WSM

WORKSHOP MANUAL
KUBOTA EXCAVATOR

KX91-3
KX101-3

Kubota

Code No.97899-60520

CONTENTS

I General

II Machine body

III Engine

IV Hydraulic System

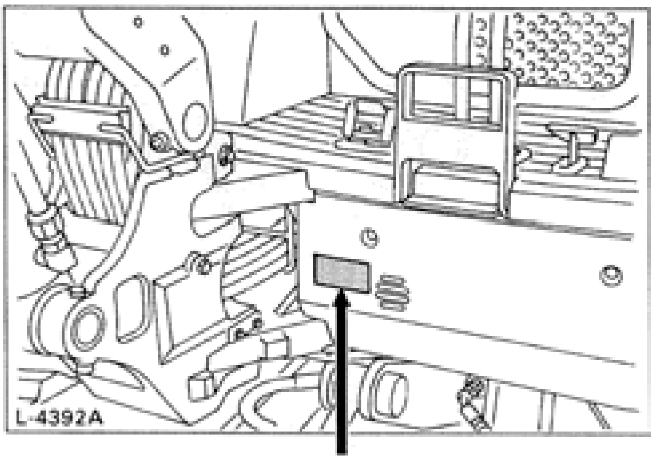
V Electrical System

I. General

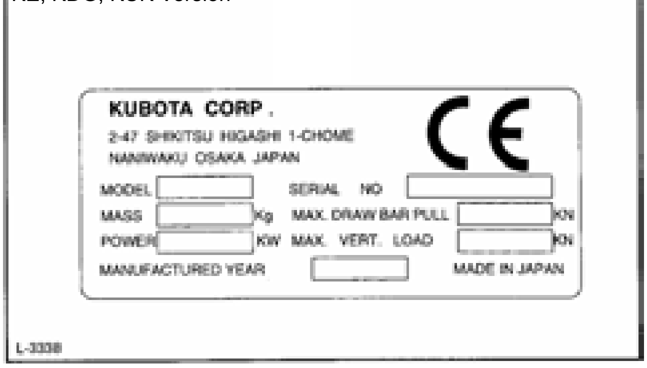
A.Body and engine identification marks

If trouble should occur during use, or if servicing is necessary, contact the dealer who handles the machine. At the time please inform the deals of

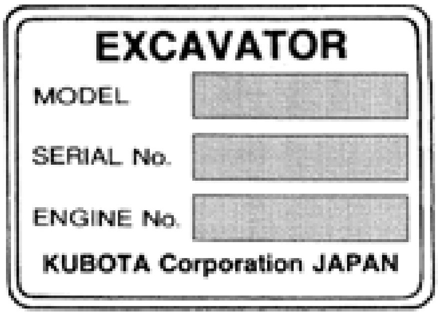
(1) Model of machine and serial number



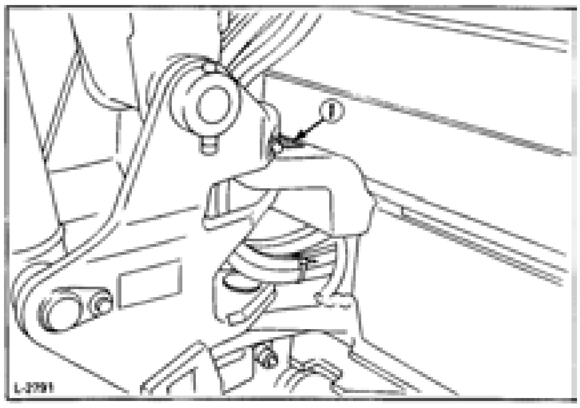
KE, KDG, KUK Version



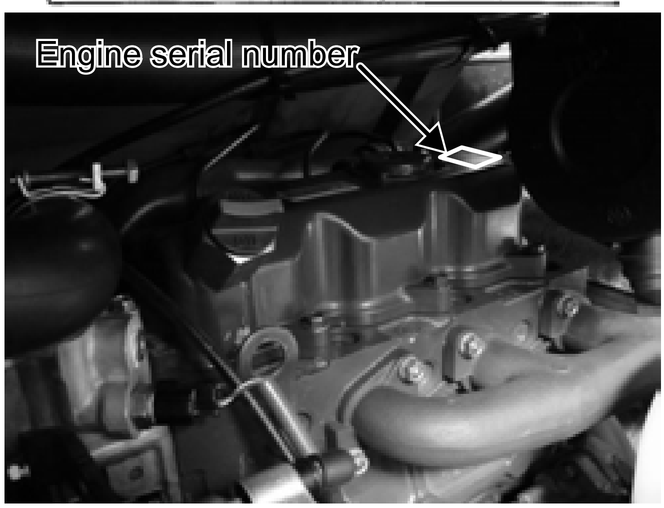
KTC, KCL, KTA Version



2) Machine serial number



(3) Engine serial number



B.Safty precautions for servicing, disassembly and reassembly

⚠ Safty precautions for servicing

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

⚠ Safty precautions for Disassembly and reassembly

Machines must be diassembled 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. Safty 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 hydrauricunits 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. Safty measures during work

(1) Protectors

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

(2) Team work

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

(3) Disassembly and assembly

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

(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 batteris, 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 tp 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 nessesary.)

(3) Equipment and tools

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

d. Precautions for disassembly and reassembly

(1) Disassembly

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

(2) Reassembly

1. Clean all parts before assembly. Repair any scratches or dents. Take special precautions against dirt and dust.
2. Parts with rust-preventive coatings must be assembles only after removing the corting.
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 SAFTY PROCESS AND CRITICAL FUNCTIONAL PROCESS

The following instructions are related to essential adhesives, important safety process $\boxed{S}$ and critical functional process $\boxed{A}$ .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 $\boxed{S}$

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

c. Important Critical Functional Process $\boxed{A}$

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

D.IMPORTANT INSPECTION ITEMS AFTER REASSEMBLING

a Operate the Machine and check for Unusual Noise and Vibrations.

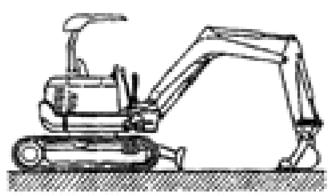
b Make Sure the Safety decals and Wireharness Clamps are in their Specified Positions.

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

Checking the oil level (For further datails, refere to the Operation Manual of each model.)

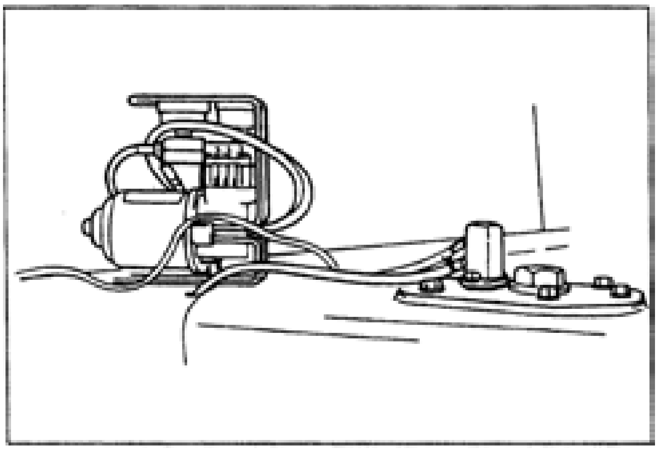
1) Park the machine on a level ground.
2) Make sure the hydrauric oil temprature is in the range of 10-30°C (50-86°F) and see if the oil level is within the specified zone of the oil level gauge.
3) Keep the machine front as shown as following posture.

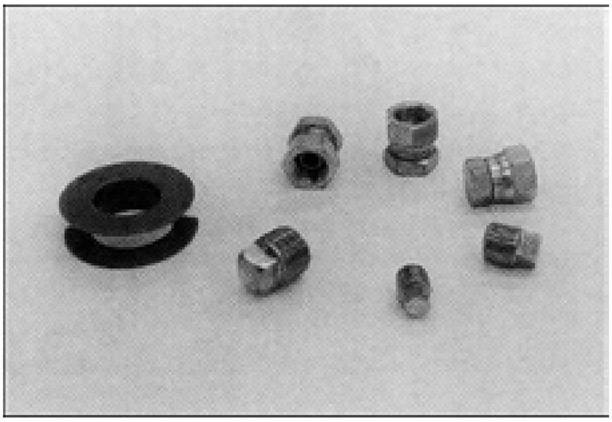
Posture: Extend the rods of the arm and bucket cylinders nealy half. Place the bucket on the ground, the offset swing at the center, and the dozer also on the ground.

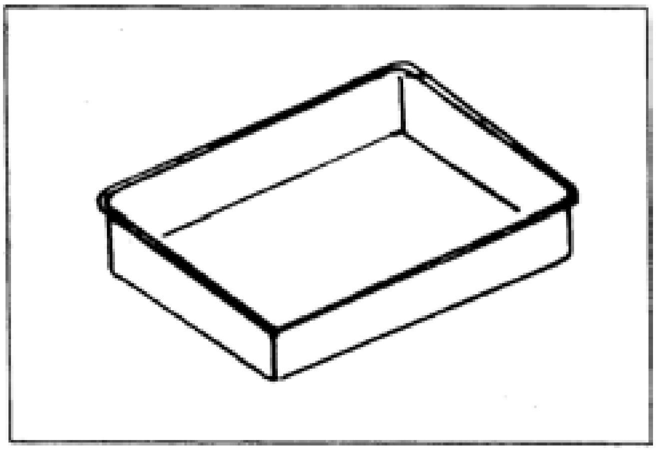


E.SERVICING FUNDAMENTALS

Locking adhesive







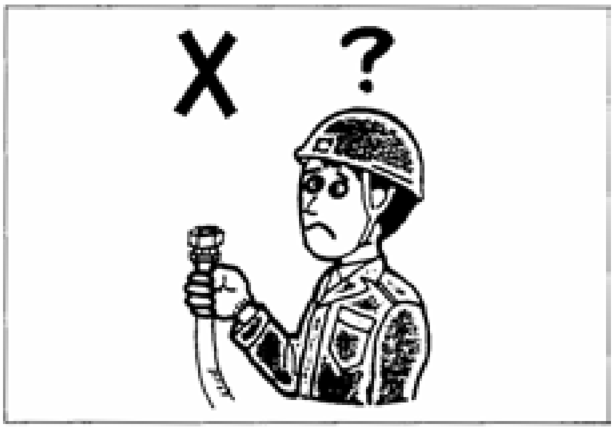
a.Items for Servicing

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

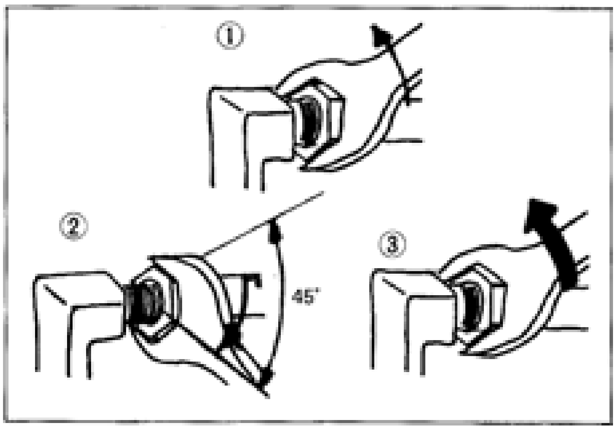
Liquid color	Feature
Red	Heavy-duty
Blue	Medium-duty

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

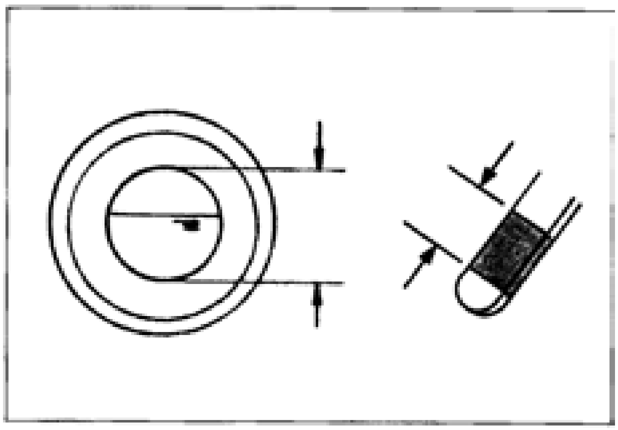
3) Precautions in disassembling the hydraulic equipment
   - Use a vacuum pump, pulgs, oil pans, waste cloth and the like to prevent oil from running out or splashing.
   - Wipe out leaking oil completely first and then add oil as required.
   - Protect the openings with plugs, covers or the like to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



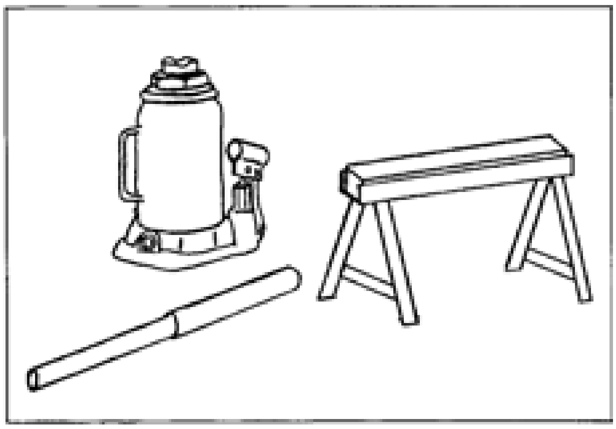
4) Precautions in tightening hoses and pipes.
   - Flexible hoses have a slight natural bend of their own. Utilize the natural bend. Be also careful not to twist them.
   - Be careful not to confuse the routes of the hoses.
   - Do not hold the hoses in tight contact with their adjacent parts and surfaces.



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

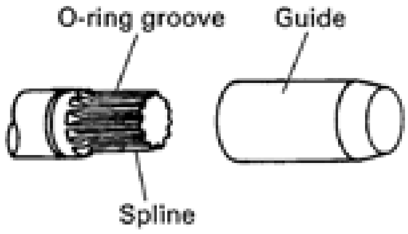


5) The quantities of oil, fuel, water and others, except for the oil to be filled in the track rollers and idlers, are listed just as reference. Fill up the fluid up to the specified center level of a level gauge if it is provided.

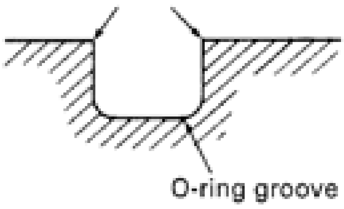


6) Security support the machine with a jack and a supporting jig when it is jacked up for servicing.
7) Be sure to use a crane in disassembling and reassembling heavy parts and components (frame, front attachment, crawler, etc.).

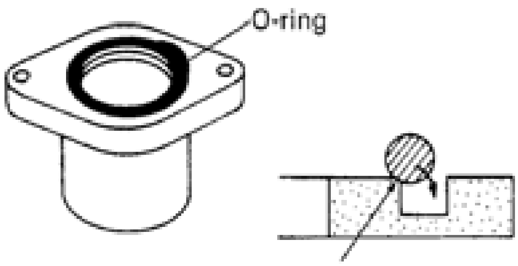
b.O-ring, Oil seal, Circlip and Roll Pin

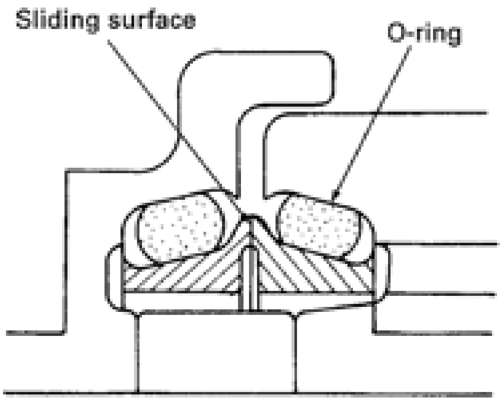


(1) General precautions
- Make sure the O-ring and the oil seal are free of anything unusual (uneven surface, scratches, chipping, etc.).
- Check the O-ring groove for burrs. Correct, if any, using an oil stone or the like.
- When putting a part past a sharp edge into position, protect such edge with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



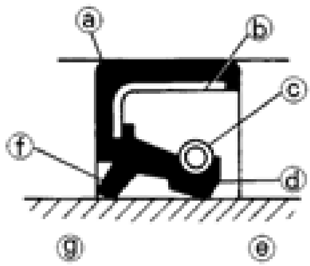
(2) O-ring
- Clean up the O-ring groove and deburr its edge as required.
- Before installing the ring, be sure to apply lubricant (grease) over it. (Do not do this to the floating seal.)
- Fit the O-ring into its groove without twist. With your fingertip, push the ring gently and evenly into the final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



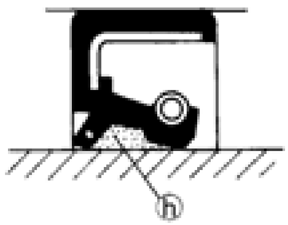


(3) Floating seal
- Be sure to wipe oil off the O-ring and the O-ring contact surface. (Note, however, that oil must be applied thinly over those of the wheel motor.)
- In fitting the O-ring into the floating seal, be careful not to twist the O-ring.
- Before installing the floating seal together with 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 hte 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.

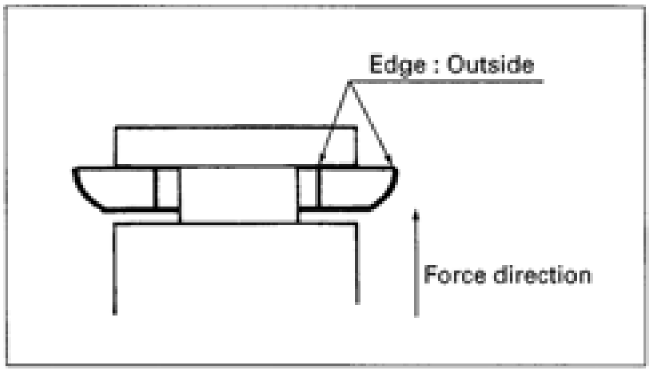
(4) Oil seal
- Do not confuse the orientation of the oil seal lips. Direct the main lip toward the oil chamber; in other word, toward what is to be sealed.



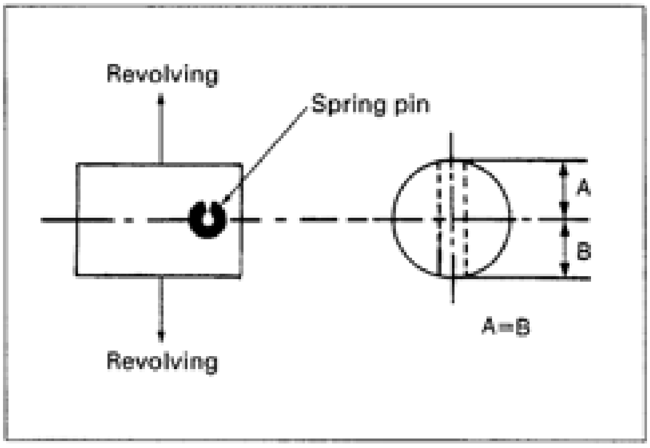
a.	Packing	f.	Dustproof lip
b.	Metal ring	g.	Atmosphere (outside)
c.	Spring	h.	Grease
d.	Main lip		
e.	Oil chamber (inside)		



- 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, allpy 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 desconnecting and reconnecting the hose and pipe, be sure to use two wrenches. With one wrench, restrain the mating part to allow no twist.
- Check the mating connector's sleeve and the hose's taper for dust deposits and scratches.
- When the pipe socket has been tightened up, wipe the joint clean. Apply the maximum operating pressure 2 or 3 times to make sure there is no oil leak.

(2) Hydraulic hose

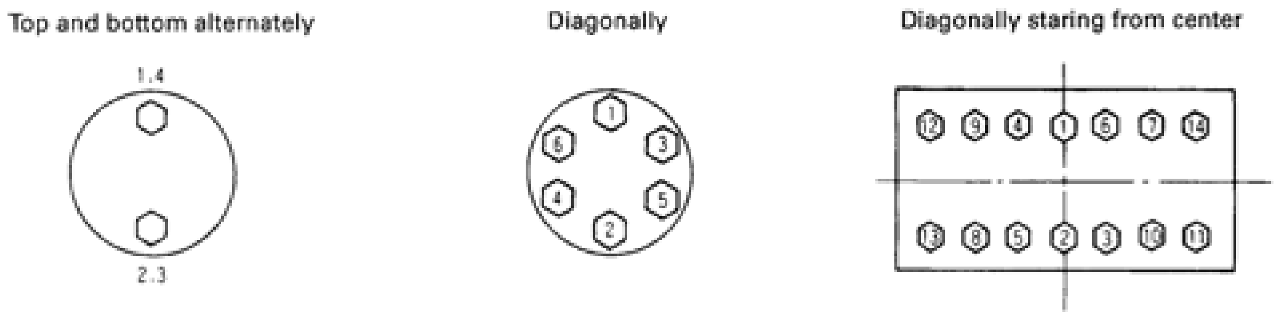
Check the hydraulic hose for too tight a connect or twist.

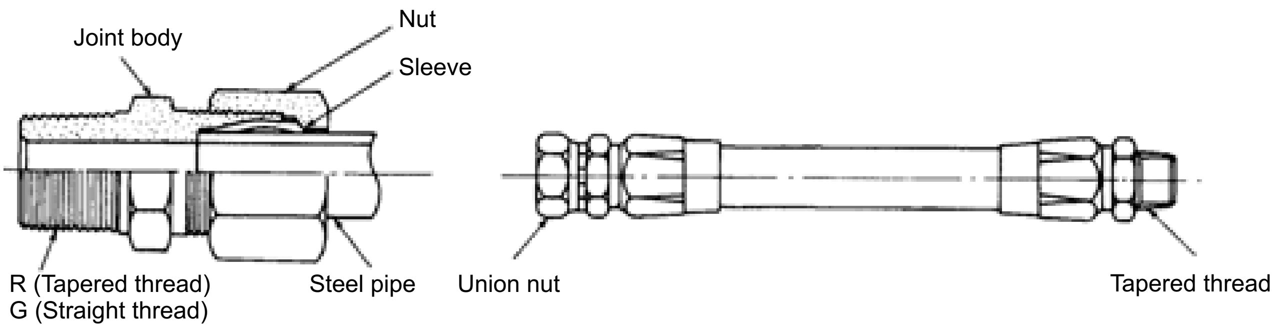
* Excessivly tight contact

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 torqoe.
- Tighten the bolts and nuts diagonally for even tightness.





(4) Hose screw

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

Metric Size Hose

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

(5) Joint bodies

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

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

No.	Dia. (mm)	Code No.	Tightening torque N·m kgf·m ft·lbf
1	Ø12 ~ 16	09318-89016	2.5 ~ 3.4 25 ~ 35 1.84 ~ 2.51
2	Ø31 ~ 40	09318-89039	2.5 ~ 3.4 25 ~ 35 1.84 ~ 2.51
3	Ø36 ~ 46	15108-72870	2.5 ~ 3.4 25 ~ 35 1.84 ~ 2.51
4	Ø15 ~ 25	RC101-64580	4.9 ~ 5.9 50 ~ 60 3.61 ~ 4.35
5	Ø26 ~ 38	68311-72820	4.9 ~ 5.9 50 ~ 60 3.61 ~ 4.35
6	Ø13 ~ 20	RB101-63630	3.4 ~ 4.4 35 ~ 45 2.58 ~ 3.31
7	Ø40 ~ 55	35820-15180	4.9 ~ 5.9 50 ~ 60 3.61 ~ 4.35

(7) Nuts for piping

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

(8) Tightening torque of bolts and nuts

Refere to the tightness torque table below.

Nomial Dia. / Bolts, Nuts	4T 4	7T 7	9T 9
	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	4	No mark or marked 4
7T	S40C S45C	Over 686 MPa 7000 kgf/cm^2 99561 lbf/in^2	H_RC 20 ~ 28	7	Marked 7
9T	SCr4	Over 882 MPa 9000 kgf/cm^2 128007 lbf/in^2	H_RC 28 ~ 34	9	Marked 9

II. Machine body(Mechanism section)

A.Front attachment

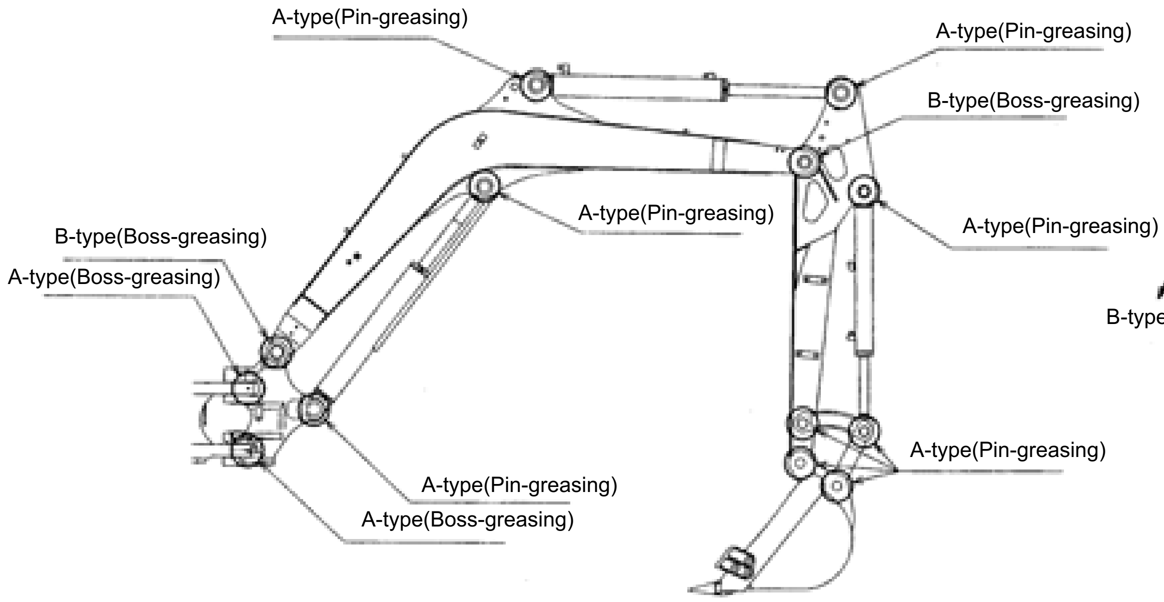
a. Greasing points

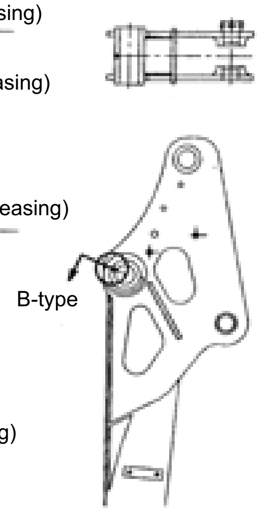
(1) Keep applying grease until it comes out of the circumference at the other end surface of each rotating part.
(2) Apply grease to the end surfaces of all the rotating parts and their related shims.


A-type: Straight type
(06611-15010)

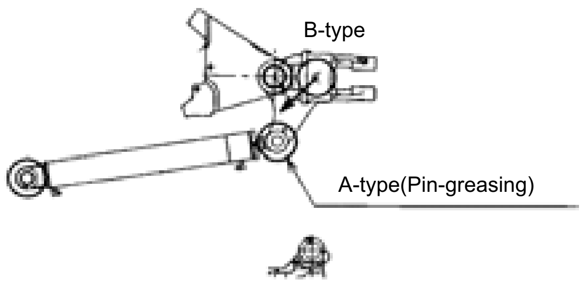

B-type: 67°C
(06616-25010)


C-type: 90°C
(06616-35010)

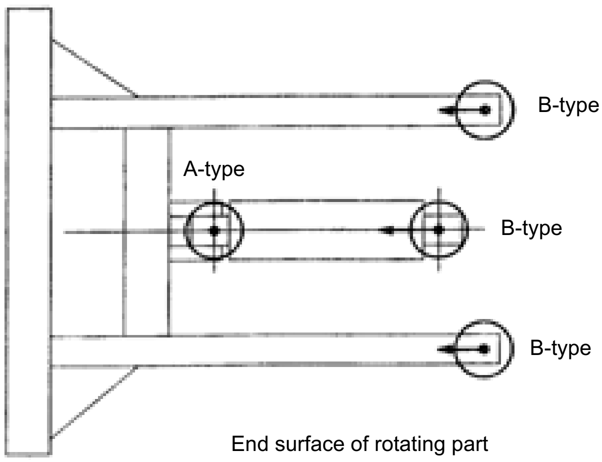


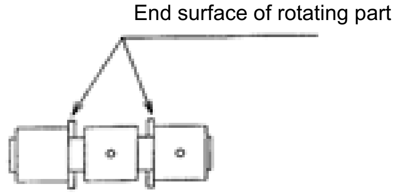


Arm

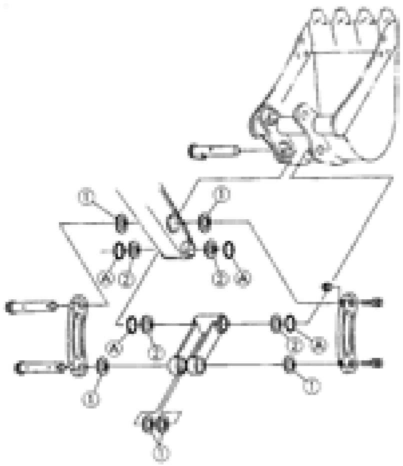


Swing bracket



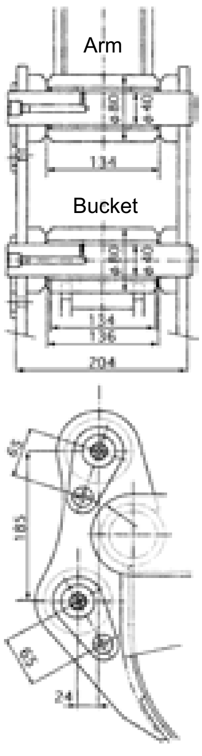
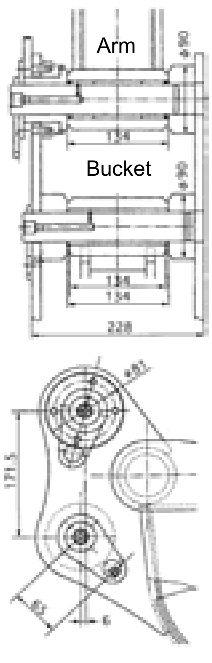
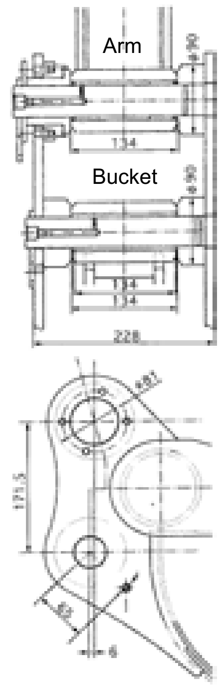
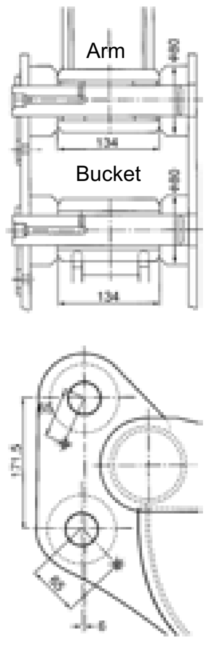


b. Bucket interchangeability



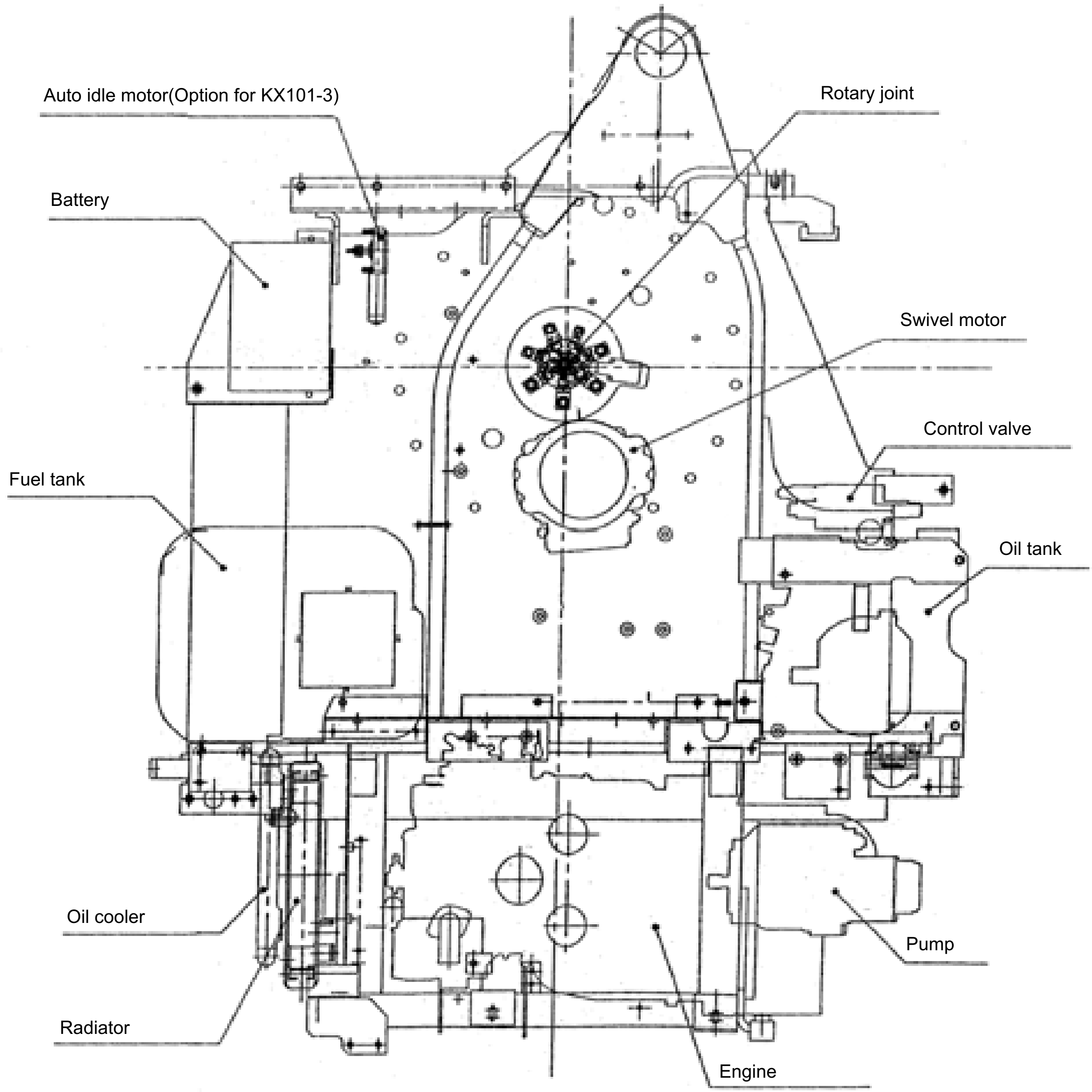
1. The bucket support is the same in dimensions for the three types (KX91-3, 101-3 and U35-3). This means the bucket is interchangeable among the five types.
2. The KX series bucket can be readily installed on the machine. (The KX-3 series pins should be employed.)
3. The bucket shims (for the arms and bucket link couplings) are not used if an old-type bucket is installed. For the KX-3 series bucket, however, be sure to apply these shims.

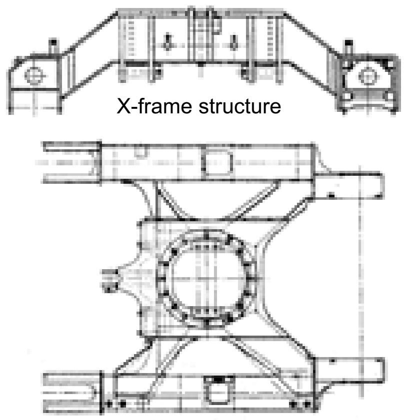
(1)Shim(0.5, 1.0mm-outer dia75mm, Inner dia41mm)
(2)Shim(0.5, 1.0mm-outer dia64mm, Inner dia41mm)
(3)O-ring ϕ 80mm)

		KX-3 series bucket	U-35 bucket	KX91-2 bucket	KX-91,101 series bucket
		With KX-3 series pins, arms and bucket links			
					
Attachable		○	○	○	○
Problems when attached	Pin	-	Short in length. Pin stopper bolt position out of alignment → Use the old-type pins.	Same as left	KX-3 series pin.
	O-ring	-	Boss diameter out of spec (L series: 80 mm dia., old type: 90 mm dia.) → Use the specific O-rings.	Boss diameter out of spec (L series: 80 mm dia., old type: 90 mm dia.) → Use the specific O-rings.	Same as left
	Interference between bucket, arm and boom	-	-	-	-

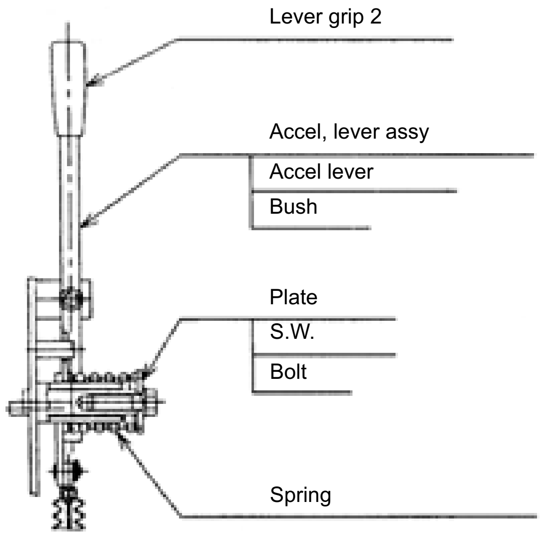
B.Swivel frame and components

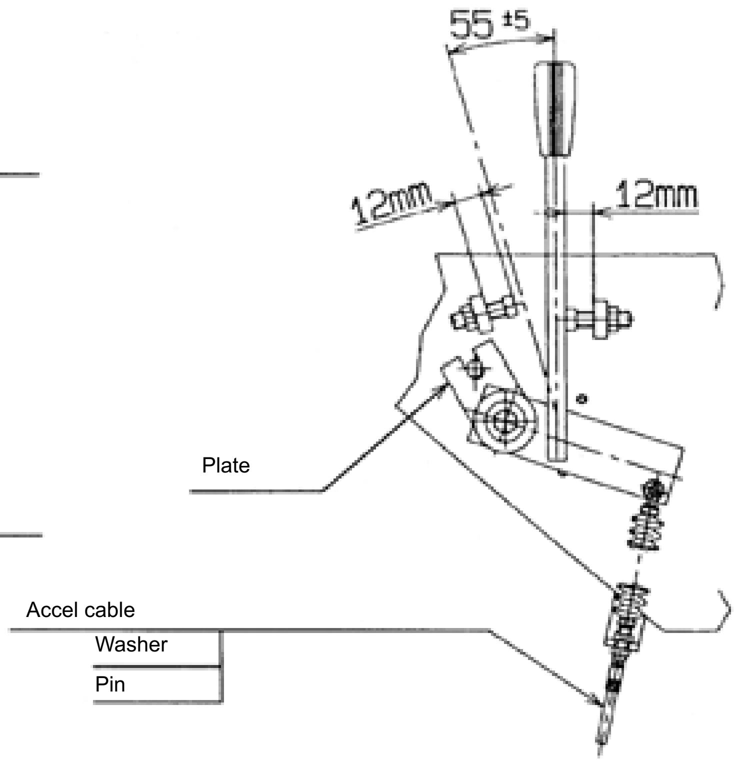
KX91-3, 101-3





a. Accel lever (Standard-version)





(1) Engine RPM

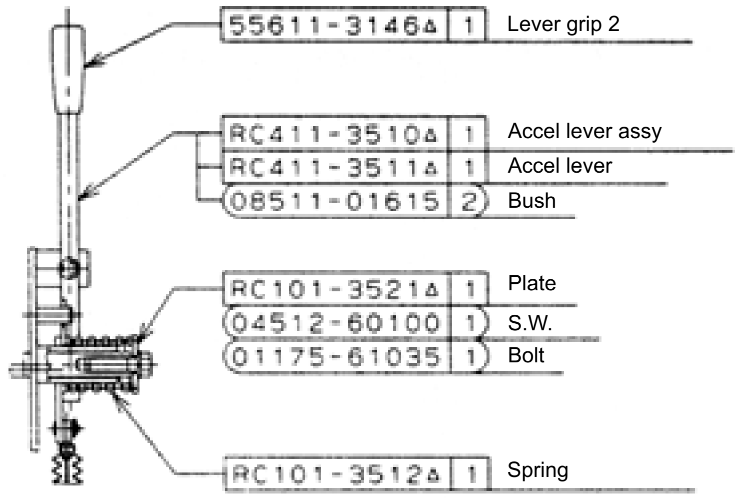
Idling
1000~1100 rpm

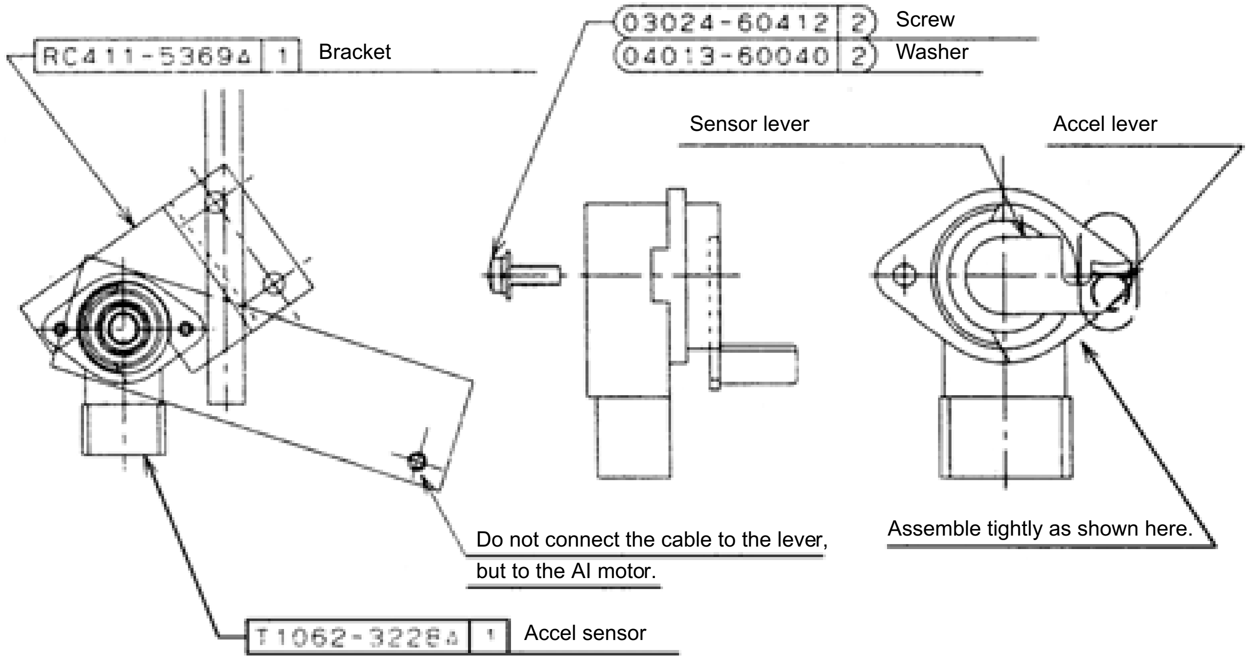
(2) Accel lever operating force

No load Max. RPM
KX91-3: 2300~2450 rpm
KX101-3: 2400~2550 rpm
Idling to Max., 3.5 kgf
Max. to idling, 3.5 kgf

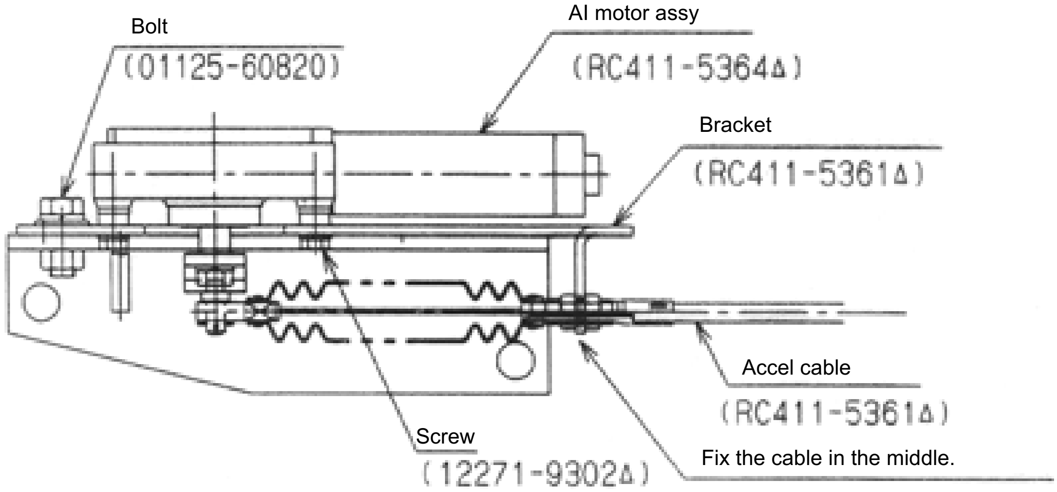
b. Auto idle-version

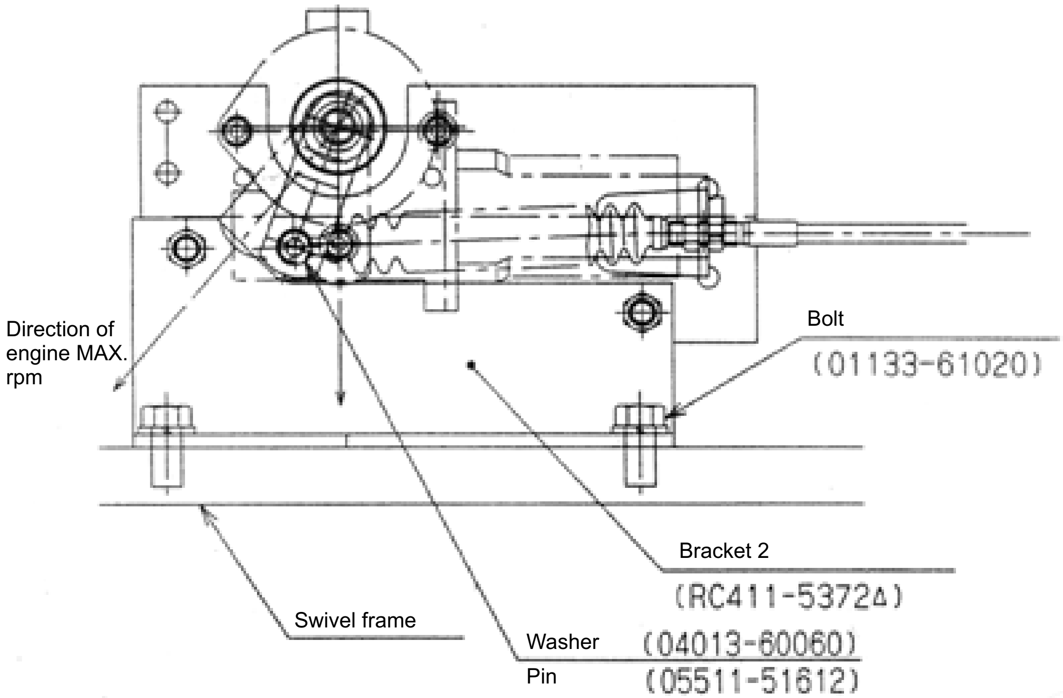
(1) Accel lever side



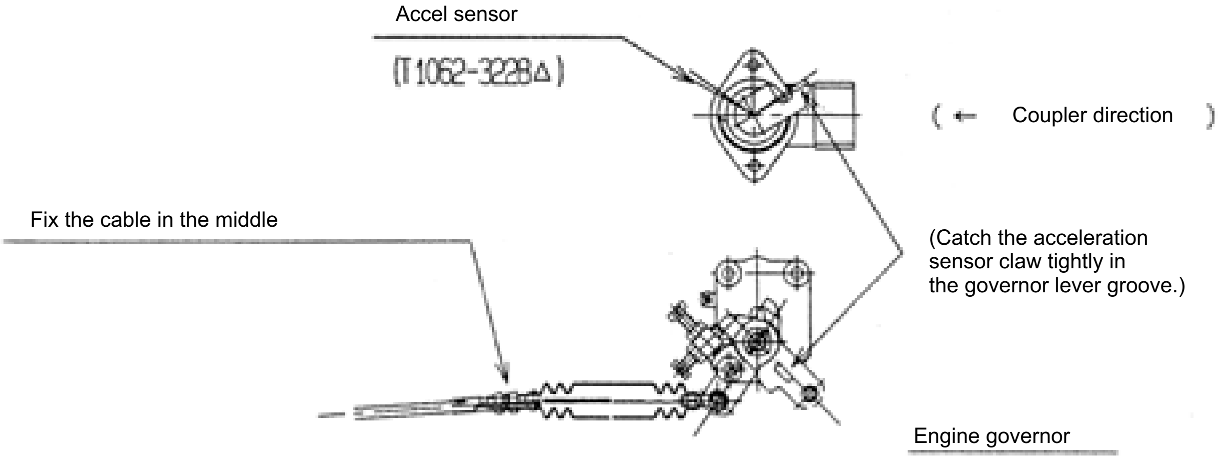


(2) AI motor side

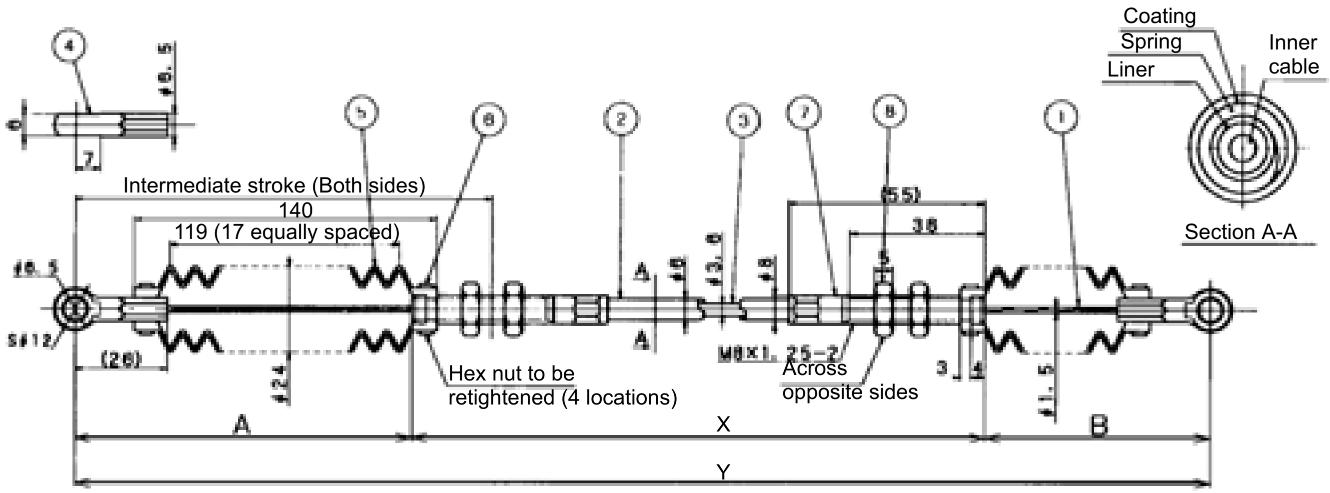




(3) Engine side



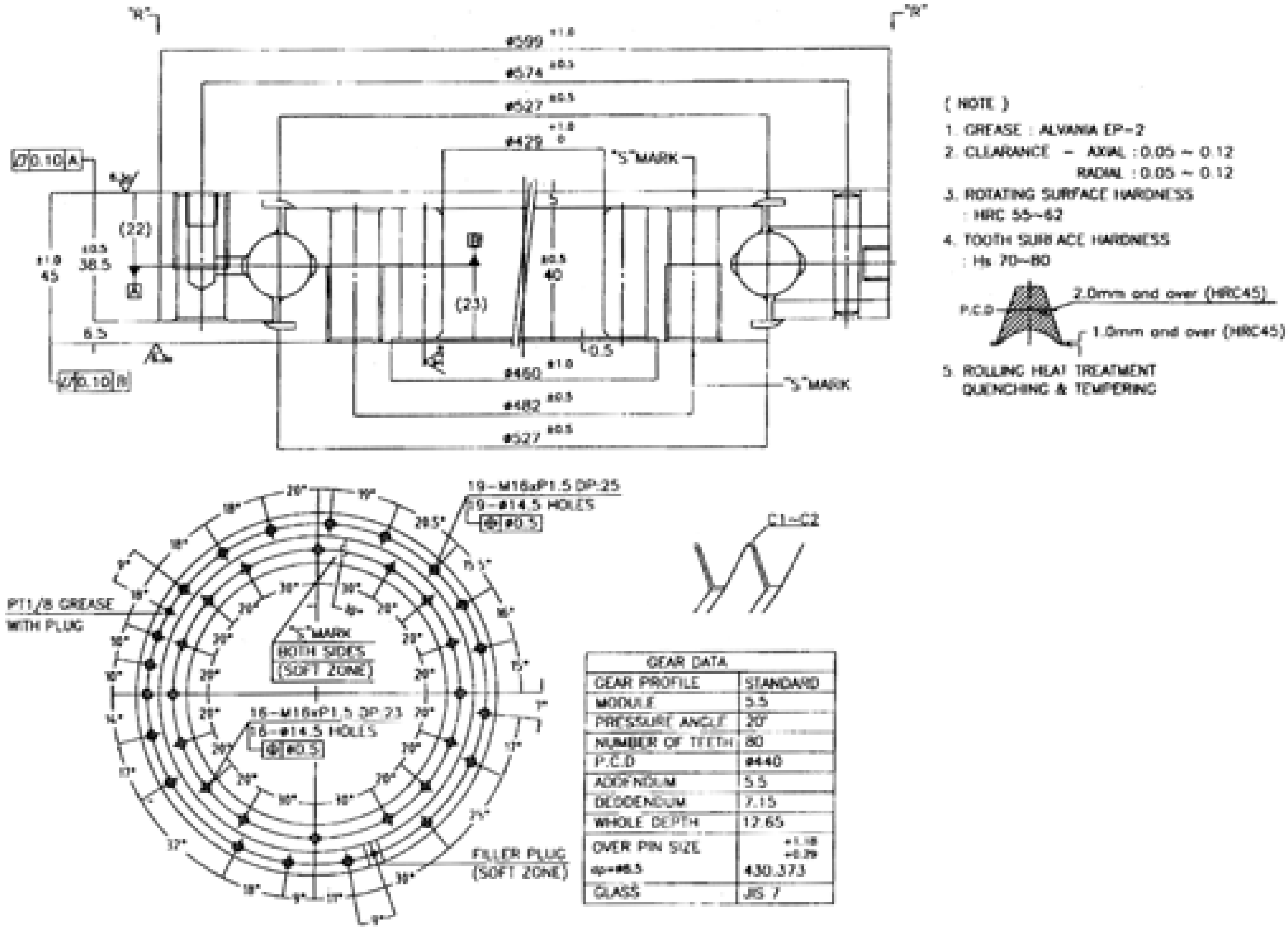
c. Accel cable



mm (inch)

Accel cable	code No.	X	Y
Standard model	RC411-35151	1141(44.9)	1350(53.1)
Auto idle model	RC411-53631	1291(50.8)	1500(59.1)

d. Swivel bearing



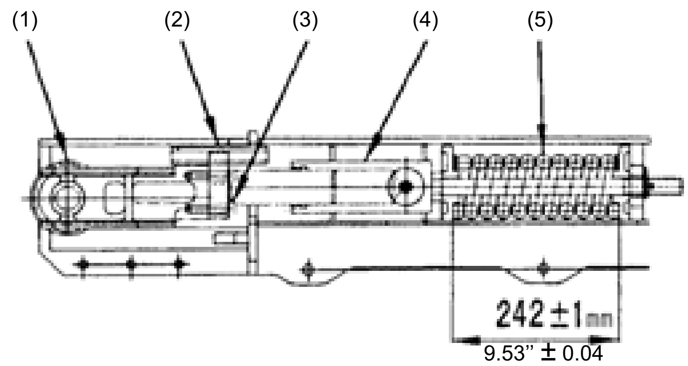
(1)	Outer race	(4)	Filler plug ϕ22	(7)	Seal
(2)	Inner race	(5)	Ball ϕ19.05	(8)	Grease Nipple PT1/8
(3)	Pin ϕ8	(6)	Support		

C.Track frame and components

a. Tension spring pre-set length

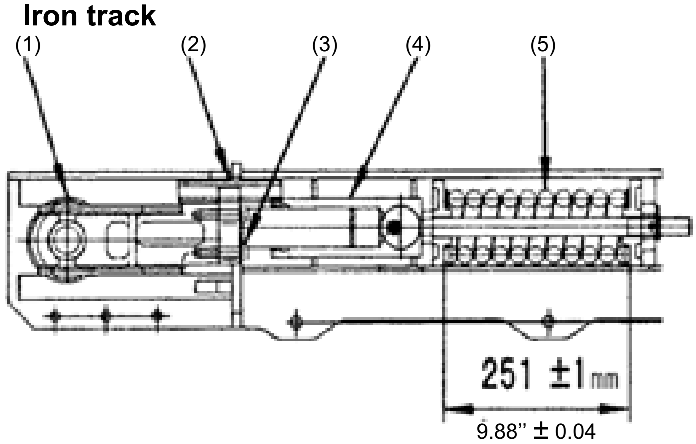
* Set to the cotter pin closest to the following dimension.

Rubber track

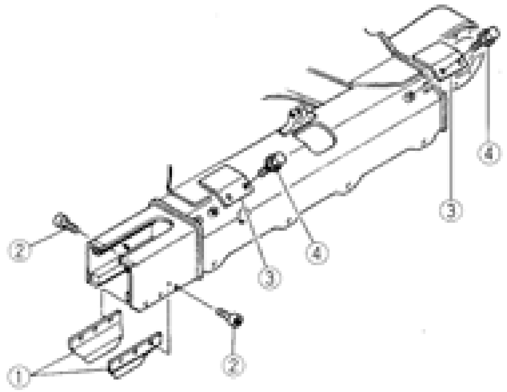


No	Part
(1)	Idler assy
(2)	Plate
(3)	Bolt
(4)	Cylinder assy R
(*)	Cylinder assy L
(5)	Spring assy

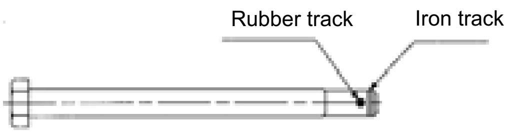
Iron track



b. Additional parts to change from rubber track to iron track



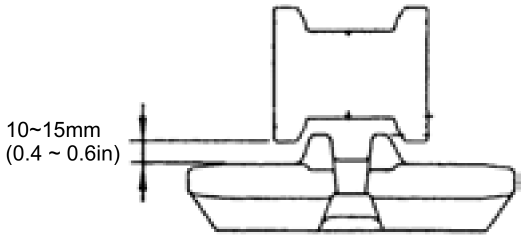
No	Part	Code No.	Q'ty
(1)	Guide	RC411-2182-0	4
(2)	Hollar bolt	68541-2118-0	12
(3)	Plate	RC411-2181-0	4
(4)	Bolt	01135-61225	8
* Reposition the nut to change the spring's pre-set length.			

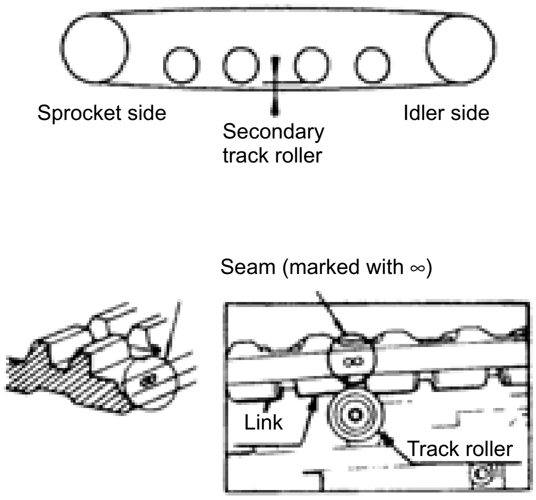


c. Track tension adjustment

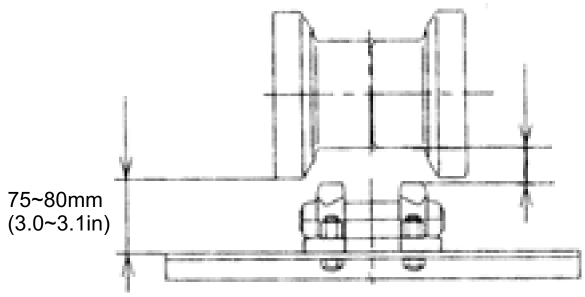
Rubber track

Run the rubber track so that its seam marking (∞) should come at the top center with the track idler roller between adjacent links.



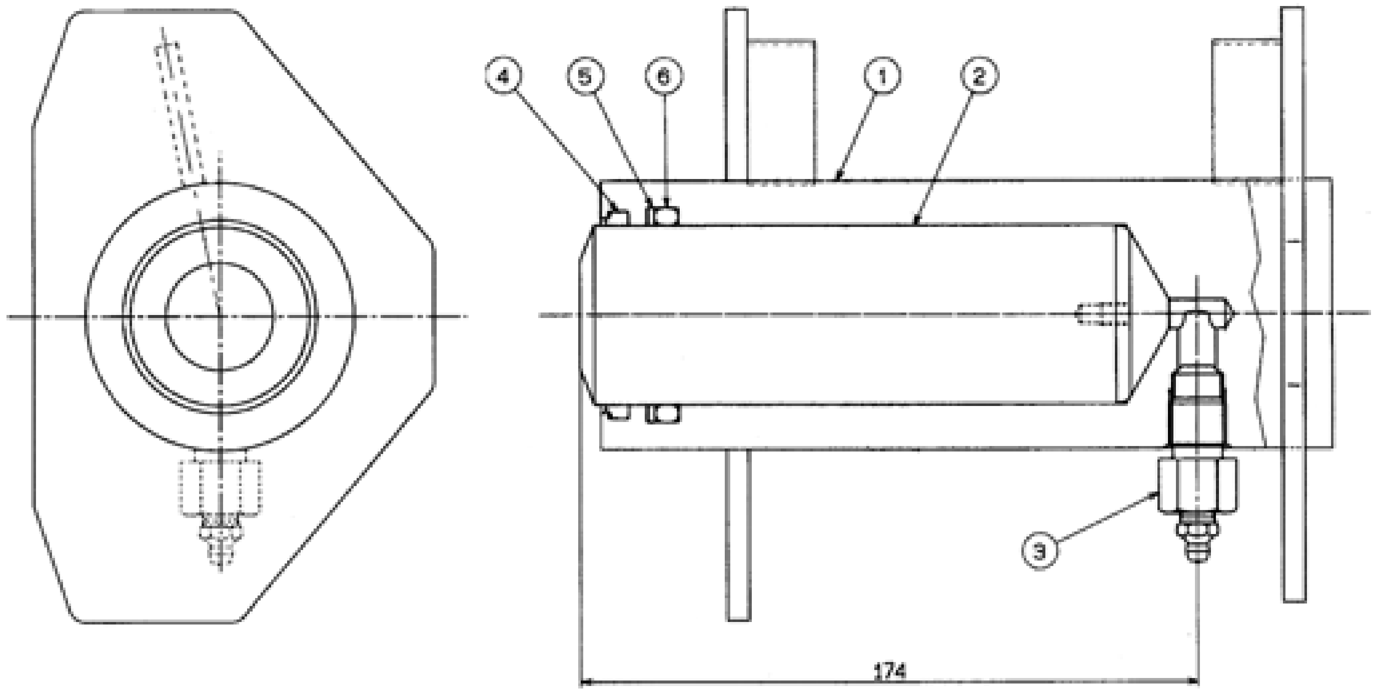


Iron track



d. Grease tension cylinder, L

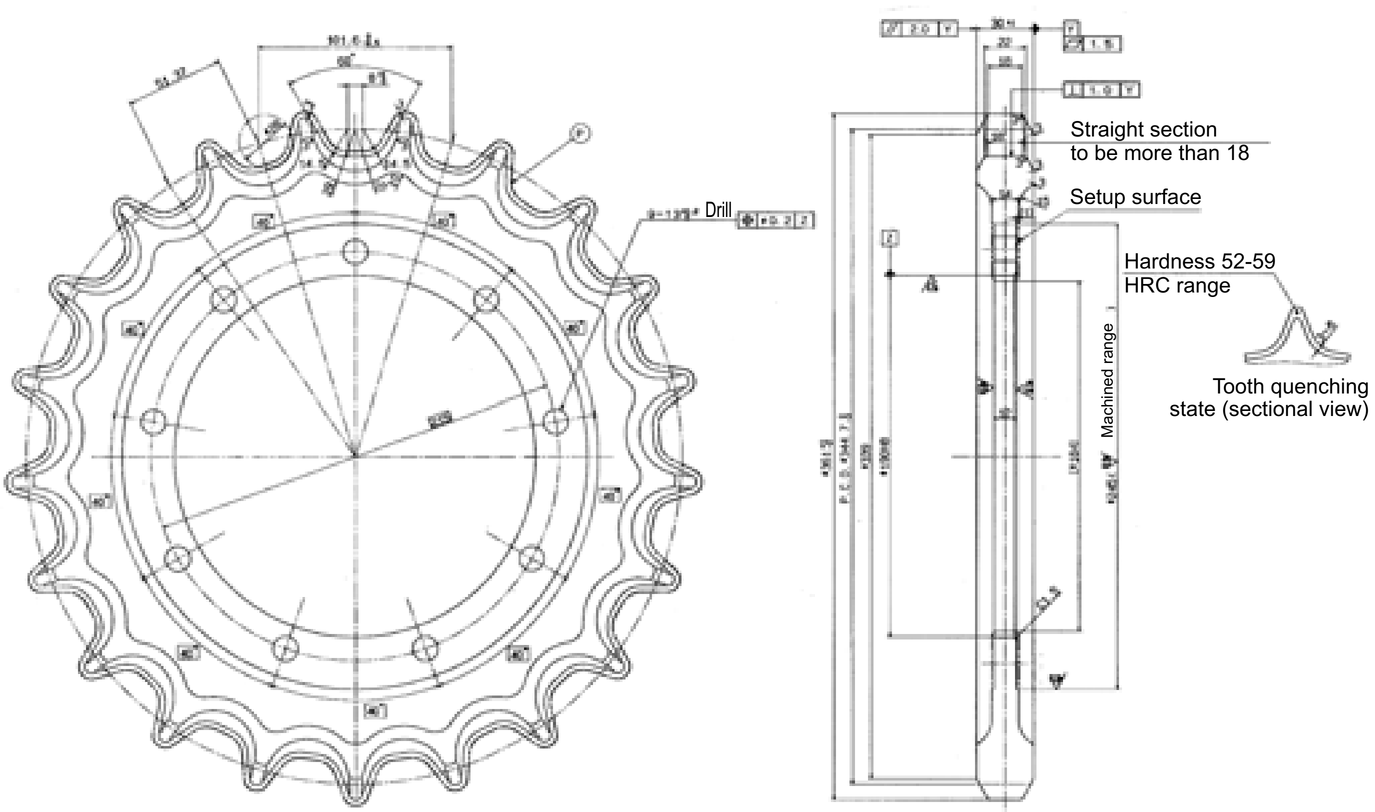
P/N = RC411-21503



(1)	Cylinder tube, L	(3)	Nipple, assy	(5)	Bulk up ring 60
(2)	Rod	(4)	Dust seal	(6)	O-ring

1. Durable pressure = 44.1 MPa (450 kgf/cm^2)
   No pressure leakage is allowed at peak pressure of 98.1 MPa (1000 kgf/cm^2)
2. Tightening torque of grease nipple = 98~107.8 N·m (1~11 kgf·m)

e. Drive sprocket



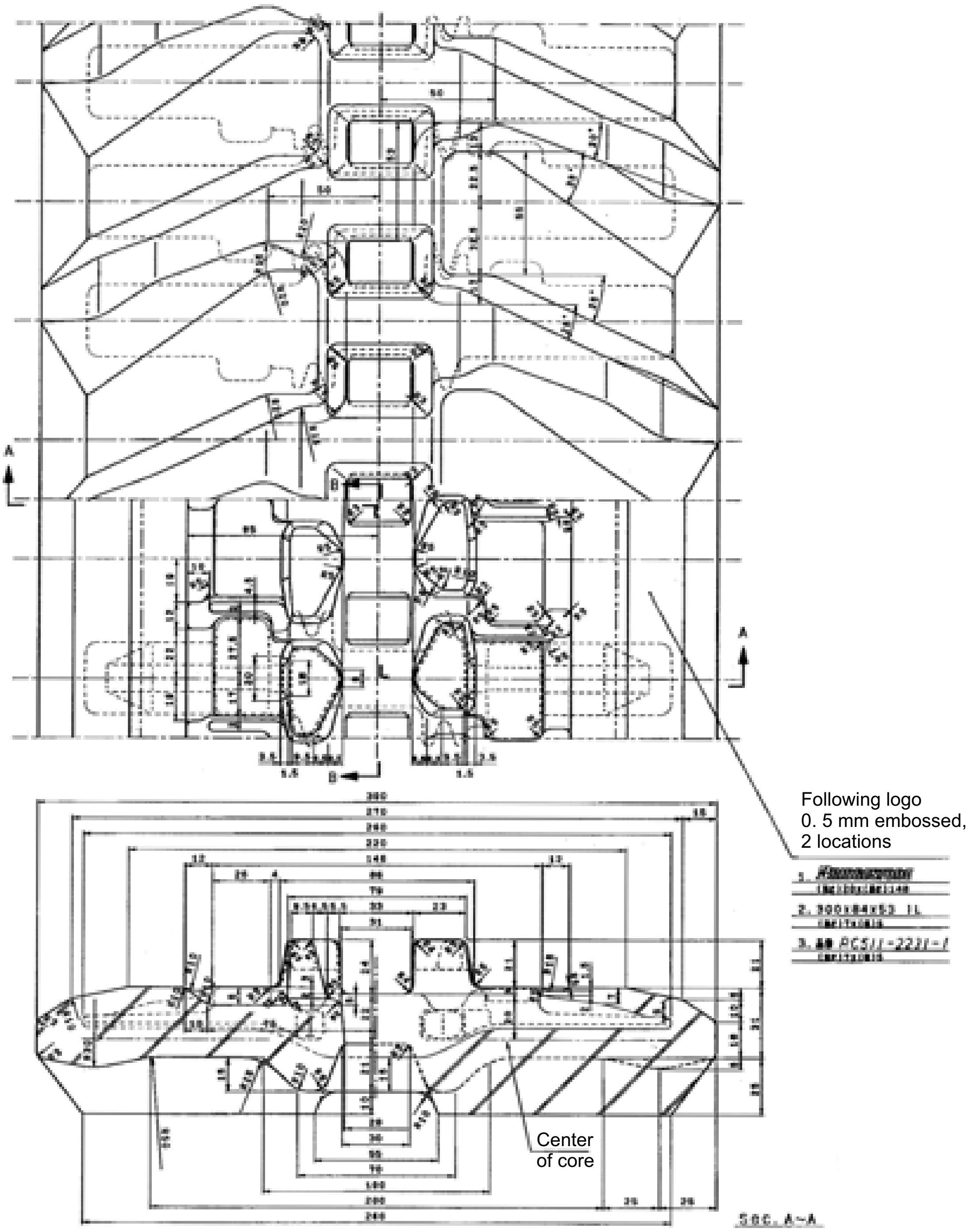
1. Reference pitch = $101.6^{0}_{-0.5}$
2. Number of torque = 21
3. P.C.D. = 344.7^{0}_{-3}
4. Outer dia = 361^{+1}_{-2}

f. Rubber track

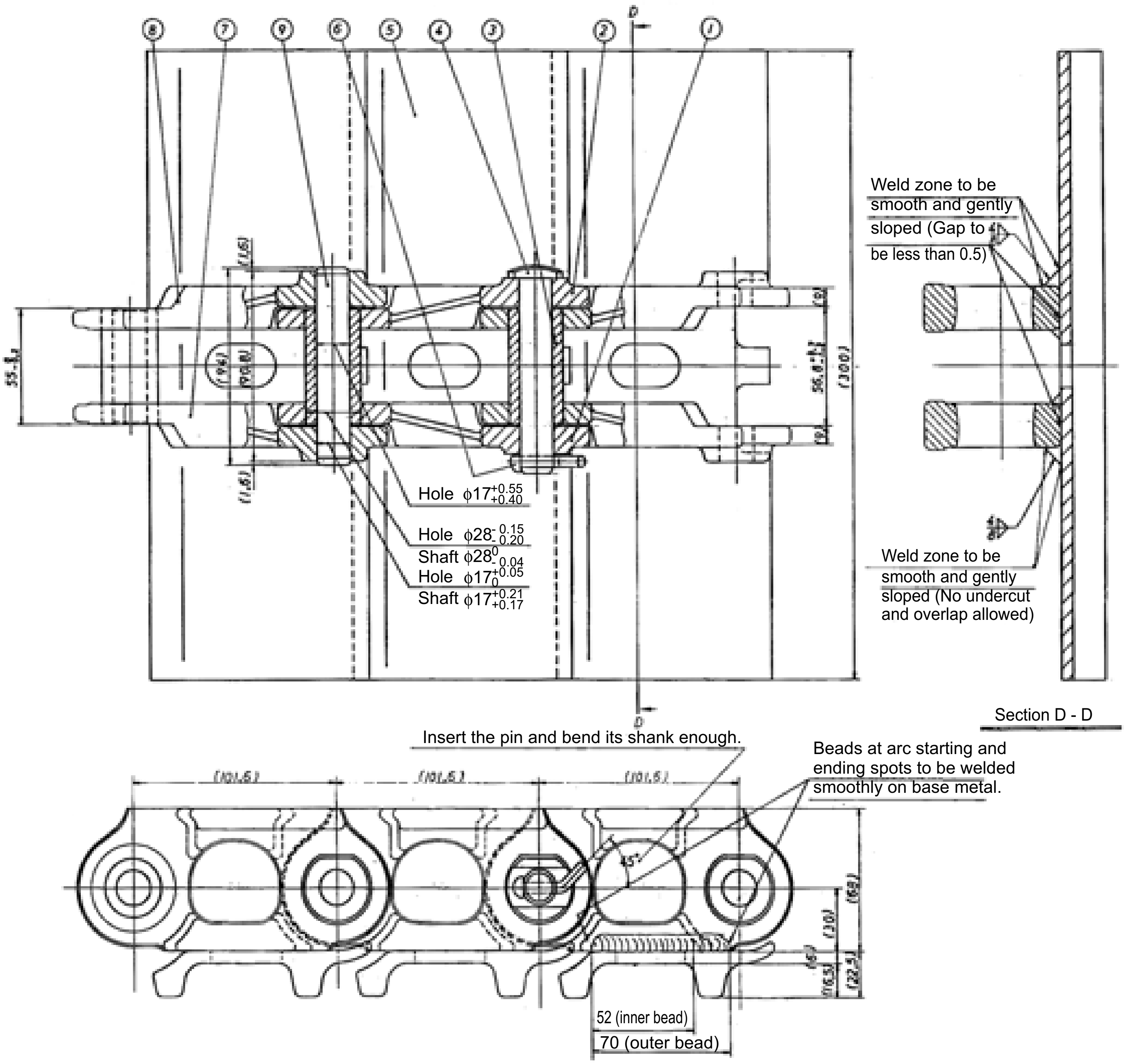
Part No. = RC511-22311
300 × 84 × 53

Specifications

1. Center circumference = 4452 ± 12 mm, 175.3 ± 0.5 inch
2. Steel cord strength = 9800 N/piece, 1000 kg/pc.
3. Steel cord number = 36^{+2}_{-0}
4. Rubber thickness = 31mm(1.23 inch)
   Endless = 36 mm(1.42 inch)
5. Rubber strength = 140 kgf/cm^2 or more
6. Steel cord overlap length = 9 pitch, 477 mm(18.8 inch)



g. Iron track



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

II. Machine body(Service section)

A.Specifications

a. Machine Weight

(1)KE, KDG, KUK version

			unit	KX91-3	KX101-3	
STD. Arm	Canopy	Rubber crawler	kg	3130	3410	
		Iron crawler	kg	3220	3500	
	Cabin	Rubber crawler	kg	3240	3520	
		Iron crawler	kg	3330	3610	
Long. Arm	Canopy	Rubber crawler	kg	3150	3430	
		Iron crawler	kg	3240	3520	
	Cabin	Rubber crawler	kg	3260	3540	
		Iron crawler	kg	3350	3630	

(2)KTC, KCL, KTA version

			KX91-3	
Canopy	Rubber crawler	kg lbs	3225 7110	
	Iron crawler	kg lbs	3320 7320	
Cabin	Rubber crawler	kg lbs	3325 7330	
	Iron crawler	kg lbs	3420 7540	

b. Machine specifications
(1) KE, KDG, KUK version

		Unit	KX91-3	KX101-3	
Engine					
Type			Vertical, water-cooled 4 cycle, 3 cylinders diesel	Vertical, water-cooled 4 cycle, 3 cylinders diesel	
Model			Kubota D1503-M-EBH-1-EC	Kubota D1503-M-EBH-2-EC	
Output power (DIN70020)		kW PS	19.6 kW/2200rpm 26.6 PS/2200rpm	20.3 kW/2300rpm 27.5 PS/2300rpm	
Displacement		cc	1499	1499	
Dimensions					
Overall length		mm	4760	4920	
Overall width		mm	1550	1550	
Overall crawler width		mm	1550	1550	
Overall height	Canopy	mm	2440	2440	
	Cabin	mm	2440	2440	
Min. ground clearance		mm	289	289	
Max. digging depth	STD. Arm	mm	2900	3095	
	Long Arm	mm	3175	3295	
Max. digging height	STD. Arm	mm	4790	4975	
	Long Arm	mm	4920	5110	
Max. digging radius	STD. Arm	mm	4995	5205	
	Long Arm	mm	5235	5395	
Max. dumping height	STD. Arm	mm	3400	3580	
	Long Arm	mm	3540	3725	
Swing angle (left/right)		deg	80 / 50	80 / 50	
Travel speed	Low speed	km/h	3.0	3.0	
	High speed	km/h	4.6	4.6	
Swing speed		rpm	8.9	8.9	
Max. traction force	Low speed	kN kgf	26.0 2655	27.1 2765	
	High speed	kN kgf	14.6 1485	15.2 1546	
Performance					
Tumbler distance		mm	1560	1670	
Tread		mm	1250	1250	
Crawler width × No. of shoe × pitch		mm	300 × 80 × 53	300 × 84 × 53	Rubber crowler
Bucket					
Capacity CECE heaped		m3	0.078	0.093	
Width		mm	470	550	
Dozer					
Width × height		mm	1550 × 335	1550 × 335	
Lift above GL / below GL		mm	350/330	350/330	

Note:Kubota Japan Bucket

(2)KTC, KCL, KTA version

		KX91-3			
Engine					
Type		Vertical, water-cooled 4 cycle, 3 cylinders diesel			
Model		Kubota D1503-M-BH			
Gross engine output (SAE J1349)		20.9 kW/2300 rpm 27.9 PS/2300 rpm			
Displacement		1499 cc	91.4 in^3		
Dimensions					
Overall length		4760mm	187.4in		
Overall width		1550mm	61.0in		
Overall crawler width		1550mm	61.0in		
Overall height	Canopy	2440mm	96.1in		
	Cabin	2440mm	96.1in		
Min. ground clearance		289mm	11.4in		
Max. digging depth	STD. Arm	3185 mm	125.4 in		
Max. digging height	STD. Arm	4940 mm	194.5 in		
Max. digging radius	STD. Arm	5245 mm	206.5 in		
Max. dumping height	STD. Arm	3530 mm	139.0 in		
Swing angle (left/right)		80 / 50			
Travel speed	Low speed	3.0 km/h	1.9 mph		
	High speed	4.8 km/h	3.0 mph		
Swing speed		9.4 rpm			
Max. traction force	Low speed	26.0 kN 2655 kgf	5853 lbf		
	High speed	14.6 kN 1485 kgf	3274 l bf		
Performance					
Tumbler distance		1560 mm	61.4 in		
Tread		1250 mm	49.2 in		
Crawler width × No. of shoe × pitch (Rubber crawler)		300 mm × 80 × 53 mm	11.8in × 80 × 2.09in		
Bucket					
Capacity heaped		0.1 m^3	3.53 ft^3		
Width		555 mm	21.9 in		
Dozer					
Width × height		1550 × 335 mm	61.0 × 13.2		
Lift above GL / below GL		350/330 mm	13.8/13.0 in		

NOTE : Kubota Japan Bucket

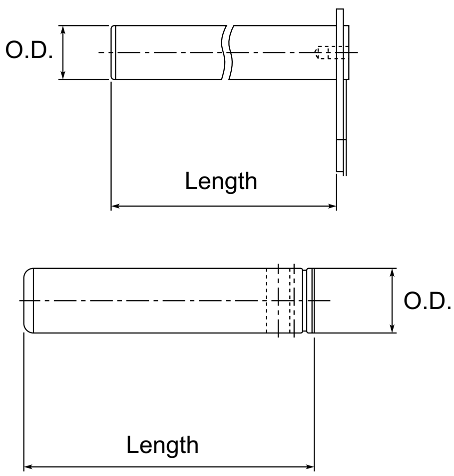
c. Lever stroke and operating force

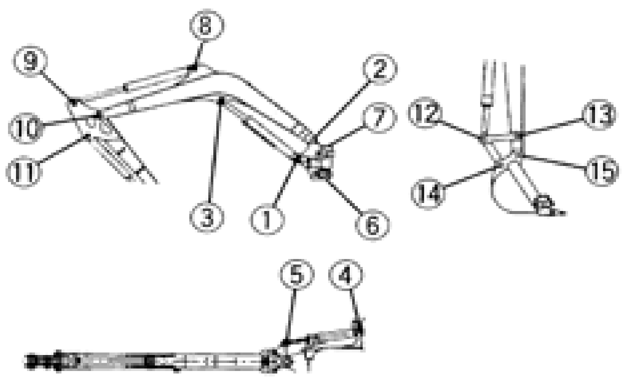
		Unit	KX91-3	KX101-3		Remarks
Boom	Stroke	mm in.	110/110 4.3/4.3	←		Up / Down
	Force	N kgf lbs	17/14 1.7/1.4 3.7/3.1	←		Up / Down
Arm	Stroke	mm in.	110/110 4.3/4.3	←		Crowd / Dump
	Force	N kgf lbs	17/14 1.7/1.4 3.7/3.1	←		Crowd / Dump
Bucket	Stroke	mm in.	85/85 3.3/3.3	←		Crowd / Dump
	Force	N kgf lbs	12/12 1.2/1.2 2.6/2.6	←		Crowd / Dump
Swivel	Stroke	mm in.	85/85 3.3/3.3	←		Right / Left
	Force	N kgf lbs	12/12 1.2/1.2 2.6/2.6	←		Right / Left
Travel	Stroke	mm in.	75/75 3.0/3.0	←		F / R
	Force	N kgf lbs	18/18 1.8/1.8 4.0/4.0	←		F / R
Dozer	Stroke	mm in.	55/55 2.2/2.2	←		Up / Down
	Force	N kgf lbs	25/25 2.6/2.6 5.7/5.7	←		Up / Down
Acceleration	Force	N kgf lbs	34/34 3.5/3.5 7.7/7.7	←		
Swing pedal	Force	N kgf lbs	59/59 6/6 13.2/13.2	←		Up / Down
Safety lock lever (Left)	Force	N kgf lbs	26/59 2.7/6.0 6.0/13.2	←		
Safety lock lever (Right)	Force	N kgf lbs	8/4 0.8/0.4 1.8/0.9	←		
Traveling Hi/Low change pedal	Force	N kgf lbs	15 1.5 3.3/3.3	←		

d. Dimensions of Parts

(1) Front pins

No.		Unit	KX91-3	KX101-3		Allowable wear limit
1	Pin diameter × length	mm in.	ϕ40 × 160 ϕ1.57 ×6.30	←		
2	Pin diameter × length	mm in.	ϕ50 × 278 ϕ1.97 × 10.94	←		
3	Pin diameter × length	mm in.	ϕ40 × 155 ϕ1.57 × 6.10	←		
4	Pin diameter × length	mm in.	ϕ40 × 132 ϕ1.57 × 5.20	←		
5	Pin diameter × length	mm in.	ϕ40 × 114 ϕ1.57 × 4.49	←		
6	Pin diameter × length	mm in.	ϕ70 × 141.5 ϕ2.76 × 5.57	←		
7	Pin diameter × length	mm in.	ϕ70 × 155 ϕ2.76 × 6.10	←		
8	Pin diameter × length	mm in.	ϕ45 × 172 ϕ1.77 × 6.77	←		
9	Pin diameter × length	mm in.	ϕ45 × 172 ϕ1.77 × 6.77	←		
10	Pin diameter × length	mm in.	ϕ40 ×239 ϕ1.57 × 9.41	←		
11	Pin diameter × length	mm in.	ϕ40 × 155 ϕ1.57 × 6.10	←		
12	Pin diameter × length	mm in.	ϕ40 × 193 ϕ1.57 × 7.60	←		
13	Pin diameter × length	mm in.	ϕ40 × 193 ϕ1.57 × 7.60	←		
14	Pin diameter × length	mm in.	ϕ40 × 233 ϕ1.57 × 9.17	←		
15	Pin diameter × length	mm in.	ϕ40 × 233 ϕ1.57 × 9.17	←		



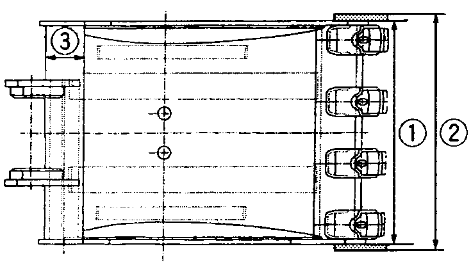


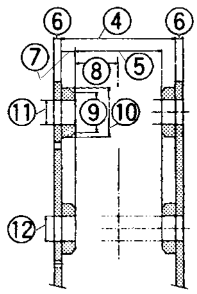
(2) Bucket

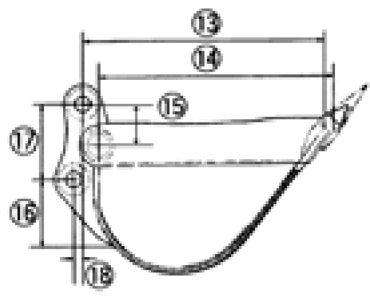
1) Bucket dimensions

No.	Unit	KX91-3	KX101-3		Remarks
1	mm in.	45.2 17.8	532 20.9		
2	mm in.	470 18.5	550 21.7		
3	mm in.	ϕ76.3 × t9.5 ϕ3.00 × t0.37	←		
4	mm in.	180 7.09	←		
5	mm in.	136 5.35	←		
6	mm in.	12 0.47	←		
7	mm in.	22 0.87	←		
8	mm in.	68 2.68	←		
9	mm in.	ϕ65 ϕ2.56	←		
10	mm in.	ϕ80 ϕ3.15	←		
11	mm in.	ϕ40 ϕ1.57	←		
12	mm in.	ϕ40 ϕ1.57	←		
13	mm in.	613 24.1	←		
14	mm in.	594 23.4	←		
15	mm in.	103 4.06	←		
16	mm in.	170 6.69	←		
17	mm in.	185 7.28	←		
18	mm in.	24 0.94	←		

NOTE: KUBOTA JAPAN BUCKET





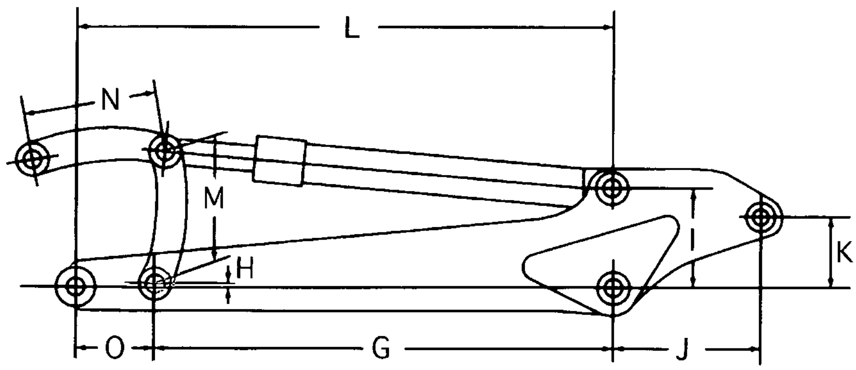


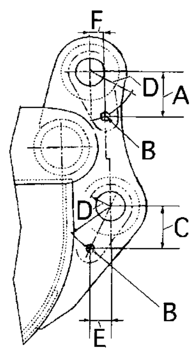
2) Bucket installation relevant dimensions

1. KE, KDG, KUK version

No.	Unit	KX91-3	KX101-3		Remarks
A	mm	62	←		
B	mm	M12 × 1.25	←		
C	mm	58	←		
D	mm	65	←		
E	mm	29.5	←		
F	mm	19.5	←		
G	mm	1275	1350		
H	mm	7.5	←		
I	mm	259	←		
J	mm	295	301		
K	mm	153	140.5		
L	mm	1151	←		
M	mm	310	←		
N	mm	310	←		
O	mm	165	←		

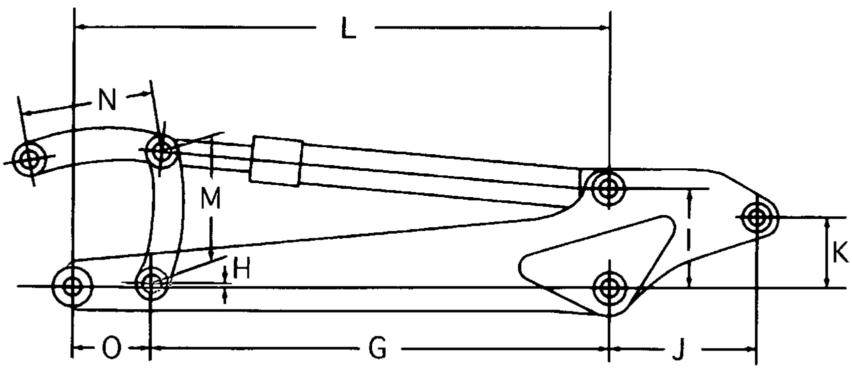
NOTE: KUBOTA JAPAN BUCKET
STANDARD ARM

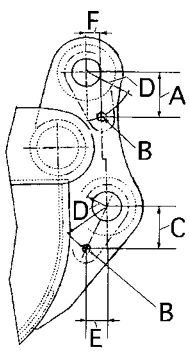




2. KTC, KCL, KTA version

No.	Unit	KX91-3		Remarks
A	mm in	62 2.44		
B	mm in	M12 × 1.25		
C	mm in	58 2.28		
D	mm in	65 2.56		
E	mm in	29.5 1.16		
F	mm in	19.5 0.77		
G	mm in	1550 61.0		
H	mm in	10 0.4		
I	mm in	260 10.2		
J	mm in	301 11.9		
K	mm in	140.5 5.5		
L	mm in	1235 48.6		
M	mm in	310 12.2		
N	mm in	310 12.2		
O	mm in	175 6.9		





(3) Rubber crawler

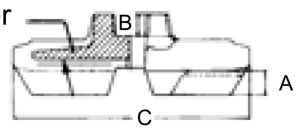
	Unit	KX91-3	KX101-3		Remarks
Identification mark (Core steel rapping position)		∞	∞		
A : Lug height	mm in.	25 0.98	←		
B : Idler side height	mm in.	24 0.94	←		
C : Crawler width	mm in.	300 11.81	←		
D : Crawler sag distance	mm in.	10 ~ 15 0.39 ~ 0.59	←		
Number of Core Iron		80	84		
Rubber crawler center round length	mm in.	4240 166.93	4452 175.28		
Core Iron pitch	mm in.	53 2.09	←		

(4) Iron crawler

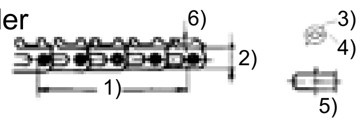
	Unit	KX91-3	KX101-3		Remarks
Crawler width	mm in.	300 11.81	←		
1) Length (A)/(B)	mm in.	406.4/416.4 16.00/16.39	←		
2) Height (A)/(B)	mm in.	68/63 2.68/2.48	←		
3) Bushing O.D. (A)/(B)	mm in.	28.0/26.5 1.10/1.04	←		
4) Bushing I.D. (A)/(B)	mm in.	17.0/19.0 0.67/0.61	←		
5) Master pin O.D. (A)/(B)	mm in.	17.0/15.5 0.67/0.61	←		
6) Grouser Height (A)/(B)	mm in.	16.5/8.0 0.65/0.31	←		
7) Crawler sag distance (1)	mm in.	85 ~ 90 3.35 ~ 3.54	←		
8) Crawler sag distance (2)	mm in.	40 ~ 45 1.57 ~ 1.77	←		
Number of links		41	43		

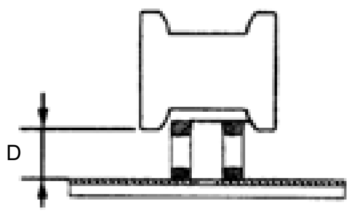
(A)New machine reference value
(B)Allowable limit

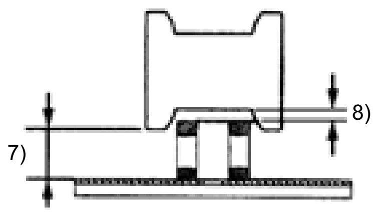
Rubber crawler



Iron crawler



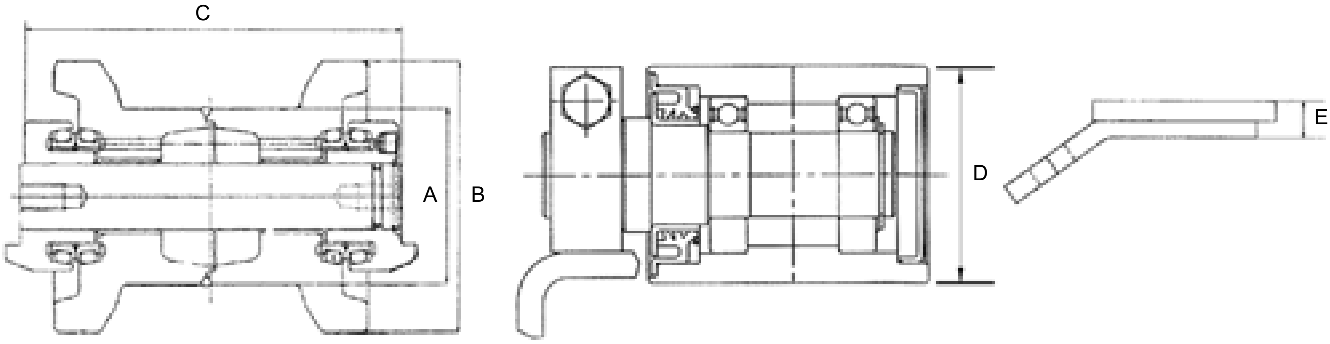




(5) Track toller, idler, sprocket

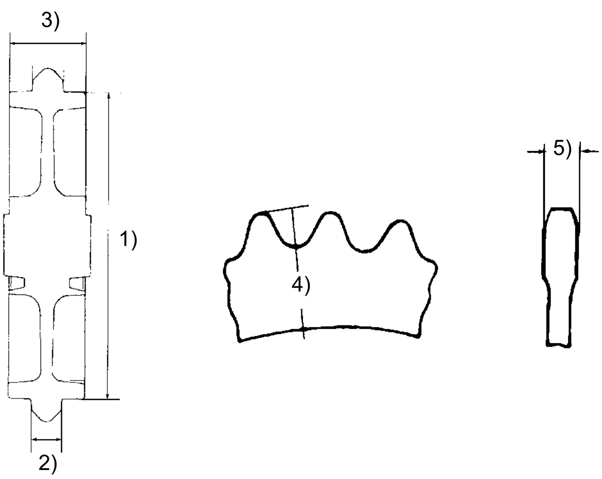
	Unit	KX91-3	KX101-3		Remarks
A : Guide width (A)/(B)	mm in.	80/76 3.15/2.99	←		
B : Outer diameter (A)/(B)	mm in.	124/120 4.88/4.72	←		
C : Roller width (A)/(B)	mm in.	175/167 6.89/6.57	←		
D : Upper roller diameter (A)/(B)	mm in.	76.3/72.4 3.00/2.85	←		
E : Sliding plate thickness (A)/(B)	mm in.	18/9 0.71/0.35	←		

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



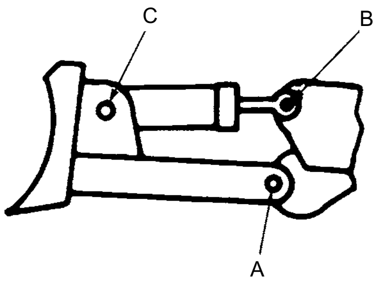
	Unit	KX91-3	KX101-3		Remarks
1) Idler O.D. (A)/(B)	mm in.	336/328 13.2/12.9	←		
2) Guide width (A)/(B)	mm in.	30/26 1.18/1.02	←		
3) Idler width (A)/(B)	mm in.	72/64 2.83/2.52	←		
4) Sprocket wheel O.D.. (A)/(B)	mm in.	361/353 14.21/13.09	←		
5) Sorocket wheel width (A)/(B)	mm in.	30/26 1.18/1.02	←		

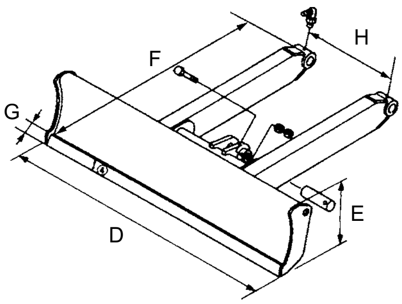
(A)New machine reference value
(B)Allowable limit



(6) Dozer

	Unit	KX91-3	KX101-3		Remarks
A : Pin diameter × length	mm in.	ϕ40 × 161 ϕ1.57 × 6.34	←		
B : Pin diameter × length	mm in.	ϕ45 × 131 ϕ1.77 × 5.16	←		
C : Pin diameter × length	mm in.	ϕ45 × 131 ϕ1.77 × 5.16	←		
D : Dozer width	mm in.	1550 61.02	←		
E : Dozer height	mm in.	336.5 13.25	←		
F : Dozer length	mm in.	1112 43.78	←		
G : Dozer tip plate height × thickness	mm in.	65 × 12 2.56 × 0.47	←		
H : Length between dozer arms	mm in.	483 19.01	←		





(7) Parts weight

1) KE, KDG, KUK version

	KX91-3	KX101-3	U35	Remarks
Track frame	360	←		
Swivel frame	400	←		
Swivel bracket	71	←		
Boom	123	129		
Standard arm	66	71		
Long arm	84	←		
Bucket	62	69		
Dozer	117	←		
Weight (left)	16	←		
Weight (right)	18	←		
Weight (rear)	274	464		
Rubber crawler	125	135		
Iron crawler	168	177		
Arch	38	←		
Engine	155	←		Dry weight
Hydraulic tank	29	←		With filter
Fuel tank	7	←		
Swivel bearing	36	←		
Buttery	18	←		
Track roller	8	←		
Upper roller	3	←		
Rops/Fops canopy	74	←		
Rops/Fops cabin	188	←		
Pump	28	←		
Traveling motor	38	←		
Swivel motor	37	←		
Control valve	34	←		Without adaptor
Boom cylinder	32	←		With protector
Arm cylinder	30	←		
Bucket cylinder	20	←		
Swing cylinder	22	←		
Dozer cylinder	21	←		
Rotary joint	19	←		

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

2) KTC, KCL, KTA version

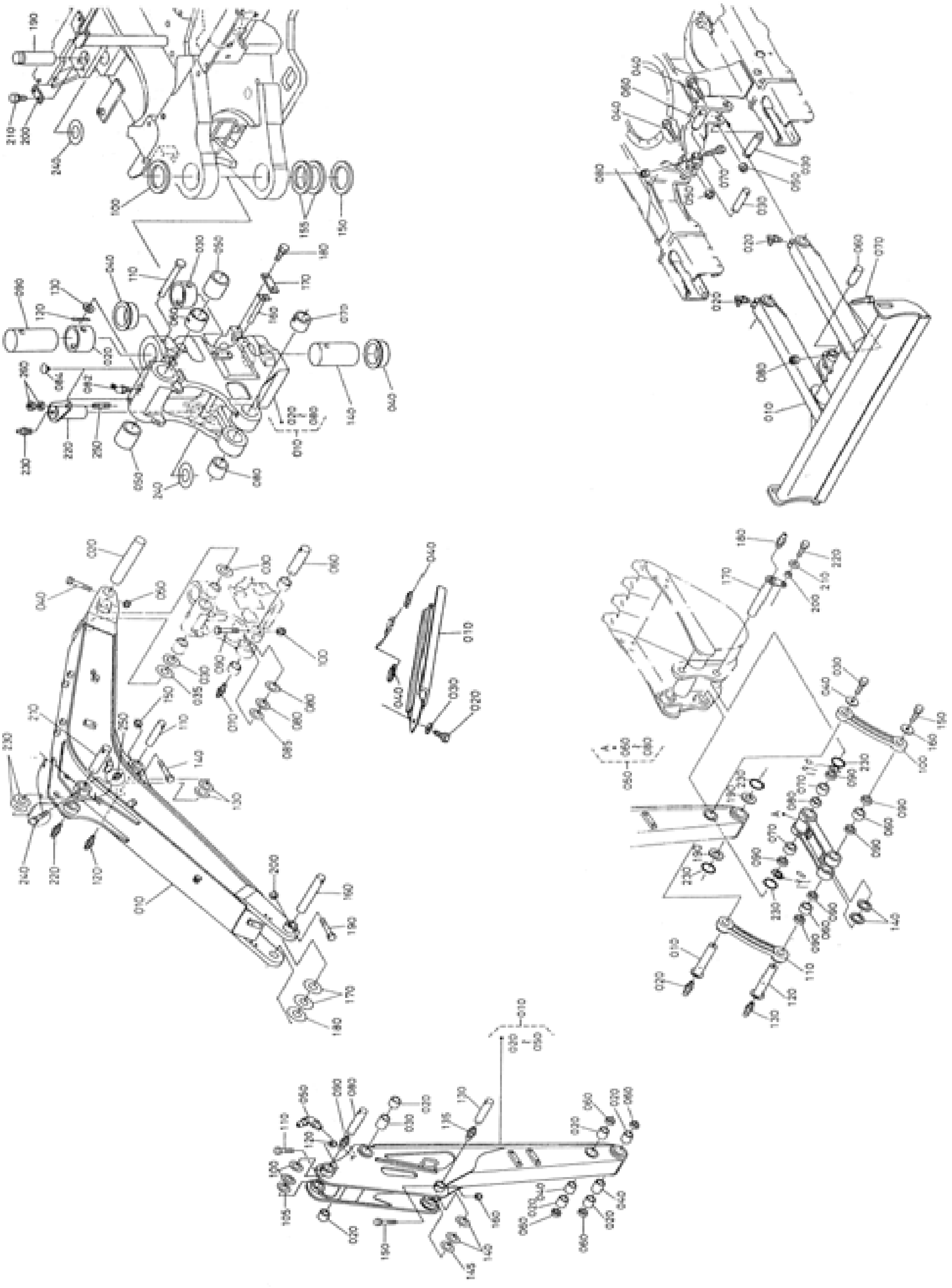
	Unit	KX91-3		Remarks
Track frame	kg lbs	360 794		
Swivel frame	kg lbs	400 882		
Swivel bracket	kg lbs	71 157		
Boom	kg lbs	116 256		
Arm	kg lbs	90 200		
Bucket	kg lbs	62 137		
Dozer	kg lbs	117 258		
Weight (left)	kg lbs	16 35		
Weight (right)	kg lbs	18 40		
Weight (rear)	kg lbs	274 604		
Rubber crawler	kg lbs	125 276		
Iron crawler	kg lbs	168 370		
Arch	kg lbs	38 84		
Engine	kg lbs	155 342		Dry weight
Hydraulic tank	kg lbs	29 64		With filter
Fuel tank	kg lbs	7 15		
Swivel bearing	kg lbs	36 79		
Buttery	kg lbs	18 40		
Track roller	kg lbs	8 18		
Upper roller	kg lbs	3 7		
Rops/Fops canopy	kg lbs	74 163		
Rops/Fops cabin	kg lbs	175 386		
Pump	kg lbs	28 62		
Traveling motor	kg lbs	38 84		
Swivel motor	kg lbs	37 82		
Control valve	kg lbs	34 75		Without adaptor
Boom cylinder	kg lbs	32 71		With protector
Arm cylinder	kg lbs	30 66		
Bucket cylinder	kg lbs	20 44		
Swing cylinder	kg lbs	22 49		
Dozer cylinder	kg lbs	21 46		
Rotary joint	kg lbs	19 42		

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

(8) Quantity Water and Oil

	Unit	KX91-3	KX101-3		Remarks
Radiator	L gal	5.6 1.48	←		L.L.C
Reserve tank	L gal	1.6 0.42	←		
Engine Crank case	L gal	5.3 1.40	←		SAE10W30(CD)
Hydraulic oil Full	L gal	55.0 14.53	←		ISO 46
Hydraulic oil Tank	L gal	36.0 9.51	←		ISO 46
Wheel motor	L gal	0.5 0.13	←		SAE90 (API GL-4)
Track roller	cc gal	70 0.018	←		SAE30(CD)
Upper roller	cc gal	60 0.02	←		SAE30(CD)
Front idler	cc gal	80 0.02	←		SAE30(CD)
Fuel tank	L gal	46.5 12.30	←		

B.Front attachment
a. Parts designation



(1) Swing bracket

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

(2) Boom

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

(3) Boom Cylinder Cover

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

(4)Arm

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

(5) Bracket Link

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

(6) Blade

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

b. Exchange of bucket (Kubota Japan Bucket)

CAUTION

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

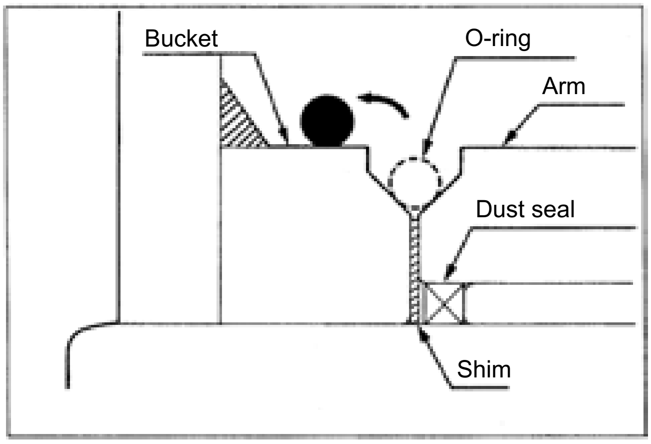
Take the following procedures to replace the bucket.

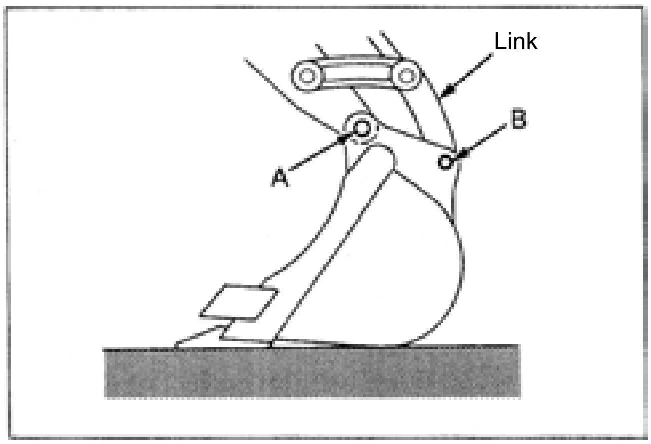
IMPORTANT

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

■ Removing the bucket

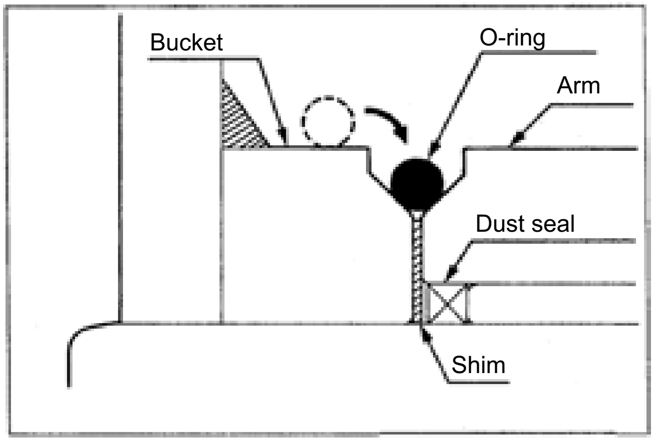
1. Place the bucket just on a flat, level ground.
2. Stop the engine and let out pressure from the hydraulic system.
3. Detach the O-ring from the groove and draw out the pins A and B.





■ Fitting the bucket

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



5. Grease up the pins.

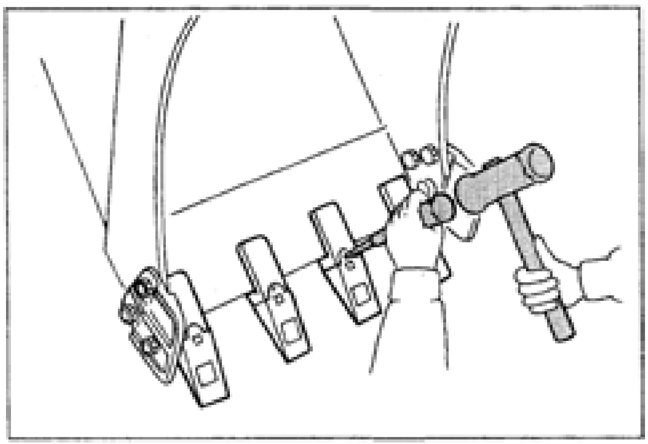
c. Exchange of bucket teeth and side cutter

■ Replacing the bucket tooth

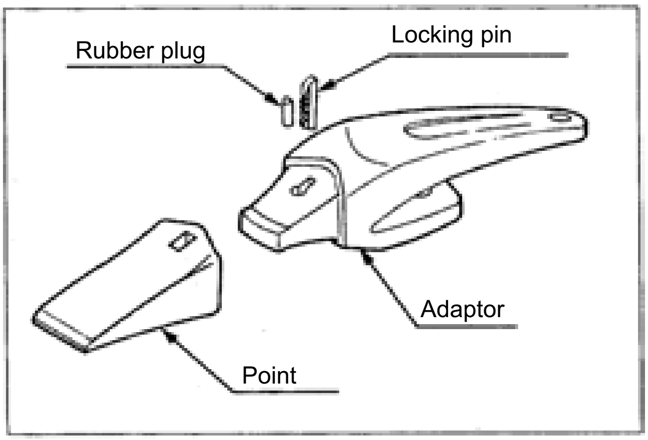
WARNING

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

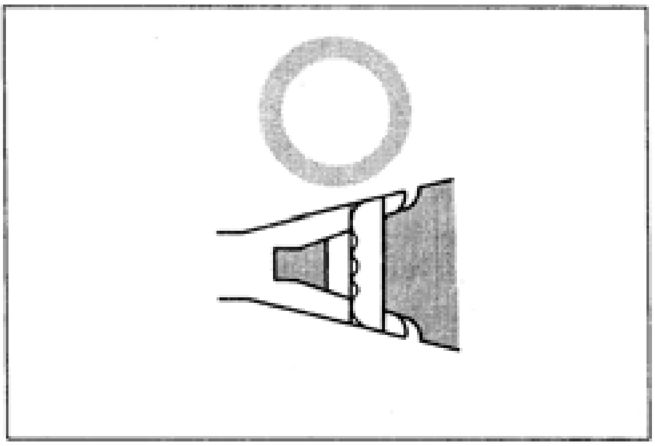
1. Apply a punch on each locking pin. Using a hammer, strike out all the locking pins.
2. Using the hammer or the like, detach a worn-out point from the adaptor.
3. Remove soil deposit off the adaptor.

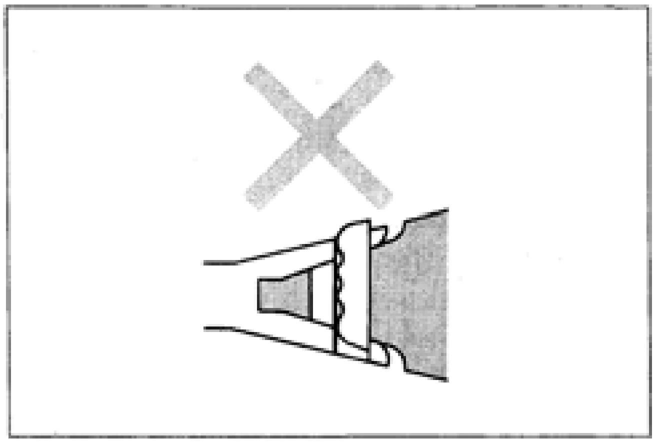


4. Fit a new point to the adaptor.

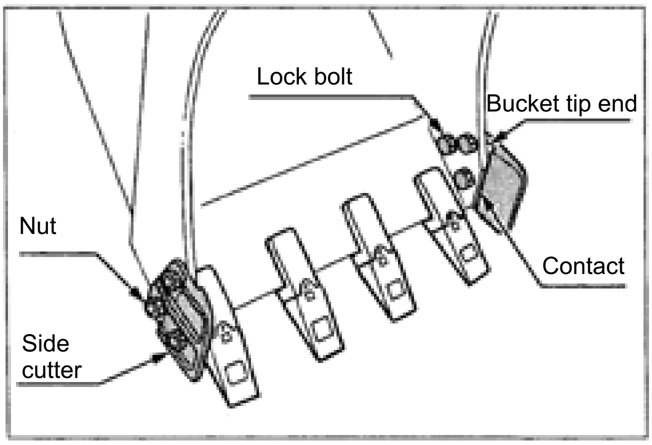


5. Align the point's hole and the adaptor's hole with each other and drive the rubber plug and locking pin into position. Finally make sure that the pin's top is flush with the adaptor's top.
(When changing the point for new one, it is advisable to replace also its rubber plug and locking pin with new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



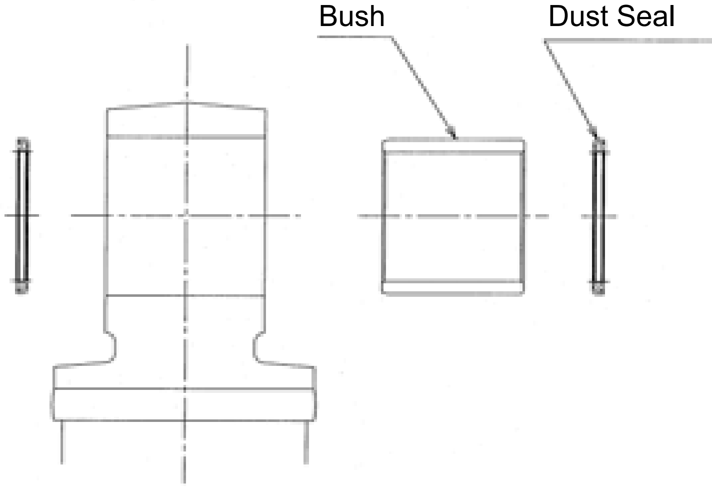


■ Replacing the side cutter
1. Using a box wrench and an adjustable wrench, remove the side cutter lock bolts.
2. Fit new side cutters. Temporarily tighten the bolts.
3. Make sure the side cutters are in close contact with the bucket tip ends. Then tighten up the bolts.



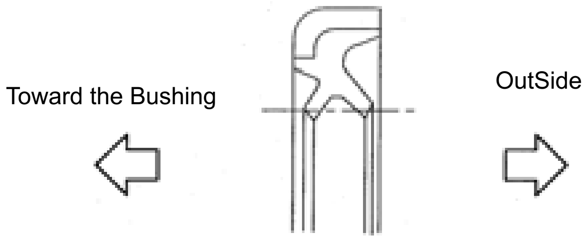
- Tighten the bolts to the torque of 260 to 304 Nm (26.5 to 31 kgf-m).
- If the side cutters are out of contact, or in poor contact with the bucket tip ends, the bolts may get loose.

d. Installing direction of dust seal

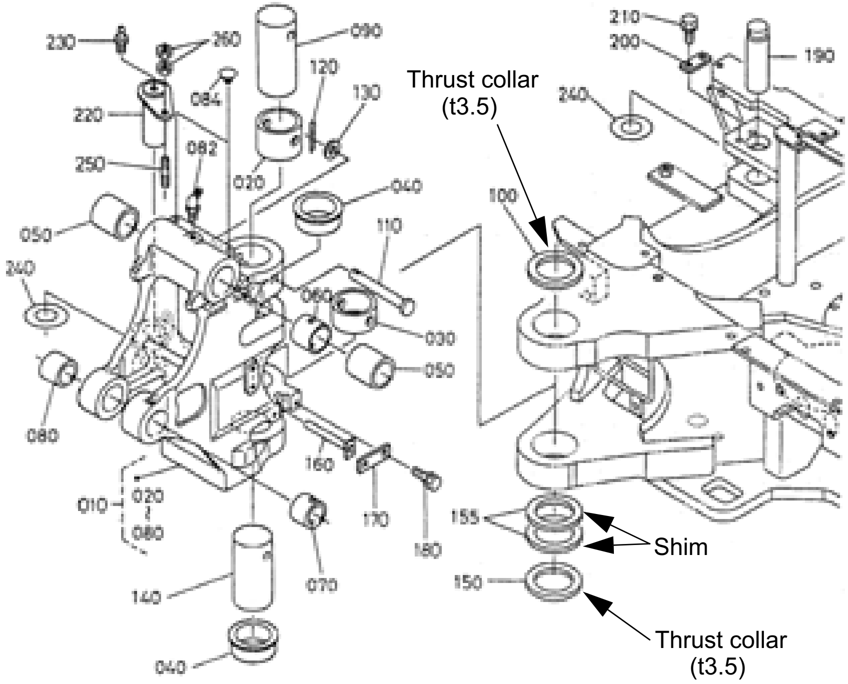


Install the dust seals in the direction as shown at left. If in the wrong direction, the sealing effect is adversely affected, which may get the pins worn out earlier.

(Enlarged view of dust seal)

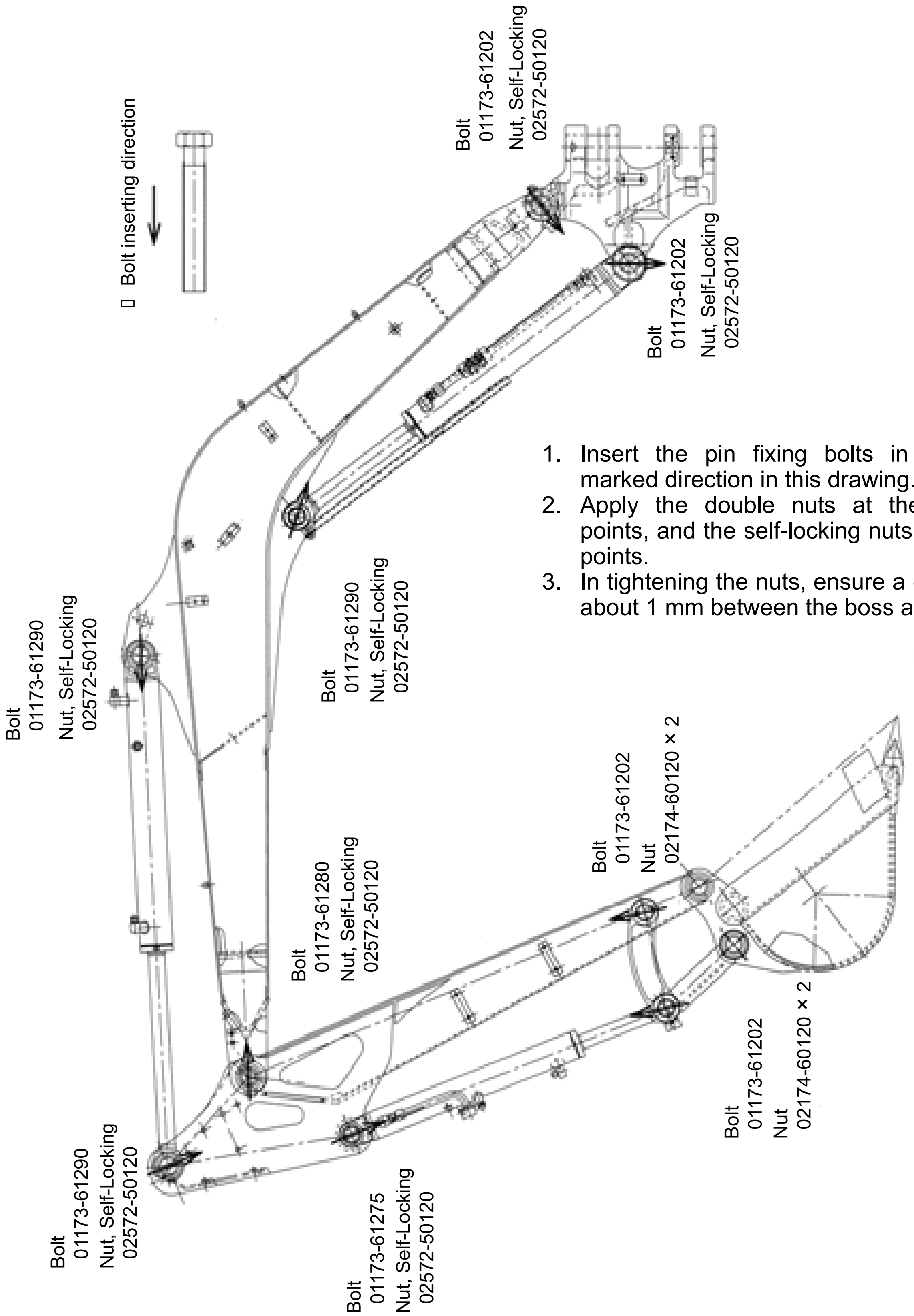


e. Installation of thrust collar on the swing bracket



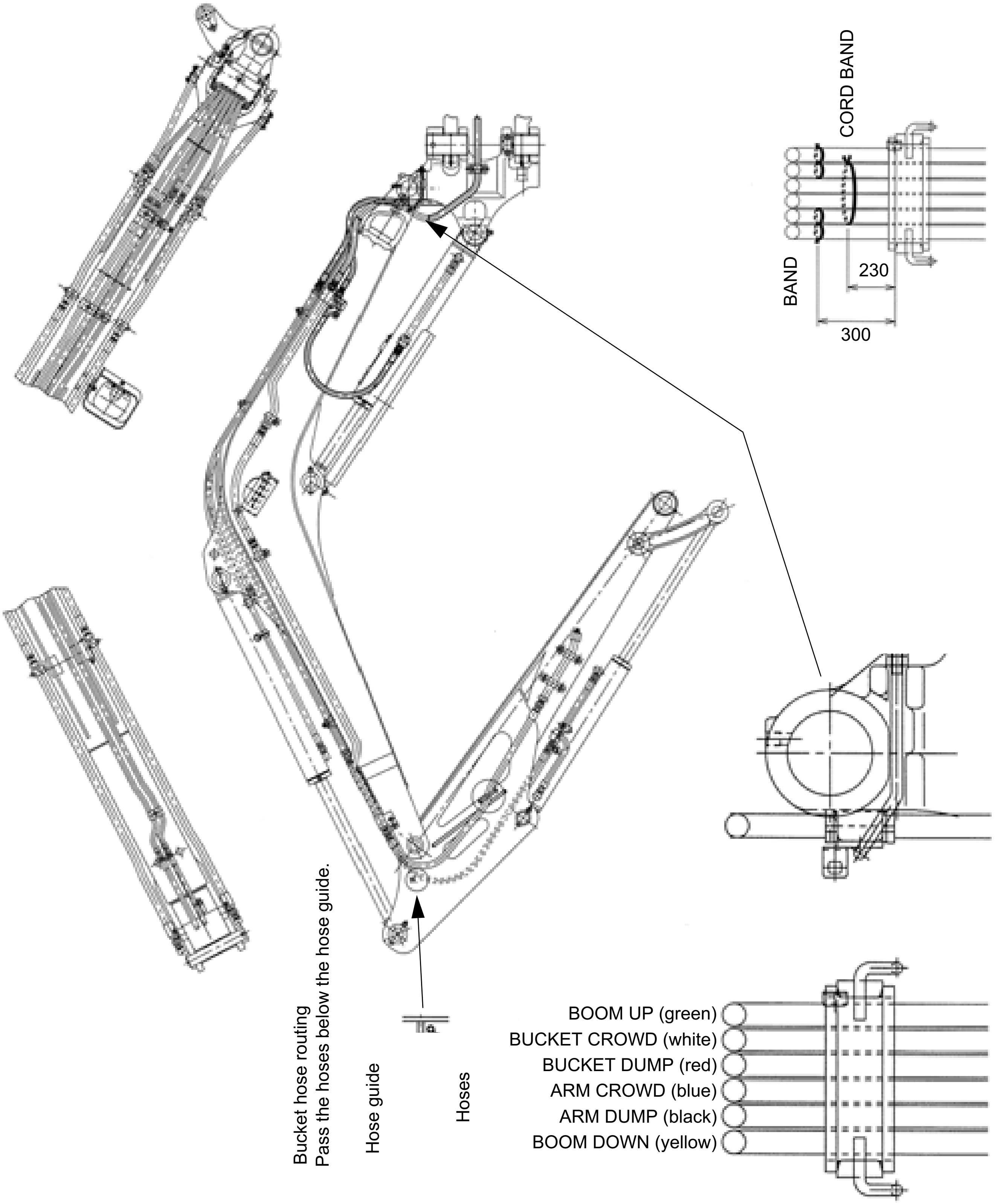
1. Install the thrust collar (t3.5), with its grooved face downward, on top of the swivel frame.
2. Select and install a 0.5 or 1.0 mm thick shim to have the clearance smaller than 0.5 mm.

f. Installing direction of fixing pin bolts



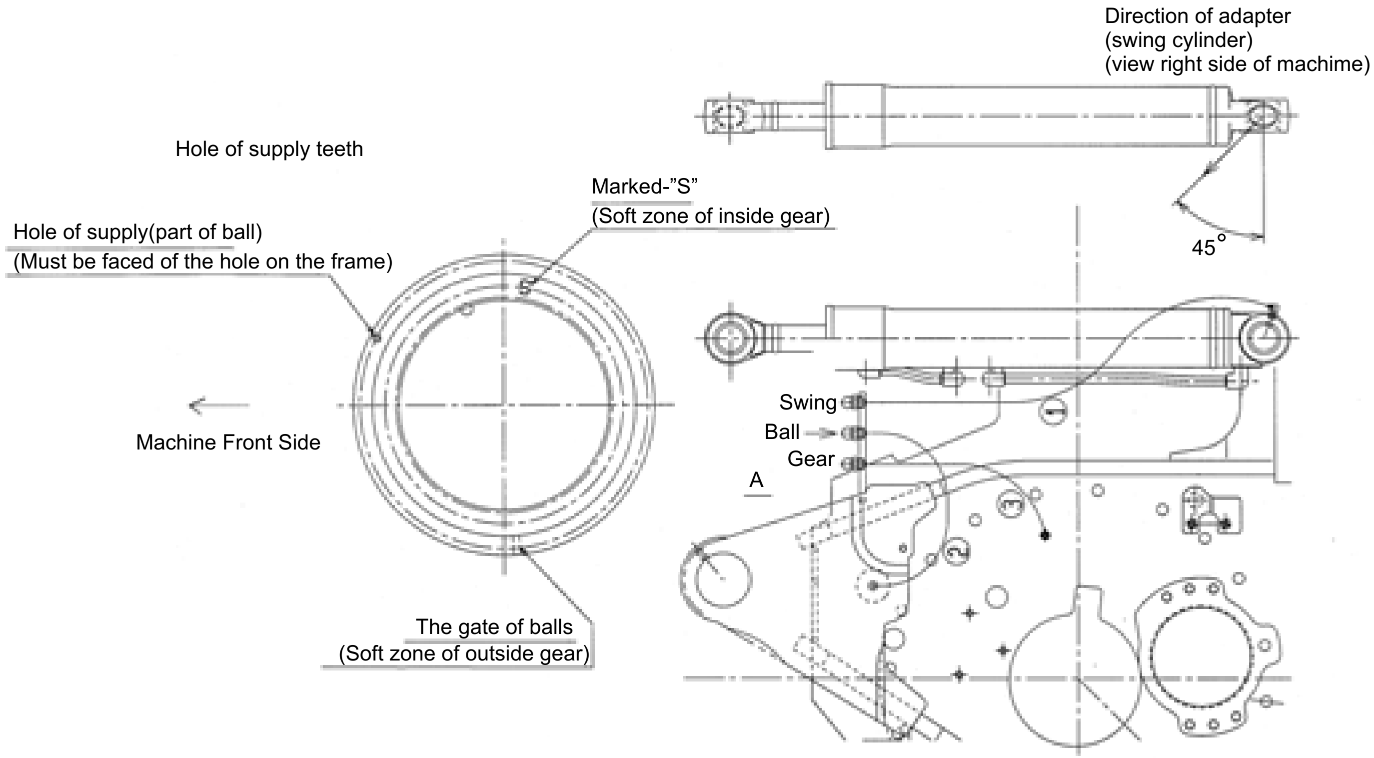
1. Insert the pin fixing bolts in the arrow-marked direction in this drawing.
2. Apply the double nuts at the □-marked points, and the self-locking nuts at the other points.
3. In tightening the nuts, ensure a clearance of about 1 mm between the boss and the nut.

g. Front hoses and clamps



C.Upper Structure

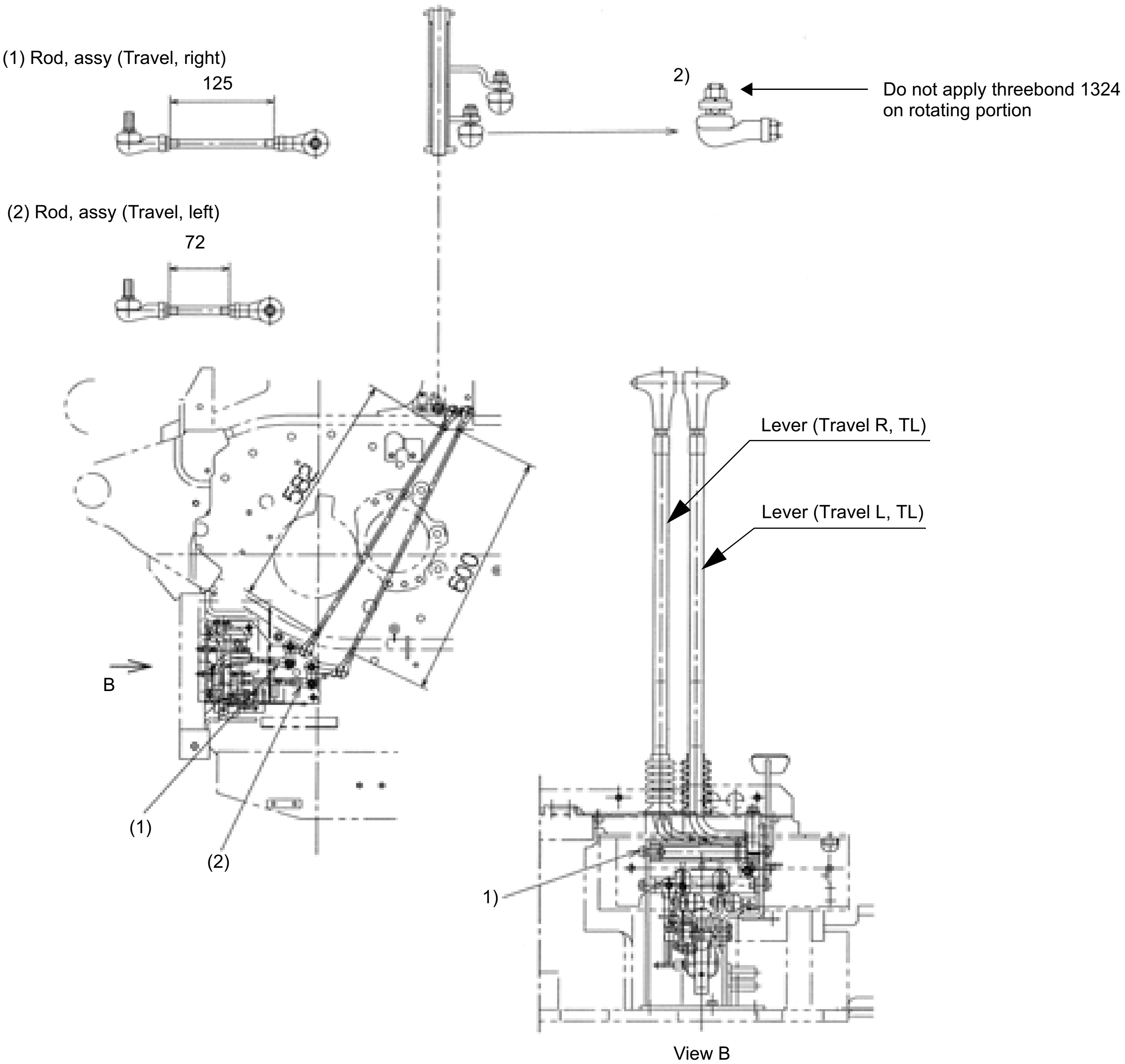
a. Swivel bearing



1. Innerring soft zone: S mark.
   - Set "S" mark at its right position.
2. Outer-ring soft zone: Ball inlet
   - This soft zone should be at its left sode.
3. Align the grease nipple hole of the swivel frame with the nipple on the bearing.

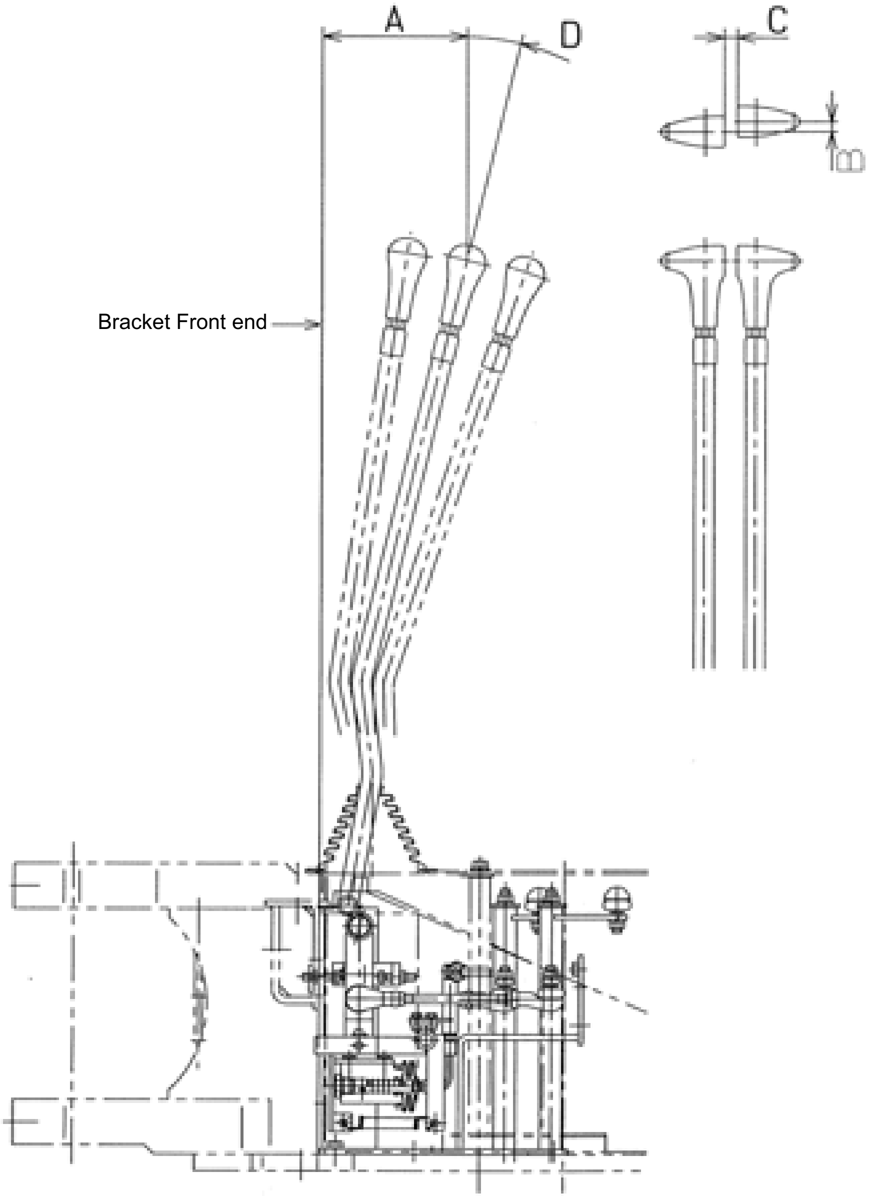
A 4. Swivel Bearing Tightening
   - Apply Locktite #271 on the bolts.
   - Tightening torque: 259.9 ~ 304.0 N·m
     26.5 ~ 31.0 kgf·m
     191.7 ~ 224.2 ft·lbs
   - Apply grease to the entire surface of the bearing teeth uniformly.

b. Traveling lever



1) Tightening torque: 60 ~ 70 N·m
   6.2 ~ 7.2 kgf·m
   44.3 ~ 51.6 ft·lbf
   Apply threebond 1324 on the bolt.
2) Tightening torque: 48 ~ 56 N·m
   4.9 ~ 5.7 kgf·m
   35.4 ~ 41.3 ft·lbf
   Apply threebond 1324 on the nut.

d. Traveling lever adjustment



Adjust the traveling lever as shown below table.

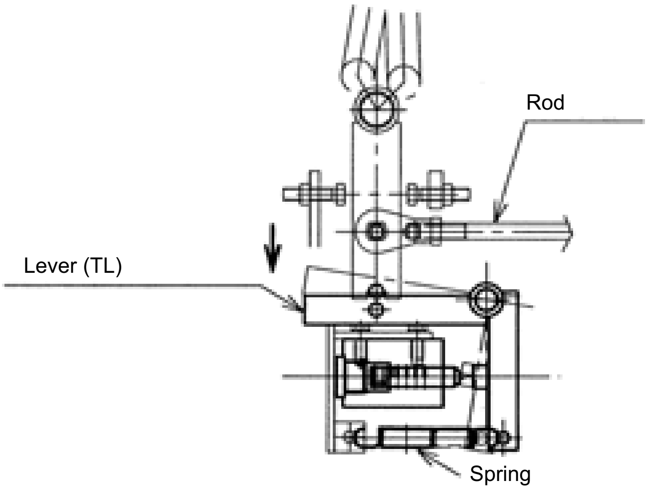
No.	Items	Dimensions	Remarks
A.	Distance beween bracket front end and newtral position center of Traveling lever grip.	160 mm 6.30 in	Reference valve
B.	Gap between left and right lever to longitudinal direction.	under 2 mm under 0.08 in	
C.	Clearance between left and right lever.	11 ~ 17 mm 0.43 ~ 0.67 in	
D.	Angle of trabeling lever at newtral position.	14 deg	

e. Traveling lever lock

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

Adjusting the lever's neutral position

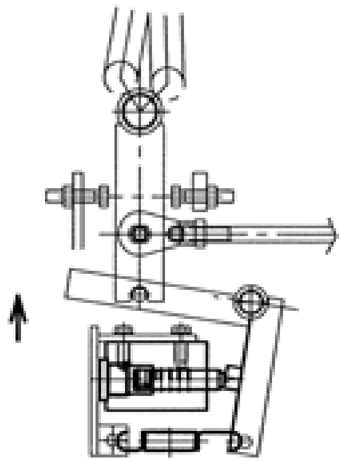
1. Lower the lever (TL) against the spring force to unlock the traveling lever.



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

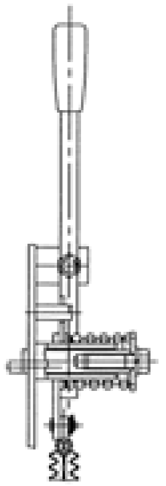
3. Return the lever (TL) to the initial position, and make sure the traveling lever gets locked tight again.

