YANMAR

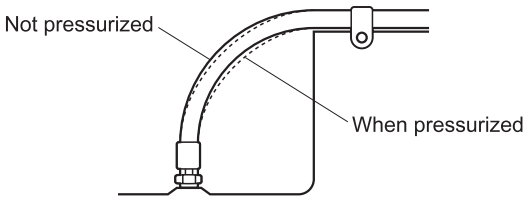
SERVICE MANUAL

EXCAVATOR

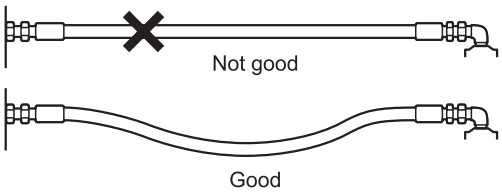
MODEL ViO20

220104

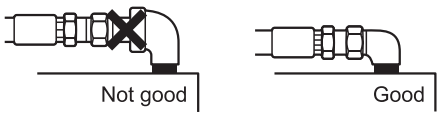
(3) When the hose is pressurized, the hose length varies slightly at the bend. Allow this change to occur and do not try to fasten the bend.



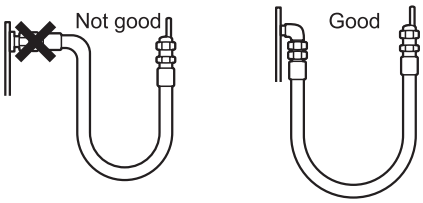
(4) It is necessary for the hose to have ample slackness for elongation and contraction, because its length will change by +2 % to -4 % when used at high pressure.



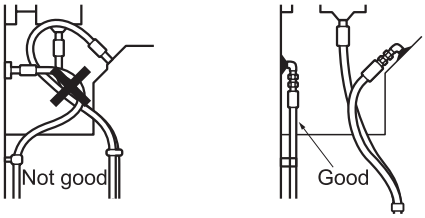
(5) Use the proper adapters, not pipes, in order to reduce the number and length of joints and improve the external appearance.



(6) Use an elbow to prevent excessive twisting or bending of the hose.



(7) Use adapters to make the hose as straight as possible. The outside appearance can be improved by avoiding the use of hoses that are too long.



2. TECHNICAL DATA

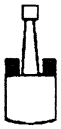
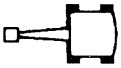
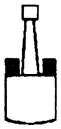
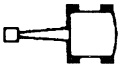
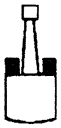
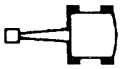
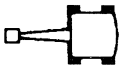
Note : *< > : W/O Quick coupler type*

Item				Unit	ViO20
Main specifications of machine					
Work performance					
Swing speed				rpm	9.5
Fuel consumption in practical operation				Gals/h (L/h)	0.77 (2.9)
Blade					
Blade	Width×Height			in. (mm)	54.3 (1380)×11.2 (285)
	Capacity			cu.ft. (cu.m)	3.88 (0.11)
	Lift above ground level			in. (mm)	14.6 (370)
	Digging depth			in. (mm)	13.4 (340)
Mean contact pressure					
JIS		Steel crawler	Cabin	PSI (KPa)	-
			Canopy	PSI (KPa)	3.6 (24.8) <3.5 (24.4)>
		Rubber crawler	Cabin	PSI (KPa)	-
			Canopy	PSI (KPa)	3.6 (24.8) <3.5 (24.4)>
Mass					
Operating mass		Steel crawler	Cabin	lbs. (kg)	-
			Canopy	lbs. (kg)	4851 (2200)
		Rubber crawler	Cabin	lbs. (kg)	-
			Canopy	lbs. (kg)	4851 (2200)
Base machine dry mass		Steel crawler	Cabin	lbs. (kg)	-
			Canopy	lbs. (kg)	3561 (1615)
		Rubber crawler	Cabin	lbs. (kg)	-
			Canopy	lbs. (kg)	3561 (1615)
Hydraulic equipment					
Hydraulic pump					
Drive method					Engine → Coupling → Pump (Direct drive)
Type of main pump					Variable displacement piston pump + Fixed displacement external gear pump + Fixed displacement internal gear pump
Number of pumps					Variable displacement piston pump : 2 + Gear pump : 1 + Trochoid pump : 1
Theoretical discharge volume				cu.in./rev (cu.cm/rev)	0.55 (9)×2, 0.54 (8.8)×1, 0.31 (5.1)×1
Maximum allowable pressure				PSI (MPa)	2986 (20.6)×2, 2417 (16.7)×1, 427 (2.9)×1
Control valve					
Number of connected valves				pcs.	11
System relief set pressure		P1, P2		PSI (MPa)	2986 (20.6)
		P3		PSI (MPa)	2417 (16.7)
Circuit relief set pressure		Boom (at rod end)		PSI (MPa)	3555 (24.5)
		Boom (at bottom end)		PSI (MPa)	Anti-cavitation
		Arm (at rod end)		PSI (MPa)	Anti-cavitation
		Arm (at bottom end)		PSI (MPa)	3271 (22.6)

2. TECHNICAL DATA

Blade above ground

Unit : lbs. (kg)

A [in. (m)]	Max.		98.4 (2.5)		78.7 (2.0)		Min.	
B [in. (m)]								
78.7 (2.0)	684 (310)	639 (290)	948 (430)	970 (440)	–	–	–	–
59.1 (1.5)	650 (295)	573 (260)	1069 (485)	937 (425)	1444 (655)	1345 (610)	–	–
39.4 (1.0)	606 (275)	518 (235)	1014 (460)	904 (410)	1433 (650)	1235 (560)	–	–
19.7 (0.5)	606 (275)	518 (235)	1014 (460)	849 (385)	1411 (640)	1202 (545)	–	–
0 (0)	617 (280)	540 (245)	970 (440)	849 (385)	1345 (610)	1180 (535)	1742 (790)	1466 (665)
-19.7 (-0.5)	684 (310)	606 (275)	970 (440)	849 (385)	1345 (610)	1180 (535)	–	–
-39.4 (-1.0)	849 (385)	772 (350)	981 (445)	871 (395)	1433 (650)	1180 (535)	–	–

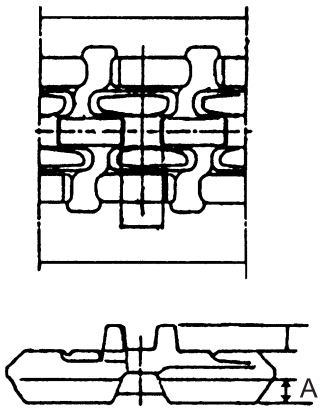
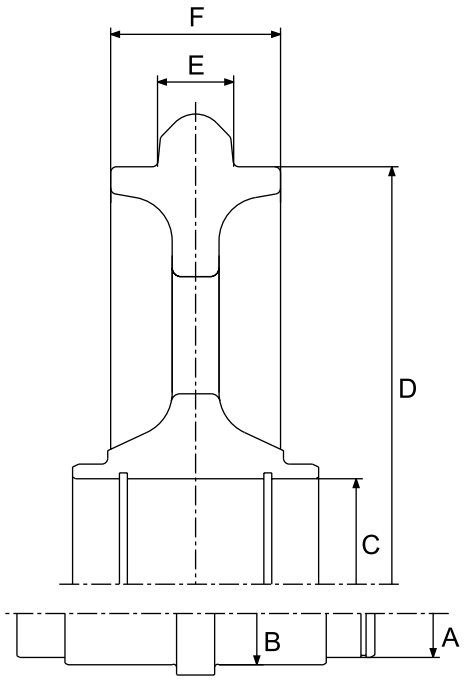
Note :

The lifting load with the asterisk (*) mark is limited by hydraulic lifting capacity rather than tipping. The lifting capacity shown in the above list is based on the ISO Standard No. 10567 and represents either 87 % of hydraulic lifting capacity or 75 % of tipping load, which is smaller.

3-3 Undercarriage

3-3-1 Rubber Crawler Specifications

[Unit : in. (mm)]

Applicable model	ViO20		
Part	Measuring position	Standard	Wear limit
Rubber crawler specifications			
(1) Rubber crawler 	A	0.91 (23)	0.39 (10)
(2) Idler & shaft 	A	Ø1.18 (Ø30)	–
	B	Ø1.38 (Ø35)	–
	C	Ø2.83 (Ø72)	–
	D	Ø11.2 (Ø285)	Ø11.0 (Ø279)
	E	1.02 (26)	0.79 (20)
	F	2.28 (58)	2.09 (53)

3-7-2 Engine

Tightening torque for major bolts and nuts

No.	Item	Thread size × Pitch	Tightening torque Unit : ft•lbf (N•m)	Lubricating oil
1	Cylinder head bolt (class 1)	M9 × 1.25	43.4 to 47.0 (58.8 to 63.7)	Yes
2	Connecting rod bolt (class 1)	M7 × 1.0	16.6 to 20.3 (22.5 to 27.4)	Yes
3	Flywheel mounting bolt	M8 × 1.25	57.9 to 65.1 (78.4 to 88.2)	Yes
4	Metal cap bolt	M8 × 1.25	57.9 to 65.1 (78.4 to 88.2)	Yes
5	Crankshaft pulley fastening bolt	M12 × 1.5	61.5 to 68.7 (83.4 to 93.1)	Yes
6	Fuel injection nozzle retainer clamp nut	M20 × 1.5	36.2 to 39.1 (49.0 to 52.9)	No
7	Glow plug	M10 × 1.25	10.9 to 14.5 (14.7 to 19.6)	No
8	Governor weight support nut	M12 × 1.25	50.6 to 54.3 (68.6 to 73.5)	Yes
9	High pressure pipe nut	M12 × 1.5	21.7 to 25.3 (29.4 to 34.3)	No

3-7-3 Tightening Torque for General Bolts and Nuts

Item		Thread size × Pitch	Tightening torque [Unit : ft•lbf (N•m)]	Remarks
Hexagon head bolt (7T) Nut	Coarse thread	M6 × 1	7.23 to 8.68 (9.8 to 11.8)	1) Apply 80% of tightening torque when tightened to aluminum. 2) Apply 60% of tightening torque for 4T bolts and lock nuts. 3) Use fine screw threads for engine only.
		M8 × 1.25	16.6 to 21.0 (22.6 to 28.4)	
		M10 × 1.5	32.6 to 43.4 (44.1 to 58.8)	
		M12 × 1.75	57.9 to 72.3 (78.5 to 98.1)	
		M14 × 2	86.8 to 108.5 (117.7 to 147.1)	
		M16 × 2	123.0 to 151.9 (166.7 to 205.9)	
		M18 × 2.5	173.6 to 209.8 (235.4 to 284.4)	
		M20 × 2.5	238.7 to 296.6 (323.6 to 402.1)	
	Fine thread	M14 × 1.5	94.0 to 108.5 (127.5 to 147.1)	
		M16 × 1.5	155.5 to 177.2 (210.9 to 240.3)	
PT plug		1/8	7.23 (9.8)	
		1/4	14.5 (19.6)	
		3/8	21.7 (29.4)	
		1/2	43.4 (58.8)	
Pipe joint bolt		M8	9.4 to 12.3 (12.7 to 16.7)	
		M12	18.1 to 25.3 (24.5 to 34.3)	
		M14	28.9 to 36.2 (39.2 to 49.0)	
		M16	36.2 to 43.4 (49.0 to 58.8)	

4-2 Measurement Procedure, Service Data and Corrective Action

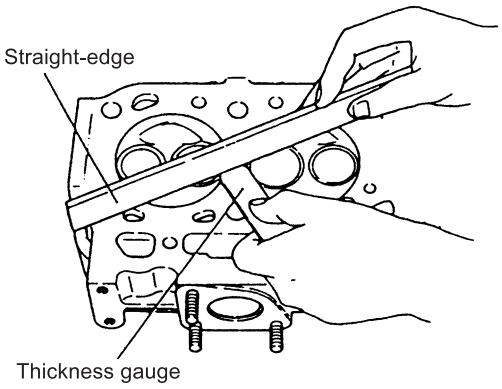
For the maintenance of all parts, make measurements according to the following measurement procedure. If any part is found to be defective or if any part is not within the allowable value, replace it with a new one. However, if it is expected that any part within the allowable value will exceed the value before the next maintenance based on the record of its use, be sure to replace such a part beforehand.

4-2-1 Cylinder Head

1) Checking the Combustion Surface for Distortion

(1) Remove the intake / exhaust valves and the fuel injection valve from the engine. Clean the surface of the cylinder head.

(2) Place a straight-edge along each of the four sides and each diagonal of the cylinder head. Measure the clearance between the straight-edge and the combustion surface with a thickness gauge.



(Measuring the combustion surface distortion)

Cylinder head combustion surface distortion	Standard	Wear limit
Refer to Section "3-2 1) Nominal and Allowable Values".		

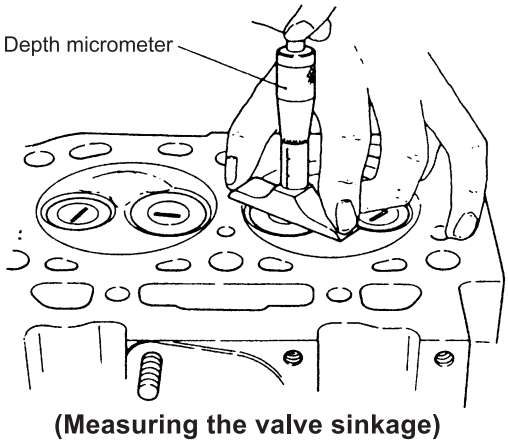
(3) Visually check if the combustion surface is free from discoloration, cracks, and crazing. In addition, use the color check kit for cracks and crazing.

2) Intake / Exhaust Valve Seat

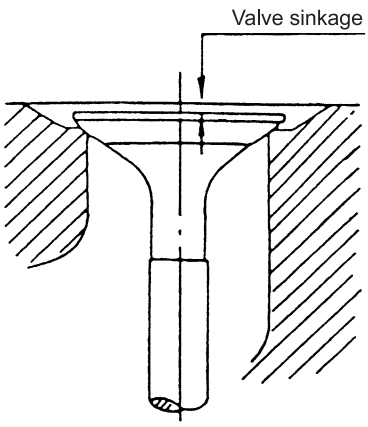
(1) Valve sinkage

Over long periods of use and repeated lappings, combustion efficiency may drop. Measure the sinking depth and replace the valve and valve seat if the valve sinking depth exceeds the standard value.

		Standard.	Wear limit
Valve sinkage	Intake valve	Refer to Section "3-2 1) Nominal and Allowable Values".	
	Exhaust valve		

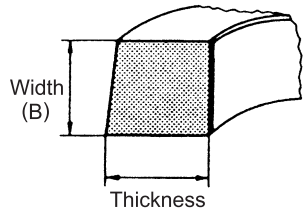


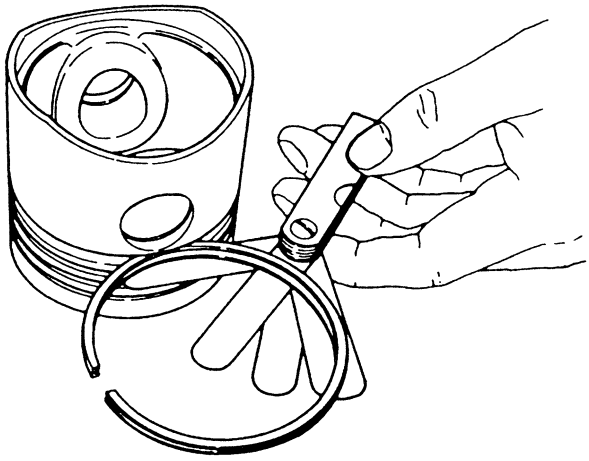
(Measuring the valve sinkage)



4) Measuring the Ring Groove Width, the Ring Width (B), and the End Gap

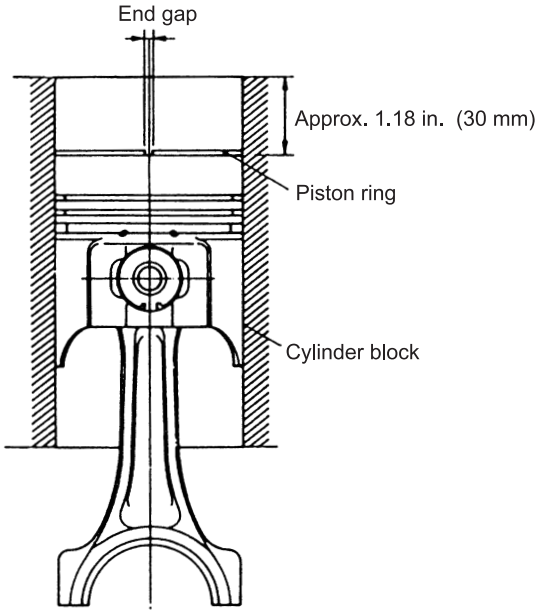
To measure the piston ring groove width, first measure the width (B) of the piston ring. Then, fit the piston ring into the ring groove after cleaning the groove carefully. Insert a thickness gauge between the piston ring and the groove to measure the clearance between them. Obtain the ring groove width by adding the ring width to the measured clearance.





