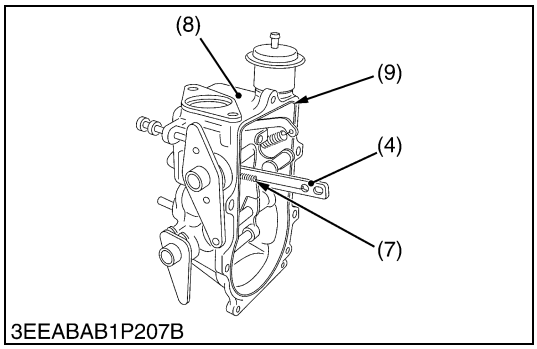
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Governor Housing Assembly

1. Remove the injection pump unit from the engine. (See the "Injection Pump Unit".)
2. Remove the governor lubricating pipe (3).
3. Remove the stop solenoid (1).
4. Detach the sight cover (2) from the injection pump unit.
5. Unhook the start spring (7) from the rack pin (6) of injection pump assembly.
6. Remove the nut (5).

■ **NOTE**

- **Be careful not to drop the nut inside.**

7. Slide off the governor connecting rod (4) from the rack pin of injection pump assembly.
8. For convenient sake, temporarily hook the start spring on the rack pin hole of the governor connecting rod.
9. Remove the governor housing mounting screws.
10. Detach the governor housing assembly (8) from the injection pump unit.

(When reassembling)

- When reassembling the inside parts, put the oil on each inside part slightly.
- After sliding on the governor connecting rod to the rack pin, tighten the nut with the specified torque with using the jig for keeping the governor connecting rod horizontal. (See the Replacing Injection Pump Assembly.)
- After tightening the nut, hook the start spring on the rack pin.
- Check the movement of control rack of injection pump assembly by the stop lever.

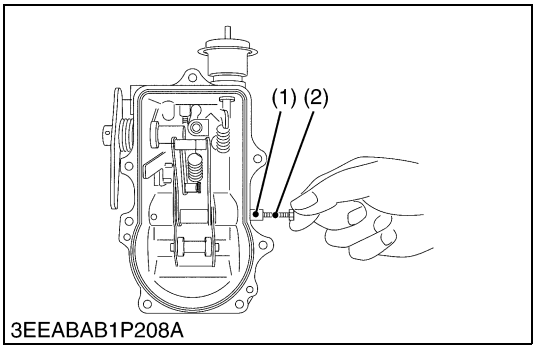
■ **NOTE**

- **When installing the governor housing assembly to the injection pump unit, be careful not to damage O-ring (9).**
- **When linking the governor connecting rod to the rack pin of injection pump, use the jig for keeping the governor connecting rod horizontal. Otherwise the control rack may be stuck, and causes to be difficult to start the engine or hunting of governor. (See the Replacing Injection Pump Assembly.)**

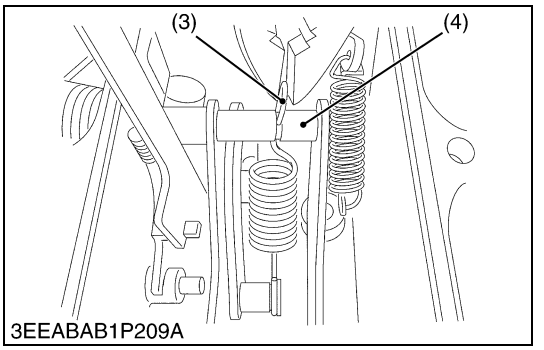
Tightening torque	Governor housing mounting screw	9.8 to 11.3 N·m 1.00 to 1.15 kgf·m 7.23 to 8.32 ft-lbs
	Anti-rotation nut	2.8 to 4.0 N·m 0.29 to 0.41 kgf·m 2.1 to 3.0 ft-lbs

(1) Stop Solenoid
(2) Sight Cover
(3) Governor Lubricating Pipe
(4) Governor Connecting Rod
(5) Anti-Rotation Nut
(6) Rack Pin
(7) Start Spring
(8) Governor Housing Assembly
(9) O-ring

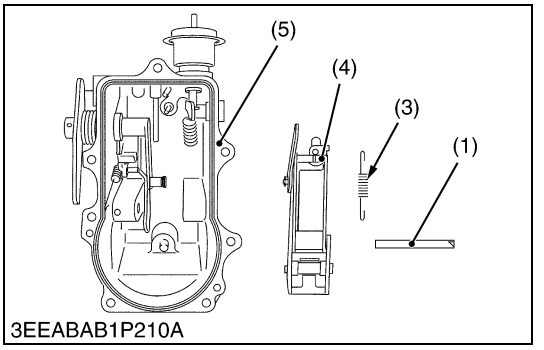
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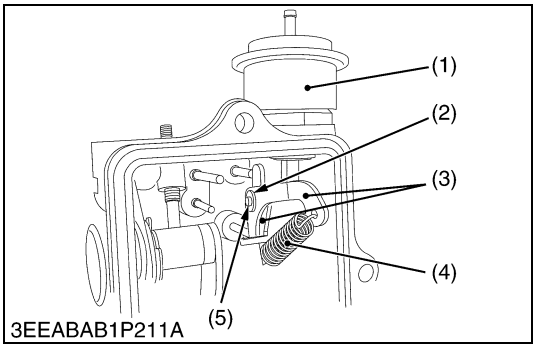
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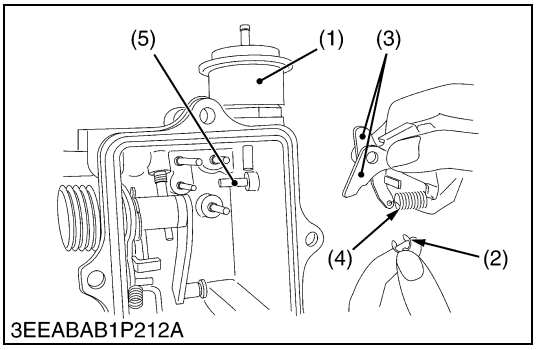
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Governor Fork Lever Assembly

1. Pull off the governor fork lever shaft (1) with the extra bolt (Dia : 4 mm, Pitch : 0.7 mm, Length : more than 25 mm) (2).
2. Unhook the governor spring (3) at the governor fork lever (4) side.
3. Remove the governor fork lever assembly from the governor housing (5).

(When reassembling)

- After reassembling the governor housing assembly, check the movement of the governor fork lever assembly, the speed control lever and the stop lever.

■ **NOTE**

- **When assembling the inside parts, put the oil on each inside part slightly.**
- **Be careful not to deform the start spring.**

(1) Governor Fork Lever Shaft
(2) Extra Bolt (Dia : 4 mm, Pitch : 0.7 mm, Length : more than 25 mm)
(3) Governor Spring
(4) Governor Fork Lever
(5) Governor Housing

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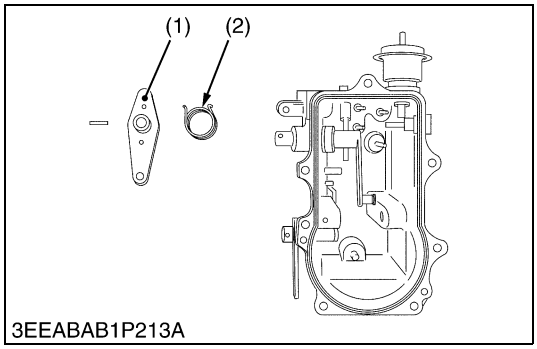
Boost Arms (If equipped Boost Compensator)

1. Remove the boost actuator (1).
2. Remove the cir-clip (2).
3. Remove the boost arms (3) and the boost spring (4) from the pin (5).

Tightening torque	Boost actuator	39.2 to 45.1 N·m 4.0 to 4.6 kgf·m 28.9 to 33.3 ft-lbs

(1) Boost Actuator
(2) Cir-clip
(3) Boost Arm
(4) Boost Spring
(5) Pin

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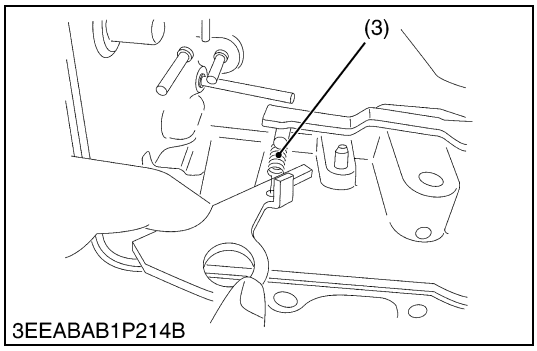


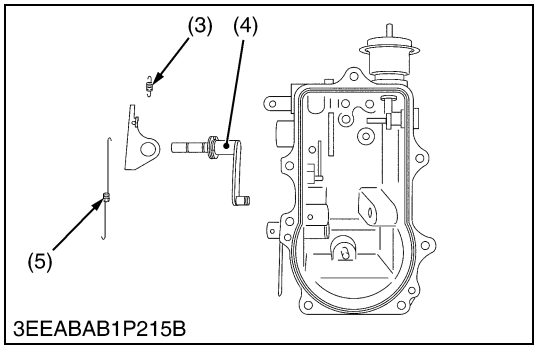
Governor Lever

1. Remove the speed control lever (1) and the return spring (2).
2. Remove the governor lever assembly (4) from the governor housing.
3. Remove the start spring (5) and the stop spring (3).

(1) Speed Control Lever
(2) Return Spring
(3) Stop Spring
(4) Governor Lever Assembly
(5) Start Spring

W1142375



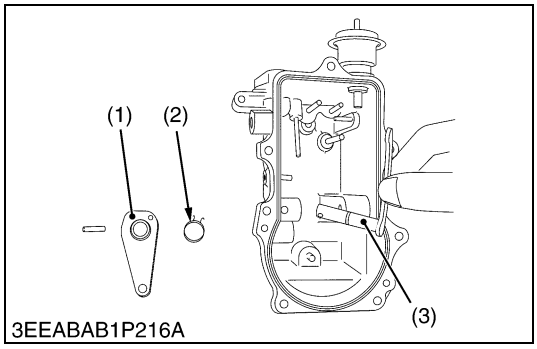


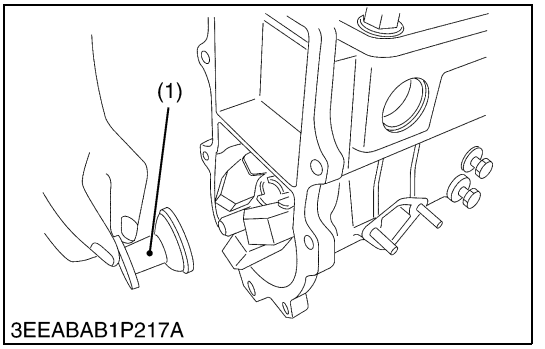
Stop Lever

1. Remove the stop lever (1) and the return spring (2).
2. Remove the stop lever shaft (3).

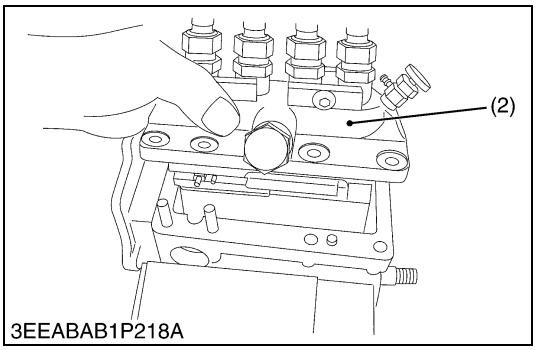
(1) Stop Lever
(2) Return Spring
(3) Stop Lever Shaft

W1143531

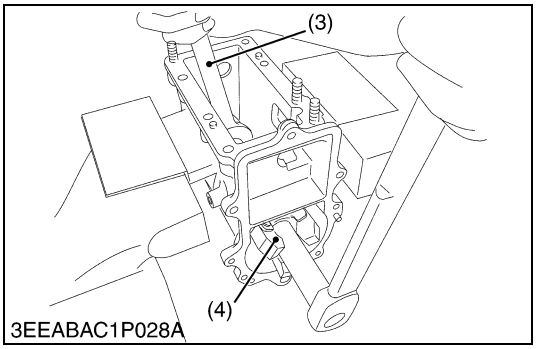




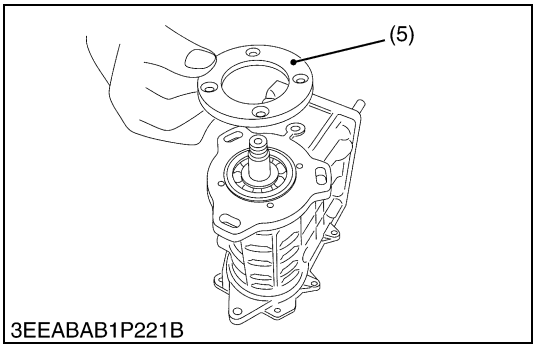
3EEABAB1P217A



3EEABAB1P218A



3EEABAC1P028A



3EEABAB1P221B

Fuel Camshaft and Governor Weight

1. Separate the governor housing assembly from the injection pump unit. (See the “Injection Pump Unit”.)
2. Remove the governor sleeve (1).
3. Remove the injection pump assembly (2).
4. Remove the fuel camshaft lock screws.
5. Fix the fuel camshaft with open end wrench (3), and remove the governor weight mounting nut and the governor weight (4).
6. Loosen the fuel camshaft stopper mounting screws and remove the fuel camshaft stopper (5).
7. Pull out the fuel camshaft (8) and bearings (6) together.
8. After removing the bearing’s cir-clip (7), press out the bearings.

■ **NOTE**

- **Do not use the fuel camshaft lock bolts, when removing the governor weight mounting nut. Otherwise, the lock bolts or injection pump housing might get damage.**

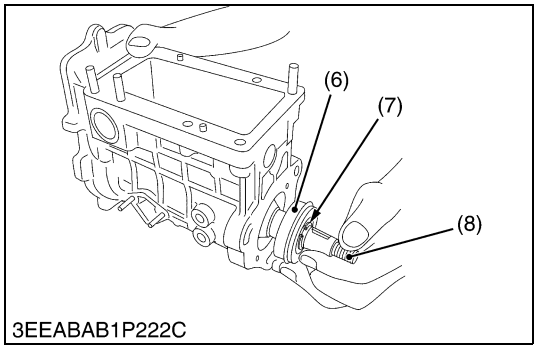
(When reassembling)

- Press the bearings into the fuel camshaft.
- Set the cir-clip at the gear side’s bearing.
- Install the fuel camshaft and bearings to the injection pump housing.
- Attach the fuel camshaft stopper and tighten the fuel camshaft stopper mounting screws with the specified torque.
- Attach the governor weight to the fuel camshaft and tighten the governor weight mounting nut with specified torque.

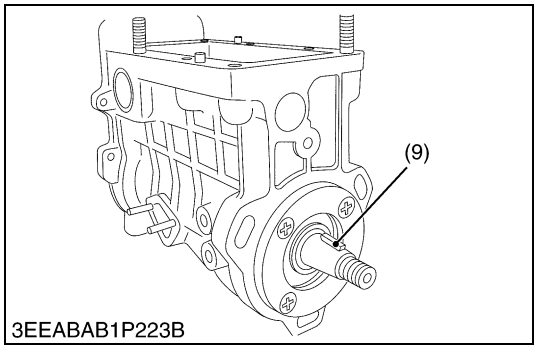
Tightening torque	Injection pump mounting screw	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs
	Injection pump mounting nut	17.7 to 20.6 N·m 1.8 to 2.1 kgf·m 13.0 to 15.2 ft-lbs

(1) Governor Sleeve
(2) Injection Pump Assembly
(3) Open End Wrench (22 mm)
(4) Governor Weight
(5) Fuel Camshaft Stopper
(6) Bearing
(7) Cir-clip
(8) Fuel Camshaft
(9) Key Way of Fuel Camshaft

W1144178



3EEABAB1P222C



3EEABAB1P223B

Fuel Camshaft and Governor Weight (Continued)

(When reassembling)

- Fix the fuel camshaft with lock bolts as the key way of fuel camshaft (9) is upward.
- Install the injection pump assembly to the injection pump housing.
- Attach the O-ring and the cover and tighten the cover mounting bolts.
- Install the governor sleeve to the fuel camshaft.
- Check the movement of the governor sleeve.

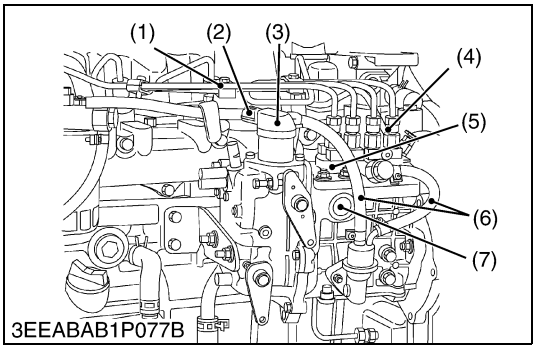
■ **NOTE**

- **Be careful not to damage the O-ring.**
- **Be careful the direction of the governor sleeve.**
- **When reassembling the inside parts, put the oil on each inside part slightly.**

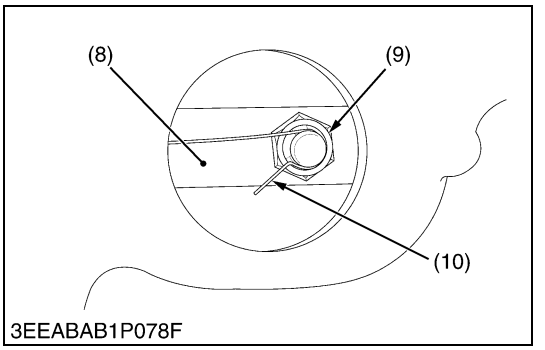
Tightening torque	Fuel camshaft stopper mounting screw	7.9 to 9.3 N·m 0.80 to 0.95 kgf·m 5.8 to 6.9 ft-lbs
	Governor weight mounting nut	62.8 to 72.6 N·m 6.4 to 7.4 kgf·m 46.3 to 53.5 ft-lbs

(1) Governor Sleeve
(2) Injection Pump Assembly
(3) Open End Wrench (22 mm)
(4) Governor Weight
(5) Fuel Camshaft Stopper
(6) Bearing
(7) Cir-clip
(8) Fuel Camshaft
(9) Key Way of Fuel Camshaft

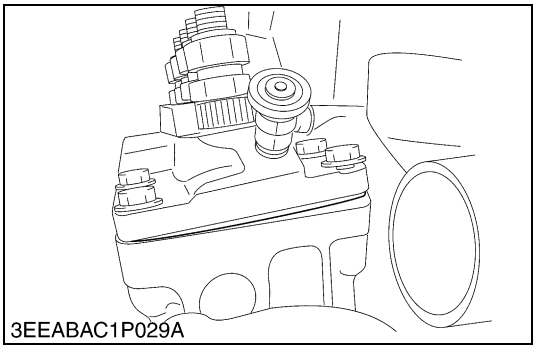
W1146489

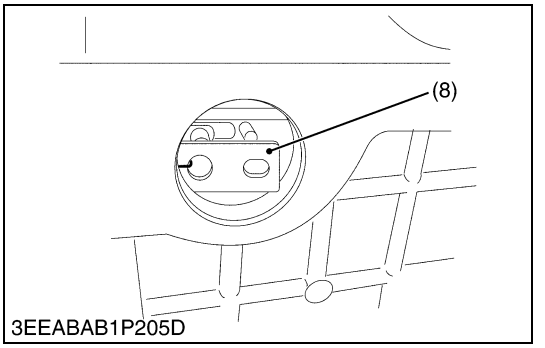


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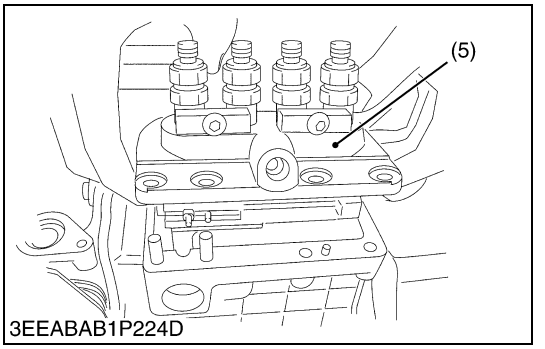


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3EEABAC1P029A



3EEABAB1P205D



3EEABAB1P224D

Replacing Injection Pump Assembly (If necessary)

- **The injection pump can be replaced with the crankshaft in whatever position.**

1. Disconnect all injection pipes (1).
2. Disconnect the fuel pipe (6) and fuel overflow pipe (4).
3. Disconnect the connector (2) from the stop solenoid. Then remove the stop solenoid (3).
4. Detach the sight cover (7) from the injection pump unit.
5. Unhook the start spring (10), and remove the anti-rotation nut (9).
6. Just loosen the injection pump assembly mounting screws and nuts like the figure, which the injection pump assembly keeps tilted.
7. Slide off the governor connecting rod (8) from the rack pin of injection pump assembly.
8. Remove the injection pump mounting screws and nuts, and take out the injection pump assembly (5).

■ **NOTE**

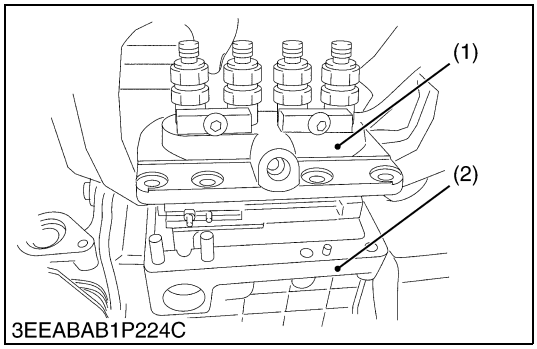
- **Be careful not to drop the anti-rotation nut (9).**
- **Be careful not to deform the start spring.**
- **When taking out the injection pump assembly, be careful not to hit it against the governor connecting rod.**

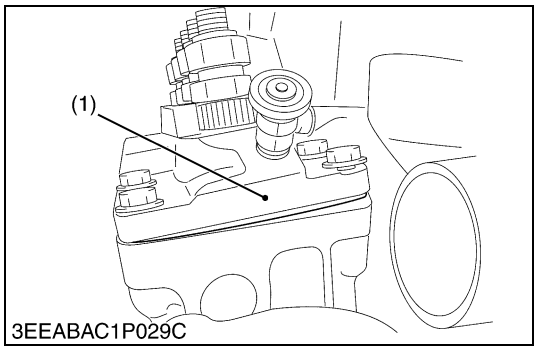
(When reassembling)

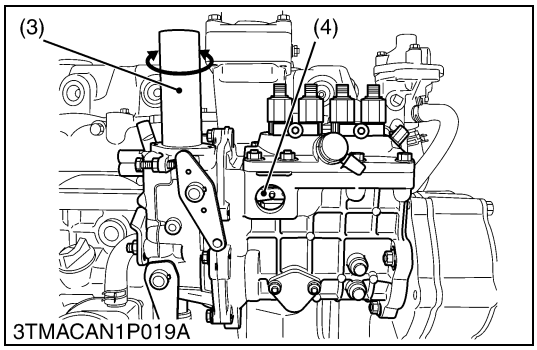
- Install the new injection pump according to the installing procedure.

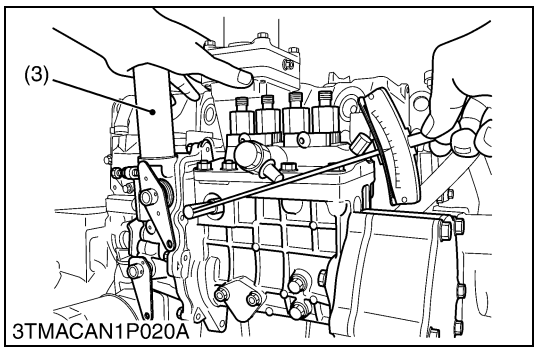
(1) Injection Pipe
(2) Connector
(3) Stop Solenoid
(4) Fuel Overflow Pipe
(5) Injection Pump Assembly
(6) Fuel Pipe
(7) Sight Cover
(8) Governor Connecting Rod
(9) Anti-Rotation Nut
(10) Start Spring

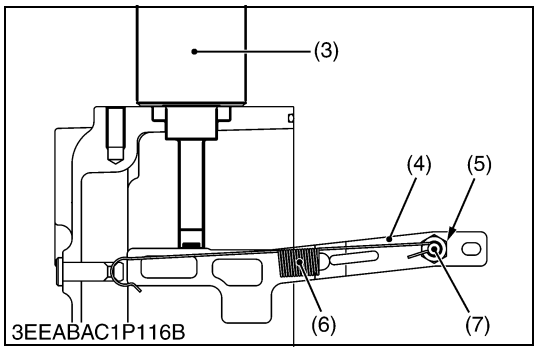
W1182379





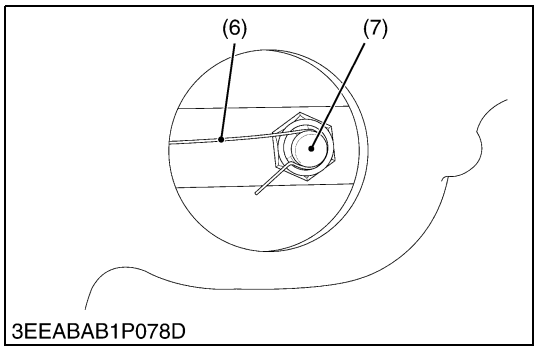






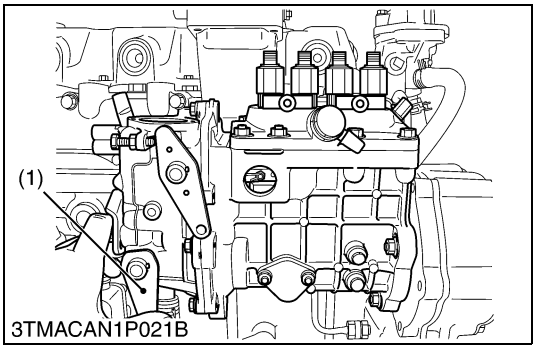
Installing Procedure of Injection Pump Assembly

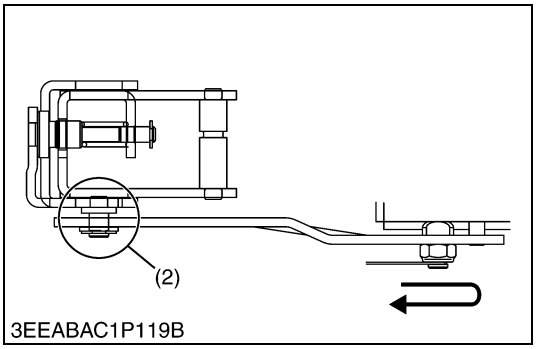
1. Install the fuel injection pump assembly (1) in its unit (2), and tighten the mounting screws and nuts like the figure, which the injection pump assembly (1) keeps tilted.
2. Hook the governor connecting rod (4) to the rack pin of the injection pump assembly (1).
3. Tighten the mounting screws and nuts with the specified torque, not to slide off the governor connecting rod (4) from the rack pin.
4. Place the service jig (3) in the stop solenoid mounting hole of the fuel injection pump unit.
5. Make sure the permanent magnet at the tip of the service jig is attracted to the governor connecting rod (4). To do this, turn the jig a little clockwise and counterclockwise and look into the fuel injection pump unit sight hole to see if the governor connecting rod (4) moves right and left accordingly.
6. Slightly tighten the anti-rotation nut of the governor connecting rod.
7. Holding down the service jig (3) by hand, tighten up the anti-rotation nut (5) to the specified torque.
8. Hook the start spring (6) to the rack pin (7).

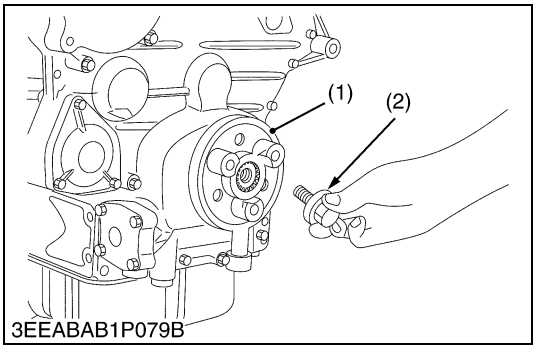


(1) Fuel Injection Pump Assembly
(2) Fuel Injection Pump Unit
(3) Service Jig
(4) Governor Connecting Rod
(5) Anti-rotation Nut
(6) Start Spring
(7) Rack Pin

W1069371







Installing Procedure (Continued)

1. Move the stop lever (1) and visually check to see if the fuel injection pump control rack comes smoothly back to the start position by the counter force of the start spring.
2. If the control rack fails to move back smoothly, remove the start spring and the anti-rotation nut, take the above steps from 2 of the former page again.
3. Finally fit the sight cover and the stop solenoid back into place.

Tightening torque	Anti-rotation nut	2.8 to 4.0 N·m 0.29 to 0.41 kgf·m 2.1 to 3.0 ft-lbs
	Injection pump mounting screw	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs
	Injection pump mounting nut	17.7 to 20.6 N·m 1.8 to 2.1 kgf·m 13.0 to 15.2 ft-lbs

(1) Stop Lever (2) Sliding Point between Governor Fork Lever and Governor Connecting Rod

W1069772

Fan Drive Pulley

1. Set the stopper to the flywheel.
2. Remove the crankshaft screw (2).
3. Draw out the fan drive pulley (1).

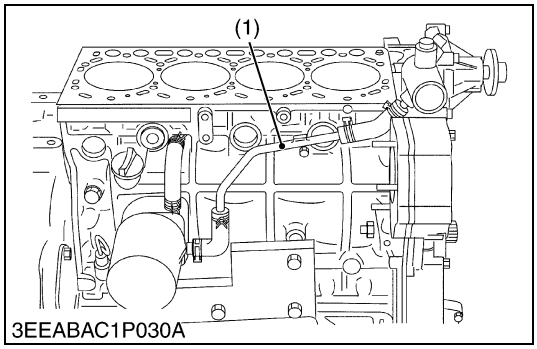
(When reassembling)

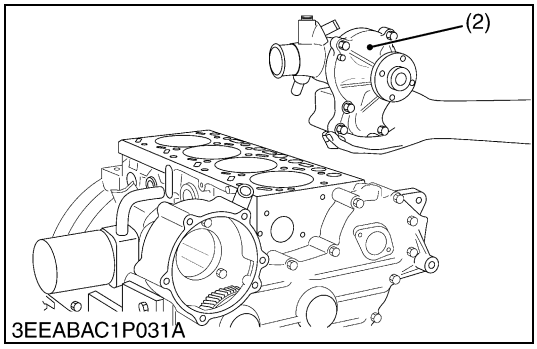
Tightening torque	Crankshaft screw	255.0 to 274.6 N·m 26.0 to 28.0 kgf·m 188.1 to 202.5 ft-lbs

(1) Fan Drive Pulley (2) Crankshaft Screw

W1185033

(6) Water Pump and Oil Cooler





Water Pump

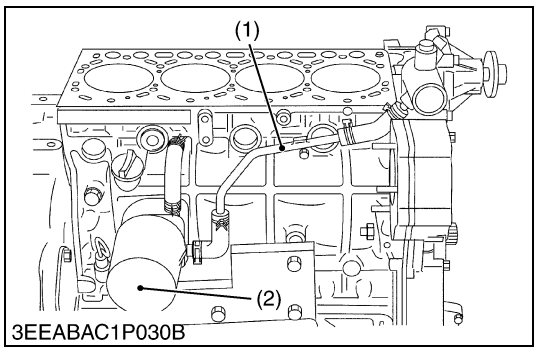
1. Remove the pipe band and the water pipe (1).
2. Remove the water pump (2).

(When reassembling)

- When mounting the water pump, take care not to forget mounting the O-ring and not to let it out of position.

(1) Water Pipe (2) Water Pump

W1187742



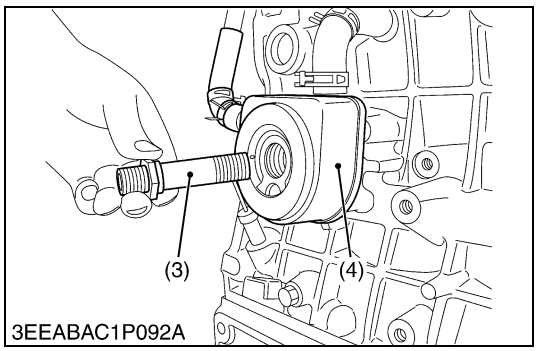
Oil Cooler

1. Remove the water pipe (1).
2. Remove the oil filter cartridge (2) and the oil cooler joint screw (3).
3. Remove the oil cooler (4).

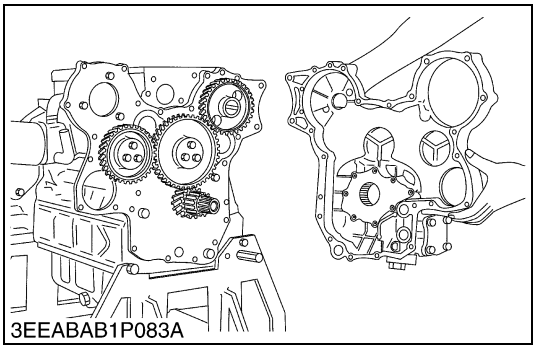
Tightening torque	Oil cooler joint screw	39.2 to 44.1 N·m 4.0 to 4.5 kgf·m 28.9 to 32.5 ft-lbs

(1) Water Pipe (3) Oil Cooler Joint Screw
(2) Oil Filter Cartridge (4) Oil Cooler

W1032266



(7) Gear Case and Timing Gears


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Gear Case Cover

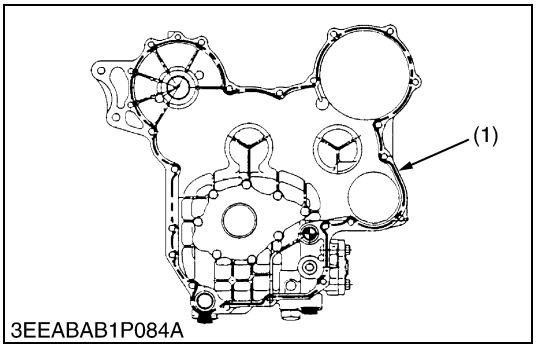
1. Remove the gear case cover.

(When reassembling)

- Confirm that the liquid gasket coating surface is free of water, dust and oil in order to maintain sealing effect.
- Carefully apply the adhesive evenly. (Refer to the figure on the left.)

■ **NOTE**

- **When mounting the adhesive-applied parts, take care to fit them to the mating parts.**
- **Assemble the adhesive-applied parts within ten minutes.**
- **Apply a liquid gasket (Three Bond 1217D) to the gear case cover.**



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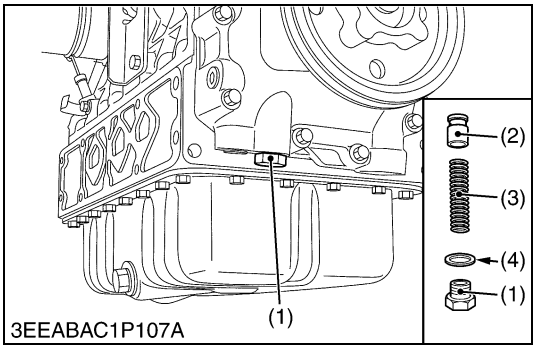
Tightening torque	Gear case cover mounting screw	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs

(1) Liquid Gasket

W1189218

Relief Valve

1. Remove the relief valve retaining screw (1).
2. Remove the relief valve (2), the spring (3) and the packing (4).



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Tightening torque	Relief valve retaining screw	68.6 to 78.4 N·m 7.0 to 8.0 kgf·m 50.6 to 57.9 ft-lbs

(1) Relief Valve Retaining Screw
(2) Relief Valve
(3) Spring
(4) Packing

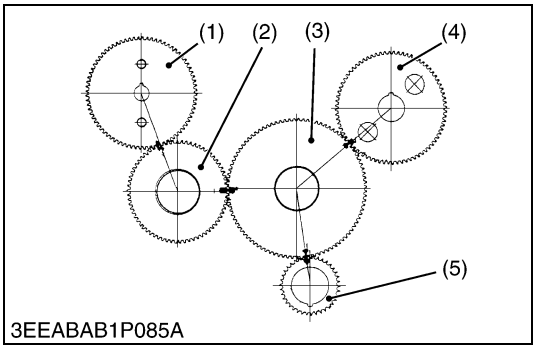
W1081251

Idle Gear and Camshaft

1. Remove three set screws of the idle gear and draw out the idle gear 1, 2.
2. Remove two set screws of the camshaft stopper and draw out the camshaft.

(When reassembling)

- Set the crankshaft at the top dead center of No. 1 and 4 cylinder and the camshaft key to the top position and align the marks of idle gear 1 (3) and idle gear 2 (2) to assemble them. (Refer to the figure on the left.)
- Mount the injection pump gear (1) after installing the gear case.

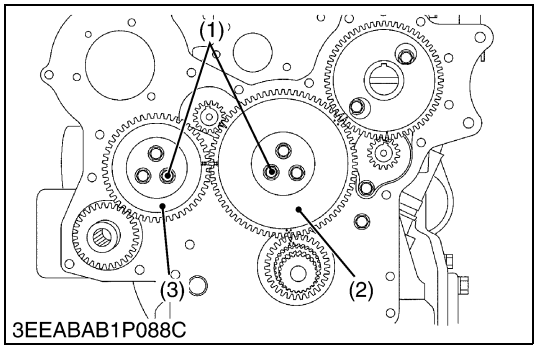


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Tightening torque	Camshaft set screw	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs
	Idle gear mounting screw	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs

(1) Injection Pump Gear
(2) Idle Gear 2
(3) Idle Gear 1
(4) Cam Gear
(5) Crank Gear

W1189797



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Idle Gear 1 and Idle Gear 2 (for Balancer Model)

1. Remove the idle gear mounting screw (1).
2. Draw out the idle gear (2) and (3).

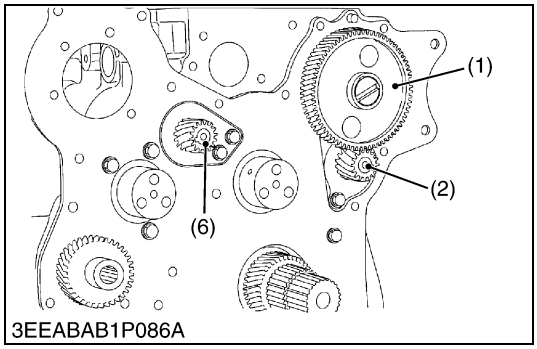
(When reassembling)

- When install the idle gear (2) and (3), be sure to place the 4th cylinder piston at the top dead center in compressio then, align all mating marks on each gear to assemble the timing gears, set the idle gear last.

Tightening torque	Idle gear mounting screw	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs

(1) Idle Gear Mounting Screw
(2) Idle Gear 1
(3) Idle Gear 2

W1032991



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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 set screws and draw out the balancer shaft 1 (2).
3. Remove the balancer shaft 2 set screws and draw out the balancer shaft 2 (6).

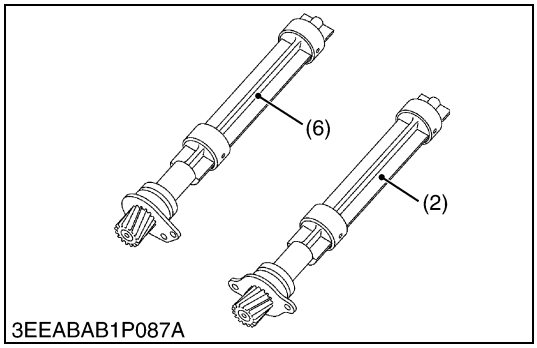
(When reassembling)

- When install the balancer shaft 1 and 2, be sure to place the 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.

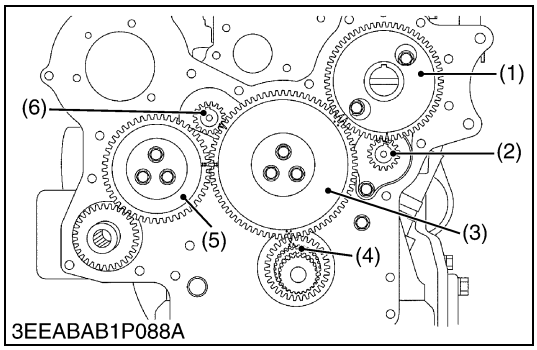
Tightening torque	Camshaft set screw	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs
	Balancer shaft set screw	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs

(1) Camshaft
(2) Balancer Shaft 1
(3) Idle Gear 1
(4) Crank Gear
(5) Idle Gear 2
(6) Balancer Shaft 2

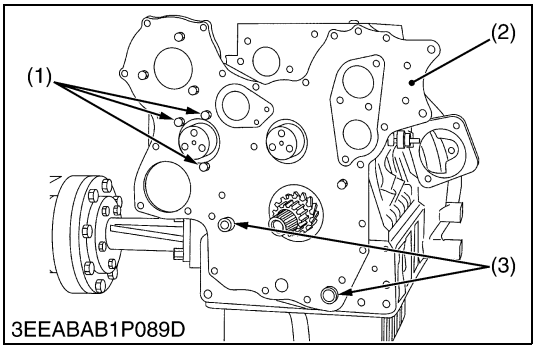
W1191037



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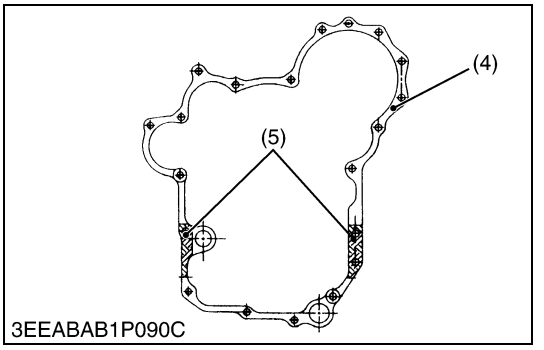


Plate (Gear Case)

1. Remove the three plate mounting screws(1). Detach the plate (2).

(When reassembling)

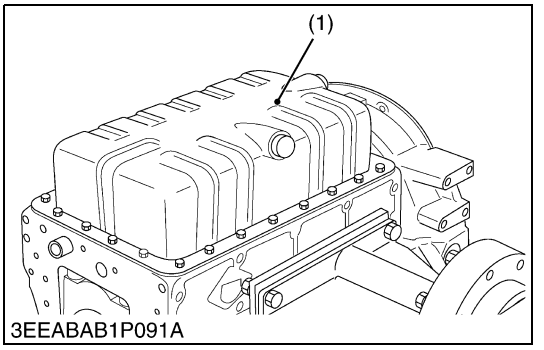
- Apply Three Bond 1217D adhesive or equivalent over the shaded zones on both sides of the gasket that will be sandwiched between the crankcase and plate.
- Be sure to fix the O-rings (3).

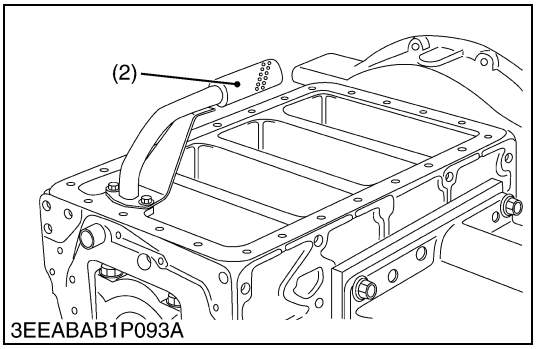
Tightening torque	Plate mounting screw	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs

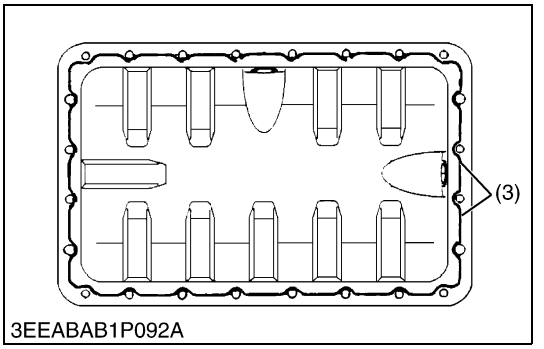
(1) Plate Mounting Screw
(2) Plate
(3) O-ring
(4) Gasket
(5) Liquid Gasket

W1057656

(8) Piston and Connecting Rod







Oil Pan and Oil Strainer

1. Unscrew the oil pan mounting screws and remove the oil pan (1).
2. Unscrew the oil strainer mounting screw, and remove the oil strainer (2).

(When reassembling)

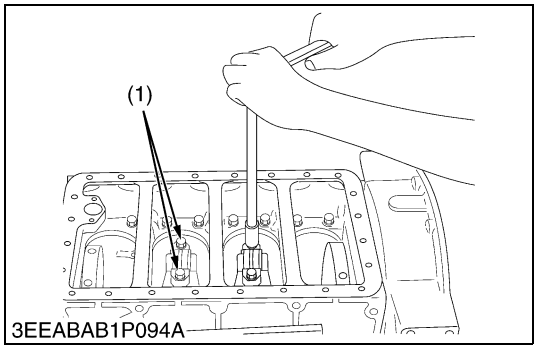
- Install the oil strainer, using care not to damage the O-ring.
- Apply liquid gasket (Three Bond 1217D) to the oil pan as shown in the figure.
- Confirm that the liquid gasket coating surface is free of water, dust and oil in order to maintain sealing effect.
- Carefully apply the adhesive evenly.

■ **NOTE**

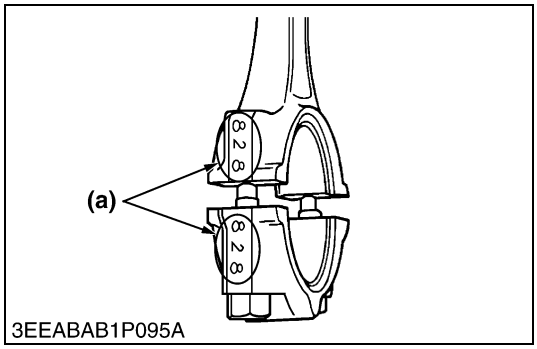
- **When mounting the adhesive-applied parts, take care to fit them to the mating parts.**
- **Assemble the adhesive-applied parts within ten minutes.**
- **To avoid uneven tightening, tighten mounting screws in diagonal order from the center.**
- **After cleaning the oil strainer, install it.**
- **Attach the oil pan with its central drain plug facing toward the air suction side.**

(1) Oil Pan
(2) Oil Strainer
(3) Liquid Gasket

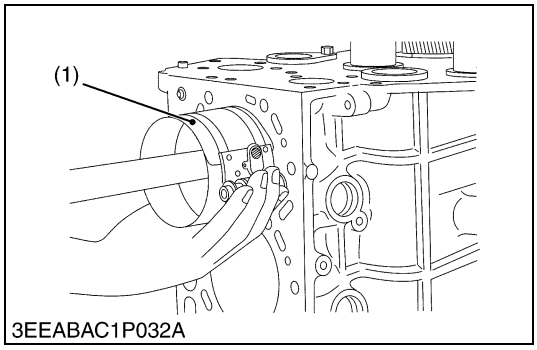
W1057949



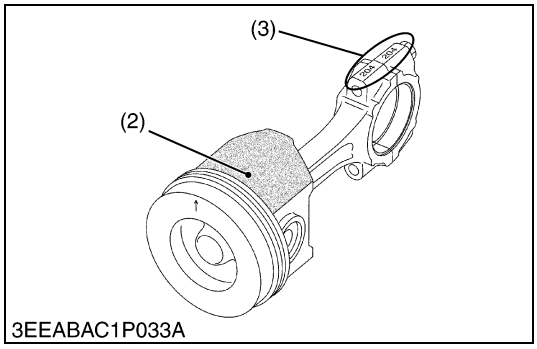
3EEABAB1P094A



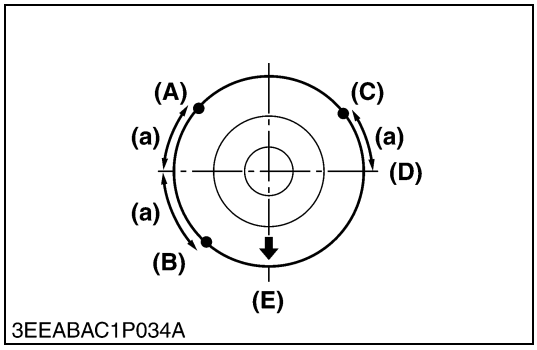
3EEABAB1P095A



3EEABAC1P032A



3EEABAC1P033A



3EEABAC1P034A

Connecting Rod Cap

1. Remove the connecting rod screws (1) from connecting rod cap.
2. Remove the connecting rod caps.

(When reassembling)

- Align the marks **(a)** with each other. (Face the marks toward the injection pump.)
- Apply engine oil to the connecting rod screws and lightly screw it in by hand, then tighten it to the specified torque.
  If the connecting rod screw won't be screwed in smoothly, clean the threads.
  If the connecting rod screw is still hard to screw in, replace it.
- When using the existing crank pin metal again, put tally marks on the crank pin metal and the connecting rod in order to keep their positioning.
- Fit the crank pin metal in place : its centrally groove side toward the connecting rod, and the non-grooved side toward the cap.

Tightening torque	Connecting rod screw	78.5 to 83.4 N·m 8.0 to 8.5 kgf·m 57.9 to 61.5 ft-lbs

(1) Connecting Rod Screw **(a) Mark**

W1058252

Piston

1. Completely clean carbon in the cylinders.
2. Turn the flywheel and set a piston to the top dead center.
3. Pull out the piston upward by lightly tapping it from the bottom of the crankcase with the grip of a hammer.

(When reassembling)

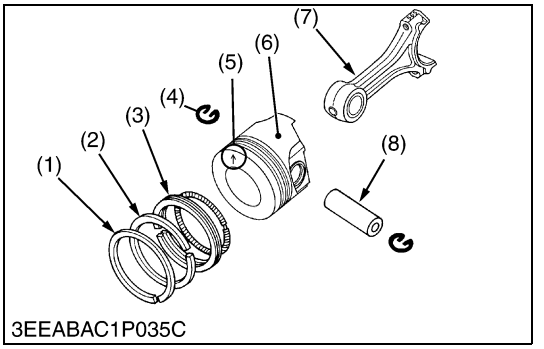
- Before inserting the piston into the cylinder, apply enough engine oil to the cylinder.
- When inserting the piston into the cylinder, face the mark (3) on the connecting rod to the injection pump.

■ IMPORTANT

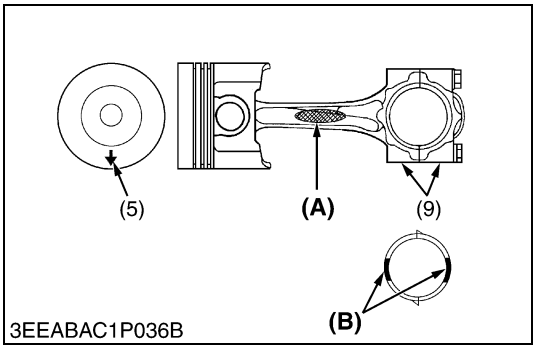
- **Do not change the combination of cylinder and piston. Make sure of the position of each piston by marking. For example, mark "1" on the No. 1 position.**
- **When inserting the piston into the cylinder, place the gap of each pison ring like the figure.**
- **Carefully insert the pistons using a piston ring compressor (1). Otherwise, their chrome-plated section of piston rings may be scratched, causing trouble inside the liner.**
- **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.**

(1) Piston Ring Compressor
(2) Molybdenum Disulfide Coating in piston skirt
(3) Mark
(a) 0.79 rad (45 <Symbol>×)
(A) Top Ring Gap
(B) Second Ring Gap
(C) Oil Ring Gap
(D) Piston Pin Hole
(E) Injection Pump Side

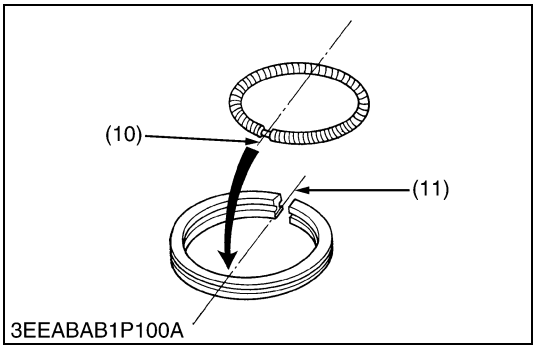
W1058433



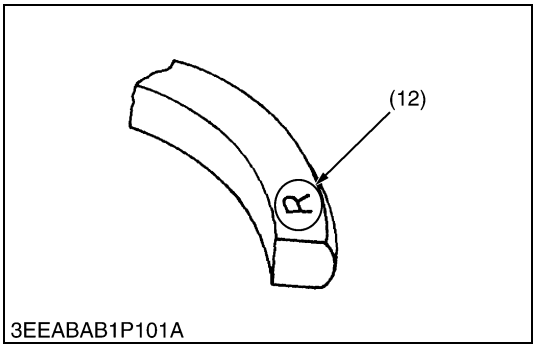
3EEABAC1P035C



3EEABAC1P036B



3EEABAB1P100A



3EEABAB1P101A

Piston Ring and Connecting Rod

1. Remove the piston rings using a piston ring tool.
2. Remove the piston pin (8), and separate the connecting rod (7) from the piston (6).

(When reassembling)

- Be sure to fix the crankpin bearing and the connecting rod are same I.D. colors.
- When installing the ring, assemble the rings so that the manufacture's mark (12) near the gap faces the top of the piston.
- When installing the oil ring onto the piston, place the expander joint (10) on the opposite side of the oil ring gap (11).
- Apply engine oil to the piston pin.
- When installing the piston pin, immerse the piston in 80 <Symbol>×C (176 <Symbol>×F) oil for 10 to 15 minutes and insert the piston pin to the piston.
- Assemble the piston to the connecting rod with the <Symbol>¦ mark (5) and the connecting rod numbering mark (9) facing same side.
- The end faces of the oil ring are plated with hard chrome. In putting the piston into the cylinder, be careful not to get the oil ring scratched by the cylinder. Use the piston ring fitter to tighten up the oil ring. If the ring's planting is scratched, it may get stuck on the cylinder wall, causing a serious trouble.

■ IMPORTANT

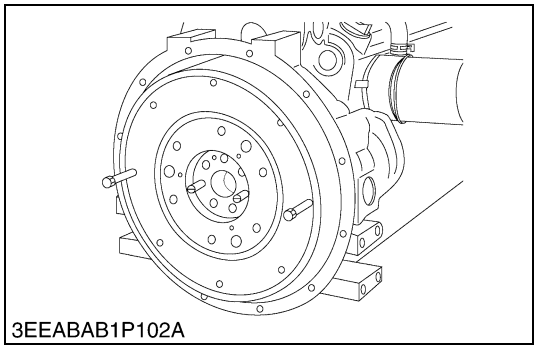
- **Mark the same number on the connecting rod and the piston so as not to change the combination.**

(1) Top Ring
(2) Second Ring
(3) Oil Ring
(4) Piston Pin Snap Pin
(5) Mark (<Symbol>¦)
(6) Piston
(7) Connecting Rod
(8) Piston Pin
(9) Numbering Mark
(10) Expander Joint
(11) Oil Ring Gap
(12) Manufacture's Mark

(A) Connecting Rod ID Color : Blue or without Color
(B) Crankpin Bearing ID Color : Blue or without Color

W1059589

(9) Flywheel and Crankshaft


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Flywheel

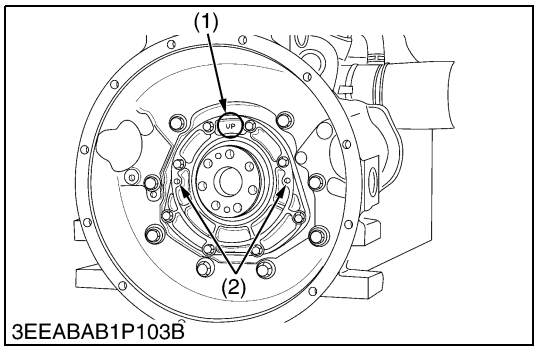
1. Install the stopper to the flywheel so that the flywheel does not turn.
- **NOTE**
- **Do not use an impact wrench. Serious damage will occur.**
2. Detach the flywheel screws.
3. Remove the flywheel.

(When reassembling)

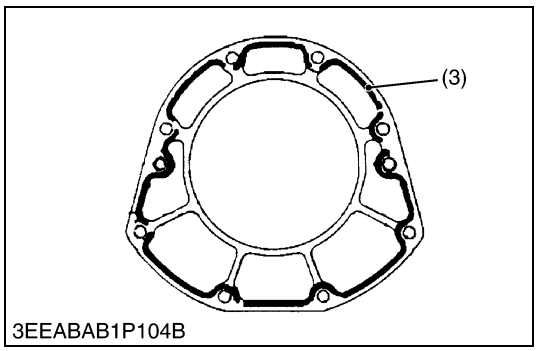
- Apply engine oil to the flywheel screws.
- Before fitting the flywheel and the crankshaft together, wipe oil, dust and other foreign substances off their mating faces.
- The flywheel and the crankshaft are fitting together in just one position. Make sure they are tightly fit and drive the bolts.

Tightening torque	Flywheel screw	98.1 to 107.9 N·m 10.0 to 11.0 kgf·m 72.3 to 79.6 ft-lbs

W1060354



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3EEABAB1P104B

Bearing Case Cover

■ **NOTE**

- **Before disassembling, check the side clearance of crankshaft. Also check it during reassembly.**

1. Remove the bearing case over mounting screws.
2. Screw two removed screws into the screw hole (2) of bearing case cover to remove it.

(When reassembling)

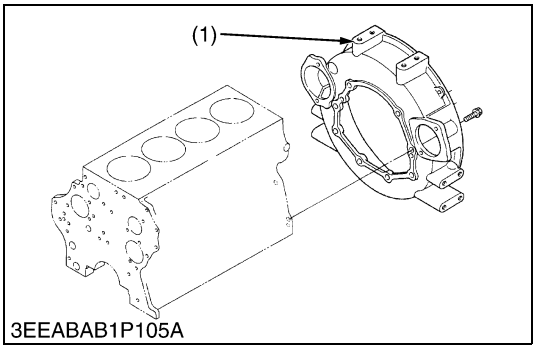
■ **IMPORTANT**

- **In case of replacing the oil seal, use caution when installing the seal in the bearing case cover as not to install it tilted. The seal should be flush with the cover.**
- **Confirm that the liquid gasket coating surface is free of water, dust and oil in order to maintain sealing effect.**
- **Apply liquid gasket (Three Bond 1217D) to the bearing case cover as shown in the figure.**
- **Before installing the bearing case cover / oil seal assembly, lube the seal tna be careful not to damage the seal while installing the assembly.**
  Install the bearing case cover / oil seal assembly to position the casting mark "UP" on it upward.
- **Tighten the bearing case cover mounting screws with even force on the diagonal line.**
- **When mounting the adhesive-applied parts, take care to fit them to the mating parts.**
- **Assemble the adhesive-applied parts within ten minutes.**

Tightening torque	Bearing case cover mounting screw	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs

(1) Top Mark **"UP"**
(2) Screw Hole
(3) Liquid Gasket

W1060482



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Flywheel Housing

1. Remove the flywheel housing.

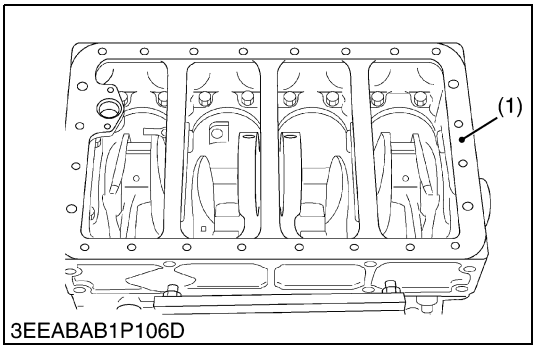
(When reassembling)

- Tighten the flywheel housing mounting screws with even force on the diagonal line.
- Make sure the crank cases 1 and 2 are clean. Install them in position, referring to the flywheel housing's contoured face.

Tightening torque	Flywheel housing mounting screw	77.5 to 90.2 N·m 7.9 to 9.2 kgf·m 57.1 to 66.5 ft-lbs

(1) Flywheel Housing

W1060705



3EEABAB1P106D

Crankcase 2

1. Remove the crankcase 2 (1).

(When reassembling)

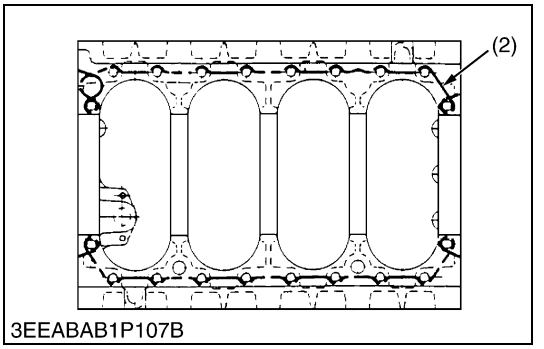
■ IMPORTANT

- **Make sure the crankcase 1 and 2 are clean.**
- **Apply liquid gasket (Three Bond 1217D) to the crankcase 2 as shown in the figure.**
- **Tighten the crankcase 2 mounting screws with even force on the diagonal line.**
- **Confirm that the liquid gasket coating surface is free of water, dust and oil in order to maintain sealing effect.**
- **Carefully apply the adhesive evenly.**

■ NOTE

- **When mounting the adhesive-applied parts, take care to fit them to the mating parts.**
- **Assemble the adhesive-applied parts within ten minutes.**

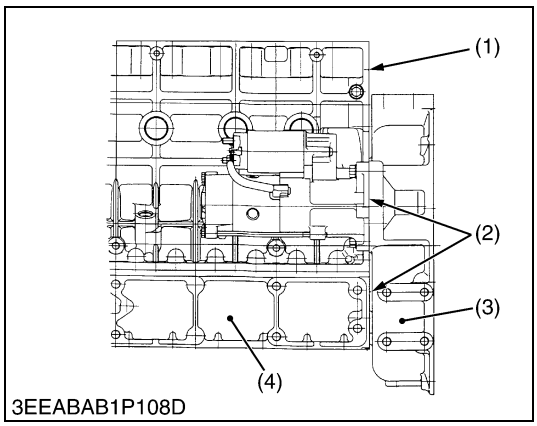
Tightening torque	Crankcase 2 mounting screw	49.0 to 55.9 N·m 5.0 to 5.7 kgf·m 36.2 to 41.2 ft-lbs



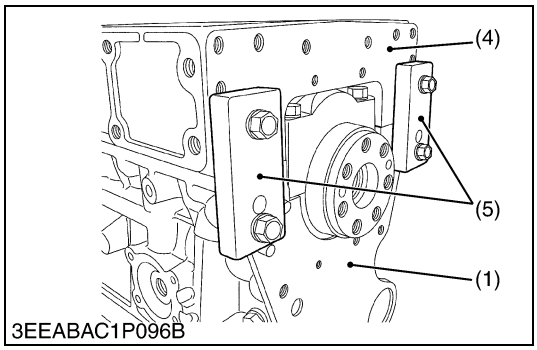
3EEABAB1P107B

(1) Crankcase 2 (2) Liquid Gasket

W1060825



3EEABAB1P108D



3EEABAC1P096B

Crankcase 1 and Crankcase 2

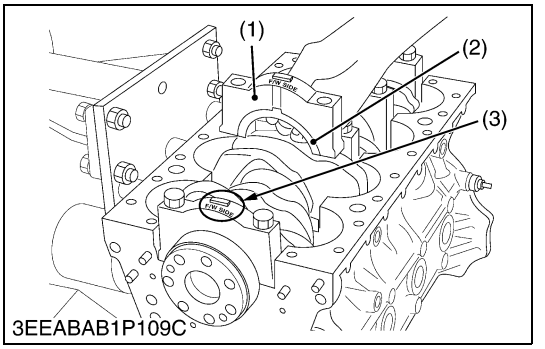
(When reassembling)

- Match the crankcase 1 and 2, referring to the flywheel housing's contoured face.
- Tighten the crankcase 2 mounting screws loosely.
- Tighten up the jig to the specified torque same as the flywheel housing screw. This helps to minimize the level difference between the crankcase 1 and the crankcase 2 (at the flywheel side). Possible gap must be 0.05 mm (0.0020 in.) or smaller.

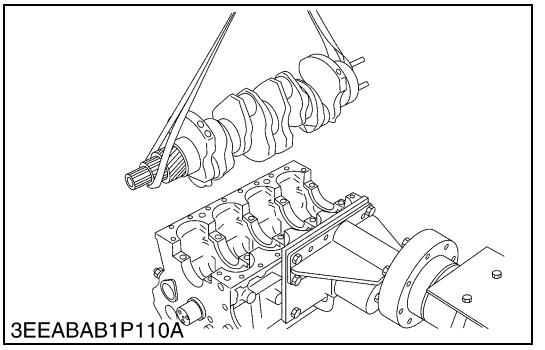
Tightening torque	Crankcase 2 mounting screw	49.0 to 55.9 N·m 5.0 to 5.7 kgf·m 36.2 to 41.2 ft-lbs
	Flywheel housing mounting screw	77.5 to 90.2 N·m 7.9 to 9.2 kgf·m 57.1 to 66.5 ft-lbs

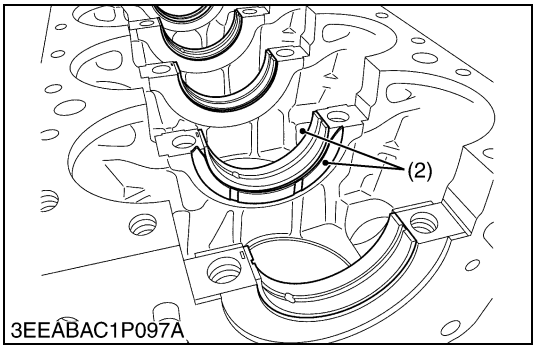
(1) Crankcase 1
(2) Gap to be smaller than 0.05 mm (0.0020 in.)
(3) Flywheel Housing
(4) Crankcase 2
(5) Jig

W1111351

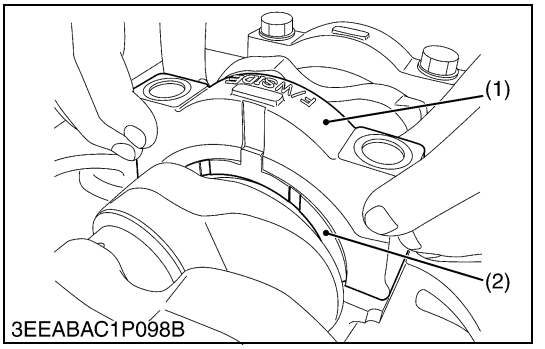


3EEABAB1P109C

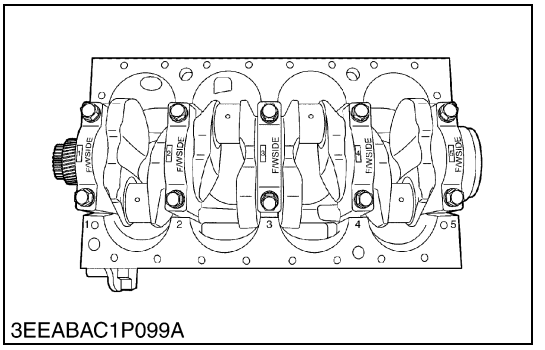

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3EEABAC1P097A



3EEABAC1P098B



3EEABAC1P099A

Crankshaft

1. Remove the main bearing case.
2. Remove the crankshaft.

(When reassembling)

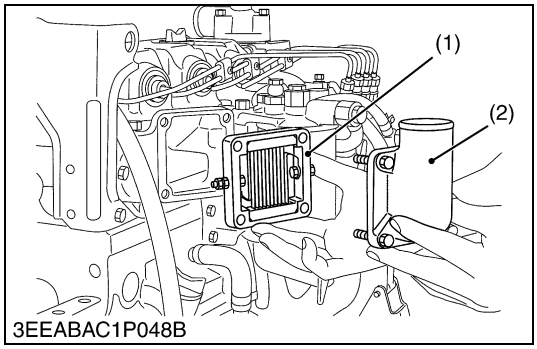
- Reassemble the main bearing case having the same number as the one engraved on the crankcase, and set the casting mark “F / W SIDE” on the main bearing case facing towards the flywheel side.
- Reassemble the thrust bearing (2), with the oil groove facing outside, into both side of the fourth main bearing case (1).
- Apply oil to the bearing case screws and tighten them to the specified torque.

Tightening torque	Main bearing case screw	137.3 to 147.1 N·m 14.0 to 15.0 kgf·m 101.3 to 108.5 ft-lbs

(1) 4th Main Bearing Case
(2) Thrust Bearing
(3) F / W SIDE Mark

W1061157

(10) Intake Air Heater



Intake Air Heater

1. Remove the inlet hose.
2. Disconnect the lead.
3. Remove the flange and the intake air heater.

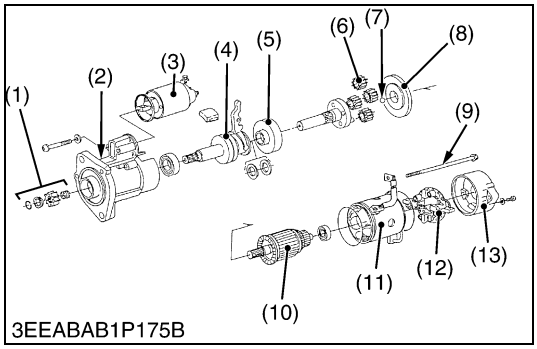
■ **NOTE**

- **When assembling the intake air heater at the side of intake manifold, assemble the intake air heater as the heater lines are vertical. Otherwise, it may be short-circuited.**

(1) Intake air heater (2) Flange

W1043265

(11) Starter



Disassembling Motor

1. Disconnect the solenoid switch (3).
2. Remove the 2 through screws (9) and the 2 brush holder lock screws. Take out the rear end frame (13) and the brush holder (12).
3. Disconnect the armature (10) and the yoke (11). Remove also the ball (7) from the tip of the armature.
4. Remove the set of packings (8), the 4 planetary gears and another packing.
5. Take out the shaft assembly. Take note of the position of the lever.

■ **IMPORTANT**

- **Before disconnecting the yoke, put tally marks on the yoke and the front bracket.**
- **Take note of the positions of the set of packings and the setup bolt.**
- **Apply grease to the gears, bearings, shaft's sliding part and ball.**

■ **NOTE**

- **Do not damage to the brush and commutator.**

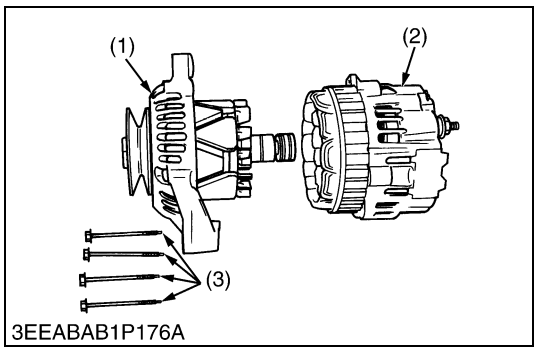
(When reassembling)

- Apply grease (DENSO CO. No.50 or equivalent) to the parts indicated in the figure.

(1) Gear
(2) Front Bracket
(3) Solenoid Switch
(4) Overrunning Clutch
(5) Internal Gear
(6) Planetary Gear
(7) Ball
(8) Set of Packings
(9) Through Bolt
(10) Armature
(11) Yoke
(12) Brush Holder
(13) Rear End Frame

W1074237

(12) Alternator



Front Bracket

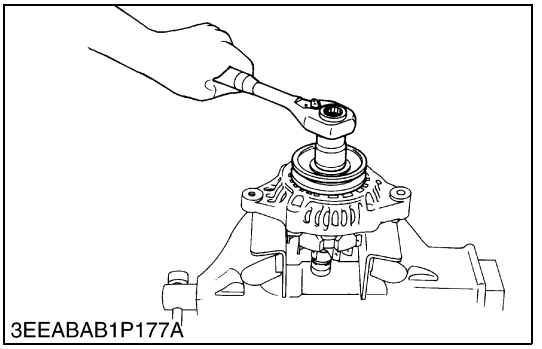
1. Remove the 4 screws (3).
2. Separate the front bracket (1) and the rear bracket (2) from each other.

■ **IMPORTANT**

- **Put a tally line on the front bracket and the rear bracket for reassembling them later.**

(1) Front Bracket
(2) Rear Bracket
(3) Screw

W1074745

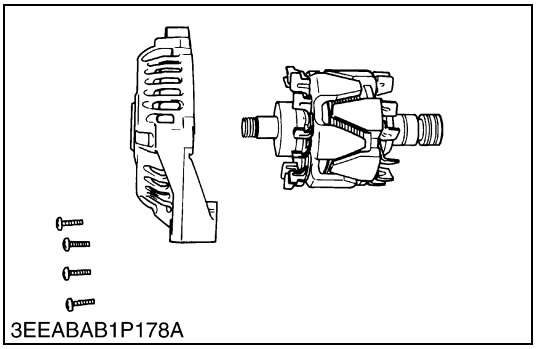

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Pulley

1. Hold the rotor (base of the claw) in a vise. Loosen the lock nut using a M24 box wrench.

Tightening torque	Pulley nut	58.3 to 78.9 N·m 5.95 to 8.05 kgf·m 43.0 to 58.2 ft-lbs

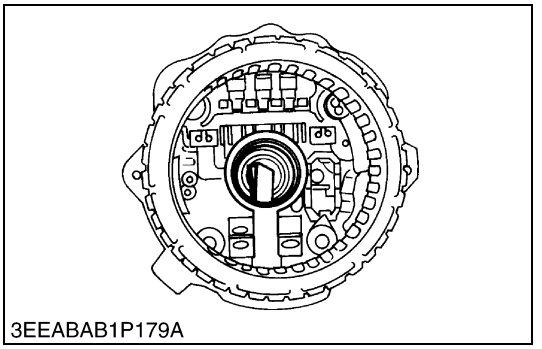
W1074849


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Rotor

1. Remove the 4 screws and detach the bearing retainer.
2. Temporarily install the nut on the pulley screw, and detach the rotor.

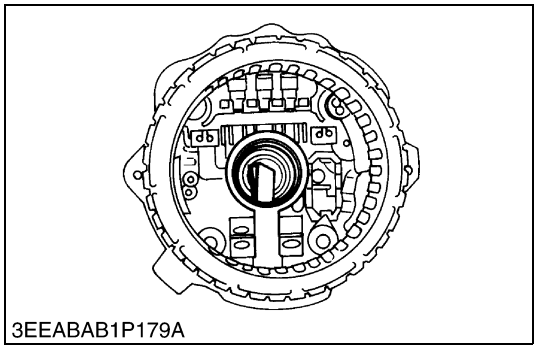
W1074920

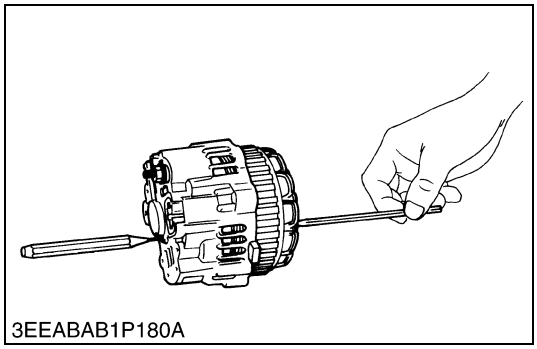

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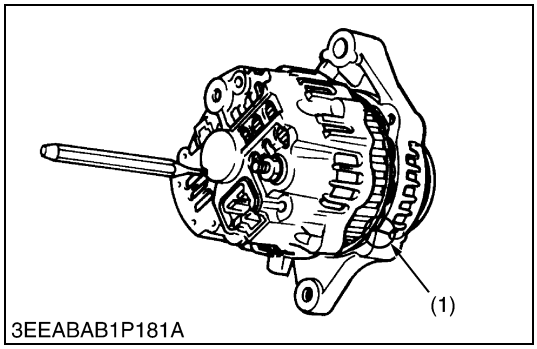
Brush

1. When the rotor is detached, the 2 brushes are found to stretch out of the shaft hole.

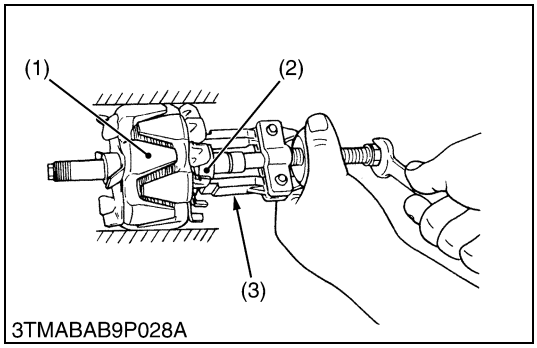
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3EEABAB1P180A



3EEABAB1P181A



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Reassembling the Brush

1. Fit the brush with its sliding face in the clockwise direction when viewed from front.

■ **IMPORTANT**

- **Be sure to keep the 2 brushes deep in the brush holder. Otherwise the rotor and the rear section can not be fitted into the position.**
- **Use a 4 mm hex. wrench to push the brushes into place.**
- **Using a pin-pointed (2 mm) punch, keep the brushes from popping out.**

2. Match the tally line of the front section with that of the rear section.
3. Tighten the 4 screws, and draw out the pin-pointed punch out of the brush holder.

(1) Marking

W1075117

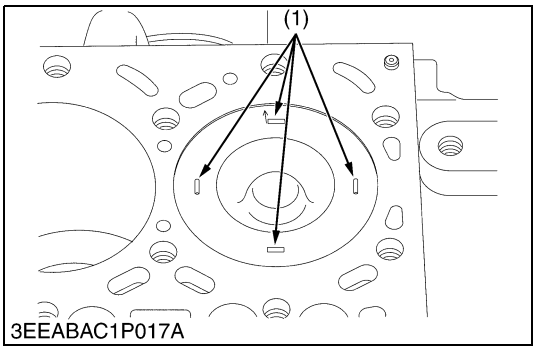
Bearing at Slip Ring Side

1. Lightly secure the rotor (1) with a vise to prevent damage, and remove the bearing (2) with a puller (3).

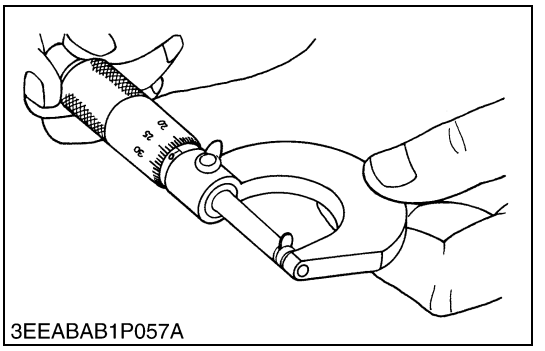
(1) Rotor
(2) Bearing
(3) Puller

W1019701

[3]SERVICING
(1) Cylinder Head



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Top Clearance

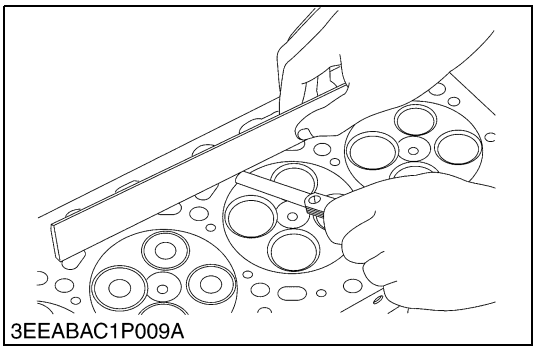
1. Remove the cylinder head (remove the cylinder head gasket completely).
2. Bring the piston to its top dead center fasten 1.5 mm dia. 5 to 7 mm long fuse wires to 3 to 4 spots on the piston top with grease so as to avoid the intake and exhaust valves and the combustion chamber ports.
3. Bring the piston to its middle position, install the cylinder head, and tighten the cylinder head screws to specification. (Head gasket must be changed to new one).
4. Turn the crank shaft until the piston exceeds its top dead center.
5. Remove the cylinder head, and measure squeezed fuse wires for thickness.
6. If the measurement is not within the specified value, check the oil clearance of the crankpin journal and the piston pin.

Top clearance	Factory spec.	0.72 to 0.90 mm 0.0283 to 0.0354 in.

Tightening torque	Cylinder head mounting screw	98.1 to 107.9 N·m 10.0 to 11.0 kgf·m 72.3 to 79.6 ft-lbs

(1) Fuse

W1049122

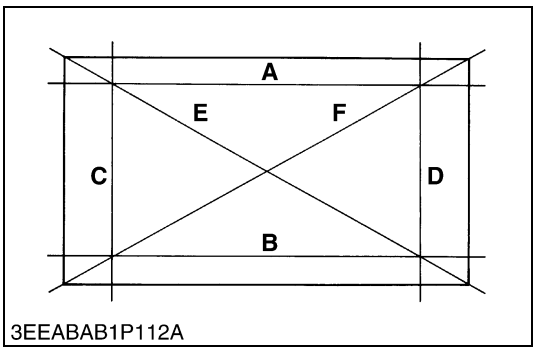

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Cylinder Head Surface Flatness

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. Measure the clearance with a feeler gauge.
3. If the measurement exceeds the allowable limit, correct it with a surface grinder.

■ **IMPORTANT**

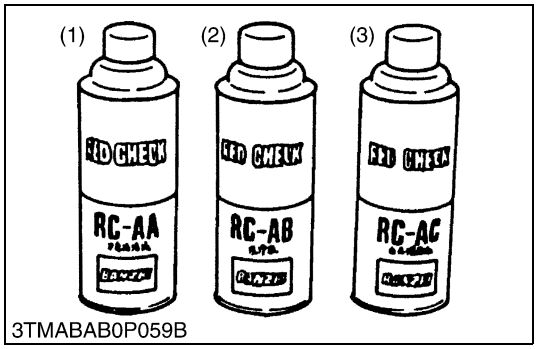
- **Be sure to check the valve recessing after correcting.**



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Cylinder head surface flatness	Allowable limit	0.05 mm 0.0020 in.

W1061323



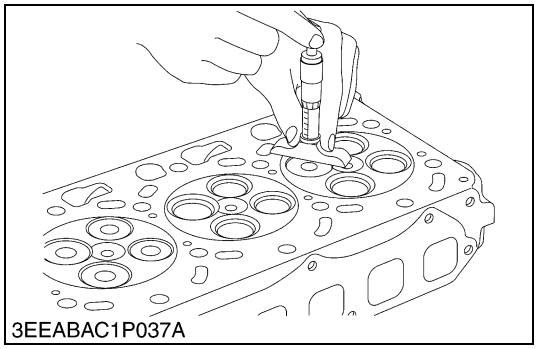
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Cylinder Head Flaw

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

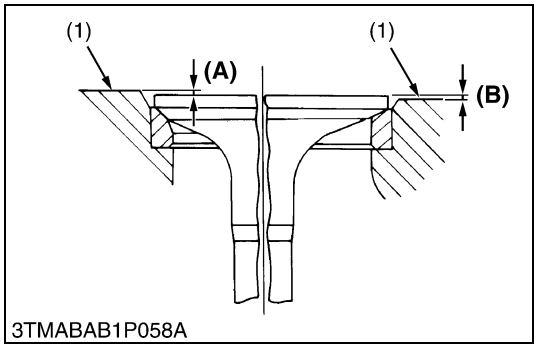
W1076542


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Valve Recessing

1. Clean the cylinder head, the valve face and 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.
   If it still exceeds the allowable limit after replacing the valve, replace the cylinder head.

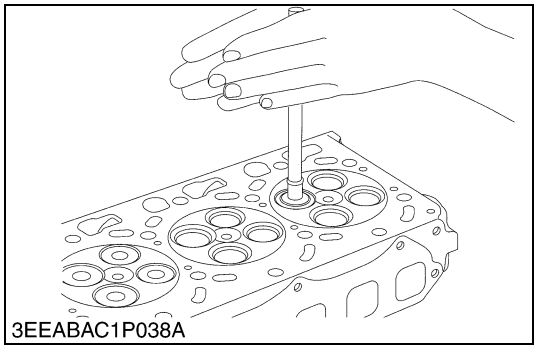
Valve recessing	Factory spec.	Intake valve	(recessing) 0.6 to 0.8 mm 0.0236 to 0.0315 in.
		Exhaust valve	(recessing) 0.85 to 1.05 mm 0.0335 to 0.0413 in.
	Allowable limit	(recessing) 1.2 mm 0.0472 in.	



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(1) Cylinder Head Surface
(A) Recessing
(B) Protrusion

W1061543

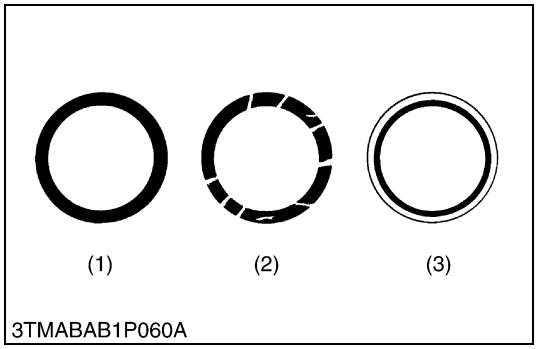

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Valve Lapping

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**

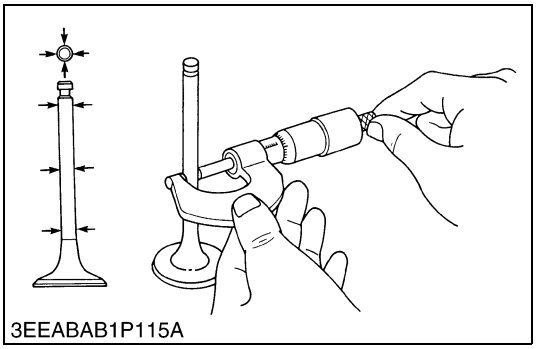
- **When valve lapping is performed, be sure to check the valve recessing and adjust the valve clearance after assembling the valve.**

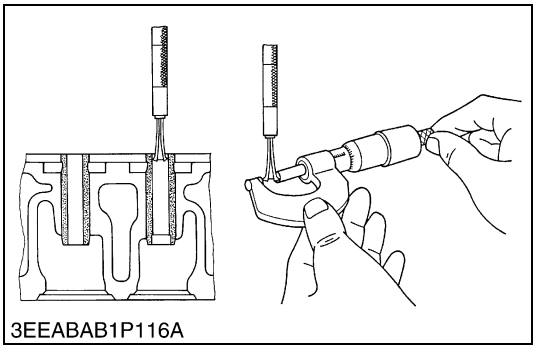


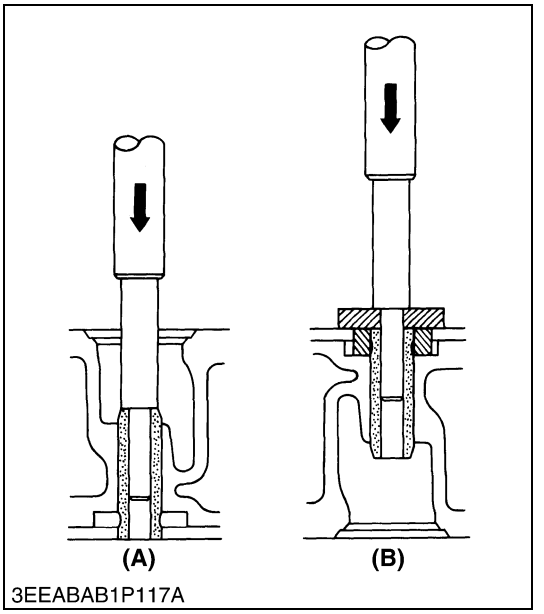
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(1) Correct
(2) Incorrect
(3) Incorrect

W1061709


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. of the cylinder head at the most wear part as shown in the figure below 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 guide	Factory spec.	Intake valve	0.055 to 0.085 mm 0.0022 to 0.0033 in.
		Exhaust valve	0.055 to 0.085 mm 0.0022 to 0.0033 in.
	Allowable limit		0.1 mm 0.0039 in.

Valve stem O.D.	Factory spec.	Intake valve	6.960 to 6.975 mm 0.2740 to 0.2746 in.
		Exhaust valve	6.960 to 6.975 mm 0.2740 to 0.2746 in.

Valve guide I.D.	Factory spec.	Intake valve	7.030 to 7.045 mm 0.2768 to 0.2774 in.
		Exhaust valve	7.030 to 7.045 mm 0.2768 to 0.2774 in.

W1061883

Replacing Valve Guide

(When removing)

1. Using a valve guide replacing tool, press out the used valve guide.

(When installing)

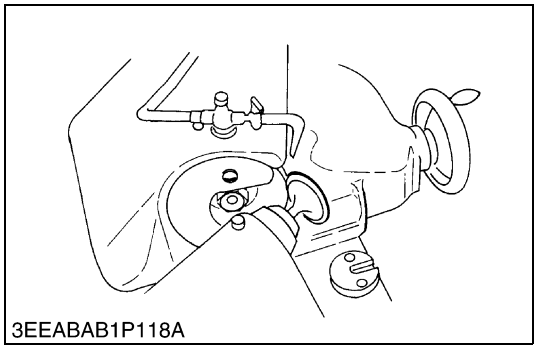
1. Clean a new valve guide, and apply engine oil to it.
2. Using a valve guide replacing tool, press in a new valve guide until it is flush with the cylinder head as shown in the figure.
3. Ream precisely the I.D. of the valve guide to the specified dimension.

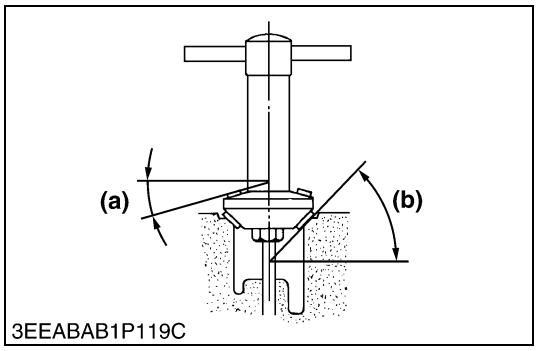
■ **IMPORTANT**

- **Do not hit the valve guide with a hammer, etc. during replacement.**

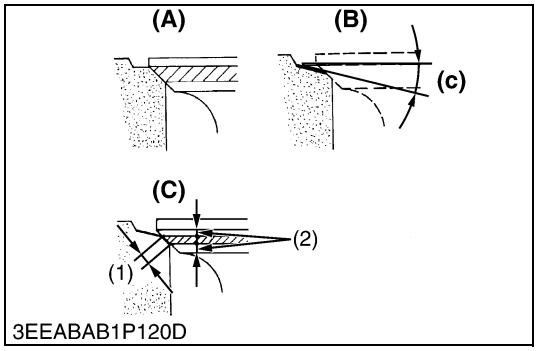
(A) When Removing **(B) When Installing**

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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.

Valve face angle	Factory spec.	IN.	1.047 rad 60 °
		EX.	0.785 rad 45 °

2) Correcting Valve Seat

1. Slightly correct the seat surface with a 1.047 rad (60 °) (intake valve) or 0.785 rad (45 °) (exhaust valve) valve seat cutter.
2. Resurface the seat surface with a 0.523 rad (30 °) valve seat cutter to intake valve seat and with a 0.262 rad (15 °) valve seat cutter to exhaust valve seat so that the width is close to specified valve seat width.

Valve seat width	Factory spec.	IN.	1.6 to 2.0 mm 0.0630 to 0.0790 in.
		EX.	2.3 to 2.6 mm 0.0906 to 0.1024 in.

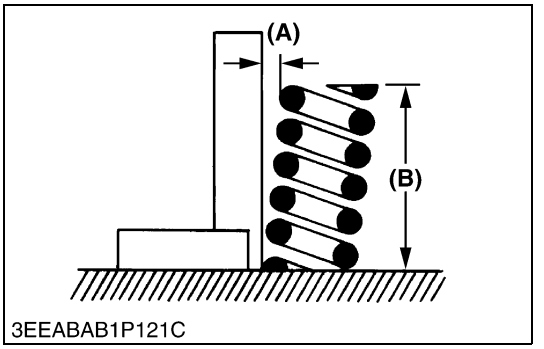
3. After resurfacing the seat, inspect for even valve seating, apply a thin film of compound between the valve face and valve seat, and fit them with valve lapping tool.
4. Check the valve seating with prussian blue. The valve seating surface should show good contact all the way around.

Valve seat angle	Factory spec.	IN.	1.047 rad 60 °
		EX.	0.785 rad 45 °

(1) Valve Seat Width
(2) Identical Dimensions

(A) Check Contact
(B) Correct Seat Width
(C) Check Contact
(a) 0.262 rad (15 °) or 0.523 rad (30 °)
(b) 0.785 rad (45 °) or 1.047 rad (60 °)
(c) 0.523 rad (30 °) or 0.262 rad (15 °)

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Free Length and Tilt of Valve Spring

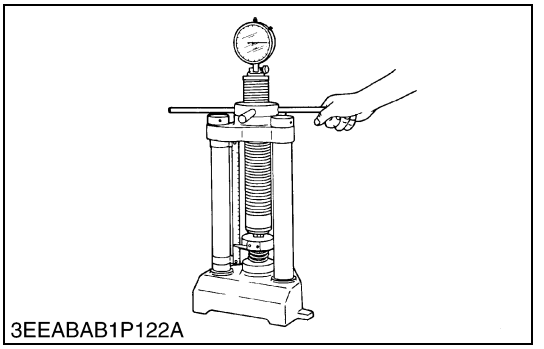
1. Measure the free length (**B**) with vernier calipers. If the measurement is less than the allowable limit, replace it.
2. Put the spring on a surface plate, place a square on the side of the spring, and check to see if the entire side is contact with the square. Rotate the spring and measure the maximum (**A**). If the measurement exceeds the allowable limit, replace.
3. Check the entire surface of the spring for scratches. Replace it, if any.

Tilt (**A**)	Allowable limit		1.0 mm 0.039 in.

Free length (**B**)	Factory spec.	Intake valve	35.1 to 35.6 mm 1.3819 to 1.4016 in.
		Exhaust valve	35.1 to 35.6 mm 1.3819 to 1.4016 in.
	Allowable limit	Intake valve	34.6 mm 1.3622 in.
		Exhaust valve	34.6 mm 1.3622 in.

(A) Tilt **(B) Free length**

W1063303

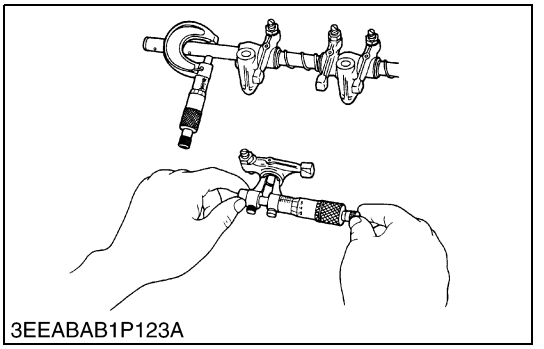

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Valve Spring Setting Load

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.	Intake valve	63.547 N / 31.5 mm 6.48 kgf / 31.5 mm 14.256 lbs / 1.2401 in.
		Exhaust valve	63.547 N / 31.5 mm 6.48 kgf / 31.5 mm 14.256 lbs / 1.2401 in.
	Allowable limit	Intake valve	45.864 N / 31.5 mm 4.68 kgf / 31.5 mm 10.296 lbs / 1.2401 in.
		Exhaust valve	45.864 N / 31.5 mm 4.68 kgf / 31.5 mm 10.296 lbs / 1.2401 in.

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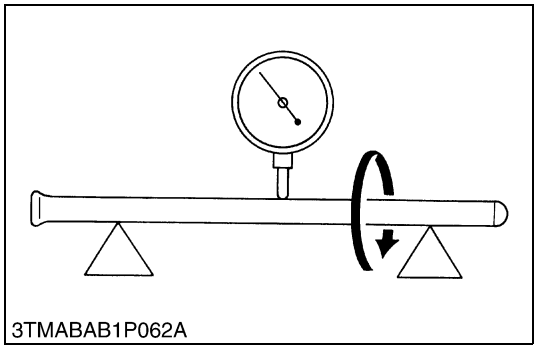
Oil Clearance between Rocker Arm Shaft and Bearing

1. Measure the rocker arm bearing I.D. with an inside micrometer.
2. Measure the rocker arm shaft O.D. with an outside micrometer, and then calculate the oil clearance.
3. If the 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 of rocker arm shaft and bearing	Factory spec.	0.016 to 0.045 mm 0.0006 to 0.0018 in.
	Allowable limit	0.15 mm 0.0059 in.

Rocker arm shaft O.D.	Factory spec.	15.973 to 15.984 mm 0.6289 to 0.6293 in.
Rocker arm I.D. for shaft	Factory spec.	16.000 to 16.018 mm 0.6299 to 0.6306 in.

W1063697

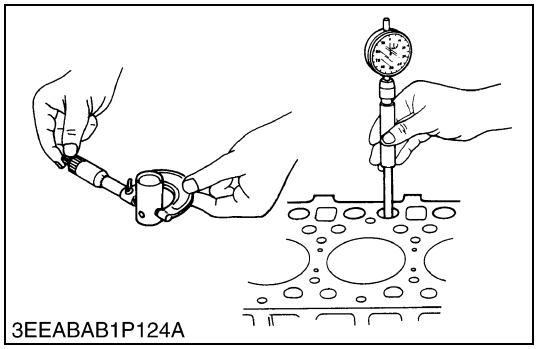

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Push Rod Alignment

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.

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Oil Clearance between Tappet and Tappet Guide Bore

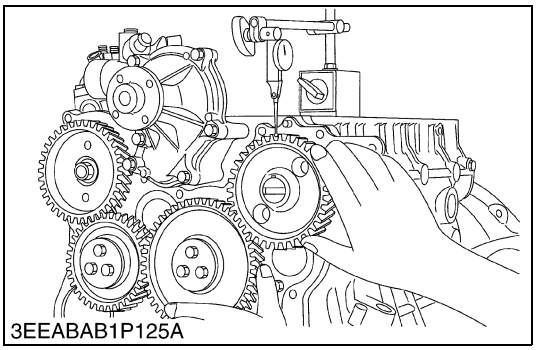
1. Measure the tappet O.D. with an outside micrometer.
2. Measure the I.D. of the tappet guide bore with a cylinder gauge, and calculate the oil clearance.
3. If the oil clearance exceeds the allowable limit or the tappet is damaged, replace the tappet.

Oil clearance between tappet and guide bore	Factory spec.	0.020 to 0.062 mm 0.0008 to 0.0024 in.
	Allowable limit	0.07 mm 0.0028 in.

Tappet O.D.	Factory spec.	23.959 to 23.980 mm 0.9433 to 0.9441 in.
Tappet guide bore I.D.	Factory spec.	24.000 to 24.021 mm 0.9449 to 0.9457 in.

W1063847

(2) Timing Gears

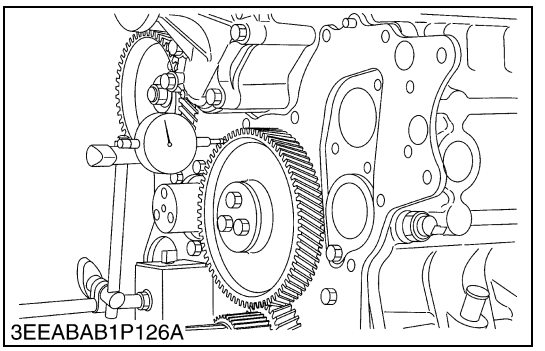

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Timing Gear Backlash

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 crank gear and idle gear 1	Factory spec.	0.049 to 0.193 mm 0.0019 to 0.0076 in.
	Allowable limit	0.22 mm 0.0087 in.
Backlash between idle gear 1 and cam gear	Factory spec.	0.049 to 0.189 mm 0.0019 to 0.0074 in.
	Allowable limit	0.22 mm 0.0087 in.
Backlash between idle gear 1 and idle gear 2	Factory spec.	0.044 to 0.185 mm 0.0017 to 0.0073 in.
	Allowable limit	0.22 mm 0.0087 in.
Backlash between idle gear 2 and injection pump gear	Factory spec.	0.044 to 0.177 mm 0.0017 to 0.0070 in.
	Allowable limit	0.22 mm 0.0087 in.
Backlash between cam gear and balancer gear 1	Factory spec.	0.047 to 0.182 mm 0.0018 to 0.0072 in.
	Allowable limit	0.22 mm 0.0087 in.
Backlash between idle gear 1 and balancer gear 2	Factory spec.	0.044 to 0.183 mm 0.0017 to 0.0072 in.
	Allowable limit	0.22 mm 0.0087 in.

W1064048

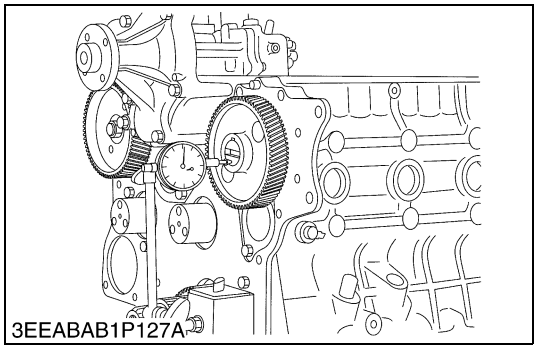

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Idle Gear Side Clearance

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.	0.15 to 0.30 mm 0.0059 to 0.0118 in.
	Allowable limit	0.9 mm 0.0354 in.

W1064208

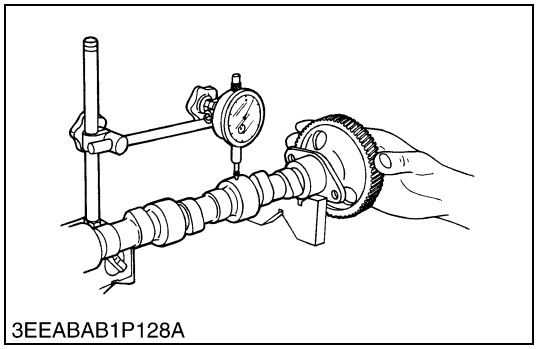

3EEABAB1P127A

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 and rear.
3. If the measurement exceeds the allowable limit, replace the camshaft stopper.

Side clearance	Factory spec.	0.07 to 0.22 mm 0.0028 to 0.0087 in.
	Allowable limit	0.30 mm 0.0118 in.

W1064307

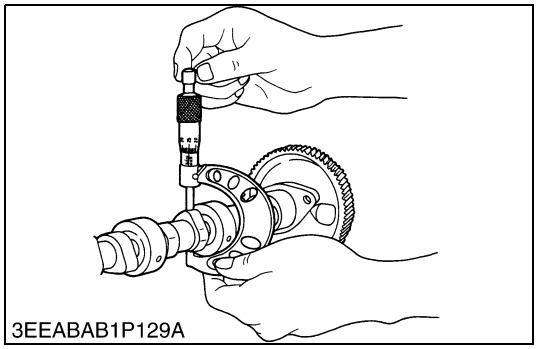

3EEABAB1P128A

Camshaft Alignment

1. Support the camshaft with V block on the surface plate and set a dial indicator with its tip on the intermediate journal at right angle.
2. Rotate the camshaft on the V blocks and get the misalignment (half of the measurement).
3. If the misalignment exceeds the allowable limit, replace the camshaft.

Camshaft alignment	Allowable limit	0.01 mm 0.00039 in.

W1064422

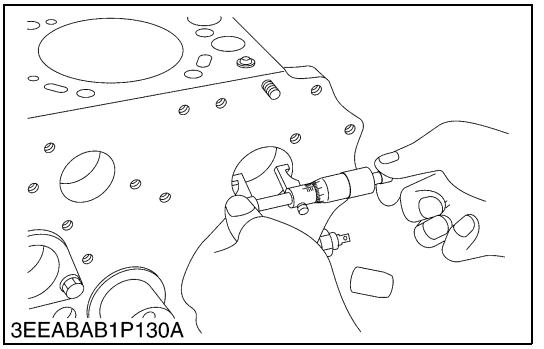

3EEABAB1P129A

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.