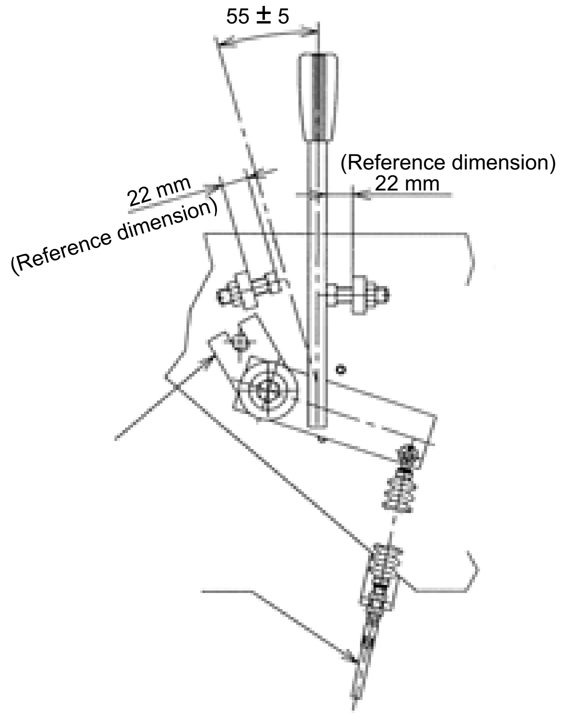
Traveling lever lock



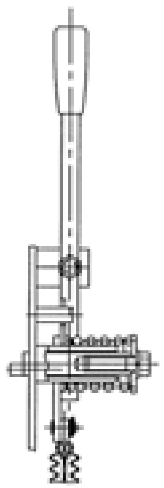
f. Accelarator lever

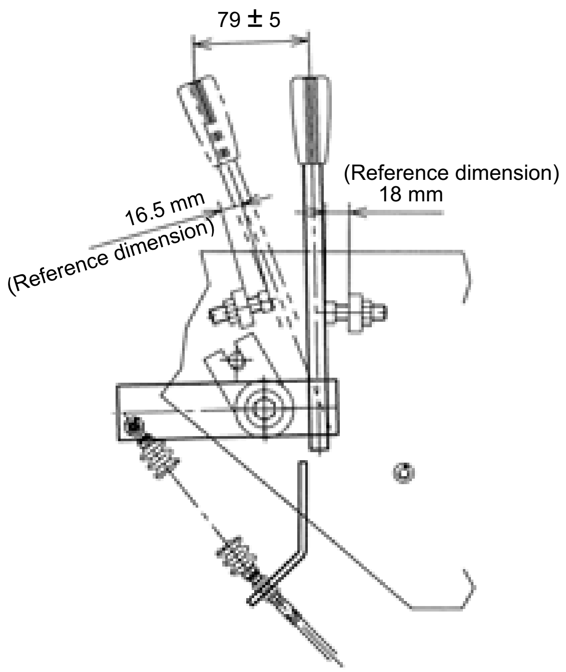
(1) KE, KUK, KDG version



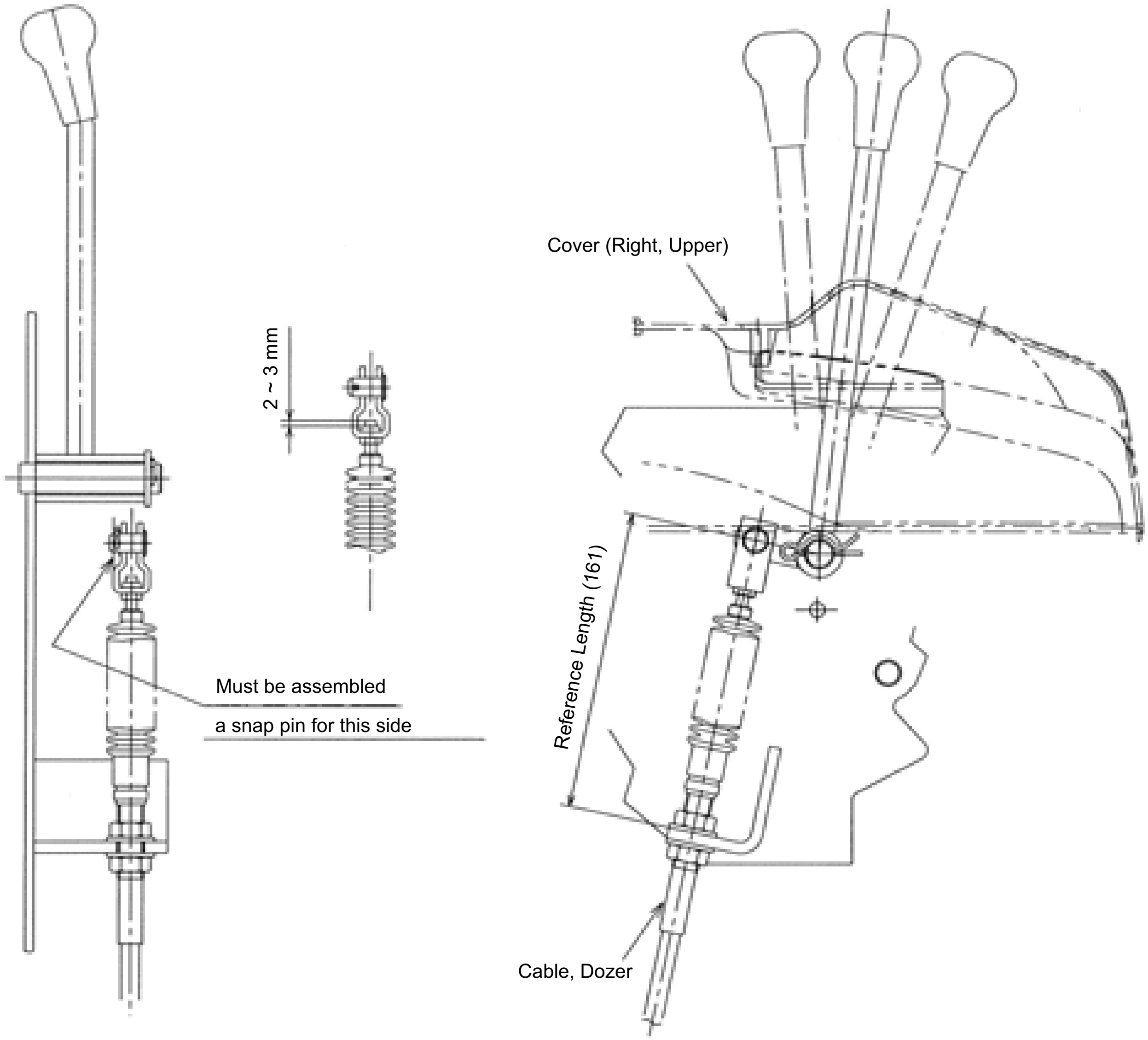


(2) KTC, KU, KTA version



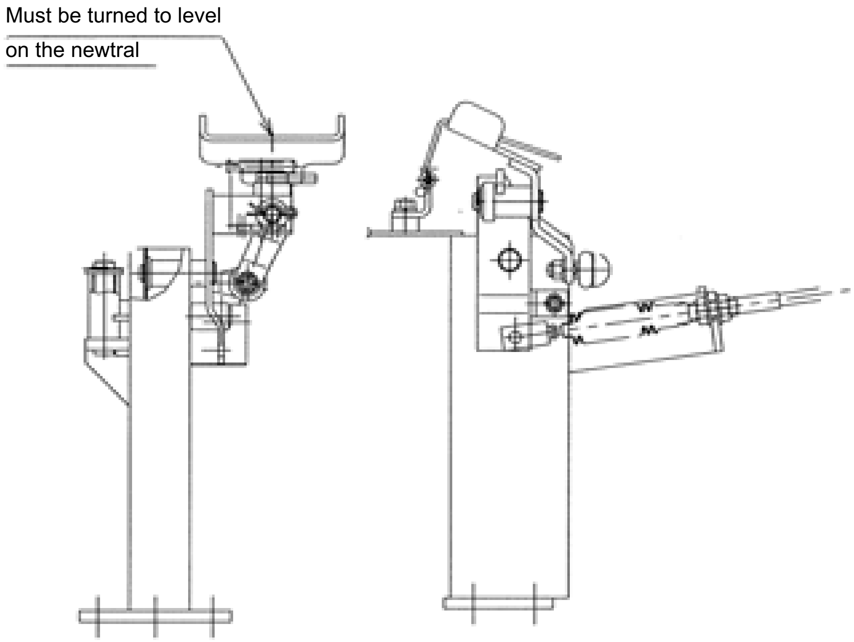


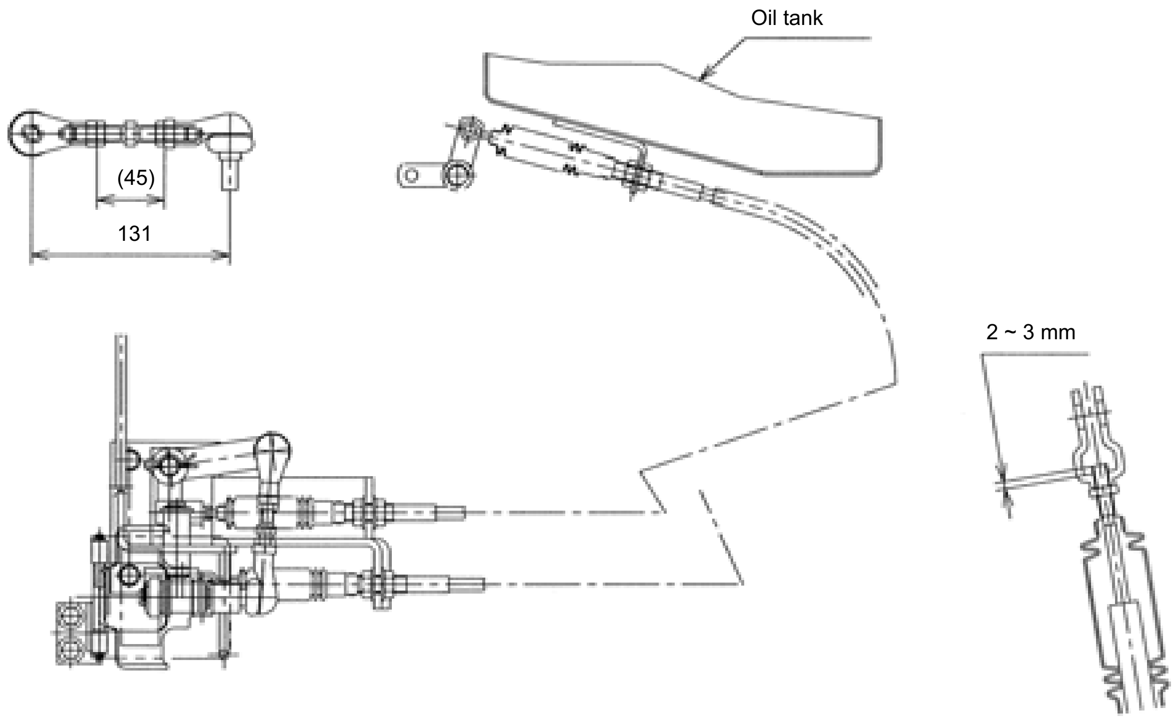
g. Dozer lever



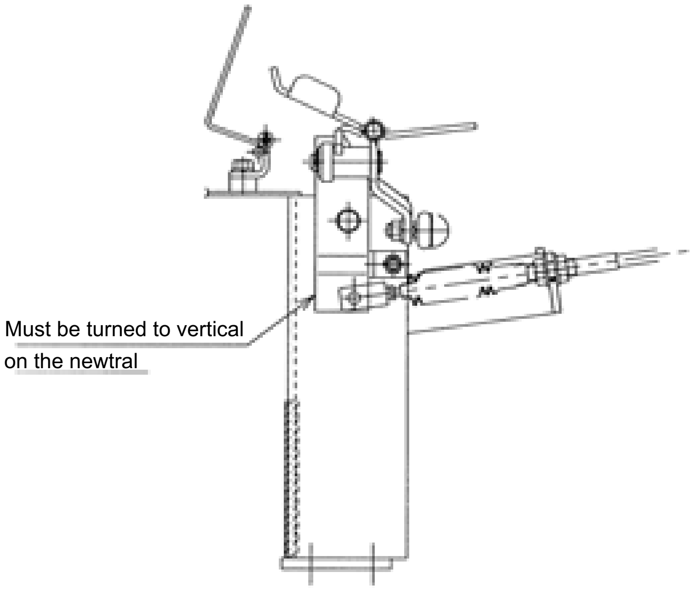
1. Connect the dozer cable to the connector, stretching the cable's threaded end 2-3 mm.
2. Ensure that the dozer cable's bending radius is over 150 mm.

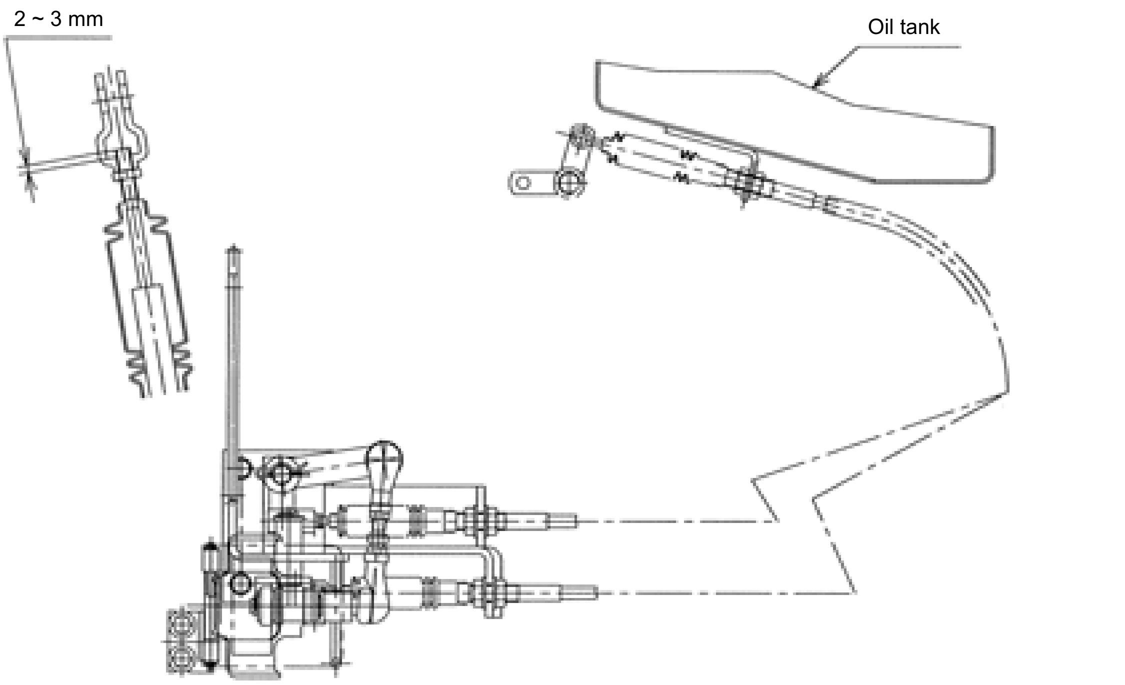
h. Swing pedal



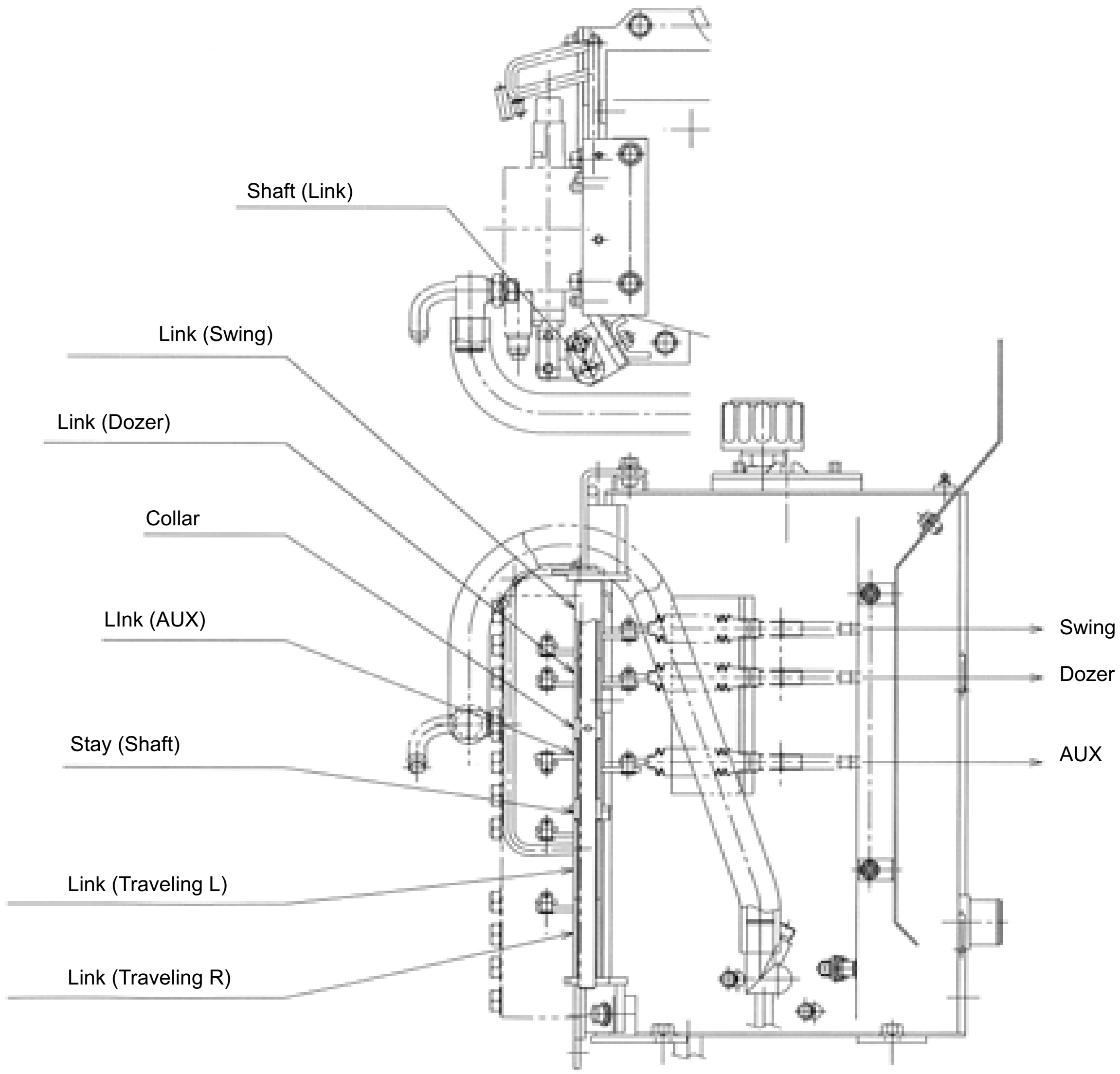


i. Auxiliary port pedal





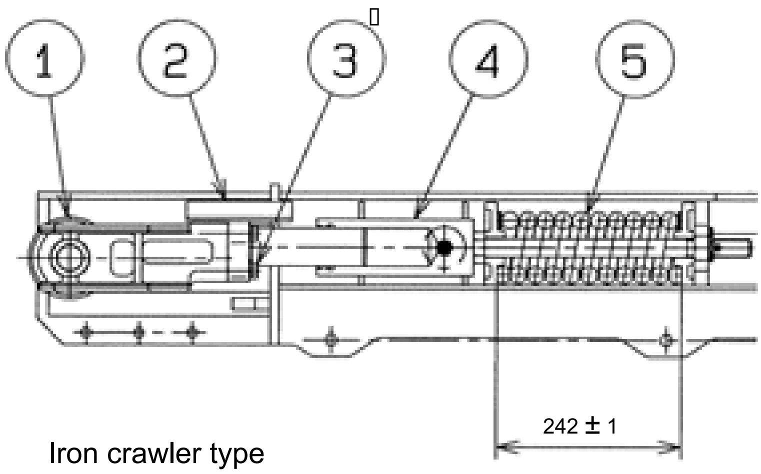
j. Location of links for each operation



D.Under carriage

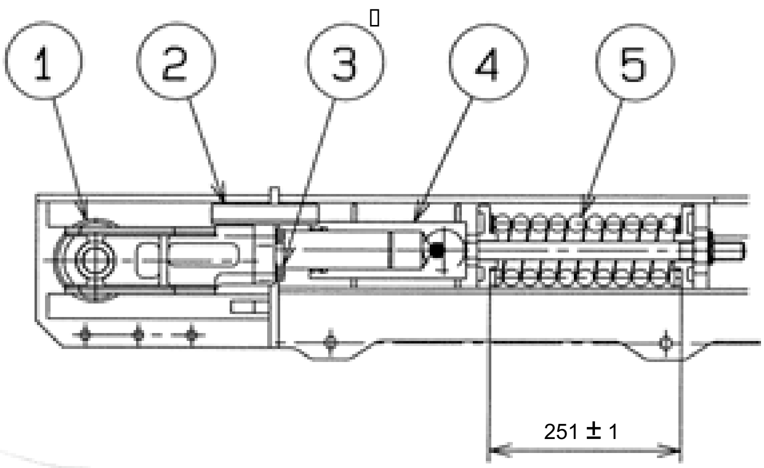
a. Track tension device

Rubber crawler type



No.	Name of parts
1	Assy Idler
2	Plate Idler
3	Bolt
4	Assy cylinder
5	Assy spring

Iron crawler type

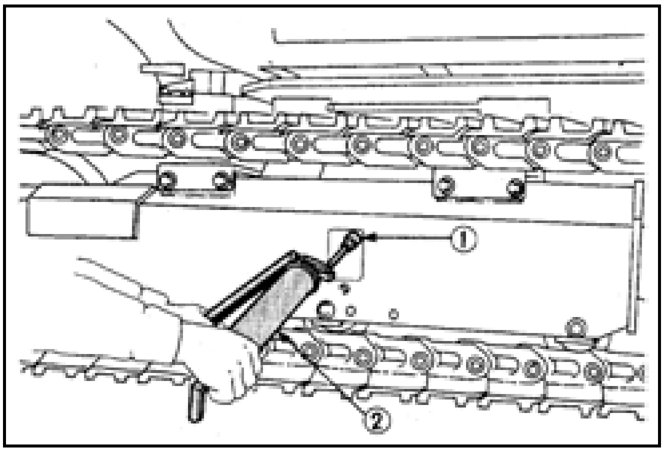


No.	Name of parts
1	Assy Idler
2	Plate Idler
3	Bolt
4	Assy cylinder
5	Assy spring

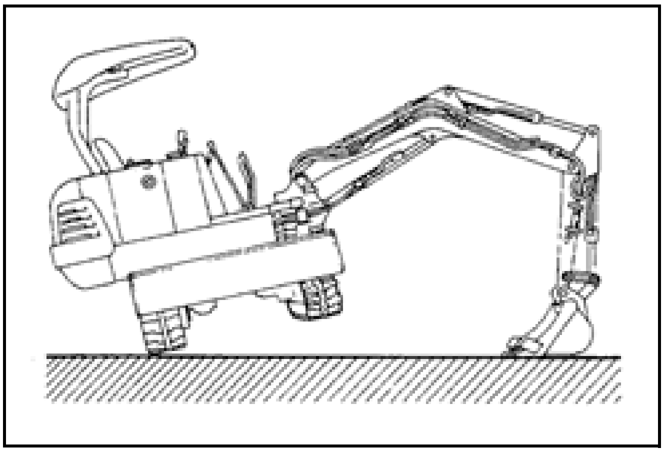
1. Tightening torque of Idler assy mounting bolts. (▯ marks bolts)
   77.4 ~ 90.2 N·m
   7.9 ~ 9.2 kgf·m
   57.1 ~ 66.5 ft·lbf
   Apply locktite #271 on the bolts.
2. Spring pre-setting length
   Rubber Crawler: 242 ± 1 mm
   9.53 ± 0.04 in
   Iron Crawler 251 ± 1 mm
   9.88 ± 0.04in

b. Crawler installation

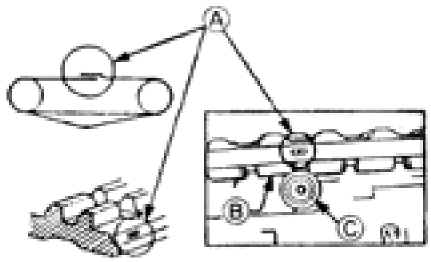
1. Feed grease into the nipple (1) with a grease gun(2).

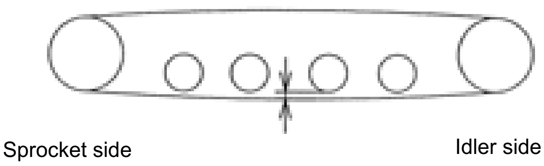


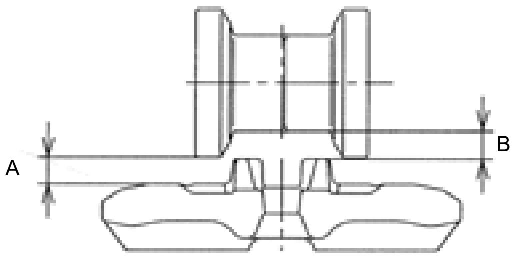
2. Proper crawler tightness is such that the clearance between track roller and link tread is as below table when one crawler is lifted as shown in the figure.



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

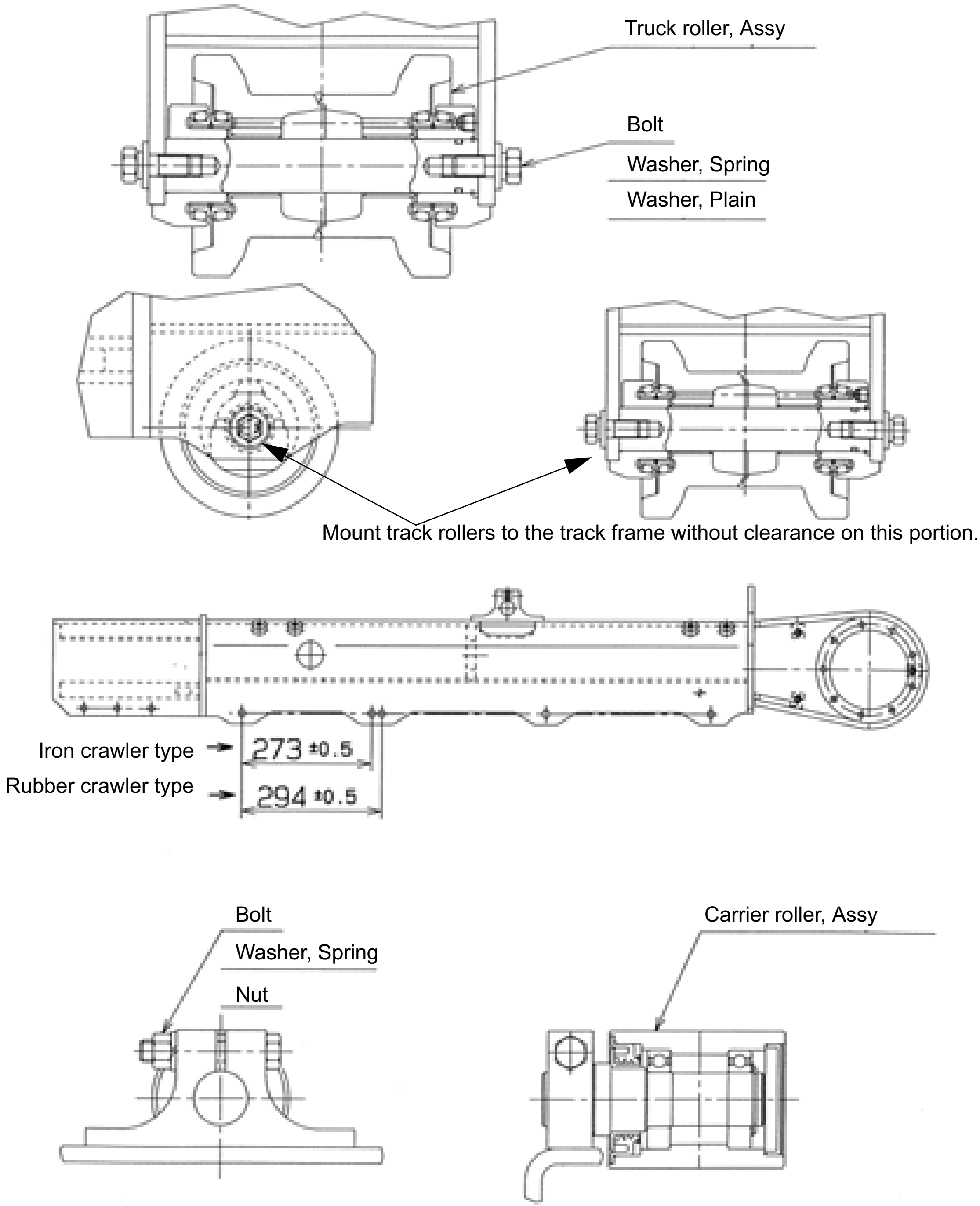






	A	B
Rubber track	10 ~ 15 mm(0.39 ~ 0.59 in)	-
Iron track	75 ~ 80 mm(2.95 ~ 3.15 in)	30 ~ 35 mm(1.18 ~ 1.38 in)

c. Track Roller and Upper Roller installation



1. Remove the stuck oil and paint on the track roller and track frame for mounting track roller.
2. Tightening torque for mounting track roller.
   103 ~ 117.7 N·m
   10.5 ~ 12.0 kgf·m
   76.0 ~ 86.8 ft·lbf
   Apply threebond #1305 on the femail thread.
3. Tightening torque for mounting upper roller.
   77.5 ~ 90.2 N·m
   7.9 ~ 9.2 kgf·m
   57.2 ~ 66.5 ft·lbf
   Apply locktite #271.

IV.Hydraulic system(Mechanism section)

A.Features of hydraulic system

No.	Function	Detail
1	Higher hydraulic pressure. (250 k on P1 and P2 only) (About 120% higher than ever before)	The powerful hydraulic system (with higher relief pressure) provides the following good points in terms of the power (size) and speed (flow rate) required. 1. Smaller actuators (boom, arm, bucket cylinder and travel motor) 2. Smaller pump and control valve and improved heat balance (passage pressure loss) thanks to low flow rate. Which in turn contribute to the advantages below. 3. Right-side centralized arrangement of hydraulic equipment 4. Improved stability (lighter-weight attachment cylinder) 5. Total hydraulic cost cutting, and others.
2	Redesigned boom anti-drift valve.	The minimum boom down speed can be controlled by the main spool, which helps inch the attachment more finely. (On conventional types, the inching is limited by the drain circuit's minimum leak amount.)
3	Straight travel circuit adopted.	In traveling and moving the front attachment at once, the third pump's flow rate serves to control the attachment. This circuit is activated once the machine travels to the right or left and the front attachment is moved.
4	Reduced shock at a stop of upcoming boom.	The control valve's main spool works to make fine-tuning. (The boom up/slow-return throttle and the pilot valve (boom down) primary-pressure shortcut are left out.)
5	Pilot valve (Kawasaki-made) redesigned.	The vertical stroke is made greater from 5.2 mm to 6.4 mm (to eliminate jerking at vertical rotation). The secondary pressure is also made higher from 19.5 kgf/cm^2 to 27.0 kgf/cm^2 for improved controllability.
6	Swivel negative brake and planetary single-step reduction gear adopted.	Release the lever lock, and the negative brake gets activated to keep the parked machine even on a slope. The number of reduction gearing parts has been cut down, and the cylinder block is commonly used.
7	Filter added to swivel make-up circuit.	An 80-mesh filter has been additionally mounted at the swivel make-up port adaptor to keep clean the make-up check valve in the motor.
8	Travel motor swash plate reconfigured and travel bi-speed circuit redesigned.	Simpler structure and better function.
9	Hydraulic equipment back pressures reduced.	The circuitry is configured to keep the travel motor, swivel motor, pilot valve and other related devices nearly free from back pressure. The pilot valve push-rod sealing effect in particular is highly expected.
10	Brand-new change valve introduced (lever lock and bi-speed travel).	Cost cutting advantage.

(11)Arm regeneration
(12)Variable displacement pump
(13)Priority throttle of boom-bucket simultaneous operation
(14)Check valve for swival anti-cavitation
(15)Auto idle version(KX101-3 EU-version only)

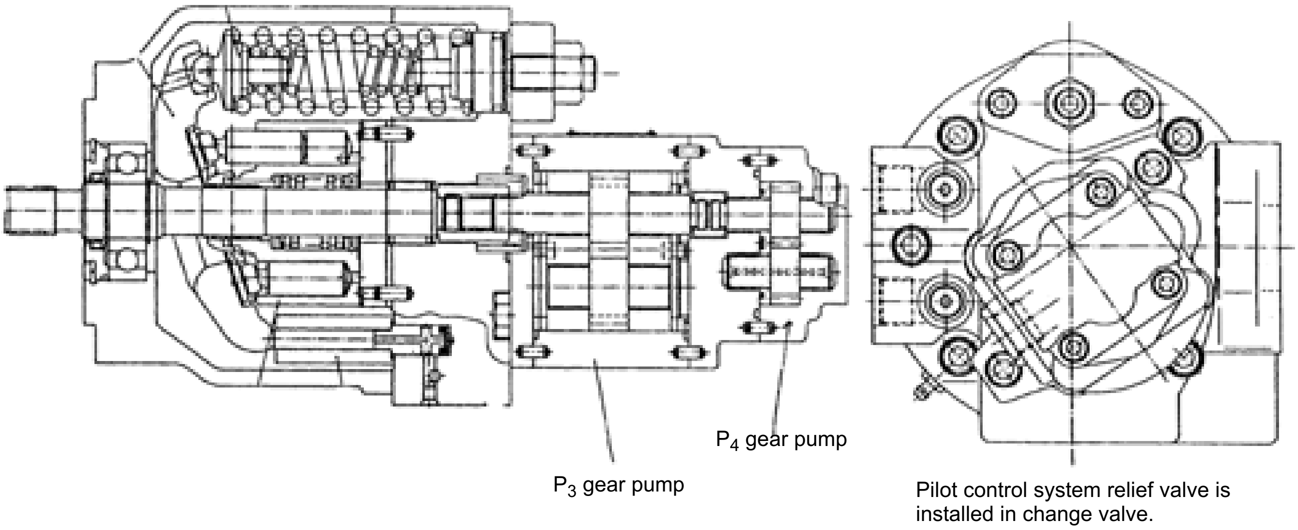
B.Hydraulic system specifications

* KTC, KCL, KTA version

Machine model			KX91-3			KX-101-3 (EU only)
Engine RPM			2200rpm		2300rpm*	2300rpm
Pump	Maker		Uchida			Uchida
	Type		AP2D18			AP2D18
			Variable pump,2 + Gear pump			Variable pump,2 + Gear pump
			+gear pump			+gear pump
	Delivery rate	P1, P2	39.6L/min	(18.0cc/rev)	41.4L/min *	39.1L/min (17.0cc/rev)
		P3	20.9L/min	(9.5cc/rev)	21.9L/min *	20.7L/min (9.0cc/rev)
		P4	8.4L/min	(3.8cc/rev)	8.9L/min *	8.7L/min (3.8cc/rev)
Control valve	Maker		NABCO			NABCO
	Type		BCV35			BCV35
	Main relief pressure	P1, P2	23.5(240)			24.5(250)
		P3	19.6(200)			19.6(200)
		P4	3.92(40)			3.92(40)
Travel motor	Maker		kubota			kubota
	Type		WM18NL			
			Two speed piston motor			
	Equivalent capacity		879/574 cc/rev			
	Speed(R)		3.0/4.6 km/hr			2.9/4.5km/hr
	Traction force(R)		1.30/0.85 (2940kg)			1.25/0.81(3200kg)
Swivel motor	Maker		kubota			kubota
	Type		SM29G			SM29G
			Position motor with negative brake			Position motor with negative brake
	Equivalent capacity		290 cc/rev			290cc/rev
	Relief pressure		16.7(170)			20.1(205)
	Swivel speed		9.0rpm			8.9rpm
	Torque		63.9(627)			75.2(738)
Cylinder	Boom	Bore dia.	φ80			←
		Rod dia	φ45			←
		Stroke	504.5mm			←
		Cushon	35mm			←
	Arm	Bore dia.	φ75			
		Rod dia	φ45			←
		Stroke	583.5mm			
		Cushon	No			
	Bucket	Bore dia.	φ65			
		Rod dia	φ40			←
		Stroke	516mm			
	Swing	Bore dia.	φ80			
		Rod dia	φ40			←
		Stroke	408.5mm			
	Dozer	Bore dia.	φ90			
		Rod dia	φ45			←
		Stroke	154			

C.Main pump

a. Structure & specifications



* KTC, KCL, KTA version

Machine model			KX91-3			KX-101-3 (EU only)	U-35-3
Engine RPM			2200		2300*	2300rpm	
Pump	Maker		Uchida			Uchida	
	Type		AP2D18			AP2D18	
			Variable pump,2 + Gear pump			Variable pump,2 + Gear pump	
			+gear pump			+gear pump	
	Delivery	P1, P2	39.6L/min	(18.0cc/rev)	41.4*	39.1L/min (17.0cc/rev)	
		P3	20.9L/min	(9.5cc/rev)	21.9*	20.7L/min (9.0cc/rev)	
		P4	8.4L/min	(3.8cc/rev)	8.7*	8.7L/min (3.8cc/rev)	

b. Performance curve

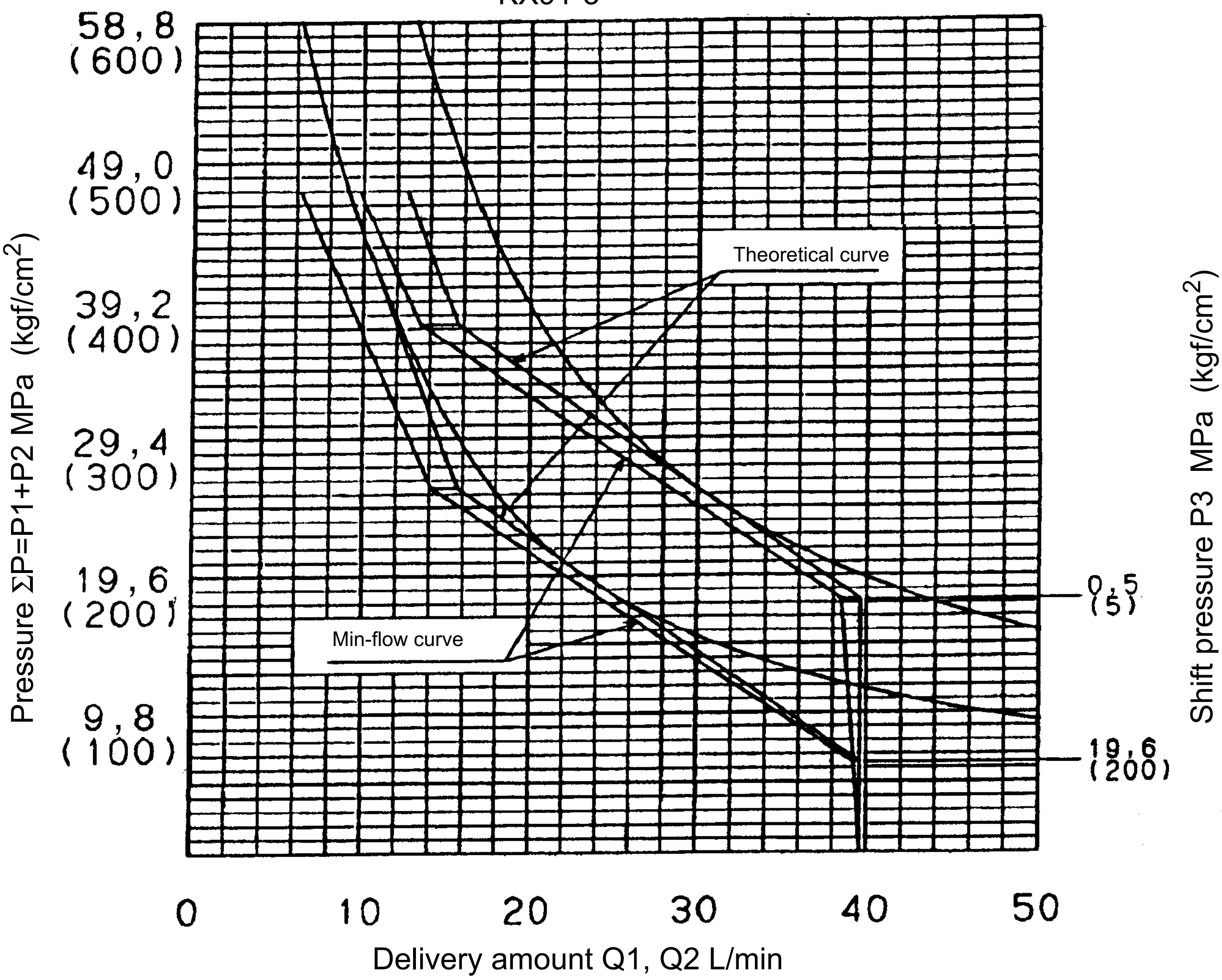
Variable displacement pump

Type=AD2D18LV1RS7-921-P
KX91-3

* KTC, KCL, KTA version

Type of pump	AP2D18		GSP2-09	G1-03
Operating pressure MPa(kgf/cm^2)	23.5(240)		19.6(200)	3.9(40)
Displacement cm^3	18.0 × 2		9.0	3.0
Delivery rate L/min	39.6 × 2	41.4 × 2 *	20.7	6.9
P_3 shift pressure MPa(kgf/cm^2)	0.5(5) → 19.6(200)		0.5(5) → 19.6(200)	
Input power kW(PS)	16.2(22.1) → 10.1(13.7)		0.6(0.8) → 7.9(10.8)	0.7(0.9)
Input shaft horse power kW(PS)	17.5(23.8) → 18.7(25.4)			
Input shaft torque N·m(kgf·m)	72.6(7.4)	77.5(7.9)		
Control type	Total horse power control			
Operating RPM min^{-1}	2200	2300 *		
Rotating direction	Clockwise, viewed from input shaft side			
Suction pressure MPa(kgf/cm^2)	-0.02 ~ +0.15(-0.2 ~ +1.5) at intet port 2500rpm.			
Weight kg	Applox. 27.5			

KX91-3

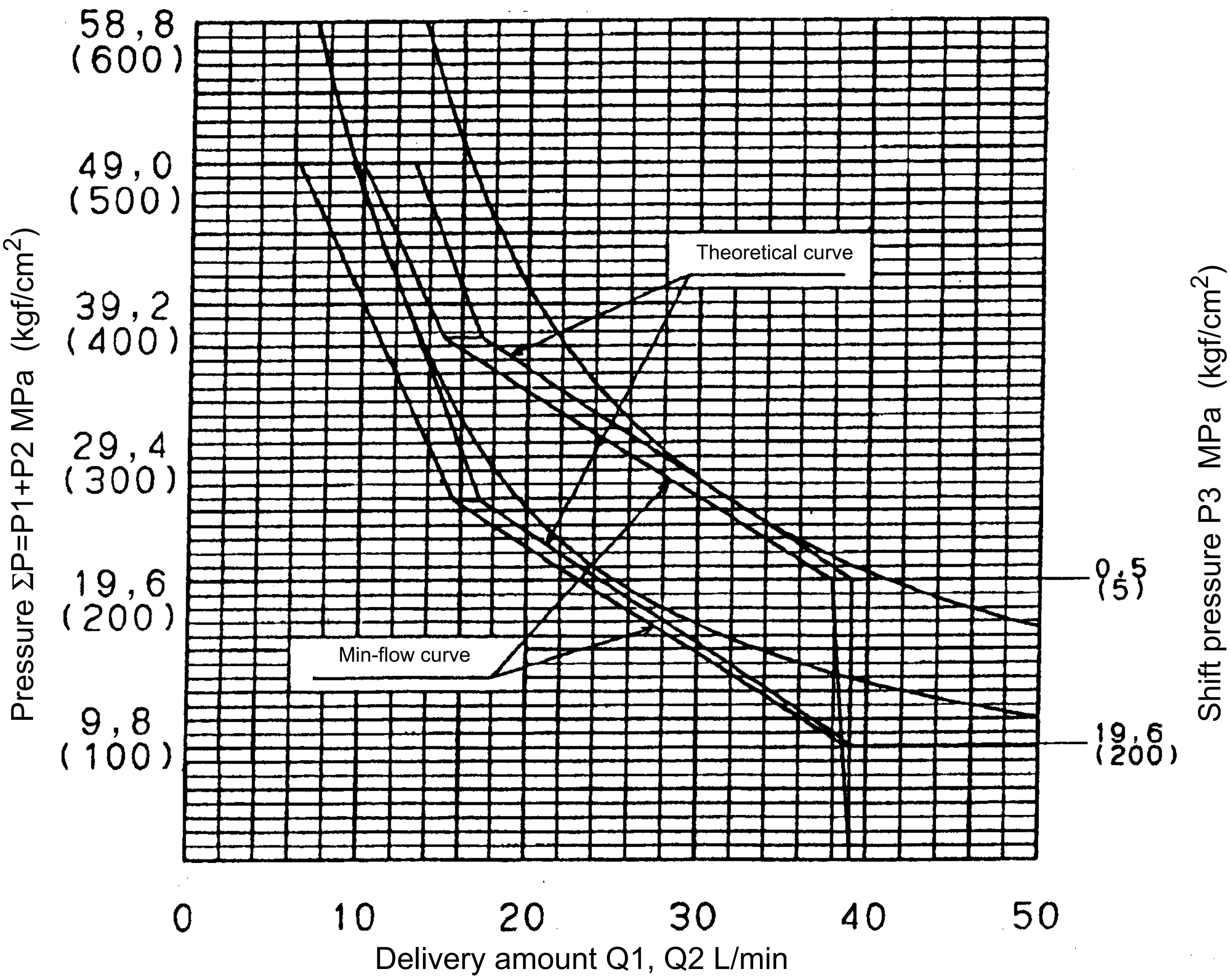


Variable displacement pump

Type=AP2D18LV1RS7-920-O
KX101-3

Type of pump	AP2D18	GSP2-09	G1-03
Operating pressure MPa(kgf/cm^2)	24.5(250)	19.6(200)	3.9(40)
Displacement cm^3	17.0 × 2	9.5	3.0
Delivery rate L/min	39.1 × 2	20.9	6.6
P3 shift pressure MPa(kgf/cm^2)	0.5(5) → 19.6(200)	0.5(5) → 19.6(200)	
Input power kW(PS)	15.6(21.2) → 9.2(12.5)	0.6(0.8) → 8.0(10.9)	0.6(0.8)
Input shaft horse power kW(PS)	17.5(22.8) → 18.7(24.2)		
Input shaft torque N·m(kgf·m)	72.7(7.4)	77.2(7.9)	
Control type	Total horse power control		
Operating RPM min^{-1}	2300		
Rotating direction	Clockwise, viewed from input shaft side		
Suction pressure MPa(kgf/cm^2)	-0.02 ~ +0.15(-0.2 ~ +1.5) at intet port 2400rpm.		
Weight kg	Applox. 27.5		

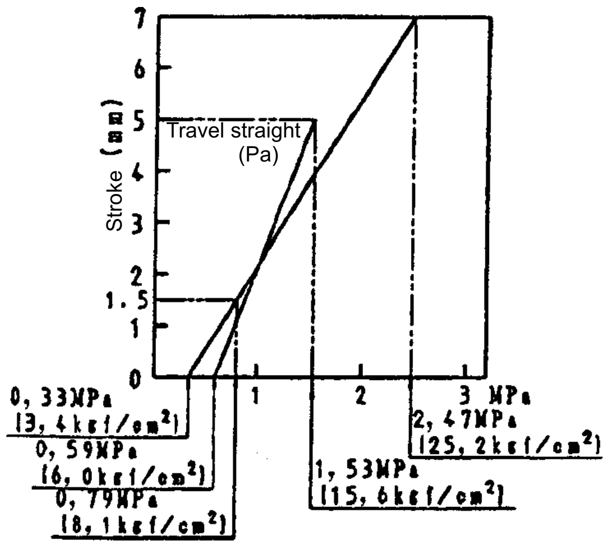
KX101-3



D.Control valve

a. Specifications

Spool operating force Return spring at neutral at full stroke	 68.6N(7kgf) 88.3N(9kgf)
Spool leakage, condition Swing (A2,B2) port Boom lock (A9) port Other ports	9.81MPa(100kgf/cm^2),37cSt 3cm^3/min or less 1cm^3/min or less 7cm^3/min or less
Tank back pressure, allowable	0.98MPa(10kgf/cm^2)
Contamination level	NAS class 9 or better



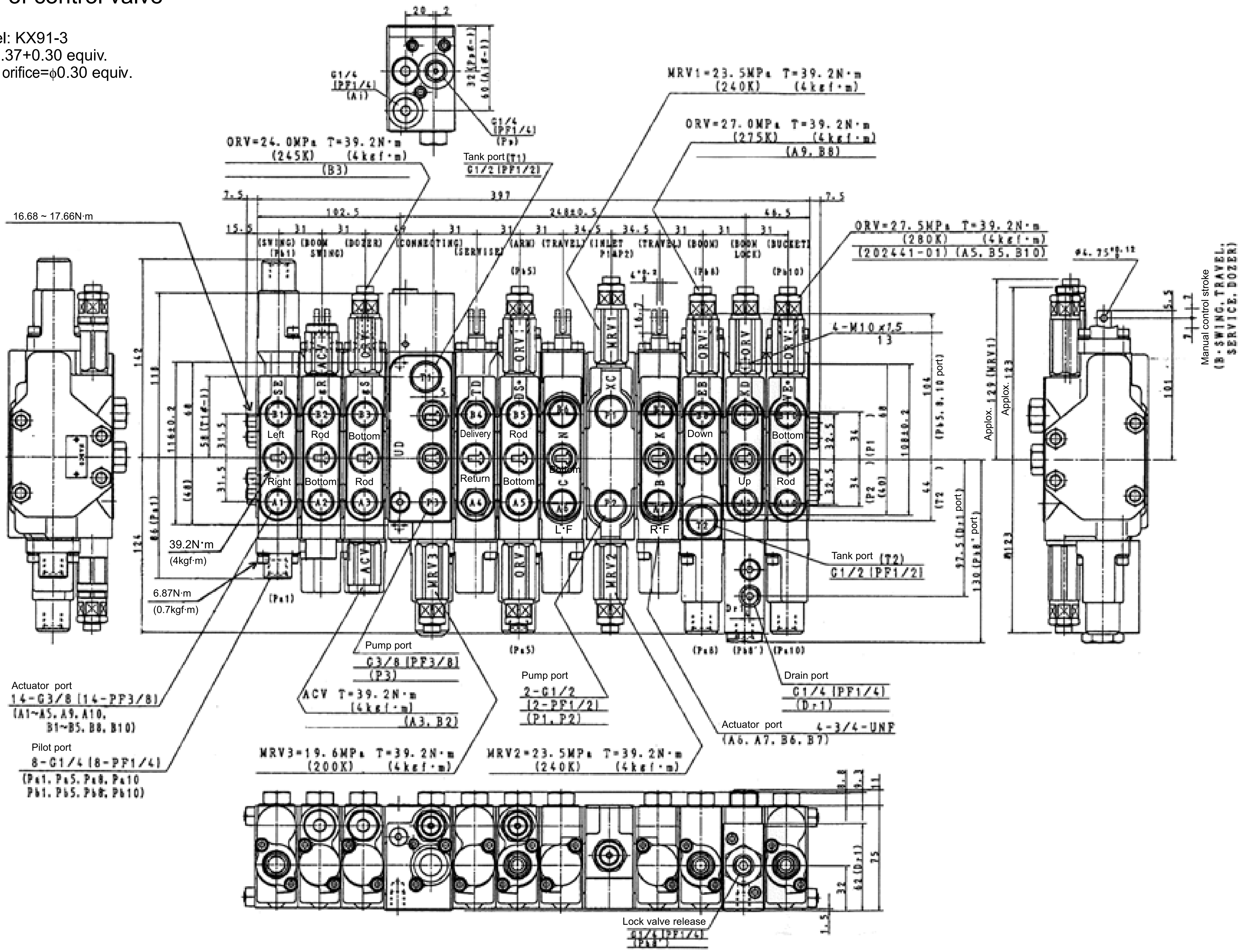
Machine model		KX91-3	KX101-3
Main relief pressure setting	MRV1 MRV2	$23.5^{+0.49}_{0}$ MPa(240^{+5}_{0} kgf/cm^2) at 39.6L/min	$24.5^{+0.49}_{0}$ MPa(250^{+5}_{0} kgf/cm^2) at 39.1L/min
	MRV3	19.6MPa(200kgf$^{+5}_{0}$ kgf/cm^2) at 20.9L/min	$19.6^{+0.49}_{0}$ MPa(200^{+5}_{0} kgf/cm^2) at 20.7L/min
Overload relief pressure setting	Dozer bottom(B3)	$24.0^{+0.49}_{0}$ MPa(245^{+5}_{0} kgf/cm^2) at 5L/min	
	Arm bottom(A5) Arm rod(B5) Bucket bottom(B10)	$27.5^{+0.49}_{0}$ MPa(280^{+5}_{0} kgf/cm^2) at 5L/min	$28.0^{+0.49}_{0}$ MPa(285^{+5}_{0} kgf/cm^2) at 5L/min
	Boom bottom(A10) Boom rod(B9)	$27.0^{+0.49}_{0}$ MPa(275^{+5}_{0} kgf/cm^2) at 5L/min	$27.5^{+0.49}_{0}$ MPa(280^{+5}_{0} kgf/cm^2) at 5L/min
	Bucket bottom(B10)	$27.5^{+0.49}_{0}$ MPa(280^{+5}_{0} kgf/cm^2) at 5L/min	$28.0^{+0.49}_{0}$ MPa(285^{+5}_{0} kgf/cm^2) at 5L/min
Pilot primary pressure		3.92MPa (40kgf/cm^2)	

Control valve

Machine model		KX91-3, KX101-3	U-35	U20
Control valve type		BCV35	KVSE70	BCV35
Section width		31mm	38mm	31mm
Totale length		412mm	535mm	*481mm
Main spool dia.		ϕ12	ϕ14.3	ϕ12
Spool stroke	Pilot section	7mm	8mm	7mm
	Mechanism section	7mm	7.2mm	7mm
	Travel straight section	5mm	←	
Pilot line air-bleeding	Orifice dia.	ϕ0.50 equiv.	ϕ0.25 equiv.	
	Stroke	6mm or more	Always	
	Boom up section	Auto-bleeding	Manual	

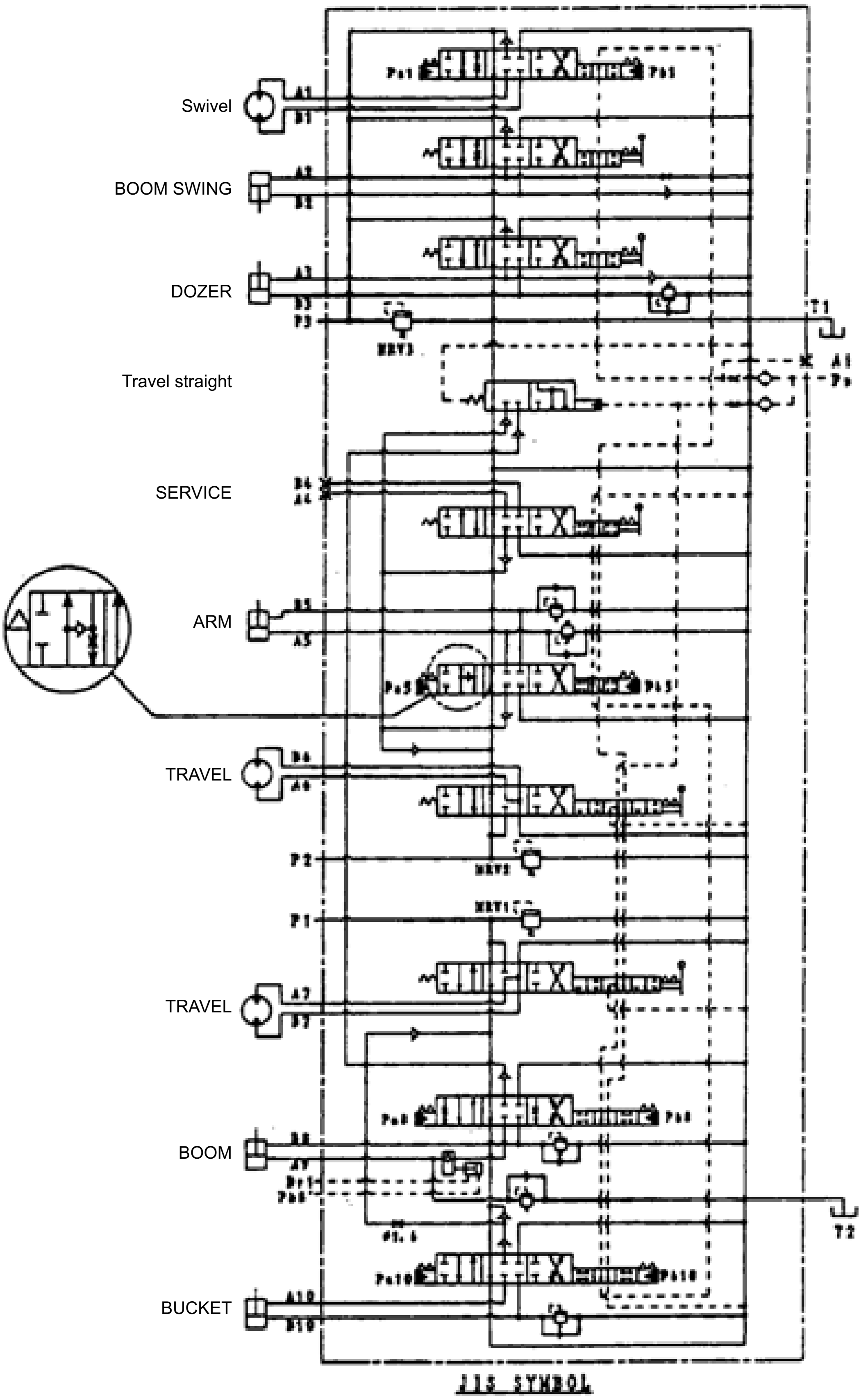
b. General view of control valve

Note:Sample model: KX91-3
AI signal orifice=ϕ0.37+0.30 equiv.
Travel straight signal orifice=ϕ0.30 equiv.



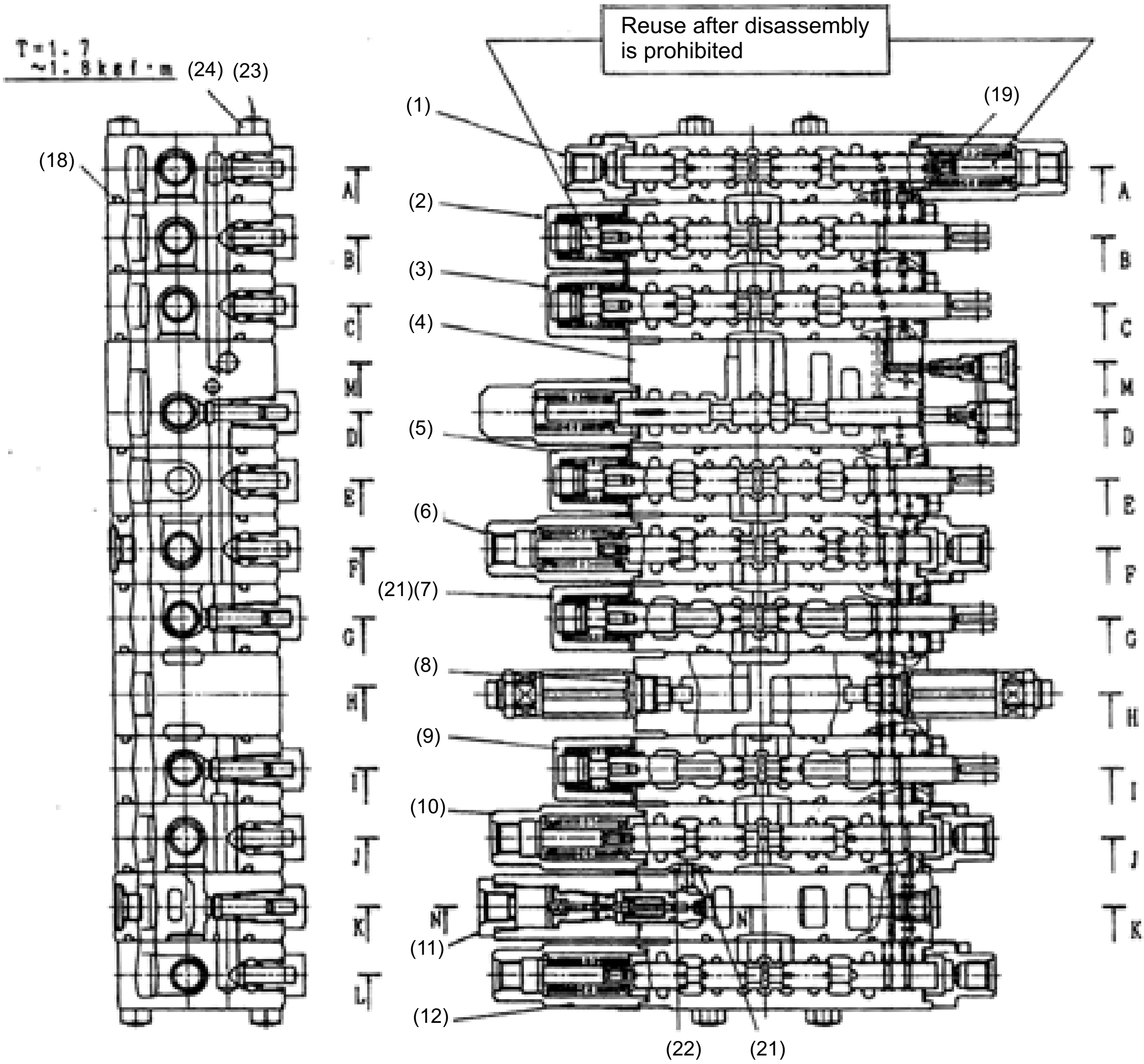
c. Control valve circuit diagram

(KX91-3 assy code No.=RC411-61133)

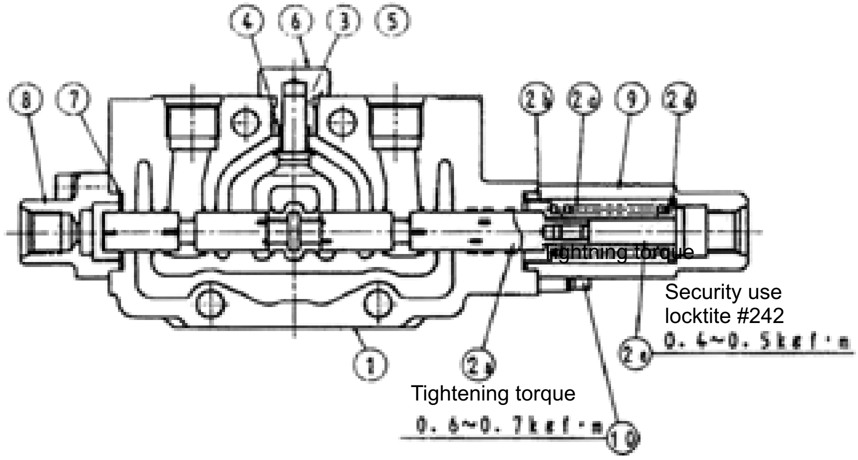


d. Control valve sectional view

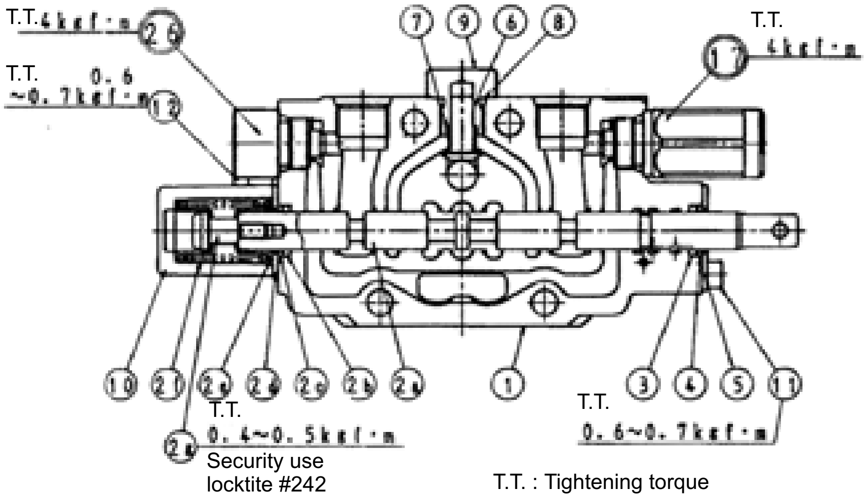
Model KX101-3
assy code No.=RC511-61131



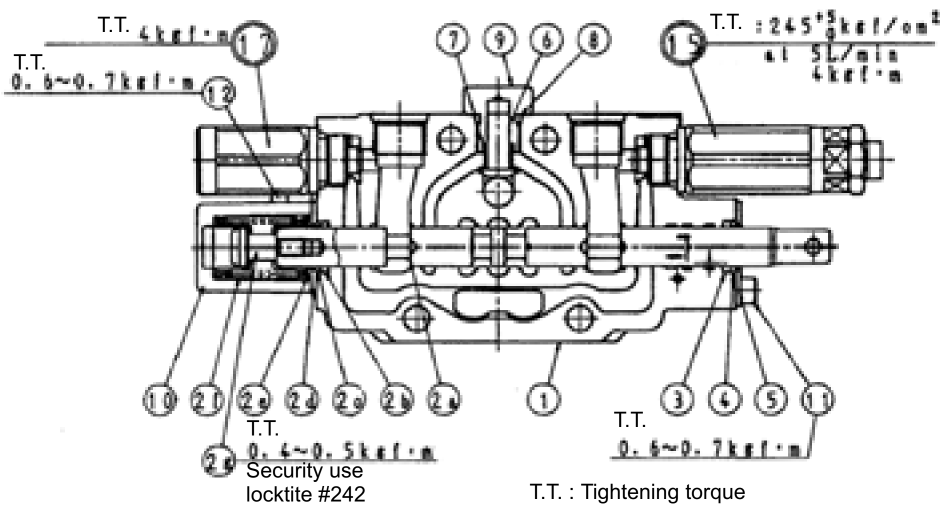
A-A: Swivel section



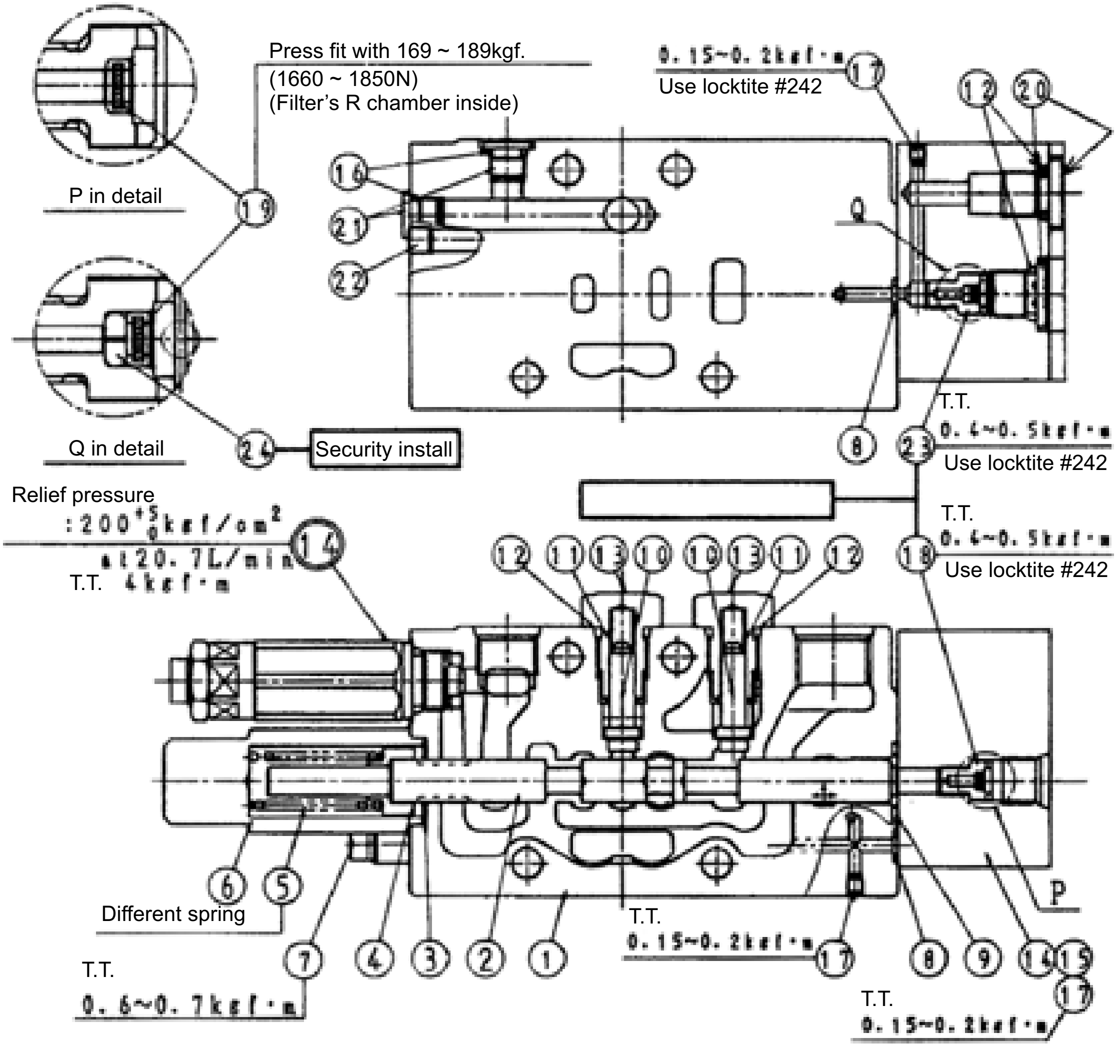
B-B: Swing section



C-C: Dozer section

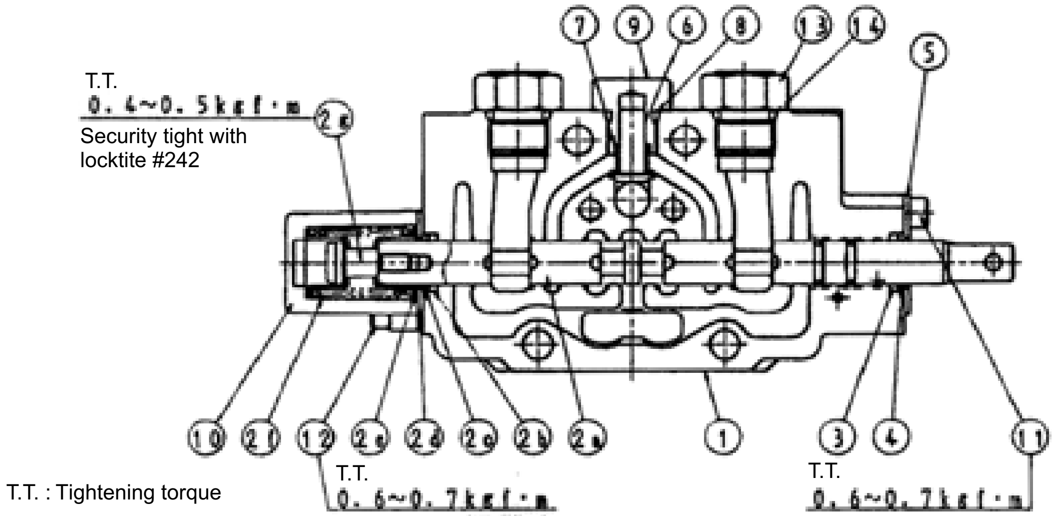


M-M, D-D: Travel straight section



T.T. : Tightening torque

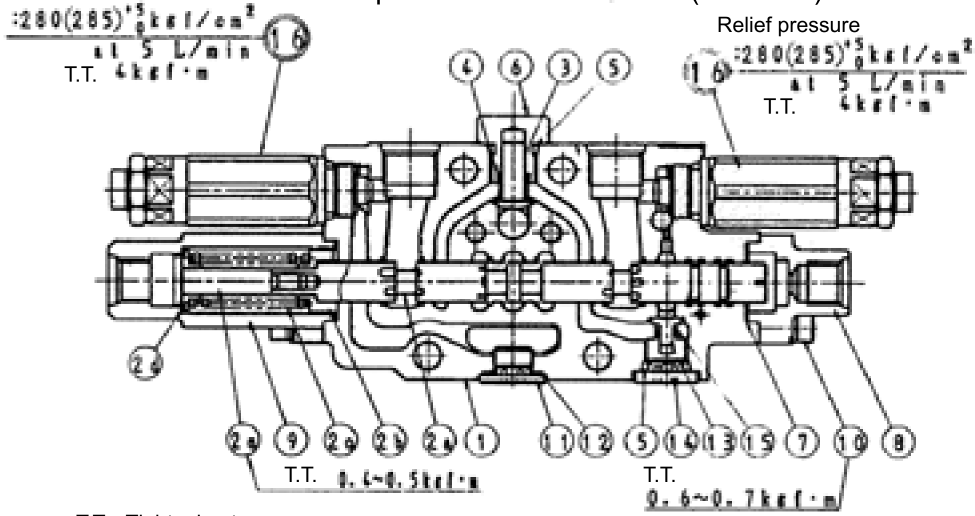
E-E: Service section



T.T. : Tightening torque

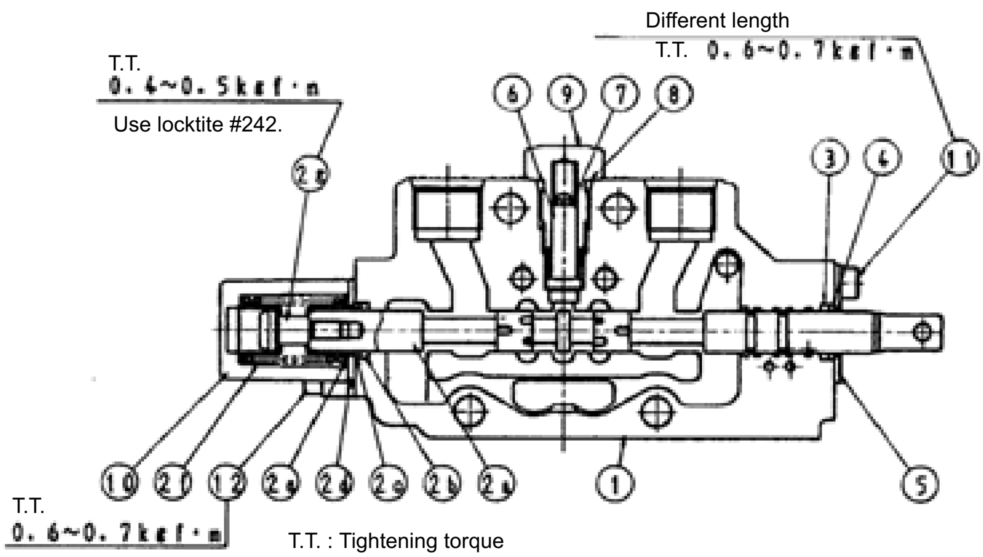
F-F: Arm section

Relief pressure value: KX91-3 (KX101-3)



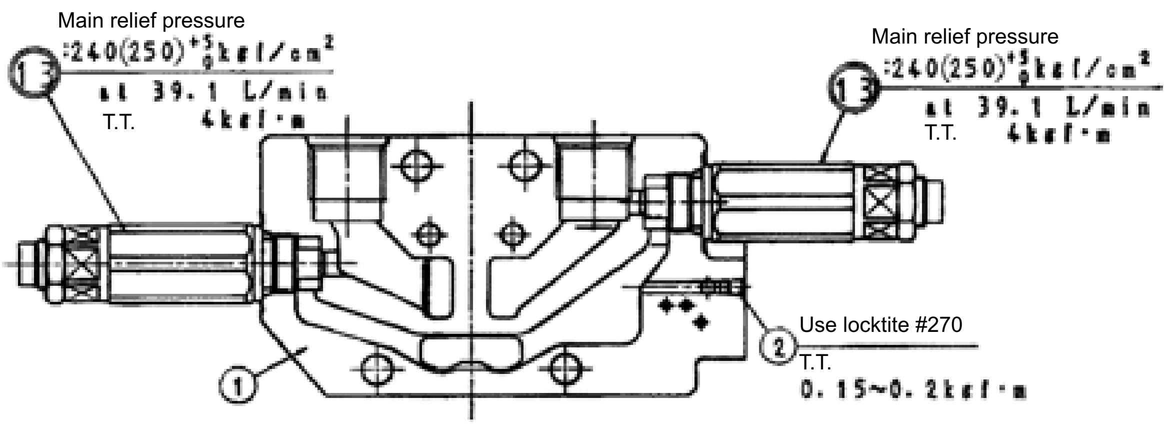
T.T. : Tightening torque

G-G: Travel section



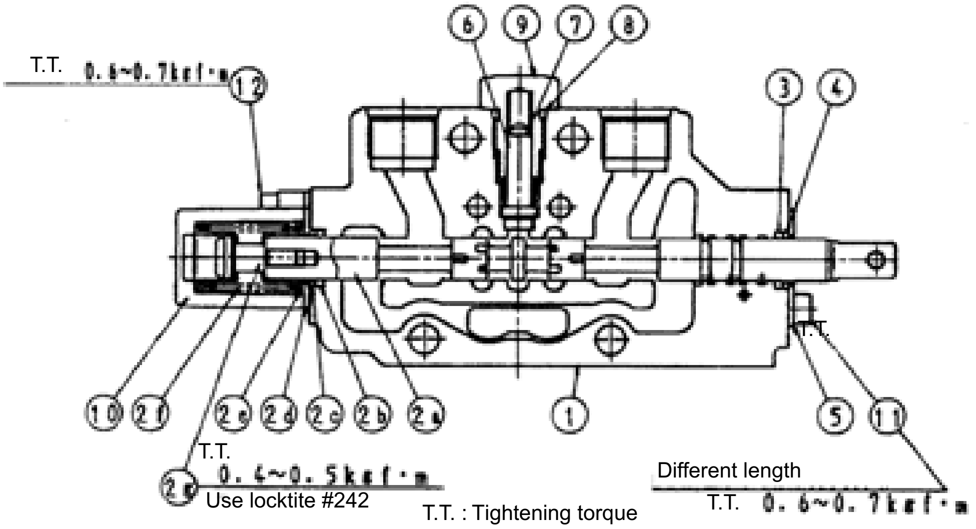
T.T. : Tightening torque

H-H: Inlet section

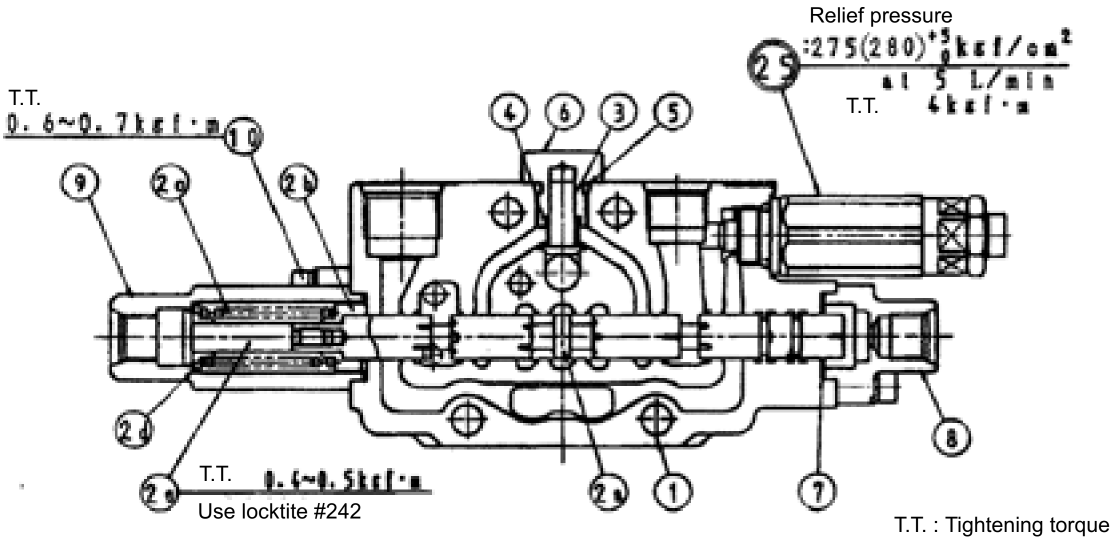


T.T. : Tightening torque

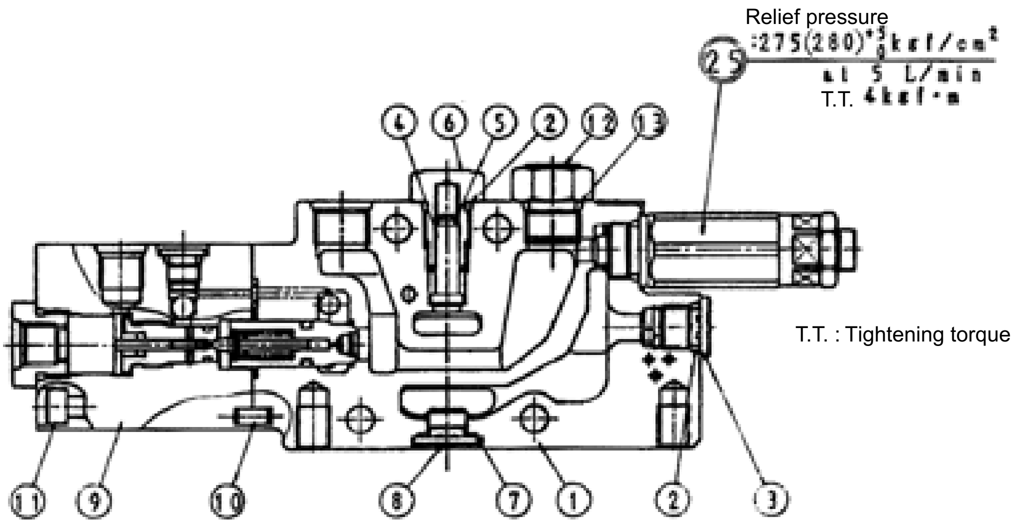
I-I: Travel R section



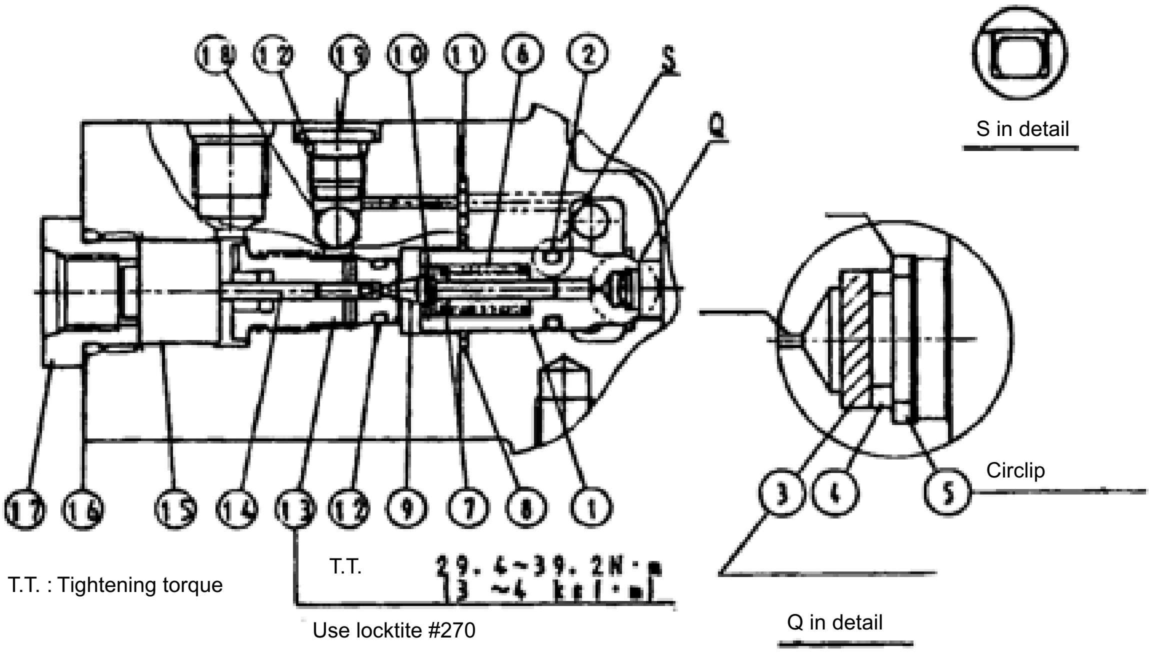
J-J: Boom section



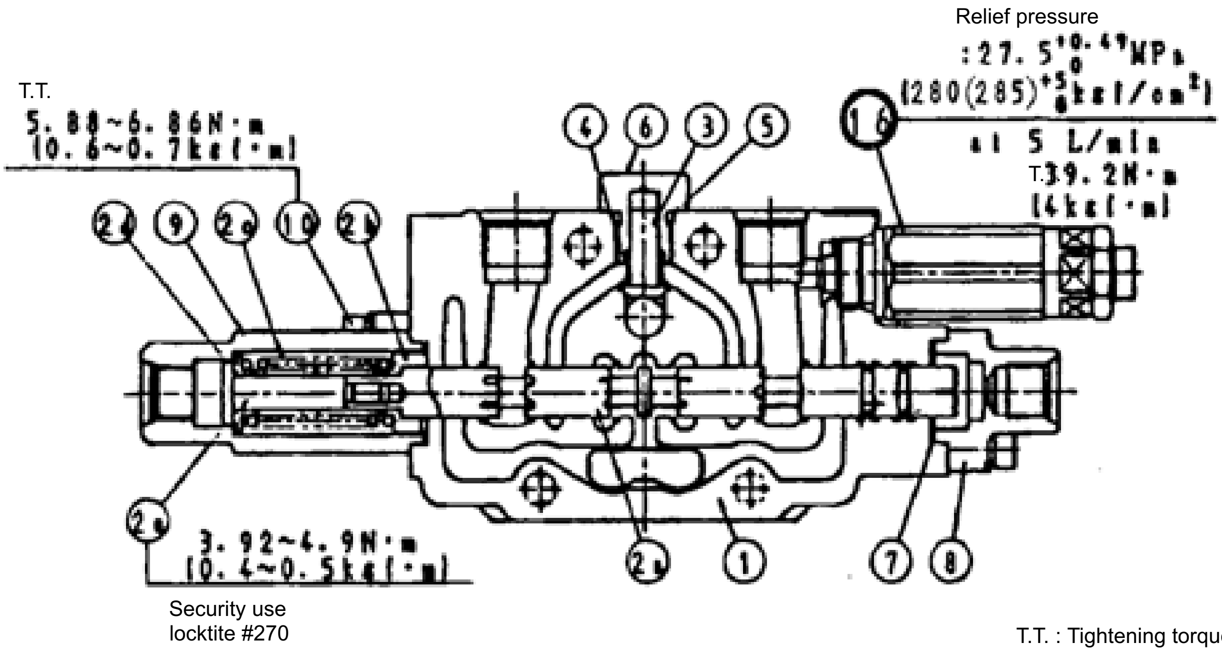
K-K: Boom lock section



N-N: Boom lock section in detail

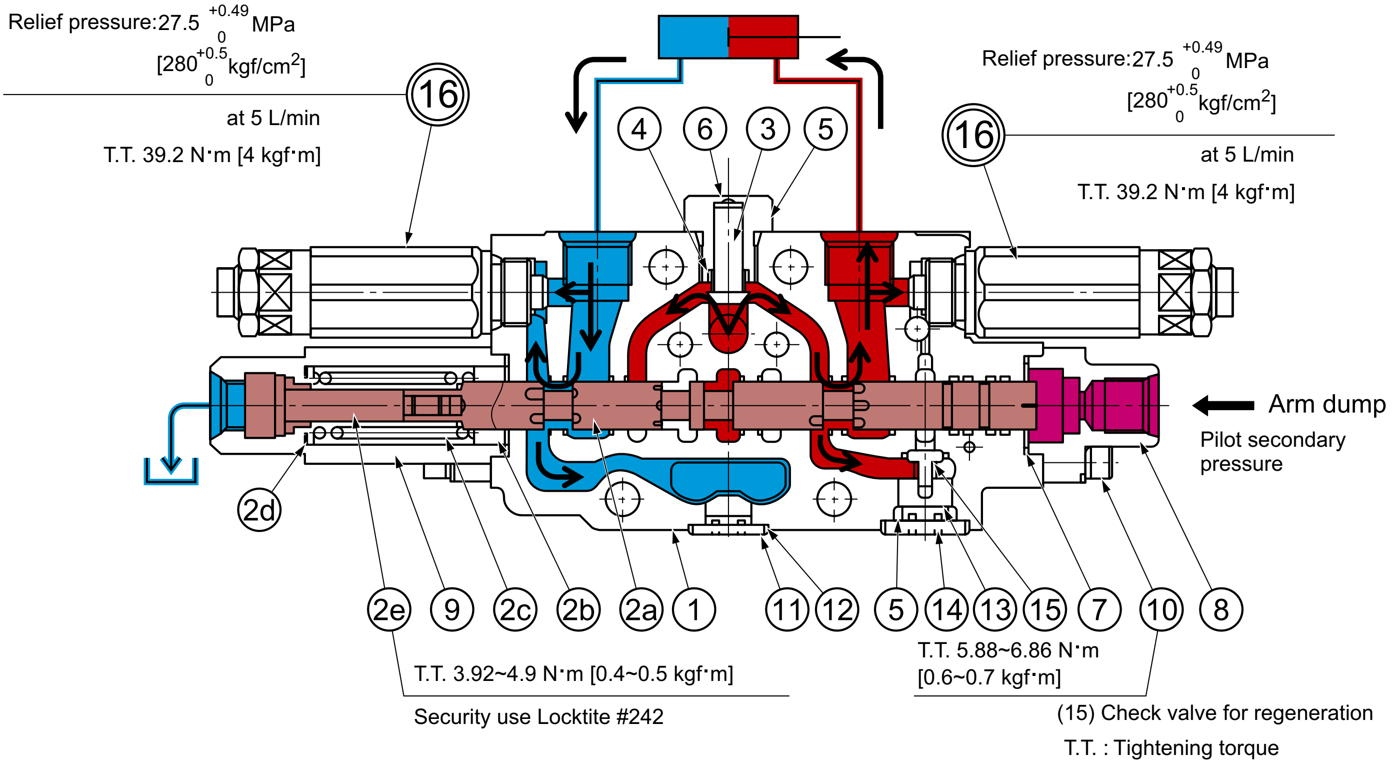


L-L: Bucket section

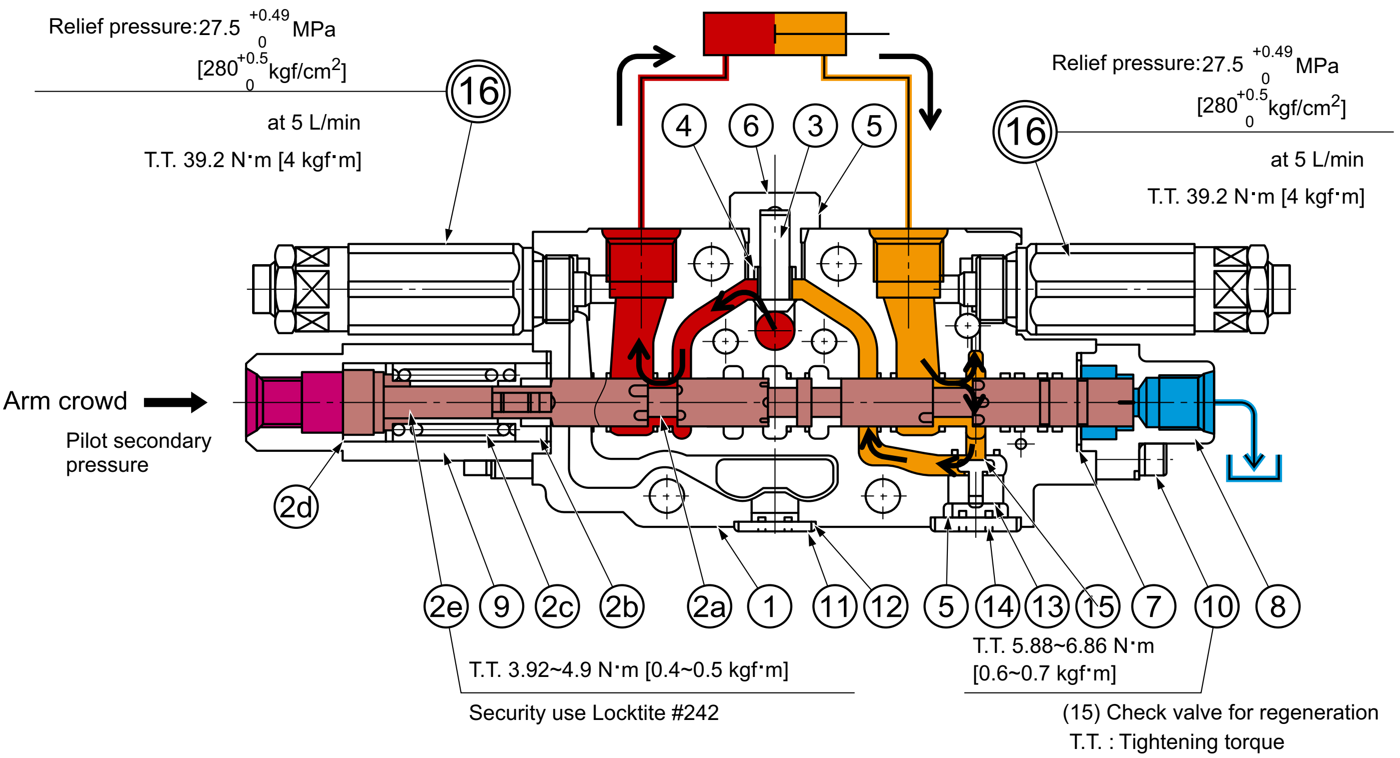


e. Arm regeneration circuit

(1) Arm dump



(2) Arm Crowd

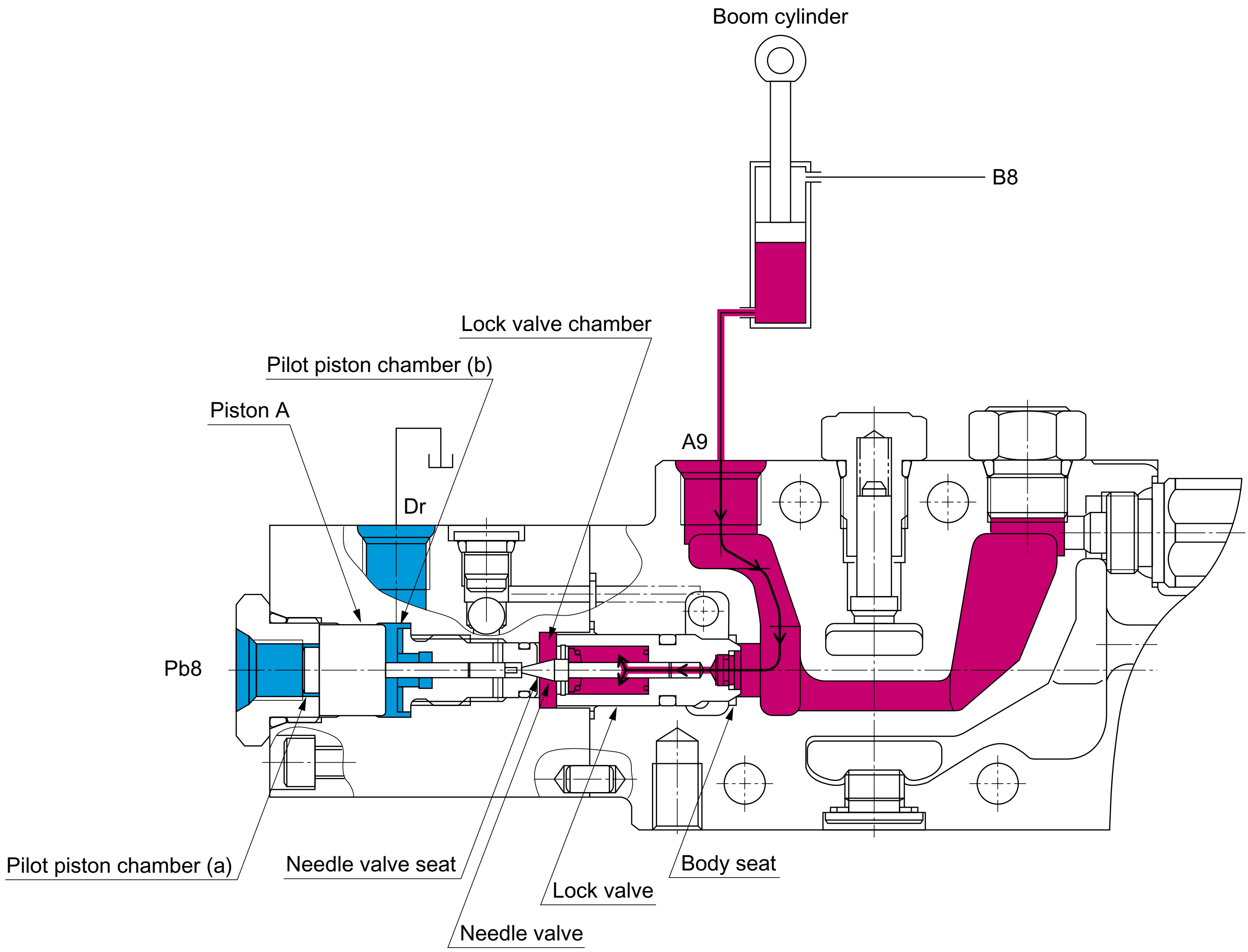


f. Oil flow of lock valve

(1) Operation of lock valve

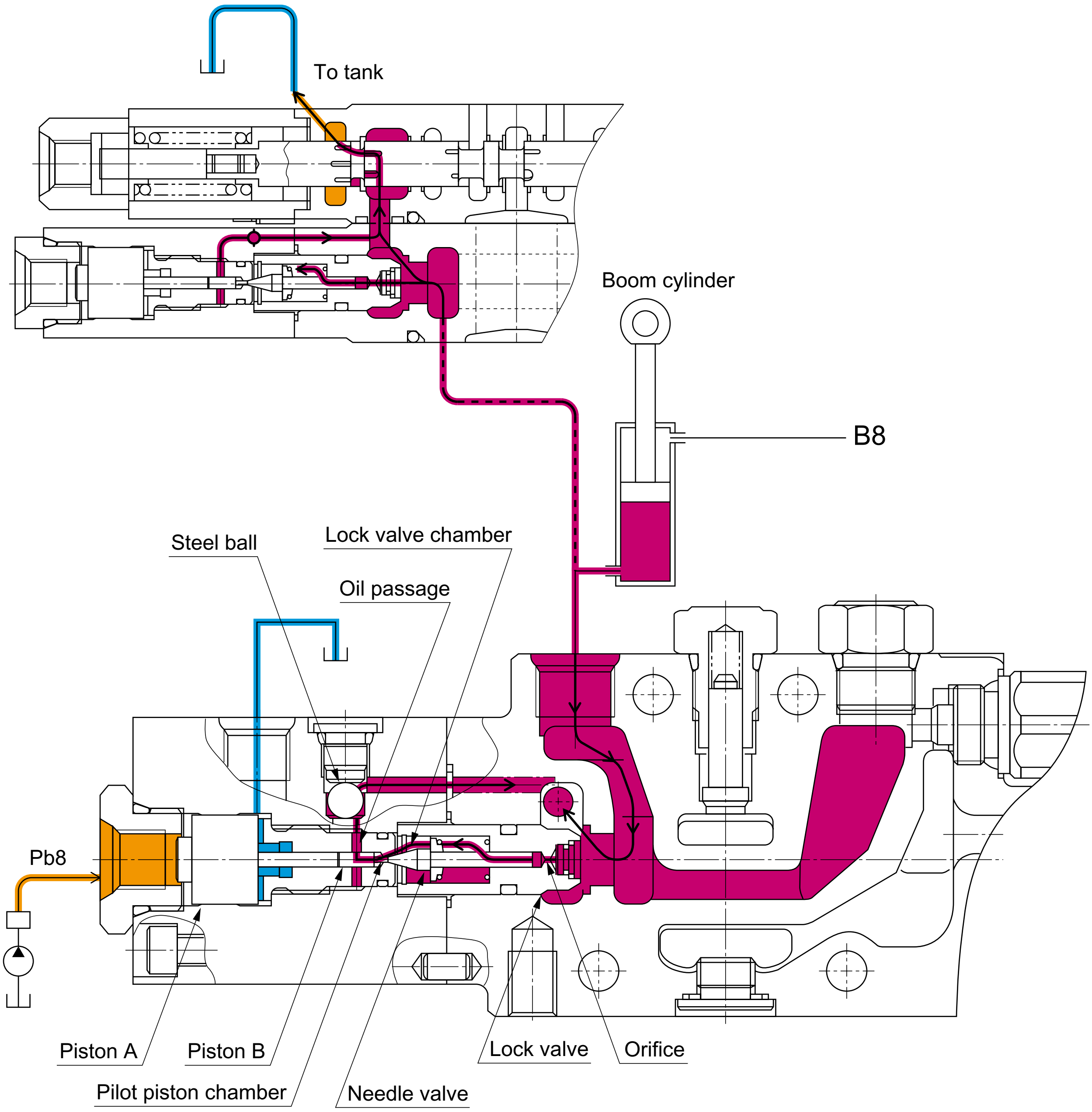
1) Holding

When the boom spool is in the neutral position, the pilot piston chamber (a) is connected to the drain passage via the pilot port for lock valve releasing (Pb8') and also the piston chamber (b) is connected to the drain passage via the drain port (Dr).
This holds the piston (A) in the state as shown below.
As illustrated below, the hold pressure of the boom cylinder acts on the lock valve chamber, pressing the needle valve and the lock valve against the needle valve seat and the body seat, respectively. This prevents leakage from the boom cylinder head, thus keeping the boom cylinder from moving due to leakage.s



2) Releasing

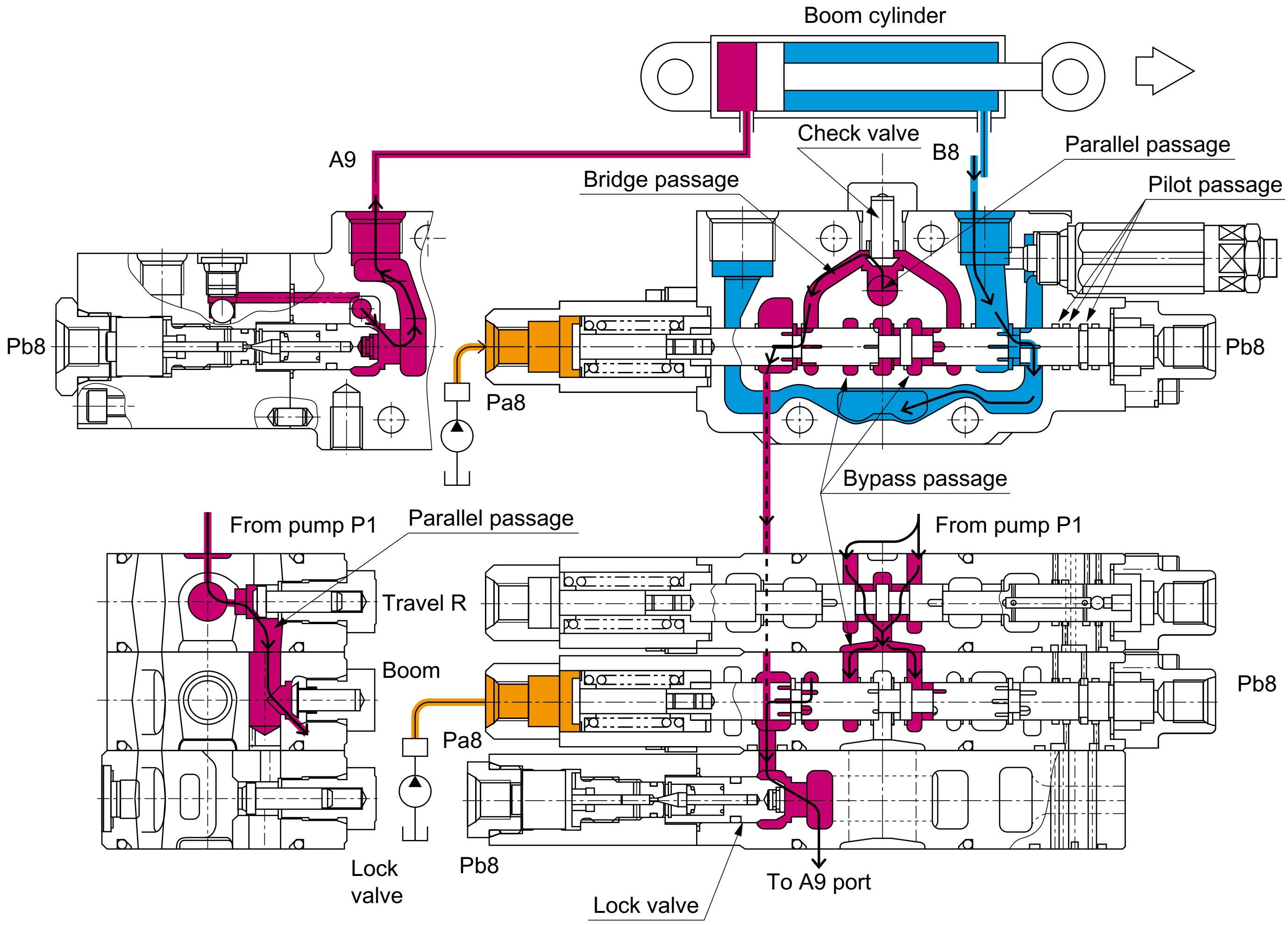
When the pilot pressure acts on the pilot port for lock valve releasing (Pb8'), the piston (A) moves to the right to push open the needle valve via the piston (B).
At this time, the return hydraulic oil from the boom cylinder flows through the orifice of the lock valve, passes through the lock valve chamber, pilot piston and oil passage in this order, pushes up the steel ball, and flows to the tank passage through the notch of the boom spool.
Because the needle valve is now open, the pressure in the lock valve chamber drops. As a result, the pressure of the return hydraulic oil from the boom cylinder opens the lock valve and the return hydraulic oil from the boom cylinder flows to the tank passage through the notch of the boom spool.



(2) Boom operation

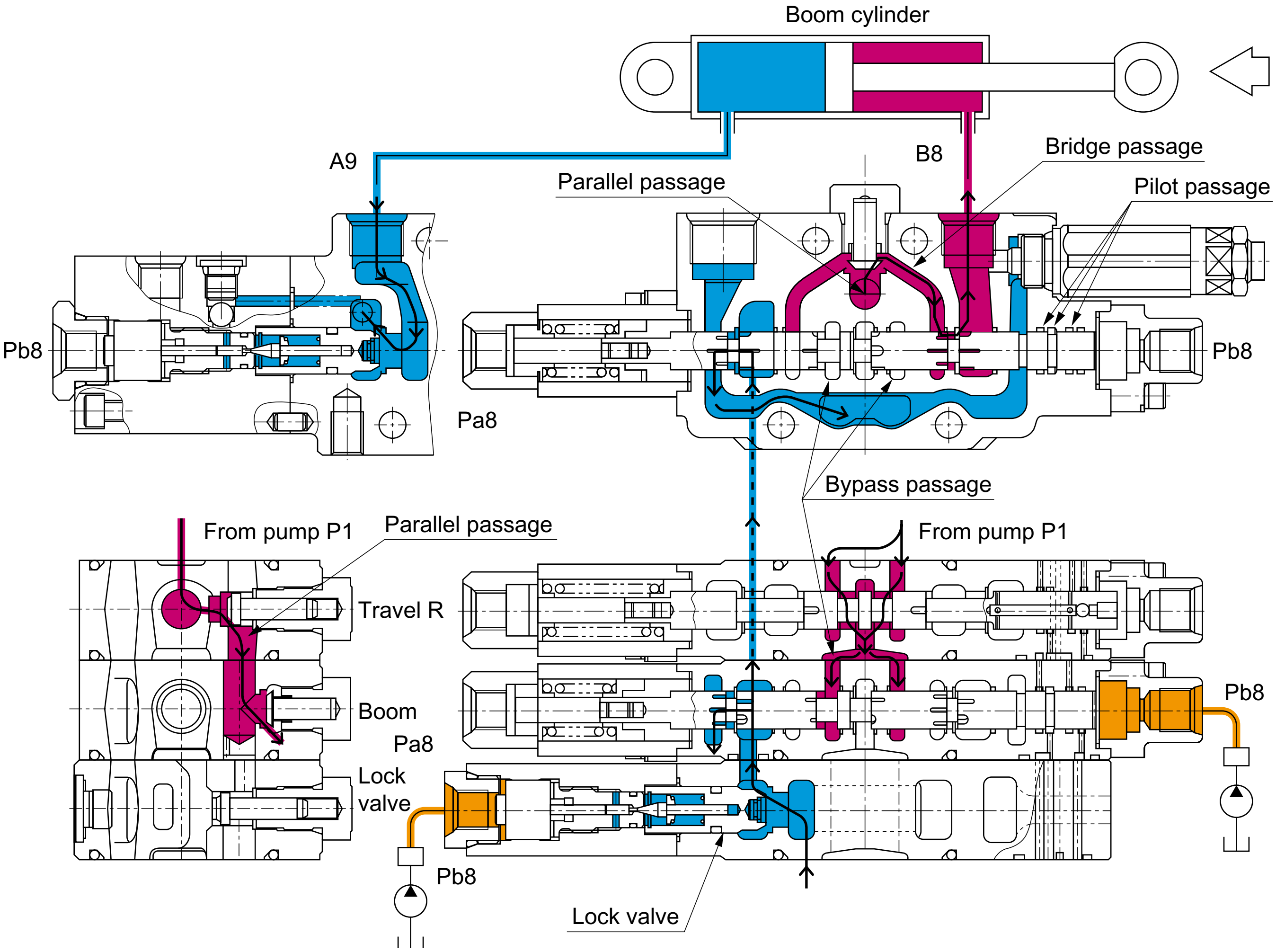
1) Boom-up operation

When the boom-up action is taken, the secondary pressure from the pilot control valve is conducted to the port “Pa8”, shifting the boom spool.
Because the bypass passage is now blocked at the boom switching section, the hydraulic oil coming from the port “P1” flows through the parallel passage via the check valve located above the travel spool bypass passage to the parallel passage in the boom switching section.
Because the passage leading to the lock valve is connected to the bridge passage as a result of the spool being shifted, the hydraulic oil in the parallel passage passes through the load check valve in the boom switching section, flows through the bridge passage, and pushes the lock valve open (free flow state). Then, after flowing into the port “A9”, it is supplied to the boom cylinder head.
The return hydraulic oil from the boom cylinder rod side, on the other hand, flows into the port “B8” and flows to the tank passage via the notch of the spool.
As a result, the boom cylinder gets extended to move up the boom.



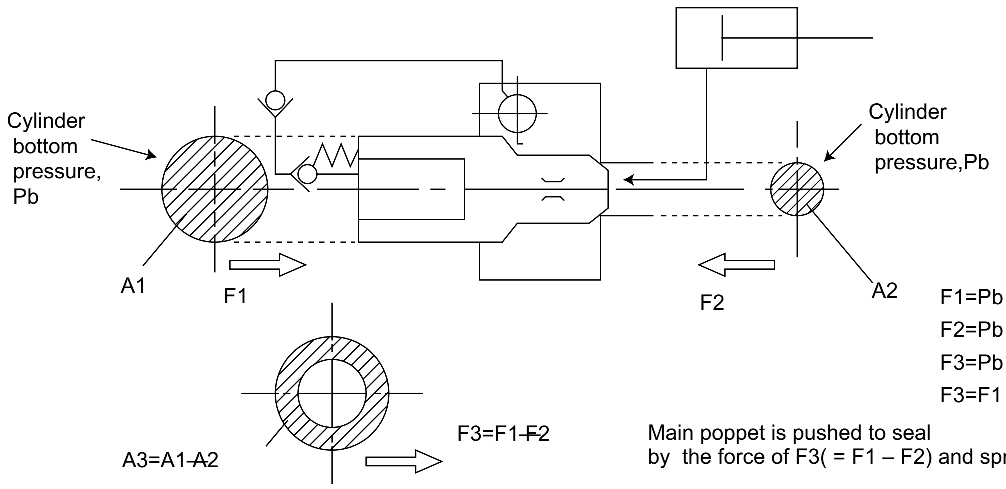
2) Boom-down operation

When the boom-down action is taken, the secondary pressure from the pilot control valve is conducted to the ports “Pb8” and “Pb8’”, shifting the boom spool.
Because the bypass passage is now blocked at the boom switching section, the hydraulic oil coming from the port “P1” flows from through the parallel passage via the check valve located above the travel spool bypass passage to the parallel passage in the boom switching section.
Because the port “B8” is connected to the bridge passage as a result of the spool being shifted, the hydraulic oil in the parallel passage passes through the load check valve in the boom switching section, flows through the bridge passage, and flows into the port “B8”. Then it is supplied to the rod side of the boom cylinder.
The return hydraulic oil from the boom cylinder head, on the other hand, flows into the port “A9”, passes through the lock valve released by the port “Pb8’” pressure, and flows to the tank passage via the notch of the spool.
As a result, the boom cylinder gets contracted to move down the boom.



g. Function of lock valve (Anti-drift valve)

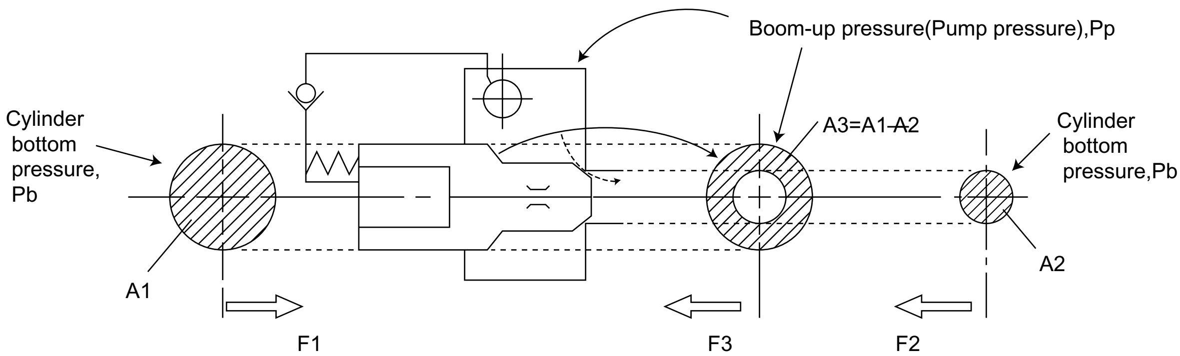
(1) Boom cylinder holding function



F1=Pb × A1
F2=Pb × A2
F3=Pb × (A1 – A2)
F3=F1 – F2

Main poppet is pushed to seal
by the force of F3(= F1 – F2) and spring.

(2) Boom up function

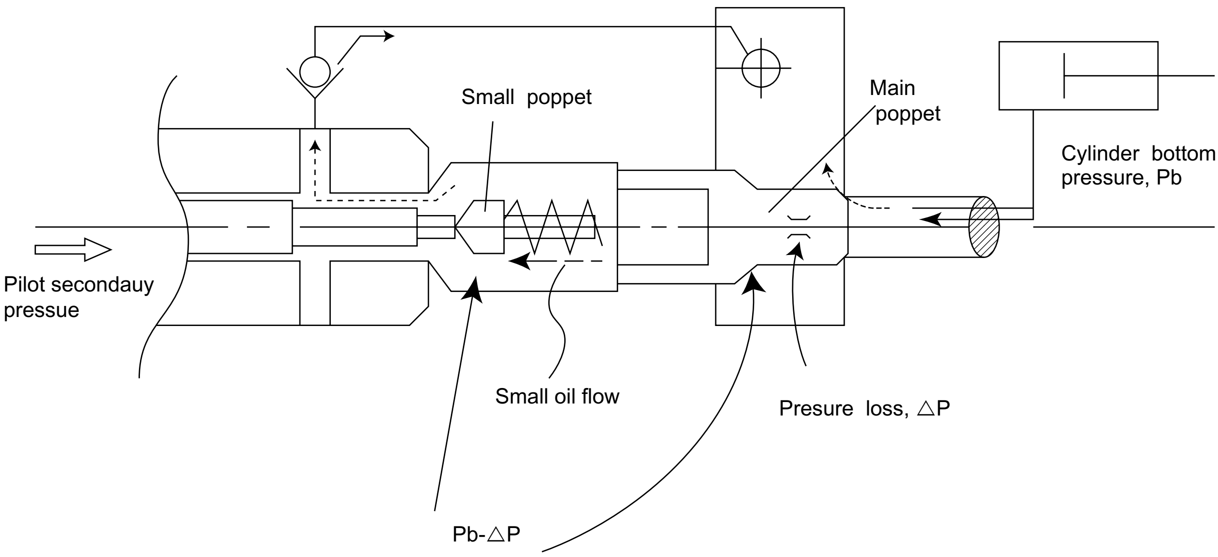


Pb A1 – Pb A2 < Pp × (A1 – A2)
Pb (A1 – A2) < Pp × (A1 – A2)

F1=Pb × A1
F2=Pb × A2
F3=Pp × (A1 – A2)

Pump pressure,Pp is larger than Pb,cylinder bottom pressure.
Therefore, main poppet is pushed to open.

(3) Boom-down function



Pilot secondary pressure applies on the end of poston and small poppet is pushed to open.
So pressure in the chamber is dumped to tank port. Thus main poppet opens.

h. Relief valve/Anti-cavitation valve

Function of relief valve

(1) The pressure oil passes first through the piston that is built in the main poppet. It then goes through the orifice B and fills the chamber A. Now the main poppet and socket are well fitted, whereas the socket and body seat are also ensured together. (Fig. 1)

(2) When the pressure oil at the port P has reached the spring's set pressure, the piston is pushed, which in turn pushes the pilot poppet open.
Now the pressure oil flows in this way:piston, orifice B, chamber A, ring orifice A, and port D. It finally passes around the socket into the tank port. (Fig. 2)

(3) With the pilot valve open, the pressure in the chamber A drops. The main poppet then opens, and the pressure oil at the port P goes through the port E and directly reaches the tank port. (Fig. 3)

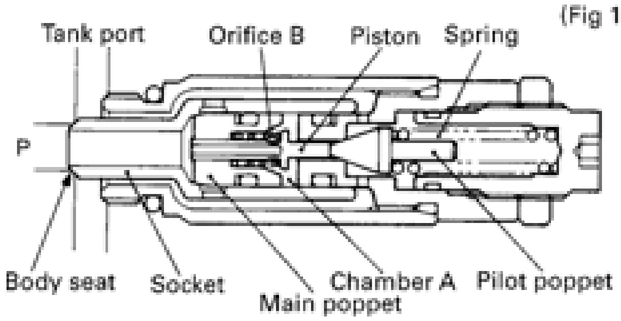
(4) When the pressure at the port P has dropped below the spring's set pressure, the pilot poppet is pressed against the seat by the spring force and the pressure of chamber A becomes equal to that of port A. The main poppet is also pressed against the socket seat resulting in the original state (Fig. 1).

Function of anti-cavitation valve

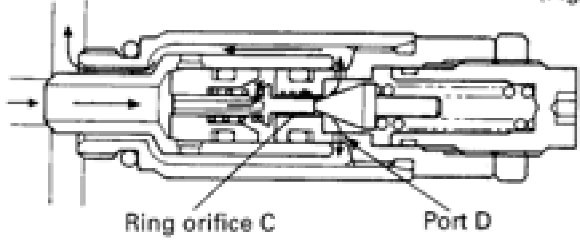
(1) This valve works to feed the oil from the tank port if a negative pressure occurs at the portP.
When the pressure at the tank port has risen above that at the port P, the socket is activated upward.
This upward force makes a space between the body seat and the socket. The oil now comes through the tank port into the port P and fills the space. (Fig. 4)

(2) This valve works to feed the oil from the tank port if a negative pressure occurs at the portP.
When the pressure at the tank port has risen above that at the port P, the valve is activated upward.
This upward force makes a space between the body seat and the valve. The oil now comes through the tank port into the port P and fills the space. (Fig. 5)

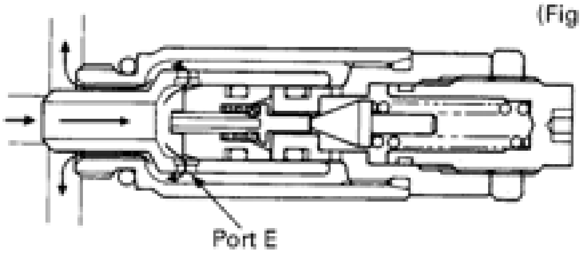
(Fig 1)



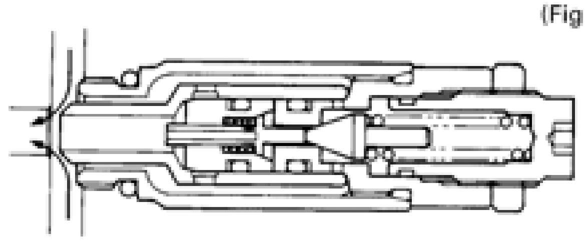
(Fig 2)



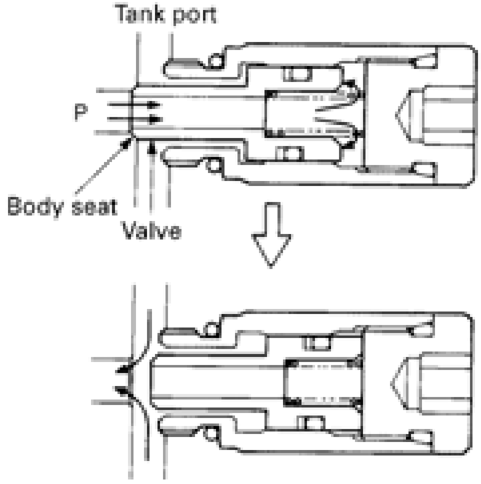
(Fig 3)



(Fig 4)



(Fig 5)



i. Straight travel circuit

(1) Feature

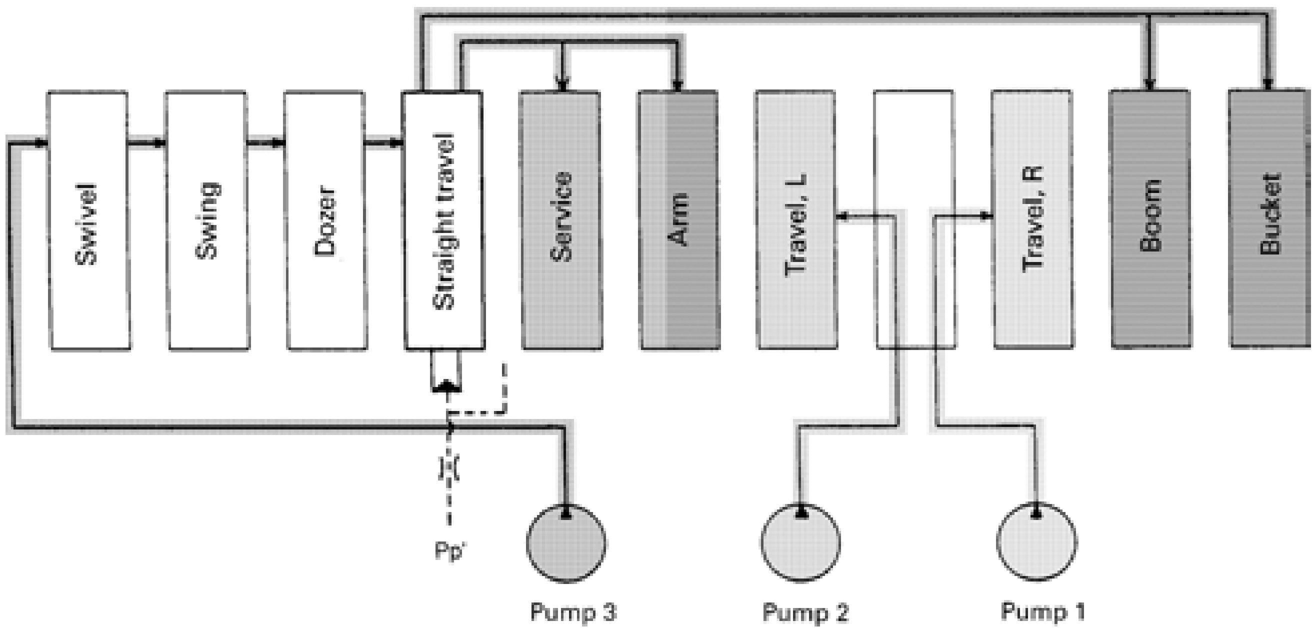
The following points are ensured even when a front attachment (boom, arm, bucket, etc.) is operated while traveling.

1) The machine keeps running straight.
2) The machine keeps running at the same speed.

(2) Working effect

1) When loading and unloading the machine on and off a truck, the front attachments can be moved up and 1)own for safe, efficient work.
2) Before lifting pipes, the front attachment can be positioned exactly to the pipes while the machine is traveling.

(3) Operating

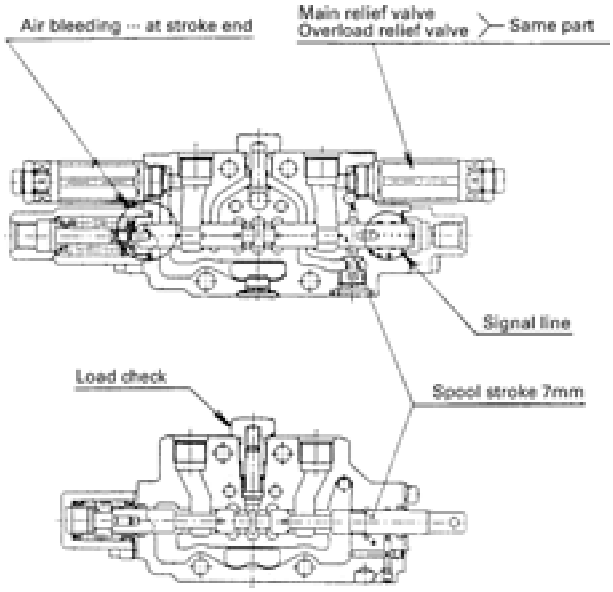


When the boom, arm, bucket or service port is used while traveling, the signal line of the related spool is activated to shut off the passage leading to the tank. The Pp' port then gets under pressure, which switches the spool of the straight travel section.
So the oil that is supplied from the pump 3 flows to the boom, arm, bucket or service port. In this design, the machine can keep running straight.

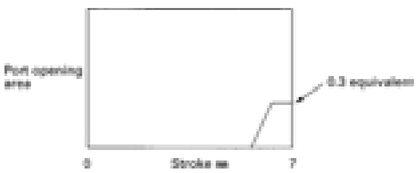
j. Other functions

(1) Interval oil flow

1) Spool stroke: 7 mm
2) Parallel passage:
   Two lines (Use on travel straight function)
3) Signal passage: For straight travel



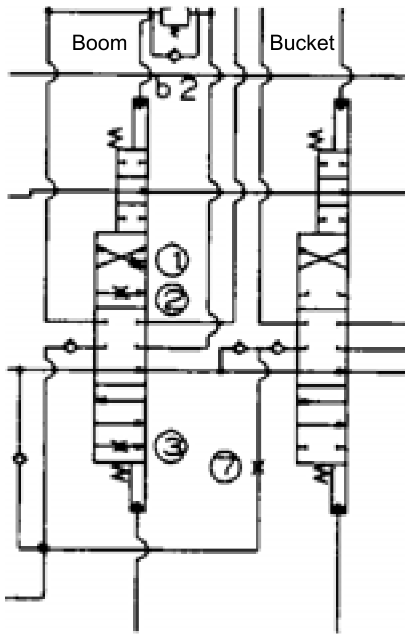
Air bleeding of pilot system



* The pilot system air bleeding circuit is of automatic type and starts opening at the spool stroke of 6 mm and gets fully open at 7 mm (0.3 mm dia.).

Straight travel circuit

When the boom, arm, bucket or service cylinder is used while traveling, the signal line of each spool is activated and the return passage to the tank is shut off. The Pp' port gets under pressure and the confluence valve spool is switched.
By this, the oil from the P_3 port reaches the boom, bucket, arm or service cylinder, and flows into the P_1 (right travel) and P_2 (left travel) ports. This enables the machine to travel straight.



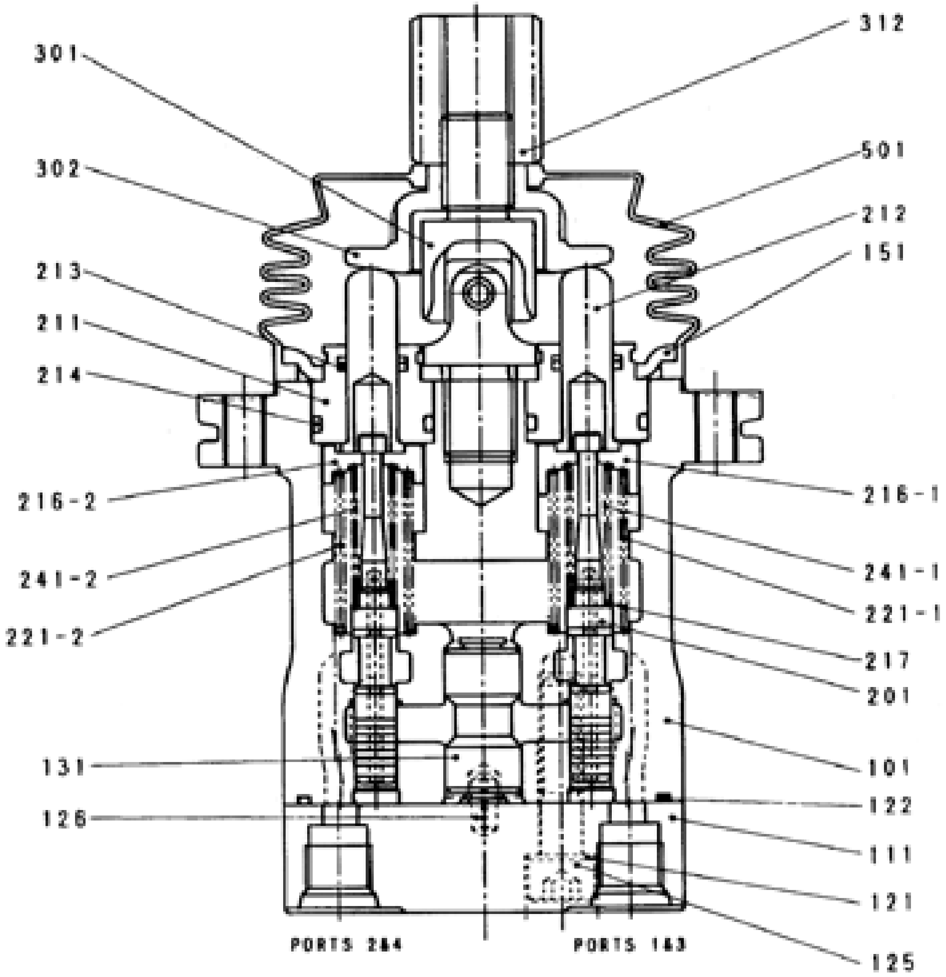
Simultaneous operation of boom & bucket

When the boom spool is switched, the bypass passage is shut off at the boom switch. And the oil coming from the P_1 port flows through the boom switching parallel passage and is fed via the boom switching port, now open by the boom spool shift, to the boom cylinder. The boom switching parallel passage and the bucket switching parallel passage are open to each other under the control of the intermediate orifice. When the bucket is used, the bucket spool gets shifted and the oil flows from the parallel passage via the load check valve to the bucket switching port that leads to the bridge passage.
While the boom and bucket are being used together, the pressure oil to the bucket switch is fed via the intermediate orifice. The orifice openness is not enough to cover the difference with respect to the attachment load, but designed to keep the best balance for simultaneous operation of the boom and bucket.

E.Pilot valve

assy No.=RC411-61721 (Kawasaki HI make)

a. Structure & specifications



121:
Not to be reused.

212:
Grease is applied on each top part.

217:
Shim for adjusting secondary pressure 1 sheet with designed thickness t = 0.4

301:
Grease is applied on each rotational part of the universal joint.

Tightening torque list

No.	SCREW SIZE	TIGHTNING TORQUE
125	M8	20.6 ± 1.5 N·m (210 ± 15 kgf·cm)
301	M14	47.1 ± 2.9 N·m (480 ± 30 kgf·cm)
312	M14	68.6 ± 4.9 N·m (700 ± 50 kgf·cm)

No.	PART NAME	Q'ty
213	Seal	4
212	ROD, push	4
211	PLUG	4
201	SPOOL	4
151	PLATE	1
131	BUSH	1
126	PIN, spring	1
125	SCREW, hex, S.M.C	2
122	O-RING	1
121	WASHER, seal	2
111	PLATE, port	1
101	CASING	1

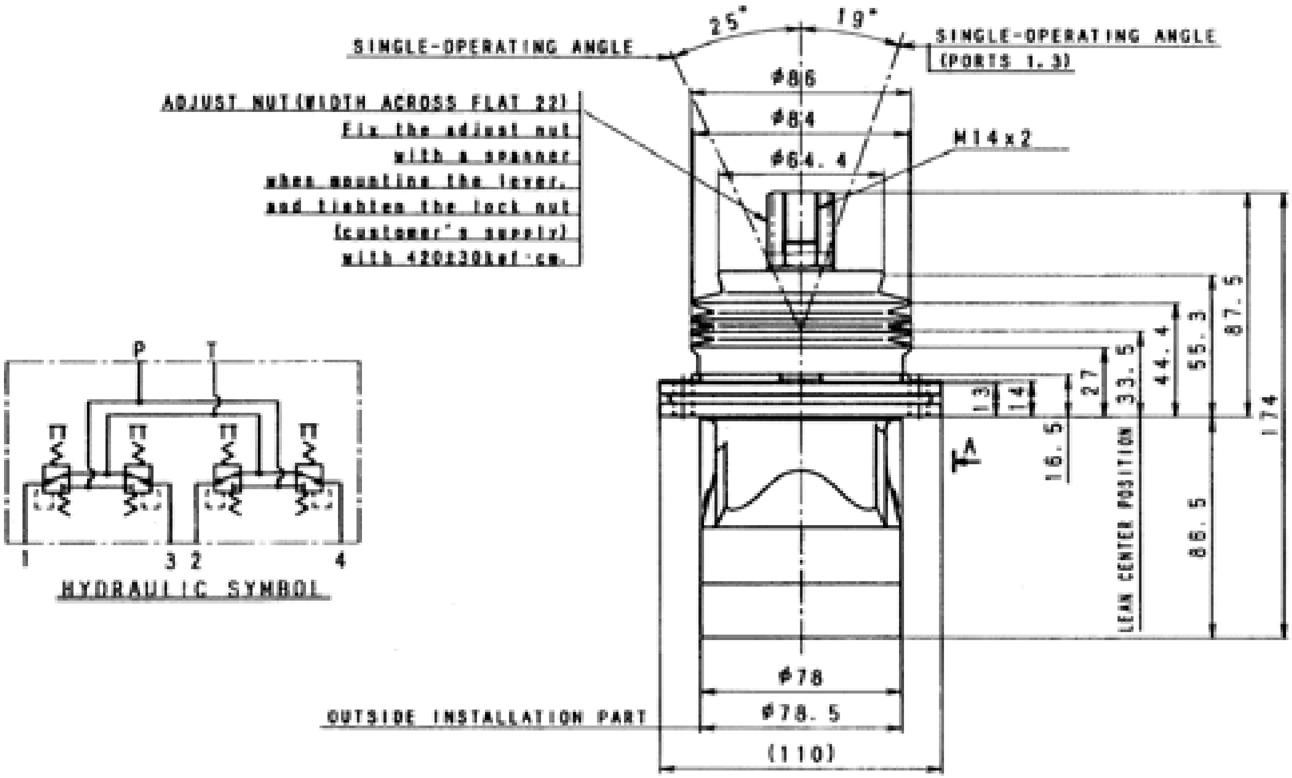
No.	PART NAME	Q'ty
501	BELLOWS	1
312	NUT, adjusting	1
302	PLATE, circular	1
301	JOINT	1
241-2	SPRING	2
241-1	SPRING	2
221-2	SPRING	2
221-1	SPRING	2
217	WASHER 2	4
216-2	SEAT 1, spring	2
216-1	SEAT 1, spring	2
214	O-RING	4

Specifications

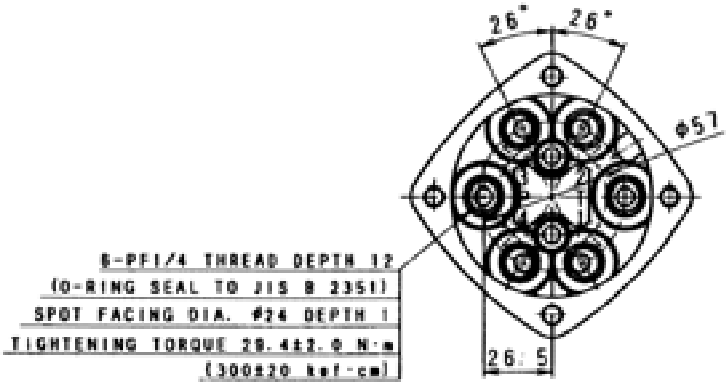
(1)	MAX PRIMARY PRESSURE	:	6.9 NPa(70 kgf/cm^2)
(2)	MAX BACK PRESSURE	:	0.3 NPa(3 kgf/cm^2)
(3)	RATED FLOW	:	15 l/min
(4)	SECONDARY PRESSURE CHARACTRISTICS	:	Refer to the "Control Diagram" shown below.
(5)	OPRERATING TORQUE	:	Refer to the "Control Diagram" shown below.
(6)	MAX. ALLOWABLE EXTERNAL TORQUE	:	Refer to the "MAX. allowable external torque" shown below.
(7)	HYDRAULIC OIL	:	MINERAL HYDRAULIC OIL
(8)	OIL TEMP. RANGE	:	-20°C ~ 90°C
(9)	FILTER	:	A filter of 40 ~ mesh and ever should be applied at the entrance of port P for preventins the spool stickine.

