KOBELCO

SERVICE MANUAL

HYDRAULIC EXCAVATOR

SK80CS-1E

Applicable: SK80CS-1E LF02-01001~

S5LF0004E-00 03/03

7) The removed parts should be put in order and tagged so as to install on proper places without confusion.
8) For common parts, pay attention to the quantity and places.

(3) Inspecting parts

1) Check that the disassembled parts are free from score, dent and seizure.
2) Measure the wear of parts and clearance, and record the measured values.
3) If an abnormality is detected, repair or replace the parts.

(4) Reassembling hydraulic equipment

1) Before cleaning, turn the fan on or open doors to ventilate air.
2) Before assembly, clean parts roughly first, and then completely.
3) Remove oil by compressed air, and apply hydraulic oil or gear oil, and then assemble them.
4) Replace the removed O ring, back-up rings and oil seal with new ones, and apply grease on them before assembling.
5) Removes stain and water on the surface on which liquid sealant are applied, decrease them, and apply liquid sealant on them.
6) Before assembling, remove rust preventives on new parts.
7) Use special tools to fit bearings, bushing and oil seal.
8) Assemble parts matching to the marks.
9) After completion, check that there is no omission of parts.

(5) Installing hydraulic equipment

1) Confirm hydraulic oil and lubrication oil.
2) Air release is required in the following cases ;
   a. Change of hydraulic oil
   b. Replacement of parts on suction pipe side
   c. Hydraulic pump
   d. Swing motor
   e. Travel motor
   f. Hydraulic cylinder

⚠ If hydraulic oil and lubricating oil are not filled and also air bleed is not performed, the hydraulic equipment may be damaged.

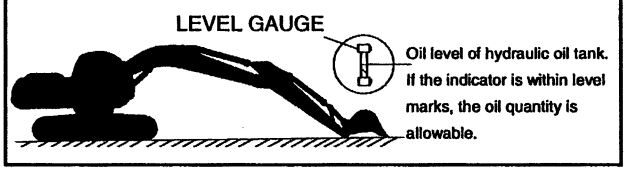
3) For air bleed of hydraulic pump and swing motor, loosen drain plug on the upper part, start engine, and run in low idling, then bleed air until hydraulic oil is oozed out. After completion of air bleed, tighten plug securely.
4) For air bleed of travel motor and hydraulic cylinder, starts engine and operate it for 10 minutes or more at no-load and low speed.

⚠ For cylinder, don't move it to the stroke end at beginning.

5) Air in pilot circuit can be bled out by only operating digging, swing and traveling motions thoroughly.
6) Check hydraulic oil level.
   Move attachments to hydraulic oil check position, and check hydraulic oil level of tank. Refill oil if the oil level is lower than the minimum level.

How to check oil level of hydraulic oil tank

Important Information



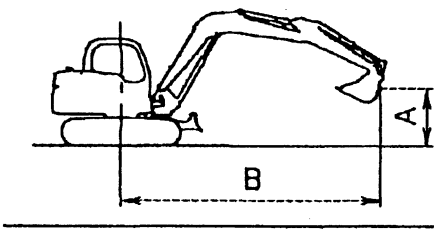
1.4 ELECTRICAL EQUIPMENT

(1) The disassembly of electrical equipment is not allowed.
(2) Handle equipment with care so as not to drop it or bump it.
(3) Connector should be removed by unlocking while holding the connector.
   Never stress in tension to the locked section by pulling wire.
(4) Check that connector is connected and locked completely.
(5) Switch key off before removing and connecting connector
(6) Switch key off before touching terminals of starter and alternator.
(7) Remove battery grounding terminal before beginning work close to battery and battery relay with tools.
(8) Wash machine with care so as not to splash water on electrical equipment and connector.

5. LIFTING DIAGRAM

5.1 LIFTING CAPACITIES

Model		SK80CS-1E	
Arm length		1.8m (5ft-11in)	2.07m (6ft-9in)
Shoe type	Rubber crawler 450mm (17.7in)	(1) LF20T01004P2	(2) LF20T01007P2
	Iron crawler 450mm (17.7in)	(3) LF20T01002P2	(4) LF20T01005P2
	Iron crawler 600mm (23.6in)	(5) LF20T01003P2	(6) LF20T01006P2



1. Do not attempt to lift or hold any load that is greater than these rated values at their specified load radius and height. Weight of all accessories must be deducted from the above lifting capacities.
2. Lifting capacities are based on machine standing on level, firm, and uniform ground.
   User must make allowance for job conditions such as soft or uneven ground out of level conditions, side loads, sudden stopping of loads, hazardous conditions, experience of personnel, etc.
3. Ratings at bucket lift hook.
4. The above rated loads are in compliance with BS1757 : 1986.
   They do not exceed 67% of hydraulic lifting capacity or 75% of tipping load.
   Rated loads marked with an asterisk (※) are limited by hydraulic capacity rather than tipping load.
5. Operator should be fully acquainted with the operator's and Maintenance Instructions before operating this machine and rules for safe operation of equipment should be adhered to at all times.
6. Capacities apply to only machine as originally manufactured and normally equipped by KOBELCO CONSTRUCTION MACHINERY CO. LTD

(1) LF20T01004P2

SK80CS LIFTING CAPACITIES

Based on machine equipped with
Arm 1800mm (5' 11") arm
Bucket 0.28m³ SAE (0.37cu. yd)
Shoe 450mm (17.7") rubber shoe
Dozer Blade Up

A \ B		LOAD RADIUS									
		5' (1.5m)		10' (3.0m)		15' (4.6m)		20' (6.1m)			
15' (4.6m)	lb					※ 3600	3330				
	kg					※ 1630	1510				
10' (3.0m)	lb					3560	3160				
	kg					1610	1430				
5' (1.5m)	lb			6140	5280	3260	2870	2020	1780		
	kg			2780	2390	1480	1300	910	800		
GROUND LEVEL	lb			5700	4870	3020	2640				
	kg			2580	2210	1370	1200				
-5' (-1.5m)	lb	※ 7750	※ 7750	5690	4870	2960	2580				
	kg	※ 3510	※ 3510	2580	2200	1340	1170				
-10' (-3.0m)	lb			5910	5070						
	kg			2680	2300						

Applicable Machines
LF02-01001～

Revision	Date of Issue	Remarks
First edition	March, 2003	S5LF0304E K

4. DOZER

4.1 DOZER DIMENSION

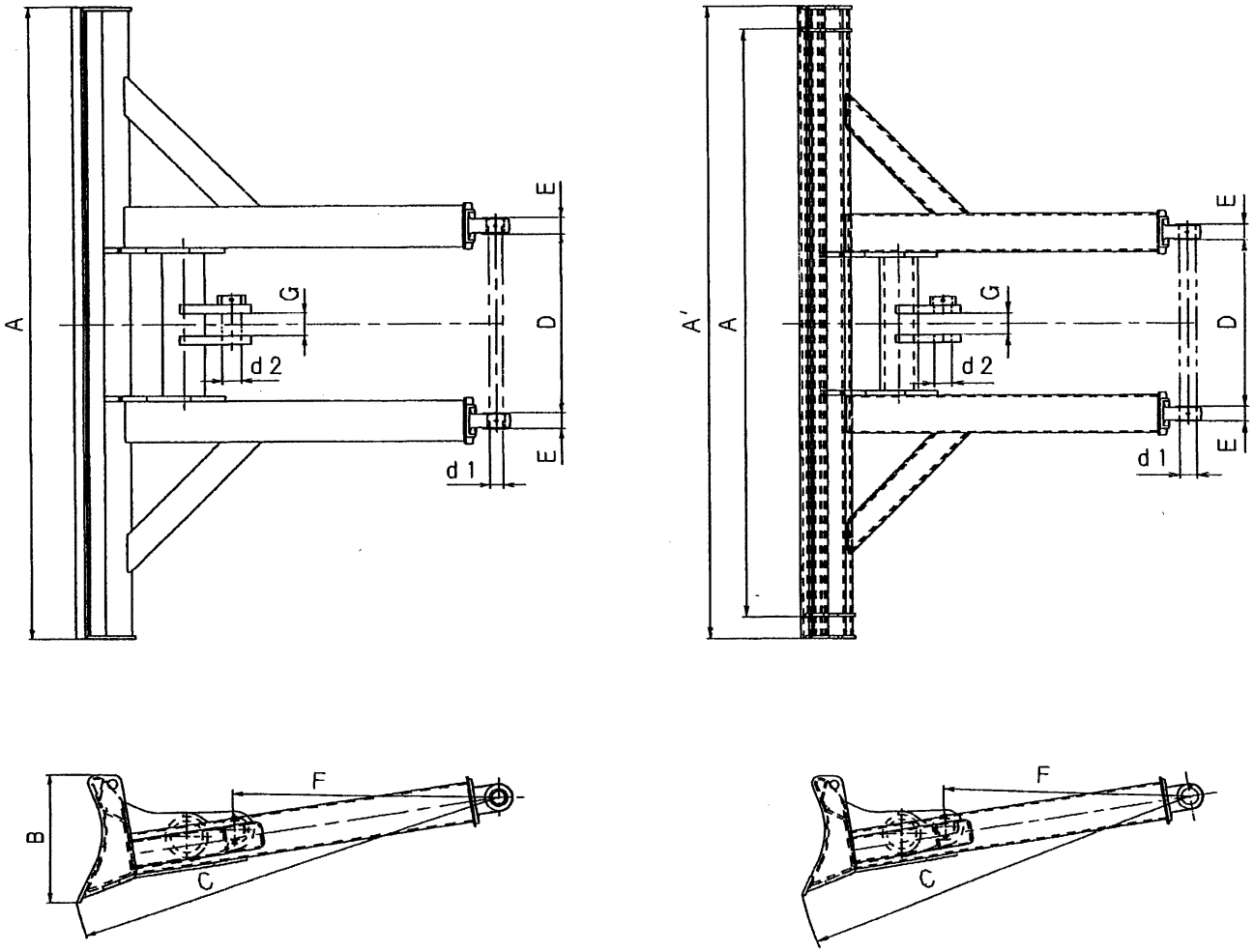


Fig. 4-1 Dozer dimension

Table 4-1 Unit : mm (ft-in)

		LF51B00007F1	LF51B00012F1
No.	Name	Standard	For 600mm (23.6″) shoes
A	Blade width	2,320 (7′7″)	←
A′	Blade width	—	2,494 (8′2.2″)
B	Blade height	470 (18.5″)	←
C	Distance from dozer attaching pin center to cutting edge end	R1,568 (4′10″)	←
D	Inner width of dozer attaching bracket	653 (25.7″)	←
E	Width of dozer attaching bracket	60 (2.36″)	←
F	Distance from dozer attaching pin center to attaching pin on dozer cylinder head side	R969 (38.1″)	←
G	Attaching bracket inner width on dozer cylinder head side	82 (3.23″)	←
d1	Dozer attaching pin dia.	Ø50 (1.97″)	←
d2	Attaching pin dia. on dozer cylinder head side	Ø70 (2.76″)	←

4. PLUG

(1) Plug for hydraulic pipe joint

1) Cap nut

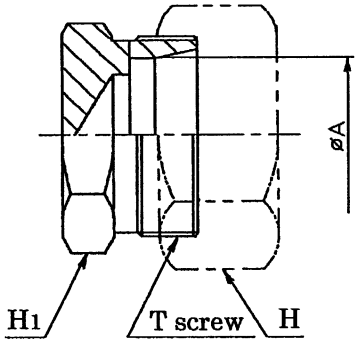


Table 4-1

Applicable pipe O. D : A	Cap nut parts No.	T screw	Opposing flat	
			H1	H
6	ZF83H06000	M12×1.5	14	14
8	ZF83H08000	M14×1.5	17	17
10	ZF83H10000	M16×1.5	17	19
12	ZF83H12000	M18×1.5	19	22
15	ZF83H15000	M22×1.5	24	27
18	ZF83H18000	M26×1.5	27	32
22	ZF83H22000	M30×1.5	32	36
28	ZF83H28000	M36×1.5	38	41

2) Plug

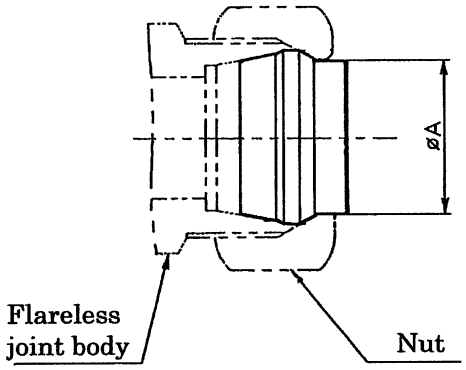


Table 4-2

Applicable pipe O. D : A	Plug parts No.
6	ZF83P06000
8	ZF83P08000
10	ZF83P10000
12	ZF83P12000
15	ZF83P15000
18	ZF83P18000
22	ZF83P22000
28	ZF83P28000

3) Nut

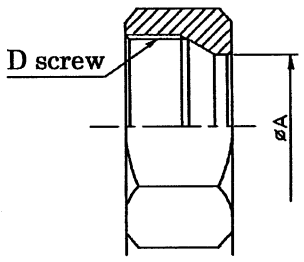


Table 4-3

Applicable pipe O. D : A	Nut parts No.	D screw	Opposing flat
6	ZF93N06000	M12×1.5	14
8	ZF93N08000	M14×1.5	17
10	ZF93N10000	M16×1.5	19
12	ZF93N12000	M18×1.5	22
15	ZF93N15000	M22×1.5	27
18	ZF93N18000	M26×1.5	32
22	ZF93N22000	M30×1.5	36
28	ZF93N28000	M36×1.5	41
32	ZF93N32000	M42×1.5	50
35	ZF93N35000	M45×1.5	55
38	ZF93N38000	M48×1.5	60

NOTES

Unit : Hour

Group		Location	Work to be done	Unit	Remarks	SK80MSR-1E / SK80CS-1E
06 Electric equipments	M-5	Cable assy (P/W motor OPT)	Replace	1		0.5
	M-6	Power window lock motor (OPT)	Replace	1		0.2
	M-7	Power window lock motor (OPT)	Replace	1		0.2
	M-8	Skylight wiper motor (OPT)	Replace	1		0.2
		Proportional valve				
	PSV-B	P2 by-pass cut proportional valve	Replace	1	Include proportional valve removing and installing.	2.0
	PSV-C	Travel straight proportional valve	Replace	1		2.0
	PSV-D	P1 neutral cut proportional valve	Replace	1		2.0
		Relay				
	R-1	Battery relay	Replace	1		0.2
	R-3	Glow relay	Replace	1		0.2
	R-4	Safety relay	Replace	1	Include guard (9) removing and installing	0.4
	R-5	Wiper motor relay	Replace	1	Include C1 controller removing and installing	0.3
	R-6	Washer motor relay	Replace	1		0.3
	R-7	Horn relay	Replace	1		0.3
	R-8	Work light relay	Replace	1		0.3
	R-9	Wiper relay assy (OPT)	Replace	1		0.3
		Sensor				
	SE-1	Pressure sensor (low pressure ; bucket digging)	Replace	1		0.2
	SE-2	Pressure sensor (low pressure ; bucket dump)	Replace	1		0.2
	SE-3	Pressure sensor (low pressure ; boom up)	Replace	1		0.2
	SE-4	Pressure sensor (low pressure ; boom down)	Replace	1		0.2
	SE-5	Pressure sensor (low pressure ; swing left)	Replace	1		0.2
	SE-6	Pressure sensor (low pressure ; swing right)	Replace	1		0.2
	SE-7	Pressure sensor (low pressure ; arm in)	Replace	1		0.2
	SE-8	Pressure sensor (low pressure ; arm out)	Replace	1		0.2
	SE-9	Pressure sensor (low pressure ; travel right)	Replace	1	Include removing and installing guard on cab lower side.	0.4
	SE-10	Pressure sensor (low pressure ; travel left)	Replace	1	Include removing and installing guard on cab lower side.	0.4
	SE-13	Engine speed sensor	Replace	1	Include guard removing and installing.	0.5
	SE-14	Engine water temperature sensor	Replace	1		0.2
	SE-15	Fuel sensor	Replace	1	Include guard removing and installing.	0.3
	SE-16	Accel potentio	Replace	1		0.2
		Solenoid				
	SV-1	Swing parking SOL	Replace	1	Include proportional valve removing and installing.	2.0
	SV-2	Conflux. single flow switching SOL (OPT)	Replace	1	Include proportional valve removing and installing.	2.0
	SV-3	2-speed travel SOL	Replace	1	Include proportional valve removing and installing.	2.0
	SV-4	Lever lock SOL	Replace	1	Include proportional valve removing and installing.	2.0
		Switch				
	SW-1	Key switch	Replace	1		0.2
	SW-2	Switch	Replace	1		0.2
	SW-3	2-speed travel switch	Replace	1		0.2
	SW-4	Swing parking release switch	Replace	1		0.2
	SW-6	Engine water temperature switch	Replace	1		0.2
	SW-7	Engine oil pressure switch	Replace	1		0.2
	SW-8	Clogged air filter switch	Replace	1		0.1
	SW-10	Horn switch	Replace	1		0.2
	SW-11	Lever lock switch	Replace	1		0.3
	SW-12	Heater switch (OPT)	Replace	1		0.2

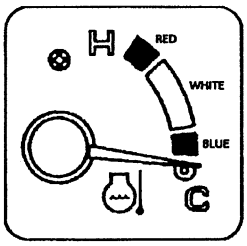
3. MEASUREMENT OF ENGINE SPEED

3.1 MEASUREMENT OF ENGINE SPEED

(1) Warming up of engine

Start engine to raise the coolant temperature of engine to 40° to 80℃. (104° to 176°F)

Engine water temperature gauge



The E/G coolant temperature gauge is used to measure. The range in white color shows the temperature of approx. 40° to 100℃ (104° to 212°F), so confirm that the measured value indicates the temperature within the range of white color.

(2) Measuring with diesel engine speed meter

1) Install diesel engine speed meter pickup on and of injection pipes on which the pickup can be easily installed. (See Fig. 1.)
2) Check E/G speed shown in Table 1 in idling speed.

(3) Engine speed measured value through service diagnosis (See Fig. 2.)

Insert precision driver (—) into convex place indicated by arrow of hard check SW [A], [B] in C—1 controller, then direct the arrow to [A] = 0, [B] = 2, and 3 digits in unit of 10rpm are displayed on service diagnostic display of controller,

Example : 210 in display→ 2100rpm

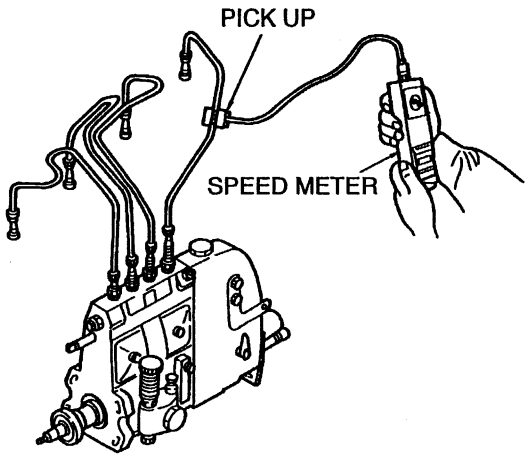


Fig. 1 Measurement of E/G speed

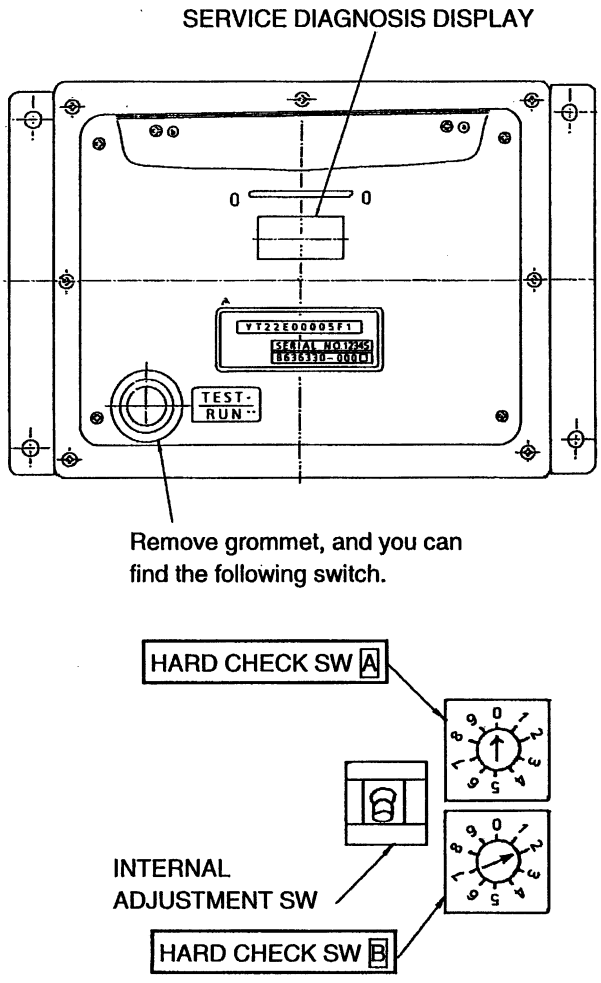


Fig. 2 E/G speed measuring hard check SW

8. MEASURING PERFORMANCES OF SLEWING BEARING

(1) Purpose

Measure the gap between the lower frame and the bottom face of the slewing bearing and estimate the degree of wear of the slewing bearing.

(2) Condition

Plain, level and solid ground

The slewing bearing mounting bolts are not loosened.

The slewing bearing is lubricated well, not making abnormal sound during turning.

(3) Preparation

1) Install a dial indicator to the magnetic base and fix it to the lower frame.
2) Direct the upper structure and the lower frame toward the travel direction, bring the probe of the dial indicator in contact with the bottom surface of the outer race and set the reading at zero.

(4) Measurement 1 (Measuring position Ⅰ and Ⅱ)

1) Measure the travel of the outer race in the axial direction in position Ⅰ [The arm at 90° ~110° and the crawler front lifted about 30cm (1ft)] and in position Ⅱ , using a dial indicator.

(5) Measurement 2 (Measuring position Ⅲ)

1) With the arm cylinder most retracted and the bucket dump, lift the tip of the tooth of the bucket about 10mm (0.4in) and move the tip of the bucket to the right and the left by man power.

But in this case, the gap of the attachment is included.

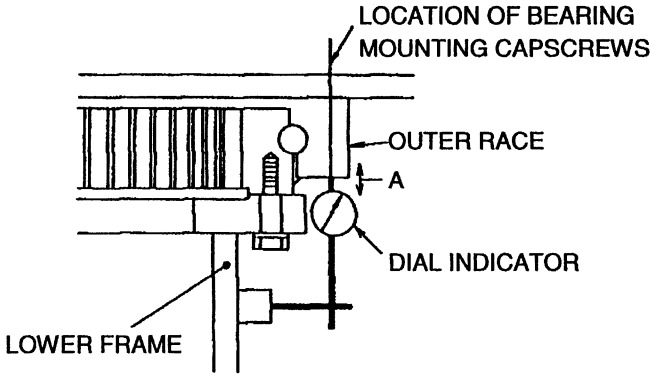


Fig. 33 How to measure the axial play of slewing bearing

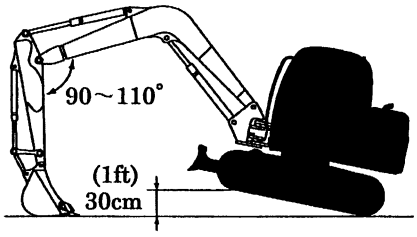


Fig. 34 Measuring position Ⅰ

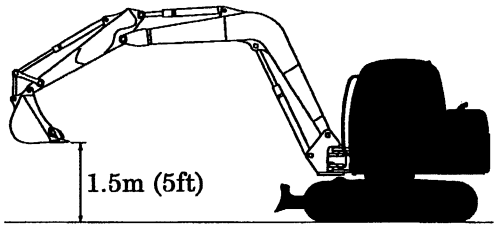


Fig. 35 Measuring position Ⅱ

Axial play of slewing bearing Table 16 Unit : mm(in)

Measuring position	Standard value	Repairable level	Service limit
A	0.5~1.5 (0.02~0.06)	1.9~2.9 (0.07~0.11)	3.0~ (0.12~)

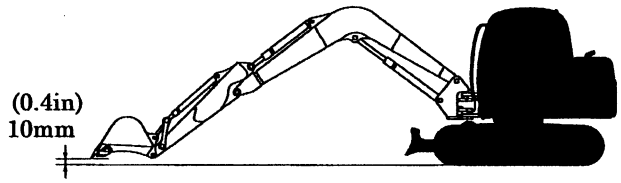


Fig. 36 Measuring position Ⅲ

Right left movement of the tip of bucket Table 17 Unit : mm(in)

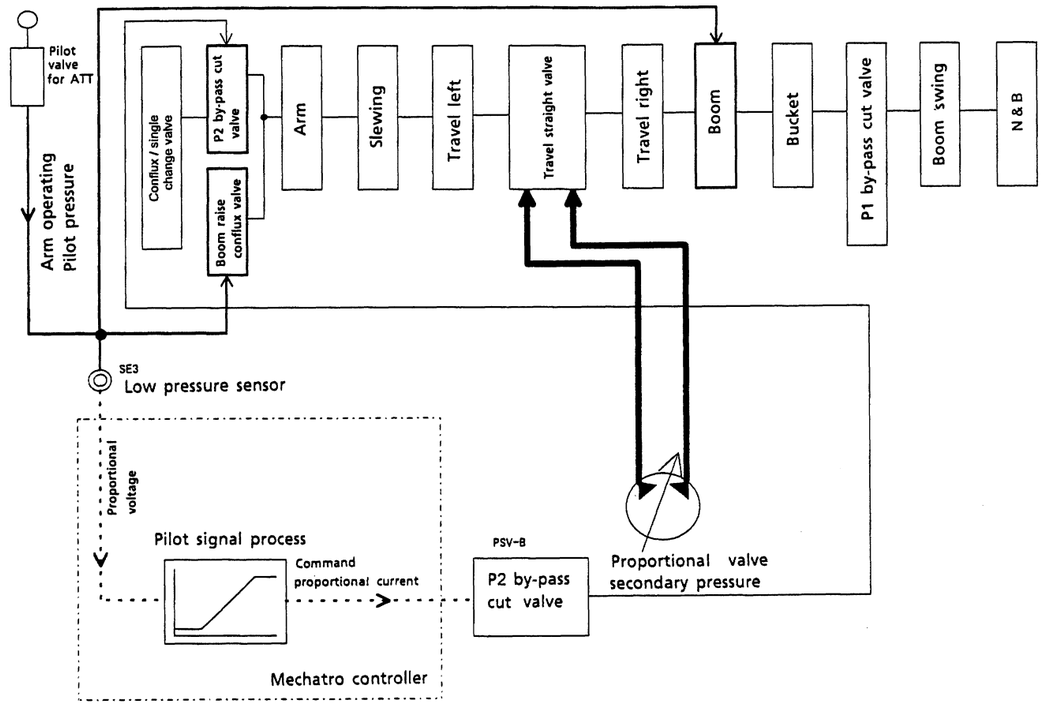
Measuring position	Standard value	Repairable level	Service limit
Bucket tiptoe	70 (2.8)	175 (6.9)	210 (8.3)

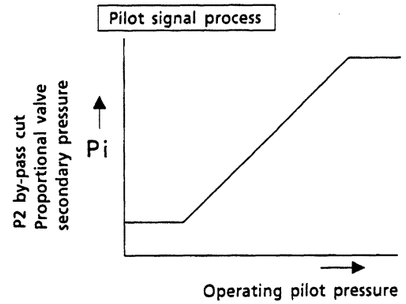
OPERATIONS AND MECHATRO CONTROL EQUIPMENT

H/V ; Pressure→Volt
V/A ; Volt→Ampere

Operation side output signal			Mechatro control equipment		Mechatro control equipment H/V	Mechatro control equipment V/A		Mechatro control equipment Solenoid valve (Current→hydraulic pressure)							Hydraulic equipment (C/V spool)					H/V
					Low pressure sensor or pressure SW.	Controller		Slewing parking brake	Conflux / single change	Travel two-speed	Safety lock lever	P2 by-pass cut	Travel straight	P1 By-pass cut	P1 By-pass cut valve	P2 By-pass cut valve	Travel straight valve	Travel two-speed select	Conflux / single change valve	Governor motor
						IN	OUT	1	2	3	4	B	C	D						M2
Hydraulic pressure	Independent operation	Bucket	Digging	SE1	○	—														○
			Dump	SE2	○	—														○
		(conflux) Boom	Raise	SE3	○	○						○				○				○
			Lower	SE4	○	—														○
		Slewing (Cut valve control)	Left	SE5	○	○	○					○				○				○
			Right	SE6	○	○	○					○				○				○
		(conflux) Arm (conflux)	In	SE7	○	○	○							○	○					○
			Out	SE8	○	○								○	○					○
		Travel	Right	SE9	○	—														○
			Left	SE10	○	—														○
		Boom swing	Left	SW30,32	○	○														○
			Right	SW31,33	○	○														○
		N & B	Close	SW35	○	○			○											○
			Open	SW35	○	○			○											○
	Combined operation	Bucket / Travel	Digging	SE1 SE9,10	○	○						○	○	○	○	○	○			○
			Dump	SE2 SE9,10	○	○						○	○	○	○	○	○			○
		Boom / Travel)	Raising	SE3 SE9,10	○	○						○	○	○	○	○	○			○
			Lowering	SE4 SE9,10	○	○						○	○	○	○	○	○			○
		Slewing / Travel	Left	SE5 SE9,10	○	○	○					○	○	○	○	○	○			○
			Right	SE6 SE9,10	○	○	○					○	○	○	○	○	○			○
		Arm / Travel	In	SE7 SE9,10	○	○	○					○	○	○	○	○	○			○
			Out	SE8 SE9,10	○	○						○	○	○	○	○	○			○
Electric		Safety lock lever	SW−11 ON		—	—	—				○									—
		Travel two-speed	SW−3 ON		—	—	—			○									○	—
		Slewing parking brake release	SW−4 ON		—	—	—	○												—
		Conflux / single change	SW−17 ON						○										○	

2. BOOM RAISE CONFLUX MECHATRO CONTROL SYSTEM





1) Start boom raise operation, and the boom raise operation pilot pressure switches boom spool and boom conflux spool, and inputs into low pressure sensor.
2) The voltage output by low pressure sensor is input into mechatro controller, and the controller processes the pilot signal and outputs the command corresponding to input voltage to P2 by-pass cut valve.
3) P2 by-pass cut valve outputs pilot proportional valve secondary pressure corresponding to the command output by mechatro controller, and switches P2 by-pass cut valve of control valve.
4) Operation pilot pressure switches boom main spool and boom conflux valve. And the oil delivered by P1 and P2 pump is confluxed in P2 by-pass cut valve switched by mechatro control.

