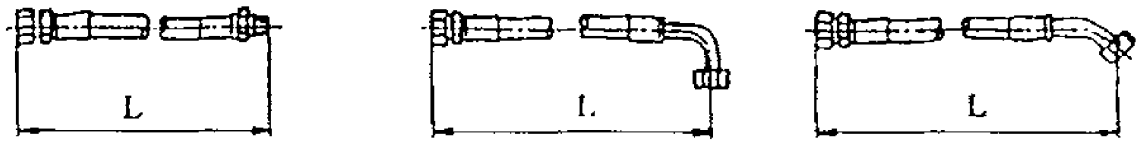
YANMAR
SERVICE MANUAL

EXCAVATOR

MODEL ViO70 (US)

1. GENERAL CAUTIONS FOR MAINTENANCE WORK

2) Total length of hose (Unit : in. (cm))



3 digit indication in cm. ***(Example)*** Nominal length 065: Full length 25.6 in. (65 cm)

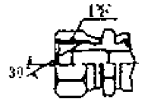
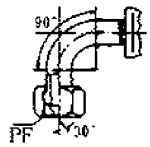
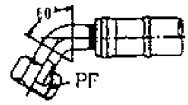
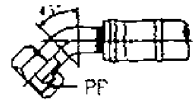
3) Hose dia. (Unit : in.)

02.....1/4"	05.....5/8"	12.....1 1/4"
03.....3/8"	06.....3/4"	14.....1 1/2"
04.....1/2"	10..... 1"	

Note: *Please note that these code numbers are different from those for the equivalent diameters for special parts on the next page.*

4) Combination of fitting

Code No.	Fitting type
1	A • B
3	A • E
4	B • B
5	B • C
6	B • E
7	B • D

A		Taper pipe thread (PT)
B		Straight pipe thread (PF) with male 30 degrees seat
C		90 degrees bent type. Straight pipe thread (PF) with male 30 degrees seat
D		60 degrees bent type. Straight pipe thread (PF) with male 30 degrees seat
E		45 degrees bent type. Straight pipe thread (PF) with male 30 degrees seat

(Example) Part code 2 3 2 0 2 – 0 3 0 8 5 5

- Rubber hose, high pressure type
- SAE J517,100R2
- Nominal dia.,3/8"
- Hose length, 33.5 in. (85 cm)
- Straight pipe thread (PF) withmale 30 degrees seat and 90 degrees bent type. Straight pipe thread (PF) with male 30 degrees seat

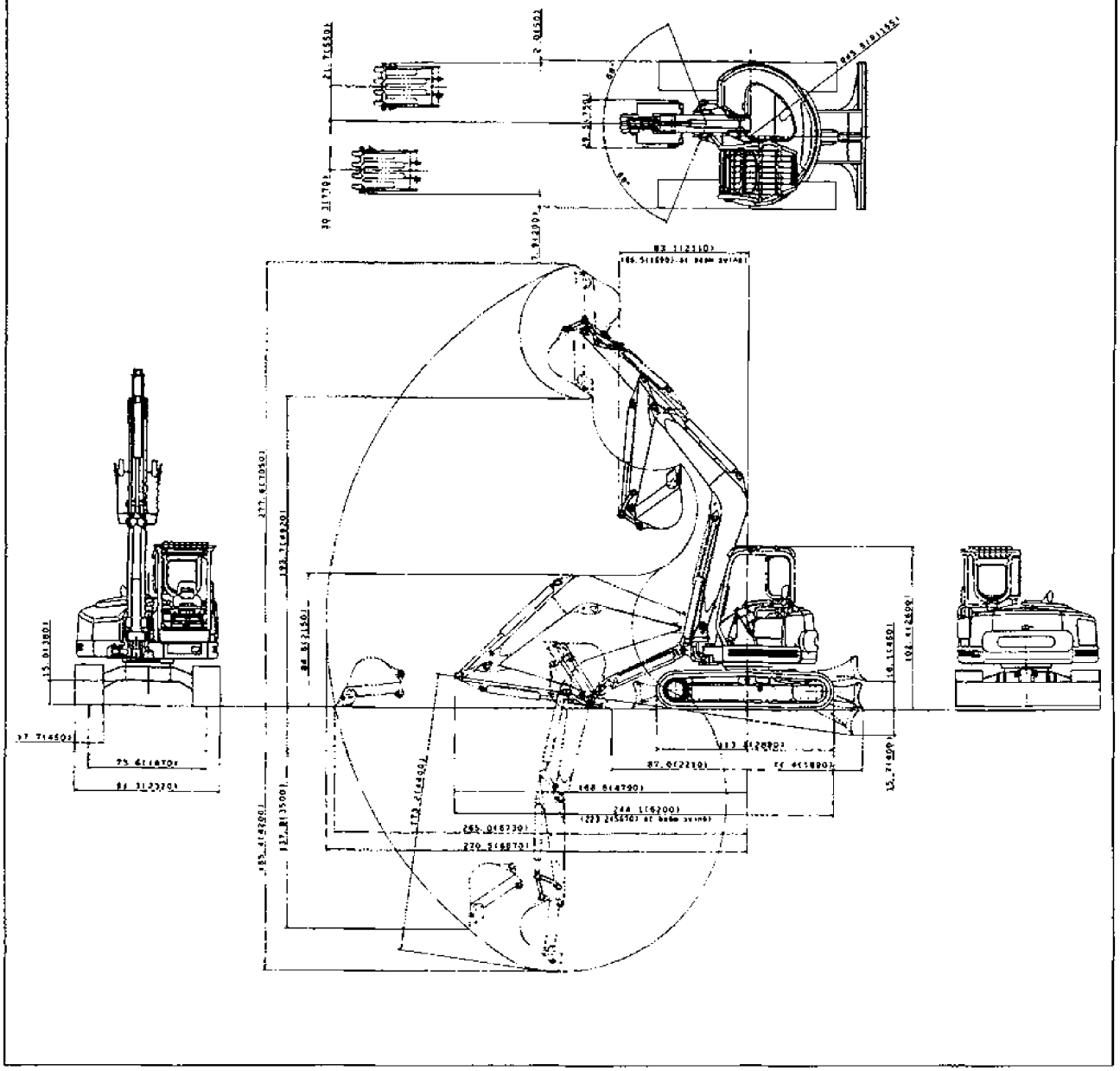
Note: *All the hoses attached with fittings other than those listed above are special parts.*

2-2 External Drawings and Working Ranges

2-2-1 Canopy Type Specifications

Unit : in. (mm)

Excavator with canopy



3. SERVICING STANDARDS

Applicable model			4TNE98-EBV	
Item		Unit	Standard	Wear limit
Oil ring	Ring groove width	in. (mm)	0.1187 to 0.1193 (3.015 to 3.030)	0.1232 (3.130)
	Ring width (B)		0.1169 to 0.1177 (2.970 to 2.990)	0.1161 (2.950)
	Clearance between groove and ring		0.0010 to 0.0024 (0.025 to 0.060)	0.0071 (0.180)
	End gap		0.008 to 0.016 (0.250 to 0.450)	0.0217 (0.550)
Connecting rod				
Crank pin side	Bushing hole inside dia.	in. (mm)	2.4016 to 2.4020 (61.000 to 61.010)	—
	Bushing thickness		0.0587 to 0.0591 (1.492 to 1.500)	—
	Outside dia.		2.2816 to 2.2820 (57.952 to 57.962)	2.2796 (57.902)
	Oil clearance		0.0015 to 0.0029 (0.038 to 0.074)	0.0059 (0.150)
Piston pin side	Bushing hole inside dia.		1.1821 to 1.1826 (30.025 to 30.038)	1.1838 (30.068)
	Outside dia.		1.1805 to 1.1811 (29.986 to 30.000)	1.1795 (29.959)
	Oil clearance		0.0010 to 0.0020 (0.025 to 0.051)	0.0043 (0.109)
Distortion			≦0.0012/4 (0.03/100)	0.003 (0.08)
Cam				
Gear side	Cam shaft dia.	in. (mm)	1.9655 to 1.9665 (49.925 to 49.950)	1.9642 (49.890)
	Oil clearance		0.0016 to 0.0051 (0.040 to 0.130)	0.0094 (0.240)
Intermediate	Cam shaft dia.		1.9650 to 1.9660 (49.910 to 49.935)	1.9636 (49.875)
	Oil clearance		0.0026 to 0.0045 (0.065 to 0.115)	0.0089 (0.225)
Fly wheel side	Cam shaft dia.		1.9655 to 1.9665 (49.925 to 49.950)	1.9642 (49.890)
	Oil clearance		0.0020 to 0.0039 (0.050 to 0.100)	0.0083 (0.210)
Crank shaft				
Journal	Outside dia.	in. (mm)	2.5572 to 2.5576 (64.952 to 64.962)	2.5552 (64.902)
	Bushing thickness		0.0785 to 0.0791 (1.995 to 2.010)	—
	Oil clearance		0.0015 to 0.0027 (0.038 to 0.068)	0.0059 (0.150)
Bend			≦0.0079 (0.02)	—
Side gap	Crank shaft	in. (mm)	0.0043 to 0.0083 (0.110 to 0.210)	—
	Cam shaft		0.0020 to 0.0079 (0.05 to 0.20)	0.0118 (0.30)
	Connected rod		0.0078 to 0.0157 (0.2 to 0.4)	—
	Idle gear		0.004 to 0.012 (0.1 to 0.3)	—

3. SERVICING STANDARDS

Applicable model			ViO70 (US		
Equipment			Thread size	Tightening torque (ft·lbf. (N·m))	Screw locking agent
	No.	Tightening part			
Hydraulic equipment					
	1	Coupling	W/Hexagon hole M14	108.4 to 122.9 (147 to 166.6)	Three Bond 1324
	2	Swivel joint × track frame	M12	57.8 to 72.3 (78.4 to 98)	Three Bond 1324
	3	Swing motor × upper frame	M16	122.9 to 151.8 (166.6 to 205.8)	Three Bond 1324
	4	Travel motor × track frame	M16	122.9 to 151.8 (166.6 to 205.8)	Three Bond 1324
	5	Hydraulic oil tank × turning frame	M16	122.9 to 151.8 (166.6 to 205.8)	Three Bond 1324
	6	Drain plug 24 × Hydraulic oil tank	M24	115.7 to 137.3 (156.8 to 186.2)	Three Bond 1104
	7	Oil gauge × Hydraulic oil tank	M10	12.3 to 13.7 (16.7 to 18.6)	Loctite 572
	8	Plug (port P , pilot valve)	M16	21.7 to 25.3 (29.4 to 34.3)	
	9	Eyebolt (port T , pilot valve)	M12	14.5 to 18.1 (19.6 to 24.5)	
	10	Hose clamp A & B (at boom rear)	M10	32.5 to 43.4 (44.1 to 58.8)	Three Bond 1324
	11	Tube clamp 1/2 (for boom hose)	M12	57.8 to 72.3 (78.4 to 98)	Three Bond 1324
	12	Breather cap (hydraulic oil tank)	M5	2.17 to 2.89 (2.94 to 3.92)	
Rigging					
	1	ROPS canopy	M14	86.7 to 108.4 (117.6 to 147)	
	2	ROPS canopy	M10	32.5 to 43.4 (44.1 to 58.8)	
Work implement					
	1	Pin lock plate	M12	57.8 to 72.3 (78.4 to 98)	Three Bond 1324
	2	Pin lock plate	M14	86.7 to 108.4 (117.6 to 147)	Three Bond 1324

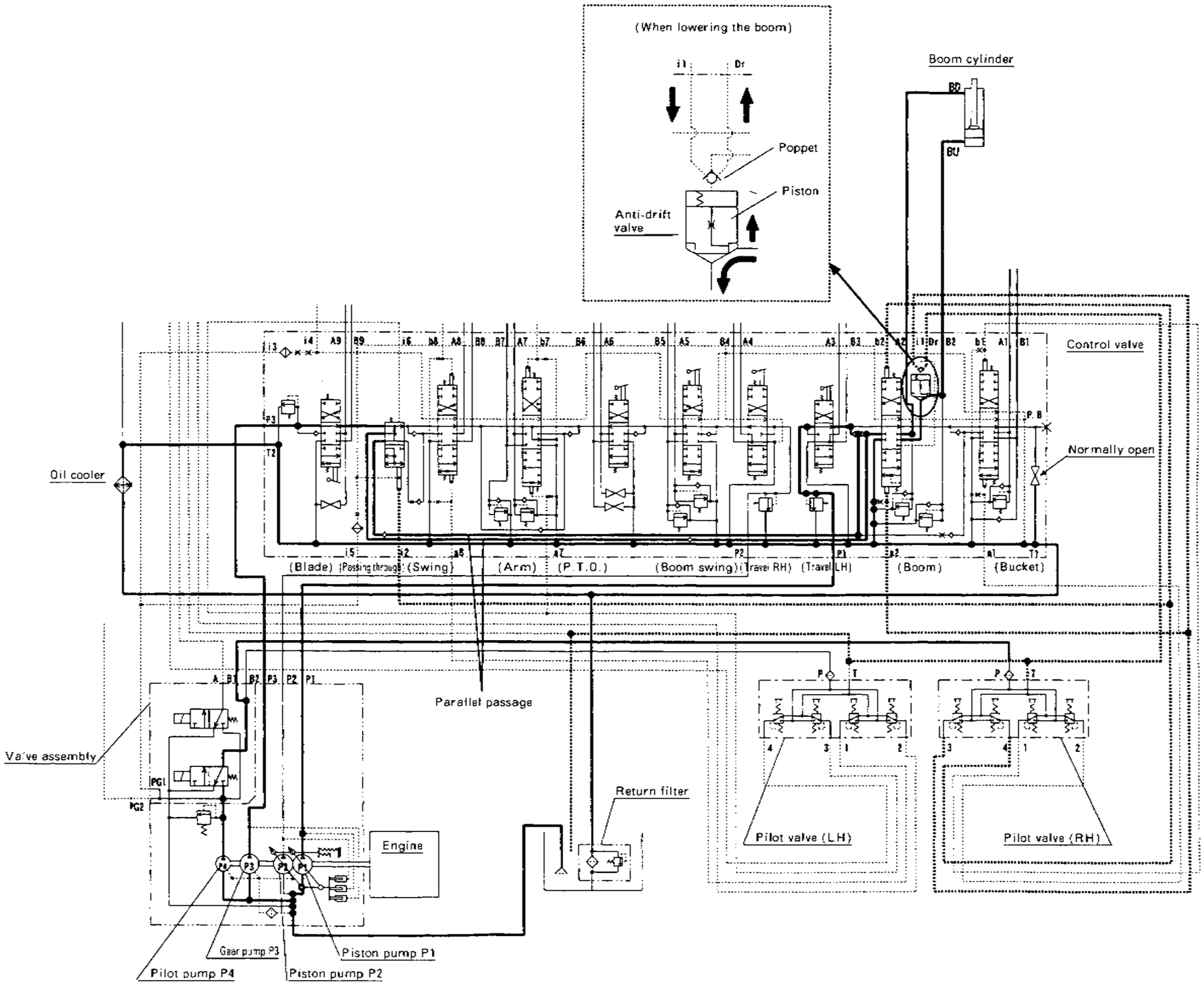
4-3 Operating Circuit

4-3-1 Boom

The anti-drift valve is installed in the bottom end circuit of the boom cylinder to reduce oil internal leakage from BU of the cylinder.

When the boom control lever is pulled rearward to raise the boom, the oil from the pilot oil pump P4 flows through the cut-off valve and the port 4 of the pilot valve (RH) to the ports b2 and i2 of the control valve to move the boom spool.
The oil discharged from the piston pump P1 flows to the port P1 of the control valve, and the oil from the gear pump P3, passing through the port P3 of the control valve, parallel-flow divider, and parallel passage, flows into the boom section to combine with the oil from the piston pump P1. The combined oil open the anti-drift valve and flows through the port B2 of the control valve to BU of the boom cylinder to extend its cylinder rod.
The return oil from BD of the boom cylinder flows to the hydraulic oil tank through the ports A2, T1 and T2 of the control valve and the return filter.

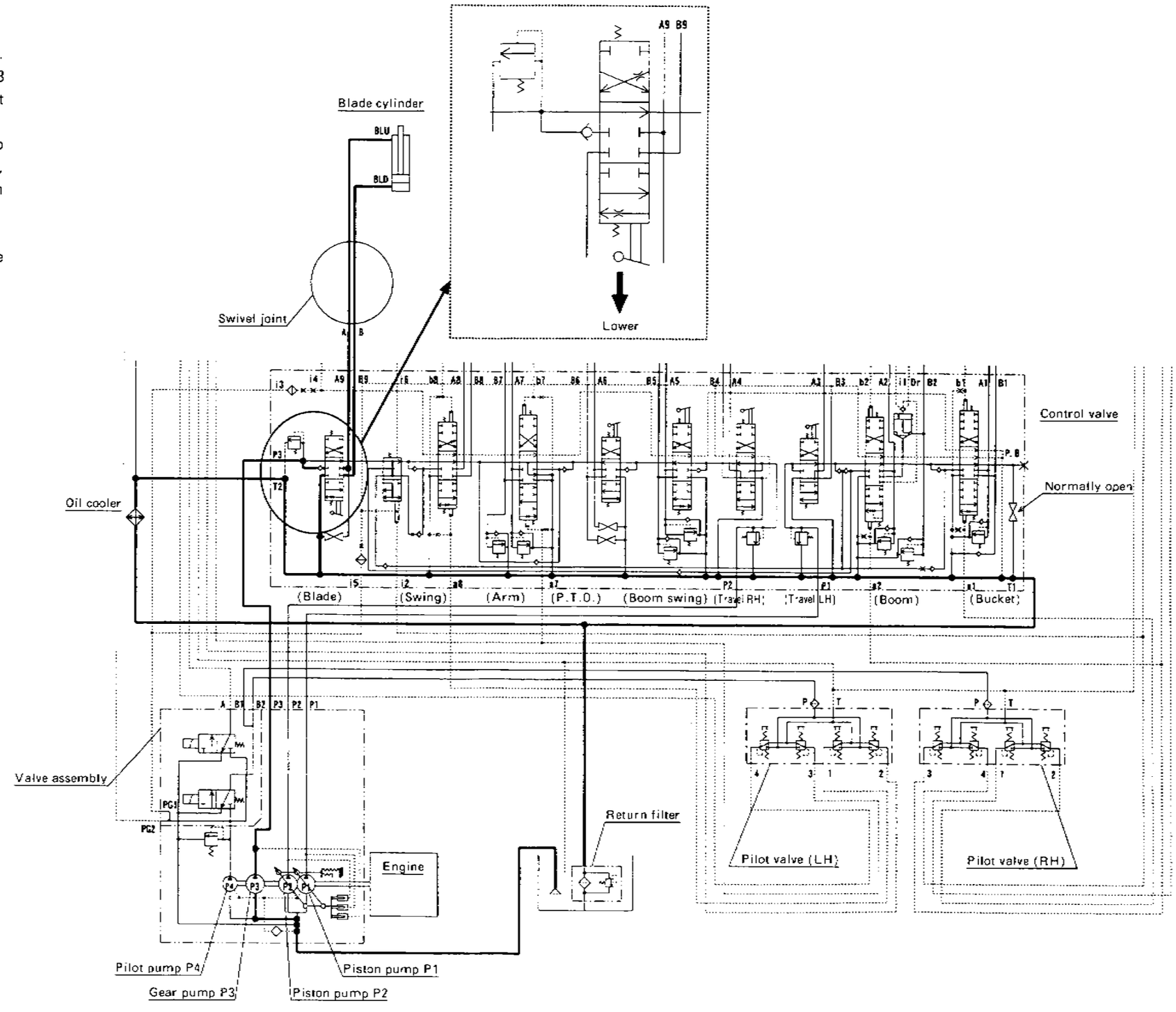
When the boom control lever is pushed forward to lower the boom, the oil from the pilot oil pump P4 flows to the port a2 of the control valve through the cut-off valve and the port 3 of the pilot valve (RH) to move the boom spool. Also, the pilot oil flows to the port i1 of the control valve to open the anti-drift valve because its poppet is opened to flow out the oil in the anti-drift valve to the port Dr.
The oil from the piston pump P1 flows through the ports P1 and A2 of the control valve to BD of the boom cylinder to retract its cylinder rod. The return oil from BU of the boom cylinder flows back to the hydraulic oil tank through the port B2 of the control valve, the anti-drift valve and the ports T1 and T2 of the control valve.



