HYDRAULIC EXCAVATOR

SHOP MANUAL model SK220 SK220LC

This is the shop manual for KOBELCO hydraulic excavator. Contained is the necessary technical data concerning the maintenance and repair of this model. The manual is divided into the following four major sections; GENERAL, SYSTEMS, COMPONENTS and PROCEDURE.

When checking or repairing the machine we suggest that you refer to this manual carefully. We hope that reference to this manual will help to maintain a high level of working efficiency and reliability. For further details on maintenance and checks refer to the "OPERATORS MANUAL" which has been supplied with the machine.

Although all data was correct at the time of printing, due to continual design changes and improvements, some contents may not conform to the actual machine. Take special care to order parts only after confirming the validity of the parts number in the "PARTS MANUAL".

If you notice any explanatory discrepancies, after consulting one of our representatives, please update your manual according to the latest data. However, in the event of any specification changes, we will issue revised edition.

INDEX

KOBELCO

Book code No. S5LQ0004E②

3. SPECIFICATIONS AND PERFORMANCE

■ SPEED AND CLIMBING ABILITY

Item \ Model	SK220	SK220LC
Swing speed	12rpm	
Travel speed	7 / 4km / h (4.3 / 2.5 MPH)	
Gradeability	35° (70%)	

■ ENGINE

Model		Mitsubishi 6 D15-T
Type		Water-cooled 4-cycle, direct injection type with exhaust turbo supercharger
Number of cylinder - Bore x Stroke		6 - 113mm(4.45in) x 115mm(4.53in)
Total displacement		6,919c.c. (422cuin)
Rated output power/revolution	JIS D 1005 Net	165ps/2,150rpm
	SAE J 1345 Net	121kw/2,150rpm
	DIN 6270 Net	121kw/2,150rpm
Maximum torque/revolution	JIS D 1005 Net	60kgf·m / 1,600rpm
	SAE J 1349 Net	588N-m / 1,600rpm
	DIN 6270 Net	60kgf·m / 1,600rpm

■ HYDRAULIC COMPONENTS

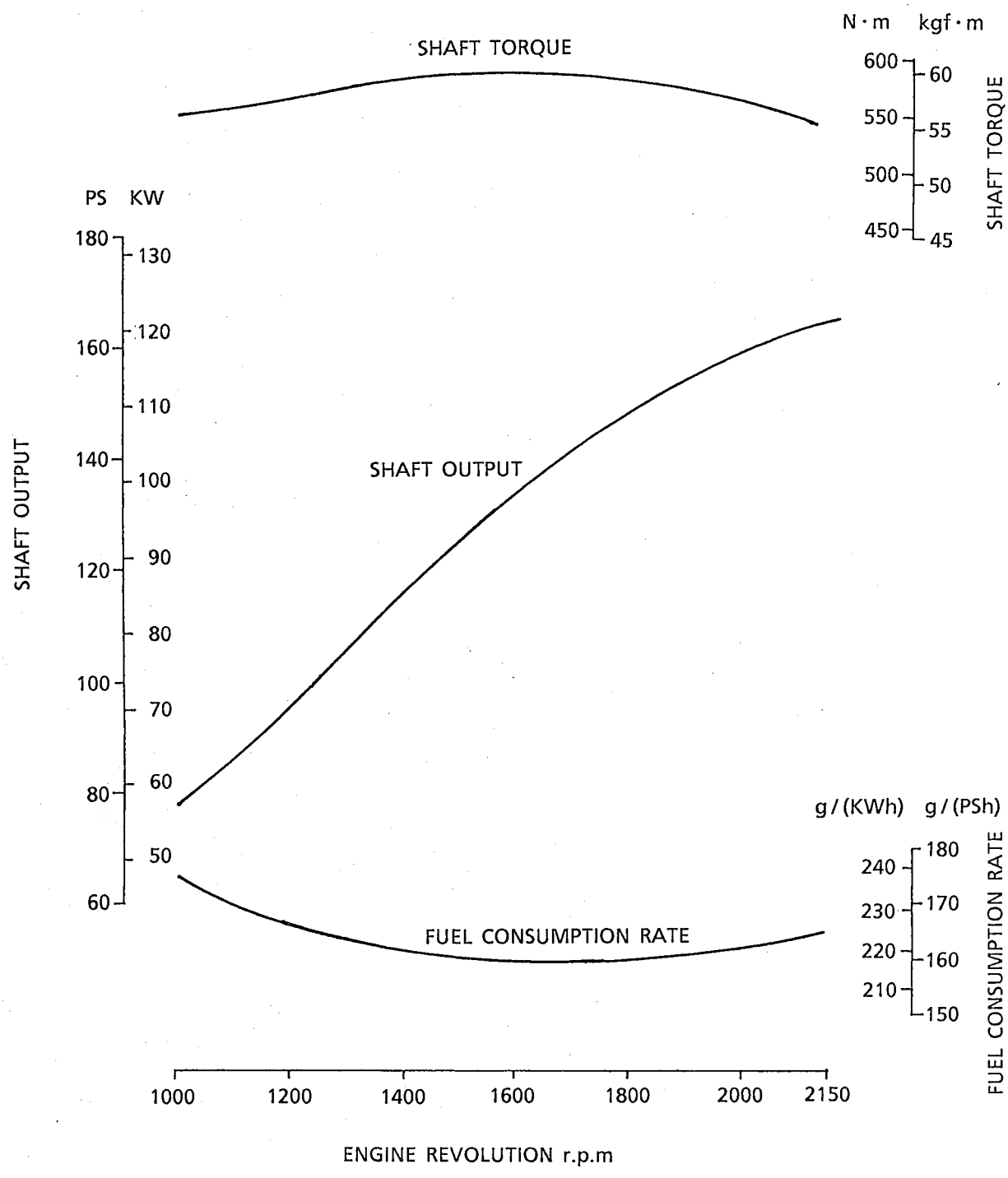
Hydraulic pump	Double-pump variable displacement, axial piston + gear pump
Hydraulic motor (swing)	Axial piston motor
Hydraulic motor (travel)	Axial piston motor
Control valve	5-section multiple control valve + 1-section control valve (swing)
Cylinders (boom, arm, and bucket)	Double acting cylinder
Return filter	Safety valve containing filter type
Oil cooler	Air-cooled type

■ WEIGHT

Unit : kg (lbs)

Fully-equipped weight	22,900 (50,500)	23,500 (51,800)
Upper machinery	9,980 (22,000)	←
Lower machinery (with 600mm (24″) grocer shoe)	8,860 (19,500)	9,460 (20,900)
Attachment 〔 6.02m(19ft 9in) boom + 2.98m (9ft 9in) arm + 0.9m³ (0.92cuyd) bucket 〕	4,070 (8,970)	←

ENGINE CHARACTERISTIC CURVE
(MITSUBISHI 6D15-T)



2. PRESSURE MEASUREMENT AND ADJUSTMENT

2.1 EQUIPMENT TO BE PREPARED

Pressure gauge	70kgf/cm2 (1000 psi)	3 pcs
	500kgf/cm^2 (7000 psi)	2 pcs
Pressure measuring set		1 set
Surface thermometer (with magnet)		1 pcs
Hydraulic oil analyzing apparatus		1 set

2.2 STANDARD MEASURING CONDITION

Within standard measuring condition in Performance Inspection Standard Table (Table 1)

(1) Measuring Procedure and Method

1) Measuring the cleanliness of operating oil
Measure cleanliness with an analysis apparatus after taking sample oil from the operating oiltank. If the oil shows a cleanliness exceeding an allowable value, flush the oil or replace the filter.

2) Raising the temperature of the operating oil
Attach a thermometer in the surface of the operating oil tank and measure temperature. Wait till the temperature rises by raising the boom or by relieving the bucket relief valve.

3) Raising the water temperature
Attach a thermometer in the surface of the radiator and measure the temperature. Run the engine and wait till temperature rises.

2.3 READING THE ENGINE REVOLUTION

Following is a procedure whereby the engine revolution is read on the multi-display:

1) With the buzzer stop switch turned to "ON", turn the starter key switch to "ON". However, keep the engine stopped. (See Fig. 2.)
2) Depress the buzzer stop switch five times and get an engine rotation mark and a controller part number.
3) Depress the buzzer stop switch by turns. An engine revolution will be indicated at the 23rd out of 24 pressings. (Fig. 3.)
4) If the engine is started here, the display will be as shown on the right, for instance. (Fig. 4.)
5) Set the throttle lever to the maximum revolution "HI".
6) Change over the operation mode (KPSS) switch to H,S,FC,D by turns and compare the revolution at no load with an existing revolution.
7) If the revolution falls within a tolerance, determine that the engine and the controller are normal, and measure and adjust the pressure of the hydraulic circuit.
Revolution at no load = present revolution $^{+5}_{-25}$
8) If the revolution runs out of a tolerance, adjust the revolution according to the procedure for the adjustment of the following mechatro controller.

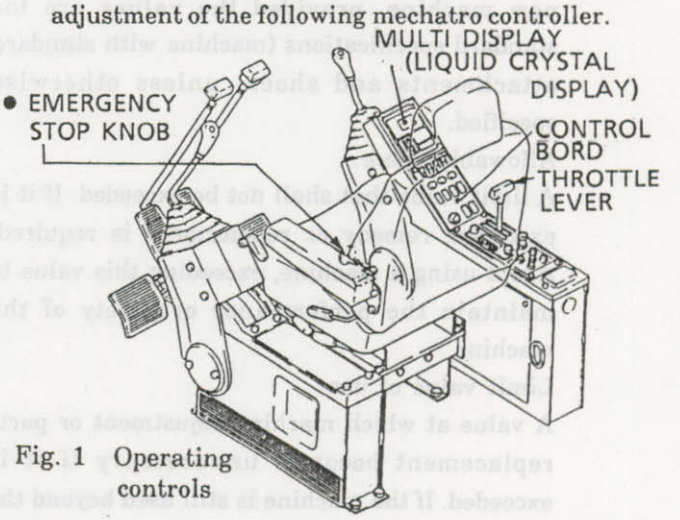


Fig. 1 Operating controls

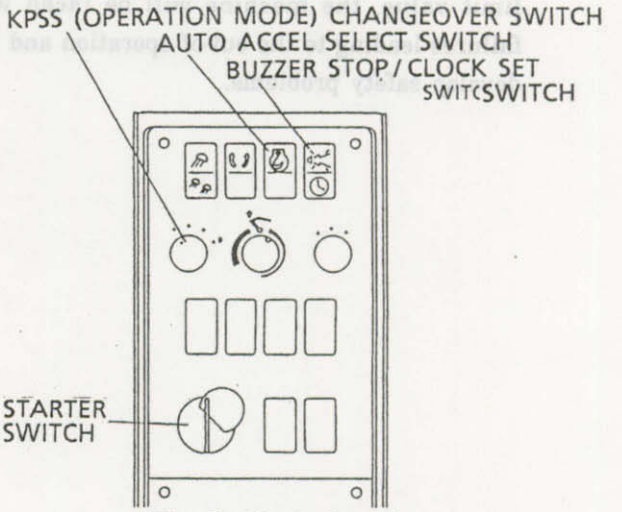


Fig. 2 Control bord

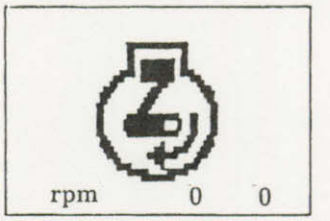


Fig. 3 Displaying the engine revolution when the engine is at rest

- 2301 ·····Present revolution
- 2300 ·····No-load revolution at mechatro adjustment (Hereinafter called no-load revolution)
- rpm ·····Revolution

Fig. 4 An example of engine revolution display when running

2.13 MEASURING THE PRESSURE OF PUMP (P2) IN LOADING MODE

(1) Pressure measuring position
Measure pressure at gauge port a2 of the main pump. (as mentioned above)

(2) Measuring method and procedure

1) Shortcircuit the swing pressure switch (133). (so the swing switch is turned on as the swing pilot pressure enters.)

2) Bring the arm cylinder and the bucket to the most extended position.

3) Set the variable loading mode switch to 0, 1, 10 notches from the left end, perform boom hoisting operation every time the notch is changed and measure the P2 pressure.

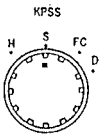
(3) Method of adjustment
Perform adjustment by means of the mechatro controller, the same way as the Engine Revolution Adjustment. Refer to the Procedure for Adjusting the Variable Loading Mode under 2.7.

2.14 MEASURING THE SECONDARY PRESSURE OF THE KPSS SOLENOID PROPORTIONAL VALVE

(1) Pressure measuring position
Remove the plug of the gauge port a3 (See Fig. 26.) of the main pump and attach a pressure gauge tapping joint and a 70kgf/cm2 (1000psi) pressure gauge.

(2) Measuring method and procedure

1) Measurement in H, S, FC and D modes
Change the operation mode switch to the H, S, FC and D modes by turns and measure the pressure.



K. P. S. S. (OPERATION MODE) SELECT SWITCH

2) Measurement in release mode
Turn the switch to the H mode, turn the KPSS operation mode release switch (Fig. 30.) to "RELEASE" and then measure pressure. Always bring the switch toward the KPSS after adjustment.

3) Measuring the attachment boost pressure
Depress the attachment boost pressure button (Fig. 31.), confirm the attachment boost pressure mark (Fig. 32.) on the multi display and measure pressure in H mode.

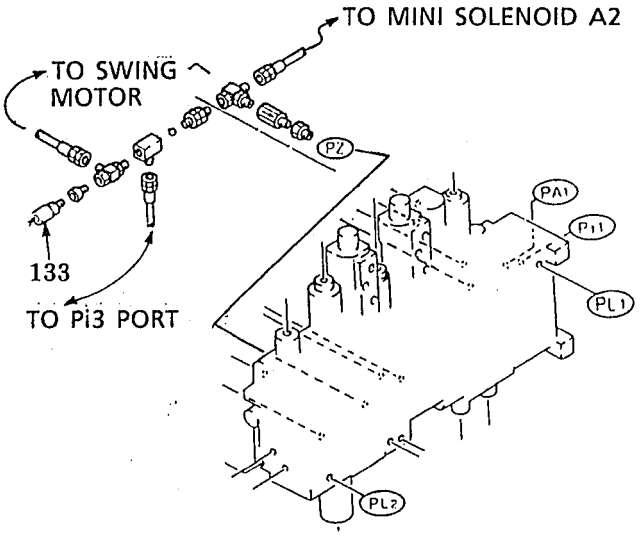


Fig. 29 Mounting position of swing pressure switch

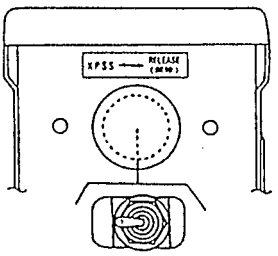


Fig. 30 K. P. S. S. operation mode release switch

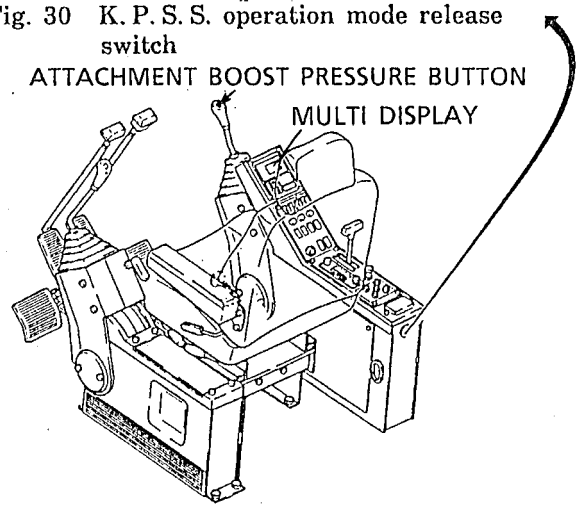


Fig. 31 Attachment boost pressure button on operating lever

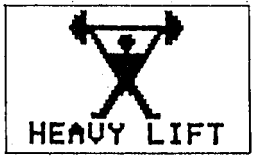
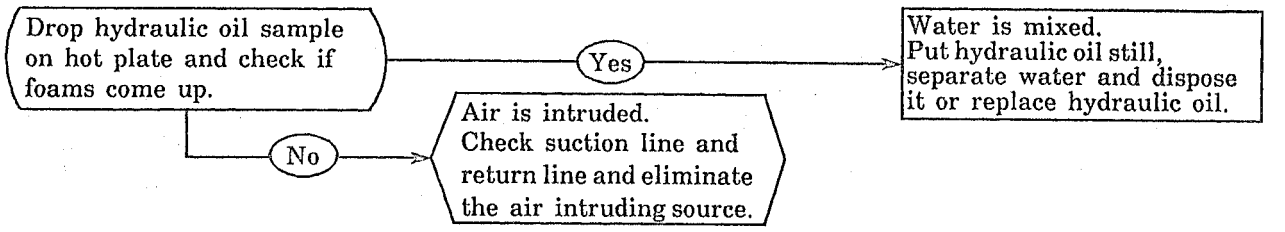


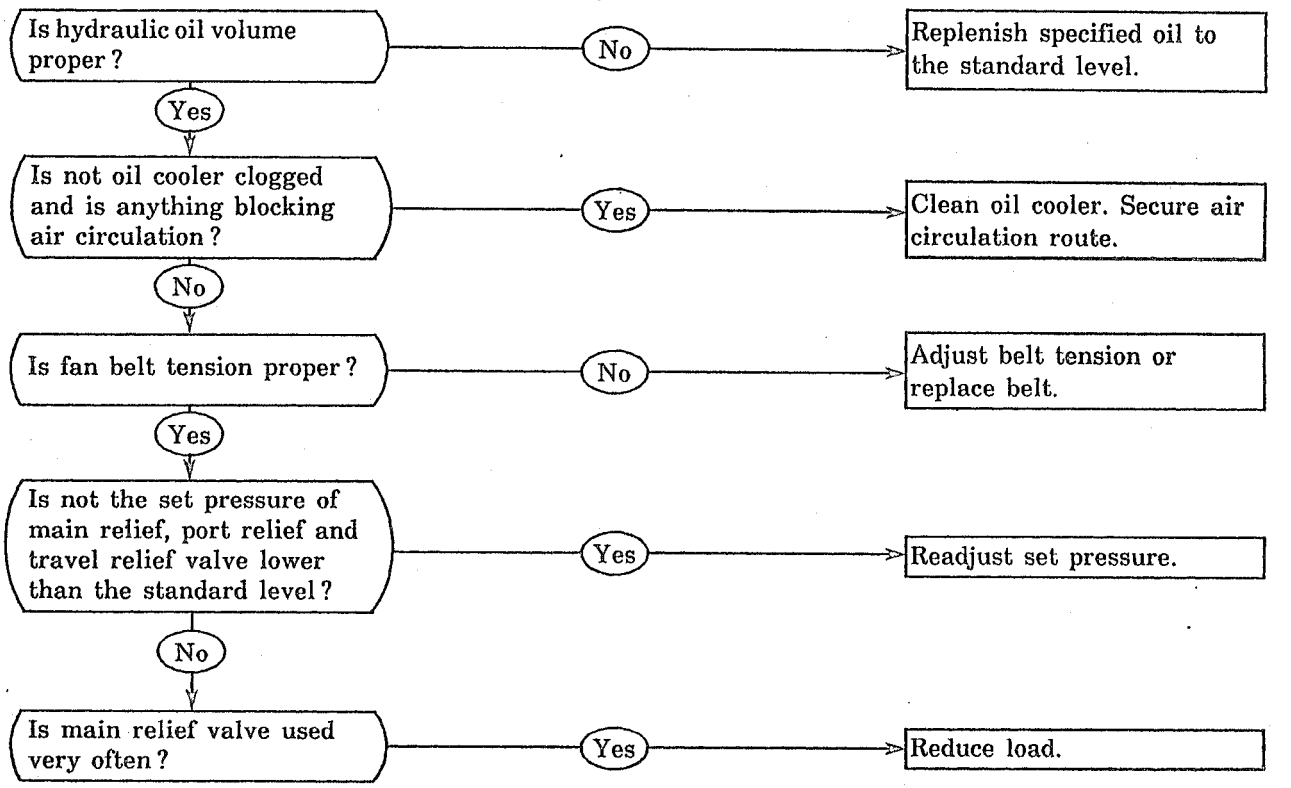
Fig. 32 Attachment boost pressure mark

3. HYDRAULIC SYSTEM

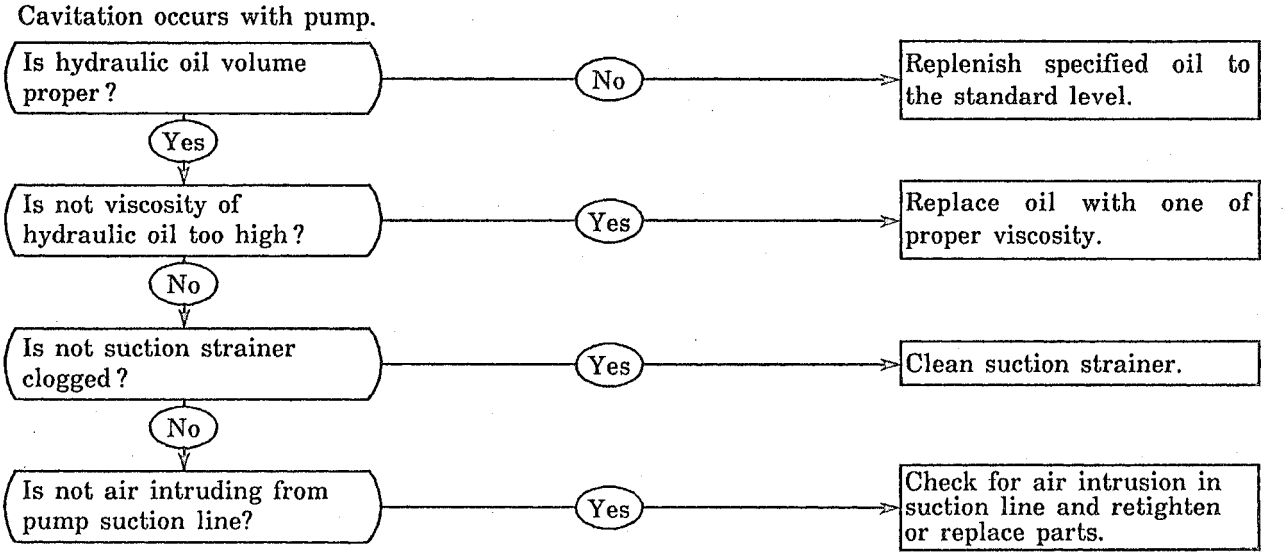
(1) Hydraulic oil is cloudy.

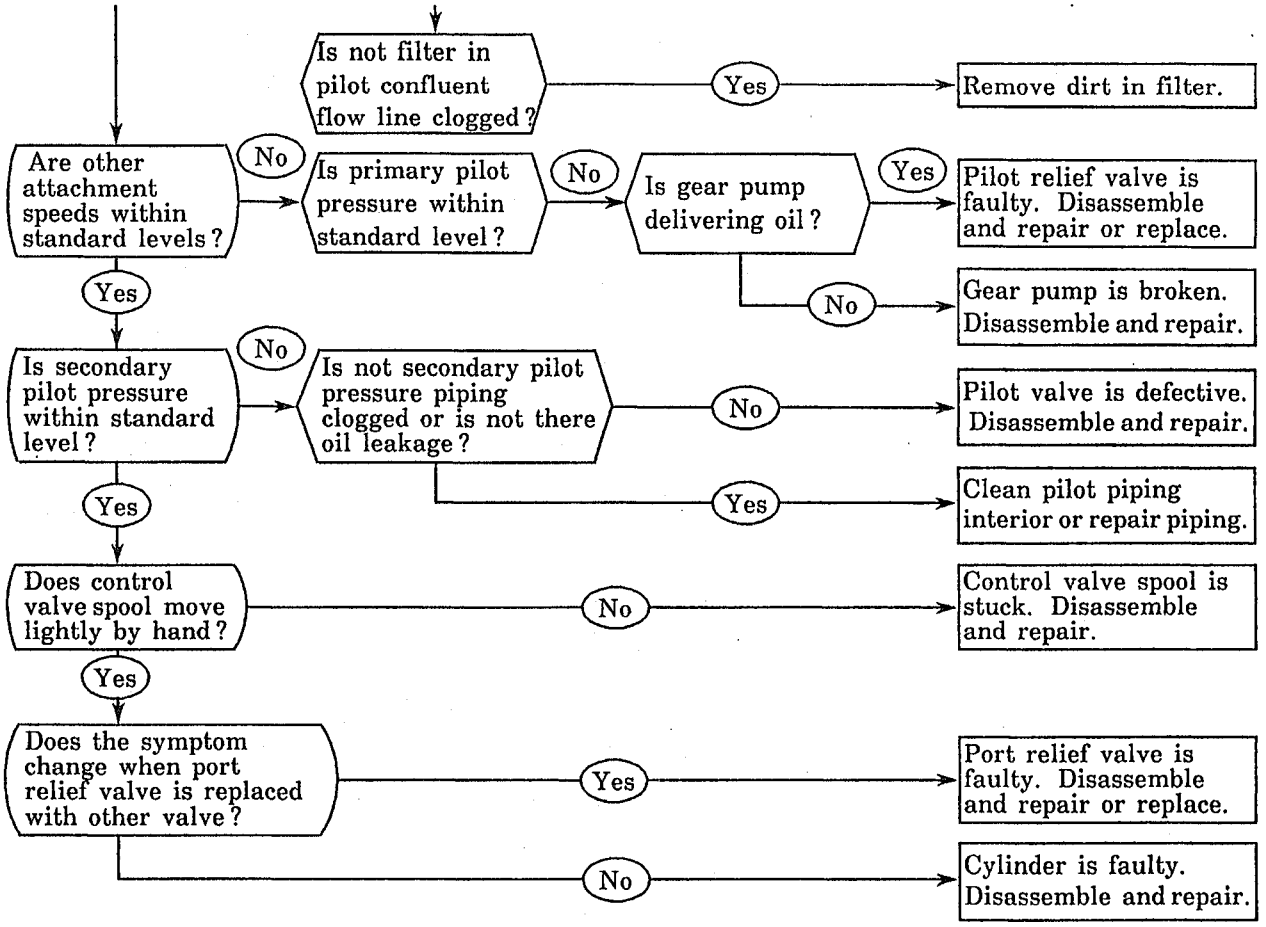


(2) Hydraulic oil temperature has risen abnormally.

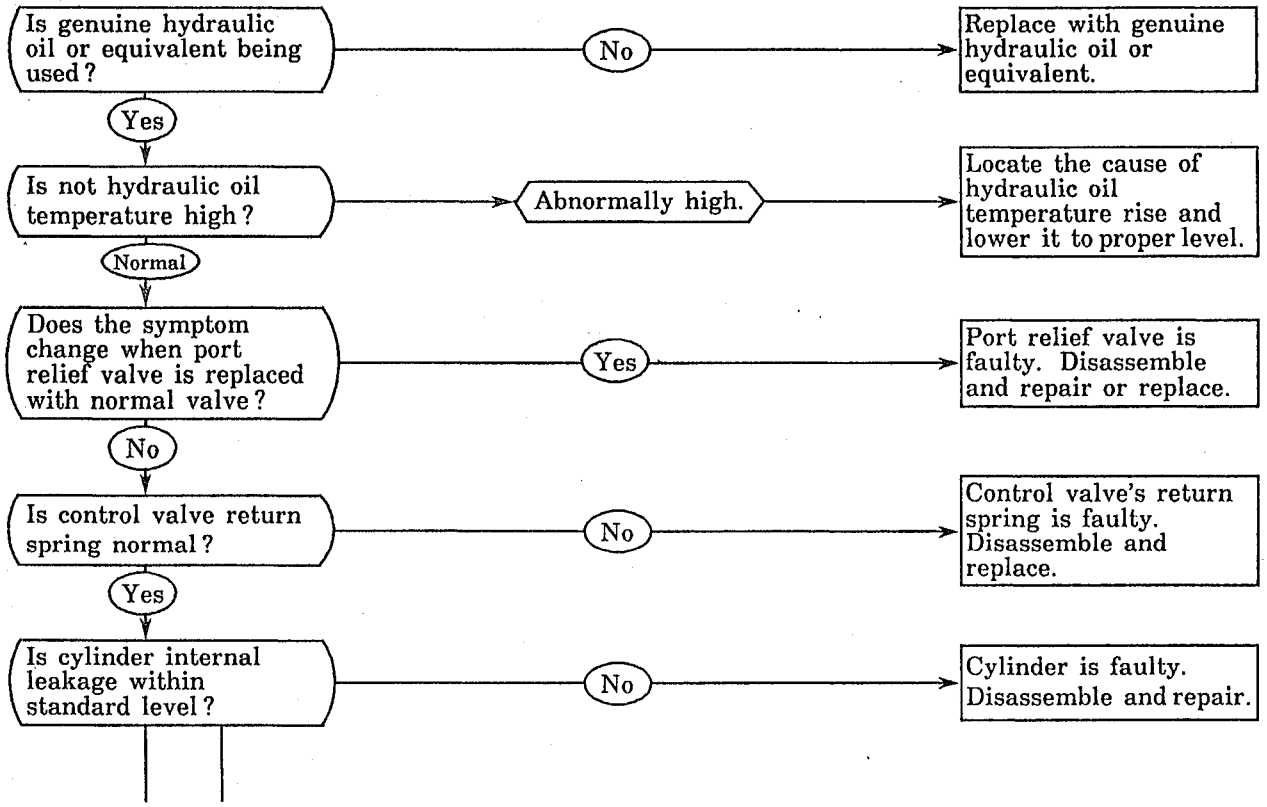


(3) Cavitation occurs with pump.





(3) Boom, arm or bucket cylinder extends or contracts itself and attachment falls.



(2) Check the error acction detail

EXAMPLE OF NORMAL DISPLAYS ON MARKIII MULTI-DISPLAY ☞ Figures are displayed, but the data has no relation.

No.	DIAGNOSIS DISPLAY	CONTENTS OF DISPLAYS	SK60	SK100	SK120	SK200	SK220	REMARKS
1	P/No.	Controller P/No	2480U332F10	2480U332F9	2480U332F8	2480U332F6	2480U332F7	
2	S1 wtmp	Thermo switch temperature	OPEN	←	←	←	←	
3	S2 oprs	E/G Oil pressure E/G Sermometer unit	OPEN	←	←	←	←	
4	S3 cpu	Mechatro 1P connector	CLOS	←	←	←	←	
5	S4 smod	S mode select switch	—	CLOS	←	←	←	S mode
			H.FC OPEN	H.FC.D OPEN	←	←	←	H.FC.D mode
6	S5 hmod	H mode select switch	H. CLOS	←	←	←	←	H mode
			FC. OPEN	S.FC.D OPEN	←	←	←	S.FC.D mode
7	S6 att	ATT Boost switch	OPEN	←	←	OFF OPEN / ON CLOS	OPEN	
8	S7 des	Auto accel pressure switch	OPEN	←	←	←	←	Decel SW. ON
			CLOS	←	←	←	←	Decel SW. OFF
			CLOS	←	←	←	←	Lever operating
9	S8 bzsp	Buzzer stop switch	OPEN	←	←	←	←	
10	S9 jpin	Controller inside switch	CLOS	←	←	←	←	
11	S10 keys	Key switch Br terminal	CLOS	←	←	←	←	
12	S11 lims	Stepping motor limit switch	OPEN	←	←	←	←	
13	S12 boom	Slewing pressure switch	OPEN	OPEN	←	←	←	Lever neutral
			OPEN	CLOS	←	←	←	Slewing
14	AD1 acel	Accel potentiometer	5	4	3	2	2	Low
			242	251	252	253	254	High
15	AD2 boom	Loading potentiometer	0	2	1	1	1	Up
			0	96	97	97	95	In
			0	255	255	255	255	Down
16	AD3 motA	Stepping motor A phase current value	36 ~ 38	35~38	33~37	33~38	34~38	
17	AD4 motB	Stepping motor B phase current value	37 ~ 38	37	34~38	33~38	34~38	
18	AD5 isvP	KPSS solenoid valve current valve (Control read current value)	0	7~8	11~14	10~12	11~13	E/G Low no load
			0	29~32	40	35~37	32~34	E/G Low arm relief
			0	7~8	7~8	7~8	7~8	E/G High no load
			0~1	7~8	7~8	7~8	7~8	E/G High arm relief
19	AD6 isvB	Loading solenoid current value (Control read current value)	0	7~16 (38~42)	9~16 (38~42)	7~16 (38~42)	7~14 (38~42)	
20	11 pump	KPSS solenoid valve current value mA (Control read current value)	150	150mA	228~281mA	212~235mA	236~251mA	E/G Low no load
			800	590~640mA	800mA	713~730mA	652~680mA	E/G Low arm relief
			150	150mA	150mA	150mA	150mA	E/G High no load
			200	150mA	150mA	150mA	150mA	E/G High arm relief
21	12 boom	Loading solenoid current value mA (Controller instructed value)	100	100mA (800mA)	100mA (800mA)	100mA (800mA)	100mA (800mA)	
22	POS	Stepping motor position	161	308	214	227	200	Low idle
			509	537	442	432	424	High idle
23	r.p.m	E/G revolution	873 888	871 878	864 883	868 886	865 866	Low idle
			2331 2346	2472 2490	2320 2334	2292 2315	2301 2318	High idle
24	18V	Source voltage 18V or more	OVER	←	←	←	←	

(1) The engine does not stop.

(2) The engine does not start.

(3) Check engine rpm by the mulchi-display.

(4) The engine stops or the engine revolution falls when loaded.

(5) Stepping motor actuate error.

(6) The height (Hi) idling revolution is low.

(7) Engine revolution is low.(at both Hi and Lo).

(8) CPU display comes out.

Blown fuse	Check fuses (For controller 5A)
Controller out of order	
Link interfere with each other	Check links for interference
Heater relay burnout	Check coil resistance. Sdtandard value: about 12Ω Check fuse [For key switch 15A (~ m/c) , 20A (~ m/c)]
Governor clearance not adjusted correctly	HI side (E/G stopped & key ON) ; Accel Hi check governor clearance 0.2mm (0.008˝) STOP side (E/G stopped & key ON) ; →Key off, less than 4sec governor clearance 0.1mm (0.004˝)
Key switch relay faulty	Check coil resistance. Sdtandard value: about 250Ω
Controller poor contact	Shake harnesses.

OPEN indication comes out when the key switch is turned off. — Yes → Check the stepping motor.

No → Check the diodes between the controller and the key switch relay. (Not use m/c~) → Replace diodes.

Replace the potentiometer.

Check the connector into the stepping motor by shaking hand. — No → Replace the stepping motor.

Is resistance valve of solenoid not normal ? Standard valve 13.5±0.7Ω — No → Replace solenoed valve.

Multiply the reading of item 18 by 20, compare it with the value of item 20 and check if they are qual.

No / Yes → Check that the proportionate valve is not stuck. Also check the hydraulic systems.

Yes

The stepping motor gears are worn out. (cause)

Replace fuses.

Replace controller.

Change battery or replace it.

Correct interference.

Replace the heater relay.

Readjust.

Replace the key switch relay.

Replace or correct the terminals.

2. REMOVAL AND INSTALLATION OF HYDRAULIC PUMP

2.1 REMOVING HYDRAULIC PUMP

1) After stopping the engine, remove the guard and the bracket above the hydraulic pump.

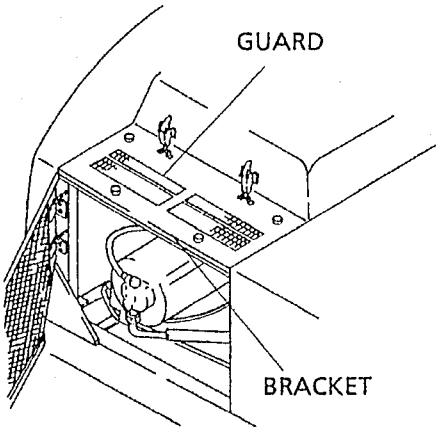


Fig. 3 Remove the guard and bracket

2) Install the suction stopper on the suction port of the hydraulic oil tank.

⚠ Be sure to loosen the air breather and bleed any residual pressure from the tank before removing the tank cover and flange.

☞ For details of the suction stopper, refer to "Details of Suction Stopper."

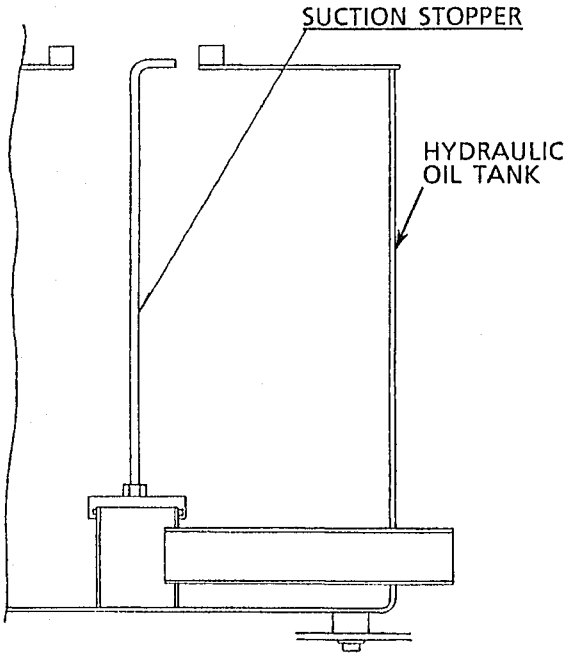


Fig. 4 Install the suction stopper

3) Disconnect the suction hose and the delivery hose of the hydraulic pump, the independent travel bypass hose, the drain hose and the pilot hose. Then put a plug into the metal fittings of each hose and the ports of the hydraulic pump.

⚠ Note that when the delivery hose mounting hex socket head bolts are removed, the flange comes off as well.

4) Loosen slightly the 4 hex socket head bolts (5) holding the pump.

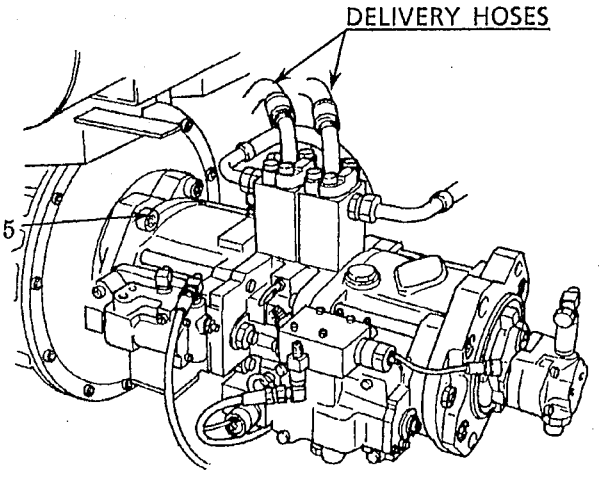


Fig. 5 Hydraulic oil pump

6. DETAILS OF SUCTION STOPPER

6.1 COMPONENTS OF SUCTION STOPPER

No.	NAME	PARTS No.	Q'ty
	Suction stopper assy	24100P978F2	
1	Rod	2420T4660D1	1
2	Nut	ZN16C08007	1
3	Cover	2414T2123D2	1
4	O ring	45Z91D6	1

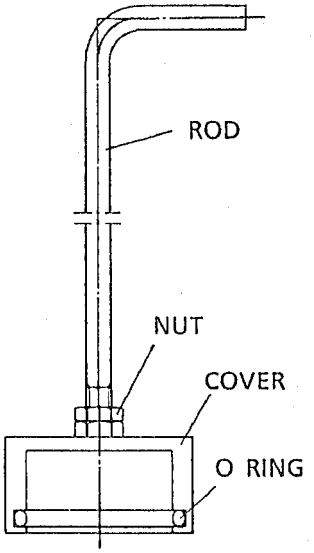


Fig. 35 Components of suction stopper

6.2 DIMENSION OF SUCTION STOPPER

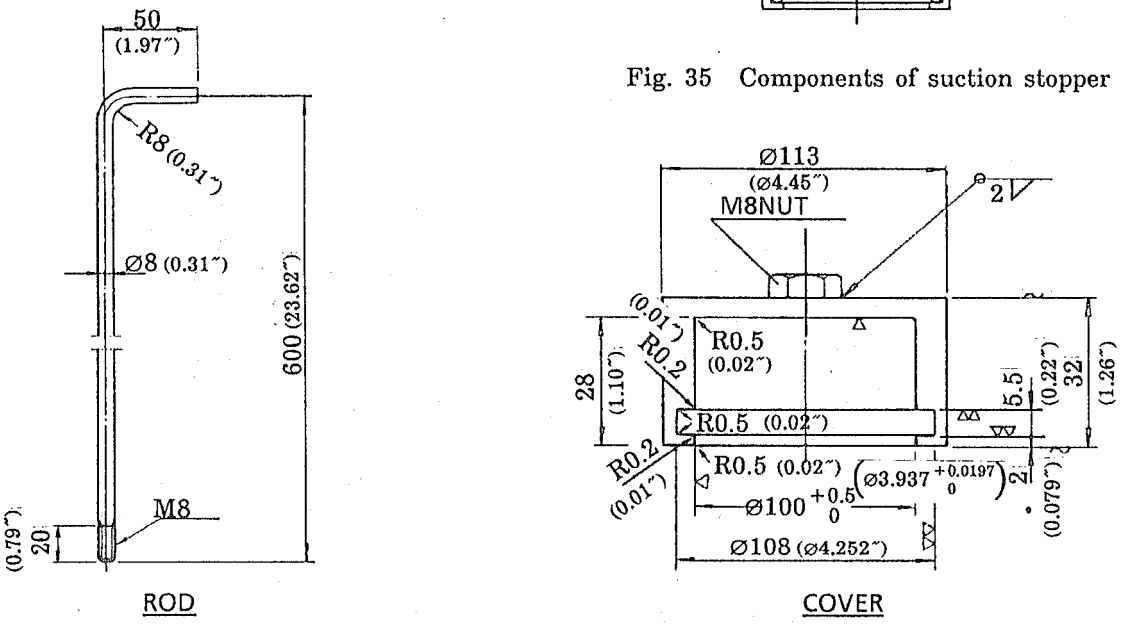


Fig. 36 Dimension of suction stopper

6.3 MACHINE MODELS TO WHICH SUCTION STOPPER IS APPLICABLE

Table 5

PART No. OF SUCTION STOPPER	APPLICABLE MODEL		
	SK SERIES	K SERIES	YS SERIES
24100P978F2	SK03,SK035,SK04,SK04L, SK04W,SK05,SK07,SK07LC, SK10,SK12,SK20,SK07-2, SK07LC-2,SK04-2,SK04L-2, SK07-N2,SK07LC-N2 SK045-N2,SK04-N2,SK100W SK200,SK220,SK100,SK120	K904SS,K905,K907B, K909,K910,K9I2, K914,K935 K904-II,K905-II, K905LC-II,K907-II, K907LC-II,K909-II, K909LC-II,	YS450C-C,YS450C,L,W-1,2, YS500,YS750-1,-2,YS1000-2, YS1200-2,YS1400-1,-2,-3, YS2000

☞ ⊙ 2 sets of 24100P978F2 are needed for K909 and K914.