2. HYDRAULIC CIRCUITS AND COMPONENT MODEL

Standard spec.		LF01Z00007P1	
No.	NAME	PART No.	MODEL No.
1	PUMP ASSY (WITH GEAR PUMP)	YT10V00002F2	K3SP36B
2	CONTROL VALVE	LF30V00001F2	BCV75—A9
3	CONTROL VALVE	YR30V00014F1	KVS65—1
4	SLEWING MOTOR UNIT	YT15V00001F3	SG025E—096
5	TRAVEL MOTOR	YT15V00008F1	GM09VN
6	BOOM CYLINDER	LF01V00005F1	110—70—916
7	ARM CYLINDER	YT01V00002F1	95—65—813
8	BUCKET CYLINDER	YT01V00019F1	80—55—735
9	SWING CYLINDER	LF01V00002F3	105—65—594
10	DOZER CYLINDER	LF01V00004F1	120—70—150
11	SWIVEL JOINT	24100J12125F2	
12	PILOT VALVE (ATT)	PA30V00002F3	PV48M1086
13	PILOT VALVE (TRAVEL)	YN30V00070F1	PVD6P4017A
14	PILOT VALVE	YN30V00080F1	
15	PROPORTIONAL VALVE BLOCK	YT35V00011F1	7KWE5G-30/G24WR-705A
16	RETURN FILTER	YR50V00004P1	Y—418900
17	CHECK VALVE	2436R576F3	Y2389
18	SUCTION STRAINER	YT50V00001F2	Y-353800
19	INLINE FILTER	YN50V00007F1	
20	BREATHER	YN57V00002F4	Y—358600
21	CONNECTOR	HH25X04004G3	
22	CONNECTOR	2444Z3541	
23	CHECK VALVE	YT21V00002P1	
24	STOP VALVE	24100P1006F1	
25	SELECT VALVE	24100P1005F1	
26	SOLENOID VALVE ASSY	YR35V00009F2	16083-00000
27	VALVE SELECTOR (OPT.)	YY30V00019F2	K16AR8-15 (D)

6. BOOM CIRCUIT

This section describes the boom raise conflux operation.

1) Boom raise pilot circuit
2) Boom raise 2 pumps conflux main circuit in C/V

6.1 BOOM RAISE PILOT CIRCUIT

Operation :

1) Start boom raise operation, and pilot proportional secondary pressure from right pilot valve (12) is output through port (3), and acts on low pressure sensor (SE3), and at the same time the pressure is branched into 2 circuits and acts on Pa2 and Pc4 ports of C/V (2).
2) The voltage output by low pressure sensor is processed by mechatro controller and outputs command current to P2 by-pass cut valve (PSV-B) and solenoid valve outputs proportional secondary pressure and the pressure acts on C/V (2) Pd4 port.
3) Then, the secondary pressure fed into C/V (2) Pa2 port switches boom conflux spool. And the solenoid proportional secondary pressure fed into Pd4 port switches P2 by-pass cut valve.

6.2 BOOM RAISE 2 PUMPS CONFLUX MAIN CIRCUIT IN C/V

Principle : Boom raise speed up

Principle : Confluxing oil from 2 pumps

Operation :

1) The oil delivered through A1 port of P1 pump flows into C/V (2) P1 port, and branches into by-pass circuit and parallel circuit. However since the boom spool is moved and by-pass circuit is closed, the oil opens load check valve through parallel circuit and flows into boom spool.
2) On the other hand, the oil delivered through A2 port or P2 pump passes through C/V (2) P2 port, flows into travel straight section, and branches into by-pass circuit and parallel circuit. However, since p2 by-pass cut valve is switched and closed, the oil passes through the outside of boom conflux spool from parallel circuit, opens load check valve from boom conflux circuit, confluxes with oil delivered by P1 pump inside, and flows into boom spool.
3) Then the oil passes through boom spool, opens lock valve of boom lock valve, and is led into H side of boom cylinder through C/V (2) A2 port.
4) The return oil from boom cylinder R side flows into tank circuit through boom spool from C/V (2) B2 port.

9. BOOM SWING CIRCUIT

The following functions are explained.

1) Boom swing action when the slewing and boom swing actions are changed over
2) Boom left swing pilot circuit
3) Boom left swing main circuit
4) Rightward drift prevention with swing lock valve

9.1 BOOM SWING ACTION WHEN THE SLEWING AND BOOM SWING ACTION ARE CHANGED OVER

[Mechatro controller]

1) If the button switch (SW-20) on the left operating lever grip is turned [ON], the slewing/swing select relay (R-14) is switched over. This energizes the solenoid (SV-5) and changes over the solenoid valve (26). (Refer to the electric circuit diagram.)
   If the solenoid valve (26) is changed over, the slewing action can be changed over to the swing action.
2) The boom swing action can be performed either if the button switch (SW-20) is kept pressed or when the boom swing action is going on. The switches that operate while the boom action is going on are the pressure switches (SW-32, SW-33) that are located between the operating pilot valve (12) and the solenoid valve (26).
   These pressure switches work on the hold relays for safety sake that prevent the boom swing action from being switched over to the slewing action in case your thumb should slips off the hold. If the lever is brought to neutral and when the secondary pressure is lowered, the hold function by the hold relay disappears.

9.2 PILOT CIRCUIT FOR BOOM SWING (LEFT)

Operation :

1) If the left operating lever is turned to the left the same way as the slewing action, the boom swings to the left.
   Secondary pilot pressure then comes out of port ⑤ of the pilot valve (12) and acts upon the low-pressure switches (SW-32, SW-30). At the same time, the pressure acts upon the Pa5 port of the control valve (2).

9.3 BOOM LEFT SWING MAIN CIRCUIT

Operation :

1) The oil delivered by the P1 pump enters the P1 port of C/V(2) and is split into the bypass line and the parallel line by means of the travel straight valve. The oil then enters the boom swing spool. However since the spool is shifted and the bypass cut is closed, the oil pushes open the load check valve by way of the parallel line and enters the boom swing spool.
2) Next, the oil enters the A5 port of C/V(2) via the boom swing spool and is supplied to the H side of the boom swing cylinder from the A5 port of C/V(2).
3) In the meantime, the oil returning from the R side of the boom swing cylinder enters the B5 port of C/V(2) and returns to the tank line.

9.4 RIGHTWARD DRIFT PREVENTION WITH SWING LOCK VALVE

Purpose :

Prevents natural rightward projection by right swing.

Operation :

< Where boom swing secondary operating pressure is available >

1) If the right boom swing operation is performed, secondary pilot pressure flows out of port ⑥ of the ATT pilot valve (12), passes through the solenoid valve (26), is split into two lines and acts upon the Pb5 and Pb5' ports of the control valve (2).
2) If the secondary pressure enters the boom swing lock valve release port Pb5', the back pressure of the lock valve reaches the tank line from the drain port DR8. This makes the lock valve easy to open. Thus the oil returning from the H side of the arm cylinder opens the lock valve and enters the arm spool.
3) If the pressure switch (SW-32, 33) is turned on by the secondary pressure with the decelerator on, the decelerator is released. However, it returns to "ON" four seconds after the pressure switch is turned off.

< Where boom swing secondary pressure is not available >

If pilot pressure lowers at the boom swing lock valve release port Pb5', the lock valve is seated completely because the back pressure receiving area of the lock valve is large. This prevents the oil on the H part of the boom swing cylinder from returning to the boom swing spool of C/V(2). This in turn reduces oil leakage through the spool to zero to prevent the swing motion from drifting to the right.

13. CONTROL LINES

Note ; Bypass cut = Newtal cut

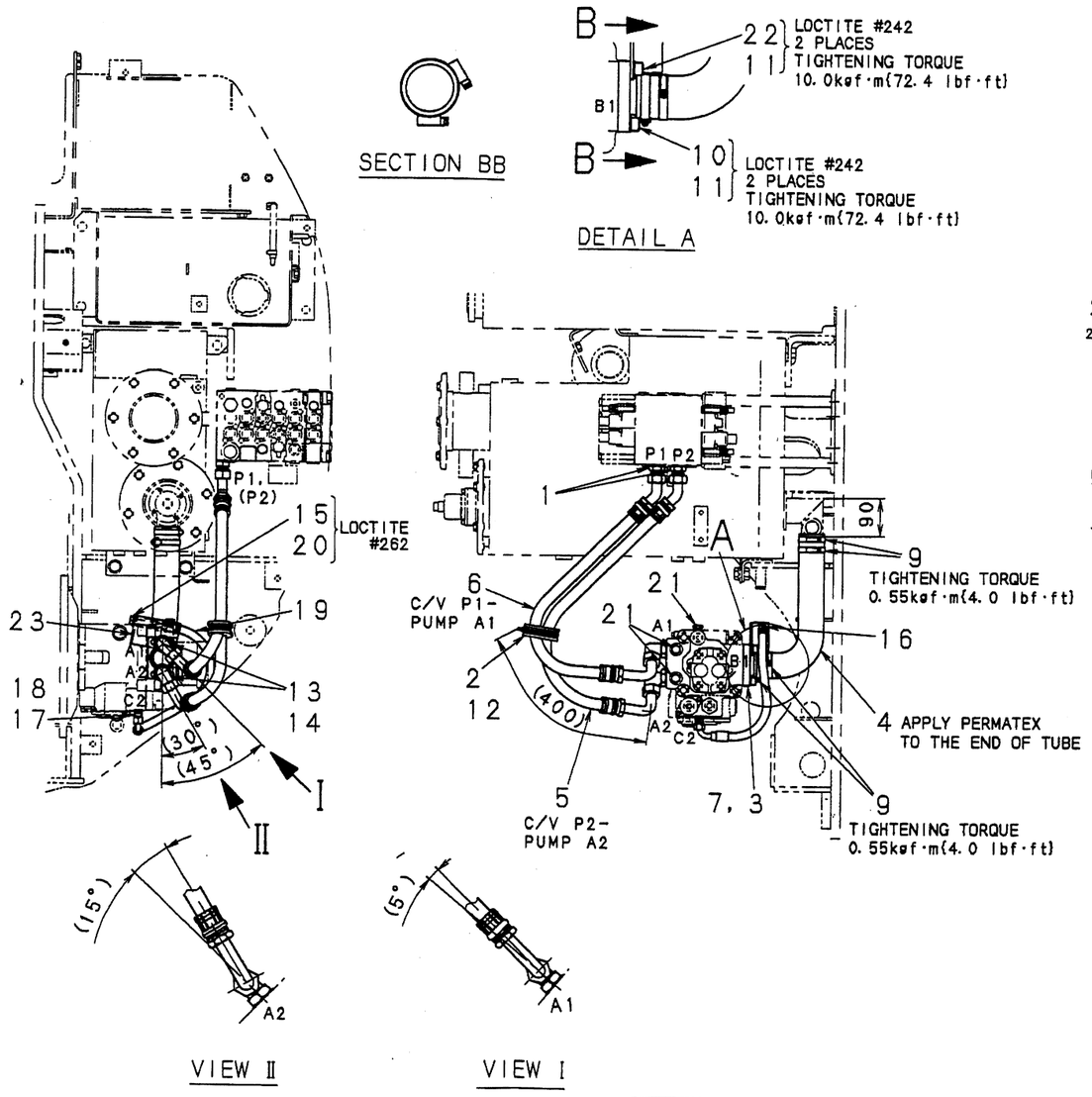
No.	NAME	Q'TY	REMARKS
(1)	YT06H00015F2		Pump control
1	INLINE FILTER	1	YN50V00007F1
2	CONNECTOR	1	PF3/8
3	ELBOW	3	PF3/8
4	PLUG	1	PF1/4
5	ELBOW	1	PF3/8
6	TEE	1	PF3/8
7	TEE	1	2-PF3/8-PF1/4
8	CAPSCREW	2	M10×20
9	WASHER	2	M10
10	HOSE ; L=550	1	Dellivery relief
11	HOSE ; L=400	1	Pilot delivery
12	CONNECTOR	1	PF1-Ø25.4
13	HOSE	1	Suction
14	CLIP	2	
15	ELBOW	1	PF3/4-Ø25.4
16	HOSE GUARD	2	
17	CONNECTOR	1	PF1/4
18	ELBOW	1	PF1/4
19	TUBE	1	
20	HOSE ; L=650	1	Drain
(2)	LF64H00010F1		SOL. valve control lines
1	SOLENOID VALVE	1	YT35V00011F1
2	CAPSCREW	2	M10×70
3	WASHER	2	M10
4	ELBOW	1	PF3/8
5	ELBOW	7	PF1/4
6	CONNECTOR	1	PF3/8 with filter
8	ELBOW	2	PF3/8
9	HOSE ; L=450 PF3/8	1	Sol. 4 ; lever lock primary press.
10	HOSE ; L=3400 PF1/4	1	Sol C ; Travel priority command
11	HOSE ; L=850 PF1/4	1	Sol. 3 ; Travel 2speed changeover
12	HOSE ; L=1550 PF1/4	1	Sol.1 ; Panking brake primary press.
13	HOSE ; L=2600 PF1/4	1	Sol. D ; P1 bypass cut & arm conflux
14	HOSE ; L=3150 PF1/4	2	Sol. B ; P2 bypass cut command Sol. 2 ; Slewing flow conflux changeover
15	HOSE ; L=3200 PF3/8	1	Drain
16	HOSE ; L=2700 PF3/8	1	A3 Pilot pump delivery
18	TUBE	1	L=500
19	GROMMET	2	
20	CLIP	8	
21	RUBBER	1	L=290
22	RUBBER	2	L=100
23	RUBBER	1	L=220
24	CLIP	3	
25	RUBBER	1	L=270
26	TUBE	1	L=750
27	TUBE	1	L=400
29	GROMMET	1	
(3)	LF64H00011F1		P/T block control lines
1	BLOCK	1	
2	CONECTOR	1	PF3/8
3	CONECTOR	2	PF1/4
4	CONECTOR	1	PF3/8 L=23
5	ELBOW	3	PF3/8
6	ELBOW	3	PF1/4
7	ELBOW	1	PF3/8
10	ELBOW	1	PF3/8-PF1/4
11	CAPSCREW	2	M8×40
12	WASHER	2	M8
13	TEE	1	PF3/8
15	CONNECTOR	1	PF1/4 L=23

No.	NAME	Q'TY	REMARKS
(4-1)	LF68H00013F1		Att remote control lines
1	PILOT VALVE	2	PA30V00002F3
2	CONNECTOR	8	PF1/4
3	CONNECTOR	2	PF1/4 with filter
4	CONNECTOR	2	PF3/8-PF1/4
5	HOSE ; L=1450 PF1/4	1	P/V P ; Primary pressure
6	HOSE ; L=2050 PF1/4	1	P/V P ; Primary pressure
7	HOSE ; L=1400 PF3/8	1	P/V T ; Drain
8	HOSE ; L=1900 PF3/8	1	P/V T ; Drain
9	HOSE ; L=2600 PF3/8	1	P/V T ; Drain
10	HOSE ; L=3450 RED	1	P/V 6 ; Slewing right
11	HOSE ; L=3450 BLUE	1	P/V 7 ; Arm in
12	HOSE ; L=3800 GREEN	1	P/V 8 ; Arm out
13	HOSE ; L=2700 GRAY	1	P/V 5 ; Slewing left
14	HOSE ; L=3200 RED	1	P/V 1 ; Bucket digging
15	HOSE ; L=2800 BLUE	1	P/V 2 ; Bucket dump
16	HOSE ; L=3200 GREEN	1	P/V 3 ; Boom up
17	HOSE ; L=2800 GLAY	1	P/V 4 ; Boom down
18	HOSE	2	
19	BOOT	2	
20	GROMMET	1	
21	WASHER	1	M10
22	CLIP	1	
23	CLIP	2	
24	CAPCREW	8	M6×25
25	CAPCREW	1	M10×20
26	WASHER	8	M6
27	BUSHING	1	
(4-2)	LF68H00014F1		ATT. remote control
1	PILOT VALVE	2	PA30V00002F3
2	CONNECTOR	8	PF1/4
3	CONNECTOR	2	PF1/4 with filter
4	CONNECTOR	2	PF3/8-PF1/4
5	HOSE ; PF1/4 L=1450	1	Pilot primary
6	HOSE ; PF1/4 L=2050	1	Pilot primary
7	HOSE ; PF3/8 L=1400	1	Drain
8	HOSE ; PF3/8 L=1900	1	Drain
9	HOSE ; PF3/8 L=2600	1	Drain
10	HOSE ; PF1/4 L=3450	1	RED PV6 ; Slewing right
11	HOSE ; PF1/4 L=3450	1	BLUE PV7 ; Arm in
12	HOSE ; PF1/4 L=3450	1	GREEN PV8 ; Arm out
13	HOSE ; PF1/4 L=3450	1	GRAY PV5 ; Slewing left
14	HOSE ; PF1/4 L=2800	1	RED PV1 ; Bucket digging
15	HOSE ; PF1/4 L=2800	1	BLUE PV2 ; Bucket dump
16	HOSE ; PF1/4 L=2800	1	GREEN PV3 ; Boom up
17	HOSE ; PF1/4 L=2800	1	GRAY PV4 ; Boom down
18	HOSE	2	
19	BOOT	2	
20	TUBE	2	
21	GROMMET	1	
22	WASHE5R	1	M10
23	CLIP	1	
24	CLIP	8	
25	CAPSCREW	8	M6×25
26	CAPSCREW	1	M10×20
27	WASHER	8	M6
28	BUSHING	1	
(5)	LF64H00006F2		Tower block control lines
1	BLOCK	1	
2	BRACKET	1	
3	ELBOW	8	

No.	NAME	Q'TY	REMARKS
5	HOSE ; PF1/4 L=500	1	B4 ; Boom down
6	HOSE ; PF1/4 L=900	1	B7 ; Arm in
7	HOSE ; PF1/4 L=1000	1	B2 ; Bucket dump
8	HOSE ; PF1/4 L=1600	1	B6 ; Slewing RH
9	CAPSCREW	2	M8×25
10	CAPSCREW	2	M10×25
11	WASHER	2	M8
12	WASHER	2	M10
13	PLUG	1	PF1/4
14	PRESSURE SENSOR	3	LC52S00011P1
(6)	LF64H00005F2		Multi control lines
1	CONTROL VALVE	1	YY30V00019F2
2	BRACKET	1	
3	SUPPORT	1	
4	ELBOW	15	PF3/8-PF1/4
5	TEE	3	PF1/4
6	ELBOW	3	PF1/4
8	ELBOW	1	PF3/8-PF1/4
9	HOSE ; PF1/4 L=300	1	⑧ : Arm out
10	HOSE ; PF1/4 L=400	2	① : Bucket digging, ③ : Boom up
11	HOSE ; PF1/4 L=600	1	④ : Boom down
12	HOSE ; PF1/4 L=900	1	⑦ : Arm in
13	HOSE ; PF1/4 L=1000	1	② : Bucket dump
14	HOSE ; PF1/4 L=1500	2	S/V P1 & P2 line
15	CAPSCREW	4	M8×20
16	CAPSCREW	4	M10×2
17	CAPSCREW	3	M10×30
18	WASHER	4	M8
19	WASHER	7	M10
20	PRESSURE SENSOR	3	LC52S00011P1
(7)	LF06H00005F1		STD Main control valve lines
1	ELBOW	16	PF1/4
2	TEE	12	PF1/4
3	CONNECTOR	21	PF1/4
4	CONNECTOR	5	PF1/4 L=38
5	PRESSURE SENSOR	4	LC52S00011P1
6	CONNECTOR	1	PF1/4-PF3/8 L=84
7	HOSE ; L=1000 PF1/4	1	DR1 ; Drain
8	HOSE ; L=1200 PF1/4	1	DR3 ; Drain
9	HOSE ; L=750 PF1/4	2	DR7 ; Drain
10	HOSE ; L=1650 PF1/4	1	DR6 ; Drain
11	HOSE ; L=750 PF1/4	2	PC3' ; Arm in check open command PS ; Slewing priority command for check close
12	HOSE ; L=1050 PF1/4	1	PC4 ; Boom conflux command
13	HOSE ; L=900 PF1/4	2	Pb2' ; Boom down check open command Pd2' ; Slewing priority command at slewing left
14	CONNECTOR	1	PF1/4 L=23
15	CONNECTOR	2	PF1/4 L=60
16	CONNECTOR	1	PF1/4 L=75
17	CLIP	5	
18	ELBOW	3	PF1/4
19	ELBOW	4	PF1/4
20	CONNECTOR	3	PF1/4-PF3/8
21	ELBOW	4	PF1/4-PF3/8
22	TEE	4	PF3/8
23	CONNECTOR	1	PF1/4 with throttling
24	CONNECTOR	1	With filter & throttling
25	CHECK VALVE	1	YT21V00002P1
26	HOSE ; L=800 PF1/4	1	Pb5' ; Boom RH swing check open command
27	HOSE ; L=1100 PF1/4	1	
28	CONNECTOR	1	PF3/8
29	HOSE ; L=900 PF1/4	2	DR4 ; Drain, DR3 ; Drain
30	GROMMET	2	

No.	NAME	Q'TY	REMARKS
32	ELBOW	1	PF3/8
(8)	LF62H00002F1		Travel P/V remote control lines
1	HOSE ; L=400 PF1/4	1	P/V P ; Primary pressure
2	HOSE ; L=450 PF3/8	1	P/V T ; Drain
3	HOSE ; L=2350 PF1/4	1	P/V 3 ; Travel LH reverse
4	HOSE ; L=3100 PF1/4	1	P/V 4 ; Travel RH forward
5	ELBOW	4	PF1/4-PF3/8
7	CONNECTOR	1	PF1/4 with filter
8	CONNECTOR	1	PF3/8-PF1/4
9	PRESSURE SENSOR	2	LC52S00011P1
10	CAPSCREW	4	M8×25
11	WASHER	4	M8
12	PILOT VALVE	1	YN30V00070F1
13	HOSE ; L=2250 PF1/4	1	P/V 3 ; Travel RH reverse
14	HOSE ; L=3300 PF1/4	1	P/V 2 ; Travel LH forward
(9)	LF68H00011F1		N&B, remo-con lines
1	HOSE ; L=2900 PF1/4	1	P/V B : Nibbler close
2	HOSE ; L=2400 PF1/4	1	P/V A : Nibbler open
3	HOSE ; L=400 PF1/4	1	P/V P ; Primary pressure
4	HOSE ; L=500 PF1/4	1	P/V T ; Drain
5	NUT	1	
6	PIN	1	
7	WASHER	3	M8
8	CAPSCREW	2	M10×20
9	LOCK WASHER	2	M10
10	CAPSCREW	2	M10×25
11	WASHER	4	M10
12	CONNECTOR	1	PF1/4 L=23
13	ELBOW	3	PF1/4
14	ELBOW	1	PF1/4 with filter
15	PILOT VALVE	1	YN30V00080F1
16	CONNECTOR	1	PF1/4-PT1/8
17	CAPSCREW	2	M8×20
18	LOCK ASSY	1	
19	PEDAL	1	
20	RUBBER	1	
21	PRESSURE SWITCH	1	GB50S00049F2
22	PLUG	1	PF1/4
(10)	LF64H00003F2		Swing / Slewing SOL/V con. Lines
1	HOSE ; L=1700 PF1/4	1	S/V PP ; Solenoid primary pressure
2	WASHER	2	M10
3	HOSE ; L=1400 PF1/4	1	Pc2 ; Slewing RH
4	HOSE ; L=2000 PF1/4	2	Pa5 ; Swing LH, Pd2 ; Slewing LH
5	HOSE ; L=1950 PF1/4	1	Pb5' ; Swing RH
6	HOSE ; L=1850 PF1/4	1	S/V T ; Drain
8	CONNECTOR	1	PF1/4
9	ELBOW	5	PF1/4
10	ELBOW	1	PF1/4 with filter
11	BRACKET	1	
12	CAPSCREW	2	M12×30
13	CAPSCREW	2	M10×70
14	WASHER	2	M12
15	CONNECTOR	2	PF1/4-PT1/8
16	ELBOW	1	PF1/4
17	TEE	2	PF1/4
18	TEE	1	PF1/4
21	ELBOW	2	
22	PILOT VALVE	1	YR35V00009F2
23	PRESSURE SWICH	4	GB50S00049F2
24	PRESSURE SENSOR	1	LC52S00011P1

(1) Pump hyd. lines ; YT30H00003F1

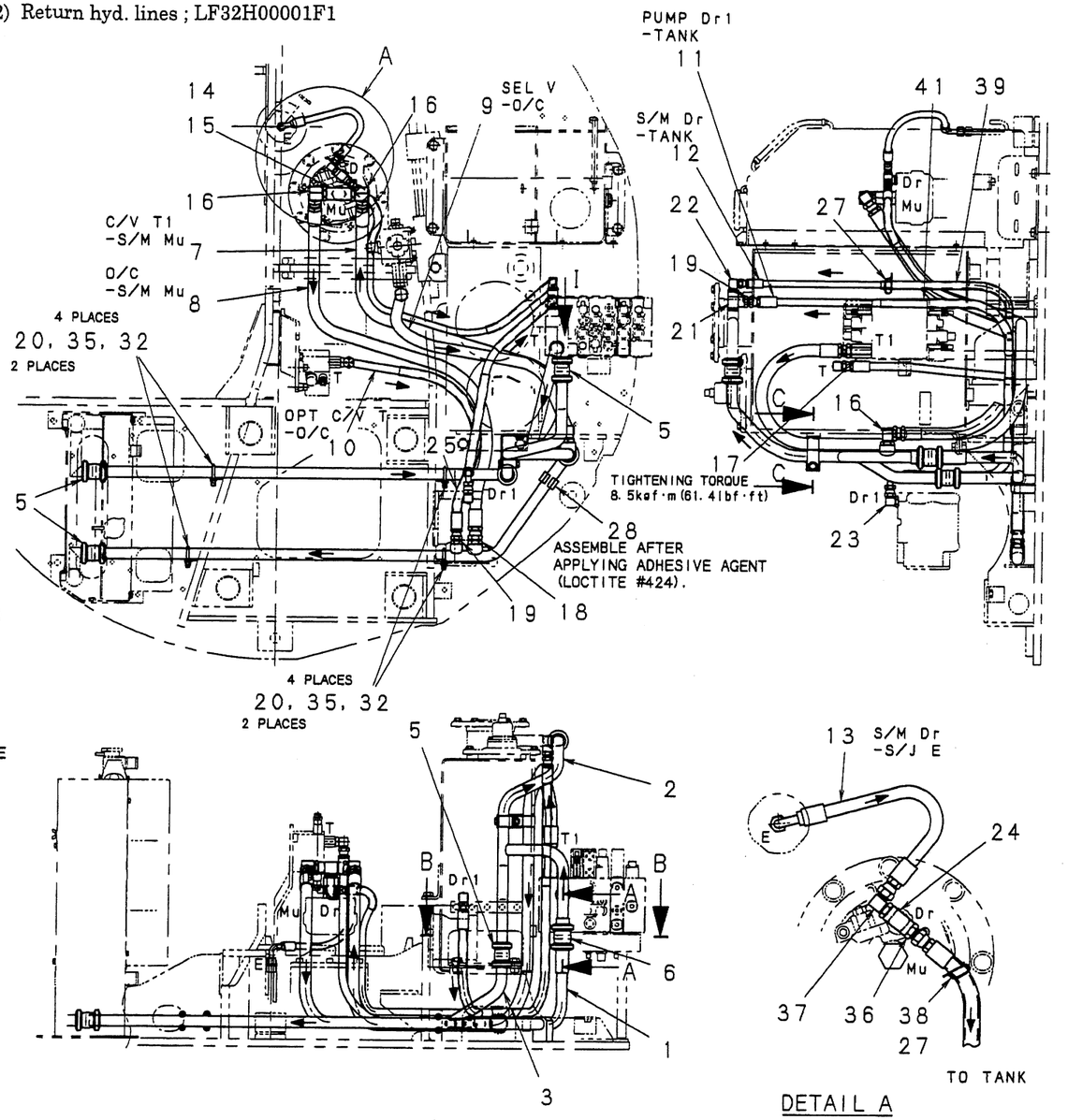


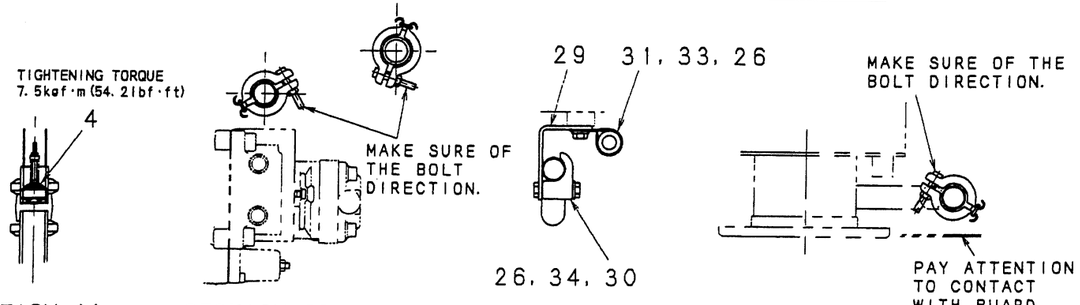
	NUT-SLEEVE TYPE JOINT	
TUBE SIZE	TOOL mm	TORQUE kgf·m (lbf·ft)
φ12×t2.0	22	7.0 (50.6)
φ22×t3.0	36	22.0 (159)

	CAPSCREW (10T)
SCREW	TORQUE kgf·m (lbf·ft)
M12	12.3 (89.3)

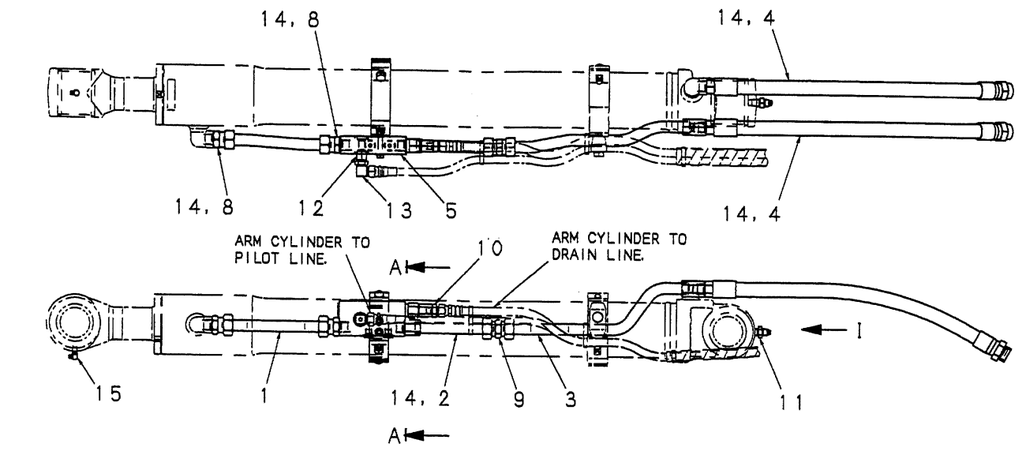
		O-RING TYPE JOINT
SCREW PF	TOOL mm	TORQUE kgf·m (lbf·ft)
1/4	19	3.7 (26.8)
1/2	32	11.0 (80.0)
3/4	36	16.5 (119)

(2) Return hyd. lines ; LF32H00001F1





(5B) Arm cyl. hyd. lines ; YT42H00058F1, Arm safety (OPT.)