4-3-6 Blade

To lower the blade, the blade control lever is pushed forward. The oil from the gear pump P3 flows through the ports P3 and B9 of the control valve and the port B of the swivel joint to BLD of the blade cylinder to extend its cylinder rod.
The return oil from BLU of the blade cylinder flows back to the hydraulic oil tank through the port A of the swivel joint, the ports A9, T1 and T2 of the control valve and the return filter.

Oil flows in the opposite direction to raise the blade when the blade control lever is pulled back.



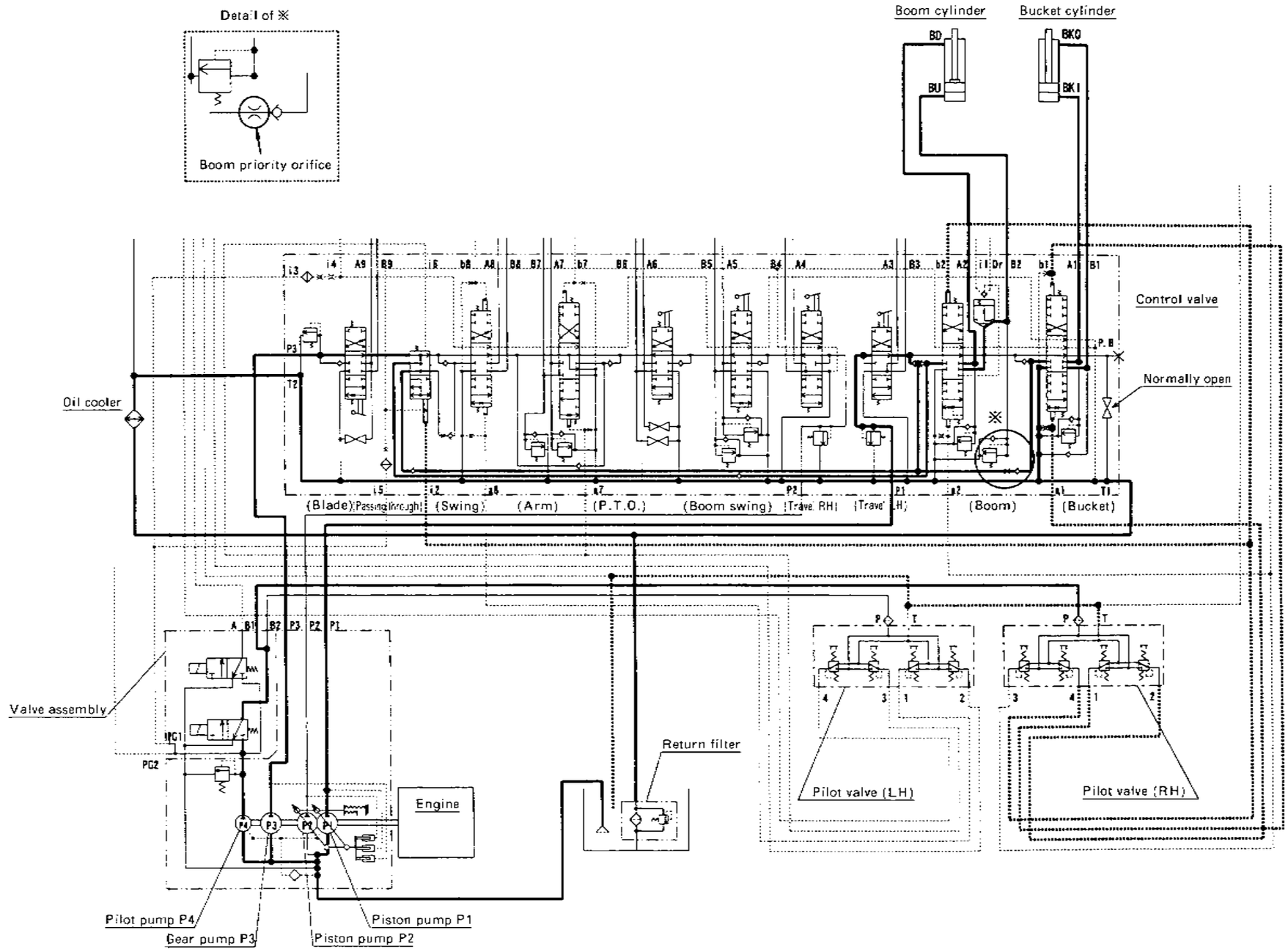
4-3-11 Simultaneous Operation of Boom-Up and Bucket

When the boom control lever is pulled back to raise the boom, oil from the pilot oil pump P4 flows through the cut-off valve and the port 4 of the pilot valve (RH) to the ports b2 and i2 of the control valve to move the boom valve spool.
Each oil from the piston pump P1 and the gear pump P3 flows to each port P1 and P3 of the control valve, combines in the boom valve and flows through the port B2 of the control valve to BU of the boom cylinder to extend its rod.
The return oil from BD of the boom cylinder flows through the ports A2, T1 and T2 of the control valve, and the return filter back to the hydraulic oil tank.

If operator moves the bucket control lever to the left to curl the bucket while the boom is rising, oil from the pilot oil pump P4 flows through the cut-off valve and the port 2 of the pilot valve (RH) to the port a1 of the control valve to move the bucket valve spool.
Each oil from the piston pump P1 and the gear pump P3 flows to each port P1 and P3 of the control valve, combines in the boom valve and flows through the port A1 of the control valve to BKI of the bucket cylinder to extend its rod.
The return oil from oil from BKO of the bucket cylinder flows through the ports B1, T1 and T2 of the control valve, and the return filter back to the hydraulic oil tank.

When the bucket control lever is moved to the right to dump the bucket, each oil flows in the opposite direction.

A check valve with an orifice (Boom priority orifice) is installed in the parallel passage before the bucket valve so as for oil to easily flow to the boom valve when boom receives heavier load at the simultaneous operation of boom-up and bucket.



1) If pressure is out of specification when control is moved to a direction:
   Something seems to be wrong with pilot valve or pilot chamber of control valve.
   Replace pilot hose with that of normal circuit and confirm the wrong part.

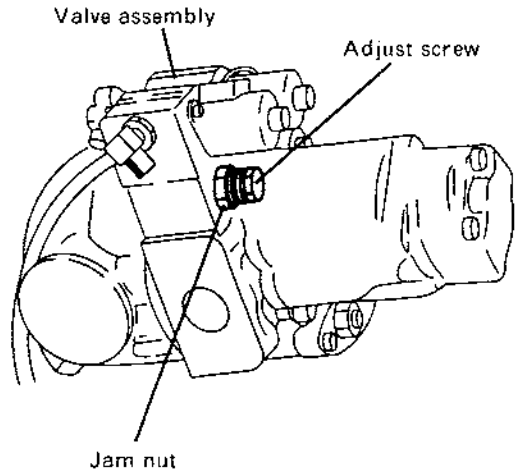
2) If pressure is out of specification over when control is moved to every direction.
   Something seems to be wrong with cut-off valve or gear pump P4.
   Decide which is failed by measurement of oil flow rate discharged from gear pump P4.

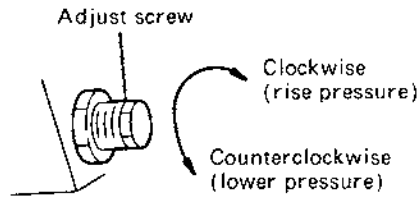
5. Adjustment

1) Loosen jam nut.

2) Turn adjust screw to obtain specified pressure

3) After adjustment, retighten jam nut.

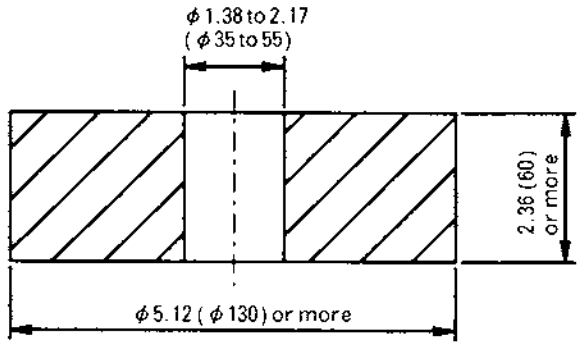




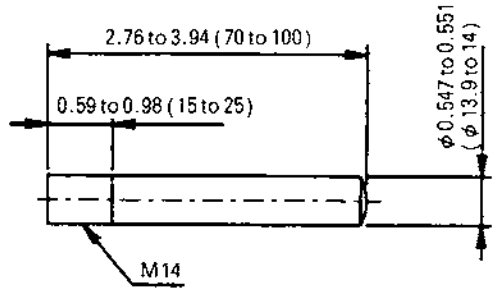
4. Special tools

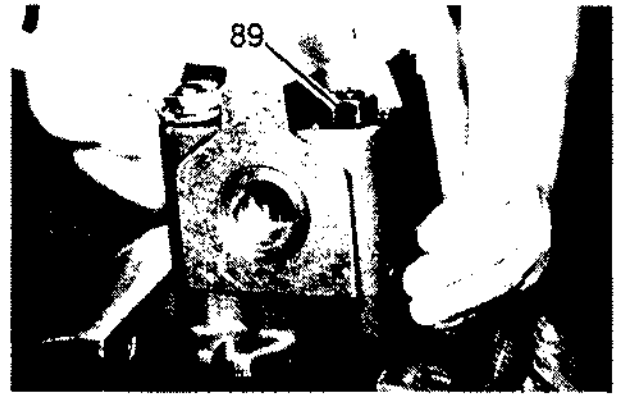
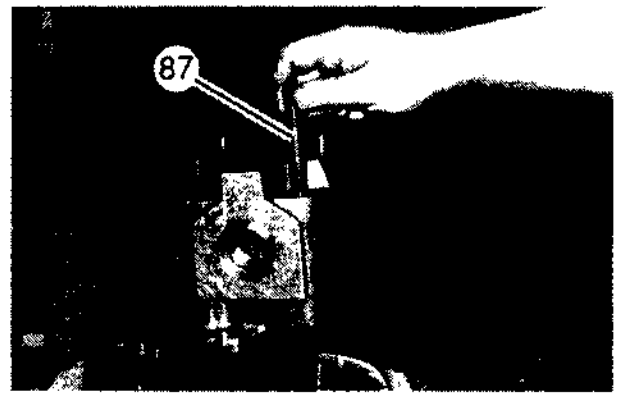
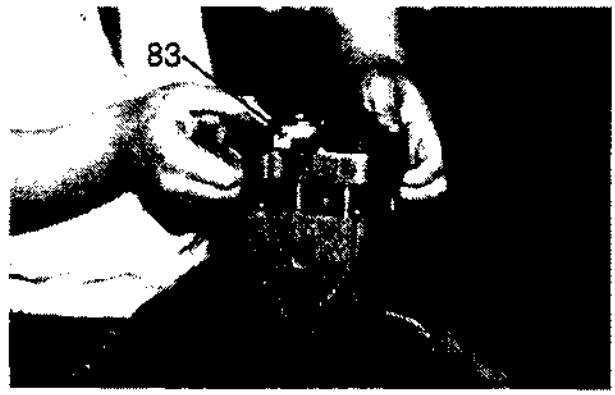
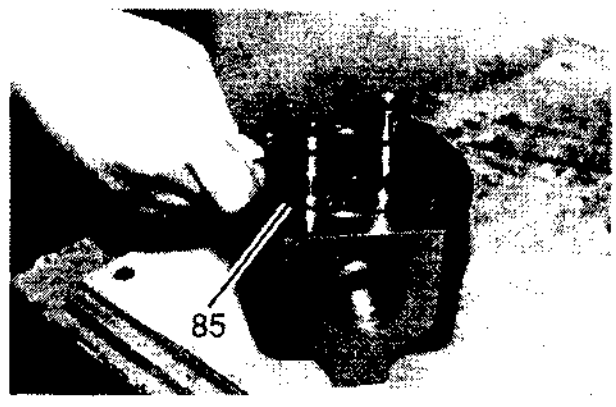
(Unit : in. (mm))

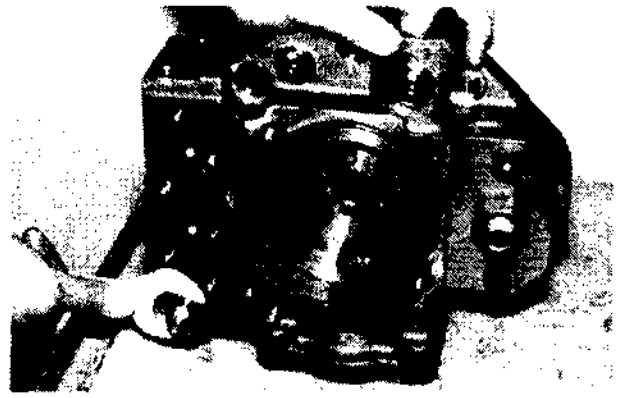
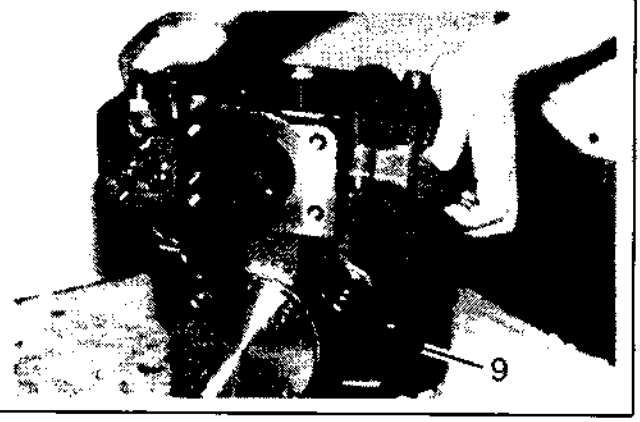
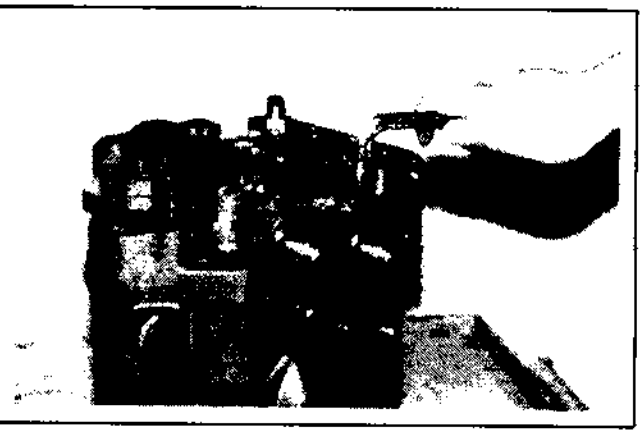
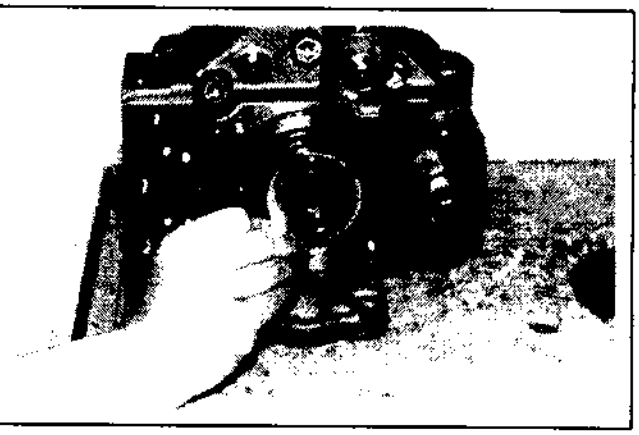
Pump stand
● Wooden block can be substituted.



Screw for cover disassembly/reassembly
● Stud (M14) can be substituted.



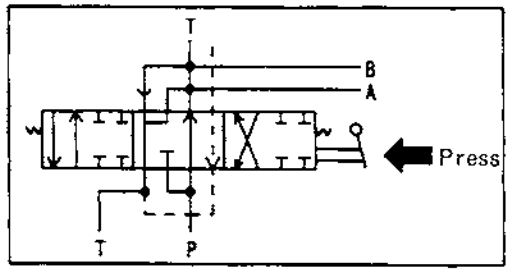
Procedure	
2. Gear pump (1) Remove each four nuts 89 and plain washers 88.	
(2) Remove four studs 87.	
(3) Remove front frame 83.	
(4) Remove O-ring 85.	

Procedure	
(29) Tighten nut 93 to 7.2 ft•lbf. (9.8 N•m).	
(30) Install packing 19 on cover 28 and install it onto housing 9 with using two special tool screws. ***Note:*** *Take care not fall dowel pins and pistons.*	
(31) Tighten each two Allen-head screws 32 and 33, and one screw 37 to 108.4 to 130.1 ft•lbf. (147.0 to 176.4 N•m).	
(32) Install side plate B73 on cover.	

2) Valve ass'y and pilot oil relief valve

Trouble	Check	Result	Cause	Remedy
1. Malfunction of valve (Oil does not flow properly.) (Pressure is not stable.)	(1) Check the relief valve.	● Set pressure is low.	● Pressure is not set correctly.	● Set to the specified value.
		● Spool does not work properly.	● Sticked spool	● Disassemble and wash the spool, and replace hydraulic oil.
			● Damaged or worn spool	● Replace the valve.
	(2) Check the solenoid-operated directional control valve.	● Voltage does not flow through solenoid.	● Damaged solenoid	● Replace the solenoid.
			● Loose connector	● Connect the connector.
		● Spool does not work properly.	● Sticked spool	● Disassemble and wash the spool, and replace hydraulic oil.
			● Damaged or worn spool	● Replace the valve.
2. Leakage	(1) Check the torque of the bolt.	● Bolt is loosened.	● Improper installation	● Retighten the bolt to the specified torque.
	(2) Check the O-ring and packing.	● O-ring or packing is faulty.	● Damaged O-ring or packing	● Replace the O-ring and packing.
	(3) Check the clamp face of the O-ring and packing.	● Clamp face is faulty.	● Damaged clamp face	● Replace the valve.