Intake and exhaust cam height	Factory spec.	Intake valve	37.63 mm 1.4815 in.
		Exhaust valve	38.96 mm 1.5338 in.
	Allowable limit	Intake valve	37.13 mm 1.4618 in.
		Exhaust valve	38.46 mm 1.5141 in.

W1064551


3EEABAB1P130A

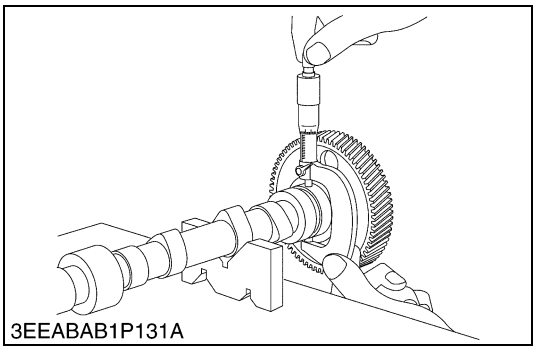
Oil Clearance of Camshaft Journal

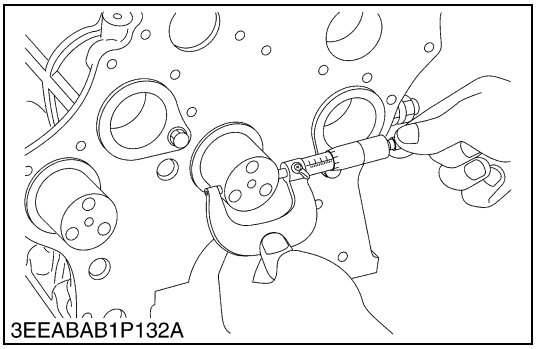
1. Measure the camshaft journal O.D. with an outside micrometer.
2. Measure the cylinder block bore I.D. for camshaft with an inside micrometer.
3. If the clearance exceeds the allowable limit, replace the camshaft.

Oil clearance of camshaft journal	Factory spec.	0.050 to 0.091 mm 0.0020 to 0.0036 in.
	Allowable limit	0.15 mm 0.0059 in.

Camshaft journal O.D.	Factory spec.	45.934 to 45.950 mm 1.8084 to 1.8091 in.
Camshaft bearing I.D.	Factory spec.	46.000 to 46.025 mm 1.8110 to 1.8120 in.

W1064798


3EEABAB1P131A


3EEABAB1P132A

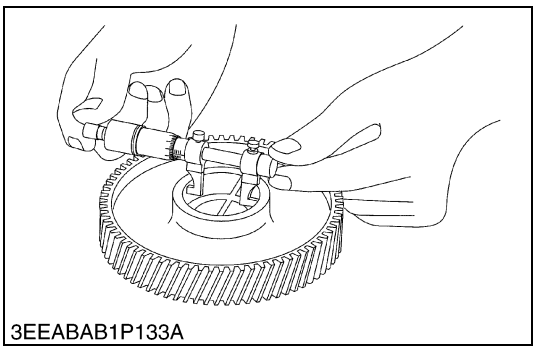
Oil Clearance between Idle Gear Shaft 1, 2 and Idle Gear 1, 2 Bushing

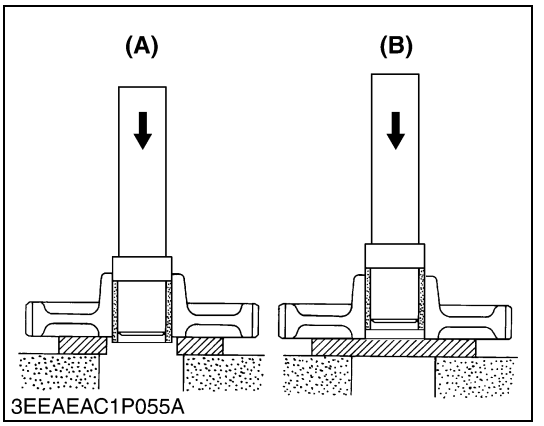
1. Measure the idle gear shaft O.D. with an outside micrometer.
2. Measure the idle gear bushings I.D. with an inside micrometer, and calculate the oil clearance.
3. If the oil clearance exceeds the allowable limit, replace the bushing.

Oil clearance between idle gear 1, 2 shaft and idle gear 1, 2 bushing	Factory spec.	0.050 to 0.091 mm 0.0020 to 0.0036 in.
	Allowable limit	0.10 mm 0.0039 in.

Idle gear 1, 2 bushing I.D.	Factory spec.	45.025 to 45.050 mm 1.7726 to 1.7736 in.
Idle gear 1, 2 shaft O.D.	Factory spec.	44.959 to 44.975 mm 1.7700 to 1.7707 in.

W1064968


3EEABAB1P133A



3EEAEAC1P055A

Replacing Idle Gear Bushing

(When removing)

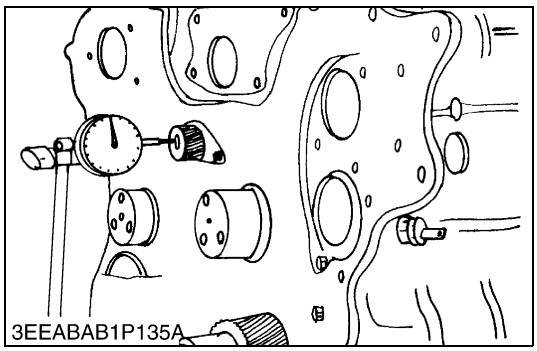
1. Using an idle gear bushing replacing tool, press out the used bushing.

(When installing)

1. Clean a new idle gear bushing and idle gear bore, and apply engine oil to them.
2. Using an idle gear bushing replacing tool, press in a new bushing (service parts) to the specified dimension. (See figure.)

(A) When Removing **(B) When Installing**

W10302410

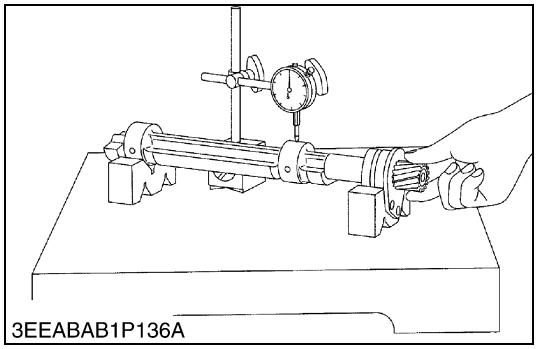

3EEABAB1P135A

Balancer Shaft Side Clearance

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.

Side clearance	Factory spec.	0.070 to 0.22 mm 0.0028 to 0.0087 in.
	Allowable limit	0.3 mm 0.0118 in.

W1065273

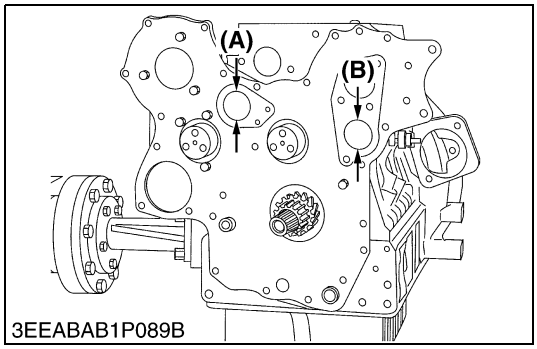

3EEABAB1P136A

Balance Shaft Alignment

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.

W1065448



3EEABAB1P089B

Oil Clearance of Balancer Shaft Journal

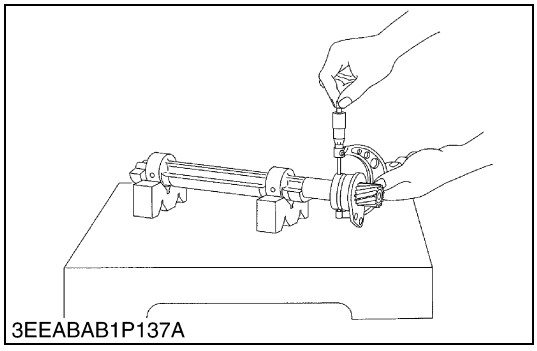
1. Measure the balancer shaft journal O.D. with an outside micrometer.
2. Measure the cylinder block bore I.D. **(A)**, **(B)** for balancer shaft with an inside micrometer.
3. If the clearance exceeds the allowable limit, replace the balancer shaft.

Oil clearance of balancer-shaft journal	Factory spec.	0.070 to 0.159 mm 0.0028 to 0.0063 in.
	Allowable limit	0.2 mm 0.0079 in.

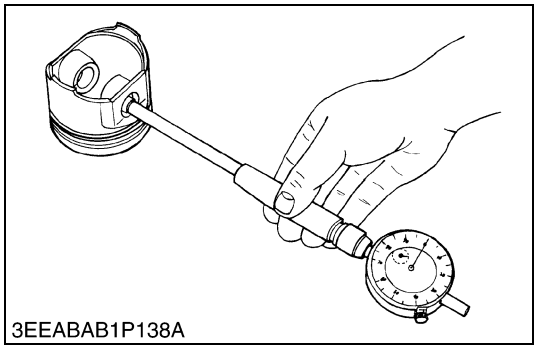
Balancer-shaft journal O.D.	Factory spec.	50.92 to 50.94 mm 2.0047 to 2.0055 in.
Balancer-shaft bearing I.D. **(A), (B)**	Factory spec.	51.01 to 51.08 mm 2.0083 to 2.0110 in.

(A) Balancer-shaft Bearing I.D. **(B) Balancer-shaft Bearing I.D.**

W1065581


3EEABAB1P137A

(3) Piston and Connecting Rod

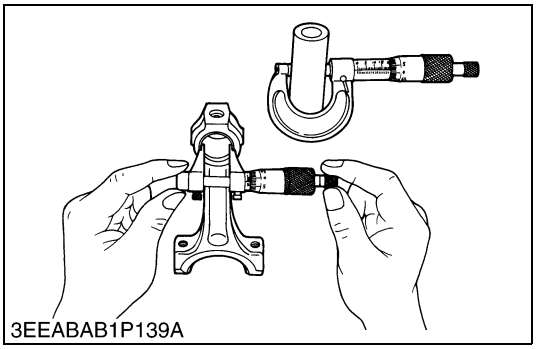

3EEABAB1P138A

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.	30.000 to 30.013 mm 1.1811 to 1.1816 in.
	Allowable limit	30.05 mm 1.1831 in.

W1065759


3EEABAB1P139A

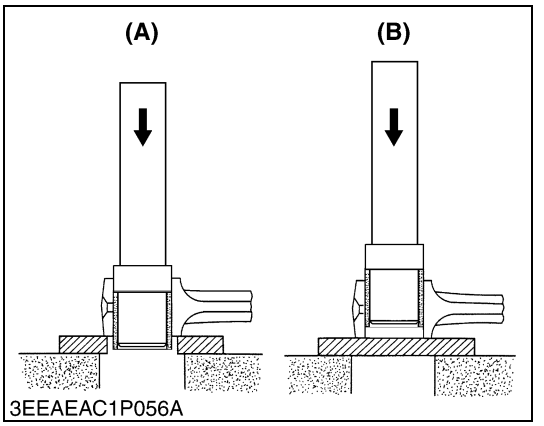
Oil Clearance between Piston Pin and Small End Bushing

1. Measure the O.D. of the piston pin where it contacts the bushing with an outside micrometer.
2. Measure the I.D. of the piston pin bushing at the connecting rod small end with a cylinder gauge.
   Calculate the oil clearance.
3. If the 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.	0.020 to 0.040 mm 0.0008 to 0.0016 in.
	Allowable limit	0.15 mm 0.0059 in.

Piston pin O.D.	Factory spec.	30.006 to 30.011 mm 1.1813 to 1.1815 in.
Small end bushing I.D.	Factory spec.	30.031 to 30.046 mm 1.1823 to 1.1829 in.

W1065897



3EEAEAC1P056A

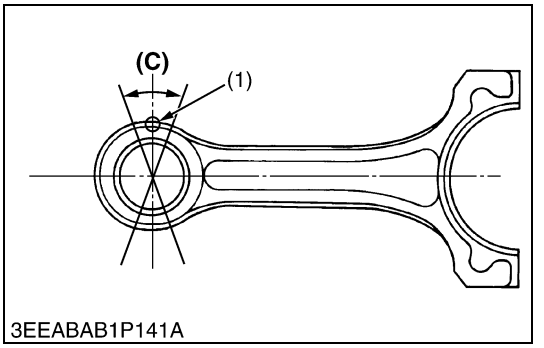
Replacing Small End Bushing

(When removing)

1. Press out the used bushing using a small end bushing replacing tool.

(When installing)

1. Clean a new small end bushing and bore, and apply engine oil to them.
2. Insert a new bushing onto the tool and press-fit it with a press so that the seam (1) of bushing position as shown in the figure, until is flash with the connecting rod.

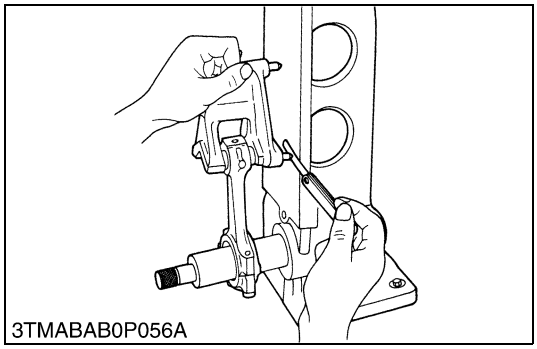


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(1) Seam

(A) When Removing
(B) When Installing
(C) 0.26 rad (15 °)

W1066057


3TMABAB0P056A

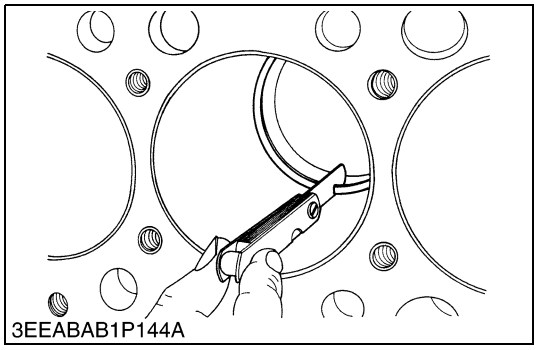
Connecting Rod Alignment

- **NOTE**
- **Since the I.D. of the connecting rod small end bushing is the basis of this check, check the bushing for wear beforehand.**

1. Remove the piston pin from the piston.
2. Install the piston pin in the connecting rod.
3. Install the connecting rod on the connecting rod alignment tool.
4. Put a gauge over the piston pin, and move it against the face plate.
5. If the gauge does not fit squarely against the face plate, measure the space between the pin of the gauge and the face plate.
6. If the measurement exceeds the allowable limit, replace the connecting rod.

Connecting rod alignment	Allowable limit	0.05 mm 0.0020 in.

W1066581


3EEABAB1P144A

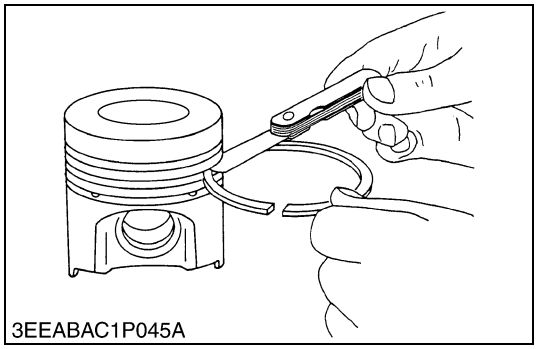
Piston Ring Gap

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 piston ring.

Top ring and second ring	Factory spec.	0.30 to 0.45 mm 0.0118 to 0.0177 in.
	Allowable limit	1.25 mm 0.0492 in.

Oil ring	Factory spec.	0.25 to 0.45 mm 0.0098 to 0.0177 in.
	Allowable limit	1.25 mm 0.0492 in.

W1066430


3EEABAC1P045A

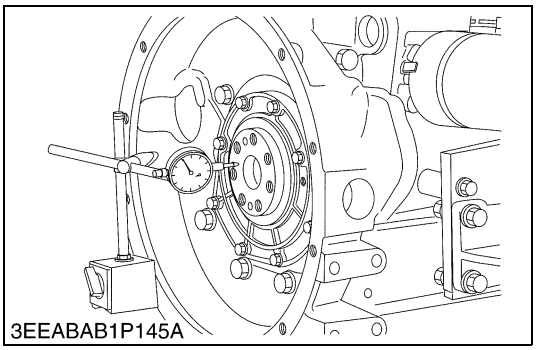
Clearance between Piston Ring and Groove

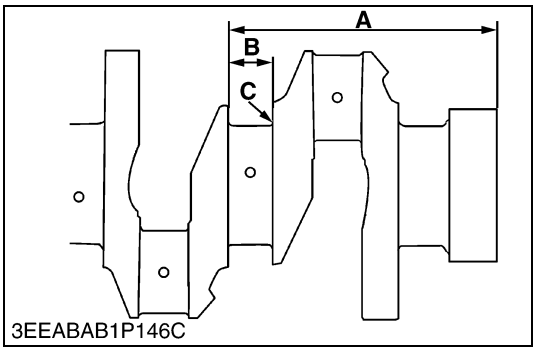
1. Remove carbon from the ring grooves.
2. Measure the clearance between the ring and the groove with a feeler gauge or depth gauge.
3. If the clearance exceeds allowable limit, check the new ring since compression leak and oil shortage result.
4. If clearance still exceeds the allowable limit after replacing the ring, replace the piston.

Factory spec.	Top ring	0.05 to 0.09 mm 0.0020 to 0.0035 in.
	Second ring	0.093 to 0.120 mm 0.0037 to 0.0047 in.
	Oil ring	0.020 to 0.060 mm 0.0008 to 0.0023 in.
Allowable limit	Top ring	0.15 mm 0.0059 in.
	Second ring	0.20 mm 0.0079 in.
	Oil ring	0.15 mm 0.0059 in.

W1066183

(4) Crankshaft


3EEABAB1P145A



3EEABAB1P146C

Crankshaft Side Clearance

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.

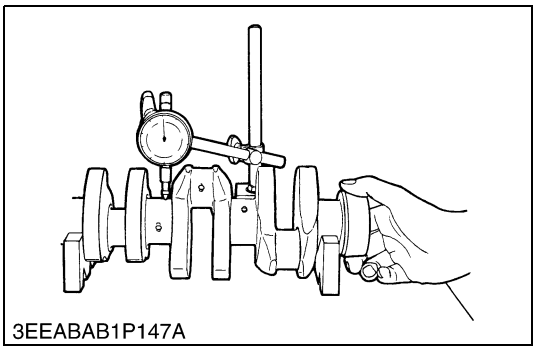
Crankshaft side clearance	Factory spec.	0.15 to 0.31 mm 0.0059 to 0.0122 in.
	Allowable limit	0.50 mm 0.0197 in.

(Reference)

- Oversize dimensions of crankshaft journal.

Oversize	0.2 mm 0.008 in.	0.4 mm 0.016 in.
Dimension **A**	169.1 to 169.15 mm 6.6575 to 6.6594 in.	169.2 to 169.25 mm 6.6614 to 6.6634 in.
Dimension **B**	29.20 to 29.25 mm 1.1496 to 1.1515 in.	29.40 to 29.45 mm 1.1574 to 1.1594 in.
Dimension **C**	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius
The crankshaft journal must be fine-finished to higher than ∇∇∇∇. (0.8S)		

W1066738

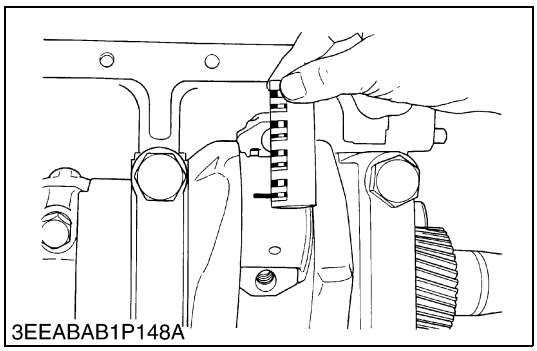

3EEABAB1P147A

Crankshaft Alignment

1. Support the crankshaft with V block on the surface plate and set a dial indicator with its tip on the intermediate journal at right angle.
2. Rotate the crankshaft on the V block and get the misalignment (half of the measurement).
3. If the misalignment exceeds the allowable limit, replace the crankshaft.

Crankshaft alignment	Allowable limit	0.02 mm 0.00079 in.

W1067285


3EEABAB1P148A

Oil Clearance between Crankpin and Crankpin Bearing

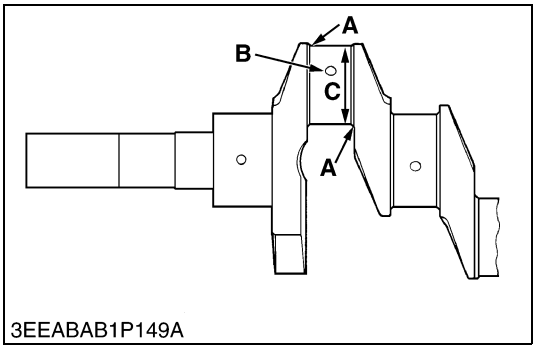
1. Clean the crankpin and crankpin bearing.
2. Put a strip of plastigage on the center of the crankpin.
3. Install the connecting rod cap and tighten the connecting rod screws to the specified torque, and remove the cap again.
4. Measure the amount of the flattening with the scale, and get the oil clearance.
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.**

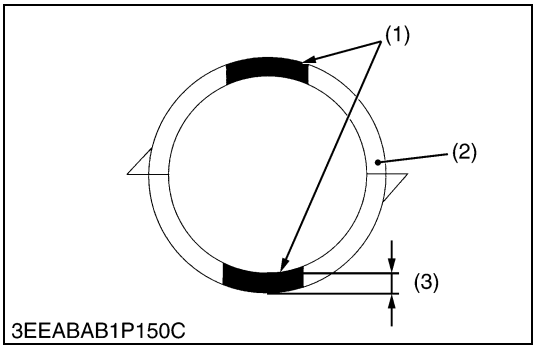
Crankpin O.D.	Factory spec.	52.977 to 52.990 mm 2.0857 to 2.0862 in.

Oil clearance between crankpin and crankpin bearing	Factory spec.	0.018 to 0.051 mm 0.0007 to 0.0020 in.
	Allowable limit	0.20 mm 0.0079 in.

W1067389



3EEABAB1P149A



3EEABAB1P150C

Oil Clearance between Crankpin and Crankpin Bearing (Continued)

■ **IMPORTANT**

- **STD size crankpin bearing.**
  To replace it with a specific STD service part, make sure the crankpin bearing has the same ID color as the connecting rod.

ID Color	Connecting rod	Crankpin bearing		
	Large-end in. dia.	Class	Part code	Center wall thick
Blue	56.01 to 56.02 mm 2.2051 to 2.2055 in.	L	1C020-22311	1.496 to 1.501 mm 0.0589 to 0.0591 in.
Without color	56.00 to 56.01 mm 2.2047 to 2.2051 in.	S	1C020-22331	1.491 to 1.496 mm 0.0587 to 0.0589 in.

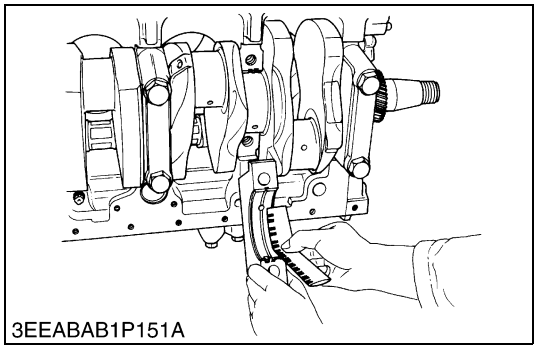
(Reference)

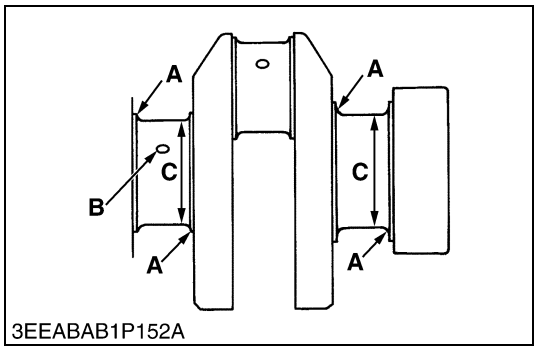
- Undersize dimensions of crankpin

Undersize	0.2 mm 0.008 in.	0.4 mm 0.016 in.
Dimension **A**	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius
*Dimension **B**	1.0 to 1.5 mm relief 0.0394 to 0.0591 in. relief	1.0 to 1.5 mm relief 0.0394 to 0.0591 in. relief
Dimension **C**	52.777 to 52.790 mm dia. 2.0778 to 2.0783 in. dia.	52.577 to 52.590 mm dia. 2.0700 to 2.0705 in. dia.
(0.8S) The crankpin must be fine-finished to higher than ∇∇∇∇. *Holes to be de-burred and edges rounded with 1.0 to 1.5 mm (0.0394 to 0.0591 in.) relief.		

(1) ID Color
(2) Crankpin Bearing
(3) Center Wall Thick

W1067741


3EEABAB1P151A



3EEABAB1P152A

Oil Clearance between Crankshaft Journal and Crankshaft Bearing

1. Clean the crankshaft journal and crankshaft bearing.
2. Put a strip of press gauge on the center of the journal.
- **IMPORTANT**
- **Never insert the press gauge into the oil hole of the journal.**
3. Install the main bearing case and tighten the screws to the specified torque, and remove the cases again.
4. Measure the amount of the flattening with the scale and get the oil clearance.
5. If the clearance exceeds the allowable limit, replace the crankshaft bearing.

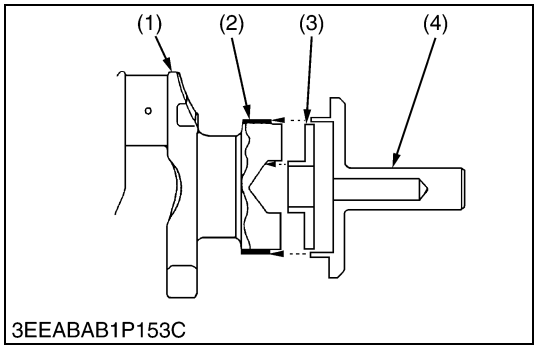
Crankshaft journal O.D.	Factory spec.	74.977 to 74.990 mm 2.9518 to 2.9524 in.

Oil clearance between crankshaft journal and crankshaft bearing	Factory spec.	0.018 to 0.062 mm 0.0007 to 0.0024 in.
	Allowable limit	0.20 mm 0.0079 in.

(Reference)
- Undersize dimensions of crankshaft journal.

Undersize	0.2 mm 0.008 in.	0.4 mm 0.016 in.
Dimension **A**	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius
*Dimension **B**	1.0 to 1.5 mm relief 0.0394 to 0.0591 in. relief	1.0 to 1.5 mm relief 0.0394 to 0.0591 in. relief
Dimension **C**	74.777 to 74.790 mm dia. 2.9440 to 2.9445 in. dia.	74.577 to 74.590 mm dia. 2.9361 to 2.9366 in. dia.
(0.8S) 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 (0.0394 to 0.0591 in.) relief.		

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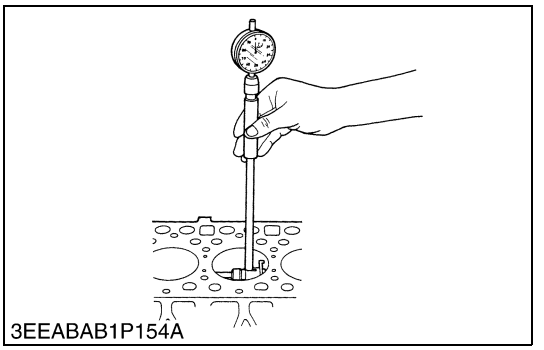
Replacing Crankshaft Sleeve

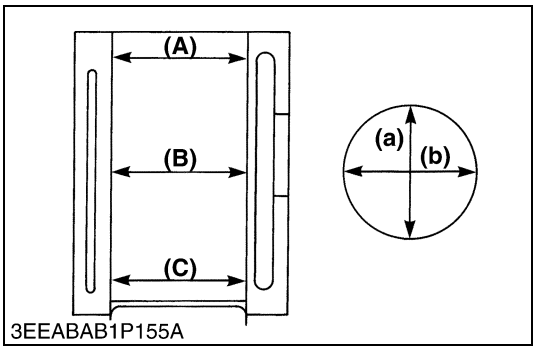
1. Remove the used crankshaft sleeve (2).
2. Set the sleeve guide (3) to the crankshaft (1).
3. Heat a new sleeve to a temperature between 150 to 200 <Symbol>×C (302 to 392 <Symbol>×F), and fix the sleeve to the crankshaft as shown in figure.
4. Press fit the sleeve using the auxiliary socket for pushing (4).
- **NOTE**
- **Mount the sleeve with its largely chamfered surface facing outward.**

(1) Crankshaft
(2) Crankshaft Sleeve
(3) Sleeve Guide
(4) Auxiliary Socket for Pushing

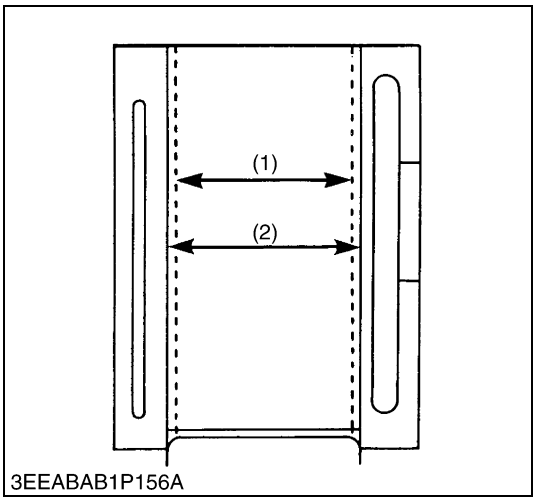
W1069911

(5) Cylinder


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3EEABAB1P155A



3EEABAB1P156A

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 Bore I.D.	Factory spec.	100.00 to 100.022 mm 3.9370 to 3.9379 in.
	Allowable limit	100.15 mm 3.9429 in.

(A) Top
(B) Middle
(C) Bottom (Skirt)
(a) Right-angled to piston pin
(b) Piston pin direction

W1070089

Correcting Cylinder (Oversize)

1. When the cylinder is worn beyond the allowable limit, bore and hone it to the specified dimension.

Cylinder I.D. (2)	Factory spec.	100.500 to 100.522 mm 3.9567 to 3.9576 in.
Maximum wear	Allowable limit	100.65 mm 3.9626 in.
Finishing	Hone to 1.2 to 3.0 μm Rz (0.000087 to 0.00012 in. Rz) ∇∇∇.	

2. Replace the piston and piston rings with oversize 0.5 mm (0.0197 in.) ones.

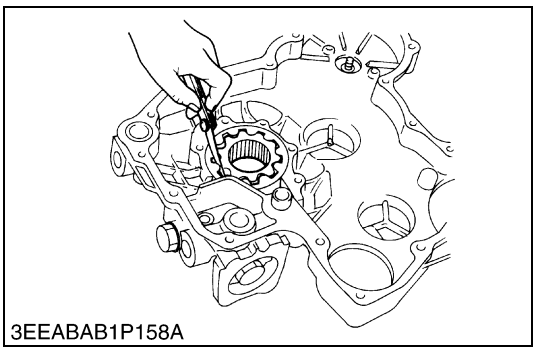
■ **NOTE**

- **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) Oversize Cylinder I.D.

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(6) Oil Pump

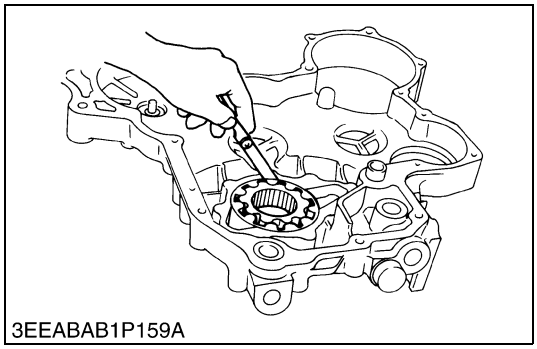

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Rotor Lobe Clearance

1. Measure the clearance between lobes of the inner rotor and the outer rotor with a feeler gauge.
2. If the clearance exceeds the allowable limit, replace the oil pump rotor assembly.

Clearance between inner rotor and outer rotor	Factory spec.	0.04 to 0.16 mm 0.0016 to 0.0063 in.
	Allowable limit	0.3 mm 0.0118 in.

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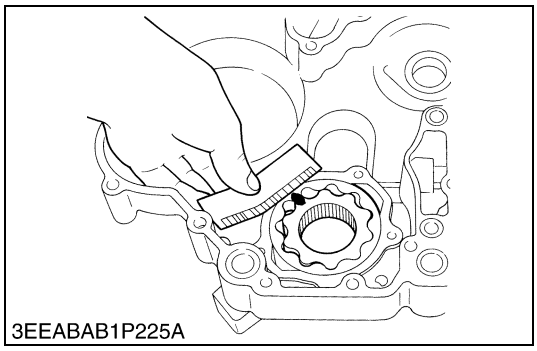

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Clearance between Outer Rotor and Pump Body

1. Measure the clearance between the outer rotor and the pump body with a feeler gauge.
2. If the clearance exceeds the allowable limit, replace the oil pump rotor assembly.

Clearance between outer rotor and pump body	Factory spec.	0.100 to 0.184 mm 0.0039 to 0.0072 in.
	Allowable limit	0.3 mm 0.0118 in.

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Clearance between Rotor and Cover

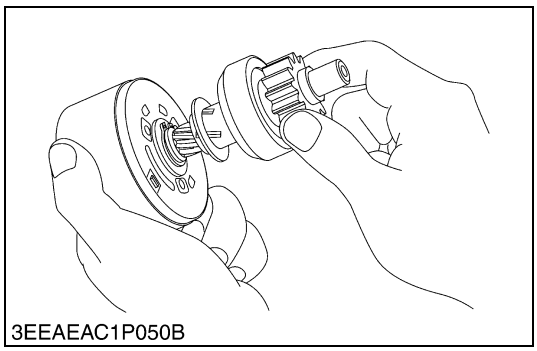
1. Put a strip of plastigage onto the rotor face with grease.
2. Install the cover and tighten the screws with the specified torque.
3. Remove the cover carefully, and measure the amount of the flattening with the scale and get the clearance.
4. If the clearance exceeds the allowable limit, replace oil pump rotor assembly and the cover.

Clearance between rotor and cover	Factory spec.	0.025 to 0.075 mm 0.0010 to 0.0030 in.
	Allowable limit	0.225 mm 0.0089 in.

Tightening torque	Oil pump cover screw	7.9 to 9.3 N·m 0.80 to 0.95 kgf·m 5.8 to 6.9 ft-lbs

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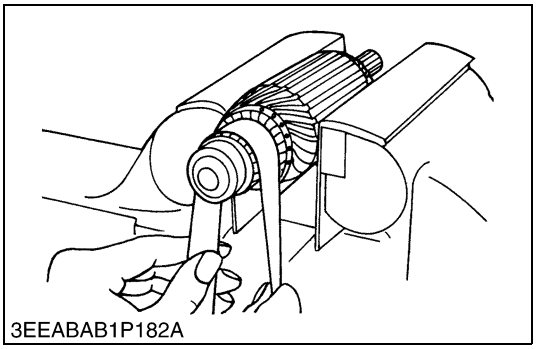
(7) Starter

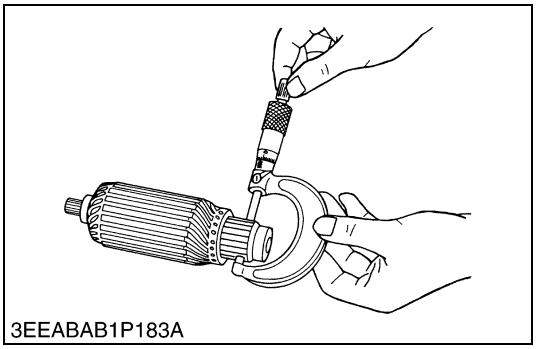

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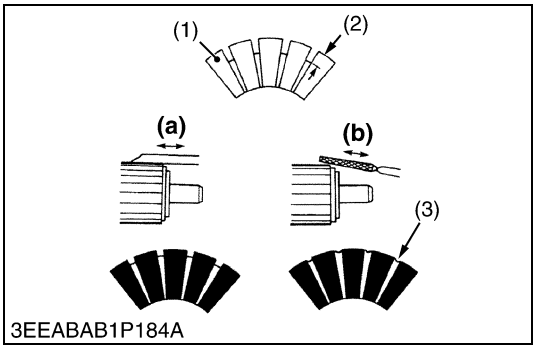
Overrunning Clutch

1. Inspect the pinion for wear or damage.
2. If there is any defect, replace the overrunning clutch assembly.
3. Check that the pinion turns freely and smoothly in the overrunning direction and does not slip in the cranking direction.
4. If the pinion slips or does not rotate in the both directions, replace the overrunning clutch assembly.

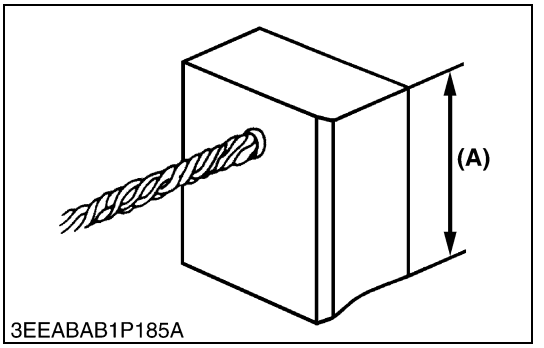
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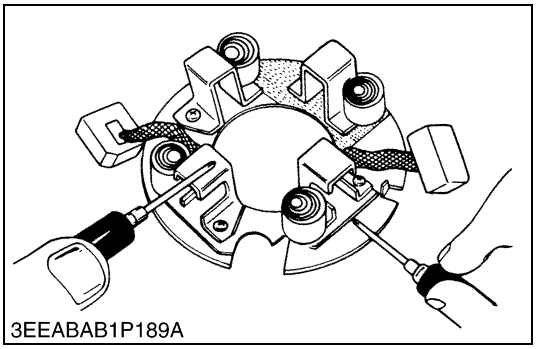

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3EEABAB1P184A



3EEABAB1P185A


3EEABAB1P189A

Commutator and Mica

1. Check the contact face 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 if with a saw blade and chamfer the segment edges.

Commutator O.D.	Factory spec.	32 mm 1.2598 in.
	Allowable limit	31.4 mm 1.2362 in.

Mica under cut	Factory spec.	0.5 mm 0.0197 in.
	Allowable limit	0.20 mm 0.0079 in.

(1) Segment
(2) Depth of Mica
(3) Mica

(a) Good
(b) Bad

W1075277

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 calipers.
3. If the length is less than the allowable limit, replace the yoke assembly and brush holder.

Brush length **(A)**	Factory spec.	18.0 mm 0.7086 in.
	Allowable limit	11.0 mm 0.4331 in.

(A) Brush Length

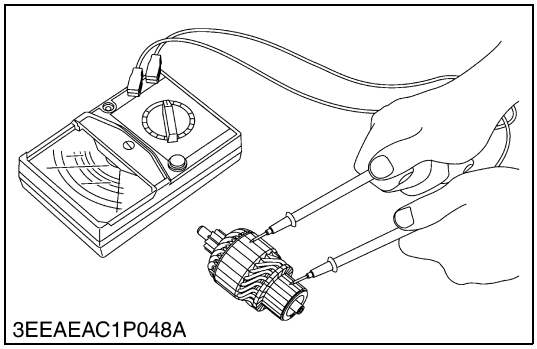
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Brush Holder

1. Check the continuity across the brush holder and the holder support with an ohmmeter.
2. If it conducts, replace the brush holder.

Resistance	Brush holder – Holder support	Infinity

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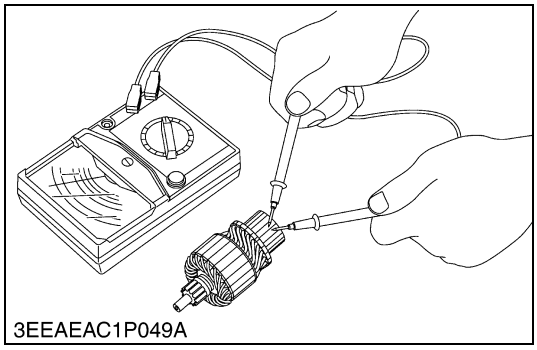

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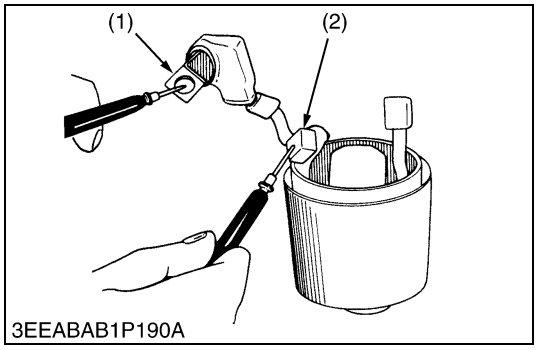
Armature Coil

1. Check the continuity across the commutator and armature coil core with an ohmmeter.
2. If it conducts, replace the armature.
3. Check the continuity across the segments of the commutator with an ohmmeter.
4. If it does not conduct, replace the armature.

Resistance	Commutator – Armature coil core	Infinity
	Commutator segment	0 Ω

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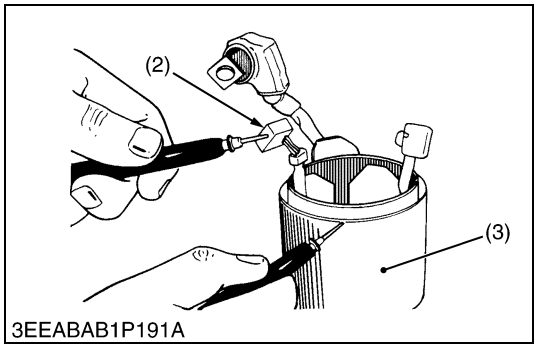
Field Coil

1. Check the continuity across the lead (1) and brush (2) with an ohmmeter.
2. If it does not conduct, replace the yoke assembly.
3. Check the continuity across the brush (2) and yoke (3) with an ohmmeter.
4. If it conducts, replace the yoke assembly.

Resistance	Lead (1) – Brush (2)	0 Ω
	Brush (2) – Yoke (3)	Infinity

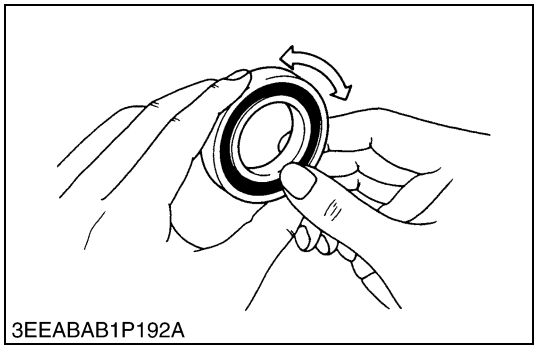
(1) Lead
(2) Brush
(3) Yoke

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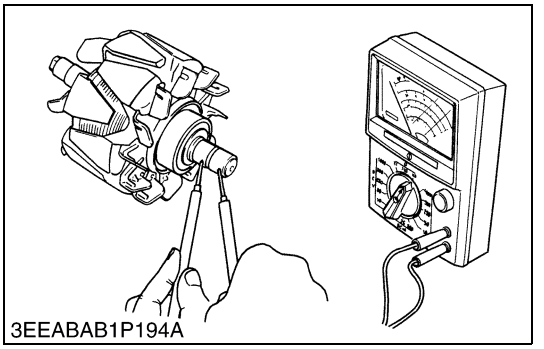
(8) Alternator


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Bearing

1. Check the bearing for smooth rotation.
2. If it does not rotate smoothly, replace it.

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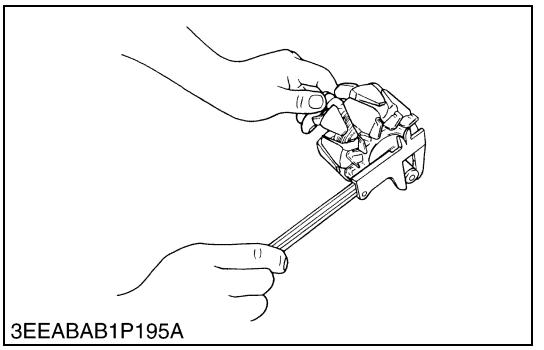

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Rotor

1. Measure the resistance across the slip rings with an ohmmeter.
2. If the resistance is not the factory specification, replace it.
3. Check the continuity across the slip and core with an ohmmeter.
4. If infinity is not indicated, replace it.

Resistance	Factory spec.	2.8 to 3.3 Ω

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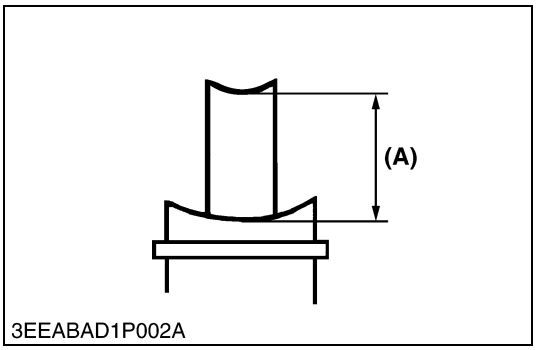

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Slip Ring

1. Check the slip ring for score.
2. If scored, correct with an sand 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.	22.7 mm 0.894 in.
	Allowable limit	22.1 mm 0.870 in.

W1076592



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Brush Wear

1. Measure the brush length **(A)** 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 **(A)**	Factory spec.	18.5 mm 0.728 in.
	Allowable limit	5.0 mm 0.197 in.

(A) Brush Length

W1076714

IV. Hydraulic system

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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

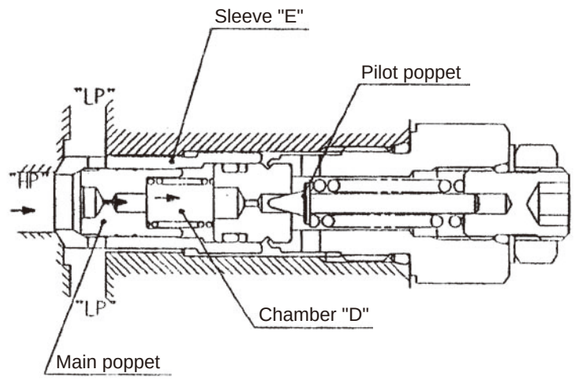
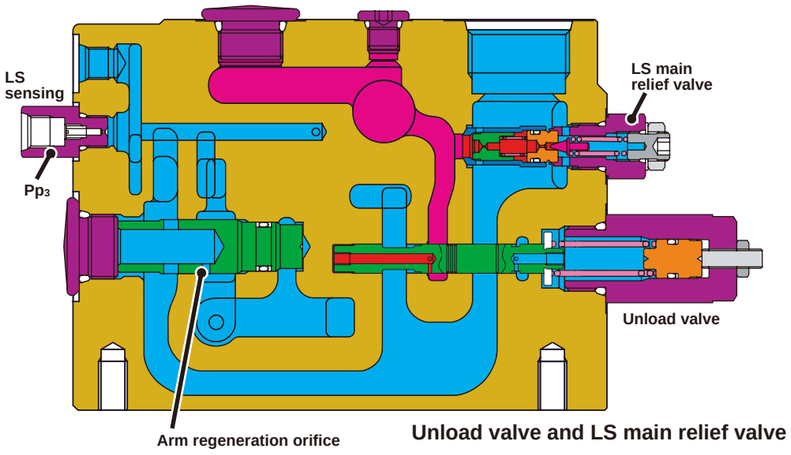
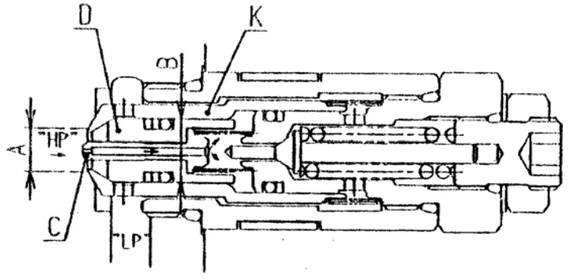


Fig. 2 Unload valve



Unload valve and LS main relief valve

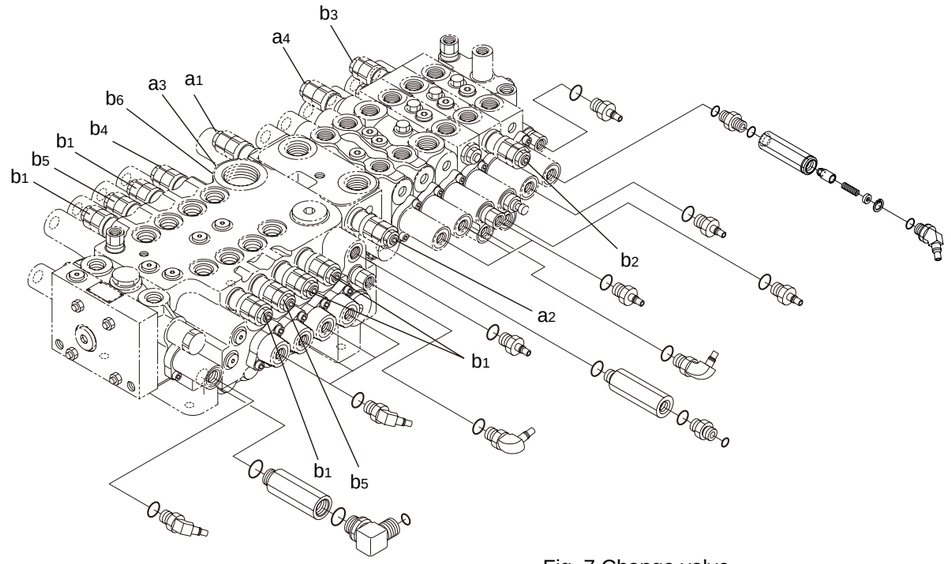
Fig. 3 Overload relief valve



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 pilot valve malfunctions.	1) Check the function of pilot valve.	
		2) Dozer: The dozer pilot valve malfunctions.	1) Check the function of pilot valve.	
		3) Service port: The service port solenoid valve malfunctions.	1) Check the solenoid valve.	
		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 high pressure selector valve.		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) High pressure selector valve is sticking. All of downstream sections pressure became low.	1) Check the corresponding high pressure selector valve.	
6	The speed of the arm crowd and boom lowering section is too low.	This problem arises when the pilot valve types 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 high pressure selector valve has got stuck. A high pressure selector 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 2) Travel independence valve spool sticks.	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) Stick 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

Fig. 4 Relief valve layout



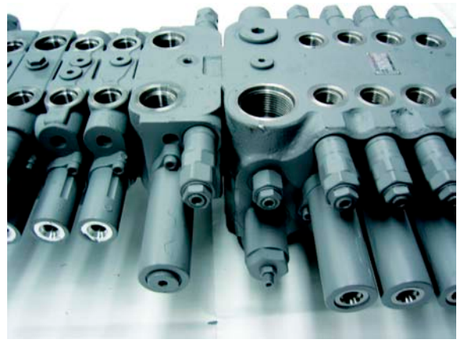


Fig. 6 Pilot filter



Fig. 7 Change valve

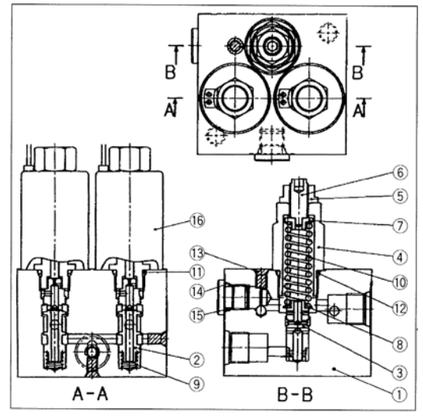
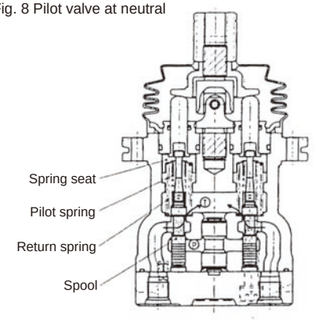


Fig. 8 Pilot valve at neutral



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 high pressure relief valve.	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 high pressure relief 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 shigh pressure relief valve.	1)Disassemble, clean and reset.	
		5) The traveling lever does not full-stroke shift.	1) Check the travel pilot valve.	
		6) Pump volumetric efficiency decreased.	1) Test pump efficiency and replace if needed.	

Fig. 9 Pilot valve, tilted

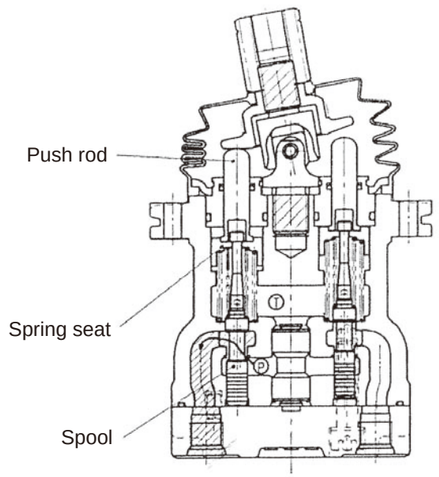


Fig. 10 Control valve

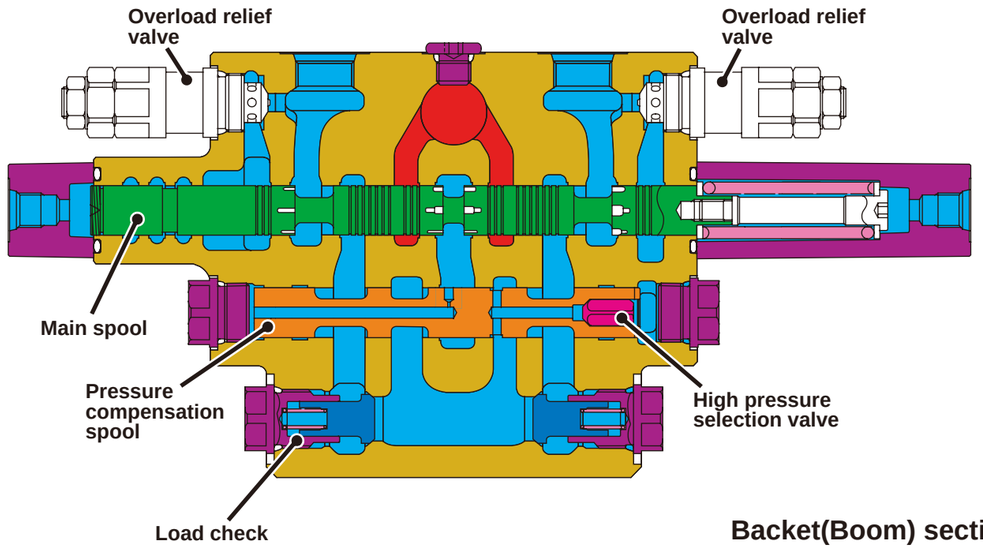
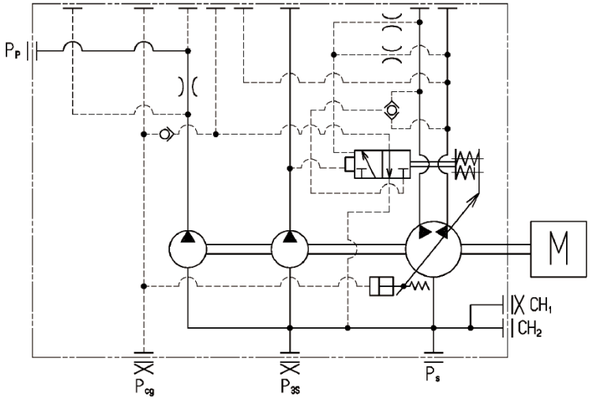
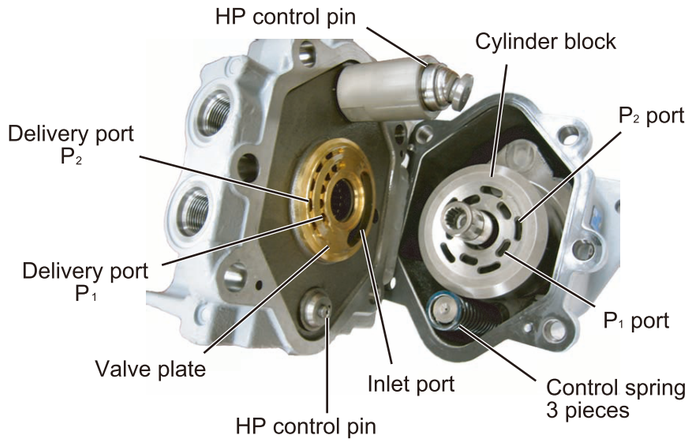


Fig. 11 Pressure compensation spool



Backet(Boom) section

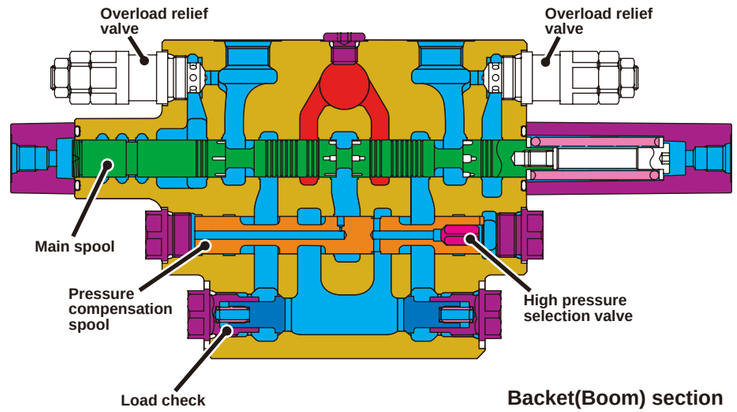
Fig. 13 Pump control

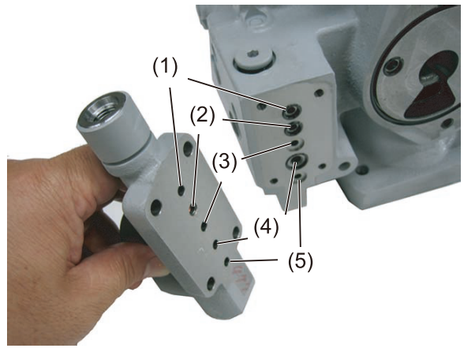


c. Case - Study : Poor Manipulation and Abnormal Operation

	Problems	Probable causes	Remedies	Ref.Fig.
1	The engine stalls at the rated rpm when a load (traveling, etc.) is imposed.	1) The 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 (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 holding 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. 12 High pressure selection valve





(1) Pump pressure sensing line
(2) HPC pilot line
(3) HPC pilot line
(4) Pilot pump pressur after the fixed orifice
(5) Pilot pump pressur before the fixed orifice

Fig. 14 Horse power control setting

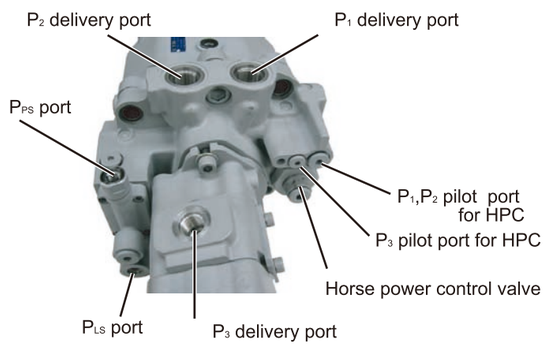
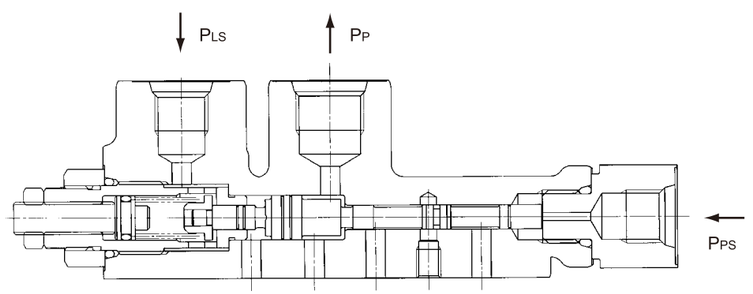


Fig. 15 LS control valve



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	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.	
10	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	
11	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.	
12	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.	
13	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.	

d. LS control system troubleshooting

(1) General

The core of the hydraulic system corprated in KX080-3 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.

- 1) Pilot control system
  - Pilot pump
  - Change valve(Unload valve)
  - Pilot valve, L&R
  - Pilot filter
- 2) Control valve
  - High pressure selector popet
  - Compensation spool
  - Relief valve(Main, overload)
  - Unload valve
- 3) Pump
  - LS regurator
  - Horse power control pin, spool
  - Control pin
- 4)Actuators
  - Cylinders
  - Swivel motor
  - Travel motor(Rotary joint)

(2) Procedures for Hydraulic Pilot System Troubleshooting

- 1) All the hydraulic pilot sections are inoperative.
  - Change valve(Unload valve)
  - Pilot filter
- 2) All the right or left pilot sections are inoperative.
  - Pilot valve
- 3) Any one hydraulic pilot system is inoperative. (Both A and B ports)
  - Stick of the control spool in the neutral position
  - Stick of the relevant spool of the pilot valve (The case where both A and B are abnormal is rare.)
- 4) Either A or B in any one hydraulic pilot section is inoperative.
  - Stick of the relevant spool of the pilot valve
  - Stick of the control valve spool on one side

(3) Procedures for LS Control Valve Troubleshooting

In the event of hydraulic trouble with the LS controller for KX080-3, 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

Make a check if the unload pressure is not built up at the maximum rpm under no load with the valve placed in the neutral position.

KX080-3: Max. engine KPM=27 kgf/cm^2 (2.65 MPa, 384 psi)
Idle RPM=23 kgf/cm^2, 2.25 MPa, 327 psi
(Check the pump discharge quantity.)

2) Main relief valve

Make a check if the main relief pressure is not built up.

KX080-3: 285 kgf/cm^2, 27.9 MPa, 4047 psi
If any one actuator is relieved, the main relief pressure is built up.
(For the dozer UP only, however, there is a 135 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) High pressure selector valve

1. If the high pressure selector valve does not move normally due to a stick, its own high pressure leaks from the 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 high pressure selector valve.
3. The sections upstream from the section of the defective high pressure selector valve work normally.
4. If the section of the defective high pressure selector 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 high pressure selector valve gets stuck, the same phenomena occur in both the A and B ports.

5) Compensation spool

1. The compensation spool moves 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.

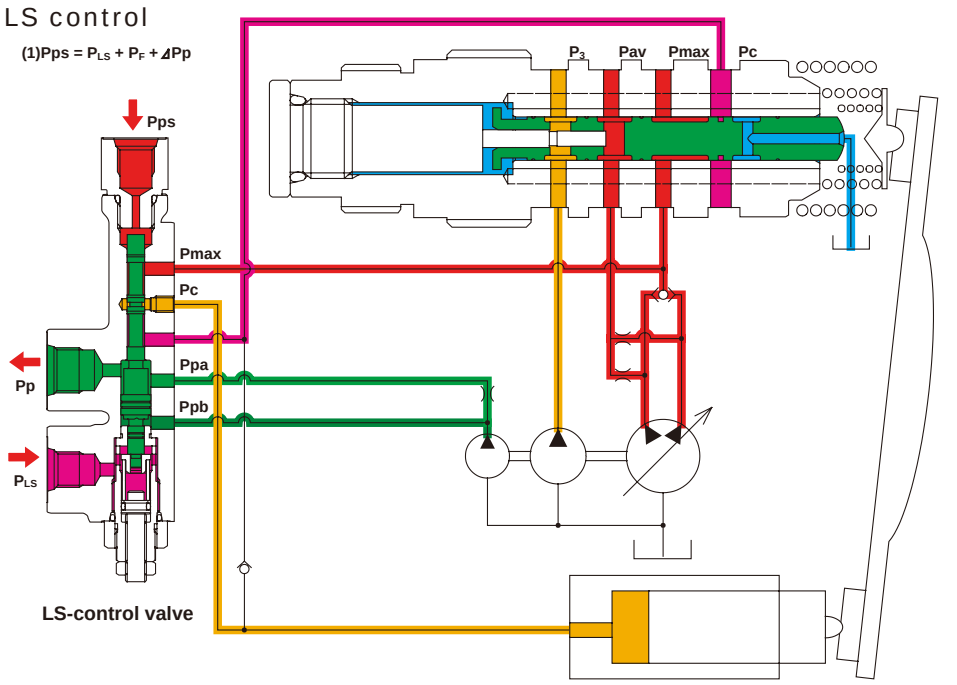
1. Exercises horse power control over the hydraulic system to prevent the maximum horsepower of the engine from being exceeded. That is, prevention of engine stall.
2. Exercises load sensing control (i.e. "Load sensing") to allow the pump to discharge the flow required on the load side.

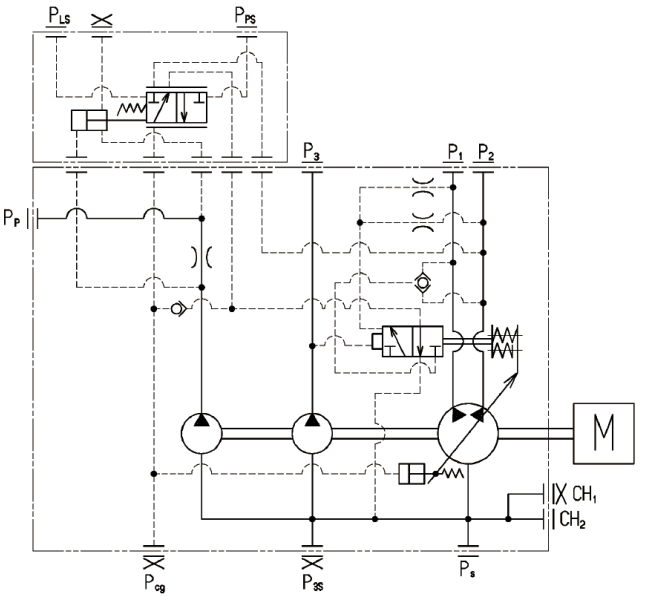
In addition, the pump is set at the minimum tilting angle, so that the pump discharges the standby flow before the LS control. Stand-by flew: 22.0 LPM (5.94 GPM)

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 provable 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.





2) Fundamentals of LS Pump Troubleshooting (Defective Portions and Symptoms)

Failure symtom		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 Pc 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 pump of approx. 72LPM 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 Pc pressure is always open to the P pressure.	The high pressure that has acted on the control pin is not released, since the control pressure of the control pin 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 pump 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. It goes into the standby state.
5. Stick of the LS regulator spool	Stick in the position where the Pc passage is dumped.	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 Pc is blocked.	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 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 flowrate 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	Remady
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 holding 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 holding 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 high pressure selector valve --

Trouble	Possible cause	Remady
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. High pressure selector valve is damaged. 6. High pressure selector valve plate is seized.	Replace the High pressure selector valve 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 system --

Trouble	Possible cause	Remady
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.
5. Machine travels obliquely	1.Excessive different track tension. 2.Different pump delivery 3.Different motor drain 4.Oil leak in swivel joint 5.Motor relief valve opens one side. 6.Counterbalance spool sticks in one side.	1.Check the track sag distance 2.Swap the pump delivery hoses and check 3.Swap the motor hoses and check 4.Check the motor (track) speed 5.Check the motor operating pressure and think 6.Check the drain amount and think

(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 return to neutral.	
	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.	Orifice plug came off
	Spring seat is not set properly.	Set the spring seat at proper position.
4. Abnormal noise is heard.	Plunger notch restricts oil flow.	
	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) 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.

B.Specifications

a.Specifications of pump

		Unit	KX080-3	Remarks
Manufacturer			KYB Co.,Ltd.	
Model			PSVL2-36C-4	
Kubota part No.			RD809-6111-0	
Rated pump rpm		rpm	2000	
Rated load pressure	Main relief pressure a1/a2	MPa kgf/cm2 psi	29.4 300 4267	
	Main relief pressure a4	MPa kgf/cm2 psi	20.6 210 2987	
	Pilot primary pressure a6	MPa kgf/cm2 psi	3.92 40 569	
Theoretical discharge capacity	Main pump P1/P2	cc/rev cu.in./rev	36.0/36.0 2.20/2.20	Sprit flow of variable displacement piston pump
	Main pump P3	cc/rev cu.in./rev	33.0 2.01	Gear pump
	Pilot pump Pp	cc/rev cu.in./rev	8.1 0.49	Gear pump
Theoretical discharge capacity	Main pump P1/P2	L/min USGPM	72.0/72.0 19.02/19.02	
	Main pump P3	L/min USGPM	67.0 17.70	
	Pilot pump Pp	L/min USGPM	16.0 4.23	
Differential pressure	LS control valve	MPa kgf/cm2 psi	1.5 15.3 218	Engine rpm propotional control with P4, Idling /Rated = about 60 - 70%
Standby flow rate		L/min USGPM	22.0 5.81	
Horsepower control			PC horsepower control valve : With P3 horsepower shift Swash plate control aided by self-tilting moment(Small piston deleted.) P1 + P2 pressure : Average pressure by orifice	
Structure			Bearing : Cradle Shoe plate : Spherical Large-diameter piston (with shoe)	

b.Relief Valve pressure setting

(1)Main relief valve(bench data)

No.	Valve location	Operating work	Unit	KX080-3	Remarks
1	Travel main relief valve a1		MPa kgf/cm^2 psi	29.4±0.3 300±3 4264±44	KX080-3: at 43 L/min (11.36 USGPM)
2	Travel main relief valve a2		MPa kgf/cm^2 psi	29.4±0.3 300±3 4264±44	KX080-3: at 43 L/min (11.36 USGPM)
3	Main relief valve a4		MPa kgf/cm^2 psi	20.6±0.3 210±3 2988±44	KX080-3: at 66 L/min (17.44 USGPM)
4	LS unload relief valve b6		MPa kgf/cm^2 psi	1.96±0.1 20±1 284±15	KX080-3: at 26 L/min (6.87 USGPM)
5	LS main relief a3		MPa kgf/cm^2 psi	27.4±0.3 279±3 3974±44	KX080-3: at 48 L/min (12.68 USGPM)

(2) Main relief valve (at the measurement port on the machine)

No.	Valve location	Operating work	Unit	KX080-3	Remarks
1	Travel main relief valve a1		MPa kgf/cm^2 psi	30.4 +1.0 -1.0 310 +10 -10 4409 +145 -145	
2	Travel main relief valve a2		MPa kgf/cm^2 psi	30.4 +1.0 -1.0 310 +10 -10 4409 +145 -145	
3	Main relief valve a4		MPa kgf/cm^2 psi	21.6 +1.0 -1.0 220 +10 -10 3133 +145 -145	
4	LS unload relief valve b6		MPa kgf/cm^2 psi	2.3 +0.3 -0.3 23 +5 -5 327 +42 -42	Idle:19 k
5	LS main relief a3	LS regurator	MPa kgf/cm^2 psi	27.9 +1.0 -1.0 285 +10 -10 4047 +145 -145	

(3) Overload relief valve (bench data)

No.	valve location	Operating work	Unit	KX080-3	Remarks
6 7 8	Control valve	Boom up/down Bucket dump/crowd Arm dump	MPa kgf/cm^2 psi	31.4 ±0.3 320 ±3 4554 ±44	at 5 L/min (4.76 USGPM)
9	Control valve	Arm crowd	MPa kgf/cm^2 psi	30.4 ±0.3 310 ±3 4409 ±44	
10	Control valve	Auxiliary port 1 delivery/return	MPa kgf/cm^2 psi	20.6 ±0.3 210 ±3 2988 ±44	
11	Control valve	Blade down	MPa kgf/cm^2 psi	27.4 ±0.3 279 ±3 3974 ±44	
12	Control valve	Blade up	MPa kgf/cm^2 psi	11.8 ±0.3 120 ±3 1711 ±44	
13	Swivel motor	Swivel, R&L	MPa kgf/cm^2 psi	21.6 ±0.3 220 ±3 3129 ±44	KX080-3: at 66 L/min (17.44 USGPM)
14	Travel motor	Travel, R&L	MPa kgf/cm^2 psi	29.4 ±0.3 300 ±3 4267 ±44	

(4) verload relief valve (at the measurement port on the machine

No.	valve location	Operating work	Unit	KX080-3		Remarks
6	Control valve	Boom up/down Bucket dump/crowd Arm dump	MPa	31.5	+1.0 -1.0	at 1500 rpm
7			kgf/cm^2	321	+10 -10	
8			psi	4569	+145 -145	
9	Control valve	Arm crowd	MPa	30.5	+1.0 -1.0	at 1500 rpm
			kgf/cm^2	311	+10 -10	
			psi	4424	+145 -145	
10	Control valve	Auxiliary port 1 delivery/return	MPa	22.1	+1.0 -1.0	at 1500 rpm
			kgf/cm^2	225	+10 -10	
			psi	3205	+145 -145	
11	Control valve	Blade down	MPa	27.4	+1.0 -1.0	at 1500 rpm
			kgf/cm^2	279	+10 -10	
			psi	3974	+145 -145	
12	Control valve	Blade up	MPa	13.2	+1.0 -1.0	at 1500 rpm
			kgf/cm^2	135	+10 -10	
			psi	1915	+145 -145	
13	Swivel motor	Swivel, R&L	MPa	21.6	+1.0 -1.0	at 1500 rpm
			kgf/cm^2	220	+10 -10	
			psi	3133	+145 -145	
14	Travel motor	Travel, R&L	MPa	35.0	+1.0 -1.0	at 1500 rpm
			kgf/cm^2	357	+10 -10	
			psi	5076	+145 -145	

Note
1.Main relief valae adjusting angle : 60 kgf/cm^2 per 90degrees.
2.As for a_1 relief valve, several hoses are required to disconnect for adjusting this main relief valve.

(5) Pilot system pressure

No.	valve location	Operating work	Unit	KX080-3	Remarks
1	Primary pilot pressure	At bench	MPa kgf/cm^2 psi	3.9 +0.2 -0.0 40 +2 -0 569 +29 -0	
2	Primary pilot pressure at machine	All pilot lines at machine port	MPa kgf/cm^2 psi	4.1 +0.5 -0.5 42 +5 -5 598 +73 -73	
3	Secondary pilot pressure	At bench	MPa kgf/cm^2 psi	2.7 +0.3 -0.0 27 +3 -0 384 +44 -0	
4	Secondary pilot pressure at machine	All pilot lines at C/V port	MPa kgf/cm^2 psi	2.8 +0.5 -0.5 29 +5 -5 406 +73 -73	

c.Swivel performance

	Unit	KX080-3	Remarks
Manufacturer		Kubota Seiki	
Model		RD118-6170-0	
Kubota part No.		RD118-6170-0	
Motor Displacement	cc/rev cu.in/rev	44.1 2.69	
Reduction ratio		20.615	
Total Displacement	cc/rev cu.in/rev	909 55.48	
Max.oil flow	L/min USGPM	66 17.44	Rated flow rate
Motor speed	rpm	72.6	KX080-3: at 66 L/min (17.44 USGPM)
Relief valve pressure (at bench)	MPa kgf/cm^2 psi	21.6 220 3129	KX080-3: at 66 L/min (17.44 USGPM)
Theoretical output torque	N.m kgf.m ft.lbs	950 96.9 701	KX080-3 : at 21.6MPa(220kgf/cm2, 3129psi)
Drain amount at lock	L/min cu.in/min	4.00 ≧ 1.06 ≧	New machine
Drain amount while roating	L/min cu.in/min	0.50 ≧ 0.13 ≧	New machine
Max. drain pressure	MPa kgf/cm^2 psi	0.3 3 43	
Swivel speed	rpm	9.5	pinion / swivel teeth KX080-3 : 13/100
3 times rotation swivel time	sec.	18.9	
Swivel block performance at engine stop	deg.	0	Bucket loaded at heaped. Slope angle at 20° 1 min engine stop. Hydraulic oil tempt : 50°±5°C
Swivel block performance at engine running	deg.	0	Bucket loaded at heaped. Slope angle at 20° 1 min engine running. Lever lock released Hydraulic oil tempt : 50°±5°C
Capable swivel rotation angle	deg.	17	Bucket crowded,Arm extended
Play at the tip of bucket	mm in.	70 ≧ 2.76 ≧	Reference value, pushing force : 30kgf
Brake release pressure	MPa kgf/cm^2 psi	1.5 15 213	

d.Traveling performance

		Unit	KX080-3	Remarks
Manufacturer			Nabtesco Corp.	
Model			GM09VN-B-21/36-3	
Kubota part No.			RD809-6129-0	
Capacity	1st	cc/rev	21.3	
		cu.in./rev	1.30	
	2nd	cc/rev	36.3	
		cu.in./rev	2.22	
Reduction ratio			1/61.6	
Total displacement	1st	cc/rev	1312.1	
		cu.in./rev	80.07	
	2nd	cc/rev	2236.1	
		cu.in./rev	136.46	
Rated oil flow		L/min	72	
		USGPM	19.02	
Theoretical torque	1st	N.m	9000	KX080-3: at 24.5MPa (300kgf/cm2, 4267 psi)
		kgf.m	917.7	
		ft.lbf	6637.9	
	2nd	N.m	5160	
		kgf.m	526.2	
		ft.lbf	3805.8	
Theoretical speed	1F	rpm	31.6	KX080-3 : at 72 L/min (19.02 USGPM)
	2F		52.7	
Relief valve pressure		MPa	29.4	
		kgf/cm^2	300	
		psi	4267	
Climbing ability		deg.	30	
Max. traction force	1F	kN	55.2	Slip 70% theoretical torque Oil temp.:50±5°C(122±9°F)
		kgf	5633	
		lbf	12420.8	
	2F	kN	34.3	Relief 60% theoretical torque
		kgf	3500	
		lbf	7717.5	
Traveling block performance		mm/10min	0	10 min engine stop Testing slope angle: 20 deg. Oil temp.:50±5°C(122±9°F)
		in./10min		
Traveling speed (Rubber/Steel)	1st	km/h	3.1	
		mph	1.93	
	2nd	km/h	4.6	
		mph	2.86	
10m(32.8ft) traveling time (Rubber crawler)	1F	sec./10m (32.8ft)		
	2F			
Straight travel performance	1F/2F	mm/10min	600 ≧	
		in./32.8ft	23.62 ≧	
Drain amount at lock	1F/2F	L/min	4.00 ≧	On new machine
		US gal/ min	1.06 ≧	

		Unit	KX080-3		Remarks
Drain amount while rotating	1F	L/min US gal/ min	0.50 ≧ 0.13 ≧		On new machine
	2F	L/min US gal/ min	1.00 ≧ 0.26 ≧		On new machine
Hi-speed change pressure Min./Max		MPa kgf/cm^2 psi	2.0 20.0 284	6.9 70.0 996	
Parking brake ; Braking torque		N.m kgf.m ft.lbf	97 9.9 71.6		
Parking brake ; Release pressure		N.m kgf.m ft.lbf	0.47 4.8 68		

e.Cylinder

(1) Speed

Unit				KX080-3 (A)	KX080-3 (B)	Remarks
Boom cylinder	Up	Canopy	sec.	-		GL to Max. height (exclude cushion time)
		Cabin	sec.	3.1 to 3.7	4.4	
	Down	Canopy	sec.	-		Max. height to GL
		Cabin	sec.	3.1 to 3.7	4.4	
	cushion		sec.	0.4 to 1.3	1.6	
Arm cylinder	Crowd		sec.	3.4 to 4.0	4.8	Cylinder full stroke
	Dump		sec.	3.2 to 3.8	4.6	
Bucket cylinder	Crowd		sec.	3.2 to 3.8	4.6	Cylinder full stroke
	Dump		sec.	1.9 to 2.5	3.0	
Swing cylinder	Left	Canopy	sec.	-		Cylinder full stroke
		Cabin	sec.	6.6 to 7.2	8.6	
	Right	Canopy	sec.	-		
		Cabin	sec.	7.8 to 8.4	10.1	
Blade cylinder	Up		sec.	1.9 to 2.5	3.0	Cylinder full stroke
	Down		sec.	2.6 to 3.2	3.8	

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

(2) Natural falll

Unit		KX080-3 (A)	KX080-3 (B)	Remarks
Load weight	kg	0.414		inclu bucket weight
	lbs	0.91		
Boom cylinder	mm	20	100	Boom raise, Arm extend, Bucket crowd, Bucket load : heaped capacity 10 min Engine stop
	in.	0.79	3.94	
Arm cylinder	mm	11	55	
	in.	0.43	2.17	
Bucket cylinder	mm	10	50	
	in.	0.39	1.97	
Blade cylinder	mm	20	100	Arm vertical
	in.	0.79	3.94	

Oil temp. : 50 ± 5 °C (122 ± 9 °F), 10 minutes

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

(3) Specifications and dimensions

1)Cylinder specifications

		Unit	KX080-3	Remarks
Boom	Tube I.D.xRod O.D.	mm in.	ø115xø65 ø4.53xø2.56	
	Stroke	mm in.	878 34.57	
	Min. retraction length	mm in.	1369 53.90	
	Manufacturer		KYB Co.,Ltd.	
	Parts No.		RD809-6750-0	
	Seal kit No.		RD809-	
	Piston tightening torque	N.m kgf.m ft.lbf		
	Piston screw size	mm		
	Width for tightening by spanner	mm		
Arm	Tube I.D.xRod O.D.	mm in.	ø100xø60 ø3.94xø2.36	
	Stroke	mm in.	912 35.91	
	Min. retraction length	mm in.	1378 54.25	
	Manufacturer		KYB Co.,Ltd.	
	Parts No.		RD809-6760-0	
	Seal kit No.		RD809-	
	Piston tightening torque	N.m kgf.m ft.lbf		
	Piston screw size	mm		
	Width for tightening by spanner	mm		

		Unit	KX080-3	Remarks
Bucket	Tube I.D. x Rod O.D.	mm in.	ø90xø55 ø3.54xø2.17	
	Stroke	mm in.	747 29.41	
	Min. retraction length	mm in.	1138 44.80	
	Manufacturer		KYB Co.,Ltd.	
	Parts No.		RD809-6780-0	
	Seal kit No.		RD809-	
	Piston tightening torque	N.m kgf.m ft.lbf		
	Piston screw size	mm		
	Width for tightening by spanner	mm		
Swing	Tube I.D.xRod O.D.	mm in.	ø110xø60 ø4.33xø2.36	
	Stroke	mm in.	715 28.15	
	Min. retraction length	mm in.	1165 45.87	
	Manufacturer		Koretsune Seiko Ltd.	
	Parts No.		RD809-6740-0	
	Seal kit No.		RD809-7238-0	
	Piston tightening torque	N.m kgf.m ft.lbf	2800 285.5 2065.0	
	Piston screw size	mm	M45x2	
	Width for tightening by spanner	mm	-	
Blade	Tube I.D.xRod O.D.	mm in.	ø125xø65 ø4.92xø2.56	
	Stroke	mm in.	250 9.84	
	Min. retraction length	mm in.	689 27.13	
	Manufacturer		Koretsune Seiko Ltd.	
	Parts No.		RD809-7510-0	
	Seal kit No.		RD809-7245-0	
	Piston tightening torque	N.m kgf.m ft.lbf	4000 407.9 2950.2	
	Piston screw size	mm	M52x2	
	Width for tightening by spanner	mm		

2)Cylinder dimensions

KX080-3

	Unit	A	B	C	D	E	F	G	H	J	Port screw size	Remarks
Boom	mm	70	70	90	90	65	115	134	57	70	G 1/2"	KYB Co.,Ltd.
	in.	2.76	2.76	3.54	3.54	2.56	4.53	5.28	2.24	2.76		
Arm	mm	60	60	85	85	60	100	118	55	58	G 1/2"	KYB Co.,Ltd.
	in.	2.36	2.36	3.35	3.35	2.36	3.94	4.65	2.17	2.28		
Bucket	mm	60	60	75	75	55	90	112	60	55	G 1/2"	KYB Co.,Ltd.
	in.	2.36	2.36	2.95	2.95	2.17	3.54	4.41	2.36	2.17		
Swing	mm	70	70	80	80	60	110	131	65	58	G 1/2"	Koretsune Seiko Ltd.
	in.	2.76	2.76	3.15	3.15	2.36	4.33	5.16	2.56	2.28		
Blade	mm	70	70	75	75	65	125	146	65	65	G 1/2"	Koretsune Seiko Ltd.
	in.	2.76	2.76	2.95	2.95	2.56	4.92	5.75	2.56	2.56		

3)Tightening torque

(1) Boom cylinder

	Unit	Tightening torque	Thread size	Adhesive
		KX080-3	KX080-3	
Cylinder head	N·m kgf·m ft·lbs	350-400 35.7-40.8 258.1-295.0		
Piston	N·m kgf·m ft·lbs	600±120 61.2±12.2 442.5±88.5		
Set screw	N·m kg·m ft·lbs	20 2.0 14.8	M8x1.25	

(2) Arm cylinder

	Unit	Tightening torque	Thread size	Adhesive
		KX080-3	KX080-3	
Cylinder head	N·m kgf·m ft·lbs	350-400 35.7-40.8 258.1-295.0		
Piston	N·m kgf·m ft·lbs	600±120 61.2±12.2 442.5±88.5		
Set screw	N·m kg·m ft·lbs	20 2.0 14.8	M8x1.25	

(3) Bucket cylinder

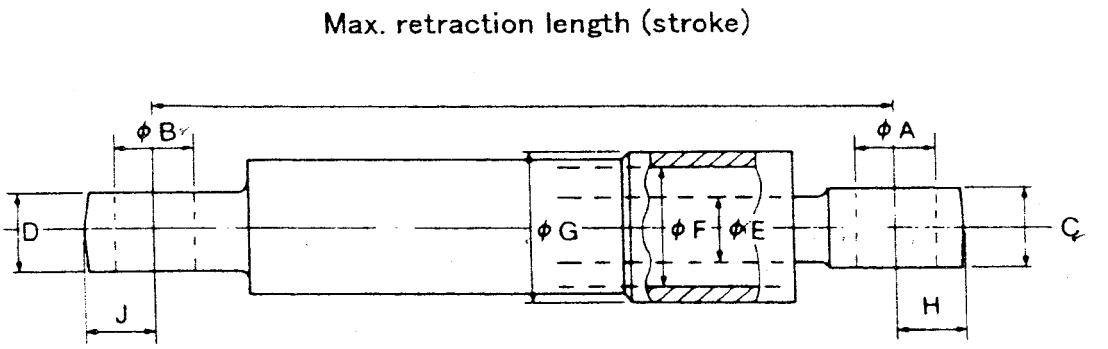
	Unit	Tightening torque	Thread size	Adhesive
		KX080-3	KX080-3	
Cylinder head	N·m kgf·m ft·lbs	300-350 30.6-35.7 221.3-258.1		
Piston	N·m kgf·m ft·lbs	600±120 61.2±12.2 442.5±88.5		
Set screw	N·m kg·m ft·lbs	20 2.0 14.8		

(4) Swing cylinder

	Unit	Tightening torque	Thread size	Adhesive
		KX080-3	KX080-3	
Cylinder head	N·m kgf 疥 ft·lbs	650 66.3 479.5	-	
Piston	N·m kgf 疥 ft·lbs	2800 285.5 2065.0	M48x2	
Set screw	N·m kg·m ft·lbs	- - -	-	

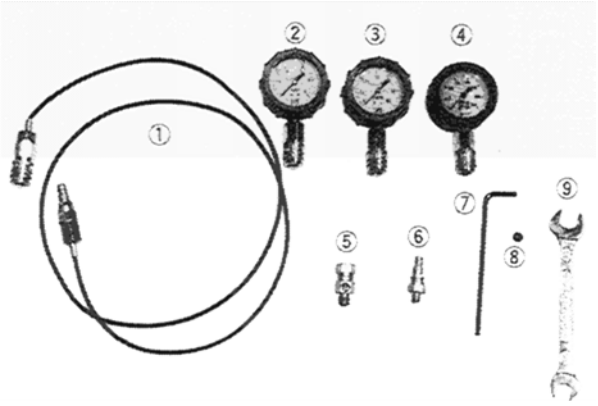
(5) Blade cylinde

	Unit	Tightening torque	Thread size	Adhesive
		KX080-3	KX080-3	
Cylinder head	N·m kgf·m ft·lbs	1200 122.4 885.3	-	
Piston	N·m kgf·m ft·lbs	4000 407.9 2950.3	M52x2	
Set screw	N·m kg·m ft·lbs	- - -	-	



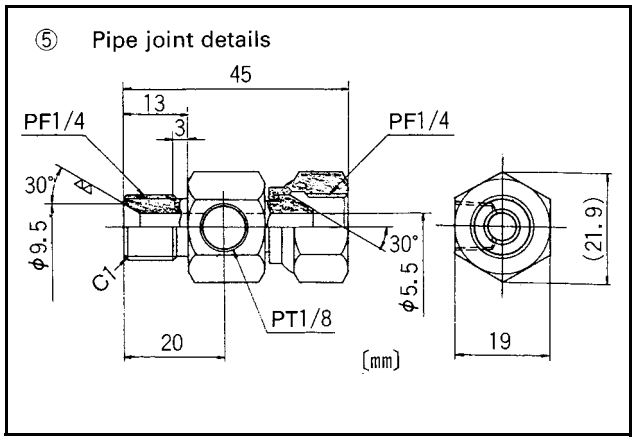
C.Testing

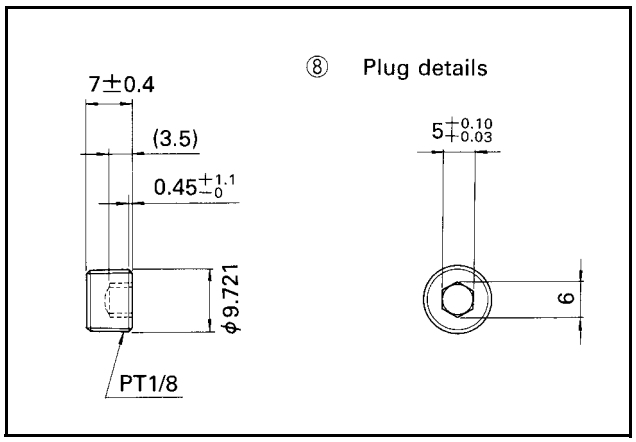
a. Testing Instruments & special tools



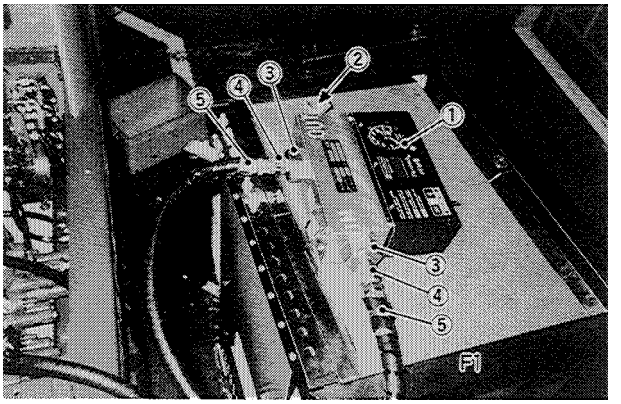
(1) Gauges and special tools for pressure testing

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; 39.2 MPa, 400kgf/cm^2, 5689psi
   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



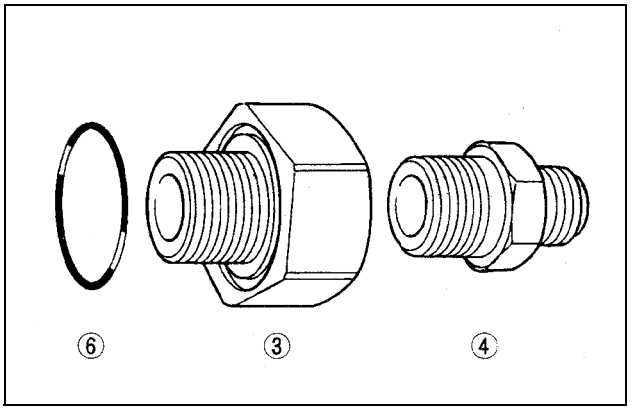


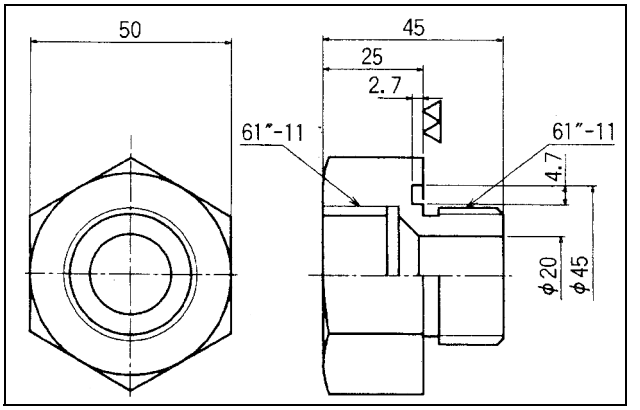




(2) Flow meter and special tools for flow testing

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

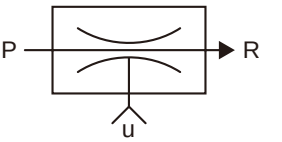




Drawing of (3) Male - female joint 1” × 1”



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 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 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 posotion.
6) Start the engine at the idling speed.
7) Try to raise the dozer at ths 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 untill 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 atarted and stopped repeatedly to allow such collection and dischrging 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) Finaly 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.

c. Pilot pressure

(1) Primary pressure



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.

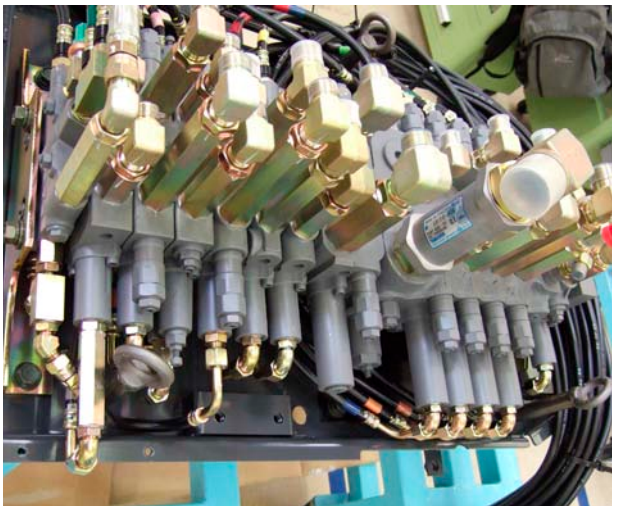
Reference valve : See specifications
1)Primary pressure test port

CAUTION

Relieve the pilot line pressure bofore removing the pressure port.
Otherwise, oil will splash out by accumulated pressure.

(2) Secondary pressure





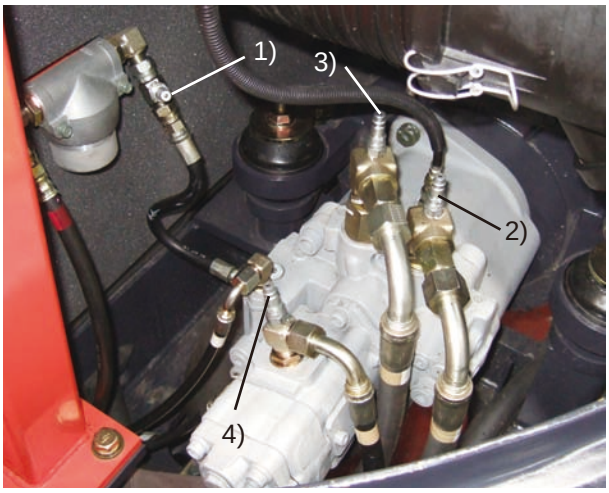
[Ex: Measurement with the arm crowd]

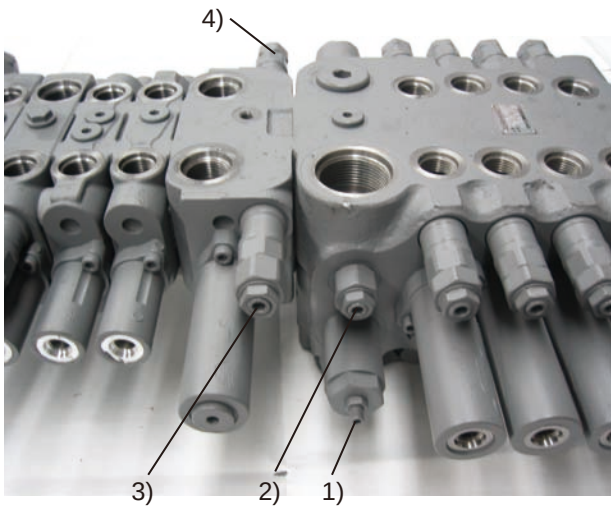
1. Remove the side cover of the tank.
2. Connect a T joint to the arrow-marked point and set the pressure gauge there.
3. Start the engine and run it at the maximum speed. Take 2 or 3 measurements to have an exact reading.
4. Hydraulic oil tempreture must be 50 ± 5°C, 122 ± 9°F.

Reference value : See specifications

1)Measurement port of secondary pilot pressure.

d. Main relief valve : LS system





(Measurement methed)

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 tempreture must be 50 ± 5°C, 122 ± 9°F.

Reference value : See specifications

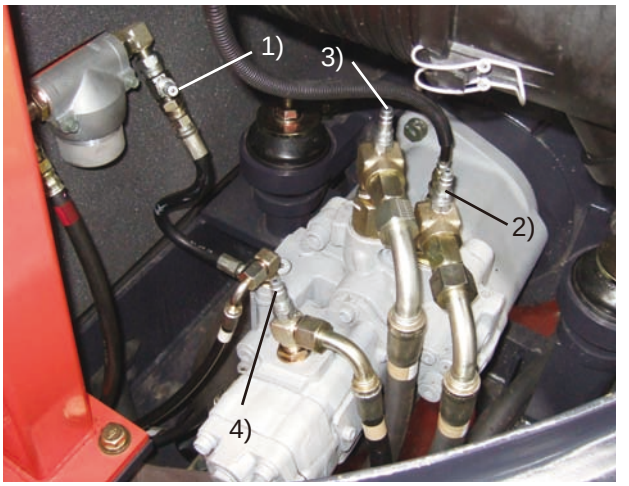
1) Primary pilot pressure port
2) Pump 1 pressure port
3) Pump 2 pressure port
4) Pump 3 pressure port

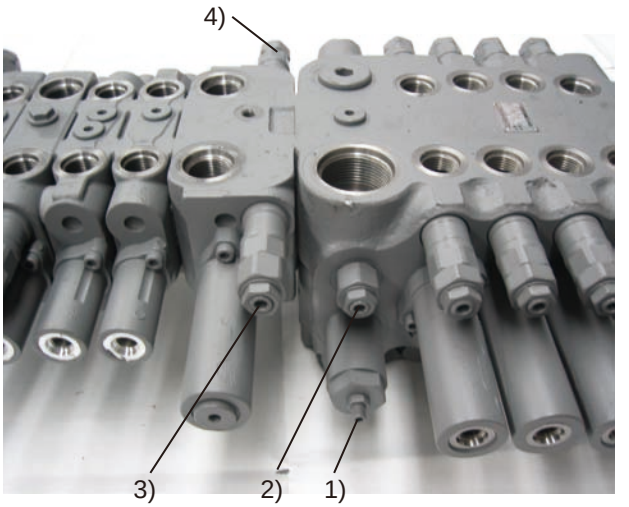
1) LS unload valve
2) LS main relief valve
3) 4) Travel main relief valve

(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. Main relief valve : Travel system





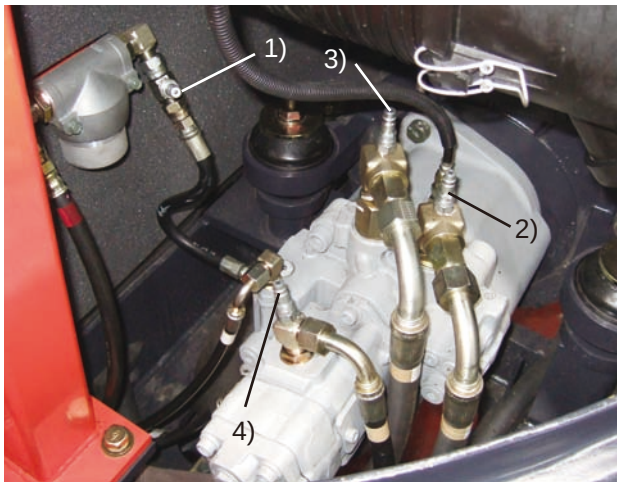
1. Set the pressure gauge to the coupler at the main pump discharge side. Or remove the plug off the main pump discharge side and set the pressure gauge there.
2. Lock the both tracks.
3. Start the engine and run it at the maximum speed. Get the following main relief valves activated.
4. Take 2 or 3 measurements to have their respective exact readings.
5. Hydraulic oil tempreture must be 50 ± 5°C, 122 ± 9°F.

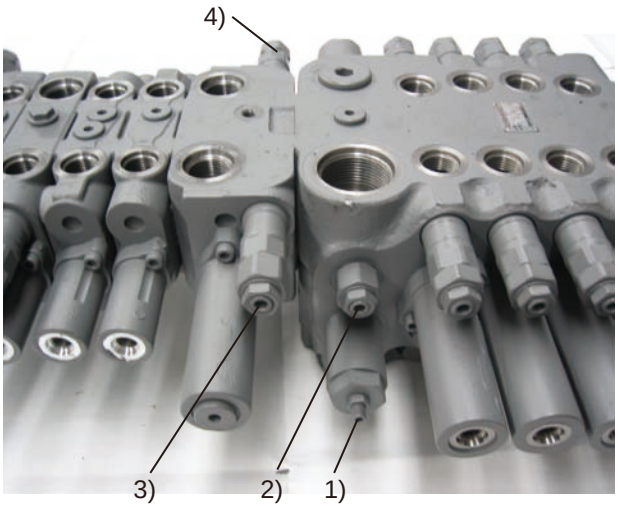
Reference value : See specifications

1) Primary pilot pressure port
2) Pump 1 pressure port
3) Pump 2 pressure port
4) Pump 3 pressure port

1) LS unload valve
2) LS main relief valve
3) 4) Travel main relief valve

f. Unload valve





(Measurement method)

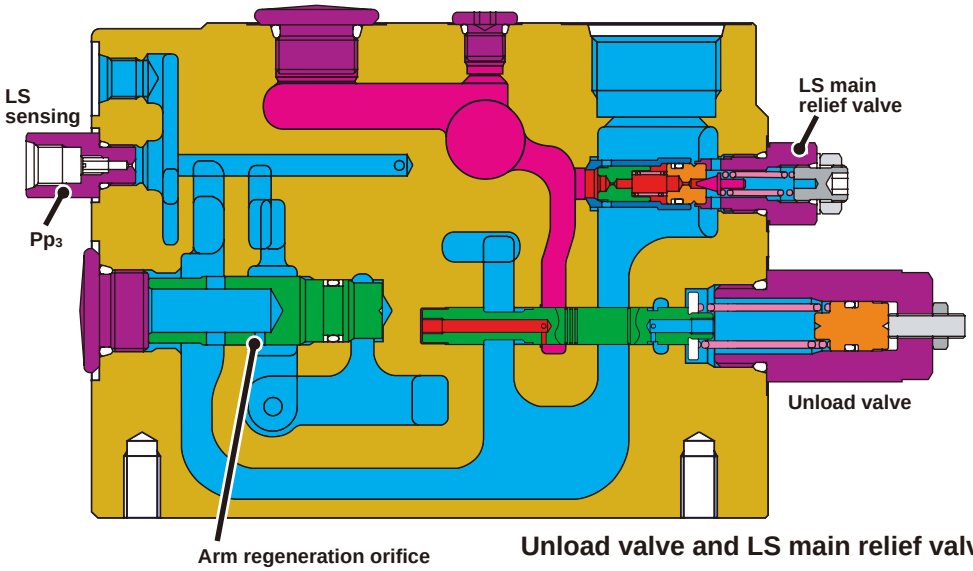
1. Set the pressure gauge to the coupler at the main pump discharge side. Or remove the plug off the main pump discharge side and set the pressure gauge there.
2. Start the engine and run it at the maximun speed.
3. Measure the unload valve pressure. At this measurement, all control levers should be at neutral position.
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

- Adjustment
  If the measured pressure is lower than specification, screw in the set screw.
  And vice-versa.