4.2.2 TRAVEL PREFERENTIAL (STRAIGHT TRAVEL) VALVE

(1) Function during normal operation

1) Travel system in neutral (fig. 5)

When the independent travel switch is not ON, the primary pressure enters the independent travel limiter circuit (68) through port PO and pushes the independent limiter (310), causing the straight travel valve (305) to be pushed to the normal function side.

The primary pressure also enters the servo pressure circuit (60) on the port PS side, but because the travel spool is in neutral, the servo pressure does not run downstream as it is blocked by the travel spool and therefore no pressure is produced on the straight travel valve. Thus, the valve remains in the normal function position.

2) During simple travel (Fig 6)

When the machine is shifted to simple travel with the independent travel switch turned OFF, the travel spool is moved, and so the downstream path to the side bypass circuit is opened. Because none of the spools except the travel spool have been moved, the oil passes by all the spools downstream of the travel spool and returns to the tank. As the pressure is not strong enough to switch the straight travel valve (305), it remains in the normal function position.

(2) Switching to travel priority function (Fig. 7)

During simultaneous operation of the travel system and an attachment, the spools downstream of the travel spool are also moved, and in the case of swing motion, the logic valve is acted upon by back pressure and blocks the return path to the tank.

Consequently, the pressure in the servo pressure circuit (60) rises to switch the neutral cut-off valves (306A,306B), while at the same time switching the straight travel valve to the travel priority function position.

(3) Switching to independent travel function (Fig. 8)

When the independent travel switch is turned ON, the independent limiter circuit is connected to the tank port, and the pressure in the independent travel limiter (310) drops. Also, the primary pressure is directed to port A2 of the pilot valve (23) and enters the swing pilot circuit (67). In the circuit, the pressure acts as back pressure on the logic valve (612), and switches the neutral cut-off valve (306A). The primary pressure enters port PZ of the control valve as well, and switches the neutral cut-off valve (306B), while at the same time switching the straight travel valve (305) to the independent travel function position.

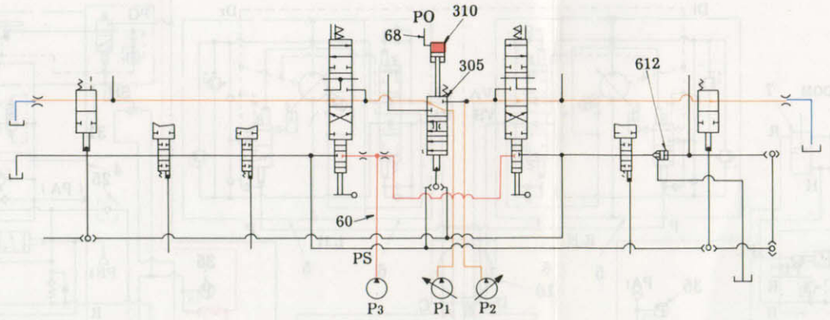


Fig. 5 Neutral

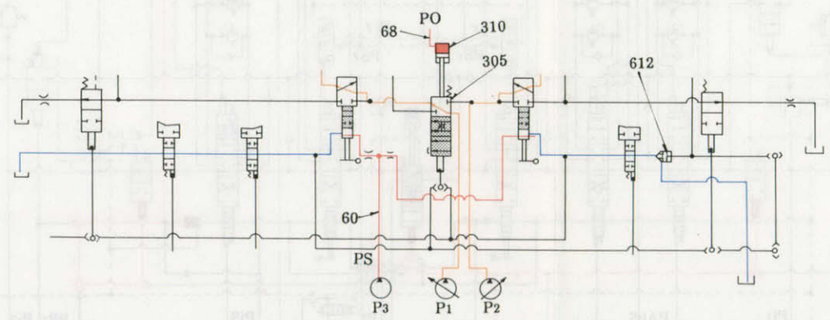


Fig. 6 During Simple Travel

60 ; Servo pressure circuit
68 ; Independent travel limiter circuit
305; Travel priority (straight travel) circuit
310; Independent travel limiter

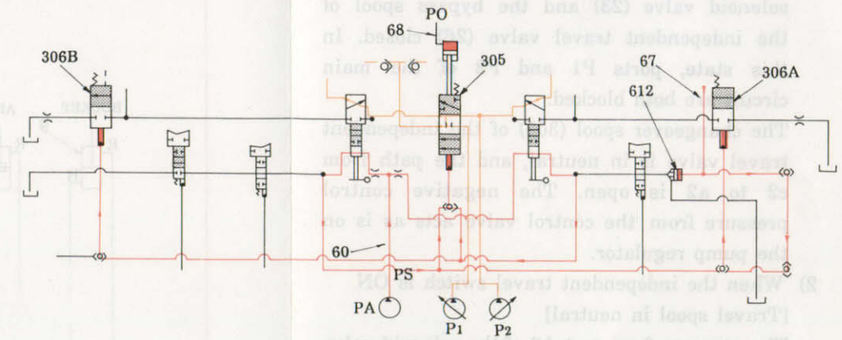


Fig. 7 At composite operation of travel and attachment motions

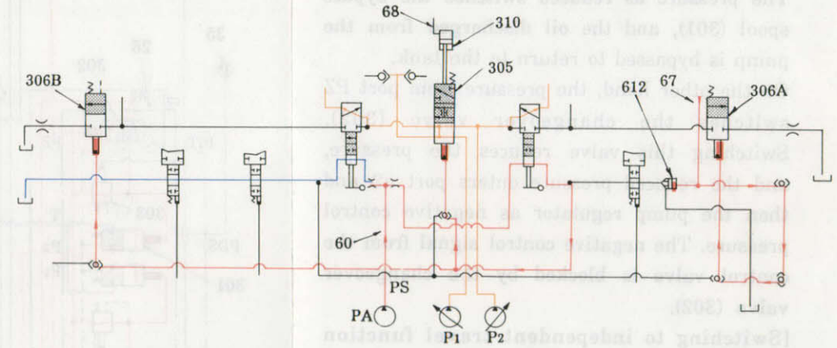


Fig. 8 Single travel operation when independent travel switch is "ON"

60 ; Servo pressure circuit
306A ; Neutral cut-off valve
306B ; Neutral cut-off valve
612 ; Logic valve

4.7.2 ARM RETRACTION
(CONFLUX CIRCUIT FOR HEAVY LOAD)

For the oil supplied for retracting the arm, i.e., for the supply of oil to the head side (H) of the arm cylinder, a single variable displacement pump and the variable recirculation circuit are run for light load.

Two variable displacement pumps are run for heavy load, and the oil from the two pumps is combined in the control valve.

(1) Pilot circuit

1) Switching the arm spool
When the operating lever is shifted to RETRACT ARM, secondary pressure from port PA3 of the pilot valve enters port PAa of the control valve to switch the arm spool position.

2) Switching the sequence valve
When the operating lever is shifted to RETRACT ARM, secondary pressure from port PA3 of the pilot valve branches off to enter port Piga of the sequence valve (59) to push the arm conflux sequence spool.
When heavy-load retraction is performed, the pump pressure on the arm side rises and pushes the arm conflux sequence valve spool. Consequently, the sequence valve spring is acted upon by the combined force of the pilot pressure and the pump pressure on the arm side, and the valve is switched over.

3) Switching the travel priority valve and neutral cut-off valve
When the arm sequence valve is switched over, ports Piga and Pigc are connected, and the travel priority valve (305) and neutral cut-off valves (72, 306B) are switched over.

4) Releasing the swing brake
When the arm is being retracted, secondary pilot pressure from port PA3 of the pilot valve enters port SH of the reducing valve (31), switching the valve, so primary pressure from port PG releases the swing brake.

(2) Main circuit
When heavy-load retraction is performed, the arm sequence valve (59) is switched over and the pilot pressure switches the travel priority valve and the neutral cut-off valve, with the result that the oil from the variable displacement pumps (A1, A2) is combined in the control valve and supplied via the valve's port Aa to the head side (H) of the arm cylinder.

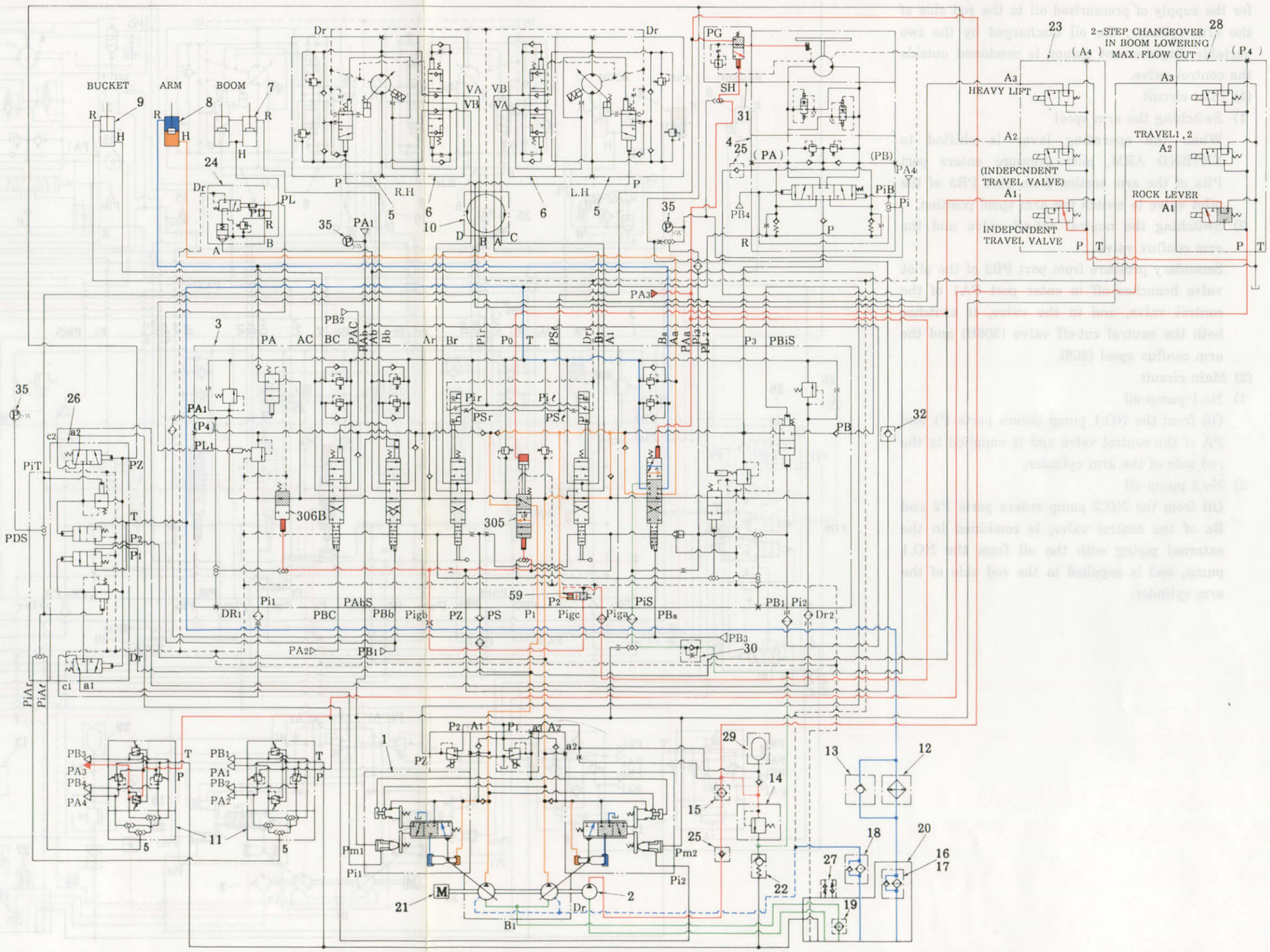
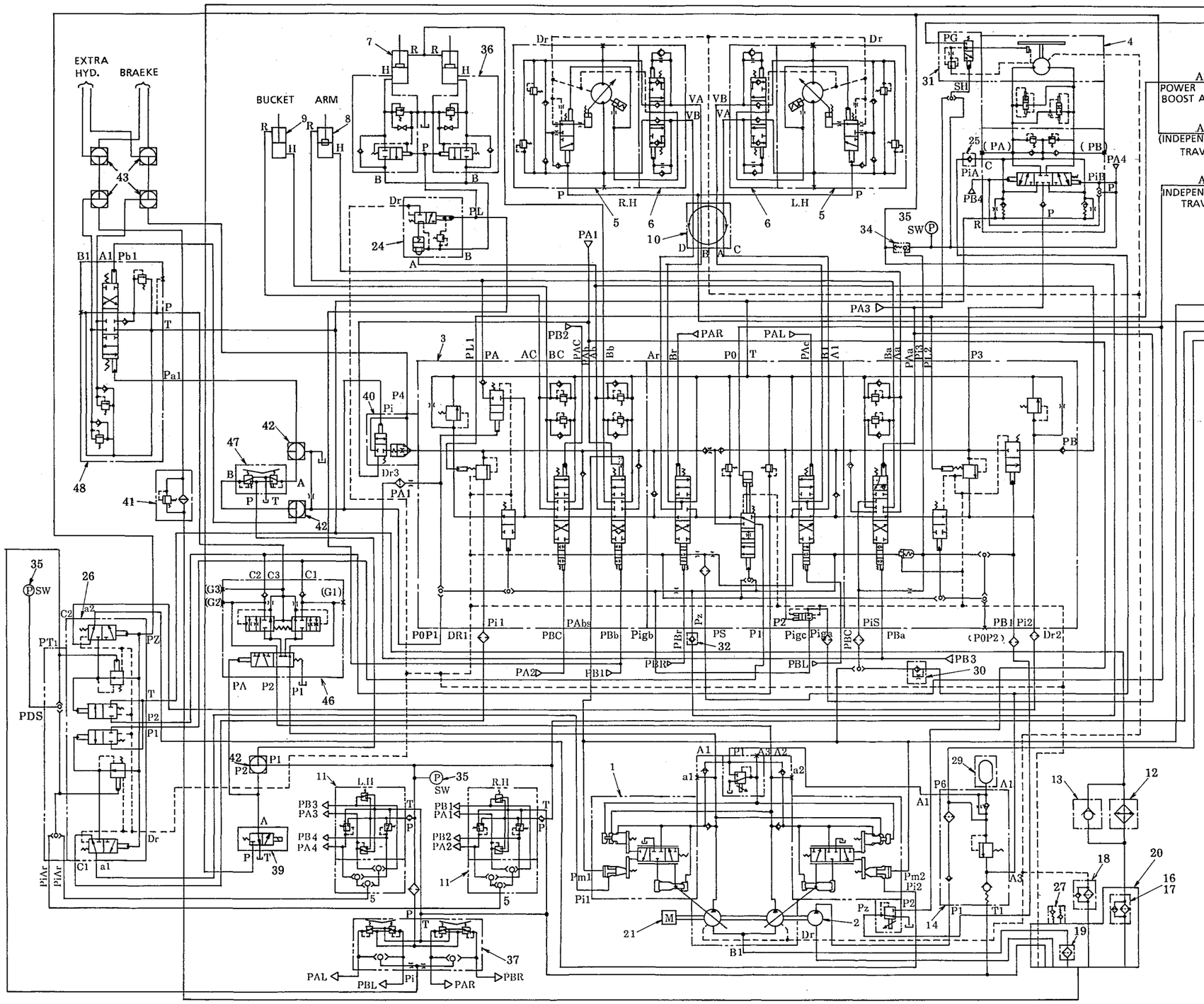


Fig. 19 Retracting the Arm (under heavy load)

SWEDEN SPEC. HOLDING VALVE, EXTRA & BREAKER & TRAVEL PILOT Applicable models LQ-02701~
LL-02001~



No.	NAME	TYPE
1	PUMP	K3V112DT
2	PUMP GEAR	KP1009
3	VALVE. CONTROL	KMX15E
4	MOTOR ASSY (SWING)	M2 x 170 + 20R
5	MOTOR (TRAVEL)	MV200 / 100
6	VALVE. BRAKE	RBV24
7	CYLINDER	
8	CYLINDER	
9	CYLINDER	
10	JOINT. SWIVEL	
11	VALVE. PILOT	TH40K
12	OIL COOLER	
13	VALVE. CHECK	Y-2395
14	BLOCK. MANIFOLD	TNCD-039
16	ELEMENT. FILTER	Y-1635
17	VALVE. BYPASS	Y-1506
18	FILTER. DRAIN	SP04-10
19	SUCTION STRAINER	F-1877
20	TANK ASSY HYDR	
21	ENGINE ASSY	
23	VALVE. SOLENOID	
24	VALVE. HOLDING	KHV20EA10
26	VALVE. BYPASS	VBY125
27	AIR-BREATHER	
28	VALVE. SOLENOID	VBY-121
29	ACCUMULATOR	ME70-500-30
30	VALVE. RESTRICTOR	
31	VALVE. REDUCING	
32	VALVE. CHECK	
34	CONNECTOR	
35	SWITCH. PRESS	
36	VALVE. HOLDING	
37	VALVE. PILOT	
39	VALVE. SOLENOID	
46	VALVE. DIVIDER FLOW	
47	VALVE. PILOT	
48	VALVE. CONTROL	6000HH
49	VALVE. SOLENOID	

4.6 ARM CIRCUIT

4.6.1 ARM DISCHARGE (EXTERNAL CONFLUX) CIRCUIT (AT S MODE)

In arm discharge operation or the supply of oil to the arm cylinder rod, oil streams discharged by two variable displacement pumps are combined in a pipeline outside of the control valve.

(1) Pilot circuit

1) Shifting the arm spool

If the operating lever is turned for arm discharge, the secondary pressure from port PB3 of the pilot valve enters port PBa of the arm section and shifts the arm spool.

2) Changing over the neutral cut valve and the arm conflux valve

The secondary pressure from port PB3 of the pilot valve is branched off to port PA1 of the control valve, changes over the neutral cut valve (306B) in the control valve and shifts the arm conflux spool (308) at the same time.

3) Power shift control in the S mode

If the work mode switch is turned to mode S, the electromagnetic proportionate reducing valve attached outside the No.1 variable displacement pump is actuated electrically. This causes the primary pilot pressure in port P1 of the electromagnetic proportionate reducing valve to run to the secondary pressure of the valve. The secondary proportionate pressure is admitted to the horsepower control of the regulator and shifts two pumps to a set value of the S-mode horsepower.

(2) Main circuit

1) No1. pump oil

The oil supply to the arm cylinder rod is effected as the oil discharged by the No.1 pump is connected with ports P1 and PA of the control valve.

2) No2. pump oil

The oil supply to the arm cylinder is effected as the oil discharged by the No.2 pump is connected with ports P2 and Ba of the control valve and combined with the oil stream from the No.1 pump in a pipeline.

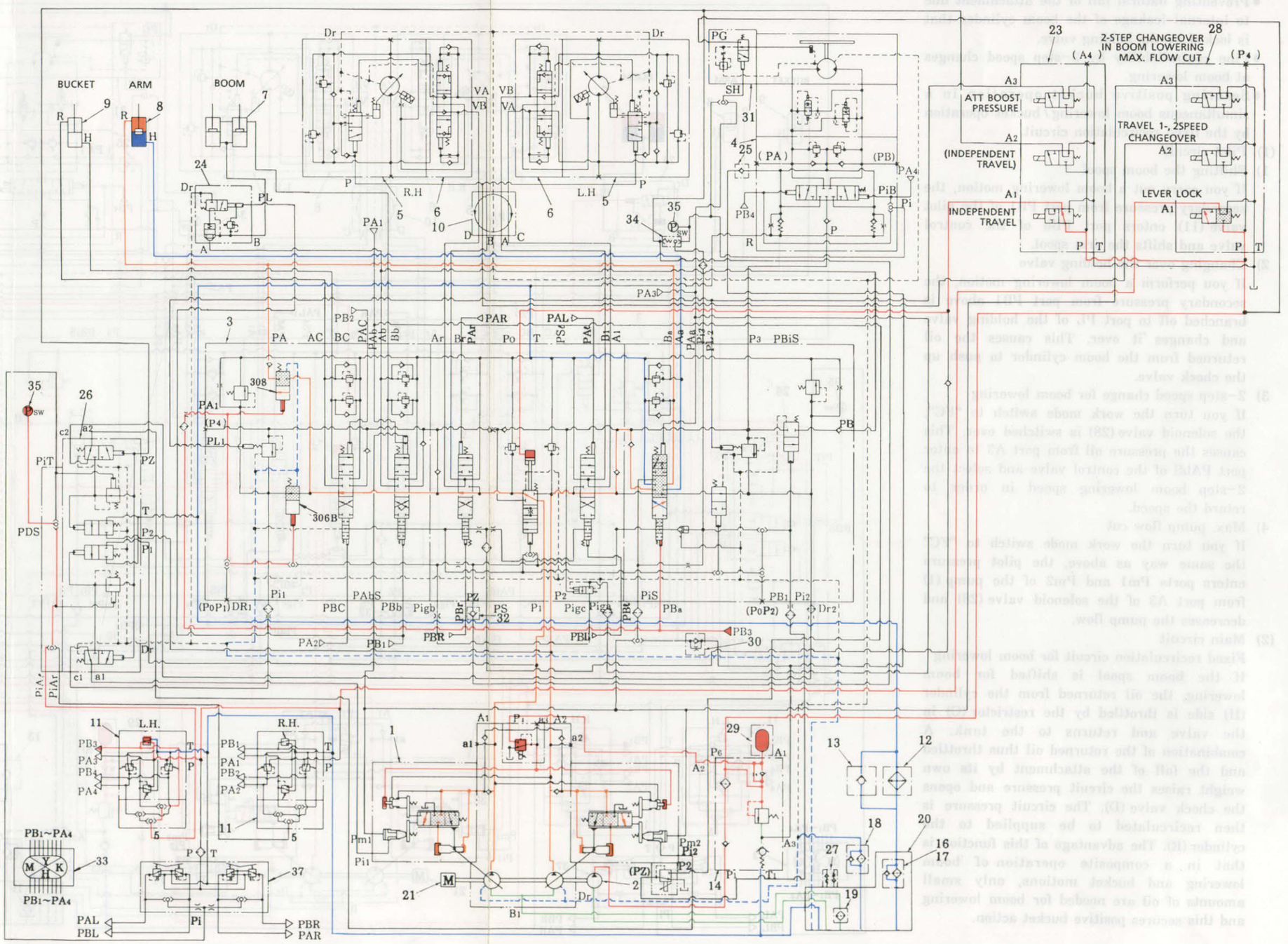


Fig. 18 Arm discharge operation

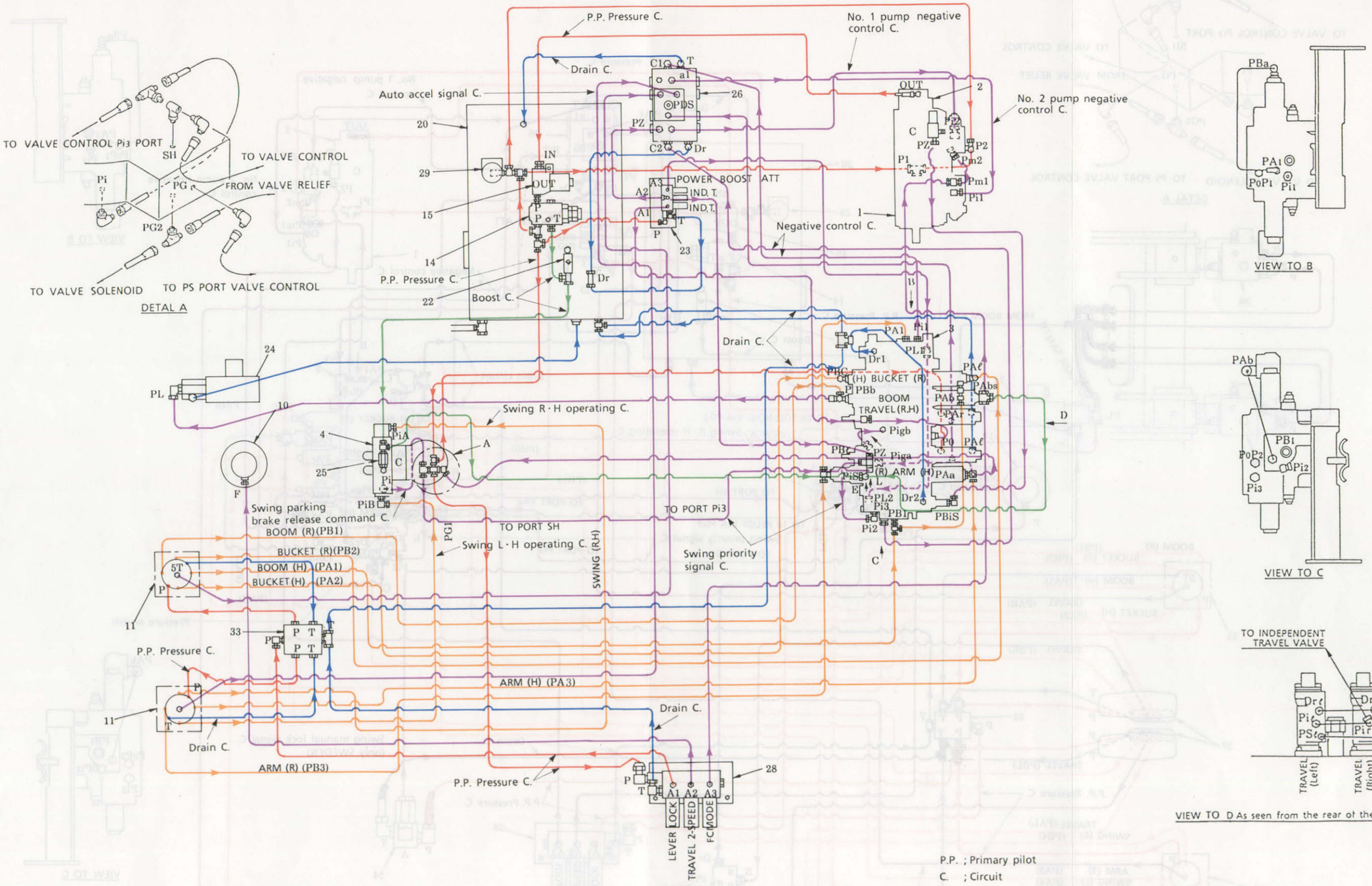


Fig. 2A Swing pilot piping

2) Reconnect to the swing motor and the swing control valve all the hydraulic piping disconnected for removal.

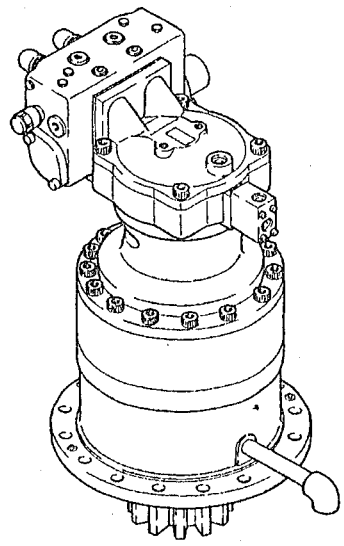


Fig. 16 Reconnect the hydraulic piping

5. REMOVING AND INSTALLING OF SWING REDUCTION UNIT

5.1 REMOVING THE SWING REDUCTION GEAR UNIT

1) Disconnect the hydraulic oil piping leading to the swing control valve and the swing motor, and plug each port.
2) Remove the hex socket head bolts (C) (M20) fixing the swing reduction gear unit.
   Extension lever : about 600 mm (24 in) long.

☞ ○ Putting match-marks on the reduction gear unit and the upper frame will facilitate installation.

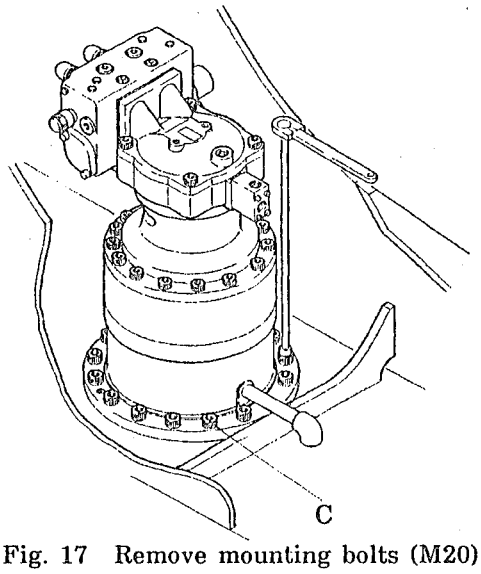


Fig. 17 Remove mounting bolts (M20)

3) Screw 2 eye-bolts into the lifting bolt holes (M12) on the top of the swing motor near the nameplate, and suspend the motor with a wire rope.

4) Remove the swing motor mounting bolts (B) joining the motor to the reduction gear unit, and lift the motor off. (Refer to "5.1 removal and installation of swing motor assembly")

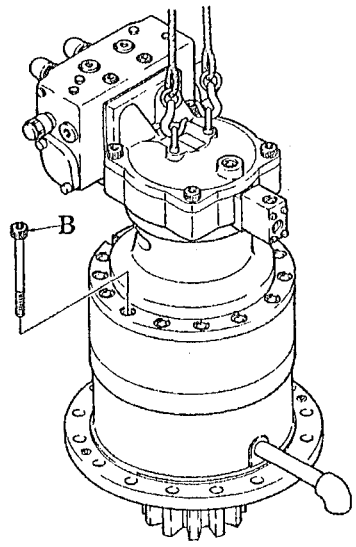


Fig. 18 Remove the motor assembly

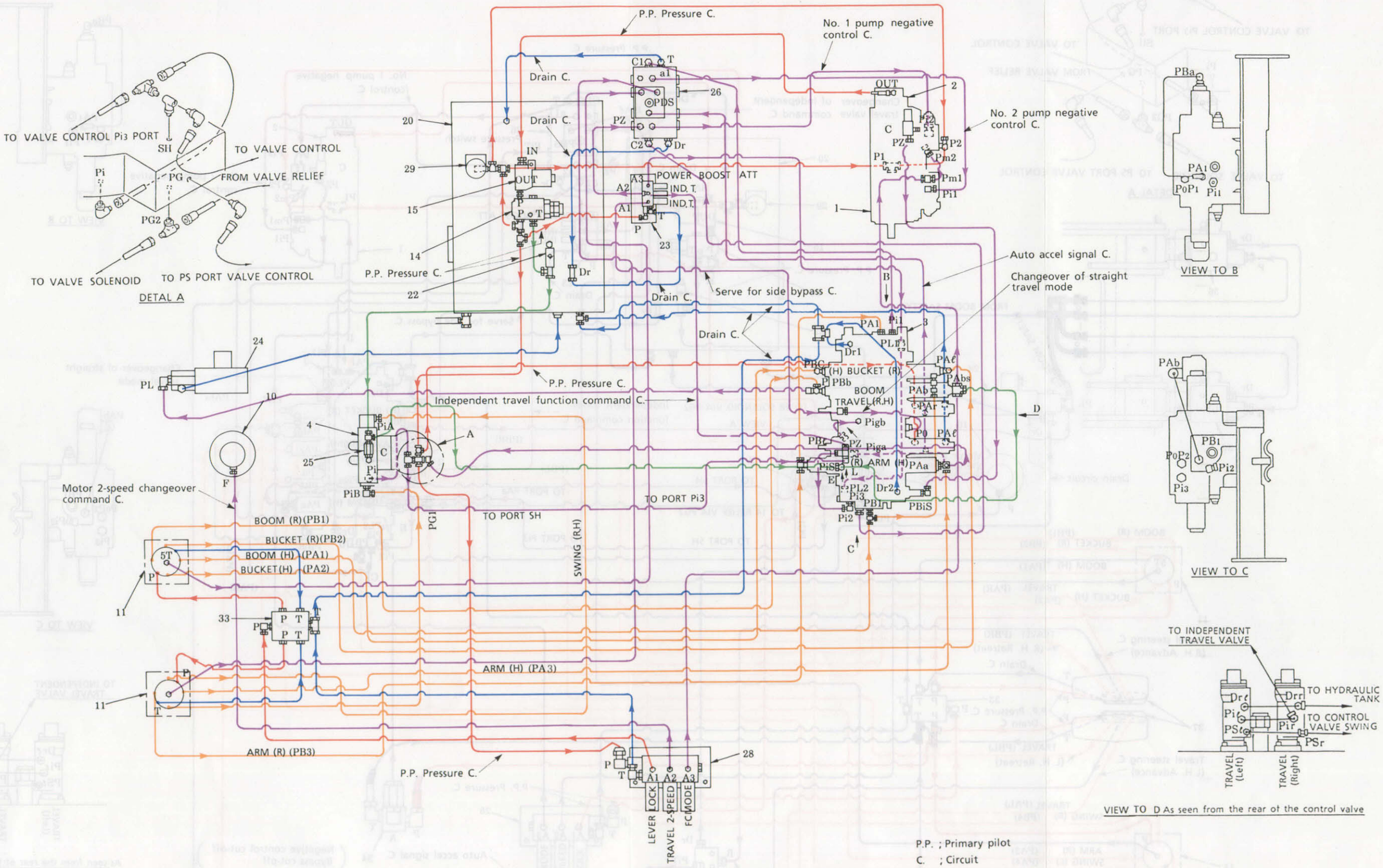


Fig. 4A Travel pilot piping

2.4 OPERATION OF PILOT HYDRAULIC FLOW

1) Primary pilot pressure circuit
   Oil from the gear pump (2) flows into the ports of the components as shown in Table 6. The flow paths shown apply when the lever lock is in the unlock position.
2) Shifting of travel priority (straight travel) valve to straight travel mode position
   If the independent travel switch is OFF, oil flows from port A1 of the solenoid valve (23) to port P0 of the control valve, and shifts the travel priority valve to the travel mode position.
3) Two-speed travel speed selection
   When the "Tortoise & Hare " mark on the knob on the travel right lever is pressed, the solenoid valve (28) is shifted, and oil is directed form port A2 to port P of the travel variable displacement motor, switching the travel speed from 1st to 2nd, or vice versa.
   The travel two-speed switch works in the independent travel mode as well, so travel speed can be switched to any one of the following four speeds:

Travel speed
- With independent travel switch OFF
  - 2nd speed; 7Km/h
  - 1st speed; 4Km/h
- With independent travel switch ON
  - 2nd speed;1.75Km/h
  - 1st speed; 1Km/h

4) Shifting of travel priority (straight travel) valve to independent travel mode position
   When the independent travel switch is pressed, the solenoid valve (23) is shifted, and the oil form port A2 flows to port PZ of the control valve, shifting the straight travel valve to the independent travel mode position.
5) Shifting of neutral cut-off valve
   Oil entering ports PZ and Pi3 of the control valve shifts the right and left neutral cut-off valves.
6) Shifting of independent travel valve to independent travel mode position
   When the independent travel switch is turned ON,oil is directed form port A2 of the solenoid valve (23) to port PZ of the independent travel valve (26), closing the open paths in the independent travel valve from c2 to a2, and from c1 to a1, and opening the paths form Pz to a2, and from Pz to a1, creating a new negative control circuit.
   Also, the oil entering port Pz shifts the bypass valve in the independent travel valve, making ports P1 and P2 open to port T to bypass oil from the pump.
7) Function of the auto accel during independent travel action by the action of the negative control cut signal circuit
   When travel action is performed, the secondary pilot pressure (high pressure selection) from port 3 of the travel pilot valve is admitted to port PiT of the independent travel valve by way of shuttle valve (38). The pressure switches over the reducing valve in the independent valve to cut off the supply of the Pi pressure from port a2 and increases the delivery of the No.2 pump.
8) Bypass cut signal circuit at independent travel action
   The independent travel valve bypasses the circuit to the control valve when the independent travel switch is "ON", but when travel action is performed, the pilot pressure is admitted to port PiT of the independent travel valve to change over the reducing valve in the independent travel valve. Then the spring in the bypass valve is brought back, so that the oil is directed to the control valve as the bypass line from the No.2 pump to the independent travel valve is blocked.
9) Decreasing the oil flow by the negative control pressure in neutral position
   When the lever is in neutral position, the Pi pressure enters the independent travel valve from the control valve. Then the negative control action reduces the delivery of the pump.
10) Auto-accel circuit
   If secondary pilot pressure enters the pressure switch, it works as auto-accel.
   If the travel lever or the pedal is actuated, secondary pilot pressure comes out of port 3 of pilot valve (11) linked to it.
   The pressure is admitted to the pressure switch at port PDS of independent travel valve (26) via shuttle valve (38) and actuates the pressure switch.
11) Drain
   Drain oil is returned to the hydraulic oil tank (20) through the ports as shown in Table 6.

4.4.2 DISASSEMBLING THE UPPER ROLLER

The numbers in parentheses following each part name in the text correspond to those in Figure 19.

1) Remove the plug (10), and drain out the oil.

2) Place the upper roller (1) on the support jig (F), and with the pliers (c), remove the snap ring (11) from the upper roller (1).

3) Using the sliding hammer (i), remove the cover (5).

4) Remove the O ring (8) from the cover (5).

5) Remover the hex socket head bolts (9) to remove the plate (4) from the upper roller (1).

6) Out the pusher Jig (g) on the shaft (2), and using the press (e) or a hammer, force out the shaft (2) and the collar (3).

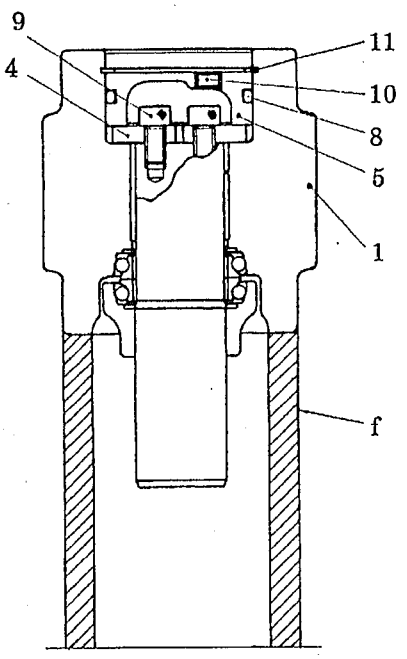


Fig. 20

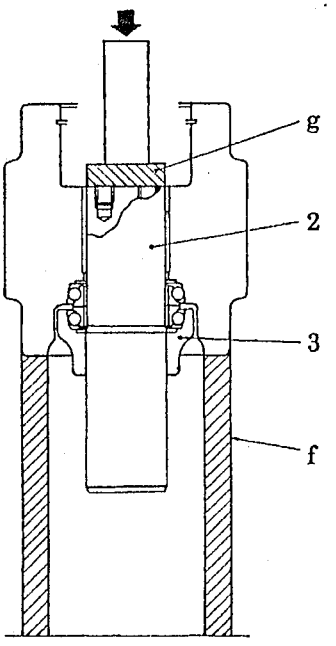


Fig. 21

7) Remove the floating seal (7) from the upper roller (1).

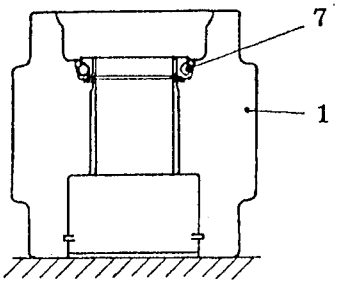


Fig. 22

6. IDLER · (TRACK SPRING)

6.1 REMOVAL AND INSTALLATION PROCEDURES

6.1.1 REMOVING THE IDLER AND THE TRACK SPRING

1) Remove the track.

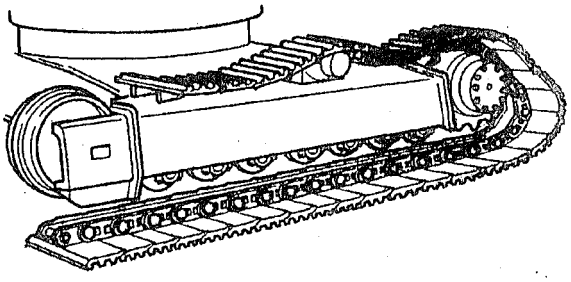


Fig. 47

2) Pass a wire rope through the hole (S) in the track spring bracket, lift the bracket, and using a lever bar, push the bracket out of the track frame.

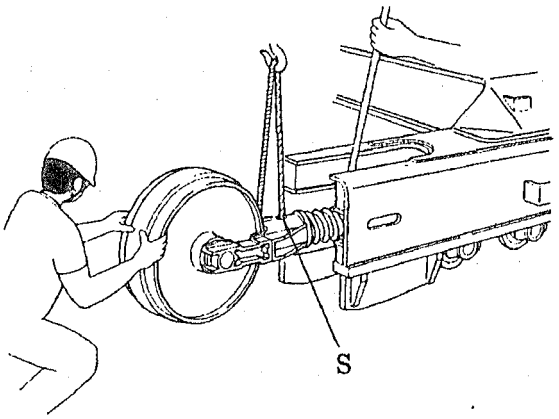


Fig. 48

6.1.2 INSTALLING THE IDLER AND THE TRACK SPRING

1) Pass a wire rope through the hole (S) in the track spring bracket, lift the bracket, then fit and push the slide block into the slide groove in the track frame.

☞ Confirm that the boss at the piston end of the track spring is in the track frame hole.

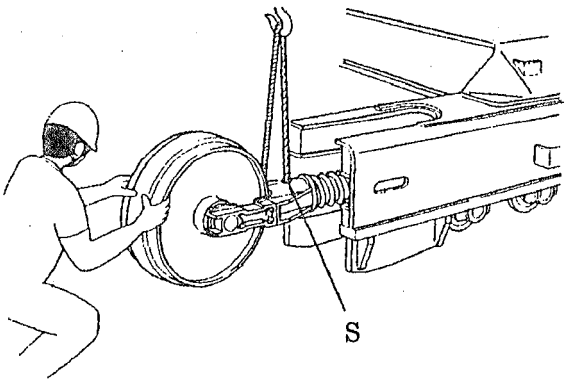


Fig. 49

2) Install the track.

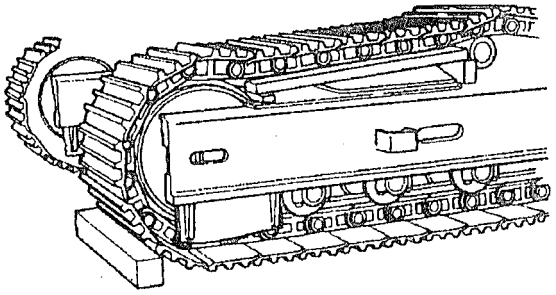


Fig. 50

9.2 INSTALLING THE TRAVEL REDUCTION UNIT

The installation procedure is the reverse of the order of removal.

☞ Carefully check the mating parts of the lower frame and the reduction unit for burrs and contaminants.

1) Pass a wire rope around the travel reduction unit and lift it. Then, install the travel reduction unit on the lower frame.