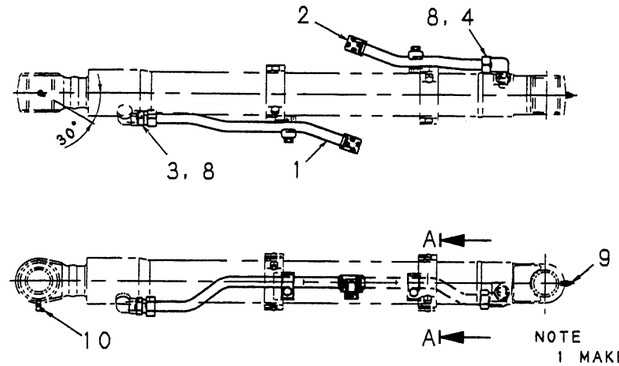


SECTION AA

VIEW I

NOTES
1. MAKE SURE NOT TO MISS O-RING AT ASSENBLING.
2. TIGHTENING TORQUES FOR M THREAD.
   M8 3.4kgf·m {24.6 lbt·ft}
   M10 6.7kgf·m {48.5 lbt·ft}
3. TIGHTENING TORQUES FOR NUT AND SLEEVES.
   ø22×3.0 22.0 kgf·m {159 lbt·ft}
4. TIGHTENING TORQUES FOR PF-THREADS
   THREADS SIZE: PF 1/8 1.7 kgf·m {12.3 lbt·ft}
   PF 1/4 3.7 kgf·m {26.8 lbt·ft}
   PF 3/8 7.5 kgf·m {54.2 lbt·ft}
   PF 1/2 11.0 kgf·m {80.0 lbt·ft}
5. APPLY LOCTITE #242 TO CLAMP ATTACHING BOLT.

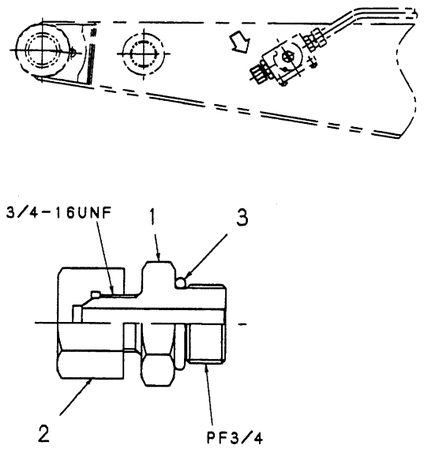
(6) Bucket cyl. hyd. lines ; YT43H00005F1, (STD)



SECTION AA

NOTE
1 MAKE SURE NOT TO MISS O-RING AT ASSEMBLING.
2 TIGHTENING TORQUE FOR M THREAD.
   THREAD SIZE TORQUE
   M10 6.7kgf·m (48.5lbf·ft)
3 TIGHTENING TORQUE FOR NUT AND SLEEVES.
   TUBE SIZE TORQUE
   ø22×3.0 22.0kgf·m (159lbf·ft)
4 TIGHTENING TORQUE FOR PF, PT THREAD.
   THREAD TORQUE
   1/8 1.7kgf·m (12.3lbf·ft)
   1/2 11.0kgf·m (80.0lbf·ft)
5 APPLY LOCTITE #242 TO CLAMP ATTACHING BOLT.

(7) N&B connector assy ; LE43H00006F1



NOTE
1 TIGHTENING TORQUE FOR PLUG.
   THREAD TORQUE
   3/4-16 5.0kgf·m (36.2lbf·ft)
2 TIGHTENING TORQUE FOR PF, PT THREAD.
   THREAD TORQUE
   3/4 16.5kgf·m (119lbf·ft)
3 MAKE SURE NOT TO MISS O-RING AT ASSEMBLING.

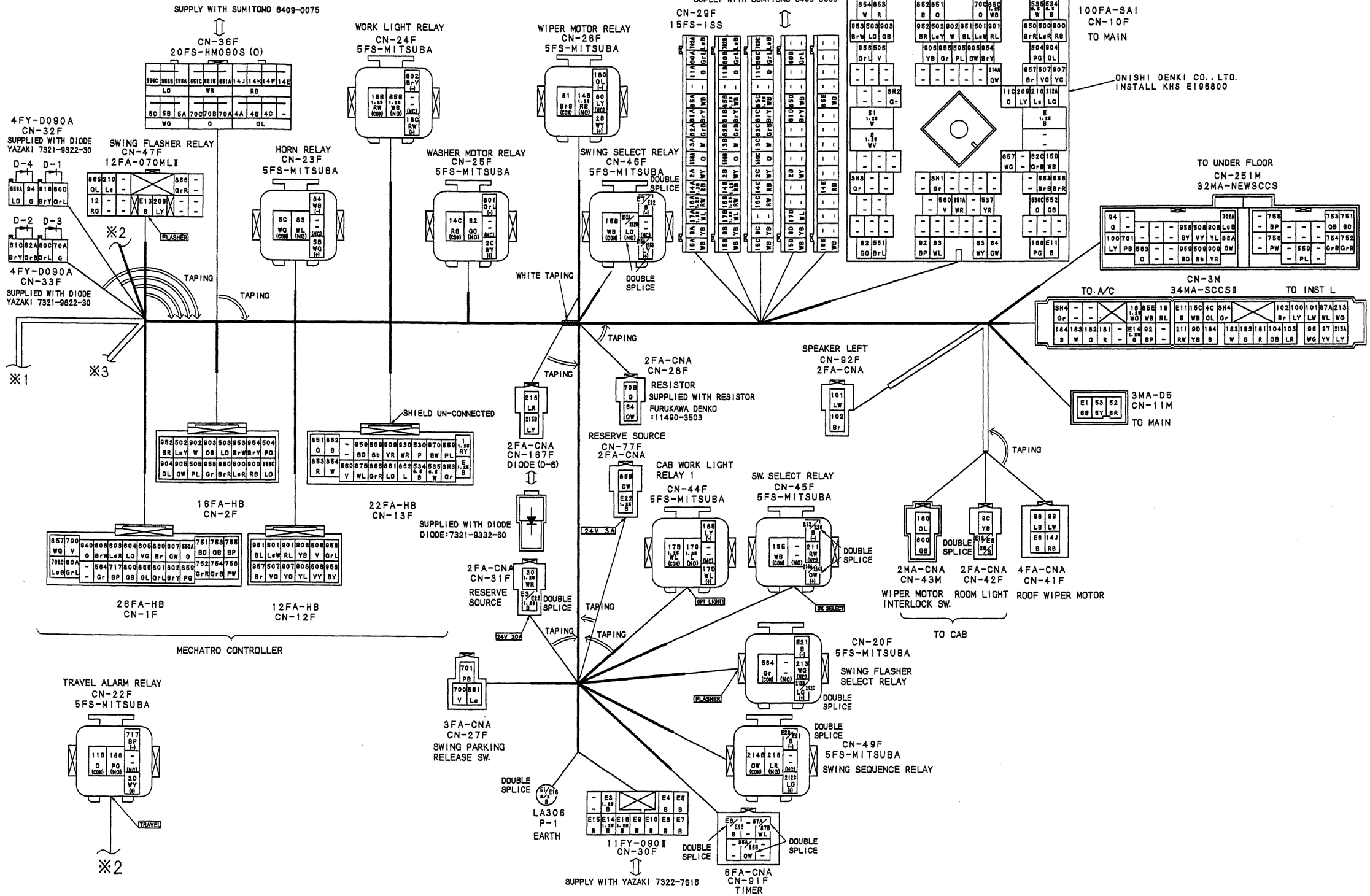


Fig. 4 (1/3) Instrument panel harness KCMA

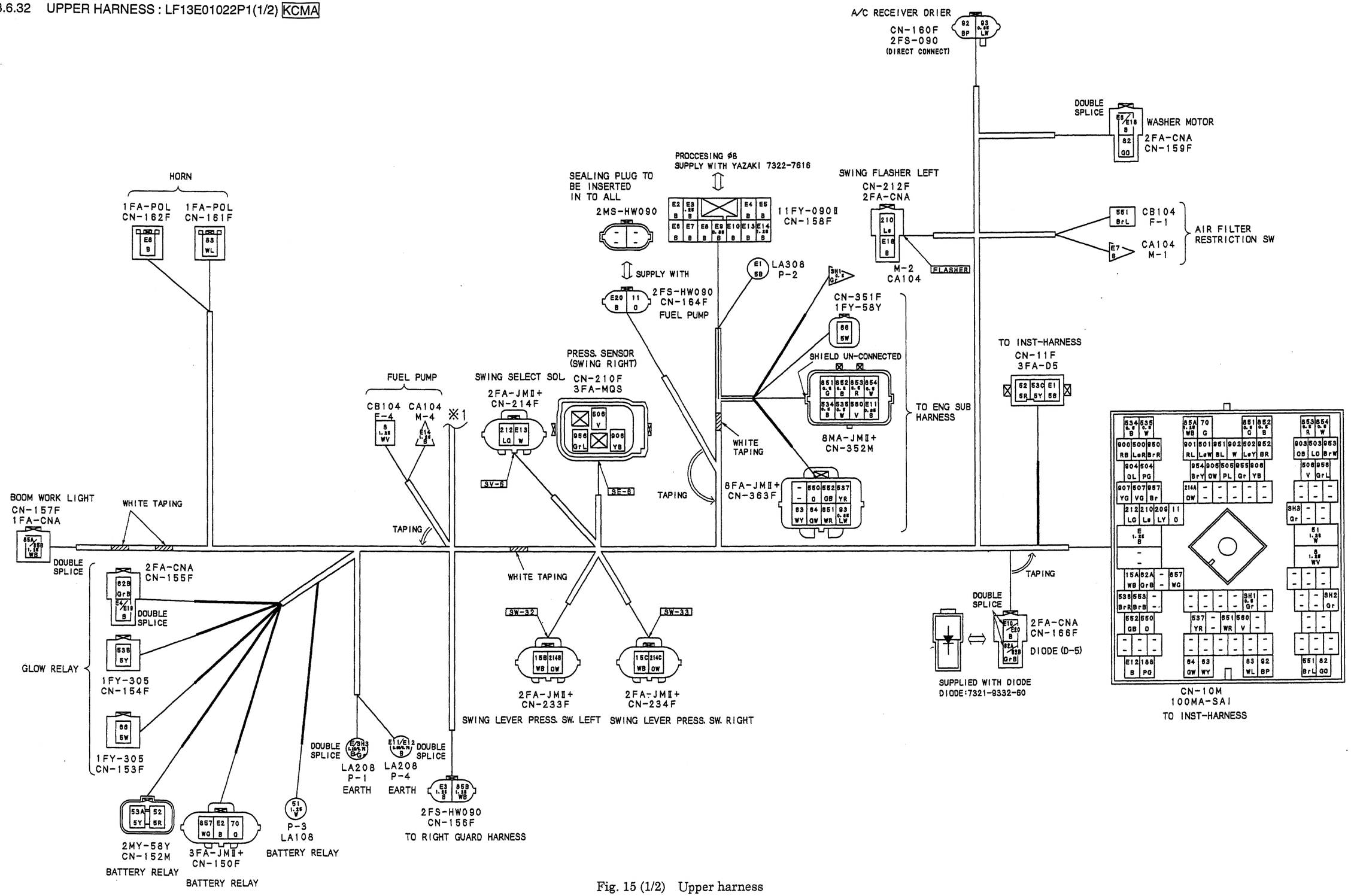
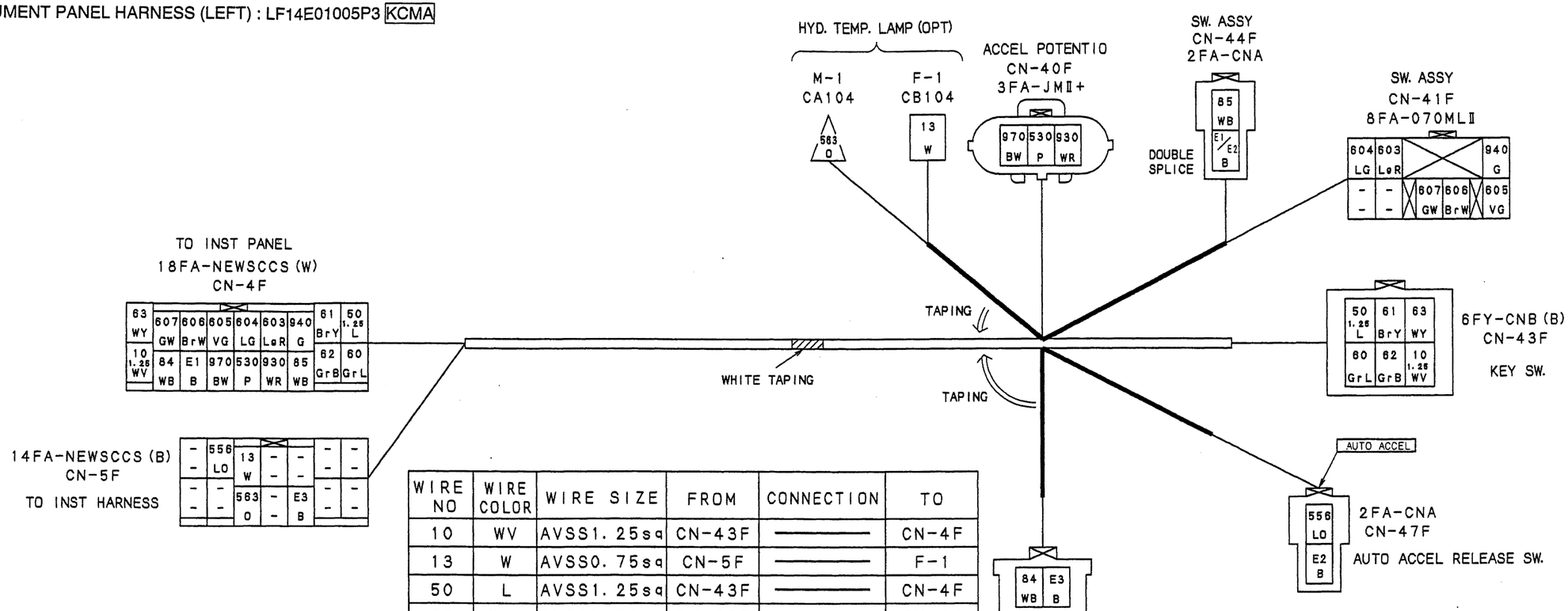


Fig. 15 (1/2) Upper harness

3.9.2 INSTRUMENT PANEL HARNESS (LEFT) : LF14E01005P3 KCMA



WIRE NO	WIRE COLOR	WIRE SIZE	FROM	CONNECTION	TO
10	WV	AVSS1.25sq	CN-43F	———	CN-4F
13	W	AVSS0.75sq	CN-5F	———	F-1
50	L	AVSS1.25sq	CN-43F	———	CN-4F
60	GrL	AVSS0.75sq	CN-43F	———	CN-4F
61	BrY	AVSS0.75sq	CN-43F	———	CN-4F
62	GrB	AVSS0.75sq	CN-43F	———	CN-4F
63	WY	AVSS0.75sq	CN-43F	———	CN-4F
84	WB	AVSS0.75sq	CN-42F	———	CN-4F
85	WB	AVSS0.75sq	CN-44F	———	CN-4F
530	P	AVSS0.75sq	CN-40F	———	CN-4F
556	LO	AVSS0.75sq	CN-5F	———	CN-47F
563	O	AVSS0.75sq	CN-5F	———	M-1
603	LgR	AVSS0.75sq	CN-41F	———	CN-4F
604	LG	AVSS0.75sq	CN-41F	———	CN-4F
605	VG	AVSS0.75sq	CN-41F	———	CN-4F
606	BrW	AVSS0.75sq	CN-41F	———	CN-4F
607	GW	AVSS0.75sq	CN-41F	———	CN-4F
930	WR	AVSS0.75sq	CN-40F	———	CN-4F
940	G	AVSS0.75sq	CN-41F	———	CN-4F
970	BW	AVSS0.75sq	CN-40F	———	CN-4F
E1	B	AVSS0.75sq	CN-44F	DOUBLE SPLICE	CN-4F
E2	B	AVSS0.75sq	CN-44F	DOUBLE SPLICE	CN-47F
E3	B	AVSS0.75sq	CN-42F	———	CN-5F

Fig.24 Instrument panel harness (left)

CONNECTORS SELECTION TABLE

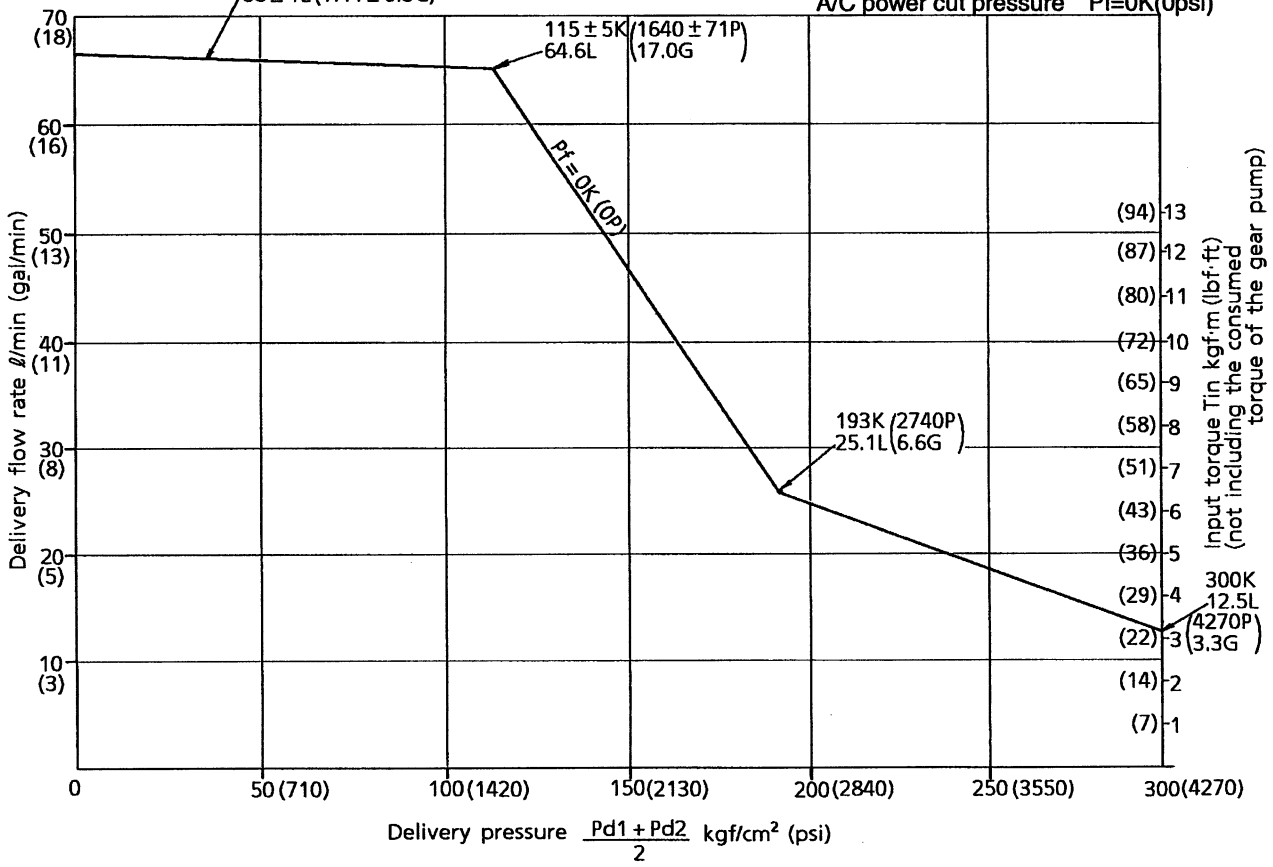
CONNECTOR NAME (PIN NUM.)	MANUFUC.	PART. NUMBER	
		HOUSING	TERMINAL
18FA-NEWSCCS (W)	AMP	178690-1	175266-2 (040 GOLD PLATING) 175269-1 (070M PLATING)
8FA-070MLII	AMP	176113-6	173631-2 (GOLD PLATING)
3FA-JMII+	AMP	174357-2	171662-1
2FA-CNA	AMP	172130-1	170032-2
6FY-CNB (B)	AMP YAZAKI	 7123-2865-30	170032-2
2FS-HM090	SUMITOMO	6090-1001	8240-4422
14FA-NEWSCCS (B)	AMP	178689-2	175266-2 (040 GOLD PLATING) 175269-1 (070M PLATING)
CB104	AMP	180889-1	170003-4
CA104	AMP	180887-1	170002-4

Applicable Machines
LF02-01001~

Revision	Date of Issue	Remarks
First edition	March, 2003	S5LF2404E K

Control chart of pump

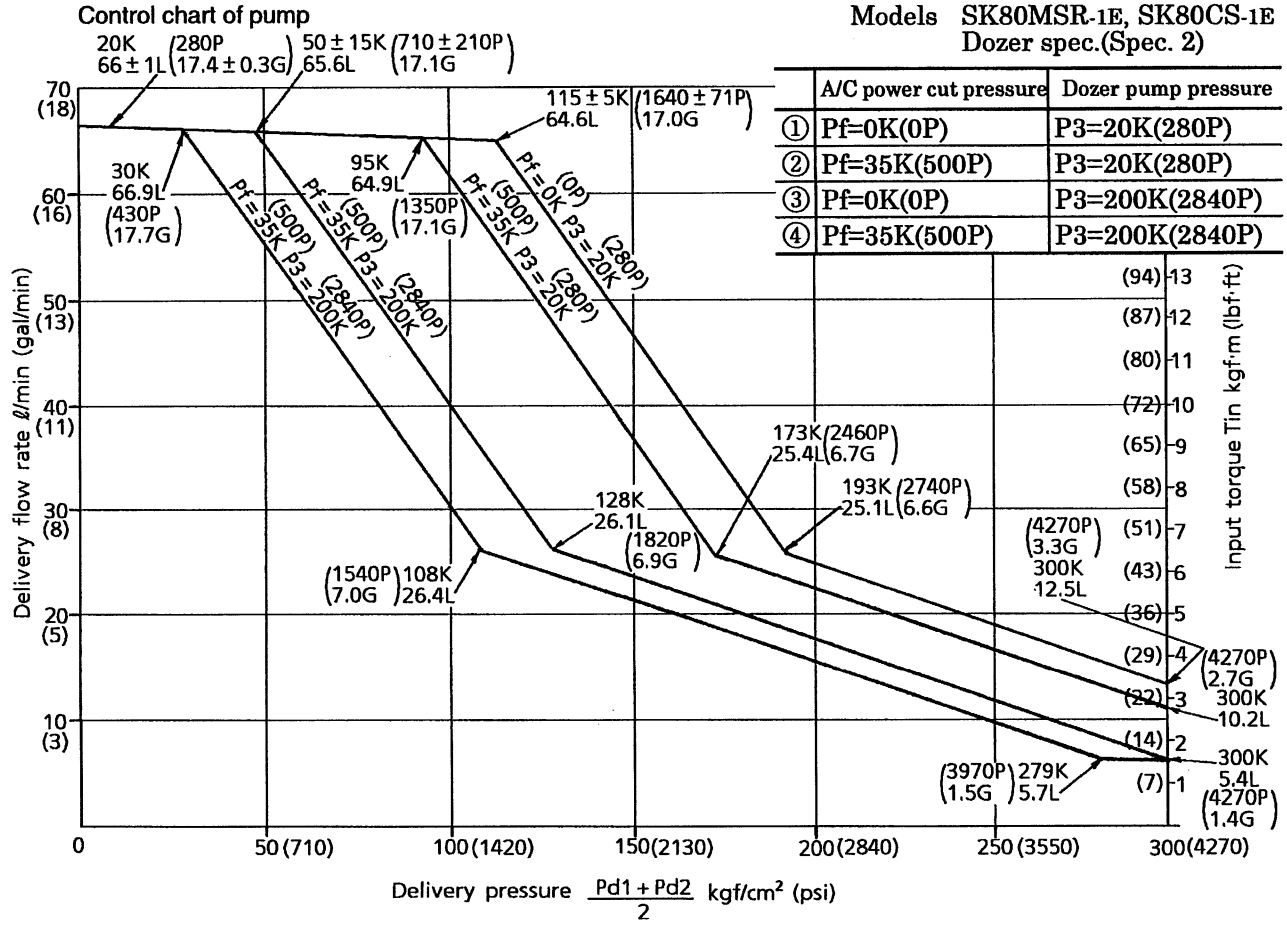
Models SK80MSR-1E, SK80CS-1E
Standard specification(Spec. 1)
A/C power cut pressure Pf=0K(0psi)



Control chart of pump

Models SK80MSR-1E, SK80CS-1E
Dozer spec.(Spec. 2)

	A/C power cut pressure	Dozer pump pressure
①	Pf=0K(0P)	P3=20K(280P)
②	Pf=35K(500P)	P3=20K(280P)
③	Pf=0K(0P)	P3=200K(2840P)
④	Pf=35K(500P)	P3=200K(2840P)



2) Travel reverse operation

If the travel reverse operation is carried out, the secondary pilot pressure enters the opposite side of the chamber of the Pb1 and Pc1 ports from the travel pilot valve; and shifts the travel spool (8). The oil which has flowed in from the pump port passes through the land of the travel spool (7) and flows to the main paths (51), (54) of travel spool (8).

The oil which flows from the main paths (51), (54) is supplied to the travel motor from the B1 and C1 ports which are now open, because the bypass paths (52), (55) are shut off by the spool (8) now shifted.

In the meantime, the oil returning from the travel motor flows into the C/V from the A1 and D1 ports and flows to the tank path (60) which is now open as the travel spool (8) has been shifted.

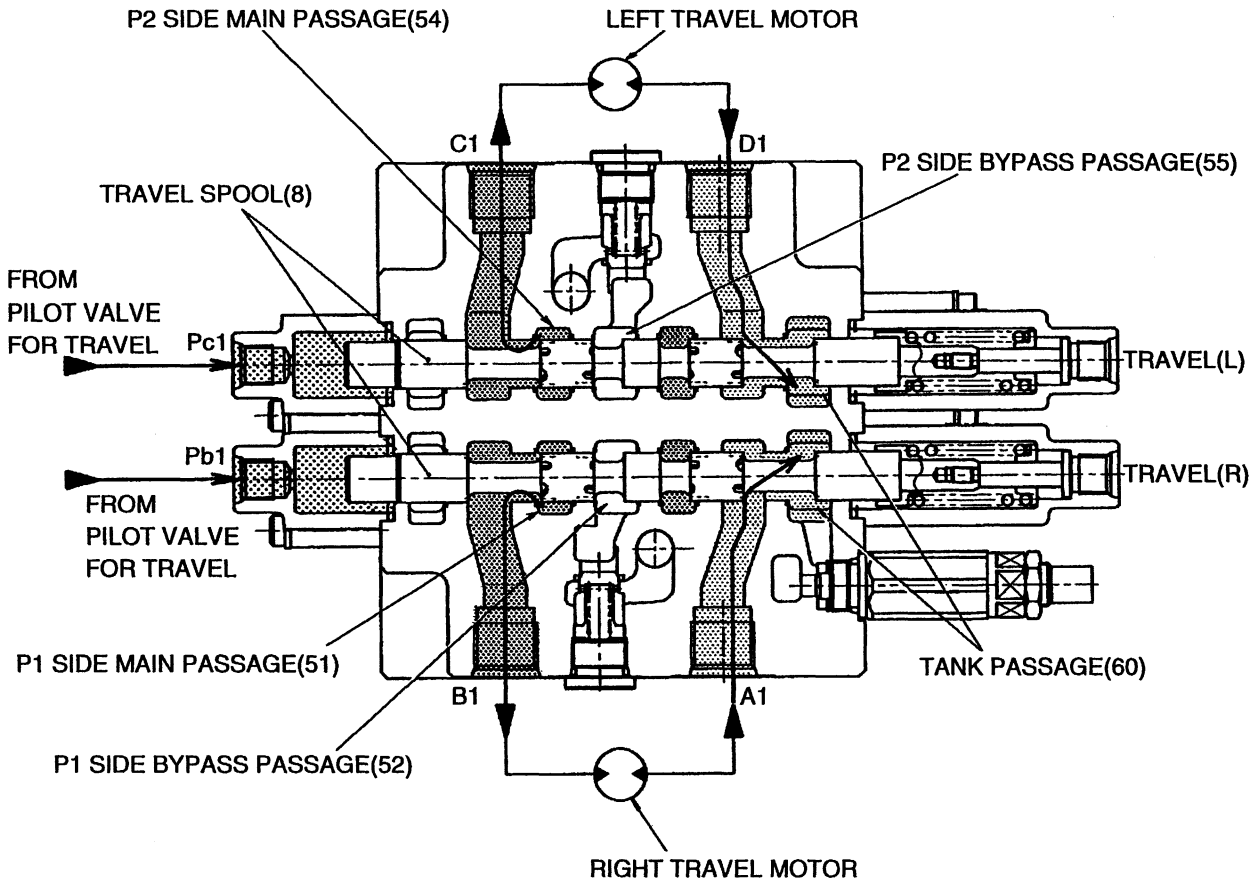


Fig. 2-8 Functions at travel reverse operation

In the meantime, the mechatro control system causes the secondary pilot pressure (electromagnetic proportional) to enter the spring chamber of the P1 bypass cut spool (15) and shifts the spool (15). (Fig. 2-19)
Shift of the P1 bypass cut spool (15) causes the P1 bypass path to be shut off. The oil which has flowed in from the P1 port flows into the P1 parallel path (53) provided in the check valve built in the P1 bypass cut spool (15) and upstream of the P1 bypass path (52).
The oil which has flowed into the check valve and the P1 parallel path (53) flows into the arm conflux path (59) which is now open by the shift of the P1 bypass cut spool (15). (Fig. 2-19)
Thus the arm cylinder head is subject to the oil stream at P1 port and that at port P2 combined.
The oil which has flowed into the arm conflux path passes through the load check valve (21) in the arm select section and is fed to the arm cylinder head from the C3 port. (Fig. 2-18)
In the meantime, the oil which has returned from the cylinder rod flows into the D3 port and flows out to the tank path (60) from the spool notch which is now open by the shift of the arm spool via the lock valve (28). (Refer to Fig. 2-14 for the functions of the lock valve.)
Consequently, the arm cylinder operates in the extending direction to cause the arm to dig.