Reference value : See Specifications

1) Primary pilot pressure port
2) Pump 1 pressure port
3) Pump 2 pressure port
4) Pump 3 pressure port

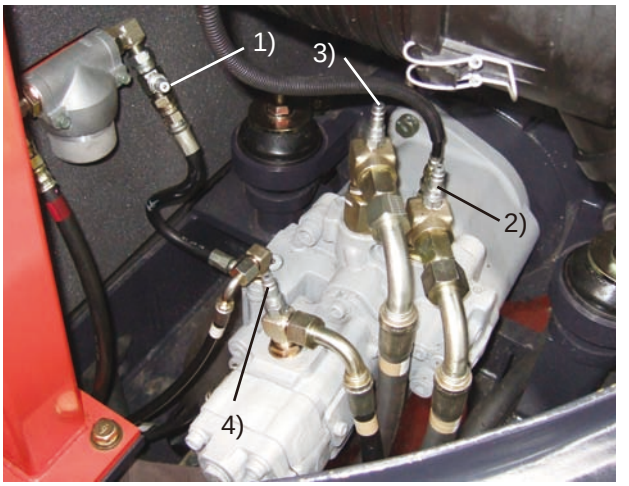
1) LS unload valve
2) LS main relief valve
3) 4) Travel main relief valve



Unload valve and LS main relief valve

g. Overload relief valve

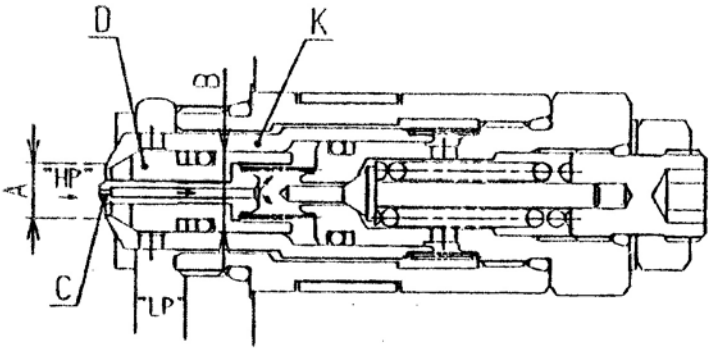
- Measurement method



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.
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.

Reference value : See Specifications

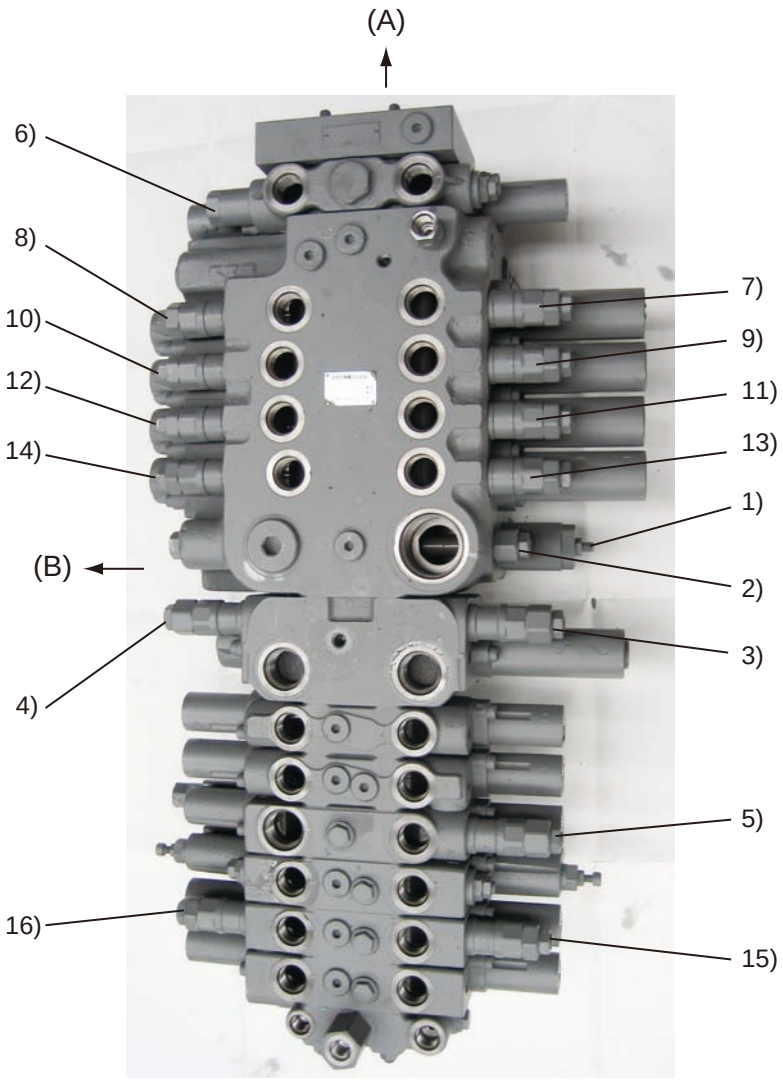
1) Primary pilot pressure port
2) Pump 1 pressure port
3) Pump 2 pressure port
4) Pump 3 pressure port



(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 1500rpm speed. Move the levers and make sure the pressure setting.

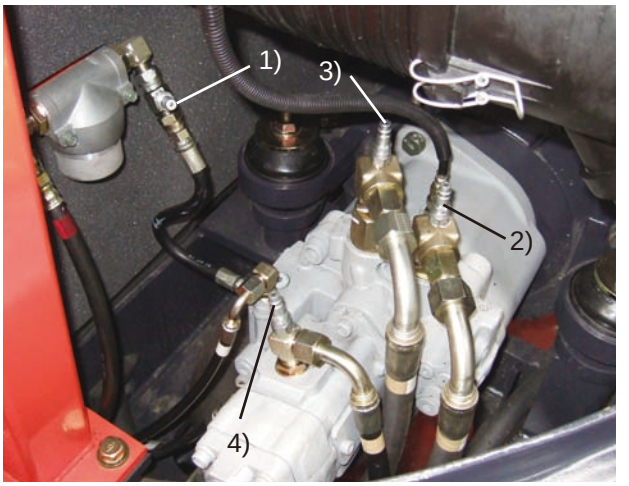
- Location of the relief valve

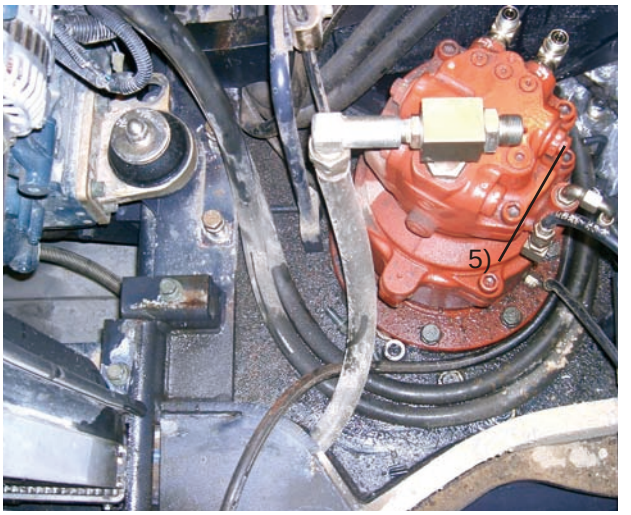


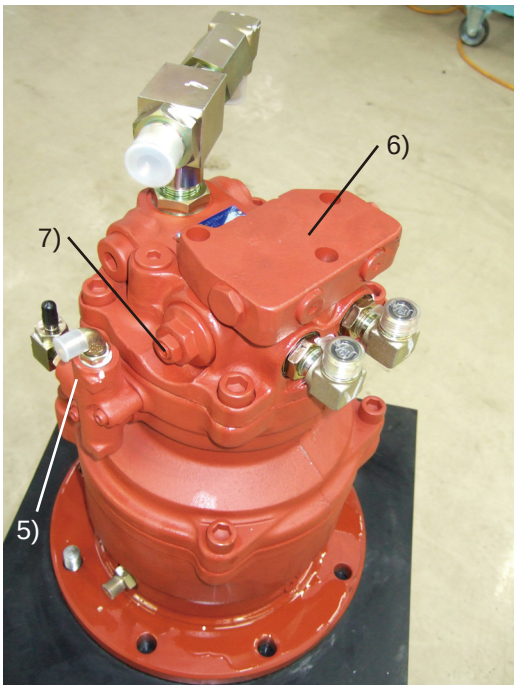
(A) Machine front
(B) Cab side
ORV : Overload Relief valve

1) LS unload valve (b6)
2) LS main relief valve (a2)
3) Travel main relief valve (a1)
4) Travel main relief valve (a2)
5) Pump 3 main relief valve (a4)
6) Swing rod, anti-void valve
7) Boom rod, ORV (b1)
8) Boom bottom, ORV (b1)
9) Service port 1, ORV (b5)
10) Service port 1, ORV (b5)
11) Bucket bottom, ORV (b1)
12) Bucket rod, ORV (b1)
13) Arm bottom, ORV (b4)
14) Arm rod, ORV (b1)
15) Dozer bottom, ORV (b3)
16) Dozer rod, ORV (b2)

h. Swivel brake valve pressure







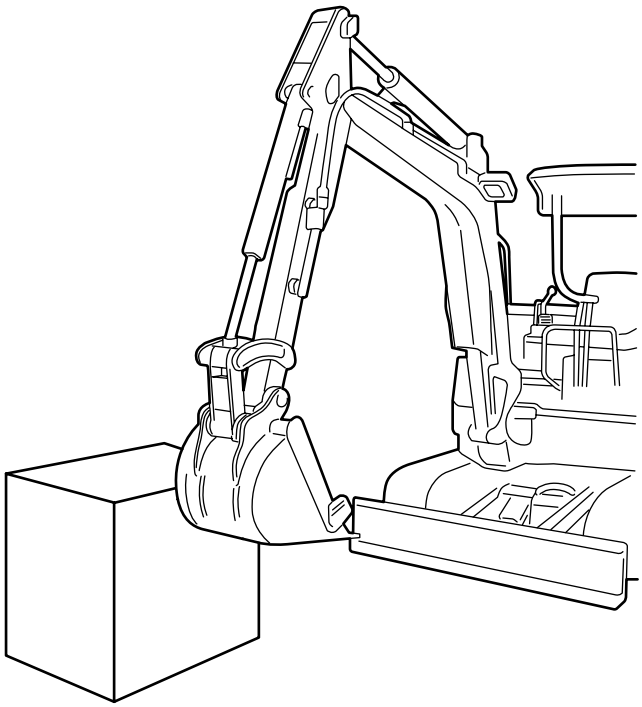
(Measurement method)

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.
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 tempreture must be 50 ± 5°C, 122 ± 9°F.

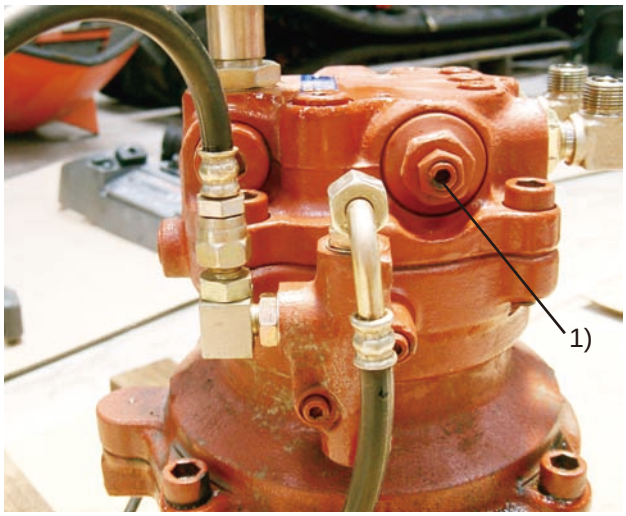
Reference valve : See Specifications

1) Primary pilot pressure port
2) Pump 1 pressure port
3) Pump 2 pressure port
4) Pump 3 pressure port

5) Swivel motor, ORV
6) Anti-swivel back valve
7) Negative brake timer



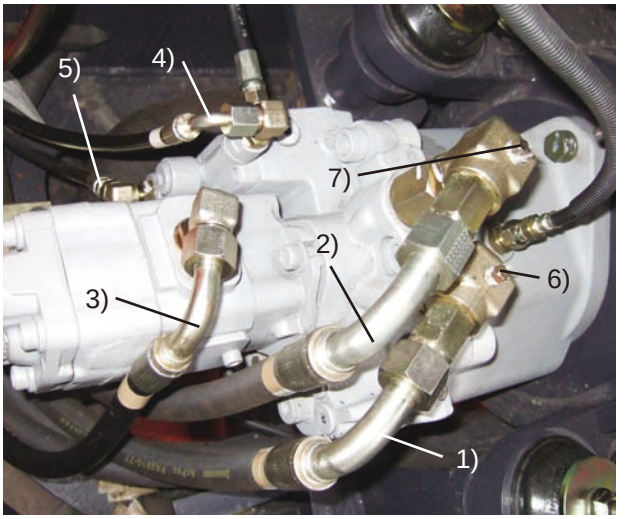
- Adjustment of the brake



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 tempreture must be 50 ± 5°C, 122 ± 9 °F.

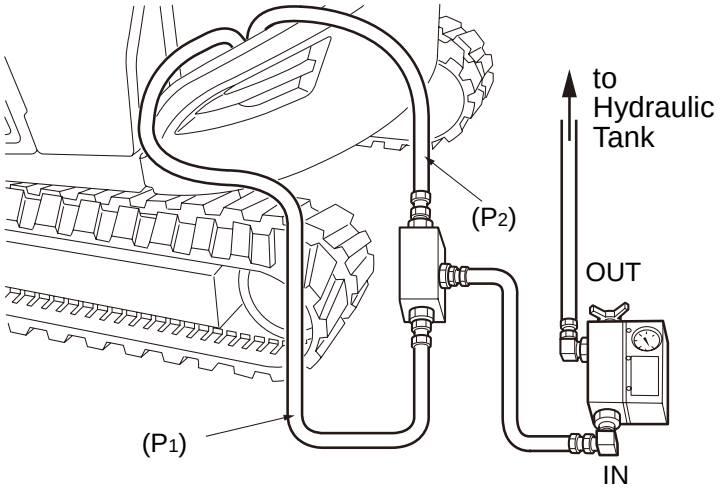
1) Swivel motor, ORV

i. Measuring the main pump Max. flow rate



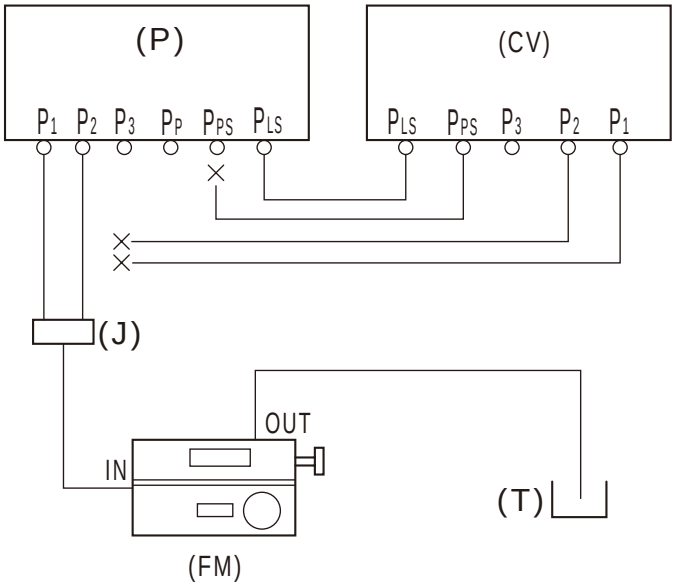
(1) P_1 delivery hose
(2) P_2 delivery hose
(3) P_3 delivery hose
(4) P_{PS} sensing line hose
(5) P_{LS} sensing line hose
(6) P_1 pressure measuring port
(7) P_2 pressure measuring port

[Preparations for measuring]
1. Park the machine on a flat, solid ground.
2. Connect a vacuum pump.
3. Disconnect the hoses from the pump's P1 and P2 ports. Put plugs into these hoses.
4. Connect hoses, with T joint (J) in place, between the control valve (P)'s P1 and P2 ports and the flowmeter (FM).
5. Let the oil return from the flowmeter (FM)' OUT port to the hydraulic oil tank (T).
6. Disconnect the P_{PS} hose and attach a plug to this hose's end. Keep the P_{PS} joint (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 the plugs from the ports (6) and (7) as shown at left. Connect pressure gauges to these ports.
   This is because the flowmeter's reading fluctuates 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.



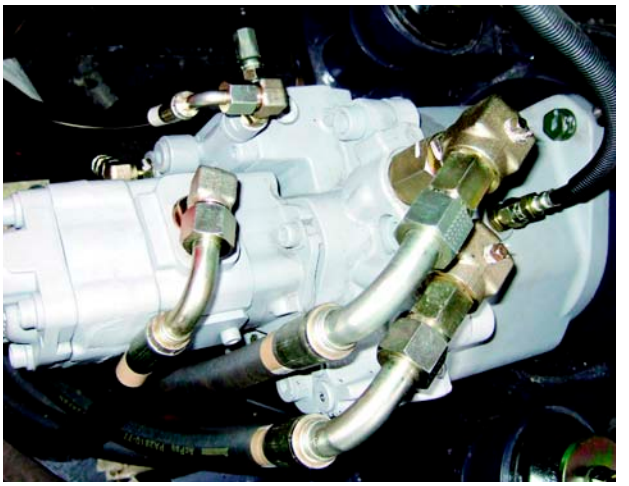
[Measurement]

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.



(P) : PumP
(CV) : Control Valve
(FM) : Flow Meter
(T) : Hydraulic Tank
(J) : T Joint
× : Plug

j. 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. Disconnect hose PLs and attach plug (1/4) to this hose's end. Keep joint PLs (at the pump) intact. (Place an oil pan to receive out-coming oil.)

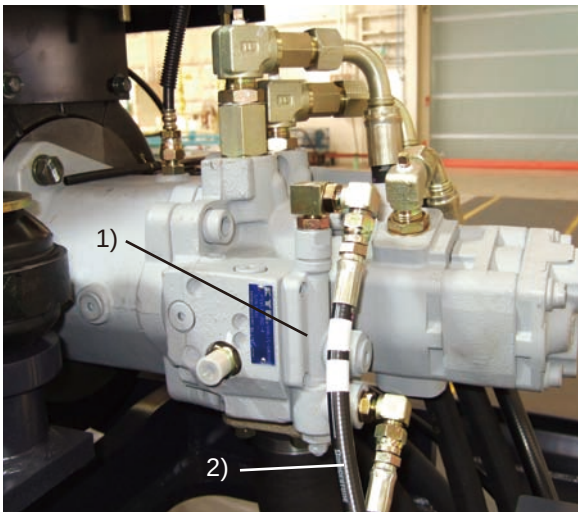
*** This is because the pump's swash plate is fixed at its minimum tilt angle.**

7 ~ 10. Same as in pump's Max. flowrate.

Reference value : See Specifications

k. 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 or travel operation. 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

Reference value : See Specifications

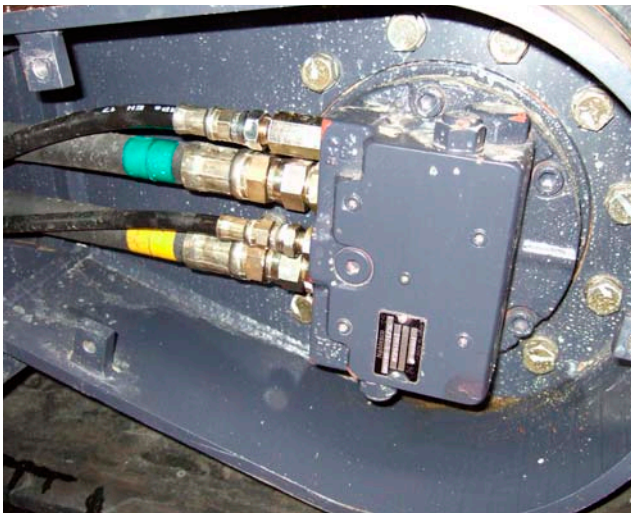
Machine condition : In case of swivel speed test
Boom raised, arm & bucket crowd
Dozer-down on ground.

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.

   1) LS control valve
   2) Set screw

I. 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 tempreture must be 50 ± 5°C, 122 ± 9°F.

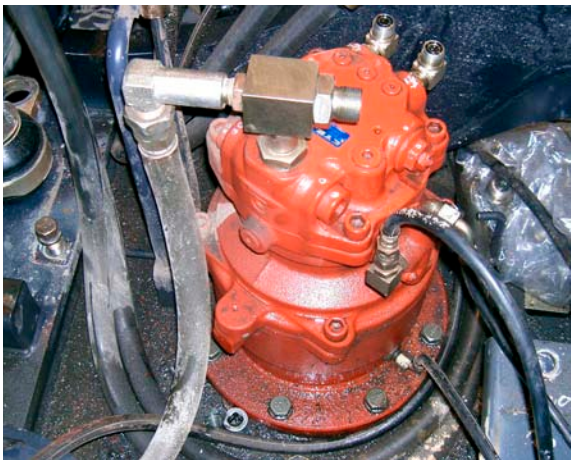
Reference value : See Specifications



Never place your body under the crawler.



m.Swivel motor drain amount



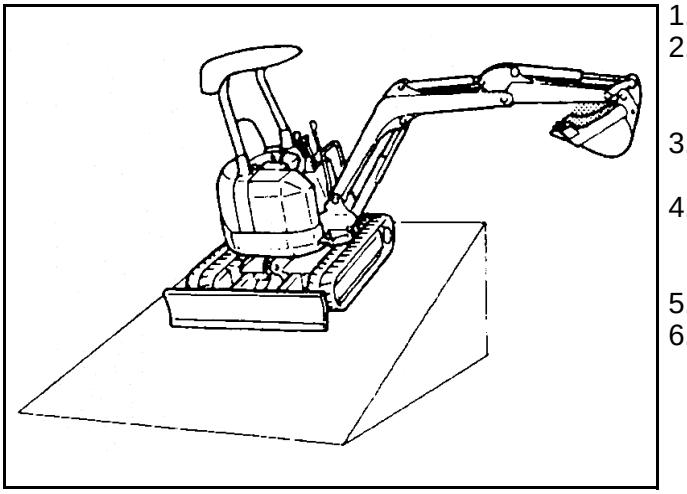


1. Remove right side cover.
2. Locate front attachment to traveling position. Bucket should be located 1 m above from ground.
3. Remove drain hose of the swivel motor and recieve drain oil in a suitable reservoir.
4. Swivel the machine one minute at max. engine rpm and measure amount of hydraulic oil in the reservoir.

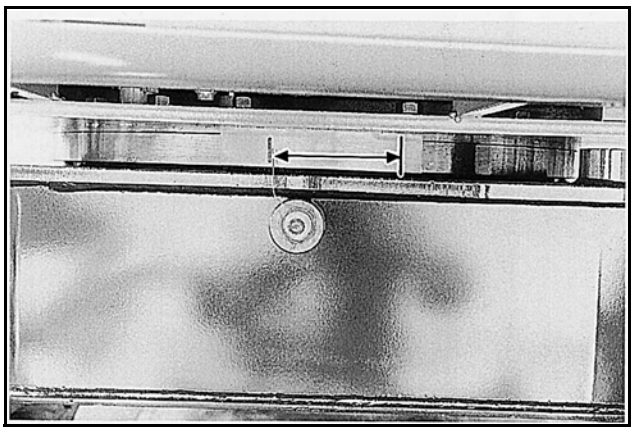
Make sure nobody is around swivel radius area.

Reference value : See Specifications

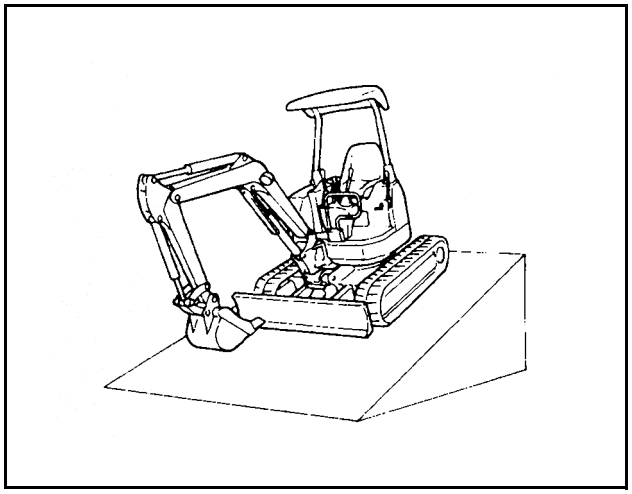
n. Swivel motor block performance



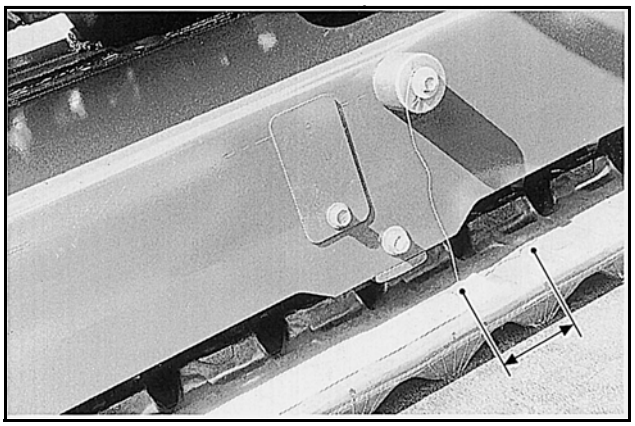
1. Locate the machine on the 20 deg. slope.
2. The front position is of arm dump and bucket crowd. Keep the boom so that the boom end pin is alignedwith the bucket pin.
3. Mark the outer ring of swivel bearing and truck frame.
4. Unlock the safety lock lever, and measure the one minute shifting distance between them with engine idling rpm.
5. Load on the bucket should be as follows.
6. Hydraulic oil temperature must be 50 ± 5°C, 122 ± 9°F.



o. 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 tempreture must be 50 ± 5°C, 122 ± 9°F.



p. Operating speed

(1) Checking each operating speed.

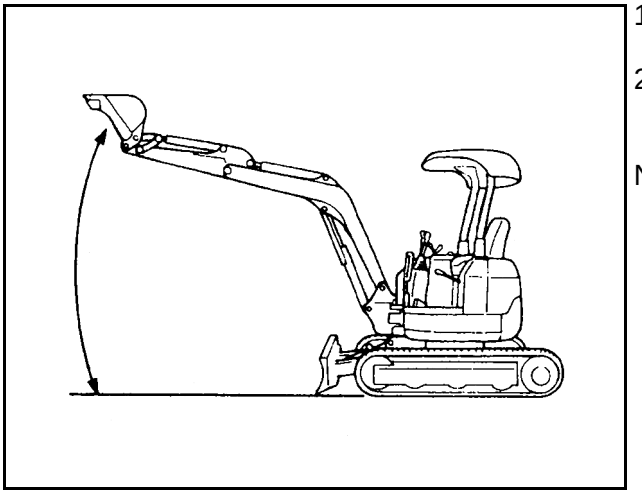
[Important points]

1. Measure full stroke operating time with no load on the standard bucket.
2. Make several mesurement 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 swivelings.
   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.

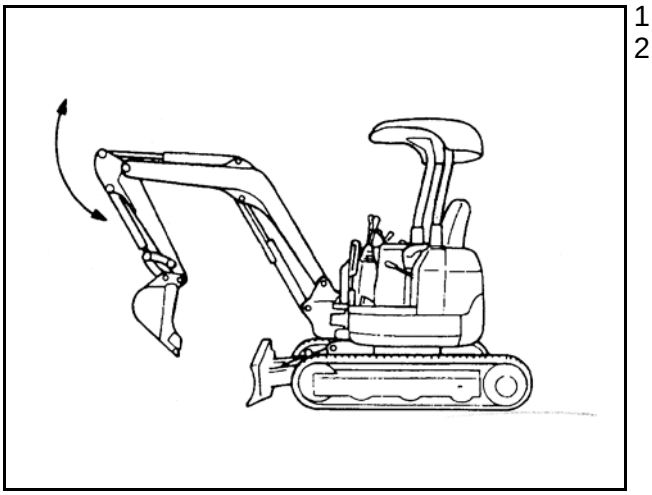
(2) Boom cylinder



1. Arm and bucket cylinder shouls be most shorted 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.

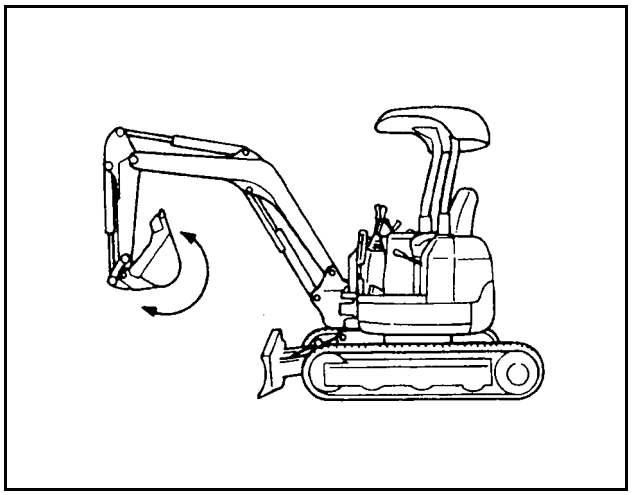
Note:The cushioning time is not included.

(3) Arm cylinder



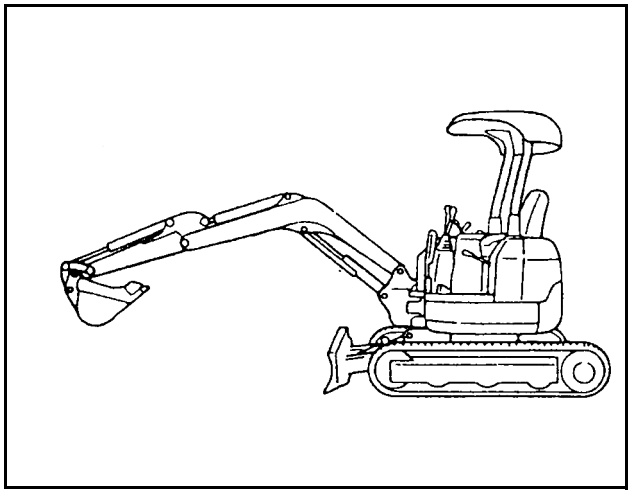
1. Position the boom and arm as showm at left.
2. Measure the arm cylinder full stroke operating time.

(4) Bucket cylinder



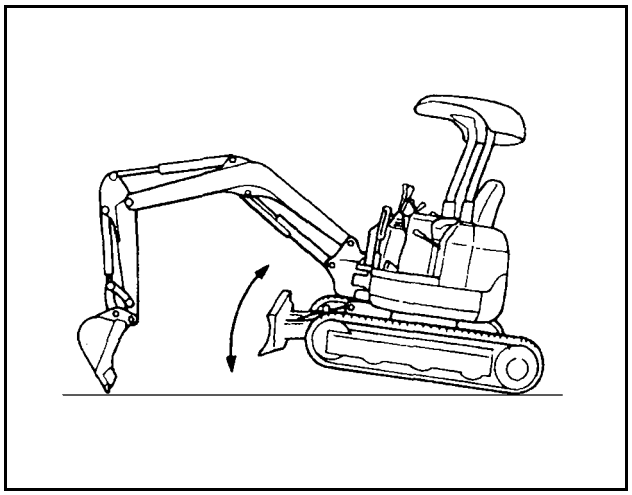
1. Position the boom and arm as showm at left.
2. Measure the bucket cylinder full stroke operating time.

(5) Swing cylinder



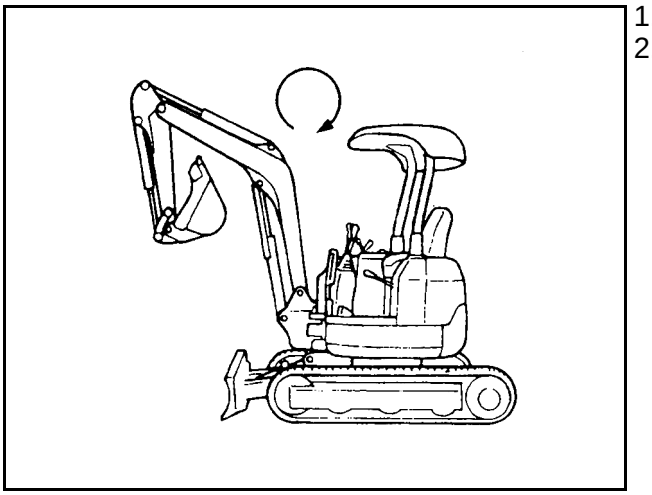
1. Position the boom, arm and bucket as showm at left. (with the bottom of the bucket about 1 m (33 ft) above from the ground.)
2. Measure the swing cylinder full stroke operating time. (right to left and left to right)

(6) Dozer cylinder



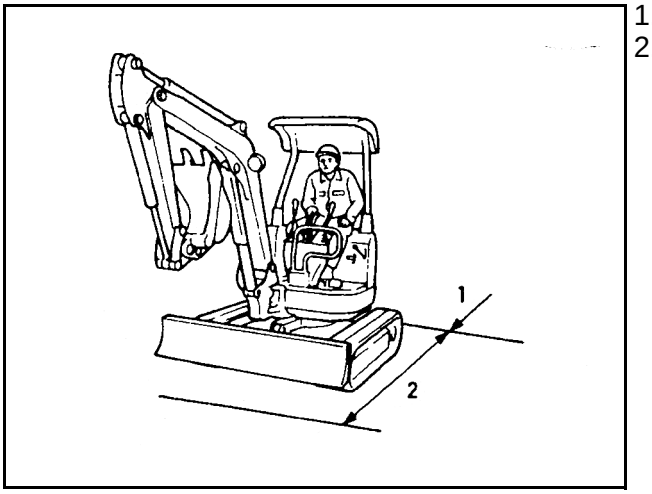
1. Place the bucket on the ground. Position the machine as shown at left for the dozer to make a full stroke.
2. Measure the dozer cylinder full stroke operating time.

(7) Swivel speed



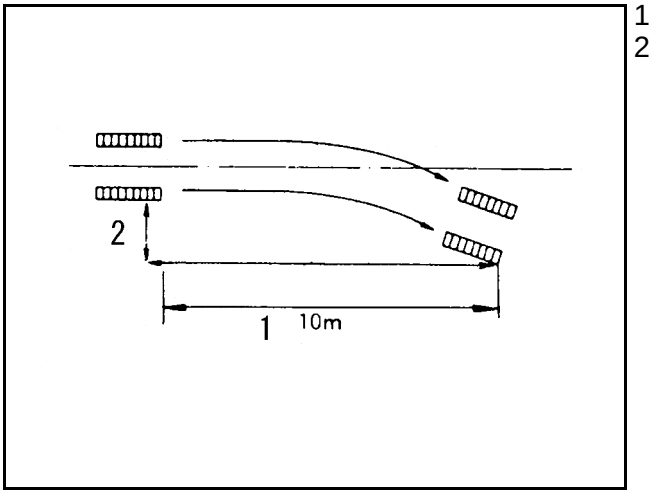
1. Position the boom, arm and bucket as showm at left.
2. Measure three times rotation time.

(8) Traveling speed



1. Travel the machine untill getting max. speed.
2. After getting max. speed, measure the 10 mm (33 ft) traveling time.

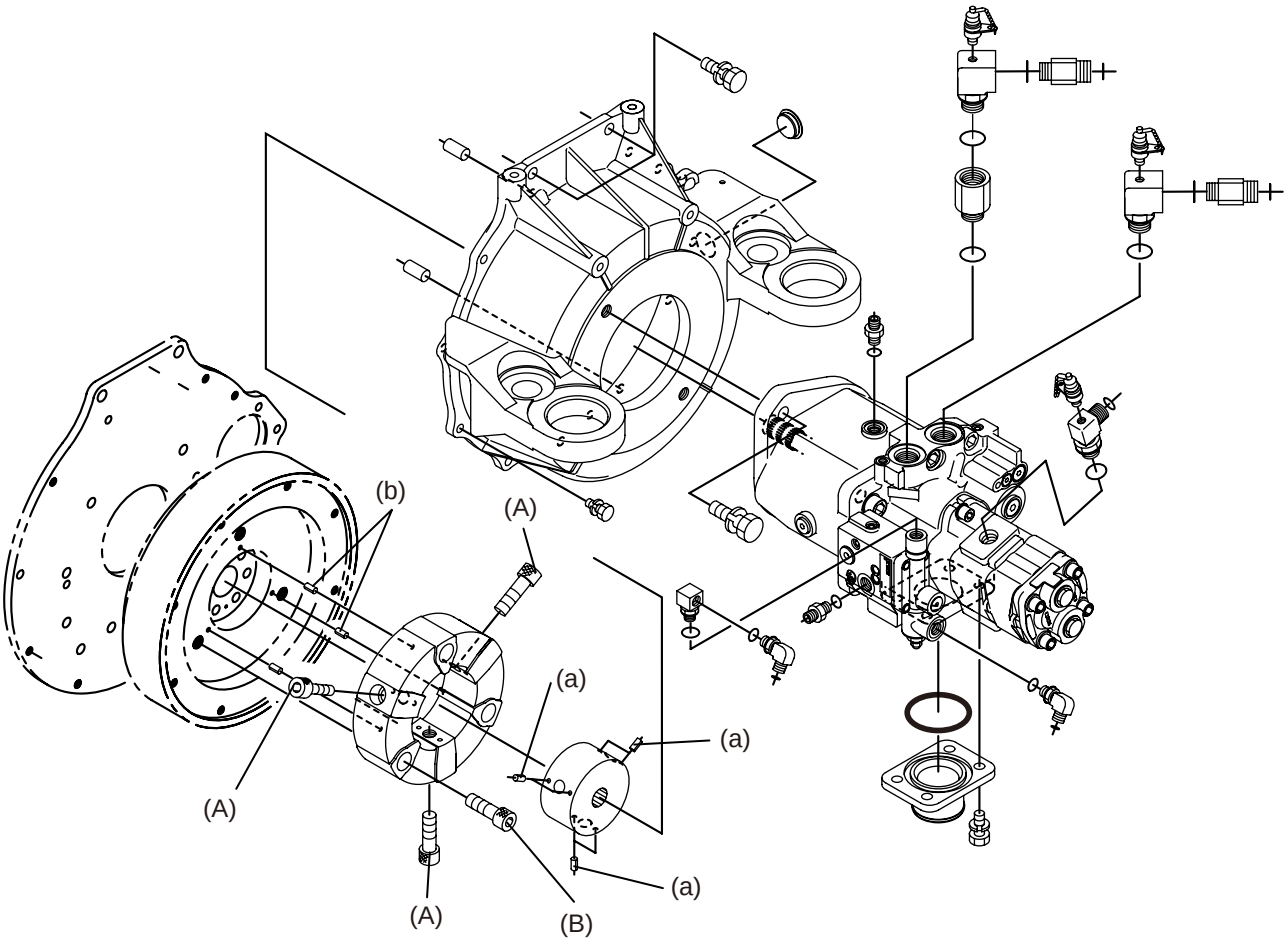
p. Straight travel performance



1. Travel the machine untill getting max. speed.
2. Measure the vertical distance from the traveling line.

D.Disassembling and Reassembling

a. Coupling flange

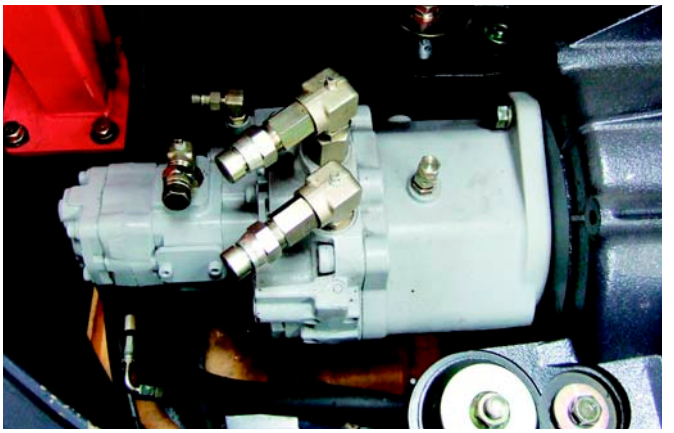


1. Apply a proper amount of grease on the splines.
   • Otherwise the splines may get burnt, making it difficult to remove the pump.
2. Keep the rubber free from grease. Immediately wipe it clean if stained with grease.
   • Otherwise the rubber may get deteriorated by the grease.
3. Fitting the coupling.
4. Tightening torque of the coupling mounting bolt: 210~230N·m, 21.4~23.5 kgf·m, 155~170 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.

A **Assembly procedure of coupling flange**

A) First tighten this bolts, aligning the spring pin (a).
B) Second tighten this bolts, aligning the spring pin (b).



b.Pump

1. Pump assy dismount

1. Disconnect the delivery hoses
2. Plug the joints.



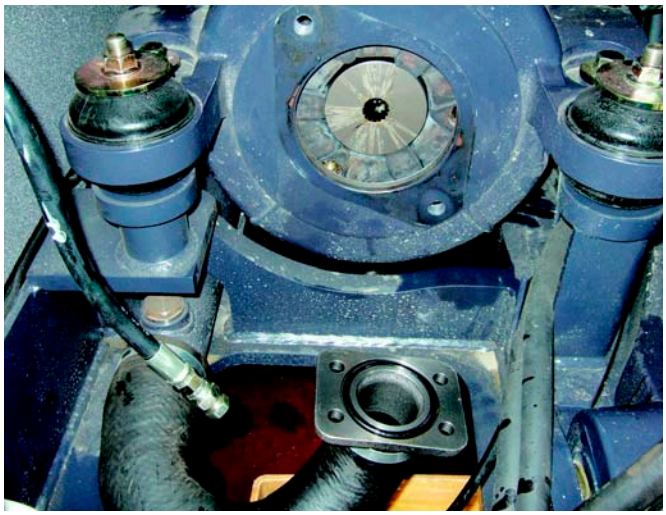
3. Remove the section hose below the pump.



4. Wound the nylon sling around the pump and remove the mounting bolts.



5. Lift up the pump assy.



6. View after pump discounting.

2.Adaptor and joint

1)Fitting the adaptor

Position the adaptor in position as shown at left.

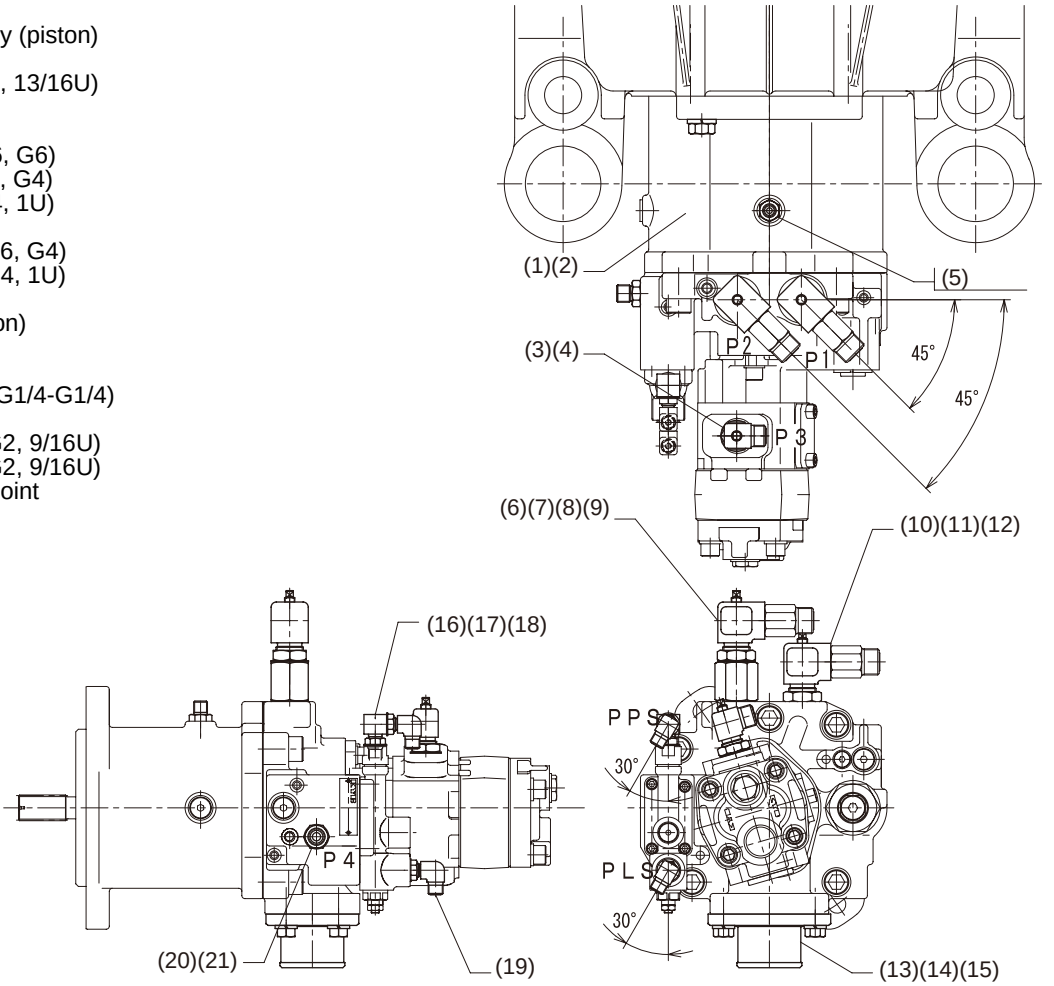
2)Adaptor tightening torque

G1/4 size
24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs
G3/8 size
37.2~42.1N.m(3.8~4.3kgf.m)27.4~31.1ft.lbs
G1/2 size
58.8~63.7N.m(6.0~6.5kgf.m)43.4~47.0ft.lbs
G3/4 size
117.6~127.4N.m(12.0~13.0kgf.m)86.7~94.0 ft.lb

3)Bolt tightening torque

196.1~225.6N.m(20.0~23.0kgf.m)144.6~166.4 ft.lbs

(1)Pump assembly (piston)
(2)Bolt
(3)Pipe joint (LG4, 13/16U)
(4)Plug
(5)Adaptor
(6)Pipe joint (SG6, G6)
(7)Pipe joint (LG6, G4)
(8)Pipe joint (SG4, 1U)
(9)Plug
(10)Pipe joint (LG6, G4)
(11)Pipe joint (SG4, 1U)
(12)Plug
(13)Flange (suction)
(14)O ring
(15)Bolt
(16)Pipe joint (L, G1/4-G1/4)
(17)O ring
(18)Pipe joint (SG2, 9/16U)
(19)Pipe joint (SG2, 9/16U)
(20)Straight pipe joint
(21)O ring



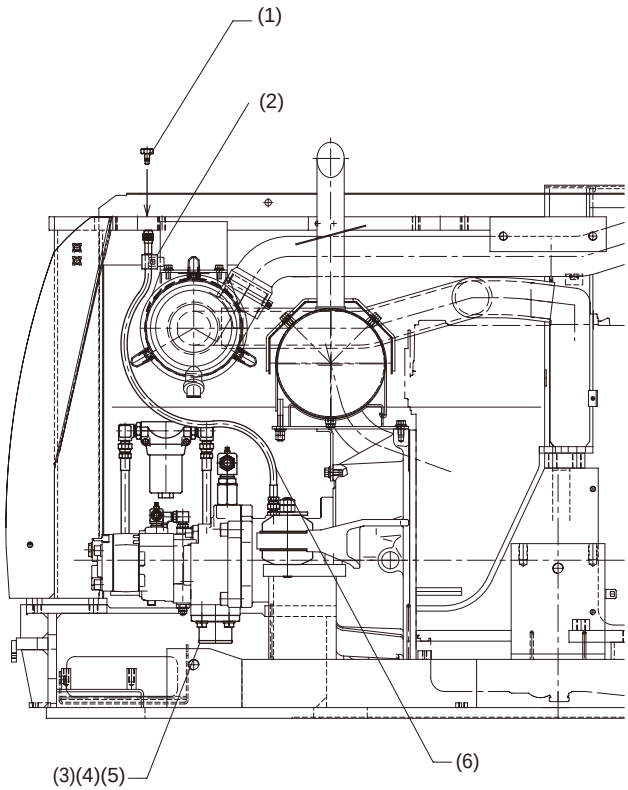
4)Fitting the flange (Suction)
Be careful to install the O ring in position.

5)Bolt tightening torque
77.5~90.2N.m(7.9~9.2kgf.m)57.2~66.5ft.lbs

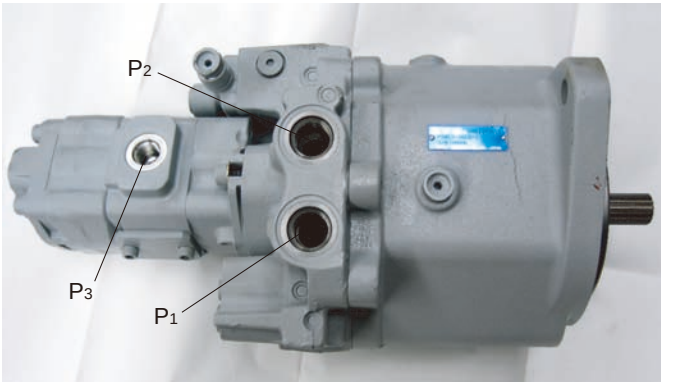
6)Fitting the hydraulic hose (3/16)
Lay the hose in the route as shown at left.
Make sure the hose is tightly hooked. Press-fit the hose until it clicks. (If not, reconnect it.)
Finally gently pull the hose to make sure it does not come off.

7)Fitting the plug (Easy Touch)
Fit the plug tight enough.

Notes:
1. To pour hydraulic oil, remove the plug (Easy Touch). After adding the oil, be sure to attach the plug (Easy Touch). Then get the engine started.
2. With the plug (Easy Touch) in place, pull it gently to make sure it does not come off.



(1)Plug (Easy Touch)
(2)Insert the clamp through the member welded on the arch.
(3)Flange (suction)
(4)O ring
(5)Bolt
(6)Hydraulic hose (3/16)

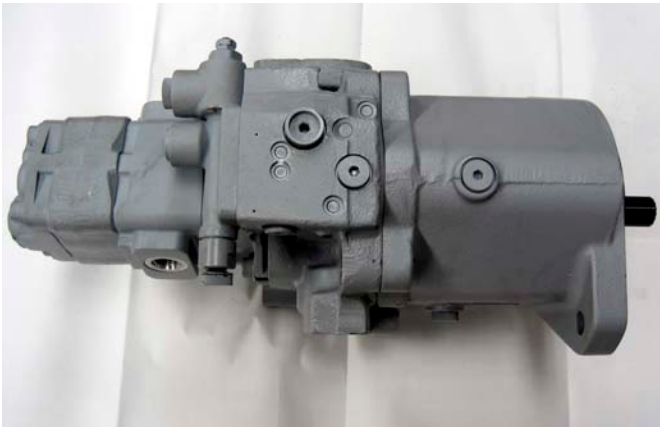


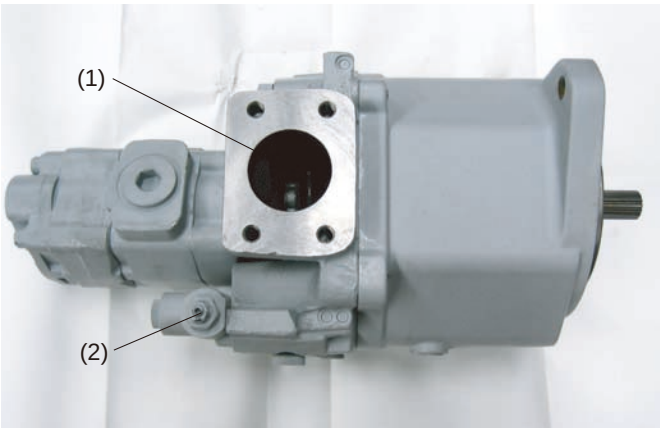
3.Disassembly and reassembly

1)Outer view

Delivery port.

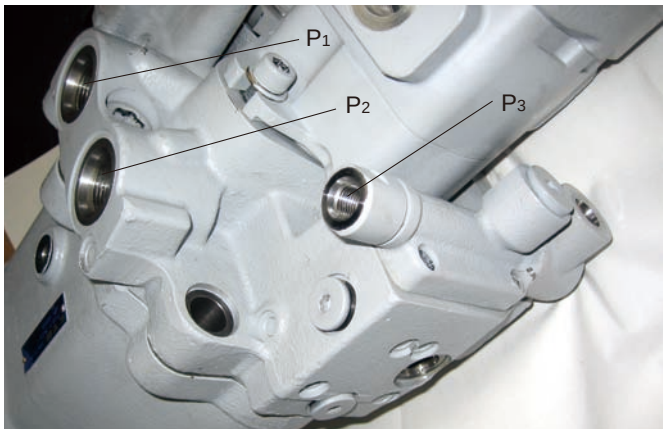
P_1
P_2
P_3



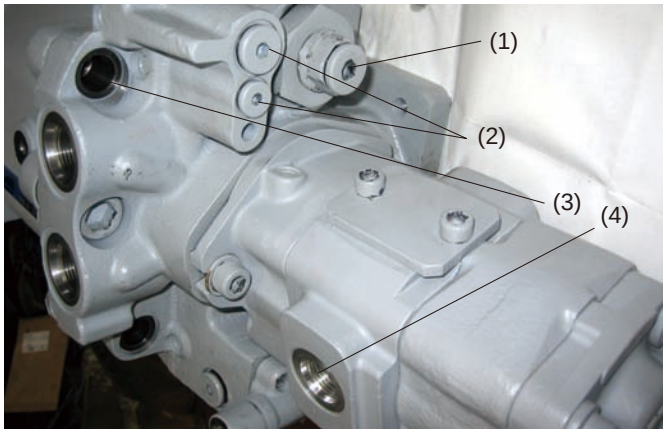


(1)Inlet port.
(2)LS control valve.





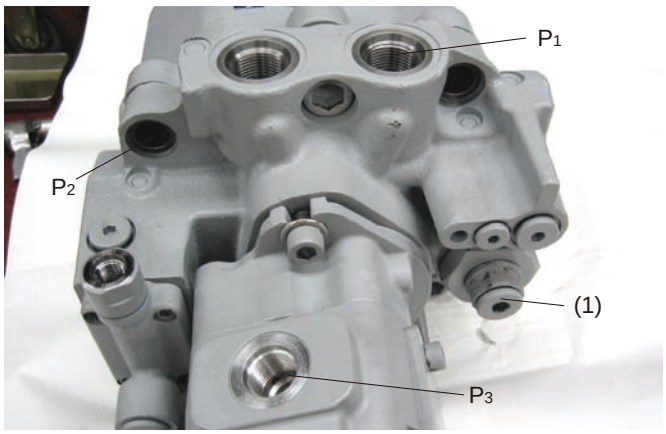
P_1
P_2
P_{LS}



(1)Horse power control valve.
(2)Horse power sensing spools.

(3) $\frac{P_1+P_2}{2}$

(4)P3



Delivery port
P_1
P_2
P_3
(1)Horse power control valve

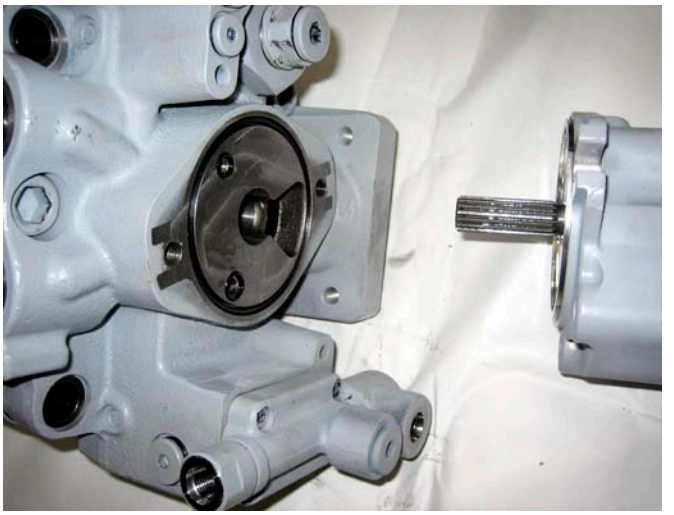


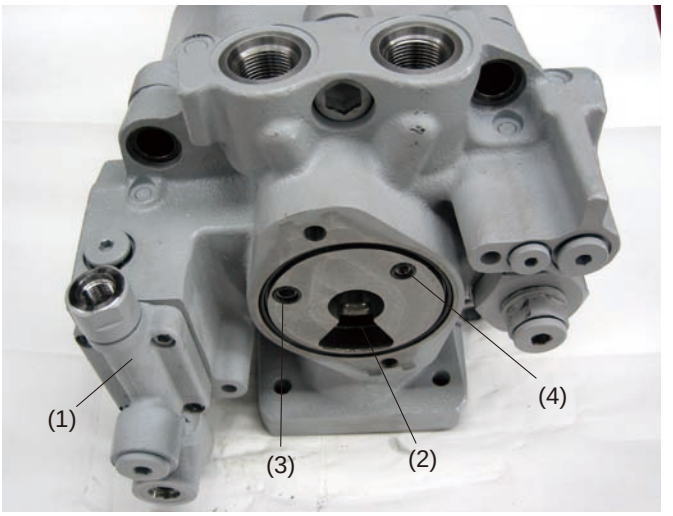
(4) P_3 delivery port
(5) P_{LS} port
(6) P_{PS} port



4.Remove gear pump.

Bolt size :
Wrench :
Tightening torque :



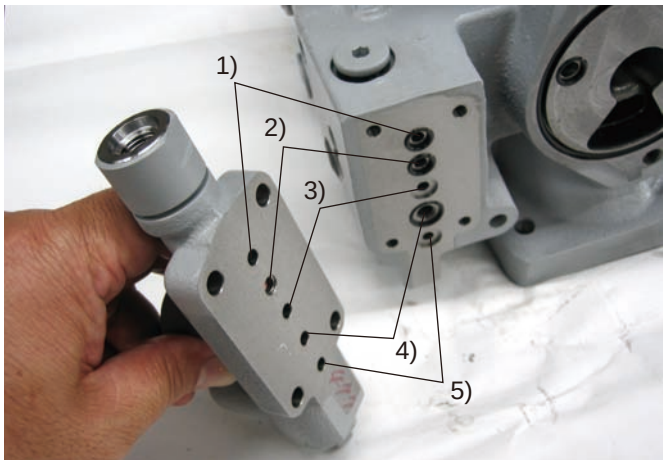


(1)LS control valve.
(2)Section port for P_3, P_p
(3)Delivery port of P_3
(4)Horsepower sensing line of P_3

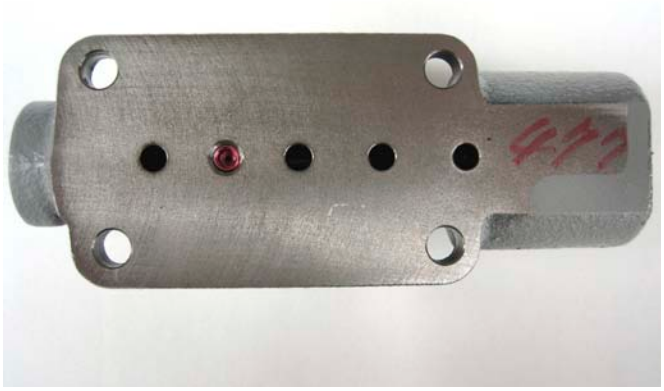


5. Remove LS control valve

1) Remove the mounting bolts.
   Bolt size :
   Wrench :



2) LS control valve.
   5 ports
   1) Pump pressure sensing line
   2) HPC pilot line
   3) HPC pilot line
   4) Pilot pump pressure after the fixd orifice
   5) Pilot pump pressure before the fixed orifice
   6) Pps port





3) Inner parts.



6. Remove horsepower control valve

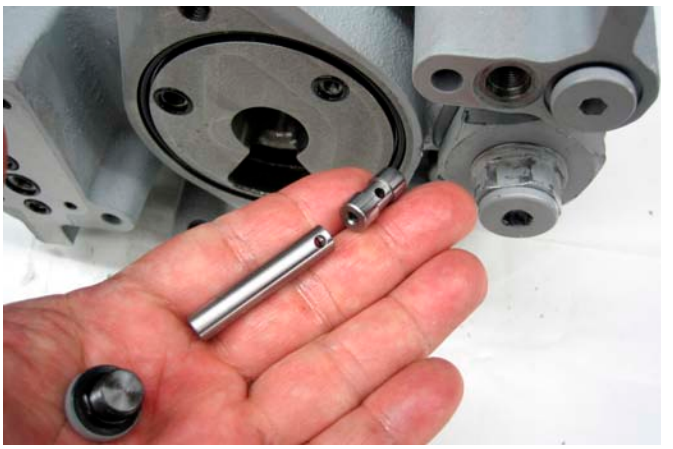
1) Horsepower control valve punch the mating mark before disassembling.



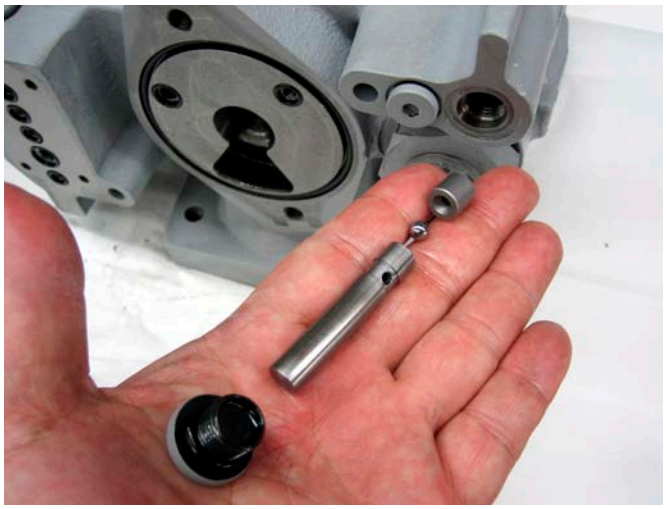
2) Take out the valve assy.



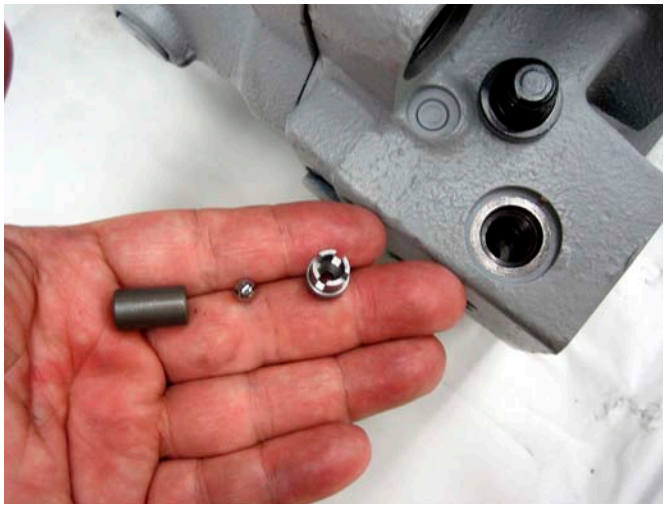
3) Inner parts.



4) Average pressure sensing puppet.



5) Max pump pressure selection check valve.



6) Check valve for Pc bypass.

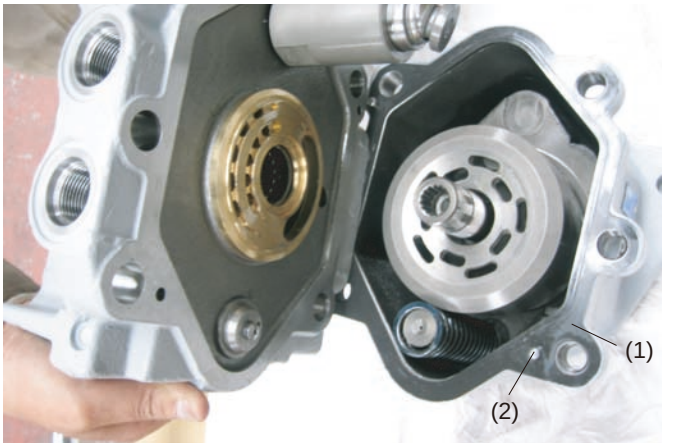


7. Remove the valve block assy

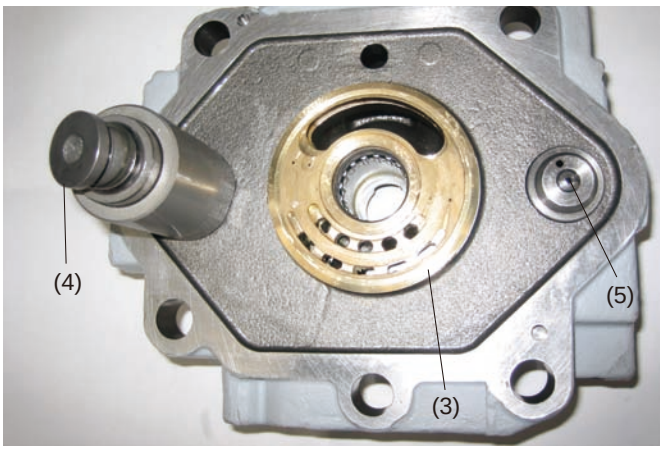
1) Remove the mounting bolts.
   Bolt size :
   Wrench :
   Tightening torque :



2) Rear view of the valve block.



3) Separate the valve block.
   (1)Gasket
   (2)Knock pins



4) View from above.
   (3)Valve plate
   (4)Control plate
   (5)Horsepower control pin



5) Control pin.



6) Control pin body.



7) Take out the valve plate.







8) Take out the spacer ring.

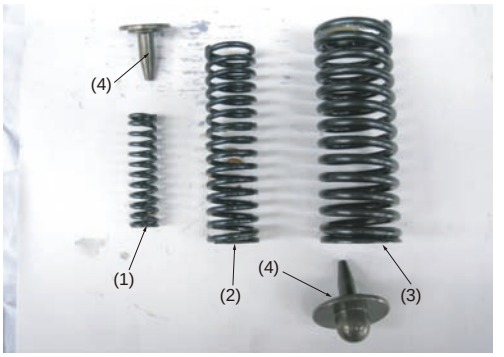


8. Remove the cylinder block assy

1) Take out the gasket.



2) Take out the control spring assy.



3) Springs

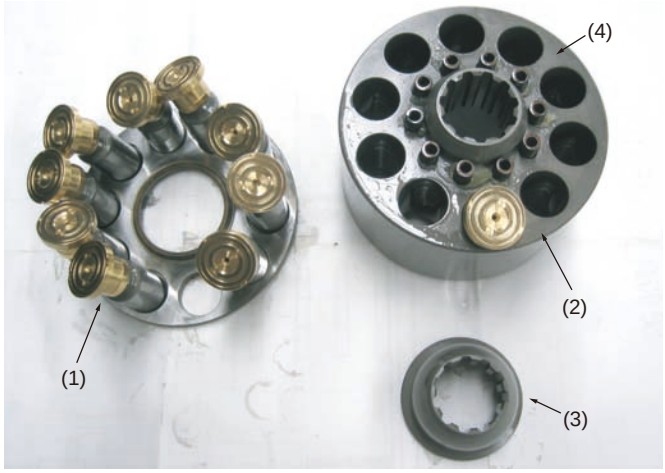
(1)Inner control spring
(2)Outer control spring
(3)Assist spring
(4)Spring seat



4) Take out the cylinder block assy.



5) Swash plate and cylinder block.



6) Inner parts of the cylinder block

(1)Pistons
(2)Cylinder
(3)Cone
(4)Springs



7) Springs



8) Piston



9) Spring seat



9. Remove the main shaft

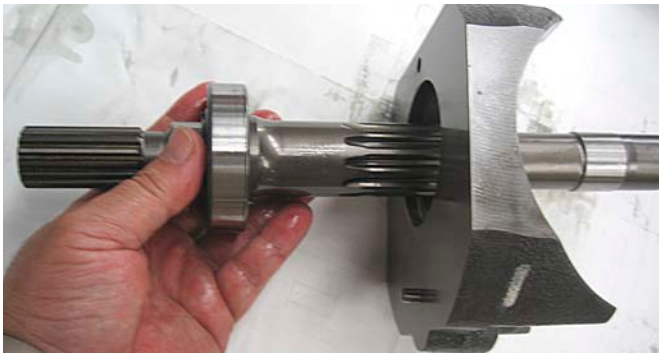
1) Remove the mounting bolts.
   Bolt size :
   Wrench :
   Tightening torque :



2) Punch out the main shaft.



3) Take out the shaft and the flange.



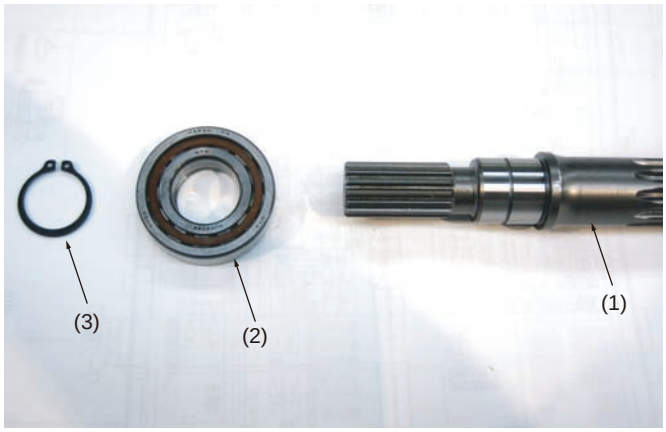
4) Take out the shaft.



5) Remove the snap ring.



6) Punch out the bearing.



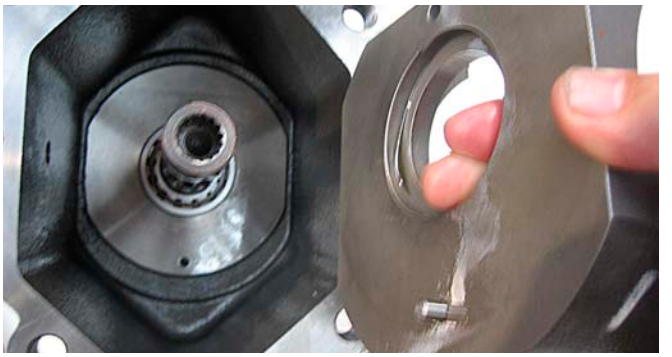
7) Disassembled parts.

(1)Main shaft
(2)Bearing
(3)Snap ring



10. When reassembling

1) Install the snap ring



2) Install the flange

(1)Knock pin



3) Tighten the flange bolt



4) Assemble the pistons and springs.
In principle, each piston should be in the original cylinder barrel.
As a mark, one piston and one spring should be remained for remembrance.



5) Assemble and inner parts and gasket.
Subsequent reassembly procedure is just the reverse to the disassembly.



c.Gear pump (P_3, P_p)

Disassemble and reassemble

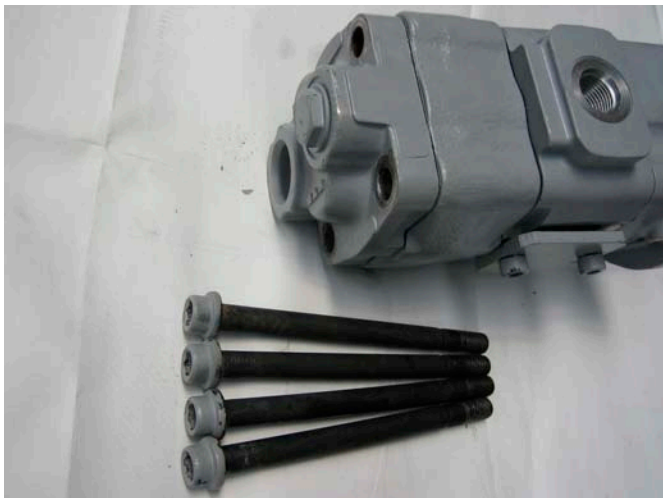
1. Outer view
   1) Output shaft
   2) P_3 delivery port



   3) P_p delivery port



2. Remove mounting bolts
   L-wrench=M10
   Tightening torque:



3. Mounting bolts
   M12 x 152



4. Remove the end cover.



5. Remove the casing of the pump 3.



6. Take out the gears and the plates.
   1) P_3 pears 12T x 43.55
   2) Plates



7. Remove the snap ring.



8. Separate the front flange and pilot pump housing
   1) Front flange
   2) Output shelf
   3) Pilot pump gear, T12 x 10.60
   4) Plates



9. Inner parts



   1) Pressure side (delivery)
   2) Suction side

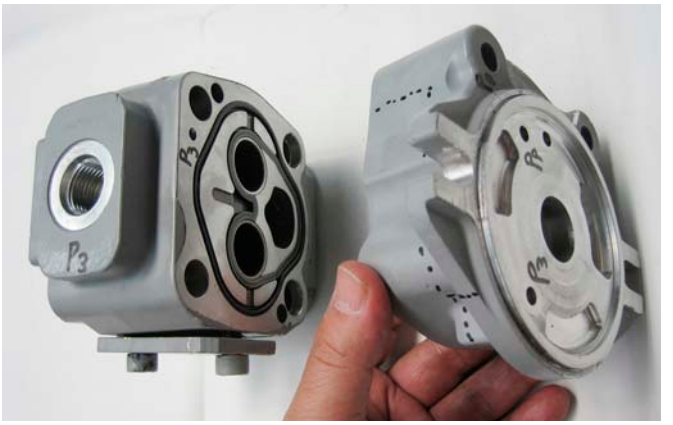


10. Remove the side cover. Take out the yoke gear.



11. When reassembling Securely check the direction and face of the plate.
    1) Delivery side
    2) Suction side

12. Oil passage
    1) Pump 3 sensing line



13. Oil passage
    2) Pilot pump delivery port



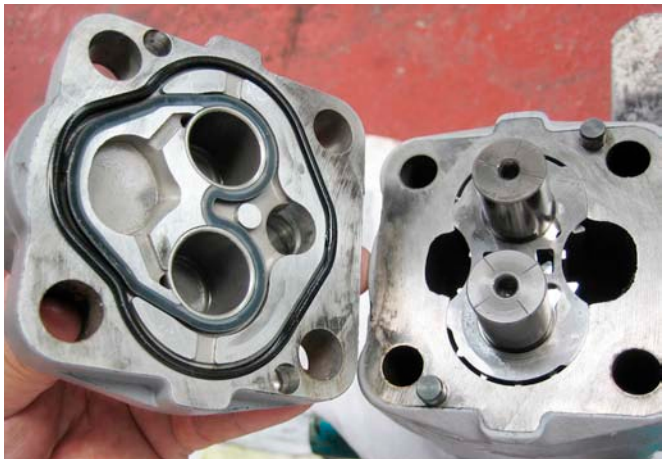
14. Oil passage
    1) Pump 3 sensing line
    2) Pilot pump delivery port



15. When reassembly:
    Insert the drive and driven gears of P3.



16. Securely check the direction and face of side plate.



17. Check the seal; rings and knock pin.

d.Control valve

1.Adaptor and joint

1)Fitting the valve assembly (control), bracket (1, valve), bracket (2, valve) and bracket (3, valve) Set them up in the following steps.

a)Fit the three brackets (1, valve) (2, valve) and (3, valve) onto the valve assembly (control). Temporarily tighten the bolts.

b)Place the valve assembly (control) on the base (valve).

c)Tighten up the bolts (1) specified in the figure to fix the bracket (3, valve) onto the base (valve).

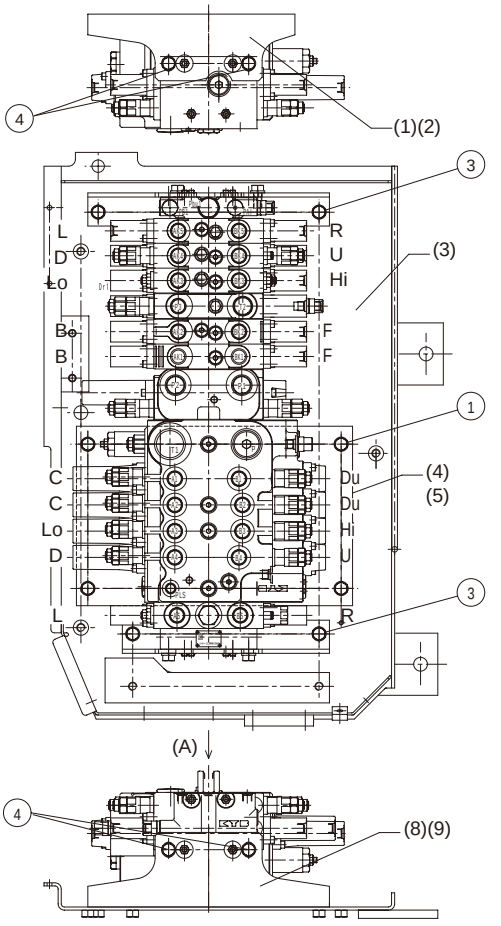
d)Tighten up the bolts (2) specified in the figure to fix the valve assembly (control) to the bracket (3, valve).

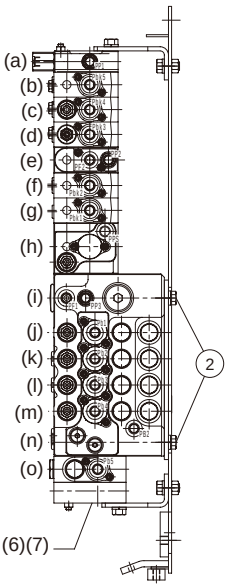
e)Tighten up the bolts (3) specified in the figure to fix the brackets (1, valve) and (2, valve) onto the base (valve).

f)Finally tighten up the bolts (4) as shown at left to fix the valve assembly (control).

2)Bolt tightening torque
77.5~90.2N.m(7.9~9.2kgf.m)57.2~66.5ft.lbs

3)Fitting the adaptor
Fit the adaptor referring to the instructions on the next page.t





(A)(Machine front)

L:(Left)
R:(Right)

D:(Down)
Lo:(LOW)
B:(Backward)
C:(Crowded)
U:(Up)
Hi:(HIGH)
F:(Forward)
Du:(Dump)

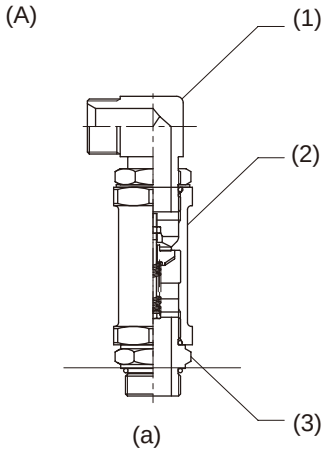
(1)Bracket (1, valve)
(2)Bolt
(3)Base (valve)
(4)Bracket (3, valve)
(5)Bolt
(6)Valve assembly (control)
(7)Bolt
(8)Bracket (2, valve)
(9)Bol

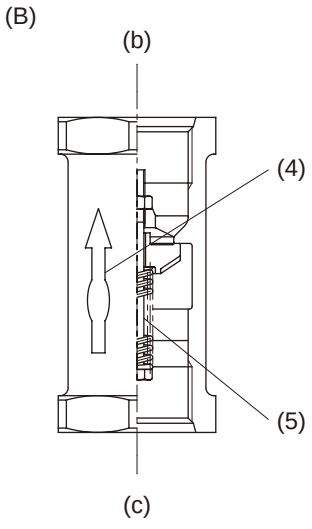
(a)(P3 confluence)
(b)(Swivel)
(c)(Dozer)
(d)(SP2)
(e)(P3, T2)
(f)(Travel left)
(g)(Travel right)
(h)(P1, P2)
(i)(T1)
(j)(Arm)
(k)(Bucket)
(l)(SP1)
(m)(Boom)
(n)(PLS)
(o)(Swing)

4)Adaptor tightening torque
G1/4 size
24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs
G3/8 size
37.2~42.1N.m(3.8~4.3kgf.m)27.4~31.1ft.lbs
G1/2 size
58.8~63.7N.m(6.0~6.5kgf.m)43.4~47.0ft.lbs
G3/4 size
117.6~127.4N.m(12.0~13.0kgf.m86.7~94.0ft.lbs
G1-1/4 size
220.5~230.3N.m(22.5~23.5kgf.m)
162.6~169.9ft.lbs
7/8-14UNF size
55.9~60.8N.m(5.7~6.2kgf.m)41.2~44.8ft.lbs

5)Tightening torque of the adaptor of port T1 Pipe joint (SG12, G12) Valve assembly (return) Pipe joint (LG12, G12)
G1-1/4 size
220.5~230.3N.m(22.5~23.5kgf.m)
162.6~169.9ft.lbs
G1-1/4 size
85.0~100.0N.m(8.7~10.2kgf.m)62.7~73.8ft.lbs
G1-1/4 size
85.0~100.0N.m(8.7~10.2kgf.m)62.7~73.8ft.lbs

6)Fitting direction of the valve assembly (return) (RD809-6351Δ)
Fit the assembly in position as shown at left.





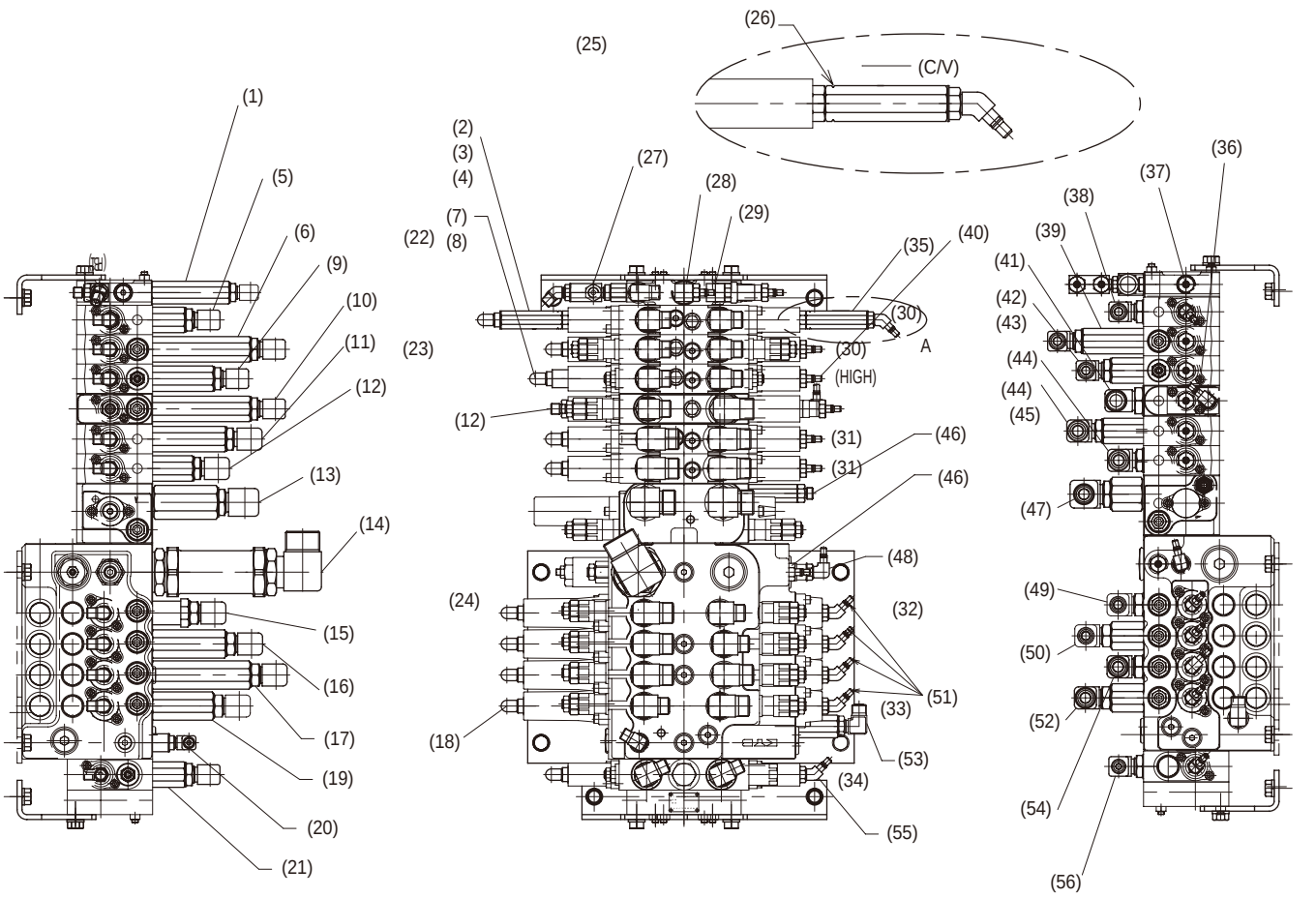
(A)Adaptor at port T1
(B)Fitting direction of the valve assembly (return)

(a)(Control valve side)
(b)(Return pipe side)
(c)(Control valve side)

(1)Pipe joint (LG12, G12)
(Tightening torque)
85.0~100.0N.m
(8.7~10.2kgf.m)62.7~73.8ft.lbs
(2)Valve assembly (return)
(Tightening torque)
85.0~100.0N.m
(8.7~10.2kgf.m)62.7~73.8ft.lbs
(3)Pipe joint (SG12, G12)
(Tightening torque)
220.5~230.3N.m(22.5~23.5kgf.m)
162.6~169.9ft.lbs
(4)Set up the assembly with the outer arrow mark pointing upward.
(5)Look into the inside and make sure the nut head faces toward the control valve.

1.Fitting the valve assembly

Fit the assembly in position as shown at left.
Tightening torque
24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs

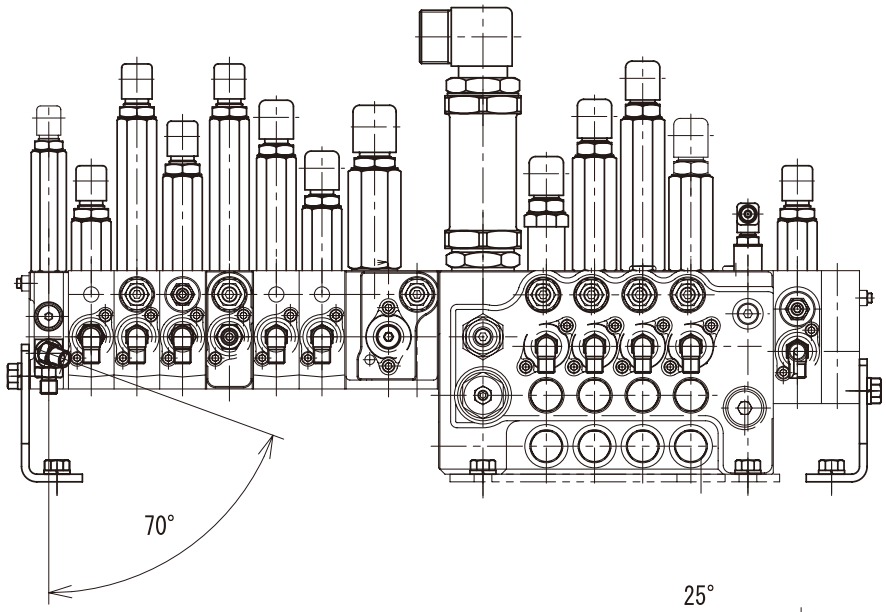


(1)Pipe joint
(2)Pipe joint
(3)O ring
(4)Valve assembly (check)
Pipe joint
(5)Pipe joint
Pipe joint
O ring
(6)Pipe joint
Pipe joint
(7)Pipe joint
Pipe joint
(8)O ring
(9)Pipe joint
Pipe joint
(10)Pipe joint
Pipe joint
(11)Pipe joint
Pipe joint
(12)Pipe joint
Pipe joint
O ring
Adaptor
O ring
(13)Pipe joint
Pipe joint
(14)Pipe joint
Valve assembly (return)
Pipe joint

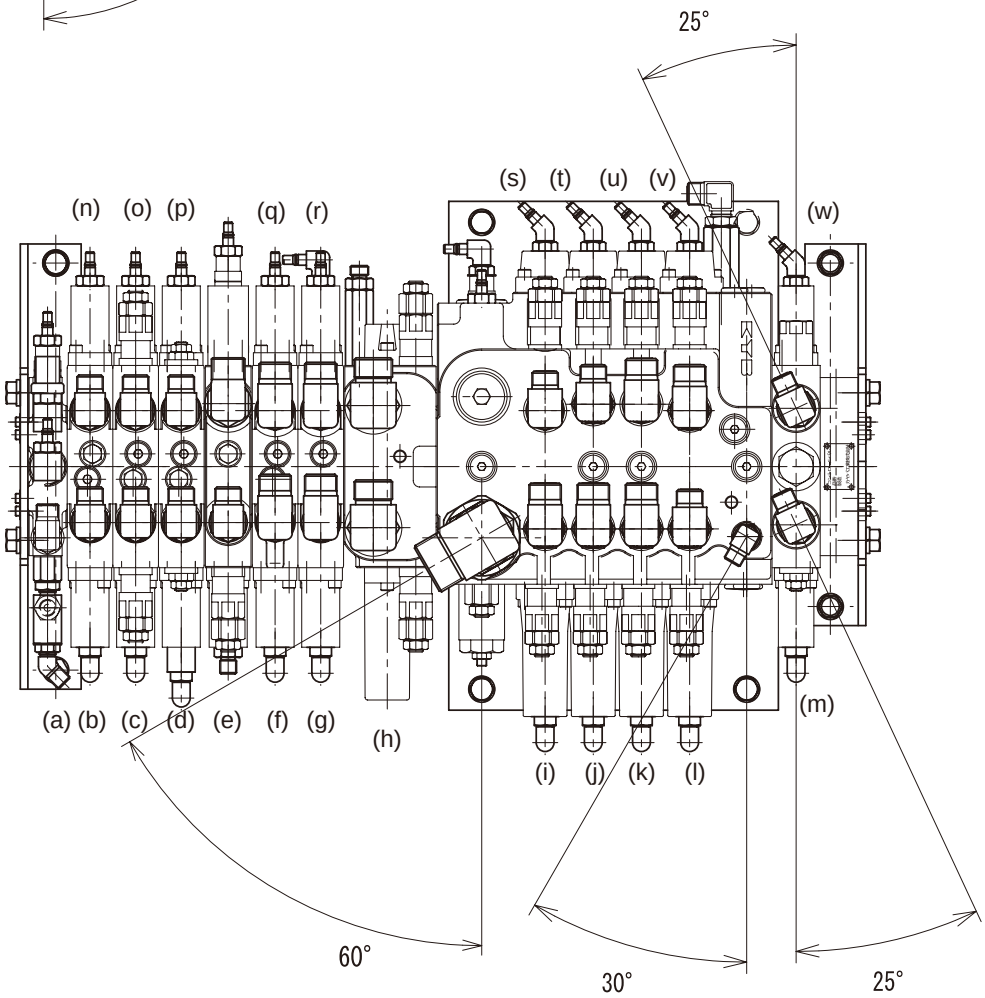
(15)Pipe joint
Pipe joint
(16)Pipe joint
Pipe joint
(17)Pipe joint
Pipe joint
(18)Pipe joint
(19)Pipe joint
Pipe joint
(20)Pipe joint
(21)Pipe joint
Pipe joint
O ring
(22)[PS bypass]
(23)[Swivel] (left)
[Dozer] (bottom)
[S/P2] (low)
[Confluence valve]
[Travel] (left backward)
[Travel] (right backward)
[Travel independent valve
(24)[Arm] (bottom)
[Bucket] (bottom)
[S/P] (low)
[Boom] (rod)
[Swing] (left)
(25)Set up the assembly with the groove toward the C/V as shown at left.

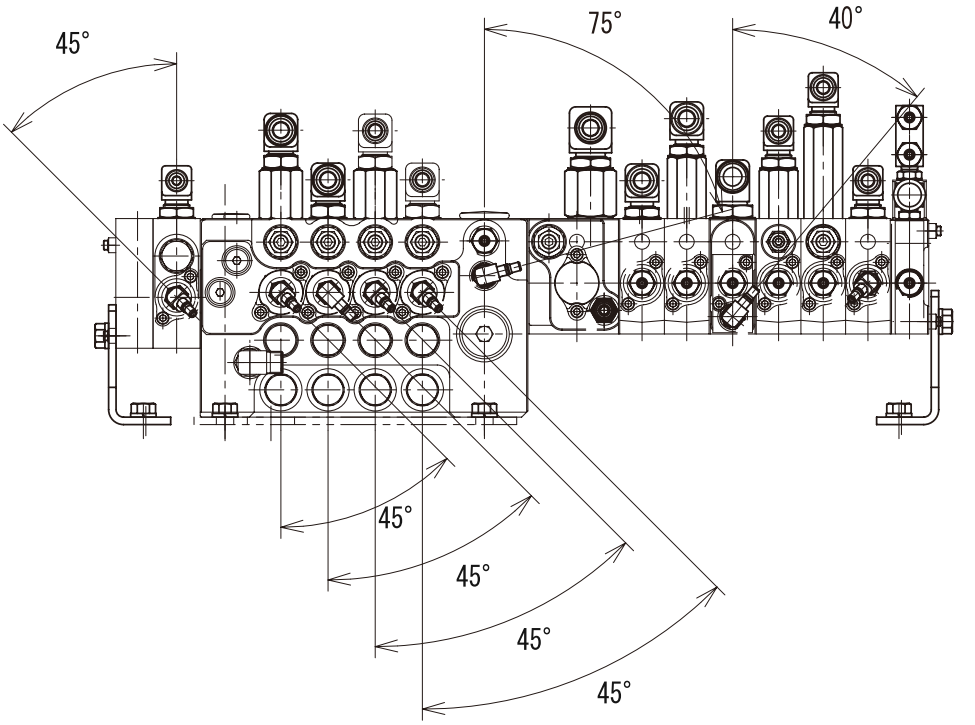
(26)Groove
(27)Pipe joint
O ring
Pipe joint
Adaptor
O ring
Pipe joint
O ring
(28)Pipe joint
Pipe joint
(29)Pipe joint
O ring
Switch
O ring
(30)(Right)
(Rod)
(31)(Left forward)
(Right forward)
(32)(Rod)
(Rod)
(33)(Bottom)
(34)(Right)
(35)Pipe joint
O ring
Valve assembly (check)
Pipe joint
(36)Pipe joint
(37)Pipe joint
(38)Pipe joint

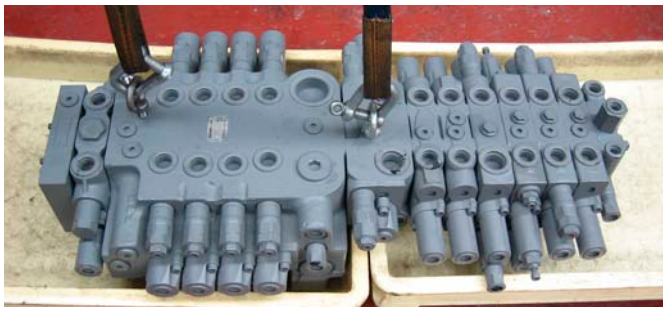
(39)Pipe joint
Pipe join
(40)Pipe joint
(41)Elbow pipe joint
(42)Pipe joint
Pipe joint
(43)O ring
(44)Pipe joint
Pipe joint
Pipe joint
(45)O ring
(46)Pipe joint
Pipe joint
Pipe joint
(47)Pipe joint
Pipe joint
(48)Pipe joint
(49)Pipe joint
(50)Pipe joint
Pipe joint
(51)Pipe joint
(52)Pipe joint
Pipe joint
(53)Pipe joint
Pipe joint
(54)Pipe joint
(55)Pipe joint
(56)Pipe joint



(a)[PS bypass]
(b)[Swivel] (left)
(c)[Dozer] (bottom)
(d)[S/P2] (low)
(e)[Confluence valve]
(f)[Travel] (left backward)
(g)[Travel] (right backward)
(h)[Travel independent valve]
(i)[Arm] (bottom)
(j)[Bucket] (bottom)
(k)[S/P] (low)
(l)[Boom] (rod)
(m)[Swing] (left)
(n)(Right)
(o)(Rod)
(p)(HIGH)
(q)(Left forward)
(r)(Right forward)
(s)(Rod)
(t)(Rod)
(u)(HIGH)
(v)(Bottom)
(w)(Right)




45°
75°
40°
45°
45°
45°
45°



2.Disassembly and reassembly

(a)Valve assy disassembly

1. Lift down the control valve any by using the crane.



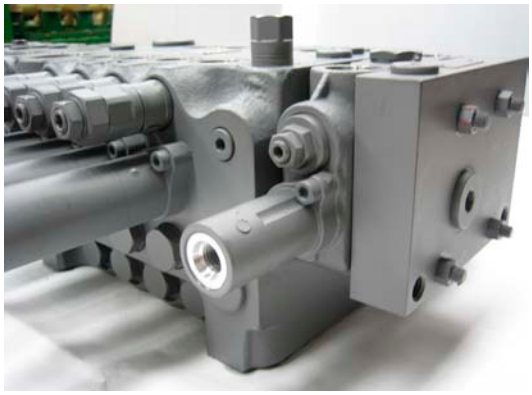
2. Lifting eye-bolt
   M10x1.5



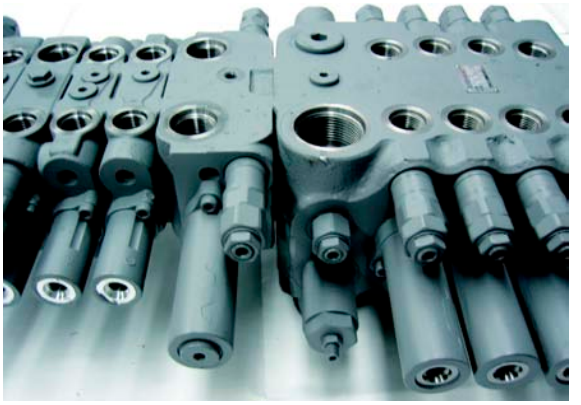
3. View from above.



4. View from side.



5. Swing shut valve portion.



6. Unload valve area.



7. Dozer, swivel section area.



8. Side view.



9. Side view, pilot port.



10. Side view, mono block pilot port.



11. Side view
    Pilot port and S/P2 section.



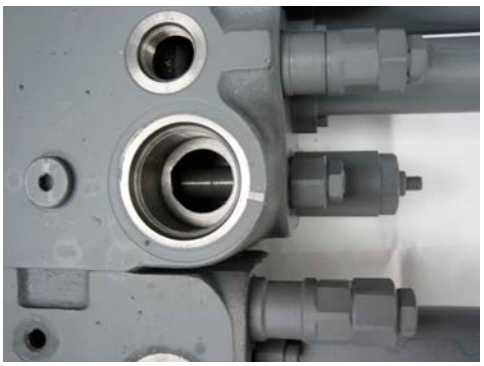
12. P_3 confluence section.



13. Screen and orifice (P_{P1})



14. Screen and orifice (P_{P2})



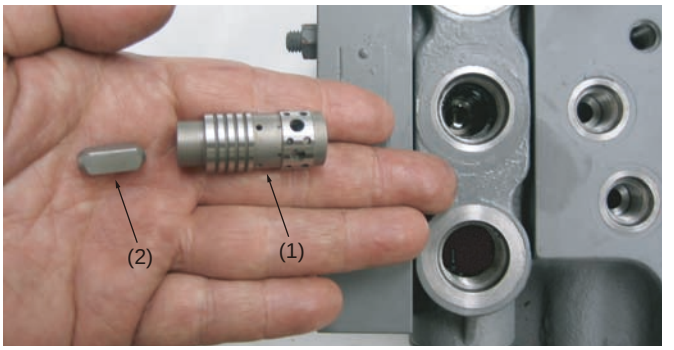
15. LS main relief valve inside.



16. P3 bypass spool



17. Plug with orifice (P_{LS})



18. Compensation spool in the swing section.

(1)Compenstaion spool
(2)High pressure selection poppet



19. Load check poppet and spring.



20. Swing section and end port plate.



21.Swing section and boom section (Mono-block)



22.Am section (Mono-block) and inlet section (Travel independent valve)



23.Inlet section (Travel independent valve) and travel R section.



24.Travel R and travel L section.



25.Travel L and P_3 inlet section.