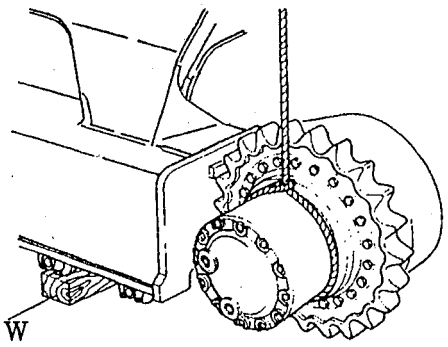


Fig. 77

2) Apply Three Bond 1305 (equivalent to Loctite #262) to the 20 travel motor mounting cap screws (A), and tighten them to the specified torque of 55±5 kgf·m (397±36ft·lbs).

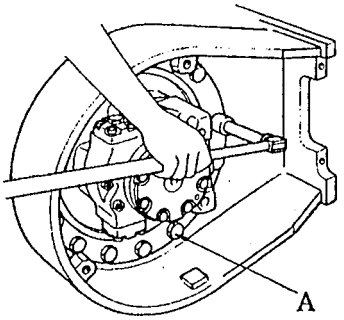


Fig. 78

3) Check the gear oil level in the reduction unit. If necessary, change it or add more.

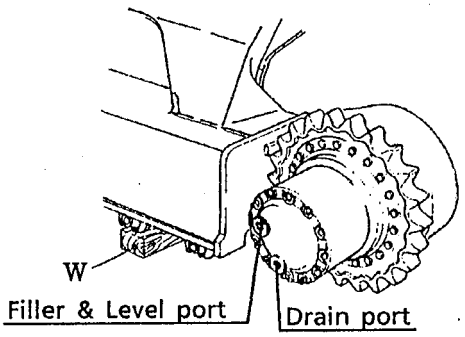


Fig. 79

2. OPERATION

2.1 SPECIAL FEATURES OF THE TRAVEL SYSTEM

The travel system of this machine has the following special features.

1) Hydraulic pilot operating method
   The control valve spool is operated by the proportionate secondary pilot pressure of the pilot valve direct-coupled to the travel operating lever.
2) 2-speed travel
   Low and high speeds are selected if the momentary switch for the travel 2-speed is pressed.
3) Straight travel
   A straight travel circuit is built in so straight travel action can be performed even in composite action with the attachment.
4) The highest travel relief pressure
   A boost pressure travel function is provided so travel power at the highest travel relief pressure continues to the last.
5) Independent travel
   In the D mode, travel action operates by the No.2 pump only, so that the independent travel mode at a fixed travel speed is selected even though composite operation is performed.
6) Auto accel

The oringe color in the figure represents pressure circuits while the blue color indicates tank circuits.

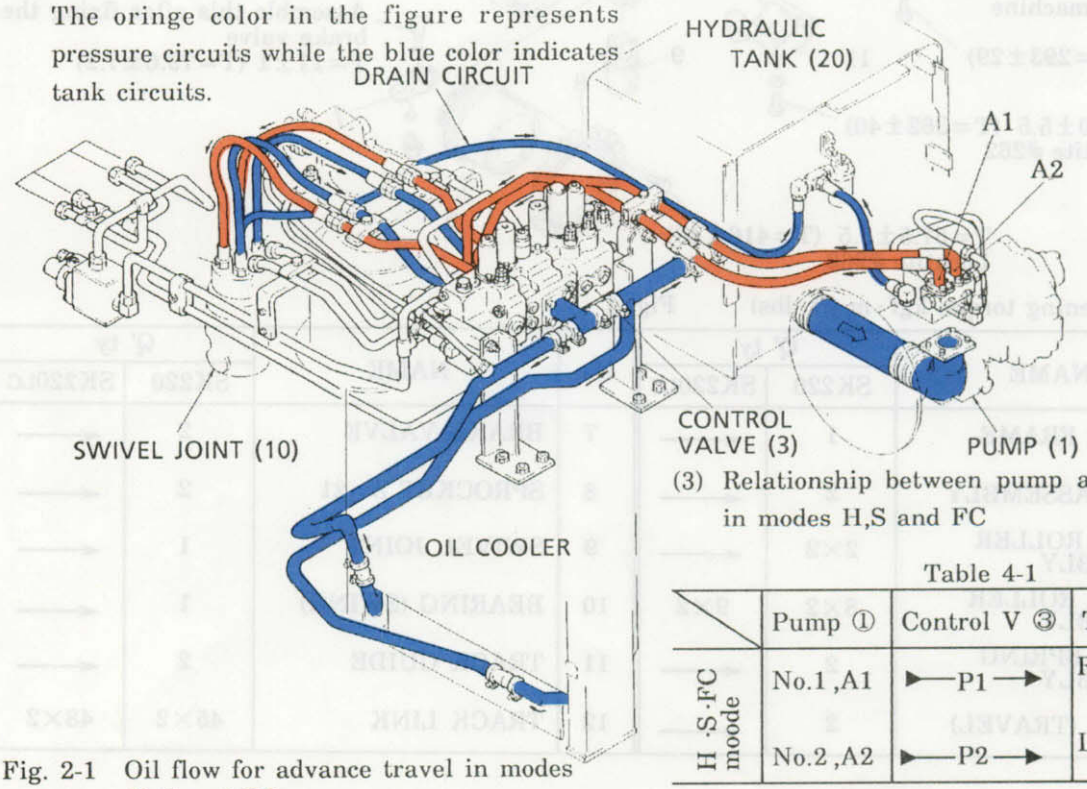


Fig. 2-1 Oil flow for advance travel in modes H, S and FC

2.2 HYDRAULIC FLOW

(1) Piping between the hydraulic oil tank and the control valve (see Table 2 and Figure 2)

Table 2 (Connecting port signs)

Component / Circuit	Oil Function: Tank (20)	Pump (1)	Control valve (3)
Feed	Tank		$A_1 \rightarrow P_1$ $A_2 \rightarrow P_2$
Return	Tank	Oil cooler	T

(2) Piping between the control valve and the brake valve (see Table 2 and Figure 2)

Table 3 (Connecting port signs)

Action	Valve	Control valve (3)	Swivel joint (10) Upper	Swivel joint (10) Lower	Brake valve (6) LH	Brake valve (6) RH
RH Advance	Feed	Ar	D	D	–	VA
	Return	Br	B	B	–	VB
LH Advance	Feed	Aℓ	C	C	VB	–
	Return	Bℓ	A	A	VA	–

(3) Relationship between pump and travel motor in modes H,S and FC

Table 4-1

	Pump ①	Control V ③	Travel motor ⑤
H·S·FC mode	No.1 ,A1	⟵P1⟶	Right (advance and retreat)
	No.2 ,A2	⟵P2⟶	Left (advance and retreat)

1.3.2 OPERATION OF ATTACHMENT PILOT PRESSURE

(1) Primary pilot pressure
Oil from the gear pump (2) enters the ports of the components as shown in table 3, provided that the lever is not locked.

(2) Solenoid proportional pressure reducing valve for control of pump

1) Horsepower reduction
When the work mode select switch is set to the FC mode, the solenoid proportional pressure reducing valve is shifted, and oil directed into port P1 of the reducing valve acts to reduce the horsepower of both the No. 1 pump and the No. 2pump.

2) Loading mode
Loading mode boom raising speed control conflux oil is introduced into port P2 of the solenoid proportional pressure reducing valve.

(3) Operate circuit (Secondary pilot pressure circuit)
When the lever is operated, primary pilot pressure in port P of the pilot valve (11) flows from the pilot valve as secondary pilot pressure to the control valve, shifting the boom, arm, or bucket spool.

(4) Holding valve, boom lower signal circuit
When pressurized valve enters port PL of the holding valve (24) and port P of the holding valve (36) from port PBb of the control valve, both holding valves are changed over and allow the returned oil from the boom cylinder (H) to bring back to the hydraulic oil tank by way of port Ab of the control valve.

(5) Boom raise conflux command circuit
When oil from port PAb of the control valve enters port PB1 of the end section, the conflux select valve and the neutral cut-off valve are shifted, stopping the oil at port P2 of the control valve from returning to the tank, and instead opening port P2 to port PB. Consequently, the oil from two pumps is merged in external piping.

(6) Circuit for two-stage boom lowering speed selection and maximum-delivery reduction.
When the work mode select switch is set to the FC mode, the solenoid valve (28) is shifted, and the oil from port A3 flows through port PAbS of the control valve to port Pm1 of the No. 1 Pump and port Pm2 of the No.2 pump, reducing the maximum delivery of the pumps.
The oil in port PAbS of the control valve restricts the stroke of the boom spool.

(7) Arm conflux signal circuit

1) Arm recirculation pilot circuit and swing pilot circuit
When pilot pressure enters port PiS of the control valve, an arm recirculation pilot circuit is created.
When swing pilot pressure enters port Pi3, a stronger arm recirculation circuit is created.

2) Arm conflux signal for retraction under a heavy load
When the arm is retracted under a heavy load, the sequence valve in the control valve is shifted, and oil flows from port Piga through port Pigc to port Pigb. This shifts the neutral cut-off valve and the travel priority (straight travel) valve in the control valve, merging the oil from two pumps in the valve.

3) Arm conflux signal for extension
When oil flows from port PBa to port PA1 in the control valve, the conflux select valve and the neutral cut-off valve are shifted, stopping the oil at port P1 of the control valve from returning to the tank, and opening port P1 to port PA. Consequently, the oil from two pumps is merged in external piping.

(8) Negative control signal circuit

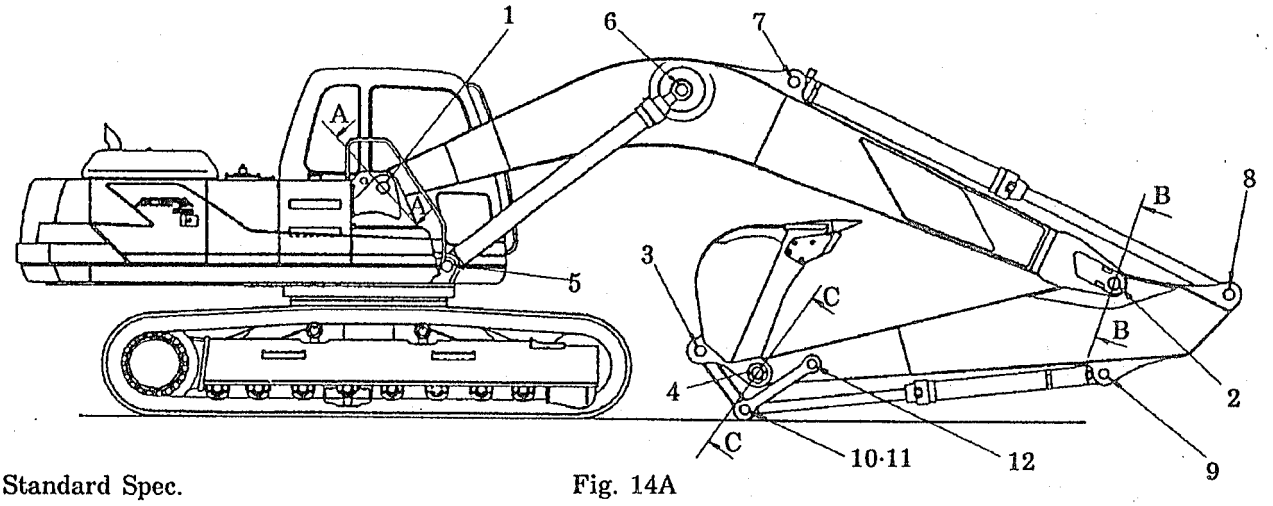
1) Negative control of No.1 pump
When a neutral circuit is completed when the machine is neither traveling nor working, oil from port Pi1 of the control valve flows from port C1 to port a1 of the independent travel valve, and then to port Pil of the No.1 pump, reducing delivery from that pump.

2) Negative control of No.2 pump
Similarly, oil from port Pi2 of the control valve flows from port C2 to port a2 of the independent travel valve, then to port Pi2 of the No.2 pump, reducing delivery from that pump.

(9) Attachment boost pressure command circuit
When the attachment boost pressure switch is turned ON, oil is directed from port A3 of the solenoid valve (23) to port PL1 and port PL2 of the control valve, raising the relief pressure of the main relief valve.

4. MAINTENANCE STANDARDS

4.1 CLEARANCE BETWEEN PINS AND BUSHING



Standard Spec. Fig. 14A

Table 5A Unit : mm (in)

No.	Item	Standard Value				Allowable Value	Remedy
		Pin Dia	Tolerance for pin O.D.	Tolerance for BushingI.D.	Clearance		
1	Boom foot	Ø100 (Ø 3.9370)	±0.020 (±0.0008)	+0.295 (+0.0116) +0.200 (+0.0079)	+0.315 (+0.0124) +0.180 (+0.0071)	3.0 (0.12)	Replace bushing or pin.
2	Arm center	Ø90 (Ø 3.5433)		+0.273 (+0.0107) +0.176 (+0.0069)	+0.293 (+0.0115) +0.156 (+0.0061)		
3	Bucket link (Bucket connection)		−0.030 (−0.0012) −0.090 (−0.0035)	+0.280 (+0.0110) +0.207 (+0.0081)	+0.370 (+0.0146) +0.237 (+0.0093)		
4	Arm point						
5	Boom cylinder (Bottom side)		±0.020 (±0.0008)	+0.250 (+0.0098) +0.050 (+0.0020)	+0.270 (+0.0106) +0.030 (+0.0012)		
6	Boom cylinder (Rod side)	Ø95 (Ø 3.7402)					
7	Arm cylinder (Bottom side)	Ø90 (Ø 3.5433)	−0.030 (−0.0012) −0.090 (−0.0035)		+0.340 (+0.0134) +0.080 (+0.0031)		
8	Arm cylinder (Rod side)						
9	Bucket cylinder (Bottom side)	Ø80 (Ø 3.496)	−0.050 (−0.0020) −0.110 (−0.0043)		+0.360 (+0.0142) +0.100 (+0.0039)		
10	Bucket cylinder (Rod side)						
11	Bucket link (Cylinder connection)			+0.134 (+0.0053) +0.005 (+0.0002)	+0.244 (+0.0096) +0.045 (+0.0018)		
12	Arm~Idler link (Connection)	Ø70 (Ø 2.7559)	−0.153 (−0.0060) −0.213 (−0.0084)	+0.281 (+0.0111) +0.210 (+0.0083)	+0.494 (+0.0194) +0.363 (+0.0143)		

1.3.2 FUNCTIONAL EXPLANATION OF ATTACHMENT PILOT PRESSURE

(1) Boost circuit

Oil supply to the gear pump is made from piping branched off from the boost line of the main circuit.

(2) Primary pilot pressure (delivery) circuit

Oil pressure discharged by the gear pump (2) enters the pilot pipings in the order of connection as shown in Table 3.

Primary pressure of the electromagnetic proportionate reducing valve for power shift control

If the KPSS mode select switch changes command current values of the electromagnetic proportionate reducing valve, secondary pressure (power shift pressure) is changed. It is then admitted to the pump regulator where a set horsepower value is shifted. (reduced horsepower control)

The controller changes current values in the H, S and FC modes so as to meet a selected mode. Note, however, that in the following circuits, all explanations are based upon the lever lock unlocked (operating) position.

(3) Maneuvering circuit (proportionate pilot secondary pressure circuit)

The primary pressure in port P of the pilot valve (11) is admitted to the control valve as secondary pressure proportionate to lever strokes and shifts the boom, arm and bucket spools of the control valve.

(4) Boom lowering command and holding circuit

If oil pressure enters port PL of the holding valve (24) through port PBb of the control valve, the oil returned from the boom cylinder (H) is connected between port B and port A of the holding valve and is returned to the tank via port Ab of the control valve.

(5) Conflux command circuit at boom raising

If boom raising operating pressure connects between P2 and PZ of the electromagnetic proportionate reducing valve fixed to the pump and hydraulic pressure enters port PB1 of the control valve, the conflux changeover valve and the neutral cut valve are changed over. As the result, hydraulic pressure which enters port P2 of the control valve gets through to port PB, instead of returning to the tank. Streams of two pumps are combined in the piping outside the valve.

(6) Boom lowering 2-step changeover and max. flow cut circuit

If the work mode select switch is turned to the FC mode, the solenoid valve (28) is changed over. The result is that hydraulic pressure flows through port A3 and port PAbS of the control valve, enters ports Pm1 and Pm2 of the pump and cuts the maximum flow rate.

Hydraulic pressure which enters port PAbS of the control valve regulates the strokes of the boom spool so as to slow down the boom lowering speed.

(7) Variable re-circulation circuit for light-duty work and arm digging

Port PiS of the control valve is subject to a constant boost pressure of 7kgf/cm^2(100psi). It forms a variable re-circulation pilot circuit for arm operation when arm digging or light-duty work is performed.

(8) Forced re-circulation circuit at arm digging and light-duty work (in the FC and D modes)

If the FC or D mode is selected, primary pilot pressure gets through to port PiS and Pi3 of the control valve. This increases the variable re-circulation circuit pressure for arm pull and makes forced re-circulation work.

(9) Sequence conflux at arm digging and heavy duty work

If the sequence valve in the control valve is changed over during heavy duty digging, hydraulic pressure reaches Pigb via ports Piga and Pigc. This changes over the neutral cut valve in the control valve and the travel priority (straight travel) valve and allows streams of two pumps to combine in the control valve.

(10) Arm discharge and conflux command circuit

If hydraulic pressure enters from port PBa to PA1 of the control valve, it changes over the conflux changeover valve and the neutral cut valve, prevents hydraulic pressure from port P1 of the control valve from returning to the tank and allows hydraulic pressure to connect to port PA. Streams of two pumps are combined in the piping outside the control valve.

(11) Swing parking brake release circuit at arm digging

If arm digging operation is done, pilot pressure enters port SH of the reducing valve (31) form port PAa of the control valve, changes over the valve and permits the primary pressure to release the swing parking break.

(12) attachment boost pressure circuit

If the attachment boost pressure switch is turned on, hydraulic pressure is admitted from port A3 of the solenoid valve (23) to ports PL1 and PL2 of the control valve and raises the pressure of the main relief valve.

(13) Loading mode / boom conflux release circuit

The more the loading potentiometer switch is turned clockwise, the more the voltage level falls. this in turn decreases the current level for the electromagnetic proportionate reducing valve attached to the pump which then decreases the proportionate secondary pressure of the reducing valve and reduces the boom conflux flow. Therefore, where loading and swing motions are performed at the same time, the swing speed approaches the single speed.

(14) Negative control signal circuit

1) No.1 pump negative control

When the circuits are neutral or no travel nor work is underway, hydraulic pressure from port Pi1 of the control valve is admitted to Pi1 port of the pump by way of ports C1 and a1 of the independent travel valve, in order to decrease the delivery rate of the No.1 pump.

2) No.2 pump negative control

In the same way as mentioned above, hydraulic pressure from port Pi2 of the control valve is admitted to port Pi2 of the pump by way of ports C2 and a2 of the independent travel valve and decreases the delivery rate of the No.2 valve.

(15) Drain line

The drain fro each component returns to the tank port past the blue circuits in the piping diagram.

2. TRAVEL CONTROL SYSTEM (PILOT VALVE SPEC.)

2.1 GEMERAL VIEW

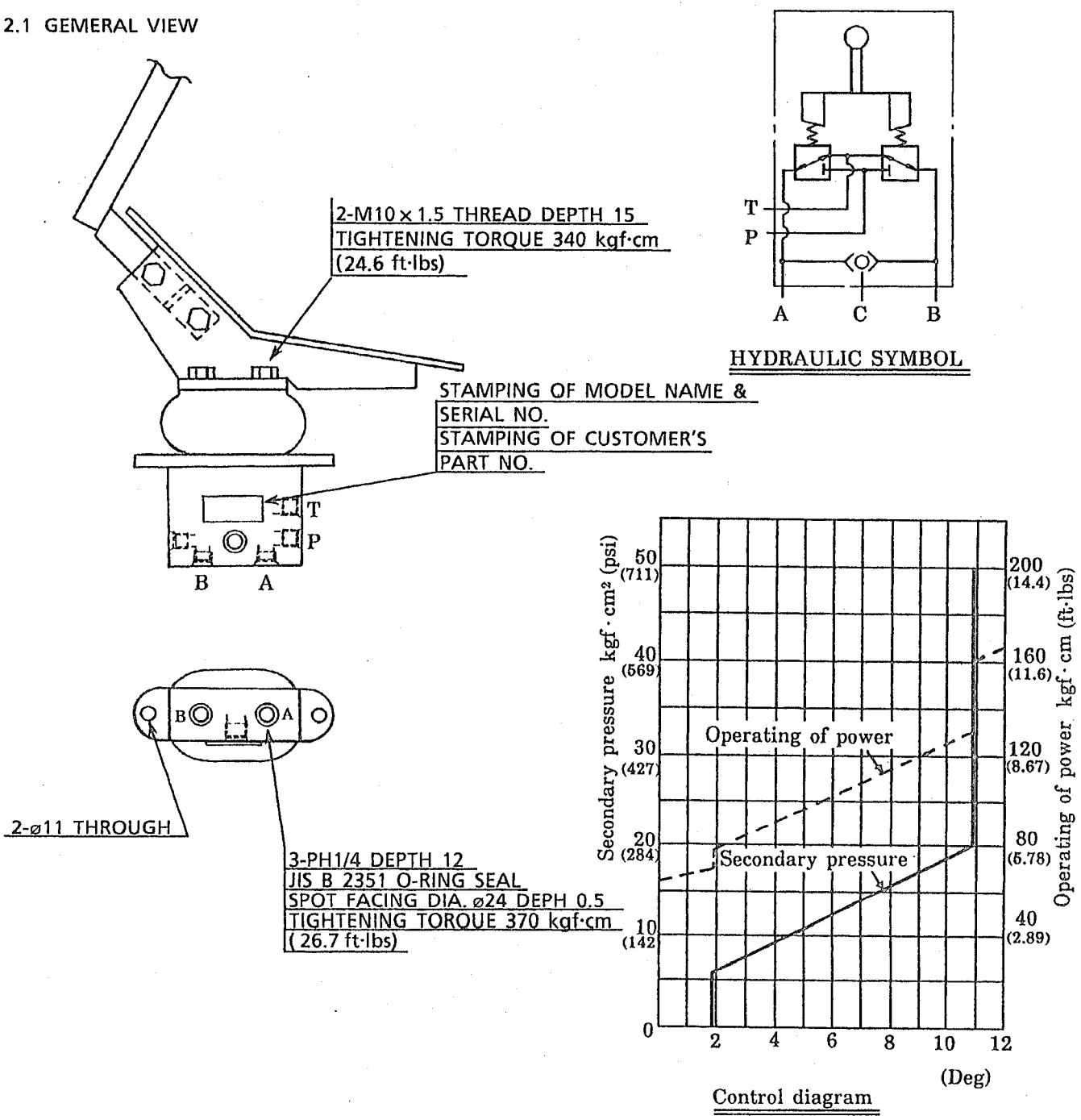


Fig. 5 Outo side view of travel pilot valve

2.2 MAJOR SPECIFICATIONS

Item		Model RCV8CC1007
Max. pressure	kgf · cm² (psi)	50 (711)
Rated flow	ℓ/min (gaℓ/min)	10 (2.64)
Weight	Kg (lbs)	4 (8.82)

1. ENGINE CONTROL SYSTEM

1.1 CONSTRUCTION

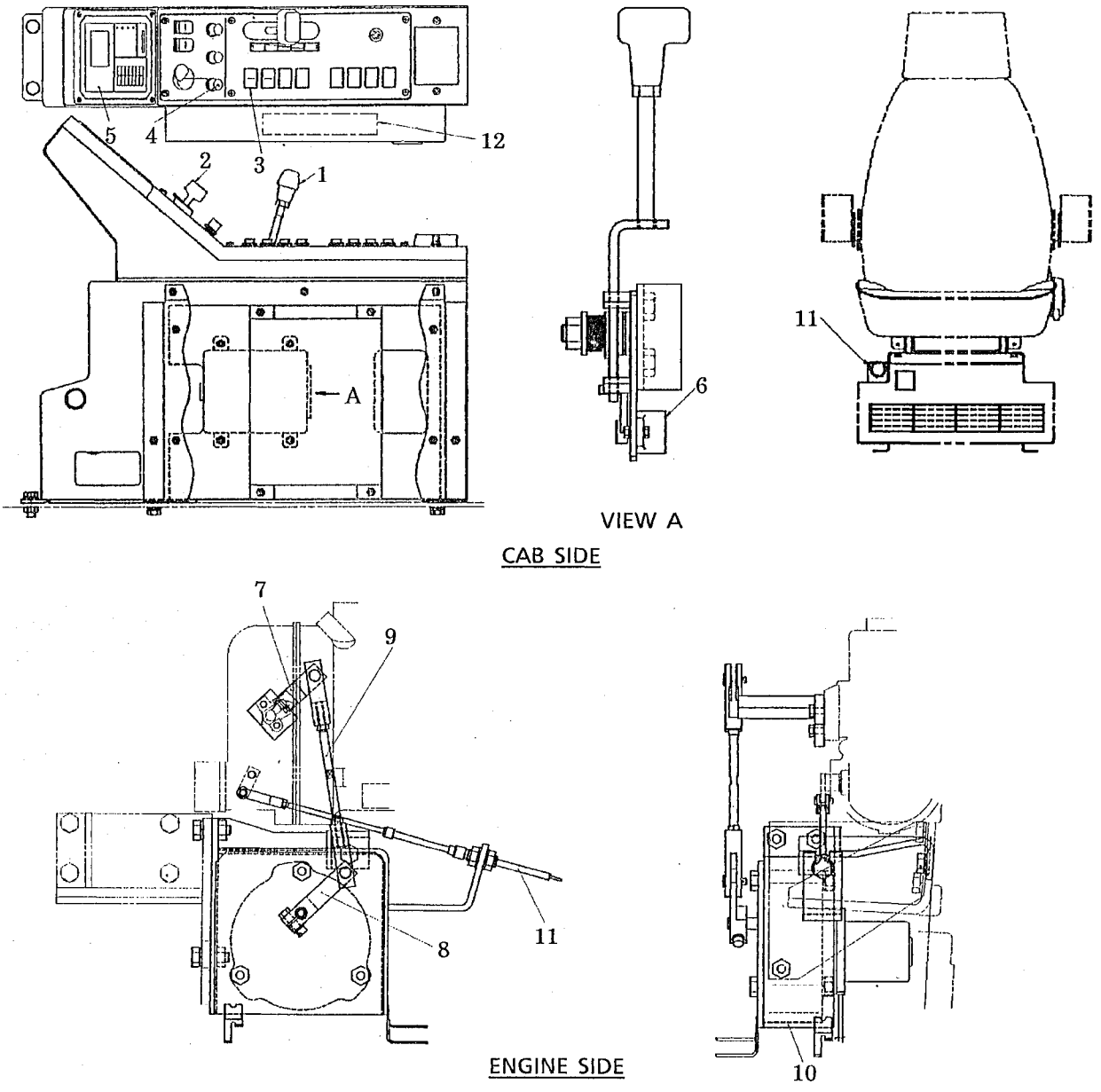


Fig. 1 Engine control assy

No.	NAME	Q'ty	No.	NAME	Q'ty
1	THROTTLE LEVER	1	7	ENGINE GOVERNOR LEVER	1
2	STARTER SWITCH	1	8	LEVER	1
3	AUTO ACCEL SWITCH	1	9	ROD	1
4	WORK MODE SELECT SWITCH	1	10	STEPPING MOTOR	1
5	GAUGE CLUSTER	1	11	CONTROL CABLE (ENGINE STOP AT EMERGENCY)	1
6	POTENTIOMETER	1	12	CONTROLLER (KPSS)	1

Applicable Machines
LQ-2101~
LL-1801~

Revision	Date of Issue	Remarks
First edition	March, 1990	S5LQ2304E K

KOBELCO

Book code No. S5LQ2504E

SHOP MANUAL

SK220
SK220LC

ELECTRICAL SYSTEM

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LQ25

KOBE STEEL, LTD.

Applicable Machines

LQ-02701~

LL-02001~

Revision	Date of Issue	Remarks
First edition	December,1991	S5LQ2506E K

3. FUNCTION

3.1 MECHANISM OF COOLING

If water is heated, the temperature of the water rises and when it gets at 100°C(212°F), it begins to boil.

In a boiling condition, the water temperature is 100°C(212°F) constant and applied heat escapes as vapor. If evaporative liquid such as alcohol is applied to your skin, alcohol evaporates as it gets heat from the skin. You feel it cold as the body temperature is taken away by the amount of evaporation. That is to say, heat is needed to change liquid to a gaseous body, and one from which heat is taken away (area in contact with liquid) is cooled off.

In general, the cooler seals liquid (called coolant) in the tubing and repeats evaporation, and liquefaction as the liquid is circulated. Heat is taken away from the outer circumference of tubing on evaporation (This part is called evaporator.) and diffuses heat from the outer circumference of the tubing (This part is called condenser.) during liquefaction.

To design a good cooling cooler, such a cooler that evaporates at as low temperature as possible and liquefies easily must be used. Evaporation of coolant in large quantities in the evaporator means good cooling. This signifies that coolant must run into the evaporator in a as perfect liquid state as possible.

If small amounts of heat are taken away from the condenser, it results in insufficient liquefaction of coolant and thereby poor cooling.

Fleon "R−12" is used as coolant for air-conditioners. The qualities are as shown in the curve on the right.

As clearly seen from the curve, coolant stays liquid to comparatively high temperature under heavy compression, but under low pressure it evaporates and takes a gaseous state at 0°C(32°F) and even at -10°C(14°F). Evaporation at 0°C(32°F) signifies that the evaporator is held at 0°C(32°F), and the air going through the evaporator must be cool.

If pressure is decreased to a level where coolant evaporates at -5°C(23°F), the evaporator is also kept at -5°C(23°F). This causes frosting of the evaporator resulting in poor air flow and consequently leads to poor cooling.

Then, evaporated coolant must be liquefied, but considering a summer environment under which

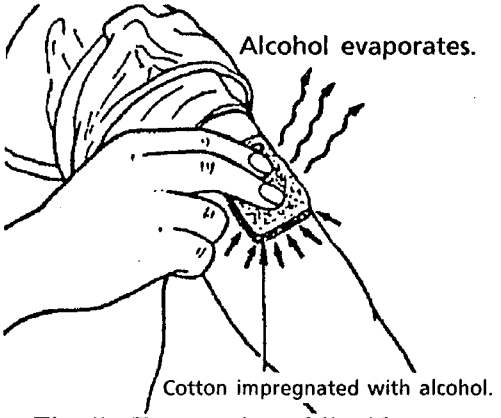


Fig. 5 Evaporation of liquid

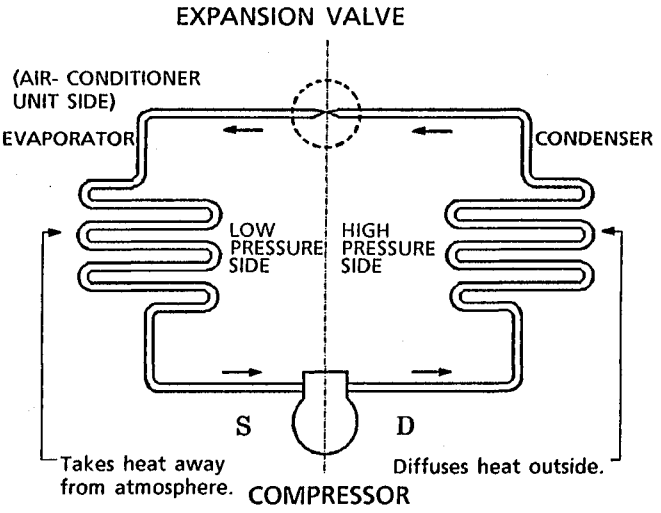


Fig. 6 Basic cooling cycle

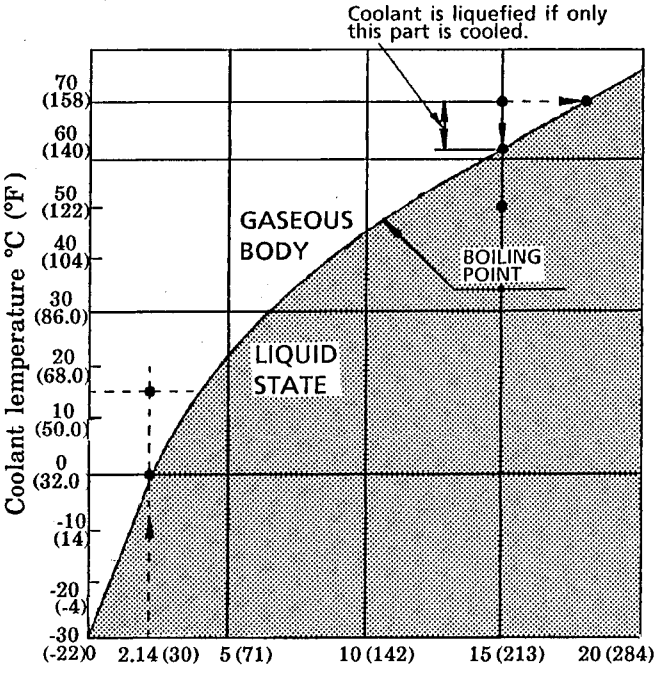


Fig. 7 Vapor pressure curve of Fleon R−12

4.3 CAUTIONS TO BE EXERCISED ON HANDLING COOLANT

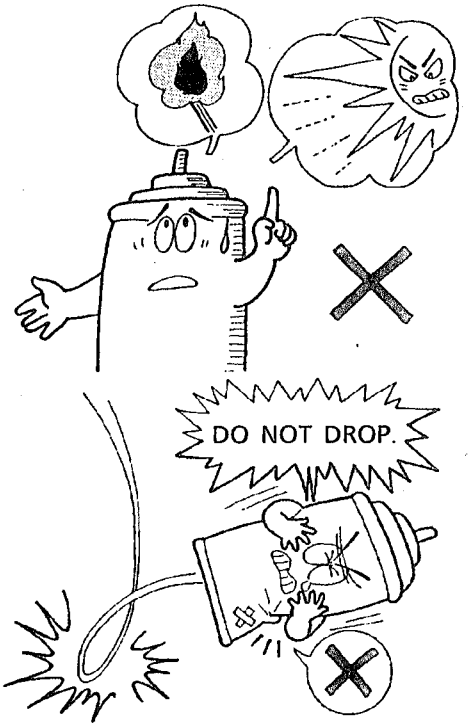
- Do not allow persons other than a full-time person in charge to perform coolant filing operation. Make related personnel thoroughly aware that a person other than full-time person in charge can not do this job as it entails danger.

- Wear protective goggles when working.
  If coolant (liquid) gets into your eyes, you may lose sight as the water content in the eyeball is frozen. Always wear protective goggles when filling coolant. Note that if coolant is splashed over your hand, you may fall into a frostbite. (Take care when attaching and removing service cans , and charging hoses.)

- Do not return coolant to the service can in ang circumstances.
  Never bring coolant under refrigeration cycle back to a service can in any circumstances as it may explode the service can.

- When handling service cans, exercise care of the following:

1) Never store service cans in areas subject to direct sunlight, near fire or places that are heated hot, such as a compartment (including a trunk room). (Store in a cool, dark place nearly free of moisture.)
   When loading service cans onto a service car, do it as little as possible and place them in a relatively cool place.
2) Store service cans without reach of children.
3) Scratches, blow marks and distortion reduce the strength of service cans ; do not drop them or strike them in any case.
   Further, do not handle packages that contain service cans.
4) Do not use service cans that have damaged screw threads and show abnormalities such as distortion.



6. TROUBLESHOOTING

6.1 CHECKING ACCORDING TO TROUBLE CONDITION

6.1.1 PRE-CHECKING

Before performing "Checking according to Trouble Condition", get yourself familiar with the construction and the functions of the air-conditioner and pre-check the following items with reference to the Connecting the Connectors and the Electric Circuit Diagram and using a circuit tester.

(1) Blowing of fuses

1. Check only those circuits where fuses may be blown, with reference to the electric wiring diagram.
2. In order to check that a component part is not shorted inside, disconnect the connector for the component part.

(2) Incomplete setting of connectors

1. Keep in mind that functional parts fail by poor setting of connectors.
2. Poor setting of connectors often bring about unstable and erroneous functions as the vehicle body vibrates.
3. If a connector is heated, it implies that it is set improperly.

(3) Poor grounding of body

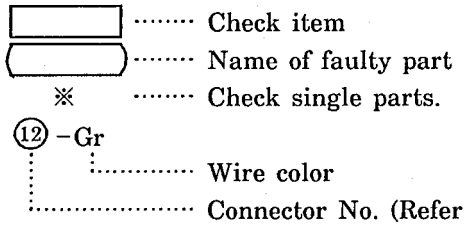
Grounding which looks all right may be complete because it is obstructed by unremoved paint or rusting

6.1.2 A LIST OF CHECK POINTS ACCORDING TO SYMPTOMS

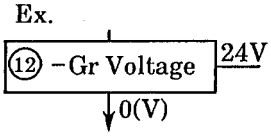
	Symptom	Operating condition of major products when faulty (○ Working normally, × Not working)					Main chacking part										Flow chart No.
		Blower · M	Mg · clutch	W/V servo motor	Servo at blowout hole	Inner/outer air servo	Compressor	Magnet clutch	Blower motor	W/V servo motor	Blowout hole servo motor	Inner/outer air servo motor	Control SW	Air-conditioner amp.	Air-conditioner harness	Fuse	
1	Deficiency in cooling capacity	–	–	–	–	–	○	○	○	○	○	○	○	○	○		A
2	Deficiency in warming capacity	–	–	–	–	–				○	○	○	○	○	○		B
3	No function	×	×	×	×	×								○	○	○	C
4	Air does not blow and clutch does not engine.	×	×	○	○	○							○	○	○		D
5	No air blow at all	×	○	○	○	○			○				○		○		E
6	Air does not blow out. (when blower switch is at Lo, Me)	×	○	○	○	○							○		○		F
7	Air velocity does not change.	×	○	○	○	○							○		○		G
8	Magnet clutch does not engage.	○	×	○	○	○		○					○	○	○		H
9	W/V service motor does not operate.	○	○	×	○	○				○			○	○	○		I
10	Blowout hole does not change over.	○	○	○	×	○					○		○	○	○		J
11	Inner and outer air streams do not change over.	○	○	○	○	×						○	○	○	○		K
12	An abnormal sound occurs.	–	–	–	–	–	○	○	○								L
13	13. High and Low pressures of compressor are abnormal.	–	–	–	–	–	○										M

6.1.3 HOW TO READ THE FLOW CHART

(1) Symbols



Ex.



Measure the voltage at Gr line at connector No. ⑫, and select and go ahead according to that value.

(2) Remarks

1) ⊖ test lead for voltage checking shall be the body earth.
2) "Earth" for resistance check means the body earth.
3) The voltages indicated on the chart differ with conditions.

(24V represents the source voltage.)

(5) Water valve servo motor

1. The motor rotates and stops at the COOL position when 24V is applied (⊕ to 1, and ⊖ to 3).
2. The motor rotates and stops at the HOT position when 24V is applied (⊕ to 1, and ⊖ to 3).

☞ Current does not run when the motor is not running.

3. Measure the resistance between terminals 2 and 4.

COOL position	Approx. 3500 [Ω]
HOT position	Approx. 500 [Ω]

The resistance must change smoothly.

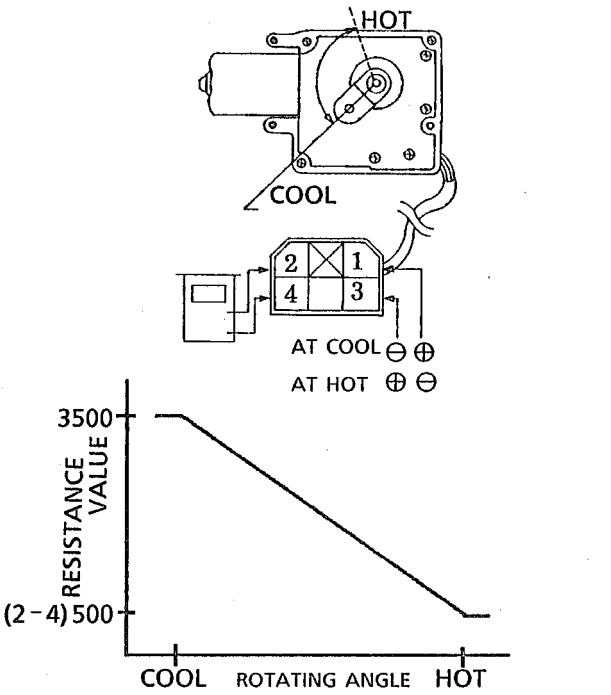


Fig. 45 Checking the water valve servo motor

(6) Clutch relay and blower relay

1. Measure resistance between terminals 1 and 2.

   Approx. 300 [Ω]

2. Apply 24V between terminals 1 and 2. Current gets through between terminals 3 and 4.

   Approx. 0 [Ω]

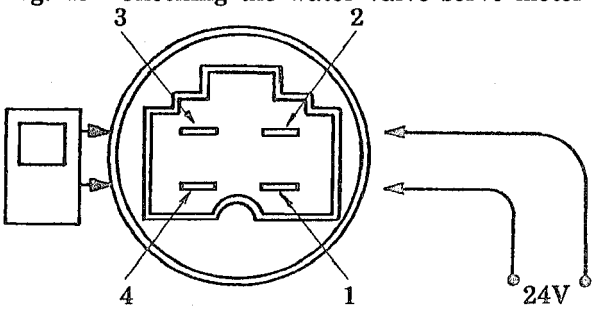


Fig. 46 Checking the clutch relay and blow relay

6.2.2 CONTROL PANEL

(1) Bolwer (fan) switch

Confirm continuity between related terminals below:

Switch position	5	4	3	2	1
OFF					
LO	○	○	—	—	○
ME	○	○	—	○	
HI	○	○	○		

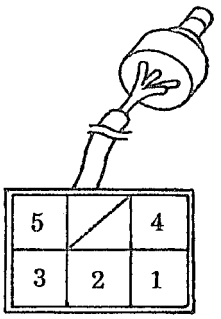


Fig. 47 Checking the blower (fan) switch

(2) Blowout hole (mode) select switch and inner/outer air select switch

Confirm continuity between related terminals below:

Switch position		1	2	3
REC		○	○	
PRISE		○	—	○

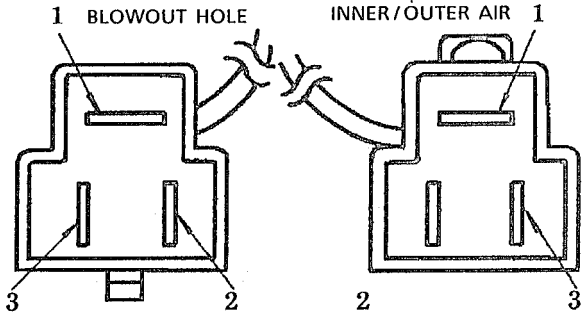
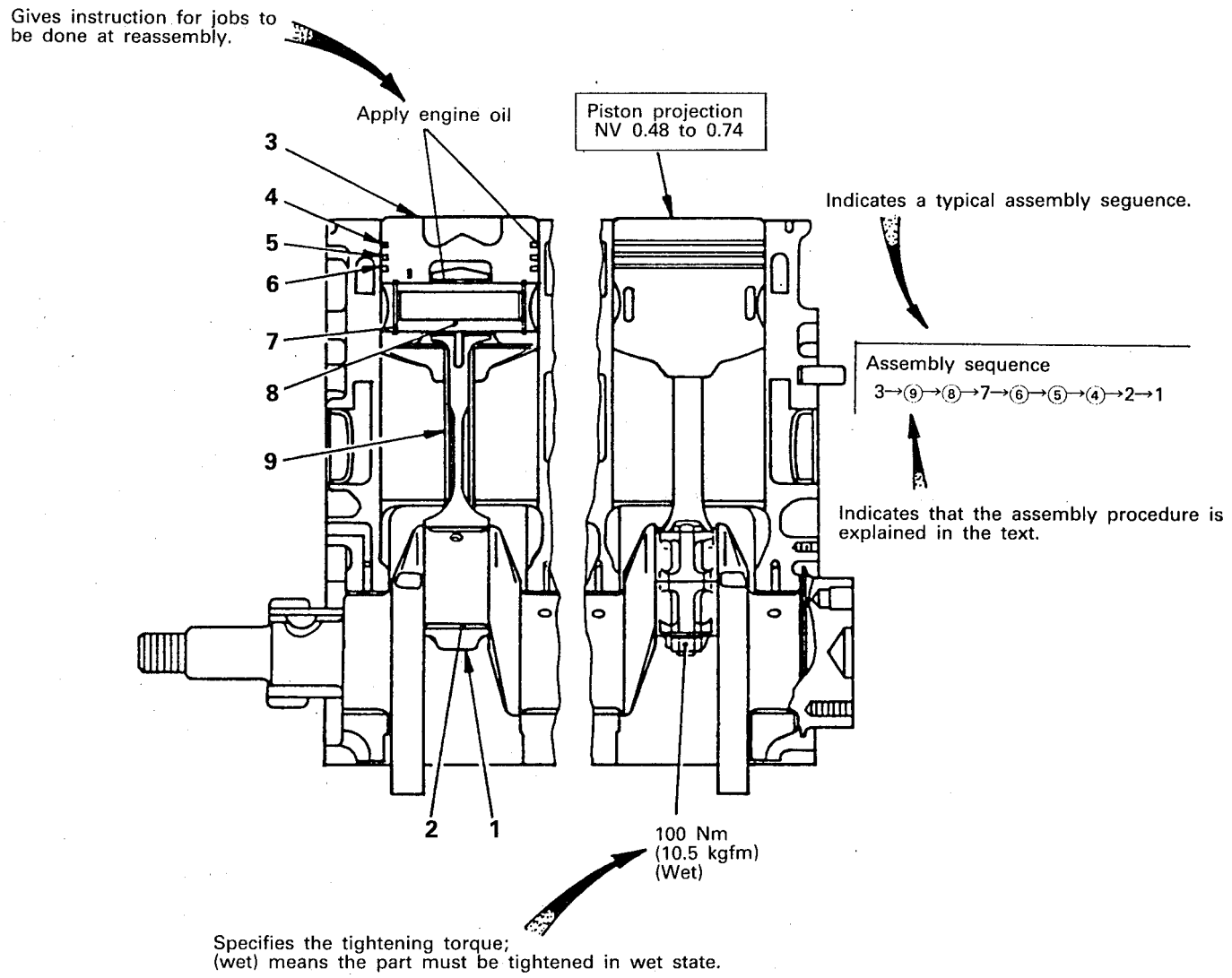


Fig. 48 Checking the blowout hole and inner/outer air select switches

(Ex. 2: Reassembly)



(1) Illustrations (exploded views and assembly drawings) show a typical service procedures if it is identical among various types of available systems and units.