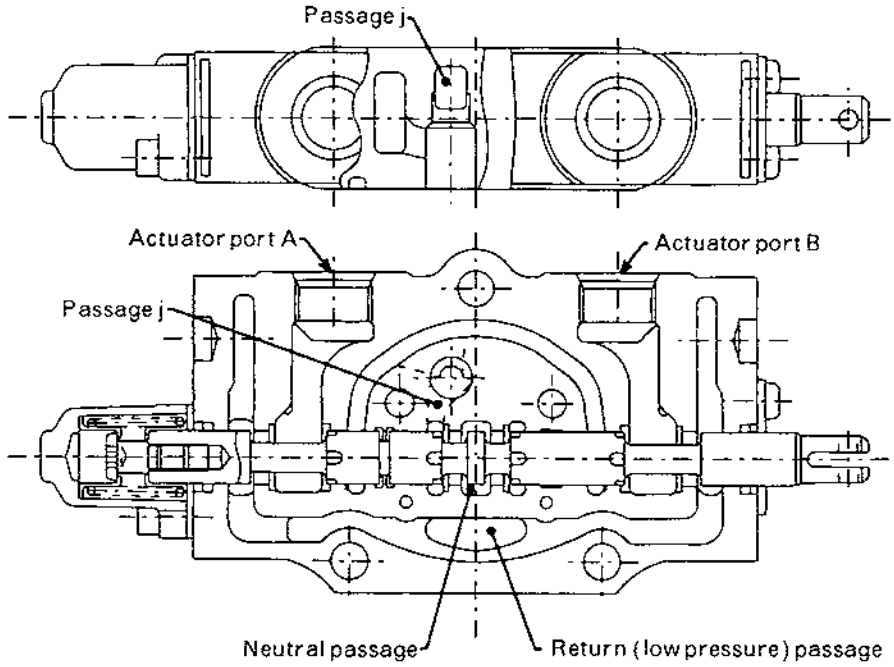
4) Travel (R)



(1) Neutral

The oil discharged from the piston pump P2 returns to the hydraulic oil tank through the neutral passage.

Both actuator ports A and B are connected to the return (low pressure) passage.



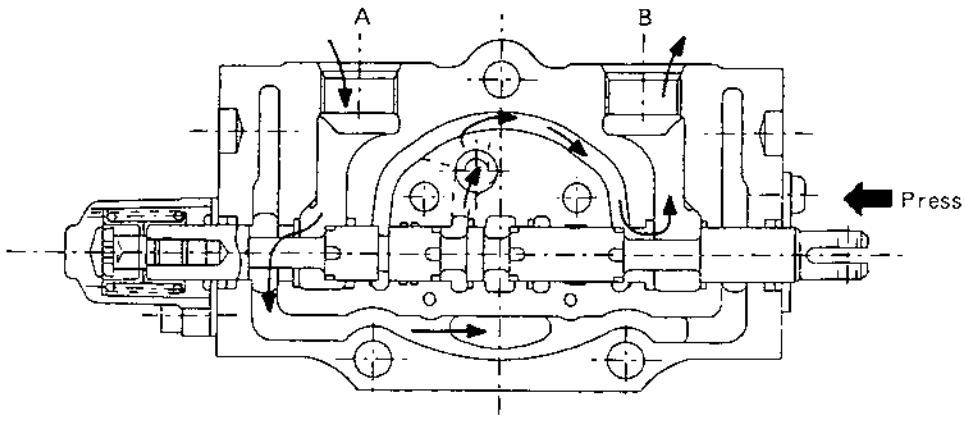
(2) Rearward travel operation

When the right travel control lever is pulled back, the spool is moved to the left and closed the neutral passage. The oil from the piston pump P2 flows through the passage j to the actuator port B.

Oil returned from the port A flows back to the hydraulic oil tank through the return (low pressure) passage.

The spool is returned to the neutral position by the return spring.

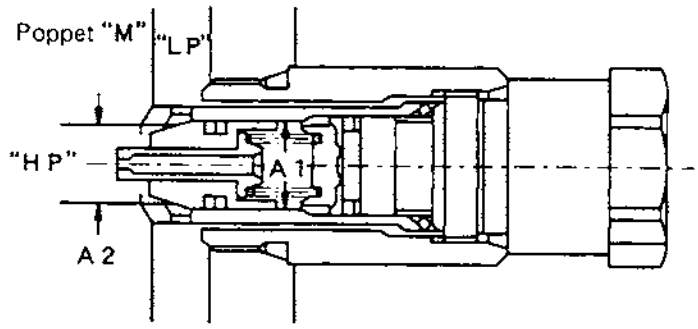
Oil flows in the opposite direction when the right travel control lever is pushed forward.



12) **Anti-void valve**

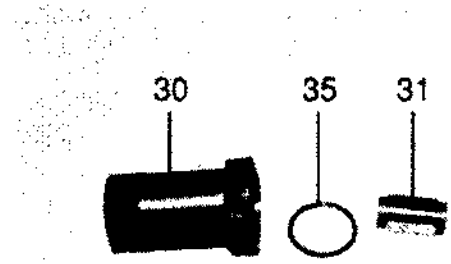
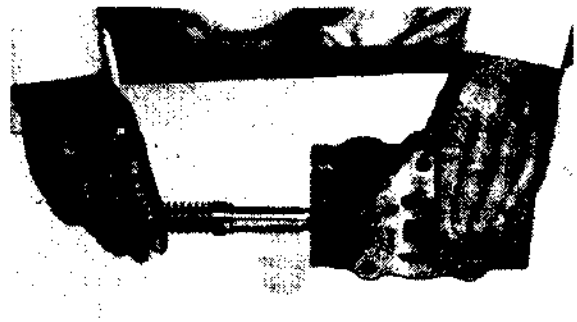
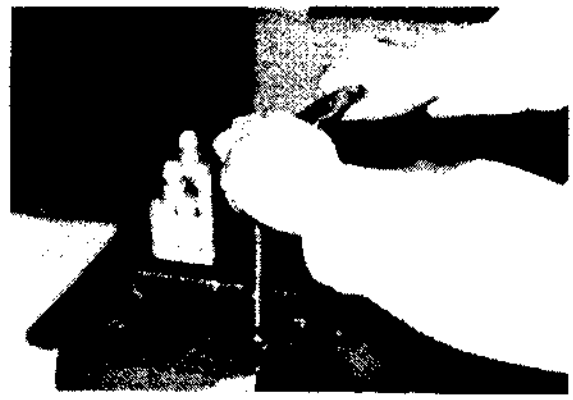
The anti-void valve is installed in the circuit of the rod end of the rod end of the bucket cylinder. When cavitation occurs in the cylinder port "HP", the anti-void valve opens to feed oil from the reservoir side.

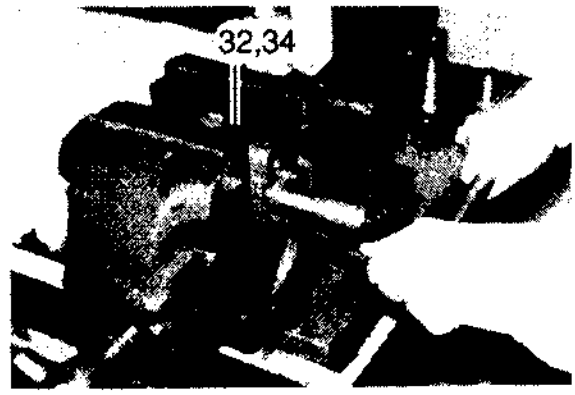
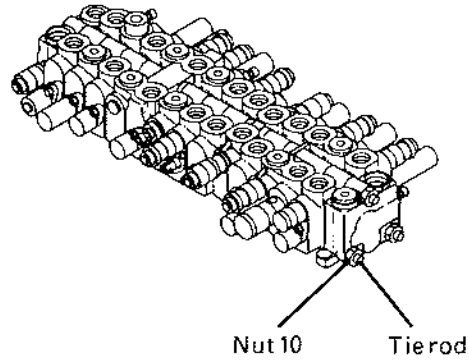
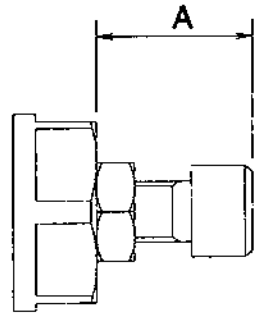
The poppet "M" is seated with the pressure "HP" in the cylinder port acting on the large area at the rear of the O-ring.



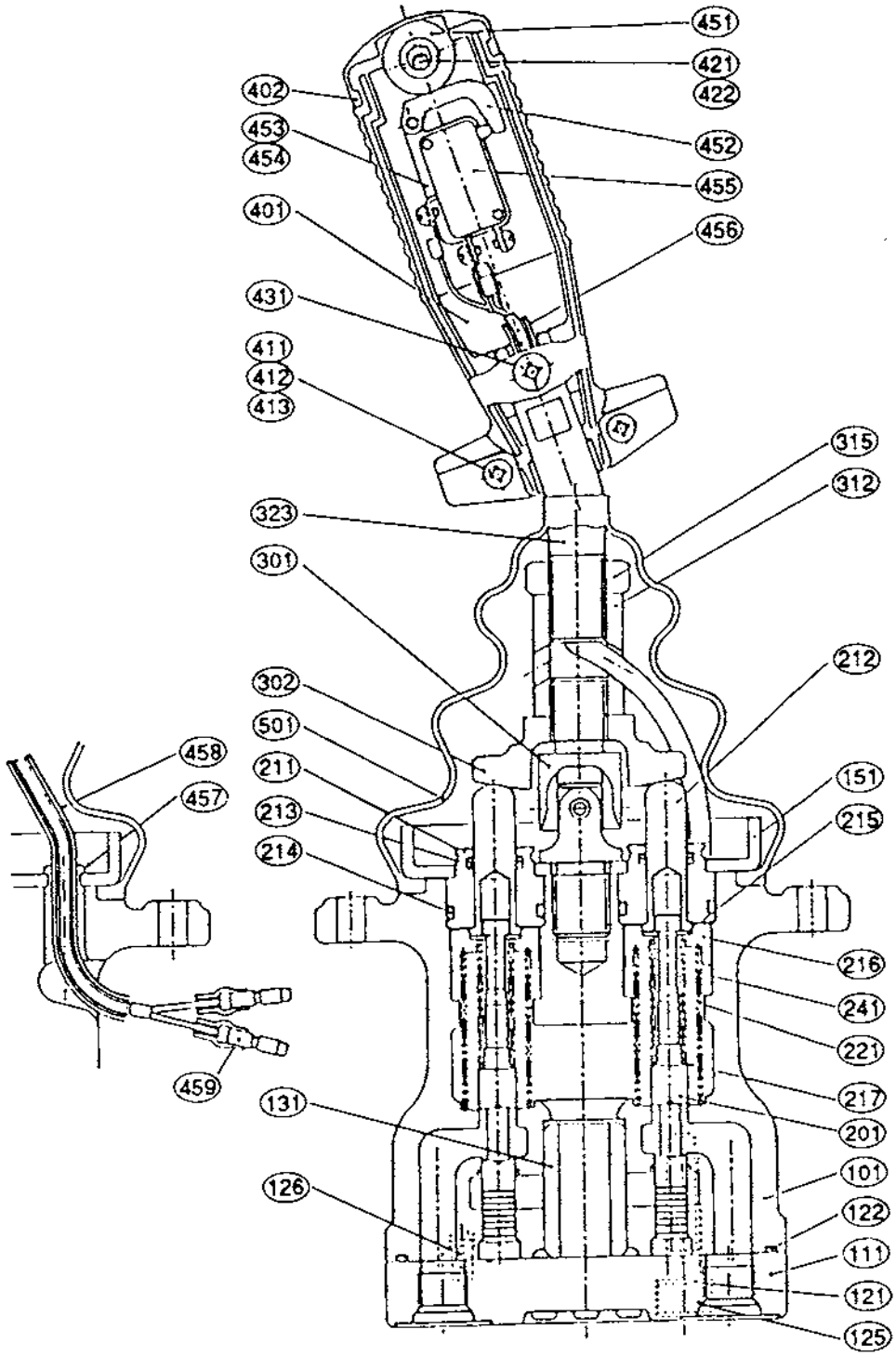
When the pressure of "HP" becomes lower than that of "LP", poppet "M" opens overcoming the cylinder port pressure and spring force by receiving the tank pressure "LP" working on the difference in pressure receiving areas (A1-A2). After filling the void area with oil, poppet "M" returns to the original position by the spring force and is completely sealed by the cylinder port pressure "HP".

• Paralle-flow devider [(20) - (24)]

Procedure	
(20) Remove O-ring 8. (21) Hold valve section with bench vice to remove cap 26, 30 and each port plugs 32, 34. ***Note:*** *a) Install jaw covers of wood when holding valve section with bench vice.* *b) Remove relief valve and/or anti-void valve as required.*	 
(22) Carefully remove spool 24 from valve section. ***Note:*** *If disassembling more than one valve section at a time, mark sure parts, spools in particular, for each section do not become mixed with other section parts.*	
(23) Hold spool assembly with bench vice. ***Note:*** *Install wooden spool holder (refer to 5-2-23) or jaw covers of wood on bench vice.*	

Procedure	
(18) Tighten plugs 32 and 34 with O-rings 33 to 49.9 to 54.2 ft•lbf. (67.6 to 73.5 N•m).	
(19) Assemble valve sections, making sure each is in correct order. Install tie rods and nuts. Tighten nuts to 33.3 to 34.7 ft•lbf. (45.1 to 47.0 N•m). ***Note:*** *a) Take care for check valve springs not to be bent.* *b) Put grease on O-ring to hold it in place during assembly.*	
(20) Adjust Allen-head cap screw height a of shut-off valve with 0.93 to 1.00 in. (23.5 to 25.5 mm).	

2) Exploded View and List of Parts



No.	Part Name	Q'ty
501	Bellows	1
459	Terminal	2
458	Tube	1
457	Bush	1
456	Cord	1
455	Switch	1
454	Seat 2, switch	1
453	Seat 1, switch	1
452	Lever switch	1
451	Roller	1
431	Screw 3	2
422	Nut	1
421	Screw 2	1
413	Plain washer	2
412	Nut	2
411	Screw 1	2
402	Handle cap	1
401	Handle	2
323	Bar handle	1
315	Lock nut	1
312	Adjust nut	1
302	Circular plate	1
301	Joint	1
241	Spring	4
221	Spring	4
217	Washer 2	4
216	Spring seat	4
215	Washer 1	8
214	O-ring	4
213	Seal	4
212	Push rod	4
211	Plug	4
201	Spool	4
151	Plate	1
131	Bush	1
126	Spring pin	1
125	Screw hex. S.H. C.	2
122	O-ring	1
121	Seal washer	2
111	Port plate	1
101	Casing	1

Procedure	Photo
Note: *Do not dry parts with compressed air, since they will be damaged and/or rusted by dust and moisture in air.*	

(22) Rust Prevention of parts : Apply rust-preventives to all parts. ***Note:*** *If left as they after being cleaned, they will rust which will affect adversely to the function after being reassembled.*	

Procedure	Photo
(28) Inject volatile rust-preventives through all ports and then put blind plugs in ports.	

5) By-pass valve

(1) Function

When the swing control lever is released (returned to the neutral position), the both ports of the swing motor are blocked, however, the upperstructure continues to swing for a short distance due to momentum.

This causes the motor to act like a pump to increase pressure of a port. The pressure stops swinging the upperstructure once but then rotates it reverse, and repeats such reverse swinging several times until the pressure enough decreases.

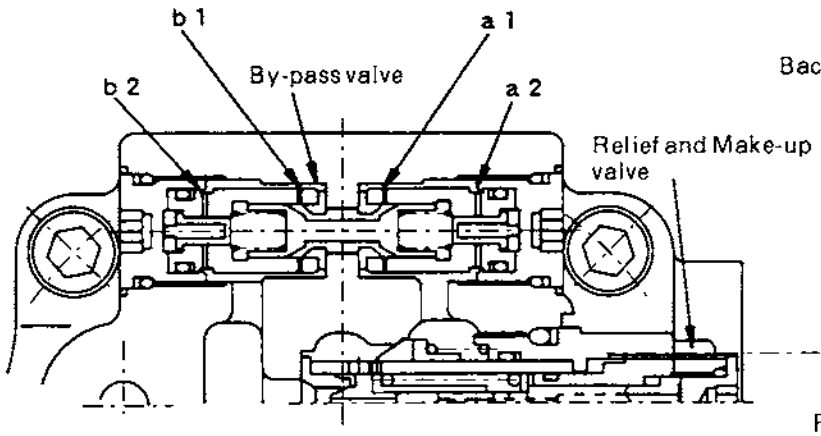
The bypass valve is normally closed but when reverse swing pressure is developed, flows specified amount of high pressure oil to the other end port for specified time to prevent increasing pressure of a port and instantly reduces the reverse momentum.

(2) Operation

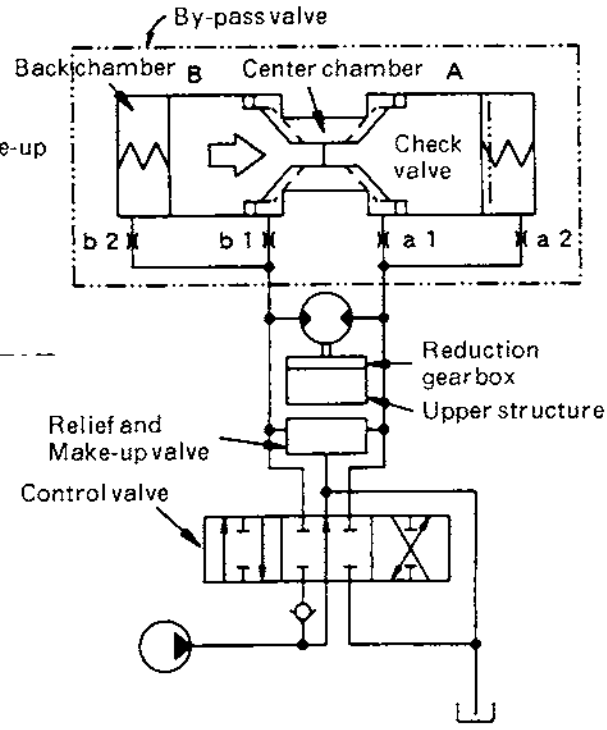
When swinging is stopped, the motor acts like a pump due to the upperstructure momentum to increase pressure of a port. If such pressure is developed in the end of port B, the high pressure oil flows into the back chamber of B through orifice b2 to move the check valve to the right and bypass port b1 is closed. This results the upperstructure to stop swinging once but instantly begin to swing reverse.