Operating specifications

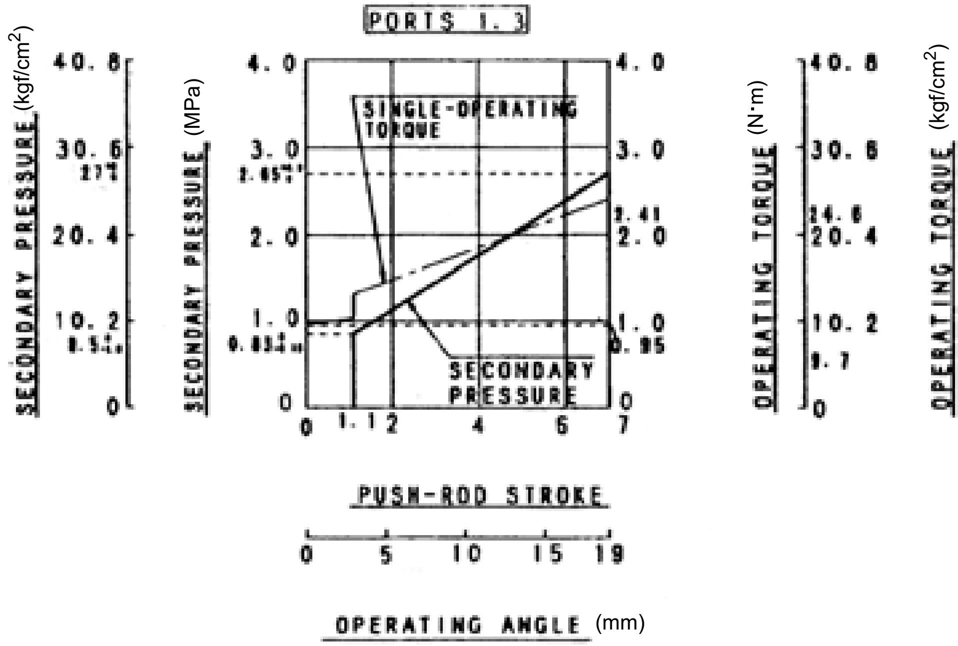
(1)	PRIMARY PRESSURE	:	3.9 NPa(40 kgf/cm^2)

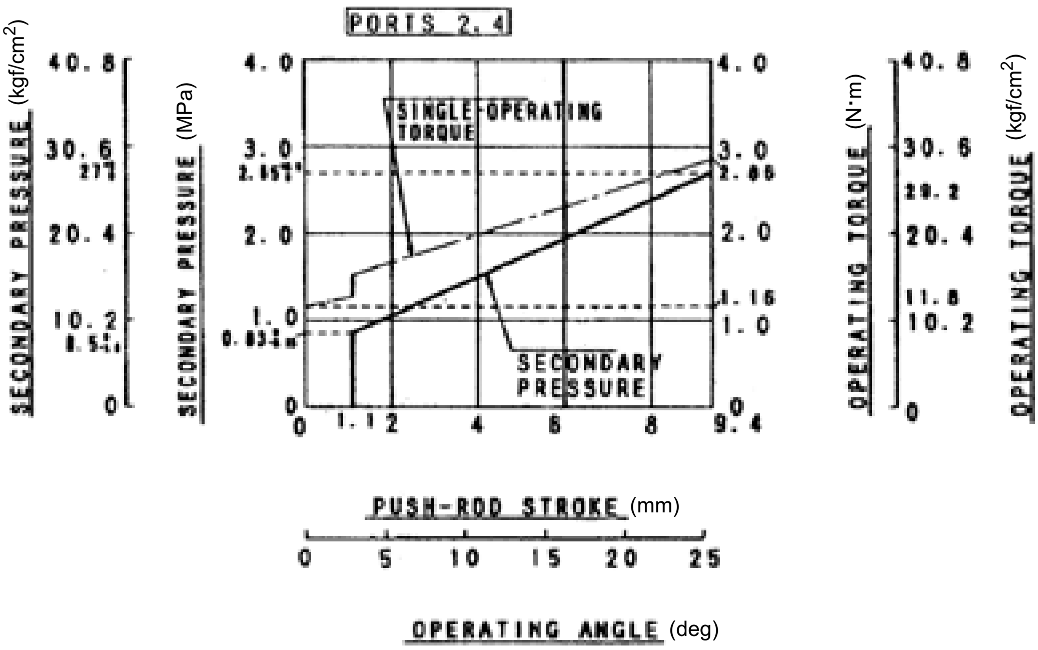


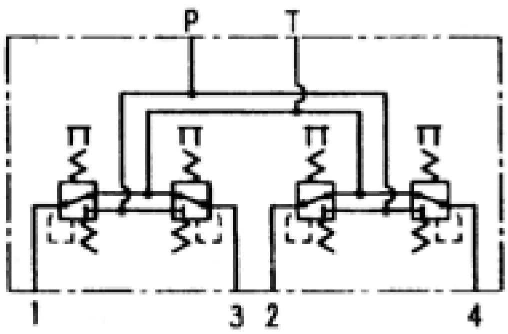
HYDRAULIC SYMBOL



b. Pilot valve control diagram



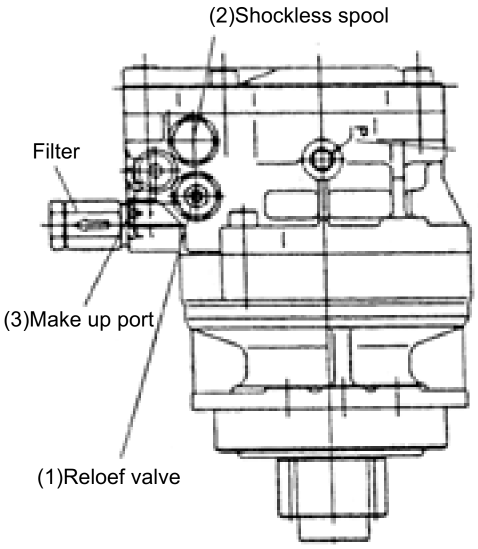




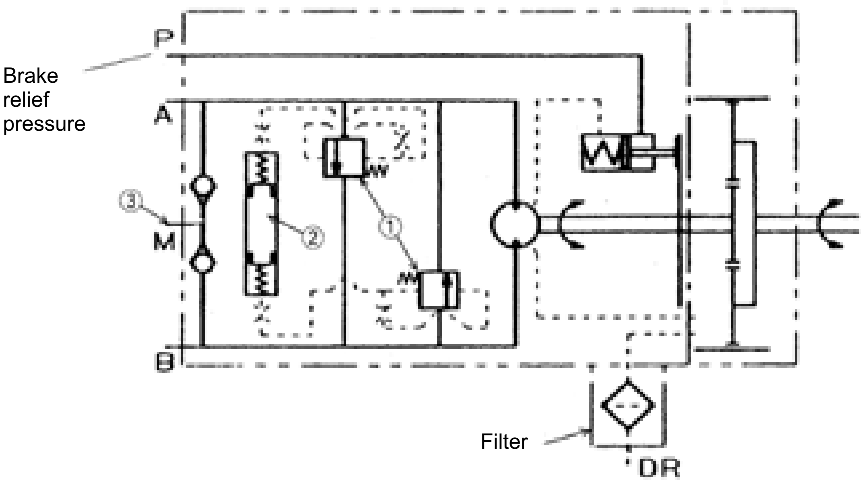
HYDRAULIC SYMBOL

F. Swivel motor

a. Structure & specifications

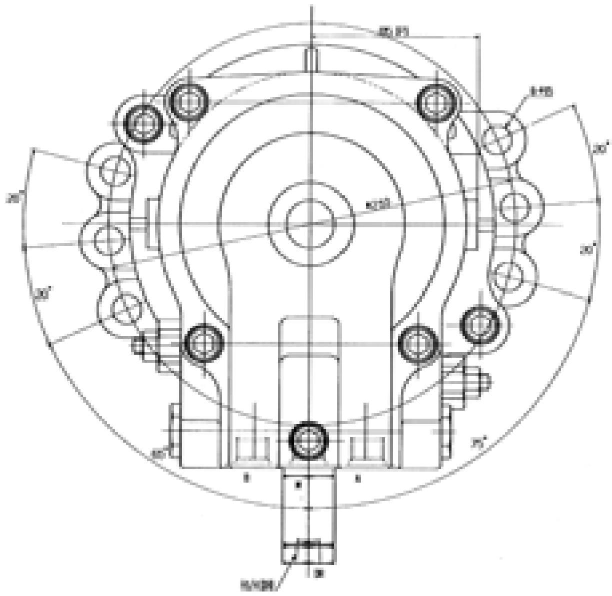


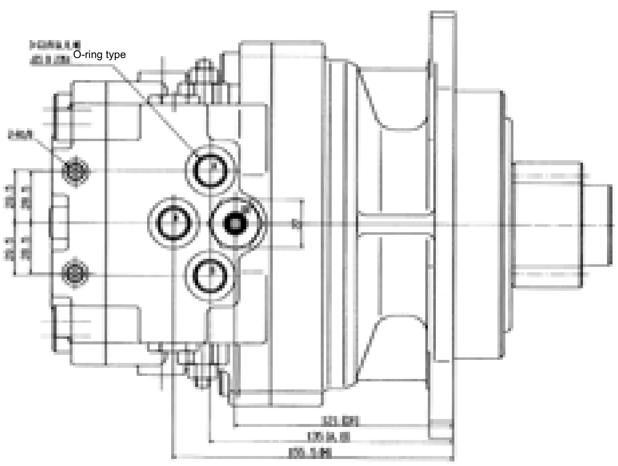
<Circuit diagram>

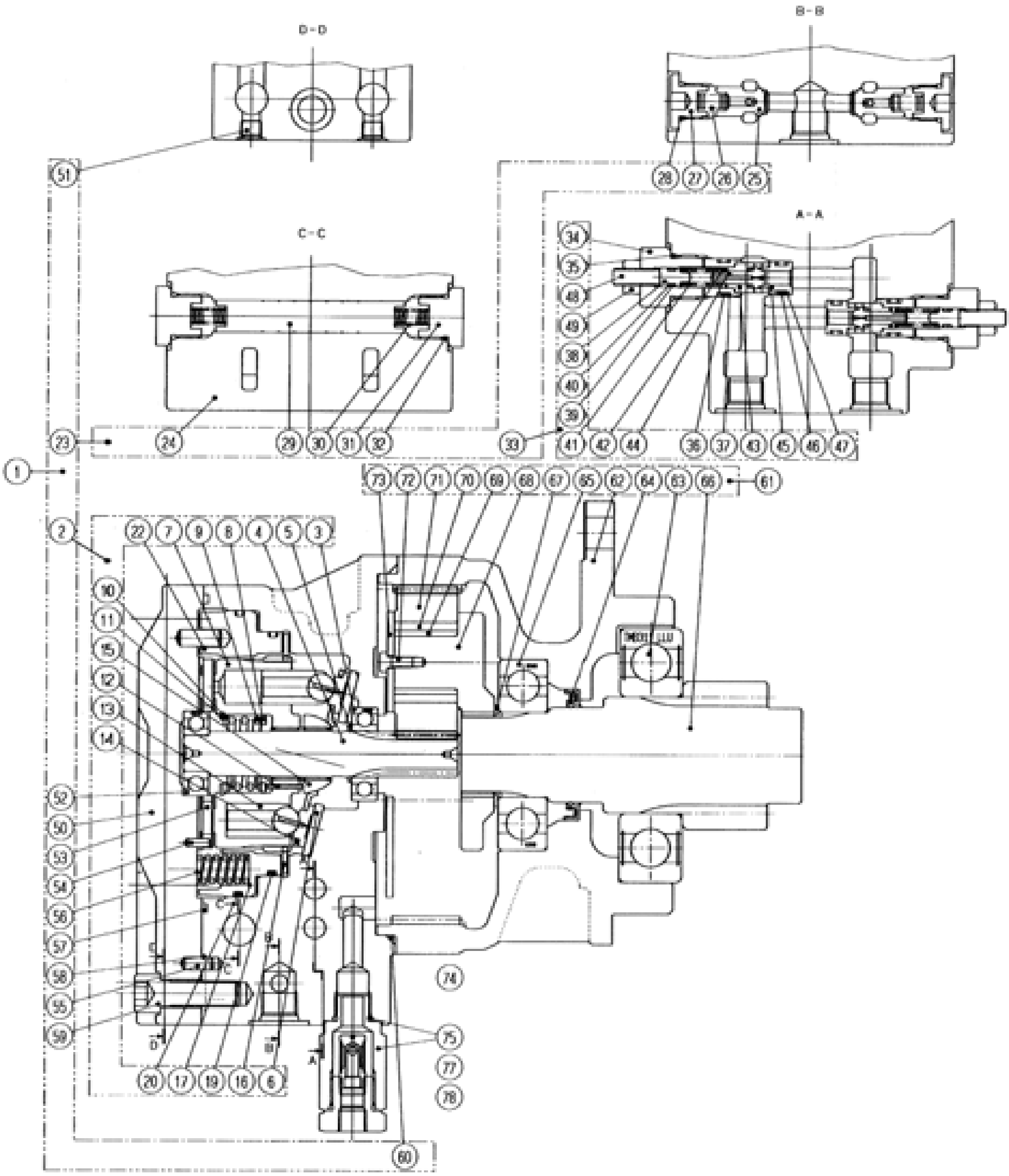


Specifications

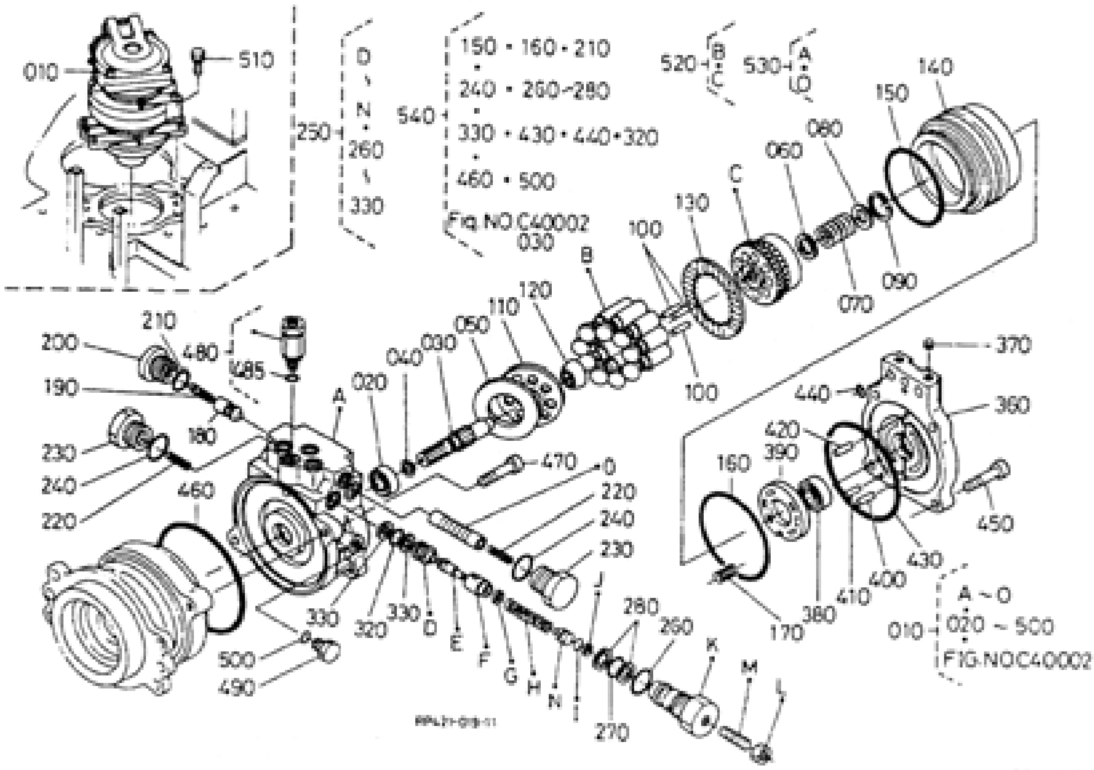
Displacement	29.271 cc/rev
Reduation ratio	9.90
Total displacement	289.78 cc/rev
Max. flow amount	20.90 l/min
Theoretical RPM	72.1 RPM
Theoretical output torque	769 N·m
Relief pressure setting	16.7 MPa(170 kgf/cm^2)
Mechanical brake torque	800N·m(82 kgf·m) or more
Negative brake releasing pressure	< 1.5 MPa(15 kgf/cm^2)
Drain pressure	< 0.3 MPa(3 kgf/cm^2)
Teeth No.	10



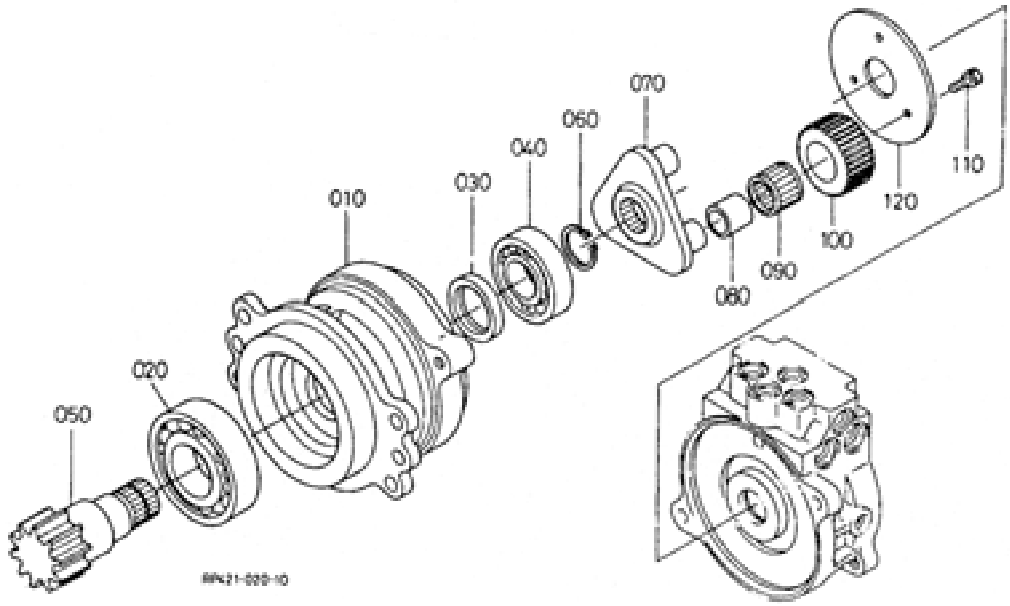




(3)	Ball bearing	(17)	Brake piston	(38)	Spring guide
(4)	Shaft	(23)	Valve assy	(43)	Poppet guide
(5)	Circlip	(24)	Valve housing	(61)	Gear case assy
(6)	Thrust plate	(25)	Poppet	(66)	Pinion shaft
(7)	Cylinder block	(29)	Shockless piston	(71)	Planetary gear
(13)	Piston plate	(33)	Relief valve assy	(73)	Thrust plate
(15)	Retainer holder	(34)	Volve housing	(75)	Filter
(16)	Frictio plate				

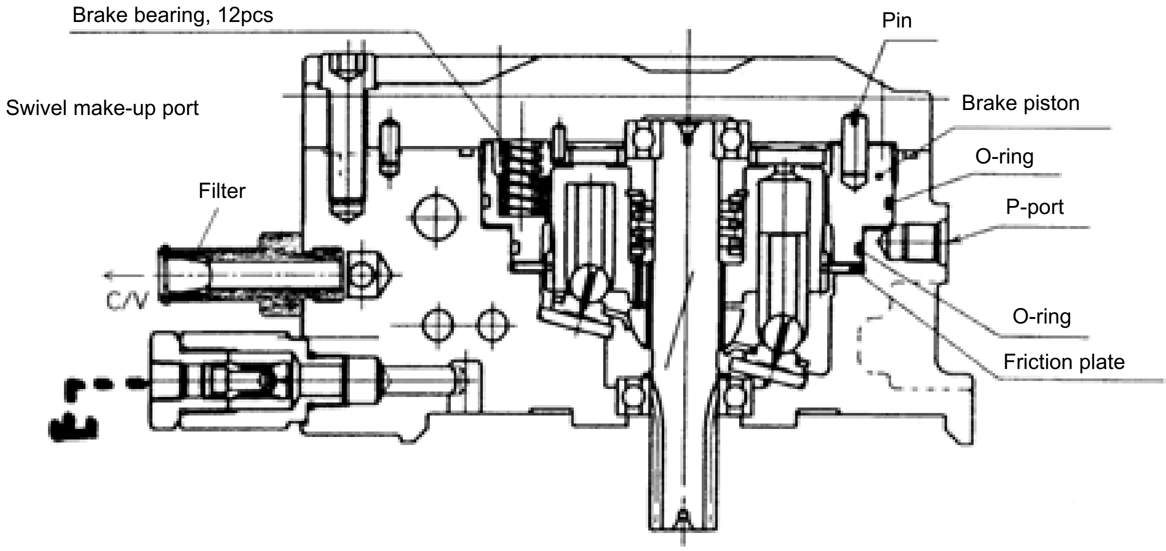


020	:Ball bearing	130	:Friction plate	360	:Motor cover
030	:Shaft	C	:Cylinder block	480	:Filter
050	:Trust plate	140	:Piston brake	520	:Cylinder block sub-assy
110	:Retainer plate	170	:Negative spring	540	:Seal kit
120	:Retainer holder	180	:Poppet		
B	:Piston assy	250	:Relief valve		



010	:Gear case	050	:Piston shaft, 10T	120	:Thrust plate
020	:Ball bearing	070	:Holder		
030	:Oil seal	090	:Needle bearing		
040	:Ball bearing	100	:Planetary gear		

b. Function of negative brake

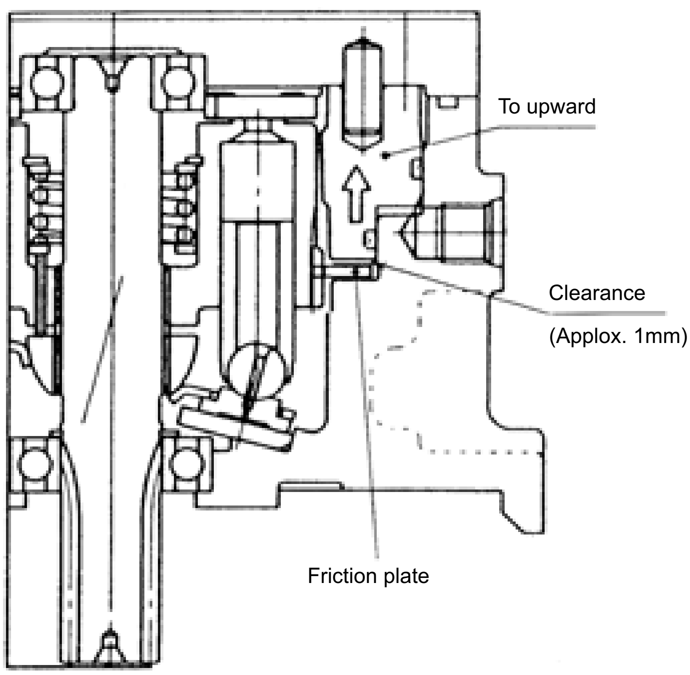


(1) Negative brake function(Unload condition)

No pressure is applied at the P-port, which means there is no piston driving force.
In this state, the force of negative brake springs pushes down the negative brake piston to get the friction plate between the piston and the casing. By so doing, the friction plate is held in this position by a friction force.
Because the motor's cylinder block and the friction plate are spline-coupled, the cylinder block is held and thus the motor is braked.

(2) Negative brake release(On-load condition)

A pilot pressure is applied at the P-port, generating a driving force to the negative brake piston.
In this state, the piston driving force surpasses the force of negative brake springs to push up the negative brake piston.
By so doing, the friction plate gets free from the friction force, allowing the motor to run freely.



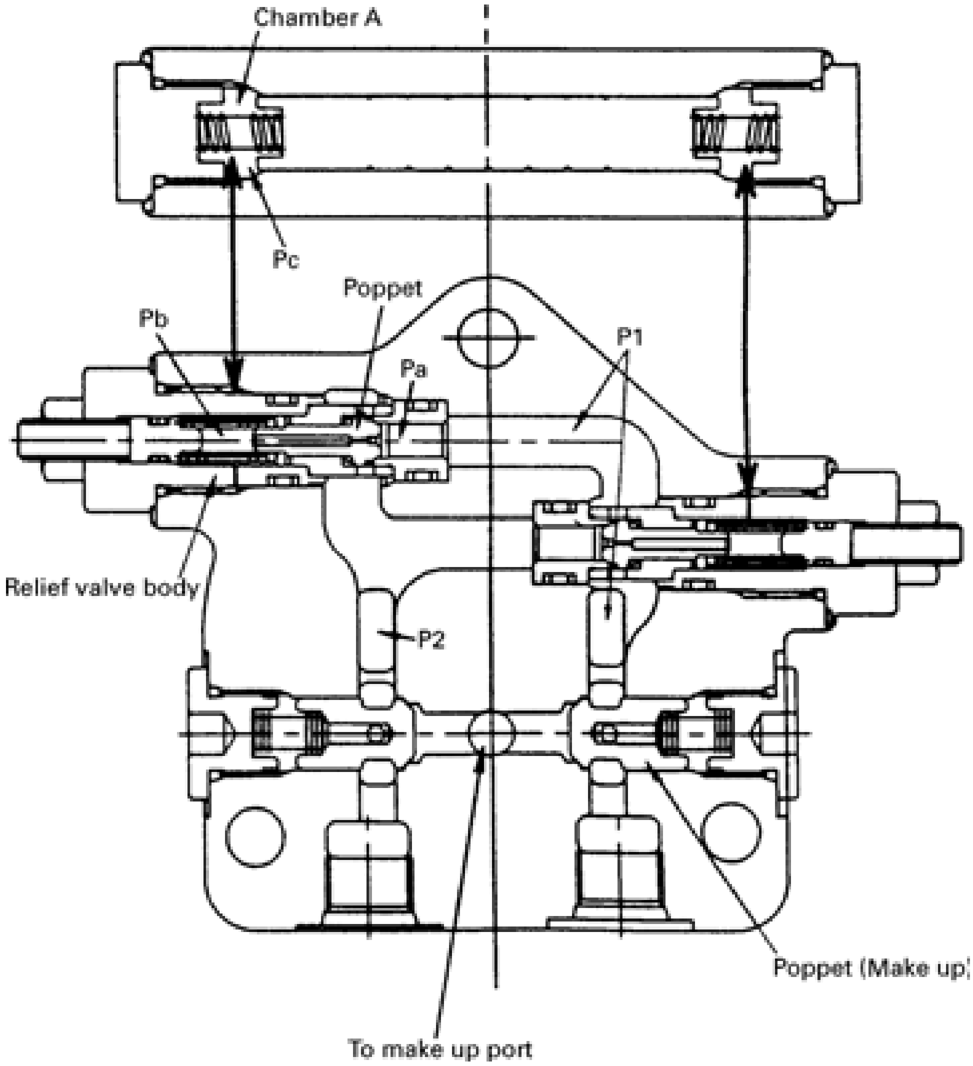
c. Function of valve section

(1)Make-up valve

When the swivel frame has been once accelerated and then decelerated with the control lever, the oil supplied to the P1 port by the pump drops. But the inertia of the swivel frame forces the hydraulic motor to run for pumping. By this, the oil amount being supplied runs short and the P1 port comes under a slightly negative pressure. To avoid this, as the P1 port pressure drops, the make-up valve's poppet is opened to allow in the return oil to compensate for such oil shortage.

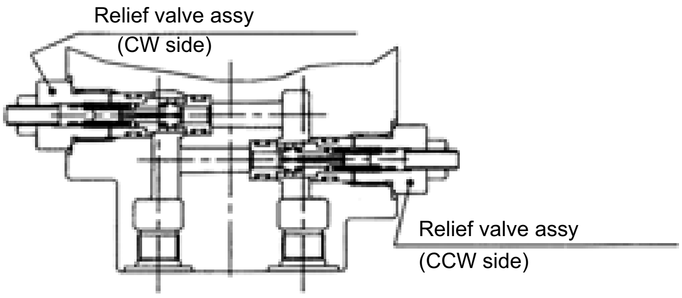
(2)Function of shockless valve

1) When the pressure oil comes to the P1 port at a start or stop, the oil flows through the orifice, which is located in the poppet and relief valve body, and into the chamber A of the free piston. With the orifice in effect, the back pressure (Pb) of the poppet is kept below the pressure (Pa) being exerted on the poppet (Pa>Pb). In this design, the relief valve works at a pressure below the set pressure, allowing the pressure oil into the low-pressure (P2) side. (Primary relief pressure)
2) The primary relief pressure continues to work until the free piston reaches its stroke end. The free piston's stroke speed is controlled by 4 orifices: 2 orifices at the inlet relief valve and 2 at the outlet one.
3) When the free piston has reached its stroke end, the pressure loss due to the above orifice effect turns zero. This means that the poppet's back pressure (Pb) becomes equal to the pressure (Pa) applied on the poppet (Pa = Pb). The relief valve that has worked at the primary relief pressure is now activated by the set pressure. (Secondary relief pressure)



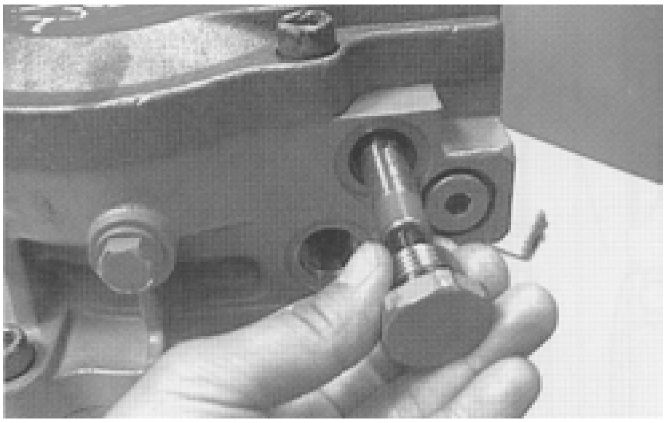
Above illustration is taken from U-WSM for functional explanation purpose.

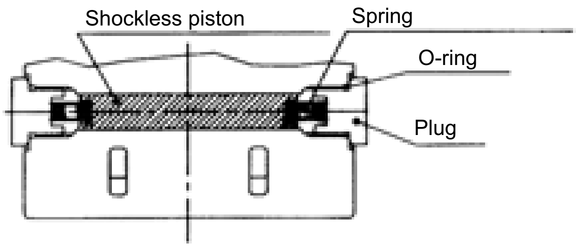
(4) Relief valve



Valve tightning torque : 58.8 ~ 68.6 N·m(6.0 ~ 7.0 kgf·m)

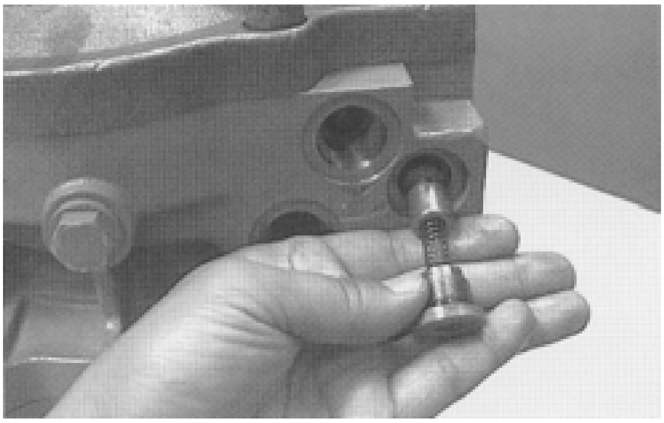
(5) Shockless piston

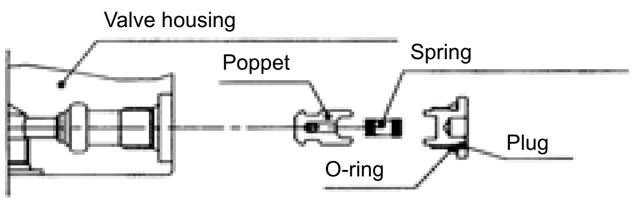




Plug tightning torque : 58.8 ~ 68.6 N·m(6.0 ~ 7.0 kgf·m)

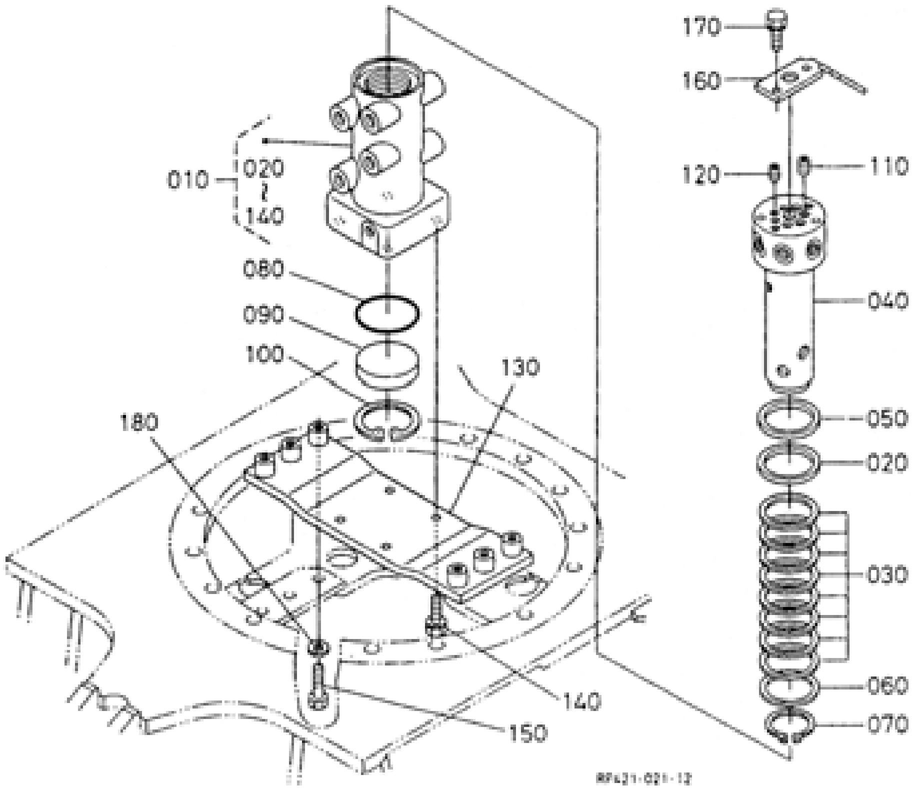
(6) Make-up poppet



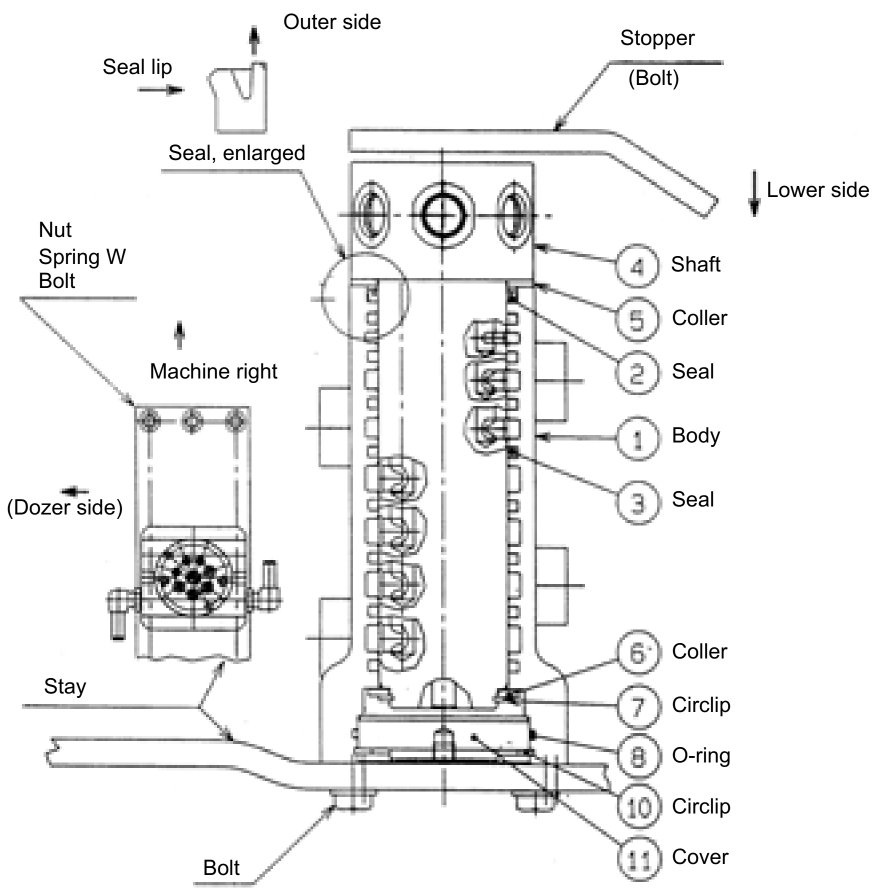


Plug tightning torque : 49.0 ~ 58.8 N·m(5.0 ~ 6.0 kgf·m)

G.Rotary joint (Swivel joint)

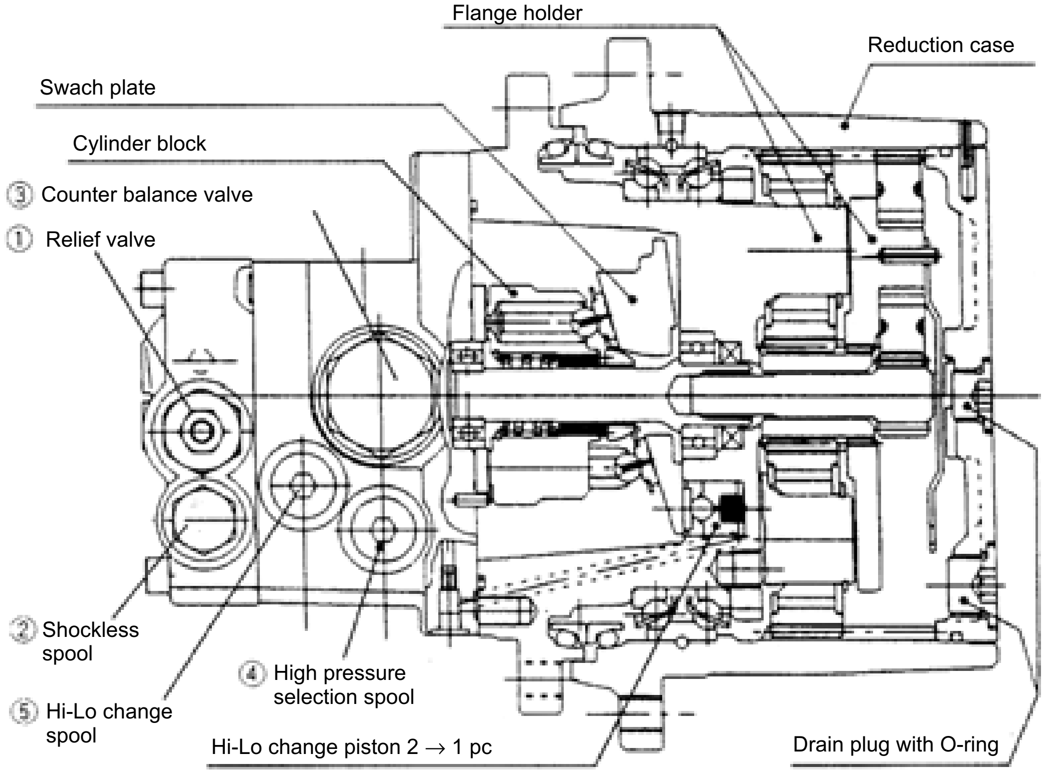


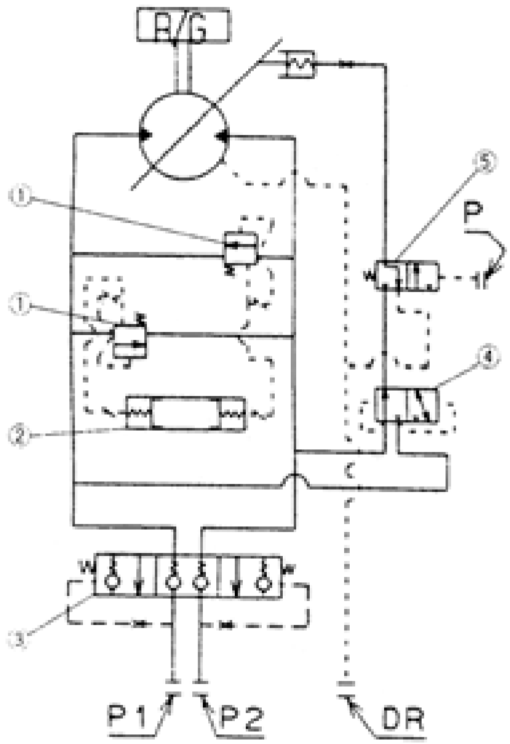
020	:Packing
030	:Packing
040	:Shaft
050, 060	:Spacer
080	:O-ring
090	:Cover
130	:Stay
160	:Stopper



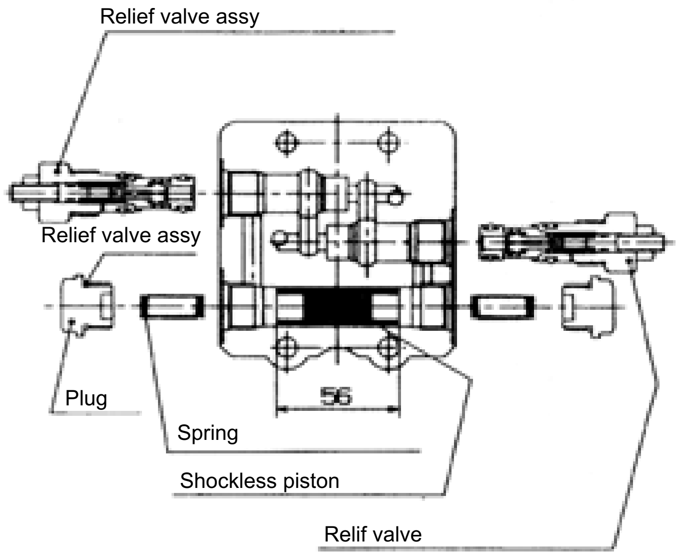
H.Travel motor

a. Structure & specifications : KTC, KCL, KTA version



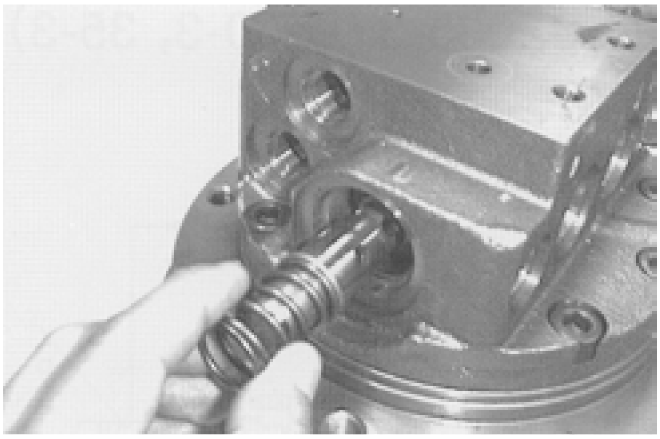


(1)Relief valve
(2)Shockless piston

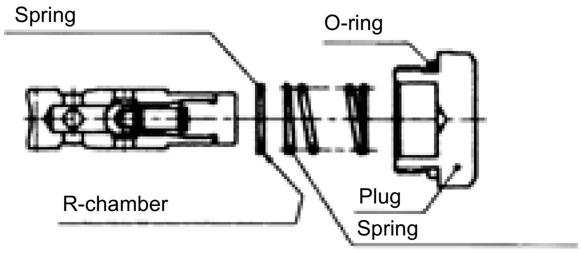


Relief valve tightning torque : 58.8 ~ 68.6 N·m(6.0 ~ 7.0 kgf·m)
Plug tightning torque : 58.8 ~ 68.6 N·m(6.0 ~ 7.0 kgf·m)

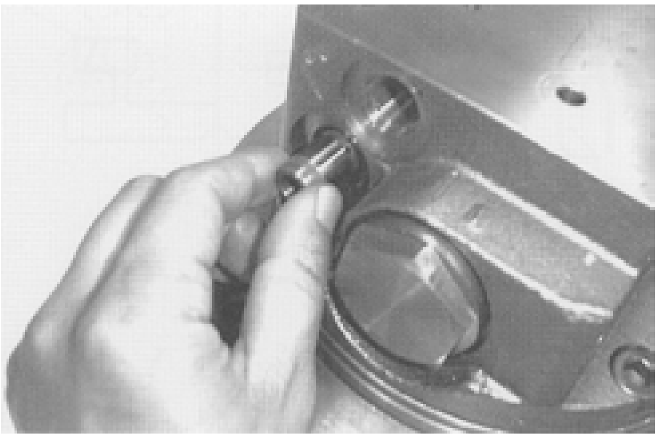
(3) Counter balance valve



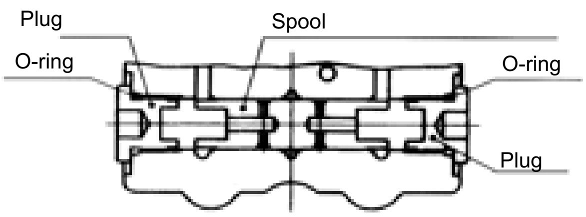
Tightning torque : 235 ~ 245 N·m(24.0 ~ 25.0 kgf·m)



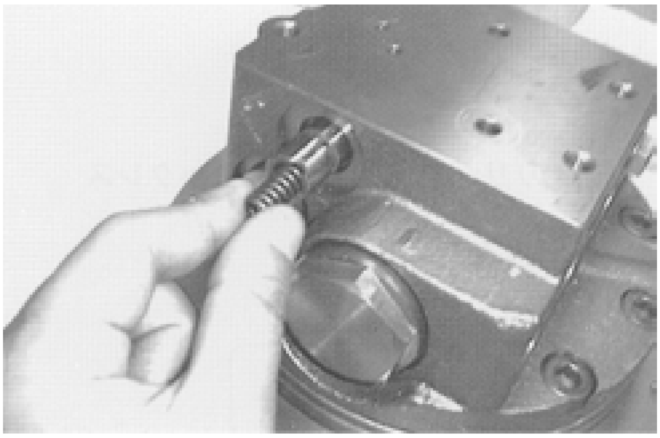
(4) High pressure selection spool



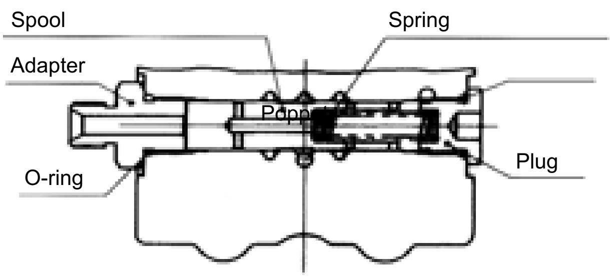
Plug tightning torque : 49.0 ~ 59.0 N·m(5.0 ~ 6.0 kgf·m)



(5) Hi-Lo change spool



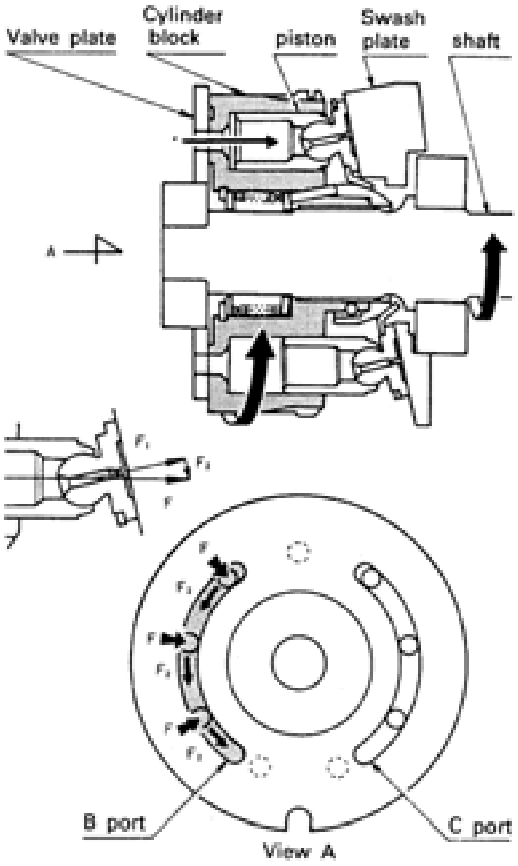
Plug tightning torque : 49.0 ~ 59.0 N·m(5.0 ~ 6.0 kgf·m)



Model	KX91-3	KX101-3	U-35-3
Maker	kubota	←	
Type	WM18NL	←	
	High/Low	←	
Total displacement (1F/2F)	879/574 cc/rev	←	
Travel speed (1F/2F)	3.0/4.6 km/hr	2.9/4.5 km/hr	
Traction force ratio (1F/2F)	1.30/0.85 (2940 kg)	1.25/0.81 (2990 kg)	

b. Operation of piston motor

Nine pistons have been incorporated in cylinder block, and its one end is touching a valve plate having two crescent ports B & C. Besides, the cylinder block is free to rotate and is coupled to a shaft through splines. On the other hand, the swash plate is fixed to the housing.
As high-pressure oil is led to port B, the swash plate is pressed with force F per piston. F=P×A, whereas P is pressure, and A is piston sectional area.
Force F a piston pushes the swash plate is divided into two components, i.e., force F_1 to push the shaft and force F_2 to rotate the cylinder block. And a turning force is generated in the cylinder block by the sum total of rotation directional components of pistons on the high-Pressure side, torque is transmitted to the shaft through splines and thus the shaft rotates. As high-pressure oil is led to port C conversely, rotation resulted becomes reverse to the aforementioned. The output torque and number of revolution of a piston motor
obtained according to the aforementioned principle of operation are calculated by the following formulae determined by pressure (P) and inflow quantity (O) supplied to the motor:



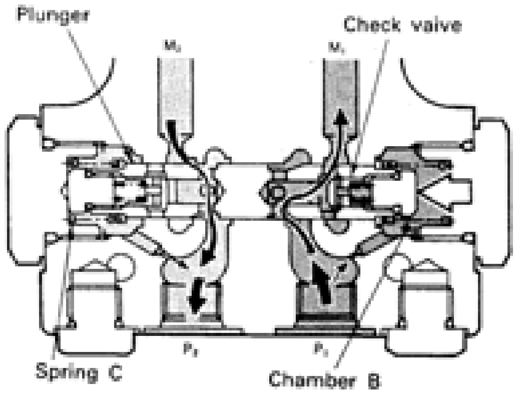
$$T=\frac{P\times q\times\eta_m}{2\times\pi\times10^2}$$

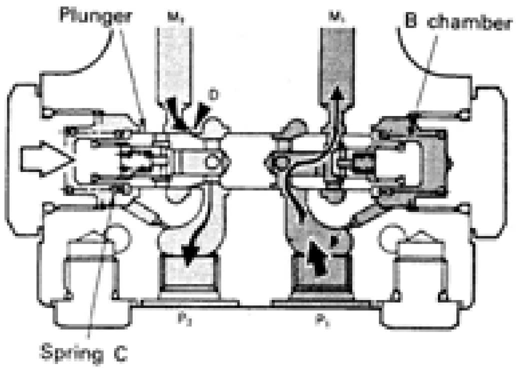
$$N=\frac{Q\times10^3\times\eta_v}{q}$$

T:Output torque (kgf·m)
N:Revolution speed (rpm)
P :Operating pressure (kgf/cm^2)
Q :Pump flow rate (l/min)
q :Theoretical displacement (cc/rev)
η_m :Mechanical efficiency
η_v :Volumetric efficiency

3, Operation of counterbalance valve

In the case when high-pressure oil is led to port P_1, oil pushes up the check valve and flows to motor port M_1 as well as flows to chamber B of the pilot unit to fill it up with oii, Since pressurized oil flows into the motor from port M_1 in an attempt to rotate the motcr but return oil from the motor is stopped of its flow by the check valve even if flowed into port M_1 pressures of port P_1 and chamber B rise, When the pressure of chamber B rises above the set valve of spring C, the plunger moves to the left to let port M_2 opened to port P_2. Consequently, the motor rotates.





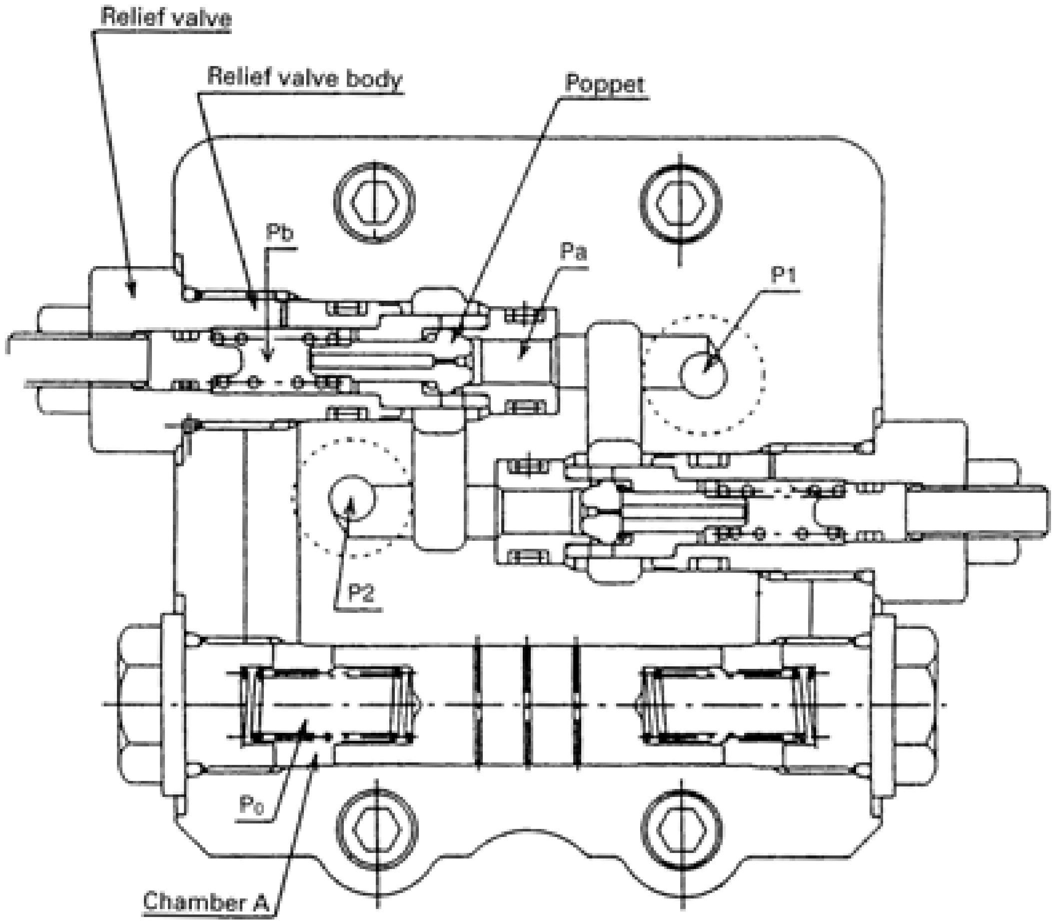
In the case when oil to flow out from port M_2 becomes greater than oil to flow into port M_1 as rotation of the motor becomes too fast, pressures of port pl and chamber B drop. When the pressure of chamber B drops below the set valve of spring C. the plunger tries to return to the right. Since return oil is consequently throttled at area D, it causes a back pressure to generate in port M_2 and thus show down rotation of the motor. Since pressures of port P_1 and chamber B rise again as rotation of the motor slows down and the plunger moves to the left, a back pressure generated in port M_2 vanishes. In this way, the counterbalance valve controls to rotate the motor at a speed corresponding to the flow rate of oil to flow into the motor. As high-pressure oil led to port P_1 is shut off, ports P_1

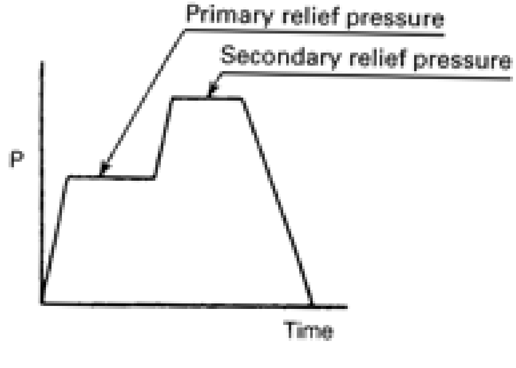
c. Function of shockless valve

(1) When the pressure oil comes to the P1 port at a start or stop, the oil flows through the orifice, which is located in the poppet and relief valve body, and into the chamber A of the free piston. With the orifice in effect, the back pressure (Pb) of the poppet is kept below the pressure (Pa) being exerted on the poppet (Pa>Pb).
In this design, the relief valve works at a pressure below the set pressure, allowing the pressure oil into the low-pressure (P2) side. (Primary relief pressure)

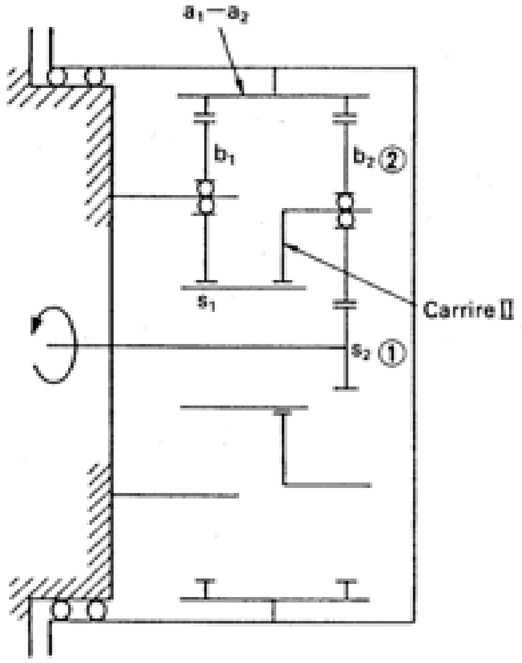
(2) The primary relief pressure continues to work until the free piston reaches its stroke end. The free piston's stroke speed is controlled by 4 orifices: 2 orifices at the inlet relief valve and 2 at the outlet one.

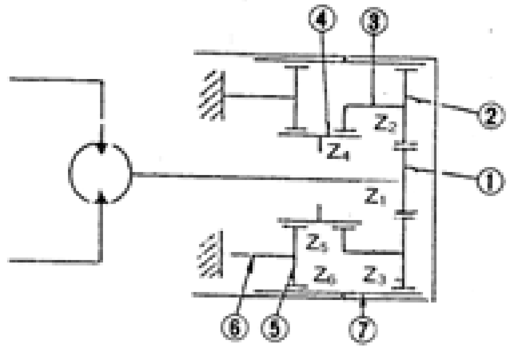
(3) When the free piston has reached its stroke end, the pressure loss due to the above orifice effect turns zero. This means that the poppet's back pressure (Pb) becomes equal to the pressure (Pa) applied on the poppet (Pa = Pb).
The relief valve that has worked at the primary relief pressure is now activated by the set pressure. (Secondary relief pressure)





Pranetary reduction gear case.
This speed reducer consists of a two-stage planetary gear mechanism.





Drive gear (1) intermeshes with the first-stage planetary gear (2); the second-stage sun gear (4), the second-stage planetary gear (5). And the second-stage planetary carrier is fixed to the body. Planetary gears (2) & (5) intermesh with ring gear (7) (housing). A driving force from a piston motor is transmitted to the drive gear (1) and then reduced in speed by the respective gears. Driving force reduced in speed is transmitted to the ring gear (7) through the planetary gear (5) of planetary carrier (6) which is fixed to the final-stage body. (A driving force is transmitted also from the first-stage planetary gear (2).) Incidentally, input rotation is reverse to the output rotation, vice versa.
Reduction gear ratio i becomes as follows according to the first-stage and second-stage reduction gear ratios i_1 & i_2:

Reduction gear ratio (i)

$$T= -(i_1 \times i_2-1)=-\left(\frac{Z_1+Z_3}{Z_1} \times \frac{Z_4+Z_6}{Z_4}-1\right)$$

Z_1 : Drive gear (1) teeth No.
Z_3 : Drive gear (7) teeth No.
Z_4 : Drive gear (4) teeth No.
Z_6 : Drive gear (7) teeth No.

Reduction gear case output torque (T)

$$T= T_M \times i \times \eta_m$$

T_M : Input torque (Motor output torque)
i : Reduction gear ratio
η_m : Mechanical efficiency

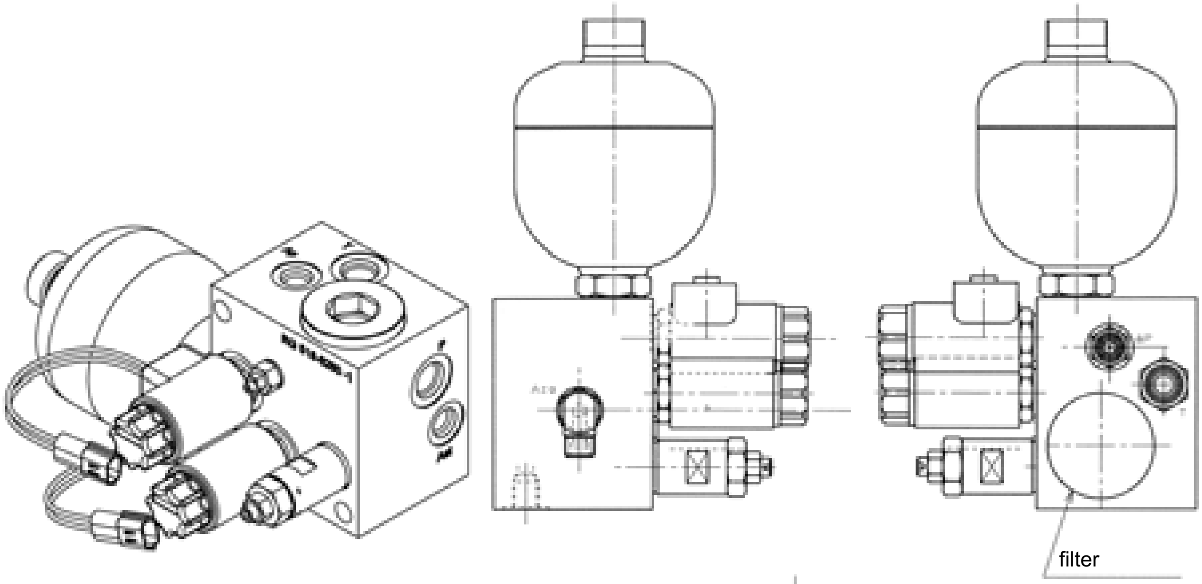
Reduction gear case output speed (N)

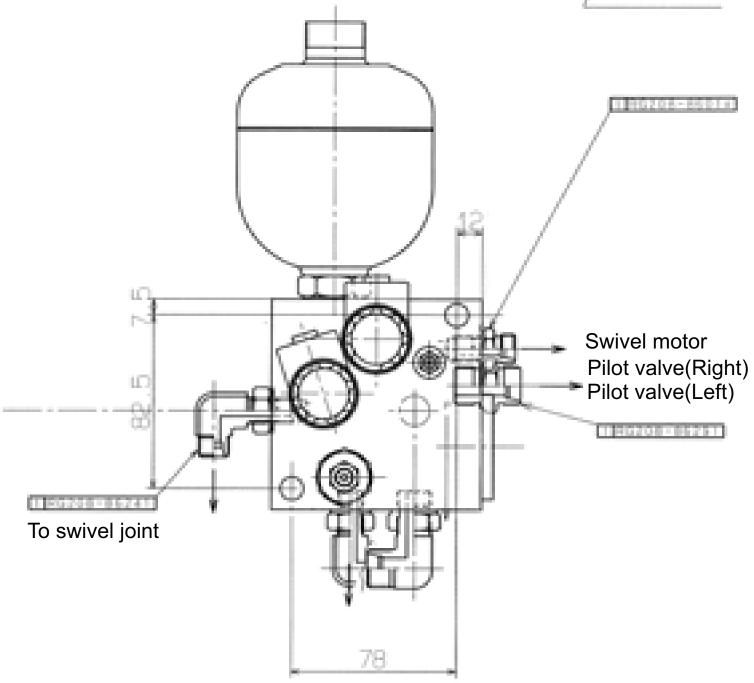
$$T= \frac{N_M}{i}$$

N_M : Input rotation speed
(Motor output speed)

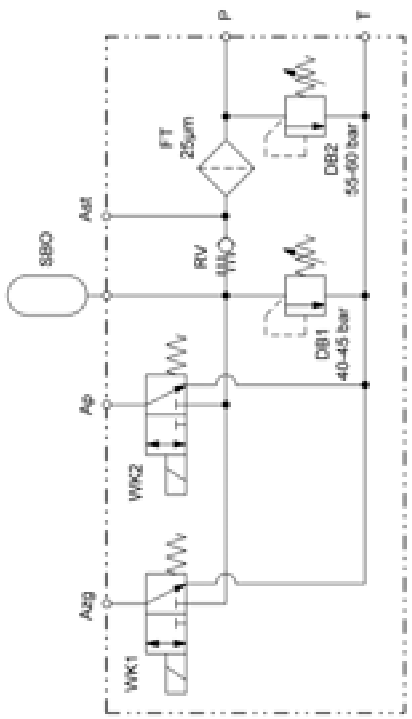
I. Other components

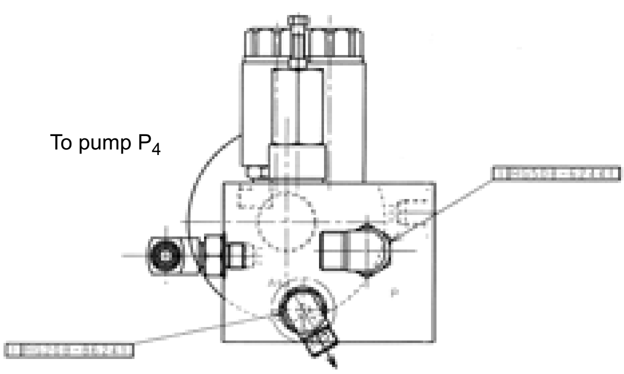
a. Change valve with accumulator : EU version





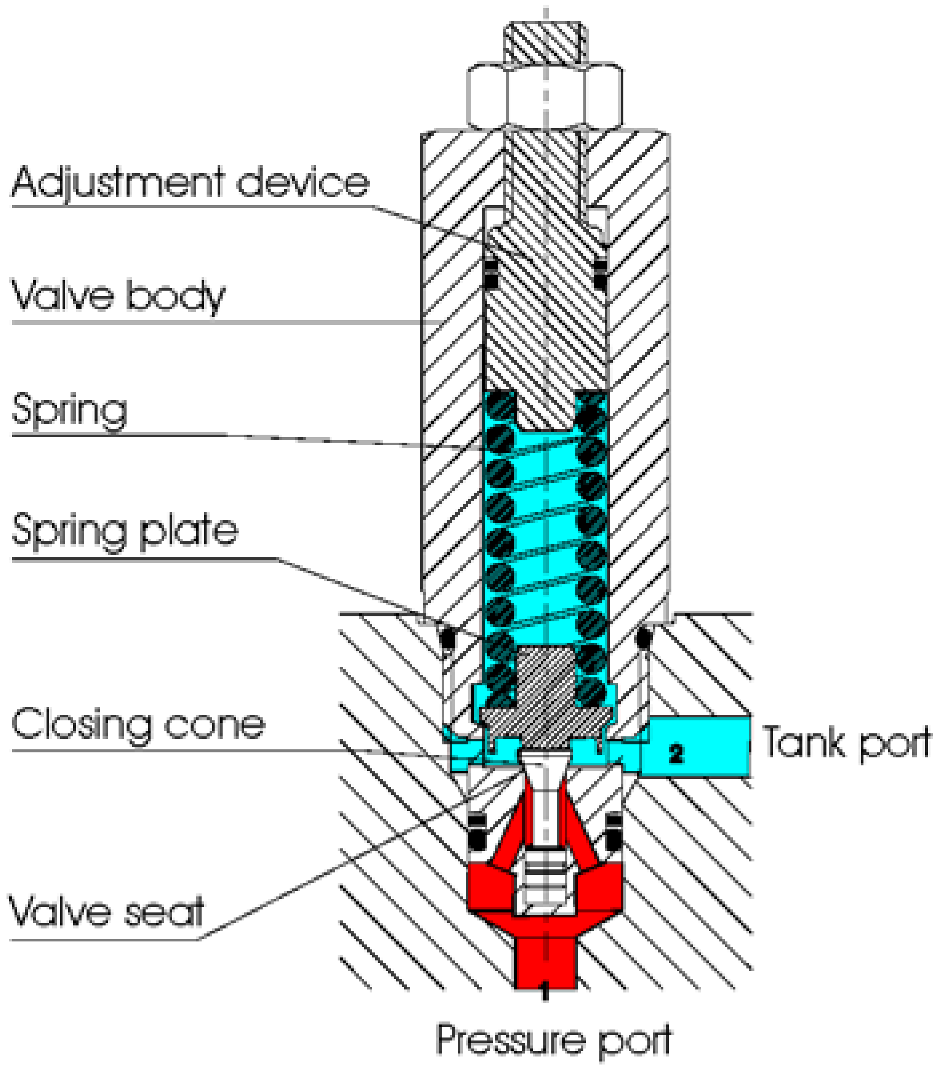
SYMBOL





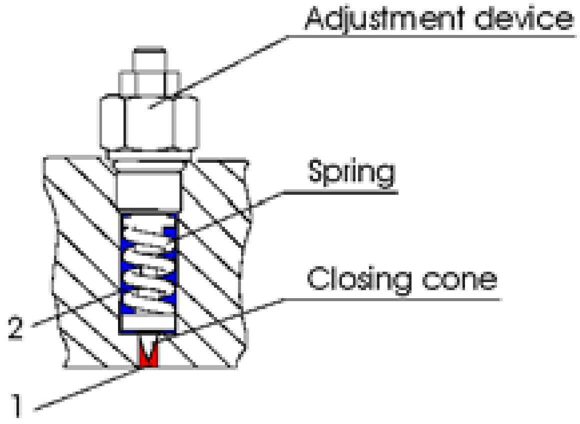
(1) Pressure relief valve: a4

It is a direct-operated, spring-loaded cone seat valve.



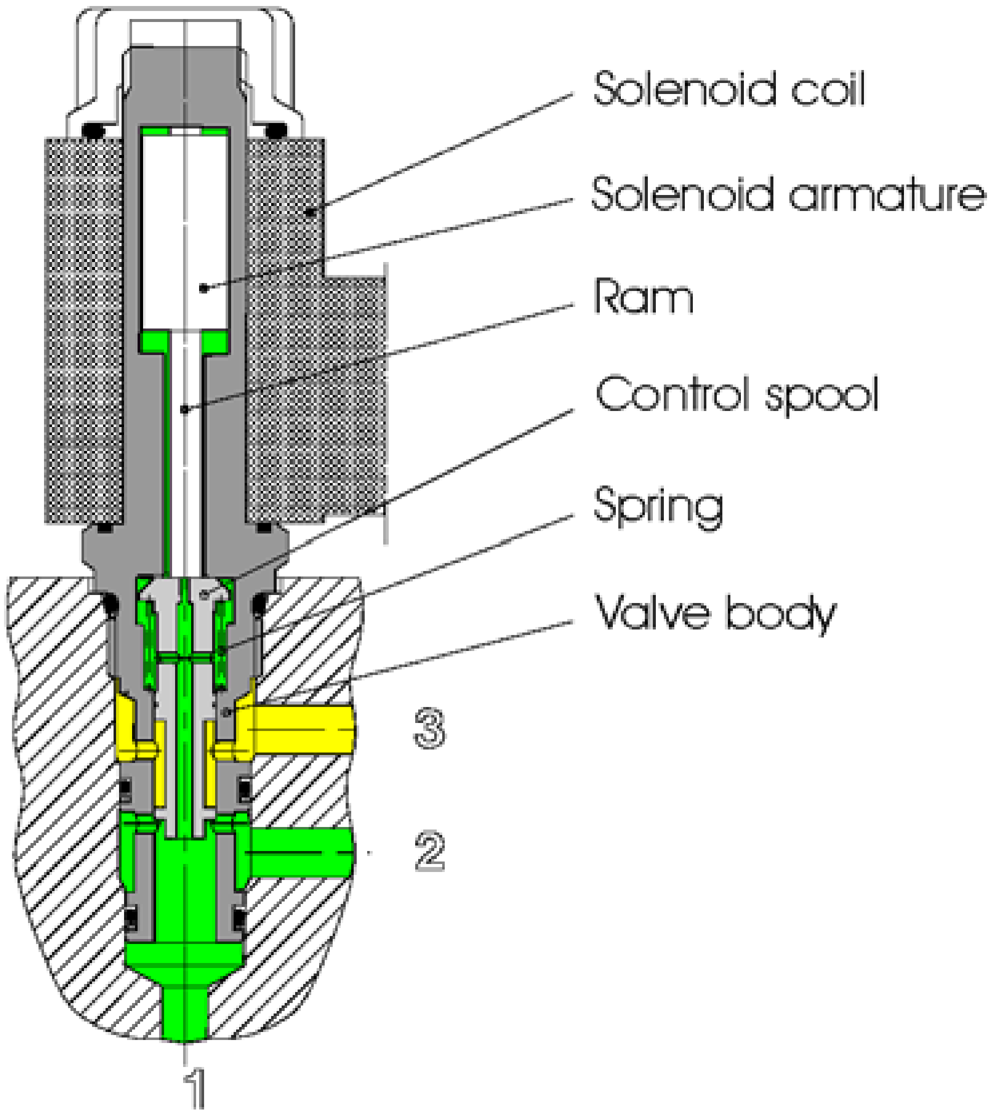
The valve basically consists of a valve body with built-in valve seat, a hardened and polished closing cone and the adjustment device for setting the initial spring tension. The spring applies this force to the closing cone and pushes it against the valve seat. On the opposite side of the closing cone, the system pressure acts via port 1 of the valve. If the hydraulic pressure force is below the pre-set spring tension, the valve is closed. If the hydraulic pressure force exceeds the pre-set spring tension, the closing cone is lifted off the valve seat and the operating fluid flows from pressure port 1 to tank port 2. This limits the pressure across port 1. To ensure that a stable operation is maintained, the closing cone is securely located in the damping piston, which has to displace oil in an aperture with each movement of the closing cone. This produces a damping force each time, opposing the direction of movement.

(2) Pressure relief valve: a5



The valve basically consists of a closing cone and the adjustment device for setting the initial spring tension. The valve seat is machined directly on the supply unit body. The spring applies this force to the closing cone and pushes it against the valve seat. On the opposite side of the closing cone, the system pressure acts via port 1 of the valve. If the hydraulic pressure force is below the pre-set spring tension, the valve is closed. If the hydraulic pressure force exceeds the pre-set spring tension, the closing cone is lifted off the valve seat and the operating fluid flows from pressure port 1 to tank port 2. This limits the pressure across port 1.

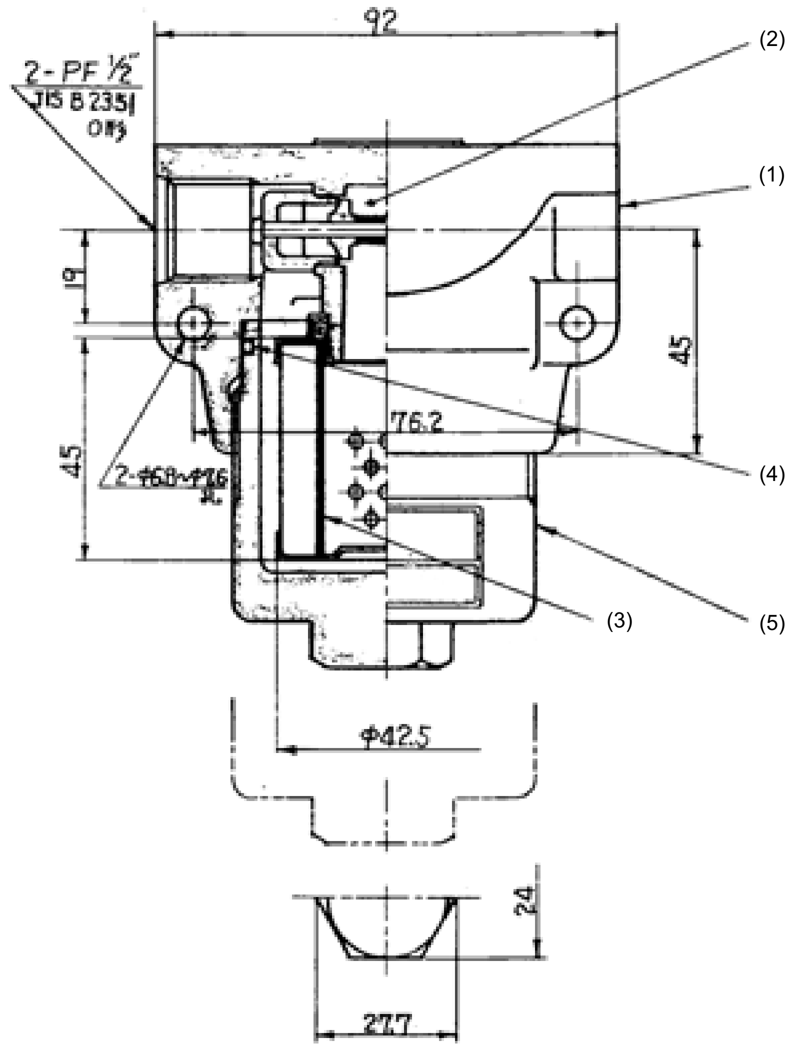
(3) Electro-magnetically directional spool valves



These valves are electro-magnetically actuated and direct operated spool valves.
The actuating spool valves are of the pressure-tight, oil immersed type: this increases the service life and lowers the operation noise.

In the initial position (kept by the spring), the port 2 is connected with the port 1 and the port 3 is shut off. When an operation voltage is applied to the solenoid coil, the solenoid armature pushes the control spool into the front switching position via the ram. In this position, the port 3 is connected with 2 and the port 1 is shut off.

b. Pilot filter



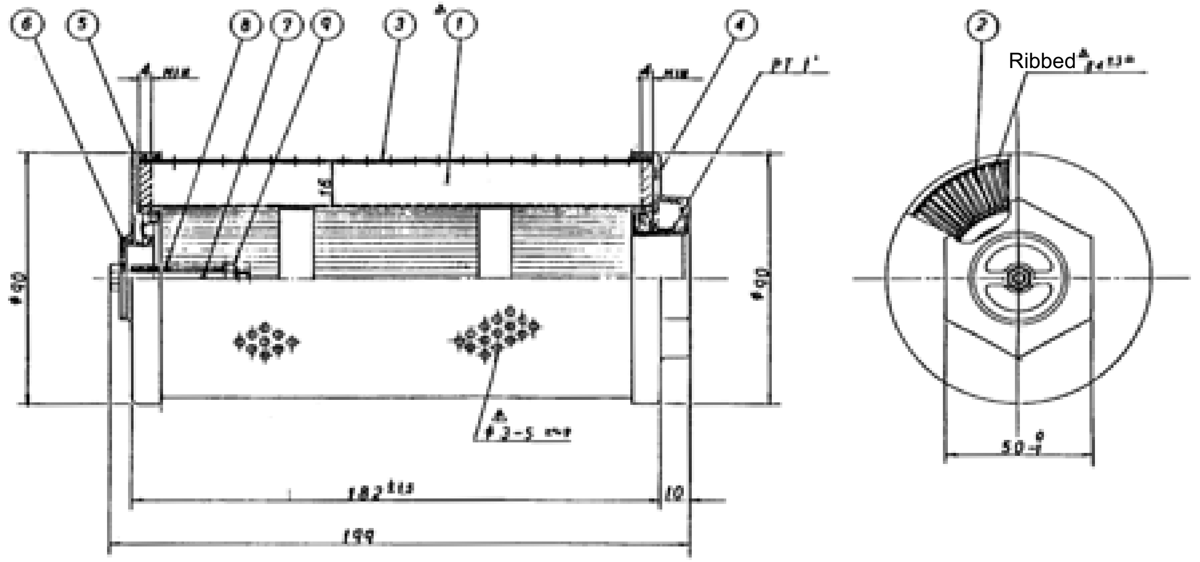
P/N RD401-61261

Durable pressure	:70kgf/cm^2
Filtering rate	:10 μ
Valve setting pressure	:1.5 kgf/cm^2
Max. flow amount	:10l/min
Applied model	= U-45

(1) Head
(2) Bypass valve
(3) Filter element
(4) O-ring
(5) Case

c. Return filter

P/N=68651-62121



Specifications:

Filtering area = 4400cm^2

Filtering rate = 10µ

Pressure drop = 0.6kgf/cm^2 or less

Condition: Oil temp. 40°C

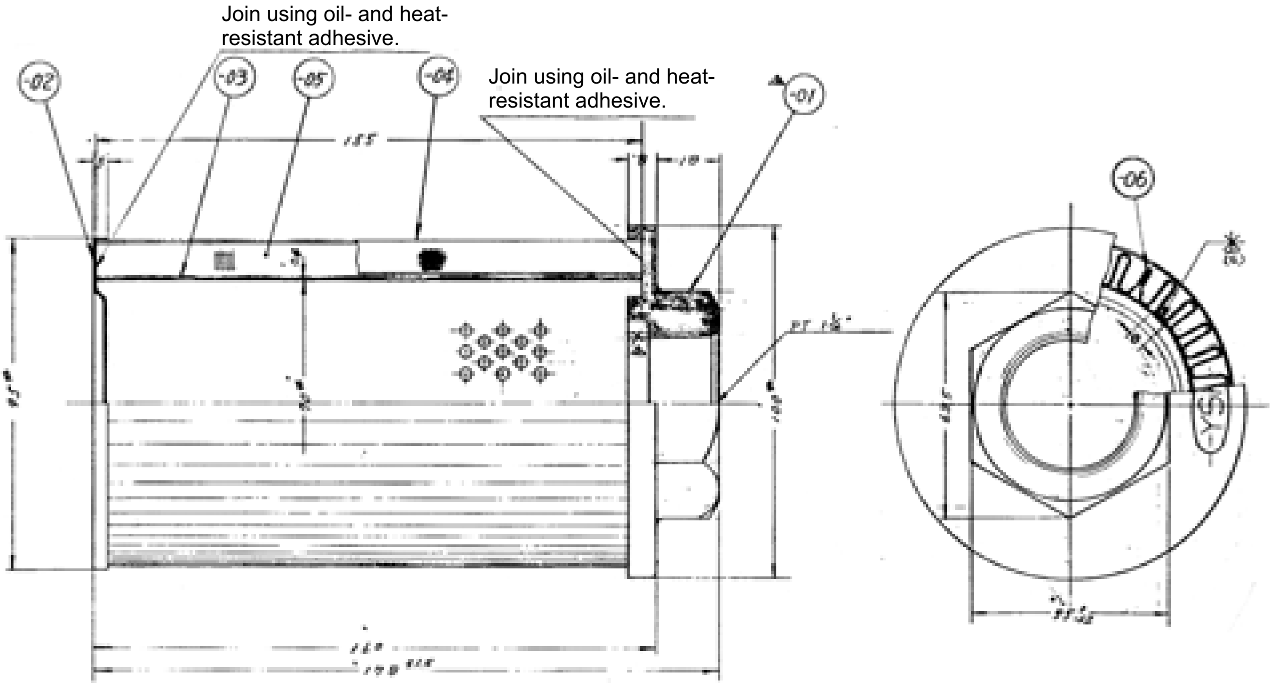
Flow rate 150l/min

Relief valve setting = 1.0 ± 0.15 kgf/cm^2

(1)Filter paper
(2)Binder
(3)Protector
(4)Cap plate
(5)End cap
(6)Valve
(7)Sleeve
(8)Spring
(9)U-nut

d. Suction strainer

P/N=68773-62211



Specifications:

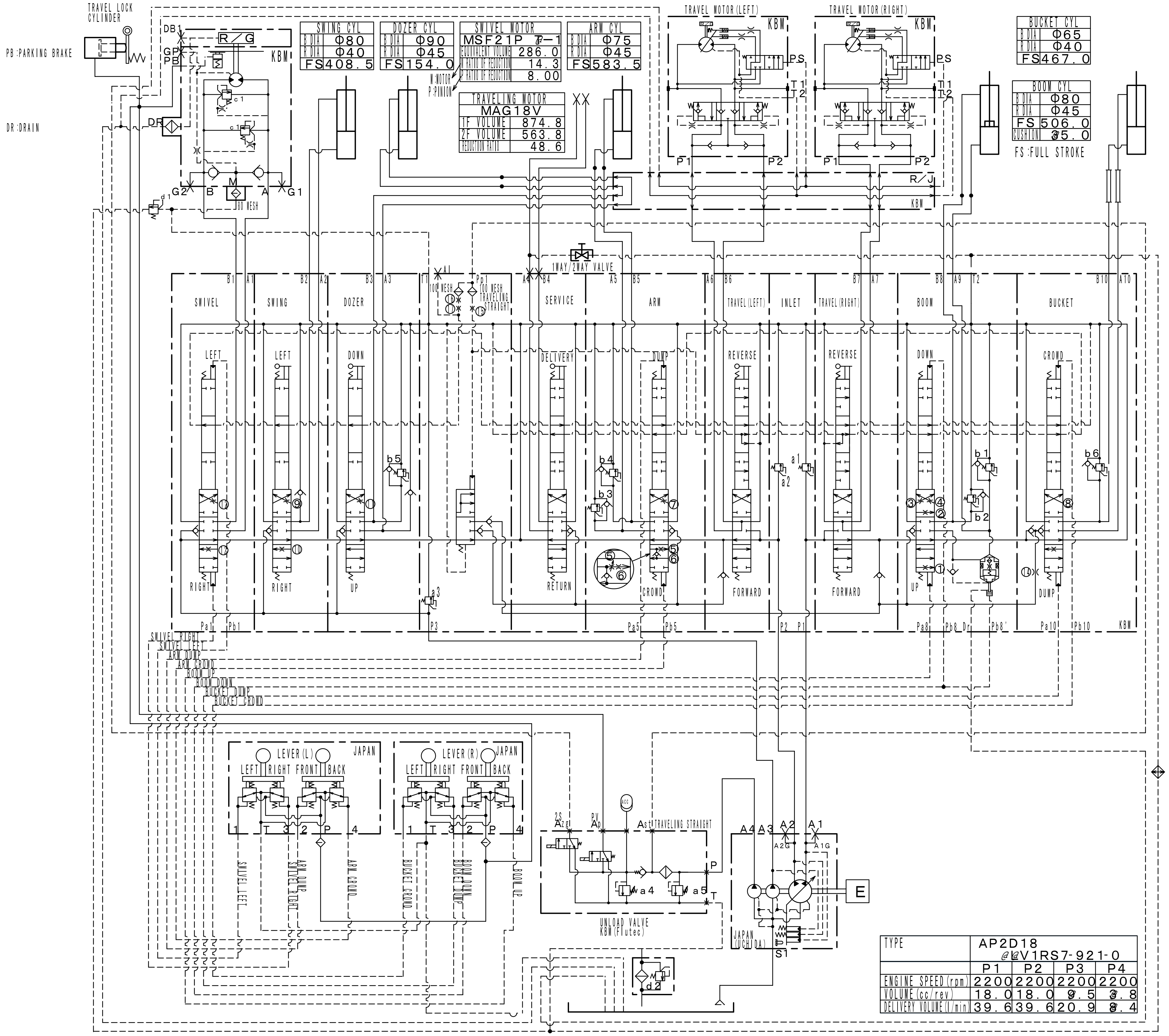
Filtering rate = 105µ(150mesh)

Max. flow amount = 150l/min

(1)Cap plate
(2)Bottom plate
(3)Screen
(4)Endless clip

J. Hydraulic circuit diagram

a. KX91-3 European - version



TYPE	AP2D18 V1RS7-921-0			
	P1	P2	P3	P4
ENGINE SPEED (rpm)	2200	2200	2200	2200
VOLUME (cc/rev)	18.0	18.0	9.5	3.8
DELIVERY VOLUME (l/min)	39.6	39.6	20.9	8.4

SIZE OF NOTCHES AND ORIFICES

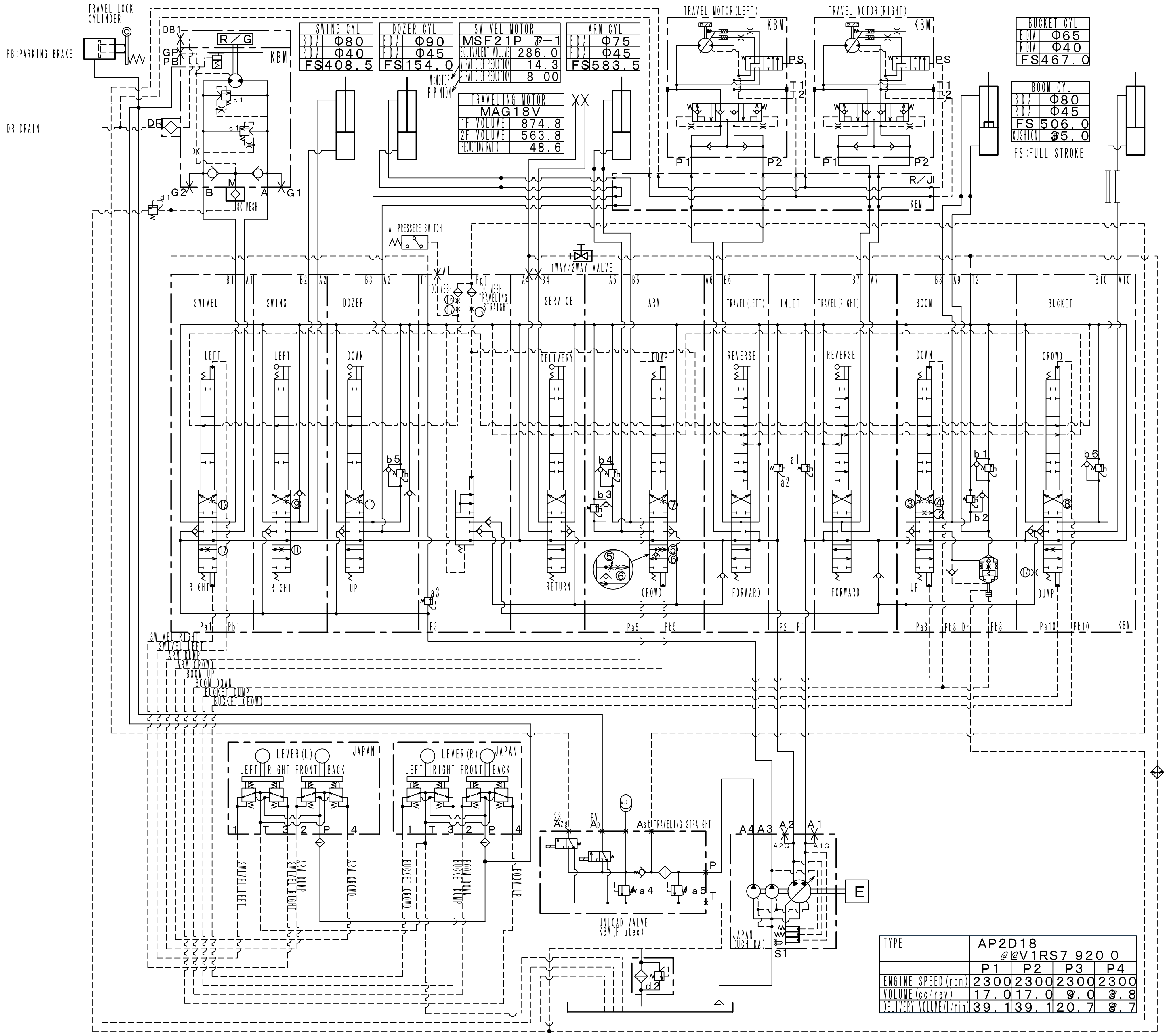
LIST OF ORIFICE DIA.		REMARKS	
1	Φ0.8 EQUIV.	BOOM UP	P→T
2	Φ1.1 EQUIV.	BOOM DOWN	P→T
3	Φ1.9 EQUIV.		P→C
4	Φ3.1 EQUIV.		C→T
5	Φ4.3 EQUIV.	ARM CROWD	C→T
6	Φ2.0 EQUIV.	ARM CROWD	FIX-TYPE
7	Φ4.0 EQUIV.	ARM DUMP	C→T
8	Φ3.6 EQUIV.	BUCKET CROWD	C→T
9	Φ2.3 EQUIV.	SWING LEFT	C→T
10	Φ2.1 EQUIV.	SWING RIGHT	C→T
11	Φ2.3 EQUIV.	DOZER DOWN	C→T
12	Φ2.9 EQUIV.	SWIVEL	C→T
13	Φ0.5 EQUIV.	AIR BLEEDING AFTER 6mm stroke	
14	Φ1.6 EQUIV.	BOOM PRIORITY ORIFICE	
15	Φ0.3 EQUIV.	TRAVEL STRAIGHT SENSING ORIFICE	
16	Φ0.37 EQUIV.	AI SIGNAL ORIFICE	
17	Φ0.3 EQUIV.	AI SIGNAL ORIFICE	

BENCH SET PRESSURE VALUE

RELIEF PRESSURE (kgf/cm2)		
a1	240.0	P1
a2	240.0	P2
a3	200.0	P3
a4	40.0	P4
a5	70.0	FILLTER
b1	275.0	BOOM (BOTTOM)
b2	275.0	BOOM (ROD)
b3	280.0	ARM (BOTTOM)
b4	280.0	ARM (ROD)
b5	245.0	DOZER (BOTTOM)
b6	280.0	BUCKET (BOTTOM)
c1	170.0	SWIVEL MOTOR
d1	2.0	CHECK VALVE
d2	1.0	RETURN FILLTER

SPECIFICATION OF OIL COOLER	
AMOUNT OF A RADIATION	8900 kcal/h
	V = 15 l/min
	Δt= 75 ℃
	tol=110 ℃
CORE TYPE	CORRUGATE TYPE WITH LOUVER
CORE SIZE	300×225.6×32
CORE TIER	15 TIERS
FIN PITCH	fp=4.0/2

b. KX101-3 European - version



TYPE	AP2D18 V1RS7-920-0			
	P1	P2	P3	P4
ENGINE SPEED (rpm)	2300	2300	2300	2300
VOLUME (cc/rev)	17.0	17.0	9.0	3.8
DELIVERY VOLUME (l/min)	39.1	39.1	20.7	8.7

SIZE OF NOTCHES AND ORIFICES

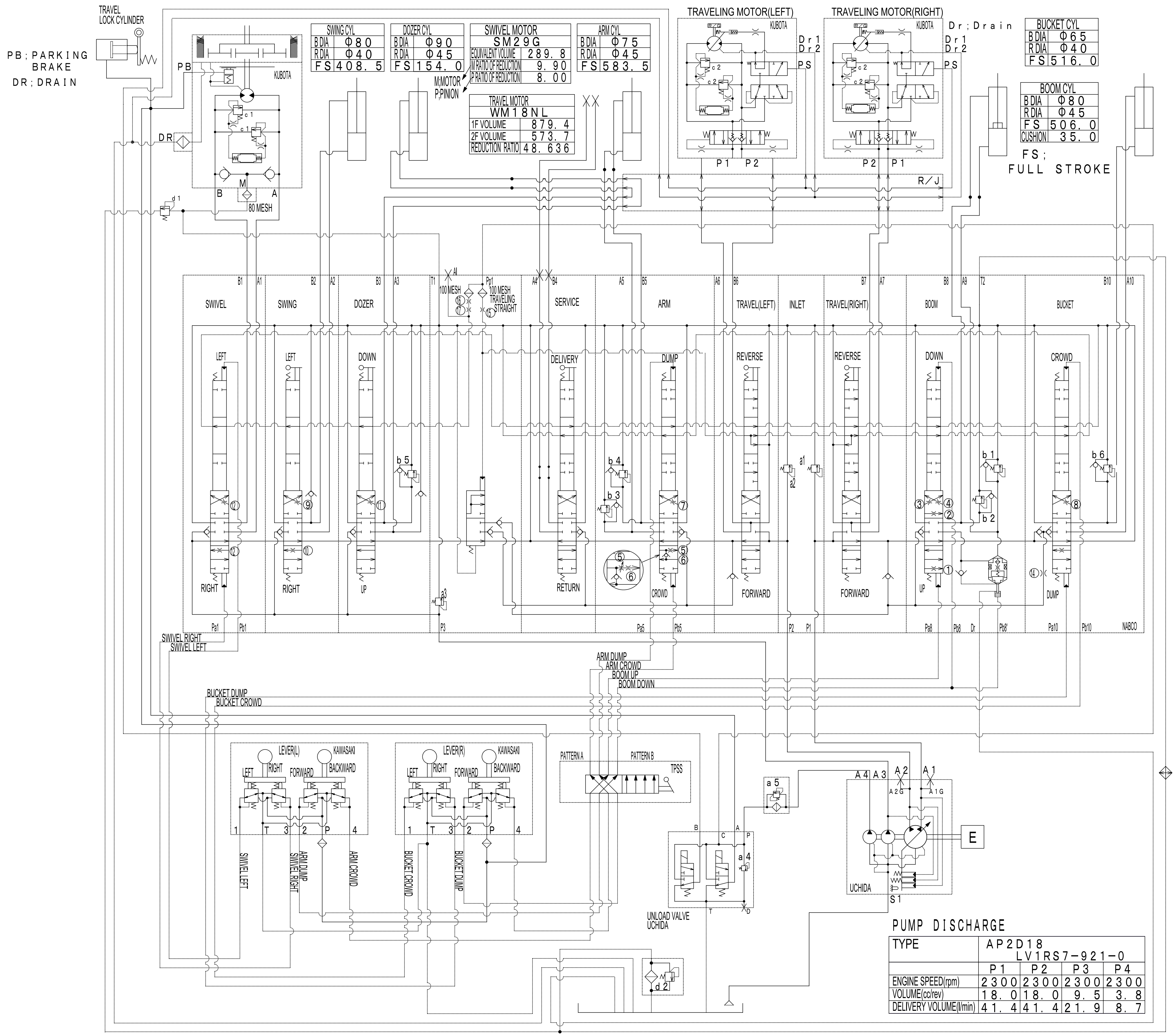
LIST OF ORIFICE DIA.		REMARKS	
1			
2	Φ1.1 EQUIV.	BOOM DOWN	P→T
3	Φ2.1 EQUIV.		P→C
4	Φ3.2 EQUIV.		C→T
5	Φ4.3 EQUIV.	ARM CROWD	C→T
6	Φ2.0 EQUIV.	ARM CROWD	FIX-TYPE
7	Φ4.0 EQUIV.	ARM DUMP	C→T
8	Φ3.6 EQUIV.	BUCKET CROWD	C→T
9	Φ2.3 EQUIV.	SWING LEFT	C→T
10	Φ2.1 EQUIV.	SWING RIGHT	C→T
11	Φ2.3 EQUIV.	DOZER DOWN	C→T
12	Φ2.9 EQUIV.	SWIVEL	C→T
13	Φ0.5 EQUIV.	AIR BLEEDING AFTER 6mm stroke	
14	Φ1.6 EQUIV.	BOOM PRIORITY ORIFICE	
15	Φ0.3 EQUIV.	TRAVEL STRAIGHT SENSING ORIFICE	
16	Φ0.37 EQUIV.	AI SIGNAL ORIFICE	
17	Φ0.3 EQUIV.	AI SIGNAL ORIFICE	

BENCH SET PRESSURE VALUE

RELIEF PRESSURE (kgf/cm2)		
a1	250.0	P1
a2	250.0	P2
a3	200.0	P3
a4	40.0	P4
a5	70.0	FILLTER
b1	280.0	BOOM (BOTTOM)
b2	280.0	BOOM (ROD)
b3	285.0	ARM (BOTTOM)
b4	285.0	ARM (ROD)
b5	245.0	DOZER (BOTTOM)
b6	285.0	BUCKET (BOTTOM)
c1	205.0	SWIVEL MOTOR
d1	2.0	CHECK VALVE
d2	1.0	RETURN FILLTER

SPECIFICATION OF OIL COOLER	
AMOUNT OF A RADIATION	8900 kcal/h
	V = 15 l/min
	Δt= 75 ℃
	tol=110 ℃
CORE TYPE	CORRUGATE TYPE WITH LOUVER
CORE SIZE	300×225.6×32
CORE TIER	15 TIERS
FIN PITCH	fp=4.0/2

c. KX91-3 KTC, KCL, KTA - version



PUMP DISCHARGE

TYPE	AP2D18 LV1RS7-921-0			
	P1	P2	P3	P4
ENGINE SPEED(rpm)	2300	2300	2300	2300
VOLUME(cc/rev)	18.0	18.0	9.5	3.8
DELIVERY VOLUME(l/min)	41.4	41.4	21.9	8.7

SIZE OF NOTCHES AND ORIFICES

A LIST OF DIAPHRAGM		REMARKS	
1	Φ0.8equiv	BOOM UP	P→T
2	Φ1.0equiv	BOOM DOWN	P→T
3	Φ2.0equiv		P→C
4	Φ3.1equiv		C→T
5	Φ4.3equiv	ARM CROWD	C→T
6	Φ2.0equiv	ARM CROWD	FIX-TYPE
7	Φ4.0equiv	ARM DUMP	C→T
8	Φ3.6equiv	BUCKET CROWD	C→T
9	Φ2.3equiv	SWING LEFT	C→T
10	Φ2.1equiv	SWING RIGHT	C→T
11	Φ2.3equiv	DOZER DOWN	C→T
12	Φ2.9equiv	SWIVEL	C→T
13	Φ0.5equiv	AIR BLEEDING AFTER 6mm stroke	
14	Φ1.6equiv	BOOM PRIORITY ORIFICE	
15	Φ0.3equiv	TRAVEL STRAIGHT SENSING ORIFICE	
16	Φ0.3equiv	AI SIGNAL ORIFICE	
17	Φ0.3equiv	AI SIGNAL ORIFICE	

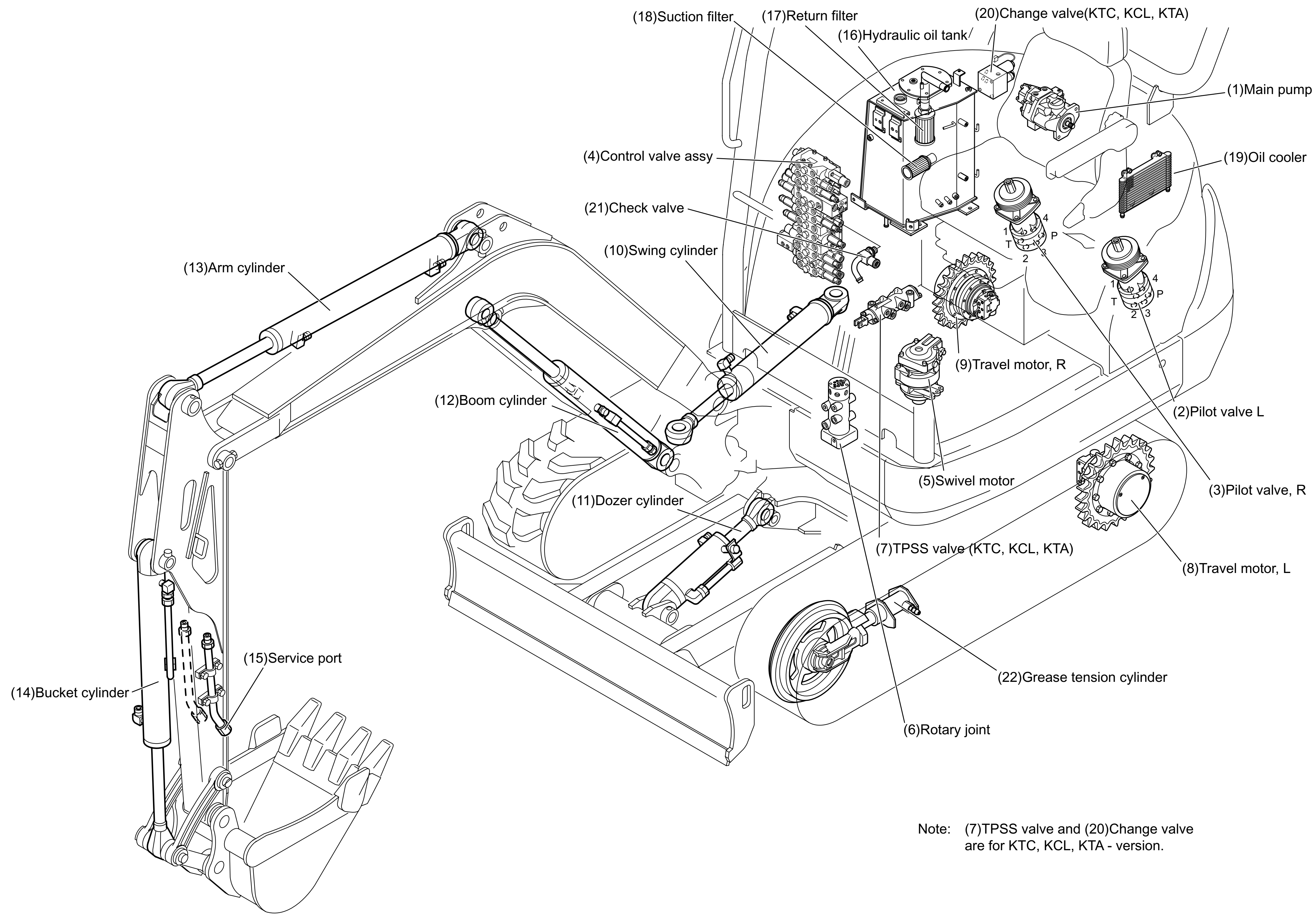
BENCH SET PRESSURE VALUE

RELIEF PRESS (kgf/cm2)		
a1	240.0	P1
a2	240.0	P2
a3	200.0	P3
a4	40.0	P4
a5	1.5	FILLTER
b1	275.0	BOOM(BOTTOM)
b2	275.0	BOOM(ROD)
b3	280.0	ARM(BOTTOM)
b4	280.0	ARM(ROD)
b5	245.0	DOZER(BOTTOM)
b6	280.0	BUCKET(BOTTOM)
c1	170.0	SWIVEL MOTOR
c2	250.0	TRAVEL MOTOR
d1	2.0	CHECK VALVE
d2	1.0	RETURN FILTTER

SPECIFICATION OF OIL COOLER	
AMOUNT OF A RADIATION	8900 kcal/h
CONDITIONS	V = 15 l/min
	Δt = 75 ℃
	tol = 110 ℃
CORE TYPE	CORRUGATE TYPE WITH LOUVER
CORE SIZE	300×225.6×32
CORE TIER	15 TIERS
FIN PITCH	fp=4.0/2

d. Hydraulic components layout

KX91-3, 101-3

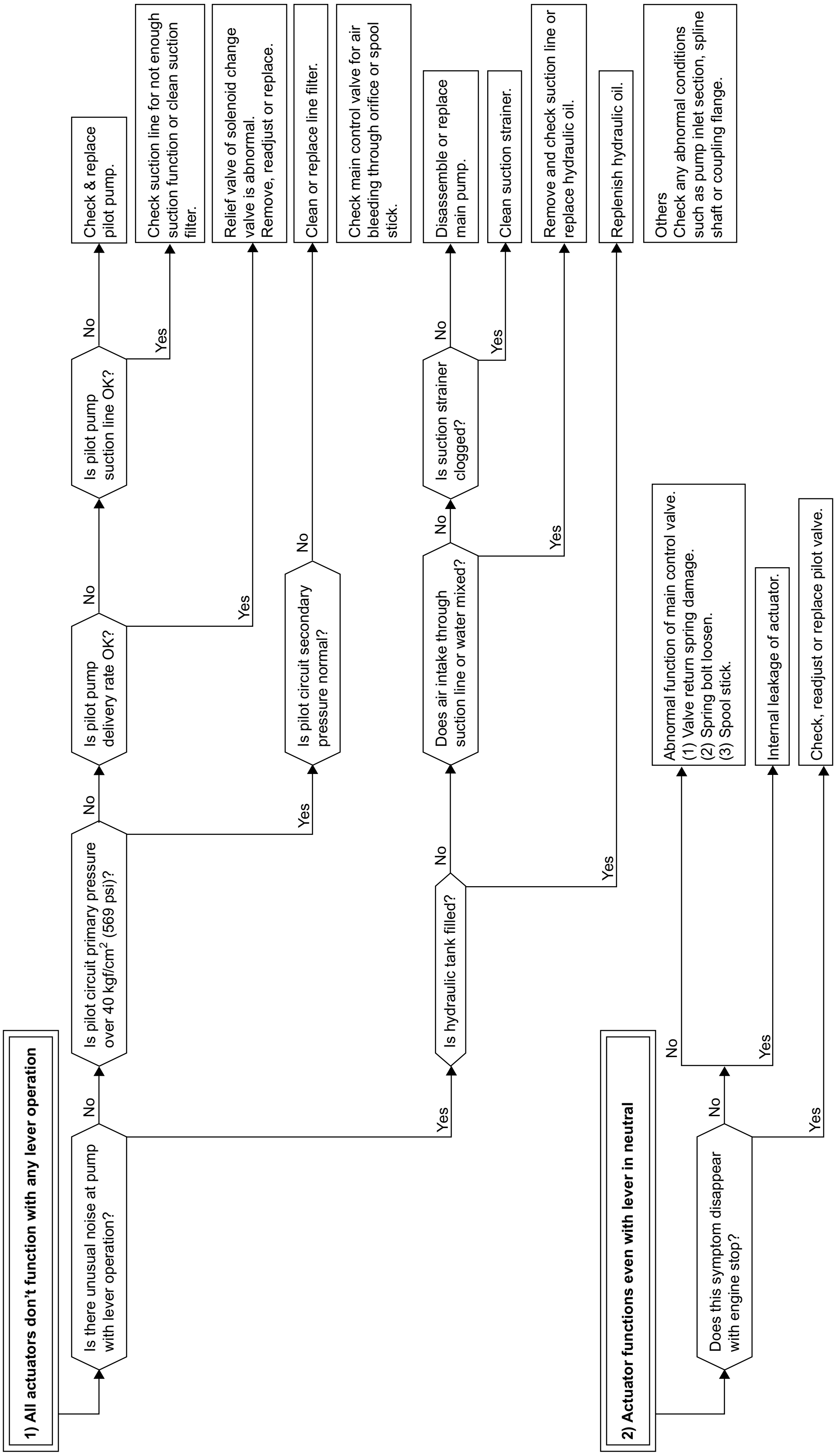


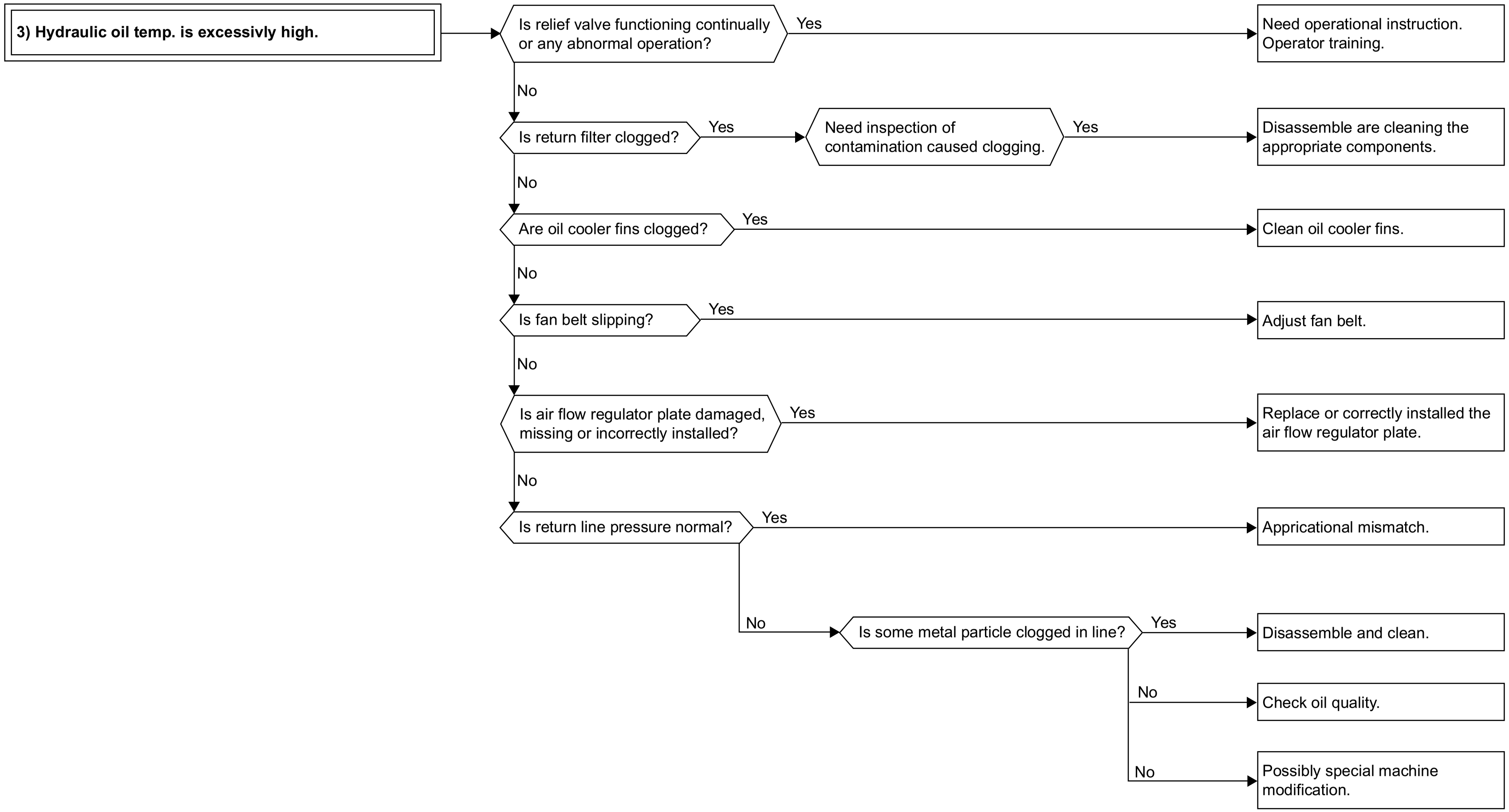
Note: (7)TPSS valve and (20)Change valve are for KTC, KCL, KTA - version.

IV.Hydraulic system(Service section)

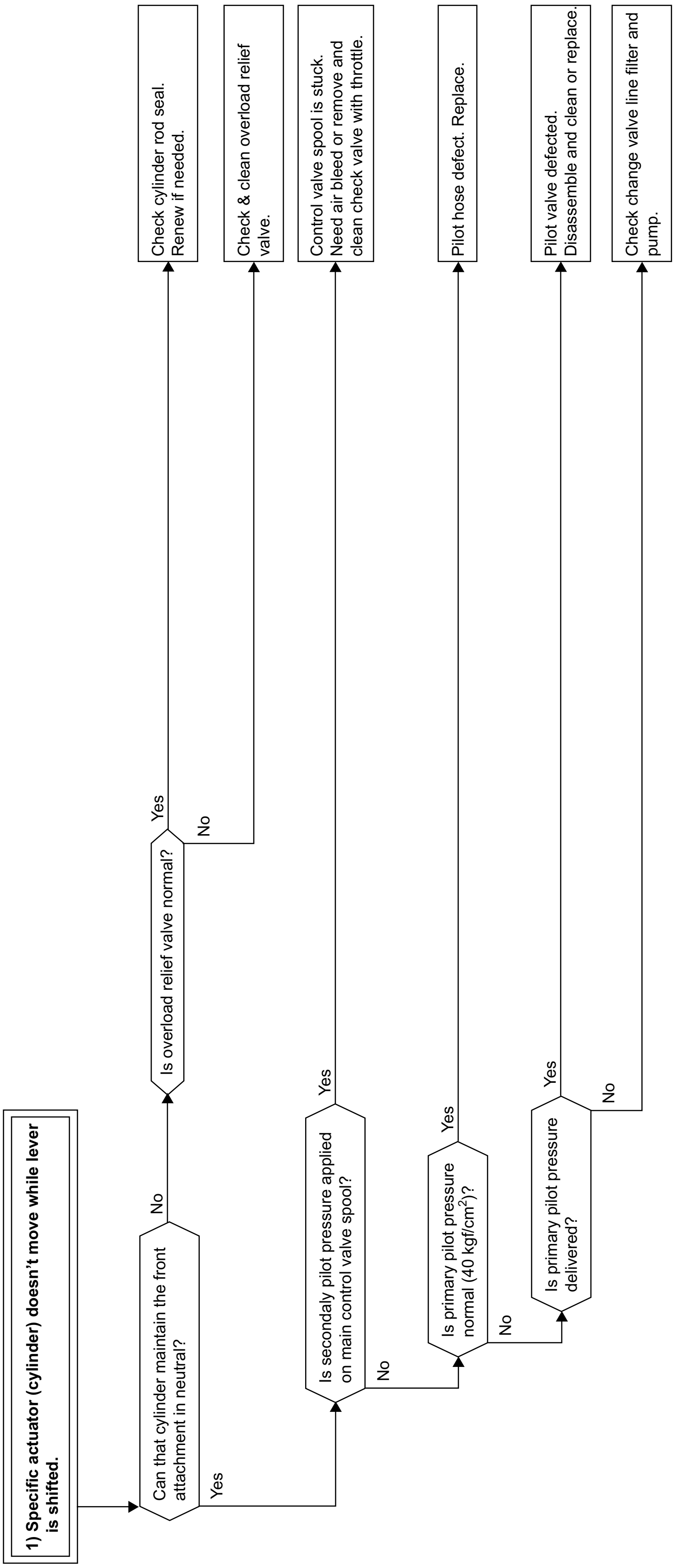
A.Troubleshooting

a. Common Circuit

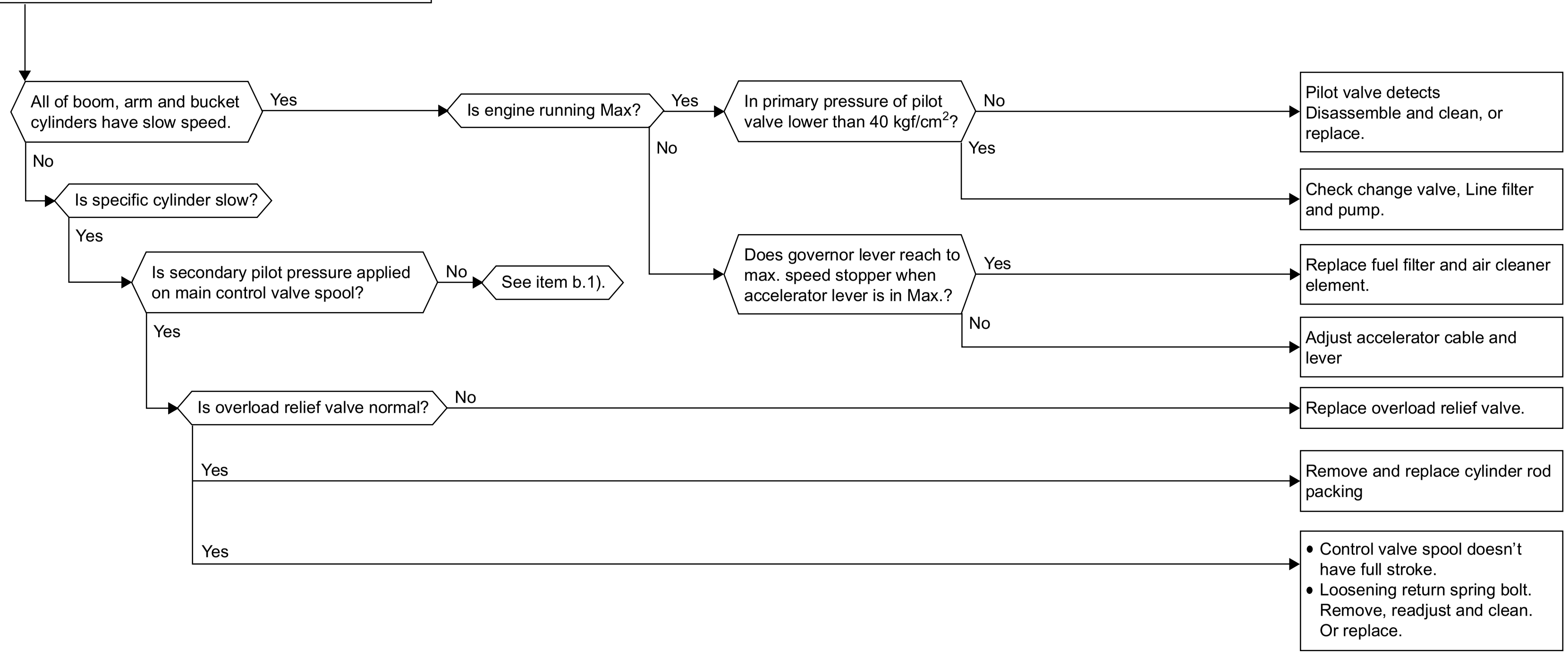



3) Hydraulic oil temp. is excessivly high.
Is relief valve functioning continually or any abnormal operation?
Yes
Need operational instruction. Operator training.
No
Is return filter clogged?
Yes
Need inspection of contamination caused clogging.
Yes
Disassemble are cleaning the appropriate components.
No
Are oil cooler fins clogged?
Yes
Clean oil cooler fins.
No
Is fan belt slipping?
Yes
Adjust fan belt.
No
Is air flow regulator plate damaged, missing or incorrectly installed?
Yes
Replace or correctly installed the air flow regulator plate.
No
Is return line pressure normal?
Yes
Appricational mismatch.
No
Is some metal particle clogged in line?
Yes
Disassemble and clean.
No
Check oil quality.
No
Possibly special machine modification.

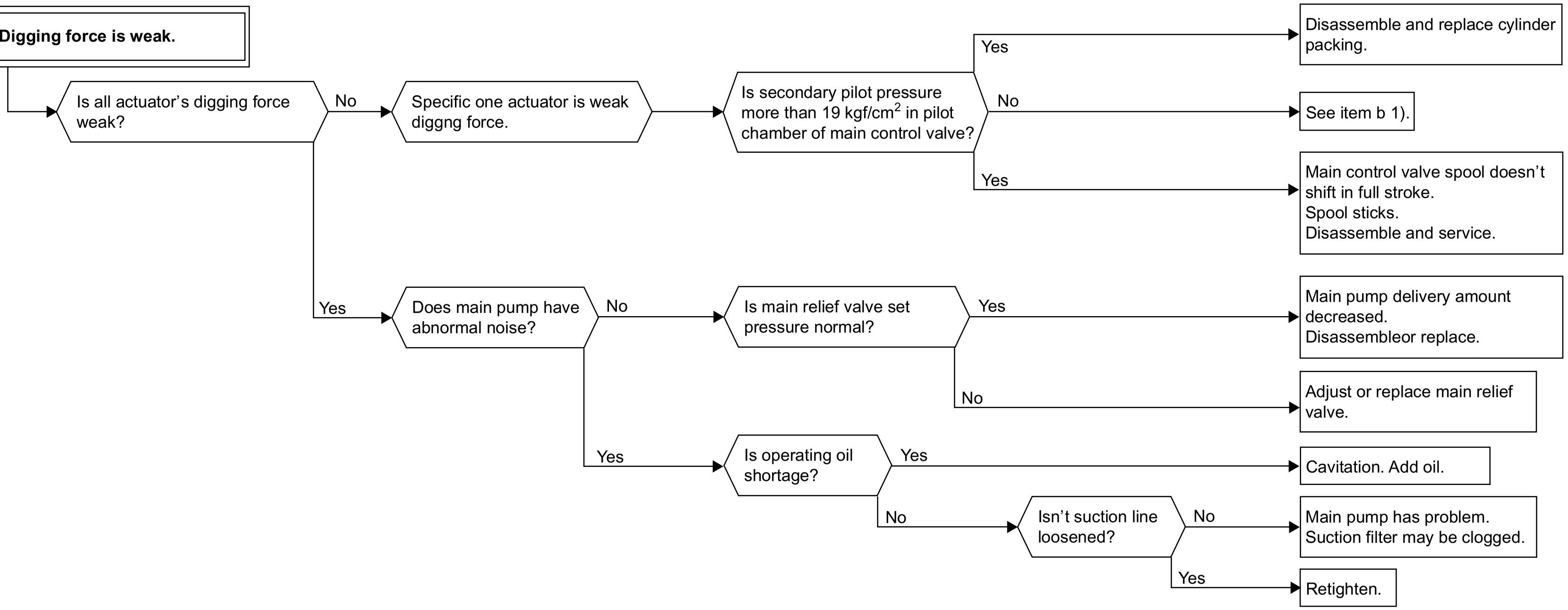
b. Front Attachment



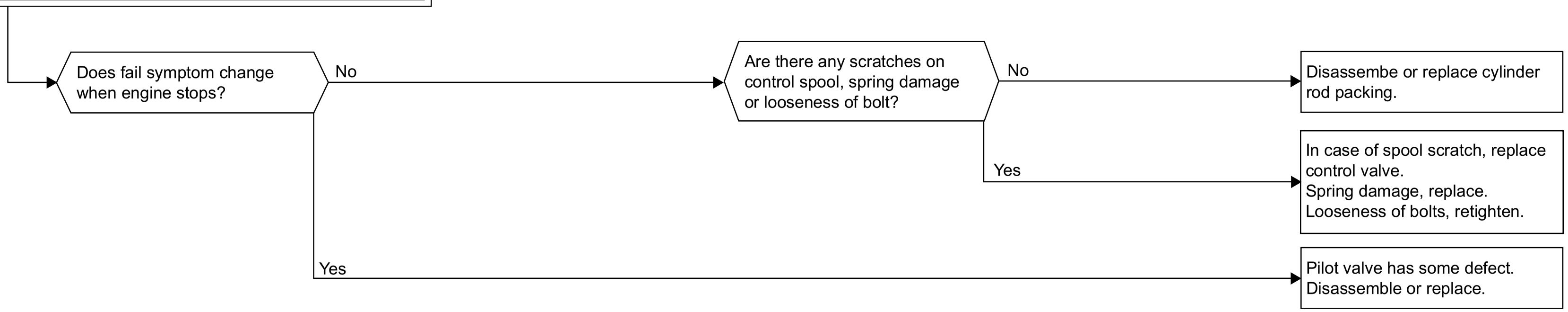
2) Front cylinder's operating speed is slow.



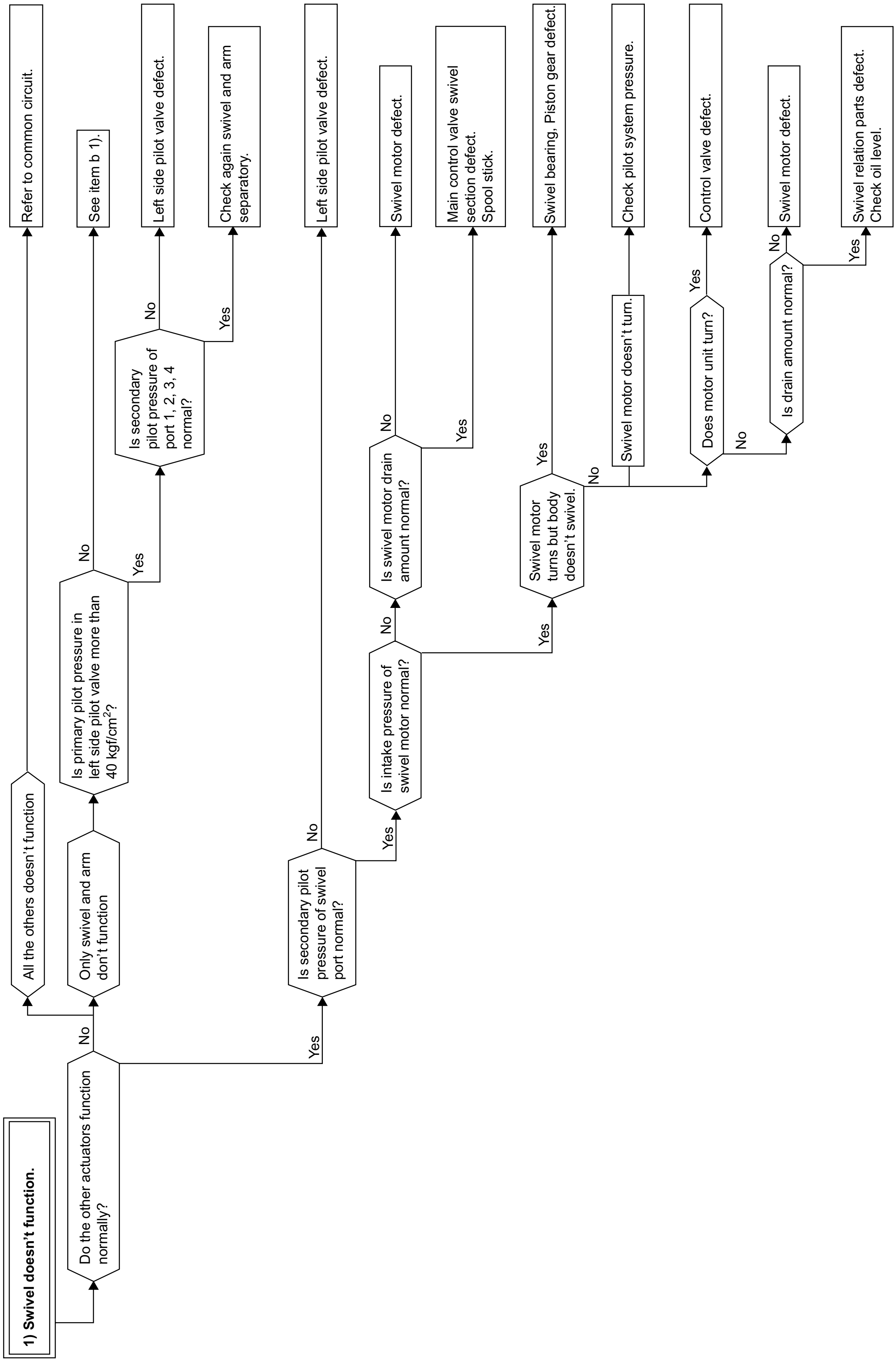
3) Digging force is weak.



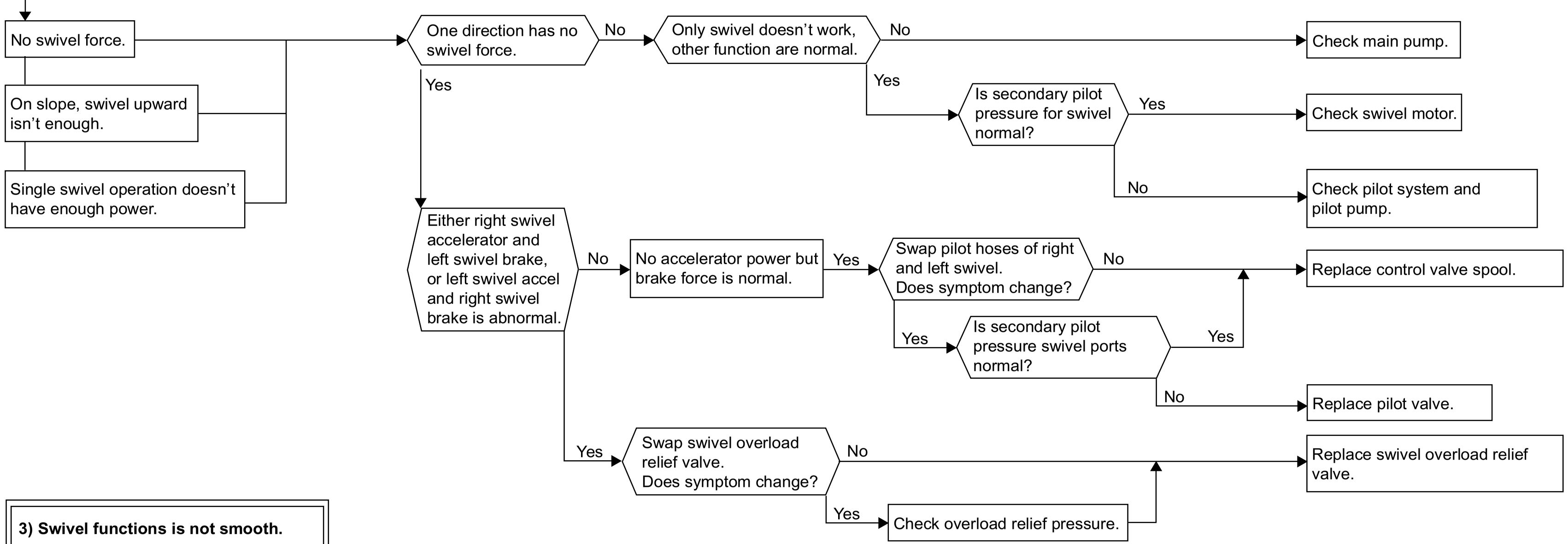
4) Front natural fall smount is excessive.



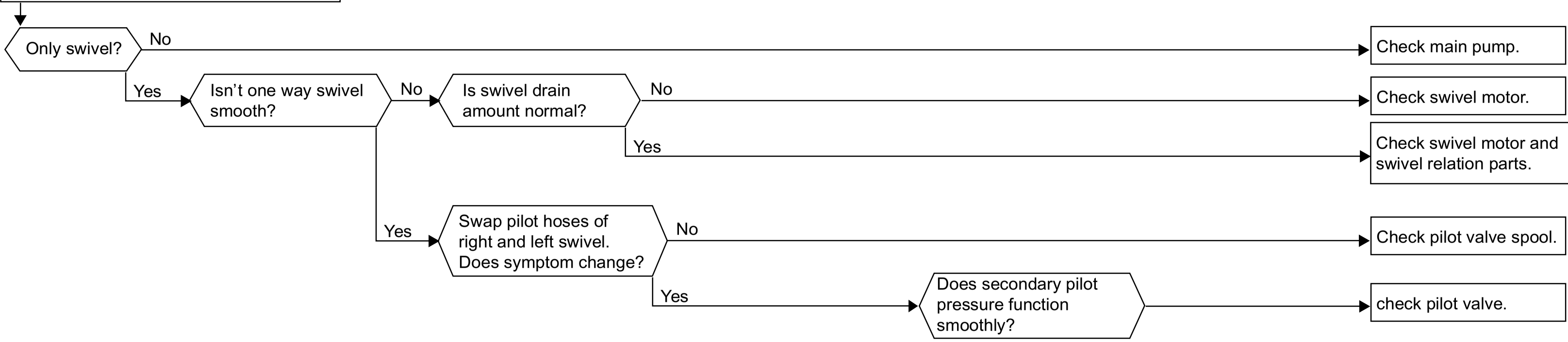
c. Swivel Circuit



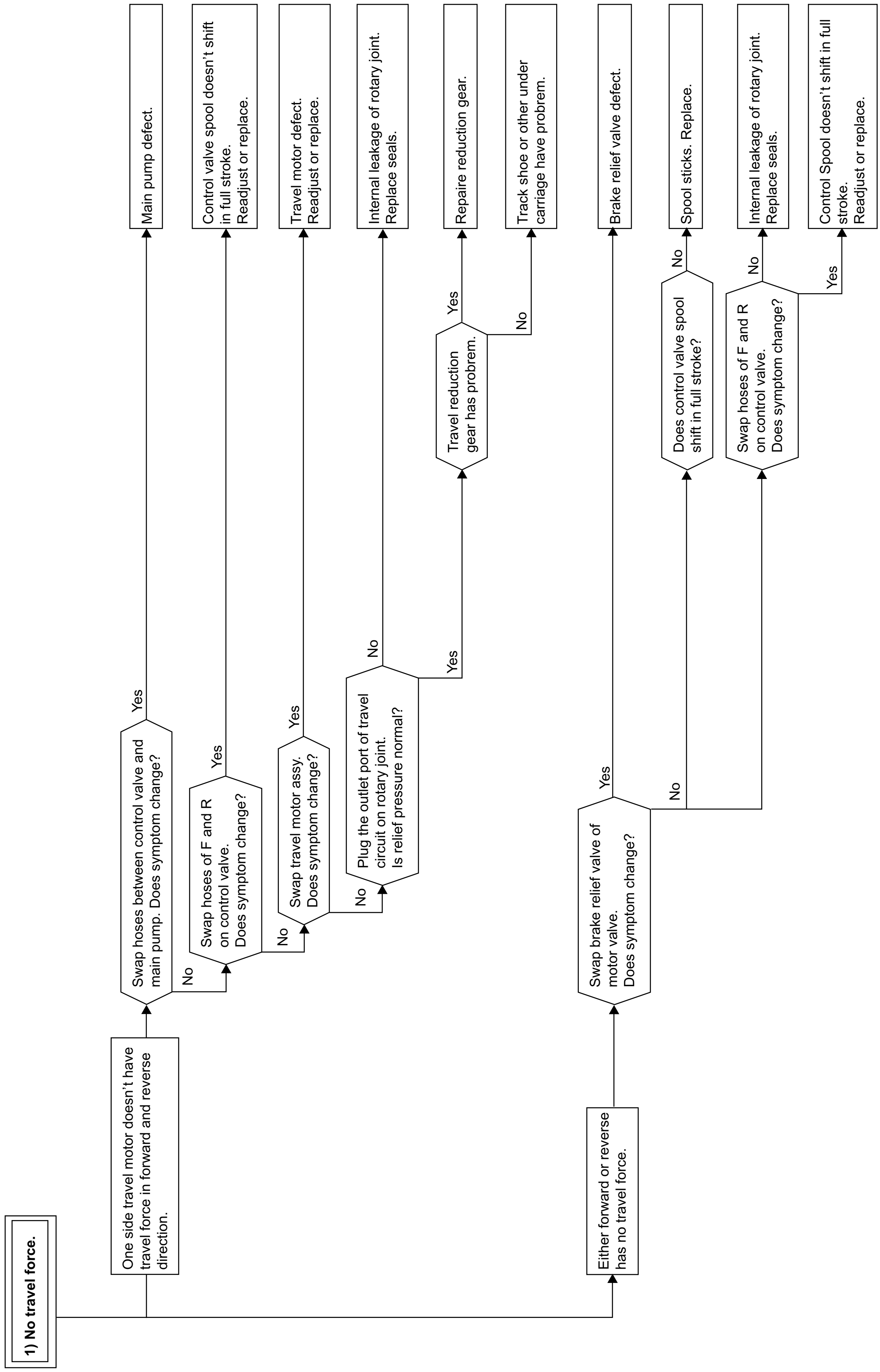
2) Swivel force is not enough.



3) Swivel functions is not smooth.