Unit: mm

Maintenence item			Nominal value (Basic diameter in [ ])	Limit	Remedy and remarks
Piston ring to ring groove clearance	1st	6D14	0.09 to 0.13	0.2	Replace piston ring
		6D14-T,	0.05 to 0.10	0.15	
		6D15, 6D15-T	0.08 to 0.11	0.2	
		6D16	0.11 to 0.15		
		6D16-T	0.13 to 0.15		
	2nd	Except 6D14-T	0.05 to 0.08	0.15	
		6D14-T,	0.07 to 0.10		
	Oil ring		0.03 to 0.06	0.15	
Piston ring end gap	1st	6D14, 6D14-T	0.3 to 0.45	1.5	Replace piston ring
		6D15, 6D15-T	0.3 to 0.5		
		6D16, 6D16-T	0.35 to 0.55		
	2nd, Oil ring	6D14 6D14-T, 6D15, 6D15-T	0.3 to 0.5	1.5	
		6D16, 6D16-T	0.35 to 0.55		
Bend and torsion of connecting rod			–	0.05	Correct or replace
Distorsion of crankcase upper surface			0.07 or less	0.2	Grind if it is slight
Cylinder liner	Projection of flange		0.03 to 0.10	–	Replace
	I.D.	6D14, 6D14-T	110 to 110.035	110.25	Correct to oversize or replace
		6D15, 6D15-T	113 to 113.03	113.25	Replace
		6D16, 6D16-T	118 to 118.03	118.25	
	Cylindricity		0.01 or less	–	Correct or replace
Oil jet check valve opening pressure	Except 6D14, 6D15		265 to 325 kPa (2.7 to 3.3 kgf/cm²)	–	Replace
Connecting rod bearing	Oil clearance		[65] 0.06 to 0.11	0.2	Replace
	Tension at free		–	Less than 69.5	
Main bearing	Oil clearance		[80] 0.05 to 0.10	0.15	Replace
	Tension at free		–	Less than 85.5	
Valve clearance			0.4	–	Adjust (on cold engine, both intake and exhaust valves)

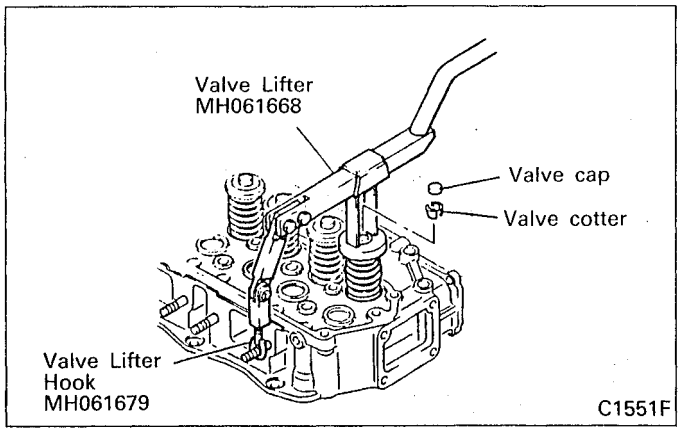
(2) Flywheel PTO

Unit: mm

Maintenence item		Nominal value (Basic diameter in [ ])	Limit	Remedy and remarks
Backlash	Between PTO idler gear A and idler gear	0.12 to 0.26	0.35	Replace
	Between PTO gear and PTO idler gear B	0.12 to 0.26	0.35	Replace
Total backlash of PTO gear		0.18 to 0.35	–	Adjust by shim or replace
PTO shaft end play		0 to 0.8	–	Replace

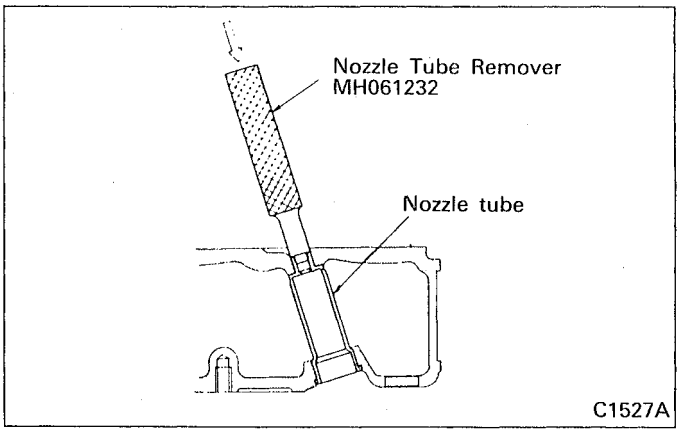
Disassembly

1) Removal of valve cotter



To remove the valve cotter, use the special tool, Valve Lifter, and compress evenly the valve spring.

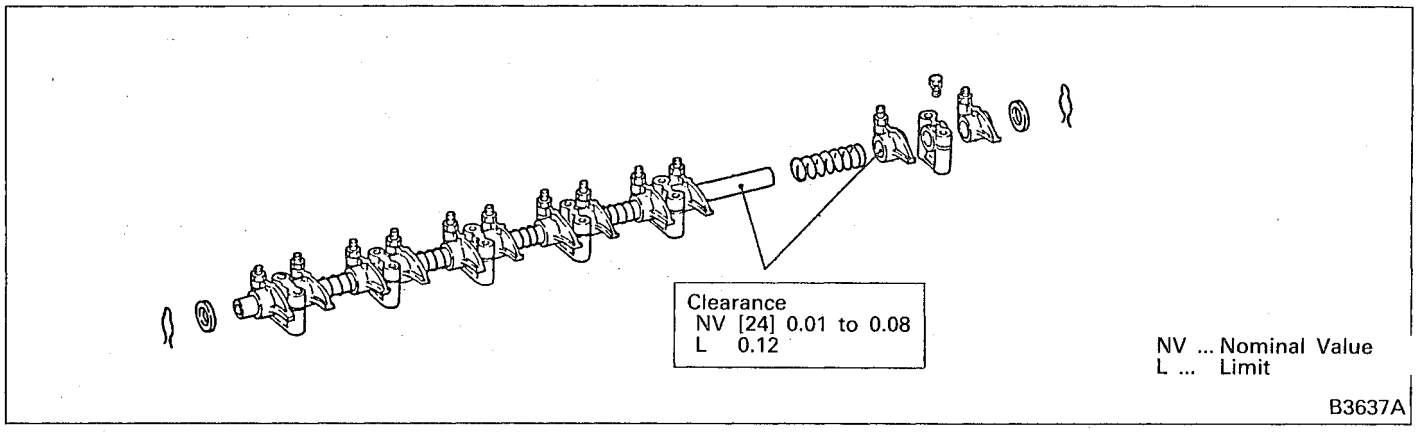
2) Removal of nozzle tube



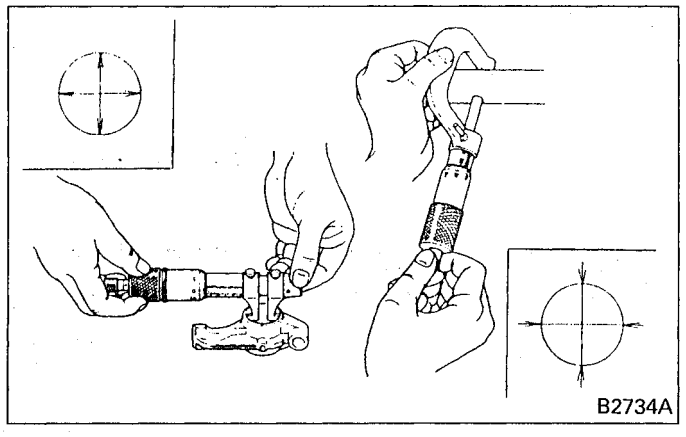
Remove the nozzle tube using the special tool, Nozzl Tube Remover.

(3) Inspection

(a) Rocker and bracket assembly



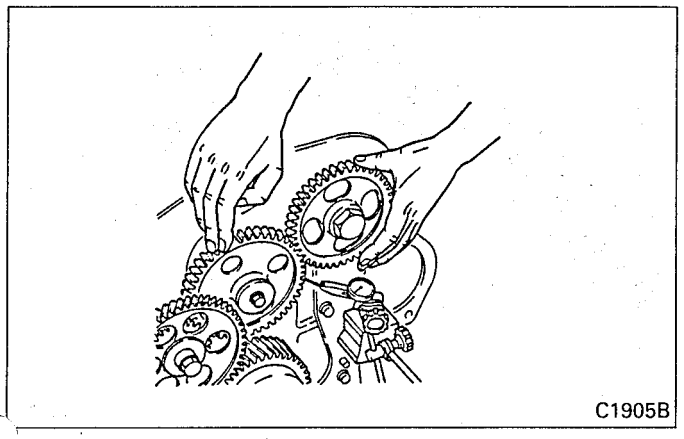
1) Measurement of rocker to rocker shaft clearance



Using the rocker I.D. and rocker shaft O.D., calculate the clearance. If the limit is exceeded, replace the bushing in the rocker using the special tool, Rocker Bushing Puller.

Disassembly

(a) Measurement of backlash

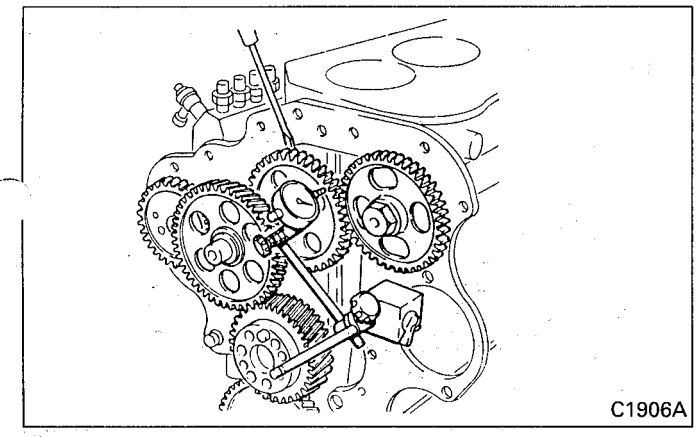


Measure the backlash of the gears and replace them if it exceeds the specified limit.

NOTE:

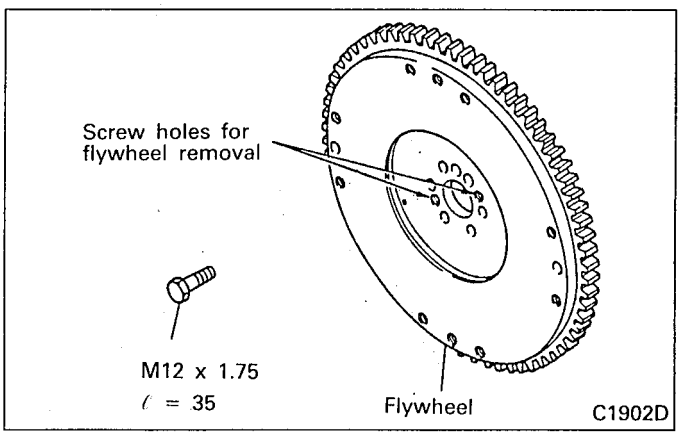
1. **Measure the backlash at three or more points for each pair of gears.**
2. **When measuring backlash with the injection pump drive gear, secure the drive gear to the rear plate.**

(b) Measurement of end play



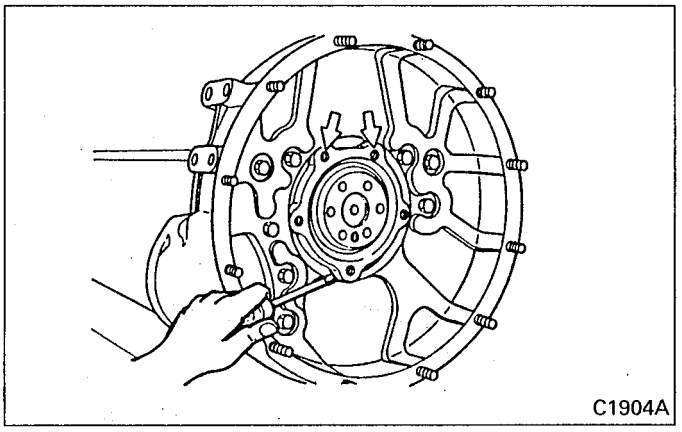
Using a thickness gauge or dial gauge, the measure end play of idler gears No. 1 and No. 2 and the camshaft. If it exceeds the specified limit, replace the part.

(c) Removal of flywheel



Screw bolts uniformly into the removal holes to remove the flywheel.

(d) Removal of oil seal retainer (with PTO only)

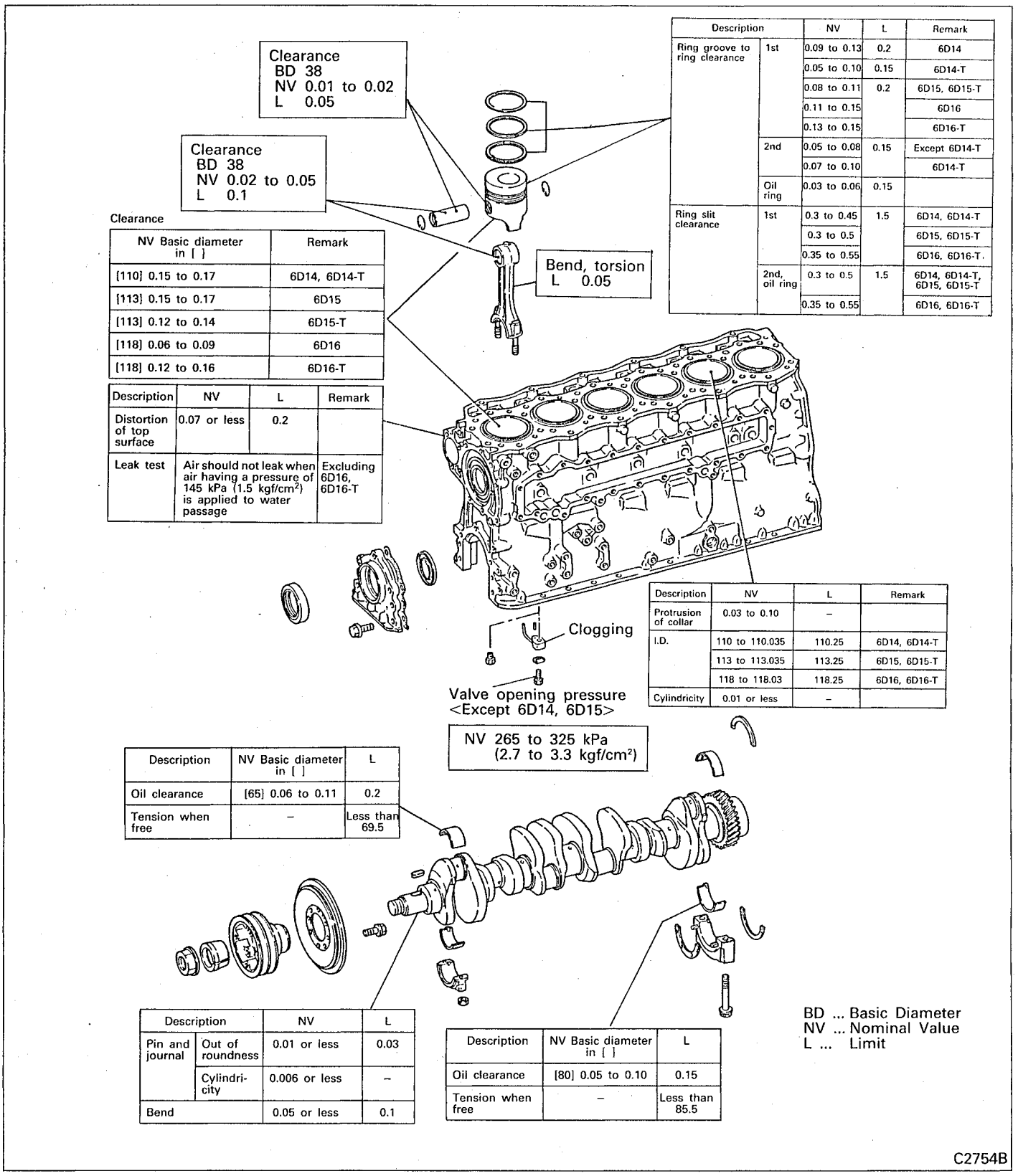


Insert a screwdriver into the three grooves of the oil seal retainer and remove the retainer together with the oil seal.

NOTE:

Remove it slowly so as not to damage the oil seal.

(2) Inspection



Description		NV	L	Remark
Ring groove to ring clearance	1st	0.09 to 0.13	0.2	6D14
		0.05 to 0.10	0.15	6D14-T
		0.08 to 0.11	0.2	6D15, 6D15-T
		0.11 to 0.15		6D16
		0.13 to 0.15		6D16-T
	2nd	0.05 to 0.08	0.15	Except 6D14-T
		0.07 to 0.10		6D14-T
	Oil ring	0.03 to 0.06	0.15	
Ring slit clearance	1st	0.3 to 0.45	1.5	6D14, 6D14-T
		0.3 to 0.5		6D15, 6D15-T
		0.35 to 0.55		6D16, 6D16-T
	2nd, oil ring	0.3 to 0.5	1.5	6D14, 6D14-T, 6D15, 6D15-T
		0.35 to 0.55		6D16, 6D16-T

Clearance

NV Basic diameter in [ ]	Remark
[110] 0.15 to 0.17	6D14, 6D14-T
[113] 0.15 to 0.17	6D15
[113] 0.12 to 0.14	6D15-T
[118] 0.06 to 0.09	6D16
[118] 0.12 to 0.16	6D16-T

Description	NV	L	Remark
Distortion of top surface	0.07 or less	0.2	
Leak test	Air should not leak when air having a pressure of 145 kPa (1.5 kgf/cm²) is applied to water passage		Excluding 6D16, 6D16-T

Description	NV	L	Remark
Protrusion of collar	0.03 to 0.10	–	
I.D.	110 to 110.035	110.25	6D14, 6D14-T
	113 to 113.035	113.25	6D15, 6D15-T
	118 to 118.03	118.25	6D16, 6D16-T
Cylindricity	0.01 or less	–	

Description	NV Basic diameter in [ ]	L
Oil clearance	[65] 0.06 to 0.11	0.2
Tension when free	–	Less than 69.5

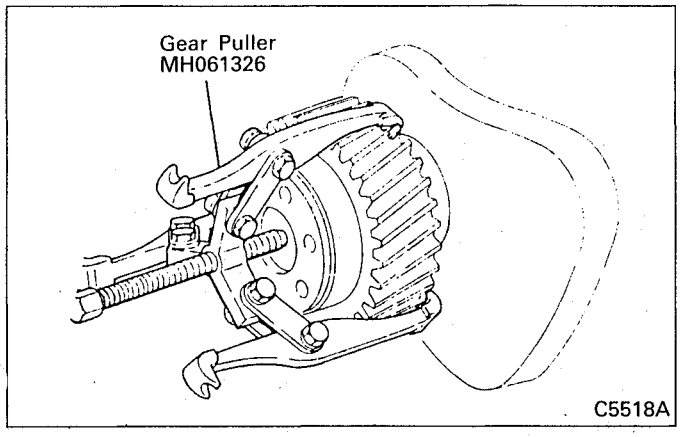
Description		NV	L
Pin and journal	Out of roundness	0.01 or less	0.03
	Cylindricity	0.006 or less	–
Bend		0.05 or less	0.1

Description	NV Basic diameter in [ ]	L
Oil clearance	[80] 0.05 to 0.10	0.15
Tension when free	–	Less than 85.5

(u) Replacement of crankshaft gear

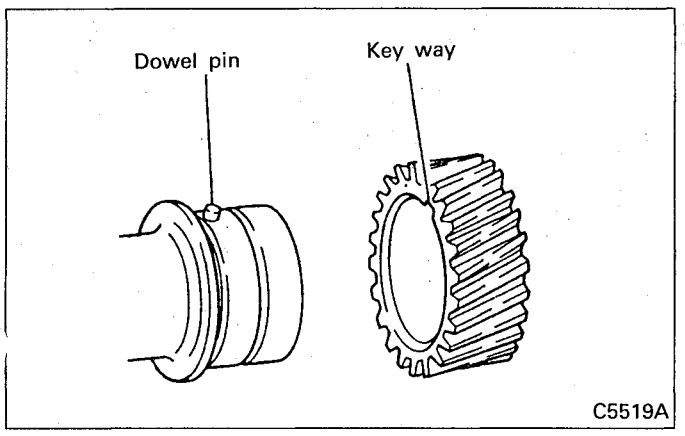
1) Without flywheel PTO

a) Remove the oil seal slinger.



b) Using the special tool, Gear Puller, remove the gear.

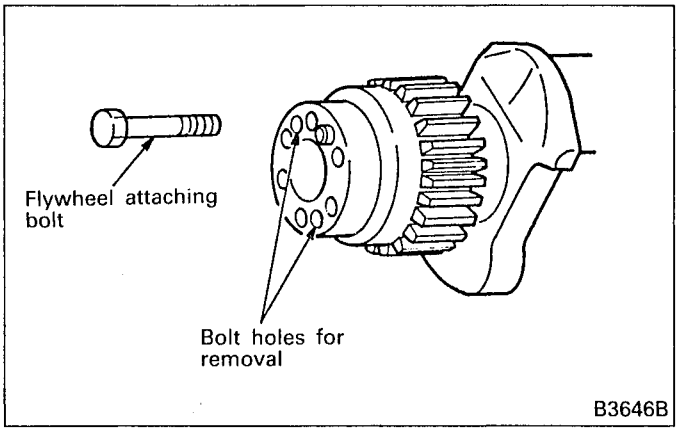
NOTE:
Do not strike the gear to remove.



c) Heat the gear to about 100°C by a heater, etc. Aligning the crankshaft dowel pin with the notch of the gear, insert the shaft into the gear, lightly striking the gear end face with a soft hammer.

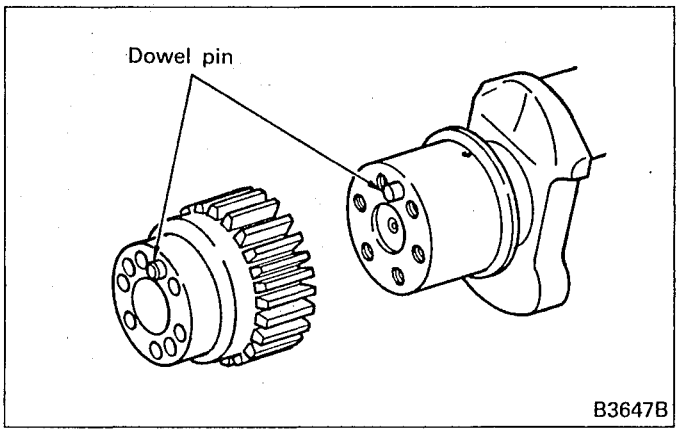
d) Install the oil seal slinger using the special tool, Oil Seal Installer. [Refer to Item (2) - (a), Section 5.1.3.]

2) With flywheel PTO



a) Remove by screwing flywheel attaching bolts uniformly into the bolt holes for removal. Pull out using the special tool, Gear Puller.

NOTE:
Do not remove the gear by striking it.



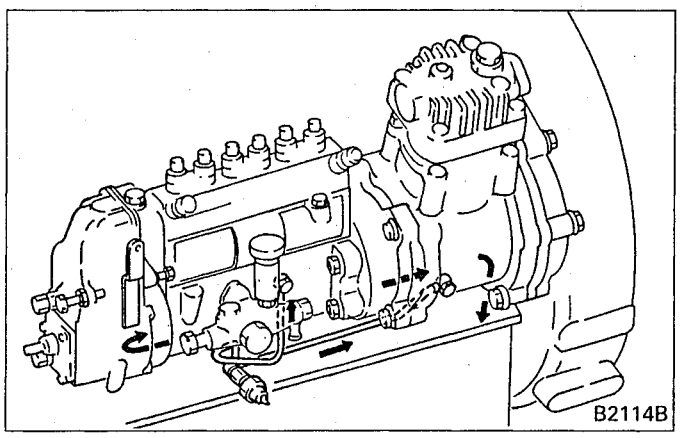
b) Heat the gear to about 100°C by a heater, etc. Aligning the crankshaft dowel pin with the dowel pin hole in the gear, insert the shaft into the gear, lightly striking the gear end face with a soft hammer.

c) Install the sleeve using the special tool, Oil Seal and Sleeve Installer. [Refer to Item (2) - (b), Section 5.1.3.]

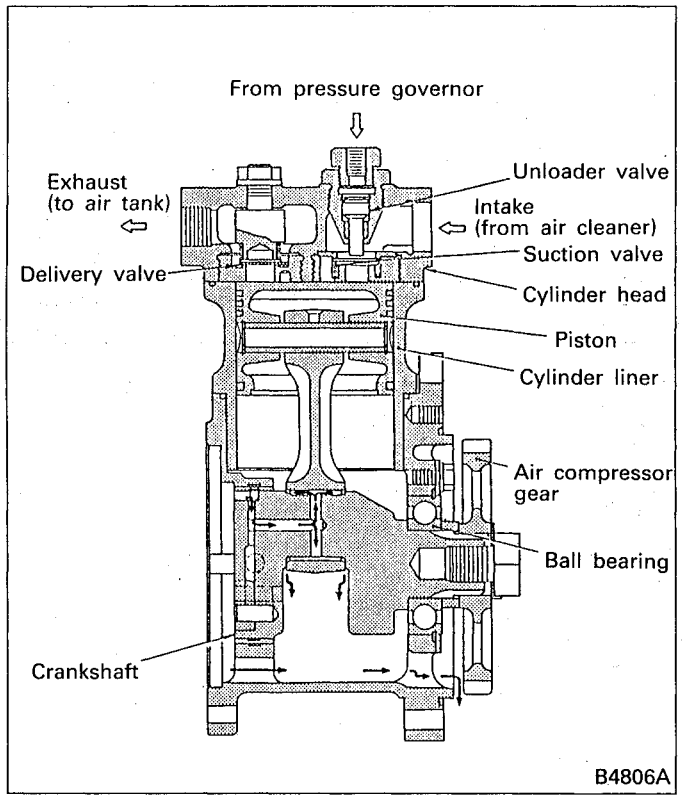
ENGINE – TROUBLESHOOTING

Symptom	Probable cause	Remedy	Ref. group
Improper exhaust color	Inadequate fuel	Adjust	Group 13
	Cooling system not functioning normally	Correct or replace defective part	Group 14
	Intake/exhaust system not functioning normally • Clogged air cleaner	Correct or replace defective part	Group 15
	• Clogged muffler		
	• Oil leaking into intake/exhaust pipes		
	Low compression pressure (see "Engine is hard to start")		
	Defective fuel system • Injection pump not functioning normally	Correct or replace defective part	Group 13
	• Injection nozzle not functioning normally		
	• Incorrect injection timing		
	Too much engine oil	Correct	Group 12
	Seizure of major moving parts	Correct or replace defective part	
Engine lacks power	Inadequate oil viscosity	Replace	Group 12
	Inadequate fuel		Group 13
	Cooling system not functioning normally	Correct or replace defective part	Group 14
	Intake/exhaust system not functioning normally • Clogged air cleaner	Correct or replace defective part	Group 15
	• Clogged muffler		
	Low compression pressure (see "Engine is hard to start")		
	Defective fuel system • Injection pump not functioning normally	Correct or replace defective part	Group 13
	• Injection nozzle not functioning normally		
	• Incorrect injection timing		
	• Air trapped in fuel system parts		
Excessive oil consumption	Oil leaking from lubrication system	Check and correct	Group 12
	Oil leaking from around engine • Defective gasket or oil seal	Replace	
	Oil up • Excessive clearance between cylinder liner and piston due to wear	Correct or replace	
	• Worn, damaged or seized piston ring	Replace set	
	• Clogged oil hole of piston and oil ring	Clean	

(f) Injection pump and air compressor

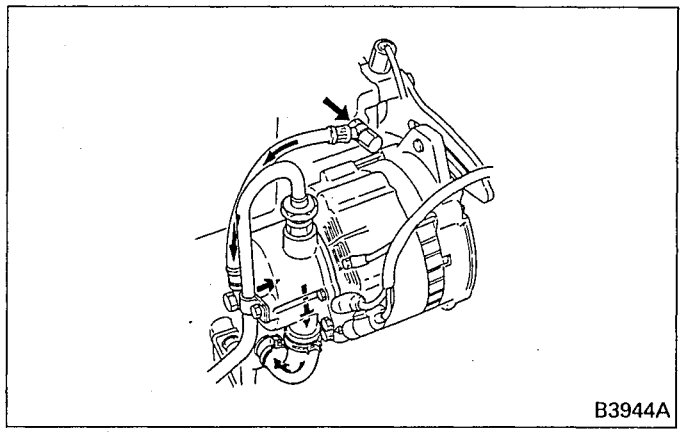


Engine oil is led from the main gallery through oil pipes to the injection pump and air compressor (or pump drive case).
After lubricating the injection pump and governor, engine oil flows through the timer case to the air compressor (or pump drive case).



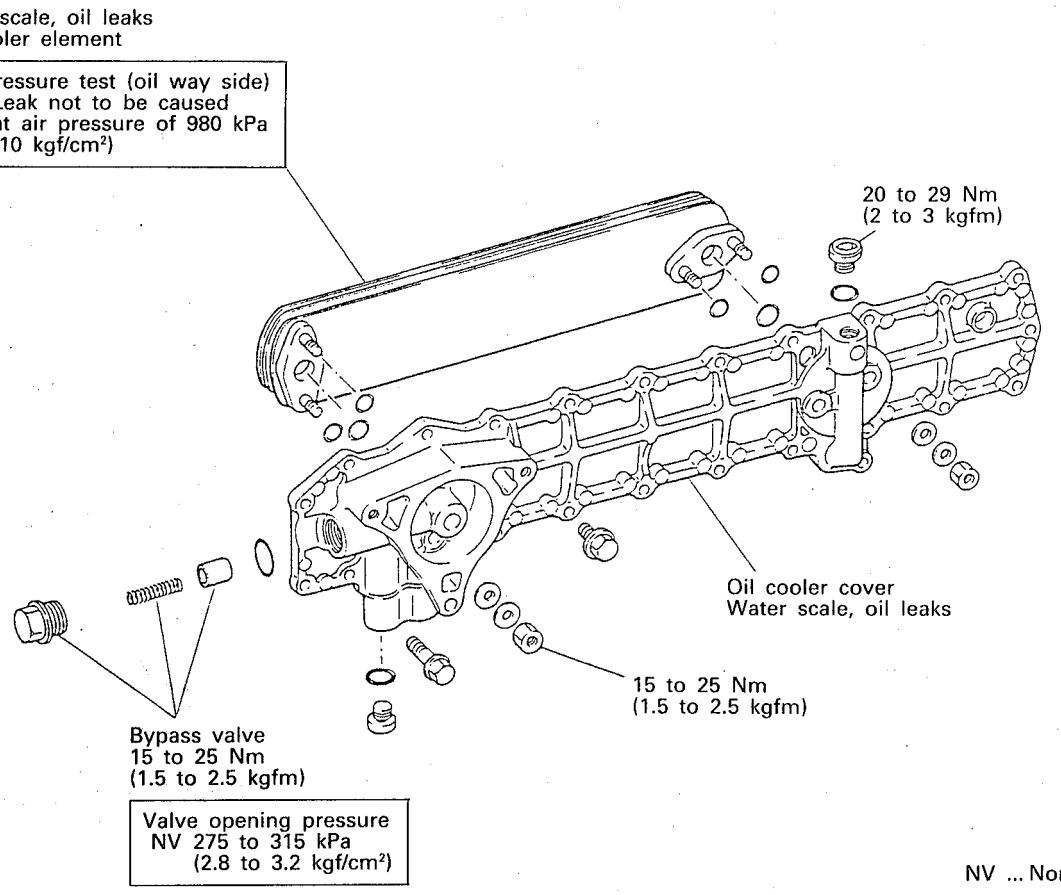
Engine oil that has flown to the air compressor from the main gallery flows through the oil hole in the crankshaft to lubricate the injection pump. It is then combined with engine oil that has lubricated the injection pump and flows through the timing gear train to return to the oil pan.
The piston and connecting rod is splash-lubricated by crankshaft rotation.

(g) Vacuum pump



Part of engine oil for lubrication of the camshaft bushing flows through the flexible hose to the housing where it lubricates the vanes. It then flows back through hose to the oil pan from the outlet at the bottom of the housing.

5.2.3 Oil cooler



(1) Cleaning

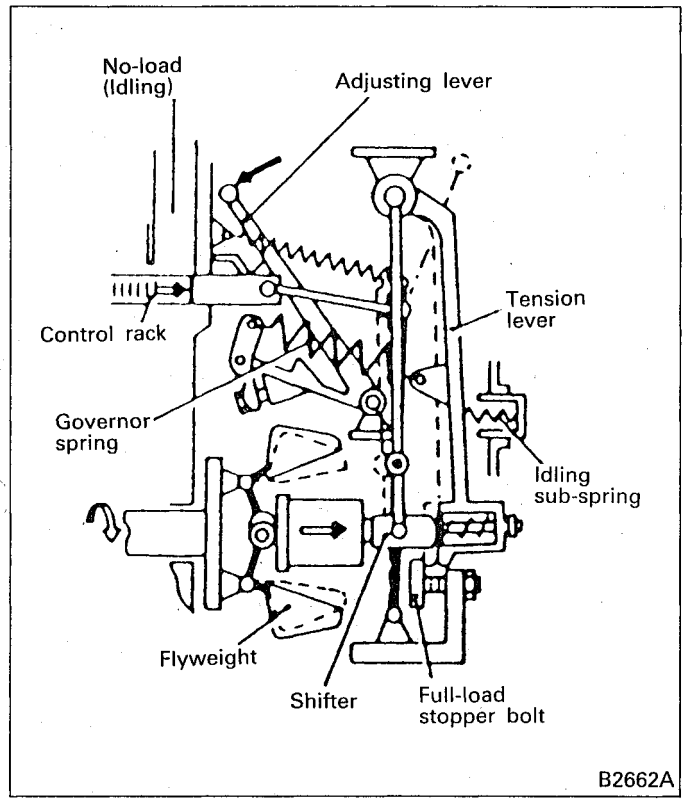
(a) Check for carbon or sludge deposited in the oil passage of the oil cooler element and bypass valve.
If contamination is evident, wash in cleaning oil.

(b) If there is much scale on the element and cover, wash them in water (hot water is preferable).

(2) Air Pressure Test
To check for oil leaks due to a broken or cracked element, air pressure test should be performed. Apply the specified air pressure to the element to check for leaks. If air leaks or other defects are evident, replace the element.

NOTE:
Make sure that the specified air pressure is not exceeded.

3) Maximum speed control



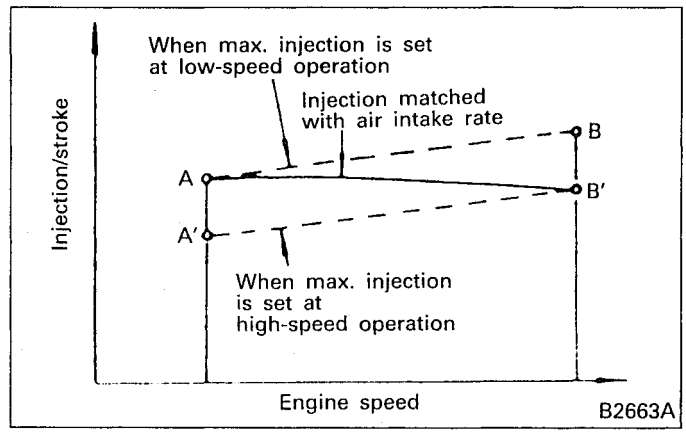
When the adjusting lever is moved to the full-load position, the tension of the governor spring is increased and pulls the tension lever until it touches the full-load stopper bolt.

When the engine exceeds the specified speed, the centrifugal force of flyweights becomes larger than the force of the governor spring pulling the tension lever. So the tension lever is moved to the right and moves the control rack in the direction that fuel is reduced, thereby preventing the engine from exceeding the specified speed.

If the speed further increases, the centrifugal force of flyweight increases and pushes the tension lever to the right and also compresses the idling sub-spring to pull the control rack back to the no-load maximum speed position, thereby preventing over-speed operation of the engine.

The RSV type governor controls the entire speed range from idling to maximum speed. If load increases or decreases at a certain speed determined by the position of the adjusting lever, the governor automatically functions and maintains the engine speed constant at all times.

4) Ungleich operation



The Ungleich device controls fuel injection in such a way as to match the engine performance (the required injection varies with engine speed).

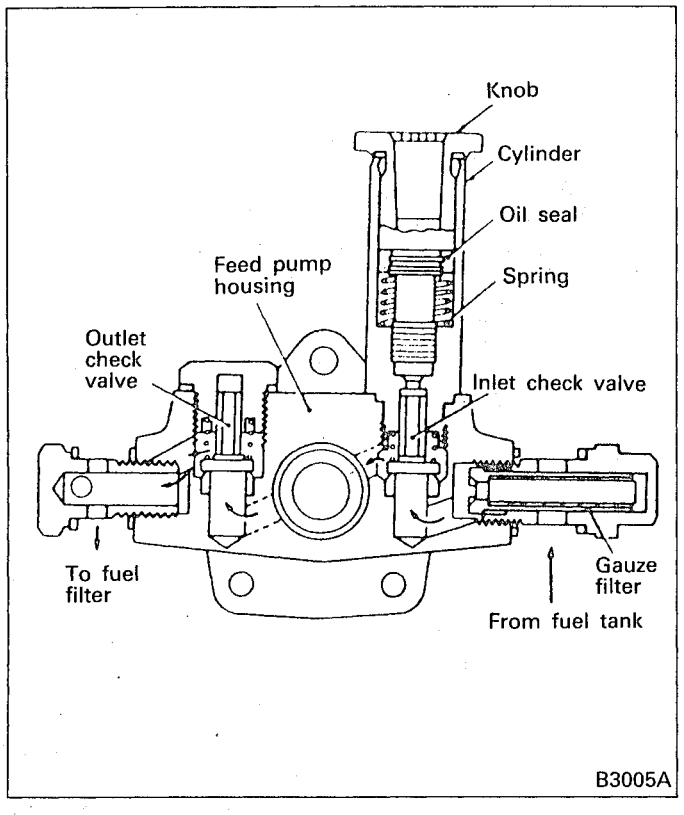
The air intake rate of the engine falls as the engine speed increases. The injection pump, on the other hand, increases the per-stroke injection as the speed increases, even with the control rack at the same position.

Therefore, if full load is set at point A to derive enough output at low speeds, the injection will reach B as the speed increases, and the engine will produce black smoke.

If full load is set at point B' to prevent black smoke, the low speed injection will come down to A', allowing combustion of more fuel.

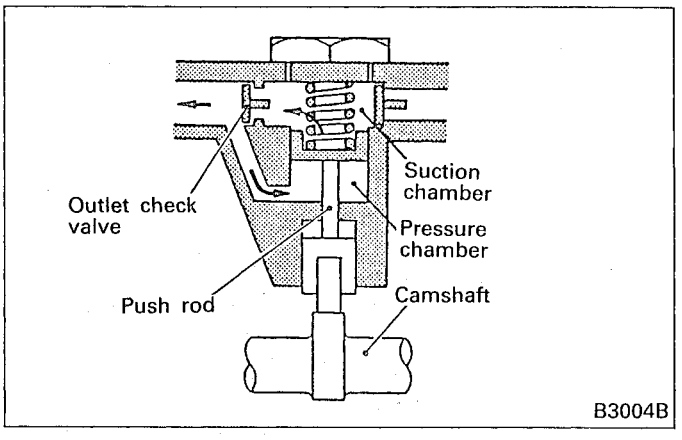
So the Ungleich device accomplishes the function of setting full load at point A to derive the largest possible torque in the low speed range, and changing it to adjust the injection to point B' in the high speed range.