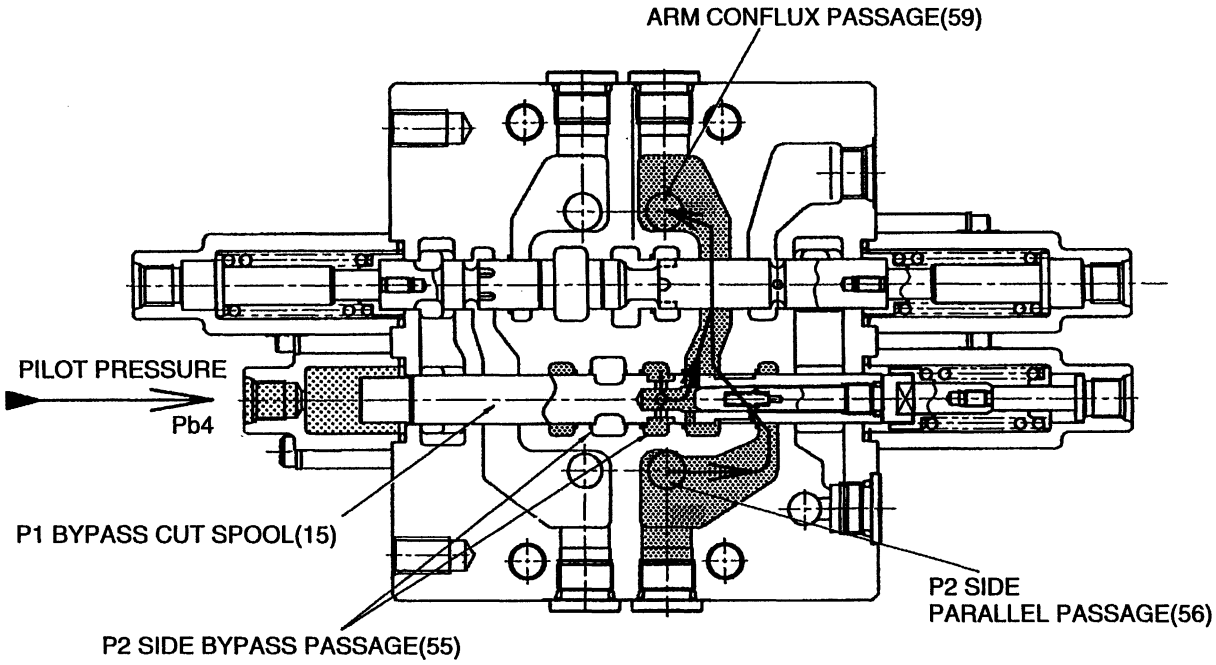


Fig. 2-19 Functions of P1 bypass cut spool

(13) Function of over load relief valve

1) Pressurized oil P is filled up in chamber A through the inside of the piston built in the plunger G and orifice B.
The plunger G and the socket are sealed securely. The socket is sealed securely against the poppet as well.

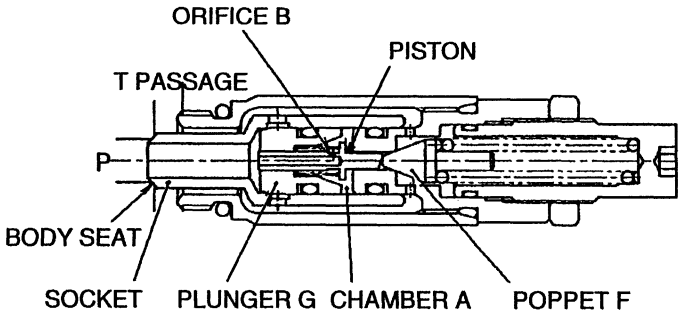


Fig. 2-31

2) When the hydraulic pressure at port P arrives at a set value of spring C, it pushes the piston which in turn opens the poppet F.
On that occasion, the hydraulic pressure goes through the inside of the piston→orifice B→ chamber A→annular orifice D and drilled hole E goes around the outer circumference of the socket and flows out to the tank passage

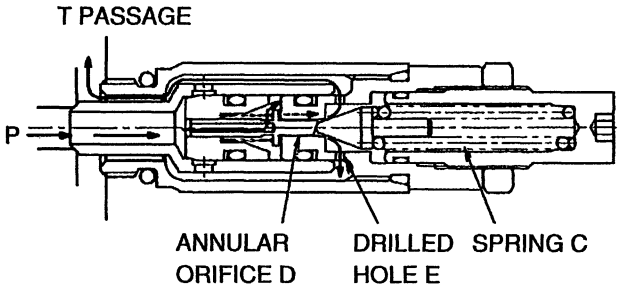


Fig. 2-32

3) If the poppet opens, the pressure of chamber A falls. Then the plunger G opens and the pressure of port P flows directly to the tank T passage through drilled hole H.

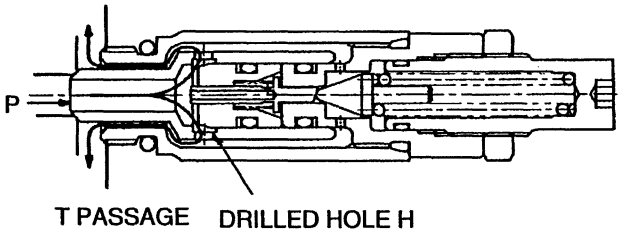


Fig. 2-33

4) If the pressure at port P falls below a set value of spring C, the poppet F is pressed against the seat by the action of spring C. As the result, the pressure of chamber A equals that of port P. This presses the plunger G against the socket seat and brings it back where it was. (Fig. 2-31)

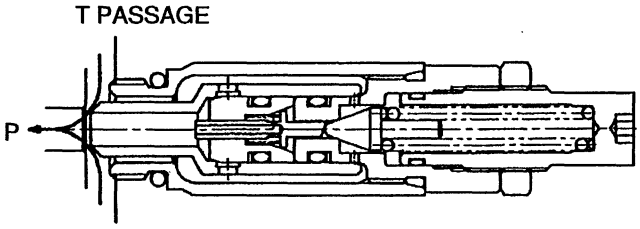


Fig. 2-34

5) Function of anti-cavitation
This function supplies oil from the T (tank) path in case negative pressure occurs at port P. When the tank path pressure gets higher than that of port P, the socket is subject to a force that pushes it up. This creates a space between the body seat and the socket. The oil from the T path (tank) flows into port P, and fills up the space.

NOTES

6.3 SPECIFICATION

Table 6-2

Type			GM09VN-B-19/34-1
Reduction unit	Reduction ratio		61.6
	Output torque 1st /2nd	kgf·m (lbf·ft)	870 (6,300) / 472 (3,410)
	Revolution speed 1st /2nd	rpm	30.5 / 53.8
Hydraulic motor	Displacement 1st /2nd	cc / rev (cu·in/rev)	34.4 (2.1) / 19.1 (1.17)
	Operation press.	kgf/cm^2 (psi)	300 (4,270)
	Revolution speed 1st /2nd	rpm	1877 / 3312
	1,2 speed select press.	kgf/cm^2 (psi)	35 (500)
	Auto 1,2 speed select press.	kgf/cm^2 (psi)	225 (3,200)
	Drain press.	kgf/cm^2 (psi)	STD 2 (28), MAX. 7 (100)
Parking brake	Braking torque	kgf·m (lbf·ft)	9.9 (72)
	Release press.	kgf/cm^2 (psi)	4.8 (68)
Lube oil	SAE #90 GL-4	ℓ (gal)	Approx. 1.3 (0.34)
Weight		kg (lb)	81 (179)

(3) High-low 2-step speed select mechanism (auto 2-step speed select mode)

1) Low-speed step

The low-speed step is the status in which pilot pressure is not being supplied from port P.

In this case, the spool (271) is pressed to the left by the force of spring (281) and by the pressure from port A or B. The pressure of port F is shut off.

The hydraulic oil of chamber S is released to drain (motor casing) via spool (271). The thrust of piston (161) is small. The swash plate (103) is located along the Y face.

At that time, the swash plate (103) takes the maximum tilting angle $\theta 1$. That is to say, the hydraulic motor takes the maximum displacement capacity and rotates at low speed.

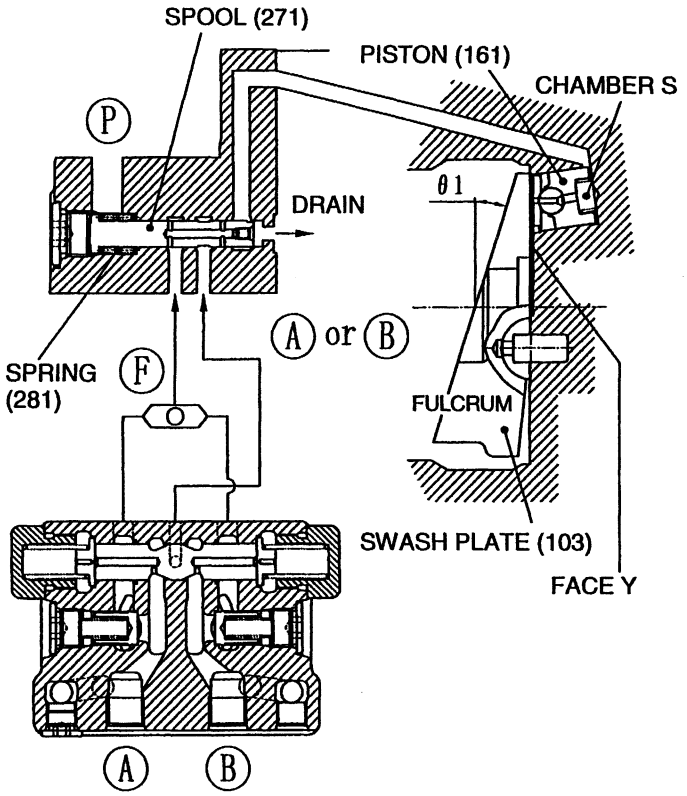


Fig. 6-12

2) High-speed step

The high-speed step is the status in which a pilot pressure of 35kgf/cm^2 (500psi) is supplied from port P. In that case, the spool (271) is pressed to the right, overcoming the force of spring (281) and the pressure from port A or B. The pressure of port F is led to chamber S via spool (271).

The thrust of piston (161) increases by the pressure of chamber S. The piston (161) is pushed up and held till swash plate (103) comes in contact with face X.

On that occasion, the swash plate (103) takes the minimum tilting angle $\theta 2$. That is to say, the hydraulic motor takes the minimum displacement capacity and rotates at high speed.

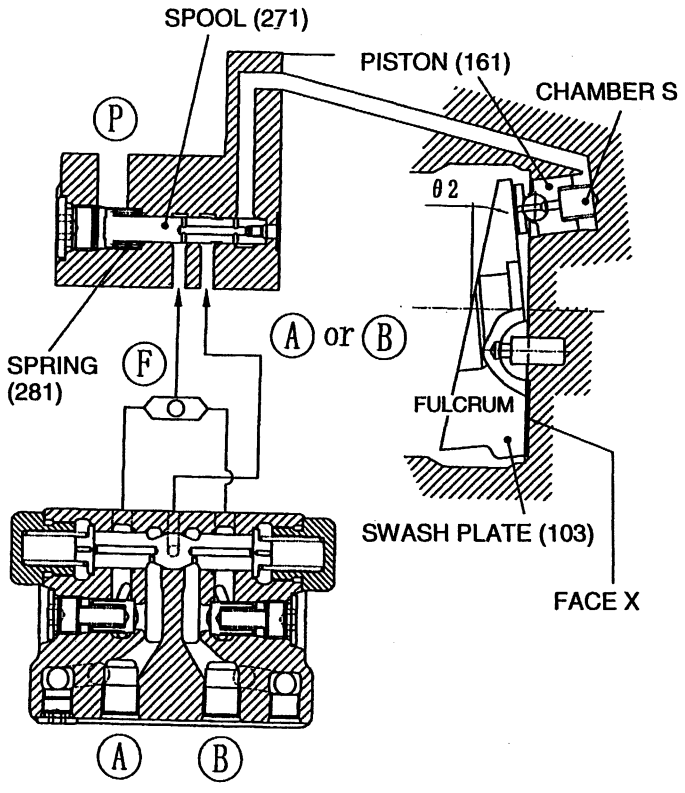


Fig. 6-13

(5) Swing cylinder

T=Tightening torque ; kgf·m (lbf·ft) [screw size]

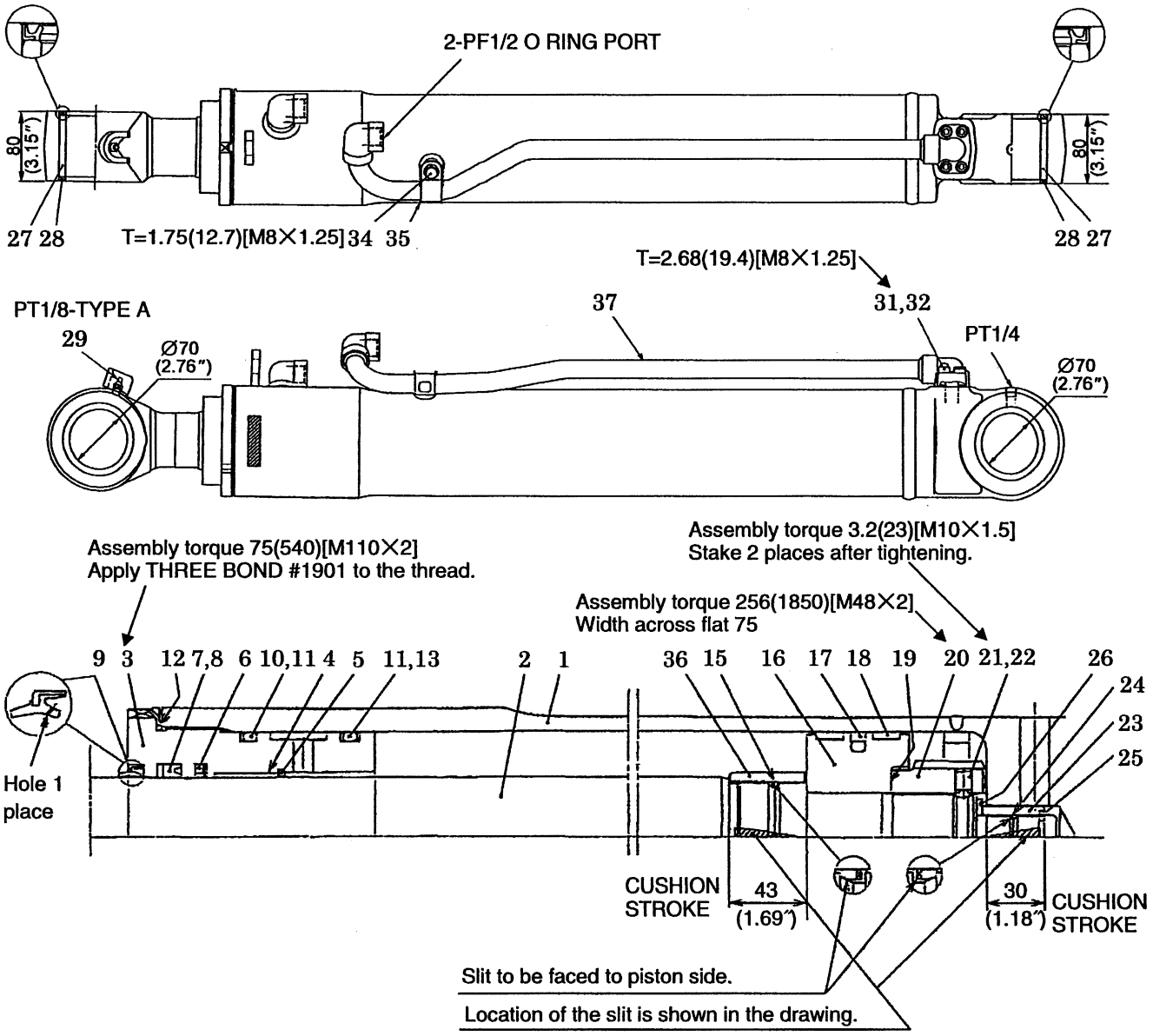
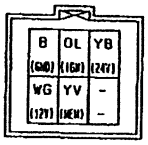
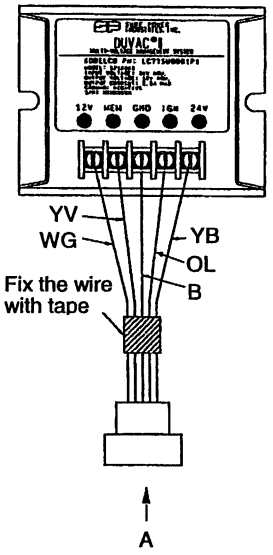
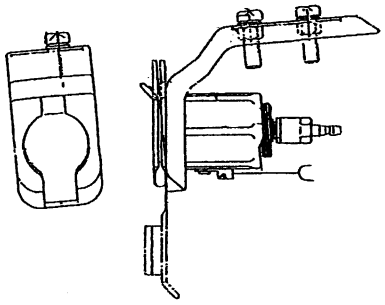
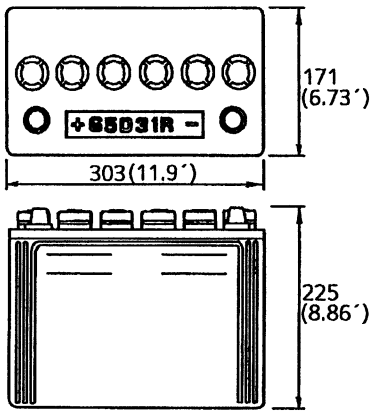


Fig. 8-6 Construction of swing cylinder

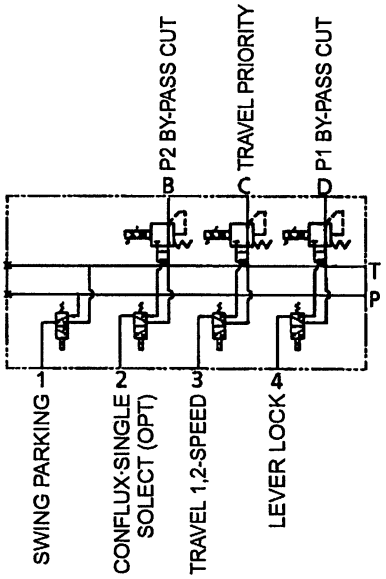
LF01V00002F3

No.	NAME	Q'TY	No.	NAME	Q'TY	No.	NAME	Q'TY
1	CYLINDER TUBE ASSY	1	13	O RING	1	26	STOPPER	2
2	PISTON ROD ASSY	1	15	CUSHION SEAL	1	27	BUSHING	2
3	ROD COVER	1	16	PISTON	1	28	WIPER RING	4
4	BUSHING	1	17	SEAL RING	1	29	GREASE NIPPLE	1
5	SNAP RING	1	18	SLIDE RING	2	31	SOCKET BOLT	4
6	BUFFER RING	1	19	SHIM	1	32	O RING	1
7	U RING	1	20	NUT	1	34	BOLT ASSY	1
8	BACKUP RING	1	21	SET SCREW	1	35	PIPE HOLDER	1
9	DUST SEAL	1	22	STEEL BALL	1	36	CUSHION BEARING	1
10	O RING	1	23	CUSHION BEARING	1	37	TUBE ASSY	1
11	BACKUP RING	3	24	CUSHION SEAL	1			
12	O RING	1	25	SNAP RING	1			

File No. Name of part Part No. Use Applicable Machine	Specification	Description
E−14 Converter YT77S00001P1 KCME KCMA DC24V→DC12V YY00101~ YH00101~ YT00101~ YF01-00101~ YU01-00101~ LF01-00501~ LF02-01001~	Input voltage: DC 24V Output voltage: DC 12V Output current: 2.5A Max Ground: Negative  VIEW A HOUSING YAZAKI 7122-2262 TERMINAL YAZAKI7114-2020	
E−15 Socket YN81S00001P1 KCME KCMA Power socket YY00101~ YH00101~ YF01-00101~ YU01-00101~ LF01-00501~ LF02-01001~	Power supply: For 12V	
E−25 Battery 2484U179 ASIA, OCE 2411U25 KCMA KCME Power YT00101~ LF01-00501~ LF02-01001~	ASIA, OCE Type: 65D31R-N70 Capacity: 12V 56Ah (5h) 70Ah (20h) Weight: About 19kg (42 lb) KCMA KCME Type: 95D31R Capacity: 12V 64Ah (5h) Weight: About 20.5kg (45 lb) (Part No.2411U25 is with handle)	

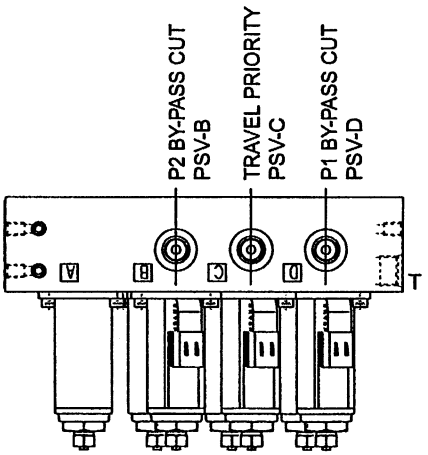
File No. Name of part Part No. Use Applicable Machine	Specification	Description
SV−1~4 Solenoid valve assy YT35V00011F1 (7-spool) Refer to hydraulic symbol LF02-01001~		

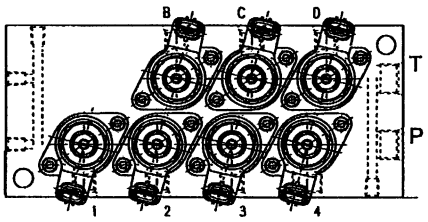
Operating pressure	35kgf/cm² (500psi)
Solenoid selector valve	Rated voltage DC24V
	Coil resistance 34±2Ω (at 20℃)
Solenoid proportionate valve	Dither current 100Hz, 300mA P-P
	Coil resistance 17.5Ω (at 20℃)
Connector specification	AMP Econoseal J Mark II Housing 174354-2 Terminal 173706-1



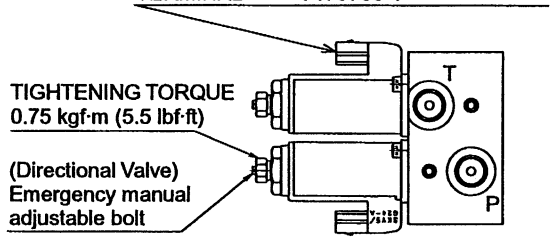
Note : This drawing shows YT35V00011F1.

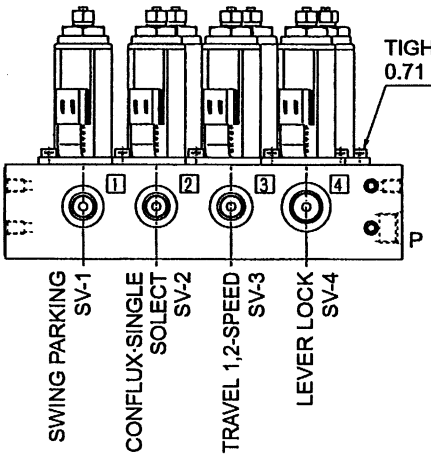
Solenoid valve assy YT35V00011F1 (7-spool) Refer to hydraulic symbol LF02-01001~

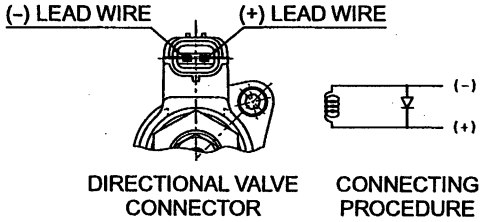




CONNECTOR : AMP Econoseal J Mark II (+)
CAP HOUSING : 174354-2
TERMINAL : 173706-1







Applicable Machines
LF02-01001~

PREFACE

We have developed an air conditioner for excavating machine which uses new refrigerant (R134a) instead of the R12 traditionally used for the air conditioner installed on excavating machines. The advantage of this new refrigerant (R134a) is that the detrimental effect of the refrigerant on the global environment is far lower, and the destruction of ozone layer does not occur. This new refrigerant R134a could not use on the traditionally used air conditioner because the characteristics of new R134a are different from that of R12. This manual provides basic knowledge and precautions required to furnish services for the air conditioner using the new refrigerant R134a which is installed on excavating machine.

Revision	Date of Issue	Remarks
First edition	March, 2003	S5LF2504E K

The expansion valve feeds the flowing high-pressure high-temperature liquid refrigerant to the evaporator as low-pressure low-temperature liquid refrigerant (damp vapor of low dryness). The expansion valve controls the feed rate of the refrigerant at the same time.

Fig.9 shows how the block type expansion valve is constructed. The temperature sensing part is provided in the shaft of the expansion valve to directly detect the refrigerant temperature at the outlet of the evaporator.

The diaphragm contains R134a in saturated state. The pressure in the diaphragm changes according to the temperature detected by the sensor. The change in the pressure causes the force acting upon the diaphragm to vary accordingly.

The high-pressure high-temperature liquid refrigerant that is fed from the receiver side reduces the pressure abruptly as it passes through the valve (throttling action). On that occasion, part of the refrigerant evaporates by the heat of the refrigerant and cooled off. The result is that low-pressure low-temperature damp refrigerant vapor is fed to the evaporator.

The opening of the valve is determined by the equilibrium between the pressure (low) of the evaporator side, the action of the adjust spring and the pressing force of the diaphragm (the temperature of the refrigerant at the outlet of the evaporator to be sensed by the thermowell). The feed rate is controlled automatically so that under the pressure in the evaporator, the refrigerant is properly overheated (3~8℃) and goes out of the evaporator. This action is carried out by sensing the refrigerant temperature at the outlet of the evaporator as against the inlet pressure of the evaporator and consequently controlling the feed rate of the refrigerant.

This means that if the refrigerant pressure drop in the evaporator is excessive, it is difficult to control the overheating or the feed rate of the refrigerant. For this reason, the smaller the pressure drop of the evaporator, the better.

The expansion valve senses the pressure and the temperature at the outlet of the evaporator and controls the overheating of the refrigerant and the refrigerant supply to the evaporator more securely. The air-conditioner of this machine adopts a block type expansion valve.

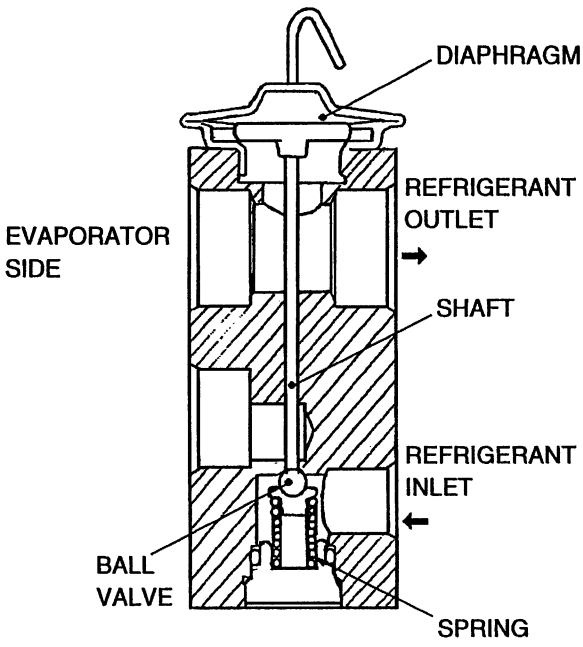


Fig. 9 Block type expansion valve

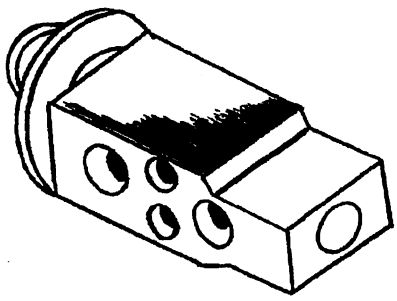


Fig. 10 Expansion valve outside view

5.3 CHARGING PROCEDURE

5.3.1 VACUUM MAKING OPERATION

(1) Connecting Gauge Manifold (See Fig.25.)

1) Close the high pressure valve (HI) and the low pressure valve (LO) of the gauge manifold.
2) Connect the charging hoses (red and blue) with the service valves of the compressor.
   Red hose : High pressure side (HI) of the gauge manifold → high pressure side (DIS) of compressor
   Blue hose : Low pressure side (LO) of gauge manifold → low pressure side (SUC) of compressor

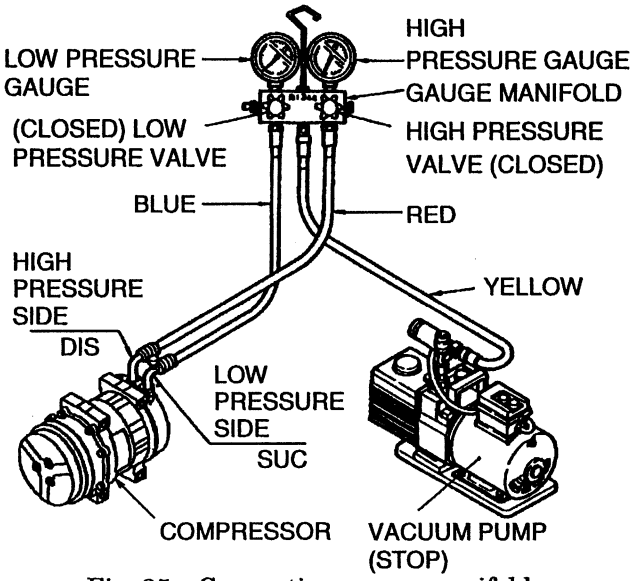


Fig. 25 Connecting gauge manifold

⚠
- Take care so as not to mistake the high pressure side for low pressure side and push it in till a click is heard.
- Connect the end bent like "L" of the charging hose with the service valve of the compressor. If the charging hose is connected the opposite way, the mini core valve of the compressor does not open. (See Fig.26.)

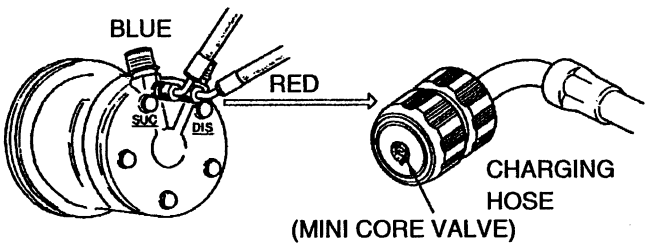


Fig. 26 Connecting piping with compressor

3) Connect the middle valve of the gauge manifold with the charging hose of the vacuum pump.

⚠ Some kinds of gauge manifolds are not equipped with an open/close valve in the center.

(2) Vacuum Making (See Fig.27.)

1) Open the high pressure valve (HI) and the low pressure valve (LO) of the gauge manifold.
2) Turn on the switch of the vacuum pump and make vacuum for more than 30 minutes.
3) When vacuum making for a specified duration is over (degree of vacuum : less than −750mmHg), close the high pressure valve and the low pressure valve of the gauge manifold.
4) Then turn off the vacuum pump.