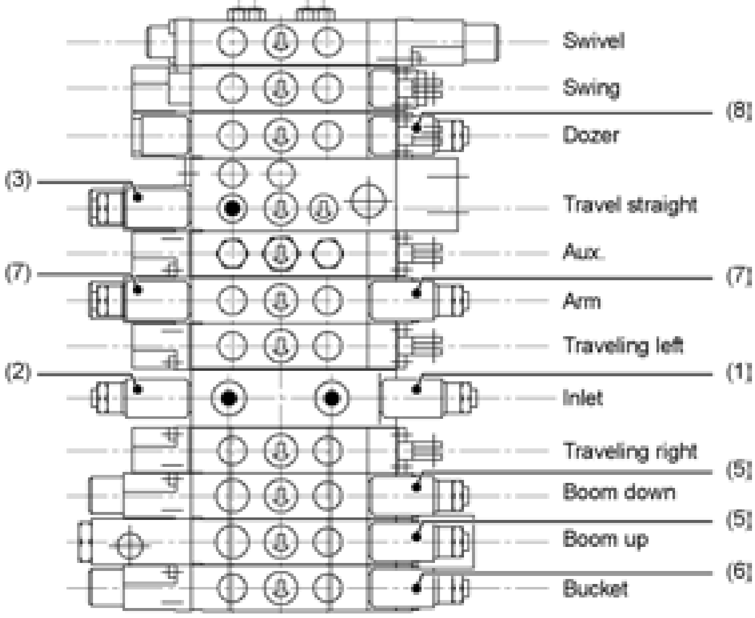


d. Travel Circuit



B.Specifications

a. Relief valve pressure setting



Main relief valve (bench data)

No.	Valve location	Operating work	Unit	KX91-3	KX101-3		Remarks
1	P1 Control valve	Travel right, Boom, Bucket	Mpa kgf/cm^2 psi	23.5 240 3414	25.0 255 3627		
2	P2 Control valve	Travel left, Arm, Auxiliary	Mpa kgf/cm^2 psi	23.5 240 3414	25.0 255 3627		
3	P3 Control valve	Dozer, Swing, Swivel	Mpa kgf/cm^2 psi	19.6 200 2845	←		
4	P4 Change valve	Control valve spool	Mpa kgf/cm^2 psi	3.9 40 569	←		

Main relief valve (at the measurement port on the machine) KE, KDG, KUK version

No.	Valve location	Operating work	Unit	KX91-3	KX101-3		Remarks
1	P1 Control valve	Travel right, Boom, Bucket	Mpa kgf/cm^2				
2	P2 Control valve	Travel left, Arm, Auxiliary	Mpa kgf/cm^2				
3	P3 Control valve	Dozer, Swing, Swivel	Mpa kgf/cm^2				
4	P4 Change valve	Control valve spool	Mpa kgf/cm^2				

Main relief valve (at the measurement port on the machine) KTC, KCL, KTA version

No.	Valve location	Operating work	Unit	KX91-3			Remarks
1	P1 Control valve	Travel right, Boom, Bucket	Mpa kgf/cm^2 psi	$24.0^{+1.0}_{-0.5}$ 245^{+10}_{-5} 3485^{+140}_{-70}			
2	P2 Control valve	Travel left, Arm, Auxiliary	Mpa kgf/cm^2 psi	$24.0^{+1.0}_{-5}$ $245^{+10}_{-0.5}$ 3485^{+140}_{-70}			
3	P3 Control valve	Dozer, Swing, Swivel	Mpa kgf/cm^2 psi	$21.1^{+1.0}_{-0.5}$ 215^{+10}_{-5} 3060^{+140}_{-70}			
4	P4 Change valve	Control valve spool	Mpa kgf/cm^2 psi	$4.1^{+0.3}_{-0.2}$ 42^{+3}_{-2} 600^{+43}_{-28}			

Overload relief valve

No.	Valve location	Operating work	Unit	KX91-3	KX101-3		Remarks
5	Control valve	Boom up Boom down	Mpa kgf/cm^2 psi	27.0 275 3911	27.5 280 3983		
6	Control valve	Bucket crowd	Mpa kgf/cm^2 psi	27.5 280 3983	27.9 285 4054		
7	Control valve	Arm dump Arm crowd	Mpa kgf/cm^2 psi	27.5 280 3983	27.9 285 4054		
8	Change valve	Dozer down	Mpa kgf/cm^2 psi	24.0 245 3485	←		

b. Pump

(1)KE, KDG, KUK version

		Unit	KX91-3	KX101-3		Remarks
Manufacturer			Uchida Hydraulics			
Model			AP2D18			
Rated pump rpm		rpm	2200	2300		
Rated load pressure	P1,P2	Mpa kgf/cm^2 psi	23.5 240 3414	←		
	P3	Mpa kgf/cm^2 psi	19.6 200 2845	←		
	P4	MpaMp a kgf/cm^2 psi	3.9 40 569	←		
Theoretical discharg capacity	P1,P2	cc/rev in^3/rev	18.0 1.1	17.0 1.0		
	P3	cc/rev in^3/rev	9.5 0.6	9.0 0.5		
	P4	cc/rev in^3/rev	3.8 0.2	←		
Theoretical discharg capacity at rated load	P1,P2	L/min gal/min	39.6 10.5	39.1 10.3		
	P3	L/min gal/min	20.9 5.5	20.7 5.5		
	P4	L/min gal/min	8.4 2.2	8.7 2.3		
Variabel displacement pump discharge capacity at specified operating pressure P=P1+P2 P3=5 kgf/cm^2 (71 psi)	P=0 kgf/cm^2 P=0 psi	L/min gal/min	39 10.3	39 10.3		
	P=200 kgf/cm^2 P=2845 psi	L/min gal/min	36 9.5	38 10.0		
	P=240 kgf/cm^2 P=3414 psi	L/min gal/min	31 8.2	33 8.7		
	P=250 kgf/cm^2 P=3556 psi	L/min gal/min	---	31 8.2		

(2) KTC, KCL, KTA version

		Unit	KX91-3		Remarks
Manufacturer			Uchida Hydraulics		
Model			AP2D18		
Rated pump rpm		rpm	2300		
Rated load pressure	P1,P2	Mpa kgf/cm^2 psi	23.5 240 3414		
	P3	Mpa kgf/cm^2 psi	19.6 200 2845		
	P4	Mpa kgf/cm^2 psi	3.9 40 569		
Theoretical discharg capacity	P1,P2	cc/rev in^3/rev	18.0 1.1		
	P3	cc/rev in^3/rev	9.5 0.6		
	P4	cc/rev in^3/rev	3.8 0.2		
Theoretical discharg capacity at rated load	P1,P2	L/min gal/min	41.4 10.9		
	P3	L/min gal/min	21.9 5.8		
	P4	L/min gal/min	8.7 2.3		
Variabel displacement pump discharge capacity at specified operating pressure P=P1+P2 P3=5 kgf/cm^2 (71 psi)	P=0 kgf/cm^2 P=0 psi	L/min gal/min	39 10.3		
	P=200 kgf/cm^2 P=2845 psi	L/min gal/min	36 9.5		
	P=240 kgf/cm^2 P=3414 psi	L/min gal/min	31 8.2		
	P=250 kgf/cm^2 P=3556 psi	L/min gal/min	---		

c. Cylinder

(1) Cylinder operating speed

Unit			KX91-3		KX101-3		Remarks
			(A)	(B)	(A)	(B)	
Boom cylinder	Up	sec.	2.1	2.4	2.6	3.1	GL to Max. height (exclude cushion time)
Boom cylinder	Down	sec.	2.7	3.0	3.0	3.6	Max. height to GL
Boom cylinder	cushion	sec.	0.4 ~ 1.3	0.4 ~ 1.3	0.4 ~ 1.3	0.4 ~ 1.3	
Arm cylinder	Crowd	sec.	2.9	3.2	2.8	3.4	Cylinder full stroke
Arm cylinder	Dump	sec.	2.7	3.0	2.6	3.1	
Bucket cylinder	Crowd	sec.	2.7	3.0	2.4	2.9	Cylinder full stroke
Bucket cylinder	Dump	sec.	1.9	2.2	1.5	1.8	
Swing cylinder	Left	sec.	7.4	7.2	6.1	7.3	Cylinder full stroke
Swing cylinder	Right	sec.	5.8	5.4	4.6	5.5	
Dozer cylinder	Up	sec.	2.1	2.4	2.8	3.4	Cylinder full stroke
Dozer cylinder	Down	sec.	2.8	3.1	2.1	2.5	

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

(2) Cylinder natural fall amount

Unit		KX91-3		KX101-3		Remarks
		(A)	(B)	(A)	(B)	
Load weight	kg lbs	280 617	-	285 628	-	include bucket weight
Boom cylinder	mm in	20 0.79	100 3.94	20 0.79	100 3.94	
Arm cylinder	mm in	15 0.59	55 2.17	15 0.59	55 2.17	
Bucket cylinder	mm in	25 0.98	125 4.92	25 0.98	125 4.92	
Dozer cylinder	mm in	20 0.79	100 3.94	20 0.79	100 3.94	

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

(3) Cylinder specifications

1) KE, KDG, KUK version

		Unit	KX91-3	KX101-3		Remarks
Boom	Tube I.D. × Rod O.D.	mm	ϕ80 × ϕ45	ϕ80 × ϕ45		
	Stroke	mm	506	506		
	Max.retraction length	mm	870	833		
	Seal Kit No.		RG518-67560	RG618-67540		
	Piston tightning torque	N·m kgf·m	600 ± 120 92 ± 12	600 ± 120		
Arm	Tube I.D. × Rod O.D.	mm	ϕ75 × ϕ45	←		
	Stroke	mm	583.5	←		
	Max.retraction length	mm	896.5	←		
	Seal Kit No.		RG518-67630	←		
	Piston tightning torque	N·m kgf·m	600 ± 120 92 ± 12	←		
Bucket	Tube I.D. × Rod O.D.	mm	ϕ65 × ϕ40	←		
	Stroke	mm	539	←		
	Max.retraction length	mm	834	←		
	Seal Kit No.		RG518-67840	←		
	Piston tightning torque	N·m kgf·m	475 ± 95 48 ± 10	←		
Swing	Tube I.D. × Rod O.D.	mm	ϕ80 × ϕ40	←		
	Stroke	mm	408.5	←		
	Max.retraction length	mm	692.5	←		
	Seal Kit No.		RG208-94410	←		
	Piston tightning torque	N·m kgf·m	475 ± 95 48 ± 10	←		
Dozer	Tube I.D. × Rod O.D.	mm	ϕ90 × ϕ45	←		
	Stroke	mm	154	←		
	Max.retraction length	mm	492	←		
	Seal Kit No.		RG518-75130	←		
	Piston tightning torque	N·m kgf·m	600 ± 120 92 ± 12	←		

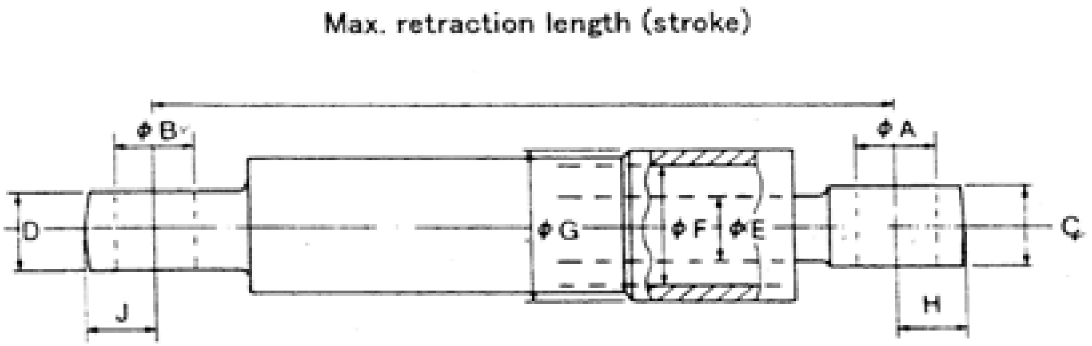
2) KTC, KCL, KTA version

		Unit	KX91-3	Remarks
Boom	Tube I.D. × Rod O.D.	mm in.	ϕ80 × ϕ45 ϕ3.15 × ϕ1.77	
	Stroke	mm in.	506 19.9	
	Max.retraction length	mm in.	870 34.3	
	Seal Kit No.		RC411-71380	
	Piston tightning torque	N·m kgf·m ft·lbf	932 95.0 687	
	Piston screw size	mm in.	M36 × 2	
	Width for tightning by spanner	mm in.	55 2.17	

		Unit	KX91-3	Remarks
Arm	Tube I.D. × Rod O.D.	mm in.	ϕ75 × ϕ45 ϕ2.95 × ϕ1.77	
	Stroke	mm in.	583.5 23.0	
	Max.retraction length	mm in.	896.5 35.3	
	Seal Kit No.		RC411-71530	
	Piston tightning torque	N·m kgf·m ft·lbf	1079 110.0 796	
	Piston screw size	mm in.	M33 × 2	
	Width for tightning by spanner	mm in.	50 1.97	
Bucket	Tube I.D. × Rod O.D.	mm in.	ϕ65 × ϕ40 ϕ2.56 × ϕ1.57	
	Stroke	mm in.	467 18.4	
	Max.retraction length	mm in.	774.5 30.5	
	Seal Kit No.		RC411-71760	
	Piston tightning torque	N·m kgf·m ft·lbf	637 65.0 470	
	Piston screw size	mm in.	M30 × 1.5	
	Width for tightning by spanner	mm in.	50 1.97	
Swing	Tube I.D. × Rod O.D.	mm in.	ϕ80 × ϕ40 ϕ3.15 × ϕ1.57	
	Stroke	mm in.	408.5 16.1	
	Max.retraction length	mm in.	692.5 27.3	
	Seal Kit No.		RC601-75260	
	Piston tightning torque	N·m kgf·m ft·lbf	784 79.9 578	
	Piston screw size	mm in.	M30 × 1.5	
	Width for tightning by spanner	mm in.	50 1.97	
Dozer	Tube I.D. × Rod O.D.	mm in.	ϕ90 × ϕ45 ϕ3.54 × ϕ1.77	
	Stroke	mm in.	154 6.1	
	Max.retraction length	mm in.	492 19.4	
	Seal Kit No.		RP401-71150	
	Piston tightning torque	N·m kgf·m ft·lbf	932 95.0 687	
	Piston screw size	mm in.	M36 × 2	
	Width for tightning by spanner	mm in.	55 2.17	

3) Cylinder dimensional specifications [KX91-3, KX121-3]

	Unit	A	B	C	D	E	F	G	H	J	Port screw size	Remarks
Boom	mm in	50 1.97	55 2.17	55 2.17	60 2.36	45 1.77	80 3.15	96 3.78	39 1.54	50 1.97	R1/2	
Arm	mm in	55 2.17	55 2.17	60 2.36	60 2.36	45 1.77	75 2.95	91 3.58	42 1.65	40 1.57	R1/2	
Bucket	mm in	50 1.97	50 1.97	50 1.97	50 1.97	40 1.57	65 2.56	77 3.03	39 1.54	36 1.42	R3/8	
Swing	mm in	50 1.97	50 1.97	50 1.97	50 1.97	40 1.57	80 3.15	93 3.66	39 1.54	39 1.54	R1/2	
Dozer	mm in	55 2.17	55 2.17	50 1.97	50 1.97	45 1.77	90 3.54	105 4.13	44 1.73	40 1.57	R3/8	



d. Swivel Performance

(1)KE, KDG, KUK version

		KX91-3	KX101-3		Remarks
Manufacturer		KAYABA&T/B	←		
Model			←		
Capacity	cc/rev	296.0	←		
Brake valve pressure	Mpa kg/cm^2	16.7 170.3	20.2 206.0		
Drain amount at lock	l/min	1.0	0.67		Actual measurement value
Drain amount while rotating	cc/min	35	63		Actual measurement value
Swivel speed	rpm	8.9	←		
3 times rotation swivel speed	sec	20.2	21.3		
Swivel block performance at engine stop	mm/min	6	6		
Swivel block performance at engine running	mm/min	30			
Capable swivel rotation angle	deg.	19	←		
Play at the tip of bucket	mm	24.0	28.0		Reference value

(2)KTC, KCL, KTA version

		KX91-3		Remarks
Manufacturer		Kubota		
Model		SM29G		
Capacity	cc/rev in^3/rev	289.8 17.7		
Brake valve pressure	Mpa kg/cm^2 psi	16.7 170.3 2422		
Drain amount at lock	l/min gal/min	1.0 0.26		Actual measurement value
Drain amount while rotating	cc/min in^3/min	35 2.14		Actual measurement value
Swivel speed	rpm	8.9		
3 times rotation swivel speed	sec	20.2		
Swivel block performance at engine performance	mm/min in/min	6 0.24		
Swivel block performance at engine running	mm/min in/min	30 1.18		
Capable swivel rotation angle	deg.	19		
Play at the tip of bucket	mm in.	24.0 0.94		Reference value

e. Traveling Performance
(1) KE, KDG, KUK version

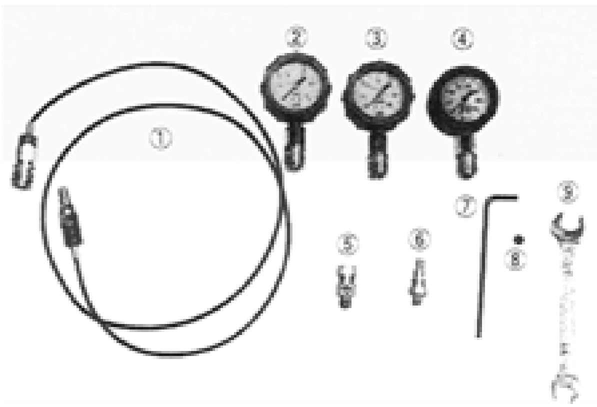
			KX91-3	KX101-3		Remarks
Manufacturer			KAYABA + T/B			
Model			702CKSP-MAG18V			
Capacity		cc/rev	18	17		
Relief valve pressure		Mpa kg/cm^2	24.7 252	←		
Climbing ability		deg.	30	←		
Max. traction force	1F	N kgf				Reference value
	2F	N kgf				
Traveling block performance		mm/10min	300	←		Allowable value of new machine Testing angle : 20deg
Traveling speed	1F	km/h	3.0	←		
	2F	km/h	4.6	←		
10m traveling time	1F	sec./10m sec./32.8ft	10.9 ~ 13.3	←		
	2F	sec./10m sec./32.8ft	7.1 ~ 8.8	←		
Crawler rotation speed	1F 2F	sec/ 1 rev	4.8 3.2	5.2 3.4		
Straight travel performance	1,2F	mm/10mm	600≧	←		
Drain amount at lock	1F	cc/min	83	←		Reference value
	2F	cc/min	82	←		
Drain amount while rotating	1F	cc/min	8	←		Reference value
	2F	cc/min	13	←		

(2)KTC, KCL, KTA version

			KX91-3		Remarks
Manufacturer			Kubota		
Model			WM18NL		
Capacity		cc/rev in^3/rev	18 1.10		
Relief valve pressure		Mpa kg/cm^2 psi	24.5 250 3553		
Climbing ability		deg.	30		
Max. traction force	1F	N kgf lbf	24.9 2543 5605		Reference value
	2F	N kgf lbf	15.2 1550 3417		
Traveling block performance		mm/10min ft/10min	300 1		Allowable value of new machine Testing angle : 20deg
Traveling speed	1F	km/h mph	3.0 1.88		
	2F	km/h mph	4.8 3.0		
10m traveling time	1F	sec./10m sec./32.8ft	10.9 ~ 13.3		Reference value
	2F	sec./10m sec./32.8ft	6.8 ~ 8.4		
Crawler rotation speed	1F 2F	sec/ 1 rev	4.8 3.1		Reference value
Straight travel performance	1,2F	mm/10mm ft/32.8ft	600≧ 1.97≧		
Drain amount at lock	1F	cc/min in^3/min	83 5.06		Reference value
	2F	cc/min in^3/min	82 5.00		
Drain amount while rotating	1F	cc/min in^3/min	8 0.49		Reference value
	2F	cc/min in^3/min	13 0.79		

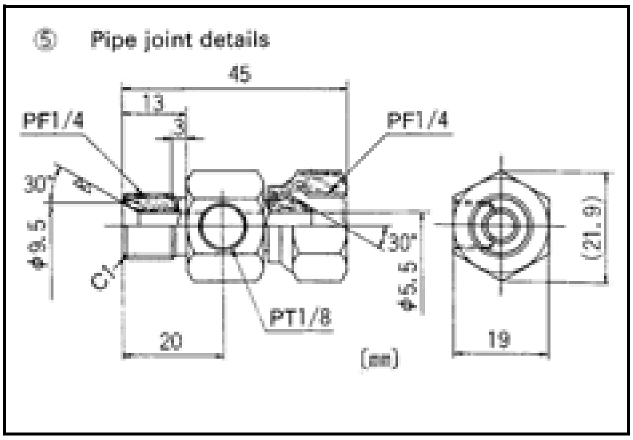
C.Testing

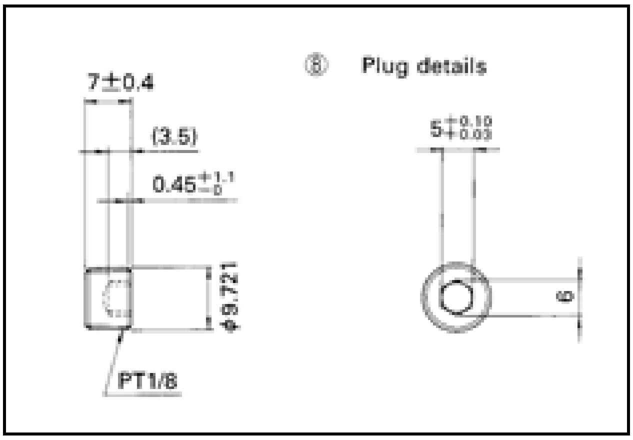
a. Testing Instruments & special tools

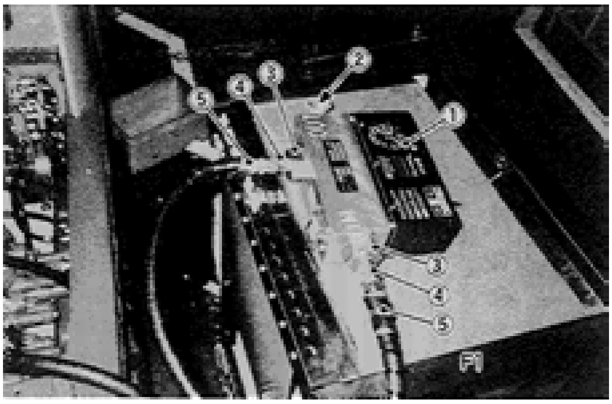


(1) Gauges and special tools for pressure testing

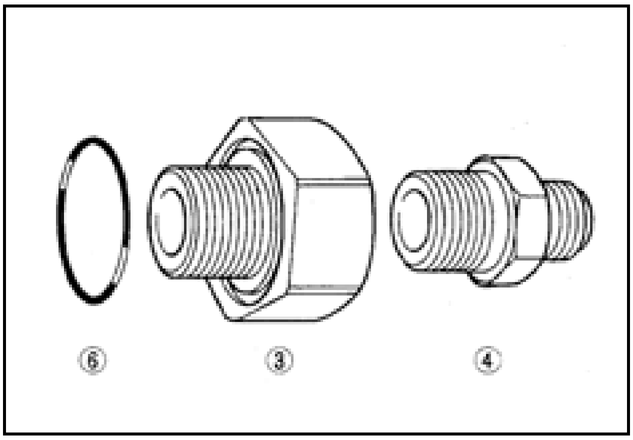
1. Pressure hose
2. Pressure gauge; 2.94 MPa, 30kgf/cm^2, 427 psi
   For Secondary pilot pressure test.
3. Pressure gauge; 5.88 MPa, 60kgf/cm^2, 853psi
   For primary pilot pressure test.
4. Pressure gauge; 64.3 MPa, 350kgf/cm^2, 4978psi
   For main relief pressure and overload relief pressure test.
5. Pipe joint (S, F2 - F2)
   code No.: 69181-63191
6. Pressure test plug; PT 1/8
7. Allen wrench; M5
8. Plug; PT 1/8 Code No.: 68311-13381
9. Wrench; Size 17 - 19 mm

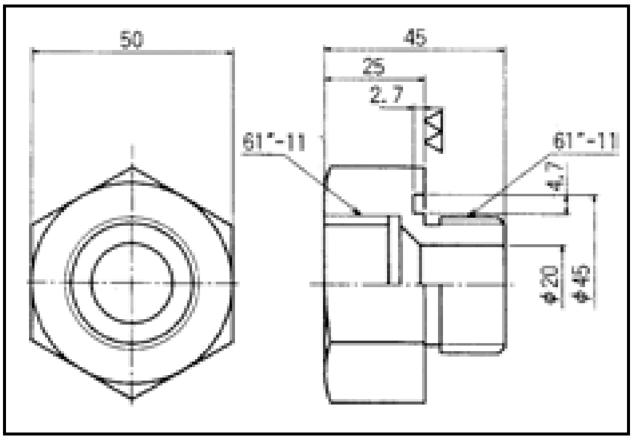






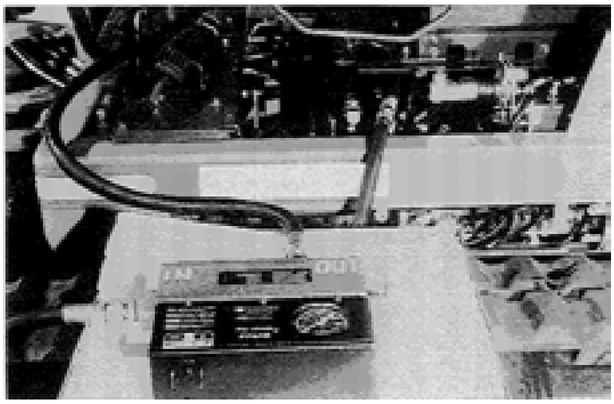
(2) Flow meter and special tools for flow testing
1. Flow meter; Flowtech Inc. make
2. Loading handle
3. Male-female joint 1” × 1”
4. joint 1” × 1/2”
5. Hose 1/2”
6. O-ring



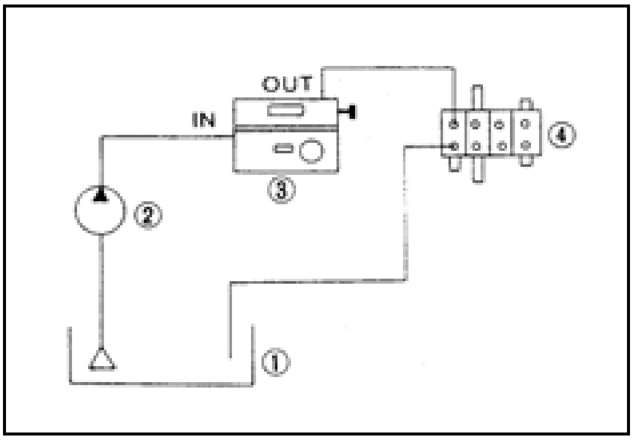


Drawing of (3) Male - female joint 1” × 1”

b. Pump flow



1 Connect the tester to the pump discharge side. Be careful not to connect the wrong port.
2 Open the loading valve of the tester to start the engine.
3, Increase the engine speed to the maximum speed.
4. While slowly closing the loading valve, apply the rated load pressure (test pressure) to the pump.
5. Measure the discharge and pump rpm (engine rpm).
6. Calculate the volumetric efficiency and judge the usability of the pump.
7. Perform steps 1 to 6 above for each pump.



[Procedure for Pump Performance Test]
The pump performance test proceeds as follows: apply the specified hydraulic load to the pump discharge side, measure the discharge at the specified revolutions, and determine the volumetric efficiency.

$$\text{Volumetric efficiency} \quad \frac{\text{Discharge at the rated load}}{\text{Theoretical discharge}} \times 100\ (\%)$$

[Caution]
1. The volumetric efficiency of the pump is proportional to its revolutions and is inversely proportional to the load pressure. The test should therefore be made with the engie revolutions increased to a maximum.
2. The volumetric efficiency is the ratio of theoretical discharge (Calculated value) to discharge per revolution of pump (c.c./rev) with the rated load. The rated load shall be the main relief setting pressure.
3. Because the pump revolutions are usually decreased, be sure to convert the measured value of discharge with the rated load into rpm.

$$\text{Discharge at the rated load (cc/rev)} = \frac{\text{Measured discharge (l/min)} \times 1000}{\text{Measured pump speed}}$$

4. The criterion for judging pump performance shall satisfy the standards of volumetric coefficiency.
5. Hydraulic oil temperature must be 50 ± 5°F, 122 ± 8°F.
(1) Tank
(2) Pump
(3) Tester
(4) Control valve

c. Pilot pressure

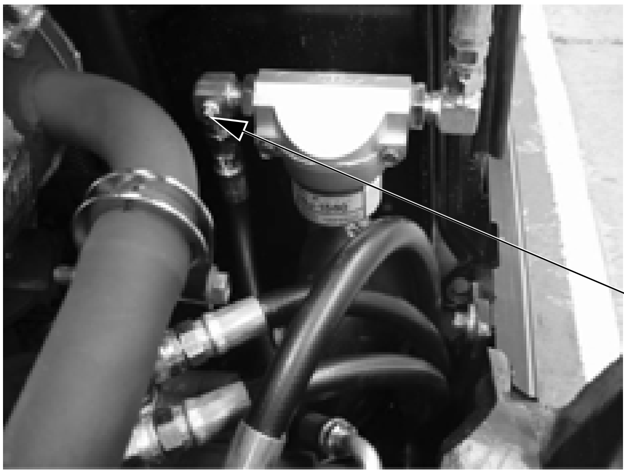
(1) Primary pressure

- Measurement method

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 tempreture must be 50 ± 5°C, 122 ± 8°F.

KE, KDG, KUK version

Reference Value	MPa kgf/cm^2



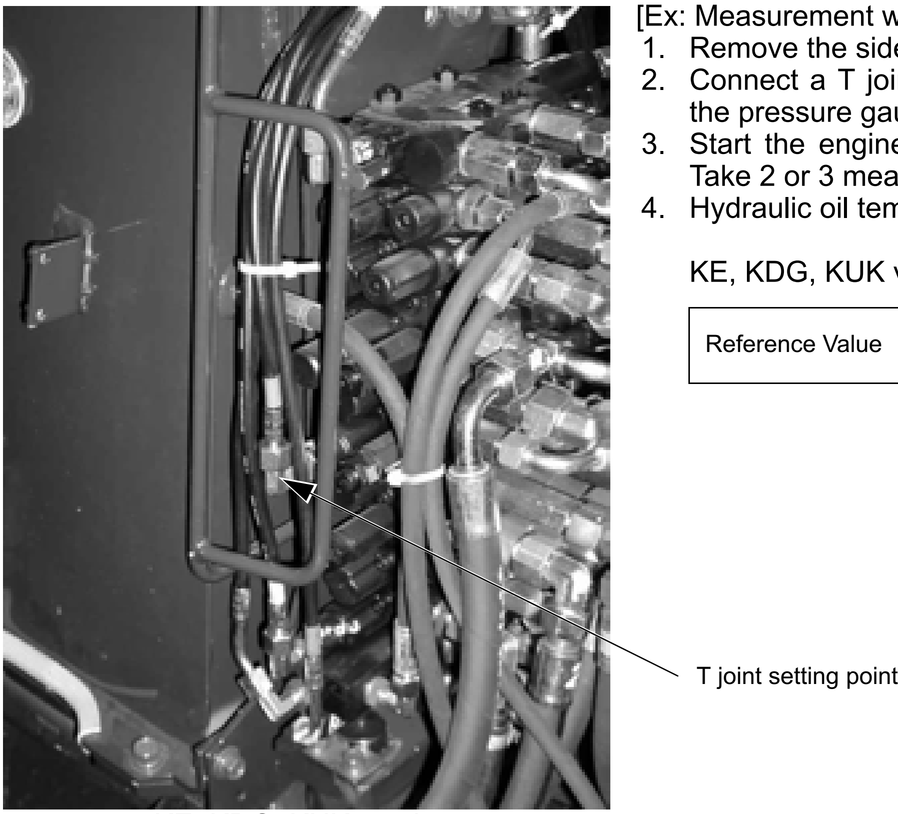
KTC, KCL, KTA version

KTC, KCL, KTA version

Reference Value	4.1 MPa 42 kgf/cm^2 600 psi

(2) Secondary pressure

• Measurement method



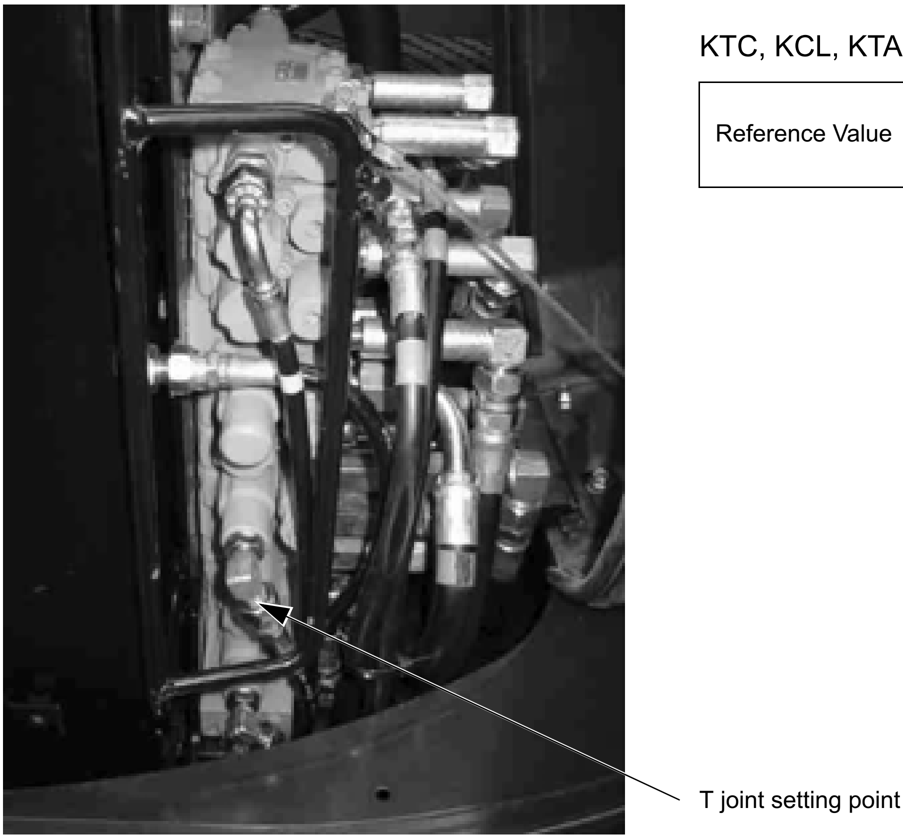
KE, KDG, KUK version

[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 ± 8°F.

KE, KDG, KUK version

Reference Value	MPa kgf/cm^2



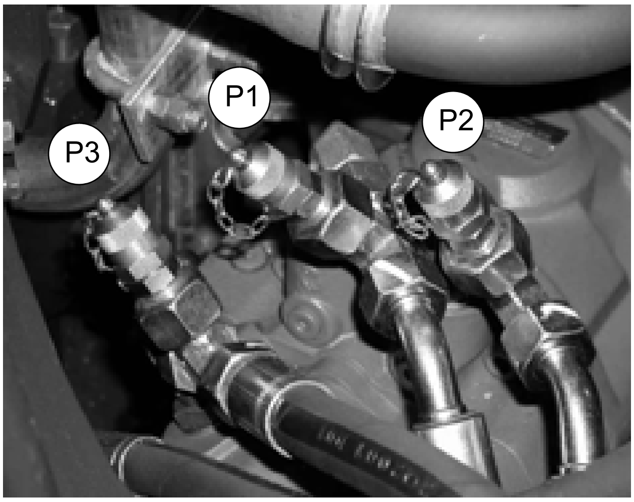
KTC, KCL, KTA version

KTC, KCL, KTA version

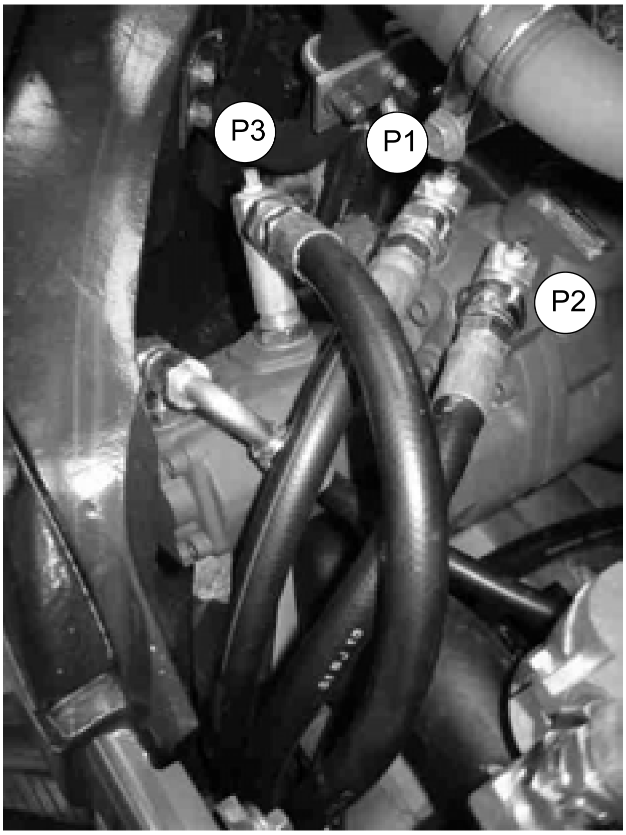
Reference Value	2.6 MPa 27 kgf/cm^2 384psi

d. Main relief valve

• Measurement method



KE, KDG, KUK version



KTC, KCL, KTA version

1. Set the pressure gauge to the coupler at the main pump discharge side. Or remove the plug off the main pump discharge side and set the pressure gauge there.
2. Start the engine and run it at the maximum speed. Get the following main relief valves activated.
   P1: Bucket movement
   P2: Arm movement
   P3: Swing and dozer movement
3. Take 2 or 3 measurements for each of P1, P2 and P3 to have their respective exact readings.
4. Hydraulic oil tempreture must be 50 ± 5°C, 122 ± 8°F.

(1)KE, KDG, KUK version
KX91-3

	P1	P2	P3
Reference Value	MPa kgf/cm^2	MPa kgf/cm^2	MPa kgf/cm^2

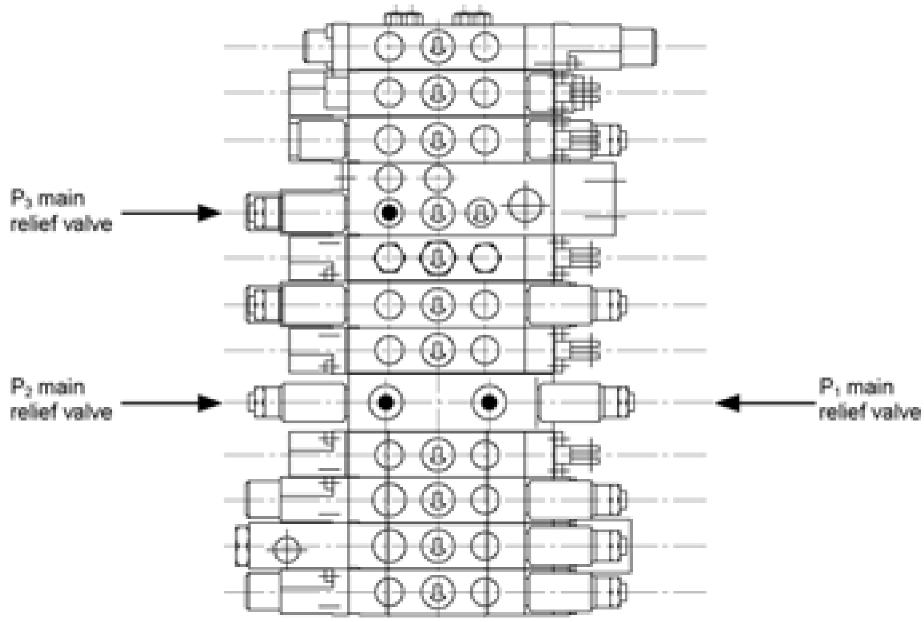
KX101-3

	P1	P2	P3
Reference Value	MPa kgf/cm^2	MPa kgf/cm^2	MPa kgf/cm^2

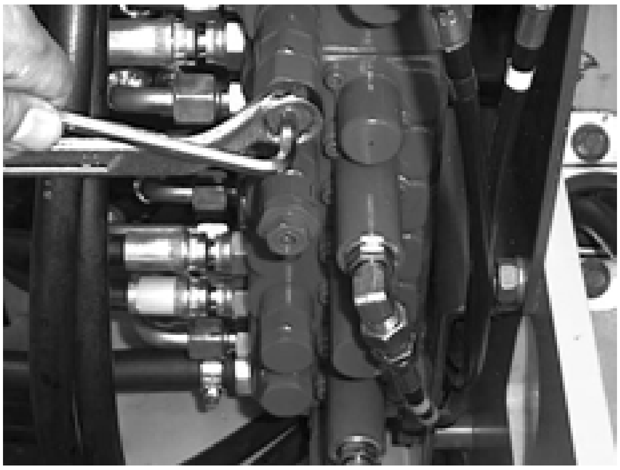
(2)KTC, KCL, KTA version
KX91-3

	P1	P2	P3
Reference Value	24.0 MPa 245 kgf/cm^2 3485 psi	24.0 MPa 245 kgf/cm^2 3485 psi	21.1 MPa 215 kgf/cm^2 3060 psi

• Location of the Main relief valve



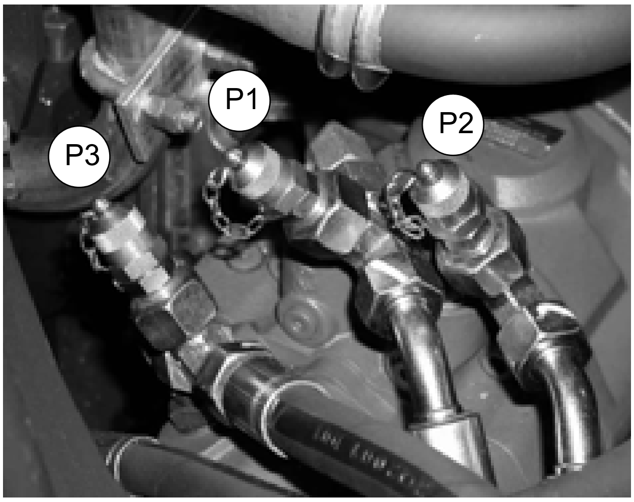
• Adjustment of the relief valve



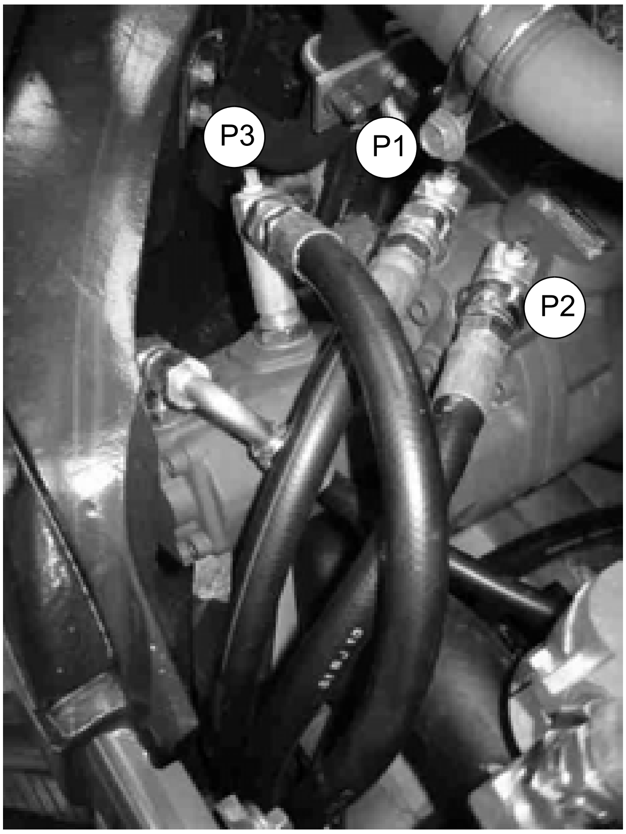
1. Loosen the lock nut of the relief valve. Using a hex wrench, turn the adjusting screw to reach the specified setting. Then tighten up the lock nut. Clockwise turn raises the pressure, and counterclockwise turn lowers it.
2. Run the engine at the maximum speed. Move the levers and make sure the pressure setting.

e. Overload relief valve

- Measurement method



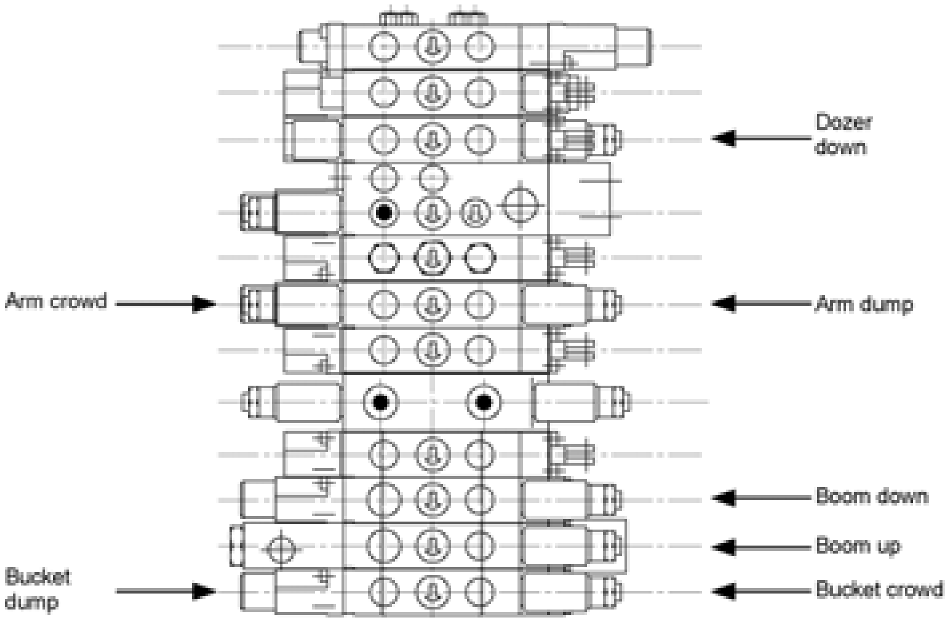
KE, KDG, KUK version



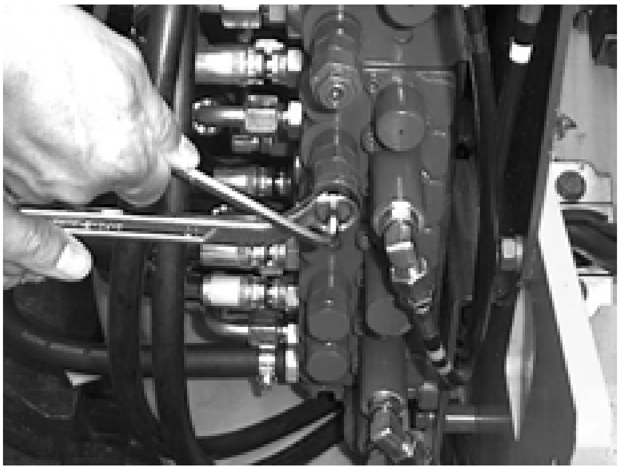
KTC, KCL, KTA version

1. Set the pressure gauge to the coupler at the main pump discharge side. Or remove the plug off the main pump discharge side and set the pressure gauge there.
2. Raise the pressure setting of the main relief valve about 0.98 MPa (10 kgf/cm^{2}, 142 psi) over that of the overload relief valve.
   P1 discharge [Boom up/down, Bucket dump/crowd]
   P2 discharge [Arm dump/crowd, Auxiliary port]
   P3 discharge [Dozer down]
3. Run the engine at the maximum speed. Move the levers to get the overload relief valve activated. Measure the pressure setting.
4. Take 2 or 3 measurements to have the exact reading.

- Location of the overload relief valve



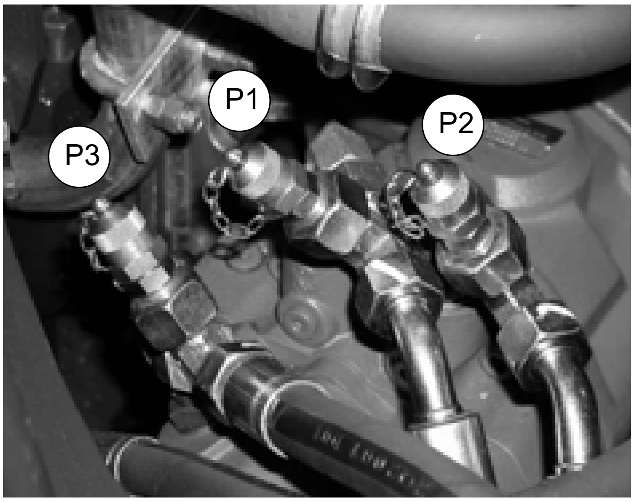
- Adjustment of the overload relief valve



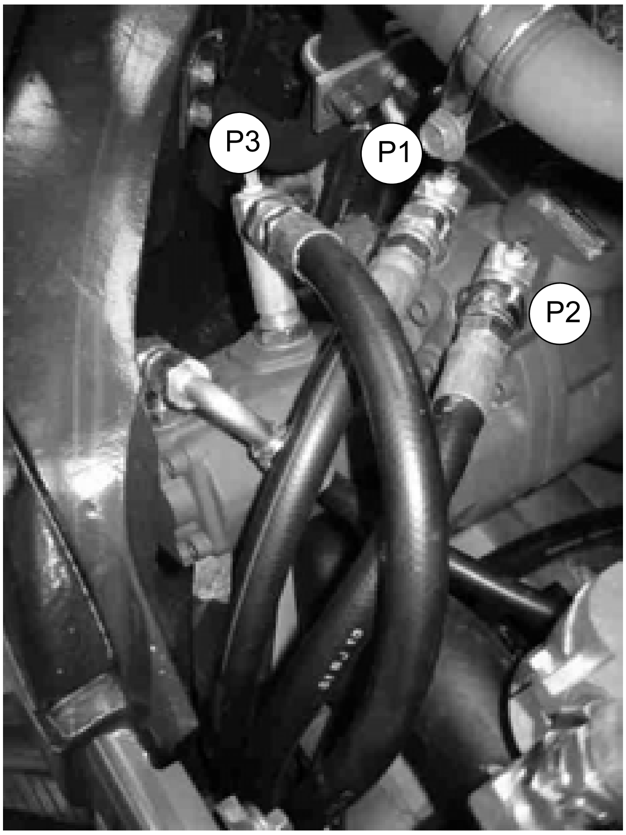
1. Loosen the lock nut of the overload relief valve. Using a hex wrench, turn the adjusting screw to reach the specified setting. Then tighten up the lock nut.
2. Run the engine at the maximum speed. Move the levers and make sure the pressure setting.

f. Swivel brake valve pressure

- Measurement method

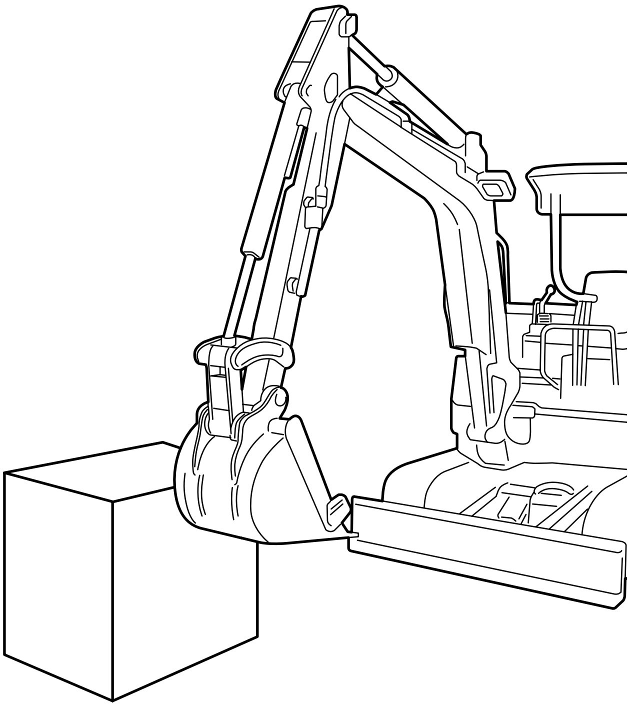


KE, KDG, KUK version



KTC, KCL, KTA version

1. Set the pressure gauge to the coupler at the main pump discharge side. Or remove the plug off the main pump discharge side and set the pressure gauge there.
2. Bring the bucket in contact with a solid block. Slowly move the bucket toward the block. With the engine at the maximum speed, measure the relief pressure.
3. Hydraulic oil tempreture must be 50 ± 5°C, 122 ± 8°F.

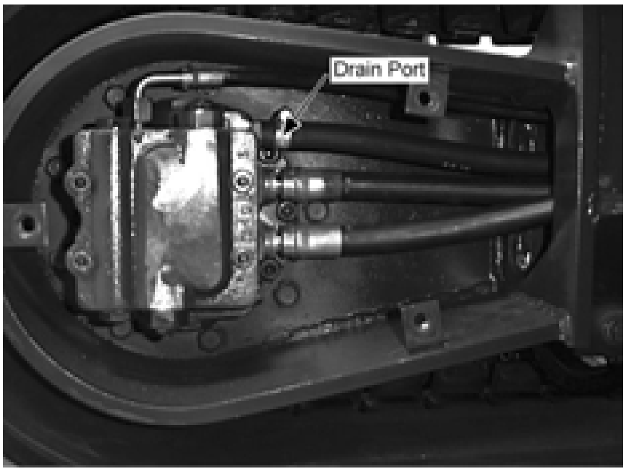


- Adjustment of the brake

KE, KDG, KUK version

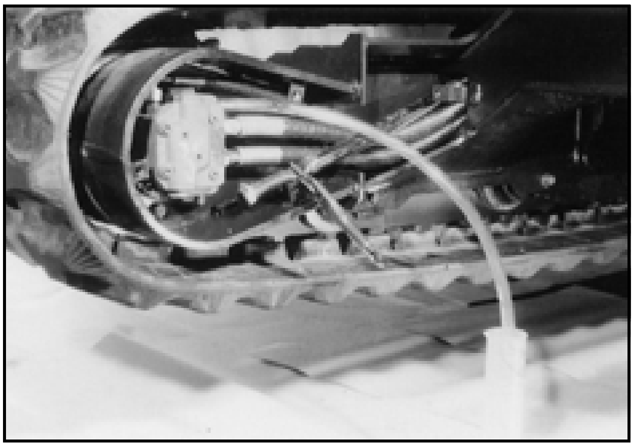
1. Loosen the lock nut of the relief valve.
2. Using a hex wrench, turn the adjusting screw to reach the specified setting. Then tighten up the lock nut.
3. Run the engine at the maximum speed. Move the levers and feel the pressure setting.
4. Hydraulic oil tempreture must be 50 ± 5°C, 122 ± 8°F.

g. Traveling motor drain amount

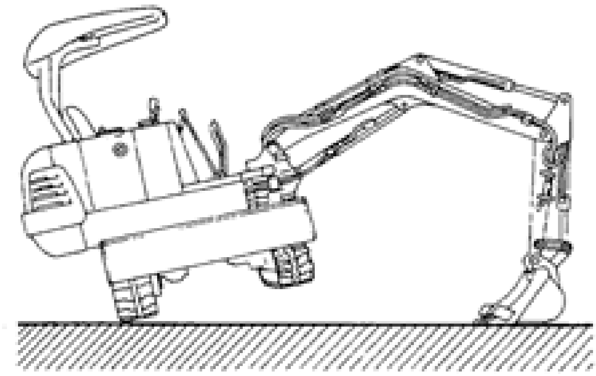


1. Disconnect the drain hose from the travel motor and connect another hose (the pressure gauge hose will do) where the drain hose was disconnected.
2. Float the crawlers as shown as below.
3. Run the engine one minute at max. rpm with the lever in the forward position and measure the amount of hydraulic 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 ± 8°F.

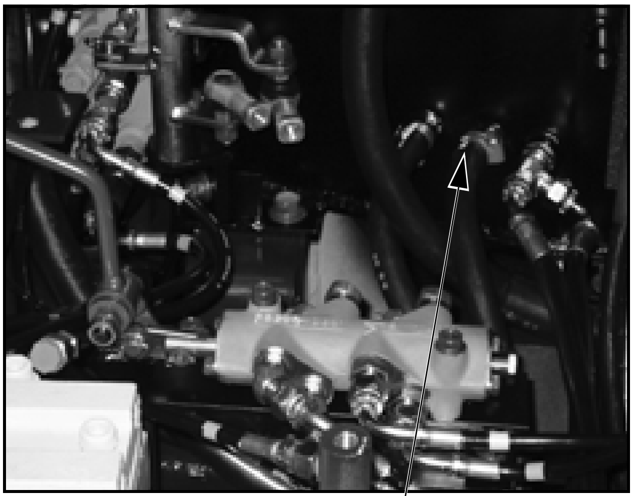
Reference Value	1F	8 cc/min 0.49 in^3/min
	2F	13 cc/min 0.79 in^3/min



⚠ Never place your body under the crawler.



h. Swivel motor drain amount



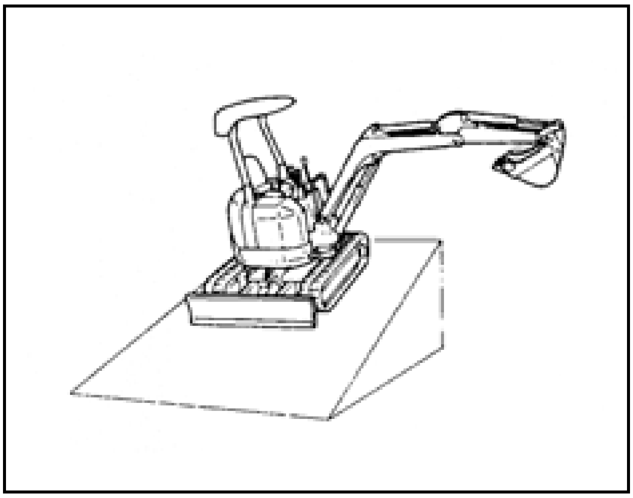
Disconnection portion

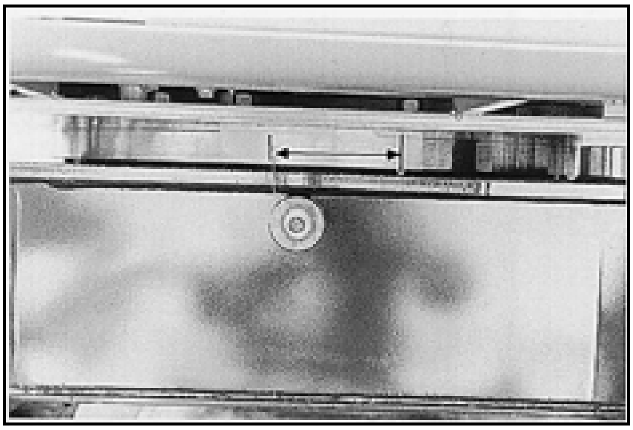
1. Remove right side cover.
2. Locate front attachment to traveling position. Bucket should be located 1 m above from ground.
3. Remove drain hose of the swivel motor and recieve drain oil in a suitable reservoir.
4. Swivel the machine one minute at max. engine rpm and measure amount of hydraulic oil in the reservoir.

⚠ Make sure nobody is around swivel radius area.

Reference Value	KX91-3	35 cc/min 2.14 in^3/min
	KX101-3	63 cc/min

i. Swivel motor block performance



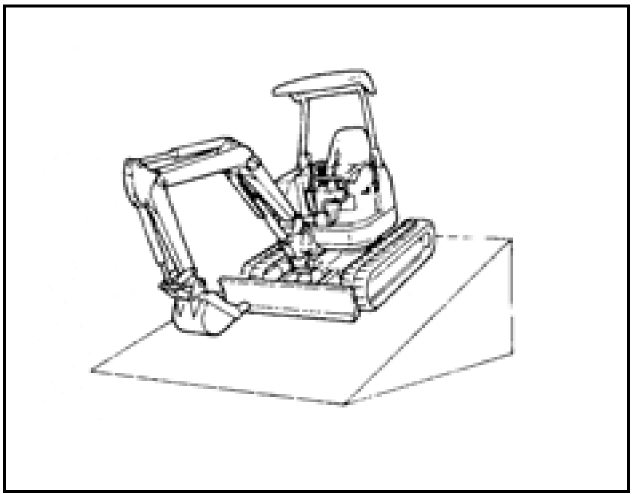


1. Locate the machine on the 20 deg. slope.
2. The front position is of arm dump and bucket crowd. Keep the boom so that the boom end pin is aligned-with the bucket pin.
3. Mark the outer ring of swivel bearing and truck frame.
4. Unlock the safety lock lever, and measure the one minute shifting distance between them with engine idling rpm.
5. Load on the bucket should be as follows.
   KX91-3: 280 kg - include bucket weight
   620 lbs - include bucket weight
   KX101-3:285 kg - include bucket weight

Reference Value	KX91-3	22 mm/min 0.87 in/min
	KX101-3	45 mm/min

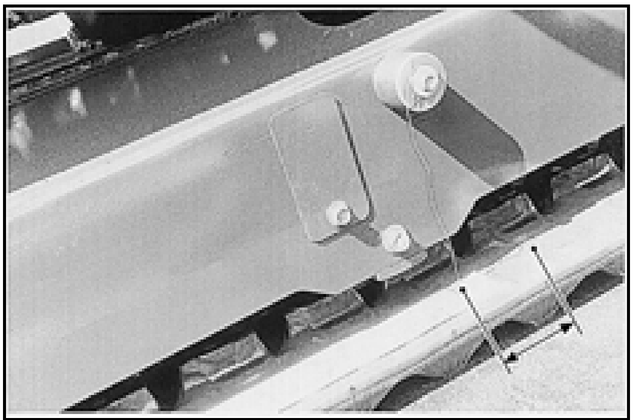
6. Hydraulic oil tempreture must be 50 ± 5°C, 122 ± 8°F.

j. 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 ± 8°F.

Reference Value	300mm/10min 1ft/10min



k. Operating speed

(1) Checking each operating speed.

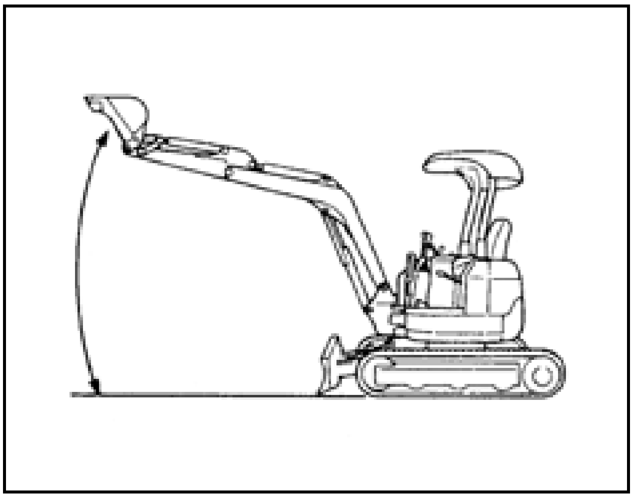
[Important points]

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 ± 8°F.
3. Ground is flat.
4. Measure time after several pre-operation.

(2) Boom cylinder

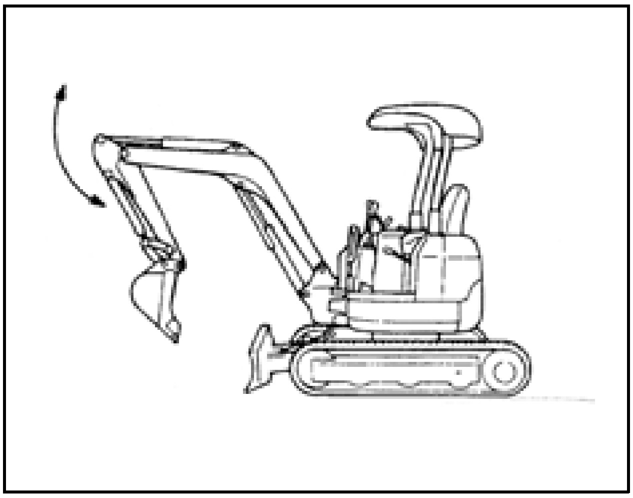


1. Arm and bucket cylinder shouls be most shorted position.
2. Measure the time from the bucket is on the ground to the boom highest position, and from the boom highest position to the ground.

Note:The cushioning time is not included.

			KE, KDG, KUK version	KTC, KCL, KTA version
Reference Value	KX91-3	Up	2.6sec	2.1sec
		Down	2.9sec	2.7sec
	KX101-3	Up	2.6sec	-
		Down	3.0sec	

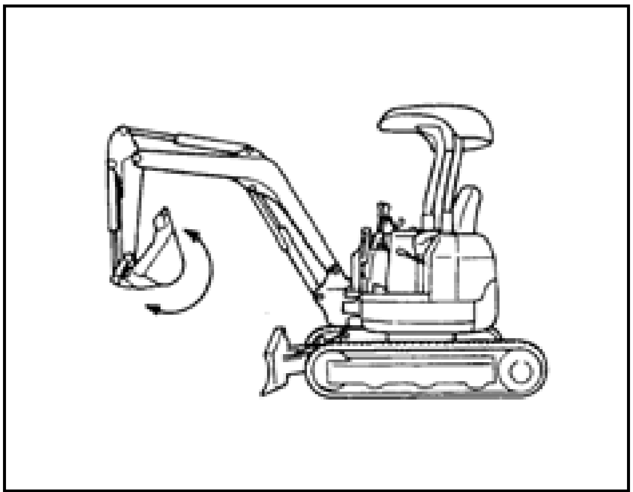
(3) Arm cylinder



1. Position the boom and arm as showm at left.
2. Measure the arm cylinder full stroke operating time.

			KE, KDG, KUK version	KTC, KCL, KTA version
Reference Value	KX91-3	Crowd	3.1sec	2.9sec
		Dump	2.5sec	2.7sec
	KX101-3	Crowd	2.8sec	-
		Dump	2.6sec	

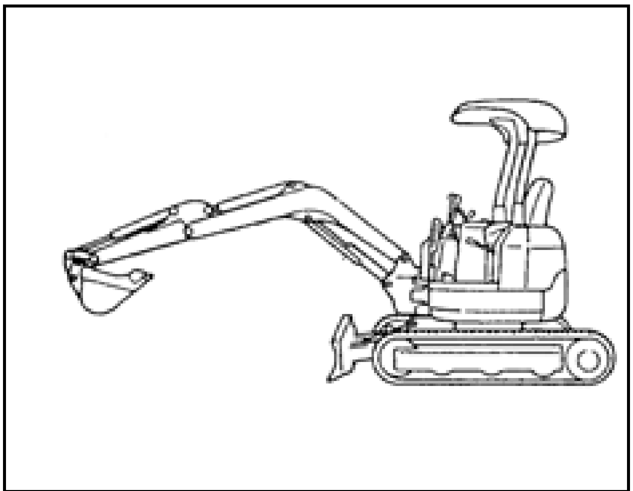
(4) Bucket cylinder



1. Position the boom and arm as showm at left.
2. Measure the bucket cylinder full stroke operating time.

			KE, KDG, KUK version	KTC, KCL, KTA version
Reference Value	KX91-3	Crowd	2.4sec	2.7sec
		Dump	1.5sec	1.9sec
	KX101-3	Crowd	2.4sec	-
		Dump	1.5sec	

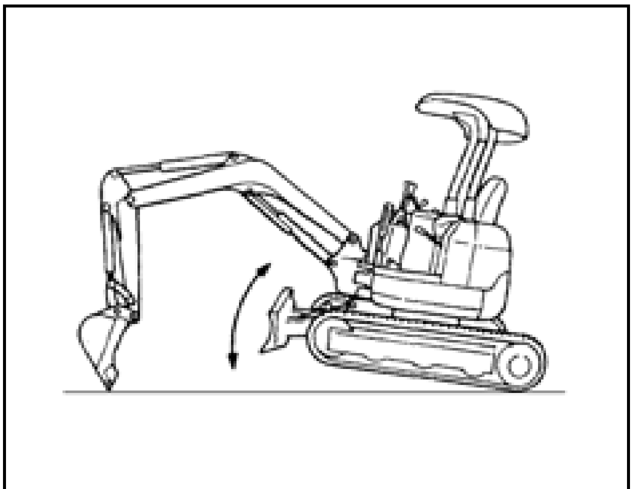
(5) Swing cylinder



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)

			KE, KDG, KUK version	KTC, KCL, KTA version
Reference Value	KX91-3	Left	6.1sec	7.4sec
		Right	4.8sec	5.8sec
	KX101-3	Left	6.1sec	-
		Right	4.8sec	

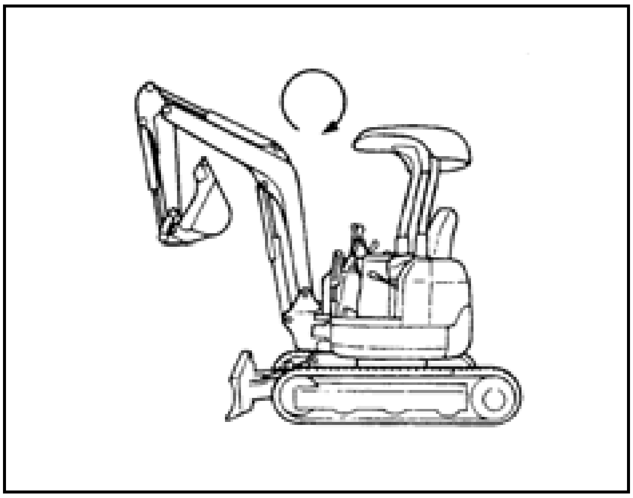
(6) Dozer cylinder



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.

			KE, KDG, KUK version	KTC, KCL, KTA version
Reference Value	KX91-3	Up	2.1sec	2.1sec
		Down	2.8sec	2.8sec
	KX101-3	Up	2.8sec	-
		Down	2.1sec	

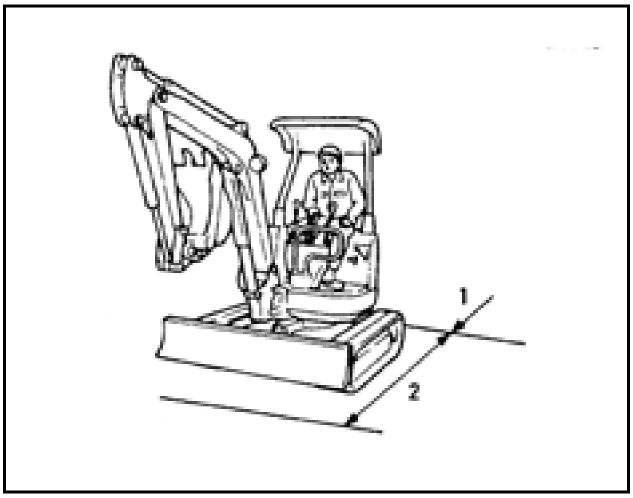
(7) Swivel speed



1. Position the boom, arm and bucket as showm at left.
2. Measure three times rotation time.

		KE, KDG, KUK version	KTC, KCL, KTA version
Reference Value	KX91-3	20.2	19.3
	KX101-3	21.3	-

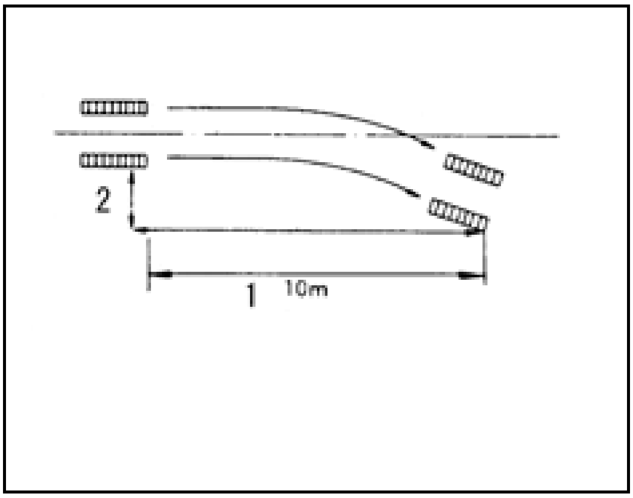
(8) Traveling speed



1. Travel the machine untill getting max. speed.
2. After getting max. speed, measure the 10 mm (33 ft) traveling time.

			KE, KDG, KUK version	KTC, KCL, KTA version
Reference Value	KX91-3	1F	10.9~13.3	10.9~13.3
		2F	7.1~8.8	6.8~8.4
	KX101-3	1F	10.9~13.3	-
		2F	7.1~8.8	

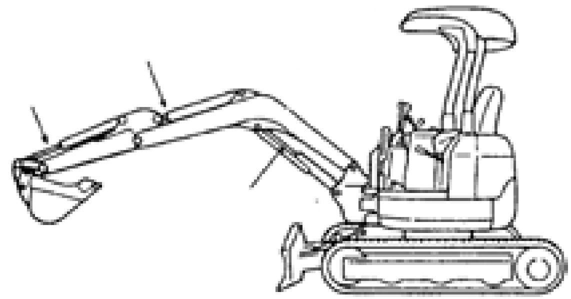
I. Straight travel performance



1. Travel the machine untill getting max. speed.
2. Measure the vertical distance from the traveling line.

Reference Value	Under 600 mm/10 m

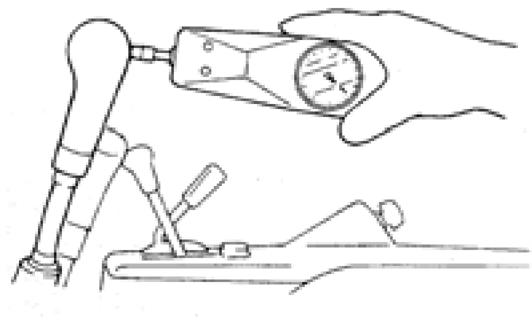
m.Cylinder natural fall amount



1. Locate the machine on the flat ground, and put the load the bucket.
   Load on the bucket should be as follows.
   KX91-3: 280 kg - include bucket weight
   620 lbs - include bucket weight
   KX101-3:285 kg - include bucket weight
2. Arm cylinder must be fully retracted. Bucket cylinder must be fully extended.
3. Locate the bottom of bracket about 1 m above from the ground. Stop the engine.
4. Mark on the rod of each cylinder.
5. Measure the fall distance after 10 min.

Reference Value	See item III.B.c.(2)

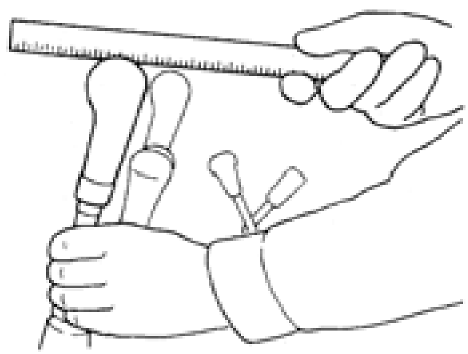
n. Control and Traveling lever operating force



1. Stop the engine.
2. Measure force of right and left control and traveling levers.
3. Start the engine, operate the control lever or traveling lever for a full stroke, and measure the max. operating force.
4. Make three measurements and take their average.
5. Hydraulic oil tempreture must be 50 ± 5°C, 122 ± 9°F.

Reference Value	See item II.c

o. Lever stroke

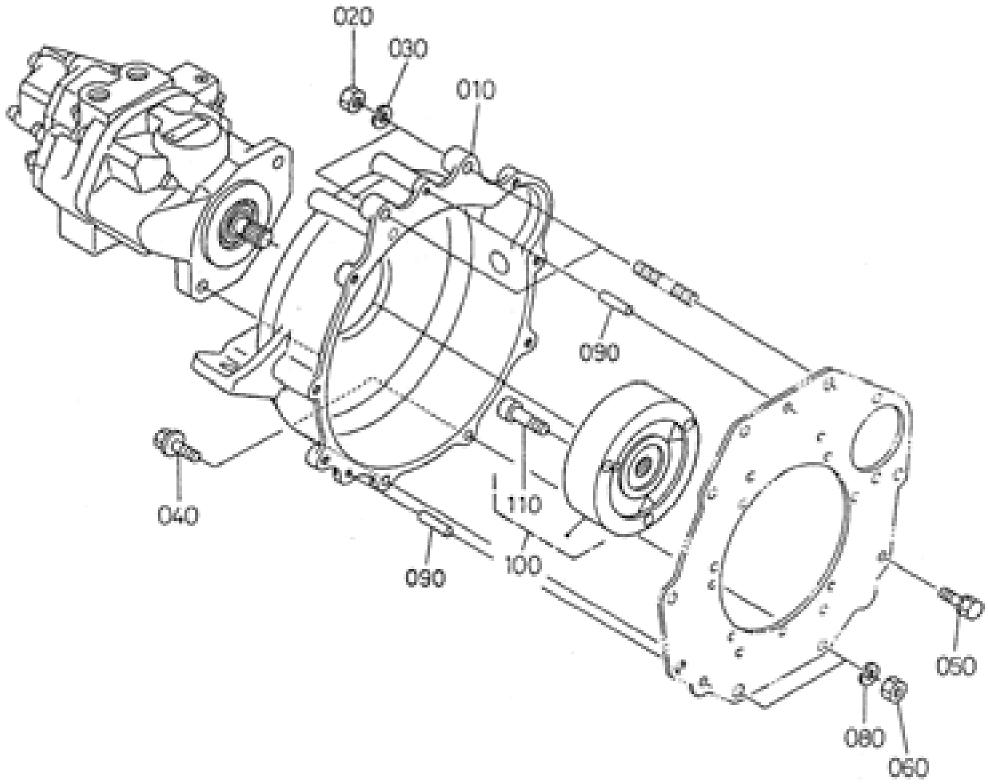


1. Stop the engine.
2. Move each lever from neutral to full stroke end, and measure each stroke with respect to the top center of the each lever glip.
3. If any lever is loose at its neutral position, measure the stroke from each loose end.
4. Make three measurements and take their average.

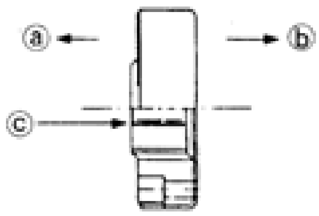
Reference Value	See item II.c

D.Disassembling and Assembling

a. Coupling flange



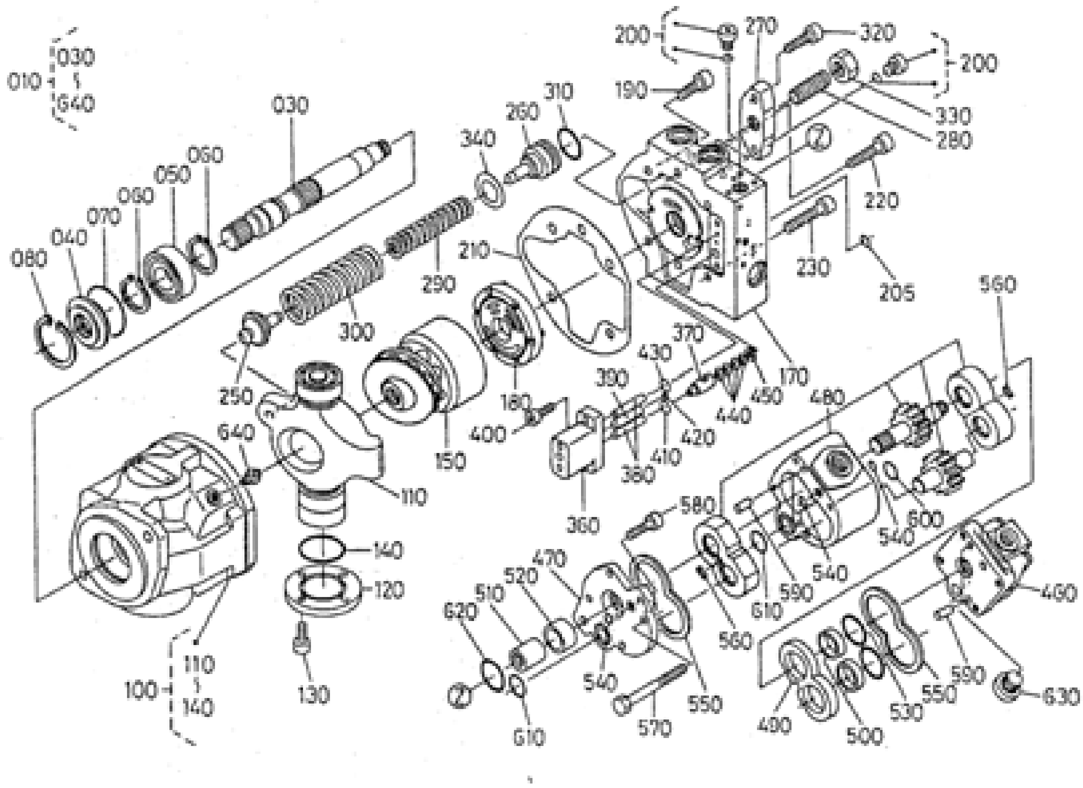
1. Apply a proper amount of grease on the splines.
   • Otherwise the splines may get burnt, making it difficult to remove the pump.
2. Keep the rubber free from grease. Immediately wipe it clean if stained with grease.
   • Otherwise the rubber may get deteriorated by the grease.
3. Fitting the coupling.
   See the figure here.
   (a) Toward the pump.
   (b) Toward the flywheel.
   (c) Splines (apply grease)



4. Tightening torque of the coupling mounting bolt: 107 ~ 117N·m, 10.9 ~ 11.9 kgf·m, 78.9 ~ 86.3 ft·lbf
   • Do not apply any adhesive.
   • Be sure to use a torque wrench to tighten up the bolts. Do not employ an impact wrench, because otherwise the coupling may be damaged.

b. Pump

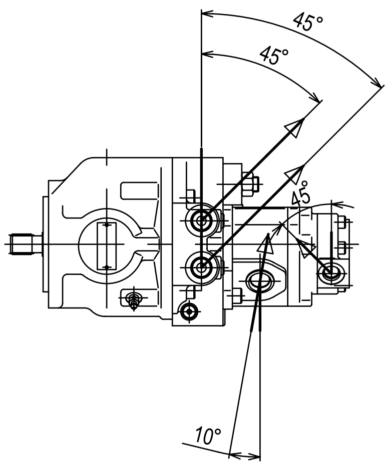
(1) Components of pump [KX91-3, KX101-3]



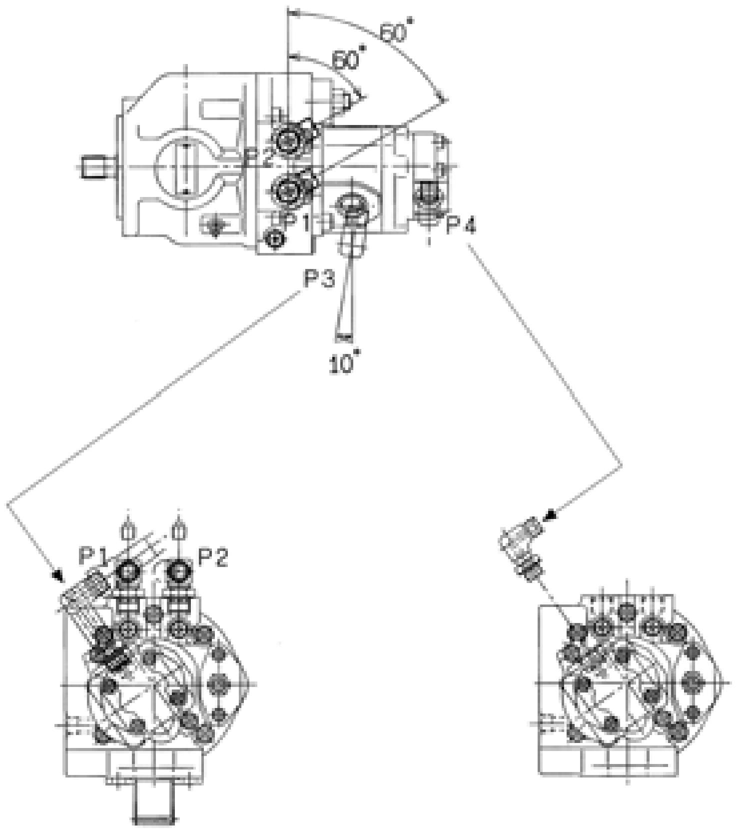
010	Assy pump, Piston	180	Plate, Control	340	Shim	500	Guide
020	Blank	190	Bolt, HEX-SOC-HD	350	Blank	510	Coupling
030	Shaft	200	Plug	360	Cylinder	520	Bush
040	Case, Seal	205	O-ring	370	Piston	530	O-ring
050	Bearing	210	Gasket	380	Pin, Straight	540	O-ring
060	Circrip, External	220	Bolt, HEX-SOC-HD	390	Pin, Straight	550	Square ring
070	O-ring	230	Bolt, HEX-SOC-HD	400	Bolt, HEX-SOC-HD	560	Square ring
080	Circrip, Internal	240	Blank	410	O-ring	570	Bolt
090	Blank	250	Seat, Spring	420	O-ring	580	Bolt, HEX-SOC-HD
100	Assy housing	260	Seat, Spring	430	O-ring	590	Pin, Straight
110	Hanger	270	Cover	440	Spring, Plate	600	O-ring
120	Cover	280	Screw, Adjust	450	Seat, Spring	610	O-ring
130	Bolt, HEX-SOC-HD	290	Spring	460	Assy pump, Gear	620	O-ring
140	O-ring	300	Spring	470	Frame	630	Assy plug
150	Assy Rotary	310	O-ring	480	Housing	640	Valve
160	Blank	320	Bolt, HEX-SOC-HD	490	Plate		
170	Cover	330	Nut				

(2) Adaptor installation on the pump

1. KE, KDG, KUK version



2. KTC, KCL, KTA version



	P1	P2	P3	P4
Tightening torque of adaptor	58.5 ~ 63.7 N·m 6.0 ~ 6.5 kgf·m 43.1 ~ 47.0 ft·lbf	←	←	49.0 ~ 53.9 N·m 5.0 ~ 5.5 kgf·m 36.1 ~ 39.8 ft·lbf

(3) Disassembling and assembling

1) Tool and jig

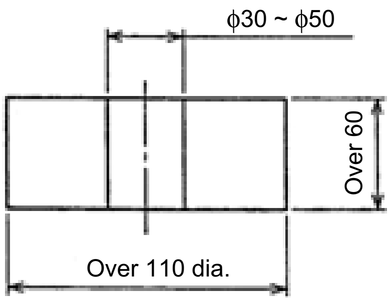
The following tools and jigs are required in disassembling and reassembling the pump.

1-1 Tools

Name	Q'ty	Size (nominal)
Hex wrench	1 each	
Hex wrench	1	6  L=35
Monkey wrench	1	14, 17, 24
Plastic hammer	1	Medium size
Snap ring pliers	1	For holes (for snap ring 62.25)
Snap ring pliers	1	For shafts (for snap ring 25)
Bladed screwdriver	2	Medium size
Torque wrench	-	For specified tightening torques
Grease	Small amount	

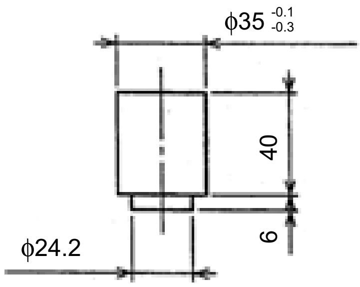
1-2 Jigs

1) Disassembling/reassembling mount

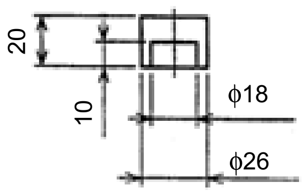


This circular mount is used to stand the pump upside down. Square blocks may also be used if the shaft end can be kept out of contact.

2) Oil seal fitting jig



3) Bearing fitting jig



2) Notice for disassembling and assembling

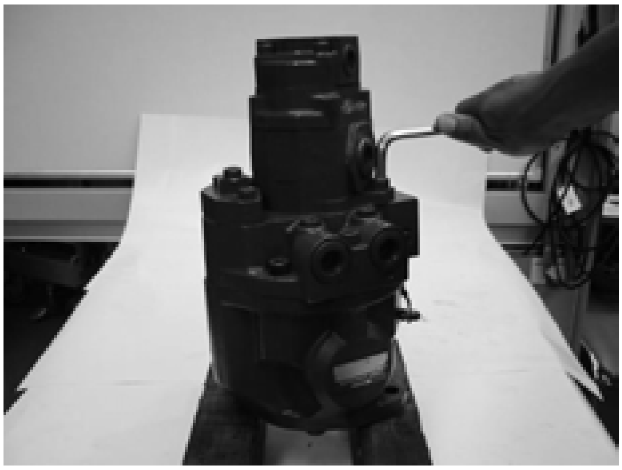
1. Precautions in disassembling
   (1) Unless otherwise specified, never handle the adjusting screws. The horsepower setting may vary, adversely affecting the machine.
   (2) Be very careful not to hit or drop the parts.

2. Precautions in reassembling
   (1) Before reassembling, clean up the parts.
   (2) Be very careful not to scratch the parts and not to allow foreign matters inside.
   (3) Basically do not reuse the O-rings and oil seals.
   (4) At Kubota, the tightening torques are controlled using torque wrenches. Employ a suitable torque wrench.

3) Disassembling

Detaching the gear pump (No. 3 pump and pilot pump)

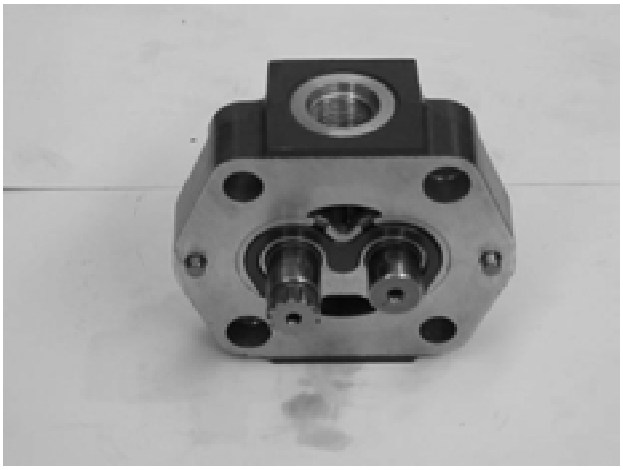
1. Remove the two M10 × 1.25 hex socket bolts, using a hex wrench (across flats: 8 mm).



2. Remove the spacer.

3. Take out the pilot pump.

4. The assembly with the pilot pump taken out is shown at right.

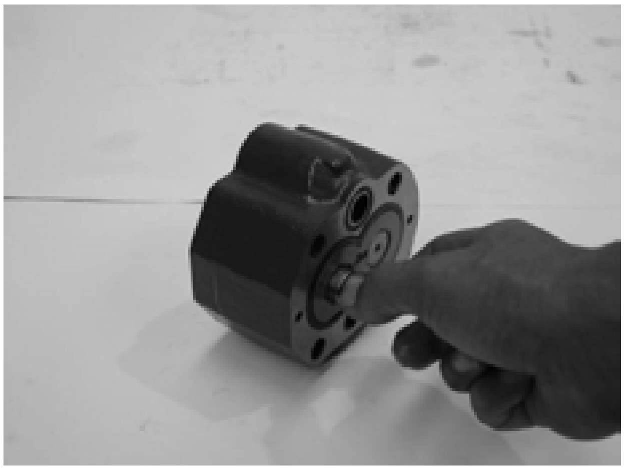


5. Detach the square link and plate.

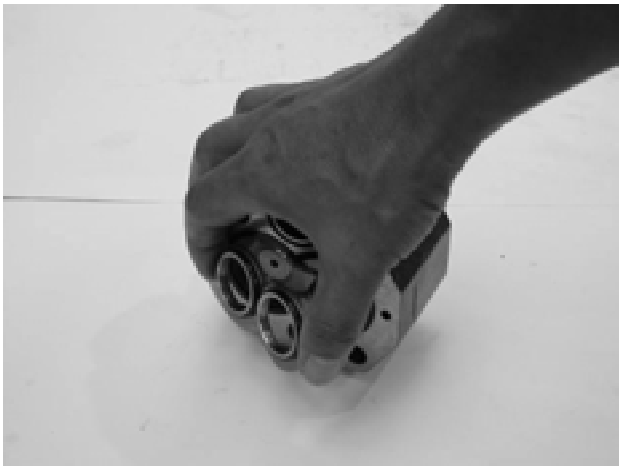
6. Disassembling the No. 3 pump
   Disconnect the coupling.

7. Remove the hex bolts.

8. Disconnect the coupling.



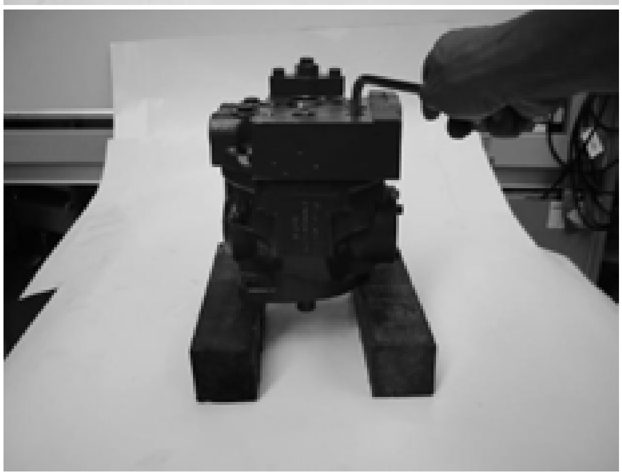
9. Take out the plate.



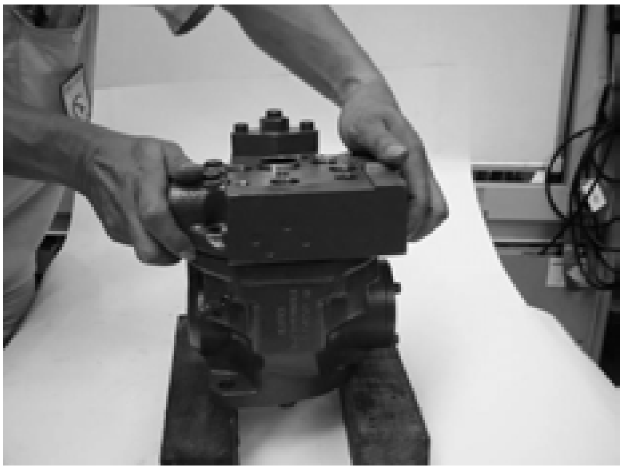
10. Remove the drive gear and idle gear.

Disassembling the main pump

11. Remove the cover.



12. Place the cover at a level to take it out.
    Note that the cover is provided at the back with the control plate. If the cover is difficult to detach, tap on it with a plastic hammer.



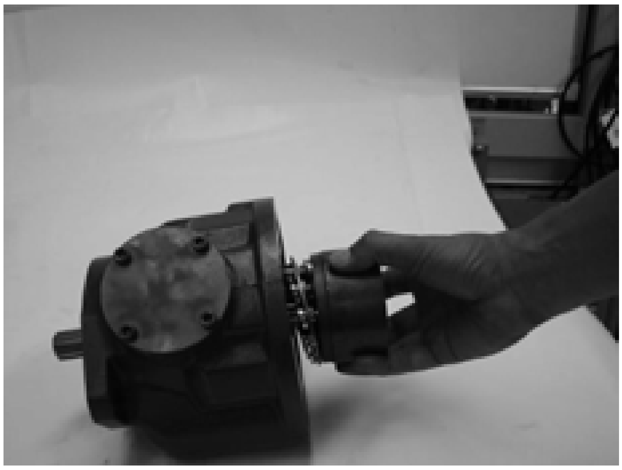
13. Remove the packing.

14. The assembly with the cover removed is shown at right.

15. Removing the control springs
    Remove the two springs (inner and outer).

16. Remove the spring seats.

17. Detaching the rotary group
    Place the pump sideways and take the rotary group from the shaft.



18. Take out the plate.

19. Pulling out the shaft
    Remove the circlip.

20. Take out the oil seal casing.

21. Remove the O-ring.

22. Tap on the rear end of the shaft with a plastic hammer and take out the shaft.

23. Remove the shaft bearing.

24. Removing the hanger
Remove the hex socket bolts and take out the plate.

25. Remove the O-ring.

26. Remove the distance piece.

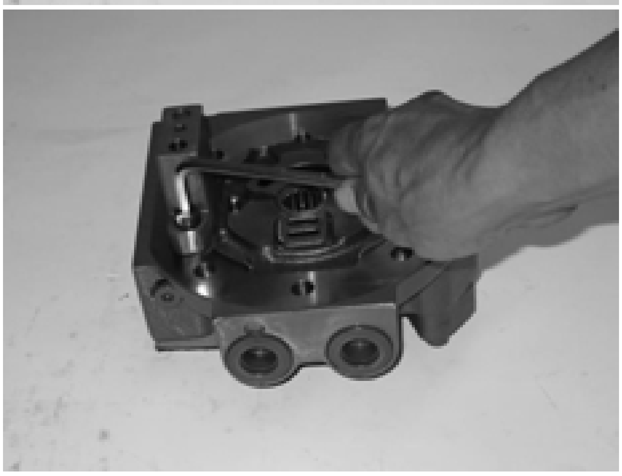
27. Take out the outer race of the bearing.

28. Take out the inner race of the bearing.

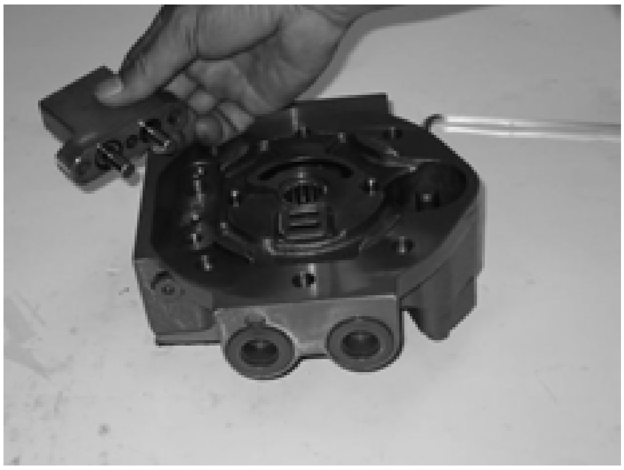
29. Remove the hanger.

30. Disassembling the cover
    Take out the control plate.

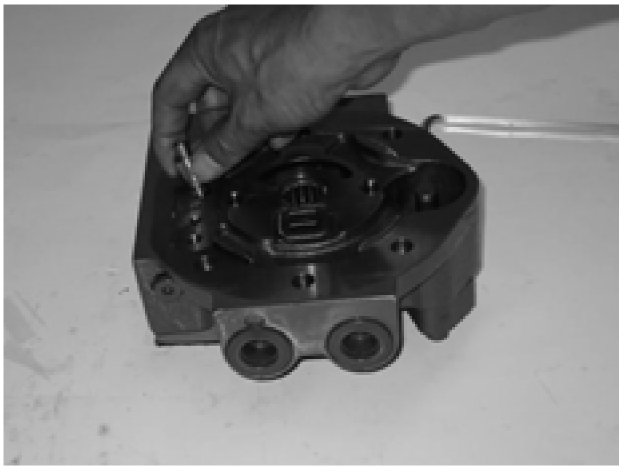
31. Taking out the control piston
    Remove the hex socket bolts.



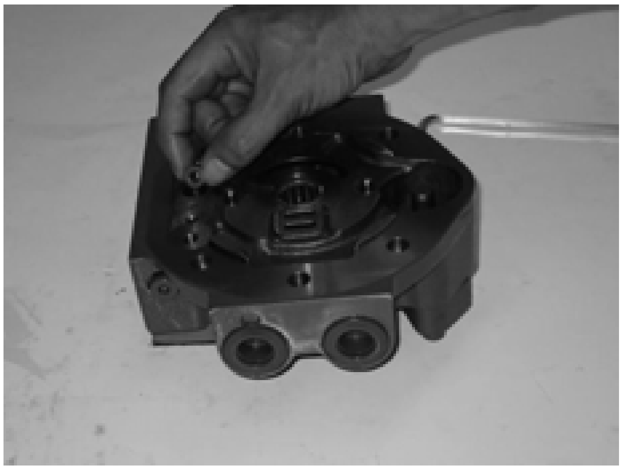
32. Take out the cylinder and parallel pin.
    Note that there are three O-rings at the cylinder.



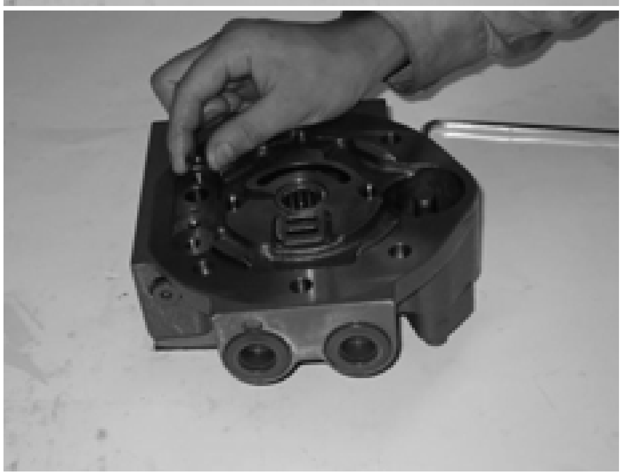
33. Take out the piston.



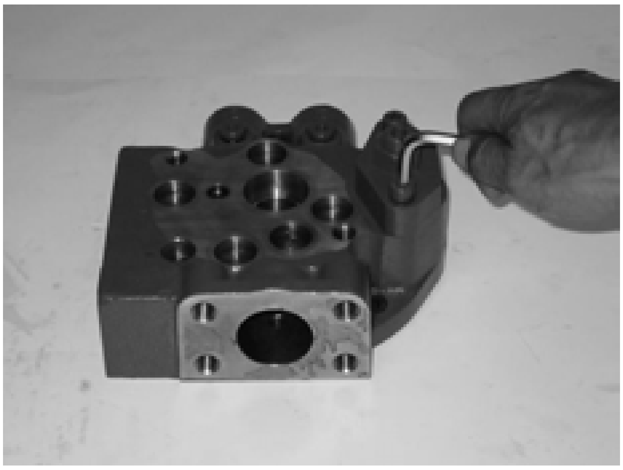
34. Remove the Bellville spring.



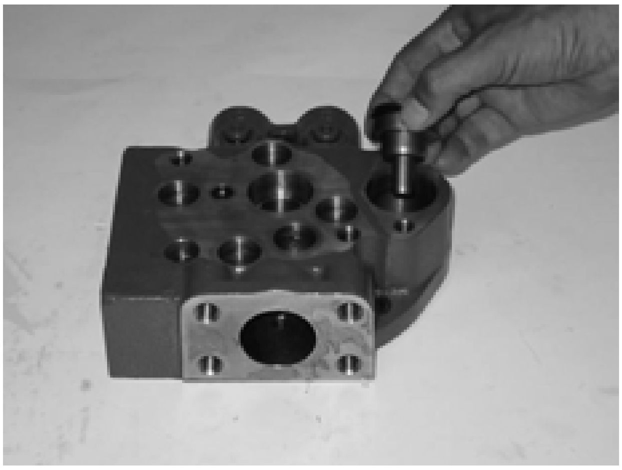
35. Remove the spring seat.



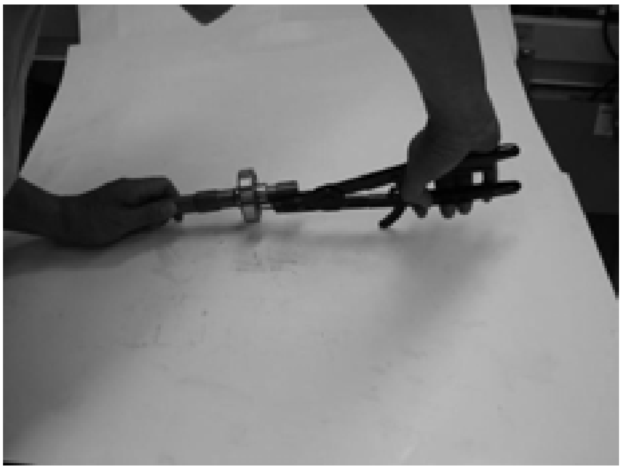
36. Taking out the control piston
    Remove the hex socket bolts and take out the cover.



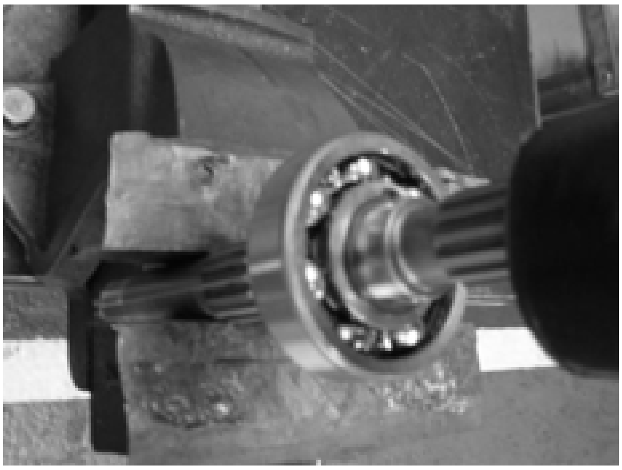
37. Remove the spring seat.



38. Disassembling the shaft and removing the bearing
    Remove the circlip.



39. Tap on the shaft end with a plastic hammer and take out the shaft.



4) Assembling

Hanger portion

1. Fit the hanger into the housing.

2. Fit the inner ring of the bearing into position.

3. Fit the outer ring of the bearing into position.

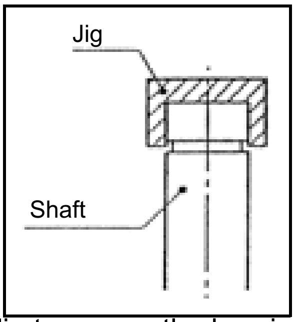
4. Place the distance piece into position.

5. Apply grease on the O-ring and put is in place.

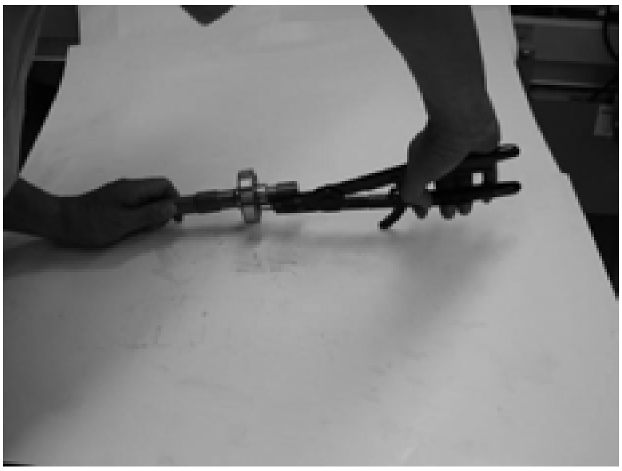
6. Using the 4 hex socket bolts (M16x16), fix the plate.

Hex wrench (across flats: 5)
Tightening torque: 12 ~ 15N·m
1.2 ~ 1.5 kgf·m
8.85 ~ 11.1 ft·lbf

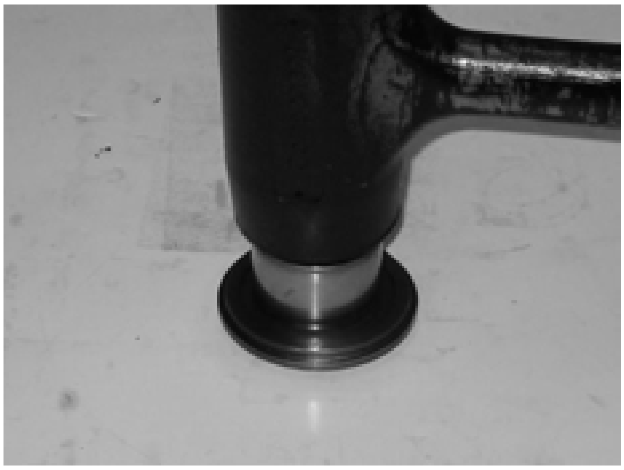
7. Reassembling the shaft
   Using the specified jig, press-fit the bearing onto the shaft. If a press is not available, use the specified jig and the plastic hammer to tap on the bearing into position.



8. Install the circlip to secure the bearing.



9. Using the specified jig and the plastic hammer, tap on the oil seal into the oil seal case. Apply loctite 572 on the inner surface of the oil seal case in advance.



10. Fitting the shaft
    Fit the shaft into the housing.
    Using the plastic hammer, tap on the spline end to fit the outer ring of the bearing into the hole of housing.

11. Apply grease to the O-ring and fit it into position.

12. Place the case with the oil seal upright into position.

13. Install the circlip to secure the shaft.

14. Reassembling the rotary group
    Install the 10 pistons into the retainer.

15. Apply grease to the 3 parallel pins and fit them in the cylinder block.

16. Apply grease to the round part of the guide.

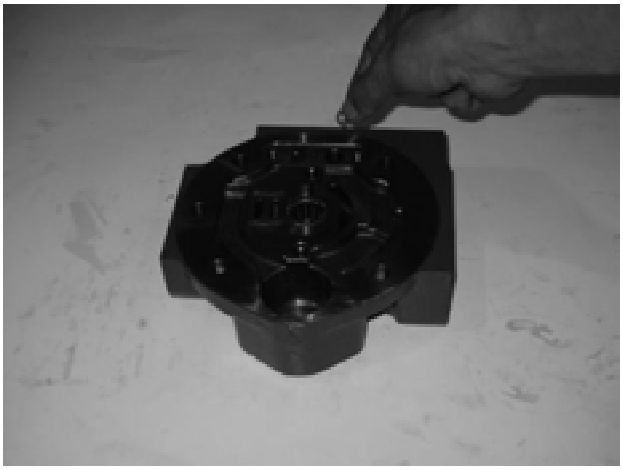
17. Place the guide between the retainer and the cylinder block, and put the piston in the cylinder block hole.

18. Fitting the rotary group
    For anti-fall measure, apply grease over the back of the plate and fit it onto the hanger.
    Apply grease over the sliding surface of the piston shoe as well as the sliding surface between the cylinder block and control plate.

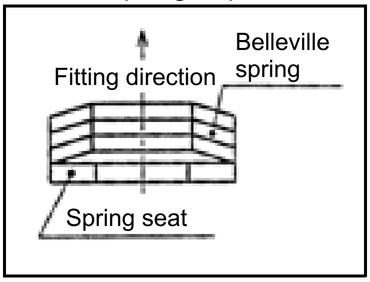
19. Fitting the control piston
    Apply grease to the round part of the spring seat, and fit the piston into position.

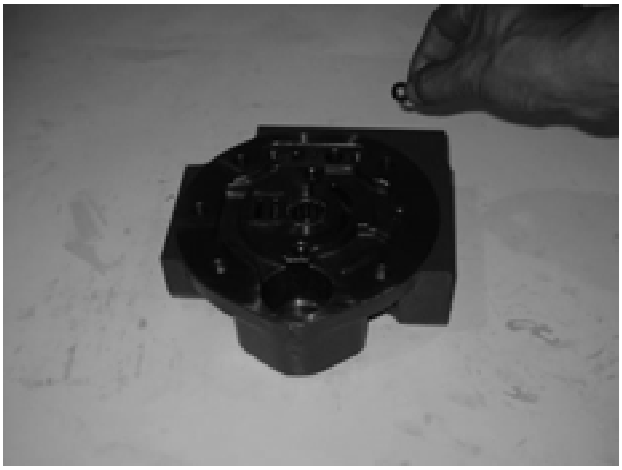
20. Fit the 2 springs (inner and outer) into place.

21. Reassembling the cover
    Fit the control piston and spring seat.

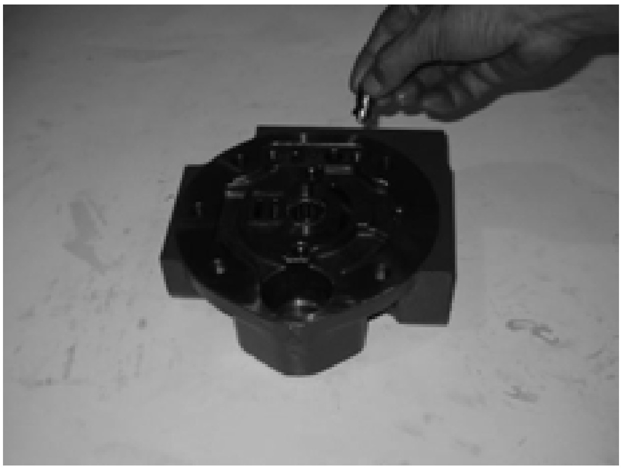


22. Install the belleville spring in place.



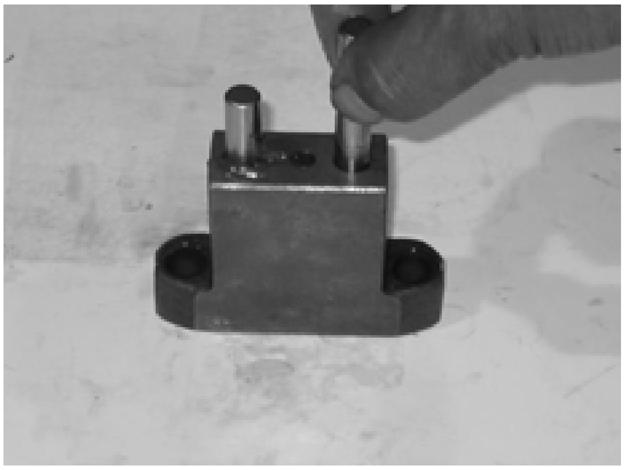


23. Fit the piston into position.



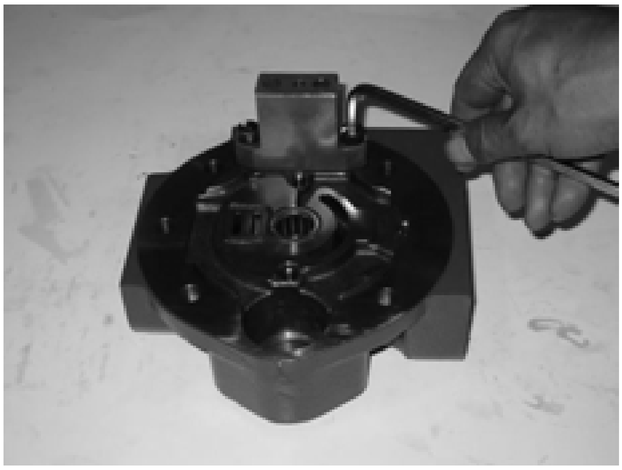
24. Apply grease to the O-ring, and fit it to the cylinder.

25. Apply grease to the 2 parallel pins and fit them to the cylinder.



26. With the 2 hex socket bolts (M8 x25), fix the cylinder. Apply loctite 270.

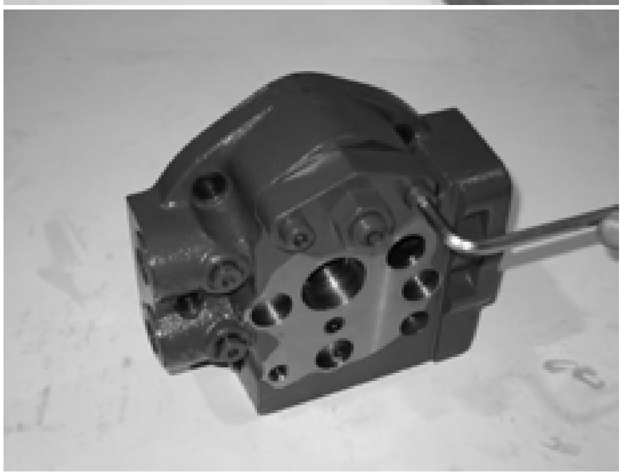
Hex wrench (across flats: 6)
Tightening torque: 28 ~ 35N·m
2.9 ~ 3.5 kgf·m
20.7 ~ 25.8 ft·lbf



27. Fitting the control spring
Fit the spring seat into position.

28. With the 2 hex socket bolts (M8 x 30), fix the cover.

Hex wrench (across flats: 6)
Tightening torque: 28 ~ 35N·m
2.9 ~ 3.5 kgf·m
20.7 ~ 25.8 ft·lbf



29. Fit the washer onto the spring.

30. Apply grease over the back of the control plate. Fit it to the cover in alignment with the knock hole.

31. Place the packing into position.

32. Place the cover in parallel with the housing mounting face.

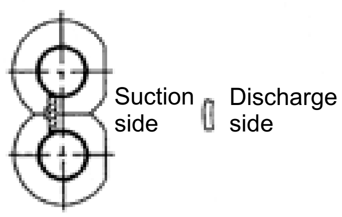
33. Fit the spacer into position.

34. With the 5 hex socket bolts (three M10x30, one M10x50 and one M10 x 55), fix the cover.

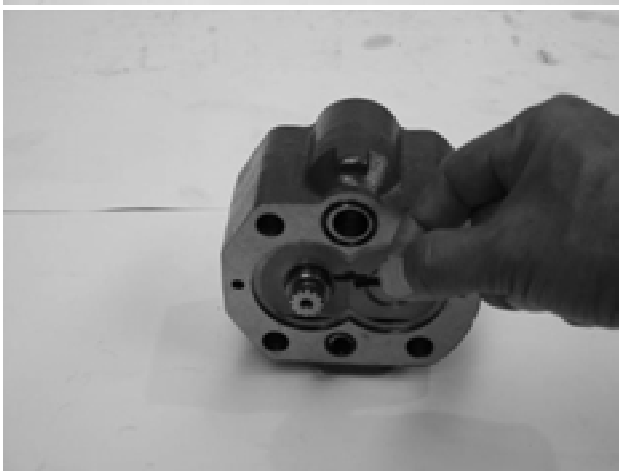
Hex wrench (across flats: 8)
Tightening torque: 55 ~ 69N·m
5.6 ~ 7.0 kgf·m
40.6 ~ 50.9 ft·lbf

35. Reassembling the gear pump
Reassemble the gears and place them in the gear case.

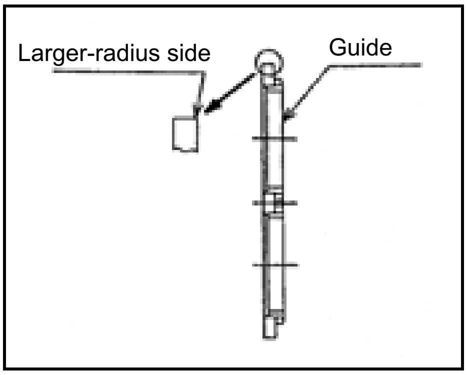
36. Fitting the square ring
In so doing, be careful not to confuse the suction and discharge sides.



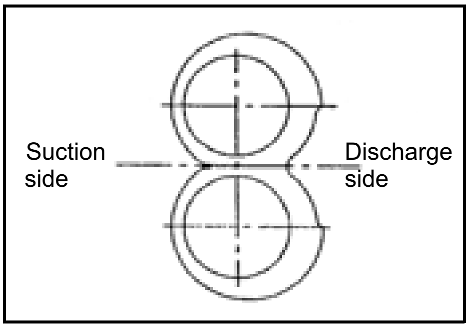
Square ring fitting direction



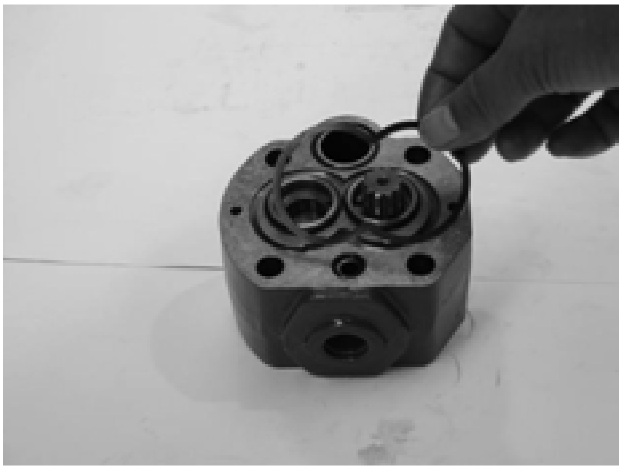
37. Install the O-ring onto the guide, and fit them in the plate.



38. Fit the sub-assembly of the plate, guide and O-ring (in Step 37 above) into position.
Be careful not to confuse the suction and discharge sides.

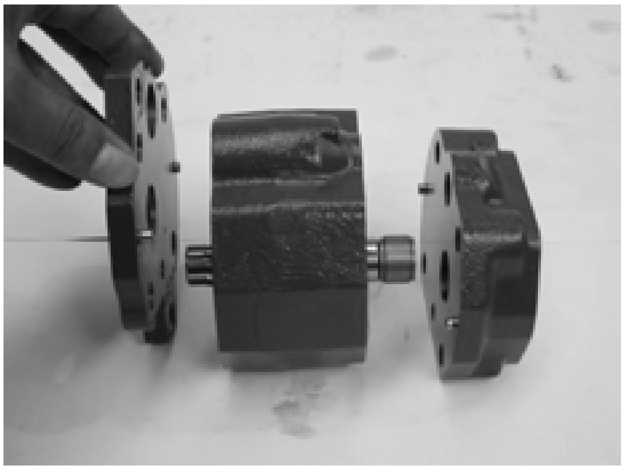


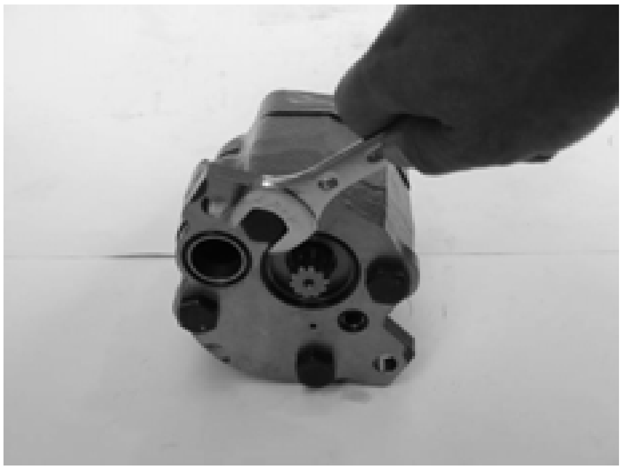
39. Fit the square ring into position.



40. Fit the coupling into position.

41. Fit the gear pump and plate in place.
4 hex socket bolts (M10x80)
Hex wrench (across flats: 17)

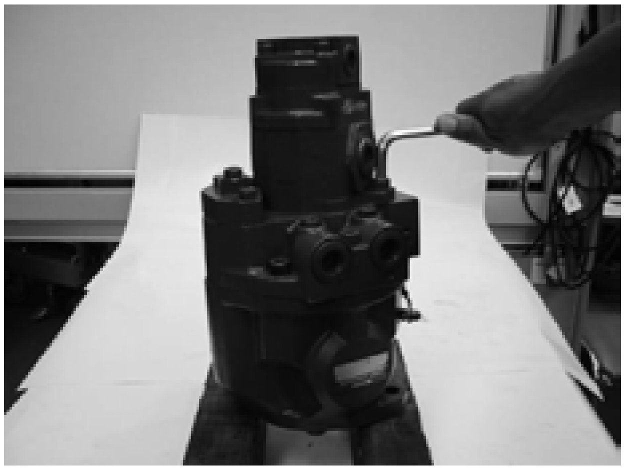




42. Reassembling the gear pump (pilot pump)
Fit the gears, plate and square ring together.
Gray square ring: Outside
Black square ring: Inside

43. Fit the pilot pump to the third pump.

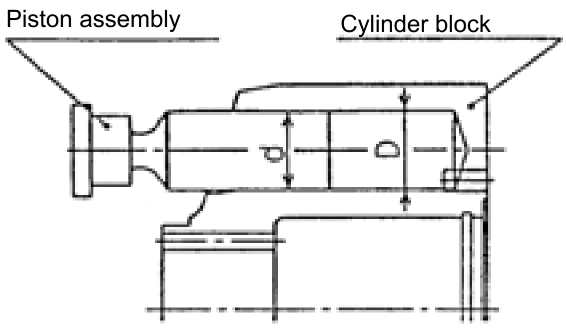
44. Finally fit the main pump, gear pump and pilot pump in their respective positions.



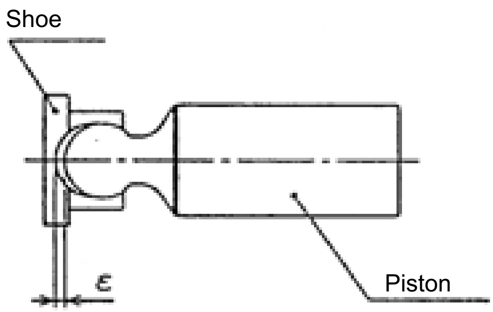
5) Checking points

Clean up and dry up the parts that are to be checked.
Check the major parts in particular very carefully for unusual out-of-limit wear and detrimental scratches. If so, replace them with new ones.
Check also the seals for deformation and other damages. Replace them as required.

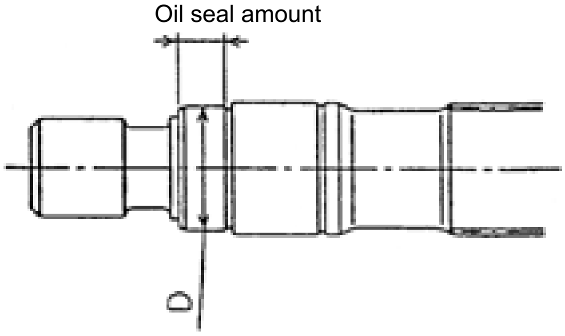
1. Piston assembly and cylinder block
   - Visual appearance check
     Check for scratches, dents, unusual wear, etc. (the sliding parts in particular).
   - Check the gap between the piston's outer diameter and the cylinder block's inner diameter.
     Specification: D - d $\leqq$ 0.050 mm



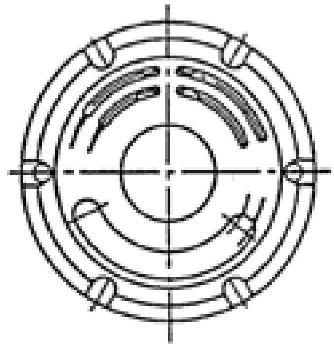
2. Piston shoe and piston
   - Check the piston and piston shoe for their axial idle movement.
     Specification: $\varepsilon \leqq 0.2$ mm



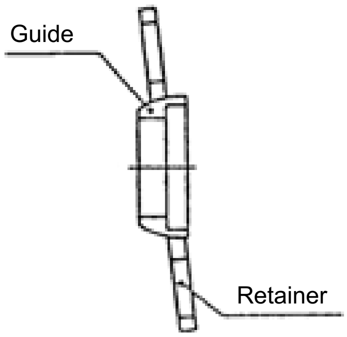
3. Shaft
   - Check the oil seal mount for unusual wear.
     Specification: Wear amount ≦ 0.025 mm



4. Control Plate
   Check the sliding surface for scratches. If deeply dented, replace the part with new one.

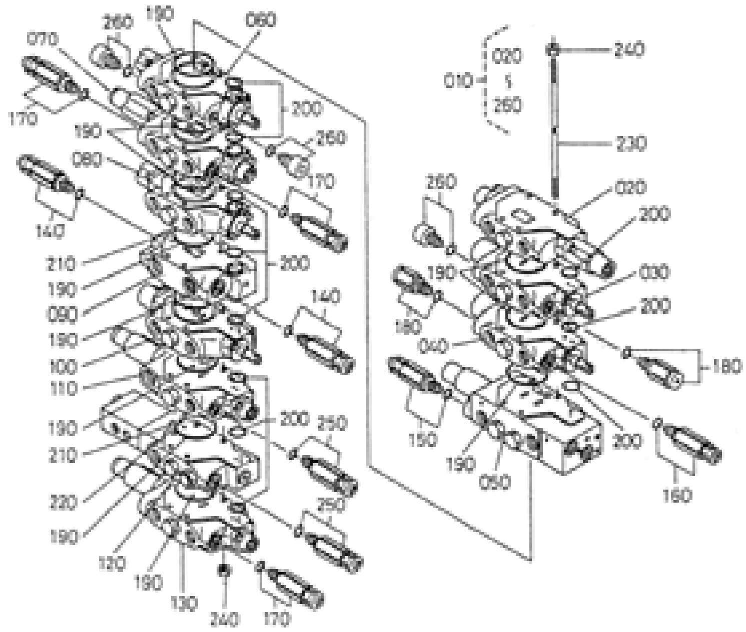


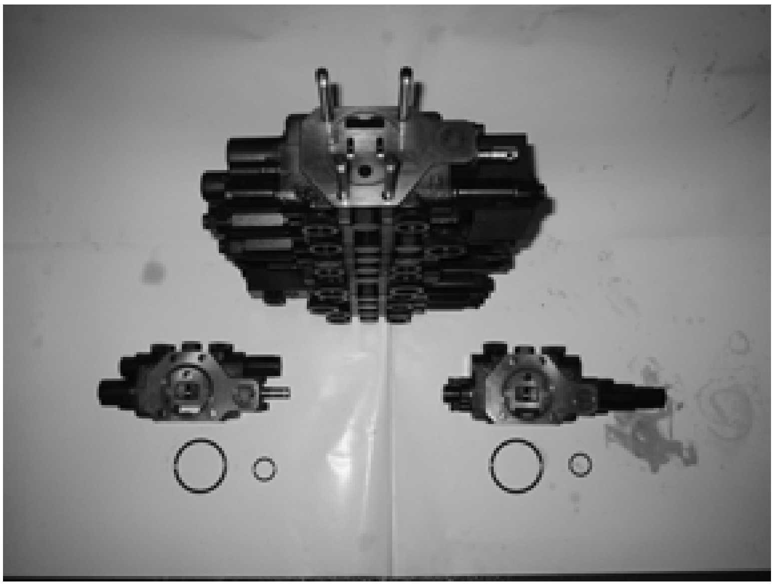
5. Guide and retainer
   - Check these parts for scratches or curved wear. If impossible to repair, replace them with new ones.
   - If found to be finely dented or scratched, lap-fit them. Clean them up enough after lapping.



c. Control valve and relief valve

(1) General precautions for servicing control valve





When dismounting and disassembling;

1. First brush away earth and sand from the control valve assy, before disconnecting the pipe and hoses.
2. Plug all inlets and outlets of hoses, pipes, joints and adaptors.
3. The body, spool, spring, and relief valve are different from section to section in the orifice shape, notch shape, free length, and relief pressure. When removing these parts, therefore, be sure to attach tags and enter identification marks or names in order not to confuse them. Be also careful not to scratch the parts in handling and storage. Otherwise malfunction or trouble may happen after they have been reassembled.

When reassembling and remounting;

1. Put on the sections one by one in the upright position as shown in the photo.
2. Take special care on poppet, spring and O-ring in the proper position and should not pinch them in between the valve section body. Some oil should be applied on O-ring and poppet.
3. Tighten the rod nuts firmly by hand.
4. Then lay down the assembly on a flat surface plate to so if the sections are parallel with each others.

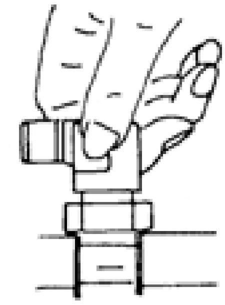
Important: Soft materials, like O-ring should be replaced with new one when reassembling the unit.
Also scratched bolt, nut or poppet should be repaired or renewed.

5. Tighten the rod nuts to the specific torque.
   - Keep a tightening torque rule when tightening the hydraulic pipes nipple and the control valve mounting bolt.
   - Oil adhered to the control valve after installation should be totally wiped out. (It is easy misxed up with oil leakage.)

Control valve tie-rod nuts tightening torque

Model	C/V Assy. No.	M8 nut
KX91-3	RC411-6113-0	16.7 ~ 17.7 N·m 1.7 ~ 1.8 kg·m 12.3 ~ 13.1 ft·lbf
KX101-3	RC511-6113-0	

Above tightening torque is basically on dry condition.



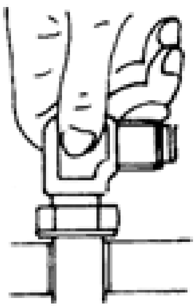
Tightening the washer-equipped elbow

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

Note:Clean up the mating seal beforehand.

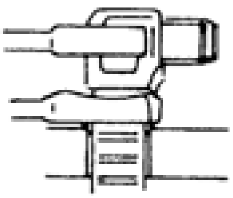
2) Positioning
- Turn the elbow back to its set position.

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

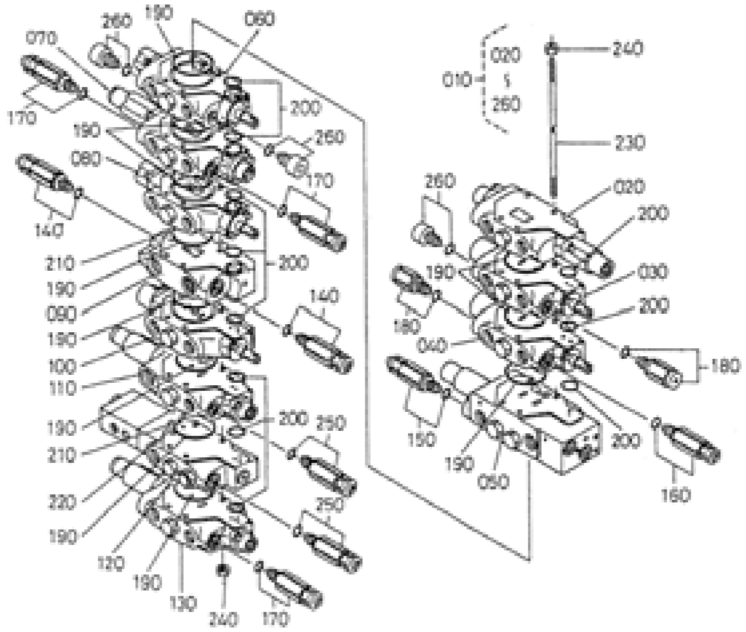


3) Fixing
- Tighten up the lock nut with a wrench.
- Lock nut tightening torque.

1/4:25 ~ 30 N·m	2.5 ~ 3.0 kg·m	18.1 ~ 21.7 ft·lbf
3/8:50 ~ 55 N·m	5.0 ~ 5.5 kg·m	36.2 ~ 39.8 ft·lbf
1/2:60 ~ 65 N·m	6.0 ~ 6.5 kg·m	43.4 ~ 47.0 ft·lbf
3/4:120 ~ 130 N·m	12.0 ~ 13.0 kg·m	86.8 ~ 94.0 ft·lbf



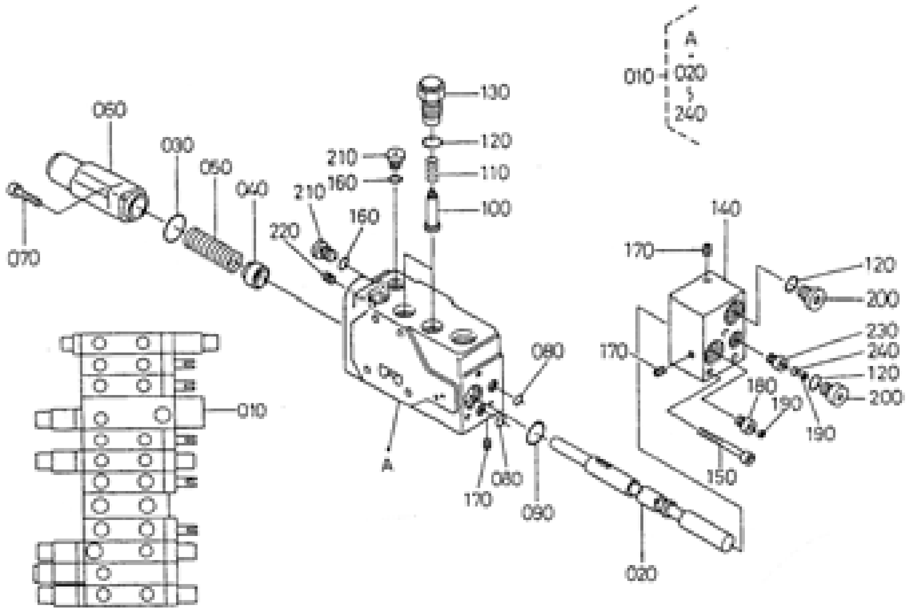
(2) Components of the control valve



010	Control valve assy
020	Swivel Section
030	Swing section
040	Dozer section
050	Travel straight section
060	Auxiliary section
070	Arm section
080	Travel section (LH)
090	Inlet section
100	Travel section (RH)
110	Boom down section
120	Boom up section
130	Bucket section
140	Main relief valve P1, P2
150	Main relief valve P3
160	Overload relief valve (Dozer)
170	Overload relief valve (Arm)
180	Anti-cavitation valve (Dozer)
190	O-ring
200	O-ring
210	O-ring
220	O-ring
230	Tie rod
240	Nut
250	Overload relief valve (Boom)
260	Plug (Swing, Auxiliary)

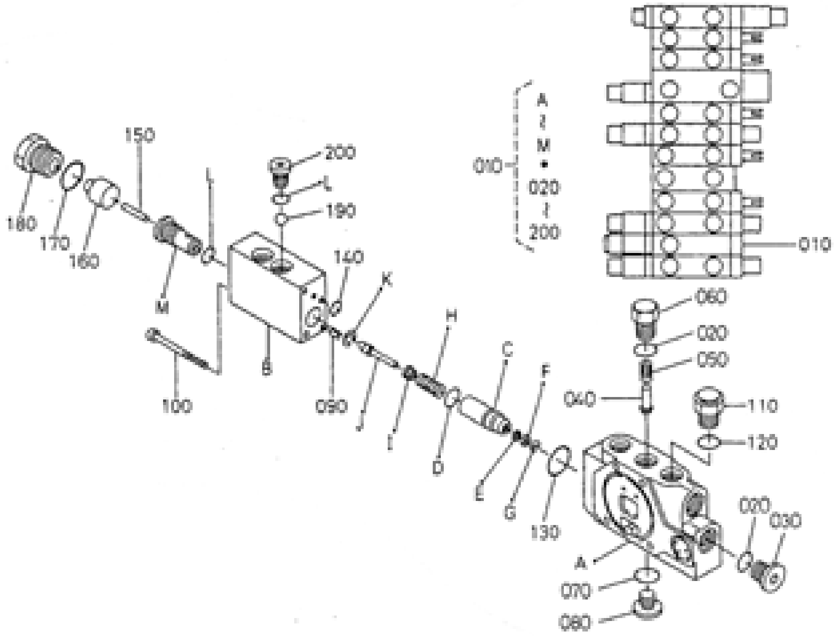
(3) Inner parts of the control valve

1) Travel straight section



010	Assy valve, Travel ST
020	Spool
030	O-ring
040	Stopper
050	Spring
060	Cap
070	Bolt, HEX-SOC-HD
080	O-ring
090	O-ring
100	Spool
110	Spring
120	O-ring
130	Plug
140	Cap
150	Bolt, HEX-SOC-HD
160	O-ring
170	Plug
180	Plug
190	Filter
200	Plug
210	Plug
220	Plug
230	Plug
240	Spacer

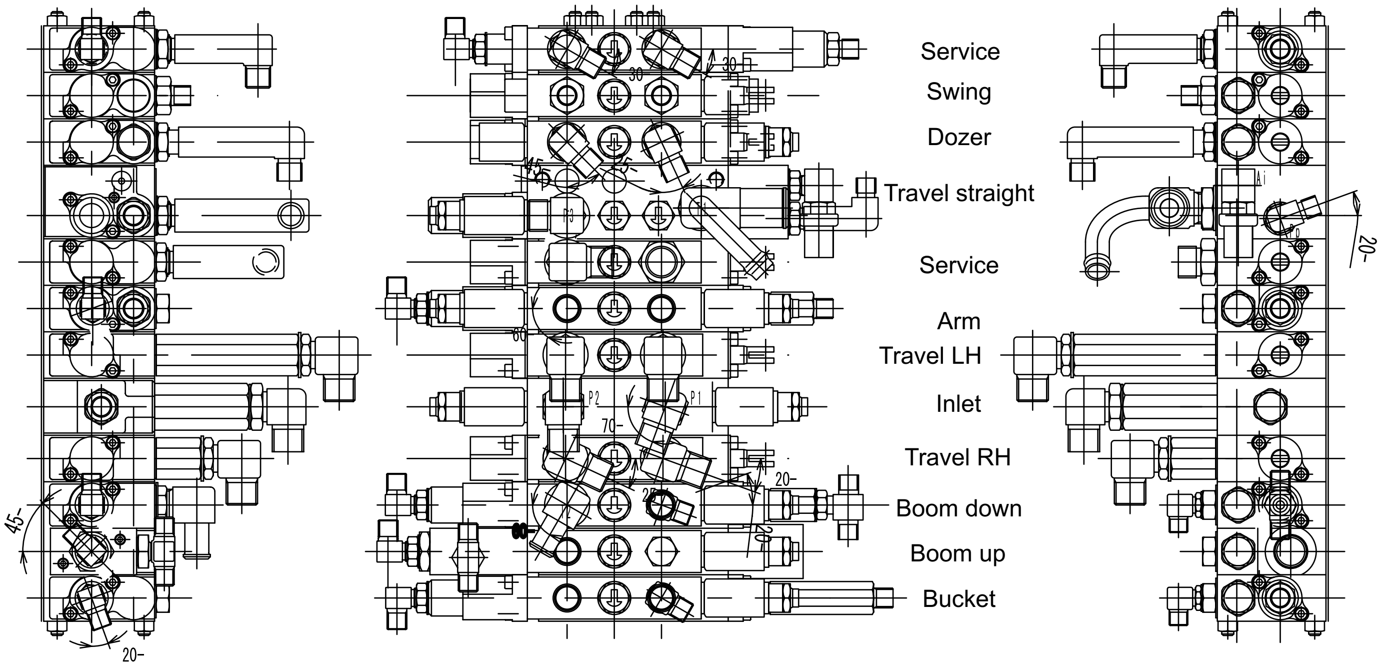
2) Boom lock section



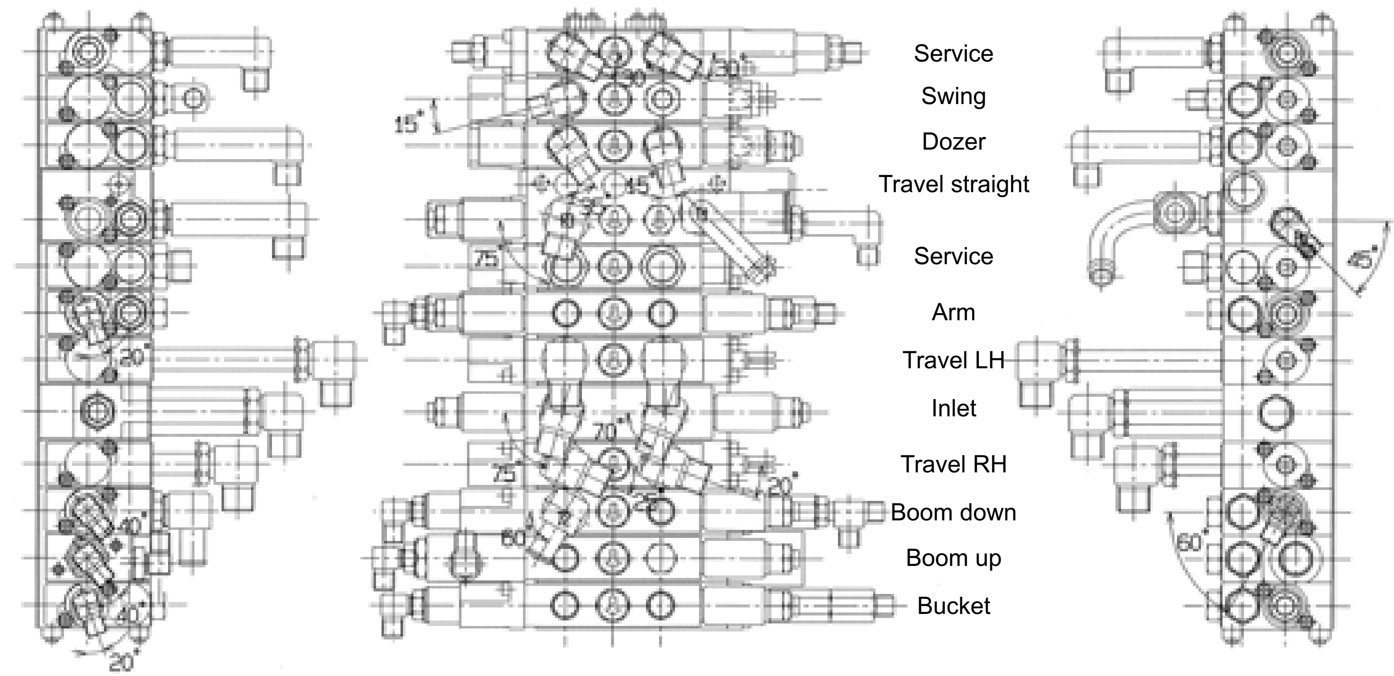
010	Assy valve, Boom lock
020	O-ring
030	Plug
040	Spool
050	Spring
060	Plug
070	O-ring
080	Plug
090	Pin, Straight
100	Bolt, HEX-SOC-HD
110	Plug
120	O-ring
130	O-ring
140	O-ring
150	Piston
160	Piston
170	O-ring
180	Bush
190	Ball
200	Plug

(4) Adaptor installation

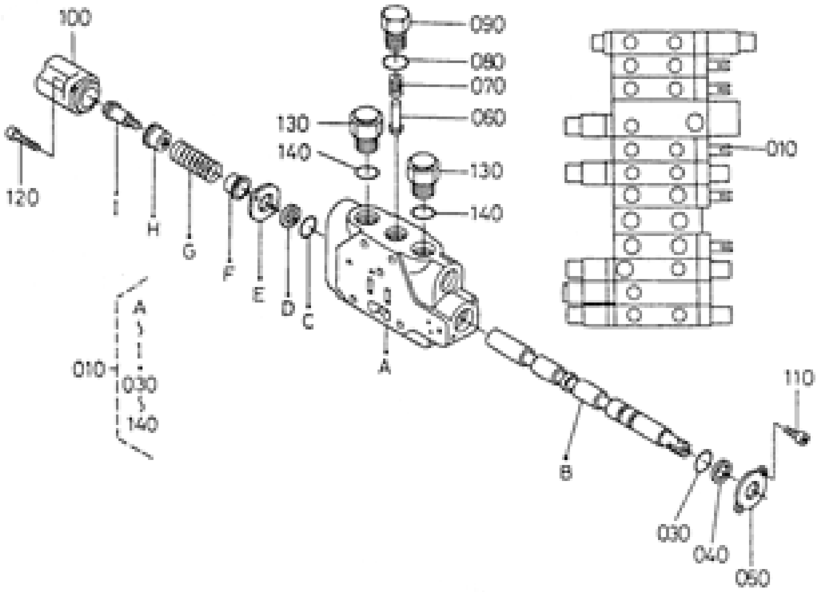
1) KE, KDG, KUK version



2) KTC, KCL, KTA version



(5) Disassembling of the control valve



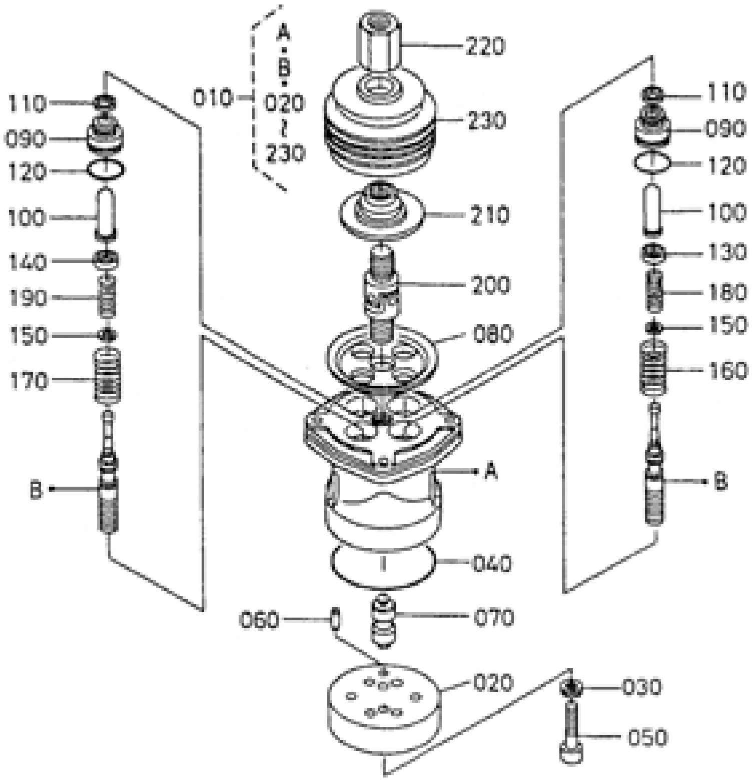
010	Assy valve, S/P
020	Blank
030	O-ring
040	Wiper
050	Plate, Seal
060	Spool
070	Spring
080	Spring
090	Plug
100	Cap
110	Bolt, HEX-SOC-HD
120	Bolt, HEX-SOC-HD
130	Plug
140	O-ring

- Service point
  - Manufacturer: NABCO
  - Type: BCV35-DM10
  - Spool Stroke: 7 mm
  - Tierod tightening torque:
    16.68 ~ 17.66 N·m
    1.7 ~ 1.8 kg·m
    12.3 ~ 13.0 ft·lbf
  - Relief and anti-void valve
    39.2 N·m
    4 kg·m
    2.95 ft·lbf

<Service point>
- When disassembling the valves, be careful of the adhesion of the garbage sufficientry.
- Check the poppet seat for scratches, the spring for deformation, and the sealings for deterioration.
- Check the spool to see if it is free from scratches and if it slides smoothly on the body.
- Check the spool for dust deposits in and around the throttle opening.

d. Pilot valve

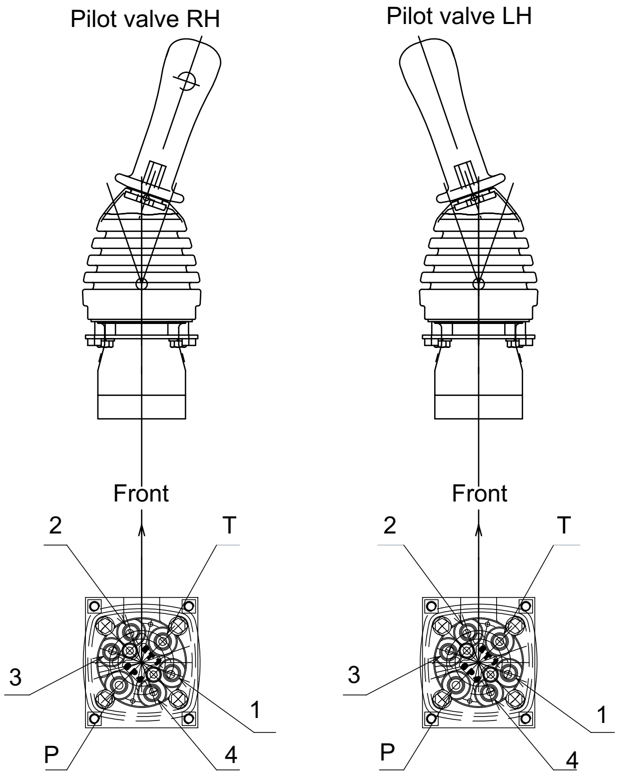
(1) Components of the pilot valve



010	Assy valve, Pilot
020	Plate
030	Washer, Seal
040	O-ring
050	Bolt, HEX-SOC-HD
060	Pin, Spring
070	Bush
080	Plate
090	Plug
100	Push rod
110	Seal
120	O-ring
130	Seat, Spring
140	Seat, Spring
150	Washer
160	Spring
170	Spring
180	Spring
190	Spring
200	Joint
210	Nut
220	Nut, Adjusting
230	Boot

(2) Adaptor and hose installation

1) KE, KDG, KUK version



•Adaptor tightning torque
24.5 ~ 29.4 N·m
2.5 ~ 3.0 kg·m

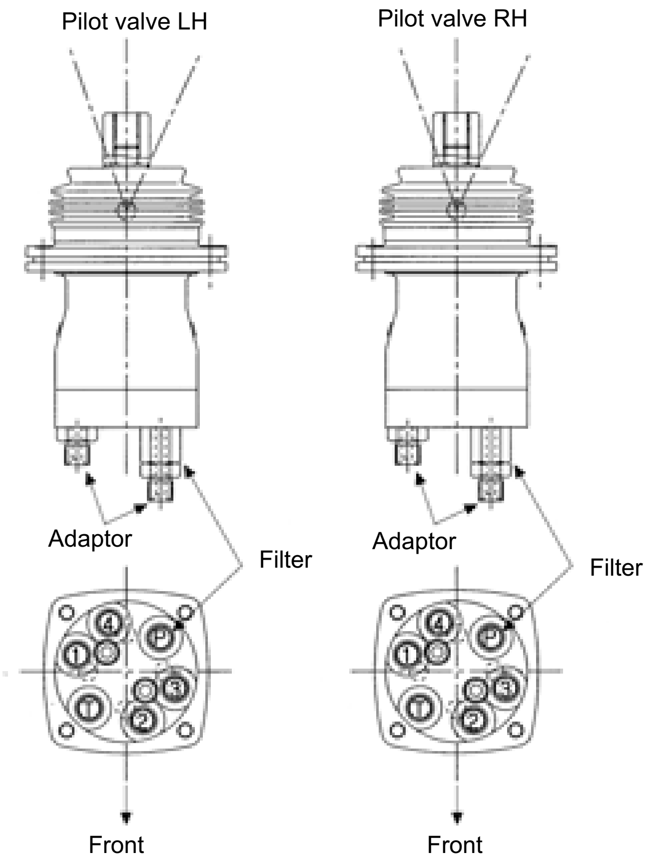
•Hose connection
Pilot valve LH

		Color of hose taping
1	Swivel left	Red
2	Arm dump	Blue
3	Swivel right	Yellow
4	Arm croud	Green
P	P port	White
T	T port	-

Pilot valve RH

		Color of hose taping
1	Bucket crowd	Pink
2	Boom down	Right Blue
3	Bucket dump	Brown
4	Boom up	Gray
P	P port	White
T	T port	-

2) KTC, KCL, KTA version



•Adaptor tightning torque
24.5 ~ 29.4 N·m
2.5 ~ 3.0 kg·m
18.1~ 21.7 ft·lbf

•Hose connection
Pilot valve LH

		Color of hose taping
1	Swivel left	Red
2	Arm dump	Blue
3	Swivel right	Yellow
4	Arm crowd	Green
P	P port	-
T	T port	-

Pilot valve RH

		Color of hose taping
1	Bucket croud	Pink
2	Boom down	Right Blue
3	Bucket dump	Brown
4	Boom up	Gray
P	P port	-
T	T port	-

(3) Disassembling and assembling (KTC, KCL, KTA version)

1) Tools and tightening torque

Tool	Size (mm)	Part No.	Part name	Screw size	Tightening torque (N·m)
Hex wrench	6	125	Hex socket bolt	M8	20.6 ± 1.5
Money wrench	22	312	Adjusting nut	M14	68.6 ± 4.9
	32	302	Disc	M14	
Special tool (Drawing on page 17)	24	301	Joint	M14	47.1 ± 2.9

Others
- Vapor phase inhibitor
- Kerosene
- Heat-resistant grease
- Sandpaper (#1000, #2000)
- Oilstone
- Vise

2) Maintenance standard

Checkpoints	Criteria	Remarks
Leak amount	Replace the pilot valve assembly with new one if the oil leak exceeds 1000 cc/min with the steering wheel at neutral or 2000 cc/min while in operation.	Conditions: Primary pressure: 2.95 MPa Oil viscosity: 23 mm^2/s
Spool	If the sliding face is worn over 10 Ép more than the non-sliding one, replace the pilot valve assembly with new one.	This amount of wear corresponds to the above leak amount. The same conditions as above are expected.
Push rod	If the tip is worn 1 mm or more, replace the push rod with new one.	
Loose control elements	If the disc (302) or joint (301) is worn out and loose 2 mm or more, replace it with new one.	If the shakiness is caused by a loose fixture, tighten it up.
Stable operation	If unusual noise, hunting, primary pressure drop, etc, occurs and it cannot be corrected according to "Chapter 8 Troubleshooting", replace the pilot valve assembly with new one.	