(3) Feed pump



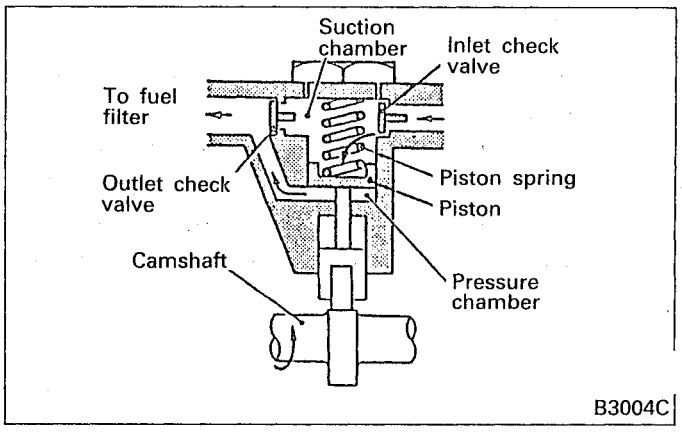
The feed pump is driven by the camshaft of the injection pump.
The priming pump makes it possible to manually lift fuel when the injection pump is stationary, so it can be used in bleeding the fuel system.
The gauze filter removes large particles of dust and dirt contained in the fuel lifted from the fuel tank to prevent clogging in the feed pump. Make sure the gauze filter is cleaned in gas oil at regular intervals.

(a) Suction stroke



When the camshaft of the injecton pump forces th push rod up, the fuel in the suction chamber is compressed and opens the outlet check valve. Most of the fuel forced out is drawn into the pressure chamber above the piston.

(b) Pressure feed stroke



When the cam, moved away by rotation of the camshaft, ceases to push up, the piston is pushed back by the pressure of the piston spring and forces out the fuel from the pressure chamber and forces it into the fuel filter.
At the time, the outlet check valve simultaneously closes, and the inlet check valve opens, so the fuel is drawn into the suction chamber.

(2) Injection pump (Nippondenso products)

Location tightened		Screw size O.D. x pitch (mm)	Tightening torque Nm (kgfm)
Injection pump	Delivery valve holder		34 to 39 (3.5 to 4)
	Screw plug		54 to 74 (5.5 to 7.5)
	Lock plate		7.8 to 11 (0.8 to 1.1)
Governor	Round nut		49 to 59 (5 to 6)
SA type automatic timer	Cover mounting bolt		22 to 24 (2.2 to 2.4)
	Round nut		83 to 98 (8.5 to 10)
	Cap		29 to 49 (3 to 5)
	Plug		13 to 15 (1.3 to 1.5)
SCZ type automatic timer	Round nut		83 to 98 (8.5 to 10)

(3) Injection nozzle (Diesel Kiki products)

Location tightened		Screw size O.D. x pitch (mm)	Tightening torque Nm (kgfm)
1-spring nozzle	Cap nut	M14 x 1	39 to 49 (4 to 5)
	Connector	M14 x 1.5	69 to 78 (7 to 8)
	Retaining nut	M19 x 1	59 to 78 (6 to 8)
2-spring nozzle	Cap nut	M22 x 1.5	39 to 49 (4 to 5)
	Lock nut	M14 x 1	20 to 25 (2 to 2.5)
	Set screw	M22 x 1.5	49 to 59 (5 to 6)
	Retaining nut	M19 x 1	59 to 78 (6 to 8)

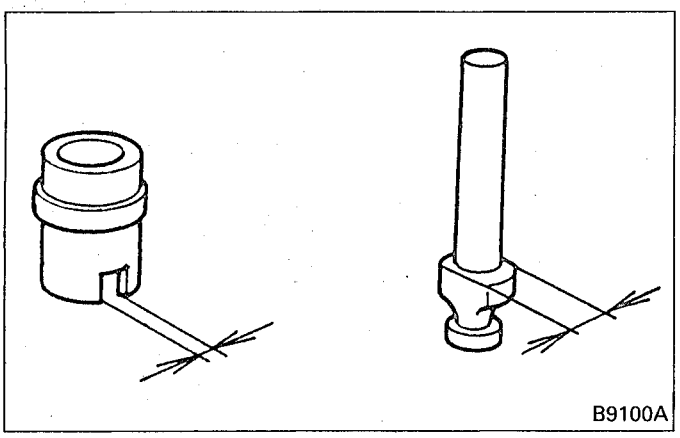
(4) Injection nozzle (Nippondenso products)

Location tightened	Screw size O.D. x pitch (mm)	Tightening torque Nm (kgfm)
Cap nut	M14 x 1	20 to 39 (2 to 4)
Connector	M14 x 1.5	59 to 69 (6 to 7)
Retaining nut	M19 x 0.75	59 to 78 (6 to 8)

(5) Others

Location tightened		Screw size O.D. x pitch (mm)	Tightening torque Nm (kgfm)
Pump drive case	Coupling bolt	M8 x 1.25	30 to 36 (3.1 to 3.7)
	Plate bolt	M8 x 1.25	14 to 18 (1.4 to 1.8)
	Drive gear bolt	M18 x 1.5	165 to 210 (17 to 21.5)
Injection pipe nut		M12 x 1.5	25 (2.5)
Injection nozzle bolt		M8 x 1.25	15 (1.5)
Fuel filter connector bolt		M14 x 1.5	34 (3.5)

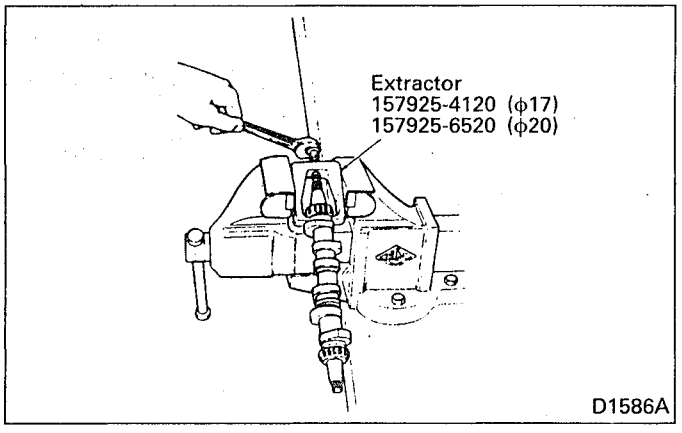
(5) Plunger driving face to control sleeve clearance



Measure the width of the plunger driving face and the groove width of the control sleeve and calculate the clearance. If it exceeds the limit, replace the control sleeve.

(6) Replacement of taper roller bearing
If defect is evident in the bearing, replace by the following procedure.

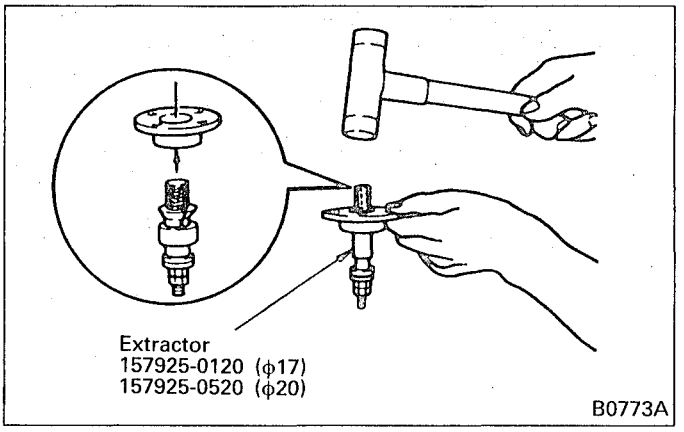
(a) Inner race



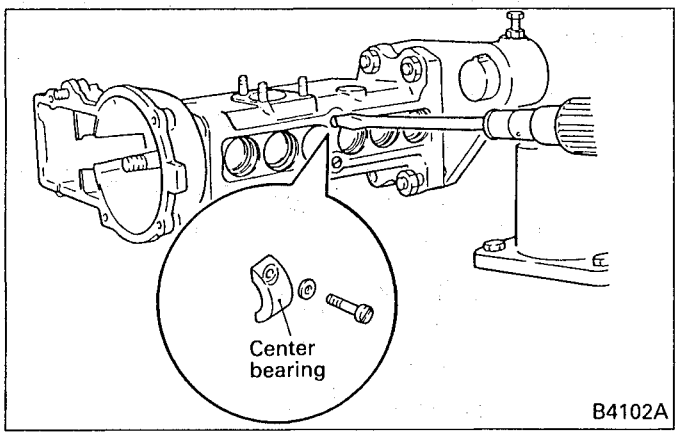
Using the special tool, Extractor, remove the inner race from the camshaft.
To install, press-fit the ring, shim and bearing in the order shown.

NOTE:
Use shims of nearly same thickness on both sides of the camshaft.

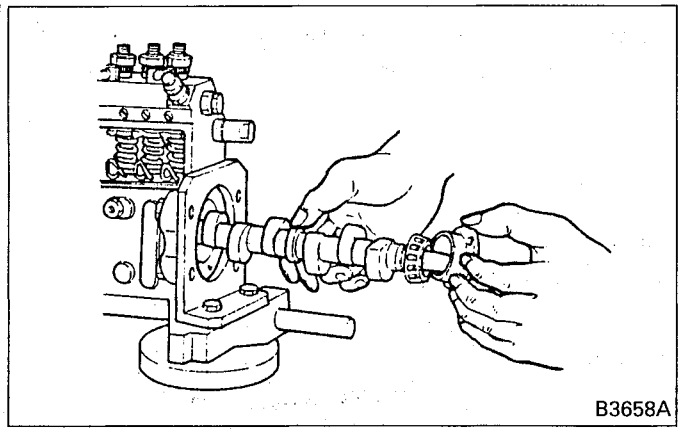
(b) Outer race



Using the special tool, Extractor, remove the outer race.
To install, press-fit using a press.



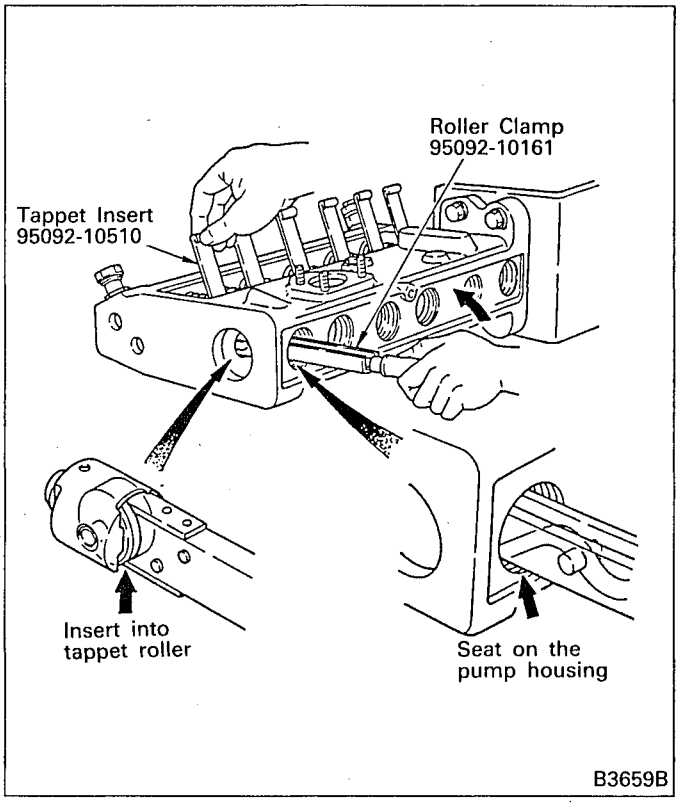
(5) Remove the center bearing.



(6) Tap the camshaft on the governor side to remove it together with the bearing cover.

NOTE:

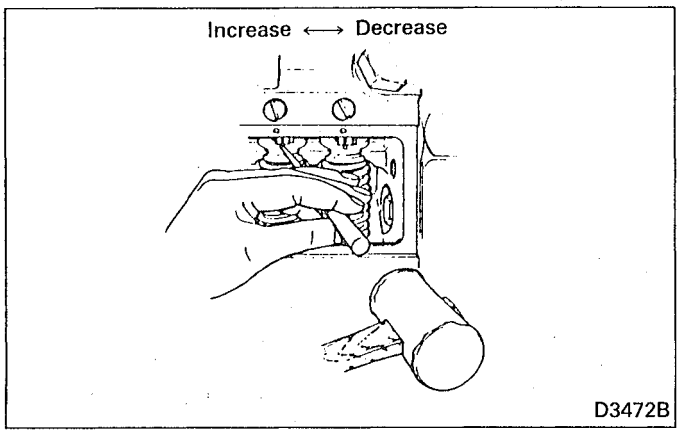
1. **Work carefully so that the camshaft cam will not contact the tappet.**
2. **Fit the flyweight round nut over the camshaft end to protect threads.**



(7) Using the special tool, Roller Clamp, push up the pump housing from the bottom to remove the special tool, Tappet Insert.

(6) Adjustment of fuel injection rate

With the rack at specified position and the engine at specified speed, adjust by the following procedures for nominal fuel injection rate. Install the overflow valve.



(a) Loosen the pinion clamp screw.
(b) With the control rack held in position, turn the control sleeve with the adjusting rod.
(c) Tighten the pinion clamp screw.

NOTE:

1. **Use the special care to make the adjustment. Improper or failure of adjustment greatly influences engine performance.**
2. **The fuel injection rate varies with nozzle and pipe used. Observe measuring requirements strictly.**
3. **Unevenness is the difference between maximum and minimum injection rates of all cylinders.**

(7) Adaptation to engine

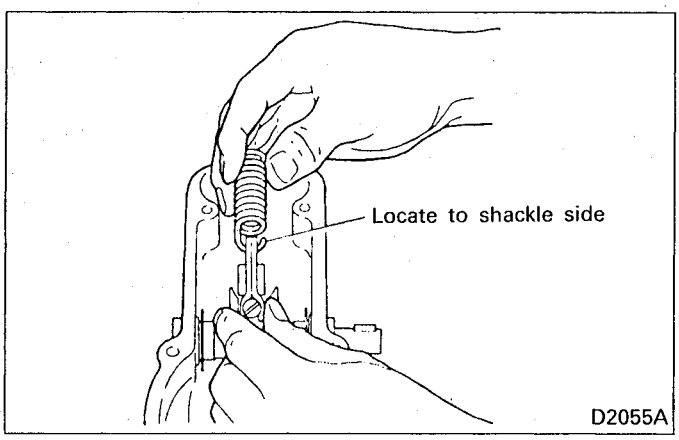
After the governor has been adjusted, check adaptation to the engine and measure the fuel injection rate.

(8) Inspection of gas oil and oil leaks

- Check the delivery valve attaching position and other parts for gas oil leaks.
- Check oil seals and other parts for oil leaks.

(9) Inspection of parts

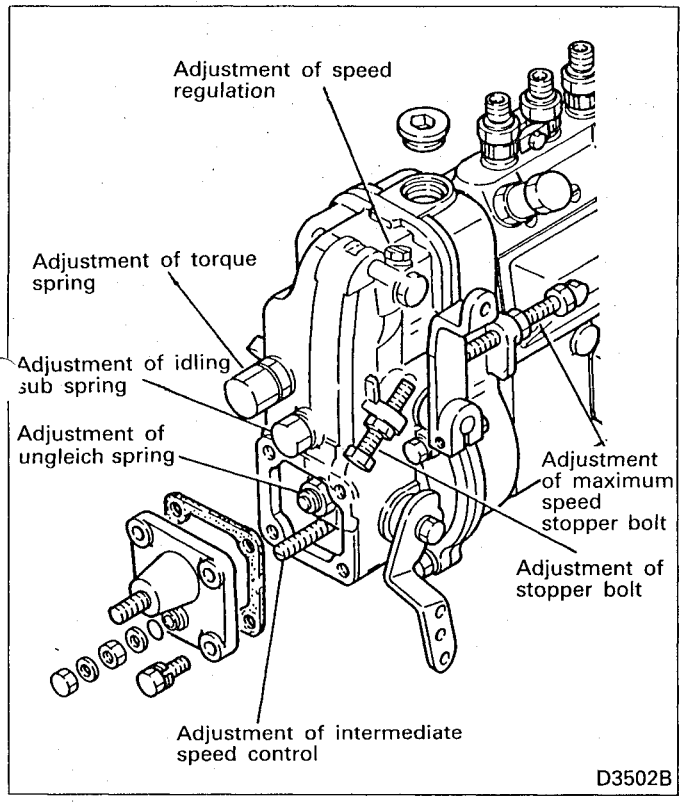
Check parts for unusual noise and bearings for excessive heat.



(2) When installing the governor spring to the swivel lever, position the spring so that its end faces the shackle.

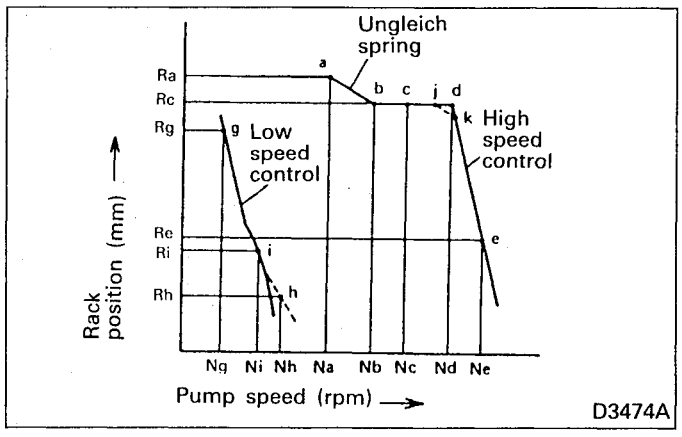
5.5.2 Adjustment after reassembly

For governor performance, curve, see Service Information published separately.



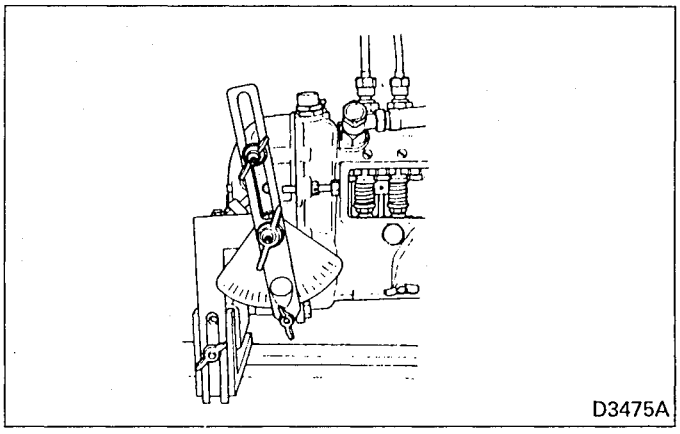
NOTE:

1. **Supply engine oil to the injection pump cam chamber.**
2. **Loosen the adjusting lever stopper bolt.**
3. **Remove the idling sub spring.**
4. **Do not allow the Ungleich spring and torque spring to work.**

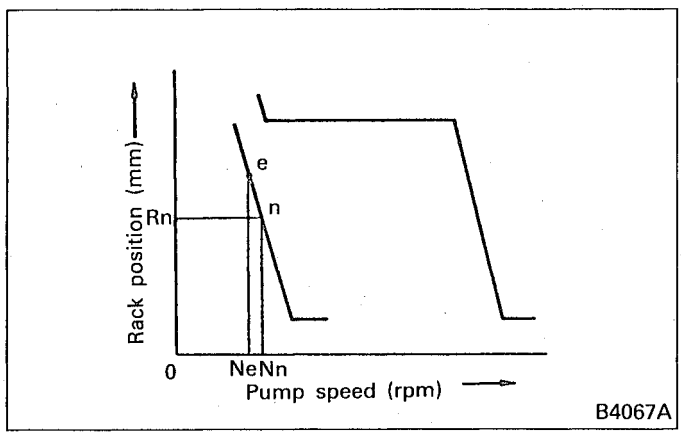


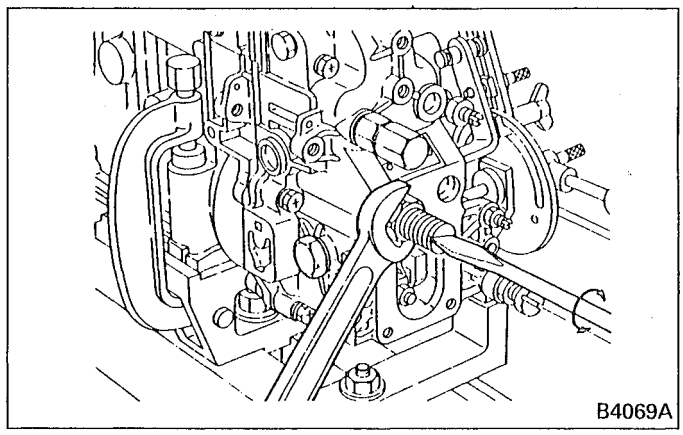
Adjust the relationship between the pump speed and the rack position to specified governor performance curve by the following procedure.

(1) "0" position setting of control rack
[Refer to Item (1), Section 5.3.4.]



(2) Install the angle scale plate for fixing the adjusting lever.

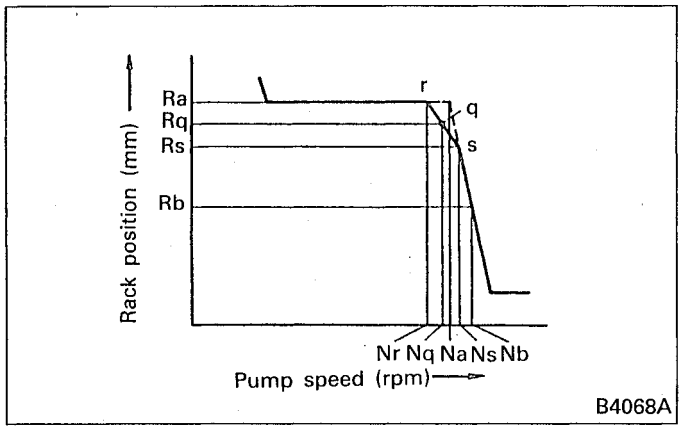




(b) Return the speed control lever to fuel decreasing direction and with the pump running at a speed "Nn" which is a little higher than the idling speed (point e), adjust and fix the stopper bolt so that the rack is positioned at "Rn".

(10)Adjustment of torque spring

(a) Hold the load control lever at the full load position. Hold the speed control lever at the maximum speed position.



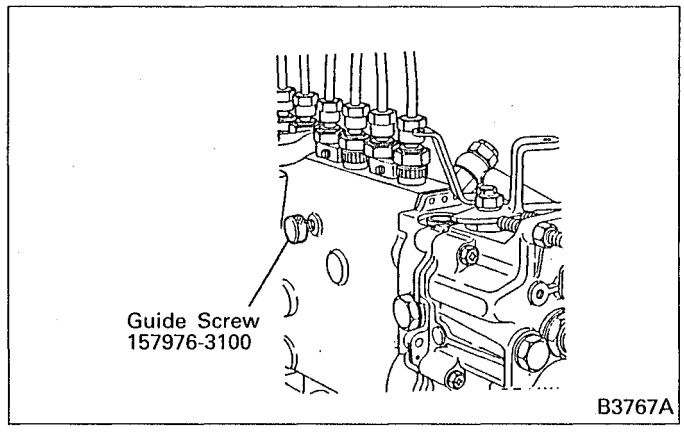
(b) Check that the governor control is started when the pump speed is "Na".

(c) Lower the pump speed slowly from "Nb" and adjust the torque spring tightening amount so that the rack is positioned at "Rq" when the pump speed is "Nq".

(d) When the pump speed is "Nr", the rack should be at "Ra". Also check that the rack is positioned at "Rs" when the pump speed is "Ns".

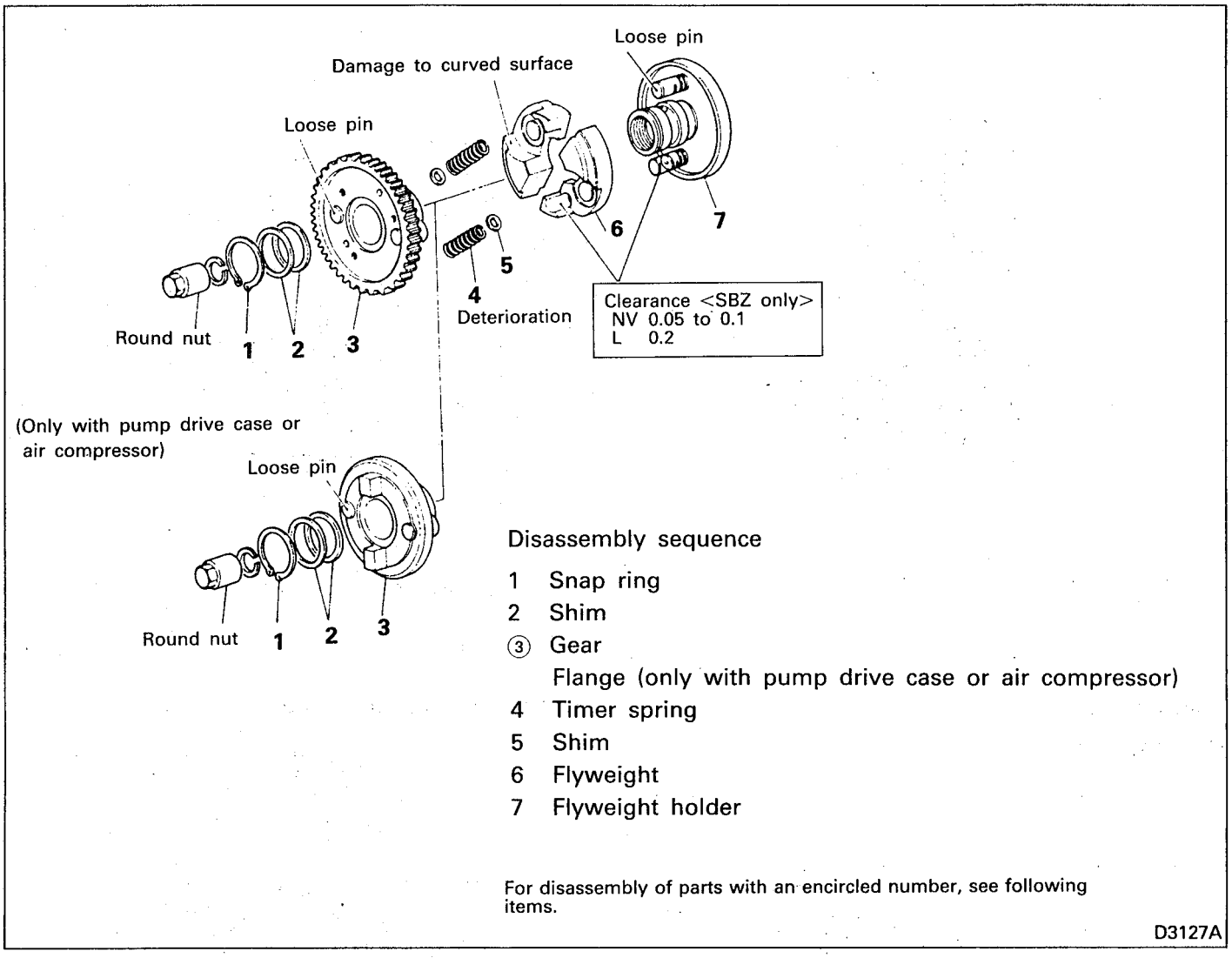
(e) Check fuel injection amount at point q.

(11)Adjustment of rack limit



(a) Remove the guide screw from the back of the pump housing and install the special tool, Guide Screw.

5.10.2 Disassembly and inspection



Disassembly sequence

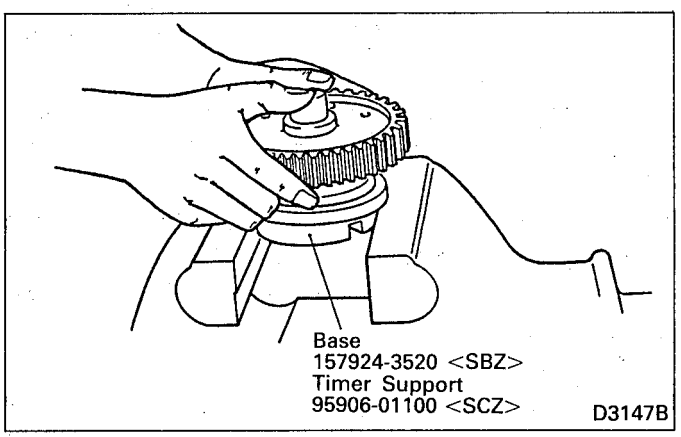
1 Snap ring
2 Shim
③ Gear
Flange (only with pump drive case or air compressor)
4 Timer spring
5 Shim
6 Flyweight
7 Flyweight holder

For disassembly of parts with an encircled number, see following items.

D3127A

Disassembly

Removal of gear or flange

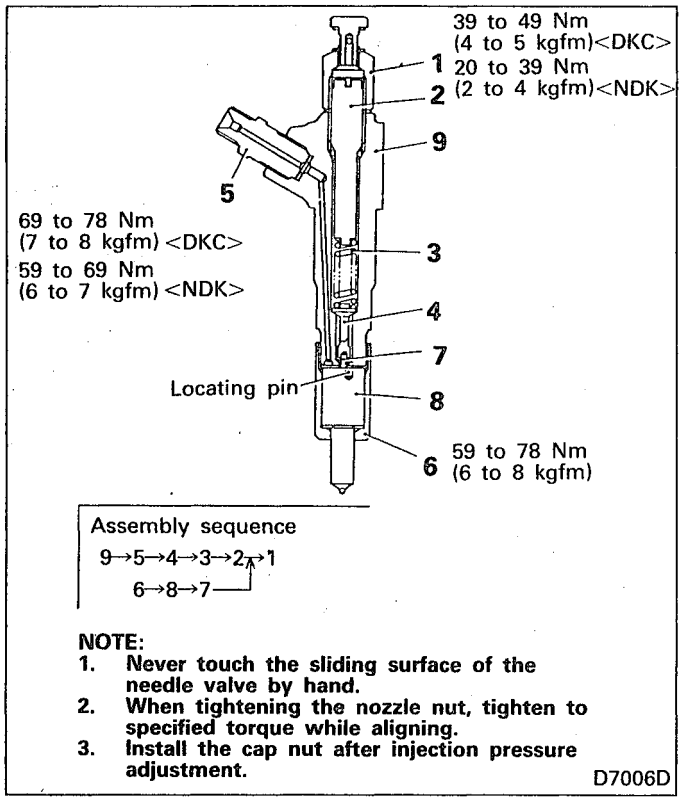


D3147B

Install the automatic timer to the special tool, Base or Timer Support, and turn it in the direction to compress the spring (clockwise). In this state, lift up until the pin clears the flyweight.

Next, pull up the needle valve vertically about 1/3 of its entire stroke and check that it falls under its own weight. If it does not fall, replace the nozzle.

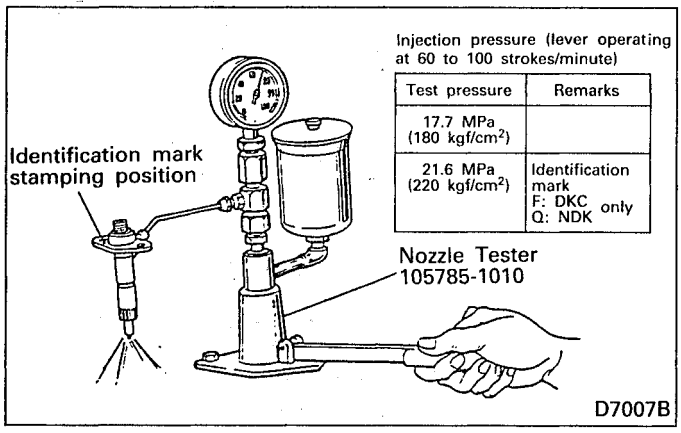
5.14.4 Reassembly and adjustment (1-spring nozzle)



NOTE:
1. **Never touch the sliding surface of the needle valve by hand.**
2. **When tightening the nozzle nut, tighten to specified torque while aligning.**
3. **Install the cap nut after injection pressure adjustment.**

D7006D

(1) Injection pressure



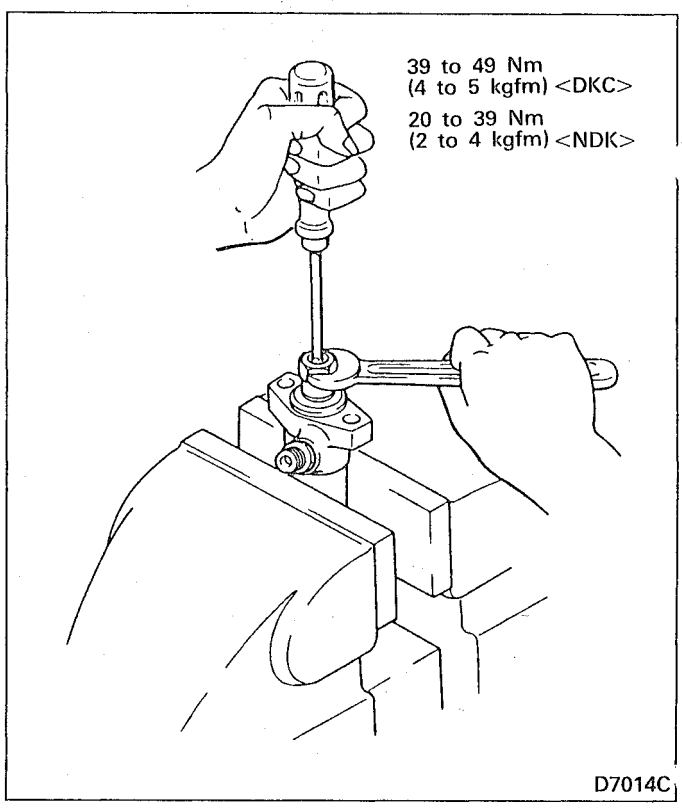
Injection pressure (lever operating at 60 to 100 strokes/minute)

Test pressure	Remarks
17.7 MPa (180 kgf/cm²)	
21.6 MPa (220 kgf/cm²)	Identification mark F: DKC only Q: NDK

D7007B

(a) Remove the cap nut and install to the nozzle tester.
(b) Loosen the adjusting screw and operate the nozzle tester two or three times for bleeding.
(c) Operate the nozzle tester at specified speed, adjusting the adjusting screw for specified injection pressure.

NOTE:
Never let yourself exposed directly to the atomized fuel injected from the nozzle.

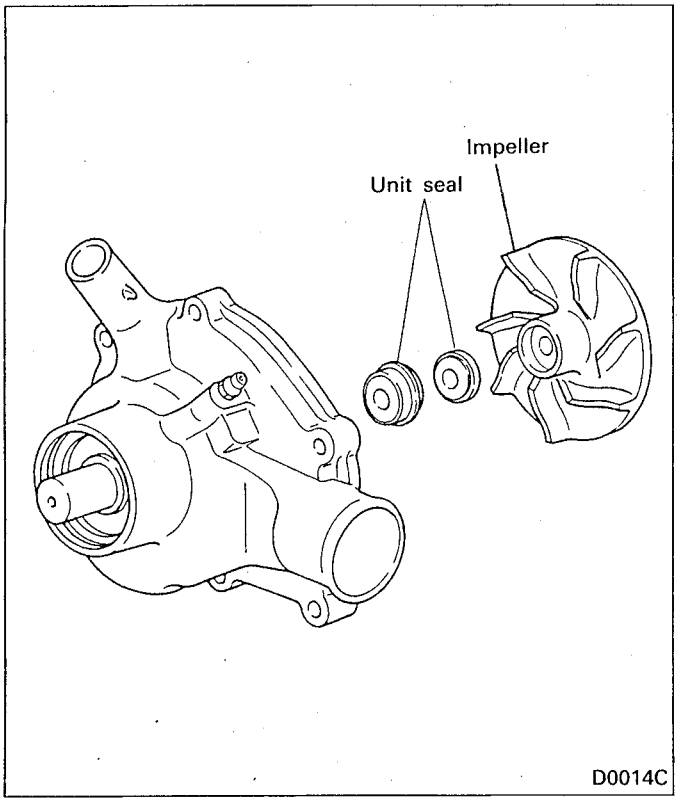


D7014C

(d) After adjustment, tighten the cap nut to specified torque. Fix the adjusting screw with a screwdriver inserted through the cap nut hole to prevent turning of the adjusting screw.
(e) After tightening the cap nut, check again the injection pressure.

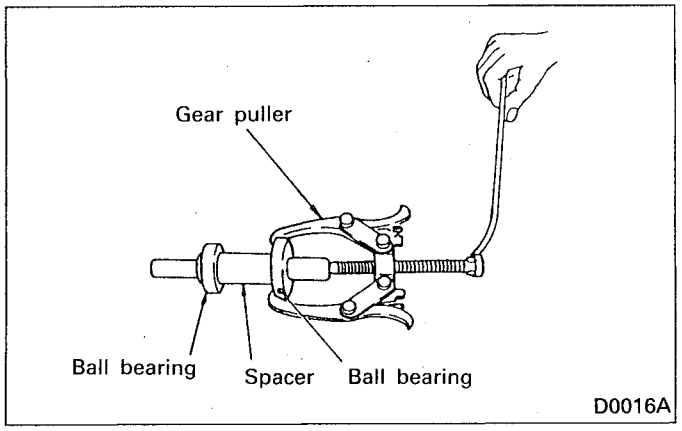
6. TROUBLESHOOTING

Symptom	Probable cause	Remedy	Ref. group
Engine is hard to start	Defective feed pump		
	• Clogged gauze filter	Clean	
	• Check valve inoperative	Replace	
	• Binding or worn piston	Replace	
	• Binding push rod	Replace	
	• Worn tappet	Replace	
	Defective injection pump		
	• Binding or worn plunger	Replace	
	• Binding control rack	Replace	
	• Binding delivery valve	Replace	
	• Worn tappet	Replace	
	• Worn camshaft	Replace	
	Defective injection nozzle		
	• Binding needle valve	Replace	
	• Valve opening pressure too low	Adjust	
	• Clogged injection orifice	Clean	
	• Nozzle not air-tight	Correct or replace	
	Fuel tank empty	Supply fuel	
	Clogged fuel pipe or fuel leak from connections	Correct or replace	
	Air or water trapped in fuel system	Bleed or replace	Group 11
	Clogged fuel filter or secondary filter	Replace	
Engine stops immediately after starting	Clogged fuel filter or secondary filter	Replace	
	Air or water trapped in fuel system	Bleed or replace	Group 11
	Defective feed pump	Check	
Engine knocks	Injection timing too early	Adjust	
	Defective injection nozzle		
	• Valve opening pressure too high	Adjust	
	• Clogged injection orifice	Clean	
	• Nozzle not air-tight	Correct or replace	
	Poor quality fuel in use	Replace	
Smoky exhaust gas and engine knocking	Defective injection pump		
	• Incorrect injection timing	Adjust	
	• Worn plunger	Replace	
	• Defective valve seat of delivery valve	Replace	



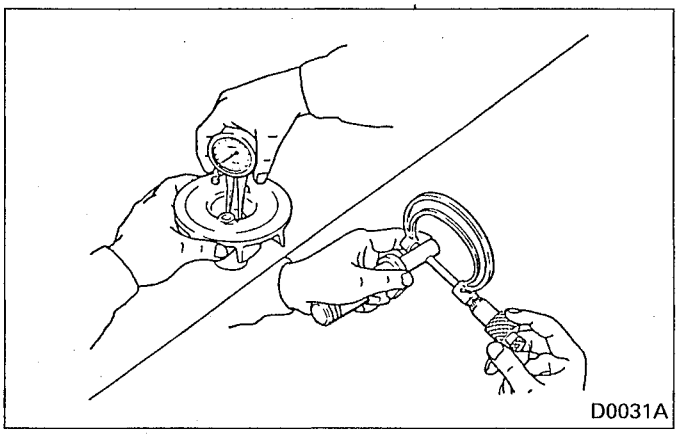
(3) Check the unit seals installed in the impeller and water pump case for damage and wear. If defects are evident, or when water leaks during operation, replace the unit seals with new ones.

NOTE:
Whenever the unit seal is removed, it must be replaced with a new one.



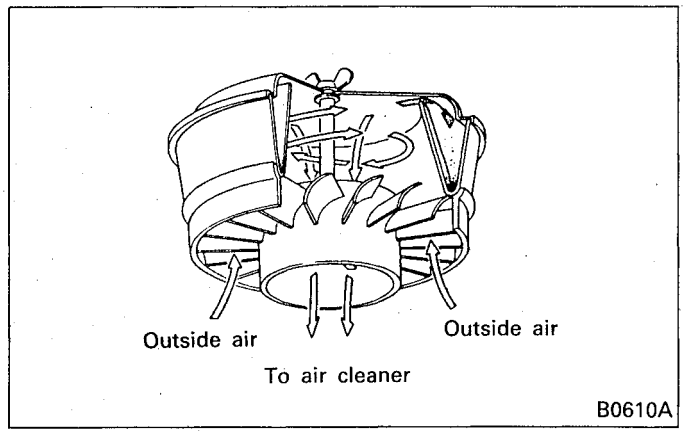
(4) Using a gear puller or press, remove the ball bearings.

NOTE:
Do not remove the ball bearing except for replacement.



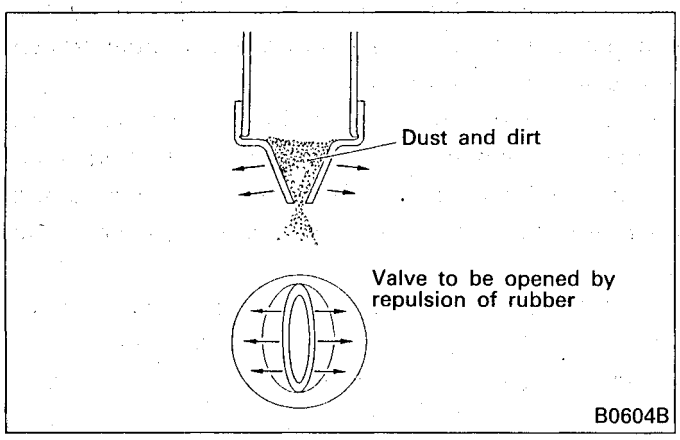
(5) When the impeller and flange are removed from the water pump shaft, it may result in insufficient interference. If the interference is below the specification even reassembly is two times or less they must be replaced with new ones.