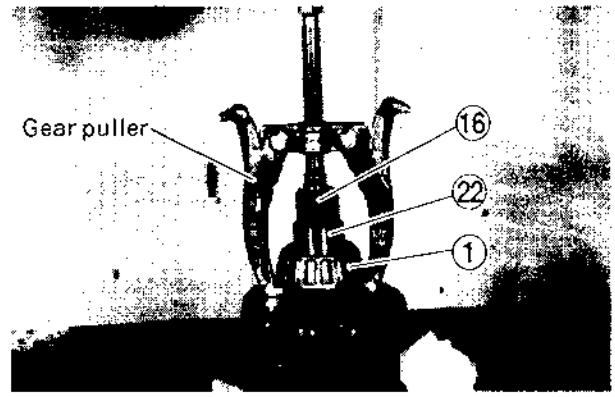
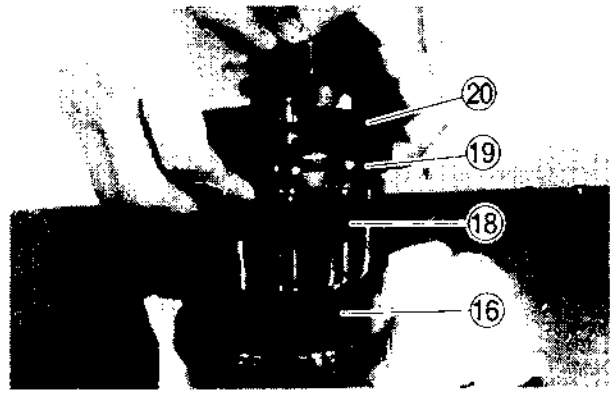
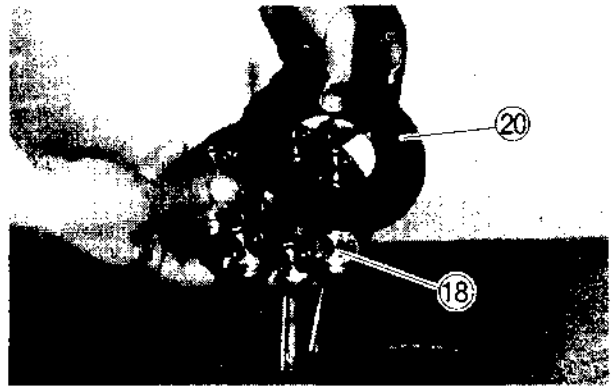
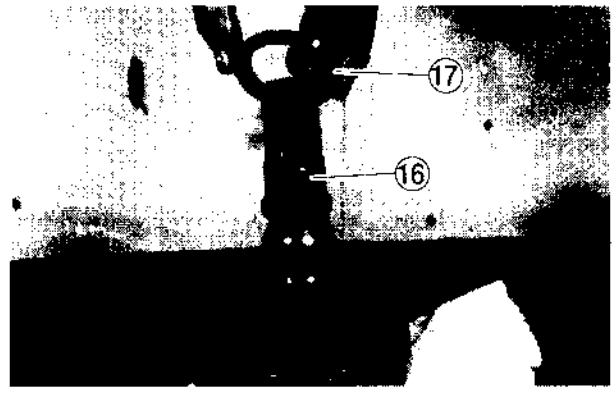
Pressure in the back chamber of A should increase and move the check valve to the left instantly but oil flows into the back chamber of A delays due to orifice a2 so that the movement of check valve to the left is also delays.

During the time, oil from the back chamber of A flows to the center chamber through bypass orifice a1 to move the check valve to the left and flows to the port B through bypass orifice b1, then the check valve close the bypass passage. While the reverse swing pressure is developed, the high pressure oil is flowed the other end not to trap oil in the circuit. That is the way that reverse swing momentum is absorbed and the upperstructure stops swinging smoothly.

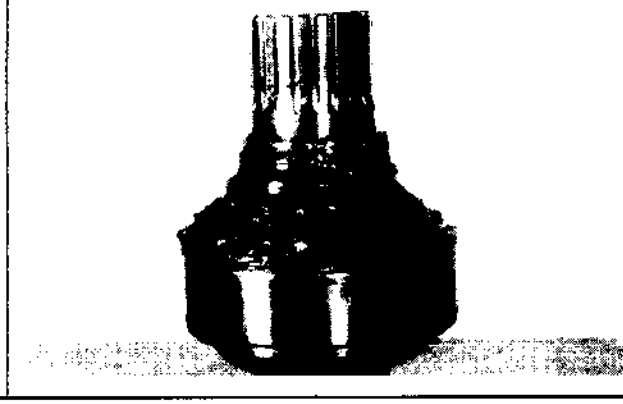
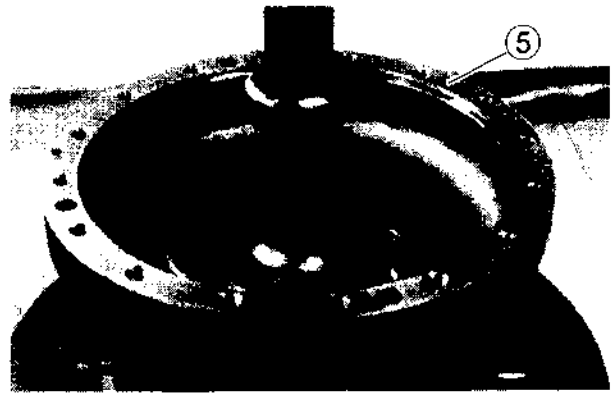
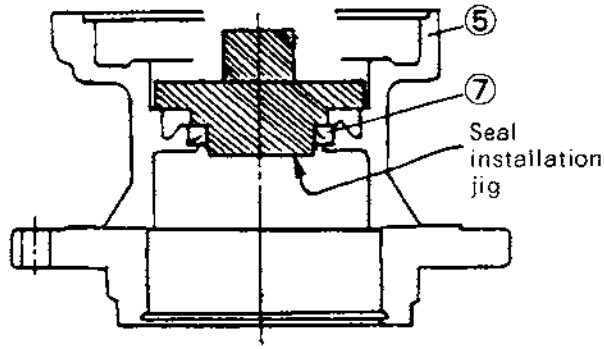
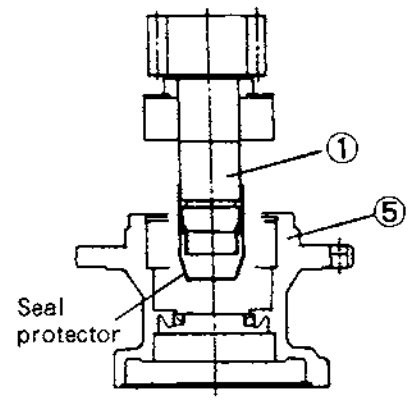


• a 1, b 1 : By-pass orifice
• a 2, b 2 : Orifice



Procedure	
(15) Install gear puller on inner race of tapered roller bearing ① and end of spline of cylinder ⑯ to remove bearing with collar ㉒.	
(16) Remove cam plate ⑳, piston S/A ⑱ and return plate ⑲ from cylinder ⑯.	
(17) Remove cam plate ⑳. ***Note:*** *Be careful not to damage mating surface of cam plate.*	
(18) Remove ring spring ⑰ from cylinder ⑯.	

[2] Reassembly

Procedure	
(1) Apply grease to rollers of tapered roller bearing. Grease : Lithium soap group (Extreme Pressure Type) Multi-porpose grease NLGI No.2 or equivalent Amount : 12.2 cu.in. (200 cu.cm)	
(2) Remove oil or grease from oil seal installation area of gear case ⑤ and seal ⑦. Apply Three Bond 1211 on outside surface of oil seal ⑦. (3) Install oil seal ⑦ on gear case ⑤ using jig. ***Note:*** *Coat grease on lip of oil seal ⑤ after installation.*	 
(4) Put gear case ⑤ upside down to install pinion gear shaft assembly on gear case ⑤. ***Note:*** *Install seal protector not to damage lip of oil seal ⑦ by spline of pinion gear shaft ①.*	

4) Relief valve (Shock reduction type)

(1) First stage

When pressure oil is fed to the chamber A, pressure P1 in chambers B and C is kept lower than pressure in chamber A. At that time poppet receives a force F (=P X A) and F1 (=P1 X A1) to be moved to the right and escapes oil in chamber A because F > F1 due to P > P1 and A > A1. While piston is moving to its stroke end, the valve is operated by low pressure because P > P1 ....(Fig. I).

(2) Second stage

Pressures in chambers A, B and C will be identical after the piston reaches its stroke end. Poppet is move to the right owing to a force, P X (A - A1), and oil with set pressure is escaped.

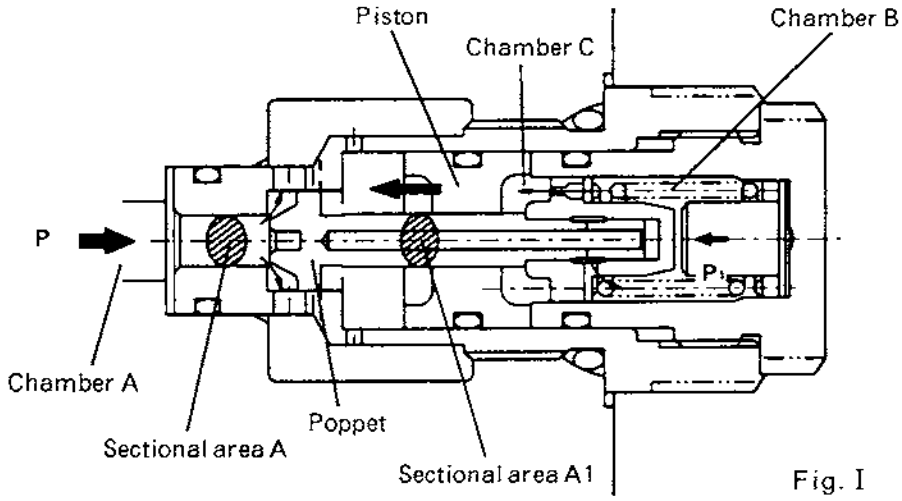


Fig. I

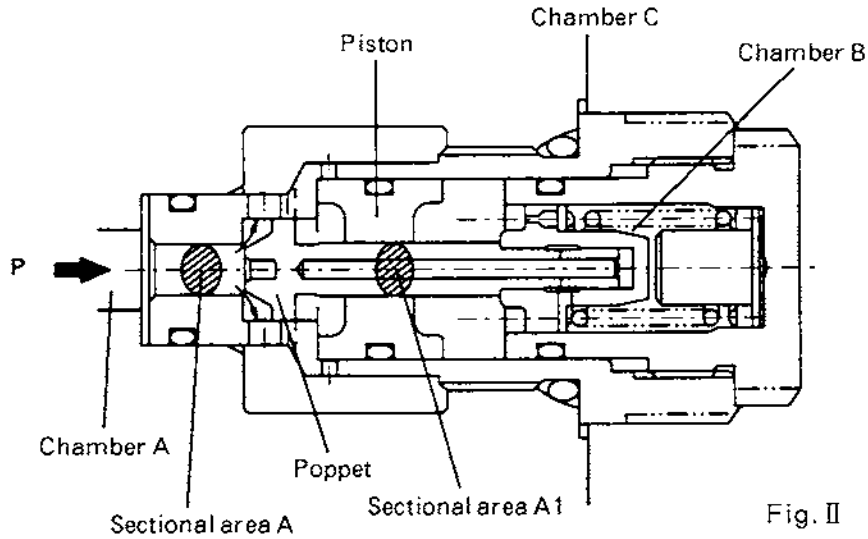
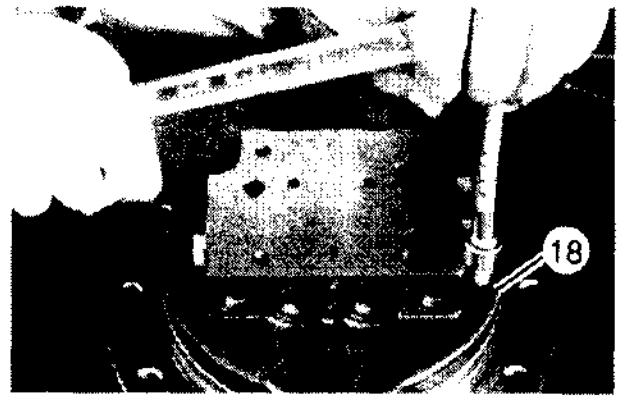
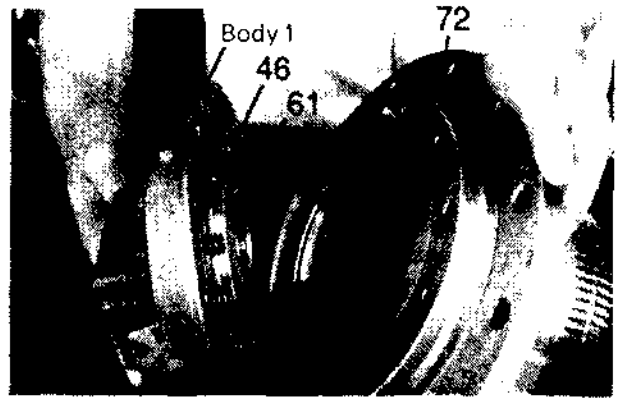
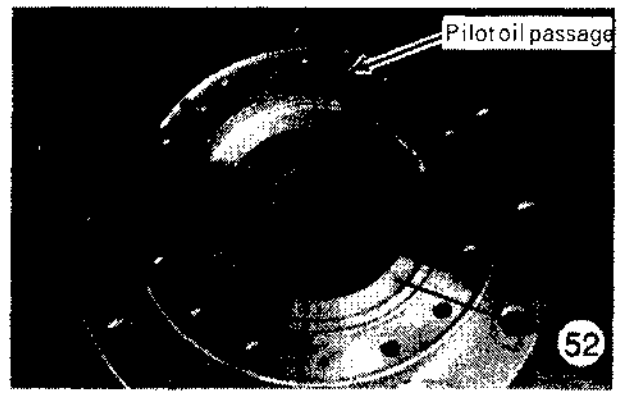
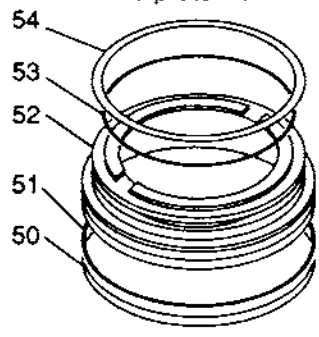
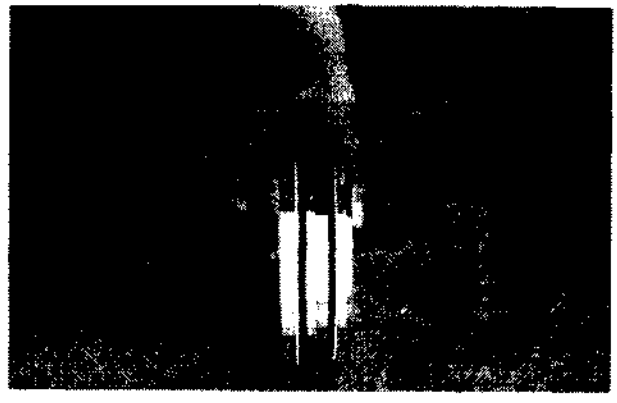
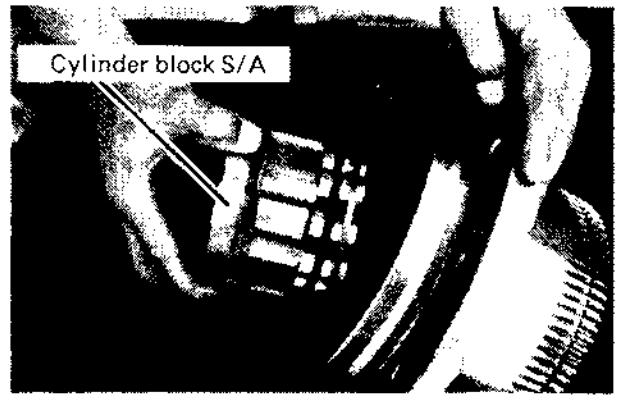
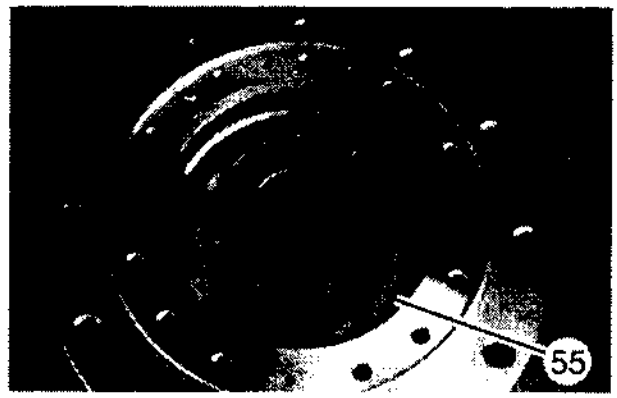
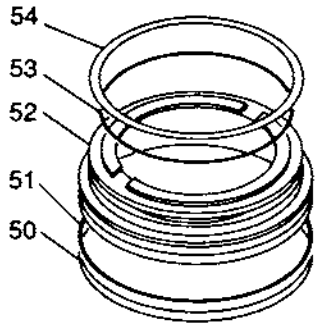
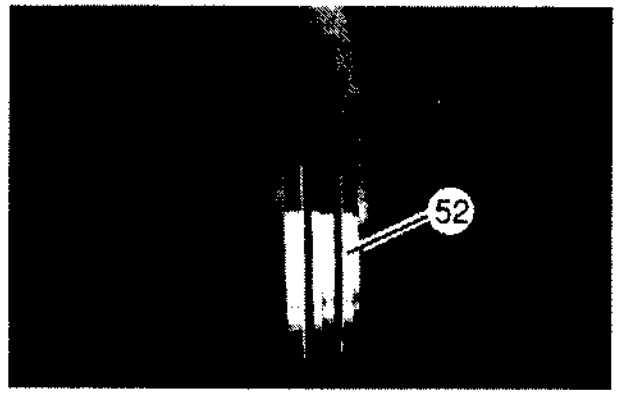
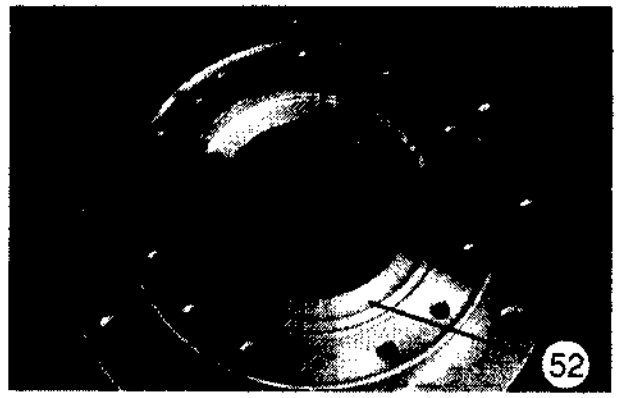


Fig. II

Procedure	
(17) Loosen seven Allen-head screws 18. ***Note:*** *Install jaw covers of soft metal as holding motor with bench vice.* (Tool : Allen socket or wrench <Hex 0.315in. (8mm)>)	
(18) Separate body 2 72 and body 1. ***Note:*** *Be careful not to fall valve plate 61 and springs 46.*	
(19) Remove brake piston 52 from body 2 72. ***Note:*** *Blow air from pilot oil passage to remove brake piston, or remove it using pulley puller after cylinder block is removed.*	
(20) Remove O-rings 51 and 53, back-up rings 50 and 54 from brake piston 52. 	