Note 1: It is advisable to replace the O-rings and other sealing elements at every disassembly. They may be reused when they are found not damaged.

Note 2: When the hex socket bolt (125) has been loosened, be sure to replace the sealing washer (121).

3) Disassembling

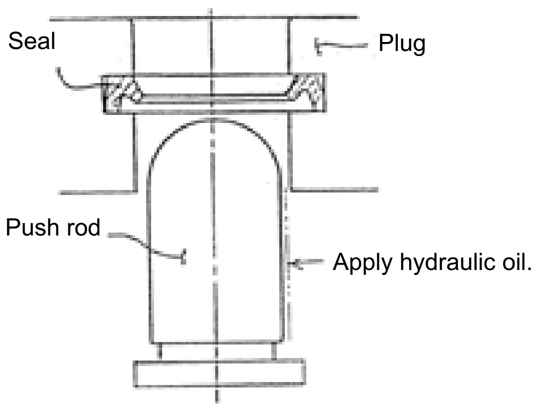
1. Preparations
   (1) Prepare a workbench that is spacious enough for the parts handled and strong and stable enough to keep the parts in place.
   (2) Also have the tools and jigs, discussed in Item 7-1, at hand.
2. General precautions
   (1) The parts are precision-machined. Handle them with enough care not to hit them against each other or drop them.
   (2) Even if any part is hard to remove, do not strike it out or pry out forcibly. Such handling may cause burrs or damages, which may invite oil leak or poor performance later. Try to do the job with patience.
   (3) Do not leave the taken-out or exposed parts unprotected. Moisture or dust may get stuck on them, causing rust. If unavoidably the job is interrupted halfway, be careful to protect such parts against rust and dust.
3. Disassembling procedure

	Procedure	Precautions
1	Clean up the pilot valve with kerosene.	* Apply blind plugs to all the open ports.
2	Fix the pilot valve on a vise using copper (or lead) sheets.	
3	Remove the bellows (501). [Photo 7-1]	* Be careful not to break the bellows (501).
4	Apply a wrench across the adjusting nut (312) and disc (302). Loosen and remove the adjusting nut and disc. [Photos 7-2, 7-3 and 7-4]	
5	With the specified jig, turn the joint (301) counterclockwise to get it loose. [Photos 7-5 and 7-6]	* Photo 7-5 shows the jig in its specified position. **CAUTION:** * When the return spring (221) is strong in force, take care in loosening and drawing out the joint (301). The plate (151), plug (211) and push rod (212) may pop out together when taking out the joint.
6	Remove the plate (151). (When the return spring (221) is strong in force) [Photo 7-7] (When the return spring (221) is weak in force) [Photo 7-8]	
7	When the return spring (221) is weak in force, the sliding resistance of the O-ring holds the plug (211) inside the casing (101). Using a bladed screwdriver, draw out the plug. [Photo 7-9]	* Using its outer groove, draw out the plug (211) with care not to get it damaged by an unbalanced load. **CAUTION:** * Keep in mind that when the plug (211) may pop out by the force of the return spring (221).
8	Pull the push rod (212), plug (211), reducing valve assembly, and return spring (221) out of the casing (101). [Photo 7-10]	* Keep record of the positional relation with the casing hole.
9	Fix the pilot valve, with its port plate (111) upward, in the vise.	
10	Using the specified hex wrench, loosen and remove the hex socket bolt (125). [Photo 7-11]	
11	Detach the port plate (111) and O-ring (122) from the casing (101). [Photos 7-12 and 7-13] Draw the bushing (131) out of the casing (101).	
12	To disassemble the reducing valve, do the following. Press in the spring seat (216) to get the secondary-pressure spring (241) warped. Then slide this spring seat sideways and pass it through the larger hole and out of the spool (201). [Photo 7-14] Next separate the following parts: spool (201), spring seat (216), secondary-pressure spring (241) and washer 2 (217). [Photo 7-15]	* Be careful not to scratch the surface of the spool (201). * Do not allow the spring seat (216) 6 mm or lower than specified. * Handle this group of parts as an assembly.

	Procedure	Precautions
13	Remove the folding-purpose spring (246) and spring seat (218) from the push rod (212). [Photo 7-16]	
14	Draw the push rod (212) out of the plug (211). [Photo 7-17]	
15	Remove the O-ring (214) and seal (213) from the plug (211). Use a small bladed screwdriver or the like to take out the seal (213). [Photos 7-18 and 7-19]	
16	Clean up the parts. 1) Put the parts one by one in a rough-washing container with kerosene. (Rough washing) 2) Put the parts one by one in a finish-washing container with kerosene. Slowly turn them and wipe them clean thoroughly inside and out. (Finish washing) Using clean waste cloth, wipe kerosene away from the parts.	* Do not wipe dirty parts in kerosene from the beginning because otherwise they might get scratched. Keep them dipped until dirt, fat and grease become loose enough off the parts. * Be attentive to keep the kerosene clean enough. Otherwise the parts may get scratched, leading to poor performance when reassembled. * Do not dry up the parts with compressed air. Dust and moisture in the air may damage the parts or get them rusty later.
17	Keep the parts against rust. Apply rust-preventive to the specified parts.	* Do not leave the parts without rust-preventive. Rust may build up, causing malfunction later.

4) Assembling

1. Preparations
   (1) As in the case of disassembling, prepare the specified workbench, tools and materials.
2. General precautions
   (1) Take the same general precautions as in disassembling.
   (2) Before reassembling, remove metal chippings and foreign matters from all the parts. Make sure the parts are free of burrs, hit marks and other problems. If a burr or hit mark is found, get rid of it with an oilstone.
   (3) In principle, replace the O-rings and backup rings with new ones.
   (4) When fitting the O-rings and backup rings, handle them with care not to damage it. (Apply a small amount of grease for smooth fitting.)
   (5) When fitting the parts in place, preferably use grease to avoid accidental drop.
   (6) Tighten the bolts and the like to the their specified torques listed in "7-1 Tightening Torque Chart". Measure the tightening torques with a torque wrench.
   (7) Finally apply blind plugs to all the open ports to avoid entry of dust.
3. Reassembling procedure

	Procedure	Precautions
1	Fit the bushing (131) and O-ring (122) to the casing (101). [Photo 7-20]	
2	Install the port plate (111), with the hex socket bolt (125) and seal washer (121) in between, on the casing (101). [Photos 7-21 and 7-22]	* Carefully position the spring pin (126) in the casing hole. * Replace the seal washer (121) with new one.
3	Tighten the hex socket bolt (125) to the specified torque. [Photo 7-23]	* Alternately tighten the two bolts.
4	Install the washer 2 (217), secondary-pressure spring (241) and spring seat (216) in this order on the spool (201). [Photo 7-24] Then press in the spring seat (216) to get the secondary-pressure spring (241) warped. Now slide this spring seat sideways and pass it through the larger hole and onto the spool (201). [Photo 7-25]	* Do not allow the spring seat (216) 6 mm or lower than specified.
5	Fit the return spring (221) in the casing (101). Also fit the reducing valve assembly to the casing (101). [Photo 7-26]	* Place these parts back in their original positions.
6	Fit the O-ring (214) to the plug (221). [Photo 7-27]	
7	Fit the seal (213) to the plug (211). [Photo 7-28]	* Place the seal (213) with its lip positioned as shown below.
8	Fit the push rod (212) into the plug (211). [Photo 7-29] Fit the folding-purpose spring (246) and spring seat (218) into the push rod (212). [Photo 7-30]	* Apply hydraulic oil over the surface of the push rod. 

	Procedure	Precautions
9	Fit the plug assembly to the casing (101). When the return spring (221) is weak in force, this assembly is kept in place by the sliding resistance of the O-ring. [Photo 7-31] When the return spring (221) is strong in force, fit all the four plugs at once using the plate (151). Apply and temporarily tighten the joint (301). [Photo 7-32]	* Be careful not to pry the spool (201) too hard. Otherwise the casing hole (101) may get damaged. **CAUTION:** * Keep in mind that the plug assembly and plate (151) may pop out.
10	Place the plate (151) in position.	
11	Using the specified jig, tighten the joint (301) to the casing (101) by the specified torque. [Photos 7-33 and 7-34]	* Photo 7-33 shows the jig in its specified position.
12	Fit the disc (302) to the joint (301). [Photo 7-35]	* Screw in the disc until it comes into even contact with the four push rods (212). **WARNING:** * Carefully adjust the final position of the disc (302). If it is screwed in too much, the secondary pressure with the lever at neutral may be wrongly applied, causing the machine to malfunction.
13	Apply the adjusting nut (312) and fix it by applying the specified wrench across the disc (302). Tighten the adjusting nut to the specified torque. [Photo 7-36]	* In tightening the nut, keep the disc (302) in position.
14	Apply grease to the turning portion of the joint (301) and the top of the push rod (212). [Photo 7-37]	
15	Fit the bellows back into position. [Photo 7-38]	* Be careful not to break the bellows (501).
16	Pour vapor phase inhibitor from the ports and apply the blind plugs.	

Photo 7-1

Photo 7-2

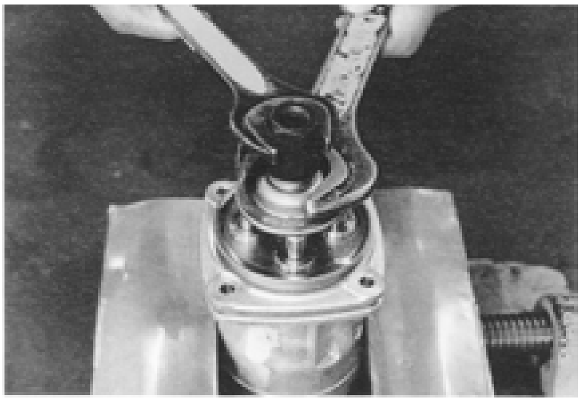


Photo 7-3

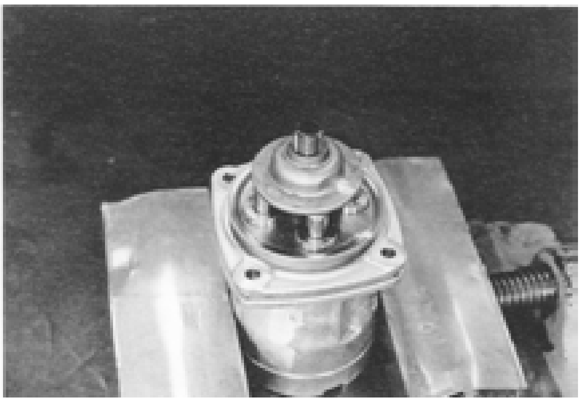


Photo 7-4

Photo 7-5

Photo 7-6

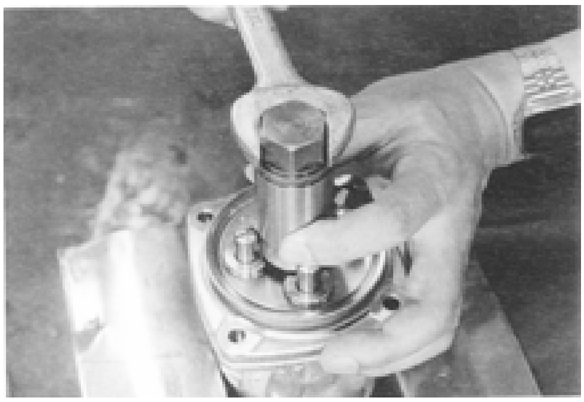


Photo 7-7

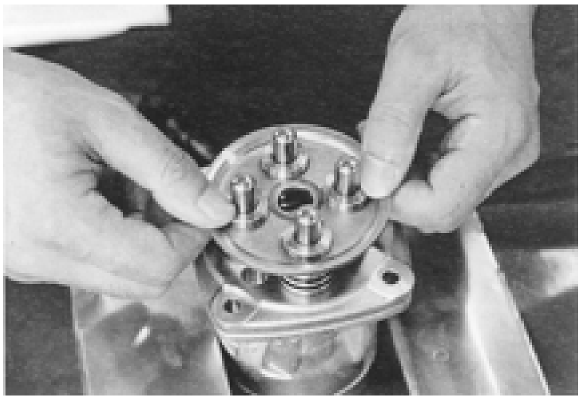


Photo 7-8

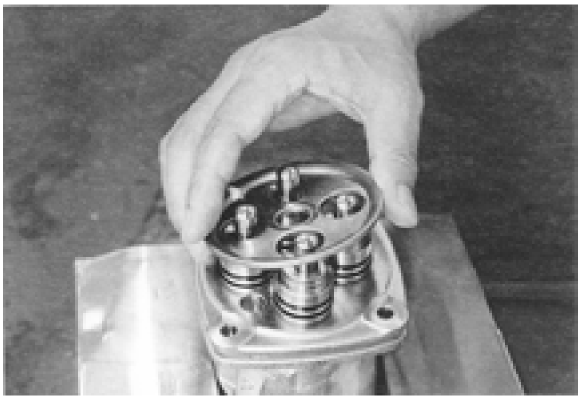


Photo 7-9

Photo 7-10

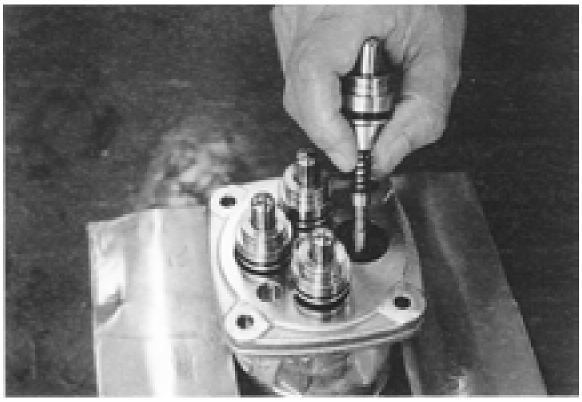


Photo 7-11

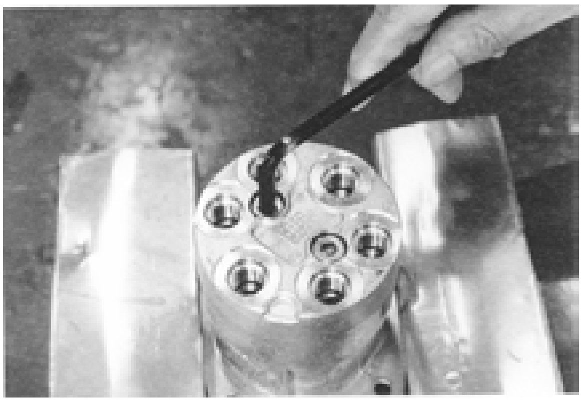


Photo 7-12

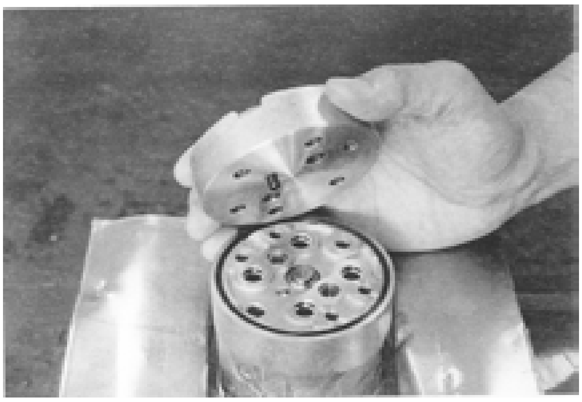


Photo 7-13

Photo 7-14

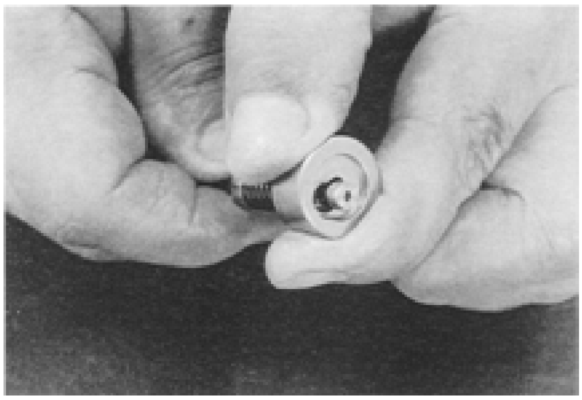


Photo 7-15

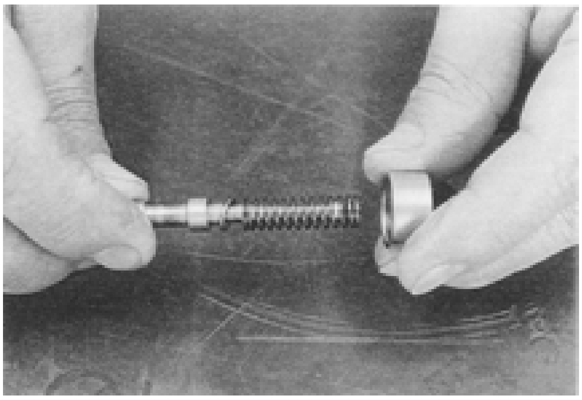


Photo 7-16

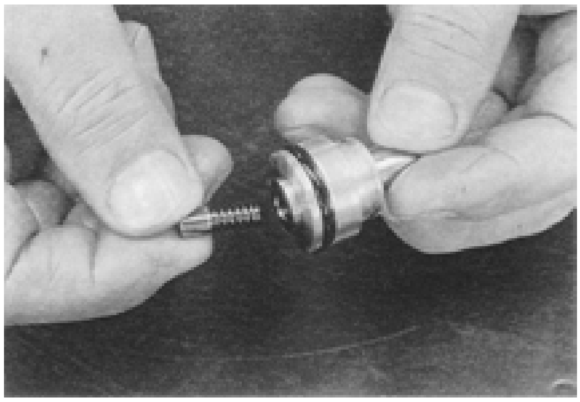


Photo 7-17

Photo 7-18

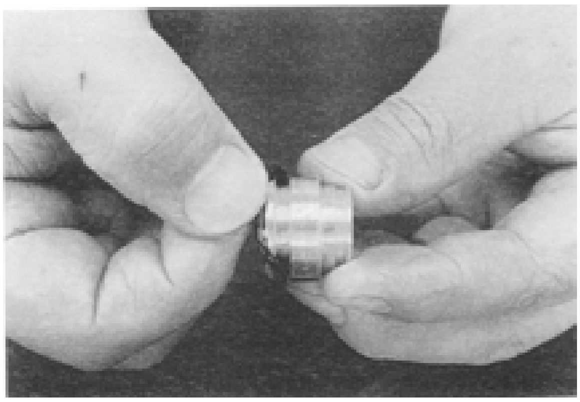


Photo 7-19

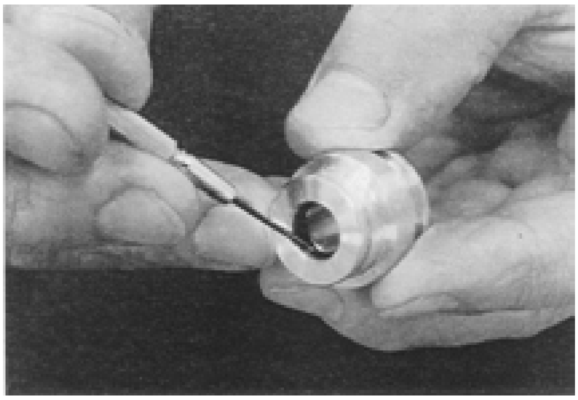


Photo 7-20

Photo 7-21

Photo 7-22

Photo 7-23

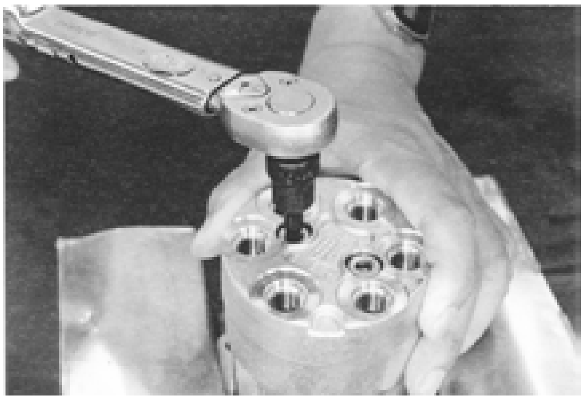


Photo 7-24

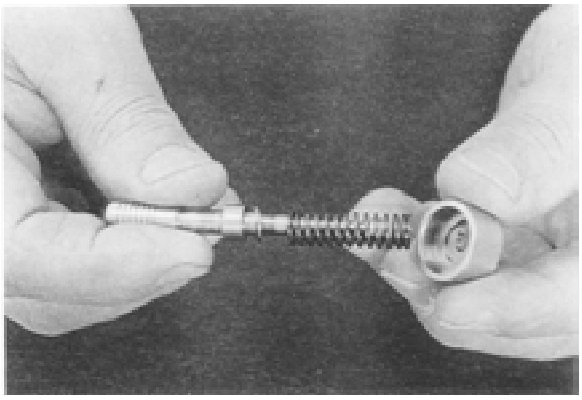


Photo 7-25

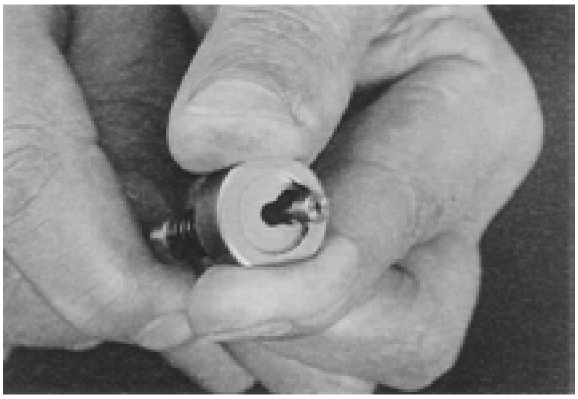


Photo 7-26

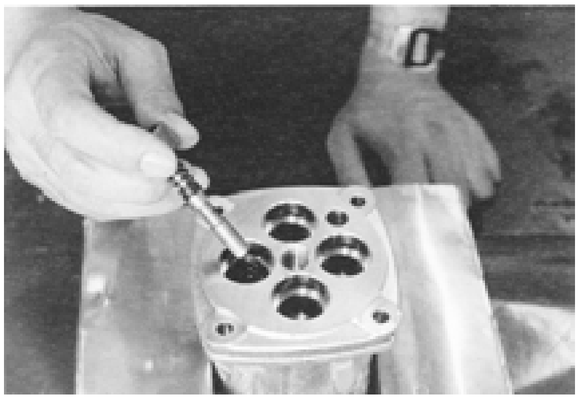


Photo 7-27

Photo 7-28

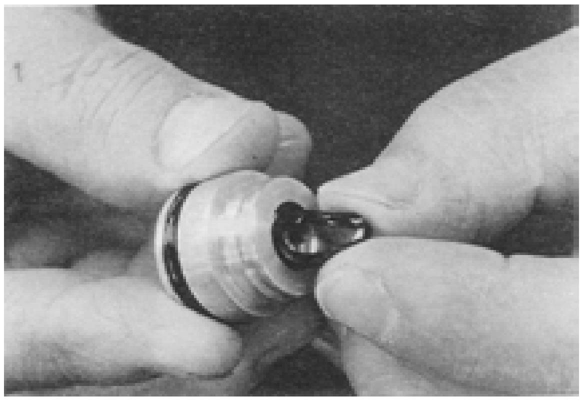


Photo 7-29

Photo 7-30

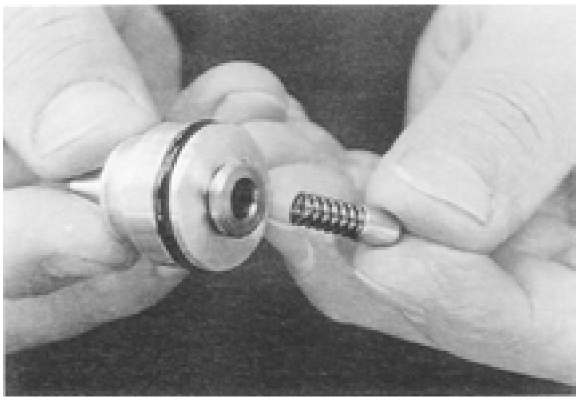


Photo 7-31

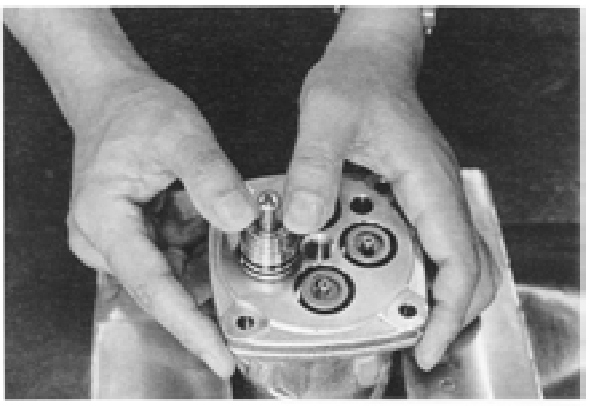


Photo 7-32

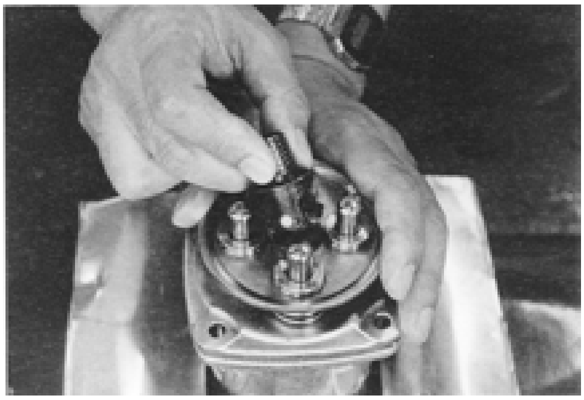


Photo 7-33

Photo 7-34

Photo 7-35

Photo 7-36

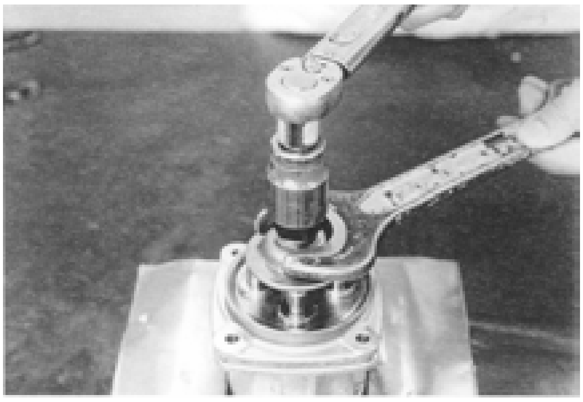


Photo 7-37

Photo 7-38

(4) Trouble shooting

It is not easy to pinpoint trouble spots. The table below lists some typical problems, their possible causes and corrections. Before starting repair jobs, refer to the table below.

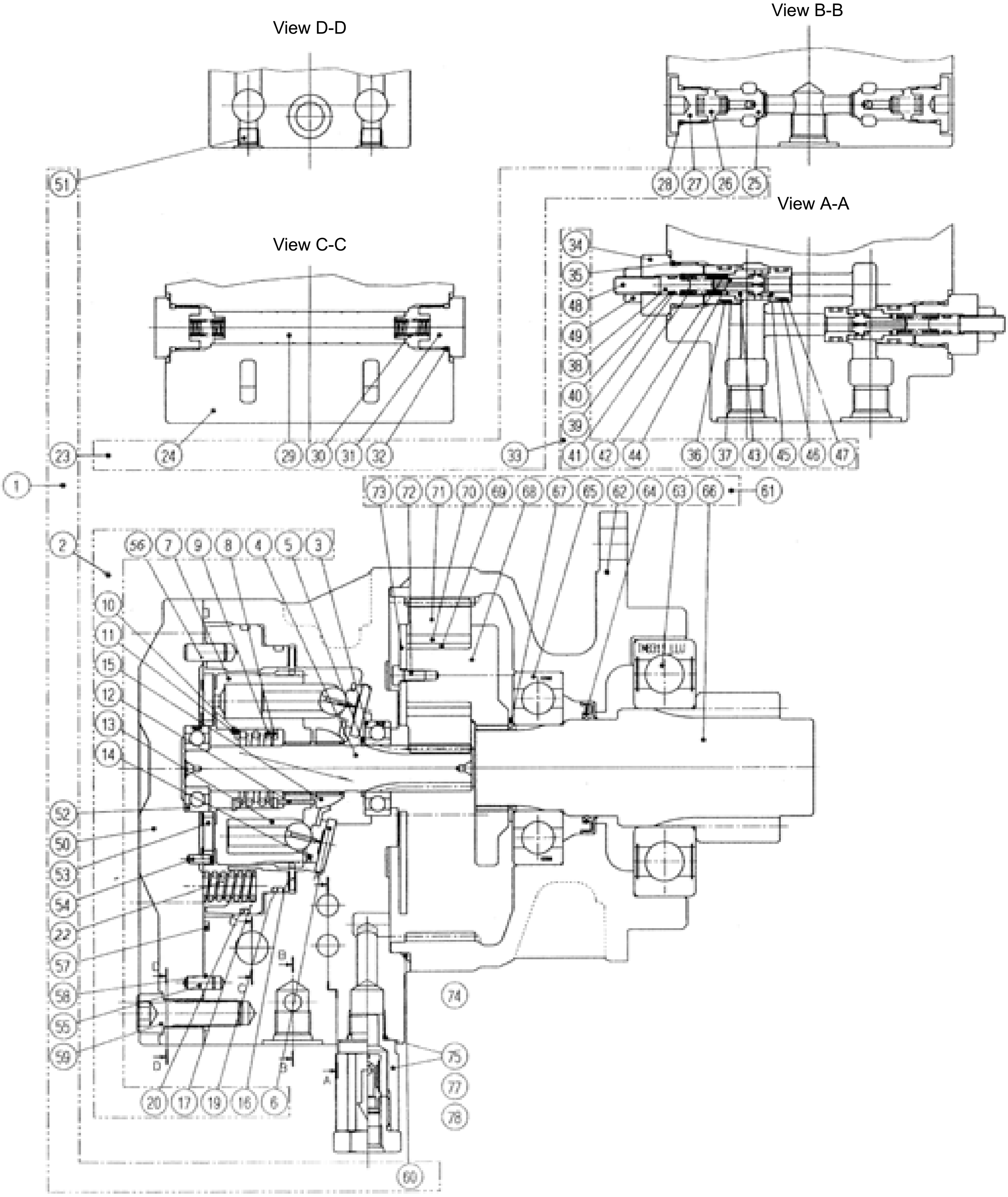
A machine trouble is not necessarily caused by just one part, but by come different parts combined. It should be noted that the corrections listed below might not be enough and additional measures might be needed.

This chart does not cover all possible causes and corrections. Whenever necessary, it is therefore essential for the repair supervisor to look further into the problem and cause in question.

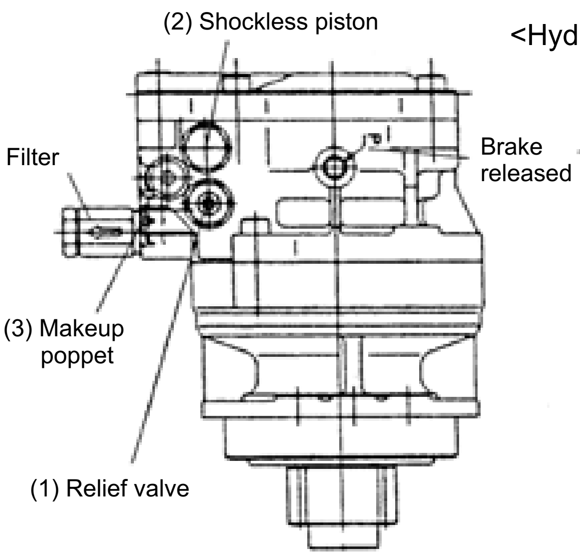
Problem	Causes	Corrections
Secondary pressure failure to rise	(1) Primary pressure too low. (2) Secondary-pressure spring (241) broken or worn out. (3) Too large a gap between the pool (201) and casing (101). (4) Steering wheel too loose.	(1) Ensure the specified primary pressure. (2) Replace the spring with new one. (3) Replace the remotely operated valve with new one. (4) Disassemble and reassemble the related section. Or replace the steering wheel as required.
Secondary pressure unstable	(1) Sliding parts stuck. (2) Tank line pressure fluctuating too much. (3) Air sucked in the piping.	(1) Correct the stuck spot. (2) Return the oil direct to the oil tank. (3) Operate the machine to let out the air.
Secondary pressure too high	(1) Tank line pressure too high. (2) Sliding parts stuck.	(1) Correct the stuck spot. (2) Return the oil direct to the oil tank.

e. Swivel motor (KTC, KCL, KTA version)

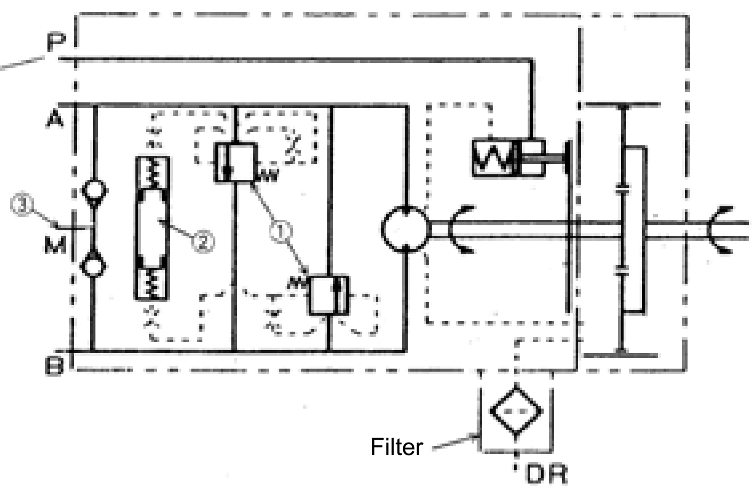
(1) Components of the swivel motor

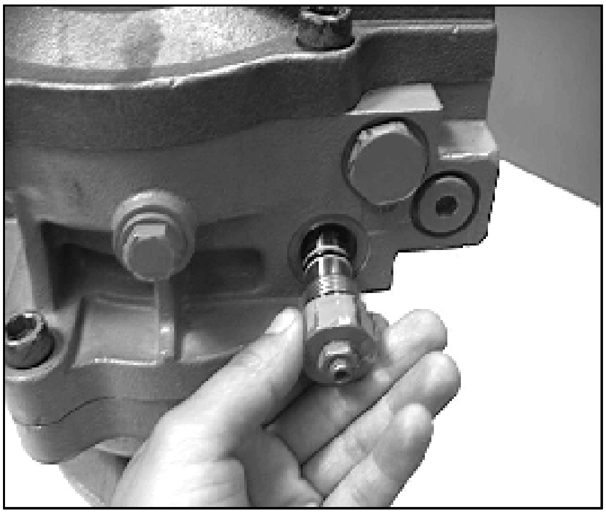


1	Mortor, assy, with valve	27	Plug	53	Plate, valve
2	Motor, assy	28	O-ring	54	Pin
3	Ball bearing	29	Piston, brake	55	Pin
4	Shaft	30	Spring	56	Pin
5	Circlip	31	Plug	57	O-ring
6	Plate thrust	32	O-ring	58	O-ring
7	Cylinder Block	33	Valve, assy (Relief)	59	Bolt
8	Washer spring	34	Housing (Relief)	60	O-ring
9	Spring	35	O-ring	61	Gear case, assy
10	Washer, Spring	36	O-ring	62	Gear case
11	Circlip	37	Ring, backup	63	Ball bearing
12	Pin	38	Guide (Spring)	64	Seal, oil
13	Piston, assy	39	O-ring	65	Ball bearing
14	Plate, retainer	40	Ring, backup	66	Shaft, pinion
15	Holder, retainer	41	Spring	67	Circlip
16	Plate, friction	42	Ring, Spring seat	68	Holder
17	Piston, brake	43	Guide, poppet	69	Collar
18	Blank	44	Poppet	70	Needle bearing
19	O-ring	45	Ring, poppet seat	71	Gear, planetary
20	O-ring	46	O-ring	72	Bolt
21	Blank	47	RIng, backup	73	Plate, thrust
22	Spring	48	Bolt	74	Bolt
23	Valve, assy	49	Nut	75	Filter
24	Housing	50	Cover, motor	77	Plug
25	Poppet	51	Plug	78	O-ring
26	Spring	52	Ball bearing		

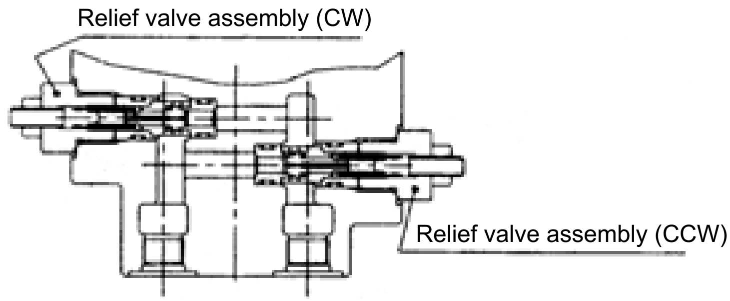


<Hydraulic Circuit Diagram>

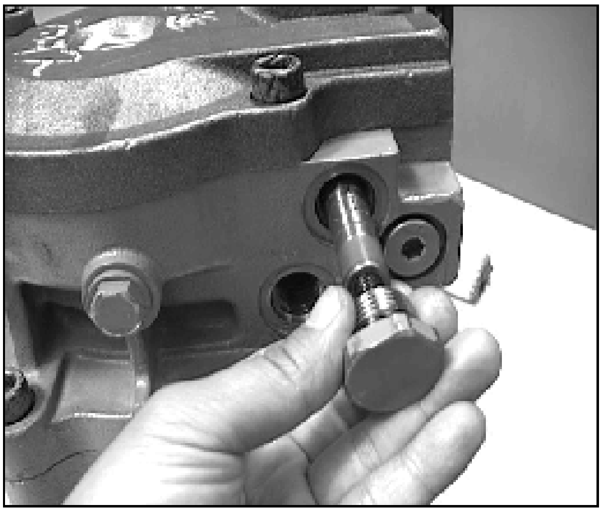




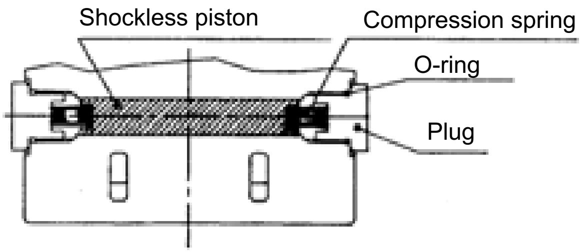
1)Relief valve



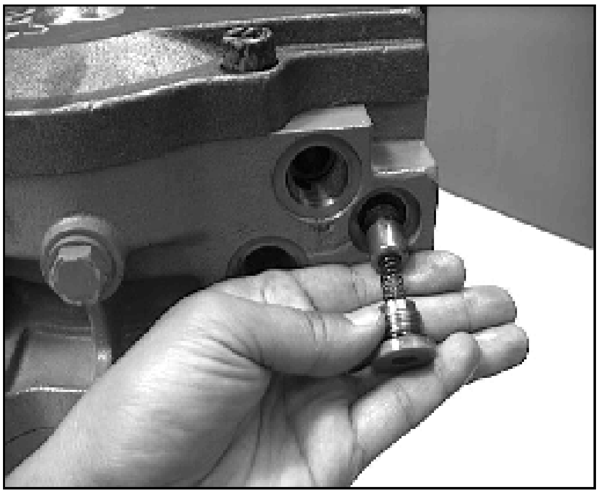
Relief valve assembly tightening torque:
58.8 ~ 68.6 N·m
6.0 ~ 7.0 kg·m
43.4~ 50.6 ft·lbf



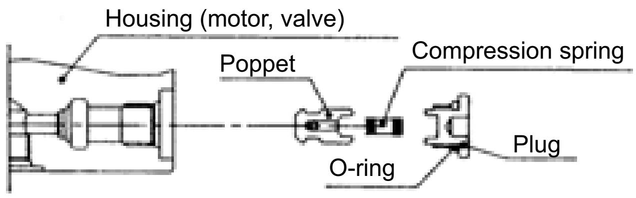
2)Piston (Shockless)



Plug tightening torque:
58.8 ~ 68.6 N·m
6.0 ~ 7.0 kg·m
43.4~ 50.6 ft·lbf



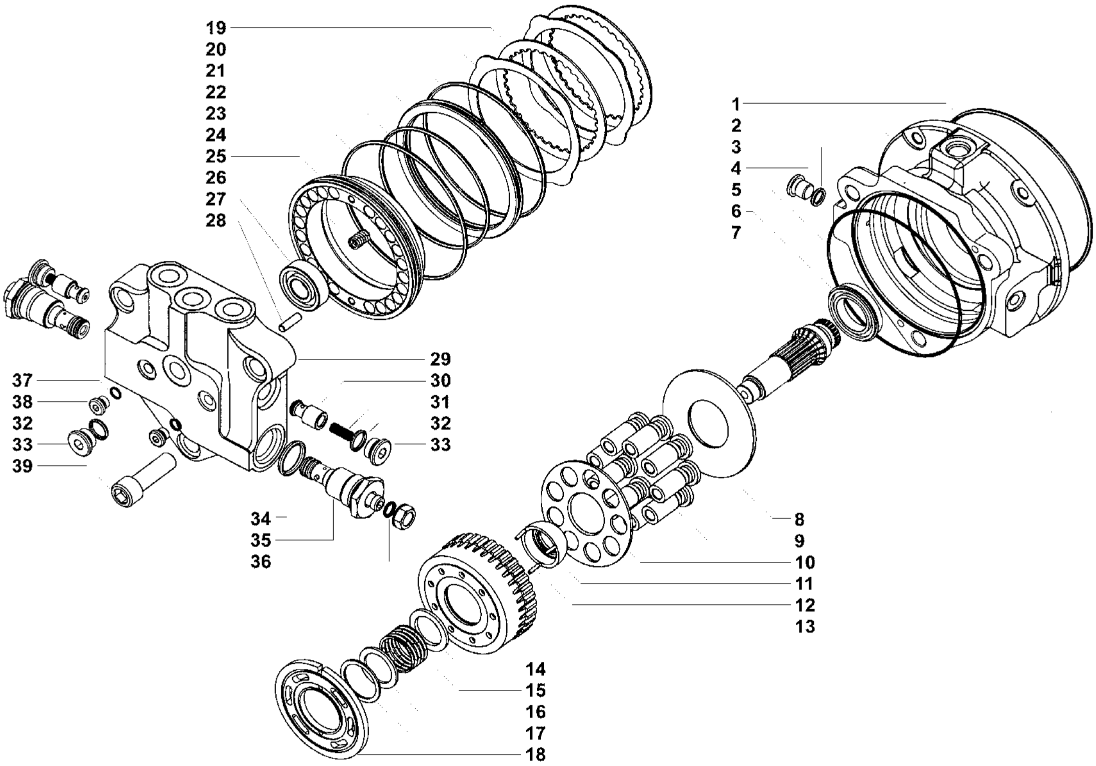
3)Poppet (Makeup)



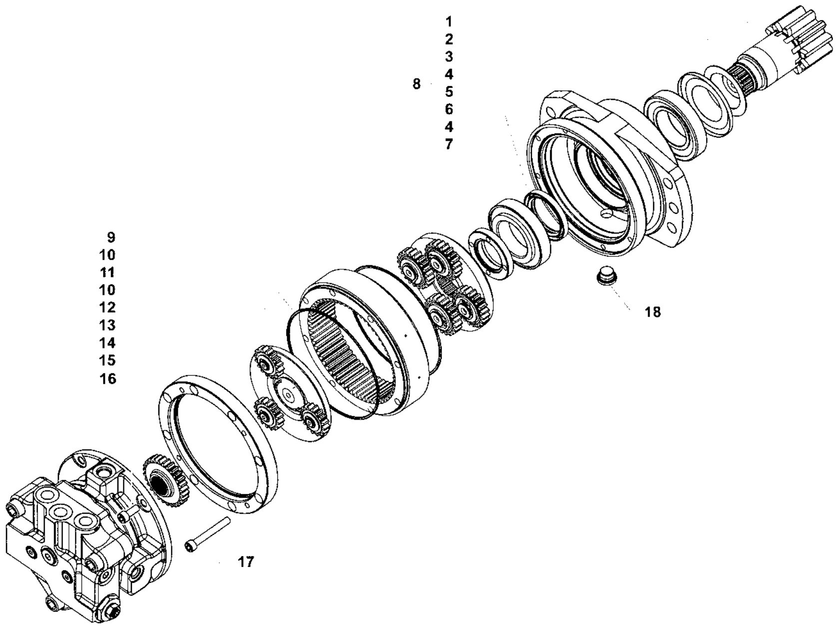
Tightening torque:
49.0 ~ 58.8 N·m
5.0 ~ 6.0 kg·m
36.1~ 43.4 ft·lbf

(2) Inner parts of the swivel motor

1) KE, KDG, KUK version

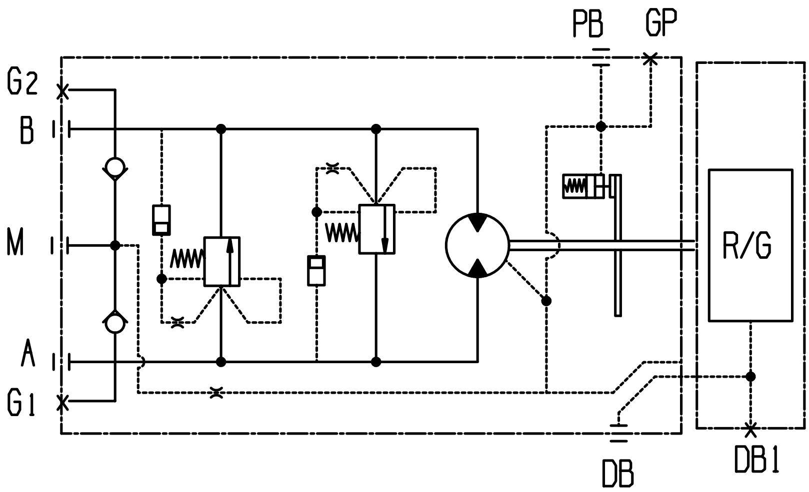


1	O-ring	14	Collar	27	Bearing
2	Motor housing Kit	15	Spring	28	Pin
3	O-ring	16	Collar washer	29	Base plate
4	Plug	17	Circrip	30	Check valve
5	O-ring	18	Valve plate	31	Spring
6	Bearing	19	Steel disc	32	O-ring
7	Motor shaft assy	20	Friction plate	33	Plug
8	Thrust plate	21	O-ring	34	O-ring
9	Piston	22	Brake spacer	35	Relief valve assy
10	Retainer plate	23	O-ring	36	O-ring
11	Spherical bush	24	O-ring	37	O-ring
12	Pun	25	Brake piston	38	Plug
13	Cylinder block	26	Spring	39	Screw

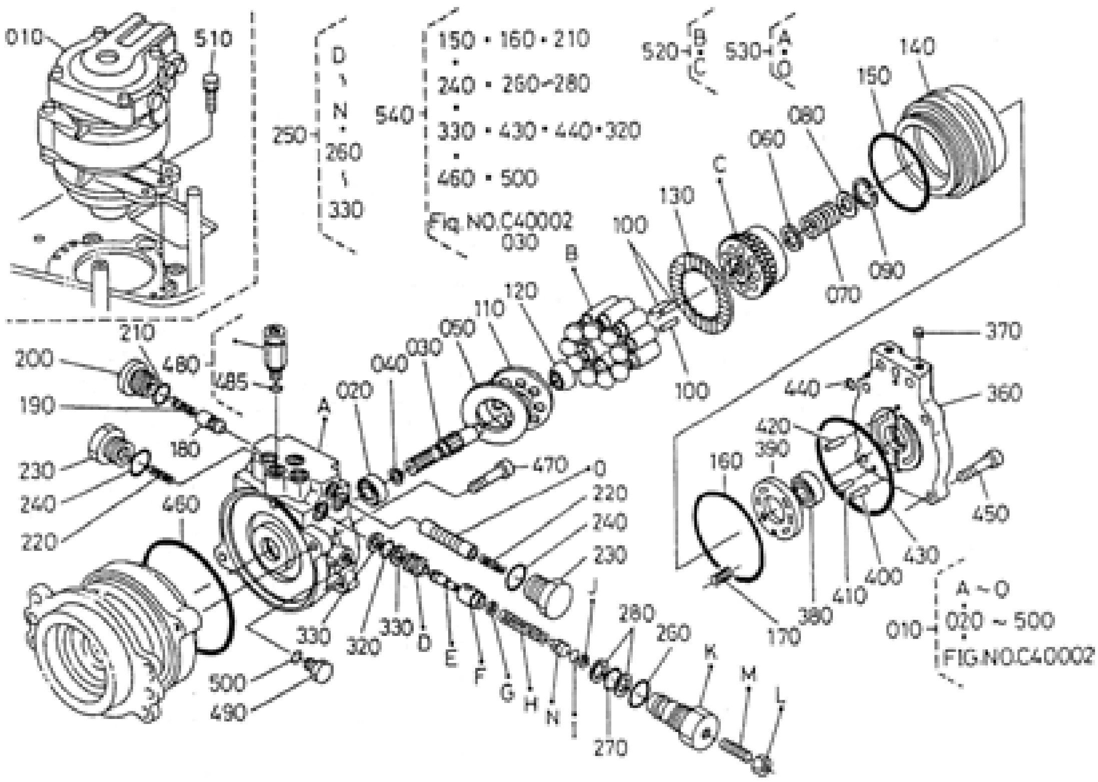


1	Pinion shaft	7	Nut	13	Motor adaptor
2	Frange	8	Output assembly	14	Sun gear
3	Nilos ring	9	Reduction assembly	15	Screw
4	Bearing	10	O-ring	16	Hydraulic motor
5	Gearbox housing	11	Toothed ring	17	Screw
6	Seal ring	12	Reduction assembly	18	Plug

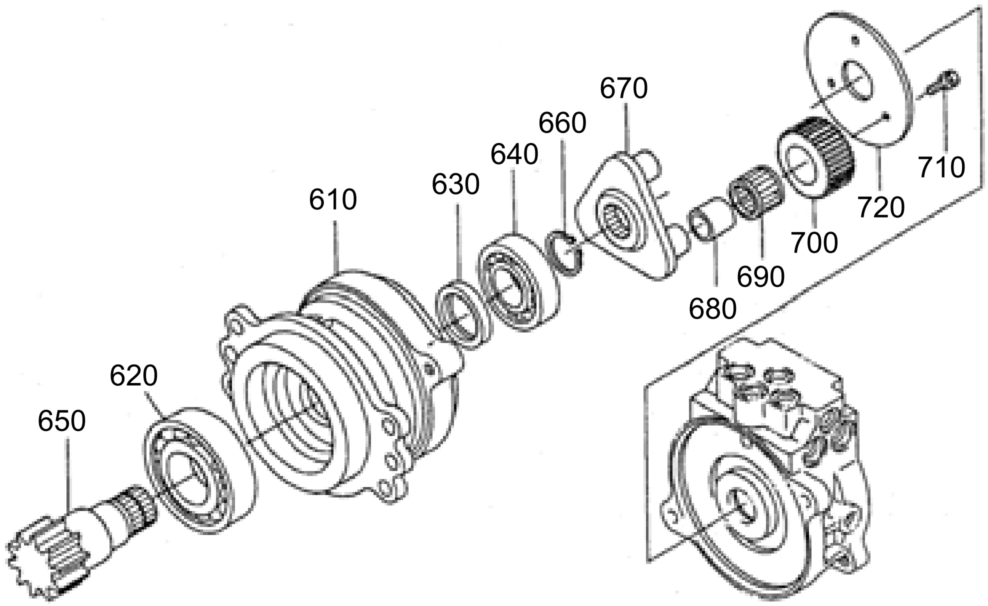
<Hydraulic circuit diagram>



2) KTC, KCL, KTA version

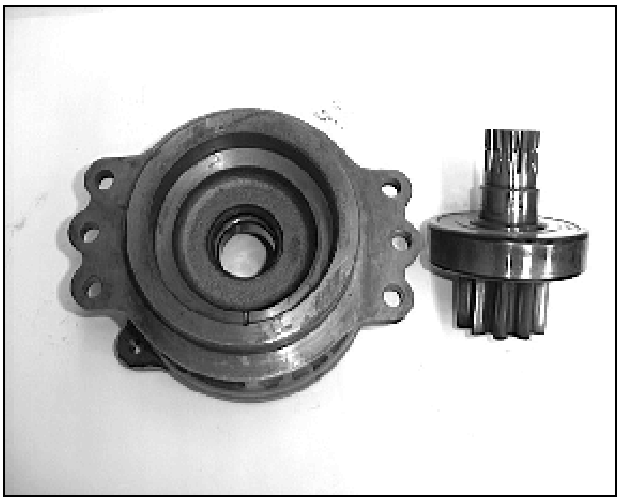


010	Mortor, assy (Swivel)
020	Ball bearing
030	Shaft
040	Circlip
050	Plate, thrust
060	Washer, spring
070	Spring
080	Washer, spring
090	Circlip
100	Pin
110	Plate, retainer
120	Holder, retainer
130	Plate, friction
140	Piston, brake
150	O-ring
160	O-ring
170	Spring
180	Poppet
190	Spring
200	Spring
210	O-ring
220	Spring
230	Plug
240	O-ring
250	Valve, assy (Relief)
260	O-ring
270	O-ring
280	Ring, backup
290	Blank
300	Blank
310	Blank
320	O-ring
330	Ring, backup
340	Blank
350	Blank
360	Cover, motor
370	Plug
380	Ball bearing
390	Plate, valve
400	Pin
410	Pin
420	Pin
430	O-ring
440	O-ring
450	Bolt
460	O-ring
470	Bolt
480	Filter
485	O-ring
490	Plug
500	O-ring
510	Bolt
520	Cylinder Block, assy
530	Housing, assy
540	Seal, kit

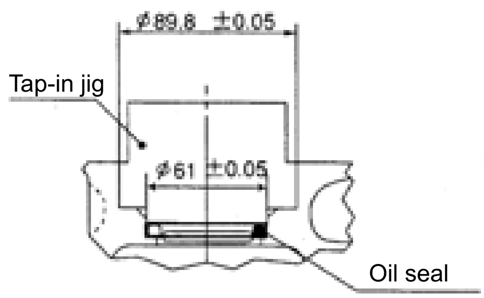


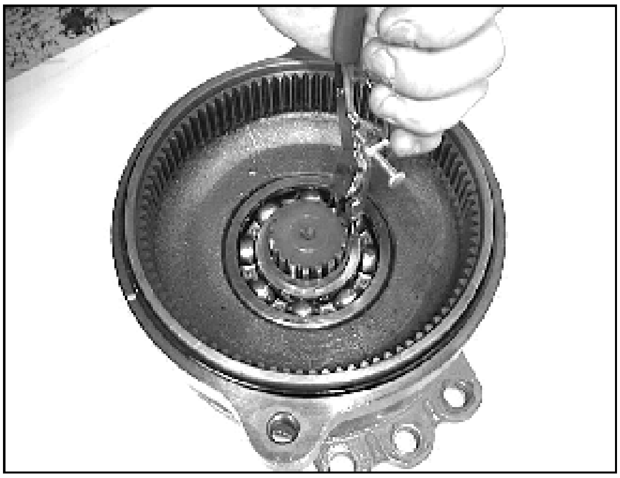
610	Case, gear	650	Shaft, pinion	690	Needle bearing
620	Ball bearing	660	Circlip	700	Gear (Planetary)
630	Seal, oil	670	Holder	710	Bolt
640	Ball bearing	680	Collar	720	Plate, thrust

(3) Assembling of the swivel motor (KTC, KCL, KTA version)

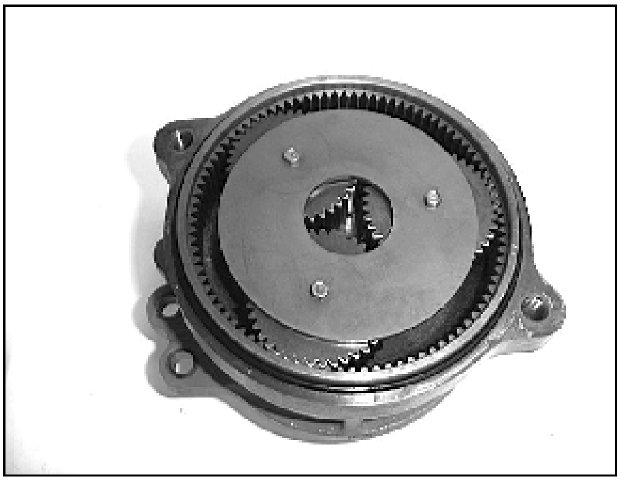


1) Apply grease to the lip and circumference of the oil seal. Using the specified jig, drive it into position.



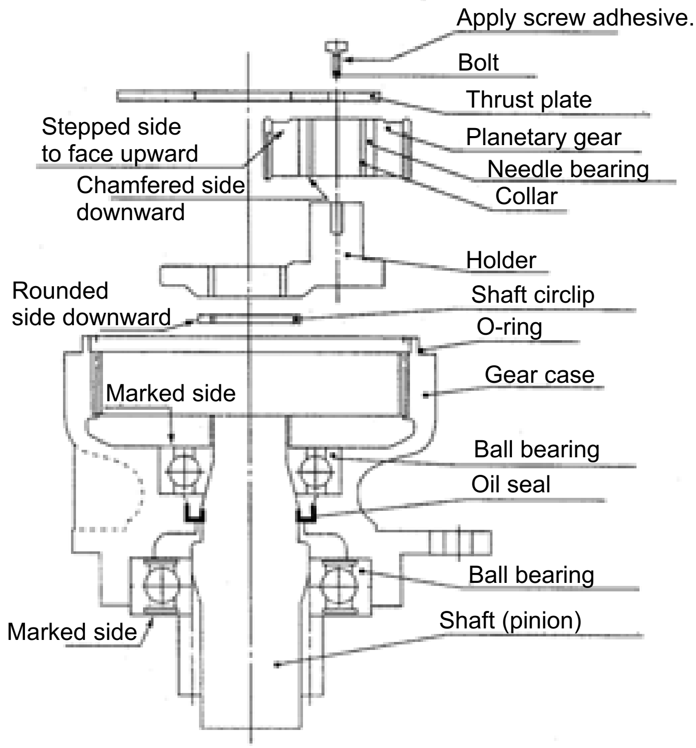


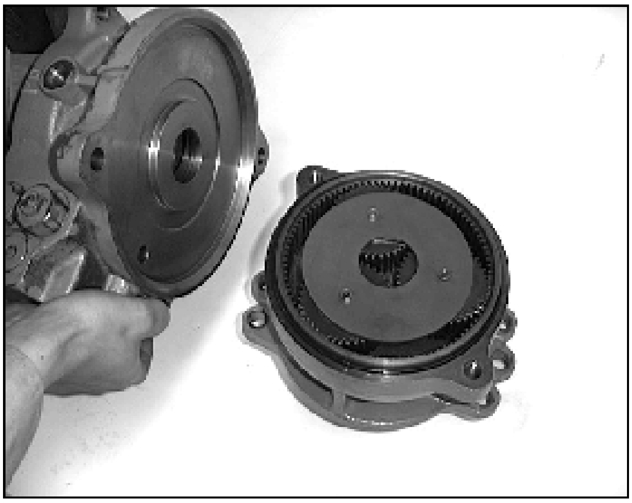
2) Using the specified jig, fit the shaft and ball bearing together and press-fit it in the gear case.
   Using the specified jig, tap on the ball bearing, with its marked side upward, in the gear case. Apply the shaft circlip in the specified direction.
   * Turn the shaft by hand to make sure it runs smoothly.



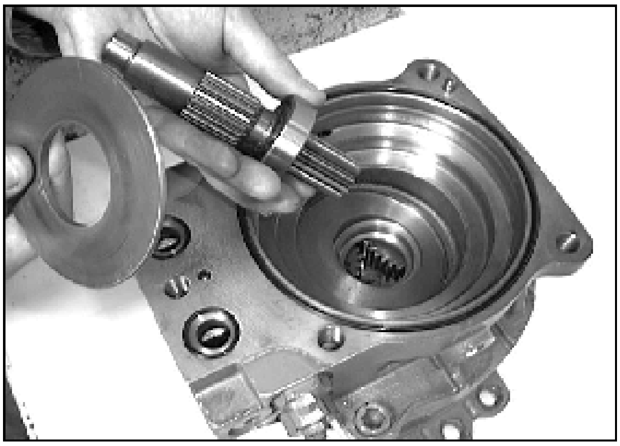
3) Place the collar, needle bearing, planetary gear and thrust plate in the specified direction on the holder. Apply screw adhesive (Locnut 271) to the bolts and tighten them to secure these parts.

Tightening torque: 2.0 ~ 2.9N·m (0.2 ~ 0.3 kg·m)
Apply grease to the O-ring and fit it on the gear case.

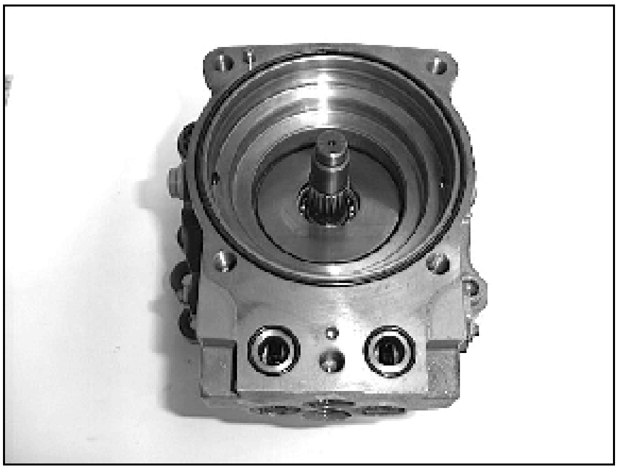




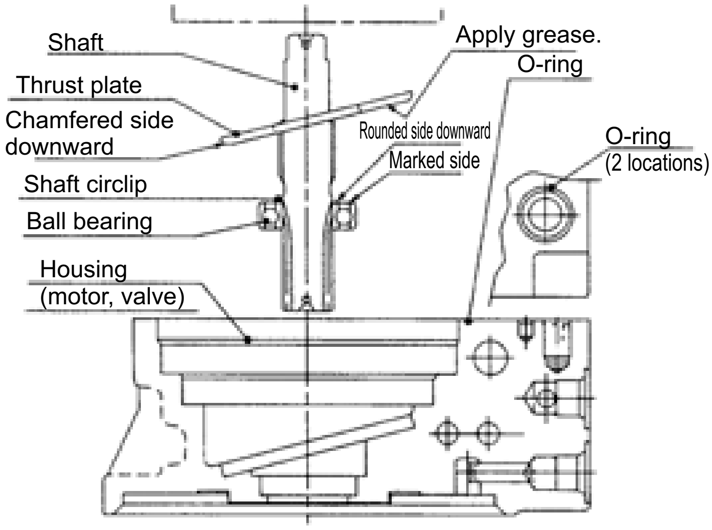
4) Fit the housing (motor, valve) in the gear case assembly. Tighten the two hex socket bolts (M12).
Tightening torque: 102.9 ~ 117.6 N·m (10.5 ~ 12.0 kg·m)

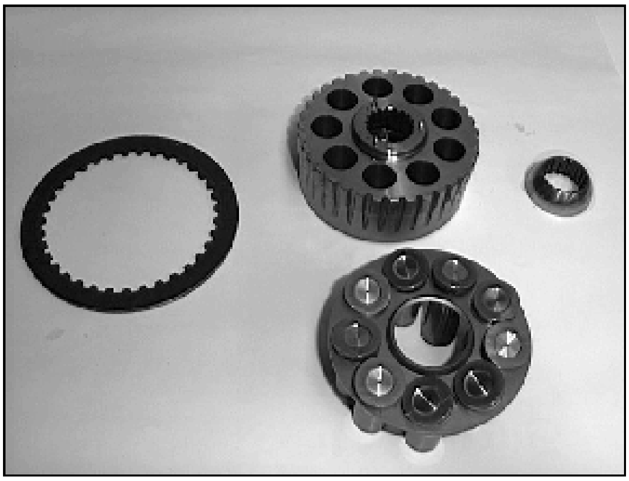


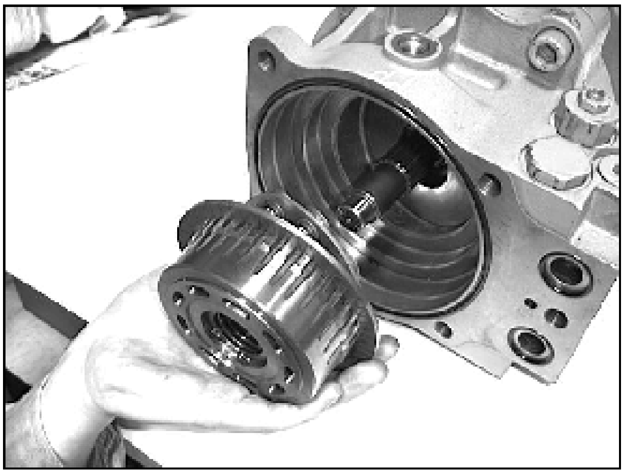
5) Using the specified jig, tap the ball bearing onto the shaft, paying attention to the marked side. Install the shaft circlip and then fit them in the housing (motor).



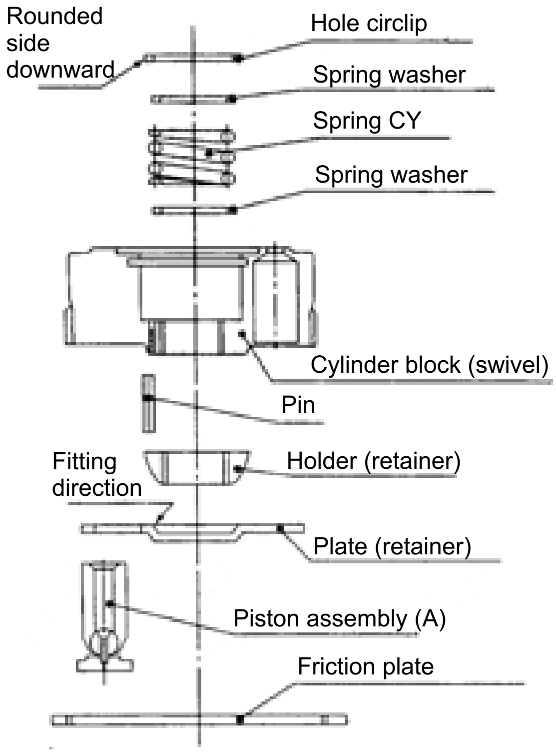
6) Dip the entire thrust plate in hydraulic oil. Apply grease over the chamfered side of the plate. Fit the plate with the chamfered side toward the housing.

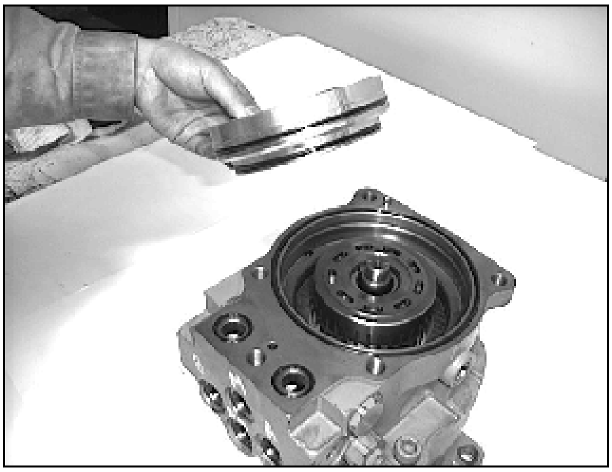




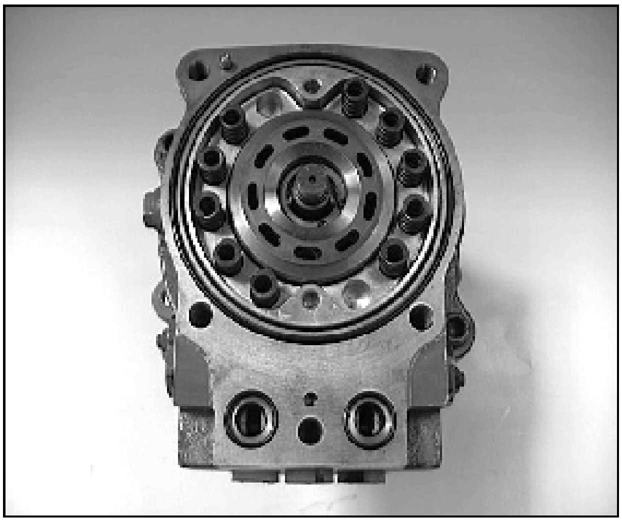


7) Install the cylinder block subassembly in place. Make sure that the sliding face of the cylinder block (swivel) is 1.4-3.0 mm below the mating face of the housing (motor, valve). Also be sure that the friction plate is not tilted.

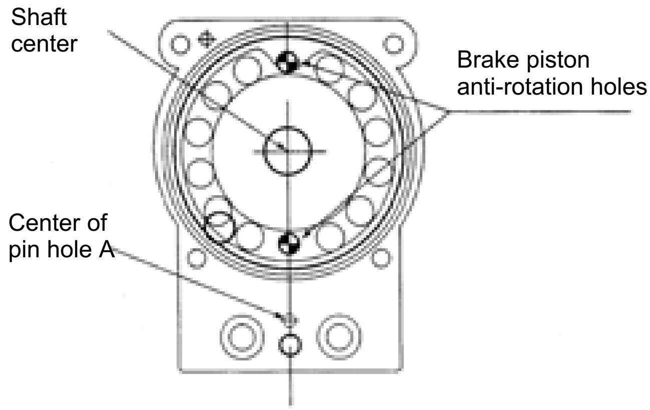


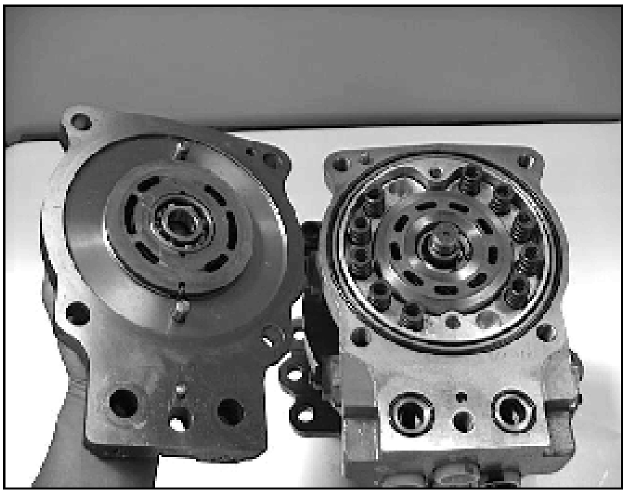


8) Install the brake piston in parallel with the insertion face. Orient the piston with its anti-rotation holes positioned as shown below.
Apply grease to the O-ring.

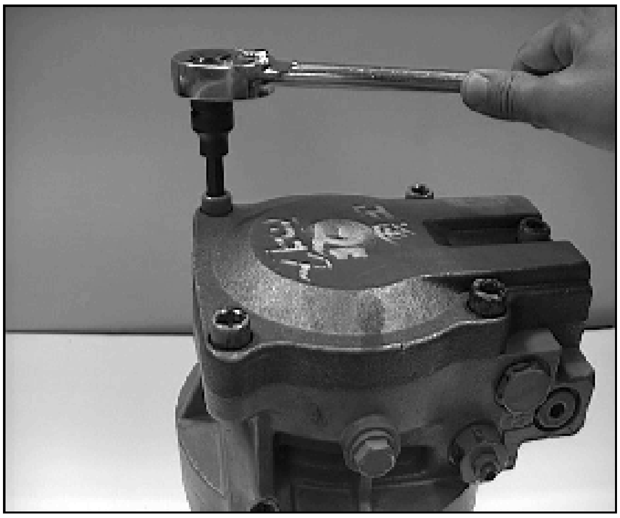


9) Fit the spring to the brake piston holes.

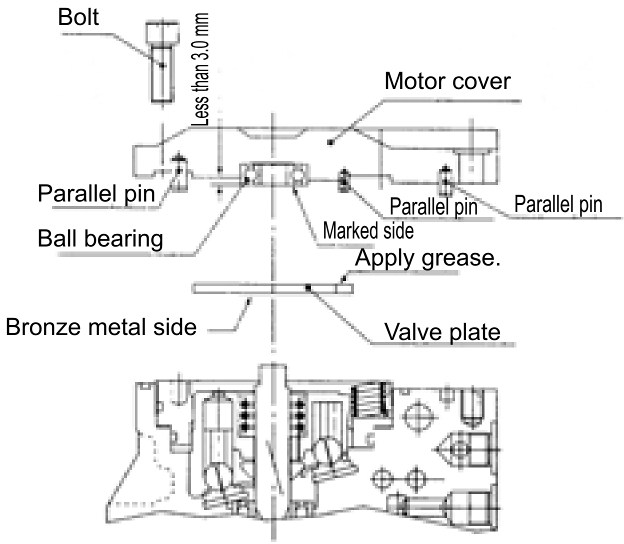




10)Using the specified jig, tap the ball bearing into position, paying attention to the marked side.
Apply grease over the surface to be in close contact with the motor cover. Then install the valve plate.

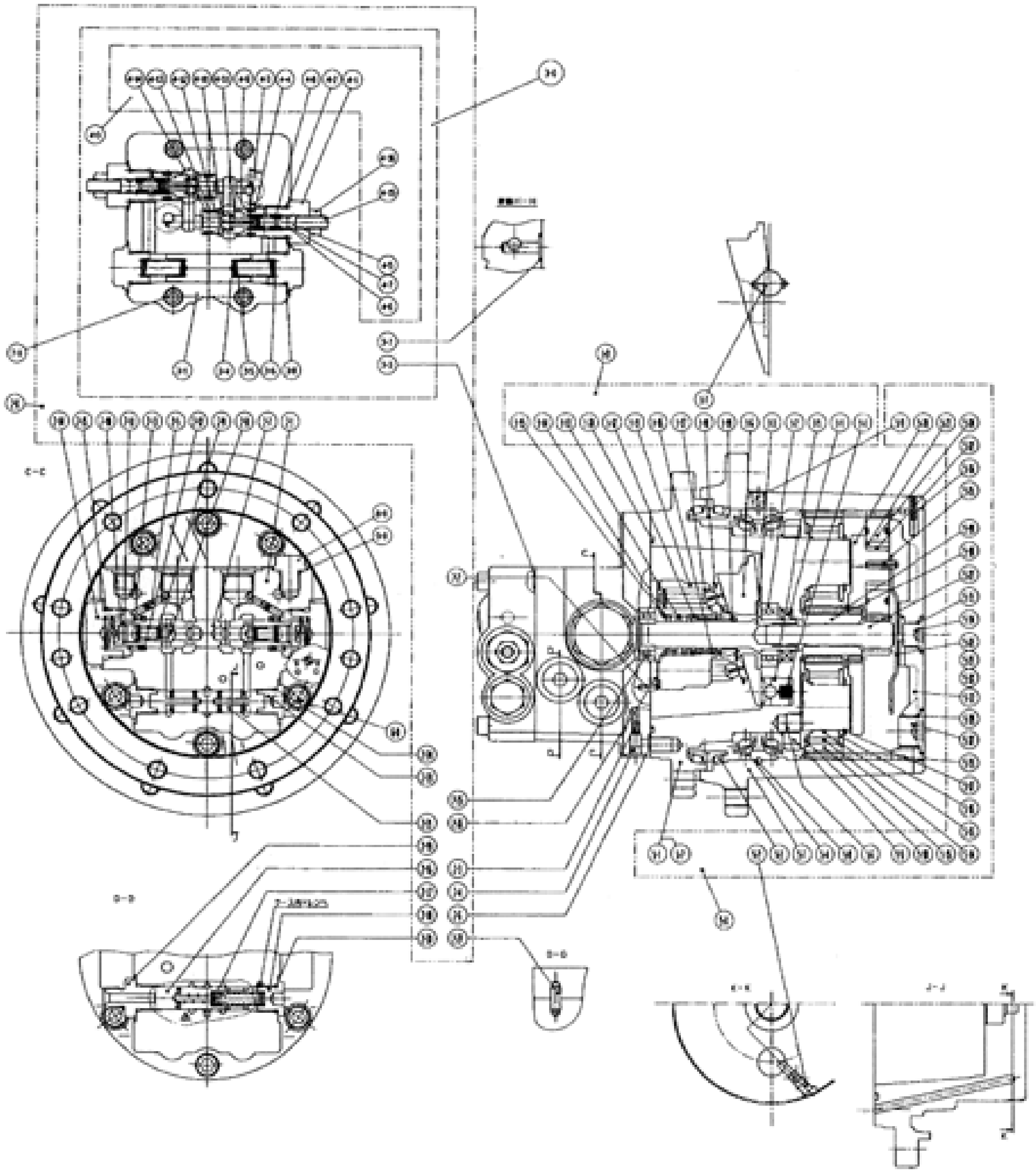


11)Fit the motor cover on the housing (motor, valve). Apply the five hex socket bolts (M12).



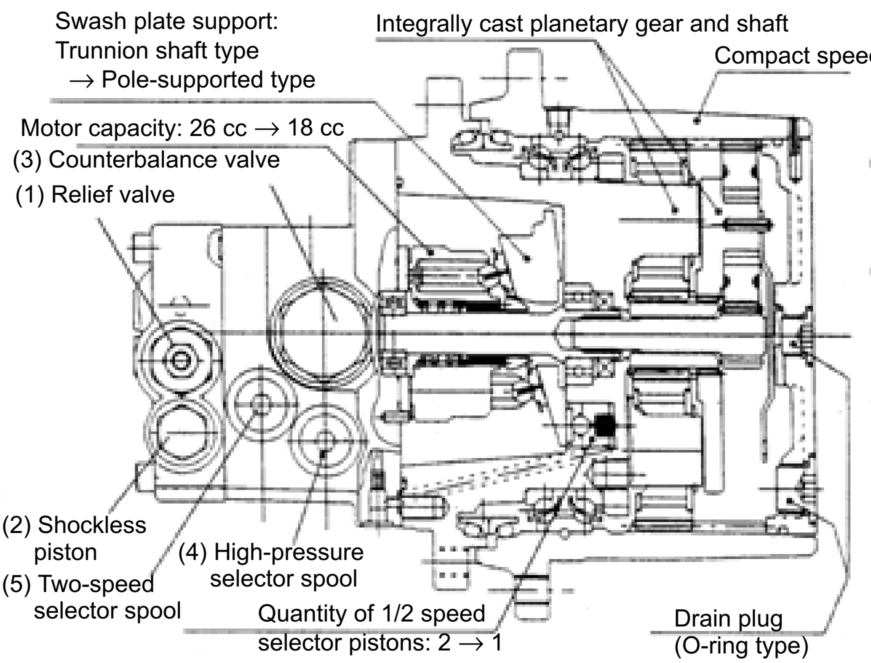
f. Traveling motor

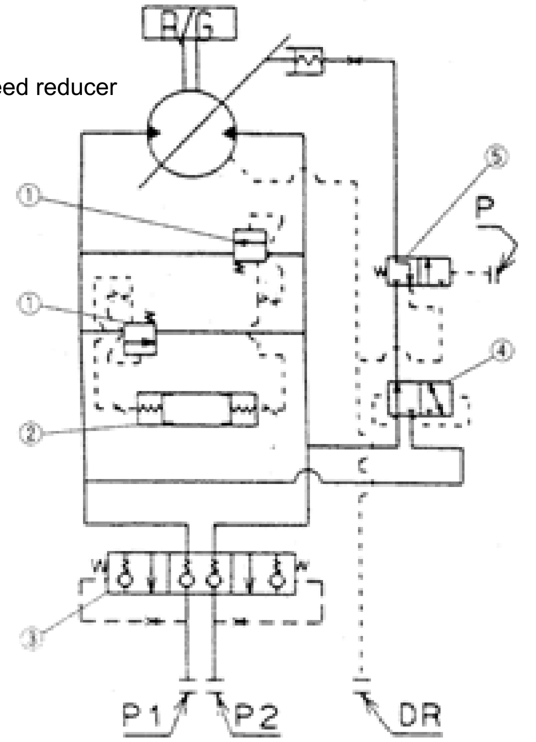
(1) Components of the traveling motor (KTC, KCL, KTA version)

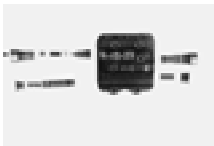


1-0	Motor assy
1-1	Seal, Oil
1-2	Bearing ball
1-3	Shaft
1-4	Spring, Piston (B)
1-5	Piston, assy (B)
1-6	Swash plate
1-7	Ball
1-11	Cylinder block
1-12	Washer, Spring
1-13	Spring, CY
1-14	Washer, Spring
1-15	Circlip, Internal
1-16	Pin
1-17	Piston, assy
1-18	Plate, Retainer
1-19	Holder, Retainer
1-20	O-ring
2-0	Valve, assy
2-1	Valve
2-2	Pin
2-3	Orifice
2-4	Plug
2-5	Orifice
2-6	O-ring
2-7	Spool
2-8	Poppet
2-9	Spring
2-10	Plug
2-11	O-ring
2-12	Washer, Spring
2-13	Spring
2-14	Plug
2-15	O-ring
2-16	Spool
2-17	Spring
2-18	Plug
2-19	Adaptor
2-20	O-ring
2-21	Spool
2-23	Plug
2-24	O-ring
2-25	Bearing, ball
2-26	Plate, valve
2-27	Pin
3-0	Valve, assy
3-1	Housing
3-3	O-ring
3-4	Piston
3-5	Spring
3-6	Plug
3-7	O-ring
3-8	O-ring
4-0	Relief valve, assy
4-1	Housing, Relief
4-2	O-ring
4-3	O-ring
4-4	Ring, backup
4-5	Guide, Spring
4-6	O-ring
4-7	Ring, backup
4-8	Spring
4-9	Ring, Spring seat
4-10	Guide, poppet
4-11	Poppet
4-12	Ring, poppet seat
4-13	O-ring
4-14	Ring, backup
4-15	Set, screw
4-16	Nut
5-0	Gear case, assy
5-1	Holder, flange
5-2	Plug
5-3	Seal
5-4	Bearing
5-5	Plug
5-7	Case, gear
5-8	Ball
5-9	Plug
5-10	Plate, thrust
5-13	Collar
5-14	Bearing, needle
5-15	Gear, B
5-16	Plate, thrust B
5-17	Circlip, external
5-18	Gear
5-19	Circlip external
5-20	Holder
5-22	Collar
5-23	Bearing, needle
5-24	Gear, A
5-25	Pin, spring
5-27	Gear, drive
5-28	Plate, thrust C1
5-29	Plate, thrust C2
5-30	Plate, thrust C3
5-32	Cover
5-33	O-ring
5-34	Plug
5-35	O-ring
5-36	Pin, spring
5-37	Plug
5-38	O-ring
6-0	Bolt, hex-soc-hd
7-0	Bolt, hex-soc-hd
8-0	Plug
9-0	O-ring

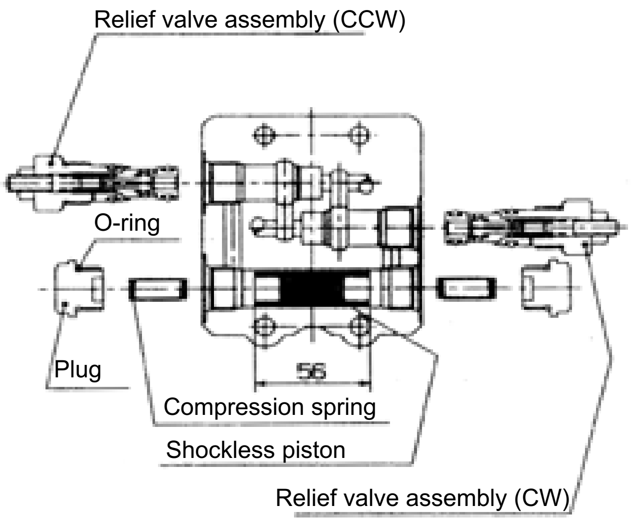
<Hydraulic Circuit Diagram>





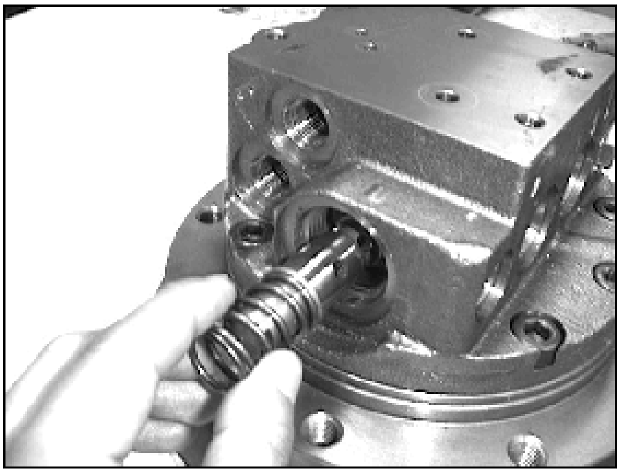


1) Relief valve
2) Shockless piston

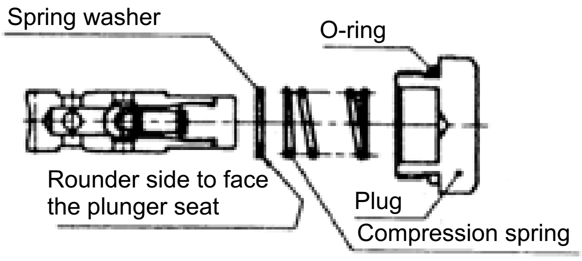


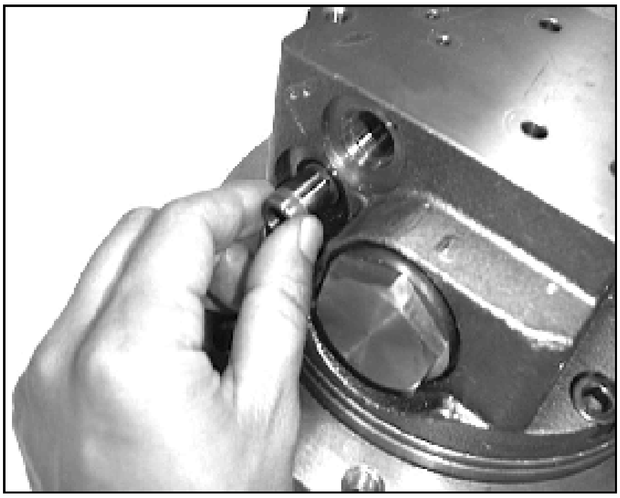
Relief valve tightening torque:
58.8 ~ 68.6 N·m
6.0 ~7.0 kg·m
43.4 ~ 50.6 ft·lbf

Plug tightening torque:
58.8 ~ 68.6 N·m
6.0~7.0 kg·m
43.4 ~ 50.6 ft·lbf

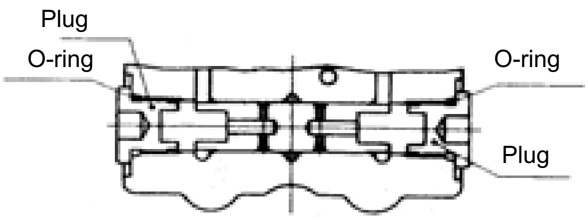


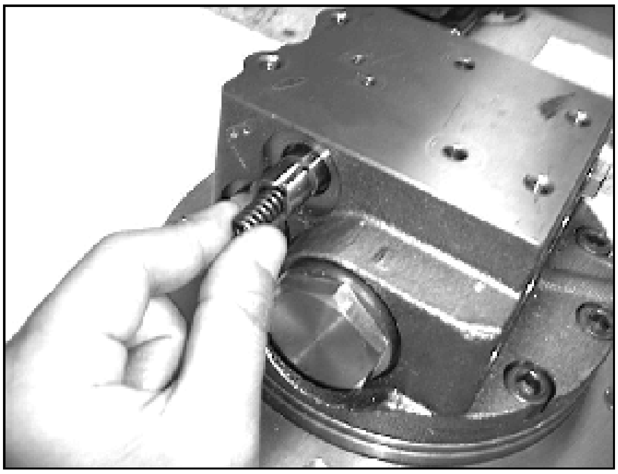
3) Counterbalance valve
*Tightening torque
235.0 ~ 245.0 N·m
24.0 ~ 25.0 kg·m
173.3~ 180.7 ft·lbf





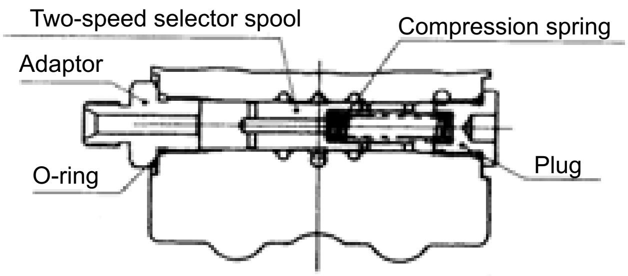
4) High-pressure selector spool
*Plug tightening torque
49.0 ~ 59.0 N·m
5.0 ~ 6.0 kg·m
36.1~ 43.5 ft·lbf





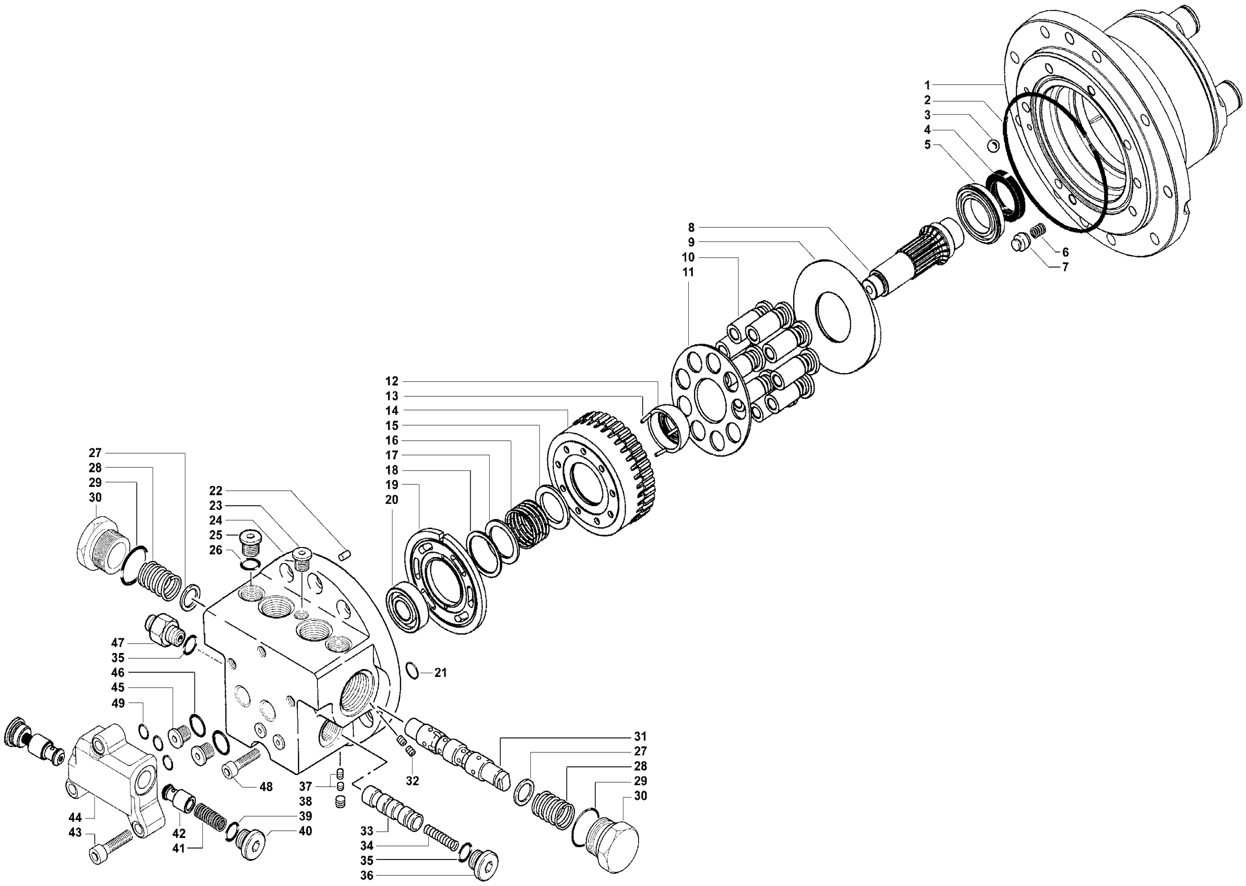
5) Two-speed selector spool
*Plug Tightening torque
49.0 ~ 59.0 N·m
5.0 ~ 6.0 kg·m
36.1~ 43.5 ft·lbf

Pay attention to the positions and directions of the parts.

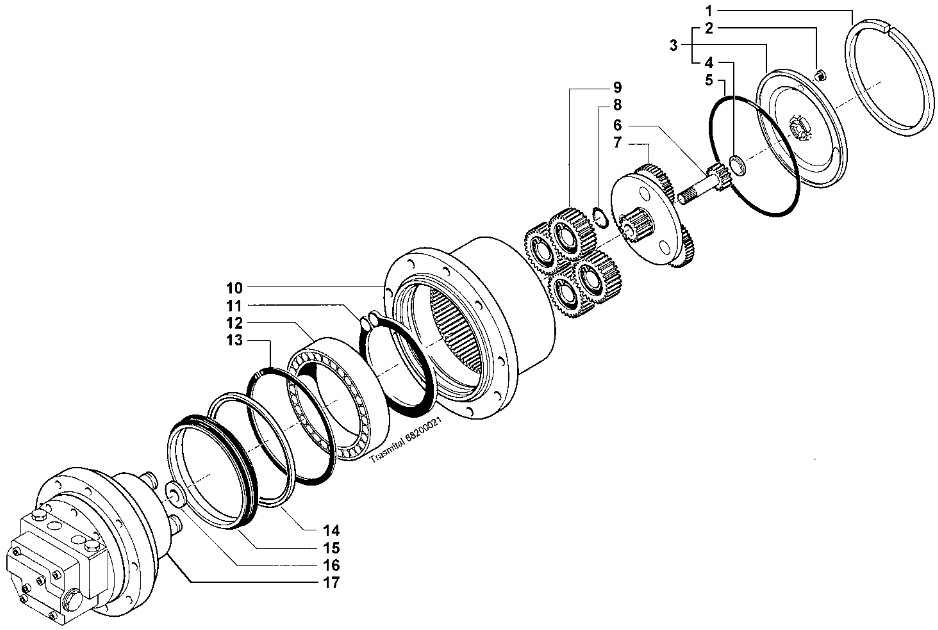


(2) Inner parts of the traveling motor

1) KE, KDG, KUK version

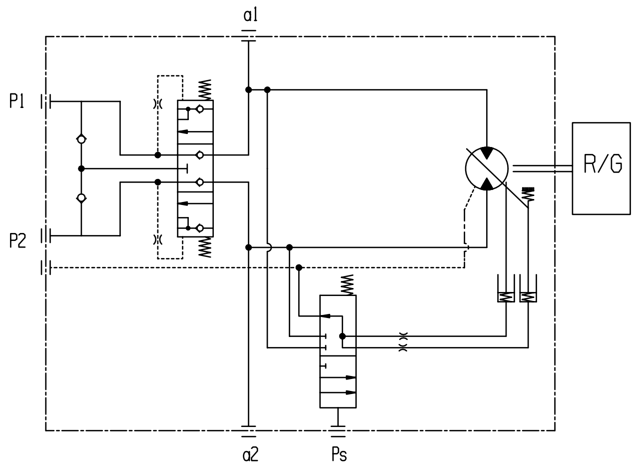


1	Hub	18	Circlip	35	O-ring
2	O-ring	19	Valve plate	36	Plug
3	Ball	20	Bearing	37	Orifice
4	Motor seal ring	21	O-ring	38	Plug
5	Bearing	22	Pin	39	O-ring
6	Spring	23	Plug	40	Plug
7	Piston	24	Base plate	41	Spring
8	Motor shaft assy	25	Plug	42	Check valve
9	Swash plate	26	O-ring	43	Screw
10	Piston	27	Spring seat	44	Valve housing
11	Retainer plate	28	Spring	45	Plug
12	Spherical bush	29	O-ring	46	O-ring
13	Pin	30	Plug	47	Plug
14	Cylinder block	31	Plunger assy	48	Screw
15	Spring holder	32	Orifice	49	O-ring
16	Spring	33	Spool		
17	Collar washer	34	Spring		

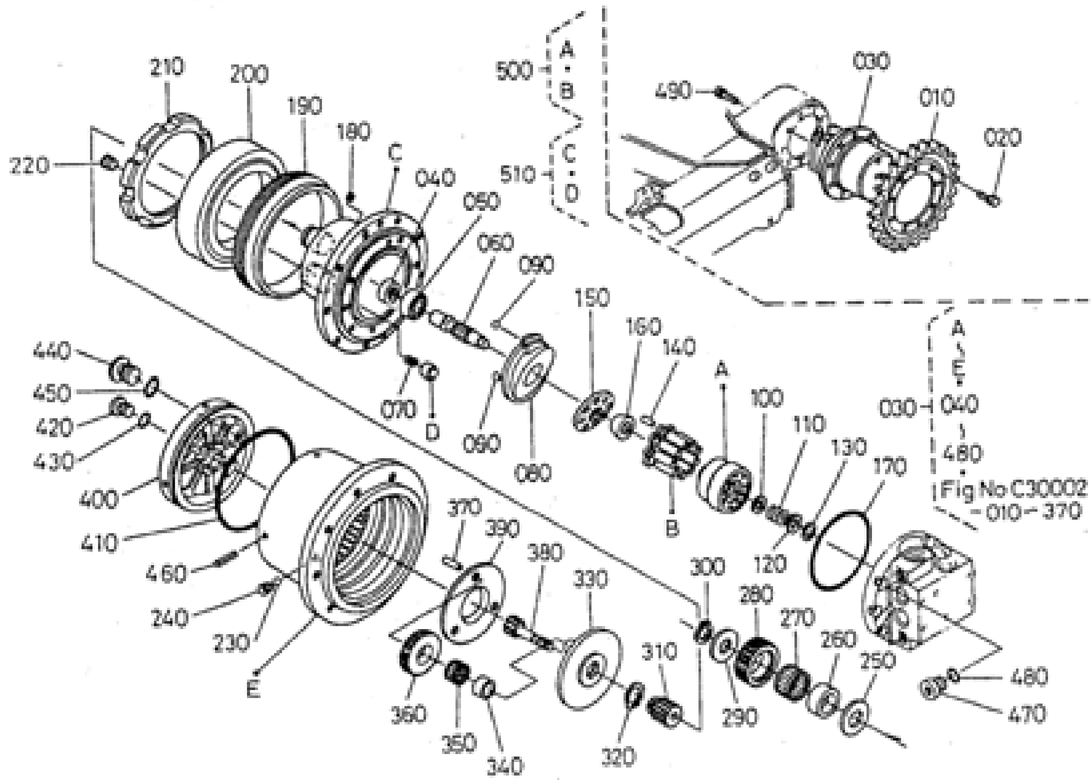


1	Circlip	7	1st. RED. assembly	13	Circlip
2	Plug	8	Circlip	14	Spacer
3	Cover assembly	9	Planetary assembly	15	Spacer
4	Pad	10	Gearbox housing	16	Centering ring
5	O-ring	11	Circlip	17	Hydraulic motor
6	Sun gear	12	Bearing		

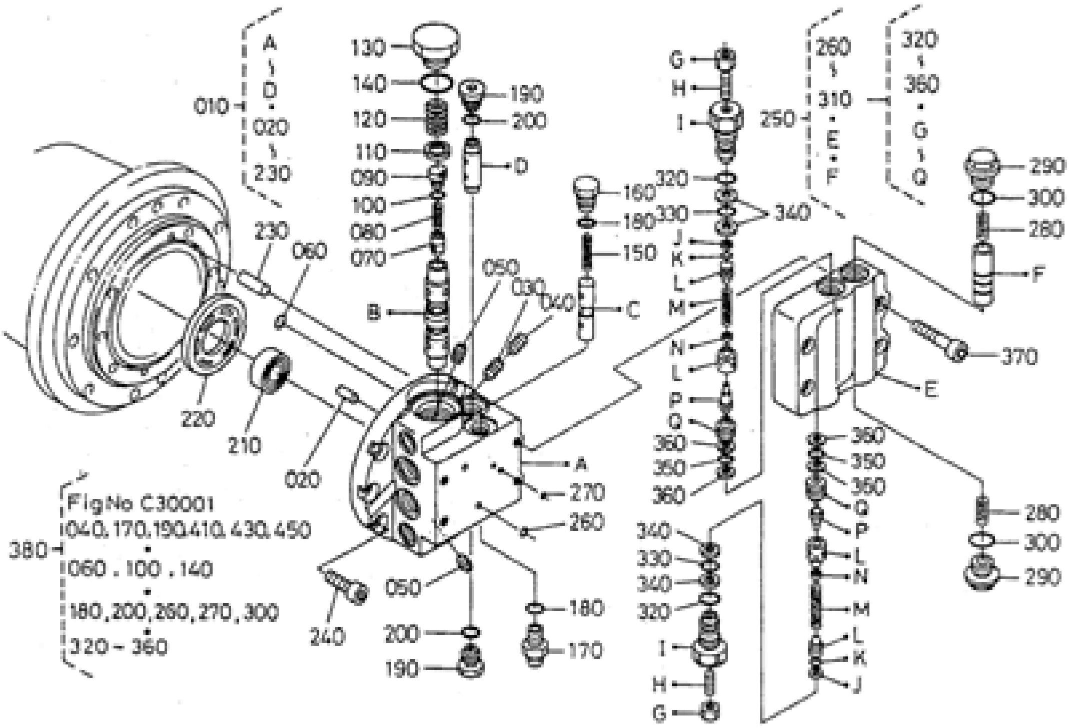
<Hydraulic circuit diagram>



2) KTC, KCL, KTA version

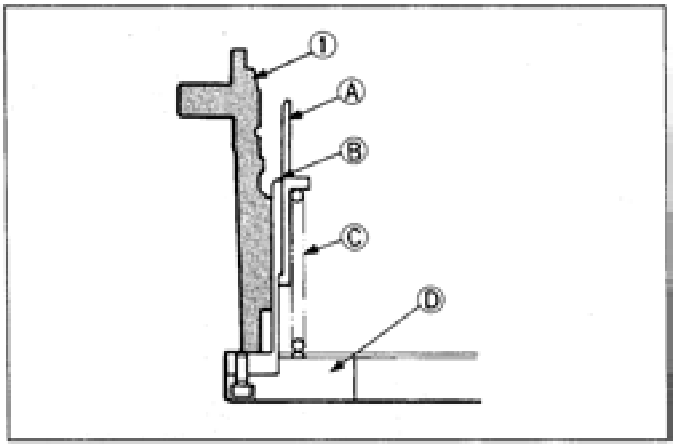


010	Sprocket, Drive	180	Plug	350	Bearing, Needle
020	Bolt	190	Seal	360	Gear
030	Assy motor, Wheel	200	Bearing	370	Pin, Spring
040	Seal, oil	210	Nut, Plug	380	Gear, Drive
050	Bearing, Ball	220	Plug	390	Plate
060	Shaft	230	Ball	400	Cover
070	Spring, Piston	240	Plug	410	O-ring
080	Swash plate	250	Plate, Thrust B	420	Plug
090	Ball	260	Collar	430	O-ring
100	Washer, Spring	270	Bearing, Needle	440	Plug
110	Spring	280	Gear	450	O-ring
120	Washer, Spring	290	Plate	460	Pin, Spring
130	Circlip, Internal	300	Circlip, External	470	Plug
140	Pin	310	Gear	480	O-ring
150	Plate, retainer	320	Circlip, External	490	Bolt
160	Holder, retainer	330	Holder	500	Assy block, Cylinder
170	O-ring	340	Collar	510	Assy holder, Frange



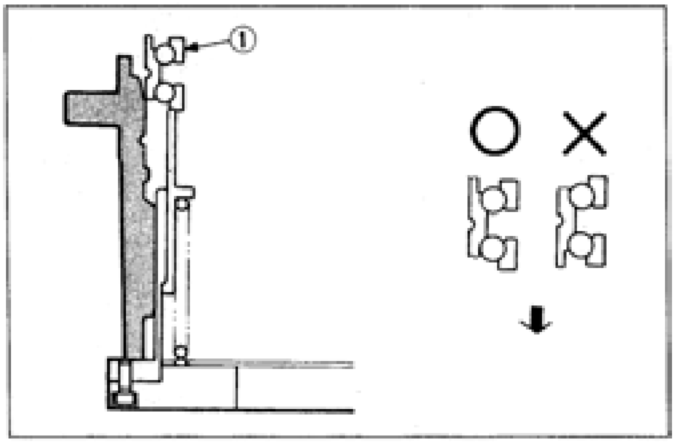
010	Assy valve
020	Pin, Straight
030	Orifice
040	Plug
050	Orifice
060	O-ring
070	Poppet
080	Spring
090	Plug
100	O-ring
110	Washer, Spring
120	Spring
130	Plug
140	O-ring
150	Spring
160	Plug
170	Adaptor
180	O-ring
190	Plug
200	O-ring
210	Bearing, Ball
220	Plate, Valve
230	Pin, Straight
240	Bolt, HEX-SOC-HD
250	Assy valve
260	O-ring
270	O-ring
280	Spring
290	Plug
300	O-ring
310	Assy valve, Relief
320	O-ring
330	O-ring
340	Ring, Backup
350	O-ring
360	Ring, Backup
370	Bolt, HEX-SOC-HD
380	Kit seal

(3) Assembling of the traveling motor (KTC, KCL, KTA version)



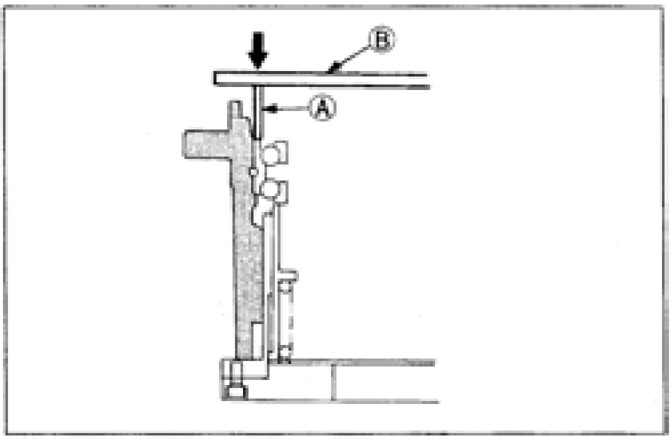
1. Set the angular bearing fitting jigs to the housing.

(1) Housing
A. Spring guide (Jig 4)
B. Housing guide (Jig 5)
C. Spring (Jig 7)
D. Base plate (Jig 6)



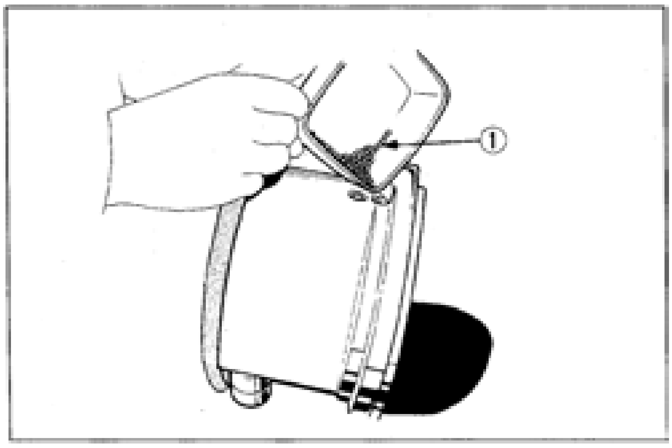
2. Place the angular bearing in its specified direction with care not to let the inner ring fall.

(1) Angular bearing



3. Press-fit the angular bearing into position.

A. Pressing jig (Jig 8)
B. Press-fitting plate (Jig 9)

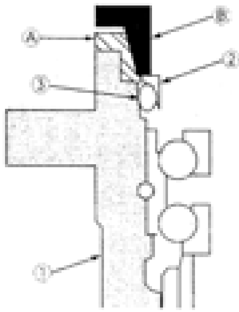


4. Put the 132 steel balls in the outer groove of the bearing.

(1) Steel balls

5. Wind sealing tape around the plug with the two end threads exposed. Apply and tighten this plug.
   Plug (R1/8) tightening torque:
   9.8 ~ 14.7 N·m
   1.0 ~ 1.5 kg·m

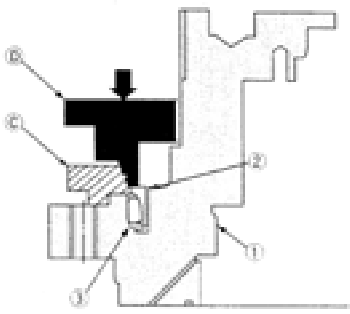
6. Place the guide jig on the housing. Apply grease to the O-ring and temporarily place the floating seal. Using the specified press-fitting jig, evenly press-fit the floating seal with care not to twist or tilt the O-ring.



(1) Housing
(2) Floating seal
(3) O-ring

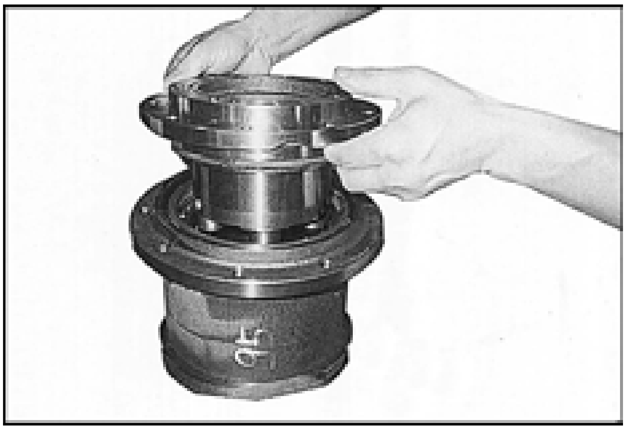
A. Guide (Jig 10)
B. Press-fitting jig (Jig 11)

7. Place the guide jig on the flange holder. Apply grease to the O-ring and temporarily place the floating seal. Using the specified press-fitting jig, evenly press-fit the floating seal with care not to twist or tilt the O-ring.

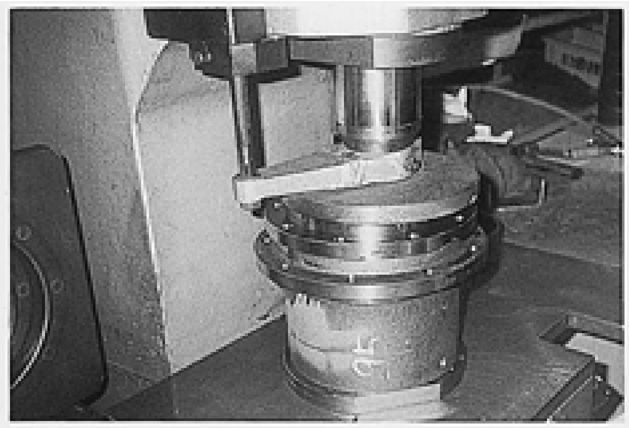


(1) Flange holder
(2) Floating seal
(3) O-ring

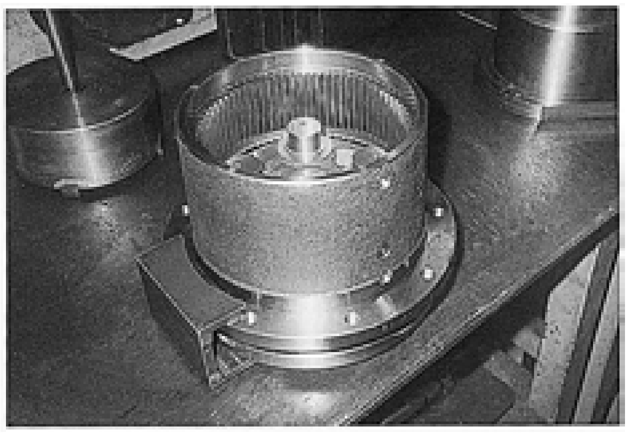
A. Guide (Jig 12)
B. Press-fitting jig (Jig 13)



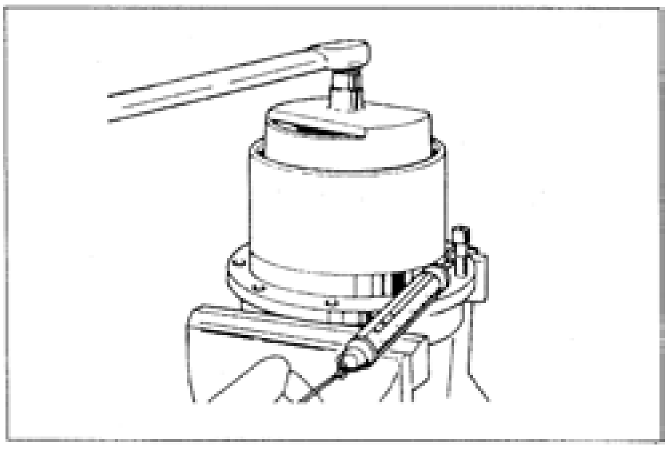
8. Clean the sliding surface of the floating seal. Apply grease over this surface and put the flange holder in the housing.



9. Using the specified press-fitting jig, set the flange holder on the housing.



10. Using the specified clamping jig, clamp the flange holder to the housing.
    Detach the press-fitting jig and turn the housing upside down. Leaving the clamping jig in place, remove all the angular bearing fitting jigs.

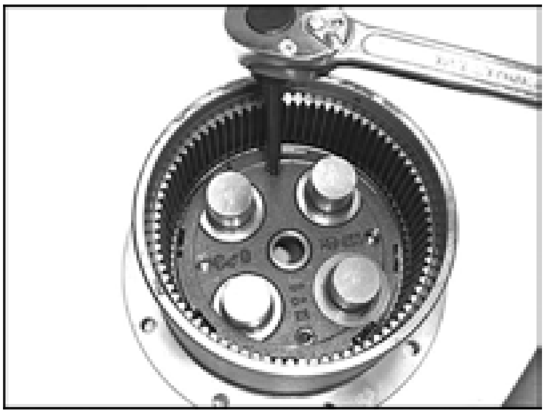


11. Using the specified ring nut fitting jig, tighten the ring nut.

Tightening procedure:

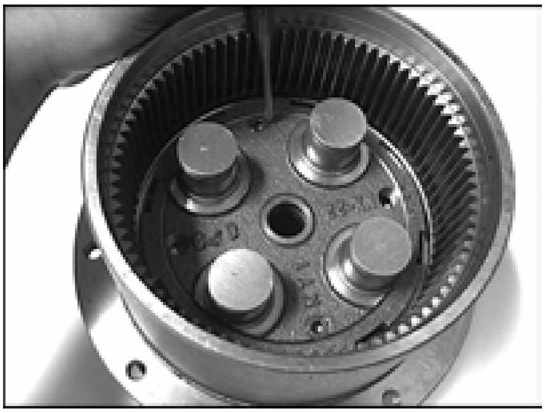
(1) Tighten the ring nut to the torque of 2400 kgf-cm so that there will be no gap between the nut and angular bearing. Turn the housing several times and measure the startup load to make sure it is about 5 kgf.

(2) Tighten the ring nut further until the startup load becomes about 6-7 kgf.

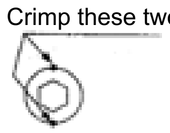


12.Using a hand tap, tap the ring nut locking plug hole R1/4. Remove cuttings and tighten the plug.

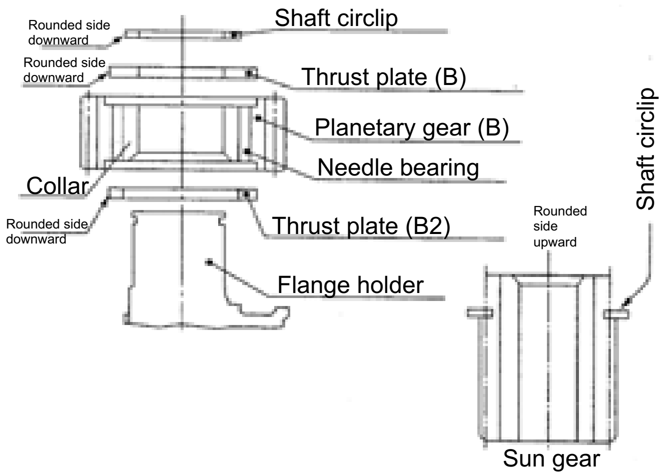
Tightening torque:
24.5 ~ 34.3 N·m
2.5 ~ 3.5 kg·m



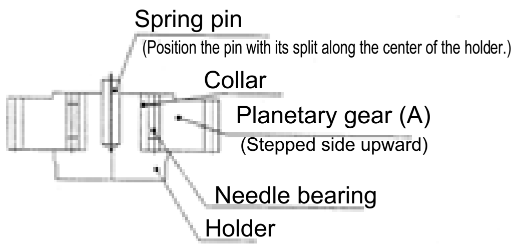
13.Using a punch, crimp the following two points to hold the plug in position.



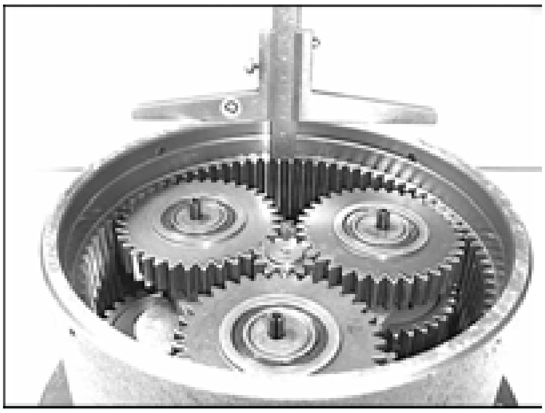
14.Using the shaft circlip, fit the thrust plate (B), planetary gear (B), needle bearing and thrust collar plate (B2) to the flange holder.



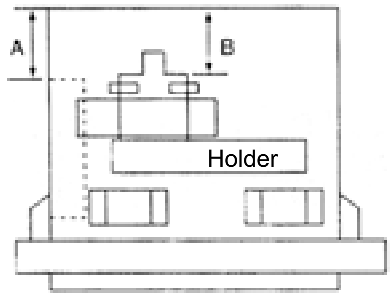
15.Fit the planetary gear (A) and assembly drive gear in their positions.

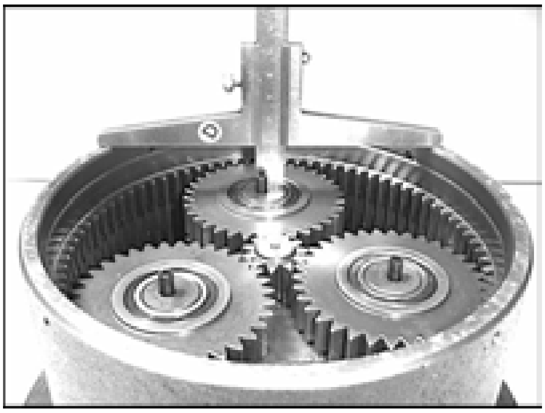


16.Fit the thrust plate in position.
* The thrust plate comes in different thicknesses. Measure the clearance in the following steps and select the right plate thickness.



Selecting the right thrust plate
(1) Measure the dimension (A) with a depth gauge.



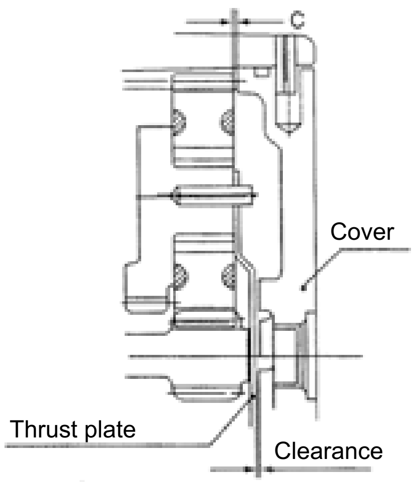


(2)Measure the dimension (B) with a depth gauge.

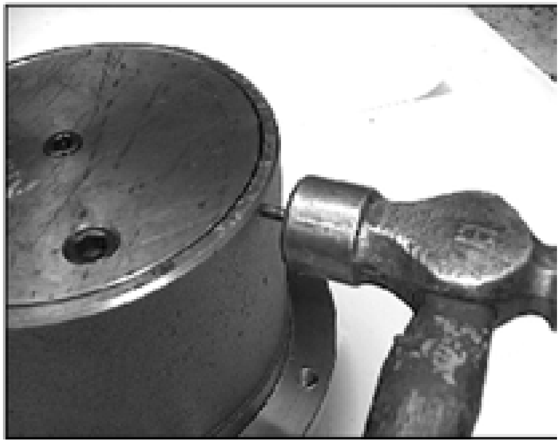
A - B = C

Dimension C	Part code	Thrust plate Thickness
0.75 ~ 1.25	68311-1355△	1.8
1.25 ~ 1.75	68311-1356△	2.3
1.75 ~ 2.25	68311-1357△	2.8

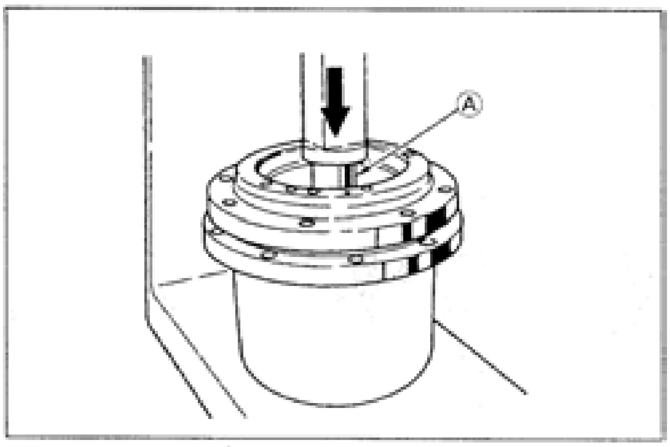
Unit: mm



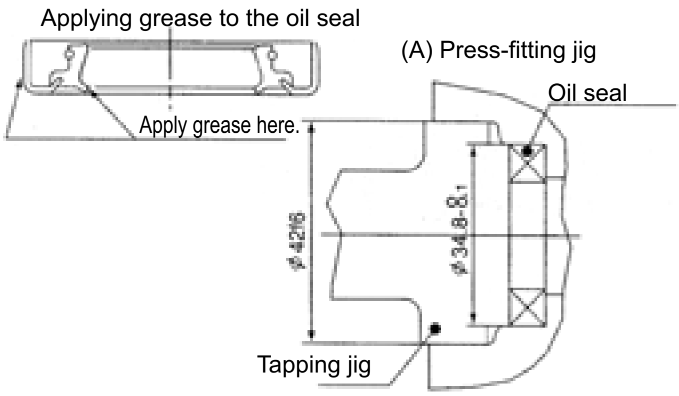
17.Apply grease to the O-ring and fit the cover to the gear case.

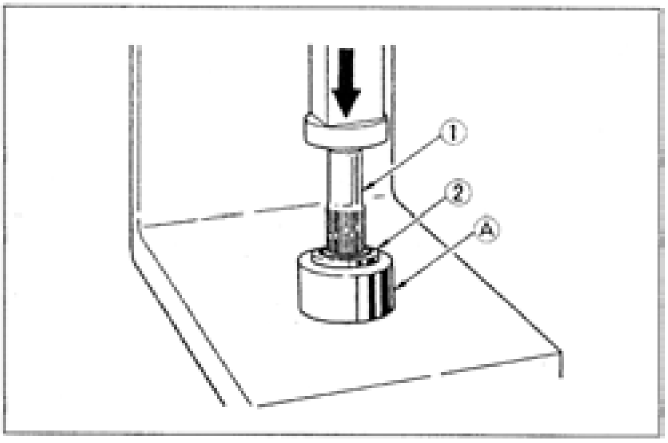


18.Drive the four spring pins into position.

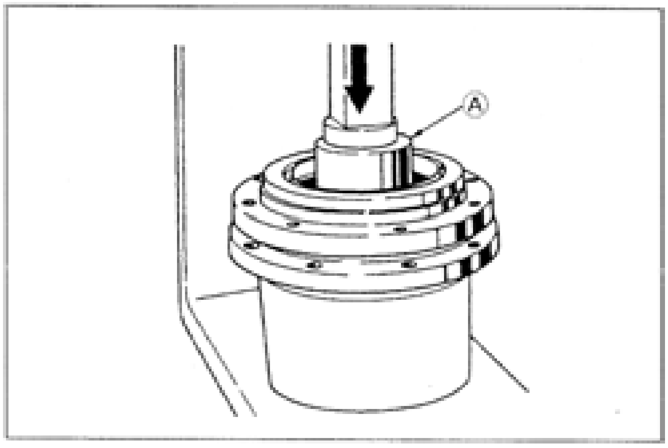


19.Apply grease to the oil seal. Using the specified press-fitting jig, press-fit the oil seal in the flange holder.

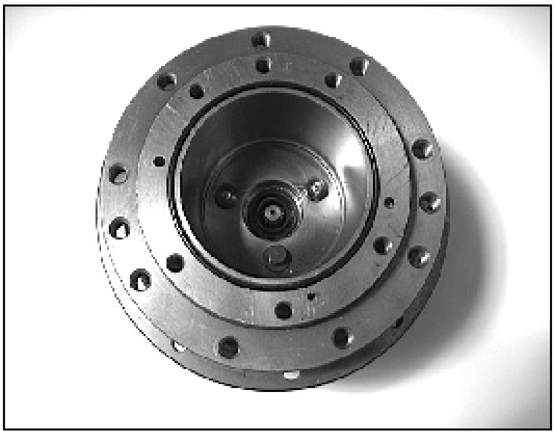




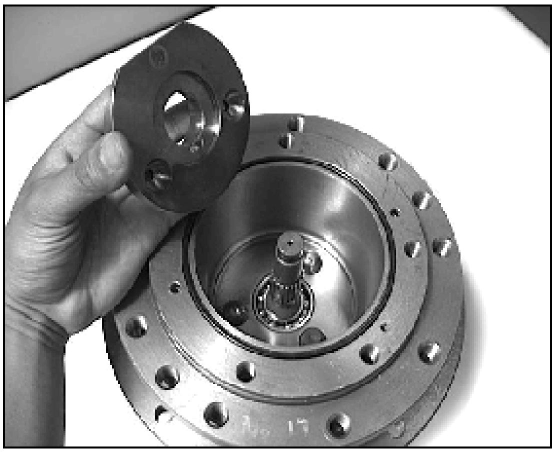
20.Using the specified press-fitting jig, press-fit the ball bearing on the shaft.
(1)Shaft
(2)Ball bearing
(3)Press-fitting jig



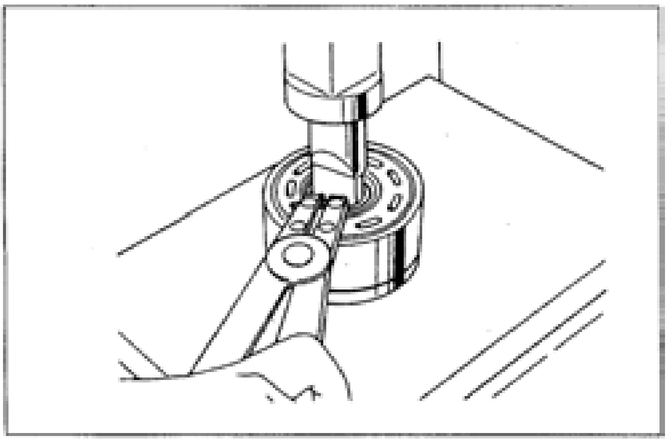
21.Using the specified press-fitting jig, press-fit the shaft sub-assembly in the flange holder.
(A)Press-fitting jig



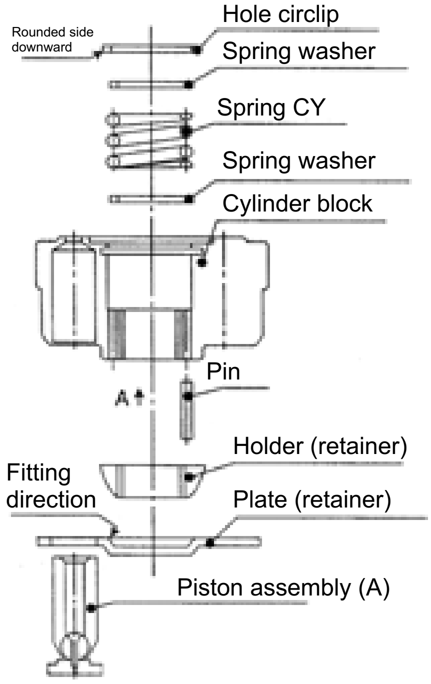
22.Apply grease to the compression spring. Fit the piston assembly in the flange holder. Apply grease to the balls and put them in the flange holder.



23.Fit the swash plate into position.

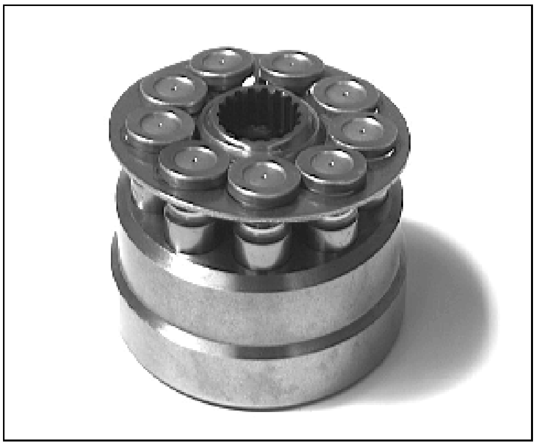


24.Install the spring and two washers in the cylinder block. Using the specified fitting jig, install the snap ring in place.

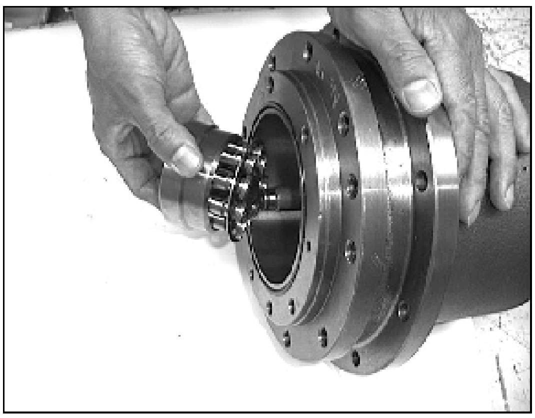


25.Fit the three pins in the cylinder block.

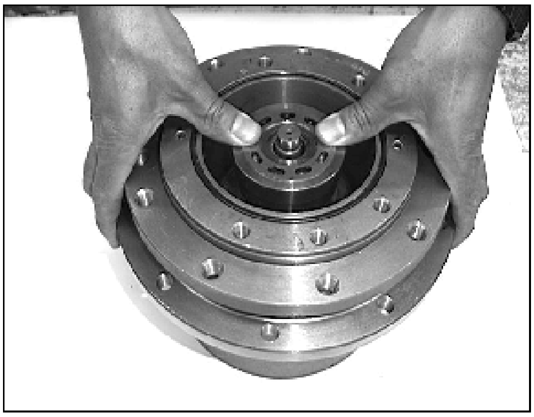
* Apply grease to the pins beforehand to avoid accidental drop.



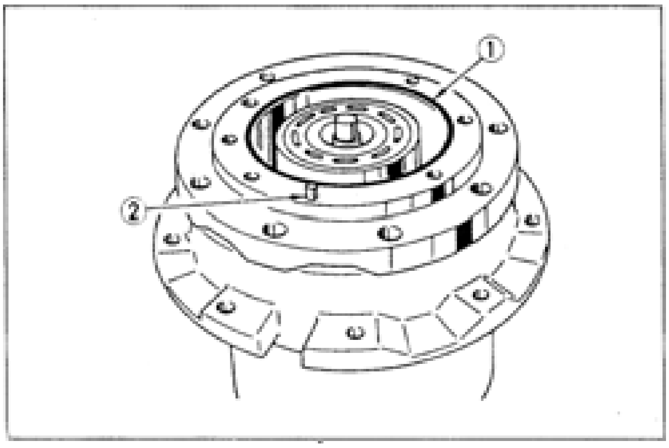
26.Apply hydraulic oil in the nine holes of the cylinder block. Put the holder (retainer), plate (retainer) and piston together into the cylinder block sub-assembly.



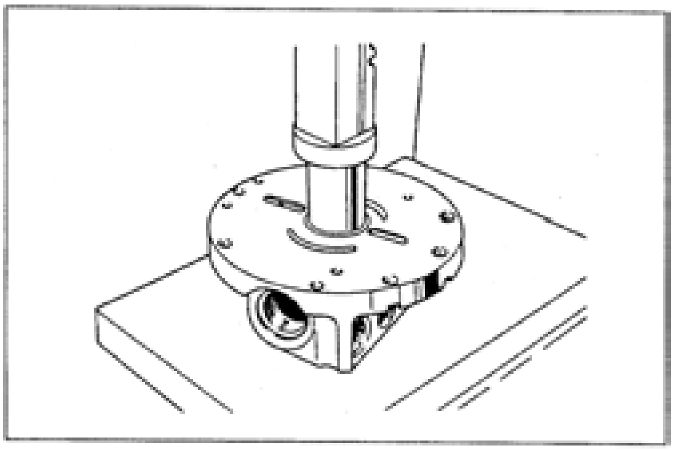
27.Place the motor sideways. Fit the cylinder block sub-assembly, along the shaft spline, into the motor.



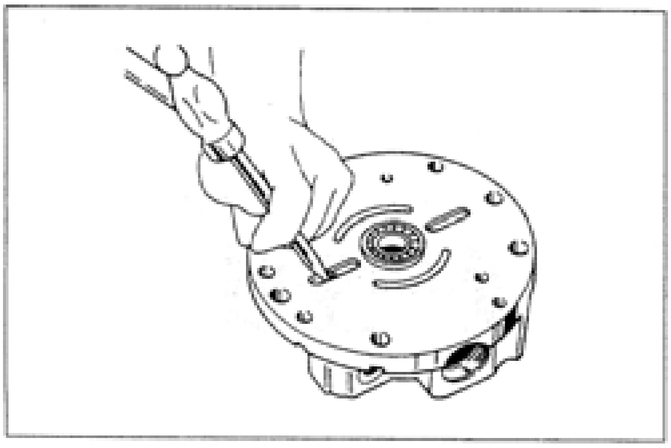
28.Hand-press the cylinder block to make sure the spring reacts. Apply hydraulic oil to the sliding surface of the cylinder block.



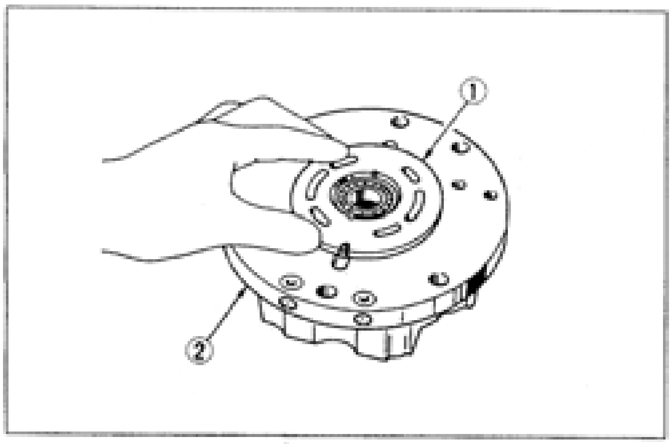
29.Apply grease to the O-ring. Fit the parallel pin and this O-ring in the flange holder.
(1)O-ring
(2)Parallel pin



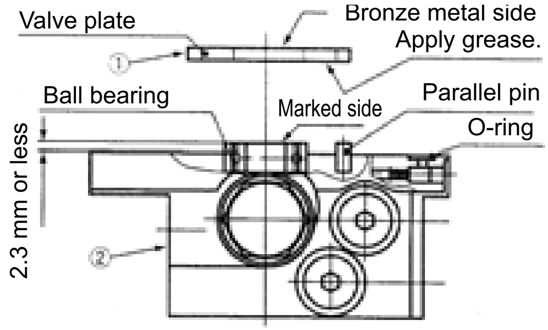
30.Using the specified jig, tap the bearing, with its marked side upward, until there is a step difference of 2.3 mm or less with the body.

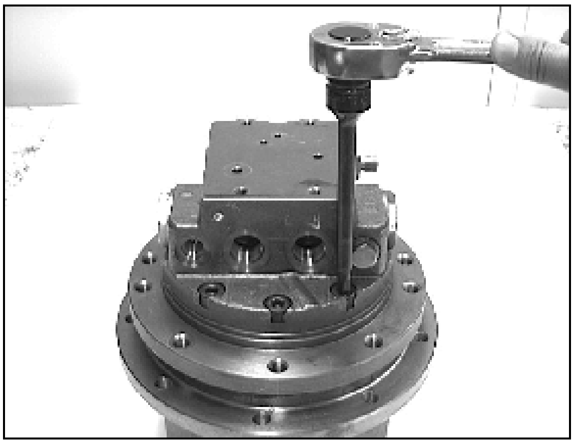


31.Drive the parallel pin all the way into contact.



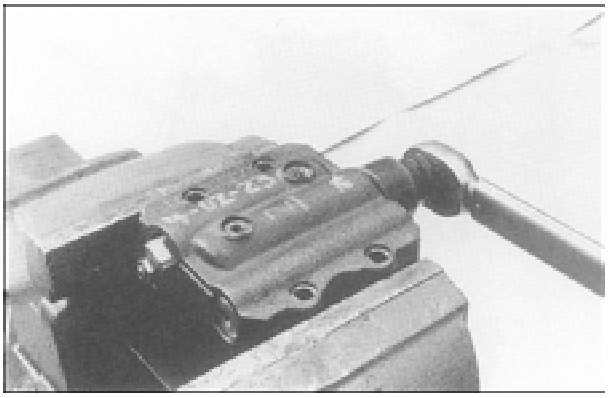
32.Apply grease over the back of the valve plate. Fit the valve plate in the body.