(2) Precleaner



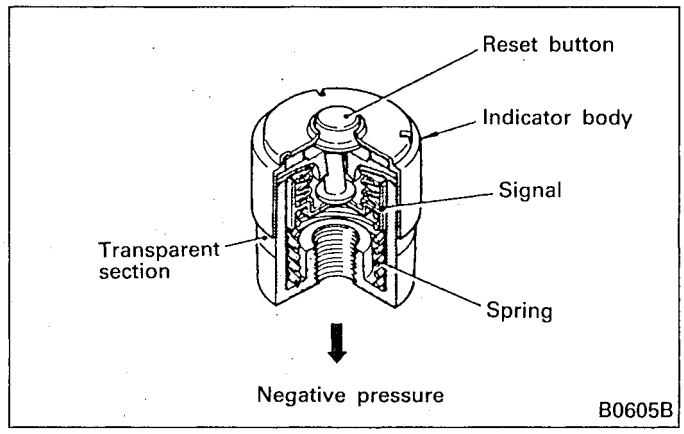
The precleaner, coupled with the air cleaner, collects relatively large particles of dust contained in the air drawn in by engine.
The air entering the precleaner is made to spin by the guide vanes of the precleaner to centrifugally separate large particles of dust before the air is drawn into the air cleaner. These dusts are collected in the precleaner.

(3) Vacuator Valve



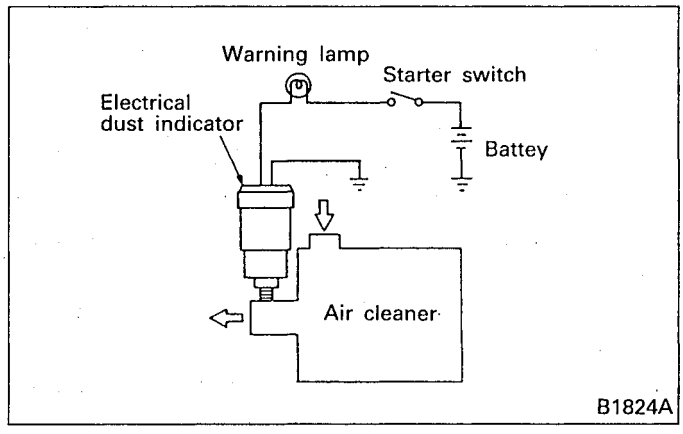
Centrifuged dust collects at the bottom of the air cleaner. A vacuator valve made of rubber is mounted to the bottom, which pulsates to automatically discharges dust and water when the engine speed is below about 800 rpm. Namely when the engine is running at a speed higher than 800 rpm, the negative pressure in the air cleaner keeps this valve closed but when the negative pressure drops as the engine speed decreases, the valve is made to open by rubber action, thereby discharging dust and water.

(4) Dust Indicator



The dust indicator is mounted near the outlet of the air cleaner.
The dust indicator operates on the negative pressure of the air drawn into the engine performing the function of indicating the time to clean or replace the element.
If dust is collected in the element, the suction resistance increases. When the negative pressure reaches 7.47 kPa (762 mmH_2O), the signal is pulled down against the spring pressure, and the transparent portion of the body changes to red, indicating the time to clean or replace the element.
After the element has been cleaned or replaced, depress the reset button on the top, and the signal will return to its original position.

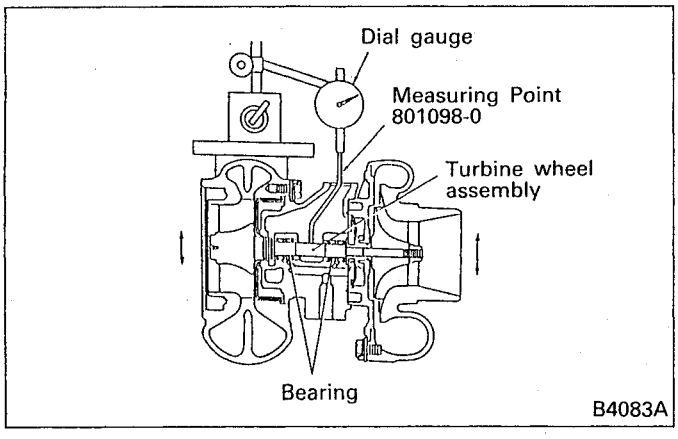
- Electrical dust indicator



In the electric dust indicator, its electric contact points close at a negative pressure of 6.23 kPa (635 mm H_2O) to turn on the warning lamp, indicating to the driver the time to clean or replace the element.

Disassembly Procedure

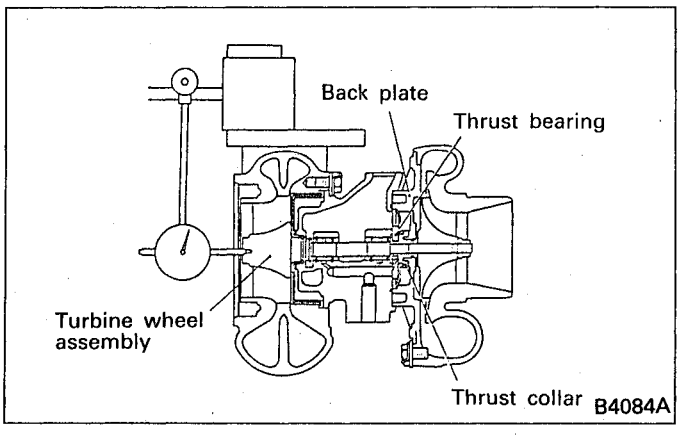
(1) Turbine wheel assembly radial play



(a) Install the special tool, Measuring Point to the dial gauge and insert the Probe through the oil outlet until it squarely contacts the shaft of the turbine wheel assembly.

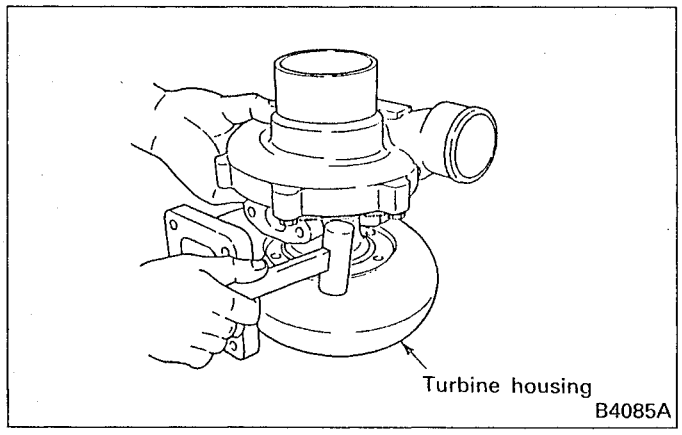
(b) Move up and down the shaft by hands to measure the radial play. If the limit is exceeded, replace the bearing.

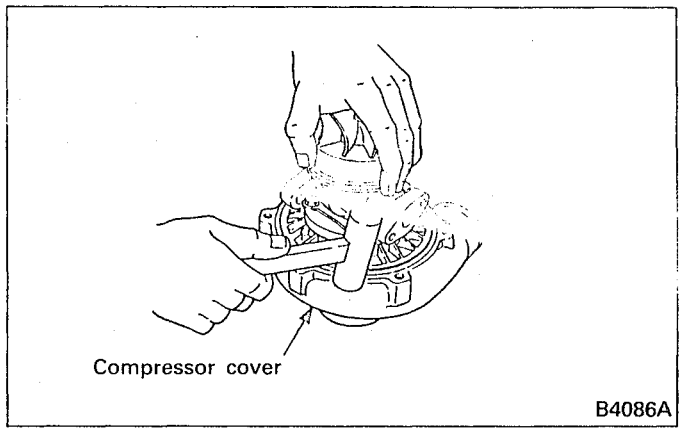
(2) Turbine wheel assembly play in right angle direction



Apply the dial gauge to the end of the turbine wheel and move the shaft axially to measure the play. If the limit is exceeded, worn thrust bearing, thrust collar or back plate is suspected. Replace faulty parts.

(3) Removal of turbine housing and compressor housing



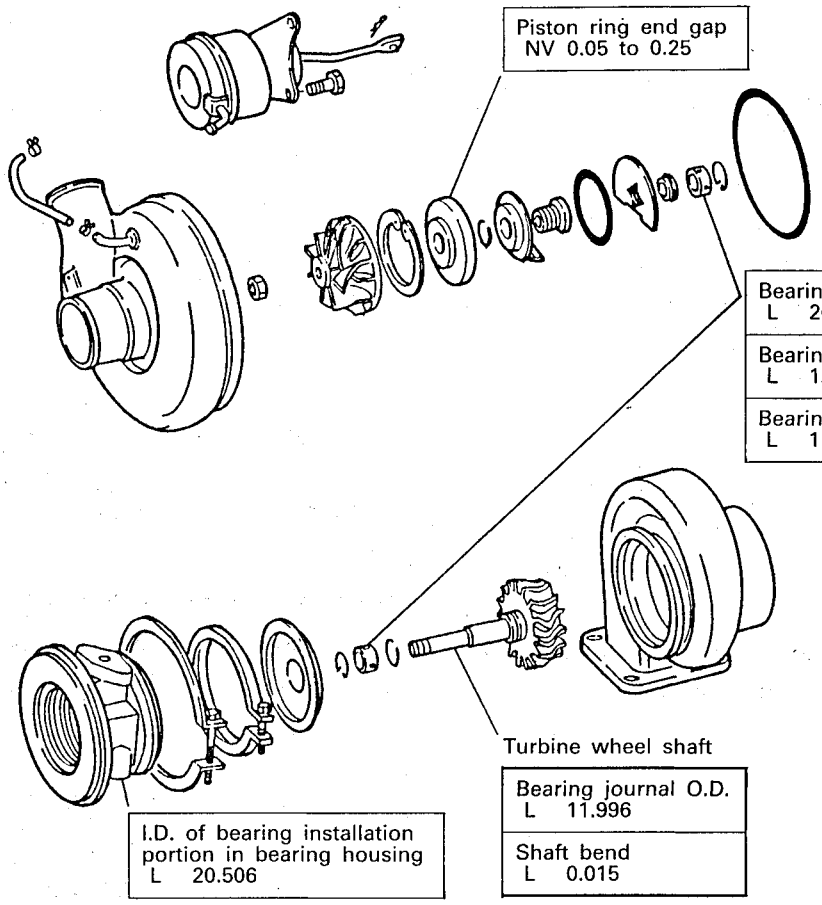


If the housing is hard to remove, tap its outside with a plastic hammer or other tools that will not damage it.

NOTE:

Use care not to damage wheels.

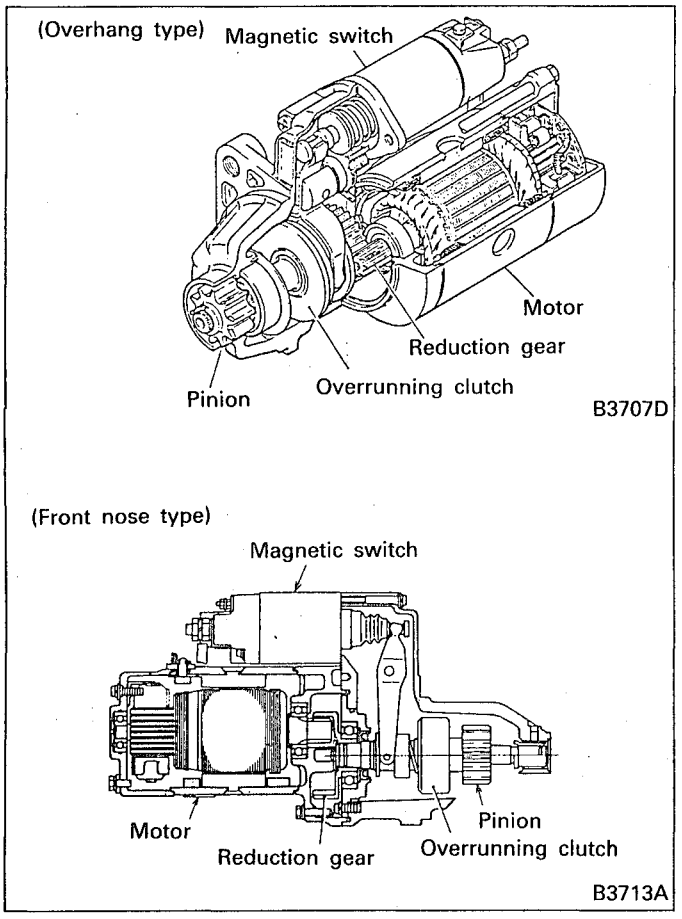
5.4.2 Inspection and cleaning



NOTE:
Before cleaning, visually check the condition of parts, check for burns, wear, and other defects which could not be identified after washing.

C9014D

1.1 Starter

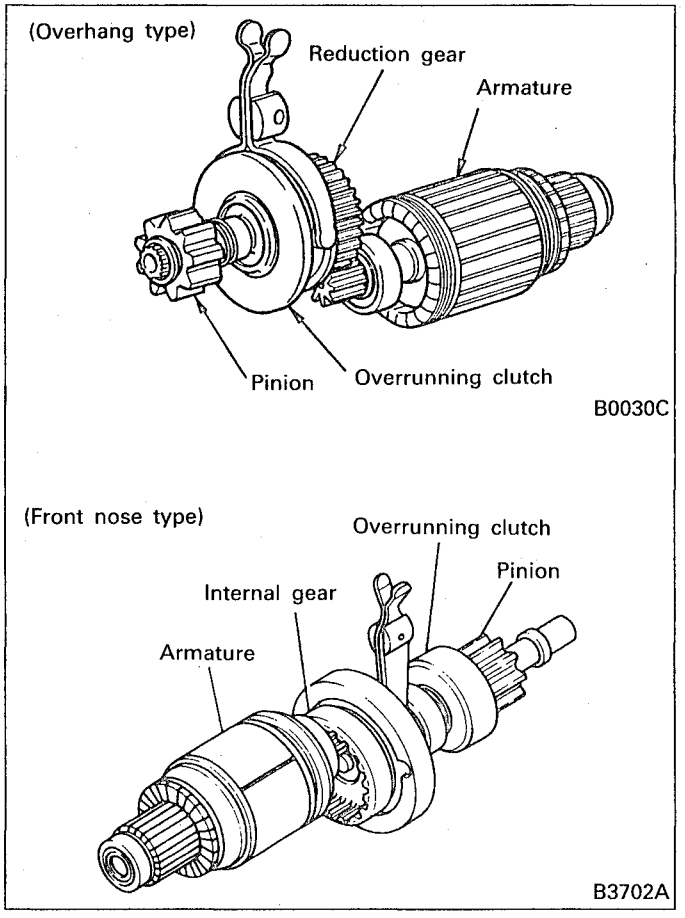


The starter is either an overhang type with the pinion sliding surfaces not exposed to the outside or a front nose type with them exposed to the outside. The overhang type is so constructed as to prevent entry of dust into the inside.

This starter is makes up for loss of torque due to reduced size and higher speed or the motor proper by incorporation of a speed reduction gears. Namely, this starter is a reduction starter.

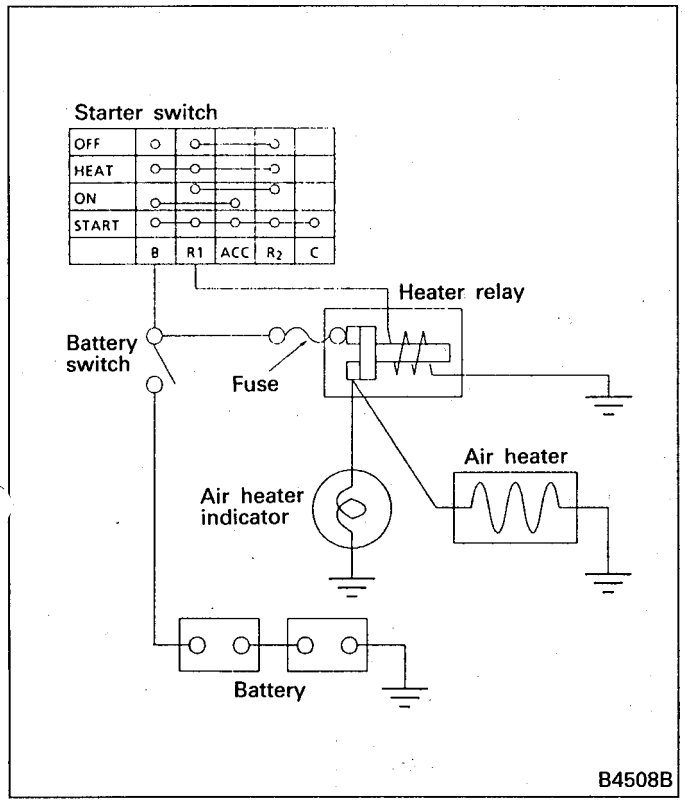
Major components include: the motor that develops torque; overrunning clutch that transmits torque and prevents the starter from overrunning after engine start; magnetic switch that brings the pinion into mesh with the ring gear while turning on/off the load current to the motor; the reduction gear that reduces armature rotation speed and transmits increased torque to the pinion.

(1) Reduction gear



The end of the armature is a gear which is in mesh with the reduction gear so that the armature torque is increased and transmitted to the pinion.

1.5 Intake Air Heater



The intake air heater heats intake air to facilitate engine startup in cold weather.
Set the starter switch to HEAT to energize the intake air heater. When the heater is energized over the specified time, it reaches 800°C or higher and the air heater indicator becomes red-hot to indicates heat state to the driver.

1.6 Automatic Stop Device

If the coolant temperature rises or the oil pressure falls abnormally while the engine is running, this device operates the stop lever of the injection pump governor to cut fuel supply and automatically stops the engine.

(5) Intake air heater

Maintenance item		Nominal value (Basic diameter in [ ])	Limit	Remedy and remarks
Time required for indicator to become red-hot	ME037260, ME037197 (1.83 kW)	40 to 60 sec.		Check
	ME077014, ME077015 (2.86 kW)	20 to 30 sec.		

(6) Automatic stop device

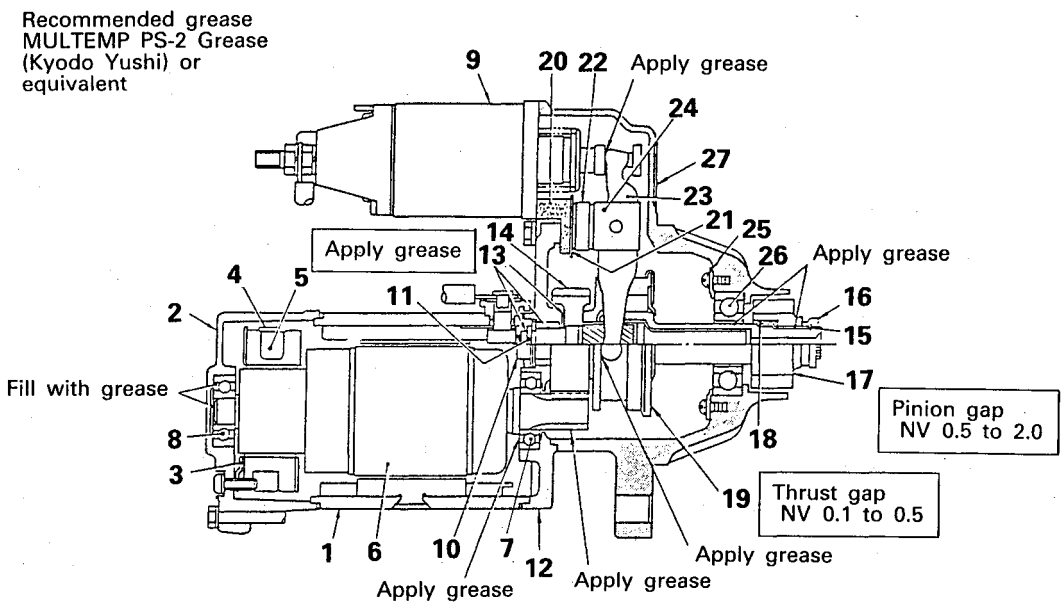
(a) Energize-to-stop type

Unit: mm

Maintenance item				Nominal value (Basic diameter in [ ])	Limit	Remedy and remarks
24 V type	Solenoid	Pointer gap		1.5 to 2.0		Replace
		Stop lever to external stopper clearance		0.4 to 0.5		
		Holding coil current		5 A or less		
	Solenoid relay	Delay time at starting (after 28.5 V applied to terminals A and B)		13 to 23 sec.		Replace
		Delay time at stopping (after 24 V applied to terminal B and no voltage to terminal A)		25 to 35 sec.		Replace
	Thermo switch actuating temperature		30098 – 39300	93 to 97°C		Replace
			30098 – 39400	96 to 100°C		
	Oil pressure switch actuating pressure			69 to 98 kPa (0.7 to 1.0 kgf/cm²) or less		Replace
	Oil pressure switch relay		Rated voltage	24 V		Replace
			Coil resistance	190 to 280 Ω		
			Min. operating voltage	16 V or less		
12 V type	Solenoid	Pointer gap		1.5 to 2.0		Replace
		Stop lever to external stopper clearance		0.4 to 0.5		
		Holding coil current		5 A or less		
	Solenoid relay	Delay time at starting (after 14 V applied to terminals A and B)		13 to 23 sec.		Replace
		Delay time at stopping (after 12 V applied to terminal B and no voltage to terminal A)		25 to 35 sec.		
	Thermo switch actuating temperature		30098 – 39300	93 to 97°C		Replace
			30098 – 39400	96 to 100°C		
	Oil pressure switch actuating pressure			69 to 98 kPa (0.7 to 1.0 kgf/cm²) or less		Replace
	Oil pressure switch relay		Rated voltage	12 V		Replace
			Coil resistance	55 to 100 Ω		
			Min. operating voltage	8 V or less		

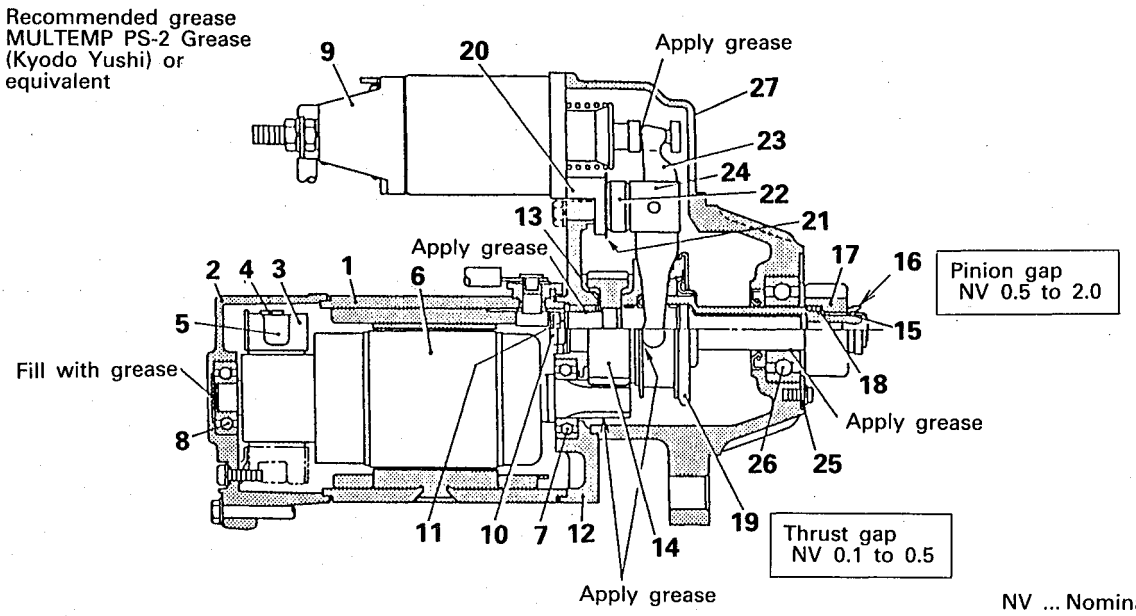
4.1.4 Reassembly

(M3T56072, M3T56073)



D7548B

(M3T56076)



NV ... Nominal Value

Assembly sequence

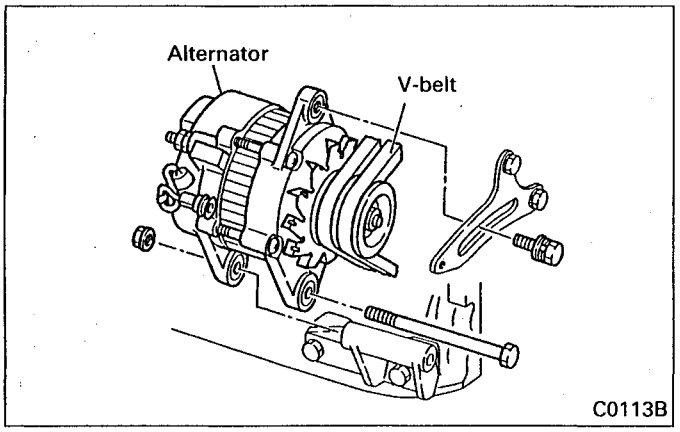
20→21→22→24→㉓→
27→26→25→19→18→⑰→⑯→⑮→14→13→⑫→11→10→⑨→
3→4→5→1→②
⑥→7→8→

For reassembly of parts with an encircled number, see following items

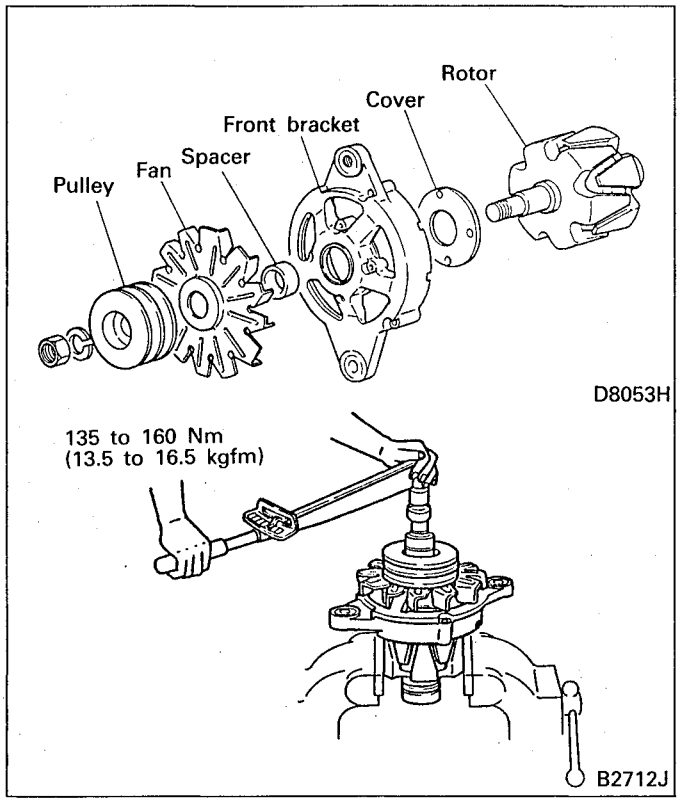
D7558B

4.5 Alternator <A2T72986, A4T57886, A4T57986, A2T32386>

4.5.1 Removal and installation

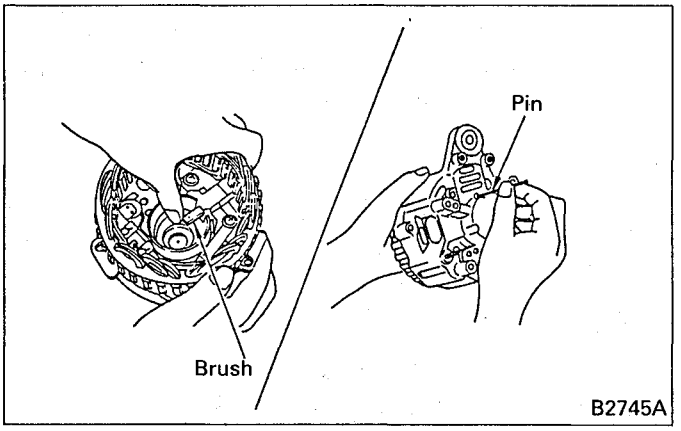


For inspection and adjustment of V-belt tension, refer to Group 14 Cooling.



(b) Install the rotor cover, front bracket, spacer, fan and pulley in the order shown and tighten the nut to specified torque.

(2) Installation of front bracket assembly and rear bracket assembly

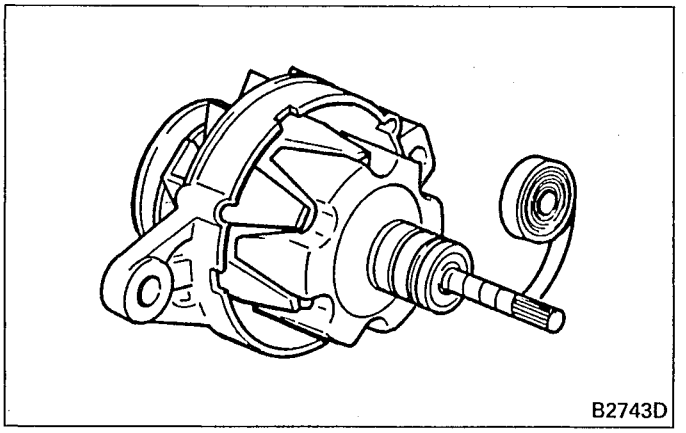


(a) Push in the brush by hand and insert the pin into the brush hole from the rear of the rear bracket to fix the brush.

(b) Noting the spring position of the rotor bearing mounted to the front bracket side, install the rear bracket assembly. [Refer to Item (5) (b), Section 4.3.3.]

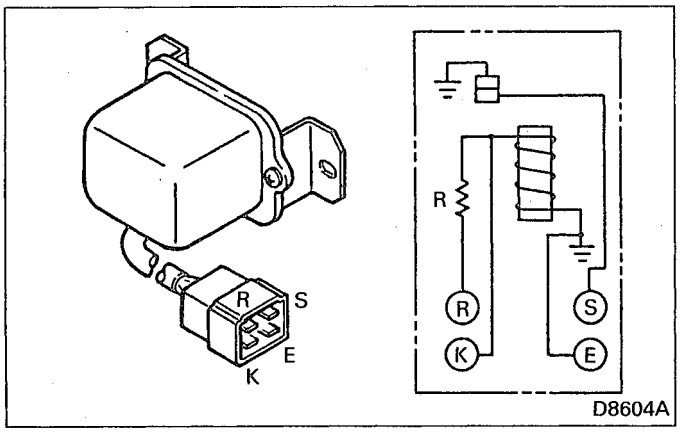
NOTE:

1. **After completion of reassembly, be sure to remove the pin and close the hole.**



2. **In the case of alternator with a vacuum pump, apply, in advance, cellophane tape, etc. to the shaft splines in order to prevent damage to the oil seal.**

(2) Inspection by RX-Q30 Safety Relay Continuity Tester



Measuring point	Normal	Faulty (fault location)
K - E	With continuity	Without continuity (open circuit in coil)
K - R	Approx. 300Ω	Large resistance (open circuit in resistance)
S - E	Zero resistance	With resistance (poor contact)
* S - E	Without continuity	With continuity (fused contact)

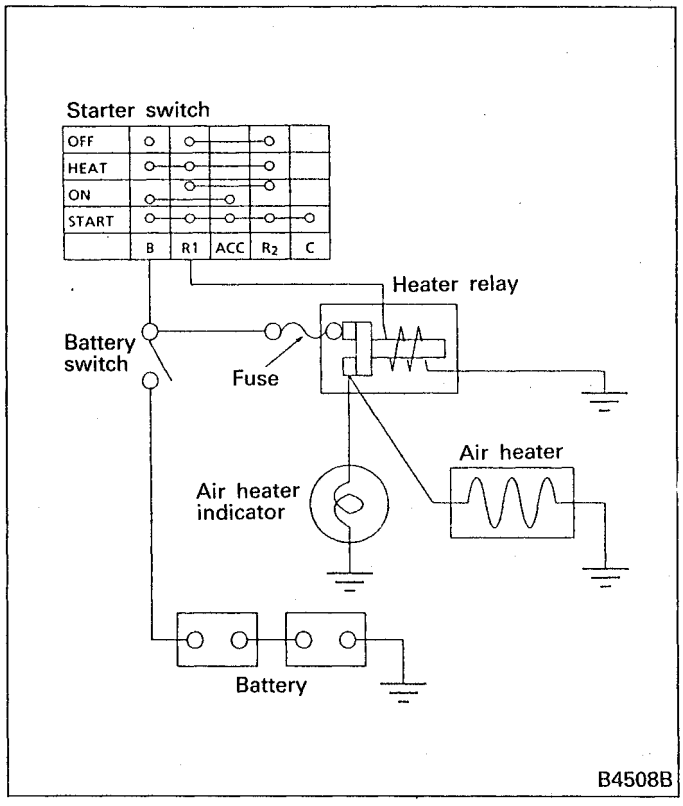
NOTE:
Check between terminals marked with * applying 15 to 17 V between "K" and "E" terminals.

4.10 Preheater

4.10.1 Intake air heater

(1) Removal and installation
(Refer to Group 15 Intake and Exhaust.)

(2) Inspection



Perform the following inspection and check the function of each part or the wiring if necessary.

(a) Time required before indicator becomes red-hot:
Standard time

Nominal value
40 to 60 seconds (ME037260, ME037197: 1.83 kW)
20 to 30 seconds (ME077014, ME077015: 2.86 kW)

(b) Check each terminal of the air heater for looseness and the heater element for damage and contact with other parts.

3. SERVICE STANDARDS

3.1 Service Standards Table

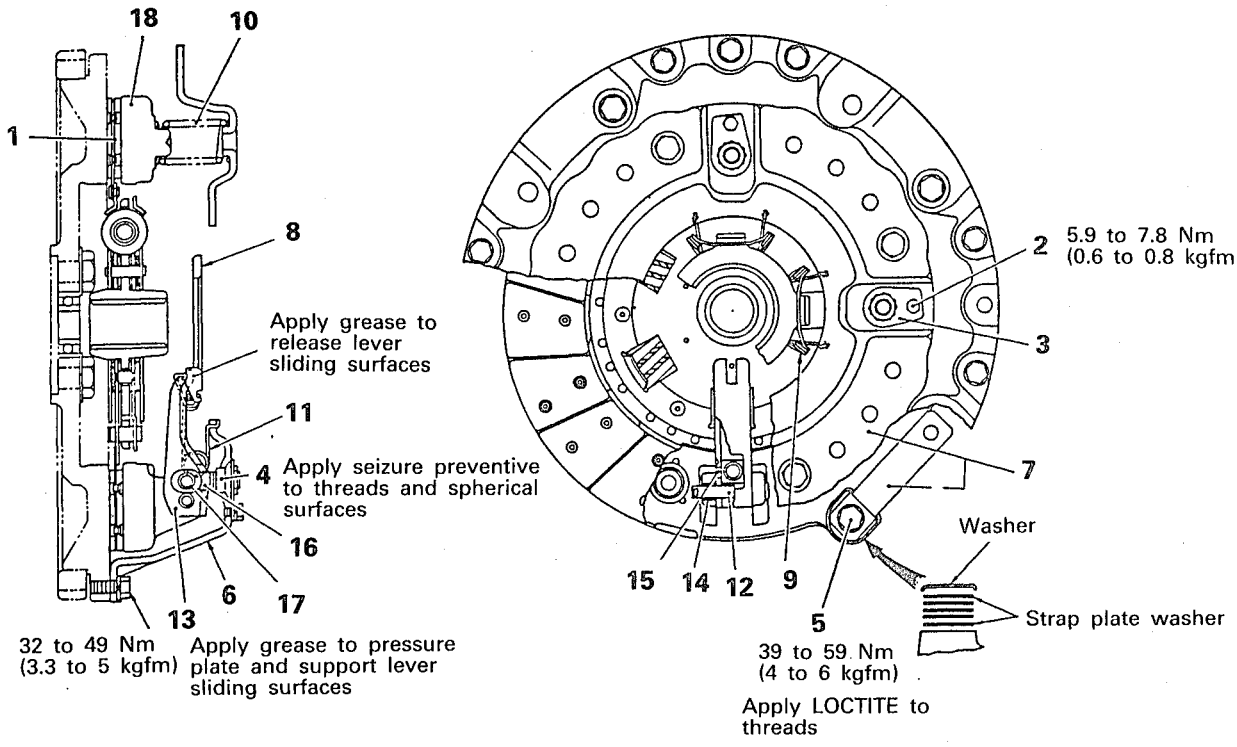
Unit: mm

Maintenance item					Nominal value (Basic diameter in [ ])	Limit	Remedy and Remarks
Clutch proper	Clutch disc	Depth from facing surface to rivet head		C4, C5	1.8 to 2.4	0.2	Replace
				C8	2.2 to 2.8		
		Flatness		C5	0.5 or less		Correct or replace
				C4, C8	0.6 or less		
		Runout	Lateral	C4	1.0 or less		
				C5	1.1 or less		
				C8	1.2 or less		
			Vertical		1.0 or less	1.5	
		Boss spline play in turning direction		C4, C5	0.05 to 0.23	0.5	Replace
				C8	0.04 to 0.11	0.3	
	Pressure plate	Thickness		C4	28.4 to 28.6	26	Replace
				C5	23.5 to 23.7	21	
				C8	33.9 to 34.1	31	
		Flatness			0.05 or less	0.2	Correct or replace
		Strap bolt fitting hole			10.2 to 10.25	10.5	Replace
		Clearance between strap plate and bolt		C4, C5	0.01 to 0.16	0.3	Replace
				C8	0 to 0.15		
	Pressure spring	Installed load/installed length		C4	510 to 565 N (52.25 to 57.75 kgf)/ 48.5	470 N (48 kgf)/ 48.5	Replace
				C5	840 to 930 N (85.69 to 94.71 kgf)/ 49.1	755 N (77 kgf)/ 49.1	
				C8	760 to 840 N (77.43 to 85.57 kgf)/ 58.2	685 N (69.5 kgf)/ 58.2	ME550649
					1090 to 1150 N (111.25 to 117.29 kgf)/ 63.8	975N (99.5 kgf)/ 63.8	43402-02200
		Spring squareness		C4	2.4 or less	4	Replace
				C5	2.7 or less	5	
				C8	3.66 or less	5.5	ME550649
					3.3 or less	5	43402-022100
	Clearance between support lever pin and bushing			C4	[8] 0.05 to 0.16	0.4	Replace
				C5, C8	[10] 0.06 to 0.16		
	Clearance between release lever pin and bushing			C4	[8] 0.05 to 0.16	0.4	Replace
				C5, C8	[10] 0.06 to 0.16		
	Bearing case	Clearance between clutch release fork shaft and needle roller bearing			[23] 0.03 to 0.08	0.12	Replace
		Clearance between clutch release fork shaft and bushing			[25] 0.14 to 0.21	0.4	Replace

5.2.2 Reassembly

<C4>

Specified grease: Molybdenum disulfide grease



Assembly sequence

⑱→14→12→10→5→4→3→2→8→9→1
16→17→⑬→15→⑥→11

For reassembly of parts with an encircled number, see following items.
Do not disassemble Part No. 7 (strap plate).

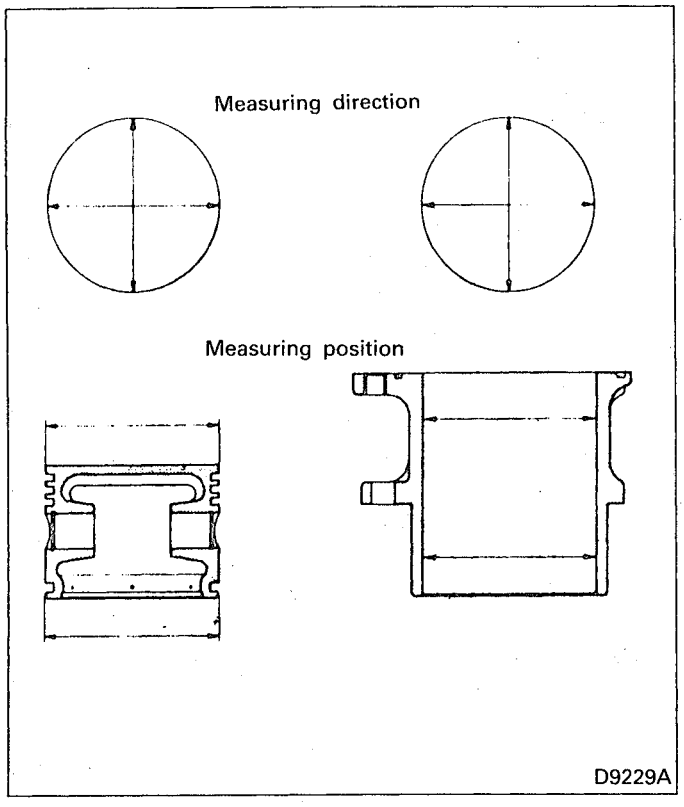
E0841

SPECIAL EQUIPMENT

CONTENTS

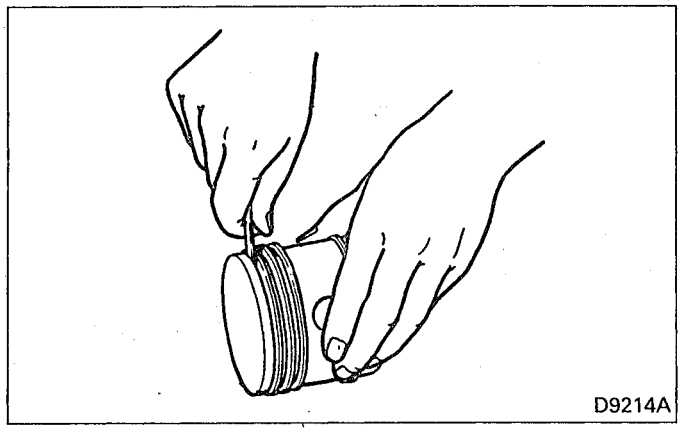
Inspection

(1) Piston to cylinder liner clearance



Calculate the clearance and if it exceeds the limit, replace the piston or cylinder liner.

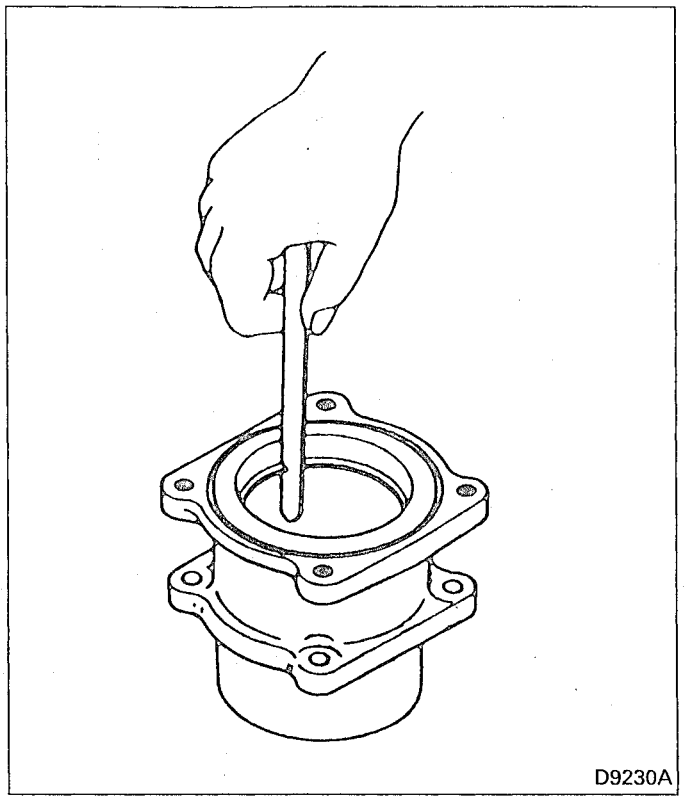
(2) Piston ring to ring groove clearance



Measure the clearance and if it exceeds the limit, replace the piston ring or piston.