(Measuring the ring groove width)

To measure the end gap, push the piston ring into the sleeve using the piston head, insert a thickness gauge between both ends of the piston ring. If the sleeve is worn, measure the end gap after pushing the piston ring into the sleeve to the portion which is less worn (approx. 1.18 in. (30 mm) from the lower end of the sleeve).



(Measuring the end gap of piston ring)

		Standard	Wear limit
Top ring	Ring groove width	Refer to Section "3-2 1) Nominal and Allowable Values".	
	Ring width (B)		
	Clearance between groove and ring		
	End gap		
Second ring	Ring groove width		
	Ring width (B)		
	Clearance between groove and ring		
	End gap		
Oil ring	Ring groove width		
	Ring width (B)		
	Clearance between groove and ring		
	End gap		

4-2-9 Trochoid Pump

1) Servicing Points

Point 1

Disassemble :

• Check if the pump rotates smoothly and see that there is no play between the shaft and gear, and inner rotor.

Reassemble :

• Install the outer rotor in the gear case so that the punch mark on the end face is seen.

• For installation on the gear case, tighten four bolts uniformly in several steps.

Note :

Always check if the pump rotates smoothly after installation on the gear case.

Running the engine when the pump rotation is heavy may cause the pump to be burnt.

• When replacing the lubricating oil pump, replace the whole ass'y.

Point 2

Disassemble - Reassemble :

• Only wash the pressure regulating valve. Disassembly is unnecessary unless any abnormality in operation is detected.

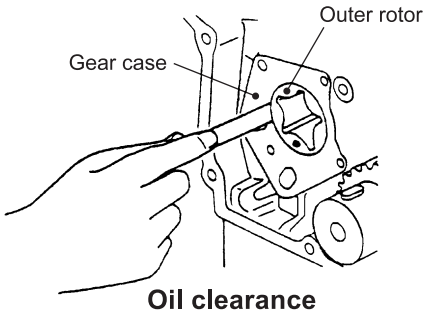
2) Parts Inspection and Measurement

(1) Outer rotor

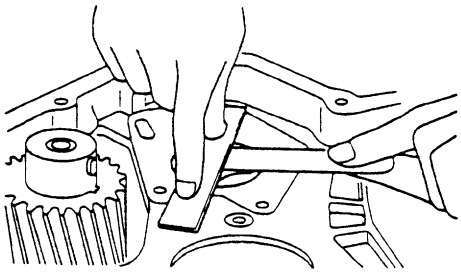
in. (mm)	Standard	Wear limit
Oil clearance	0.0039 to 0.0063 (0.10 to 0.16)	0.0098 (0.25)
Side clearance	0.0020 to 0.0039 (0.05 to 0.10)	0.0059 (0.15)

(2) Rotor shaft

in. (mm)	Standard	Wear limit
Shaft O.D.	0.3928 to 0.3932 (9.978 to 9.987)	0.3924 (9.968)
Bearing I.D.	0.3945 to 0.3952 (10.020 to 10.038)	0.3960 (10.058)
Clearance	0.0013 to 0.0024 (0.033 to 0.060)	0.0035 (0.090)

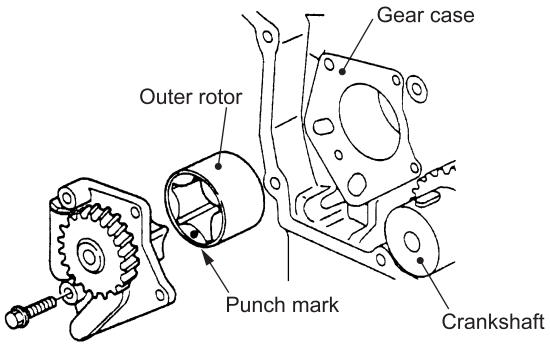


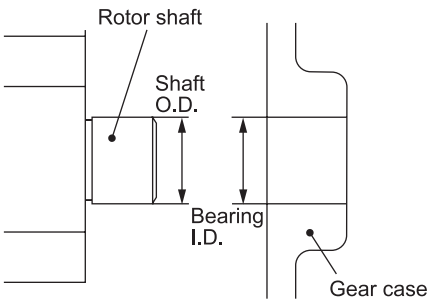
Oil clearance



Side clearance

3) Trochoid Pump Components





Lube oil pump bearing

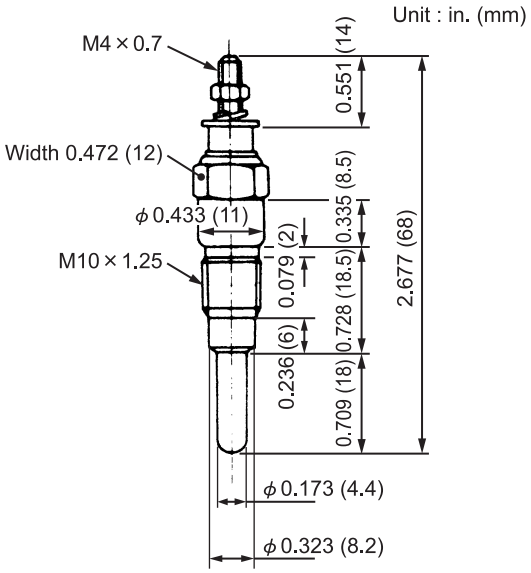
4-5-3 Glow Plug

The air heater is available for warming combustion chamber during starting in cold weather. The glow plug is mounted on the cylinder head.
The device is operated by the key switch on the instrument panel.

Specifications

Yanmar code	129155-77801
Rated voltage	DC10 V
Rated current	8.5 to 11.5 A
Rated operating time	4 sec.
Applicable model	3TNE74-ENBV

Dimensions



Tightening torque :
Body : 10.8 to 14.5 ft•lbs. (14.7 to 19.6 N•m)
Nut : 0.72 to 1.08 ft•lbs. (1.0 to 1.5 N•m)

5-3 Circuit Operation

5-3-1 Boom

1) Boom "Up"

(1) Pilot oil flow

When the boom control lever is pulled back to raise the boom, the oil from the pilot pump P4 flows through the cut-off valve and the port 1 of the pilot valve (RH) to the port a8' of the parallel-flow divider and the port a8 of the boom section to move their spools.

(2) Oil flow from hydraulic pump

The oil discharged from the piston pump P1 flows to the boom section through the port P1 of the inlet section, while the oil discharged from the gear pump P3 flows to the boom section through the port P3 of the parallel-flow divider and the parallel passage, and combines with the oil from the piston pump P1. Then the combined oil opens the check valve of the anti-drift valve in the boom section and flows through the port A9 to BU of the boom cylinder to extend its cylinder rod, raising the boom. The return oil from BD of the boom cylinder flows back to the hydraulic oil tank through the port B8 of the boom section and the ports T1 and T2 of the control valve.

2) Boom "Down"

(1) Pilot oil flow

When the boom control lever is pushed forward to lower the boom, the oil from the pilot pump P4 flows to the piston of the anti-drift valve through the cut-off valve, the port 3 of the pilot valve (RH) and the port b8' of the anti-drift valve to open the check valve. The pilot oil also flows to the port b8 of the boom section to move its spool.

(2) Oil flow from hydraulic pump

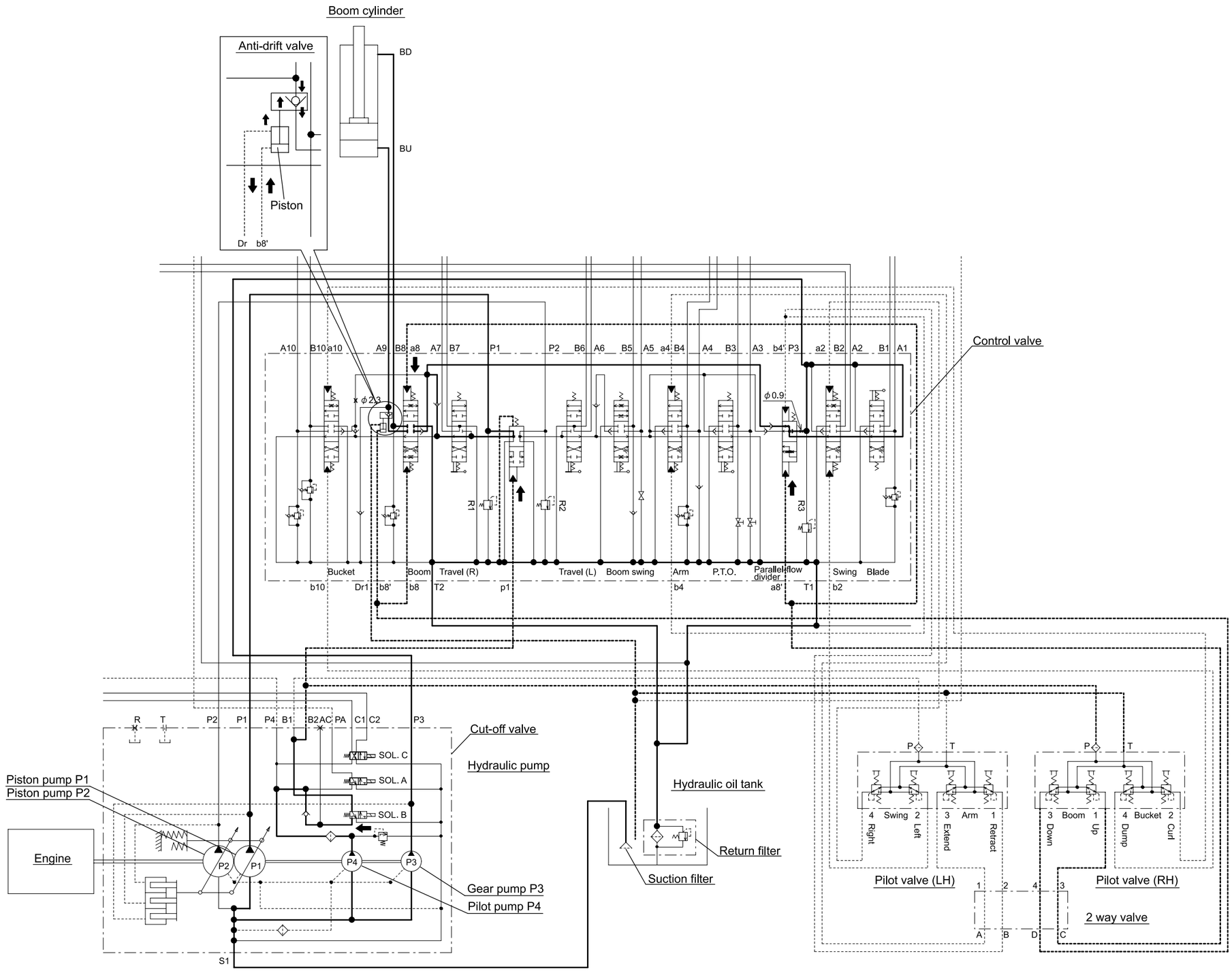
The oil flows in the opposite direction to the oil flow in the boom up operation with regard to the boom cylinder.

<OPT> pattern

The boom control lever and the arm control lever changes mutually operation from standard pattern.

The oil from port 1 of the pilot valve (LH) flows to port C of the 2 way valve to move the boom section spool in boom up position.

The oil from port 3 of the pilot valve (LH) flows to port D of the 2 way valve to move the boom section spool in boom down position.



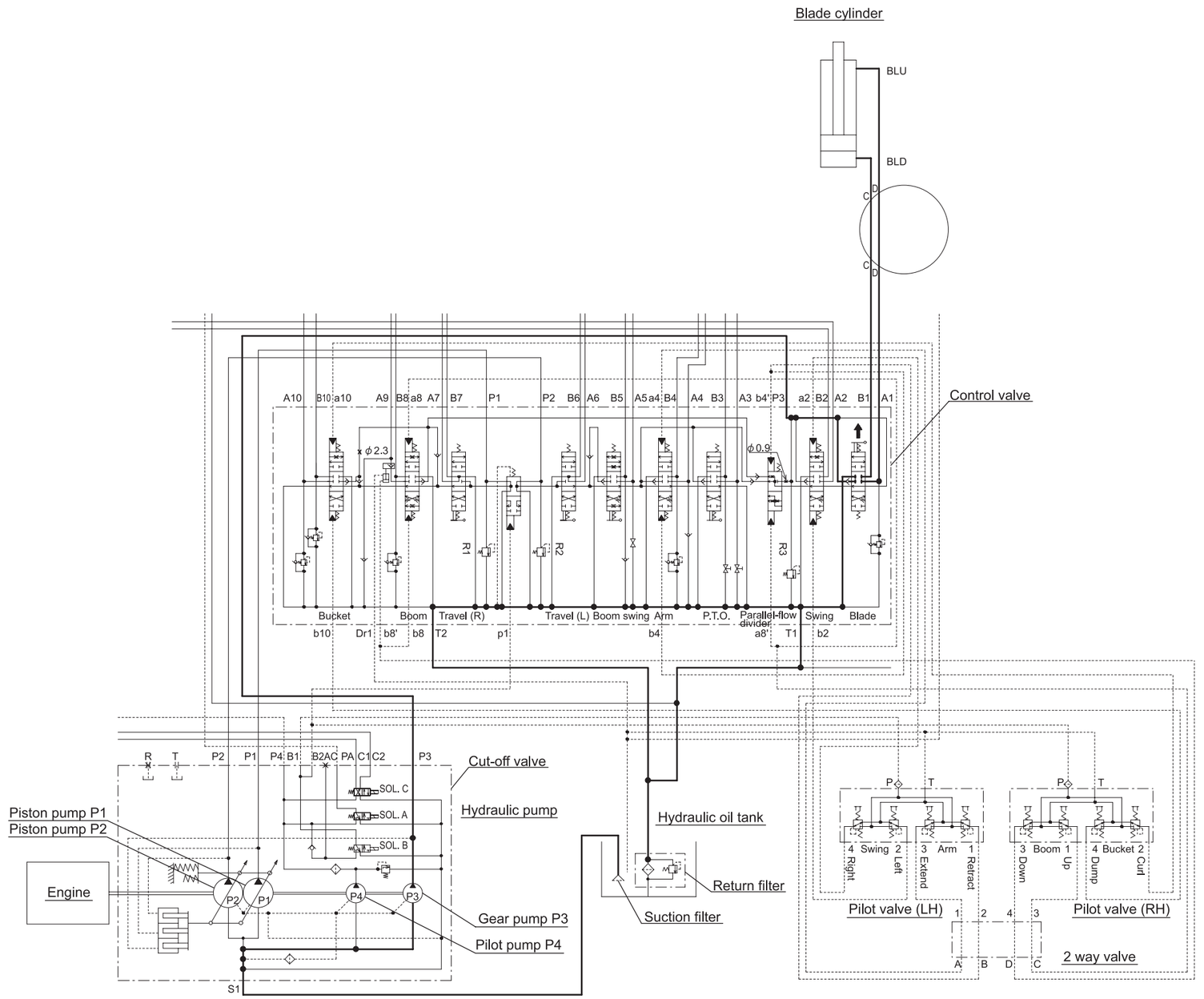
5-3-6 Blade

The blade lever is linked to the spool of the control valve through an L-ball and a blade cable.

