Service Manual

JS200
from machine no. 705001
JS210
from machine no. 705648
JS220
from machine no. 705001
JS240
from machine no. 708001
JS260
from machine no. 708501

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Contents Page No.

* **Note:** Except where indicated otherwise, information for the JS200 applies to all variants of this machine, including the JS220. Similarly, information for the JS240 applies also to all variants of that machine, including the JS260.

Contents Page No.

* **Note:** Except where indicated otherwise, information for the JS200 applies to all variants of this machine, including the JS220. Similarly, information for the JS240 applies also to all variants of that machine, including the JS260.

Pump

	Type	Twin variable displacement piston pump
	Displacement Volume	96.6 (cc/rev) x2
*	Working Pressure	350 kgf/cm^2 (343 bar, 4977 lb/in^2)
	Maximum Output	198.7 litre/min (43.7 UK gal)
	Fixed Displacement Gear Pump Displacement Volume	 10 cc/rev
*	Working Pressure	40 kgf/cm^2 (39.2 bar, 569 lb/in^2)
	Maximum Output	20.5 litre/min (4.5 UK gal)
	Dry weight	* 132 kg (291 lb)

Control Valve

	Type	Hydraulic Pilot System
	Operating System	Set pressure relief
	Main Relief Pressure Standard * Pressure Raising	 320 kgf/cm^2 (314 bar, 4550 lb/in^2) at 138 litre/min (30.3 UK gal) 350 kgf/cm^2 (343 bar,4977 lb/in^2) at 155 litre/min (34 UK gal)
*	Overload Relief Pressure	
*	Dipper, Bucket (except JS220LC Long Reach)	370 kgf/cm^2 (363 bar, 5263 lb/in^2) at 20 litre/min (4.4 UK gal)
*	Dipper out (JS220LC Long Reach only)	370 kgf/cm^2 (363 bar, 5263 lb/in^2) at 20 litre/min (4.4 UK gal)
*	Dipper in (JS220LC Long Reach only)	220 kgf/cm^2 (216 bar, 3132 lb/in^2) at 20 litre/min (4.4 UK gal)
*	Bucket (JS220LC Long Reach only)	240 kgf/cm^2 (235 bar, 3407 lb/in^2) at 20 litre/min (4.4 UK gal)
*	Boom Raising	370 kgf/cm^2 (363 bar, 5263 lb/in^2) at 20 litre/min (4.4 UK gal)
*	Boom Lowering Pressure	250 kgf/cm^2 (245 bar, 3555 lb/in^2) at 20 litre/min (4.4 UK gal)
*	Function	Travel priority, Slew priority, Boom and Dipper Load Holding Valve, Boom and Dipper 2 Speed Confluence
*	Dry Weight	* 165 kg (364 lb)

Slew Equipment

	Type	Fixed displacement piston motor
	Suction Capacity	151 cc/rev
*	Working Pressure	285 kgf/cm^2 (279 bar, 4052 lb/in^2)
*	Work Flow	198.7 litre/min (43.6 gal/min)
*	Set Pressure Relief	
*	All models except JS220LC Long Reach	285 kgf/cm^2 (279 bar, 4053 lb/in^2) at 155 litre/min (34 UK gal)
*	Model JS220LC Long Reach only	245 kgf/cm^2 (240 bar, 3480 lb/in^2) at 155 litre/min (34 UK gal)
*	Reduction Gear Ratio	16.757 : 1
	Slew Brake Brake Torque	 More than 75.4 kgf m (739.4 Nm, 545 ft lbs) (not including reduction gear)
*	Brake Pressure Release	Min 30 kgf/cm^2 (29.4 bar, 426 lb/in^2)
	Dry Weight	* 197 kg (434 lb)

Travel Equipment

Type	Fixed Displacement Piston Motor (automatic 2-speed change)
Suction Capacity	157.8/92.9 cc/rev
Working Pressure	350 kgf/cm^2 (343 bar, 4977 lb/in^2)
Working Flow	199 litre/min (43.7 UK gal)
Reduction Gears Deceleration Ratio	 44.384
Parking Brake Brake Torque Brake Pressure Release * Brake Valve Pressure Relief	 2135 kgf/m (20.9 kN/m) including reduction gear > 14 kgf/cm^2 (6.8 bar, 101 lb/in^2) 360 kgf/cm^2 (353 bar, 5119 lb/in^2) at 40 litre/min (8.8 UK gal)
Dry Weight	* 270 kg (595 lb)

Boom Ram

Cylinder Inside Diameter	125 mm
Rod Diameter	85 mm
Max Contracted Length	1790 mm
Stroke	1295 mm
Dry Weight	* 176 kg (388 lb)

Dipper Ram

Cylinder Inside Diameter	135 mm
Rod Diameter	100 mm
Max Contracted Length	2150 mm
Stroke	1580 mm
Dry Weight	* 275 kg (606 lb)

Bucket Ram

Cylinder Inside Diameter	120 mm
Rod Diameter	80 mm
Max Contracted Length	1582 mm
Stroke	1012 mm
Dry Weight	* 146 kg (322 lb)

Pump

Type	Twin variable displacement piston pump
Displacement Volume	96.4 cc/rev x2
Working Pressure	320 kgf/cm^2 (309 bar, 4550lb/in^2)
Maximum Output	212.2 litre/min (46.6 UK gal)
Fixed Displacement Gear Pump Displacement Volume	10 cc/rev
* Working Pressure	40 kgf/cm^2 (39.2 bar, 568lb/in^2)
Maximum Output	22.0 litre/min (4.8 UK gal)
Dry Weight	* 132 kg (291 lb)

Control Valve

Type	Hydraulic Pilot System
Operating System	Set relief pressure
Main Relief Standard * Pressure Raising	 320 kgf/cm^2 (314 bar, 4550 lb/in^2) at 168 litre/min (37 UK gal) 350 kgf/cm^2 (343 bar, 4977 lb/in^2) at 155 litre/min (34 UK gal)
Overload Relief Pressure Boom Raising, Arm, Bucket * Boom Lowering Pressure	 370 kgf/cm^2 (363 bar, 5263 lb/in^2) at 20 litre/min (4.4 UK gal) 250 kgf/cm^2 (245 bar, 3555 lb/in^2) at 20 litre/min (4.4 UK gal)
* Function	Travel priority, Slew priority, Boom and Dipper Load Holding Valve, Boom and Dipper 2 Speed Confluence
Dry Weight	* 165 kg (364 lb)

Slew Equipment

Type	Fixed displacement piston motor
Suction Capacity	151 cc/rev
Working Pressure	285 kgf/cm^2 (279 bar, 4053 lb/in^2)
Work Flow	212.2 litre/min (46.6 gal/min)
* Set Pressure Relief	285 kgf/cm^2 (279 bar, 4052 lb/in^2) at 188 litre/min (41.3 UK gal)
* Reduction Gear Ratio	22.097 : 1
Slew Brake	
Brake Torque	More than 75.4 kgf m (739.4 Nm, 545 ft lbs) (Not including reduction gear)
* Brake Pressure Release	Min 30 kgf/cm^2 (min 29.4 bar, 426 lb/in^2)
Dry Weight	* 325 kg (716 lb)

Travel Equipment

	Motor	Fixed displacement piston motor (automatic 2-speed change)
	Suction Capacity	164.4/98.1 cc/rev
*	Working Pressure	350 kgf/cm^2 (343 bar, 4977 lb/in^2)
	Working Flow	211 litre/min (46.4 UK UK gal)
	Reduction Gears Deceleration Ratio	 44.384
	Parking Brake Brake Torque Brake Pressure Release Brake valve pressure relief	 2135 kgf/m (20.9 kNm, 15436 ft/lb) including reduction gear > 14 kgf/cm^2 (13.5 bar, 199 lb/in^2) 360 kgf/cm^2 (353 bar, 5119 lb/in^2) at 40 litre/min (8.8 UK gal)
	Dry Weight	* 270 kg (595 lb)

Boom Rams

Cylinder Inside Diameter	130 mm
Rod Diameter	90 mm
Max Contracted Length	1843 mm
Stroke	1278 mm
Dry Weight	* 214 kg (472 lb)

Dipper Ram

Cylinder Inside Diameter	150 mm
Rod Diameter	105 mm
Max Contracted Length	2234 mm
Stroke	1632 mm
Dry Weight	* 341 kg (752 lb)

Bucket Ram

Cylinder Inside Diameter	135 mm
Rod Diameter	90 mm
Max Contracted Length	1687 mm
Stroke	1073 mm
Dry Weight	* 211 kg (465 lb)

All Machines (see Note on Contents Page)

Pump

Part Name	Size	Torque			Tool	Name
		Nm	kgf m	lbf ft		
Hexagonal Socket Head (Material quality SCM 435)	M5	7	0.70	5	B = 4	
	M6	12	1.20	9	5	
	M8	29	3.00	22	6	
	M10	57	5.8	42	8	
	M12	98	10.00	72	10	
	M14	157	16.00	116	12	Allen wrench
	M16	235	24.00	174	14	
	M18	333	34.00	246	14	
	M20	432	44.00	318	17	
PT UMESEN (Material quality S45C) Wrap seal tape 1.5~2 times	PT 1/16	7	0.70	5	4	
	PT 1/8	10	1.05	8	5	
	PT 1/4	17	1.75	13	6	Allen wrench
	PT 3/8	34	3.50	25	8	
	PT 1/2	49	5.00	36	10	
PO PLUG (Material quality S35C) PF PLUG (Material quality S45C)	PF 1/4	29	3.00	22	6	
	PF 1/2	98	10.00	72	10	
	PF 3/4	147	15.00	109	14	Allen wrench
	PF 1	186	19.00	137	17	
	PF 11/4	265	27.00	195	17	
	PF 11/2	275	28.00	203	17	

This table refers to the Hydraulic pump sectional drawing

Component	Nm	kgf m	lbf ft	Part No.	Remarks	Qty
Hexagonal socket head bolts	432	44	318	401	M20	8
Hexagonal socket head bolts	29	3	22	406, 413	M8	4
Hexagonal socket head bolts	12	1.2	9	407	M6	3
Vp plug	36	3.7	27	466	$PF^{1}/_{4}$	3
Vp plug	168 9	17 0.9	123 6	468 490	$PF^{3}/_{4}$ $NPTF^{1}/_{16}$	4
* Tilting pin, Servo Piston	333	34	246	531, 532	M24 x 2	2, 2
Hexagon nut	235	24	174	808	M20	2

* All Machines (see Note on Contents Page)

This table refers to the regulator sectional drawing

*

Regulator	Nm	kgf m	lbf ft	Part No.	Remarks	Qty
Hexagonal socket head bolts	29	3	22	412, 413	M8	2, 2
Hexagonal socket head bolts	12	1.20	9	436, 438	M6	2, 10
Plug	36 9	3.7 0.9	27 6	466 496	$PF^{1}/_{4}$ $NPTF^{1}/_{16}$	5
Lock nut	157	16	116	630	M30 x 1.5	1
Hexagon nut	16	1.6	12	801	M8	3

*

Component	Nm	kgf m	lbf ft	Remarks
Rotary coupling, lock bar bolts	109-125	11.1-12.7	80-92	Apply Loctite 262
Hydraulic pump to engine bolts	65-76	6.6-7.7	48-56	Apply Loctite 262
Control valve mounting bolts	267-312	27.2-31.8	192-230	
Rotary coupling bottom cover	31-37	3.2-3.8	23-27	
Rotary coupling mounting bolts	103	10.5	76	Apply Loctite 242
Rotary coupling filter bolts	39	4	29	
Rotary coupling motor cover	157	16	116	
Rotary coupling motor make-up and by-pass valve; Relief valve	78	8	58	
Make-up and by-pass cap	137	14	101	
Relief valve cap	157	16	116	

* Boom Ram JS200 (see Note on Contents Page)

This table refers to the JS200 Boom Ram sectional drawing

	Nm	kgf m	lbf ft	Part No.	Remarks	Qty
Hexagonal socket head bolts	265	27	195	12	M16 x 2	12
Set Screw	57 ±11	5.8 ±1.09	42 ±8	22	M12 x 1.75	1
Nut	5000	510	3690	21	M65 x 2	1

* Dipper Ram JS200 (see Note on Contents Page)

This table refers to the JS200 Dipper Ram sectional drawing

	Nm	kgf m	lbf ft	Part No.	Remarks	Qty
Hexagonal socket head bolts	367	38	270	12	M18 x 2.5	12
Set Screw	57 ±11	5.8 ±1.09	42 ±8	22	M12 x 1.75	1
Nut	9340	952	6885	21	M70 x 2	1

* Bucket Ram JS200 (see Note on Contents Page)

This table refers to the JS200 Bucket Ram sectional drawing

	Nm	kgf m	lbf ft	Part No.	Remarks	Qty
Hexagonal socket head bolts	265	27	195	12	M16 x 2	12
Set Screw	57 ±11	5.8 ±1.09	42±8	21	M12 x 1.75	1
Nut	7140	728	5265	20	M62x2	1

* Boom Ram JS240 (see Note on Contents Page)

This table refers to the JS240 Boom Ram sectional drawing

	Nm	kgf m	lbf ft	Part No.	Remarks	Qty
Hexagonal socket head bolts	367	38	270	12	M18 x 2.5	12
Set Screw	57 ±11	5.8 ±1.09	42 ±8	22	M12 x 1.75	1
Nut	5790	590	4265	21	M70 x 2	1

* Dipper Ram JS240 (see Note on Contents Page)

This table refers to the JS240 Arm Cylinder sectional drawing

	Nm	kgf m	lbf ft	Part No.	Remarks	Qty
Hexagonal socket head bolts	520	53	380	12	M12 x 2.5	12
Set Screw	57 ±11	5.8 ±1.09	42 ±8	22	M14 x 2.0	1
Nut	13200	1348	9746	21	M80 x 2	1

* Bucket Ram JS240 (see Note on Contents Page)

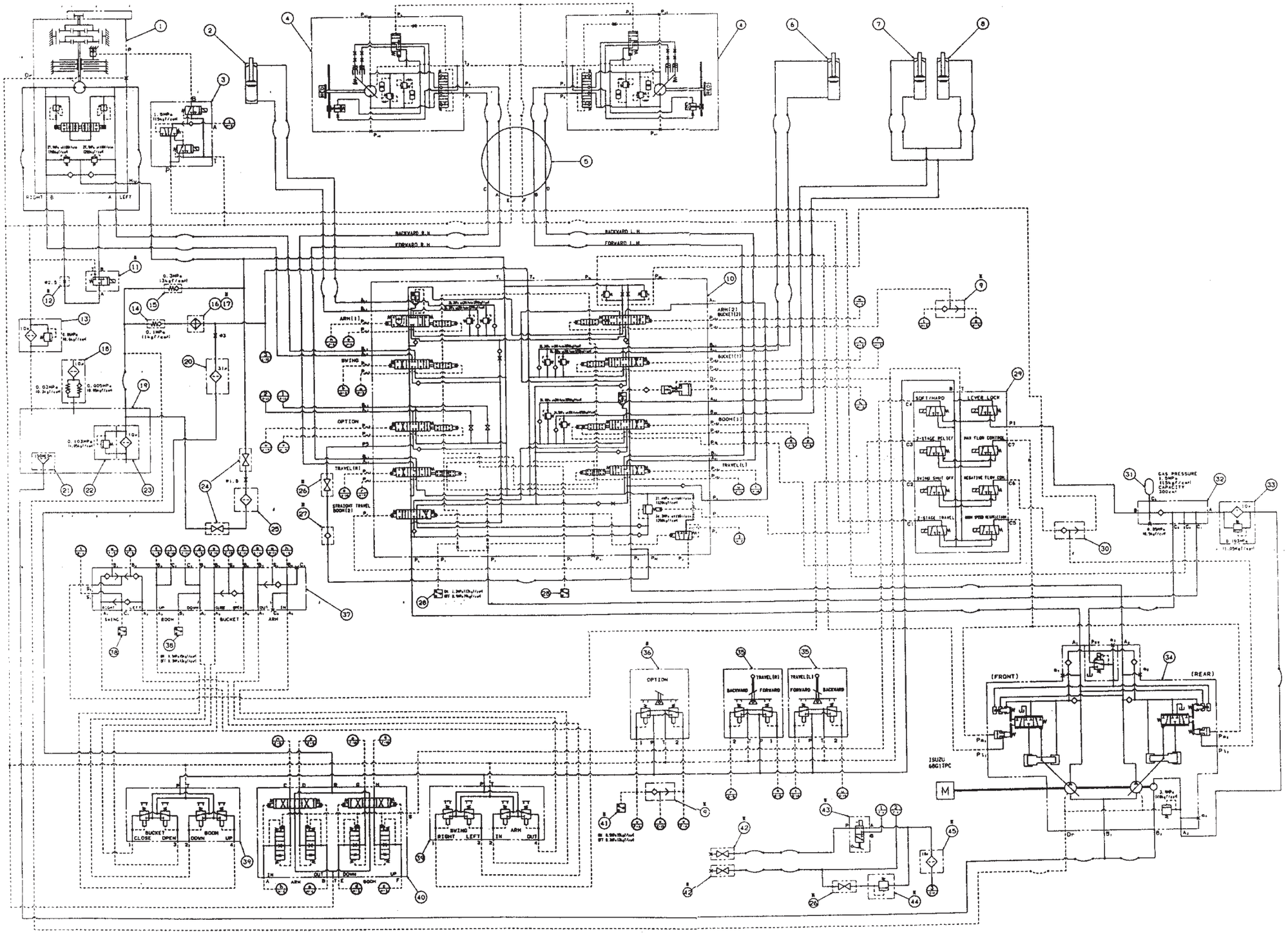
This table refers to the JS240 Bucket Ram sectional drawing

	Nm	kgf m	lbf ft	Part No.	Remarks	Qty
Hexagonal socket head bolts	367	38	270	12	M18 x 2.5	12
Set Screw	57 ±11	5.8 ±1.09	42 ±8	21	M12 x 1.75	1
Nut	9340	952	6885	20	M70 x 2	1

* **Schematic, Hydraulic Circuit JS200 (and Variants)**

	1	MOTOR; SLEW
	2	RAM; DIPPER
	3	VALVE; ASSEMBLY
	4	MOTOR; TRACTION
*	5	COUPLING; ROTARY
	6	RAM; BUCKET
	7	RAM; BOOM (L)
	8	RAM; BOOM (R)
	9	VALVE; SHUTTLE
	10	VALVE; CONTROL
	11	VALVE; SOLENOID
	12	ORIFICE
	13	FILTER; LINE
	14	VALVE; CHECK
	15	VALVE; CHECK
	16	RADIATOR
	17	RADIATOR
	18	BREATHER; AIR
	19	TANK; SUMP
	20	FILTER; LINE
	21	STRAINER
	22	VALVE; RELIEF
	23	FILTER; RETURN
	24	VALVE; STOP
*	25	FILTER; NEPHRON
	26	VALVE; STOP
	27	VALVE; CHECK
	28	SWITCH; PRESS.
	29	VALVE; SOLENOID

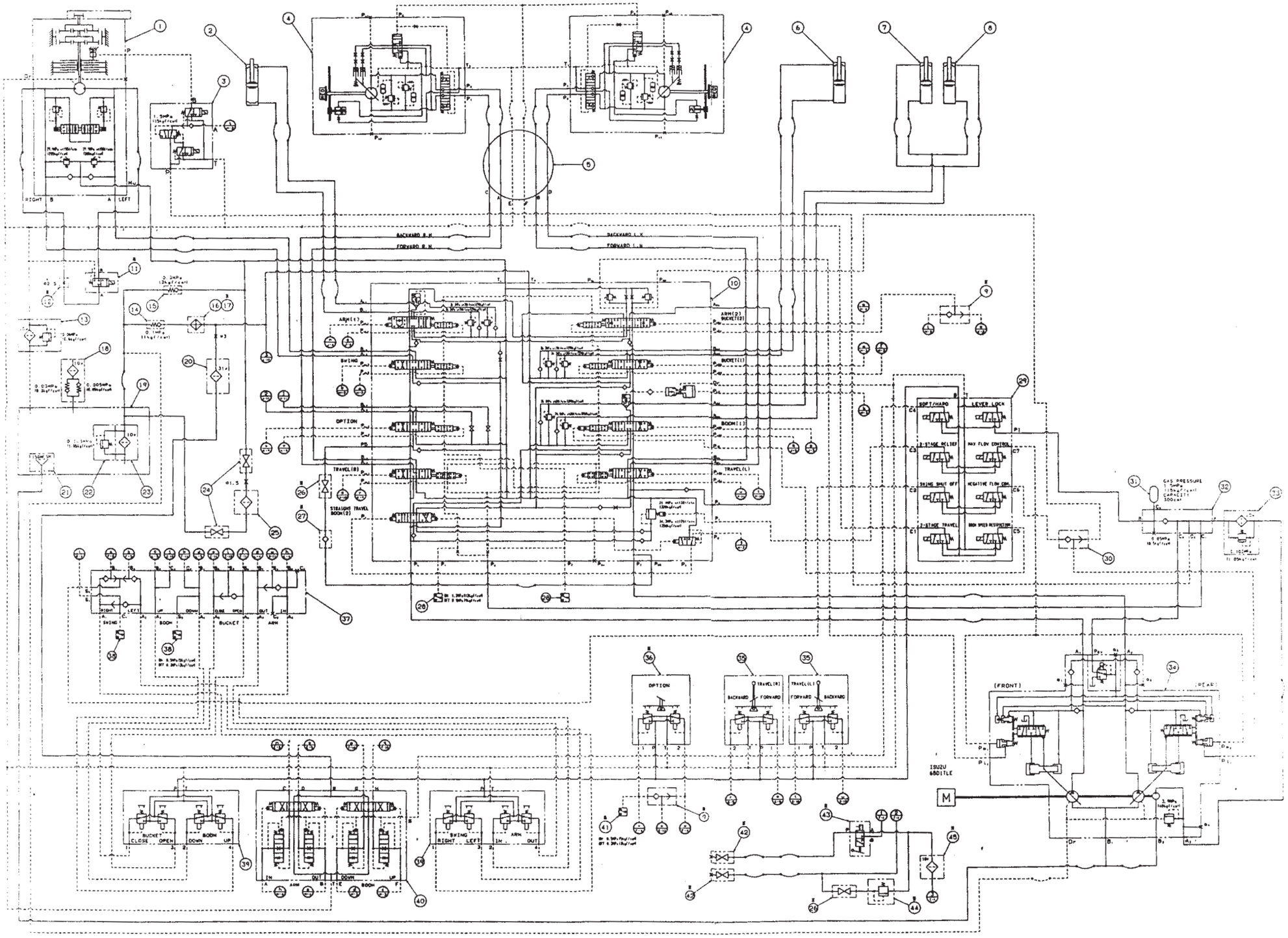
30	VALVE; SHUTTLE
31	ACCUMULATOR
32	VALVE; CHECK
33	FILTER; LINE
34	PUMP; HYD
35	VALVE; REMOTE CONT
36	VALVE; REMOTE CONT
37	VALVE; SHUTTLE
38	SWITCH; PRESS
39	VALVE; STOP
40	VALVE; SPL
41	SWITCH PRESS.
42	VALVE; STOP
43	VALVE; SPL
44	VALVE; RELIEF
45	FILTER; LINE


RIGHT
LEFT
BACKWARD R.H
FORWARD R.H
BACKWARD L.H
FORWARD L.H
ARM(1)
BUCKET(1)
SWING
BOOM(1)
OPTION
TRAVEL(R)
TRAVEL(L)
STRAIGHT TRAVEL BOOM(2)
ARM(2) BUCKET(2)
SOFT/HARD
LEVER LOCK
2-STAGE RELIEF
MAX FLOW CONTROL
SWING SHIFT OFF
NEGATIVE FLOW CON.
2-STAGE TRAVEL
HIGH SPEED REGULATOR
GAS PRESSURE
CAPACITY
SWING
BOOM
BUCKET
ARM
BUCKET CLOSE OPEN
BOOM DOWN UP
SWING RIGHT LEFT
ARM IN OUT
BOOM DOWN UP
ARM IN OUT
OPTION
TRAVEL(R) BACKWARD FORWARD
TRAVEL(L) FORWARD BACKWARD
(FRONT)
(REAR)
ISUZU
6BG1TPC
M

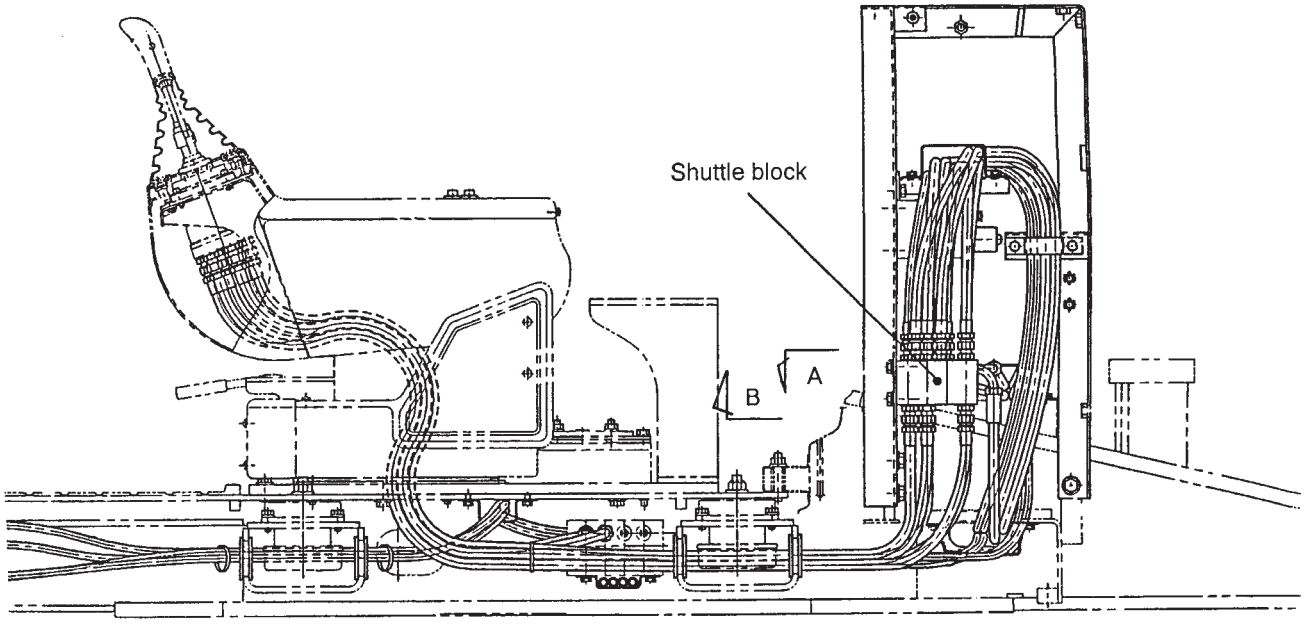
Schematic, Hydraulic Circuit JS240 (and Variants)

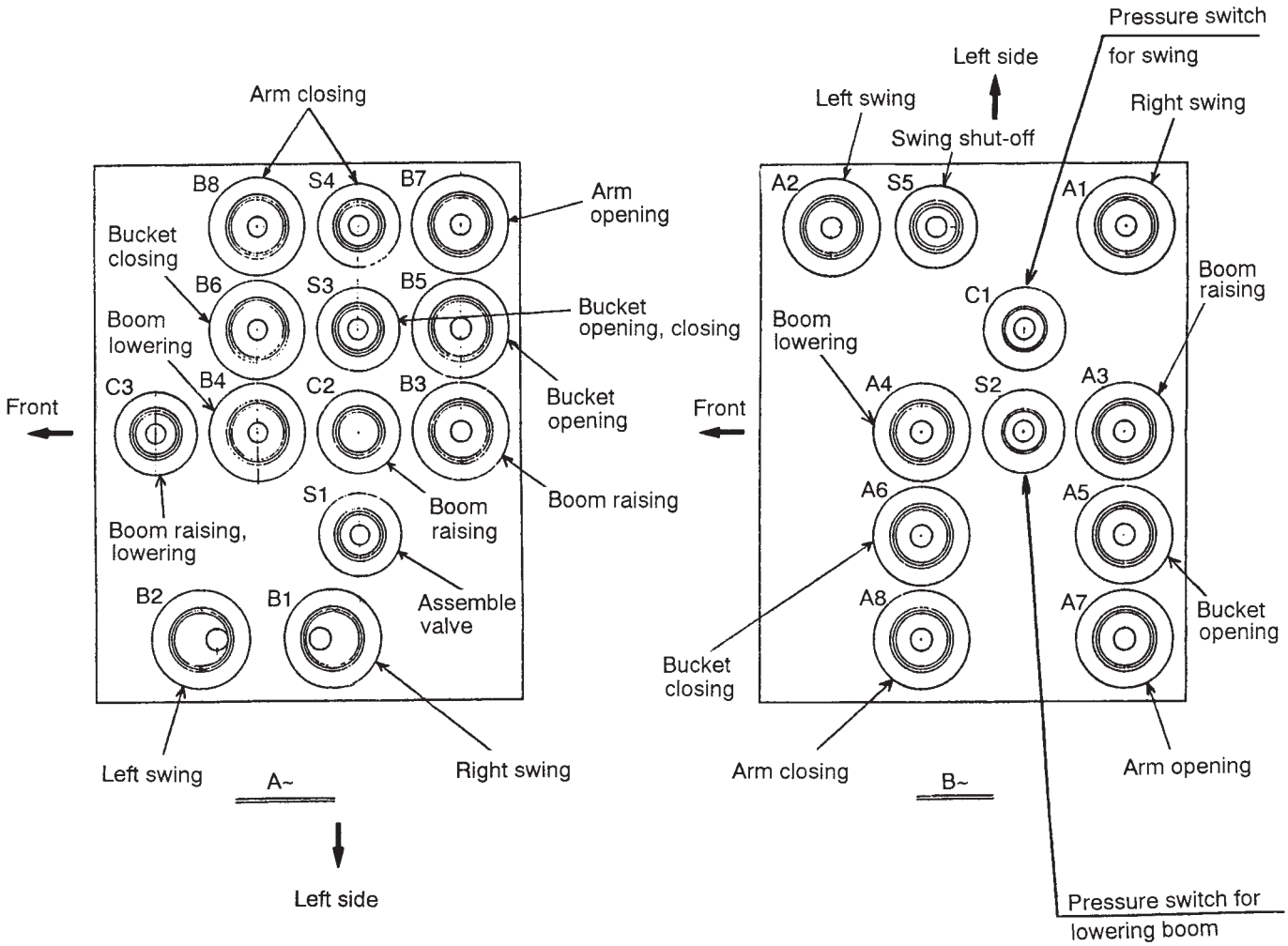
1	MOTOR; SLEW
2	RAM; DIPPER
3	VALVE; ASSEMBLY
4	MOTOR; TRACTION
5	COUPLING; ROTARY
6	RAM; BUCKET
7	RAM; BOOM (L)
8	RAM; BOOM (R)
9	VALVE; SHUTTLE
10	VALVE; CONTROL
11	VALVE; SOLENOID
12	ORIFICE
13	FILTER; LINE
14	VALVE; CHECK
15	VALVE; CHECK
16	RADIATOR
17	RADIATOR
18	BREATHER; AIR
19	TANK; SUMP
20	FILTER; LINE
21	STRAINER
22	VALVE; RELIEF
23	FILTER; RETURN
24	VALVE; STOP
25	FILTER; NEPHRON
26	VALVE; STOP
27	VALVE; CHECK
28	SWITCH; PRESS.

30	VALVE; SHUTTLE
31	ACCUMULATOR
32	VALVE; CHECK
33	FILTER; LINE
34	PUMP; HYD
35	VALVE; REMOTE CONT
36	VALVE; REMOTE CONT
37	VALVE; SHUTTLE
38	SWITCH; PRESS
39	VALVE; STOP
40	VALVE; SPL
41	SWITCH PRESS.
42	VALVE; STOP
43	VALVE; SPL
44	VALVE; RELIEF
45	FILTER; LINE

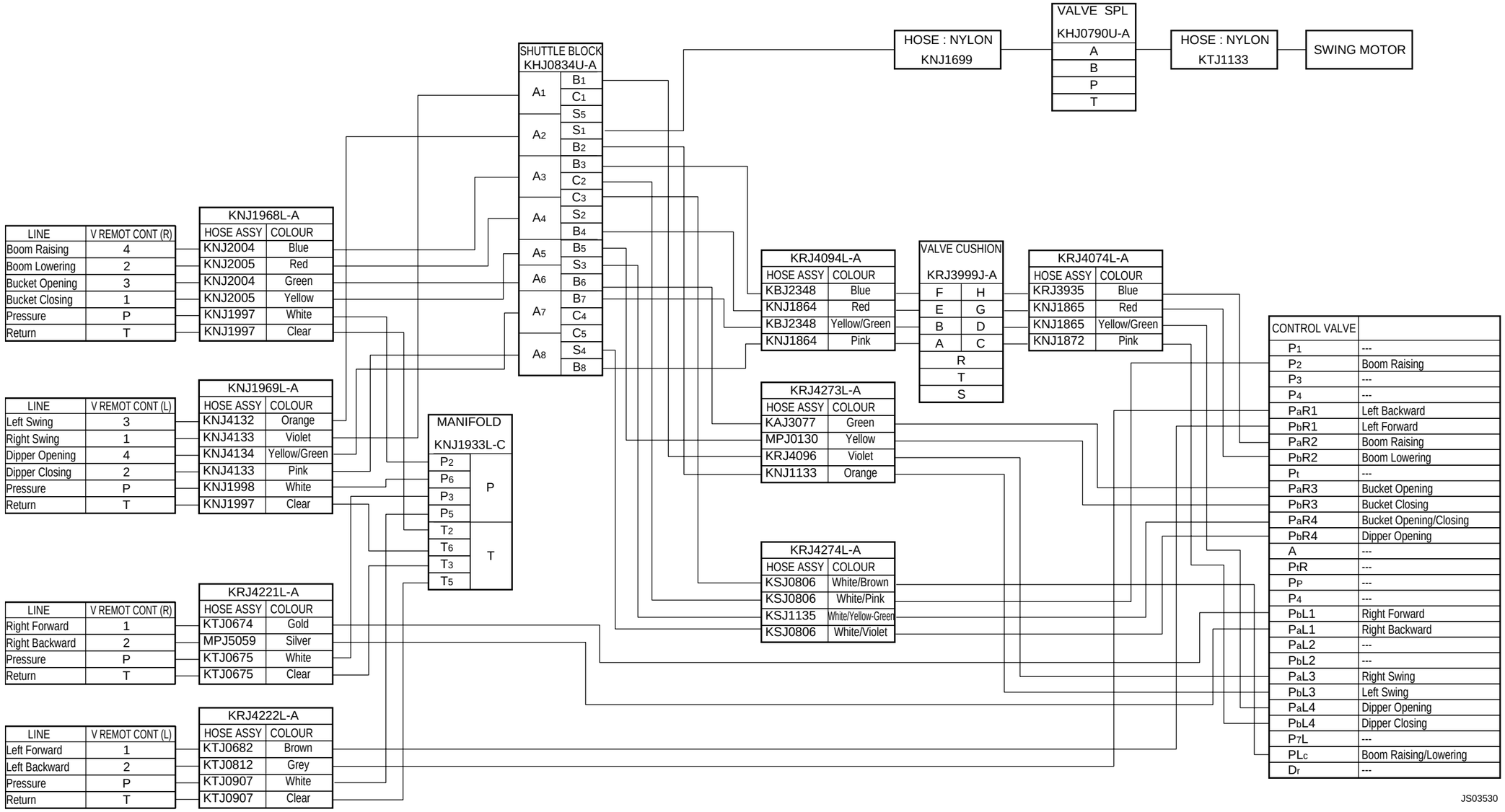

RIGHT
LEFT
BACKWARD R.H
FORWARD R.H
BACKWARD L.H
FORWARD L.H
ARM(1)
SWING
OPTION
PD
TRAVEL(R)
TRAVEL(L)
STRAIGHT TRAVEL BOOM(2)
BUCKET(1)
BOOM(1)
ARM(2) BUCKET(2)
SOFT/HARD
LEVER LOCK
2-STAGE RELIEF
MAX FLOW CONTROL
SWING SHUT OFF
NEGATIVE FLOW CONT.
2-STAGE TRAVEL
HIGH SPEED RESTRICTION
GAS PRESSURE
SWING
BOOM
BUCKET
ARM
CLOSE
OPEN
DOWN
UP
IN
OUT
RIGHT
LEFT
BACKWARD
FORWARD
(FRONT)
(REAR)
ISUZU
6BD1TLE
M

Shuttle Block JS200, JS240





Pilot Control Line Hose Connection Diagram, JS200, JS240



Main Relief Valve Pressure

Note:- *P1 refers to test point on pump.*

1. Prepare the machine
Put the operator levers into neutral, lower the gate lock lever.
Start the engine and place the machine on level ground, lower and open the dipper and set the bucket on the ground. Stop the engine. Release the hydraulic oil tank pressure. *(See **Releasing Tank Pressure**).*

* **1.1** Connect a 0-400 bar (0-6000 lb/in²) pressure gauge and adaptor to the P1 pressure test point, see **A**.

1.2 Start the engine, and confirm that the engine is at its maximum no-load speed and it is in the **S** mode.

* **1.3** Operate the dipper and read the pressure gauge with the ram at end of stroke.

2. High Pressure Setting *(Pressure raising)*

a. Release lock nut **B** and tighten the adjusting screw **C** until the piston **E** touches the inner face marked *, make sure, when locking screw **C** with lock nut **B**, that nut **F** does not turn.

b. Tighten plug **D** and adjust the pressure *(while watching the pressure gauge and gradually tightening plug **D**)*. After setting the pressure, 338 bar ± 19 bar(4977 lb/in² ± 284.4 lb/in²), lock with nut **G**.

3. Low pressure setting *(Standard)*

a. Adjust the pressure as in the high pressure setting above by loosening plug **D**. If the plug **C** is also loosened, the piston **E** moves to the plug **C** the spring loading is reduced.

b. Pressure is therefore reduced. The setting pressure is 314 bar ± 19 bar (4621 lb/in² ± 284.4 lb/in²).

Note: *The pressure is adjusted 209 bar (3086 lb/in²) per revolution.*

c. Lock with the plug **B.**

4. Stop the engine

5. Confirmation of the rated pressure

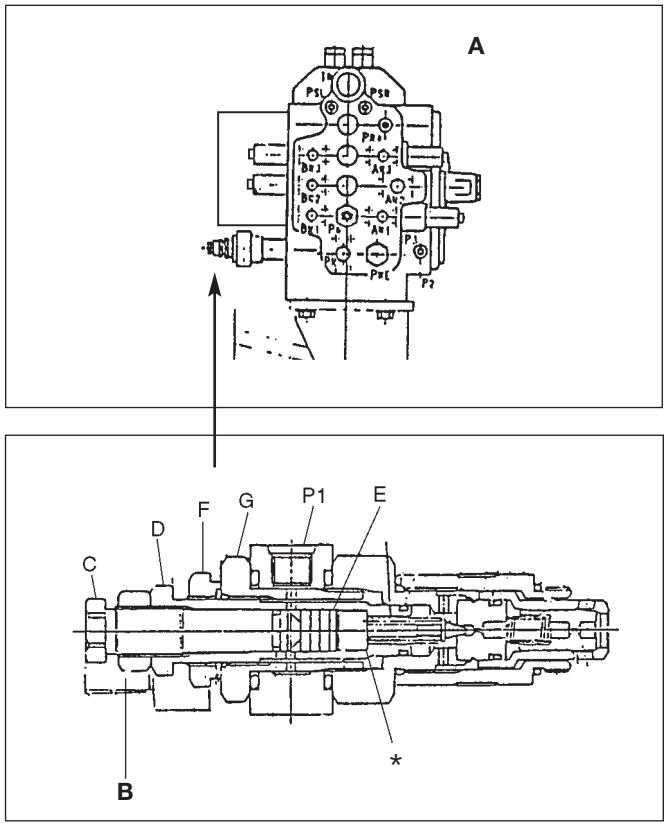
* **a.** Start the engine, raise the r.p.m to maximum in the **S** mode, operate the pressure raising switch in the RH Joystick and check for leakage at the adjusted points.

* **b.** Operate the dipper, hold the service in the stalled position and then stop the control at the standard pressure.

* **c.** Press the pressure raising switch on the RH Joystick and check the pressure.

* **d.** If it needs adjusting, repeat the procedure from step 1.3.

6. Stop the engine and relieve the pressure in the hydraulic oil tank *(see **Releasing Tank Pressure**)* . Remove the pressure gauge and adaptor and reconnect the hose.



Accumulator Pressure

Prepare the engine
Put the operators lever into neutral, lower the gate lock lever, Start the engine and place the machine on level ground, lower and open the dipper and set the bucket on the ground.

1. Release the hydraulic oil tank pressure *(See **Releasing Tank Pressure**)*.

* **2.** Connect a 0-100 bar (0-1500 lb/in²) pressure gauge to the port **A** on the accumulator housing.

3. Start the engine, and let it idle for a few minutes before switching the engine **OFF** and then setting the Key Switch to **ON** with engine **OFF**.

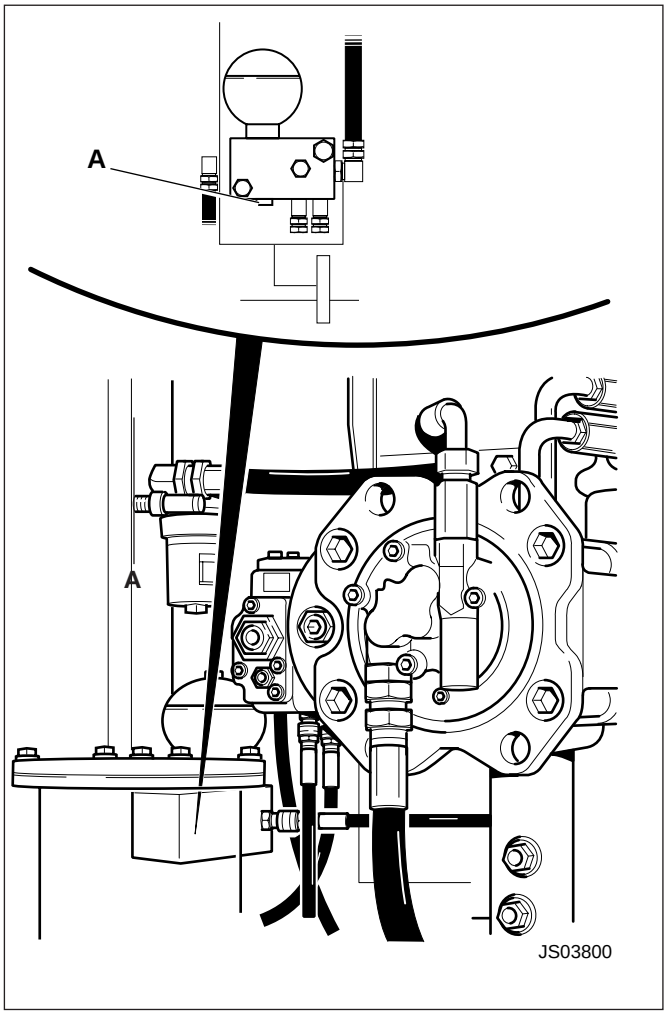
4. Move the slew lever slowly either to the left or the right. Check the pressure just before it suddenly drops. Set pressure is 14.4 ± .47 bar (213 ± 7 lb/in²)

5. If the pressure is unsatisfactory, renew the accumulator unit.

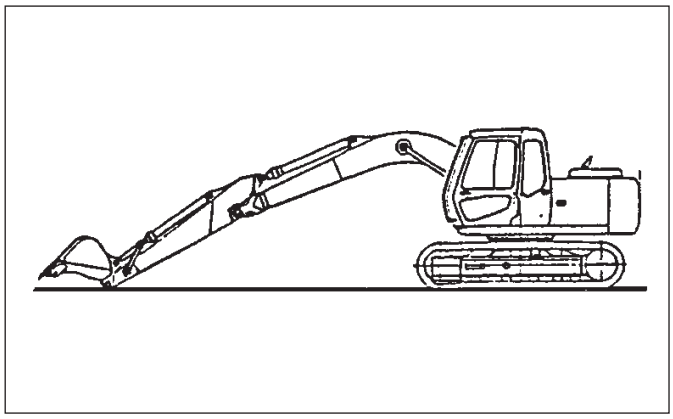
6. Set the Key Switch to **OFF** and release hydraulic tank pressure before disconnecting the gauge and adaptor.

7. Replace plug.

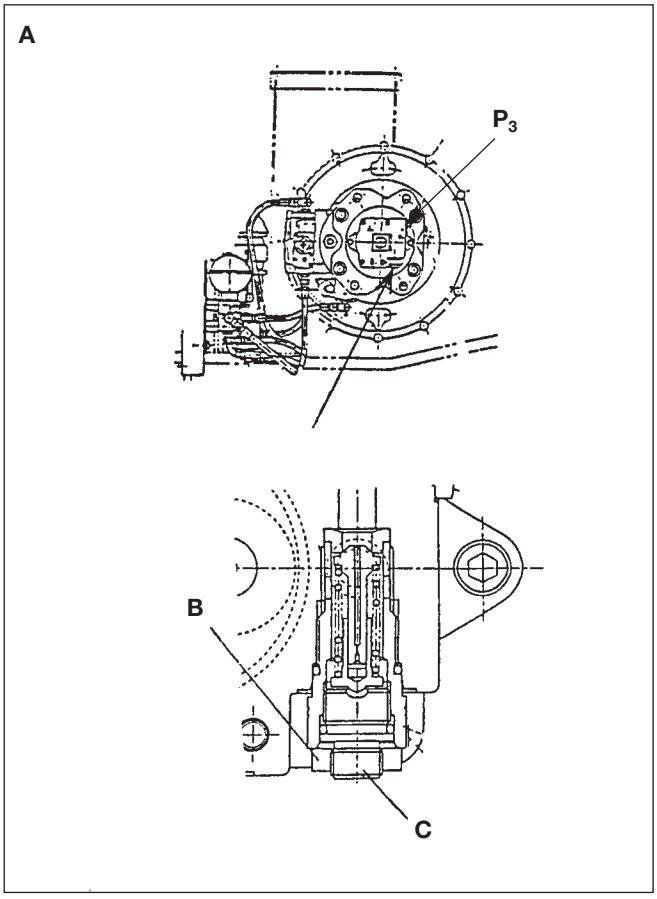
*



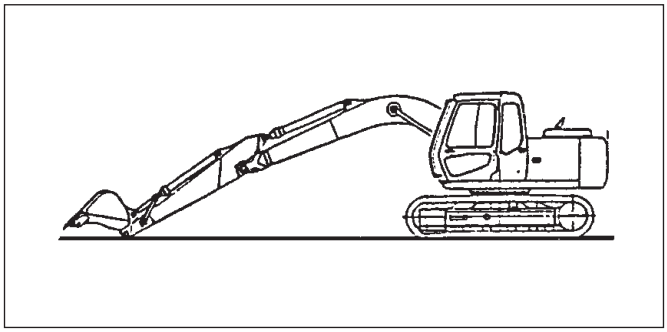
Pilot Relief Pressure



1. **Prepare the machine**
   Put the operator levers into neutral, lower the gate lock lever. Start the engine and place the machine on level ground, lower and open the dipper and set the bucket on the ground. Stop engine.
2. Release the hydraulic oil tank pressure. *(See **Releasing Tank Pressure**)*.
3. Connect a 0-100 bar (0-1500 lb/in^2) pressure gauge and adaptor (see **A**) to the port marked P3 on the pump.
4. Start the engine and confirm that the engine is at its maximum no-load speed and it is in the **S** mode.
5. Loosen the lock nut **B** of the Pilot Relief Valve.
6. Adjust the adjusting screw **C**, to the correct pressure 39.6 ± 2.9 bar (583 ± 48 lb/in^2)
7. Hold the adjusting screw **C** in position and tighten the lock nut **B**.
8. **After locking, check the relief pressure again.** If it is not within the limits above, perform steps 4 onwards again.
9. Stop the engine, release the tank pressure, then remove the gauge and adaptor from the pump.



Slew Motor Pressure Relief



1. Prepare the machine
Put the operators lever into neutral, lower the gate lock lever. Start the engine and place the machine on level ground, lower and open the dipper and set the bucket on the ground. Stop the engine.

2. Release the hydraulic oil tank pressure. *(See **Releasing Tank Pressure**).*

3. Connect a 0-500 bar (0-7000 lb/in²) pressure gauge and adaptor to the port marked P1 on the pump.

4. Initiate slew lock procedures.

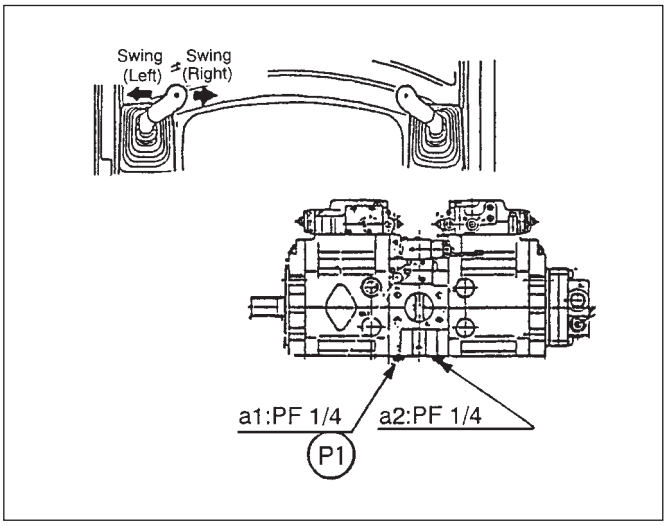
a. Remove the water-proof connector on the slew lock solenoid valve, which is on the hydraulic pump side.

b. Press the slew lock switch which is on the left hand console inside the cab, and confirm that the slew (swing) lock symbol appears on the monitor.

* **c.** Start the engine, and operate the engine at around 1000 r.p.m, then operate the slew lever slowly. Listen to confirm that the relief sound is heard and that the machine does not slew.

d. Run the engine at maximum no-load speed and in the **S** mode.

e. Operate the slew lever.



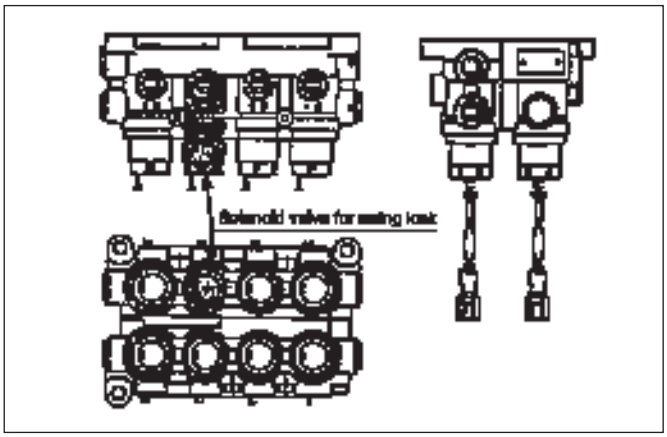
5. Confirm the pressure of 299.8 ± 14.4 bar (4408 ± 213 lb/in²) at the gauge.

Notes:

1. *If the water-proof slew lock solenoid valve is not removed, slew lock status can be obtained with the slew lock switch **ON**, but slew relief is not carried out.*

2. *Wire colour code to the solenoid is Dark Green.*

3. *Pressure measurement is also possible on the slew motor, upper section.*



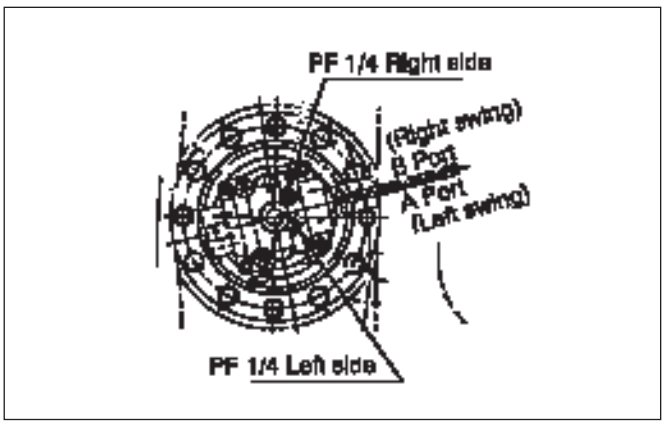
6. If the pressure is within the limits, stop engine release tank pressure and remove the gauge and adaptor; If the readings are outside the limits, continue as below.

7. Pressure Adjustment

a. Confirm the present pressure reading.

b. The difference between the set pressure and the present pressure determines the number of shims **F** required for adjustment.

$$\text{The No of shims} = \frac{\text{Set pressure-Present Pressure}}{4.83 \text{ bar } (71.1 \text{ lb/in}^2)}$$



8. Remove the relief valve assembly from the slew motor.

Note: *If both relief valves are removed at the same time, mark them left and right to facilitate reassembly in the correct position.*

Slew Motor Pressure Relief *(continued)*

9. Disassemble

a. Place the relief valve in a vice and remove the cap **A** with a 14 mm **A/F** hexagonal socket, take out the piston **B**, liner **C**, poppet **E**, shim **F** and spring **D**.

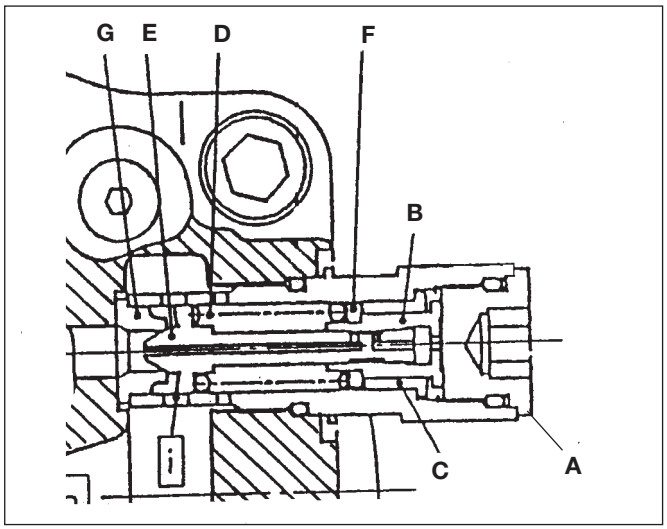
b. Remove the poppet **E** away from the seat **G**, and spring **D** and add or remove a shim (as required by the above calculation) between the spring **D** and spacer.

c. After shim adjustment, install the poppet **E**, spring **D**, shim(s) **F**, piston **B** and liner **C** onto the sleeve.

d. Fix the sleeve into a vice and install the cap **A** with a torque of 156.9 Nm (115.17 ft).

10 a. Install the relief assembly in the slew motor unit, and confirm the pressure.

b. If it is not within the setting pressure, repeat the procedure from step 7.

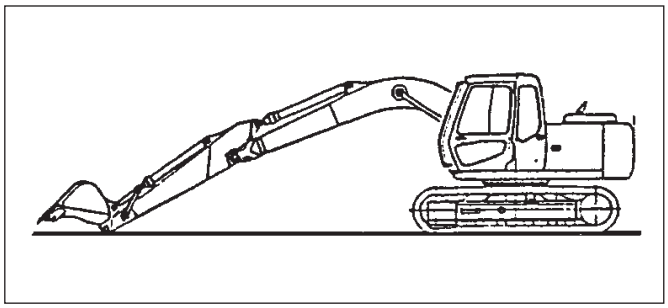


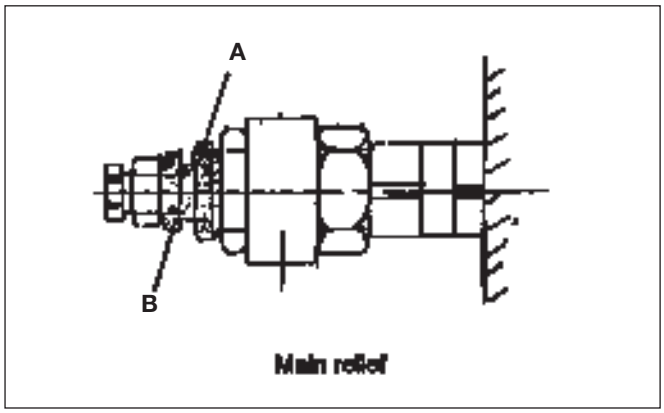
Port Relief Pressure

Note: *Because port relief pressure is set higher than main relief pressure, it is necessary to temporarily set the main relief pressure higher than port pressure.*

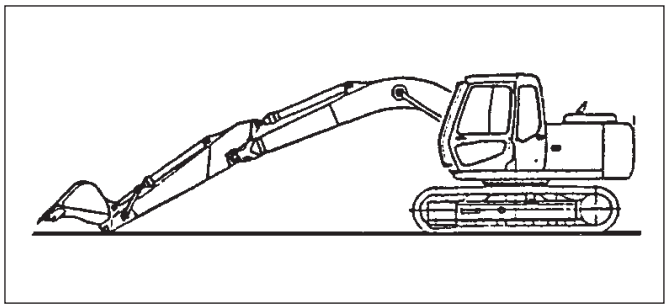
Temporary setting of main relief pressure

1. **Prepare the machine**
   - **a.** Put the operators lever into neutral, lower the gate lock lever. Start the engine and place the machine on level ground, lower and open the dipper and set the bucket on the ground.
   - **b.** Run the engine at maximum no-load speed and in the **S** mode.
2. Loosen the lock nut **A** and tighten the pressure raising adjusting screw **B** 180° clockwise, then tighten the lock nut **A** of the Main Relief Valve.
3. After completing an adjustment on a particular port relief valve, loosen the lock nut **A** and unscrew the pressure raising adjusting screw **B**, over 180° to return to the standard setting pressure.
4. **Stop the engine**

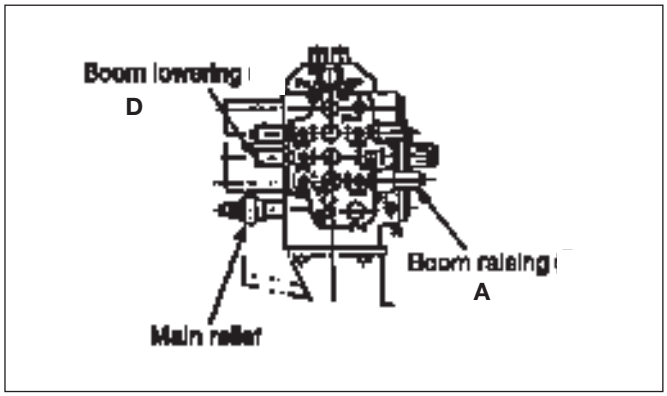


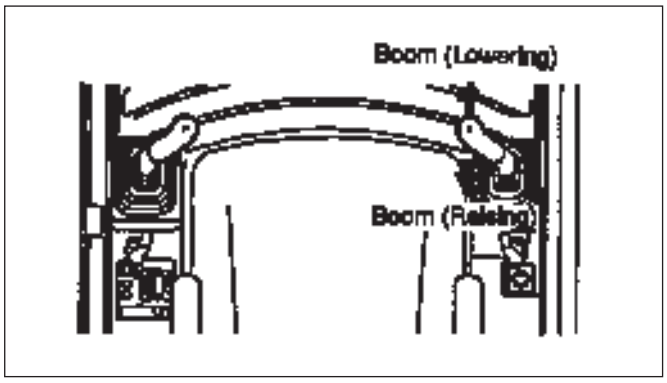


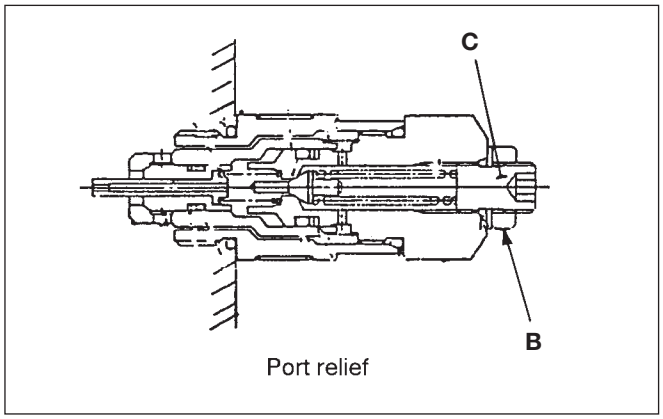
Port Relief for Boom Ram



1. **Prepare the machine**
   - **a.** Put the operator lever into neutral, lower the gate lock lever. Start the engine and place the machine on level ground, lower and open the arm and set the bucket on the ground.
   - **b.** Stop the engine, and release hydraulic pressure. *(See **Releasing Tank Pressure**).*
   - **c.** Connect a 0-500 bar (0-7000 lb/in²) pressure gauge and adaptor to port P2 on the hydraulic pump.
2. Refer to the previous section "Temporary setting of main relief pressure" and complete step 2.
3. **Pressure Adjustment**
   - **a.** Start the engine and lower the gate lock lever, run the engine at maximum no-load speed and in the **S** mode.
   - **b.** Position the boom lever in the raised position and maintain.
   - **c.** Check the gauge for the set pressure of 377 bar ± 14.4 bar (5546 ± 213 lb/in²). If it is outside the limits, adjust the port relief valve **A** by loosening the lock nut **B** and always coming up to the correct set pressure by first unscrewing, and then screwing in adjusting screw **C**.
4. Adjust the boom lowering port relief valve **D**, as above, to the set pressure of 241 ± 14.4 bar (3555 ± 213 lb/in²) by first positioning the boom lever in the lowered position and maintaining it.
5. If the boom cannot be lowered fully, the two ARV's can be exchanged so that the ARV of the boom lowering can be adjusted in the boom raising position (boom lever in raised position) and then replaced.
6. **Adjust the main relief Pressure**
   See previous section "Temporary setting of main relief pressure", item 3.
7. Stop the engine and release the hydraulic pressure, *(see **Releasing Tank Pressure**)*, remove the pressure gauge and adaptor.

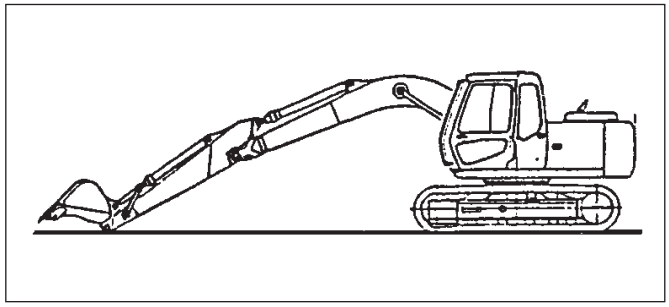




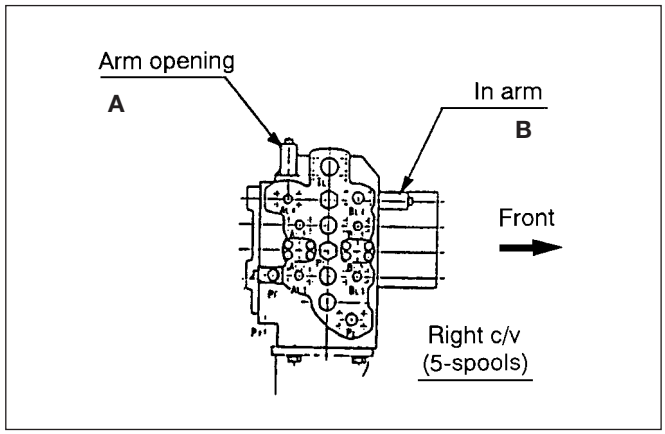


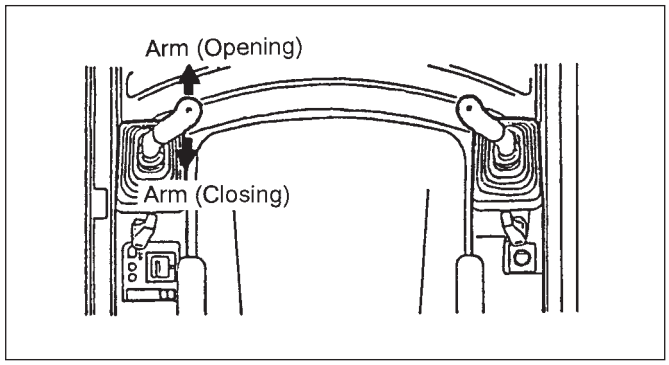
Port relief

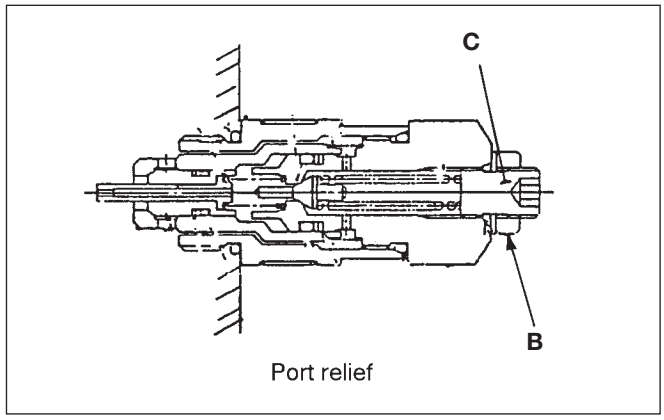
Port Relief for Dipper Ram



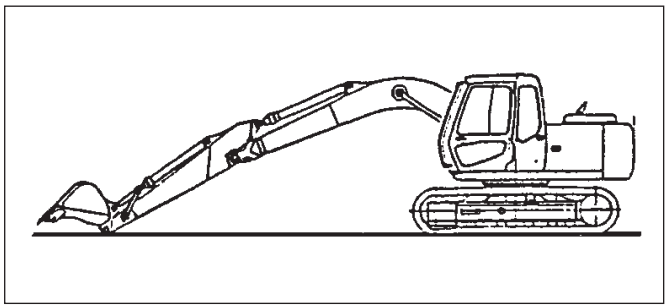
1. **Prepare the Machine.**
   - **a.** Put the operator lever into neutral, lower the gate lock lever. Start the engine and place the machine on level ground, lower and open the dipper and set the bucket on the ground.
   - **b.** Stop the engine and release hydraulic pressure. *(See **Releasing Tank Pressure**)*.
   - **c.** Connect a 0-500 bar (0-7000 lb/in²) pressure gauge and adaptor to port P1 on the hydraulic pump.
2. Refer to the section "Temporary setting of main relief pressure" and complete step 2.
3. **Pressure Adjustment**
   a. Start the engine and lower the gate lock lever, run the engine at maximum no-load speed in the **S** mode.
   - **b.** Position the arm operating lever in the opening position and maintain.
   - **c.** Check the gauge for the set pressure of 377 bar ± 14.4 bar (5546 ± 213 lb/in²). If it is outside the limits, adjust the port relief valve **A** by loosening the lock nut **B** and always coming up to the correct set pressure by first unscrewing, and then screwing in adjusting screw **C**.
   - **d.** Operate the dipper operating lever in the closing position and maintain, perform the above procedure (**c**), adjusting port relief valve **B**.
4. **Adjust the main relief pressure**
   See previous section "Temporary setting of main relief pressure", item 3.
5. **Stop the engine and release the hydraulic pressure** *(See **Releasing Tank Pressure**)*, remove the pressure gauge and adaptor.



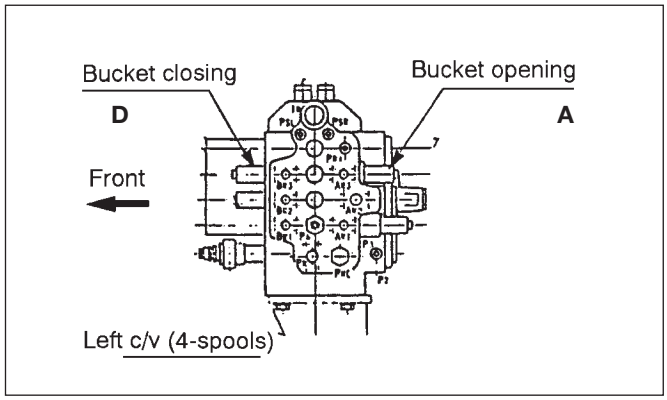


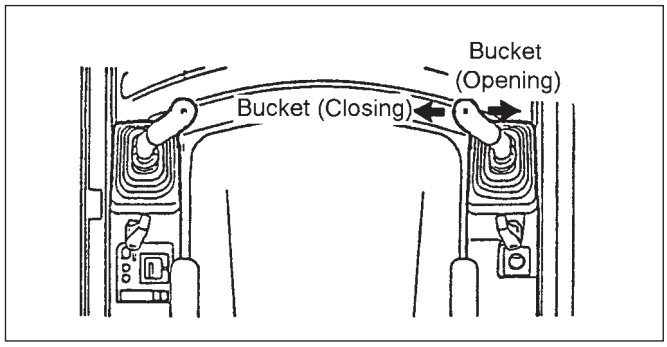


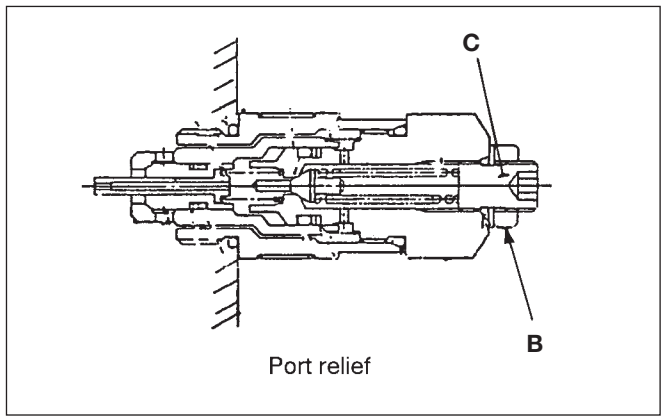
Port Relief for Bucket Ram



1. **Prepare the Machine**
   - **a.** Put the operator lever into neutral, lower the gate lock lever, start the engine and place the machine on level ground, lower and open the dipper and set the bucket on the ground.
   - **b.** Stop the engine, and release hydraulic pressure. *(See **Releasing Tank Pressure**)*.
   - **c.** Connect a 0-500 bar (0-7000 lb/in²) pressure gauge and adaptor to port P2 on the hydraulic pump.
2. Refer to the section "Temporary setting of main relief pressure" and complete step 2.
3. **Pressure Adjustment**
   - **a.** Start the engine and lower the gate lock lever, run the engine at maximum no-load speed in the **S** m o d e .
   - **b.** Position the bucket lever in the opening position and maintain.
   - **c.** Check the gauge for the set pressure of 377 bar ± 14.4 bar (5546 ± 213 lb/in²). If it is outside the limits, adjust the port relief valve **A** by loosening the lock nut **B** and always coming up to the correct set pressure by first unscrewing, and then screwing in adjusting screw **C**.
   - **d.** Operate the bucket lever in the closing position and carry out the above procedure (**c**) for adjusting port relief valve **B**.
4. **Adjust the main relief pressure**
   See previous section "Temporary setting of main relief pressure", item 3.
5. **Stop the engine and release the hydraulic pressure**
   *(See **Releasing Tank Pressure**)*, remove the pressure gauge and adaptor.







Travel Motor Relief Pressure

1. Prepare the Machine

a. Put the operator lever into neutral, lower the gate lock lever, start the engine and place the machine on level ground, lower and open the dipper and set the bucket on the ground.

b. Stop the engine and release hydraulic pressure. *(See **Releasing Tank Pressure**).*

c. Connect a 0-500 bar (0-7000 lb/in²) pressure gauge and adaptor to port P1 (left travel), P2 (Right travel).

***Note:** Because the travel motor relief pressure is higher than the relief pressure, raise the main relief pressure to more than 350 bar (5120 lb/in²).*

2. Refer to the section "Temporary Setting of main relief pressure" and complete step 2.

3. Insert lock pin **A** into the drive sprocket, on the appropriate side being measured.

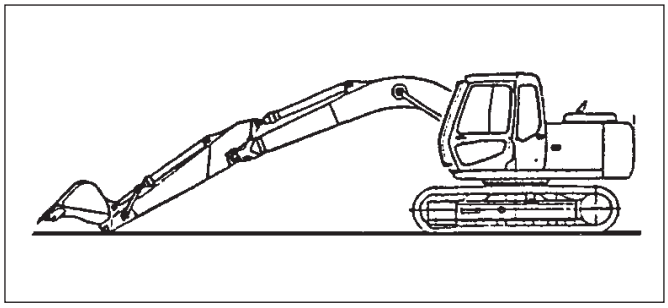
4. Pressure Adjustment

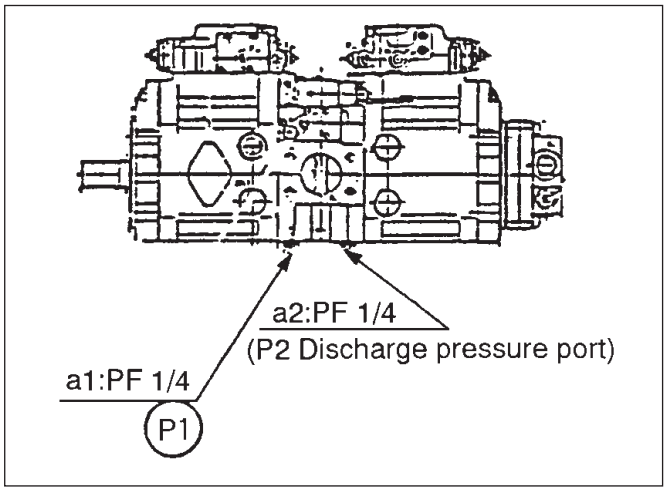
a. Start the engine and lower the gate lock lever, run the engine at maximum no-load speed in the **S** mode.

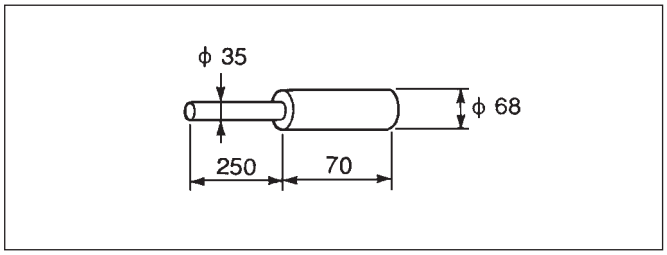
b. Slowly engage the travel motor left or right whichever is locked up.

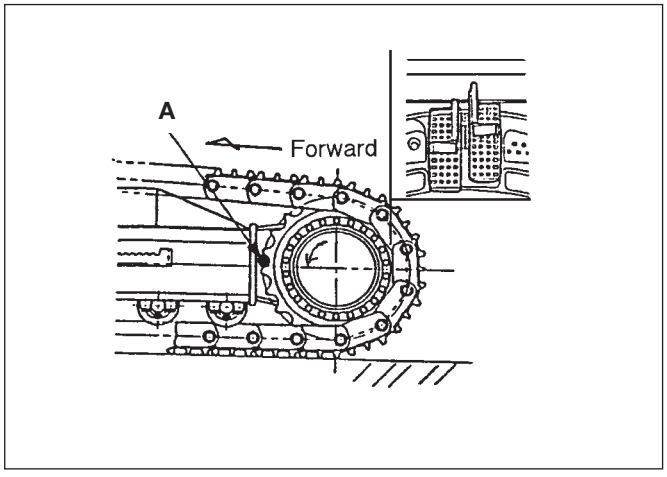
c. Check the gauge for the set pressure of 402 bar ± 20 bar (5830 ± 284 lb/in²). If it is outside the limits, adjust the port relief valve **A** by loosening the lock nut **B** and always coming up to the correct set pressure by first unscrewing, and then screwing in adjusting screw **C**.

d. Repeat the procedure from step 3 for the other side.





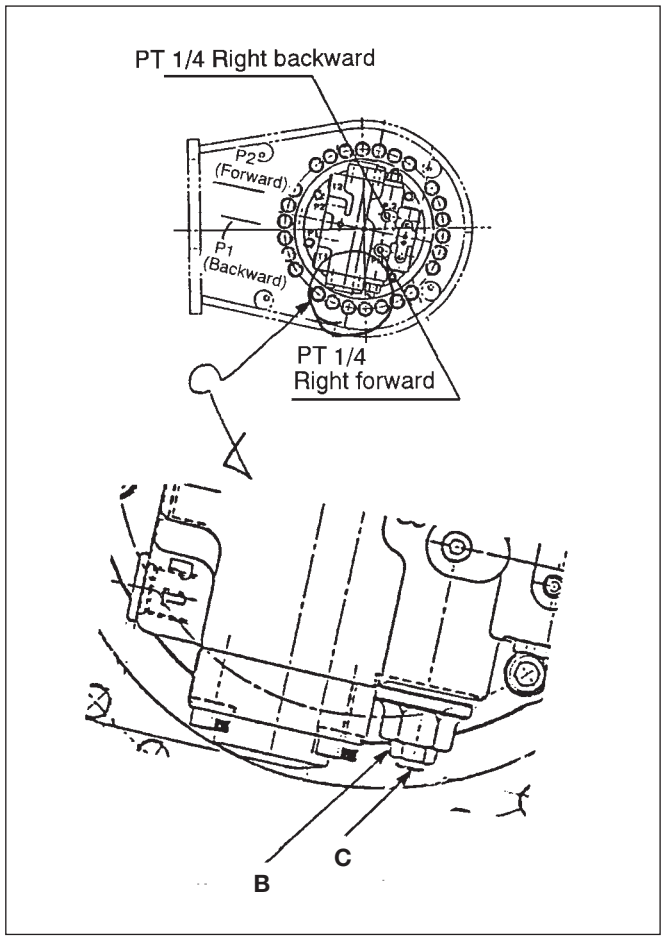




Travel Motor Relief Pressure *(continued)*

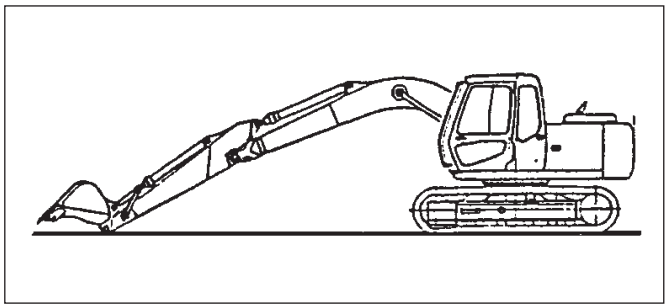
5. Adjust the main relief pressure
See previous section "Temporary setting of main relief pressure", item 3.

6. Stop the engine and release the hydraulic pressure. *(See **Releasing Tank Pressure**)*, remove the pressure gauge and adaptor.



Hydraulic Pump

Proportional Pressure Reduction Valve.



1. Prepare the Machine

a. Put the operator lever into neutral, lower the gate lock lever, start the engine and place the machine on level ground. Lower and open the dipper and set the bucket on the ground.

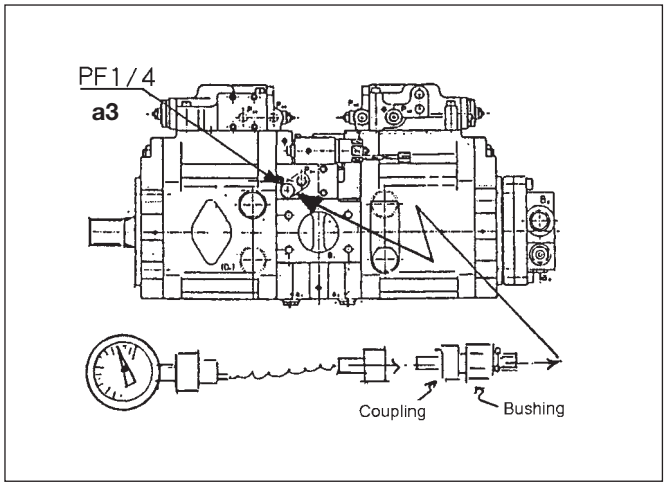
b. Stop the engine and release hydraulic pressure. *(See **Releasing Tank Pressure**).*

c. Connect a 0-500 bar (0-7000 lb/in^2) pressure gauge and adaptor to port a3.

2. Pressure

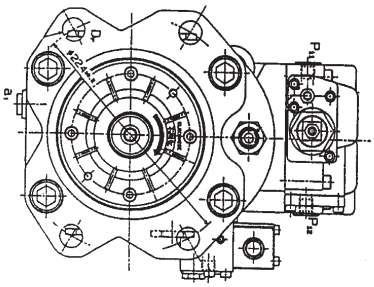
a. Start the engine and lower the gate lock lever, run the engine at maximum no-load speed, with the operator lever in neutral.

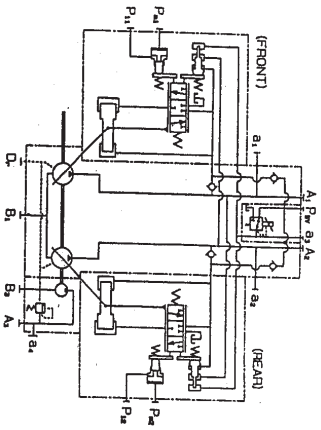
b. Refer to the chart below for the pressure reading in the relevant modes.



Engine revolutions		Max.
Lever operation		Neutral
Mode Operation	H	99.5 lb/in^2-355 lb/in^3, 6.7 bar - 24.1 bar (7 - 25 kgf/cm^2)
	S	367 lb/in^2-455 lb/in^2, 24.9 bar - 30.9 bar (26 - 32 kgf/cm^2)
	L.F.	_
Pressure gauge		0-500 bar, 0-7000 lb/in^2 (50kgf/cm^2)
Measurement port		a3

No adjustment is possible

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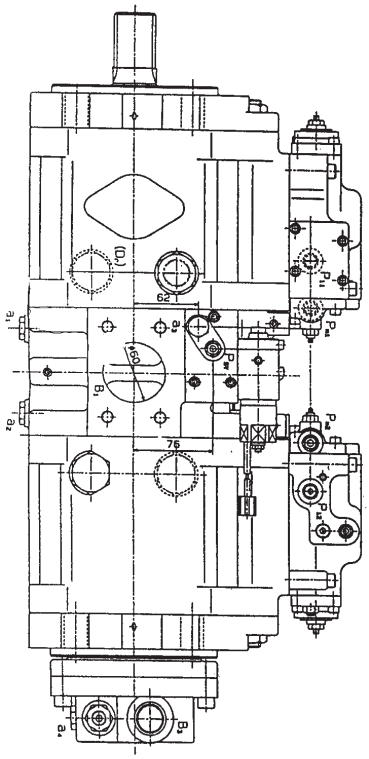
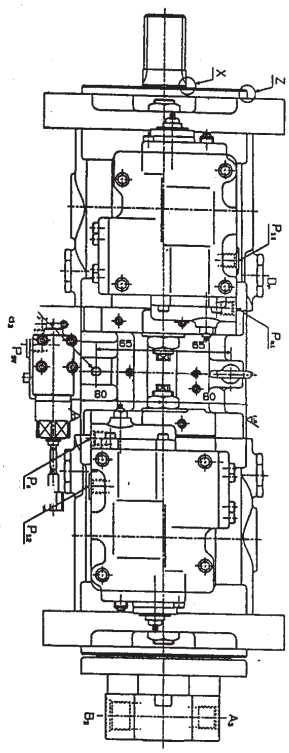
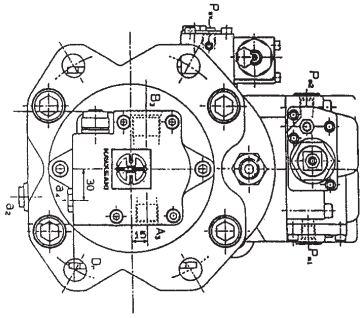
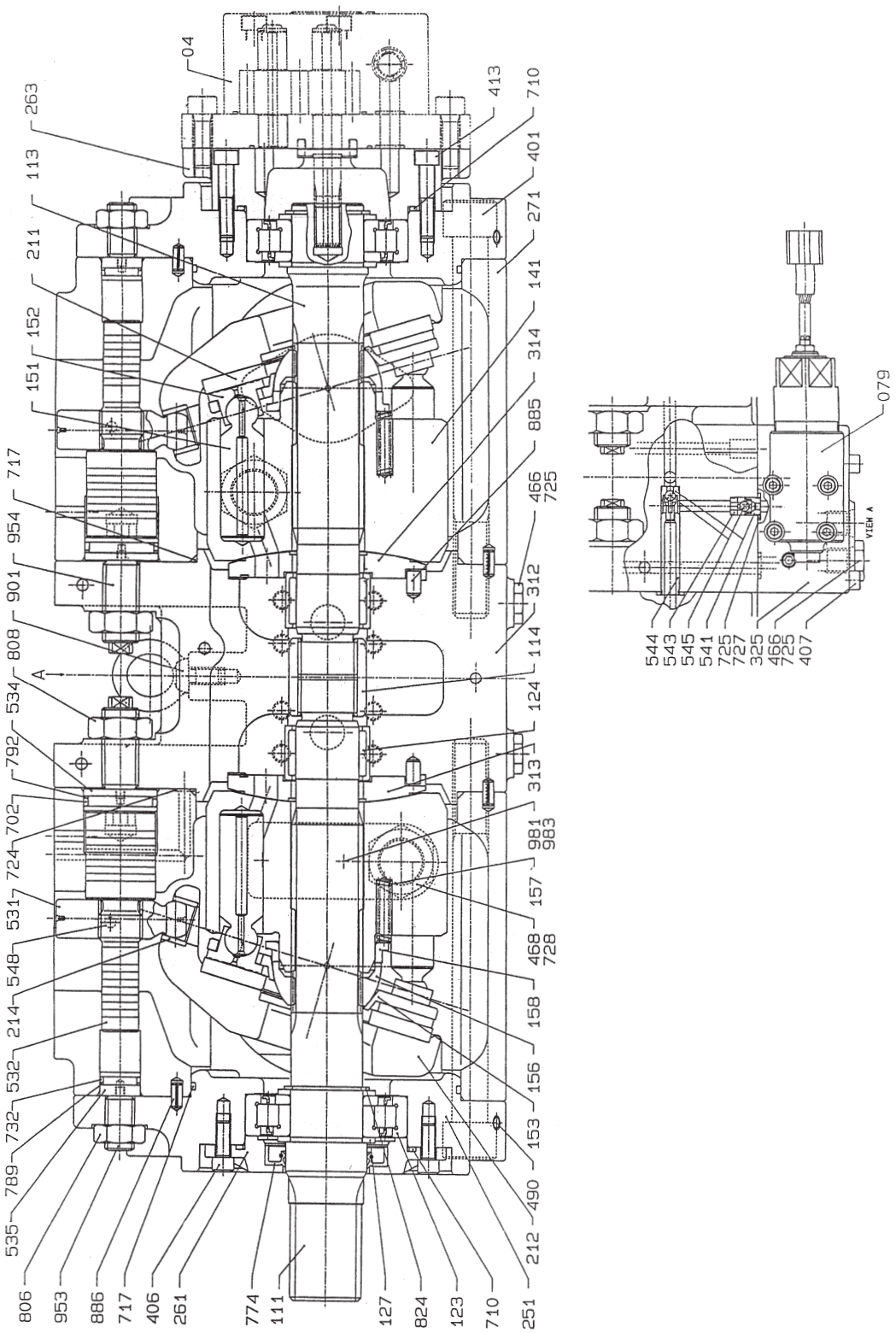
(REAR)





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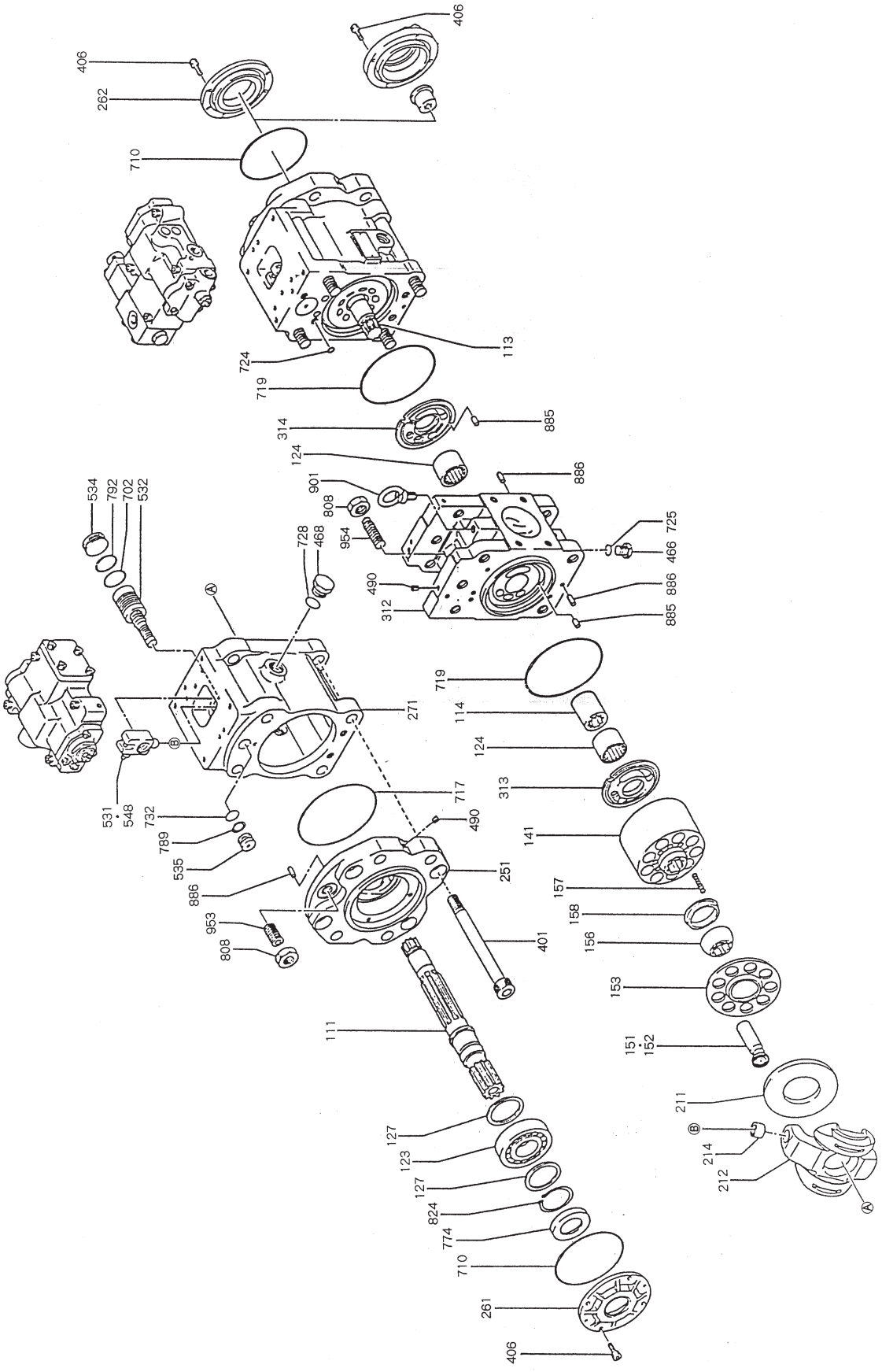
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Schematics, Technical Data

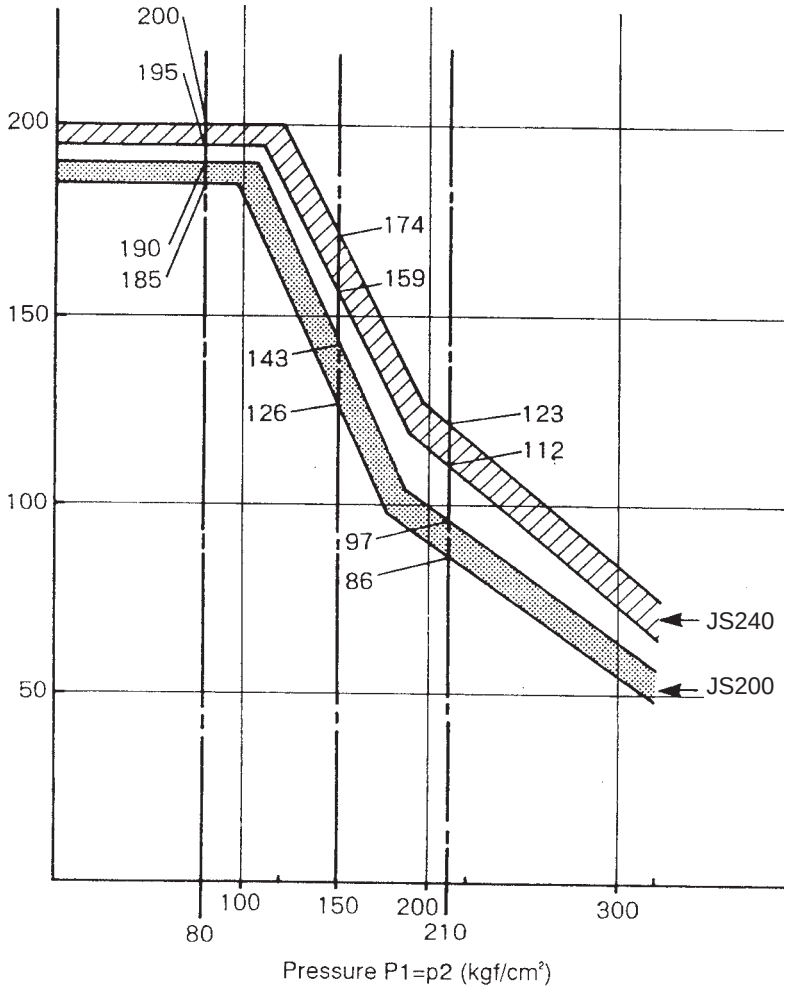
JS200, JS240 Hydraulic Pump P-Q Line Diagram

This diagram shows the values for the new machine. Changes occur depending on the conditions of use.