Procedure	
(16) Install cylinder block onto body 2 72.	
(17) Install steel plate 55 on body 2 72.	
(18) Install O-rings 51 and 53, back-up rings 50 and 54 on brake piston 52. 	
(19) Install brake piston 52 on body 2 72. ***Note:*** *Coat grease on O-rings and evenly drive on piston with plastic hammer.*	

2) Valve and motor

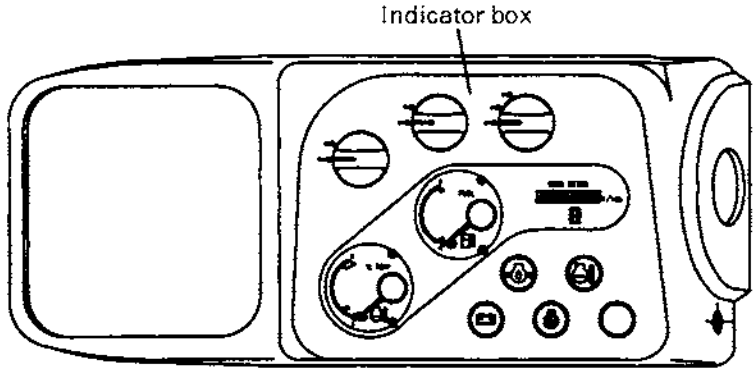
No.	Parts	Inspection parts	Inspection standards	Remedy
1	Body 1 43	● Spool surface ● Ball check seat surface	Heavy scoring and scuffing Heavy scoring	Replace kit (D)
2	Spool 22, 38	● Spool bore of body 1	Heavy scoring and scuffing	Replace kit (D)
3	Body 2 72	● Spline gear teeth surface ● Small piston bore ● Mating surface with swash-plate ● Mating surface with ball	Heavy scoring and scuffing Heavy scoring and scuffing Clearance : 0.00091in. (0.023mm) or more Heavy scoring and scuffing Heavy scoring and scuffing	Replace kit (E)
4	Shaft 69	● Spline gear teeth surface ● Mating surface with oil seal lip	Heavy scoring and scuffing Heavy scoring and scuffing (wear : 0.00098in. (0.025mm) or more)	Replace
5	Cylinder block 63	● Piston bore ● Mating surface with valve plate	Heavy scoring and scuffing Clearance : 0.0012in. (0.030mm) or more Heavy scoring and scuffing (wear : 0.00079in. (0.020mm) or more)	Replace kit (F) Lapping Replace kit (F) when lapping is ineffective
6	Valve plate 61	Mating surface with cylinder block	Refer to No.5	Refer to No.5
7	Piston 66 Slipper 105	● Mating surface with cylinder block ● Mating surface with swash-plate ● Play in slipper installation	Refer to No.5 Heavy scoring and scuffing (wear : 0.00079in. (0.020mm) or more) Play : 0.0118in. (0.3mm) or more	Refer to No.5 Lapping Replace kit (F) when lapping is ineffective Replace kit (F)
8	Slipper holder 65	Mating surface with block holder	Heavy scoring and scuffing	Replace kit (F)
9	Block holder 64	● Spline gear teeth surface ● Mating surface with slipper holder	Heavy scoring and scuffing Heavy scoring and scuffing	Replace kit (F)
10	Swashplate	● Mating surface with piston slipper ● Mating surface with ball	Refer to No.7 Heavy scoring and scuffing	Lapping Replace lapping is ineffective Replace
11	Small piston 104	Small position bore in body 2	Refer to No.3	Refer to No.3
12	Friction plate 56	Lining	Heavy scuffing	Replace
13	Steel plate 55	Surface	Heavy scuffing	Replace
14	Oil seal 71	Seal lip	Heavy scoring and scuffing	Replace
15	Bearing 49, 70	Rolling surface	Scoring or flaking on balls and races	Replace 70 Replace kit (D) for 49
16	Spring 21, 28, 32, 46, 60	Surface	Cracks	Replace
17	O-ring 20, 26, 31, 44, 48, 51, 53, 73	Surface, hardness	Cut, deformation and hardening	Replace

2. Function of alarm sensor

- All the lamps should go on for 2-3 seconds when the engine is started.
- All the lamps should go off when the engine is running.
- The engine oil and battery charge lamps should go on when the engine is stopped.
- The buzzer should sounds when a lamp goes on while the engine is running.

Structure

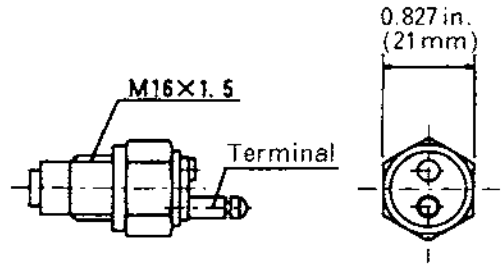
1) Panel

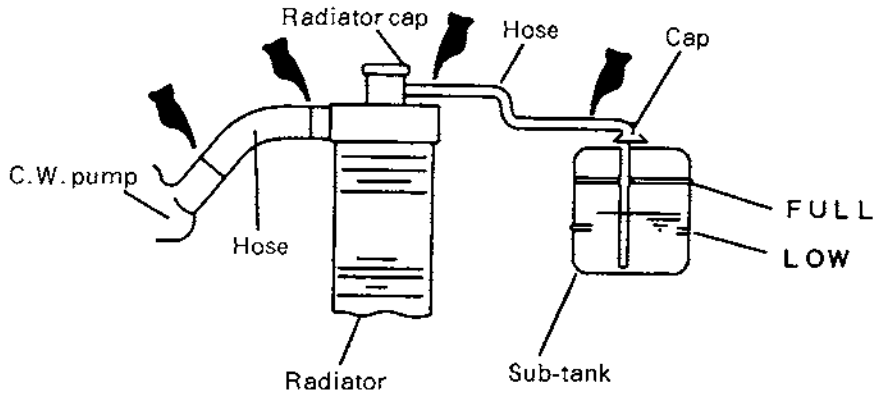


2) Overheating sensor (C.W. switch)

- Turned on.....Hydraulic oil temp. at 224.6 to 235.4°F (107 to 113°C)
- Turned off.....Hydraulic oil temp. below 212°F (100°C)
- Installation position.....C.W.pump on engine

The water volume in the tank changes before (low water temp.) and after (high water temp.) operation. Check the water level. If there is no change in the water level, check for water leakage at the illustrated positions and tighten the clamp.

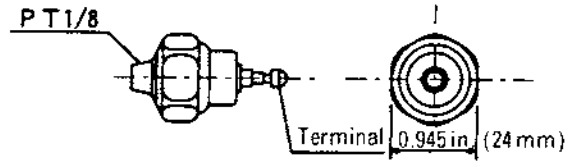




3) Lube oil pressure drop monitoring (L.O. switch)

The switch monitors the lube oil pressure drop of the engine and causes the engine oil pilot lamp to go on and the alarm buzzer to sound.

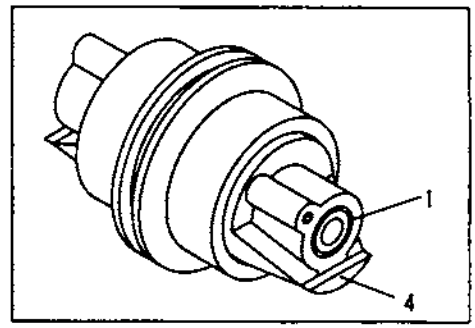
- Working pressure...5.7 to 8.6 PSI (39 to 59 kpa)
- Installation position.....Engine block



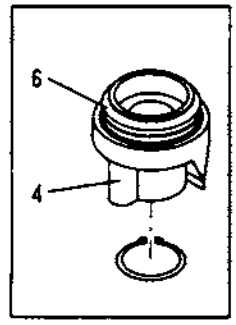
6-2-7 Disassembly and Reassembly of Track Roller

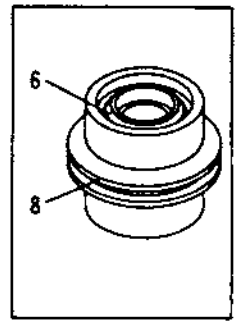
1) Disassembly

(1) Remove snap ring ① to remove seal cover B ④.



(2) Remove floating seals ⑥ from seal cover B ④ and roller ⑧.



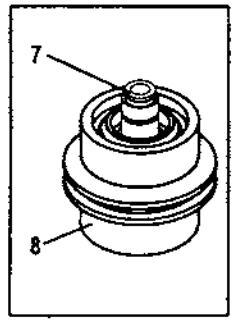


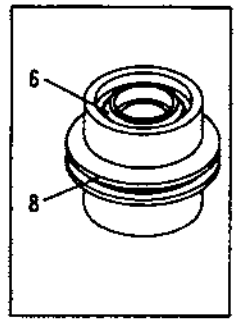
(3) Remove roller ⑧ from shaft ⑦.

Note:

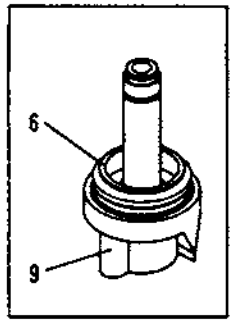
Drain oil, 0.211 to 0.233 Qts. (0.2 to 0.22 L) from roller ⑧.

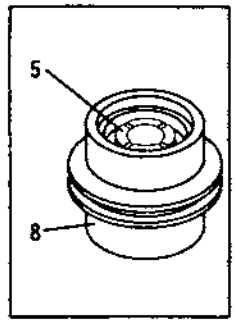
(4) Remove floating seals ⑥ from roller ⑧ and seal cover A ⑨.

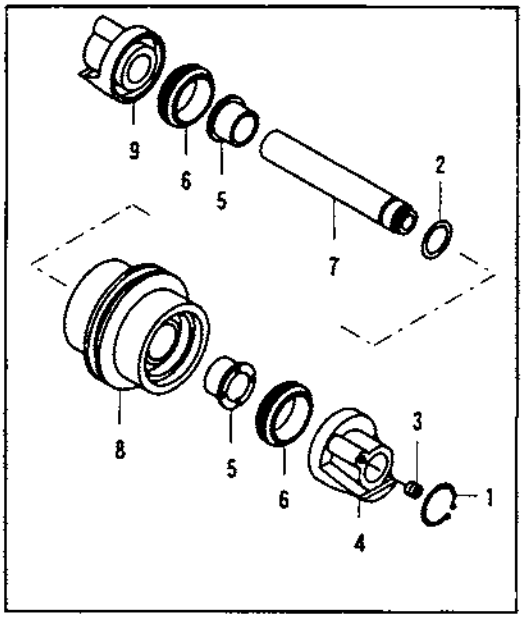




(5) Remove bushing ⑤ from roller ⑧.





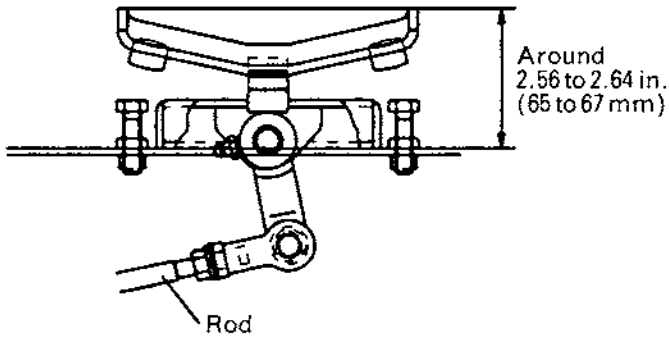


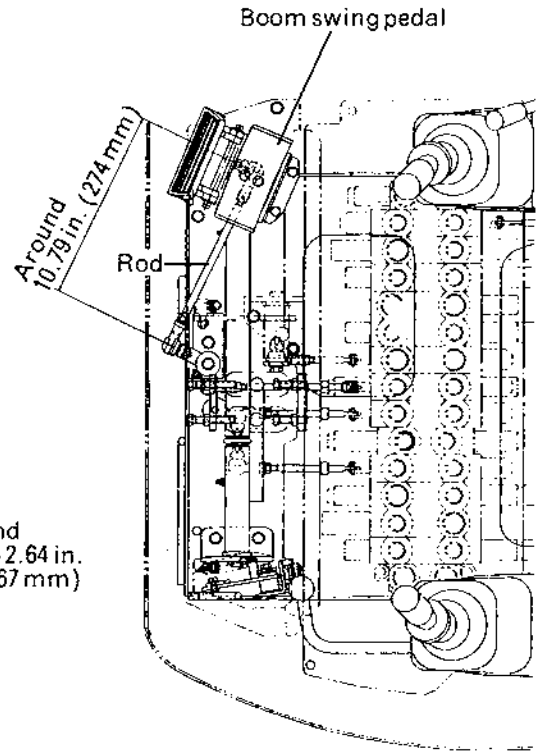
No.	Parts	Q'ty
1	Snap ring	1
2	O-ring	1
3	Plug PT1/8	1
4	Seal cover B	1
5	Bushing	2
6	Floating seal	2
7	Shaft	1
8	Roller	1
9	Seal cover A	1

6-3-6 Adjustment of Boom Swing Pedal

1) Adjustment of pedal

(1) Adjust rod until pedal is horizontal.



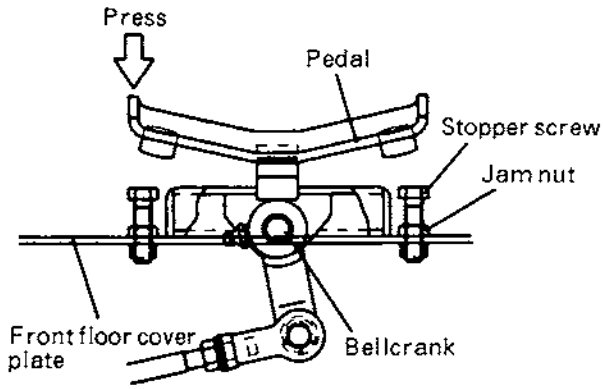


2) Adjustment of stopper screws

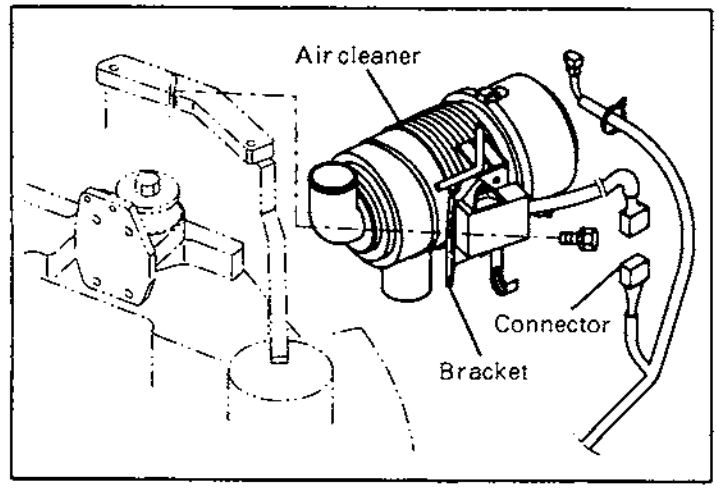
(1) Screw in stopper, screw.

(2) Press pedal fully and screw out stopper until it contacts pedal.

(3) Release pedal and screw out stopper 1 more turn and tighten jam nut.



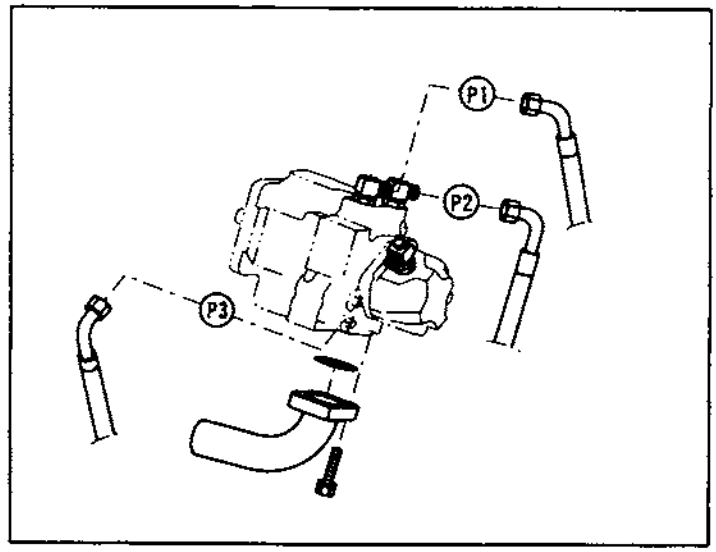
(18) Remove air cleaner assembly with its bracket.



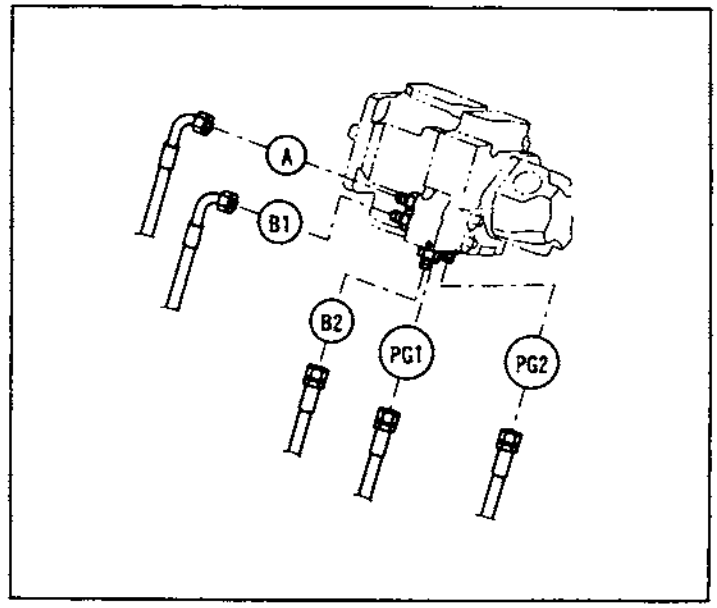
(19) Disconnect intake flange and pump outlet hoses P1, P2 and P3.