1) Blade "Down"
Oil Flow from Hydraulic Pump
When the blade lever is pushed forward to lower the blade, the spool is pulled back. The oil from the gear pump P3 flows through the port P3 of the parallel-flow divider, the parallel passage, the port B1 of the blade section and the port D of the swivel joint to BLD of the blade cylinder to extend its cylinder rod, lowering the blade.
The return oil from BLU of the blade cylinder flows back to the hydraulic oil tank through the port C of the swivel joint, the port A1 of the blade section and the ports T1 and T2 of the control valve.

2) Blade "Up"
Oil Flow from Hydraulic Pump
When the blade lever is pulled back to raise the blade, the spool is pressed forward. The oil flows in the opposite direction to the oil flow in the blade down operation with regard to the blade cylinder.

3) Circuit Relief Valve Installed in Blade "UP" Circuit
When the blade is raised while the machine is traveling, the oil quantity control function of the hydraulic pump operates to reduce its discharge volume, and the travel speed is slowed down. To minimize such speed reduction, a circuit relief valve with the set pressure lower than that of the system relief valve is installed in the blade cylinder circuit for raising the blade.

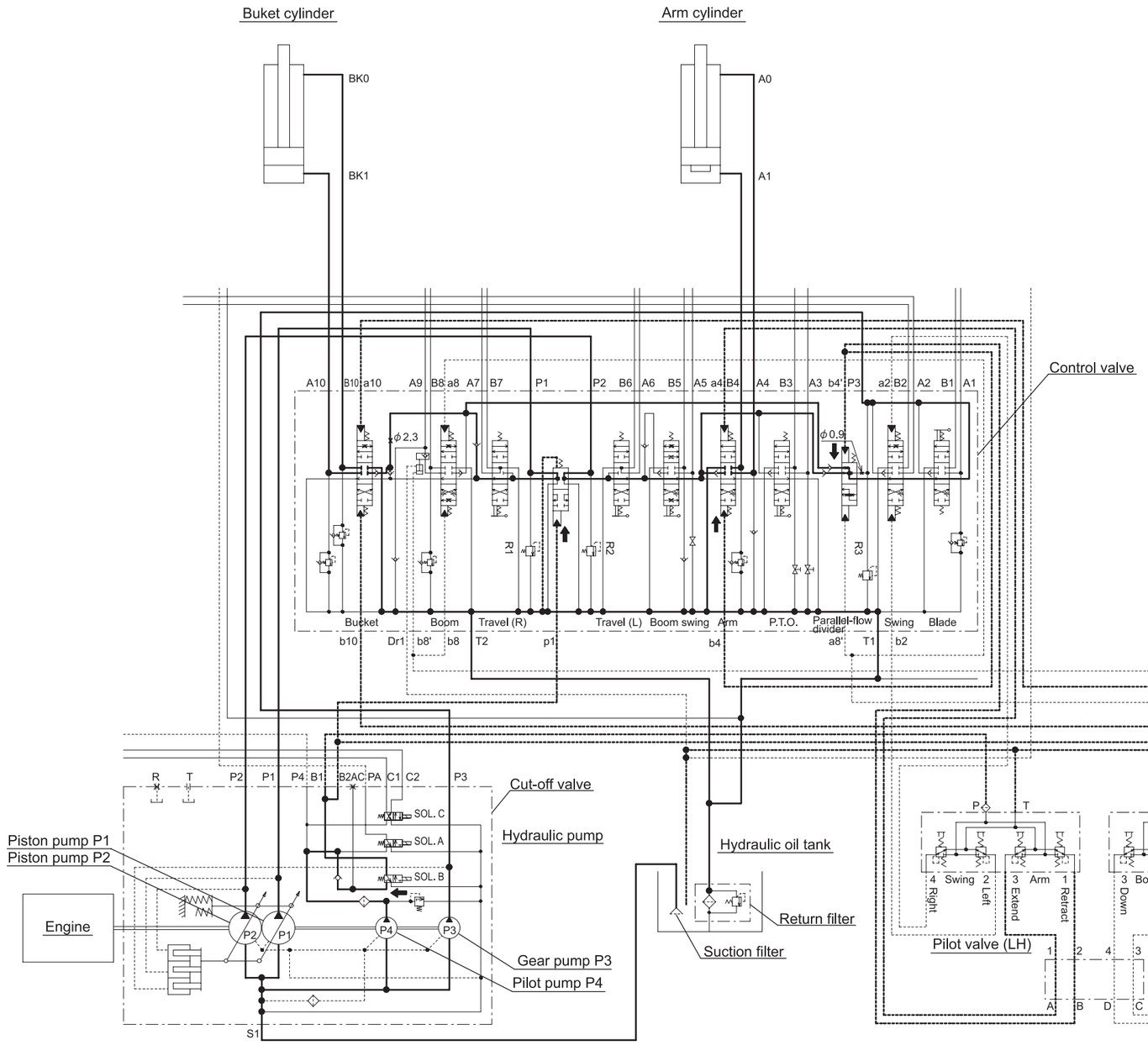


5-3-11 Simultaneous Operation of Arm and Bucket

Oil Flow from Hydraulic Pump

When the arm is given a heavy load, the horsepower control shift of the gear pump P3 works to discharge volume of the piston pump P2, so that the arm speed slows down. To make up for the arm speed reduction, the oil from the gear pump P3 flows through the throttle of the parallel-flow divider and the parallel passage to the arm section and combines with the oil from the piston pump P2.

Refer to Section "5-3-2 Arm" and Section "5-3-3 Bucket" for the oil flow with regard to the arm and bucket cylinders.



5-4-2 Swing Brake Valve

1) Conditions

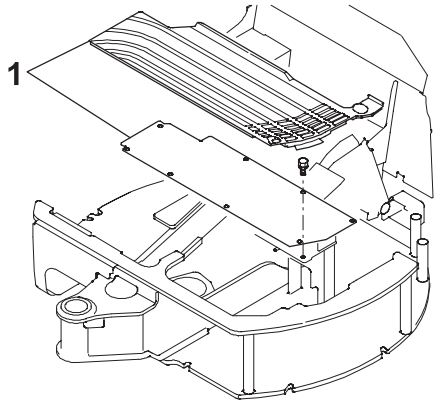
(1) Engine : rated speed
(2) Hydraulic oil temperature : 122 to 140 °F (50 to 60 °C)
(3) Pressure gauge capacity : 4977.1 PSI (34.3 MPa)
(4) Set pressure : 1635.3 (11.3 MPa)

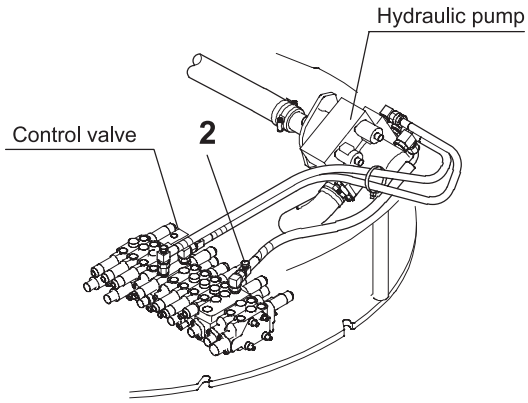
2) Measuring Procedure

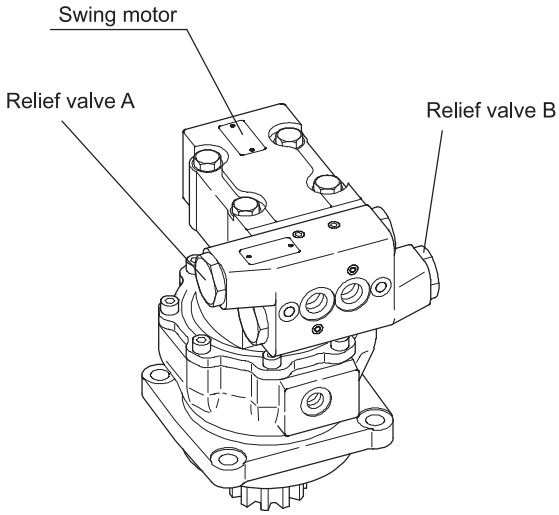
(1) Remove the floor mat and step **1**.
(2) Remove the plug (PT1/8) **2** to install the pressure gauge.
(3) Fix the upperstructure and move the swing lever to the right and the left, hold the lever with relief pressure applied and read the gauge.

3) Adjustment Procedure

(1) Since this relief valve is not adjustable, replace the relief valve assembly with a new one if the relief pressure needs to be adjusted.

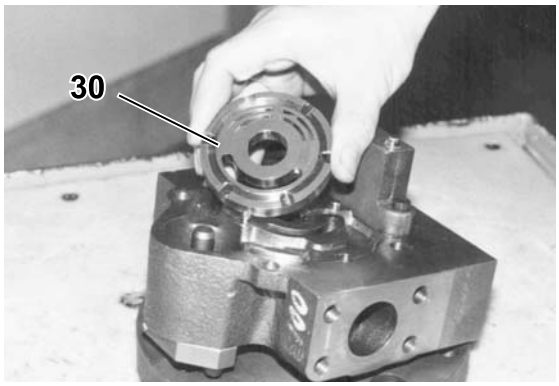
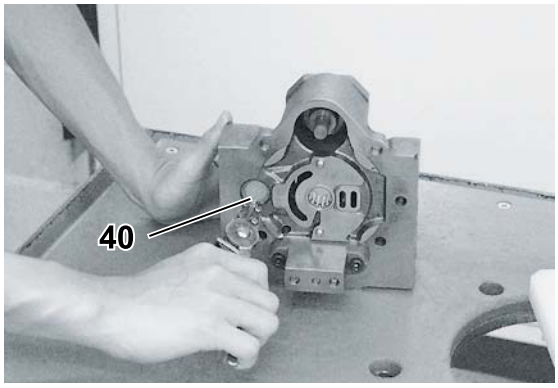
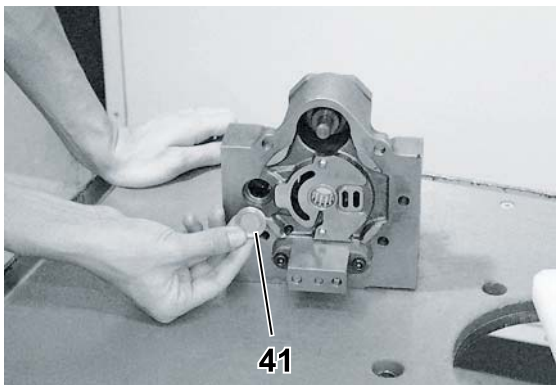
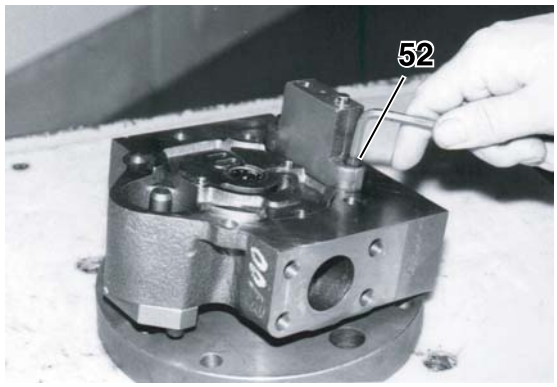


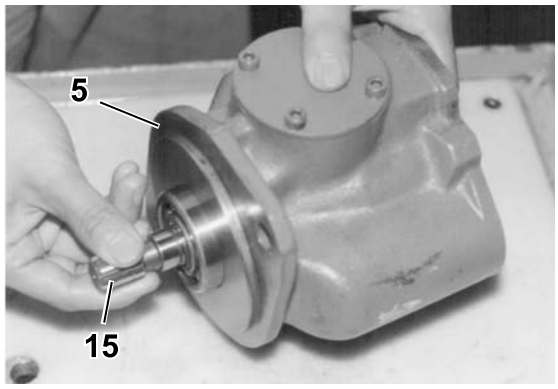
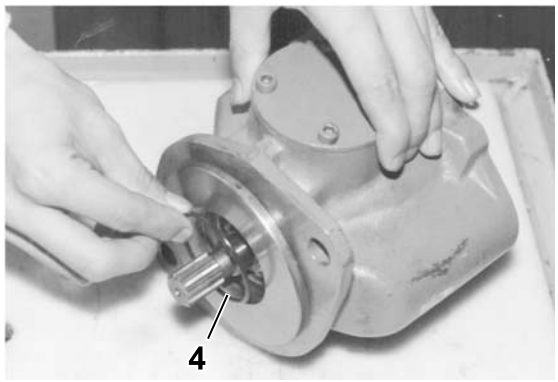
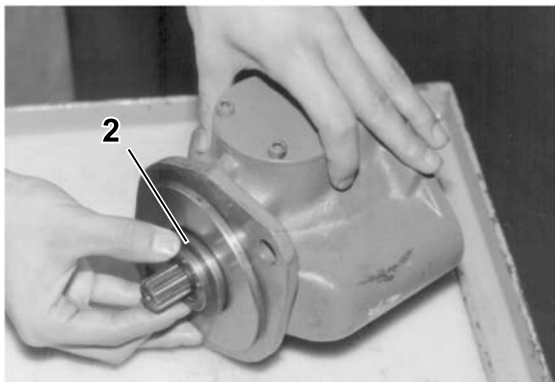
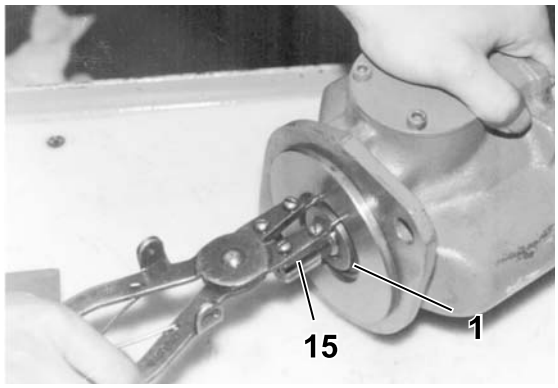