26. P_3 inlet section and SP2 section.



27. SP2 section and dozer section.



28. Dozer section and swivel section.



29. Swivel section and P3 confluence section.



(b)Each section and inner parts

1.Inlet section (P1,P2) (Travel independent valve)

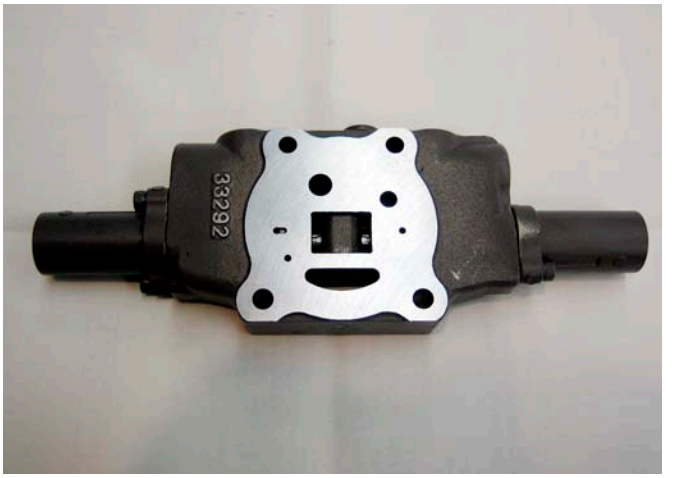
1) Outer view



2) Other side

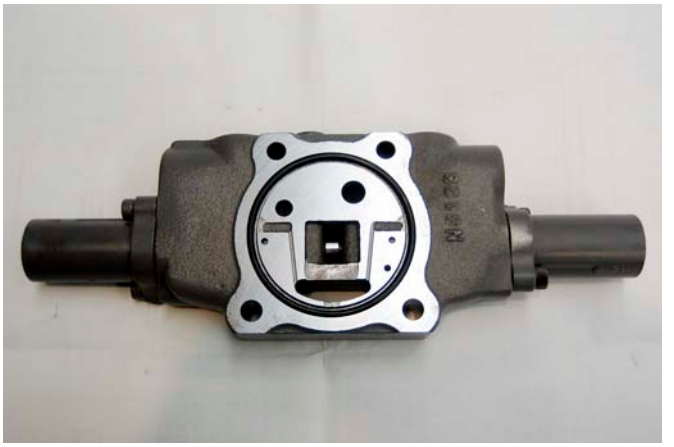


3) Inner parts

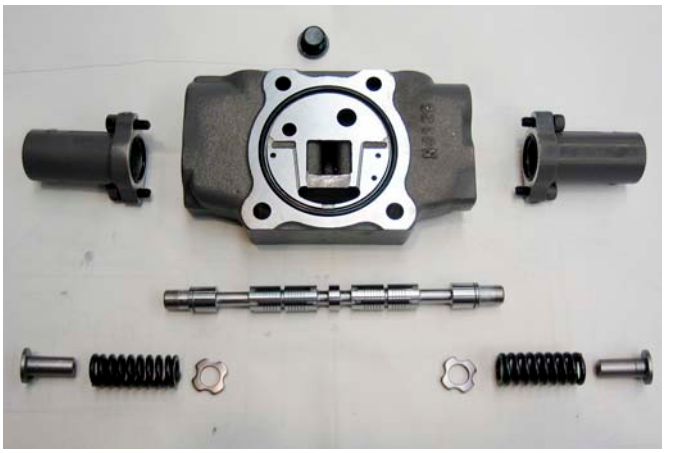


2. Travel R section

1) Outer view



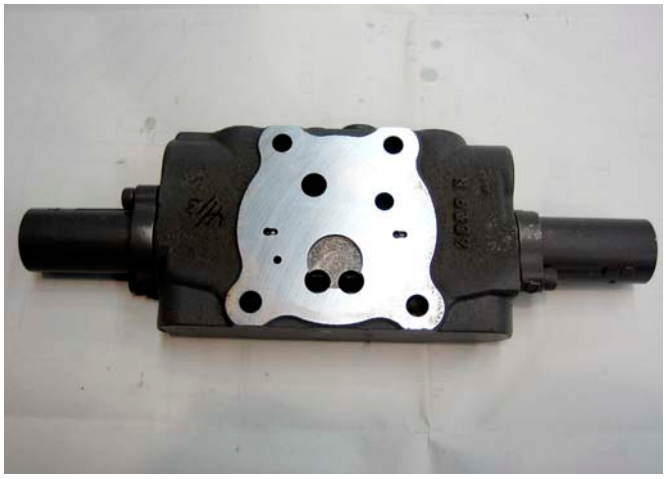
2) Other side



3) Inner parts



4) Spiral notch-type drain groove of the spool

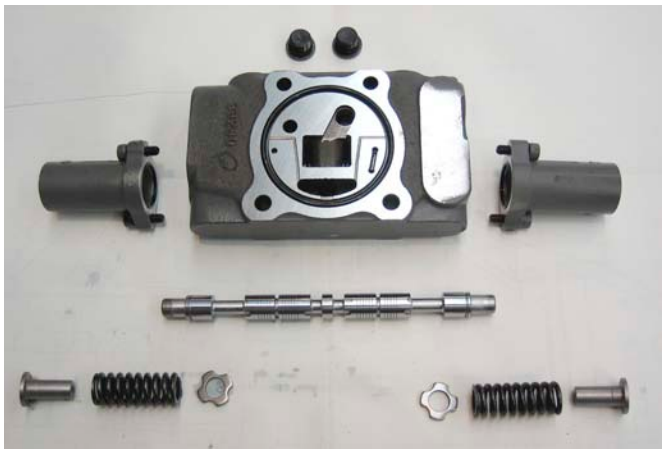


3. Travel L section

1) Outer view



2) Other side



3) Inner parts

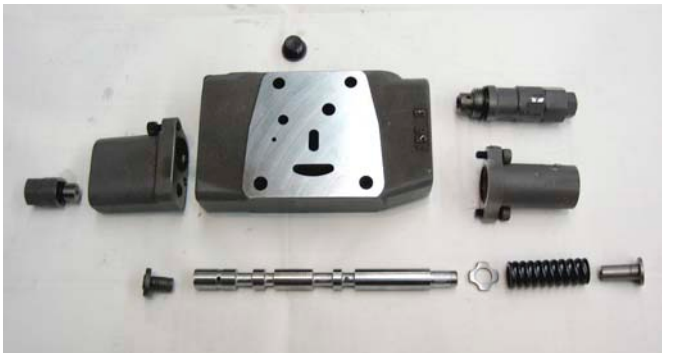


4. P_3 inlet section

1) Outer view



2) Other side



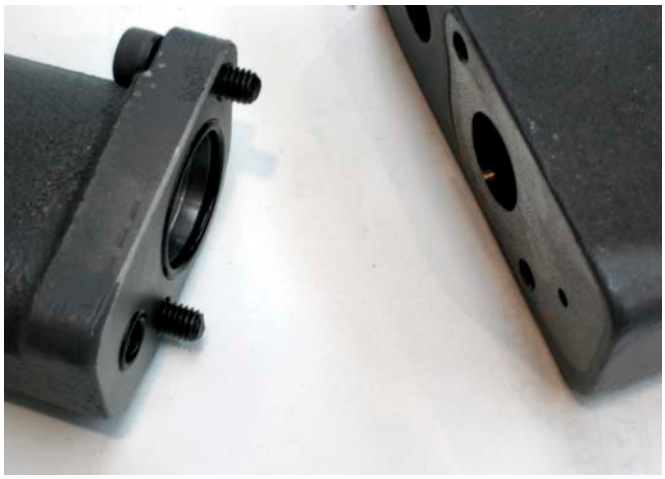
3) Inner parts



4) P_3 confluence spool



5) Pilot port



6) Pilot pressure passage



7) Orifice (P_{P2})



8) Screen (P_{P2})



9) P3 confluence section and spool.

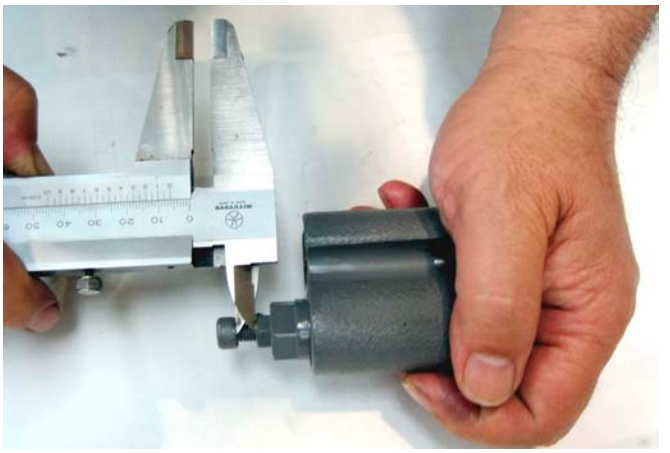


5. S_{P2} valve section

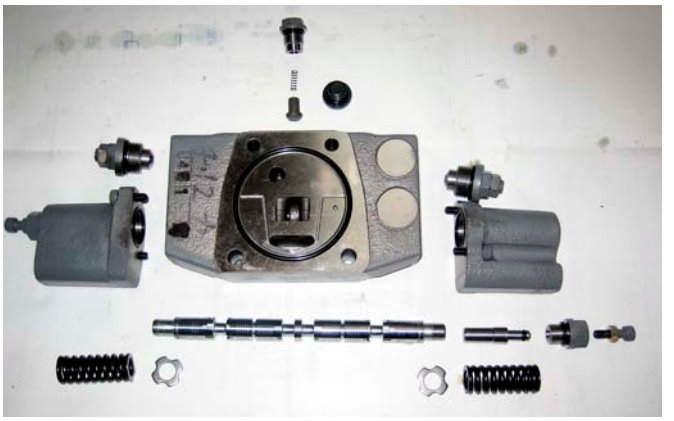
1) Outer view



2) Other side



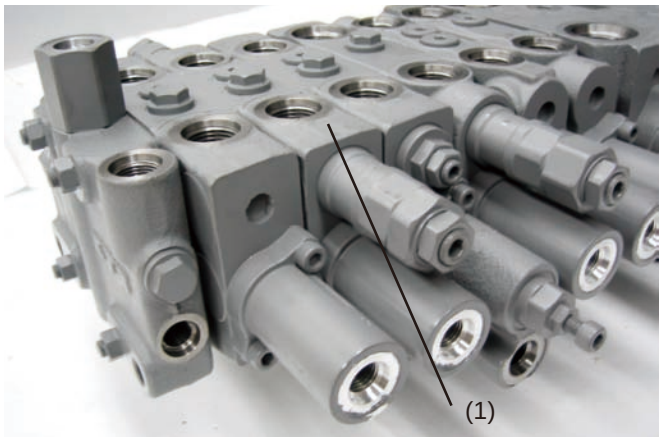
3) Adjusting bolt of SP2 spool.



4) Inner parts

6. Dozer section

1) Outer view

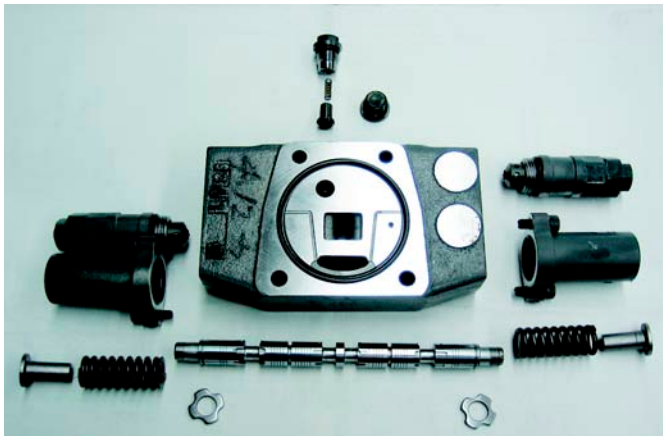


(1) Dozer section

2) Other side



3) Inner parts





7. Swivel section

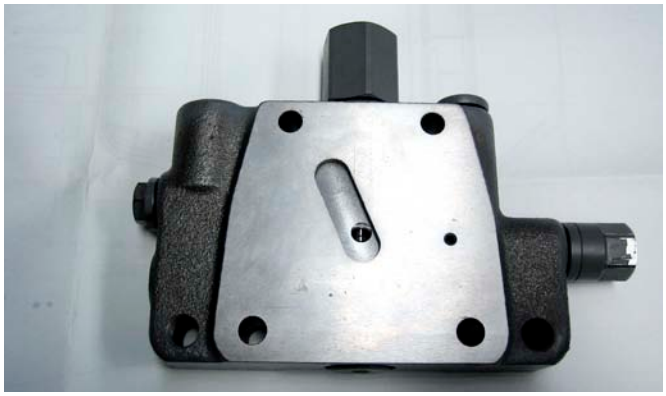
1) Outer view



2) Other side



3) Inner parts

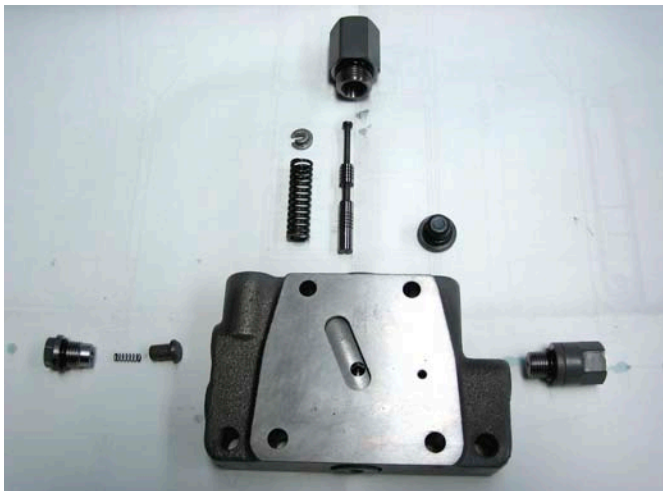


8. P_3 confluence valve

1) Outer view



2) Other side



3) Inner parts

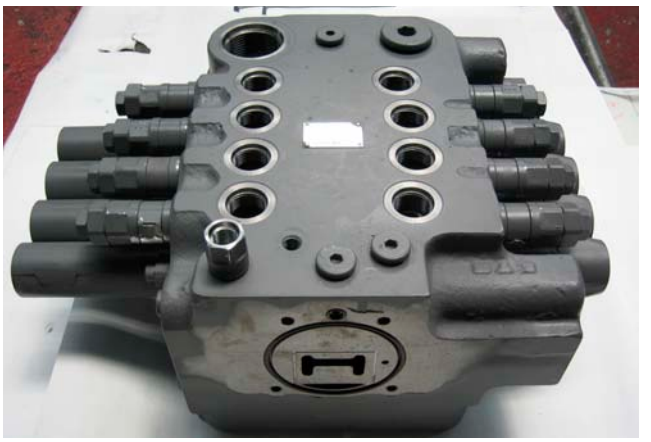


9. Mono-block valve assy

1) Outer view



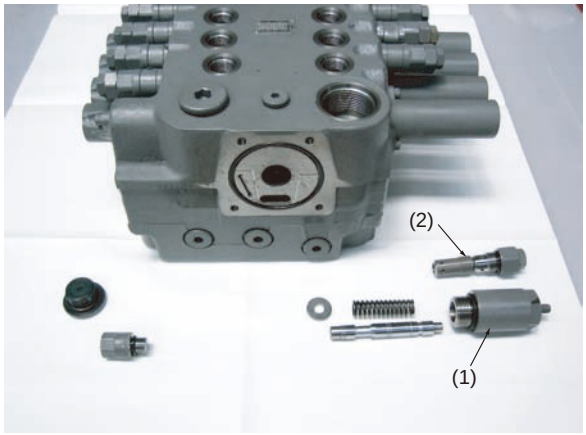
2) Other side
LS main relief valve Unload valve



3) Boom valve section.

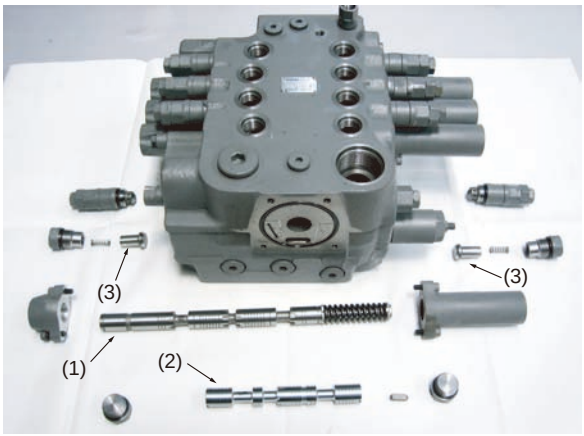


4) Arm valve section



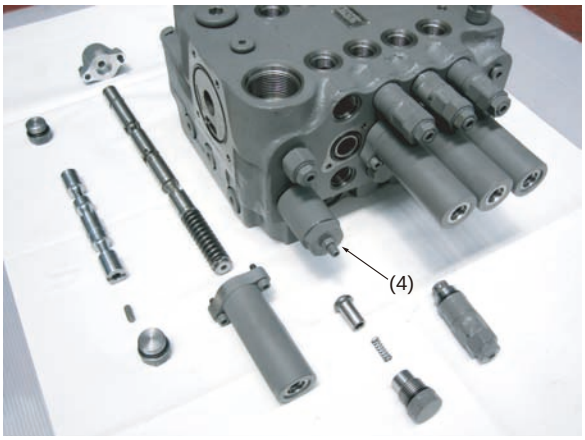
5) Inner parts

(1)LS main relief valve
(2)Unload valve



6) Inner parts Arm section

(1)Main spool
(2)Pressure compensation spool
(3)check valve



7) Side view

(4)Unload valve



8) Side view, P_{P3}

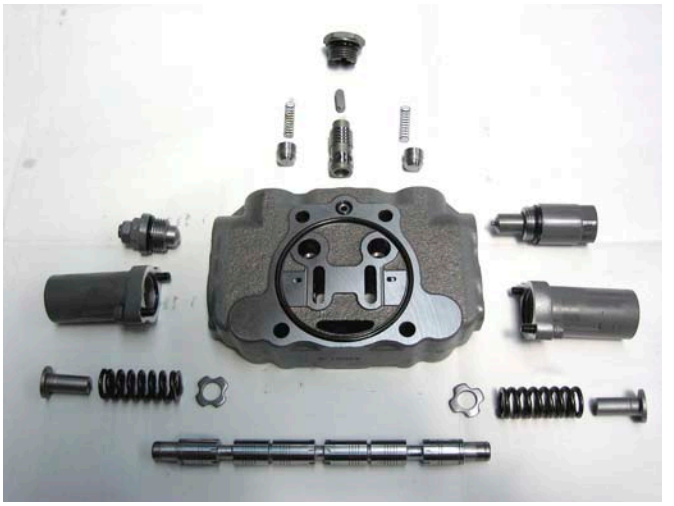


10. Swing valve section

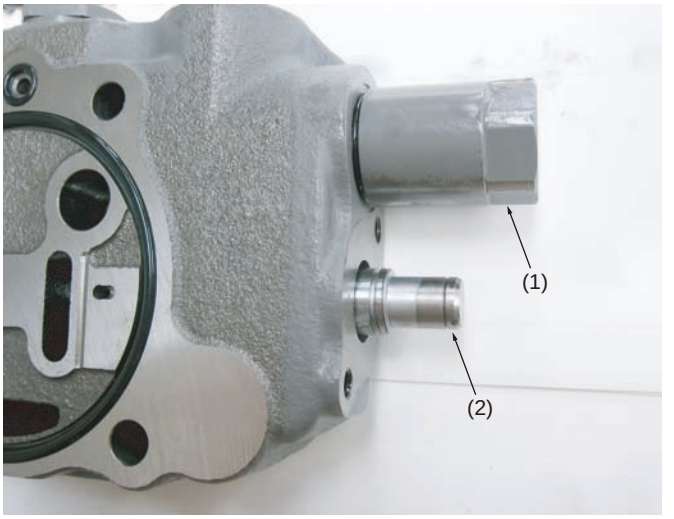
1) Outer view



2) Other side



3) Inner parts



4) Anti-void valve

(2)Spool ID mark



11. End plate

1) Tie rod

2) Tightening method of tie rod.

e. pilot valve

1.Fitting the adaptor

Port P
Filter
Pipe joint
Ports T, 1, 2, 3 and 4
Pipe joint

2.Adaptor tightening torque

G1/4 size
24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs

3.Fitting direction of the valve

Position the valve with port (2) facing the machine front.

4.Quick-coupling adaptor

Pipe joint
Make sure the hose connection is free from detrimental scratches.

5.Fitting the thermal insulation (21, cooler) and valve assembly (pilot, R)

Tightening torque
12.3~14.2N.m(1.3~1.5kgf.m)9.1~10.5ft.lbs

6.Fitting the plate (1, partition) and plate (2, partition)

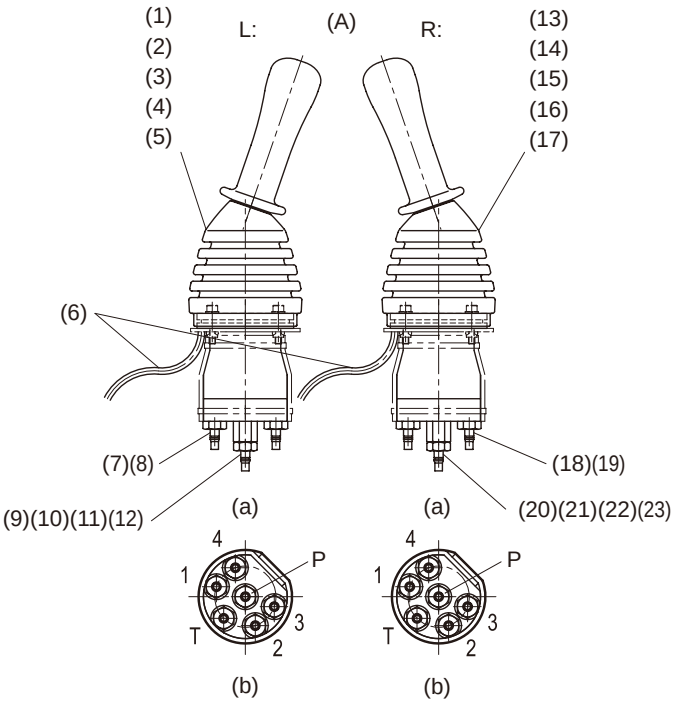
When winding the thermal insulation around the valve, be careful not to wrap the wire harness together.

Left P/V

	Location	Hose tape color
1	Swivel left	Gray
2	Arm dump	Yellowish green
3	Swivel right	Sky-blue
4	Arm crowded	Blue
P	Port P	White
T	Port T	None

Right P/V

	Location	Hose tape color
1	Bucket crowded	Orange
2	Boom down	Yellow
3	Bucket dump	Red
4	Boom up	Green
P	Port P	White
T	Port T	None

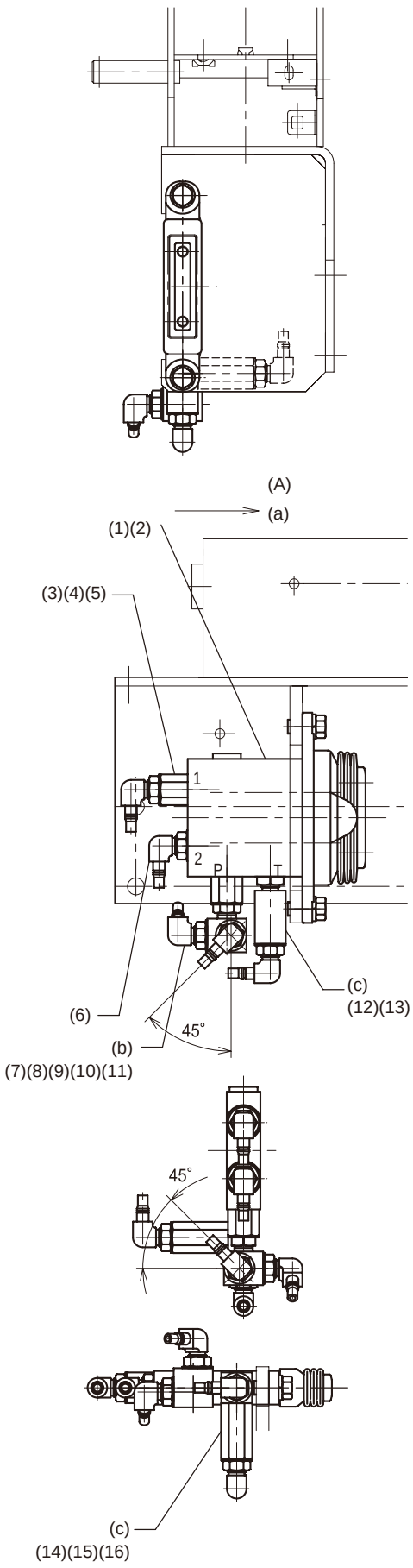


((A)(Viewed from the operator's seat)

L:Left P/V
R:Right P/V

(a)(Back)
(b)(Front)

1)Valve assembly (pilot, L)
(2)Thermal insulation (21, cooler)
(3)Inlet pipe band
(4)Lock socket bolt
(5)Spring washer
(6)Wire harness
(7)Other than port P
(8)Pipe joint (S, G1/4-8.4)
(9)Port P
(10)Filter
(11)O ring
(12)Pipe joint (S, G1/4-8.4)
(13)Valve assembly (pilot, R)
(14)Thermal insulation (21, cooler)
(15)Inlet pipe band
(16)Lock socket bolt
(17)Spring washer
(18)Other than port P
(19)Pipe joint (S, G1/4-8.4)
(20)Port P
(21)Filter
(22)O ring
(23)Pipe joint (S, G1/4-8.4)



f.Dozer pilot valve

1. Adapter and joint

1)Fitting the adaptor
Port P
Filter
Pipe joint
Pipe joint
Ports T, 1 and 2
Fit the adaptor in position as shown at left.

2)Adaptor tightening torque
G1/4 size
24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7t.lbs

3)Fitting direction of the valve
Position the valve with ports P and T facing the machine bottom.

4)Quick-coupling adaptor
Pipe joint
Make sure the hose connection is free from detrimental

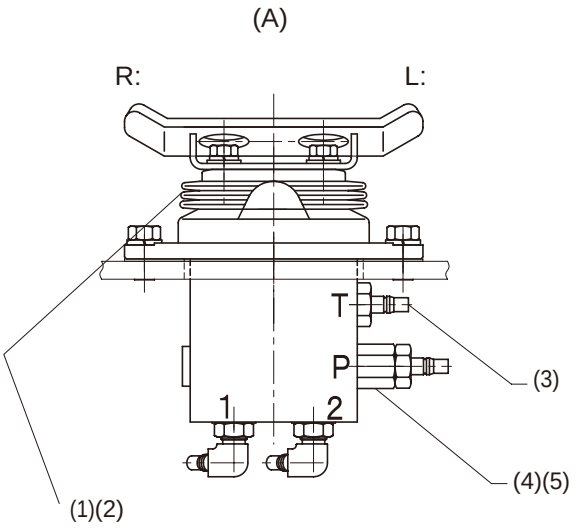
5)Fitting the valve assembly (pilot OFF)
Tightening torque
48.1~55.9N.m(4.9~5.7kgf.m)35.5~41.2t.lbs

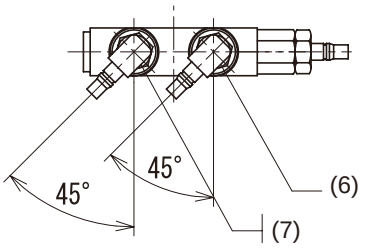
Dozer P/V

	Location	Hose tape color
1	Dozer (down)	Brown
2	Dozer (up)	Pink
P	Port P	White
T	Port T	None

(A)(Viewed from the machine center)
(a)Machine fron
(b)(Port P)
(c)(Port T)

(1)Valve assembly (pilot OFF)
(2)Bolt
(3)Pipe joint (bushing G1/4)
(4)O ring
(5)Pipe joint (QL, G1/4-8.4)
(6)Pipe joint (QL, G1/4-8.4)
(7)Filter
(8)O ring
(9)Pipe joint (L, G1/4-G1/4)
(10)O ring
(11)Pipe joint (QL, G1/4-8.4)
(12)Pipe joint (T, G2-G2-G2)
(13)Pipe joint (QL, G1/4-8.4)
(14)Pipe joint (bushing G1/4)
(15)O ring
(16)Pipe joint (QL, G1/4-8.4)





g.Swing pilot valve

1.Fitting the adaptor

Port P
Filter
Pipe joint
Port T
Pipe joint
Ports 1 and 2
Pipe joint

2.Adaptor tightening torque

G1/4 size
24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs

3.Fitting direction of the valve

Position the valve with ports P and T facing the machine left side.

4.Quick-coupling adaptor

Pipe joint
Make sure the hose connection is free from detrimental scratches.

5.Fitting the valve assembly (pilot OFF) (RD809-6551Δ)

Tightening torque
48.1~55.9N.m(4.9~5.7kgf.m)35.5~41.2ft.lbs

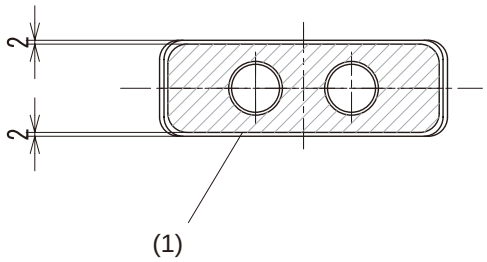
Swing P/V

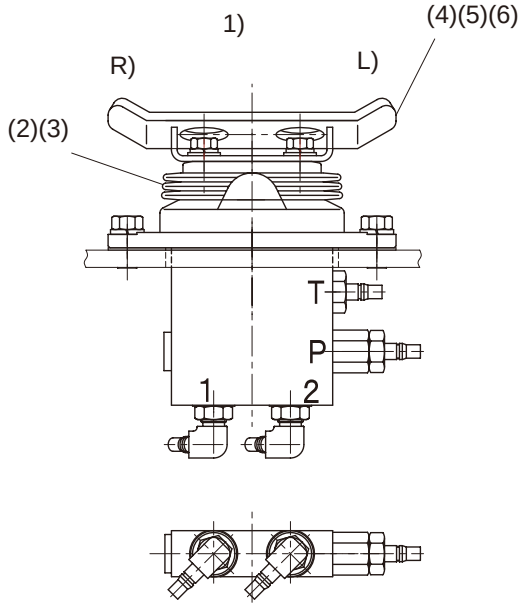
	Location	Hose tape color
1	Swing (right)	Yellowish green, double
2	Swing (left)	Orange, double
P	Port P	White
T	Port T	None

(A)(Viewed from the machine front)

R:(Right swing)
L:(Left swing)

(1)Valve assembly (pilot OFF)
(2)Bolt
(3)Pipe joint (S, G1/4-8.4)
(4)Filter
(5)Pipe joint (S, G1/4-8.4)
(6)Pipe joint (QL, G1/4-8.4)
(7)Pipe joint (QL, G1/4-8.4)





6.Fitting the valve assembly (pilot OFF)

Tightening torque
48.1~55.9N.m(4.9~5.7kgf.m)35.5~41.2ft.lbs

7.Applying the non-slip sheet (swing pedal)

Apply the sheet as shown at left.

(1)Non-slip sheet (swing pedal)
(2)Valve assembly (pilot OFF)
(3)Bolt
(4)Pedal (swing)
(5)Bolt
(6)Non-slip sheet (swing pedal)

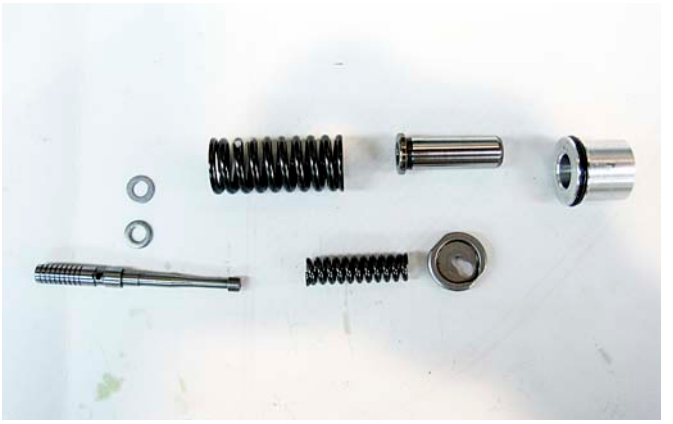
1)View from machine front
R)Right swing
L)Left swing

7. Pilot valve disassemble (Dozer, swing)

1. Overall structure
   1)
   2)
   3)
   4)



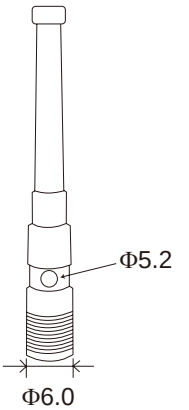
2. Remove the rubber boot and pivot link.

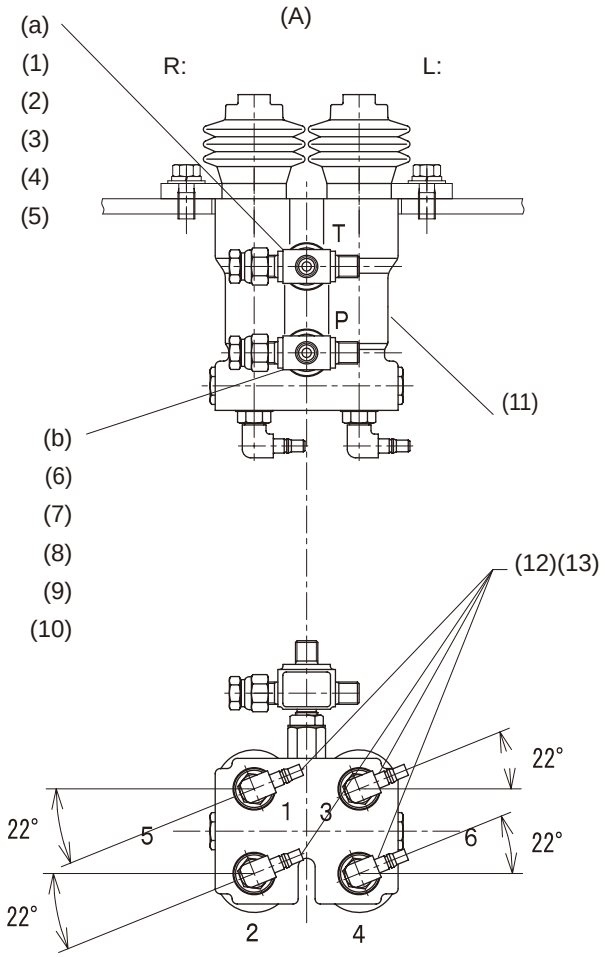


3. Inner parts of push rod and spool



Shims : t=1.0 and 0.5mm





Note: Set up with the hose fixtures out of contact with each other.

(A)(Viewed from the machine back)

R:(Right)
L:(Left)

(a)(Port P)
(b)(Port T)

(1)Pipe joint (bushing G1/4)
(2)O ring
(3)Pipe joint (cross, G1/4)
(4)O ring
(5)Plug
(6)Pipe joint (bushing G1/4)
(7)O ring
(8)Pipe joint (cross, G1/4)
(9)O ring
(10)Plug
(11)Valve assembly (PV, travel)
(12)Pipe joint (QL, G1/4-8.4)
(13)O ring

h.Travel pilot valve

1.Fitting the adaptor

Ports P and T
Pipe joint (bushing G1/4)
Pipe joint (cross, G1/4)
Plug
Ports 1, 2, 3 and 4
Pipe joint

2.Adaptor tightening torque

G1/4 size
24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs

3.Plug tightening torque

G1/4 size
24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs

4.Fitting direction of the valve

Pipe joint
Position the valve with port (2) facing the machine front.

5.Quick-coupling adaptor

Pipe joint
Make sure the hose connection is free from detrimental scratches.

6.Fitting the valve assembly (PV, travel)

Tightening torque
48.1~55.9N.m(4.9~5.7kgf.m)35.5~41.2ft.lbs

Travel P/V

	Location	Hose tape color
1	Travel (left) backward	Blue, double
2	Travel (left) forward	Red, double
3	Travel (right) backward	Green, double
4	Travel (right) forward	Yellow, double
P	Port P	White
T	Port T	None

7.Troubleshooting and corrective measures

Troubleshooting is not easy. Some assumed causes are listed in the table below. Since repair is difficult, refer to the assumed causes and corrective measures in the table.
Symptoms, assumed causes, and corrective measures in general are listed in the table below. In most cases, a trouble isnot caused bya failureonlywitha singlepart, but caused bya failure involving more than one part.
For this reason, be aware of the fact that corrections may also be necessary other than listed.
Also, the table below does not cover al I the assumed causes and corrective measures.
The persons in charge of repair must further investigate problems and causes as necessary.

Symptom	Cause	Correction
Secondary pressure does not rise.	[1] Insufficient primary pressure [2] The secondary-pressure-setting spring (324) no longer has enough elasticity. [3] The gap between the spool and the casing is too wide. [4] The operating section is not fixed firmly.	[1] Secure primary pressure. [2] Replacewith a new one. [3] Replace the spool and casing assembly. [4] Disassemble, reassemble and replace the operating section component part.
Secondary pressure is unstable.	[1] Sticking portion in siiding part [2] Fluctuations in tank line pressure [3] Air trapped in thepipe	[1] Correct the sticking portion. [2] ReturntheoiI intotheoiI tank directly. [3] Bleed the pipe several times.
Secondary pressure is too high.	[1] Tank line pressure is high. [2] Stickingportion in siidingpart	[1] Return to the oiI into the oiI tank directly. [2] Correct the sticking portion.
Damping function does not work.	[1] Air is trapped inside the piston chamber. [2] Sticking portion in siiding part [3] The damping springs (336, 337) no longer have enough elasticity. [4] The gap between the dampingpiston (224) and the casing is too wide. [5] Malfunction of the check valve [6] The orifice of the damping piston is too large.	[1] Bleed the air several times. [2] Correct the sticking portion. [3] Replace with a new one. [4] Replace the damping piston and casing assembly. [5] Disassemble and investigate the check valve portion. [6] Replace the damping piston.
Damping torque is large.	[1] Stickingportion in siiding part [2] Clogging of the orifice in the damping piston.	[1] Correct the sticking portion. [2] Correct or replace the damping piston.
Shuttle valve does not work. (RCVD8CC only)	Malfunction of the shuttle valve	Disassemble and investigate the shuttle valve portion.

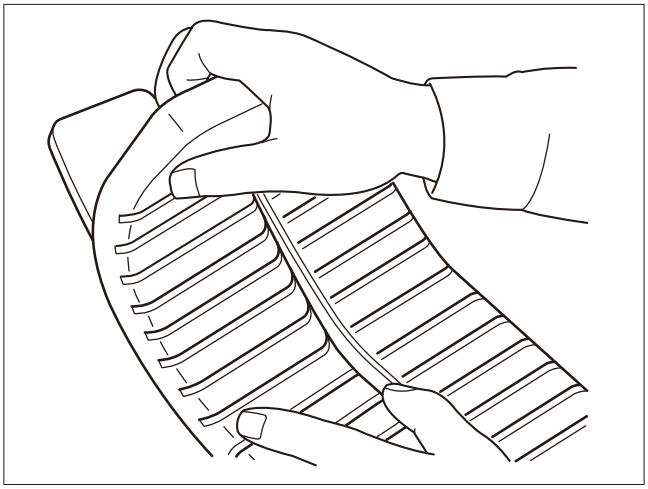
8. Disassembling procedures

1) Operational precautions in general

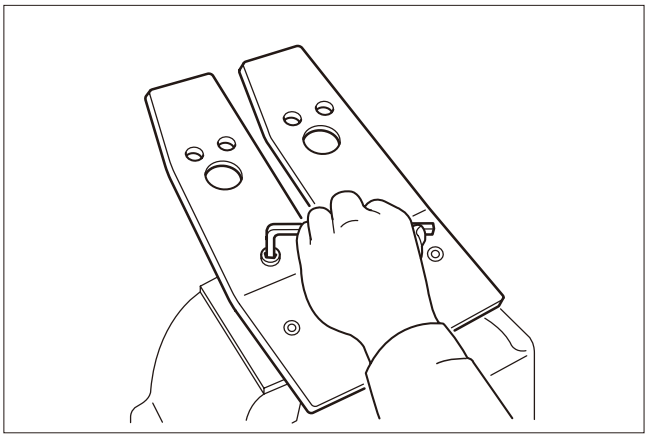
1. Prepare a solid and rattle-free working bench that is wide enough to place parts on and that does not allow the parts to drop or move.
2. Prepare tools and materials.
3. Sinee the parts are very precise, handIe themwith much care not to bump them each other or drop them.
4. Do not hit or wrench the parts even when they are hardly moved. Otherwise, burrs may be generated or the parts may be damaged, causing an oil leakage or degradation in performance. Always work with patience with much care.
5. Leaving the parts disassembled may cause them to rust as a result of humidity or contamination. If it is absolutely necessary to stopworking before reassembling, pay attention to prevent rust and dust.

2) Disassembling procedures

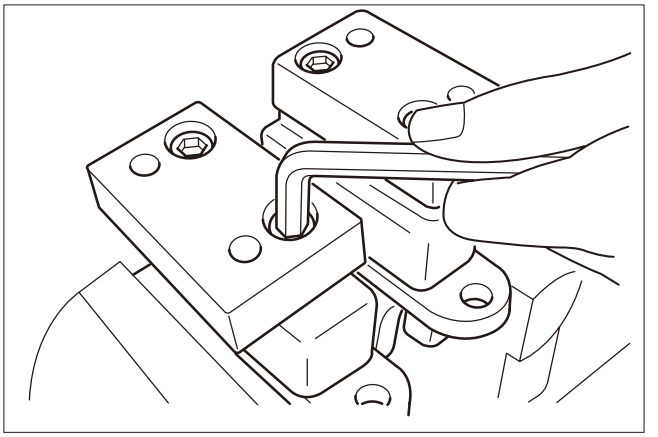
1.Clean the pilot valve with kerosene.
Close each port with a blind plug.



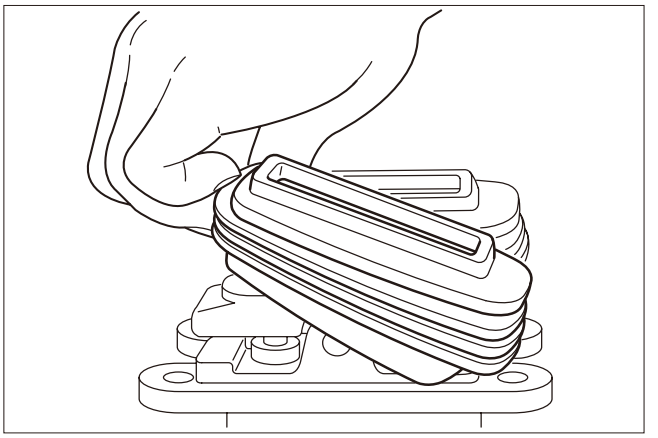
2.Fix the pilot valve on a vice using cushion sheets.
Remove the pedal cover (521) from the pedal (520)



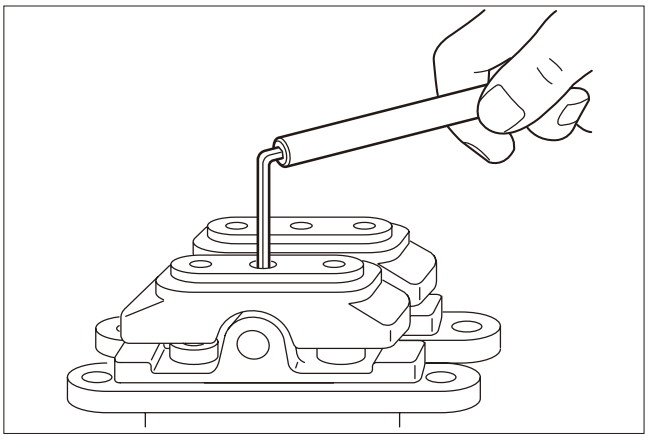
3.Unscrew the Allen screw (522) with an Allen wrench. Remove the pedal (520).



4.Unscrew the Allen screw (473) with an Allen wrench. Remove the block (431).

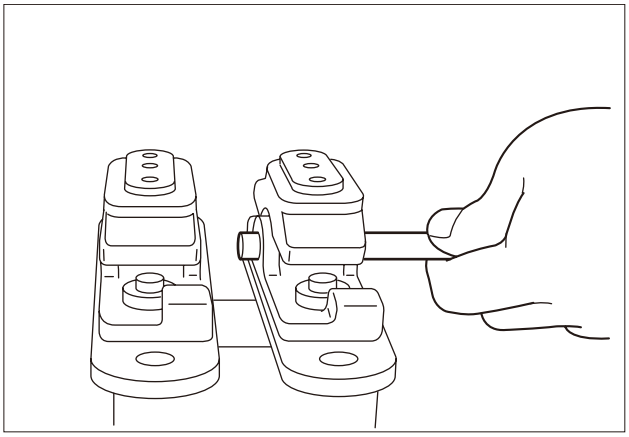


5.Remove the bellows (501) from the cover (201) by pulling the bellows upward.

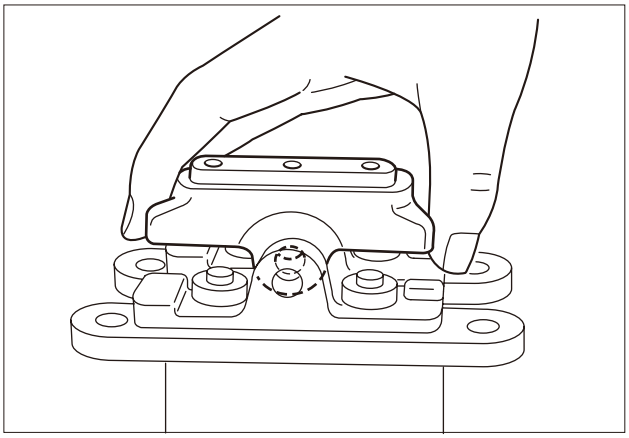


6.Loosen the setscrew (423) with an Allen wrench.

Be careful because Loctite #241 is applied to the setscrew and the tightening torque is large.



7.Putting a round bar (<|)8 or less) on one end of the cam axis (413), tap the bar gently with a hammer to pull out the axis.

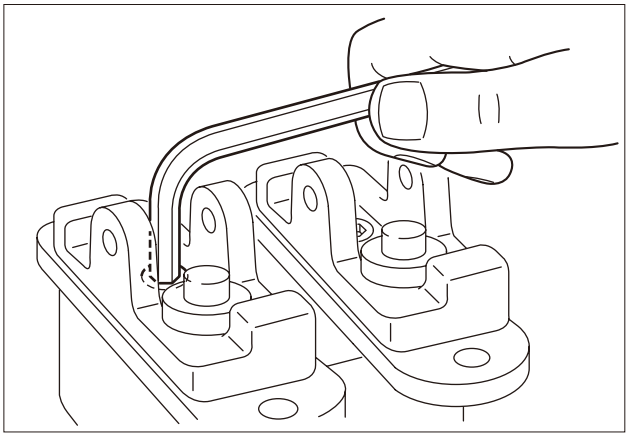


8.Remove the cam (420) as an assemblywith the setscrew (471) and lock nut (472) attached.

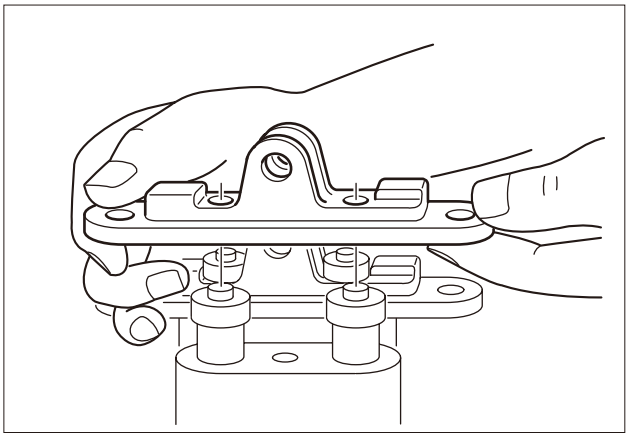
Note down the positional relationship between the cam and the cover (201).

Be careful because the push rod (214) may push out while the cam is removed.

Caution



9.Unscrew the Allen screw (271) with an Allen wrench.

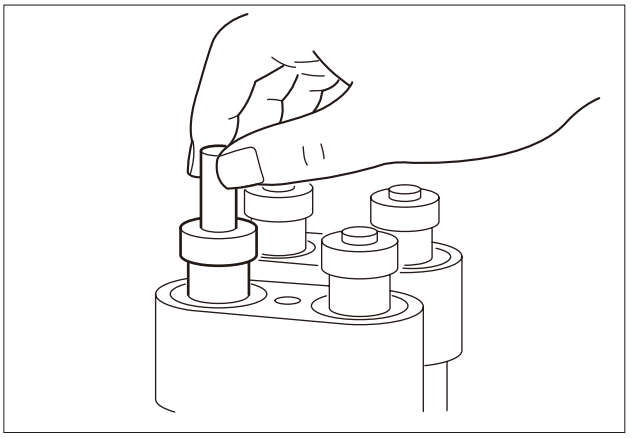


10.Remove the cover (201).

Note down the positional relationship between the cover and thecasing (101).

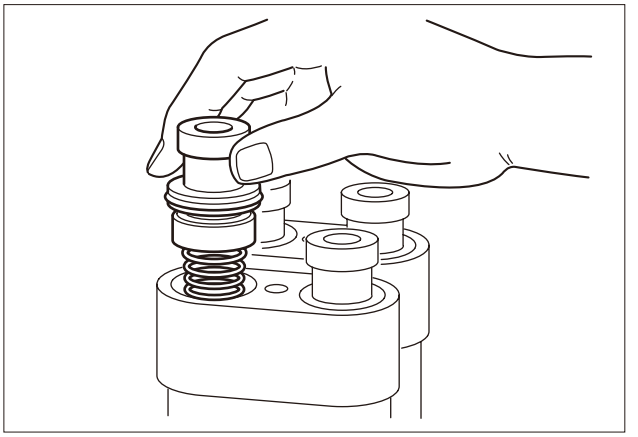
Be careful because the push rod (214) and theplug (202) maybe pushed out by the damping springs (336, 337) while the cover is removed. (The plug remains inside the casing as a result of the friction of the 0-ring (212) only.)

Caution



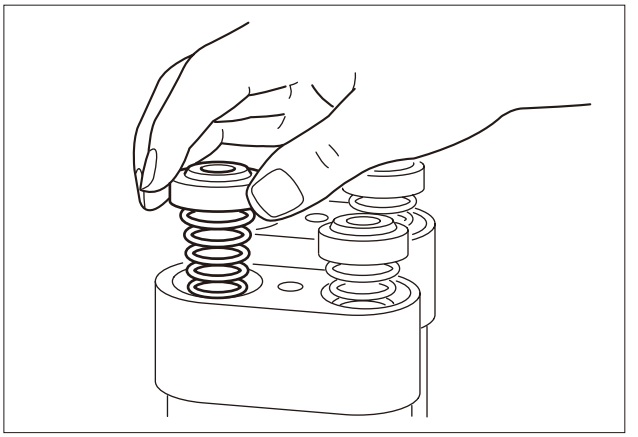
11.Pull out the push rod from the plug.
Note down the positional relationship between the plug and the push rod.
Take care not to scratch the push rod surface.
Be careful because the plug may be pushed out while the push rod is removed.

Caution

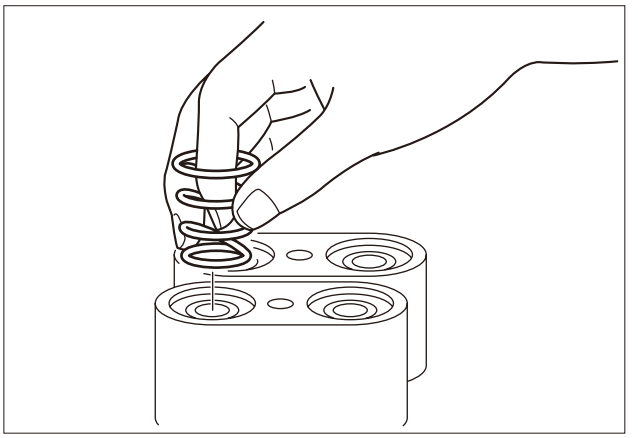


12.Remove the plugwith the grease cup (203),NHU packing (210) and O-ring (212) attached.
Note down the positional relationship between the plug and the casing.
Be careful because the piston is pushed out by the damping spring while the plug is removed.

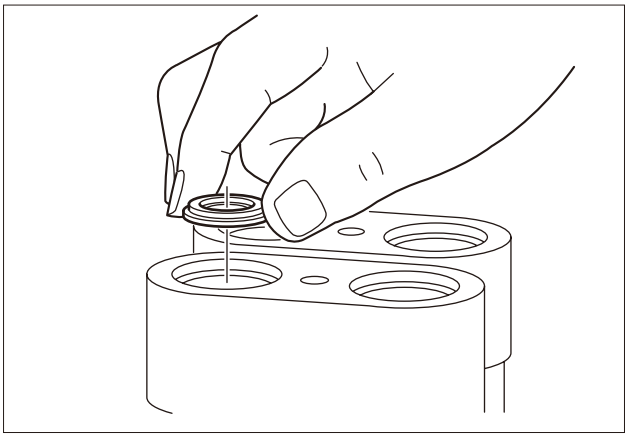
Caution



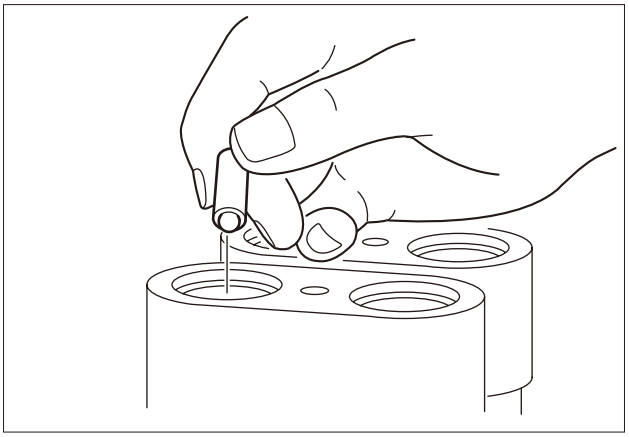
13.Remove the piston (224).
Note down the positional relationship between the piston and the hole in the casing.



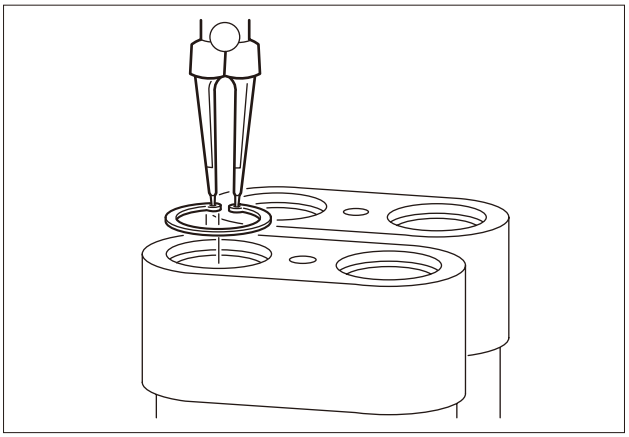
14.Remove the damping springs (336, 337) from the casing.
Note down the positional relationship between the damping spring and the hole in the casing.



15.Remove the spring seat (218) from the casing.
Note down the positional relationship between the spring seat and the hole in the casing.

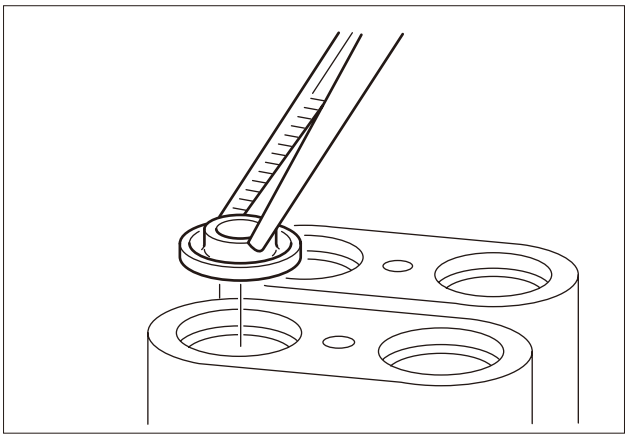


16.Remove the steel balI (225) usingadevice, such as a magnet.
Take care not to losethe steel ball.

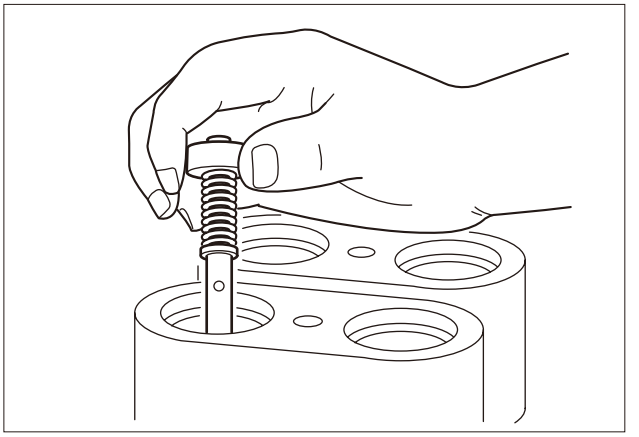


17.Remove the locking ring (221) from the casing using piiers.
Note down the positional relationship between the locking ring and the hole in the casing.
Be careful because the bush may be pushed out by the return spring (335) while the locking ring is removed.
Take care not to damage the casing inside surface.

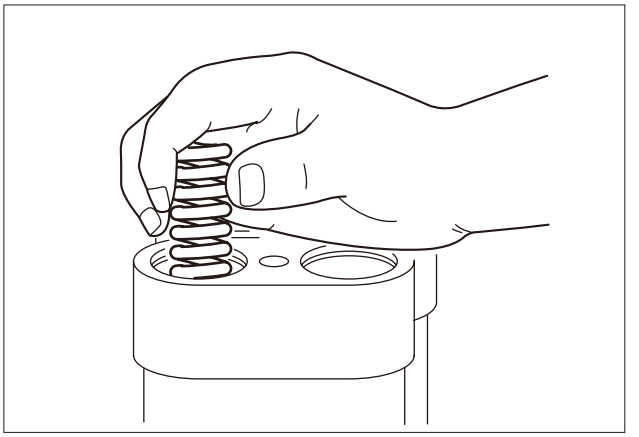
Caution

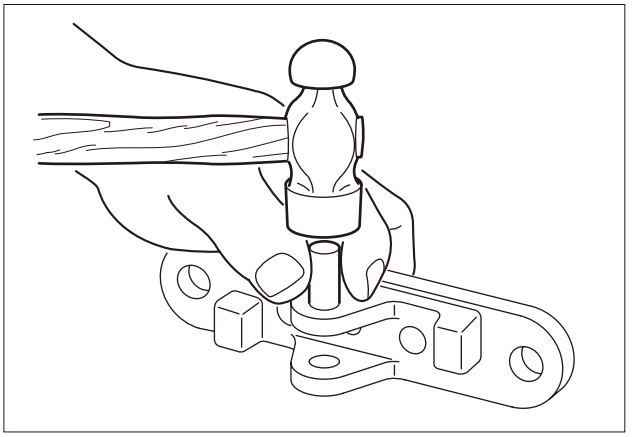


18.Takethebush (223) out of the casing using tweezers.
Note down the positional relationship between the bush and the hole in the casing.

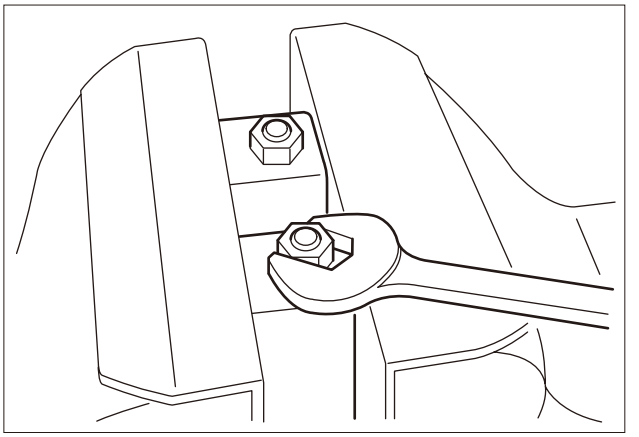


19.Remove the reducing valve section assembly and the return spring (335) from the casing.
Note down the positional relationship with the casing hole.

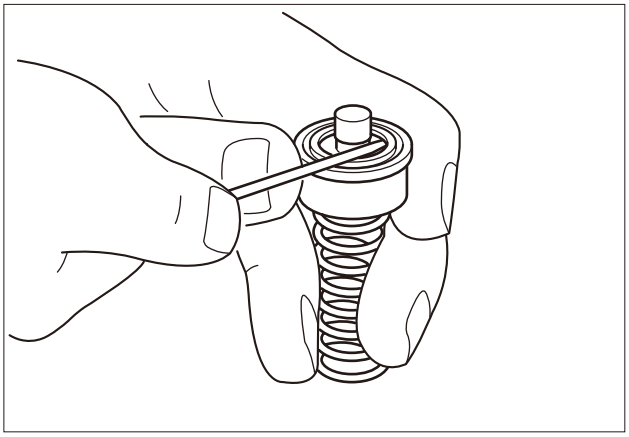




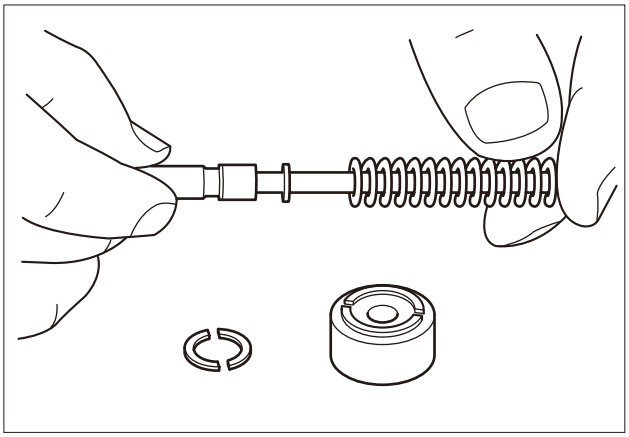
20.Place the cover (201) with its side downward on aflattable. Puttingthespecial tool 1 on thebush (412), tap the tool with a hammer to pull out the bush.



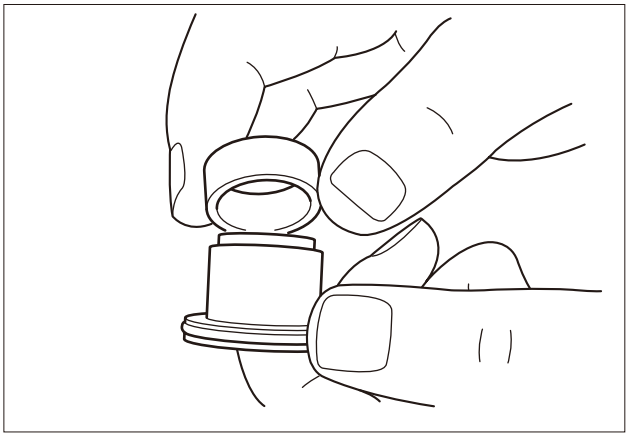
21.Fix the camassembly on avice, untighten the lock nut (472) with a spanner then remove the lock nut and setscrew (471).
If setscrew replacement is not required, handle the setscrews as part of the cam assembly thereafter since neutral position adjustment is required when setting up the cam assembly.



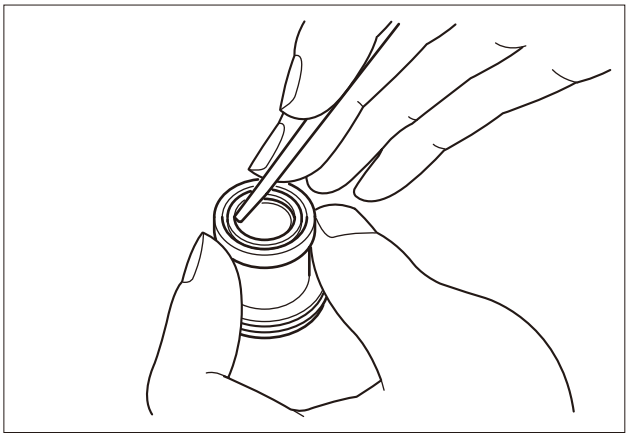
22.To dismantle the reducing valve section assembly, stand upright the spool (301) bottom end on a flat work bench, push down the spring seat (311) then remove 2 semicircular washers 1 (215) usinga small flat-head screwdr iver tip.
Take care not to scratch the spool surface.
Do not lower the spring seat by more than 4 mm.



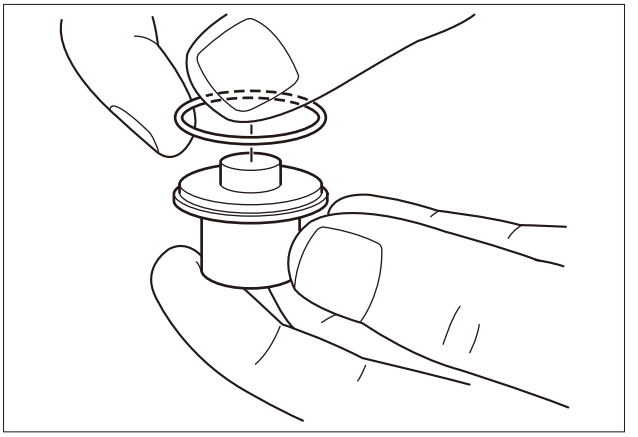
23.Remove the spool (301), spring seat (311), secondary-pressure-setting spring (324), washer 2 (217) and washer 3 (313).
Treat the parts as an assembly until they are installed.
The washer 2, whose thickness varies dependingon the spool assembly, is for adjustment to preset the secondary-pressure-setting spr ing.
However, in some cases, the washer is not used.



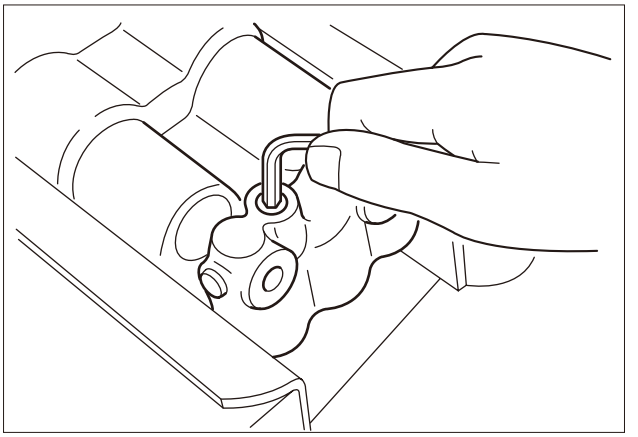
24.Remove the grease cup (203) from the plug (202).



25.Remove the NHU packing (210) from the plug using a small flat-head screwdriver or the like.
Take care not to scratch the internal surface of the plug.

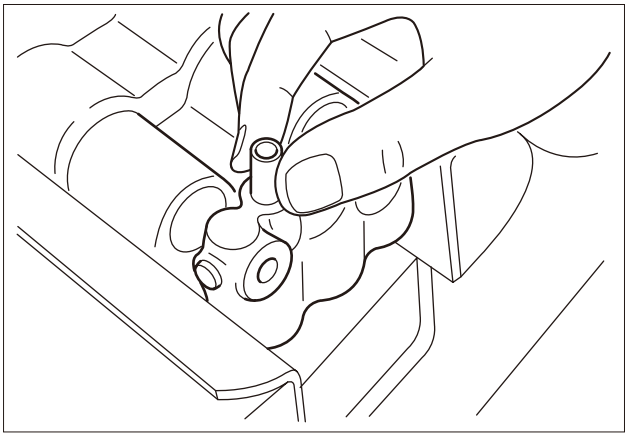


26.Remove the 0-ring (212) from the plug.



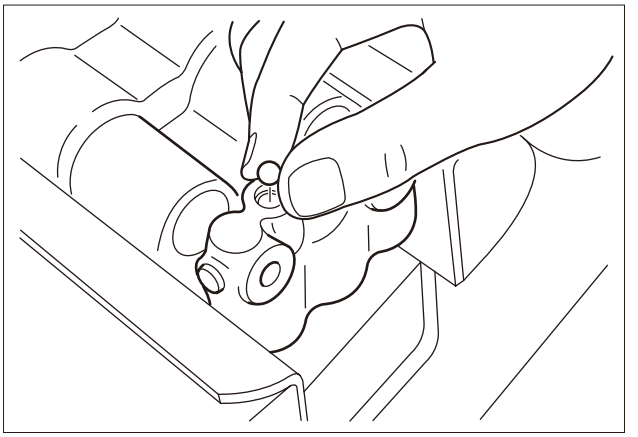
27.Fix the Casing (101) on a vice using cushion sheets. Unscrew the Plug (153) with an Allen wrench.

(RCVD8CC only)



28.Pull out the Seat (191) from the Casing (101).

(RCVD8CC only)



29.Remove the Steel ball (192) from the Casing (101).

(RCVD8CC only)

30.Cleaning the parts

1) Put the parts into the kerosene contained in a rough-cleaning container, and clean them. (Rough-cleaning)

If the parts are washed immediately after put into the kerosene, they are easily scratched. Wait until contaminations and oily substances are detached and floated on the surface of the kerosene.

Contaminated kerosene tends to cause the parts to be damaged, and the performance of the parts becomes degraded after they are assembled.
Pay much attention to the degree of contamination of the kerosene.

2) Put the parts into the kerosene contained in a finish-cleaning container, and rotate them slowly untiI their internal surfaces can be cleaned well (Finish-cIeaning).
Wipe out the kerosene from the parts with a clean waste cloth.

Do not dry the parts with compressed air. Otherwise, they may be scratched or rusted with the dust or moisture in the air.

31.Preventing the parts from rusting Apply a rust inhibitor to the parts.

Leaving the parts without wiping the kerosene causes them to rust, resulting in degraded performance after assembled.

9. Assembling instructions

1) Operational precautions in general

(1)As done for disassembling, prepare a working bench and tools.

(2)Pay attention as done for disassembling.

(3)Before assembling, remove bits of metal or foreign material from all the parts, and also check that there is no burrs or dents on the parts. If you find burrs or dents, remove them with an oilstone.

(4)As a rule, replace all 0-rings and NHU packing with new one.

(5 Install the 0-rings and NHU packing, taking care not to damage them. (Apply a little amount of grease for smooth installation.)

(6)To prevent the parts from dropping, use grease.

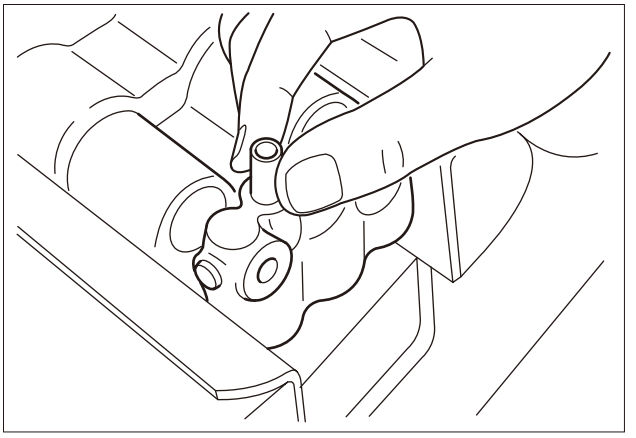
(7)Tighten the bolts with the torque shown in the assembly cross-section drawing.

(8)After the assembling is completed, close all the ports with plugs to prevent dust from entering.

2) Assembling procedures

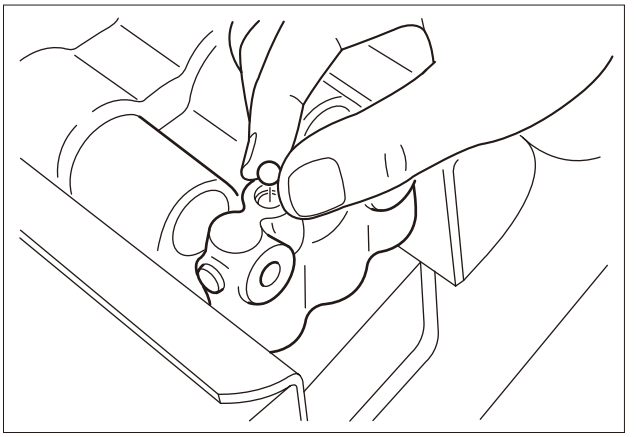
1.Fix the Casing (101) on a vice using cushion sheets. Set the steel ball (192) in the Casing (101).

(RCVD8CC only)



2.Set the Seat (191) in the Casing (101).

(RCVD8CC only)





3.Tighten the Plug (153) with the torque specified.

(RCVD8CC only)

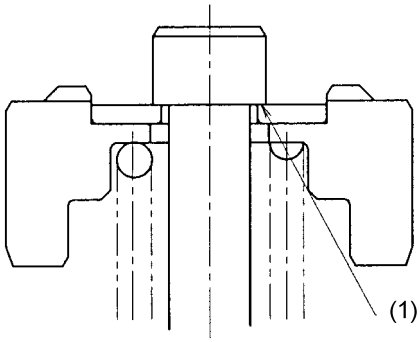


4.Attach the washer 3 (313), the washer 2 (217), the secondary-pressure-setting spring (324), and the spring seat (311) to the spool (301) in this order.

The washer 2, whose thickness varies depending on the spool assembly, is for adjustment to preset the secondary-pressure-setting spr ing. However, in some cases, the washer is not used.

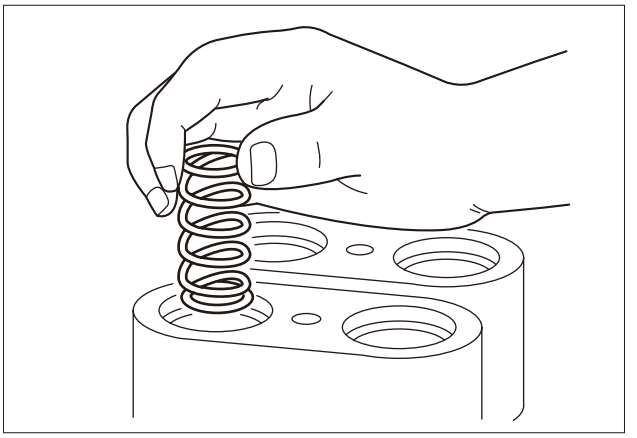


5.Stand the spool (301) bottom end upright on a flat work bench, push the springseat (311) down then fit 2 semicircular washers 1 (215) to the spring seat top without overlapping the washers.

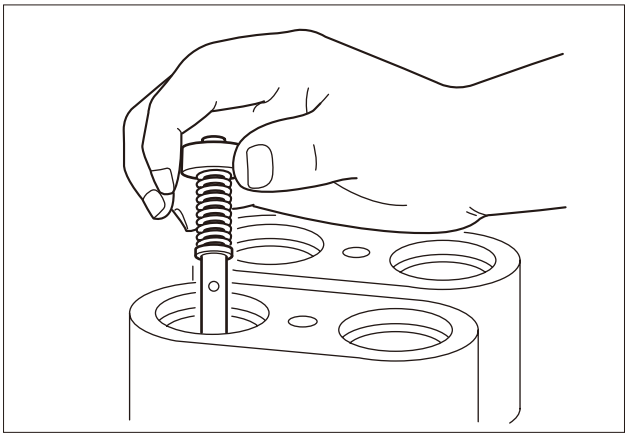


Fit washers 1 with the sharp edges turned upward and hooked on the spool head.
Do not lower the spring seat by more than 4 mm.

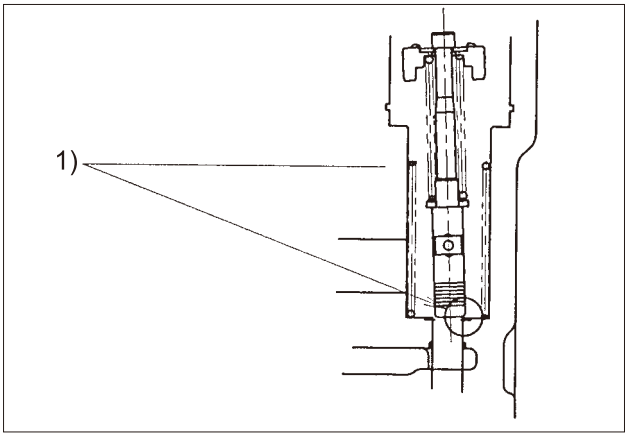
(1)Sharp edge side



6.Install the return spring (335) into the casing.
Install it at the previous position before it was disassembled.

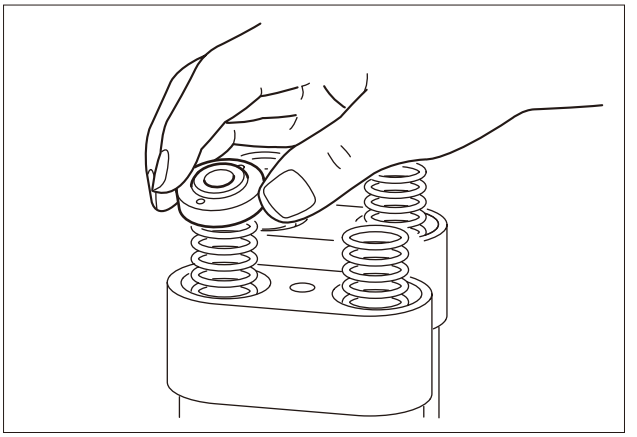


7.Install the reducing valve section subassembly, assembled in 1 and 2 above, into the casing.
Install it at the previous position before it was disassembled.

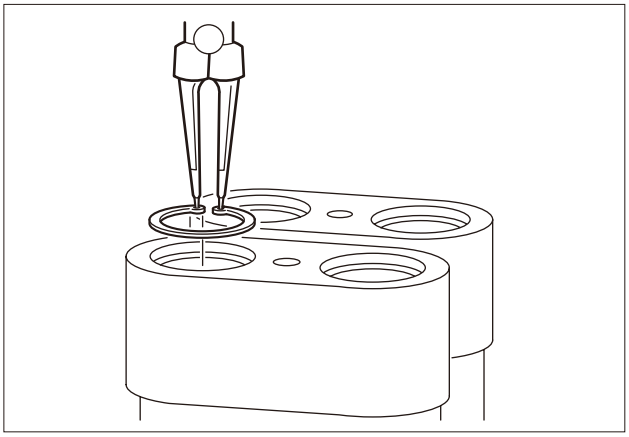


Take care not to hit the bottom of the spool strongly onto the corner of the casing while installing the reducing valve section subassembly.

1)Pay attention to the corner of the casing



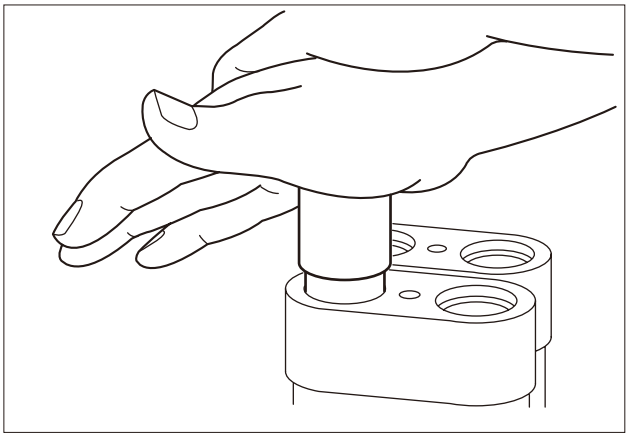
8.Install the bush (223) in the casing, and set it on the spring seat (311).
Install it at the previous position before it was disassembled.



9. Tentatively set the locking ring (221) in the casing hole using pliers.

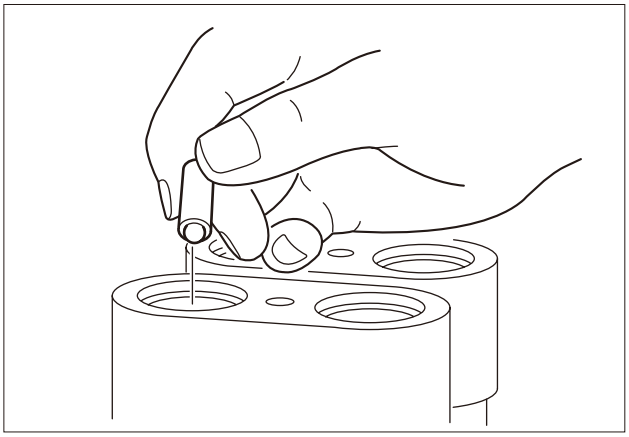
   Set the locking ringwhere it was before the disassembly.
   Set the locking ring horizontally.
   Take care not to damage the casing inside surface.
   Turn the locking ring sharp edge upward.

Caution

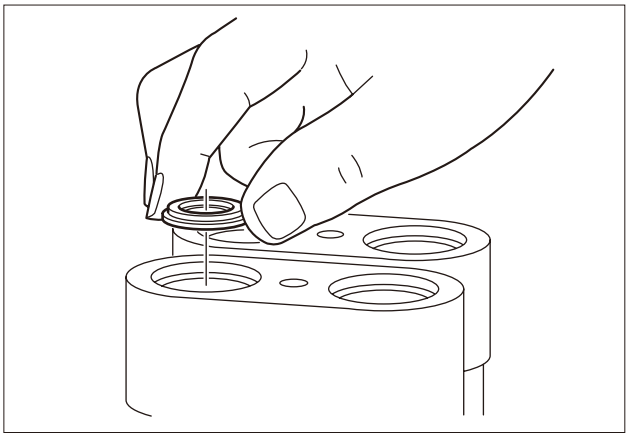


10. Set special tool 2 in thecasinghole, and push it in together with the return spring andbushuntil the lockingring is fit inthe groove with a click.

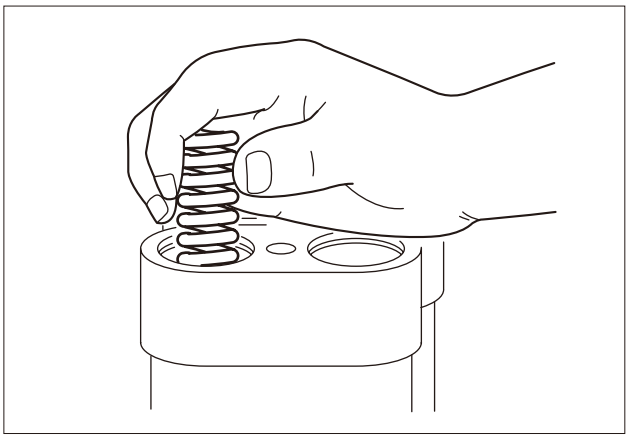
    Push the tool slowly and carefully so the casing inside surface cannot be damaged.



11. Set the steel ball (225) in thebush.

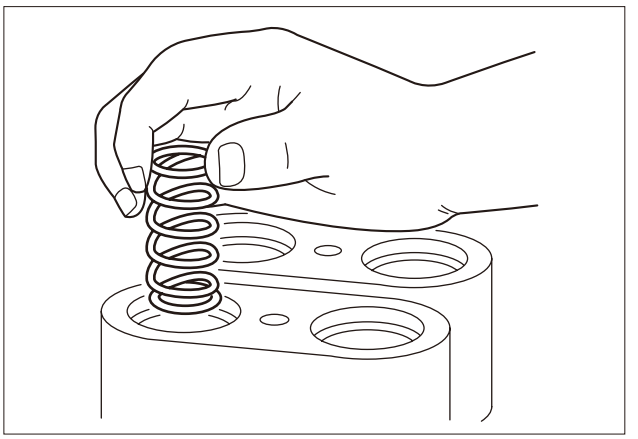


12. Set the springseat (218) inthebush.
    Install it at the previous position before it was disassembled.

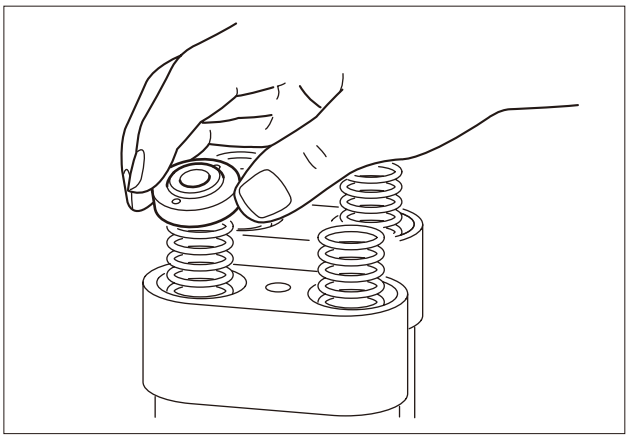


13.Install the damping spring (336) in the casing.

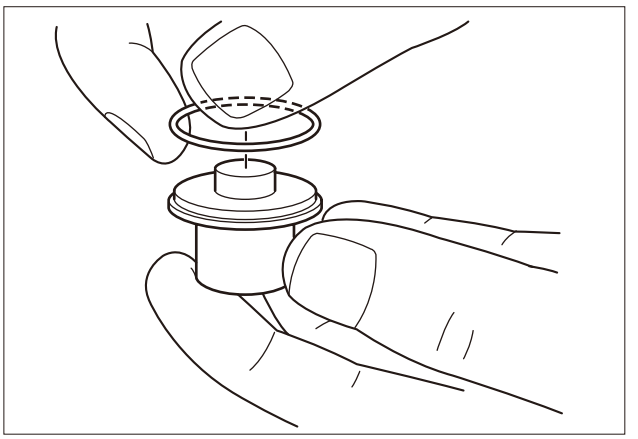
Install it at the previous position before it was disassembled.



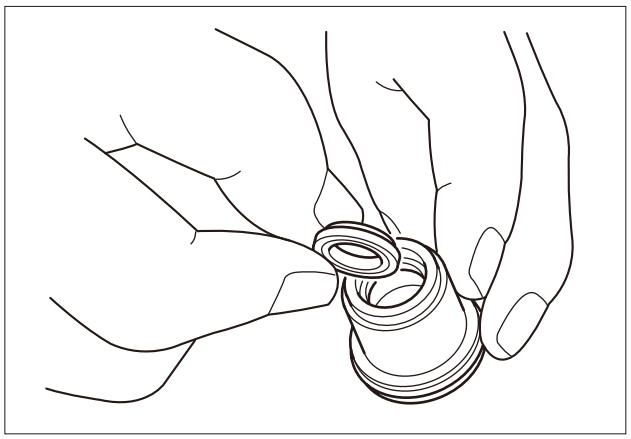
14.Install the damping spring (337) in the casing.
Install it at the previous position before it was disassembled.
Take care so the damping spring (337) does not interfere with the damping spring (336).



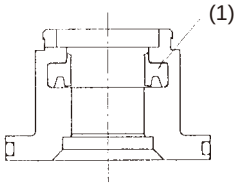
15.Install the piston (224).
Install it at the previous position before it was disassembled.



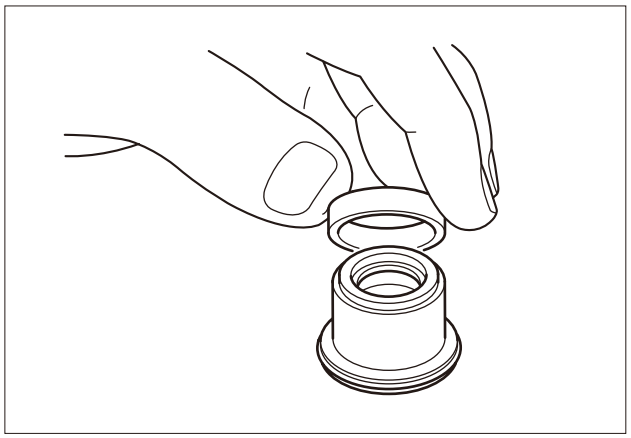
16.Install the O-ring (212) ontheplug (202).



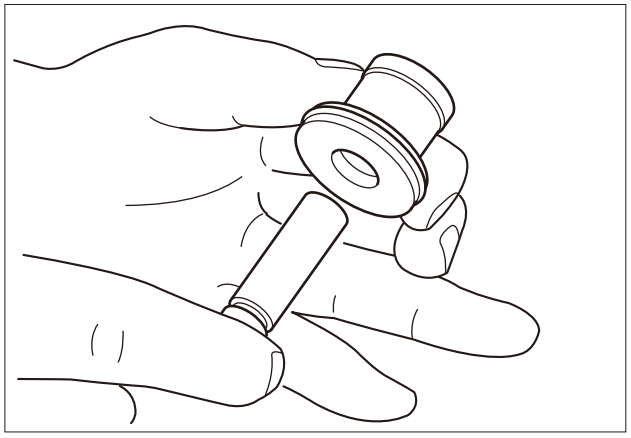
17.Install the NHU packing (210) into the plug.
When you install the NHU packing, pay attention to its direction. (Refer to the following figure.)
Apply a thin film of grease to the NHU packing before installing it.



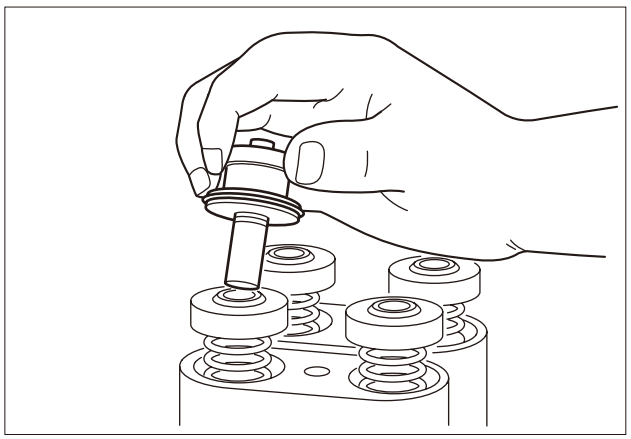
1)NHU packing



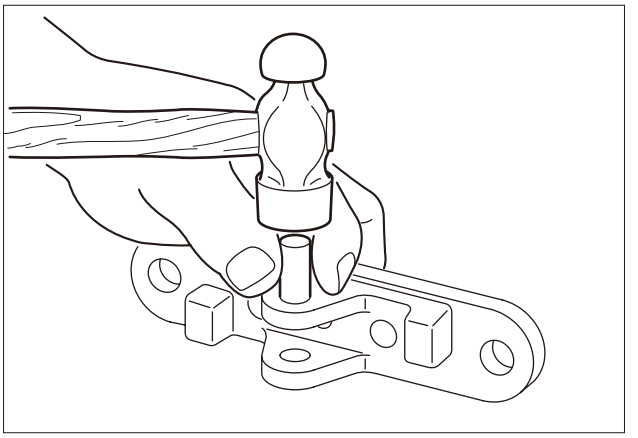
18.Install the grease cup (203) into the plug.



19.Install the push rod (214) into the plug.
Apply the lubricating oil to the surface of the push rod before installing it.
Do not insert the push rod with a strong force so as not to damage the lip of the NHU packing.

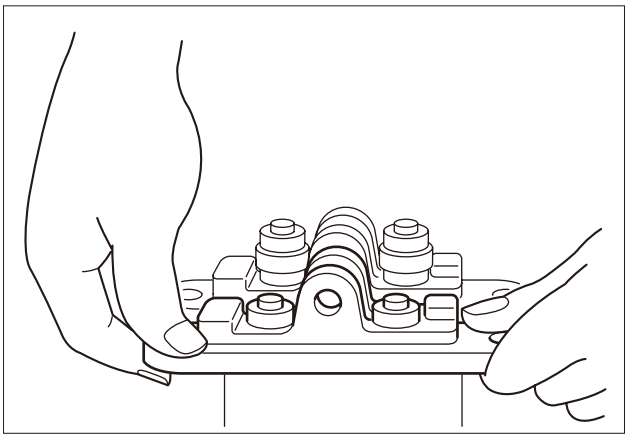


20.Install the push rod subassembly, assembled in 13-16 above, in the casing.



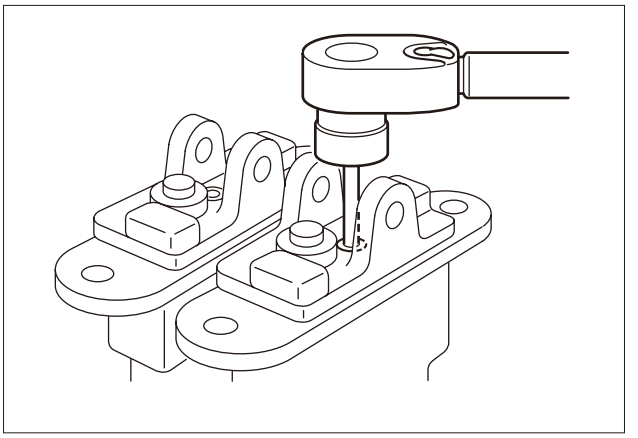
21.Press the bush (412) to the cover (201) using special tool 1 then lightly tap to press it in with a hammer.

Be careful because the end of the bush comes out of the cover.

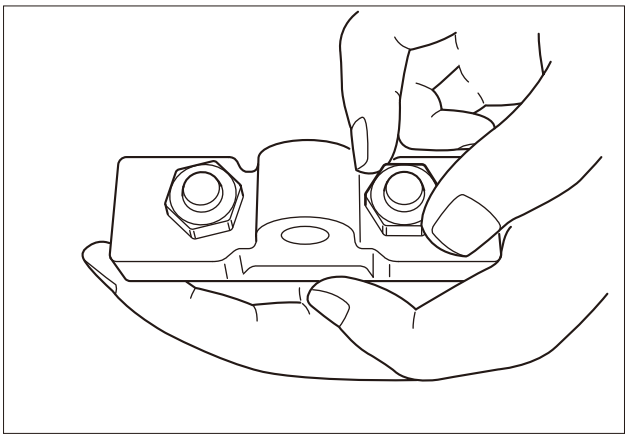


22.Install the cover into the casing.

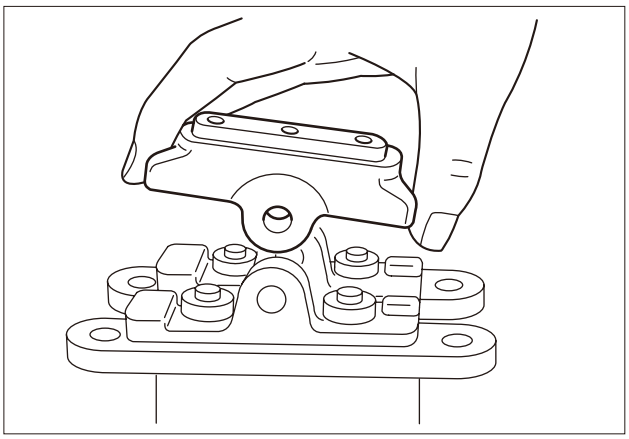
Install it at the previous position before it was disassembled.
Be careful because the cover moves upward by the force of the damping springs (336, 337).



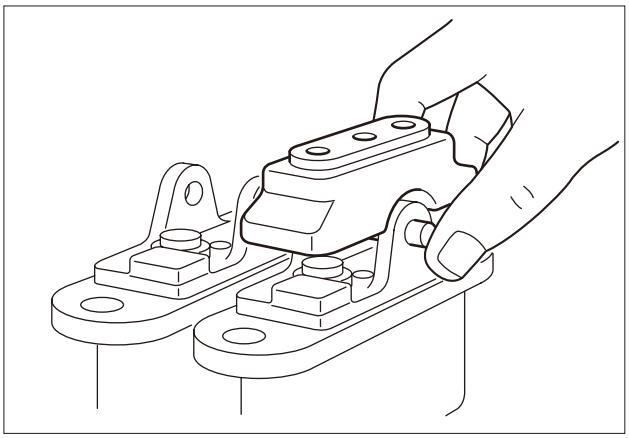
23.Tighten the Allen screw (271) with the torque specified.
Pay attention to place the cover at horizontal position.



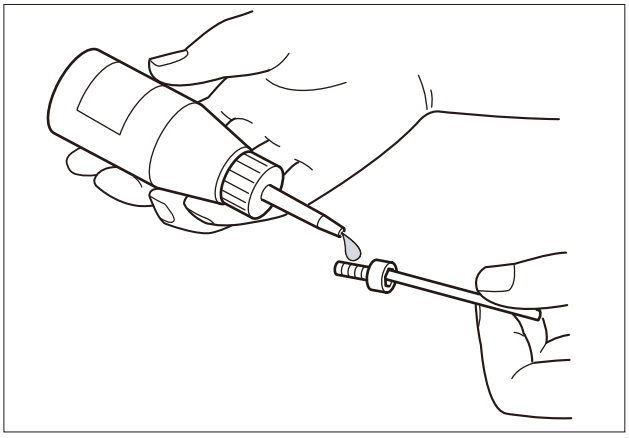
24.Tentatively set the setscrew (471) and lock nut (472) on the cam (420).



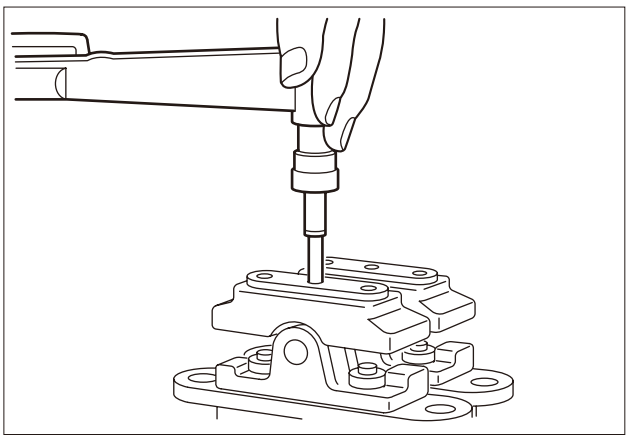
25.Install the cam (420) into the cover.
Install it at the previous position before it was disassembled.



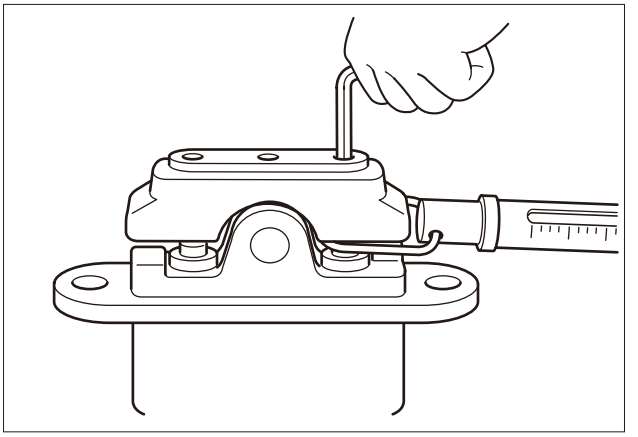
26.Holding down the cam (420), insert the cam shaft (413) from outside.



27.Apply Loctite #241 or equivalent to the surface of the setscrew (423).

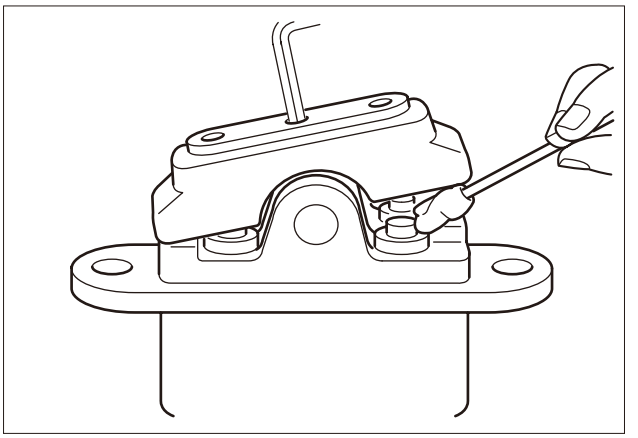


28.Tighten the setscrew (423) with the torque specified.



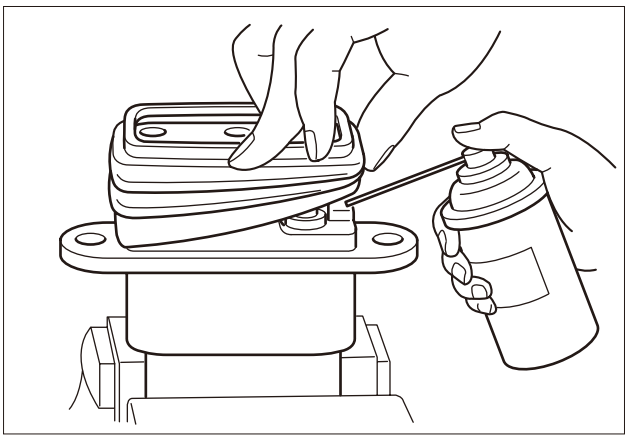
29.Adjust the setscrew (471) height so the cam (420) top surface can be parallel with the cover bottom surface, rotate the cam to the right and left to check that it can be in a neutral position without backlash, and then tighten the lock nut (472) with the specified torque.

Take care not to press the push rod (214) in too much with the setscrew.
Otherwisethecam inaneutraI position backlashes and may suddenly move when the engine starts or in other cases.



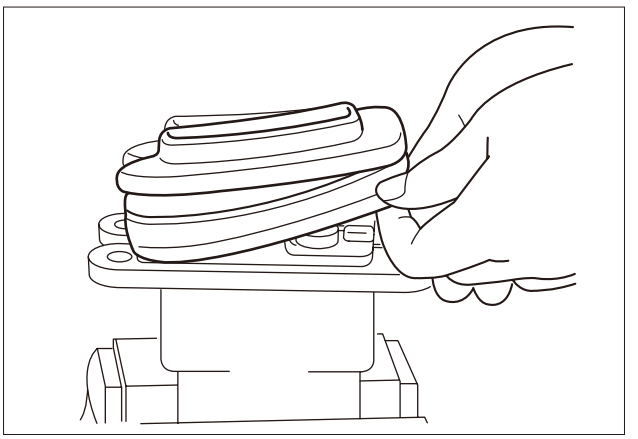
30.TiIting the cam, apply grease to the top of the push rod and also inject grease into the grease cup (203) in the plug (202).

When you apply or inject grease, use a soft spatula so as not to scratch the surfaces of the push rod and the plug.

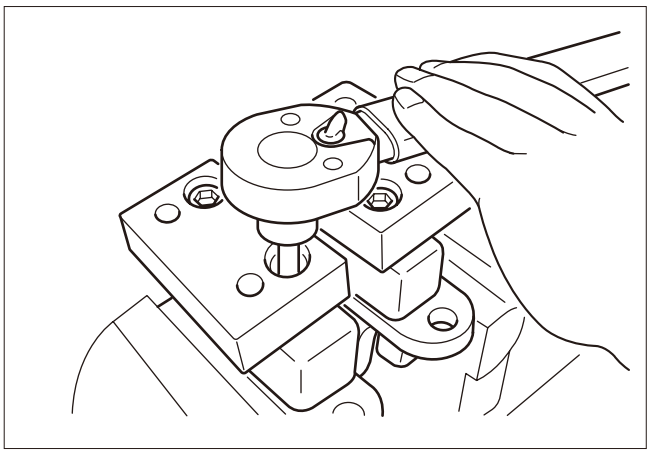


31.Engaging the upper edge of the bellows (501) with the cam, fit the lower edge of the bellows into the groove of the cover.

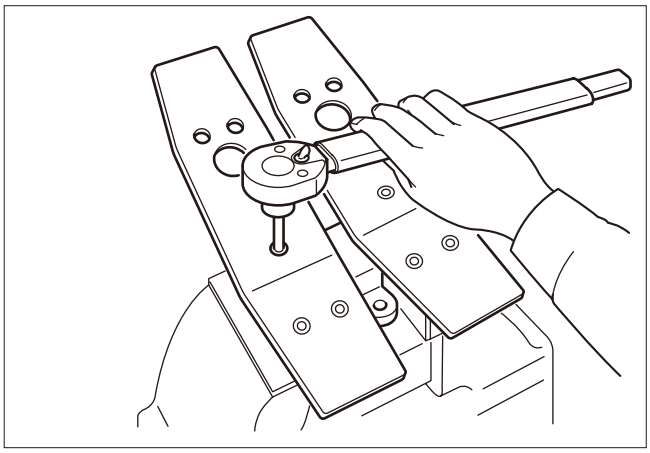
Before fitting the lower end of the bellows into the groove of the cover, spray anti-rust oil over the parts inside the bellows.



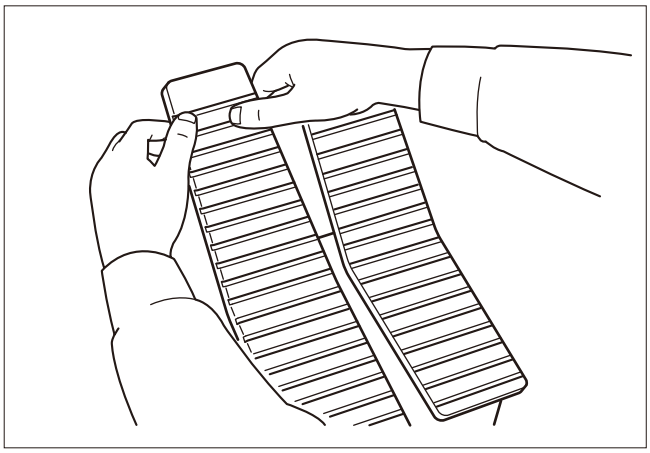
32.Be careful because anti-rust and water-proof capabi I ities are degraded if the bellows is not fixed completely or fixed bellows is twisted.



33.Install the block (431) and tighten the Al len screw (473) with the torque specified.



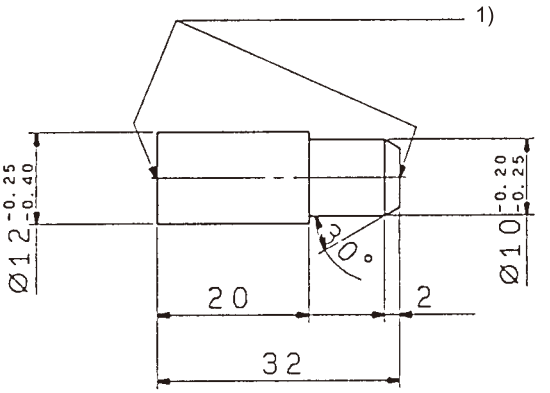
34.Install the pedal (520) and tighten the Al len screw (522) with the torque specified.