Note:

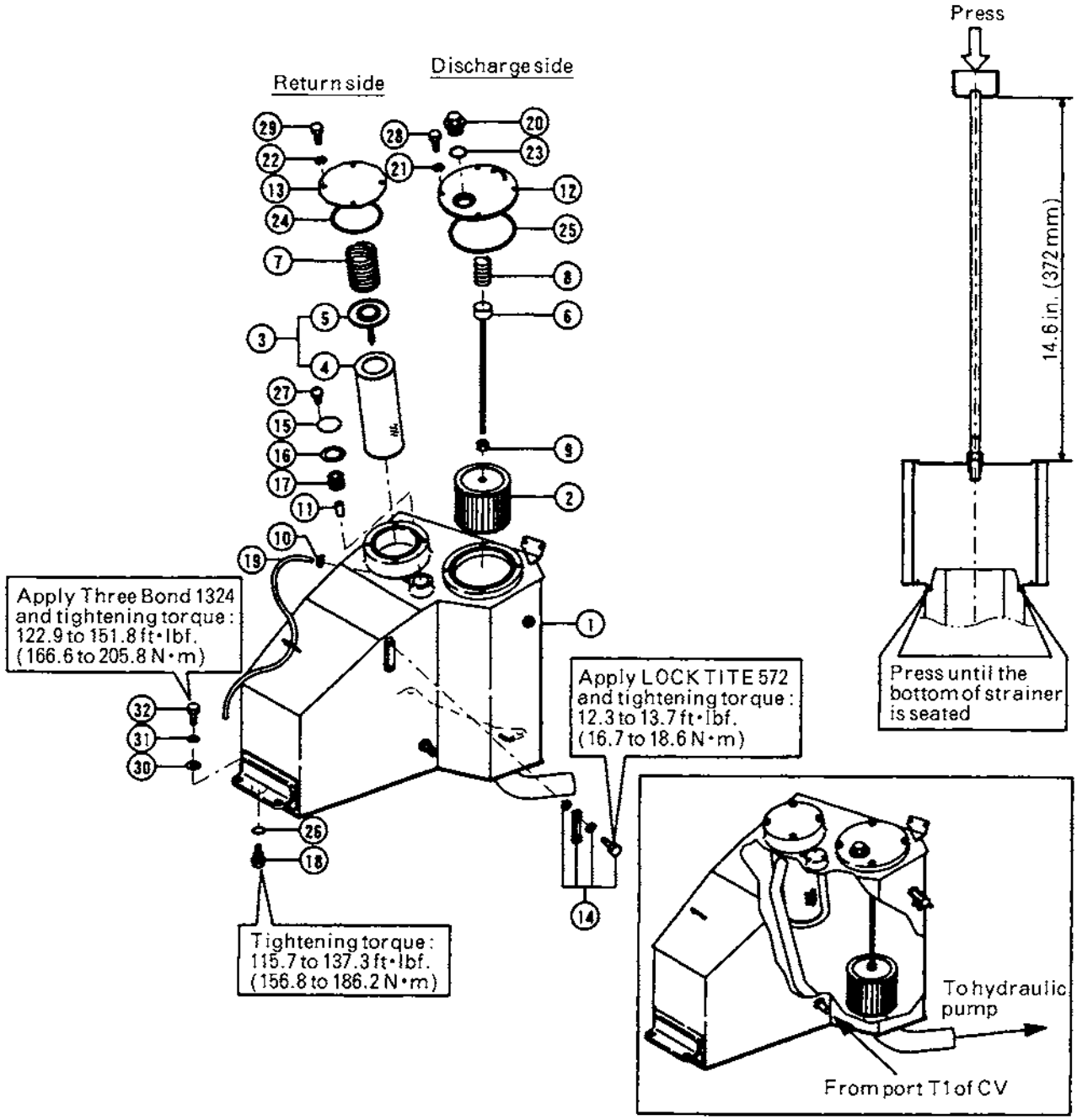
Cover all openings of hydraulic pipings.



(20) Disconnect five pilot oil hoses A, B1, B2, PG1 and PG2.

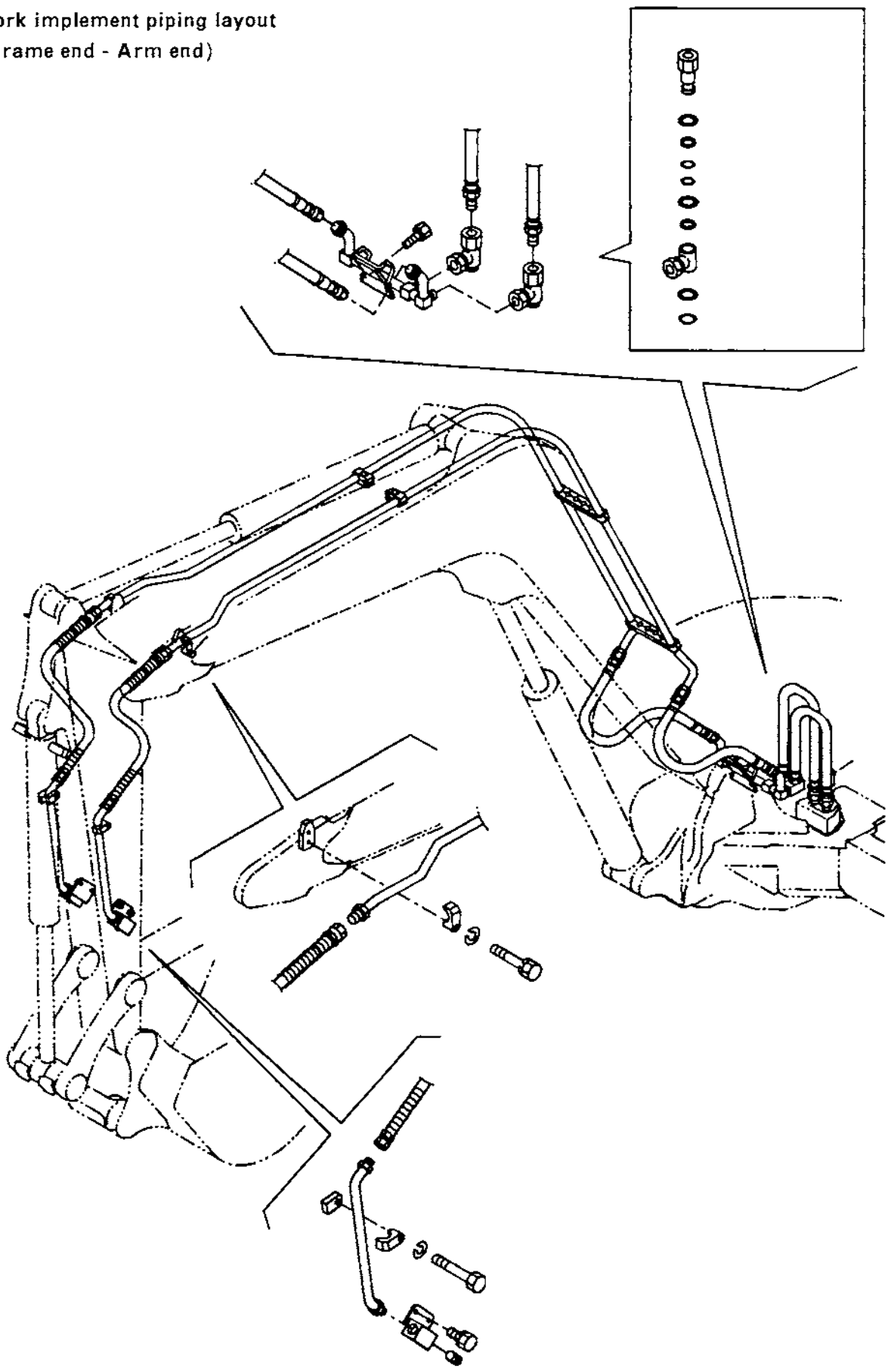


3) Points for reassembly



No.	Parts	No.	Parts	No.	Parts
1	Hydraulic oil tank body	13	Hydraulic oil tank cover A	25	O-ring 1AG 170.0
2	Suction strainer	14	Oil level gauge	26	O-ring 1AS 30.0
3	Return filter ass'y	15	Plate	27	Pan head screw M5 × 10
4	Filter element	16	Packing	28	Cap screw M10 × 25
5	Bypass valve	17	Element	29	Cap screw M10 × 25
6	Strainer push rod	18	Magnet plug	30	Washer 16
7	Filter spring	19	Hose	31	Lock washer 16
8	Filter spring	20	Filter plug	32	Cap screw M16 × 40
9	Nut M10	21	Lock washer 10	33	
10	Hose clip 12	22	Lock washer 10	34	
11	Pipe	23	O-ring 1AP 38.0	35	
12	Reservoir cover CMP	24	O-ring 1AG1 35.0		

10) Work implement piping layout
(Frame end - Arm end)



5) Install door lock

(1) Inner handle

[1] Install inner handle in reverse sequence procedure of disassembly.

[2] Adjust length of screw ⑦.

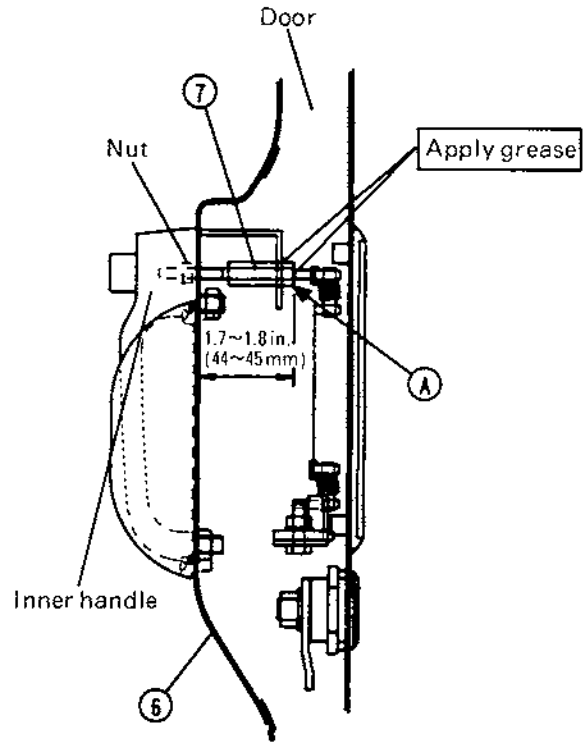
<1> Temporarily fix screw ⑦ to 1.7 - 1.8 in. (44 - 45 mm) of length.

<2> Press door cover B ⑥ with hand and check for play with operating push button of inner handle.

<3> Tighten screw ⑦ 1/2 turn to obtain proper clearance at Ⓐ. (Check if slight play of push button remains).

<4> Install door cover B ⑥.

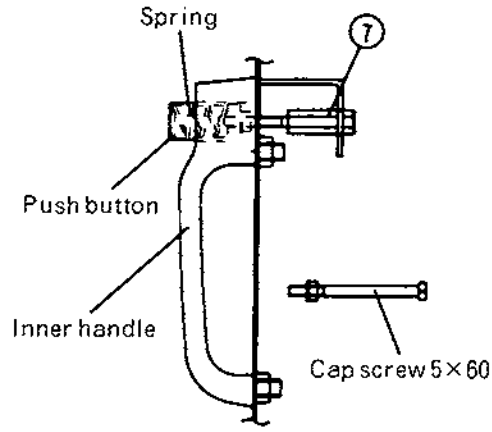
[3] When inner handle is required to be replaced with new one, replace screw (5 × 60) built in new service parts with screw ⑦, and remove spring from push button.



(2) Outer handle

[1] Install outer handle in reverse sequence procedure of disassembly.

[2] When outer handle is required to be replaced with new one, replace link which is built in new service parts with link C ⑬. Also, disconnect upper side of handle return spring to adjust spring pressure.

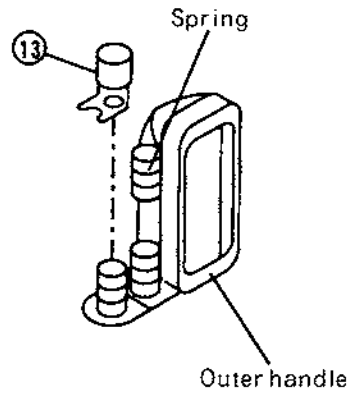


(3) Key CMP

[1] Install key CMP in reverse sequence procedure of disassembly.

Note:

After installation, adjust in order for plate ⑨ to engage with link ⑬ smoothly.



7. PERIODIC INSPECTION AND SERVICING

◇:Check ○:Resupply ●:Replace □:Adjust(clean) △:Oil & grease

Check & service items			Daily	Every 50	Every 100	Every 250	Every 500	Every 1000 hrs
Under-carriage	Check, adjust track tension		◇		□			
	•Check air pressure, wear, flaw in tyres		◇					
Steering equipment	Check performance, play of steering lever		◇					
	Check performance, play of travel lever		◇					
	•Check performance of speed change lever		◇					
	•Check performance of forward/reverse pedal		◇					
	•Check performance, play of steering wheel		◇					
	•Brake pedal	Stroke	◇					
		Performance	◇					
	•Parking brake	Stroke	◇					
		Performance	◇					
	Check performance of accel. level		◇					
Electric equipment	Check front & work lights, horn		◇					
	Check hourmeter function		◇					
	Check function of change, oil and pilot lamps		◇					
	Check wire breakage, short-circuits, loosened terminals, retighten		◇					
	Check, resupply battery fluid		◇					
	Check specific gravity of electrolyte						□ As required	
	Check function of OK monitor		◇					
Engine	Retighten cylinder head bolts				◇ 1 st time		◇	
	Check, adjust intake/exhaust valve clearance				◇ 1 st time		◇	
	Lap intake/exhaust valve seat							□
	Clean combustion chamber							□
	Fuel pump & injection valve	Check & adjustment of FO injection pressure & atomizing condition					□	
		Check & adjustment of fuel injection timing						□

•Applicable to models with the relevant equipment

Note:

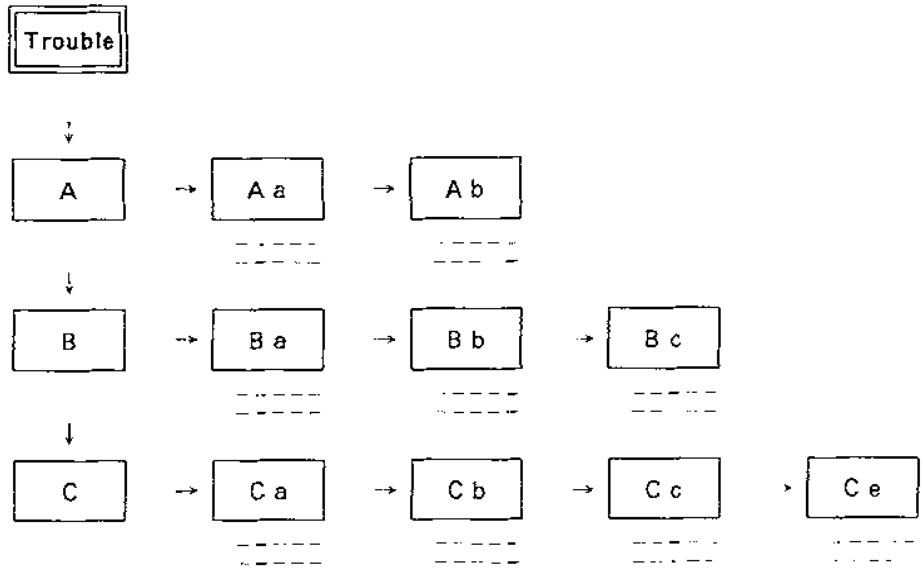
1) When machine is used at dusty worksites clean and replace filter element twice or more frequently than specified in the table.

2) Execution of periodic inspection and servicing is indispensable to conform the EPA emission control regulations.
Keep a record of the results.

9-2 Troubleshooting

9-2-1 Machine and Engine

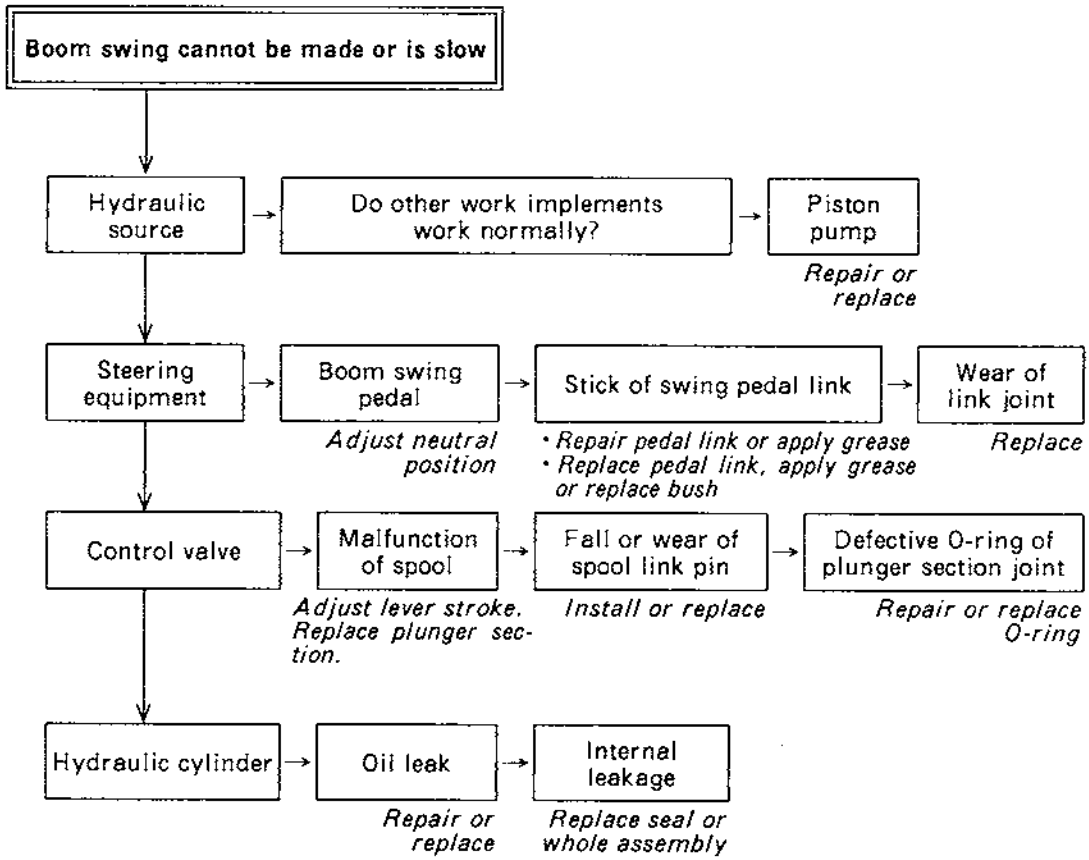
(How to use the charts)