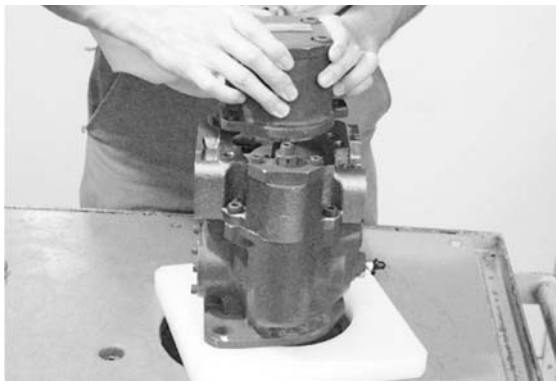
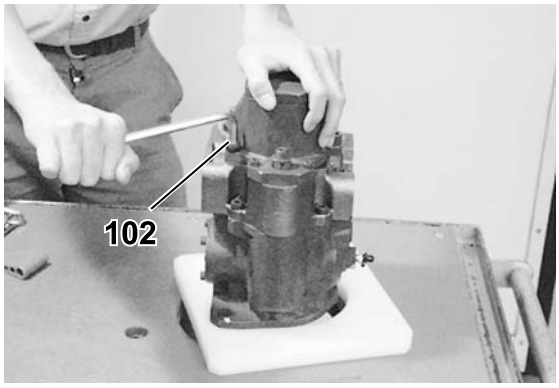
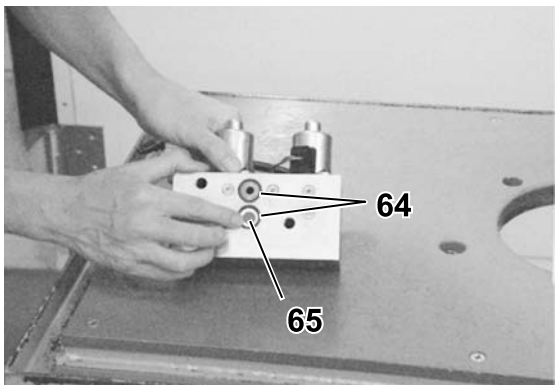
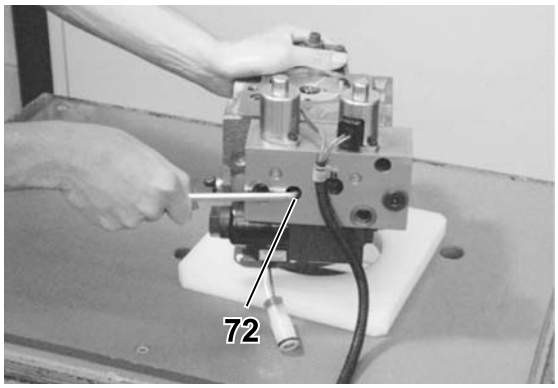


6. HYDRAULIC EQUIPMENT

No.	Part	Q'ty	No.	Part	Q'ty	No.	Part	Q'ty
1	Internal snap ring C 62	1	39	Hexagon socket head bolt M8×55	2	77	Solenoid (A)	1
2	Seal case	1	40	Internal snap ring C	1	78	Solenoid (B)	1
3	Oil seal	1	41	Filter	1	79	Clamp	1
4	O-ring 140	1	42	Cover	1	80	Cover	1
5	Housing	1	43	Spring seat	1	81	Wire clamp	1
6	O-ring 1B P14	2	44	Spring	1	82	Spool	1
7	Bushing	1	45	Spring	1	83	Spring	1
8	Bleeder valve	1	46	Spring seat (B)	1	84	Shim	1
9	Plug	1	47	O-ring 1A P9	1	85	O-ring	1
10	Bearing	2	48	Spring seat (A)	1	86	Adjust screw	1
11	Distance piece	1	49	O-ring 1A P18	1	87	Hexagon nut	1
12	O-ring 1A G45	1	50	Dowel pin	1	88	Spring pin	1
13	Cover	1	51	Piston	2	89	Side plate (B)	1
14	Hexagon socket head bolt M6×12	4	52	Hexagon socket head bolt M6×20	3	90	Gear	1
15	Shaft	1	53	Cylinder	1	91	Side plate (A)	1
16	Key	1	54	O-ring 015	1	92	O-ring	1
17	Bearing	1	55	O-ring 012	2	93	Plate	1
18	External snap ring C 20	1	56	Piston	1	94	Case	1
19	Bush	1	57	Cone disc spring	2	95	Spring pin	1
20	Hanger	1	58	Spring seat	1	96	Hexagon socket head bolt M5×12	3
21	Plate	1	59	Shim	—	97	O-ring 1A G90	1
22	Piston	10	60	Cover	1	98	Internal snap ring C 13	1
23	Retainer	1	61	Adjust screw	1	99	Coupling	1
24	Retainer holder	1	62	Hexagon nut M12	1	100	O-ring 1B P16	1
25	Dowel pin	3	63	Body	1	101	Housing	1
26	Cylinder barrel	1	64	O-ring 017	2	102	Hexagon socket head bolt M10×25	2
27	Spring seat	2	65	Filter element	1	103	Plate	1
28	Spring	1	66	Plug	8	104	Square ring	2
29	Internal snap ring C 25	1	67	Plain washer	1	105	Side plate assembly	2
30	Valve plate	1	68	Hexagon socket head bolt M4×10	5	106	Gear (Drive)	1
31	Packing	1	69	Steel ball	1	107	Gear (Idle)	1
32	Bearing	1	70	Spring	1	108	Plate	1
33	Dowel pin	2	71	Plug assembly	1	109	O-ring	2
34	Orifice	2	72	Hexagon socket head bolt M8×30	2	110	Guide	2
35	Plug M8	3	73	Plug assembly	1	111	Square ring	1
36	Plug M6	7	74	Spring	2	112	Cover	1
37	Hexagon socket head bolt M8×20	2	75	Spool	2	113	Body (Quick coupler type)	1
38	Hexagon socket head bolt M8×40	1	76	O-ring 1A P16	2	114	Solenoid (Quick coupler type)	1

Procedure	
(29) Disassembly of the cover section. Remove the valve plate **30**.	
(30) Removal of the filter **41**. Remove the internal snap ring C 25 **40**. (Snap ring pliers for internal snap ring C 25)	
(31) Remove the filter **41**.	
(32) Removal of the control piston section. Remove the two hexagon socket head bolts (M6×20) **52**. (Hexagon bar wrench : 5) ***Note :*** *The control piston section should be removed only when required, since Loctite (#270) or its equivalent is applied on the threads of the bolts.*	

Procedure	
(9) Installation of the shaft part. Install the shaft **15** in the housing **5**. Slightly drive the end of the spline with a plastic hammer, until the flange of the bearing **17** is securely installed into the hole in the housing **5**.	
(10) Apply grease to the O-ring **4** and install it.	
(11) Install the case **2** with the oil seal **3** fitted keeping it level. ***Notes :*** • *Apply grease to the oil seal lip.* • *Wind a masking tape around the spline part not to make flaws on the oil seal.*	
(12) Install the internal snap ring C 62 **1** to fix the shaft **15**.	

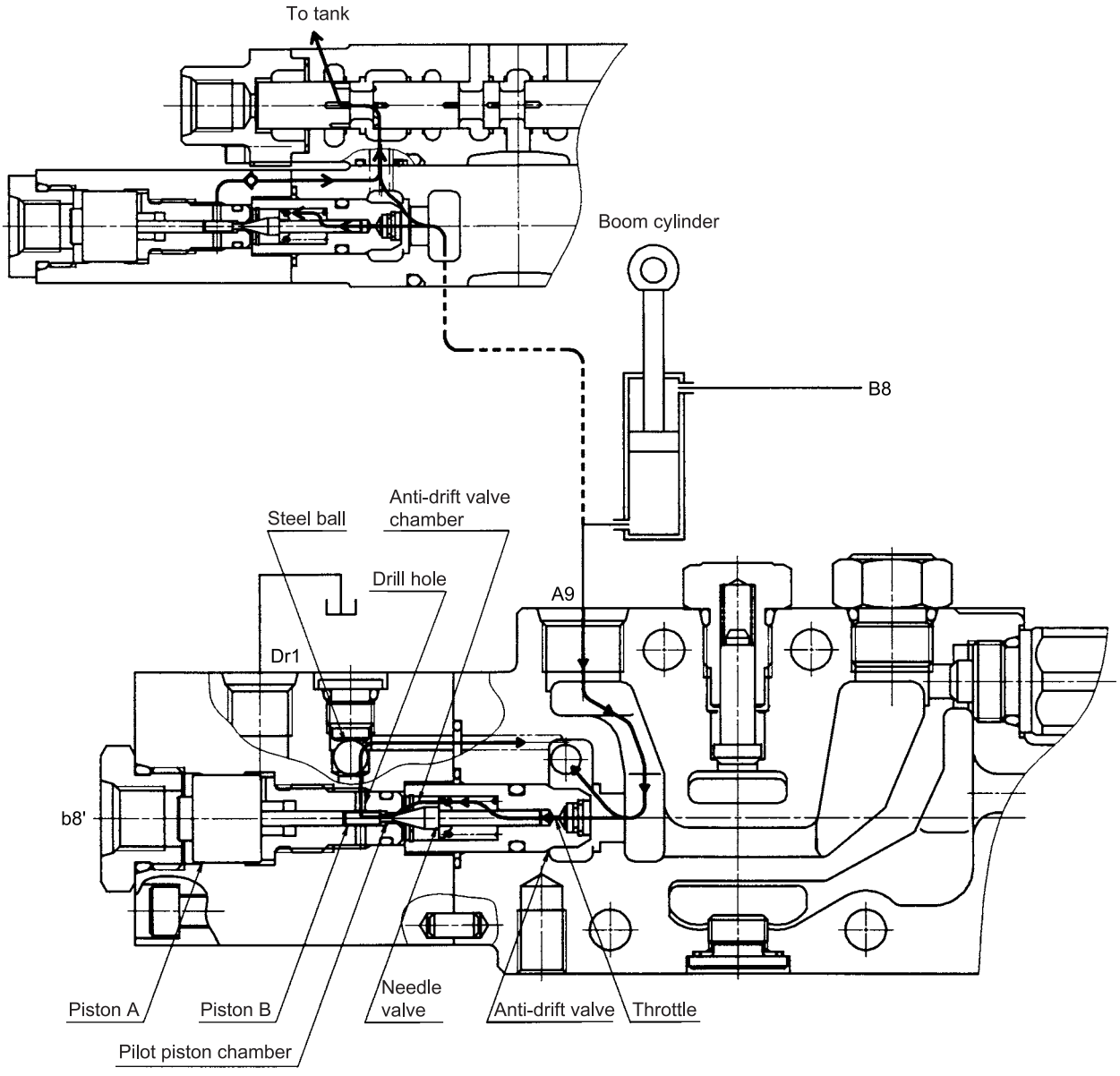
Procedure	
(49) Connect the piston pump and the gear pump. ***Note :*** *Apply grease to the two O-rings **97** and **100** before installing them.* *(O-ring 1A G 90 89.4×3.1)* *(O-ring 1B P6 5.8×1.9)*	
(50) Tighten the two hexagon socket head bolts (M10×25) **102** to fix the gear pump. (Hexagon bar wrench : 8) Tightening torque : 41 to 51 ft·lbf (55 to 69 N·m)	
4. Reinstallation of the valve assembly (51) Install the O-rings **64** and the filter **65**.	
(52) Applicable to Quick coupler type Tighten the two hexagon socket head bolts (M8×30) **72** to fix the valve assembly. (Hexagon bar wrench : 6) Tightening torque : 21 to 26 ft·lbf (28.4 to 35.3 N·m)	

Trouble	Cause	Inspection	Measure
5. Rev. speed drop when dynamic load is applied	(1) Development of peak pressure due to decreased relief valve sensitivity. (2) Decreased sensitivity of controls.	Check for abnormal vibrations in the circuit and measure pressure. • Check for foreign substances caught in pilot line. • Check for foreign substances caught in the sliding areas of controls.	Replace the relief valve. • Remove foreign substances. • Repair or replace the part.
6. Abnormal heat	(1) Increased oil leak from pump.	Measure actuator speed.	Replace the pump.
	(2) Mechanical loss of bearing etc.	Check parts that are abnormally hot of noisy.	Replace the damaged part or pump.
	(3) Seizure of sliding parts.	Check the source of heat.	Replace the damaged part or pump.
7. Oil leak	(1) Drain back pressure exceeding specified valve.	Find where the oil leaks and check for abnormal pressure.	Replace the seal.
	(2) Damaged oil seal.	Check for damage due to foreign substances, and for abnormal pressure.	Replace the seal.
	(3) Input shaft contact area with oil seal is worn.	Check for foreign substances on the input shaft and abnormal pressure.	Replace the input shaft or pump.
	(4) Loosened plugs.	Find where the oil leaks.	Retighten the plug or replace the seal.

(2) Releasing (boom down)

When the pilot oil flows to the pilot port b8' for release of the anti-drift valve, the pilot pressure moves the piston A to the right, and the piston B presses the needle valve to open. At that time, the return oil from the boom cylinder flows through the throttle of the anti-drift valve, the anti-drift valve chamber, the pilot piston chamber, and the drill hole and pushes up the steel ball to flow through the throttle (drill hole) in the boom spool to the tank passage.

The pressure in the anti-drift valve chamber decreases as the needle valve has been opened, and the return oil from the boom cylinder has opened the anti-drift valve so that the return oil from the boom cylinder flows to the tank passage through the notch in the boom spool.

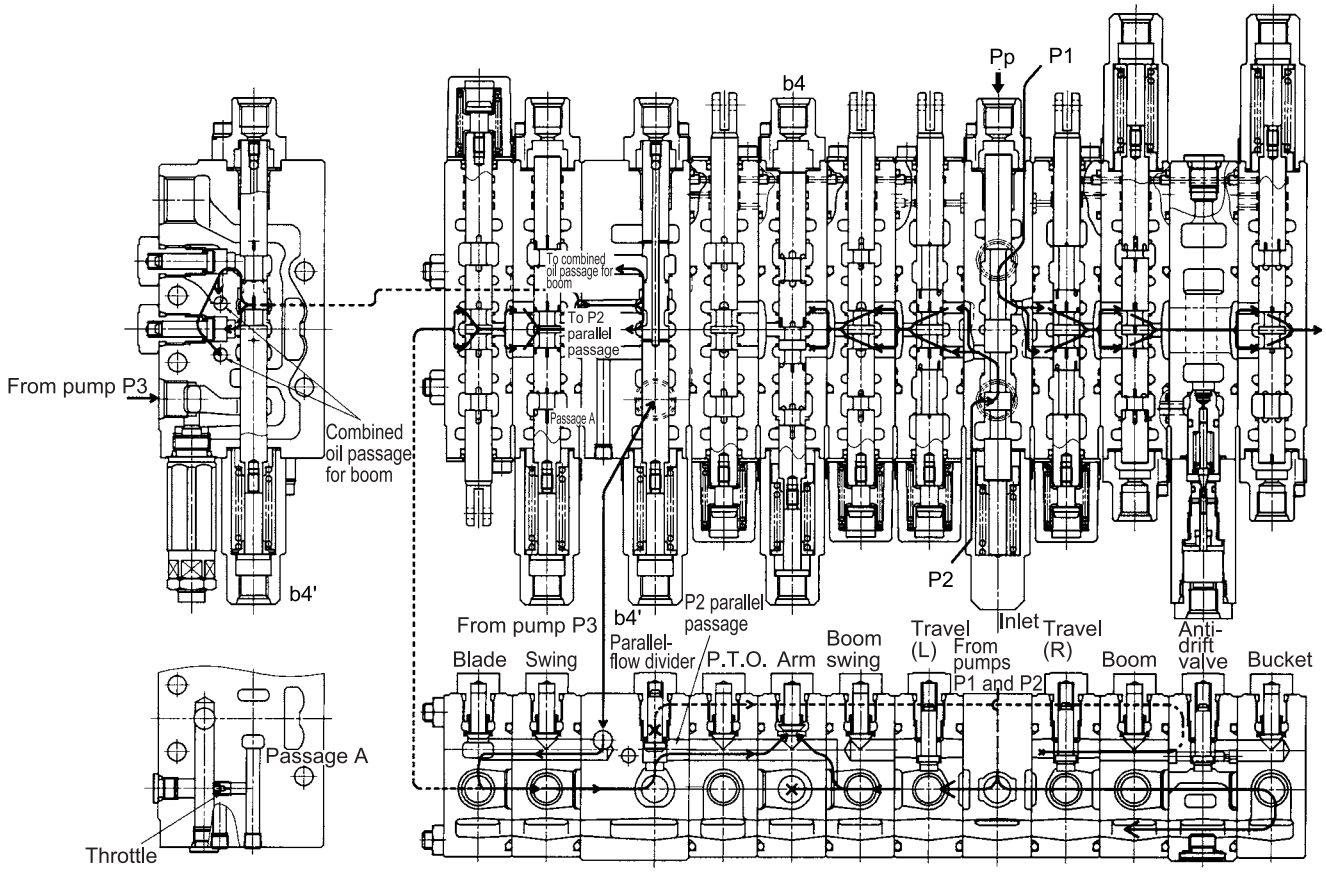


Release operation of anti-drift valve

(2) In arm retract operation

When the arm control lever is pulled back to retract the arm, the secondary pressure oil from the pilot valve flows to the ports b4 and b4' to move the spool of the arm section and keep the spool of the parallel-flow divider in the neutral position, respectively. Therefore, the oil from the pump P3 flows through the spool land opening of the parallel-flow divider and the P2 parallel passage to the arm section.