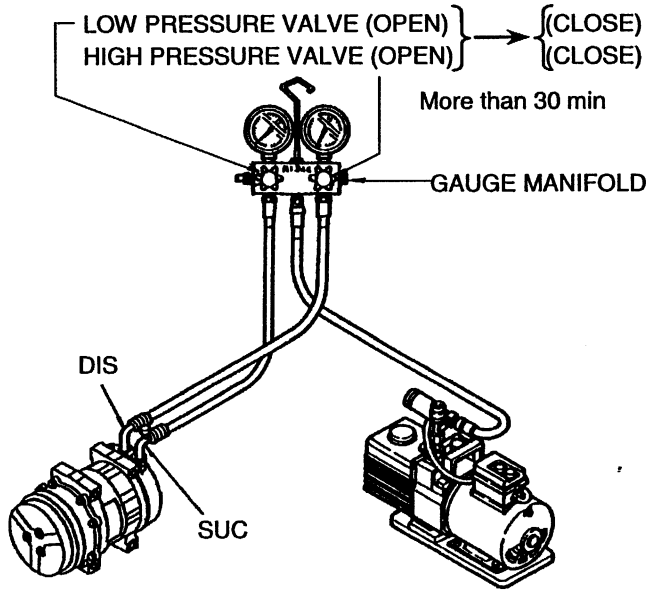
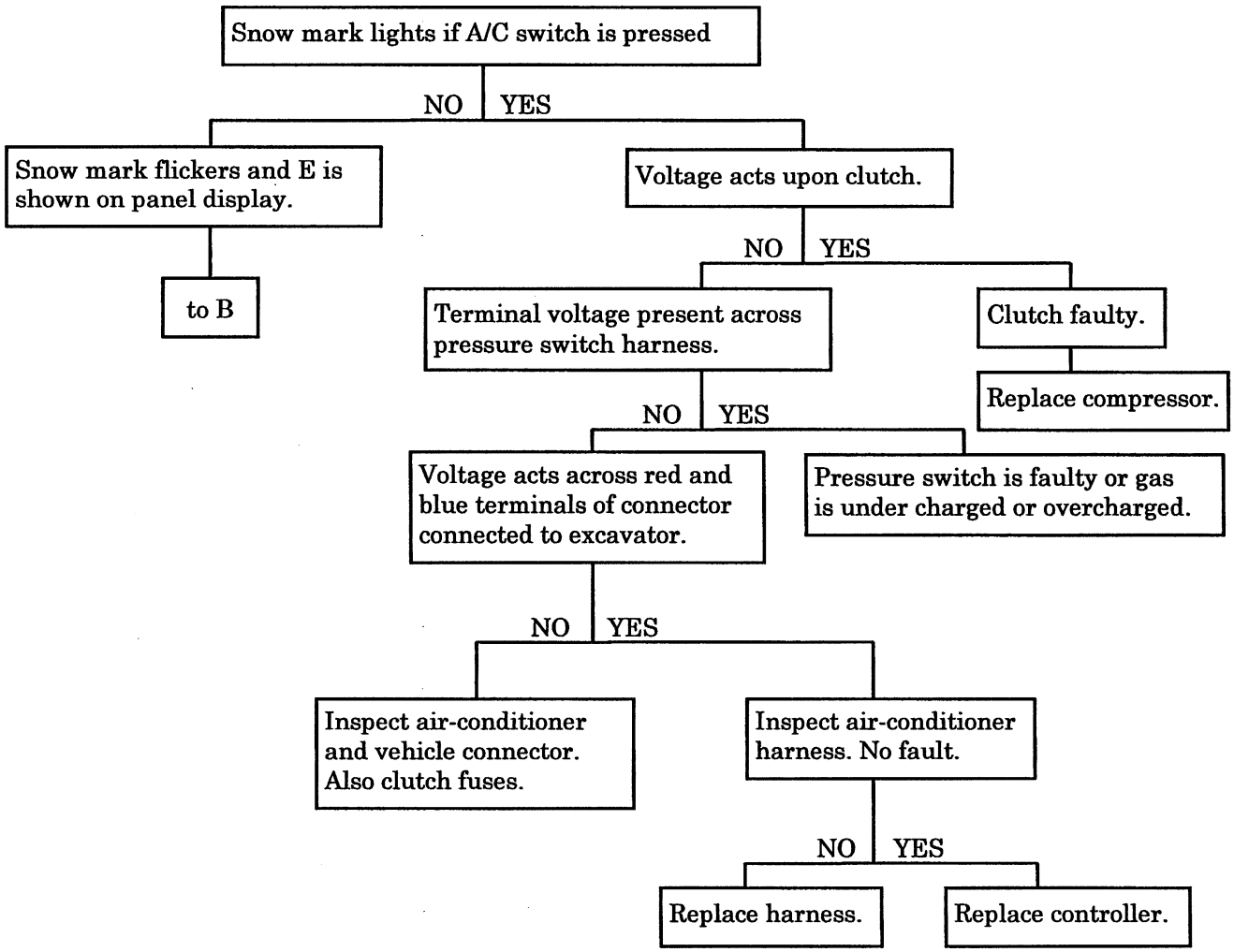
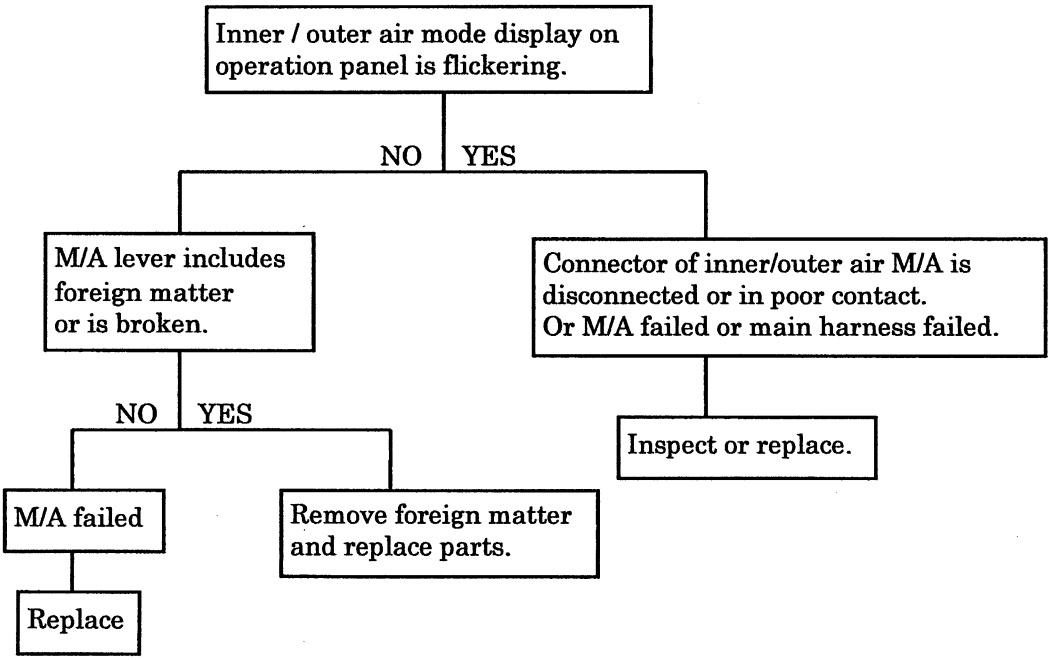


Fig. 27 Vacuum making operation

【Magnet clutch does not engage.】



【Inner air and outer air do not change over.】



2. BUCKET

2.1 REMOVING BUCKET

(1) Put the machine in position to remove bucket.

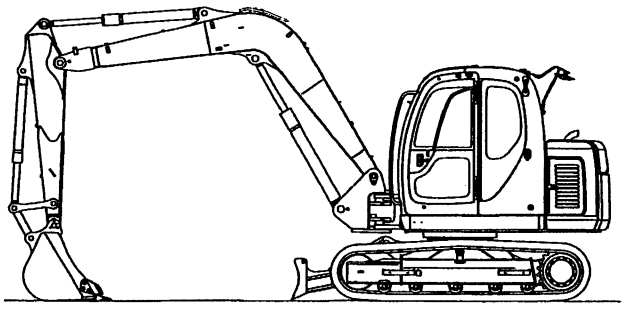


Fig. 2-1 Position to remove bucket

(2) Removing pin (2)
Expand slit of ring (1) with driver, and remove it. Push out the pin (2) with driver (−).

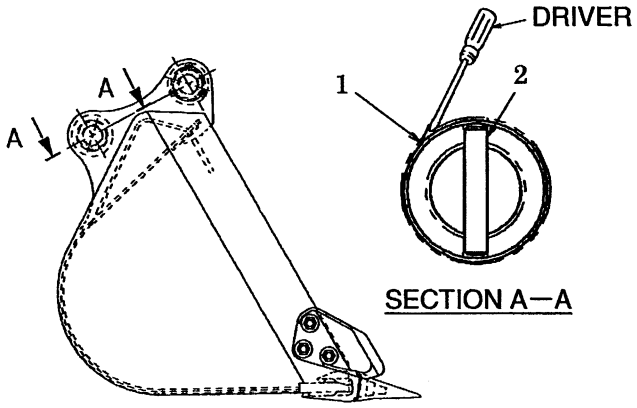


Fig. 2-2 Removing pin (2)

(3) Removing bucket attaching pin (K).
Lift up bucket, position it so that bucket attaching pin (K) is not loaded, adjust bucket link, and pull out bucket attaching pin (K).

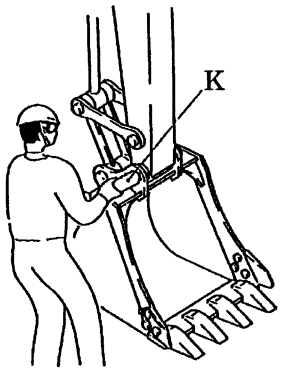


Fig. 2-3 Removing bucket attaching pin

(4) Removing bucket drive pin (J)
Put bucket on the ground, position it so that the bucket drive pin (J) is not loaded, adjust bucket link, and pull out pin (J).

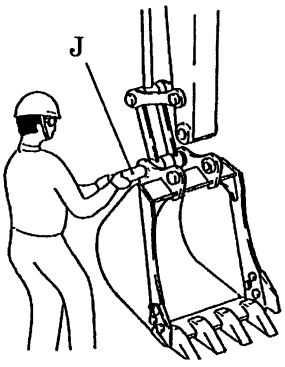


Fig. 2-4 Removing bucket drive pin

6. DOZER

6.1 REMOVAL

(1) Put a support of appropriate height under the mounting side of dozer body, and make the dozer at a stable condition not to exert any load to the pin (P).

(2) Disconnect the hydraulic hose and apply a plug to the connecting portions.
: 22mm

(3) Apply a nylon sling to the dozer cylinder (C1), and lift it up slightly not to exert any load to the Pin (Q) of rod side.

(4) Remove the capscrew (C2) and nuts (C3) those are preventing the pin (Q) from coming out. Remove the pin (Q), and support the cylinder (C1) with wood block, etc.
: 19mm

(5) Remove the capscrew (B2) and nuts (B3) those are preventing the dozer body fixing pin (Q) from coming out, and remove the two pins (P).
: 19mm

(6) Gradually move the machine to backward to remove the dozer.
Weight of dozer assy

Standard	283kg (624 lb)
With cutting edge	300kg (661 lb)

(7) If necessary, remove the dozer cylinder by means of removing the pin (R) of head side.
Weight of dozer cylinder : 55kg (121 lb)

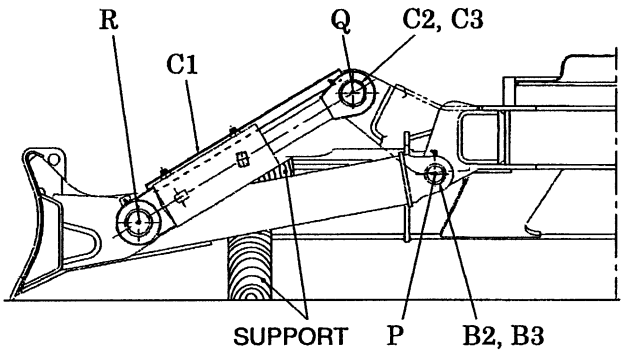


Fig. 6-1 Removing / Installing dozer

6.2 INSTALLATION

The installation is carried out with the reverse order of the removal paying attention to the following.

(1) Referring to the Chapter LF03 "ATTACHMENT DIMENSIONS" replace the worn-out bushings and dust seals to new ones.

(2) Before installing pin (P), (Q) and (R), apply grease to their shaft area.

(3) Referring to Fig. 6-2, install the nuts for capscrew to prevent the pin from coming out.
: 19mm

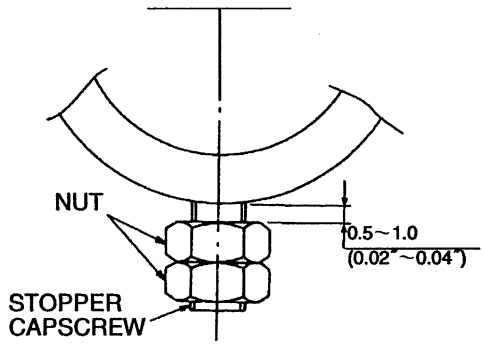


Fig. 6-2 Tightening proceduers for nuts

1.4 ASSEMBLING

Start install with the sub assy listed below :

- ○ Cylinder tube assy
- ○ Piston rod assy
- ○ Rod cover assy
- ○ Piston assy

1.4.1 ASSEMBLING CYLINDER TUBE ASSY, PISTON ROD ASSY

1) Apply hydraulic oil on the head in which pin bushing is inserted and on the pin bushing hole of rod.

2) Press pin bushing (26) into cylinder tube (1) and piston rod (2), using a press.

3) Insert wiper ring (27) in both sides.

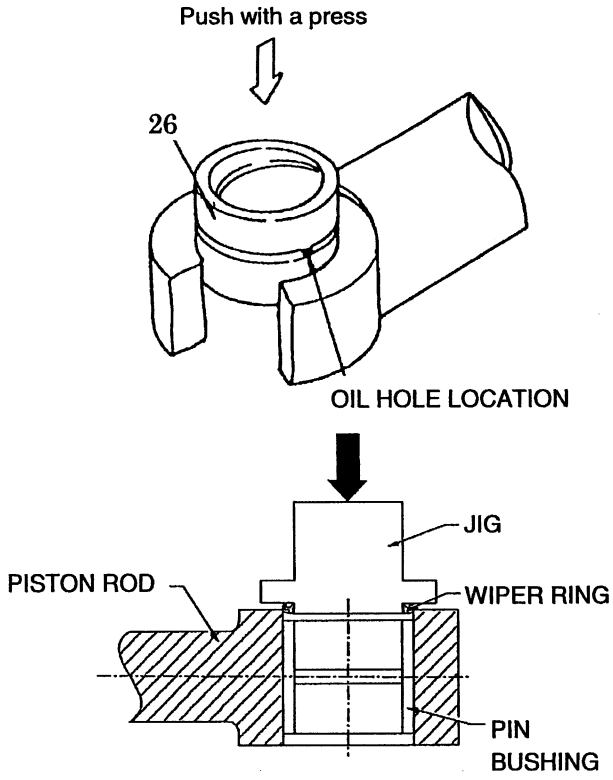


Fig. 1-21 Pressing in pin bushing (rod & tube)

1.4.2 ASSEMBLING ROD COVER ASSY

(1) Press fit bushing (4) in rod cover (3) applying jig on the section. After press-fitting, check that the bushing is not projected from the end surface (A). (See Fig.1-22.)

(2) Fit snap ring (5).

(3) Fit backup ring(8) on U ring groove.

(4) Apply hydraulic oil on U ring (7) and fit it on the U ring groove.

- The U ring is harder than other seals, so fit it in the groove by hand first, then press in with pushing bar until it is fitted with a click.
- Fitting U ring paying attention to the direction.
- After fitting backup ring (8) and U ring (7), check that they are free from the permanent set.

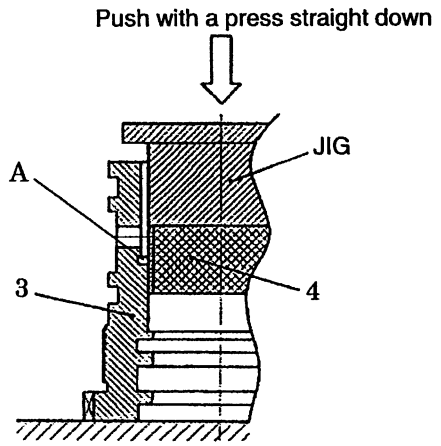


Fig. 1-22 Pressing in bushing

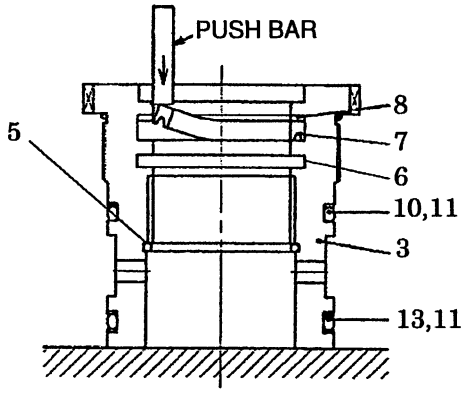


Fig. 1-23 Fitting U ring

(3) Bushing press-fit jig
Material : STKM13A or equivalent

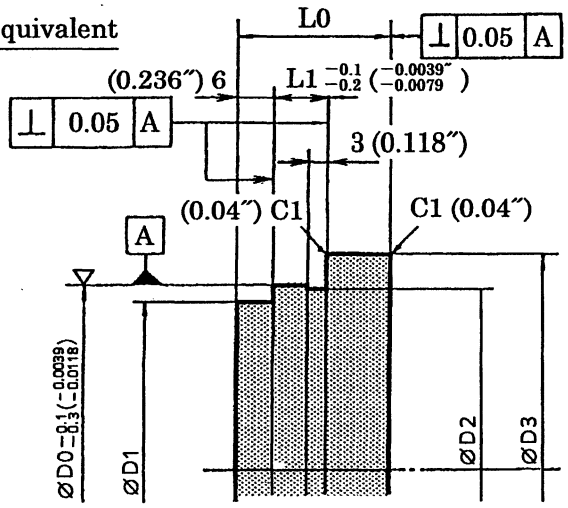


Fig. 1-45

Table 1-10 Unit : mm (in)

Applicable cylinder	D0	D1	(D2)	D3	L0	(L1)
Boom	75 (2.9528)	69.5 (2.74)	68 (2.68)	95 (3.74)	65.5 (2.58)	59.5 (2.3425)
Arm	70 (2.7559)	64.5 (2.54)	63 (2.48)	90 (3.54)	65.3 (2.57)	53.3 (2.0984)
Bucket	60 (2.3622)	54.5 (2.15)	53 (2.09)	80 (3.15)	20.5 (0.807)	8.5 (0.3346)
Dozer	75 (2.9528)	69.5 (2.74)	68 (2.68)	95 (3.74)	65.5 (2.58)	59.5 (2.3425)
Swing	70 (2.3622)	64.5 (2.54)	63 (2.48)	90 (3.54)	65.5 (2.58)	53.5 (2.1063)

(4) Wiper ring (rod cover) press-fit jig
Material : STKM13A or equivalent

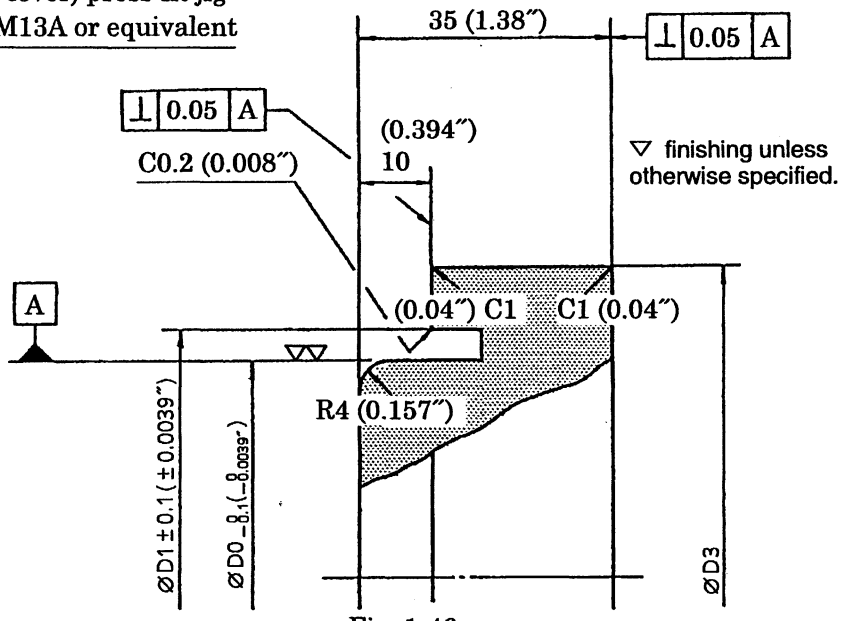


Fig. 1-46

Table 1-11 Unit : mm (in)

Applicable cylinder	D0	D1	L
Boom, Dozer	70 (2.7559)	78.5 (3.0905)	95 (3.74)
Bucket	55 (2.1654)	63.5 (2.5000)	80 (3.15)
Swing & Arm	65 (2.5591)	73.5 (2.8937)	90 (3.54)

Applicable Machines
LF02-01001~

PREFACE

1. This Manual describes all the procedures from removing to installing, arranging them by item.

2. This Manual consists of Part Ⅰ. Removing and installing assy, and Part Ⅱ. Disassembling and assembling.

3. The removing and installing can be performed in the procedure specified in Table of Contents, but in view of actual repairing or time saving some process can be omitted.

4. The removing and installing procedure does not completely cover all possible situations because of differences of field condition and defective section.

5. Please be aware that the procedure to be followed must be determined according to the above conditions.
   When disassembly and assembly are required, select the necessary section, itemize the work contents with good understanding, then starts working.

Revision	Date of Issue	Remarks
First edition	March, 2003	S5LF3304E K

8. AIR CLEANER

8.1 PREPARATION FOR REMOVAL

(1) Opening bonnet assy (5)

1) Unlock it with starter key.

2) Open bonnet (5) and support it with stay (15).

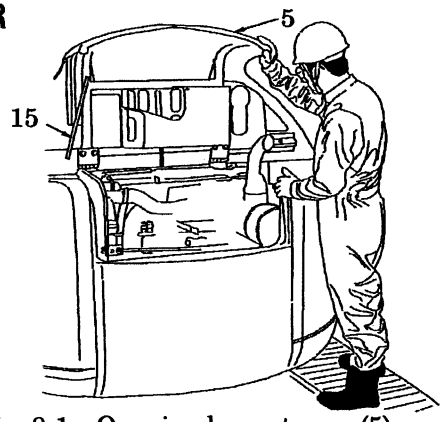


Fig. 8-1 Opening bonnet assy (5)

(2) Opening cover assy (4)

(3) Unplug terminal on indicator lines (5-5) (See Fig.8-4.)

8.2 REMOVAL

(1) Pulling out hose (2)

1) Loosen clip (8) on air cleaner side.

2) Pulling out hose (2)

: Flat-blade screw driver

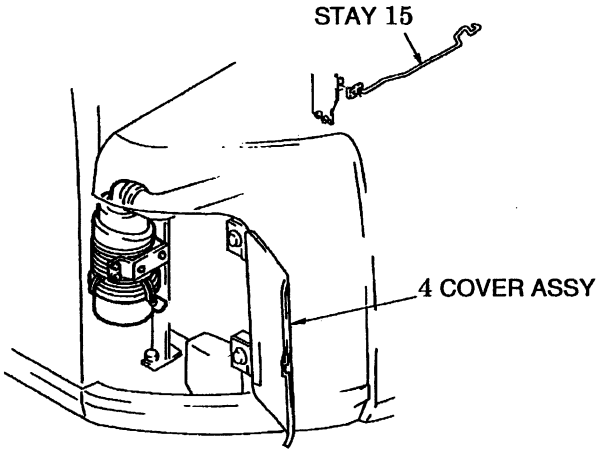


Fig. 8-2 Opening cover assy (4)

(2) Pulling out hose (1)

1) Loosen clip (8) on air cleaner side.

2) Pulling out hose (1)

: Flat-blade screw driver

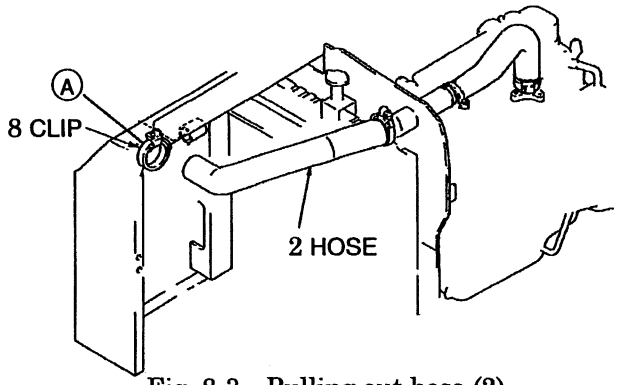


Fig. 8-3 Pulling out hose (2)

(3) Remove air cleaner assy (5)

1) Remove 2 capscrews (14)M8×20

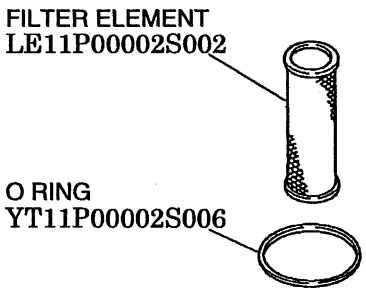
2) Remove air cleaner assy (5) together with bracket (4).

: 13mm

8.3 INSTALLATION

(1) Installing is done in the reverse order of removing.

(2) Spare parts for replacing elements



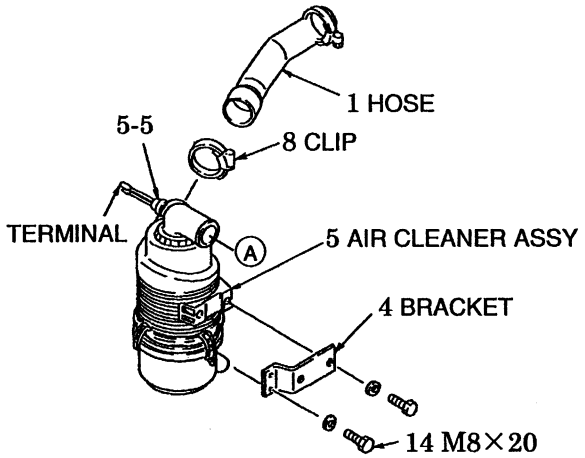


Fig. 8-4 Pulling out hose (1)

13. RADIATOR & OIL COOLER

13.1 PREPARATION FOR REMOVAL

⚠ Connection of hoses for air-con should not be loosened and removed. Refrigerant may be leaked.

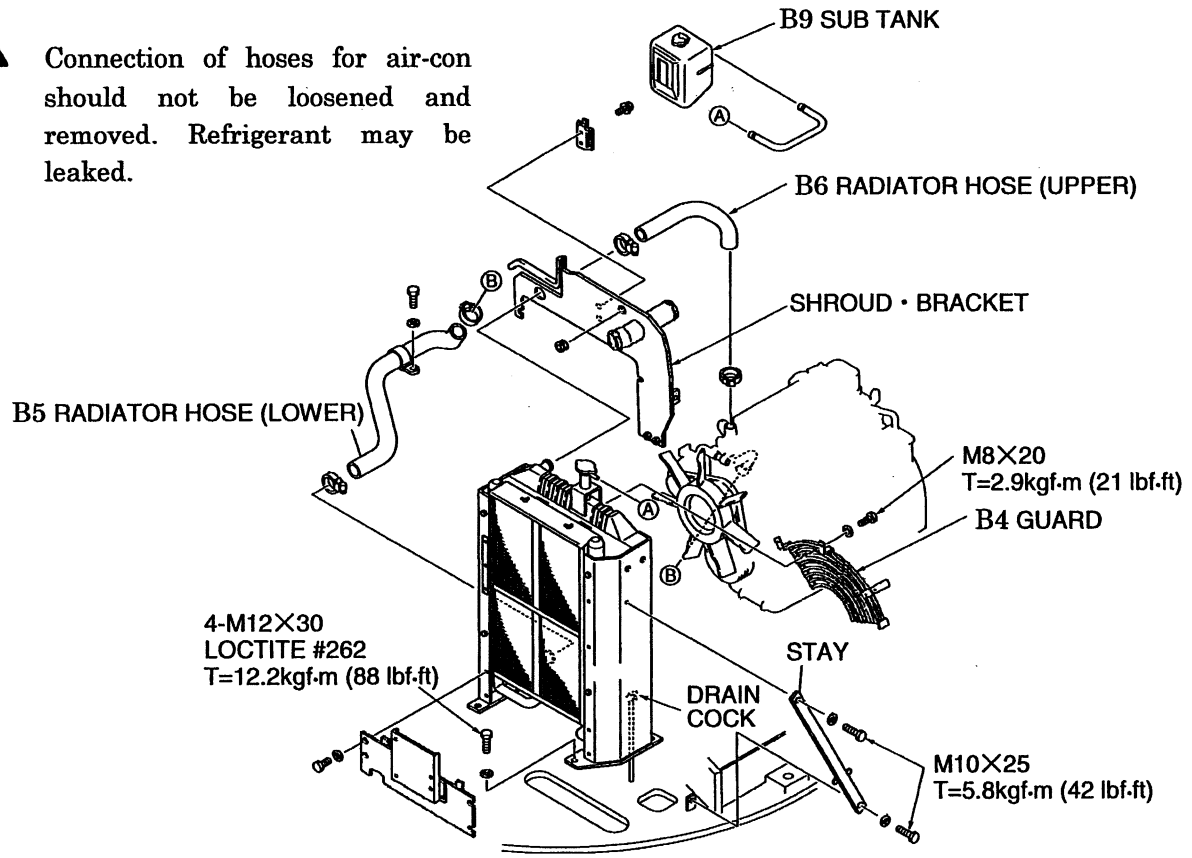


Fig. 13-1 Relative drawing of radiator

(1) Remove counterweight

(2) Bleeding internal air of hydraulic oil tank

(3) Remove cover of suction strainer, and adjust oil quantity so that oil level becomes lower than the return tube level.

(4) Remove air cleaner hose
1) Loosen two bands (7). ┐ Ⅰ-10
2) Pulling out hose (2). ├ Refer to
3) Pulling out hose (3). ┘ air cleaner

: Flat-blade screwdriver

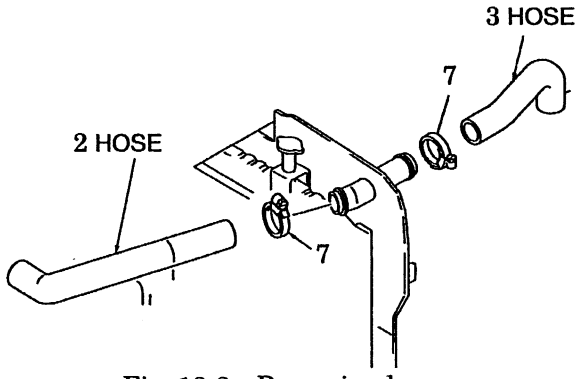


Fig. 13-2 Removing hose

(5) Removing under cover installed on lower side of radiator.
1) Remove four sems bolts (A9)M12×25.
2) Remove cover (A5).