Magnetic proportional value electric current
JS200 - 305mA
JS240 - 330mA
Engine revolutions
JS200 - 1,920r.p.m
JS240 - 2,050r.p.m

JS240			
Measured Pressure			Flow (l/min)
bar	lb/in²	kgf/cm²	
77.3	1137	80	195 - 200
145.1	2133	150	159 - 174
203.1	2986	210	112 - 123

JS200			
Measured Pressure			Flow (l/min)
bar	lb/in²	kgf/cm²	
77.3	1137	80	185 - 190
145.1	2133	150	126 - 143
203.1	2986	210	86 - 97



Precautions During Use

Installation

Item	Precautions	Model
1. Removal of anti-rust coating	The shaft end spline party is coated with anti-rust coating so remove it with cleaning agent and apply a lubricant such as molybdenum disulphide and install to the coupling. When using cleaning agent, do not get it on the oil seal.	Both models
2. Tightening installation bolts	* Refer to tightening torque for each screw size on page E 2-1 for installation bolts for the pump.	Both models

Laying Up

Item	Precautions	Model
1. Long term non-use	It is not desirable to leave the pump motor unused for a long period of time (more than one year.) At intervals, start the engine even if for short periods of time. When left unused by itself, rotating the shaft end by hand can be effective. If left unused for an extended period of time, inspection for overhaul will become necessary.	Both models
2. Revolution direction	The direction of revolution for the pump is as described by the arrow on the name plate.	Both models

Oil Filling and Air Bleeding

Item	Precautions	Model
1. Oil filling	Fill the pump casing inside fully with oil. Inside the pump are the bearing, piston/shoe, spherical bush and other high speed moving parts. There is the danger that these parts may seize or be damaged.	Both models
2. Air Bleeding	If there is any air left in the circuit or pump, this may cause faulty operation or damage so be sure to bleed the air completely.	Both models

Pump Trouble Shooting

Often the regulator and attendant valves or pump are combined which makes it very difficult to discover the reason for the trouble. Inspect the following categories which will assist in discovering the abnormal point.

1. Filter and Drain Oil Inspection.

Inspect the filter element. Check to see whether there is an abnormally large amount of foreign matter. There will be a small amount of metallic powder due to wear of the shoe or cylinder, but if there is a large amount of metallic powder in the filter, it may be due to trouble with the shoe.
Also check the drain oil in the pump casing.

2. Abnormal Vibration and Sound.

Check to see if there is any abnormal vibration or sound in the pump main body. Check to see if it is like the regular frequency sound of the regulator's working or attendant valve relief working. If it is an abnormal vibration or sound, it is possible that there is damage or cavitation inside the pump.

3. Measure Pressure of Each Part.

When it is a control problem, do not unnecessarily open ports for inspection purposes, measure the pressure for each section and find the abnormal item.

Prime Mover Overload

Cause	Treatment	Note
1. Are the revolutions - pressure higher than pre-determined values?	**1.** Set to pre-determined value.	
2. Is the regulator torque setting too high?	**2.** Re-inspect regulator.	**2**. Refer to regulator instructions.
3. Seizure or damage of pumps internal parts	**3.** Replace damaged parts.	**3**. Check the filter or drain oil for signs of abnormal wear.
4. Wrong regulator hose connection.	**4.** Correct hose lines.	

When pump flow is extremely low, delivery pressures does not increase

Cause	Treatment	Note
1. Regulator breakdown	**1.** Repair the regulator	**1.** Refer to regulator instructions
2. Seizure or damage of pump internal parts.	**2.** Replace damaged parts.	**2.** Check filter, drain oil.
3. Pump breakdown.	**3.** Replace damaged parts.	**3.** Remove pump and inspect shaft coupling.
4. Attendant valve breakdown.	**4.** Inspect attendant valve.	
5. Incorrect regulator hose connection.	**5**. Correct hose lines.	

Pump Trouble Shooting *(continued)*

Abnormal Sound and Vibration

	Cause	Treatment	Note
	1. Cavitation.	**1.** Prevent cavitation. Check to see if hydraulic oil is white and cloudy.	**1.1.** Boost pressure is low **1.2.** Pump is broken. **1.3.** Air is sucked by suction pipe. **1.4.** Suction resistance is high.
	2. Damage of shoe caulking part.	**2**. Replace piston, shoe, shoe plate.	
	3. Crack in cylinder.	**3**. Replace cylinder.	
	4. Bad installation of pump.	**4**. Correct installation.	
*	**5**. Relief valve bouncing.	* **5**. Repair relief valve.	* **5**. Refer to relief valve instructions.

Operation

The rotary group consists of the drive shaft F (111), cylinder rod (141), piston shoe (151, 152), press plate (153), spherical bush (156), spacer (158) and cylinder spring (157). The drive shaft is supported on both sides by the bearings (123, 124). The shoe is caulked on the piston and forms the spherical coupler, and because it slides slightly on the shoe plate (211), it has a pocket to balance the oil pressure. The subgroup, which is made up of the piston and shoe is held down on the shoe plate by the cylinder spring through the press plate and spherical bush. In the same way, the cylinder block is held down on the valve plate (313) by the cylinder spring.

* The swash plate group consists of the swash plate (212), shoe plate (211), swash plate support (251) bush (214) pin (531) and servo piston (532). The swash plate is supported by the swash plate support at the cylindrical part formed by the side opposite to the shoe sliding surface. The oil pressure controlled by the regulator is guided to the hydraulic cavities on both sides of the servo piston which moves the servo piston to the left and right, causing the swash plate, through the spherical portion of the pin, to press on the swash plate support and changes the angle (a).

The valve cover group is comprises the valve block (312), valve plate (313) and valve plate pin (885). The valve plate, which has two oval shaped ports, is on the valve block and delivers oil to and recovers oil from the cylinder block. The oil directed by the valve plate flows through the valve block and is connected to the outer piping.

When the drive shaft is driven by the engine, the cylinder block rotates simultaneously with the spline coupling. When the swash plate is leaning, the piston in the cylinder block rotates simultaneously with the cylinder block and causes reciprocal motion relative to the cylinder.

Therefore, during one rotation, the piston moves away from the valve plate for 180° (enough for oil suction) and approaches the valve plate for the remaining 180°. When the swash plate leaning angle is at the minimum 5° the piston does not stroke and does not deliver oil.

Dismantling

Refer to the drawing on the previous pages of the pump and associated components.

Before attempting to dismantle the hydraulic pump, drain all oil, blank all inlet and outlet ports and wash the outer surfaces with a suitable solvent to remove all dirt and dust. Dry using compressed air.

Make different alignment marks across each sub-assembly joint face as an aid to assembly.

The rotary groups, servo pump, relief valve and proportional pressure reduction valve must be replaced as entire assemblies.

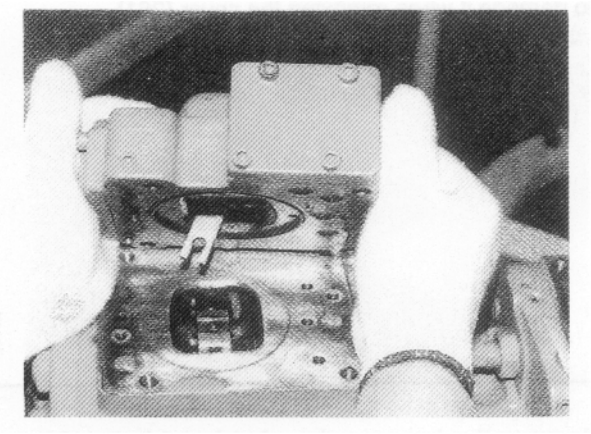
Adjusting screws should only be moved when absolutely necessary. Moving the adjusting screws will alter the power output settings. If the adjusting screws must be moved, measure and record the dimensions and positions.

The pump contains two rotary groups and control systems; the No.1 (subsidiary) pump and the No.2 (drive) pump. Take care not to confuse parts between the two.

During disassembly, record the number and dimensions of shims. Take care to reassemble in the same manner.

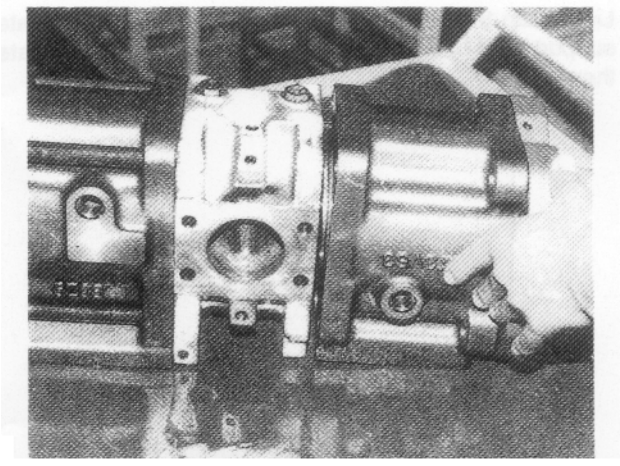
1. Remove the drain port plugs and drain the oil from both the front and rear pump.

2. Remove the hexagonal socket head bolts (412, 413) and remove the regulator (refer to the regulator maintenance section for the disassembly procedures).



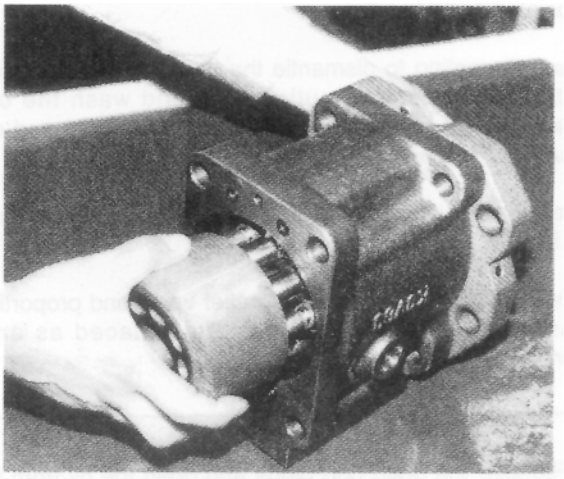
3. Loosen the hexagonal socket head bolt (401) which connects the swash plate support (251), pump casing (217) and valve block (312). If the gear pump etc. are attached to the back of the pump, remove them first.

4. Place the pump so that the regulator installation side is down and place level on the work bench. Separate the pump casing (271) and valve block (312).

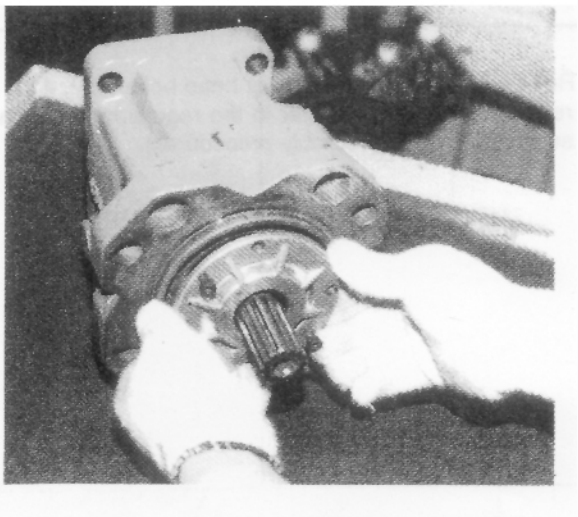


Dismantling *(continued)*

* **5.** Pull out the cylinder (141) (keeping it straight in relation to the drive shaft (111)) from the pump casing (271) and also pull out the piston (151), press plate (153), spherical bush (156) and cylinder spring (157) at the same time.

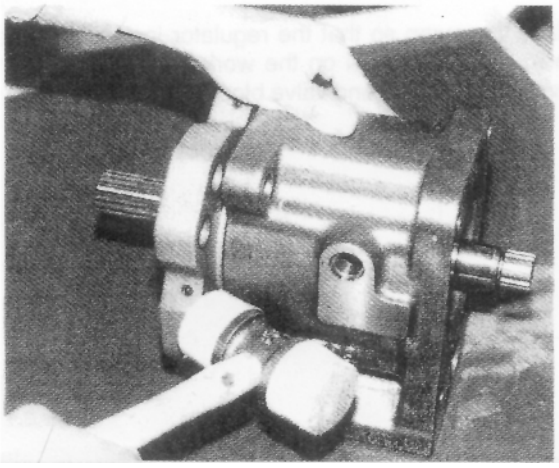


6. Remove the hexagonal socket head bolt (406) and remove the seal cover (261).
This is an oil seal on the seal cover (261) be careful not to damage it when removing the cover (261).



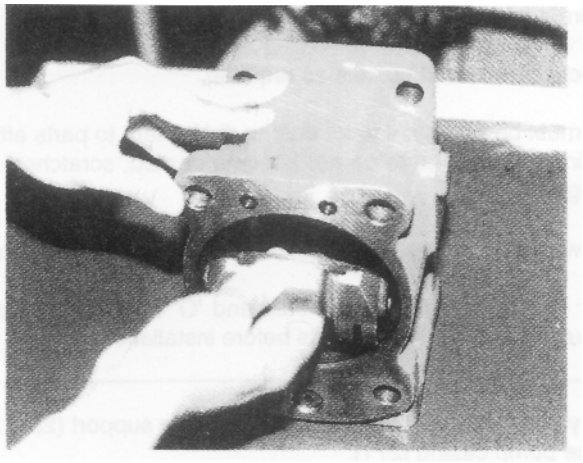
7. Remove the hexagonal socket head bolt (408) and remove the rear cover (263).

8. Lightly tap the installation flange part of the swash plate support (251) from the pump casing side and separate them.

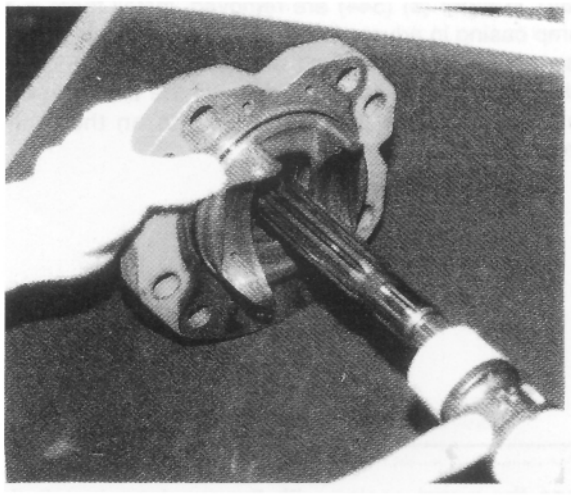


Dismantling *(continued)*

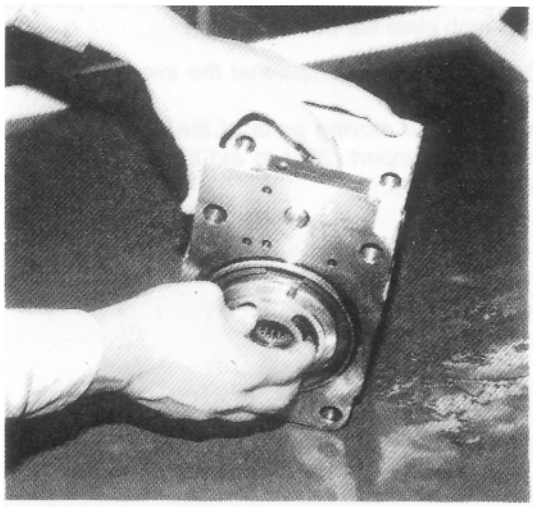
9. Remove the shoe plate (211) and swash plate (212) from the pump casing (271).



10. Lightly tap the drive shaft (111, 113) end with a plastic hammer and remove the drive shaft from the swash plate supporter.



11. Remove the valve plate (313, 314) from the valve block (312). It may be removed in step **4**.



12. If necessary, remove the stopper (L) (534), stopper (S) (535), servo piston (532), tilting pin (531) from the pump casing (271) and also the needle bearing (124) and spline coupling (114) from the valve block (312).
Use a jig to remove tilting pin (531) take care not to damage the fitting part of the tilting pin (531) and servo piston (532) because it is coated with Loctite. Do not remove the needle bearing (124) unless the life of the bearing is in question.

Note: *Do not loosen the hexagonal nuts of the valve block and swash plate support because the flow setting will change.*

Assembly

Clean each part in a suitable solvent and dry using compressed air.

Inspect all parts and replace as required.

Care must be taken not to let dust or dirt adhere to parts after cleaning and that parts do not become dented, scratched or damaged.

Fit new 'O' rings, plugs, packing, oil seals and fastener seals.

Apply grease to all new oil seals and 'O' rings, and clean hydraulic fluid to all sliding parts before installation.

All tapped holes and gasket faces should be thoroughly degreased by washing as liquid packing and adhesive is used on all gasket surfaces and threads.

Apply adhesive to the final few threads of a bolt or screw. Do not apply excessive amounts of adhesive. Wipe off any surplus.

Leave the pump for at least twelve hours after assembly to allow the adhesive to fully dry.

Ensure that the pump controllers are fitted to the positions from which they were removed.

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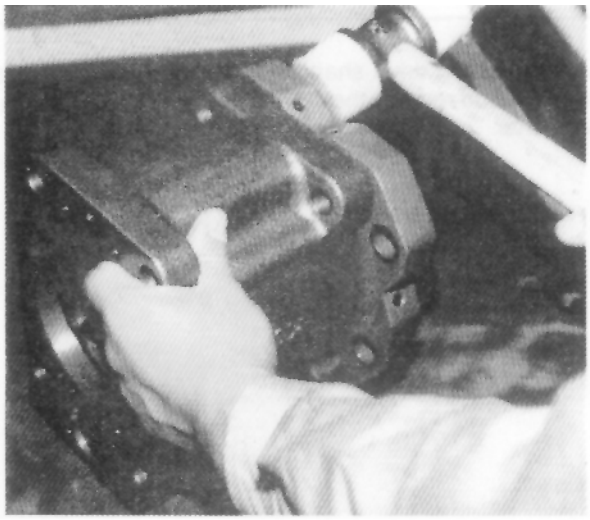
1. By lightly tapping, install the swash plate support (251) to the pump casing (271).
When the servo piston (532), tilting pin (531) stopper (534), stopper (s) (544) are removed, install them in the pump casing in advance.
Use a jig when tightening the servo piston (532) and tilting pin (531) so as not to damage the tilting pin head and feedback pin. Also, coat Loctite on the screw threads when assembling.



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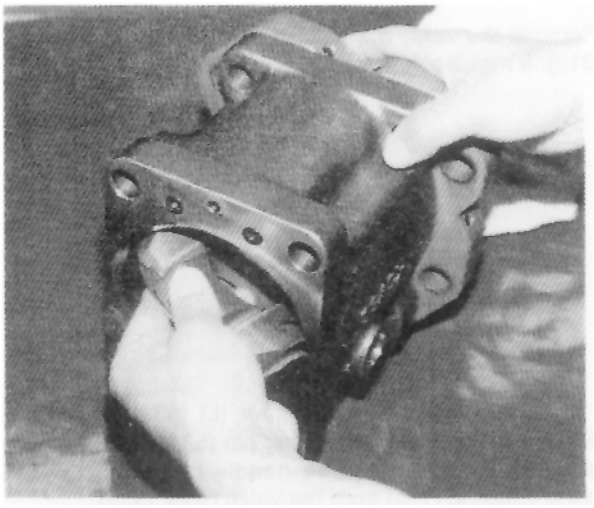
2. Place the pump casing with the regulator installation surface facing down. Fit the swash plate tilting bush to the tilting pin (531) and then mate the swash plate (212) to the swash plate support (251).

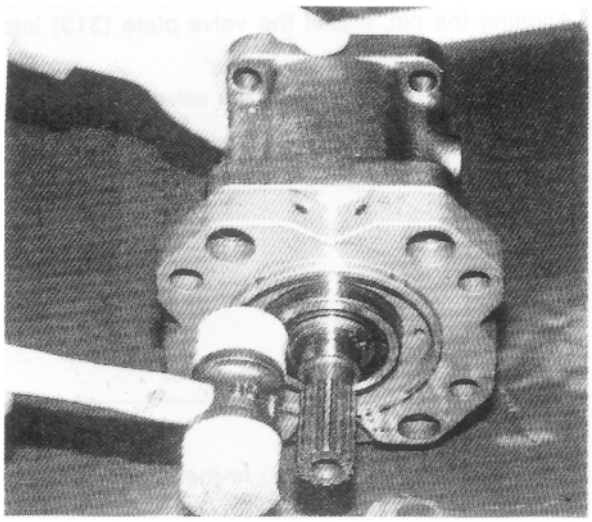
* ***Note:*** *Check with the fingertips that the swash plate moves smoothly.*
Apply grease to the moving parts of the swash plate (212) and swash plate support (251) to aid the installation of the drive shaft (113) (111).



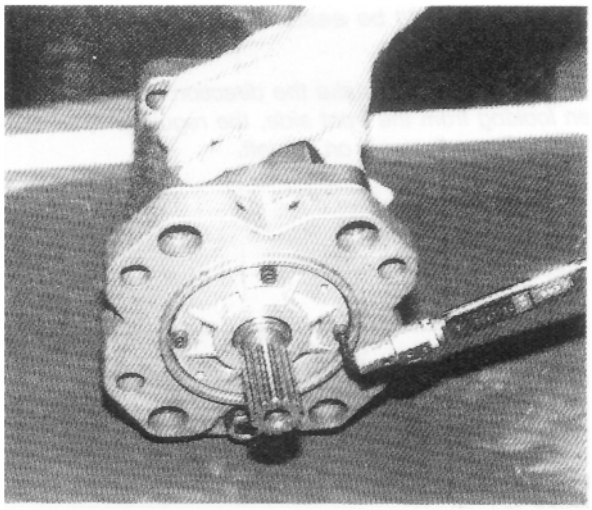
Assembly *(continued)*

3. Install the drive shaft (111) which has the bearing (123), bearing spacer (127) and stop ring (824) set on it to the swash plate support (251).

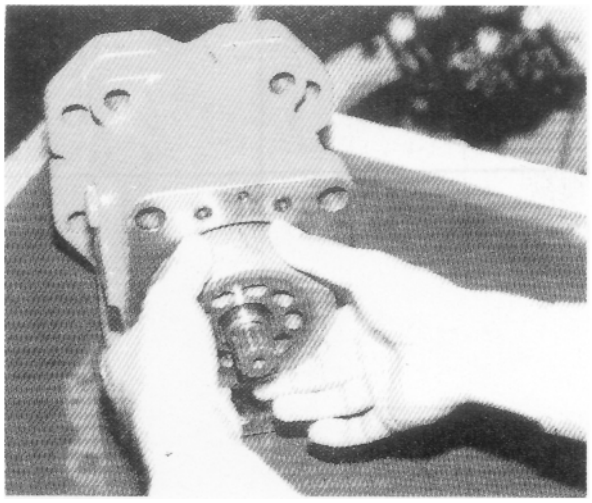
Note: *Do not hit the drive shaft with the hammer. Tap the outer ring of the bearing with a plastic hammer to install it and use a steel bar to fit it securely.*



4. Install the seal cover (F) (261) to the pump casing (271) and fix with hexagonal socket head bolt (406).
Coat the oil seal inside the seal cover (F) with a thin coat of grease.
Install the oil seal taking care not to damage it.
Attach the rear cover (263) and the seal cover (262) in the same way if it is a tandem pump.



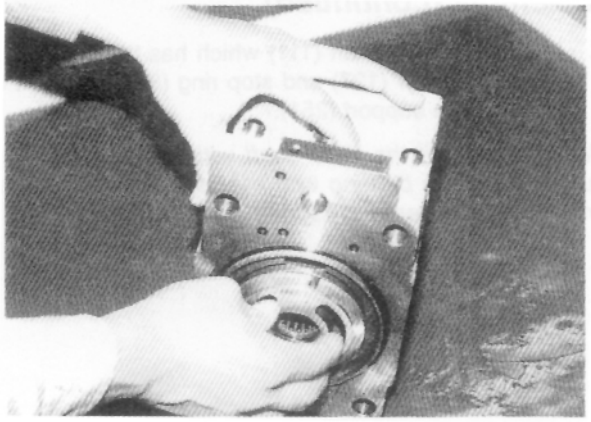
* **5.** Assemble the piston cylinder sub-assembly (cylinder (141), piston shoe (151, 152), press plate (153), spherical bush (156), spacer (158), cylinder spring (157)), align the spherical bush and cylinder spline and insert into the pump casing.



Assembly *(continued)*

6. Aligning the pin, install the valve plate (313) into the valve block (312).

Note: *Be careful not to mistake the valve plate suction and delivery directions.*

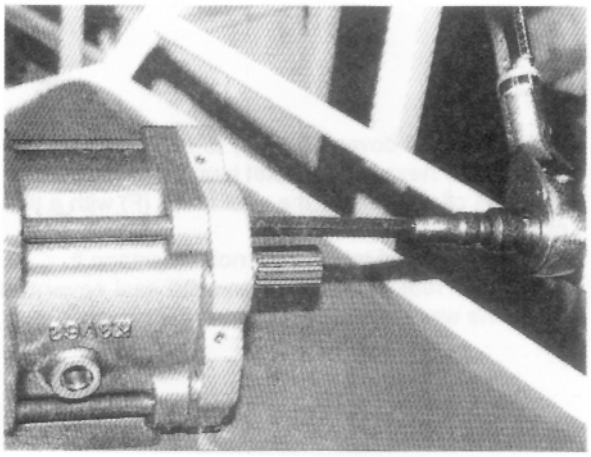


7. Install the valve block (312) to the pump casing (271) and tighten the hexagonal socket head bolt (401).

Note:

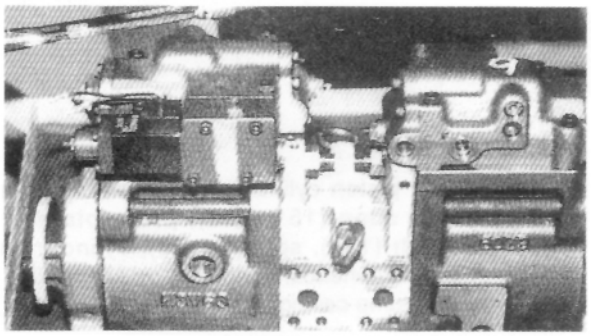
a. *The work would be easier if the rear of the pump is assembled first.*

b. *Take care not to mistake the direction of the valve block. When looking from the front side, the regulator is on the top and the delivery flange is on the left.*



8. Insert the feedback pin of the tilting pin into the feedback lever of the regulator and install the regulator, tightening the hexagonal socket head bolts (412, 413).

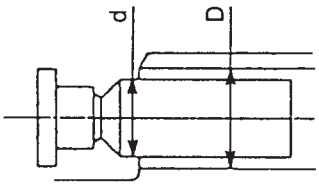
Note: *Take care not to mistake the front and rear of the regulator.*



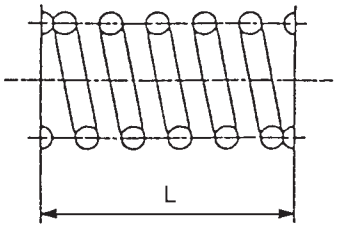
Main body wear limit

If the wear of the parts exceeds the standards below, replace or readjust. However, if they are extremely damaged judging from the external appearance, replace with the appropriate part.

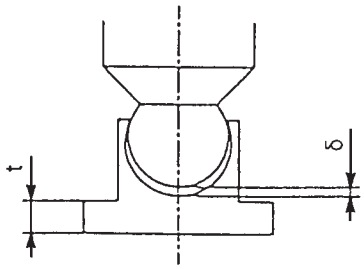
	Part Name and Inspection Item	Standard Dimensions/Recommended Replacement Value Pump Model KRJ3785, KBJ2316			Treatment
	Clearance between piston and cylinder bore (D-d)	0.028 / 0	0.039 / 0	0.043 / 0	0.0375 / 0.078	Replace piston or cylinder
*	Backlash of piston and shoe caulking part(δ)	0~0.1 / 0.3	0~0.1 / 0.3	0~0.1 / 0.3	0~0.1 / 0.35	Replace piston shoe assembly
	Shoe thickness(t)	3.9 / 3.7	4.9 / 4.7	5.4 / 5.0	5.4 / 5.0	Replace piston shoe assembly
	Cylinder spring free height (L)	31.3 / 30.2	41.1 / 40.3	47.9 / 47.1	40.9 / 40.1	Replace cylinder spring
	Assembled height of press plate and spherical bush	10.5 / 9.8	9.8 / 8.8	13.5 / 12.5	13.5 / 12.5	Replace press plate or spherical bush



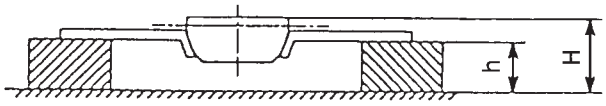
Clearance between piston and cylinder bore: D-d



Cylinder spring free height: L



Backlash of piston and shoe caulking part: δ
Shoe thickness: t



Assembled height of press plate and spherical bush: H-h

Main body wear limit *(continued)*

Cylinder, Valve Plate, Swash Plate (Shoe Plate) Modification Standards

Valve Plate (sliding part) Swash Plate (shoe plate part)	Surface roughness requiring modification	3-Z
Cylinder (sliding part) Roughness of each surface	Standard surface roughness (modification value)	* Less than 0.4 (lapping)

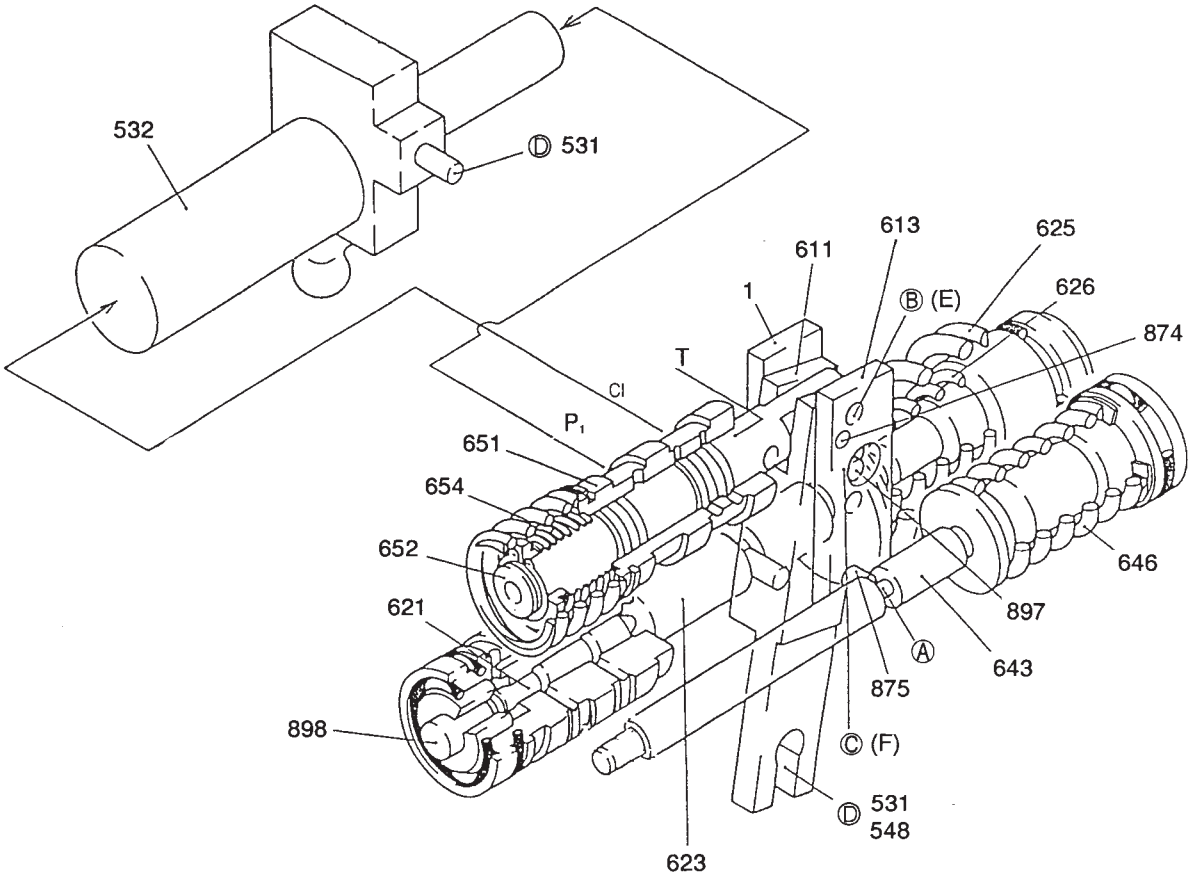
* Specifications

Displacement	*	97.2 (96.5) cc/rev
Revolving Speed Range		Rated 2070 (2200) rev/min
Pressure		Rated 320 (320) kgf/cm^2. Max 350 (350) kgf/cm^2
Maximum Flow Rate		201 (211) l/min (Rated revolution load pressure 80 Kgf/cm^2)
Minimum Flow Rate		50 (50) l/min (Rated revolution load pressure 80 Kgf/cm^2)
Input Horsepower		125 (154) PS
Maximum Input Torque		43.4 (49.1) kgf-m
Control Function		Full horsepower control
		Power shift control
		Negative flow control
		Q $_{max}$ cut control
Other		KHI 10 cc/rev with gear pump
		Proportional pressure reducing valve (KDRDE5PR-10/40C04)

Volume change is by Regulator Adjustment

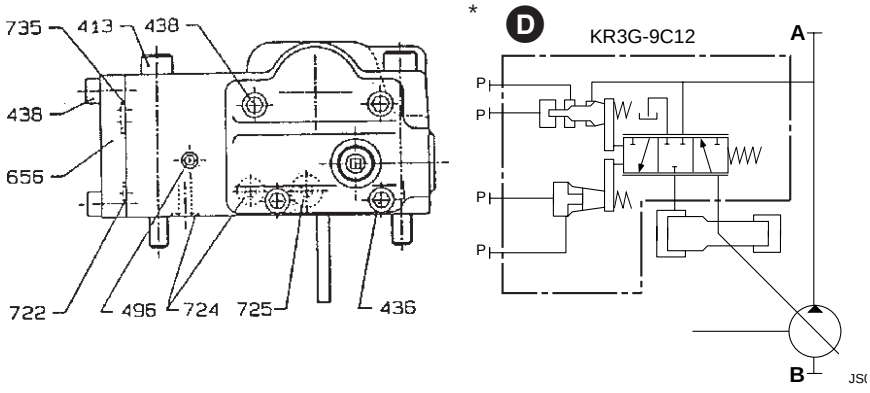
Pump Speed		2070 min-1	2400 min-1
Maximum Flow Rate		Adjust screw (954) at 1/4 revolution Flow rate [3] Q=6.0 L/min (1.31 imp gal)	Adjust screw (954) at 1/4 revolution Flow rate [3] Q=6.3 L/min (1.31 imp gal)
Minimum Flow Rate		Adjust screw (953) at 1/4 revolution Flow rate [3] Q=4.8 L/min (1.05 imp gal)	Adjust screw (953) at 1/4 revolution Flow rate [3] Q=5.1 L/min (1.12 imp gal)
Input Horsepower	Outer Spring Adjustment	Adjust screw (923) at 1/4 revolution Flow rate [3] Q=18 L/min (3.9 imp gal) Pressure [3] P=16kg/cm^2 (227 lb/in^2, 15.4 bar) Torque [3] T=4.2 kgf m Factor A=1.6 of return revolution for set change of inner spring	Adjust screw (928) at 1/4 revolution Flow rate [3] Q=20 L/min (4.3 imp gal) Pressure [3] P=18kg/cm^2 (225 lb/in^2, 17.3 bar) Torque [3] T=4.7 kgf m Factor A=1.9 of return revolution for set change of inner spring
	Inner Spring Adjustment	Adjust screw C1(925) at 1/4 revolution Flow rate [3] Q=11 L/min (2.4 imp gal) Pressure [3] P=36kg/cm^2 (511.9 lb/in^2, 34.8 bar) Torque [3] T=4.9 kgf m	Adjust screw C1(925) at 1/4 revolution Flow rate [3] Q=11 L/min (2.4 imp gal) Pressure [3] P=27kg/cm^2 (383.9 lb/in^2, 26.1bar) Torque [3] T=4.2 kgf m
Flow Rate Control Characteristic		Adjust screw (924) at 1/4 revolution * Pilot Pressure [3] Pi=1.7 kg/cm^2 (24.1lb/in^2,1.63bar) [3]Q=13 L/min (2.8 imp gal)	Adjust screw (924) at 1/4 revolution * Pilot Pressure [3] Pi=1.7 kg/cm^2 (24.1lb/in^2,1.63bar) [3]Q=14 L/min (3.07 imp gal)
Qmax Cut Characteristic		Adjust screw (642) at 1/4 revolution Qmax cut flow rate *	Adjust screw (642) at 1/4 revolution Qmax cut flow rate *

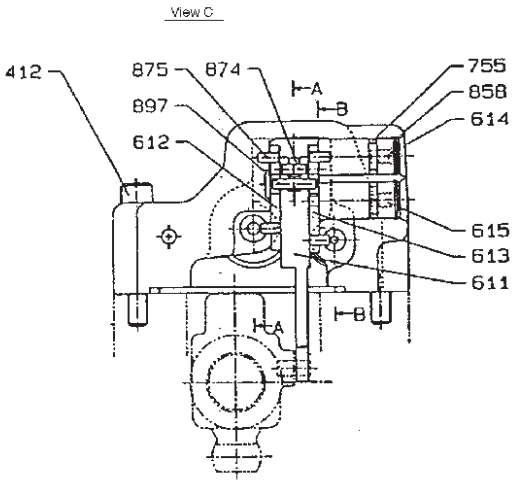
Specifications, *(continued)*

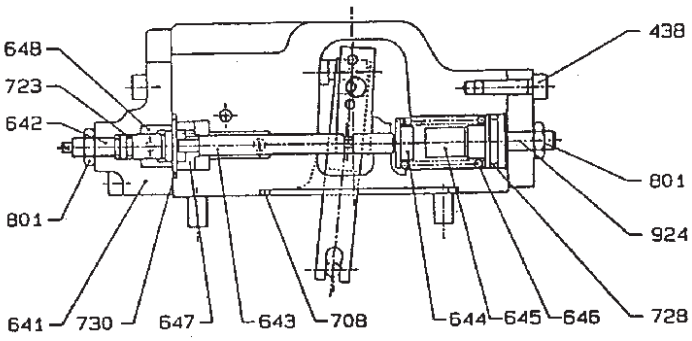


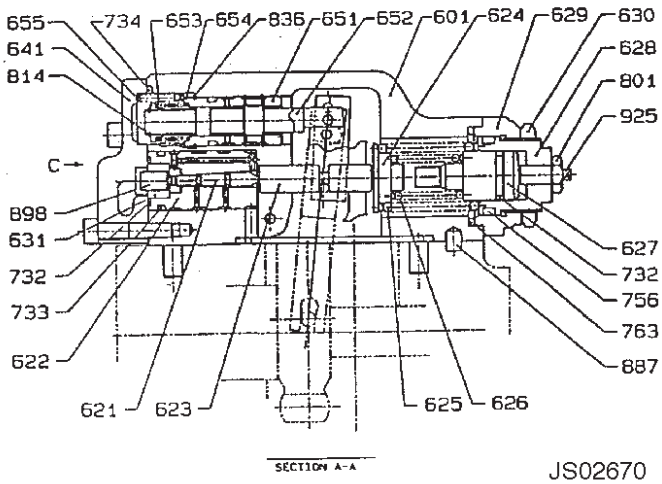
Key

531	Tilting pin
532	Servo piston
548	Feedback pin
611	Feedback lever
621	Compensator piston
623	Compensator rod
625	Outer spring
626	Inner spring
643	Pilot piston
646	Pilot spring
651	Sleeve
652	Spool
654	Return spring
874	Pin
875	Pin
897	Pin
898	Pin









JS02670

Section	Part Name	Q'ty
925	Adjust screw	1
924	Hexagonal socket lock screw	1
898	Pin	1
897	Pin	1
887	Pin	1
875	Pin	4
874	Pin	1
858	Locking ring	2
836	Lock pin	1
814	Stop ring	1
801	Hexagon nut	3
763	O-ring	1
756	O-ring	1
755	O-ring	2
735	O-ring	1
734	O-ring	1
733	O-ring	1
732	O-ring	2
730	O-ring	1
728	O-ring	1
725	O-ring	1
724	O-ring	9
723	O-ring	1
722	O-ring	3
703	O-ring	1
856	Blind cover	1
655	Set spring	1
854	Return spring	1
853	Spring base	1
852	Spool	1
851	Sleeve	1
848	Piston (QMC)	1
647	Stopper	1
646	Pilot spring	1
645	Adjust ring (Q)	1
644	Spring base (Q)	1
643	Pilot piston	1
642	Adjust screw (QMC)	1
641	Pilot cover	1
631	Pf Sleeve	1
630	Lock nut	1
629	Cover (C)	1
628	Adjust screw (C)	1
627	Adjust ring (C)	1
626	Inner spring	1
625	Outer spring	1
624	Spring base (C)	1
623	Compen rod	1
622	Piston case	1
621	Compen piston	1
615	Adjust plug	1
614	Fulcrum plug	1
613	Lever (2)	1
612	Lever (1)	11
611	Feedback lever	
601	Casing	1
496	-	5
438	Hexagonal socket head bolt	10
436	Hexagon socket head bolt	2
413	Hexagon socket head bolt	2
412	Hexagon socket head bolt	2
-	Regulator sub	1

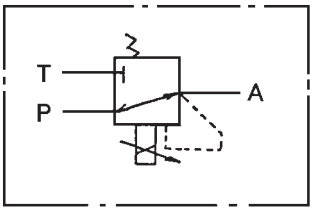
Specifications, *(continued)*

Proportional Pressure Reducing Valve Specifications (Reference)

1. Specifications

(1)	Max. primary pressure	40 kgf/cm^2
(2)	Max, back pressure (allowable pressure)	10 kgf/cm^2
(3)	Secondary pressure setting range	0-40 kgf/cm (at primary press.=40 kgf/cm^2)
(4)	Max. flow rate	6 l/min
(5)	Electrical specifications	
1	Rated current	800 mA
2	Coil resistance (at 20°C)	* 13.5 ± 0.7
* 3	Recommended fluctuation of proportional solenoid current	70 ~ 75 Hz, 400 ~ 600 mApp

2. Hydraulic symbol



* **Checking the Proportional Solenoid Current**

* **Service Procedure**

* **Method 1**

* Refer to **Self Test, Self Test Function, Pump Input Amperage**.

* **Method 2**

* **1** Switch engine off.

* **2** Pull apart bullet connector on any of the two wires leading from the Proportional Solenoid on the Hydraulic Pump.

* ***Note:*** *Depending on which wire is disconnected will determine the polarity of the current reading.*

* **3** Insert an appropriate Multimeter in series between the bullet connector and the wire that has been disconnected.

* **4** Ensure that the Multimeter is scaled to mAmps **not** Amps.

* **5** Switch engine on to maximum revs.

* **6** Measure the current at the Proportional Solenoid.

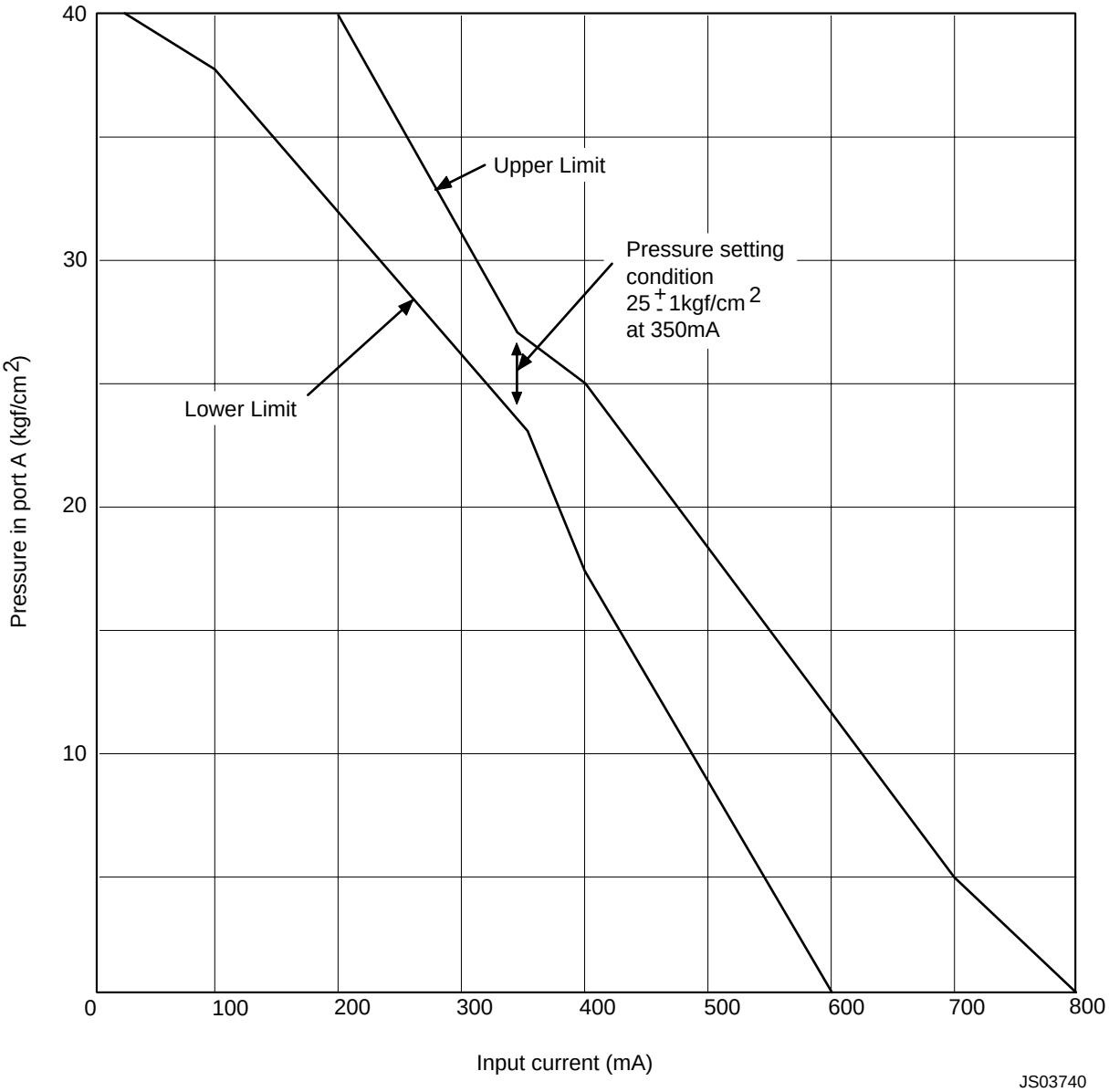
Specifications, *(continued)*

PROPORTIONAL PRESSURE REDUCING VALVE

ALLOWABLE RANGE OF CURRENT-PRESSURE PROFILE

- Primary press. 40 kgf/cm² (38.6 bar, 568.8 lb/in²)
- Flow in port A 0 l/min
- * Fluctuation of proportional solenoid current * 70 - 75 Hz, 400 ~ 600 mApp

*



Operation

Refer to the sectional drawings at the beginning of this section.

The regulator consists of the following control mechanisms:

1. **Horsepower control.**
   * Automatically reduces the pump swash angle (delivery flow) according to the increase in P_1 pump delivery pressure and P_2 pump delivery pressure and limits the input torque to below a preset value.
   * The system operates by the summation of load pressure of the two pumps so that engine overload is prevented.

* 2. **Power shift control (Power modes H, S, L).**
   * The pump output horsepower set value is shifted by changing the electric current supplied to the proportional pressure reducing valve attached to the regulator.
   * There is one proportional pressure reducing valve but the secondary pressure Pf (power shift pressure) goes through the pump's inner passages to the horsepower control part of the regulator for each pump, shifting each pump to the same horsepower set value. With this mechanism, it is possible to change the output power of the pump to the most suitable power for the machine application.

* 3. **Flow rate control (Negative control).**
   * The pump swash angle and therefore the delivery flow rate is controlled by changing the pilot pressure Pi. (see illustration **D** on page 20 - 3). The regulator has the flow rate control (negative control) system in which the delivery flow rate Q reduces in relation to valve block negative pressure. The pump delivers only the required flow so that power is not wasted.

4. **Q max cut control.**
   * Maximum delivery flow is controlled by pilot pressure Pm. This control is a two-position control so by switching **ON-OFF** pilot pressure P_m, the maximum delivery flow rate can be reduced by 35%. Either of the two steps only can be selected, not intermediate sections.

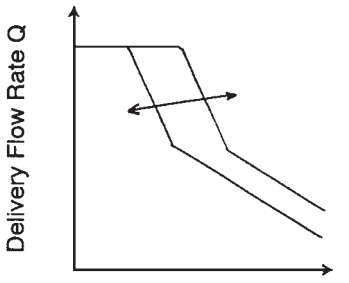
* The regulator possesses the above four control mechanisms but when each control works in combination with another, the low swash (low flow rate) instructions have priority as explained below.

* Priority Mechanism of Low Tilt (Low Flow Rate) Command

As explained above, the flow rate control and horsepower control tilt commands are relayed to the feedback lever and spool through the large hole (C, F parts) of lever 1 and lever 2. Because the C, F parts are structured so that the pin (o4) protrudes in the large hole (o8), the lever which decreases the tilt and pin (897) touch while the o8 hole of the lever which is in the larger tilt command state and the pin (897) do not touch and is free. By this mechanical selection method, the commands for low tilt side for flow rate control and horsepower control have priority.

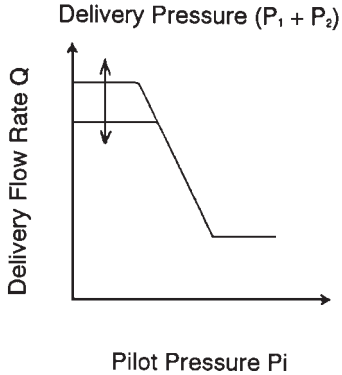
* Power Shift Control

As shown in the graph, the pump horsepower is controlled at will by power shift pressure Pf.
When power shift pressure Pf increases, the compensatory rod (623) moves to the right through the pin (898) and compensatory rod (621) so the pump tilting angle decreases and horsepower set is lowered, which is the same as in the explanation for overload prevention operation of the horsepower control. On the other hand, when power shift pressure Pf decreases, horsepower increases.



* Qmax Cut Control

As shown in the graph, the maximum flow can be switched in two steps by the pilot pressure Pm.
When pilot pressure Pm is applied, Pm pressure is led to the left of piston QMC (648) and piston QMC overcomes the spring force of spring (646) moving the stopper (647) and pilot piston (643) to the right and decreasing the pump delivery flow rate.
The adjust screw QMC (642) has a collar, so piston QMC comes into contact with that collar and stops. Thus the position of the pilot piston sets the pump maximum flow rate.



Regulator Trouble Shooting

Engine Overloads

Put a load on each pump to determine if the front or rear pump is malfunctioning. If both pumps are abnormal, check **1** and **2**. If only one pump is abnormal, begin with **3**.

1. Check to see if the power shift command current value I is normal or not.

2. Power shift pressure is low
- * Check fluctuation of solenoid current.
- * Renew the proportional pressure reducing valve.

3. Disassemble and clean the compensatory piston, compensatory rod.

4. Disassemble and clean the pin (898).

Maximum Flow Rate Is Not Achieved

1. Confirm that the pilot pressure Pi is normal or not.

2. Disassemble and clean the pilot piston.

* **3.** Disassemble and clean the piston (648).

4. Disassemble and clean the spool.

Note: *If any of the parts shows wear or scratches, replace it.*

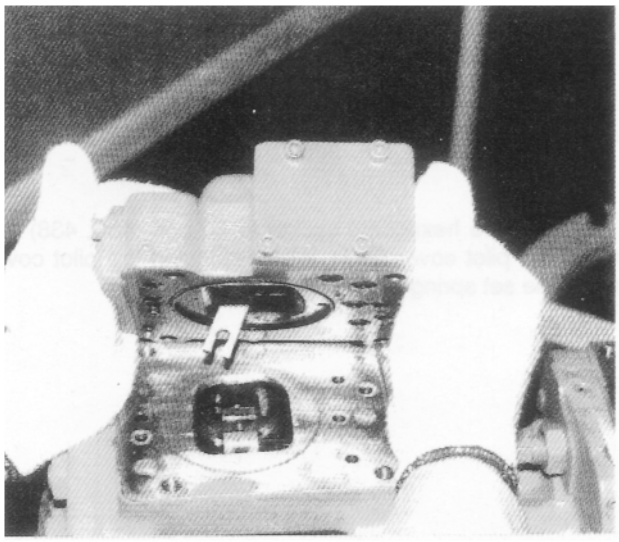
Regulator Disassembly

Refer to the sectional drawings at the beginning of this section.

Before dismantling, blank all inlet and outlet ports and wash the outer surfaces with a suitable solvent to remove all dirt and dust. Dry using compressed air.

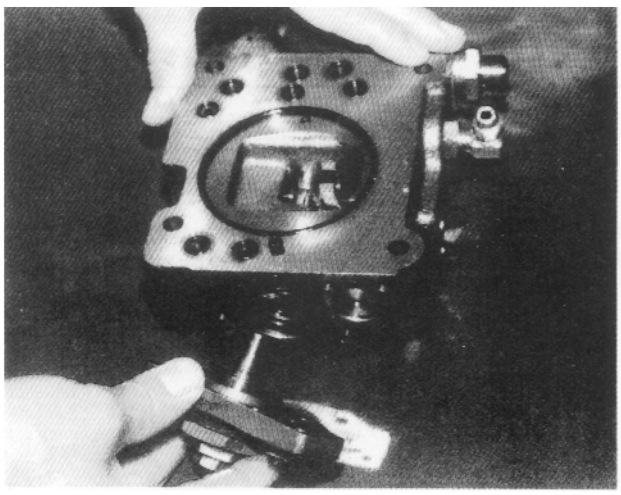
Adjusting screws should only be moved when absolutely necessary. Moving the adjusting screw will alter the power output settings. If the adjusting screws must be moved, measure and record the dimensions and positions.

1. Remove the hexagonal socket head bolts (412, 413) and remove the pump main body from the regulator.



2. Remove the hexagonal socket head bolt (438) and remove the cover (C) (629).

Note: *Adjusting screws (C), (CI) (628, 925), adjusting ring (C) (672), lock nut (630), hexagonal nut (801), adjusting screw (921) is assembled on the cover (C). Do not loosen these nuts and screws, for the adjusted pressure and flow rate setting will be changed.*

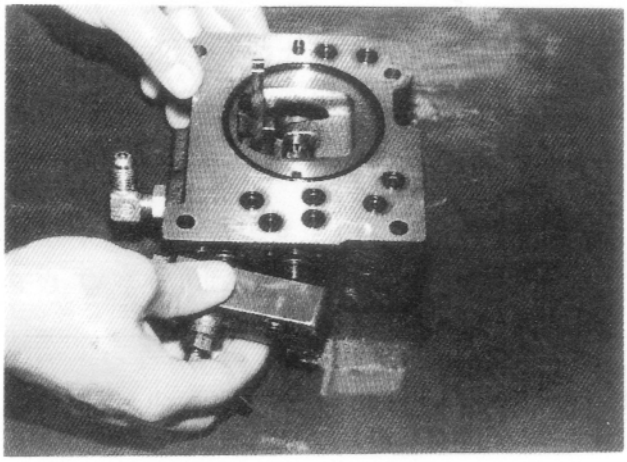


Regulator Disassembly *(continued)*

3. After removing the cover (C) (629) SUB, remove the outer spring (625), inner spring (626), spring base (C) (624) from the compensatory part and pull out the adjusting ring (Q) (645), pilot spring (646), spring base (644) from the pilot part.

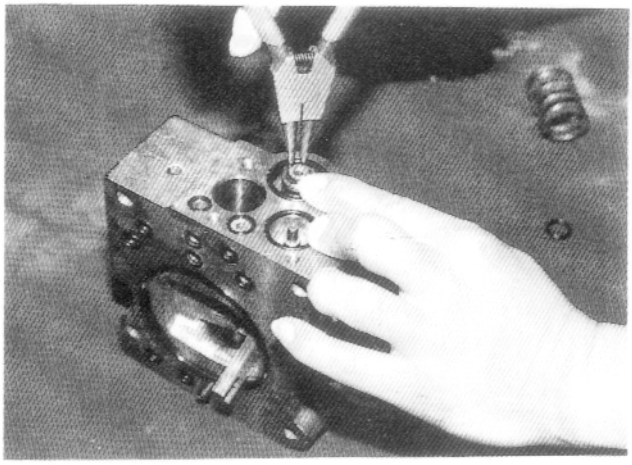
Note: *For easy removal, use M4 bolt to pull out adjusting ring (Q) (645).*

4. Remove the hexagonal socket head bolt (436, 438) and remove the pilot cover (641). After removing the pilot cover, remove the set spring (655) from the pilot part.



5. Remove the stop ring (814) and remove the spring base (653), return spring (654) and sleeve (651).

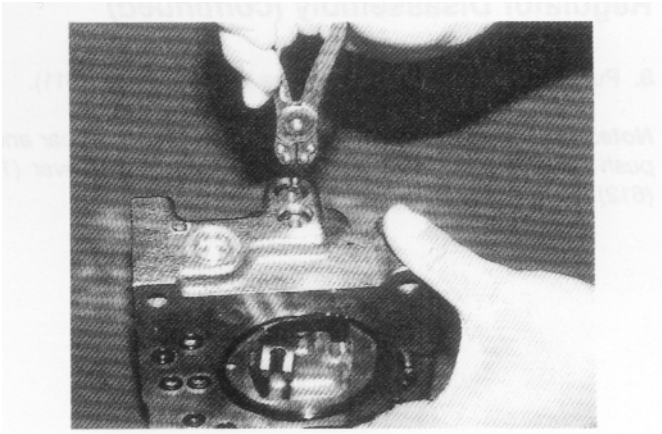
Note: *(1) The SAAKURIPPU (836) is assembled to the sleeve (651). (2) When removing the stop ring (814), the return spring (654) will jump out so do not lose it.*

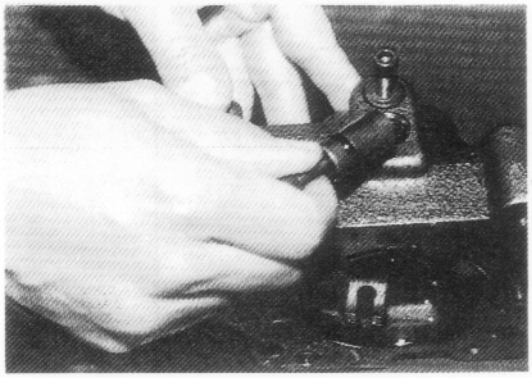


Regulator Disassembly *(continued)*

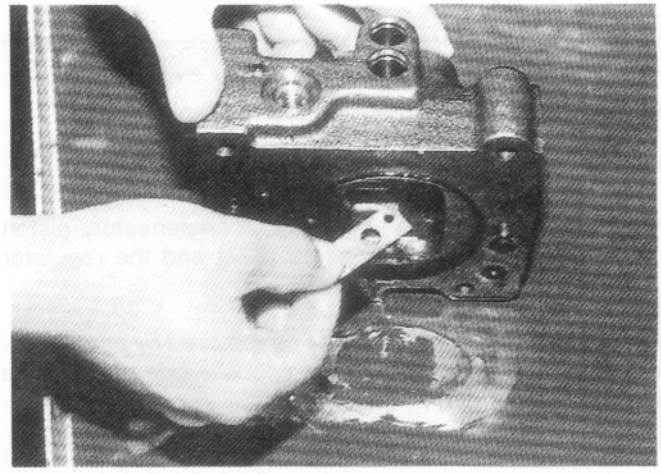
6. Remove the locking ring (858) and remove the fulcrum plug (614) and adjusting plug (615).

Note: *For easy removal, use M6 bolt to pull out the fulcrum plug (614) and adjusting plug (615).*





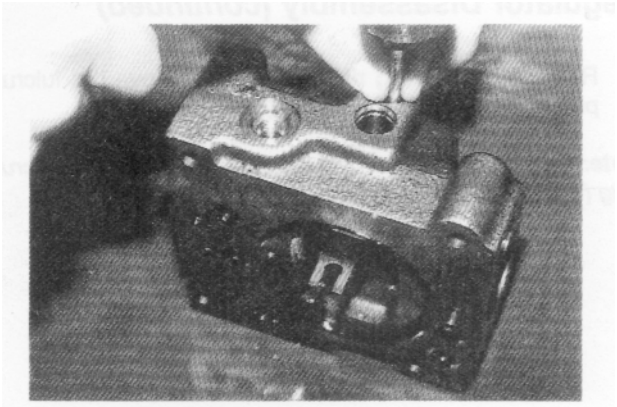
7. Remove the lever (2) (613). Do not pull out the pin (875).

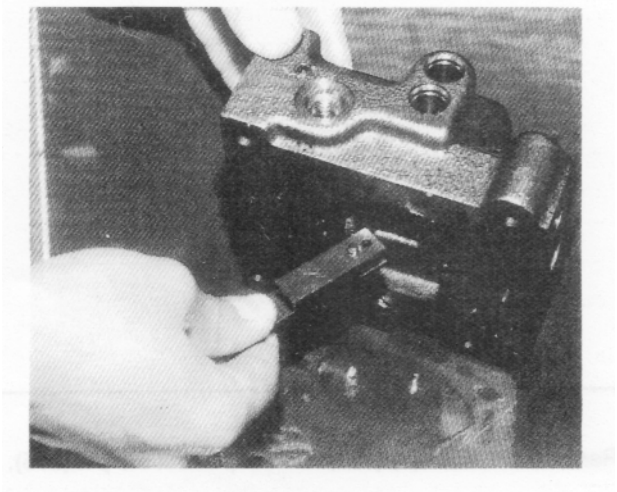


Regulator Disassembly *(continued)*

8. Pull out pin (874) and remove the feedback lever (611).

Note: *To remove the pin (874) (o4), use a slim steel bar and push out from above taking care not to touch the lever (1) (612).*





9. Remove lever (1) (612). Do not remove pin (875).

10. Take out the pilot piston (643) and the spool (652).

11. Take out the piston case (622), compensatory piston (621) and compensatory rod (623) and the regulator disassembly is complete.

Note: *The piston case (622) can be removed by pushing the compensatory rod (623) from the opposite side of the piston case.*

Regulator Assembly

Clean each part in a suitable solvent and dry using compressed air.

Inspect all parts and replace as required.

Care must be taken not to let dust or dirt adhere to parts after cleaning and that parts do not become dented, scratched or damaged.

* Fit new 'O' rings, plugs, packing and oil seals, and apply clean hydraulic fluid to all sliding parts before installation.

---

1. Assemble the compensatory rod (623) into the compensatory hole of the casing (601).

2. Insert the pin which is press-fitted into the lever (1) (612) into the compensatory rod groove and assemble the pin which is press-fitted into the casing to the lever (1).

---

3. Assemble the spool (652) and sleeve (651) into the spool hole of the casing.

Note: *(1) Confirm that the spool and sleeve slide smoothly inside the casing. (2) Be careful of the spool direction.*

---

4. Assemble the feedback lever (611) and insert the pin (874), aligning with the feedback pin hole.

Note: *(1) To facilitate work, insert the pin a little into the feedback lever beforehand. (2) Be careful not to mistake the direction of the feedback lever.*

---

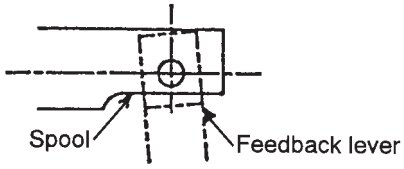
5. Assemble the pilot piston (643) to the casing hole for flow rate control.

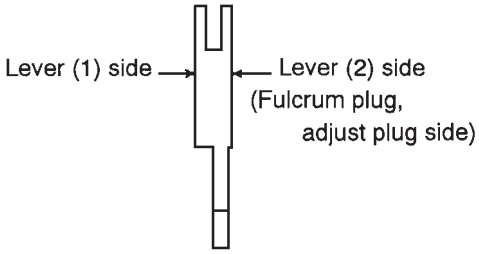
Note: *(1) Confirm that the pilot piston slides smoothly.*

All tapped holes and gasket faces should be thoroughly degreased by washing as liquid packing and adhesive is used on all gasket surfaces and threads.

Apply adhesive to the final few threads of a bolt or screw. Do not apply excessive amounts of adhesive. Wipe off any surplus liquid packing.

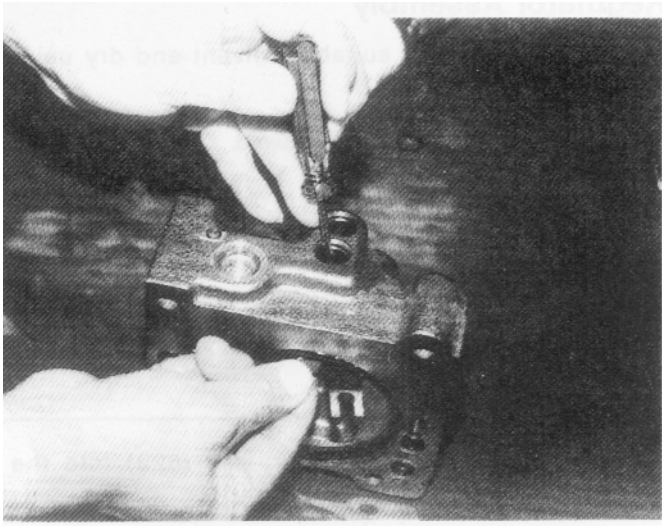
Ensure that the pump controllers are fitted to the positions from which they were removed.



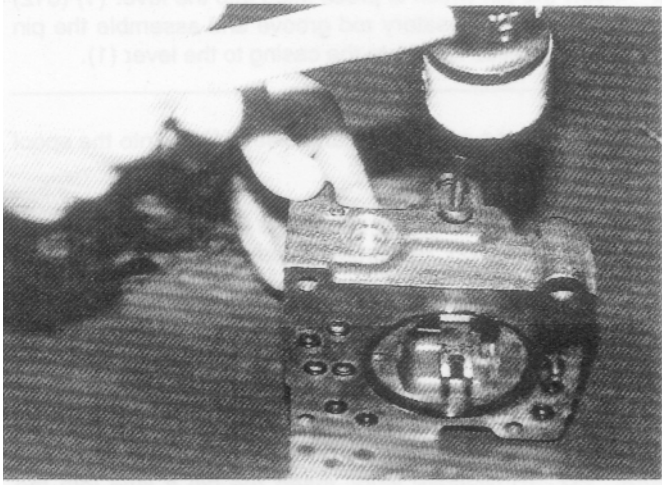


Regulator Assembly *(continued)*

6. Insert the pin, which is press-fitted into the lever (2) (613), into the pilot piston groove and assemble lever (2).



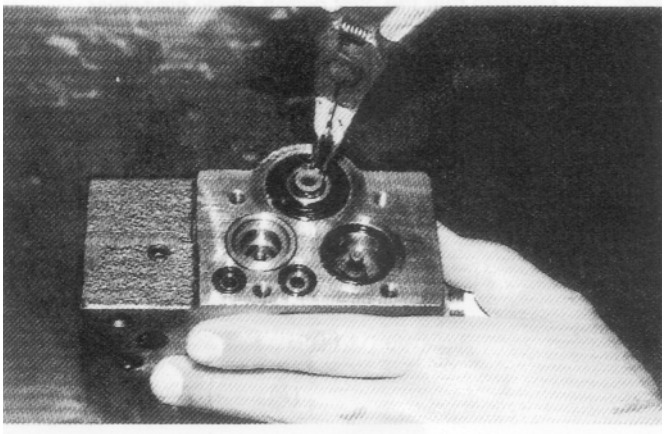
7. Assemble the fulcrum plug so that the pin, which is press-fitted in the fulcrum plug, is inserted in the lever (2) pin hole. Install the locking ring (858).



8. Insert the adjusting plug (615) and assemble the locking ring.

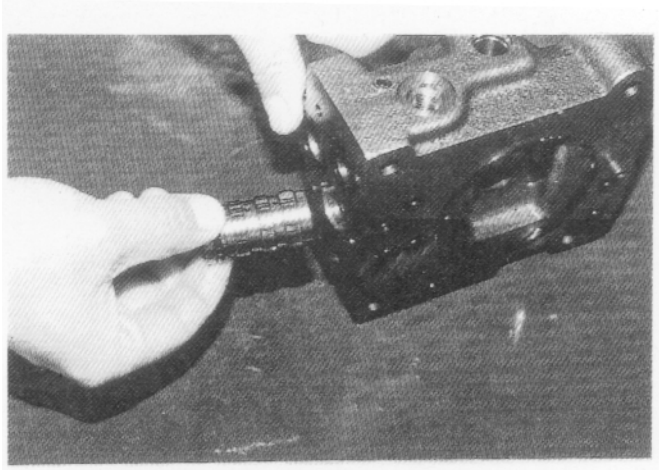
Note: *(1) Ensure that the fulcrum plug and adjusting plug are inserted into the correct hole. (2) Check the feedback lever moves smoothly and is not too loose.*

9. Assemble the return spring (654) and spring base (653) into the spool hole and install the stop ring (814).



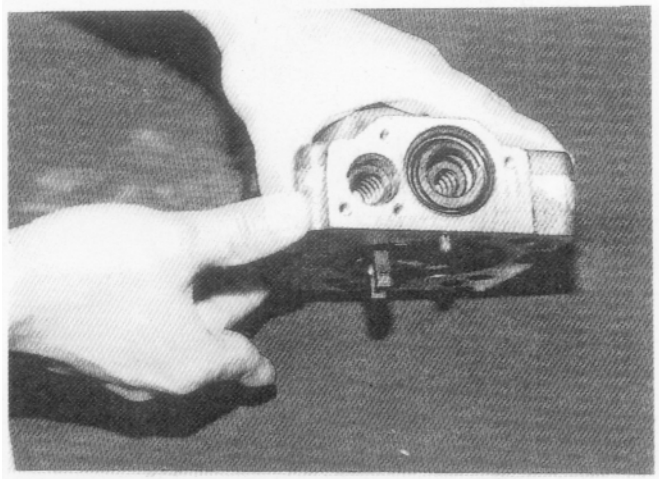
Regulator Assembly *(continued)*

10. Assemble the set spring (655) into the spool hole and the compensatory piston (621) and piston case (622) into the compensatory hole. Install the pilot cover (641) and tighten with hexagonal socket head bolts (436) (438).



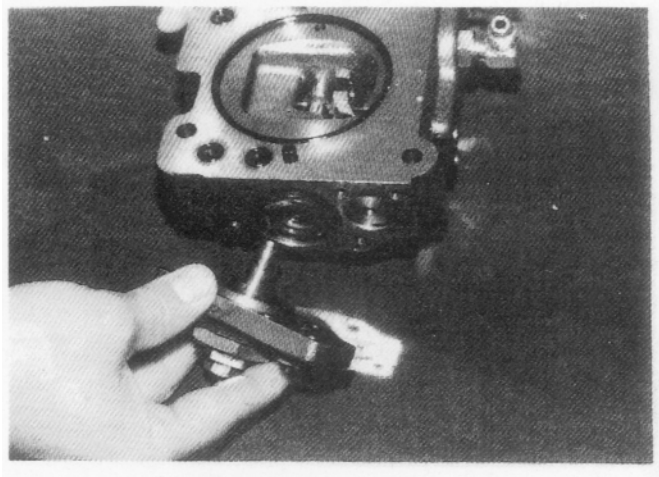
11. Assemble the spring base (644), pilot spring (646) and adjusting ring (Q) (645) into the pilot hole and assemble the spring base (624), inner spring (626) and outer spring (625) into the compensatory hole.

Note: *Make sure the spring base is fitted in the correct direction.*



*

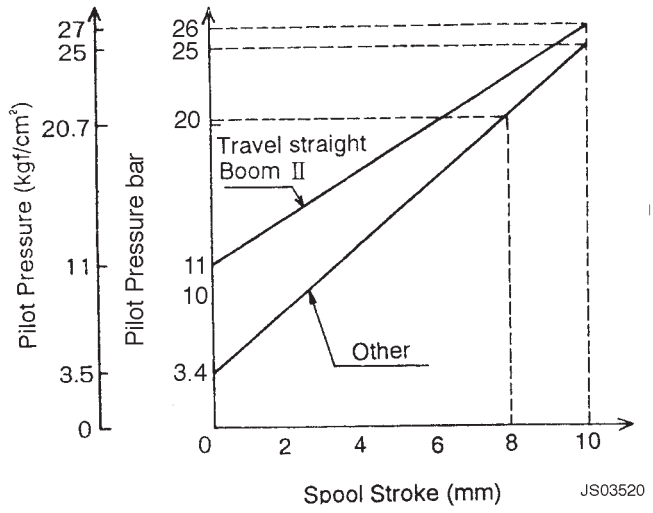
12. Install the cover (C) (629) complete with the adjusting screw (628),(925), adjusting ring (C) (627), lock nut (630), hexagonal nut (801) adjusting screw (924d) and tighten the hexagonal socket head bolt (438). This completes the reassembly.



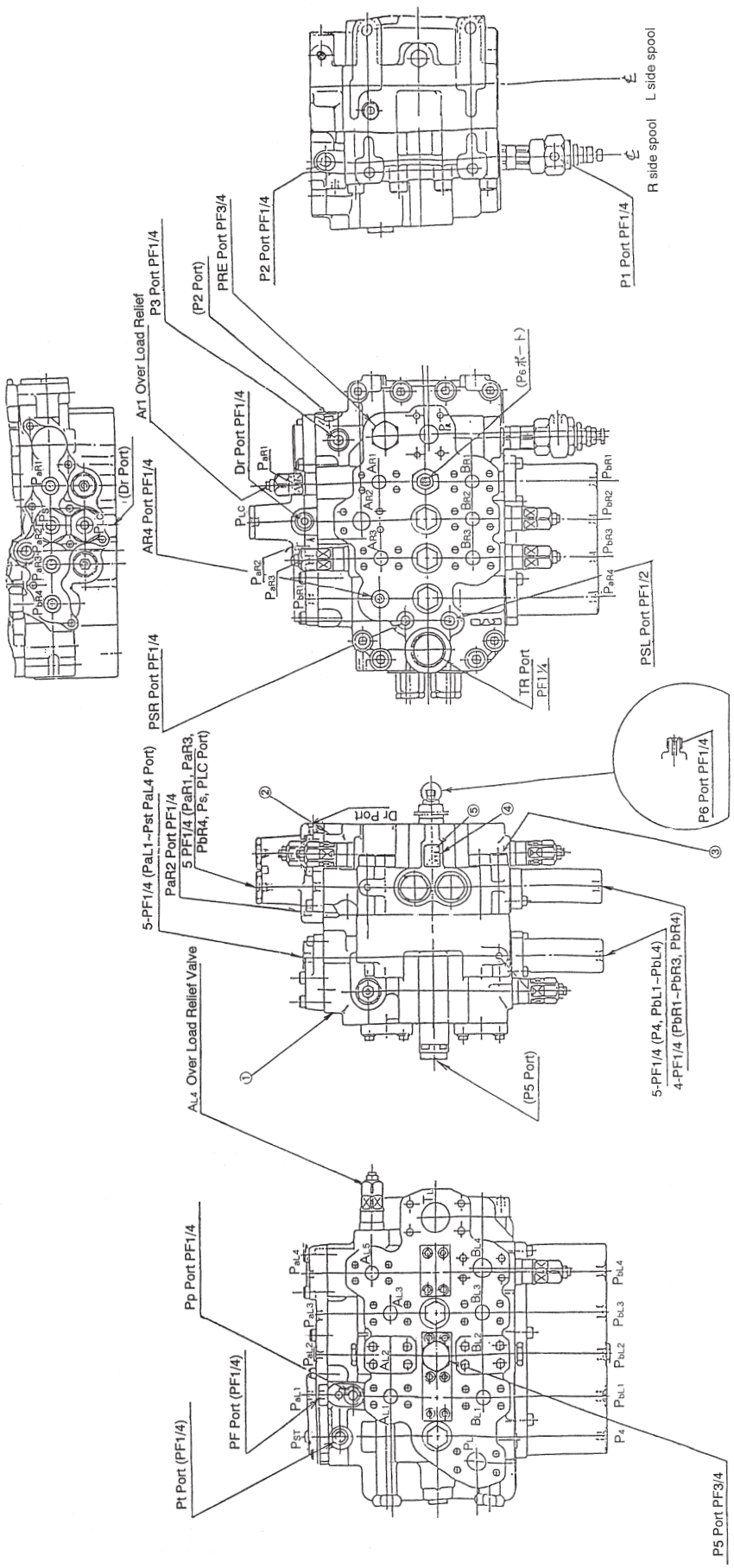
Specification, Technical Data

Weight: 165kg (74.8lb)

* **Spool Stroke versus Pilot Pressure**



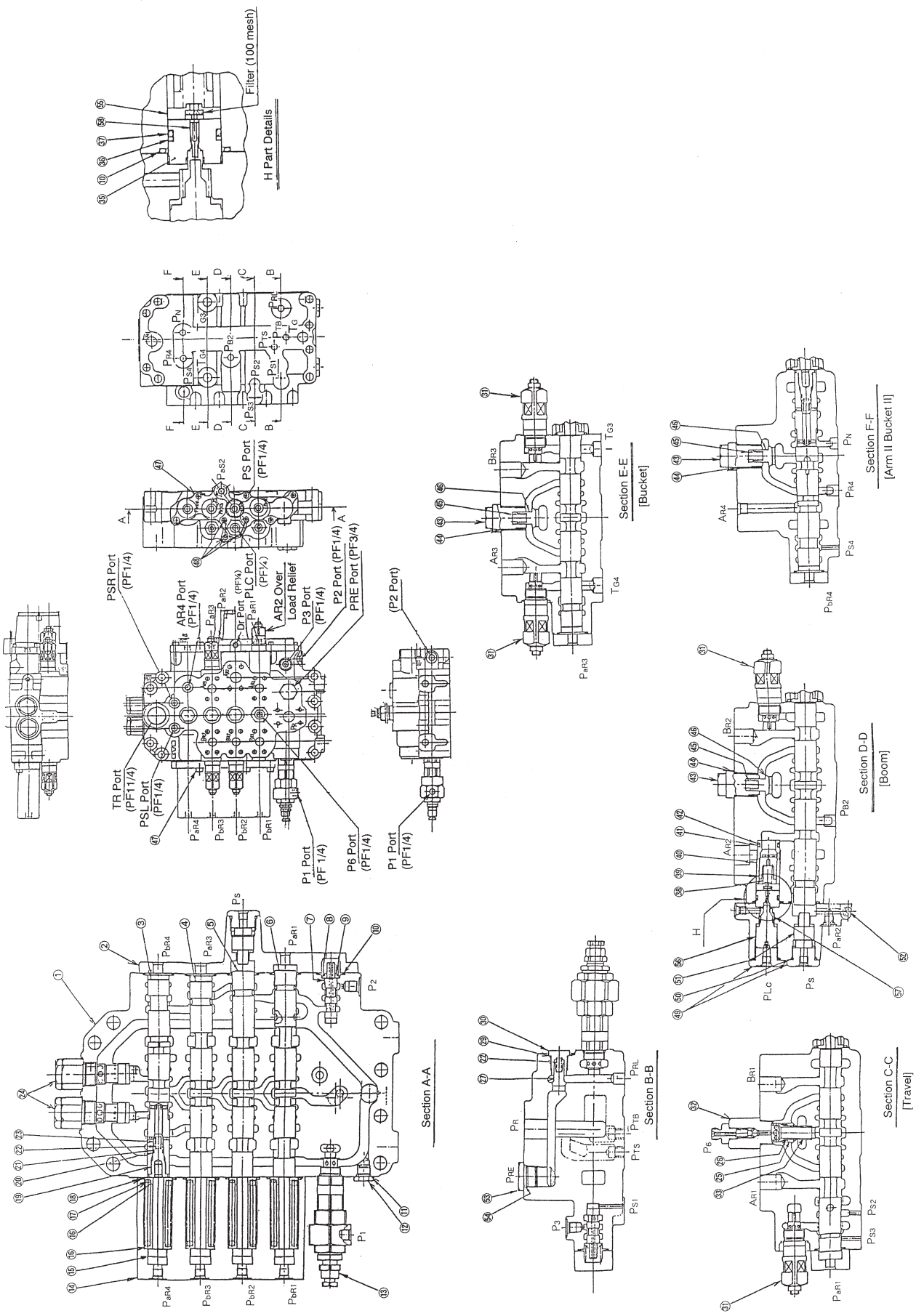
	* **Control Valve Set Pressures**		
*	Maximum Flow:	†(JS200/220) P_L, P_K 198.7 l/min (43.7 imp gal), P_P 20.5 l/min (4.5 imp gal), P_S 20.5 l/min (4.5 imp gal) †(JS240/260) P_L, P_K 212.2 l/min (46.67 imp gal), P_P 22 l/min (4.8 imp gal), P_S 22 l/min (4.8 imp gal)	
*	Main Relief Set Pressure †(JS200/220)	(Lo) 320 kgf/cm² (309 bar, 4550.4 lb/in²) at 138 l/min (30.3 imp gal) (Hi) 350 kgf/cm² (338 bar, 4977 lb/in²) at 126 l/min (27.7 imp gal)	
*	Main Relief Set Pressure †(JS240/260)	(Lo) 320 kgf/cm² (309 bar, 4550.4 lb/in²) at 168 l/min (36.9 imp gal) (Hi) 350 kgf/cm² (338 bar, 4977 lb/in²) at 155 l/min (34.09 imp gal)	
*	AL_4 (Dipper Out)	Port Overload Relief Set Pressure:	370 kgf/cm² (363 bar, 5263 lb/in²) at 20 l/min (4.3 imp gal)
*	BL_4 (Dipper In) (except JS220LC Long Reach)	Port Overload Relief Set Pressure:	370 kgf/cm² (363 bar, 5263 lb/in²) at 20 l/min (4.3 imp gal)
*	BL_4 (Dipper In) (JS220LC Long Reach only)	Port Overload Relief Set Pressure:	220 kgf/cm² (216 bar, 3132 lb/in²) at 20 l/min (4.3 imp gal)
*	AR_2 (Boom Raise)	Port Overload Relief Set Pressure:	370 kgf/cm² (363 bar, 5263 lb/in²) at 20 l/min (4.3 imp gal)
*	BR_2 (Boom Lower)	Port Overload Relief Set Pressure:	250 kgf/cm² (245 bar, 3555 lb/in²) at 20 l/min (4.3 imp gal)
*	AR_3 (Bucket Open) (except JS220LC Long Reach)	Port Overload Relief Set Pressure:	370 kgf/cm² (363 bar, 5263 lb/in²) at 20 l/min (4.3 imp gal)
*	AR_3 (Bucket Open) (JS220LC Long Reach only)	Port Overload Relief Set Pressure:	240 kgf/cm² (235 bar, 3407 lb/in²) at 20 l/min (4.3 imp gal)
*	BR_3 (Bucket Close) (except JS220LC Long Reach)	Port Overload Relief Set Pressure:	370 kgf/cm² (363 bar, 5263 lb/in²) at 20 l/min (4.3 imp gal)
*	BR_3 (Bucket Close) (JS220LC Long Reach only)	Port Overload Relief Set Pressure:	240 kgf/cm² (235 bar, 3407 lb/in²) at 20 l/min (4.3 imp gal)
	Pilot Port Maximum Pressure: (JS200/JS240) P_P, P_S 40 kgf/cm² (38.6 bar, 568.8 lb/in²)		
*	†Including all variants.		