Refer to 6) Arm Operation for the operation of the arm section in the arm retract operation.



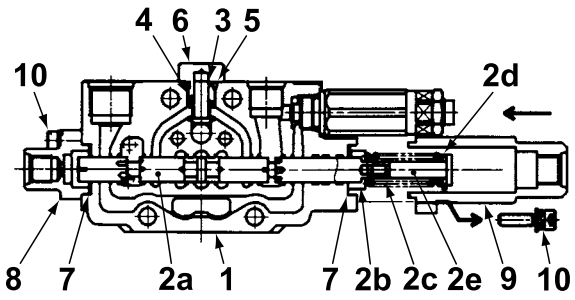
Operation of parallel-flow divider in arm retract operation

2) Tools for Disassembly and Reassembly

Tool	Q'ty	Size
Hexagon bar wrench (mm)	1 (for each)	4, 5, 6, 8
Wrench (mm)	1 (for each)	10, 13, 19, 21, 22, 26
Socket wrench (mm)	1 (for each)	13, 19, 21, 22, 26
Torque wrench [ft·lbf (N·m)]	1	1.45 to 14.5 (1.96 to 19.6)
Torque wrench [ft·lbf (N·m)]	1	14.5 to 72.3 (19.6 to 98.1)
Magnet	1	
Player	1	
Screwdriver	1	
Tweezers	1	

[4] Make sure that the O-ring **7** is installed to the flange on the other side of the valve section body before installing the pilot case **8** to the flange of the valve section body. Tighten the hexagon socket head bolt and washer assemblies **10** with a hexagon bar wrench (4 mm) at the specified torque.

Tightening torque : 4.3 to 5.1 ft·lbf (5.9 to 6.9 N·m)



Pilot operated type
(Boom and Bucket Sections)

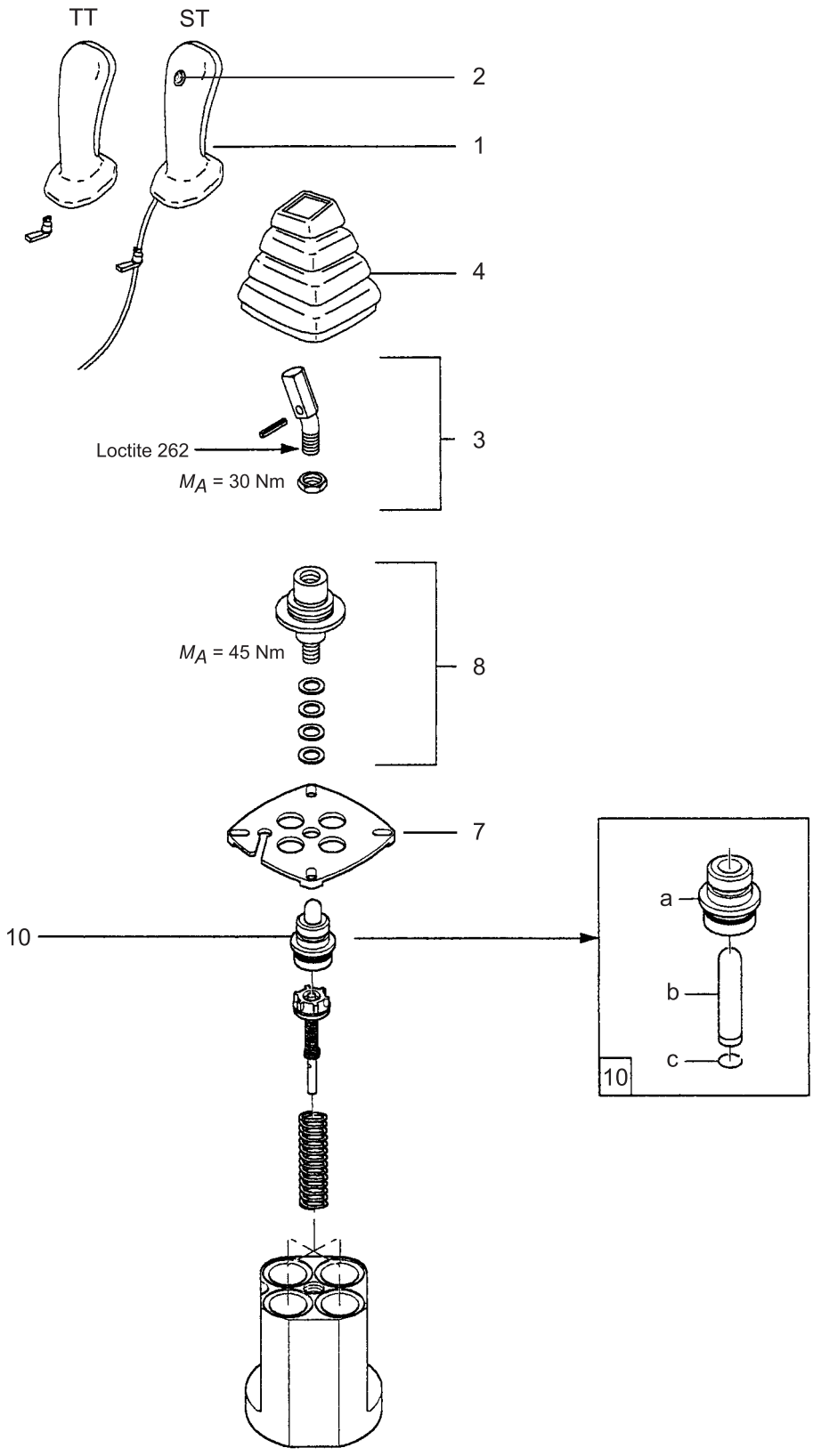
No.		Part
1		Body (symbol EF)
2		Boom spool assembly
	a	Valve rod (for boom)
	b	Return spring holder
	c	Return spring (26K)
	d	Return spring holder
	e	Valve rod edge
3		Check valve
4		Check valve spring
5		O-ring 1B P11
6		Check valve retainer
7		O-ring 1B S22
8		Pilot case B1
9		Pilot case A1
10		Hexagon socket head bolt M5×20 SWP washer assembly

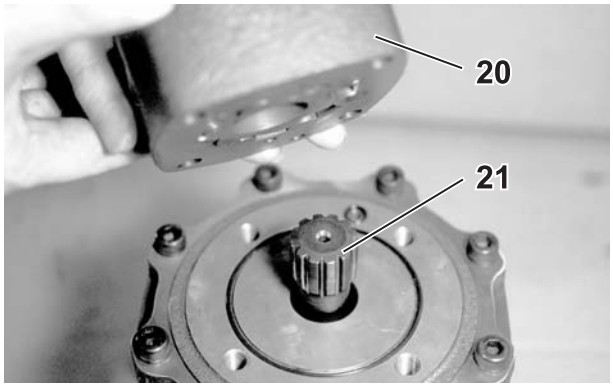
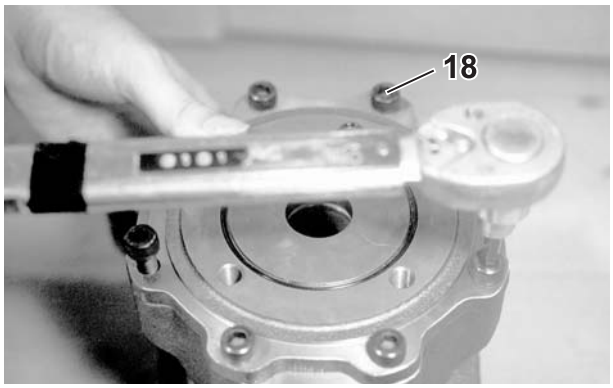
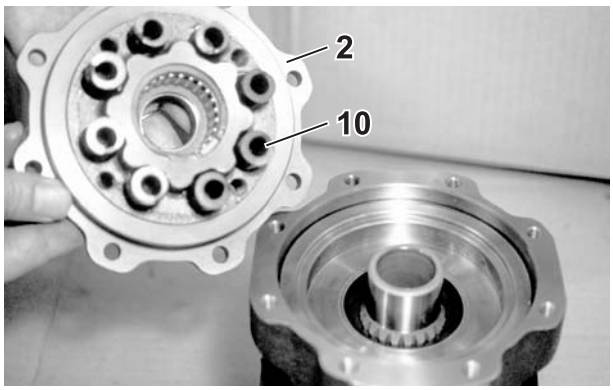
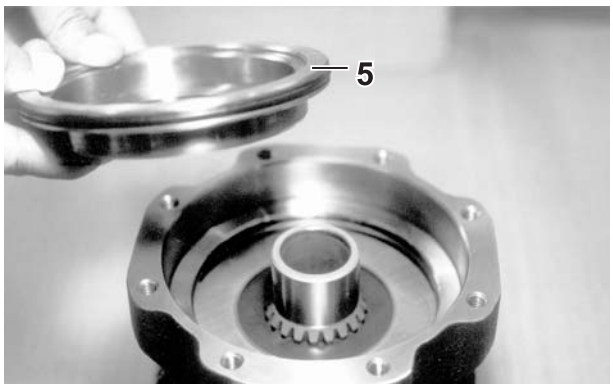
7. Troubleshooting

1) Control Valve

Trouble	Cause	Measure
1. Attachment does not operate, operates slowly, or at low pressure Time lag when operating attachment	(1) Malfunction of relief valve • *Dust caught between poppet and seat. • *Dust caught between poppet and seat. • *Sticking of poppet • *Breakage or permanent set of spring • Loose adjust screw (2) Dust caught between body and spool, or sticking of spool.	(1) Measurement of relief valve pressure • *Replace as assembly • *Replace as assembly • *Replace as assembly • *Replace as assembly • Readjust relief valve pressure with adjust screw and tighten lock nut at specified torque. • Disassembly and cleaning • Replace body and spool if seriously damaged.
2. Drifting of cylinder is large when spool is in neutral position	(1) Too large clearance between section body and spool (2) Spool does not return to the neutral position completely. • Dust caught between section body and spool, or sticking of spool • Breakage or permanent set of spring (3) Malfunction of circuit relief valve (4) Malfunction of anti-drift valve • Dust caught between anti-drift valve and needle valve seat • Sticking of anti-drift valve or needle valve • Clogged throttle of anti-drift valve	(1) Replace spool. (2) Measurement of secondary pilot pressure • Disassembly and cleaning. Replace section body together with spool in case of sticking. • Replace spring. (3) Measurement of circuit relief valve pressure (4) Replace anti-drift valve section assembly (including anti-drift valve)
3. Cylinder is retracted in extend operation and at start of operation	(1) Malfunction of load check valve • Dust caught between load check valve and section body • Sticking of load check valve • Breakage or permanent set of spring	(1) • Disassembly and cleaning Replace body and load check valve if seriously damaged. • Replace spring.

In case of malfunctions marked with*, be sure to replace the relief valve as a relief valve assembly.


TT
ST
2
1
4
3
Loctite 262
M_A = 30 Nm
8
M_A = 45 Nm
7
10
a
b
c
10

Procedure	
(5) Remove the roller **20** and the drive **21**.	
(6) Remove the hexagon socket head bolts **18**.	
(7) Remove the flange mounting **2**, and then remove the springs **10**. ***Note :*** *Do not remove the shaft face seal **19**, the rear bearing **14** and the internal snap ring **7**, if not required.*	
(8) Remove the piston **5**.	

6-5 Travel Motor

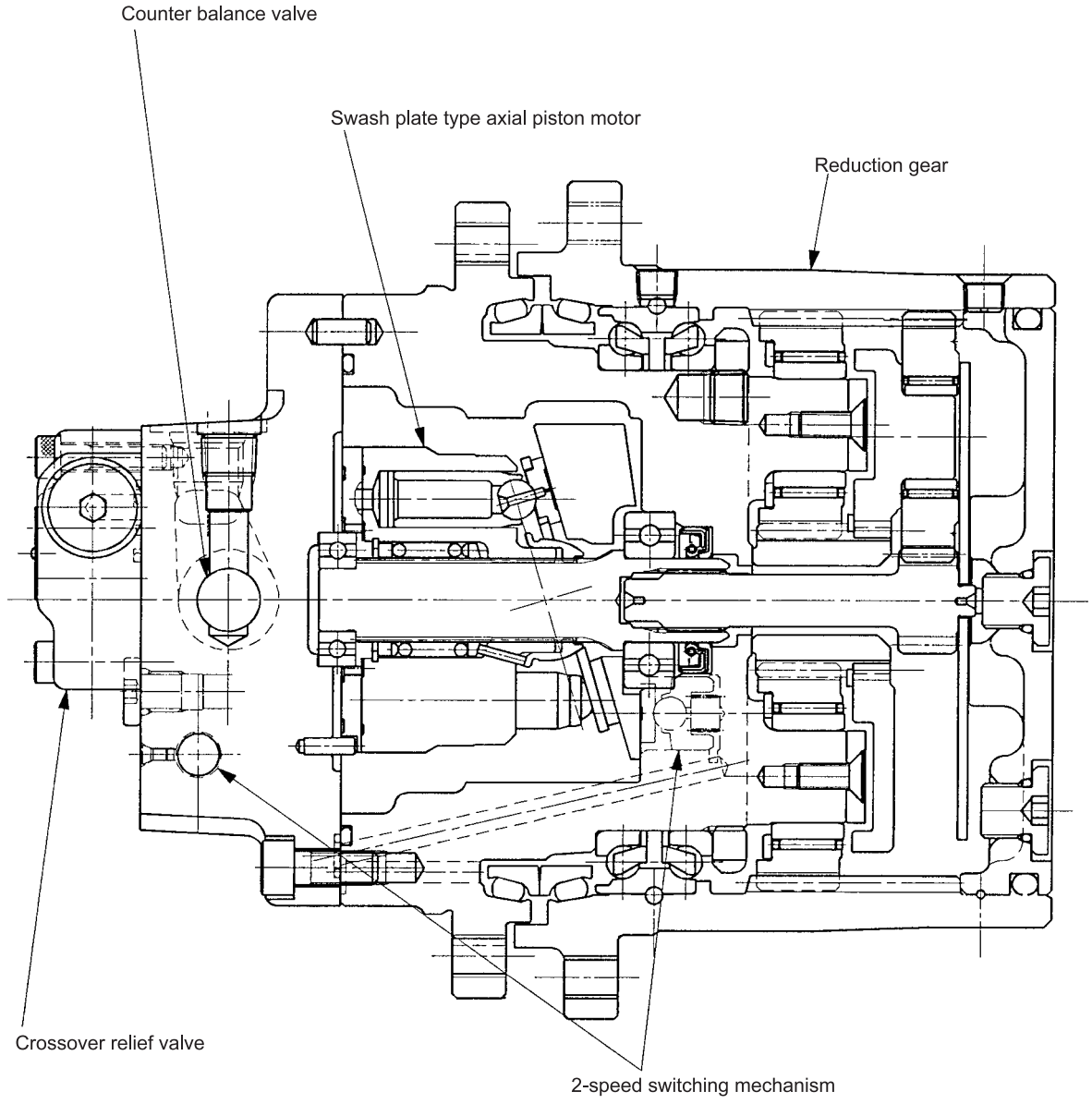
1. Structure

The travel motor consists of a swash plate type anti-cavitation valve, 2-speed switching mechanism and a reduction gear.

The swash plate type axial piston motor has 9 pistons and a 2-speed (low and high) switching mechanism.

The counter balance valve and the anti-cavitation valve are integrated with the piston motor which is housed in the reduction gear.