35.Attach the pedal cover (521)

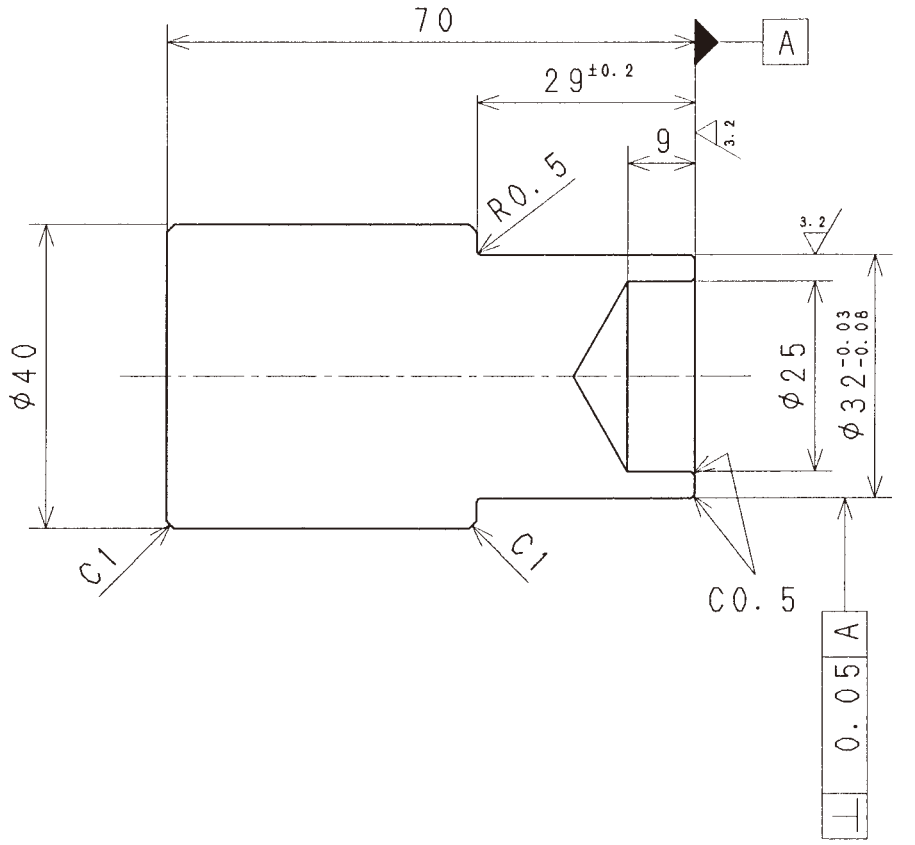
3)Special jig for disassembling/reassembling

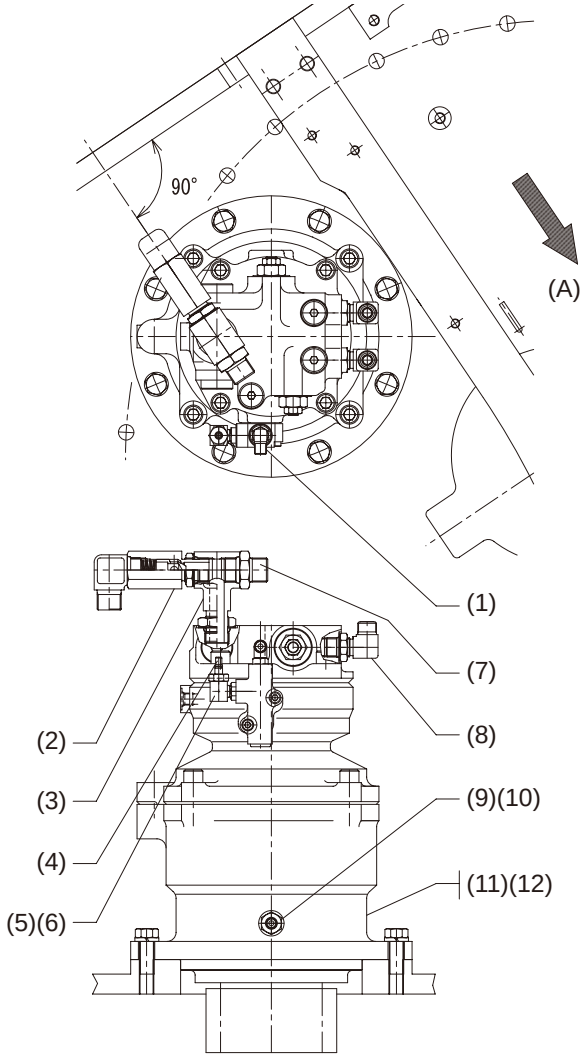
(1) Special jig 1 (for removing and pressing the bush)



1)Center hole allowed (*2 or less)

(2) Special jig 2 (for fitting the locking ring)





i.Swive. motor

1.Fitting the adaptor

Fit the adaptor in position as shown at left.

1) Adaptor tightening torque

G1/4 size
24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs
G3/8 size
37.2~42.1N.m(3.8~4.3kgf.m)27.4~31.1ft.lbs
G1/2 size
58.8~63.7N.m(6.0~6.5kgf.m)43.4~47.0ft.lbs
G3/4 size
117.6~127.4N.m(12.0~13.0kgf.m)86.7~94.0 ft.lbs

2) Fitting direction of the motor

Fit the motor in position as shown at left.

3) Quick-coupling adaptor

Pipe joint
Make sure the hose connection is free from detrimental scratches.

4) Fitting the motor assembly (swivel)

Tightening torque
259.9~304.0N.m(26.5~31.0kgf.m)191.7~224.2 ft.lbs
* Apply Loctite 271.

(A)Machine front
(1)Pipe joint (LG1/4-G1/4)
(2)Valve assembly (check, 15)
(3)Pipe joint (TG6, G6, G6)
(4)Pipe joint (S, G1/4-8.4)
(5)Pipe joint (LG1/4-G1/4)

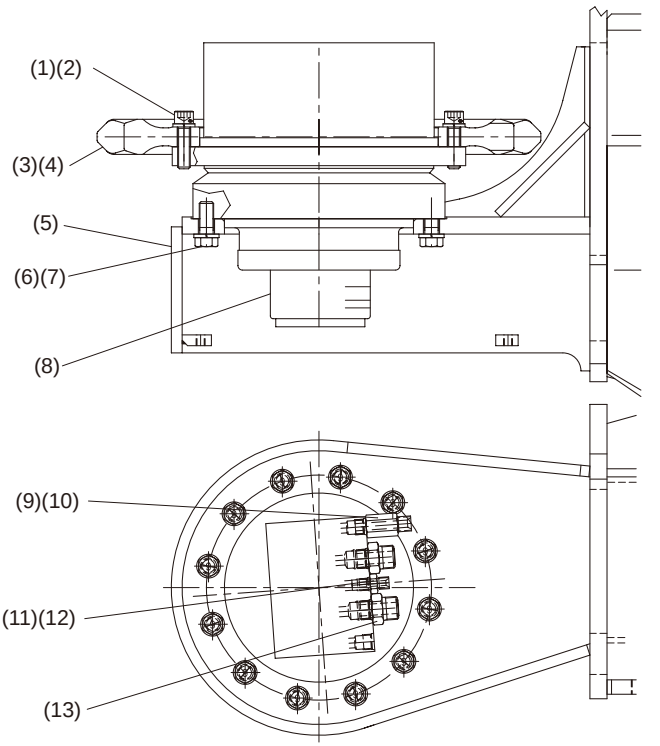
j.Travel motor (Wheel motor)

1.Adaptor and joint

1)Fitting direction of the track frame
Make sure the port side faces the machine front.

2)Tightening torque for the travel motor
Track frame sprocket
Motor mounting bolt
259.9~304.0N.m(26.5~31.0kgf.m)
191.7~224.2ft.lbs
Sprocket mounting bolt
166.7~196.1N.m(17.0~20.0kgf.m)
123.0~144.6ft.lbs
* Apply screw adhesive (Loctite 271).

3)Connecting position of the motor drain hose
Connect the hose to the drain port located at the top. (The bottom is the plug.)

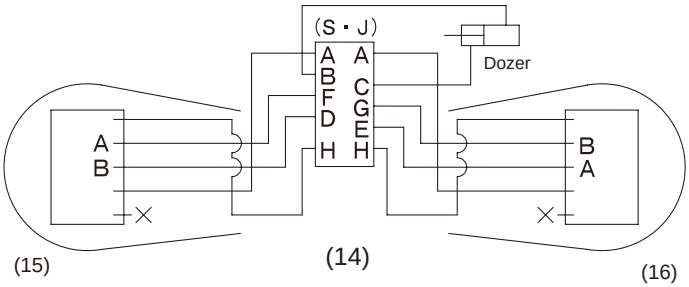


(1)Sprocket mounting bolt
(2)Hex socket bolt
(3)Spring washer
(4)Drive sprocket
(5)Frame (track)
(6)Motor mounting bolt
(7)Bolt (M16P2L40)
(8)Motor assembly (wheel)
(9)Pipe joint (S, F3/8-F3/8)
(10)O ring
(11)Adaptor
(12)O ring
(13)Pipe joint (SG4, 1U)

2.Hose routing

See (2/2).

As shown in Fig. 2, keep the hoses free from too tight contact, such as twist or crossing, inside the track frame.



(14)Fig. 2 Hose route
(15)Left foot
(16)Right foot

S/J side	Travel motor sylinder side
A Bi-speed pilot	Left/right travel bi-speed
B Dozer down	Cylinder, bottom
C Dozer up	Cylinder, rod
D Left forward	Left B
E Right forward	Right A
F Left backward	Left B
G Right forward	Right B
H Drain	Left/right drain port(top)

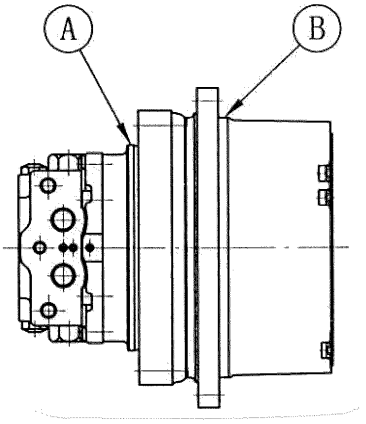
Route	Part name	Tape color	Length mm(inch)
S/J(E)-Motor right bottom (A)	Hydraulic hose (5/8)	Yellow W (right front)	1355(53.3)
S/J(G)-Motor right top (B)	Hydraulic hose (5/8)	Green W (right back)	1355(53.3)
S/J(D)-Motor left top (A)	Hydraulic hose (5/8)	Red W (left front)	1355(53.3)
S/J(F)-Motor left bottom (B)	Hydraulic hose (5/8)	Blue W (left back)	1355(53.3)
S/J(A)-Motor left/right bi-speed	Hydraulic hose (1/4)		1385(54.5)
S/J(H)-Motor left/right drain	Hydraulic hose (3/8)		1310(51.6)
S/J(C)-Dozer relay	Hydraulic hose (1/2)	Pink	430(16.9)
S/J(B)-Dozer relay	Hydraulic hose (1/2)	Brown	430(16.9)
Dozer relay-Dozer cylinder (rod)	Hydraulic hose (1/2)	Pink	790(31.1)
Dozer relay – Dozer cylinder (bottom)	Hydraulic hose (1/2)	Brown	790(31.1)

Travel motor servicing (GM090N, Nabtesco make)

a. Handling precautions

1. Positioning

(Refer to the Dimensional Outline Drawing.)
Before setting up the motor, remove the oil level check port plug and make sure the reduction gears lube oil (gear oil) is up to the check port level.



CAUTION

If the GM motor is hoisted for moving or setting up, never step in below the suspended motor. You may get injured.

A: Main body (fixed section) fixture
B: Drive (rotary section) fixture

*In setting up the GM motor, do not hit it with a hammer or the like.

NOTE
Use lock bolts with the JIS Strength Class 10.9 or higher.

*Fit the above sections A and B in place and tighten up the lock bolts.

Lock bolt tightening torque

	Q'ty	Thread size	Tightening torque	Bolt strength class
Main body lock bolt	14	M16 (P2.0)	252±39N.m (25.7±4.0kgf.m) 186±29ft.lbs	Higher than 10.9 as per JIB B1051 requirement
Drive section lock bolt	11	M14 (P2.0)	163±25N.m (16.6±2.5kgf.m) 120±18ft.lbs	

2. Piping

*The GM motor has been delivered with covers or plugs at the pipe ports. This is to keep out dust, weld scale and other foreign substances. Remove such covers or plugs before connecting the pipes.

CAUTION

Before connecting the pipes, make sure the GM motor turning direction and the pipe port locations are as specified (referring to the Dimensional Outline Drawing). If in the wrong turning direction, you may get injured.

NOTE
Before getting the motor started, be sure to fill the motor casing with hydraulic oil.
Oil amount required in the casing: 0.5 liters (0.13 US gal.)
Otherwise the hydraulic motor may reach its service life earlier than expected.

3. Selecting the right hydraulic oil

1.Types and recommended brands of hydraulic oil
(1)Use ISO VG32 or VG46 antiwear hydraulic oil.

(2)Keep the hydraulic oil cleanliness better than the NASA9 level.
(3)Keep the hydraulic oil operating temperature range and viscosity range with the following ones.
Operating temperature range: -10 to +80°C (-50 to +176°F)
Practical viscosity range: 15 to 500 cst
(4)If using any other hydraulic oil than listed below, contact us.

Grade	Viscosity (40°C)	32cst	46cst	56cst
	JIS-equivalent	VG32	VG46	#VG56
Company name	Showa Shell Oil	Tellus Oil 32	Tellus Oil 46	Tellus Oil 56
	Idemitsu Kosan	Super Hydraulic Fluid 32	Super Hydraulic Fluid 46	Super Hydraulic Fluid 56
	Cosmo Oil	Cosmo Hydro AW32	Cosmo Hydro AW46	Cosmo Hydro AW56
	Nippon Oil	Nisseki Super Hiland Oil 32	Nisseki Super Hiland Oil 46	Nisseki Super Hiland Oil 56
	Mobil Oil	DTE Oil 24	DTE Oil 25	
	General Oil	Panol P32	Panol P46	Panol P56
	Japan Energy	Hydlux 32	Hydlux 46	Hydlux 56

(in random order)

b. Maintenance and inspection

1. Daily inspection

Before running the GM motor, check the following points daily.

CAUTION

Be sure to turn off the motor before checking the following points, except checking for unusual operating noise. Otherwise, you may get injured or burnt. When checking for unusual operating noise, keep yourself at a safe distance. Do not touch nor come too close to the running motor to avoid injury and burn.

1. Oil leak (hydraulic oil and gear oil)
2. Loose bolt
3. Unusual operating noise
4. Overheated casing
   (Usual casing outer surface temperature during continuous run: Max. 80°C)

CAUTION

Immediately after a run, the casing is still hot. Measure the casing temperature with a temperature gauge. Do not touch it with your hands to avoid burn.

2. Changing the hydraulic oil

*Change the hydraulic oil every 1000 operating hours under normal operating conditions.
*If the hydraulic oil gets degraded earlier, change it referring to the requirements below.

Test item	Criteria
Viscosity change (40°C)	±10%
Total oxidation (mgKOH/g)	Type of additive is different from manufacturer to manufacturer. Contact them.
Water content (%)	0.1%
mpurities	10mg/100m
Insoluble content (%)	0.05%

3. Changing the lube oil

The reduction gears have been delivered filled with lube oil (gear oil).

1. Types and recommended brands of gear oil

(1)Use SAE#90 or equivalent gear oil (API classification, Class GL-4 or higher) with extreme-pressure additive.
(2)The following brands are for your reference.

Company name	Product name
Idemitsu Kosan	Apolloil HE 90 S
Esso Oil	Esso Gear Oil GP 90
Showa Shell Oil	Spirax EP 90
Cosmo Oil	Cosmo Gear GL-4 90
Nippon Oil	Nisseki Hypoid Gear 90
Mobil Oil	Mobilube HD 90

(in random order)

2. Gear oil changing intervals

(1)First interval (first change after running-in): After 50 operating hours.
(2)Intervals thereafter: Every 500 operating hours Avoid mixing different types of lube oil. Before pouring another type of lube oil, get the reduction gears flushed.

3. Gear oil quantity: 1.3 liters

4. Gear oil changing procedure

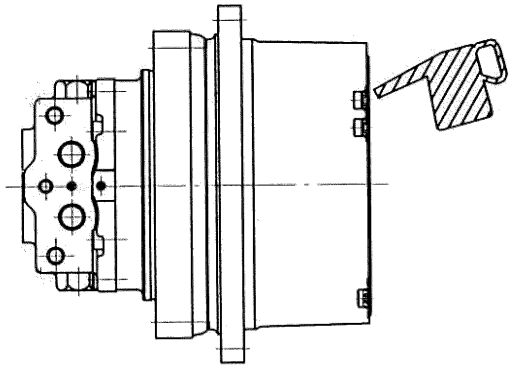
CAUTION

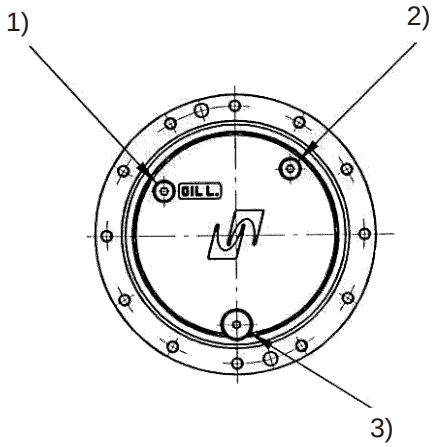
Immediately after a run, the casing is still hot. Do not touch it with your hands to avoid burn.
Do not remove any port plug while still hot, either. Hot gear oil may gush out because of the
pressure relief of the reduction gears, which may get you scaled. Wait long enough until the casing
cools down.

NOTE
If the gear oil runs short unexpectedly, pinpoint and remove the cause. Then replenish gear oil.

NOTE
When letting out the gear oil, be sure to receive it in a pan, not on the ground. Handle waste oil according to your local waste disposal rules and regulations.

NOTE
Oil may gush out when removing the plugs. Turn them slowly to relieve the internal pressure.





1)Oil level check port (PF 3/8)
2)Oil filler port (PF 3/8)
3)Oil drain port (PF 3/8)

(1)Stop the GM motor so that the oil level check port comes to the top and the oil drain port to the bottom. (See the above figure.)

(2)Place an oil pan below the GM motor.

(3)To change the gear oil, remove all the three port plugs and let out the oil. Just for adding oil, keep the oil drain port plug intact.

(4)To add oil, remove the oil filler port and oil level check port plugs. If the oil has been let out, tighten the oil drain port plug.
Tightening torque:
58.8±9.8N-m (6.0±1.0kgf.m) 43.4±7.2 ft.lbs

(5)Pour gear oil through the oil filler port. Stop pouring just before the gear oil overflows the oil level check port.

(6)Tighten the oil level check port plug.
Tightening torque:
58.8±9.8N-m (6.0±1.0kgf.m) 43.4±7.2 ft.lbs

(7)Finally tighten the oil filler port plug.
Tightening torque:
58.8±9.8N-m (6.0±1.0kgf.m) 43.4±7.2 ft.lbs

c. Troubleshooting

Phenomenon 1	Phenomenon 2	Possible cause	Correction
Failure to run	No pressure rise	Relief pressure setting too low	Make correct setting.
		Pump defective	Repair.
		Directional control valve defective	Repair.
	Proper pressure rise	Brake valve defective	Replace or repair the brake valve.
		Hydraulic motor defective	Repair.
		Reduction gears damaged	Replace the GM motor.
		Overloaded	Remove the cause of overload.
Oil leak	Leak at mating surfaces	Mating surface scratched	Smooth the surface with whetstone, sand-paper or the like.
		Loose bolt	Retighten up.
	Leak at casing	Loose plug	Retighten up.
		Broken by stone or the like	Replace the GM motor.
	Leak at floating seal	Sliding face worn out	Replace the GM motor.
		O-ring crept	Replace the GM motor.
	Leak at hydraulic motor	Loose bolt	Retighten up.
		O-ring damaged	Replace the O-ring
		Sealing surface scratched	Smooth the surface with whetstone, sand-paper or the like.
Load-caused run in operation	More hydraulic oil leak	Hydraulic motor volumetric efficiency drop	Replace the GM motor.
		Brake valve internally leaky	Replace or repair the brake valve.
	Parking brake not working	Spring damaged	Replace the spring.
		Friction disc worn out	Replace the friction and mating discs.
Reduction gears casing surface temperature too high		Gear oil short	Add oil up to the proper level.
		Pitching at bearing	Replace the GM motor.
		Hydraulic oil into the casing	Replace the oil seal.
Zigzag travel (when used as travel motor)	At low pressure	Left and right discharge rates not equal	Repair the pump.
		Left and right hydraulic motor drain amounts not equal	Replace the GM motor.
	At high pressure	Left and right discharge rates not equal	Repair the pump or control valve.
		Left and right hydraulic motor drain amounts not equal	Replace the GM motor.
		Left and right brake valve actions not equal	Replace the brake valve.
		Relief pressure drop at left or right control valve	Make correct pressure setting. Replace the relief valve.
No speed-up	Pump discharge rate short	Pump malfunctioning	Repair or replace the pump.
		Too much leak out of pump	Repair or replace the pump.
		Too much leak out of hydraulic motor	Replace the GM motor.
Unusual operating noise	At GM motor	Hydraulic motor or reduction gears dam-aged	Replace the GM motor.
	At piping	Piping vibrated	Clamp the piping.
Two-speed selection impossible	Failure to switch from low to high speed	High-pressure check valve malfunctioning	Repair or replace.
		Selector valve malfunctioning	Repair or replace.
		Pilot pressure too low	Set to the specified pressure.
		Two-speed selector piston malfunctioning	Repair or replace.
	Failure to switch from high to low speed	Selector valve malfunctioning	Repair or replace.
		Two-speed selector piston malfunctioning	Repair or replace.

1. SERVICE OUTLINE

1-1. Tools

1-1.1. Standard tools

Applicable parts (Usage method or parts No.)	Name	Description	Remarks	Q'ty
284	Torquewrench	Dial type, approx. 45N	JIS B 4650	1
33, 121, 126, 143, 144, 152, 154		Dialtype, approx. 180N	JIS B 4650	1
19, 124		Dialtype, approx. 560N	JIS B 4650	1
284	Hexagon wrench	Nominal5mm	JIS B 4648	1
33, 34, 221		Nominal8mm	JIS B 4648	1
126		Nominal 10mm	JIS B 4648	1
154	Hexagon socket Insert angle 12.7mm	Nominal 4		1
284		Nominal 5		1
33, 34, 221		Nominal 8		1
245, 282		Nominal 10		1
289	Socket Insertangle 12.7mm	Nominal 22		1
19,224		Nominal36		1
19	Extension bar	Nominal200 Insert angle 19mm		1
19,124	Adapter	Insert angle 12.7X19		1
1,21,132,	Hand hammer	Nominal 12mm	JISB4613	1
8, 102,	Plastic hammer	ABT. 300mm		1
24, 25	Snap ring pliers	For shafts		1
20, 145		For holes		1
1	Centerpunch	ø9.5X100		1
21	Pin punch	ø3X150		1
For washing	Washing brush			1
For washing	Wire washing brush			1
Match marking	Paint marker	Paint maker: white		1
For oil draining and holding balls	Receptacles	Volume: W450XD300XH120		3
17	Metal-net basket			2
149	Leather gloves			1pair
21	Vinyl sheets	500X500X1.0		1
For oil filling	Oil pot with handle			2
21	Gear puller			1set

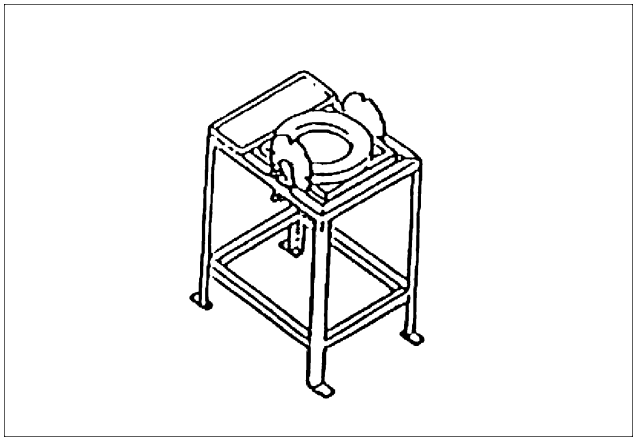
1-1.2. Equipment and materials

Applicable parts (Usage method or parts No.)	Name	Description	Remarks	Q'ty
For disassembling And reassembling works	General work stand			1
Forwashing GMY motor and parts	Washing sink	One for drain One for rinsing		2
104, 149	Press	Press capacity: 1960 N (200 kgf) 441lbs		1
149	Heating vessel	Volume: 1960 N (200 kgf) 441lbs Heating capacity: Over 100 °C 212 °F		1
1	Electricdrill	Portable drill diameter: 10 mm (0.39 in)	JIS C 9605	1
1	Drill	Diameter: 2 mm (0.08 in)		1
GM motor, 1, 2	Crane			1
3	Lathe			1
	Grinder			1
For drying washed parts	Compressed air supply	Pressure: 0.29 - 0.49 Mpa (3 - 5 kgf/cm2) 43~71 psi		1

1-1.3. Measuring devices

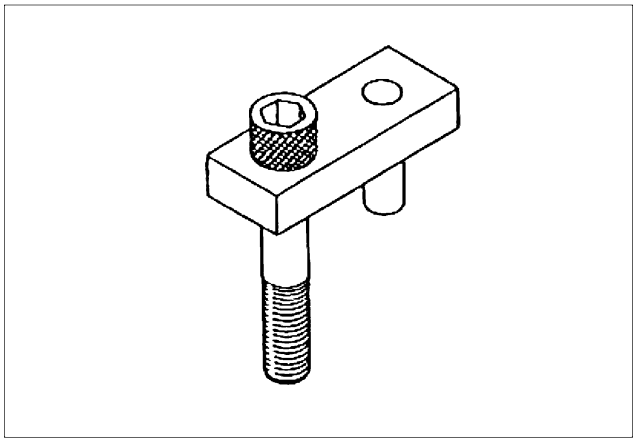
Applicable parts (Usage method or parts No.)	Name	Description	Remarks	Q'ty
For adjusting thickness of snap ring [20]	Thickness gauge	Measurement: 0.04-0.3 mm(0.002~0.01 in.)		2
	External micrometer	Measurement range: 0-25mm (0~0.98 in.) Min. graduation: 0.01 mm (0.0004 in.)		1
For pre-load adjustment of ball bearing [21]	Depth micrometer	Measurement range: 0-25mm (0~0.98 in.) Min. graduation: 0.01 mm (0.0004 in.)		1

1-1.4. Manufacturing tools



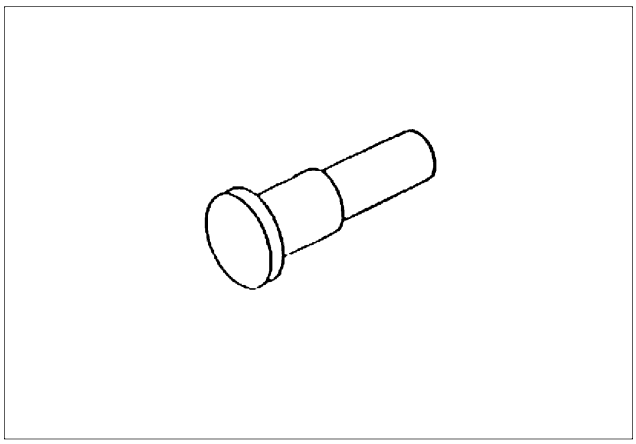
Tool name : Work stand

To be used for safe and easy disassembly and reassembly of GM motor.



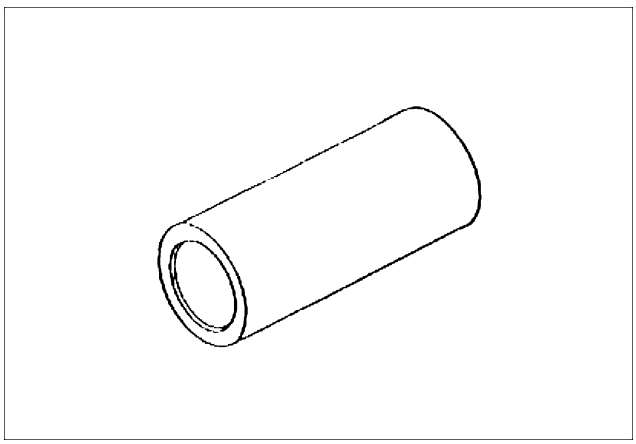
Tool name : Fixture

To be used for holding together hub [1] and spindle [2] when disassembly and reassembly.



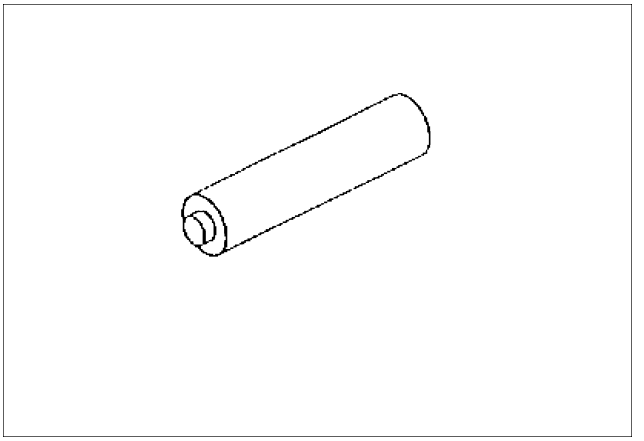
Tool name : retainer (1)

To be used for inserting coil spring [114], washers [110] and snap ring [145] into cylinder block [104].
To be used for removing coil spring [114] from cylinder block [104].



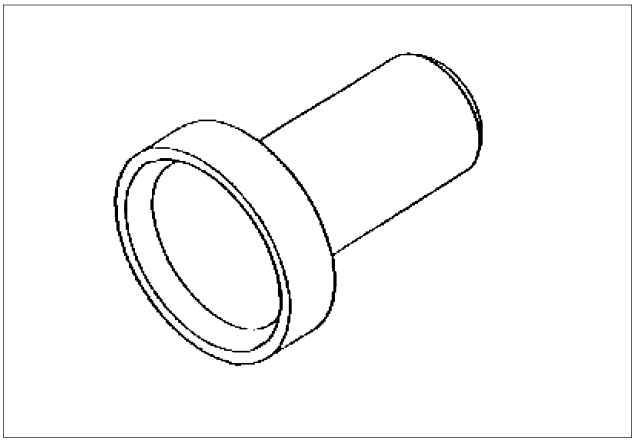
Tool name : retainer (2)

To be used for applying push to bearing when removing ball bearing [149] from shaft [102].



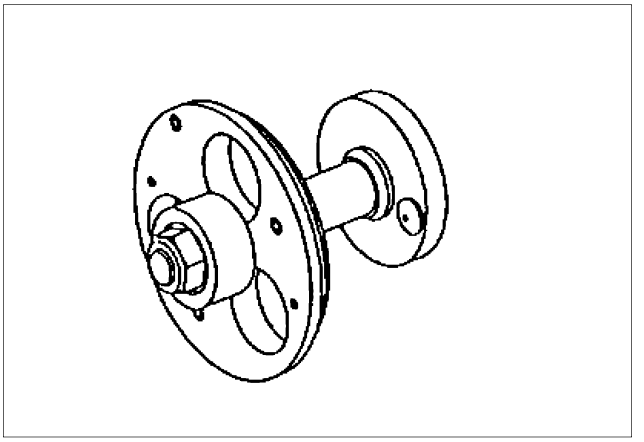
Tool name : Retainer (3)

To be used for pushing oil seal [132] when installing it in spindle [2].



Tool name : Retainer (4)

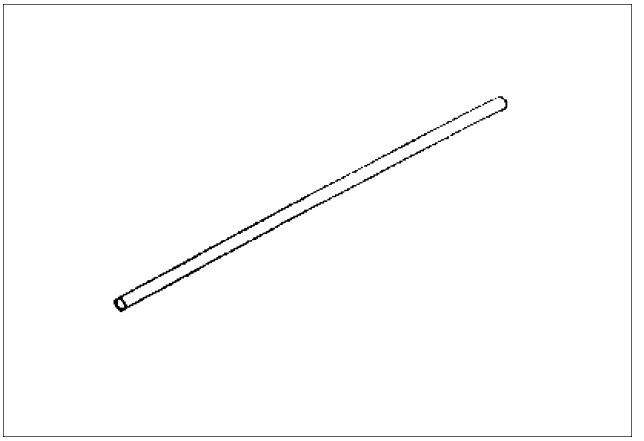
To be used for installing RV gear sub-assembly on spindle [2].



Tool name : Bearing pre-load adjuster

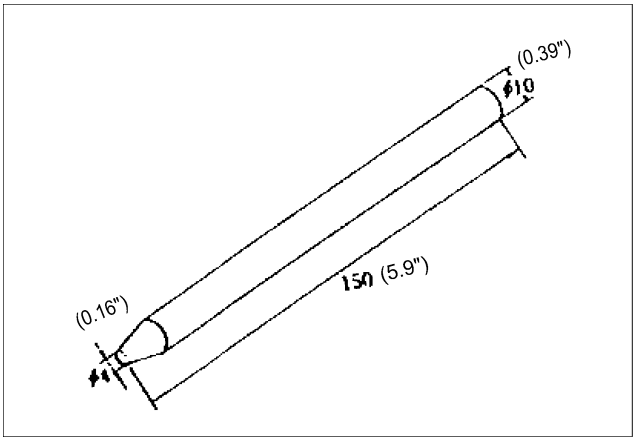
To be used for pushing ball bearing [21] when installing it in hub [1].

To be used for measuring axial clearance between hold flange [3] and ball bearings [21].



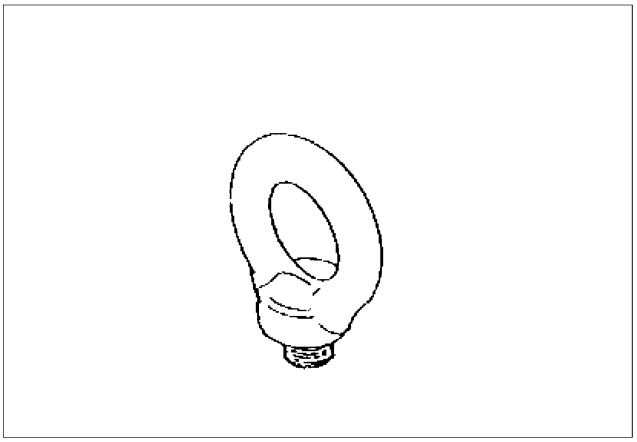
Tool name : Steel rod

To be used for removing ring [18] for hub [1]



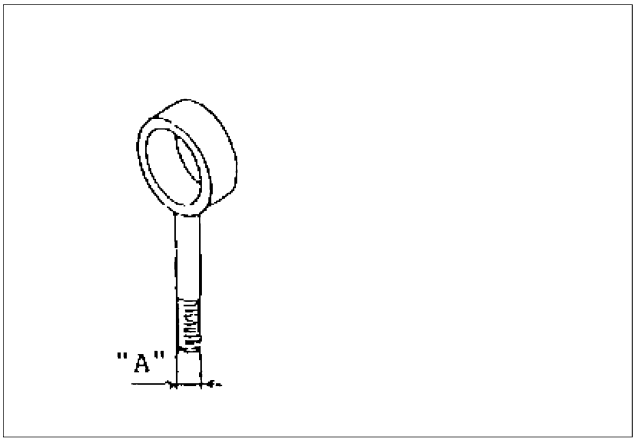
Tool name : Aluminum rod

To be used for removing oil seal [132] and collar [11] from spindle [2].
To be used for removing ball bearing [21] from hub [1].



Tool name : PF eye bolt

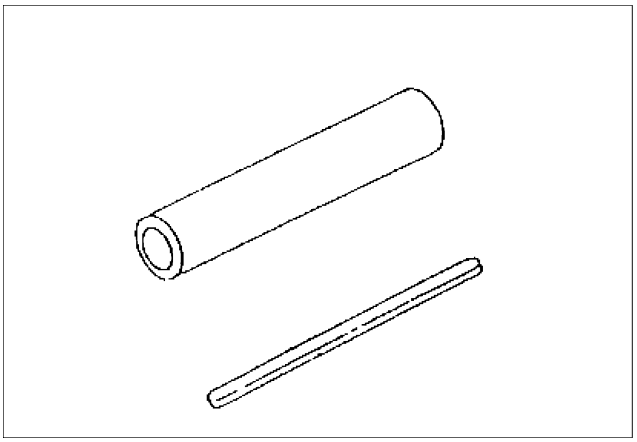
To be used for lifting cover [8] off hub [1] with a crane and wire rope.



Tool name : Long eye bolt

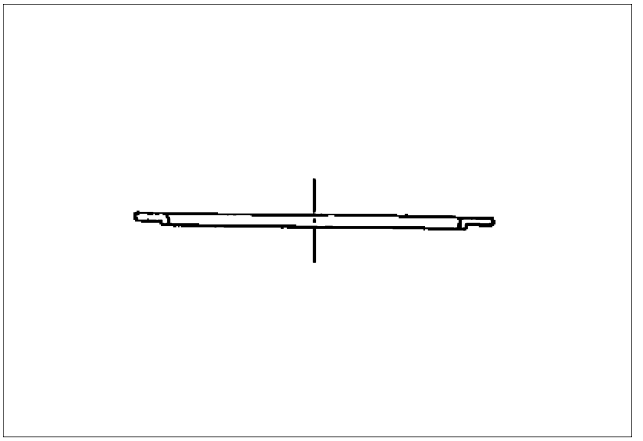
To be used for lifting GM motor, spindle [2] and hub [1].

	"A"
Hub	M14
Spindle	M16
GM motor	M16



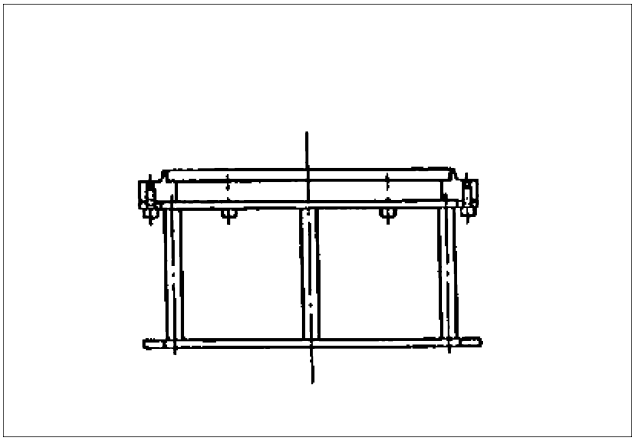
Tool name : Flat barand steel pipe

To be used for removing ball bearing [21] from spindle [2].
To be used for removing timing plate [109] from rear flange [101].
To be used for fixed hub [1] and work stand.



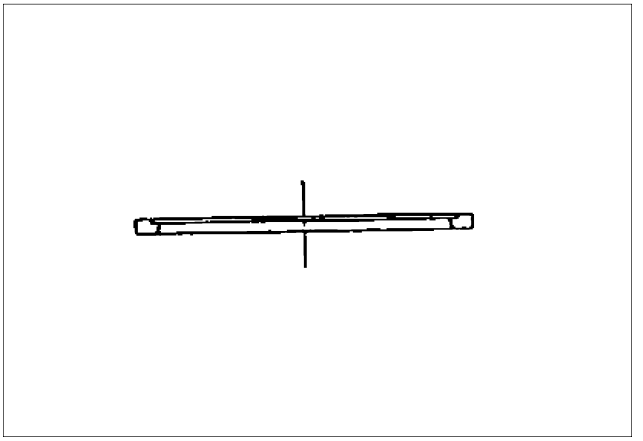
Tool name : F/S installationtool (1)

To be used for installing floating seal on hub [1]



Tool name : F/S installation tool (2)

To be used for installing floating seal on hub [1] and spindle [2]



Tool name : F/S installation tool (3)

To be used for installing floating seal on spindle [2]

1-2. Tightening torque

Applicable parts (Structural drawing)	Bolt/Nut Used		Hexagonal 2 surface width mm	Q'ty	Tightening Torque N.m (kgf.m)
	Name	Nominal Designation			
19	Reamerbolt	M24 X2.0	36mm	3	794 ± 49.0 N.m (81 ± 5 kgf.m) 580 ± 36 ft.lbs
33	Hexagon socket plug	PF3/8	8mm	3	58.8 ± 9.81 N.m (6 ± 1.0 kgf.m) 43.4 ± 7.2 ft.lbs
245	Hexagon socket bolt	M12X1.75	10mm	4	102 ± 15.7 N.m (10.4 ± 1.6 kgf.m) 75.2 ± 11.6 ft.lbs
34	Hexagon socket plug	PF3/8	8mm	1	58.8 ± 9.81 N.m (6 ± 1.0 kgf.m) 43.4 ± 7.2 ft.lbs
224	Plug	M30X1.5	36mm	2	353 ± 39.2 N.m (36 ± 4 kgf.m) 260 ± 29 ft.lbs
289	Plug	PF1/2	22mm	2	98.1 ± 19.6 N.m (10 ± 2.0 kgf.m) 72.3 ± 14.5 f.lbs
221	Hexagon socket plug	PF3/8	8mm	3	58.8 ± 9.81 N. m (6 ± 1.0 kgf.m) 43.4 ± 7.2 ft.lbs
282	Hexagon socket plug	PF1/2	10mm	2	98.1 ± 19.6 N.m (10 ± 2.0 kgf.m) 72.3 ± 14.5 ft.lbs
284	Hexagon socket plug	PF1/8	5mm4		12.3 ± 2.45 N.m (1.25 ± 0.25 kgf.m) 9.04 ± 1.81 ft.lbs

1-3. Weight table

Applicable parts (Structural drawing)	Component	Weight : N (kg)
GM motor	Travel motor assembly	Approx.794N (81kg) 179 lbs
[1]	Hub	Approx.186N (19 kg) 42 lbs
[2]	Spindle	Approx.265 N (27 kg) 60 lbs
[101] Other	Rear flange assembly	Approx.95N (9.7 kg) 21 lbs

2. DISASSEMBLY

2-1. Preparation

Perform the following preparations before disassembling.

2-1.1. Workbench preparations

Provide a travel motorworkbench.
Provide a sturdy workbench with which the internal parts of the travel motor can be disassembled or assembled, is wide enough to place parts so they do not move or fall off the bench while working.
Spread a rubberor vinyl sheet on the workbench.

2-1.2. Preparation of tools and materials

Provide the tools and materials listed in 1-1.

2-2. General suggestionswhen working

Caution

Internal parts are coated with hydraulic fluid during disassembly and are slippery If a parts slips out of your hand and falls, it could result in bodily injury or could damage the parts. Be very careful when handling.

Caution

Combustibles such as white kerosene are used forwashing parts. These combustibles are easily ignited, and could result in fire of injury. Be very careful when handling.

(1) Before disassembling, perform inspections and clearly determine the nature of any abnormalities which might be occurring, and work according to the disassembly procedure.
(2) Each parts is manufactured to extreme precision. Handle with care and be sure not to hit the parts together or drop them.
(3) When working, do not attempt to forcefully beat or wrench tightly fitting parts. Doing so could produce burrs or damage the parts so they can't be mounted or may reduce their performance. You should exercise patience when working.
(4) If you leave parts disassembled or partially disassembled, rust could develop on the parts due to moisture or dirt. If you have to interrupt work before completion, be careful to take measures to protect against rust or dust.
(5) Place a counter mark on mating faces of parts when disassembling.
(6) Arrange removed parts neatly when disassembling so as not to damage or lose the parts while working.
(7) As a rule, once any type of seal is disassembled it should be replaced with a new one even if it shows no signs of damage. You should have a new ready when disassembling.
(8) The photographs and drawings contained in the manual are of representative models. Disassembly procedure is however not affected even if the product you are using differs in part.



2-3.Disassembly procedure

(1) Washing the travel motor

1) Fasten the eyebolts in the screw holes for mounting the spindle [2].

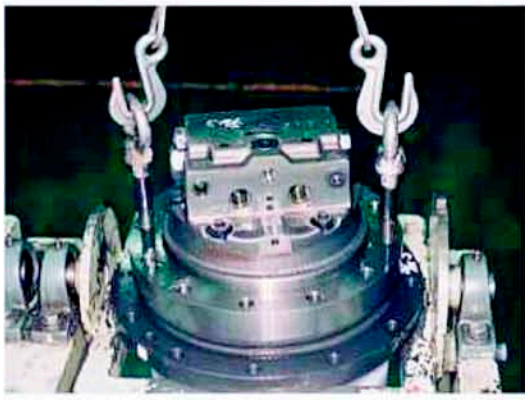
Note : Fasten the 2 eye bolts in the screw holes for mounting the spindle [2] so they are positioned symmetrically.



2) Hook the wire in the eye bolts, hoist the travel motor with a crane and carry to the washing tank.

3) Wash each part of the travel motor with a car wash brush.

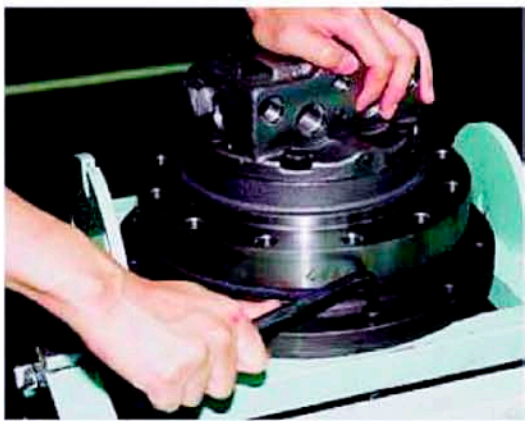
Note : Earth and sand get in the clearance between the hub [1] and spindle [2] (floating seal mounting section). Be sure to wash this part with special care.



(2) Travel motor installation

1) Set the travel motor on a workbench

Note : While matching the hub bolts of the hub [1] and screw holes of the workbench, carefully place the travel motor in the mounting holes of the workbench.



2) Mount the travel motor on the workbench and tighten hexagon nuts to the hub bolts.

Caution

Tighten the hexagon nuts securely. Failure to do so could result in injury cased by the travel motor falling when it is inverted.



(3) Lubricating oil drain

Note : If disassembling the rear flange only, proceed to below 1) of item (7).

1) Invert the travel motor.

2) Loosen and remove the hexagon socket plug [33] (1 plugs), [34] (2 plugs).

Note : When draining the lubricating oil, place a container below the workbench.



3) Slowly invert the travel motor and drain the lubricating oil.

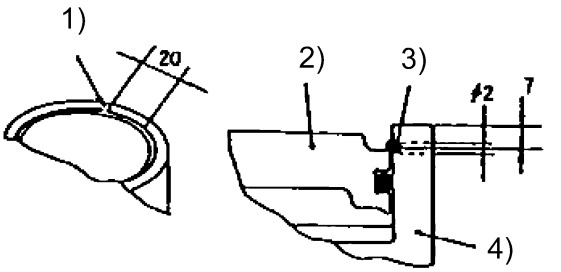


(4) Cover removal

1) Scribe match marks across the joint seam between hub [1] and cover [8] by using a paint marker.

2) Look into the seam to locate the gap of ring [18]. Make a punch mark on the hub [1] at a point about 20mm (0.79 in.) from the ring [18] end in circular direction and 7mm (0.28 in.) from the end face of hub [1].





1)(Gap of ring}
2)Cover
3)Ring
4)Hub



3) Using an electric drill, make a 2mm (0.08 in.) diameter hole at the punch mark.

Note : Be sure to centerthe drill on the punch mark, and keep drilling until the ring starts rising. After drilling clear through the wall of hub [1], be sure to wipe off the chippings completely.

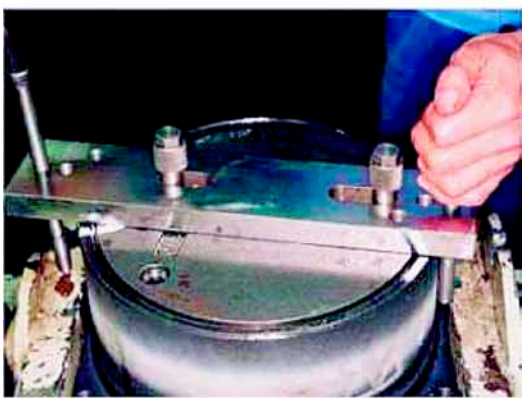


4) Insert the steel rod into the drilled hole and push it into makethe ring [18] comeout.

Note : In this case, the advanced of ring come out.



5) Pickthe end portion of ring [18] and pull it out to remove the ring [18] off the groove.



6) Fasten the PF eye bolts in the screw holes for fastening the hexagon socket plugs [33] of the cover [8] (2 places).

7) Hookthe hook and wire in the PT eyebolts, hoist with a crane and remove the cover [8].

Note : If the cover [8] is difficult to remove due to resistance of the O-ring [29], hoist while tapping the outer edges of the cover equally with a plastic hammer.

8)Remove the O-ring [29] from the cover [8].

Note : Do not reuse the O-ring [29] which has been removed.



(5) Input gear removal

1) Removethe snap ring [24] from the shaft [15].



2) Remove the input gear [6], from the shaft [15].

3) Remove the steel ball [36] from shaft [15].

4) Removethe shaft [15] from the spindle [2]



(6) Spur gears removal

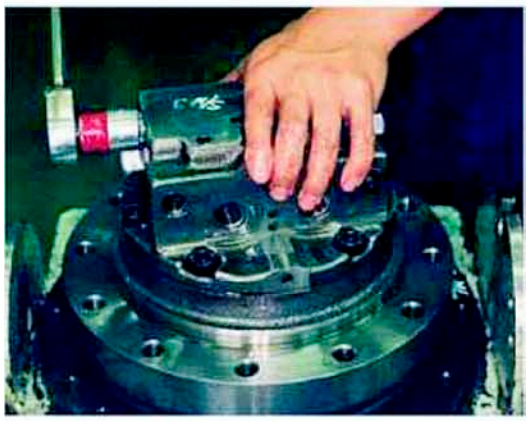
1) Remove snap rings [25] (3 rings) from crankshaft [9].

Caution

Take notice when taking off the snap ring by the top with a plierthe snap ring will spring out of the snap rings hole.



2)Remove spur gears [7] from each crankshaft [9].



(7) Remove the rear flange
1)Invert the travel motor.

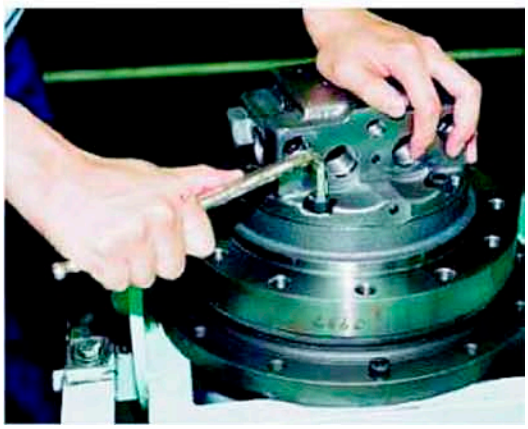
Note : The following task is carried out to facilitate plug removal if disassembling the rear flange [201] inside. Plugs must be loosened to the degree where they can be removed by hand. If not disassembling the rear flange [201] inside, do not loosen the plugs.

2)Loosen the plugs [282] (2 plugs).

3)Loosen the plugs [289] (2 plugs).

4)Loosen the plugs [224] (2 plugs).

5)Loosen the plugs [282] (2 plugs)



6)Remove the hexagon socket bolts [245] (6 bolts).



7)Remove the rear flange [201] from the spindle [2].

Note : Grip the rear flange [201] with both hands and remove by carefully straight upward. If removed by forcefully wrenching or beating, the timing plate [109] could fall and become damaged.

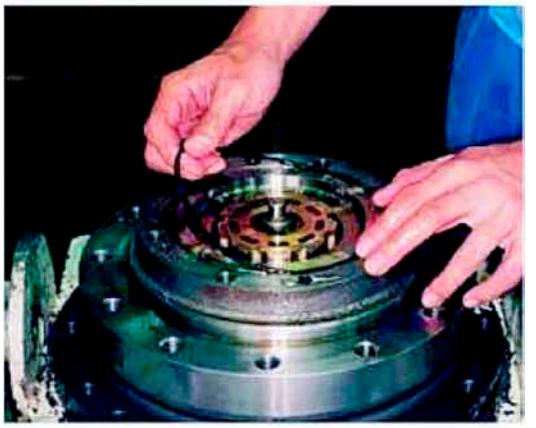
8) Remove the springs [113] (8 springs).



9) Remove the parallel pins [43] from the spindle [2].

10)Remove the O-rings [28], [30] from the spindle [2].

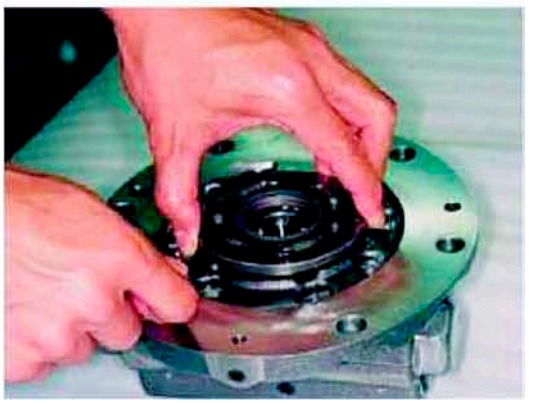
Note : Do not reuse the O-rings [28], [30] which have been removed.



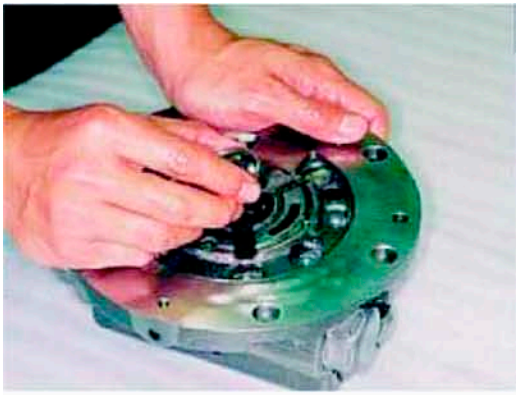
(8) Disassembly of rear flange mounted parts

1) Place the rear flange [201] on the workbench in position where its mating face with the spinclle [2] faces upward.

2) Remove the timing plate [109] from the rear flange [201].

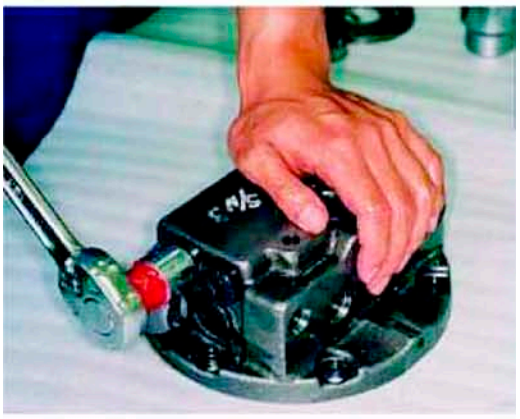


Note : The mating face with the rear flange [201] may be difficult to remove due to adherence of oil. It will come off if you insert a knife in the casting groove of the mating face of the rear flange [201] side and gently lift the timing plate [109]. Inserting sharp tools such as a screwdriver in the mating face will damage the mating face and cause oil leakage. Do not use sharp tools such as a screwdriver.



3) Remove the parallel pins [242] from the rear flange [201].

4) Remove the ball bearing [150] from the rear flange [201].

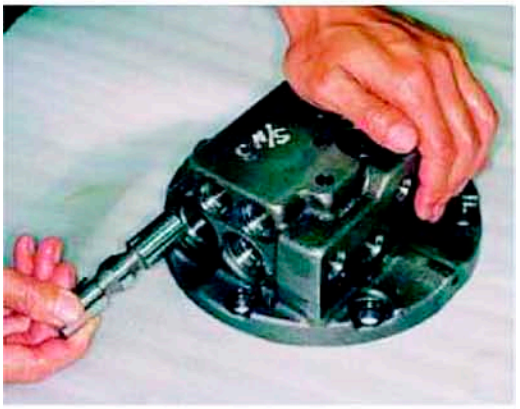


(9) Disassembly of plugs inside rear flange

1) Remove the plugs [224] (2 plugs) from rear flange [201].

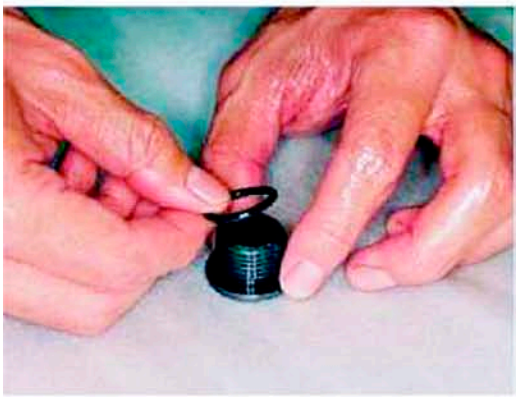
2) Remove the O-ring [236] from the plug [224].

Note : Do not reuse the O-ring [236] which has been removed.



3) Remove the spool [223] from the rear flange [201].

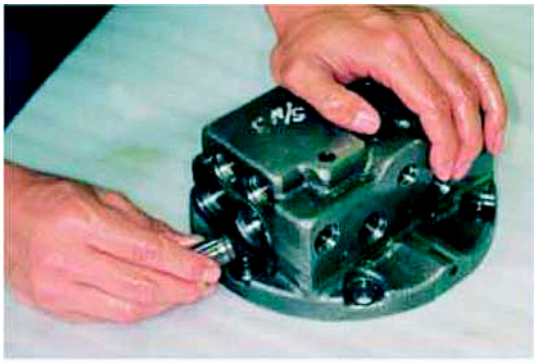
Note : The spool [223] will slip out and fall if you tilt the rear flange [201] so that one of the plug ports is facing downward. Grip the ends and remove.



4) Remove the plugs [282] (2 plugs) from rear flange [201].

5) Remove the O-ring [238] from the plug [282].

Note : Do not reuse the O-ring [238] which has been removed.

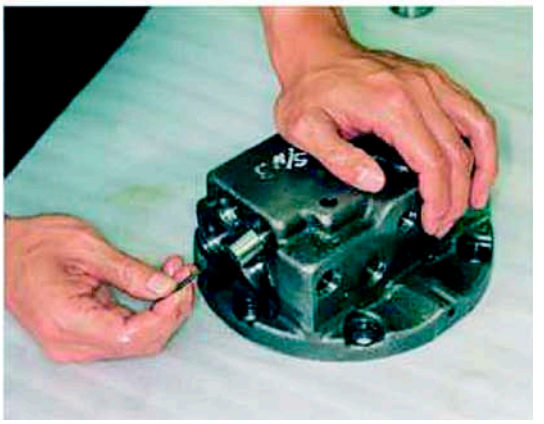


6) Remove the spring [230] (2 springs), valve [227] (2 valves) from the rear flange [201].

(10) Disassembly of SRV mounted into the rear flange

1) Loosen and remove the plug [282] (2 plugs) from the rear flange [201].
2) Remove the O-ring [238] from the plug [282],

Note : Do not reusethe O-ring [238] which has been removed.



3) Remove the piston [286] from the rear flange [201].

Note : The rear flange [201] and the piston [286] are watched as a set. keep them so you will know the combination.

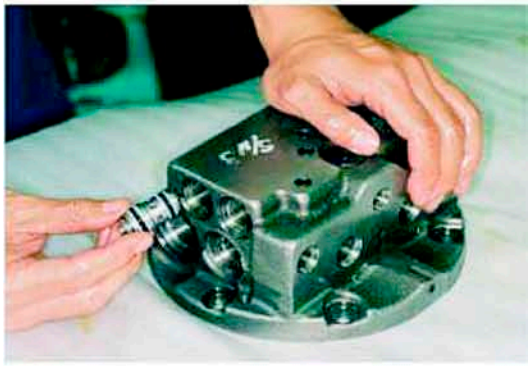
Note : If the piston [286] is difficult to remove, screw the bolt of M3 to the screw hole for the disassembly of the piston [286]. Be careful not to do damaged the piston hole.



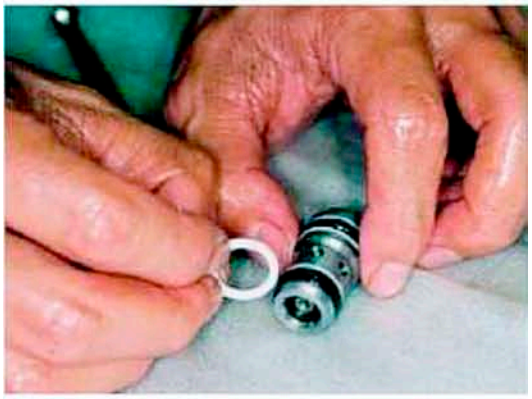
4) Loosen and remove the plugs [289] (2 plugs) from the rear flange [201].

5) Remove the O-ring [238] from the plug [289].

Note : Do not reuse the O-ring [238] which has been removed.

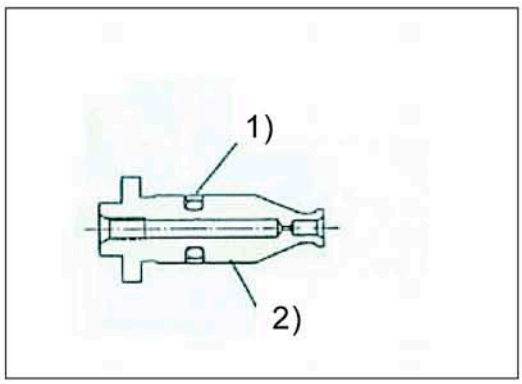


6) Remove the spring [290], valve [287], sleeve [288] from the rear flange [201].



7) Remove the O-ring [292], backup ring [294] from the sleeve [288].

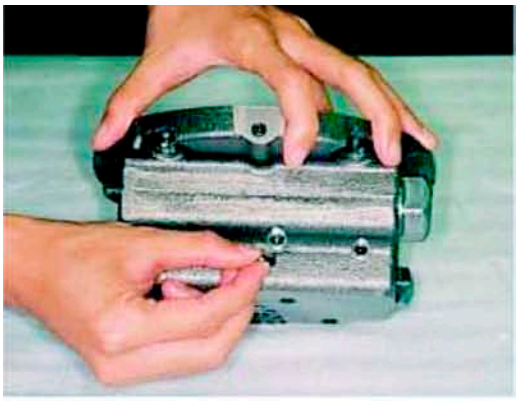
Note : Do not reuse the O-ring [292], backup ring [294] which has been removed.



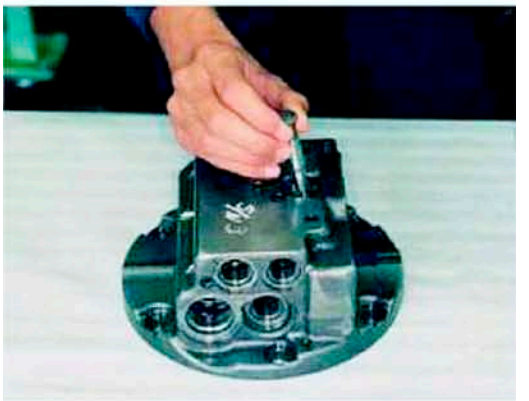
8) Remove the piston seal [293] from the valve [287].

Note : Do not reuse the piston seal [293], which has been removed.

1) Piston seal
2) Valve



9) Remove the plugs [285], steel-ball [296] from the rear flange [201].



(11)Disassembly of pilot valve from the rear flange

1) Remove the plug [221], spool [271], spring [281] from the rear flange [201].

2) Remove the O-ring [292]from the plug [221].

Note : Do not reuse the O-ring[292], which has been removed.



(12) Disassembly of parking brake section

Caution

If compressed air is introduced suddenly, the piston [112] will fly off the spindle [2] and could result in injury.
A protective cover, etc., must therefore be placed over the piston [112].



1) Inject compressed air into the passage hole for parking brake of the spindle [2], and remove the piston [112] from the spindle [2].

2) Remove the O-rings [135], [141] from the piston [112].

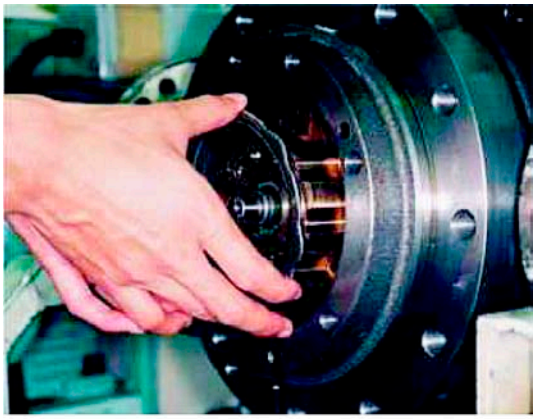
Note : Do not reuse the O-rings [135], [141] which have been removed.

(13)Disassembly of hydraulic motor parts

Note : Oil spills from the travel motor when faced sideways, so place a container under the travel motor.

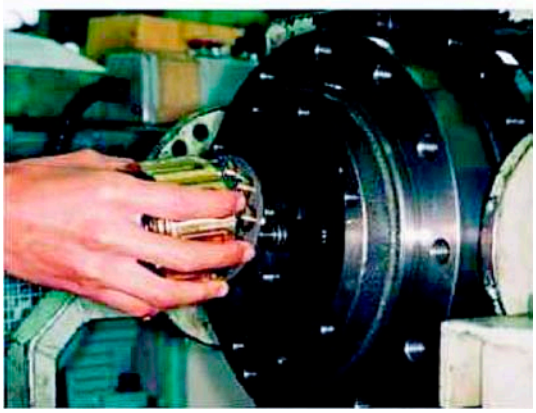
1) Tilt the travel motor 90 degrees.

2) Extract the oil from inside the travel motor.



3) Grip the cylinder block [104] with your hands, turn alternately 2~3 times, and cut away the shoe [106] bonded to the swash plate [103].

Note : If you remove the cylinder block [104] as is, the shoe [106] remains bonded to the swash plate [103], and the parts (piston [105], shoe [106], etc.) mounted on the cylinder block [104] will come off the cylinder block [104] and fall into the spindle [2],



4) Draw out the cylinder block [104] from the shaft [102].

Note : At this time the friction plates [115] and mating plates [116] are also mounted on the cylinder block [104] and will come off.

5) Remove the friction plates [115] and mating plates [116] (2each) mounted on the removed cylinder block [1 04].



6)Remove the piston assembly (piston [105], shoe [106]) and retainer plate [107] from the cylinder block [104].

Note : When removing, grip the retainer plate [107] with both hands and remove together with the retainer plate [107]. The piston [105] and shoe [106] are squeezed into a single part at the round surface section of the piston [105]. The piston [105] and shoe [106] cannot be separated without damaging the shoe [106]. If replacement is necessary, replace the piston [105] and shoe [106] as a pair (hereinafter referred to as "piston assembly") in a 9-pair unit (hereinafter referred to as "piston kit").



7) Draw out the piston assembly [105], [106] from the retainer plate [107]. (9 pair)



8) Remove the thrust ball [108] from the cylinder block [104].



9) Remove the needle rollers [151] (3 rollers) From the cylinder block [104].

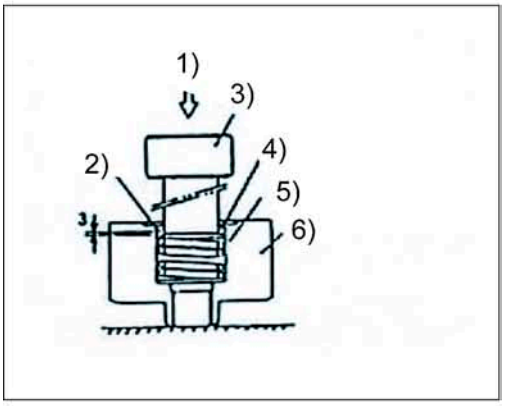


(14)Removal of spring inside cylinder block

1) Place the cylinder block [104] on the press bench.

Note : The spring is removed only when replacing. The spring is removed by lining up the shaft centers of the retainer (1) and washer [110] in order to prevent damage to the cylinder block [104] through contact.
Cover the cylinder block [104] with a vinyl sheet to prevent the sliding surface of the cylinder block [104] from being damaged.

2) Place the retainer (1) on the washer [110], and while clamping the retainer (1) with the press, remove the THS snap ring [146] from the snap ring groove of the cylinder block [104] with a pair of snap ring pliers.



1)Press
2)Washer
3)Retalner
4)Snap ring
5)Spring
6)Cylinder brock

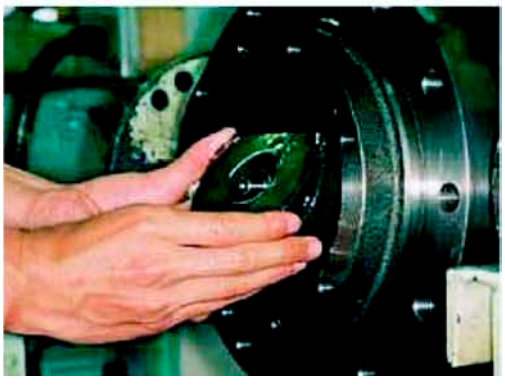
Caution

If the press is loosened suddenly, the spring could jump out resulting in injury. Loosen the press slowly.

3) Loosen the press slowly until the spring force is released.



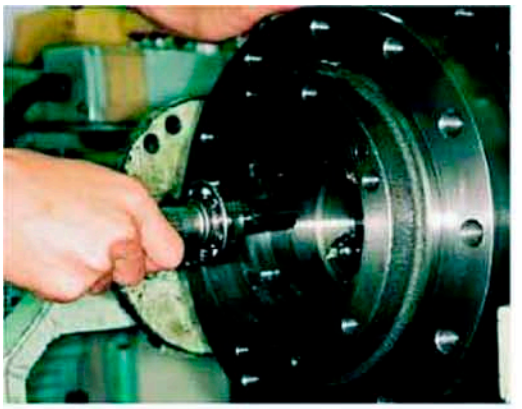
4) Remove the THS snap ring [146], washer [110], spring [114], and washer [110] from the cylinder block [104].



(15)Shaft removal

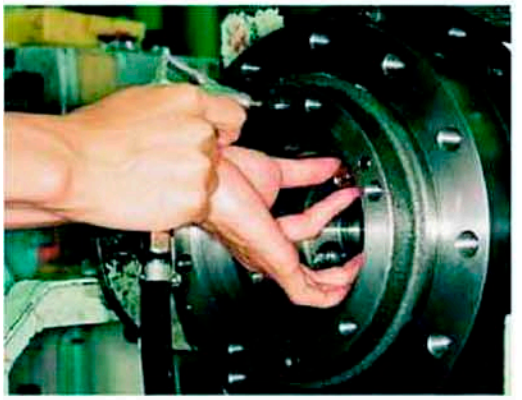
1) Remove the swash plate [103] from the spindle [2].

Note : At the time of swash plate [103] removal, the pivot [176] is attached to the swash plate [103] in some cases.



2) Draw out the shaft [102] and ball bearing [149] from the spindle [2].

Note : The speed reducer side shaft can be drawn out easily after tapping the tip of the shaft gently with a plastic hammer. The shaft however may jump put if struck forcefully.



3) Remove the pivots [176], parallel pins [177] (2 each) from the spindle [2].

4) Remove the 2-speed switching piston assembly (piston [161], shoe [162]) and spring [185] from the spindle [2].

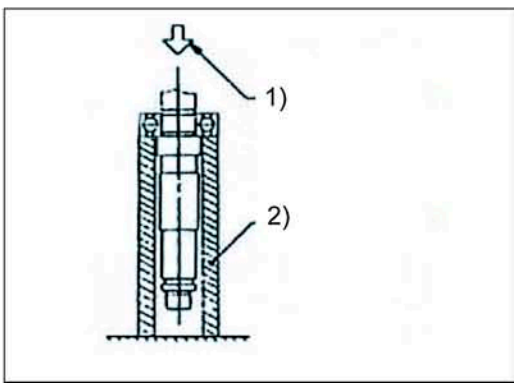
(16)Removal of ball bearing

Note : The ball bearing is removed only when replacing.

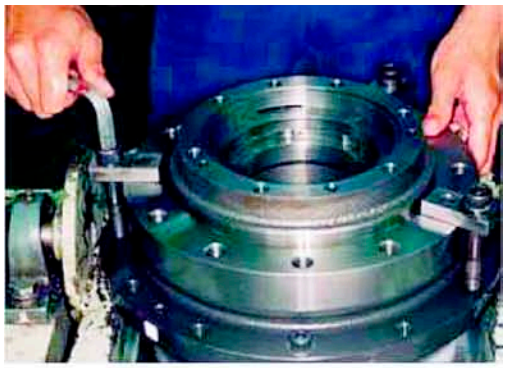
1) Place the retainer (2) on the press bench, and place the shaft [102] inside.

2) Clamp the tip of the shaft [102] with the press and remove the ball bearing [149] from the shaft [102].

Note : Do not reuse the ball bearing.



1)Press
2)Retainer(1)



(17)Removal of hold flange
1)Invert the travel motor

2)Fasten the fixtures (2 fixtures) to the hub [1] and spindle [2] and fix in place. At this time, fasten the fixtures so they are positioned symmetrically.

Note : If the hold flange [3] is removed without fastening the fixture, the hub [1] and spindle [2] become separated, and the spindle [2] will fall from the workbench. Be sure to fasten the fixture.



3)Invert the travel motor

Caution

When removing the snap ring [20], you could become injured if the tip of pliers comes out of the hole of snap ring [20], and snap ring [20] jumps out.



4)Remove the snap rings [20] (3 rings) from the hold flange [3].

5)Put a counter mark on the snap ring [20] and hold flange [3] with an oil base paint marker.

Note : This is so the parts can be assembled in the same position when reassembling.

6)Loosen the reamer bolts [19] (3 bolts).



Note : Bonding agent is used for the screw holes of reamer bolts [1 9].When loosening, disassembly may become difficult. Loosen the reamer bolts [19] as slowly as possible. If the bolts become hard to turn, do not forcefully loosen, but rather screw them in once and then loosen them again slowly. Tightening torque is 794 ± 49.0 N-m (81 ± 5 kgf-m) 586 ±36 ft-lbs, but because bonding agent is applied to the screw portion, loosening torque 794 ± 49.0 N-m (81 ± 5 kgf-m) 586 ± 36 ft-lbs, or more is required for loosening.

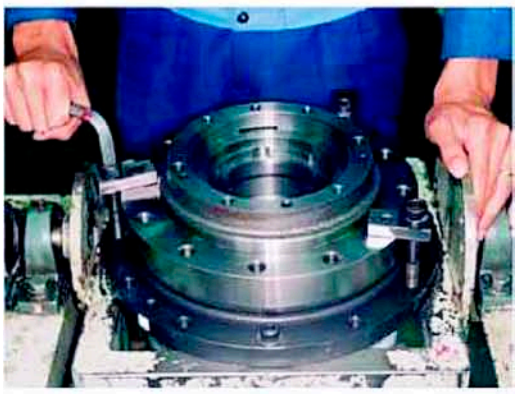




7) Remove the hold flange [3] from the spindle [2].

8) Write the counter mark of the hold flange [3] and spindle [2] on the hold flange [3] and spindle [2] with an oil base paint marker.

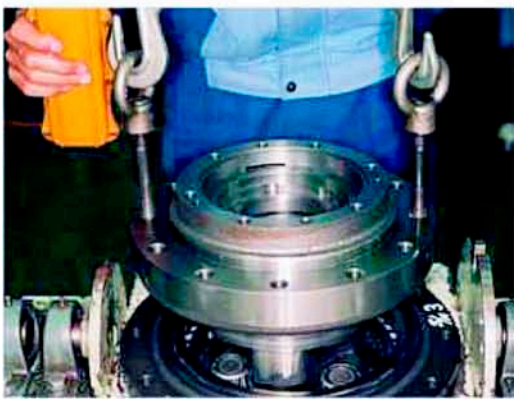
Note :This is so the hold flange [3] can be assembled in the same position as the spindle [2] before disassembly when reassembling. If replacement is necessary, replace the spindle [2] and hold flange [3] as a pair (assembly). (This assembly will hereinafter be referred to as "spindle assembly".)



(18)Fixture removal

1)Invert the travel motor.

2)Remove the fixtures (2 fixtures).



(19)Spindle removal

1) Fasten two eyebolts in the mounting holes of the spindle [2] so they are symmetrically positioned.

2) Hook the hook on the eyebolt, gently and slowly hoist with a crane, and remove the spindle [2] from the hub [1].
At this time, the floating seal [31], outer ring of the tapered roller bearing [22] and oil seal [132] come off together.



(20)Removal of ball bearing, RV gear assembly and pin

1)Remove the floating-seal [31] from the hub [1].

Note : When removing the ball bearing [21], tap the end face of the pins equally in 3-4 places around the circumference a little at a time so as not to wrench the ball bearing [21].
When the mating part of the outer ring of the ball bearing [21] is removed from the hub [1], the ball bearing [21], RV gear assembly and pin [17] will fall from the hub [1]. In order to keep the parts from being damaged, place a container underneath the workbench, and place a rubber mat over it.



2)Strike the end face of the pin [17] with a pin punch and a hammer, and remove the ball bearing [21] from the hub [1].
At this time, the RV gear assembly (RV gear A [4], RV gear B [5], crankshaft [9], tapered roller bearing [22], needle roller bearing with retainer [23], spacer [12]) and pin [17] can be taken out together.

3)Remove the ball bearing [21], RV gearassembly and pin [17] which have fallen.

Note : The tapered roller bearing [22], needle roller bearing [23], spacer [12] are not removed from the crankshaft [9] except when replacing.



(21) Ball bearing removal

Note : When removing, the ball bearing [21] falls from the hub [1]. Place a rubber mat underneath the workbench to keep the part from being damaged.

1)From the cover [8] side of the hub [1], strike the end face of the pin [17] with a pin punch and hammer, and remove the ball bearing [21] from the hub [1].



(22) Removal of spindle mounted parts

1) Takethefloating seal [31] out of the spindle [2].

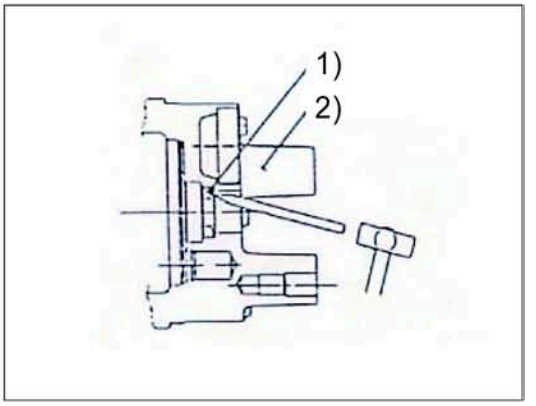


2) Remove the outer rings (3 rings) of the tapered roller bearing [22] from the spindle [2].

Note : The mounting surfaces of the outer ring of the tapered roller bearing [22] and spindle [2] may adhere due to oil film of the lubricating oil. Outer ring removal may therefore be difficult. If so, if you provide a light impact to the center of the mounting hole section of the spindle [2] with an aluminum bar, the film will be broken thus facilitating removal.

3)Removal the oil seal [132]from the spindle [2].

Note : Absolutely do not reuse the oil seal [132] which has been removed.



1) Oil seal
2) Spindle



(23) Disassembly of hold flange mounted parts

1)Take the outer ring of the tapered roller bearing [22] out of the hold flange [3].



(24) Rough washing of various parts

1) Divide the hub [1], spindle [2], cover [8], rear flange [101] parts (4 parts) and other parts (hereinafter referred to as "internal parts").

2) Place the hub [1], spindle [2], cover [8] and rear flange [101] into the washing tank and wash.

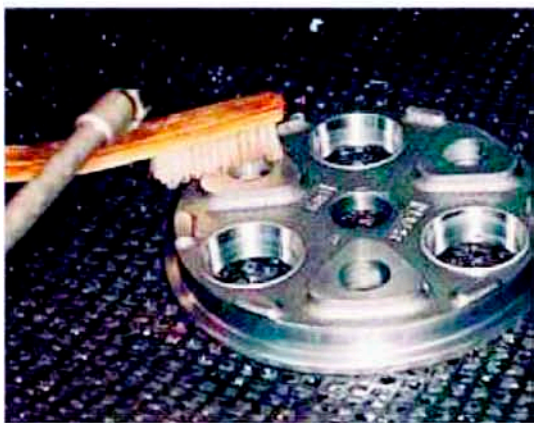
Note : Earth and sand may adhere to the outer surface of the various parts. Wash well and remove the earth and sand.

Caution

White kerosene is a combustible.
Beware off ire or burns or injury due to fire.

Note : Injury may occur easily if you wash various parts which are still dirty in oil from the beginning. Let soak until the dirt and grease become loose and float up.

3)Place the internal part in a rough washing container of white kerosene and wash.



(25) Finish washing

1) Place the various parts in finish washing container of white kerosene and wash well including the inside of parts while slowly turning.

2) Wipe away the white kerosene adhering to each part with a clean waste cloth.

Note : Dry the inside surfaces of the hub [1], spindle [2] and hold flange [3] by blowing with compressed air in a place free of dust and moisture. After drying, coat each part with hydraulic fluid. Let the inside surface of the rear flange [101], hydraulic motor parts and RV gear assembly dry naturally in a place free of dust and moisture. If the pins [17] (24 pins) are treated roughly, the surfaces will become damaged from mutual contact or lost. Handle the pins with care.

3. SERVICE PREPARATIONS

Follow these standards when disassembling and inspecting the GMY motor.

Handle the various parts carefully. Be especially careful not to damage the moving and sliding parts. Seals

3-1. Once disassembled, all seals (O-rings, oil seals, floating seals) should be replaced with new ones even if no damage is observed.

3-2. Service standards for parts subject to wear

(1) Replace all parts which show striking damage.

(2) Replace if various parts have the following problem (phenomenon).

Part No.	Parts Name	Phenomenon	Reference Value (Standard Dimensions)	Tolerance Value (Criterion Value)
(2) (3) (19) (37)	Spindle kit Spindle Hold flange Reamer bolt Expander	・Serious damage in appearance. ・Abnormal wear such as scuffing.		
(4) (5) (9) (12) (22) (23)	RV gear assembly RV gear (A) RV gear (B) Crank shaft Spacer Tapered roller bearing Needle roller bearing With retainer	・RV gear teeth surface are worn unequally. ・Movement of various parts not smooth when crank shaft [9] is turned.		
20	Snap ring	・Circumferential end face has abnormal wear.		
21	Ball bearing	・Has indentation. ・Exhibits flaking phenomenon. ・Worn unequally.		
102	Shaft	・Working face with oil seal [132] is worn. ・Spline is worn.		
104	Cylinder block	・Spline section is worn. ・Inner surface of bore is worn too much. ・Flaw and unequal wear on sliding plate surface with timing plate [109].		
(105) (106)	Piston assembly Piston Shoe	・There is clearance in shaft direction of the piston [105] and shoe [106]. ・Shoe [106] is abnormally worn. ・Shoe [106] is unequally worn.	Clearance 0.04 mm 0.0016in.	Clearance 0.14 mm 0.0016in.
107	Retainer plate	・Circumference end face is unequally worn.		
108	Thrust ball	・Ball surface sliding part with retainer plate [107] is worn unequally.		
109	Timing plate	・Sliding surface has burning phenomenon and unequal wear.		
115 116	Friction plate Matching plate	・Both end faces are unequally worn. ・Torque is not specified torque. ・Has burning phenomenon.	Braking torque 97.1 N・m (9.9kgf・m) 71.6ft・lbs	Braking torque 97.1 N・m (9.9kgf・m) 71.6ft・lbs
149 150	Ball bearing Ball bearing	・Has indentation. ・Exhibits flaking phenomenon. ・Worn unequally.		
153	Thrust plate	・Has burning phenomenon		

4. ASSEMBLY

Assembly, as a rule, assembly is carried out by performing the procedure for disassembly inreverse.

4-1. Preparation

2.Provide a workbench, tools and materials in the same way as for disassembly of section2.

4-2. General suggestion when working

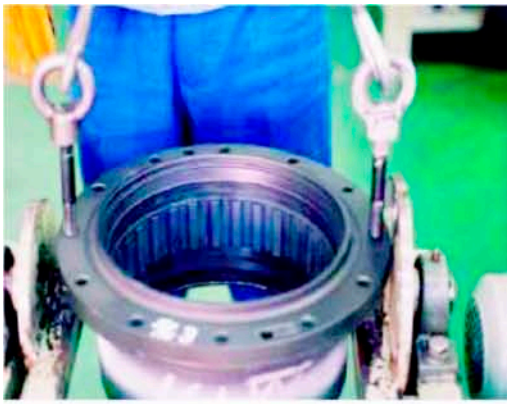
(1) Pay the same attention as for general suggestions for disassembly of section 2.
(2) When assembling, remove all foreign objects or metal fragments from parts, and make sure there are no burrs or dents, etc., on parts.
If there are burrs or dents, remove with an oil stone.
(3) Replace O-rings, oil seals and floating seals with new ones.
(4) Replace reamer bolts [19] with newones.
(5) Bonding agent is applied to the screw section of reamer bolts [19] and screw holes of reamer bolts [19] of the spindle [2] when assembling.
Degrease in order to remove grease.
(6) Be careful not to damage O-rings, oil seals and floating seals when mounting. (Apply a small amount of grease to make them slippery.)
(7) Be sure to coat the moving and sliding parts of the hydraulic motor section and valve section with clean hydraulic fluid (NAS standard class 9 or higher) and assemble.
(8) Do not use cloth gloves for assembly. (To prevent fiber pieces from causing faulty operation.)
(9) Bolts and plugs should be tightened by torque value given in 1-2. Tightening torque table.
(10) When assembly is complete, plug all ports to prevent dirt from entering.
(11) The photographs and drawing contained in the manual are of representative models.
Disassembly procedure is however not affected even if the product you are using differs inpart.

4-3. Assembly procedure

Note : If reassembling after replacing parts, pre-load adjustment of the ball bearing [21] and shaft direction clearance adjustment of the tapered roller bearing [22] are necessary.
Before assembling, therefore, make sure the following parts have been replaced.

(1) Renewal parts required for pre-load adjustment of the ball bearing [21] : Hub [1], spindle kit, collar [11], ball bearing [21].
(2) Renewal parts required for shaft direction clearance adjustment of the tapered roller bearing [22] : Spindle kit, RV gearassembly.

Note : If reassembling after replacing the parts listed above, be sure to reassemble using parts which have been adjusted.
If you reassembly with parts that have not been adjusted, it will cause the travel motor to operate poorly or break down prematurely.



(1) Hub section assembly

1) Fasten 2 eyebolts in the screw holes of the hub [1] so they are symmetrically positioned.

2) Hookthe hook and wire in the eyebolts, hoistthe hub [1] with a crane, and set the hub [1] on the workbench.

Note : While matching the hub bolts of the hub [1] and mounting holes of the workbench, place the hub [1] gently in the mounting holes of the workbench.



3) Fasten the hub [1] to the workbench and tighten the hexagon nuts are symmetrically positioned.

Caution

Tighten the hexagon nuts securely.
Failure to do so could result in injury if the travel motor is inverted and falls.



4) Press fit the ball bearing [21] in the hub [1] with an aluminum rod and hammer.

Note : When pressing ball bearing [21] , be sure to keep it true and square by shifting the aluminum rod around and pushing it in just a little at each spot.



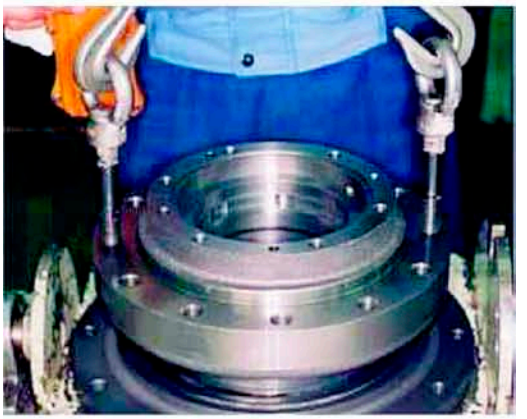
5) Fit floating-seal [31] to hub [1], holding it by both hands and lowering it slowly into position.



(2) Spindle section assembly

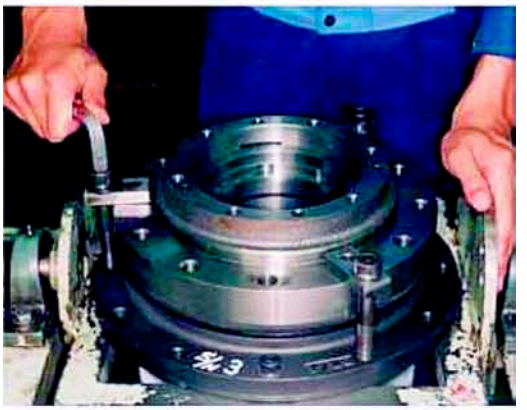
1)Apply oil to the O-ring of the floating seal [31], and mount the floating seal in the floating seal groove of the spindle [2].

Note : Separate the O-ring parts of floating seal [31], and Oil it all around, and then combine itwith the seal ring part. Seat the O-ring part snugly in the groove, and after fitting the floating seal [31] in the groove, checkto be sure that it is true and square in spindle [2].



2) Mount 2 eye bolts in the spindle [2] so they are symmetrically positioned.

3) Hook the hook and wire in the eyebolts, hoist the spindle [2] with a crane, and slowly place the spindle [2] inthe hub [1].



4) Fasten the hub [1] and spindle [2] with fixtures. At this time, fasten the fixtures so they are symmetrically positioned

5) Invert the travel motor.



6) Fit the outer rings (3 rings) of the tapered roller bearing [22] into the respective outer ring fastening holes in the spindle [2].

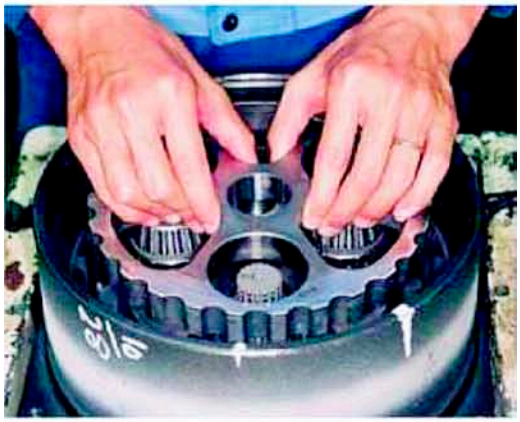


(3) Mount the RV gear assembly.
1)I nstall RVgearA[4] inthehub [1].



2) Install the crankshaft [9] in the hub [1].

Note : Match the inner race of the tapered roller bearing [22] of the crank shaft [9] with the outer race hole of the tapered roller bearing [22] fit in the spindle [2].



3) Install RVgearB [5] inthe hub [1].



4) After applying lubricating oil to the pins [17] (24 pins), insert between the pin groove of the hub [1] and gear teeth groove.



(4) Hold flange mounting

1) Insertthe ball bearing [21] inthe hub [1].

Note : The fit of the ball bearing [21] outer diameter and hub [1] inner diameter is press fit. Press fit gradually and uniformly by tapping the pin punch.
At this time, place the ball bearing [21] securely in the hub [1].

2) Check if the hub [1], spindle kit, ball bearing [21] (2 bearings) parts haven't been replaced with new ones.

Note : If there are no renewal parts, proceed to the next step (3).
If there is even 1 renewal part, proceed to the next step Æ after carrying out "(18) Pre-load adjustment of the ball bearing".

3) Mount the outer ring of the tapered roller bearing [22] on the tapered roller bearing of the RV gear assem bly.



4) Fitthe hold flange [3] in the innerring of the ball bearing [21] in the hub [1].

Note : Match the counter marks of the spindle [2] and crank shaft [9] and fit the hold flange [3] on the ball bearing [21] so that it is in the same position as before disassembly.
If it is hard to place the hold flange [3] in the inner ring of the ball bearing [21], insert into the ball bearing [21] by tapping the hold flange [3] uniformly with a plastic hammer.



(5) Reamer bolt fastening

Note : If grease adheres to the screw section corresponding to the reamer bolt [19] of the spindle [2], degrease with degreaser and wash.

1)Apply bonding agent to screw section of the spindle [2].

Note : Tighten the 3 reamer bolts [19] equally, a little at a time.
If you tighten 1 or 2 before the other, the hold flange [3] will tilt, and you will not be able to correctly insert the ball bearing [21] in the hold flange [3].

2)Tighten the reamer bolts [19] (3 bolts) to the specified torque.
Specified torque : 794±49.0 N-m
(81.0±5.0kgf-m)
586±36 ft-lbs

3)Invert the travel motor.

4)Remove the fixtures (2 fixtures).

5)Invert the travel motor.



(6) Fitting the snap ring

1)Check if the spindle kit and RV gear assembly parts haven't been replace with new ones.

Note : If there are no renewal parts, proceed to the next step (2).
If there is even 1 renewal part, proceed to the next step (6) after carrying out "(19) Shaft direction clearance adjustment of the tapered roller bearing".

Note : f using by replacing the snap ring [20] only with a new part, select the same type of snap ring [20] as before disassembly or one which is similar from among the 15 types.

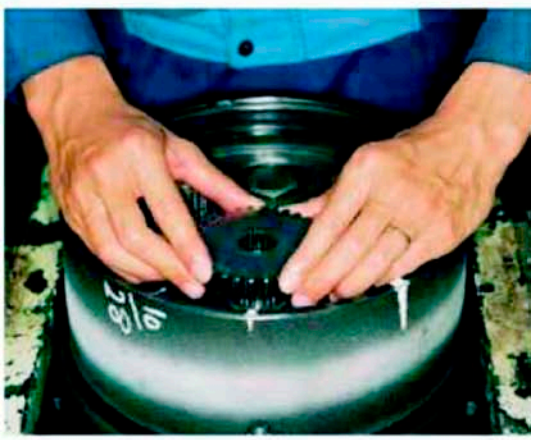
2) Mount the snap ring [20] in the snap ring groove of the hold flange [3].

Note : Match the 3 snap rings [20] with the counter mark of the hold flange [3], and mount each in the same position as before disassembly.
If using a new snap ring [20], mount a snap ring [20] of the thickness selected in the previous step in the snap ring groove.



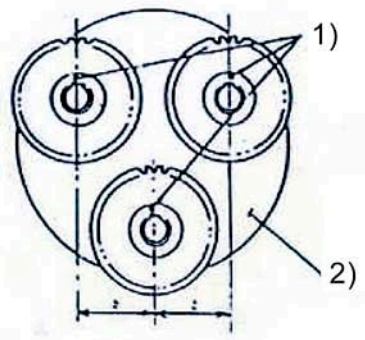
(7) Spur gear assembly

1) Install the snap ring [25] (3 rings) into the crankshaft [9].



2) Match the counter marks of the spur gear [7] (3 gears) and mount on the crankshaft [9].

Note : Insert the spur gear [7] (3 gears) on the crank shaft [9] by matching the counter marks (punch holes) as shown in the figure below.



1) Position matching marks (punched holes) of spur gears like this.
2) Hold flange



Caution

When mounting the snap ring [25], if the tip of the pliers slips out of the hole of the snap ring, the snap ring [25] couldjump out.

Note : Mount with the acute angle of the snap ring end face facing up.

3) Mount the snap rings for the shaft [25] (3 snap rings) in the snap ring groove of the crankshaft [9].

(8) Mounting on the spindle



Caution

You could get burned while performing this task, so use leather gloves to perform insertion.
Be careful not to get burned.

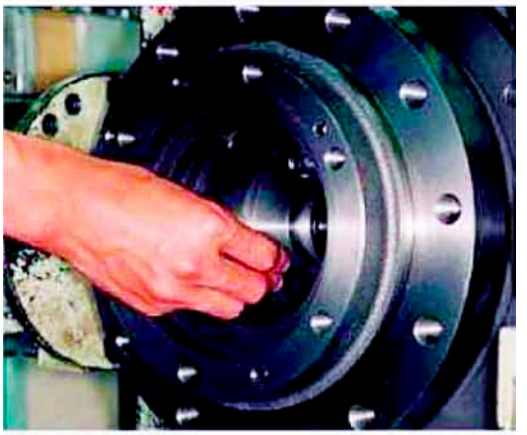
Note : Insert until the large diameter side collarofthe inner ring of the ball bearings [149] adhere to the collar surface of the shaft [102].

1) Place ball bearings [149] in a heating tank, heat at 100±10°C for 10 minutes, and pressfiton the shaft [102].



2) Invert the travel motor

3) Apply lithium grease to the lip section of the oil seal [132], and press fit the oil seal [132] in the oil seal hole of the spindle [2] with the retainer (2) and hammer.

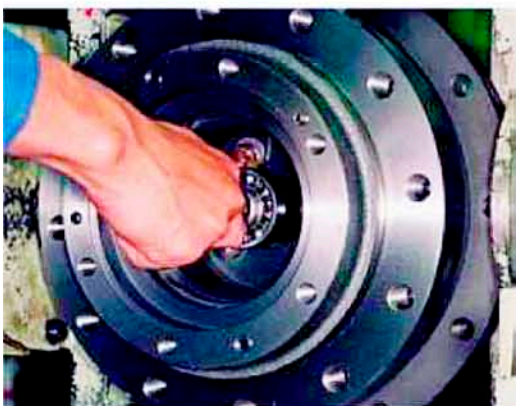


4) Mount the parallel pins [177] (2 pins) in the pin holes of the spindle [2].

5) Apply lithium grease to the hemispherical surface of the pivots [176] (2 pivots), and set in the parallel pins [177] of the spindle [2].

6) Attach to the spring [185], piston assembly (piston [161], shoe [162]).

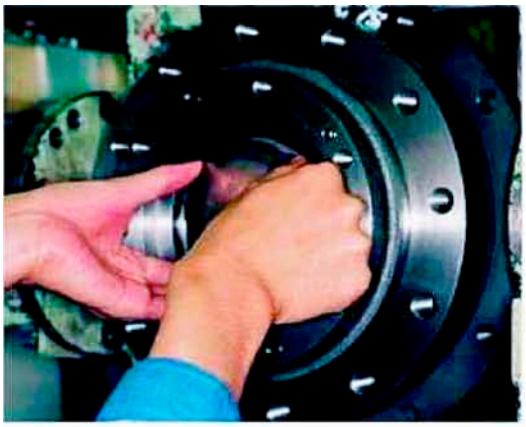
7)Dip hydraulic fluid in the sliding parts of the piston assembly (piston [161], shoe [162]) and mount in the piston hole of the spindle [2].



8) Tilt the travel motor90 degrees.

9) Apply lithium grease to the splines of the motor shaft [102].

Note : Take care not to scratch or cut the lip portion of the oil seal [132] in place with splined foremost end of the shaft [102].



10)Fitting the motor shaft [102] slowly into the spindle [2].

11)Insert the swash plate [103] into the spindle [2].

Note : Apply lithium grease to the swash plate [103] where matching surface of spindle [2].
Make sure that the locating pivot of the spindle enters the pivot holes of the swash plate [103].



(9) Assembly of cylinder block interior

Note : Introduce the sharp side of the angled section of the THS snap ring [146] and washer [110] as shown in the figure on the left.

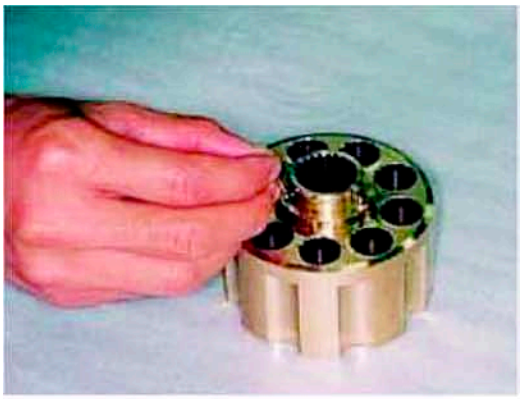
1) Insert parts in the cylinder block [104] in order of washer [110], spring [114], washer [110], and THS snap ring [146].

2) Place the cylinder block [104] on the press bench.



3) Place retainer (1) on the washer [110], and while clamping with the press, mount the THS snap ring [146] in the snap ring groove of the cylinder block [104] with a pairof snap ring pliers.

Note : Press force of spring [114] is 588 N (60 kgf) 132 lbs or more. Protect by covering the cylinder block [104] with a vinyl sheet so the contact surface with the timing plate of the cylinder block [104] does not become damaged.



(10) Assembly of hydraulic motor parts

1) Place the needle rollers [151] (3 rollers) in the holes of the cylinder block [104], and thrust ball [108] on the top.

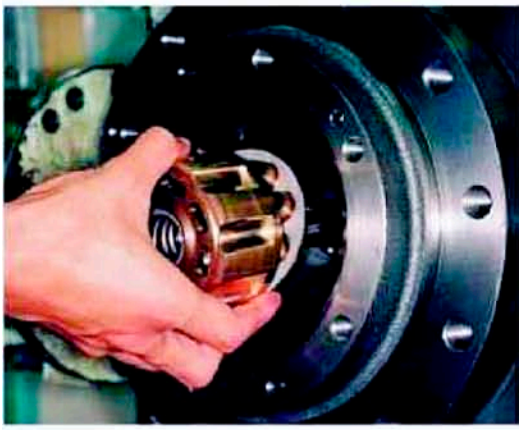
2)Mount the 9 piston assemblies in the retainer plate [107].

Note : After assembling, dip the whole thing in hydraulic fluid.



3) Mount the retainer plate [107] and 9 piston assemblies in the cylinder block [104].

Note : Match the round surface sections of the retainer plate [107] and thrust ball [108].



4) Install cylinder block [104] on the motor shaft [102], matching its splines to the shaft splines.

Note : Turn the cylinder block [104] back and forth to be sure there is no play. Aplay, if any, means that the splines are worn to require replacement of the part.

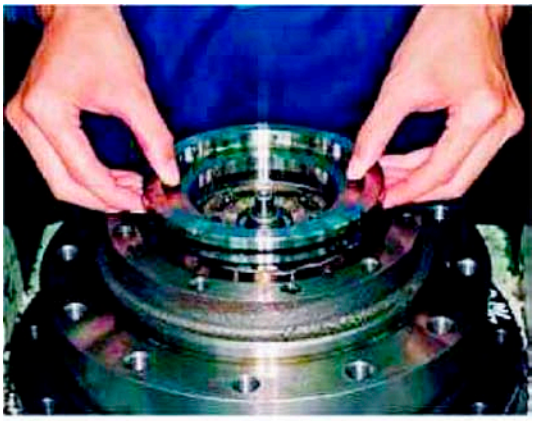


(11)Assembly of parking brake section

Note : Mount the friction plate [115] after dipping in hydraulic fluid.

1) Mount the friction plate [115], mating plate [116] (2 each) alternately in the outer circumference groove of the cylinder block [104] and inner circumference groove of the spindle [2].

2) Mount the O-rings [135], [141] in the O-ring grooves of the piston [112].
At this time, apply a thin coat of grease to the O-rings [135], [141].



3) Mountthe piston [112] in the spindle [2].

Note : If it is difficult to place the piston [112] in the spindle [2] due to resistance of the O-rings [135], [141], insert by tapping the end face of the piston [112] with a plastic hammer. When mounting the piston [112], be careful not to damage the O-rings.