NOTE:
Measure over entire circumference of the piston.

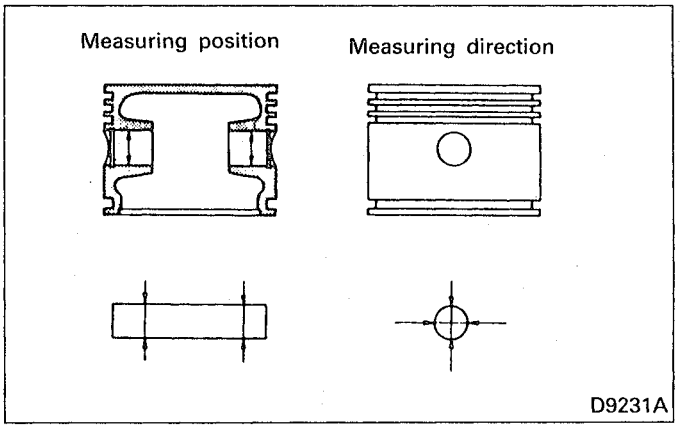
(3) Piston ring open end gap



Fit the piston ring to a new cylinder liner or gauge and measure the open end gap. If the gap exceeds the limit, replace the ring.

NOTE:
Push in the piston ring flat by the piston and measure.

(4) Piston to piston pin clearance



Calculate the clearance and if it exceeds the limit, replace the piston or piston pin.

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SHOP MANUAL

HYDRAULIC GEAR PUMP

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KOBE STEEL, LTD.

8) Fit O ring (11) in cover (2) and mount cover (2) on gear plate (1).

☞ • Bring the letters "IN" to suction side.
• If there is a gap of over 1.3mm (0.05in) between cover(2) and gear plate (1) when the cover is pushed lightly. it indicates that O ring(11) is off the slot. Remove the cover again and refit the O ring in place.

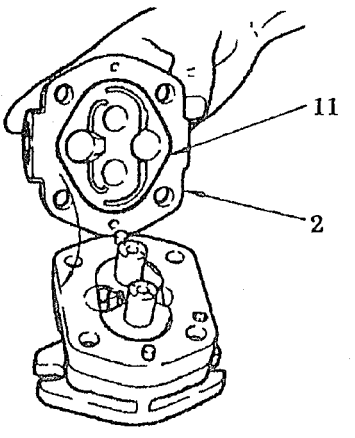

Fig. 27 Attaching the gear plate

9) Install washers(15) and bolts(14) Pinch the pump mounting flange of the mounting flange(3) in a vise with a torque of 3.5~4.0kgf·m (25~29ft·lbs)

☞ Wet the threaded parts by spraying hydraulic oil and fit bolts.

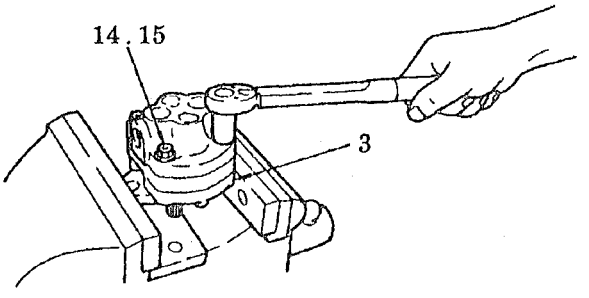

Fig. 28 Fastening bolts

10) Hold the end of the drive gear shaft in a vise and turn the pump. Assembly is complete if the pump can be turned lightly. In case the pump cap not be turned with ease. the seal may be bound or pinched. Disassemble the pump and assemble it again.

11) This completes assembly, but pay attention to:
   a) that the rotation direction is correct,
   b) that all parts are assembled,
   c) that the spigot part of the pump has no struck burn,
   d) that the pump mounting surface has no struck dent, and
   e) that there is no flaw or dirt on the pump piping.

5) Draw out cylinder (141) out of pump casing (271) in parallel to drive shaft (111). Then draw out piston (151), shoe (152), retainer (153), spherical bush (156), cylinder spring (157) and spacer (158) as well.

☞ Use care so as not to score the sliding surface of the cylinder. spherical bush (156). shoe (152) and the swash plate (212).

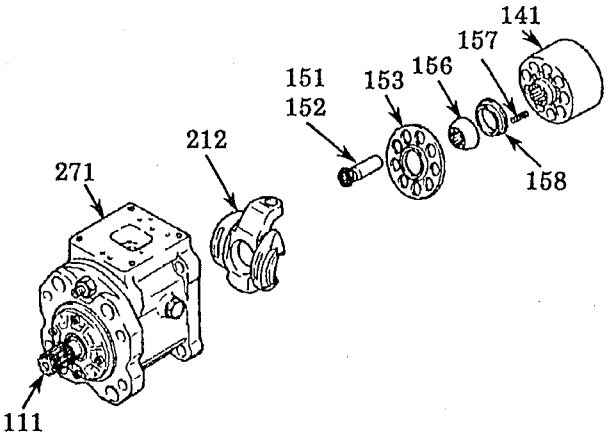

Fig. 13 Disassembling parts in the pump casing

6) Loosen the socket head capscrew (406) fastening seal cover (F) (261) and remove seal cover (F) (261).

☞ • The seal cover (F) (261) can easily be removed if capscrews are put into the extracting holes (tapped holes M6) to draw out the seal cover.
• The seal cover (F) (261) is fitted with O ring (710) and oil seal (774). Exercise care so the oil seal is not scored when disassembled.

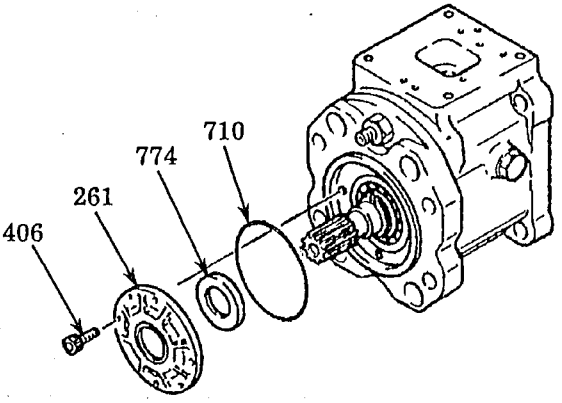

Fig. 14 Removing seal cover (261)

7) Separate pump casing (271) by lightly tapping the flange fastening swash plate support (251) on the pump casing side, using a plastic mallet.

☞ An O ring (717) is attached to swash plate support (251).Use care so the O ring is not scored when removed.

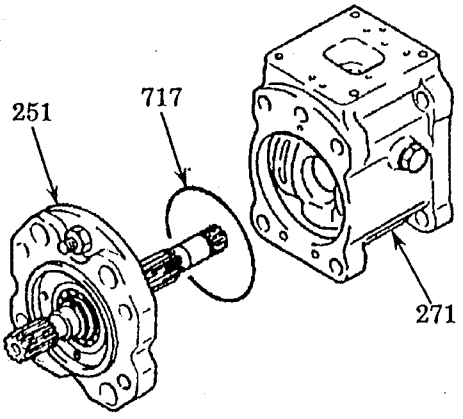

Fig. 15 Removing the swash plate support (251)

8) Separate shoe plate (211) and swash plate (212) from pump casing (271).

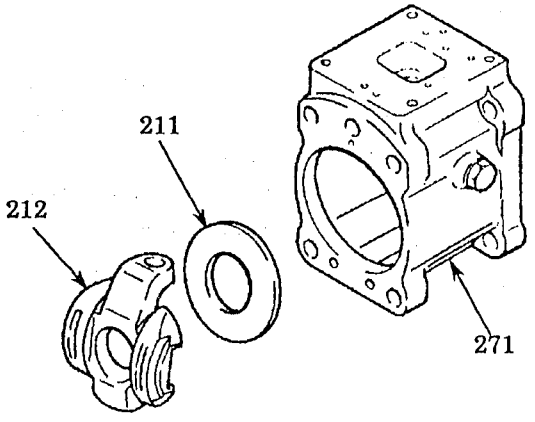

Fig. 16 Removing the swash plate (212)

2.3 ADJUSTING THE REGULATOR

The regulator may be adjusted in terms of maximum flow, minimum flow, horsepower control characteristics, flow control characteristics and Qmax cut flow, using the adjust screw.

2.3.1 ADJUSTING THE MAXIMUM FLOW

Adjust the maximum flow by loosening hexagon nut (808) and by tightening stop screw (954) (or loosening it). Tightening stop screw (954) decreases the delivery rate, as indicated in Fig. 9.
Only the maximum flow varies, but other control characteristics remain unchanged.

	Spec. 1	Spec. 2
Adjust screw No.	954	←
No. of turns for tightening	1/4	←
Pilot pressure Pi kgf/cm² (psi)	No change	←
Max. decrease in discharge flow ℓ/min (gal/min)	6.2 (1.64)	←

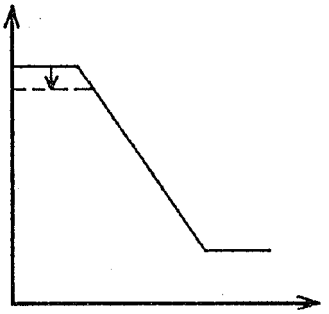

Fig. 9 Adjusting the max. discharge flow

2.3.2 ADJUSTING THE MINIMUM FLOW

Adjust the minimum flow by loosening hexagon nut (806) and by tightening socket head capscrew (953) (or loosening it). Tightening the socket head capscrew increases the delivery rate, as indicated in Fig. 10.
Other control characteristics remain unchanged in the same way as maximum flow adjustment care should be used of the fact that overtightening may increase a required power at the maximum delivery pressure (at relieving action).

	Spec. 1	Spec. 2
Adjust screw No.	953	←
No. of turns for tightening	1/4	←
Pilot pressure Pi kgf/cm² (psi)	No change	←
Min. increase in discharge flow ℓ/min (gal/min)	5.0 (1.32)	←

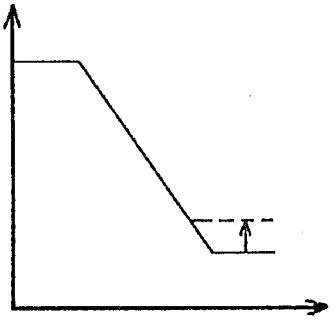

Fig. 10 Adjusting the min. discharge flow

2.3.3 ADJUSTING THE INPUT HORSEPOWER

Since the regulator is of total cumulative horsepower type, turn the adjust screws of both the front and rear pumps when changing horsepower set values. Adjust the horsepower settings of both pumps to a same level. The pressure change values by adjustment are based on two pumps pressurized at the same time, and the values will by halved when only one pump is loaded.

8) Fit locking ring (858) to fulcrum plug (614).

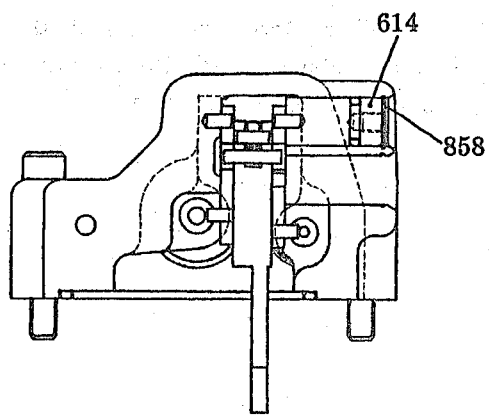

Fig. 39

9) Fit adjust plug (615).

Use care so as not to mistake the hole for adjust plug (615).

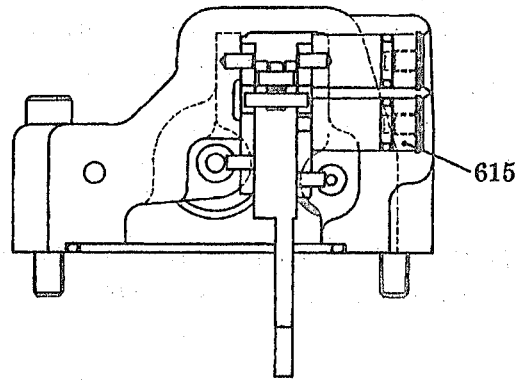

Fig. 40

10) Fit locking ring (858) to adjust plug (615).

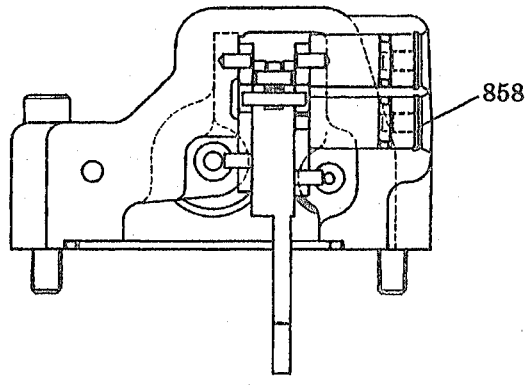

Fig. 41

11) Fix return spring (654) and spring seat (653) into the spool hole.

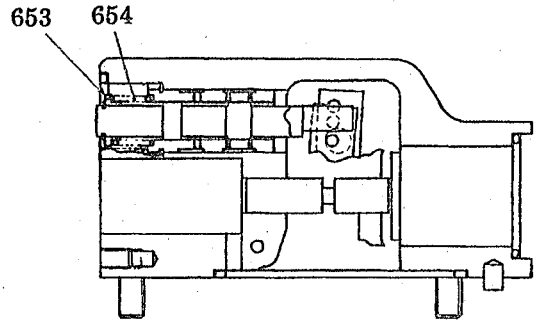

Fig. 42

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SHOP MANUAL

PILOT VALVE (TH40K)

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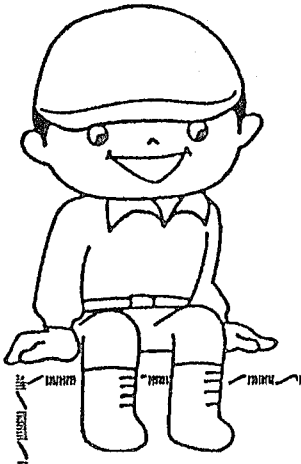


PREFACE

The swing control valve KSC series is direct-connected to the swing motor and controls smoothly the swing body having large inertial force according to external pilot pressure signals. The valve is provided with such functions as control of rotating direction, acceleration / deceleration, anti-cavitation, hold of a stop position and prevention of swing-back.

Models	Applicable Machines	Notes	Models	Applicable Machines	Notes
SK200	YN-6501~				
SK200-LC	YQ-1101~				
SK220	LQ-2101~				
SK220-LC	LL-1801~				

Revision	Date of Issue	Remarks
First edition	March, 1990	S5130666E K

3.5 ASSEMBLY

☞ •This section provides operating procedures only. For further details, refer to construction drawings (Fig.2, 4 and 9).
•The numbers in parentheses after part names in the instructions correspond to those in construction drawings (Fig.2, 4 and 9).

3.5.1 PRECAUTIONS TO BE TAKEN IN ASSEMBLY

In general, assembly is the reverse order of disassembly, but notice the following precautions:

1) Before proceeding to assembly, remove metallic particles and foreign matter from parts and confirm that parts are free from burr and blow marks. If burr and blow marks are present, remove them with an oilstone.
2) Replace O rings, packing and backup rings with new ones as a rule.
3) When fitting O rings, packings and backup rings, use care not to damage them. (Coat them with a thin film of grease for smooth functioning.)
4) When fitting parts, use grease to prevent them from falling down.
5) Tighten socket bolts and plugs to the torques specified under Maintenance Standards to be mentioned later.
6) When assembly is complete, put a plug to each of the ports to prevent entry of dirt.

3.5.2 ASSEMBLY PROCEDURE

(1) Assembling relief valve

1) Fit ball (311), spring seat (343) and spring (323) to piston (303). Put the piston into bush (342) and then spring seat (331).

☞ •Coat ball (311) with grease, fit spring seat (343), and attach piston (303) as if it were covered from above.
•Direct piston (303) so spring (323) faces up, and take care so ball (311) may not come off from the seat hole.
•Confirm that spring (323) is set in the guide hole of bushing (342).

2) Fit the bushing assembly into plug (201).

☞ Lightly knock on the end face of piston (303) with a plastic mallet.

3) Fit seat (341), plunger (301) and piston (302) to body (101).
4) Fit springs (321,322) to plug (201) and set C ring (291), pressing plug (201) against body (101).

☞ Work will be facilitated if C ring (291) is bent a little, the opposite side of its opening is put in and then it is pushed in straight.

(2) Attach O ring (164,165,166) to plug (151,152, 153) and tighten it against casing (101) to the specified torque.

(3) Assembling boost check valve

1) Insert poppet 2 (512) and spring 2 (522) to casing (101).
2) Attach O ring (561) to plug (551) and tighten it to casing (101) to the specified torque.

(4) Assemble poppet 1 (511), spring 1 (521) and plug (551) into the anti-cavitation check valve, in the same manner as above-mentioned.

(5) Assemble poppet 1 (511), spring (521) and plug (551) into the holding check valve, in the same manner as above-mentioned.

(6) Screw relief valve (601) into casing (101).

☞ Direct casing (101) so relief valve (601) can be set in a horizontal position so as to prevent seat (231) from falling down.

(7) Tighten relief valve (601) to the specified torque, using a torque wrench.

1. SPECIFICATIONS

1.1 EXTERNAL VIEWS

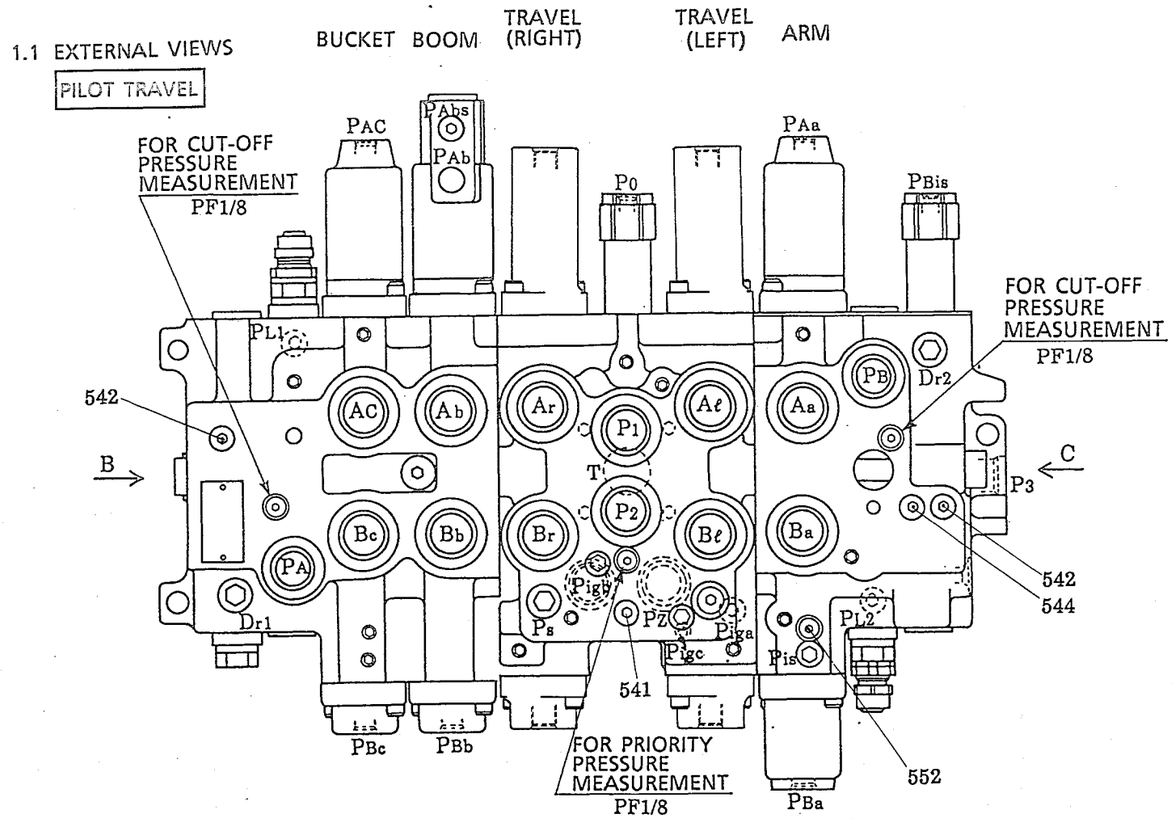


Fig. 1B External views of control valve

Table 1B

Port dia.	Tightening torque kgf·cm (ft·lbs)	Port name	Description
PF1	2250±250 (162.4±18)	P1	Pump P1 port
		P2	Pump P2 port
		Ab	Boom raise port
		Bb	Boom lower port
		Ac	Bucket dump port
		Bc	Bucket retract port
		Ar	Right travel port (forward)
		Br	Right travel port (reverse)
		A1	Left travel port (forward)
		B1	Left travel port (reverse)
		Aa	Arm retract port
		Ba	Arm extend port
PF3/4	1650±150 (119.1±11)	P3	Swing port
		PA	Arm conflux port
		PB	Boom conflux port
		(P4)	Option port
PF3/8	750±50 (54.1±3.6)	PAa	Arm retract pilot port
		PAb	Boom raise pilot port
		PAbs	Boom lower 2-step switching port
		PAc	Bucket dump pilot port
		PBa	Arm extend pilot port
		PBb	Boom lower pilot port
		PBc	Bucket retract pilot port
PF1/4	370±20 (26.7±1.4)	PA1	Arm extend conflux signal port
		PB1	Boom raise conflux signal port
		Dr1	Drain port
		Dr2	Drain port
		Ps	Servo pressure port
		P0	Straight travel valve limiter port
		P0p1	Option pilot port
		P0p2	Option pilot port
		Pi1	Negative control signal port
		Pi2	Negative control signal port
		Pi3	Swing pilot port
		PBis	Boom conflux limiter port
PF1/8	170±20 (12.3±1.4)	Pis	Arm oil recirculation port
		Piga	Arm conflux sequence port (primary)
		Pigb	Arm conflux sequence port (secondary)
		Pigc	Arm conflux sequence port (secondary)
		PL1	Attachment boost pressure port

Port dia.	Tightening torque kgf·cm (ft·lbs)	Port code	Description
PF1/8	170±20 (12.3±1.4)	PL2	Attachment boost pressure port
		Pz	Independent travel function port
M10	580±80 (41.9±5.8)	T	Tank port

1.2 PRINCIPAL SPECIFICATIONS

Table 2B

Item		Specification
Model		KMX15D/23011
Max. flow rate	ℓ/min (gal/min)	208×2 (54.9×2)
Max. pressure	kgf/cm² (psi)	350 (4977)
Main relief valve set pressure	kgf/cm² (psi)	$300\pm5/335^{+15}_{0}$ $(4266\pm71/4764^{+213}_{0})$ at 20ℓ/min (5gal/min)
Port relief valve set pressure (Boom head, bucket head)	kgf/cm² (psi)	350±5 (4977±71) at 20ℓ/min (5gal/min)
Miscellaneous set pressure (at 4 locations)	kgf/cm² (psi)	335±5 (4764±71) at 20ℓ/min (5gal/min)
Travel relief valve set pressure	kgf/cm² (psi)	350±5 (4977±71) at 40ℓ/min (11gal/min)
Low pressure relief valve set pressure	kgf/cm² (psi)	29^{+6}_{0} (412^{+85}_{0}) at 30ℓ/min (8gal/min)

3) When both spools are moved (See Fig. 14)
In this case, the flow of oil in each converter is the same as when the spool of either converter is moved. The flow characteristics are shown in Fig.14.
When the variable reduced area of each spool is totally closed off, the pressure at Pi becomes equal to the sum of that created by both reduced areas, about 30 kgf/cm² (427psi).

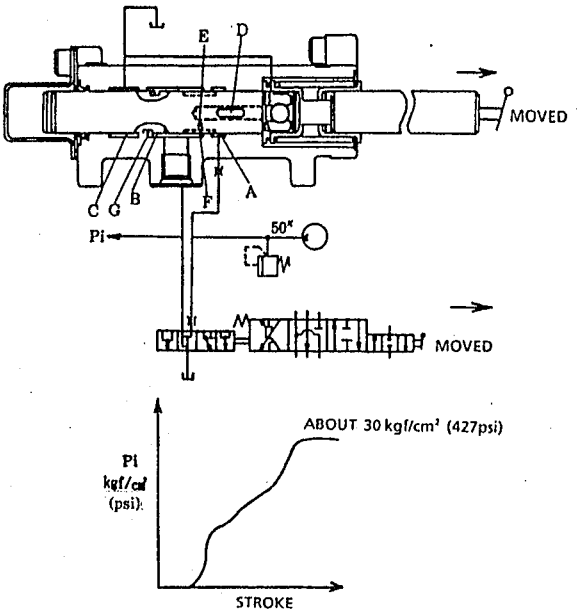


Fig. 14 When spools of both converters are moved

(4) Operation of the travel priority valve

1) When the independent travel mode switch if OFF
See Fig.15. Because pilot pressure of 50 kgf/cm² (711psi) is introduced at Po (chamber (1)), piston A is pushed against the lower end, and restricts the stroke of spool C.
During either attachment operation or simple travel, spool C is restricted to and fixed at position [I].
During simultaneous attachment operation and travel, when pilot pressure is introduced into chamber (2), spool C is moved to position [III] (Straight travel).

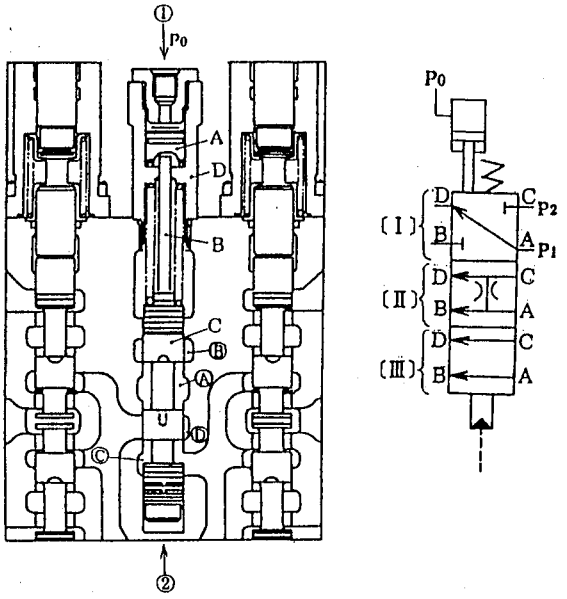


Fig. 15 Travel priority limiter

2) When the independent travel switch is ON
Port A1 of the solenoid valve (23) is connected to the tank, and pressure Po in the travel priority limiter (252) drops to 0 kgf/cm², stopping the restriction of the stroke of spool C. On the other hand, pilot pressure is directed from port A2 of the solenoid valve to port PZ of the control valve, and changes the pressure in chamber (2) to 50 kgf/cm² (711psi). This shifts the travel priority spool (305) to position [III] in Fig.16. Pump P1 is reserved for a working attachment, and pump P2, for travel. Thus, attachment motion and travel do not interfere with each other even if they occur simultaneously.

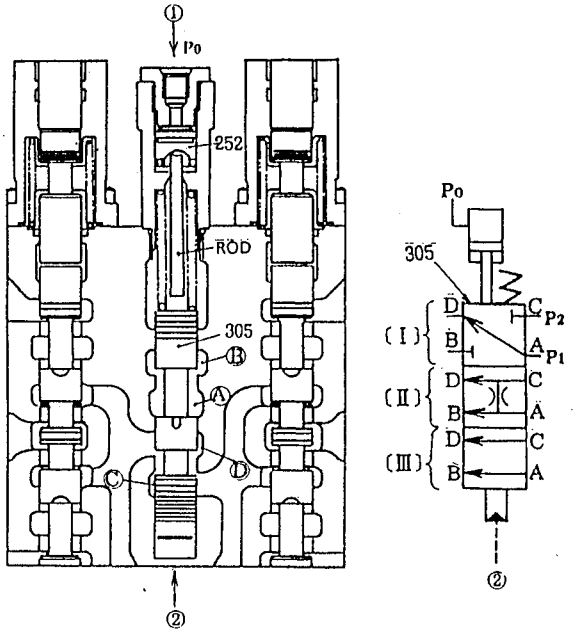


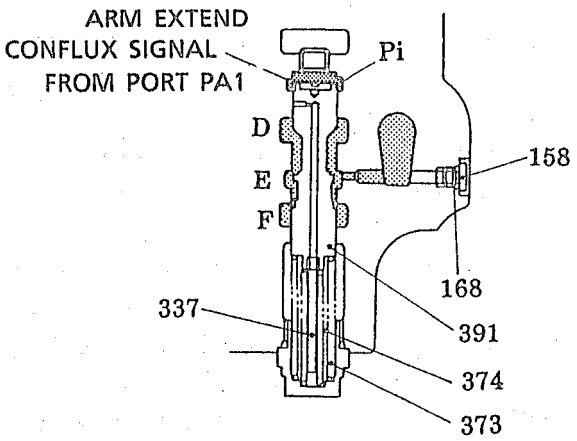
Fig. 16 Travel priority limiter

Conflux for arm extend

When the arm is extended, secondary pilot pressure from port PB3 of the pilot valve is divided, entering port PA1 in the end section of the control valve and entering notch Pi in the neutral cut-off spool (306B), where it pushes this spool, closing off the low pressure circuit.

The secondary pilot pressure entering port PA1 is again divided inside the control valve, entering notch Qi in the arm conflux spool (391), pushing this spool.

Thus, oil from pump P1 flows through the bypass circuit (52), passes through notch D in the arm conflux spool to enter notch F, forces the check valve open, to flow out of port PA. The oil then merges in the piping with other oil, and enters the rod end of the arm cylinder.



SECTION Q-Q

Fig. 30

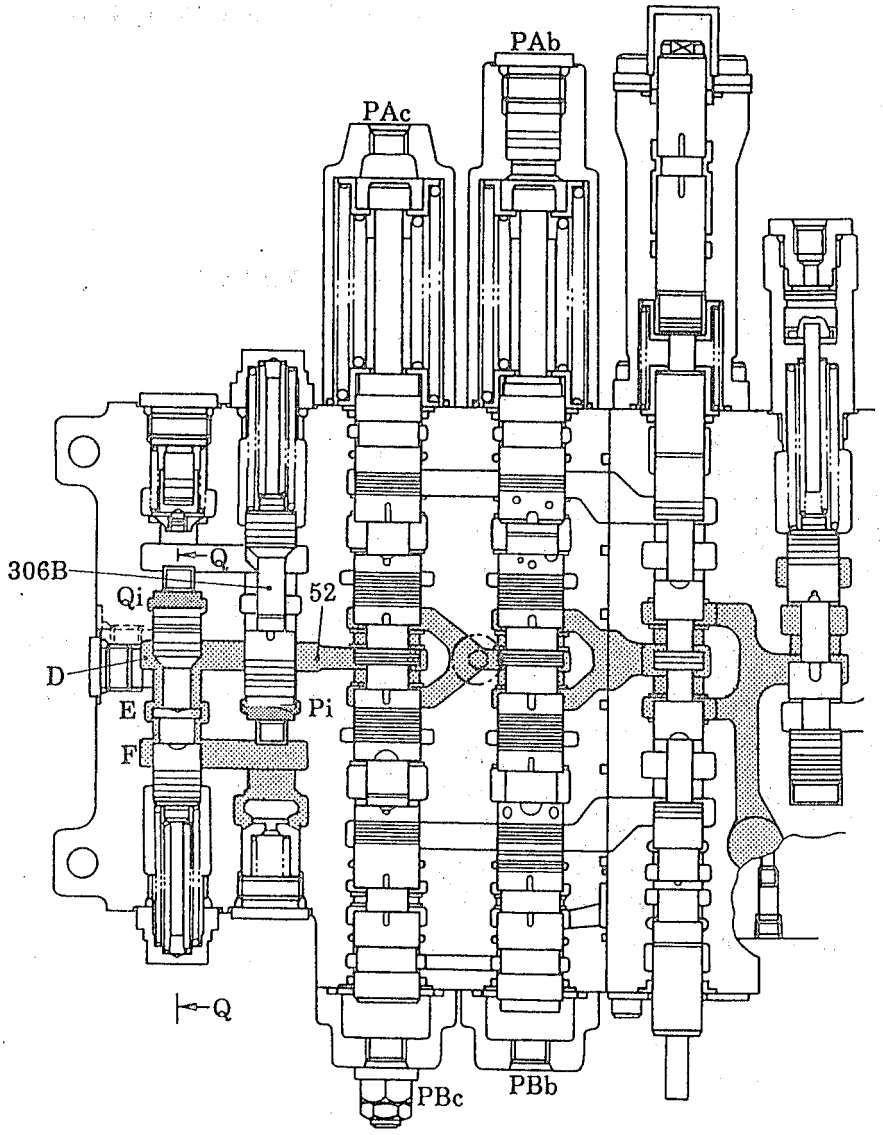


Fig. 31

3) With the boom stroke limiter (206) in a vise, remove the plug (551), then the piston (355).

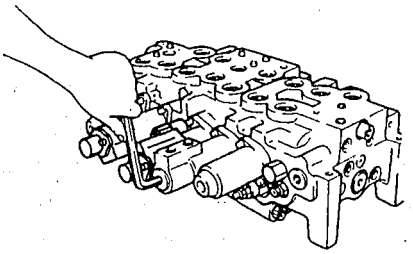


Fig. 62

3.3.7 NEGATIVE CONTROL RELIEF VALVE

1) Remove the plug (551), and then remove the bushing (472), spring (471), and poppet (470).

☞ Take care not to lose the filter (473) installed on the poppet (470).

3.3.8 CHECK VALVE

1) Remove the plug (551), and the remove the poppets (511,513) and the spring (521).

☞ • Remove all the check valves: seven are installed on the underside of the casing, and two on the side.
• The travel check valve is fitted with two special poppets (513). Mark them with a tag or the like to prevent them from being confused with each other.

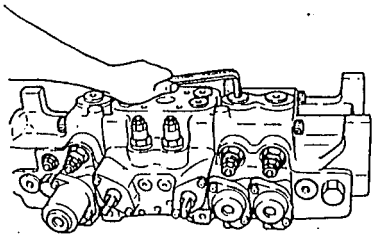


Fig. 63

3.3.9 SHUTTLE VALVE

1) Remove the plug (552), and then remove the seats (541,542,543,544) and the ball (512).

☞ One shuttle valve is installed in the travel block (101), three in casing A (102), and two in casing B (103). Mark the shuttle valves with a tag or the like to prevent them from being confused with each other during reassembly, as their seats (541,542,543, 544) differ in length from each other.

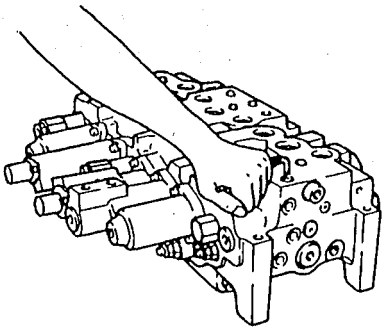


Fig. 64

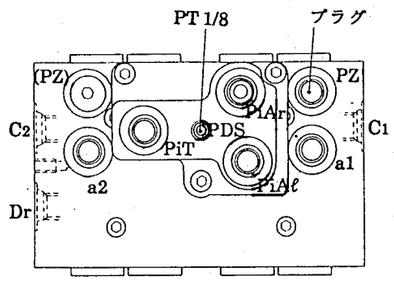
CONTROL VALVE

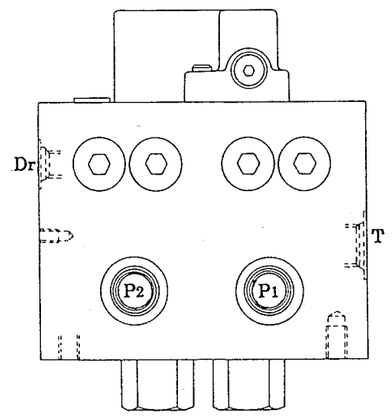
Unit : kgf-m (ft-lbs)

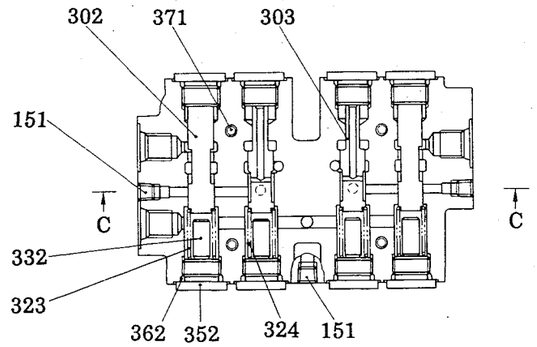
No.	Name	Tightening torque	Remarks
152	Plug	0.85~1.15 (6.2~8.3)	PT1/8
153	Plug	2~2.4 (14~17)	RO-PF1/4
154	Plug	4~5 (29~36)	RO-PF3/8
156	Plug	2.5~3 (18~22)	RO-M14×1.5
157	Plug	2~2.4 (14~17)	PT1/4
158	Plug	0.75~1 (5.4~7.2)	RO-PF1/8
171	Plug	10~12 (72~87)	RO-1/2
251	Plug	7~8 (51~58)	M27×1.5
252	Travel priority limiter subassembly	7~8 (51~58)	
253	Boom conflux limiter subassembly	7~8 (51~58)	
271	Socket bolt	2.7~3.3 (20~24)	M8×12
273	Socket bolt	2.7~3.3 (20~24)	M8×25
336	Spacer bolt	1.6~1.8 (12~13)	Apply loctite #241
351	Orifice	1.55~1.85 (11.2~13.4)	M8×8
551	Plug	15~18 (108~130)	RO-M27×1.5
552	Plug	1~1.25 (7.2~9.0)	RO-M12×1.5
601	Main relief valve	7~8 (51~58)	KRM15
602	Travel relief valve	7~8 (51~58)	KRS10
603	Port relief valve	7~8 (51~58)	KRS10
604	Port relief valve	7~8 (51~58)	KRS10
611	Negative control relief valve	15~18 (108~130)	KMX15C
711	Plug	15~18 (108~130)	RO-3/4
971	Socket bolt	20~22 (144~159)	M18×1.5
972	Socket bolt	20~22 (144~159)	M18×1.5
973	Socket bolt	20~22 (144~159)	M18×1.5
974	Socket bolt	20~22 (144~159)	M18×1.5

☞ Plugs 152 and 157 are applied meck.

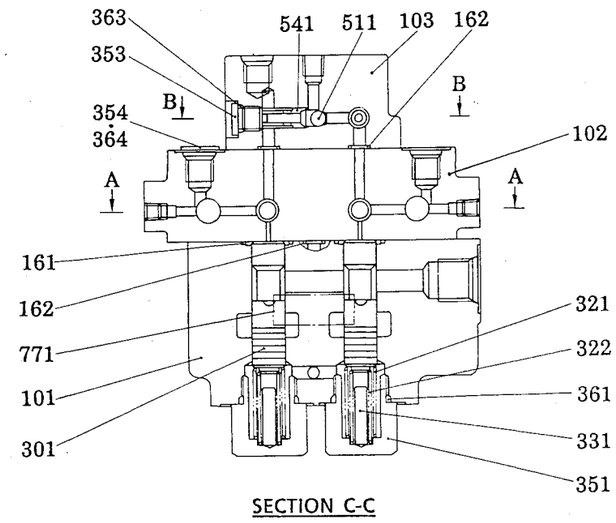
(5) Independent travel valve (VBY−125A)



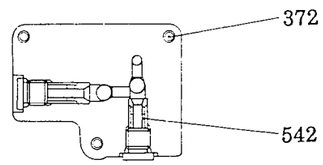




SECTION A-A



SECTION C-C



SECTION B-B

Unit : kgf · cm (ft · lbs)

PORT SIZE	TIGHTENING TORQUE	PORT NAME	DESCRIPTION
PF1/2	1100±100 (79.5±7.2)	P1	Pump P1 port
		P2	Pump P2 port
		T	Tank port
PF1/4	370±20 (26.7±1.4)	PiAr	Operating pilot valve signal port
		PiAℓ	Operating pilot valve signal port
		PiT	Travel converter signal port
		a1	Pump No.1 negative control signal port
		a2	Pump No.2 negative control signal port
		c1	Negative control signal port
		c2	Negative control signal port
		Dr	Drain port
		PZ	Main pilot pressure port
PT1/8		PDS	Pressure switch port

NO.	NAME	Q'ty	REMARKS
101	CASING (1)	1	
102	CASING (2)	1	
103	SHUTTLE VALVE CASING	1	
151	PLUG	8	
161	O RING	2	
162	O RING	3	
301	BYPASS SPOOL	2	
302	SPOOL	2	Direction control valve spool
303	SPOOL	2	Pressure reducing valve spool
321	SPRING	2	
322	SPRING	2	
323	SPRING	2	
324	SPRING	2	
331	ROD	2	
332	ROD	4	
351	PLUG	2	M27×1.5
352	PLUG	8	M18
353	PLUG	2	M12
354	PLUG	1	
361	O RING	2	
362	O RING	8	
363	O RING	2	
364	O RING	1	
371	SOCKET BOLT	4	M6×45
372	SOCKET BOLT	3	M6×20
511	BALL	2	
541	SEAT	1	
542	SEAT	1	
771	NAMEPLATE	1	

Fig. 6 Independent travel valve

(2) Variable loading mode operation

Boom raising and swing speeds may be selectively controlled by turning the loading mode potentiometer.

If the loading mode potentiometer is turned clockwise, it decreases the voltage for the electromagnetic proportionate reducing valve that lowers the secondary pressure of the proportionate reducing valve. If the stroke of the boom conflux spool (307) decreases, the amount of oil combined from notch A to B decreases. The pressure controlled by the electromagnetic proportionate reducing valve falls further whereby conflux from notch A to B is shut off.

As the result, conflux flow for boom action by the secondary pressure of the electromagnetic proportionate reducing valve ceases to occur, so that single swing speed is regained even when simultaneous swing / boom motion is performed.

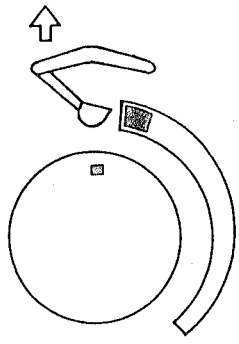


Fig. 21 Loading mode potentiometer

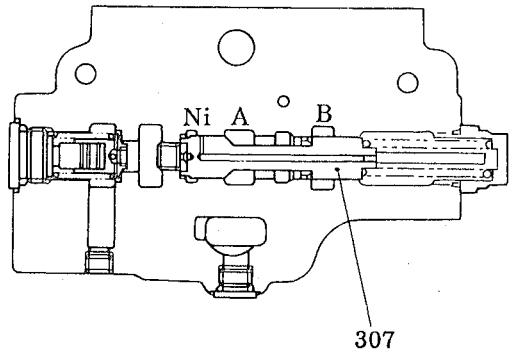


Fig. 22 Boom conflux spool

2) Loosen the socket bolt (273) on the opposite side and take off the spring cover (202) and the O ring (266).