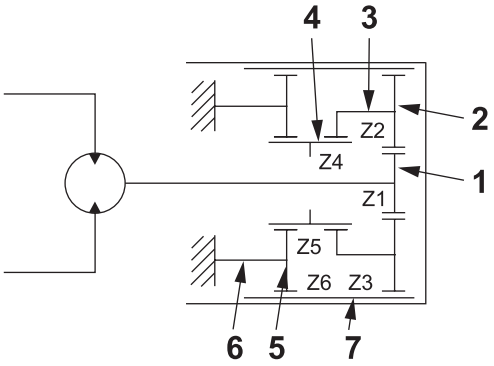
The reduction gear reduces the output revolutions of the piston motor through the planetary double-reduction mechanism and increases the output torque to transmit it to the sprocket.



Structure of travel motor

5) Reduction Gear

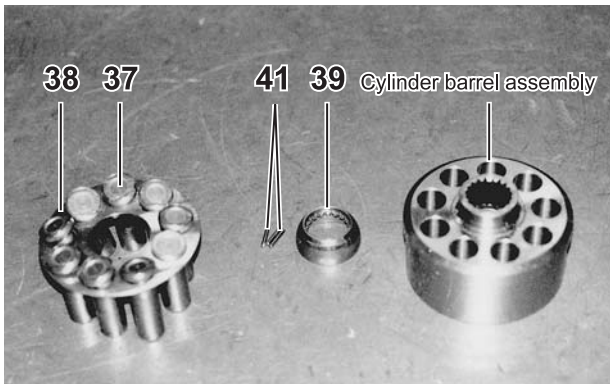
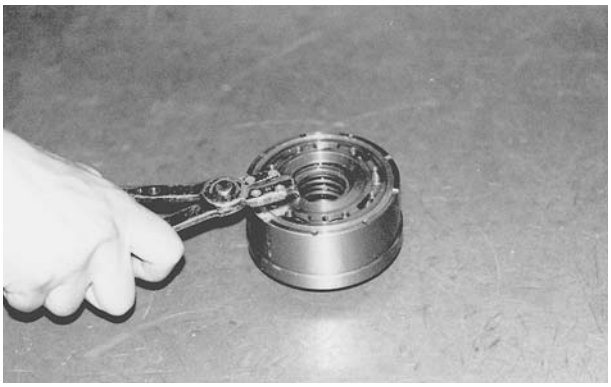
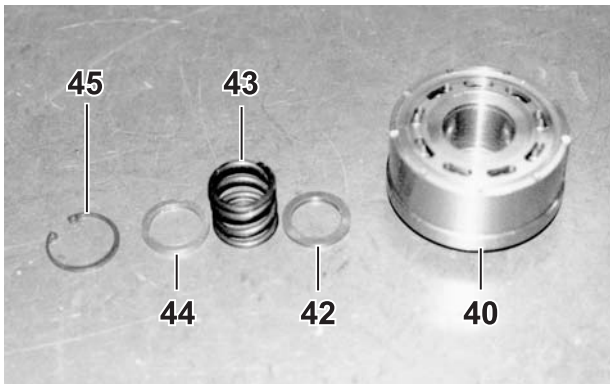
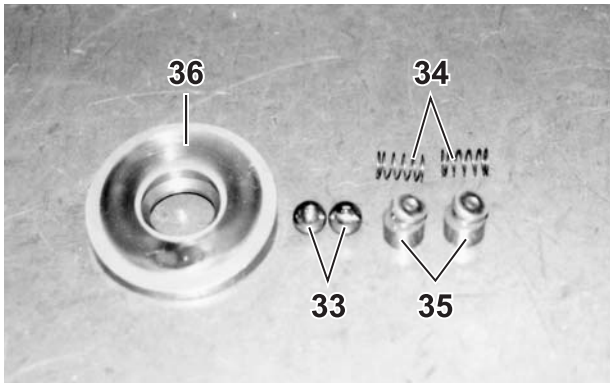
The reduction gear comprises a planetary double-reduction mechanism.

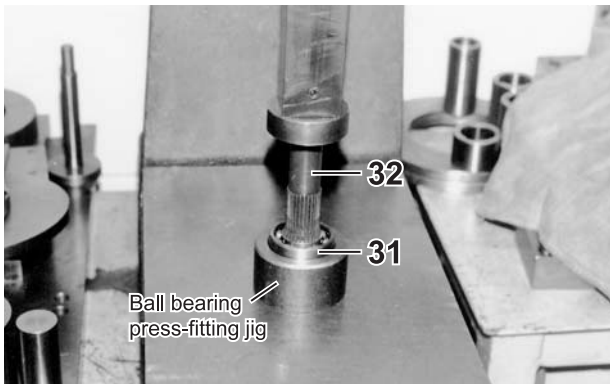
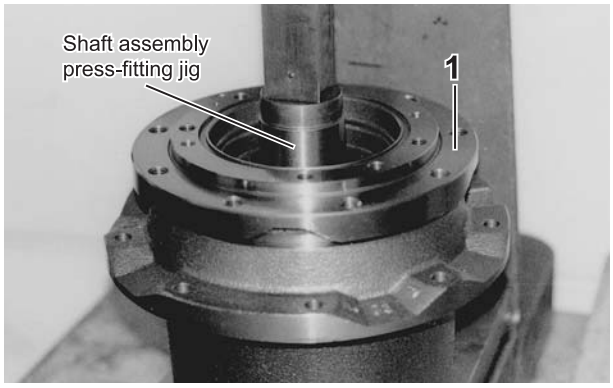
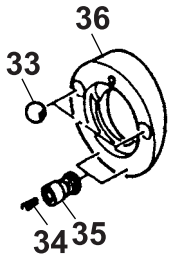
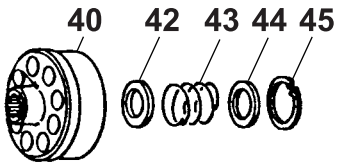
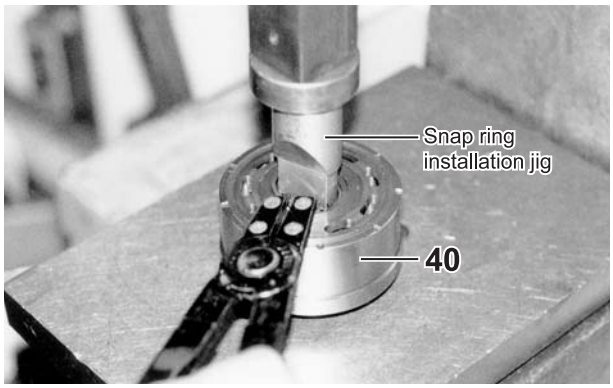


Structure

The drive gear **1** engages with the 1st-stage planetary gear **2** and the 2nd-stage sun gear **4** engages with the 2nd-stage planetary gear **5**. The 2nd-stage planetary carrier **6** is fastened to the machine body. The planetary gears **2** and **5** engage with the ring gear (housing) **7**.

The driving force from the piston motor is transmitted to the drive gear **1** and reduced by the gears. The reduced driving force is then transmitted to the ring gear **7** though the planetary gear **5** of the 2nd-stage planetary carrier **6** fastened to the machine body. (Driving force is also transmitted from the 1st-stage planetary gear **2**.) The input and output revolutions are opposite to each other.

Procedure	
(13) Remove the cylinder barrel assembly, the pins **41**, the retainer holder **39**, the retainer plate **38** and the piston assemblies **37**. ***Note :*** *Take care not to damage the sliding surface of the cylinder barrel.*	
(14) Remove the internal snap ring **45** from the cylinder barrel **40**. ***Note :*** *Take care not to damage the sliding surface of the cylinder barrel.* **Tool :** • Snap ring pliers 15	
(15) Remove the washer **44**, the spring **43** and the collar **42**.	
(16) Remove the swash plate **36**, the steel balls **33**, the piston assemblies **35** and the springs **34**.	

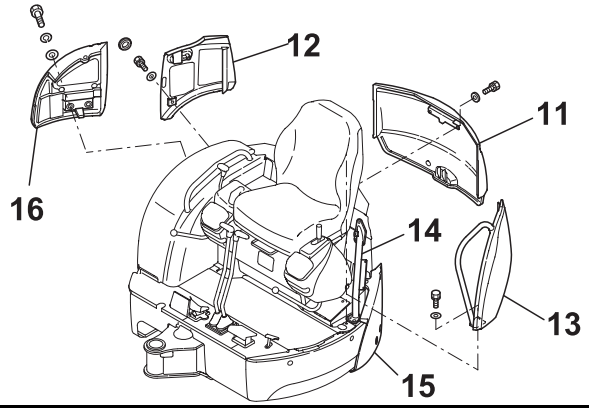
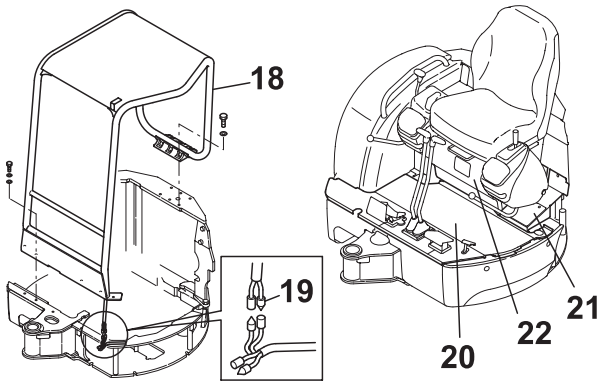
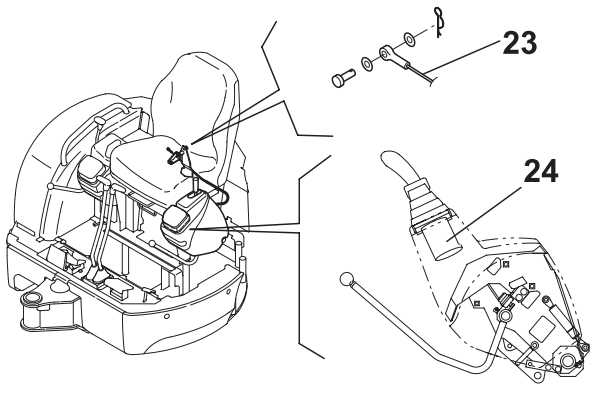
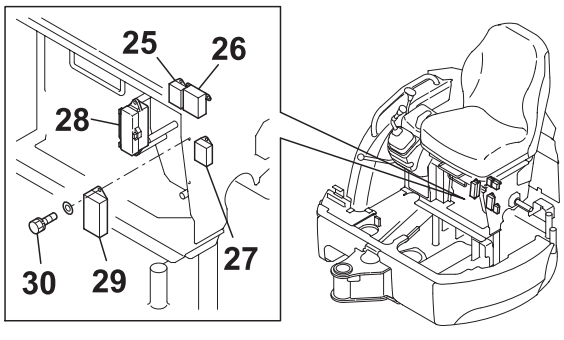
Procedure	
(18) Press-fit the ball bearing **31** onto the shaft **32**. **Tool :** • Ball bearing press-fitting jig (S-9)	
(19) Press-fit the shaft assembly into the flange holder **1**. **Tool :** • Shaft assembly press-fitting jig (S-10)	
(20) Install the steel balls **33**, the spring **34**, the piston assemblies **35** and the swash plate **36** into the flange holder **1**. ***Note :*** *Apply hydraulic oil to the sliding surface of the swash plate before installation.* 	
(21) Install the collar **42**, the spring **43**, the washer **44** and the snap ring **45** into the cylinder barrel **40**. **Tools :** • Snap ring pliers 15 • Snap ring installation jig (S-11) 	

2) Counter Balance Valve

Trouble	Cause	Measure
1. Motor does not turn or motor speed is low.	1) Plunger is not moved. (1) No pilot pressure oil supplied.	Check the piping for breakage.
	(2) Foreign substances caught between plunger and base plate.	Remove all the foreign substances, repair any damaged area, clean and reassemble the parts. If the damage is serious and oil leak is bad, replace the part.
	(3) Clogged orifice.	Clean the part with cleaning oil and reinstall it.
2. Motor does not stop or is slow to stop.	1) Plunger does not return. (1) Foreign substances caught between plunger and base plate.	Remove all the foreign substances, repair any damaged area, clean and reassemble the parts. If the damage is serious and oil leak is bad, replace the part.
	(2) Broken spring.	Replace the spring. Then, remove all the foreign substances, repair any damaged area, clean and reassemble the parts.
	(3) Spring is not installed.	Install a spring in the correct position.
	(4) Clogged orifice.	Clean the part with cleaning oil and reinstall it.
3. Fluctuation in motor revolutions.	1) Plunger does not move smoothly. (1) Foreign substances caught inside.	Remove all the foreign substances and repair any damaged area. Then, clean the parts and reassemble them. If the damage is serious and oil leak is bad, replace the part.
	(2) Clogged orifice.	Clean the part and reinstall it.
4. Large shock on stopping traveling.	1) Plunger is quick to return. (1) Spring seat is not installed.	Install a spring seat in the correct position.
5. Abnormal sound.	1) Plunger does not return. (1) Foreign substances caught inside.	Remove al the foreign substances, repair any damaged area, clean the parts and reassemble them. If the damage is serious and oil leak is bad, replace the part.
	(2) Broken spring.	Replace the spring. Remove all the foreign substances, repair any damaged area, clean the parts and reassemble them.
	(3) Clogged orifice.	Clean the part with cleaning oil and reassemble it.

6) Troubleshooting

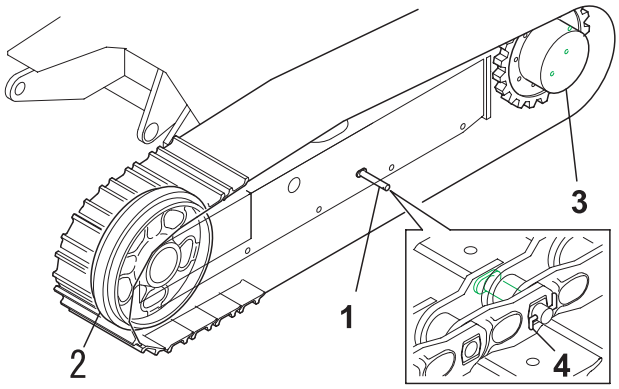
Trouble	Cause	Measure
Malfunction of operate check valve	[1] Flaws in seat portion [2] Dust caught in seat portion [3] Permanent set of spring	[1] Replace poppet [2] Disassemble and clean, and replace hydraulic oil. [3] Replace spring
External leakage	[1] Damaged O-ring [2] Damaged surface of installation area	[1] Replace O-ring [2] Replace valve body

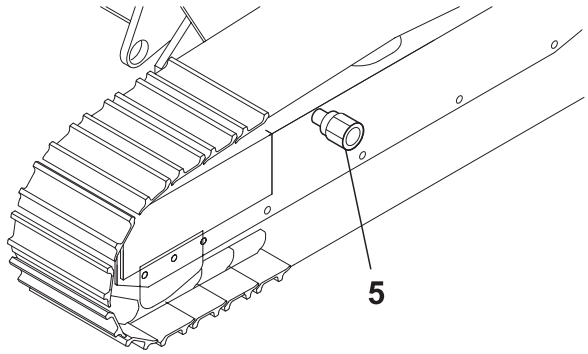
Procedure	
(6) Remove the engine hoods A **11** and R **12**. (7) Remove the engine hood L **13** and the pipe **14**. (8) Remove the weights L **15** and R **16**.	
(9) Remove the canopy pole **18**. (Remove the harness (headlight) **19**.) (10) Remove the floor step **20**, the cover **21** and the grille **22**.	
(11) Disconnect the accelerator cable **23** on the engine side. (12) Remove the control lever L assembly **24** (with the hoses).	
(13) After removing the cover, disconnect the connectors for the glow resister **25**, the glow relay **26**, the timer **27** and the fuse box **28**. (14) Remove the installation bolts **30** and the safety relay **29**.	