L side spool
R side spool
P1 Port PF1/4
P2 Port PF1/4
PRE Port PF3/4
(P2 Port)
P3 Port PF1/4
Ar1 Over Load Relief
Dr Port PF1/4
AR4 Port PF1/4
(Dr Port)
PSR Port PF1/4
TR Port PF1/4
PSL Port PF1/2
P6 Port PF1/4
5-PF1/4 (PaL1~Pst PaL4 Port)
PaR2 Port PF1/4
5 PF1/4 (PaR1, PaR3, PbR4, Ps, PLC Port)
Dr Port
(P5 Port)
5-PF1/4 (P4, PbL1~PbL4)
4-PF1/4 (PbR1~PbR3, PbR4)
AL4 Over Load Relief Valve
Pp Port PF1/4
PF Port (PF1/4)
Pt Port (PF1/4)
P5 Port PF3/4

Code	Part Name	Q'ty
1	Valve housing	1
2	Spool (Arm 1)	1
3	Spool (Swing)	1
4	Spool (Spare)	1
5	Spool (Travel)	1
6	Spool (Linear, Boom 2)	1
7	O-ring	5
8	Spring seat	10
9	Spring	4
10	Spool end	5
11	Cap	1
12	Plug	2
13	O-ring	2
14	Cap	1
15	O-ring	5
16	Plug	1
17	Back up ring	1
18	O-ring	3
19	Spring	1
20	Poppet	1
21	Plug	1
22	O-ring	1
23	Spring	1
24	Poppet	1
25	O-ring	2
26	Plug	2
27	Spring	2
28	Poppet	2
29	Sleeve	1
30		
31	Spring	1
32	Poppet	1
33	O-ring	3
34	Plug	2
35	Plug	2

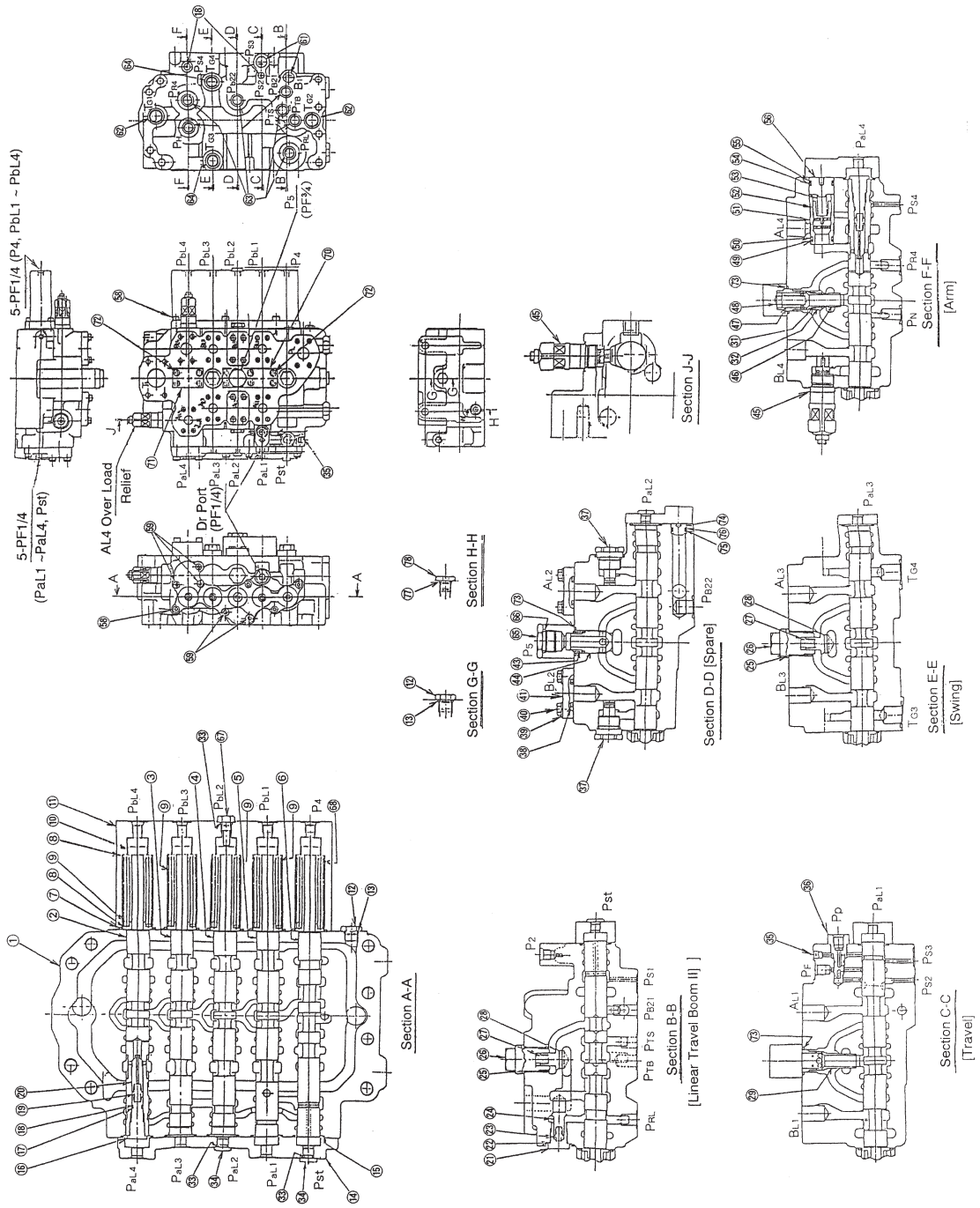
Code	Part Name	Q'ty
36	Plug Assembly	1
37	Plug Assembly	2
38	O-ring	2
39	Washer	8
40	Bolt	8
41	Plate	2
42		
43	Spring	1
44	Poppet	1
45	Relief Valve Assembly	2
46	Sleeve	1
47	Poppet	1
48	Spring	1
49	Back up ring	1
50	O-ring	1
51	Sleeve	1
52	Poppet	1
53	Spring	1
54	O-ring	1
55	Back up ring	1
56	Plug	1
57		
58	Socket head bolt	10
59	Socket head bolt	5
60		
61	O-ring	2
62	O-ring	2
63	O-ring	7
64	O-ring	2
65	Plug	1
66	O-ring	1
67	Plug	1
68	Spring	1
69		

Code	Part Name	Q'ty
70	Flange	1
71	Flange	1
72	Socket head bolt	10
73	O-ring	3
74	Plug	1
75	O-ring	1
76	Back up ring	1
77	O-ring	1
78	Plug	1


Filter (100 mesh)
H Part Details
PS Port (PF1/4)
PSR Port (PF1/4)
AR4 Port (PF1/4)
AR2 Over Load Relief
P3 Port (PF1/4)
P2 Port (PF1/4)
PRE Port (PF3/4)
Dr Port (PF1/4)
PLC Port (PF1/4)
TR Port (PF11/4)
PSL Port (PF1/4)
P1 Port (PF 1/4)
P6 Port (PF1/4)
P1 Port (PF1/4)
(P2 Port)
Section A-A
Section B-B
Section C-C
[Travel]
Section D-D
[Boom]
Section E-E
[Bucket]
Section F-F
[Arm II Bucket II]

Code	Part Name	Q'ty
1	Valve housing	1
2	Cap	1
3	Spool (Arm 2 Bucket 2)	1
4	Spool (Bucket 1)	1
5	Spool (Boom 1)	1
6	Spool (Travel)	1
7	Spool	1
8	Spring	1
9	Spring seat	1
10	O-ring	6
11	O-ring	1
12	Plug	1
13	Relief Valve Assembly	1
14	Cap	1
15	Spool end	4
16	Spring seat	8
17	Spring	4
18	O-ring	4
19	Plug	1
20	Back up ring	1
21	O-ring	1
22	Spring	2
23	Poppet	1
24	Relief Valve Assembly	2
25	Poppet	1
26	Spring	1
27	Poppet	1
28		
29	O-ring	1
30	Plug	1

Code	Part Name	Q'ty
31	Relief Valve Assembly	4
32	Check Valve Assembly	1
33	sleeve	1
34		
35	Plug	1
36	Back up ring	1
37	O-ring	1
38	Spring	1
39	Poppet	1
40	sleeve	1
41	O-ring	1
42	Back up ring	1
43	Plug	3
44	O-ring	3
45	Spring	3
46	Poppet	3
47	Socket head bolt	11
48	Socket head bolt	3
49	Plug	2
50	O-ring	2
51	Piston	1
52	Plug	1
53	Plug	1
54	O-ring	1
55	Spacer Assembly	1
56	Piston	1
57	Spring	1
58	Poppet	1


5-PF1/4 (P4, PbL1 ~ PbL4)
5-PF1/4 (PaL1 ~PaL4, Pst)
AL4 Over Load Relief
Dr Port (PF1/4)
Section A-A
Section B-B [Linear Travel Boom II]]
Section C-C [Travel]
Section D-D [Spare]
Section E-E [Swing]
Section F-F [Arm]
Section G-G
Section H-H
Section J-J

Code	Part Name	Q'ty
1	Valve housing	1
2	Cap	1
3	Spool (Arm 2 Bucket 2)	1
4	Spool (Bucket 1)	1
5	Spool (Boom 1)	1
6	Spool (Travel)	1
7	Spool	1
8	Spring	1
9	Spring seat	1
10	O-ring	6
11	O-ring	1
12	Plug	1
13	Relief Valve Assembly	1
14	Cap	1
15	Spool end	4
16	Spring seat	8
17	Spring	4
18	O-ring	4
19	Plug	1
20	Back up ring	1
21	O-ring	1
22	Spring	2
23	Poppet	1
24	Relief Valve Assembly	2
25	Poppet	1
26	Spring	1
27	Poppet	1
28		
29	O-ring	1
30	Plug	1

Code	Part Name	Q'ty
31	Relief Valve Assembly	4
32	Check Valve Assembly	1
33	sleeve	1
34		
35	Plug	1
36	Back up ring	1
37	O-ring	1
38	Spring	1
39	Poppet	1
40	sleeve	1
41	O-ring	1
42	Back up ring	1
43	Plug	3
44	O-ring	3
45	Spring	3
46	Poppet	3
47	Socket head bolt	11
48	Socket head bolt	3
49	Plug	2
50	O-ring	2
51	Piston	1
52	Plug	1
53	Plug	1
54	O-ring	1
55	Spacer Assembly	1
56	Piston	1
57	Spring	1
58	Poppet	1

Precautions During Use
Installation

• Be careful that excessive force is not put on the valve by the piping.

• Tighten the installation bolts in the same manner.

• When welding work is done near the installation bolts, excessive heat or spatter can damage the seals, so be careful.

• To prevent foreign matter from entering the ports, do not remove the plugs from the ports until installation.

Running

• Operate only after confirming that the hydraulic circuit and hydraulic oil are clean.

• Use the hydraulic oil specified in this manual.

• Do not raise the pressure of the main relief valve or port relief valve set pressure.

• The difference between the main relief valve and port relief valve set pressure should be more than 2.0 MPa (20 kgf.cm^2).

• Perform warming up sufficiently before beginning actual operations.

In particular, to prevent sticking of the main spool due to heat shock because of low temperature of the hydraulic oil and valve at starting, be careful of the following points.

* **1.** When operating the services, do not induce overload or full travel conditions which will cause sudden and frequent operation of the relief valves. Operate steadily, enabling the hydraulic oil in the rams to circulate and warm each part uniformly.

2. Fine and combined operations cause heat build up, so do not perform sudden operations at low temperatures.

The following details refer to the illustrations at the beginning of this Section.

Operation

The control valve is constructed with the 4-spool and 5-spool sides overlapping and integrated into one.

When all spools are neutral

1. Neutral passage (Refer to Fig. 1,2)

The oil delivered by P_R port passes through the (A) cavity by the 4-spool neutral passage, and is returned to the tank by T_R port. Part of the oil passes through the (C) (D) (E) (F) passage and is returned to the tank by T_L port. If the machine is started from cold, the oil also pushes open the negative control relief valve (B).

Pressure in (A) cavity is led from P_{sr} port to the pump and controls the P_R port delivery volume. (Negative control).

Also, when there is a large volume of oil flowing through the neutral passage due to a lag in the pump's delivery control, the low pressure relief valve, which is contained in the negative control relief valve, works to prevent the pressure of P_{SR} port from becoming abnormally high.

The oil delivered by P_L port passes through the neutral passage A of the 5-spool control valve via passage Y into the 4-spool passage W passing through (G) cavity, pushing open negative control valve (H) and flowing to the T_R port. Part of the oil passes through the (C) (D) (E) (F) passage and is returned to the tank from the Tl port.

The pressure of (G) cavity is led from the P_{SL} port to the pump and controls the P_L pump delivery volume.

2. Signal Passage (Refer to Fig. 1,3,9)

The oil from the signal hydraulic source entering the P; port flows through the restriction (a) and is led to the P_P port and passage (b), 5-spool travel spool signal land part, passing through passage (c) (d) and is released to the 4-spool tank passage.

Part of the oil entering P_P port flows through restriction (I) and is led to P_P port and passage (e), flows through each spool of the 5-spool signal land part and is released to the tank passage.

Also, the oil passing through restriction (J) flows through passage (f), land (k) and flows to the tank passage. Part of the oil flow from passage (g) (h) to land (L) and is released to the 4-spool tank passage.

Operation *(continued)*

Individual Operation

1. Travel Spool Switch (Refer to Fig. 1,3,4).
When the P_{bl1} (P_{al1}) is pressurised and the 5-spool travel spool is selected (Fig. 4), the neutral passage **A** is closed and downward flow is cut off, so the oil delivered from the P_L port flows from the 5-spool neutral passage **A** past the sleeve (M) into passage I to the spool neck, to the passage **K** (passage J) and flows to the cylinder port B_{Li} (A_{Li}).

When the P_{bR1} (P_{ar1}) port is pressurised and the 4-spool travel spool is selected to neutral, passage **a** is closed and downward flow is cut off, so the oil delivered from the P_R port flows from the 4-spool neutral passage **a** to the sleeve K(N), passage **f** to the spool neck, passage **g** (passage **h**) and flows to the cylinder port B_{RI} (A_{RI}).

The return oil from the cylinder port flows through the spool neck and is released to the tank.

When one side of the 4-spool (5-spool) travel spool is selected (Fig. 3,4), the signal land (K) (L) is closed but the oil entering from the signal port P_p flows through the restriction (I) (J) passage, land (K) (or restriction (I) (J) passage (f) (g) (h) then land (L) and is connected with the tank passage so the signal passage (f) pressure does not rise and the travel linearity spool maintains its indicated position due to spring force. (Fig.1)

When the above operations (4,5 spool simultaneous, or separate) are made, flow to the tank passage of the signal passage (b) is cut off so the P_t port pressure rises.

* Boom Spool Selection

2. Up (II speed confluence) (Refer to Fig. 1,3,5,8,).
When pilot port P_{aR2} is pressurised and the boom I spool is selected, the 4-spool neutral passage a is closed and the oil delivered from the P_R port flows from the 4-spool parallel passage **b** and pushes up the load check valve (O), flowing through passage **i** spool neck and passage **K** and pushes open the lock valve poppet (P) and flows into A_{R2} port.
When P_{aR2} is pressurised (Fig. 1,8) part of the oil flows from the outer passage through the P_2 port and flows to the shuttle (Q) passage z x, and from the P_3 port flows through the outer passage again and pressurises P_4 port and selects the boom II spool. At this time, due to the spool being selected (Fig. 8) and the flow to the neutral passage A from passage D being cut off, the oil delivered from P_L flows through passage B, pushes open load check valve (R) and flows through passage C H L1 (Fig. 3) L_2 (Fig. 5), converging with passage **K** from 4-spool passage **m**.

The return oil from cylinder port B_{R2} flows though passage **j** and through boom **I** spool neck and is released to the tank passage. (Fig. 5)

3. Lower (Refer to Fig. 6, 14).
When the pilot port P_{bR2} is pressurised and the boom I spool is selected (Fig. 6), the 4-spool neutral passage a is cut off and the oil delivered from the P_R port flows through the 4-spool parallel passage b, pushes open the load check valve (O) and flows through passage **i j** from cylinder port B_{R2}.
The return oil from cylinder port A_{R2} flows through the lock valve poppet (**P**) and, through passage K, flows to the spool neck and is released to the tank passage.

Operation *(continued)*

* Dipper Spool Selection

1. Dump (Refer to Fig. 9).

* When the pilot port P_{aL4} is pressurised and the arm I spool is selected, the oil delivered from P_L port through the 5-spool neutral passage A pushes up the sleeve (S) load check valve (T) and, through passage U, passes through the spool neck and passage V, pushing open the load sensing valve poppet (U) and flowing from the cylinder port A_{L4}.
Also, part of the oil delivered by P_L flows from 5-spool parallel passage B to the restriction (V), pushes open the load check valve (W) and converges in passage U.
The return oil from cylinder port B_{L4} flows through the spool neck from passage X and is released to the tank passage.

2. Crowd (Refer to Fig. 10, 15, 16).

When the pilot port P_{bl4} is pressurised and dipper **I** spool is selected (Fig. 10), the oil delivered from P_L through the 5-spool neutral passage **A** pushes up the sleeve (S) load check valve (T) and from passage **U** flows through spool neck and passage **X** and flows from the cylinder port B_{L4}. Also, part of the oil delivered from P_L flows through the restriction from the 5-spool parallel passage **b,** pushes open the load check valve (W) and converges in passage **U**.

* The return oil from cylinder port A_{L4} pushes open the load sensing valve poppet (U), flows through passage **V** and is released to the tank passage, but at this time, part of the oil flows through the spool hole (**X**), pushes open the regenerative circuit poppet (Y) inside the spool, flows through the restriction (Z) and converges in the passage U (Fig. 15,16).

3. II Speed Confluence

* When the dipper **I** spool is selected (Dump, Crowd: Fig. 9, 10), when the pilot port P_{bR4} is pressurised and dipper II spool is switched, the oil delivered from P_R port flows through 4-spool neutral passage a and pushes open load check valve (z) and converges into passage **U** from passage **t** or **Z** and at the same time pushes open the check valve (y) poppet (x) (Fig. 3). It flows through the outer passage from the P6 port, through passage **v** from A_{R4} port and flows through the spool restriction (w) and converges in passage u.

Operation *(continued)*

* Bucket Spool Selection

Dump: Crowd (Refer to Fig. 11).
When the pilot port P_{bR3} (P_{aR3}) is pressurised and the bucket I spool is selected, the 4-spool neutral passage a is cut off and the oil delivered from P_R flows through the 4-spool parallel passage b, pushes up the load check valve (v) and from the passage n flows through the spool neck and from passage P (q) flows to the cylinder port B_{R3} (A_{R3}).

The return oil from the cylinder port A_{R3} (B_{R3}) flows through the spool neck from passage q (P) and is released to the tank passage.

II Speed Confluence (Refer to Fig. 11, 12).
When the bucket I spool is selected, (Dump: Crowd: Fig. 11), when pilot port P_{aR4} is pressurised and bucket II is selected (Fig. 12), the oil delivered from P_L flows into passage Y w from the 5-spool neutral passage A and arm I spool land, flows through the bucket II spool hole (u), pushes up the poppet (t) and converges in bucket I passage n from passage o (Fig. 1).

Slew Spool Switch (Refer to Fig. 11).
When the pilot port P_{bL3} (P_{aL3}) is pressurised and the spool is selected, the 5-spool neutral passage A is cut off and the oil delivered from P_L port flows through the 5-spool parallel passage B and pushes open the load check valve (s) and flows through the spool neck from passage P and flows from passage R (Q) to cylinder port B_{L3} (A_{L3}).

The return oil from cylinder port A_{L3} (B_{L3}) flows through the spool neck and is released to the tank.

Spare Spool Switch (Refer to Fig. 5).
When the pilot port P_{bL2} (P_{aL2}) is pressurised and the spool is switched, the 5-spool neutral passage A is cut off and the oil delivered from the P_L port flows through the 5-spool parallel passage B and pushes up the load check (r). From passage M, it flows through the spool neck, through the passage o and flows to cylinder port B_{L2} (A_{L2}). Also, the oil delivered from the outside to the P_5 port flows through the load check valve (r) passage (q) and converges in passage M.

The return oil from cylinder port A_{L2} (B_{L2}) flows through the spool neck and is returned to the tank.

Travel Linearity Spool (Refer to Fig. 18).
When an excavator spool is selected, the signal passage is cut off, but when the travel spool is in neutral, the signal oil is released to the tank at the travel spool signal land (K) (L) so the pressure of the signal passage (f) does not rise and the travel linearity spool is in the neutral condition. (Fig. 1)
(When the boom is raised, it is selected to boom II. Fig. 8)
Also, when the spool at the front is switched, the flow to the tank passage of the signal passage (e) is cut off so the P_f port pressure rises.
(For travel linearity spool selection conditions, refer to the next item, 'Travel Combination Operations').

Operation *(continued)*

Combined Operations

1. Travel Combination Operations (Refer to Fig. 1, 13).

When travelling forward or backward (including spin turn) any spool other than the travel spool is selected or when operating the excavator, when the travel spool (left, right travel) spool is selected, the signal passage and tank passage are cut off at that spool signal land and the signal passage pressure rises to the relief set pressure.

The pressure of P_t, P_f ports rises and when the signal passage pressure rises, the pressure of the signal passage (f) connects to the straight travel spool recess (Fig. 1). It passes through the straight travel spool passage (p), (o) cavity pressure rises and the spool selects to the left as shown. (Travel forward state).

Whilst the boom is lifting (boom II selected), when the travel spool is selected the pressure passing through the (i) (j) passage rises, so the shuttle (Q) resists the spring force and moves to the right as shown (Fig. 13).

For this reason, passage x y is connected and the P_4 port oil flows from the outer piping through P_3 port and is released to the tank passage. The straight travel spool is then selected so the straight travel state is achieved.

(Fig. 1,13)

In this straight travel state, the oil delivered from P_R port activates the 4-spool traction motor, passes through passage d F and activates the 5-spool traction motor. (Fig. 13)

In this way, the left and right traction motors are activated so straight travel can be maintained while simultaneous actions with other services are carried out.

Also, the oil delivered to the P_L port is delivered to the 5-spool side from the 5-spool side parallel passage B. Part of the oil pushes open the load check (R) and is led from passage C G c to the 4-spool parallel passage b, activating other services. (Fig. 13)

2. Boom Lowering Stroke Regulation (Refer Fig. 7).

Puts pressure on the Ps port of the boom section and activates the piston, moving the boom I spool back a little as shown. When the spool is pushed back, the spool neutral passage a is opened and delivers oil to other spool sections.

3. Slew Priority Circuit (Refer to Fig. 2).

When operating the dipper and slew simultaneously, when the dipper load is light, the flow of oil for the slew section upstream is obtained by means of the constrictions (v), so slew priority is maintained.

Relief Valve (Refer to Fig. 3, 5, 8, 9, 11).

P_L port is connected to the load check (n) and passage E and P_R port is connected to load check (m) and passage e. Both are connected to the relief valve which prevents the maximum pressure of the 4-spool and 5-spool pump from exceeding the set pressure. (Fig. 8) (=main relief valve).
The relief valve has a booster function so that when pressure is put on P_1 port, the set pressure of the high pressure side can be changed.

Also, there is a relief valve on each ram port of the boom I (Fig. 3,5), bucket I (Fig. 11), dipper I (Fig. 9, 5-spool sectional diagram J-J) and prevents the actuator pressure from becoming abnormally high due to outside forces. (=overload relief valve)
When the ram pressure becomes negative, the relief valve also functions to absorb oil from the tank and prevent cavitation. (Combination port relief valve).

Operation *(continued)*

* Load Holding Valve

* **1. Boom Section (refer to fig. 5, 6, 14) .**

When the boom is lowered (Fig 6), the spool moves to the right as shown. At the same time, when **PLC** is pressurised, the load holding valve piston **D** pushes the poppet **B,** connecting Dr port. The oil in the load holding valve poppet (P) spring cavity **C** is released to the Dr port and poppet (P) opens.

2. Dipper Section (refer to fig. 9, 10, 15) .

* During dipper crowd, the spool moves to the left as shown and the passage **W** from the load holding valve is connected to the tank passage. The oil in the load holding valve poppet spring cavity **A** side creates differential pressure between the ram port **B** and is released, opening the poppet. (Fig 10)

* During dipper dumping, the spool moves to the left as shown (Fig. 9) and when oil flows to passage **V** (Fig. 15-2) it resists the force of the spring **D** of the load holding valve poppet (U), pushes open the poppet and flows to **AL4** port.

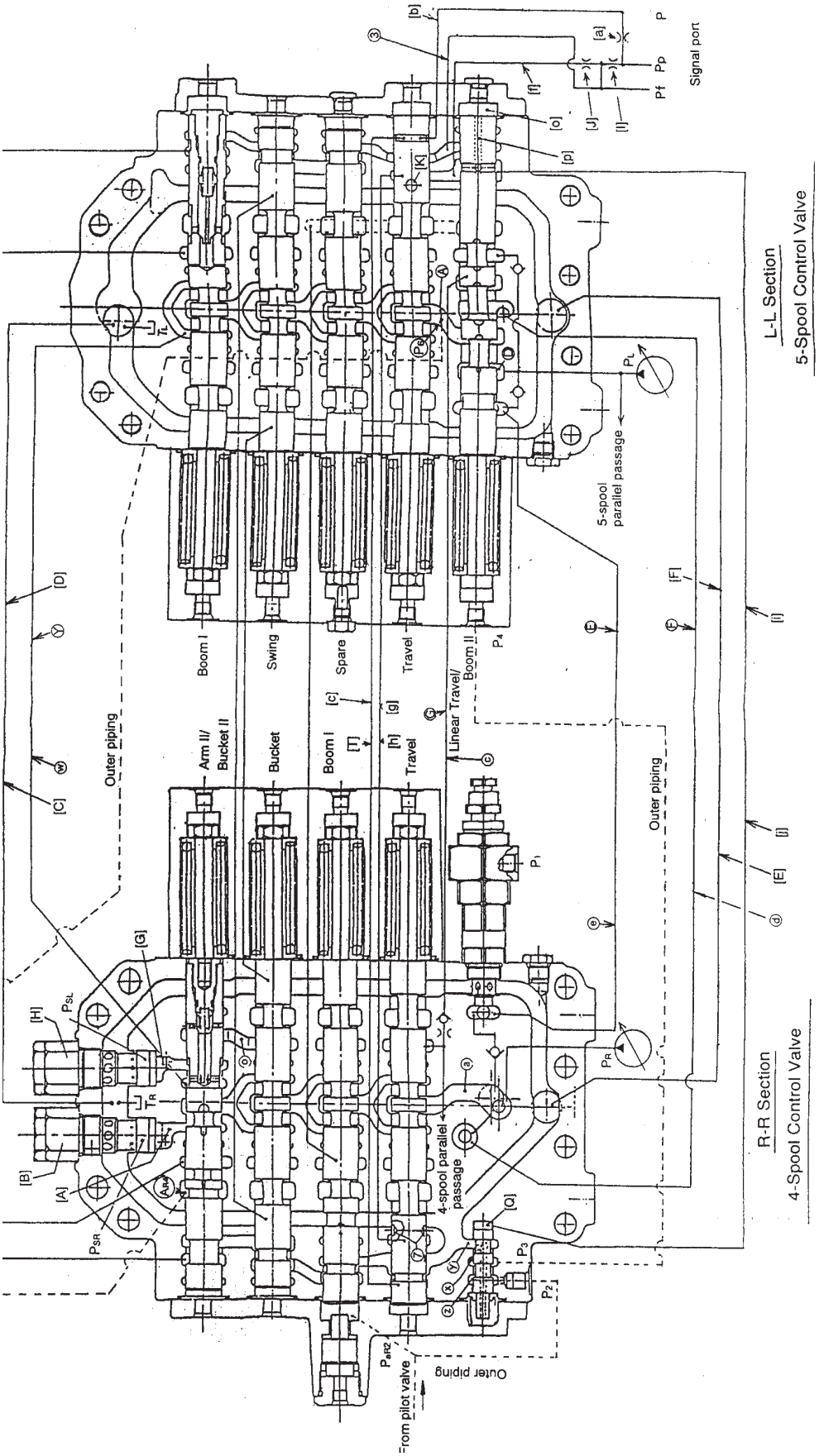
When the spool is in neutral, the pressure from the cylinder port **B** is fed through hole **C**, goes around the poppet spring cavity side **A** and, by the spring **D** force, seats the poppet.

Regenerative Circuit (Refer to Fig. 10, 16)

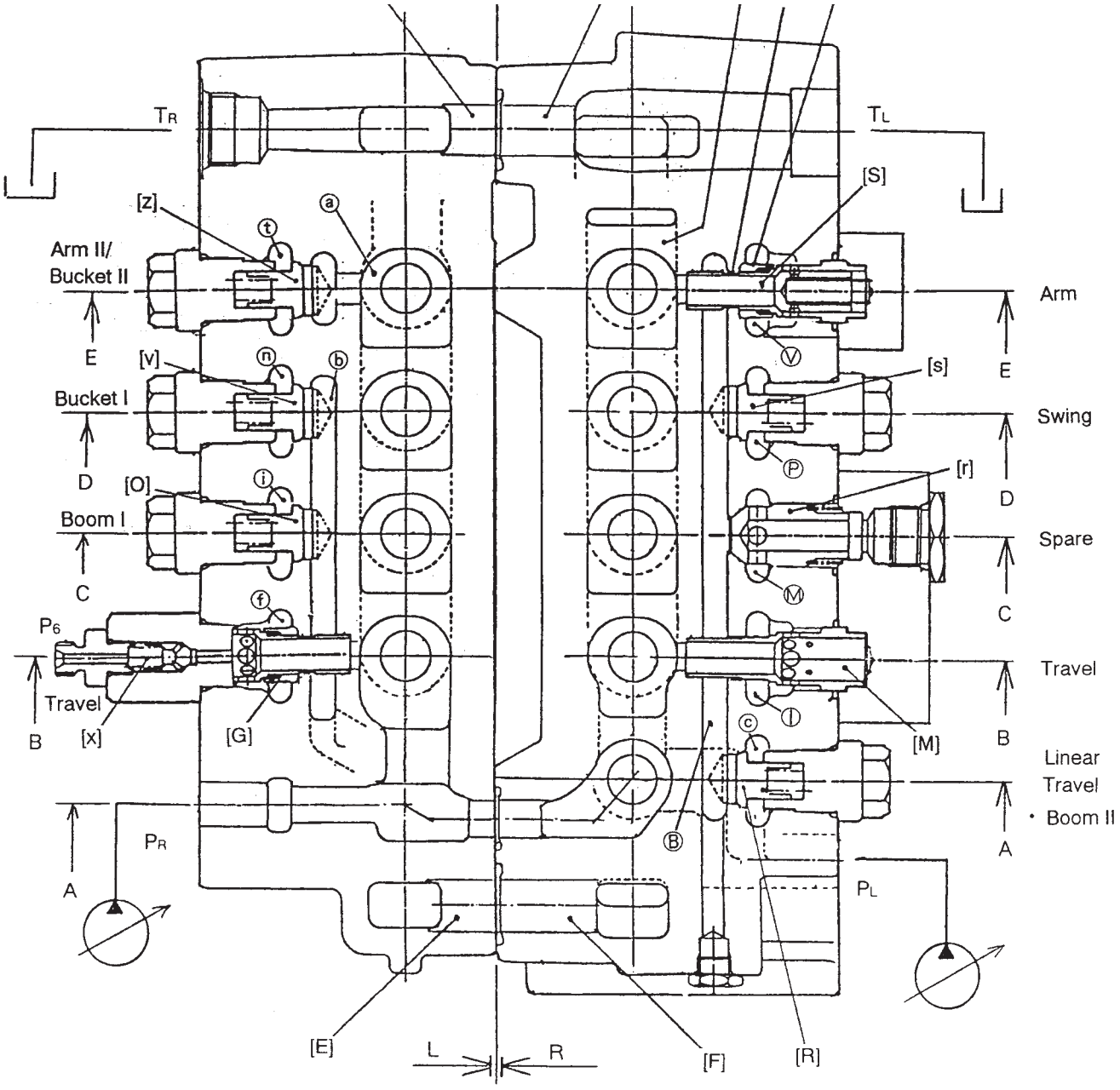
For this valve, a regenerative circuit is built into the dipper I spool.

During dipper crowd, (Fig. 10, 16), with the ram extending, the bottom side oil is insufficient and the pressure of passage **U** becomes lower than that of passage **V.** The pressure of passage **V** overcomes the spring **C** force and part of the oil which flows from the cylinder port **D** through the spool neck to the tank pushes open the poppet (Y) and by flowing through the constriction (Z), raises the pressure of passage **U** and prevents cavitation.

Operation *(continued)*

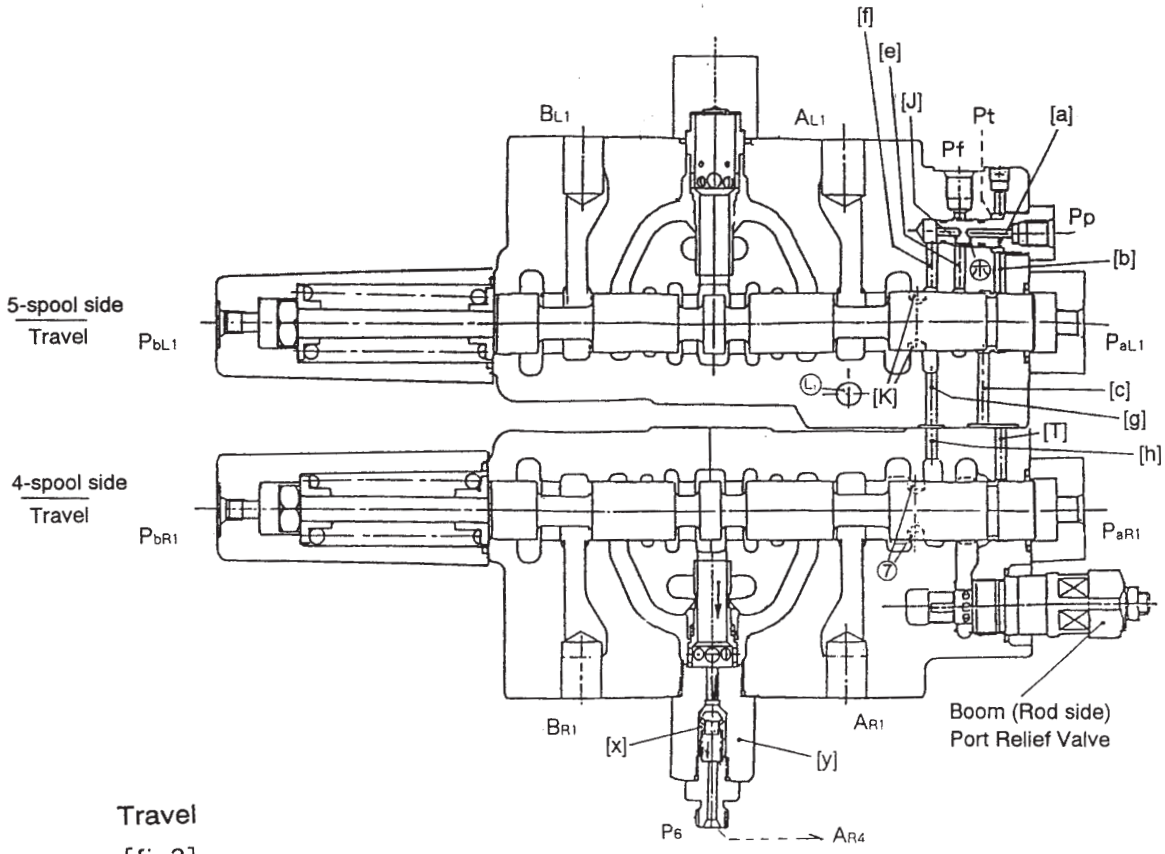


Operation *(continued)*

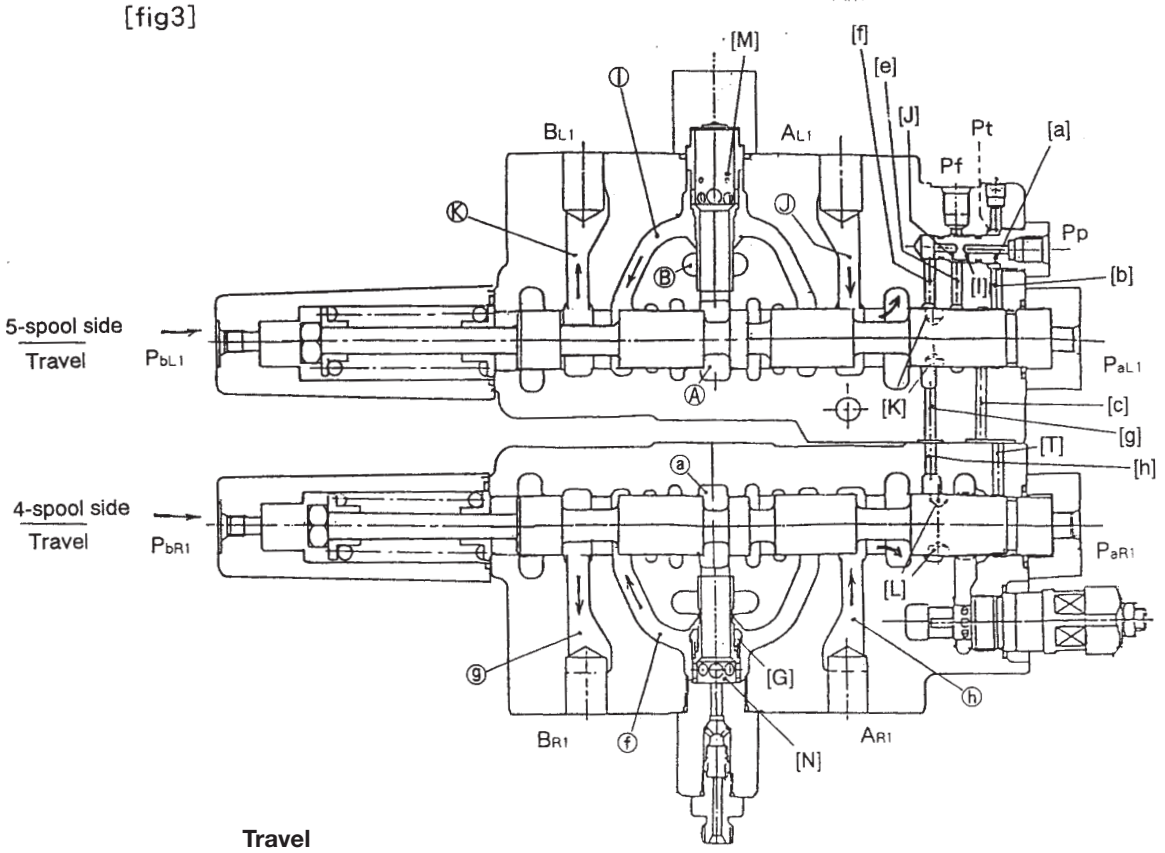


[fig2]

Operation *(continued)*



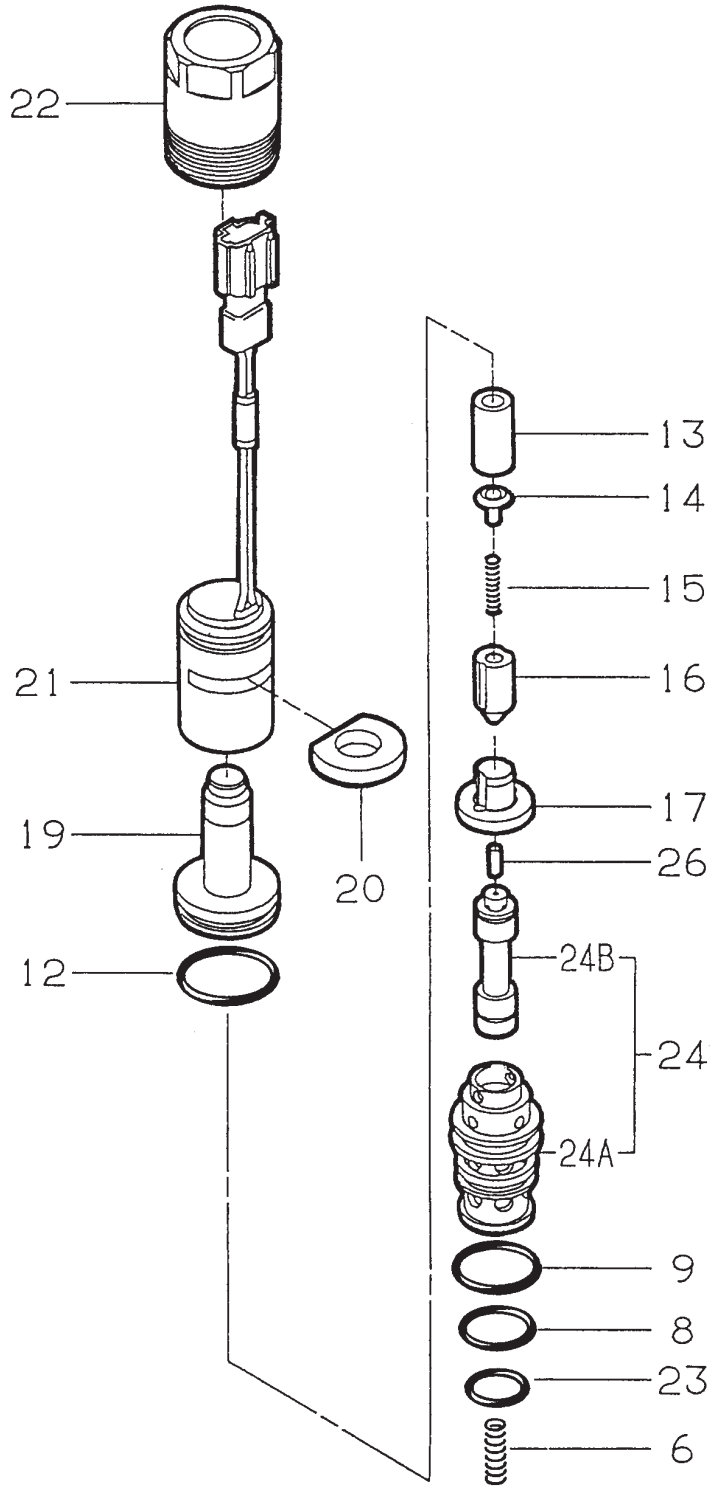
Travel
[fig3]



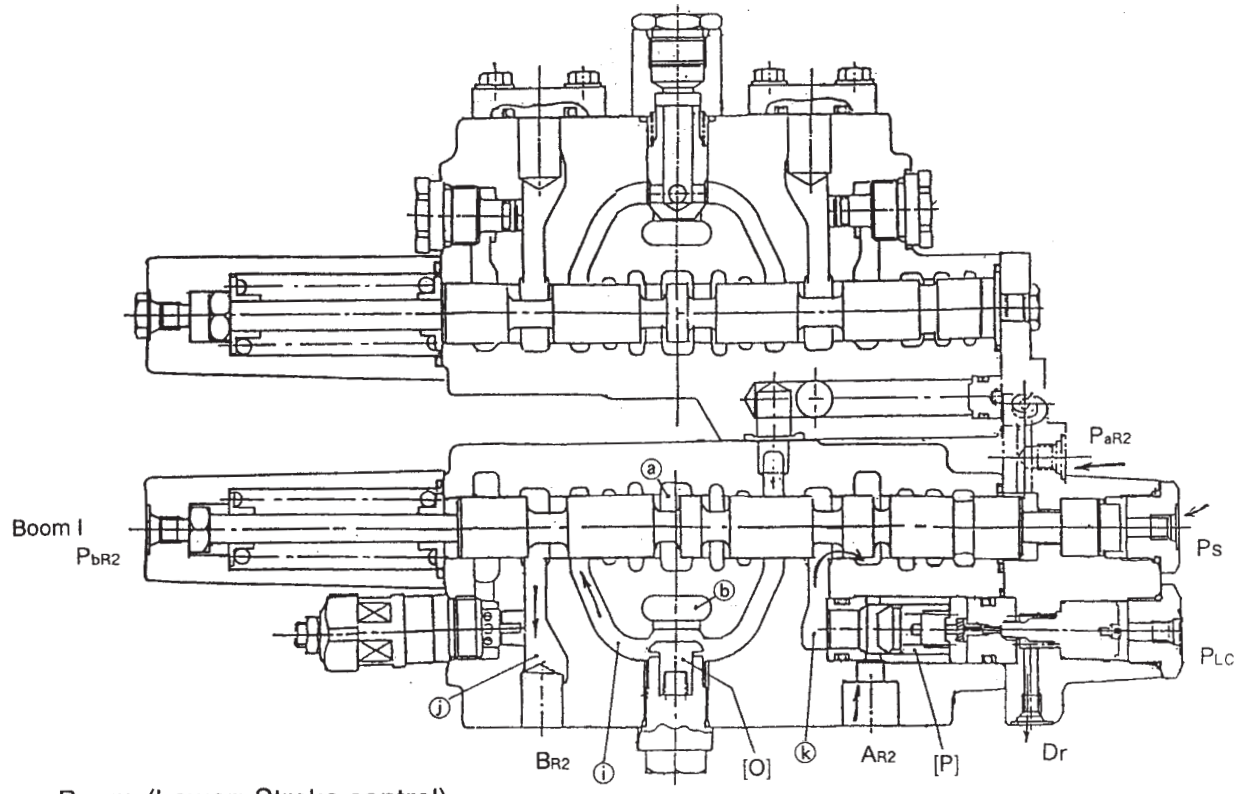
Travel
(Fig.4)

Operation *(continued)*

easure 1/2)

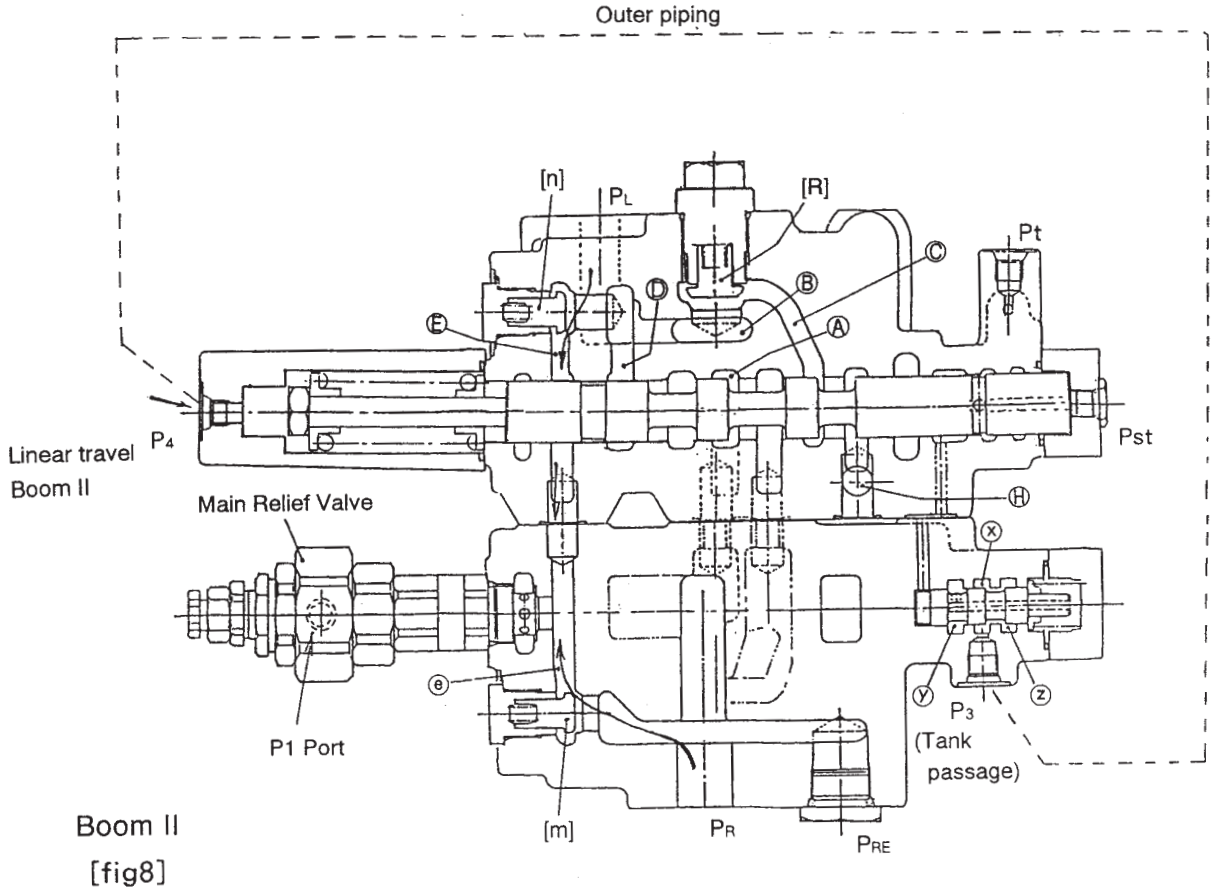


Operation *(continued)*



Boom (Lower: Stroke control)

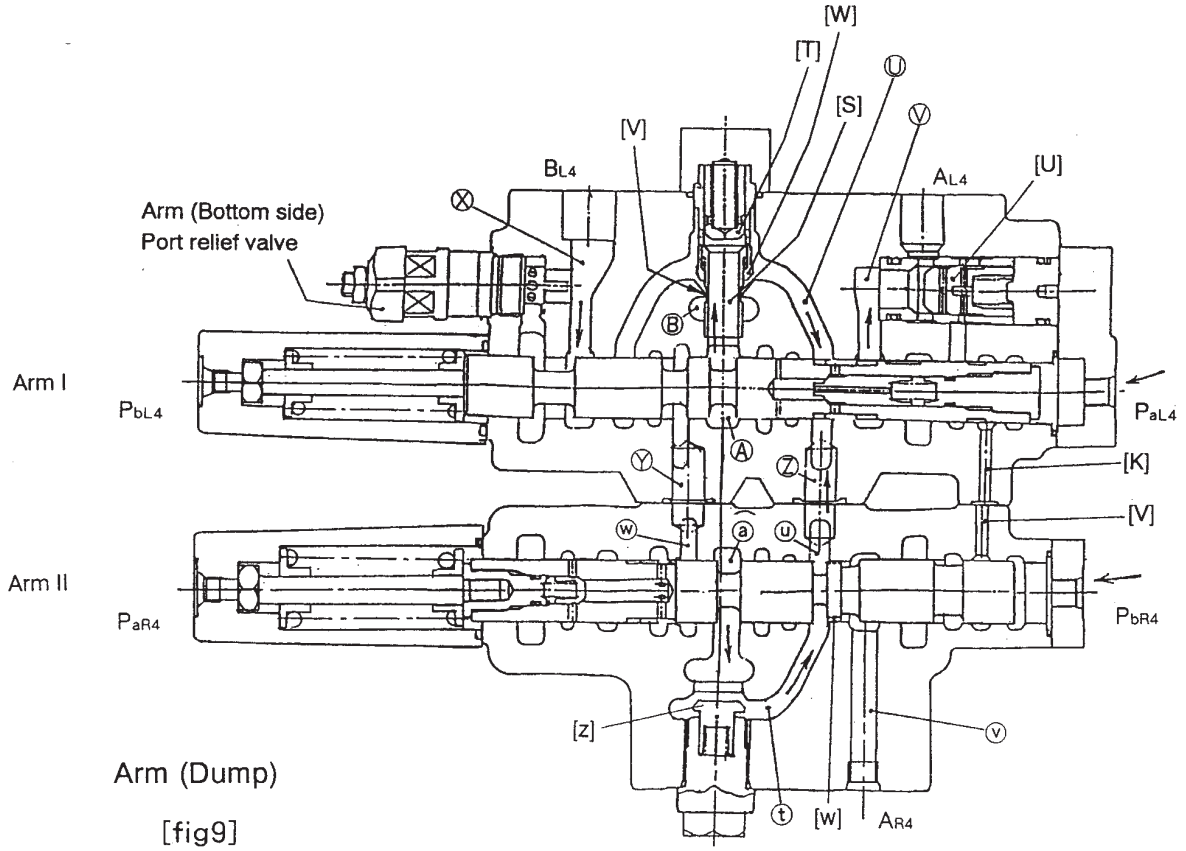
[fig7]



Boom II

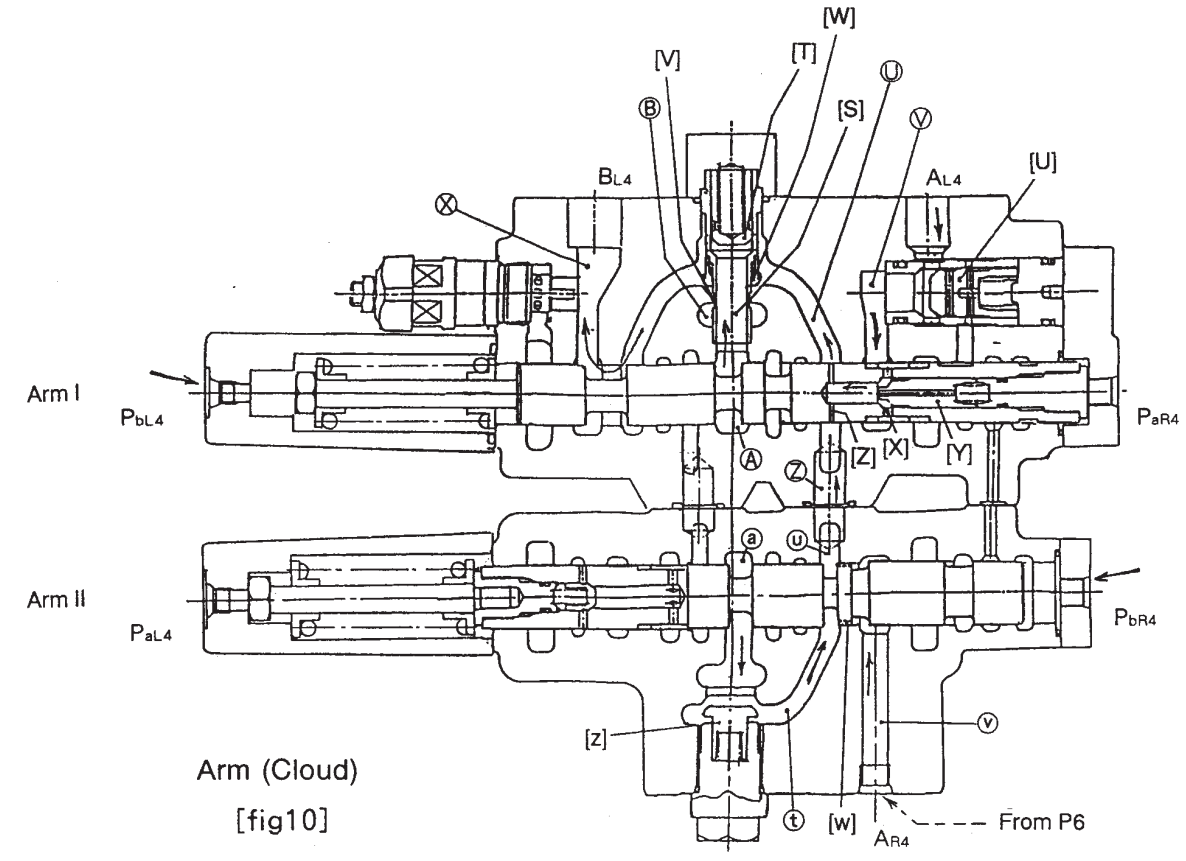
[fig8]

Operation *(continued)*



Arm (Dump)

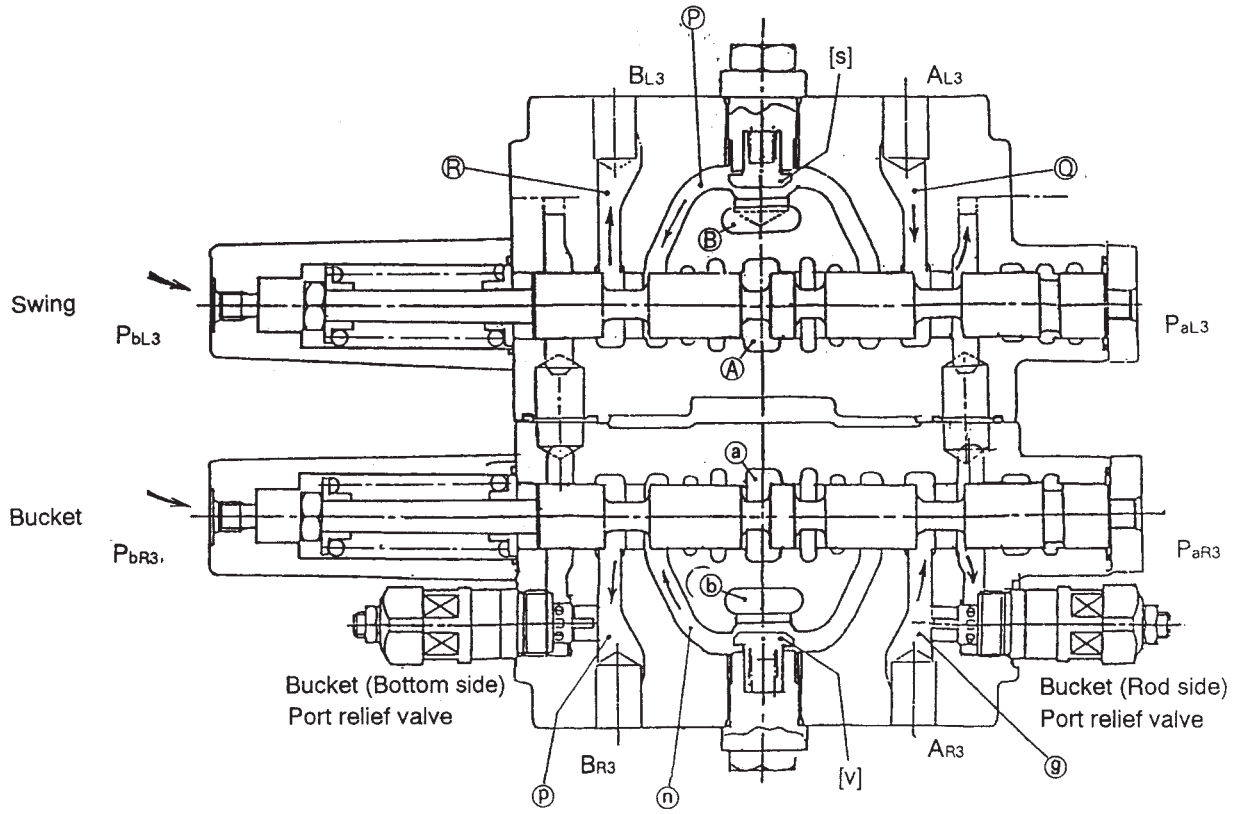
[fig9]



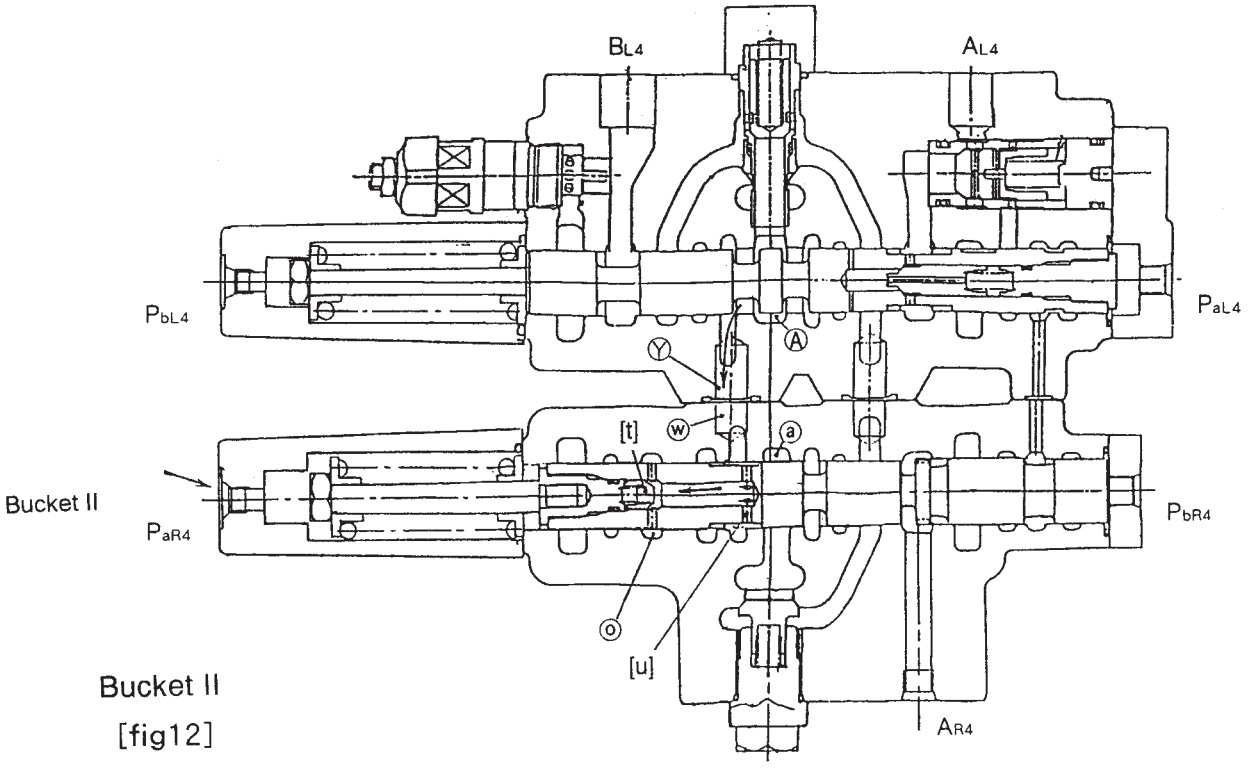
Arm (Cloud)

[fig10]

Operation *(continued)*

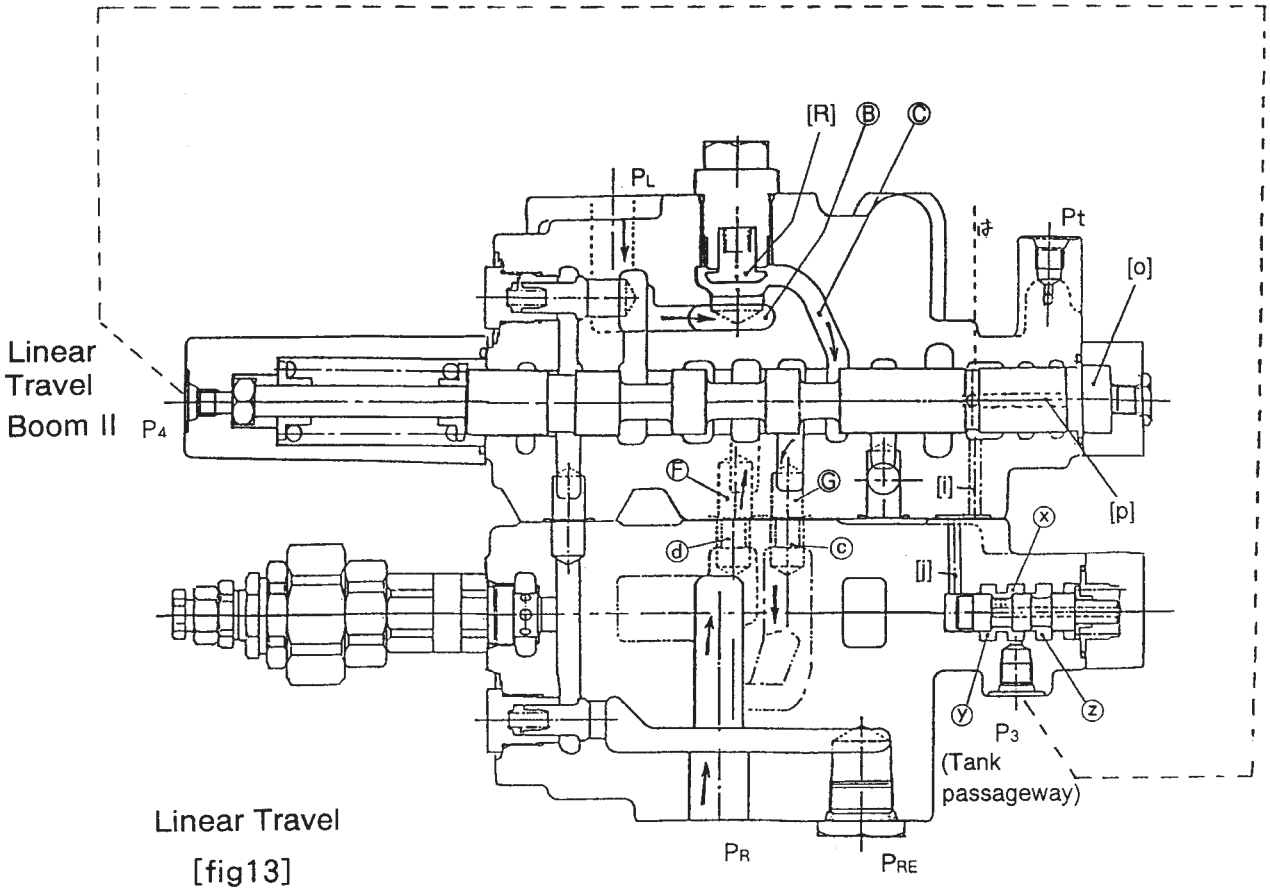


Swing
Bucket (Cloud)
[fig11]



Bucket II
[fig12]

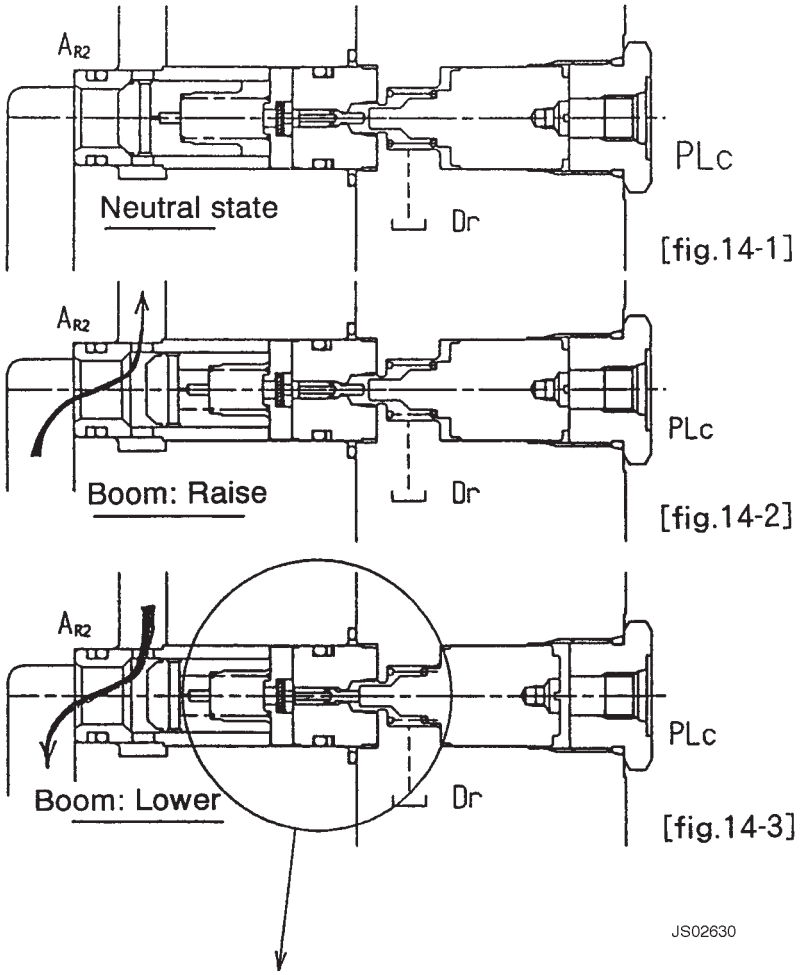
Operation *(continued)*

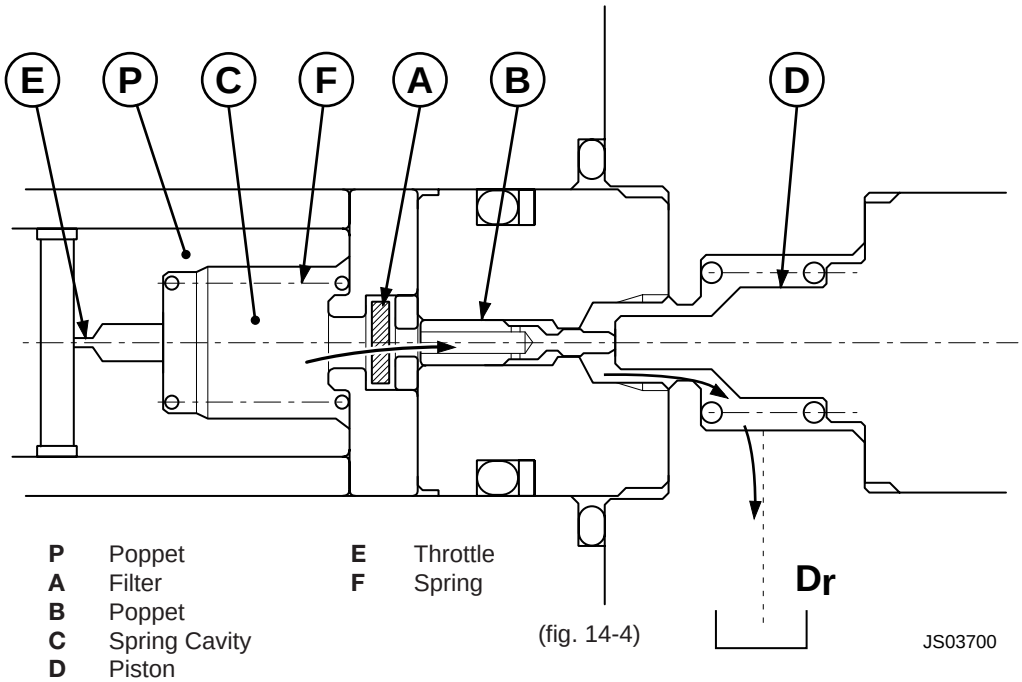


Linear Travel
[fig13]

Operation *(continued)*

*





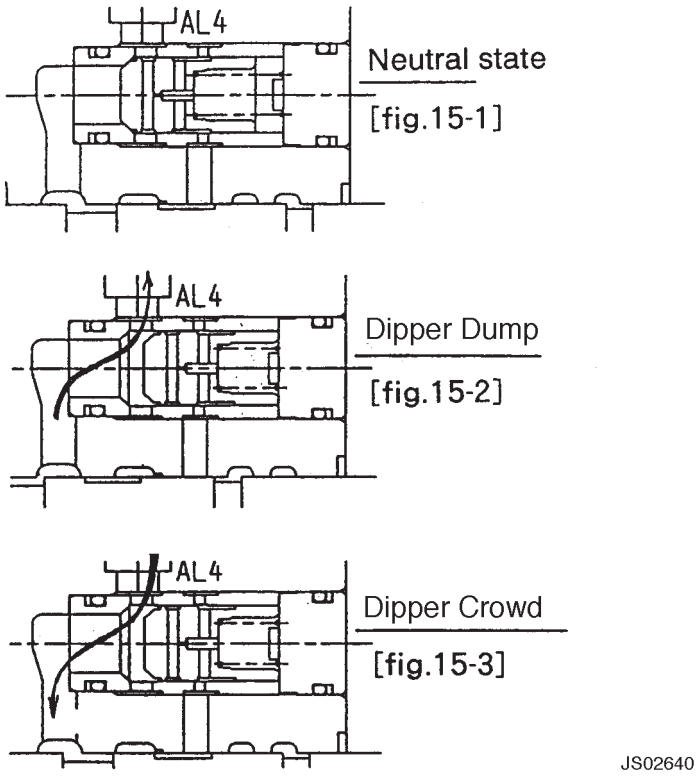
P Poppet
A Filter
B Poppet
C Spring Cavity
D Piston
E Throttle
F Spring

(fig. 14-4)

*** Load Holding Valve : Boom (fig. 14)**

Operation *(continued)*

*



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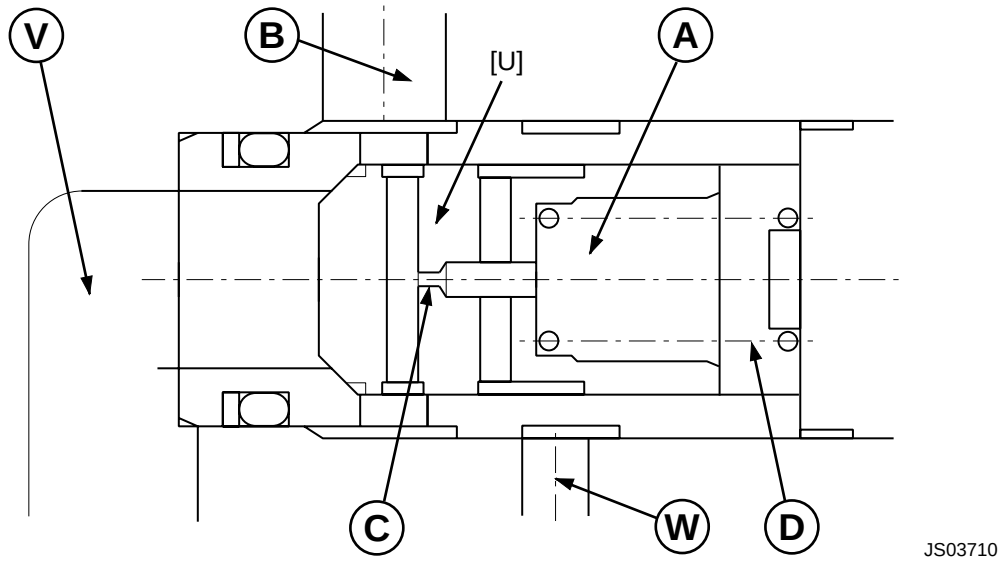

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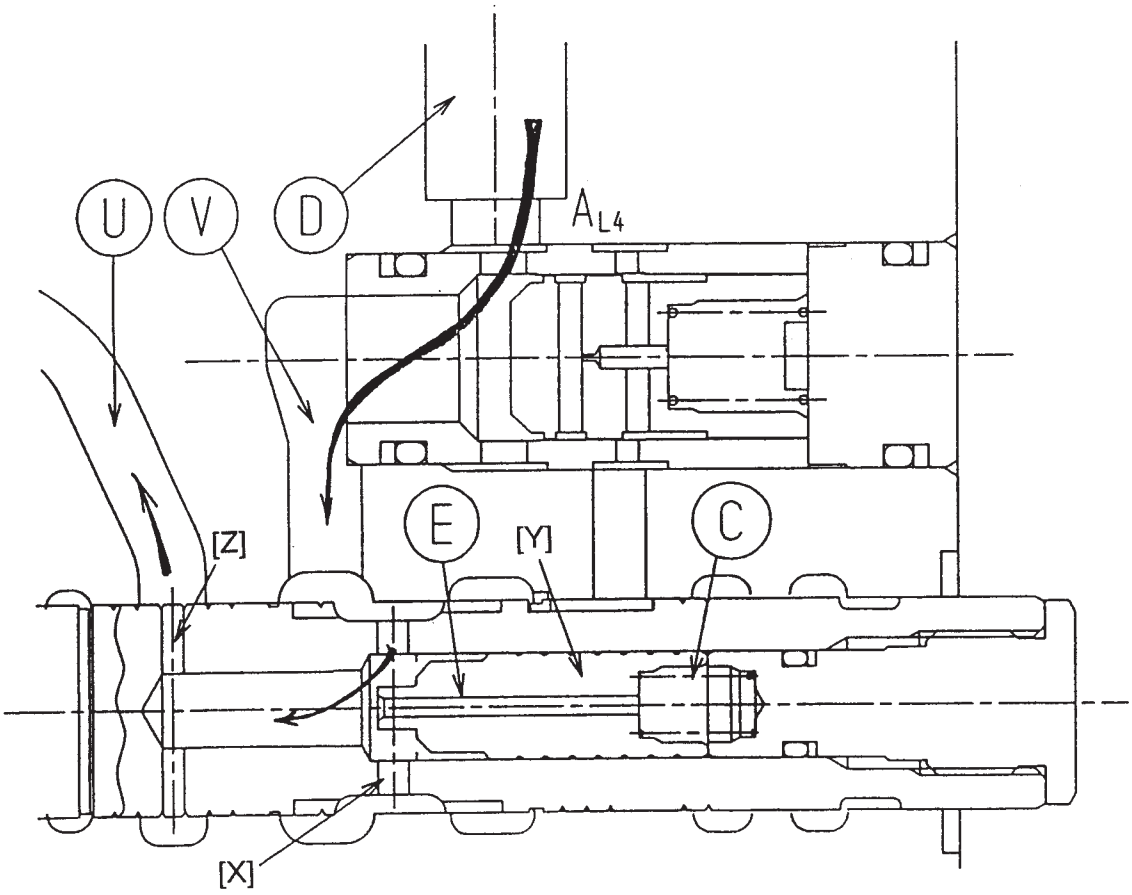
(U)	Poppet	**D**	Spring
A	Spring Cavity	**E**	Passage
B	Ram port passage	**F**	Passage
C	Throttle		

(fig. 15-4)

*** Load Holding Valve : Dipper (fig. 15)**

Operation *(continued)*



[Y] : Regenerative poppet
[X] : Spool inner passage
[Z] : Throttle
C : Spring
D : Cylinder Port
E : Popper inner passage
U : Passage
V : Passage

Regenerative Circuit [Arm: Cloud] [fig.16]

Control Valve Trouble Shooting

Control Valve in General

Symptoms	Possible Causes	Countermeasures
Spool sticking	1. Oil temperature is abnormally high.	Remove the obstruction.
	2. Hydraulic oil is dirty	Replace the hydraulic oil and clean the circuit at the same time.
	3. Port connector is tightened too much	Check the torque.
	4. Valve housing is deformed due to Installation	Loosen the installation bolt and check.
	5. Pressure is too high	Attach pressure gauge to pump port and ram port and check the pressure.
	6. Spool is bent	Replace the valve assembly.
	7. Return spring is damaged	Replace the damaged parts.
	8. Spring or cap is not on straight	Loosen the cap and after aligning, tighten.
	9. Temperature inside valve is not even.	Warm up the circuit.
Spool does not stroke	1. Valve is clogged inside with dirt	Remove the dirt (flushing).
Load cannot be maintained	1. Oil leakage from the ram	Check the ram.
	2. Oil is by-passing from the valve spool	Replace the valve assembly.
	3. Oil leakage from the port relief valve	Remove the port relief from the housing and clean the housing seat and relief valve seat.
	4. Oil leakage from the lock valve	Disassemble the lock valve and clean the poppet seat and sleeve, plug seat. If the seat is damaged, replace the poppet, or lap the poppet and seat.
When the spool is selected from neutral to raise position, the load falls.	1. Foreign matter in load check valve	Disassemble the check valve and clean.
	2. Check valve poppet or seat damaged	Replace the poppet or lap the poppet and seat part.

Control Valve Trouble Shooting *(continued)*

Relief Valve

Symptoms	Possible Causes	Countermeasures
Pressure does not rise at all	1. The main poppet, sleeve or pilot poppets are sticking open or foreign matter is in the valve seat.	Check whether foreign matter is in each poppet. Check whether each part is sliding smoothly. Clean all the parts.
Relief pressure is unstable	1. The pilot poppet seat is damaged.	Replace the damaged parts.
	2. The piston is sticking to the main poppet.	Remove the surface scratches. Clean all the parts.
Relief pressure is out of control	1. Wear due to foreign matter.	Replace the worn parts
	2. Lock nut and adjuster are loose.	Reset the pressure and tighten the lock nut to the rated torque.
Oil leakage	1. Damaged seat or worn O-ring.	Replace damaged or worn parts. Check whether each part is sliding smoothly.
	2. Parts are sticking due to foreign matter.	Check for scratches, cuts or foreign matter. Clean all the parts.

Hydraulic System

Symptoms	Possible Causes	Countermeasures
The hydraulic system is not working well or not at all	1. Pump problem.	Check the pressure or replace the pump.
	2. Foreign matter clogging inside the relief valve.	Disassemble the relief valve and clean.
	3. Relief valve trouble.	Check according to the maintenance procedures.
	4. Ram trouble.	Repair or replace.
	5. Load is too heavy.	Check the circuit pressure.
	6. Crack in the valve.	Replace the valve assembly.
	7. Spool does not stroke fully.	Check the spool movement and operation link.
	8. Oil level too low.	Replenish hydraulic oil.
	9. Filters inside circuit are clogged.	Clean filter or replace.
	10. Hose runs are kinked.	Check the hoses.

These procedures refer to the sectional drawings at the beginning of this section.

Dismantling

Notes:

1. All parts are manufactured with a high degree of precision and require the utmost care when handling. Do not let parts knock against each other and take extra precautions when handling parts to prevent them being dropped.

2. During dismantling, do not hit parts with excessive force if they are stuck and do not damage parts by twisting them or making burrs on bearing surfaces. Failure to follow these instructions will cause oil leaks leading to poor performance.

3. Label all parts during dismantling to ensure correct assembly.

4. Storing of the control valve in a dismantled or partly dismantled state could cause rusting of parts due to moisture or dirt. If the dismantling procedure must be interrupted, be sure to provide anti-rust treatment and keep the parts free from dirt and corrosion.

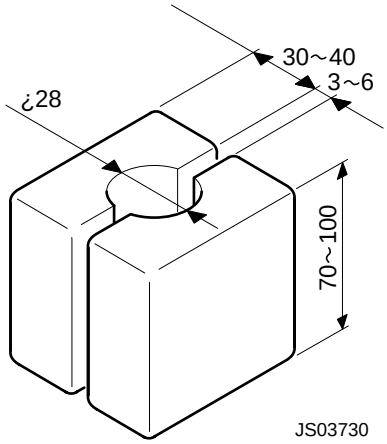
5. During assembly ensure that all parts are free from dirt and foreign matter and make sure that all parts are free from burrs and scratches. Remove minor burrs and scratches using and oil stone.

6. Use new 'O' rings and back-up rings.

7. During assembly, apply grease to 'O' rings.

8. Tighten all bolts to the quoted tightening torque.

9. Refer to the Control Valve Schematics when dismantling and assembly.



* Dismantling, 5-spool control valve section

1. Loosen and remove the socket head bolts 58, 59 of the caps 11, 14. Be careful that the 'O'-ring 7 15 does not fall off, and remove the bolts from the cap.

2. Pull out spools 2, 3, 4, 5, 6 from the valve housing 1 in the sub-assembly state.

3. Because each spool end has adhesive coating on the thread portion, heat the spool outer periphery at the threaded section to about 200~250 °C and loosen the spool end, plugs, etc. immediately after heating.

4. In order not to damage the spool periphery, insert the spool between hard wooden blocks shown above and fix in a vice during work.

5. Heat the spool 2 and remove the plug 16 (hexagonal A/F 24) and take out the spring 19 and poppet 20 from inside the spool.

6. Do not reuse the 'O'-ring 17 because heating was used during disassembly.

7. Heat spools 3, 4, 5, 6 and loosen the spool end 10 (Hexagonal A/F 22). Disassemble the spring seat 8 and springs 9, 68.

8. Attach tags to the springs 9, 68 and each spool to ensure correct assembly position and direction during reassembly.

9. Heat the spool 3 and remove the plug 19 (Hexagonal 24 A/F). Take out the spring 22 and poppet 23 from inside the spool and remove the 'O'-ring 21 and backup ring 20.

10. Do not reuse the 'O'-ring 21 and backup ring 20 because heating was used during disassembly.

11. Take out the spool 7 and spring seat 9 from the valve housing 1.

12. Take out the plug 35 (M10) from the valve housing and remove the 'O'-ring 37 and backup ring 36. Be careful not to lose the poppet 58.

13. Take out the spacer assembly 55, spring 38, poppet 39 and sleeve 40 from the valve housing and remove the 'O'-ring 41 and backup ring 42.

14. Remove the check valve assembly 32 (Hexagonal 36 A/F).

15. Take out the sleeve 33, spring 26 and poppet 25 from the valve housing 1.

16. Loosen the plug 43 (Hexagonal 27 A/F) and remove the 'O'-ring 44, spring 45 and poppet 46.

17. Loosen the plug 30 (Hexagonal 27 A/F) and remove the 'O'-ring 29, spring 22 and poppet 27.

Dismantling *(continued)*

18. Remove the main relief valve 13 (Hexagonal 32 A/F) from the valve housing.

19. Remove the port relief valve 31 (Hexagonal 31.5 A/F) from the valve housing.

20. Remove the negative control relief valve 24 (Hexagonal 36 A/F) from the valve housing.

21. If possible, do not disassemble the relief valve. Refer to Relief Valve dismantling and assembly.

22. The blind plugs 12 (Hexagonal 22 A/F) and 53 (Hexagonal 36 A/F) should not be disassembled unless there is a defect.

23. 52 (Hexagonal socket 5 A/F) is attached to the taper screw plug so do not disassemble unless necessary.

24. Remove plug 74 (M6) and remove the 'O'-ring 75 and backup ring 76.

25. Remove plug 56 (M6) and remove the 'O'-ring 54 and backup ring 55, then disassemble the spring 53, poppet 52, sleeve 51, backup ring 49 and 'O'-ring 50.

26. Loosen bolt 40 (Hexagonal 36 A/F) and separate the washer 39, plate 41 and 'O'-ring 38.

27. Loosen plug 65 (Hexagonal 36 A/F) and remove the 'O'-ring 66.

28. Loosen the socket head bolt 72 (Hexagonal 8 A/F) and remove the flanges 70, 71. Disassemble the sleeve 29, 46, poppet 32, 44, 47 and spring ring 31, 43, 48. Remove the 'O'-ring.

29. Loosen plug 21 (Hexagonal 27 A/F) and disassemble the 'O'-ring 22, spring 23 and poppet 24.

30. Loosen plug 26 (Hexagonal 27 A/F) and disassemble the 'O'-ring 25, spring 27 and poppet 28.

31. Remove the plug assembly 36 (Hexagonal 27 A/F).

32. Remove the relief valve 45 (Hexagonal 31.5 A/F) from the valve housing. Do not disassemble the relief valve unless necessary.

33. The blind plugs 13 (Hexagonal 31.5 A/F), 34 (Hexagonal socket 6 A/F), 37 (Hexagonal 31.5 A/F), 67 (Hexagonal 19 A/F), 78 (Hexagonal socket 10 A/F) should not be disassembled unless there is some defect.

34. 35 (Hexagonal socket 5 A/F) is attached to the taper screw plug and should not be disassembled unless there is some defect.

35. If possible, the 5-spool side valve housing and 4-spool side valve housing should not be separated.

36. Loosen the socket head bolt (Hexagonal 14 A/F) and remove the 'O'-rings 18, 61, 62, 63, 64.

* Dismantling, 4-spool control valve section

1. Loosen plug 49 and take out piston 51, 56 and spring). Remove 'O'-ring 50.

2. Loosen and remove the socket head bolt 47, 48 (Hexagonal socket 8 A/F) of the cap 2, 14. At this time be careful not to drop the 'O'-rings 10, 18 and spring 8 when removing from the cap.

3. Pull out the spool 3, 4, 5, 6 as a sub-assembly from the valve housing 1.

4. Heat the spool 3, 4, 5, 6 and loosen the spool end 15 (Hexagonal 22 A/F). Disassemble the spring seat 16 and spring 17.

5. Attach tags to the spring and each spool to insure the correct direction and position when reassembling.

* Assembly

Note:

1. During assembly, be careful when handling the 'O'-rings as follows.

a. Check for defects due to improper handling or from manufacturing.

b. Apply grease to the 'O'-ring and to the area where it is fitted.

c. Do not pull the 'O'-ring so hard that its shape is permanently changed.

d. Do not install the 'O'-ring in a twisted state. (It is difficult to return a twisted 'O'-ring to its original state and this can be the cause of oil leakage).

2. Be careful when handling the spools and check the following.

a. Excessive torque causes defective operation of the spool so observe the set torque.

b. Be sure that each spring and spool are reassembled in the original state.

3. Applying adhesives. (Male and female screw parts requiring adhesive).

a. Cleansing (Degreasing)
Steam degrease with acetate or use alkaline cleansing agent. Do not use gasoline or kerosene as cleansers.

b. Drying
Blow with clean air or dry naturally and dry the adhesive surface. If not dried sufficiently, the adhesion effect diminishes.

c. Primer application
Spray (Loctite Primer T), hardening agent, lightly on the adhesion surface and wait 3~5 minutes for it to dry.

b. Applying adhesive
Apply a small amount to the spool end and 2~3 threads of the plug male screw. Be careful that this surface does not come into contact with the spring seat when installing.

* Assembly, 5-spool control valve section

1. Assemble the poppet 20 and spring 19 into the spool 2. After completely degreasing the screw part of the plug (Hexagonal 24 A/F) 16 which has the 'O'-ring 17 and backup ring 18 attached (degrease the spool side too), apply adhesive (Loctite 271 or equivalent) and screw in the spool, with a torque of 9.8-12Nm (7.23-8.67lb/ft).

2. Assemble the spring seat 8 and spring 9, 68 in the spool end 10 (Hexagonal 22 A/F), apply adhesive to the thread and screw into the spool 3, 4, 5, 6 with a torque of 9.8-12Nm(7.23-8.67 lb/ft).

3. Install the spool assembly into the valve housing 1 in the same position and direction as when disassembling.

4. Assemble the sleeve 51 fitted with the 'O'-ring 50 and backup ring 49 into the valve housing, assemble the poppet 52 and spring 53 and push in the plug 56 complete with the 'O'-ring 54 and backup ring 55 (Check direction of plug 56).

5. Fit the cap 11, 14 with 'O'-rings 7, 15 fitted and tighten socket head bolts (Hexagonal socket 8 A/F) to the valve housing, with a torque of 39-44 Nm(28.93-32.53 lb/ft).

6. Install the port relief valve 45 (Hexagonal 31.5 A/F) to the valve housing, with a torque of 78-88 Nm (57.84-65.07 lb/ft).

7. Install the plug assembly 36 (Hexagonal 27 A/F), with a torque of 59-69 Nm (43.38-50.61 lb/ft).

8. Assemble the poppet 24, spring 23 into the valve assembly and install the 'O'-ring 22 to the plug 21 (Hexagonal 27 A/F) and screw it in, with a torque of 83-93 Nm (61.45-68.68 lb/ft).

9. Assemble the poppet 28 and spring 27 into the valve assembly and install the 'O'-ring 25 to the plug 26 (Hexagonal 27 A/F) and screw it in, with a torque of 267-275 Nm (195.21-202.44 lb/ft).

10. Assemble the poppet 28 and spring 31 to the sleeve 46 and assemble to the valve assembly. Install the poppet 47 and spring 48. Assemble the sleeve 29, poppet 44 and spring 43 with the flange 70 71 and tighten with socket head bolt 72 (Hexagonal socket 8 A/F), with a torque of 57-65 Nm (41.93-47.71 lb/ft).

11. Install the 'O'-ring 66 to the plug 65 (Hexagonal 36 A/F) and screw it in, with a torque of 118-127 Nm (86.76-93.99 lb/ft).

12. Assemble the spring and piston 51 56 to the cap 2 and tighten the plug 49 (Hexagonal 38 A/F) with 'O'-ring 50 fitted, with a torque of 93-108 Nm (68.68-79.53 lb/ft).

* Assembly, 5-spool control valve section *(continued)*

* **13.** Install the main relief valve 13 (Hexagonal 31.5 A/F) to the valve housing, with a torque of 78-88 Nm (57.84-65.07 lb/ft).

* **14.** Install the port relief valve 31 (Hexagonal 31.5 A/F) to the valve housing, with a torque of 78-88 Nm (57.84-65.07 lb/ft).

15. Install the negative control relief valve 24 (Hexagonal 36 A/F) to the valve housing, with a torque of 88-98 Nm (65.07-72.3 lb/ft).

16. Screw in the plug 53 (Hexagonal 36 A/F) with the 'O'-ring 54 fitted, with a torque of 83-93 Nm (61.45-68.68 lb/ft).

17. Assemble the poppet 25, spring 26 to the sleeve 3 and assemble in the valve housing.

18. Install the check valve assembly 32 (Hexagonal 36 A/F), with a torque of 265-275 Nm (195.21-202.44 lb/ft).

19. Assemble the poppet 27 and spring 22 into the valve housing and install the 'O'-ring 29 to the plug 30 (Hexagonal 27 A/F). Screw in, with a torque of 83-93 Nm (61.45-68.68 lb/ft).