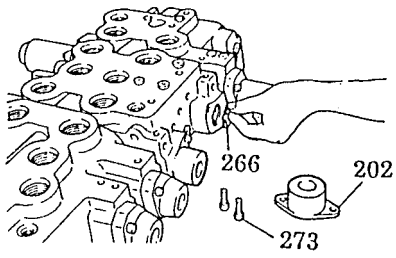


Fig. 41

3) Draw out the spool assembly that consists of travel spool (919), spring seat (331), springs (328) (329) and stopper (334).

☞ When drawing out the spool assembly from the block (101), take care so the block (101) is not scored.

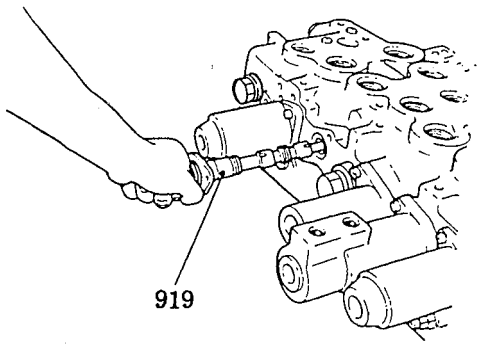


Fig. 42

4) Place and hold the travel spool assy in a vise. Remove the spacer bolt (333) and separate the spring seat (331), the springs (328) (329) and the stopper (334) from the travel spool (919).

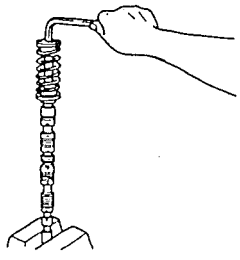


Fig. 43

3.3.2 BOOM SPOOL

1) Remove the socket bolts (273), then remove the boom stroke limiter (206). Pull the spool assembly mode up of the boom spool (303), spring seat (920), springs (371,372), and stopper (338), from casing B (103).

☞ • Take care not to damage casing B (103) when pulling the spool assembly from the casing.
• Mark the spool with a tag or the like to prevent it from being confused with other spools during reassembly; it differs in shape from the others, and has a particular direction in which it must be reinstalled.

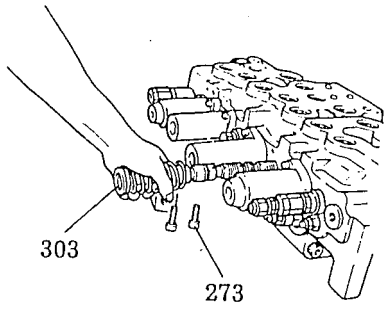


Fig. 44

3.4.11 TRAVEL SPOOL

1) Hold the center of spool (travel) (919) in a vise. Set spring seat (331), springs (328,329) and stopper (334). Then tighten spacer bolt (333) to a specified torque.

☞ Before tightening spacer bolt (333), coat it Locktite #241.

2) Fix the spool assy under 1) and 2) in travel block (101).

☞ When fixing the spool assy into travel block (101), do it slowly with care; never force it in any case.

3) Place O ring (265) and cover (202) to the opposite part of travel block (101) and tighten socket bolt (273) to a specified torque.

3.4.12 COVERS

1) Mount the spool covers (203) on the side opposite the boom and bucket spool springs, and tighten the socket bolts (273) to the specified torque.

☞ Confirm that the O rings (263,264) are installed.

2) Mount the spring coves (201) on the spring side of the bucket and arm spools, and tighten the socket bolts (273) to the specified torque.

☞ Confirm that the O ring (261) is installed.

3) Insert the piston (355) in the boom stroke limiter cover (206), put an O ring (561) on the plug (551) and tighten the plug to the specified torque.
4) Install the boom stroke limiter (206), reassembled in step 3) above, on the spring side of the boom spool, and tighten the socket bolts (273) to the specified torque.

☞ Confirm that the O ring (261) is installed.

5) Install the arm cover (205), piston (353) and spring (354) on the side of the arm spool opposite the spring side, and tighten the socket bolts (273) to the specified torque.

☞ ◎ Confirm that the piston (353) moves smoothly in the arm cover (205).
◎ Confirm that the O rings (261,264) is installed.

3.4.13 MAIN RELIEF VALVE

1) Install the main poppet (427), spring (428), and seat (429) in the body (420).
2) Put an O ring (436) on the spring seat (435), install the spring (434) and poppet (433) on the plug (421), and tighten adjusting the screw (437) and lock nut (438).
3) Force-fit the assemblies reassembled in steps 1) and 2) above.

☞ ○ Confirm that the seat (429) and the poppet (433) are securely inserted.
○ Use a bearing puller or the like to force-fit the assembly, as only a little force is required.

4) Install the O rings (423,424).
5) The adjusting screw (437) may be temporarily tightened at this point, as pressure is adjusted later in accordance with the "Maintenance Standards."

3.4.14 TRAVEL RELIEF VALVE AND PORT RELIEF VALVE

1) Install the main poppet (406), spring seat (417), spring (407), and seat (413) in the body (401).
2) Put an O ring (405) on the plug (404), and put an O ring (415) on the spring seat (411).
3) Install the spring seat (411) assembly, spring (412), and poppet (410) on the plug (404), and tighten the adjusting screw (414) and the lock nut (416).
4) Tighten the assemblies reassembled in steps 1) and 3) above to the specified torque.
5) Install the seat (409) and spring (408), and put on the O rings (402,403).
6) The adjusting screw (414) may be temporarily tightened at this point, as pressure is adjusted later in accordance with the "Maintenance Standards."

1. SPECIFICATIONS

1.1 GENERAL VIEW

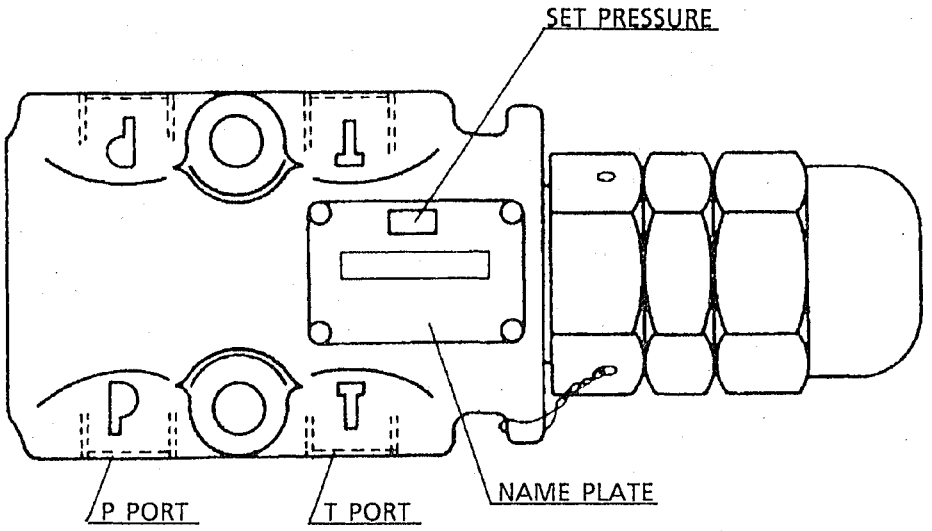


Fig. 1 Outside view of pilot relief valve

1.2 MAJOR DIMENSIONS

Table 1

Item	1	2	3	4	5	15	25
Model	VRD – 0300					VRD–03	VRD–06
P Port (Screw size)	PT3/8					JIS PF3/8 (O ring Port)	JIS PF3/4 (O ring Port)
T Port (Screw size)	PT3/8					JIS PF3/8 (O ring Port)	JIS PF3/4 (O ring Port)
Proof Pressure kgf/cm² (lbs/in²)	140 (1991)						210 (2987)
Relief Set Pressure kgf/cm² (lbs/in²)	10~100 (142~1422)						
Rated Flow ℓ/min (gal/min)	30 (7.9)						75 (19.8)
Relief Set Pressure kgf/cm² (lbs/in²)	35 (498)	20 (285)	40 (569)	125 (1778)	43 (612)	50 (711)	50 (711)
Relief Set Flow ℓ/min (gal/min)	20 (285)	18 (256)	18 (256)	30 (427)	17 (242)	18 (256)	45 (640)
Weight kg (lbs)	1.8 (3.9)						3.4 (7.5)

3.3 DISASSEMBLY PROCEDURE

The numbers in parentheses after part names in the disassembly and assembly instructions correspond to those in the construction drawing (Fig. 2).

1) Remove the valve from the machine and put it on the work bench.
   Take off O rings (13, 14) on the gasket surface.
2) Loosen socket bolt (12) and detach cover (7).
3) Draw out O rings (5, 6), spring (4) and spring seat (3).
4) Draw out spool (2) from body (1).
   Spool (2) cannot be separated any further as it is fixed with locking compound applied to the screw thread section.
5) Draw out plug (10) of cover (7), spring (9) and restrictor (8).

3.4 INSPECTION BEFORE ASSEMBLY

After disassembly, wash all parts with clean oil and inspect the following items. After inspection, coat them with hydraulic oil.

1) Spool
   Inspect that the oil grooves are free from burr, dust, dent and rust.
2) Sliding area
   Inspect that the sliding areas move smoothly and without foreign matter in the groove, holes and paths.
3) Check valve
   Inspect that the seat surfaces are free from dents, damage and without clogged holes.
4) Seal face (matching surface)
   Inspect that the seal surfaces are without burr, dust and rust.
5) Restrictor
   Inspect that the seat surface has no dent, damage and without plugged holes.
6) Seals
   Replace seals each time disassembly is performed, in principle.

If any damage is seen on the body and the spool on inspection, replace the assembly.

3.5 PRECAUTIONS TO BE TAKEN ON ASSEMBLY

1) Perform operation in a clean area.
2) Use care so all parts are brought back to their original positions.
3) Eliminate scars made during disassembly with an oilstone or something.
4) A small amount of hydraulic oil applied to parts will facilitate assembly operation.
5) Replace O rings with new ones in principle.

3.6 ASSEMBLY PROCEDURE

1) Fit restrictor (8) and spring (9) to cover (7).
2) Fit O ring (11) to plug (10) and tighten cover (7) to the specified torque.
   Tightening torque: 4～8 kgf·m (28.9～57.8 ft·lbs)
3) Put O rings (5, 6) into body (1).
4) Assemble spool (2), spring seat (3) and spring (4) in body (1).

NOTE

Keep in mind that the spool (2) has a direction in which it must be fitted.

5) Install cover (7) to body (1) and tighten socket bolts (12) to the specified torque.
   Tightening torque: 8±0.8 kgf·m (57.8±5.7 ft·lbs)
6) Fit O rings (13, 14) to the gasket face.
7) Tightening torque 4 ～8 kgf·m (28.9～57.8 ft·lbs)of pressure gauge port plug (15).

KOBELCO

BooK code No. S5 15043 4E

SHOP MANUAL

HYDRAULIC MOTOR(SWING)

TABLE OF CONTENTS

15

KOBE STEEL, LTD.

10) Fix O rings (706,707) to casing (301).
11) Fix brake spring (712) to brake piston (702).

☞ ◎ Fit the four slits on the brake piston (702) in the position shown in Fig. 20.
◎ When the brake piston (702) is hard to enter due to the resistance of Orings, screw in a M6 socket bolt into the brake piston and knock it evenly by means of a plastic mallet.
◎ Confirm that the brake spring is fitted securely in the spot facing of the brake piston (702).

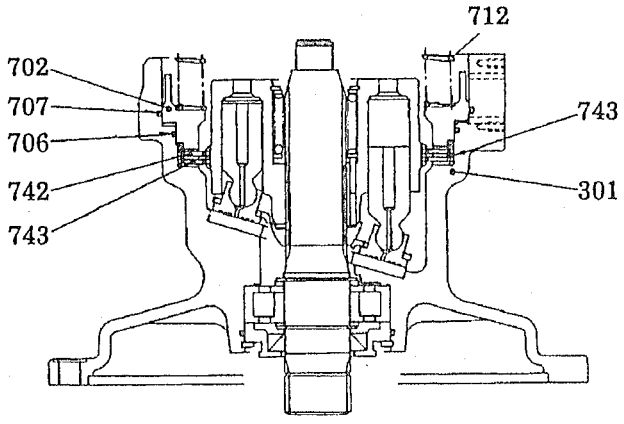
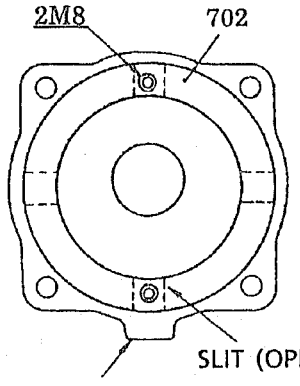


Fig. 20 Assembling the parking brake



MOUNTING POSITION OF CHANGEOVER VALVE
Fig. 21

12) Fix valve plate (131) to valve cover (303) and fit Oring (472) then.
13) Attach valve cover (303) to casing (301) and fasten them with socket bolt (401).

☞ ◎ Notice the direction in which the valve plate (131) is to be fitted. (Direct the roundness part of the valve plate in the opposite direction of the flange.)
◎ Coat the jointing surface of the valve plate (131) with a thin film of grease.
◎ Use care so that the brake spring (712) does not come off.
◎ Exercise care so that the brake spring (712) may not fall down.
◎ Tighten socket bolt (401) evenly all around.

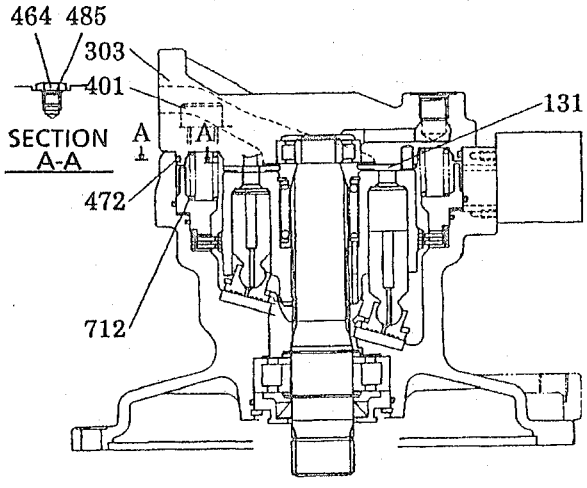


Fig. 22 Mounting valve cover (303)

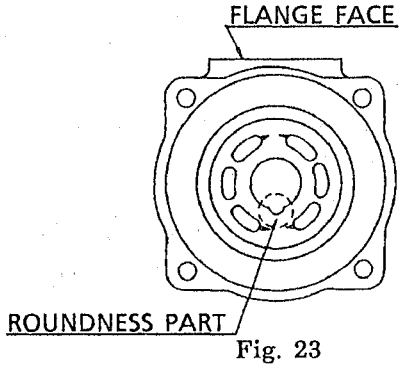


Fig. 23

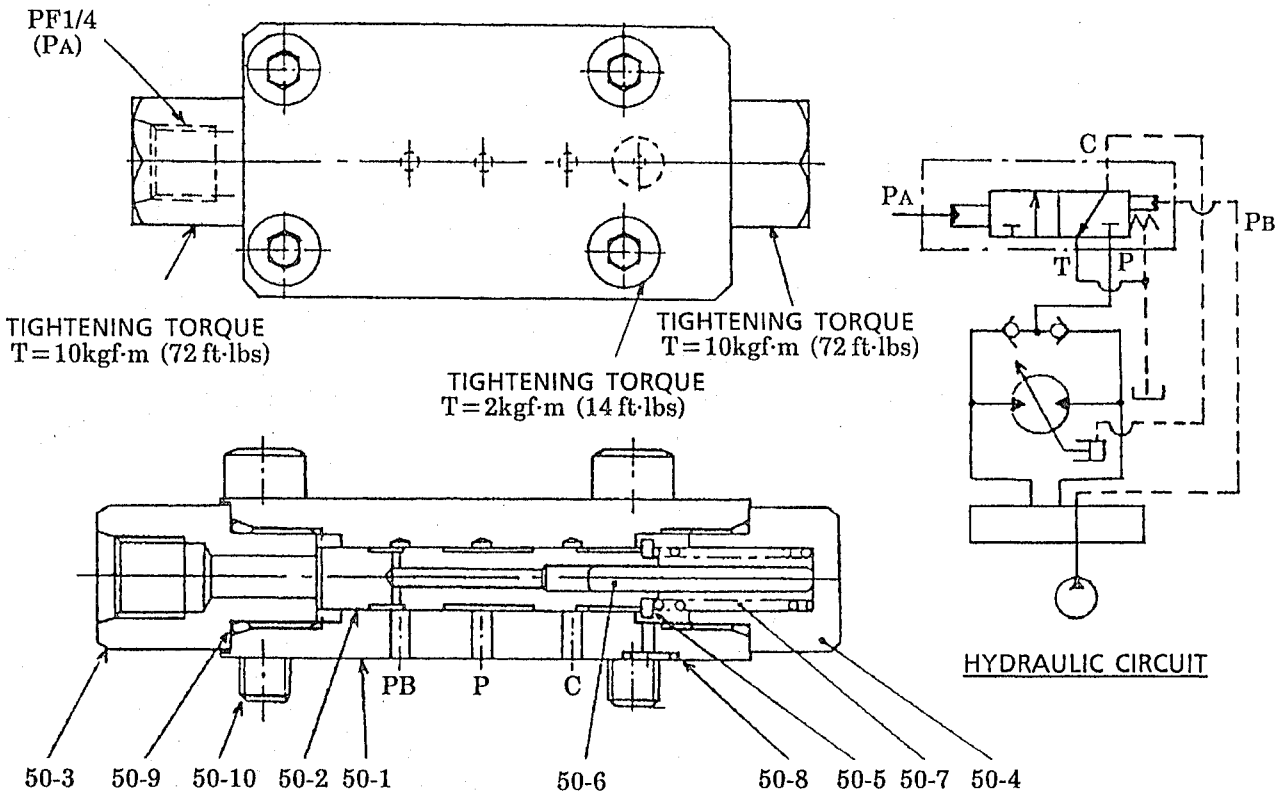


Fig. 3 Pilot selector valve

No.	NAME	Q'ty	No.	NAME	Q'ty	No.	NAME	Q'ty
50-1	VALVE	1	50-5	SPRING SEAT	1	50-9	O RING	2
50-2	SPOOL	1	50-6	PIN	1	50-10	CAPSCREW	4
50-3	JOINT	1	50-7	SPRING	1			
50-4	PLUG	1	50-8	O RING	1			

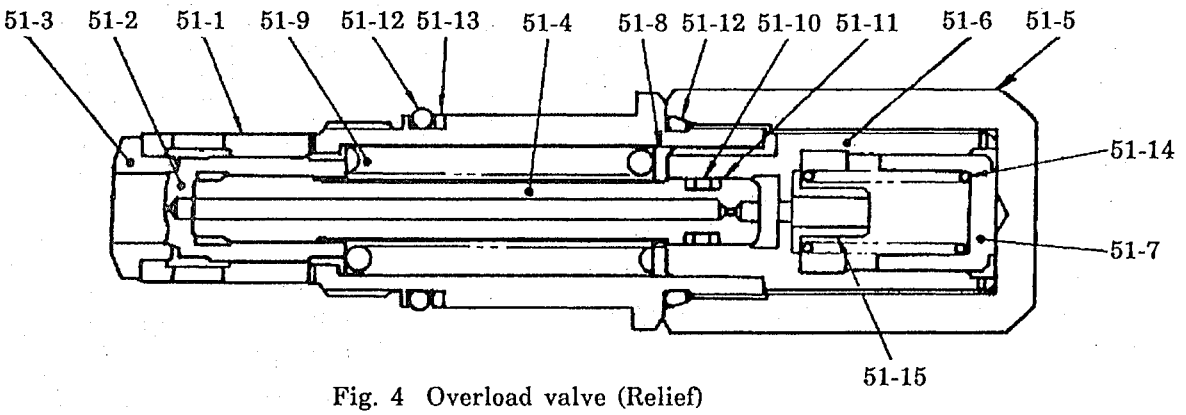
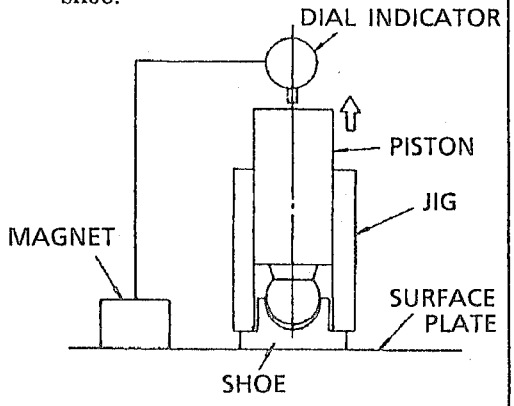
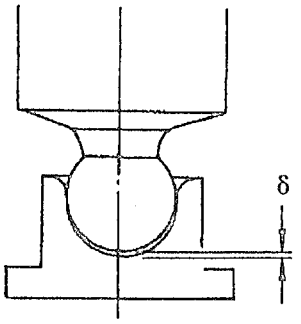
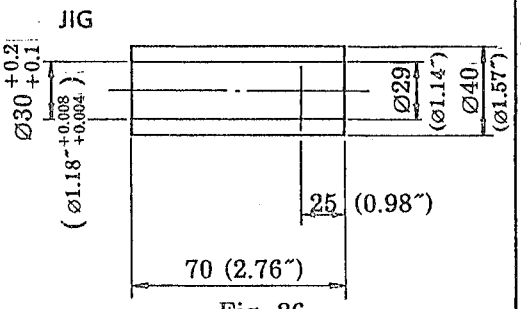


Fig. 4 Overload valve (Relief)

No.	NAME	Q'ty	No.	NAME	Q'ty	No.	NAME	Q'ty
51-1	SOCKET	1	51-6	PILOT BODY	1	51-11	BACKUP RING	2
51-2	VALVE	1	51-7	PISTON	1	51-12	O RING	2
51-3	VALVE SEAT	1	51-8	SHIM	1	51-13	BACKUP RING	1
51-4	PISTON	1	51-9	ADJUST SPRING	1	51-14	SPRING	1
51-5	PLUG	1	51-10	O RING	1	51-15	SPRIG GUIDE	1

Inspection Item / Method	Acceptance Standard and Remedy
(3) Gap of piston shoe Hold down the shoe to the surface plate by means of jig, draw out the piston upward,and measure the gap between the piston and the shoe.  Fig.25	 Fig. 24 Table 7 Unit : mm(ft-in) Part name and inspection item / Standard dimension / Allowable value / Remedy Gap between piston caulked and part of shoe / 0~0.1 (0~0.004″) / 0.3 (0.012″) / Replace piston. ☞ When any piston is be replaced, replace nine pistons altogether.
 Fig. 26	
(4) After assembly, measure the torque at the end of the shaft when it begins to turn, using a torque wrench.	Table 8 Unit : kgf·m(ft·lbs) Part name and inspection item / Standard dimension / Allowable value / Remedy Brake torque / 52(376) / 47(339) / Replace all separator plates,friction plates and springs.
(5) Shaft Measure the wear of the shaft seal by means of a roughness meter.	Allowable stepped wear is up to 0.05mm (0.002″) ☞ When the shaft is to be replaced. replace the oil seal at the same time.
(6) Bearing Replace bearing (2) and needle bearing (3) within 10,000 hours of the hourmeter on the machine. Since the inner race of needle bearing (3) is shrinkage fitted to the shaft, replace it with the shaft together.	
(7) Spline Replace spline if it is worn beyond its allowable limit.	Serviceable stepped wear is up to 0.3 mm (0.012″) on the contact surface.
(8) Relief valve section This is the overload relief valve section. Pressure can not be checked and regulated without a special test bench.	Replace it as a sub-assembly every 10,000 hours.

4. MAINTENANCE STANDARDS

4.1 INSPECTION PROCEDURE AND REMEDY

Table 3

Interval	Check Item	Checking Procedure	Remedy
2,000Hrs.	Seal for oil leakage outside	Check oil leakage outside	Replace O ring, if any oil leakage can be found.
4,000Hrs. In principle, disassemble and check regardless of oil leakage or not.	All sealing parts		Replace all sealing parts such as slipper seal with square seal and O ring.
	All rubbing parts	Check abnormal wear, scoring or corrosion caused by foreign particles or burning.	Repair or replace referring to their limit of serviceability.
When disassembled for repair	All parts	Check them for burning, foreign particles, abnormal wear, and defect of seals.	Repair or replace referring to their limit of serviceability. O rings should be replaced.

4.2 USABLE LIMIT OF THE PARTS

Table 4

Parts		Maintenance Standards	Remedy
Body, Stem	Sliding surface with sealing sections	Plating worn or peeled due to seizure or contamination.	Replace
	Sliding surface between body and stem other than sealing sections	1) Worn abnormality or damaged more than 0.1mm (0.0039in) in depth due to seizure contamination.	Replace
		2) Damaged more than 0.1mm (0.0039in) in depth.	Smooth with oilstone.
	Sliding surface with thrust plate	1) Worn more than 0.5mm (0.02in) or abnormality.	Replace
		2) Worn less than 0.5mm (0.02in).	Smooth
		3) Damage due to seizure or contamination remediable within wear limit (0.5mm) (0.02in).	Smooth
Cover	Sliding surface with thrust plate	1) Worn more than 0.5mm (0.02in) or abnormality.	Replace
		2) Worn less than 0.5mm (0.02in).	Smooth
		3) Damage due to seizure or contamination remediable within wear limit (0.5mm) (0.02in).	Smooth

3.1.3 NECESSARY TOOLS

Tools and jigs vary with types of cylinders, but it is necessary to prepare the tools in Table 3 as a guideline.

Table 2 List of Tools and Jigs

Tool/Jib	Remarks	Tool/Jib	Remarks
Hammer	1. Steel hammer 2. Wooden or plastic malles	Spatula	Metallic one with smooth corners.
		Gimlet	A sharp-point tool may be used in place of a gimlet.
Screwdriver	A few types of large and small sizes	Jig	1. For fitting seal ring 2. For holding in seal ring 3. For inserting piston rod bushing 4. For pressing in dust seal
Chisel	Flat chisel, Punch		
Vise	One having an opening wide enough to hold rod cover O. D. and tube mounting pins (clevis).	Rust remover	
Wrench	1. Hook wrench 2. Hexagon key wrench 3. Pin wrench 4. Extension pipe for wrenches	Measuring instruments	1. Slide calipers 2. Micrometer 3. Cylinder gauge (Fig. 7) 4. V-block

☞ For the details of special tools and jigs, refer to the back pages of this manual.

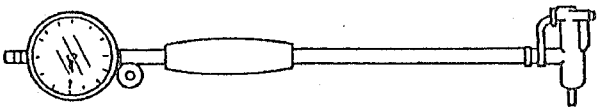


Fig. 7 Cylinder Gauge

3.1.4 EXTERNAL CLEANING

The cylinder taken off the excavator has dust and foreign matter, and grease is usually adhered to the clevis part. For this reason, remove external soil and contamination from the cylinder with water and steam before bringing it into the workshop.

☞ The cylinder described below is of the cushionattached type. However, check the construction of the cylinder with the parts catalogue when disassembling and servicing the cylinder.

3.1.5 DISCHARGING OIL

Place a wooden-block on the work beach and mount the cylinder on it to prevent it from rotating. Charge air into ports A and B alternately to actuate the piston rod till the hydraulic oil in the cylinder is drained out. At this time, connect a suitable hose to each port so that the hydraulic oil may not gush out.

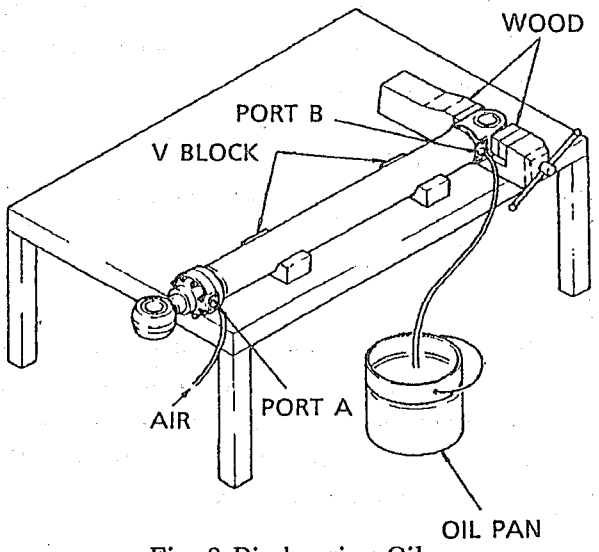


Fig. 8 Discharging Oil

5) After tightening piston nut (9), put in steel ball (11) and always tighten setscrew (14) to a specified torque. Then caulk the outer circumference of setscrew (14) at two points.

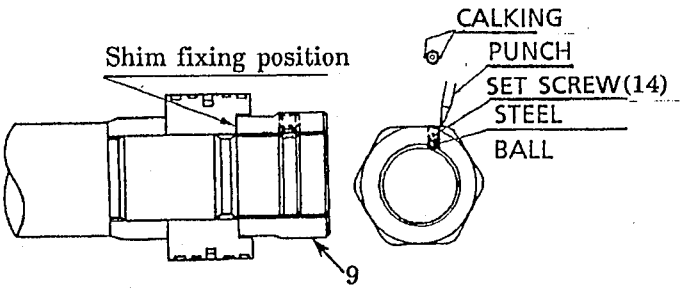


Fig. 38 Tightening setscrew (14)

6) Fit slide rings (8,29). Coat slide rings (8,29) with vaseline (or good-quality grease if not available) and fit them so they are coiled around the grooves. Place them 180° apart from each other so the 30° slits do not face the same direction.

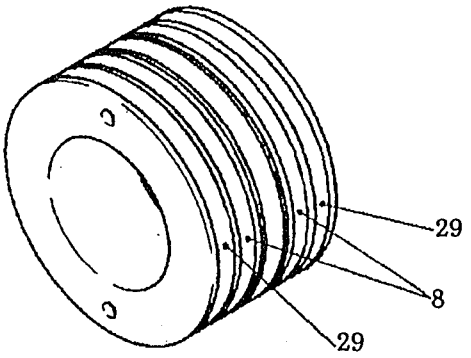


Fig. 39 Fitting slide rings (8,29)

3.4.6 OVERALL ASSEMBLY

1) Place a V-block on a rigid work bench (A wooden V-block is preferable.). Mount the cylinder tube ass'y (1) on it and fix the ass'y by passing a bar through the clevis pin hole to lock the ass'y.

2) Insert the piston rod ass,y into the cylinder tube assy, while lifting and moving the piston rod ass'y with a crane. In this operation, apply vaseline (or hydraulic oil) to the inner surface of the tube mouth and the circumference of the piston. Align the center of the piston rod ass'y with the center of the cylinder tube ass'y and put it in straight forward. When inserting, make sure that wear ring (8) on the perimeter of the piston is not out on the groove. Apply a suitable amount of liquid packing all around the side corner of the flange on cylinder cover (13). (To prevent the outside surface of the cylinder head from rusting due to intrusion of moisture.) This treatment is not necessary for the piston that has an O ring in this position.

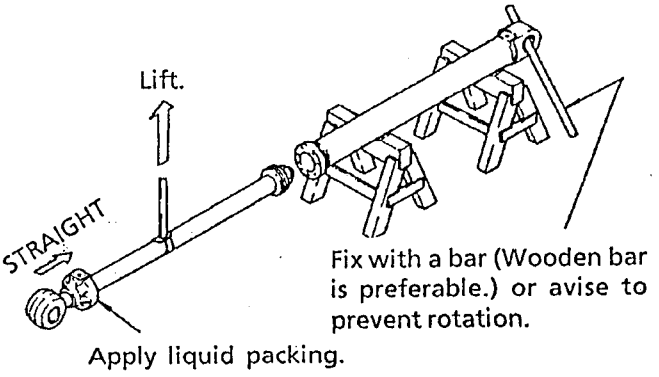


Fig. 40 Inserting rod assy piston

3) Turn up socket bolt (23). Match the bolt holes of the rod cover flange to the tapped holes in the cylinder ass'y, and screw in socket head bolts (23) one by one. Tighten the bolts to a specified torque, exercising care so the bolts may not be fastened unevenly.

☞ Exercise care so as not to damage the rod surface by accidentally slip a wrench. Covering the rod surface with rag or something is recommended to prevent damage to it.
For the tightening torques, refer to "Maintenance Standards".

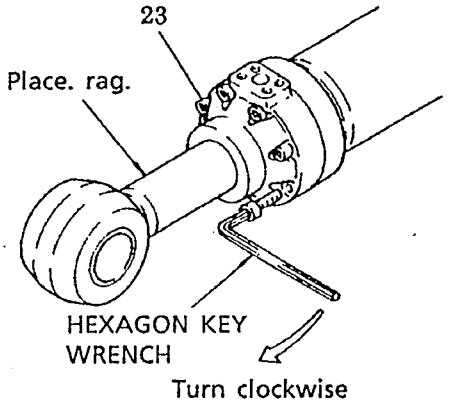


Fig. 41 Tightening socket head capscrew (23)

2. CONSTRUCTION AND FUNCTION

2.1 CONSTRUCTION

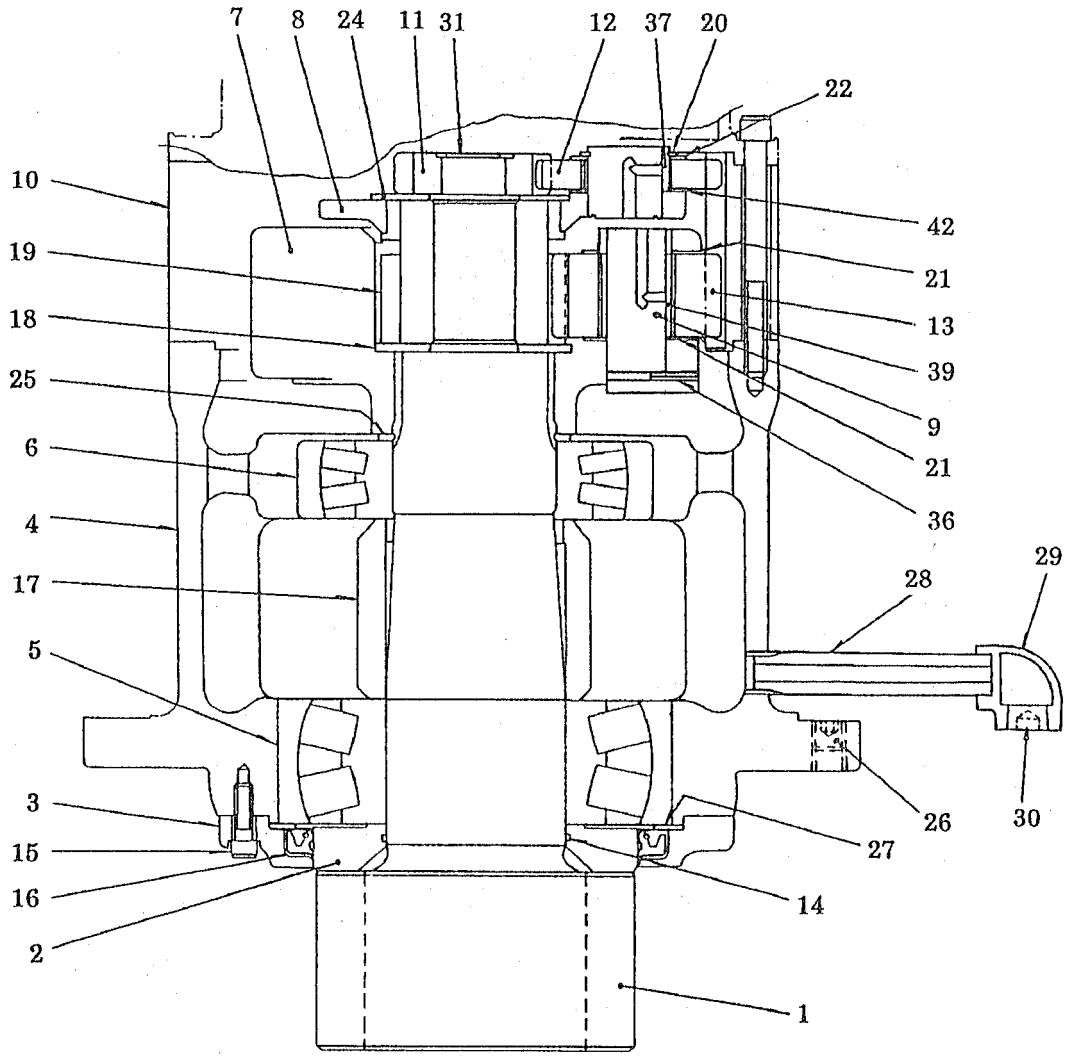


Fig. 2 Fig section of reduction unit

No.	NAME	Q' ty	No.	NAME	Q' ty	No.	NAME	Q' ty
1	PINION SHAFT	1	13	PINION	4	26	SETSCREW	2
2	SLEEVE	1	14	O RING	1	27	SPACER	1
3	RETAINER	1	15	SOCKET BOLT	12	28	PIPE	1
4	HOUSING	1	16	OIL SEAL	1	29	ELBOW	1
5	ROLLER BEARING	1	17	SPACER	1	30	PLUG	1
6	ROLLER BEARING	1	18	SPACER	1	31	SNAP RING	1
7	SPIDER	1	19	SUN GEAR	1	36	SPRING PIN	4
8	SPIDER ASSEMBLY	1	20	SNAP RING	4	37	BEARING	4
9	SHAFT	4	21	THRUST WASHER	8	39	BEARING	4
10	INTERNAL GEAR	1	22	THRUST WASHER	4	42	THRUST WASHER	4
11	SUN GEAR	1	24	SPACER	1			
12	PINION	4	25	SNAP RING	1			

(8) Attaching #1 spider ass'y
Attach #1 spider ass'y

(9) Attaching #1 sun gear
Attach #1 sun gear (11).

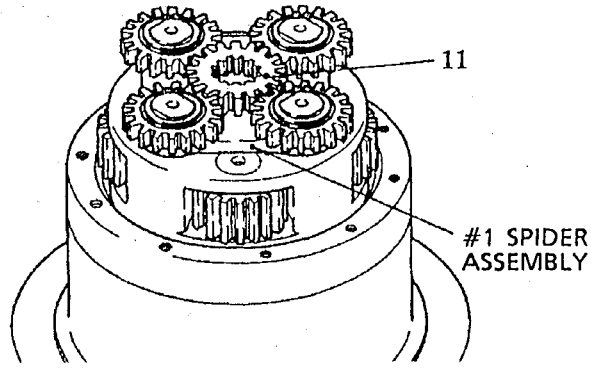


Fig.32 Attaching #1 sun gear

(10) Attaching the internal gear
Coat the matching surface between housing (4) and internal gear (10) with Three Bond 1215 and fix the internal gear while meshing the gear teeth.

☞ Reassemble the internal gear, following the matching marks left on each matching surface at disassembly.

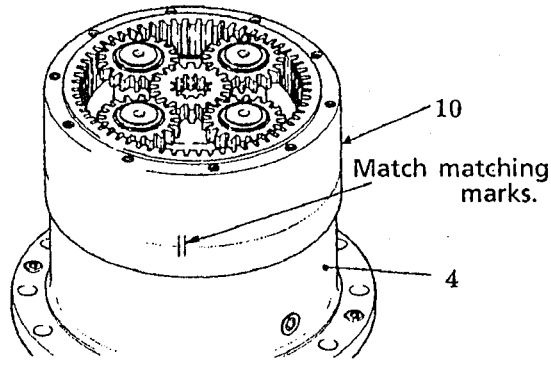


Fig.33 Attaching the internal gear

2.2 PREPARATION BEFORE DISASSEMBLY

1) The reduction unit dismantled from the machine has dust and mud. Wash them with cleaning oil.

☞ Before washing, confirm that each port is plugged.

2) Loosen drain plug (9) and drain the oil out of the reduction unit.

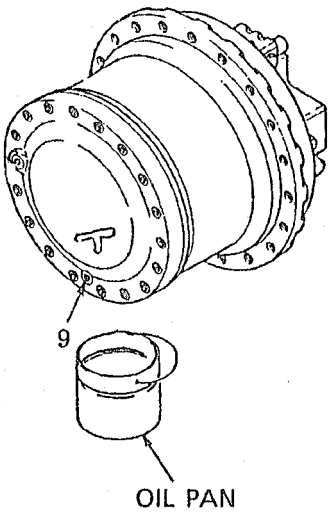


Fig. 6 Emptying oil

2.3 DISASSEMBLY

☞ The figures in parentheses after part names in the instructions correspond to those in Fig. 2.

1) Mount the motor fixing jig (m) on the reduction unit ass'y.
2) Remove capscrew (5) and separate cover (7) from ring gear (6).

☞ Sealing agent is applied to the mating area between cover (7) and ring gear (6). Therefore, it may be a little difficult, in some cases, to remove the cover (7).

3) Attach lifting gear (d) and an eye bolt M8 to #1 spider ass'y (10,11,13,14,15,16,17) and remove the ass'y.
4) Remove spacer (11), sun gear (12) and spacer (50). The M8 screw in spacer (11) is for removing spacer (11). Note that if the spacer will come out if the spider ass'y is separated by the use of the screw.

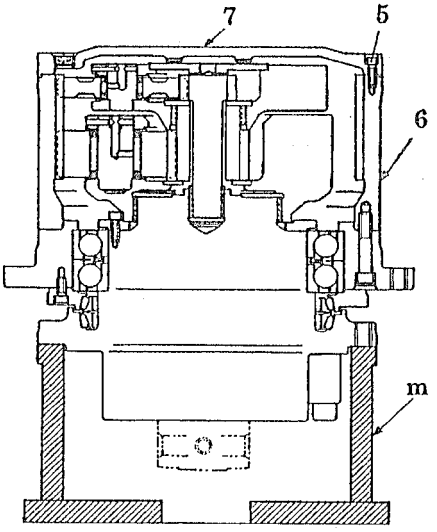


Fig. 7 Separating cover (7)

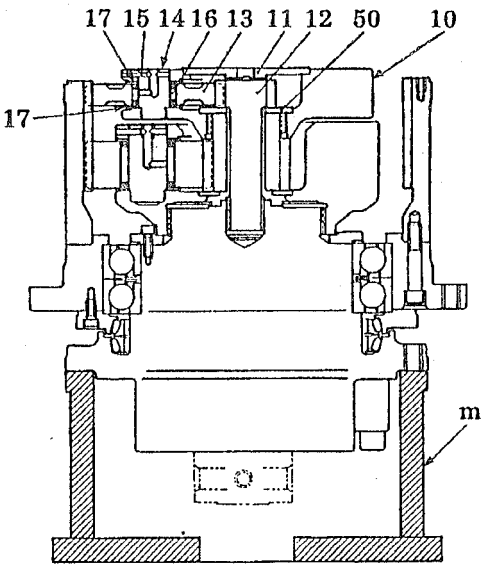


Fig. 8 Dismantling #1 spider ass'y