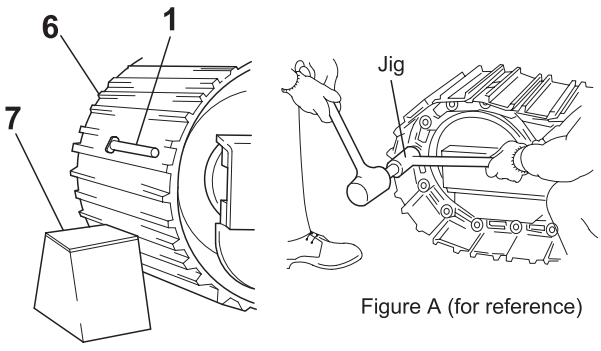
3) Removal of Steel Crawler

⚠ Do not put your fingers between the shoes.

⚠ Handle the steel crawlers with great care, as they are heavy.
Steel crawler : 233.7 lbs. (106 kg) / for each crawler

Procedure	
(1) Stop the machine so that the master pin **1** should be in the lower middle position between the idler **2** and the sprocket **3**. (2) Remove the cotter pin **4**.	

(3) Lower the implement to the ground, and remove the nipple valve **5** to loosen the steel crawler tension. ***Note :*** *Move the machine back and forth if the grease does not come out smoothly.*	

(4) Turn the track shoe **6** until the master pin **1** is positioned in the front of the idler **2**. (5) Set the block **7**. (6) Put a jig on the master pin **1** and remove it by patting with a hammer. ***Note :*** *When using a hammer to remove the master pin, take care not to give a permanent set on the top of the master pin.* *[Reference] : Use a jig as illustrated in Figure A.*	 Figure A (for reference)

4) Reinstallation of Steel Crawler

Install the steel crawler in the reverse order of the removal procedure.

Note :

*For how to bend the cotter pin **4**, refer to the description below.*

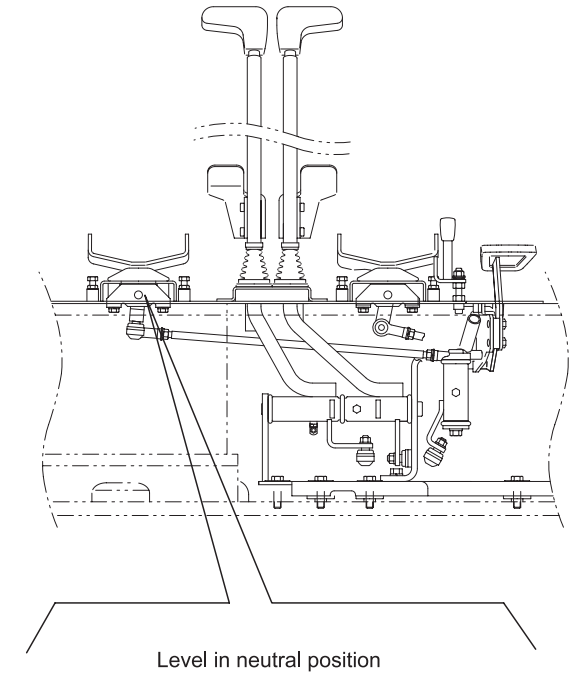
7-3-4 Adjustment of Boom Swing Pedal

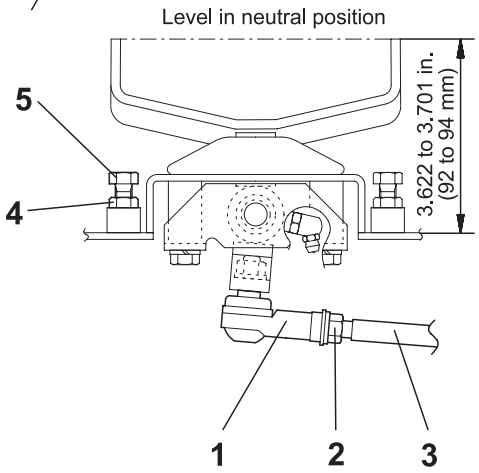
1) Setting Pedal Level

(1) Loosen the nut **2** of L-ball **1**.
(2) Adjust the boom swing pedal with rod **3** so that the pedal is level.
(3) Tighten the nut **2** of L-ball **1**.

2) Adjustment of Stopper Bolts (Right and Left Boom Swing)

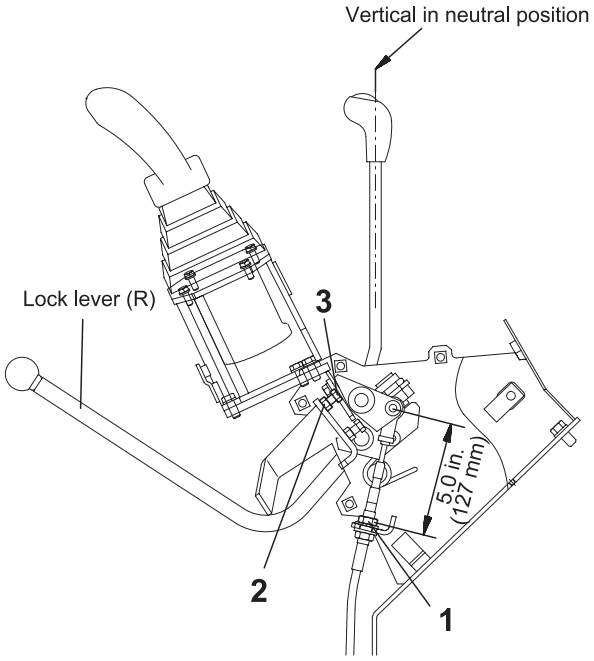
(1) Loosen the lock nuts **4** and screw in the stopper bolts **5** until they have no contact with boom swing pedal.
(2) Move the boom swing pedal to its stroke ends, and loosen the stopper bolts **5** until their heads contact with the pedal.
(3) Loosen the stopper bolts **5** one more turn and tighten the lock nuts **4** to fix them.

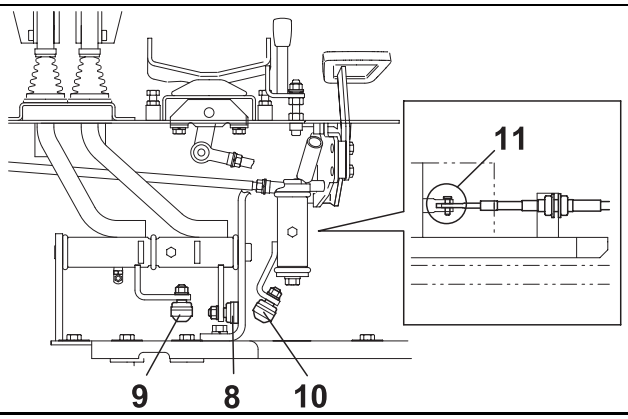


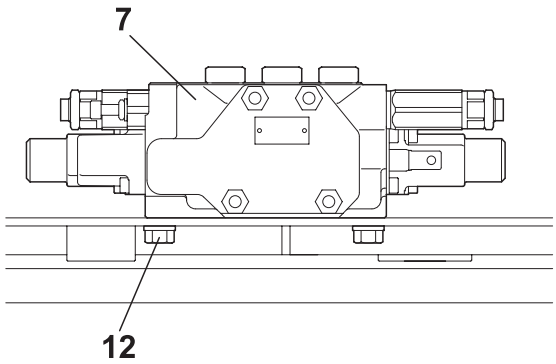


7-3-5 Adjustment of Blade Control Lever

(1) Loosen the nut **1** and adjust the blade control lever so that it is vertical in neutral position.
(2) Adjustment of stopper bolts (blade up and down)
[1] Loosen the lock nuts **2** and screw in the stopper bolts **3** until they have no contact with the blade lever.
[2] Move the blade lever to its stroke ends, and loosen the stopper bolts **3** until they contact with the blade lever.
[3] Loosen the stopper bolts **3** one more turn and tighten the lock nuts **2** to fix them.

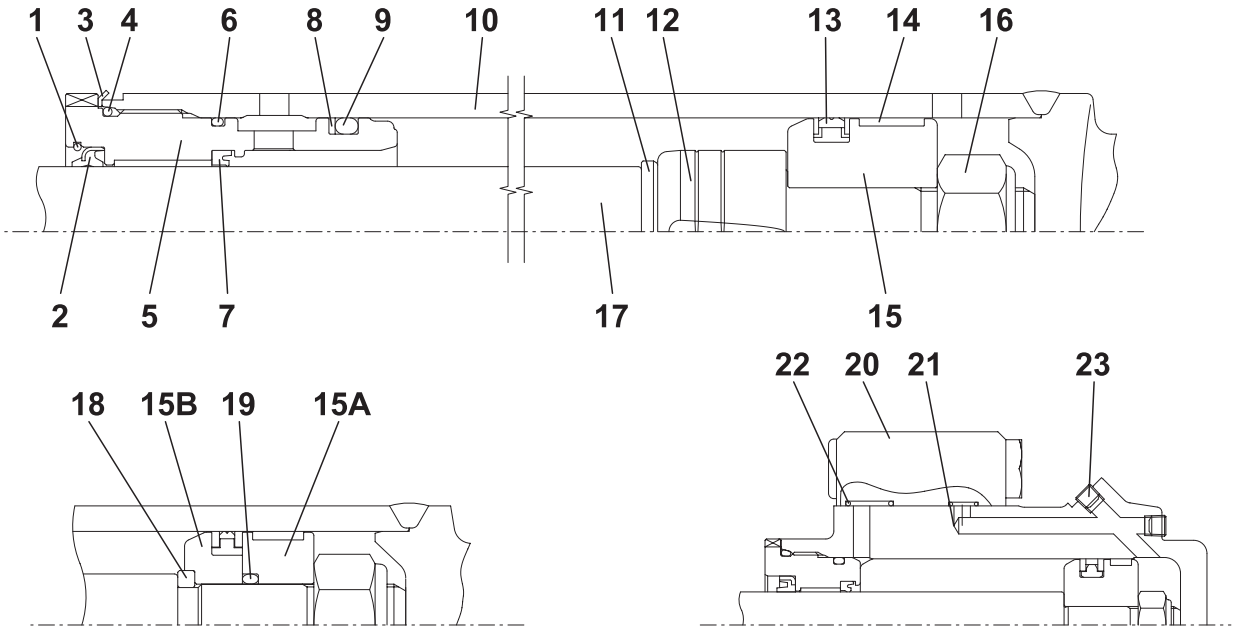


Procedure	
(5) Remove the L-balls **8**, **9** and **10** connecting to the travel R and L, and the boom swing section spools of the control valve. (6) Remove the blade wire connection **11** from the blade section.	

(7) Remove the bolt **12** (M10) to remove the control valve **7**.	

7-5-6 Disassembly and Reassembly of Hydraulic Cylinders

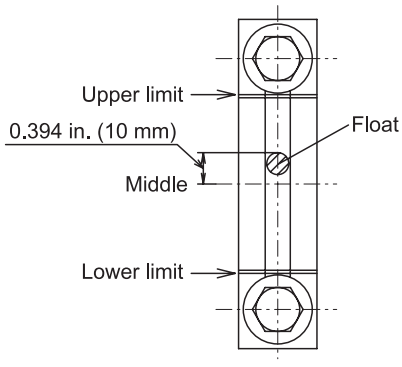
1) Sectional View and Parts



No.	Part	Boom cylinder	Arm cylinder	Bucket cylinder		Boom swing cylinder	Blade cylinder	Quick coupler cylinder
				W/O Quick coupler	Quick coupler			
1	Spring ring	O	O	O	O	O	O	—
2	DKB seal	O	O	O	O	O	O	Dust seal DW
3	Lock washer	O	O	O	O	O	O	—
4	O-ring	O	O	O	O	O	O	O
5	Head	O	O	O	O	O	O	O
6	O-ring	O	O	O	O	O	O	O
7	ISI packing	O	O	O	O	O	O	O
8	Back-up ring	O	—	—	—	—	—	—
9	O-ring	O	—	—	—	—	—	—
10	Cylinder tube	O	O	O	O	O	O	O
11	Cushion collar	O	—	—	—	—	—	—
12	Cushion plunger	O	—	—	—	—	—	—
13	SPGTI seal	O	O	O	O	O	O	SPGW
14	Wearing ring	O	O	O	O	O	O	O
15	Piston	O	O	O (A, B)	O	O	O	O
16	U-nut	O	O	O	O	O	O	O
17	Rod	O	O	O	O	O	O	O
18	Collar	—	—	O	—	—	—	—
19	O-ring	—	—	O	—	—	—	—
20	Operate check valve	—	—	—	—	—	—	O
21	O-ring P8	—	—	—	—	—	—	O
22	O-ring P14	—	—	—	—	—	—	O
23	Screw plug 1/16	—	—	—	—	—	—	O

3) Oil Level Check

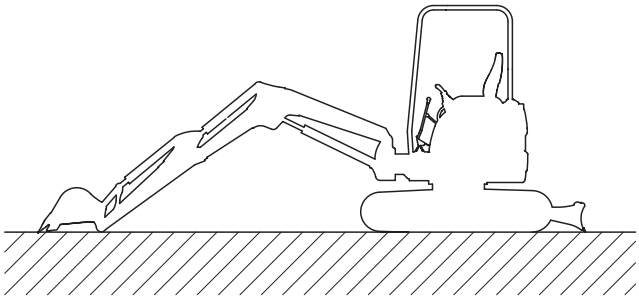
(1) Place the machine on a firm and flat ground when checking the hydraulic oil level.
(2) Check the hydraulic oil level with the oil level gauge when the oil temperature is 32 to 86°F (0 to 30°C).
(3) The proper oil level is 0.394 in. (10 mm) above the middle of the oil level gauge. The hydraulic oil level increases or decreases depending on the hydraulic oil temperature due to its nature; therefore, check it when the oil is cooled.



Oil level gauge

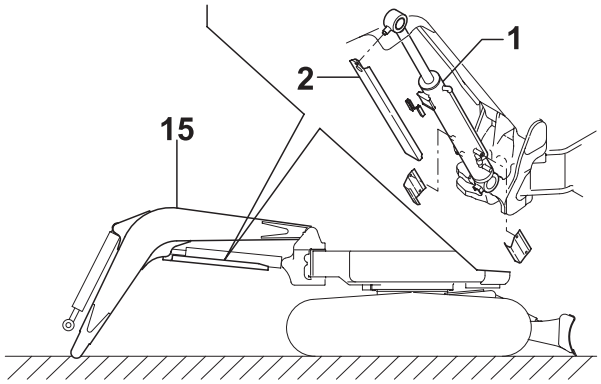
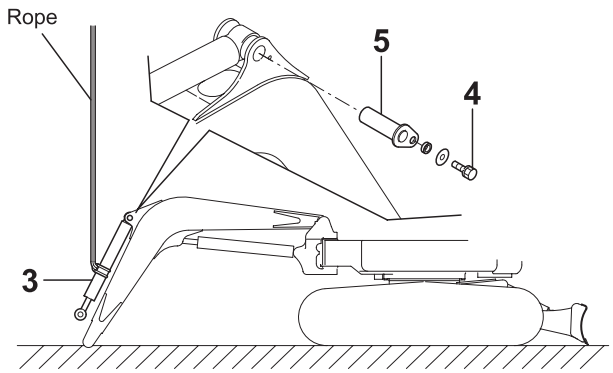
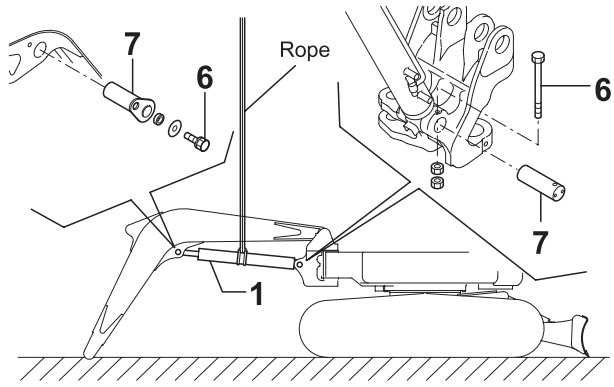
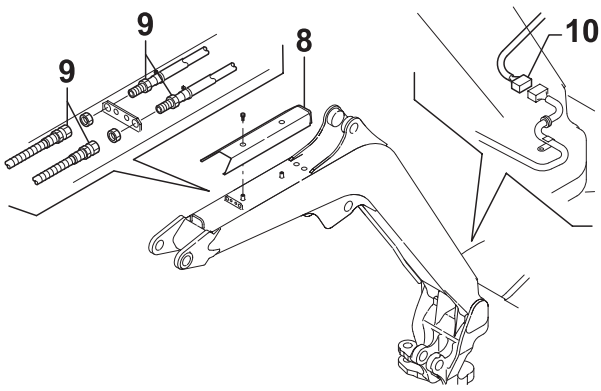
4) Machine Position in Oil Level Check

(1) Retract the bucket and arm cylinder rods completely to lower the bucket to the ground.
(2) Lower the blade to the ground.