: 19mm

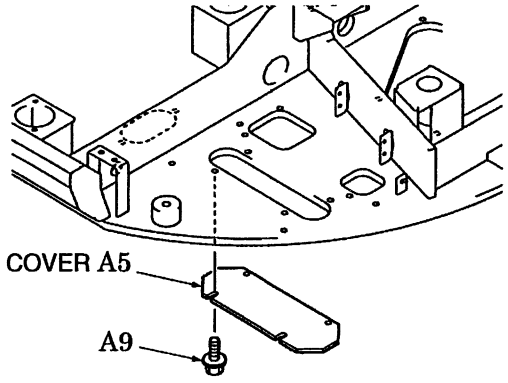


Fig. 13-3 Removing under cover (A5)

18. SLEWING UNIT

18.1 PREPARATION FOR REMOVING

(1) Park machine on flat and solid ground and put attachment and dozer on ground.

(2) Stop engine and release pressure in circuit operating dozer lever.

(3) Release internal pressure through bleeder of hydraulic oil tank.

(4) Remove boom as necessary to make work easier. (Refer to Chapter of BOOM.)

(5) Remove cab if necessary to make work easier. (Refer to Chapter of CAB.)

(6) Remove cover under engine.

(7) Attach tag to hose.

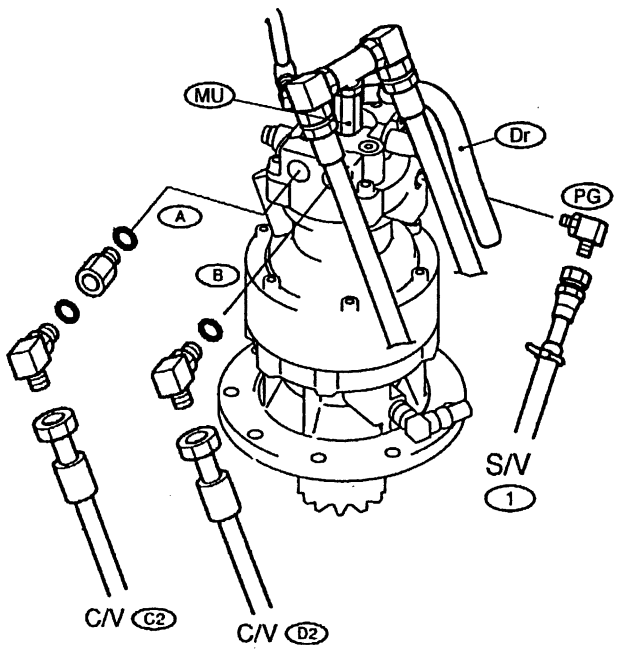


Fig. 18-1 Slewing unit piping

18.2 REMOVAL

(1) Remove hose.

1) Two hoses from tee of MU port.
: 36mm
Tightening torque=12.0kgf·m (87 lbf·ft)

2) One hose from tee of Dr port.
: 22mm
Tightening torque=5.0kgf·m (36ft lbf·ft)

3) One hose from elbow of PG port (for swing parking brake).
Tightening torque=3.0kgf·m (22ft lbf·ft)
: 19mm

4) Two hoses from tee of A, B ports.
: 32mm
(※ special service tool No.6−3)
Tightening torque=15.0kgf·m (110 lbf·ft)

5) Install PF1/2 plug
Plug No.4−2−1

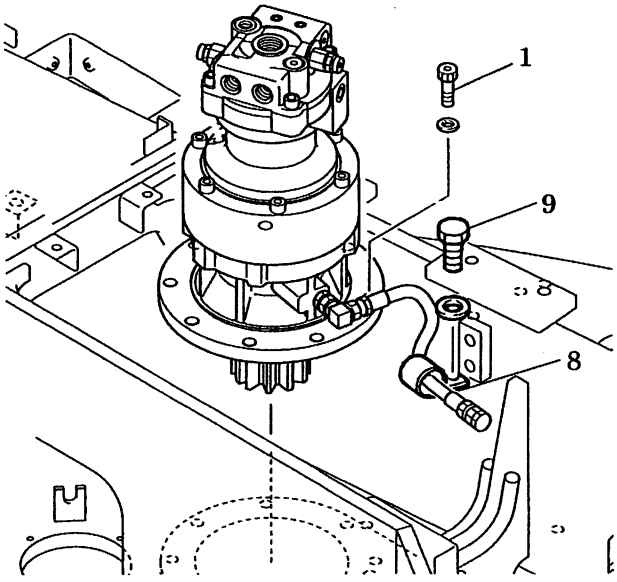


Fig. 18-2 Removing slewing unit

1.2 REMOVAL AND INSTALLATION

(1) Tools

The right list shows the tools required for remove and install.

Table 1-2

Tools	Dimension
Allen wrench	Opposing flats 4,5,6,8,10,14mm
Eye wrench Socket wrench Wrench with double heads (single head)	Opposing flats 27mm
Adjust wrench	Medium size 1pc.
Screw driver	Flat-bladed screw driver 1pc.
Hammer	Plastic mallet 1pc.
Plier	For snap ring TSR-160
Steel bar	Steel bar for key Approx.10×8×200 (0.40″×0.31″×0.79″)
Torque wrench	1~10kgf·m (7.2~72 lbf·ft), 5~30kgf·m (36~220 lbf·ft)

(2) General precautions for remove

1) Work in clean area.

2) Spread rubber sheet or cloth on work bench to protect parts from damaging.

3) Remove dust and rust, etc. on pump surface with wash oil.

(3) Removal

1) Draining oil

Remove drain plug (467) and drain oil from casing (271).

: 27mm

2) Remove coupling (114)

Remove socket bolts (402) used to fasten valve cover (312) and gear pump, remove gear pump, and remove coupling (114) from inside of valve cover (312).

: 6mm

3) Remove valve cover (312)

① Remove socket bolt (401) used to fasten valve cover (312) and casing (271).

: 14mm

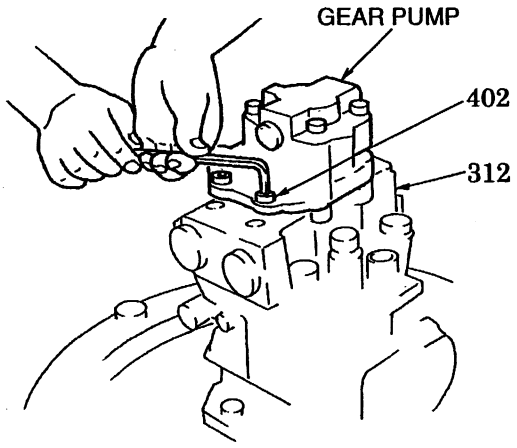


Fig. 1-2 Remove gear pump

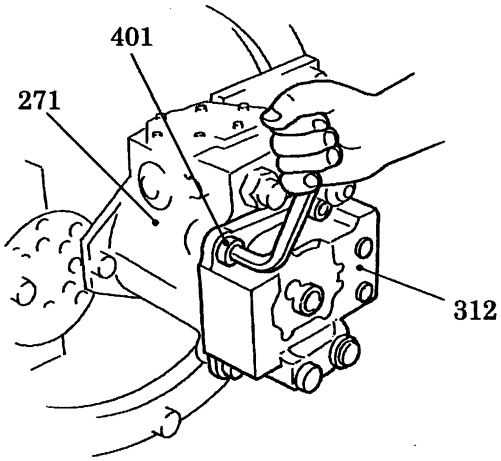


Fig. 1-3 Remove socket bolt (401)

2.2 DISASSEMBLY

(1) Pulling out travel straight spool (7), travel right and left spool (8), slewing spool (9), bucket spool (12), conflux / single sw. spool (81) and N&B spool (82). (Spool without lock valve) (See Figs.2-2, 2-3, 2-13.)

1) Remove two socket bolts (47) of each spool, then pilot cover C (18).
(See Fig.2-3.)
: 5mm

⚠ • Then, special care must be taken that O ring (52) of pilot cover C (18) does not slip out.

2) Hold each spool with spring (26) section, pull it out slowly in parallel to spool hole, and remove spool assy from body (1), (80).

⚠ • Don't disassemble spool assy. If it is damaged, replace it.
• When two types of spool have been removed, attach tag and record the position before disassembling.

(2) Pulling out P2 by-pass cut spool (14), P1 by-pass cut spool (15) and boom conflux spool (13). (Spool without lock valve)
(See Figs.2-2, 2-4.)

1) Remove two socket bolts (47) of each spool and pilot cover C (18). (See Fig.2-4.)
: 5mm

⚠ • Then, special care must be taken that O ring (52) of pilot cover C (18) does not slip out.

2) Hold each spool with spring (26) section, pull it out slowly in parallel to spool hole, and remove spool assy from body (1).

3) Pull out boom conflux spool (13) in the reverse direction.

⚠ • Don't disassemble spool assy. If it is damaged, replace it.
• When two types of spool have been removed, attach tag and record the position before disassembling.

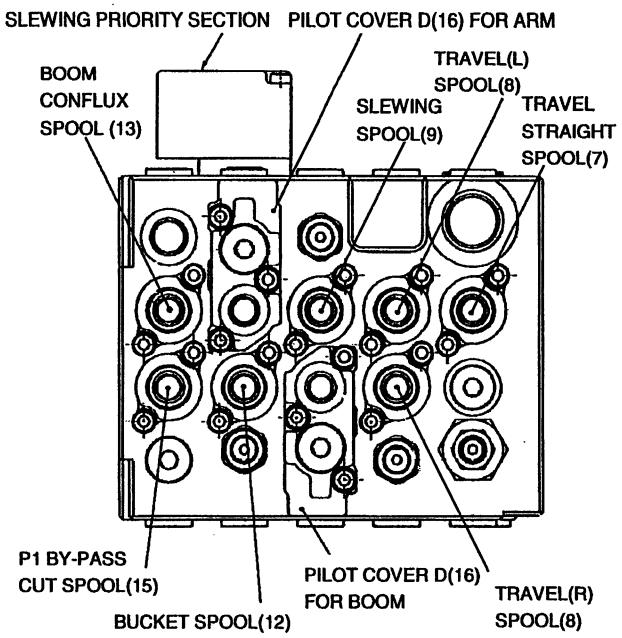


Fig. 2-2 Position of spool without lock valve

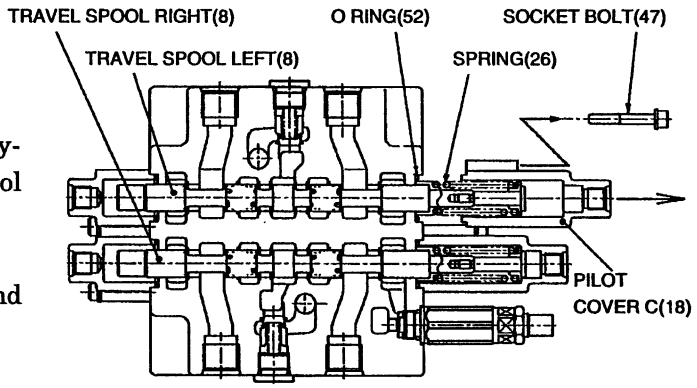


Fig. 2-3 Pulling out travel right and left spool (Section B−B)

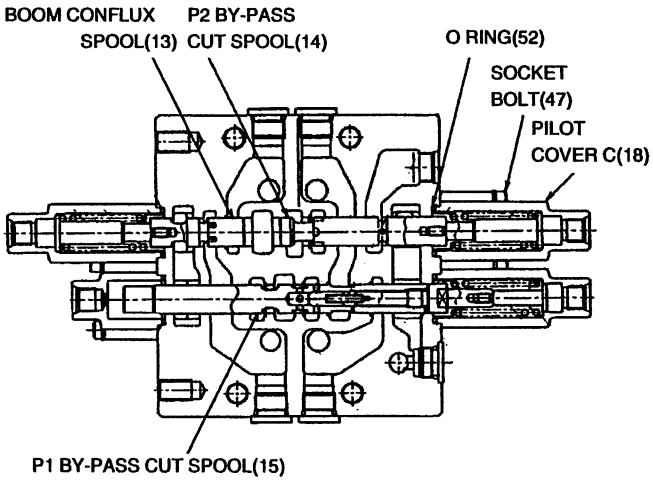


Fig. 2-4 Pulling out P2 by-pass cut spool, P1 by-pass cut spool and boom conflux spool (Section E−E)

NOTES

22) Apply Loctite #241 or equivalent to the thread of socket bolt.

23) Tighten socket set bolt (472) to the specified torque.

24) Incline cam (420), apply grease to the top end of push rod (214), and fill grease cup (203) of plug (202) with grease.

25) After fitting the top end of bellows (501) in cam (402), fit the lower side in the groove of cover (201).

③ Remove cam plate (23) from the piston assy (21) as is by sliding it on sliding surface of piston assy (21).

⚠ Handle cam plate with care so as not to damage its sliding surface.

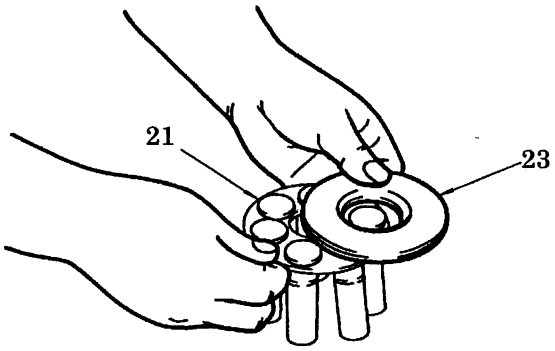


Fig. 5-19 Removing cam plate (23)

④ Remove retaining spring (20) from cylinder (19).

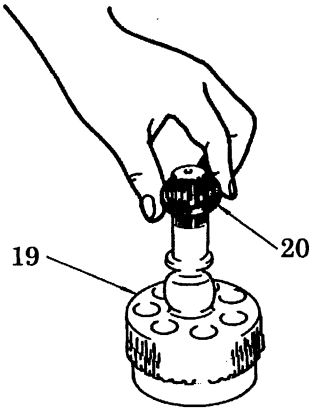
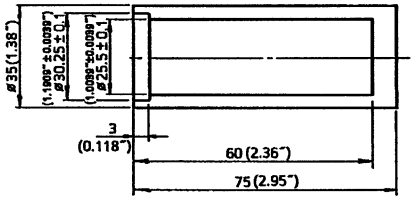
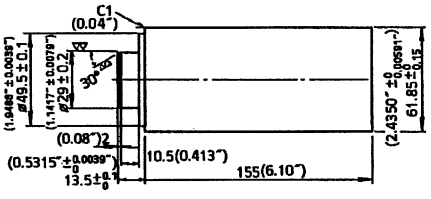
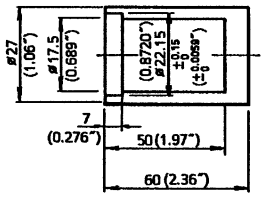
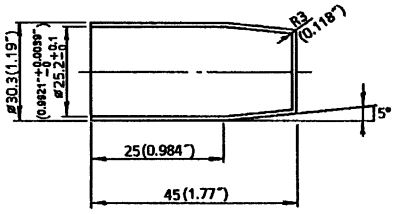


Fig. 5-20 Removing retaining spring (20)

(2) Installation
Install slewing motor unit in the reverse procedure of remove.

1) Jigs
Jig used for installing is not provided with part number.

Name	Dimensions	Name	Dimensions
Press-fitting jig for inner race of tapered roller bearing (1)		Press-fitting jig for oil seal (28)	
Press-fitting jig for collar (27)		Seal protector	

(4) Removing seals

1) Pull out O ring (6) from the O ring groove with the aid of a spatula (f).

⚠ Use the tip of the spatula taking not to harm the body. Also do not strike the spatula.

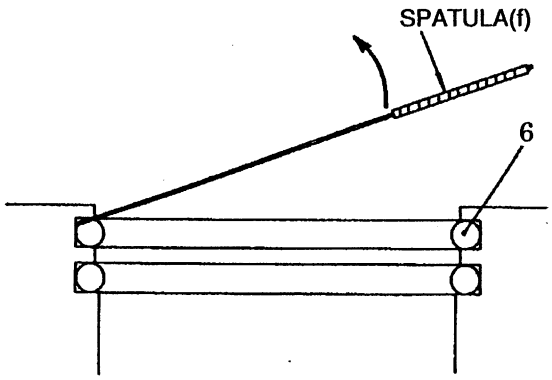


Fig. 6-6 Taking out O ring (6)

2) Stick pin (e) to seal (5) and extract slipper ring (5). Fig.6-7 shows the use of one pin, but by using two pins, this can be extracted with more sureness.
As the backup ring is made of rubber, remove this in the same procedure as O ring (6).

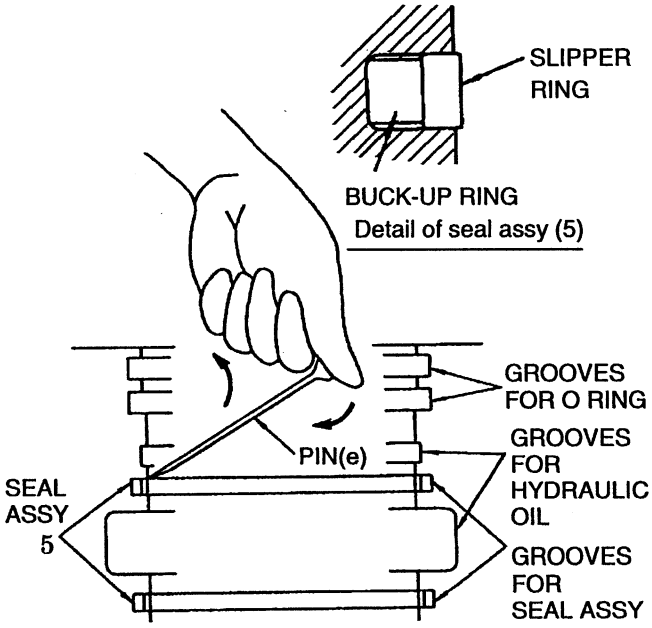


Fig. 6-7 Taking out seal assy (5)

6.2.5 ASSEMBLY

Prior to assembly, clean each parts (excluding the O ring and seal), and arrange in the sequence of assembly.

(1) Assembling seals to body

1) Coat O ring (6) lightly with hydraulic oil and install in the O ring groove. Also make sure that the O ring is not twisted after installation.

2) Deform and fit slipper ring of seal assy (5) as shown in the figure after inserting backup ring. And after inserting entire seal section, fit it in seal groove completely with spatula.

⚠ Before fitting slipper ring, check that seal groove is free from, hydraulic oil, grease, etc.

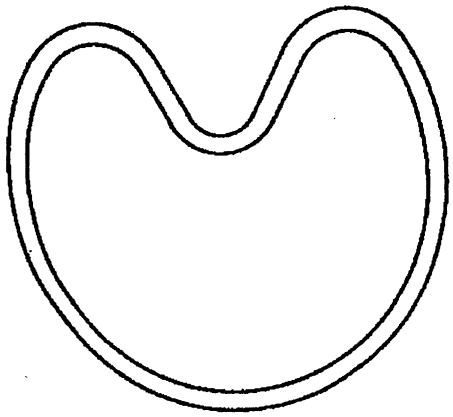


Fig. 6-8 Inserting seal assy (5)

(2) Iron crawler　　Track link assy(YT62D00001F1)

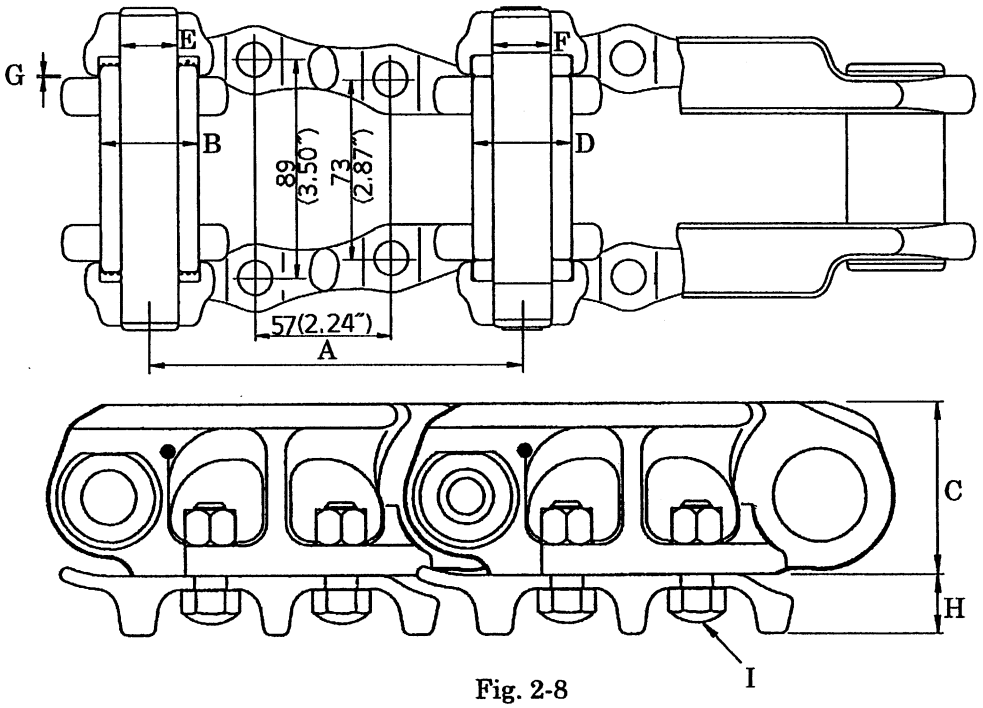
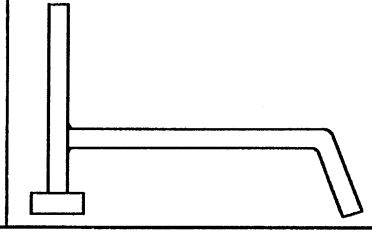


Fig. 2-8

Table 2　　Unit : mm (in)

No.	ITEM	STANDARD VALUE			REPAIRABLE LEVEL	SERVICE LIMIT	REMEDY
A	Link pitch	155.6±0.1 (6.126±0.0039)			160 (6.30)	164 (6.46)	Replace the link ass'y if the service limit is exceeded.
B	O.D. of bushing	$41^{+0.214}_{+0.174}$ ($1.6142^{+0.0084}_{+0.0069}$)			Ø37 (1.46)	Ø36 (1.42)	
C	Height of link	75±0.15 (2.9528±0.0059)			69 (2.72)	67 (2.64)	
D	Interference between bushing and link	Basic dimension	Tolerance		Fit	Fit	Replace
		Ø41 (1.6142)	Shaft	+0.214 +0.174 (+0.0084 +0.0069)	Interference 0.05 (0.0020)	Interference 0	
E	Interference between track pin and link	Ø24 (0.9449)	Shaft	±0.04 (+0.0016)	Interference 0.05 (0.0020)	Interference 0	
F	Interference between master pin and link	Ø24 (0.9449)	Shaft	−0.05 −0.08 (−0.0020 −0.0032)	Interference 0.05 (0.0020)	Interference 0	Replace Link
G	Clearance between links (both sides)	1.6 (0.06)			8 (0.32)	10 (0.39)	Replace
H	STD shoe plate	26 (1.02)			15 (0.59)	13 (0.51)	Replace
I	Tightening torque of shoe bolt	30kgf·m (220 lbf·ft)					Retighten

2.5 TOOLS AND JIGS

No.	NAME	SHAPE
a	Master pin fixing jig	

7) Installing O ring (6)
Install O ring (6) to shaft groove.

- Grease O ring.
- Replace O ring with new one without fail at reassembling.

8) Press fitting collar (7)
Press-fit collar (7) to shaft (2).

- Press-fit collar (7) on aligning pin (4) hole.

9) Inserting pin (4)
Press-fit pin (4) described in to the pin hole mating pin hole of collar (7) with pin hole on the end side of shaft (2).

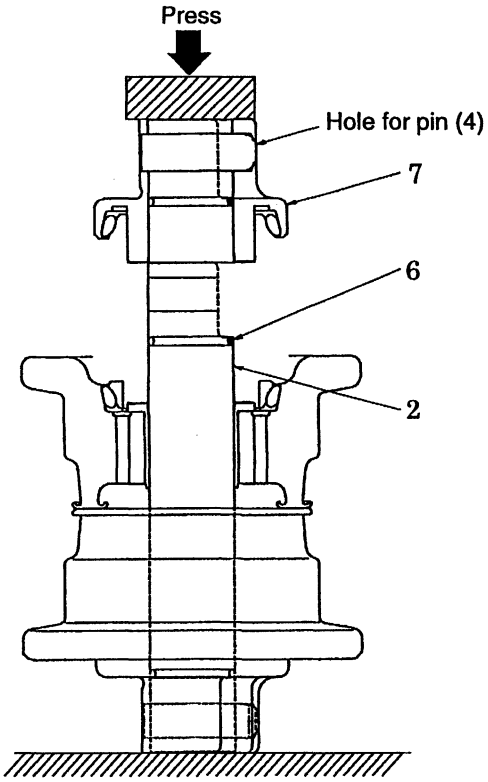


Fig. 4-15 Installing O ring (6), collar (7)

10) Filling oil
Remove plug (8) and fill in 90cc (5.49cu·in) of engine oil API grade CD#30.

11) Check it for leakage
Before tightening plug (8), check it for leakage in the condition of air pressure 2.0kgf/cm^2 (28psi).

12) Installing plug (8)
Apply oil resistant sealant on plug (8), and tighten it in the plug hole on the collar (7) end face.
:6mm,
Tightening torque : 2.4kgf·m (17 lbf·ft)

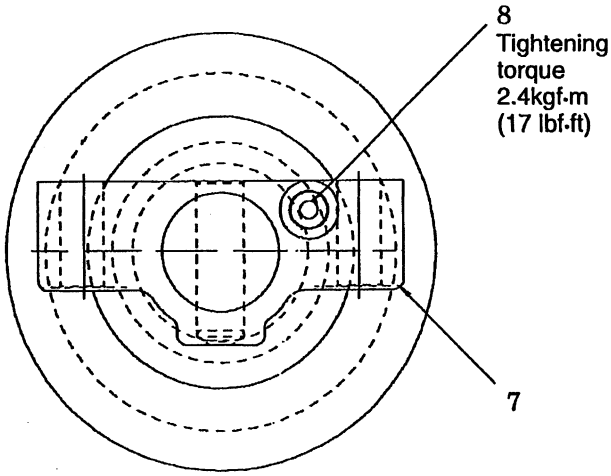


Fig. 4-16 Installing filling oil plug (8)

⚠ After assembling the lower roller, confirm that oil is not leaking and that the roller rotates smoothly by hand.

(2) Assembly

Assembly is done in the reverse order of disassembly.

1) Installing spring (5), grease cylinder (1)

Insert grease cylinder (1) into spring (5) and attach lifting eye nut (W) to screw M36×P3 at the tip of the grease cylinder. Lift the grease cylinder by crane and erect it in the center of the jig stand upright.

2) Fixing idler adjuster assy

Install bracket (2) on top of spring (5). Center the rod of grease cylinder (1) and the holes in bracket (2). Attach the retainer plate and four holding-down nuts. Fasten the nuts evenly all round and fix the idler adjuster assy to the jig body.

: 46mm

3) Compressing spring (5) and tightening nut (3)

Extend the hydraulic jack, compress spring (5) to a set length and screw in nut (3) to the screwed part at the tip of grease cylinder (1).

Set length of the spring : 270mm (10.63in)

4) Installing spring pin (4)

Tighten nut (3) till the holes for locking spring pins (4) are aligned. Then drive spring pin (4).

: 46mm

: 55mm

5) Removing idler adjuster assy

Remove idler adjuster assembly from jig.