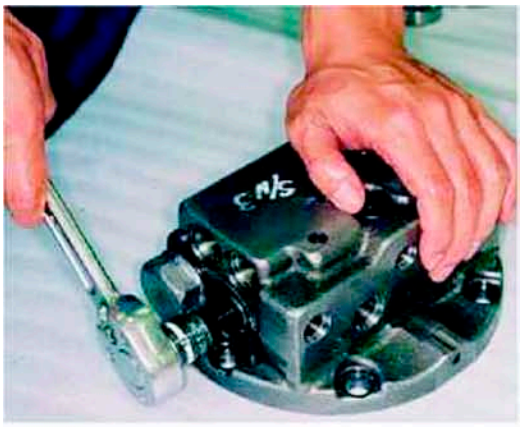
(12)Assembly of plugs in the rear flange
1) Insert the valve [227] into the rear flange [201].

2) Mount the O-rings [238] (2 rings) on the plugs [282] (2 plugs).

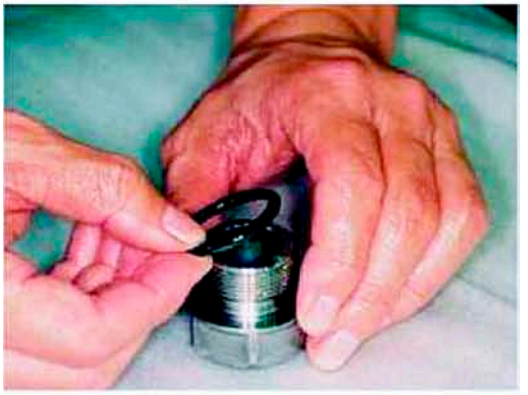
Note : Apply grease to the O-rings [282].



3) Insert the unified plugs [282] (2 plugs) in the rear flange [201] and temporarily tighten with a hexagonal wrench.



Note : Apply hydraulic fluid to the spool [223] and insert The spool [223] into the rear flange [201]
When mounting the spool [223], match the hole center of the rear flange [201] with the shaft center of the spool [223] in order to prevent damage of the rear flange [201] by contact and damage of the outer circumference surface of the spool [223].
If damage by contact is produced on the hole section of the rear flange [201] and spool [223] outer surface, after assembly, it will cause internal leaking and will cause a reduction in performance of the travel motor.
The clearance between the rear flange [201] and spool [223] in adjusted.
If replacing, replace by rear flange kit.



4) Insert the spool [223] in the rear flange [201].

5) Mount the O-rings [236] (2 rings) on the plugs [224] (2 plugs).

Note : Apply grease to the O-rings [236].



6) Screw the plugs [224] (2 plugs) in the rear flange [201] and temporarily tighten.

7)Insert the steel ball [296] in the mounting hole of rear flange [201].

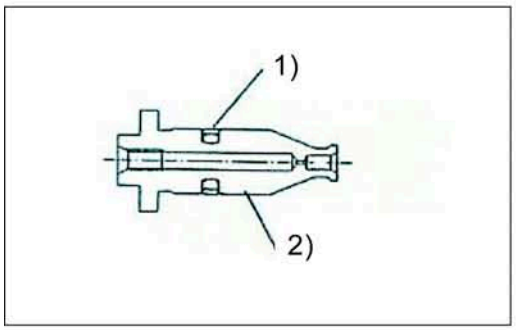
8) Temporarily tighten the plug [284].



(13)Assembly of SRV in the rear flange
1) Mount the O-rings [291], [292], back up ring [294], [295], on the sleeve [288].

2) Mount the O-rings [238] on the plugs [289].

Note : Apply grease to the O-rings [291], [292], [238].



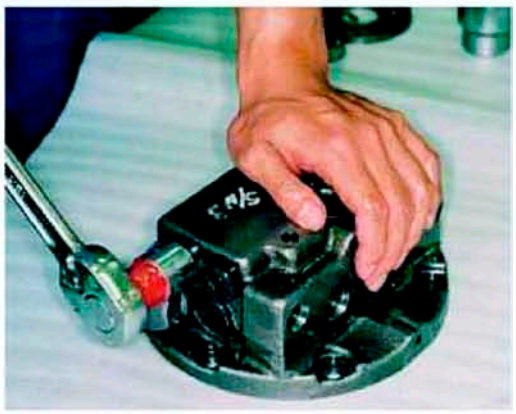
3) Mount the piston-seal [293] on the valve [287].

Note : The piston-seal [293] is consist of O-ring and tefron-ring.
Apply grease to the O-ring and tefron-ring.
First mount the O-ring and after mount tefron-ring.

1)Piston seal
2)Valve



4) Insert the sleeve [288], valve [287], spring [290] in the rear flange [201].



5) Temporarily tighten the plug [289].



(14) Assembly of the rear flange mounted parts
1) Apply hydraulic fluid to the outer ring of the ball bearing [150], and fit the outer ring of the ball bearing [150] in the rear flange [201].



2) Fit the parallel pins [241] (2 pins) in the pin holes of the rear flange [201].



3) Apply grease to the mating face with the rear flange [201] of the timing plate [109].

Note : Mounting of the timing plate [109] is carried out until the timing plate [109] adheres to the rear flange [201].
Adhesion prevents the timing plate [109] from falling from the rear flange [201] when mounting the rear flange [201] on the spindle [2].

4) Mount the timing plate [109] on the rear flange [201] using the parallel pin [242] as a guide.

Note : Apply a sufficient amount of grease to the spring [113], and fix so it does not fall from the rear flange [201].

5) Mount the springs [113] (8 springs) on the rear flange [201] and fix with grease.



(15) Connection of rear flange with spindle

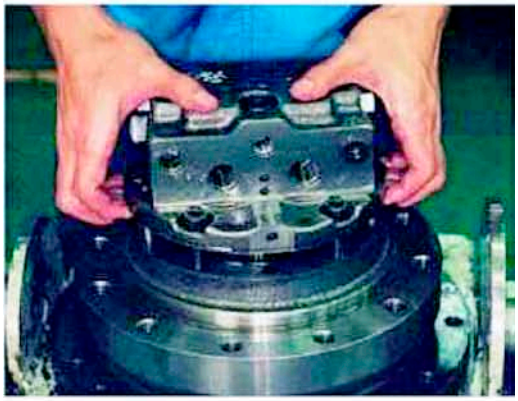
1) Mount the O-rings [28], [30] in the O-ring groove of the spindle [2].

Note : Mount the O-ring [30] without applying grease. If reassembled with grease applied, the grease may bleed from the mating face of the rear flange [201] and spindle [2] when the travel motor is running.
This maybe mistaken as an oil leak, so do not apply grease.



2) Fitthe parallel pins [43] (2 pins) in the spindle [2].

3) Put 0.5 liters of hydraulic fluid in the spindle [2].

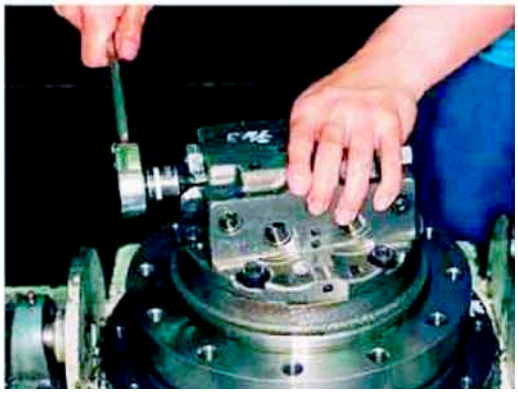


4) Match the parallel pins [43] (2 pins) mounted in the spindle [2] with the pin holes of the rear flange [201] and mount the rear flange [201] in the spindle [2].



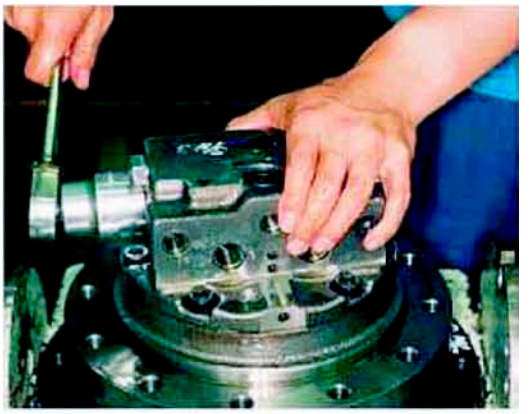
5) Tighten the hexagon socket bolts [245] (6 bolts) in the spindle [2] to the specified torque.

Tightening torque : 102± 15.7 N-m
(10.4 ±1.6kgf-m)
75.2 ±11.6 ft-lbs

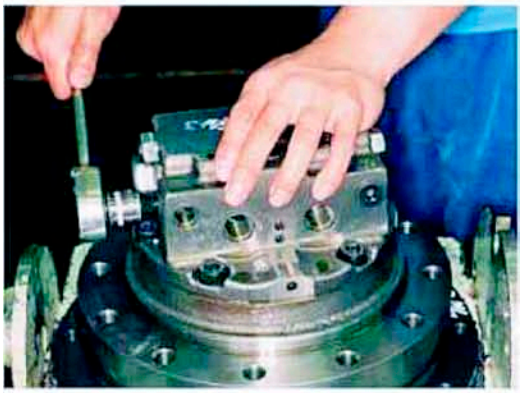


6)Tighten the plugs [282] to the specified torque.

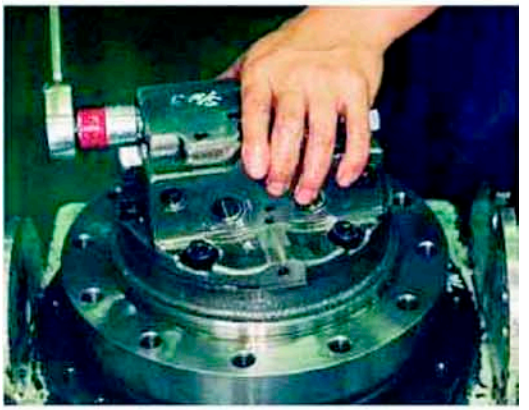
Tightening torque :98.1 ±19.6 N-m
(10 ±2.0kgf-m)
72.3±14.5 ft-lbs



7)Tighten the plugs [224] to the specified torque.
Tightening torque :353±39.2 N-m
(36±4.0kgf-m)
260 ±29 ft-lbs



8)Tighten the plugs [282] to the specified torque.
Tightening torque : 98.1±19.6 N-m
(10± 2.0kgf-m)
72.3 ±14.5 ft-lbs



9)Tighten the plugs [289] to the specified torque.
Tightening torque : 98.1± 19.6 N-m
(10 ±2.0kgf-m)
72.3 ±14.5 ft-lbs



(16)Assembly of the input gear
1)Invert the travel motor.

2)Mountthe shaft [15] on the shaft [102].



3)Mountthe input gear[6] on the shaft [15].

Note : Apply grease to the steel ball [36] so it doesn't fall out when mounting the cover [8].

4)Fit the steel ball [36] in the steel ball mounting hole of the input gear [6].



(17) Cover assembly

1) Introduce 1.3 liters of lubricating oil.

Note : Apply grease to the O-ring [29].

2) Mount the O-ring [29] in the O-ring groove of the cover [8].



3) Place the cover [8] on the hub [1], matching the marks to restore it is its original position.

Note : After positioning the cover above, force it into the hub [1] by lightly tapping with a plastic hammeron and around its rim. Avoid strong tapping or the O-ring [29] will get out of its groove to result in imperfect sealing.

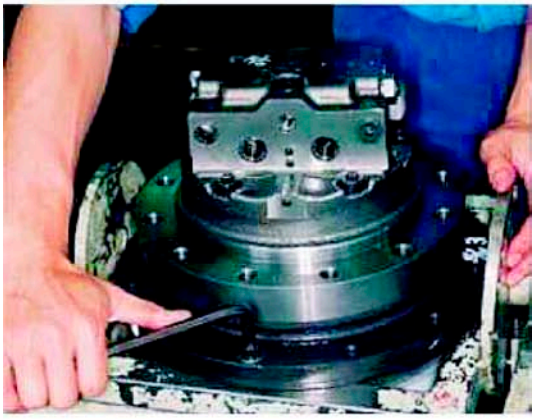


4) Look the cover [8] in place by installing the ring [18].



5)Tighten plugs [33] to the specified torque.
Tightening torque : 58.8± 9.81 N-m
(6 ±1.0kgf-m) 43.4±7.2 ft-lbs

6)Mount the O-rings [35] on the plugs [34] (2plugs).
Tighten the plugs [34] to the specified tongue.
Tightening torque : 58.8±9.81 N-m
(6±1.0kgf-m) 43.4±7.2 ft-lbs



(18) Removal of travel motor

1) Invert the travel motor.

2) Removal the travel motor installation nuts from hub bolts.

3) Fasten the eyebolts (2 bolts) in the spindle [2].

Note : Fasten the 2 eye bolts in the screw holes of the spindle [2] so they are symmetrically positioned.



4) Hook the hook and wire on the eye bolts, and remove the travel motor from the workbench with a crane.

(19) Pre-load adjustment of ball bearing

Note : In order to ensure the proper life for the baa bearing [21], it is necessary to provide a certain pre-load.
Therefore, if replacing a part that influences the amount of pre-load, temporarily assemble in accordance with the following procedure, and check the amount of pre-load.

If you reassemble without checking, it could cause the GMY motor to operate poorly or break down prematurely.

Parts which influence amount of pre-load of the ball bearing Hub [1], spindle kit, collar[11], ball bearing [21]

If not replacing the parts listed above, skip this process and proceed to the process of section(3).

Pre-load check and pre-load adjustment instructions are as follows.



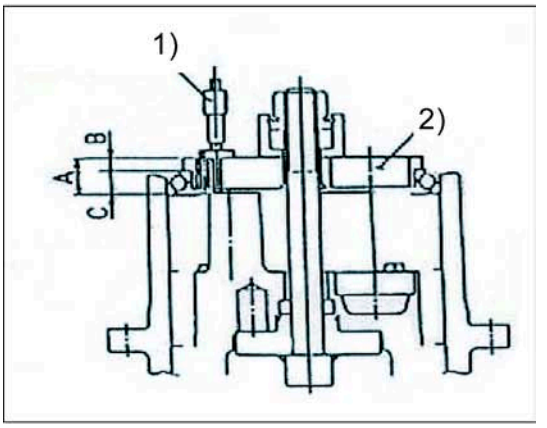
(1)Ball bearing pre-load adjustment procedure
1) Mount the main Brg pre-load adjustment jig on the spindle [2], tighten the special nut, and apply pre-load to the ball bearing [21].
Special nut tightening torque : 39.2± 9.81 N-m (4±1.0kgf-m) 28.9±7.2 ft-lbs



2) Measure depth dimension "A" with a depth micrometer from the measurement hole of the main Brg pre-load adjustment jig.

3) The "B" dimension of the main Brg pre-load adjustment jig is known, so determine the clearance "C" dimension by the following formula.

"C"="A"-"B"
A : Actual measurement value
B : Jig bodydimension
C : Specified dimension

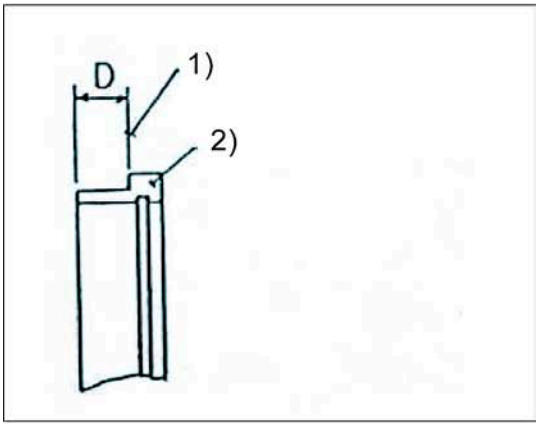


4)Next find the "D" dimension of the hold flange [3].

5)Adjust the hold flange [3] with the measurements taken in 2) ~ 4) and following procedure.
The "C" dimension is the specified dimension of the hold flanae.

1) Depth micrometer
2) Jig

I. If dimension "D" of the actual hold flange [3] 0.02 mm or smaller than specified dimension "C" : Cut the "E" surface of the hold flange [3] down to the specified dimension with a turning machine, etc..



II. If dimension "D" of the actual hold flange [3] is within tolerance * 0.02 mm (0.00079 in.) of specified dimension "C" :
Use the unmodified hold flange [3] as it is.

1) "E" inner surface
2) Hold flange

III. If dimension "D" of the actual hold flange [3] is 0.02 mm or larger than specified dimension "C" :
Replace with a new spindle assembly.
A new hold flange [3] in always provided with an arrangement allowance.



Note : The hold flange and spindle have been machined as a pair and are therefore con figured as an assembly.
The hold flange alone therefore cannot be replaced.
At this time, the spindle must be replaced together with it.
This assembly is referred to as the "spindle assembly".
If replacing by spindle assembly, perform disassembly and assembly again.

6) Remove the main Brg pre-load adjustment jig from the spindle [2].

7) After completing hold flange adjustment by the adjustments of items I , II, Ill, proceed to the process of (3) section (3).

(20) Shaft direction clearance adjustment of the tapered roller bearing

Note : If the following parts are replaced, the shaft direction clearance of the tapered roller bearing [22] must be adjusted to the specified value by thickness adjustment of the snap ring [20].
If you reassemble without adjusting, it could cause the GM motor to operate poorly or break down prematurely.

Spindle kit, RV gear assembly

If not replacing the parts listed above, snap ring adjustment is unnecessary, and main assembly is carried out from section (6) as is.

Shaft direction clearance adjustment method of the tapered roller bearing is as follows.



1)Tap the outer ring of the tapered roller bearing [22] attached to the crank shaft [9] with a hammer and retainer (4).

Note : This is in order to reliably insert the RV gear assembly in the spindle [2].

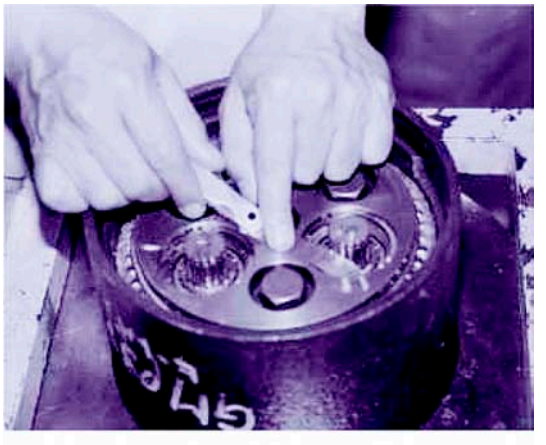


2) Mount the thinnest ring [20] in the snap ring groove of the hold flange [3].



3)Tap the ring [20] side with a hammer and retainer (4).

Note : Check whether the RV gear assembly has been reliably inserted in the spindle [2].



4)Place a thickness gauge between the ring [20] and tapered roller bearing [22] and measure the clearance.

5)Ring [20] thickness measurement

Set thickness (MAX.) of the ring

MAX. = Thickness of thickness gauge + Thickness of Currently mounted ring

Set thickness (MIN.) of the ring

MAX. = Thickness of thickness gauge + Thickness of Currently mounted ring - 0.002 Inch (0.05 mm)



6) After deciding thickness of the ring, select from among the 15 types and mount on the hold flange.
(See 6. CLEARANCE ADJUSTMENT PART DIMENSIONS TABLE.)

7) After mounting the ring of the set thickness, proceed to (6).

5. PERFORMANCE CONGIRMATION TEST

- After servicing the GM motor, perform the following performance tests by the following procedure.

1) Required measuring devices

Pressure gauge {for 3.43MPa 35kgf/cm^2 498psi}	2 pieces
Graduated cylinder {for 5 liter 1.32usgal.}	1 piece
Stopwatch	1 piece

2) Test procedure

1 GM motor Mounting / piping

Mount the GM motor to body (frame section) and connect piping.
The track shoe must not be attached here at this time.
[This is because for conducting the performance test (no-load operation) of the motor.]

Note :
1. When connecting, connect so that the pressure gauge (main circuit) can be mounted and drain volume of the hydraulic motor can be measured.
2. When mounting the GM motor, do not strike with a hammer, etc., but rather mount gently using the bolt holes.

2 Brake-in operation Of the GM motor

GM motor r.p.m.	Pressure	Rotation direction	Running time
10 r.p.m.	No-load	Left / right	Min. 1 minute each

3 GM motor performance confirmation test

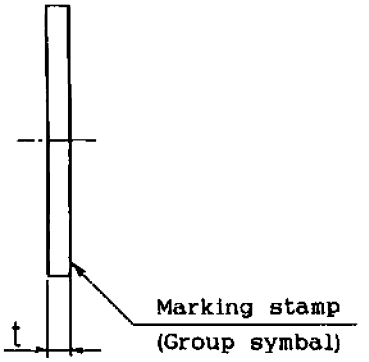
1 Pre-load preparatory operation
Perform preparatory operation until approximately the following temperatures.
- Hydraulic fluid temperature : 45 ~ 55 ℃ (113~131°F)
- Speed reducer hub external temperature : 40 ~ 80 ℃ (104~176°F)

2 Confirmation test
Measure the following items to decide with the motor passes of fails the test.
Passing criteria
GM motor drive pressure : Max. 16 kgf/cm^2 (228psi) / when 10 r.p.m
Hydraulic motor drain volume : Max. 0.5 l/min. (0.13usgal) / when 10 r.p.m

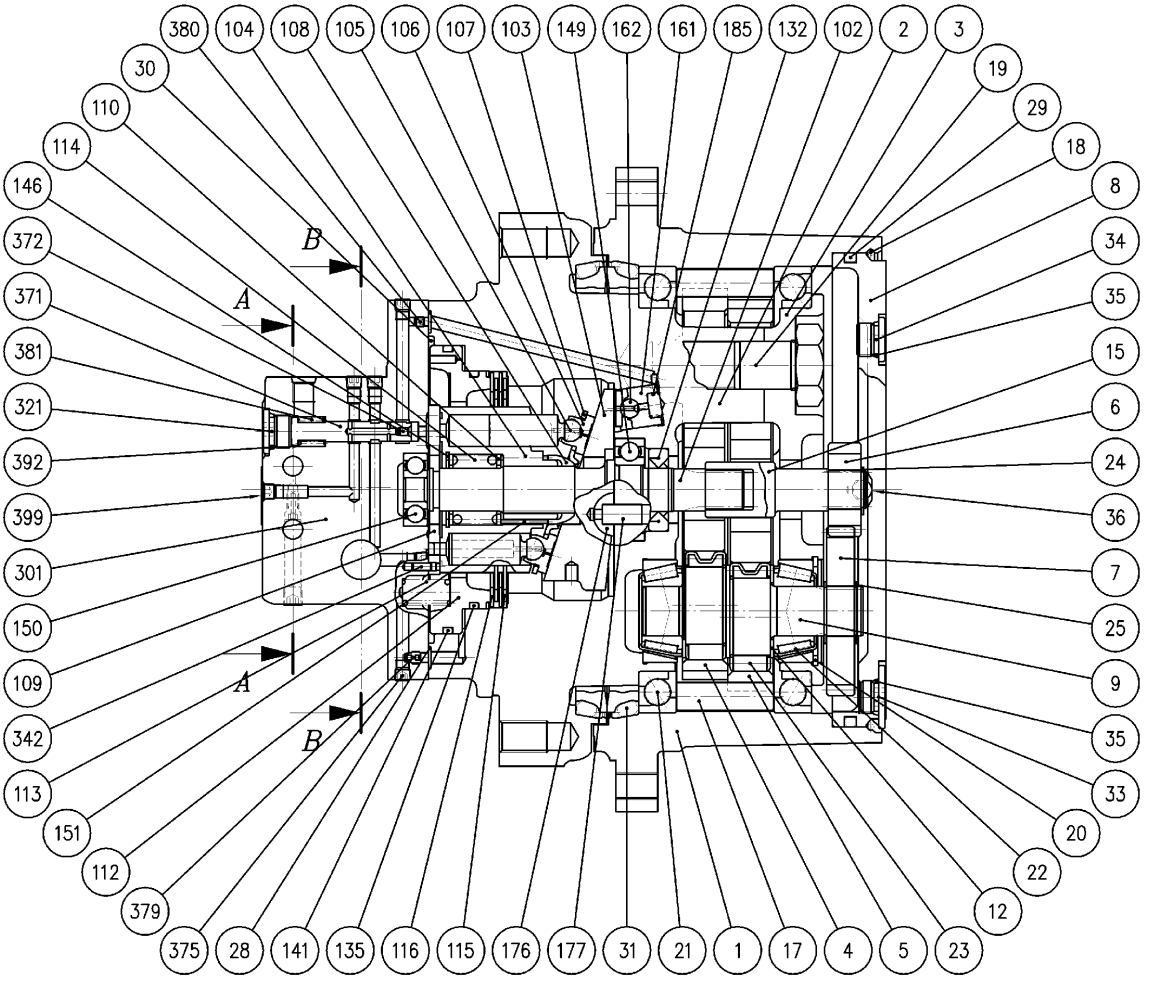
- Pass → Attach the track shoe
- Fail → Disassemble and adjust again

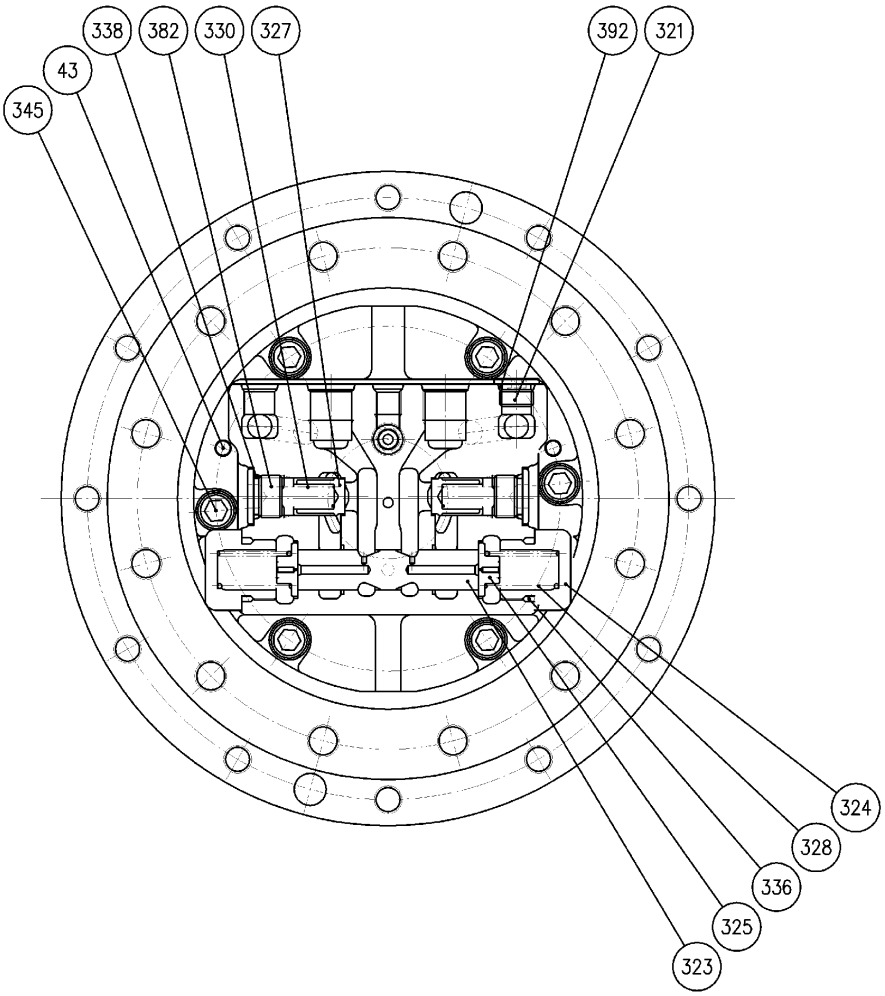
3.CLEARANCE ADJUSTMENT PARTS
DIMENSIONS TABLE

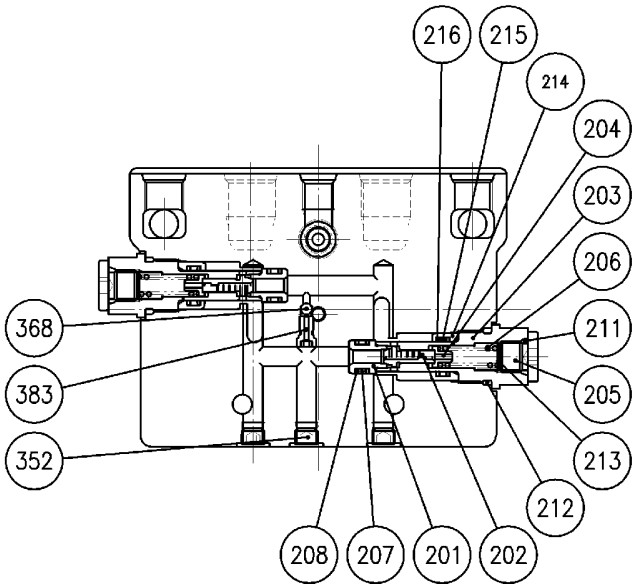
Part Name	Dimensions
Snap ring [20]	



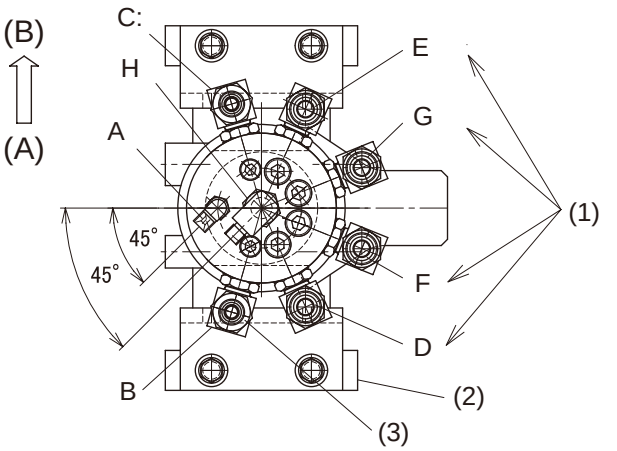
Classification symbol	Dimension(T) [Inch (mm)]
A	1.90 < T ≦ 1.95
B	1.95 < T ≦ 2.00
C	2.00 < T ≦ 2.05
D	2.05 < T ≦ 2.10
E	2.10 < T ≦ 2.15
F	2.15 < T ≦ 2.20
G	2.20 < T ≦ 2.25
H	2.25 < T ≦ 2.30
I	2.30 < T ≦ 2.35
J	2.35 < T ≦ 2.40
K	2.40 < T ≦ 2.45
L	2.45 < T ≦ 2.50
X	1.75 < T ≦ 1.80
Y	1.80 < T ≦ 1.85
Z	1.85 < T ≦ 1.90







1) Hub
Spindle kit
*Spindle assembly
2) **Spindle
3) **Hold flange
19) *Reamer bolt
RV gear assembly
*RV gear kit
4) **RV gear A
5) **RV gear B
9) *Crank shaft
12) *Specer
22) *Tapered roller bearing
23) *Needle roller bearing
6) Input gear
Spur gear kit
7) Sper gear
F-Seal kit
31) Floating seal
8) Cover
15) Shaft (G)
17) Pin
18) Ring
20) Snap ring
21) Ball bearing
24) Snap ring
25) Snap ring
28) O-ring
29) O-ring
30) O-ring
33) Plug
34) Plug
35) O-ring
36) Steel ball
43) Parallel pin
102) Shaft
103) Swash plate
104) Cylinder block
Piston kit
*Pisdton assembly
105) **Piston
106)**Shoe
107)Retainer plate
108) Thrust ball
109) Timing plate
110) Washer
112) Piston
113) Spring
114) Sptring
115) Friction plate
116) Mating plate
132) Oil seal
135) O-ring
141) O-ring
146) Snap ring
149) Ball bearing
150) Ball bearing
151) Needle roller
Piston assembly
161) *Piston
162) *shoe
176) Pivot
177) Parallel pin
185) Spring
Rear Flange assembly
*Rear flange kit
201) **Rear flange
223) Spool
286) **piston
252) **Hex.. Socket plug
268) **Steel ball
275) **Hex.. Socket plug
279) **Filter
280) **Orifce
283) **Plug
298) **Orifce
299) **Name plate
*Sppl kit
271) **Spool
272) **Oil stopper
221) *Plug
224) *Plug
225) *Spring retainer
227) *valve
228) *Spring
230) *Spring
236) *O-ring
238) *O-ring
281) *Spring
282) *Plug
284) *Plug
285) *O-ring
287) *valve
288) *Sleeve
289) *Plug
290) *Spring
291) *O-ring
292) *O-ring
293) *Piston seal
294) *Back up ring
295) *Back up ring
296) *Steel ball
297) *Orifice
242) Parallel pin
245 Hex.. Socket bolt



A: Bi-speed
B: Dozer down
C: Dozer up
D: Left front
E: Right front
F: Left back
G: Right back
H: Drain

(a)(Hose, crane angle)
(b)(Hose, crane angle)
(c)(Hose, crane angle)
(d)(Hose, crane angle)
(e)(Hose, crane angle)
(f)(Hose, crane angle)

k.Rotary joint (Swivel joint)

1.Adaptor and joint

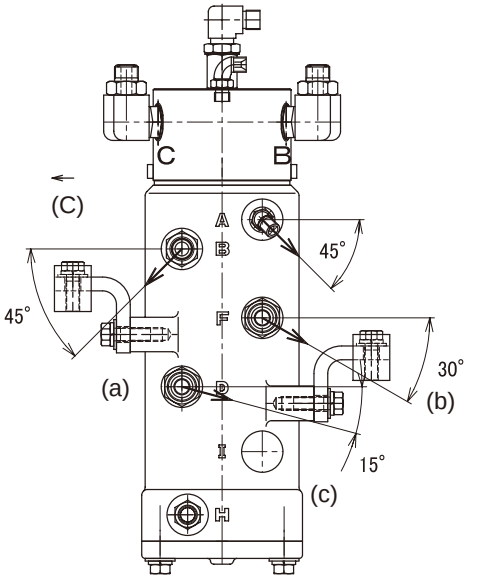
1)Fitting direction of the hydraulic adaptor
Fit the adaptor in position as shown in the figure.

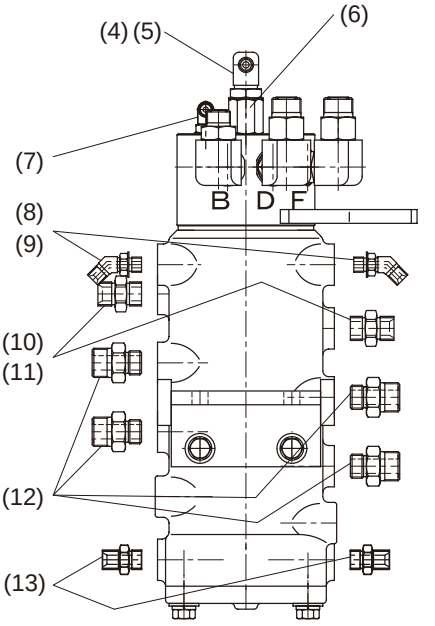
2)Hydraulic adaptor tightening torque
24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs
37.2~42.1N.m(3.8~4.3kgf.m)27.4~31.1ft.lbs
58.8~63.7N.m(6.0~6.5kgf.m)43.4~47.1ft.lbs

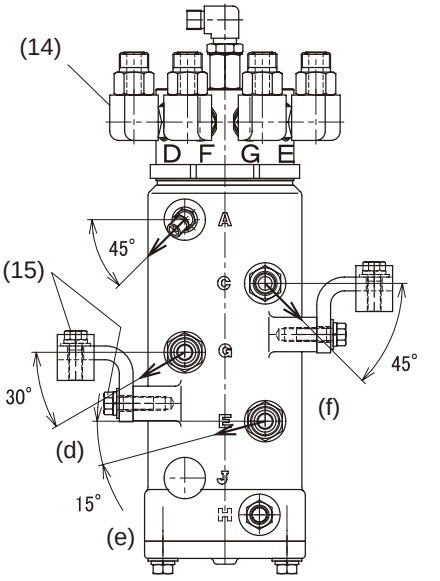
3)Fitting the swivel joint assembly (RD809-6230D) and track frame
Bolt tightening torque
77.5~90.2N.m(7.9~9.2kgf.m)57.2~66.5ft.lbs
(Apply screw adhesive (Loctite 271).)

(1)Pipe joint (SG4, 1U)
(2)Bracket (swivel joint)
(3)Pipe joint (SG4, 13/16U)(Ports C and B)
(4)Washer-fitted elbow
(5)O ring
(6)Pipe joint (bushing, 1/2)
(7)Pipe joint (L, G1/4-G1/4)
(8)Pipe joint (L, G1/4-G1/4)
(9)O ring
(10)Adaptor 7
(11)O ring
(12)Pipe joint (SG4, 1U)
(13)Adaptor elbow
(14)Elbow pipe joint (G1/2-2)(Ports A thru G)
(15)Bolt

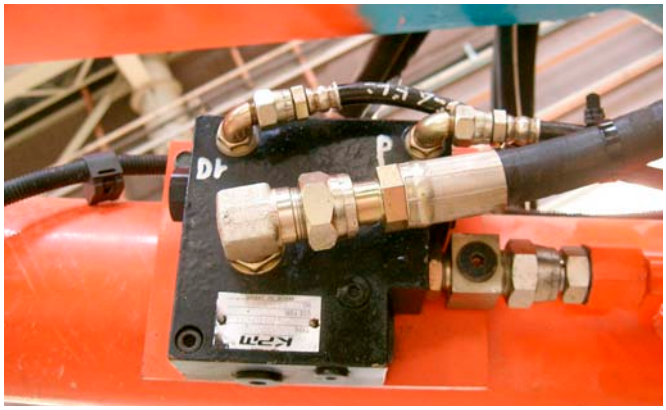
(A)Reference: Machine front
(B)(Dozer side)
(C)(Dozer side)

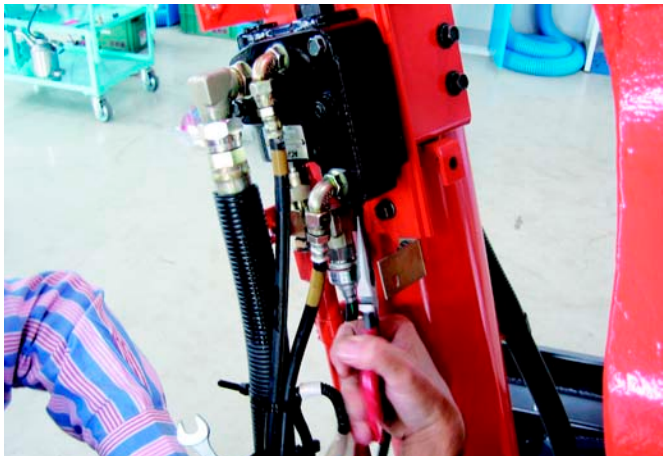








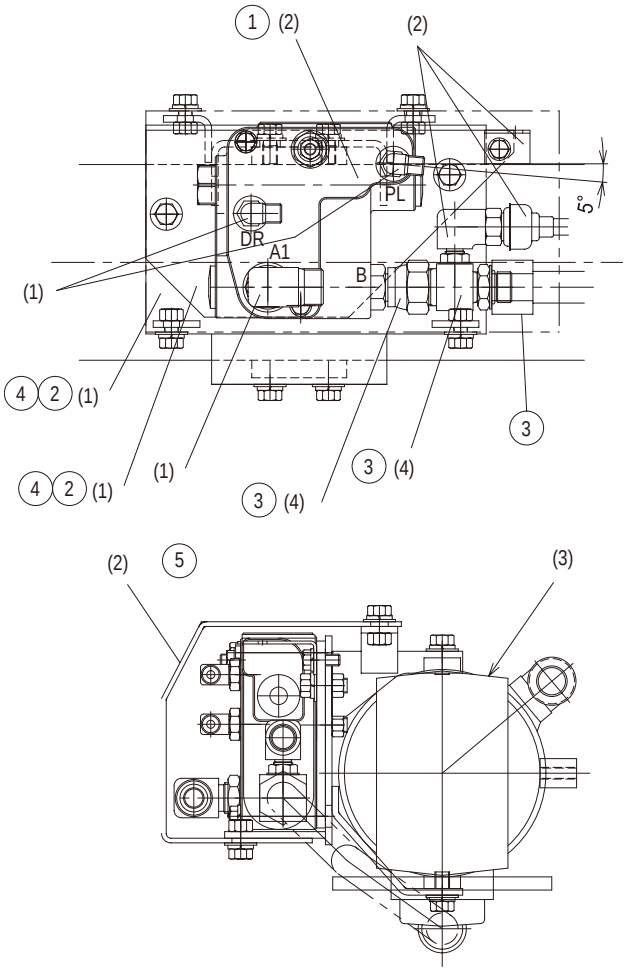






I. Holding valve

1) Boom cylinder
2) Holding Valve assy



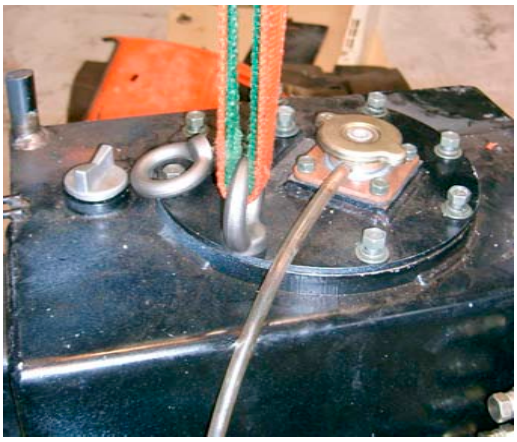
1. Fitting the adaptor
   Fit the adaptor in position as shown at left.

2. Adaptor tightening torque
   G1/4 size
   24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs
   G1/2 size
   58.8~63.7N.m(6.0~6.5kgf.m)43.4~47.0ft.lbs

3. Assembling procedure
   (1)Fit the valve assembly (holding) in position.
   (2)Place the bracket (1, H/V) and bracket (2, H/V) in position, and tighten the bolts temporarily.
   (3)Connect the pipe joint (SG4, 1U), pipe joint (FG4, 1U) and the pipes.
   (4)Tighten up the bolts for the bracket (1, H/V) and bracket (2, H/V). Be careful not to get the pipes twisted.
   (5) Finally set the cover (H/V) in place.

   Bolt tightening torque
   17.7~20.6N.m(1.8~2.1kgf.m)13.0~15.2ft.lbs
   39.2~45.1N.m(4.0~4.6kgf.m)28.9~33.3ft.lbs
   39.2~45.1N.m(4.0~4.6kgf.m)28.9~33.3ft.lbs

(1)Pipe joint (L, G1/4-G1/4)
   Bracket (2, H/V)
   Bolt
   Bracket (1, H/V)
   Bolt
   Pipe joint (LG4, 1U)
(2)Valve assembly (holding)
   Bolt
   Pipe joint (L, G2-G3)
   Switch (pressure, 35M)
   Stay (wire harness clamp)
   Bolt
   Cover (H/V)
   Bolt
(3)Hydraulic cylinder assembly (boom)
(4)Pipe joint (SG4, 1U)
   O ring (1UNF)
   Pipe joint (LG4, 1U)
O ring



m. Hydraulic tank

(1) Tank assy

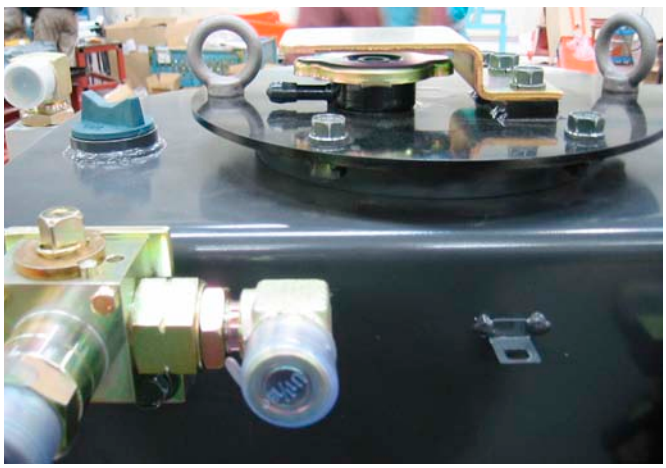
(2) Oil gauge
(3) Return filter

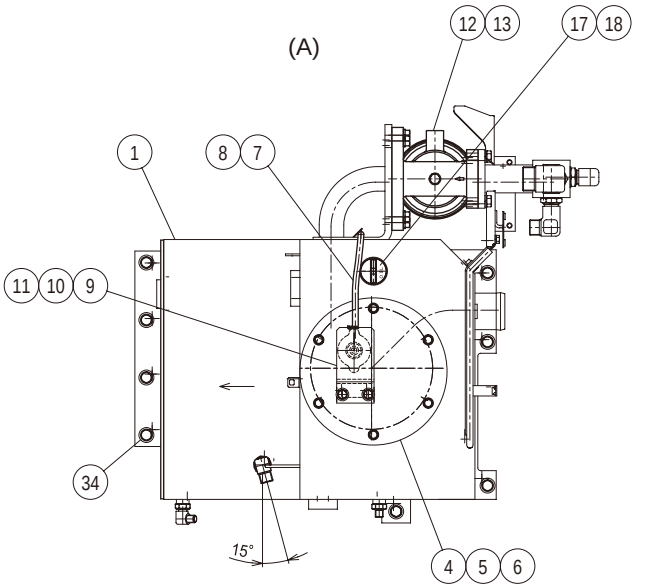


(4)Connector



(5) Tank cap





(34)Bolt
(33)O ring
(32)Elbow pipe joint
(31)Plug
(30)Grommet (170)
(29)Trim (390)
(28)Trim (660)
(27)Bolt
(26)Plate (2, partition)
(25)Bolt
(24)Plate (1, partition)
(23)Straight pipe joint
(22)Adaptor 7
(21)Pipe joint (L, G3/8-G3/8)
(20)O ring
(19)Pipe joint (L, F3-F2)
(18)O ring
(17)Plug (fuel filler)
(16)Thermal insulation (hydraulic tank)
(15)Gauge (oil tank)
(14)Filter assembly (suction)
(13)Bolt
(12)Filter assembly (return)
(11)Bolt
(10)Plain washer
(9)Plate (breather)
(8)Pipe clip
(7)Tube (breather)
(6)Bolt
(5)O ring
(4)Cover assembly (hydraulic tank)
(3)Rubber-fitted washer
(2)Plug
(1)Hydraulic tank

(A)Machine front

1.Tightening the filter assembly (return)
77.5~90.2N.m(7.9~9.2kgf.m)57.2~66.5 ft.lbs

2.Fitting the gauge (oil tank)
Tightening torque
8.0~10.0N.m(0.82~1.0kgf.m)5.9~7.4 ft.lbs

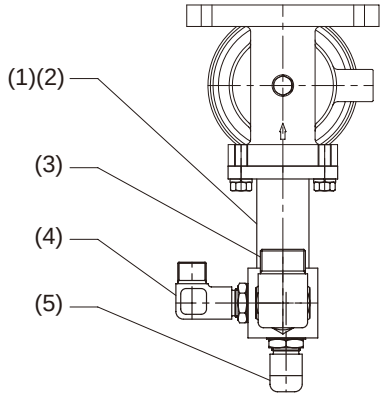
3.Fitting the cover assembly (hydraulic tank)
Tightening torque
48.1~55.9N.m(4.9~5.7kgf.m)35.5~41.2 ft.lbs
Fitting direction
Place the assembly with the breather facing the machine front as shown at left.

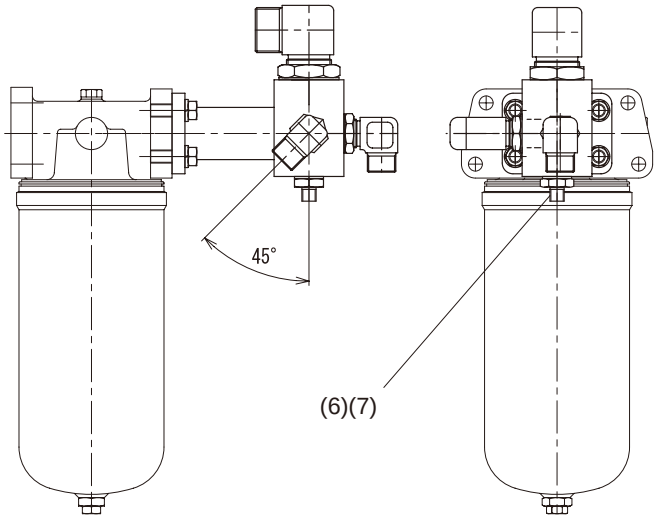
4.Fitting the adaptor
See (2/2).
Tightening torque
G3/8 size
49.1~53.9N.m(5.0~5.5kgf.m)36.2~39.8 ft.lbs
G1/2 size
58.8~63.7N.m(6.0~6.5kgf.m)43.4~47.0ft.lbs

5.Fitting the hydraulic tank
Tightening torque
77.5~90.2N.m(7.9~9.2kgf.m)57.2~66.5ft.lbs
Apply screw adhesive (Loctite 271).

6.Fitting the plate(1, partition) and plate (2,partition)
Tightening torque
23.5~27.5N.m(2.4~2.8kgf.m)17.3~20.3ft.lbs

7.Filter assembly (suction)
Make sure the assembly does not stretch out of the top of the hydraulic tank. (See Fig. D on (4/4).)





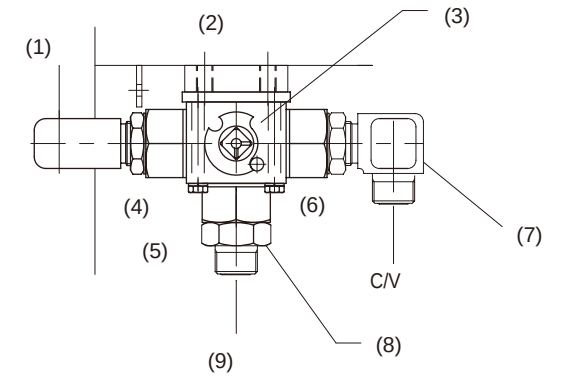
n.Filters

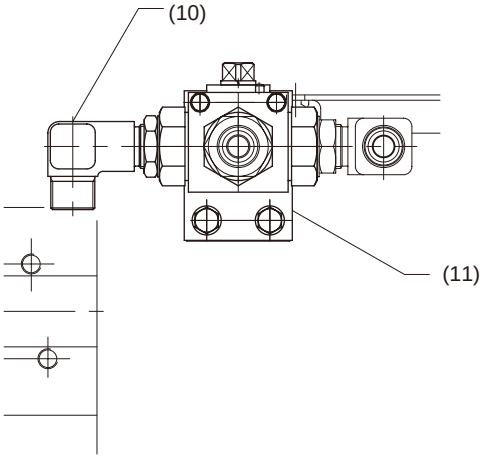
1.Fitting the adaptor
Fit the adaptor in position as shown at left.

2.Adaptor tightening torque
G1/2 size
58.8~63.7N.m(6.0~6.5kgf.m)43.4~47.0ft.lbs
G3/4 size
117.6~127.4N.m(12.0~13.0kgf.m)
96.7~94.0ft.lbs
G1-1/4 size
220.5~230.3N.m(22.5~23.5kgf.m)
162.6~169.9ft.lbs

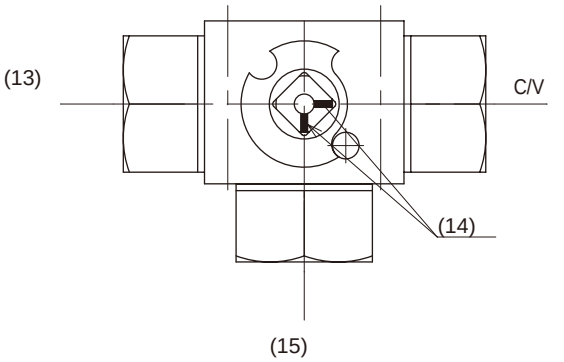
3.Fitting the pipe (return)
Tightening torque
62.8~72.6N.m(6.4~7.4kgf.m)46.3~53.5ft.lbs

(1)Pipe (return)
(2)Bolt
(3)Pipe joint (LG12, G12)
(4)Pipe joint (LG6, G6)
(5)Elbow pipe joint
(6)Adaptor
(7)O ring





(12)



o.Three way change valve

1.Fitting the valve assembly (3-way)
Fit the assembly in position as shown at left.

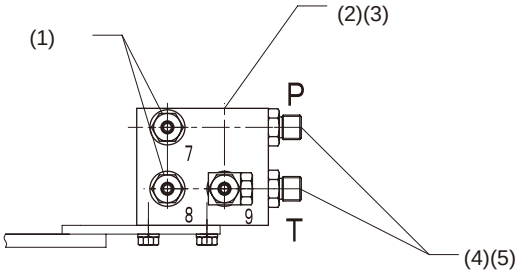
No. 1 port
Pipe joint (SG6, 1U)
(RD809-6151D)
No. 2 port
Pipe joint (LG6, G6)
(RD809-6917D)
No. 3 port
Pipe joint (LG6, G6)
(RD809-6154D)

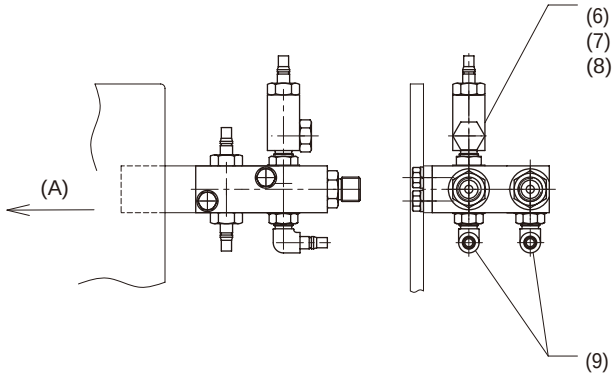
2.Adaptor tightening torque
G3/4 size
117.6~127.4N.m(12.0~13.0kgf.m)
86.7~94.0ft.lbs

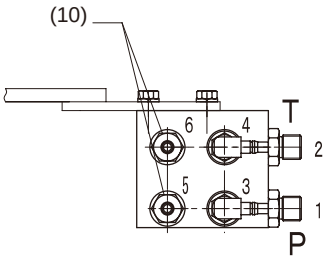
3.Factory-setting the oil flow direction
Set the oil flow direction before shipping, referring to the details given at left.
(Front pipe → C/V)

4.Fitting the bracket (selector, 3-way)
Tightening torque
48.1~55.9N.m (4.9~5.7kgf.m) 35.5~41.2ft.lbs

(1)Oil tank
(2)(Oil tank)
(3)Valve assembly (3-way)
Bolt
(4)No. 2 port
(5)No. 1 port
(6)No. 3 port
(7)Pipe joint (LG6, 1U)
(8)Pipe joint (SG6, 1U)
(9)Front pipe
(10)Pipe joint (SG6, G6)
(11)Bracket (selector, 3-way)
Bolt
(12)(Details of the selector lever)
As shown below, the lever of this valve has grooves. The oil flows along these grooves. In installing the lever, make sure the grooves are positioned as shown below.
(13)Oil tank
(14)Groove
(15)Front pipe







p.Pilot primary line and T port block

1.Fitting the adaptor
Ports 1 and 2
Straight pipe joint
Ports 3, 4, 5, 6, 7 and 8
Pipe joint
Pipe joint
Port 9
Pipe joint
Pipe joint
Plug

2.Adaptor tightening torque
G3/8 size
37.2~42.1N.m(3.8~4.3kgf.m)27.5~31.1ft.lbs
G1/4 size
24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs

3.Fitting direction of the valve
Position the valve in position as shown at left.

4.Quick-coupling adaptor
Pipe joint
Pipe joint
Pipe joint
Make sure the hose connection is free from detrimental

5.Fitting the adaptor (pilot hose, 1)
Tightening torque
23.5~27.5N.m(2.4~2.8kgf.m)17.4~20.3ft.lbs
48.1~55.9N.m(4.9~5.7kgf.m)35.4~41.2ft.lbs

(Hose and tape color)

	Location	Hose tape color
1	Port P	White
2	Port T	None
3	Dozer P/V (P)	White
4	Dozer P/V (T)	None
5	Left control P/V (P)	White
6	Left control P/V (T)	None
7	Travel P/V (P)	White
8	Travel P/V (T)	None
9	Boom H/V (T)	None

(A)(Machine front)

(1)Pipe joint (S, G1/4-8.4)
(2)Adaptor (pilot hose, 1)
(3)Bolt
(4)Straight pipe joint
(5)O ring
(6)Pipe joint (T, G2-G2-G2)
(7)Pipe joint (S, G1/4-8.4)
(8)Plug (G1/4)
(9)Pipe joint (QL, G1/4-8.4)
(10)Pipe joint (S, G1/4-8.4)

q.Swivel shuttle valve

1.Fitting the adaptor
Position the adaptor in position as shown at left.

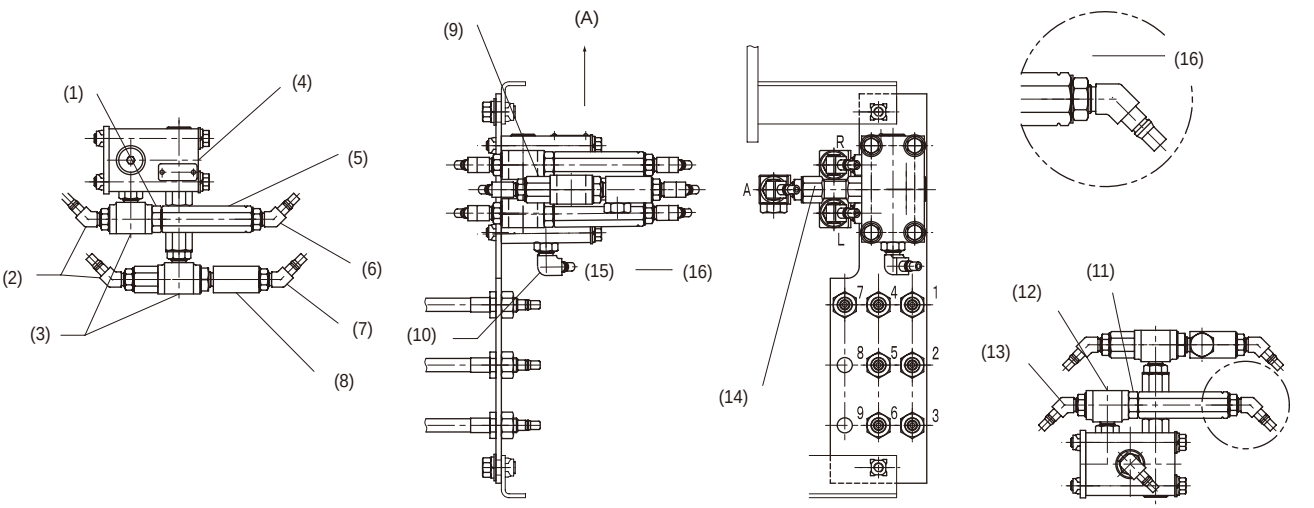
2.Adaptor tightening torque
G1/4 size
24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs

3.Plug tightening torque
G1/4 size
24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs

4.Fitting direction of the valve
Position the vale with the nameplate facing the machine front.

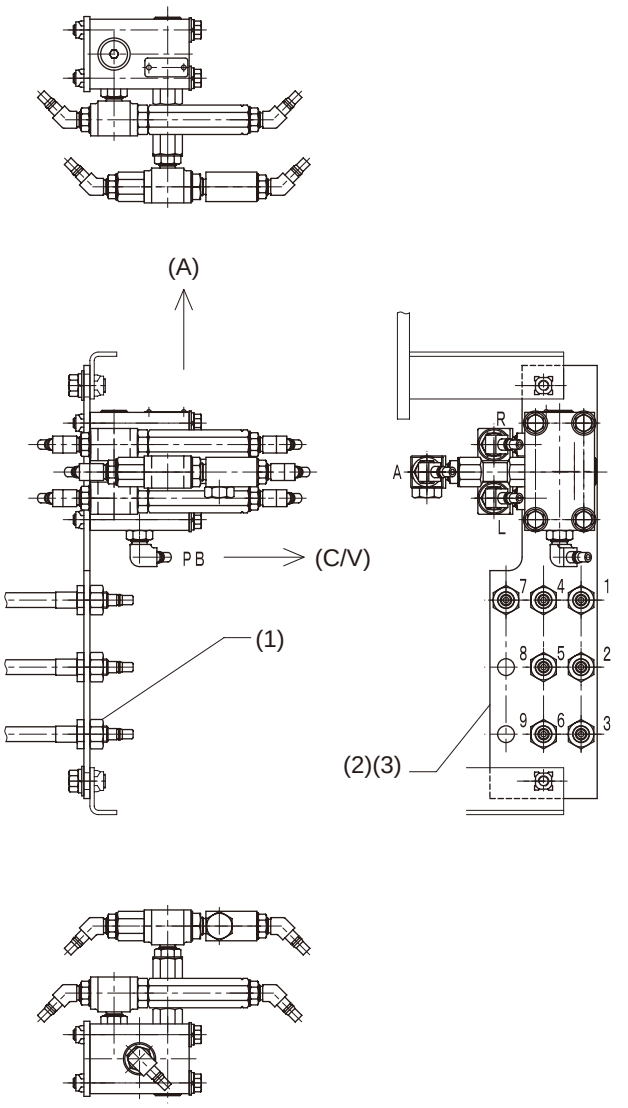
5.Quick-coupling adaptor
Pipe joint
Pipe joint
Pipe joint
Make sure the hose connection is free from detrimental scratches.

6.Fitting the valve assembly (swivel shuttle)
Tightening torque
23.5~27.5N.m(2.4~2.8kgf.m)17.4~20.3ft.lbs



(A)(Machine front)

(1)Pipe joint (S, G1/4-8.4)
(2)Pipe joint (to Q, G1/4-8.4)
(3)Pipe joint (T, G2, filter)
(4)Valve assembly (swivel shuttle)
(5)Pipe joint (to Q, G1/4-8.4)
(6)Pipe joint (T, G2-G2-G2)
(7)Pipe joint (bushing, G2)
(8)Plug (G1/4)
(9)Pipe joint (S, G1/4-G1/4)
(10)Pipe joint (QL, G1/4-8.4)
(11)Pipe joint (S, G1/4-8.4)
(12)Pipe joint (T, G2, filter)
(13)Pipe joint (to Q, G1/4-8.4)
(14)Pipe joint (bushing, G2)
(15)PB
(16)C/V



r.pilot hose relay plate

1.Fitting the bracket (pilot hose)
Position the bracket in position as shown at left.

2.Bolt tightening torque
48.1~55.9N.m(4.9~5.7kgf.m)35.4~41.2ft.lbs

3.Connecting the quick-coupling hoses
Connect the hoses to the holes. Match the numbers of holes in the figure and those of the hoses in the table, as shown at left.

4.Nut tightening torque
62.8~72.6N.m(6.4~7.4kgf.m)46.3~53.5ft.lbs

5.Quick-coupling hose ends
Make sure the hose connection is free from detrimental scratches.

(Pilot hose relay plate)

	Location	Tape color
1	Boom (up)	Green
2	Bucket (dump)	Red
3	Dozer (up)	Pink
4	Boom (down)	Yellow
5	Bucket (crowded)	Orange
6	Dozer (down)	Brown
7	Arm (dump)	Yellowish green
8	Spare	None
9	Spare	None

(A)(Machine front)

(1)Nut
(2)Bracket (pilot hose)
(3)Bolt

s.Pilot hose relay adapter

1.Fitting the adaptor
Position the adaptor in position as shown at left.

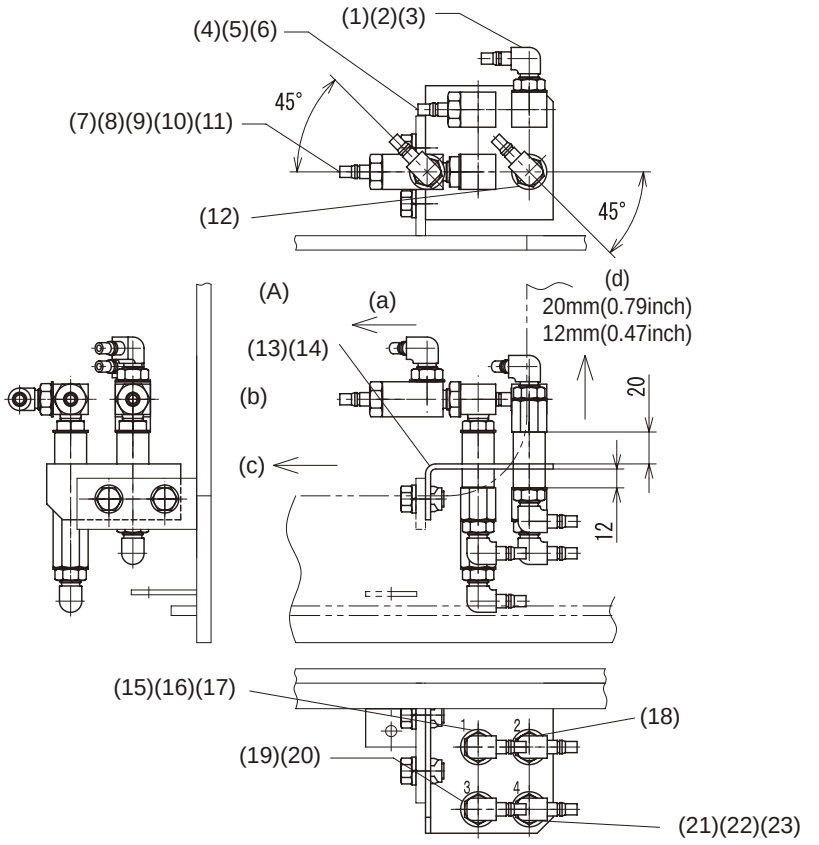
2.Adaptor tightening torque
G1/4 size
24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs

3.Quick-coupling adaptor
Pipe joint
Pipe joint
Make sure the hose connection is free from detrimental scratches.

4.Fitting direction of the adaptor (pilot hose, 2)
Place the adaptor with the longer port facing the swivel center, as shown at left.

5.Fitting the adaptor (pilot hose, 2)
Tightening torque
39.2~45.1N.m(4.0~4.6kgf.m)28.9~33.3ft.lbsAdaptor (pilot hose, 2)

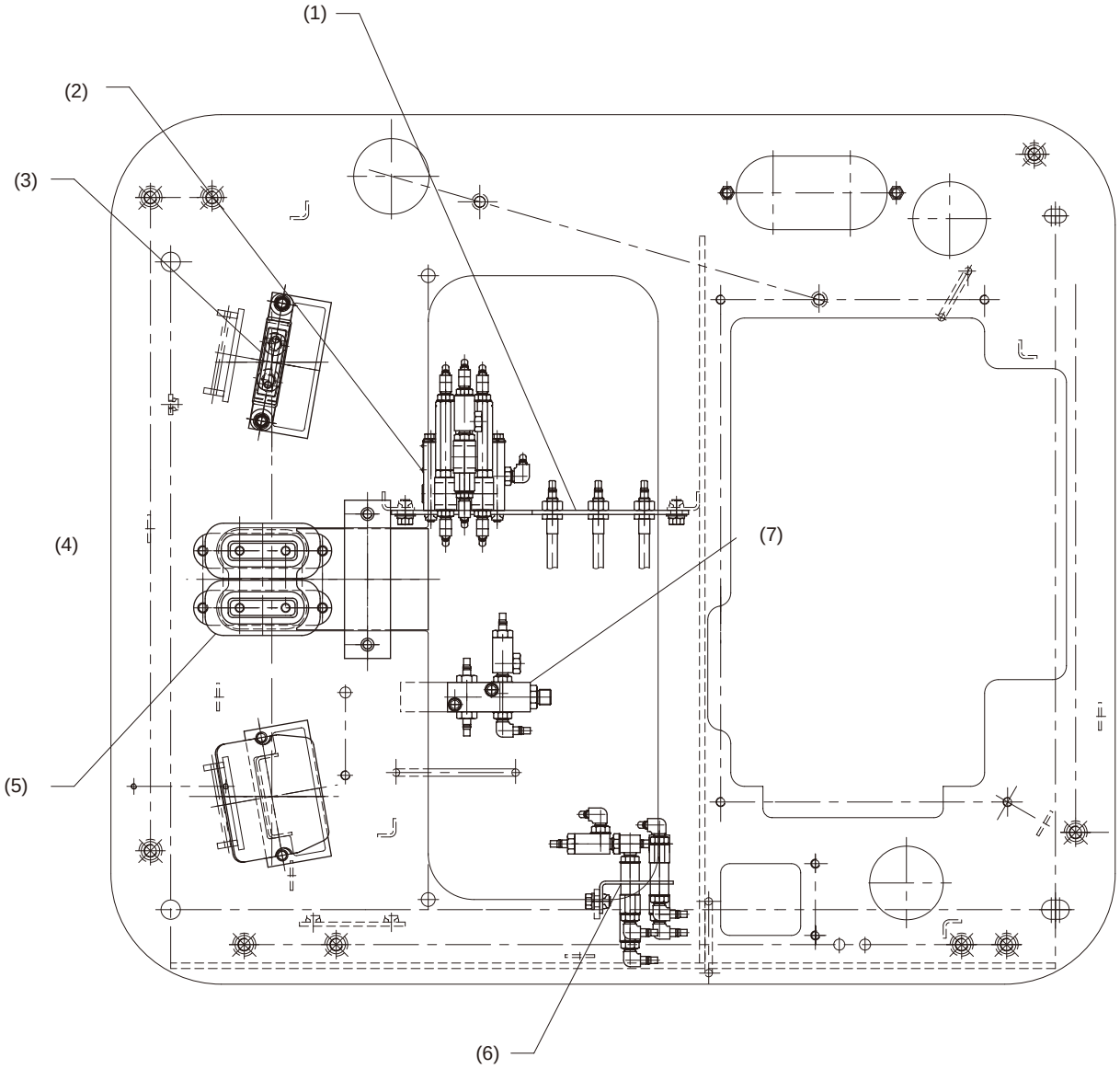
	Location	Hose tape color
1	Boom (down)	Yellow
2	Arm (dump)	Yellowish green
3	Arm (crowded)	Blue
4	Boom (up)	Green



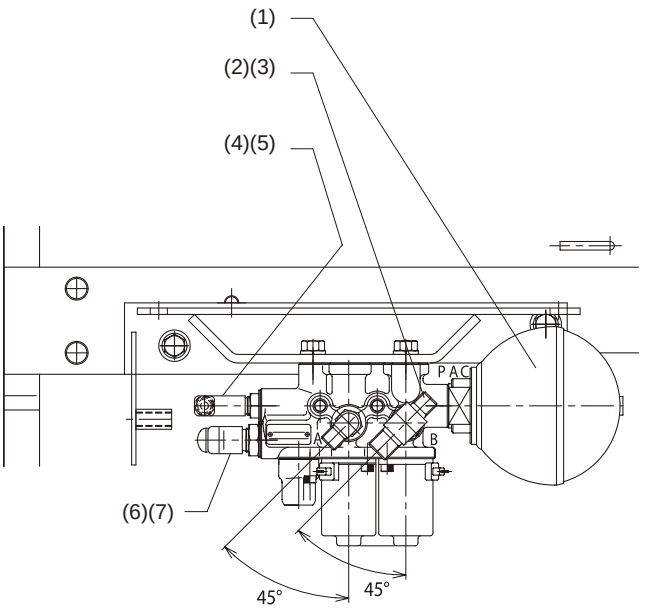
(A)(Viewed from the machine top)

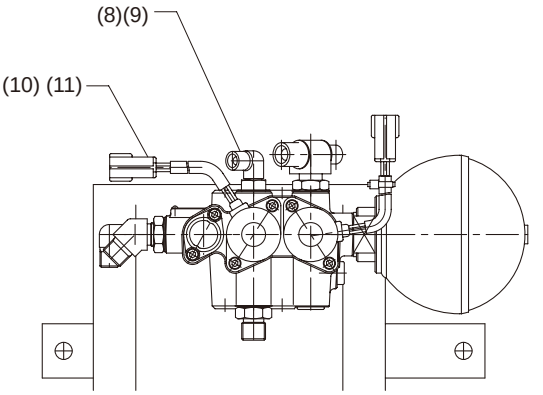
(a)(Relay plate)
(b)(To boom H/V)
(c)(Machine front)
(d)(Swivel center)

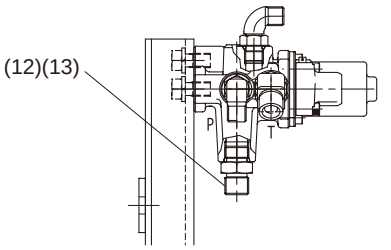
(1)Pipe joint (L, G1/4-G1/4)
(2)O ring
(3)Pipe joint (QL, G1/4-8.4)
(4)Pipe joint (L, G1/4-G1/4)
(5)O ring
(6)Pipe joint (S, G1/4-8.4)
(7)Pipe joint (L, G1/4-G1/4)
(8)O ring
(9)Pipe joint (T, G2-G2-G2)
(10)Pipe joint (S, G1/4-8.4)
(11)Pipe joint (QL, G1/4-8.4)
(12)Pipe joint (QL, G1/4-8.4)
(13)Adaptor (pilot hose, 2)
(14)Bolt
(15)Pipe joint (bushing G1/4)
(16)O ring
(17)Pipe joint (QL, G1/4-8.4)
(18)Pipe joint (QL, G1/4-8.4)
(19)Pipe joint (bushing G1/4)
(20)Pipe joint (QL, G1/4-8.4)
(21)Pipe joint (bushing G1/4)
(22)O ring
(23)Pipe joint (QL, G1/4-8.4)



(1)Bracket (pilot hose)
(relay plate)
(2)Valve assembly (swivel shuttle)
(shuttle valve)
(3)Valve assembly (pilot, OFF)
(swing P/V)
(4)Front
(5)Valve assembly (PV, travel)
(travel P/V)
(6)Adaptor (pilot hose, 2)
(relay adaptor)
(7)Adaptor (pilot hose, 1)
(P4, T collective block)







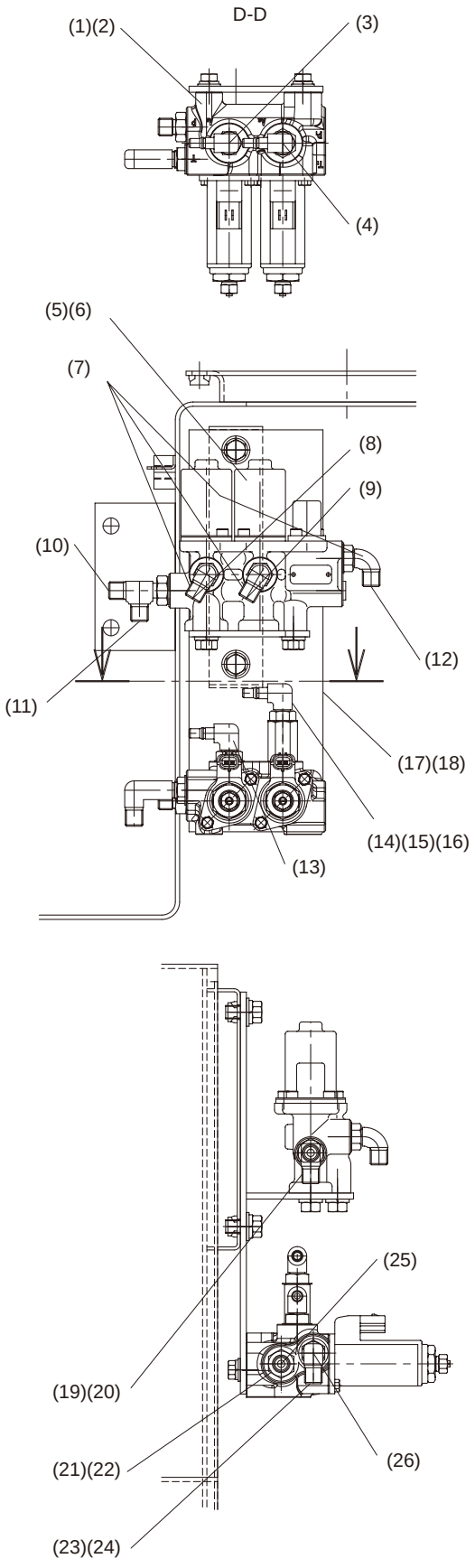
t.Unload valve

1. Fitting the adaptor
   Fit the adaptor in position as shown at left.

2. Adaptor tightening torque
   G1/4 size
   24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs
   G3/8 size
   37.2~42.1N.m(3.8~4.3kgf.m)27.5~31.1ft.lbs
   G1/2 size
   58.8~63.7N.m(6.0~6.5kgf.m)43.4~47.0ft.lbs

3. Fitting the valve assembly (unload)
   Tightening torque
   48.1~55.9N.m(4.9~5.7kgf.m)35.4~41.2ft.lbs

(1)Accumulator
(2)Pipe joint (T, F2-F3)
(3)O ring
(4)Pipe joint (L, G1/4-G1/4)
(5)O ring
(6)Straight pipe joint(3-3-45)
(7)Pipe joint(L, G3/8-G1/2)
(8)Pipe joint (L, G3/8-G3/8)
(9)O ring
(10)Valve assembly (unload)
(11)Bolt
(12)Straight pipe joint
(13)O ring



u.SP1 and SP2 solenoid valve

1. Fitting the adaptor
   Fit the adaptor in position as shown at left.

2. Adaptor tightening torque
   G1/4 size
   24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs

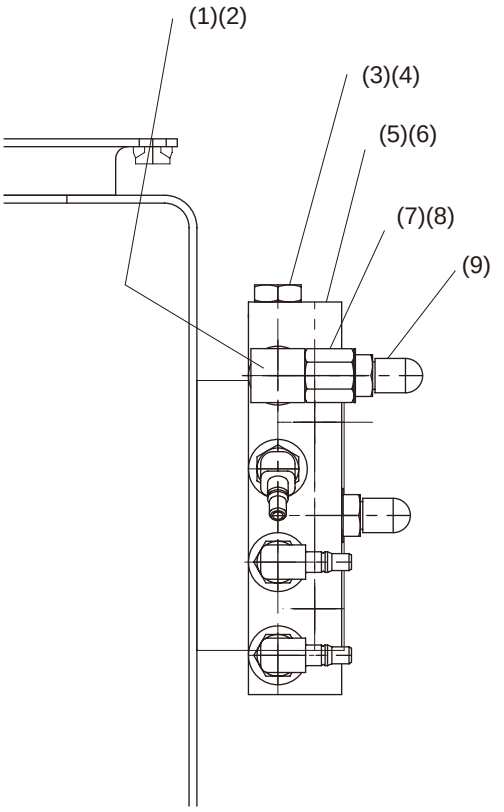
3. Quick-coupling adaptor
   Pipe joint(QL, G1/4-8,4)
   (RP812-6197D)
   Make sure the hose connection is free from detrimental scratches.

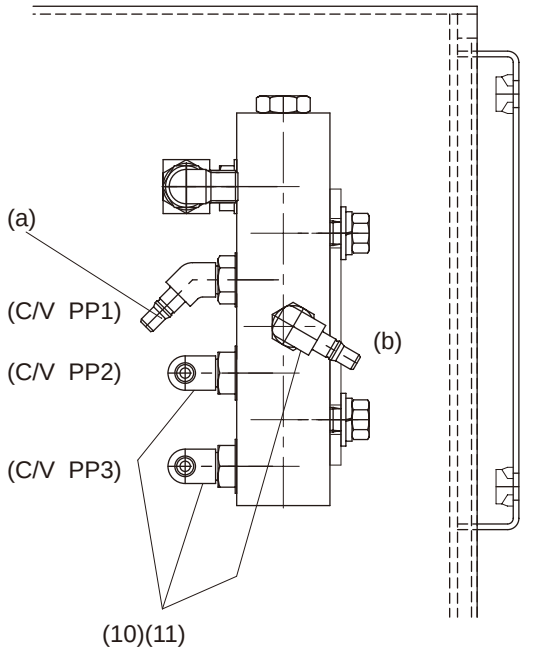
4. Fitting the bracket (valve, SP)
   Fitting the valve assembly (unload)
   Fitting the valve assembly(proportional)
   Tightening torque
   39.2~45.1N.m(4.0~4.6kgf.m)28.9~33.3ft.lbs

   Tightening torque
   48.1~55.9N.m(4.9~5.7kgf.m)35.4~41.2ft.lbs

   Tightening torque
   23.5~27.5N.m(2.4~2.8kgf.m)17.4~20.3ft.lbs

(1)Valve assembly (proportional)
(2)Bolt
(3)C/V(SP1 LOW)
(4)C/V(SP1 HIGH)
(5)Valve assembly(unload)
(6)Bolt
(7)Pipe joint (L, G1/4-G1/4)
(8)C/V(SP2 HIGH)
(9)C/V(SP2 LOW)
(10)(Unload, port B)
(11)(SP1)
(12)(Tank)
(13)Pipe joint (QL, G1/4-8.4)
(14)Pipe joint (S, G1/4-G1/4)
(15)O ring
(16)Pipe joint (QL, G1/4-8.4)
(17)Bracket (valve, SP)
(18)Bolt
(19)T pipe joint (F2)
(20)O ring
(21)Adaptor
(22)O ring
(23)Washer-fitted elbow
(24)O ring
(25)(SP2)
(26)(Tank)





v.Pilot pump relay block

1. Fitting the adaptor
   Fit the adaptor in position as shown at left.

2. Adaptor tightening torque
   G1/4 size
   24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs

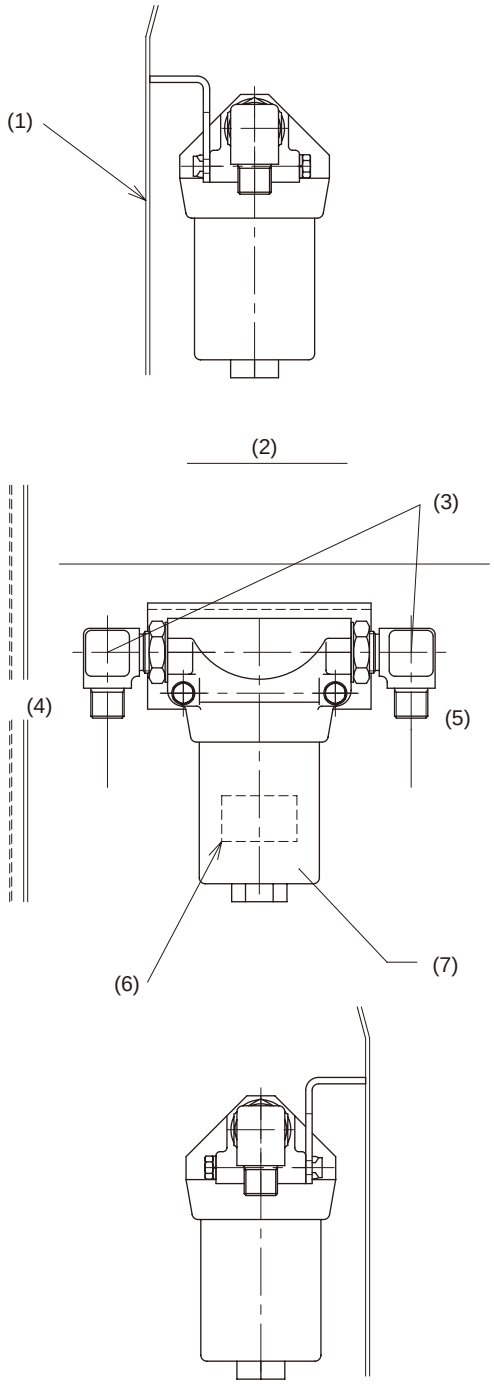
3. Plug tightening torque
   G1/4 size
   24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs

4. Quick-coupling adaptor
   Pipe joint
   Pipe joint
   Make sure the hose connection is free from detrimental scratches.

5. Fitting the joint (block, PP)
   Tightening torque
   48.1~55.9N.m(4.9~5.7kgf.m)35.4~41.2ft.lbs

(a)(Unload P)
(b)(Swivel motor PG)

(1)Pipe joint (L, G1/4-G1/4)
(2)O ring
(3)Plug (1/4)
(4)O ring
(5)Pipe joint (block, PP)
(6)Bolt
(7)Pipe joint (S, G1/4-G1/4)
(8)O ring
(9)Pipe joint(L, G1/4-G1/4)
(10)Pipe joint (to Q, G1/4-8.4)
(11)Pipe joint (QL, G1/4-8.4)



w.Pilot line filter

1.Fitting the adaptor
Fit the adaptor in position as shown at left.
Pipe joint (L, F1/2,-F3/8)
(69251-6185D)

2.Adaptor tightening torque
G1/2 size
58.8~63.7N.m(6.0~6.5kgf.m)43.4~47.0ft.lbs

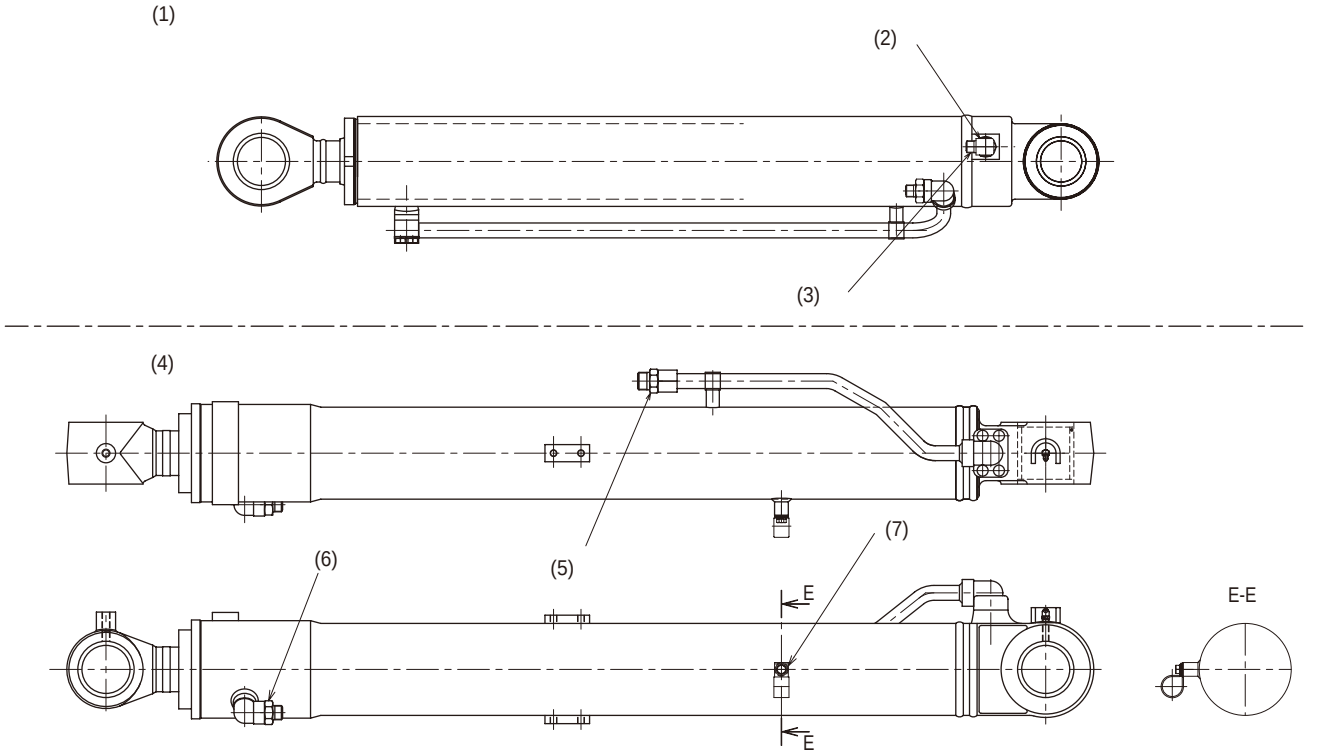
3.Fitting the filter assembly (hydraulic)
Bolt tightening torque
9.8~11.3N.m(1.0~1.15kgf.m)7.2~8.3ft.lbs
Fitting direction of the filter
Make sure the label faces toward the arch wall.

(1)Frame (arch)
(2)Oil flow direction
(3)Pipe joint (L, F1/2-F3/8)
O ring
(4)Unload valve
(5)Pump (P4)
(6)Label to face toward the arch wall
(7)Filter assembly (hydraulic)
Bolt

x.Cylinders

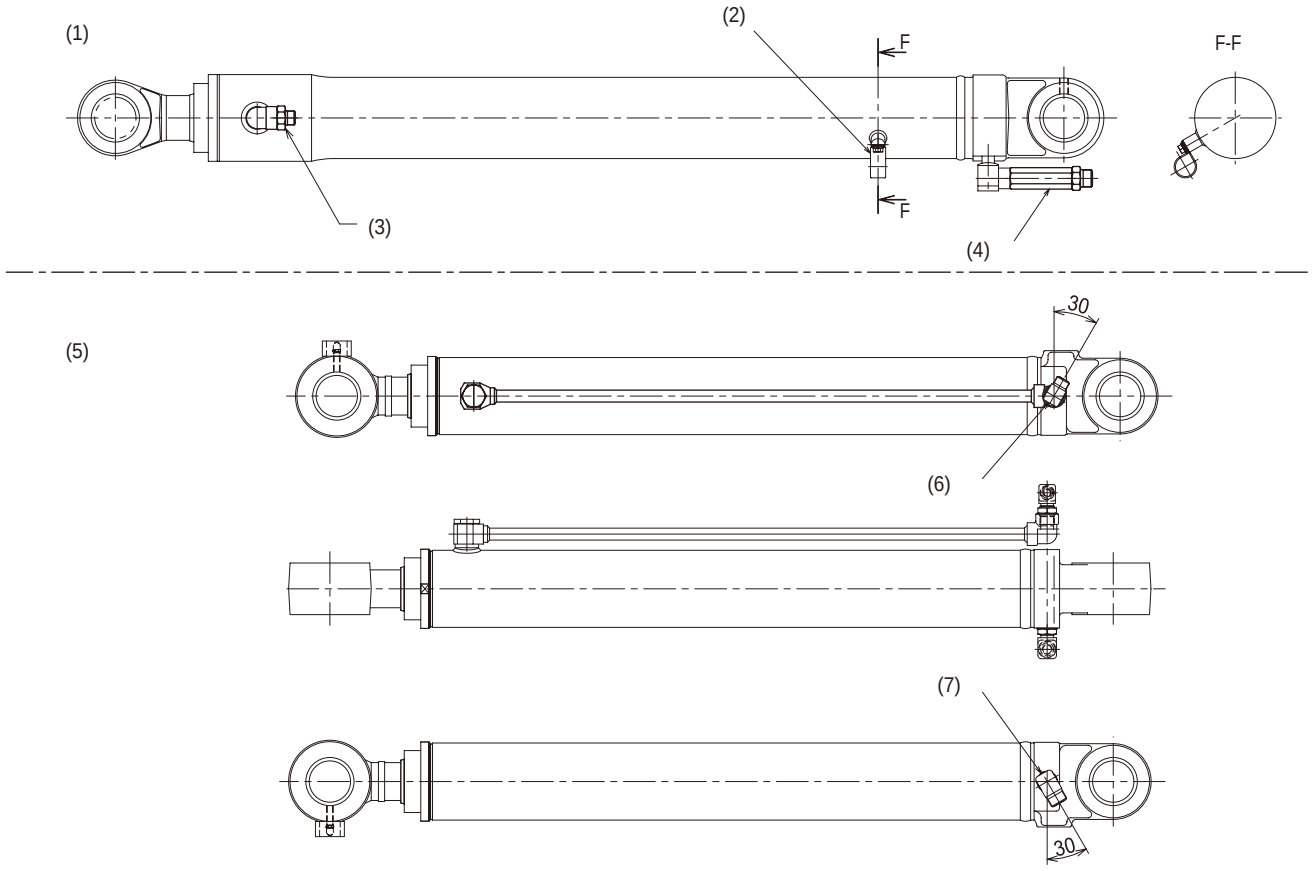
1 .Fitting the adaptor of each cylinder
Fit the adaptors at the angle specified in the figure.

2. Adaptor tightening torque
G1/2 size
58.8~63.7N.m(6.0~6.5kgf.m)43.4~47.0ft.lbs



(1)(Swing cylinder)
(2)Pipe joint (LG4, 11/16U)
(3)Pipe joint (SG4, 11/16U)
(4)(Boom cylinder)
(5)Pipe joint (SG4, 1U)
(6)Pipe joint (SG4, 13/16U)
(7)Clamp

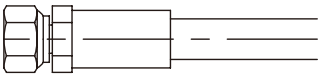
Bolt



(1)(Arm cylinder)
(2)Clamp
Bolt
(3)Pipe joint (SG4, 13/16U)
(4)Pipe joint (bushing, 1/2)
Pipe joint (SG4, 1U)
(5)(Bucket cylinder)
(6)Pipe joint (LG4, 13/16U)
(7)Pipe joint (LG4, 1U)

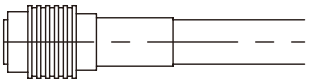
y.Hydraulic hose

1.Metallic sealing type



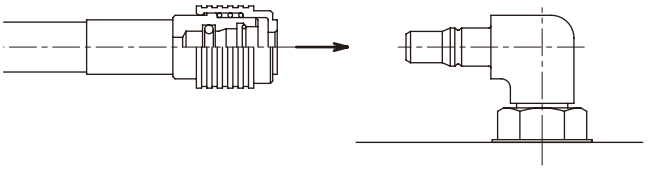
Tighten to the specified torque.
G1/4 size
24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs
G3/8 size
37.2~42.1N.m(3.8~4.3kgf.m)27.5~31.1ft.lbs
G1/2 size
58.8~63.7N.m(6.0~6.5kgf.m)43.4~49.0ft.lbs

2.Quick-coupling type

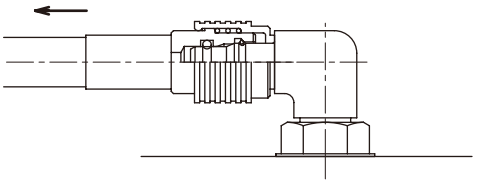


G1-1/4 size
Couple the hose in position as shown at left.
Finally, make sure the hose does not come off.