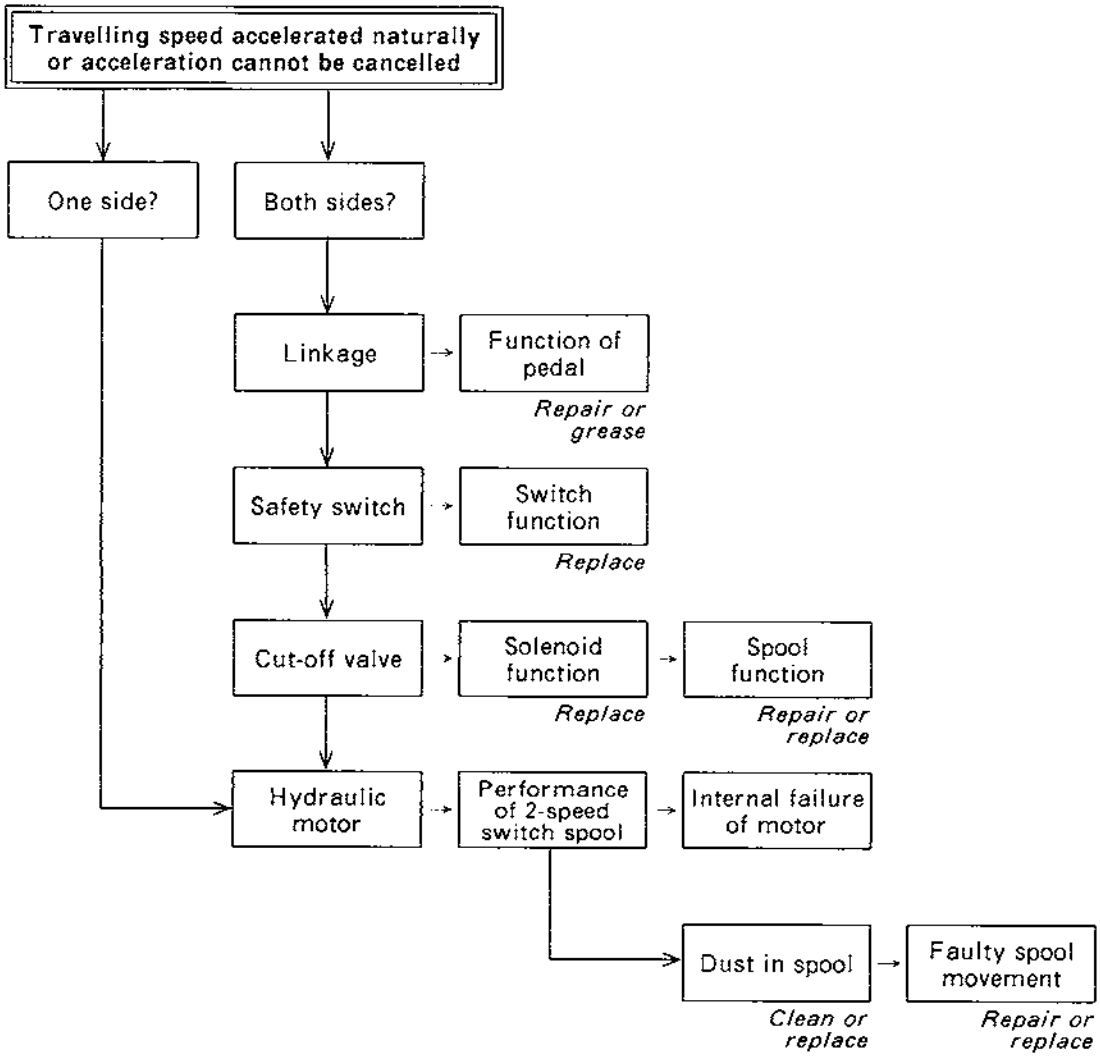


Factors related to the trouble are enumerated in the columns and instructions for corrective procedures are given below. It is recommended that the troubles be inspected and corrected one by one according to the chart.

 ← Inspection item

 ← Remedy for failure


Boom swing cannot be made or is slow
Hydraulic source
Do other work implements work normally?
Piston pump
Repair or replace
Steering equipment
Boom swing pedal
Adjust neutral position
Stick of swing pedal link
• Repair pedal link or apply grease
• Replace pedal link, apply grease or replace bush
Wear of link joint
Replace
Control valve
Malfunction of spool
Adjust lever stroke. Replace plunger section.
Fall or wear of spool link pin
Install or replace
Defective O-ring of plunger section joint
Repair or replace O-ring
Hydraulic cylinder
Oil leak
Repair or replace
Internal leakage
Replace seal or whole assembly


Travelling speed accelerated naturally or acceleration cannot be cancelled
One side?
Both sides?
Linkage
Function of pedal
Repair or grease
Safety switch
Switch function
Replace
Cut-off valve
Solenoid function
Replace
Spool function
Repair or replace
Hydraulic motor
Performance of 2-speed switch spool
Internal failure of motor
Dust in spool
Clean or replace
Faulty spool movement
Repair or replace

CHAPTER 10

REFERENCE DATA

1. GENERAL

3. ENGINE BODY

- Measurement with hydrometer

When using a hydrometer, the measured specific gravity must be corrected according to the temperature at the time of measurement. The specific gravity of battery electrolyte is defined with 68° F (20℃) as the standard. Since the specific gravity increases or decreases by 0.0007 when the temperature varies by 33.8° F (1℃), correct the value according to the equation below.

$S_{20} = St + 0.007 (t-20)$

- S_{20}: Converted specific gravity at 68° F (20℃)
- St: Specific gravity at measurement
- t: Electrolyte temperature at measurement (℃)

Temperature	To convert	Into	Multiply by
	℃	°F	℃ = 5/9 (°F = 32)

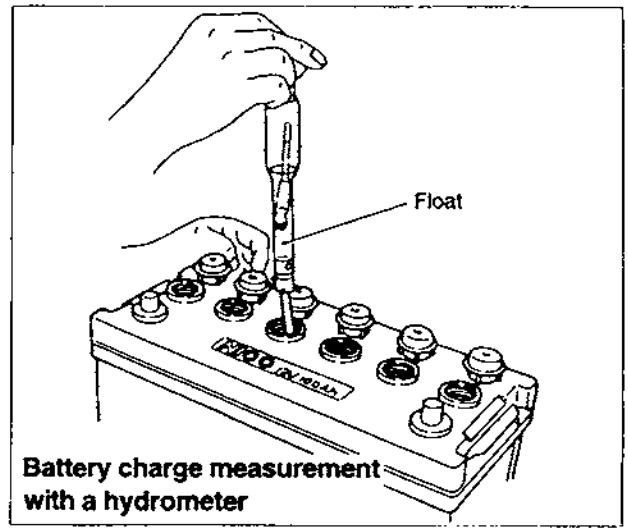
Specific gravity and remaining battery charge

Specific gravity 68° F (20℃)	Discharged quantity of electricity (%)	Remaining charge (%)
1.260	0	100
1.210	25	75
1.160	50	50
1.110	75	25
1.060	100	0

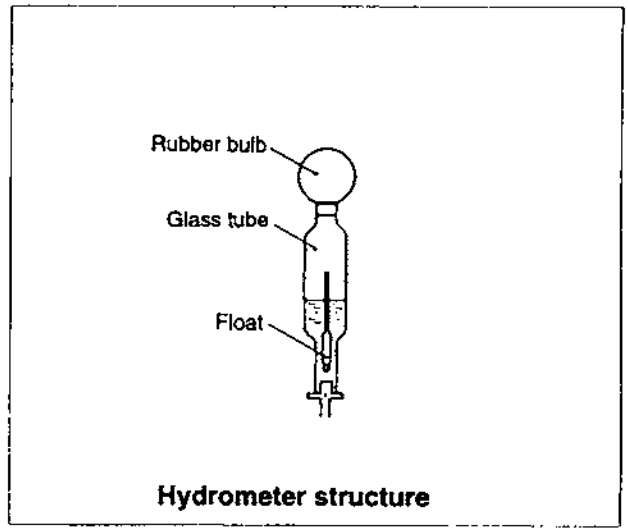
③ Terminals
Clean if corroded or soiled.

④ Mounting bracket
Repair or replace it if corroded. Retighten if loosened.

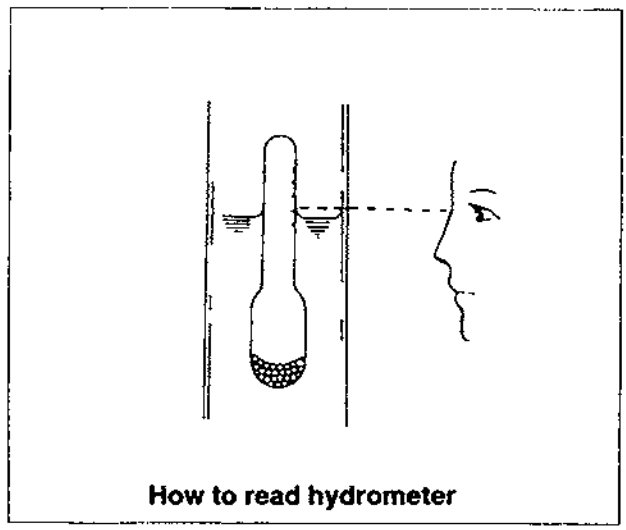
⑤ Battery appearance
Replace the battery if cracked or deformed.
Clean with fresh water if contaminated.



Battery charge measurement with a hydrometer



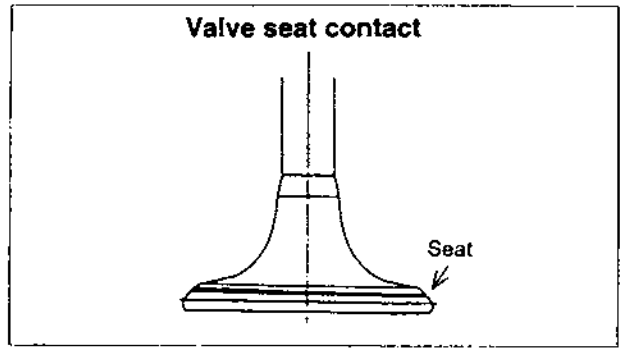
Hydrometer structure


How to read hydrometer

(e) Seat contact

Apply a thin coat of minium on the valve seat. Insert the valve in the cylinder and push it against the seat to check seat contact.

Standard : Continuous contact all around



Valve seat contact

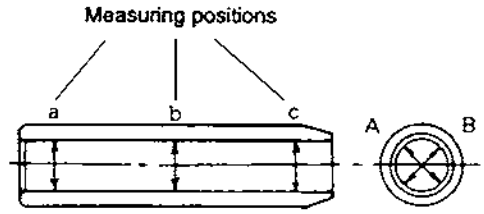
(5-2) Valve guide

Mainly check damage and wear on the inside wall. Apply supply part code 129150-11810 when replacing the part.

① Inside diameter

in. (mm)

		Standard	Limit
Intake valve	Stem O.D.	0.3136 to 0.3142 (7.965 to 7.980)	0.3116 (7.915)
	Guide I.D.	0.3156 to 0.3161 (8.015 to 8.030)	0.3189 (8.100)
	Clear-ance	0.0014 to 0.0026 (0.035 to 0.065)	0.0073 (0.185)
Exhaust valve	Stem O.D.	0.3012 to 0.3138 (7.955 to 7.970)	0.3112 (7.905)
	Guide I.D.	0.3156 to 0.3161 (8.015 to 8.030)	0.3189 (8.100)
	Clear-ance	0.0018 to 0.0030 (0.045 to 0.075)	0.0077 (0.195)



Valve guide inside diameter

(5-3) Intake/exhaust valve

Mainly clean and check damage and wear at the valve stem and seat.

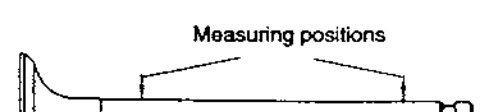
(a) Seat contact: See 5-1-(e) above.

(b) Stem outside diameter: See 5-2-① above.

(c) Valve head thickness

in. (mm)

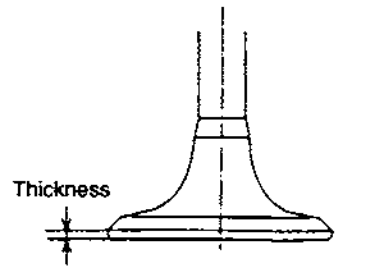
	Standard	Limit
Intake	0.067 (1.71)	0.039 (1.00)
Exhaust	0.065 (1.65)	0.039 (1.00)



Valve stem outside diameter

(d) Valve stem bend

Limit	0.00039 in. (0.01 mm)

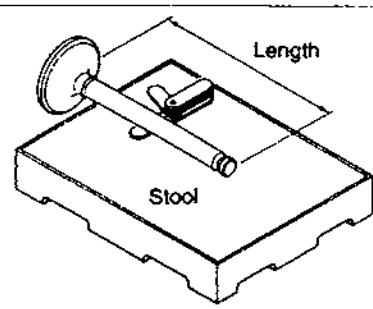


Valve head thickness

(e) Overall length

in. (mm)

	Standard	Limit
Intake	4.53 (115)	4.51 (114.5)
Exhaust	4.53 (115)	4.51 (114.5)



Valve bend and length

(4) Servicing points

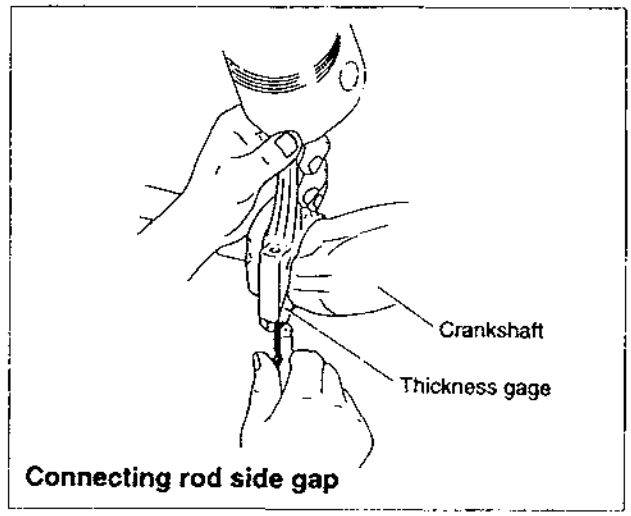
Point 1 Oil pan

Disassemble:

- Sealant is applied to the oil pan mounting surface on the block. Carefully operate so as not to damage or distort the bonding surface.

Reassemble:

- Apply sealant (code No.977770-01212) before reassembly.



Connecting rod side gap

Point 2 Piston w/rod

Disassemble:

- Measure the connecting rod side gap.

Standard : 0.0079 to 0.0157 in. (0.20 to 0.40 mm)

- Carefully remove the carbon deposit on top of the cylinder so as not to damage the inner side of the cylinder.
- Set the piston at the BDC position and remove the connecting rod cap. Then set the piston at the TDC position, and push the connecting rod big end with the wooden shaft of a hammer. Proceed carefully so as not to cause the cylinder block catch the rod big end. Set the rod caps and crankpin metals in their correct combinations.

Reassemble:

- Apply oil especially carefully to the sliding contact surfaces of the pistons, rods and rings.
- Use the piston insertion tool (see 10-1-9 in Chapter 10) to insert each piston w/rod in the cylinder block and install the bearing metal cap.

Rod bolt tightening torque : T = 39.8 to 43.4 ft·lbf. (53.9 to 58.8 N·m), apply lube oil

Point 3 Mounting flange

Disassemble:

Place the engine on a stable base with the cylinder block upper surface facing down, and remove the mounting flange carefully so as not to damage the combustion surface.

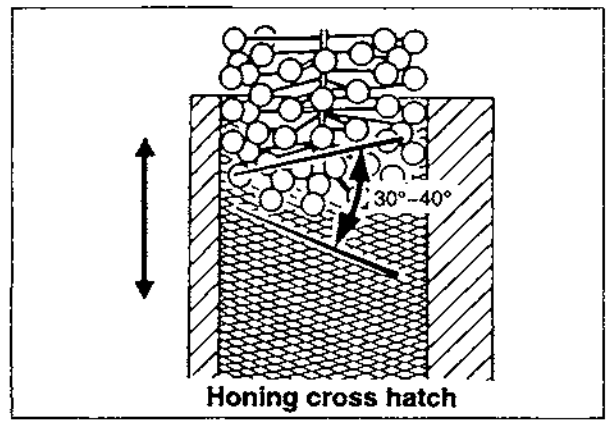
Reassemble:

Apply sealant (code No.977770-01212) and install the mounting flange by matching the two dowel pins. After assembly, raise the engine with its mounting flange on the bottom side.

⚠ CAUTION

Unforeseen injury may arise due to falling of slipping when raising or reversing the engine. Carefully operate so as not to lose balance.

③ Apply the honing fluid to the Flex-Hone and turn the electric drill at 300 to 1200 RPM. Then insert the Flex-Hone into the cylinder bore while turning it, and move it up and down for about 30 sec. to obtain a honing mark with a cross hatch angle of 30 to 40 degrees.

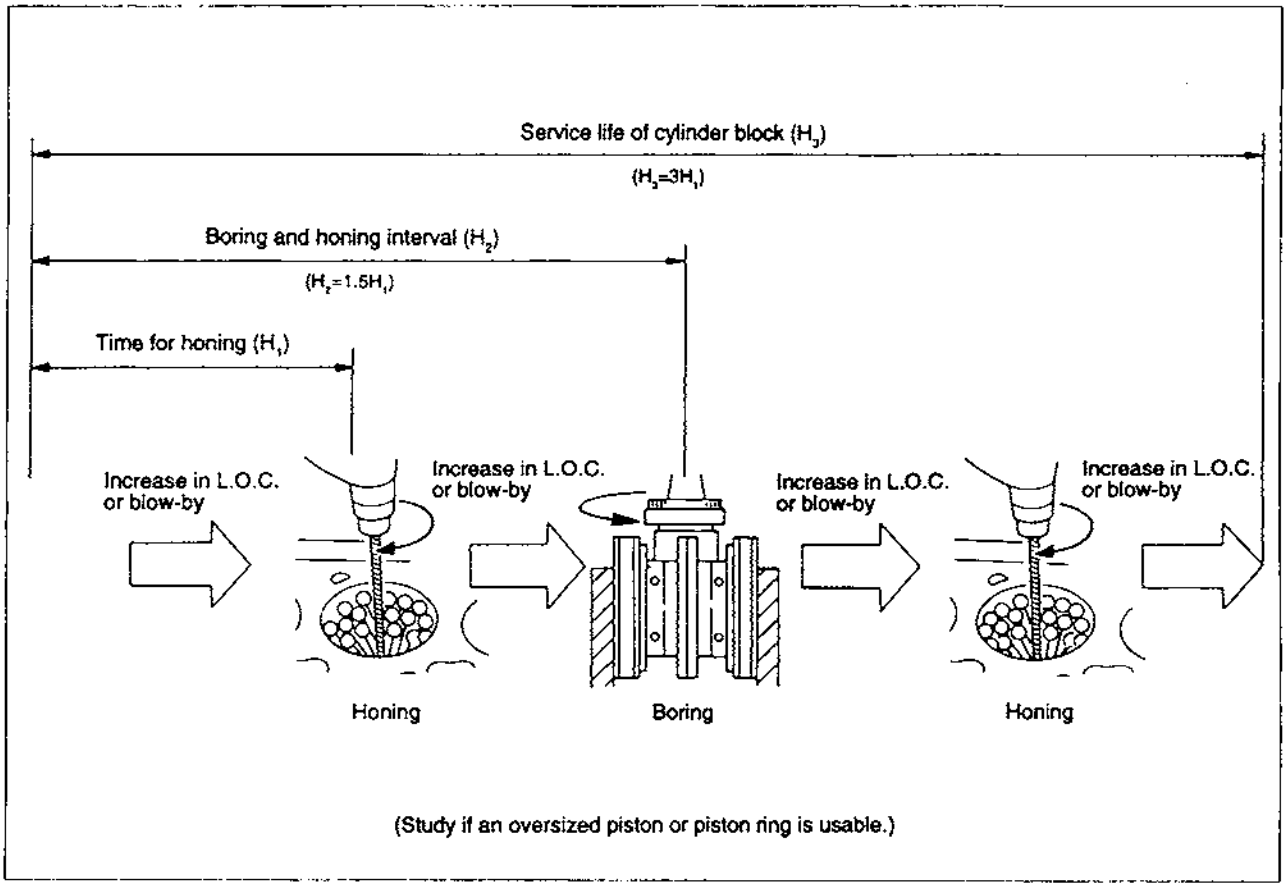


[NOTICE]

(1) Avoid faster revolution than 1200 RPM since it may cause breakdown.