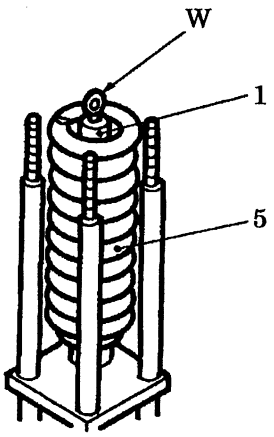


Fig. 5-21 Placing spring (8) and grease cylinder (1) to the jig

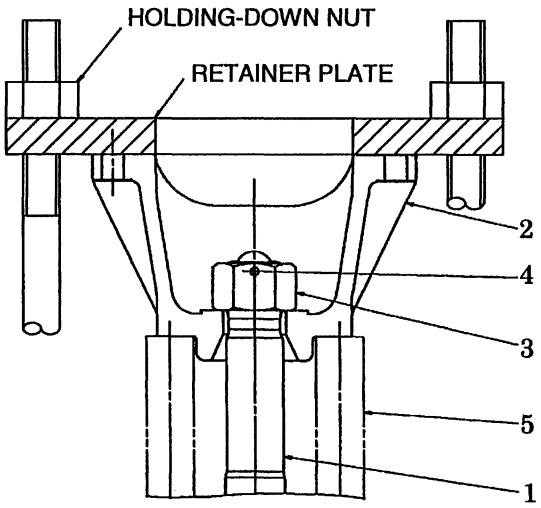


Fig. 5-22 Compression of spring (5), and attaching nut (3) and spring pin (4)

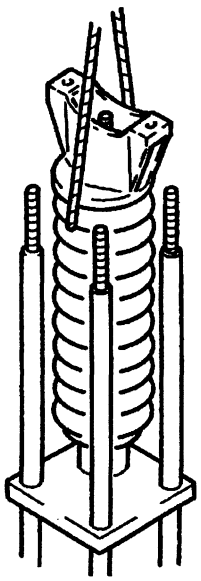
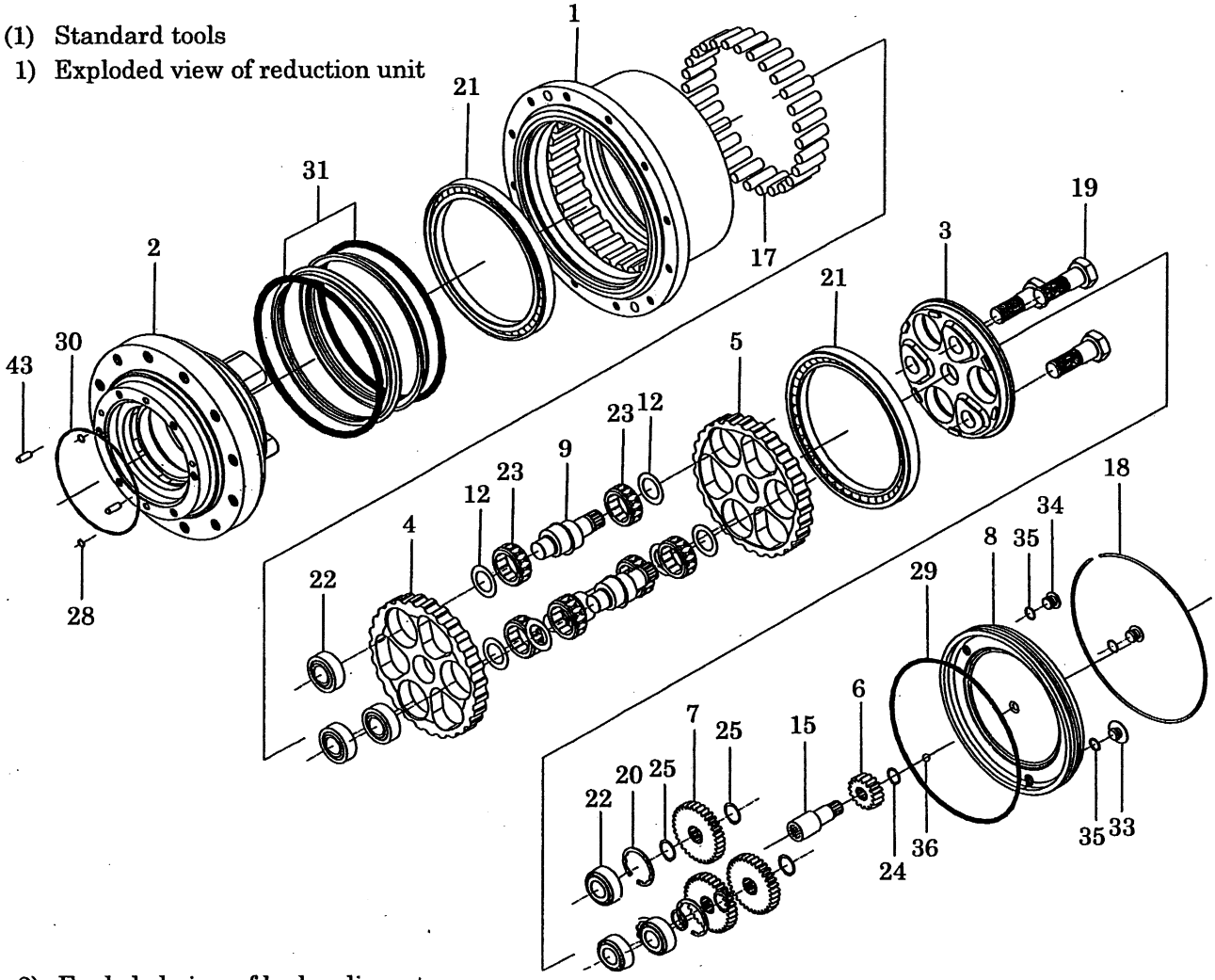


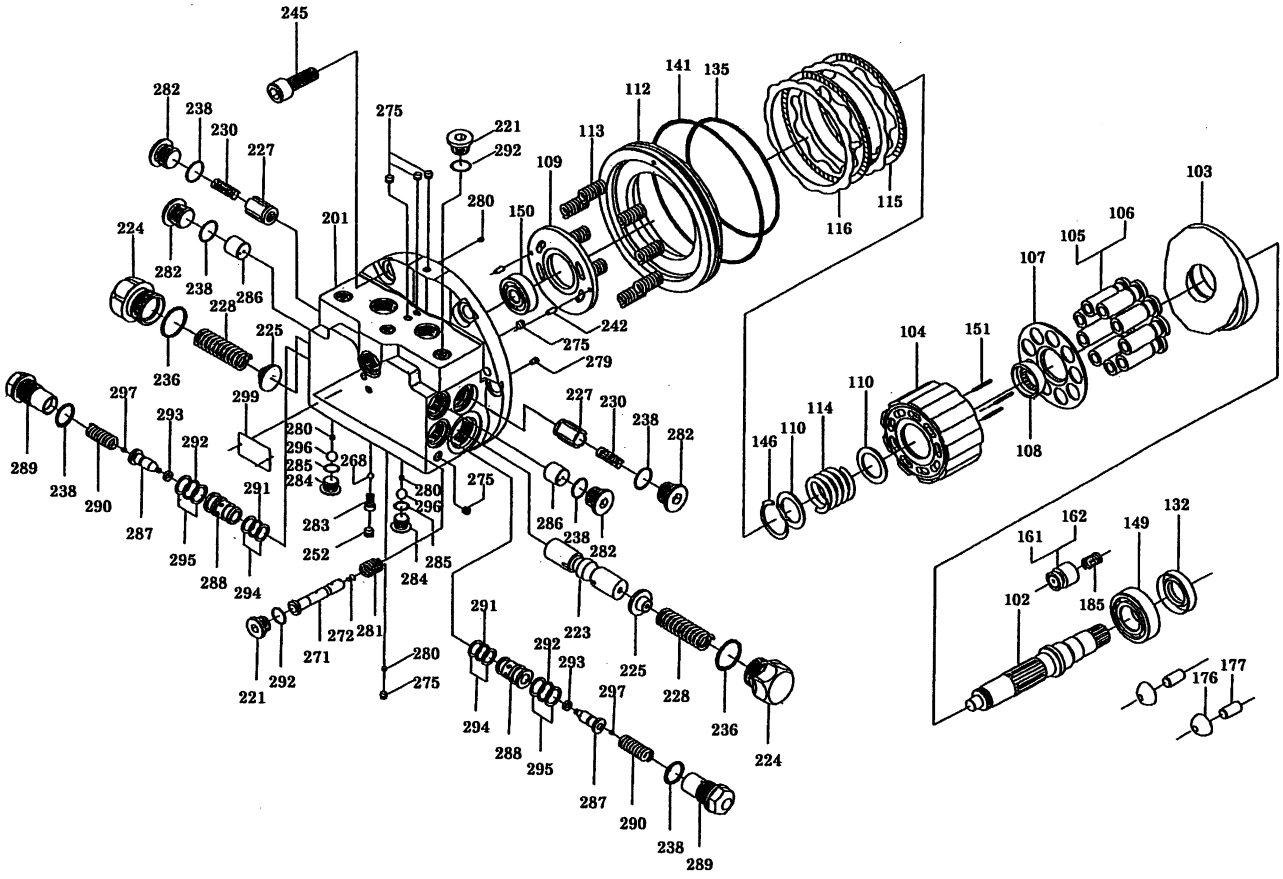
Fig. 5-23 Removing idler adjuster assy

(1) Standard tools

1) Exploded view of reduction unit



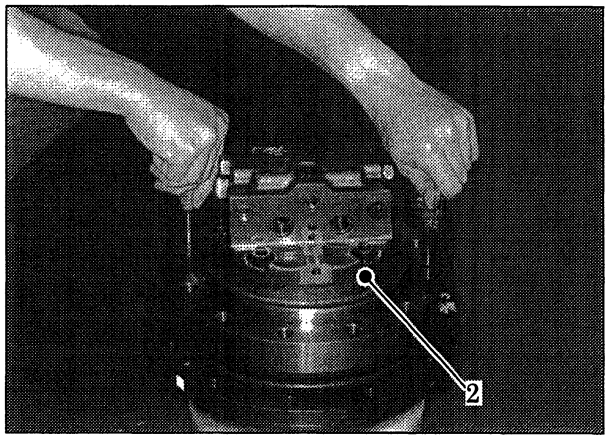
2) Exploded view of hydraulic motor



(3) Removing

1) Cleaning travel motor

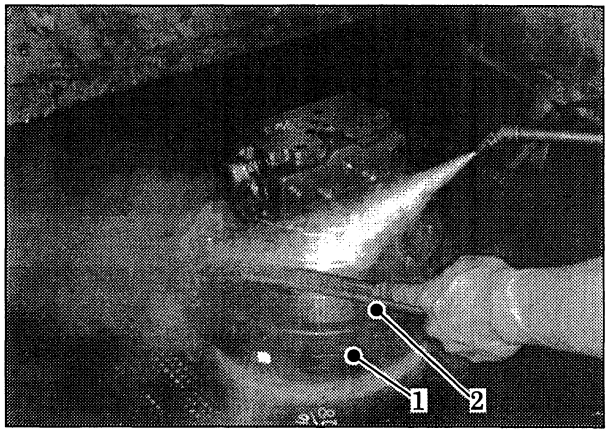
① Tighten the eye bolts into the tapped holes of the spindle (2).



⚠ ● Fasten two eye bolts into the tapped holes for the spindle so they are located diagonally opposite to one another.

② Place a wire sling in the eye bolts, lift the travel motor by hoist, and carry in to the cleaning bath.

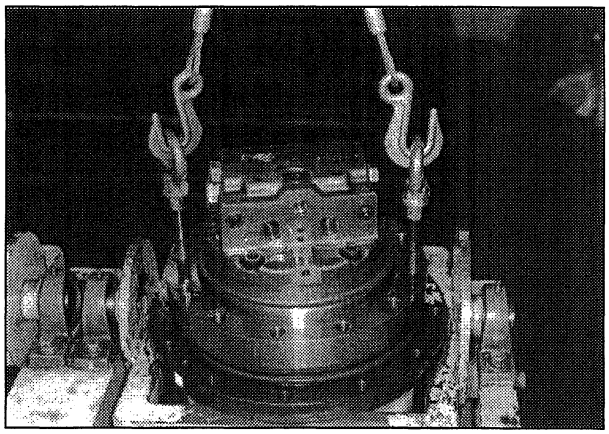
③ Clean the travel motor with a car brush.



⚠ ● Since soil and sand are entered in the clearance (where the floating seal is fixed) between hub (1) and spindle (2), clean it with particular care.

2) Installing travel motor

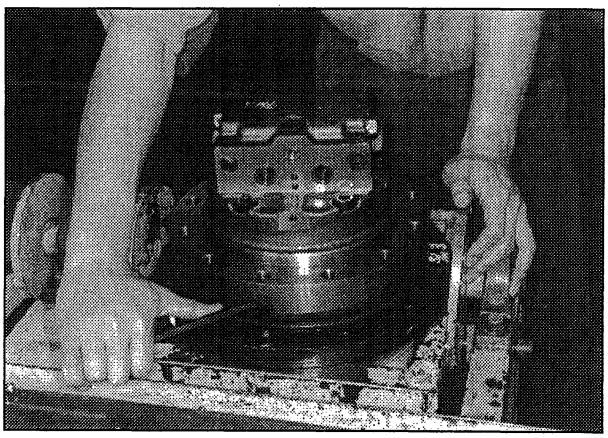
① Fix travel motor with two socket bolts on working bench.



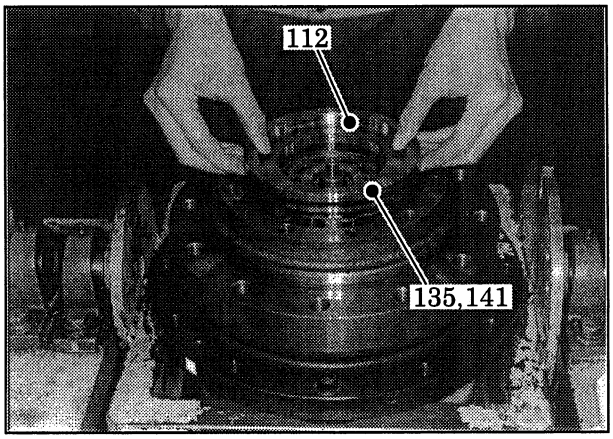
⚠ ● Align threaded holes of hub (1) and working bench and place travel motor in fixing hole of working bench slowly.

⚠ CAUTION

Tighten up the socket bolts rigidly. Unless tightened rigidly, the components drop as the travel motor is turned over and cause bodily injuries.

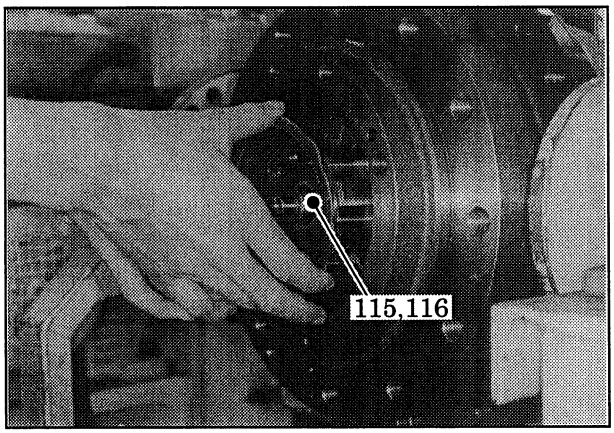


2) Remove O ring (135), (141) from piston (112).



⚠ ● Do not reuse removed O ring (135), (141).

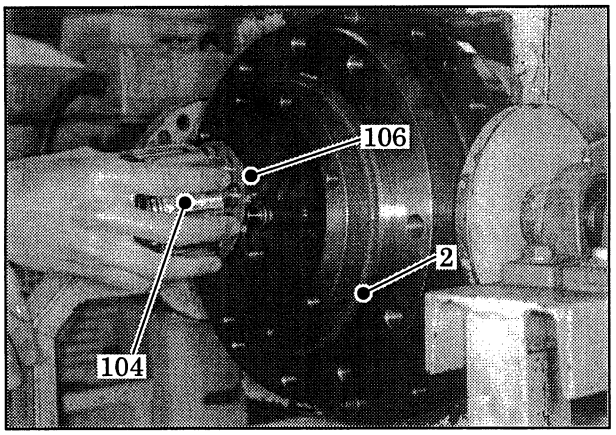
14) Removing the hydraulic motor section



⚠ ● When placing the travel motor on its side, oil spills ; place a container under the travel motor.

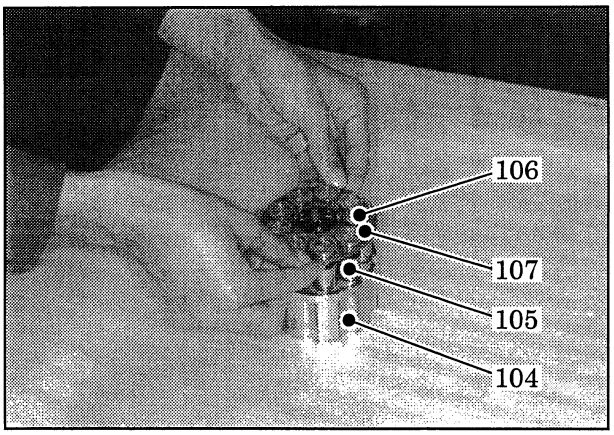
① Incline travel motor 90 degree. (Lay it down.)
② Drain out the oil of the travel motor.
③ Remove two friction plate (115) and two separator plate (116).

④ Hold cylinder block (104) by hand, remove shoe (106) adhered on swash plate (103) turning 2 or 3 times alternately.



⚠ ● If the cylinder block is pulled out without separating shoe, the shoe (106) remained on swash plate (103) (piston, shoe) may drop in spindle (2).

⑤ Remove cylinder block (104) from shaft (102).
⑥ Remove piston assy [piston (105) and shoe (106)] and retainer plate (107) from cylinder block (104).



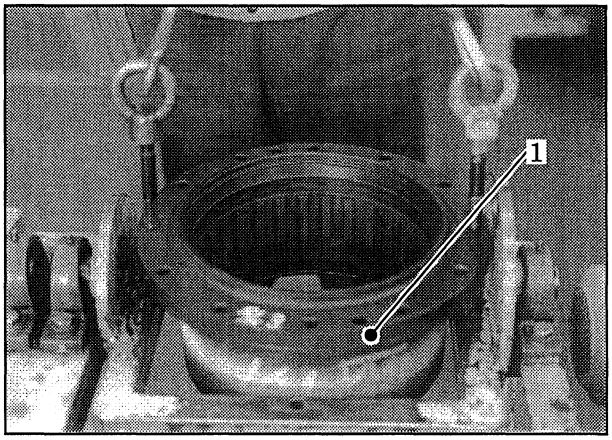
⚠ ● When removing the cylinder block, hold the retainer plate (107) by both hands and remove it with the piston assy.
● The piston (105) and the shoe (106) are made in piece as they are caulked by the spherical surface of the piston. It is not possible to remove the piston from the shoe without damaging the shoe. When replacement is required, replace 9 sets of piston (105) and shoe (106). (Hereafter called piston assy.)

1) Installing hub (1).

① Install two eye bolts into the tapped holes of hub (1) so they are located in diagonally opposite positions.

② Hook eye bolt of hub (1), and lift up and place it on working bench.

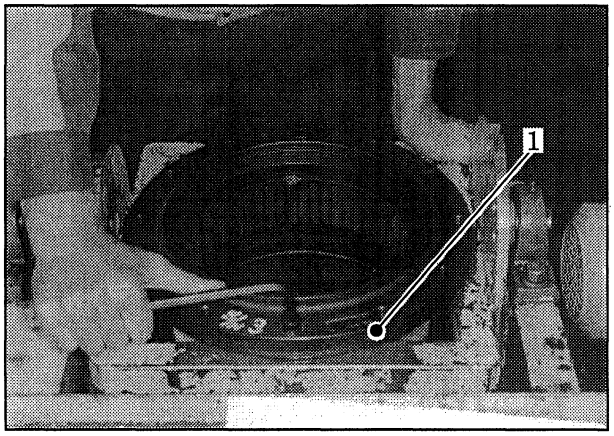
- Align hub (1) to the mounting holes of the work bench, while matching the holes in hub (1) with those in the work bench.



③ Install hub (1) to the work bench and fasten socket bolts so they are located in diagonal positions.

⚠ CAUTION

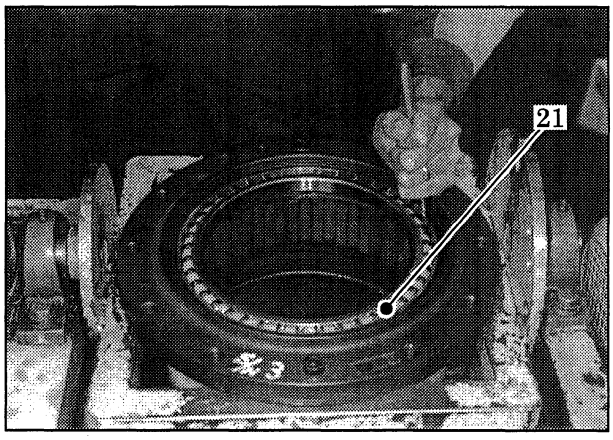
Fasten the socket bolts securely. If the bolts are not tightened sufficiently, the travel motor may fall when turned over, which is dangerous.



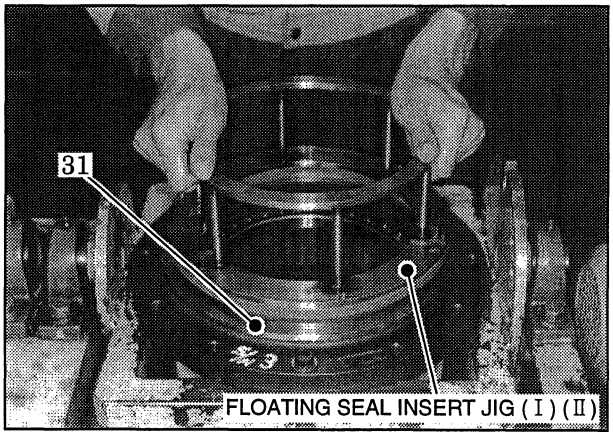
④ Insert bearing (21) in hub (1).

⚠

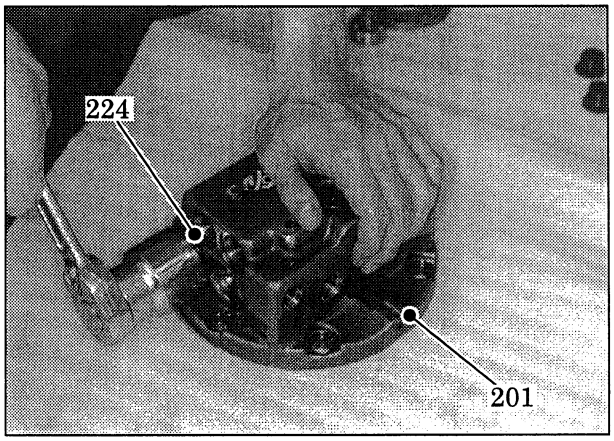
- Place a pin punch against the outer race of bearing (21), hammer it lightly all around and press in the bearing little by little.



⑤ Assemble floating seal (31) to hub (1), using the assembling jigs (I), (II).



⑧ Tighten two plugs (224) into rear flange (201).



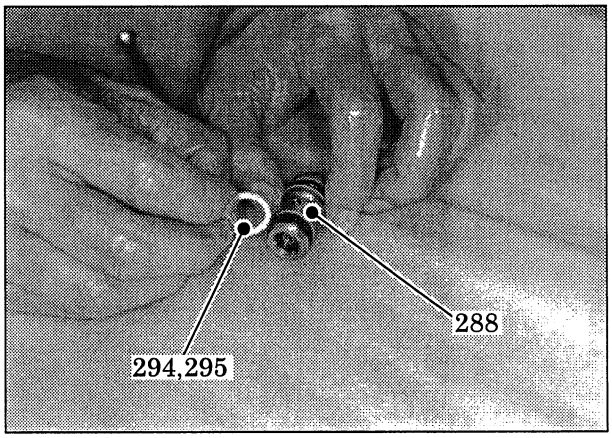
⚠ ● When tighten the plugs into the rear flange, use care so as not to deform the spring.

⑨ Temporarily tighten two plugs (224) to rear flange (201) by means of a spanner.

14) Into rear flange assembling shockless relief valve (SRV).

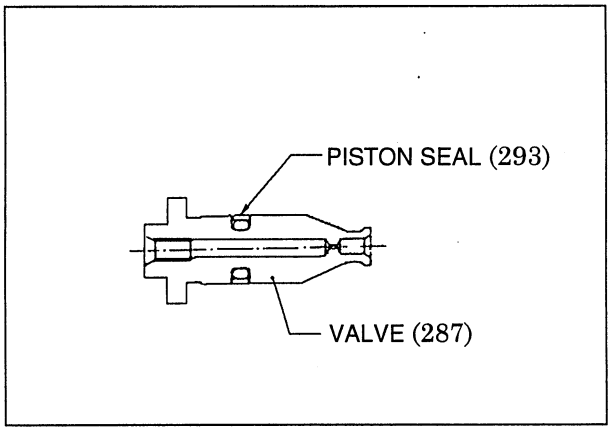
① Fit O ring (291), O ring (292) and backup ring (294),(295) to sleeve (288).

② Fit O rings (238) to plug (289).



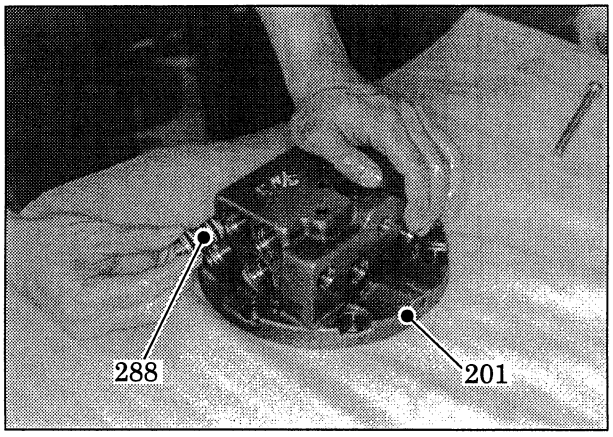
⚠ ● Coat O ring (291),(292),(238) with grease.

③ Install piston seal (293) to valve (287).



⚠ ● Piston seal (293) is made up of O ring and teflon ring, and apply grease on both rings and fit O ring first, then teflon ring.

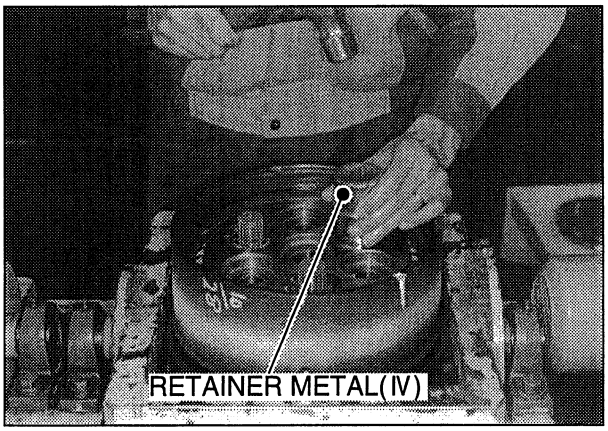
④ Insert sleeve (288), valve (287) and spring (290) to rear frange (201)



⚠ ● Apply hydraulic oil on valve (287) and insert it in sleeve (288).

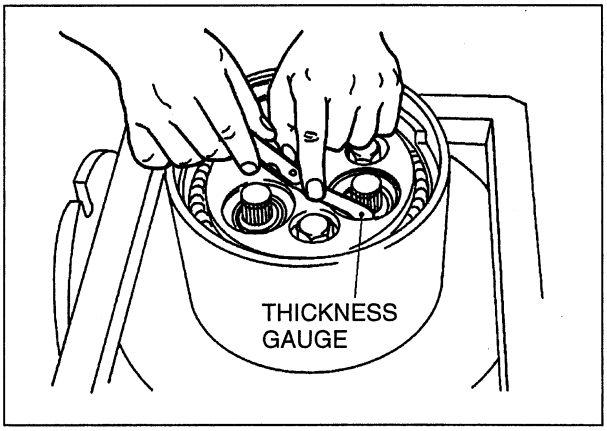
● Parts inside of sleeve are fitted in the work shop as a sleeve kit, so take care not to make a wrong combination.

③ Lightly tap the outer periphery of snap ring (20) via jig (Ⅳ).



⚠ ● Confirm that the RV gear assy is securely set in spindle (2).

④ Insert a thickness gauge between snap ring (20) and bearing (22) and measure the clearance.



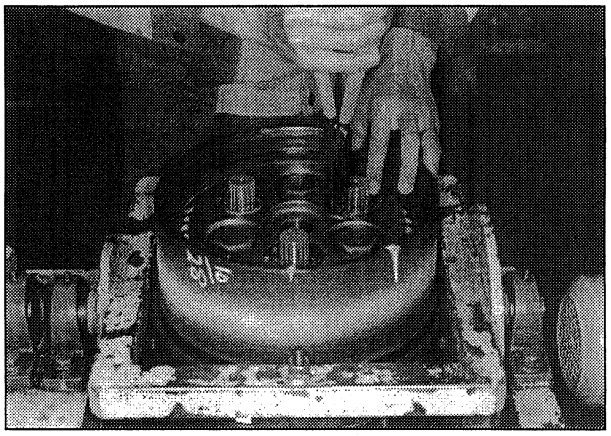
⑤ Thickness measurement of snap rings

● Set thickness of snap ring (max.)

MAX.= [Thickness of thickness gauge] + [Thickness of presently set snap ring]

● Set thickness of snap ring (min.)

MIN.= [Thickness of thickness gauge] + [Thickness of presently set snap ring] − [0.05 mm (0.002in)]



⑥ When the thickness of the snap ring has been determined, select one out of twelve kinds A through L (refer to page Ⅱ−53 1.8) and fit it to the hold flange.

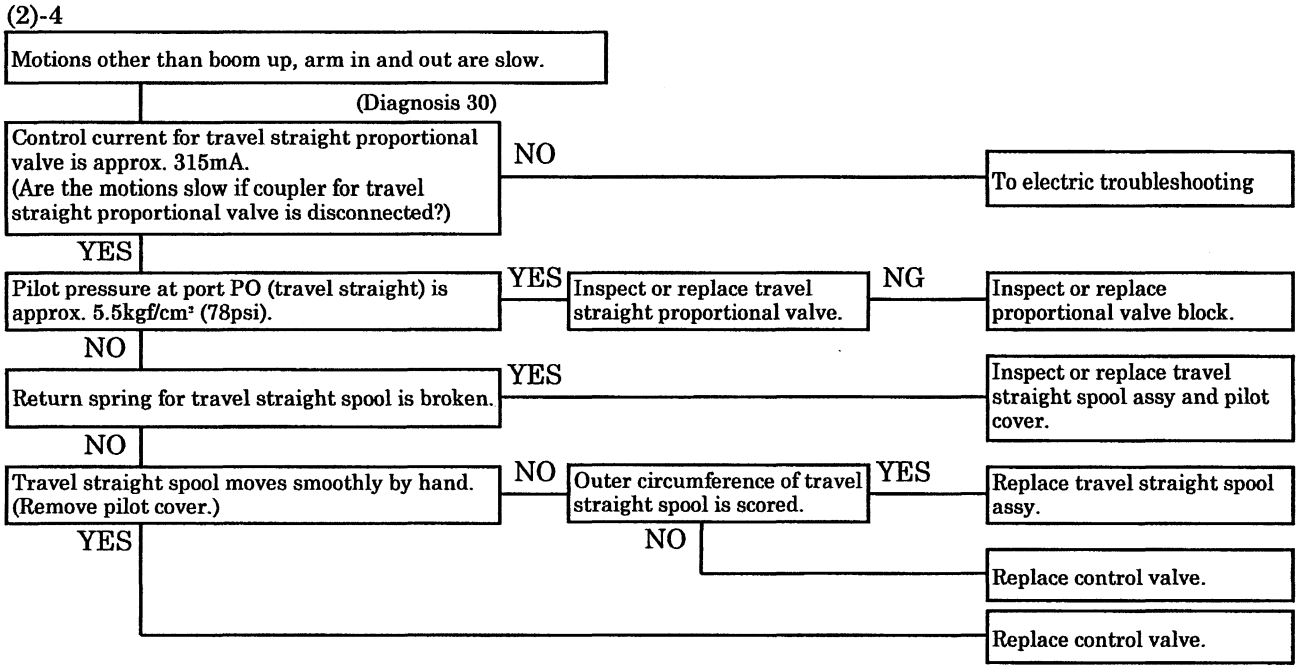
⑦ Install snap ring satisfying the set thickness, and proceed to the procedure in Item ② in page Ⅱ−1−36 6).