20. Assemble the poppet 46 and spring 45 to the valve housing. Install the 'O'-ring 44 to the plug 43 (Hexagonal 27 A/F) and screw in.
If the plug 12 (Hexagonal 22 A/F) is disassembled, install the 'O'-ring 11 and tighten, with a torque of 49-59 Nm (36.15-43.38 lb/ft).

21. If the plug 53 (Hexagonal 36 A/F) is disassembled, install the 'O'-ring 54 and tighten, with a torque of 83-93 Nm (61.45-68.68 lb/ft).

22. If the plug 52 (Hexagonal socket 5 A/F) is disassembled, wrap seal tape around the plug periphery (leave one thread open from the end and wrap to the right 1.5~2 times so that the tape bites into the threads). Tighten, with a torque of 6.85-8.82 Nm (5.06-6.5 lb/ft).

23. Check for any disassembled parts not reassembled and then tighten.
The above tightening torque values are for the threads lubricated with hydraulic oil.

24. Install 'O'-ring 38 in the valve housing and fit plate 41. Secure with bolt 40 (Hexagonal 14 A/F) and washer 38 tightened to a torque of 39-44 Nm (28.92-32.53 lb/ft).

25. If the plugs are disassembled, assemble as follows.

Plug (Hexagonal A/F) No.	'O'-ring No.	Tightening Torque Nm
12 (22)	13	49~59 Nm (36.15-43.38 lb/ft)
34 (Hexagonal socket 6 A/F)	33	34~39 Nm (25.3-28.92 lb/ft)
67 (19)	33	34~39 Nm (25.3-28.92 lb/ft)
78 (Hexagonal socket 10 A/F)	77	88~98 Nm (65.07-72. lb/ft)
37 (31.5) Assembly replacement		78~88 Nm (57.84-65 lb/ft)

26. When assembling the plug 35 (Hexagonal socket 5 A/F), wrap seal tape around the plug periphery (leave open one thread from the end and wrap 1.5~2 times to the right so that the seal tape bites into the thread), torque the plug with a force of 6.85-8.82 Nm (5.06-6.5 lb/ft).

27. Recheck for parts not reassembled and tightened.

28. When assembling the 4-spool side and 5-spool side valves, attach the 'O'-rings 18, 62, 61, 63 to the bottom of the 5-spool side valve (21153-50103, 21153-50104) and secure with socket head bolts 3, tightening to a torque of 170-180 Nm (122.91-130.14 lb/ft).

* Assembly, 4-spool control valve section

1. Assemble the poppet 23 and spring 22 into the spool 3. After completely degreasing the thread part (and the spool side) of the plug 19 (Hexagonal 22 A/F), fit the 'O'-ring 21 and backup ring 20 attached, apply adhesive and screw into the spool, with a torque of 9.8-12 Nm (7.23-8.67 lb/ft).

2. Assemble the spring seat 16 and spring 17 to the spool end 3 (Hexagonal 22 A/F). Apply adhesive to the thread and screw into the spool 4, 5, 6, to a torque of 9.8-12 Nm (7.23-8.67 lb/ft).

3. Assemble the spool assembly into the valve housing 1 at the same position and direction as before.

4. Assemble the sleeve 40 with the 'O'-ring 41 and backup ring 42 attached and assemble the poppet 39, spring 38, and spacer assembly 55 and attach the 'O'-ring 37 and backup ring 36 to the plug 35 and assemble into the valve housing.

5. Assemble the spool 7 into the valve housing and install the spring seat 9 and spring 8.

6. Tighten the caps 2, 14 with 'O'-rings 10, 18 attached, with socket head bolts 47, 48 (Hexagonal socket 8 A/F) to the valve housing.

7. Assemble the spring and piston 51, 56 to the cap 2 and tighten the plug 49 (Hexagonal 38 A/F), with 'O'-ring 50 attached, to a torque of 93-108 Nm (68.68-70.53 lb/ft).

8. Install the main relief valve 13 (Hexagonal 31.5 A/F) to the valve housing, with a torque of 78-88 Nm (57.84-65.07 lb/ft).

9. Install the port relief valve 31 (Hexagonal 31.5 A/F) to the valve housing, with a torque of 78-88 Nm (57.84-65.07 lb/ft).

10. Install the negative control relief valve 24 (Hexagonal 36 A/F) to the valve housing, tightening to a torque of 88-98 Nm (65.07-72.3 lb/ft).

11. Screw in the plug 53 (Hexagonal 36 A/F) with the 'O'-ring 54 assembled, with a torque of 83-93 Nm (61.45-68.68.lb/ft).

12. Assemble the poppet 25, spring 26 to the sleeve 3 and assemble in the valve housing.

13. Install the check valve assembly 32 (Hexagonal 36 A/F), with a torque of 265-275 Nm (195.21-202.44 lb/ft).

14. Assemble the poppet 27 and spring 22 into the valve housing and install the 'O'-ring 29 to the plug 30 (Hexagonal 27 A/F) and fasten with torque of 83-93 Nm (61.45-68.68 lb/ft).

15. Assemble the poppet 46, spring 45 to the valve housing and install the 'O'-ring 44 to the plug 43 (Hexagonal 27 A/F) and screw in.
* If the plug 12 (Hexagonal 22 A/F) is disassembled, install the 'O'-ring 11 and tighten, to a torque of 49-59 Nm (36.15-43.38 lb/ft).

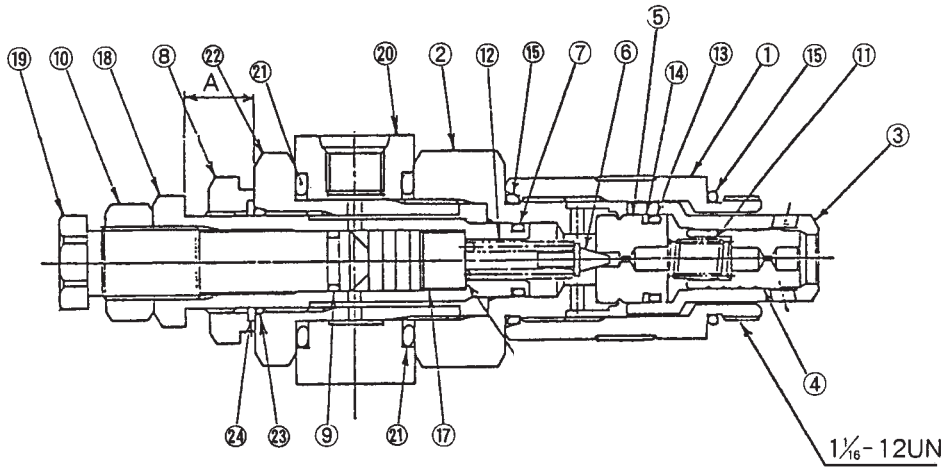
16. If the plug 53 (Hexagonal 36 A/F) is disassembled, install the 'O'-ring 54 and tighten, to a torque of 83-93 Nm (61.45-68.68 lb/ft).

17. If the plug 52 (Hexagonal socket 5 A/F) is disassembled, wrap seal tape around the plug periphery (leave one thread open from the end and wrap to the right 1.5~2 times so that the tape bites into the threads) and tighten, to a torque of 6.85-8.82 (5.06-6.5 lb/ft).

18. Check for any disassembled parts not reassembled and tightened.
The above tightening torque values are for threads lubricated with hydraulic oil).

Dismantling

Loosen the cap 1 (Hexagonal 31.5 A/F) and remove from plug 2. Remove the sleeve 3 and take out the main poppet 4 and spring 11.
Loosen hexagonal nut 10 (Hexagonal 22 A/F) and remove plug 19 (Hexagonal 19 A/F), piston 17, pilot poppet 6 and spring 12.
Loosen the nut 8 (Hexagonal 32 A/F) and remove the plug 18 (Hexagonal 26 A/F). Loosen the plug (Hexagonal 41 A/F) and remove the spacer 20.
The pilot seat 5 is firmly installed at the plug 2 end so do not disassemble it.



Cleaning, Inspection

Clean all the parts with clean oil and dry with compressed air. Inspect each part.

1. Check that the seat face of each poppet and sleeve end has no defects and even surface.

2. Check that the main poppet 3, sleeve 2, piston 19 and plug 17 slide smoothly.

3. Check that the springs have no defects, deformation or wear.

4. Check that there is no foreign matter clogging the main poppet, pilot seat orifice.

5. Check that the 'O'-ring and backup ring are not worn or deformed.

If a slight defect is found during the above inspection, remove by lapping.

If an abnormal part is found, replace the relief valve assembly.

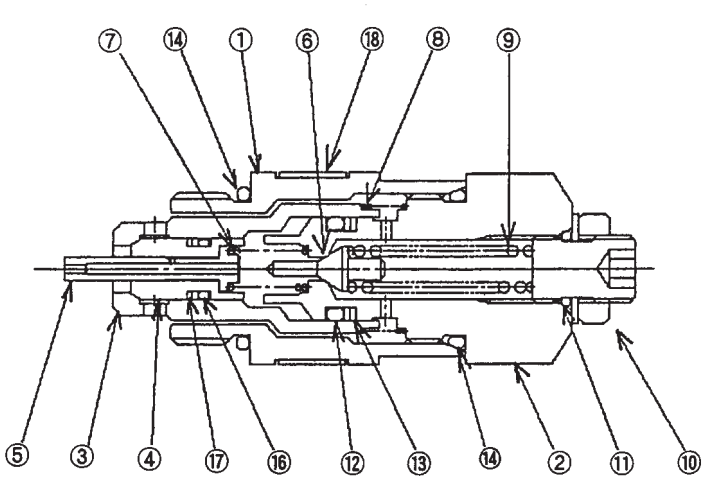
Assembly

Insert the main poppet 4 and spring 11 inside the sleeve 3 and secure with the pilot seat 5 which has 'O'-ring 13 and backup ring 14 assembled to it. (Be careful of the assembly position of 13, 14).
Assemble the spacer 20 with the attached 'O'-ring 21 and the plug 2. (Tightening torque 78~88 N•m (57.84-65.07 lb/ft) [Lubricated state]).
Assemble the nut 8, 'O'-ring 7 and 'O'-ring 23 and backup ring 24 to the plug 18. Screw in plug 18 to plug 22 and insert pilot poppet 6, spring 12, piston 17. Fit 'O'-ring 9 and hexagonal nut 10 to plug 19 and temporarily assemble it.
Attach 'O'-ring 15 to plug 2 and tighten cap 1 with ring 15 installed to the valve housing (tightening torque 78~88 Nm (57.84-65.07 lb/ft). Adjust pressure, see "Main Relief Valve Pressure".

Do not reuse 'O'-rings or backup rings. Replace with new ones.

Dismantling

Remove the plug 2 and disassemble the sleeve 3, main poppet 4, piston 5 and springs 7, 8.
Loosen the adjuster nut 10 and take out the pilot poppet 6 and spring 9.



Cleaning, Inspection

Clean all the parts with clean oil and dry with compressed air. Inspect each part.

1. Check that there are no defects on the seat surface of each poppet and sleeve end and that the contact surface is even.

2. Check that the main poppet 4 and sleeve 3 slide smoothly. Also check there are no scratches on the main poppet outer periphery and sleeve inner surface.

3. Check that the springs are not broken, deformed or worn.

4. Check that there is no foreign matter clogging the piston 5 hole. The end seat contact surface should be even.

5. Check that the 'O'-ring and backup rings are not worn or deformed.

If a small defect is found in the above inspection, remove it by lapping.
If an abnormal part is found, replace the relief valve assembly.

Assembly

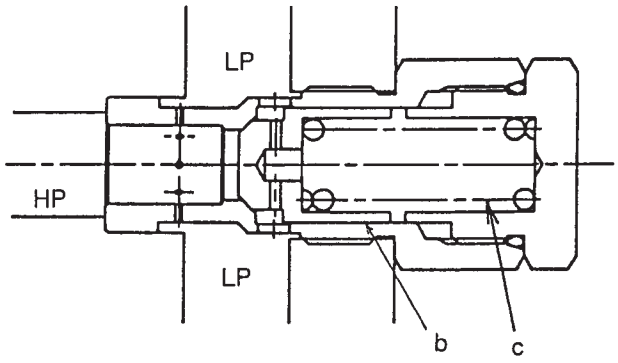
Install the 'O'-ring 16 and backup ring 17 (2 pcs) to the main poppet 4, assemble the piston 5 and insert into the sleeve 3.
After attaching 'O'-ring 12, backup ring 13 (2 pcs) and 'O'-ring 14 to the plug 2, assemble the sleeve 7, 8 mentioned above.
Tighten cap 1. (Torque 78~88 Nm) (57.84-65.07 lb/ft).
Insert the pilot poppet 6 and spring 9 into the plug 2 and temporarily assemble the adjuster nut 10 and 'O'-ring 11.
Attach 'O'-ring 14 to the cap 1 and assemble into the valve housing. Adjust pressure according to its application, see "Pressure Testing".

Do not reuse 'O'-rings and backup rings. Replace with new parts.

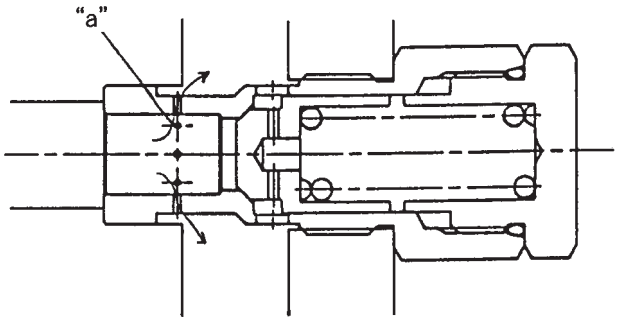
Operation

The negative control relief valve is situated between the neutral passage HP and low pressure passage LP and operates in the following manner.

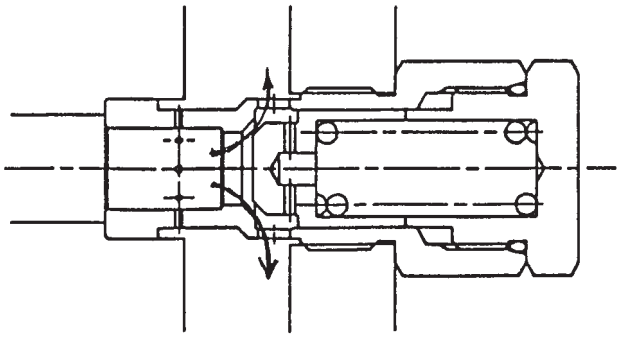
1. No passage of oil (Engine is stopped, spool at full stroke).



2. Spool is neutral (Negative control signal)
The oil from neutral passage HP flows through signal orifice "a" to the low pressure passage LP.
Pressure develops from signal orifice "a".

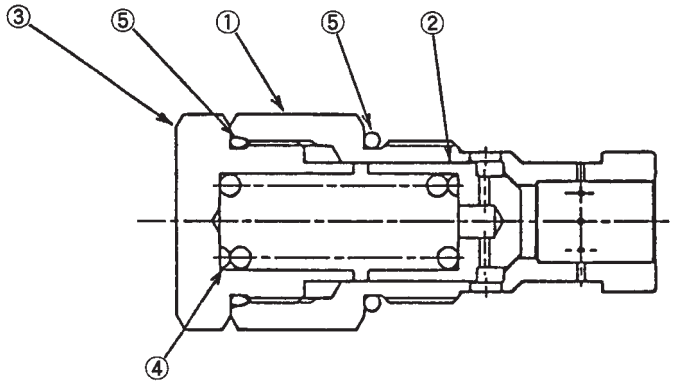


3. Low pressure relief operation
When an excessive amount of oil flows through neutral passage HP, it flows through the signal orifice and to the low pressure passage. At the same time poppet b, which is set by spring c, opens and HP flows to LP preventing the build up of abnormal pressure.



Dismantling

Remove plug 3 (Hexagonal 36 A/F) and remove spring 4 and poppet 2 from the plug 1 (Hexagonal 36 A/F). Keep the disassembled negative control relief parts in such a way that they can be assembled so as to achieve the same set relief pressure after reassembly.



Cleaning, Inspection

Clean all the parts with clean oil and dry with compressed air. Inspect each part.

1. Check that the poppet seat surface has no defects and that the contact surface is even.
2. Check that the poppet slides smoothly.
3. Check that the springs are not broken, deformed or worn.
4. Check that the 'O'-rings are not worn or deformed.

If a slight defect is found during the above inspection, remove it by lapping.

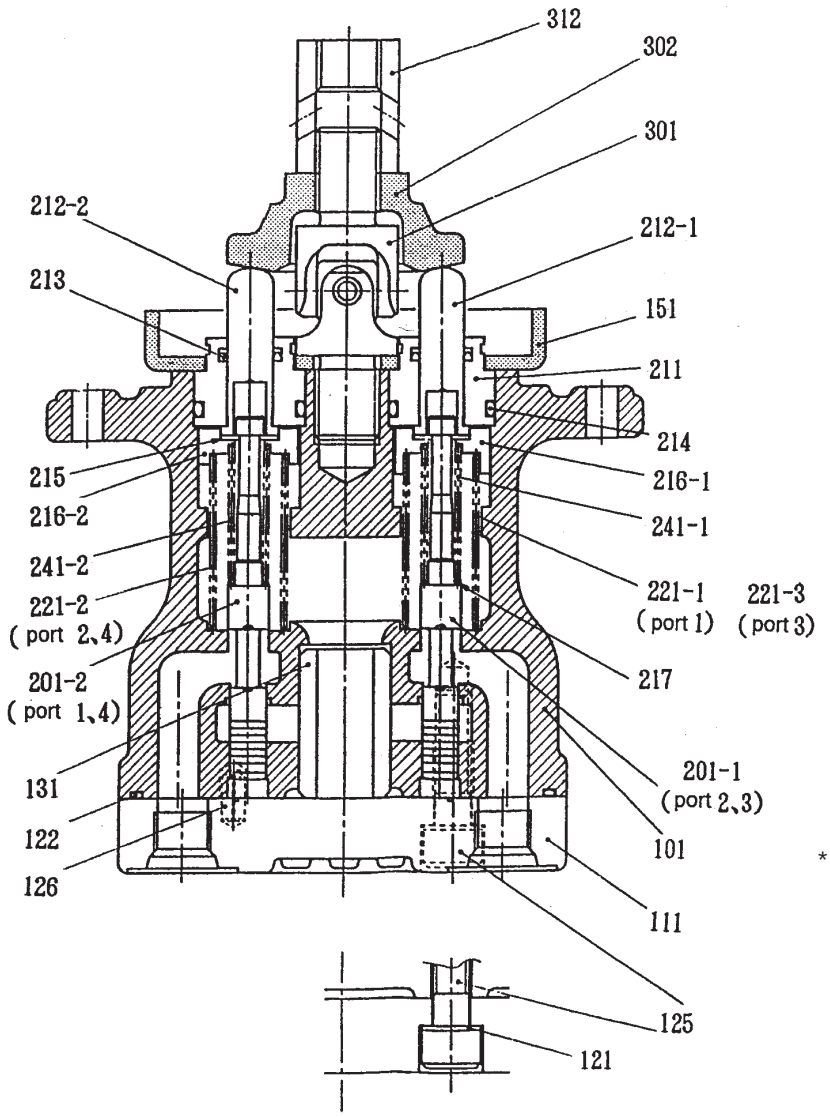
If an abnormal part is found, replace the relief valve assembly.

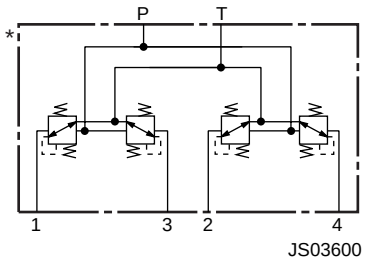
Assembly

Assemble the poppet 2 and spring 4 into the plug 1. Install the 'O'-ring 5 to the plug 3 and tighten at the plug 1. Torque 88~98 Nm (65.07-72.3 lb/ft).
Install the 'O'-ring 5 to the plug 1 and assemble to the valve housing.(Torque 88~98 Nm (65.07-72.3 lb/ft)

Do not reuse the 'O'-rings and backup rings but replace with new ones.

Schematics, Technical Data

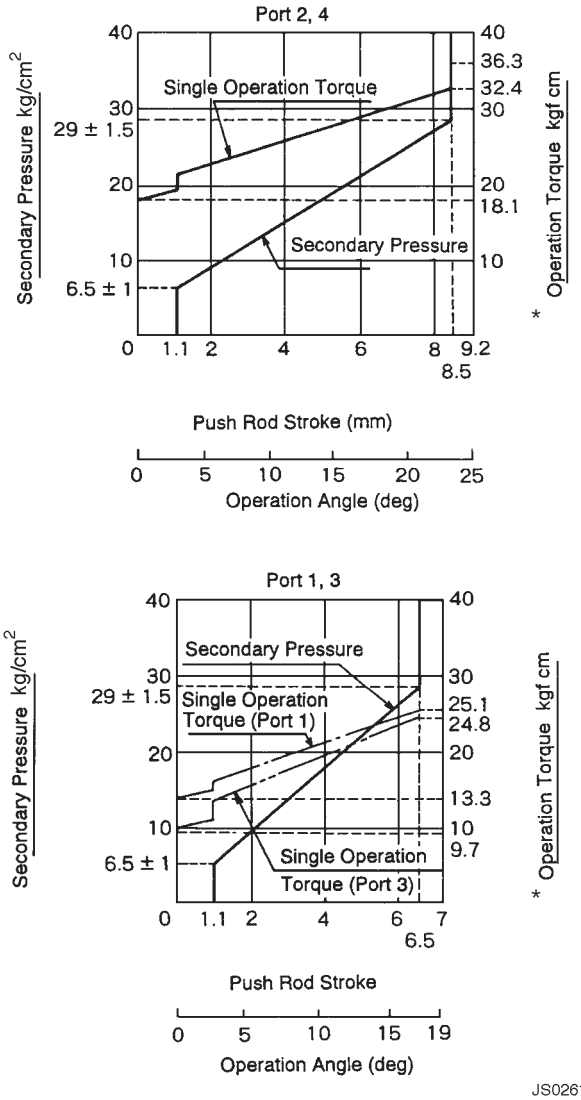




Symbol	Part Name	Qty	Symbol	Part Name	Qty	Symbol	Part Name	Qty
101	Case	1	211	Plug	4	221-2	Spring	2
111	Port plate	1	212-1	Push rod	2	221-3	Spring	1
121	Seal washer	2	212-2	Push rod	2	241-1	Spring	1
122	O-ring	1	213	Seal	4	241-2	Spring	1
125	Hexagonal socket bolt	2	214	O-ring	4	301	* Joint	1
126	Spring pin	1	215	Washer 1	8	302	* Disc	1
131	Bushing	1	216-1	Spring seat	2	312	* Adjusting Nut	1
151	Plate	1	216-2	Spring seat	2			
201-1	Spool	2	217	Washer 2	4		Seal kit 1 set	
201-2	Spool	2	221-1	Spring1			(121,122, 213, 214)	

Schematics, Technical Data

* Working pressure	40 kgf/cm² (38.6 bar, 568.9 lb/in²)	
* Primary pressure	Max. 100 kgf/cm² (96.7 bar, 1422 lb/in²)	
* Secondary pressure (differs for each machine type)	0~45 (maximum control pressure) kgf/cm² (0-43 bar, 639.2 lb/in²)	
* Allowable back pressure	Max. 3 kgf/cm² (2.89 bar, 42.6 lb/in²)	
Flow rate	20 l/m (4.39 imp gal)	
Control operation angles	Single handle	Alone ±19°
	Simultaneous	±25°
	Double handle	±26.5°
Weight	Single handle	Approx. 4.6 kg (2.08lb)
	Double handle	6 kg (2.72lb)



Operation

The structure of the pilot valve is shown in the assembly drawings (see previous page). The pressure reduction valve unit is built into the vertical bore in the casing.
The pressure reduction unit consists of the spools (201), secondary pressure setting springs (241), return springs (221), washers 1 (215), spring seats (216) and washers 2 (217). The secondary pressure setting springs are set to give a secondary pressure of 5~24 kgf/cm 2 (depending on the model). The spools are pressed against the push rods (212) by the return springs. When the handle is tilted, the push rods are forced down, pushing down the spring seats, to adjust the setting of the secondary pressure setting springs. An oil inlet (primary) port P and oil outlet (tank) port T are provided in the casing. In addition, secondary outlet ports 1,2,3 and 4 are situated on the lower surface of the casing.

Basic Functions

The pilot valve controls the stroke and direction, etc. of the control valve spool. This is achieved by providing a spring at one end of the control valve spool and applying the output pressure of the pilot valve to the other end. (There is also the method where the pilot valve output pressure is used on both ends of the control valve).
In order to provide this function, the pilot valve consists of the following:

1. Inlet port (P) which is supplied with oil from the pump.

2. A number of outlet ports (1,2,3,4) to supply the pressure from the inlet port to control valve spools.

3. Tank port (T), required to control the pressure output from 2.

4. Spools to connect the outlet ports to the inlet port and tank port.

5. Mechanism, including springs, to control the spools in 4 above.

Functions of the Major Parts

Oil supplied by the hydraulic pump is received by P port and the function of the spool (201) is to switch the pressurised oil from the inlet port P to the output port (1, 2, 3, 4) or alternatively, from the output port to the tank port (T). The springs (241) act on the spools and determine each outlet pressure. The push rods (212) are able to slide in the plugs (211) to adjust the compression of the springs. The handle acts through the disk (302) and adjusting nut (312) to move the push rods. The handle is able to rotate a full circle around the joint (301).
The springs (221) operate against the casing (101) and the spring seats (216) act, regardless of the outlet pressure, to return the push rods to their natural position, thus ensuring that the spools return to their neutral position. This spring also provides a resistive force which gives the controls a suitable "feel" to the operator.

Dismantling

Notes:

1. All parts are manufactured with a high degree of precision and require the utmost care when handling. Do not let parts knock against each other and take extra precautions when handling parts to prevent them being dropped.
2. During dismantling, do not hit parts with excessive force if they are stuck and do not damage parts by twisting them or making burrs on bearing surfaces. Failure to follow these instructions will cause oil leaks leading to poor performance.
3. Label all parts during dismantling to ensure correct assembly.
4. Storing of the control valve in a dismantled or partly dismantled state could cause rusting of parts due to moisture or dirt. If the dismantling procedure must be interrupted, be sure to provide anti-rust treatment and keep the parts free from dirt and corrosion.
5. During assembly ensure that all parts are free from dirt and foreign matter and make sure that all parts are free from burrs and scratches. Remove minor burrs and scratches using an oil stone.
6. Use new 'O'-rings and backup rings.
7. During assembly, apply grease to 'O'-rings.
8. Tighten all bolts to the quoted tightening torque.

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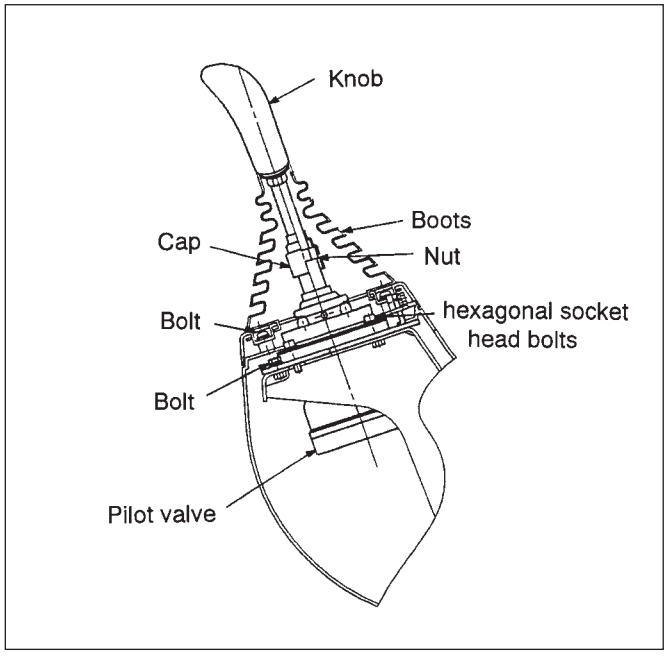
1. Remove knob from pilot valve.
Note: *Take care when removing the pilot valve because of the wiring loom.*

2. Remove the boots (cover) from the pilot valve.

3. Remove the piping. *(Attach tags to the connecting ends of the piping to facilitate reassembly)*.

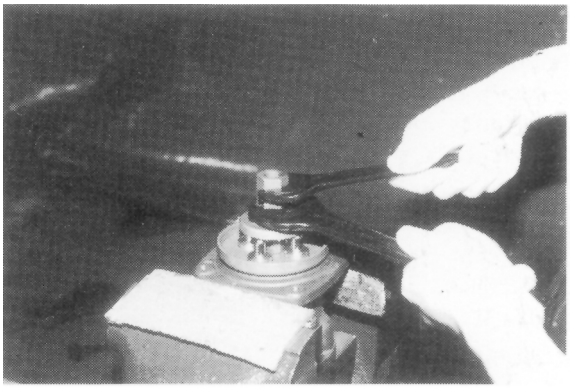


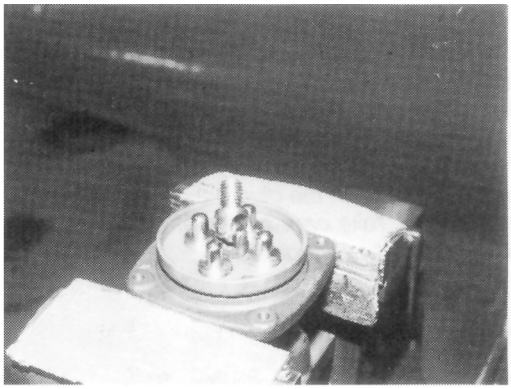
Dismantling *(continued)*

4. Wash the pilot valve (by itself) with kerosene.
Note: *Blank off the parts with plugs.*

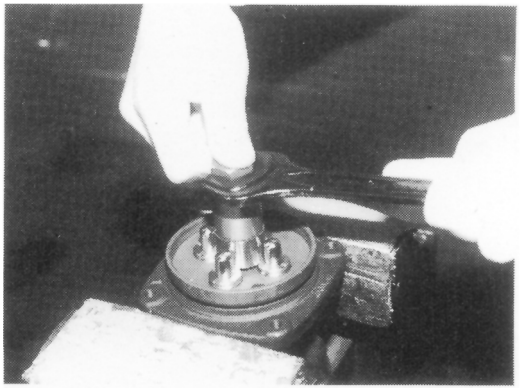
5. Using a copper or lead plate for protection, secure the pivot valve in the vice.

6. Put spanners on the adjusting nut (312) and the flats of the disk (302) and remove them





7. Turn the joint to the left using a jig and loosen it. The jig is shown in position in the photograph.
(If the return springs (221) are strong, the plate (151), plug (211), push rod (212) will rise up when the joint is loosened.

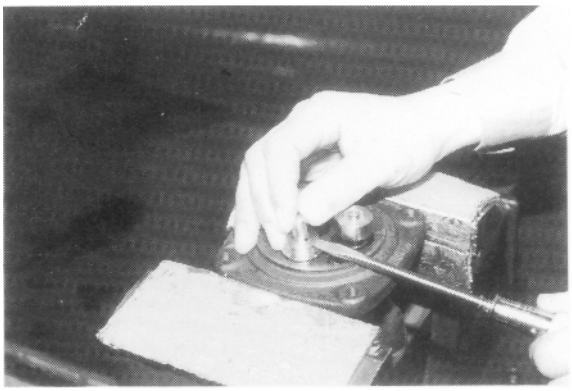


Dismantling *(continued)*

8. Remove the Plate (151)

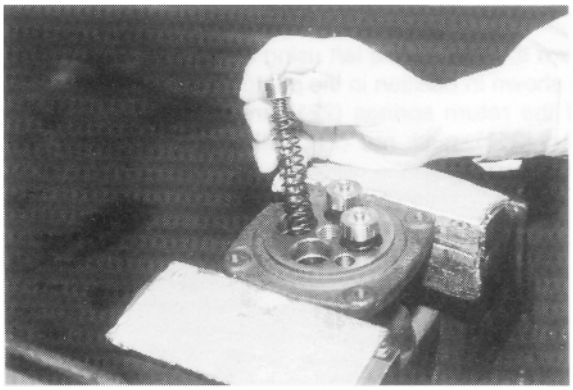
9. If the return springs (221) are weak, the sliding resistance of the 'O'-ring causes the plugs (211) to stick in the casing. In this case, remove the plugs with a straight-headed screwdriver.

Note: *Use the groove in the plug periphery, taking care not to damage the plug. Take care as the plugs may fly out due to the force in the return springs (221).*

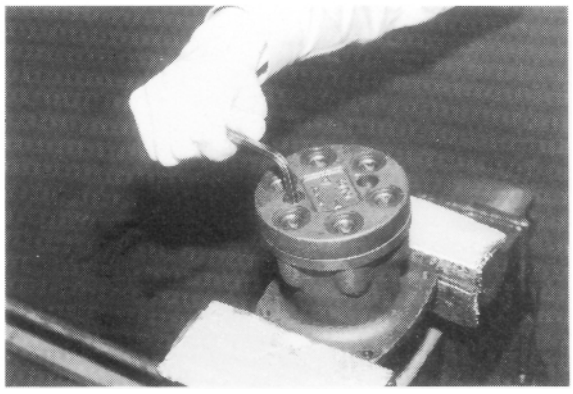


10. Remove the pressure reduction assembly return springs (221) from the casing.

Note: *Make a note of the relationship of positions of the pressure reduction assembly and the hole in the casing to facilitate reassembly. (When reassembling, install in the same position as that before disassembly).*

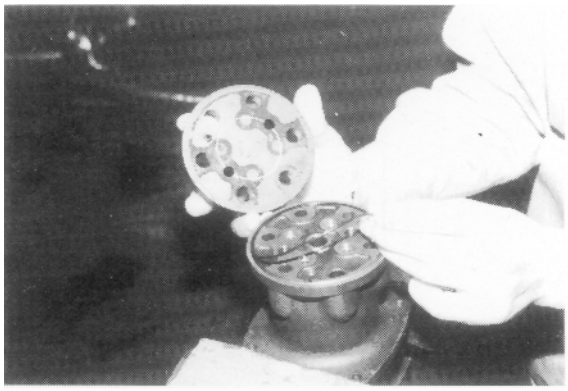


11. Loosen and remove the hexagonal socket head bolts (125) with an Allen wrench.

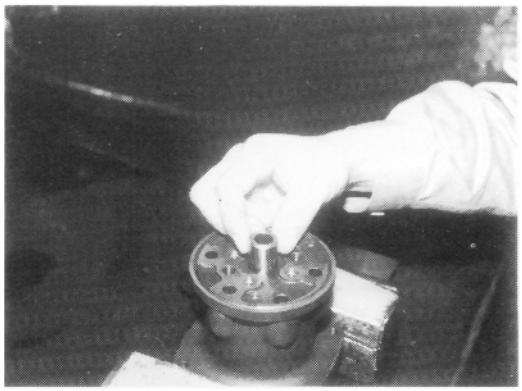


Dismantling *(continued)*

12. Remove the port plate (111) and 'O'-ring (122) from the casing.

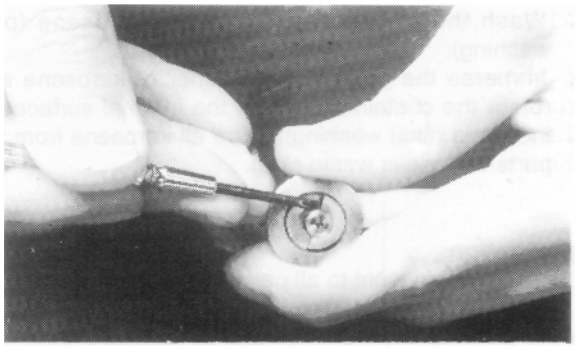


13. Remove the bushing (131) from the casing.



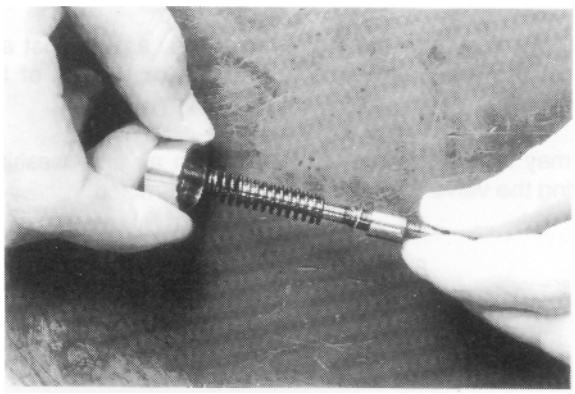
14. To disassemble the pressure reduction assembly, stand the spool (201) on a level work bench, pull the spring seat (216) down and remove the two semicircular washers 1 (215) with a small screwdriver.

Note: *Take care not to scratch the surface of the spool. Do not pull down the spring seat by more than 6 mm.*



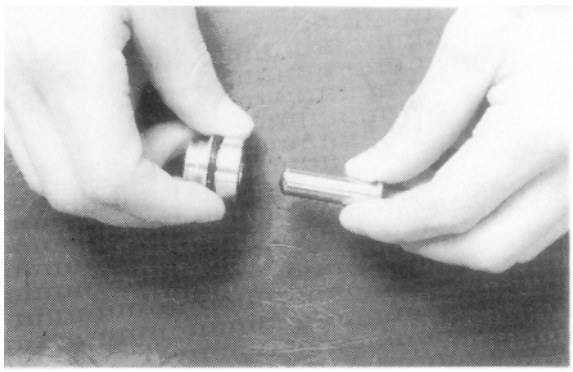
15. Separate the spool (201), spring seat (216), spring (241) and washer 2 (217).

Note: *Keep the parts of the assembly together until reassembly.*



Dismantling *(continued)*

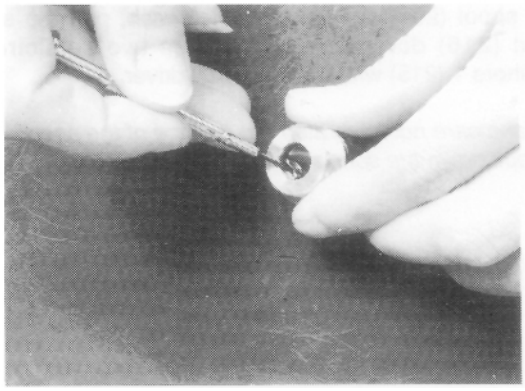
16. Remove the push rod (212) from the plug (211).



17. Remove the 'O'-ring (214) and the seal (213) from the plug (211). Use a small straight-headed screwdriver to remove the seal.

18. Wash all the parts

- **a.** Wash the parts in a container of kerosene (pre-washing).
- **b.** Immerse the parts in a container of kerosene and rotate the container to wash the internal surfaces of the parts (final washing). Wipe all kerosene from the parts with clean waste cloth.



Rust prevention

Apply rust-inhibiting agent to all parts.

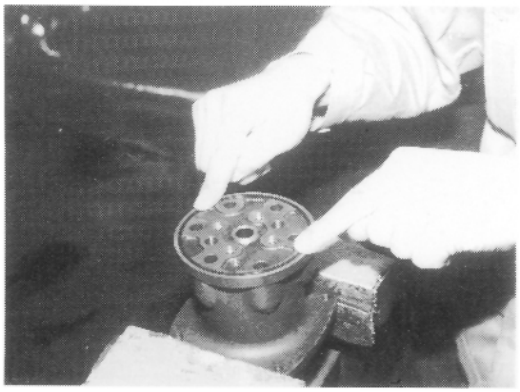
Leave the parts to soak until oil and dirt become free. The parts may be scratched if they are washed when dirty. Washing the parts in dirty kerosene may scratch the surfaces, impairing performance after reassembly. Make sure that the kerosene being used does not become too dirty.

Do not dry the parts with compressed air, as the dust and water in the air may cause scratching or rusting of the surfaces.

Parts may rust if they are left in the open air after washing, impairing the valve function after it is reassembled.

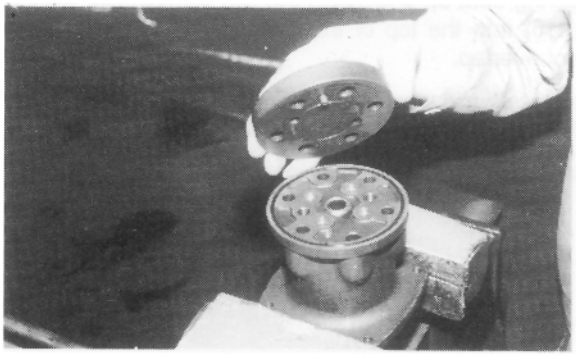
Assembly

1. Mount the bushing (131) and 'O'-ring (122) on the casing (101).



2. Attach the port plate with hexagonal socket head bolts (125) and seal washer (121) to the casing (101).

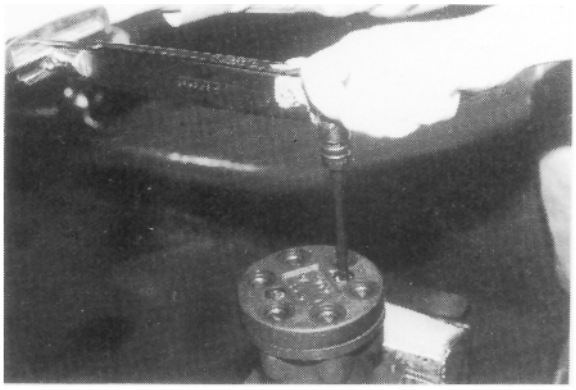
Note: *Align the plate so that the spring pins (126) enter the holes in the casing.*



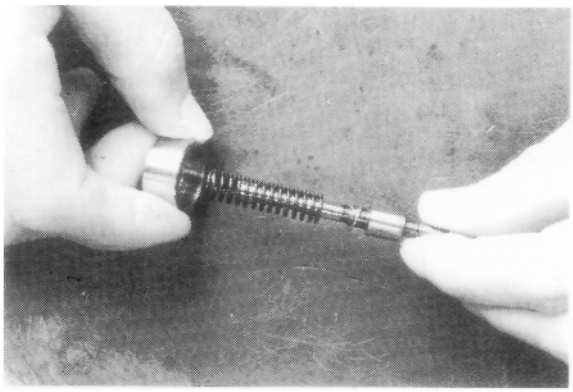
Assembly *(continued)*

3. Tighten the hexagonal socket head bolts (125) to the specified torque. (300 kgf-cm).

Note: *Tighten the bolts alternately a little at a time until they are tightened to the specified torque.*



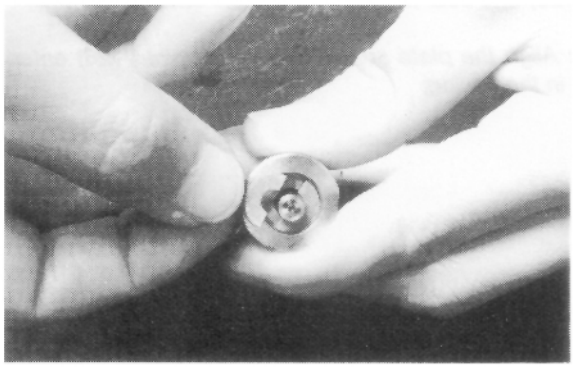
4. Mount the washers 2 (217), springs (241) and spring seats (216) in order onto the spools (201).



5. Stand each spool (201) on a level work bench, push the spring seat up and insert the two semicircular washers 1 (215) into the top of the spring seat, such that they do not overlap.

Note: *Install the washer 1 (215) so that its sharp edge side catches on the spool head.*

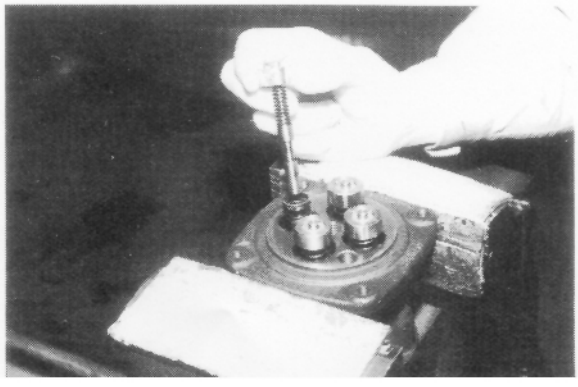
Do not pull down the spring seat by more than 6 mm.



6. Mount the spring (221) into the case.

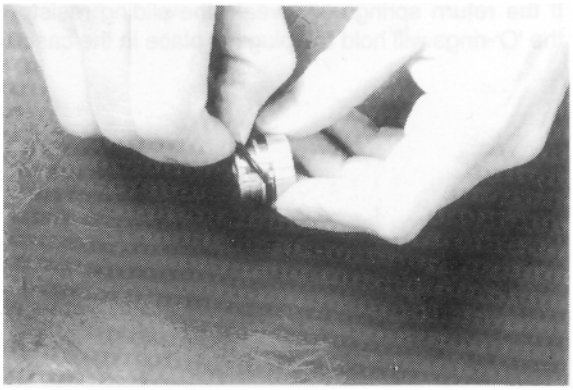
Mount the pressure reduction assembly into the casing.

Note: *Assemble them in the original positions before assembly.*



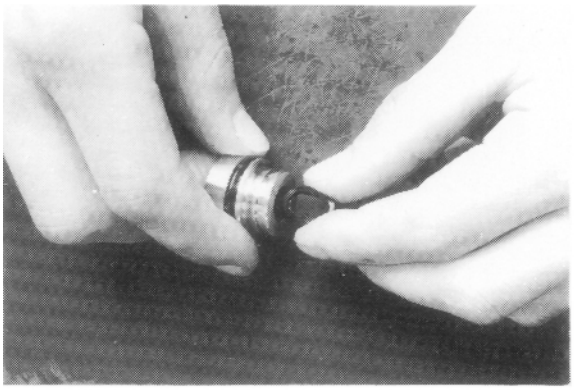
Assembly *(continued)*

7. Mount the 'O'-rings (214) into the plug (211).



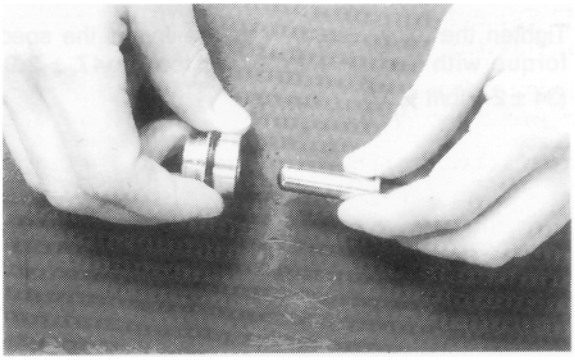
8. Mount the seals (213) into the plug (211).

Note: *Mount the seals so that the lips are as shown in the illustration.*



9. Mount the push rods (212) into the plug (211).

Note: *Apply hydraulic oil to the surfaces of the push rods.*

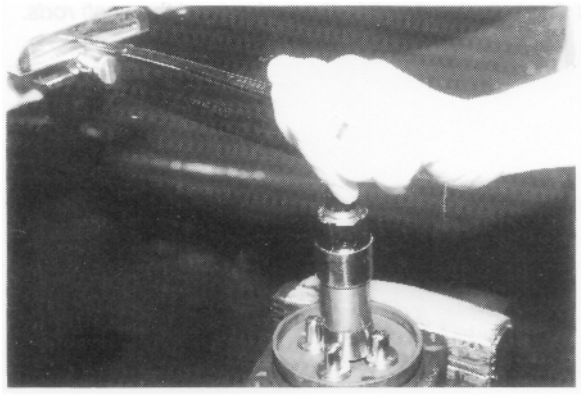


Assembly *(continued)*

10. Mount the plug assembly into the casing.
If the return springs are weak, the sliding resistance of the 'O'-rings will hold the plugs in place in the casing.

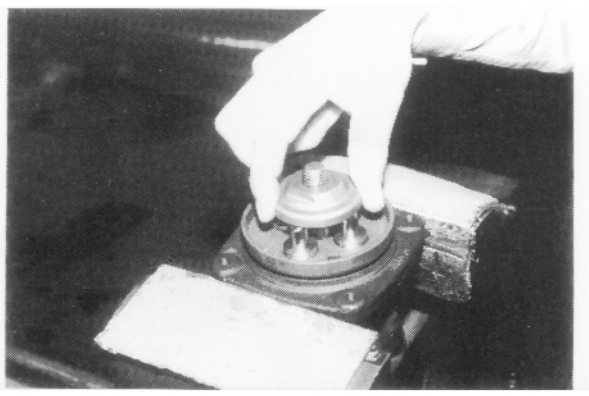
11. Mount the plate (151).

12. Tighten the joint (301) into the casing to the specified torque with the jig. Tightening torque 47 ± 2.9 Nm (34 ± 2.1 lb/ft).



13. Mount the disk (302) to the joint.

Note: *Screw in the disk until it is in equal contact with all four push rods. (Do not over tighten).*



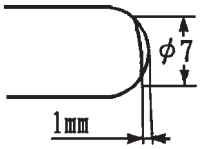
Assembly *(continued)*

14. Mount the adjusting nut (312) and tighten it to the specified torque, using a spanner on the flats of the disk. (Adjusting nut tightening torque 68.6 ± 4.9 Nm (50 ± 3.6 lb/ft).

Trouble Shooting

	Symptoms	Possible Causes	Counter measures
*	**1**. Low secondary pressure	**a**. Primary pressure is low.	Apply the correct primary pressure.
		b. Spring (241) is damaged.	Replace the spring.
		c. Clearance between the spools and casing is too large.	Replace the remote control valve assembly.
		d. The handle unit is loose.	Disassemble, reassemble or replace the handle unit.
*	**2**. Unstable secondary pressure	**a**. Sliding parts are sticking	Repair the sticking part.
		b. Fluctuations in the tank line pressure.	Check return line and filter for blockage.
		c. Air is trapped in the piping.	Operate the valve several times to remove the air.
*	**3**. High secondary pressure	**a**. The tank line pressure is too high.	Check return line and filter for blockage.
		b. Sliding parts are sticking.	Repair the sticking part.

Maintenance Specifications

Maintenance Item	Standard	Note
Leakage Amount	Replace if the leakage exceeds 1000cc/min with the handle in the neutral position or 2000cc/min during operation.	Condition Primary pressure 30 kgf/cm^2 (29 bar, 426.6 lb/in^2) Oil viscosity 23 cst
Spool	* Replace when the sliding contact faces are worn more than 10 micron or more than the non-sliding contact faces.	The conditions are approximately the same as for the leakage above.
Push rod	Replace if the tip is worn more than 1mm. 	
Play in the Operating Controls	Replace the parts if the wear in the pin, shaft and joint leads to play of more than 2mm.	
Actuation Stability	Consult Troubleshooting for Hydraulic Pump or Control Valve if abnormal noises, hunching or drops in primary pressure are experienced during operation. Replace the valve if the problem cannot be solved.	

Caution
1) It is recommended to replace the 'O'-rings and other seals at each disassembly, but if they are not damaged, they can be used again.
2) If the hexagonal socket head bolt (125) is loosened, always replace the washer (121).

Schematics, Technical Data

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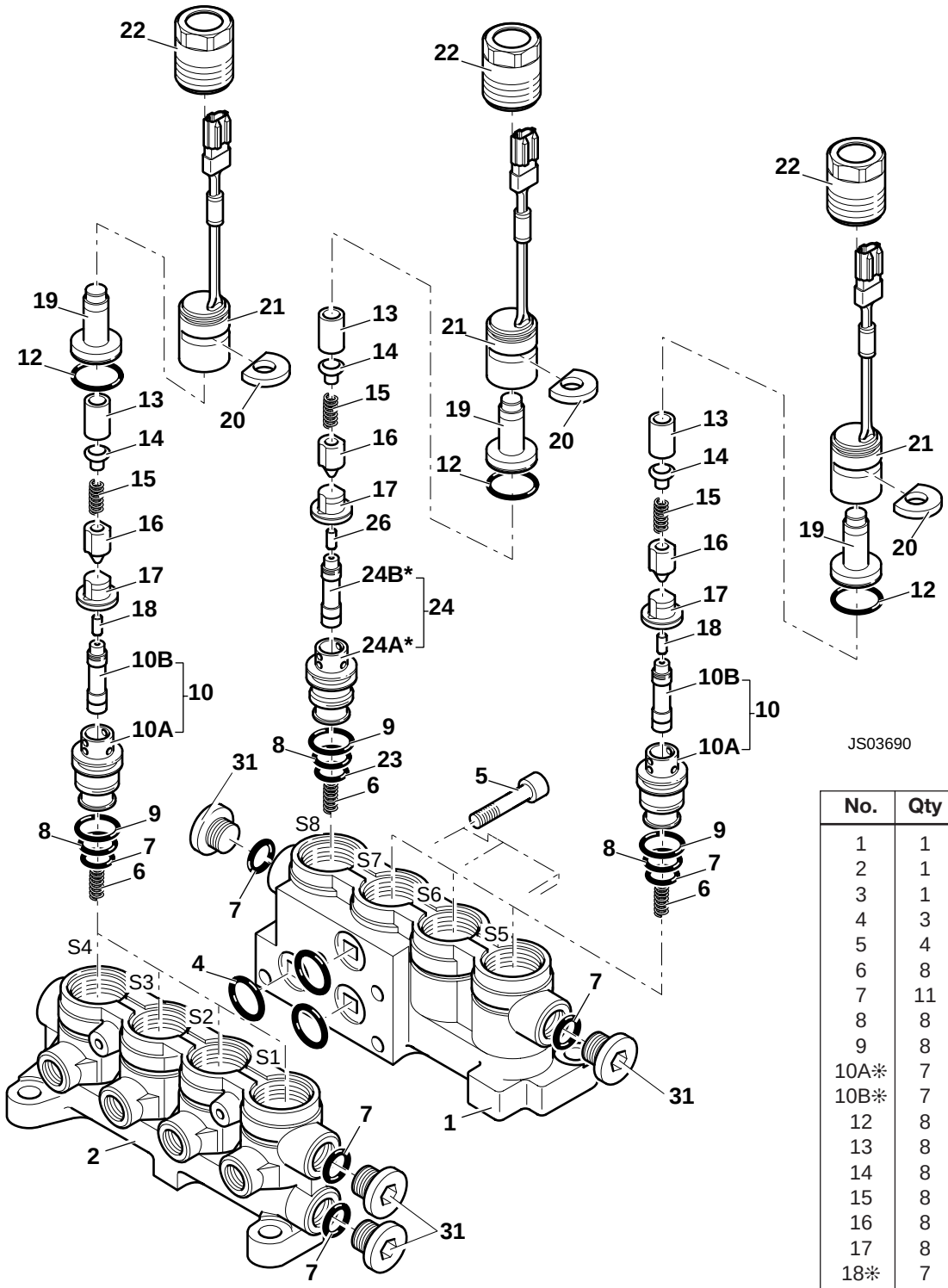
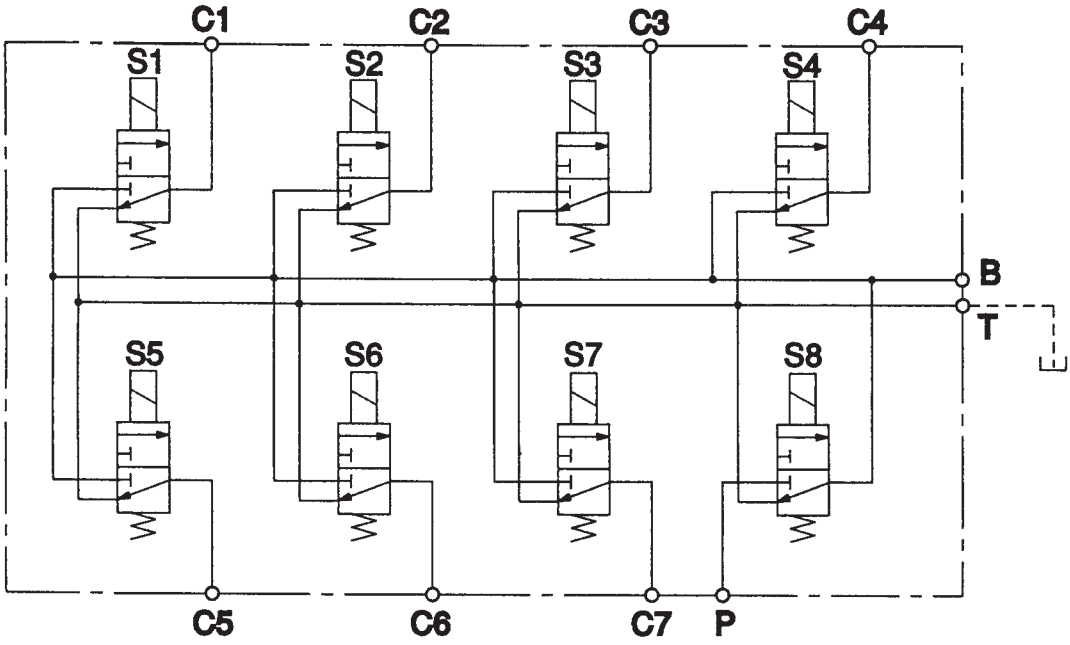


JS03690

S1~S7	10A Body inner diameter	ø10mm
	10B Spool outer diameter	ø10mm
	18 Rod total length	8.6mm
S8	24A Body inner diameter	ø12mm
	24B Spool outer diameter	ø12mm
	26 Rod total length	9.0mm

No.	Qty		Parts Name
1	1		Housing
2	1		Housing
3	1		Plug
4	3		O-ring
5	4		Socket head bolt
6	8		Spring
7	11		O-ring
8	8		O-ring
9	8		O-ring
10A※	7		Body
10B※	7		Spool
12	8		O-ring
13	8		Pipe
14	8		Spring seat
15	8		Spring
16	8		Plunger
17	8		Stopper
18※	7		Rod
19	8		Inner housing
20	8		Spacing
21	8	*	Coil assembly
22	8	*	Cap
23	1		O-ring
24A※	1		Body
24B※	1		Spool
26※	1		Rod
31	4		Plug

Schmatics, Technical Data



Schematics, Technical Data

Rated Pressure	40 kgf/cm^2 (38.69 bar, 568.8 lb/in^2)
Rated Flow	5 l/min (1.09 imp gal)
Pressure Loss Characteristic	
P → B	<.967 bar (1.0 kgf/cm^2, 14.22 lb/in^2) at 10 l/min (2.199 imp gal) 31 cSt
* B → C1~C7	<1.93 bar (2.0 kgf/cm^2, 28.44 lb/in^2) at 5 l/min (1.099 imp gal) 31 cSt
B → T	<1.93 bar (2.0 kgf/cm^2, 28.44 lb/in^2) at 5 l/min (1.099 imp gal) 31 cSt
Inner leakage	
P → B	<70 cc/min at 3.8 bar (3.99 kgf/cm^2, 56.73 lb/in^2) 31 cSt (3.1 x 10.^{5} M^2/s)
B → T	<490 cc/min at 3.8 bar (3.99 kgf/cm^2, 56.73 lb/in^2) 31 cSt (3.1 x 10.^{5} M^2/s)
Hydraulic Oil	
Hydraulic Oil Temperature	-20~+95°C
Ambient Temperature	-30~+80°C
Connectors	
Connector Specifications	7222-1424-30
Housing	7114-1471
Terminal	DC 24 Volt
Rated Voltage	20~32 Volt
Allowable Voltage Range	Resistance Welding Time 20~30 Volt
Current	~0.6A at 24 Volt 20°C
Lead Wire	AVX 0.85 mm^2
Terminal Pull-out Strength	78.9 N (8 kgf less than 30 sec)
Degree of Waterproof	JIS-D-0203, S2
* Weight	11 kg (24 lb)
Insulation Resistance	More than 1 M (at 500 VM)
Degree of Shockproof	JIS-D-1601 3rd Class B Type Step 7 (6.9G)

Refer to illustrations at the end of this section.

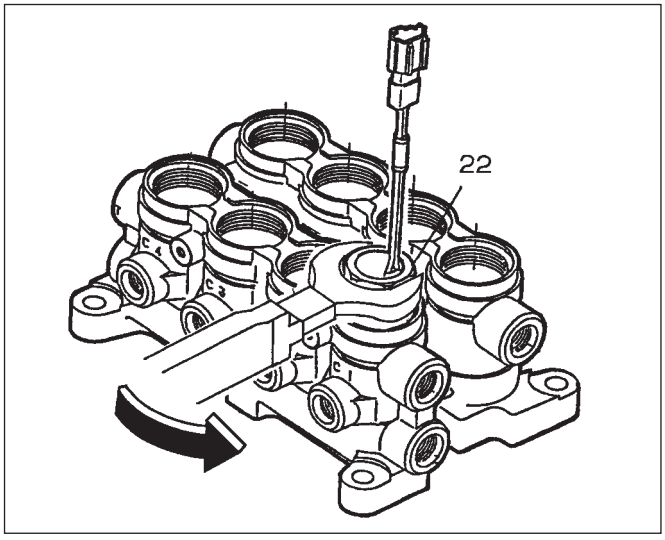
Dismantling

Notes:

1. *All parts are manufactured with a high degree of precision and require the utmost care when handling. Do not let parts knock against each other and take extra precautions when handling parts to prevent them being dropped.*
2. *During dismantling, do not hit parts with excessive force if they are stuck and do not damage parts by twisting them or making burrs on bearing surfaces. Failure to follow these instructions will cause oil leaks leading to poor performance.*
3. *Label all parts during dismantling to ensure correct assembly.*
4. *Storing of the solenoid valve in a dismantled or partly dismantled state could cause rusting of parts due to moisture or dirt. If the dismantling procedure must be interrupted, be sure to provide anti-rust treatment and keep the parts free from dirt and corrosion.*
5. *During assembly ensure that all parts are free from dirt and foreign matter and make sure that all parts are free from burrs and scratches. Remove minor burrs and scratches using an oil stone.*
6. *Use new 'O'-rings and backup rings.*
7. *During assembly, apply grease to 'O'-rings.*
8. *Tighten all bolts to the quoted tightening torque.*

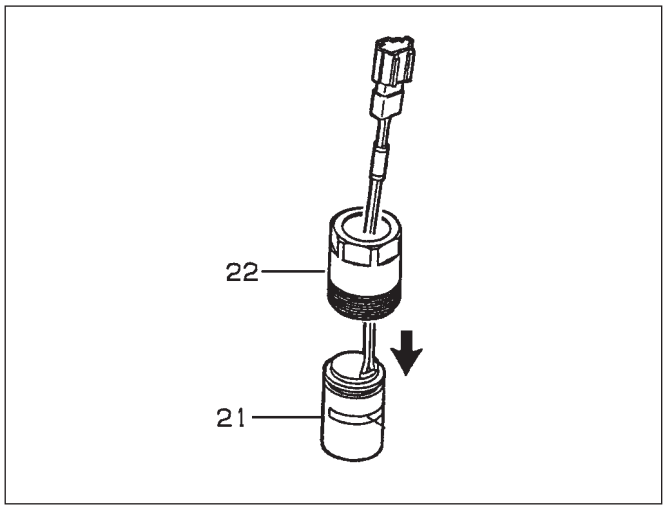
Dismantling

1. Use a socket or torque wrench to remove the screw (22).

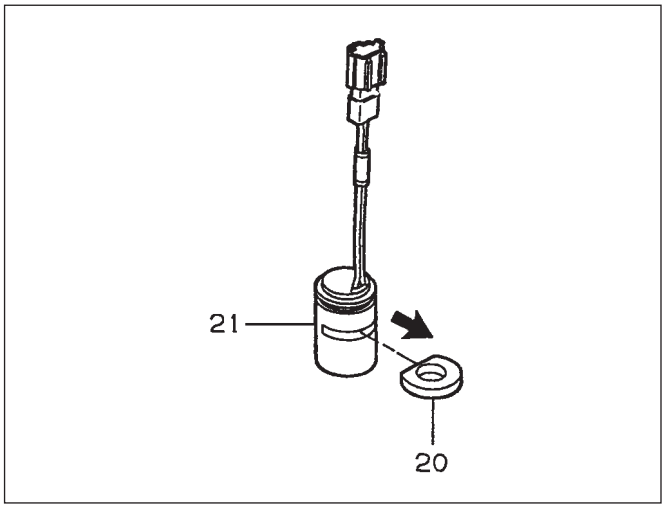


Dismantling *(continued)*

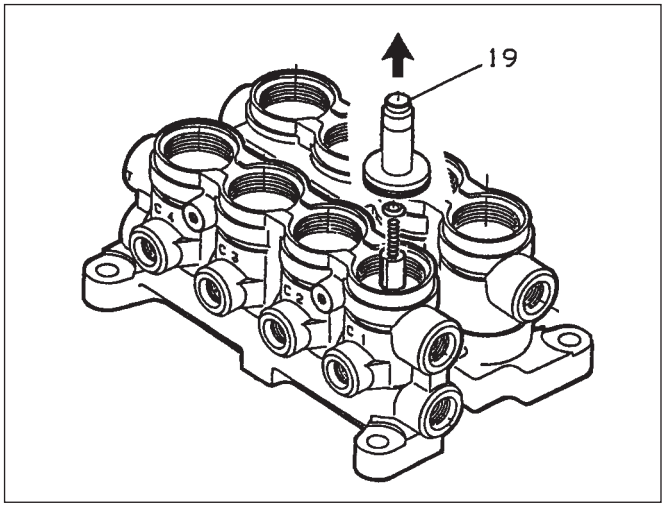
* **2.** Remove the coil assembly (21) from the cap (22).



3. Remove the spacer (20) from the coil assembly.

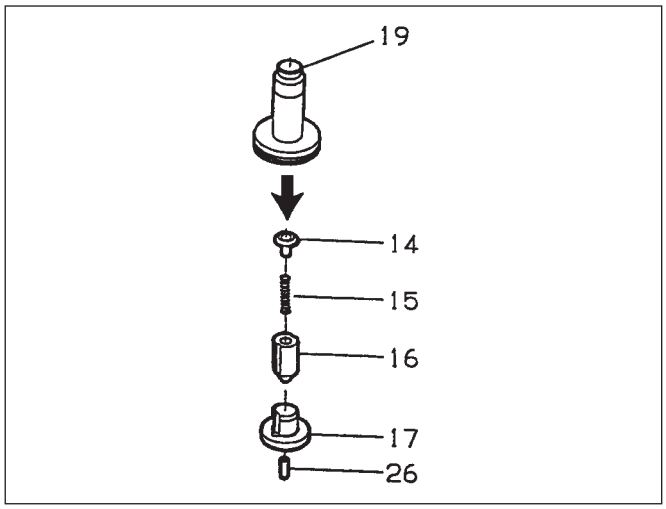


4. Remove the inner housing (19). Remove slowly so that the parts inside the housing do not fly out.

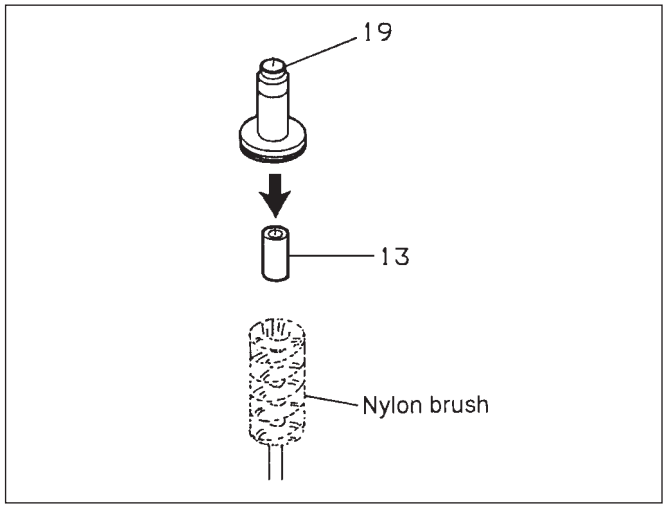


Dismantling *(continued)*

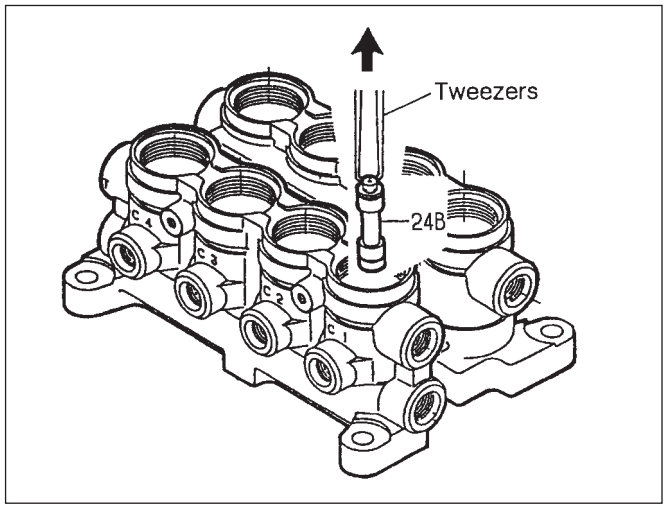
5. Remove the rod (26), stopper (17), plunger (16), spring (15), and spring seat (14). If the spring seat is stuck to the inside of the inner housing, use tweezers to remove it.



6. Pull out the pipe (13) from the inner housing using a nylon brush.

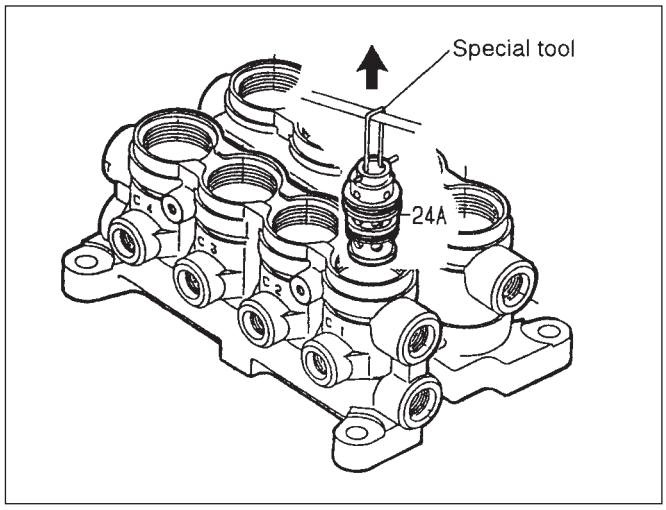


7. Slowly remove the spool (24B).

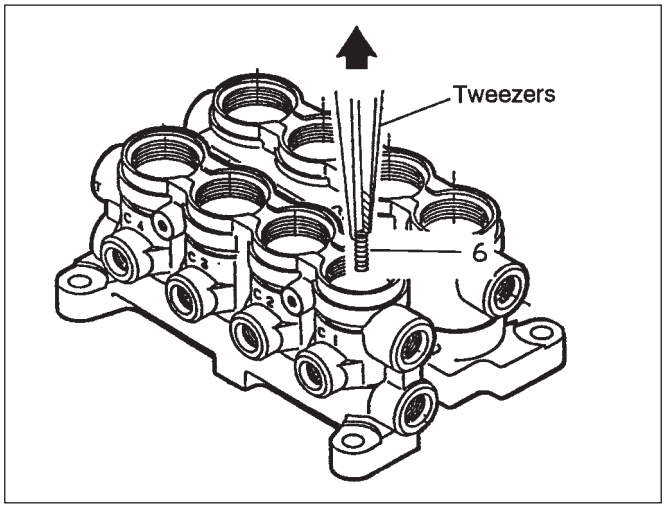


Dismantling *(continued)*

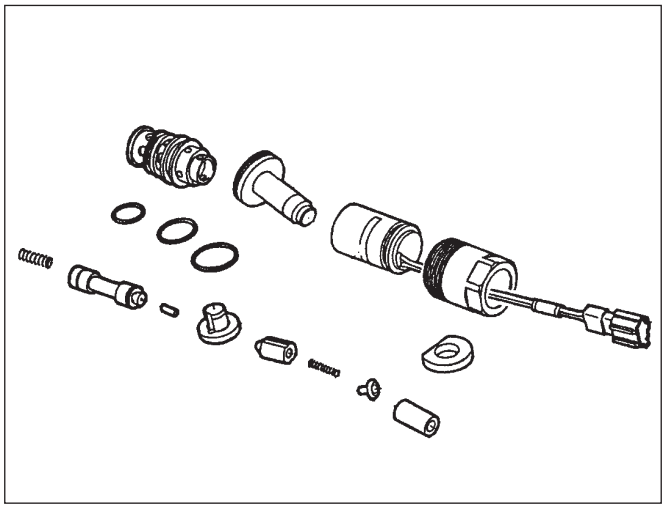
8. Remove the body (24A) with the special tool (A).



9. Remove the spring (6) using tweezers.

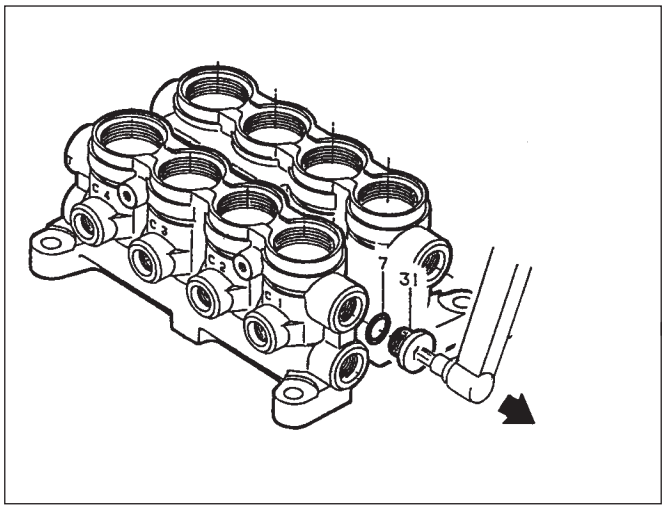


10. Line up the disassembled parts on a clean place in such a way to facilitate reassembly.

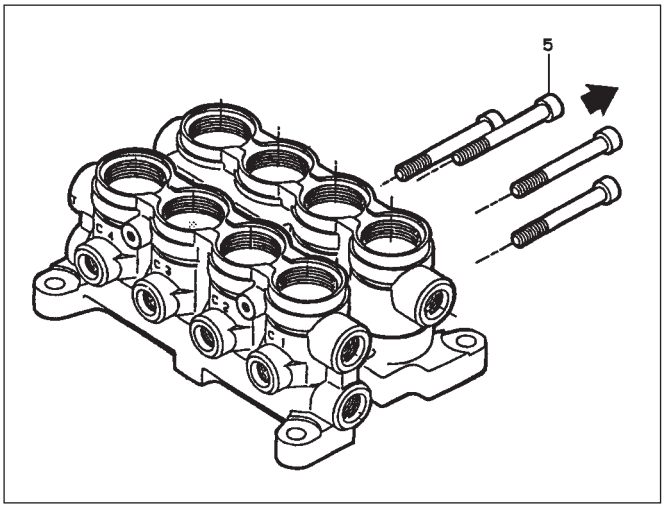


Dismantling *(continued)*

11. Use a socket or torque wrench to remove the plug (31).

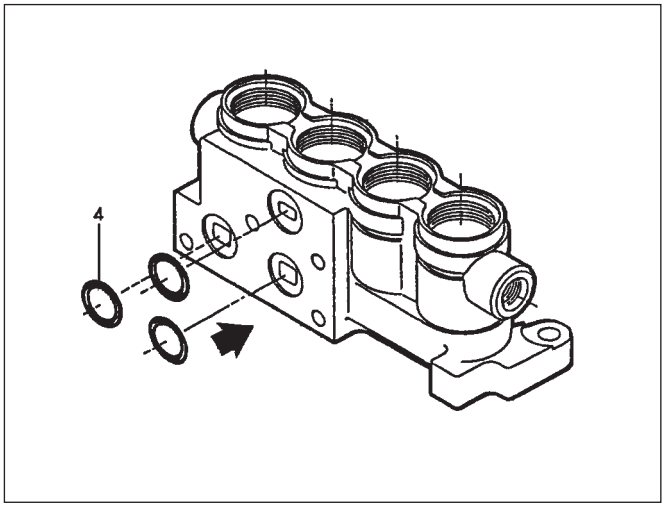


12. Use a socket or torque wrench to remove the socket head bolt (5).

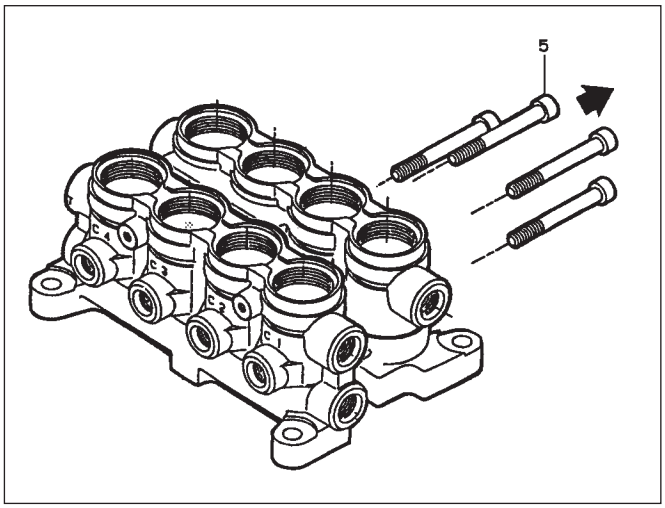


Assembly

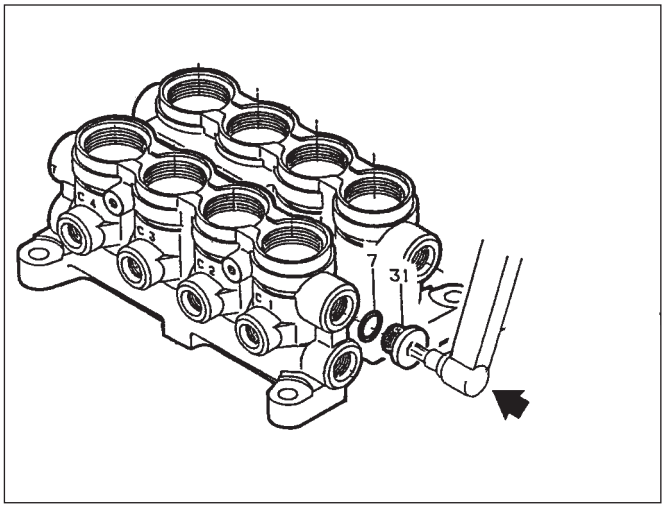
1. Install the 'O'-ring (4) on the housing (1).



* **2.** Use the socket head bolt for housing (1) and (2) and tighten to 24.5 + 4.9 Nm (18.08 + 0.5 kgf m).
- 0 Nm - 0 kgf m

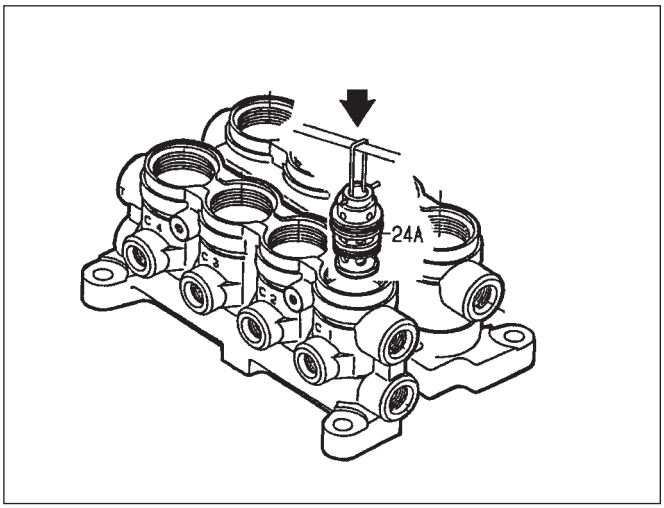


* **3.** Install the 'O'-ring (7) on the plug (31) and assemble to the housing, tighten to 19.6 + 4.9 Nm (14.47 + 0.5 kgf m).
-0 Nm -0 kgf m)

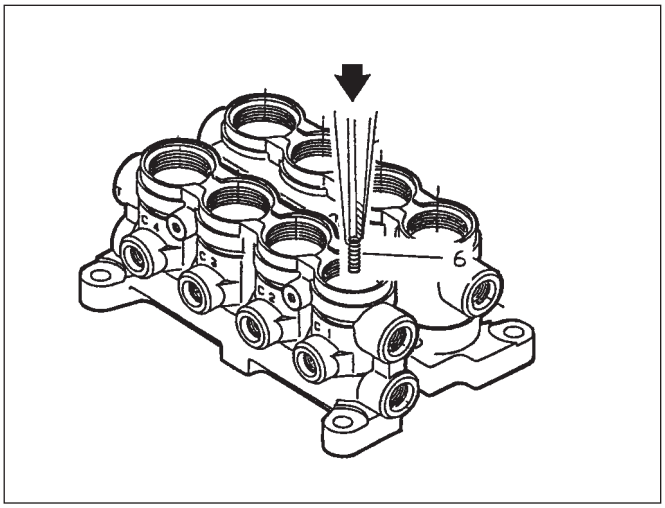


Assembly *(continued)*

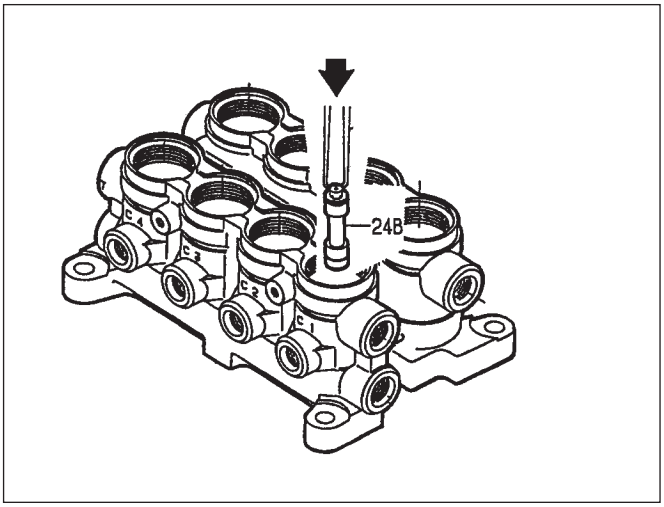
4. Install the 'O'-rings (8, 9, 23) on the body (24A) and use the special tool (B) on the housing and push it in.
The inner diameter of the S8 body is 12 mm.
(Apply grease to the 'O'-ring).



* **5.** Drop in the spring (6) from the middle of the body (24A). At this time, make sure it stays in line with the inner hole of the housing.

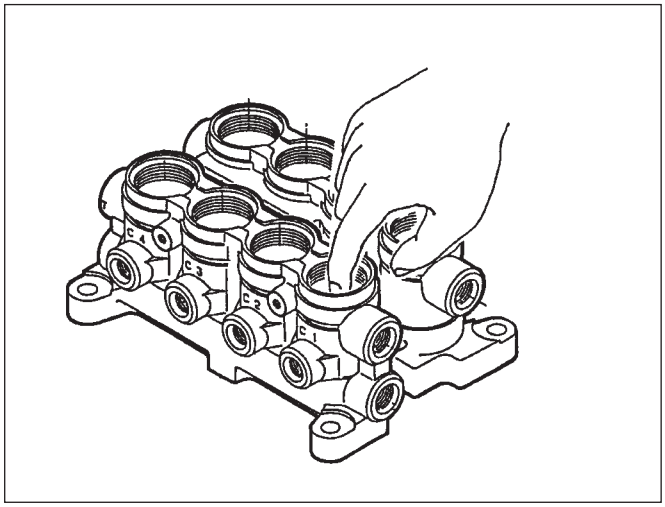


6. Gently insert the spool (24B) into the body. At this time, be careful not to damage the edge inside the body.
(Spool diameter for S8 is 12 mm).

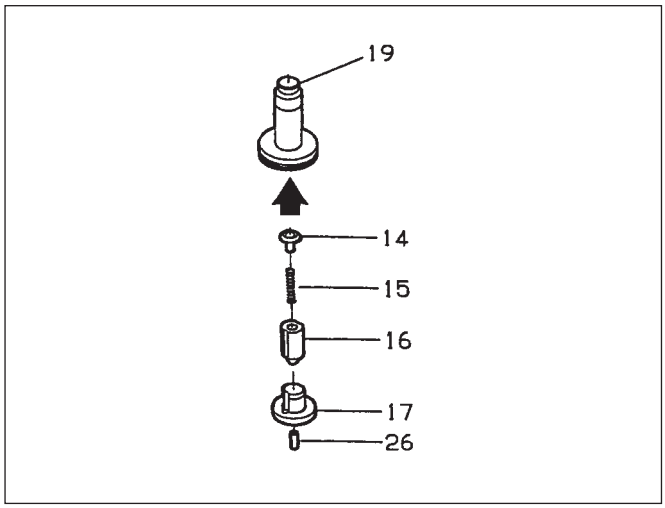


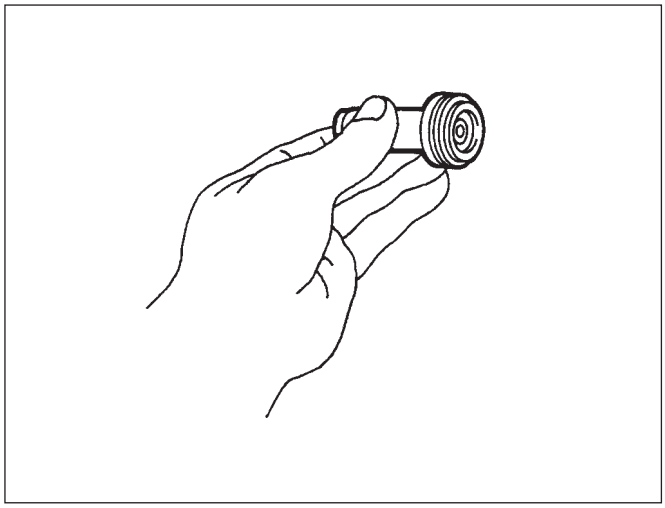
Assembly *(continued)*

7. After inserting the spool, push the top of the spool with your finger and slide it. The spool should slide smoothly and if there is any resistance, do not use it.



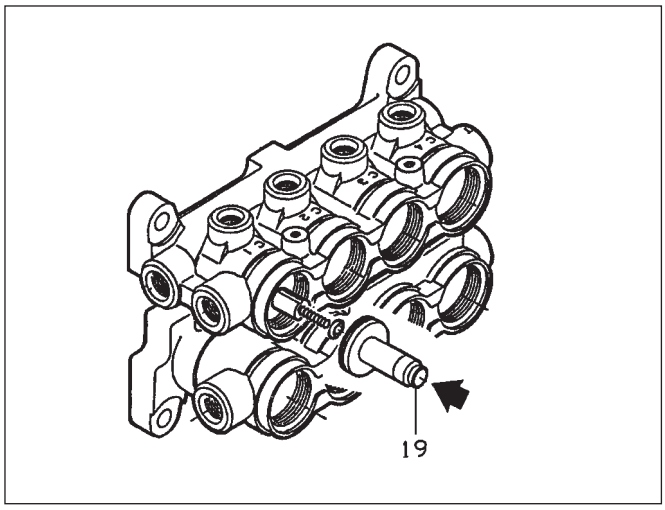
8. Fit the 'O'-ring to the inner housing (19) and install pipe (13), spring seat (14), spring (15), plunger (16), stopper (17) and rod (26) into the housing. (Rod for S8 total length is 9.0 mm).



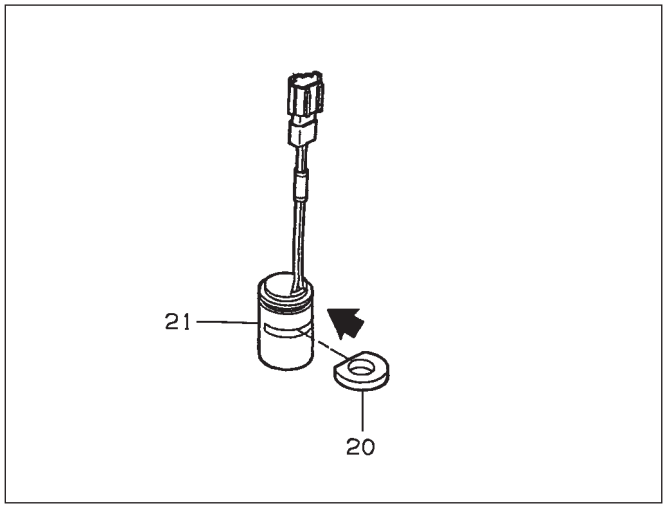


Assembly *(continued)*

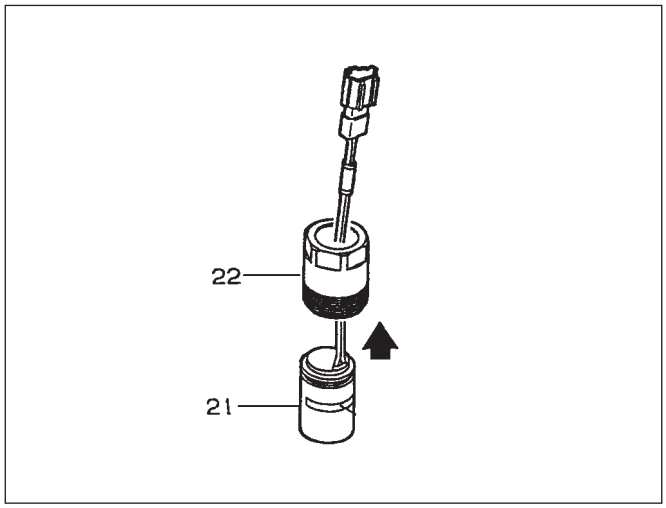
9. Place the housing horizontally and install the inner housing (19). Take care that parts which are assembled to the inner housing do not drop off. (Apply grease to the 'O'-ring).