Machine position

3) Removal of Boom

Procedure	
(1) After raising the boom **15** to the maximum, remove the slide cover **2** from the boom cylinder **1**. (2) Place the top end of the boom **15** on the ground. ***Note :*** *Install an expansion plug to the joint of the removed hydraulic hose and start the engine.*	
(3) After putting a rope to the arm cylinder **3**, remove the hydraulic hose from the arm cylinder. (4) Remove the bolt **4** (M10) to pull out the pin **5**, and remove the arm cylinder **3**. ***Note :*** *Put a rope to the arm cylinder to remove it using a lifting device.*	
(5) After putting a rope to the boom cylinder **1**, remove the hydraulic hose from the boom cylinder. (6) Remove the bolt **6** (M10) to pull out the pin **7**, and remove the boom cylinder **1**. ***Note :*** *Put a rope to the boom cylinder to remove it using a lifting device.*	
(7) Remove the cover **8** to separate the joint sections **9** of the hydraulic hoses to the bucket cylinder. (8) Disconnect the boom light wiring at the connector section **10**.	

8. PERIODIC INSPECTION AND SERVICING

◇ : Check ○ : Supply ● : Replace □ : Adjust (clean) ■ : Oil & grease

Check & service items		Daily	Every 50	Every 200	Every 400	Every 1000	Every 2000 hrs
Fuel oil	Check & supply of oil to the tank	◇					
	Drain the fuel tank		□				
	Clean the oil/water separator		□				
	Replace the fuel filter element				●		
Lube oil	Check the quantity of engine oil	◇					
	Replace the engine oil		● 1st time	●			
	Replace the engine oil filter element		● 1st time	●			
Cooling water	Check & supply of cooling water	◇					
	Clean radiator fins			□			
	Check the fan-belt tension		◇ 1st time	□			
	Replace the cooling water					●	
	Clean & check the cooling water system					● within one year	
Rubber hose	Check & replace fuel oil pipe, cooling water pipe						●
Operation system	Check & adjust governor lever, accelerator	◇		□			
Intake system	Clean air cleaner & replace element			□	●		
	*Check turbocharger, adjust					□	
Cylinder head	Adjust the intake and exhaust valve clearance					□	
	Lapping the intake and exhaust valve						□
Fuel pump & injection valve	Check fuel valve nozzle, clean					□	
	Check & adjustment of fuel injection pressure & atomizing condition					□	
	Check fuel pump, adjust						□

*Applicable to models with the relevant equipment

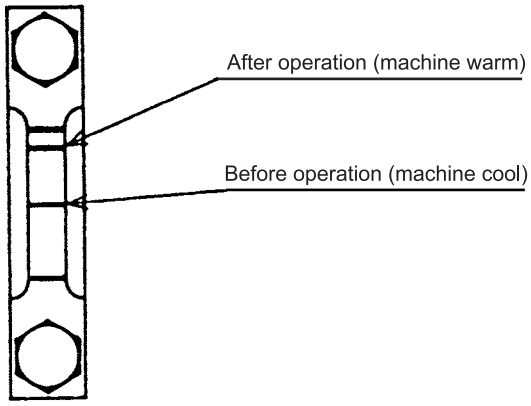
Note :

- *When machine is used at dusty worksites clean and replace filter element twice or more frequently than specified in the table.*
- *Execution of periodic inspection and servicing is indispensable to conform the EPA emission control regulations. Keep a record of the results.*

10-1-8 Fluctuation in Oil Level of Hydraulic Oil Tank Due to Temperature Change

Phenomenon

The oil level of the hydraulic oil tank varies between before operation (the machine is cool) and after operation (the machine is warm).

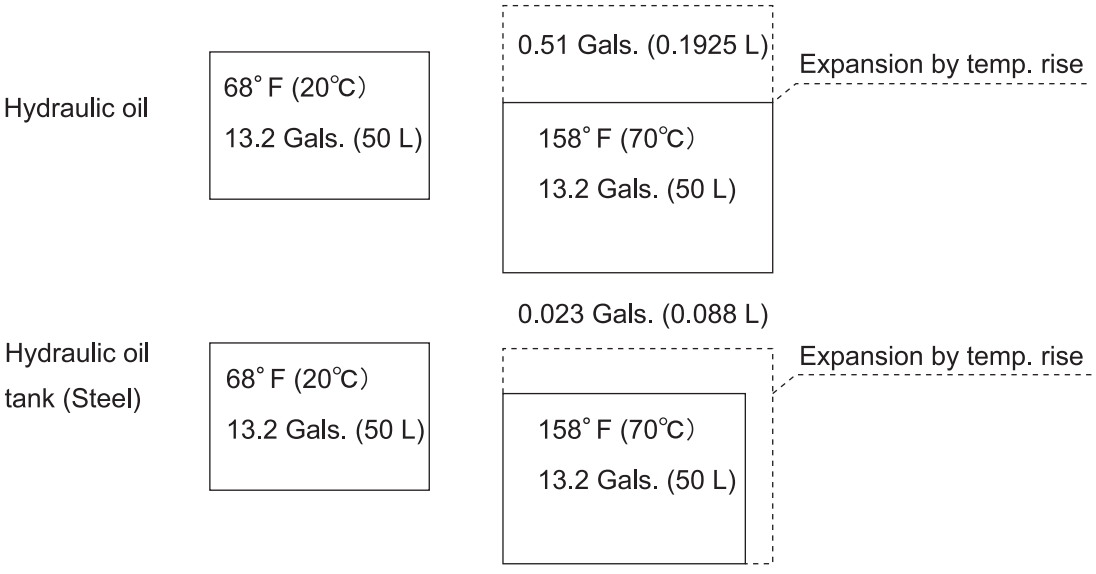


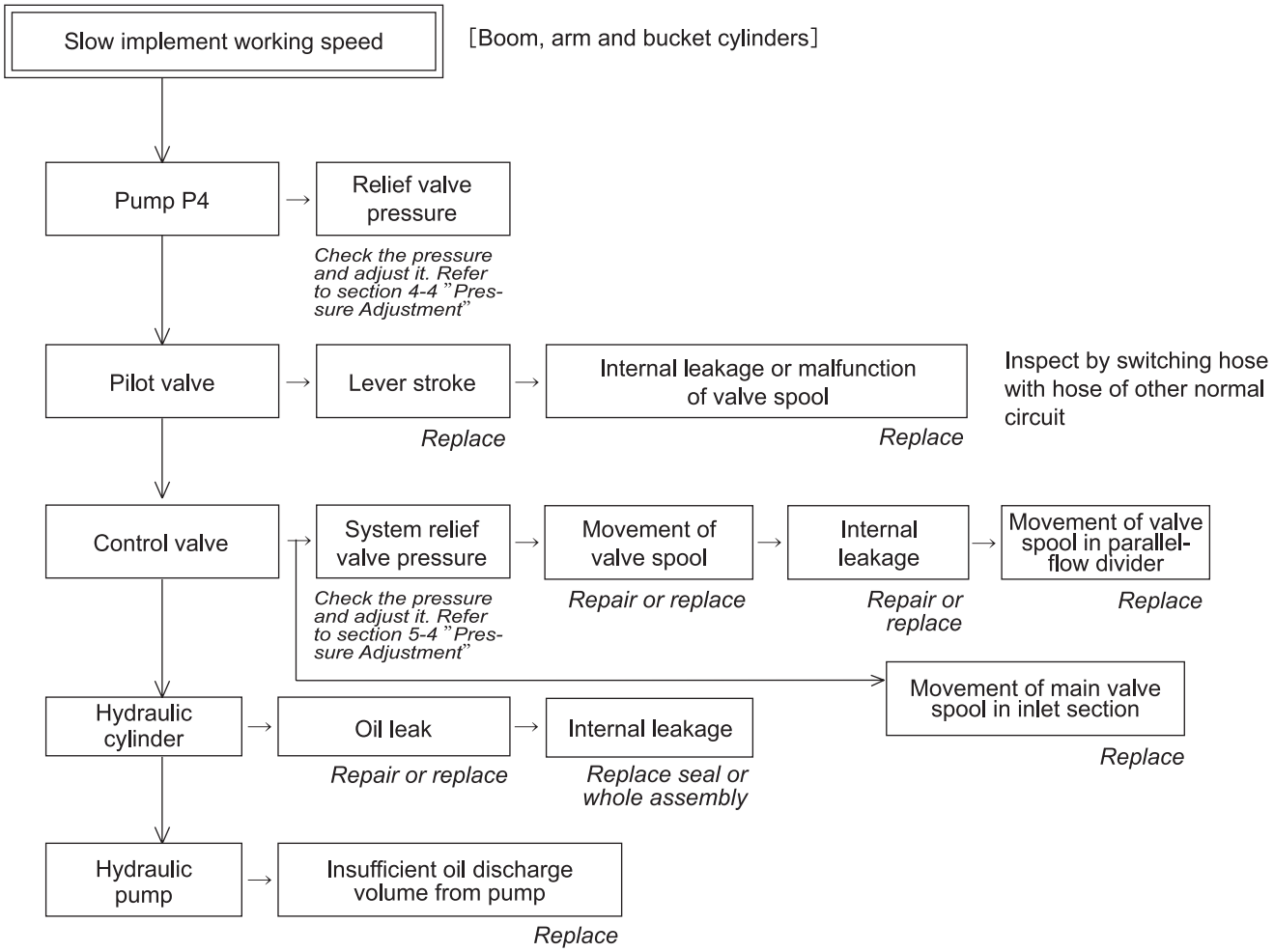
Reason

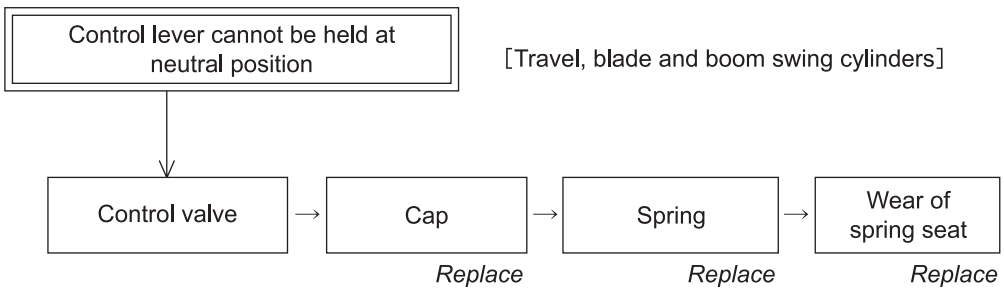
The oil level changes because the thermal expansion factor of oil is far larger (about 20 times) than that of steel.

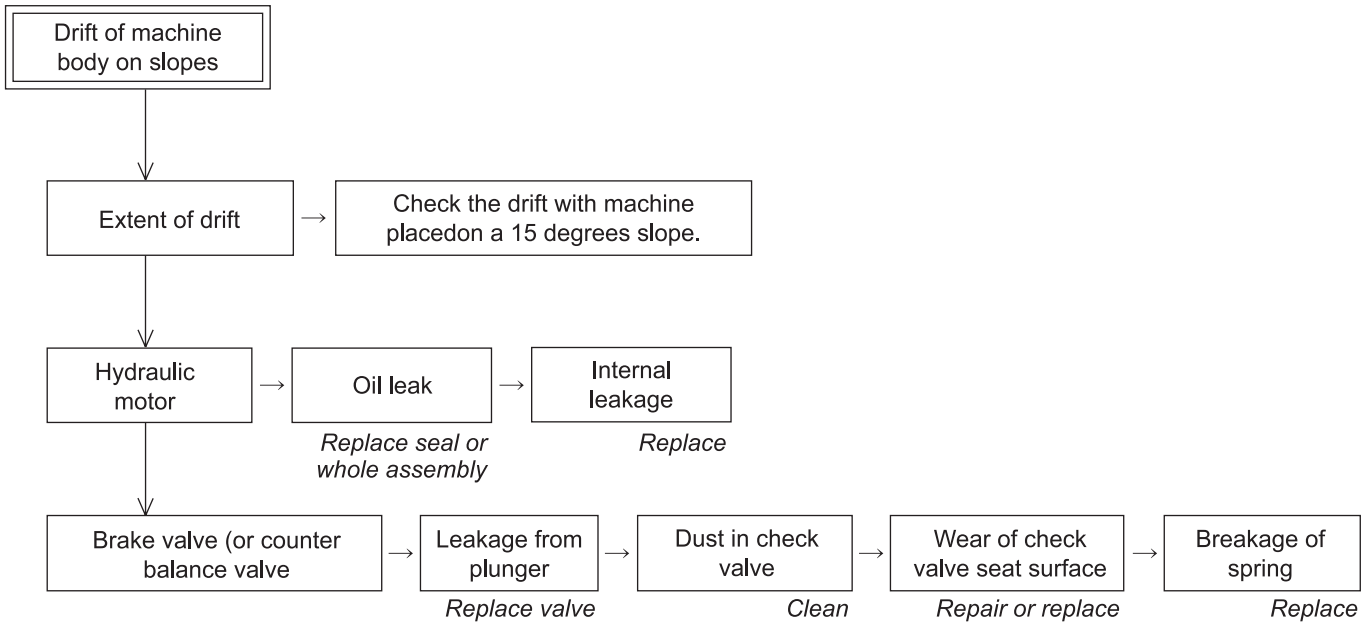
1. Liner thermal expansion factor of steel : 11.7×10^{-6}
2. Cubical thermal expansion factor of steel : 3.51×10^{-5}
3. Cubical thermal expansion factor of hydraulic oil : 7.7×10^{-4}

(Example)




Slow implement working speed
[Boom, arm and bucket cylinders]
Pump P4
Relief valve pressure
Check the pressure and adjust it. Refer to section 4-4 "Pressure Adjustment"
Pilot valve
Lever stroke
Replace
Internal leakage or malfunction of valve spool
Replace
Inspect by switching hose with hose of other normal circuit
Control valve
System relief valve pressure
Check the pressure and adjust it. Refer to section 5-4 "Pressure Adjustment"
Movement of valve spool
Repair or replace
Internal leakage
Repair or replace
Movement of valve spool in parallel-flow divider
Replace
Movement of main valve spool in inlet section
Replace
Hydraulic cylinder
Oil leak
Repair or replace
Internal leakage
Replace seal or whole assembly
Hydraulic pump
Insufficient oil discharge volume from pump
Replace


Control lever cannot be held at neutral position
[Travel, blade and boom swing cylinders]
Control valve
Cap
Replace
Spring
Replace
Wear of spring seat
Replace



Inspection procedures

Check the drift with the machine placed on a slope with an inclination angle below 15 degrees.

[1] Continuous drift : Brake valve (or counter balance valve) is faulty.

[2] Discontinuous drift : Hydraulic motor is faulty.