3.Connecting the quick-coupling type hose



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



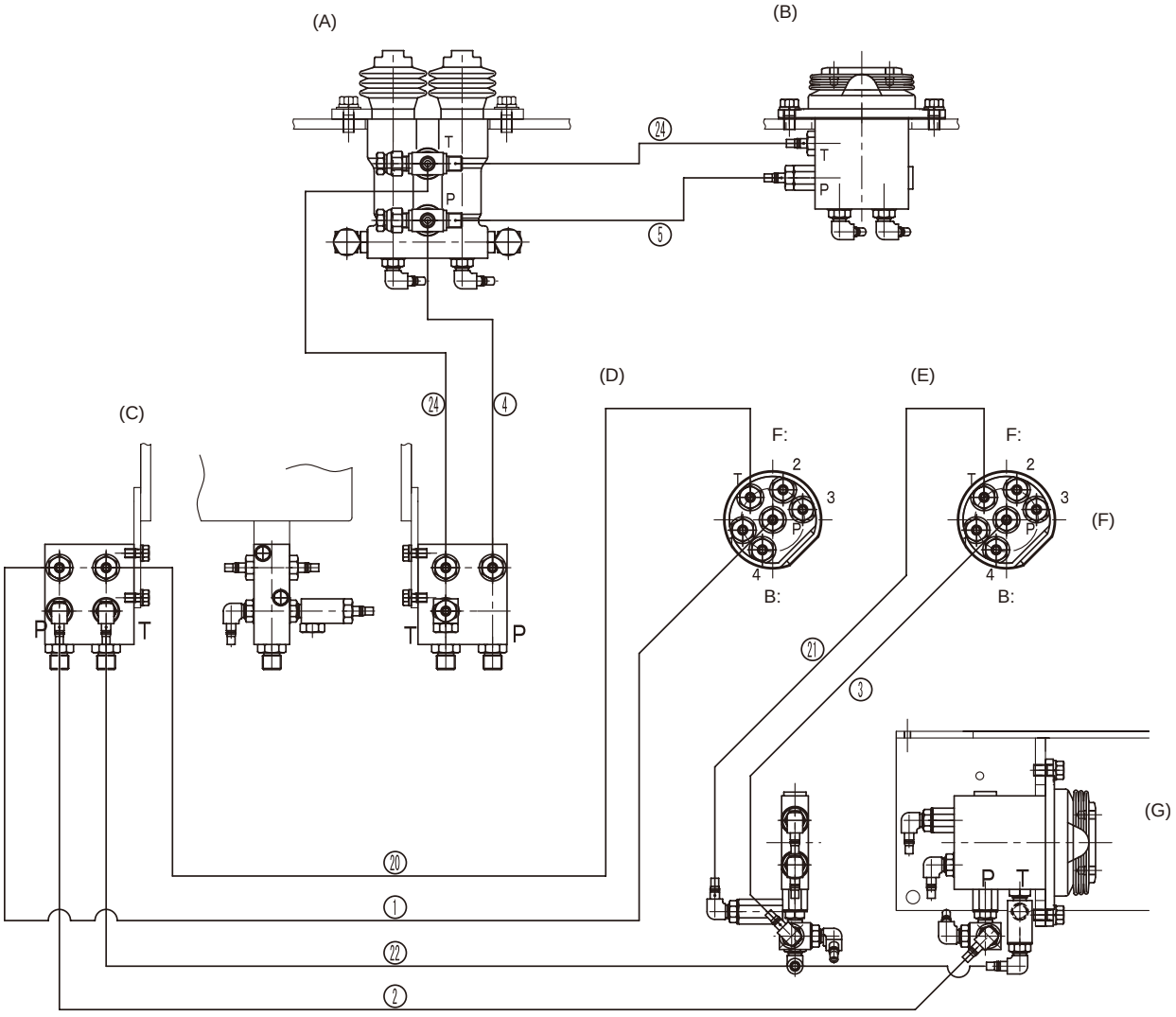
2) Pull the hose in the direction of arrow, as shown below, to make sure it does not come off the joint.

z.Hose route

1.Pilot hose 1

Pilot hoses

No.	Location		Tapecolor	Q'ty
1	(P4, T) Collective block ~ P/V (left) (P)	P/V boost	White	1
2	(P4, T) Collective block ~ Dozer P/V (P)	Dozer P/V boost	White	1
3	Dozer P/V (P) ~ P/V (right) (P)	P/V boost	White	1
4	(P4, T) Collective block ~ Travel P/V (P)	Travel P/V boost	White	1
5	Travel P/V (P) ~ Swing P/V (P)	Swing P/V boost	White	1
20	P/V (left) (T) ~ (P4, T) Collective block	Drain		1
21	P/V (right) (T) ~ Dozer P/V (T)	Drain		1
22	Dozer P/V (T) ~ (P4, T) Collective block	Drain		1
23	Swing P/V (T) ~ Travel P/V (T)	Drain		1
24	Travel P/V (T) ~ (P4, T) Collective block	Drain		1



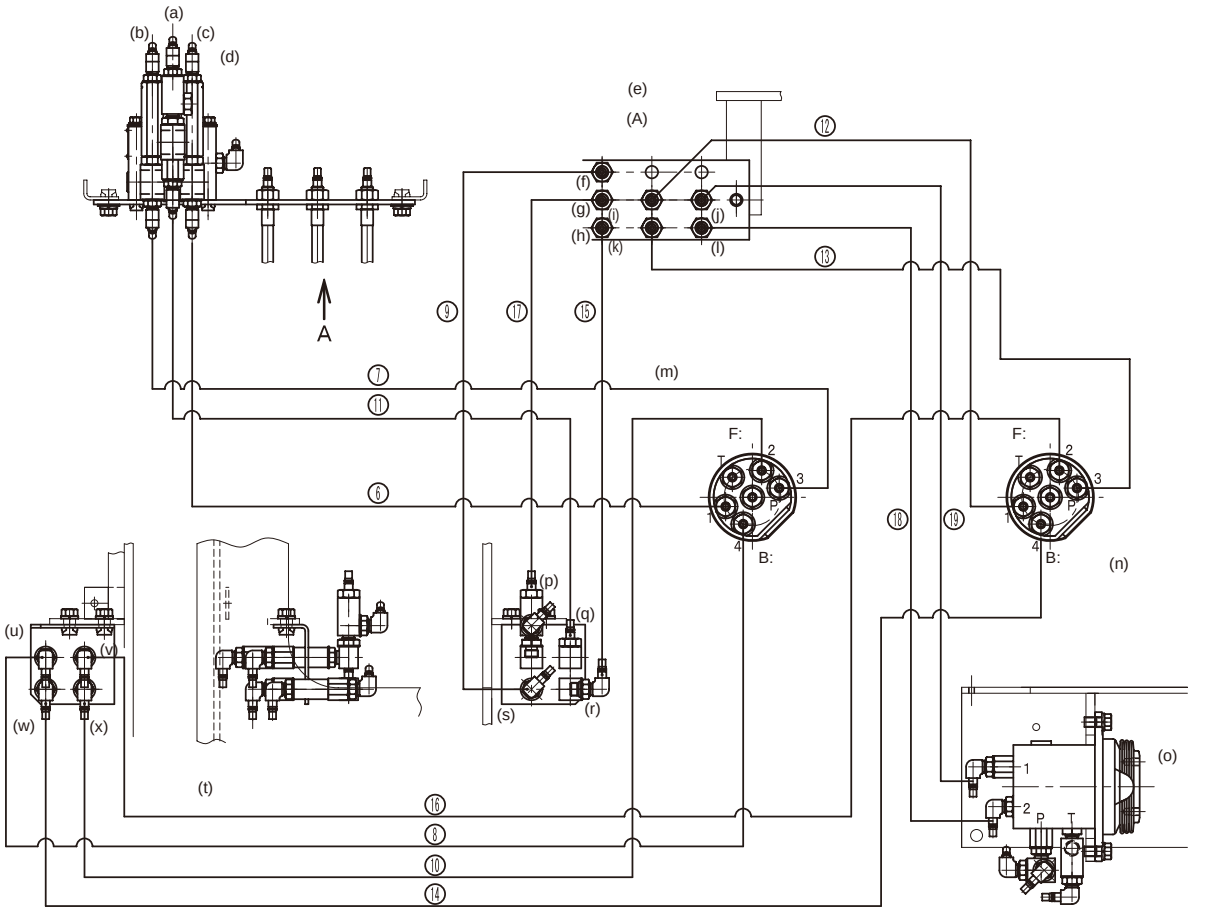
(A)Valve assembly (PV, travel)
(B)(Used for the swing pedal)Valve assembly (pilot, OFF)
(C)Adaptor (pilot hose, 1)
(D)Valve assembly (pilot, L)
(E)Valve assembly (pilot, R)
(F)(Port positions when viewed from above the valve)
(G)(Used for the dozer lever)Valve assembly (pilot, OFF)

F:(Front)
B:(Back)

2.Pilot hose 2

Pilot hoses

No.	Location		Tapecolor	Q'ty
6	P/V (swivel left) – Shuttle valve	Swivel (left)	Gray	1
7	P/V (swivel right) – Shuttle valve	Swivel (left)	Sky-blue	1
8	P/V (arm crowded) – Relay adaptor	Arm (crowded)	Blue	1
9	Relay adaptor – Relay plate (arm crowded)	Arm (crowded)	Blue	1
10	P/V (arm crowded) – Relay adaptor	Arm (dump)	Yellowish green	1
11	Relay adaptor – Shuttle valve (arm crowded)	Arm (dump)	Yellowish green	1
12	P/V (bucket crowded) – Relay plate	Bucket (crowded)	Orange	1
13	P/V (bucket dump) – Relay plate	Bucket (dump)	Red	1
14	P/V (boom up) – Relay adaptor	Boom (up)	Green	1
15	Relay adaptor – Relay plate (boom up)	Boom (up)	Green	1
16	P/V (boom down) – Relay adaptor	Boom (down)	Yellow	1
17	Relay adaptor – Relay plate (boom down)	Boom (down)	Yellow	1
18	Dozer P/V (up) – Relay plate	Dozer (up)	Pink	1
19	Dozer P/V (down) – Relay plate	Dozer (down)	Brown	1



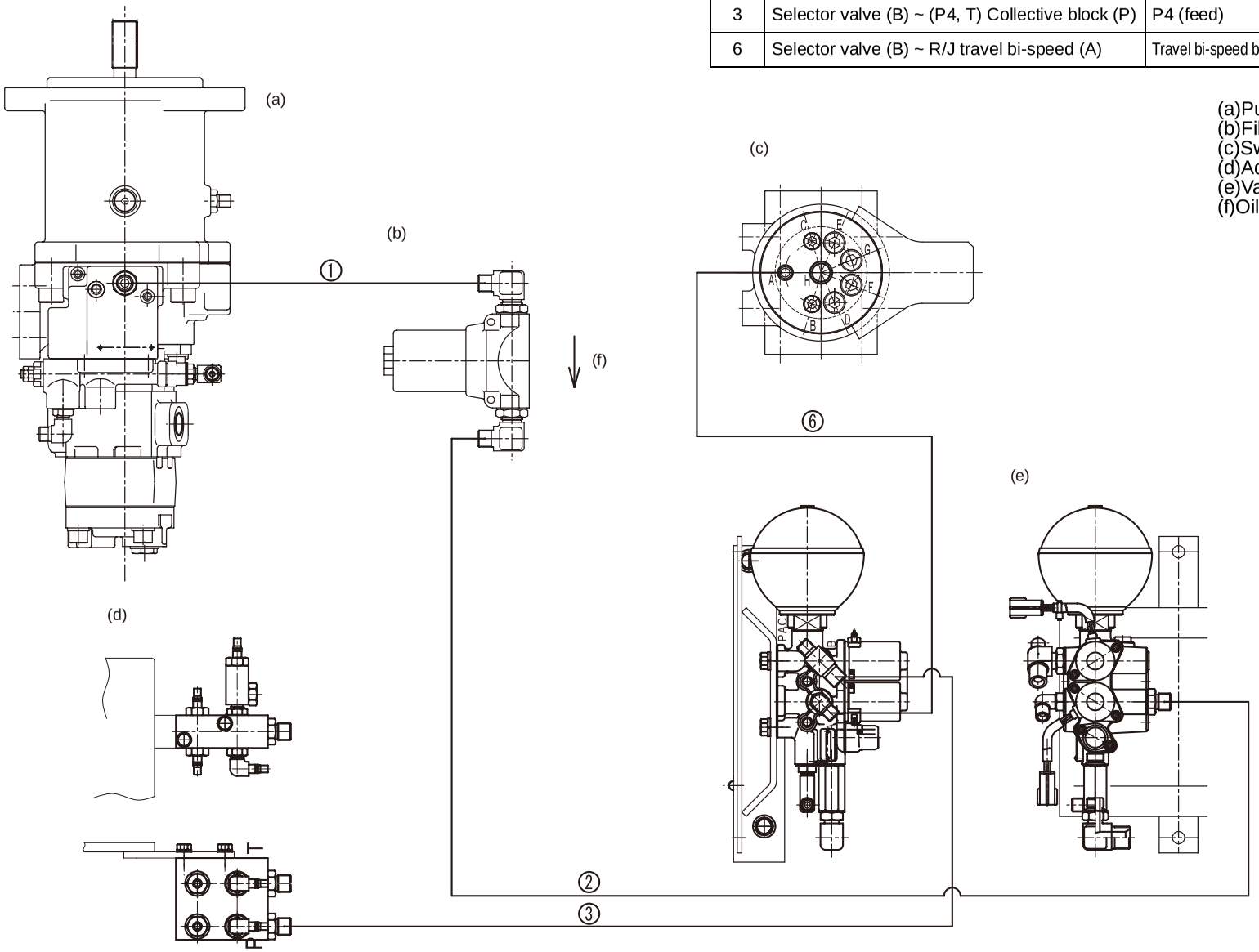
(a)Arm (crowded)
(b)Swivel (right)
(c)Swivel (left)
(d)Valve assembly (swivel shuttle)
(e)Adaptor (pilot hose, 1)
(f)Arm (dump)
(g)Boom (down)
(h)Boom (up)
(i)Bucket (crowded)
(j)Dozer (down)
(k)Bucket (dump)
(l)Dozer (up)
(m)Valve assembly (pilot, L)
(n)Valve assembly (pilot, R)
(o)(Used for the dozer lever)Valve assembly (pilot, OFF)
(p)Boom (down)
(q)Arm (crowded)
(r)Boom (up)
(s)Arm (dump)
(t)Adaptor (pilot hose, 2)
(u)Arm(crowded)
(v)Boom (down)
(w)Boom (up)
(x)Arm (dump)

(A)(View A)
F:(Front)
B:(Back)

3.Pilot hose 3

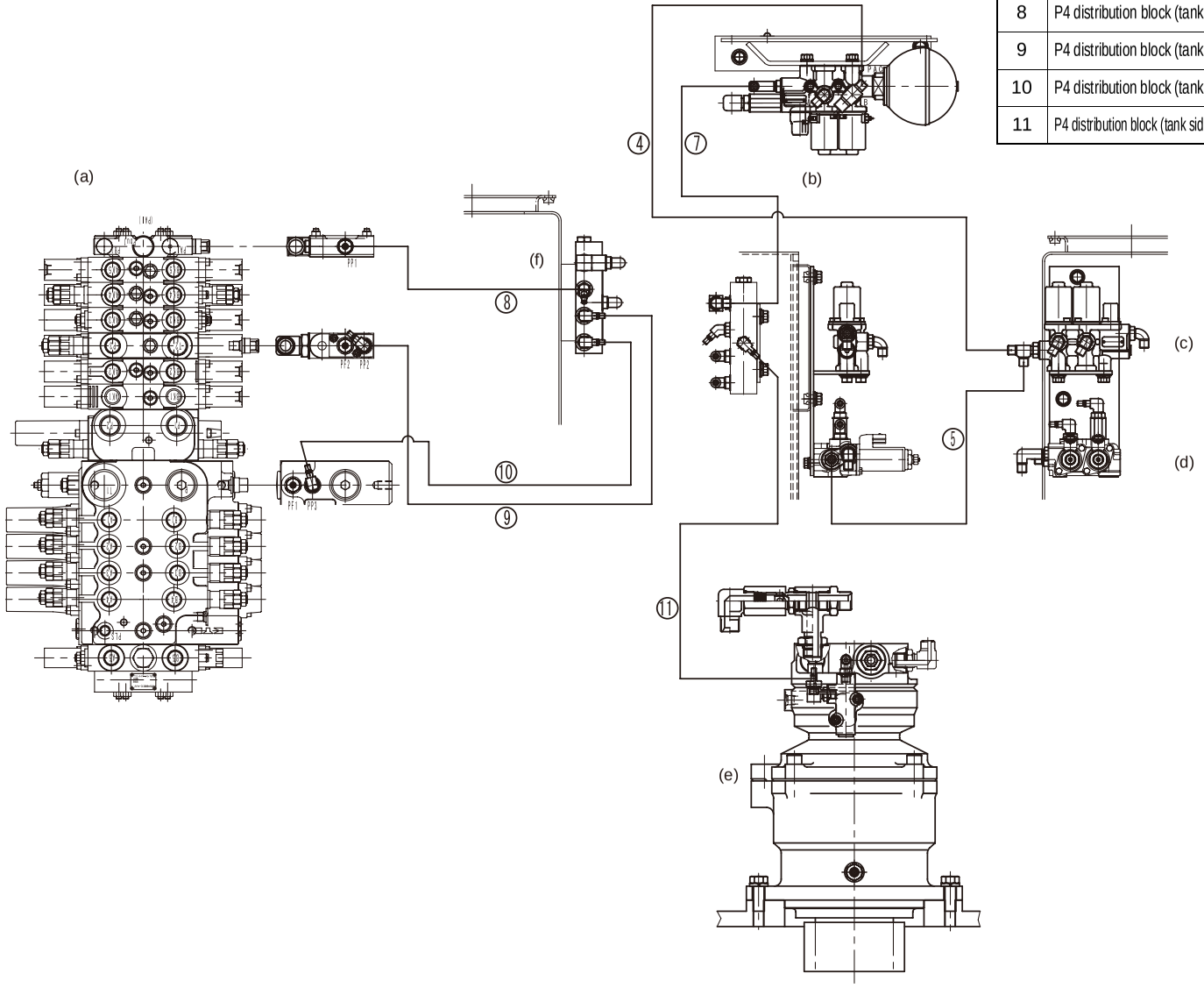
No.	Location		Tapecolor	Q'ty
1	Pump ~ Line filter	P4 (feed)		1
2	Life filter ~ Selector valve (C)	P4 (feed)	Red	1
3	Selector valve (B) ~ (P4, T) Collective block (P)	P4 (feed)	Red	1
6	Selector valve (B) ~ R/J travel bi-speed (A)	Travel bi-speed boost	Yellowish green	1

(a)Pump assembly (piston)
(b)Filter assembly (hydraulic)
(c)Swivel joint assembly
(d)Adaptor (pilot hose, 1)
(e)Valve assembly (unload)
(f)Oil flow



4.Pilot hose 4

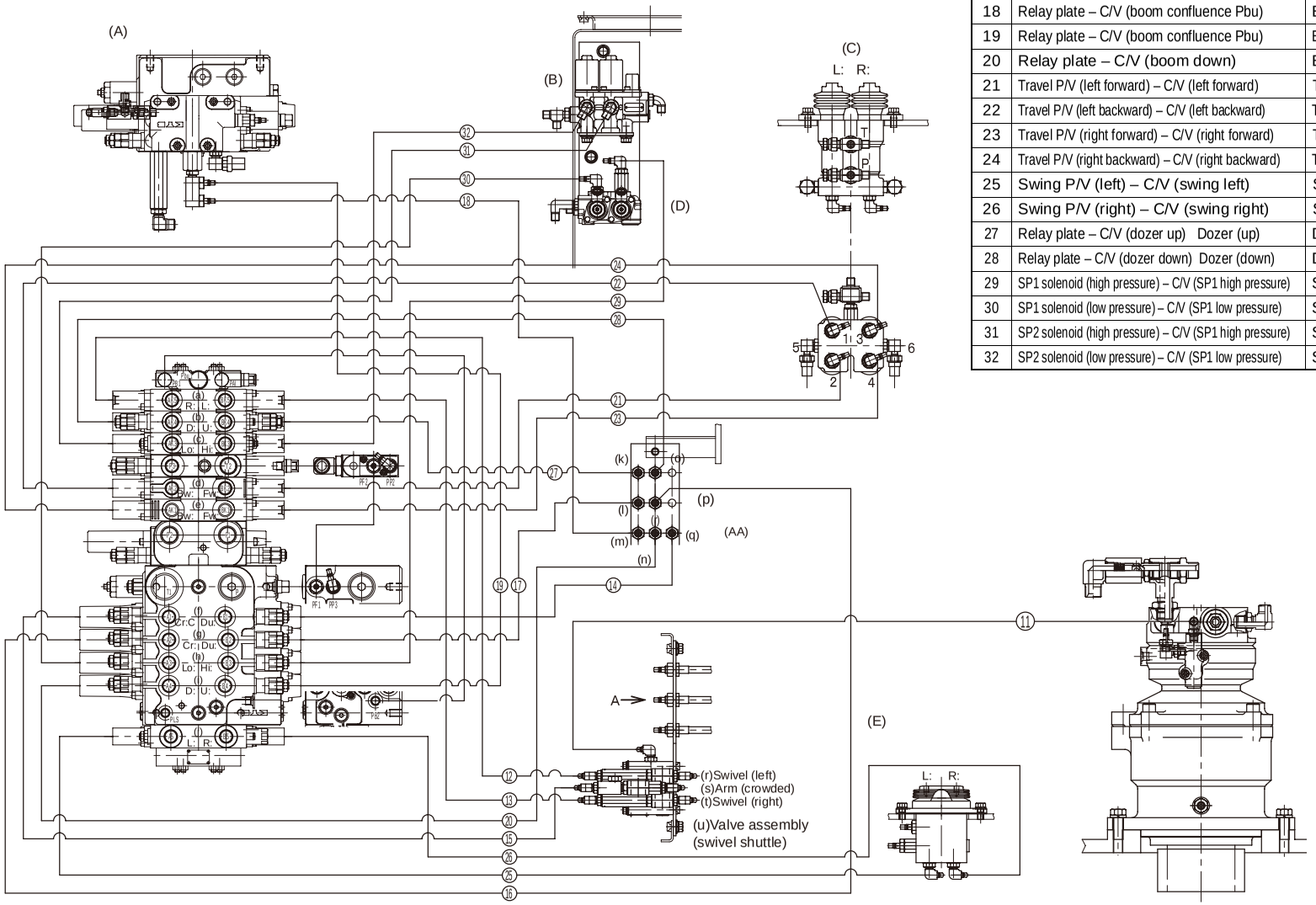
No.	Location		Tapecolor	Q'ty
4	Selector valve (B) ~ SP2 solenoid valve (P)	SP2 (feed)	Blue	1
5	SP2 solenoid valve (P) ~ SP1 solenoid valve (P)	SP1 (feed)		1
7	Selector valve (P) ~ P4 distribution block (tank side)	Distribution block (feed)	White	1
8	P4 distribution block (tank side) ~ C/V (PP1)	AI boost	Blue	1
9	P4 distribution block (tank side) ~ C/V (PP2)	P3 confluence boost	Yellow	1
10	P4 distribution block (tank side) ~ C/V (PP3)	P3 confluence boost	Green	1
11	P4 distribution block (tank side) ~ Swivel motor brake (PG)	Swivel brake release (feed)	Sky-blue	1



(a)Control valve assembly
(b)Valve assembly (unload)
(c)Valve assembly (unload)
(d)Valve assembly (proportional)
(e)Motor assembly (swivel)
(f)Joint (block, PP)

5.Pilot hose 5

No.	Location		Tape color	Q'ty
12	Shuttle valve – C/V (swivel left)	Swivel (right)	Sky-blue	1
13	Shuttle valve – C/V (swivel right)	Swivel (left)	Gray	1
14	Relay plate – C/V (arm dump)	Arm (dump)	Blue	1
15	Shuttle valve – C/V (arm crowded)	Arm (crowded)	Yellowish green	1
16	Relay plate – C/V (bucket crowded)	Bucket (crowded)	Orange	1
17	Relay plate – C/V (bucket dump)	Bucket (dump)	Red	1
18	Relay plate – C/V (boom confluence Pbu)	Boom (up)	Green	1
19	Relay plate – C/V (boom confluence Pbu)	Boom (confluence, up)	Green	1
20	Relay plate – C/V (boom down)	Boom (down)	Yellow	1
21	Travel P/V (left forward) – C/V (left forward)	Travel (left, forward)	Red	1
22	Travel P/V (left backward) – C/V (left backward)	Travel (left, backward)	Blue	1
23	Travel P/V (right forward) – C/V (right forward)	Travel (right, forward)	Yellow	1
24	Travel P/V (right backward) – C/V (right backward)	Travel (right, backward)	Green	1
25	Swing P/V (left) – C/V (swing left)	Swing (left)	Orange	1
26	Swing P/V (right) – C/V (swing right)	Swing (right)	Yellowish green	1
27	Relay plate – C/V (dozer up) Dozer (up)	Dozer (up)	Pink	
28	Relay plate – C/V (dozer down) Dozer (down)	Dozer (down)	Brown	
29	SP1 solenoid (high pressure) – C/V (SP1 high pressure)	SP1 (high pressure)	Pink	
30	SP1 solenoid (low pressure) – C/V (SP1 low pressure)	SP1 (low pressure)	Brown	
31	SP2 solenoid (high pressure) – C/V (SP1 high pressure)	SP2 (high pressure)	Pink	
32	SP2 solenoid (low pressure) – C/V (SP1 low pressure)	SP2 (low pressure)	Brown	

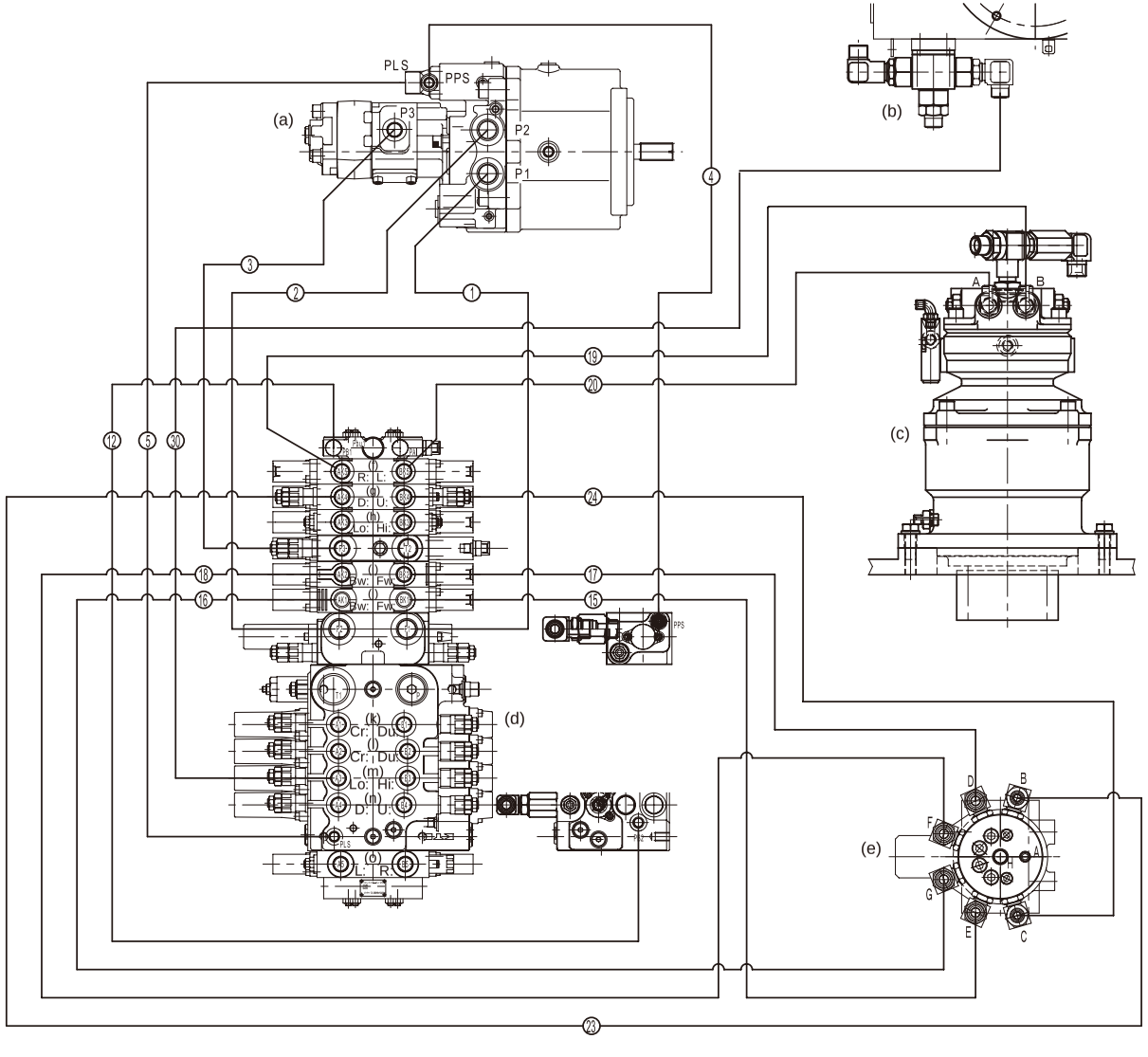


(A)Control valve assembly
(B)Valve assembly (unload)
(C)Valve assembly (PV, travel)
(D)Valve assembly (proportional)
(E)(Used for the swing pedal)
Valve assembly (pilot, OFF)

(a)Swivel
(b)Dozer
(c)SP2
(d)Travel left
(e)Travel right
(f)Arm
(g)Bucket
(h)SP1
(i)Boom
(j)Swing
(k)Dozer (up)
(l)Bucket (dump)
(m)Boom (up)
(n)Boom (down)
(o)Dozer (down)
(p)Adaptor (pilot hose, 1)
(q)Arm(dump)(r)
Bucket (crowded)

(AA)(View A)
L:(Left)
R:(Right)
D:Down
U:Up
Lo:Low
Hi:High
Bw:Backward
Fw:Forward
Cr:Crowded
Du:Dump

6.High and low pressure hose 1



No.	Location		Tapecolor	Q'ty
1	Pump (P1) ~ C/V (P1)	Delivery (P1)	Red, White	1
2	Pump (P2) ~ C/V (P2)	Delivery (P2)	Red, White	1
3	Pump (P3) ~ C/V (P3)	Delivery (P3)	Red, White	1
4	Pump (PPS) ~ C/V (PPS)	LS signal	Blue	1
5	Pump (PLS) ~ C/V (PLS)	LS signal	Yellow	1
12	C/V (PB1) ~ C/V (PB2)	Boom confluence	Green	1
15	C/V (travel right forward) ~ R/J (E)	Travel (right) forward	Sky-blue	1
16	C/V (travel right backward) ~ R/J (G)	Travel (right) backward	Blue	1
17	C/V (travel left forward) ~ R/J (D)	Travel (left) forward		1
18	C/V (travel left backward) ~ R/J (F)	Travel (left) backward	White	1
19	C/V (swivel left) ~ Swivel motor (B)	Swivel (left)	Blue	1
20	C/V (swivel right) ~ Swivel motor (A)	Swivel (right)	Yellow	1
23	C/V (dozer down) ~ Dozer cylinder (bottom)	Dozer (down)	Green	1
24	C/V (dozer up) ~ Dozer cylinder (rod)	Dozer (up)	Sky-blue	1
30	3-way valve ~ C/V (SP1 low pressure)	SP1 (low pressure)	Brown	1

R:Right
L:Left
D:Down
U:Up
Lo:Low
Hi:High
Bw:Backward
Fw:Forward
Cr:Crowded
Du:Dump

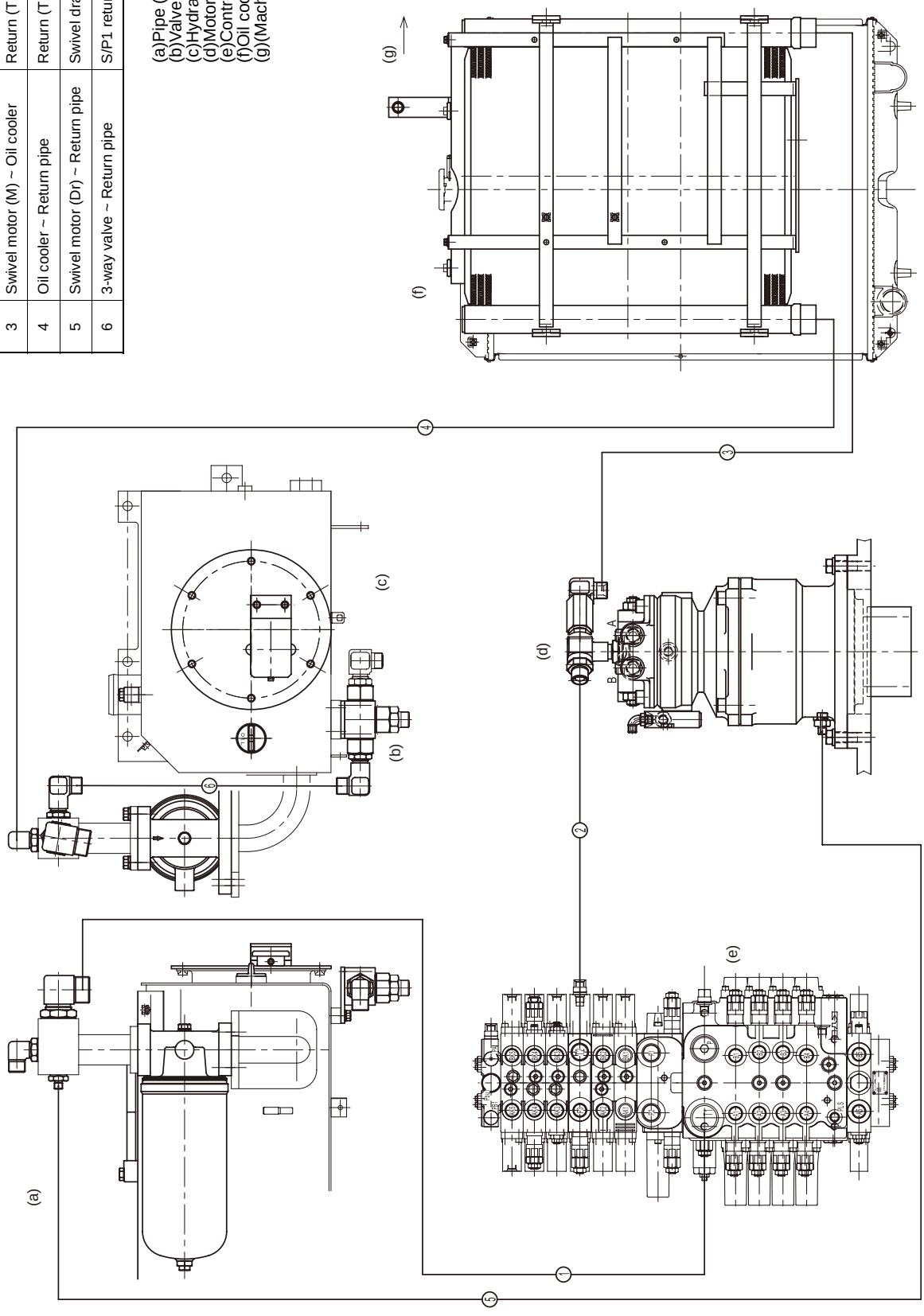
(a)Pump assembly (piston)
(b)Valve assembly(3-way)
(c)Motor assembly (swivel)
(d)Control valve assembly
(e)Swivel joint assembly
(f)Swivel
(g)Dozer
(h)SP2
(i)Travel left
(j)Travel right
(k)Arm
(l)Bucket
(m)SP1
(n)Boom
(o)Swing

R:Right
L:Left
D:Down
U:Up
Lo:Low
Hi:High
Bw:Backward
Fw:Forward
Cr:Crowded
Du:Dump

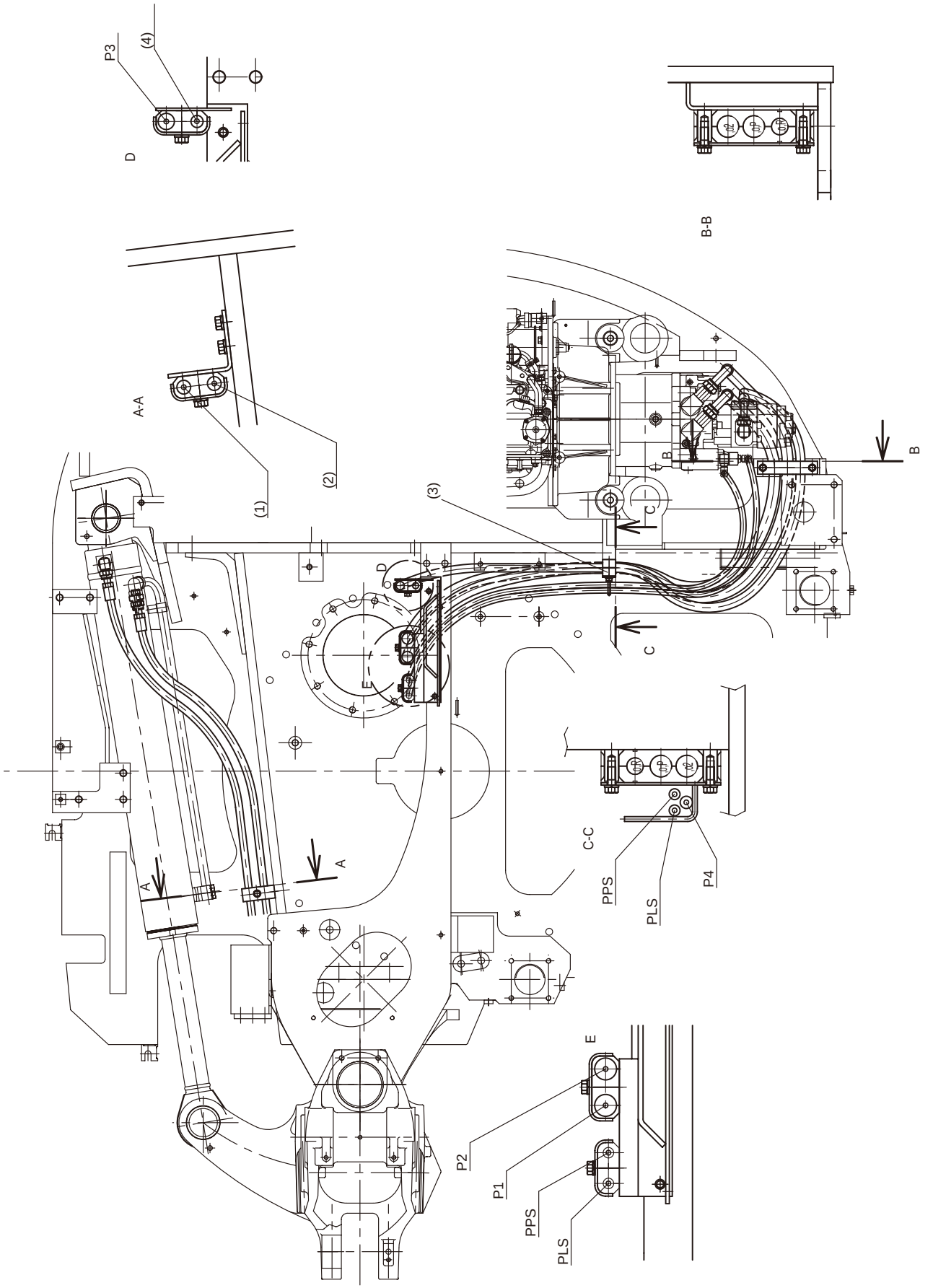
7.High and low pressure hose 2

No.	Location		Tapecolor	Q'ty
1	C/V (T1) ~ Return pipe	Return (T1)	Black	1
2	C/V (T2) ~ Swivel motor (M)	Swivel makeup		1
3	Swivel motor (M) ~ Oil cooler	Return (T2)	Black	1
4	Oil cooler ~ Return pipe	Return (T2)		1
5	Swivel motor (Dr) ~ Return pipe	Swivel drain	Pink	1
6	3-way valve ~ Return pipe	S/P1 return		1

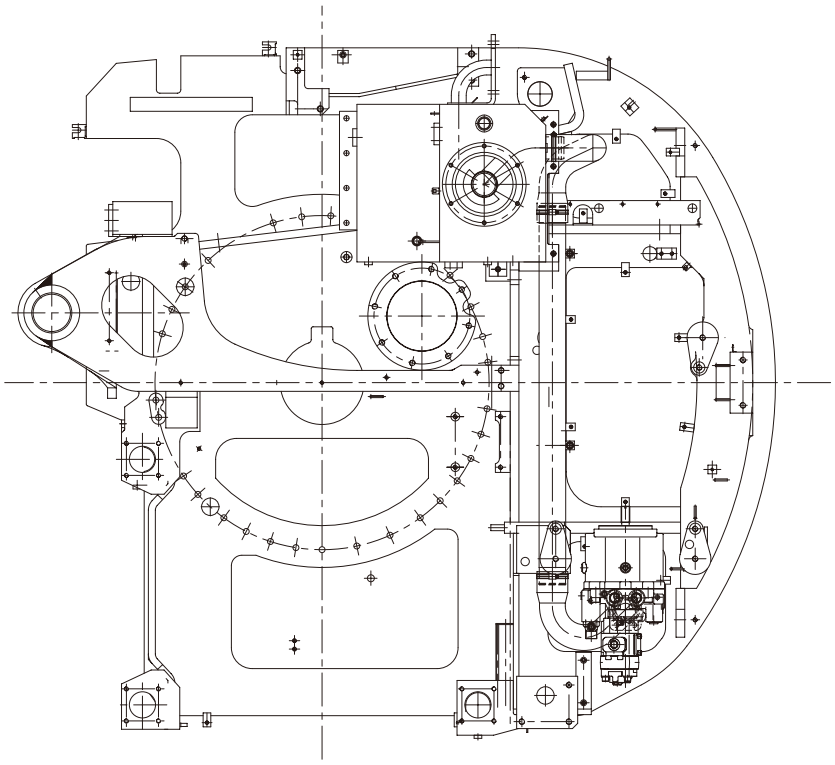
(a)Pipe (return)
(b)Valve assembly (3-way)
(c)Hydraulic tank
(d)Motor assembly (swivel)
(e)Control valve assembly
(f)Oil cooler
(g)(Machine front)

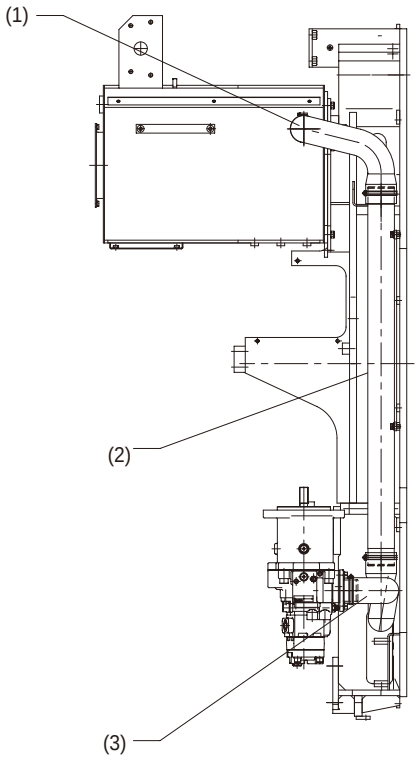


8.Pump delivery



9.Suction



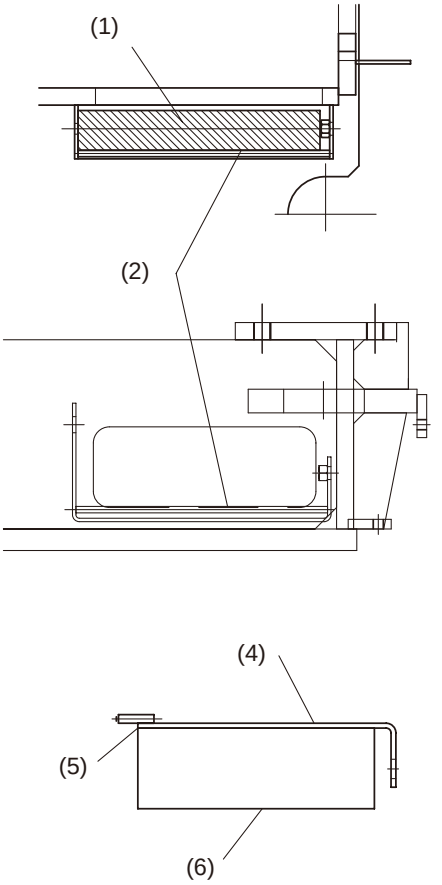


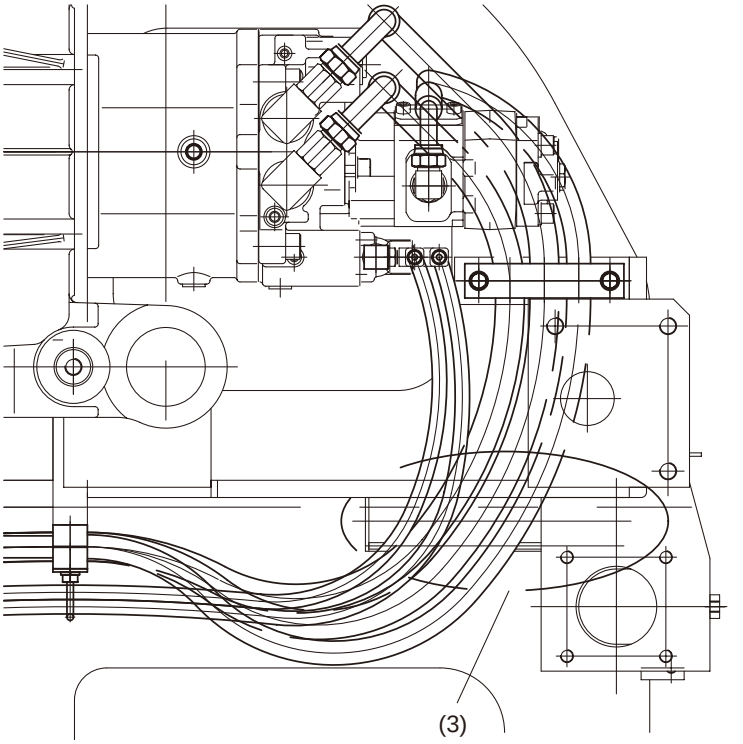
(1)Hose (1, suction)
Hose clamp (68-85)
Hose clamp (77-95)
(2)Pipe (suction)
Bolt
(3)Hose (2, suction)
Hose clamp (68-85)
Hose clamp (77-95)

10.Swivel frame partition

1.Applying position of the cushion
(1, delivery)
Apply the cushion to the position, shown in the figure, on the swivel frame.

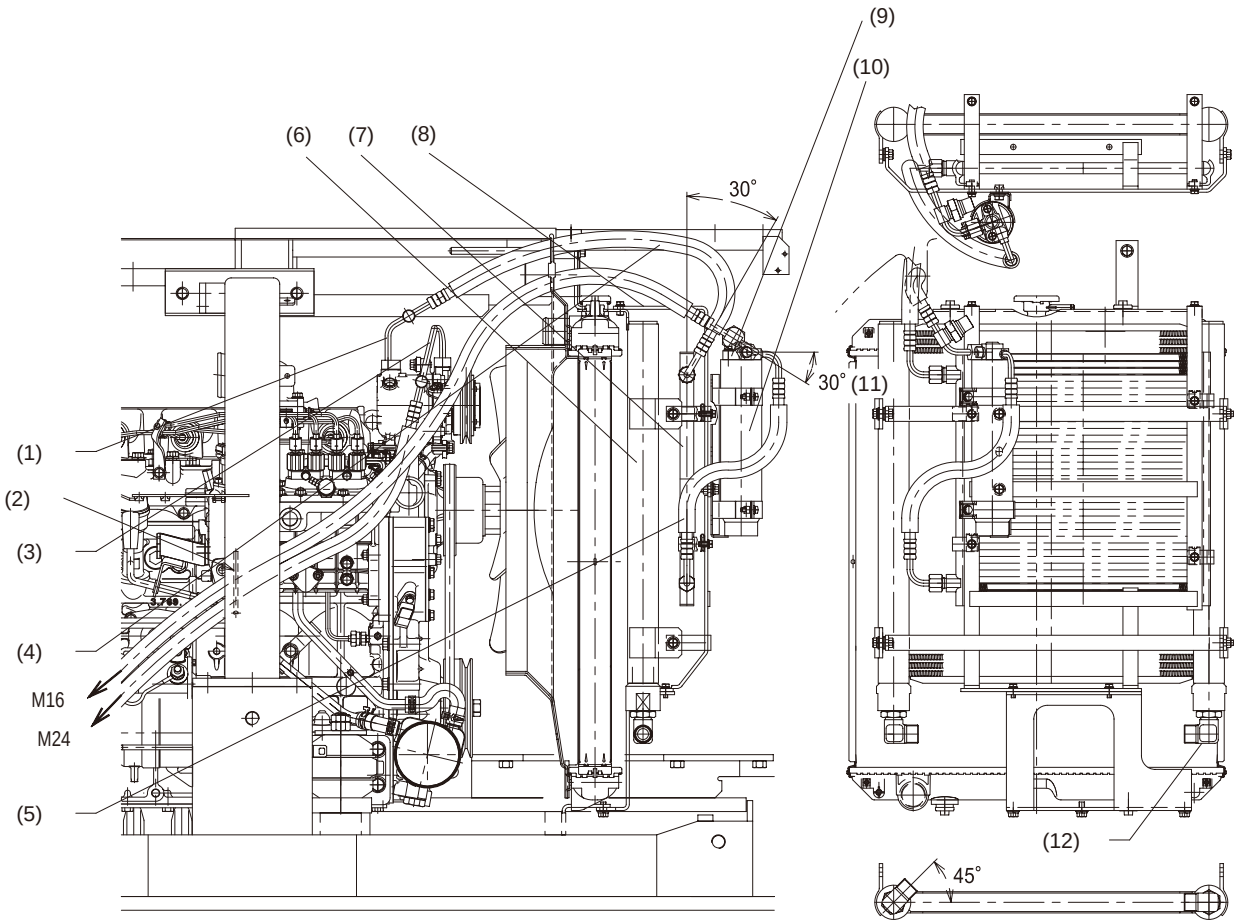
2.Applying position of the sticker
(2, delivery)
Apply the sticker to the position, shown in the figure, on the plate (delivery) .





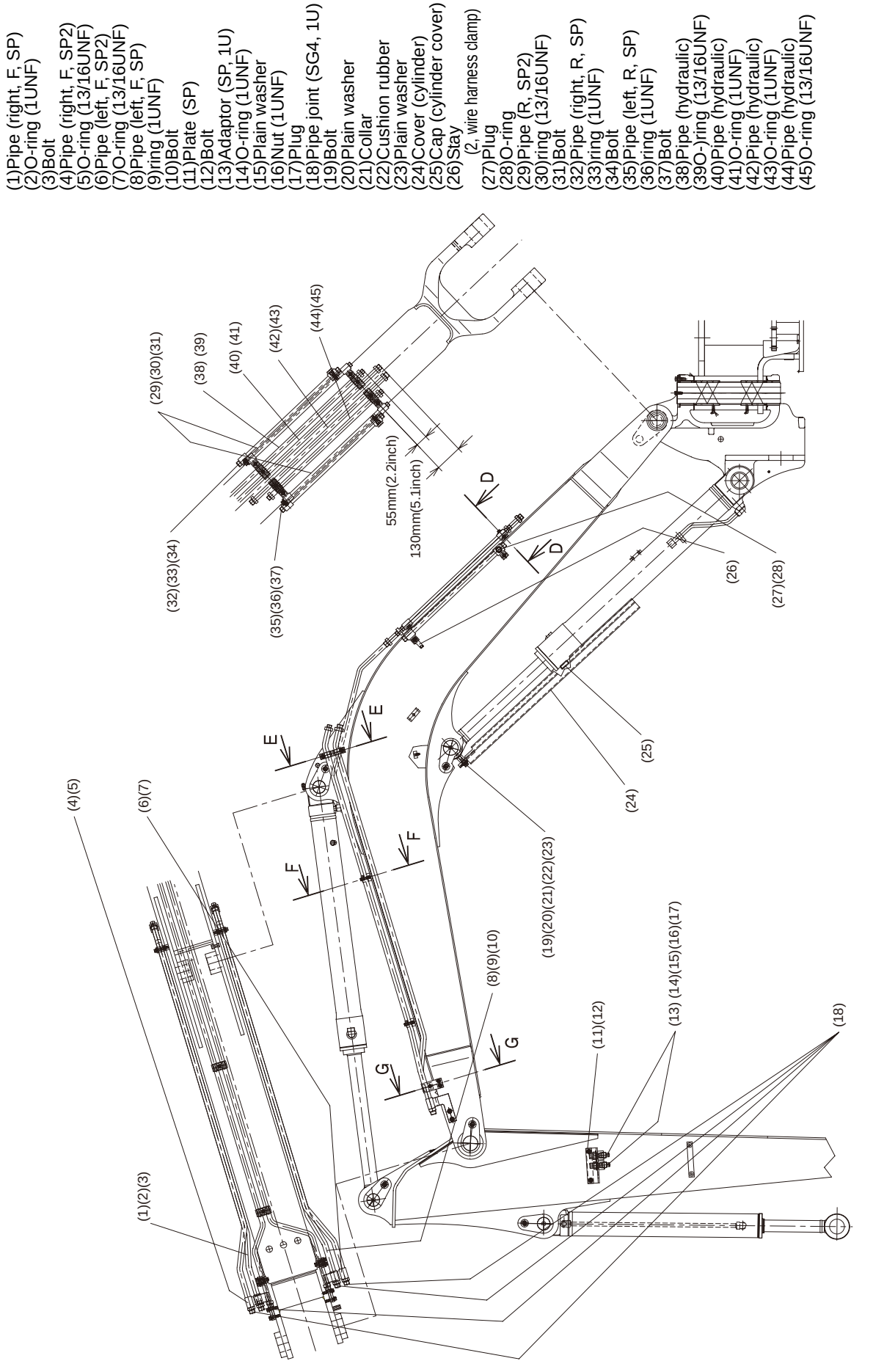
(1)Cushion (1, delivery)
(2)Apply the cushion in contact with the round bar.
(3)Finally, make sure this opening is covered as much as possible with the sealing material.
(4)Plate (delivery)
(5)End face to be aligned
(6)Sticker (2, delivery)

11.Hose route : Oil cooler

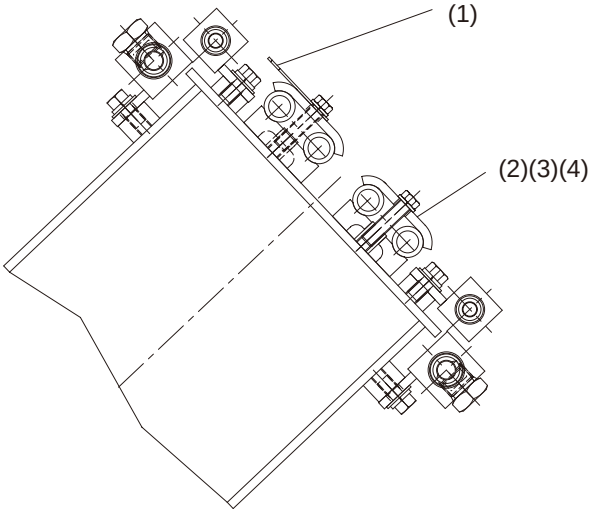


(1)Oil cooler holder (receiver)
Bolt tightening torque
17.7~20.6N.m(1.8~2.1kgf.m)13.1~15.2ft.lbs
(2)Condenser
Support (condenser)
Joint (receiver)
Bolt tightening torque
7.8~9.3N.m(0.8~0.95kgf.m)5.8~6.9ft.lbs
(3)Adaptor tightening torque
(4)G3/4 size
117.6~127.4N.m(12.0~13.0kgf.m)86.7~94.0 ft.lbs
(5)Hose (discharger)
(6)Guide bar
(7)Hose (suction)
(8)Hose (liquid, pressure)
(9)Hose (liquid)
(10)Oil cooler
Bolt
Plain washer
(11)Condenser
Nut (condenser)
Bolt
(12)Support (condenser)
Bolt
(13)Joint (receiver)
Bolt
(14)Receiver
Holder (receiver)
Bolt
(15)(Actual dimension)
(16)Elbow pipe joint

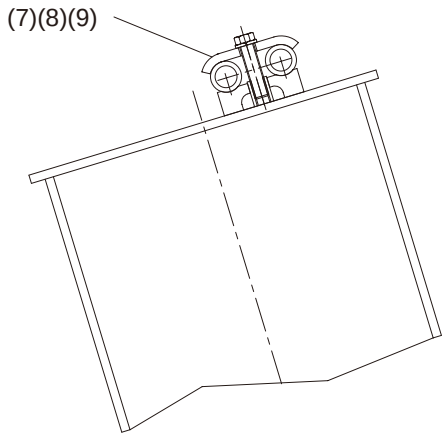
12.Front hoses and pipes



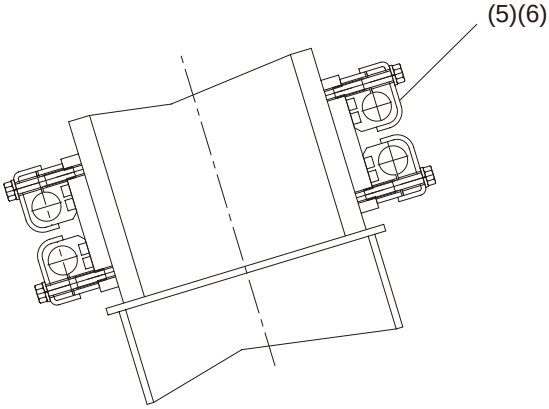
D—D



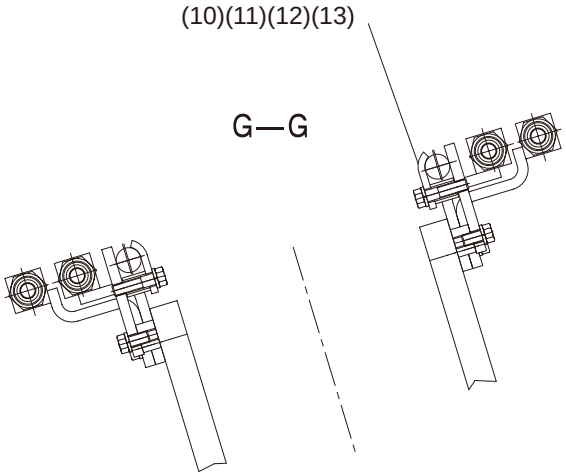
F—F



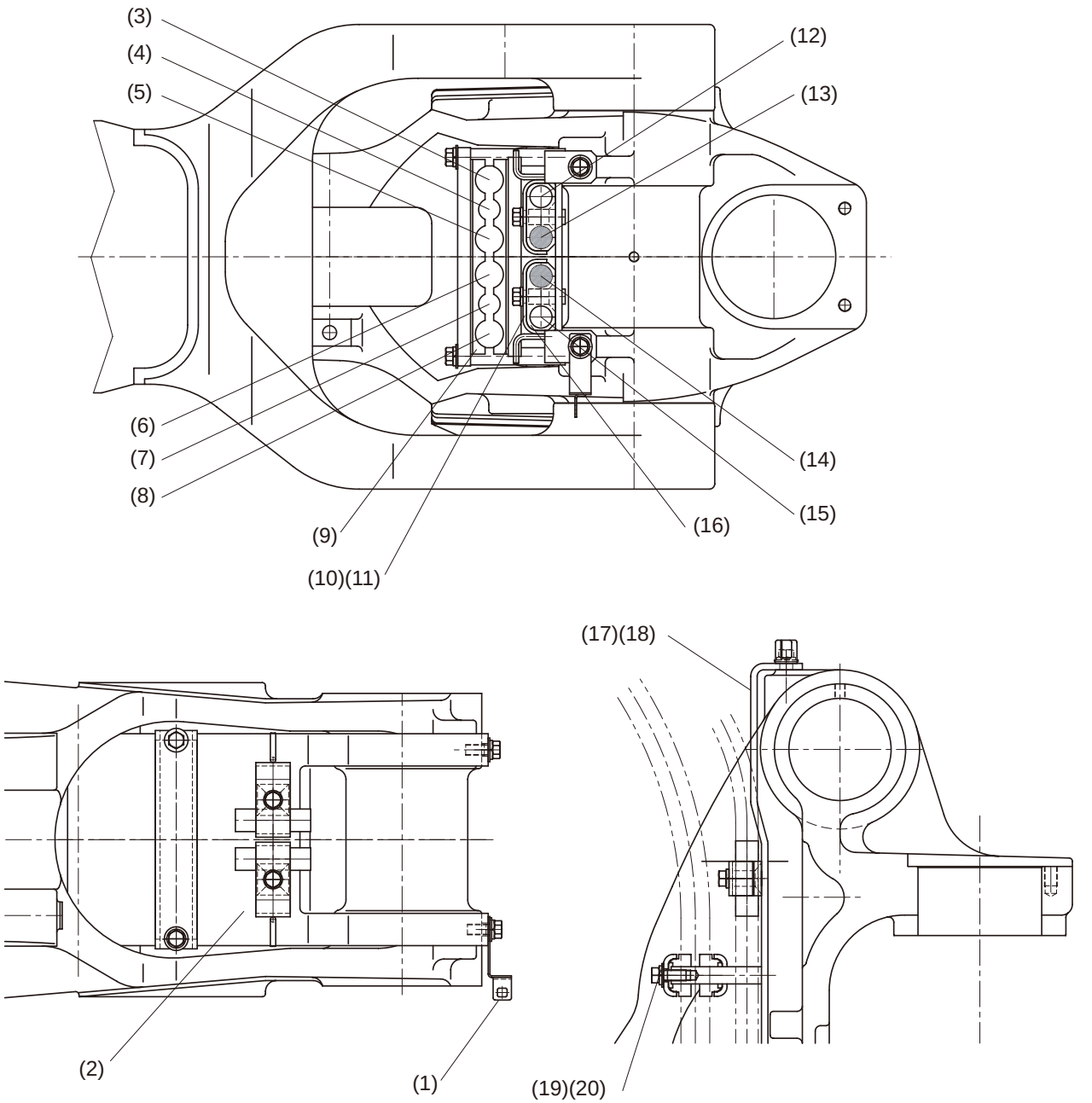
E—E



G—G



(1)Stay (2, wire harness clamp)
(2)Clamp (4, front)
(3)Clamp (front)
(4)Bolt
(5)Clamp assembly
(6)Bolt
(7)Clamp (4, front)
(8)Clamp (front)
(9)Bolt
(10)Bracket (clamp)
(11)Clamp (pipe, front)
(12)Bolt
(13)Bolt



(1)Stay (1, wire harness clamp)
(2)Cushion (hose, dummy)
(3)S/P1
(4)Bucket (orange)
(5)Bucket (red)
(6)Arm (blue)
(7)Arm (yellowish green)
(8)S/P1
(9)Cushion
(10)Clamp (2P, front)
(11)Bolt
(12)S/P2
(13)Dummy
(14)Dummy
(15)S/P2
(16)Cushion (hose, front)
(17)Bracket (hose guide)
(18)Bolt
(19)Plate
(20)Bolt

aa.Hose list :

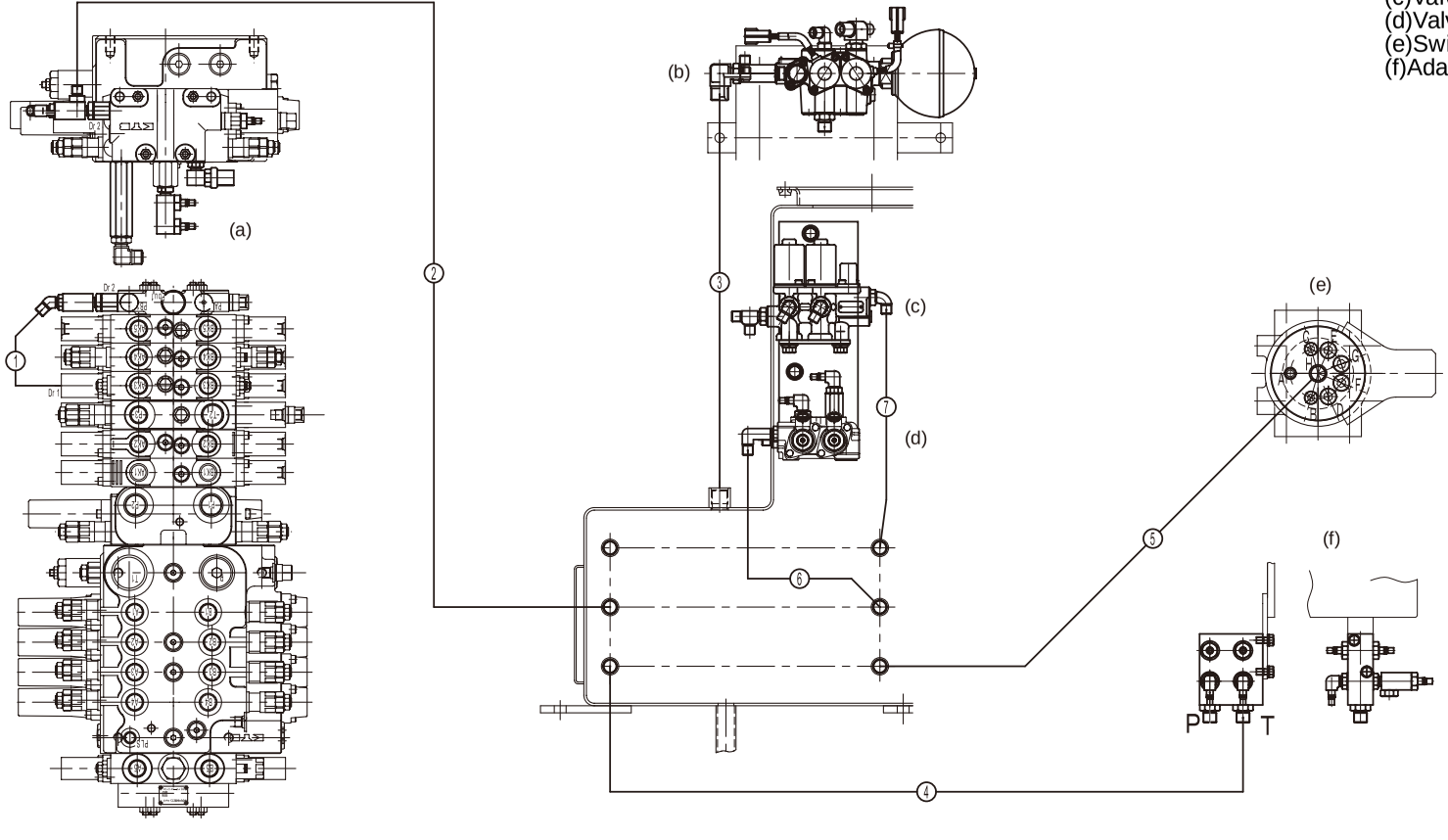
1.List of pilot hoses (upper structure) (swivel frame, C/V side)

No.	Location	Part name	Q'ty	Dimension mm (inch)	Tape color	Hose configuration	Remarks
1	Pump ~ Line filter	Hydraulic hose (3/8)	1	360(14.2)		G3/8 PF1406 G3/8	
2	Life filter ~ Selector valve (accumulator)	Hydraulic hose (3/8)	1	2050(80.7)	Red	G3/8 PF1406 G3/8	
3	Selector valve (B) ~ (P4, T) Collective block (P)	Hydraulic hose (3/8)	1	2010(79.1)	Red	G3/8 PLT06 G3/8	
4	Selector valve (B) ~ SP2 solenoid valve (P)	Hydraulic hose (1/4, SP2, P)	1	340(13.4)	Blue	G1/4 PLT04 G1/4	
5	SP2 solenoid valve (P) ~ SP1 solenoid valve (P)	Hydraulic hose (1/4P, SP1, 2)	1	340(13.4)		G1/4 PLT04 G1/4	
6	Selector valve (A) ~ R/J travel bi-speed boost	Hydraulic hose (1/4, bi-speed)	1	1350(53.1)	Yellowish green	G1/4 PLT04 G1/4	
7	Selector valve (P) ~ P4 distribution block (tank side)	Hydraulic hose (1/4)	1	430(16.9)	White	G1/4 PLT04 G1/4	
8	P4 distribution block (tank side) ~ C/V (PP1)	Hydraulic hose (1/4, P4-PP1)	1	220(8.7)	Blue	Quick PLT04 Quick	
9	P4 distribution block (tank side) ~ C/V (PP2)	Hydraulic hose (1/4, P4-PP2)	1	240(9.4)	Yellow	Quick PLT04 Quick	
10	P4 distribution block (tank side) ~ C/V (PP3)	Hydraulic hose (1/4, P4-PP3)	1	400(15.7)	Green	Quick PLT04 Quick	
11	P4 distribution block (tank side) ~ Swivel motor brake (PG)	Hydraulic hose (1/4, P4-swivel M)	1	480(18.9)	Sky-blue	Quick PLT04 Quick	
12	Shuttle valve ~ C/V (swivel left)	Hydraulic hose (1/4, swivel L2)	1	1860(73.2)	Gray	G1/4 PLT04 G1/4	
13	Shuttle valve ~ C/V (swivel right)	Hydraulic hose (1/4, swivel R2)	1	1460(57.5)	Sky-blue	G1/4 PLT04 Quick	
14	Shuttle valve ~ C/V (arm crowded)	Hydraulic hose (1/4, arm C3)	1	1860(73.2)	Blue	Quick PLT04 G1/4	
15	Relay plate ~ C/V (arm dump)	Hydraulic hose (1/4, arm D3)	1	1500(59.1)	Yellowish green	Quick PLT04 Quick	
16	Relay plate ~ C/V (bucket crowded)	Hydraulic hose (1/4, bucket C2)	1	2000(78.7)	Orange	Quick PLT04 G1/4	
17	Relay plate ~ C/V (bucket dump)	Hydraulic hose (1/4, bucket D2)	1	1470(57.9)	Red	Quick PLT04 Quick	
18	Relay plate ~ C/V (boom confluence Pbu)	Hydraulic hose (1/4, boom U3)	1	1760(69.3)	Green	Quick PLT04 Quick	
19	C/V (boom confluence Pbu) ~ C/V (boom up)	Hydraulic hose (1/4, boom confluence)	1	860(33.9)	Green	Quick PLT04 Quick	
20	Relay plate ~ C/V (boom down)	Hydraulic hose (1/4, boom D3)	1	2000(78.7)	Yellow	Quick PLT04 G1/4	
21	Travel P/V (left forward) ~ C/V (left forward)	Hydraulic hose (1/4, travel LF)	1	1660(65.4)	Red	Quick PLT04 Quick	
22	Travel P/V (left backward) ~ C/V (left backward)	Hydraulic hose (1/4, travel LR)	1	1950(76.8)	Blue	Quick PLT04 G1/4	
23	Travel P/V (right forward) ~ C/V (right forward)	Hydraulic hose (1/4, travel RF)	1	1550(61.0)	Yellow	Quick PLT04 Quick	
24	Travel P/V (right backward) ~ C/V (right backward)	Hydraulic hose (1/4, travel RR)	1	1840(72.4)	Green	Quick PLT04 G1/4	
25	Swing P/V (left) ~ C/V (swing left)	Hydraulic hose (1/4, swing L)	1	1850(72.8)	Orange	Quick PLT04 G1/4	
26	Swing P/V (right) ~ C/V (swing right)	Hydraulic hose (1/4, swing R)	1	1450(57.1)	Yellowish green	Quick PLT04 Quick	
27	Relay plate ~ C/V (dozer up)	Hydraulic hose (1/4, dozer U2)	1	1570(61.8)	Pink	Quick PLT04 Quick	
28	Relay plate ~ C/V (dozer down)	Hydraulic hose (1/4, dozer D2)	1	1900(74.8)	Brown	Quick PLT04 G1/4	
29	SP1 solenoid (high pressure) ~ C/V (SP1 high pressure)	Hydraulic hose (1/4, SP1H)	1	790(31.1)	Pink	Quick PLT04 Quick	
30	SP1 solenoid (low pressure) ~ C/V (SP1 low pressure)	Hydraulic hose (1/4, SP1L)	1	1040(40.9)	Brown	Quick PLT04 G1/4	
31	SP2 solenoid (high pressure) ~ C/V (SP1 high pressure)	Hydraulic hose (1/4)	1	490(19.3)	Pink	G1/4 PLT04 Quick	
32	SP2 solenoid (low pressure) ~ C/V (SP1 low pressure)	Hydraulic hose (1/4)	1	830(32.7)	Brown	G1/4 PLT04 G1/4	

2.List of pilot hoses (drain) (upper structure) (hydraulic system)

No.	Location	Part name	Q ty	Dimension mm (inch)	Tape color	Hose configuration	Remarks
1	C/V (Dr1) ~ C/V (Dr2)	Hydraulic hose (1/4DR1-DR2)	1	255(10.0)		G1/4 PLT04 G1/4	
2	C/V (Dr2) ~ Tank	Hydraulic hose (1/4, P3DR)	1	610(24.0)	Sky-blue	G1/4 PLT04 G1/4	Two pieces of sky-blue tape to be wound around the center of hose
3	Selector valve (T) ~ Tank	Hydraulic hose (1/2)	1	470(18.5)	Green	G1/2 PA0308 G1/2	
4	(P4, T) Collective block ~ Tank	Hydraulic hose (3/8)	1	1670(65.7)	Gray	G3/8 PLT06 G3/8	
5	R/J (T) ~ Tank	Hydraulic hose (3/8, travel drain)	1	990(39.0)	Orange	G3/8 PLT06 G3/8	
6	SP1 solenoid (T) ~ Tank	Hydraulic hose (1/4T, SP1SV)	1	225(8.9)	Brown, Pink	G1/4 PLT04 G1/4	
7	SP2 solenoid (T) ~ Tank	Hydraulic hose (1/4T, SP2SV)	1	310(12.2)		G1/4 PLT04 G1/4	

(a)Control valve assembly
(b)Valve assembly (unload)
(c)Valve assembly (unload)
(d)Valve assembly (proportional)
(e)Swivel joint assembly
(f)Adaptor (pilot hose, 1)



3.List of pilot hoses (upper structure) (platform, control system)

No.	Location	Part name	Q'ty	Dimension mm(inch)	Tape color	Hose configuration	Remarks
1	(P4, T) Collective block ~ P/V (left) (P)	Hydraulic hose (1/4P, L-PV)	1	1390(54.7)	White	Quick PLT04 Quick	
2	(P4, T) Collective block ~ Dozer P/V (P)	Hydraulic hose (1/4P, dozer PV)	1	1190(46.9)	White	Quick PLT04 Quick	
3	Dozer P/V (P) ~ P/V (right) (P)	Hydraulic hose (1/4P, R-PV)	1	470(18.5)	White	Quick PLT04 Quick	
4	(P4, T) Collective block Travel P/V (P)	Hydraulic hose (1/4P, travel PV)	1	210(8.3)	White	Quick PLT04 G 1/4	
5	Travel P/V (P) ~ Swing P/V (P)	Hydraulic hose (1/4P, swing PV)	1	190(7.5)	White	G 1/4 PLT04 Quick	
6	P/V (swivel left) ~ Shuttle valve	Hydraulic hose (1/4, swivel L1)	1	1660(65.4)	Gray	Quick PLT04 Quick	
7	P/V (swivel right) ~ Shuttle valve	Hydraulic hose (1/4, swivel R1)	1	1660(65.4)	Sky-blue	Quick PLT04 Quick	
8	P/V (arm crowded) ~ Relay adaptor	Hydraulic hose (1/4, arm C1)	1	1080(42.5)	Blue	Quick PLT04 Quick	
9	Relay adaptor ~ Shuttle valve (arm crowded)	Hydraulic hose (1/4, arm C2)	1	490(19.3)	Blue	Quick PLT04 Quick	
10	P/V (arm dump) ~ Relay adaptor	Hydraulic hose (1/4, arm D1)	1	1070(42.1)	Yellowish green	Quick PLT04 Quick	
11	Relay adaptor ~ Relay plate (arm dump)	Hydraulic hose (1/4, arm D2)	1	530(20.9)	Yellowish green	Quick PLT04 Quick	
12	P/V (bucket crowded) ~ Relay plate	Hydraulic hose (1/4, bucket C1)	1	1590(62.6)	Orange	Quick PLT04 Quick	
13	P/V (bucket dump) ~ Relay plate	Hydraulic hose (1/4, bucket D1)	1	1610(63.4)	Red	Quick PLT04 Quick	
14	P/V (boom up) ~ Relay adaptor	Hydraulic hose (1/4, boom U1)	1	1690(66.5)	Green	Quick PLT04 Quick	
15	Relay adaptor ~ Relay plate (boom up)	Hydraulic hose (1/4, boom U2)	1	530(20.9)	Green	Quick PLT04 Quick	
16	P/V (boom down) ~ Relay adaptor	Hydraulic hose (1/4, boom D1)	1	1770(69.7)	Yellow	Quick PLT04 Quick	
17	Relay adaptor ~ Relay plate (boom down)	Hydraulic hose (1/4, boom U2)	1	470(18.5)	Yellow	Quick PLT04 Quick	
18	Dozer P/V (up) ~ Relay plate	Hydraulic hose (1/4, dozer U1)	1	1130(44.5)	Pink	Quick PLT04 Quick	
19	Dozer P/V (down) ~ Relay plate	Hydraulic hose (1/4, dozer D2)	1	1185(46.7)	Brown	Quick PLT04 Quick	

4.List of pilot hoses (drain) (upper structure) (platform, control system)

20	20 P/V (left) (T) ~ (P4, T) Collective block	Hydraulic hose (1/4T, L-PV)	1	1460(57.5)		Quick PLT04 Quick	
21	21 P/V (right) (T) ~ Dozer P/V (T)	Hydraulic hose (1/4T, R-PV)	1	420(16.5)		Quick PLT04 Quick	
22	22 Dozer P/V (T) ~ (P4, T) Collective block	Hydraulic hose (1/4T, dozer PV)	1	1205(47.4)		Quick PLT04 Quick	
23	23 Swing P/V (T) ~ Travel P/V (T)	Hydraulic hose (1/4T, swing PV)	1	210(8.3)		G 1/4 PLT04 Quick	
24	24 Travel P/V (T) ~ (P4, T) Collective block	Hydraulic hose (1/4T, travel PV)	1	210(8.3)		Quick PLT04 G 1/4	

5.List of high-pressure hoses (upper structure) (swivel frame, C/V side)

No.	Location	Part name	Q'ty	Dimension mm (inch)	Tape color	Hose configuration	Remarks
1	Pump (P1) — C/V (P1)	Hydraulic hose (5/8)	1	2890(113.8)	Red, White	1-14UNS PA2810 1-14UNS	
2	Pump (P2) — C/V (P2)	Hydraulic hose (5/8)	1	2940(115.7)	Red, White	1-14UNS PA2810 1-14UNS	
3	Pump (P3) — C/V (P3)	Hydraulic hose (5/8)	1	3170(124.8)	Red, White	13/16UN PF2108 13/16UN	
4	Pump (PPS) — C/V (PPS)	Hydraulic hose (1/4)	1	2740(107.9)	Red, White	9/16UNF PFH04 9/16UNF	
5	Pump (PLS) — C/V (PLS)	Hydraulic hose (1/4)	1	3160(124.4)	Red, White	9/16UNF PFH04 9/16UNF	
6	C/V (boom up) — Boom back (pipe)	Hydraulic hose (5/8)	1	2760(108.7)	Green	1-14UNS PA2810 1-14UNS	With corrugated tube
7	C/V (boom down) — Boom back (pipe)	Hydraulic hose (1/2)	1	3320(130.7)	Yellow	13/16UN PFH08 13/16UN	With corrugated tube
8	C/V (arm crowded) — Boom back (pipe)	Hydraulic hose (5/8)	1	3260(128.3)	Blue	1-14UNS PA2810 1-14UNS	With corrugated tube
9	C/V (arm dump) — Boom back (pipe)	Hydraulic hose (1/2)	1	3200(126.0)	Yellowish green	13/16UN PFH08 13/16UN	With corrugated tube
10	C/V (bucket crowded) — Boom back (pipe)	Hydraulic hose (5/8)	1	3320(130.7)	Red	1-14UNS PA2810 1-14UNS	With corrugated tube
11	C/V (bucket dump) — Boom back (pipe)	Hydraulic hose (1/2)	1	3260(128.3)	Orange	13/16UN PFH08 13/16UN	With corrugated tube
12	C/V (PB1) — C/V (PB2) (boom confluence)	Hydraulic hose (3/8)	1	910(35.8)	Black	11/16UN PFH06 11/16UN	
13	Boom back (pipe) (arm crowded) — Arm cylinder (bottom)	Hydraulic hose (5/8)	1	720(28.3)	Blue	1-14UNS PA2810 1-14UNS	Yokohama-made
14	Boom back (pipe) (arm dump) — Arm cylinder (rod)	Hydraulic hose (1/2)	1	1955(77.0)	Yellowish green	13/16UN PA2808 13/16UN	Yokohama-made
15	C/V (travel right forward) — R/J (E)	Hydraulic hose (5/8)	1	920(36.2)	Yellow double	1-14UNS PA2808 1-14UNS	Yokohama-made
16	C/V (travel right backward) — R/J (G)	Hydraulic hose (5/8)	1	1025(40.4)	Green double	1-14UNS PA2808 1-14UNS	Yokohama-made
17	C/V (travel left forward) — R/J (D)	Hydraulic hose (5/8)	1	950(37.4)	Red double	1-14UNS PA2808 1-14UNS	Yokohama-made
18	C/V (travel left backward) — R/J (F)	Hydraulic hose (5/8)	1	1065(41.9)	Yellowish green double	1-14UNS PA2808 1-14UNS	Yokohama-made
19	C/V (swivel left) — Swivel motor (left)	Hydraulic hose (1/2)	1	810(31.9)	Gray	13/16UN PA2808 13/16UN	Yokohama-made
20	C/V (swivel right) — Swivel motor (right)	Hydraulic hose (1/2)	1	670(26.4)	Sky-blue	13/16UN PA2808 13/16UN	Yokohama-made
21	C/V (left) — Swing cylinder (bottom)	Hydraulic hose (3/8)	1	1950(76.8)	Yellowish green	11/16UN PFH06 11/16UN	
22	C/V (right) — Swing cylinder (rod)	Hydraulic hose (3/8)	1	2020(79.5)	Orange	11/16UN PFH06 11/16UN	
23	C/V (dozer down) — R/J (B)	Hydraulic hose (1/2)	1	1175(46.3)	Brown	13/16UN PA2808 13/16UN	Yokohama-made
24	C/V (dozer up) — R/J (C)	Hydraulic hose (1/2)	1	2020(79.5)	Pink	13/16UN PA2808 13/16UN	Yokohama-made
25	Boom back (pipe) — Bucket cylinder	Hydraulic hose (5/8)	2	960(37.8)		1-14UNS PA2810 1-14UNS	Spring wound overall

6.List of high-pressure hoses (upper structure) (swivel frame, C/V side)

No.	Location	Part name	Q'ty	Dimension mm (inch)	Tape color	Hose configuration	Remarks
26	C/V (SP1 high pressure) ~ Boom back (pipe)	Hydraulic hose (5/8)	1	3260(128.3)	Pink	1-14UNS PA2810 1-14UNS	With corrugated tube
27	3-way valve ~ Boom back (pipe)	Hydraulic hose (5/8)	1	3680(144.9)	Brown	1-14UNS PA2810 1-14UNS	With corrugated tube
28	S/P intermediate (SP1)	Hydraulic hose (5/8)	2	540(21.3)		1-14UNS PA2810 1-14UNS	Yokohama-made
29	S/P end (SP1)	Hydraulic hose (5/8)	2	960(37.8)		1-14UNS PA2810 1-14UNS	Yokohama-made, spring wound overall
30	3-way valve ~ C/V (SP1 low pressure)	Hydraulic hose (5/8)	1	460(18.1)	Brown	1-14UNS PA2810 1-14UNS	
31	C/V (SP2 high pressure) ~ Boom back (pipe)	Hydraulic hose (1/2)	1	3390(133.5)	Pink	13/16UN PA2808 13/16UN	With corrugated tube
32	C/V (SP2 low pressure) ~ Boom back (pipe)	Hydraulic hose (1/2)	1	3590(141.3)	Brown	13/16UN PA2808 13/16UN	With corrugated tube
33	S/P intermediate (SP2)	Hydraulic hose (1/2)	1	605(23.8)		13/16UN PA2808 13/16UN	Yokohama-made
34	S/P end (SP2)	Hydraulic hose (5/8)	1	960(37.8)		1-14UNS PA2810 1-14UNS	Yokohama-made, spring wound overall

7.List of low-pressure hoses (upper structure)

No.	Location	Part name	Q'ty	Dimension mm (inch)	Tape color	Hose configuration	Remarks
1	C/V (T1) ~ Return pipe	Hydraulic hose (1-1/4, return)	1	805(31.7)		G1･1/4 PA0320 G1･1/4	
2	C/V (T2) ~ Swivel motor (M)	Hydraulic hose (3/4, swivel M)	1	560(22.0)	Black	G3/4 PA0310 G3/4	
3	Swivel motor (M) ~ Oil cooler	Hydraulic hose (5/8)	1	1240(48.8)		G3/4 PA0310 G3/4	PVC tube wound
4	Oil cooler ~ Return pipe	Hydraulic hose (5/8)	1	690(27.2)	Black	G3/4 PA0310 G3/4	PVC tube wound
5	Swivel motor (Dr) ~ Return pipe	Hydraulic hose (1/4, swivel DR)	1	1430(56.3)		G1/4 PLT04 G1/4	PVC tube wound
6	3-way valve ~ Return pipe	Hydraulic hose (5/8)	1	460(18.1)	Pink	G3/4 PA0310 G3/4	

V. Electrical system

Service Section

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A. Troubleshooting

a. General guideline

(1) How to diagnose

The most important point in troubleshooting is to determine "Probable Causes". Once the probable causes are determined, parts to be checked can be limited to those associated with such probable causes. Therefore, unnecessary checks can be eliminated. The determination of the probable causes must be based on a theory and be supported by facts and must not be based on intuition only.

TROUBLESHOOTING STEPS

If an attempt is made to solve a problem without going through correct steps for troubleshooting, the problem symptoms could become more complicated, resulting in failure to determine the causes correctly and making incorrect repairs.The four steps below should be followed in troubleshooting.

1	Observation of Problem Symptoms	Observe the symptom carefully. Check if there are also other problems.
2	Determination of Probable Causes	In determining the probable causes, it is necessary to check the wiring diagram to understand the circuit as a system. Knowledge of switches, relays and other parts is necessary for accurate determination. The causes of similar problems in the past must be taken into account.
3	Checking of Parts Associated with Probable Causes and Determination of Faulty Parts.	Troubleshooting is carried out by making step by step checks until the true cause is found. Always go through the procedures considering what check is to be made where for the best results.
4	Repair and Confirmation	After the problems are corrected, be sure to check that the system operates correctly. Also check that new problems have not been caused by the repair.

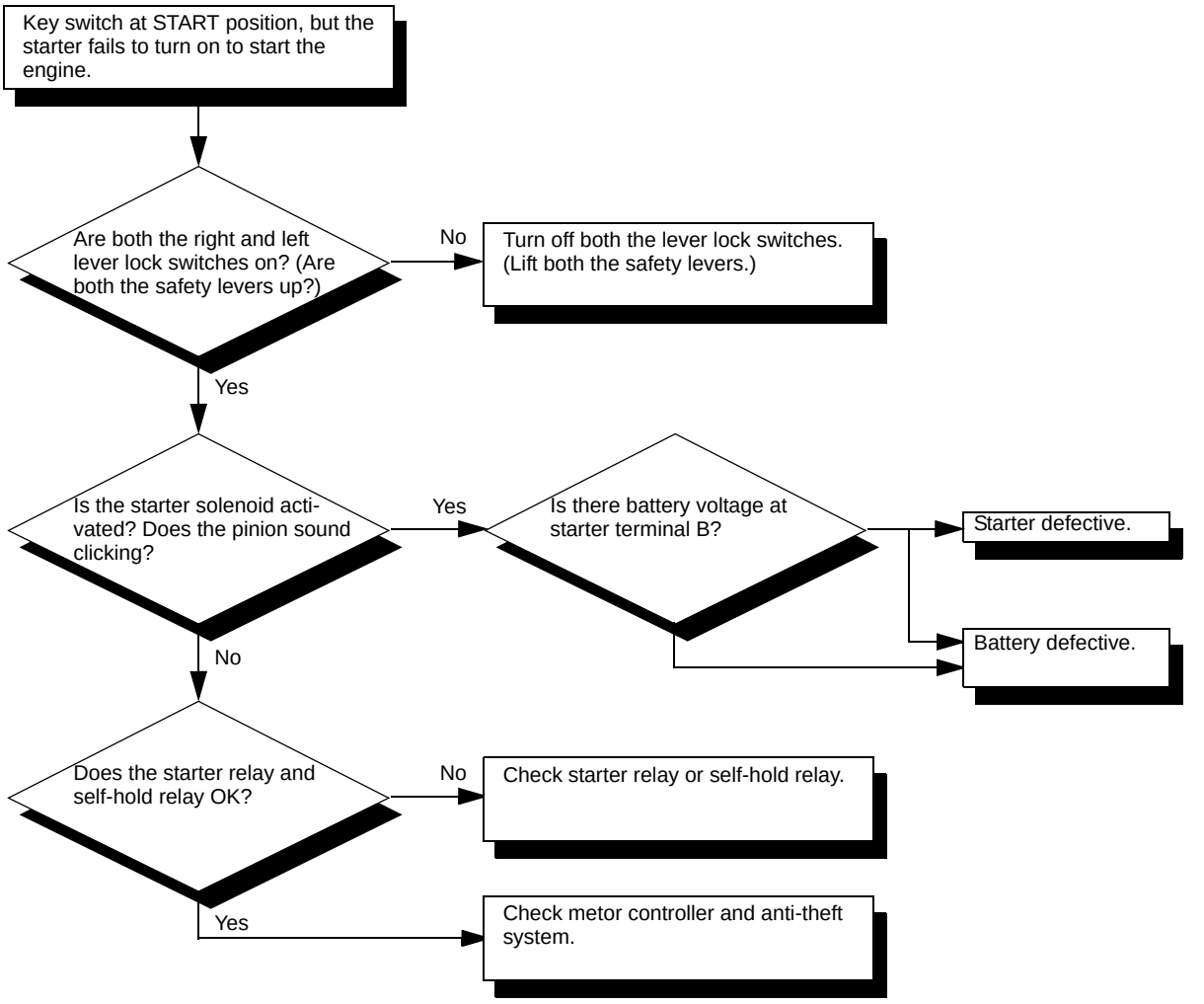
FOUR BASIC CHECKING ITEMS FOR ELECTRICAL DIAGNOSIS

This manual contains the cable diagrams as well as the individual circuit drawings, operational explanations, and troubleshooting hints for each component required to facilitate the task of troubleshooting. The information is compiled in the following manner:

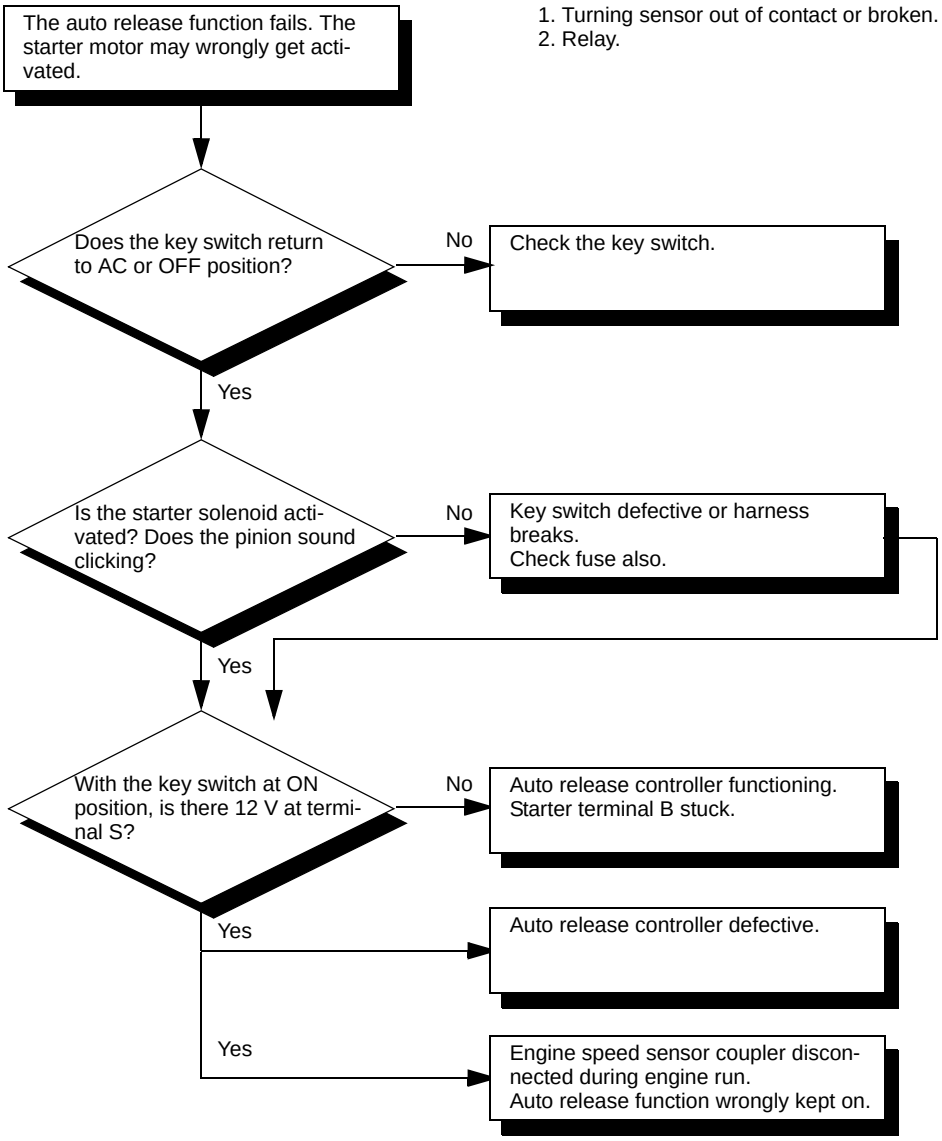
1. “Power source”
   Is the supply voltage as specified? (Battery voltage at 12 V or microcomputer output at 5 V)
   → If not specified, the system fails to work.
2. “Continuity”
   Is there continuity along the specified lines and wire harnesses? Are the system’s resistance values as specified?
   → If not specified, no current flows.
3. “Earth”
   Is the system completely grounded?
   → If not grounded as specified, the electrical circuitry fails to function well.
4. “Insulation”
   Are the system’s insulation resistances as specified?
   → If an electric leak occurs, the current gets out of spec and the electrical devices malfunction.

b. Troubleshooting flow chart

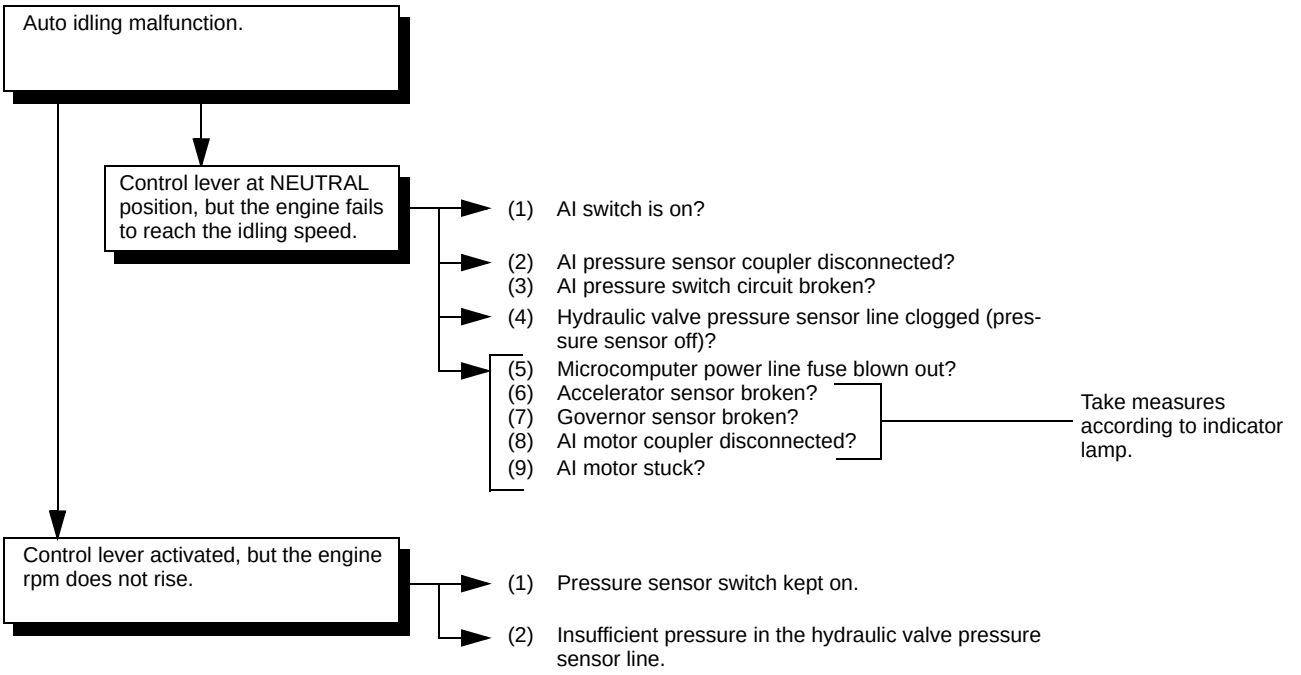
(1) Starter motor failure to turn on



(2) Auto release malfunction



(3) AI system failure



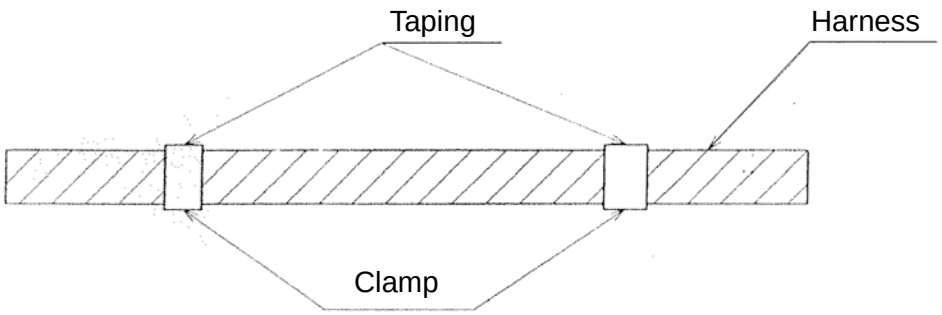
B.Wire harness installation

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



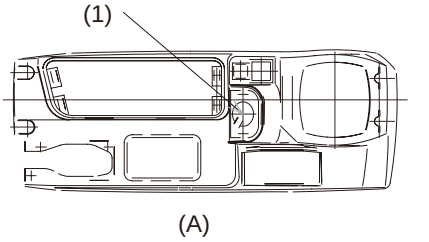
1) The harness tapings indicate the clamping positions. Clamp at these specified points.
2) Clamp the harness tight enough not to come off nor get loose.
3) Insert the handgrip-equipped harness deep into their mating holes.
* Do not allow the harness to come out of the corrugated slit.
* Catch the cord clamp at the corrugated winding.

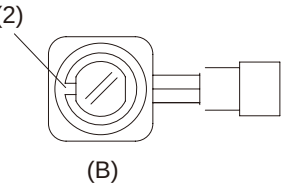
b. Engine earth, starter switch

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) 4.34~8.68ft.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 ~ 0.51 kgf·m) 2.89~3.69ft.lbs

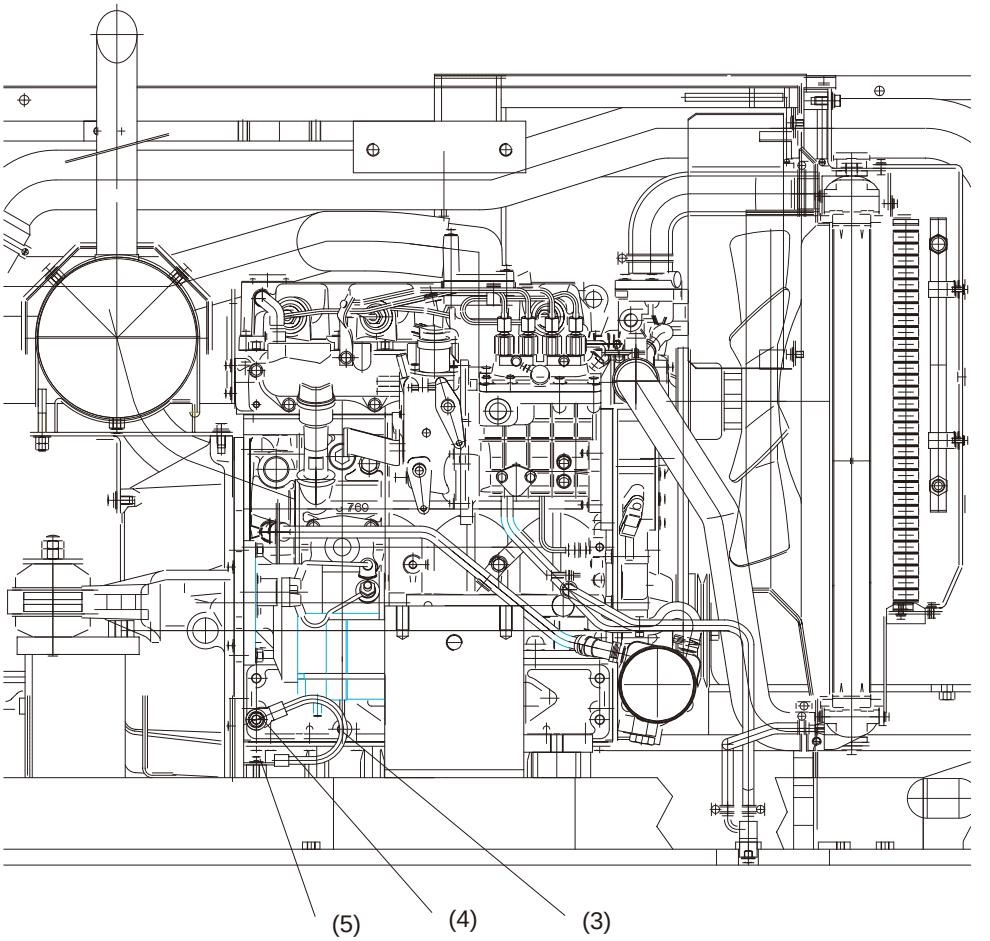
S **(3) Checking the automatic starter release function**
Start the engine, place the key switch back to the start position and make sure the starter is not activated.

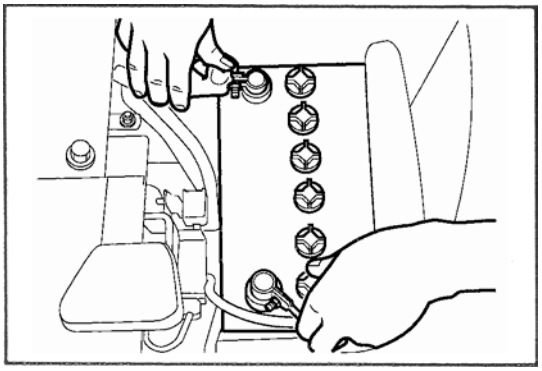


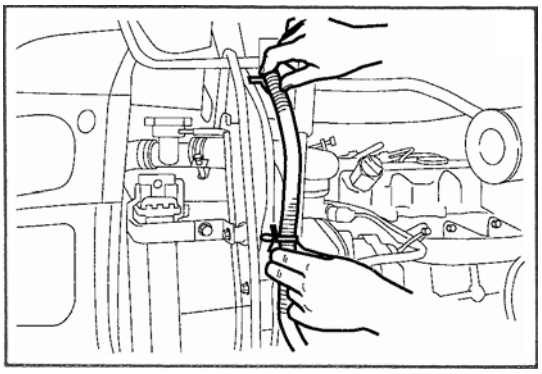


(A)Cover (right, top)
(B)Starter switch

(1)Projection (behind)
(2)Groove
(3)Cord (body ground)
(4)Bolt
(5)Bolt

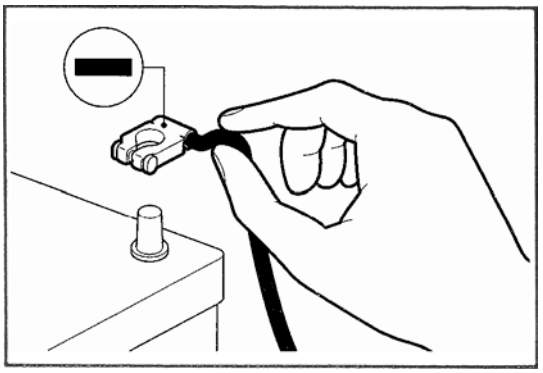






c. Checking cables, wires and battery

1) Check connections for looseness, rust and stains.
2) Check terminals and wires for corrosion by battery electrolyte, etc.
3) Check terminals and wires for open circuit or impending open circuit.
4) Check wire insulation and coating for damage, cracks and degrading.
5) Check conductive parts of terminals for contact with other metallic parts (vehicle body and other parts).
6) Check grounding parts to verify that there is complete continuity between attaching bolt(s) and vehicle body.
7) Check for incorrect wiring.
8) Check that wirings are so clamped as to prevent contact with sharp corners of the vehicle body, etc. or hot parts (exhaust manifold, pipe, etc.).
9) Check that wirings are clamped firmly to secure enough clearance from the fan pulley, fan belt and other rotating or moving parts.
10) Check that the wirings between the fixed parts such as the vehicle body and the vibrating parts such as the engine are made with adequate allowance for vibrations.



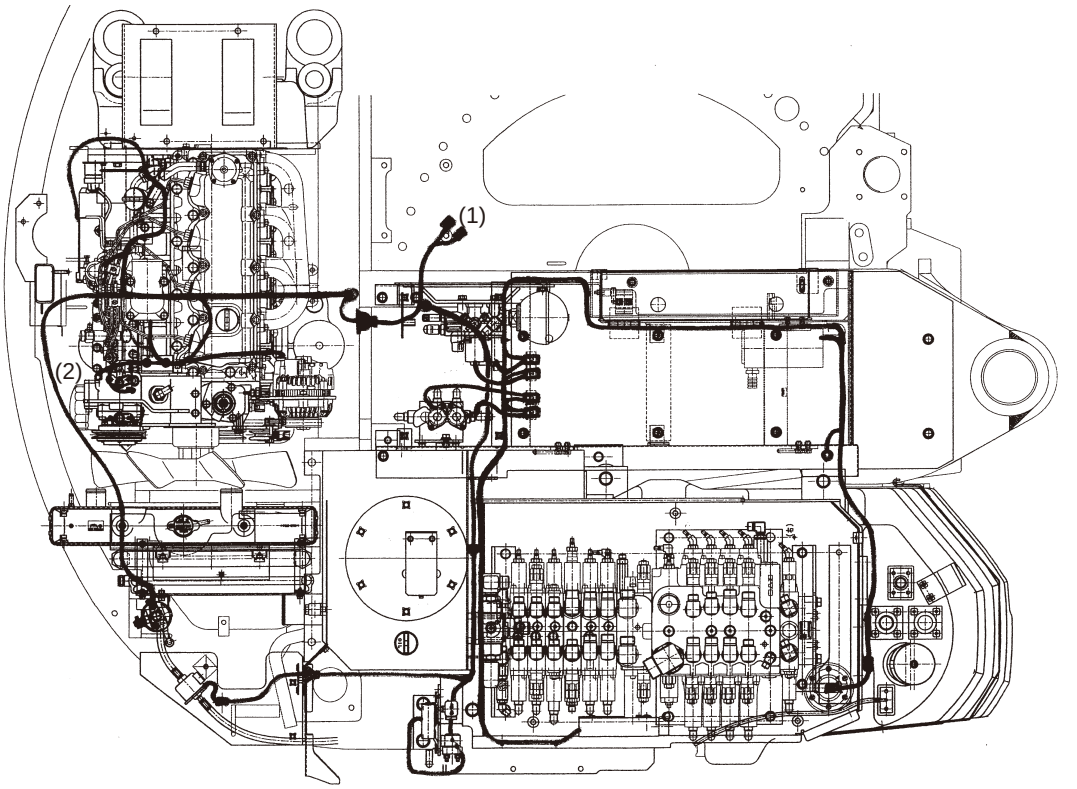
(1) HANDLING ON-VEHICLE BATTERY

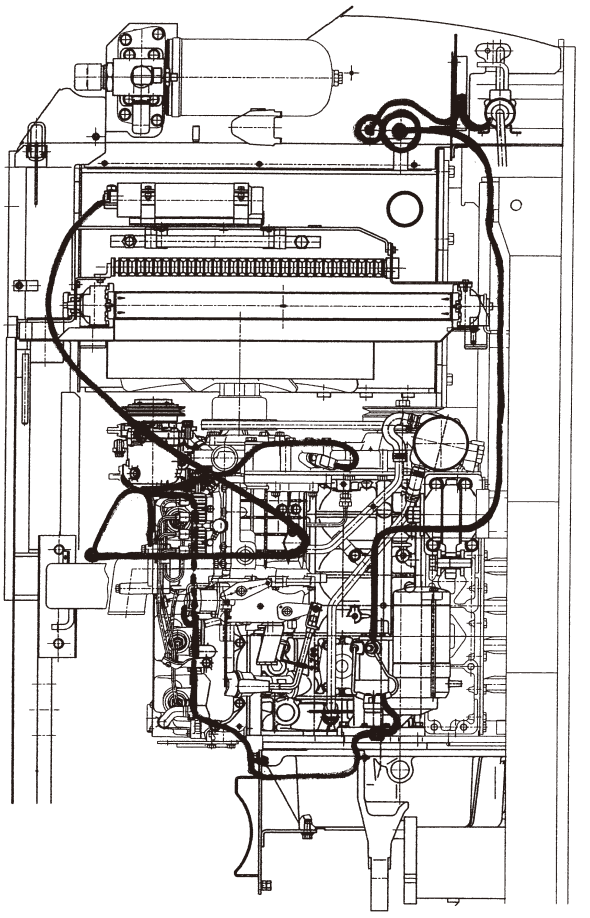
When checking or servicing does not require power from the on vehicle battery, be sure to disconnect the cable from the battery (-) terminal. This is to prevent problems that could be caused by shorting of the circuit. Disconnect the (-) terminal first and reconnect it last.

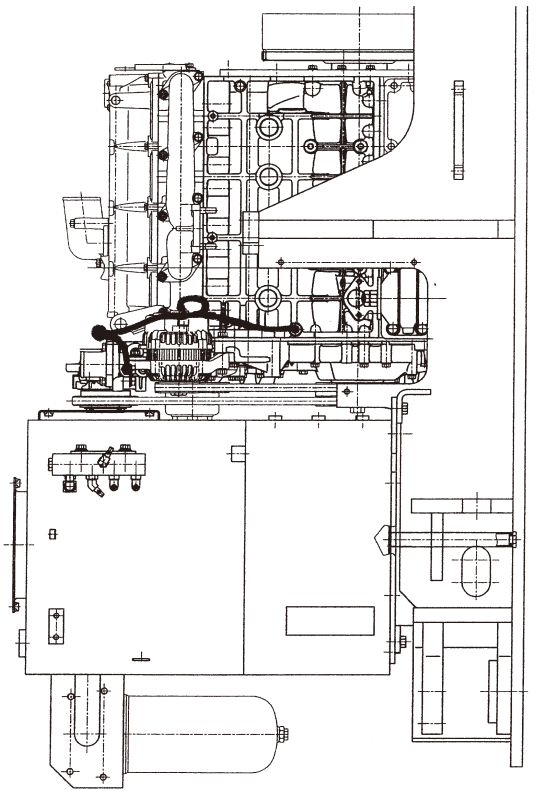
Caution

1. **Before connecting or disconnecting the negative cable, be sure to turn off the ignition switch and the lighting switch.**
   (If this is not done, there is the possibility of semiconductor parts being damaged.)