10. Install the spacer (20) to the coil assembly (21).

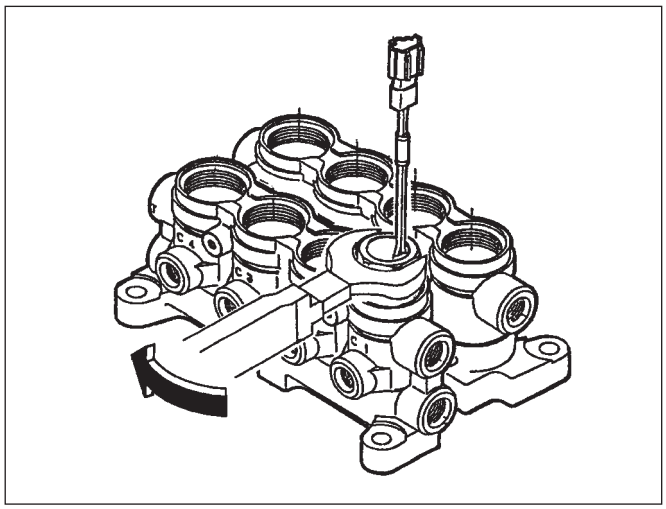


11. Install the housing (22) to the coil assembly.



Assembly *(continued)*

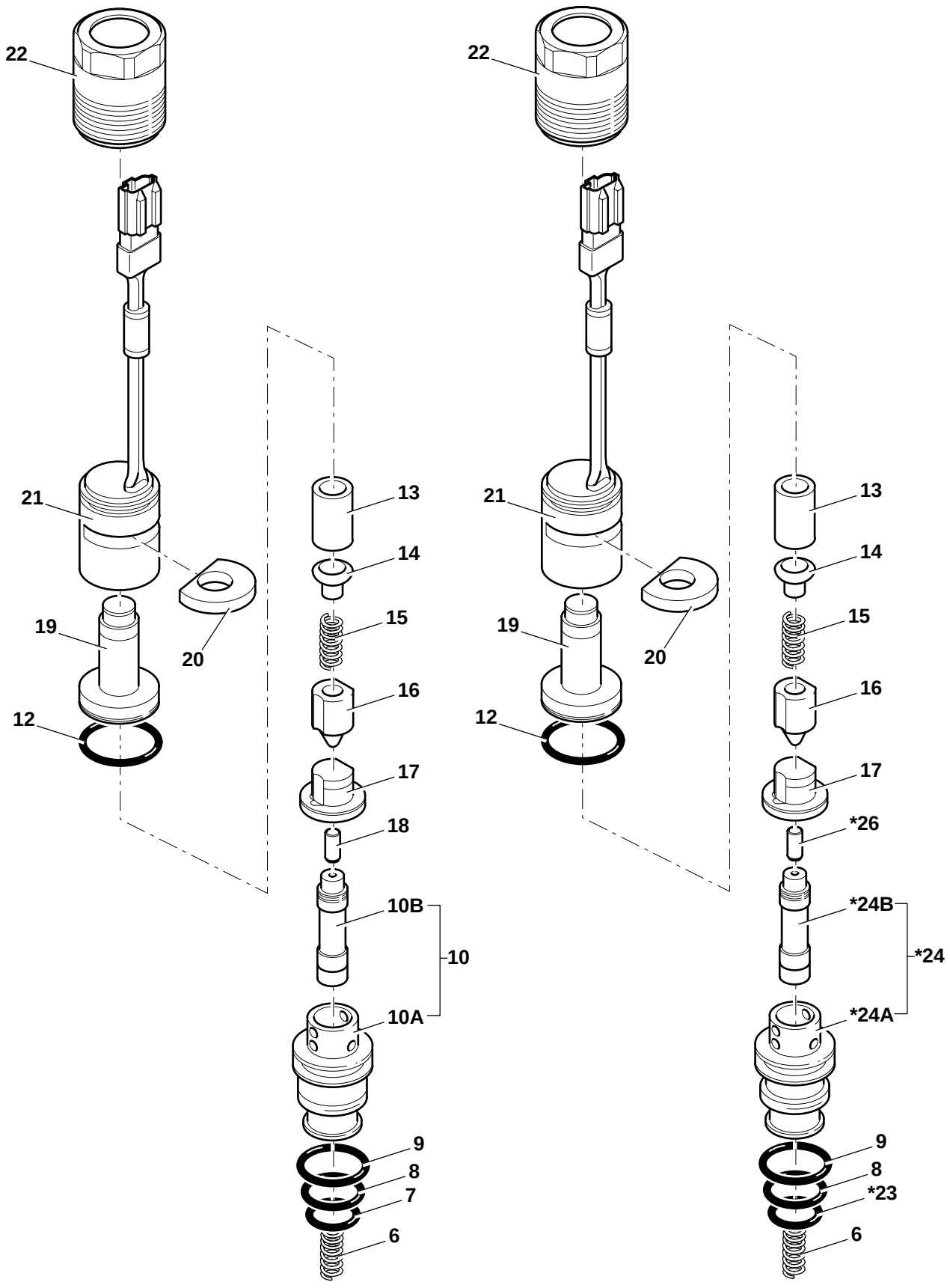
12. Apply anaerobic adhesive Loctite 242 to the screw thread and using a torque wrench, tighten it to 29.4 ± 9.3 Nm (21.1 ± 7.23 lb/ft).



* **Solenoids S1, S3~S7**

The assembly procedure for the solenoids at housing positions C1 and C3 to C7 is identical to that described in steps 11 to 12, but note that O-ring **7**, body **10A**, spool **10B** (10 mm diameter) and rod **18** (8.6 mm long) are of different dimensions to items **23**, **24A**,**24B** and **26** respectively.

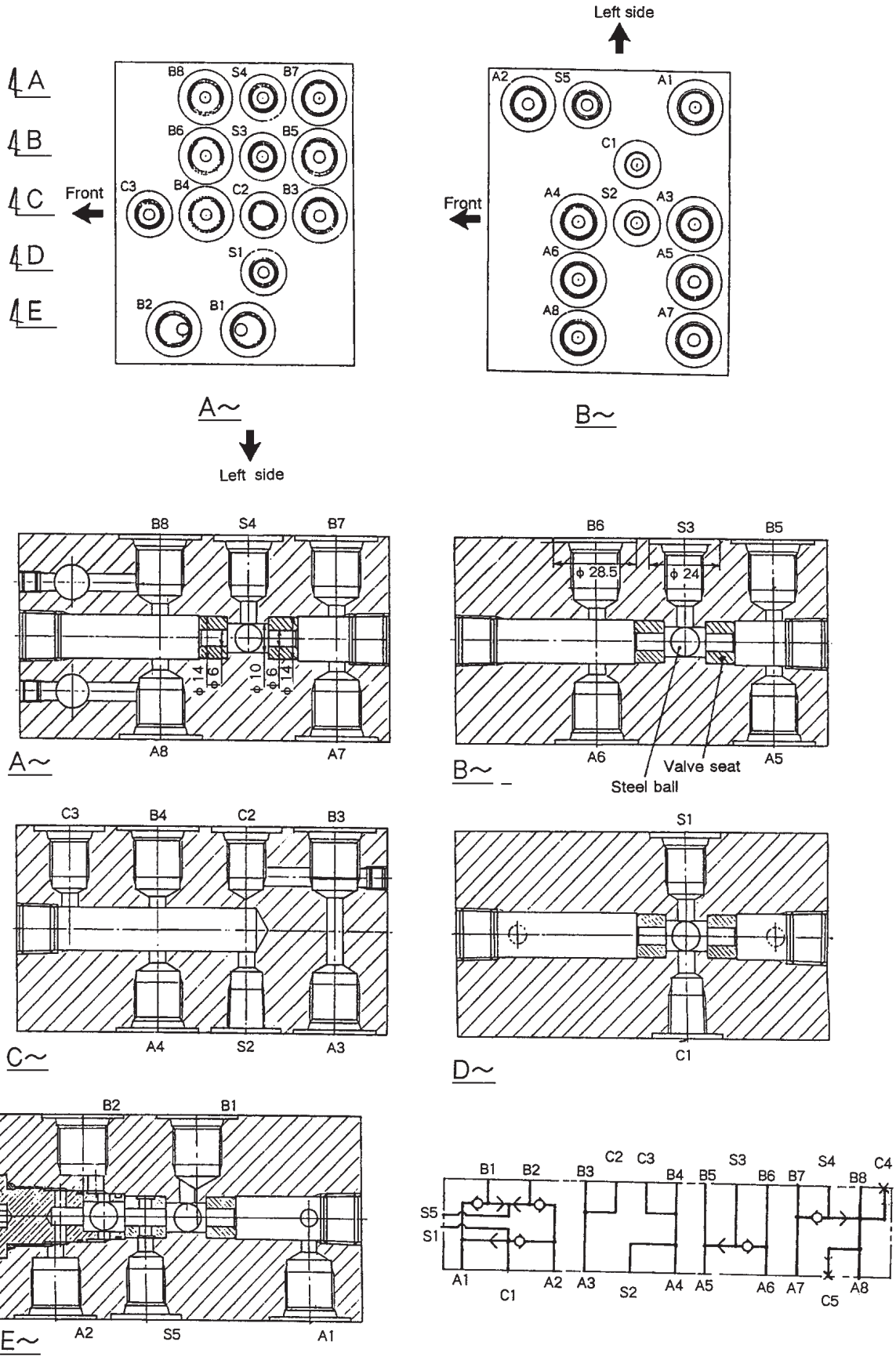
*


22
21
19
12
20
13
14
15
16
17
18
10B
10
10A
9
8
7
6
22
21
19
12
20
13
14
15
16
17
*26
*24B
*24
*24A
9
8
*23
6

JS02620

91
125
150
Tape
Diode installation part
Port Color
P Blue
C1 Red
C2 Green
C3 Yellow
C4 Yellowgreen
C5 Pink
C6 White
C7 Black
BOOM SPEED RESTRICTION
NEGATIVE FLOW CONTROL
MAX FLOW CONTROL
LEVER LOCK
SOFT/HARD
2-STAGE RELIEF
SWING SHUT OFF
2-STAGE TRAVEL
224
149
Electric Circuit
POWER
GROUND

Schematic


Left side
4A
4B
4C
4D
4E
Front
B8 S4 B7
B6 S3 B5
C3 B4 C2 B3
S1
B2 B1
A~
Left side
Front
A2 S5 A1
C1
A4 S2 A3
A6 A5
A8 A7
B~
B8 S4 B7
ϕ14 ϕ6 ϕ10 ϕ6 ϕ14
A8 A7
A~
B6 S3 B5
ϕ 28.5 ϕ 24
A6 Valve seat A5
Steel ball
B~
C3 B4 C2 B3
A4 S2 A3
C~
S1
C1
D~
B2 B1
A2 S5 A1
E~
B1 B2 B3 C2 C3 B4 B5 S3 B6 B7 S4 B8 C4
S5
S1
A1 C1 A2 A3 S2 A4 A5 A6 A7 A8 C5

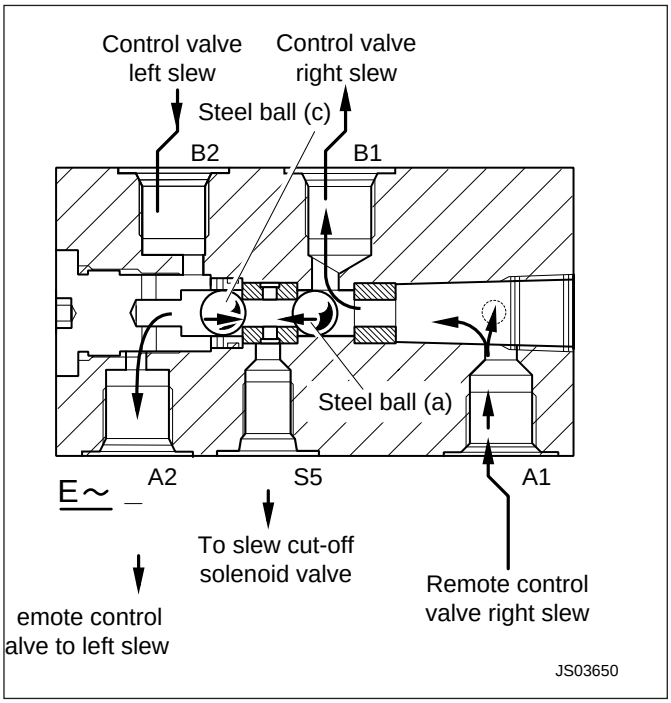
Operation

When right slew is selected, pressurised oil enters the **A1** port of the shuttle block from the remote control valve. The pressurised oil moves steel ball (a) to the left side and enters the right slew port of the control valve from the **B1** port.
The pressurised oil which enters the **A1** port goes passes the through hole (a) and is led to cavity (a) and moves the steel ball (b) to the left side and is then dispersed to **C1** and **S1** ports.
The return oil from the control valve enters **B2** port and moves the steel ball (c) to the right side and returns to the remote control valve from **A2** port.

* **Key for illustrations opposite and on previous page**

	A1	Right slew
	A2	Left slew
	A3	Boom up
	A4	Boom down
	A5	Bucket open
	A6	Bucket close
	A7	Dipper open
*	A8	Dipper close
	B1	Right slew
	B2	Left slew
	B3	Boom up
	B4	Boom down
*	B5	Bucket close
	B6	Bucket open
	B7	Dipper open
	B8	Dipper close
	C1	Slew pressure switch
	C2	Boom up
	C3	Boom up, down
	S1	Collected valve
	S2	Boom lowering pressure switch
	S3	Bucket open
	S4	Dipper close
	S5	Slew shut-off

*



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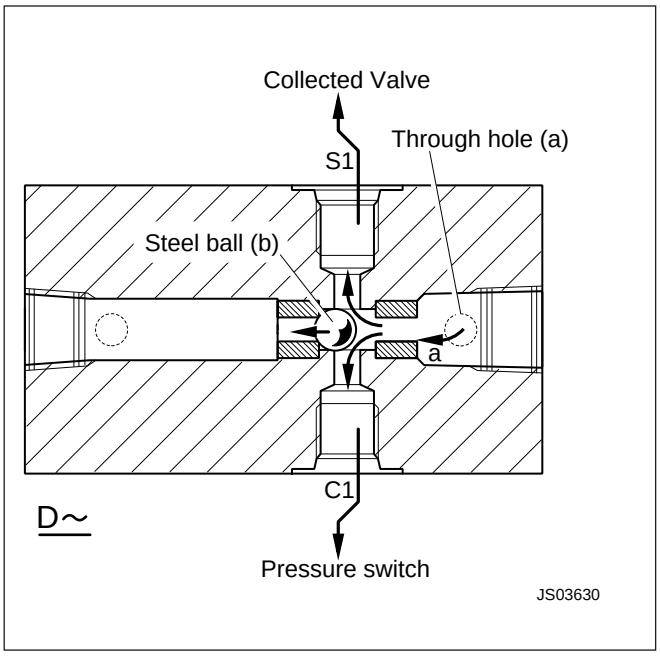
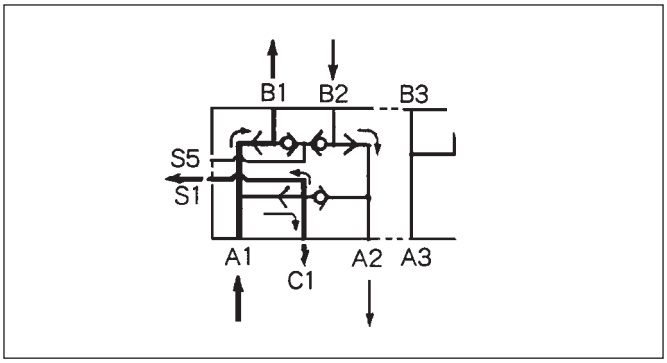
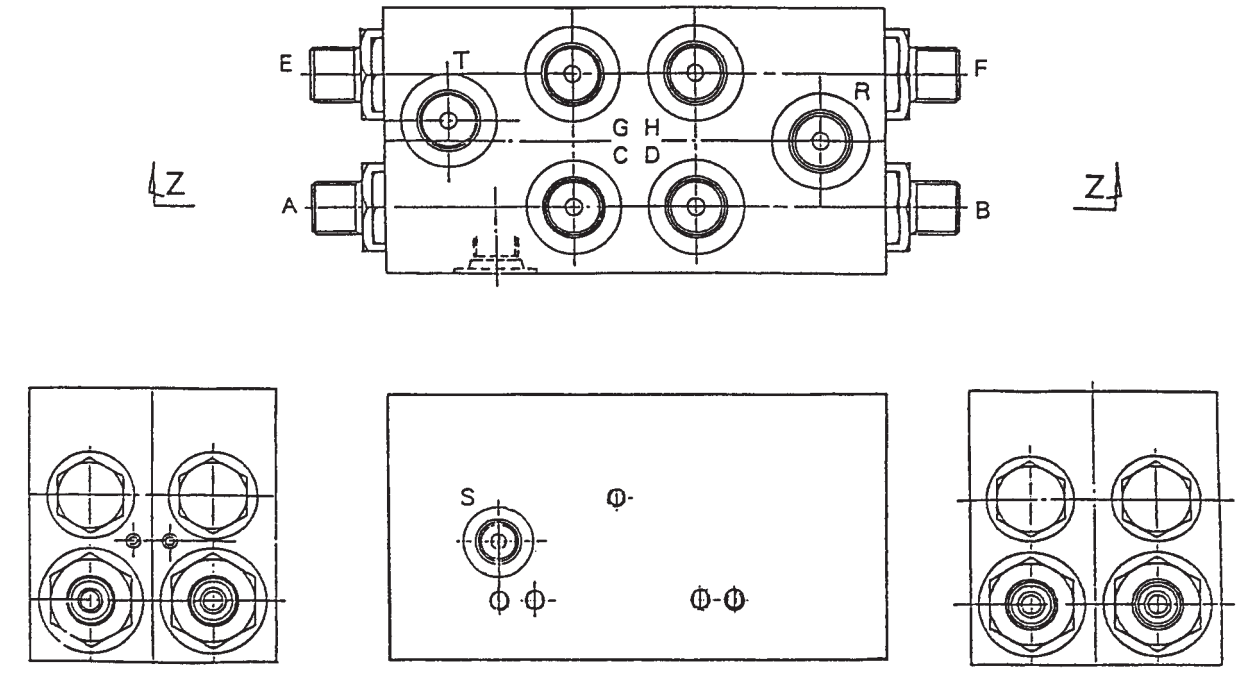




Schematic



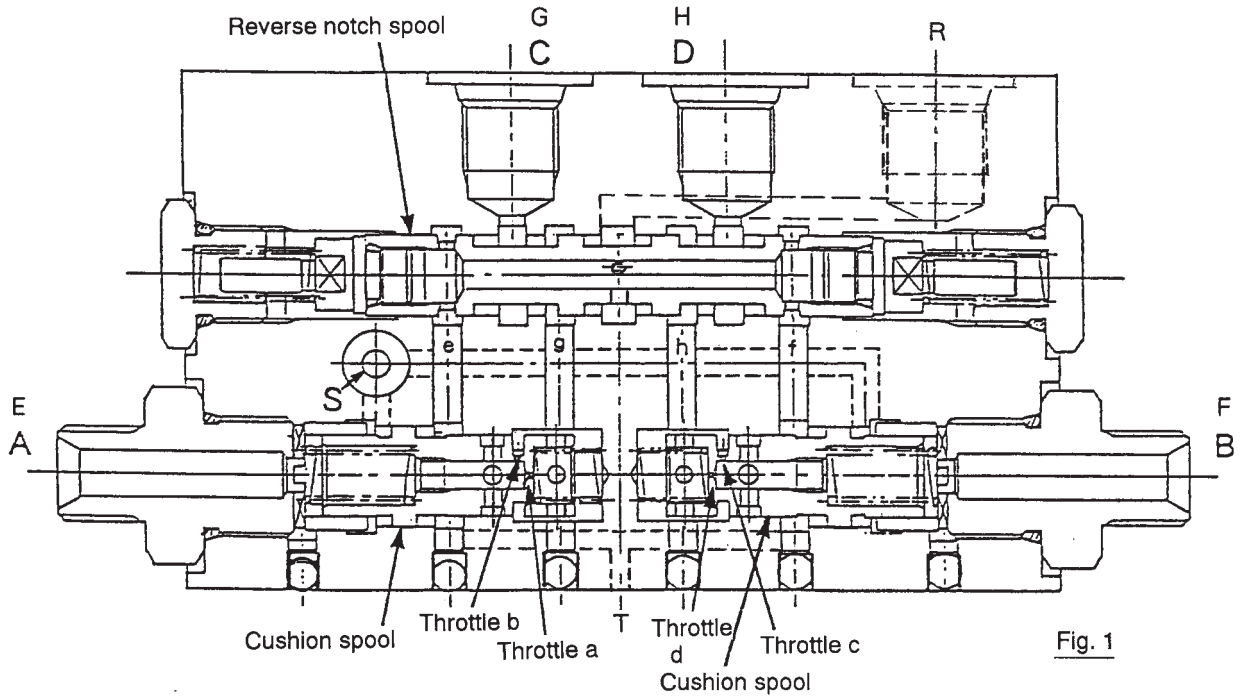
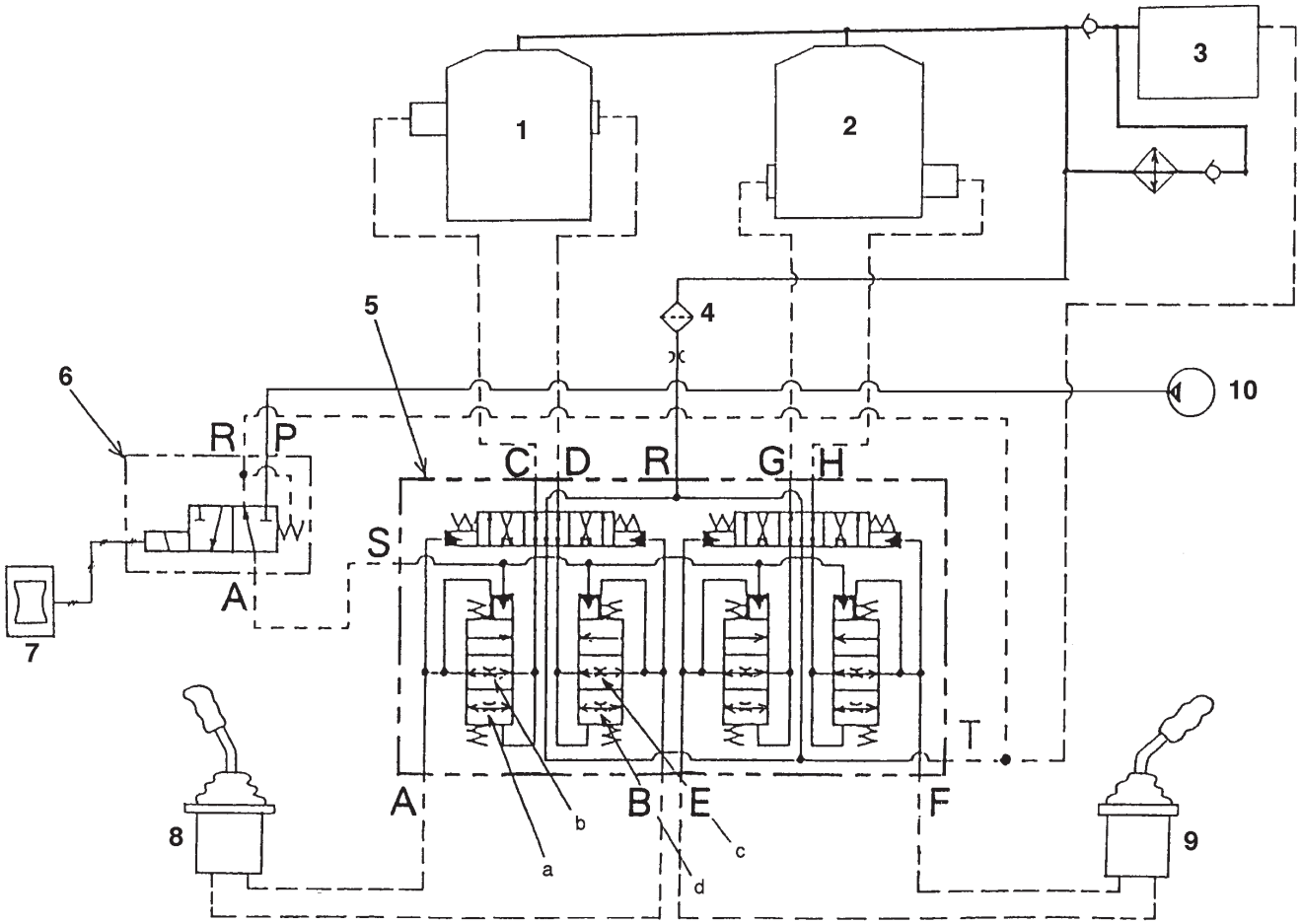


Fig. 1



Key

1	Dipper Control Valve
2	Boom Control Valve
3	Hydraulic Oil Tank
4	Filter
5	Cushion Valve
6	Solenoid Valve
7	Cushion Switch
8	Dipper Remote Control
9	Boom Remote Control Valve
10	Pilot Gear Pump

Operation

In the Soft State

When lever is in neutral (Refer to Fig. 1).

a. The hot oil separated from the oil cooler line enters the **R** port of the cushion valve.

b. It flows through the reverse notch spool interior and through passages e and f.

Then, after flowing through passages e and f, it flows through the outer periphery of the respective cushion spools, returning to the hydraulic oil tank through the **T** port of the cushion valve.

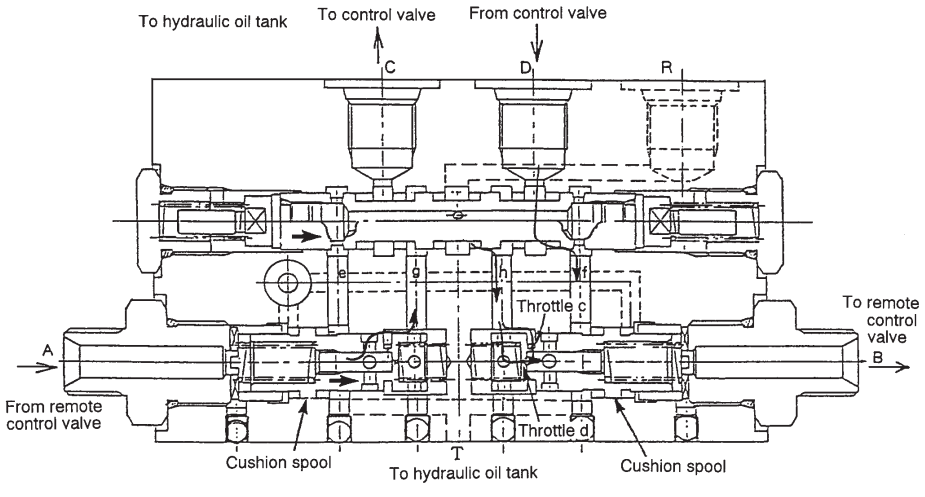
During Dipper Closing Operation

a. Pilot pressure enters the **A** port of the cushion valve from the remote control valve. Because this pilot pressure enters at the left end of the cushion spool and left end of the reverse notch spool, the respective spools move to the right.

b. The pilot pressure inside the cushion spool enters the g cavity through the spool hole. It then passes the reverse notch spool outer periphery and enters the control valve from **C** port.

c. The return oil (pilot pressure) from the control valve enters the f cavity after passing from the **D** port to the outer periphery of the reverse notch spool. It then passes through the cushion spool outer periphery and returns to the hydraulic oil tank from the **T** port.

d. At this point, the hot oil from **R** port flows through the h passageway and enters the right end of the cushion spool because the reverse notch spool is switched to the right, so the e and f passageways are closed. The hot oil passes through throttle **c** and **d** and enters the remote control valve from B port. *(The hot oil warms the remote control valve)*.



During Arm Closing Operation

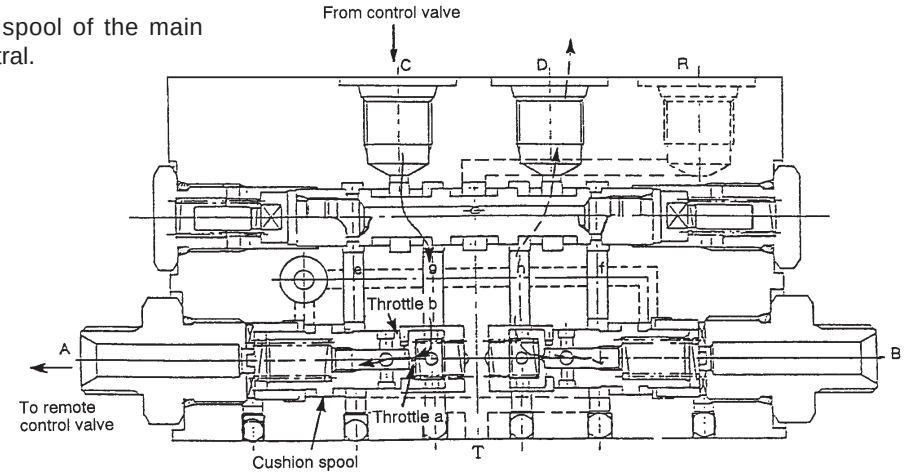
Operation *(continued)*

During Dipper Closed and Stopping

a. When the pilot pressure from the remote control valve stops, the reverse notch spool returns to neutral.

b. Also, the cushion spool returns to neutral and the pilot oil returning from the control valve passes through the throttle **a** and **b**. Because the cushion spool moves to the left side due to the differential pressure before and after the throttle, the pilot return oil is throttled by throttle **a**.

c. Due to this throttling effect, the spool of the main control valve slowly returns to neutral.



Normal State

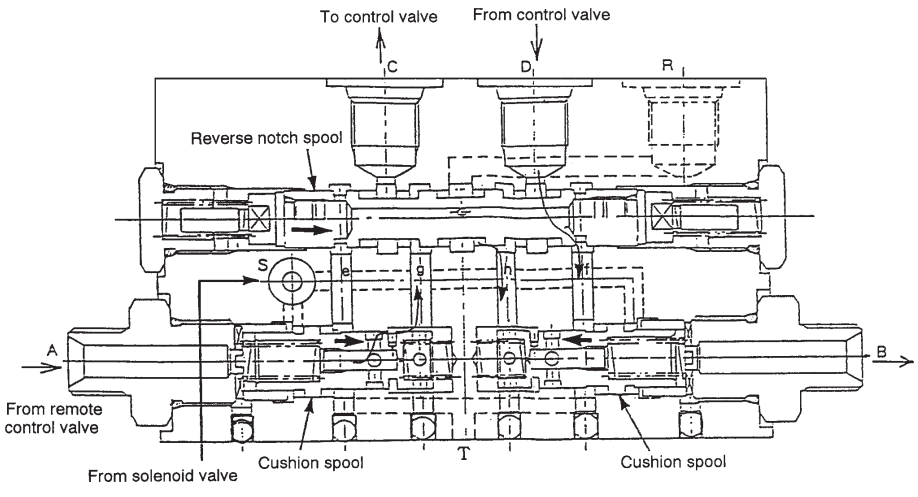
When the cushion switch is switched to the normal position, the solenoid valve is selected and the pilot pressure (40 kgf/cm ^{2}) of the gear pump enters the **S** port of the cushion valve.

All the cushion spools (Boom, dipper - total of 4) are selected forcibly to the inner side.

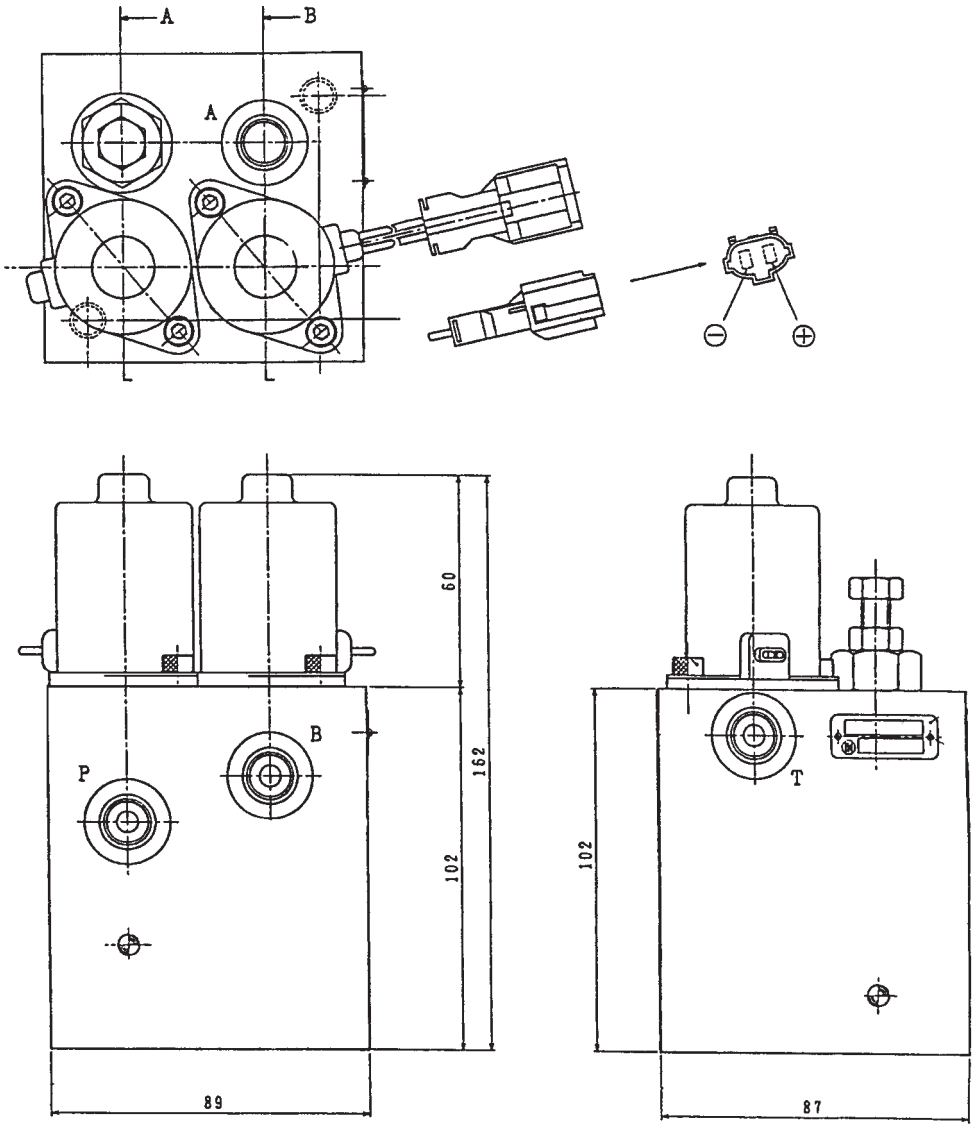
Because the cushion spool is forcibly pushed down, the pilot pressure does not pass through the throttle of the cushion spool during the dipper closing or stopping operations but passes through the cushion valve inside.

The hot oil from **R** port returns to the hydraulic oil tank from the **T** port when the lever is at neutral.

When the lever is being moved, it flows to the remote control valve.



Schematic



Solenoid Part

1. Voltage	DC24V
2. Consumed Power	12W
3. Other	* Surge Suppressor

Valve Part

1. Working Pressure	3.9 MPa (40 kgf/cm^2)
2. Working Flow	16 l/min

3. Decompressor Pressure

	JS200/240
Pressure	1.5^{+0} MPa (15^{+0} kgf/cm^2)

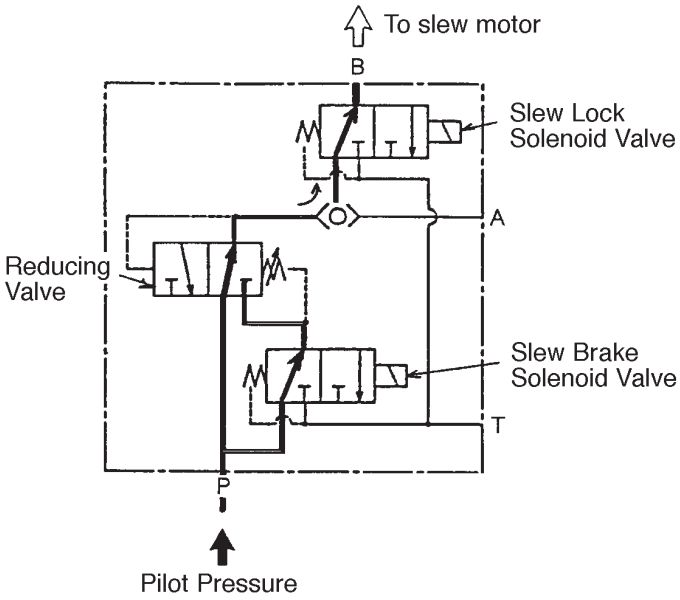
Operation

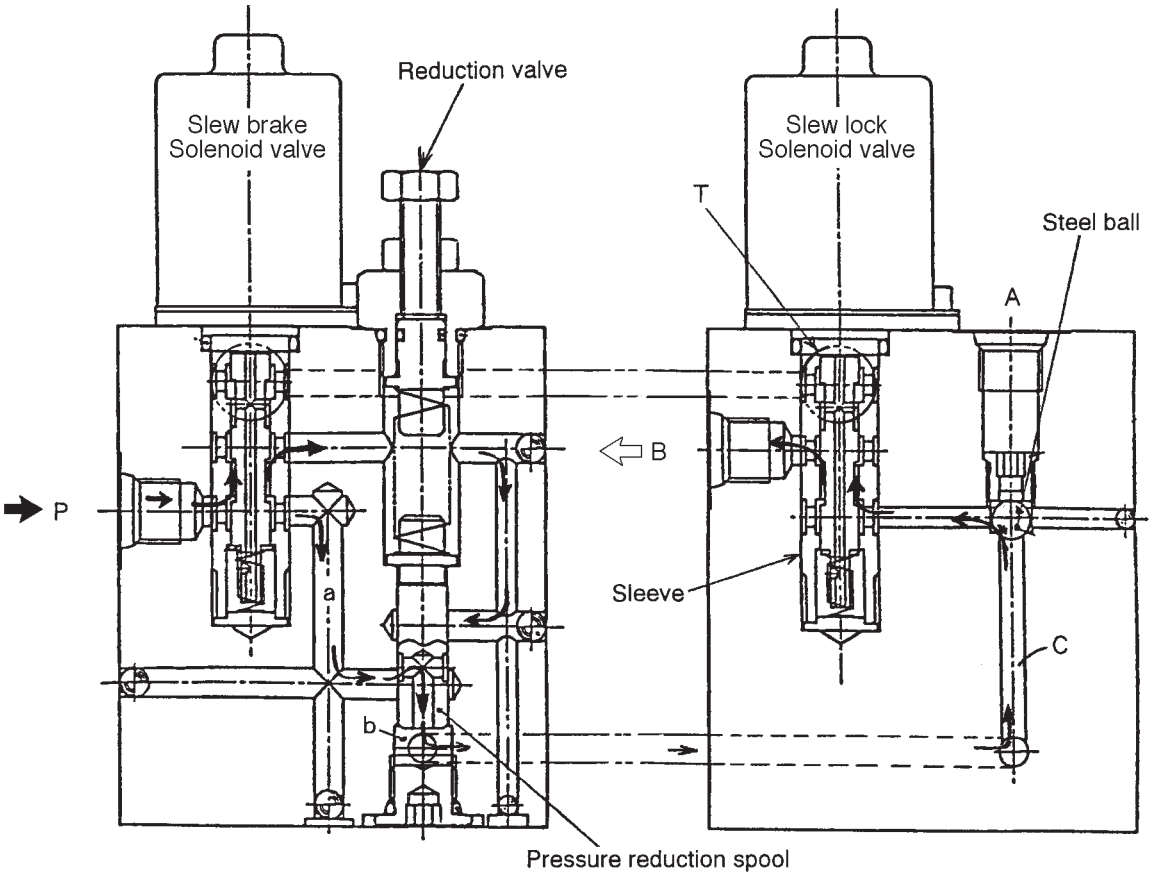
* **Hydraulic Brake Release**

The pilot pressure (40 kgf/cm^2) enters **P** port of **A** section and passes through the outer periphery of the sleeve of the solenoid valve for slew brake and enters passageway **a**.

It then passes the lower side of the inner passage way of the reducing spool and enters gallery b. Gallery **b** is connected to the **C** passageway of the **B** section.

The pressurised oil which entered **C** passageway pushes up the steel ball and passes through the outer periphery of the spool of the solenoid valve for slew lock and exhausts through **B** port. The pressure of 40 kgf/cm^2 enters the brake gallery of the slew motor and releases the mechanical brake.





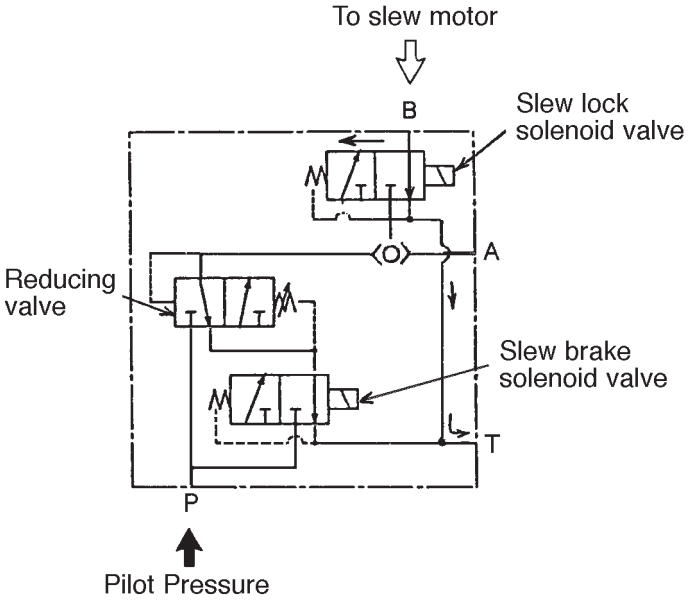
Operation *(continued)*

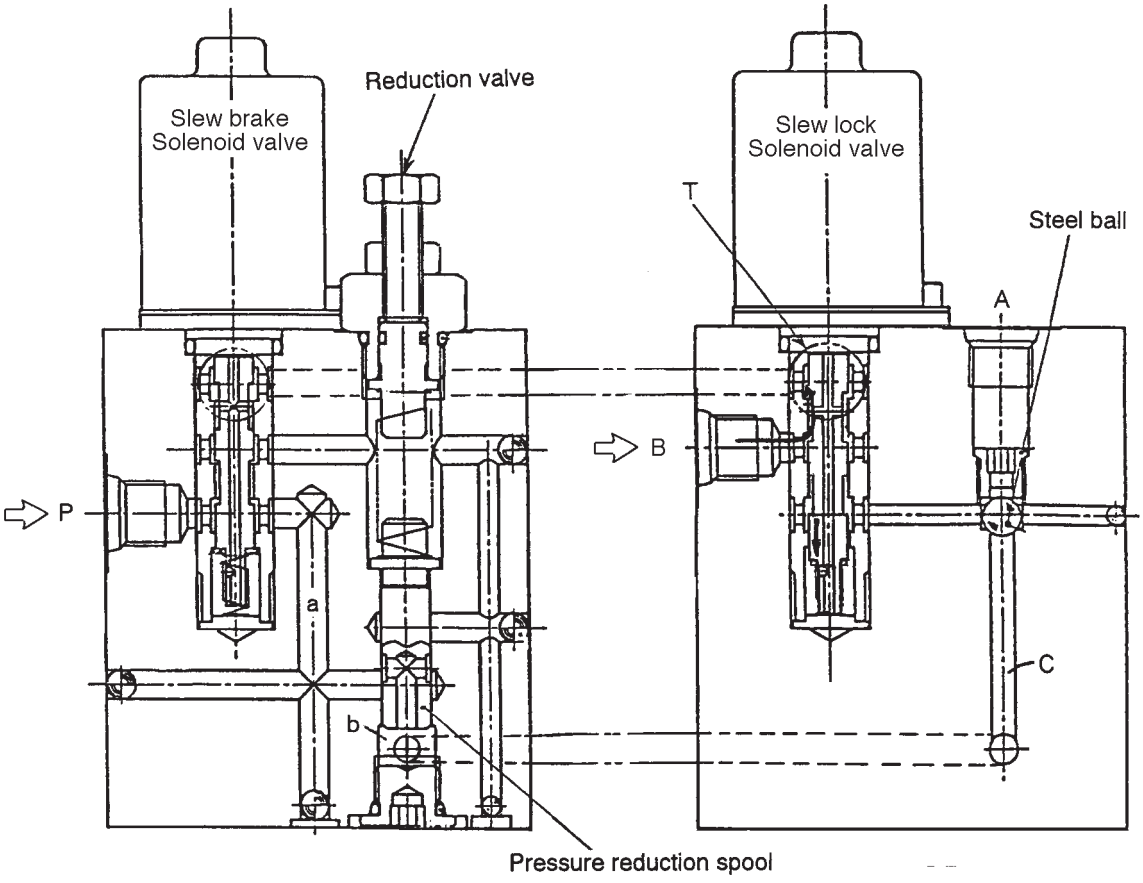
* **Hydraulic Slew Brake - 100% Engagement**

When the solenoid valve for slew lock is put **ON** (locking the slew lock switch), the spool moves downwards. The pressurised oil from passageway **C** is stopped by the spool.

Also, the pressurised oil from port **B** of the slew motor flows through the spool passage and to the tank port.

Because the pressurised oil for brake release runs off to the tank due to the solenoid for slew lock being selected, the slew motor brake gallery pressure is fully applied onto the brake.





Operation *(continued)*

* **Hydraulic Slew Brake - 50% Engagement**

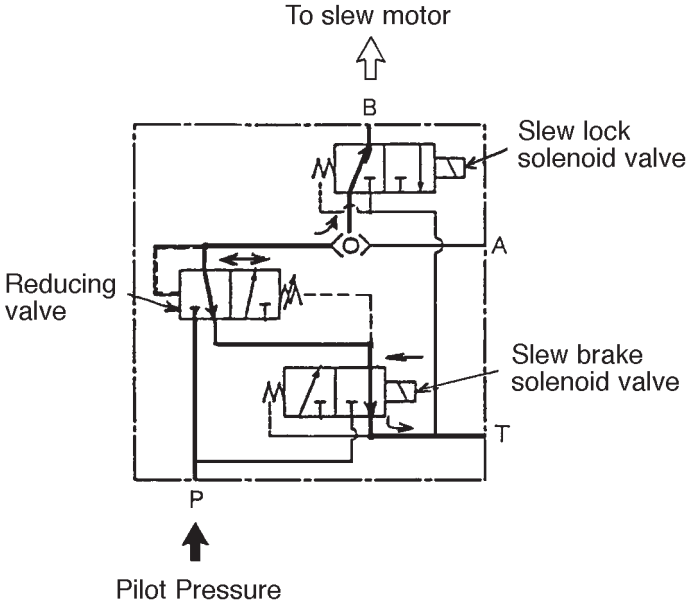
When the slew lever is placed in neutral and 5 seconds have passed, an electric signal enters the solenoid valve for slew brake from the controller and the spool is selected. *(In the figure, it moves down-ward)*.

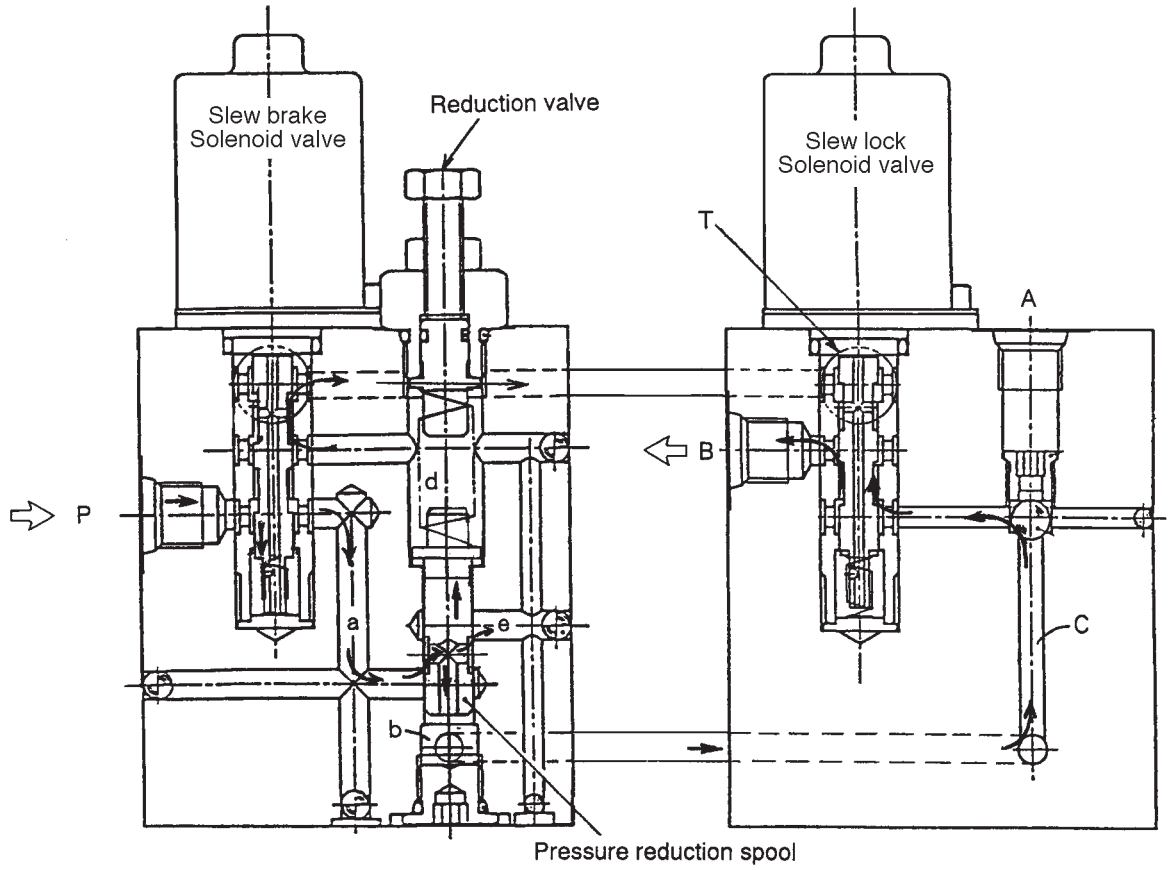
The oil of the spring cavity **d** of the reducing pressure spool is connected to the tank passageway.

The pressurised oil which enters through **P** port flows to gallery **a** , **b** and tries to push up the reducing spool.

The pressurised oil is throttled from gallery **b** and flows to **e** and **d** and then the tank. Also, it flows from gallery **b** to **c** to the solenoid valve for slew lock to **B** to the brake gallery of the slew motor.

The reducing valve rises by a set amount only and oil enters the brake gallery of the slew motor, applying the brake at 50%.





Specifications

Ram	JS200/JS200LC		JS240/JS240LC	
Boom Ram Left & Right	Cylinder Inside Diameter: Rod Diameter: Max. Contraction: Stroke: Dry Weight:	125mm 85mm 1790mm 1295mm 176kg	Cylinder Inside Diameter: Rod Diameter: Max. Contraction: Stroke: Dry Weight:	130mm 90mm 1843mm 1278mm 214kg
Dipper Ram	Cylinder Inside Diameter: Rod Diameter: Max. Contraction: Stroke: Dry Weight:	135mm 100mm 2150mm 1580mm 275kg	Cylinder Inside Diameter: Rod Diameter: Max. Contraction: Stroke: Dry Weight:	150mm 105mm 2234mm 1632mm 341kg
Bucket Ram	Cylinder Inside Diameter: Rod Diameter: Max. Contraction: Stroke: Dry Weight:	120mm 80mm 1583mm 1012mm 146kg	Cylinder Inside Diameter: Rod Diameter: Max. Contraction: Stroke: Dry Weight:	135mm 90mm 1687mm 1073mm 211kg

Precautions during use JS200/JS240

1. Precautions when installing the ram on the machine

When installing and removing from the machine, suspend the ram safely.

Suspending the ram by the piping is not only dangerous, but can also cause damage to the cylinder.
Secure the rod with a band. It is very dangerous if the rod should fly out unexpectedly. Also, the rod can be damaged and become unusable.

Welding after installing the ram may result in damage.

If electric welding is done even at a point away from the ram, there may be sparking inside the ram and it will become necessary to replace the ram with a new one.

When painting the machine, mask the ram.

If paint adheres to the rod surface or to the wiper ring and the ram is worked, the wiper ring cannot function properly and foreign matter from the outside and paint can easily enter the ram and cause damage to the seals, drastically shortening the life of the ram.

Install the ram only when it is clean.

2. Caution During Use

Use only under designated conditions.

If hydraulic oil other than the designated oil is used, the seals quickly degenerate and become damaged. If the relief valve is set at a value higher than specified, it may cause ram damage and is dangerous.
In high temperature environments (Approx. 90°C and above) or low temperature environments (Below -20°C), seals quickly become damaged. Special seal materials are necessary so check to see if the ram that you are using is suitable or not.
The number one cause of ram oil leakage is due to rod damage. Be careful not to damage the rod.

Warm up sufficiently before beginning work.

In cold conditions the rod seals may be frozen so if the ram is operated at maximum pressure and maximum speed, the seals will be damaged.
There is a large amount of air in a new ram or one which has been left for a long time, so the ram will not operate smoothly. Also, if pressure is applied suddenly without bleeding the air, high temperature will be generated due to adiabatic compression and the seals may burn.
Before beginning work, always move the ram at full stroke with no load and expel air from the cylinder.

When stopping or storing, do it at a safe and fixed position.

The installed ram cannot maintain the same position for a long period of time.
The oil inside the ram may leak and due to the temperature change in the hydraulic oil, the hydraulic oil volume changes. For that reason, the ram expands and contracts, causing unexpected movement to the machine which is dangerous. Stop or store the machine in a safe and fixed position.

3. Maintenance, Inspection Points.

Carry out daily maintenance and inspection.

The key point for correct long-term ram function is daily maintenance and inspection. Carry out maintenance and inspection so that the ram functions fully at all times. Always remove any mud, water, dust or oil film adhering to the rod and keep it in normal condition. However, when cleaning the wiper ring and seals, do not get them wet with water but wipe clean with a rag. If leaving for more than one week, apply anti-rust oil to the rod surface.

Use genuine JCB parts when replacing parts.

If parts other than genuine JCB parts are used, the desired results may not be obtained. Use only genuine JCB parts.

Caution during disassembly and reassemble.

Disassembling the ram while it is still installed on the machine can be dangerous as unexpected movements of the machine can occur. Remove the ram from the machine and then disassemble.
If reassembled with dirty hands, foreign matter can enter the ram causing a shorter life span and also the other hydraulic equipment may be damaged. Reassemble in a clean state.
Follow the instructions in the diagrams regarding torque tightening for screwed parts. If the torque is too high or too low, it can cause damage.

Bucket Ram
Removal

⚠ WARNING

Hydraulic Pressure

Hydraulic fluid at system pressure can injure you. Before disconnecting or connecting hydraulic hoses, stop the engine and operate the controls to release pressure trapped in the hoses. Make sure the engine cannot be started while the hoses are open.

INT-3-1-11/1

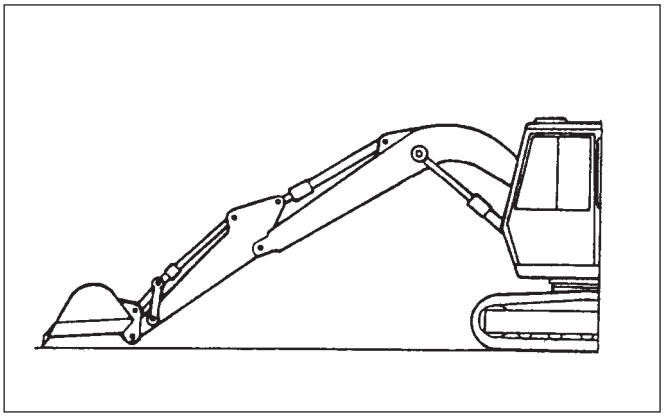
⚠ WARNING

Lifting Equipment

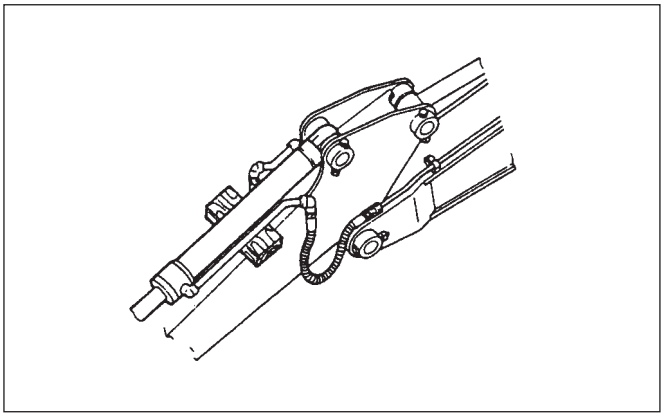
You can be injured if you use faulty lifting equipment. Make sure that lifting equipment is in good condition. Make sure that lifting tackle complies with all local regulations and is suitable for the job. Make sure that lifting equipment is strong enough for the job.

INT-1-3-7

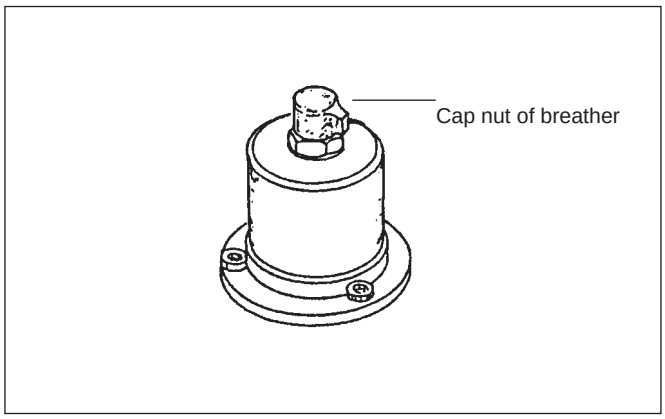
1. Prepare the Machine, and lower the attachment to the ground.



2. Place a wooden block under the bucket ram.

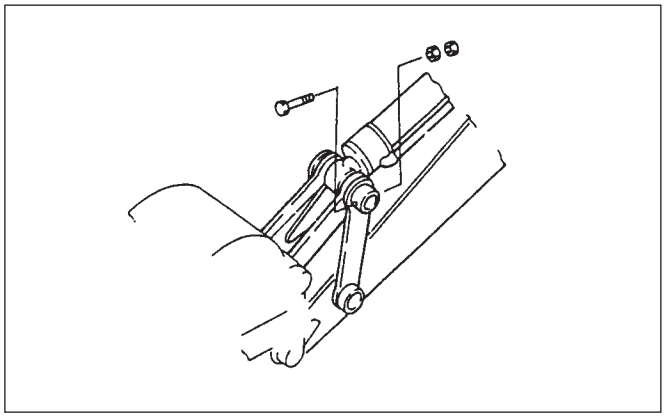


3. Stop the engine, remove the key.
Release the Tank pressure, ***see Releasing the Tank Pressure*.**

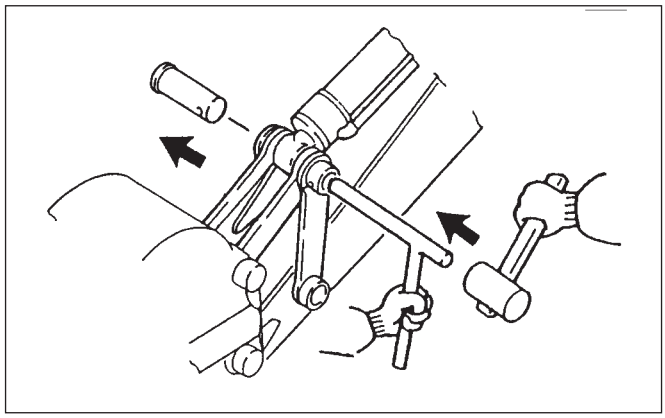


Bucket Ram *(continued)*

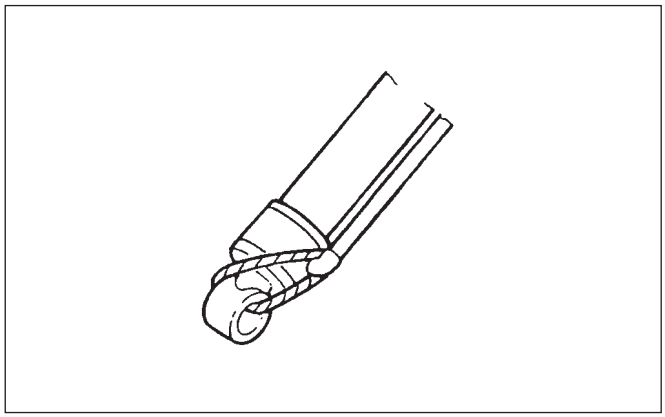
4. Remove nuts and bolts.



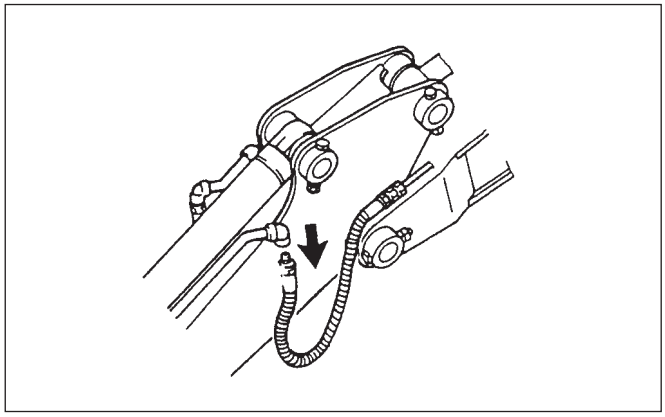
5. Push the pin out using a bar and hammer.



6. Restrain the eye end of the bucket ram rod to the ram cylinder to prevent the ram rod from extending.

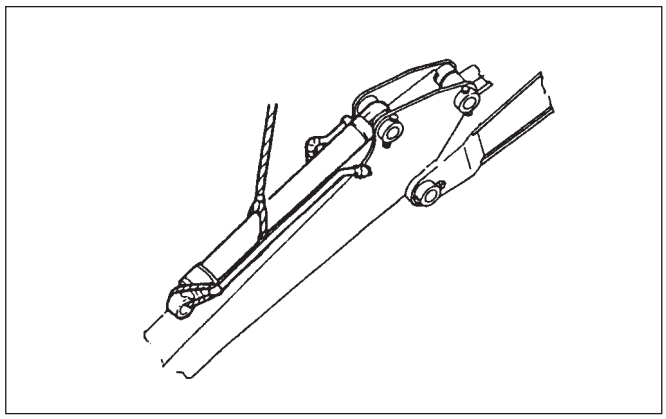


7. Remove the bucket ram hoses, and install plugs or caps to prevent contamination.

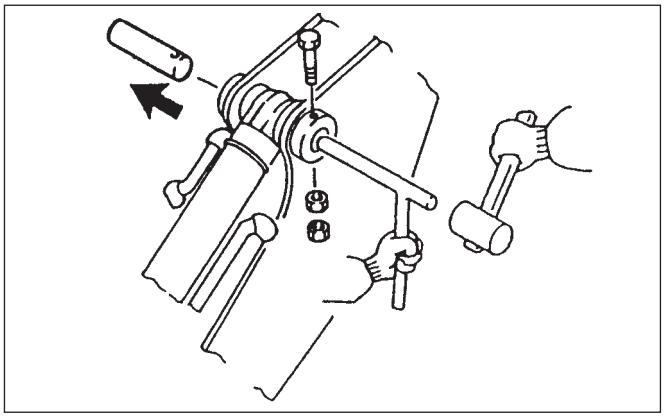


Bucket Ram *(continued)*

8. Attach a sling and lift the bucket ram.

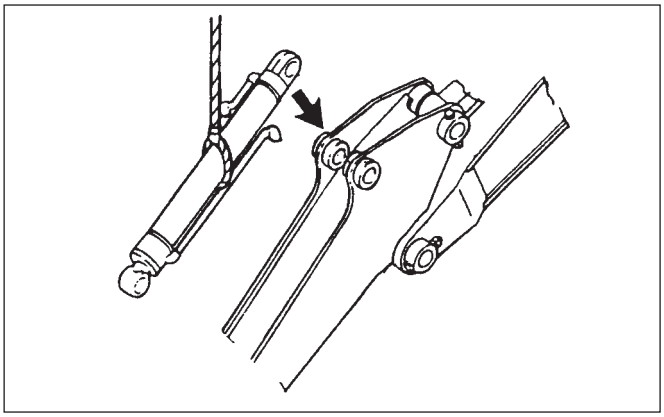


9. Remove the nuts and bolts. Push out the pin using a bar and hammer.

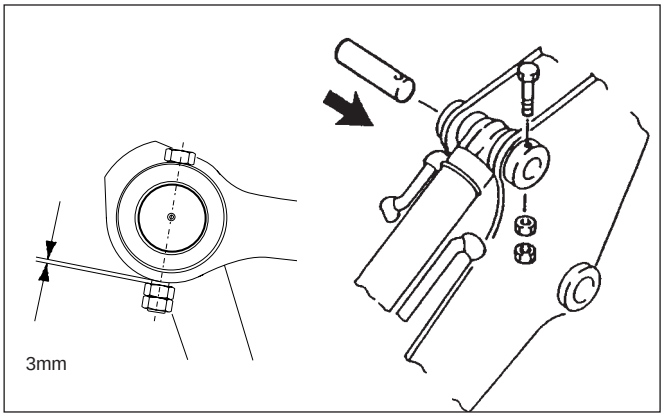


Installation

1. Attach a sling to the bucket ram and lift it into the dipper.

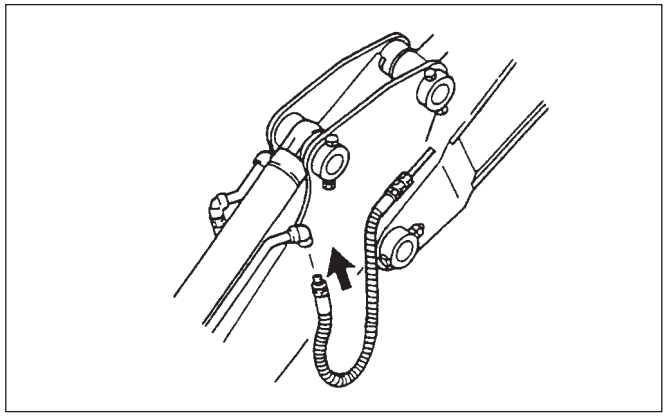


* **2.** Install the pin, bolt and nuts. When checking or refitting JS machine pivot pins, the retaining nuts and bolts should not be fastened up tight but must have approximately 3mm of play so that the pin is free from tension.

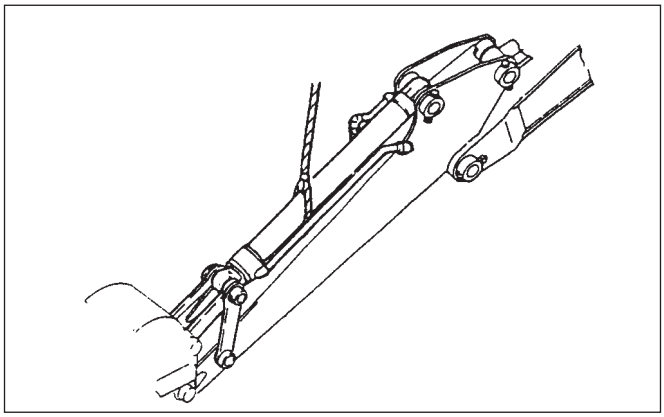


Bucket Ram *(continued)*

3. Connect the hose to the bucket ram.

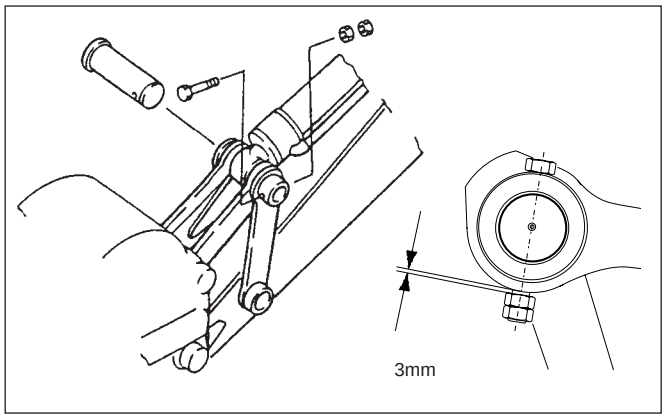


4. Hoist the bucket ram to align with the link.



* **5.** Install the pin, bolt and nuts. When checking or refitting JS machine pivot pins, the retaining nuts and bolts should not be fastened up tight but must have approximately 3mm of play so that the pin is free from tension.

Note: *Stroke the ram to release entrapped air. After releasing the air, check for oil leakage*



Dipper Ram

WARNING

Hydraulic Pressure

Hydraulic fluid at system pressure can injure you. Before disconnecting or connecting hydraulic hoses, stop the engine and operate the controls to release pressure trapped in the hoses. Make sure the engine cannot be started while the hoses are open.

INT-3-1-11/1

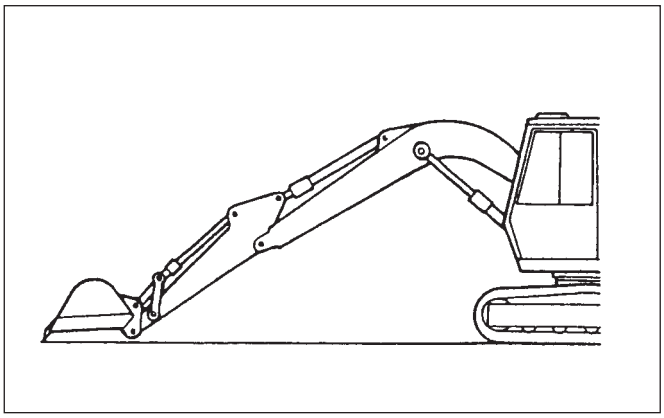
WARNING

Lifting Equipment

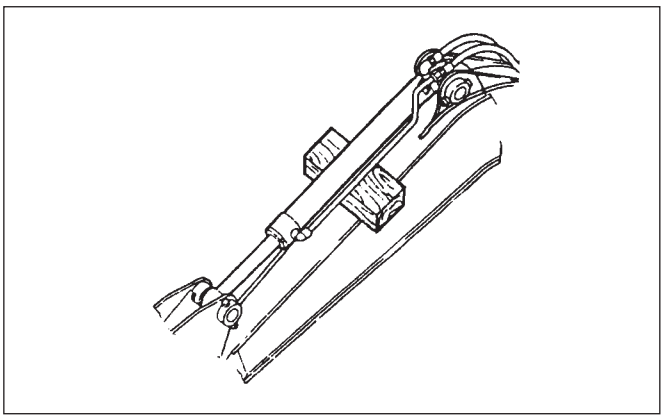
You can be injured if you use faulty lifting equipment. Make sure that lifting equipment is in good condition. Make sure that lifting tackle complies with all local regulations and is suitable for the job. Make sure that lifting equipment is strong enough for the job.

INT-1-3-7

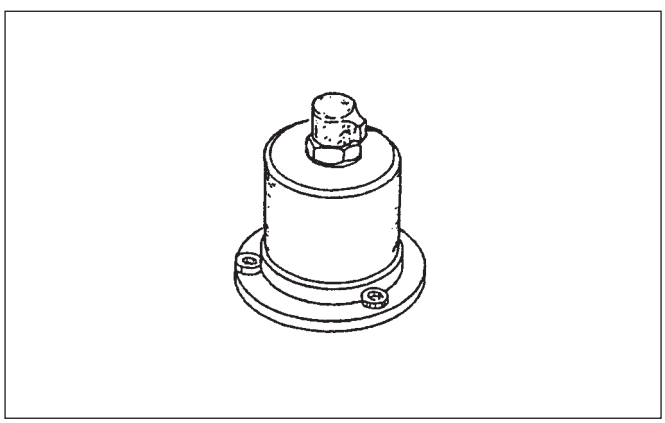
1. Prepare the Machine, and lower the attachment to the ground.



2. Place a wooden block under the Dipper ram.

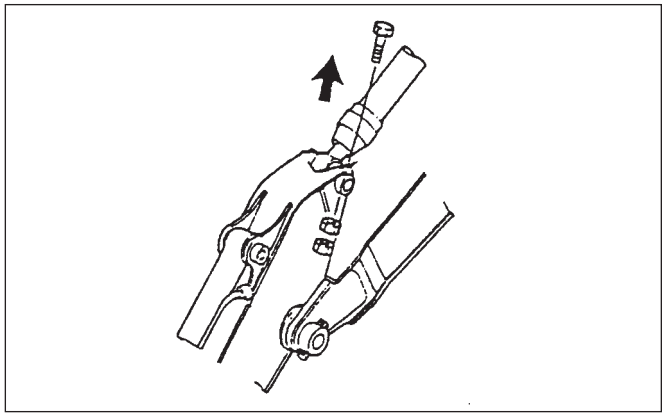


3. Stop the engine, remove the key.
Release the Tank Pressure.
See Releasing the Tank Pressure.

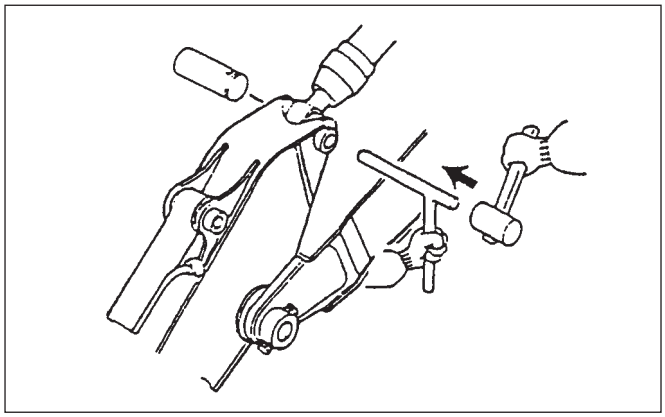


Dipper Ram *(continued)*

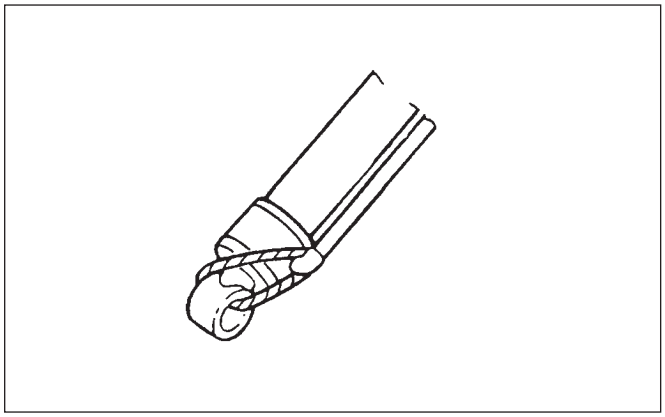
4. Remove the nuts and bolts.



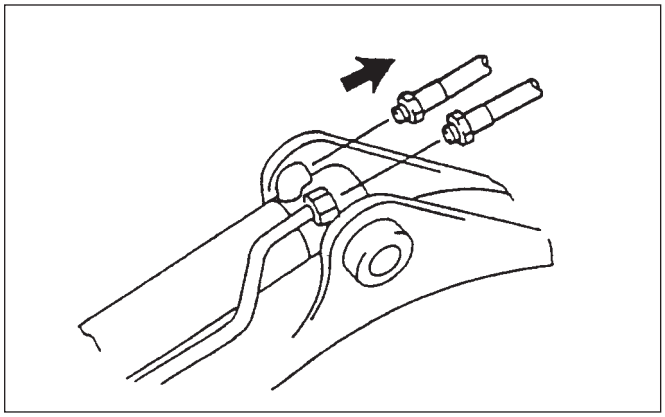
5. Push out the pin, using a bar and hammer.



6. Restrain the eye end of the Dipper ram rod to the ram cylinder to prevent the rod from extending.

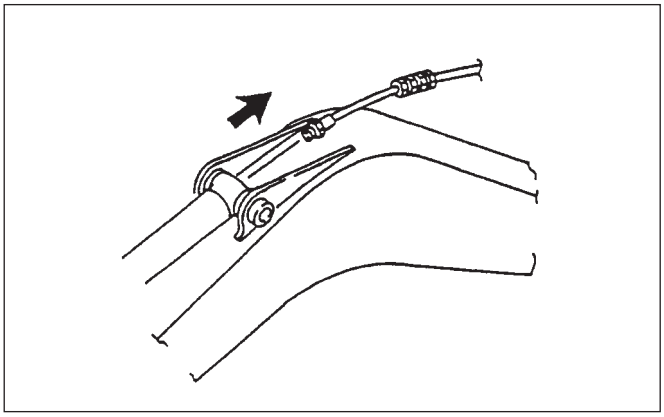


7. Remove the Dipper ram hoses, and install plugs or caps to prevent contamination.

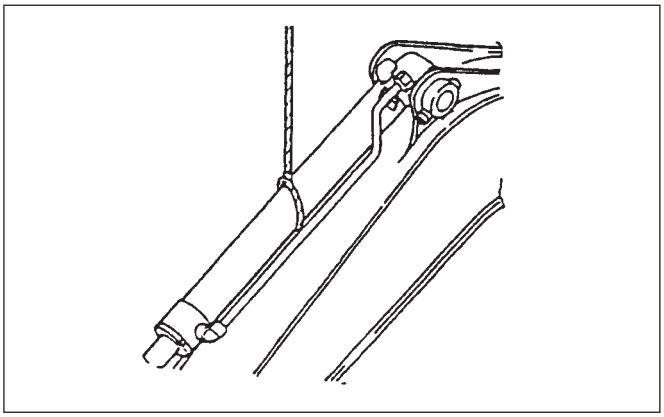


Dipper Ram *(continued)*

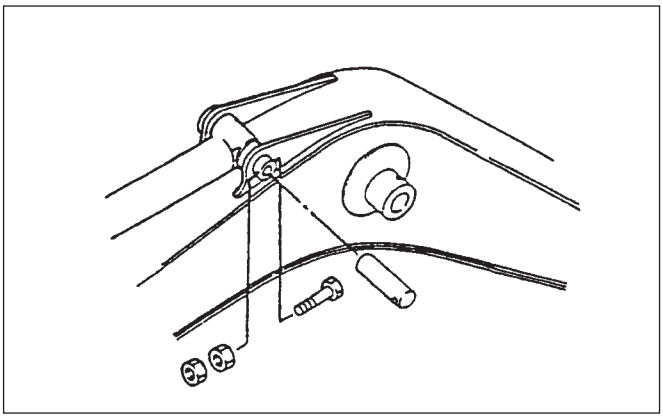
8. Remove the grease tube, from the Dipper ram.



9. Attach a sling and lift the Dipper ram.

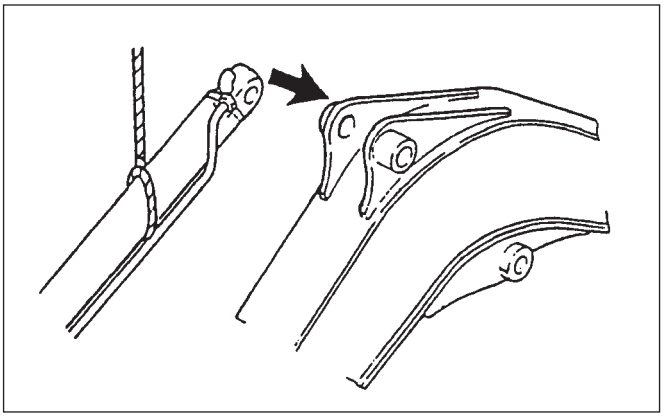


10. Remove the nuts and bolts, push out the pin using a bar and hammer. Lift the ram from the boom.



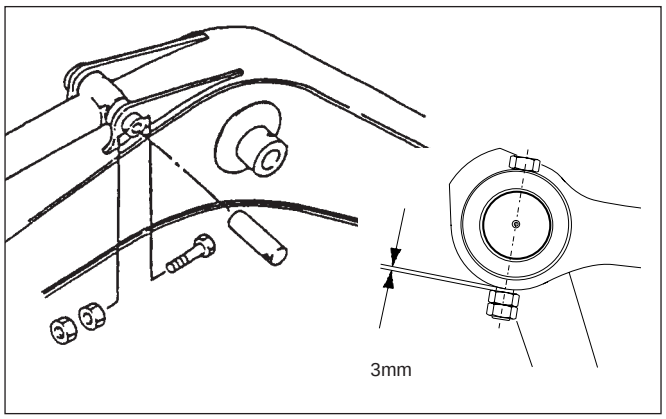
Installation

1. Attach a sling and lift the Dipper ram onto the boom.

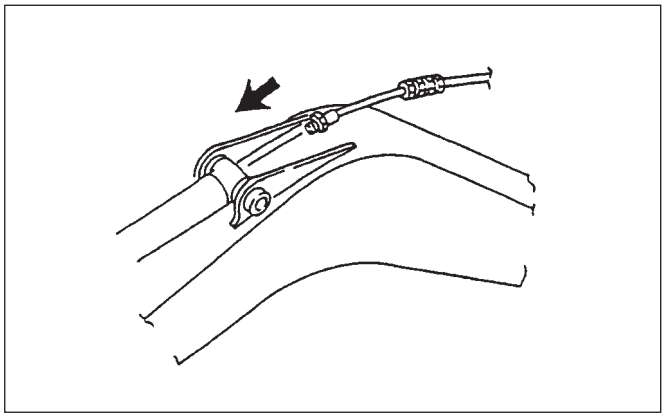


Dipper Ram *(continued)*

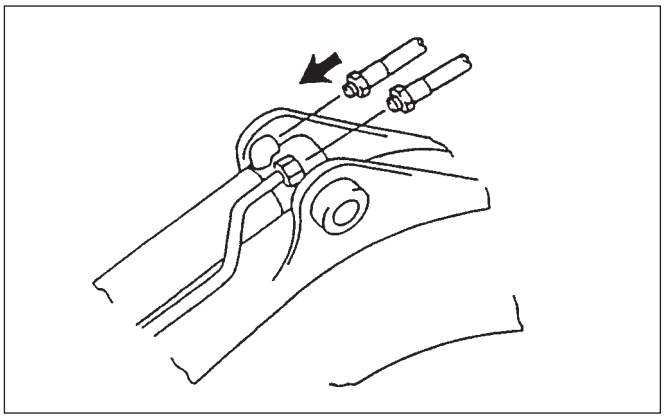
* **2.** Install the pin, bolts and nuts. When checking or refitting JS machine pivot pins, the retaining nuts and bolts should not be fastened up tight but must have approximately 3mm of play so that the pin is free from tension.



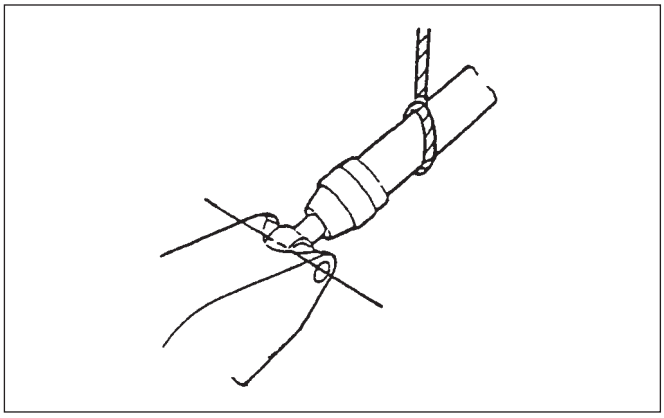
3. Install the grease tube to the Dipper ram.



4. Connect the hoses to the Dipper ram.



5. Hoist the Dipper ram to align the ram eye end with the dipper pin position.

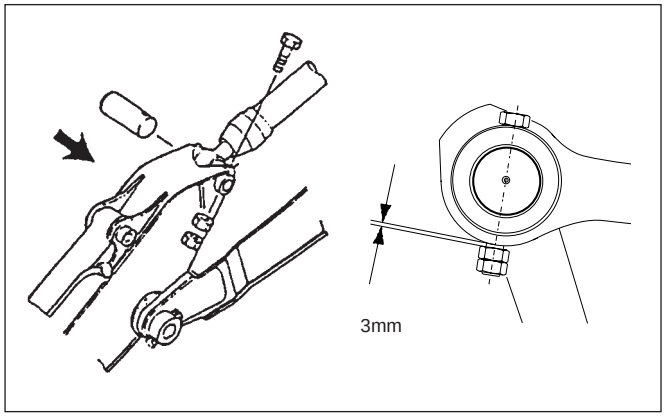


Dipper Ram*(continued)*

*

6. Install the pin, bolt and nuts. When checking or refitting JS machine pivot pins, the retaining nuts and bolts should not be fastened up tight but must have approximately 3mm of play so that the pin is free from tension.

Note: *Stroke the ram to release entrapped air. After releasing the air, check for oil leakage.*



Boom Ram

⚠ WARNING

Hydraulic Pressure

Hydraulic fluid at system pressure can injure you. Before disconnecting or connecting hydraulic hoses, stop the engine and operate the controls to release pressure trapped in the hoses. Make sure the engine cannot be started while the hoses are open.

INT-3-1-11/1

⚠ WARNING

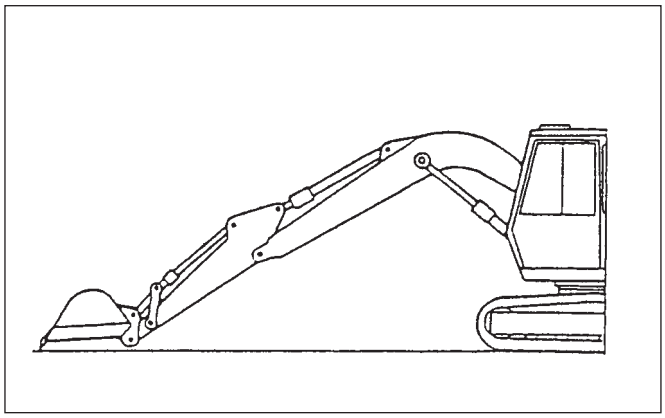
Lifting Equipment

You can be injured if you use faulty lifting equipment. Make sure that lifting equipment is in good condition. Make sure that lifting tackle complies with all local regulations and is suitable for the job. Make sure that lifting equipment is strong enough for the job.

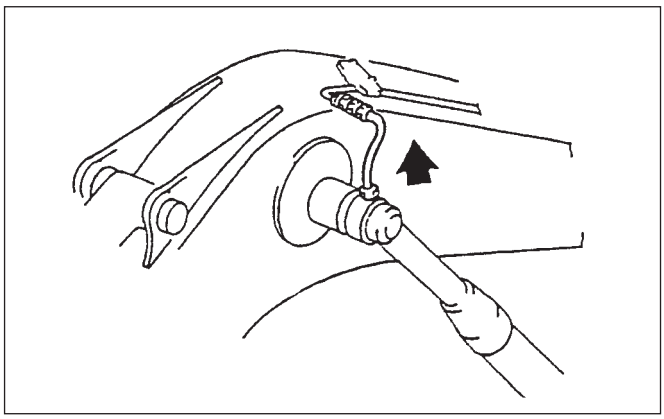
INT-1-3-7

1. Prepare the Machine, and lower the attachment to the ground.

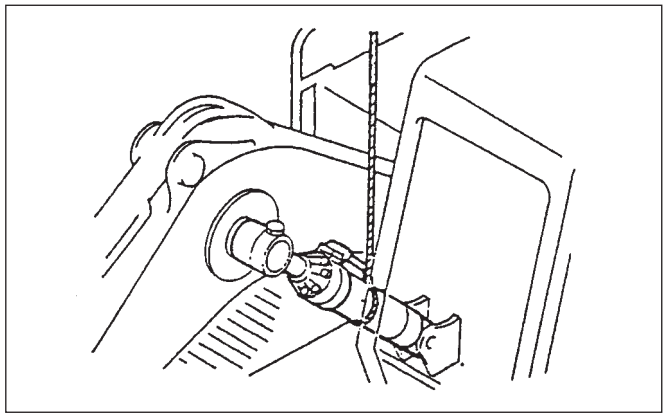
   Stop the engine, remove the key.



2. Remove the greasing tube.



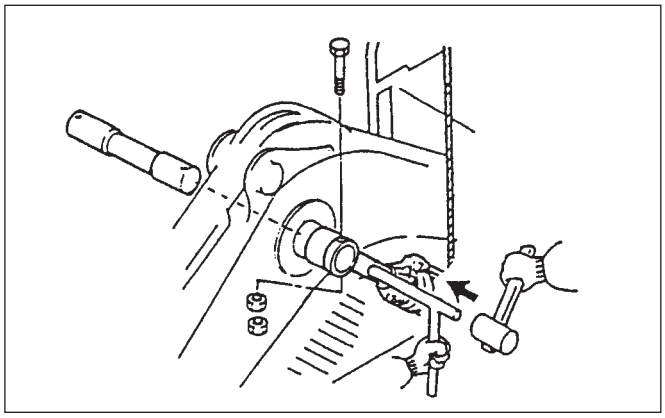
3. Attach a sling for lifting the boom ram.



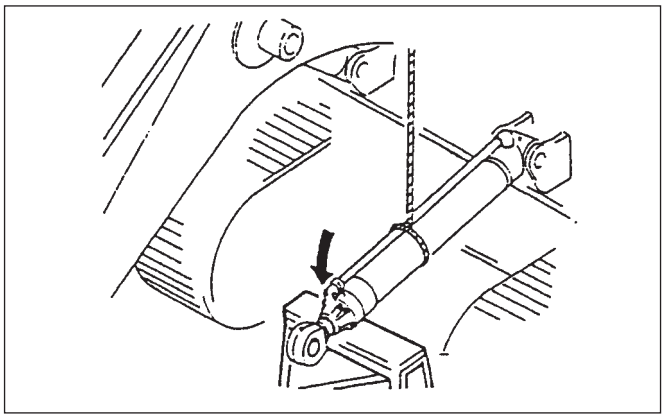
Boom Ram *(continued)*

4. **a.** Remove the nuts, bolt and collar.