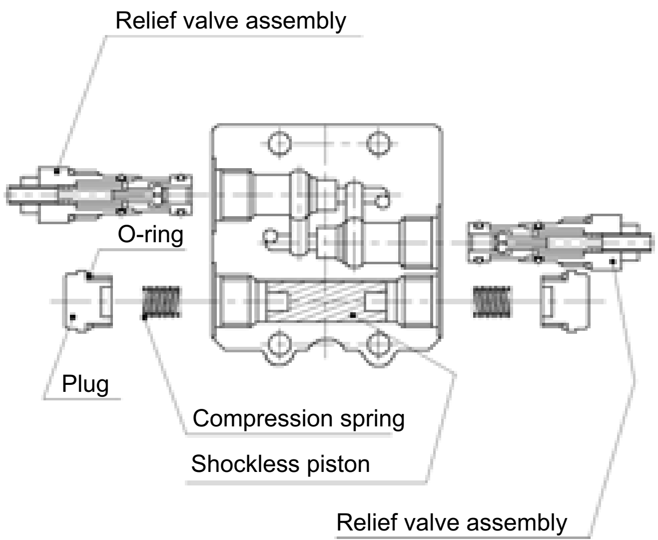


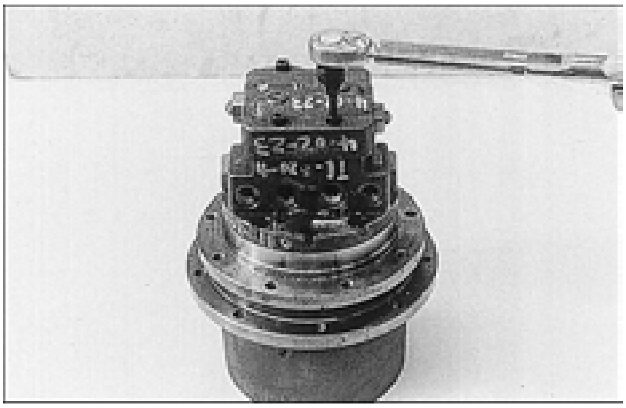
33.Fix the valve assembly in position with the hex socket bolts (M10).

Tightening torque:
48.1 ~ 55.9 N·m
4.9 ~ 5.7 kg·m



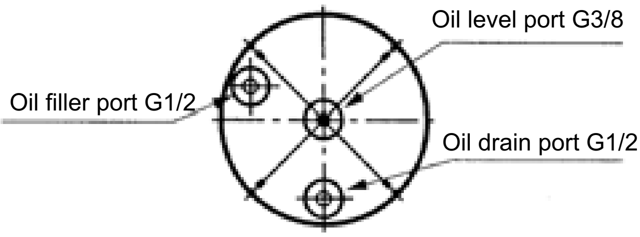
34.Fit the shockless piston and relief valve assembly into the valve body.
Plug tightening torque:
58.8 ~ 68.6 N·m (6.0 ~ 7.0 kg·m)
Relief valve tightening torque:
58.8 ~ 68.6 N·m (6.0 ~ 7.0 kg·m)





35.Fit the relief valve sub-assembly in place and tighten the socket head bolts.

Tightening torque: 27.4 ~ 31.4 N·m (2.8 ~ 3.2 kg·m)

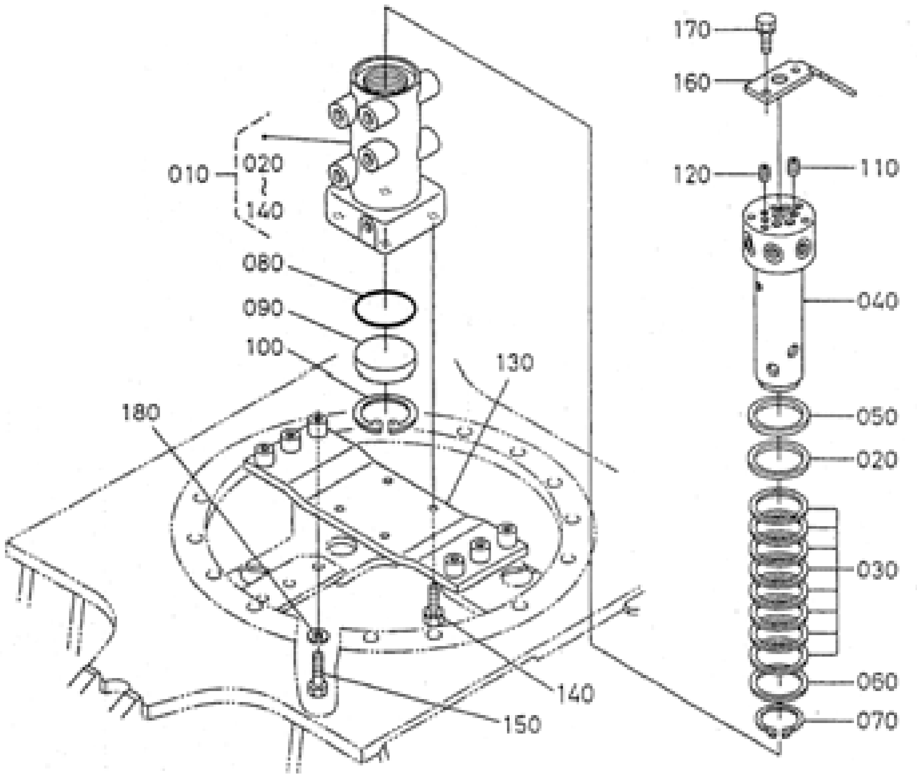


36.Pour the following amount of gear oil through the plug screw hole. Tighten up the plug.

Gear oil (SAE#90): 0.5 l
Plug tightening torque:
G3/8: 49.0 ~ 58.8 N·m (5.0 ~ 6.0 kg·m)
G1/2: 58.8 ~ 68.6 N·m (6.0 ~ 7.0 kg·m)

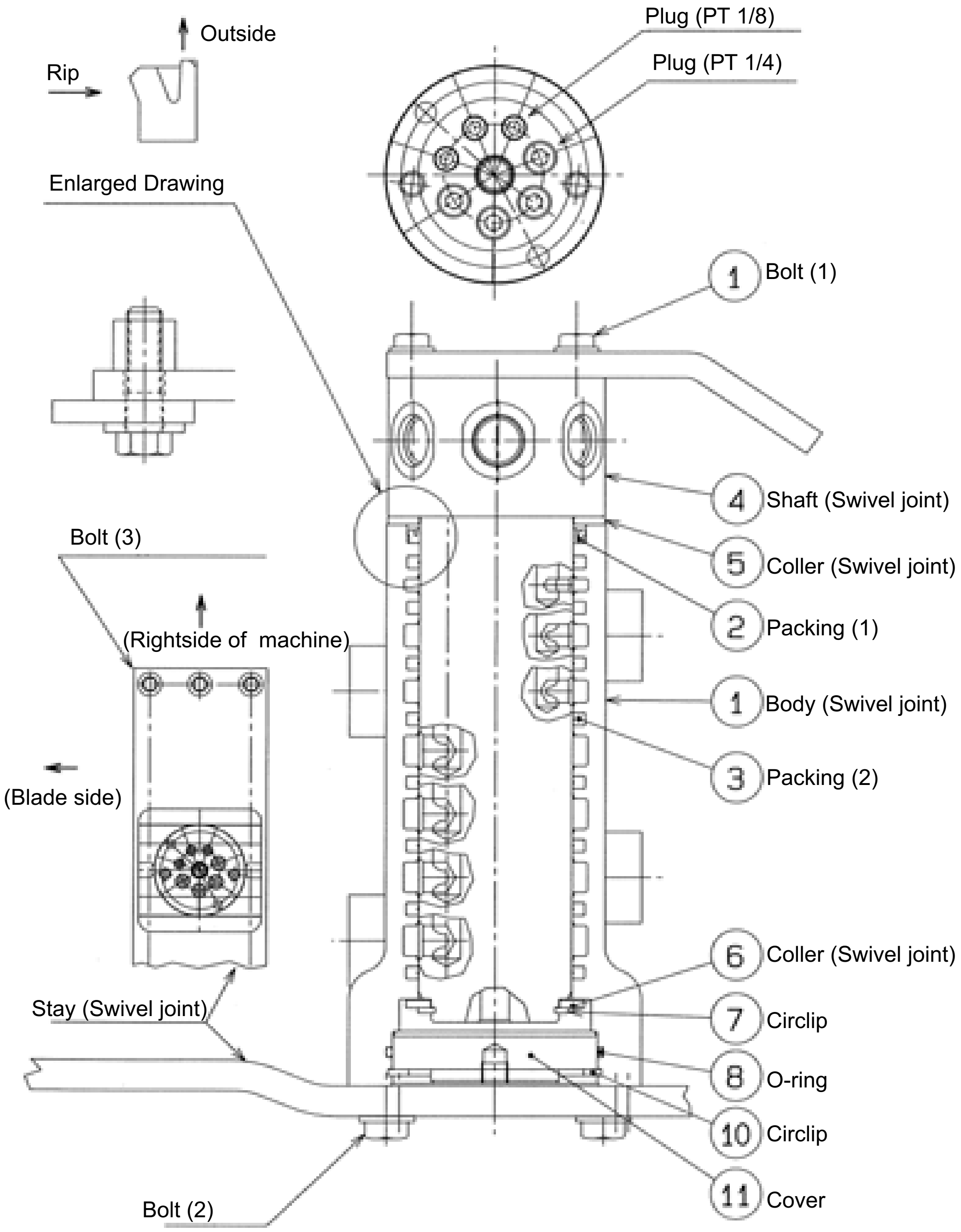
g. Rotary joint

(1) Inner parts of the rotary joint



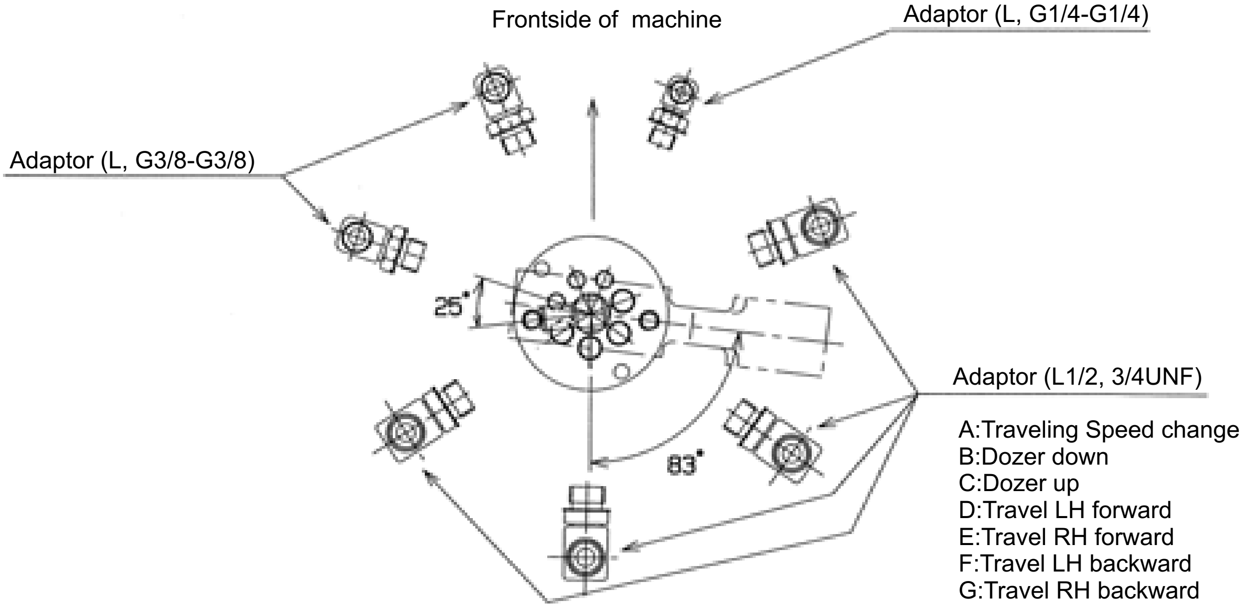
010	Assy joint, Swivel	070	Circlip, Internal	130	Stay
020	Gasket	080	O-ring	140	Bolt
030	Gasket	090	Cover	150	Bolt
040	Shaft, Swivel joint	100	Circlip, Internal	160	Stopper
050	Collar	110	Plug	170	Bolt
060	Collar	120	Plug	180	Washer, Spring

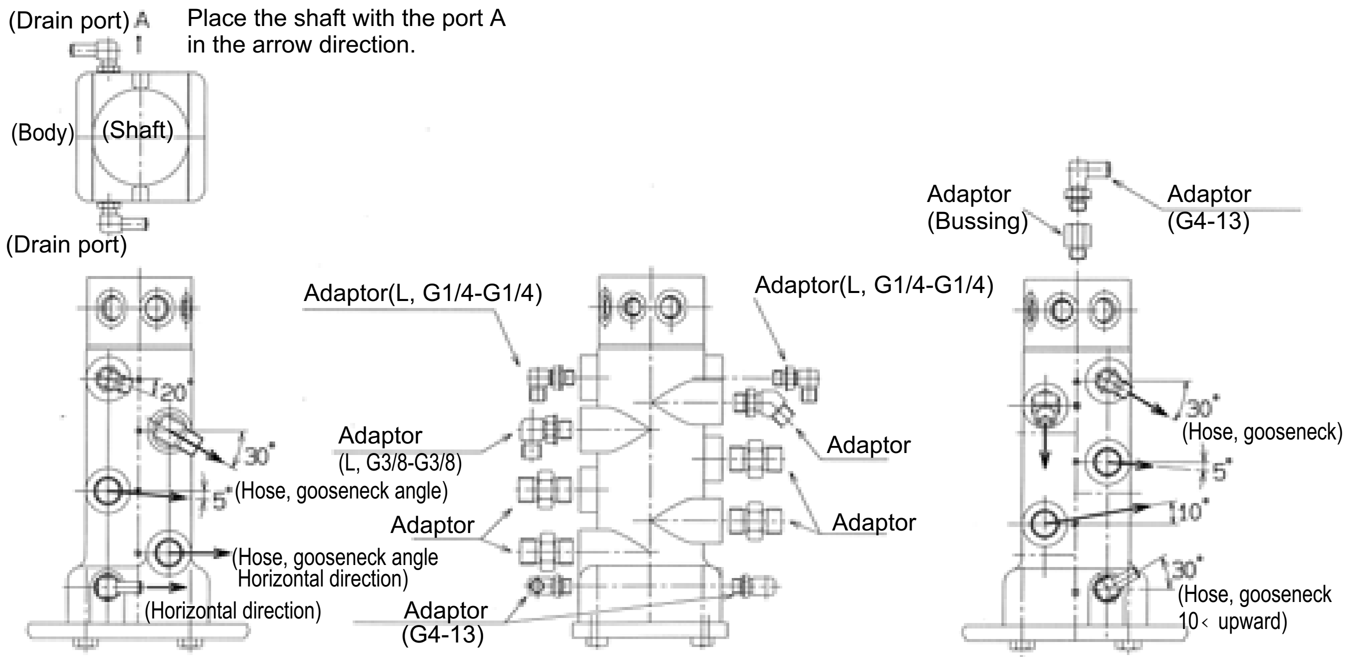
(2) Assembling of the rotary joint



1. Place the packing (1) with its lip in the arrow direction, as shown above. Apply grease over the inner and outer surfaces of the packing (1) beforehand.
2. Apply grease over the inner and outer surfaces of the packing (2) beforehand.
3. Apply screw adhesive (Three Bond #1324) to the bolt (1).
4. Apply screw adhesive (Three Bond #1324) to the bolt (2).
   Bolt tightening torque: 77.5 ~ 90.2 N·m
   7.9 ~ 9.2 kg·m
   57.2 ~ 66.5 ft·lbf
5. Apply screw adhesive to the bolt (3).
   166.7 ~ 196.1 N·m
   17.0 ~ 20.0 kg·m
   123.0 ~ 144.6 ft·lbf

(3) Adaptor installation on the rotary joint (KTC, KCL, KTA version)



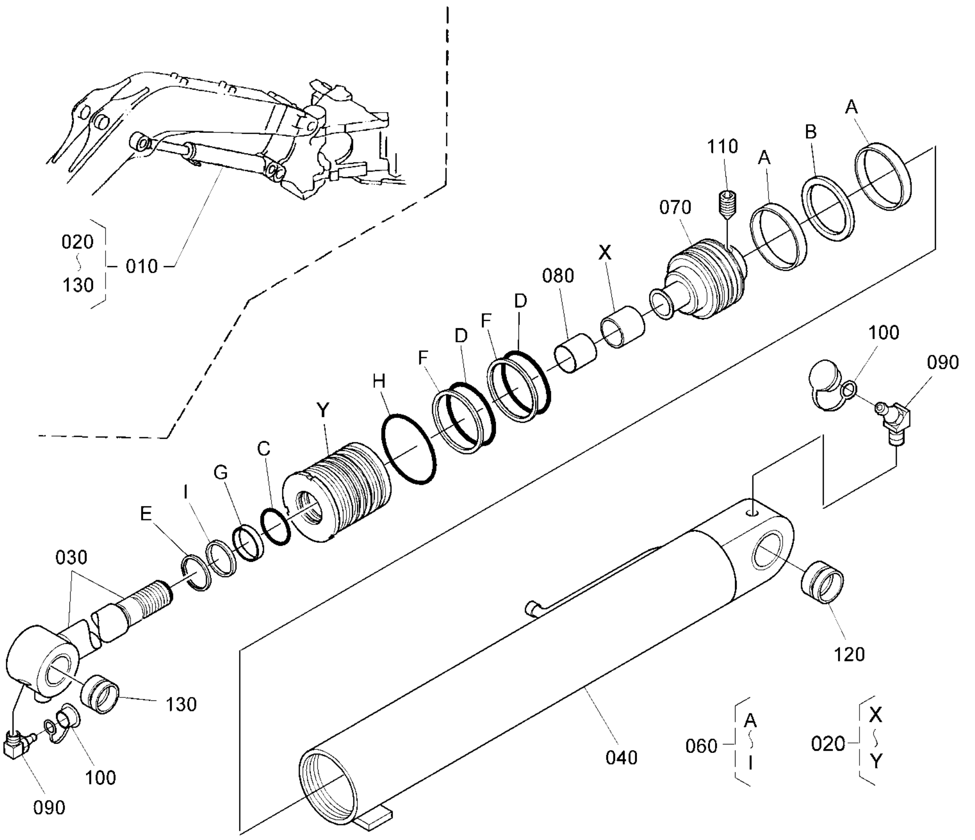


Note: The adaptors at the ports D, E, F and G are unified-threaded. Tighten these adaptors to the torque of 44.1 ~ 53.9 N·m, 4.5 ~ 5.5 kgf·m, 32.5 ~ 39.8 ft·lbf.

h. Cylinder (KE, KDG, KUK version)

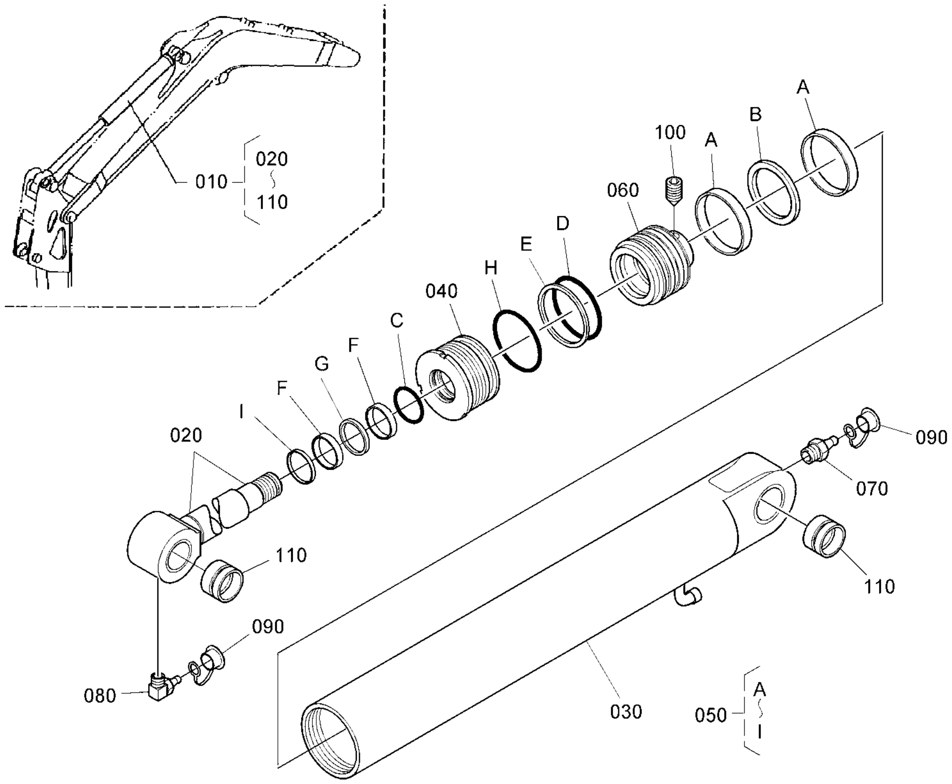
(1) Inner parts of the cylinder

1) Boom cylinder



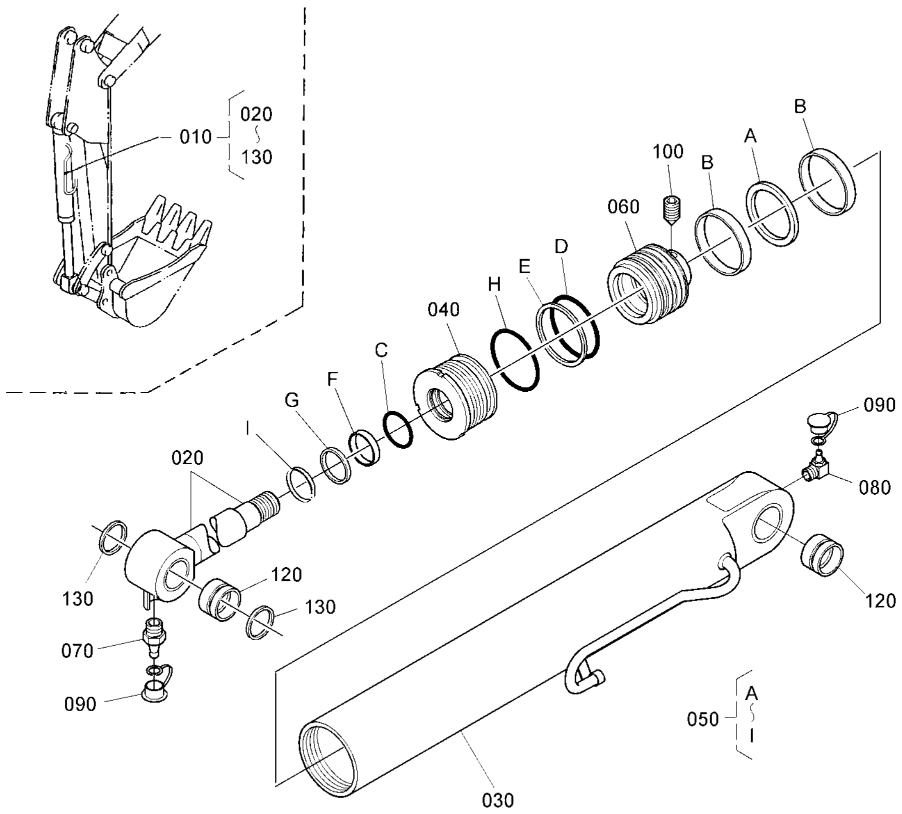
010	Assy cylinder, Boom	060	Kit, Seal	110	Screw, Set
020	Kit, Cushion	070	Piston	120	Bush
030	Rod, Piston	080	Spacer	130	Bush
040	Tube, Cylinder	090	Greace Nipple		
050	-	100	Plug		

2) Arm cylinder



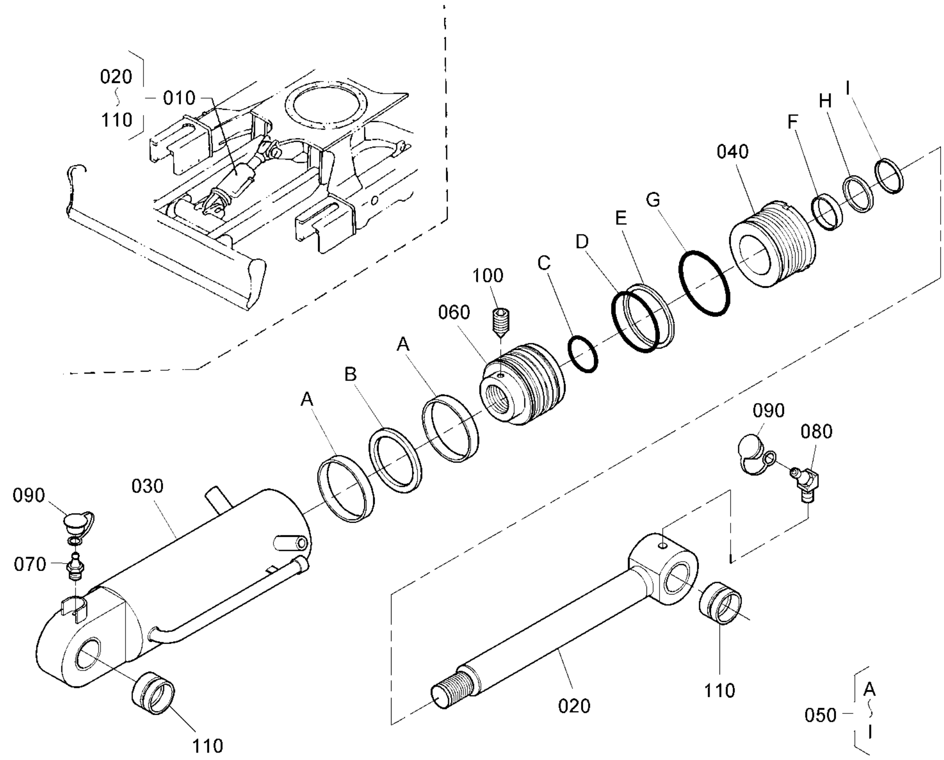
010	Assy cylinder, Arm	050	Kit, Seal	090	Plug
020	Rod, Piston	060	Piston	100	Set, Screw
030	Tube, Cylinder	070	Greace Nipple	110	Bush
040	Cylinder head	080	Greace Nipple		

3) Bucket cylinder



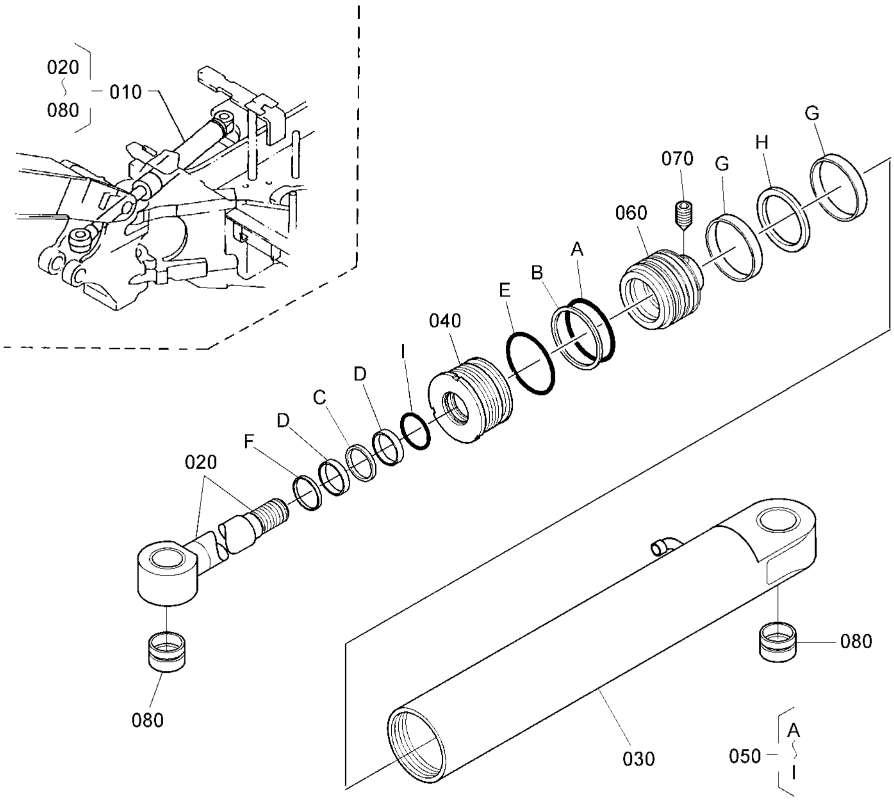
010	Assy cylinder, Bucket	060	Piston	110	-
020	Rod, Piston	070	Greace Nipple	120	Bush
030	Tube, Cylinder	080	Greace Nipple	130	Seal
040	Cylinder head	090	Plug		
050	Kit, Seal	100	Set, Screw		

4) Dozer cylinder



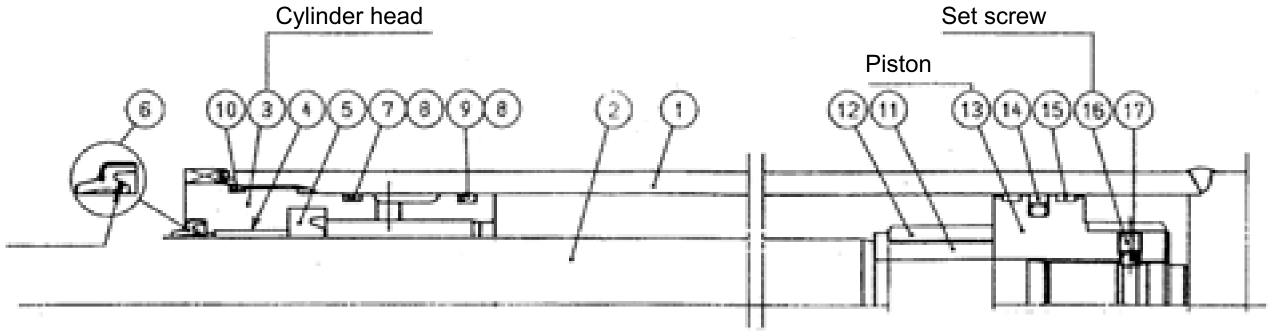
010	Assy cylinder, Dozer	050	Kit, Seal	090	Plug
020	Rod, Piston	060	Piston	100	Set, Seal
030	Tube, Cylinder	070	Greace Nipple	110	Bush
040	Cylinder head	080	Greace Nipple		

5) Swing cylinder



010	Assy cylinder, Swing	040	Cylinder head	070	Set, Screw
020	Rod, Piston	050	Kit, Seal	080	Bush
030	Tube, Cylinder	060	Piston		

(2) Tightening torque



1. Boom cylinder

	Tightening torque	Adhesive	Remarks
Cylinder head	375 ± 25 N·m 38.2 ± 2.6 kgf·m		
Piston	600 ± 120 N·m 61.2 ± 12.2 kgf·m		
Set screw	20 N·m 2.0 kgf·m		

2. Arm cylinder

	Tightening torque	Adhesive	Remarks
Cylinder head	375 ± 25 N·m 38.2 ± 2.6 kgf·m		
Piston	475 ± 95 N·m 48.5 ± 9.7 kgf·m		
Set screw	20 N·m 2.0 kgf·m		

3. Bucket cylinder

	Tightening torque	Adhesive	Remarks
Cylinder head	275 ± 25 N·m 28.1 ± 2.6 kgf·m		
Piston	475 ± 95 N·m 48.5 ± 9.7 kgf·m		
Set screw	20 N·m 2.0 kgf·m		

4. Dozer cylinder

	Tightening torque	Adhesive	Remarks
Cylinder head	275 ± 25 N·m 28.1 ± 2.6 kgf·m		
Piston	600 ± 120 N·m 61.2 ± 12.2 kgf·m		
Set screw	20 N·m 2.0 kgf·m		

5. Swing cylinder

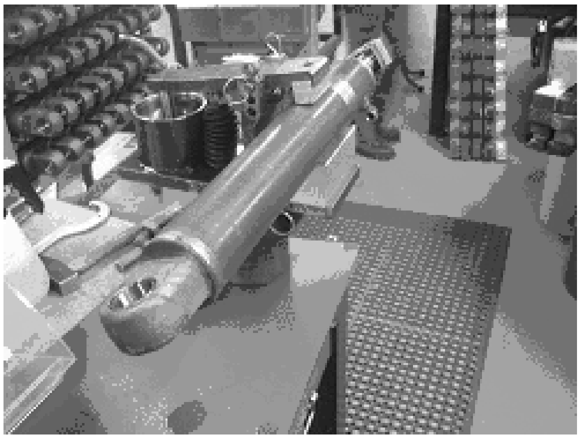
	Tightening torque	Adhesive	Remarks
Cylinder head	375 ± 25 N·m 38.2 ± 2.6 kgf·m		
Piston	475 ± 95 N·m 48.5 ± 9.7 kgf·m		
Set screw	20 N·m 2.0 kgf·m		

(3) Disassembling and assembling

1) Proceeding Disassembly and Reassembly of BOOM-Cylinders. (EX. Boom Cylinder)

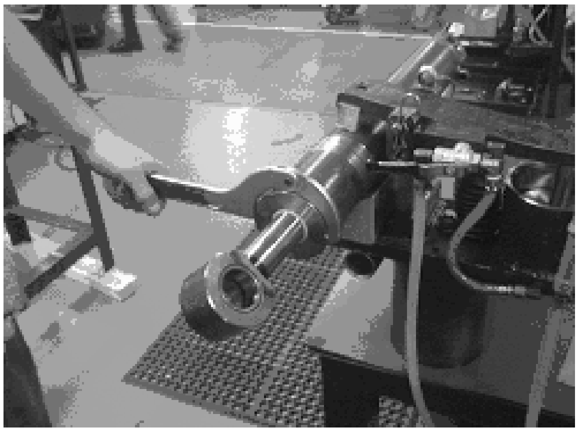
DISASSEMBLY

Place the cylinder into a vice fitted out with soft jaws. Clamp moderately to avoid deformations of the cylinder tube. Buckle out the collar of the notch and unscrew the cylinder head (mark16) with the help of a hook wrench. When the cylinder head is mounted with glue (never on first mounting) and difficult to unscrew, you have to warm up the cylinder head about 250ÅãC. Prefer a pistol pipe oven instead of a blowpipe. Unscrew completely the cylinder head and take out carefully the kit cylinder rod.



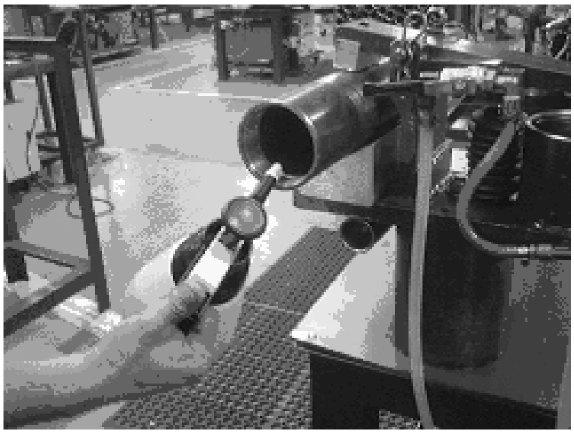
CONTROL

Make a visual control of the whole cylinder. Degrease and clean up the inside of the cylinder tube. Be sure that the inside is free of technical pollution like oxydation or stripes.



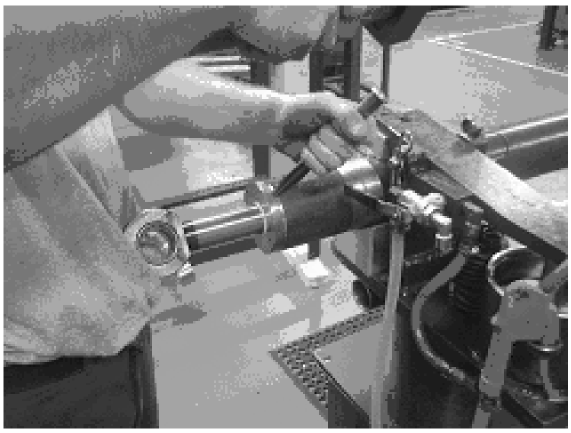
REASSEMBLY

Apply hydraulic oil on the piston seals with a paint brush. Move the kit cylinder rod 2/3 of his length into the cylinder tube (mark9). ← Assure a well alignement to the axe of the cylinder tube.
Apply hydraulic oil on cylinder head seals and engage the cylinder head . ← Be sure that the seals are not degraded when you engage the cylinder head into the locked zone.
Block it up with the tightening torque mentioned on drawing.
Save the cylinder head by buckling the collar in one notch.
Enter the whole rod to abutment.



PRECAUTIONS

- Use only non-agressive solvants like AXETHANE 212, cold degreaser.
- Try to protect all openings and components when not in use.
- If possible, test the cylinder before mounting on machine.

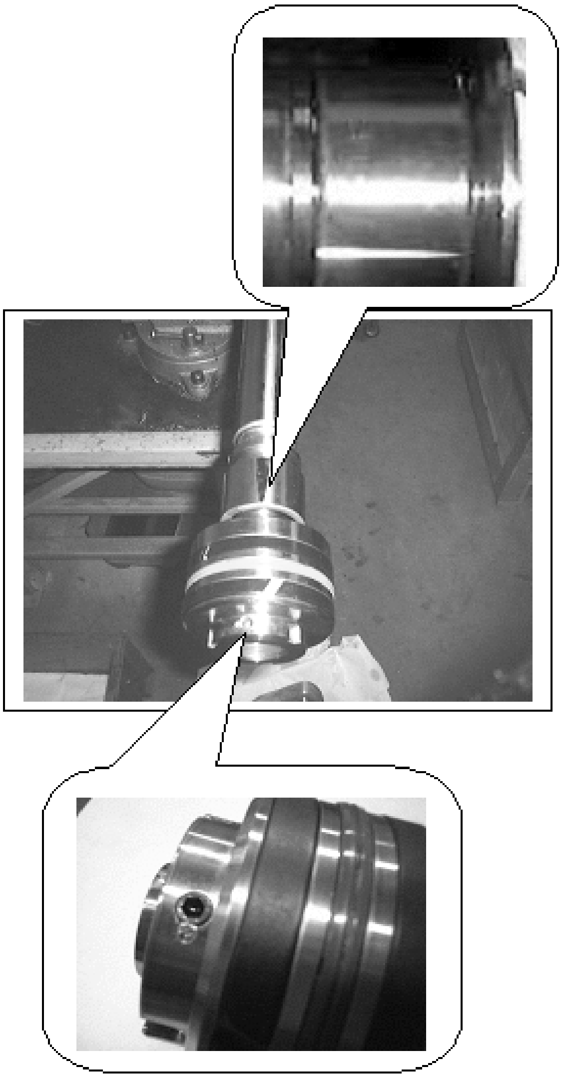


2) Proceeding Disassembly Reassembly Kit Boom-Cylinder Rod (EX. Boom Cylinder)

DISASSEMBLY

Place the kit cylinder rod into a vice fitted out with soft jaws to protect the surface and to avoid turnability. Take off the locking screw (mark1) and unscrew completely the piston (mark2) with the help of a hook wrench. Take off the piston seals (mark 3/4/5). Take care about grooves and chamfers. Take off the distance tube (mark7) and the damping ring (mark6). Remove the cylinder head (mark16) ring from the back to avoid seals' damaging. Take off the seals from the cylinder head (mark10/12/13/14/15).

CONTROL



Degrease and clean up piston and cylinder head. Grooves, chamfers and fronts must be without damages. Be sure that there are no coarse dust particles in the grooves and insides. Control every seal and change if necessary. Control the surface eveness with the help of a comparator. Check the absence of mechanical spalling and pollution.

REASSEMBLY

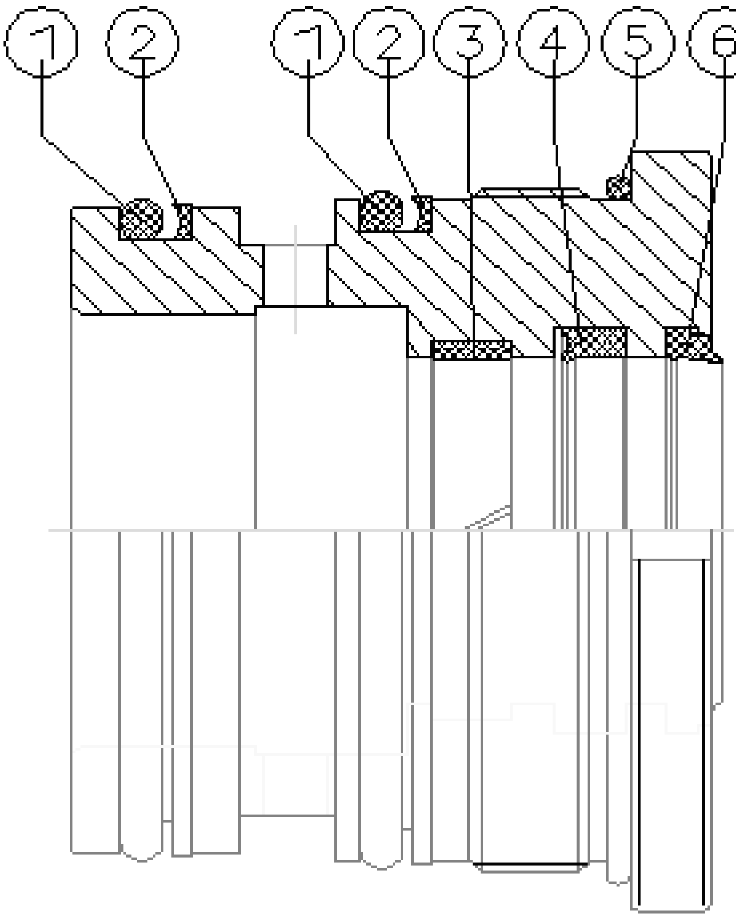
Grease all internal seals with hydraulic oil. The cylinder head must be mounted from the back to the cylinder rod. Assemble the piston on the cylinder rod. Use the tightening torque mentionned on drawing. Place the locking screw (mark1) with one drop of glue and give a blow of the tap next (2mm) to the entree of the internal screw thread to lock.

3) SEALS ASSEMBLING OF THE CYLINDER HEAD WITH CUSHIONNING

Make a visuel check up of the cleanless of the cylinder head.
Control the absence of stripes, flashes and check the slickness of the grooves.
Included coarse dust particles must be eliminated.

Mount the cylinder head seals like shown in the following scheme :

Mark 1 → O-ring placed manually or with a tool without sharp edges.
Mark 2 → Anti extrusion ring placed manually or with a tool without sharp edges.
Mark 3 → Bearing mounted manually.
Mark 4 → Piston rod seal mounted manually or with a special pliers (3fingers).
Mark 5 → O-ring placed manually or with a tool without sharp edges.
Mark 6 → Mud scroper ring mounted with a press.



Attention

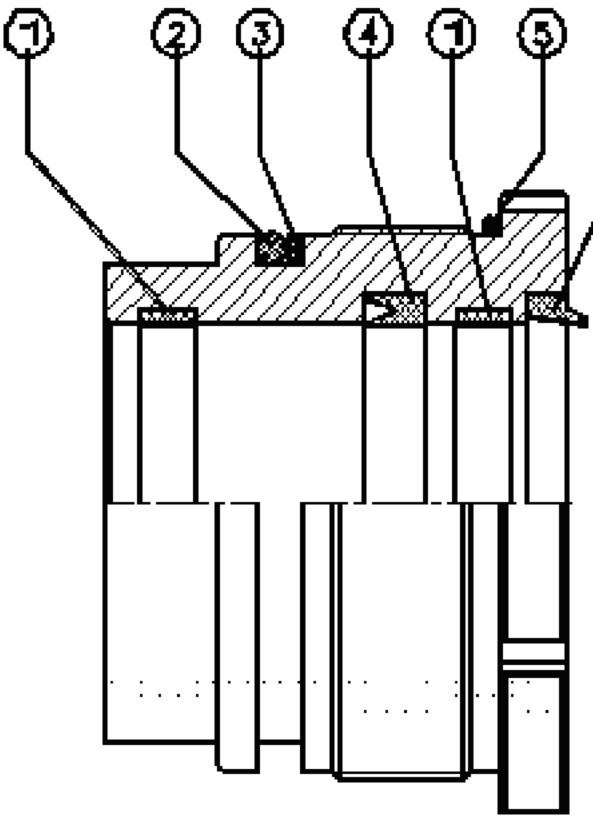
→ The hollow side of the anti-extrusion ring (2) must be directed to the O-ring.
→ The sealing lips of the piston rod seal (4) must be directed to the pressure.

4) SEALS ASSEMBLING OF THE CLINDER HEAD WITHOUT CUSHIONNINIG

Make a visuel check up of the cleanless of the cylinder head.
Control the absence of stripes, flashes and check the slickness of the grooves.
Included coarse dust particles must be eliminated.

Mount the cylinder head seals like shown in the following scheme :

Mark 1 → Bearing mounted manually.
Mark 2 → O-ring placed manually or with a tool without sharp edges.
Mark 3 → Anti extrusion ring placed manually or with a tool without sharp edges
Mark 4 → Piston rod seal mounted manually or with a special pliers (3fingers).
Mark 5 → O-ring placed manually or with a tool without sharp edges.
Mark 6 → Mud scroper ring mounted with a press.



Attention

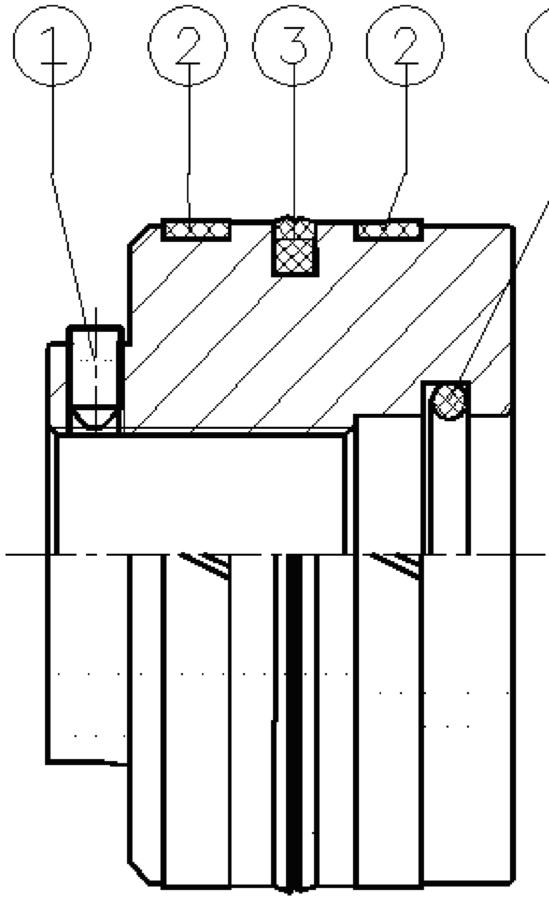
→ The hollow side of the anti-extrusion ring (3) must be directed to the O-ring.
→ The sealing lips of the piston rod seal (4) must be directed to the pressure.

5) SEALS ASSEMBLING OF THE PISTON

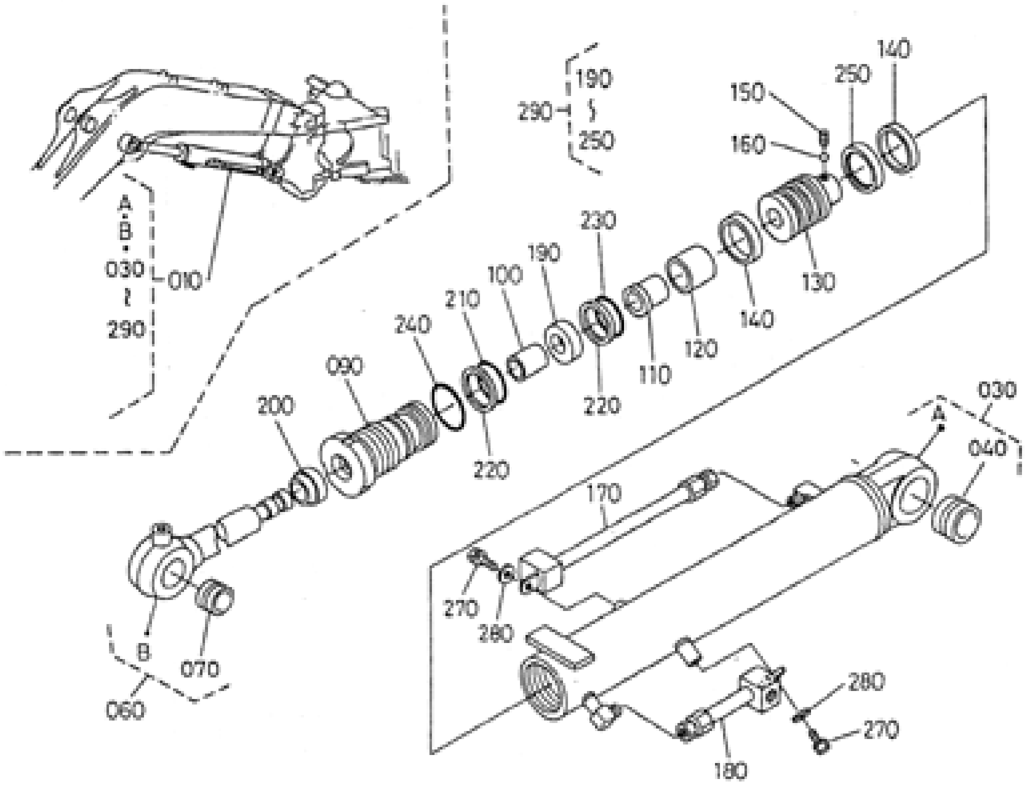
Make a visuel check up of the cleanless of the piston.
Control the absence of stripes, flashes and check the slickness of the grooves.
Included coarse dust paricles must be eliminated.

Mount the cover ring seals like shown in the following scheme.

Mark 1 → Locking screw mounted with a drop of " Loctite ".
Mark 2 → Piston rings mounted manually.
Mark 3 → Piston seal mounted with a tool free of sharp edges.
Mark 4 → O-ring placed with a tool free of sharp edges or manually.

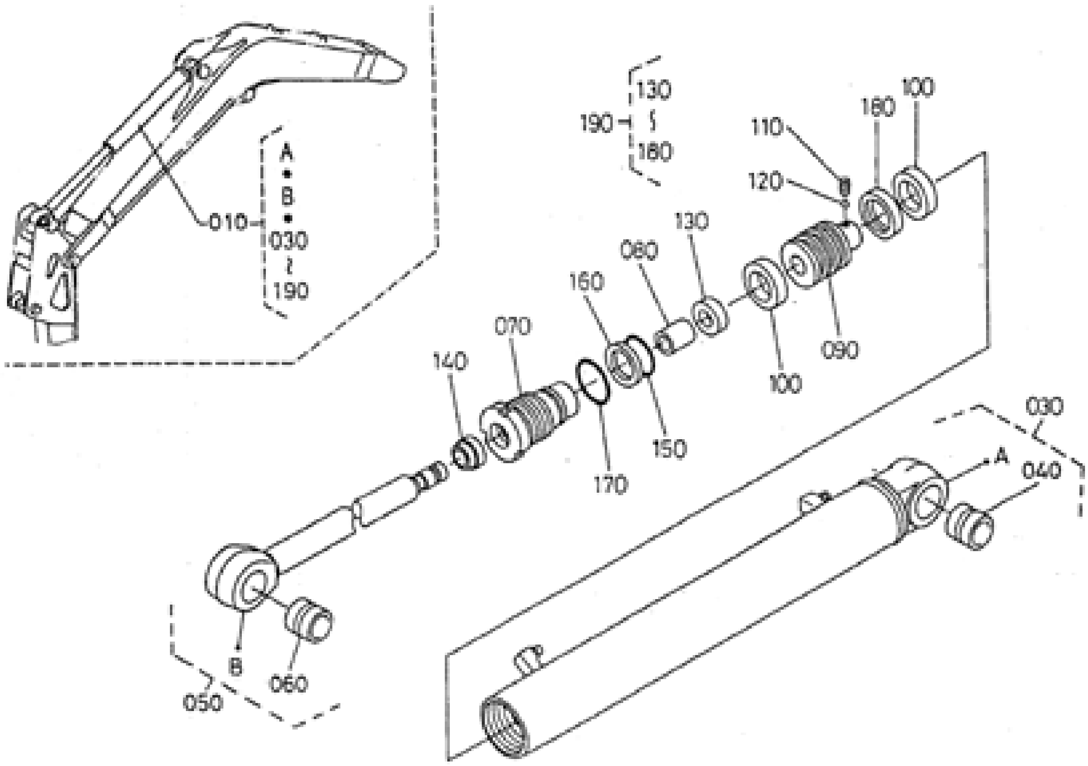


h. Cylinder (KTC, KCL, KTA version)
(1) Inner parts of the cylinder
1) Boom cylinder



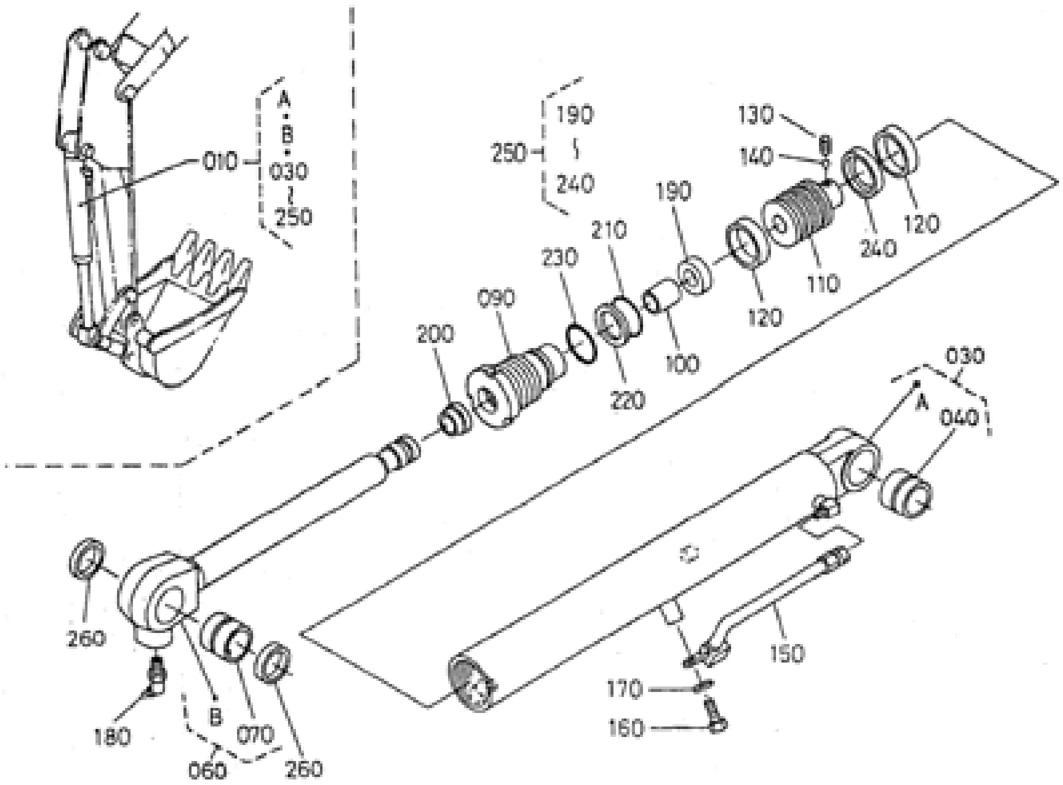
010	Assy cylinder, Boom	110	Spacer	210	O-ring
020	Blank	120	Bearing, Cushion	220	Ring, Backup
030	Assy tube, Cylinder	130	Piston	230	O-ring
040	Bush	140	Ring, Slide	240	O-ring
050	Blank	150	Screw, Set	250	Assy ring, Seal
060	Assy rod, Piston	160	Ball	260	Blank
070	Bush, Pin	170	Pipe	270	Bolt
080	Blank	180	Pipe	280	Washer, Plain
090	Cylinder head	190	U-ring	290	Kit seal
100	Bush	200	Ring, Wiper		

2) Arm cylinder



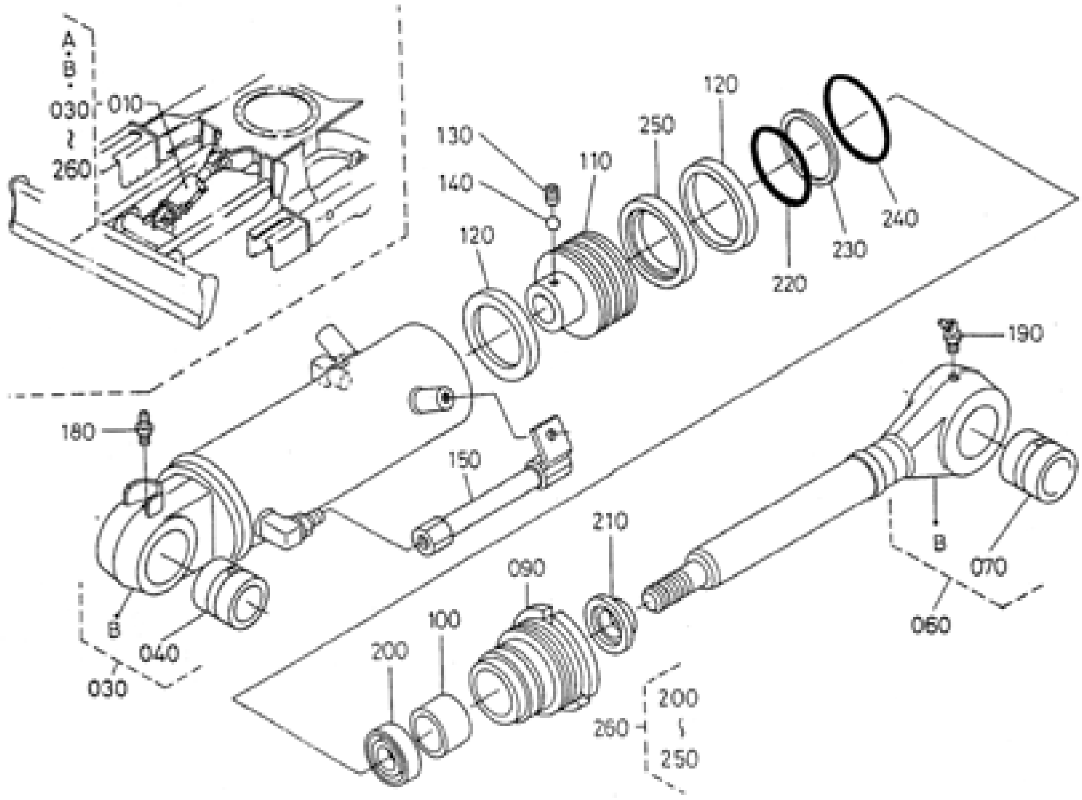
010	Assy cylinder, Arm	080	Bush	140	Ring, Wiper
020	Blank	090	Piston	150	O-ring
030	Assy tube, Cylinder	100	Ring, Slide	160	Ring, Backup
040	Bush	110	Screw, Set	170	O-ring
050	Assy rod, Piston	120	Ball	180	Assy ring, Seal
060	Bush	130	U-ring	190	Kit seal, Bucket
070	Cylinder head				

3) Bucket cylinder



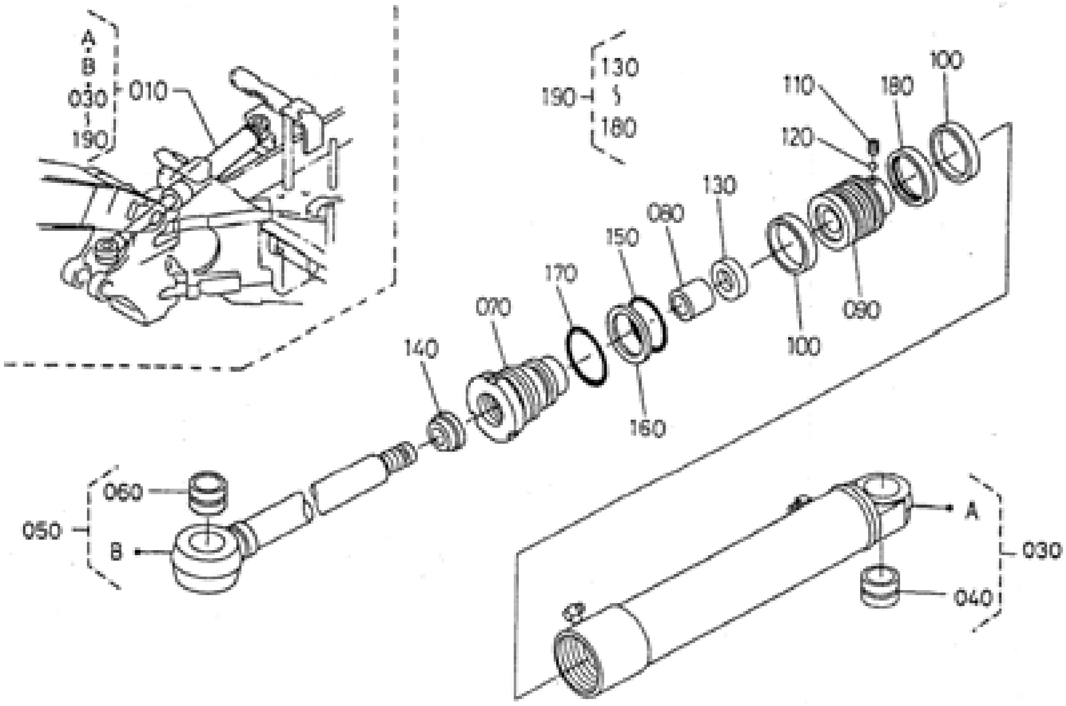
010	Assy cylinder, Bucket	100	Bush	190	U-ring
020	Blank	110	Piston	200	Ring, Wiper
030	Assy tube, Cylinder	120	Ring, Slide	210	O-ring
040	Bush,Pin	130	Screw, Set	220	Ring, Backup
050	Blank	140	Ball	230	O-ring
060	Assy rod, Piston	150	Pipe	240	Assy ring, Seal
070	Bush, Pin	160	Bolt	250	Kit seal
080	Blank	170	Washer, Plain	260	Seal, Dust
090	Cylinder head	180	Nipple, Grease		

4) Dozer cylinder



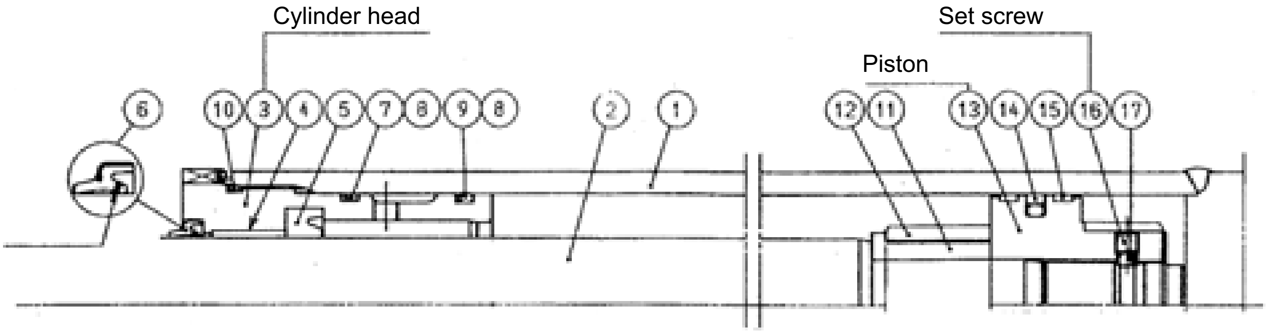
010	Assy cylinder, Blade	100	Bush	190	Nipple, Grease
020	Blank	110	Piston	200	U-ring
030	Assy tube, Cylinder	120	Ring, Slide	210	Ring, Wiper
040	Bush,Pin	130	Screw, Set	220	O-ring
050	Blank	140	Ball	230	Ring, Backup
060	Assy rod, Piston	150	Pipe	240	O-ring
070	Bush, Pin			250	Assy ring, Seal
080	Blank			260	Kit seal
090	Cylinder head	180	Nipple, Grease		

5) Swing cylinder



010	Assy cylinder, Swing	080	Bush	140	Ring, Wiper
020	Blank	090	Piston	150	O-ring
030	Assy tube, Cylinder	100	Ring, Slide	160	Ring, Backup
040	Bush, Pin	110	Screw, Set	170	O-ring
050	Assy rod, Piston	120	Ball	180	Assy ring, Seal
060	Bush, Pin	130	U-ring	190	Kit, Cylinder repair
070	Cylinder head				

(2) Tightening torque



1) Boom cylinder

	Tightening torque	Adhesive	Remarks
Cylinder head	451 N·m 46 kgf·m 333 ft·lbf	Threebond #1901	Thread size:M85 × 2
Piston	932 N·m 95 kgf·m 687 ft·lbf	-	Thread size:M36 × 2
Set screw	16.2 N·m 1.65 kgf·m 11.9 ft·lbf	-	Thread size:M8 × 1.25 Punch at two positions on the other of the set screw.

2) Arm cylinder

	Tightening torque	Adhesive	Remarks
Cylinder head	422 N·m 43 kgf·m 311 ft·lbf	Threebond #1901	Thread size: M80 × 2
Piston	1079 N·m 110 kgf·m 796 ft·lbf	-	Thread size: M33 × 2
Set screw	16.2 N·m 1.65 kgf·m 11.9 ft·lbf	-	Thread size: M8 × 1.25 Punch at two positions on the other of the set screw.

3) Bucket cylinder

	Tightening torque	Adhesive	Remarks
Cylinder head	343 N·m 35 kgf·m 253 ft·lbf	Threebond #1901	Thread size: M70 × 2
Piston	637 N·m 65 kgf·m 470 ft·lbf	-	Thread size: M30 × 1.5
Set screw	16.2 N·m 1.65 kgf·m 11.9 ft·lbf	-	Thread size: M8 × 1.25

4) Dozer cylinder

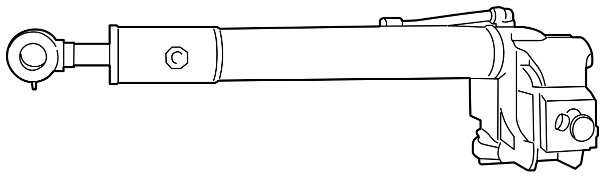
	Tightening torque	Adhesive	Remarks
Cylinder head	530 N·m 54 kgf·m	Threebond #1901	Thread size: M95 × 2
Piston	932 N·m 95 kgf·m	-	Thread size: M36 × 2
Set screw	16.2 N·m 1.65 kgf·m 11.9 ft·lbf	-	Thread size: M8 × 1.25

5) Swing cylinder

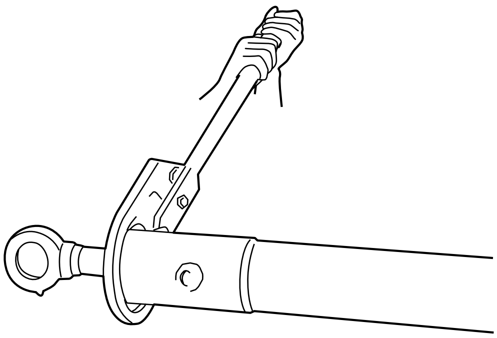
	Tightening torque	Adhesive	Remarks
Cylinder head	451N·m 46 kgf·m 333 ft·lbf	Threebond #1901	Thread size: M85 × 2
Piston	784 N·m 80 kgf·m 578 ft·lbf	-	Thread size: M30 × 1.5
Set screw	16.2 N·m 1.65 kgf·m 11.9 ft·lbf	-	Thread size: M8 × 1.25

(3) Disassembling and assembling

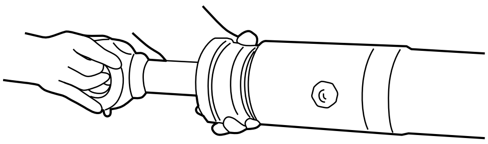
1) Disassembling



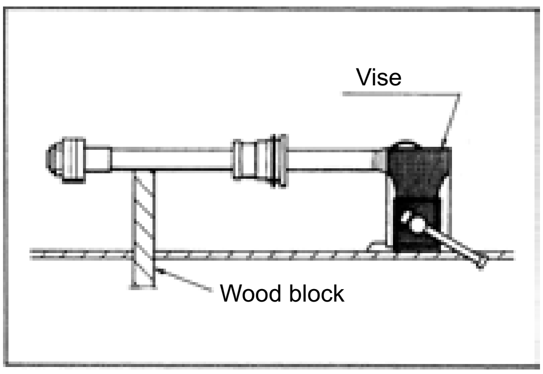
1. Place the cylinder on a vise.
2. Let hydraulic oil out of the cylinder.



3. Straighten the lock washer.
4. Unscrew and remove the cylinder head.
* If the cylinder head is hard to unscrew, employ the head wrench.

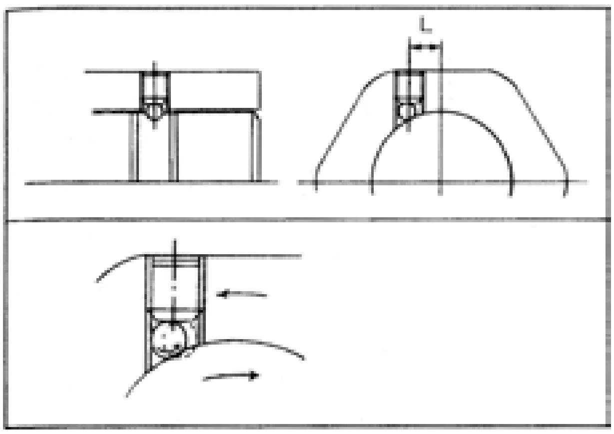


5. Draw out the piston rod together with the cylinder head.
* If the pipe ports are open, place an oil pan below the port at the retracting-side cylinder head.

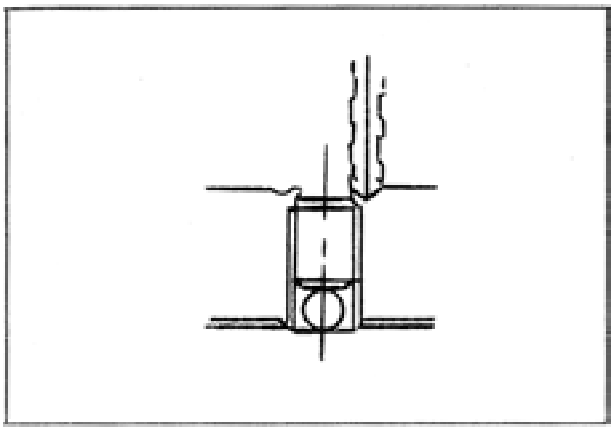


6. Fix the piston rod in the vise.

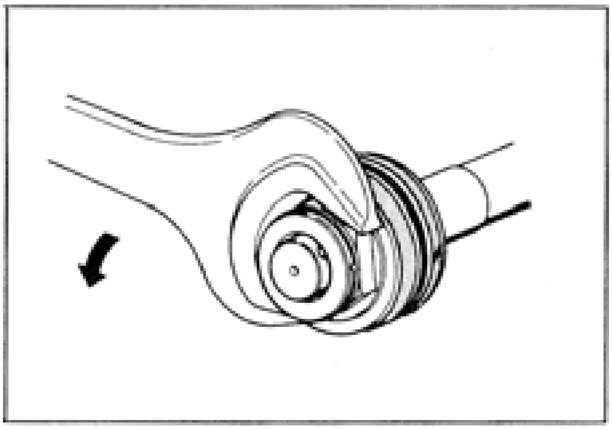
⚠ Place a wood block under the rod.



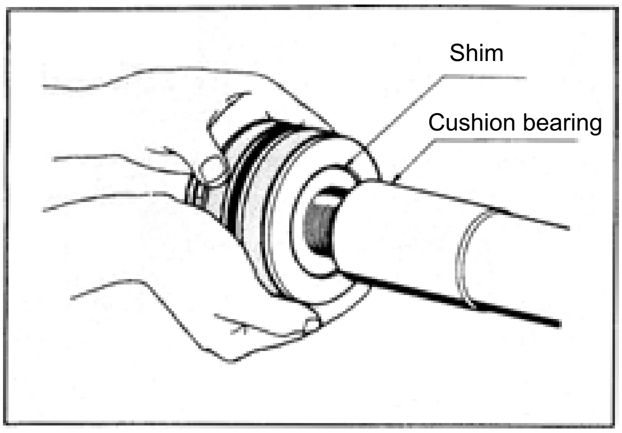
* Anti-rotation measure with steel ball
- Place a steel ball in the position the distance "L" away from the axial center of the nut (rod) and tighten the setscrew. (Fig. 1)
- When the screw gets loose and the nut (rod) starts turning, the ball also rotates and bites to the narrower side of the taper. (Fig. 2)
- Now the steel ball's biting resistance works for keeping the nut from turning.



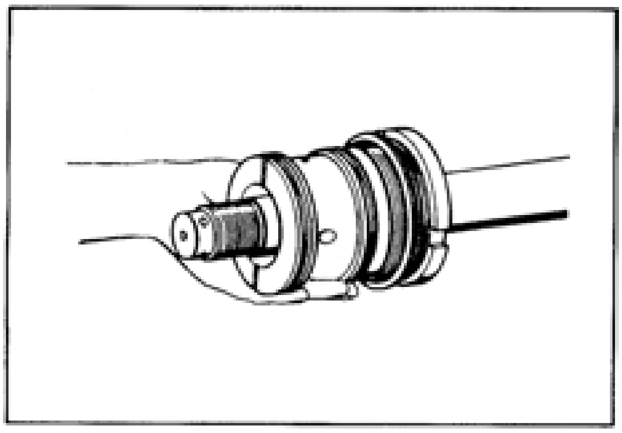
7. Remove the setscrew.
- The setscrew has been crimped at two points using a punch. Scrape the punched spots using a hand drill, loosen the setscrew and take out the steel ball.



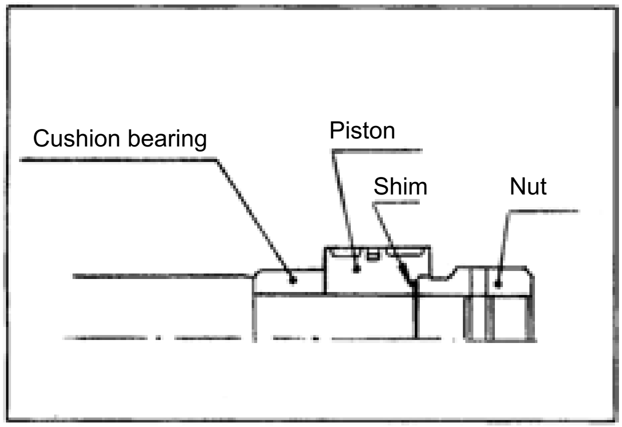
8. Apply a wrench to the hex nut of the piston. Loosen the nut.



9. Draw out the piston and remove the shim
10. Remove the cushion bearing.



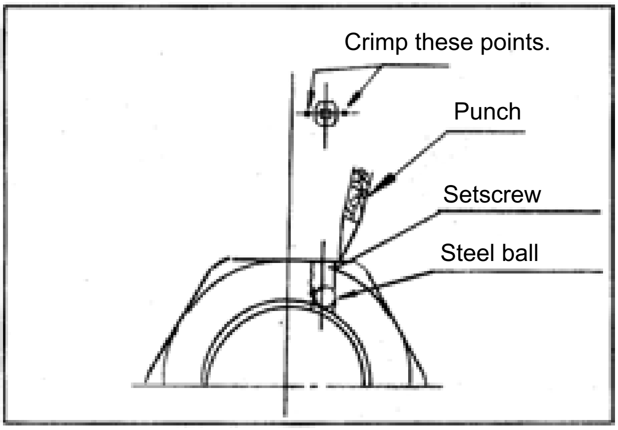
11.Draw out the cylinder head.
12.Release the piston rod from the vise.



2.Assembling

1. Fix the piston rod.
2. Fit the cylinder head into position.
- Be careful not to get the lips of the wiper ring and U ring caught by the step.
3. Install the spacer, cushion bearing and shim in their positions. Fit the piston back into place and tighten the nut.

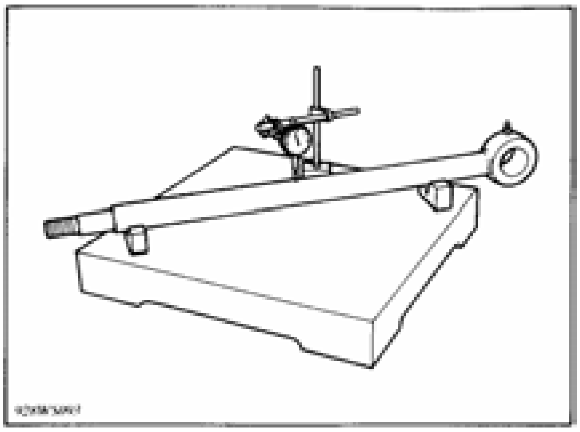
Tightening torque: 853 N·m (87 kgf·m)



4 1.Put the steel ball, tighten the setscrew, and crimp its two outer points with the punch.

Tightening torque: 16.2 N·m (1.65 kgf·m)

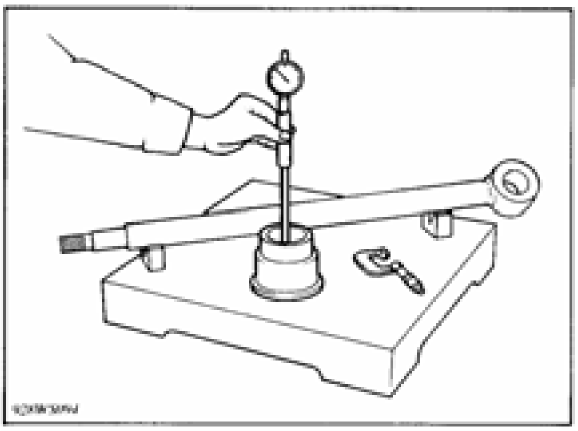
(4) Inspection



1.Piston rod warp

1. Mount the piston rod on a V-block.
2. Set a dial indicator at the center of the rod.
3. Rotate the piston rod and read the indicator. Warp is one-half of the difference between the maximum and the minimum readings.
4. If the valve exceeds the allowable limit, replace the piston rod.

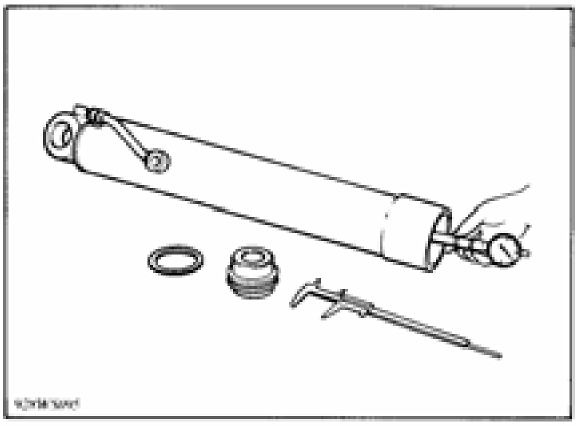
- Reference value .. warp within 0.05 mm, 0.002in.
- Allowable value ... warp within 0.5 mm, 0.0197in.



2.Clearance between piston rod and bushing

1. Measure the piston rod O.D. and cylinder head bushing I.D. and determin the clearance.

	Rod size	Clearance
Reference value	ϕ25 to ϕ40 mm	less than 0.25 mm
	ϕ45 to ϕ75 mm	less than 0.30 mm
Allowable limit	ϕ25 to ϕ40 mm	0.4 mm
	ϕ45 to ϕ75 mm	0.5 mm
Reference value	ϕ0.9843 to 1.5748 in	less than 0.010 in
	ϕ1.7717 to 2.9528 in	less than 0.012 in
Allowable limit	ϕ0.9843 to 1.5748 in	0.0158 in
	ϕ1.7717 to 2.9528 in	0.0197 in



3.Clearance between cylinder tube I.D. and Piston ring O.D.

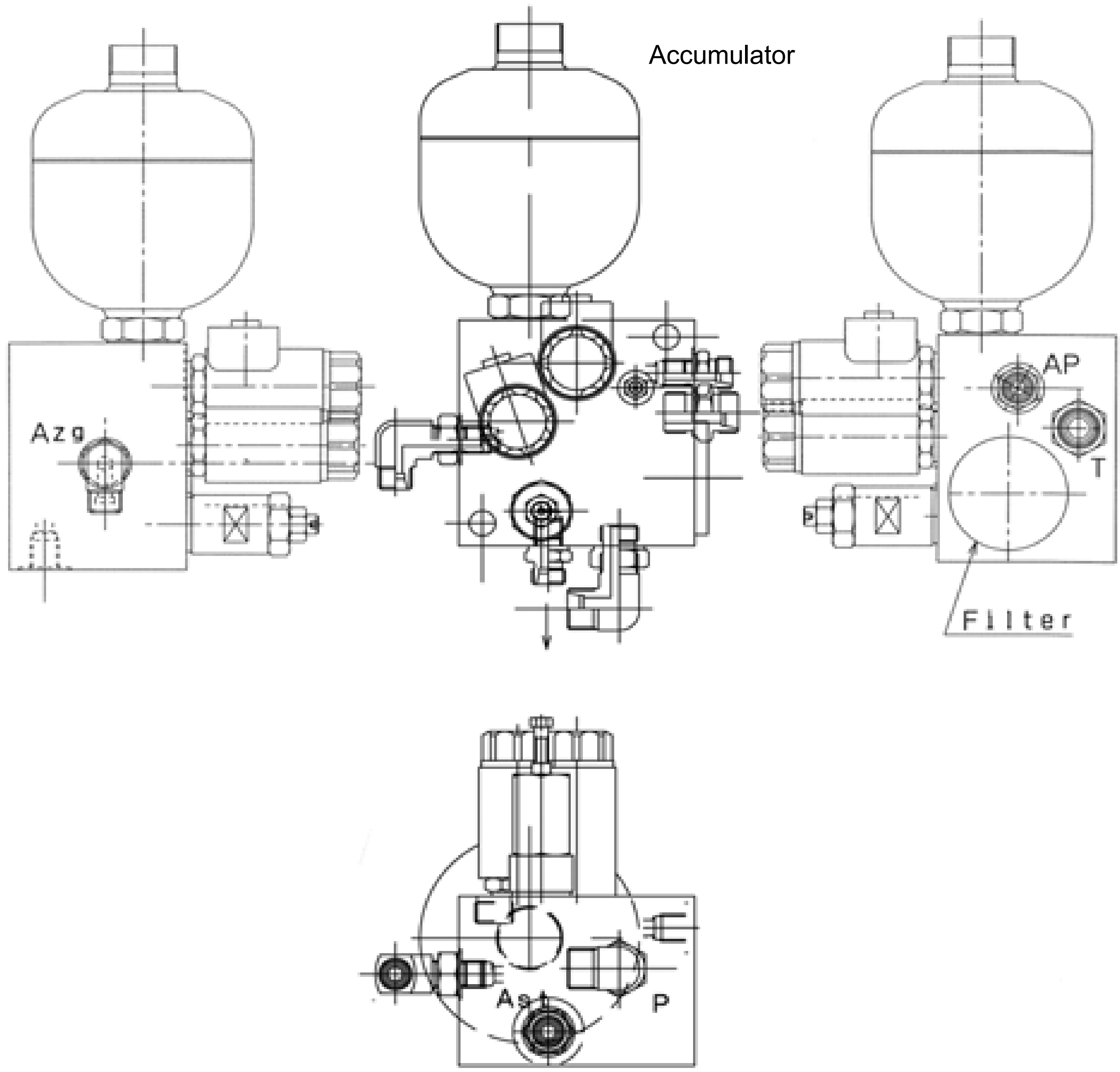
1. Measure the cylinder tube I.D.
2. Calculate the piston ring thickness plus piston ring groove O.D. determin the clearance.

	Rod size	Clearance
Reference value	less than ϕ60 mm	0.05 to 0.30 mm
	ϕ65 to ϕ115 mm	0.05 to 0.35 mm
	more than ϕ120 mm	0.05 to 0.40 mm
Allowable limit	less than ϕ60 mm	0.60 mm
	ϕ65 to ϕ115 mm	0.70 mm
	more than ϕ120 mm	0.80 mm
Reference value	ϕ2.3622 in less	0.0020 to 0.0118 in
	ϕ2.5590 to 4.5276 in	0.0020 to 0.0138 in
	ϕ4.7244 in more	0.0020 to 0.0157 in
Allowable limit	ϕ0.9843 to 1.5748 in	0.0236 in
	ϕ1.7717 to 2.9528 in	0.0276 in
	ϕ4.7244 in more	0.0315 in

i. Other hydraulic device

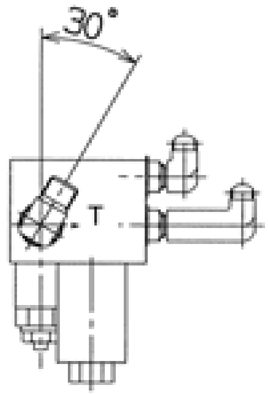
(1)Change value

1) KE, KUK, KDG version

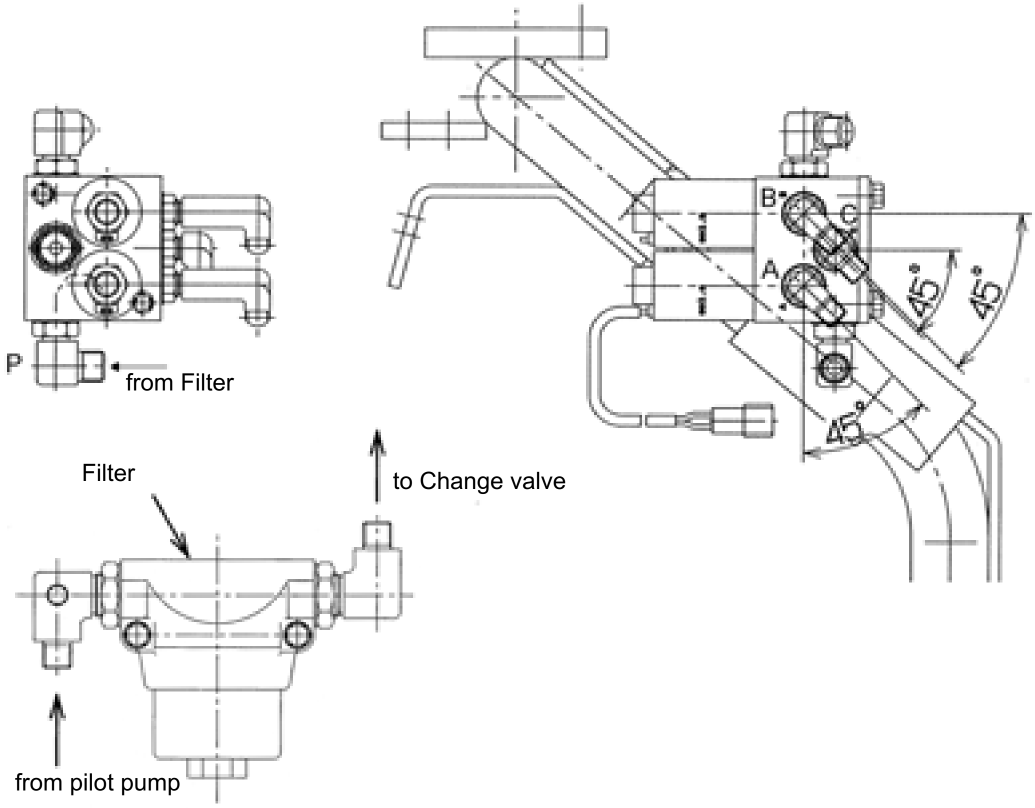


No.	Mark on the value	Connection
1	Azg	Rotary joint Traveling speed change port
2	Ap	Pilot value LH Pilot value RH Swivel Motor (Parking brake) Travel rock cylinder
3	T	Oil trank
4	Ast	Control valve straight travel section
5	P	Pilot pump

2) KTC, KCL, KTA vertsion



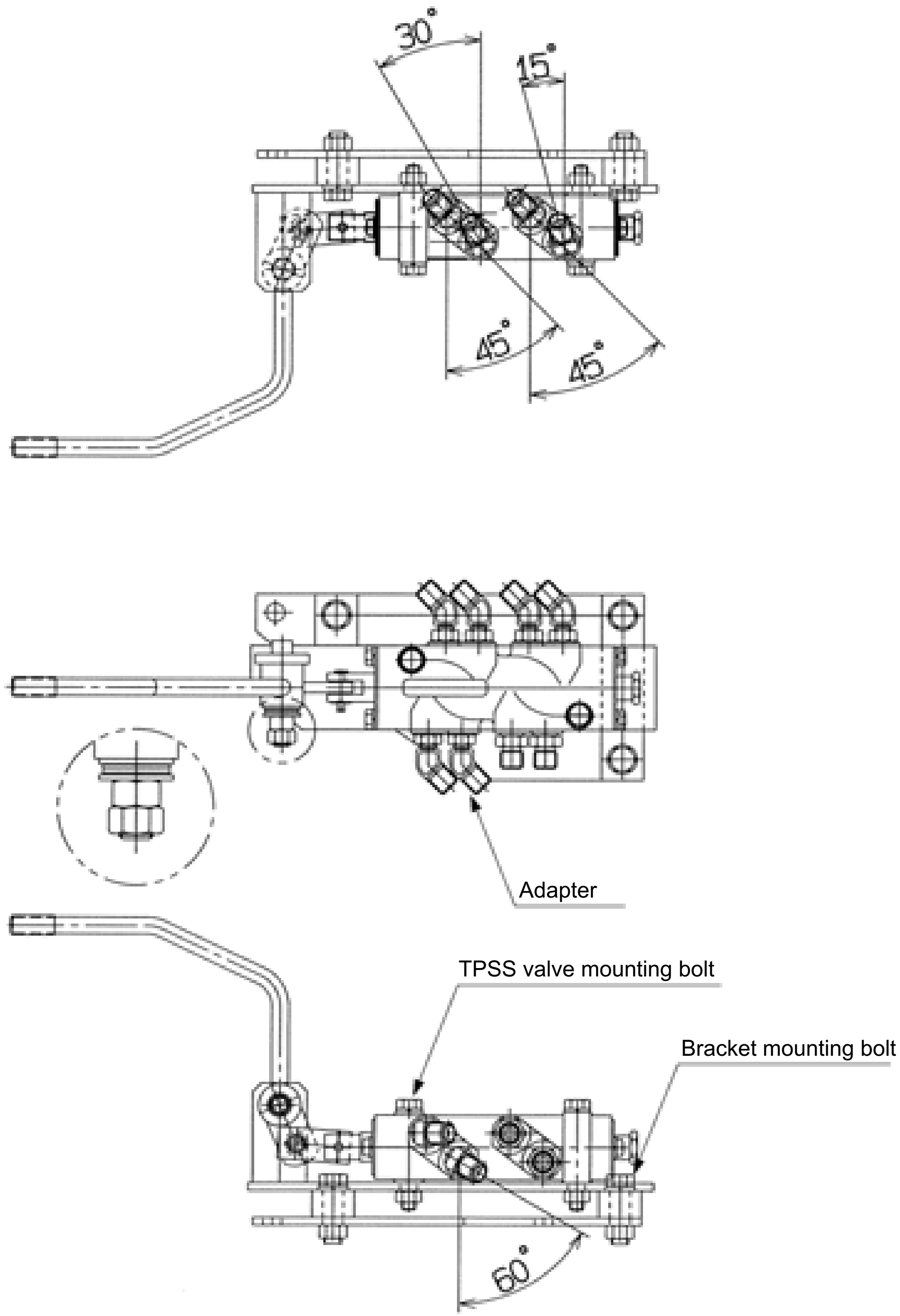
No.	Mark on the value	Connection
1	P	Filter
2	T	Tank
3	A	Pilot value LH Pilot value RH Swivel Motor (Parking brake) Travel rock cylinder
4	B	Rotary joint Traveling speed change port
5	C	Control valve straight travel section



Tighening torque

Change value mounting bolt	48.1 ~ 55.9 N·m, 4.9 ~ 5.7 kgf·m,35.5 ~ 41.2 ft·lbf
Adaptor P portion	49.1 ~ 53.9 N·m, 5.0 ~ 5.5 kgf·m, 36.2 ~ 39.8 ft·lbf
T	49.1 ~ 53.9 N·m, 5.0 ~ 5.5 kgf·m, 36.2 ~ 39.8 ft·lbf
A	24.5 ~ 29.4N·m, 2.5 ~ 3.0 kgf·m, 18.1 ~ 21.7 ft·lbf
B	24.5 ~ 29.4N·m, 2.5 ~ 3.0 kgf·m, 18.1 ~ 21.7 ft·lbf
C	24.5 ~ 29.4N·m, 2.5 ~ 3.0 kgf·m, 18.1 ~ 21.7 ft·lbf

(2) TPSS valve (KTC, KCL, KTA version only)



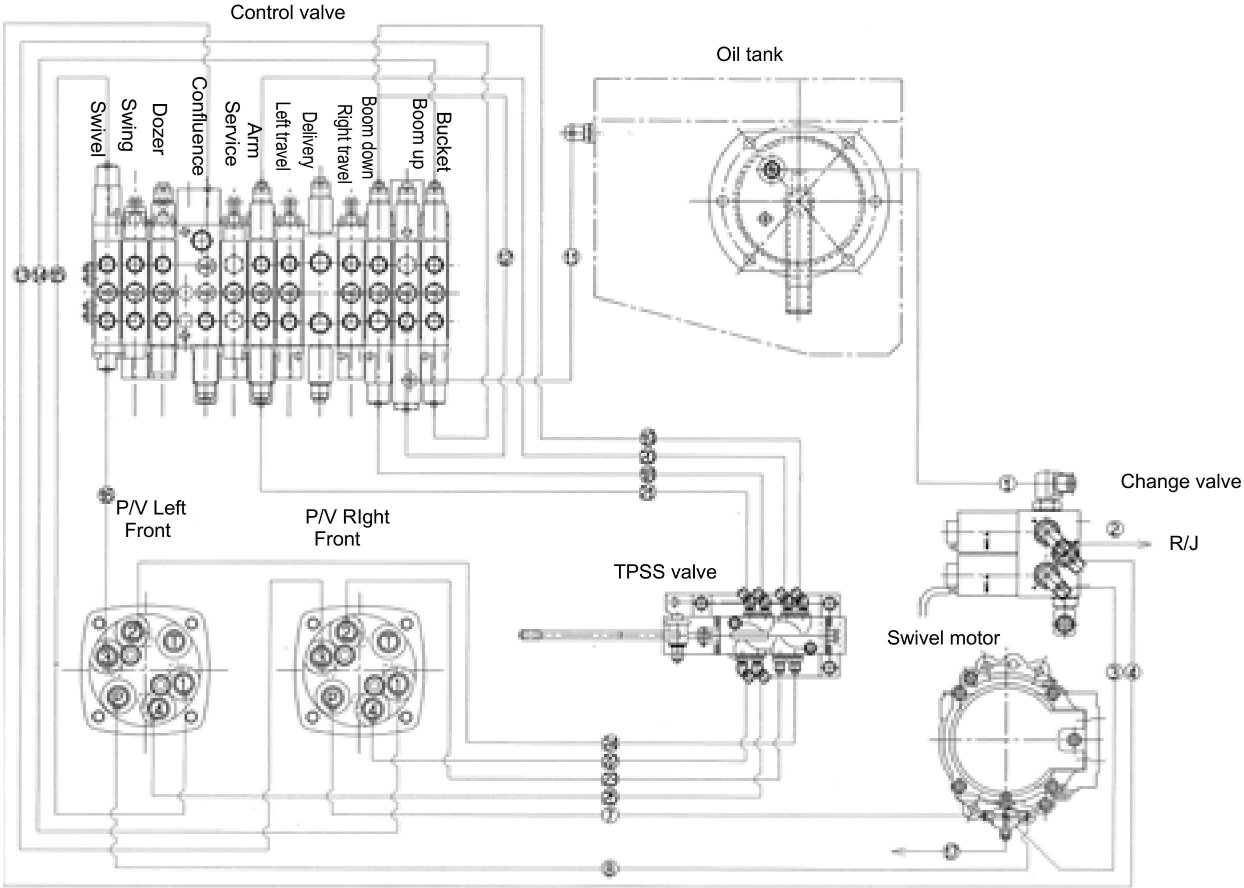
Tightening torque

TPSS value mounting bolt	23.5 ~ 27.5 N·m, 2.4 ~ 2.8 kgf·m, 17.3 ~ 20.3 ft·lbf
Adaptor	7.8 ~ 11.8 N·m, 0.8 ~ 1.2 kgf·m, 5.8 ~ 8.7 ft·lbf
Bracket mounting bolt	48.1 ~ 55.9 N·m, 4.9 ~ 5.7 kgf·m, 35.5 ~ 41.2 ft·lbf

j. Hose

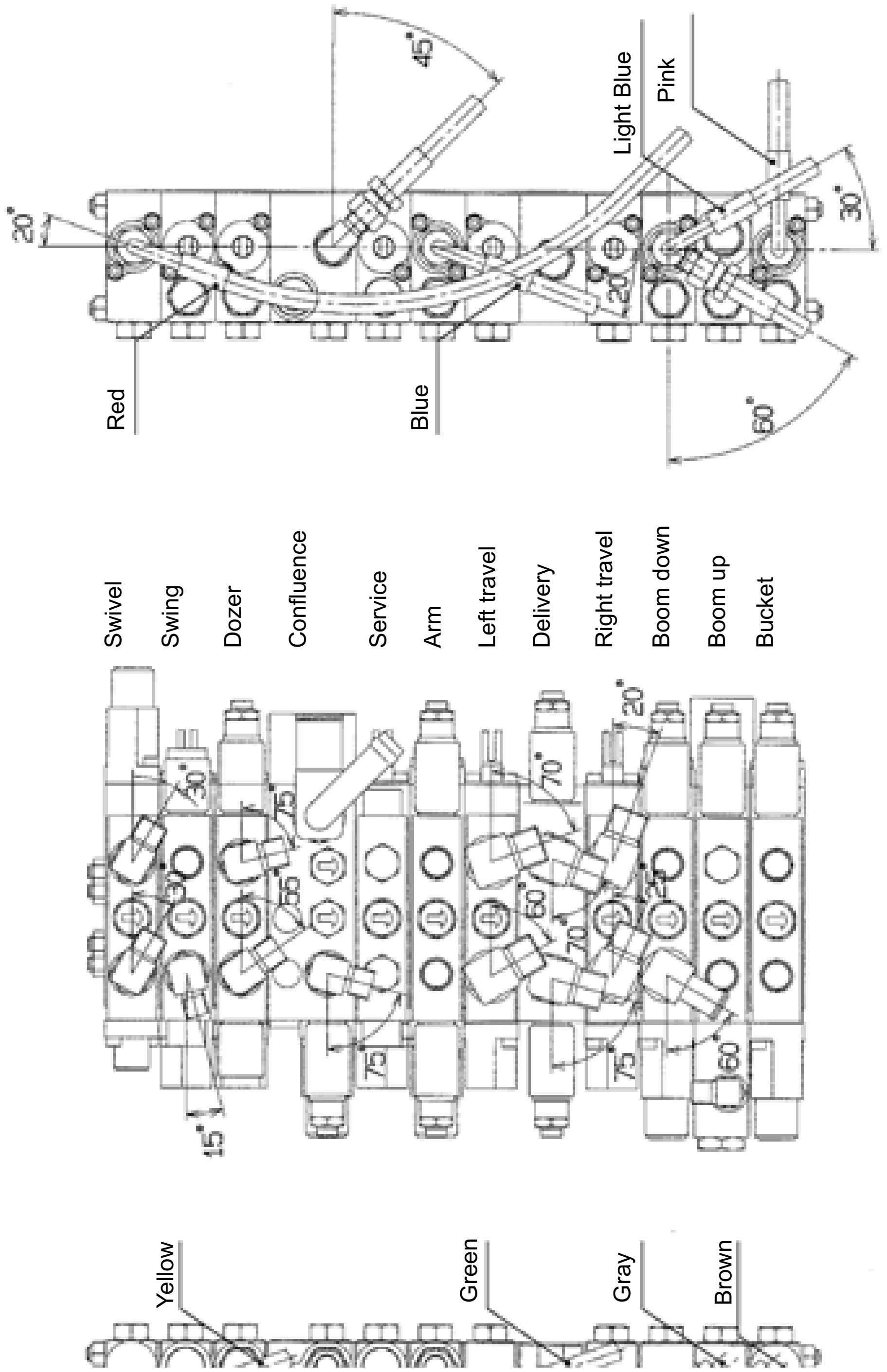
(1) Pilot hose

1) Connection and color marking on the tape (KTC, KCL, KTA version)

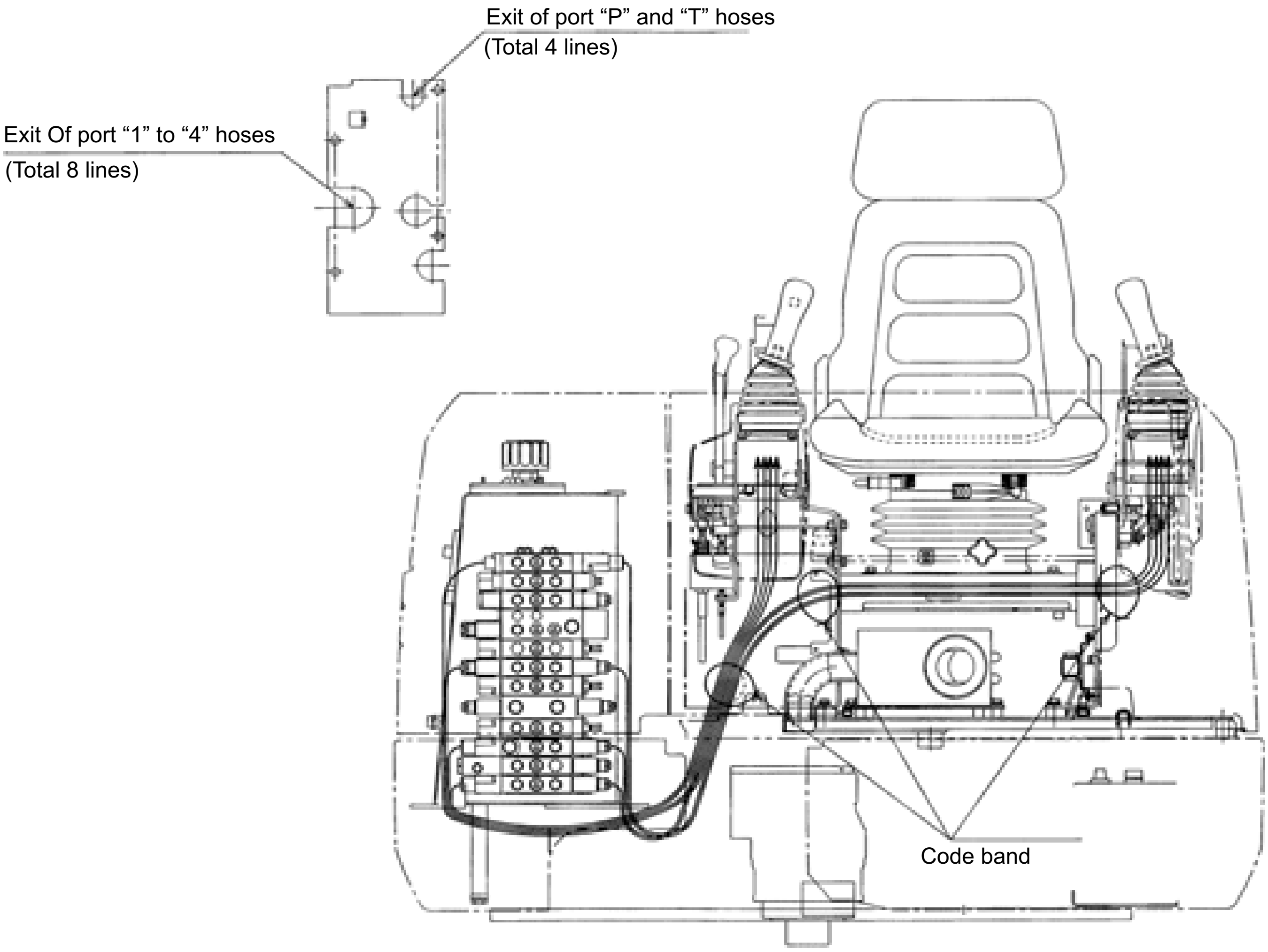


No	Used Place		Tape color
1	Change valve ~ Hydraulic tank	Drain	-
2	Change valve ~ R/J	Travel high speed	-
3	Change valve ~ Swivel motor	Parking brake	-
4	Change valve ~ C/V	Travel straight	-
7	Swivel motor ~ P/V RH P Port	P/V RH main	-
8	Swivel motor ~ P/V LH P Port	P/V LH main	-
11	C/V ~ Hydraulic tank	Boom-lock drain	-
12	C/V ~ C/V	Boom-lock release	-
13	P/V ~ C/V	Bucket dump	Brown
14	P/V ~ C/V	Bucket crowd	Pink
15	P/V ~ C/V	Swivel left	Red
16	P/V ~ C/V	Swivel right	Yellow
17	Swivel motor ~ Travel-lock	Travel-lock release	-
18	C/V ~ TPSS	Boom up	Gray
19	C/V ~ TPSS	Boom down	Light Blue
20	C/V ~ TPSS	Arm dump	Blue
21	C/V ~ TPSS	Arm crowd	Green
22	P/V ~ TPSS	Boom up	Gray
23	P/V ~ TPSS	Boom down	Light Blue
24	P/V ~ TPSS	Arm dump	Blue
25	P/V ~ TPSS	Arm crowd	Green

2) Pilot hose connection angle (KTC, KCL, KTA version)



3) Fixing location of code band



(2) Delivery hose

1) Hose connection from pump to control valve

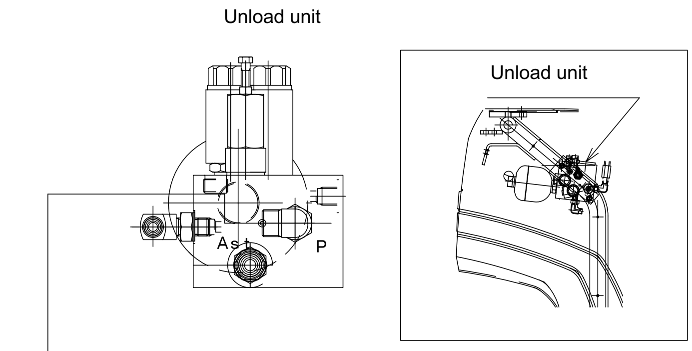
1. KE, KDG, KUK version

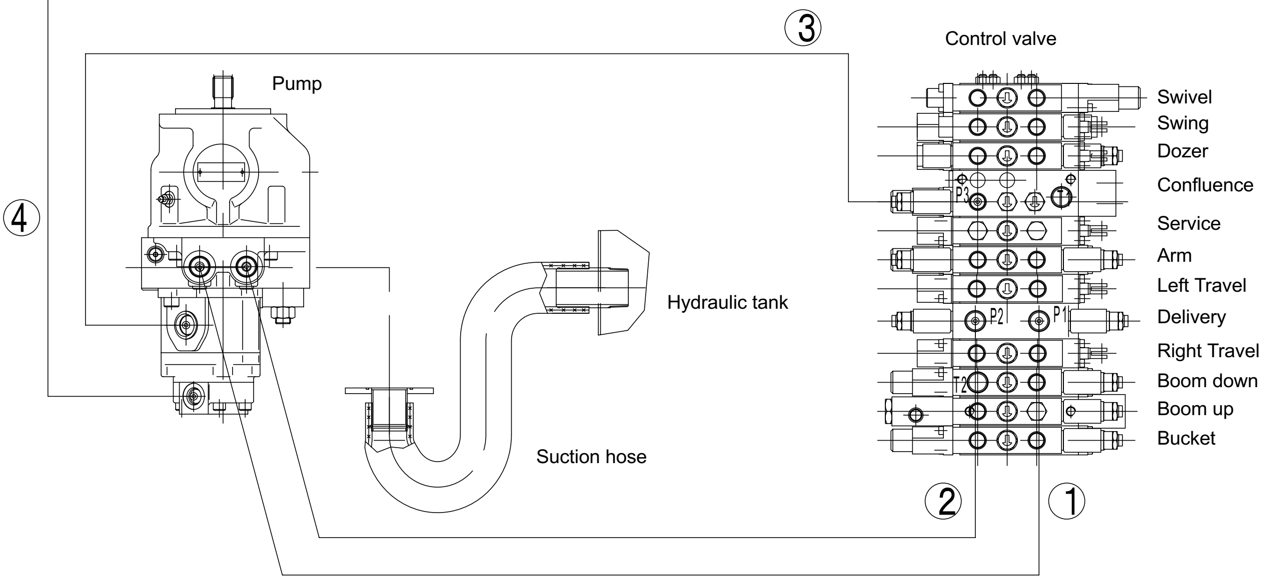
High pressure hose

No.	Part	
1	Pump ~ C/V	P1
2	Pump ~ C/V	P2
3	Pump ~ C/V	P3

Pilot hose

No.	Place used	
1	Pump ~ Unload unit	P4



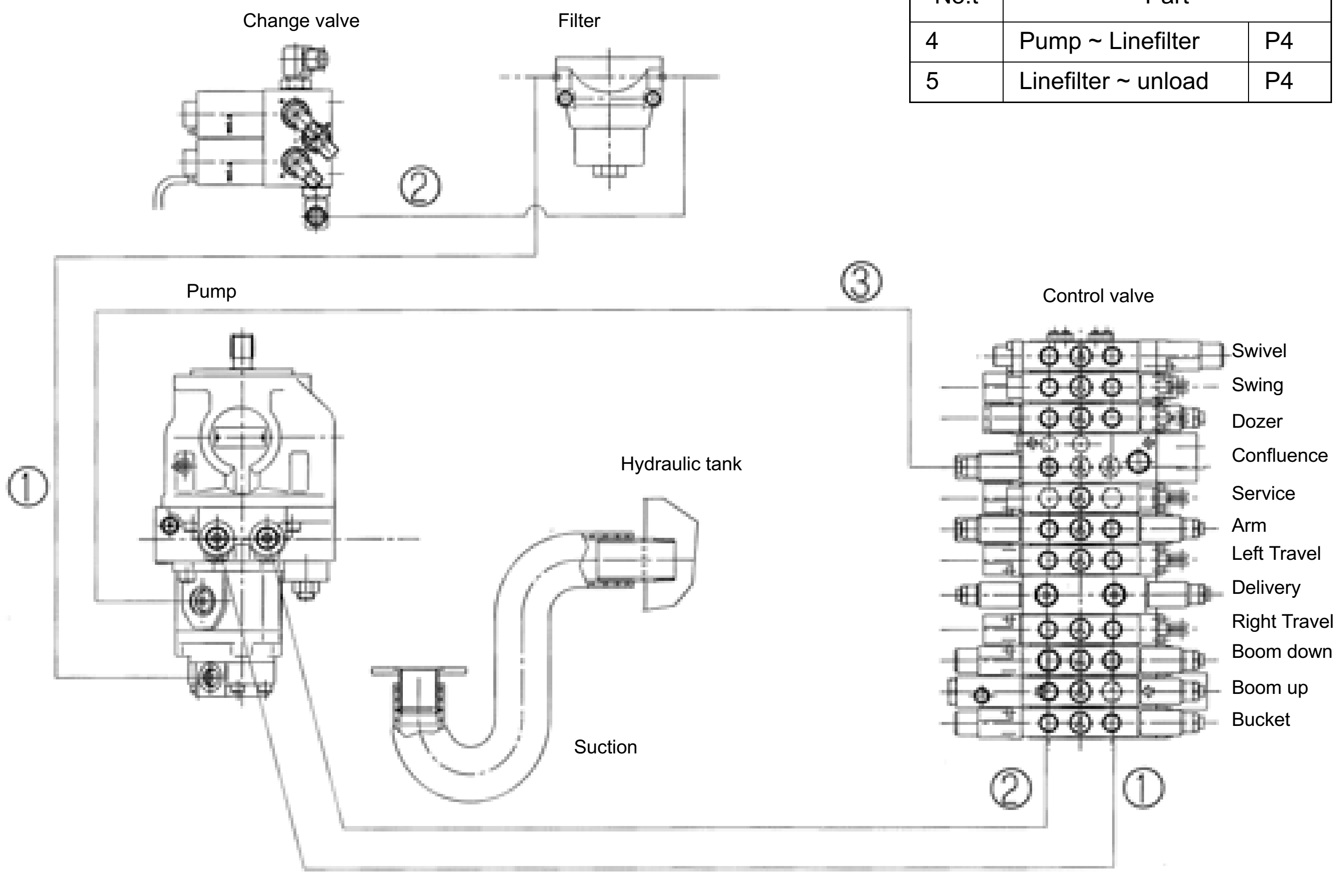


2. KTC, KCL, KTA version

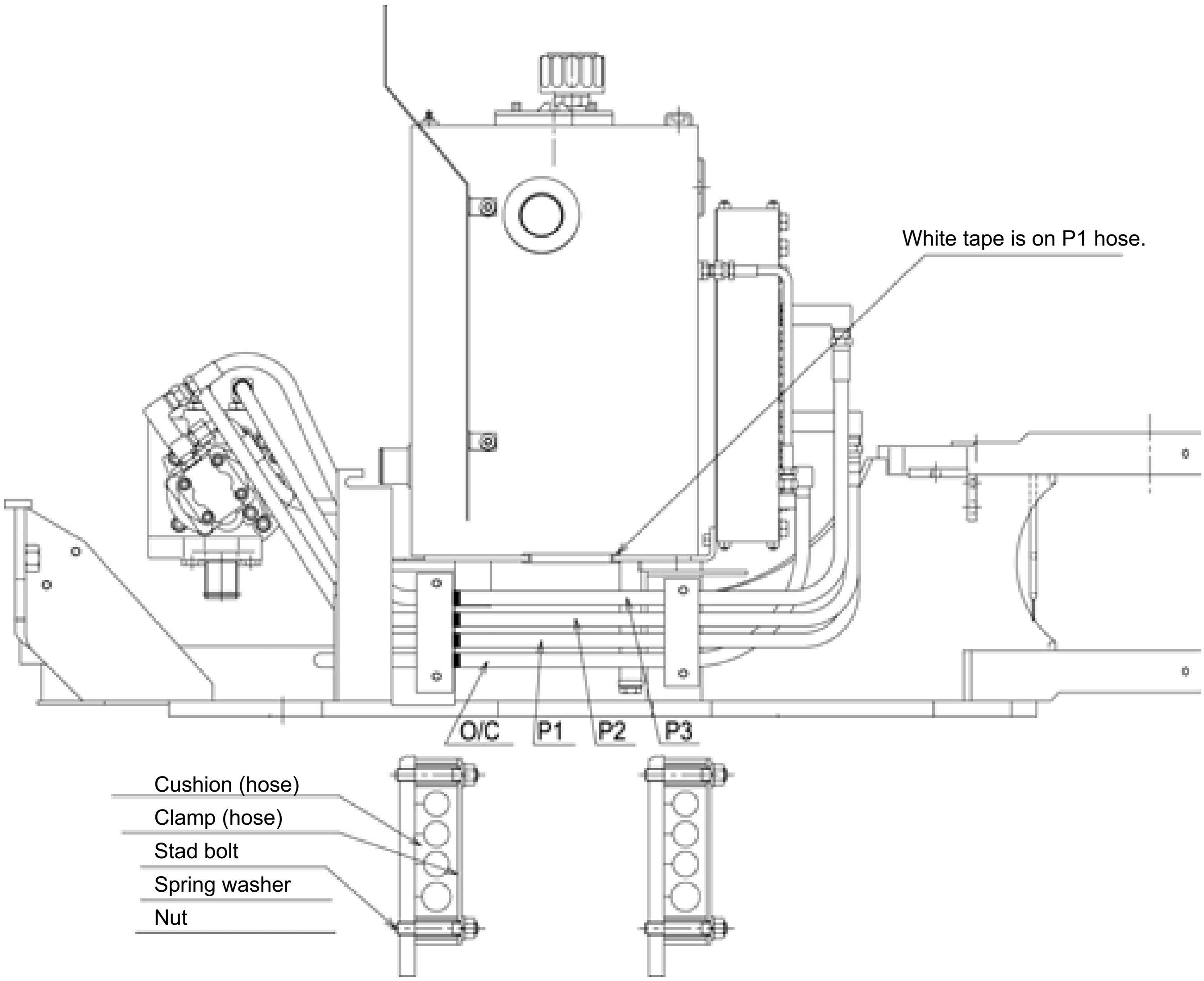
No.t	Part	
1	Pump ~ C/V	P1
2	Pump ~ C/V	P2
3	Pump ~ C/V	P3

Pilot hose

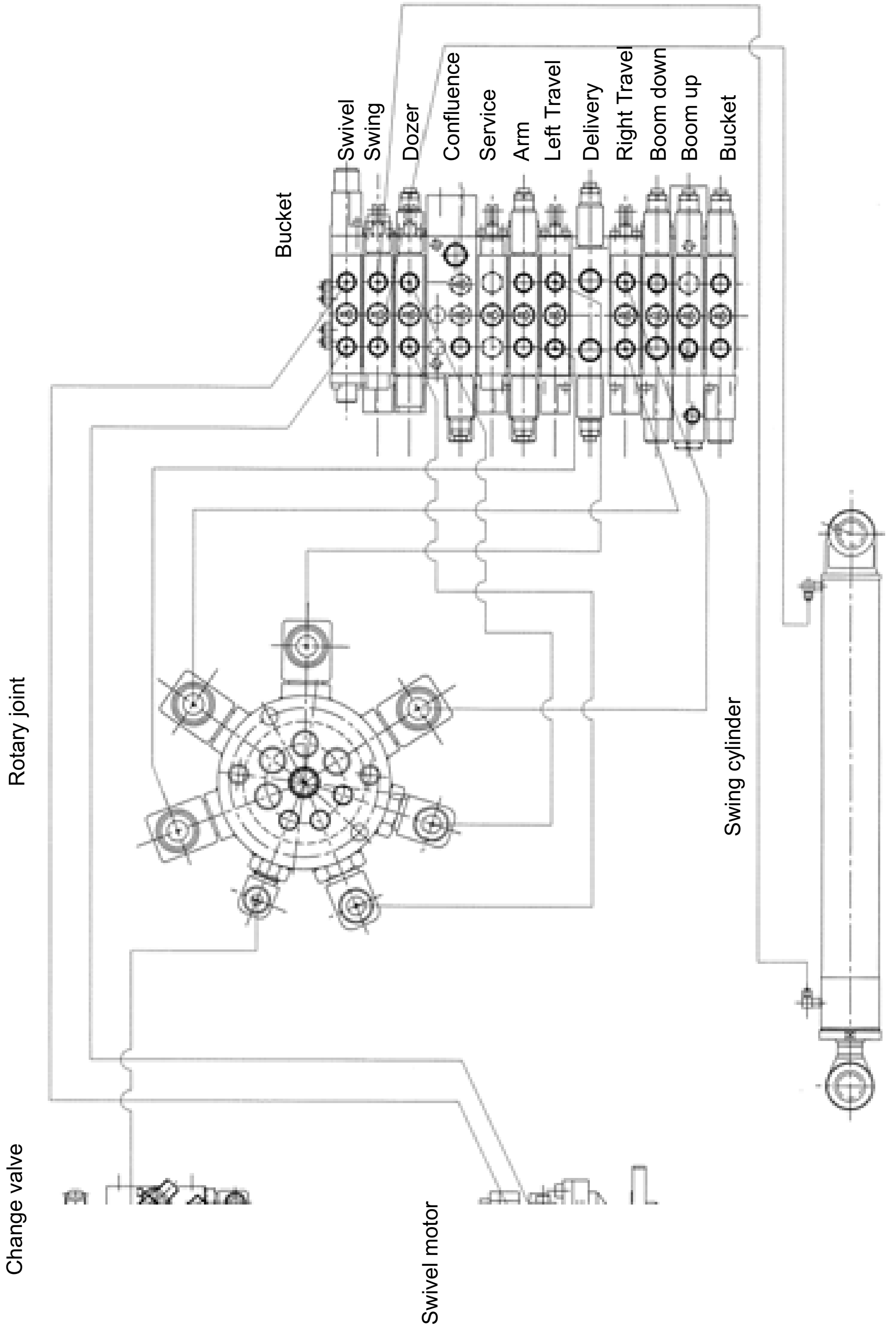
No.t	Part	
4	Pump ~ Linefilter	P4
5	Linefilter ~ unload	P4



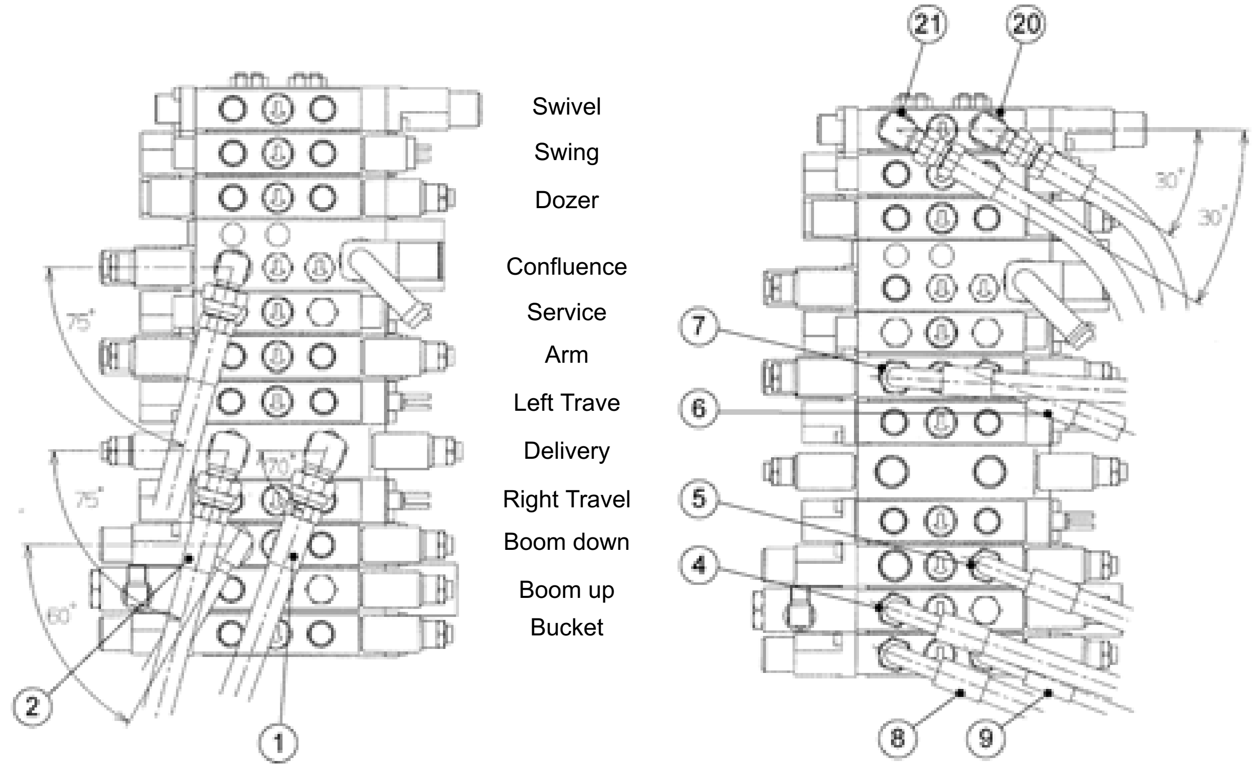
2) Hose connection from hydraulic tank to pump



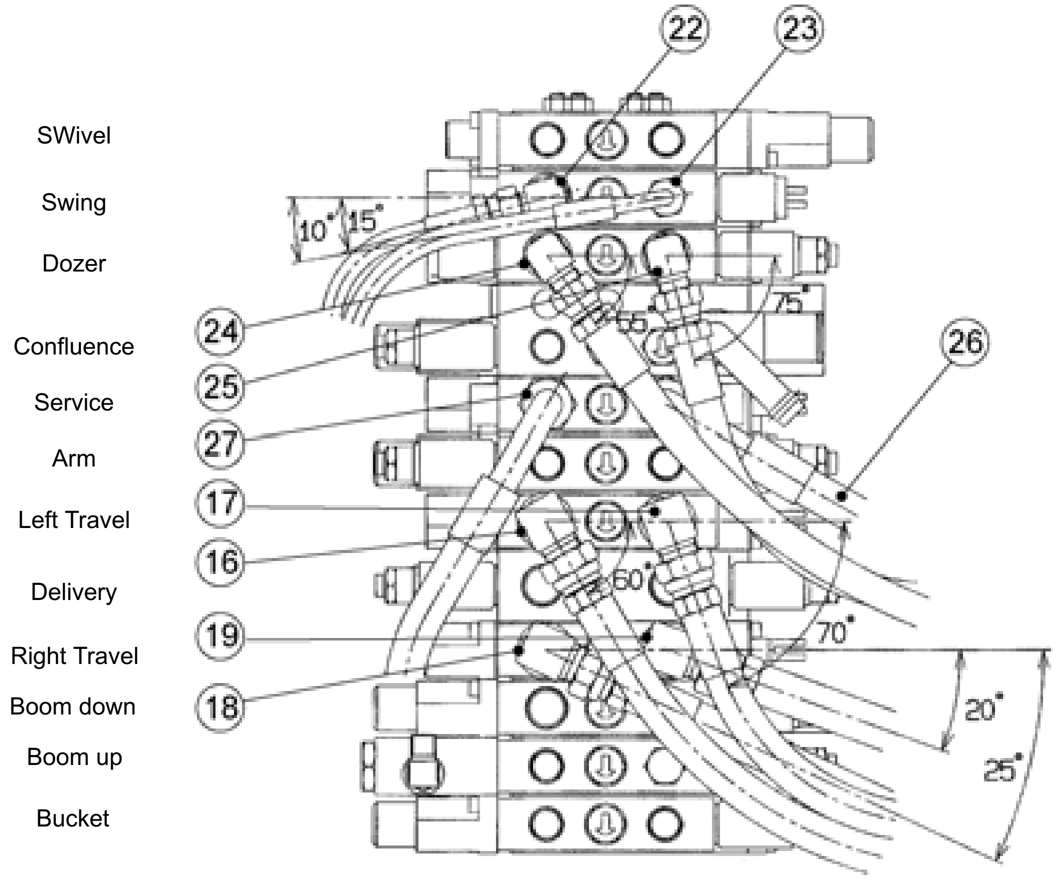
(3) Hose connection around Rotary Joint (KTC, KCL, KTA version)



(4) Hose connection on control valve (KTC, KCL, KTA version)

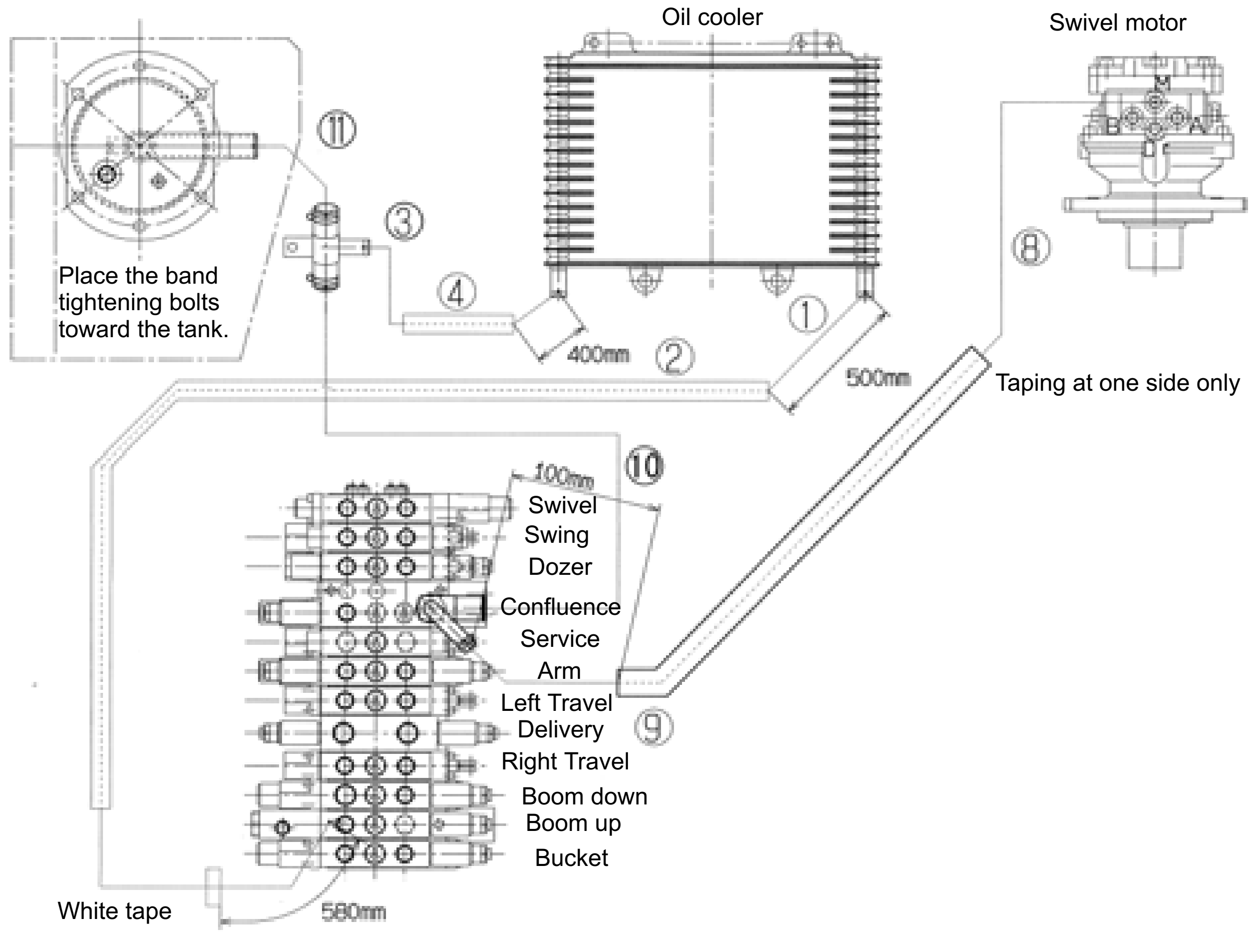


1	P1	RC411-6321△	70° left downward
2	P2	RC411-6322△	75° left downward
3	P3	RC411-6323△	75° left downward
4	Green	RC411-6411△	
5	Yellow	RC411-6412△	
6	Black	RC411-6413△	
7	Blue	RC411-6414△	
8	Red	RC411-6415△	
9	White	RC411-6416△	
20		RC411-6451△	30° right downward
21		RC411-6451△	30° right downward



16	Blue	RC411-6441△	45° right downward
17	Red	RC411-6442△	45° right downward
18	Green	RC411-6443△	25° right downward
19	Yellow	RC411-6444△	20° right downward
22		RC411-6461△	5° left downward
23		RC411-6462△	
24	Pink	RC411-6471△	35° right downward
25	Brown	RC411-6472△	15° right downward
26	White	RC411-9231△	
27	White	RC411-9232△	

(5)Return circuite (KTC, KCL, KTA version)



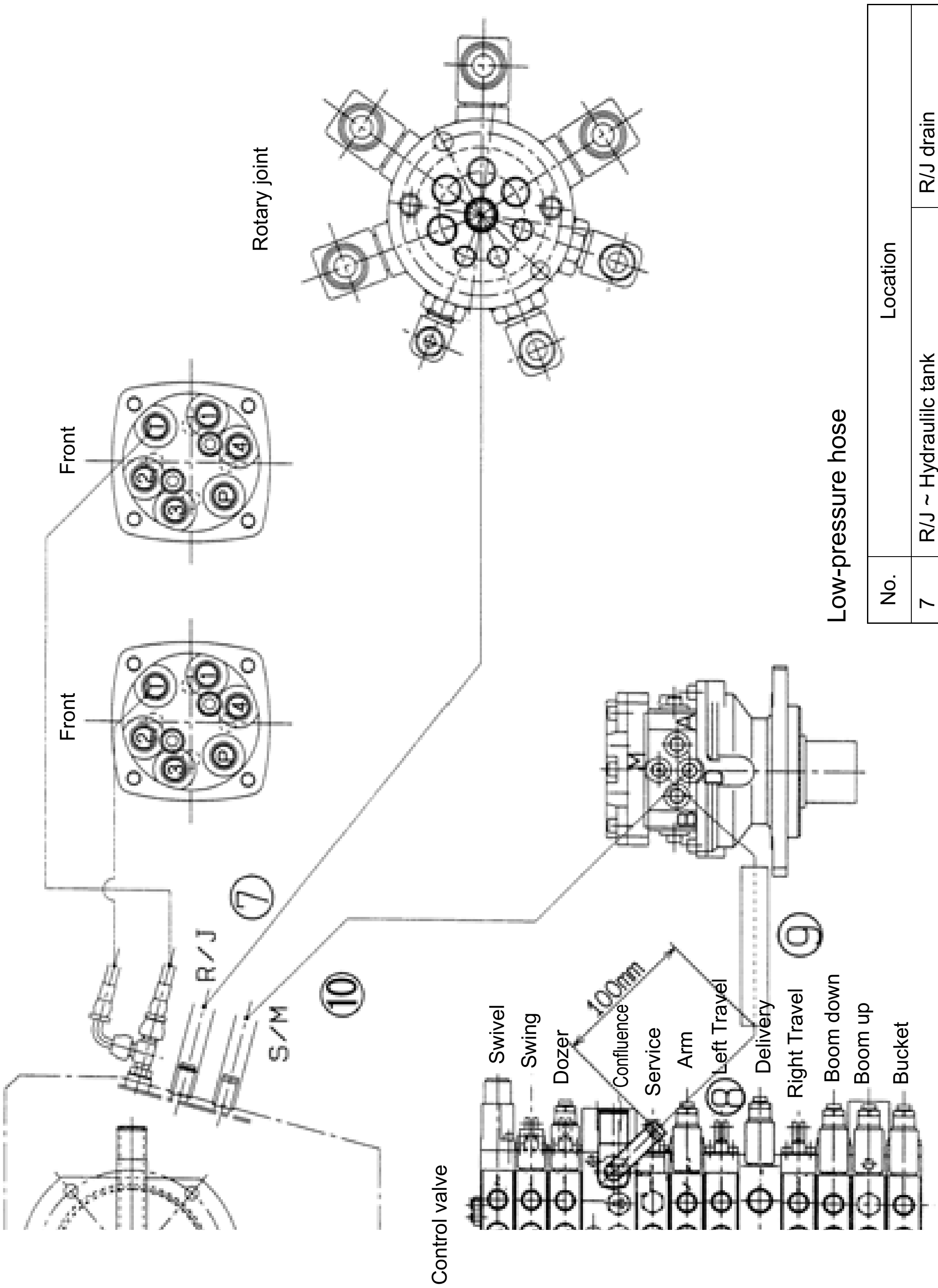
Low-pressure hose

No.	Location	
1	Oil cooler to control valve	Oil cooler
2	(Protective tube)	
3	Oil cooler to return pipe	Oil cooler
4	(Protective tube)	
8	Control valve to swivel makeup	Swivel makeup
9	(Protective tube)	

Formed hose

2	Control valve to return pipe	Return
3	Return pipe to hydraulic tank	Return

(6) Drain circuit (KTC, KCL, KTA version)



Low-pressure hose

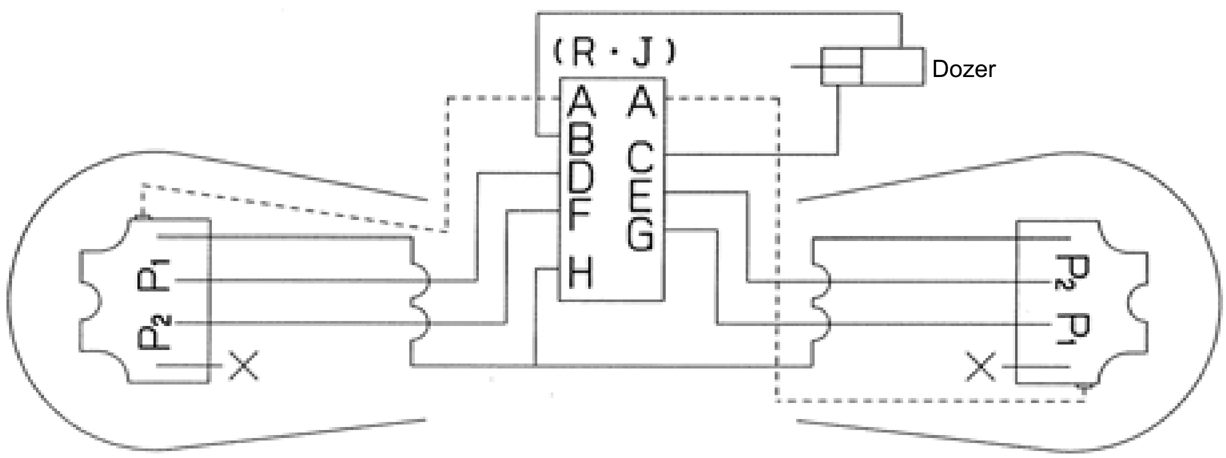
No.	Location	
7	R/J ~ Hydraulilc tank	R/J drain
10	S/M ~ Hydraulic tank	Swivel motor drain

Pilot hose

7	P/V RH T port ~ Hydraulic tank	Pilot valve drain
8	P/V LH T port ~ Hydraulic tank	Pilot valve drain

(7) Traveling motor and dozer

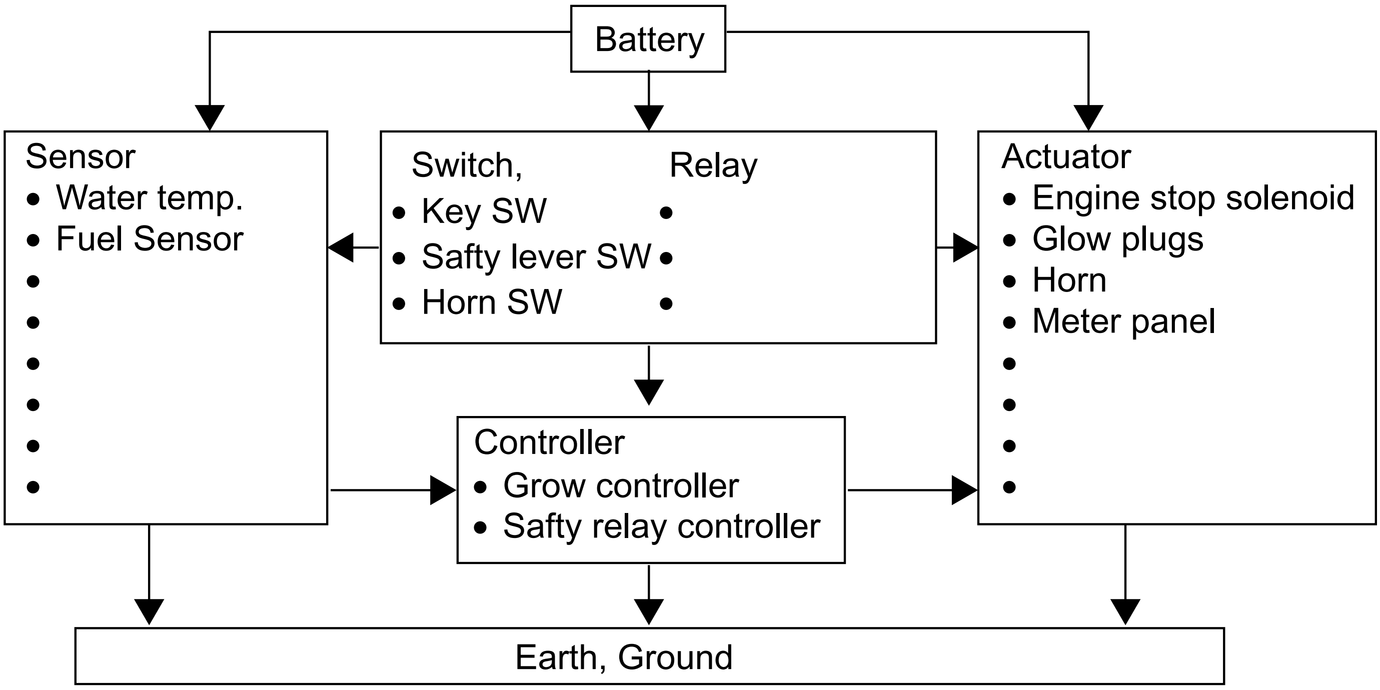
.	Rotary Joint side	Motor & Cylinder side
A	Travel High Speed	Travel high speed
B	Dozer, Down	Cylinder, Bottom
C	Dozer, Up	Cylinder, Rod
D	Travel, LH, Forward	Travel, LH, P1
E	Travel, RH, Forward	Travel, RH, P2
F	Travel, LH, Backward	Travel, LH, P2
G	Travel, RH, Backward	Travel, RH, P1
H	Drain	Drain



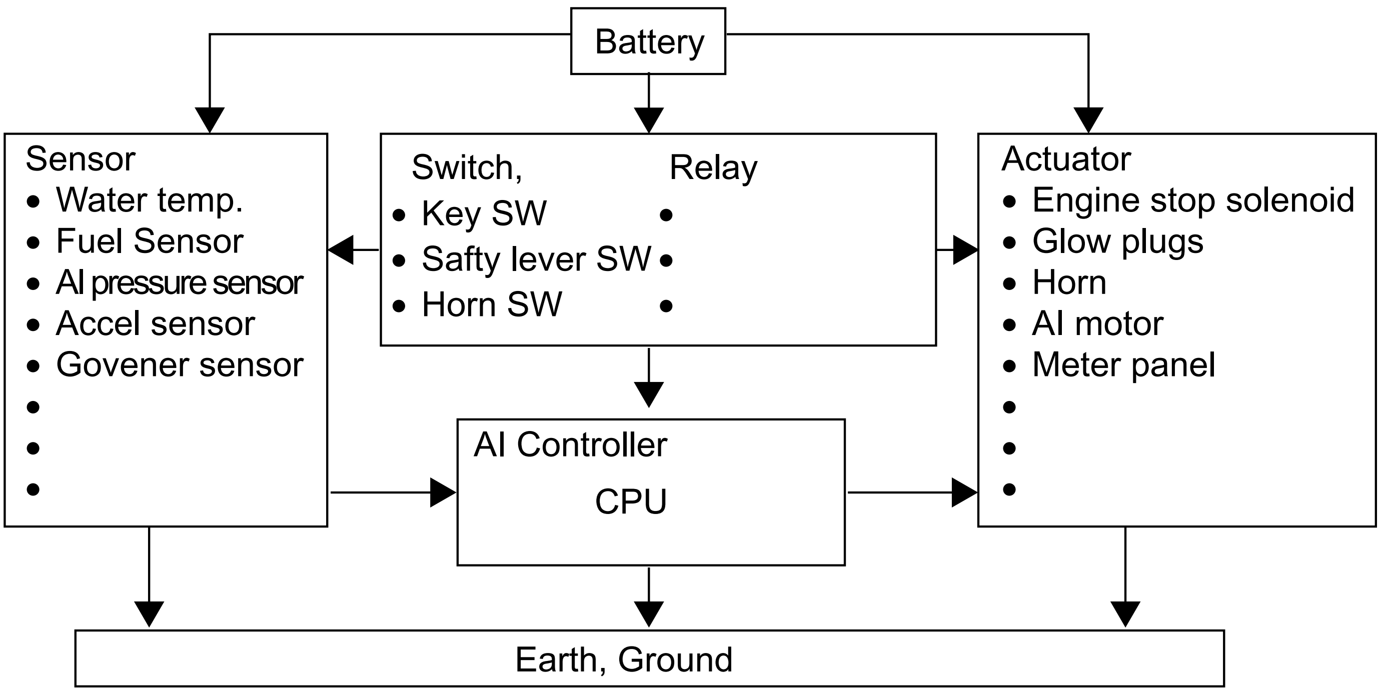
Ⅴ. Electrical system(Mechanism section)

A.Outline

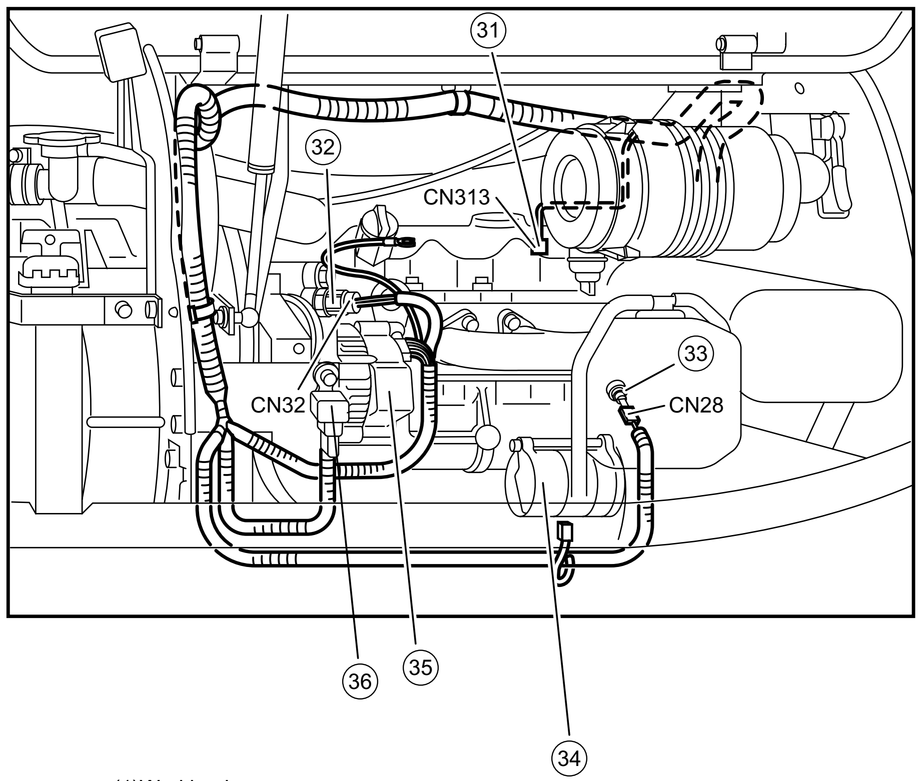
Standard-version

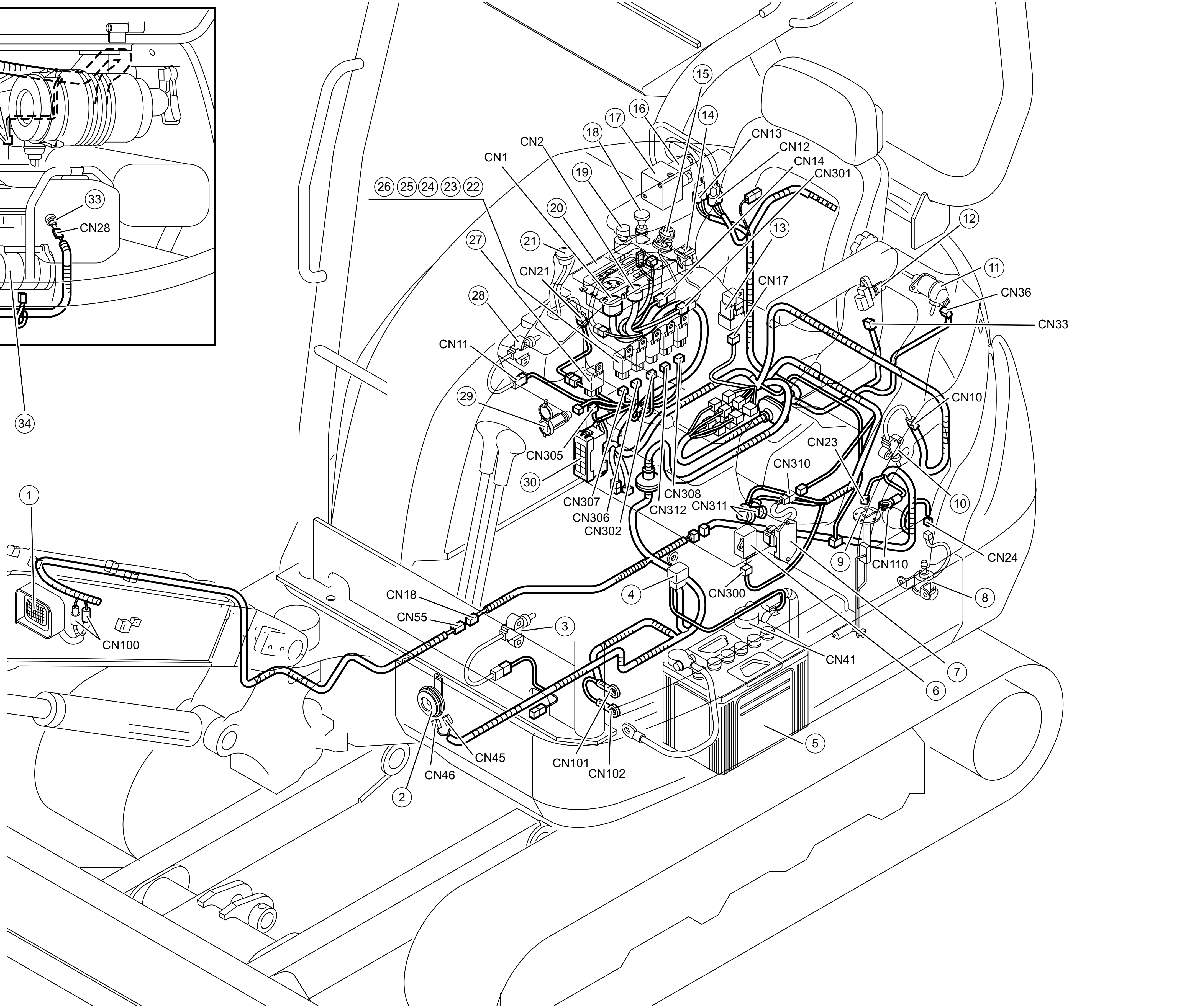


AI-version



B.Components & harness layout

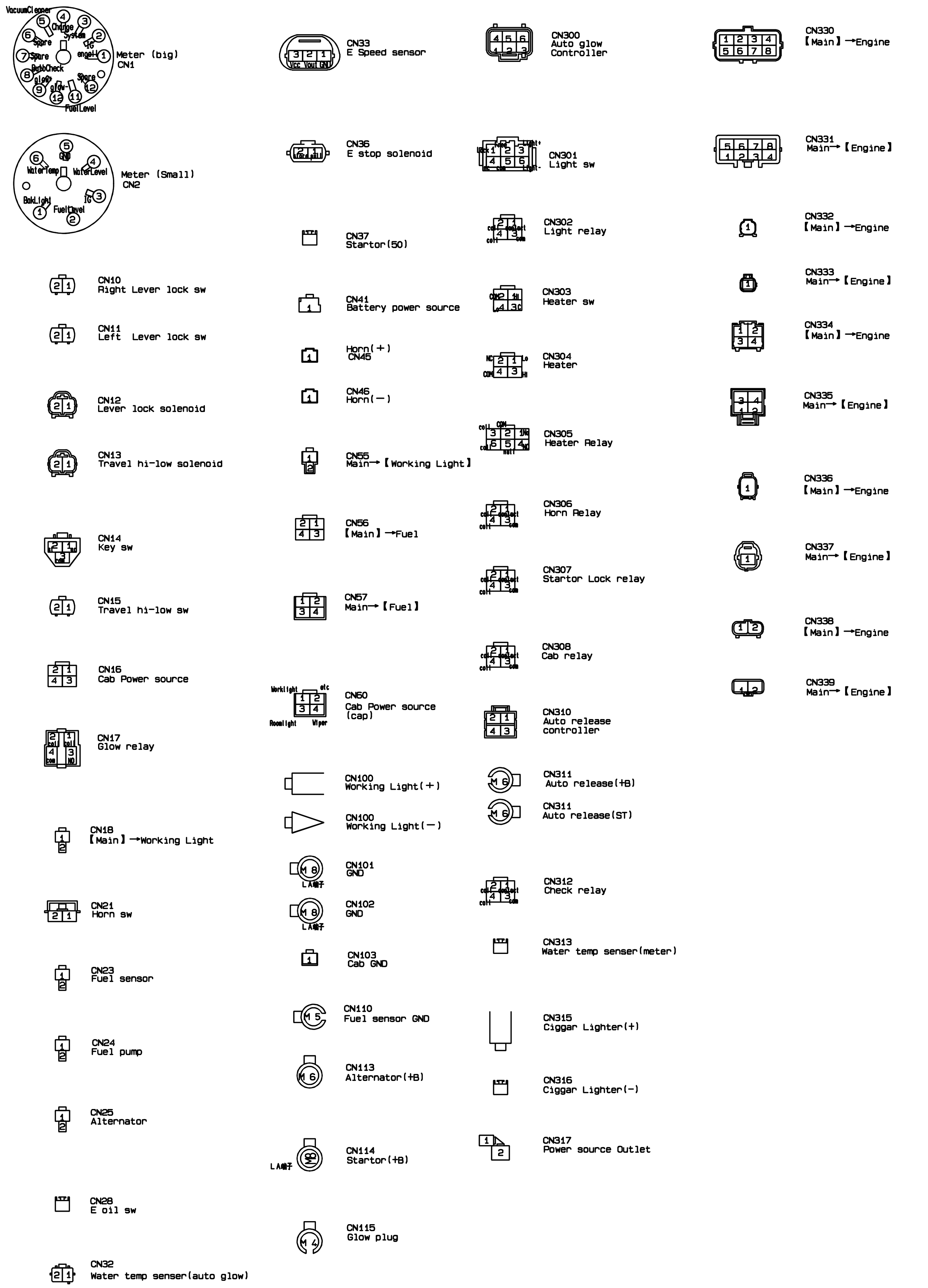




(1)Working lamp
(2)Horn
(3)Hi-Low SW
(4)SBF (slow blow fuse) 50A
(5)Battery
(6)Auto glow unit
(7)Safty controller
(8)Fuel pump
(9)Fuel sensor
(10)Safty lock SW
(11)E.Stop solenoid
(12)Engine speed sensor
(13)Glow relay
(14)Working lamp SW
(15)Key SW
(16)Hi-Low solenoid
(17)Lever lock solenoid
(18)Engine stop knob
(19)Cigger lighter
(20)Meter panel
(21)Horn SW
(22)Cab relay (Br)
(23)Check relay (R)
(24)Light relay (Y)
(25)Horn relay (G)
(26)Starter lock relay (L)
(27)Heater relay (B)
(28)Safty lock SW
(29)Power outlet
(30)Fuse box
(31)Water temp. sensor (Meter)
(32)Water temp. sensor (Auto glow)
(33)Engine oil pressure SW
(34)Starter motor
(35)Alternator
(36)SBF (slow blow fuse) 60A

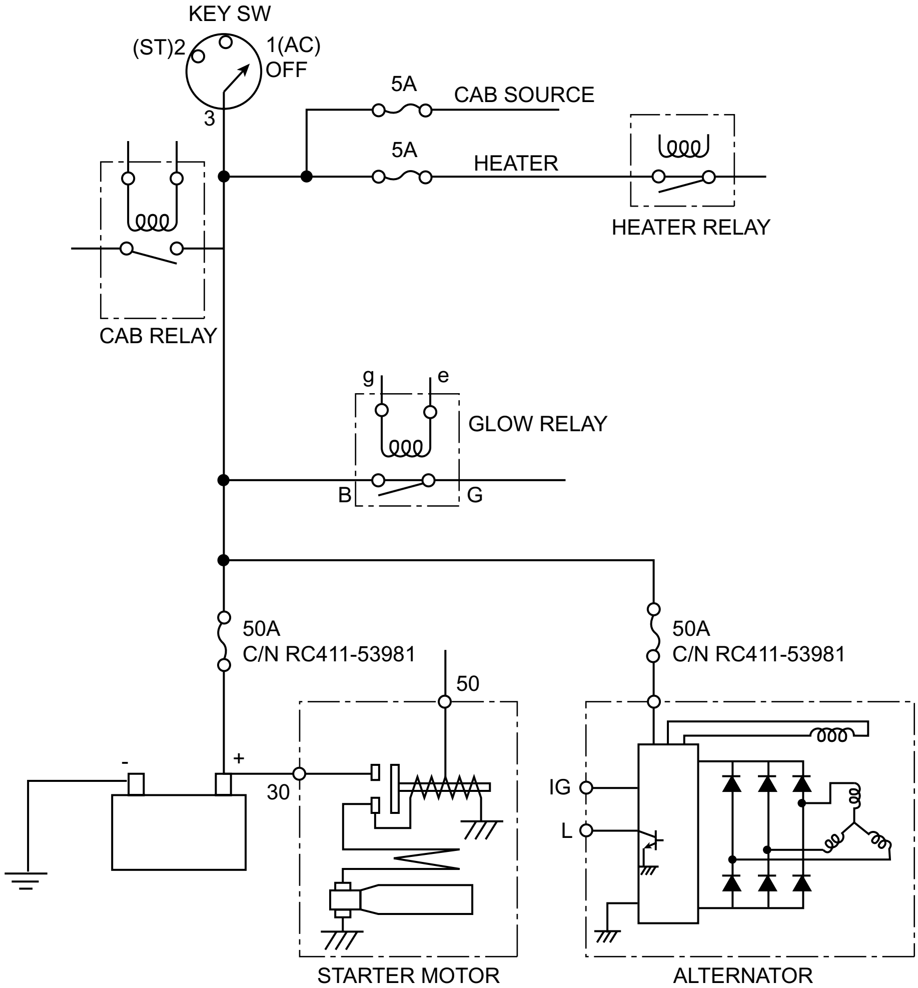
(16), (17) are KTC, KCL, KTA version.