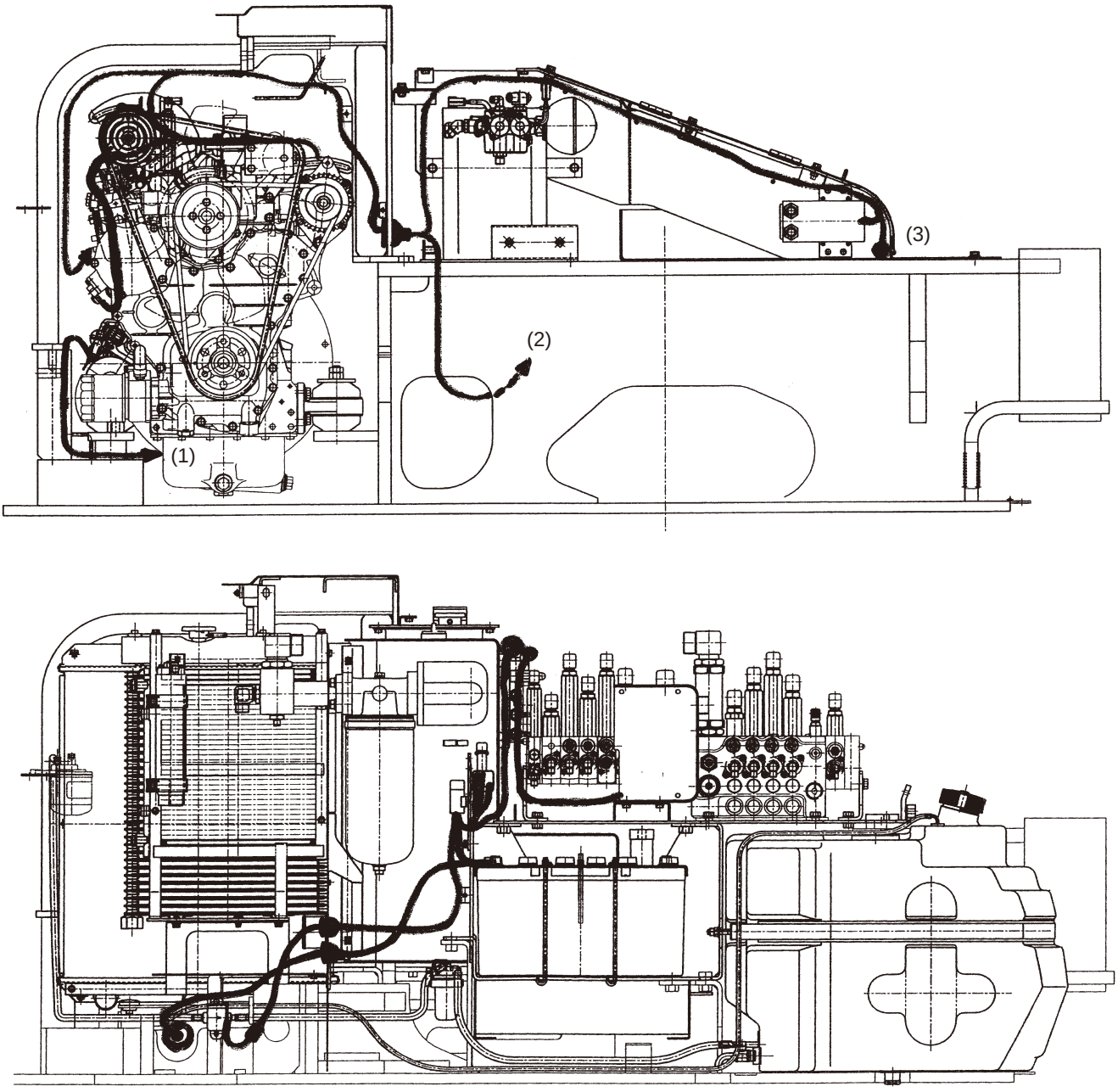
d.Wireharness route



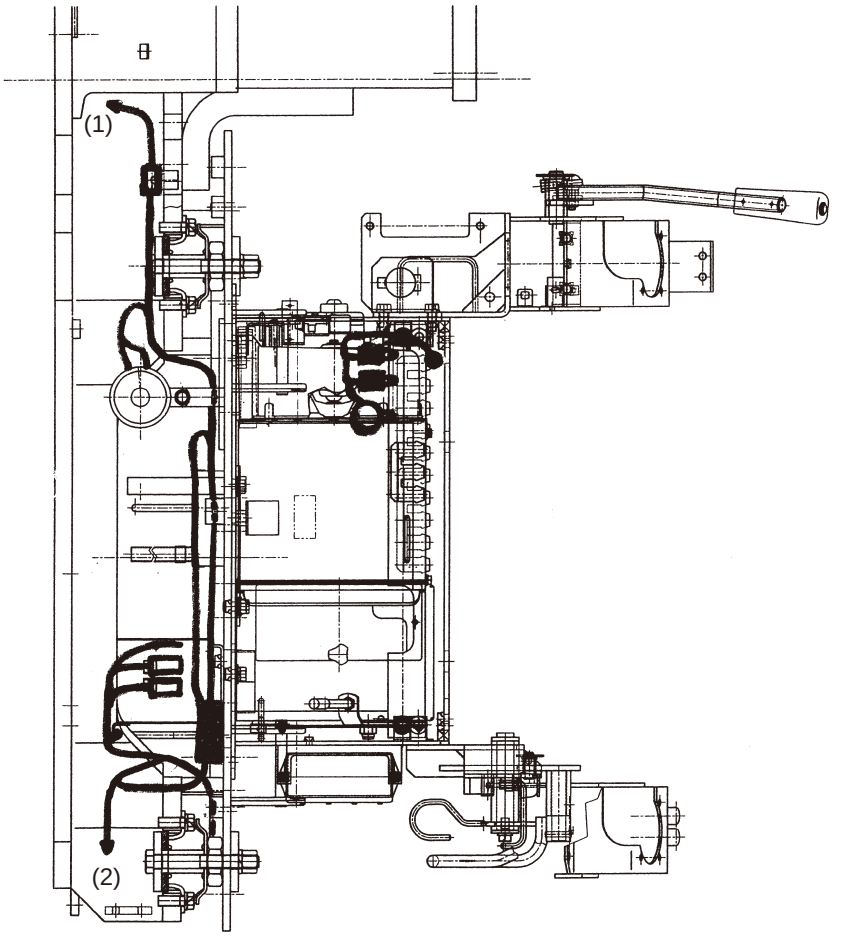


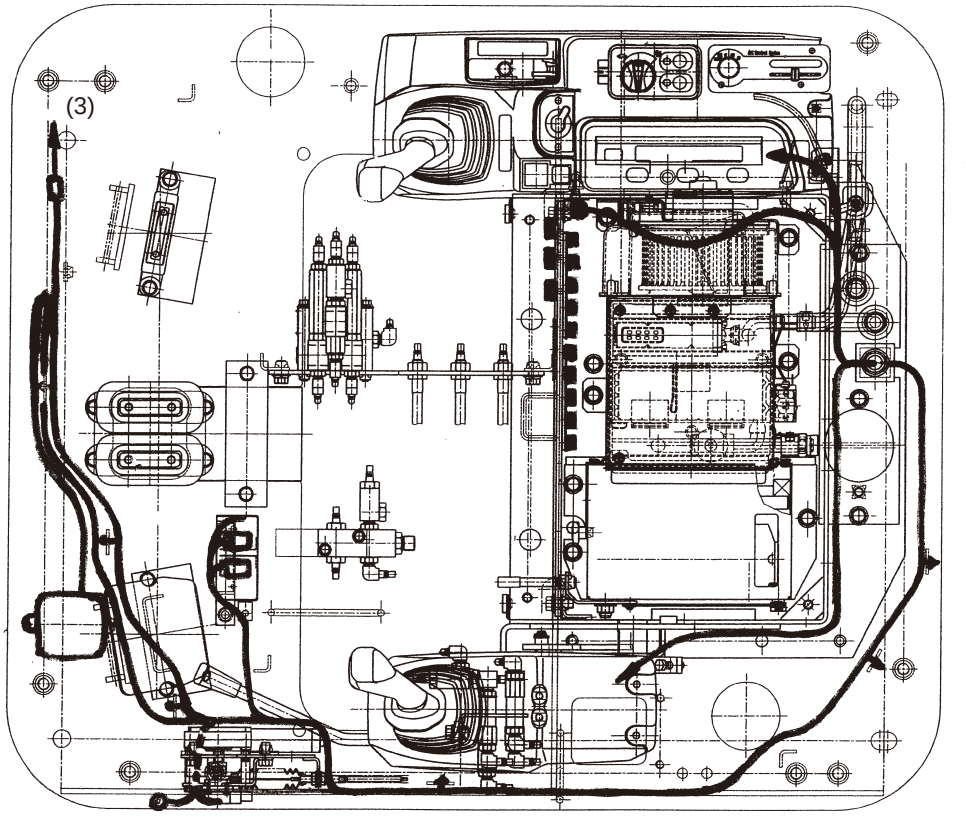


(1)To main wire harness
(2)Run sensor

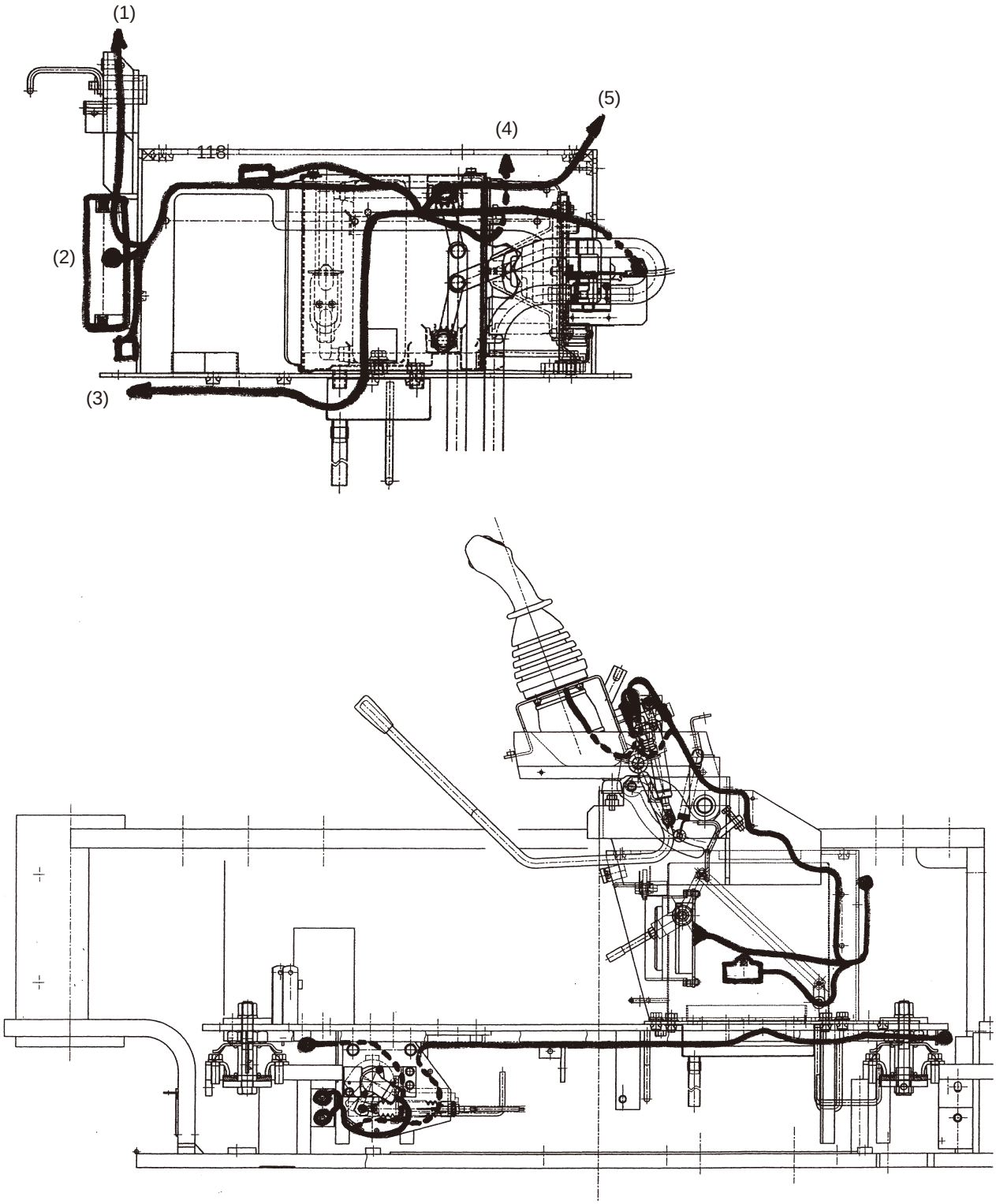


(1)Battery
(2)Main wire harness
(3)To fuel tank

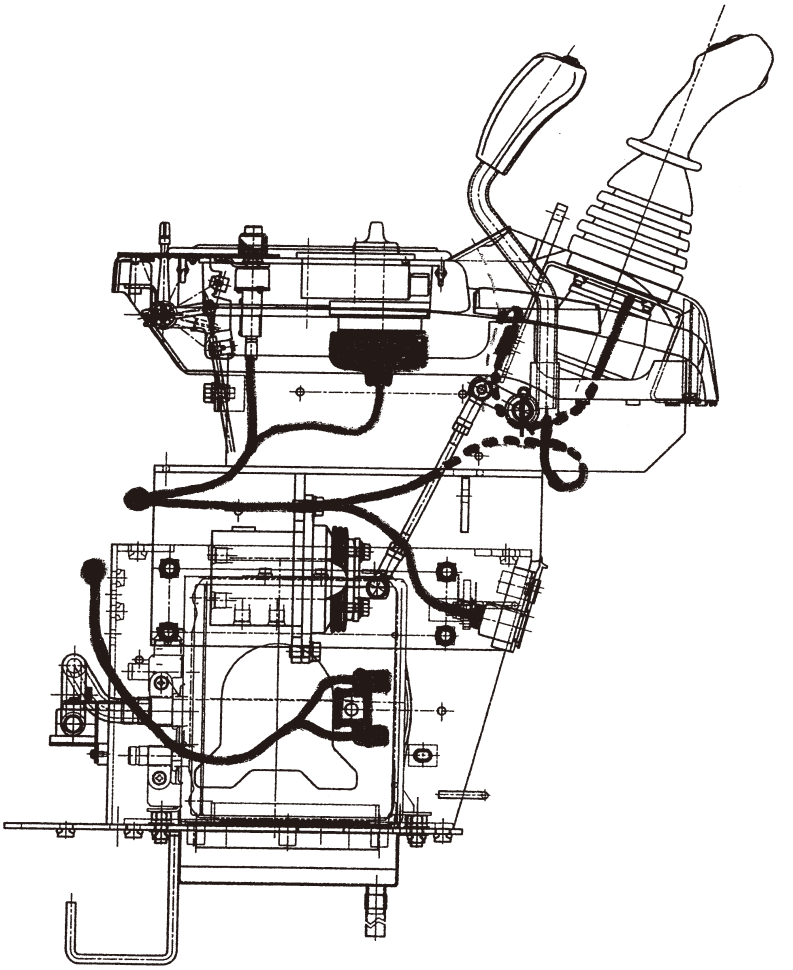


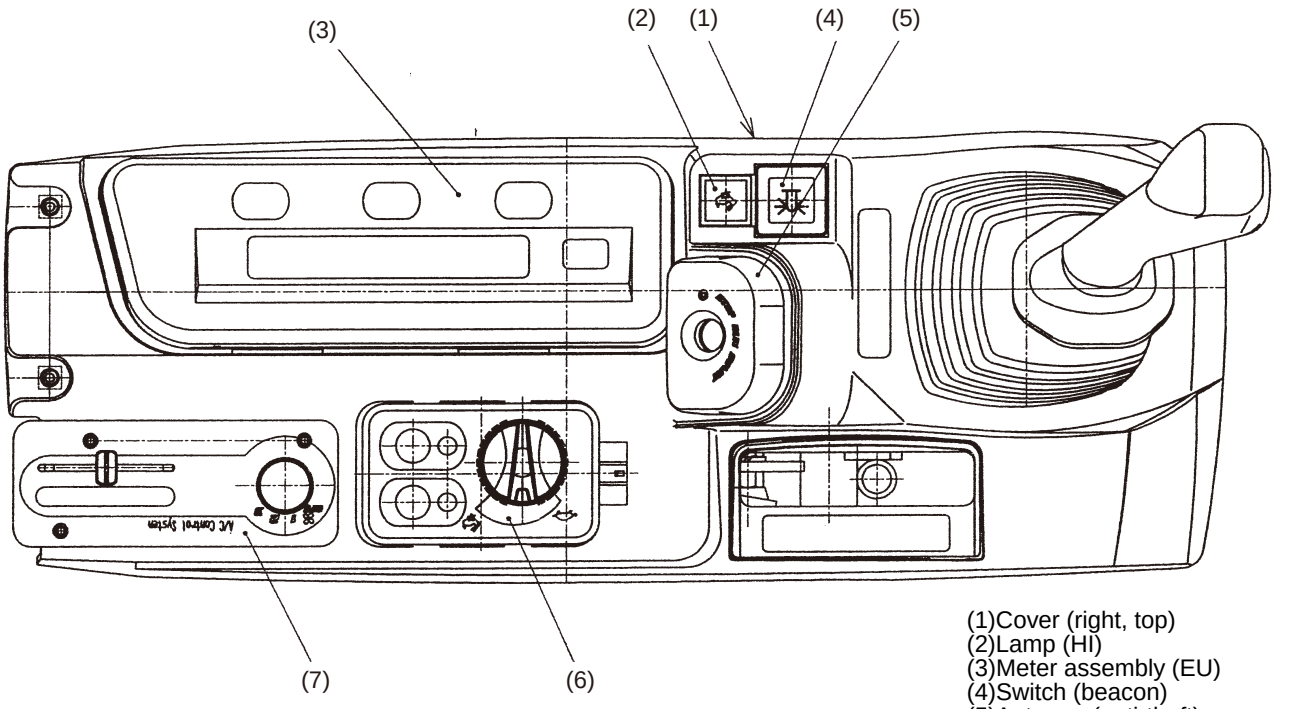


(1)To machine front
(2)AI motor
(3)To machine front

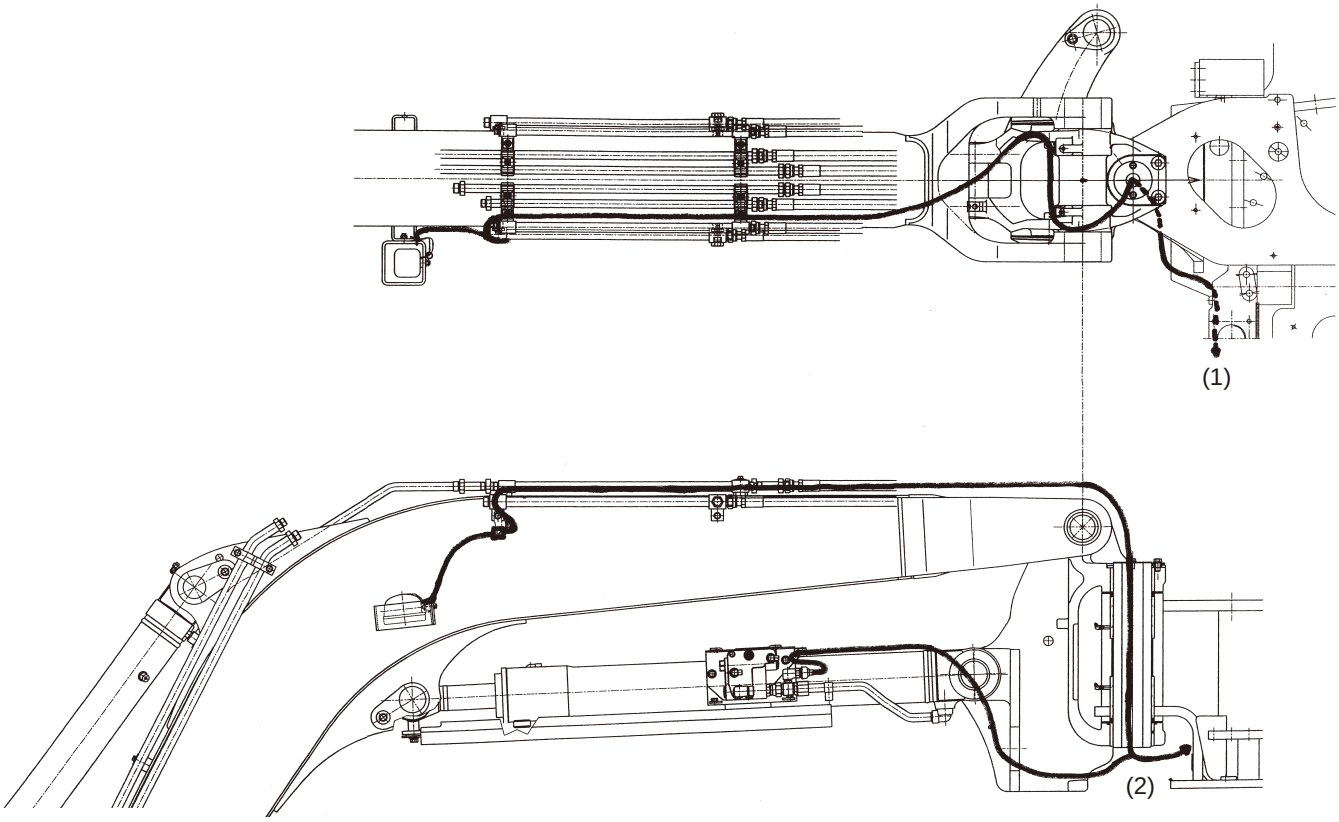


(1)To left control
(2)Fuse box
(3)Front of the step
(4)To front of the operator's seat
(5)To right control (meter)





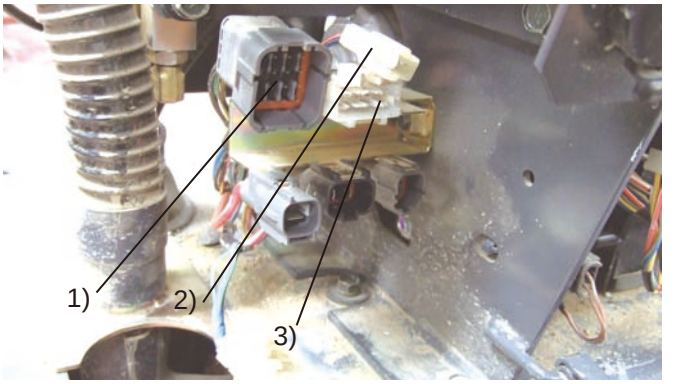
(1)Cover (right, top)
(2)Lamp (HI)
(3)Meter assembly (EU)
(4)Switch (beacon)
(5)Antenna (anti-theft)
(6)Meter assembly (AI, SC)
(7)Switch assembly (A/C)

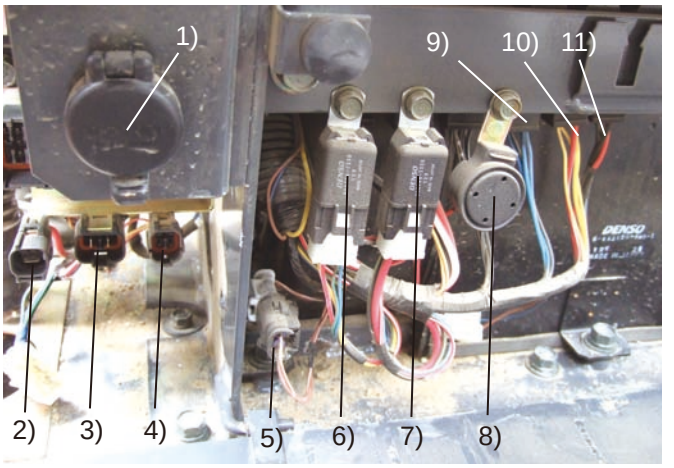


(1)To main wire harness
(2)To main wire harness

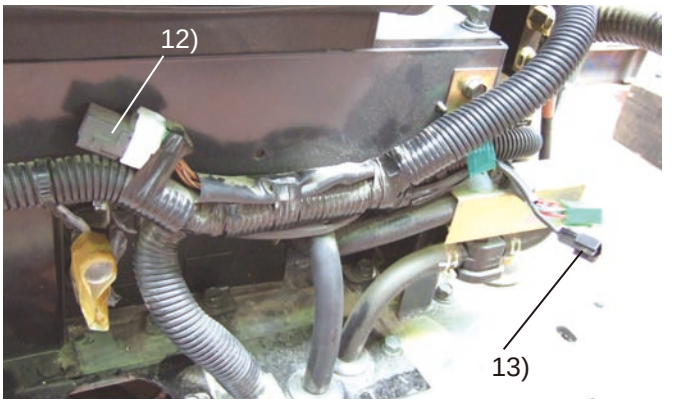
C.Installation of main parts, couplers and harnesses

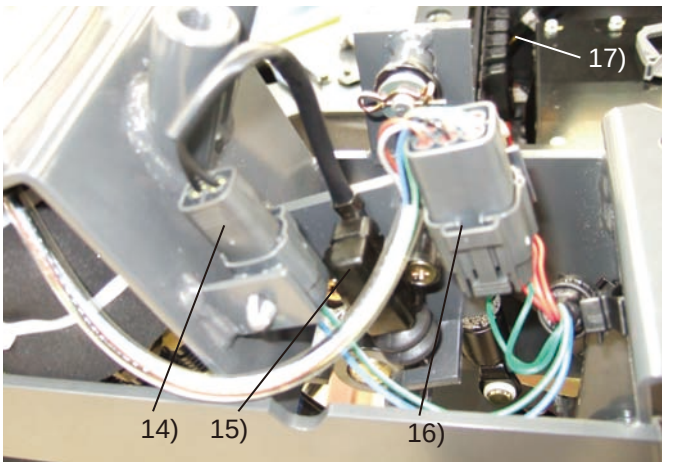
a.Around the operator's seat



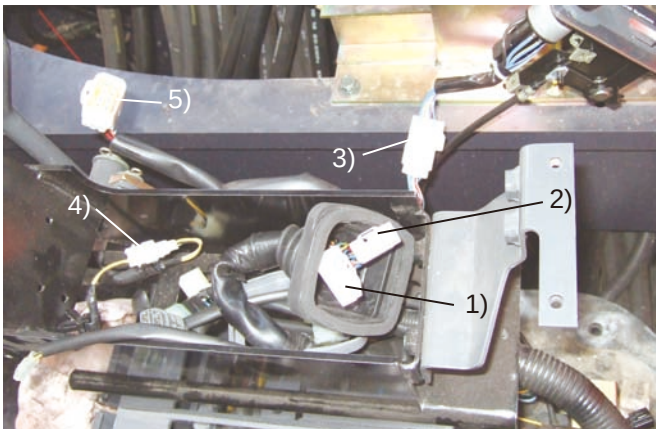


1)Power source, outlet
2)
3)
4)Coupler, to heater relay
5)
6)Compressure dutch relay
7)A/C blower relay
8)Buzzar, boom overload
9)
10)
11)

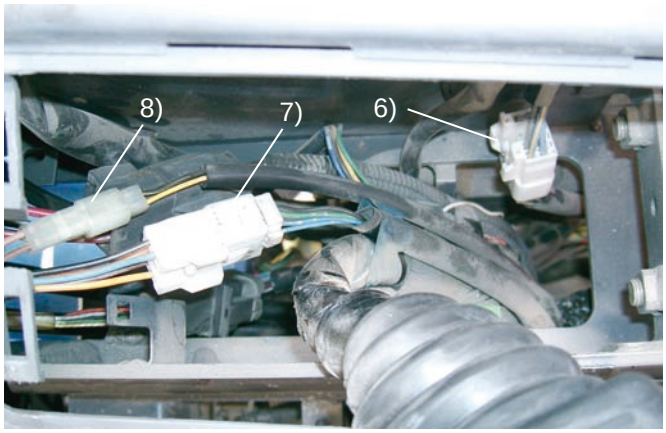




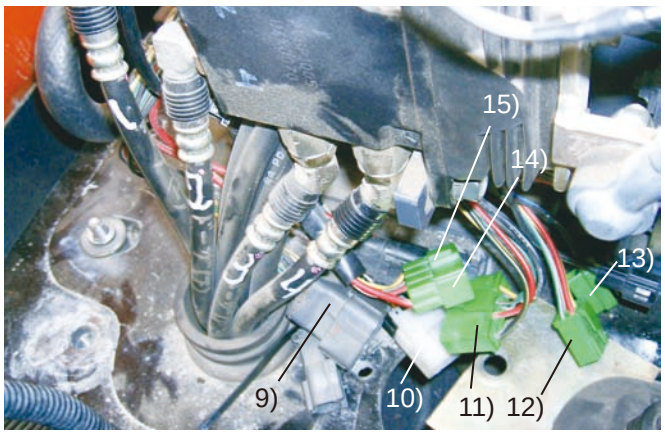
14)Coupler, unload switch
15)Switch, unload
16)Coupler, S/P 2 switch

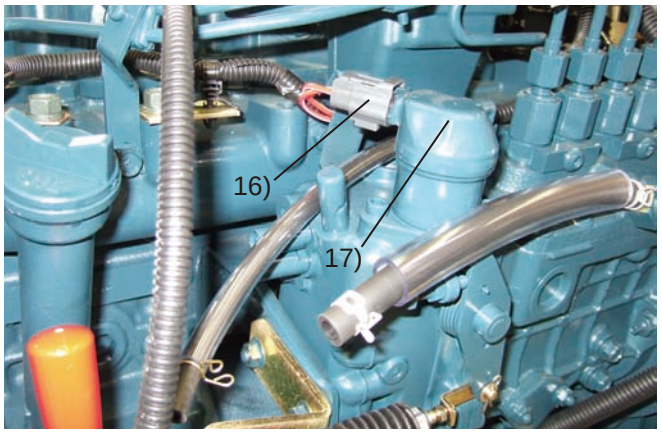


1)Meter coupler, L (22p)
2)Meter coupler, S (20p)
3)Coupler, A/C SW
4)Coupler, hi-low SW
5)Coupler, AI SW



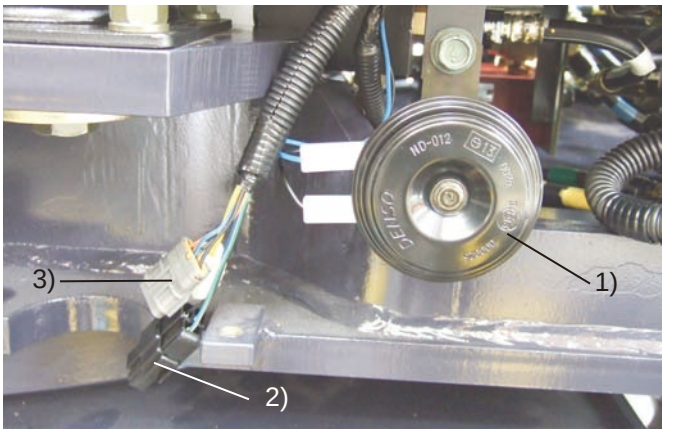
6)
7)Coupler, hbeacomSW
8)Coupler, travel high lamp



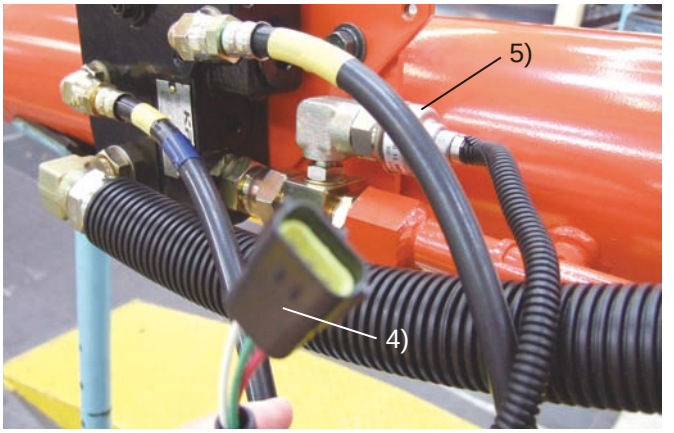


16)Coupler,
17)Engine stop solenoid

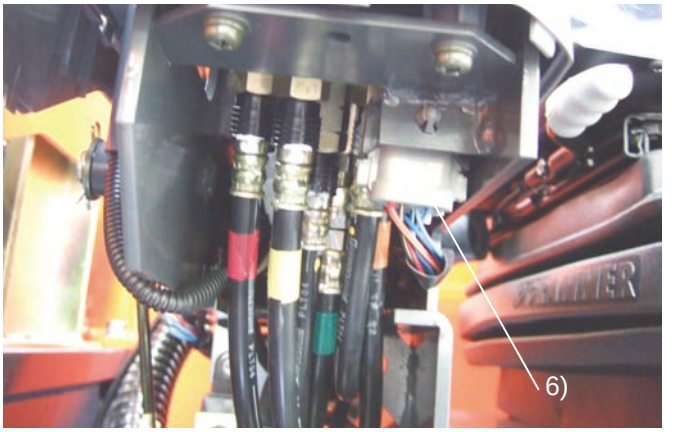
b.Front



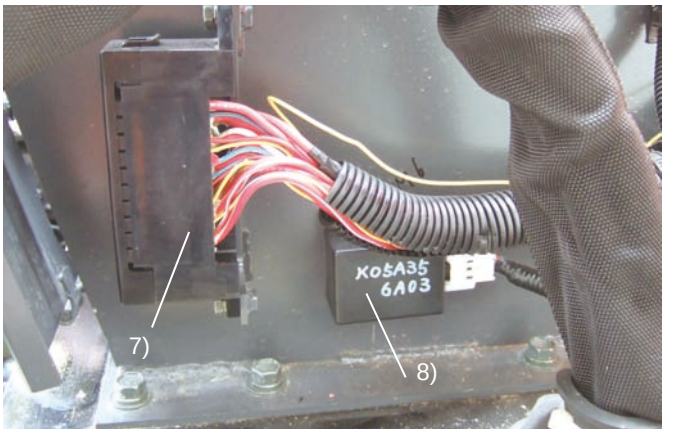
1)Horn
2)Coupler, work lamp
3)Coupler, boom overload SW



4)Coupler, boom overload SW
5)Boom overload SW



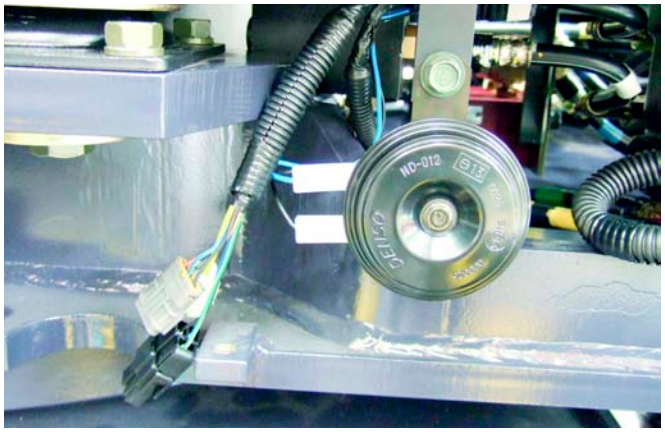
6)Coupler, S/P 1, right



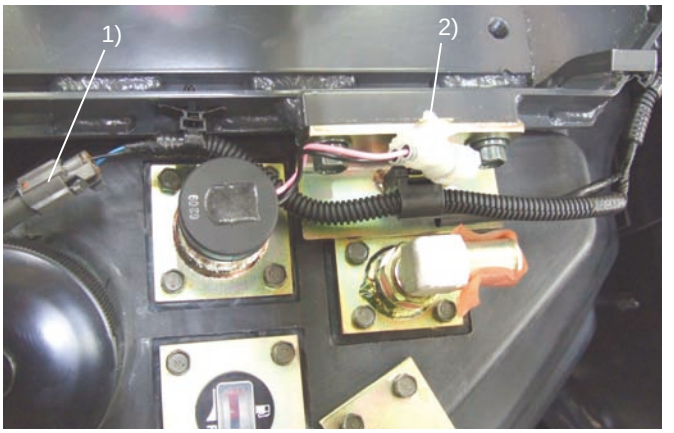
7)Fuse box
8)Amp. unit







WorK lamp harness

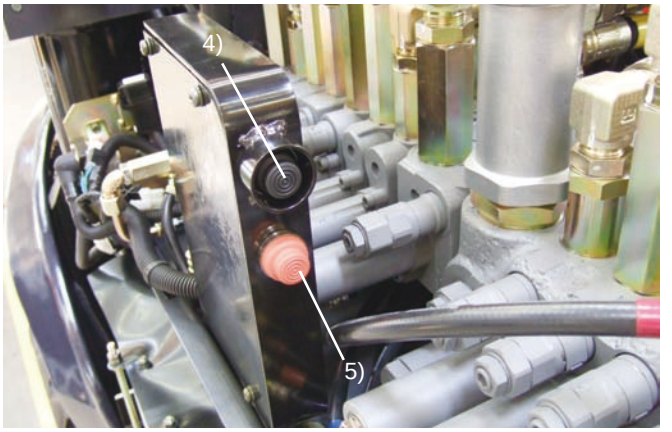


c.Fuel tank

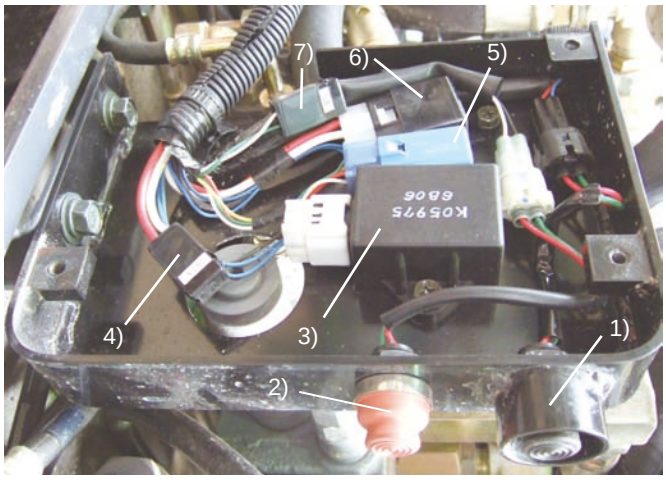
1)Fuel sensor
2)Lead SW, fuel amount



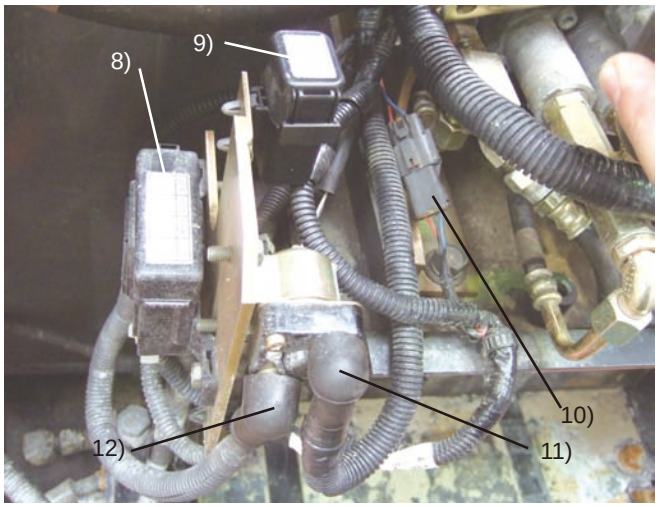
3)Fuel supply pump



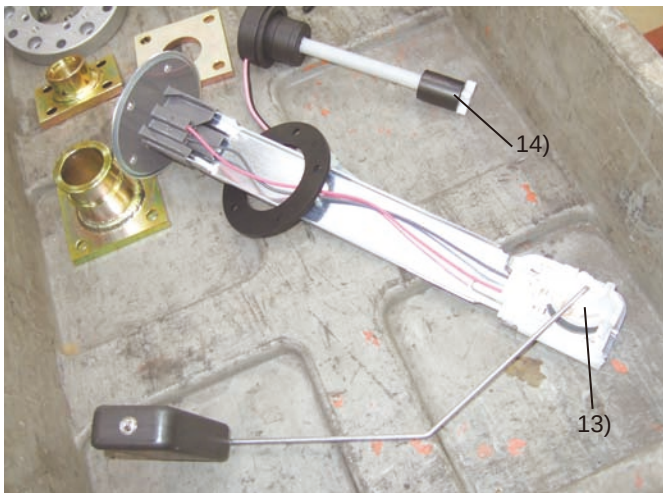
4)ON SW
5)OFF SW



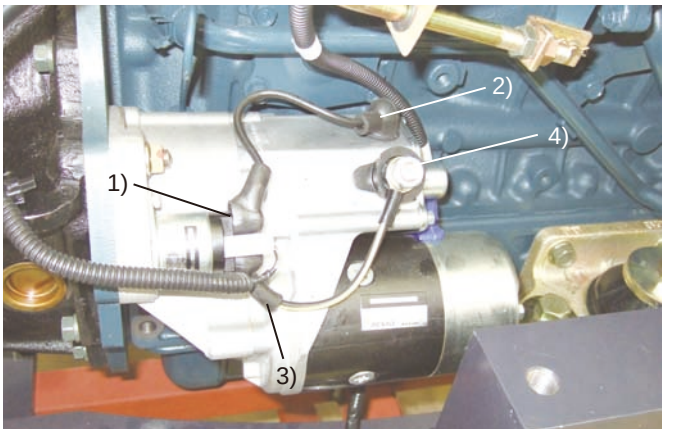
1)Switch ON
2)Switch OFF
3)4min. controller
4)Fuse A
5)Stop relay (NC, blue)
6)Stop relay (NO, NC)
7)Fuse A



8)Fuse box
9)Fuse
10)Coupler
11)
12)

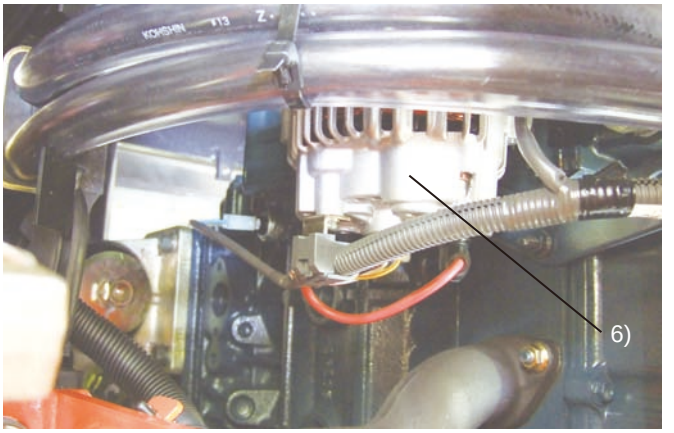


13)Fuel slide sensor
14)Lead sensor



d.Starter, alternator, battery

1)Relay terminal
2)
3)
4)
5)



6)Alternator



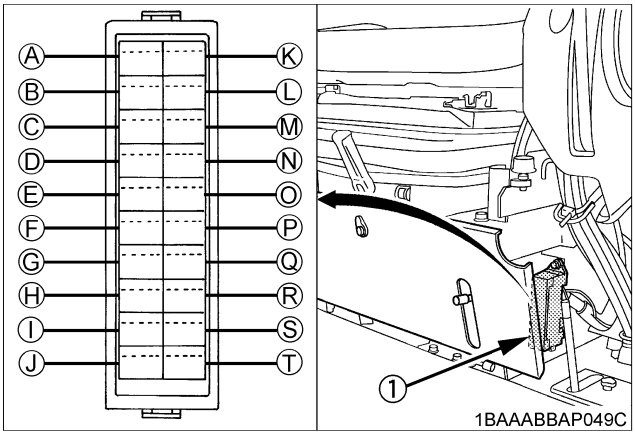
7)Fuse box



8) Fuse box(Slow blow fuse)
9) Battery

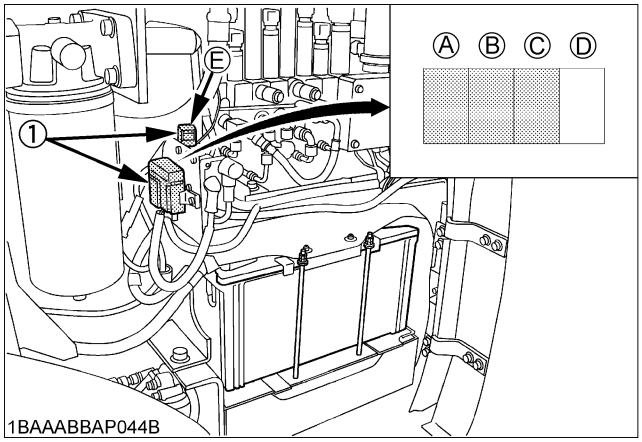
e.Fuses

1.Fuse capacities and Circuits



(A)	5A Room Light
(B)	20A Work Light
(C)	5A Meter Sub
(D)	10A Compressor(A/C)
(E)	15A Cigarette Lighter
(F)	15A Auxiliary
(G)	15A Wiper / Washer
(H)	5A Glow
(I)	10A Overload Warning
(J)	10A Starter
(K)	20A Blower Motor (A/C)
(L)	15A AI Motor
(M)	10A Anti-theft Sub
(N)	10A Alternator
(O)	5A Lever Lock
(P)	10A Horn
(Q)	10A Meter Main
(R)	5A Travel Hi-Low
(S)	5A Relay Source
(T)	5A Anti-theft Main

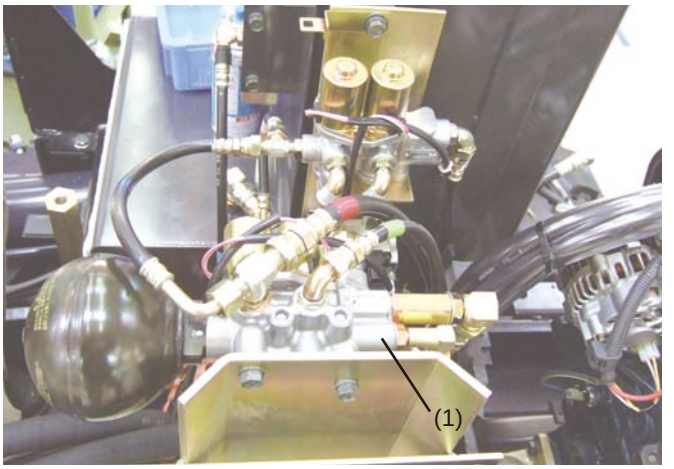
(1) Slow blow fuse



2.Slow blow fuse

Slow blow fuse is provided to protect the electrical circuits.If the fusible link is blown, check the electrical circuits fortrouble and then replace with a new compatible slow blowfuse.

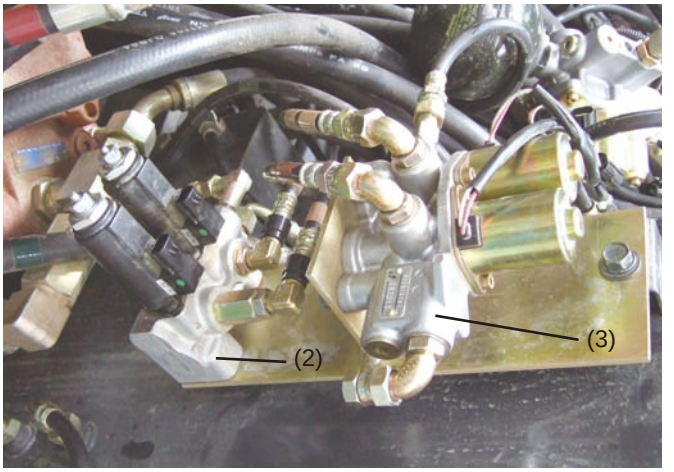
(A)	80A Alternator
(B)	100A Intake Heater
(C)	30A Fuel Supply Pump
(D)	
(E)	60A Main Power



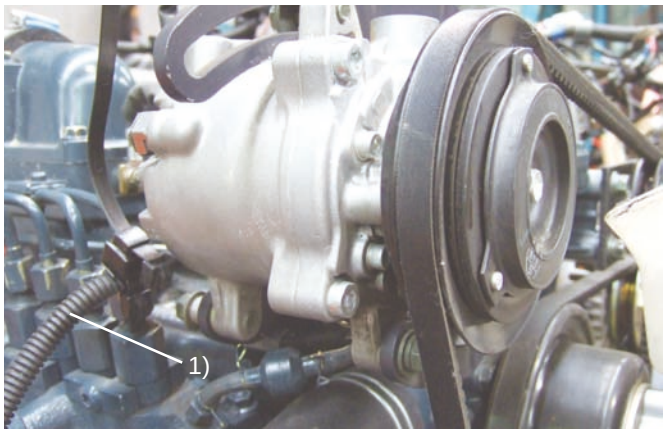
f. Solenoid valve wiring

(1) Unload solenoid valve
(Travel Hi-Low solenoid)



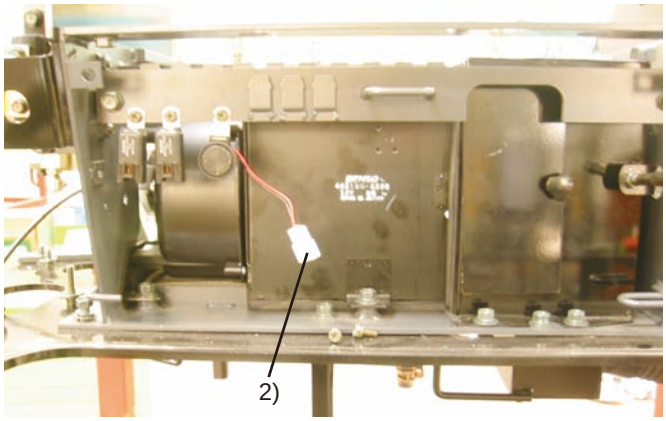


(2)Service port 1 proportional solenoid valve
(3)Service port 2 solenoid valve



g. Air conditioner wiring

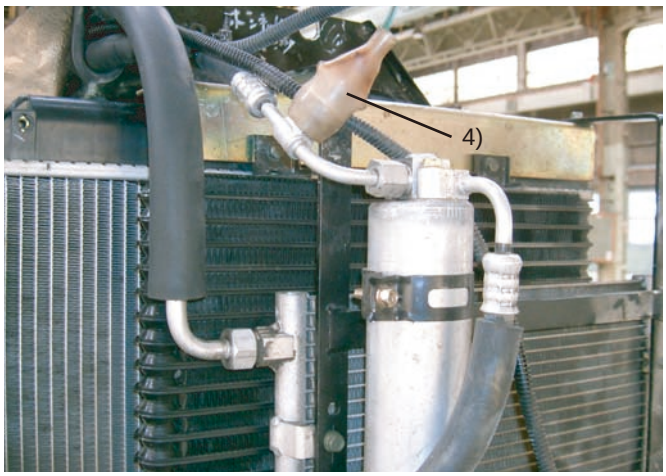
1) Compressor harness



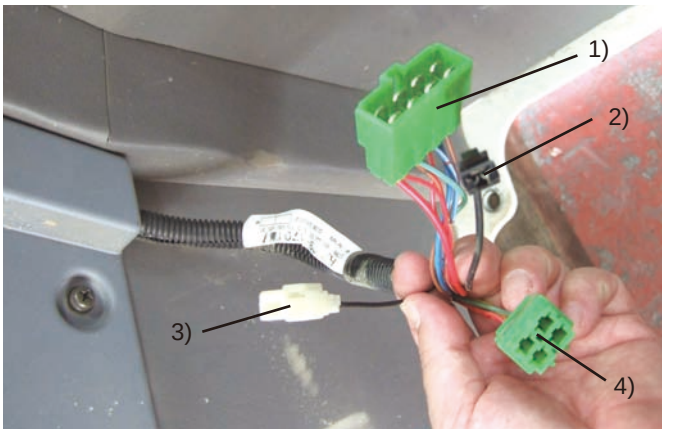
2) Blower harness coupler



3) Blower harness coupler



4) Dual pressure switch



h.Cab wire harness

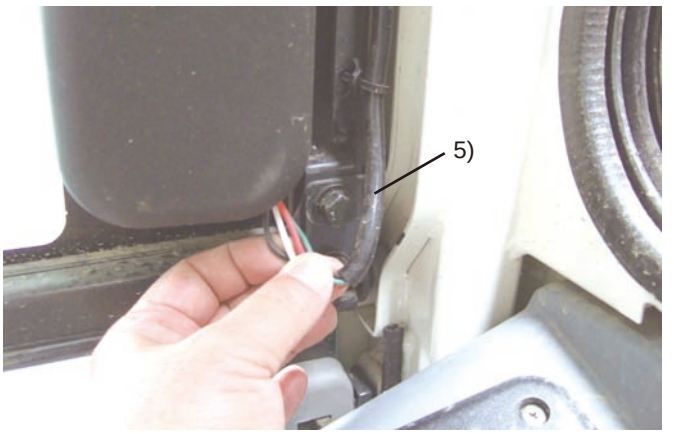
1.Couplers of cab harness

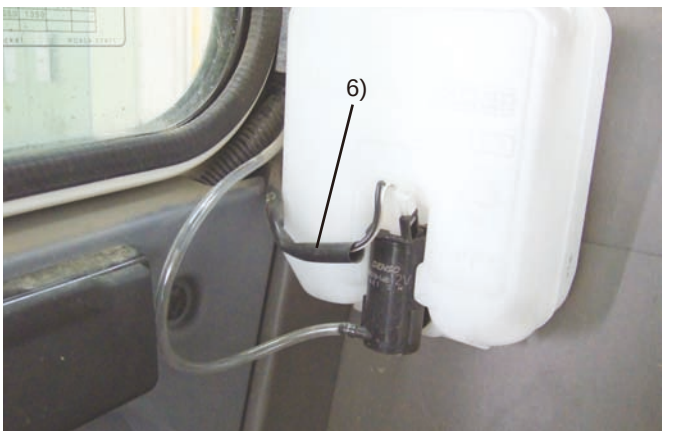
1)Main line to cab
2)GND
3)Auxiliary outlet
4)GND



2.Wire harness for woper motor

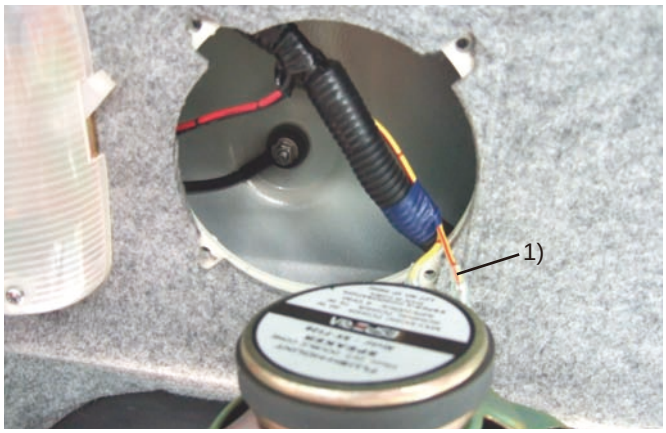
5)Wiper motor





3.Wire harness for washer tank

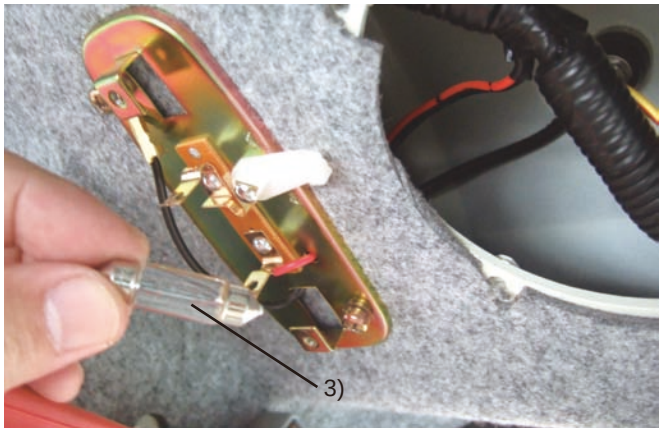
6)Washer motor



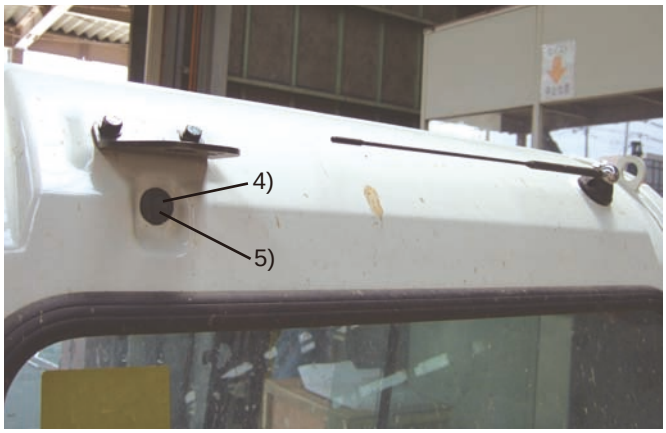
4.Wire harness for speaker and antenna



5.Wire harness for room lamp



3)Bulb of the room lamp
12V 10W



6.Auxiliary harness outlet

5)Outlet grommet



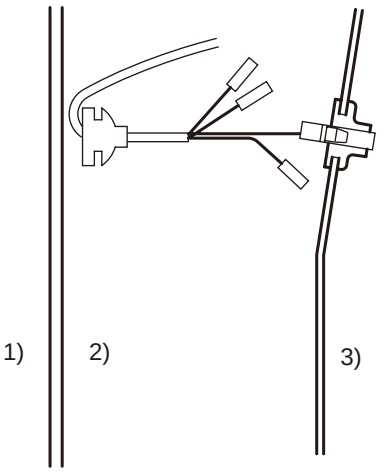
6)Pull out the grommet.



7)Remove the antenna and get the harness outside.



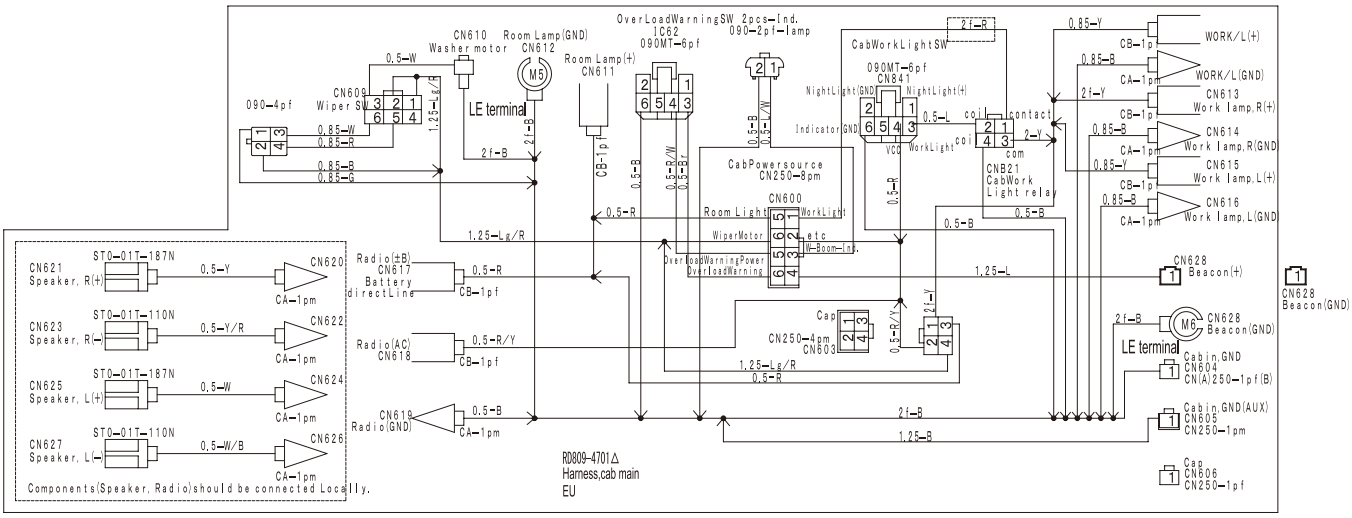
8)Auxiliary terminals for rotating lamp or rear work lamp.

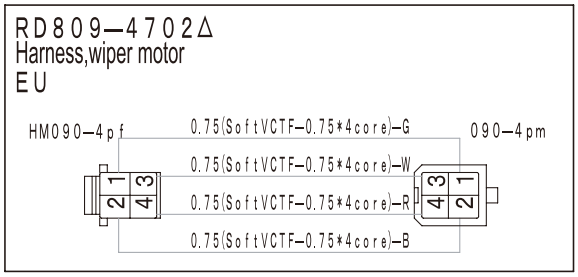


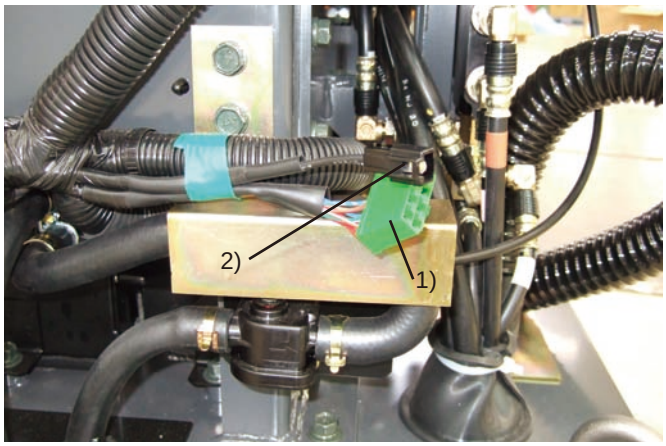
9) Wire harness storage.

1)Inside the cap
2)Between the walls
3)Outside

i.Circuit diagram of cab harness







1)Coupler, cab main
2)Coupler, earth

VI. Air Conditioner

Service Section

A. Servicing specifications VI-S-3
a. Specifications of A/C system and components VI-S-3
b. Performance specifications VI-S-5
c. Adjustment and testing. VI-S-5
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e. Tightening torques VI-S-7
B. Regular check and service points VI-S-8
a. Maintenance interval ; Air conditioner VI-S-8
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a. Procedure. VI-S-9
b. Asking the user and confirming the phenomenon VI-S-9
c. Troubleshooting from problem symptoms (except refrigeration cycle troubles). VI-S-10
d. Connecting the pipes VI-S-10
e. Checking the refrigeration cycle. VI-S-11

A.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	
			Rotating speed	700 ~ 6000 rpm	
			Lubricant	ND-0il 8 140 ± 10 cm^3	
		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	35 W or less	
		Weight		2.82kg	
	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	
	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	3350rpm ± 10%	12 V
			Current	12 A or less	
		Weight		6.9 kg	
	Receiver	Actual capacity		370 cm^3	Inner gas = N_2
		Moisture absorption capacity		32 g	60ºC, 90% in air (Desiccant: 290 g)

	Item		Specifications		Remarks
Component	Pressure switch	High-pressure relief	Opening pressure	3.43 ~ 4.1 MPa	Installed in the compressor
			Closing pressure	2.75 MPa or more	
		High-pressure OFF	3.14 MPa (DIFF 0.59 MPa)		High-pressure cut
		Low-pressure OFF	0.196 MPa (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. 15.0> 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.

c. Adjustment and testing

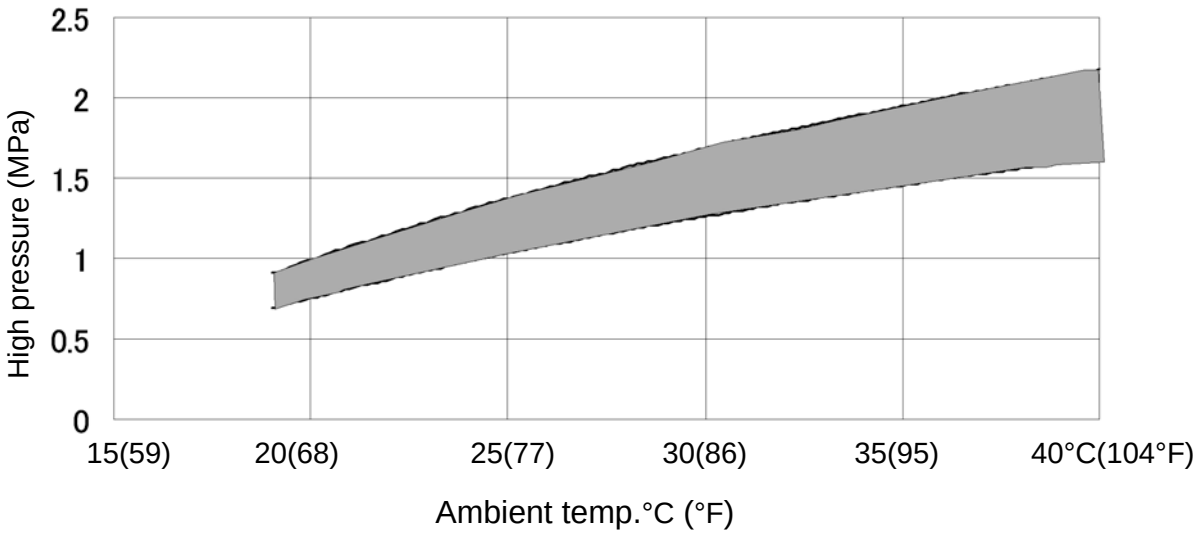
Item		Factory Specification	Allowable Limit
Refrigerant amount	Type : R134a	800 ± 50 g 1.76 ± 0.11 lbs	
Lub. oil amount in total system	Type : ND-Oil 8	140 ± 10 cc 0.037 ± 0.003 us gal	In new compressor
Air-gap of A/C Compressor Magnet Clutch	Swash Plate Type Compressor Scroll Type Compressor	0.25 to 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

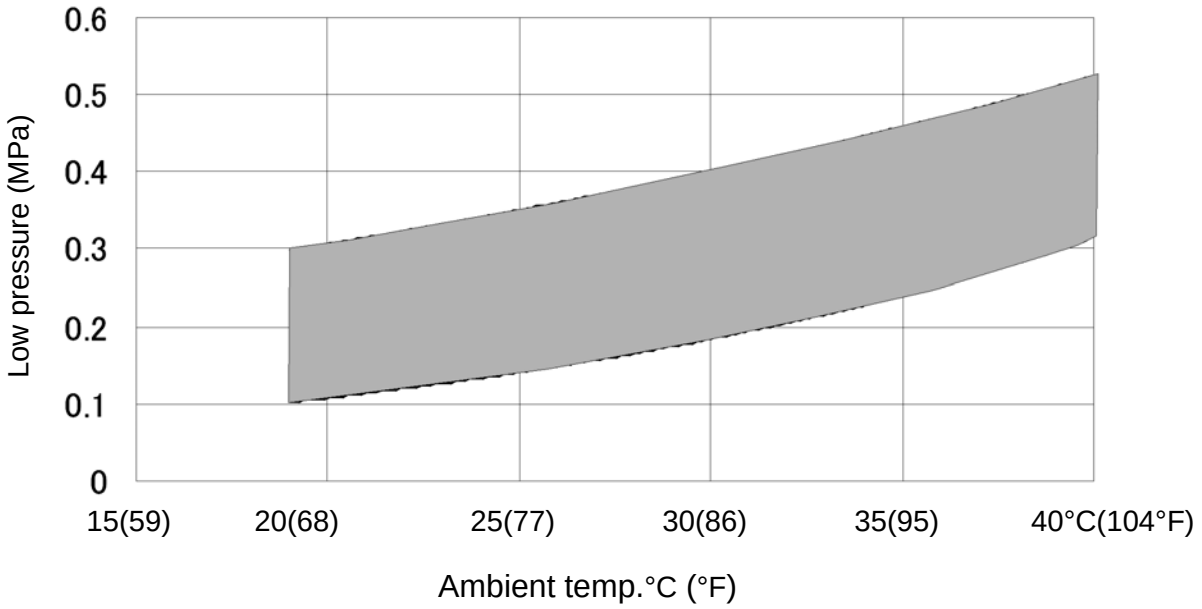
Conditions :

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)

B.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		

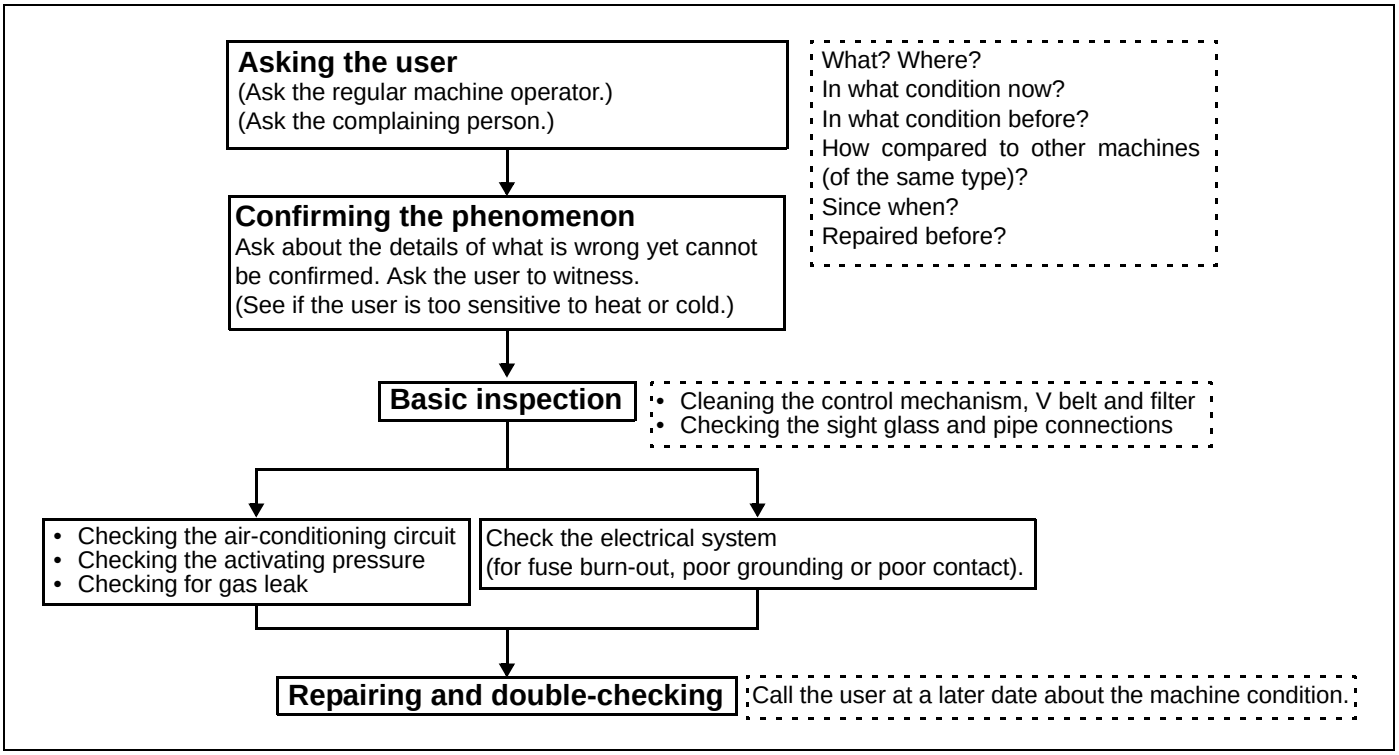
Important

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

C.Troubleshooting

a. Procedure

- The chart shows the basic troubleshooting procedure.
- Car air conditioner troubles are roughly classified in the refrigeration cycle and electrical system. In this chapter the basic troubleshooting procedure is discussed.



b. Asking the user and confirming the phenomenon

Before troubleshooting, it is essential to fully understand what is wrong and how it happened. If a trouble occurs from time to time or if it cannot be reproduced, in particular, the first step must be to ask the machine operator about the situation of the trouble.

What to ask

What	Type of machine, model of engine, model of air conditioner
When	Date, time, how often
Where	Worksite (road) condition
Why	Running condition, weather
How	Feeling of phenomenon

c. 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 (insuffi-cient 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.

d. Connecting the pipes

(1) Replacing the O-rings

- Replace the O-rings with new ones (for R134a and R12). Use a toothpick for removing the old O-rings.
- When connecting the pipes, be sure to apply compressor oil to them.
- Tighten the connections to their specified torques.

Connection	Tube size or bolt size	Tightening torque
Nut	ϕ8 pipe	12 ~ 15 N·m (120 ~ 150 kmf/cm^2)
	ϕ1/2 pipe	20 ~ 25 N·m (200 ~ 250 kmf/cm^2)
	ϕ5/8 pipe	30 ~ 35 N·m (300 ~ 350 kmf/cm^2)
Block joint	M6 bolt (4T) at receiver	4.0 ~ 7.0 N·m (40 ~ 70 kmf/cm^2)
	Other M6 bolts (6T)	8.0 ~ 12.0 N·m (80 ~ 120 kmf/cm^2)

Compressor oil (spray type): ND-OIL8 (995500-0300)

(2) Charging compressor oil in replacing the functional parts

	Condenser	Evaporator	Receiver	Pipes
Oil charge	40 cc	40 cc	10 cc	10 cc (scroll)
				20 cc (swash plate type)

Compressor: Charge the same amount of oil as that of the old compressor.

* Compressor oil: ND-8 for the scroll (SCS) and swash plate types
ND-OIL9 for the vane (SV) type

Note : An open oil container is easy to absorb moisture from the air. Close the lid immediately after use.

e. Checking the refrigeration cycle

Troubleshooting the refrigeration cycle

Checking the refrigeration cycle

Checking the refrigerant amount [Using a gauge manifold] [Using the sight glass]

↓

Checking the refrigerant gas pressure [Using a gauge manifold]

Repairing defective spot(s)

Recovering the refrigerant

↓

Replacing defective part(s)

↓

Charging the refrigerant

Double-checking

Performance test

(1) Checking the refrigerant amount

1. Using a gauge manifold

1) Attach a gauge manifold in position and place the machine in the following conditions.

Item	Conditions
Door	Fully open
Air conditioner (magnetic clutch)	ON
Engine rpm	1500 rpm
Inside/outside air select damper position	Inside air mode
Temperature setting	MAX COOL (Coolest)
Blower speed	HI
High-pressure side level	Below 1.86 MPa (19 kgf/cm^2)*

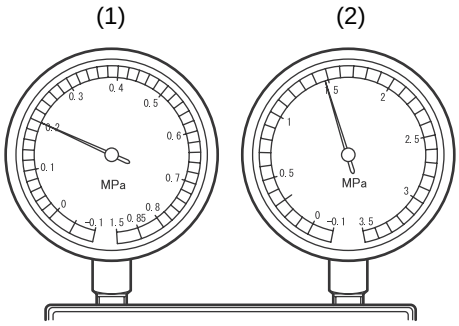
*1: If the outside air temperature is higher than 40°C, the high-pressure side level may be above 1.86 MPa (19 kgf/cm^2) in the above conditions. In such case, (1) fully close the door and set the blower speed to LO, and/or (2) park the machine in a workshop or in the shade, in order to get the level lower than 1.86 MPa (19 kgf/cm^2).

2) Check the pressure reading of the gauge manifold.

Pressures when the refrigerant gas charge is as specified

Low-pressure side level	0.15 ~ 0.25 MPa (1.5 ~ 2.5 kgf/cm^2)
High-pressure side level	1.37 ~ 1.57 MPa (14 ~ 16 kgf/cm^2)

<Reference>
- On the EPR (Evaporator Pressure Regulator) type car air conditioner, the low-pressure side level rises and drops from the level of about 0.18 MPa (1.8 kgf/cm^2) at regular intervals, if the outside air temperature is low.
- The gauge manifold may read somewhat different pressures depending on the conditions.
- An overcharge of refrigerant may cause poor cooling effect, overheat or other trouble.



(1) Low-pressure side
(2) High-pressure side

2. Using the sight glass

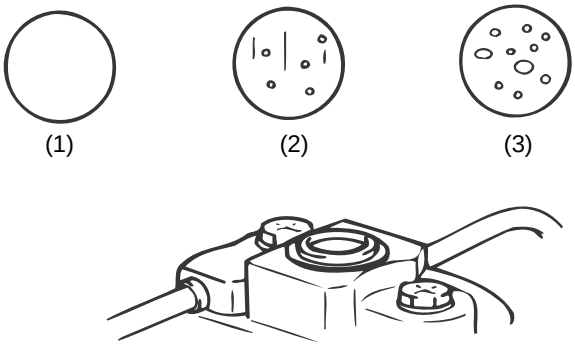
1) Place the machine in the following conditions.

Item	Conditions
Door	Fully open
Air conditioner (magnetic clutch)	ON
Engine rpm	1500 rpm
Inside/outside air select damper position	Inside air mode
Temperature setting	MAX COOL (Coolest)
Blower speed	HI

2) Look at the sight glass to see how well the refrigerant flows in the air conditioner circuit.

For all the systems other than subcool condenser type

Refrigerant charge	Condition
Proper amount	No or little bubbles are contained. Gradually raise the engine speed from idling to 1500 rpm, and the bubbles disappear and the fluid becomes transparent.
Overcharge	No bubbles are contained. The pressures at both the high-pressure and low-pressure sides are too high, resulting in poor cooling effect.
Refrigerant shortage	Bubbles appear continuously.



(1) Too much
(2) Proper
(3) Too short

(2) Using a gauge manifold

1. Using a gauge manifold, measure the pressures at the low-pressure and high-pressure sides of refrigeration cycle.
2. Attach a gauge manifold in position and place the machine in the following conditions.

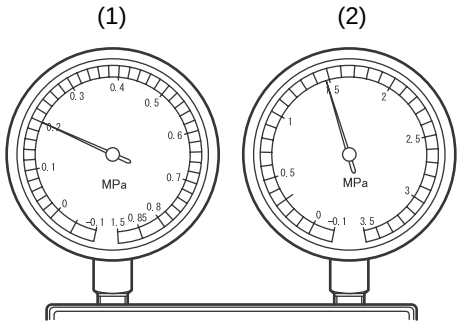
Item	Conditions
Engine	Warmed up
Door	Fully open
Air conditioner	ON
Engine rpm	1500 rpm
Inside/outside air selection	Inside air mode
Temperature setting	MAX COOL (Coolest)
Blower speed	HI
Air conditioner suction port temperature	30°C ~ 35°C

<Reference>

- On a machine equipped with variable displacement compressor or EPR, the suction pressure is controlled. Even if the low-pressure side level is not as specified, the gauge may fail to show such error. In such case, consider the high-pressure side level, blow-out temperature, sight-glass bubbles and other factors to make an overall judgment.
- The gauge manifold may read somewhat different pressures depending on the conditions.

1) Normal condition

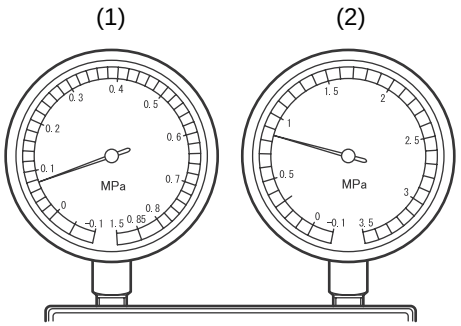
Low-pressure side level	0.15 ~ 0.25 MPa (1.5 ~ 2.5 kgf/cm^2)
High-pressure side level	1.37 ~ 1.57 MPa (14 ~ 16 kgf/cm^2)



(1) Low-pressure side
(2) High-pressure side

2) Refrigerant shortage

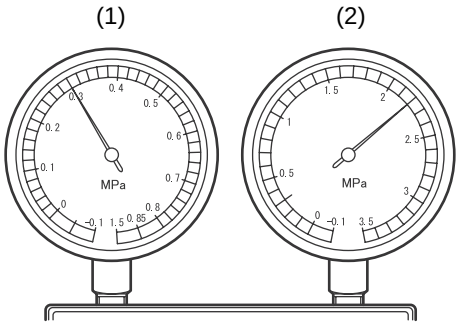
Phenomenon	Possible cause	Correction
• Too low pressure at both low-pressure and high-pressure sides • Bubbles flowing continuously in the sight glass • Poor cooling effect	• Refrigerant too short. Gas leak.	• Pinpoint and repair the leaky spot. • Add refrigerant.



(1) Low-pressure side
(2) High-pressure side

3) Too much refrigerant and poor condenser cooling

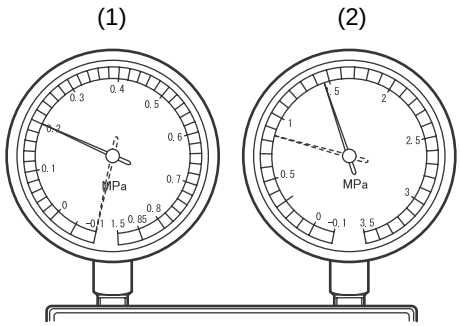
Phenomenon	Possible cause	Correction
• Too high pressure at both low-pressure and high-pressure sides • No bubbles appearing in the sight glass even at low rpm • Poor cooling effect	• Refrigerant too much • Poor condenser cooling effect	• Optimize the refrigerant amount. • Clean the condenser fins. • Check the machine's cooling system (electric fan, etc.).



(1) Low-pressure side
(2) High-pressure side

4) Water mixed in the circuit

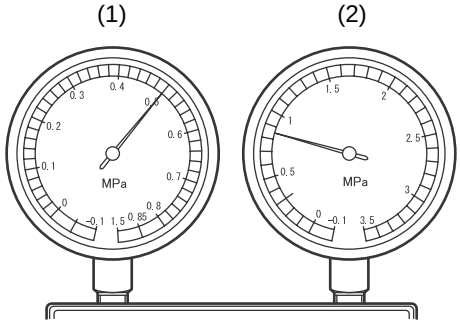
Phenomenon	Possible cause	Correction
Gradual drop to negative pressure at low-pressure side after a certain period of use	Water mixed (Water mixed in the refrigeration cycle freezes at the extension valve port, which temporarily blocks the refrigerant flow. After the ice has thawed, the normal state resumes.)	Do the complete vacuuming before charging fresh refrigerant into the receiver (dryer). This helps keep off water.



(1) Low-pressure side
(2) High-pressure side

5) Poor compressor performance

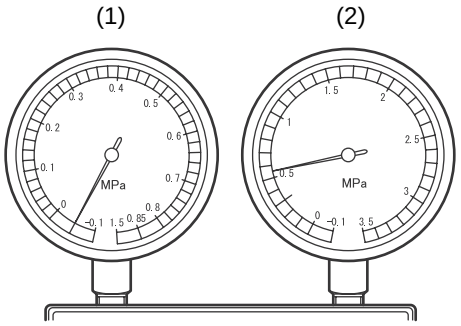
Phenomenon	Possible cause	Correction
• Too high pressure at low-pressure side and too low pressure at high-pressure side • Same pressure levels at high-pressure and low-pressure sides soon after the air conditioner is turned off	Compressor in trouble	Check and repair the compressor as required.



(1) Low-pressure side
(2) High-pressure side

6) No refrigerant circulation (clogged circuit)

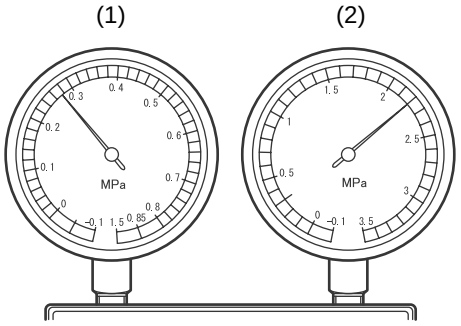
Phenomenon	Possible cause	Correction
• Negative pressure immediately shown at low-pressure side if the circuit is fully clogged. Gradual drop to negative pressure at low-pressure side if the circuit is partially clogged. • Temperature difference generated between before and after a clogged spot.	Dust buildup or water freezing at the small port of expansion valve or EPR, which blocks the refrigerant flow.	Replace the receiver with new one (replace the dryer and clean the strainer). Do the complete vacuuming.



(1) Low-pressure side
(2) High-pressure side

7) Air mixed in the circuit

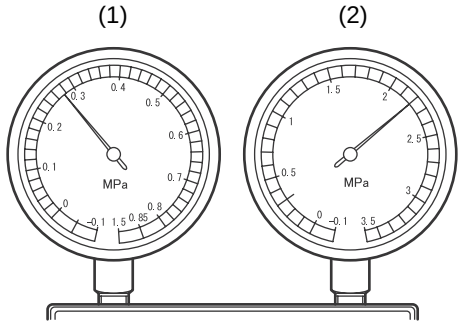
Phenomenon	Possible cause	Correction
• Too high pressure at both low-pressure and high-pressure sides • Nothing cold at a touch of low-pressure pipe • Bubbles appearing in the sight glass	• Air mixed in the refrigeration cycle	• Change the refrigerant for fresh one. • Do the complete vacuuming.



(1) Low-pressure side
(2) High-pressure side

8) Too open expansion valve

Phenomenon	Possible cause	Correction
• Too high pressure at both low-pressure and high-pressure sides • Frosty low-pressure pipe	• Too much refrigerant in low-pressure pipe • Expansion valve too open	• Replace the expansion valve with new one.



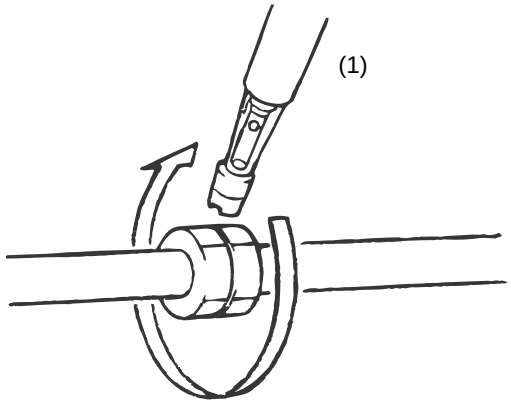
(1) Low-pressure side
(2) High-pressure side

(3) Checking for gas leak

1. If a refrigerant leak is suspected, check for it with a gas leak detector in the following procedure.
   1) Preparatory checking: Connect a gauge manifold and check the refrigeration cycle pressure. Add refrigerant as required to raise the in-circuit pressure. This helps to improve the gas leak detection accuracy.

- Read the gauge pressure with the compressor at rest. The outside air temperature must be above 15°C, however.
- When the gauge pressure is above 0.4 MPa (4 kgf/cm^2) or so, go straight to check.
- If the gauge pressure is below 0.4 MPa (4 kgf/cm^2), add refrigerant to achieve the 0.4 MPa (4 kgf/cm^2) level and then go to check.

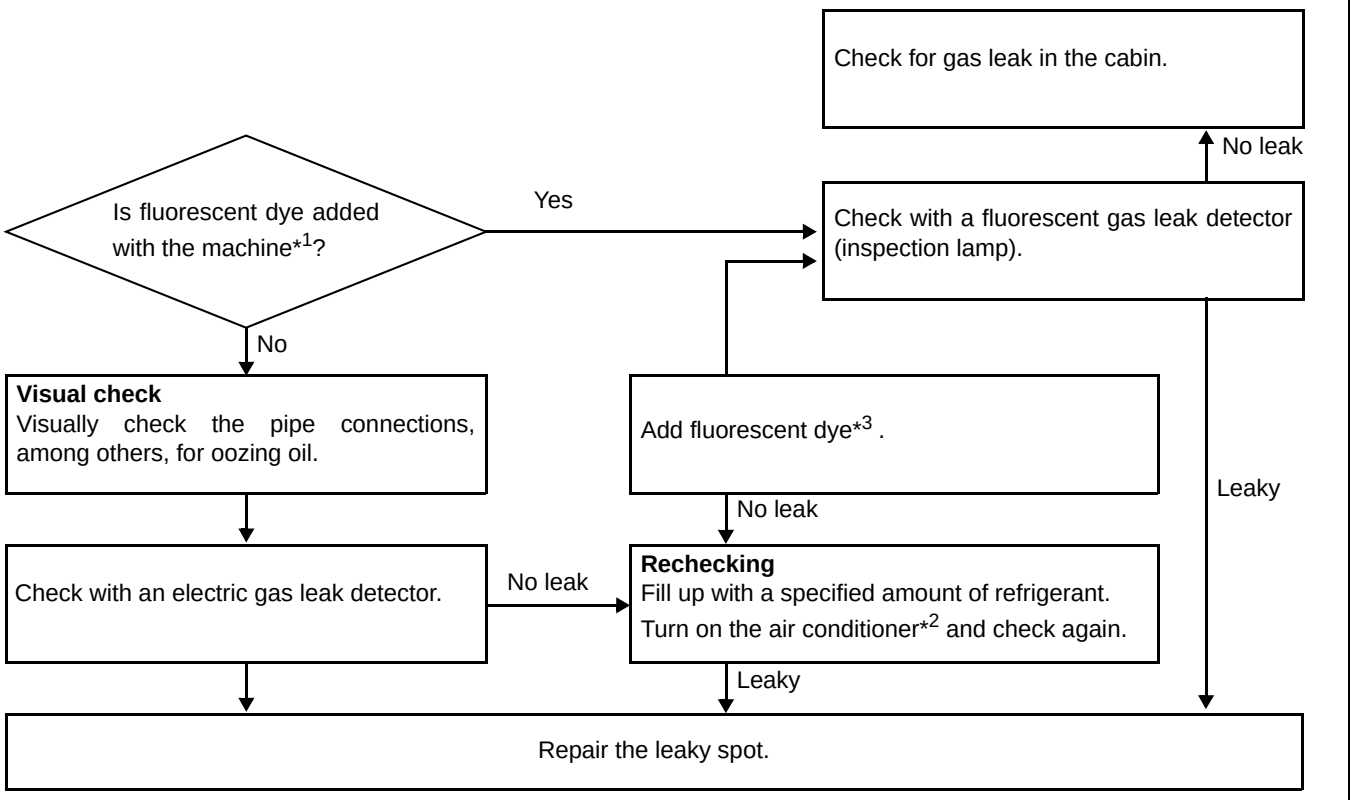
<Reference>
- Check for gas leak in a well-ventilated place. If the sensor of an electric gas leak detector gets exposed to gasoline, light oil or auto emission, it may wrongly react to these gases.
- Gas leaking from a pipe connection may get blown away even by breeze. Apply the tip of the probe all around the connection, not on a single spot.



(1) Probe

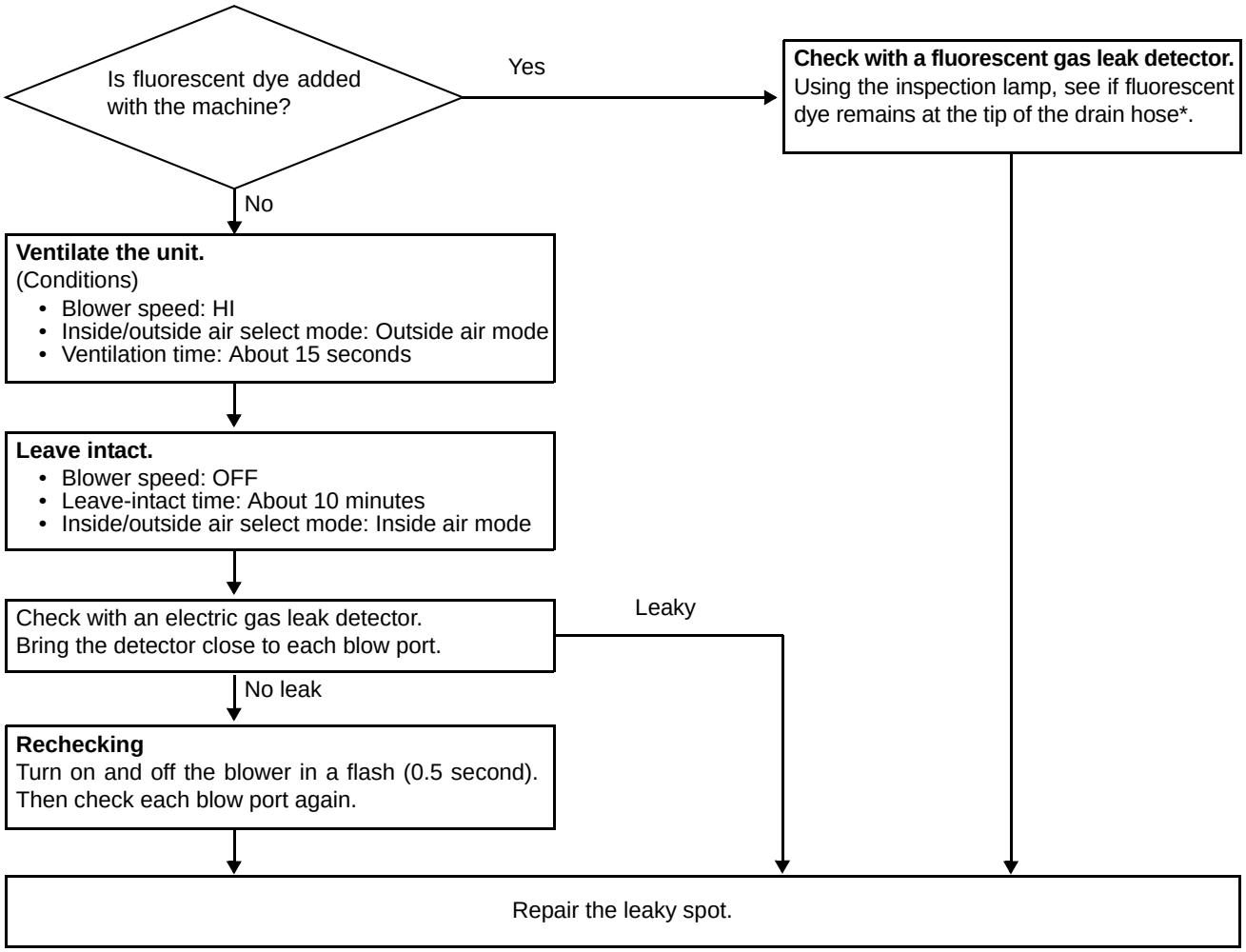
2. Checking for gas leak

1) Gas leak checking procedure in the engine room



*1: Machines with fluorescent dye added are identified with a label or the like.
*2: When the air conditioner runs, the engine gets vibrated and the refrigeration cycle gets under pressure for easily detecting a leak.
*3: Fluorescent dye is added under the pressure of a gas container. Be careful not to apply it too much.

2) Gas leak checking procedure in the cabin (cooler unit)



*: Take this action, because fluorescent dye flows away with drain if the evaporator is leaky.

3) Efficient use of a fluorescent gas leak detector

<Reference>

- An electric gas leak detector works only when a gas leak occurs during inspection. A fluorescent gas leak detector, on the other hand, can find an occasionally leaky spot too, because it traces fluorescent dye that remains at the leaky point. If no leaky spot is found in the primary inspection with an electric gas leak detector, therefore, advisably take the secondary inspection with a fluorescent gas leak detector.

(4) Precautions ⚠

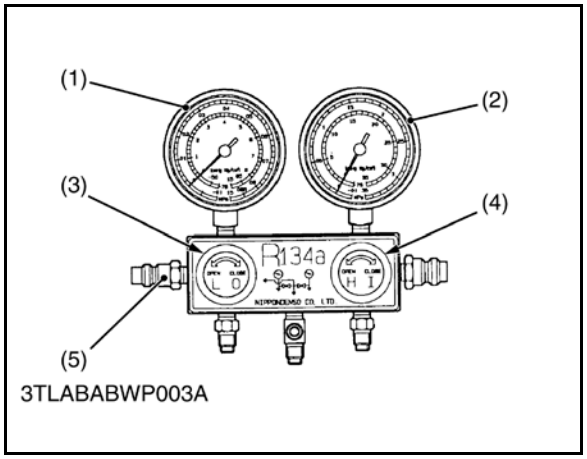
Preparations		
• Gauge manifold kit	• Dry-bulb thermometer	• CFC gas recovery unit
• Psychrometer	• Thickness gauge	• Circlip pliers
• Circuit tester	• Platform scale	•

1. Precautions for training (charging refrigerant)
   1) Allow qualified personnel only to join the training.
      ⇒High-pressure gas (about 3.0 MPa) is handled. It is hazardous.
   2) Wear protective goggles during training.
      ⇒If liquid refrigerant gets in your eye, you may lose your eyesight. If your hand gets splashed with it, it may get it frostbitten.
      (Do not bend over when handling the service container and gauge manifold.)
   3) Do not return gas to the service container.
      (The service container is prohibited for reuse. The recovery unit's cylinder can be reused.)
   4) Store the service container with care.
      (Be careful not to drop and hit upon it. ' Apply no pressure upon it. Store it in a dark cool place without risk of get corroded.)
      ⇒Do not use any gas container deformed or with broken threads.
   5) Be sure to use specified type of gas (R134a or R12).
      ⇒The service valve diameter and shape are designed to avoid wrong type of gas.
   6) Be careful not to confuse the type of compressor oil. ND-OIL08 Denso-brand
      (ND-OIL06 only for R12)

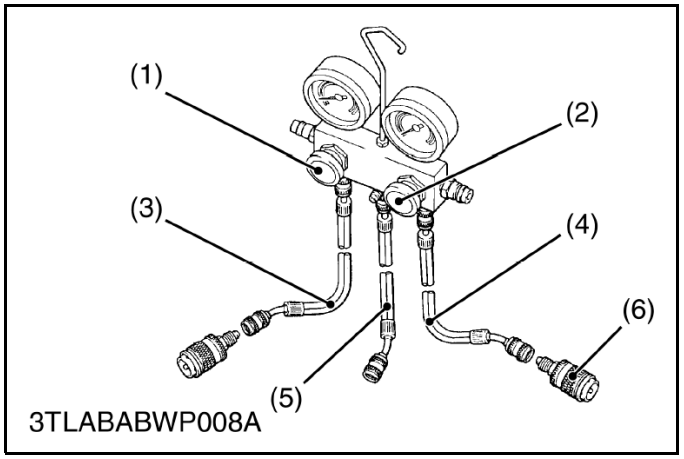
2. Precautions for checking and charging air conditioner refrigerant gas
   1) Select a well-ventilated place.
      ⇒Refrigerant gas is heavier than the air. If the room if filled with this gas, it may result in lack of oxygen.
   2) Handle the high-pressure valve with care.
      ⇒Do not open this valve while the engine (compressor) is running.
      (The fluid will flow back, possibly bursting the service container.)
   3) Remember the toxicity of refrigerant gas. The gas itself is not toxic, but if burnt, a harmful gas is emitted.
      ⇒If the gas gets exposed to a space heater or other open flame, it turns to a toxic substance.
   4) Be careful not to overcharge the gas.
      ⇒It may result in a trouble (poor cooling effect, overheat, refrigerant gas gushing from the safety valve).
   5) The service container cools down during charging. Do not get it heated.
      ⇒Keep water below around 40°C. Do not dip the connection port in warm water.
   6) Do not turn the service container upside down.
      ⇒Refrigerant will come into the circuit in a liquid form, getting the compressor in trouble.
   7) Make sure the service container packing is not clogged.
   8) After charging, immediately disconnect the hose.
   9) Be sure to do the vacuuming (below 750 mmHg).
      ⇒If water or air is left inside the pipe, it may cause poor cooling effect.
   10) If unavoidably the high-pressure and low-pressure hoses and/or the pipes are left open for a long time, be sure to cover their ends with plugs or plastic bags to keep out dust and water.

Training 1: Setting the gauge manifold

1) Close the gauge manifold's valves (for HI and LO).
2) Connect the charging hoses. (Connect the red one to HI and the blue one to LO.)
3) Slightly loosen the high-pressure and low-pressure valves to let air out of the hoses.
4) Fully close the high-pressure and low-pressure valves.



(1) LO Pressure Gauge
(2) HI Pressure Gauge
(3) LO Pressure Side Valve
(4) HI Pressure Side Valve
(5) Schrader Valve



(1) LO Pressure Side Valve
(2) HI Pressure Side Valve
(3) Blue Hose
(4) Green Hose
(5) Red Hose

(5) 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.

HOW TO READ THE GRAPH:
After measuring the temperatures of wet- and dry-bulb thermometers at the evaporator air inlet, relative humidity (%) can be obtained.
Example: Supposing dry- and wet- bulb temperatures at the evaporator air inlet are 25°C (77°F) and 19.5°C (67°F) respectively. The point of intersection of the dotted lines in the graph is 60%.

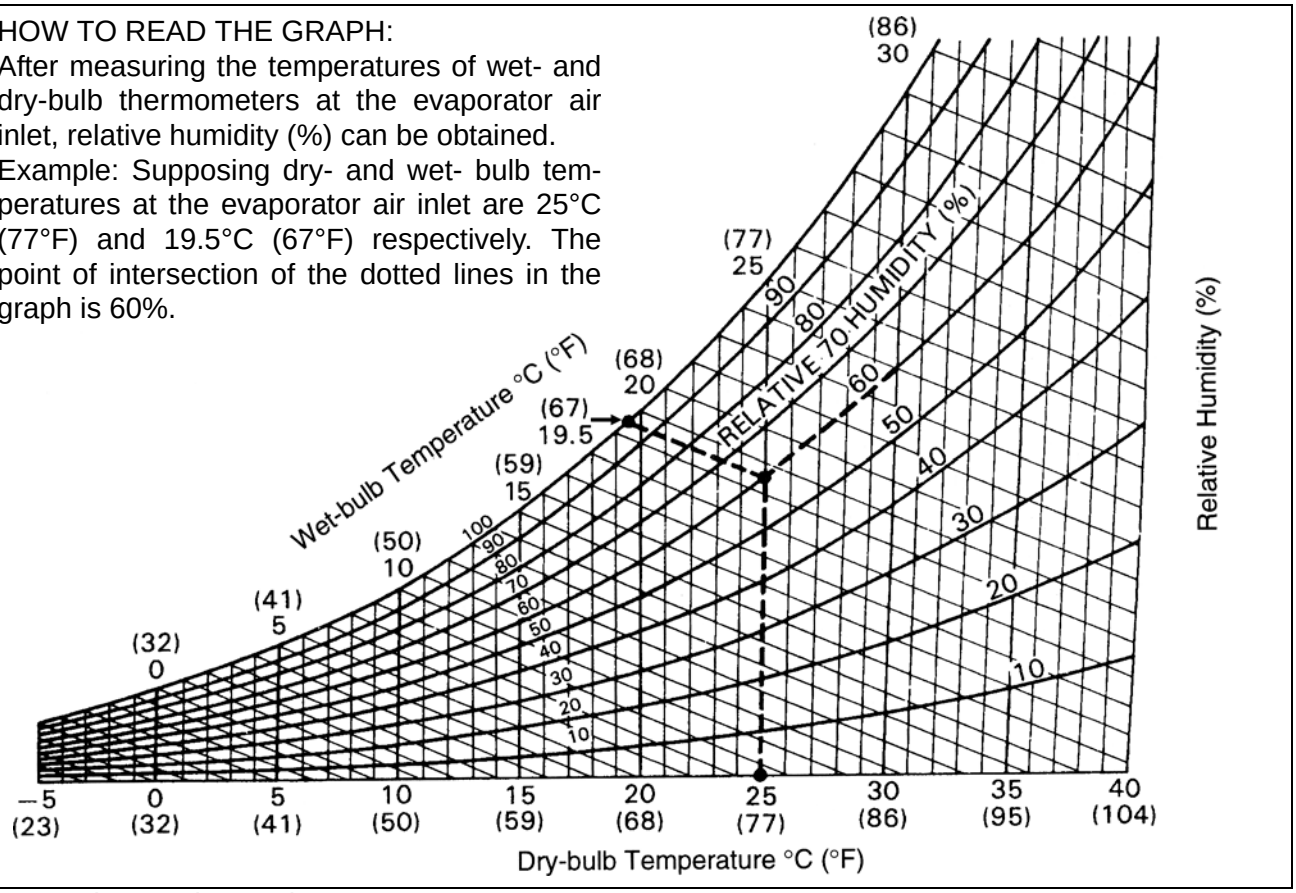


Fig. Psychrometric Graph

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
   outlet dry-bulb = 8°C
   Then, temp. difference = 17°C
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.

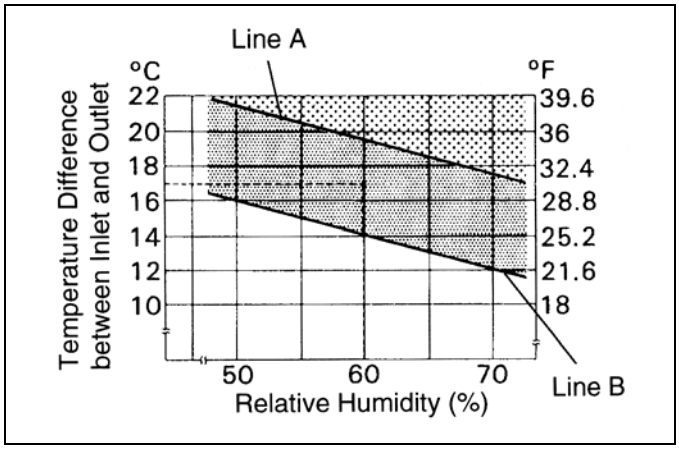


Fig. Relative Humidity Graph