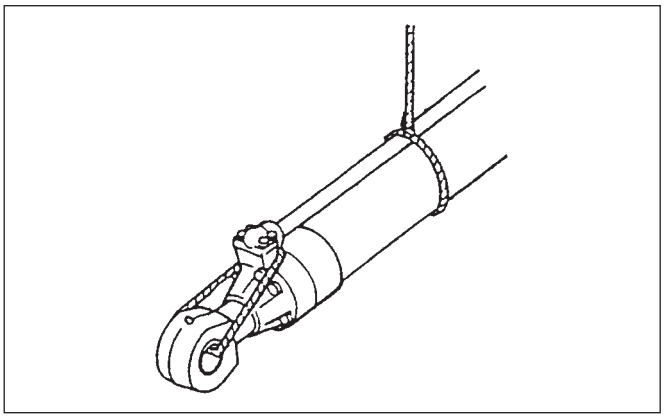
b. Push out the pin, using a bar and hammer.



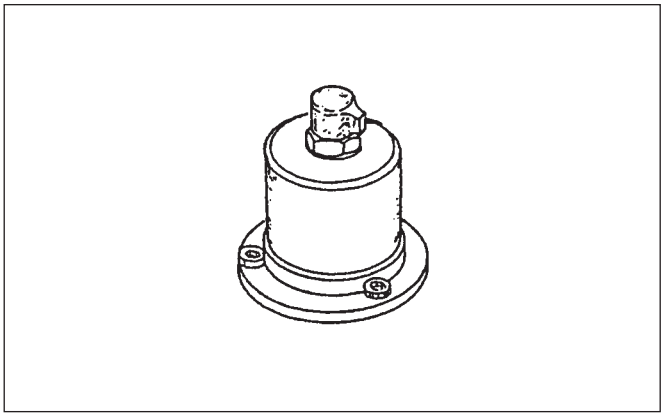
5. Lower the Boom ram and place it on a stand.



6. Restrain the eye end of the Boom ram rod to the ram cylinder, to prevent movement of the rod.

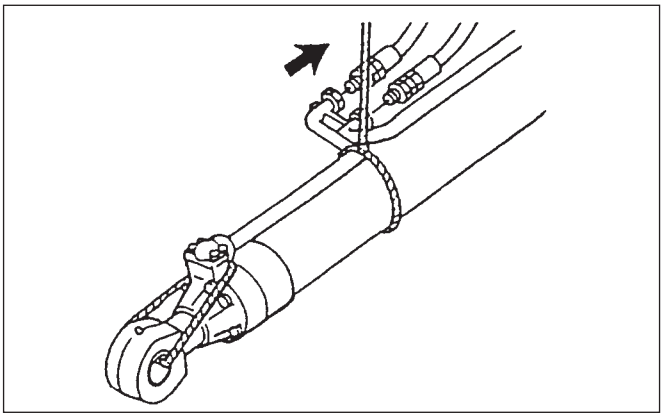


7. Release the Tank Pressure.
See Releasing the Tank Pressure.

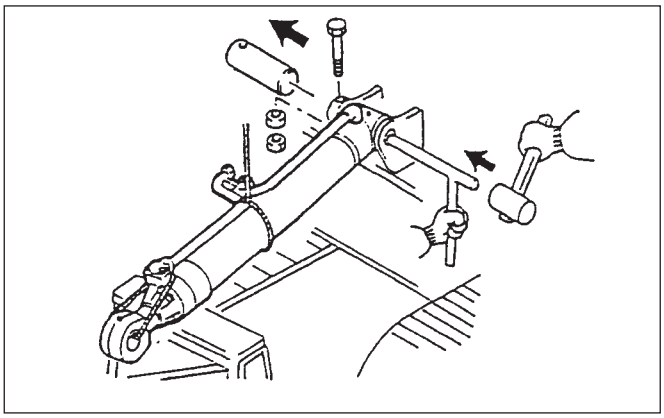


Boom Ram *(continued)*

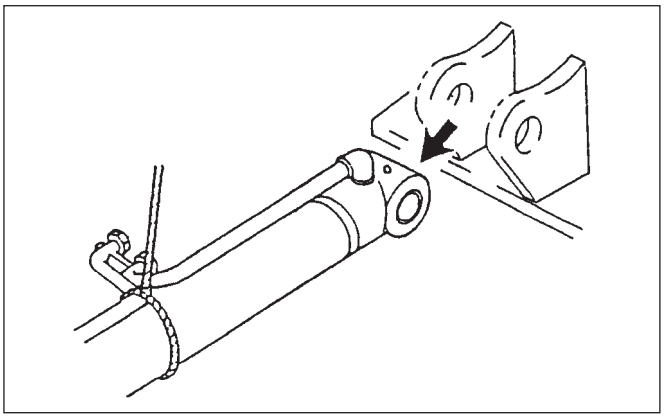
8. Remove the boom ram hoses, and install plugs or caps to prevent contamination.



9. Remove the nut and bolt and push out the pin with a hammer and bar.

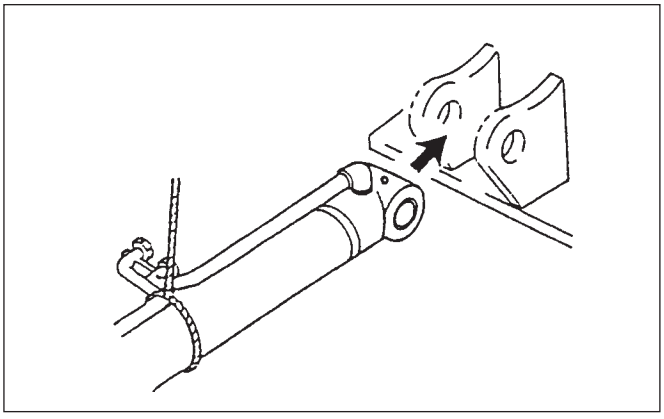


10. Lift the boom ram away from the unit.



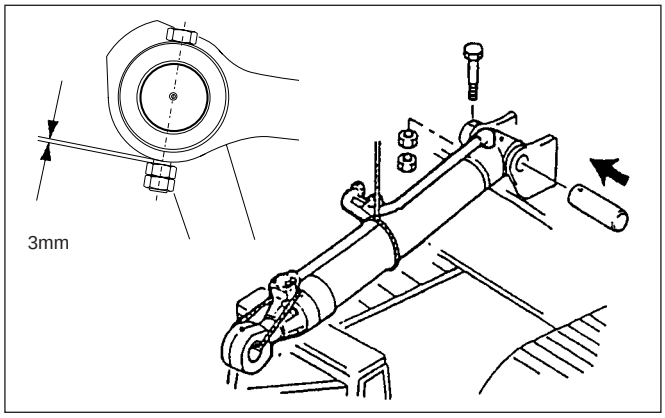
Installation

1. Attach a sling to lift the boom ram.
Align the main frame to the installation position.

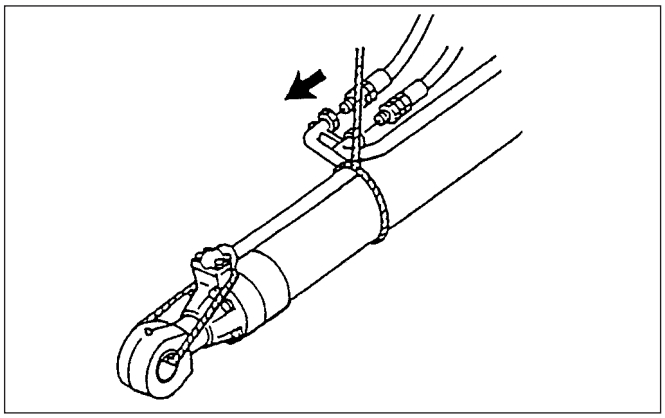


Boom Ram *(continued)*

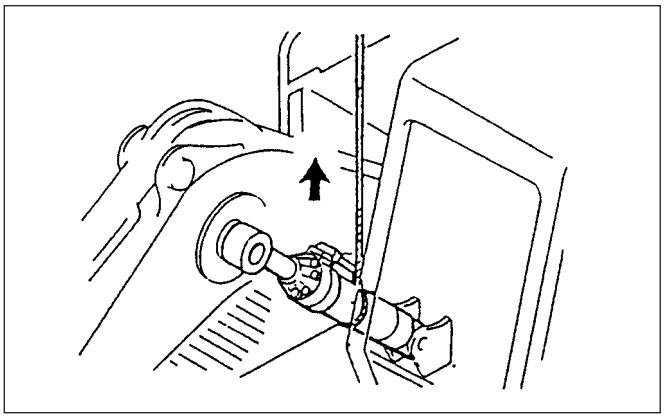
* **2.** Install the pin and then the bolt and nuts. When checking or refitting JS machine pivot pins, the retaining nuts and bolts should not be fastened up tight but must have approximately 3mm of play so that the pin is free from tension.



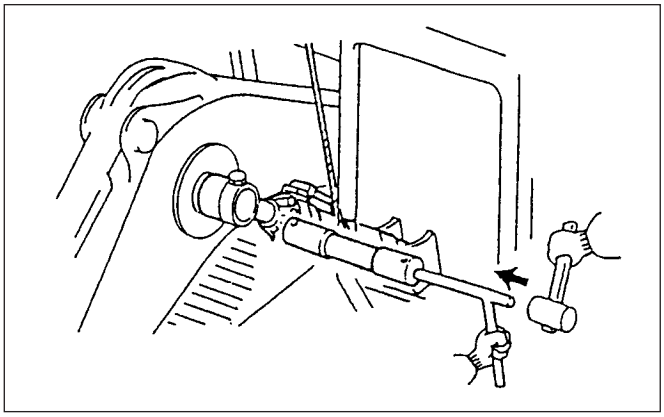
3. Install the hoses to the boom ram.



4. Lift the boom ram and align the rod eye end with boom pin position.

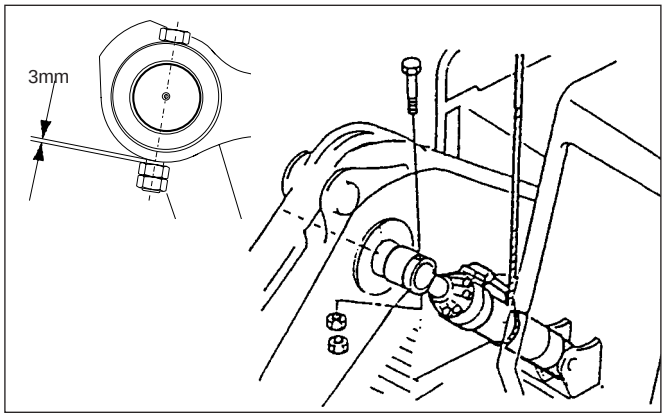


5. Install the pin with a bar and hammer.



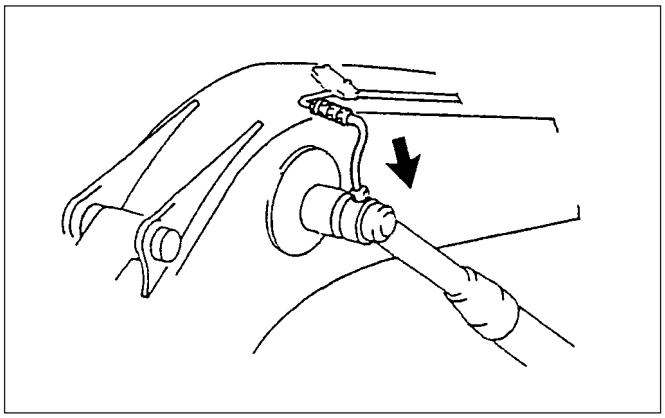
Boom Ram *(continued)*

* **6.** Install the collar and then the bolt and nuts. When checking or refitting JS machine pivot pins, the retaining nuts and bolts should not be fastened up tight but must have approximately 3mm of play so that the pin is free from tension.

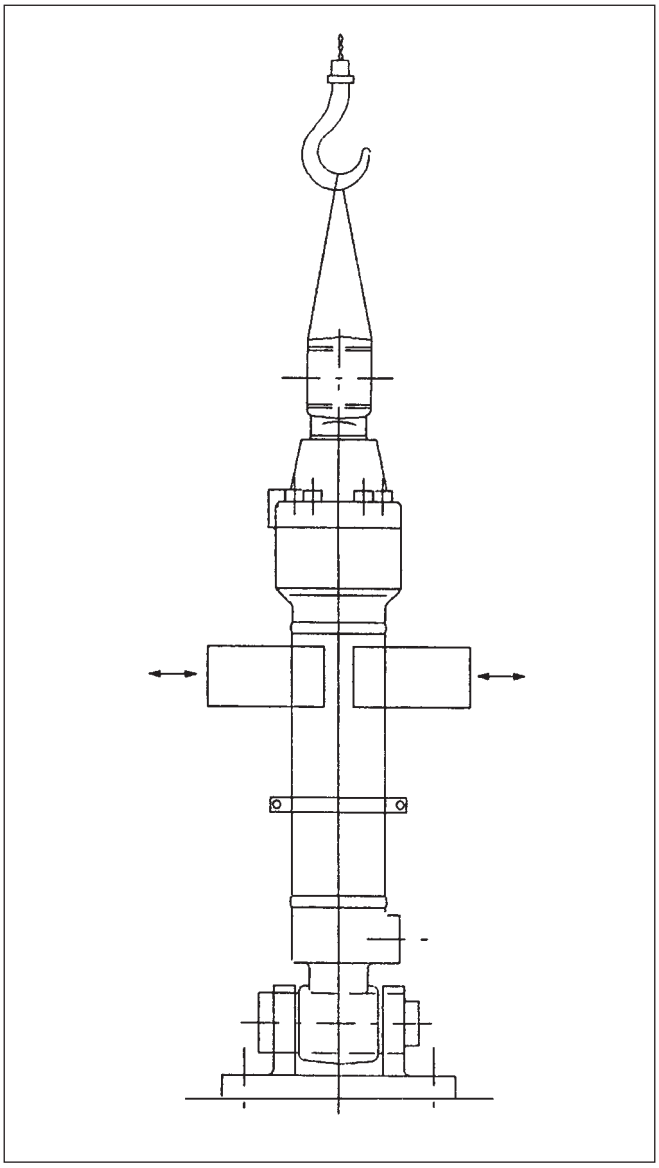


7. Connect the greasing tube.

Note: *Stroke the ram and release entrapped air. After releasing the air, check for oil leakage.*



Disassembly JS200/JS240



Details of Service Tools used in the dismantling and Assembly procedures are given in **Service Tools**, Section 1 .

Before starting work, clean all surfaces with a suitable solvent and dry with compressed air.

Each part is precision made, so handle with care and do not force any part as this may cause damage.

Protect the dismantled parts if they are to be left for a period of time.

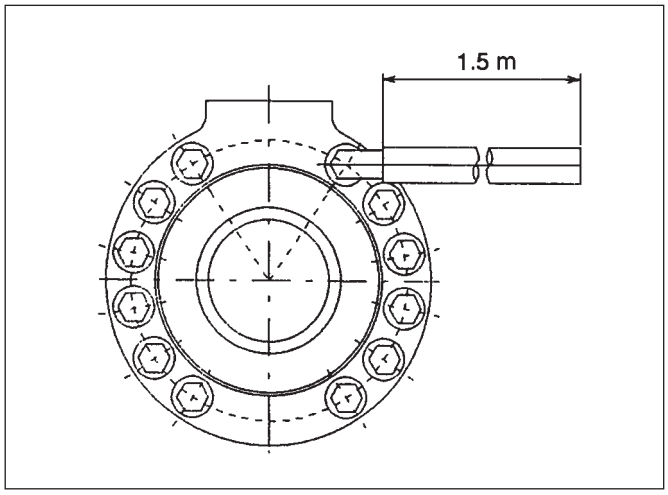
1 Drain the oil

2 Disconnect the external piping.

3 Secure the ram.

* **Note:** Fix the ram in a vertical or horizontal position. The vertical position is more favourable for disassembly/reassembly work. Use the bottom pin hole for preventing the ram from turning on its axis and for fixing the ram in the axial position.

* Remove the cylinder head cap screws (12 off) with an Allen wrench. Use an extension pipe such as shown in the figure below to facilitate bolt loosening.



Disassembly JS200/JS240 *(continued)*

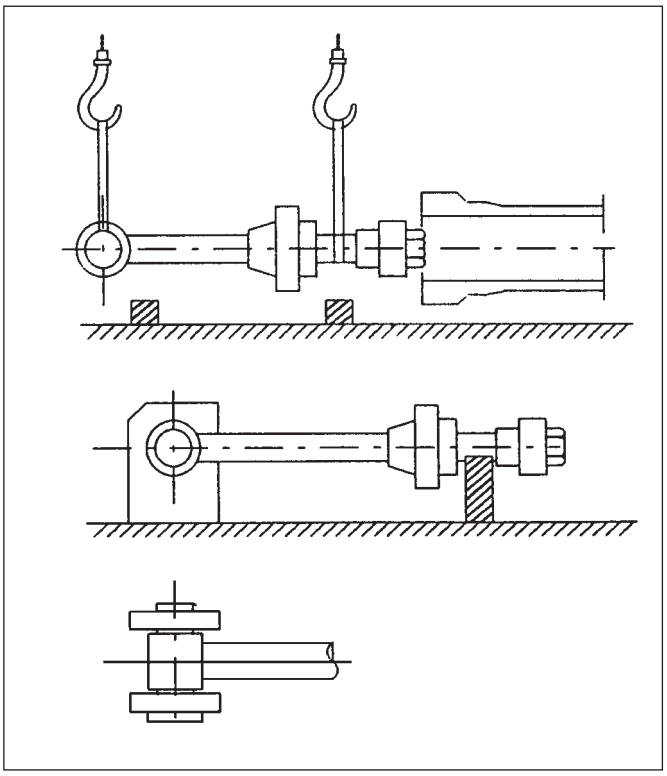
4 Remove the piston rod.

Make sure that the piping ports are opened.

Catch the oil coming out from the rod side (cylinder head side) port.

With the piston rod extended fully, remove the cylinder head carefully.

Lay down the piston rod and the cylinder head together on wood blocks.



* **Note:** Once all the bolts are removed, do not lift the piston rod, as the cylinder may fall suddenly when separating.

⚠ WARNING

* **You can be injured if you use faulty lifting equipment. Make sure that lifting equipment is in good condition. Make sure that lifting tackle complies with all local regulations and is suitable for the job. Make sure that lifting equipment is strong enough for the job.**
INT-1-3-7

⚠ WARNING

* **Raised equipment can fall and injure you. Do not walk or work under raised equipment unless safely supported.**
13-1-1-6

When pulling out the piston rod from a horizontally positioned ram, be careful to prevent the rod from falling just after it leaves the cylinder. During removal of the piston rod, support it horizontally on blocks.

5 Secure the piston rod.

*

Use the flat rod head or the rod end eye to prevent the piston rod from rotating.

6 Remove the piston nut.

*

Remove the set screw, noting the following:

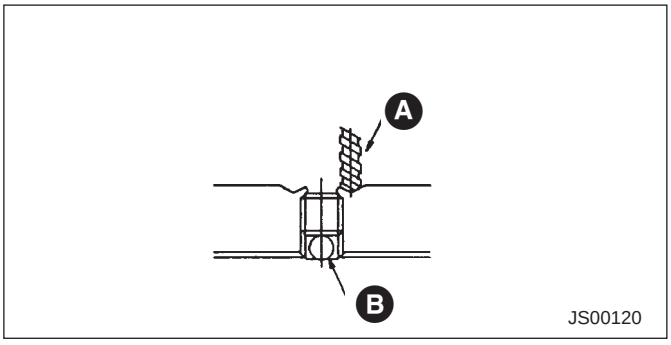
After being installed, the set screw is crimped at two places with a punch.

Remove the crimped portions with a drill **A**, then loosen the set screw. Remove the steel ball **B** located below the end of the set screw.

Remove the piston nut.

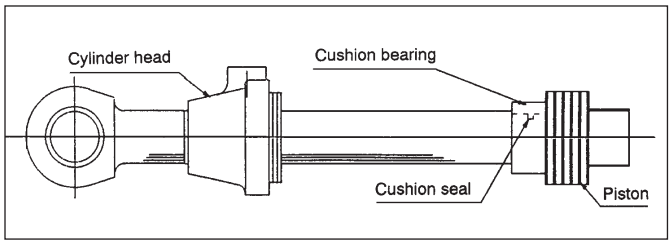
* **Note:** The piston nut was torque tightened on assembly. A torque 1.5 times the tightening torque is necessary to loosen the piston nut. Prepare a power wrench using a hydraulic cylinder (see **Ram Piston Head Nut - Removal and Fitting**).

*



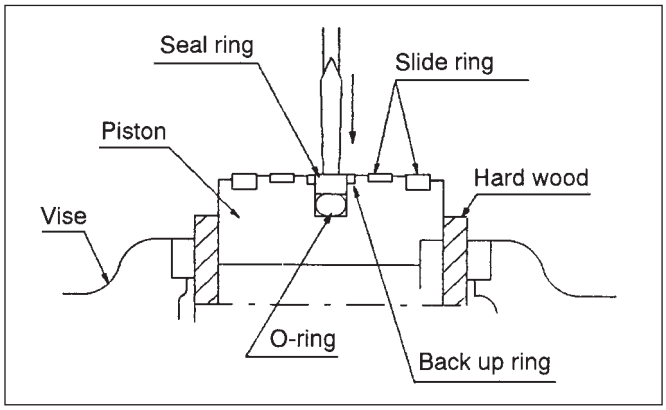
Disassembly JS200/JS240 *(continued)*

Remove the piston, cushion bearing, cushion seal, cylinder head in that order. *(There is no cushion seal for the bucket ram)*.



7. Remove the piston seal.
The slide ring can be easily removed by hand.
To move the seal ring, put a screwdriver against the seal ring as shown and hammer the driver until the seal ring is cut out.
Remove the 'O'-ring by prying it with a pry bar.

Note: *Discard the removed seals. Do not reuse.*

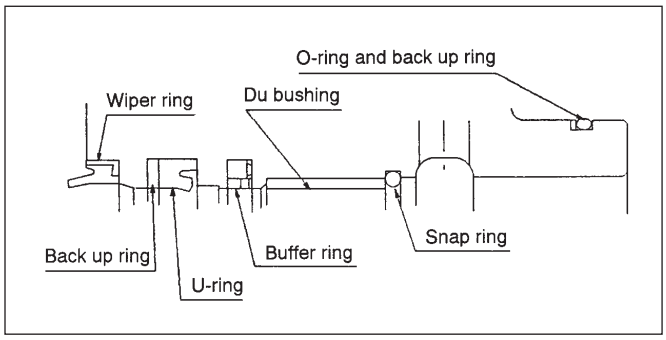


8. Remove the buffer ring.
A buffer ring *(Teflon ring)* is installed in a groove in the cylinder head inside wall. To remove, thrust a sharp-tipped tool into the buffer ring, pull out the ring from the groove to allow insertion of a pry bar under the ring and pry the ring out with a pry bar.

Note: *Discard the removed seals.*

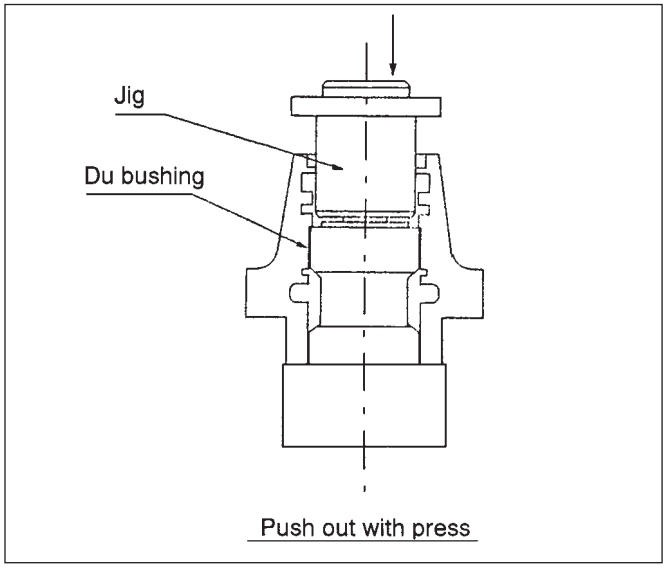
9. Remove the U-ring, back up ring and wiper ring.
Remove the U-ring and back up ring with a screwdriver.
To remove the press-fitted wiper ring, pull it out after thrusting a sharp-tipped tool such as a screwdriver into the rubber of the ring.

Note: *Discard the removed seals.*



10. Removing the Du bushing.
Pry the snap ring with a screwdriver and remove it from the cylinder head.
Remove the Du bushing using a jig and push out with a press.

Note: *Cleaning and storage.*
After cleaning the removed parts with Kerosene, coat with hydraulic oil and cover for storage.
If left as disassembled, rust and dust may adhere and prevent full performance after reassembly.



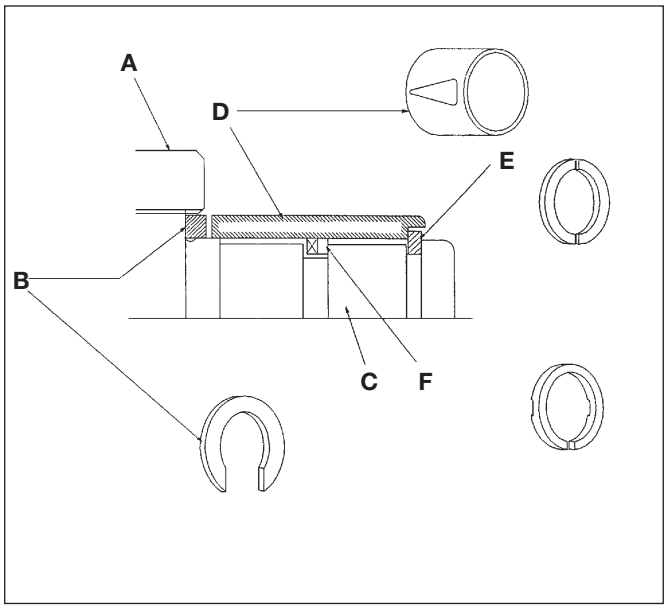
Disassembly JS200/JS240 *(continued)*

11. Dismantling the retraction side cushion (dipper ram).
When there is a cushion bearing installed on the piston rod, after removing the nut **A**, disassemble as indicated below.

a. Tap the snap ring **B** on the piston rod end **C** with a plastic hammer and remove.

b. Push the cushion bearing **D** back so that the stopper **E** can be removed.

c. Pull off the cushion bearing **D** then widen the slit of the cushion seal **F** and remove.



Assembly JS200/JS240

Clean each part in a suitable solvent and dry using compressed air.

Inspect all parts and replace as required.

Care must be taken not to let dust or dirt adhere to parts after cleaning and that parts do not become dented, scratched or damaged.
Fit new 'O'-rings, and seals when assembling together with a new back up ring.

Take care to install the back up ring in the proper position.

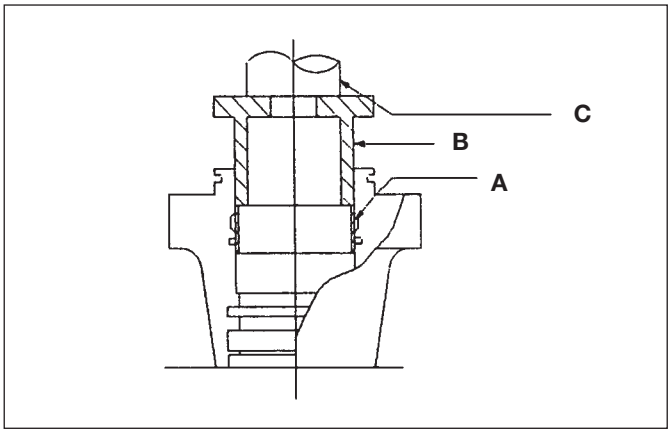
Apply grease and or hydraulic oil to all new oil seals and 'O'-rings, and clean hydraulic fluid to all sliding parts before installation.

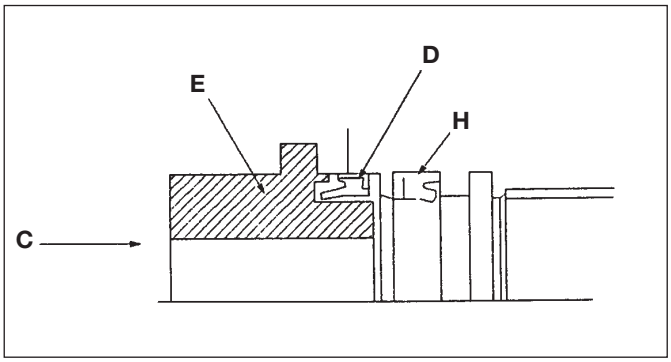
1. Cylinder head assembly.

a. Assemble the Du bushing **A** using a jig **B** and press **C**.

b. Assemble the wiper ring **D** using a jig **E** and press **C**.

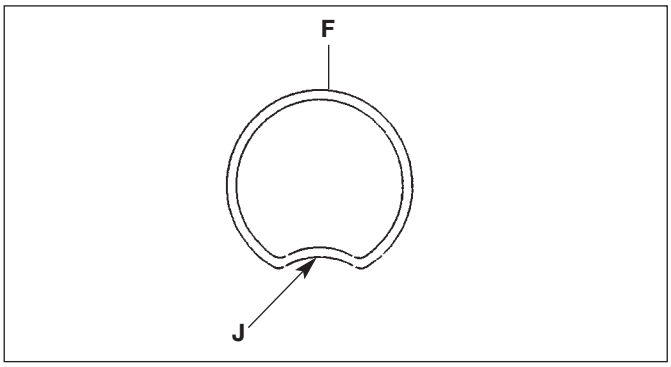
c. Assemble the back up ring **F** and U-ring **G.**





2. Buffer ring assembly.

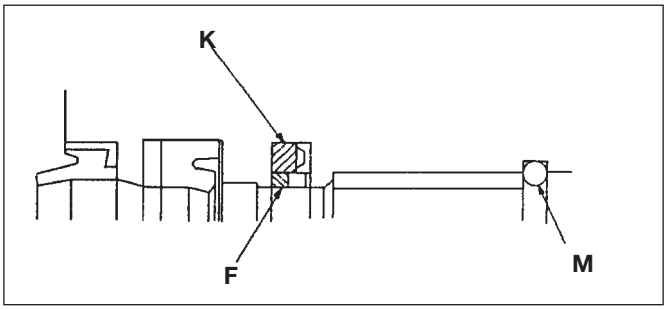
Note: *After installing the square ring K in the groove, bend the buffer ring F into a U-shape (J) and set it in the groove H, then press on the outer circumference of the ring to fit it into place. Bending the ring in too small a radius causes wrinkles which remain in the ring after installation. Keep the bending radius at 6 mm or greater. Make sure there are no wrinkles in the ring after installation.*



Assembly JS200/JS240 *(continued)*

Note: *Be careful to install the seal in the proper direction. Installing it backwards causes extremely high pressure to build up between it and the U-ring and could cause deformation of the cylinder head.*

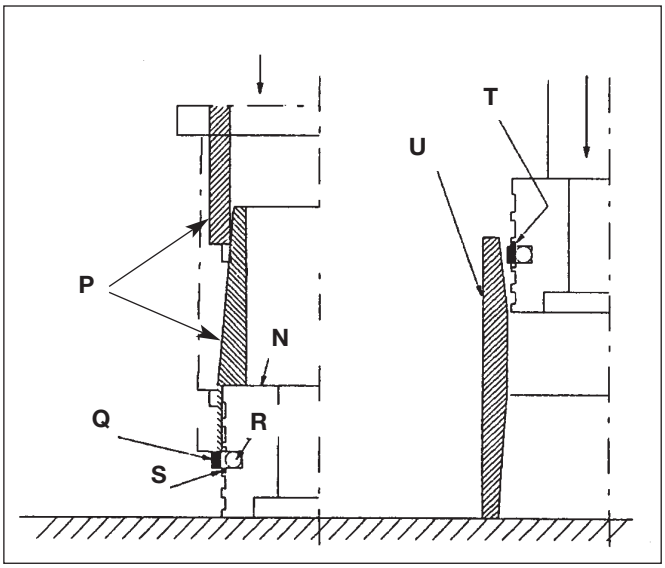
a. Install the snap ring **M** to prevent the Du bushing **A** from coming off.

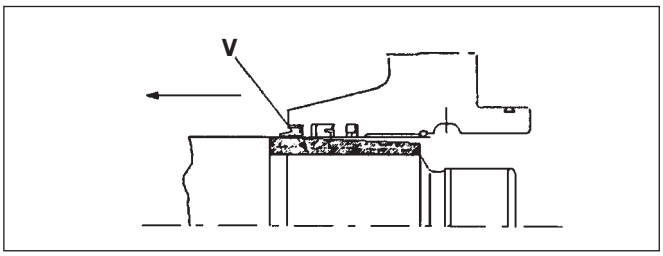


3. Piston Assembly.

a. Place the piston **N** on the press and using the jig **P** as shown, install the seal ring **Q** (pre-assemble the 'O'-ring **R** and one back up ring **S** beforehand).

b. After attaching the seal ring **Q** and one more back up ring **T**, correct the seal ring **Q** with the corrective jig **U** so that it does not remain extended.





4. Piston Rod Assembly.

a. Secure the piston rod.

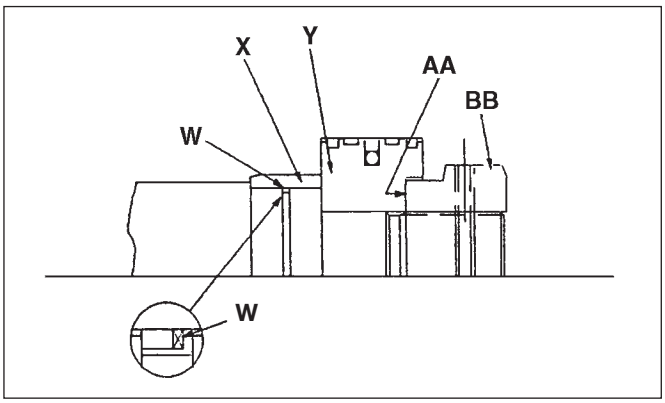
b. Fit the cylinder head onto the piston rod using assembly jig **V**.

Note: *Do not get the wiper ring **D** and the O-ring **H**, caught on the stepped portion.*

c. Fit the cushion seal **W**, cushion bearing **X** and piston **Y** in place.

Note: *The cushion seal W is unnecessary for the bucket cylinder.*

Where there is a cushion at the retraction side (end of piston rod), assemble the cushion bearing as detailed in paragraph 5 before fitting the piston **Y**.



d. Insert a shim **AA** and tighten the piston nut **BB** to the specified torque.

Note: *Face the cushion seal slit **W** towards the piston side.*

Assembly JS200/JS240 *(continued)*

e. After tightening the piston nut **BB**, insert the steel ball **CC** and install the set screw **DD**, tighten it to the specified torque, then stake the set screw in two places with a punch **EE**.

5. Retraction side cushion assembly (dipper ram)
Where there is a cushion at the retraction side *(end of piston rod **JJ**)* assemble the cushion bearing as follows:

a. Expand the slit of the cushion seal **HH** and place the seal on the end of the piston rod **JJ**.

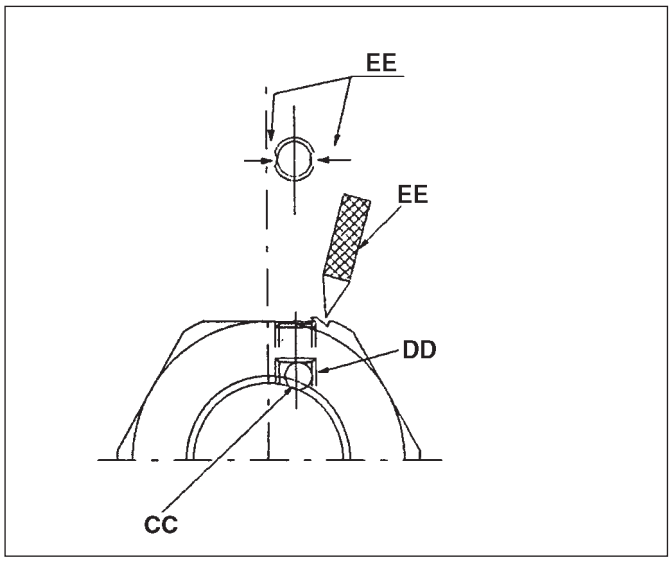
b. Insert the cushion ring **KK** on the **P** surface and install the stopper **LL**.

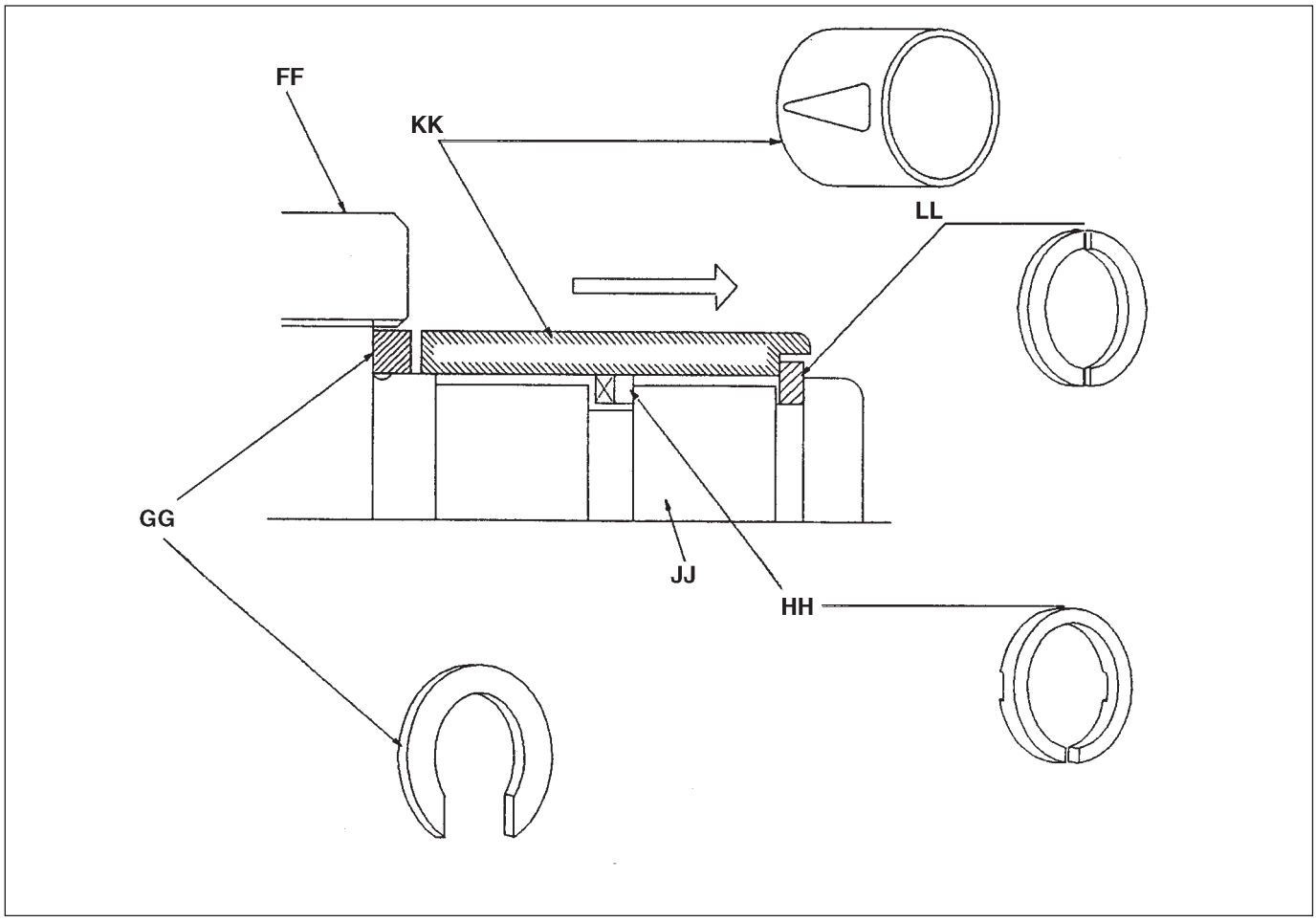
Note: *While fitting the stopper **LL**, take care that it does not break.*

c. More the cushion ring **KK** to the right until it is in contact with the stopper **LL**.

d. Tap the snap ring **GG** with a plastic hammer to install.

e. Install the piston nut **FF** after assembling the snap ring **GG**.





Assembly JS200/JS240 *(continued)*

6. Assemble the piston rod into the cylinder.

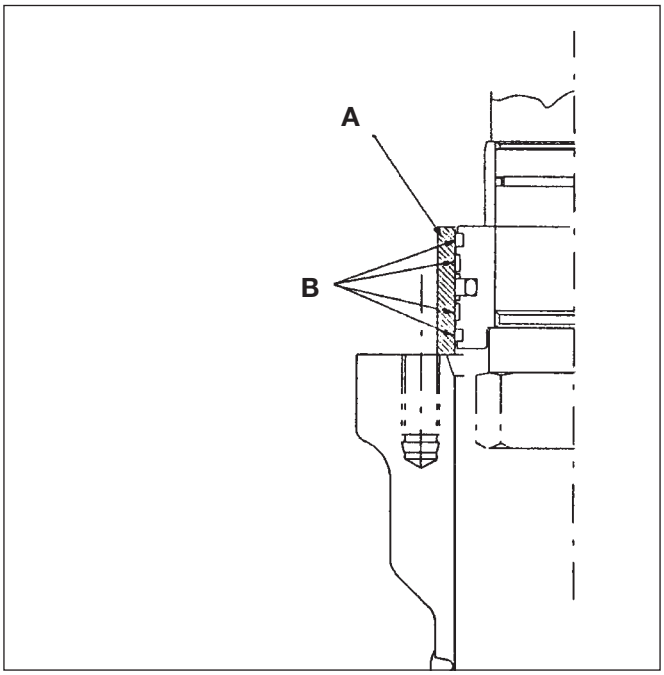
a. Secure the cylinder vertically or horizontally, insert the piston into the cylinder.

b. If the cylinder is vertical the piston rod will enter under its own weight. If horizontal, it must be helped in.

Note: *When inserting the piston into the cylinder take care to prevent the slide rings from falling off.*

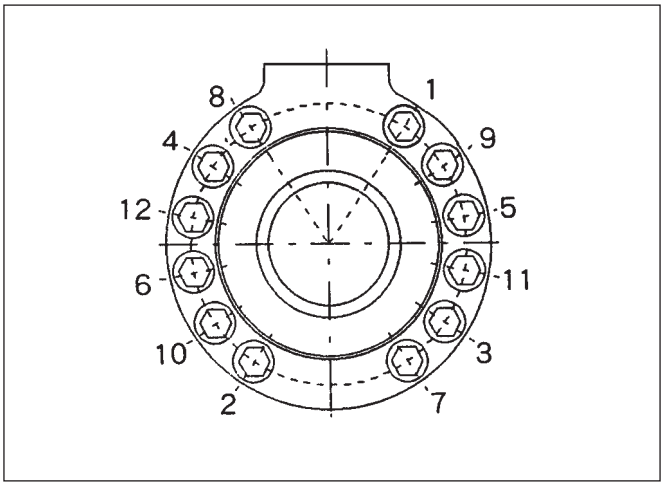
c. Use a jig **A** (split nylon pipe) to compress the slide rings **B** during insertion.

e. Phase the gaps of slide rings **B** at 180°.



7. Position the cylinder head as shown.

Install the mounting bolts, temporarily tighten them in the order shown and re-tighten the bolts to the specified torque in the sequence shown.



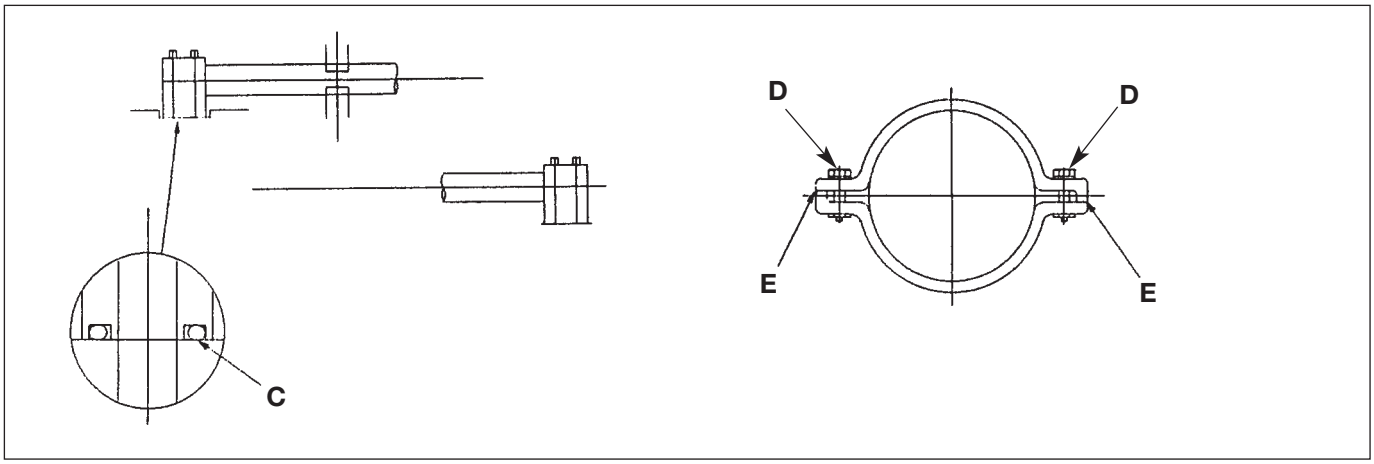
8. Installing the piping.

a. Make sure the 'O'-rings **C** are properly installed in the respective grooves.

b. Fasten the bolts at each port first.

c. Fasten the bolts to the specified torque.

d. Fasten the piping band screws **D** equally on both sides to the specified torque so that the gap clearances **E** are eliminated.

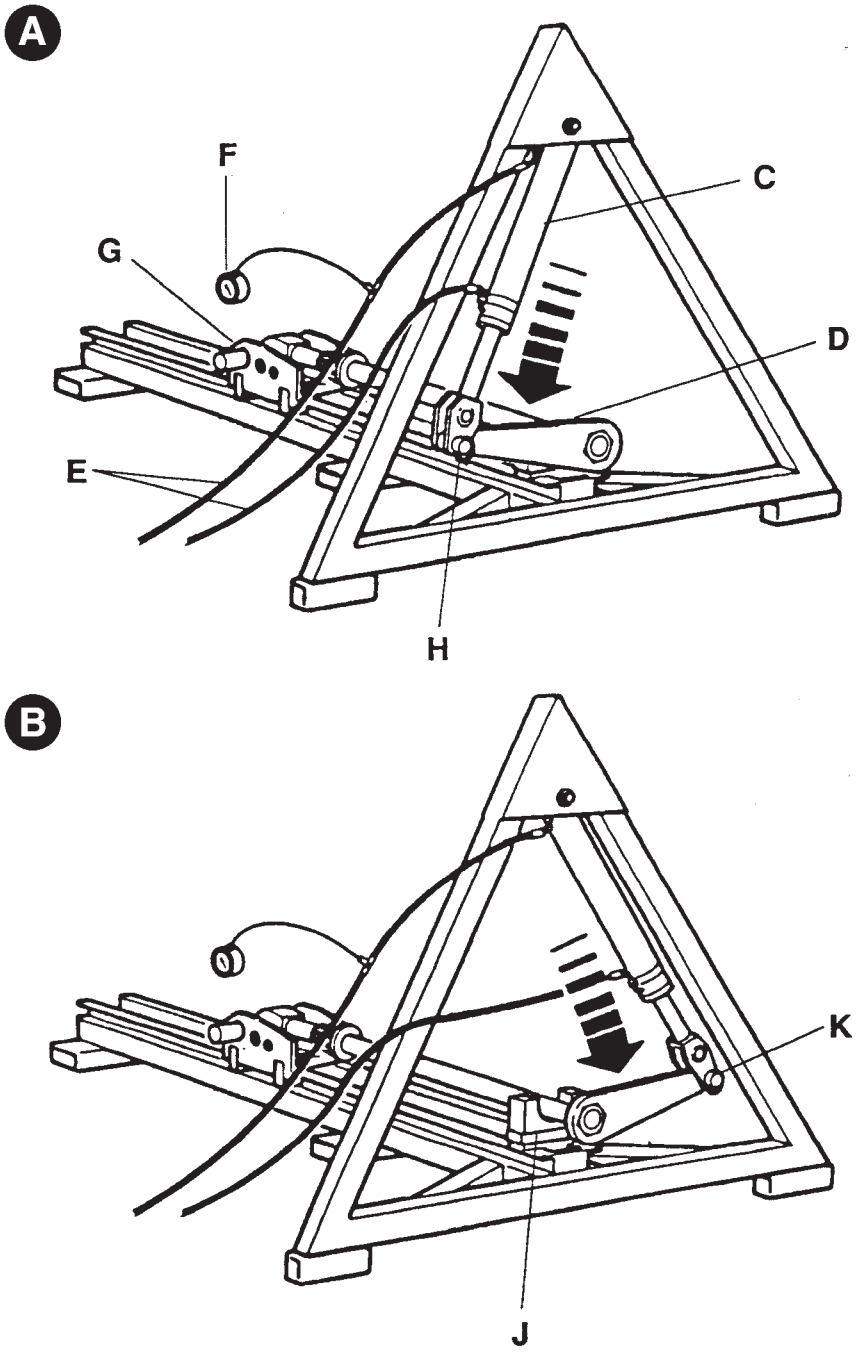


Assembly JS200/JS240 *(continued)*

9. Inspection after Assembly

<table>
<tr><td>No-load Operation Inspection</td><td colspan="6">Operations are smooth and there are no abnormalities with each part after full stroking more than five times with no load.</td></tr>
<tr><td>Measurement</td><td colspan="6">Confirm the maximum extension and stroke.</td></tr>
<tr><td>Inspection</td><td colspan="6">There is no looseness, permanent deformation or outer leakage after applying the test pressure shown in the diagram for three times to each stroke end.</td></tr>
<tr><td>Outer Leakage</td><td colspan="6">Check the oil leakage amount at the rod.</td></tr>
<tr><td rowspan="3">Inner Leakage Inspection</td><td colspan="6">unit ml/10min</td></tr>
<tr><td>inner diameter mm</td><td>oil leakage amount</td><td>inner diameter mm</td><td>oil leakage amount</td><td>inner diameter mm</td><td>oil leakage amount</td></tr>
<tr><td>32
40
50
63
80</td><td>0.4
0.6
1.0
1.6
2.3</td><td>100
125
140</td><td>4.0
5.6
6.0</td><td>160
180
200
220
250</td><td>10.0
12.6
15.6
20.0
22.0</td></tr>
</table>

Ram Piston Head Nut



JS00980

Ram Piston Head Nut (cont'd)

Due to the high piston nut tightening torques used on the rams, it is necessary to use a special rig (see opposite) for ram piston head nut fitting and removal (see **Service Tools** - page 1/5-4 for the component parts of the rig).

As shown in illustrations **A** and **B**, the rig uses a modified lift ram **C** acting on a heavy-duty ring spanner **D** to loosen or tighten the piston nut. Hydraulic power to operate the rig may be obtained from a suitable hydraulic power pack (maximum pressure required 150 bar (2175 lb/in^2) or from the auxiliary circuit of a JCB machine equipped with quick-release couplings. In either case, small bore hoses **E** (Part No. 892/00137 - 2 off) must be used to connect the rig to the power source to limit the speed of operation of ram **C**. In addition **F**, test point (Part No. 892/00262) and pressure gauge (Part No. 892/00279) should be fitted in the line to the piston side of the ram **C** to measure the tightening pressure being applied.

See the table on page 75 -12 for details of the pressure necessary to achieve the required tightening torques.

Nut Removal

It is assumed that the ram has been removed from the machine, hydraulic piping removed and the piston rod assembly separated from the cylinder.

Note: Before using the nut removal/fitting rig, operate the rig cylinder over its full range for 5 or 6 strokes to remove all air from the cylinder.

1 Install the piston rod assembly in the dismantling/assembly rig with the piston rod supported by block **J**.

2 Secure the eye end of the piston rod to the rig at position **G**, using a suitable pivot pin.

3 Fit a ring spanner to the piston nut and connect it to the eye end of ram **C** at position **H**.

4 Power the ram slowly downwards, noting the pressure at which the piston nut first moves on the piston rod. (The pressure should be 1.0 to 1.5 times the tightening pressure for the particular size).

5 Remove the piston nut.

6 Remove the piston rod assembly from the rig and then proceed with dismantling as detailed earlier for individual rams.

Nut Fitting

Before assembly ensure that all components have been thoroughly cleaned and all new seals, backing rings and 'O'-rings are available. Smear all seals, etc. with hydraulic fluid.

1 Assemble the piston rod components as detailed earlier for individual rams.

2 Install the piston rod assembly in the nut removal/fitting rig with the piston rod supported by block **J**.

3 Secure the eye end of the piston rod to the rig at position **G**, using a suitable pivot pin.

4 Fit a ring spanner to the piston nut and connect it to the eye end of ram **C** at position **K**.

5 Using the rig, tighten the piston head nut **H** to the torque specified for individual rams by powering the ram slowly downwards. The torque being applied is indicated by gauge **F** (see table on page 75 - 12).

6 Remove the piston rod assembly from the rig and insert into the ram cylinder as detailed earlier for individual rams.

Ram Piston Head Nut (cont'd)

Nut Fitting (cont'd)

JS200

Ram Location	Piston Nut AF (mm)	Piston Nut Torque Nm (lbf ft)	Gauge Pressure bar (lb/in^2)
Boom	95	5000 (3700)	35 (500)
Dipper	100	9340 (6912)	65 (935)
Bucket	90	7140 (5284)	50 (715)

JS240

Ram Location	Piston Nut AF (mm)	Piston Nut Torque Nm (lbf ft)	Gauge Pressure bar (lb/in^2)
Boom	100	5790 (4285)	40 (580)
Dipper	115	13200 (9769)	90 (1320)
Bucket	100	9340 (6912)	65 (935)

Note: The gauge pressures in the above table assume that the rig is used with spanners having 500 mm centres (see **Service Tools, Hydraulics, Ram Dismantling and Assembly, Spanner Requirements**).

Reconditioning

Structure and Characteristics of Special Jigs for Repair of Rams

Inserting seal ring and correction jig.

a. Jig components

Part no	Part Name	Qty	Note
WDB 2052	Seal ring inserting and correction jig set	1	
	Inner Guide	(1)	
	Outer Guide	(1)	
	Plate	(1)	
	Collection	(1)	

* ***Note:*** *For the above Part No. the tube diameter is 120 mm.*

b. Special characteristics
Because the seal ring is hard, it requires a lot of time to insert it without a special jig. By using the special jig, anyone can insert the seal ring on the piston quickly, easily and accurately without damaging the seal ring.

Bushing removal jig

a. Jig components

Part no	Part Name	Qty	Note
WDB 2166	Jig set for pulling out bushing	1	Also to be used for press-fitting bushing
	Chuck assembly	1	
WDB 2166-1	Retainer	1	Also to be used for press-fitting wiper ring
	Block	1	Prepare locally
	Lever	1	Prepare locally
	Allen wrench	1	

* ***Note:*** *For the above Part No. the tube diameter is 120 mm.*

b. Special characteristics
Because the bushing is press-fitted by the hydraulic press at the central part of the cylinder head, it requires a lot of time and work in order to remove the bushing from the cylinder head quickly, easily and accurately without damaging the inside of the cylinder head.

Reconditioning *(continued)*

Bushing press-fitting jig

a. Jig components

Part no	Part Name	Qty	Note
WDB 2166	Bushing press-fitting jig set	1	Also to be used for removing bushing
	Chuck assembly	1	
WDB 2166-1	Retainer	1	Also to be used for press-fitting wiper ring

* ***Note:*** *The above Part No. indicates those for rod diameter 80 mm.*

b. Special characteristics
If this special jig is used, anyone can press-fit the bushing into cylinder head quickly, easily and accurately without damaging the cylinder head.

Wiper ring press-fitting jig

a. Jig components

Part no	Part Name	Qty	Note
WDB 2166-1	Jig for press-fitting wiper ring (Retainer)	1	Also to be used for removing bushing

* ***Note:*** *The above Part No. indicates those for rod diameter 80 mm.*

b. Special characteristics
By using this special jig, anyone can press-fit the wiper ring easily, quickly and accurately into the specified groove of the cylinder head evenly without deforming or damaging it.

Cylinder head insertion guide jig

a. Jig components

Part no	Part Name	Qty	Note
WDB 2174	Cylinder head insertion guide jig	1	

* ***Note:*** *The above Part No. indicates those for rod diameter 80 mm.*

b. Special characteristics
By using this special jig, anyone can slide the cylinder head assembly onto the piston rod quickly, easily and accurately without damaging any of the seals.

Reconditioning *(continued)*

Jig Table

For inserting and correcting seal ring

Note: The mark O in the table below indicates KCH type.

		Cylinder inner diameter Unit: mm													
		80	90	95	100	105	110	115	120	125	130	135	140	150	160
JS200/ 200LC	Boom									O					
	Dipper											O			
	Bucket								O						
JS240/ 240LC	Boom										O				
	Dipper													O	
	Bucket											O			
	Boom														
	Dipper														
	Bucket														
Jig No.		WSB 2162	WDB 2163		WDB 2049	WDB 2120	WDB 2050	WDB 2051	WDB 2052	WDB 2054	WDB 2164		WDB 2055	WDB 2056	WDB 2057

* **For pulling out and press-fitting bushing**

Note: The mark O in the table below indicates KCH type.

		Piston rod diameter Unit: mm													
		50	55	60	65	70	75	80	85	90	95	100	105	110	
JS200/ 200LC	Boom								O						
	Dipper											O			
	Bucket							O							
JS240/ 240LC	Boom									O					
	Dipper												O		
	Bucket									O					
	Boom														
	Dipper														
	Bucket														
Jig No.							WDB 2165	WDB 2166	WDB 2167	WDB 2168	WDB 2169	WDB 2170	WDB 2171	WDB 2172	

Reconditioning *(continued)*

For press-fitting wiper ring (Can be used for pulling out and press-fitting bushing)

Note: The mark O in the table below indicates KCH type.

		Piston rod diameter													Unit: mm
		50	55	60	65	70	75	80	85	90	95	100	105	110	
JS200/ 200LC	Boom								O						
	Dipper											O			
	Bucket							O							
JS240/ 240LC	Boom									O					
	Dipper												O		
	Bucket									O					
	Boom														
	Dipper														
	Bucket														
Jig No.							WDB 2165-1	WDB 2166-1	WDB 2167-1	WDB 2168-1	WDB 2169-1	WDB 2170-1	WDB 2171-1	WDB 2172-1	

Note: The jig for press-fitting the wiper ring can also be used for pulling out and press-fitting the bushing.
The jig is set for KCH type only.

Jig for inserting cylinder head

Note: The mark O in the table below indicates KCH type.

		Piston rod diameter													Unit: mm
		50	55	60	65	70	75	80	85	90	95	100	105	110	
JS200/ 200LC	Boom								O						
	Dipper											O			
	Bucket							O							
JS240/ 240LC	Boom									O					
	Dipper												O		
	Bucket									O					
	Boom														
	Dipper														
	Bucket														
Jig No.							WDB 2173	WDB 2174	WDB 2175	WDB 2176	WDB 2177	WDB 2178	WDB 2179	WDB 2180	

Note: The jig is set for the KCH type only.

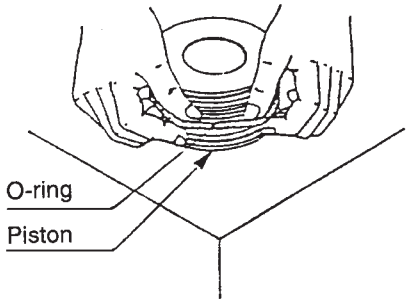
Reconditioning *(continued)*

Jig Usage

Note: The special jigs are different, according to the cylinder diameter, so choose the appropriate jig from the table. The lower part of the inner guide jig is very thin, so be careful with handling and storage.

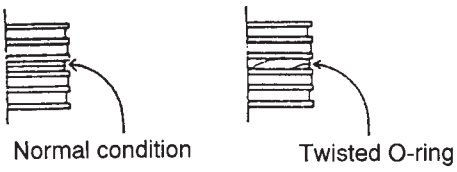
Procedures for inserting, correcting the seal ring.

1. O-ring installation

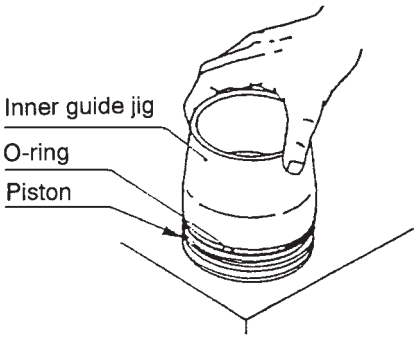


Stretch the 'O'-ring by hand and fit it into the piston groove.

Be sure not to twist the 'O'-ring. A twisted 'O'-ring may cause oil leakage.

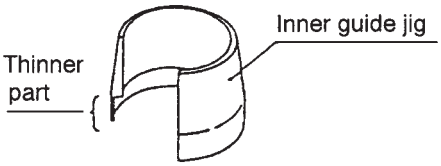


2. Attaching the inner guide jig

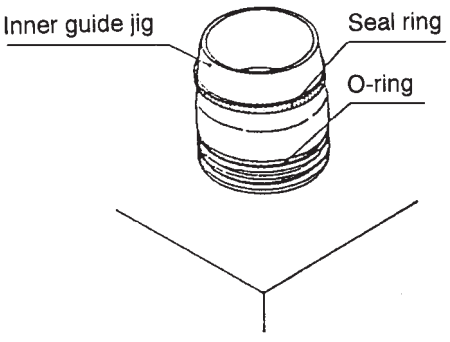


Fit the inner guide jig on the upper section of the piston.

Carefully fit the thinner end of the inner-guide jig on the upper section of the piston.



3. Seal ring installation



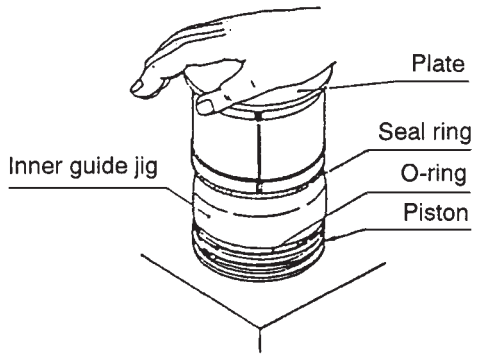
Apply a thin coat of lubricant to the inner guide jig periphery and then set the seal ring on the inner guide jig.

Make sure that any foreign matter like dust, chipped metal and lint do not adhere to the outer surface of the inner guide jig.

Reconditioning *(continued)*

Jig Usage *(continued)*

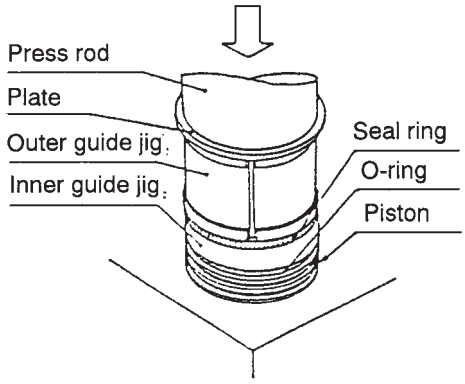
4. Outer guide jig fitting



Put the plate on the outer guide jig and then continue to push the plate by hand until the seal ring touches the outer guide jig.

Be sure to set the seal ring straight on the inner guide jig.

5. Press-fitting

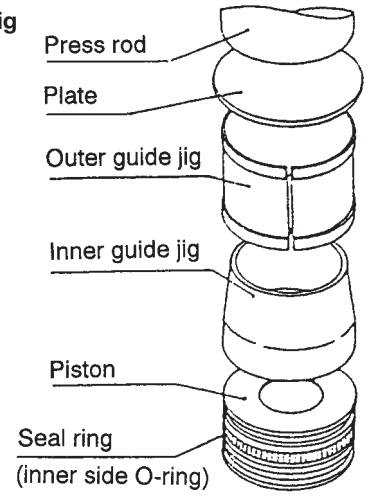


Continue to press the plate on the outer guide jig by hydraulic press until the seal ring fits into the groove.

Be sure to press the plate carefully so that the seal ring will fit straight on the inner guide jig and into the groove.

Finish this work quickly.

6. Removal of jig



After confirming that the seal ring is completely fitted into the piston groove, remove the jigs in the following order.

1. Remove the press rod.

2. Remove the plate.

3. Remove the outer guide jig.

4. Remove the inner guide jig.

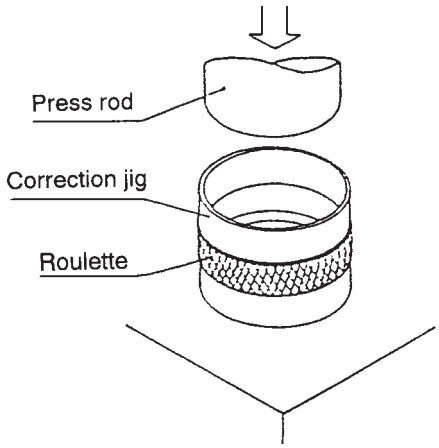
The fitting of the seal ring is completed at this stage.

Next, correct the fitting of the seal ring using the correction jig.

Reconditioning *(continued)*

Jig Usage *(continued)*

7. Correction jig preparation

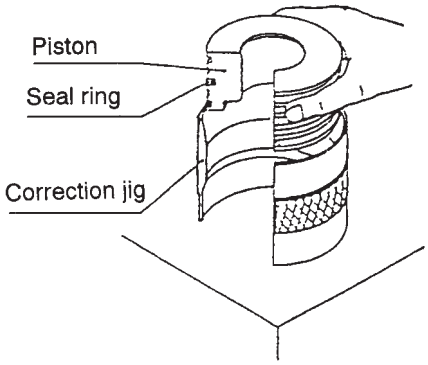


Set the correction jig underneath the press.

Apply a thin coat of lubricant to the tapered section of the correction jig and place the jig with the tapered section facing up.

Be careful that no dust, chipped metal and lint adheres to the jig.

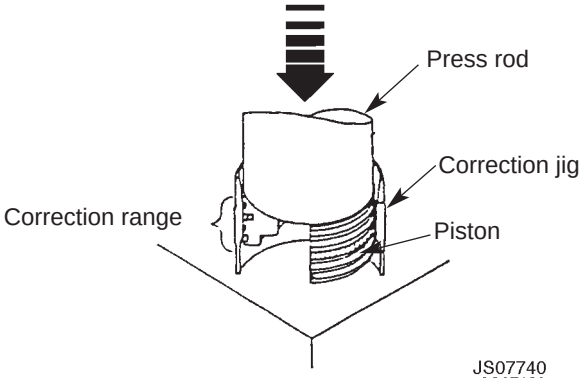
8. Inserting the piston



Slowly insert the piston, with the seal ring fitted, into the correction jig.

Insert the piston evenly inside the correction jig.

9. Press fit



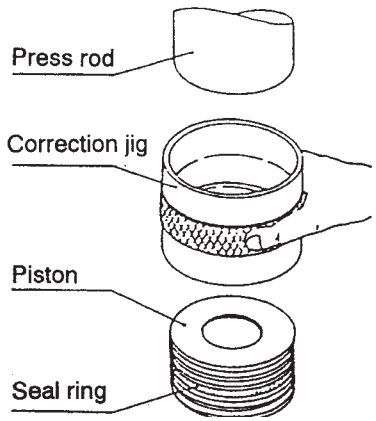
Press the piston slowly with a press rod that has smaller diameter than the piston, until the seal ring fits correctly in the groove.

Note: Stop pressing temporarily for three to five seconds when the piston reaches the point of correction and then repress the piston to the end.

Reconditioning *(continued)*

Jig Usage *(continued)*

10. Removal of correction jig



After completion of the correction of the seal ring, remove the jig in the following order.

1. Remove the press rod.

2. Remove the correction jig.

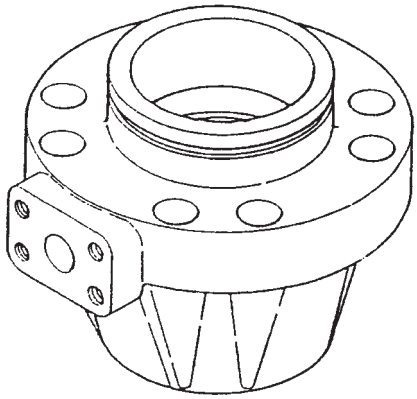
This completes the fitting and correction of the seal ring.

Reconditioning *(continued)*

Bush removal

Note: The jigs differ, depending on the piston rod diameter, so please refer to the table and select the appropriate jig.
The chuck blade section is a very important part, so handle and store with utmost care.

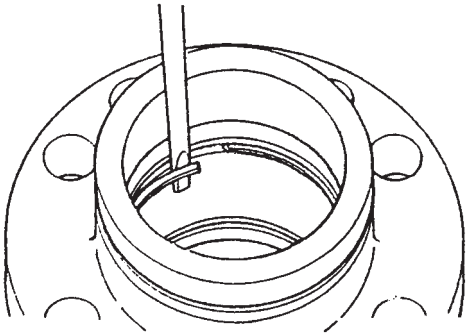
1. Cylinder head setting

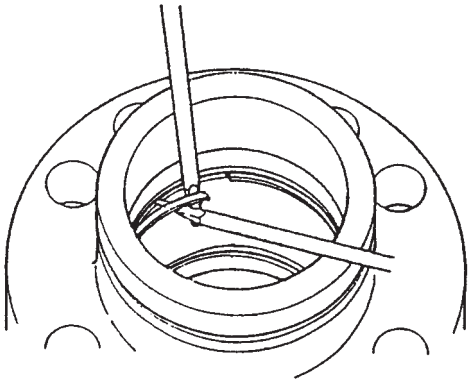


Place the cylinder head on the work bench with the cylinder tube connecting surface facing up.

The work bench should be clean so that no dust or other foreign matter can cause damage to the pipe joint .

2. Removing snap ring





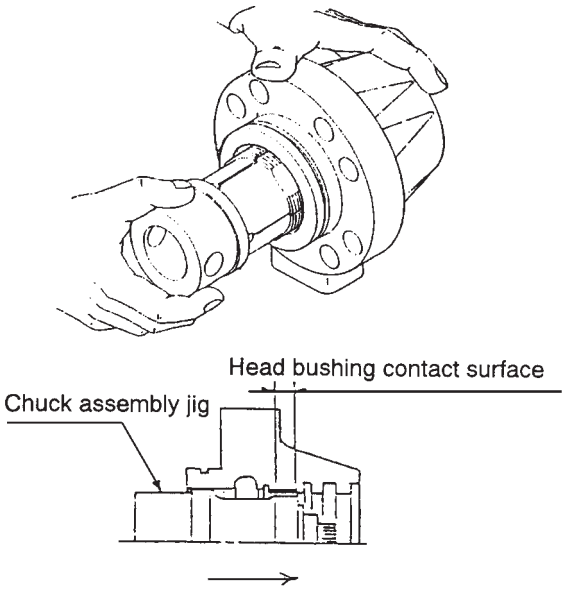
Remove the bushing securing snap ring.

Secure the cylinder head in a vice, etc. and with the end of a special tool, pull out the snap ring and remove.

Reconditioning *(continued)*

Bush removal *(continued)*

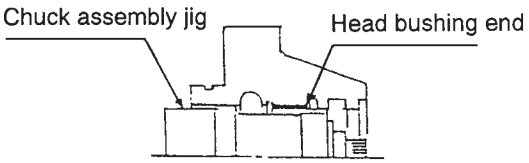
3. Setting the chuck assembly (jig)



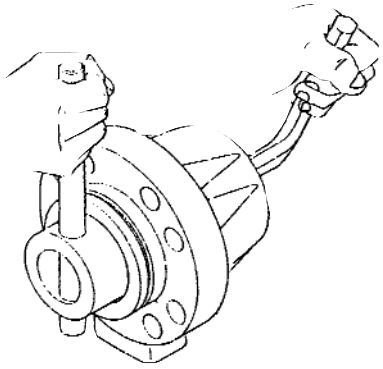
Gradually insert the chuck assembly into the cylinder head until its blade end reaches the bushing end.

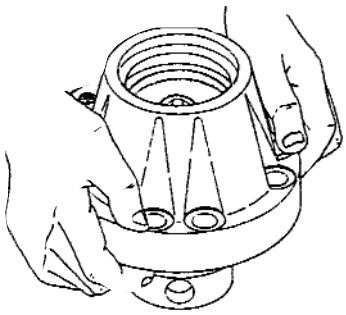
1. Insert the chuck assembly into the cylinder head, taking care that parts of the blade do not damage the inner circumferential surface.

2. Be careful that the blade does not jump out from the bushing end surface.



4. Temporary tightening





1. Fit the Allen wrench into the chuck assembly adjuster head and at the same time insert the lever into the chuck assembly rear hole.

2. Tighten enough so that when the cylinder head is lifted, the jig will not fall off.

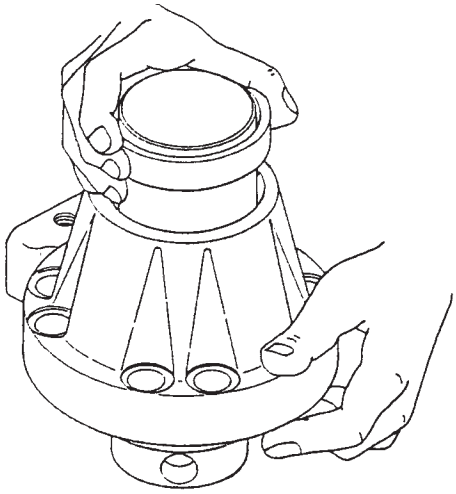
Note: *Tightening torque less than 5 kgf m is sufficient.*

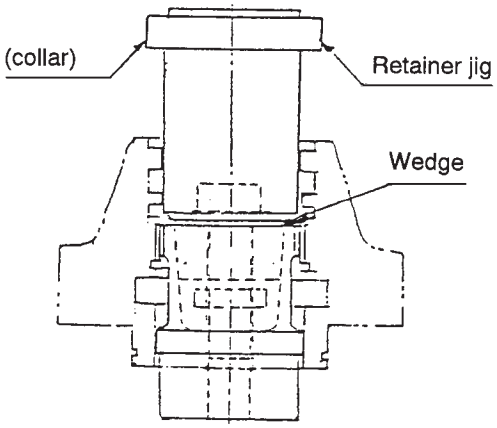
Move the cylinder head with the chuck assembly attached, by grasping it on both sides with both hands, to the press bench, taking care not to drop it.

Reconditioning *(continued)*

Bush removal *(continued)*

5. Attaching the retainer

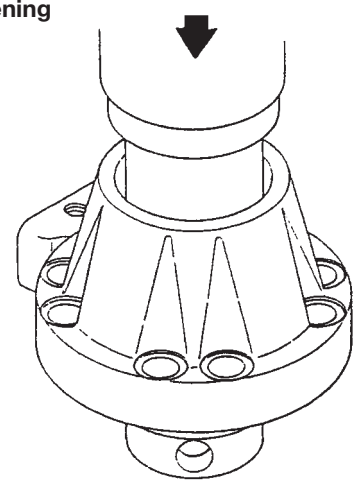




Gently place the retainer on the stepped portion of the wedge inside the chuck assembly (jig).

1. Place so that the larger diameter (collar) is facing up as shown in the figure.
2. Keep the press work bench clean so that dust, chipped metal and other foreign material do not cause damage to the bottom of the chuck assembly.

6. Tightening



Press the upper part of the retainer gradually so that the blade part of the chuck assembly jig digs into the bushing surface part of the retainer (jig).

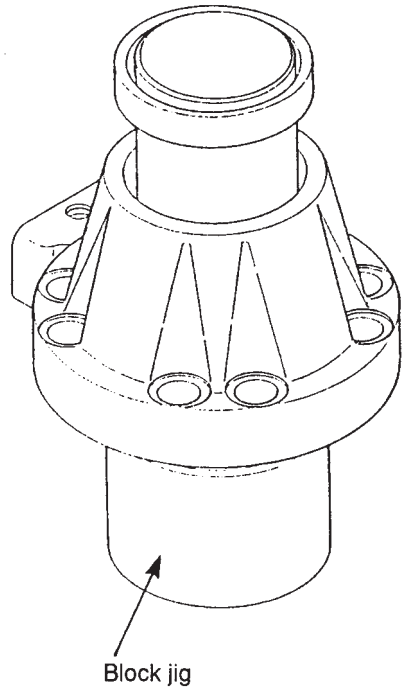
Note: *Press load should be 2~3 tons.*

If necessary use a retainer when pressing.

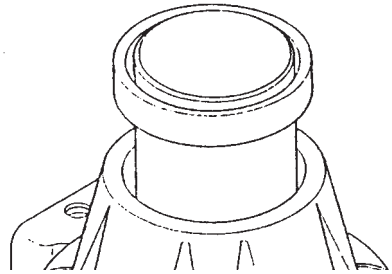
Reconditioning *(continued)*

Bush removal *(continued)*

7. Block (jig) preparation

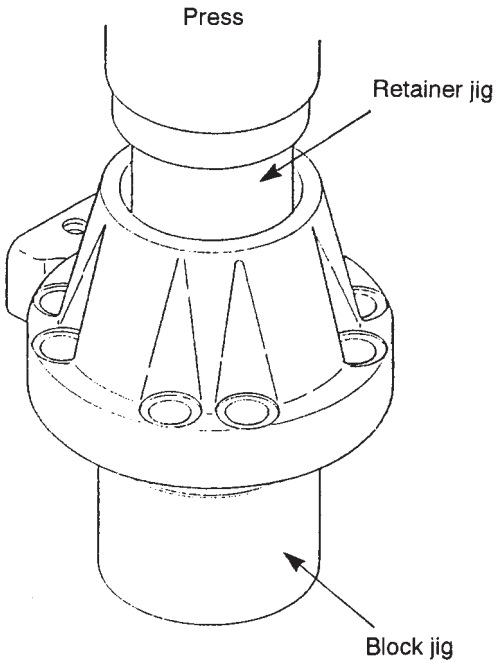


Prepare a block and align the shaft centre while placing the cylinder head on the block. Choose a block suitable in shape and size from the table below.



Division	d1	d2	h	Nominal size
For ø 75	82	110	80	75
80	87	112	80	80
85	92	124	80	85
90	97	130	80	90
95	102	136	80	95
100	107	140	80	100
105	112	146	80	105
110	117	150	80	110

8. Removing bushing



1. Position the block *(jig)* and cylinder head assembly *(retainer jig and chuck assembly)* underneath the press.
2. Gradually press the retainer *(jig)* upper surface until the bushing falls out from the cylinder head *(the sound of the bottom surface of the chuck assembly jig hitting the work bench will be heard)*.

Note: *Normally it falls out with a load of less than 3 tons.*

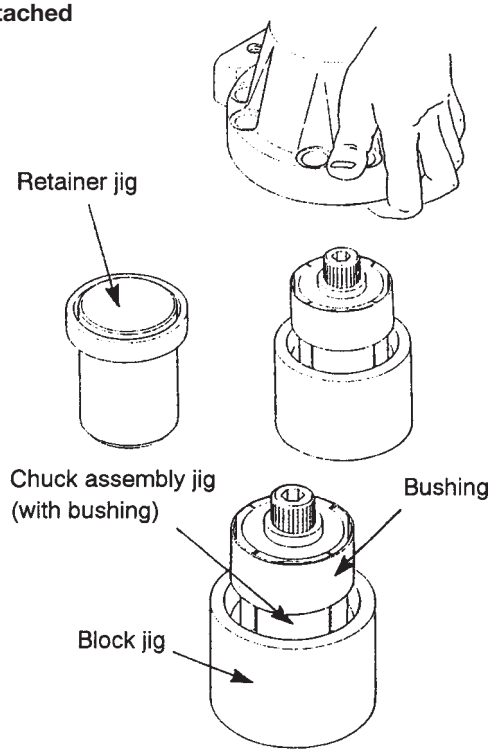
The press ram stroke varies with the cylinder head size and is about 32~52 mm.

1. Use a retainer when pressing.
2. When the shaft centre of the block and cylinder head assembly are not aligned, stop the press work and move the block, aligning the shaft centre, and proceed.

Reconditioning *(continued)*

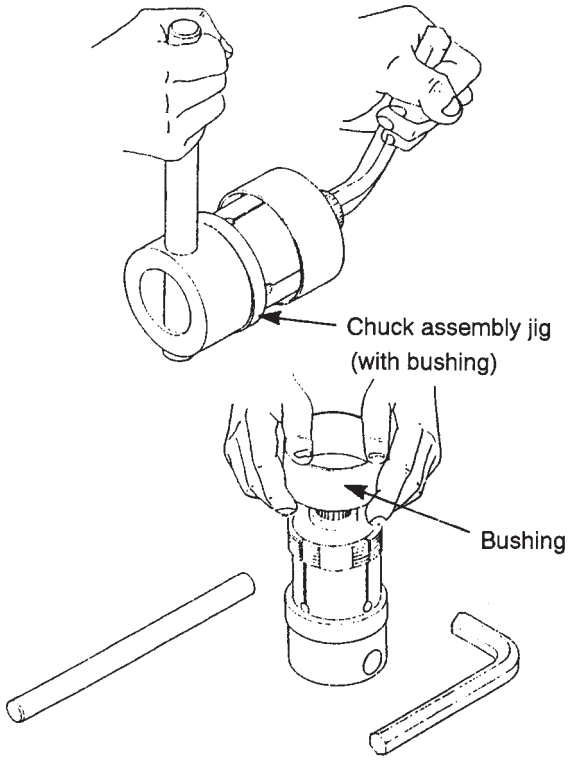
Bush removal *(continued)*

9. Removing chuck assembly (jig) with bushing attached



1. After removing the cylinder head assembly (retainer jig and chuck assembly jig attached) from under the press, remove the retainer from the cylinder head and, grasping both sides of the cylinder head, move it to another place.
2. Remove the chuck assembly with bushing attached and move to the work bench.

10. Removing bush

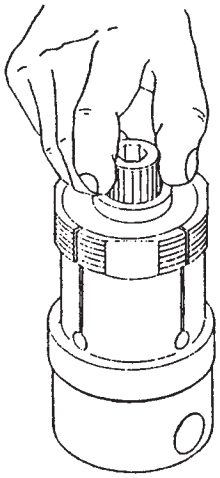


1. Place the chuck assembly with bushing (jig) on the work bench horizontally and insert the Allen wrench into the chuck assembly adjuster head section. At the same time insert a lever into the round hole of the chuck assembly rear section.
2. Use the lever and Allen wrench so they are pushed down front and back and loosen the adjuster.
3. Place the chuck assembly vertically and turn the adjuster with your finger until the wedge rises about 5 mm.
4. After confirming that the bushing is not touching the chuck blade section, gently remove the bushing from the chuck assembly.

Keep the work bench clean so that no dust or foreign matter adheres to or damages the bottom surface of the chuck or the outer periphery. Also be sure that the work bench is level.

Reconditioning *(continued)*

Bush removal *(continued)*

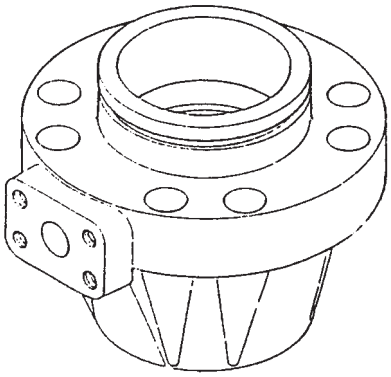
11. Retightening the adjuster 	With the chuck assembly (jig) and bushing removed, turn the adjuster with your fingers until there is no gap between the adjuster and the wedge upper surface. ***Note:*** *Do not remove the adjuster and wedge from the chuck assembly .*

Reconditioning *(continued)*

Bush Assembly

Note: *The jigs differ, depending on the piston rod diameter, so please refer to the table and select the appropriate jig. The chuck blade section is a very important part, so handle and store with utmost care.*

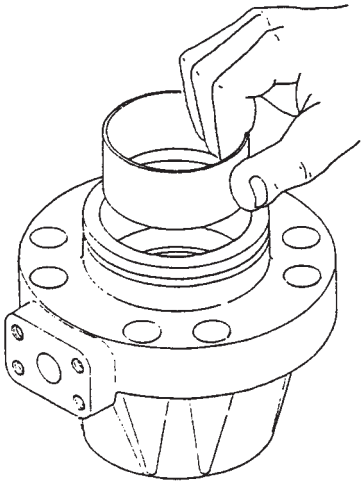
1. Cylinder head setting



Set the cylinder head on the press bench with the tube connecting surface facing up.

1. Keep the work bench clean so that dust or other foreign matter does not damage the bottom surface of the cylinder head. Also make sure that it is level.
2. Use compressed air to remove the foreign matter.

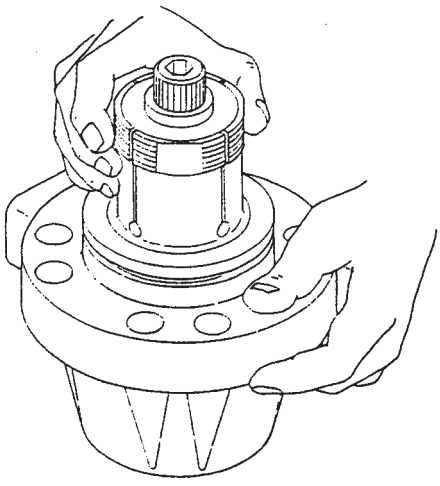
2. Temporary setting of bushing



Temporarily place the bushing evenly inside the cylinder head inner diameter.

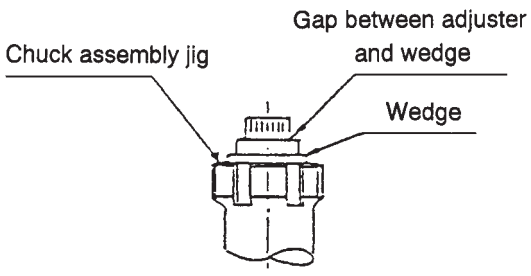
Verify that there is no foreign matter adhering to the inner and outer peripheral surfaces.

3. Attaching chuck assembly (jig)



Supporting the chuck assembly with your fingers, gradually attach it to the cylinder head.

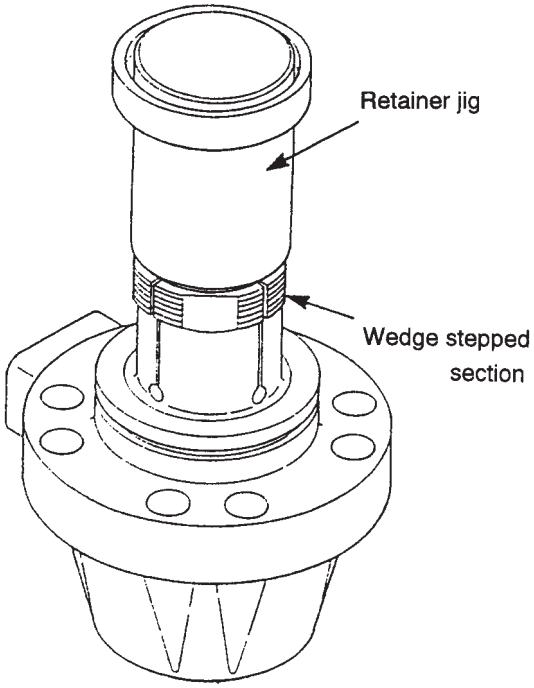
Verify that there is no gap between the chuck assembly adjuster and wedge.



Reconditioning *(continued)*

Bush Assembly *(continued)*

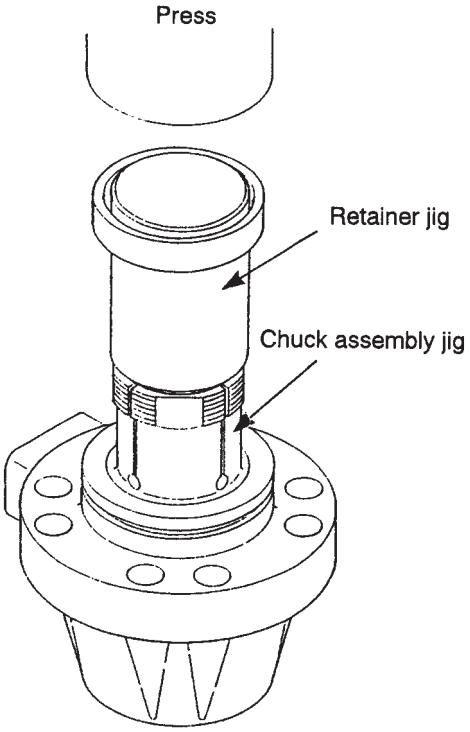
4. Attaching the retainer (jig)



Gently place the retainer so that its end is aligned with the wedge stepped section of the chuck assembly jig.

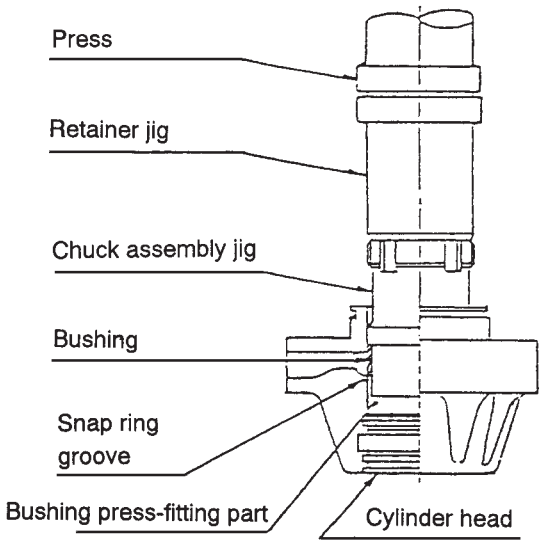
Place the retainer so that the larger diameter part is facing up as shown.