C.Couplers, KX91-3, 101-3 Standard version



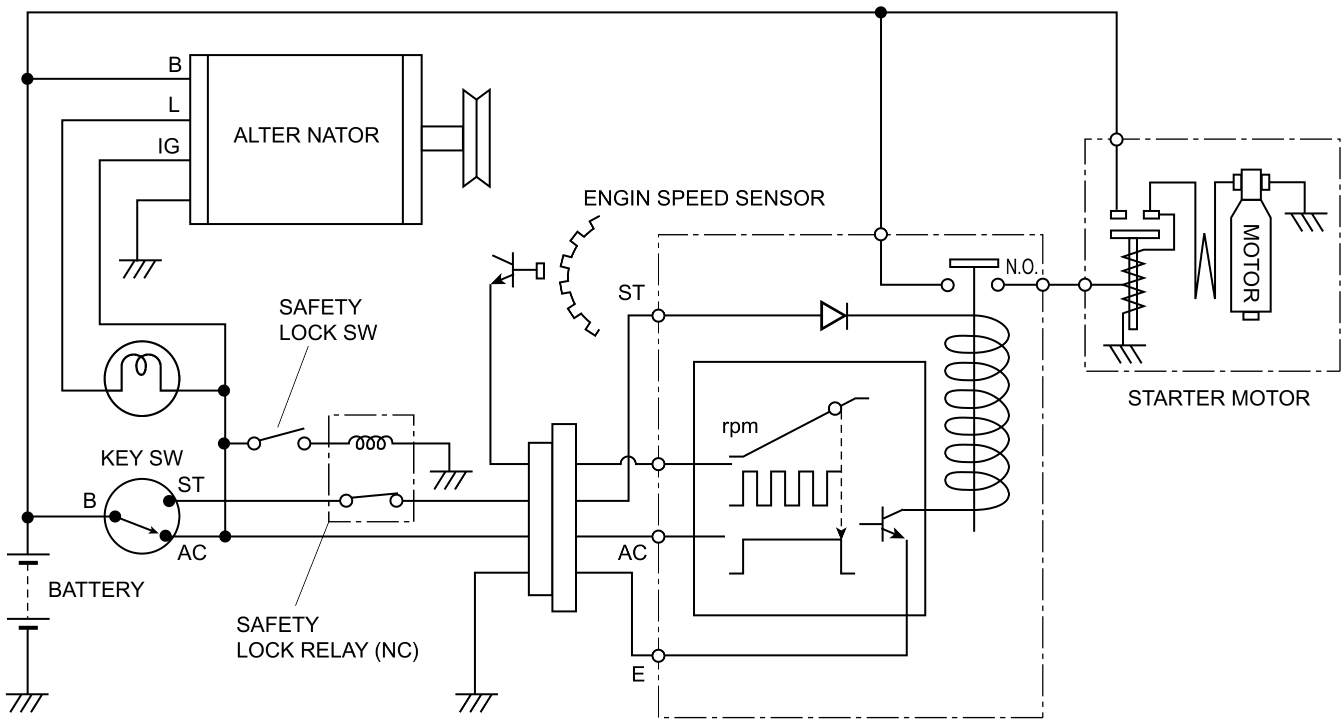
D.Function of main circuit

a. Battery circuit (Standard-version)



1. Keep in mind that the battery voltage is applied through the above circuit all the time.
2. A 60A fuse is added close to the alternator, because otherwise part of the harness may get short-circuited due to the alternator's current generated while the engine is running. In this way, the devices and harness can be protected against burn-out.
3. The battery's cold cranking amperage is rated at 582 A.

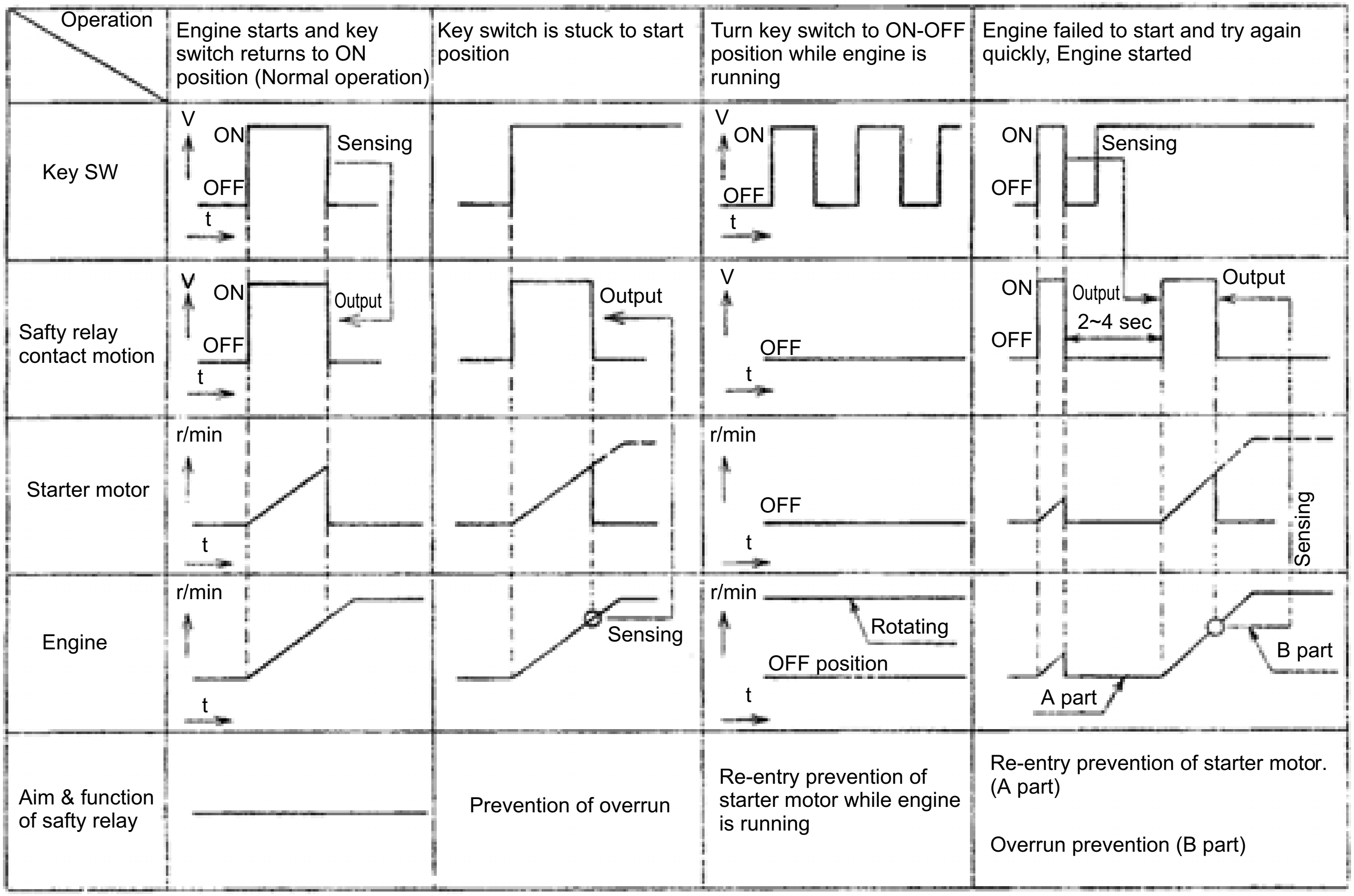
b. Safty Relay circuit (Automatic release function) Standard-version



(1) Operation

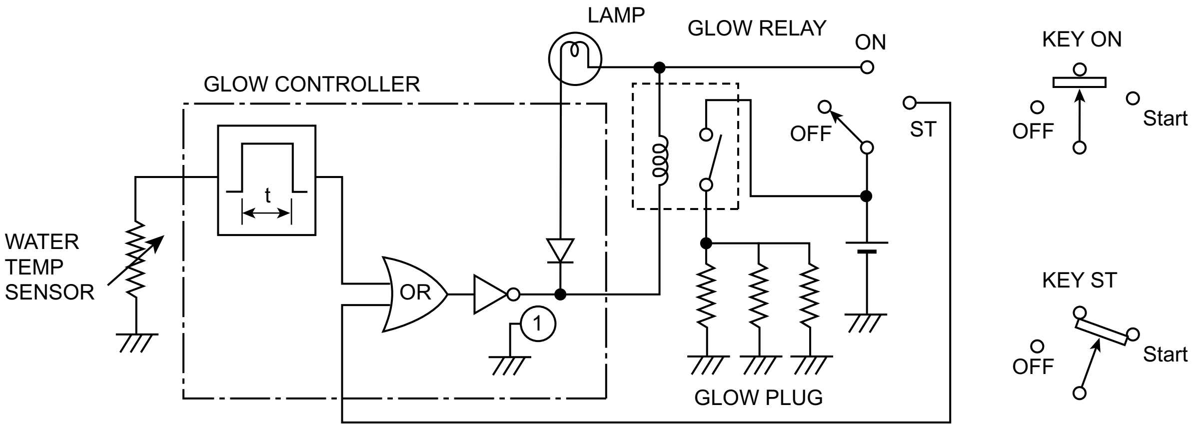
1. Turn the key switch from the AC to START position, and the safety relay controller transistor turns on. This causes a current to flow to the coil and invites an electromagnetic action to close the contact.
2. Then the battery voltage is applied to the starter coil, getting the engine started.
3. Once the engine is started, the engine speed sensor gets activated and gives pulse signal to the safety relay controller. When the pulse signal level rises above the specified rpm of 850 rpm, the transistor turns off.
4. Now the contact becomes open and the current flowing to the starter motor is cut off.
5. In this manner, the starter motor contact opens itself by the signal from the engine speed sensor, no matter what position the key switch is in.
6. This design prevents the starter motor from burn-out in case of the key switch getting stuck or failing to return.
7. The engine cannot be restarted for several seconds after the key switch is set to the START position. This is to keep the starter from getting reactivated immediately.

(2) Function chart of auto release controller



V=voltage, r/min=revolution per minute, t= time

c. Auto glow circuit (Standard-version)



(1) Function

1. The glow controller receives a water temperature sensor signal or a key switch start position signal and makes the signal voltage (1) drop to the ground level. Now the current starts flowing to the relay coil. (NOR signal circuit)
2. Turn the key switch from the OFF to ON position, and the glow relay is kept on for the time "t" as shown in Fig. 2 (Function chart) to light up the glow lamp.
3. While the key switch is set at the ST position, the glow relay is turned on again to light up the glow lamp.
4. As indicated in Fig. 3 (Timer curve), the pre-glow time (glow lamp-on time) "t" is compensated depending on the water temperature.
5. Once the current flows to the relay coil, the battery voltage starts flowing to the glow plug.

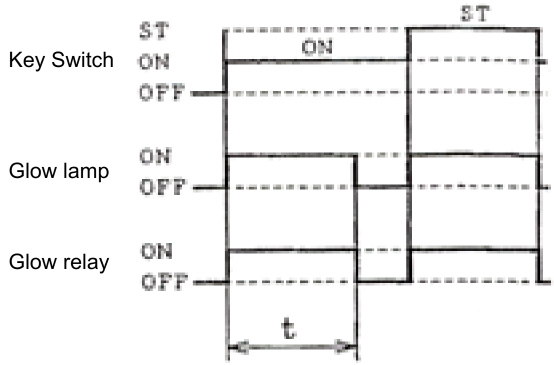
Reference: NOR logic circuit

Water temp sensor signal	Key SW ST signal	OR	NOT
H	H	H	L
H	L	H	L
L	H	H	L
L	L	L	H

H: High level, 12V
Indicates that a signal voltage is applied.
L: Low level, 0V
Indicates that no signal voltage is applied or that the terminal is grounded.

The NOR logic circuit is a composite circuit of OR gate and NOT gate.

Fig 2. Function chart



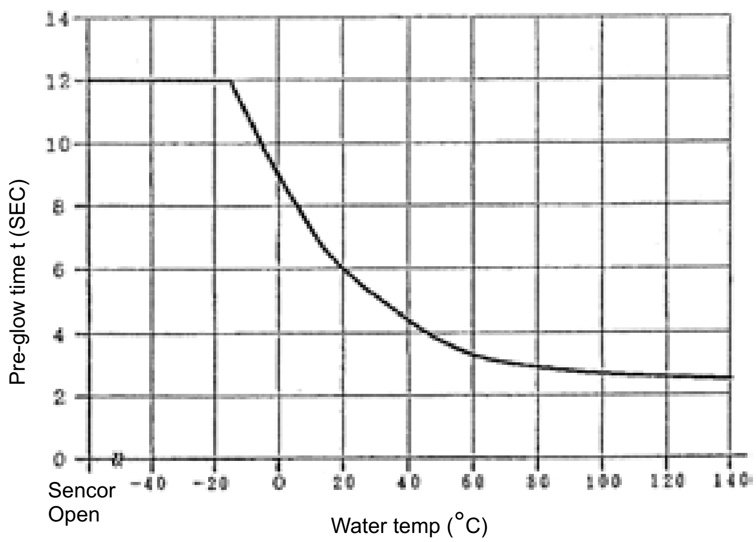


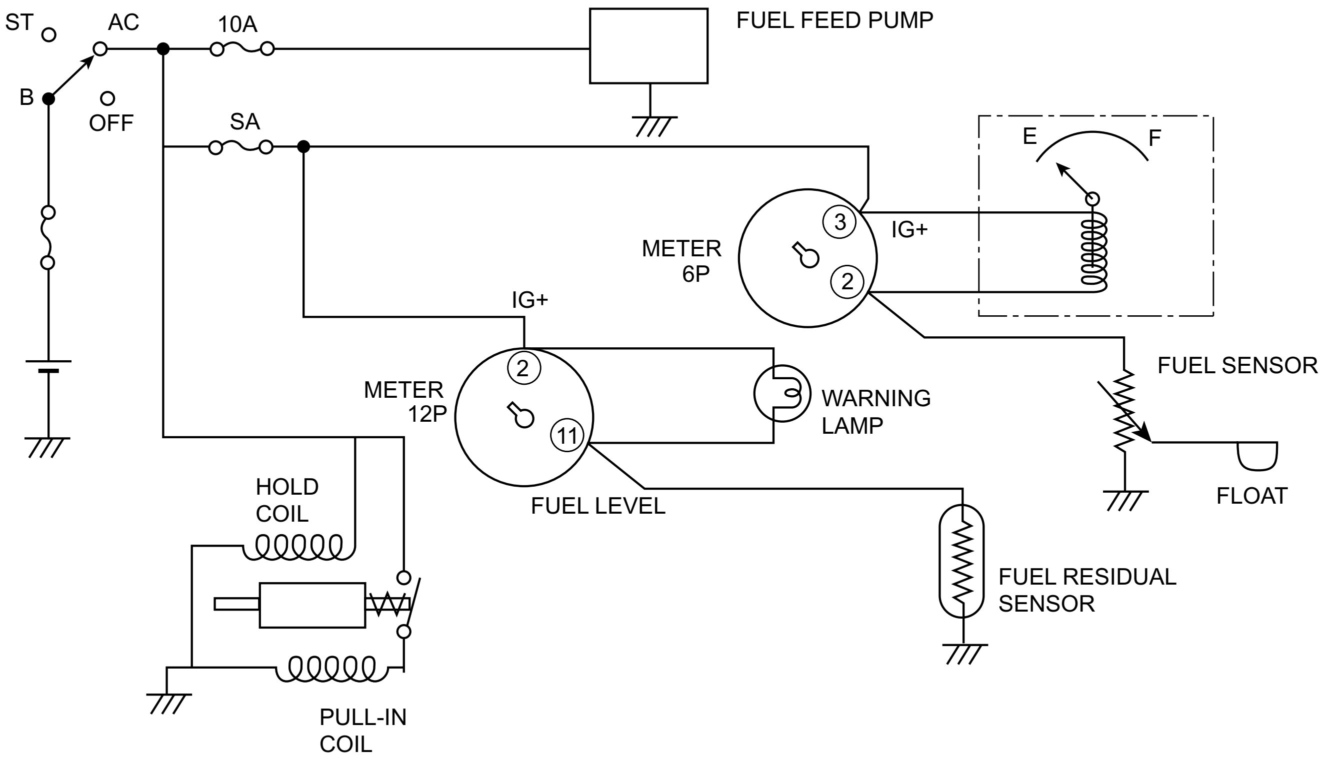
Fig 3. Timer curve

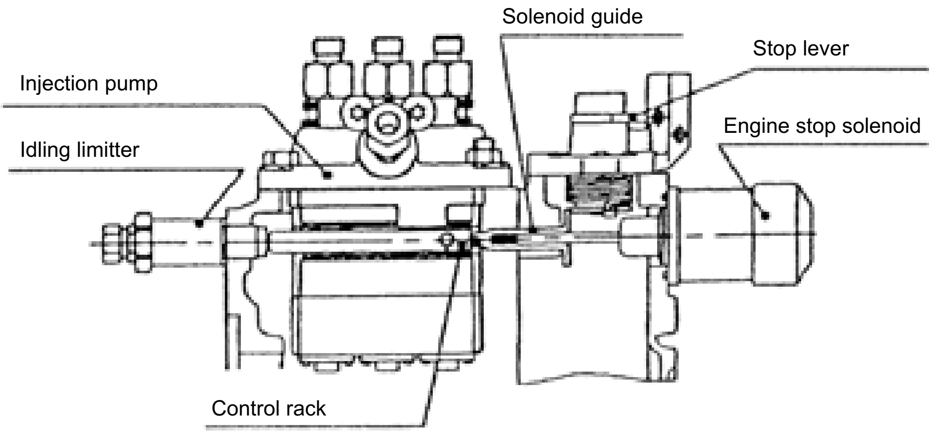
Table 1. Timer function values

Water temp (°C)	Thermistor resistance (Ω)	Pre-glow time (sec)
140	58	2.55
100	155	2.73
80	277	2.95
60	530	3.37
40	1100	4.22
20	2525	5.85
10	3997	7.12
0	6544	8.77
-10	11123	10.81
-20	19716	12.00
-30	36630	12.00
-40	71770	12.00

d. Fuel control circuit (STD, AI-version)

(1) Function

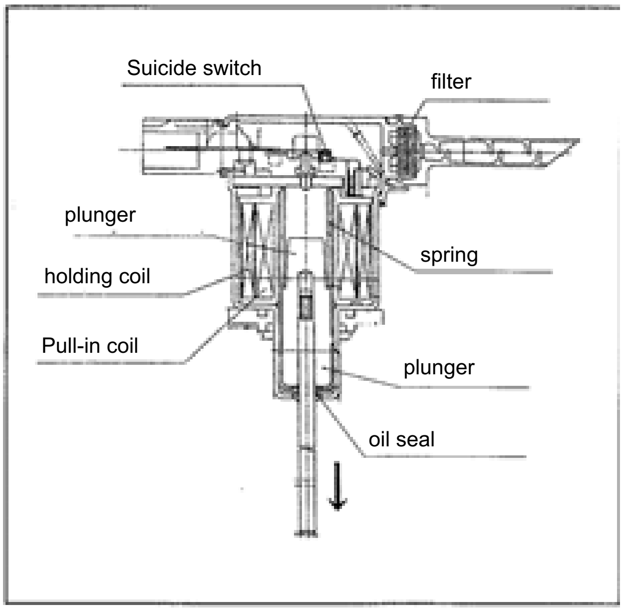




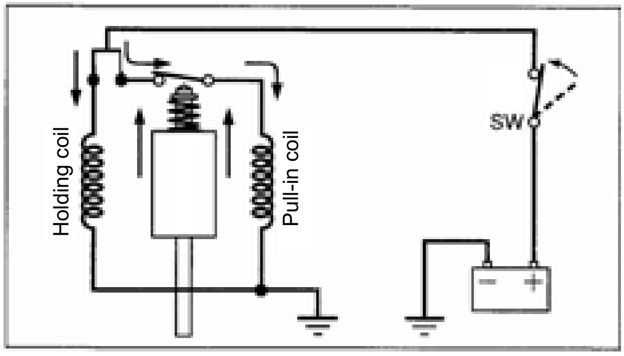
1. The fuel control circuit is mainly composed of the following devices.
   1)Fuel feed pump
   2)Engine stop solenoid
   3)Fuel gauge
   4)Fuel sensor
   5)Fuel residual sensor
2. The fuel sensor detects the position of the float and the remaining fuel amount is displayed in the fuel gauge.
3. The fuel residual sensor has a thermistor. When the sensor is well below the fuel level, the resistance value is high enough to allow no current to the warning lamp. If the fuel level has dropped below specified, however, the thermistor gets exposed to the air and becomes smaller in resistance. This allows the current to flow to the warning lamp that will light up.

(2) Engine stop solenoid (STD, AI-version)

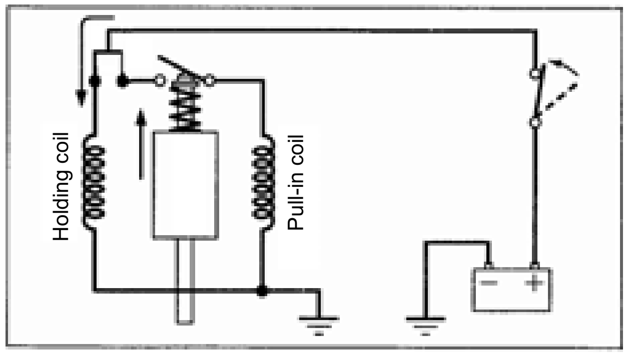
1) Structure

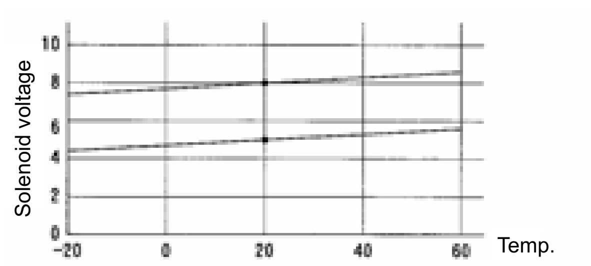


Specifications
1. Rated voltage :DC12V
2. Rated ampare
   Pull-in coil :32A / DC12V
   Hold coil :77A / DC12V
   at 20°C
3. Resistance
   Pull-in coil : Ω
   Hold coil : Ω

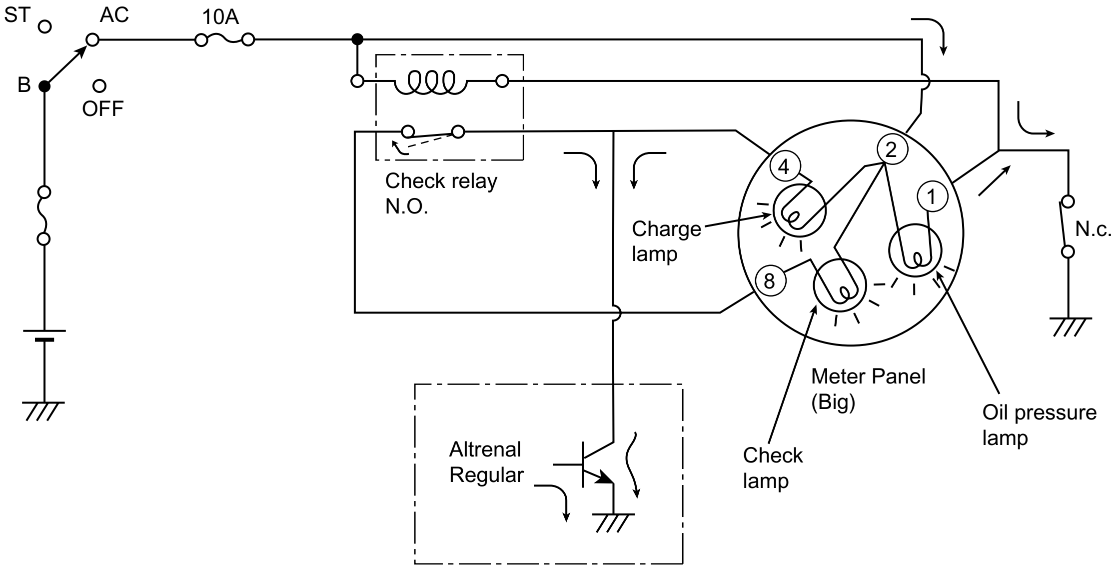


2) Circuit and its function
The engine stop solenoid circuit is as shown at left.
Turn the key switch to the ON position, and the battery current flows both to the pull-in coil and the holding coil. These coils are excited to attract and lift the plunger.
Now the fuel injection pump is ready to get the engine started.
Being attracted upward, the plunger pushes and opens the contact, which discontinues the current flow to the pull-in coil.
With the current still flowing to the holding coil, the plunger stays in this position.
Turn the key switch to the OFF position, and the current flow to the holding coil is also interrupted. By the force of the return spring, the plunger comes back to the original position. By so doing, the fuel injection pump will be back to the engine-off status.



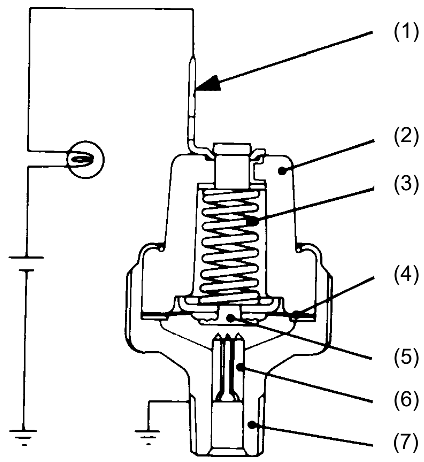


e. Engine oil pressure sensor circuit (STD, AI-version)



1. Engine oil pressure sensor is N.C.(Normal close) type.
2. Check relay is N.O.(Normal open) type.
3. Meter panel (Big): (1)Engine oil pressure line.
   (2)Battery IG(+)
   (3)Charge line
   (4)Check relay line

(1) In normal



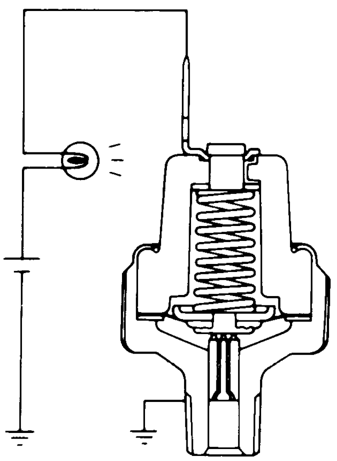
Oil switch

1. Code No, :15531-39011
2. DC12V
3. Warning lamp :SW
4. Operating pressure :0.5 ± 0.1 kgf/cm^2
5. Insulation resistance :3MΩ or more

(1) In normal condition
When the engine lube oil pressure goes up, the contact of oil switch 6 opens to turn off the lamp.

(2) In trouble
When the above pressure comes down, the contact of oil switch 6 closes to turn on the lamp.

(2) In trouble

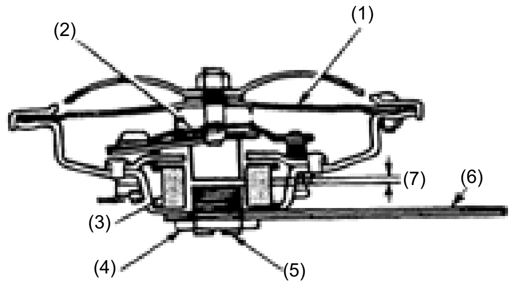


Operating pressure of oil switch
······Ref. value : 0.5 kgf/cm^2 , 7.1 psi, 0.05 MPa

(1) Turminal	(5) Contact revet
(2) Insulator	(6) Contact
(3) Spring	(7) Body
(4) Rubber	

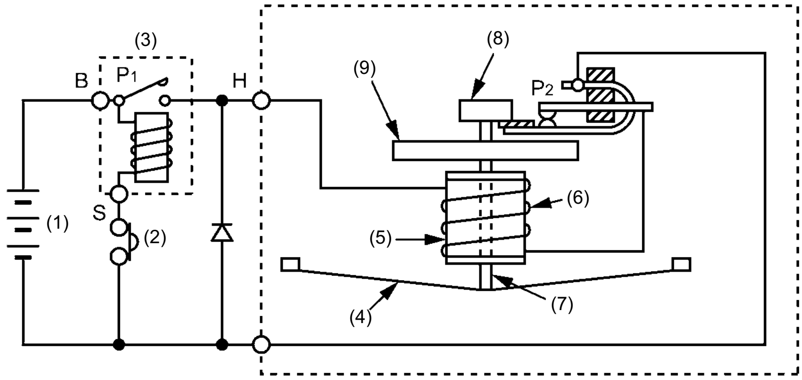
f. Horn circuit (STD, AI-version)

(1) Structure



(1) Diaphram
(2) Point
(3) Horn coil
(4) Nut
(5) Stop screw
(6) Stay
(7) Air gap

The horn consists of acoustic diaphragm, point, horn coil and other parts. It comes in spiral, flat and other types in construction.
Currently, the flat type is most widely used. A typical flat horn is shown at right.

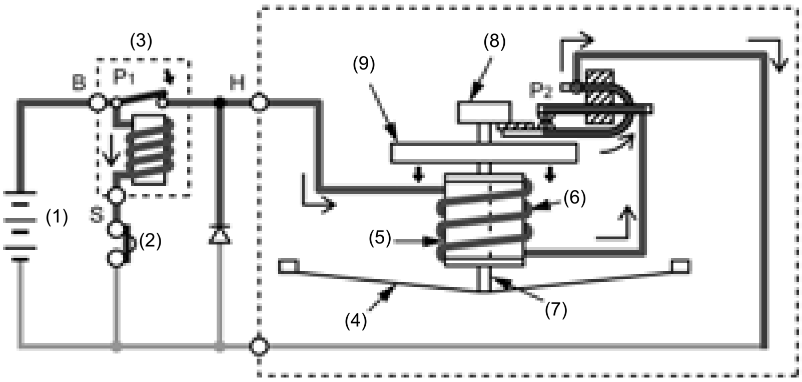


(1) Battery
(2) Horn switch
(3) Horn relay
(4) Diaphram
(5) Core
(6) Coil
(7) Moving bolt
(8) Adjust nut
(9) Moving plate

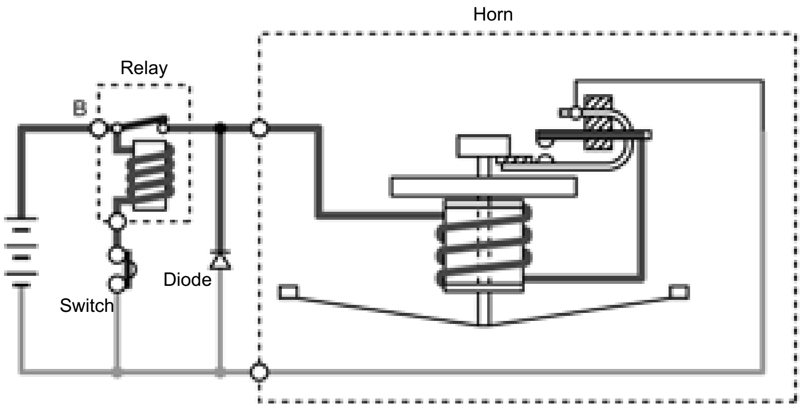
(2) Function

Shown above is the horn drive circuit. When the horn switch is pressed, current flows to the horn relay to get its contact P1 closed. The current from the battery now flows directly through the horn coil and the contact P2, which magnetizes the core and attracts the moving plate. Then the contact P2 opens itself and the current is interrupted. The magnetic force then disappears and the spring-loaded diaphragm comes back to the original position. The contact P2 closes itself, and the current flows again through the coil to attract the moving plate. The above series of actions are repeated to keep the diaphragm vibrating, producing sound.

(3) Current flow



(1) Battery
(2) Horn switch
(3) Horn relay
(4) Diaphram
(5) Core
(6) Coil
(7) Moving bolt
(8) Adjust nut
(9) Moving plate



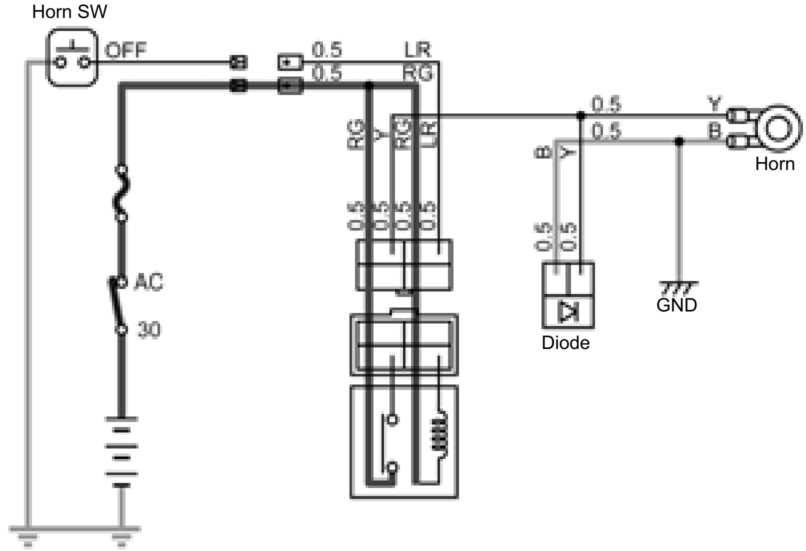
For your information

1. Function of diode: Prevention of horn switch by absorbing the surge current.
   Inductive type of load, such as solenoid valve generates arc spark at switch point.
   This diode installed parallel to solenoid valve let the surge current energy flow back to coil to consume as a joule heat.
   In this way, surge current won't flow to horn switch.

(4) Horn circuit

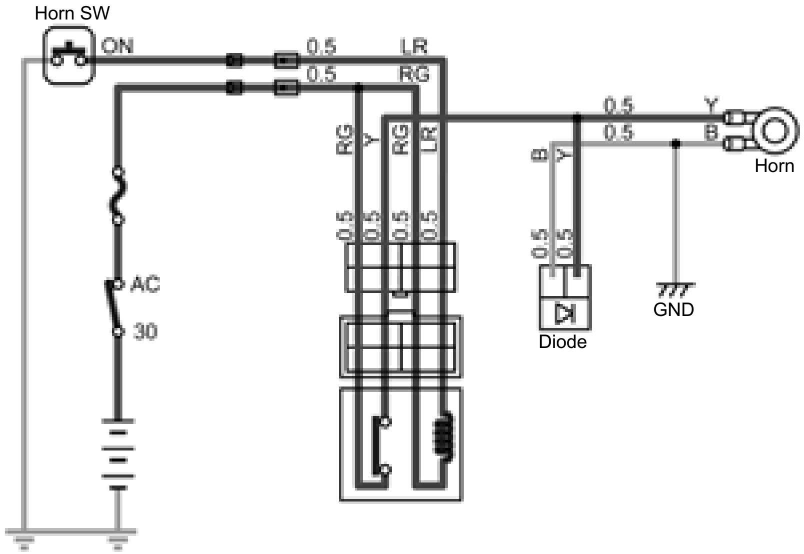
- When horn switch is off, current doesnít flow through relay.
  So relay remains off condition and horn doesnít sound.

(Horn SW is off position)

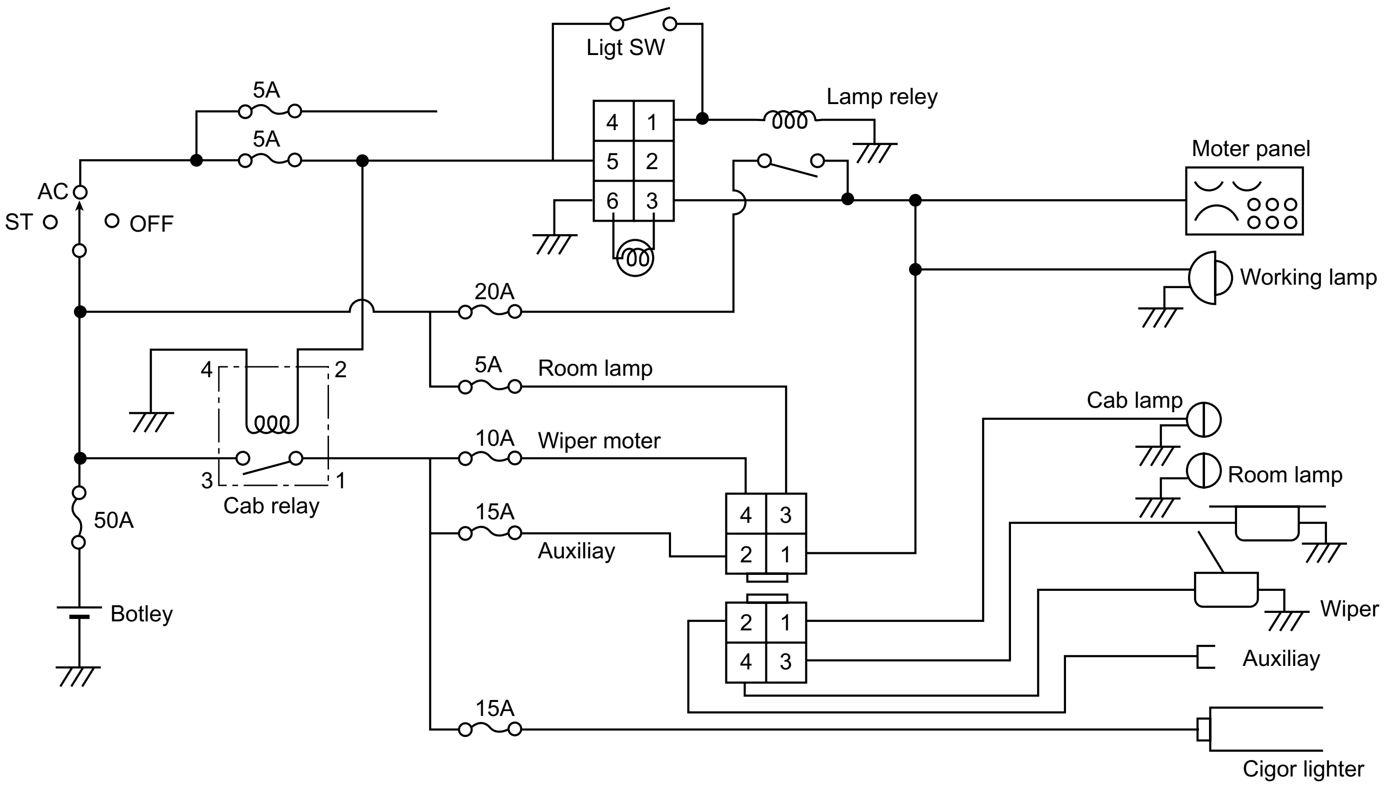


- When horn switch is on position, current flows through relay, magnetizes it and activates horn.

(Horn SW is on position)

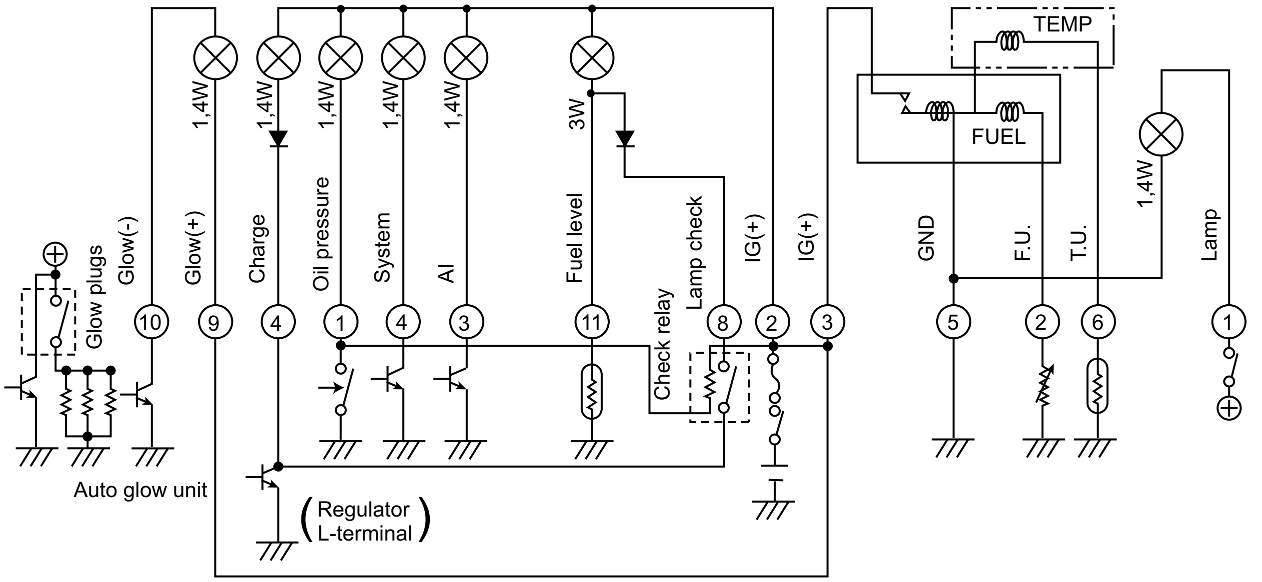


g. Cab & Working lamp circuit (STD, AI-version)



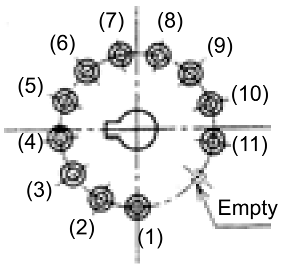
h. Meter panel (Standard-version)

Circuit diagram



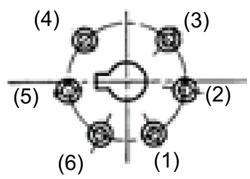
12p connector		6p connector	

12p connector



No	Connection
1	Engine Pressure
2	IG(+)
3	AI
4	Charge
5	-
6	-
7	-
8	Check SW
9	Glow (+)
10	Glow(-)
11	Fuel level

6p connector



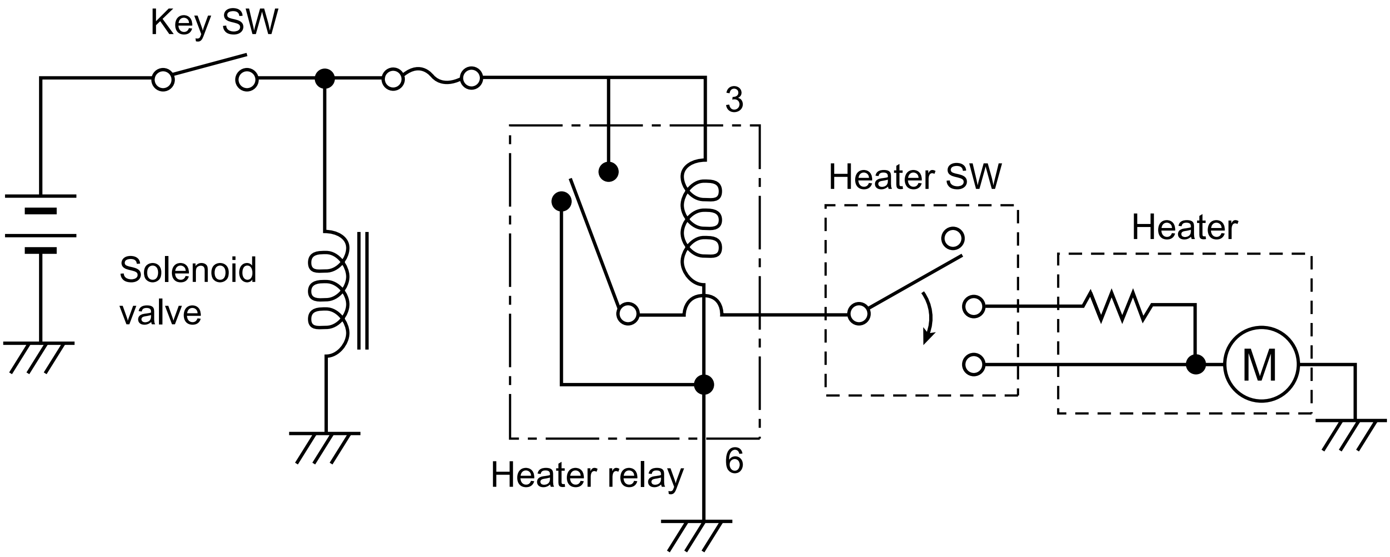
No	Connection
6	Temp. unit
1	Lamp(+)
2	Fuel unit
3	IG(+)
4	System lamp
5	GND

1. Turn the key switch to the ON position, and the battery current starts flowing as shown in the figure. Because the engine oil pressure switch is of NC type, the check relay comes on too and all the warning lamps light up.(The regulator terminal L also lights up when the key switch is turned to the ON position.)

2. When the engine has started and reached the specified speed, the engine oil pressure rises too and the switch is turned off. The charge voltage also rises, which discontinues the current flow to the terminal L. Thus the check relay turns itself off and all the warning lamps go out.

3. During usual operation, the indicator lamps are ready to light up according to their respective circuits. Let's take some examples. The glow lamp stays on while the current is flowing to the glow plug. The AI lamp is kept on during the AI function. The charge lamp lights up if the charge voltage drops below the specified level. The fuel level lamp lights up if the fuel runs short.

i. Heater circuit (STD, AI-version)



(1) Current flow

1.Turn the key switch to the ON position, and the battery current starts flowing to the heater relay, making the relay contact.

2.By changing the heater switch to the High and Low position, the heater can be controlled in two steps.

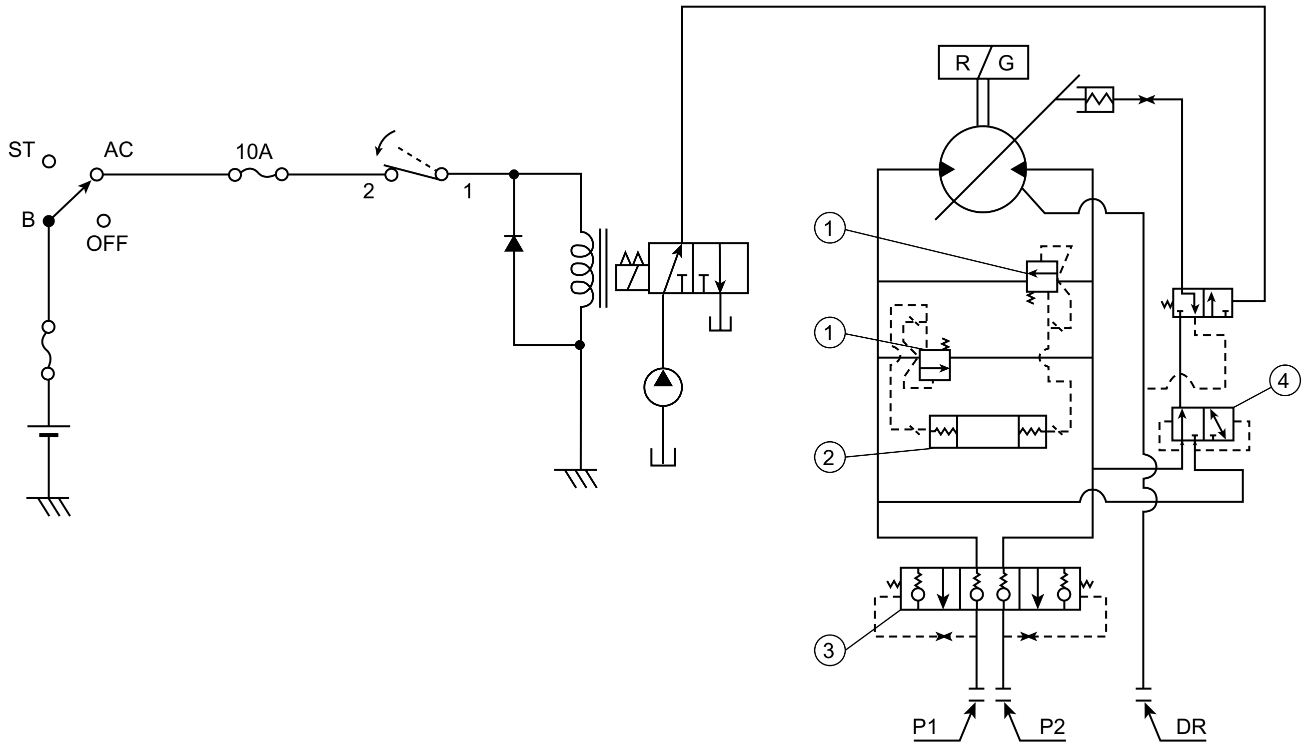
(2) Electromagnetic braking

Turn the key switch to the OFF position with the heater switch still on, and the heater motor usually keeps turning by inertial force and generates electricity. Since the relay terminal is always grounded, however, the self-generated current causes an inverse electromagnetic action, which interrupts the motor quickly. This process is called electromagnetic braking.

(3) Purpose of relay

Without the relay, the above-mentioned self-generated current at a stop of the heater motor might flow into other solenoid valves for example. The relay is thus used to prevent malfunction of other devices.

j. Travel hi-speed control circuit (STD, AI-version)



Troubleshooting: Travel hi-speed malfunction

1. Turn the key switch to the ON position to see if 12 V is applied to terminal 2 of the travel hi-speed switch.

2. Press the travel hi-speed switch to see if the 12 V signal comes to terminal 1.

3. Turn on and off the travel hi-speed switch and check the continuity and discontinuity.

4. Check the continuity of the travel hi-speed solenoid coil and measure its resistance.

5. If there is no problem with the above steps, it means the electrical system functions. Now go to the hydraulic system.

6. Possible troubles with the hydraulic system include stuck solenoid spool, poorly performing pilot pump, malfunctioning primary relief valve, stuck Hi-Lo selector spool, etc.

k. Auto idle control system (AI-version)

(1)Purpose

When you interrupt a job and set the control lever to neutral, the engine will come to the automatic idling rpm in 4 seconds. This helps save energy and keep quiet.

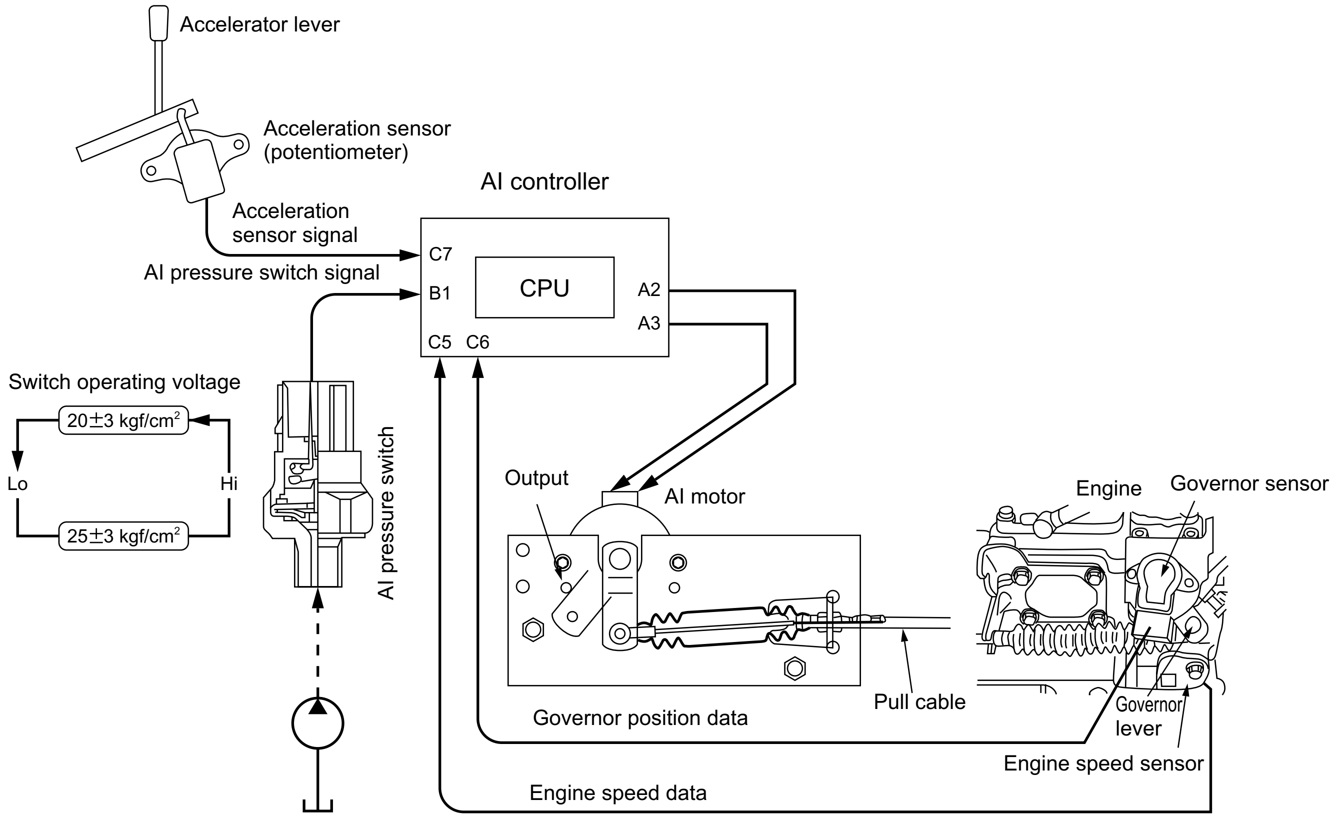
(2)Auto idle function mechanism

1. The auto idle type machines are equipped with the electrical devices that are shown in the accompanying AI function layout.
   (1) Meter panel (AI system lamp)
   (2) AI motor
   (3) Pull cable
   (4) Acceleration sensor
   (5) AI pressure switch
   (6) Governor sensor
   (7) Engine speed sensor
2. To enable the auto idle function, first turn on the AI switch.
3. When you operate the machine, the AI pressure switch detects the primary pressure of the hydraulic pilot system and opens the contact. The signal is then sent to the CPU of the AI controller.
   The AI pressure switch is attached on the control valve. This switch is of normally closed type (the contact is usually kept closed).
4. The acceleration sensor is attached on the support of the accelerator lever. The lever position is detected in terms of turning angle by a potentiometer, and the signal is sent to the AI controller CPU.
5. The governor sensor and the engine speed sensor are installed on the engine governor. The governor position signal is sent to the AI controller CPU.
6. The AI controller CPU processes the above information and feeds a current command to the AI motor so that the engine governor should run at maximum speed.
7. Receiving the command, the AI motor starts and controls for the engine governor, through the pull cable, to reach maximum rpm. This leads to the maximum engine speed.
8. When all the hydraulic actuators are at neutral, the AI pressure switch gets normally closed and sends the signal to the AI controller CPU.
9. The CPU of the AI controller then feeds a current command to the AI motor so that the engine governor should run idle. In this way, the engine will also set itself to the idling speed.
   The CPU will get idling, too, 4 seconds after receiving the pressure switch signal.

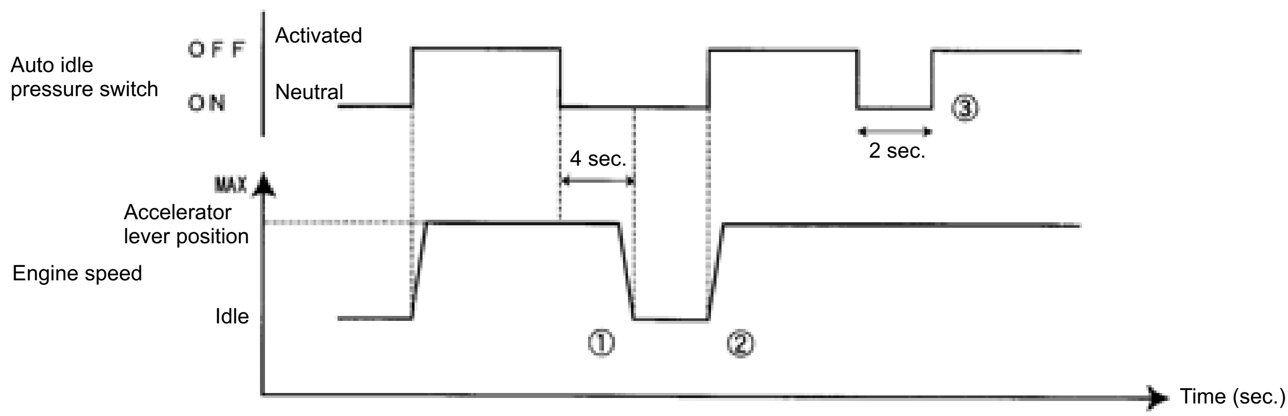
☆**Trouble cases**

Electrical system:
If the AI switch or its coupler is out of position or if the harness is broken, the circuit gets open (contact off). In other words, the microcomputer judges that the hydraulic actuator is running, and the auto idle function fails.
Hydraulic system:
If a trouble occurs in the hydraulic system, there is no pressure rise often. In other words, the AI pressure switch gets normally closed, and the microcomputer judges that the hydraulic system is not running, namely, the control lever is at neutral. (Even by moving the control lever, the initial; engine speed cannot be resumed.)

(3) AI function layout

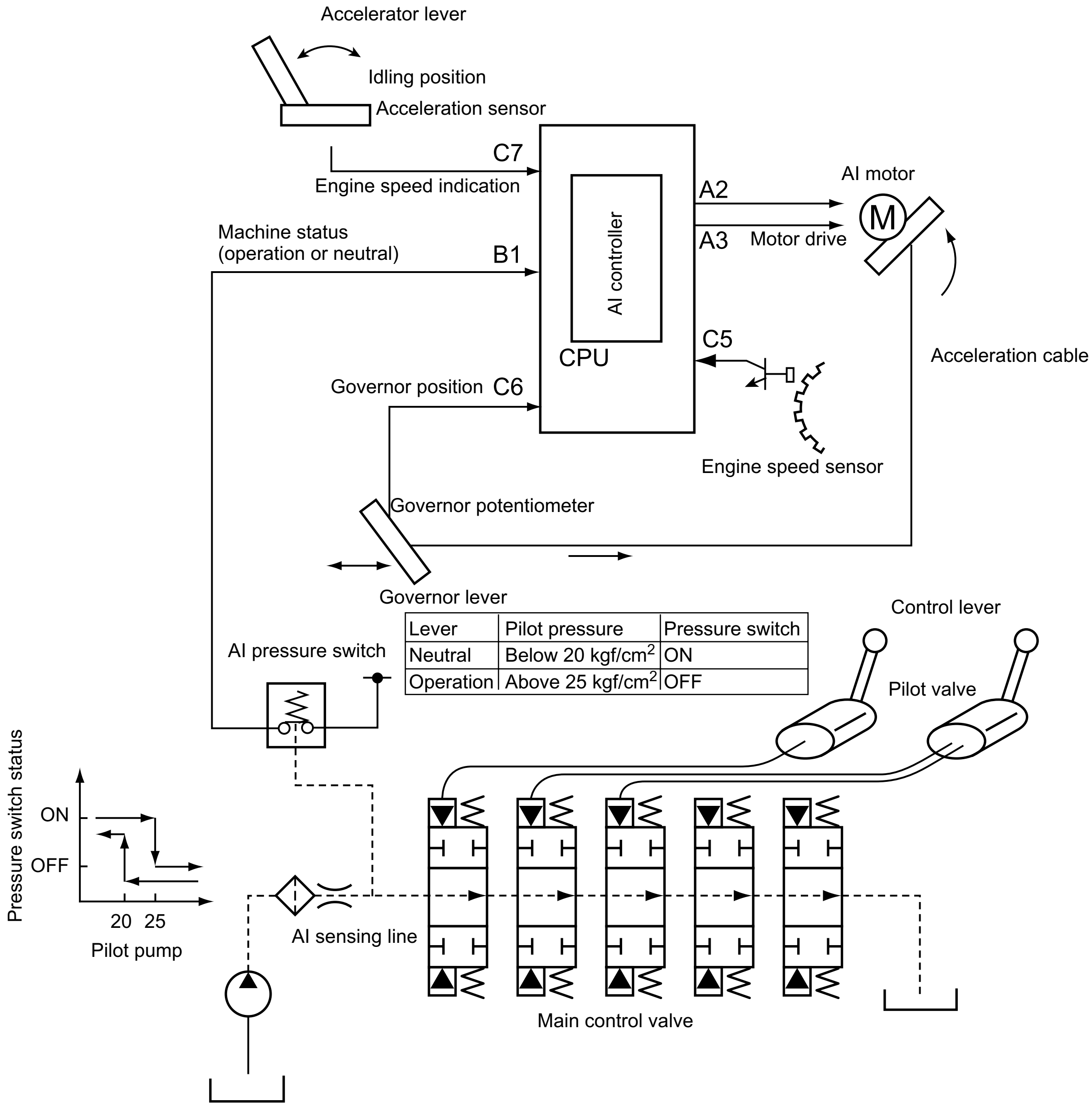


<Operating chart>



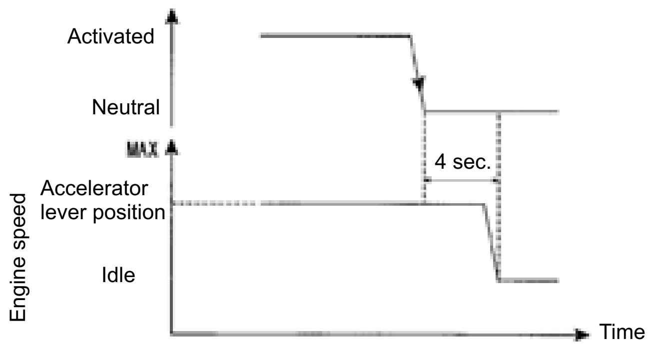
(1) The idling speed can be achieved 4 seconds after the control lever is set to neutral.
(2) The initial speed is resumed just after the control lever is moved.
(3) The speed remains the same if the control lever is kept at neutral for 2 seconds.

(4) Behavior when the control lever is returned to neutral

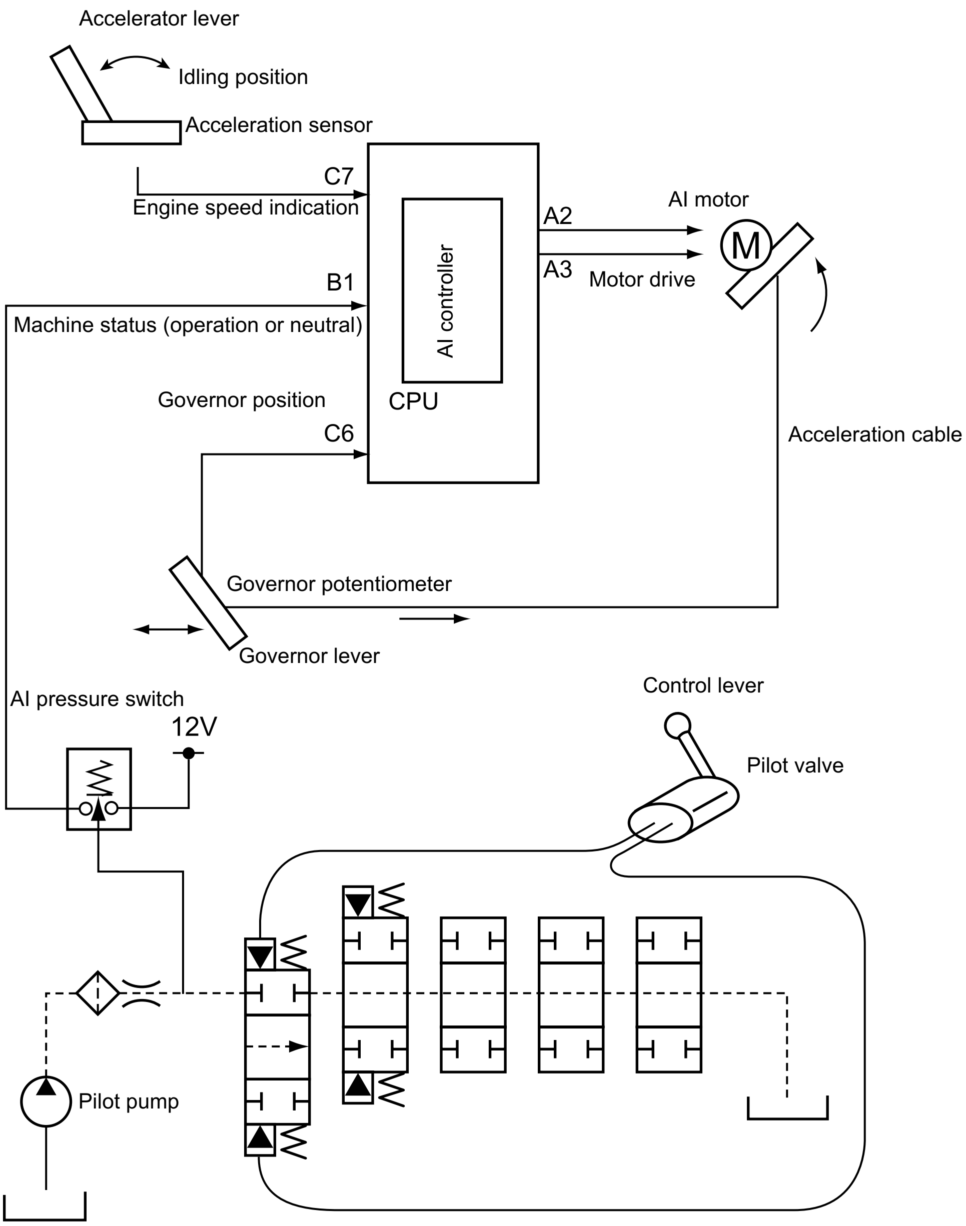


Lever	Pilot pressure	Pressure switch
Neutral	Below 20 kgf/cm^2	ON
Operation	Above 25 kgf/cm^2	OFF

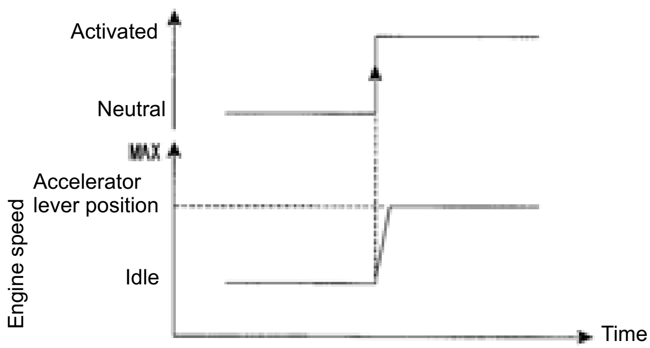
1. When returning the control lever back to neutral:
   - AI pressure switch at ON and accelerator lever at MAX:
     When the control lever has been placed back to neutral, the oil flows from the pilot pump through the neutral passage of the control valve to the tank. The pressure drops, which turns on the pressure switch. In about 4 seconds, the AI motor gets started to reduce the engine speed to the idling level.



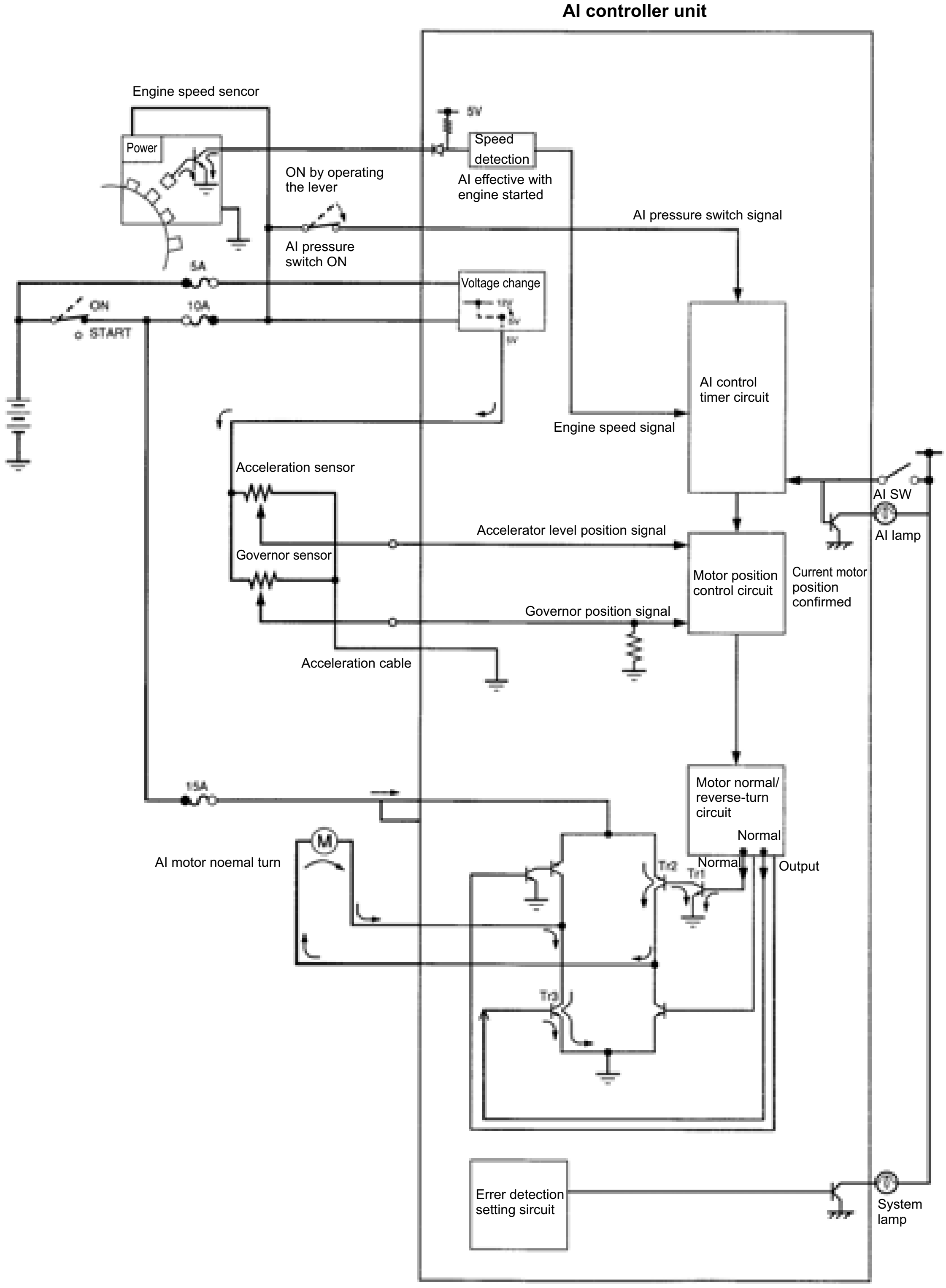
(5) Behavior when the control lever is operated:



- AI pressure switch at ON and accelerator lever at MAX:
  When the control lever is operated (left swivel, for example), the control valve is activated to cut off the oil flowing from the pilot pump. The primary pilot pressure is applied to turn off the pressure switch.
  The AI controller functions to run the AI motor so that the engine governor should reach maximum position. The engine speed rises quickly to maximum rpm.



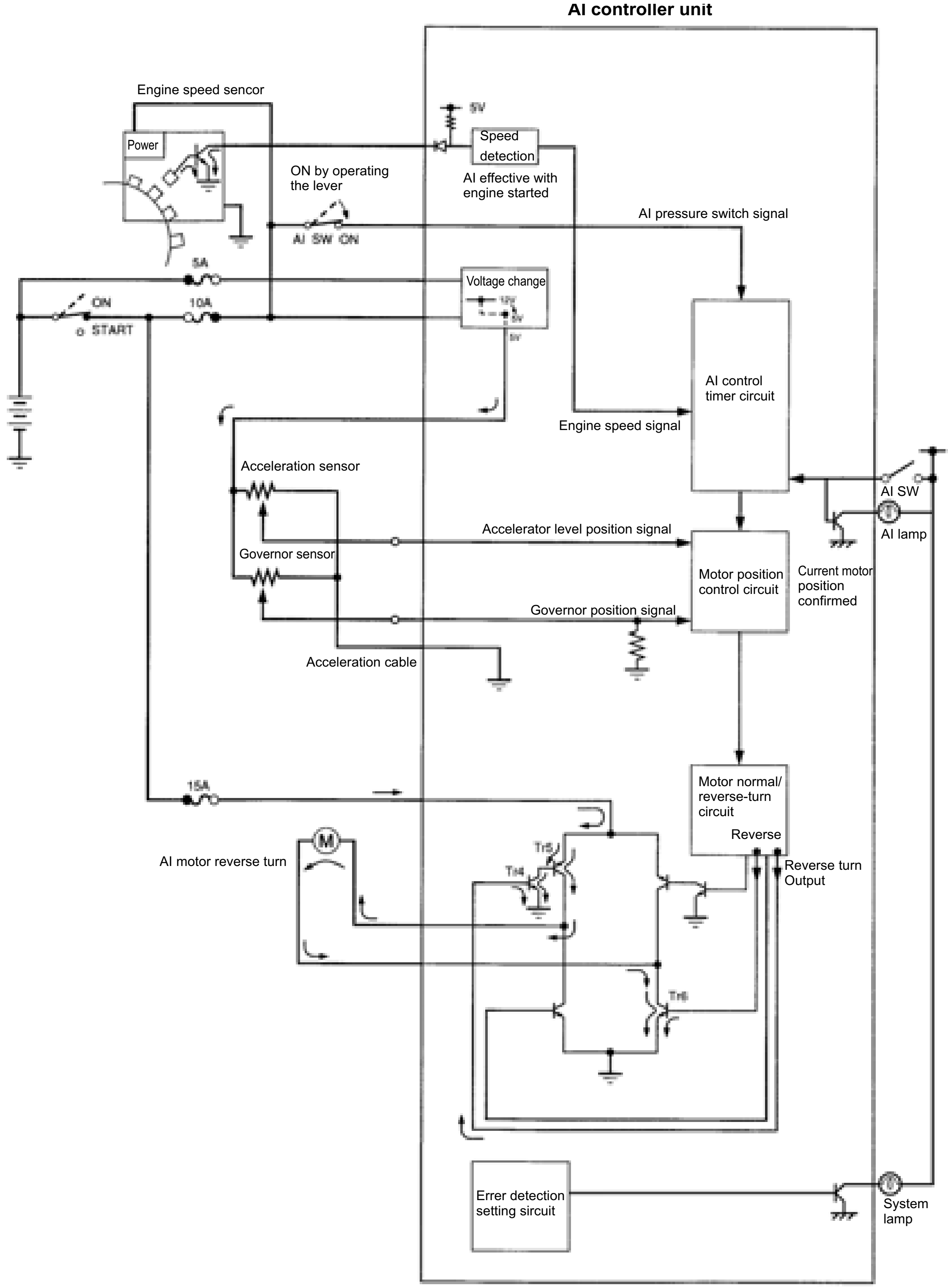
(6) AI motor normal-turn circuit



Behavior:

1. The acceleration sensor signal and governor sensor signal are fed to the motor position control circuit.
2. The motor normal/reverse-turn circuit serves to select the AI motor turning direction based on the lever position by the operator.
3. When the normal turn is selected as shown in the figure, the base current flows to the transistor Tr1. Now the battery current flows for running the AI motor in the normal direction.

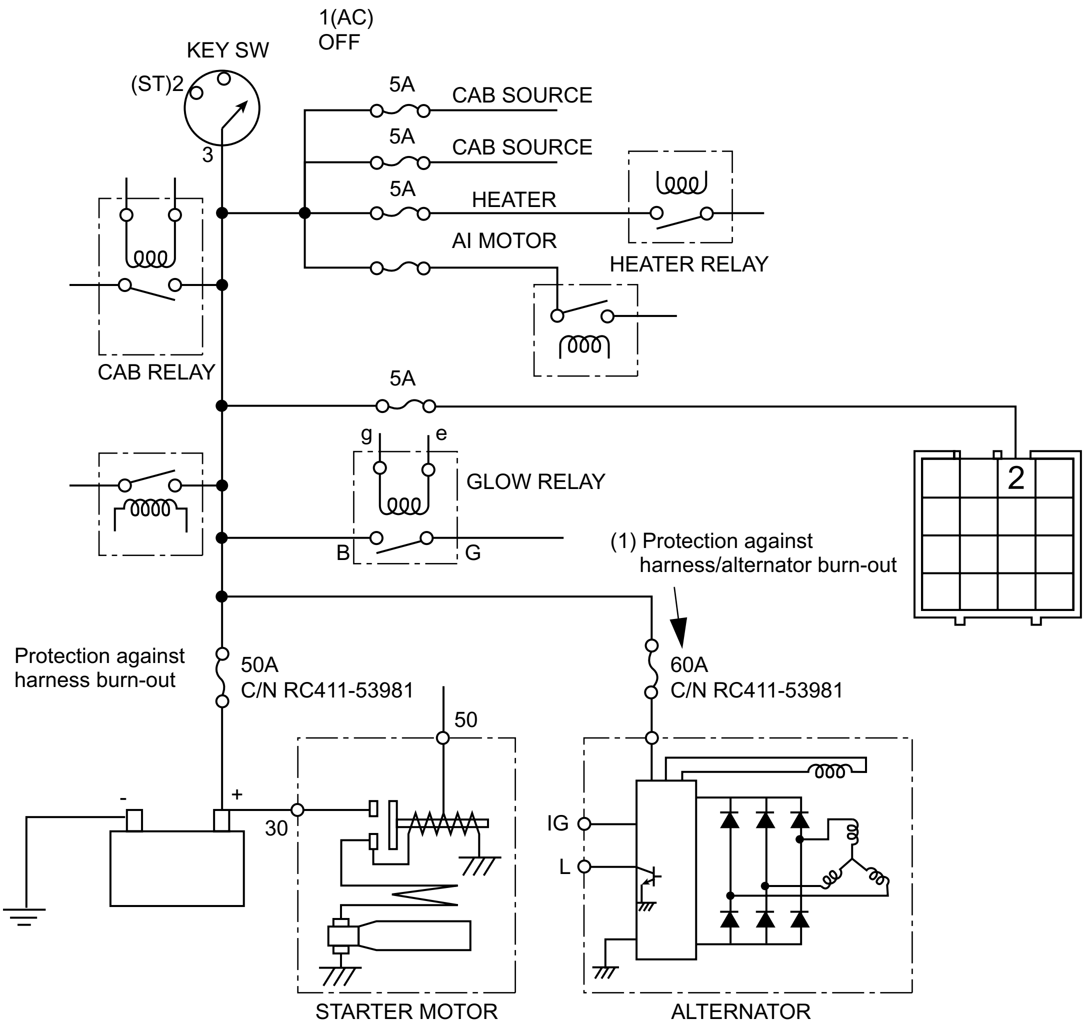
(7) AI motor reverse-turn circuit



Behavior:

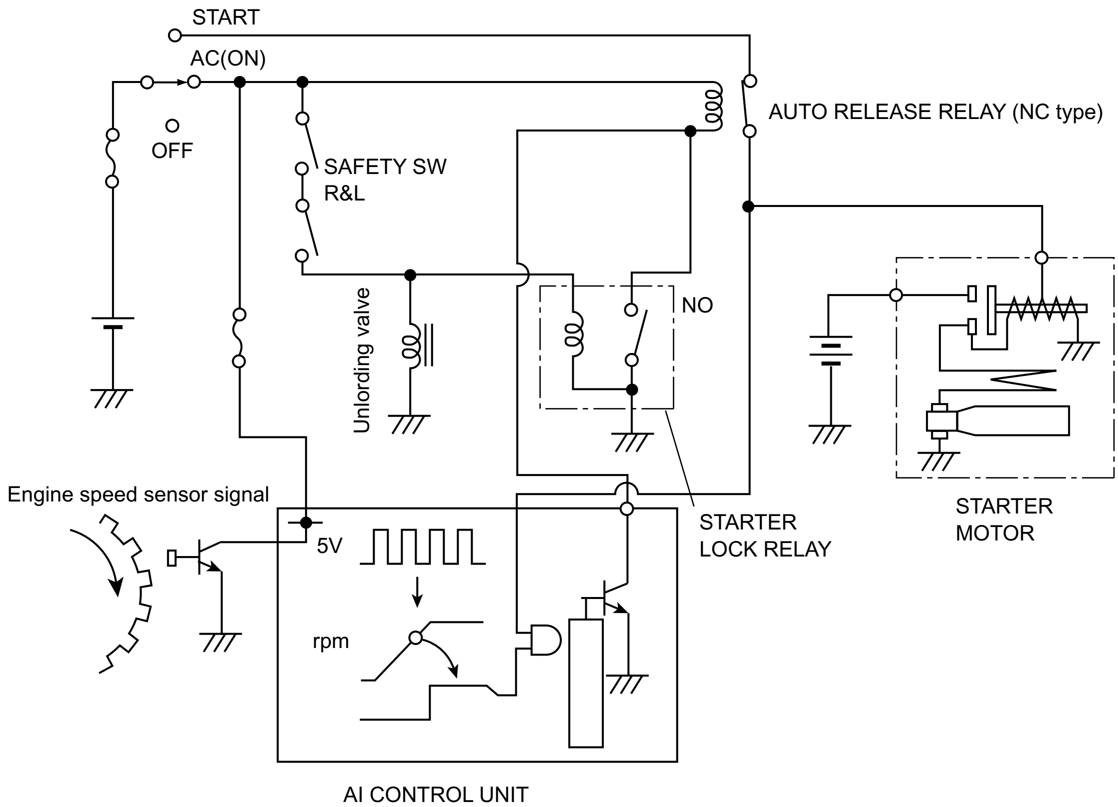
1. When the reverse turn is selected by the motor normal/reverse-turn circuit as shown in the figure, the battery current flows for running the AI motor in the reverse direction.
2. The reverse-turn electrical signal activates the transistors Tr4, Tr5 and Tr6 in this order. Now the battery current flows for running the AI motor in the reverse direction.

I. Battery direct line (AI-version)



1. Keep in mind that the battery voltage is applied through the above circuit all the time.
2. The 50A fuse is used to protect the harness against burn-out. Otherwise the battery current would keep flowing if a downstream harness gets short-circuited.
3. The 60A fuse is used to protect the alternator against burn-out. Otherwise the current of the alternator itself flows erroneously if the harness gets short-circuited.
4. The battery's cold cranking amperage is rated at 582 A.

m.Starter lock relay & auto release relay (AI-version)

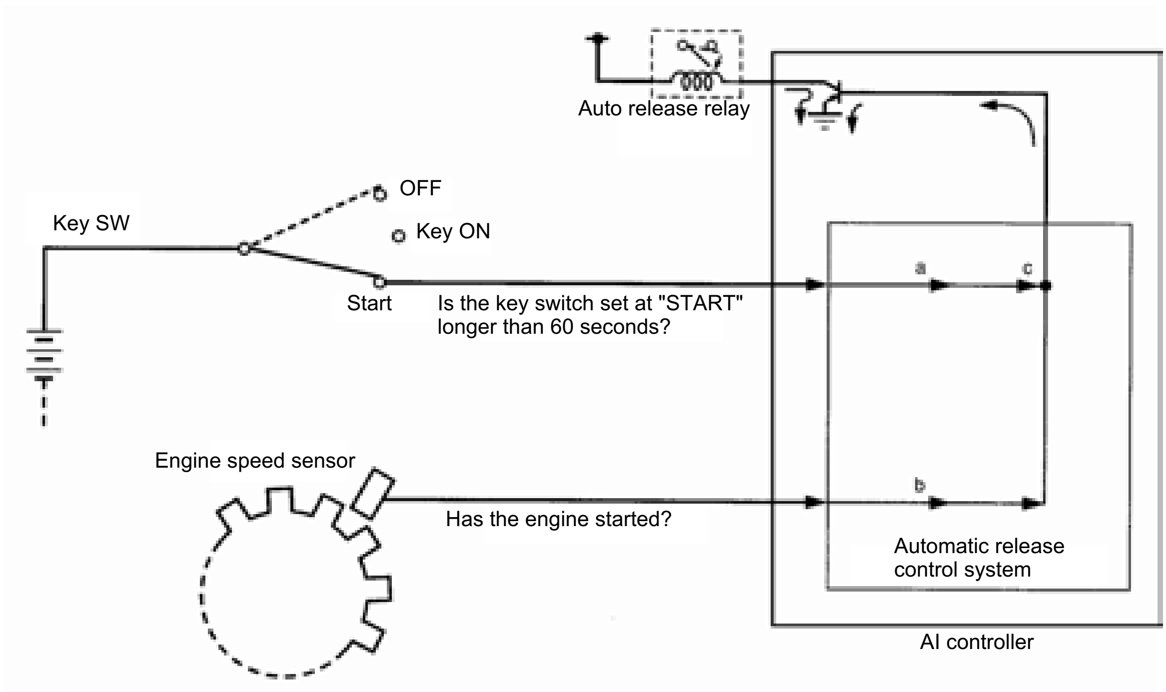


(1) Safety start system

1) The starter lock relay is deactivated only when the right or left safety switches on the safety lock lever is off. Because the automatic release relay is of NC type, the starter motor can be activated just by turning the key switch to the START position.
2) When the safety lock lever switch turns on, the starter lock relay is activated and then the automatic release relay is deactivated. By this, the starter motor is powered off to keep the engine from getting started.
   (Raise the safety lock lever, and the safety switch turns off. Lower it, and the safety switch turns on.)

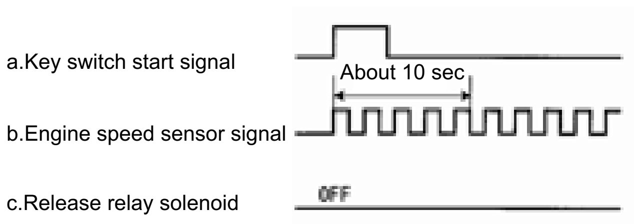
The automatic release relay is of NC (Normally Closed) type.

(2) Auto release function (AI- version)



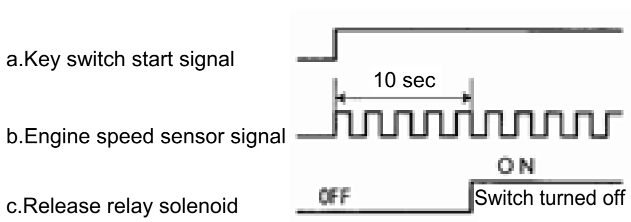
1) Function chart

1. When in normal operation



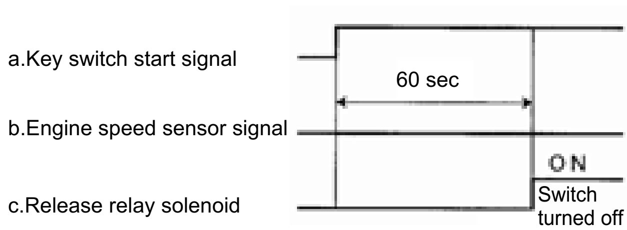
When the key switch is turned off within 10 seconds after the engine got started, the release relay is not activated as shown above.

2) If the engine has started but the key switch fails to return (key switch failure)



Suppose that the key switch fails to return and the key switch start signal stays on. But if the engine speed sensor signal is fed for 10 seconds in this state, the automatic release control system (3) lets the transistor's base current flow, which turns on the release relay solenoid (1) and turns off the relay switch.

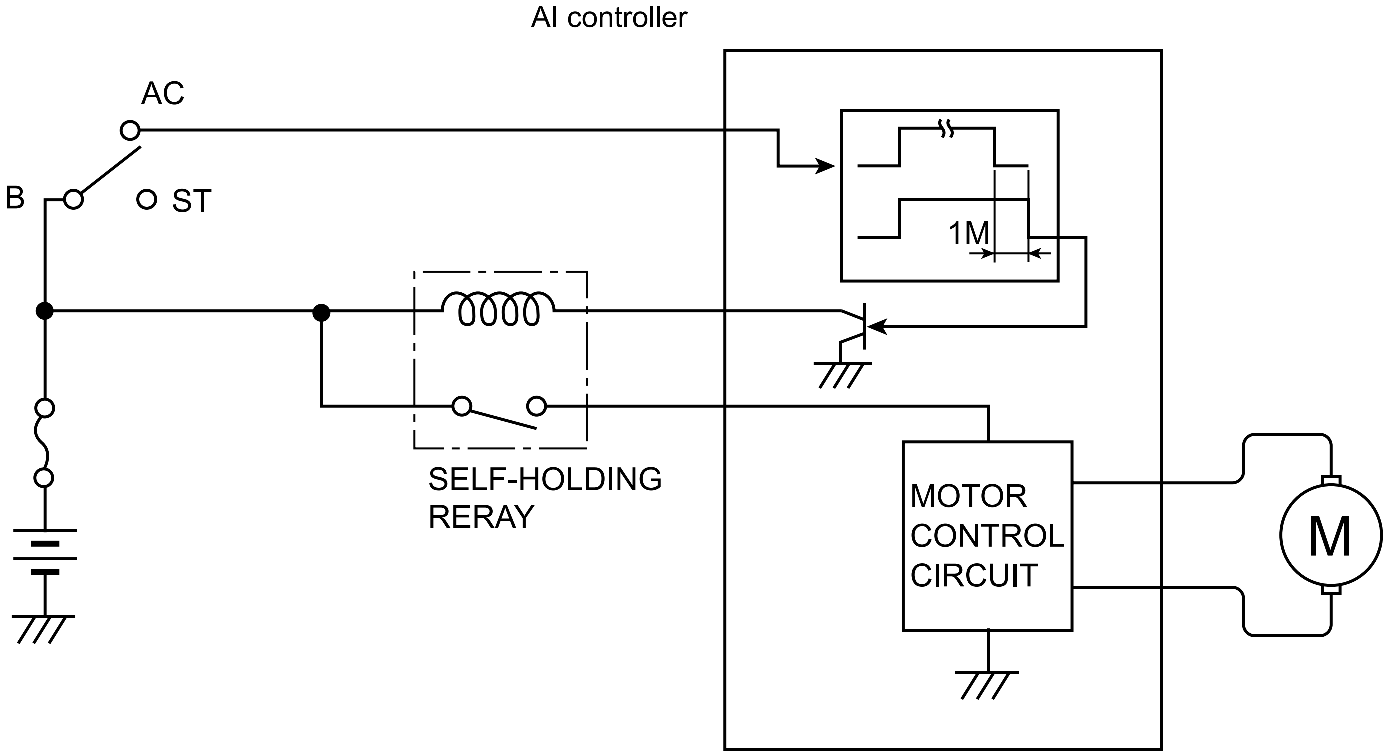
3) If the key switch fails to return and the engine speed sensor is also in trouble



If the key switch start signal is detected to have been on for 60 seconds, the automatic release control system (3) lets the transistor's base current flow, which turns on the release relay solenoid (1) and turns off the relay switch.

	a:Key switch status	b:Engine speed sensor status	c:Release relay solenoid action
(1)	Normal: No particular action	Normal	Normal: No particular action
(2)	Start position → Failure to return	Normal	Relay deactivated 10 seconds after the engine start
(3)	Start position → Failure to return	Engine failure to start, or no engine speed sensor signal	Relay deactivated 60 seconds after the key switch turn to "START"

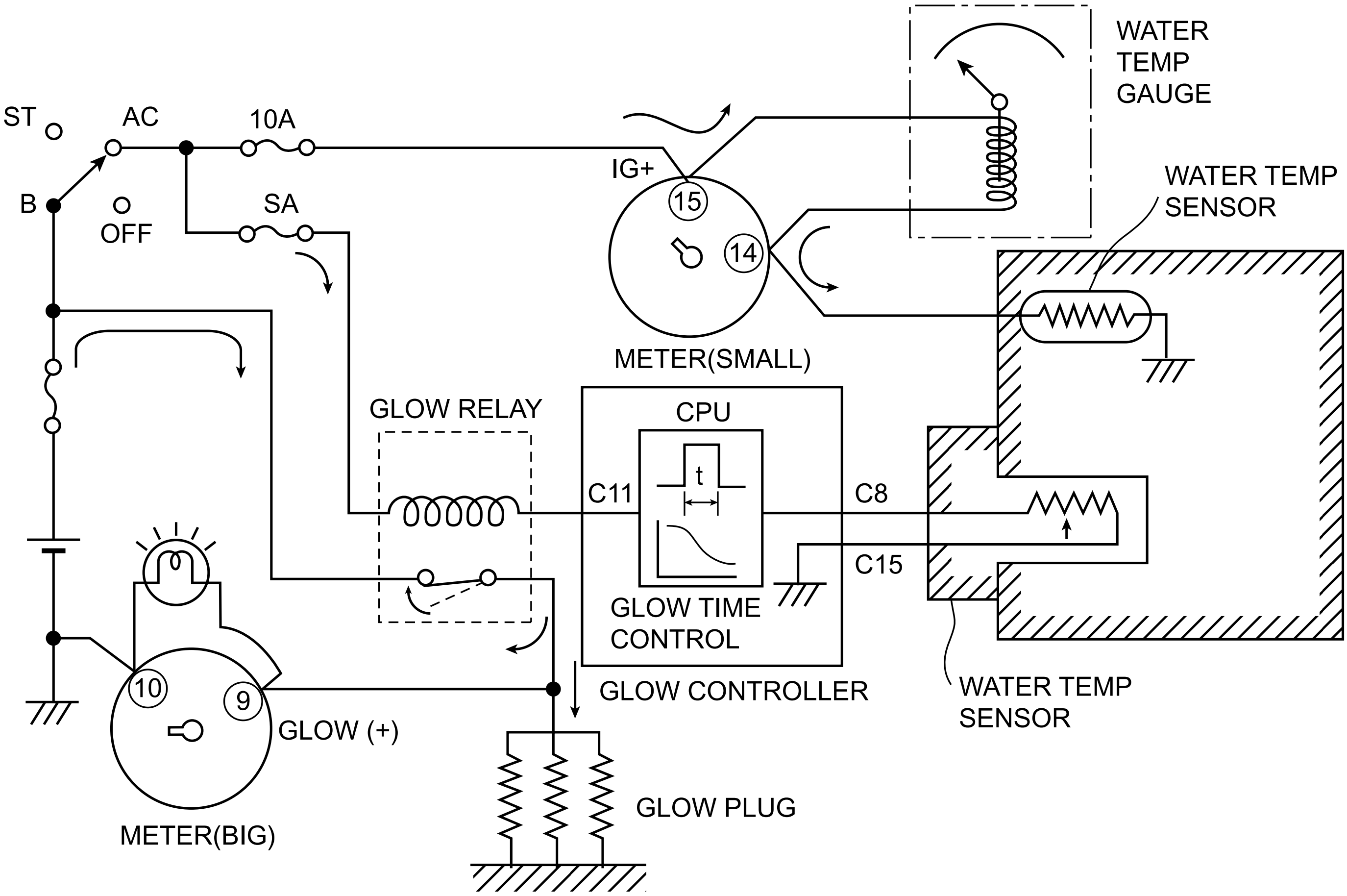
n. Self holding relay circuit (AI-version)



(1) Function

1) Suppose that the key switch is turned to the OFF position while the auto idle function is on. In such case, the self-hold relay stays on and the battery voltage is applied all the time to the AI motor control circuit of the AI controller. In other words, even if the key switch is set to the OFF position, the AI motor can be kept running for about 1 minute by using the accelerator lever.
2) The AI release switch is incorporated in the circuit to deactivate the AI self-hold relay.
3) The motor stops itself in 1 minute or so.

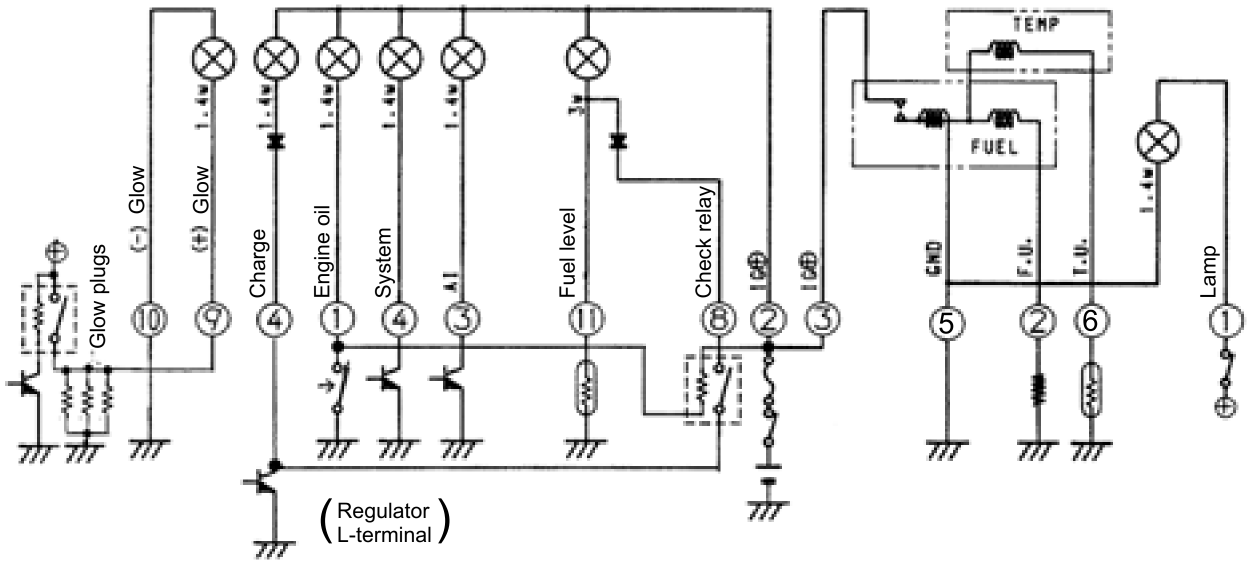
o. Water temp. sensor circuit (AI-version)



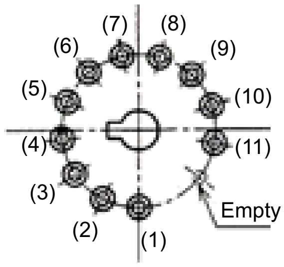
1. Two water temperature sensors are incorporated in the engine cylinder head.
2. One of them is for the water temperature gauge to display the reading. The sensor is equipped with a thermistor, the resistance value of which changes in response to the water temperature. The current flowing to the temperature gauge coil varies accordingly for displaying the water temperature.
3. The other sensor is used for sending the water temperature data to the glow controller. The glow controller receives the resistance value of this sensor and computes a necessary glow time. In this way, the current flow to the glow lamp and glow plug is controlled.

p. Meter panel (AI-version)

Circuit diagram

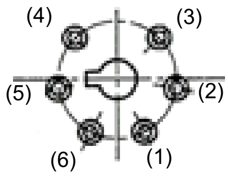


12p connector



No	Connection
1	Engine Pressure
2	IG(+)
3	AI
4	Charge
5	-
6	-
7	-
8	Check SW
9	Glow (+)
10	Glow(-)
11	Fuel level

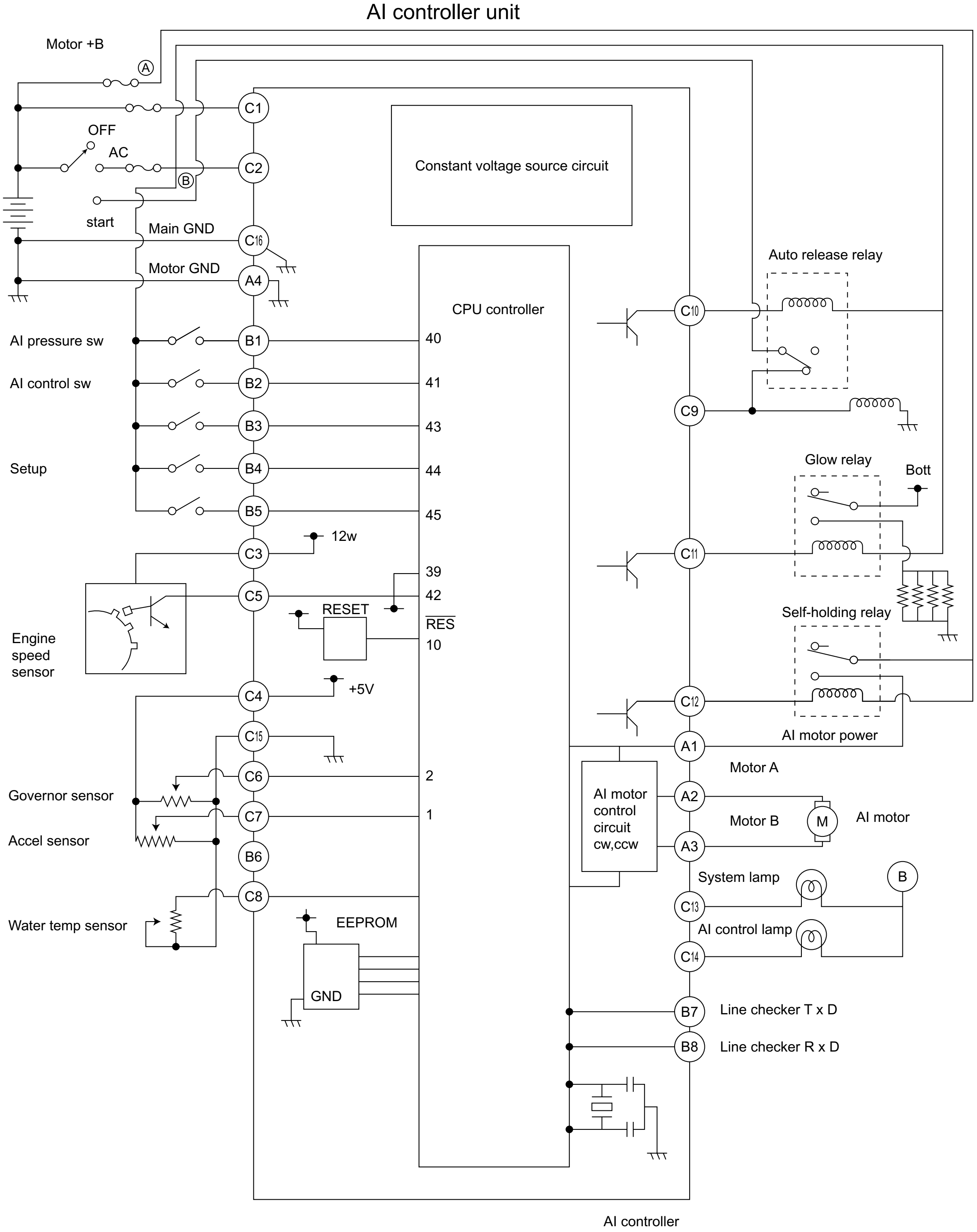
6p connector



No	Connection
6	Temp. unit
1	Lamp(+)
2	Fuel unit
3	IG(+)
4	System lamp
5	GND

1. Turn the key switch to the ON position, and the battery current starts flowing as shown in the figure. Because the engine oil pressure switch is of NC type, the check relay comes on too and all the warning lamps light up.(The regulator terminal L also lights up when the key switch is turned to the ON position.)
2. When the engine has started and reached the specified speed, the engine oil pressure rises too and the switch is turned off. The charge voltage also rises, which discontinues the current flow to the terminal L. Thus the check relay turns itself off and all the warning lamps go out.
3. During usual operation, the indicator lamps are ready to light up according to their respective circuits. Let's take some examples. The glow lamp stays on while the current is flowing to the glow plug. The AI lamp is kept on during the AI function. The charge lamp lights up if the charge voltage drops below the specified level. The fuel level lamp lights up if the fuel runs short.

q. AI controller unit (AI-version)



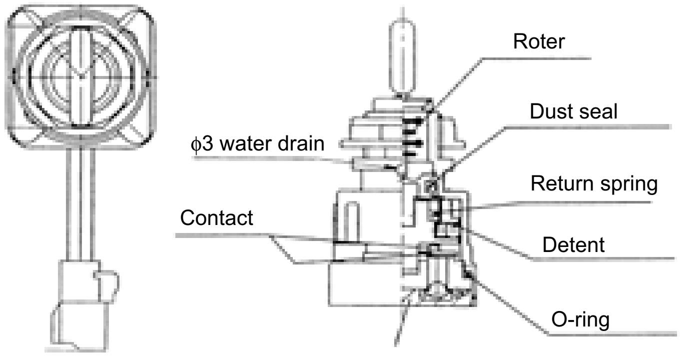
A1 ~ A4 :AI controller coupler small,4p

B1 ~ B8 :AI controller coupler middle,8p

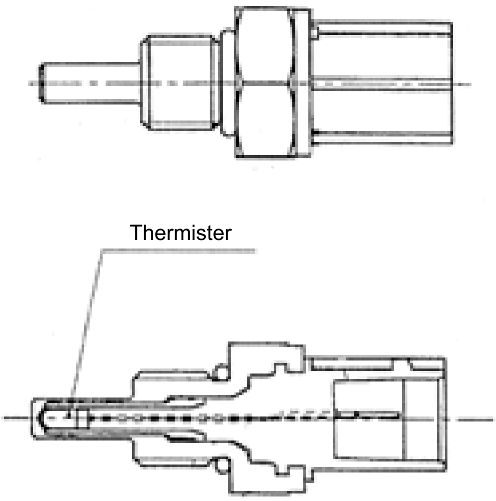
C1 ~ C16 : AI controller coupler large,16p

E.Structure and function of main components

a. Key switch (Engine starter switch)

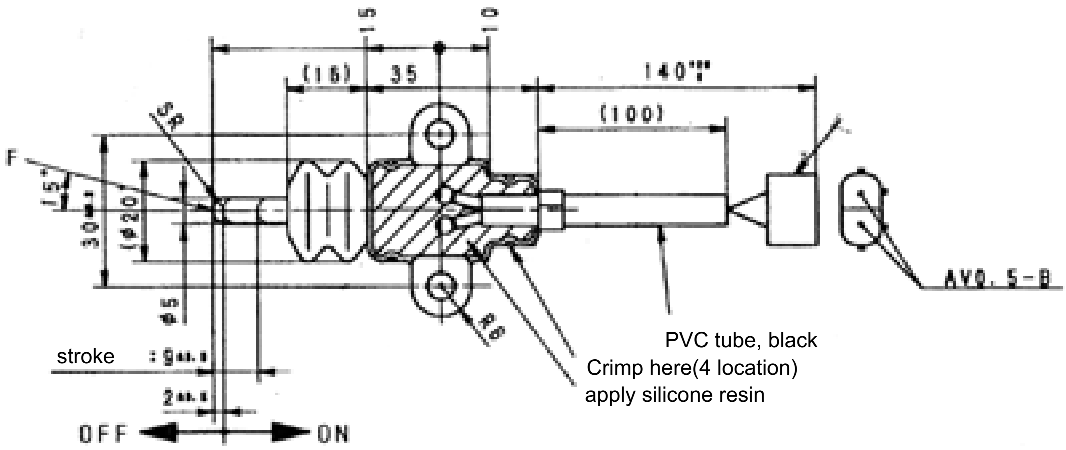


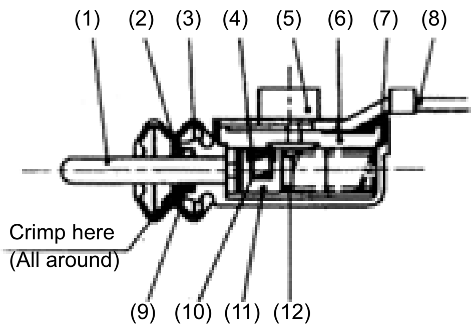
b. Water temp. sensor



c. Safty lever lock switch, travel hi-low pedal switch

Part No.:RC411-53473





(1) Plunger
(2) Washer
(3) Boot
(4) Contact plate
(5) Body
(6) Base comp.
(7) Packing
(8) Cord
(9) O-ring
(10)Action spring
(11)Roller
(12)Spring

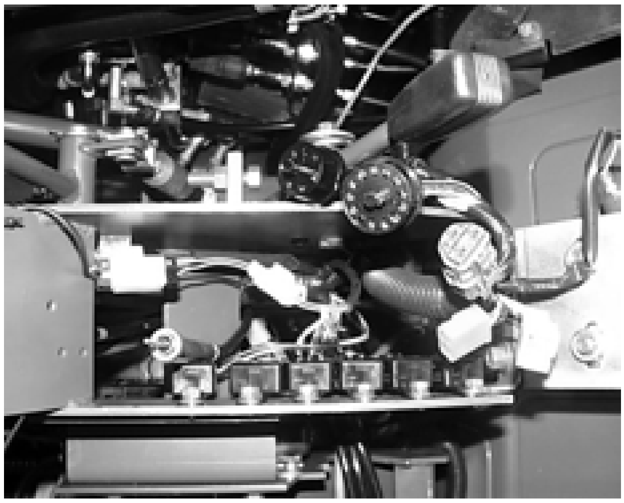
Specifications

1. Rated :DC14V, 1.5A
2. Insulasion :2MΩ or more
3. Operationg force of plunger:
   at Free position =17 ± 3 N
   at Max. stroke =32 ± 4 N
4. Full stroke :9 ± 5 mm

d. Relay

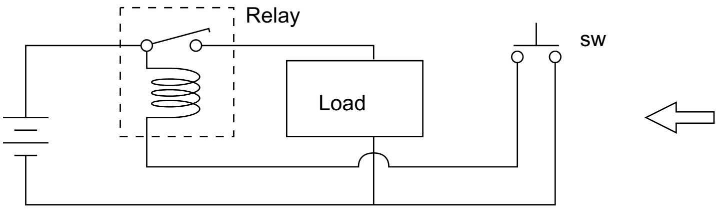
(1) Relays

(Type of relay)	(Color of coupler)	(Version)
(1)AI self holding relay	Black	AI
(2)Auto release relay	Blue	AI
(3)Starter lock relay	Blue, Black	STD, AI
(4)Heater relay	White	STD, AI
(5)Horn relay	Black	STD, AI
(6)Light relay	Black	STD, AI
(7)Check relay	Black	STD, AI
(8)Cab relay	Black	STD, AI



(2) Purpose of relays

Electrical devices on the load side - heater, glow plug, cab instruments, for example - tend to require large current. This means that the wire harnesses running the power source up to the switches and loads must involve thick, large-capacity cables. This is disadvantageous in costs, weight and safety. What's worse, turning on and off a large-current circuit with a manual switch may cause a spark and get the switch in trouble.
Here come the relays in the switching circuits. The relays can be on/off-controlled using fine, small-current cables, and the switches can last longer. These switches may also be conveniently located.
A large-capacity harness may be connected from the power source via the relay to the load. In this design, the harness is made shorter, less expensive, and safer.

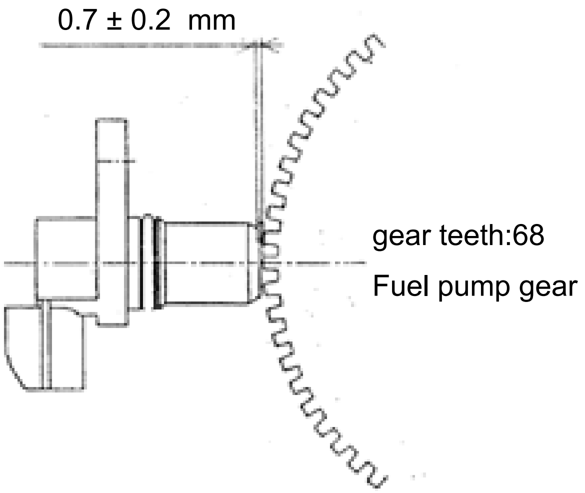


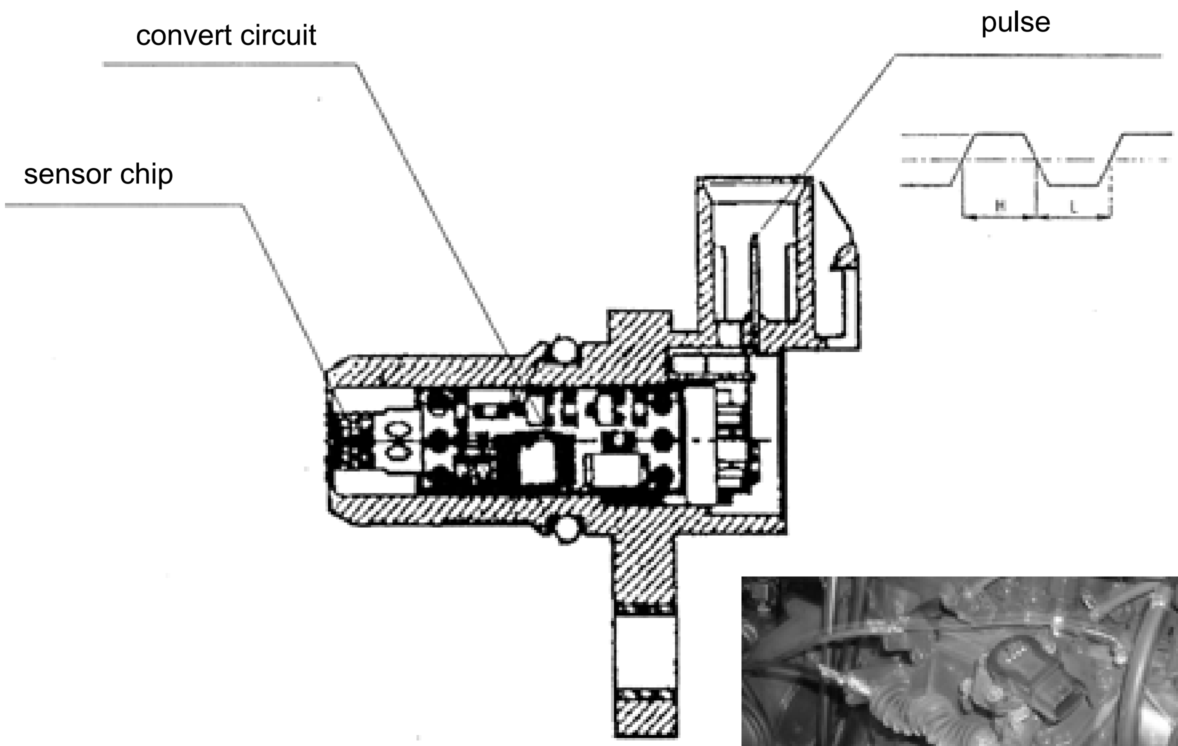
e. Engine speed sensor

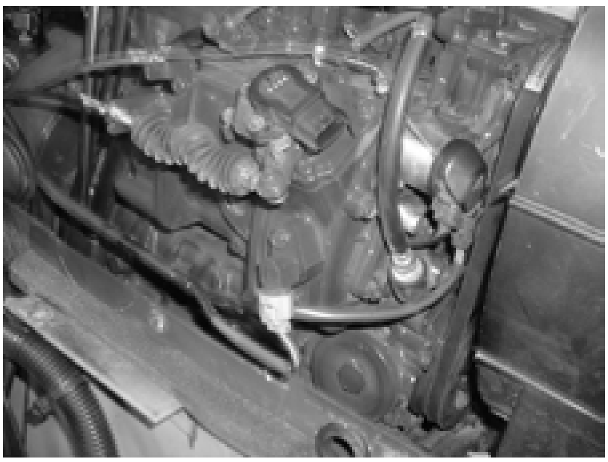
The engine speed sensor is a quick-response proximity switch. When the teeth of a gear pass close, the magnetic field inside the switch changes and the variation is converted to pulses.
The number of pulses for "t" seconds is counted by the microcomputer. The engine speed is then computed in the following equation.

$$\frac{2 \times 60}{68 \times t} \text{ [rpm]}$$

Such speed data is used for the starter's automatic release system.

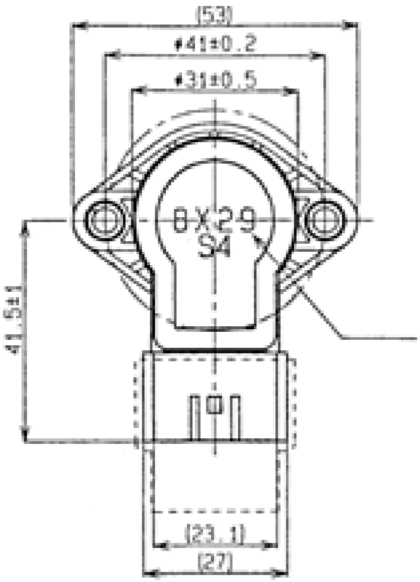




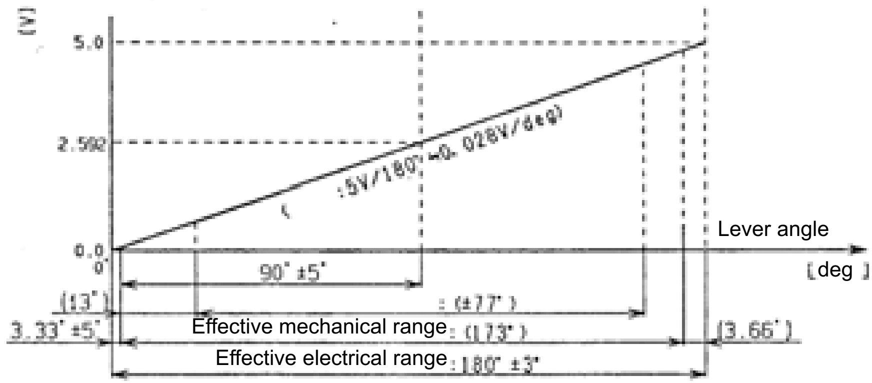


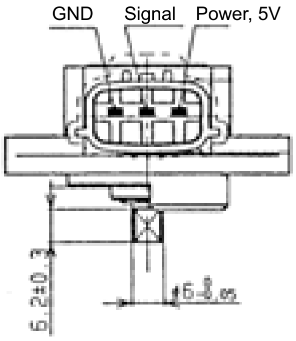
f. Accel sensor, governor sensor

Code No.:RP421-5371-1

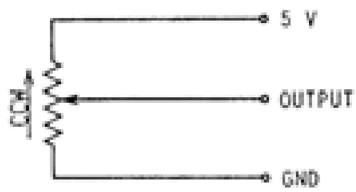


Specifications
1. Rated voltage :DC5V
2. Total resistance :2KΩ ± 20%
3. Insulasion resistance :100MΩ or more
4. Output performance :

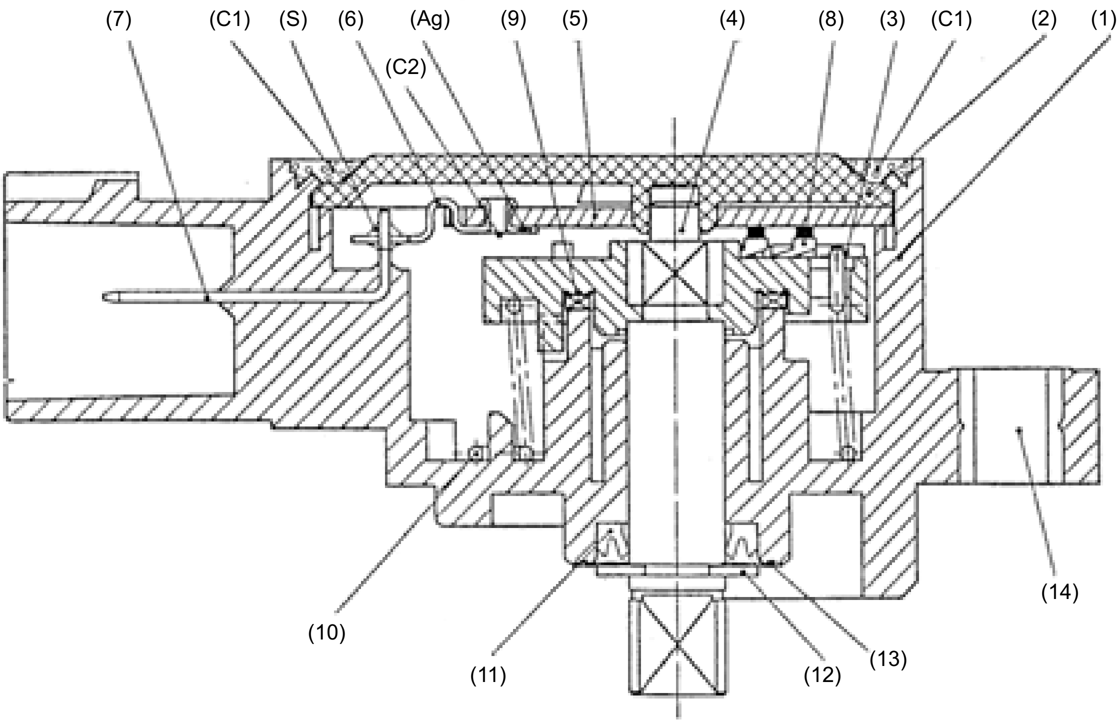




Circuit diagram

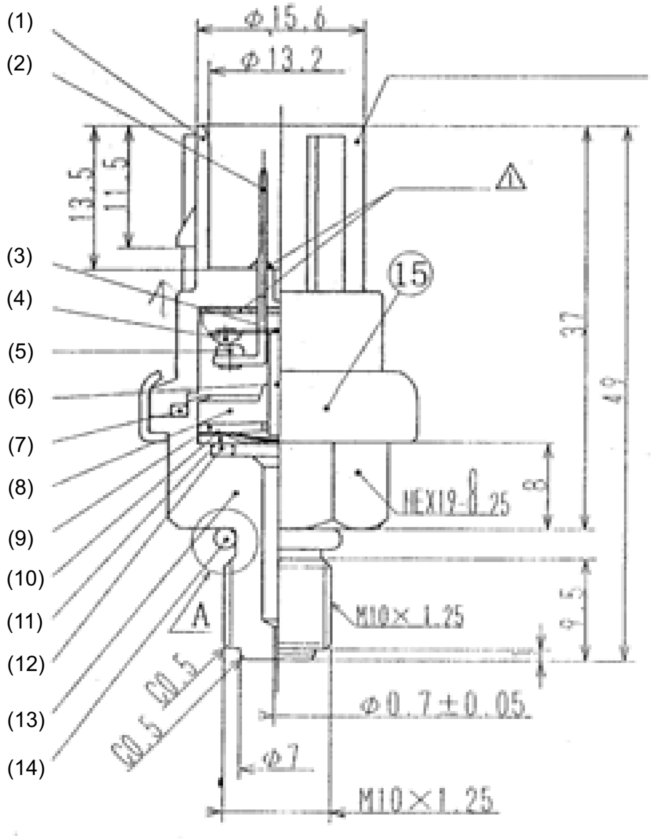


(1) Case
(2) Cover
(3) Roter
(4) Shaft
(5) Resistance
(6) Element terminal
(7) Connector terminal
(8) Slider
(9) Wave washer
(10) Return spring
(11) Rubber seal
(12) E-ring
(13) Washer
(14) Sleeve
C1, C2:Adhesive



g. AI pressure switch

C/N RC411-53681, 25kgf/cm^2, Normal close type



1. Function

When the pressure sensed by the oil pressure detection circuit for auto idle control has dropped below 20 kgf/cm^2, the contact of the AI switch, shown at left, gets closed. The microcomputer picks up the resulting ON signal and sends a command to the AI motor to reach the engine idling speed. The idling speed approach is preset to be 4 seconds after the switch has been turned on by the microcomputer.

When the control lever is moved, on the other hand, the pressure in the hydraulic pilot circuit rises. At 25 kgf/cm^2, the hydraulic pressure pushes the diaphragm as shown at left, which opens the contact. The microcomputer picks up the resulting OFF signal and raises the engine speed up to the accelerator lever rpm setting.

2. Switch specifications

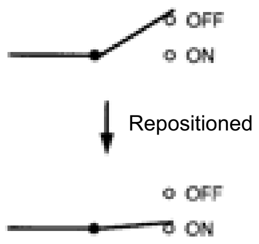
(1) Detection method: Metallic diaphragm
(2) Switching logic: Normally closed (NC)
Continuity resistance =0.2Ω
(3) Operating pressure:
2.45 ± 0.3 MPa (25 ± 3 kgf/cm^2) --> Switch OFF
1.96 ± 0.3 MPa (20 ± 3 kgf/cm^2) --> Switch ON
(4) Insulation resistance: Over 100 MΩ (with DC500V megger)
(5) Code No.: RC411-53681

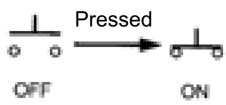
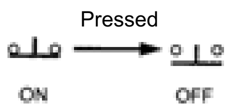
1	Terminal block	9	Stopper
2	Terminal	10	Flex plate
3	Movable contact plate	11	Cap
4	Movable contact	12	O-ring B
5	Fixed contact	13	Coupling
6	Shaft	14	O-ring C
7	O-ring A	15	Clamp plate
8	Guide plate		

h. Foundamentals

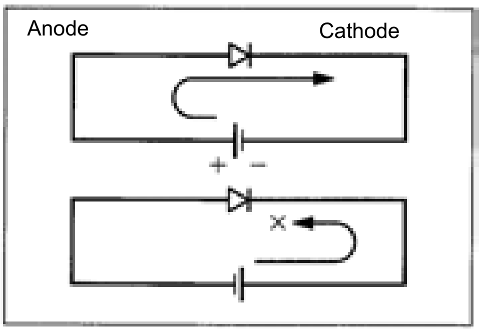
(1) Switch

Selector switch



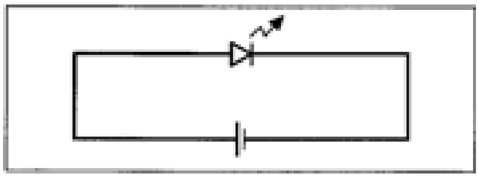
Pushbutton switch	
Normally Open (NO) type	Normally Closed (NC) type
 NO: Normally Open	 NC: Normally Closed
Note:With the NO type the current flow is shut off by the switch, whereas with the NC type the circuit is usually closed to let the current flow.	

(2) Diode



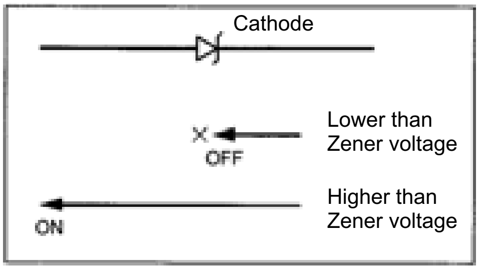
When a positive voltage is applied to the anode, the diode lets the current flow in the triangle-pointed direction.
A positive voltage to the cathode increases the resistance and interrupts the current flow.

(3) Light emitting diode (LED)

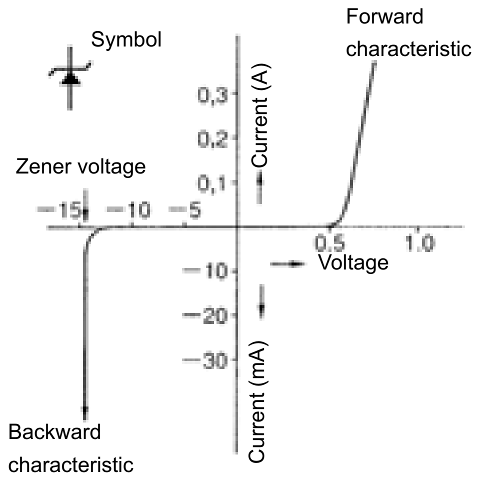


Being given a forward voltage, the diode lights up.

(4) Zener diode



When the voltage at the cathode rises above a certain level, the diode lets the current flow in the opposite of the triangle-pointed direction. This backward voltage is called Zener voltage.

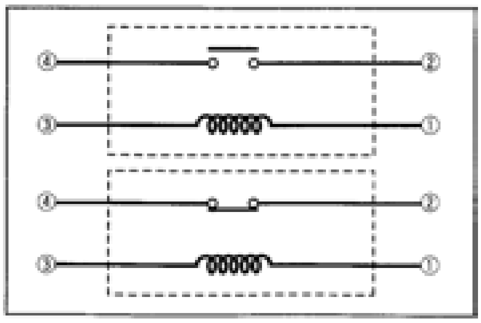


<Typical characteristics of Zener diode>

Zener diode function

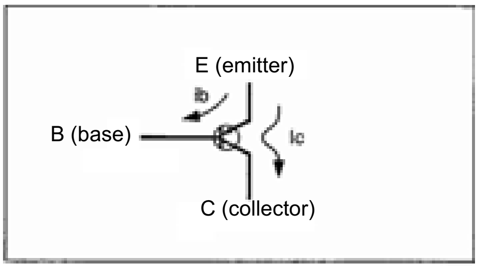
A Zener diode has similar rectification characteristic to general diodes. While a voltage is being applied backward, however, the current starts flowing suddenly at higher than a certain voltage (Zener voltage). The current is shut off when the voltage drops below the Zener voltage.
This characteristic is used to detect adjusted voltage.