(2) Do not insert or extract the Flex-Hone in stopped state because the cylinder will be damaged.

• Cylinder overhaul (reference)



(7) Piston pin bushing replacement

Replace bushing by using the special service tool (see 10-1-3 in Chapter 10).

(8) Oil seal replacement

① Replace oil seal, when mounting flange is removed. Extract the used oil seal.

② Insert a new oil seal with the oil seal insertion tool.

③ Apply lithium grease.

⑨ Remove the tappet. *(Point 8)*
⑩ Remove the plunger, spring and spring retainer, control sleeve and pinion.
⑪ Remove the lock plate, and remove the delivery valve, holder and spring.
⑫ Remove the plunger & barrel.
⑬ Remove the control rack from the pump housing.

[NOTICE]
Tappets, shims, springs, spring retainer, plunger & barrel, delivery valves, springs and delivery valve holders shall be grouped for each cylinder to enable mounting at original positions unless abnormalities are found.

(4) Assembly procedure

Reverse the disassembly procedure.

(5) Servicing points

Point 1

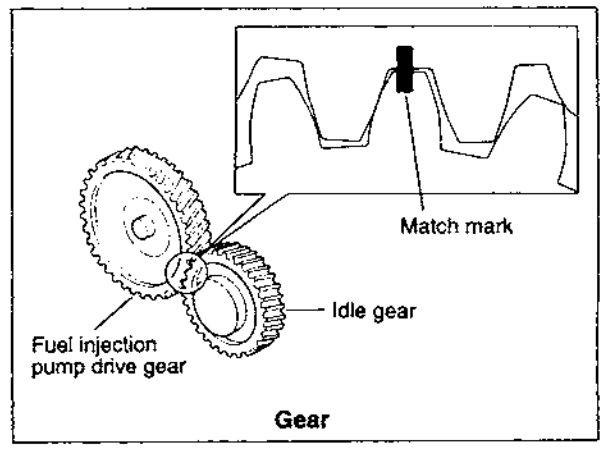
Disassemble:

- Remove the fuel injection pump drive gear and idle gear after putting a match mark.

Reassemble:

- Assemble them by aligning the match marks.

Pump drive gear nut : T = 61.4 to 68.7 ft·lbf. (83.3 to 93.1 N·m)



Gear

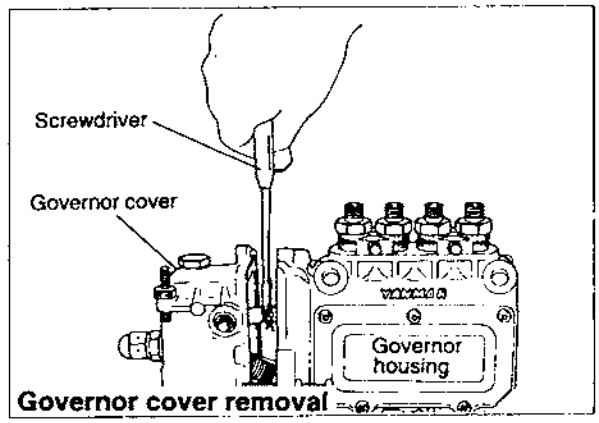
Point 2

Disassemble:

- Governor cover removal (See 7-5 (1) governor components.)

Because the link is connected to the control rack and the starting spring is connected to spring eye, disconnect the link connection by shifting the governor cover to the left (or right) after pushing the link leaf spring down with a screwdriver and disconnect the starting spring from the spring eye with long-nosed pliers before separating the governor cover from the governor housing.

[NOTICE]
When removing the governor cover, carefully operate so as not to bend the governor cover to either side from the governor housing. If the governor cover is bent while the link is connected, the link is bent to increase the sliding resistance of the control rack upon completion of the governor assembly, resulting in stiff governor movement.

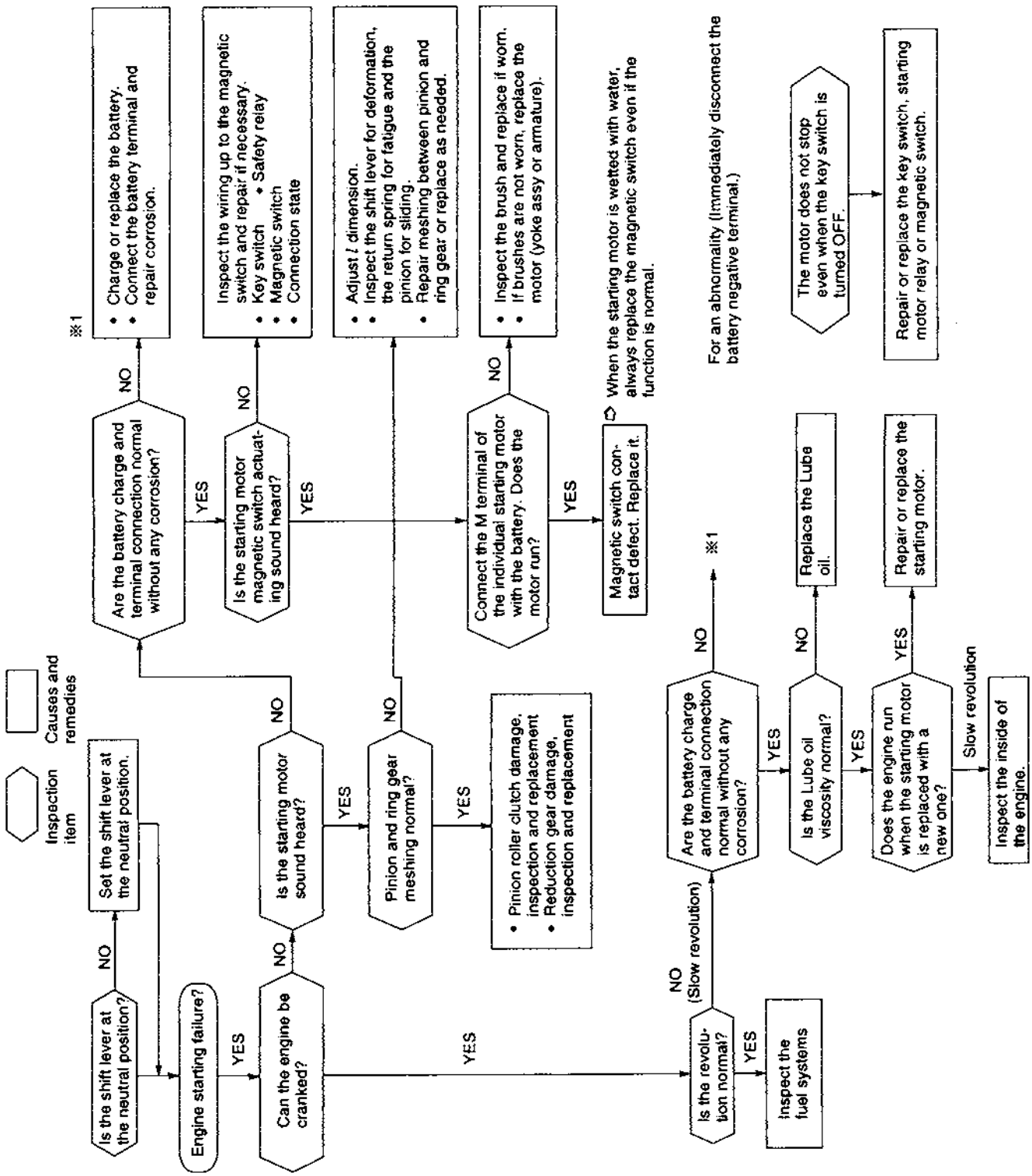


Governor cover removal

Reassemble:

- Coat sealant (code No.977770-01212) on the mating faces of the governor cover and governor housing.

8-3 Troubleshooting



(b) **Pinion sliding inspection**

Check if the pinion slide smoothly in the axial direction.

If damaged, rusted or heavy in sliding, repair it.

If grease is applied too much on the pinion shaft, sliding becomes heavy.

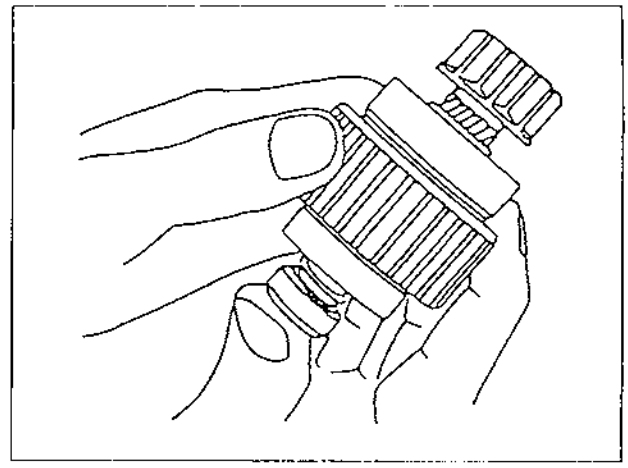


Fig. 25

(c) **Ball bearing inspection**

Rotate the ball bearing while holding the outer race with fingertips. Inspect if it is sticking or if there is play.

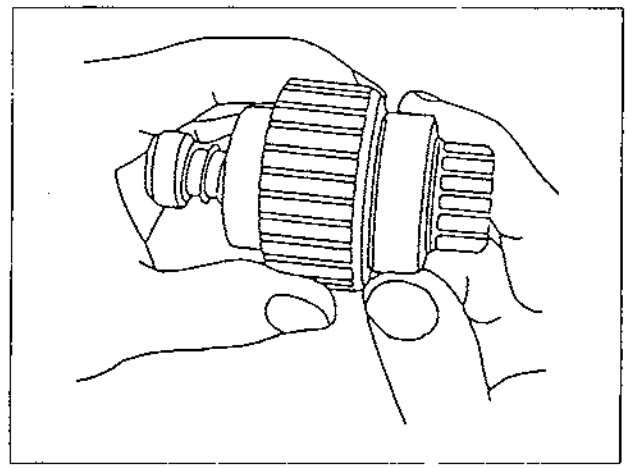


Fig. 26

Disassembly Procedures

1) Through bolt M5

Remove the M5 through bolt. Increase the temperature at the center of the rear cover by about 68 °F (20℃) using a soldering iron, insert two flat-head screwdrivers between the front cover and the stator core and separate the assembly into the front side (front cover and rotor) and the rear side (rear cover and stator).

Note:

Be sure careful not to damage the stator coil with the edges of the screwdrivers.

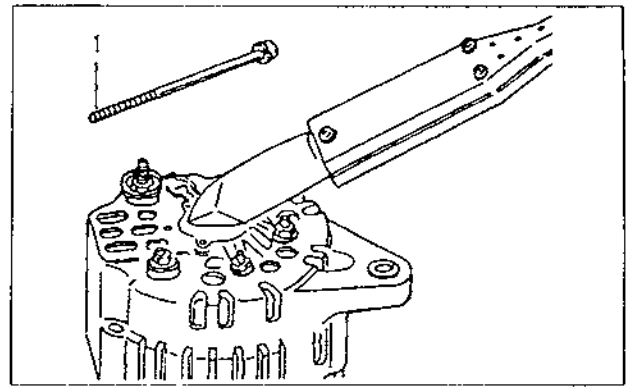


Fig. 1

2) Pulley nut

3) Pulley assembly

4) Rotor

Fix the rotor in a vice and remove the M15 (0.87 in. (22mm)) pulley nut to separate the pulley, front cover and rotor.

※ Dimensions shown in ( ) indicate the spanner sizes to be used.

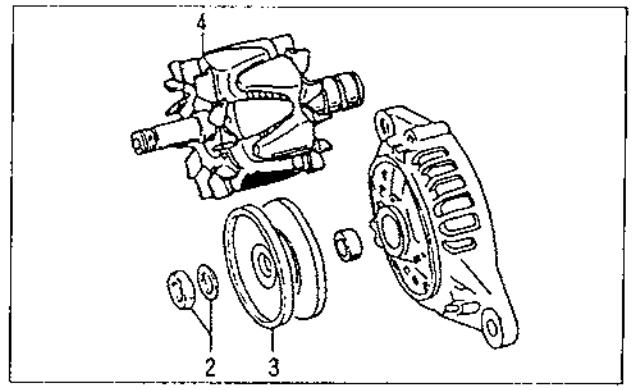


Fig. 2

5) Screw M4

6) Bearing retainer

7) Ball bearing

8) Front cover

Remove the M5 screw securing the bearing retainer to separate the bearing retainer, ball bearing and front cover.

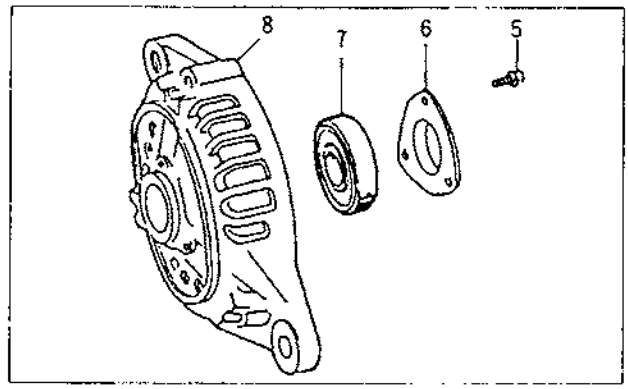


Fig. 3

9) Nuts M5 and M6

10) Rear cover

11) Lead wire assembly

Remove the M5 and M6 nuts securing the diode and IC regulator. Press in the grommet and lead wire of the lead wire assembly into the hole in the rear cover to separate the stay and rear cover.

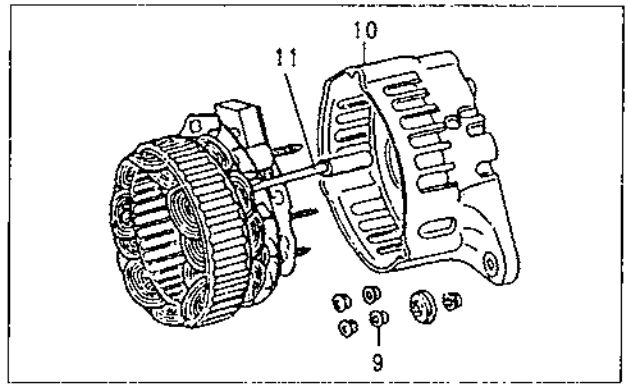
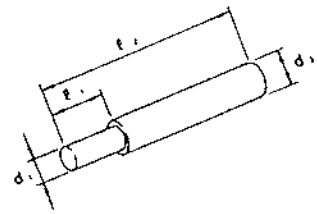
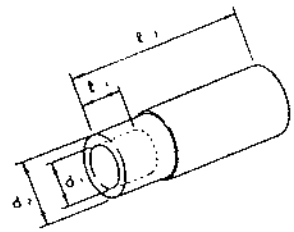
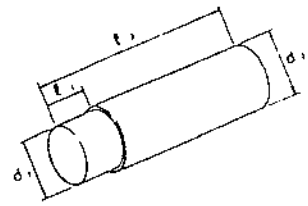
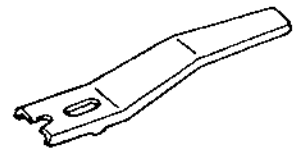
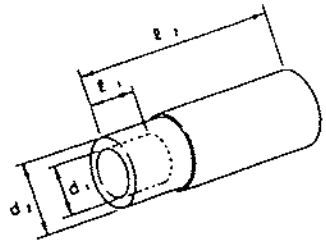


Fig. 4

10-1 Special Tools

<table>
<tr><th>No.</th><th>Tool name</th><th>Applicable model and tool size</th><th>Illustration</th></tr>
<tr><td>1</td><td>Valve guide tool (for extracting valve guide)</td><td>in. (mm)
<table><tr><th>ℓ1</th><th>ℓ2</th><th>d1</th><th>d2</th></tr><tr><td>0.79
(20)</td><td>2.95
(75)</td><td>0.30
(7.5)</td><td>0.43
(11)</td></tr></table>※ Locally manufactured</td><td>  </td></tr>
<tr><td>2</td><td>Valve guide tool (for inserting valve guide)</td><td>in. (mm)
<table><tr><th>ℓ1</th><th>ℓ2</th><th>d1</th><th>d2</th></tr><tr><td>0.59
(15)</td><td>2.56
(65)</td><td>0.55
(14)</td><td>0.79
(20)</td></tr></table>※ Locally manufactured</td><td>  </td></tr>
<tr><td>3</td><td>Connecting rod bushing replacer (for removal/ installation of connecting rod bushing)</td><td>in. (mm)
<table><tr><th>ℓ1</th><th>ℓ2</th><th>d1</th><th>d2</th></tr><tr><td>0.39
(10)</td><td>3.94
(100)</td><td>1.157 to 1.170
(29.4 to 29.7)</td><td>1.276 to 1.287
(32.4 to 32.7)</td></tr></table>※ Locally manufactured</td><td>  </td></tr>
<tr><td>4</td><td>Valve spring compressor (for removal/ installation of valve spring)</td><td><table><tr><th>Yanmar code No.</th></tr><tr><td>129100-92630</td></tr></table></td><td>  </td></tr>
<tr><td>5</td><td>Stem seal inserter (for inserting stem seal)</td><td>in. (mm)
<table><tr><th>ℓ1</th><th>ℓ2</th><th>d1</th><th>d2</th></tr><tr><td>0.75
(19)</td><td>2.56
(65)</td><td>0.65
(16.5)</td><td>0.91
(23)</td></tr></table>※ Locally manufactured</td><td>  </td></tr>
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