5. Preparation for press-fitting



Place the cylinder with the retainer (jig) and chuck assembly (jig) attached underneath the press.

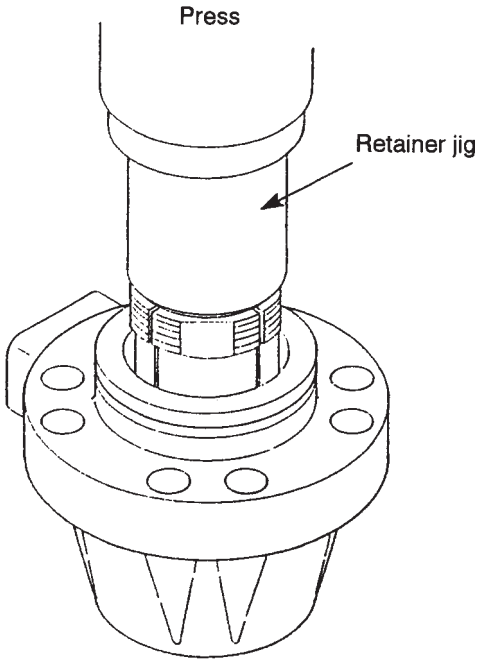
Adjust so that the shaft centre of the press (ram) is in line with that of the retainer and chuck assembly.



Reconditioning *(continued)*

Bush Assembly *(continued)*

6. Press-fitting the bushing

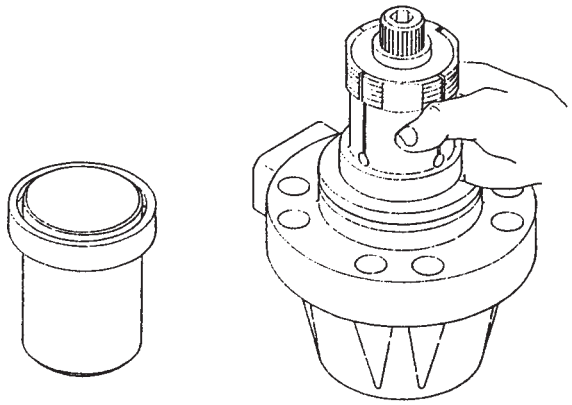


At the press, push on the bolt head of the adjuster and gradually press-fit the bushing into the specified position in the cylinder head.

The press load should be less than 5 tons.

Verify that the bushing end surface is below the snap ring groove.

7. Removal of retainer (jig) and chuck assembly (jig)

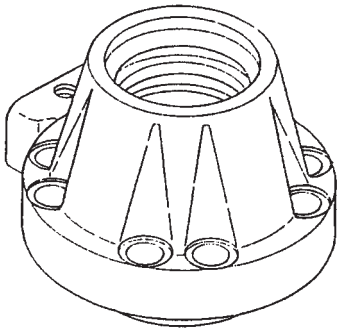
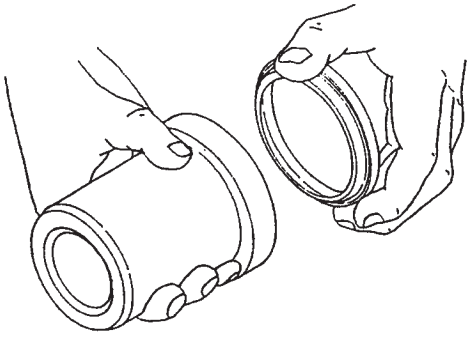
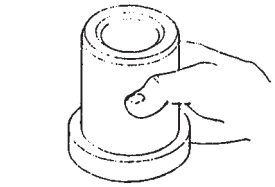
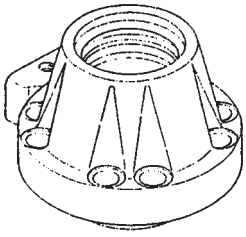


After the press-fitting of the bushing is completed, remove the retainer and chuck assembly from the cylinder head. Continue attaching the seals and press-fitting the wiper ring.

Verify that the bushing is press-fitted correctly.

Reconditioning *(continued)*

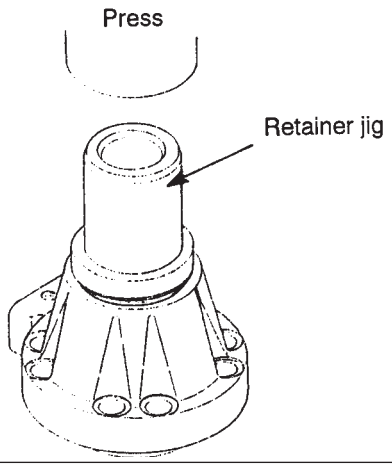
Wiper Ring Assembly

1. Setting the cylinder head 	Set the cylinder head on the work bench with the tube connecting surface facing down. Keep the work bench clean so that no dust or other foreign matter can damage the bottom surface of the cylinder head.
2. Inserting the wiper ring 	Face the lip side of the wiper ring to the groove of the retainer (jig) and insert. Verify that there is no foreign matter in the groove where the wiper ring or the retainer is to be inserted.
3. Attaching the retainer (jig)  	Gently attach the retainer, with the wiper ring inserted, facing down onto the upper part of the cylinder head. Gently place the retainer on the cylinder head, making sure that it is level with the work bench.

Reconditioning *(continued)*

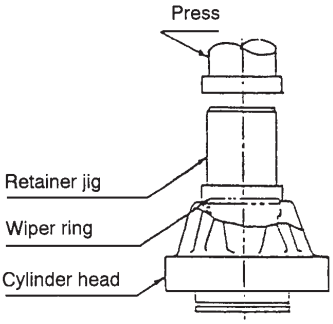
Wiper Ring Assembly *(continued)*

4. Preparation for press-fitting

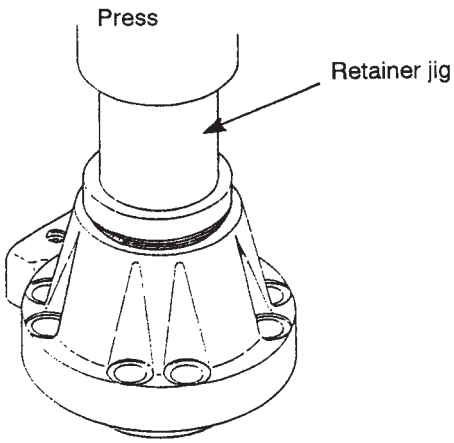


Move the cylinder head with the retainer (jig) on it underneath the press.

Adjust so that the shaft centre of the press (ram) and retainer are in line.



5. Press-fitting wiper ring

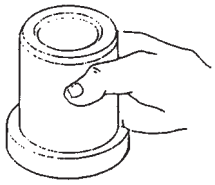


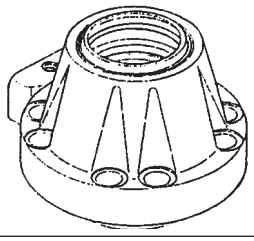
Pressing on the head section of the retainer (jig), press-fit the wiper ring into the specified position in the cylinder head.

The press load should be less than 1 ton.

Press fit until the retainer's collar reaches the cylinder head end surface.

6. Removal of retainer





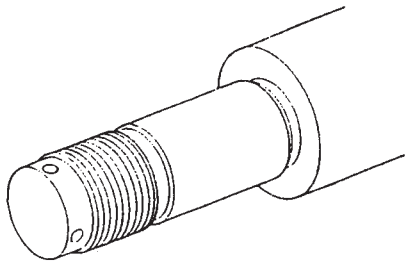
After the wiper ring press-fitting is completed, remove the retainer from the cylinder head.

Verify that the wiper ring is properly press-fitted.

Reconditioning *(continued)*

Cylinder Head Assembly

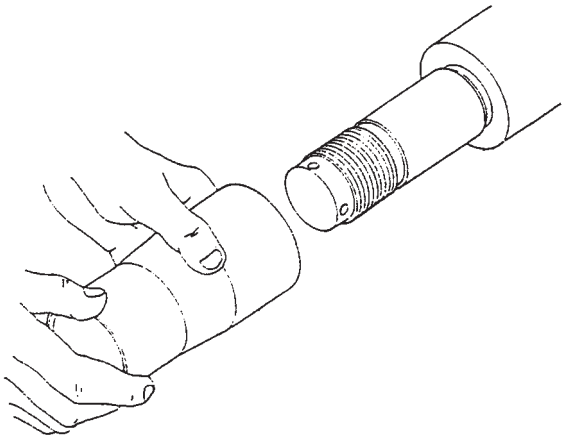
1. Fixing the piston rod

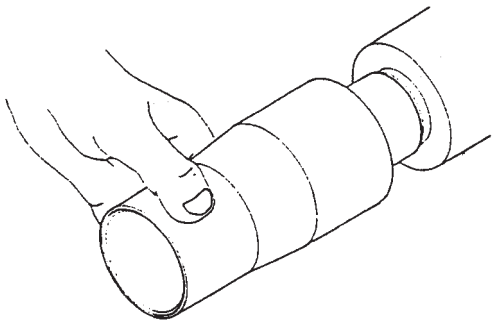


Fix the piston rod so that the threaded part is facing you.

Handle the piston rod with care so that no damage is done to its outer peripheral surface.

2. Attaching guide (jig)





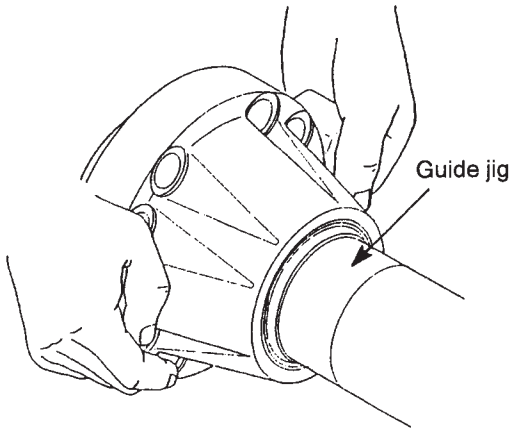
Insert the guide with the larger diameter first until it reaches the stepped part of the piston rod.

1. When inserting the guide onto the piston rod, be careful not to damage the thread part of the piston rod.
2. Be careful that the thread part of the piston rod and the outer peripheral surface of the stepped part are not damaged by dust or other foreign matter.

Reconditioning *(continued)*

Cylinder Head Assembly *(continued)*

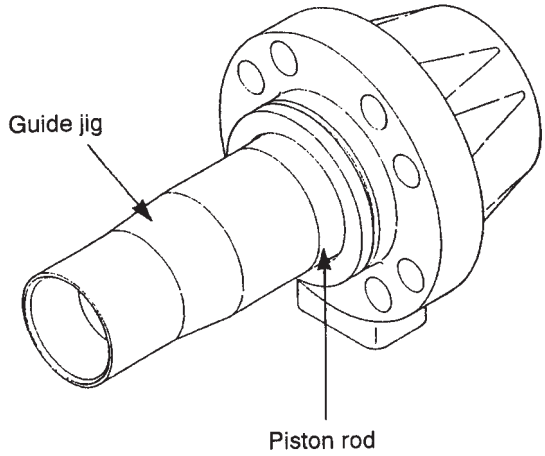
3. Inserting the cylinder head

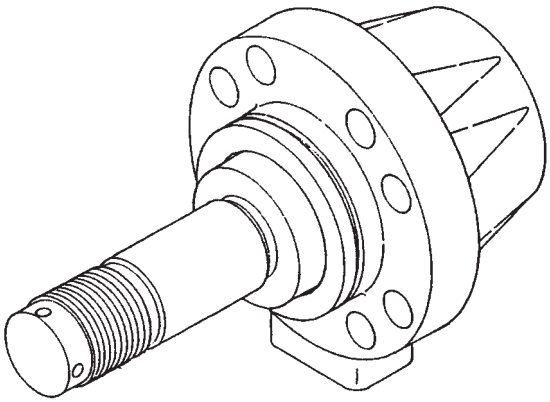


Insert the cylinder head onto the piston rod, wiper ring side first, to the specified position, sliding on the peripheral surface of the guide (jig).

1. Support the cylinder assembly with both hands and be careful not to drop it.
2. If oil is thinly coated on the peripheral surface of the guide and piston rod, the cylinder assembly can be inserted smoothly.

4. Removal of Guide (jig)





After verifying that the cylinder head assembly has been completely inserted on the piston rod, remove the guide from the piston rod. Next, assemble the piston, etc. on the piston rod.

When removing the guide, be careful not to damage the threaded part of the piston rod.

Trouble Shooting

Hydraulic ram trouble and its remedies.
It is not easy to find the part causing the trouble. In the chart below, possible problems are listed. Repair is difficult so refer to the estimated cause and treatment listed in the chart. In the chart, the general phenomenon, estimated causes and treatment are shown. However, machine trouble is most often caused, not by just one faulty part, but its relationship with other parts. Not all of the possible causes and treatments are listed in the chart below, therefore, it may be necessary for the person responsible for repairs to make further investigations to find the cause of the trouble.

Item	Symptoms
1	Oil leakage from piston rod sliding part
2	Oil leakage from cylinder head meeting part
3	Oil leakage from pipe and cylinder tube welded part
4	Faulty operation

Item	Symptoms	Related Parts	Trouble	Treatment
1	Piston rod sliding part oil leakage	Piston rod	On the sliding surface, there are scratches and rust that can be felt by the fingernail.	**1.** Use an oil stone and remove the scratch and make the sliding surface smooth. (Less than 1.5 S). If oil leakage continues even though the rod surface is made smooth, the scratch may cause damage to the U-ring and other seals, so disassemble and inspect. **2.** If the scratches and rust cover such a wide area that they cannot be repaired by an oil stone, replace the piston rod and U-ring, wiper ring and seals and the piston rod bearing member.
			The plating is peeling.	Re-plate or replace the piston rod. Also inspect the seal and piston rod bearing member and replace if damaged.
		Rod packing (Buffer ring, U-ring)	Foreign matter is biting into the inner and outer surfaces of the packing.	Remove foreign matter. If there is damage to packing, replace it.
			There is a scratch on the inner and outer surface of the packing.	Replace.
			The lip and groove parts are locally carbonized (burned).	Possibly due to burning caused by adiabatic compression from air remaining inside the ram. After replacing the packing, first operating the ram at low-pressure, low speed to sufficiently bleed the air.

Trouble Shooting *(continued)*

Item	Symptoms	Related Parts	Trouble	Treatment
1	Piston rod sliding part oil leakage	Rod packing (Buffer ring, U-ring)	Packaging rubber elasticity is gone and breaks into pieces.	The packing life or hydraulic oil deterioration and high temperature are possible reasons. **1.** Renew hydraulic oil. **2.** Check the hydraulic oil temperature. (Below 80 C is advisable). **3.** Check if high temperature locally.
			Lip is deficient all around.	Replace. It is possible that abnormal high pressure is working on the packing. **1.** Check the operation pressure, cushion pressure. **2.** Part which is attached to the buffer ring may be abnormal. Inspect the buffer ring.
		Back up ring	The protrusion of the heel of the packing is excessive.	As a rule, replace the rod packing at the same time. (It is desirable to replace parts which are attached to the buffer ring at the same time). It is possible that abnormal high pressure is the cause. Check the same as above (heel of packing protruding).
		Wiper ring	Foreign matter is biting into the lip. The lip is damaged.	Remove the foreign matter.
			There are also other abnormal damage.	Replace.
		Bushing	Wear is large and the clearance with piston rod exceeds the *maximum permissible value. (*Refer to maintenance standards for maximum permissible value.)	Replace.
			Large scratch on the sliding part.	Replace. Also inspect the piston rod.
		Cylinder head	Scratches, rust on the seal attachment parts.	Remove scratch, rust with oil stone. If it cannot be repaired, replace the cylinder head.

Trouble Shooting *(continued)*

Item	Symptoms	Related Parts	Trouble	Treatment
2	Oil leakage from cylinder head joint	O-ring	Foreign matter biting on inner and outer diameter. O-ring damaged.	• Remove foreign matter. • Replace 'O'-ring if damaged. • Inspect inside tube: if any scratches or rust, make surface smooth with oil stone. • Inspect cylinder head 'O'-ring groove: if any scratches or rust, make surface smooth with oil stone. • Inspect back up ring: if any deformation or protrusion, replace. Confirm the above and replace 'O'-ring.
		Back up ring	Deformation, protrusion	• Replace with 'O'-ring.
		Cylinder head	Looseness	• Disassemble cylinder head and inspect 'O'-ring and back up ring. • Check tube and cylinder head thread for damage. If any damage, replace. • After inspection, tighten to specified torque.
		Bolt	Looseness, stretching, broken	Replace all bolts and tighten to specified torque.
		Cylinder tube	Abnormal bulge	Replace with new parts. Oil leakage from connecting parts may be caused by abnormal pressure (including cushion pressure). Inspect the tube for bulges, deformation and check the circuit pressure.
3	Oil leakage from pipe and cylinder tube welded seam	Cylinder tube pipe (hollow piston rod)	Crack in welding	Replace with new parts. • Cracks will develop into fractures. Fractures are very dangerous, so if any cracks are found, stop work immediately and replace with new parts. • Welding on top of cracks will have no effect.

Trouble Shooting *(continued)*

Item	Symptoms	Related Parts	Trouble	Treatment
4	Poor operation 4-1 Movement not smooth	Piston rod cylinder tube	Bending is more than the specified limit. (Bending distortion: Refer to maintenance standards)	• Replace with new part. The seal and sliding part material may be damaged too, so inspect. If abnormal, replace.
		Cylinder tube	There is a recess	• Replace with new part. As above, inspect the seal and sliding part material.
		Piston rod cylinder rod sliding part	Abnormal wear, damage of sliding area Foreign matter intruding on piston and cylinder head sliding area	• Replace with new part. As above, inspect the seal and sliding part material. • Remove foreign material. As above, inspect the seal and sliding part material.
	4-2 Inner oil leakage. Piston rod extends when work stops or lowers abnormally during work. Also, specified operating speed is not achieved.	Piston seal	Scratches, wear are present	• Replace with new part. Inspect the cylinder tube inner surface also.
		Cylinder tube	Scratches, rust on inside	• Remove the scratches, rust by honing or with an oil stone and make the surface smooth. If the scratch is deep and cannot be repaired, replace cylinder tube. • Replace piston seal.
		Piston Nut	Loose nut	• Tighten to specified torque.
		Valves	Leak from valve	• Inspect the valve leakage amount and service.
	Note: *Hydraulic oil expands and contracts due to changes in temperature and pressure. Accordingly, the ram also expands and this can be mistaken for internal leakage. When inspecting for internal leakage, do so at set conditions.*			

Trouble Shooting *(continued)*

Item	Symptoms	Related Parts	Trouble	Treatment
4	4-3	Air	Air remaining inside ram Operation is unsteady	• Bleed the air. For rams that do not have an air bleeder, operate back and forth several times at low pressure and low speed to bleed the air. For rams with an air bleeder, remove the load to reduce the pressure then loosen the air bleeder and completely bleed the air. ***Note:*** *The ram may expand if it is stopped suddenly. This is due to the compression of the hydraulic oil. This occurs especially with long stroke rams.*
	4-4 Heavy shock loading when changing from extension to retraction and back	Pin bushing Pin	Gap between installation part and pin bushing is too large	Measure the pin and pin bushing and replace parts if measurements exceed the specifications.
	4-5 Noisy operation	Oil supply	Insufficient oil	• Add oil.
		Pin bushing Pin	Scuffing at connecting part	• Replace with new part and add oil.
	Note: *If left in the state where operation is poor, the ram will no longer move and other parts will be effected adversely. Inspect early and carry out appropriate measures.*			

Maintenance Specifications

In order to ensure long life of the hydraulic ram, carry out inspection and maintenance regularly. If an abnormal point is found, repair as soon as possible referring to the troubleshooting chart.

Inspection, Maintenance Point	Inspection, Maintenance Contents	Daily	Monthly	Annually	Note
Appearance	Is the ram kept clean (especially the rod sliding part)?	O			
	Is there oil leakage from piping installation and fixing points?		O		
	Is there any peeling paint, separation or rust?	O			
Operation	Are the movements smooth and are there any abnormal sounds?	O			
	Is the response good?	O			
	Is there oil leakage from the sliding parts?	O			
	Is there internal leakage?			O	
	Is the working pressure normal?		O		
	Is the set pressure for the overload relief valve normal?		O		
Hydraulic Oil	Is the hydraulic oil dirty or deteriorated?		O		
	Is the hydraulic oil replaced periodically?			O	
	Are the filters inspected periodically?		O		
Installation with Main Body	Is the pin greasing sufficient?		O		
	Is there any abnormal sound at the pins or seizure?	O			
	Is there backlash or wear in the pins?	O			
	Is the pin seal normal?		O		
	Are the installation screws loose or missing?	O			
	Tightening of the installation screws?			O	
Piston Rod	Are the sliding parts worn?			O	When the rod sliding part is exposed for a long period of time apply anti-rust oil to the rod.
	Are there scratches or dents on the sliding parts?	O			
	Is there coating separation on the sliding parts?	O			
	Are the sliding parts bent?		O		
	Are there cracks in the welding or other damage?	O			
Ram Cylinder (Including Piping)	Are the bolts, nuts loose?	O			
	Are the bolts, nuts tightened?			O	
	Are there cracks in the welding or other damage?	O			
	Are there big depressions or dents in the cylinder?	O			

Maintenance Specifications JS200/JS240

Use Limit

Piston Rod Outer Diameter Wear Limit

Nominal diameter (mm)	Minimum outer diameter (mm)	Treatment
55~80	-0.023	Replace or replate
85~120	-0.027	Replace or replate

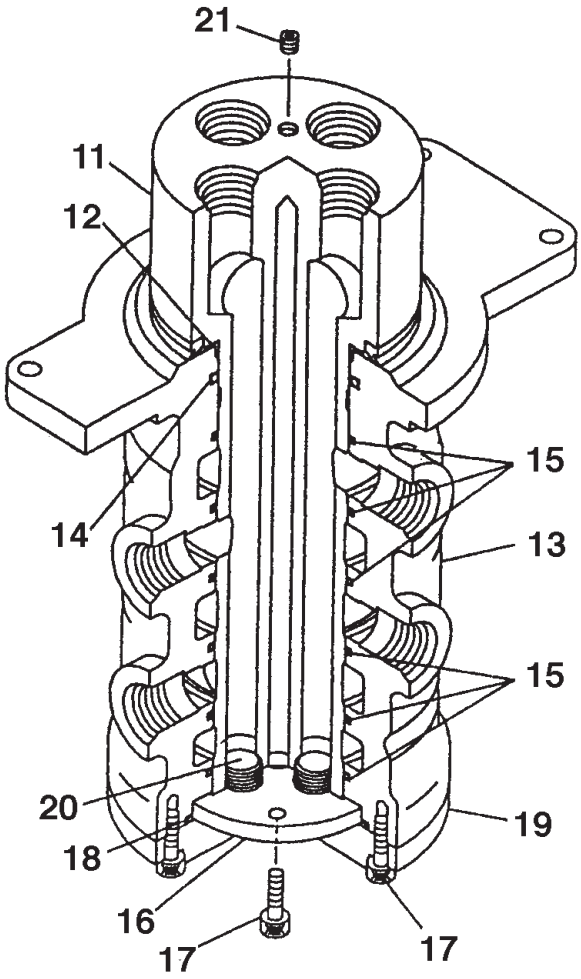
Rod Bushing Inner Diameter Wear Limit

Nominal diameter (mm)	Standard inner diameter (mm)	Maximum inner diameter (mm)	Treatment
55~75	+0.06~+0.19	+0.30	Bushing replacement
80~120	+0.06~+0.195	+0.30	Bushing replacement

Piston Slide Ring Thickness Wear Limit Section

Nominal diameter (mm)	Standard thickness (mm)	Maximum thickness (mm)	Treatment
95~160	2.42~2.48	2.37	Replace slide ring
165~250	2.92~2.98	2.87	Replace slide ring

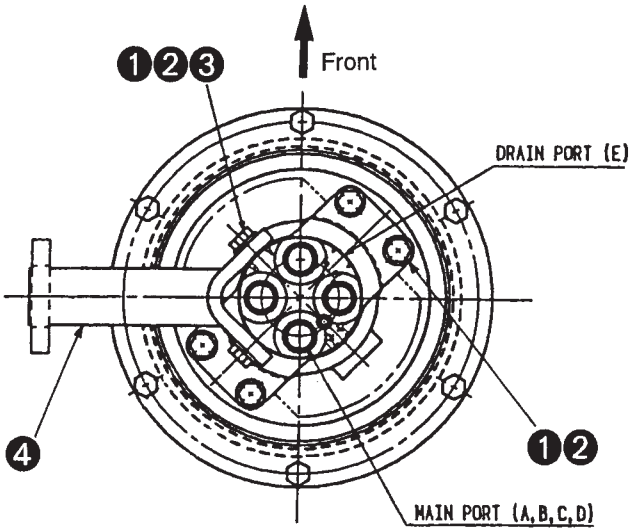
Schematic, Technical Data

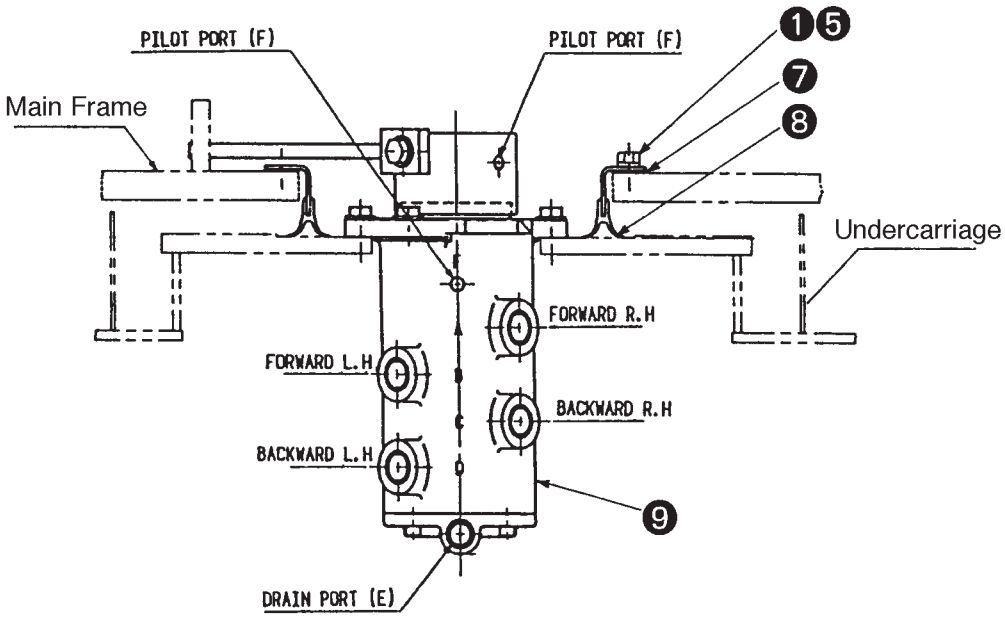


Item	Part Name
11	Axle
12	V-ring
13	Rotor
14	O-ring
15	Packing ring
16	Thrust plate
17	Hexagonal socket head bolt
18	O-ring
19	Cover
20	Plug
21	Plug

Schematic, Technical Data *(continued)*

Item	Part Name
1	High strength bolt
2	High strength washer
3	Loctite 262
4	Lock bar
5	Seal washer
6	Seal cap
7	Rubber packing
8	Seal ring
9	Rotating joint assmebly
The unit weighs 35kg.	





Operation

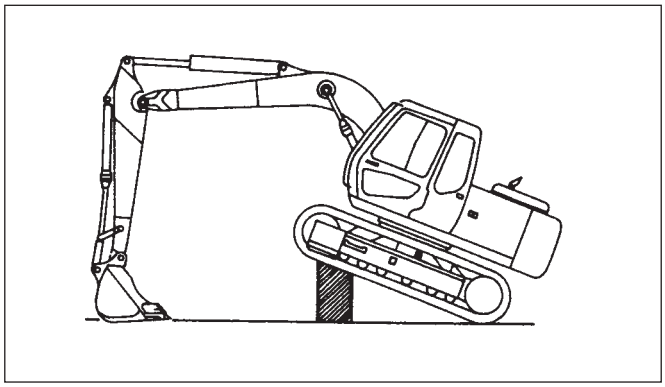
The rotary coupling consists of the inner axle and outer rotor with packing rings, 'O'-rings, thrust plate and cover. In the axle and rotor, there are pairs of ports and oil passages each pair being sealed from the others by packing rings and 'O'-rings. Both the axle and rotor can rotate and the oil can flow freely through the oil grooves.

The coupling is located in the centre of the machine between the lower and upper sections and rotates around the slew centreline. It receives the supply and return pressurised oil passing from the control valve to the traction motor and is not affected by the rotation of the lower and upper sections, allowing the machine to slew 360° in both directions.

Dismantling JS200/JS240

Refer to the sectional illustration on the previous page as a guide to the dismantling and assembly procedures.

Details of the service tools used in the dismantling and assembly procedures are given in Section 1, Service Tools.

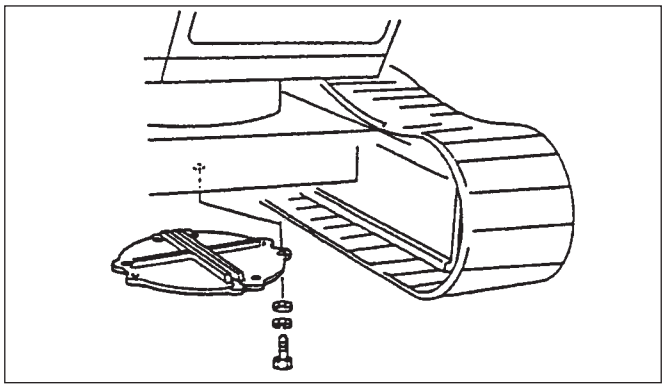


1. Prepare the machine.

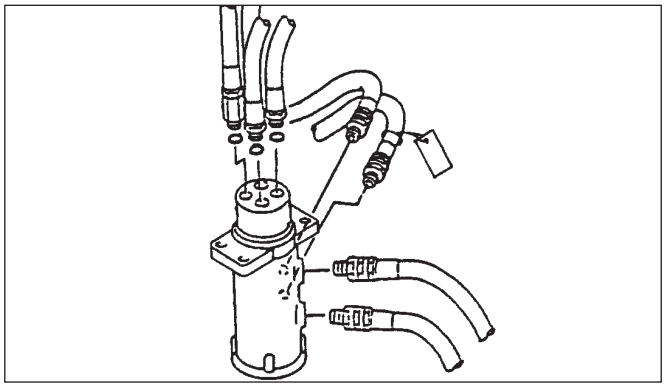
a. Stop the machine and release the hydraulic pressure *(See Releasing Tank Pressure)*.

b. Jack up the machine and insert wooden blocks under the tracks.

2. Remove the access panel.

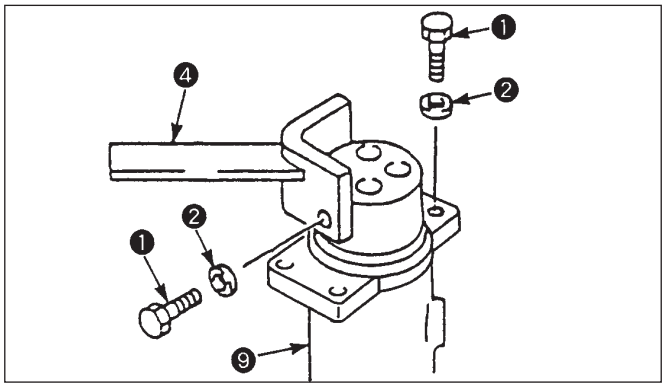


3. Attach identification tags to the rotary coupling hoses for reconnection purposes. Remove the hoses and install blind plugs and caps to prevent contamination.



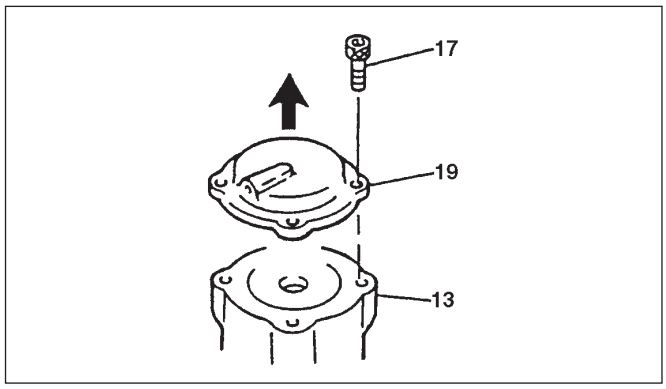
4. Remove the Coupling.

Remove the lock bar (4), remove the rotary coupling installation bolt (1).
Lift out the rotary coupling.



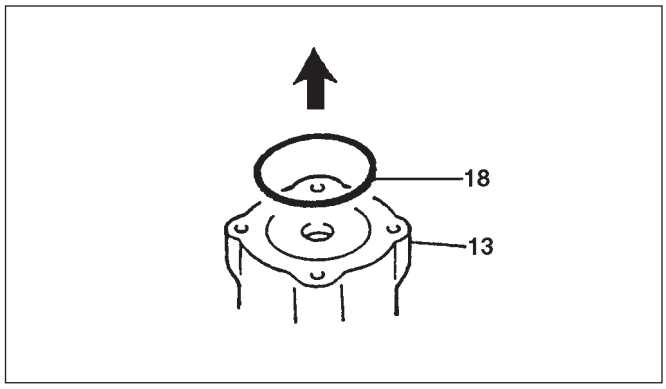
Dismantling JS200/JS240 *(continued)*

5. Remove the cover 19 with the bolt 17.

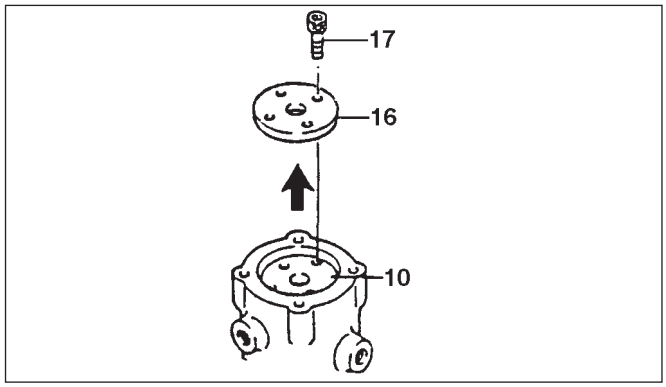


6. Remove the 'O'-ring 18.

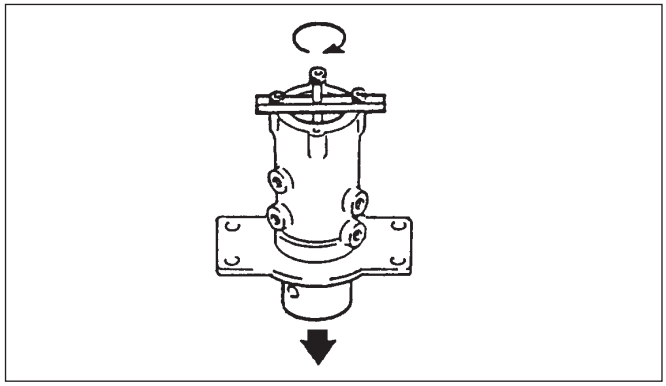
Do not reuse the 'O'-ring 18.



7. Remove the thrust plate 16 with the bolt 17.



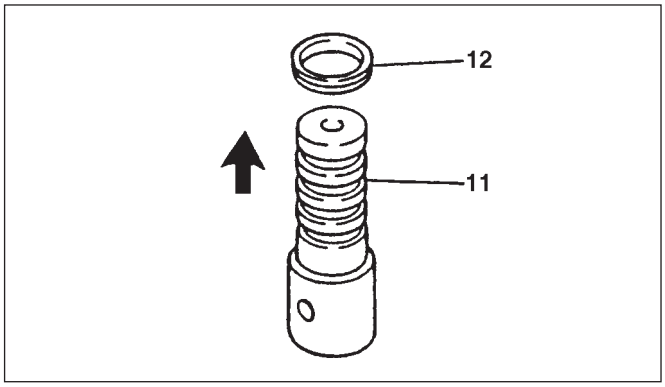
8. Using a jig push off the axle 11 from the rotor 13.
Do not hit with a hammer.



Dismantling JS200/JS240 *(continued)*

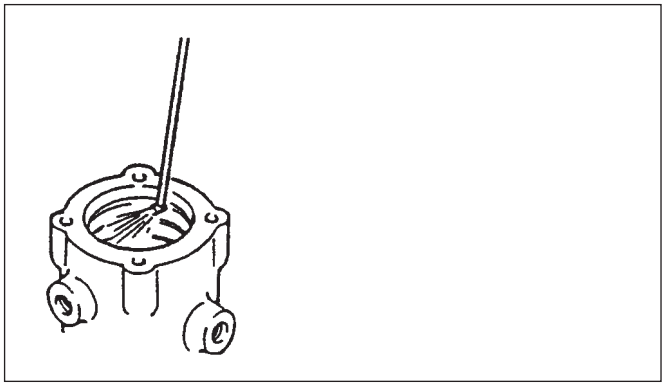
9. Remove the V-ring 12 from the axle 11.

Note: *Do not reuse the V-ring 12.*



10. Remove the 'O'-ring 14, and packing ring from the rotor 13.

Note: *Do not reuse the packing ring 15.*



Assembly JS200/JS240

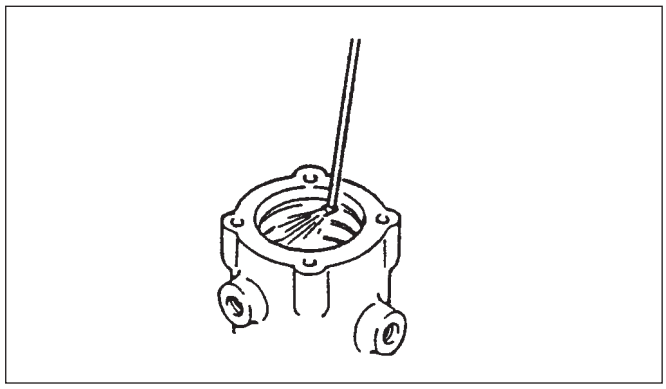
Inspect the parts for signs of wear, pitting, scratching, discolouration etc. Polish out scratches using a fine grade oil stone.

Before assembly, thoroughly clean all parts using a suitable solvent: Do NOT use solvents on 'O'-rings, backup rings and seals.

Fit new 'O'-rings, backup rings and seals.

Lubricate all 'O'-rings, backup rings and seals, with clean hydraulic fluid before fitting.

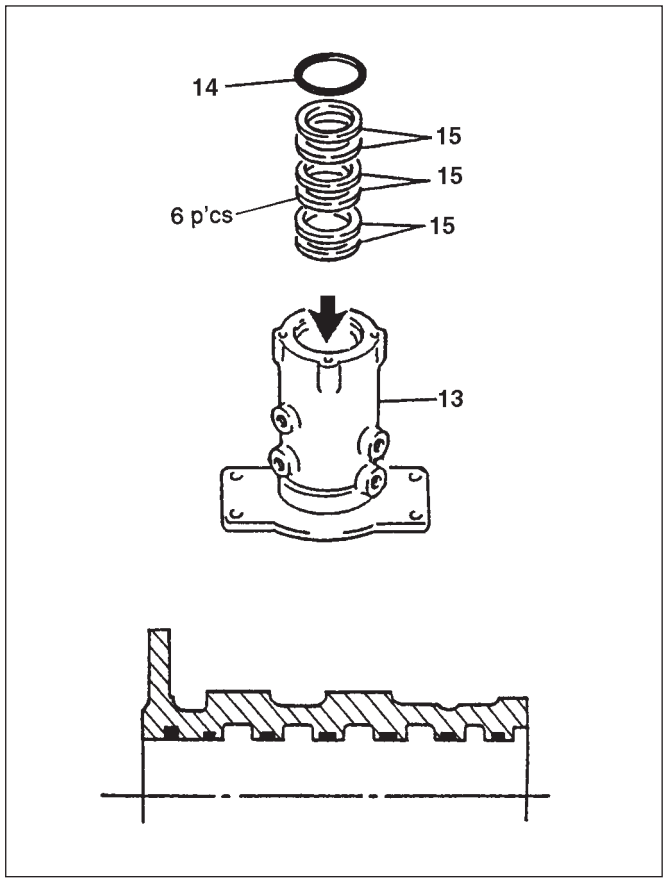
1. **a.** Clean the rotor 13 with cleaning fluid or compressed air.
b. After cleaning, check to see if there are any scratches or roughness on the inner side of the rotor or grooves.



2. Check the number of packing rings 15 and 'O'-rings 14. Coat with Vaseline and install in the order below.

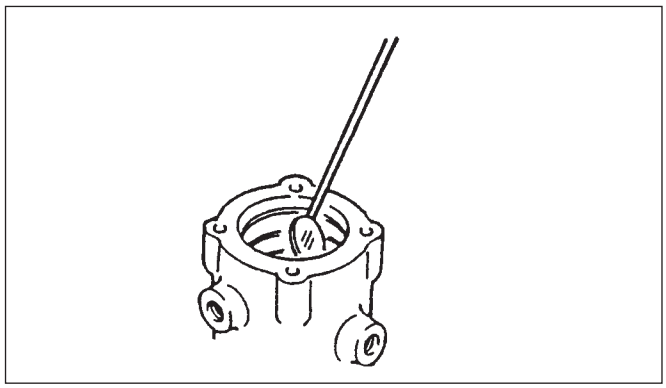
a. Set one packing ring in each groove starting from the 2nd groove from the top.

b. Set the 'O'-ring in the top groove.

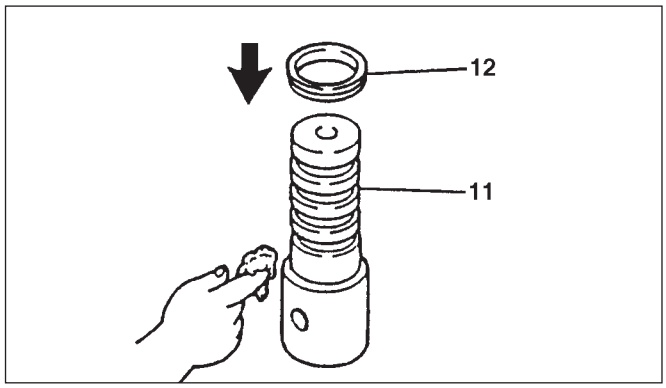


Assembly JS200/JS240 *(continued)*

3. After installing the 'O'-ring, packing ring and packing, check with a mirror to see if they are installed correctly. After checking, coat with grease then check once more for any protrusion, twisting, etc.

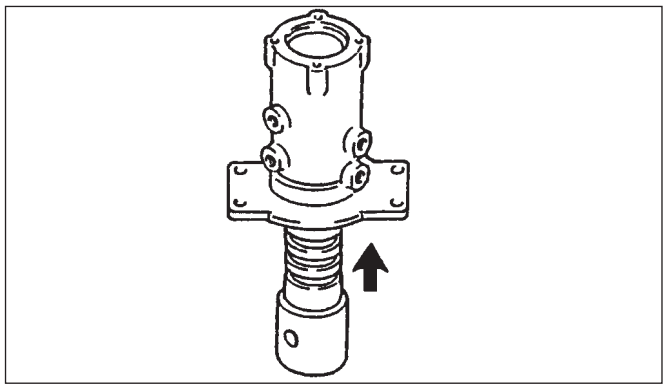


4. Install the V-ring 12 on the axle 11 and grease adequately.
Take care to prevent contamination of the grease by water or dirt.

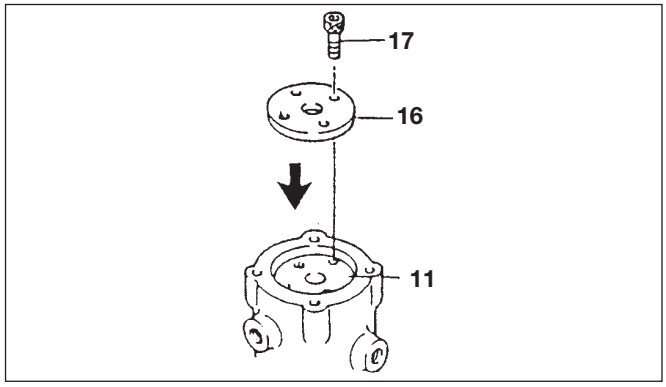


5. Install the axle 11 to the rotor 13.

Note: *Set the V-ring 12 so that it will not be cut or scratched.*

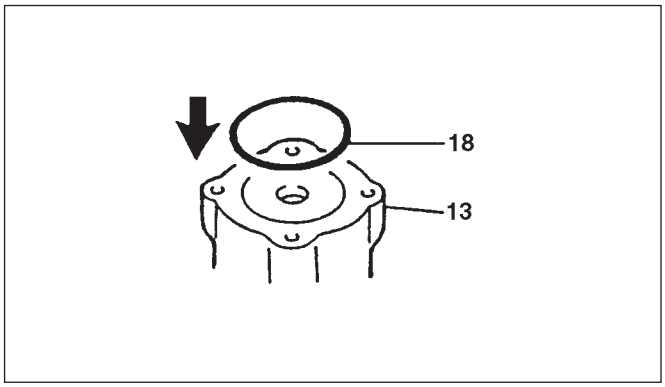


6. Install the thrust plate.

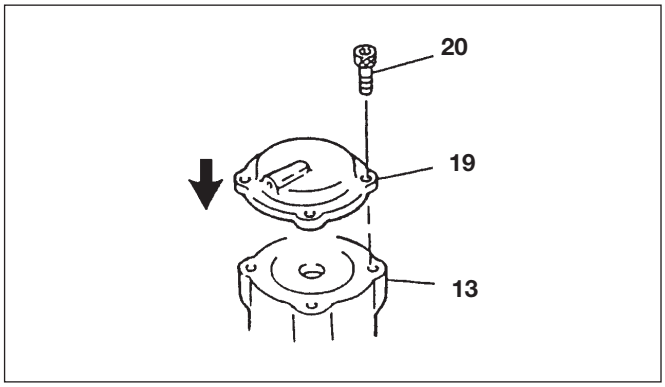


Assembly JS200/JS240 *(continued)*

7. Install the 'O'-ring.

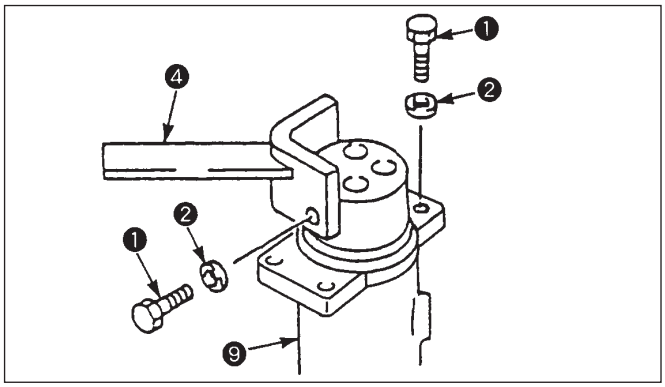


8. Install the cover.

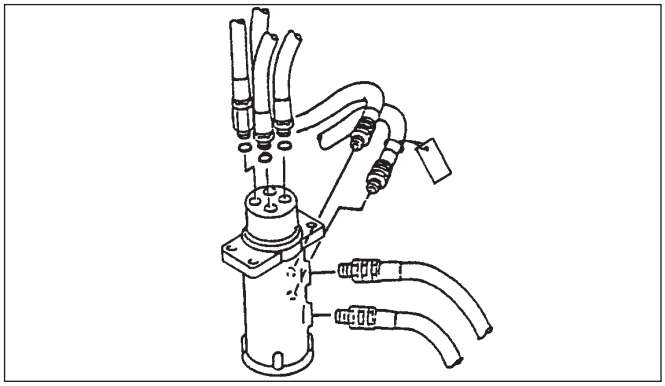


9. Align the coupling (9) to the lower frame and tighten the rotating joint installation bolt (1) and.

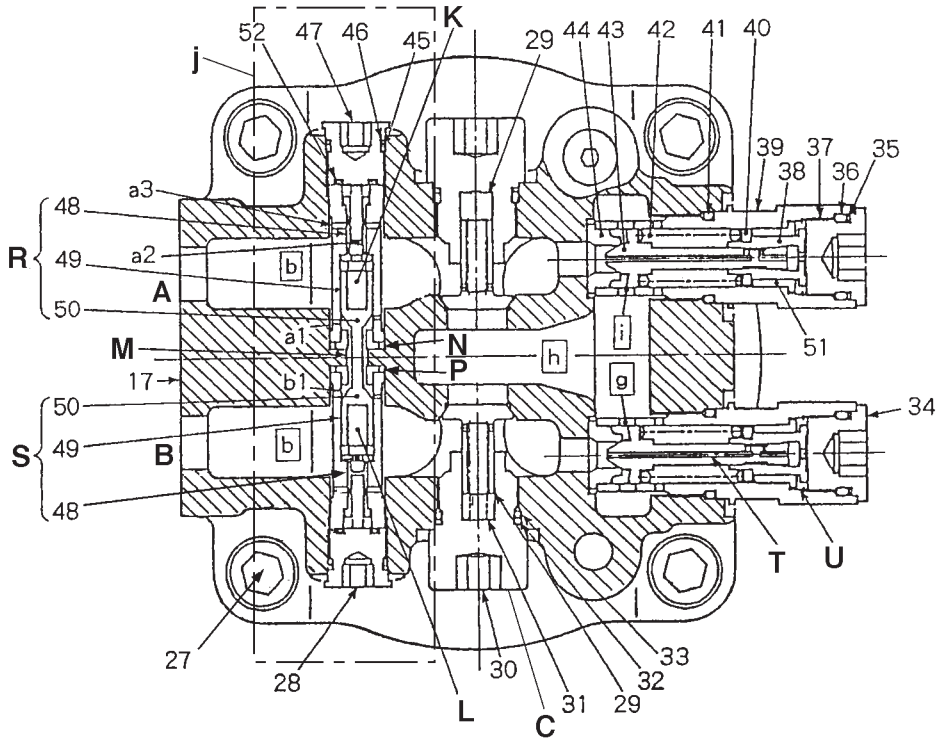
Tighten the lock bar installation bolt (1) and washer (2) to the specified torque, 109-127 Nm (11.1-12.9 Kgf/m, 80.28-93.28 lb/ft) and install the lock bar.



10. Reconnect the hoses, and install the access cover, remove the wooden block, lower the machine to the ground.
Start the machine and check for leaks.

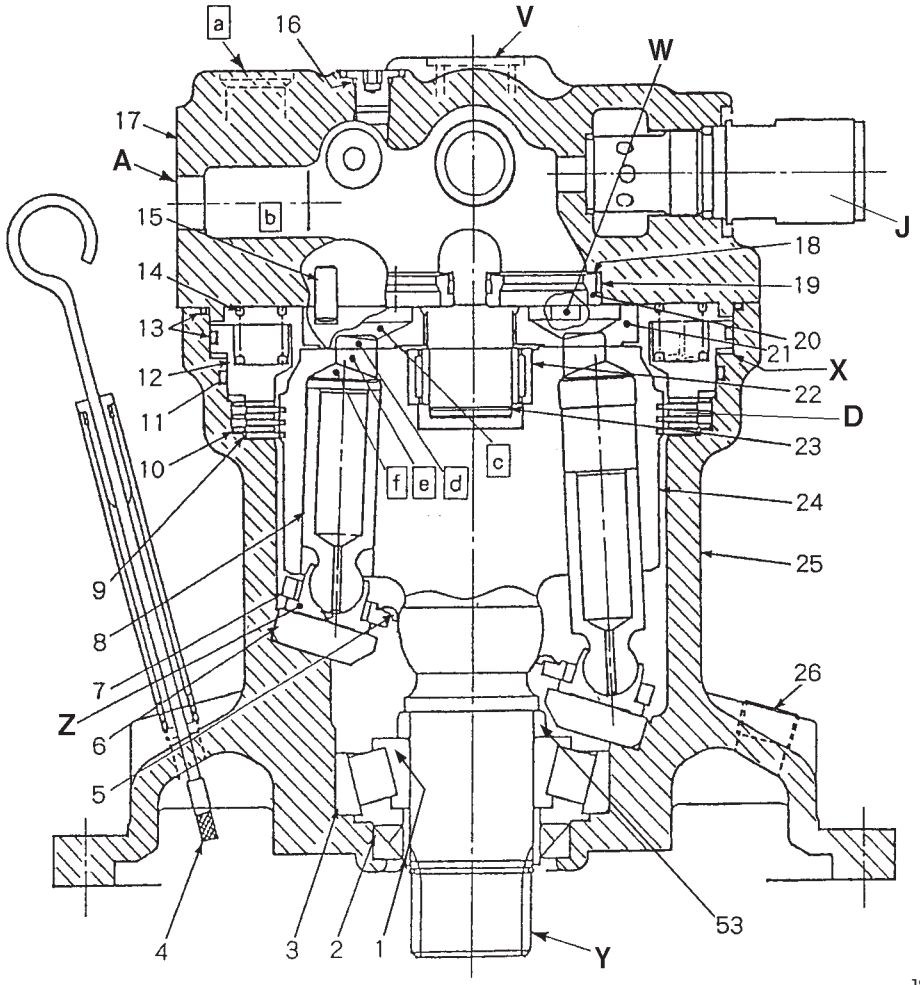


* Hydraulic Motor Components



Key

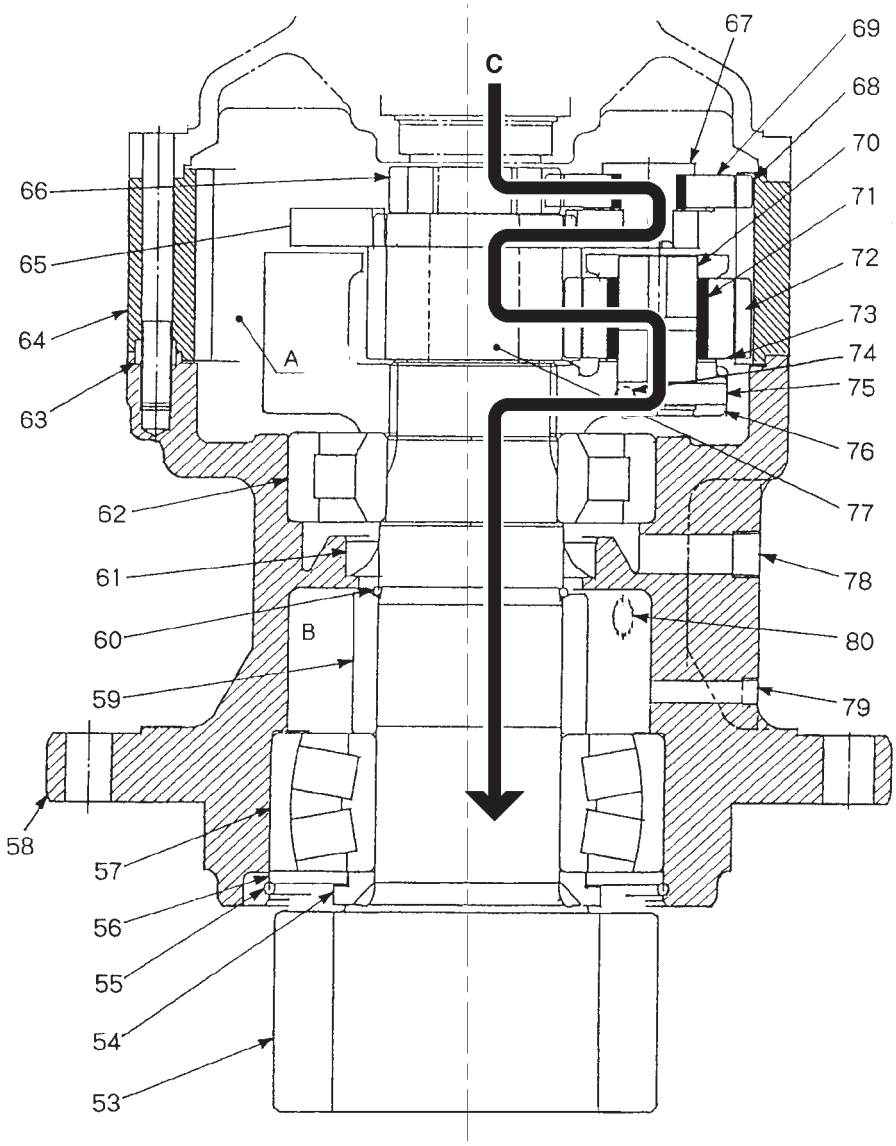
a	Drain port
a1 **b1**	Pilot port
a2 **a3**	Pilot hole
b **c** **d** **e**	Flow paths
f	Piston bore
g **h** **i**	Flow paths
j	By pass valve
A	Inlet port
B	Outlet port
C	Anti-cavitation check valve
D	Mechanical brake
J	Cross-line relief valve
K	A side cavity
L	B side cavity
M	Intermediate cavity
N	A side seat
P	B side seat
R	Anti-pendulum valve
S	Anti-pendulum valve
T	Pilot hole
U	Spring chamber
V	Make-up port
W	Piston
X	Mechanical brake release port
Y	Motor output shaft
Z	Slipper foot



JS00960

Note: Item numbers are referred to on the following pages.

* Reduction Gear Components



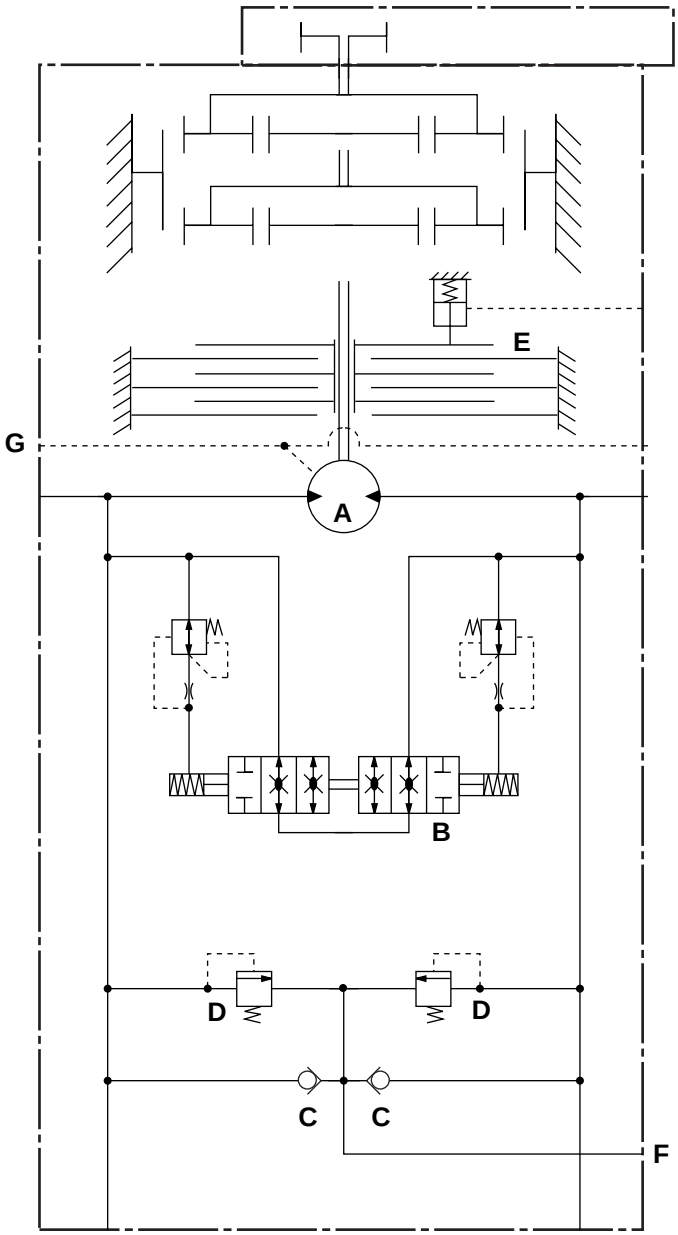
Key

A A chamber
B B chamber
C Torque path

JS00970

Note: Item numbers are referred to on the following pages.

* Hydraulic Circuit



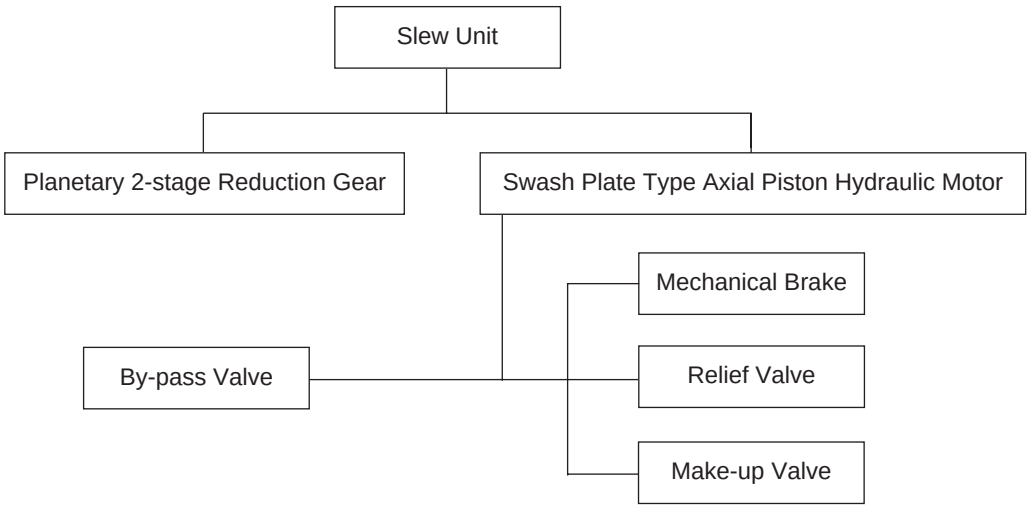
Key

A Hydraulic motor (151 cm^3/rev)
B Bypass/Anti-pendulum valve
C Anti-cavitation check valve
D Relief valve (285 kgf/cm^2 @ 155 l/min)
E Mechanical brake
F Tank line
G Drain line

JS02680

* Operation

Slew Motor Configuration



The above diagram indicates the relationships between the main components of the slew motor, whose working principles are described on the following pages.

* Operation *(continued)*

Hydraulic Motor Working Principles

(illustration reference page 83 - 1)

Oil supplied from the pump via the control valves enters port **A** (or port **B**) on cover **17** and is discharged from port **B** (or port **A**).

Oil which leaks past and through clearances between the sliding parts returns to the tank via the drain port **a** in cover **17**.

The pressurised oil supplied to port **A** passes through path **b** in cover **17** and path **c** in bush **20**. It is supplied for 180° of each revolution of the motor, passing through path **d** in balance plate **21** (which has crescent-shaped ports to switch between supply and discharge), through path **e** of cylinder **24** and then to piston bores **f** of the cylinder.

Oil pressure in bores **f** of the piston assemblies **8** forces the pistons down on the angled swash plate **6** via slipper feet **Z**. The angle of the swash plate causes the slipper feet to 'slide' around the plate, rotating the cylinder assembly **24** to produce torque at the output shaft **Y**.

In this way, each of piston assemblies **8** is supplied with pressurised oil during its stroke from the top dead point to the bottom dead point and this hydraulic pressure is converted to torque which turns cylinder assembly **24**. The oil is discharged during the piston stroke from the bottom dead point to the top dead point.

The oil discharge path is the reverse of the supply path described above and the oil is discharged from port **B**. The output torque of the hydraulic motor is determined by the supply pressure and the rotational speed.

Mechanical Brake Working Principles

The mechanical brake serves as a parking brake for the machine.

Friction plate **9** is splined to the periphery of cylinder assembly **24** and mating plate **10** is connected to housing **25**. When the servo pressure at the brake release port **X** is zero, the spring **14** force acts through brake piston **12** to press the friction and mating plates together, locking cylinder **24** (output shaft) to housing **25** so that it cannot rotate. When the servo pressure at brake release port **X** is 40 kgf/cm^2 (568 lbf/in^2), the pressure at the brake piston overcomes the spring force and the brake piston moves to the end face between the friction and mating plates, releasing the brake.

Make-Up Valve Working Principles

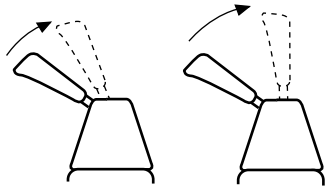
1 Under partial hydraulic cross-line relief braking (relief valve not functioning).

When slowing down the slew structure with the hand control valve lever in the half-way position, the volume of oil supplied to port **A** from the pump is reduced. If the rotational speed of the slew structure is relatively high, the motor acts as a pump and causes a negative pressure to develop at **c** and oil must be supplied to avoid cavitation. If the pressure at port **B** is lower than the cross-line relief valve operating pressure and the supply of oil from the control valve is insufficient to provide the amount of oil needed, the make-up check valve assembly **29 - 31** operates to make up the insufficiency at **c** from the make-up port **V**.

2 Under full hydraulic braking (cross-line relief valve functioning).

When the lever is rapidly moved to the neutral position from the position in paragraph **1**, the supply of oil from the pump to port **A** drops to zero, but the slew structure continues to rotate due to inertia. In this case, port **B** cross-line relief valve **J** operates and the oil from the relief valve passes through the paths **g** and **h**, pushes open port **B** make-up check valve **29** and is supplied to paths **b** and **c**. As oil is short by the amount of leakage past motor pistons, the make-up check valve opens and oil is supplied to paths **b** and **c** from the make-up port to prevent cavitation.

Halfway Position = Partially Selected



Partial Braking Full Braking

JS02750

* Operation *(continued)*

Relief Valve Working Principles

1 On starting

Due to the superstructure's inertia there is a build-up of pressure in the motor when it begins to slew. To prevent damage, excess pressure is diverted between ports **A** and **B** via poppet valves **43** (part of cross-line relief valve **J**).

2 When the brake is applied (cushioning)

When the slew control valve is returned to neutral the oil return path from the motor is closed. While the superstructure is coming to a halt it is, in effect, 'driving' the motor as a pump. This results in a pressure build-up at the outlet port (**A** or **B** depending on slew direction). This increased pressure opens poppet valve **43**, which allows oil to flow via paths **g** and **h**, opening check valve **29** and relieving the pressure into cavity **C**.

At the same time, oil flows between the two ports via the cross-line relief valve **J**, which has already been partially opened by poppet valve **43**.

The result is a 2-stage relief action which momentarily delays the pressure build-up as the superstructure comes to a halt. This reduces the shocks arising due to sudden braking.

3 Anti-Pendulum Feature

While the superstructure is coming to a halt, as described in **2**, it drives the motor as a pump. The initial result is a braking effect on the superstructure. However, the resulting pressure build-up in port **A** (or **B**, depending on direction) tends to cause the superstructure to 'bounce back' a little. The process repeats itself to create what is known as a 'pendulum effect'.

To prevent this happening, check valves **50** and flow control valves **48** work together to divert oil pressure between ports **A** and **B** until the superstructure has come to a halt.

Reduction Gear Structure and Working Principles **(illustration reference page 83 - 2)**

Power transmitted by the hydraulic motor output shaft is transmitted to second sun gear **77** via first sun gear **66**, planetary gear **69** and holder **65**. Power is then transmitted to output shaft **53** via second sun gear **77**, planetary gear **72** and holder **76**. The output shaft is constructed with an integral pinion and is supported in gear case **58** by bearings **57** and **62**.

Due to the severe conditions under which the output shaft operates, an oil seal **61** is provided in the centre of gear case **58** to protect the bearings from metal waste worn from the gears. The bearing in chamber **A** is lubricated with gear oil and the bearing in chamber **B** with grease.

Maintenance Specifications

*

Item	Inspection and Maintenance Standards
Balance Plate **21**	The crescent-shaped ports in the balance plate, which are in sliding contact with the end face of the cylinder assembly shaft, act to switch between high and low oil pressure. Any damage to the sliding contact face will increase leakage, causing a decrease in volumetric efficiency and an increase in slip. Any seizure of the sliding contact face causes a reduction in mechanical efficiency and can lead to further damage. If the grooves or marks depths are less than 0.03 mm (.001 in), the plate can be corrected using fine emery cloth. If the wear is greater than 0.03 mm (.001 in), the plate should be renewed. The plate should be renewed if it shows any sign of seizure.
Piston assembly **8** slipper feet	Correct any damage to the sliding contact face of the slipper feet by using fine emery cloth. Renew the motor if the depth of any slipper foot oil groove is less than 0.45 mm (.018 in) or if the slipper foot surfaces are seriously damaged.
Piston assembly **8** pistons	The external surfaces of the piston assemblies should be practically unworn. The motor should be renewed if a piston assembly shows any sign of seizure.
Cylinder assembly **24** piston bores	The piston bores should be practically unworn. The motor should be renewed if the bores show any sign of seizure or are badly damaged.
HYDRAULIC MOTOR Taper roller bearing **3** Needle bearing **22** REDUCTION GEAR Self-aligning roller bearing **57** Roller Bearing **62**	The bearings should be renewed if any slight damage is noticed on the contact surfaces of the rollers or needles. It is recommended that all bearings be renewed on reassembly of the motor because bearings can be damaged when the motor is dismantled.
HYDRAULIC MOTOR Oil seal **2** REDUCTION GEAR Oil seal **61**	Renew any oil seal if damage to the lip is apparent. New seals must be used when reassembling the motor.
HYDRAULIC MOTOR O-rings **11**, **13**, **33**, **36**, **41**, **45**, **52**	Renew any 'O'-ring that appears to be damaged. New 'O'-rings must be used when reassembling the motor.
HYDRAULIC MOTOR Back-up ring **32**, **35**, **46**	The back-up rings must be renewed when reassembling the motor.

⚠ CAUTION

If the machine is operated at full load, before its initial run-in procedure is complete, it may cause scuffing and seizing which can adversely effect the service life of the machine.

8-3-1-5

⚠ WARNING

Hydraulic Fluid

Fine jets of hydraulic fluid at high pressure can penetrate the skin. Do not use your fingers to check for hydraulic fluid leaks. Do not put your face close to suspected leaks. Hold a piece of cardboard close to suspected leaks and then inspect the cardboard for signs of hydraulic fluid. If hydraulic fluid penetrates your skin, get medical help immediately.

INT-3-1-10/1

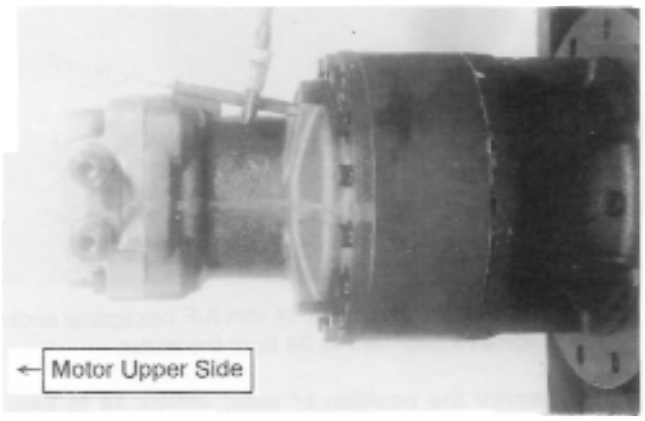
⚠ WARNING

Hydraulic Pressure

Hydraulic fluid at system pressure can injure you. Before disconnecting or connecting hydraulic hoses, stop the engine and operate the controls to release pressure trapped in the hoses. Make sure the engine cannot be started while the hoses are open.

INT-3-1-11/1

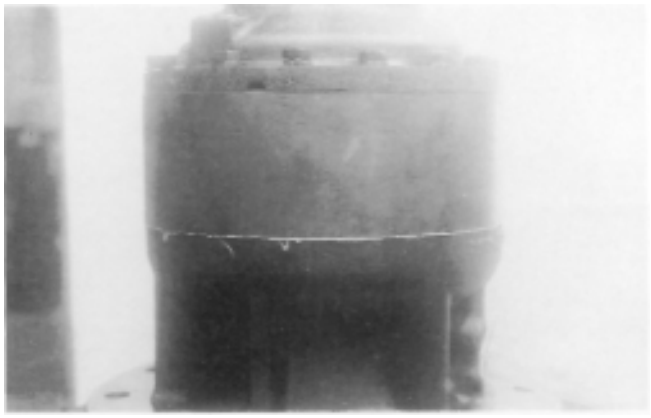
* Motor Assembly/Cylinder Assembly Dismantling

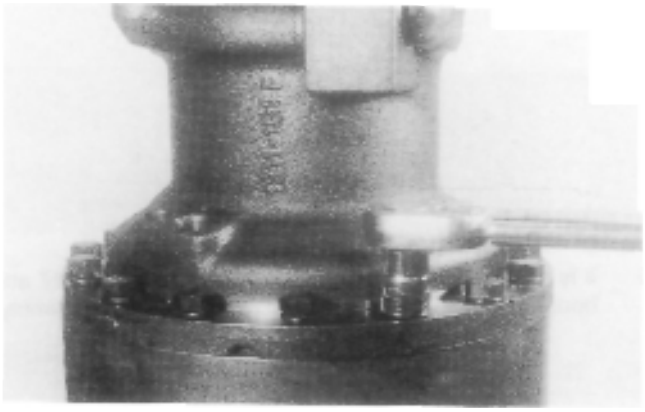


Refer to the sectional drawing on page E/83-1 as a guide to dismantling and assembling.

Before attempting to dismantle the slew motor assembly, the inlet and outlet ports should be blanked and the outer surfaces washed down with a suitable solvent to remove all dirt and dust. Dry using compressed air.

1 Remove the level gauge with a pipe wrench.



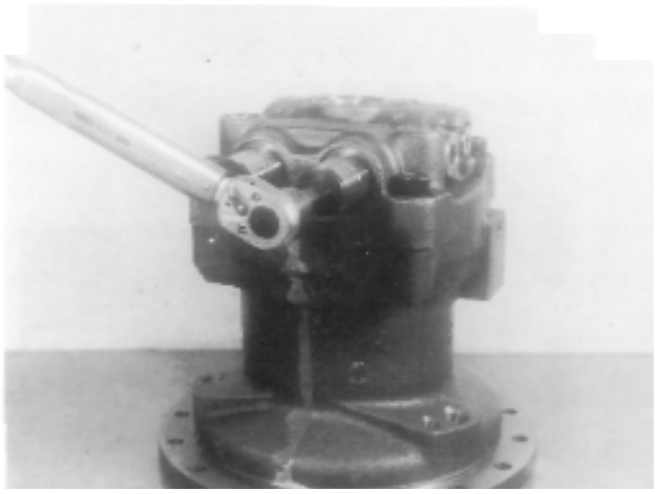


2 Remove plug **26** with an 8 mm Allen key and drain the gear oil.

3 Loosen the bolts with a 19 mm socket wrench and remove the motor.

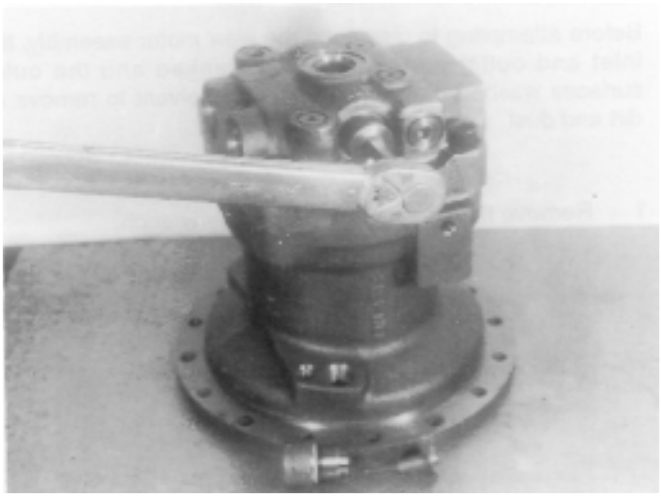
Note: Before removing the motor from the reduction gear, it is advisable to make an alignment mark on the mating faces to facilitate reassembly.

* Motor Assembly/Cylinder Assembly Dismantling (cont'd)



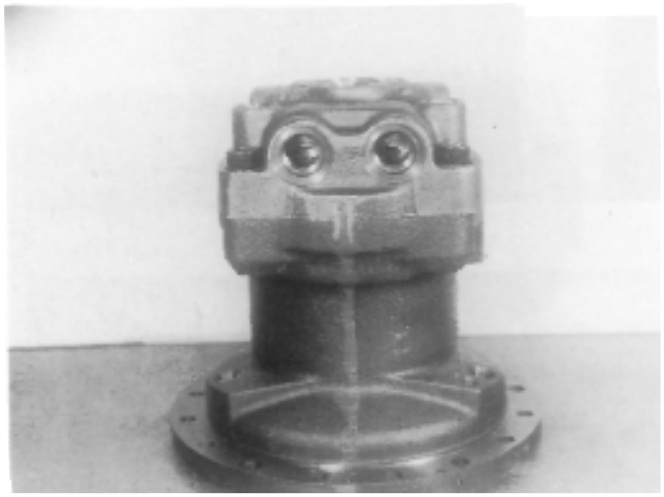
4 Remove the caps **37** with 14 mm A/F hexagonal sockets and remove relief valves **34** from the motor.

Note: Record the position of relief valves **34** to ensure correct reassembly.

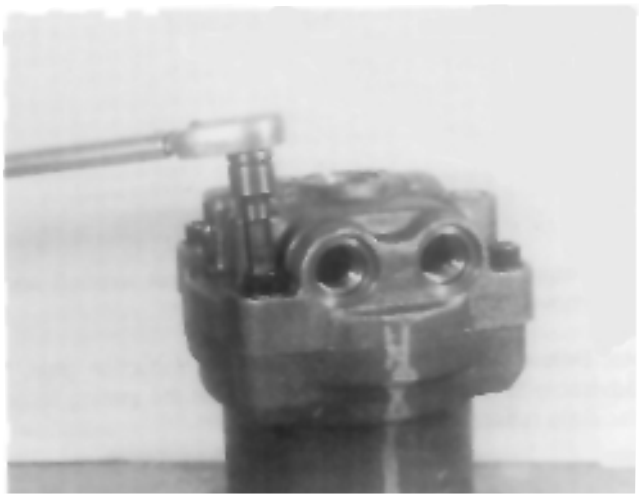


5 Remove the caps **30** with a 14 mm A/F hexagonal key and take out the springs **31** and check valves **29**. Remove by-pass valve assembly by unscrewing cap **28** using a 10 mm A/F hexagonal key.

Note: Record the relative positions of the parts to ensure correct reassembly.

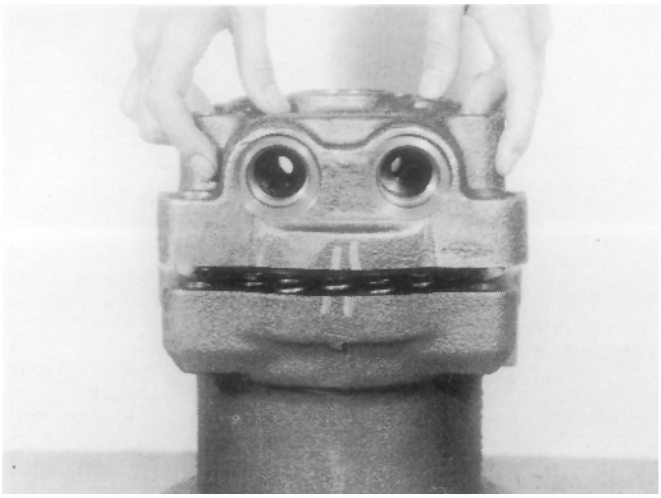


6 It is advisable to make alignment marks on cover **17** and housing **25** with white paint, etc. to facilitate reassembly.

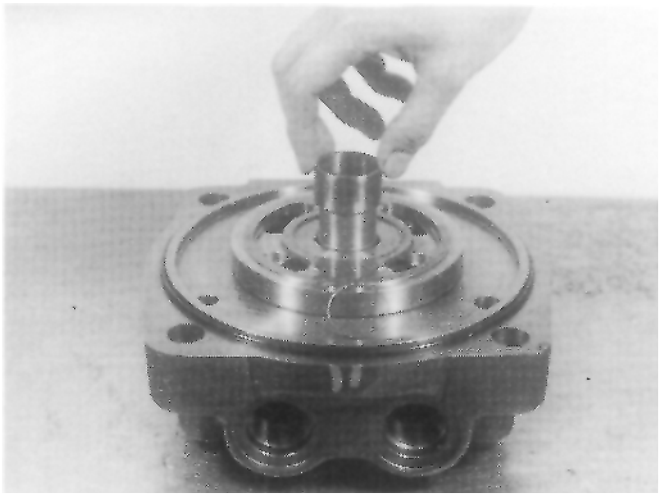


7 Loosen the bolts attaching cover **17** and housing **25** with a 12 mm hexagonal key.

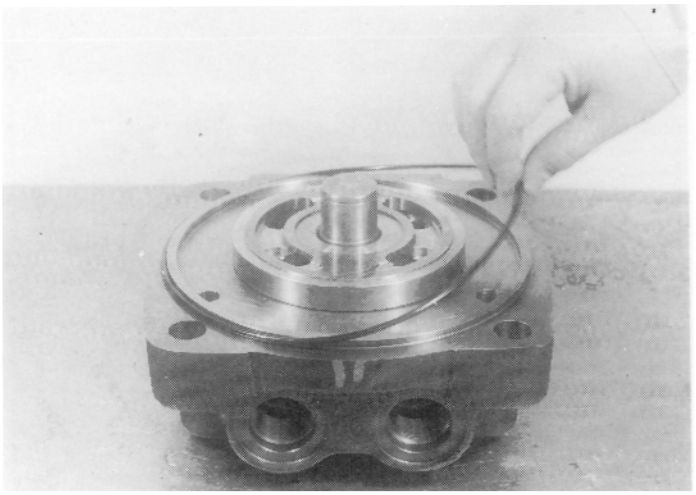
* Motor Assembly/Cylinder Assembly Dismantling (cont'd)



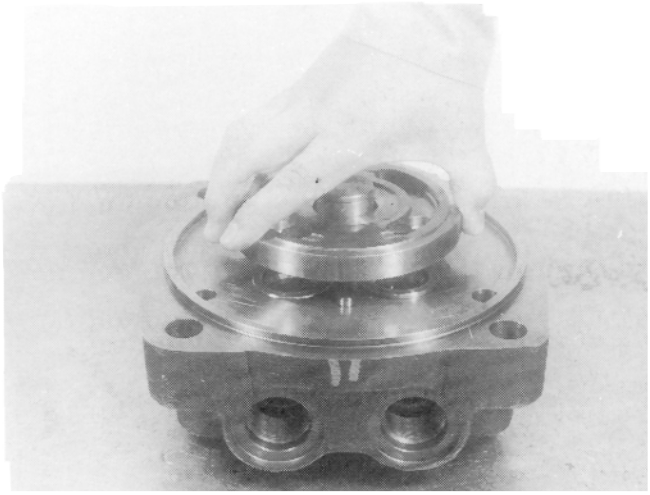
8 Place the motor with the main shaft downwards and lift off cover **17**.



9 Remove snap ring **23** and remove the inner ring of needle bearing **22**.



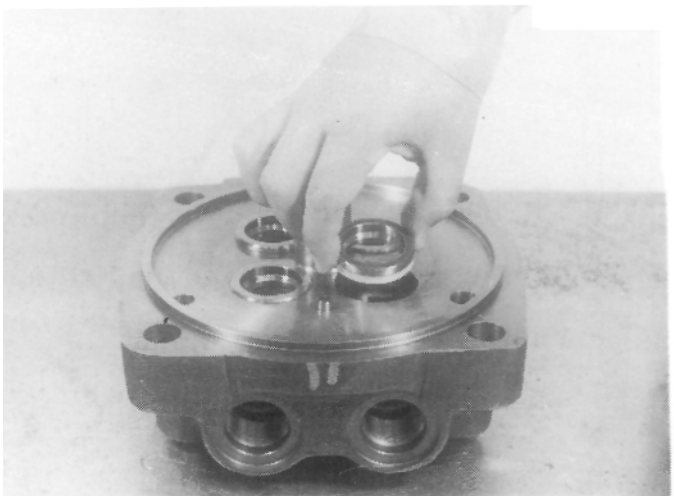
10 Remove 'O'-ring **13**.



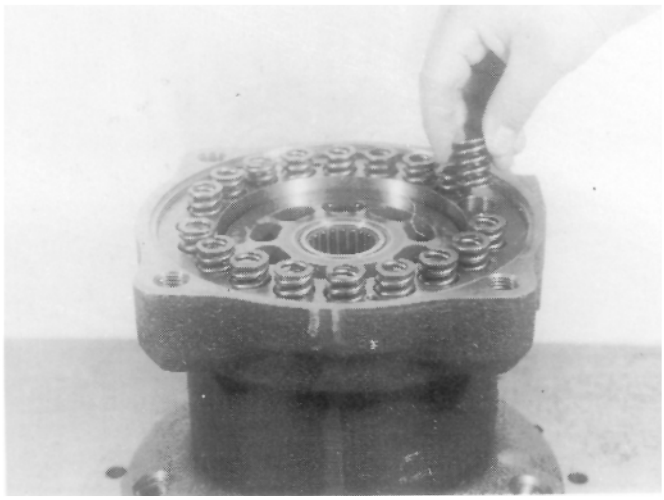
11 Remove balance plate **21**. Remove the pins **15** from the balance plate.

Note: The balance plate **21** must be reinstalled correctly on cover **17**. (The alignment of the hair groove and round groove which select high and low pressure is very important. Before removing the balance plate, note the correct relationship with cover **17**.)

*Motor Assembly/Cylinder Assembly Dismantling (cont'd)

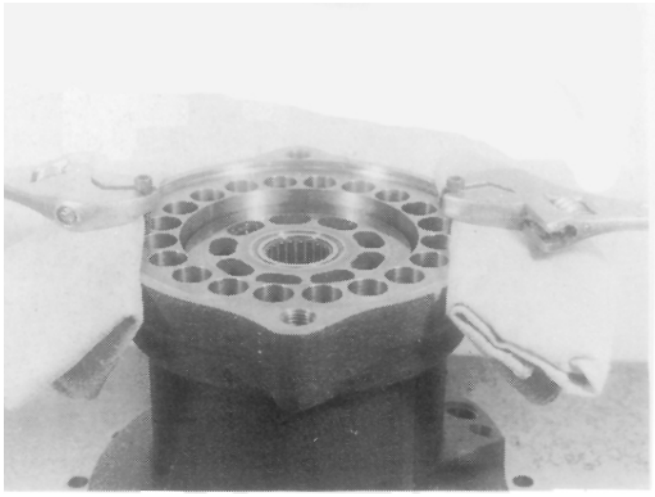


12 Remove the bushings **20** with Teflon rings **19** and the plate springs **18**.

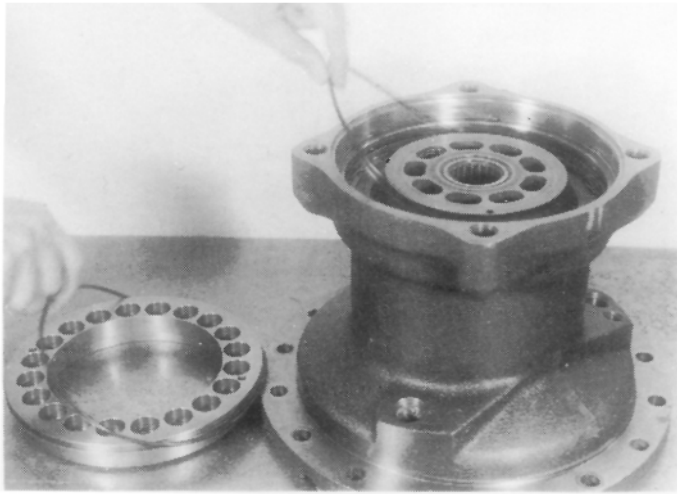


13 Remove the springs **14** from brake piston **12**.

Note: Keep the springs in the order in which they are to be reinserted.

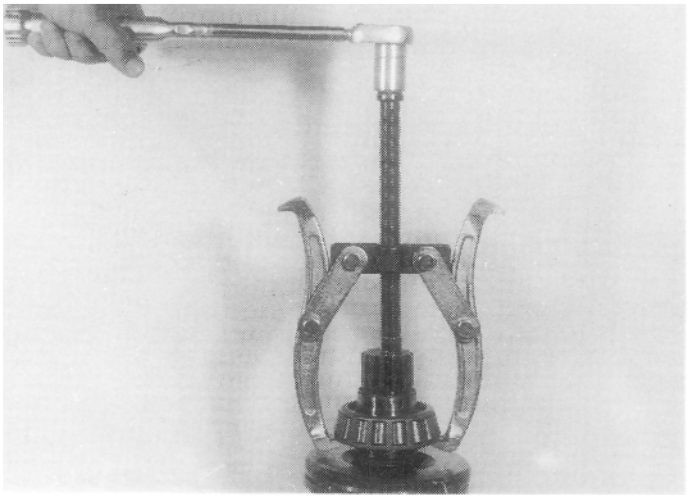


14 It may be difficult to remove brake piston **12** from housing **25** due to resistance caused by 'O'-rings **11** and **13**. Therefore remove brake piston **12** using the tapped M6 holes as shown in the photograph.