(5) Relay

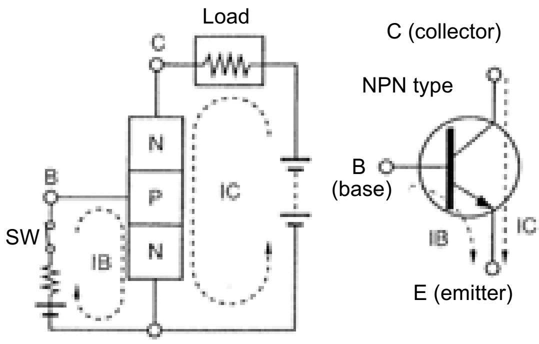


- Normally Open (NO) relay
  When a current flows between both ends (1) and (3) of the coil, the coil gets excited, which turns on the relay. The line (2)-(4) is kept on during this time.
- Normally Closed (NC) relay
  When a current flows between both ends (1) and (3) of the coil, the coil gets excited, which turns off the relay. The line (2)-(4) is kept off during this time. It helps measure the coil resistance to check the coil for breakage.

(6) Transistor



PNP type
When the base current "ib" higher than specified flows from E (emitter) to B (base), the current "Ic" goes from E to C (collector) and the transistor turns on. When the base current drops to zero, continuity between E and C is cut off.
In this manual, transistors of this type are used in the operation circuits and glow circuit.

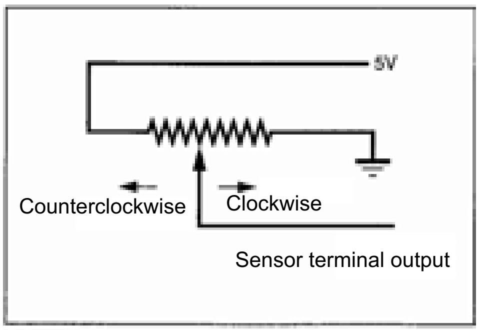


<Behavior of transistor>

Transistor function

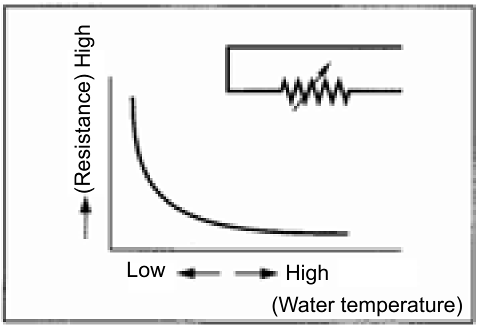
On the NPN type transistor, when a small current (called the base current IB) flows from the base to the emitter, continuity takes place between the emitter and collector. The current (called the collector current IC) flowing in the emitter is scores of times the base current.
With no more base current, continuity between the collector and emitter is shut off, which in turn cuts off the collector current.

(7) Potentiometer



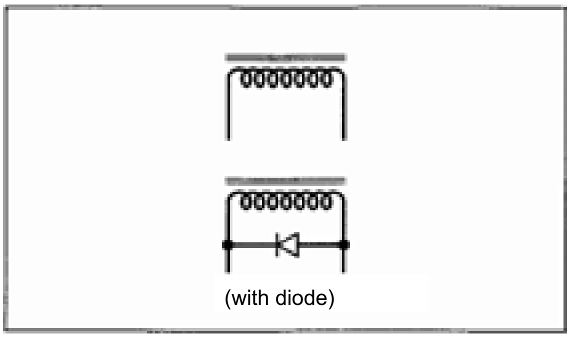
Potentiometer is a variable resistance sensor with sliding sensor terminal. The sensor terminal slides to put out a voltage from 1 to 5V.
On this machine, they are used for the following functions.
(1) Acceleration
(2) Governor
As these components run, their respective sensor terminals slide accordingly. The voltage level for each position is fed to the microcomputer.

(8) Water temperature sensor



The water temperature sensor is used to detect the engine's cooling water temperature and mounted on the water flange of the cylinder head. This sensor is equipped with a thermistor. As shown at left, the lower the water temperature, the higher the sensor resistance, and vice versa.

(9) Solenoid valve



Once energized, the coil is excited and an electromagnetic force pushes and pulls the spool inside. Depending on applications, some solenoid valves are provided with diode in order to absorb a surge current of the coil.

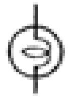
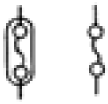
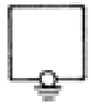
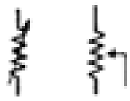
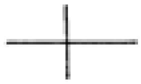
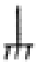
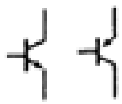
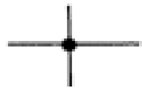
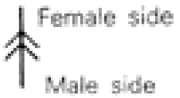
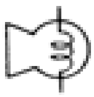
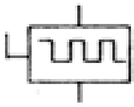
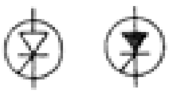
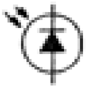
(1) Function

When a voltage is applied to a solenoid valve, as shown at left, the current starts flowing in the arrow direction. The coil is then excited and an electromagnetic force is generated around the coil, pushing the spool. (The attraction type is also available with different winding direction.)

A surge current produced when the switch is turned on or off is absorbed by the diode.

(10)SYMBOLS

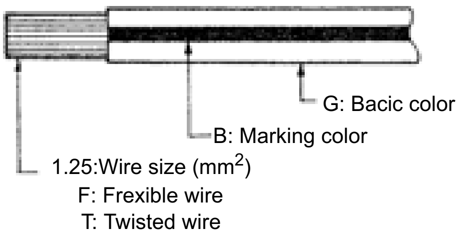
The various devices and equipment identifiedin circuit diagrams are represented by the symbols described below.

Battery 	Body ground 	Single bulb 	Resister 	Diode 	Capacitor 
Fuse 	Equipment ground 	Dual bulb 	Variable resister 	Zener diode 	Crossing of wires without connection 
Fusible link	Ground within ECU 	Speaker 	Coil 	Transistor 	Crossing of wires with connection 
Connector 	Moter 	Horn 	Pulse generator 	Buzzer 	Chime 
Thyristor 	Piezo-electric element 	Thermister 	Light-emitting diode 	Photo diode 	Photo transistor 

(11)WIRING COLOR CODES

Wire colors are identified by the following color codes.

Example: 1.25F-GB



Code	Wire color	Code	Wire color
B	Black	Sb	Sky blue
Br	Broun	O	Orange
G	Green	P	Pink
Gr	Gray	R	Red
L	Blue	Y	Yellow
Lg	Light green	W	White

NOTE
If a cable has two colors, the first of the two color code charactors indicates the basic color (color of the cable coating) and the second indicates the marking color.

(1)No code indicates 0.5 mm^2
(2)Cable color code in parentheses indicates 0.3 mm^2

(12)Important formulas of electrical system

1) $I = \frac{Q}{t}$

I :Electric current [A]
Q:Electron [C]
t :time [sec]

2) Ohm's law

$V = IR$ [V] $I = \frac{V}{R}$ [A] $R = \frac{V}{I}$ [Ω]

3) $R = \rho \frac{l}{A}$ Ω]

R :Resistance [Ω]
l :Length [m]
A :Area [m^2]
ρ :Resistance Ratio

$\frac{1}{\rho} = \sigma$ [s/m] σ :Electrical conductivity

4) Joules Heart

$H = RI^2 t$ [J]
$H = 0.24I^2 Rt$ [J]

5) Electric power

$P = IR^2 = IV = (\frac{V}{K})^2 R = \frac{V^2}{K}$
1 [J/S] = 1 [W]
1 kw = 0.24 × 3600 × 10^3 = 860 kcal

6) Coulomb's low

$F = 6.33 \times 10^4 \frac{m_1 m_2}{r^2}$ [N]

m1,m2 :Magnetic power [wb]
r :mutual distance
F :Force [N]

$\beta = \mu_o H = 4\pi \times 10^{-7} \times H$

β :Magnetic density [T]
H :Magnetic field strength [A/m]

7) $E = \frac{pz\phi}{60 \cdot a} N = K\phi N$ [V]

a :Number of parallel circuits of armature winding
p :Number of poles
z :Number of armature conductors
ϕ :Effective magnetic flux per pole [WB]
N :Revolutions per minute
I :Armature current [A]

8) Motor's torque : T

$T = \frac{pz\phi}{2\pi a} I = K\phi I$ [N·m]

9) Synchronous speed : Ns

$Ns = \frac{120f}{p}$

$N = Ns(1-s)$

f :frequency [Hz]
p :Number of poles
s :slip

10) Motor's mechanical power :P

$T = F \cdot r$
$\upsilon = r\omega$
$p = T\omega = F \cdot \upsilon$

ω :Angler velocity [rad/s]
T :Magnetic Torque [N·m]
F :Force
υ :speed [m/s]

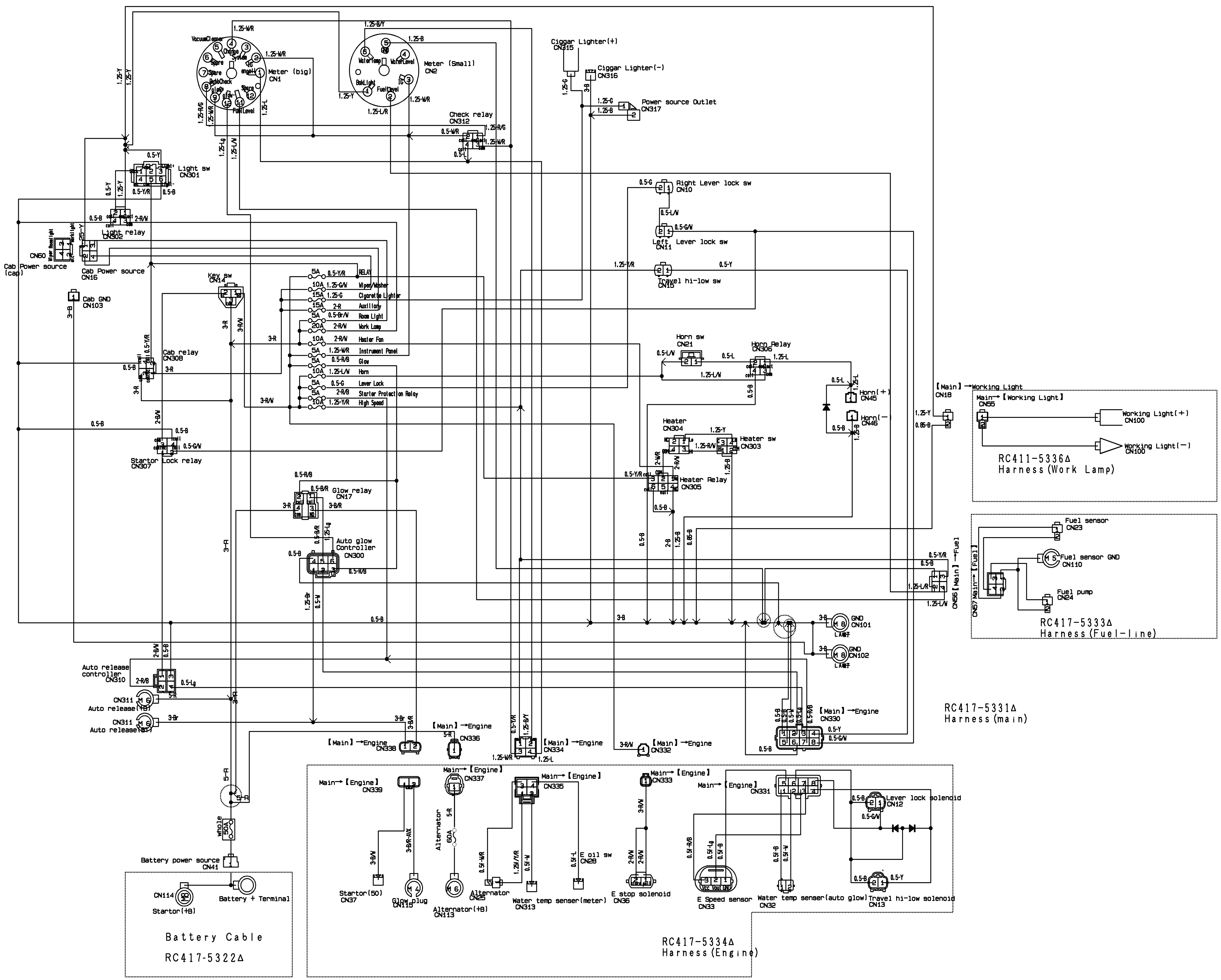
11) Battery

$PbO_2 + 2H_2SO_4 + Pb \leftrightarrows PbSO_4 + 2H_2O + PbSO_4$

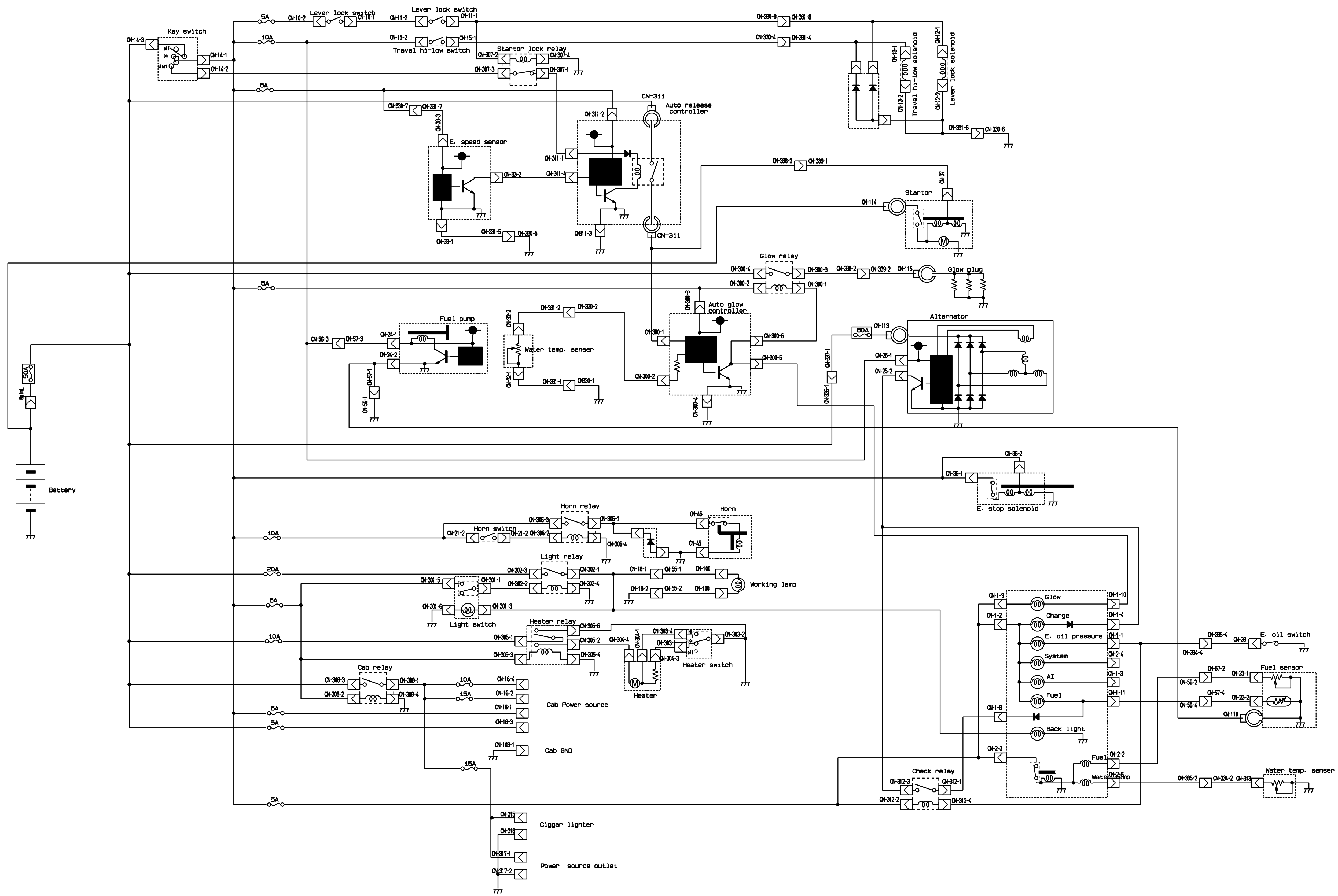
$2NiOOH + Cd + 2H_2O \leftrightarrows 2Ni(OH)_2 + Cd(OH)_2$

F. Circuit diagram

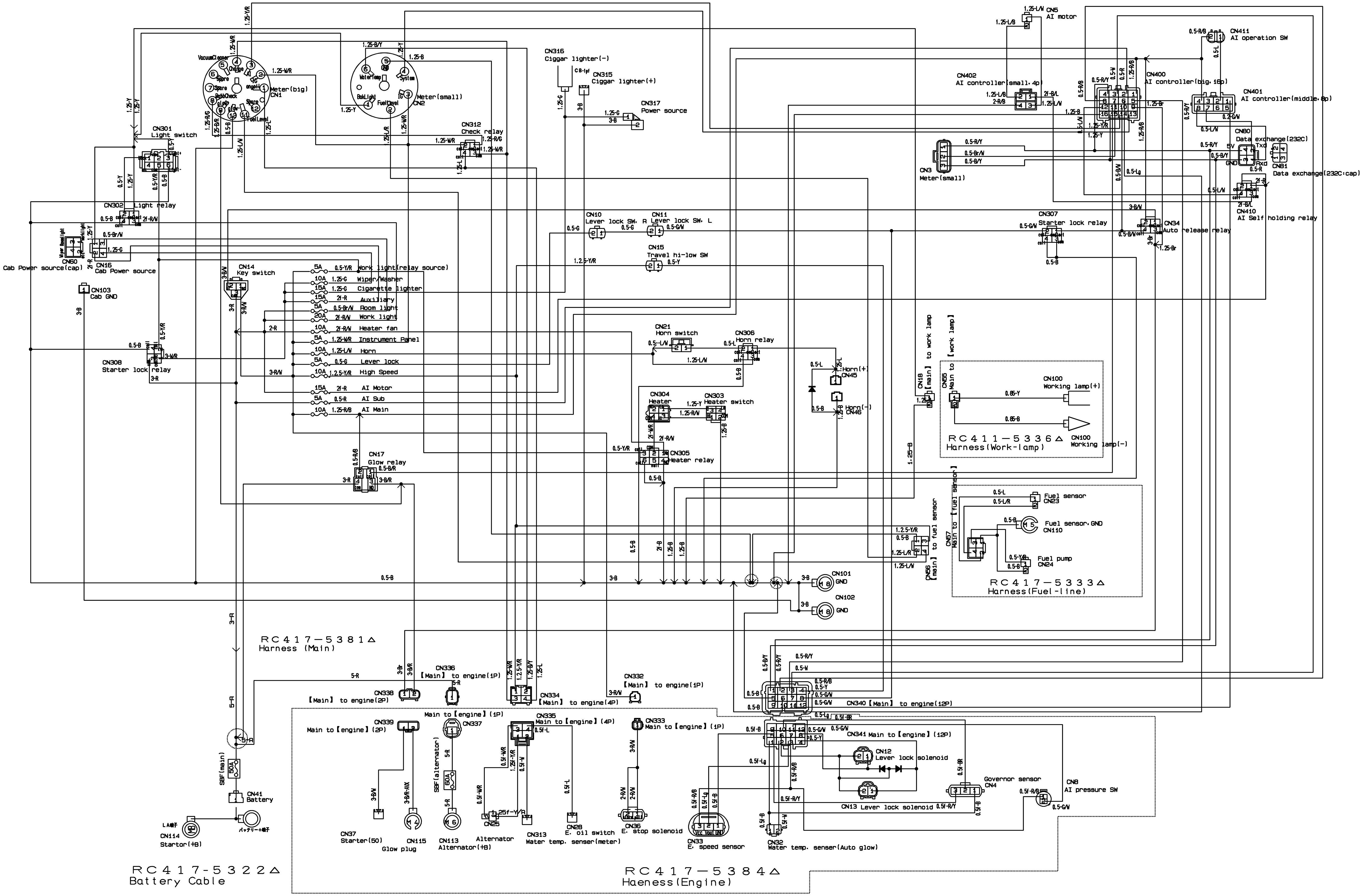
a. Electric Circuit Diagram: KX91-3, 101-3 (Standard-version)



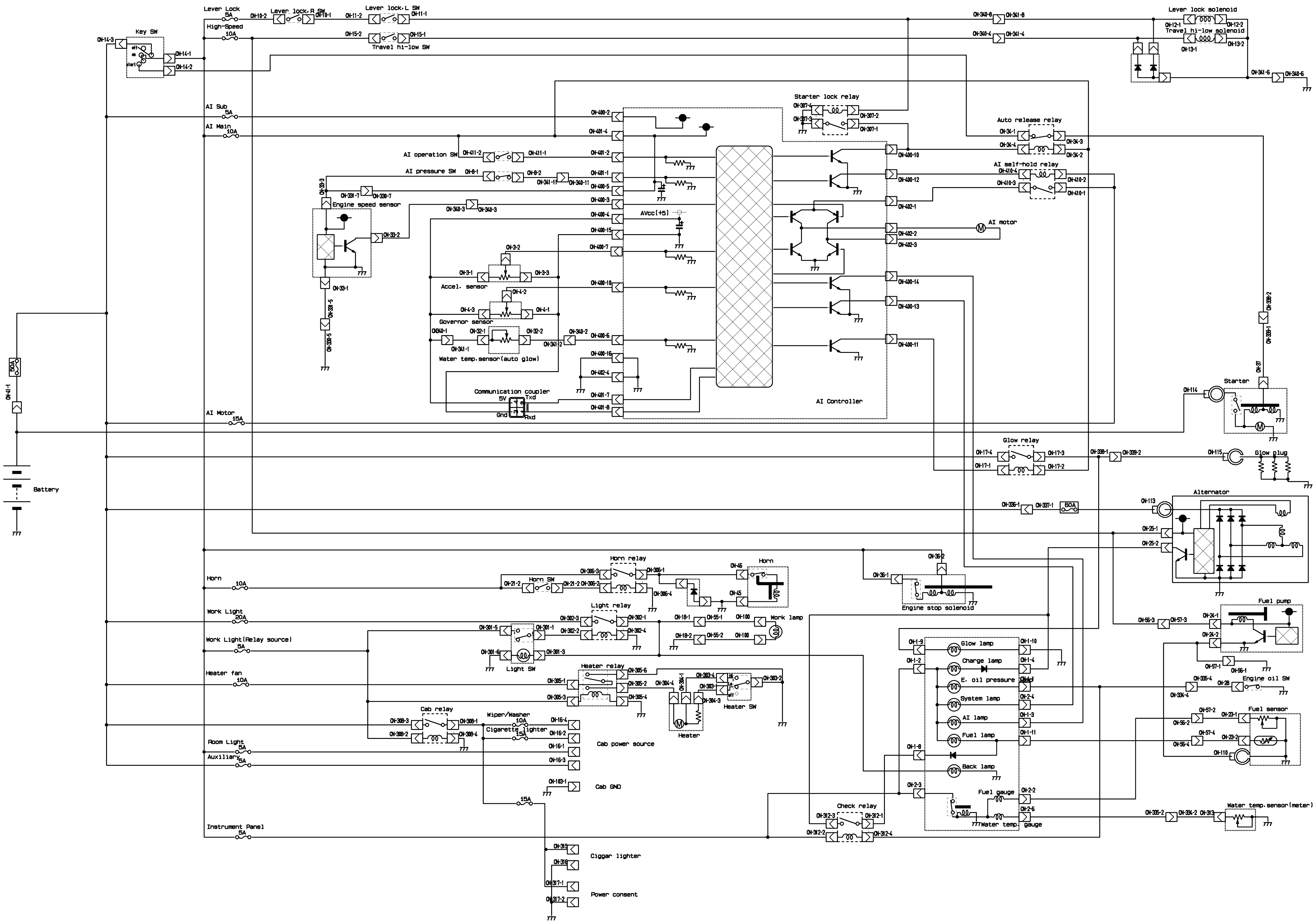
b. Functional Electric Circuit Diagram: KX91-3, 101-3 (Standard-version)



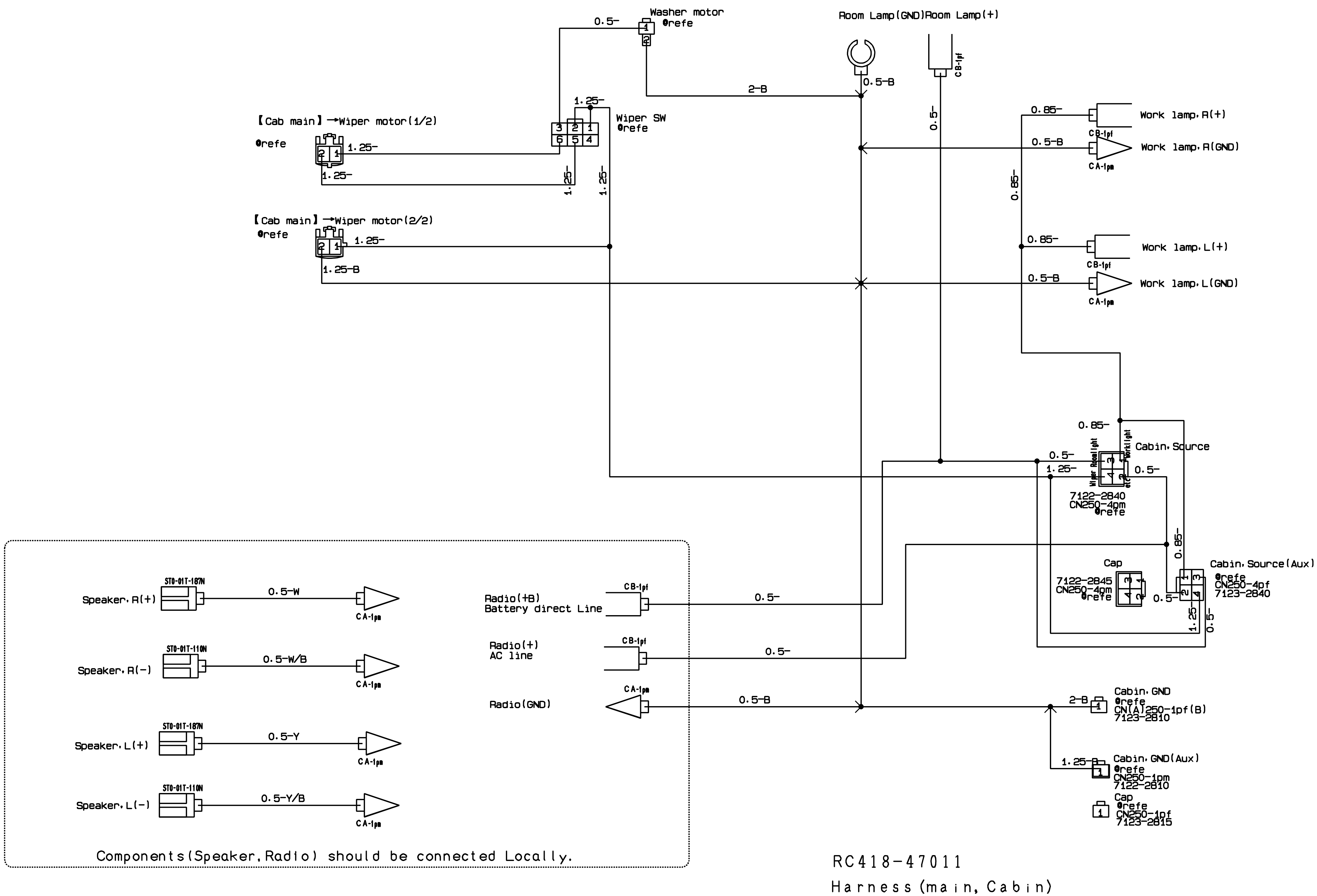
c. Electric Circuit Diagram: KX101-3 (AI-version, EU)



d. Functional Electric Circuit Diagram: KX101-3 (AI-version, EU)



e. Cab Electrical Diagram
KX91-3, KTC, KCC, KTA-version



f. Harness couplers of KX101-3, AI-version

Ⅴ. Electrical system(Service section)

A.Troubleshooting

a. General

(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.

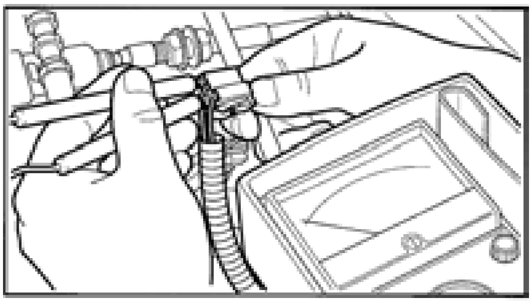
1	Observation of Problem Symptoms	Observe the symptom carefully. Check if there are also other problems.
2	Determination of Probable Causes	In determining the probable causes, it is necessary to check the wiring diagram to understand the circuit as a system. Knowledge of switches, relays and other parts 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:

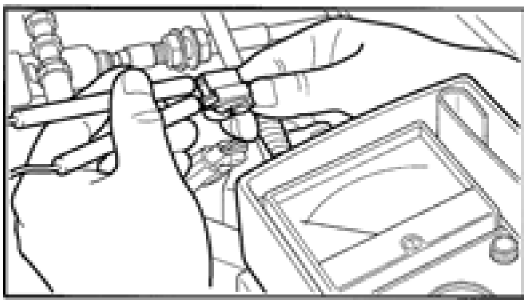
1. “Power source”
   Is the supply voltage as specified? (Battery voltage at 12 V or microcomputer output at 5 V)
   → If not specified, the system fails to work.
2. “Continuity”
   Is there continuity along the specified lines and wire harnesses? Are the system’s resistance values as specified?
   → 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.

(2) INSPECTION OF HARNESS CONNECTOR



CONTINUITY AND VOLTAGE TEST FOR CONNECTOR

Following procedures shall be followed for testing continuity and voltage at connector in order to prevent improper contact and deterioration of waterproof in connector.



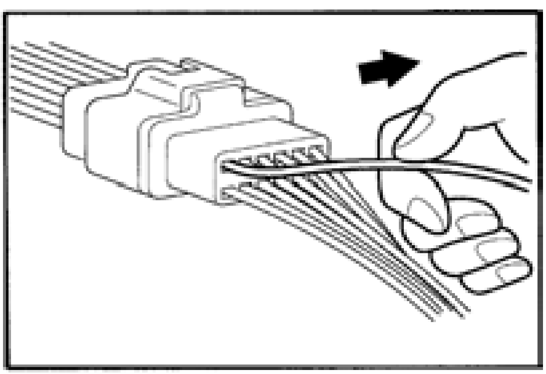
CONVENTIONAL (NON-WATERPROOF) CONNECTOR

Check shall be done by inserting a probing needle from harness side.

WATER PROOF CONNECTOR

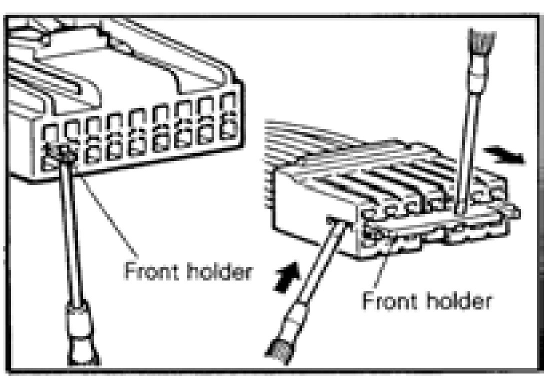
Caution

Do not insert probing needle from harness side as it will deteriorates waterproof and cause for rusting.



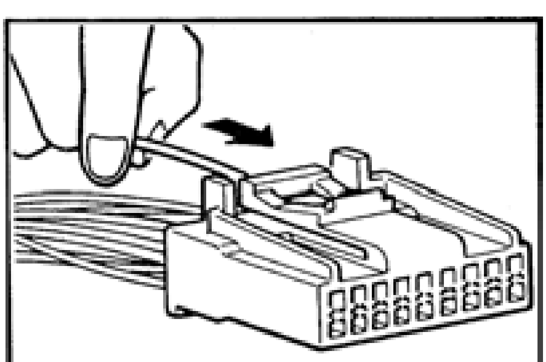
CHECK FOR IMPROPER ENGAGEMENT OF TERMINAL

When terminal stopper of connector is out of order, engagement of male and female terminals becomes improper even when connector itself is engaged perfectly and terminal sometimes slips out to rear side of connector. Ascertain, therefore, that each terminal does not come off connector by pulling each harness wire.



ENGAGING AND DISENGAGING OF CONNECTOR TERMINAL

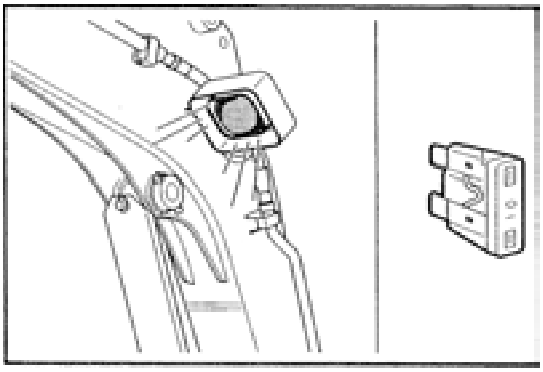
Connector which gives loose engagement shall be rectified by removing female terminal from connector housing and raise its lance to establish securer engagement. Removal of connector housing and raise its lance to establish securer engagement. Removal of connector terminal used for ECI and ELC 4 Arr control circuit shall be done in the following manner.



COMPUTER CONNECTOR

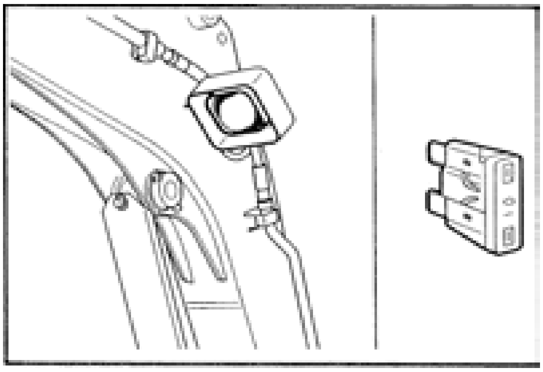
(1) Insert screwdriver [1.4 mm (.06 in.) width] as shown in the figure, disengage front holder and remove it.
(2) Insert harness of terminal to be rectified deep into connector from harness side and hold it there.

(3) Inspection



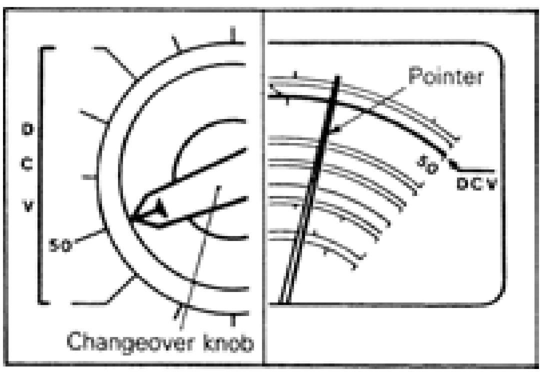
1) Visual and aural checks

Check relay operation, blower motor rotation, light illumination, etc. visually or aurally. The flow of current is invisible but can be checked by the operation of the parts.



2) Simple checks

For example, if a headlight does not come on and a faulty fuse or poor grounding is suspected, replace the fuse with a new one or ground the light to the body by a Jumper wire to determine which part is responsible for the problem.

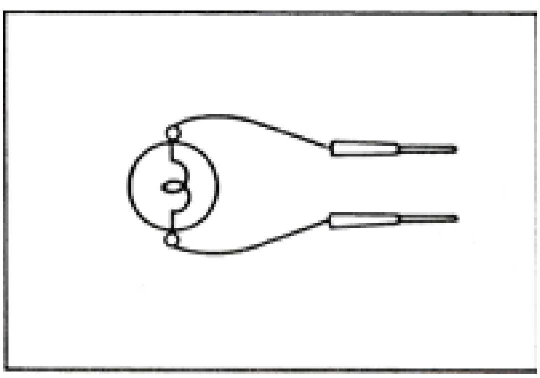


3) Checking with instruments

Use and appropriate instrument in an adequate range and read the indication correctly. You must have sufficient knowledge and experience to handle instruments correctly.

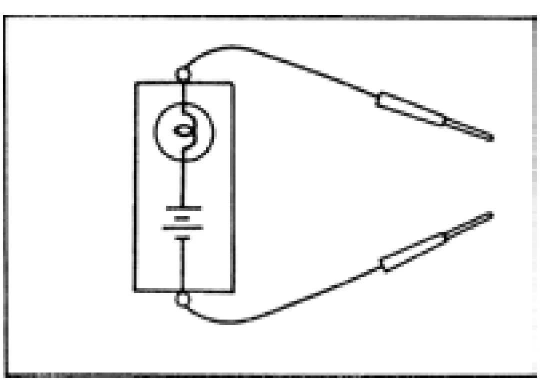
(4) INSPECTION INSTRUMENTS

In inspection, make use of the following instruments.



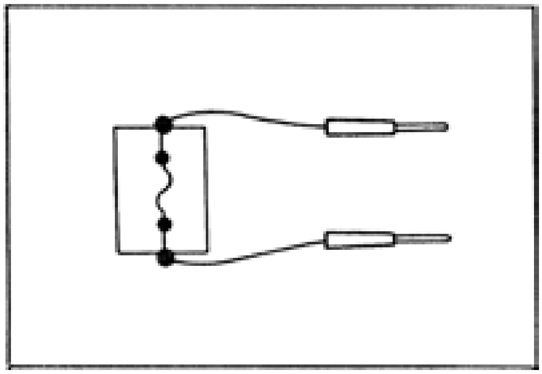
1) Test lights

A test light consists of a 12 V bulb and lead wires. It is used to check voltages or shortcircuits.



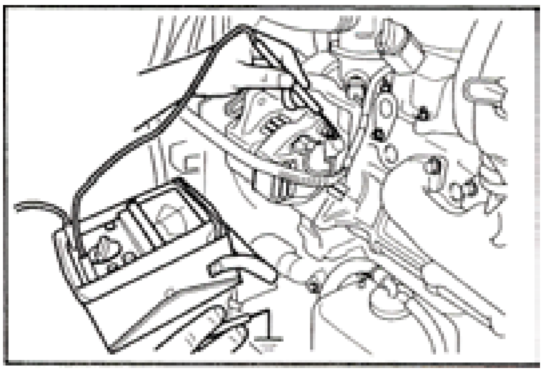
2) Self-power test light

A self-power test light consists of bulb, battery and lead wires connected in series. it is used to check continuity or grounding.



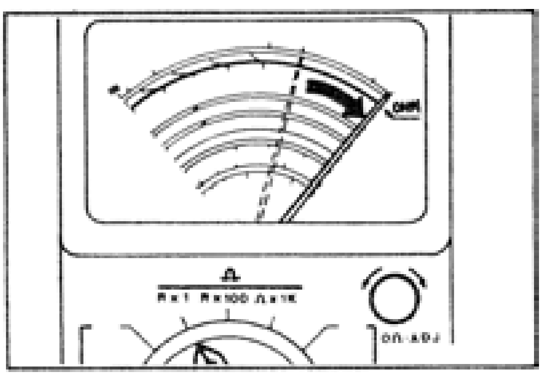
3) Jumper wire

A jumper wire is used to close an open circuit. Never use one to connect a power supply directly to a load.



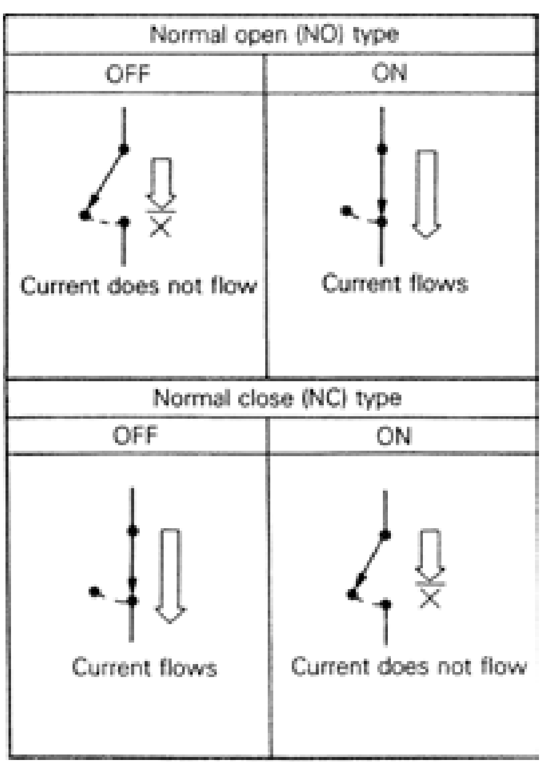
4) Voltmeter

A voltmeter is used to measure the circuit voltage.Normally, the positive (red lead) probe is applied to the point of voltage measurement and the negative (black lead) probe to the body ground.



5) Ohmmeter

An ohmmeter is used to check continuity or measure resistance of a switch or coil. If the measuring range has been changed, the zero point must be adjusted before measurement.

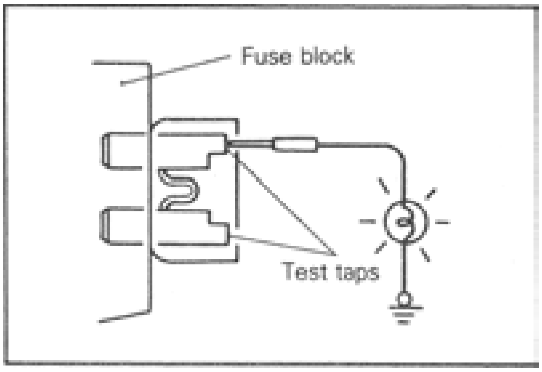


(5) CHECKING SWITCHED

In a circuit diagram, a switch is represented by a symbol and in the idle state.

1) Normal open or normal close switch

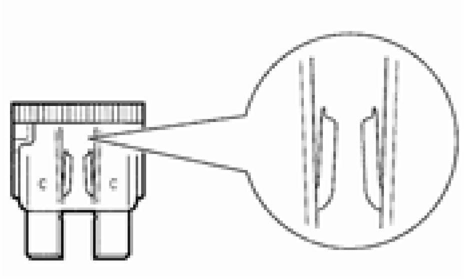
Switches are classified into those which make the circuit open and those which make the circuit closed when off.



(6) Checking fuses

A blade type fuse has test taps provided to allow checking of the fuse itself without removing it from the fuse block. The fuse is okay if the test light comes on when its one lead is connected to the test taps (one at a time) and the other lead is grounded. (Change the ignition switch position adequately so that the fuse circuit becomes live.)

State of fuse blown due to overcurrent

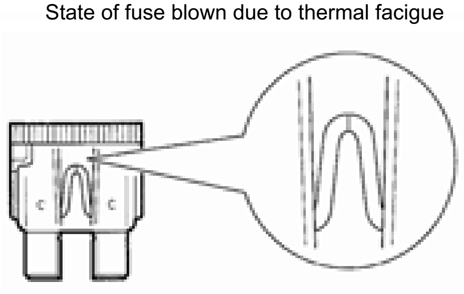


CAUTIONS IN EVENT OF BLOWN FUSE

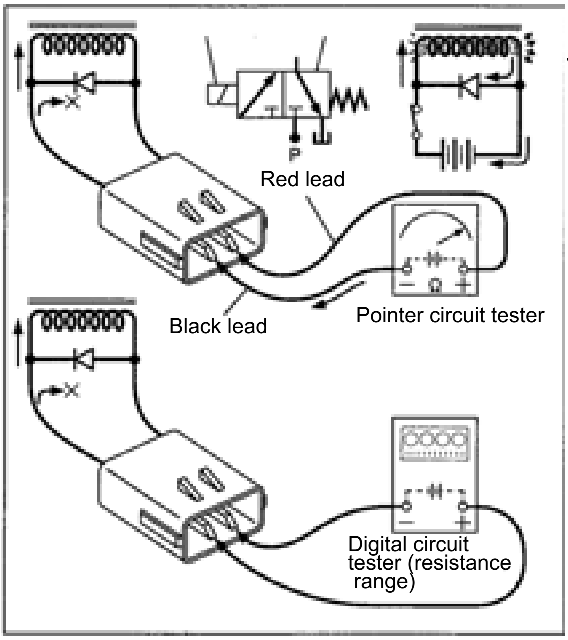
When a fuse is blown, there are two probable causes as follows: One is that it is blown due to flow of current exceeding its rating. The other is that it is blown due to repeated on/off current flowing through it. Which of the two causes is responsible can be easily determined by visual check as described below.

(1) Fuse blown due to current exceeding rating
The illustration shown the state of a fuse blown due to this cause. In this case, do not replace the fuse with a new one hastily since a current heavy enough to blow the fuse has flowed through it. First, check the circuit for shorting and check for abnormal electric parts. Only after the correction of such shorting or parts, fuse of the same capacity should be used as a replacement. Never use a fuse of lager capacity than the one that has blown, If such a fuse is used, electric parts or wirings could be damaged before the fuse blows in the event an overcurrent occurs again.

State of fuse blown due to thermal facigue



(2) Fuse blown due to repeated current on/off
The illustration shown the state of a fuse blown due to repeated current on/off. Normally, this type of problem occurs after fairly long period of use and hence is less frequent than the above type. In this case, you may simply replace with a new fuse of the same capacity.

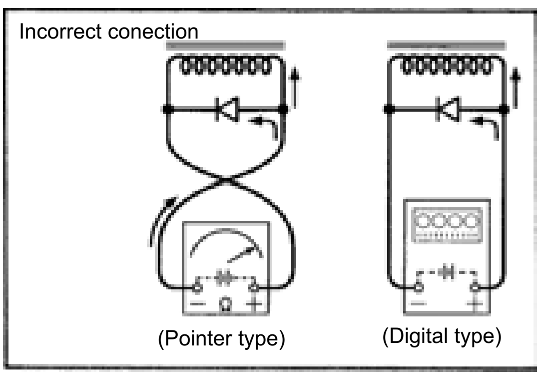


(7) Solenoid test method

Solenoid continuity test procedure

Connect the black and red leads to the positive (+) and negative (-) terminals, respectively, of a circuit tester (pointer type). Make sure the coupler is positioned as shown in the figure. In this state, the coil resistance can be measured properly.

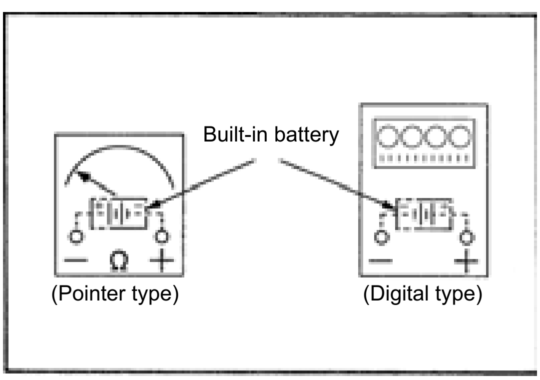
Be careful not to confuse the above connections. If reverse-connected, the measuring current of the circuit tester flows to the diode too and the coil resistance cannot be measured correctly.

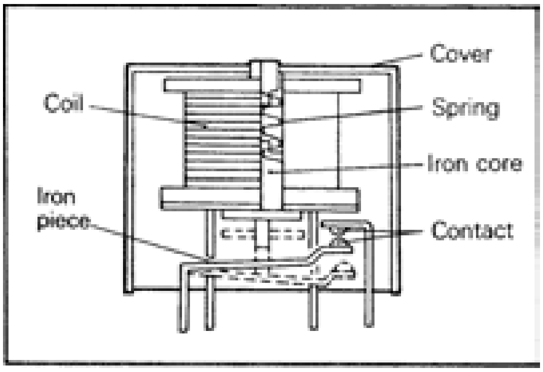


[TIPS]

The circuit tester is battery-powered. The battery voltage is applied across the resistor, by which a current flows and the resistance is measured.

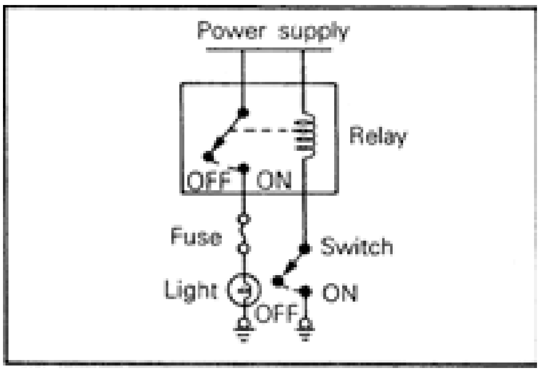
The built-in battery's polarities are different between the pointer type and digital type as illustrated below. In measuring the resistance of a diode-fitted coil, make connection between the positive (+) output terminal of the built-in battery and the cathode of the diode.



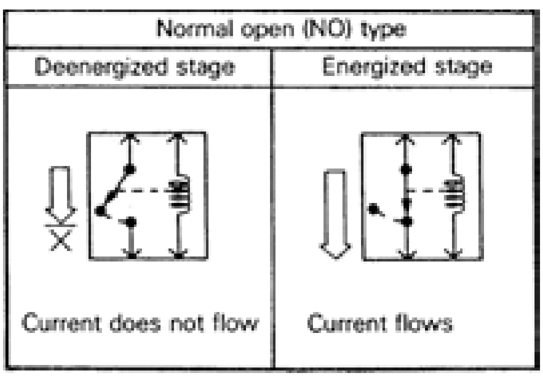


(8) Checking relays

1. When current flows through the coil of a relay, its core is magnetized to attract the iron piece, closing (ON) the contact at the tip of the iron piece. When the coil current is turned off, the iron piece is made to return to its original position by a spring, opening the contact (OFF).

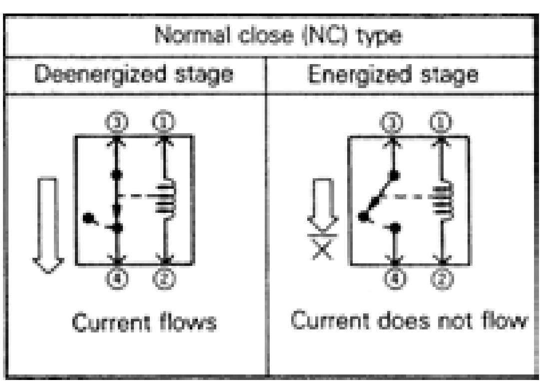


2. By using a relay, a heavy current can by turned on and off by a switch of small capacity. For example, in the circuit shown here, when the switch is turned on (closed), current flows to the coil of the relay. Then, its contact is turned on (closed) and the light comes on. The current flowing at this time to the switch is the relay coil current only and is very small.

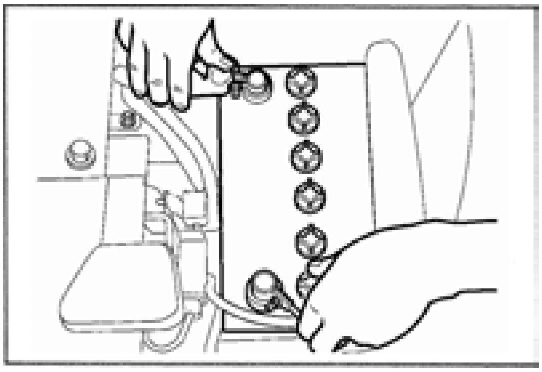


3. The relays may be classified into the normal open type and the normal close type by their contact construction.

NOTE
The deenergized state means that no current is flowing through the coil and the energized state means that current is flowing through the coil.

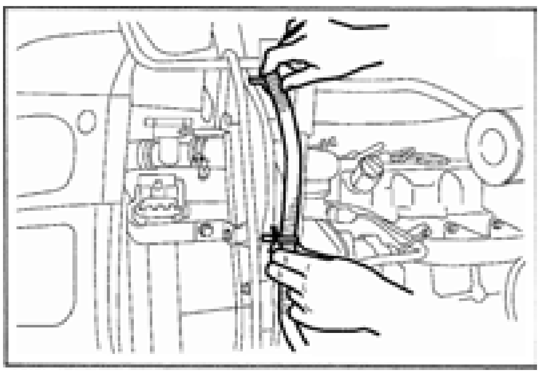


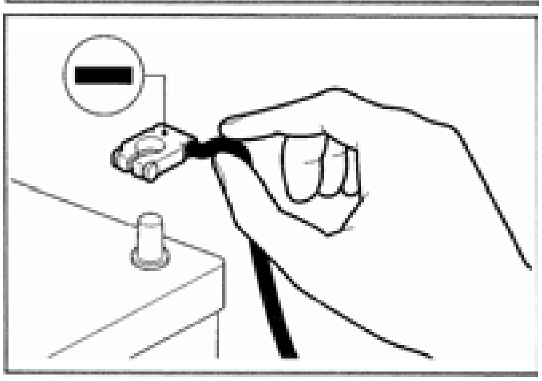
When a normal close type relay as illustrated here is checked, there should be continuity between terminals (1) and (2) and between terminals 3 and 4 when the relay is deenergized, and the continuity should be lost between terminals 3 and 4 when the battery voltage is applied to the terminals I and 2. A relay can be checked in this manner and it cannot be determined if a relay is okay or faulty by checking its state only when it is deenergized (or energized).



(9)Checking cables and wires

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.





(10)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.)

b. Front attachment

(1) Working lamp failure

1) Check for continuity to make sure the working lamp's 10A fuse is not blown out.

2) Check for continuity to make sure the working lamp's bulb is not broken.

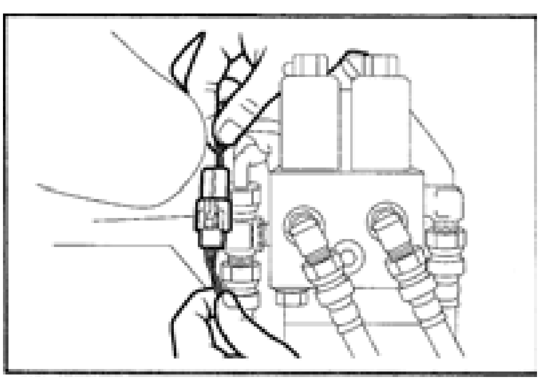
3) Pull the harness to see if the working lamp terminal and the relay couplers are not out of position. Be sure that the coupler harness is tightly connected. (Pull by a 3 kg or less force.)

4) Battery voltage check
   1. Disconnect coupler of working light.
   2. Turn on key switch.
   3. Check if batteryvoltage is at (+) terminal.

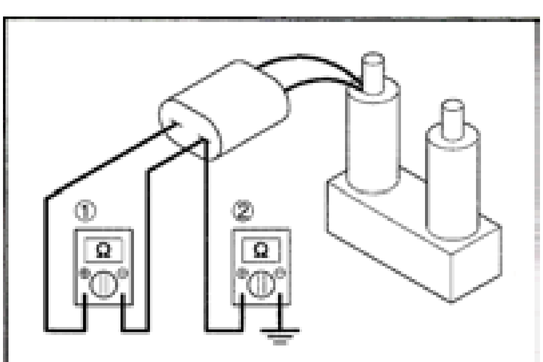
(2) Safety lever lock circuit malfunction

1) Check battery voltage at (+) terminal of coupler. Check the fuse if no voltage were tested.

2) Check lever lock switch for continuity by operating the lever.



3) Pull the harness to see if the coupler is not out of the lever lock solenoid valve. (Pull by a 3 kg or less force.)
4) Continuity test of corresponding harness are required.



5) Solenoid valve check
   1. Coil resistance
      Specification: 6 - 15 Ω
      • Shown here is a measurement with digital tester. (Note that the positive (+) and negative (-) connections are reversed with the analog type.)
   2. Coil insulation
      Specification: Over 1 MΩ

c. Engine electrical system

(1) Engine oil pressure failure

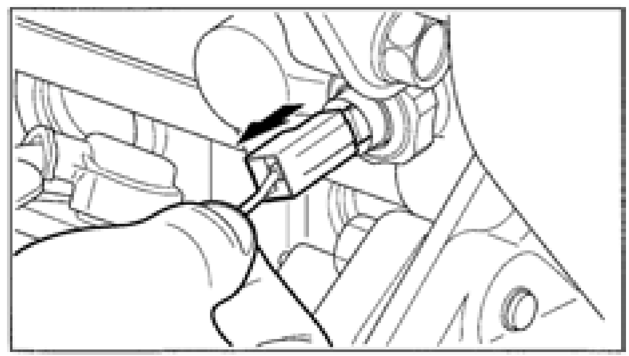
1) Check engine oil pressure lamp.

Engine Condition	Lamp condition		
	Normal	Trouble case (1)	Trouble case (2)
Before engine starts	ON	ON	OFF
After engine starts	OFF	ON	OFF

Trouble case (1) :Engine oil pressure is low or oil switch fails.
Trouble case (2) :Wire harness is cut or oil switch fails.

2) Check oil amount and replenish if nessesary.

3) Pull the harness to see if the oil switch coupler is not out of position. Be sure that the coupler harness is tightly connected. (Pull by a 3 kg or less force.)
   • If out of position, attach the coupler tightly and check the meter reading again.



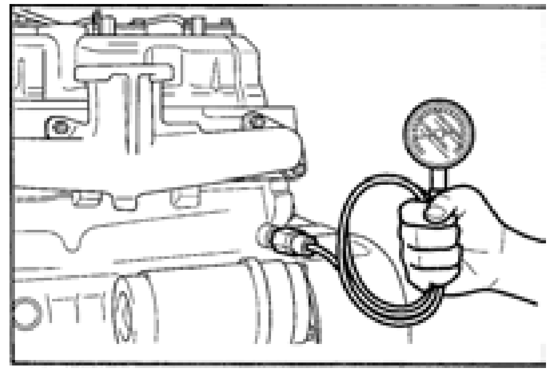
4) Check battery valtage at (+).
   Terminal of wireharness coupler. If no battery voltage, check the fuse and continuity of wireharness.

5) Check continuity of oil switch between switch terminal and body earth.

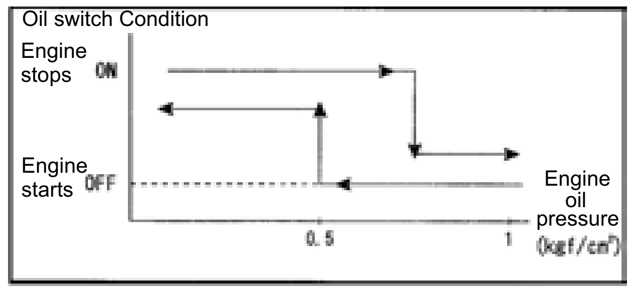
Engine condition	Continuity of oil switch
Engine stop	Yes
Engine starts	No
Engine oil switch is NC (Normal) type.	

6) Check engine oil pressure

Idling rpm	0.4 MPa(4 kgf/cm^2)
MAX. rpm	0.6 MPa(6 kgf/cm^2)



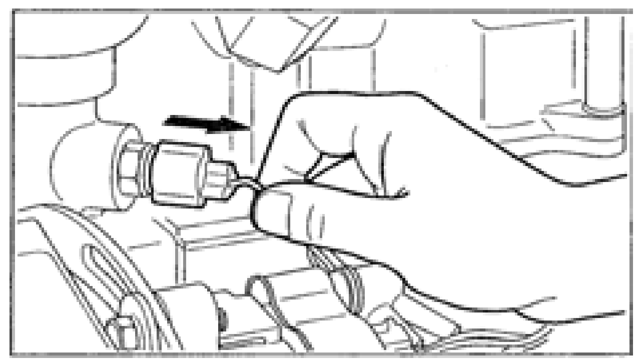
• Oil switch operating pressure
Ref. value:0.05 ± 0.01MPa (0.5 ± 0.1kgf/cm^2)



(2) Water temp. sensor circuit malfunction

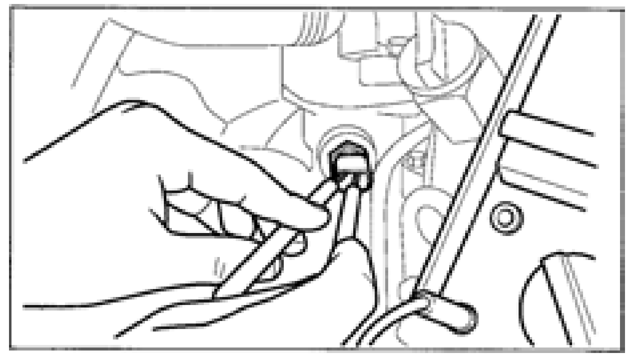
There are two sensors installed on the engine.
1. For warning lamp and gauge
2. For auto glow system

1) Check couplers
Pull the harness to see if the water temperature sensor coupler is not out of position. Be sure that the coupler harness is tightly connected. (Pull by a 3 kg or less force.)
- If out of position, attach the coupler tightly and check the lamp and gauge again.



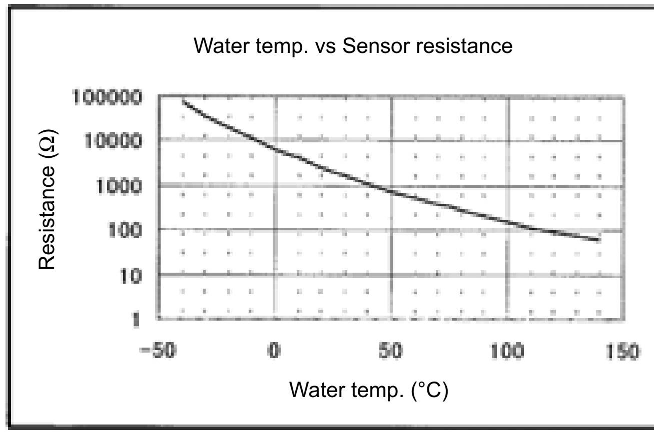
2) Check battery voltage at (+) terminal of harness coupler.
If no battery voltage, check the fuse and continuity of wireharness.

3) Water temperature sensor check
   • Disconnect the coupler from the water temperature sensor and measure the resistance referring to the figure at right.



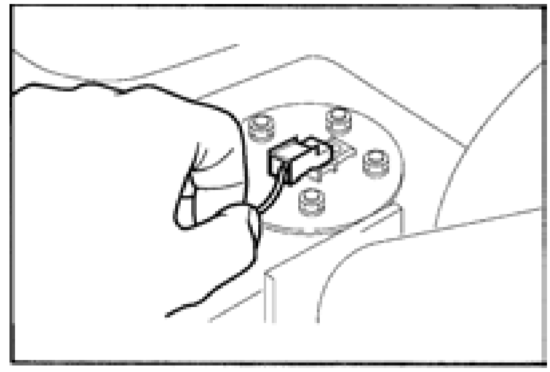
The temperature vs. resistance curve must meet the criteria listed below.

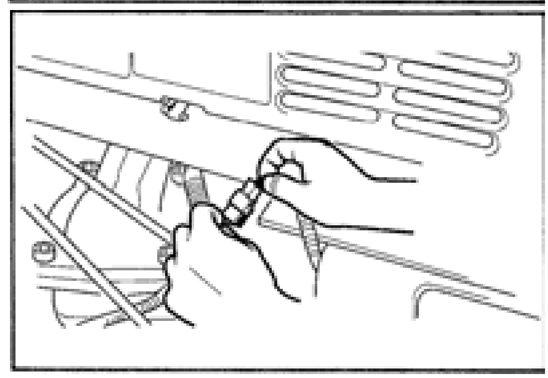
Temp (°C)	Resistance (kΩ)
-20	18.80 ± 12.6%
40	1.136 ± 8.4%
100	0.1553 ± 4.5%



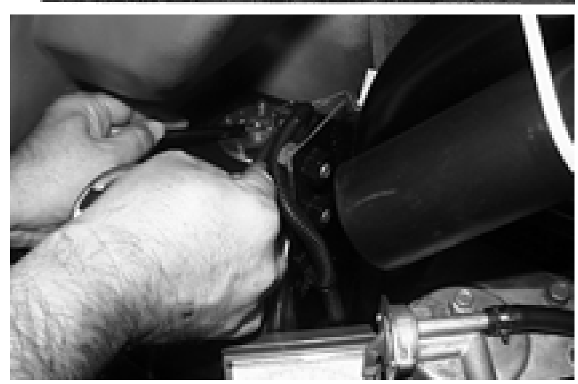
(3) Fuel sensor circuit

1) Pull the harness to see if the fuel sensor couplers and the relay couplers are not out of position. Be sure that the coupler harness is tightly connected. (Pull by a 3 kg or less force.)
   • If out of position, attach the coupler tightly and check the meter reading again.





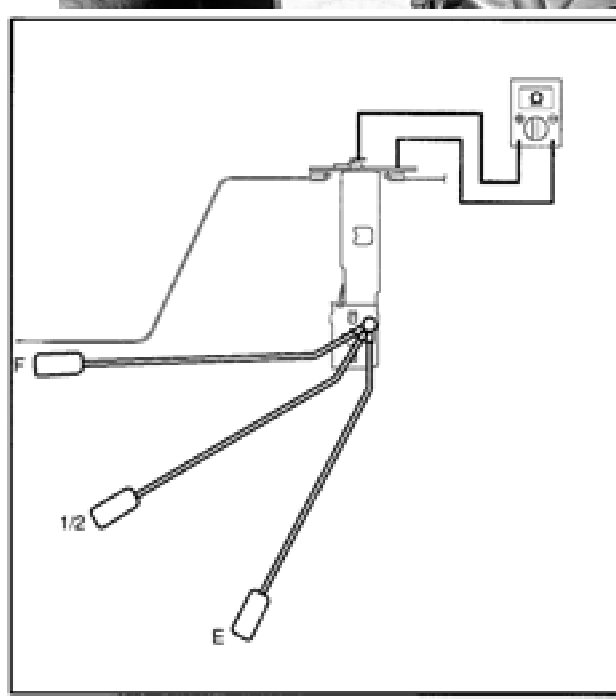
2) Check battery voltage at (+) terminal of wireharness-coupler.
   If no battery voltage, check the fuse and continuity of wireharness.



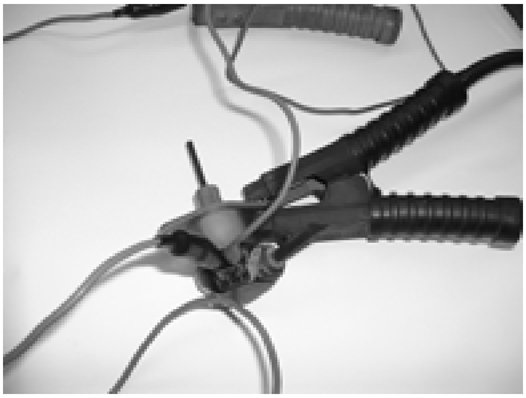
3) Fuel sensor check
   • Apply the positive (+) test lead to the coupler-fitted terminal.
   • Apply the negative (-) test lead to the plated part to measure the resistance.

   • Ref. value

Float position	F	1/2	E
Resistance (Ω)	3 ± 2	32.5 ± 4	110 ± 7



4) Directly connect the (+) terminal of wireharness coupler to the earth.
   Then meter gauge indication raises gradually up to full range.
   Because resistance is 0Ω.
   In this case, meter gauge function is normal.



(4) Engine stop solenoid

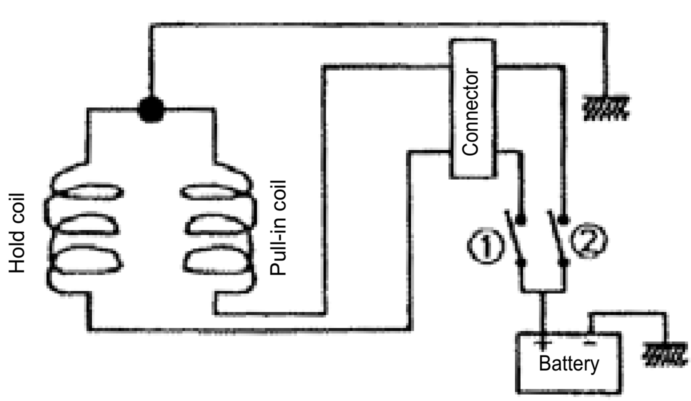
(C/N 1A021-6001-3)

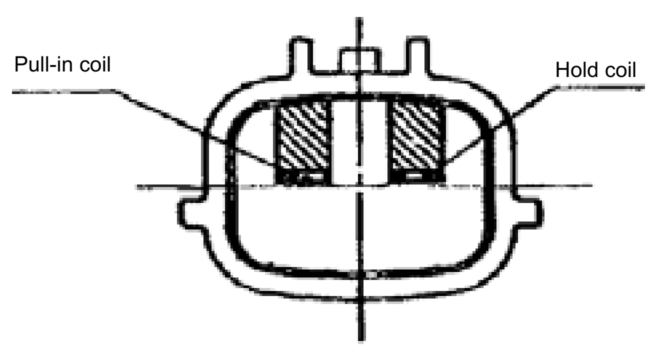
Operation of engine stop solenoid can be test as in the pictures.

1) Connect 12 V battery voltage to two terminal of engine stop solenoid.
2) Get body earth as shown in picture.
3) Then plunger pin comes out.
   This means pull-in coil is normal.

4) Take off pull-in coil terminal connection.
5) Plunger pin still keeps pushing out.
   This means hold-coil is normal.

6) Take off second terminal connection.
7) This time plunger pin should be returned back by spring.
   This means engine stop solenoid functions normal.





(5) Charging system malfunction

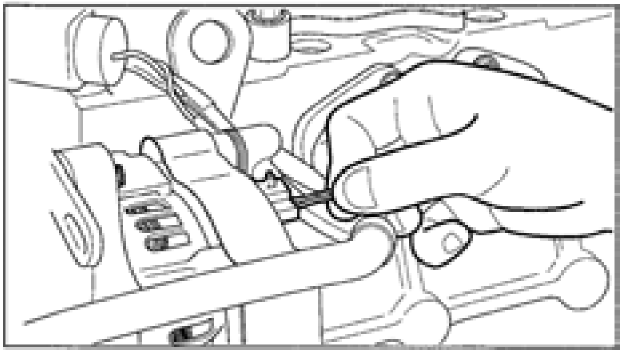
1) Check charge lamp condition.

Engine Condition	Lamp condition		
	Normal	Trouble case (1)	Trouble case (2)
Engine stops	ON	ON	OFF
Engine starts	OFF	ON	OFF

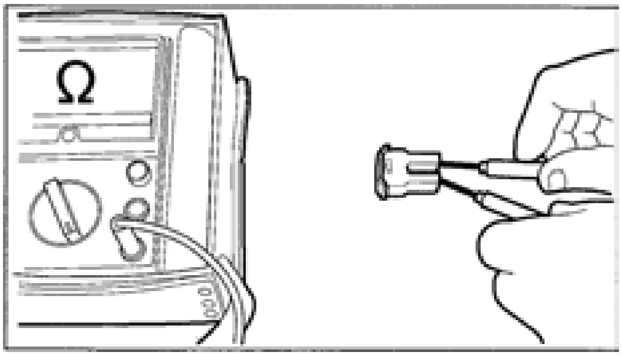
Trouble case (1):Fan belt breakage, B-terminal failure charging system malfunction.
Trouble case (2):Wireharness problem, L-terminal failure

2) Pull the harness to see if the alternator coupler is not out of position. Be sure that the coupler harness is tightly connected. (Pull by a 3 kg or less force.)

- If out of position, attach the coupler tightly and check the lamp.

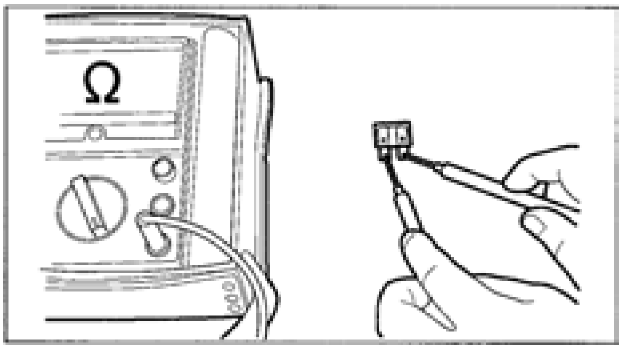


3) Check for continuity to make sure the 60A slow-blow fuse (60A) is not blown out.



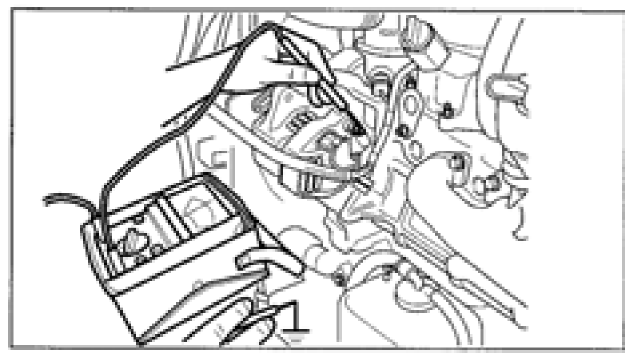
4) Check for continuity to make sure the 15A fuse is not blown out. (For the travel hi-speed and fuel pump)

- If this fuse is blown out, both the fuel pump and travel hi-speed control do not work.



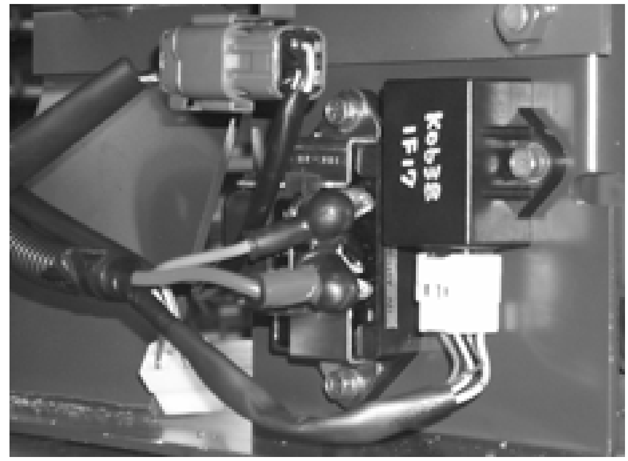
5) Check battery voltage at B-terminal of wireharness coupler.
   If no battery voltage, check the fuse and continuity of wireharness.

6) Alternator check
   1)Measure the voltage between the alternator's terminal B and the body ground. Make sure the measurement is 12 V or so. If the measured voltage is lower than this, it means that the battery capacity may be low or that the wire connections before the alternator may be loose.
   2)Next start the engine and measure the voltage being generated while the alternator is running. For this, measure the voltage between the alternator's terminal B and the body ground. Make sure the measurement goes up to 14 V or so (alternator-generated voltage). If the measurement is still the battery voltage (12 V or so), it means that the alternator or the regulator may be in trouble.

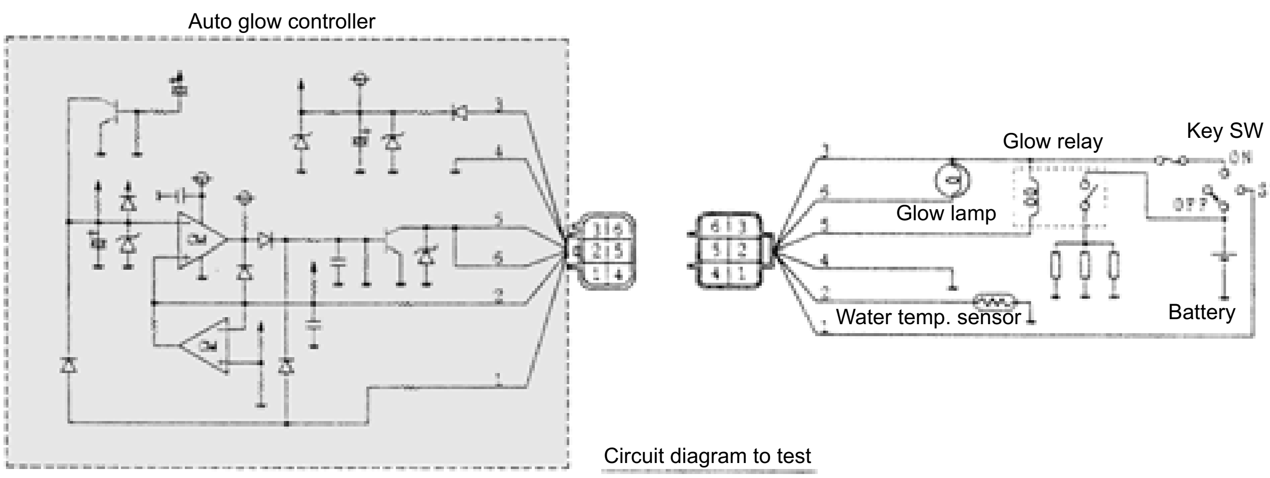


(6) Auto glow controller

(C/N RC417-53791)



1) If the automatic glow controller seems to malfunction, take it out of the machine, as shown at left, and check the performance of the controller itself referring to the circuit diagram below.
2) The circuit diagram below shows the actual connections. In practice, apply the battery voltage between the coupler pin 3, and ground the coupler pin 4.
3) When the coupler pins 5 and 6 are connected as shown in the diagram, the glow lamp stays on for a certain period of time, and the relay gets activated, it means that the automatic glow controller functions well.
4) If the water temperature sensor signal is not fed to the coupler pin 2, the controller will be in action for about 12 seconds the same way as for the -20 °C condition.



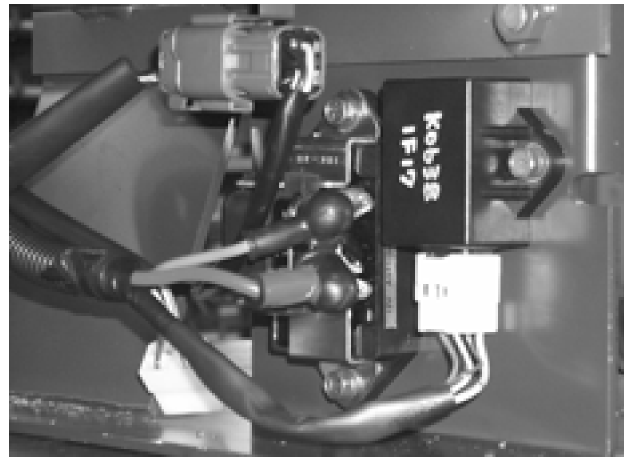
Circuit diagram to test

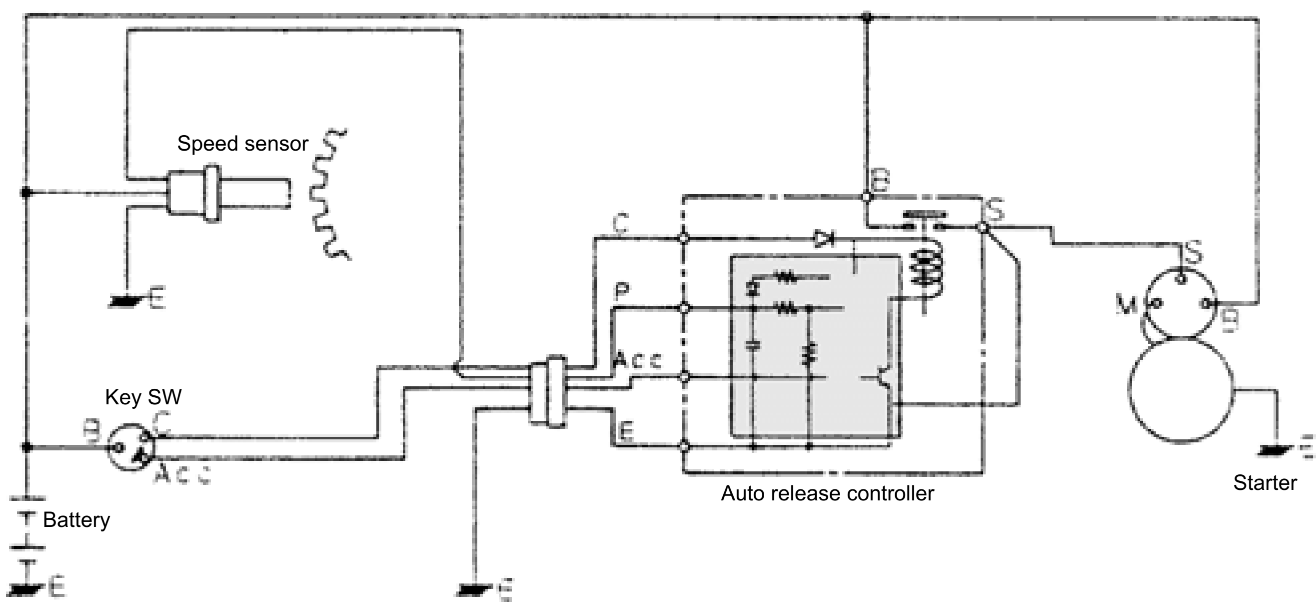
Note: If a test-purpose glow lamp is not available, set the circuit tester to the V range and watch the tester's pointer movement.

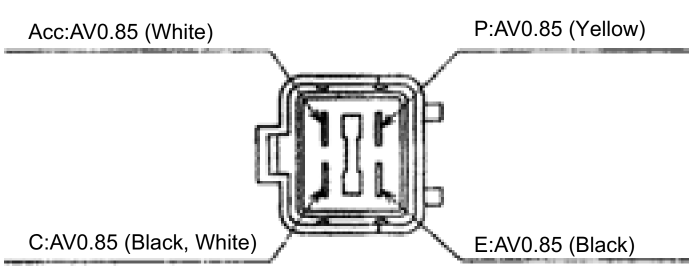
(7) Auto release controller

(C/N RC417-53791)

1) If the automatic release controller seems to malfunction, take it out of the machine, referring to the photo at left.
2) Referring to the circuit diagram below, ground the terminal E and connect the terminals Acc and C to the battery's 12V terminal. Now the relay gets activated, which closes the B-S contact.
3) Make sure the B-S contact closes and opens according to the input voltage at Acc, as shown below.



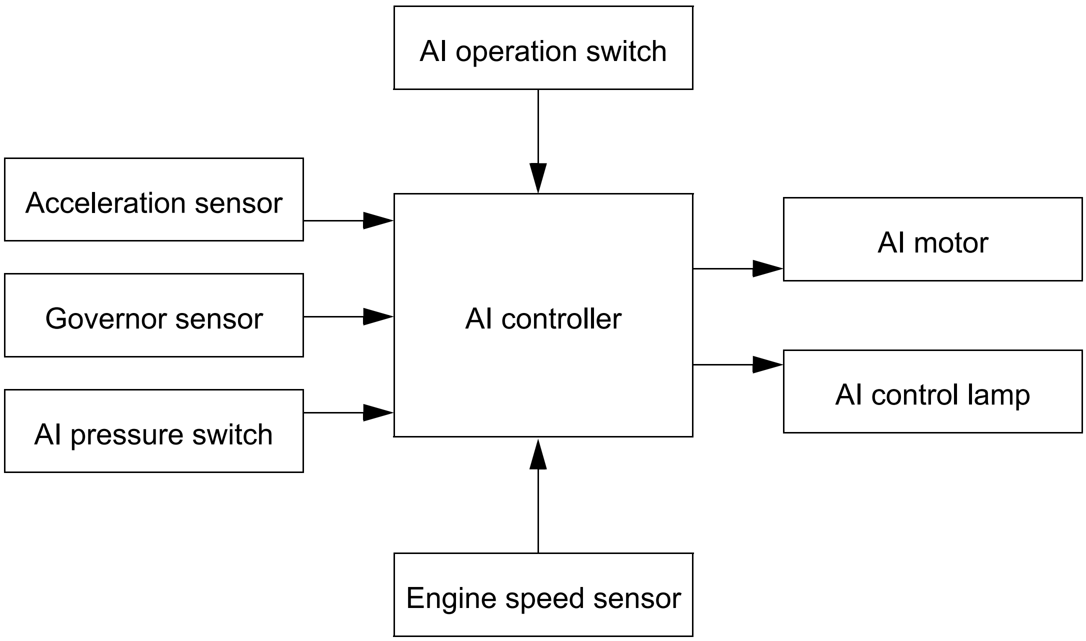




d. Auto idle system

(1) Troubleshooting outline

The auto idle mechanism consists mainly of the following 8 components. They are systematically interactive.

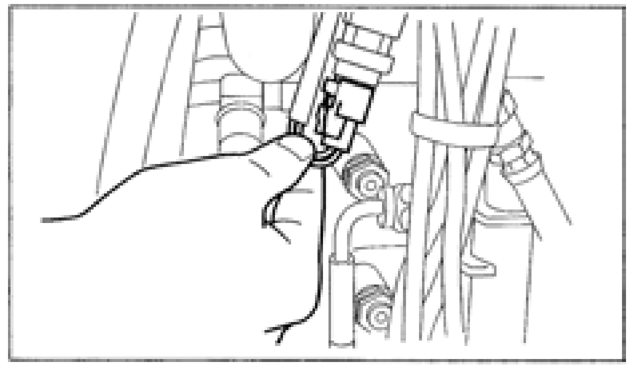


Below listed are typical possible troubles and causes of the auto idle mechanism. To pinpoint a trouble spot, check the relevant component for performance and the harness for continuity.
Let's suppose that the above 7 components, except for the AI controller, are found functioning well and that there is no problem with the hydraulic system. In such case, it is advisable to replace the AI controller itself with new one and check its performance.

a.Typical trouble	b. Possible causes and correction
1. Accelerator lever moved, but engine speed did not change accordingly.	1. Acceleration sensor defective. 2. AI motor defective. 3. Governor sensor defective. 4. Acceleration cable defective.
2. Control lever at neutral, but engine speed not idling.	1. AI pressure switch defective. 2. Speed sensor defective. 3. AI motor defective.
3. Control lever moved with engine idling, but engine speed failure to rise.	1. AI pressure switch defective. 2. Speed sensor defective. 3. AI motor defective.

(2) AI pressure switch test method

1) Pull the harness to see if the AI pressure switch coupler is not out of position. Be sure that the coupler harness is tightly connected. (Pull by a 3 kg or less force.)
   • If out of position, attach the coupler tightly and check the performance again.



2) Disconnect the AI pressure switch coupler and start the engine. Apply the circuit tester to the switch terminal to check continuity.
   For continuity or no continuity while in normal condition and in trouble, see the table below.

(continuity : Yes or No)

Control lever position	Normal	Trouble case (1)	Trouble case (2)
Neutral	Yes	Yes	No
Shifting	No	Yes	No

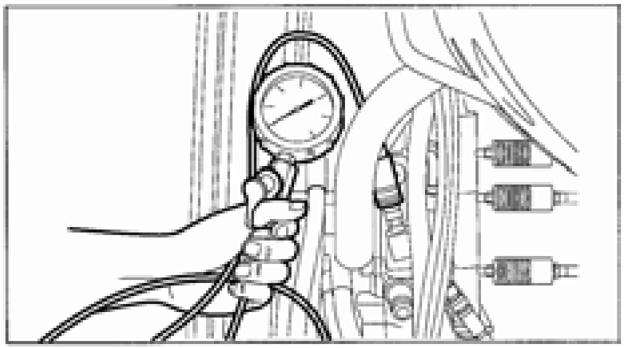
Trouble case (1): AI sensing pressure is low.
AI pressure switch malfunction.
Trouble case (2): AI pressure switch malfunction.
AI pressure switch is NC (Normal close) type.

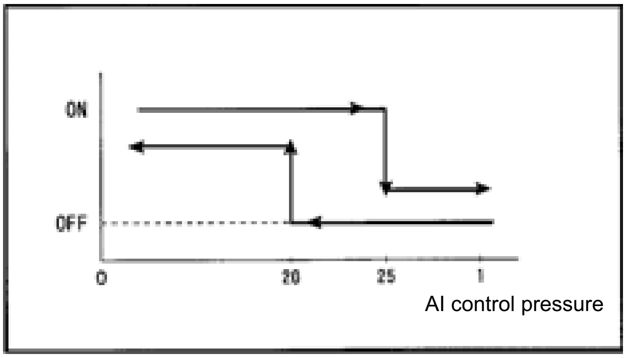
3) Check battery voltage at (+) terminal of wireharness coupler.
   If no battery voltage, check the fuse and continuity of wireharness.

4) Inspect AI control pressure

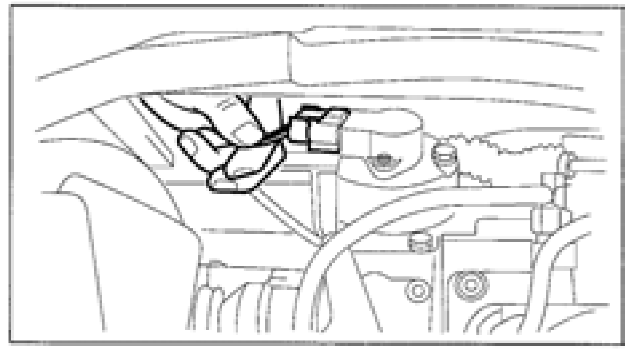
Control pressure	AI pressure switch	Engine rpm.
25 ± 3 kgf/cm^2	OFF	Idling to MAX.
20 ± 3 kgf/cm^2	ON	MAX. to Idling

All pressure SW is N.C.(normal close) type.





(3) Accel & governer sensor test method



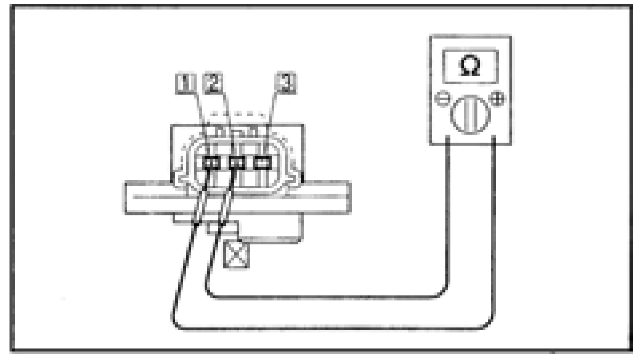
1) Move the accelerator lever and check to see if the engine speed rises smoothly from the idling to maximum level. If so, the sensors function well. If not, go to the next step.

2) Pull the harness to see if the governor sensor coupler is not out of position. Be sure that the coupler harness is tightly connected. (Pull by a 3 kg or less force.)
   - If out of position, attach the coupler tightly and check the meter reading again.

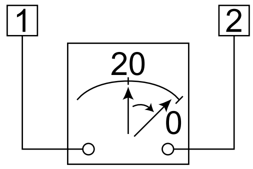
3) Control voltage test
   Disconnect the sensor coupler. With the key switch at the ON position, measure the voltage between the coupler terminals [1] and [3] to see if it is 5V.
   Take the same procedure for the acceleration sensor and governor sensor.

4) Continuity test
   With the key switch at the OFF position, check continuity between the related wire harness terminals. If there is no continuity, a wire may be broken. Follow the circuit diagram in checking for a broken wire.

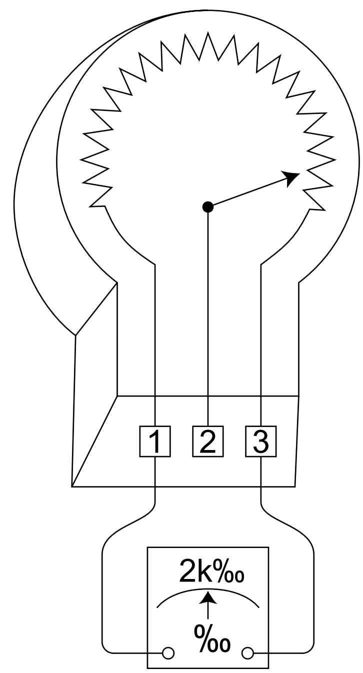
5) Sensor test (Accel, governor sensors)
   1. Check sensor's resistance
      (1) [1] - [3] : 2 kΩ ± 20 %



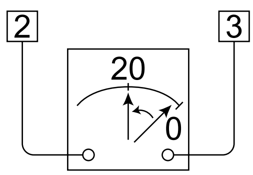
(2)



Turn the potentiometer shaft, and the resistance between the terminals [1] and [2] will drop smoothly from about 2 kΩ to 100-200 kΩ.



(3)



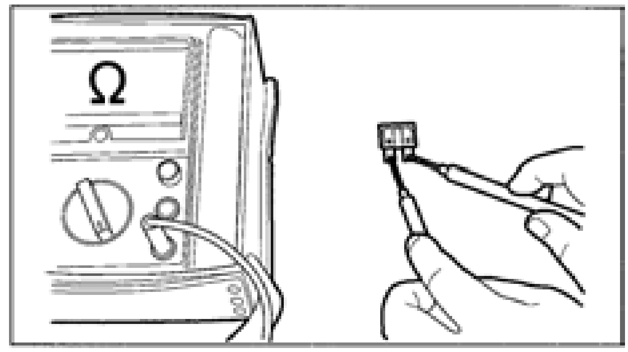
Turn the potentiometer shaft, and the resistance between the terminals [2] and [3] will rise smoothly from about 100-200Ω to about 2 kΩ.

(4) Turn the sensor shaft about 180° by hand, and release it to make sure it returns itself.
If any of the above performances and resistances is not found as specified, it means the sensor itself may be in trouble. Replace the sensor with new one.

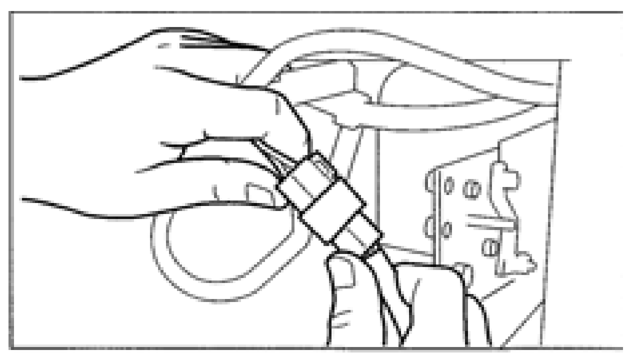
(4) AI motor test method

1) Move the accelerator lever and check to see if the engine speed rises smoothly from the idling to maximum level.

2) Check for continuity to make sure the 15 A AI fuse is not blown out.

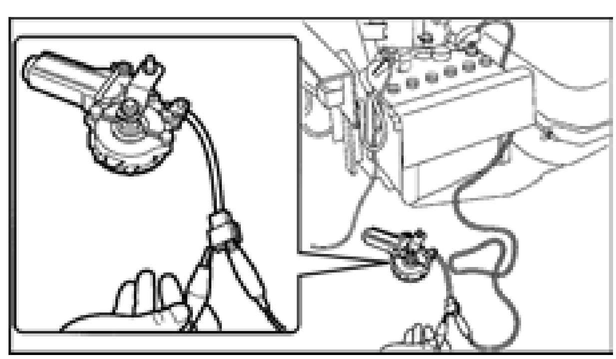


3) Pull the harness to see if the AI motor coupler is not out of position. Be sure that the coupler harness is tightly connected. (Pull by a 3 kg or less force.)
   - If out of position, attach the coupler tightly and check the performance again.



4) Continuity test
   With the key switch at the OFF position, check continuity between the related wire harness terminals. If there is no continuity, a wire may be broken. Follow the circuit diagram in checking for a broken wire.

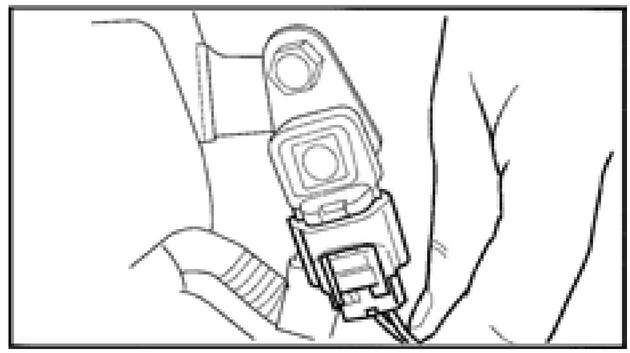
5) AI motor check (Fig. 6)
   Apply 12 V between the AI motor coupler terminals [1] and [2] to make sure the motor gets started. Reverse the connections and make sure the motor runs in the opposite direction.
   * Precautions !
   Feed the power for 1 second or shorter.
   This test can also be made by disconnecting the acceleration cable and keeping the AI motor on the machine.



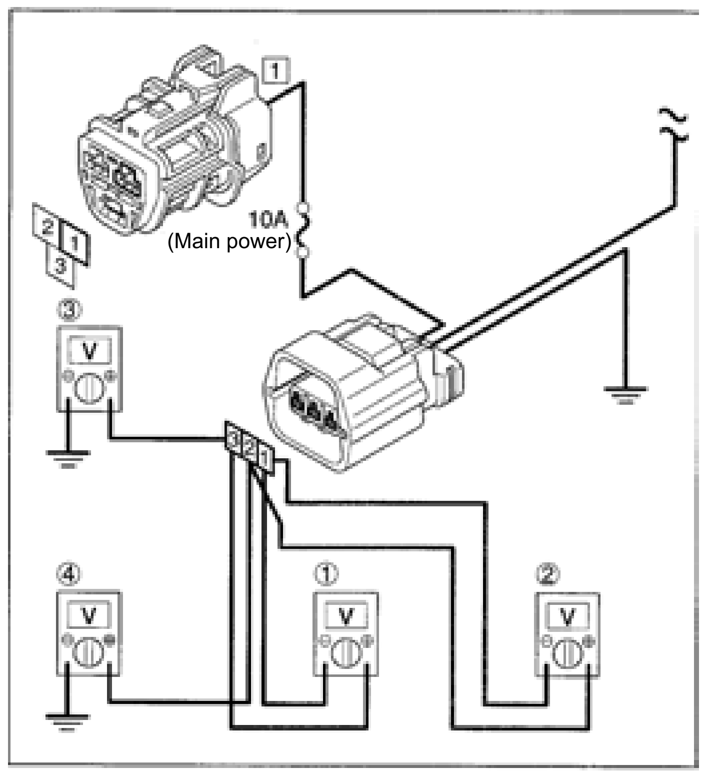
(5) Engine speed sensor

This engine speed sensor is provided for AI control and starter auto-release control. As ever before, the meter reading of the engine speed is sent through the techmeter cable to the speed gauge. If the AI controller malfunctions and this speed sensor is a suspect, take the following test procedure.

1) Pull the harness to see if the engine speed sensor coupler is not out of position. Be sure that the coupler harness is tightly connected. (Pull by a 3 kg or less force.)
   * If out of position, attach the coupler tightly and check the performance again.

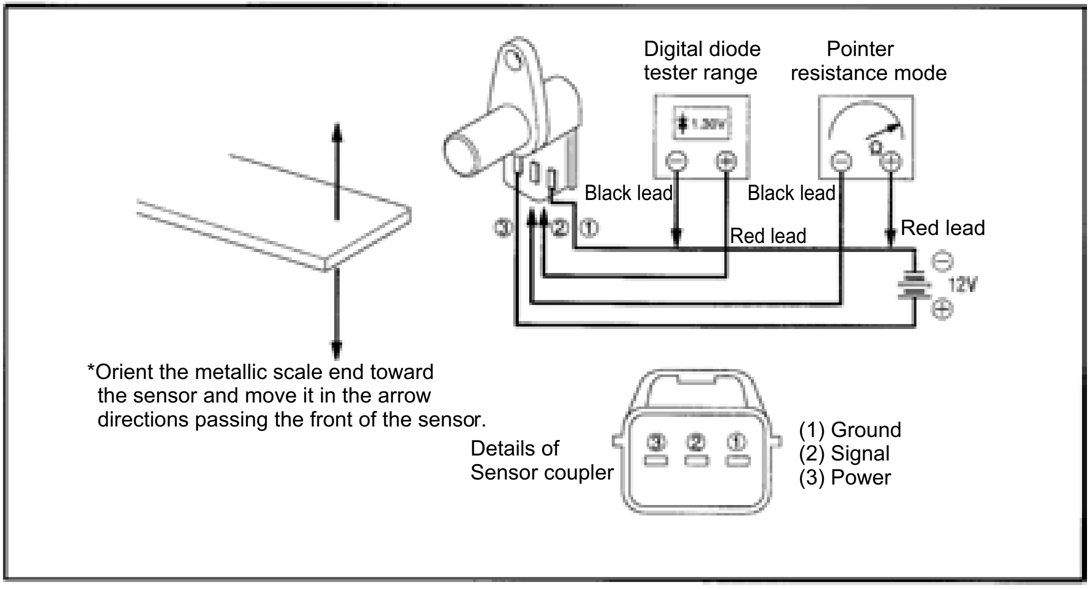


2) Voltage check (Fig. 5)
   • Disconnect the engine speed sensor coupler.
   • Turn the key switch to the ON position.
   1 Measure the voltage between the speed sensor coupler terminals [1] and [3] to make sure it is 12 V.
   2 Measure the voltage between the speed sensor coupler terminals [1] and [2] to make sure it is 5 V.
      * Measurements 12 V and 5 V: Check the speed sensor.
      * Other measurements: Measure the voltages in the steps (3) and (4) below. Check for continuity.
   3 Measure the voltage between the speed sensor coupler terminal [3] and the body ground to make sure it is 12 V.
   4 Measure the voltage between the speed sensor coupler terminal [2] and the body ground to make sure it is 5 V.



3) Continuity test
   With the key switch at the OFF position, check continuity between the related wire harness terminals.

4) Engine speed sensor check
   • Disconnect the speed sensor from the engine and check the sensor.
   * Keep in mind that the positive (+) and negative (-) leads are differently connected between the pointer and digital types.
   * Bear in mind that when the power supply is connected, a short-circuit might occur.
   * Shown below is the measuring procedure with the pointer and digital types. Test by either one that you have in the shop.



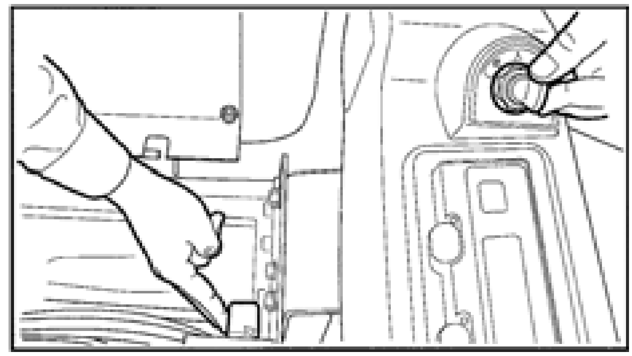
[REFERENCE]

- In measuring with the pointer type, make sure the pointer swings. Set the tester range between 1 Ω and 1 kΩ. (Too small a range makes it difficult to recognize the pointer swing.)
- In measuring (diode test) with the digital type, make sure the reading changes between the 0.0-1.5 range and the over-range.

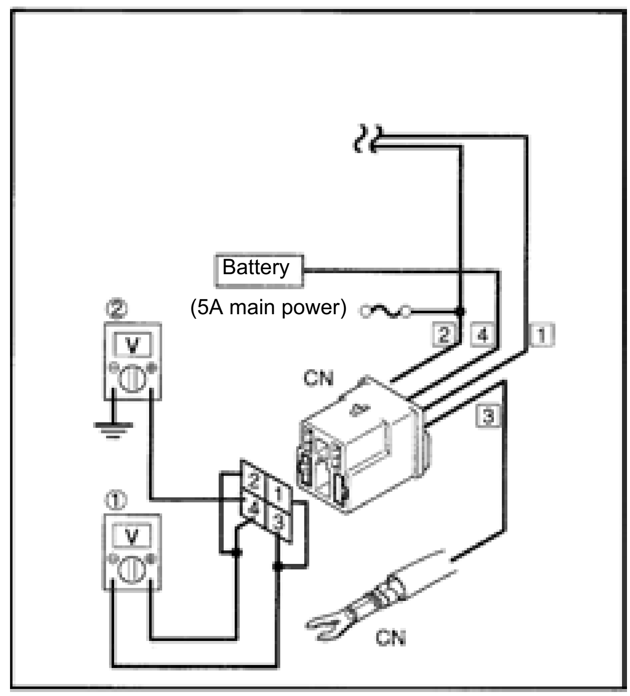
(6) Auto glow circuit

1) Water temperature sensor circuit check
When the water temperature sensor and its wiring function, the engine's water temperature is detected and the glow plug is preheated for a time required to get the engine started.

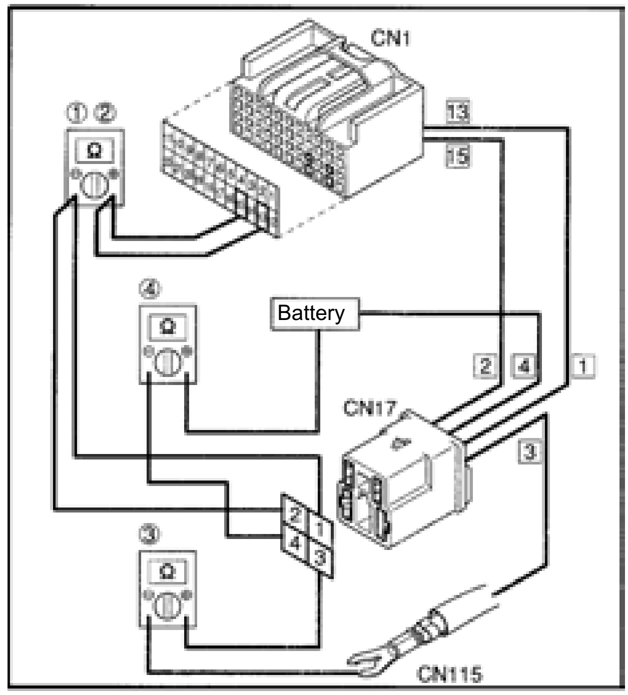
2) First make sure the water temperature sensor functions. Disconnect the water temperature sensor coupler and put your fingers in slight contact with the glow relay. Now turn the key switch to the ON position and feel the glow relay clicking.
   - When it clicks, check the glow plug coupler as well as the glow relay.
   - If it does not click, measure the voltage, check for continuity (Fig. 4), and check the glow relay (Fig. 5).



3) Voltage check
   - Keep the glow relay coupler in position.
   - Turn the key switch to the ON position.
   1. Measure the voltage between the auto glow relay coupler terminals [3] and [4] as well as between [1] and [2] to see if it is 12 V.
      - 12 V reading for both: Check the glow relay.
      - Other reading: Measure the voltage in Step (2) below. Also check for continuity.
   2. Measure the voltage between the glow relay coupler terminal [4] and the body ground to see if it is 12 V.



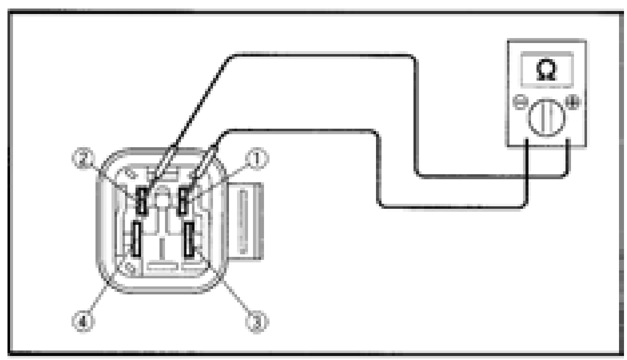
4) Continuity check
   - Turn the key switch to the OFF position.
   - Disconnect the meter coupler .
   - Disconnect the glow relay coupler .
   1. Check for continuity between the meter coupler terminal [13] and the auto glow relay coupler CN terminal [1].
   2. Check for continuity between the meter coupler terminal [12] and the glow relay coupler terminal [2].
   3. Check for continuity between the glow relay coupler terminal [3] and the glow plug coupler.
   4. Check for continuity between the glow relay coupler terminal [4] and the battery's positive (+) terminal.



5) Glow relay check
   1. Disconnect the glow relay coupler. Measure the resistance between points (1) and (2) on the glow relay alone.

Specification	52 - 80 Ω
Actual measurement	About 65 Ω

   2. Apply 12 V between points (1) and (2) of the glow relay to check for continuity between points (3) and (4).

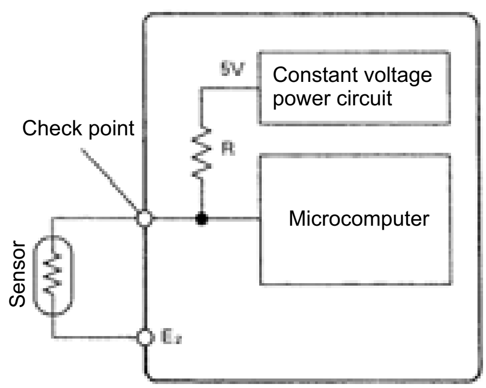


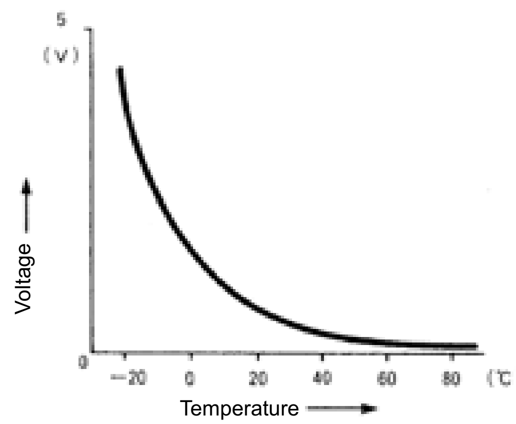
e. AI version: AI controller (built-in microcomputer) Cases of trouble diagnosis with circuit tester

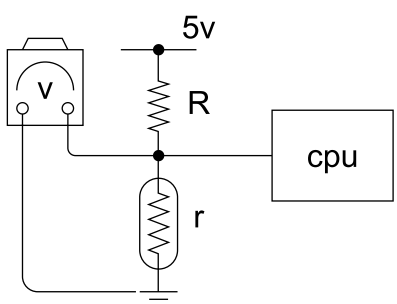
If the auto idle control system malfunctions or the electrical circuitry gets in trouble on the AI type machines, a cause of trouble can be traced by checking the status of signals to the AI controller.
Referring to “Functions and status of signals sent from the sensors to the AI controller”, let’s discuss how to trace the causes of troubles in terms of the signal status.

(1) “Water temperature sensor” line in trouble

1) The water temperature sensor’s detection voltage is formed by a thermistor. The voltage plotted in the chart below is fed to the microcomputer through the circuit shown below.





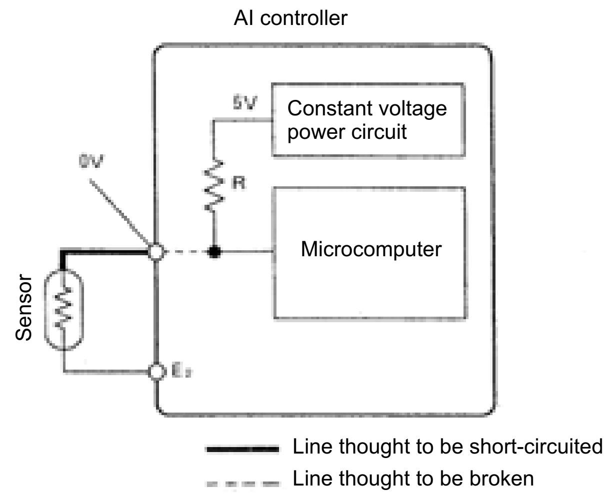


The input voltage to the microcomputer is expressed

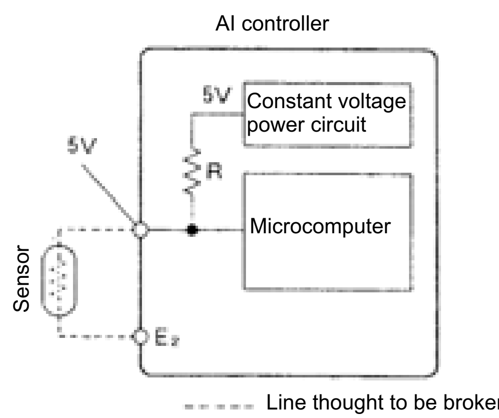
$$\text{Vin} = \frac{5}{R + r} \sim r$$

The value r varies depending on water temperature. Thus the water temperature versus the microcomputer input voltage is plotted in the chart above.

2) If the water temperature sensor voltage at the microcomputer input terminal is measured to be “0 V” or “5 V”, the following cases are taken into consideration.
   1. “0 V” measurement
      Let’s suppose that 5 V is being supplied from the constant voltage power circuit but the measured voltage is 0 V.
      - There is a short-circuit, which interrupts the 5 V supply from the constant voltage power circuit.
      - The circuit in the controller is broken, which interrupts the 5 V output to the water temperature sensor circuit.



   2. “5 V” measurement
      Let’s suppose that 5 V is being supplied from the constant voltage power circuit and the measured voltage is 5 V.
      - The circuit is open (broken) somewhere.



3) With these results in mind, go to the next procedure “Checking the sensor and actuator”.

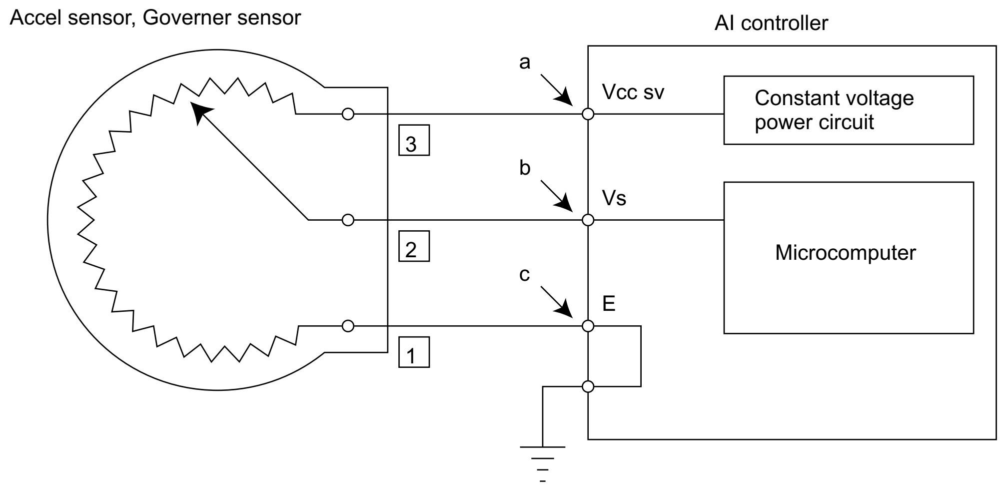
4) Checking the sensor itself
   Disconnect the sensor coupler from the microcomputer. Check the sensor for continuity. For the water temperature sensor, its resistance corresponding to the water temperature will be measured. If there is no continuity, it means there may be a broken wire or the sensor may malfunction.
   For the switch, see if it is of Normally open or Normally closed type. The Normally closed type shows continuity.

5) Checking the wire harness
   When the sensor itself is found functioning, check the wire harness insulation.

(2) Other circuitry layouts and their trouble diagnosis

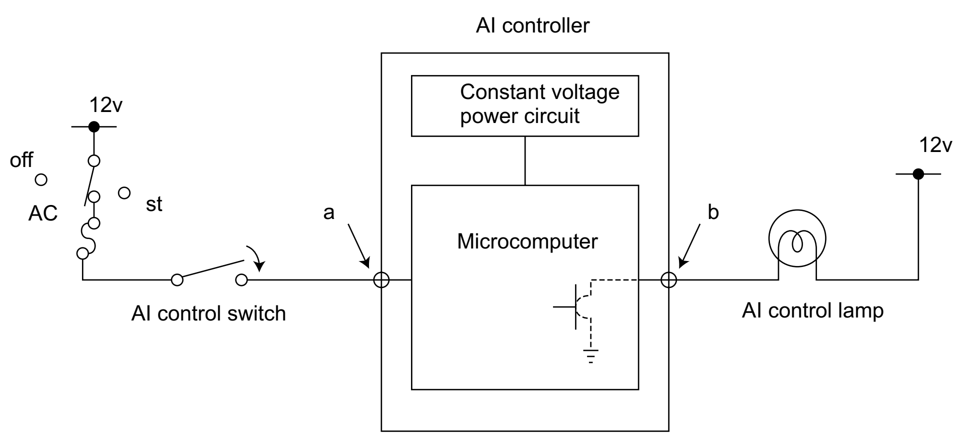
The AI controller may also be incorporated in the following circuits with sensors, switches and actuators. The procedure of trouble diagnosis is almost the same as discussed before. You are requested to train yourself, with a circuit tester in one hand and the circuit diagram in the other, to learn about the electronic control circuit.

1) Vcc voltage (5 V) application



Measure the voltages at points “a”, “b” and “c” in the figure above to see if the sensor or the AI controller malfunctions.

2) With external input signal and external output



Measure the voltages at points “a” and “b” in the figure above to see if the sensor or the AI controller malfunctions.

The AI motor circuit can also be readily diagnosed, referring to “t. AI controller unit input/output circuits”

f. Auto Idle(AI) version: Trouble diagnosis with lamp

(1) General

On the AI type machines, the AI controller's input and output signals are used for AI control. A program has been factory-installed in the microcomputer to detect and display these input and output signals for easy trouble diagnosis.
The error display comes in the following 3 modes.

1) Operating mode:
The machine condition during ordinary run and operation is detected and displayed. As shown in Table 1, fail symptoms are identified by the number of blinks of the system lamp.
2) Setup mode:
The AI control settings are made and saved in the AI controller in this mode. When the AI control devices (such as acceleration sensor, governor sensor, AI motor and acceleration cable) have been disassembled and reassembled at the factory or workshop, possible small deviation produced in fabricating or fitting these devices can be detected and the initial settings can be resumed.
3) Service mode:
If a trouble occurs with the AI control system components, for example, the trouble spot can be located. Then a service engineer is supposed to operate the machine and diagnose the trouble and to restore the function. This mode includes the following menus. The service engineer uses the AI operation switch for trouble diagnosis.
   1) Top menu
   2) Trouble indicator lamp menu for usual control
   3) Engine speed sensor check menu
   4) AI pressure switch/water temperature sensor check menu
   5) Sensor break check menu (Accel, & governor)
   6) Fail record display menu
   7) Fail record delete menu
   8) EEPROM read menu
   9) AI motor drive menu

(note: EEPROM means electrically erasable program read only meomry . In this case, it contains data of machine conditions in the micro computer.)

(2) Display and identification of errors in operating mode

If any of the AI control devices gets in trouble during the machine run, the AI control lamp (red) starts blinking and indicates the type of error as listed inTable 1.

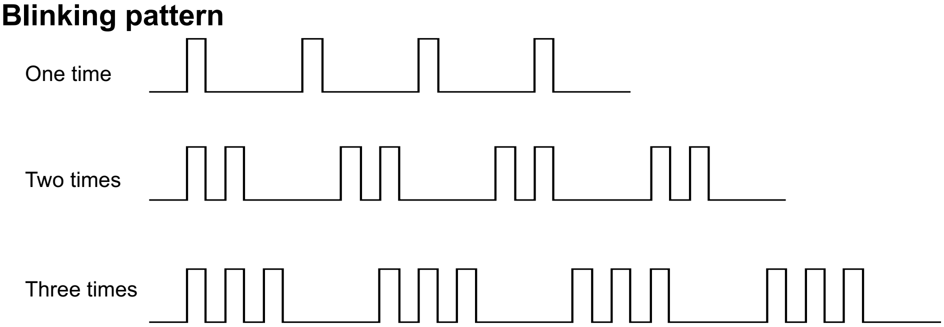
Table 1 Trouble indicator lamp blinks in operating mode

Fail No.	Fail symptom	Trouble indicator lamp blinking times in operating mode
(1)	Water temperature sensor line break	-
(2)	Acceleration sensor line break	2
(3)	Governor sensor line break	3
(4)	AI motor drive line break	4
(5)	Self-holding relay circuit malfunction	5
(6)	AI motor drive line short-circuit	6
(7)	AI motor restrict malfunction	-
(8)	Engine speed sensor line break	-
(9)	Starter motor auto release	-
(10)	Battery voltage abnormal	10
(11)	Controller system malfunction	11

Remarks:

1. The lamp keeps blinking for a predetermined time. The microcomputer has been programmed to recognize these errors as machine troubles.
2. If the detection voltage of the acceleration sensor or governor sensor drops and stays below 0.2 V for 150 msec or so, for example, the microcomputer judges this as a breakdown and gives a signal to make the lamp blink.
3. If two or more failures occur at a time – governor sensor line break and AI motor drive line break at once, for example, the lamp starts blinking twice and 3 times soon after. This cycle is repeated.

Blinking pattern



In case No.1 and No. 2 fails exist, lamp blinking pattern should be as follows.

Fail contents only in the operating mode are recorded in the AI controller.

(3) Entering the service mode

Of the 3 couplers that are connected with the AI controller, disconnect the 8-pin coupler.

↓

Turn the AI operation switch to the OFF position.

↓

Turn the key switch to the ON position or get the engine started. (Decide which way according to the diagnosis menu.)

↓

Reconnect the 8-pin coupler.

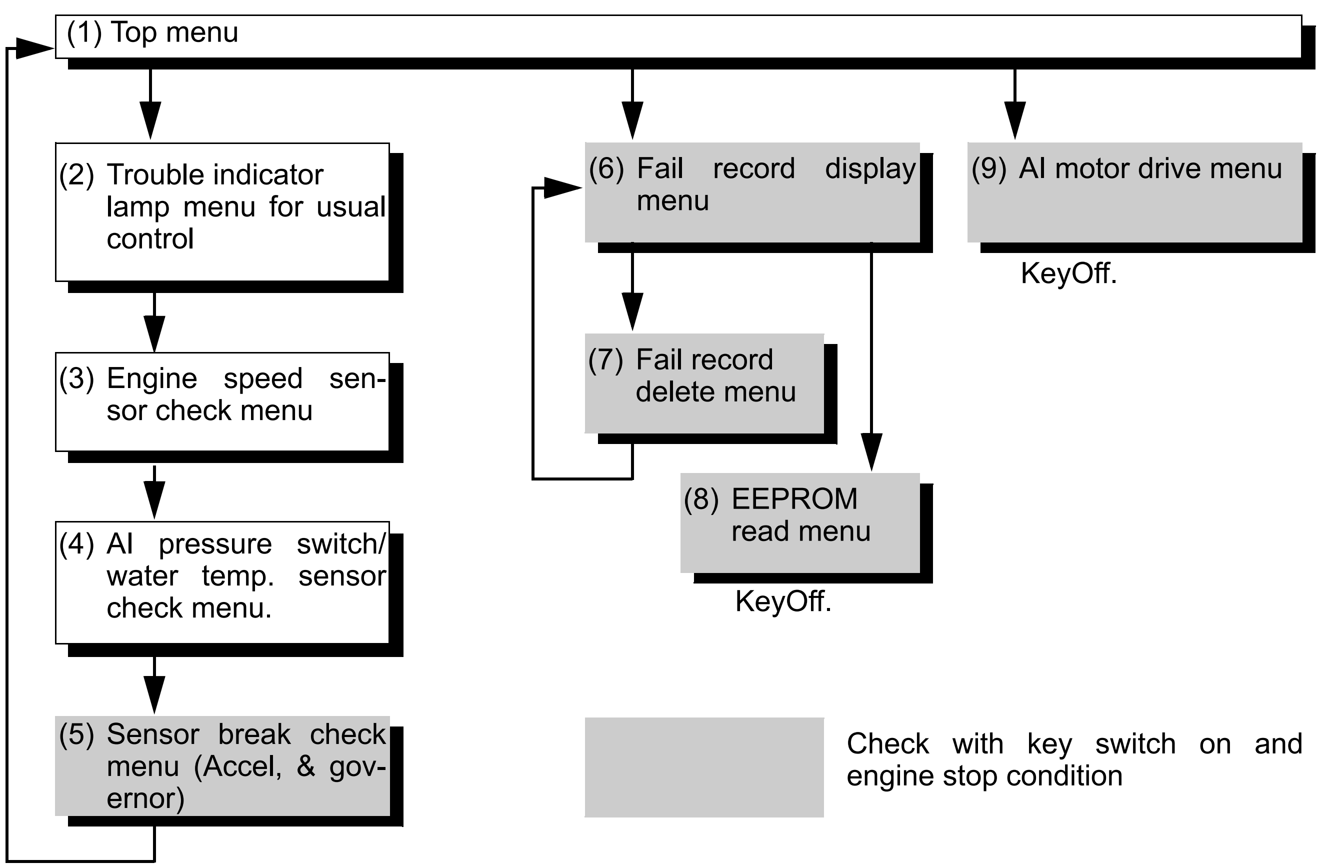
↓

(1) Top menu	The red and green lamps blink alternately.

Now the service mode is established. Make sure that the red and green lamps are blinking alternately and that the top menu of the service mode appears.

(Precautions in handling the key switch in the service mode)

1. For checking the points starting with the top menu (1), first get the engine started.
2. For checking on the menus that follow the sensor break check menu (5), you may also take the procedure with the key switch at the ON position. In such case, turn the AI operation switch on and off on the top menu (1) screen to skip the menus (2), (3) and (4) and go direct to the menu (5).



(4) Working on the 5 menus in the service mode

(1) Top menu | The red and green lamps blink alternately.

Turn the AI operation switch to ON first and then to OFF.

1) Take this action within 2 seconds, and the green lamp stays on and the menu (2) is called up.
2) Take this action within 3-40 seconds, and the red and green lamps start blinking slowly and the menu (6) is called up.
3) Take this action over 40 seconds, and the red and green lamps start blinking quickly and the menu (9) is called up.

(2) Trouble indicator lamp menu for usual control

Normally the red and green lamps stay off.
If any trouble exist, red lamp blinks according to Table 2.

Turn the AI operation switch to ON first and then to OFF.

1) Take this action within 2 seconds, and the green lamp stays on and the menu (3) is called up.

(3) Engine speed sensor check menu

The engine speed is indicated by the blinking rate of the red lamp. (Example: 2000 rpm → about 20 blinks for 10 seconds)
The green lamp stays off.
Note: In case of acceleration & governor sensor break, lamp stays off. In case AI motor line break, engine speed can't be checked

Turn the AI operation switch to ON first and then to OFF.

1) Take this action within 2 seconds, and the green lamp stays on and the menu (4) is called up.

(4) AI pressure switch/water temperature sensor check menu

- The red lamp stays off when the water temperature sensor functions, and on if it is defective.
- The green lamp is used to check the AI pressure switch line.
  The lamp lights up when the control lever is moved.
  The lamp goes out while the control lever stands at neutral.
  Make this test with the safety lock lever lowered.
  If the lamp behaves differently, there may be a trouble with the AI pressure switch line.

Turn the AI operation switch to ON first and then to OFF.

1) Take this action within 2 seconds, and the green lamp stays on and the menu (5) is called up.

(5) Sensor break check menu | ⚠ For safty, pull up the engine stop knob to stop engine.

The red lamp is used to check the governor sensor and harness.
It stays off when there is no problem, and on if there is a problem. It starts blinking when the problem is solved.
The green lamp is used to check the acceleration sensor and harness.
It stays off when there is no problem, and on if there is a problem. It starts blinking when the problem is solved.

Turn the AI operation switch to ON first and then to OFF.

1) Take this action within 2 seconds, and the green lamp stays on and the top menu (1) is called back.

(1) Top menu | The red and green lamps blink alternately.

(5) Working on the 3 menus in the service mode

Key switch is ON position.

(1) Top menu	The red and green lamps blink alternately.

Turn the AI operation switch to ON first and then to OFF.

1) Take this action within 2 seconds, and the green lamp stays on and the menu (2) is called up.
2) Take this action within 3-40 seconds, and the red and green lamps start blinking slowly and the menu (6) is called up.
3) Take this action over 40 seconds, and the red and green lamps start blinking quickly and the menu (9) is called up.

(6) Fail record display menu	Lamps blink as in the following sequence. Red, green, red & green and repeat.

Turn the AI operation switch to ON and OFF once. Then the fail record in Table 2 is read sequentially from the microcomputer memory. When there is no fail record, the green lamp lights up. Take this status as "0". If there is a fail record, the red lamp lights up.Take this status as "1". The items (1) thru (11) are checked one by one. The red or green lamp lights up according to the presence or absence of a failure.
The service engineer is supposed to enter "1" for a trouble item and pinpoint and diagnose the trouble spot.

(Entry example)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1	0	0	0	0	0	1	0	0	0	0

For your trial

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)

Let's suppose the entries are as shown here according to the lamp light-up. The first [1] and seventh [7] imply water sensor line break and AI motor restrict malfunction, respectively.

Turn the AI operation switch to ON first and then to OFF.

1) Take this action within 10 seconds, and the green lamp stays on and the fail record is indicated from the beginning.
2) Take this action slowly within 11-29 seconds, and the fail record delete menu (7) is called up.
3) Take this action slowly over 30 seconds, and the EEPROM read menu (8) is called up.

(7) Fail record delete menu	Lamps blink as in the following sequence. Red, green, red, red & green and repeat.

Turn the AI operation switch to ON first and then to OFF, and the fail record is deleted and the menu (6) is called back.
With all deleted, the AI operation lamp (green) alone starts blinking for 11 times.
This means all fail record as deleted and menu (6) is already being indicated.

(8) EEPROM read menu	Lamps blink as in the following sequence. Red, green, red, green, red & green and repeat.

Turn the AI operation switch to ON first and then to OFF, and the lamps start lighting up.
When the green lamp lights up, write down "0"; when the red lamp does, jot down "1". Lamp lights up 16 times continuously and goes off. By turning the AI operatin switch to ON and "OFF" next 16 data come up. Each time the AI operation switch is turned on and off, the read addresses change incrementally and the lamps behave accordingly.
(Entry example)

Address No.	Data contents			
0	1000	0000	1100	0000
1	0000	1000	0000	0000
2	1001	0001	0000	0000
·	·	·	·	·
63	0000	0000	1000	0000

Binary data in the left indicates machine conditions and can only be deciphered in KBM or KBT.You are required to send these data for diagnosis in detail.

Key OFF

(6) Working on the AI motor drive menus in the service mode

Key switch is ON position

(1) Top menu | The red and green lamps blink alternately.

Turn the AI operation switch to ON first and then to OFF.

1) Take this action within 2 seconds, and the green lamp stays on and the menu (2) is called up.
2) Take this action within 3-40 seconds, and the red and green lamps start blinking slowly and the menu (6) is called up.
3) Take this action over 40 seconds, and the red and green lamps start blinking quickly and the menu (9) is called up.

(9) AI motor drive menu | [illegible]

The AI operation switch is used to run the AI motor directly. Keep in mind that the AI motor must run no longer than 3 seconds.

1) Turn on the AI operation switch an odd-numbered time, and the AI motor runs in the normal direction. The green lamp lights up and the red lamp goes out.
2) Turn on the AI operation switch an even-numbered time, and the AI motor runs in the reverse direction. The green lamp goes out and the red lamp lights up.
3) AI motor runs while AI operation switch is,on.
   Every time AI operation switch turn ON-OFF, AI motor's rotating direction changes.
4) Turn off the AI operation switch, and the AI motor stops. Both the green and lamps go out.
5) Finally Key OFF.

Note: The AI motor runs very fast. To stop it at a desired position, turn the AI operation switch

(7) Entering the setup mode

When the AI control components such as sensor and motor have been readjusted and reinstalled, it is necessary to make the control data settings of the AI controller again. Take the procedure below.

Of the 3 couplers connected with the AI controller, disconnect the 8-pin coupler.

(The AI operation switch may be set either at ON or OFF.)

Start the engine.

In case any fail exists:

The green lamp stays on, whereas the red lamp is blinking.

(Blinking of red lamp indicates there are errers in the system.)

Stop the engine, reconnect the 8-pin coupler, and repair a trouble spot corresponding to the number of blinks.Refer to Table 3.

(Now the setup mode is on.)

The red and green lamps light up.

Turn the electronic accelerator all the way to MAX and MIN several times.

(Now the acceleration sensor and governor sensor data as well as maximum and minim engine speeds are programmed in the microcomputer.)
If the electronic accelerator weren't turned to MAX. and Min., acceleration sensor data isn't programmed in the microcomputer correctly. Therefore, speed control would be abnormal.

The red and green lamps go off.

Stop the engine.

Reconnect the 8-pin coupler.

The AI control settings are complete.

Table 2 Fail Record Indication

First Last

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)

0:Normal

1:Abnormal

(1)	Water temperature sensor line break
(2)	Acceleration sensor line break
(3)	Governor sensor line break
(4)	AI motor drive line break
(5)	Self holding relay malfunction
(6)	AI motor drive line short-circuit
(7)	AI motor restricted, malfunction
(8)	Engine rotating sensor line break
(9)	Starter motor auto release
(10)	Battery voltage abnormal
(11)	Controller data abnormal

Table 3 Fail system & lamp indication

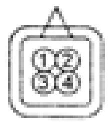
Fail No.	Fail system	Operation mode		Setup mode		Service mode	
		Diagnosis	Lamp ON-OFF number	Diagnosis	Lamp ON-OFF number	Diagnosis	Lamp ON-OFF number
(1)	Water temperature sensor line break	○	-	○	-	○	1
(2)	Acceleration sensor line break	○	2	○	2	○	2
(3)	Governor sensor line break	○	3	○	3	○	3
(4)	AI motor drive line break	○	4	○	4	○	4
(5)	Self holding relay malfunction	○	5	○	5	○	5
(6)	AI motor drive line short-circuit	○	6	○	6	○	6
(7)	AI motor restricted, malfunction	○	-	○	7	○	7
(8)	Engine rotating sensor line break	-	-	○	8	○	-
(9)	Starter motor auto release	○	-	○	-	○	9
(10)	Battery voltage abnormal	○	10	○	10	○	10
(11)	Controller system malfunction	○	11	-	11	○	11

Table 4 EEPROM Data Dump Address

Add.	Contents	Remarks	Add.	Contents	Remarks
0	Machine model code	A/D conversion 8bit	32	Fail number	AI motor drive line break
1	Accel. sensor Max. value	A/D conversion 8bit	33	Fail sequence	AI motor drive line short,CW,ST
2	Accel. sensor Min. value	A/D conversion 8bit x4	34	Fail number	AI motor drive line short,CW,ST
3	Governor sensor Max. value	A/D conversion 8bit x4	35	Fail sequence	AI motor drive line short,CW,OP
4	Governor sensor Min. value	A/D conversion 8bit x2	36	Fail number	AI motor drive line short,CW,OP
5	AN5 value at 0A to motor	A/D conversion 8bit x2	37	Fail sequence	AI motor drive line short,CCW,ST
6	AN5 value at 5A to motor	A/D conversion 8bit x2	38	Fail number	AI motor drive line short,CCW,ST
7	AN4 value at 0A to motor	A/D conversion 8bit x2	39	Fail sequence	AI motor drive line short,CCW,OP
8	AN4 value at 8A to motor	A/D conversion 8bit x2	40	Fail number	AI motor drive line short,CCW,OP
9	Actual current value at 8A to motor	mA	41	Fail sequence	AI motor restricted
10			42	Fail number	AI motor restricted
11			43	Fail sequence	Hunting
12			44	Fail number	Hunting
13			45	Fail sequence	Accel. Sensor line break
14			46	Fail number	Accel. Sensor line break
15			47	Fail sequence	Governor sensor line break
16			48	Fail number	Governor sensor line break
17			49	Fail sequence	Abnormal battery voltage
18			50	Fail number	Abnormal battery voltage
19	Check sum value of AI setup		51	Fail sequence	Engine speed sensor line break
20	Check sum value of current adjustment		52	Fail number	Engine speed sensor line break
21			53	Fail sequence	Water temp.sensor line break
22			54	Fail number	Water temp.sensor line break
23			55	Fail sequence	Current adjusting data abnormal
24			56	Fail number	Current adjusting data abnormal
25			57	Fail sequence	AI setup data abnormal
26			58	Fail number	AI setup data abnormal
27			59	Fail sequence	Auto release applied
28			60	Fail number	Auto release applied
29	Serial no.	Upper 16 bit	61	Fail sequence	Self-holding relay line fail
30	Serial no.	Lower 16 bit	62	Fail number	Self-holding relay line fail
31	Fail sequence	AI motor drive line break	63		

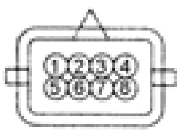
Table 5 AI controller coupler numbers

Connector A;4P



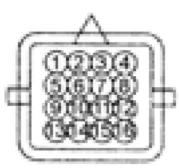
No.	Type & color	Signal
1	AVSS2, RW	Motor power
2	AVSS2, WR	Motor CCW
3	AVSS2, WB	Motor CW
4	AVSS2, BW	Motor GND

Connector B;8P



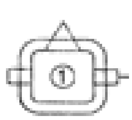
No.	Type & color	Signal
1	AVSS0.5, Y	AI pressure SW1
2	AVSS0.5, YB	AI release SW
3	AVSS0.5, YR	SW1
4	AVSS0.5, YG	SW2(setup)
5	AVSS0.5, Lg	SW3
6	AVSS0.5, LgR	
7	AVSS0.5, LgB	Line checker,Txd
8	AVSS0.5, LgY	Line checker,Rxd

Connector C; 16P



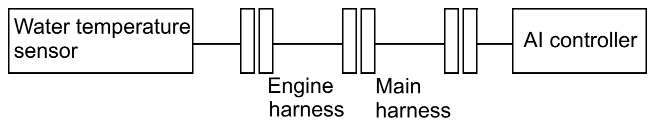
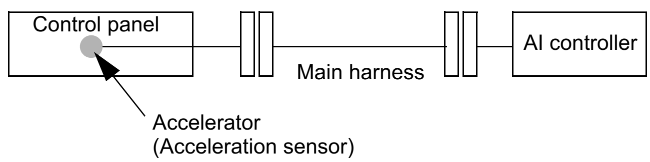
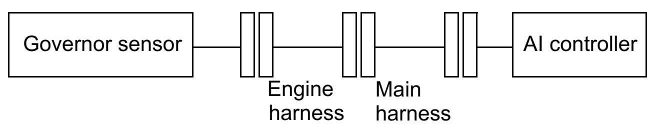
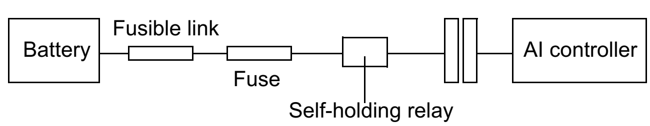
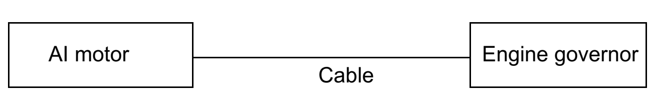
No.	Type & color	Signal
1	AVSS0.5, R	Battery, main
2	AVSS0.5, RB	Battery, sub
3	AVSS0.5, RG	+12V
4	AVSS0.5, RL	Sensor power(+5V)
5	AVSS0.5, L	Engine speed sensor
6	AVSS0.5, LR	Motor governor
7	AVSS0.5, LB	Accel. VR
8	AVSS0.5, LgY	water temp. sensor
9	AVSS0.5, LW	Starter motor SW input
10	AVSS0.5, G	Auto release relay coil
11	AVSS0.5, GR	Glow relay coil
12	AVSS0.5, GW	Self-hold relay
13	AVSS0.5, V	System lamp
14	AVSS0.5, P	AI lamp
15	AVSS0.5, BR	Sensor GND
16	AVSS0.5, BR	main GND

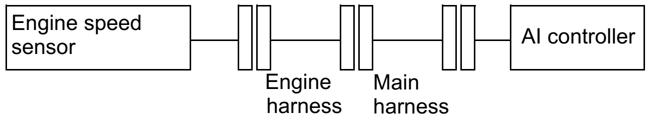
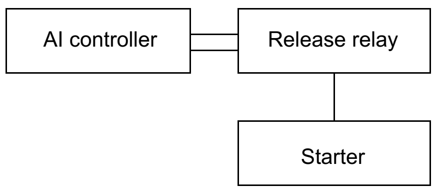
Connector A;4P



No.	Type & color	Signal
1	AVSS0.5, WL	Test

(8) Lamp-identified fail symptoms, trouble spots and possible causes

Fail No.	Fail symptom	Trouble spot	Possible causes
(1)	Water temperature sensor line break		• Water temperature sensor defective • Harness broken • Coupler in poor contact or disconnected • AI controller defective
(2)	Acceleration sensor line break		• Electronic accelerator defective • Harness broken • Coupler in poor contact or disconnected • AI controller defective
(3)	Governor sensor line break		• Governor sensor defective • Harness broken • Coupler in poor contact or disconnected • AI controller defective
(4)	AI motor drive line break		• AI motor defective • Harness broken • Coupler in poor contact or disconnected • AI controller defective
(5)	Self-holding relay circuit malfunction		• Self-holding relay defective • Fuse blown out • Harness broken • Coupler in poor contact or disconnected • AI controller defective
(6)	AI motor drive line short-circuit		• Harness short-circuited • AI controller defective
(7)	AI motor restrict malfunction		• Foreign matter stuck in motor arm or governor • Cable sliding resistance too high • Cable disconnected or broken • Cable in poor fitting or maladjusted • Governor sensor in poor fitting or loose • This indication also occurs if the AI controller settings have not been made after replacing the acceleration sensor or governor sensor.

Fail No.	Fail symptom	Trouble spot	Possible causes
(8)	Engine speed sensor line break		• Acceleration cable in poor fitting • Engine speed sensor defective • Harness broken • Coupler in poor contact or disconnected • AI controller defective • This indication also occurs if you try the trouble diagnosis without starting the engine. Be sure to start the engine for checking this item.
(9)	Starter motor auto release		• Key switch stuck toward ON position
(10)	Battery voltage abnormal		• Indicated if the voltage rises above 18 V
(11)	Controller system malfunction		• AI controller defective • This indication also occurs when the AI controller, governor sensor or acceleration sensor has been replaced, but the AI controller settings have not been made yet.

Failure Nos. 4 and 7 are indicated only when there is no problem with failure Nos. 2, 3, 5, 10 and 11.
Failure No. 6 is also indicated only when there is no problem with failure Nos. 5, 10 and 11.
Because if (2), (3) and (5) were failed, AI controller can’t send any signal to AI motor.
Therefore, AI drive line fail can’t be detected.

KUBOTA Corporation
CONSTRUCTION MACHINERY DIVISION
2-47, SHIKITSUHIGASHI 1-CHOME, NANIWA-KU, OSAKA, JAPAN
EDITOR:
CONSTRUCTION MACHINERY MANUFACTURING DEPT.
SERVICE SECTION
HIRAKATA PLANT
1-1-1 NAKAMIYA-OHIKE, HIRAKATA-CITY, OSAKA, JAPAN
PHONE :+81-72-840-1195
FAX :+81-72-840-1195

KUBOTA Corporation Printed in Japan 0111.CMC.e.10 Code No.97899-60520