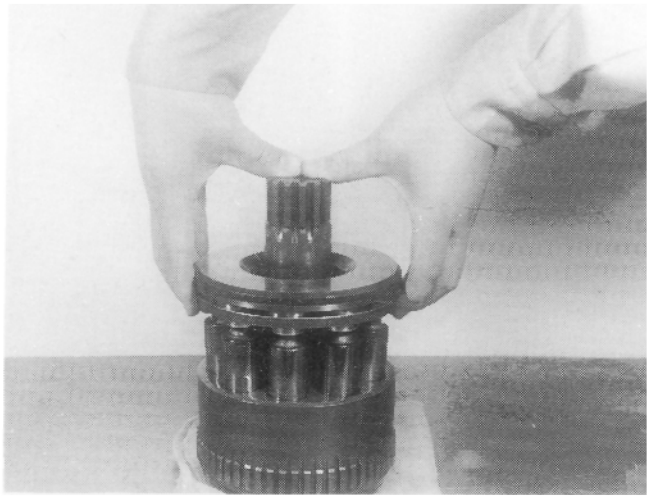


15 Remove 'O'-ring **11** from housing **25** and 'O'-ring **13** from brake piston **12**.

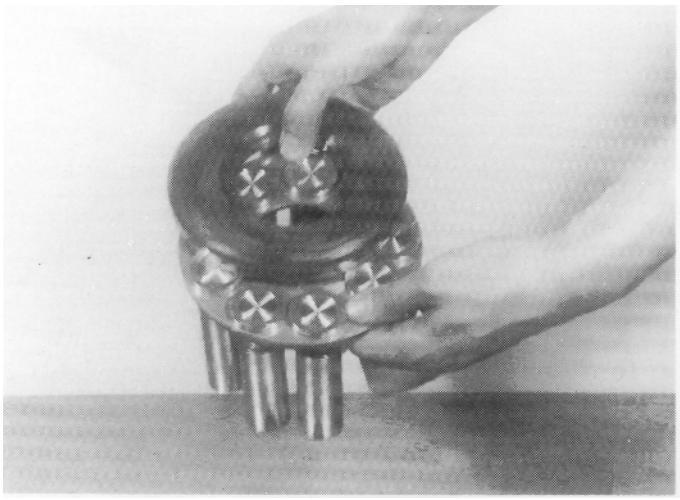
* Motor Assembly/Cylinder Assembly Dismantling (cont'd)



16 Attach a puller to the inner ring of taper roller bearing **3** at two places and on the end of cylinder **24** spline, then extract bearing inner ring **1**. Take out collar **53**.

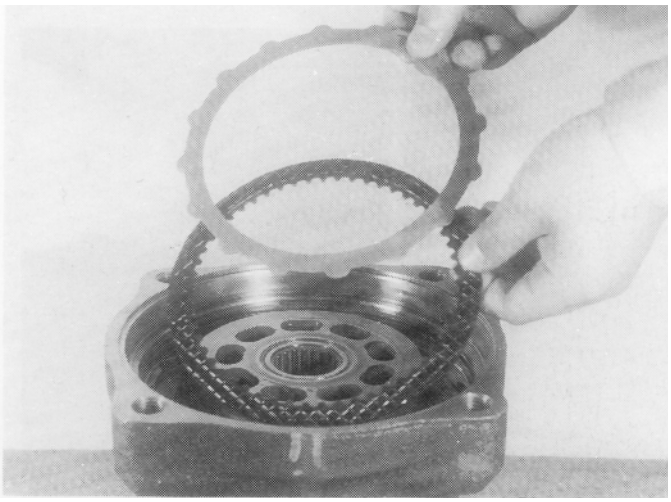


17 Remove swash plate **6**, piston assemblies **8** and retainer plate **7** together from cylinder **24**.



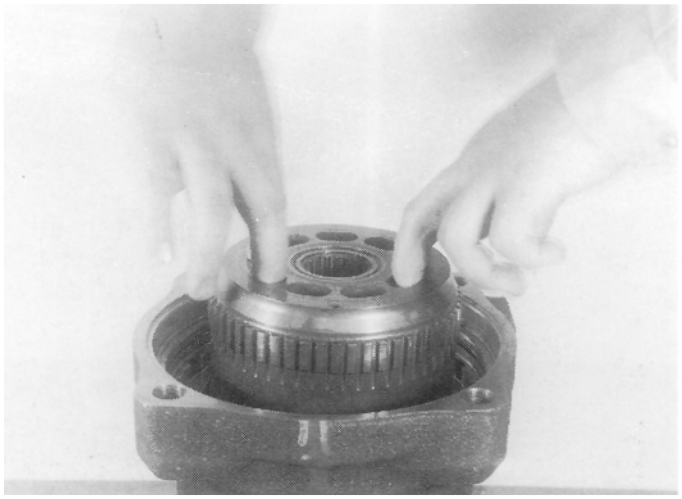
18 Slide swash plate **6** from the sliding faces of the piston assemblies.

Note: Take care not to damage the swash plate during handling.



19 Remove friction plate **9** and mating plate **10**.

* Motor Assembly/Cylinder Assembly Dismantling (cont'd)

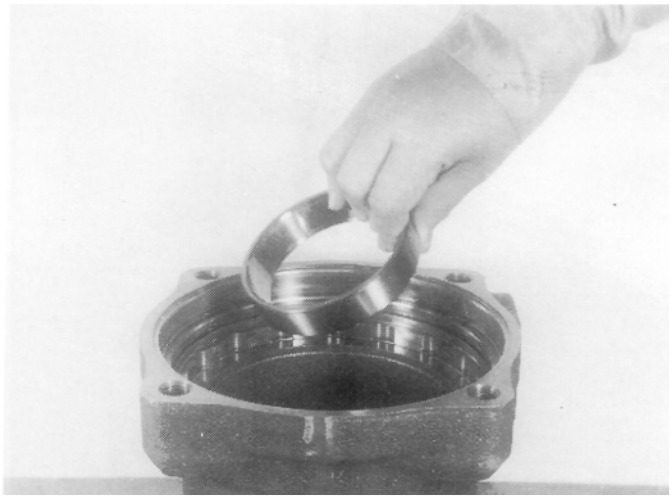


20 Hold the end of cylinder **24** by hand and pull out the cylinder assembly from housing **25**.

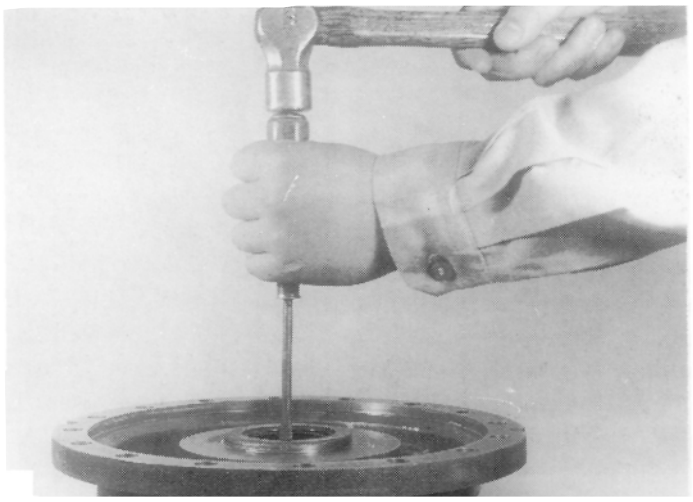
Note: The oil seal **2** and the outer ring of taper roller bearing **3** remain in the housing.

The end face of the cylinder should be protected by clean cloth to prevent it from being damaged.

Make alignment marks or write numbers on the piston bores and the piston assemblies so that the piston assemblies can be replaced in the same bores during reassembly.

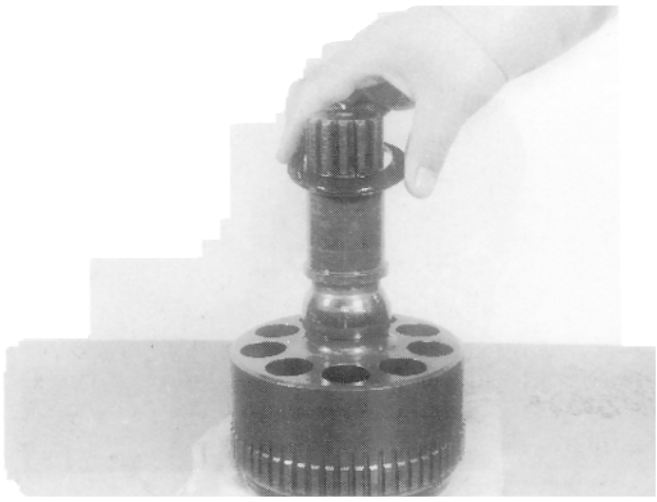


21 Remove the outer ring of taper roller bearing **3** from the housing.



22 Tap oil seal **2** with a screwdriver and hammer to remove it from housing **25**.

Note: The oil seal cannot be reused.



23 Remove the spring from cylinder **24**.

* Motor Assembly/Cylinder Assembly Assembly

Refer to the sectional drawing on page 83 - 1 as a guide to dismantling and assembling.

Check all parts before assembly and remove any scratches with a fine oil stone or carborundum paper. Wash with a suitable solvent and blow dry.

Replace all seals with new ones.

Apply clean hydraulic oil to all sliding faces during assembly.

⚠ CAUTION

Cleaning

Cleaning metal parts with incorrect solvents can cause corrosion. Use only recommended cleaning agents and solvents.

INT-3-2-11

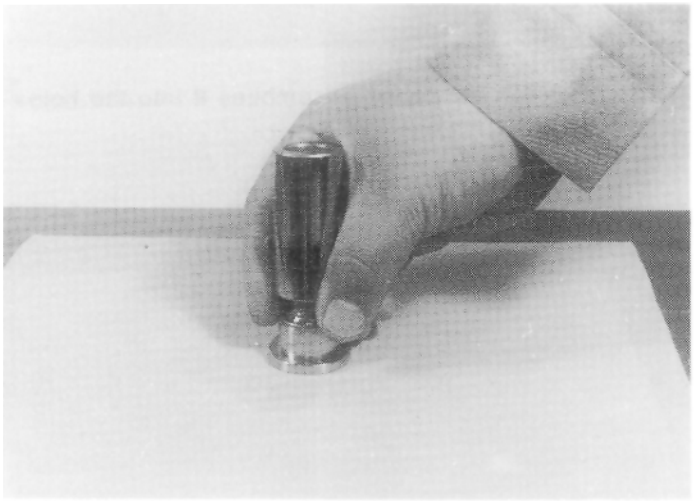
⚠ CAUTION

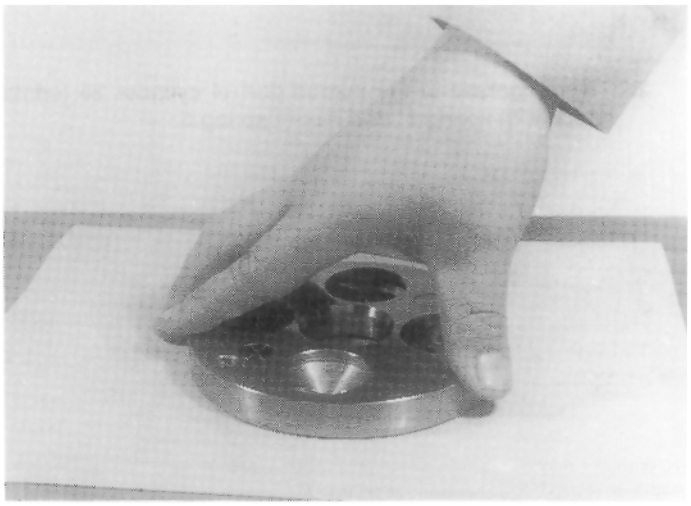
'O'-rings, Seals and Gaskets

Badly fitted, damaged or rotted 'O'-rings, seals and gaskets can cause leakages and possible accidents. Renew whenever disturbed unless otherwise instructed. Do not use Trichloroethane or paint thinners near 'O'-rings and seals.

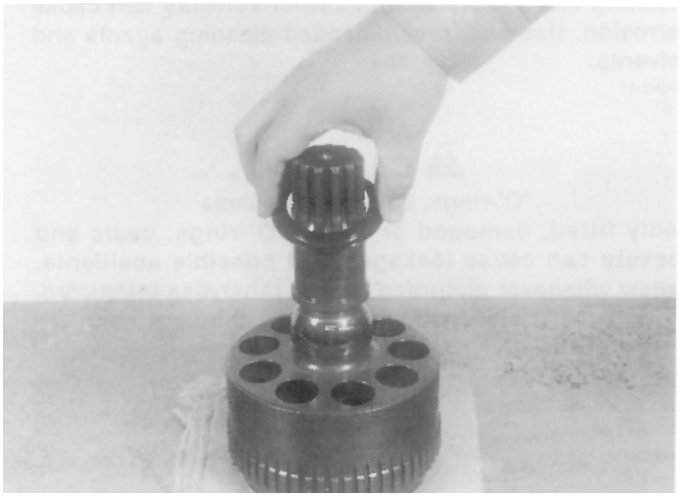
INT-3-2-12

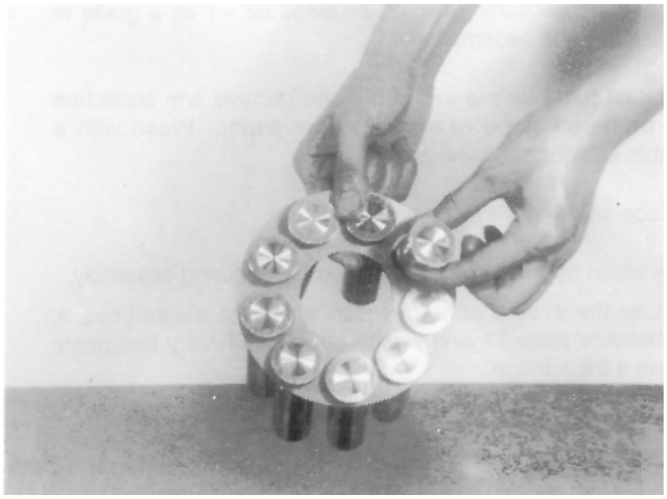
1 Lap the sliding contact faces of piston assemblies **8**, balance plate **21** and swash plate **6** with very fine paste on a flat surface.





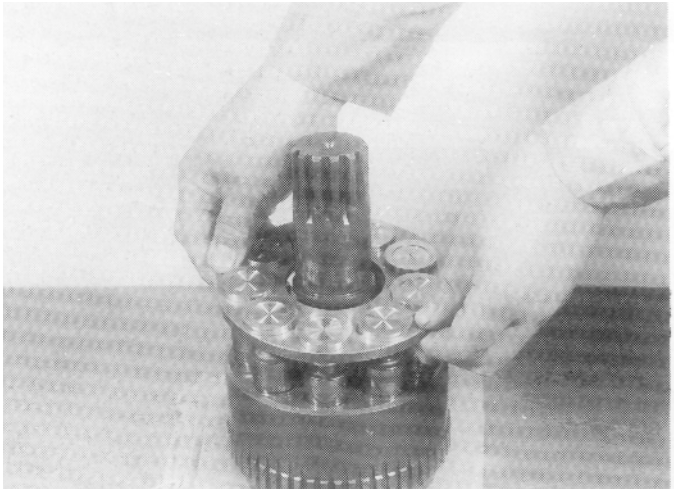
* Motor Assembly/Cylinder Assembly Assembly (cont'd)





2 Apply grease to the curved part of cylinder **24** (contact face with spring **5**) and mount spring **5**.

3 Position the piston assemblies **8** into the holes of retainer plate **7**.



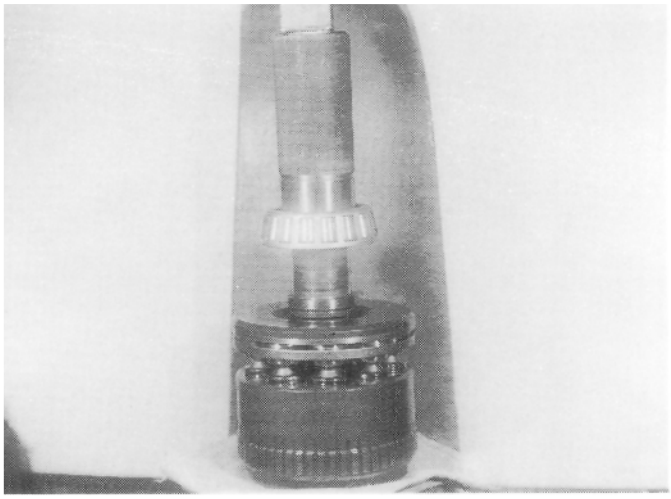
4 Mount the piston assemblies **8** together with retainer plate **7** into cylinder **24**.

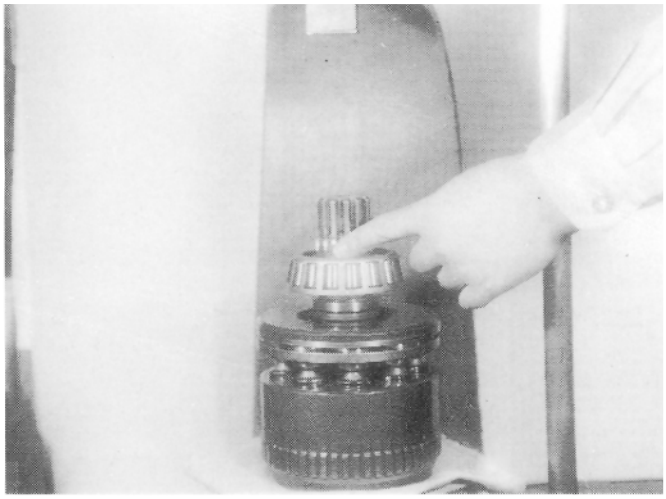
Note: Insert the piston assemblies into the same bores from which they were removed.

Apply clean hydraulic oil to all cylinder **24** bores before reassembling.

5 Apply clean hydraulic oil to piston assembly **8** shoe sliding surface and mount the swash plate **6**.

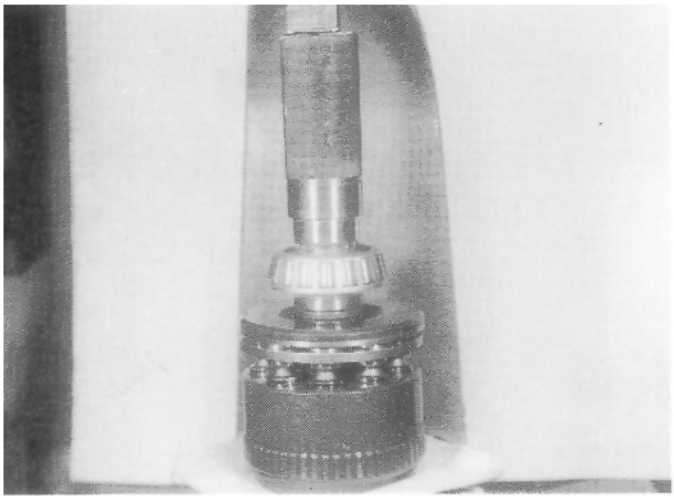
* Motor Assembly/Cylinder Assembly Assembly (cont'd)

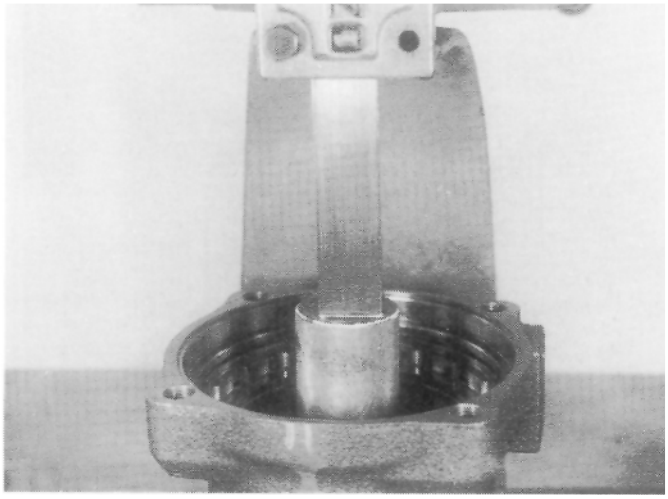




6 Mount collar **53** and inner ring of taper roller bearing **1** on motor output shaft **24**.

7 Apply a thin coat of JCB Retainer where the inner ring is mounted on motor output shaft **24**.

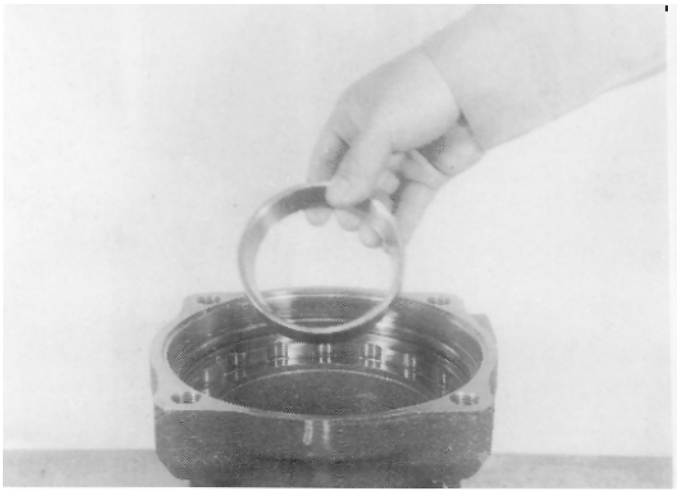


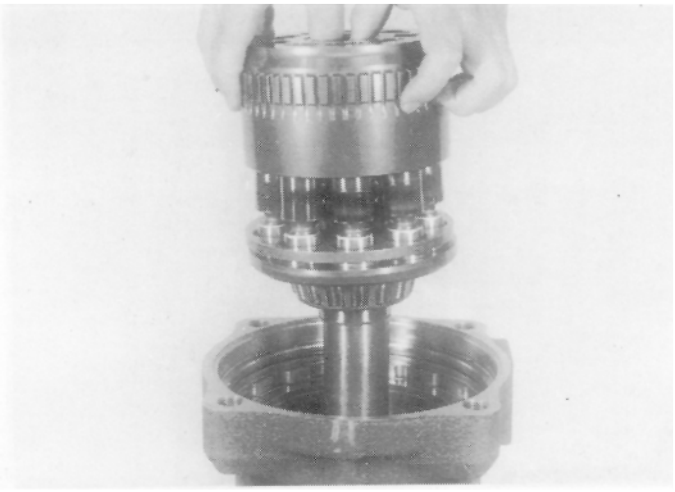


8 Using a jig, (see **Special Tools**, Section 1) mount inner ring **1** on output shaft **24**.

9 Apply grease to the lip of seal **2** and use a press and jig (see **Special Tools**, Section 1) to force fit the seal into position.

* Motor Assembly/Cylinder Assembly Assembly (cont'd)

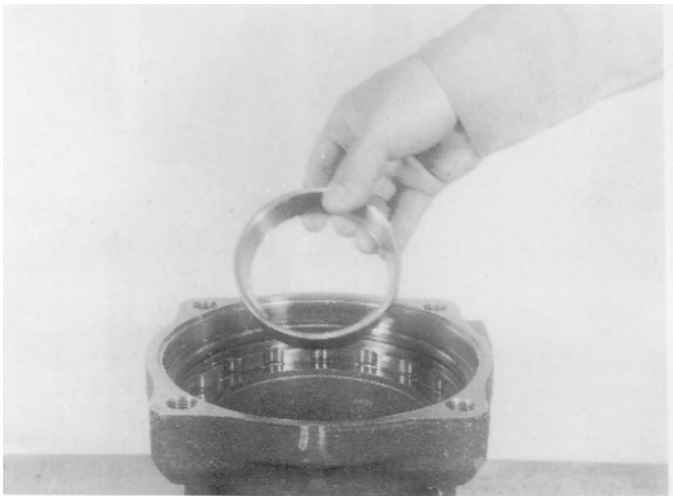


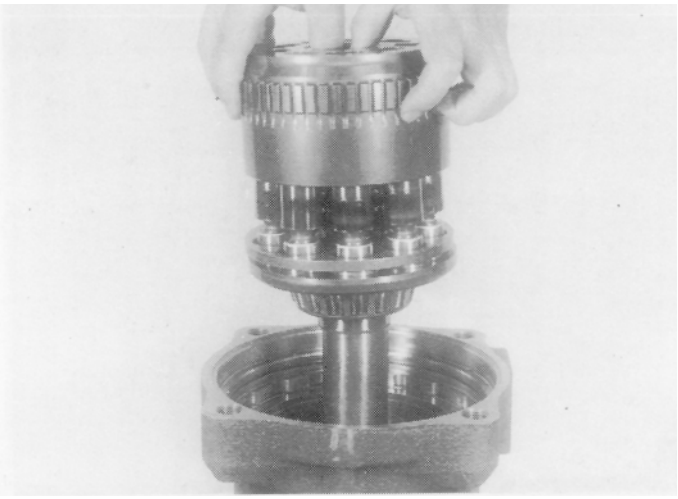


10 Mount the outer ring of the taper roller bearing into housing **25**.

11 Hold the end of cylinder **24** by hand and carefully insert the cylinder assembly into housing **25**. Use the seal protector on the splines.

Note: The splines of the cylinder assembly protrude beyond the housing, so use a guide of 30-50 mm (1.2-1.9 in) on the lower part of the housing. Verify that spring **5** is inserted correctly into the back face of retainer plate **7**.





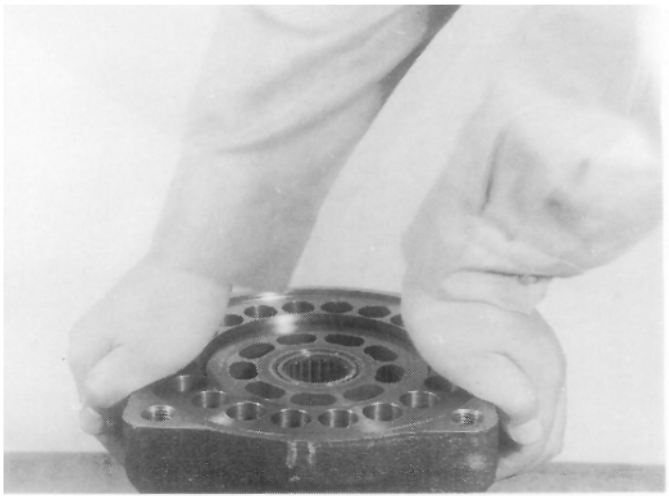
12 Mount friction plate **9** and mating plate **10**.

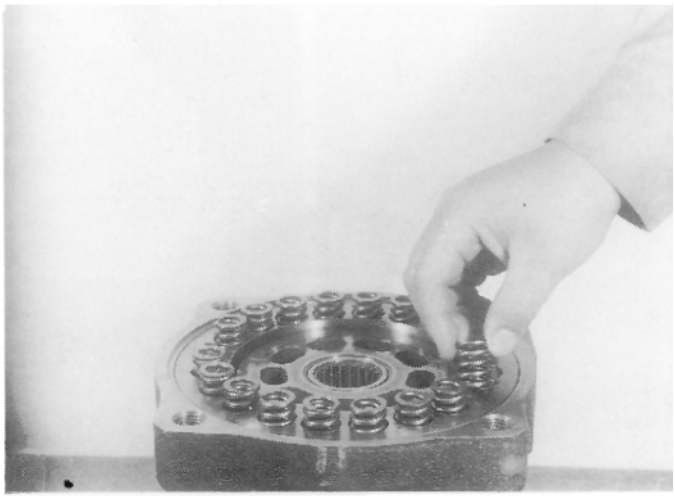
Note: Apply hydraulic oil to both faces before mounting the plates.

13 Mount 'O'-ring **11** in housing **25** and 'O'-ring **13** on piston **12**.

Note: Grease the 'O'-rings before mounting.

* Motor Assembly/Cylinder Assembly Assembly (cont'd)



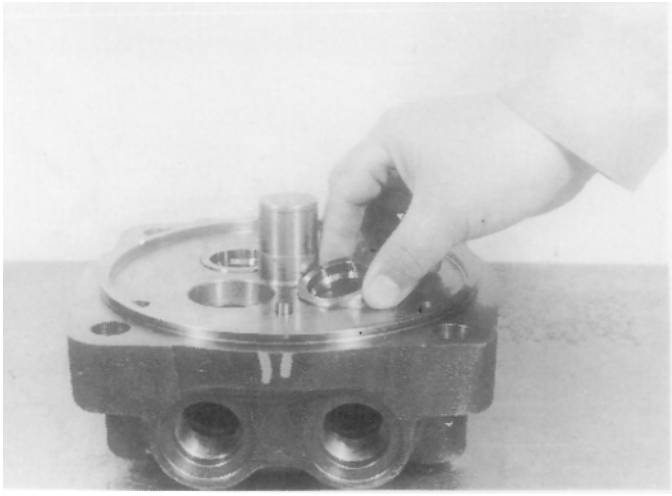


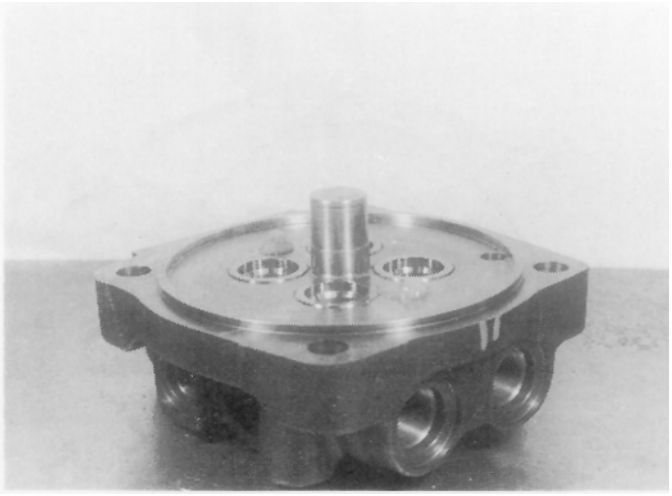
14 Apply hydraulic oil to the sliding surface around piston **12** and slide it into housing **25**.

Note: It is difficult to insert piston **12** into the housing due to O'-rings **11** and **13**. Hold the piston horizontally and push it into the housing with one movement.

15 Insert the brake unit springs **14** back into brake piston **12**.

Note: Insert the springs **14** the same order as they were found during dismantling.



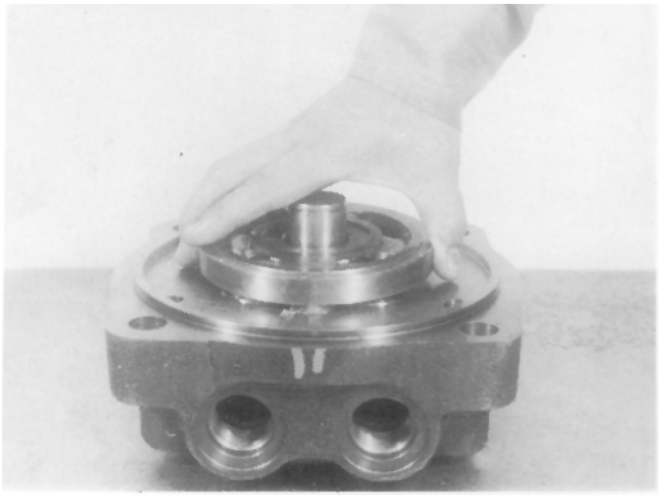


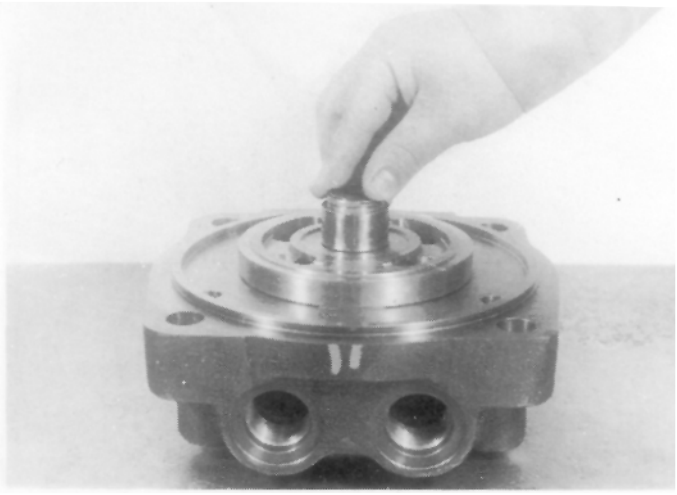
16 Mount the bushings **20** with Teflon rings **19** and the plate springs **18** into the bushing holes in cover **17**.

Note: Apply a coating of grease to the end faces and peripheries of the bushings **20** and to the Teflon rings **19** before mounting them, as this helps prevent them from falling out when the cover is mounted onto the housing.

17 Generously grease the pins **15** and insert into cover **17**.

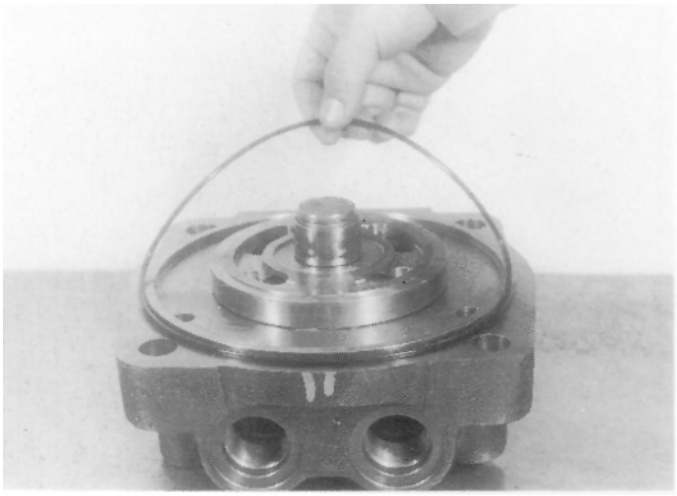
* Motor Assembly/Cylinder Assembly Assembly (cont'd)

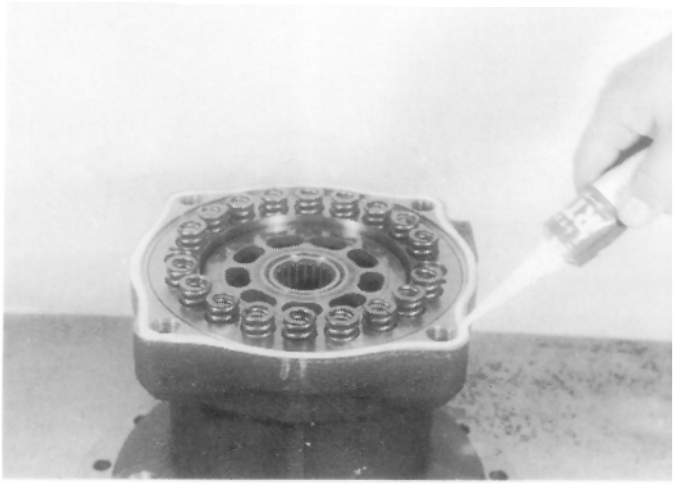




18 Mount balance plate **21** onto cover **17**.

19 Press needle bearing **22** inner ring into cover **17** and attach snap ring **23**.

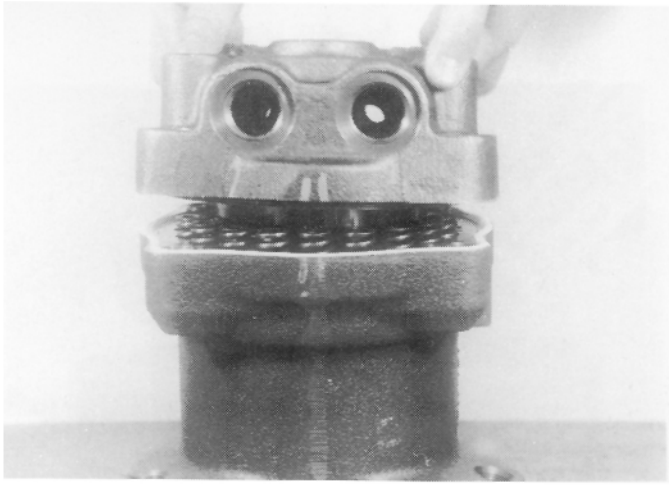


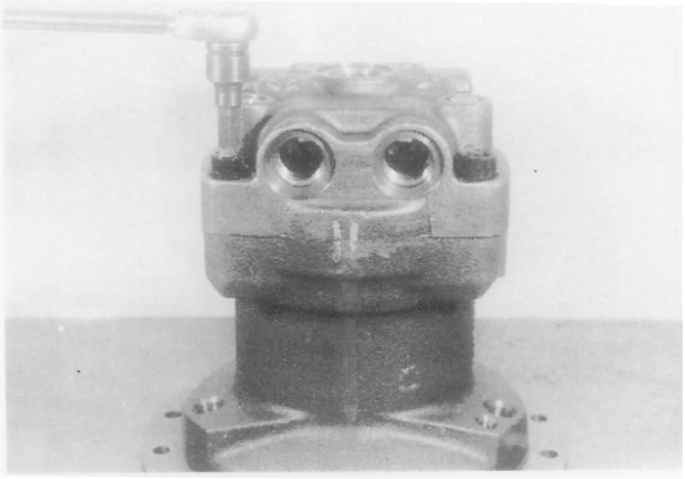


20 Apply grease to the 'O'-ring and install 'O'-ring **13** to cover **17**.

21 To prevent oil leakage from the cover bolt holes apply JCB Multi-gasket to the surface.

* Motor Assembly/Cylinder Assembly Assembly (cont'd)

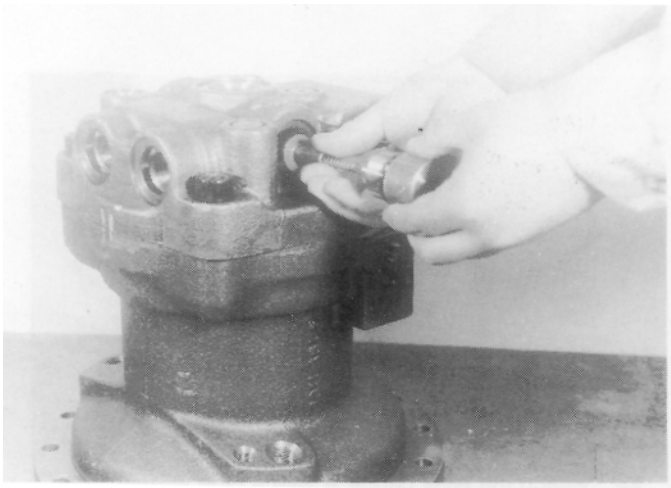


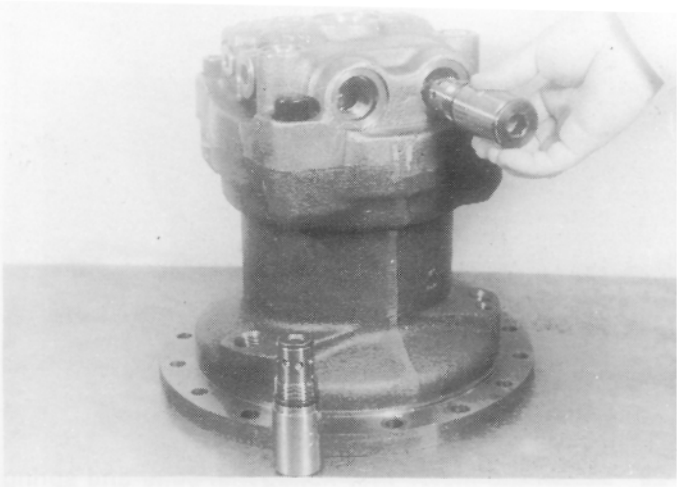


22 Lift cover **17** and balance plate **21** by hand and mount them carefully on housing **25**.

Take care that balance plate **21** and bushings **20** do not fall out while mounting cover **17**. Align housing **25** and cover **17** alignment marks which were made before dismantling.

23 Tighten the cap screws **27** (with a 12 mm A/F hexagonal socket) which attach cover **17** to housing **25** to a torque of 157 Nm (116 lbf ft).





24 Assembling the Make-up and by-pass valves.

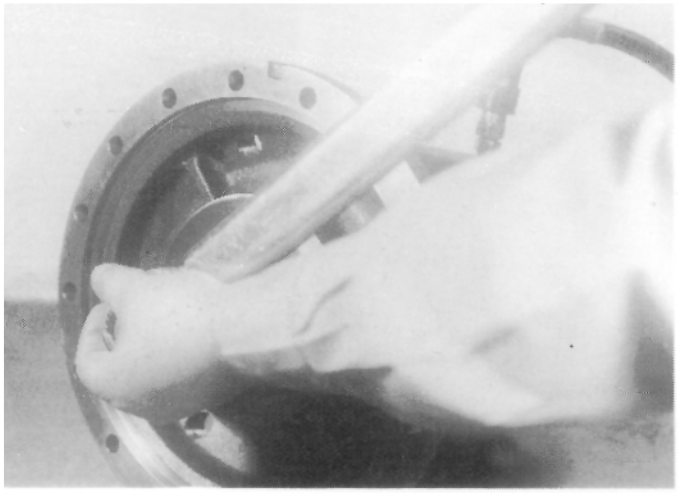
Assemble the check valves **29** and springs **31** in cover **17** and tighten the caps **30** (14 mm A/F hexagonal sockets) to a torque of 137 Nm (101 lbf ft).

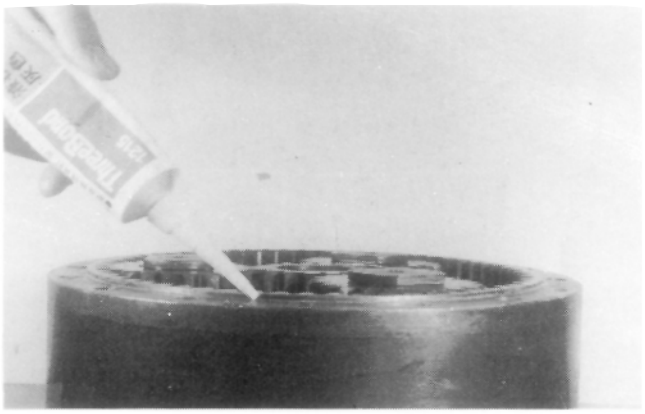
Assemble by-pass valve assembly **28** to cover **17** and tighten the caps (10 mm A/F hexagonal sockets) to a torque of 78.65 Nm (58 lbf ft).

25 Insert the relief valve assemblies **34** into cover **17** and tighten the caps **37** (14 mm A/F hexagonal sockets) to a torque of 78.65 Nm (58 lbf ft).

Note: Ensure that the relief valves are replaced in their original positions.

* Motor Assembly/Cylinder Assembly Assembly (cont'd)



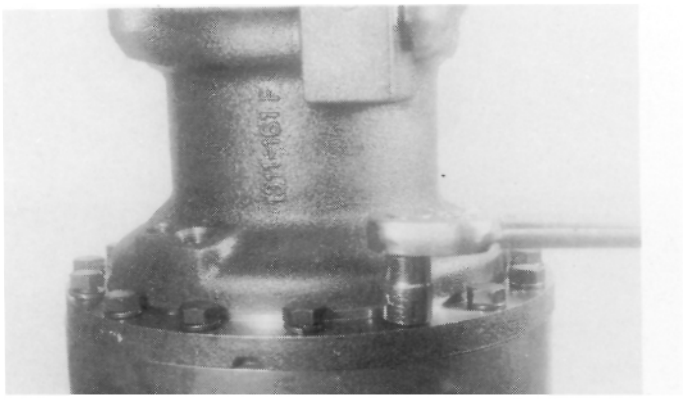


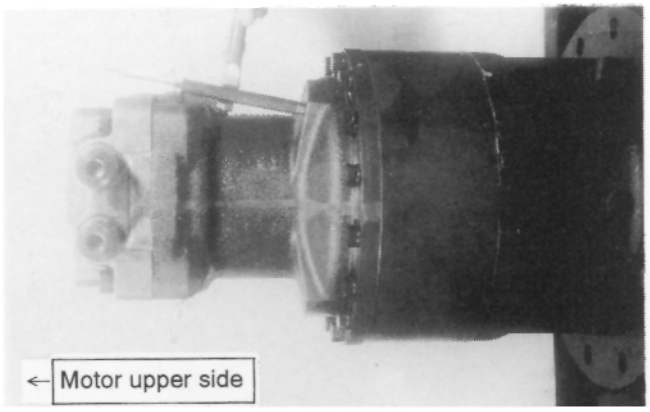
26 Final checks after assembling.

Open the inlet and outlet ports and apply 30 kgf/cm^2 (427 lbf/in^2) pilot pressure to the brake release port. (Take care as oil will be discharged from the drain port). Check that the drive shaft can be rotated smoothly for at least one full revolution by applying a torque of approx. 39.32 Nm (29 lbf ft).

Note: If the shaft does not turn, the unit has not been assembled correctly so dismantle again and inspect.

27 Degrease the mating faces of the gear unit ring gear **64** and motor housing **25** and apply Multi-gasket to the ring gear.

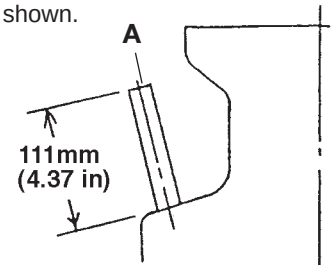




28 Attach the motor with hexagonal bolts and spring washers.

Size: 19 mm
Tightening torque: 103 Nm (76 lbf ft).

29 Attach the level gauge **A** with a pipe wrench, setting the height as shown.



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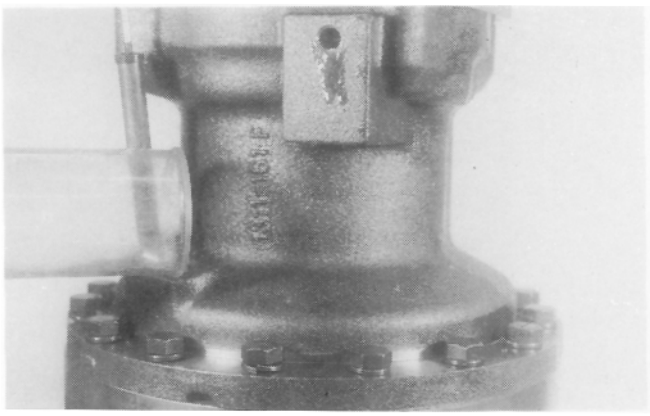
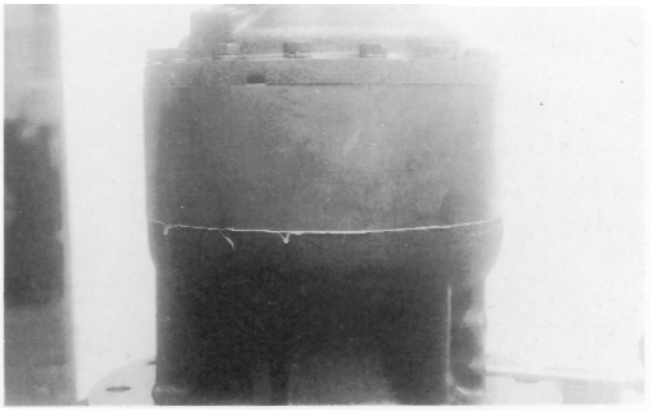
* Motor Assembly/Cylinder Assembly Assembly (cont'd)





30 Insert plug **26** with an 8 mm Allen key and tighten to torque of 39.32 Nm (29 lbf ft).

Fill with gear oil through the filler port.

Note: Fill the hydraulic motor case with hydraulic oil before connecting the piping to the drain port.

See **Fluids and Lubricants**, Section 3, for type and quantity of oil.

31 Apply grease (type and capacity is given in **Fluids and Lubricants**).

Note: Bleed air in the chamber from the air bleed port before filling with grease, as a build-up of internal pressure can damage the oil seal.

After the unit is filled, run it for around 10-15 minutes at zero load, and at low speed and verify that there is no abnormal noise or vibration. Gradually bring the system into high speed and loaded operation.

* Relief Valves
Dismantling

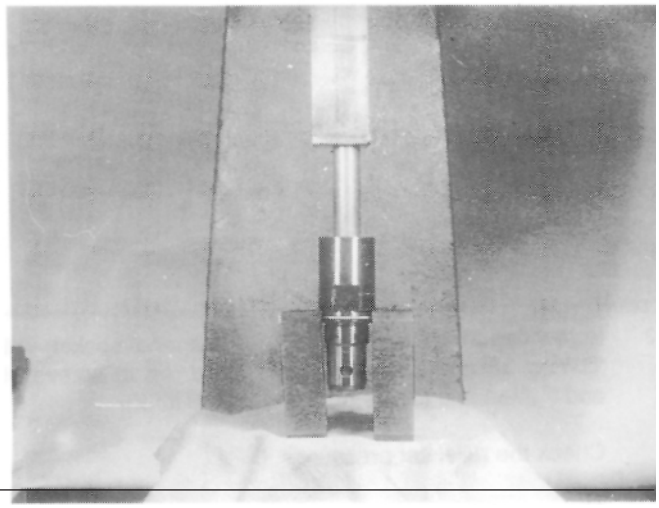
Refer to the sectional drawing on page E/83-1 as a guide to dismantling and assembling.

Take steps during dismantling to ensure that all the parts are returned to their original positions.

Clean the parts with a suitable solvent and blow them dry. Replace all used 'O'-rings

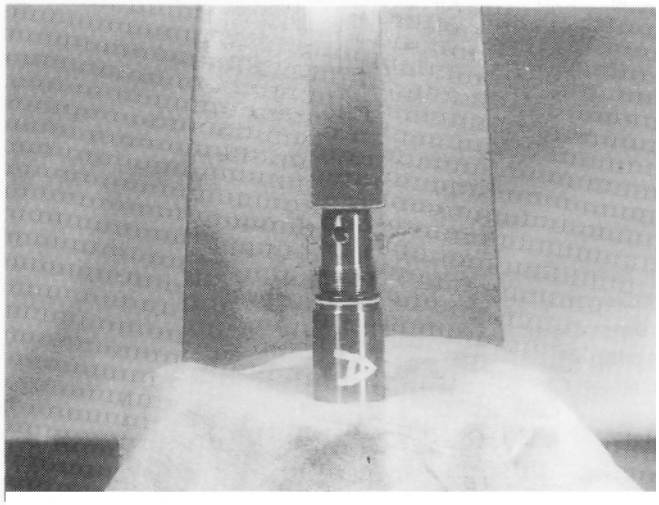
1 If not already done, remove cap **37** (with a 14 mm A/F hexagonal socket) from the relief assemblies **34** and remove piston **38**, liner **51**, shim **40**, poppet **43** and spring **42**.

2 The seat **44** is press-fitted into sleeve **39**. Remove it using a soft object, taking care not to scratch the seat face.

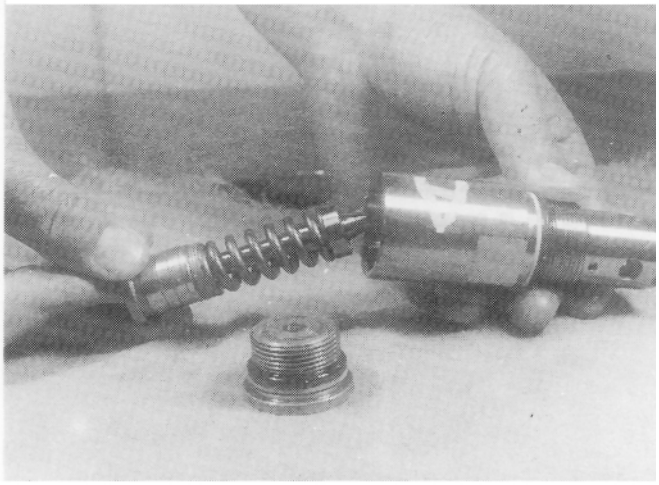


* Relief Valves Assembly

1 Press fit seat **44** into sleeve **39** which has an 'O'-ring **41**.



2 Mount poppet **43**, spring **42**, shim **40**, piston **38**, liner **51** onto sleeve **39**.

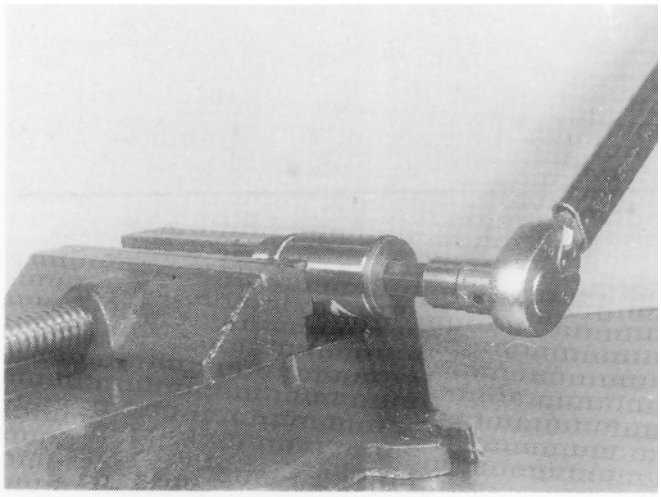


3 Screw cap **37** (with a 14 mm A/F hexagonal socket) with 'O'-ring **36** and back-up **35** mounted, on to sleeve **39** and tighten to a torque of 157 Nm (116 lbf ft).

Check the relief set pressure.

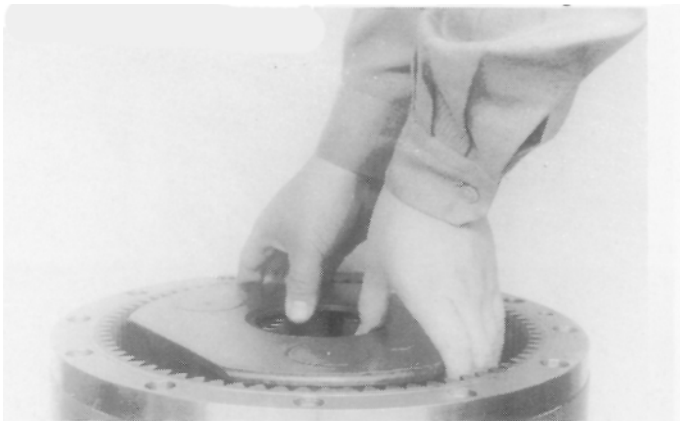
The correlation between the set pressure of the relief valve and the adjusting shims is shown below. However, adjustment must not be attempted if the pressure cannot be checked.

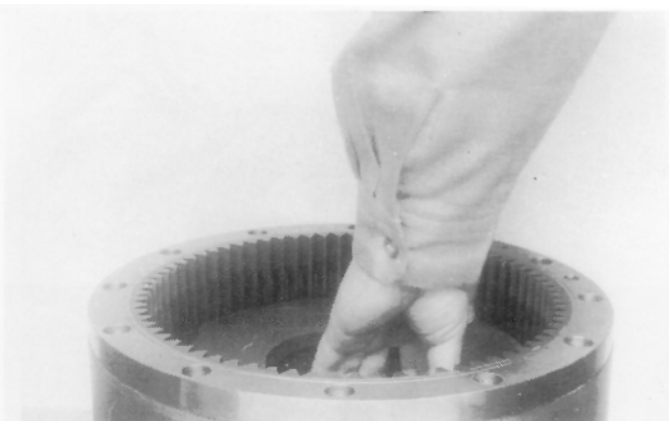
A 0.1 mm (0.003 in) shim equals 5 kgf/cm^2 (71 lbf/in^2) approximately.



* Reduction Gear Dismantling

Refer to the sectional drawing on page E/83-2 as a guide to dismantling and assembling.





1 Removal of the sun gear, 1st stage holder assembly.

Remove sun gear **66** and 1st stage holder assembly **65**.

* **⚠ WARNING**

You can be injured by flying metal splinters when driving metal pins in or out. Use a soft faced hammer or drift to remove and fit metal pins. Always wear safety glasses.

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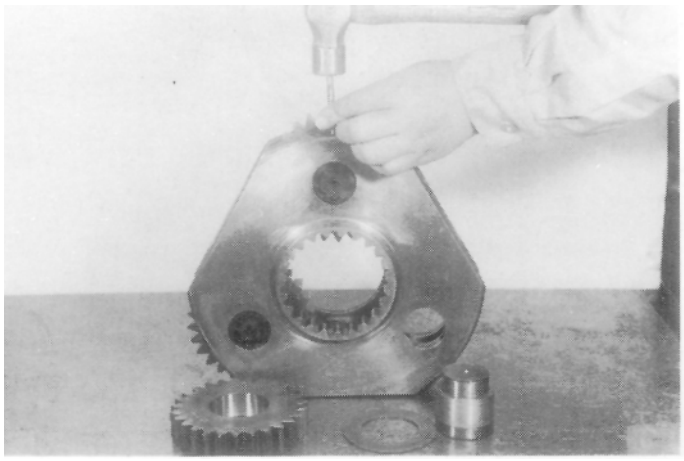
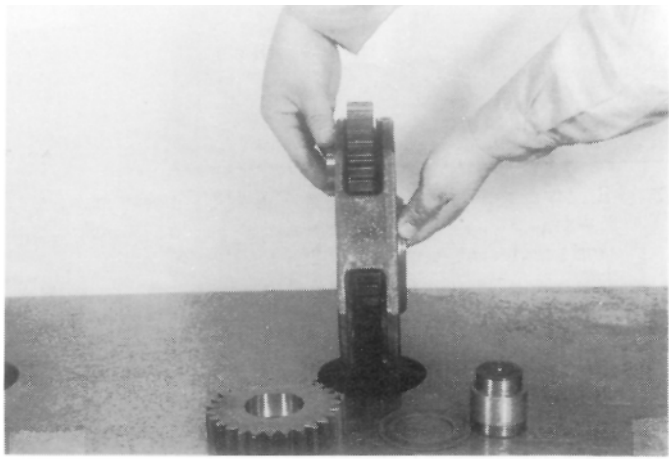
2 Remove the spur gear and 2nd stage holder assembly **76**.





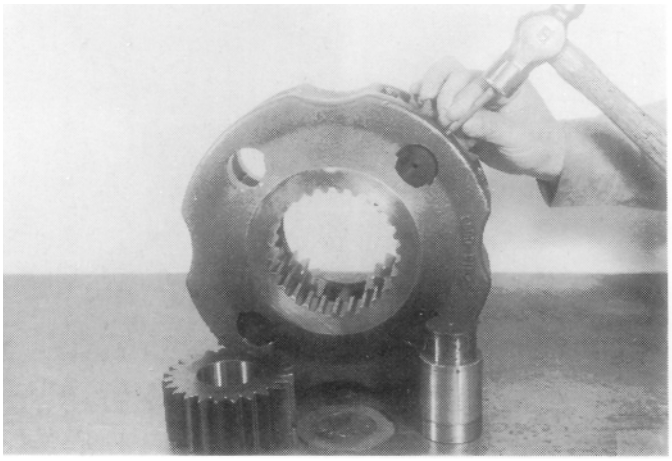
3 Dismantling of the 1st stage holder assembly.

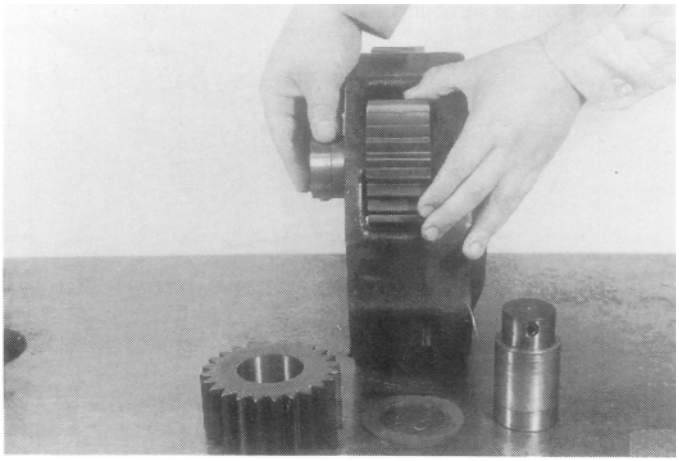
Drive the spring pins into shaft **67**.

Note: The spring pins cannot be reused.

4 Support planetary gears **69** by hand and withdraw shaft **67** from holder **65**.

* Reduction Gear Dismantling (cont'd)





5 Dismantling of 2nd stage holder assembly.

Drive spring pins **75** into shaft **70**.

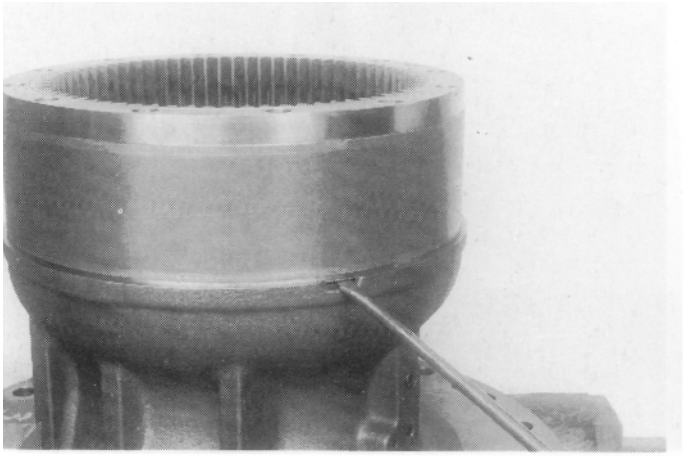
Note: The spring pins cannot be reused.

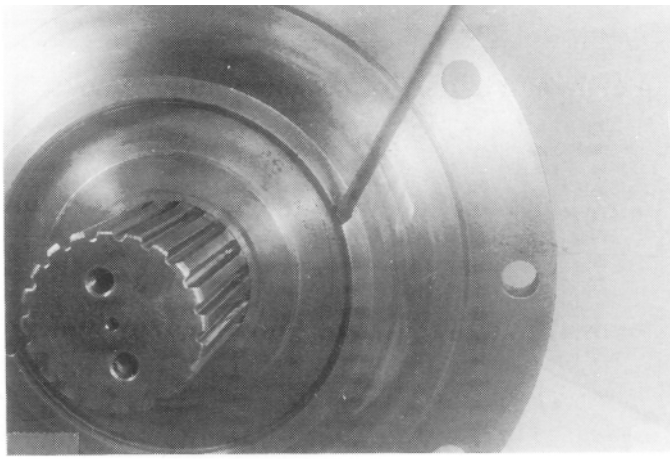
6 Support planetary gears **72** by hand and withdraw shaft **70** from holder **76**.

* **⚠ WARNING**

You can be injured by flying metal splinters when driving metal pins in or out. Use a soft faced hammer or drift to remove and fit metal pins. Always wear safety glasses.

INT-3-1-3





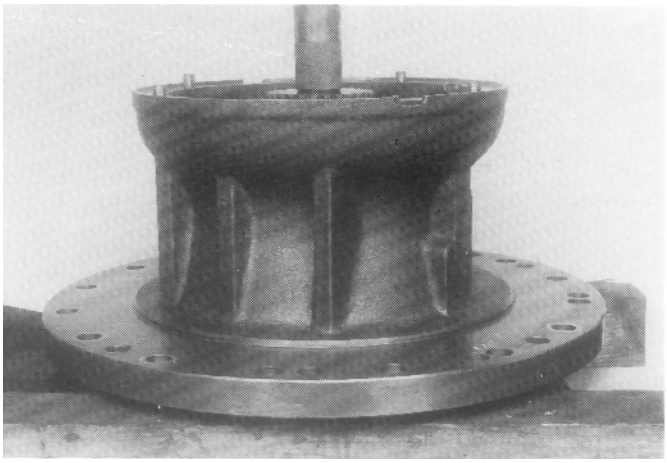
7 Ring gear removal

Remove ring gear **64** from gear case **58**. JCB High Strength Gasketing is applied on the assembly to prevent oil leaks from between the ring gear and gear case. To remove ring gear **64** use the notch on gear case **58**.

8 Removal of pinion gear assembly.

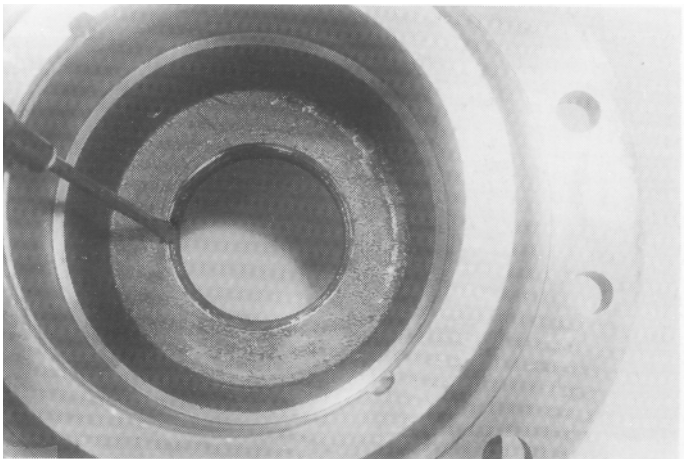
Remove snap ring **55** with a screwdriver using the notch in the case for leverage.

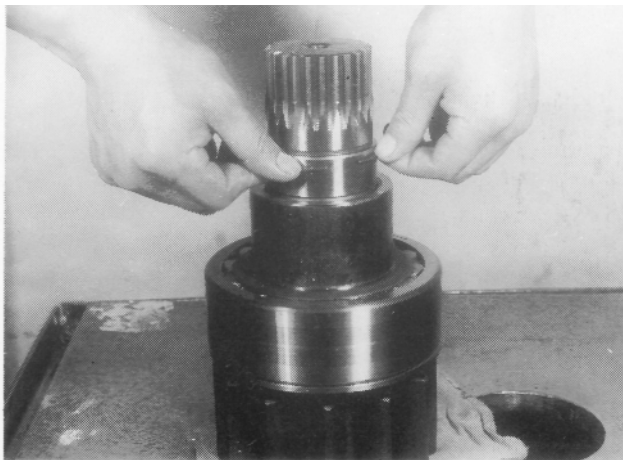
* Reduction Gear Dismantling (cont'd)



9 Support the flange part of gear case **58** on 300 mm (11.8 in) blocks and press shaft end with a hydraulic press to push out shaft **53**, collar **54**, plate **56**, self-aligning roller bearing **57**, snap ring **60** and collar **59** from the assembly.

10 Remove the roller bearing **62** from gear case **58**.



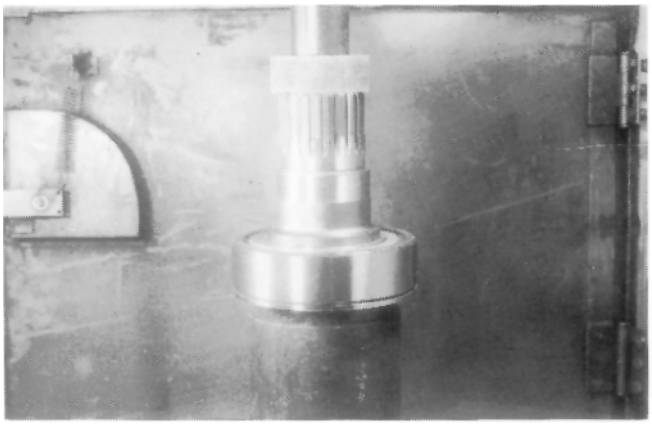


11 Remove and discard oil seal **61** from gear case **58** by tapping.

12 Remove snap ring **60** from pinion shaft **53** and remove collar **59**.

Note: Before removing collar **59**, make a note of which way round it is, to ensure correct reassembly.

* Reduction Gear Dismantling (cont'd)



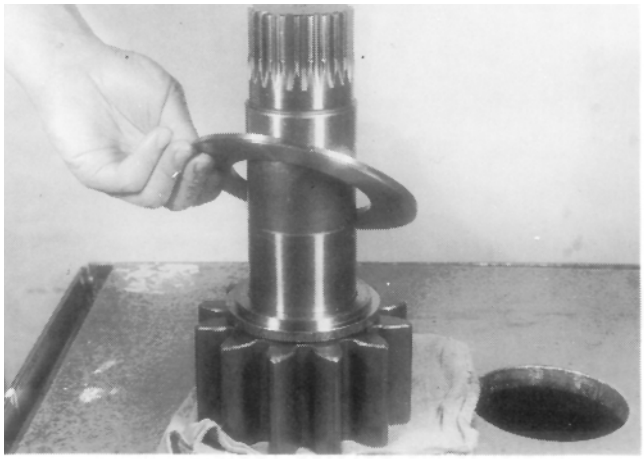
13 Carry out the following procedure only when bearing **57** is damaged or badly worn, and dismantling is necessary.

Support the self aligning roller bearing **57**, then press the motor end of shaft **53** to remove bearing **57**, plate **56** and collar **54** from the shaft **53**.

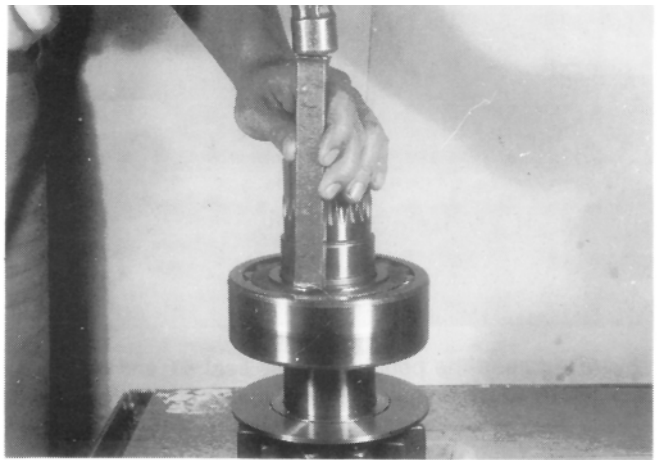
* Reduction Gear Assembly

Refer to the sectional drawing on page E/83-2 as a guide to dismantling and assembling.

Apply clean hydraulic fluid to all sliding contact faces during assembly.

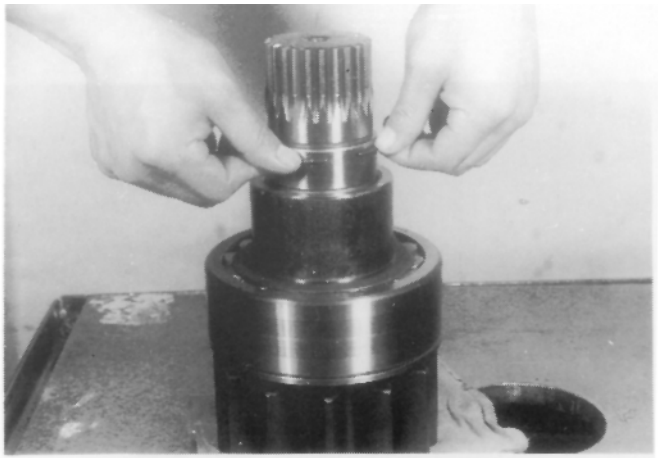


1 Position collar **54** on pinion shaft **53** and mount the plate **56**. Take care to mount in the correct direction.

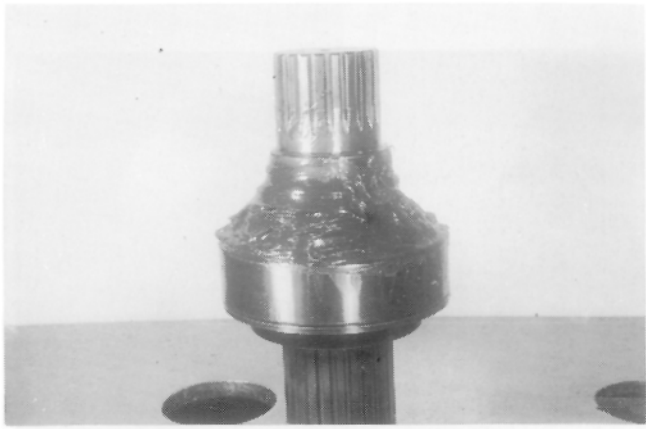


2 Heat the bearing **57** to 50 °C above ambient temperature and press fit it on the pinion shaft.

Note: Do not heat to a temperature greater than 100 °C.



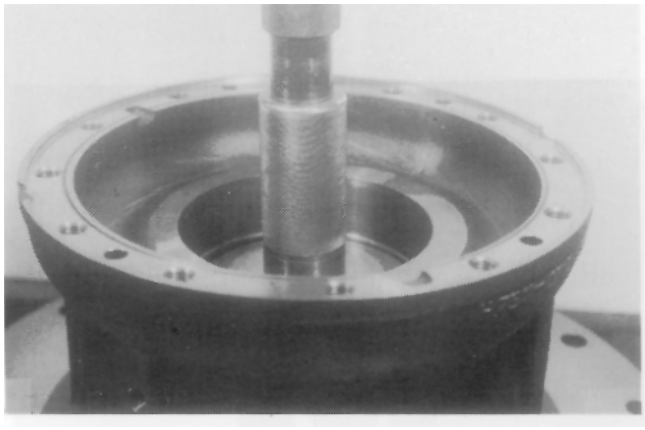
3 Mount collar **59** and put snap ring **60** in position. Take care to mount the collar in the correct direction, as noted in **Dismantling**.

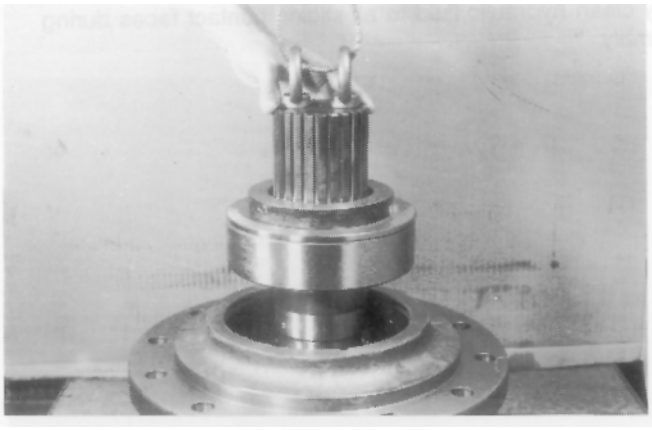


4 Grease the rollers of bearing **57**.

Note: Although the total grease capacity is 1000 cc, only 400 cc is used in the above procedure; the rest should be added after assembly.

* Reduction Gear Assembly (cont'd)





5 Degrease the periphery of oil seal **61** and its mounting face in gear case **58** and apply JCB High Strength Retainer to these surfaces. Press the oil seal into the gear case using a jig. Grease the oil seal after it has been pressed into place.

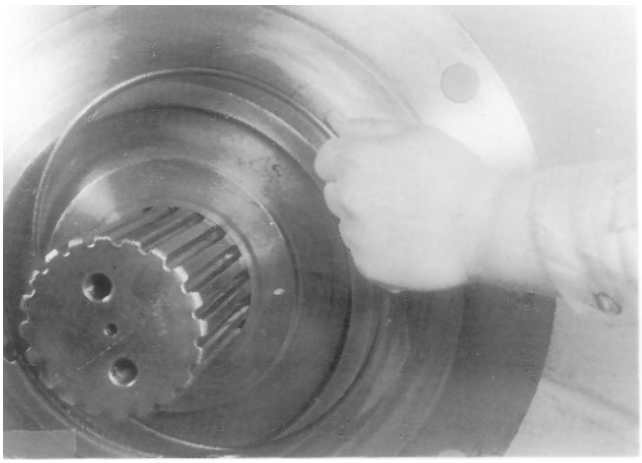
Note: Refer to seal press-fitting jig in the **Service Tools** section.

6 Use the seal protector to prevent the splines of pinion shaft **53** from scratching the lip of the oil seal.

(Refer to the **Service Tools** section for the seal protector.)

a Turn gear case **58** so that the output shaft is upwards and mount the pinion shaft assembly **53** onto the gear case using an M16 eye bolt screwed into the tapped hole in the output end of the pinion shaft.

b To prevent the seal protector hitting the work bench, place 150 mm (6 in) blocks under gear case **58**.

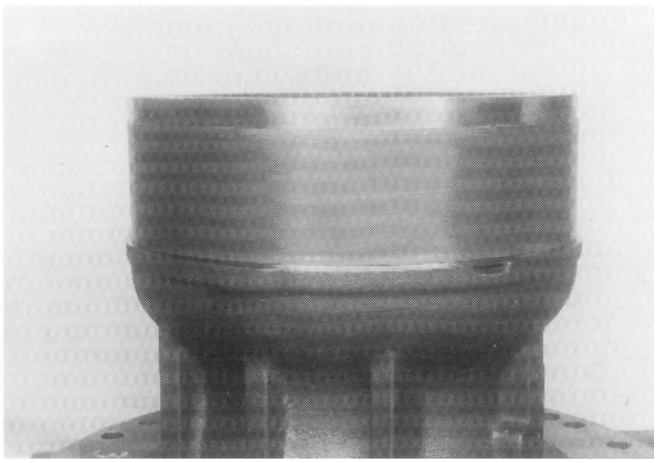


7 Mount the snap ring **55**.

To make it easy to remove the snap ring again, position the gap in the snap ring approx. 30 mm (1.2 in) away from the notch in the gear case.

8 Turn the output shaft of the gear case downwards. Heat the inner ring of the roller bearing **62** to 50°C over the ambient temperature and mount it on the shaft.

* Reduction Gear Assembly (cont'd)

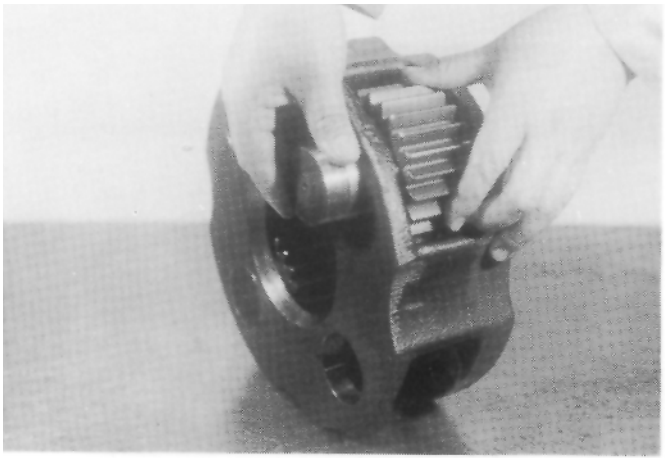


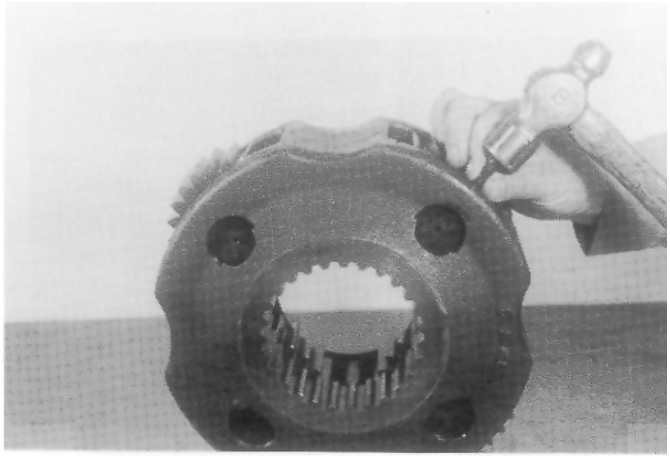
9 Ring gear mounting

a Degrease the contact surfaces of gear case **58** and ring gear **64**.

Mount the collars **63** on the gear case and apply JCB Multi-gasket. Also apply a thin coat on the gear case.

b Mount ring gear **64**.





10 Holder assembly mounting

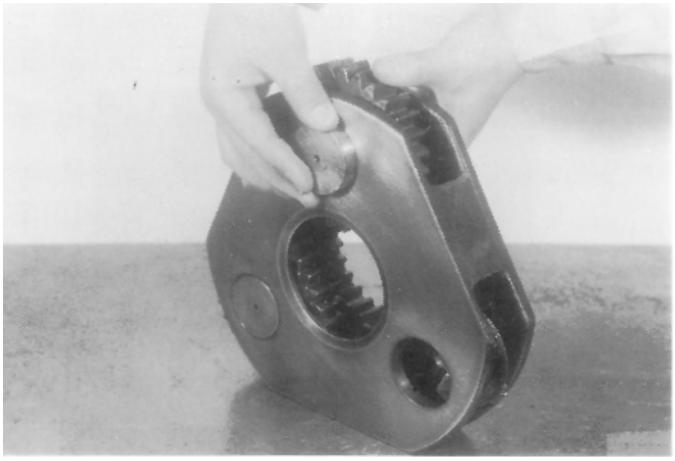
a Insert the planetary gear **72**, bushing **71** and thrust plate **73** into holder **76** and then insert shaft assembly **70**.

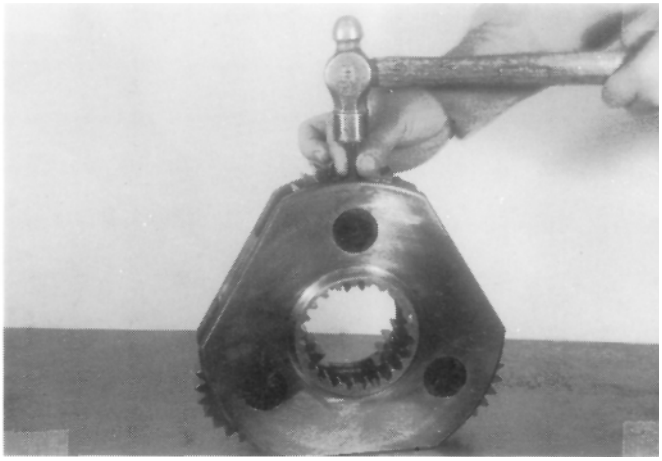
Note: Apply gear oil to the internal surface of the spur gear and shaft assembly outer surface.

b Drive in spring pins **75**.

Note: Drive in the pins with the splits facing towards planetary gears **72**.

* Reduction Gear Assembly (cont'd)





11 Holder assembly 65 **mounting**

a Insert planetary gear **69** and the thrust plate into holder **65** and insert shaft assembly **67**.

Note: Apply gear oil to the spur gear internal surface and shaft assembly outer surface.

a Carefully lower holder assembly **76** so that it meshes correctly with the internal teeth of ring gear **64**.

Turn the holder assembly slightly to engage the splines of pinion shaft **53**.

b Insert the sun gear **77** so that the teeth mesh with

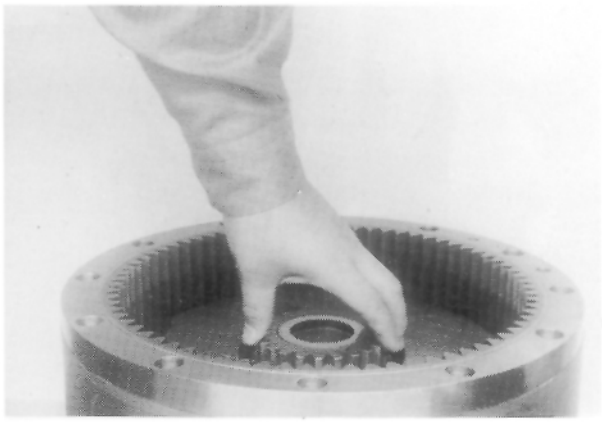
b Drive in the spring pin.

Note: Drive in the pins with the splits facing towards planetary gear **69**.

⚠ WARNING

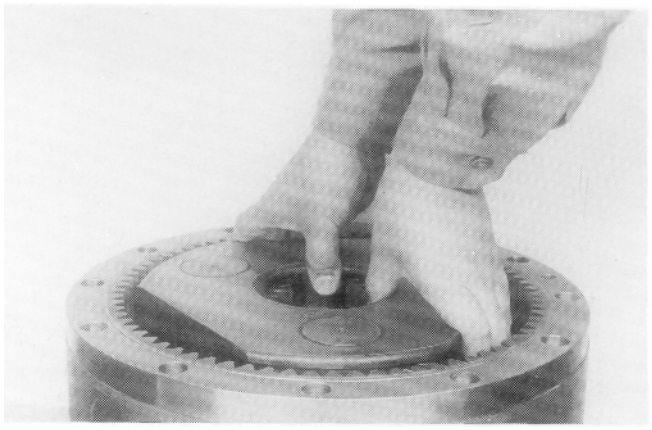
You can be injured by flying metal splinters when driving metal pins in or out. Use a soft faced hammer or drift to remove and fit metal pins. Always wear safety glasses.
INT-3-1-3

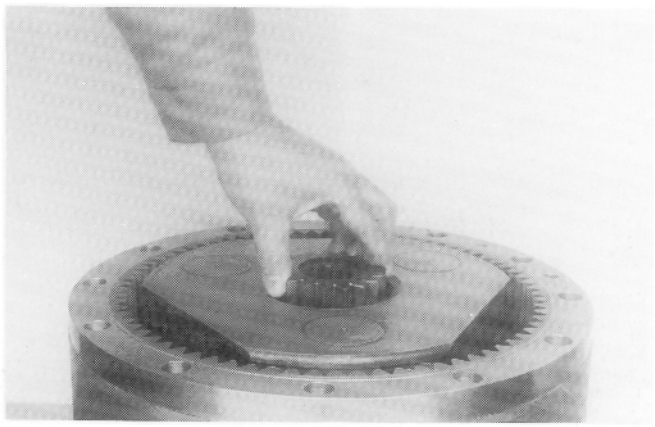
12 Holder assembly 76 **and spur gear mounting**



planetary gears **72**.

Reduction Gear Assembly (cont'd)

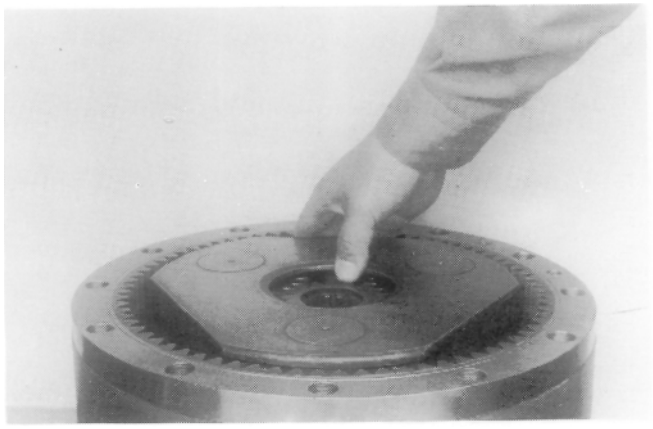




13 Sun gear 1st stage holder assembly mounting

a Carefully lower the holder assembly so that it meshes correctly with the internal teeth of ring gear **64**. Turn the holder assembly slightly to mesh the teeth of the spur gear with the teeth of holder **65**.

b Carefully insert sun gear **66** and mesh the teeth of planetary gear **69**.



14 Turn the 1st stage holder assembly by hand to check that the output shaft rotates smoothly.

Fault Finding

Table 1.

Symptom	Cause	External Inspection	Countermeasure	Repair
Motor does not run	Internal damage to the motor.	Measure the oil drain volume.	High possibility of damage to the sliding surfaces if the supply volume is approximately equal to the drain volume. Dismantle and inspect.	Refer to Table 2.
	Internal damage to the motor.	Open the motor inlet and outlet ports and apply 20 kgf/cm^2 (284 lbf/in^2) pilot pressure to the brake release port. Try to rotate the shaft with a torque of approx. 39.32 Nm (29 lbf ft).	High possibility of internal damage to the motor if the supply shaft does not rotate smoothly when this torque is applied. Dismantle and inspect.	Renew damaged parts or renew the motor assembly.
	Relief valve in circuit not set correctly.	Measure pressure.	Reset to the prescribed setting.	
Excessive slip	Wear or damage to the motor sliding surfaces or to the high-pressure seal.	Measure the oil drain volume.	Leakage is too high if the oil drain volume exceeds 5 l/min (1.1 gal/min). Dismantle and inspect.	Refer to table 2.
	Oil hot and excessive leakage in the motor.	Measure the oil temperature.	Reduce the oil temperature.	Refer to table 2.
Abnormal heating	Seizure of motor sliding parts or circuit.	Check for any metallic matter deposited in motor drain oil or drain filter. Apply a 30 kgf/cm^2 (427 lbf/in^2) pilot pressure to the brake release port and try to rotate the shaft with a torque of approx. 39.32 Nm (29 lbf ft).	If metallic matter is discovered or the supply shaft does not rotate smoothly when torque is applied, there is a high possibility of internal damage to the motor. Dismantle and inspect.	Repair or renew the damaged parts. Renew the motor assembly.
Leakage from oil seals	Damage or wear to oil seal lip.			Renew the oil seals.
	Damage or wear of the shaft seal.			Repair the problem or renew the motor assembly.
	Abnormal pressure in the casing.	Check the pressure in the casing and measure the drain volume.	Set the pressure in the casing below 3 kg/cm^2. (43 lbf/in^2) Dismantle and inspect if drain volume is excessive.	Renew the oil seal. Repair or renew the damaged parts. Renew the motor assembly.

Fault Finding (cont'd)

Symptom	Cause	External Inspection	Countermeasure	Repair
Insufficient torque	Wear or seizure of the motor sliding surfaces.	Open motor inlet and outlet ports and apply 20 kgf/cm^2 (284 lbf/in^2) pilot pressure to the brake release port.Try to rotate the shaft with a torque of approx. 39.32 Nm (29 lbf ft).	High possibility of internal damage to the motor if the supply shaft does not rotate smoothly when this torque is applied. Dismantle and inspect.	Inspect the parts and bearing according to Table 2 a-e and renew any defective parts.
	Relief valve in the circuit is not set correctly.	Measure relief pressure.	Reset to the prescribed setting.	
	Internal damage to the motor.	Check if any metallic matter is deposited in the motor drain oil or drain filter.	High possibility of internal damage to the motor if metallic matter is discovered. Dismantle and inspect.	Repair or renew damaged parts. Renew the motor assembly.
Abnormal noise	Large amount of air mixed in the oil.	Check the oil in the tank and motor casing.	Thoroughly bleed the air.	
	Loosening of bolts or pipes	Check if the piping connections, attachment mounting bolts, motor attachment bolts or other bolts are loose.	Tighten to the specified torque.	
Oil leakage from mating surfaces	O-ring is damaged			Renew O-rings.
	Seal face is damaged.			Repair seal face or renew.
	Bolts are loose.	Check the bolt tightness.	Tighten the bolts to the correct torque.	

Table 2.

No.	Part Inspected	Repair
a	Wear of the sliding surface of balance plate **21**.	Repair or renew the part
b	Damage to sliding surface of cam plate **6**.	Repair the part or renew the motor.
c	Damage to sliding surface of the piston assemblies **8**.	Repair the part or renew the motor.
d	External wear to the piston assemblies **8**.	Repair the part or renew the motor.
e	Wear to piston bores in cylinder assembly **24**.	Renew the motor.
f	Damage to Teflon ring **19** or 'O'-rings **52**.	Renew the part.