3. TROUBLESHOOTING SUMMARIZED ; MECHATRO CONTROL

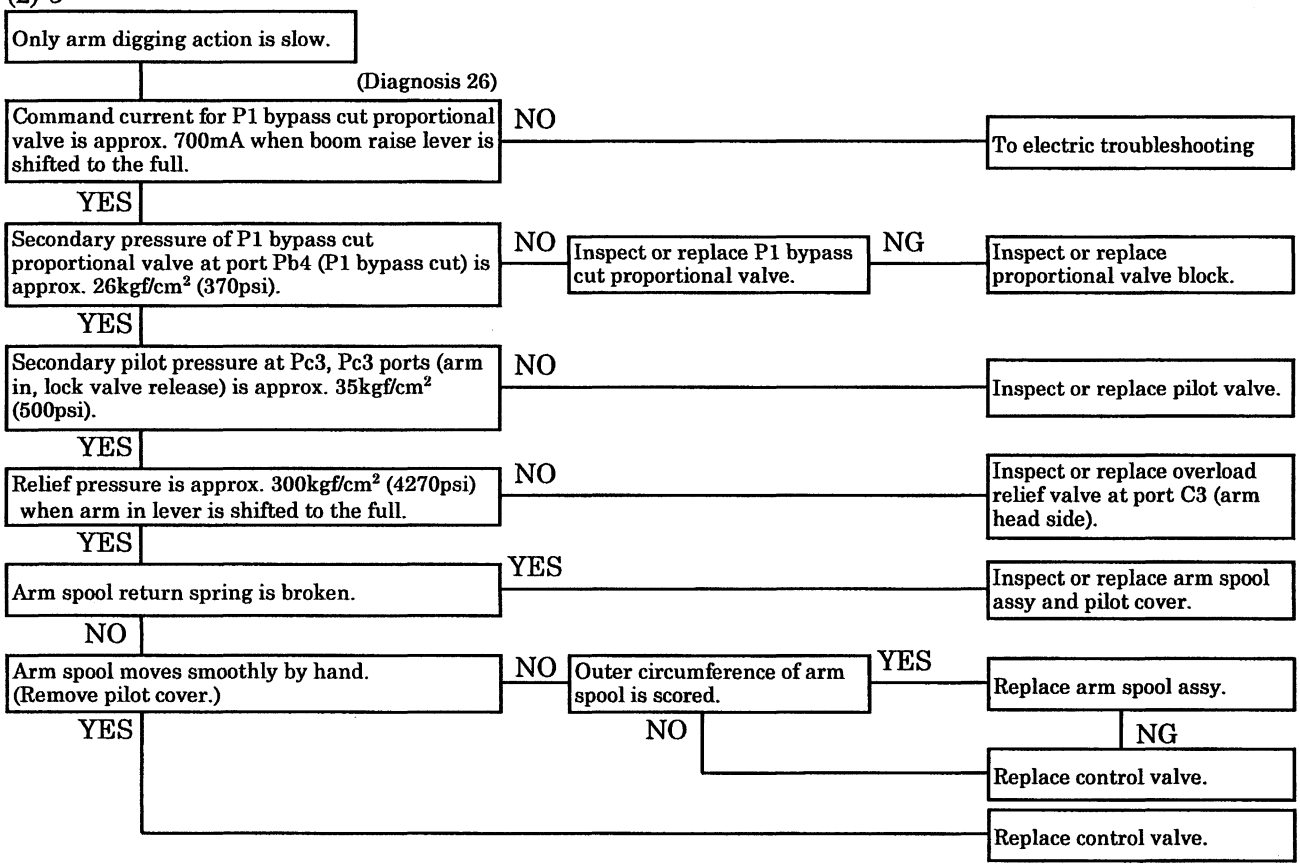
Note : The below table shows items to be highlighted in the electrical and hydraulic troubleshooting.
"Normal criterion" is a list of figures which come up in the electrical and hydraulic troubleshooting.
Regarding the inspecting procedures, refer to each troubleshooting.

No.	Trouble	Operating condition	Electric or hydraulic cause		Hydraulic or electric	Normal criterion		
			Cause	Check point		1	2	3
1-1	No operation works.	Safety lock lever down at full stroke.	Safety lock lever solenoid (SV-4) does not change over and there is no hydraulic source for pilot valve.	SOL(SV-4)	Electric	24V at SV-4 connector.	24V at SW-11.	24V at fuse box connector CN-14M) white & black
1-2	Moves unexpectedly.	Lever at neutral	P1 bypass cut proportional valve moves unexpectedly and the P1 circuit pressure rises.	P1 bypass cut proportional valve (PSV-D) connector	Electric	Current for P1 bypass cut proportional valve : 315mA.	Arm in sensor and arm out sensor values : less than 1.3V.	—
					Hydraulic	Secondary pilot pressure for P1 bypass cut valve : 5.5kgf/cm²(78psi).	Secondary pilot pressure : 6kgf/cm² (85psi)	
		Lever at neutral	P2 bypass cut proportional valve moves unexpectedly and the P2 circuit pressure rises.	P2 bypass cut proportional valve (PSV-B) connector	Electric	Current for P2 bypass cut proportional valve : 315mA.	Boom raise sensor and slewing right / left sensor values : less than 1.3V.	—
					Hydraulic	Secondary pilot pressure for P2 bypass cut proportional valve : 5.5kgf/cm² (78psi).	Secondary pilot pressure : 6kgf/cm² (85psi).	—
2-2	Only bucket is slow.	Bucket lever and other levers at full stroke	P2 bypass cut proportional valve moves unexpectedly, P2 circuit pressure rises, and P1 circuit flow decreases.	P2 bypass cut proportional valve (PSV-B) connector	Electric	Current for P2 bypass cut proportional valve : 315mA.	Boom raise sensor and slewing right / left sensor values : less than 1.3V.	—
					Hydraulic	Secondary pilot pressure for P2 bypass cut valve : 5.5kgf/cm² (78psi).	Lever at neutral Secondary pilot pressure with lever neutral : 6kgf/cm² (85psi).	Secondary pilot pressure for bucket : 35kgf/cm² (500psi)
2-3	Only boom raise speed is low.	Boom lever at full stroke	P2 bypass cut proportional valve does not move and the boom conflux flow is not done.	P2 bypass cut proportional valve (PSV-B) feedback current	Electric	Feedback current for P2 bypass cut proportional valve : 709mA	Command current for P2 bypass cut proportional valve : 709mA	Boom raise sensor : more than 4.0V
					Hydraulic	Secondary pilot pressure for P2 bypass cut valve : 26kgf/cm² (370psi)	←	Secondary pilot pressure for travel : 24kgf/cm² (340psi)
		Travel lever at neutral	Travel straight valve moves unexpectedly and is actuated by P1 pump flow.	Travel straight proportional valve (PSV-C) command current	Electric	Command current for P2 bypass cut proportional valve : 315mA	Travel right and left sensors : less than 1.3V	—
					Hydraulic	Secondary pilot pressure for P2 bypass cut valve : 5.5kgf/cm² (78psi)	Secondary pilot pressure for travel : 6kgf/cm² (85psi)	—
	Only speeds other than boom raise, arm in and out are low.	Travel lever at neutral	Travel straight valve moves unexpectedly and P2 pump flow to tank.	Travel straight proportional valve (PSV-C) command current	Electric	Command current for travel straight proportional valve : 315mA	Travel right and left sensor value : less than 1.3V	—
					Hydraulic	Secondary pilot pressure for PO port travel straight valve : 5.5kgf/cm² (78psi).	Secondary pilot pressure for travel : 6kgf/cm² (85psi)	—
2-4	Only arm in speed is low.	Arm lever at full stroke	Arm conflux flow is not done.	P1 bypass cut proportional valve (PSV-D) command current	Electric	Command current for P1 bypass cut proportional valve :709mA	—	Arm in sensor : more than 4.0V
					Hydraulic	Secondary pilot pressure for P1 bypass cut : 26kgf/cm² (370psi)	—	Secondary pilot pressure for arm in : 35kgf/cm² (500psi)
2-5	Only arm out speed is low.	Arm lever at full stroke	Arm conflux flow is not done.	P1 bypass cut proportional valve (PSV-D) command current	Electric	Command current for P1 bypass cut proportional valve : 709mA	Arm out sensor : more than 4.0V	—
					Hydraulic	Secondary pilot pressure for P1 bypass cut valve : 26kgf/cm² (370psi)	—	Secondary pilot pressure for arm out : 35kgf/cm² (500psi)
4-1	Fine bucket digging and dump operations can not be done.	Fine bucket operation	P1 bypass cut proportional valve moves unexpectedly and the p1 circuit pressure rises.	P1 bypass cut proportional valve (PSV-D) connector	Electric	Command current for P1 bypass cut proportional valve : 315mA	Arm in and arm out sensor values : less than 1.3V	—
					Hydraulic	Secondary pilot pressure for P1 bypass cut valve : 5.5kgf/cm² (78psi)	Secondary pilot pressure for arm in and out : 6kgf/cm² (85psi)	Unload pressure for P1 pump : approx. 20kgf/cm² (280psi)
4-2	Fine boom raise and lower operations can not be done.	Fine boom raise and lower operations	P1 bypass cut proportional valve moves unexpectedly and the P1 circuit pressure rises.	P1 bypass cut proportional valve (PSV-D) connector	Electric	Command current for P2 bypass cut proportional valve : 315mA	Arm in and arm out sensor values : more than 1.3V	—
					Hydraulic	Secondary pilot pressure for P1 bypass cut valve : 5.5kgf/cm² (78psi)	Secondary pilot pressure for arm in and out : 6kgf/cm² (85psi)	Unload pressure for P1 pump : approx. 20kgf/cm² (280psi)
4-3	Fine slewing right and left operations can not be done.	Fine slewing right and left operations	P2 bypass cut proportional valve moves unexpectedly and the P2 circuit pressure rises.	P2 bypass cut proportional valve (PSV-D) connector	Electric	Command current for P2 bypass cut proportional valve : 315mA	Slewing right and left sensor and boom raise sensor values : less than 1.3V	—
					Hydraulic	Secondary pilot pressure for P2 bypass cut valve : 5.5kgf/cm² (78psi)	Unload pressure for P2 pump:approx.20kgf/cm² (280psi) or less	Secondary pressure for slewing right / left and boom raise : 6kgf/cm² (85psi)
	Fine slewing right and left operations impossible.	Slewing left or right lever to full stroke	Slewing parking solenoid is not de-exited.	Slewing parking solenoid (SV-1) connector	Electric	Command voltage for slewing parking solenoid : 0V	Slewing right / left sensor values : more than 4.0V	—
					Hydraulic	Secondary pilot pressure for slewing parking solenoid : 35kgf/cm² (500psi)	—	Secondary pilot pressure for slewing right / left : 35kgf/cm² (500psi)
4-4	Fine arm in and out motions impossible.	Fine arm in or out operation	P2 bypass cut proportional valve moves unexpectedly and the P2 circuit pressure rises.	Connector of P2 bypass cut proportional valve (PSV-B)	Electric	Command current for P2 bypass cut proportional valve : 315mA	Slewing right / left sensor and boom raise sensor values : less than 1.3V	—
					Hydraulic	Secondary pilot pressure for P2 bypass cut valve : 5.5kgf/cm² (78psi)	Secondary pressure for slewing right, left and boom raise actions : 6kgf/cm² (85psi)	Unload pressure for P2 pump : approx. 20kgf/cm² (280psi)
5	Travel 1-2 speed change impossible.	Travel 1-2 speed select switch is on.	Travel 1-2 speed solenoid (SV-3) does not change over.	Connector for travel 1-2 speed solenoid	Electric	24V across power supply for travel 1-2 speed solenoid and ground.	100th is indicated as 1 in controller service diagnosis 23 and slewing right / left sensor and travel pressure sensor values : less than 1.3V lever in nentral.	—
					Hydraulic	—	—	Secondary pilot pressure for command travel 1-2speed select : 35kgf/cm² (500psi)
6	Travel speed is low. (single operation)	Travel lever at full stroke. (Other levers in neutral)	Travel straight valve moves unexpectedly and the machine travels only by the delivery rate of P1 pump.	Command current of travel straight proportional valve (PSV-C)	Electric	Command current of travel straight proportional valve : 315mA	8 sensor values for bucket, boom, slewing and arm : less than 1.3V	—
					Hydraulic	Secondary pilot pressure of PO port travel straight valve : 5.5kgf/cm² (78psi)	8 sensor values for bucket, boom, slewing and arm : 6kgf/cm² (85psi)	Secondary pilot pressure for travel : 24kgf/cm² (340psi)
8	Machine can not travel straight.	Levers at full stroke in combined slewing / travel or arm / travel actions.	Travel straight valve does not change over and the travel action is affected by the delivery rate of P1 pump.	Command current of travel straight proportional valve (PSV-C)	Electric	Command current for travel straight proportional valve : 315mA	—	Slewing right / left sensor and arm in / out sensor : more than 4.0V
					Hydraulic	Secondary pilot pressure for PO port travel straight valve : 26kgf/cm² (370psi)	—	Secondary pilot pressure for slewing right / left and arm in / out : 35kgf/cm² (500psi)
		Levers at full stroke in combined operations of boom / travel or bucket / travel.	Travel straight valve does not change over and the travel action is affected by the delivery rate of P1 pump.	Command current of travel straight proportional valve (PSV-C)	Electric	Command current for travel straight proportional valve : 315mA	—	Boom raise / lower sensor and bucket close / open sensor : more than 4.0V
					Hydraulic	Secondary pilot pressure for PO port travel straight valve : 26kgf/cm² (370psi)	—	Secondary pilot pressure for boom raise / lower and bucket close / open : 35kgf/cm² (500psi)
10	Slewing power is not available.	Slewing lever at full stroke	Slewing parking solenoid does not de-exited.	Connector for slewing parking solenoid (SV-1)	Electric	0V across power supply of slewing parking solenoid and ground.	—	Slewing right / left sensor : more than 4.0V
					Hydraulic	Secondary pilot pressure for slewing parking solenoid : 35kgf/cm² (500psi)	—	Secondary pilot pressure for slewing right / left : 35kgf/cm² (500psi)
11	Slewing speed is low.	Slewing lever at full stroke	P2 bypass cut proportional valve does not change over and part of the delivery of P2 pump flows to tank.	Feedback current of P2 bypass cut proportional valve (PSV-B)	Electric	Feedback current for P2 bypass cut proportional valve : 709mA	Command current for P2 bypass cut proportional valve : 709mA	Slewing right / left sensor : more than 4.0V
					Hydraulic	Secondary pilot pressure for P2 bypass cut valve : 26kgf/cm² (370psi)	—	Secondary pilot pressure for slewing right / left : 35kgf/cm² (500psi)
12	Slewing power is poor.	Slewing lever at full stroke	P2 bypass cut proportional valve does not change over and the P2 circuit pressure does not rise.	Feedback current of P2 bypass cut proportional valve (PSV-B)	Electric	Command current for P2 bypass cut proportional valve : 709mA	Command current for P2 bypass cut proportional valve : 709mA	Slewing right / left sensor : more than 4.0V
					Hydraulic	Secondary pilot pressure for P2 bypass cut valve : 26kgf/cm² (370psi)	—	Secondary pilot pressure for slewing right / left : 35kgf/cm² (500psi)
13	Slewing motion can not be held on a slope.	Slewing lever at neutral.	Slewing parking brake is released.	Connector for slewing parking solenoid	Electric	24V across power supply of slewing parking solenoid and ground.	Slewing right / left sensor and arm in sensor values : more than 1.3V	—
					Hydraulic	Secondary pilot pressure of slewing parking solenoid : 35kgf/cm² (500psi)	Secondary pressure for slewing right / left and arm in : 6kgf/cm² (85psi)	—

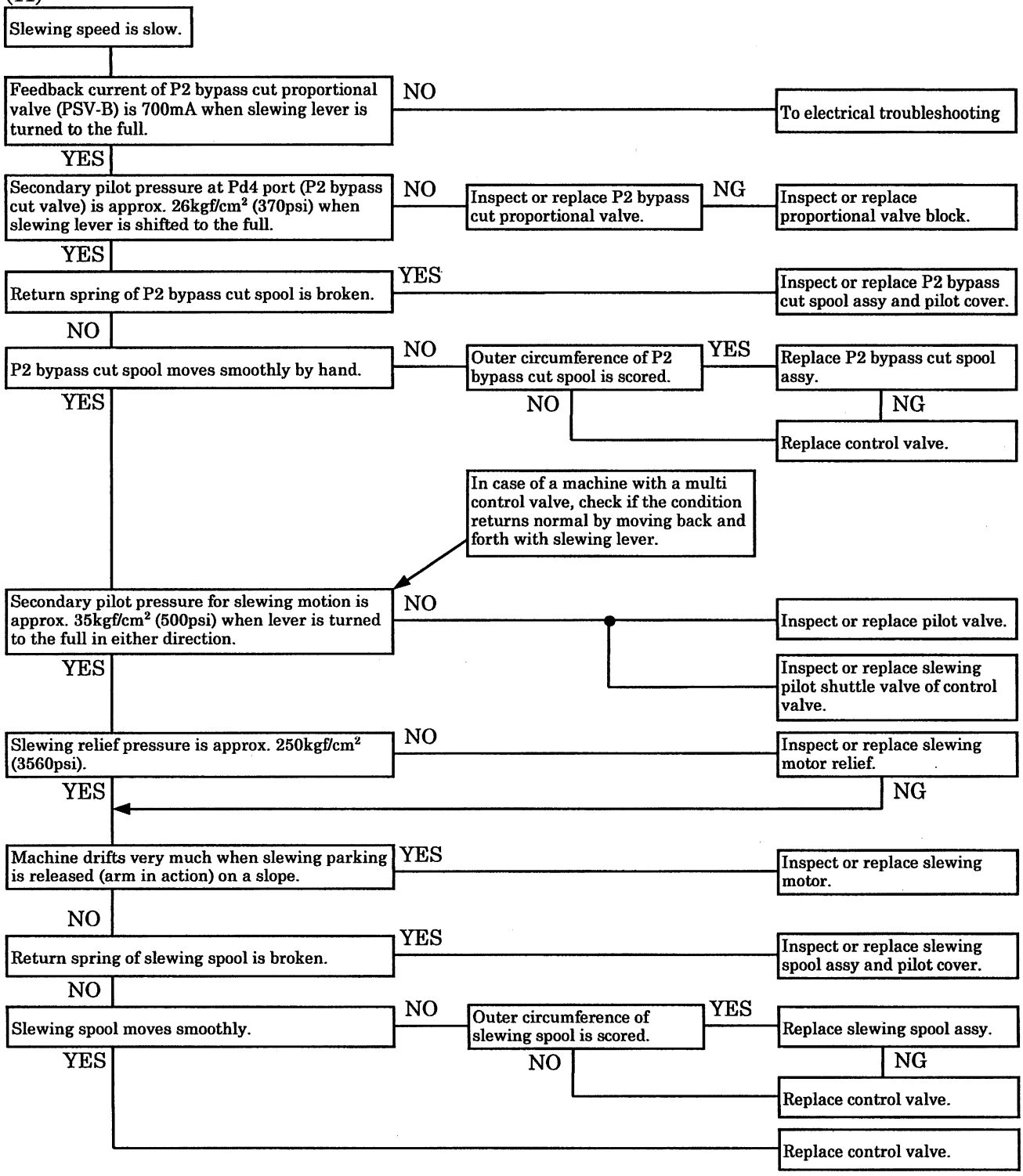
(2)-4

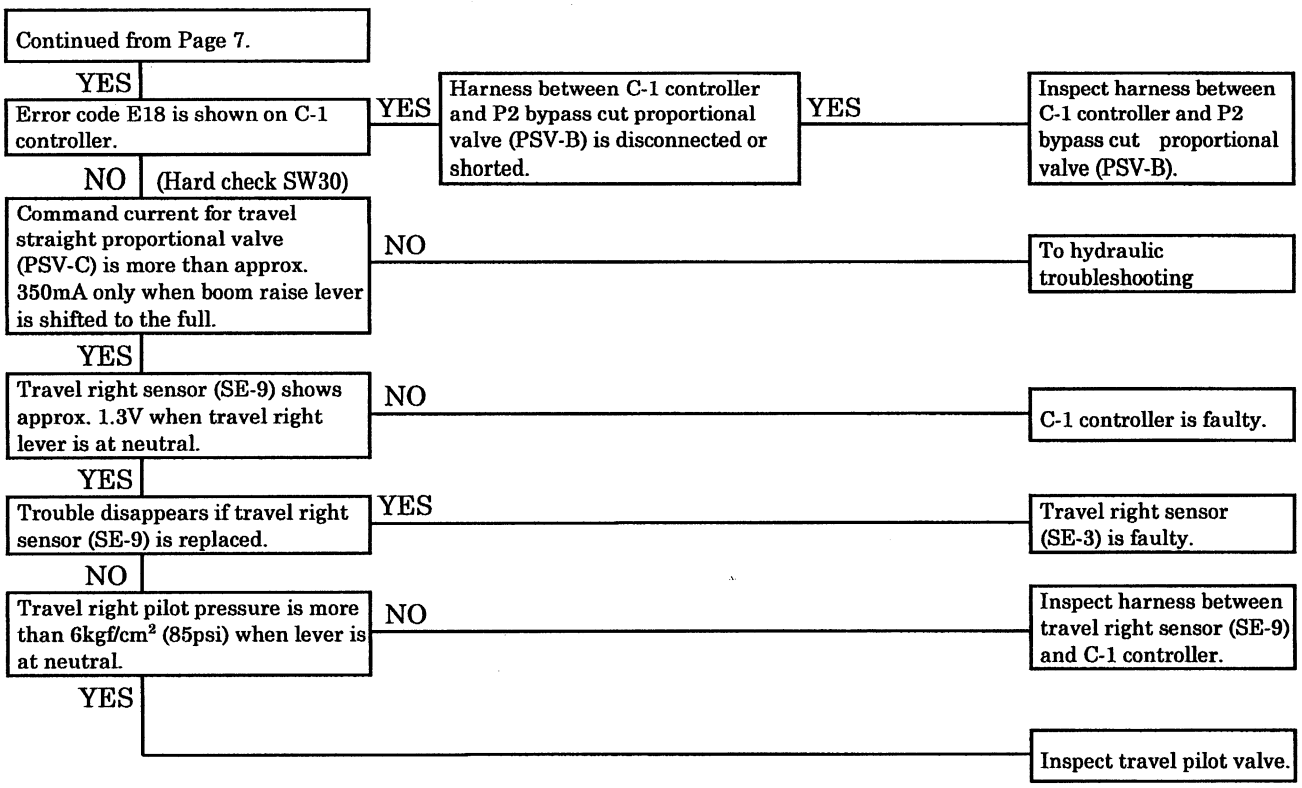

Motions other than boom up, arm in and out are slow.
(Diagnosis 30)
Control current for travel straight proportional valve is approx. 315mA. (Are the motions slow if coupler for travel straight proportional valve is disconnected?)
NO
To electric troubleshooting
YES
Pilot pressure at port PO (travel straight) is approx. 5.5kgf/cm² (78psi).
YES
Inspect or replace travel straight proportional valve.
NG
Inspect or replace proportional valve block.
NO
Return spring for travel straight spool is broken.
YES
Inspect or replace travel straight spool assy and pilot cover.
NO
Travel straight spool moves smoothly by hand. (Remove pilot cover.)
NO
Outer circumference of travel straight spool is scored.
YES
Replace travel straight spool assy.
NO
Replace control valve.
YES
Replace control valve.

(2)-5

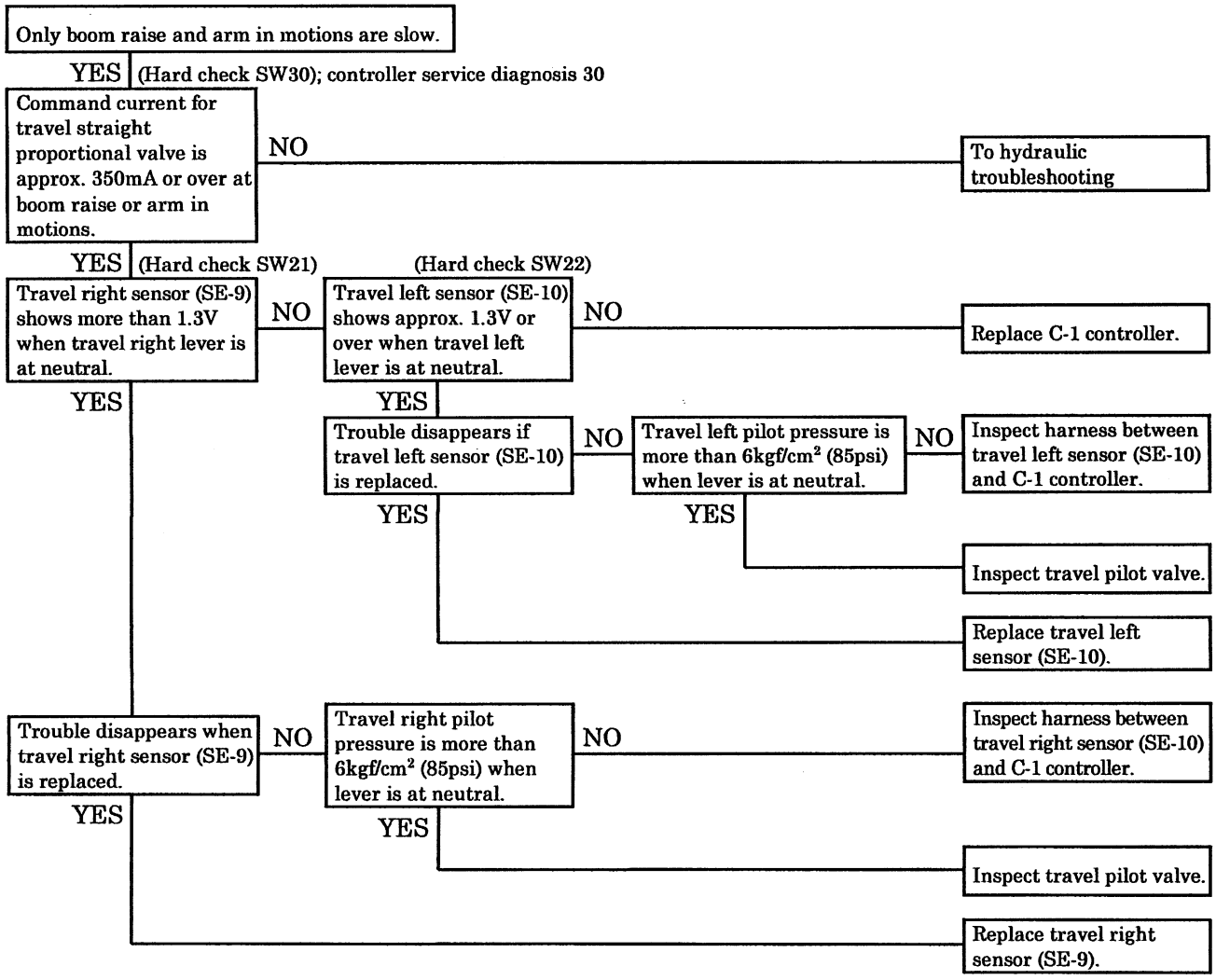

Only arm digging action is slow.
(Diagnosis 26)
Command current for P1 bypass cut proportional valve is approx. 700mA when boom raise lever is shifted to the full.
NO
To electric troubleshooting
YES
Secondary pressure of P1 bypass cut proportional valve at port Pb4 (P1 bypass cut) is approx. 26kgf/cm² (370psi).
NO
Inspect or replace P1 bypass cut proportional valve.
NG
Inspect or replace proportional valve block.
YES
Secondary pilot pressure at Pc3, Pc3 ports (arm in, lock valve release) is approx. 35kgf/cm² (500psi).
NO
Inspect or replace pilot valve.
YES
Relief pressure is approx. 300kgf/cm² (4270psi) when arm in lever is shifted to the full.
NO
Inspect or replace overload relief valve at port C3 (arm head side).
YES
Arm spool return spring is broken.
YES
Inspect or replace arm spool assy and pilot cover.
NO
Arm spool moves smoothly by hand. (Remove pilot cover.)
NO
Outer circumference of arm spool is scored.
YES
Replace arm spool assy.
NG
NO
Replace control valve.
YES
Replace control valve.

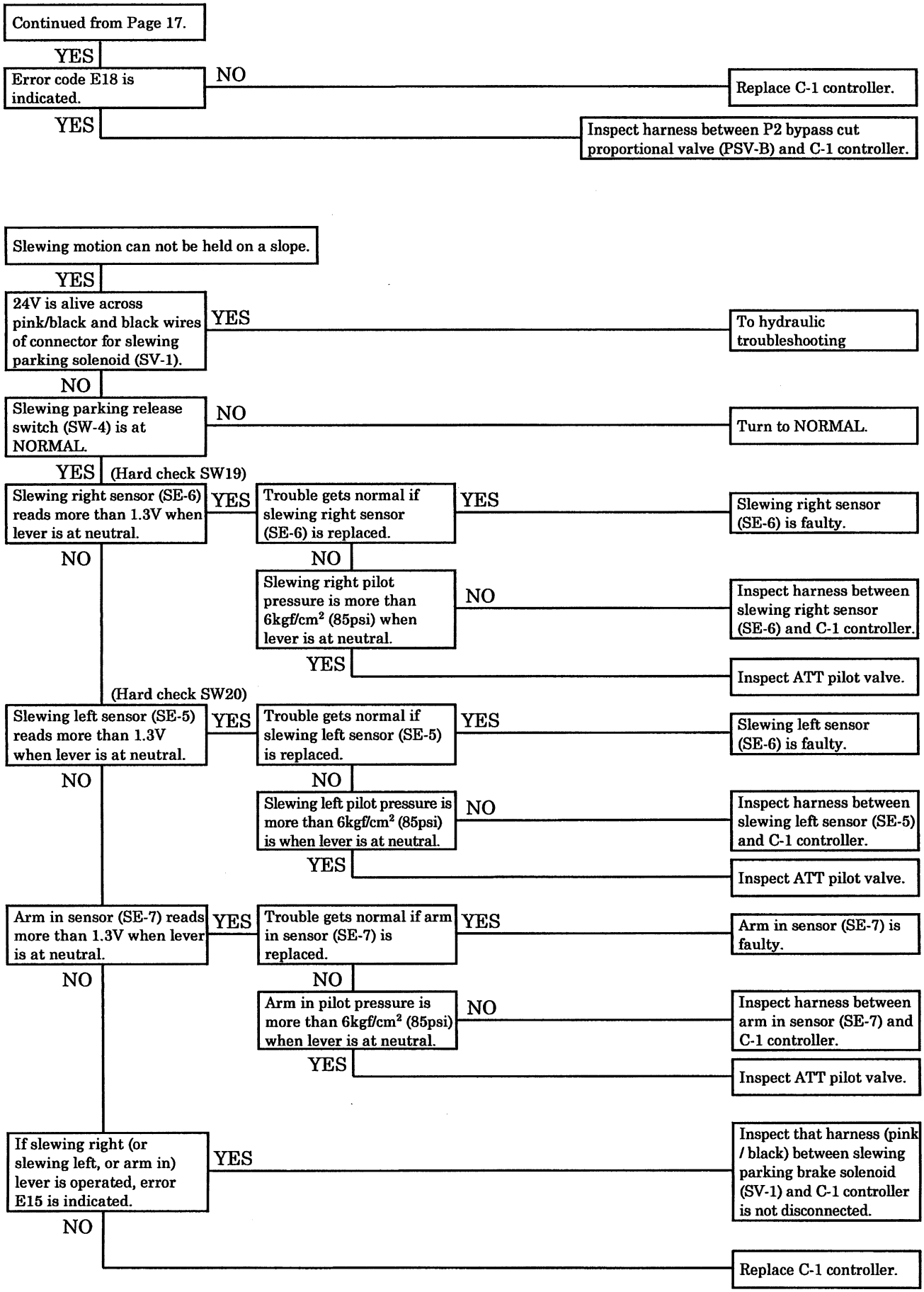
(11)


Slewing speed is slow.
Feedback current of P2 bypass cut proportional valve (PSV-B) is 700mA when slewing lever is turned to the full.
NO
To electrical troubleshooting
YES
Secondary pilot pressure at Pd4 port (P2 bypass cut valve) is approx. 26kgf/cm² (370psi) when slewing lever is shifted to the full.
NO
Inspect or replace P2 bypass cut proportional valve.
NG
Inspect or replace proportional valve block.
YES
Return spring of P2 bypass cut spool is broken.
YES
Inspect or replace P2 bypass cut spool assy and pilot cover.
NO
P2 bypass cut spool moves smoothly by hand.
NO
Outer circumference of P2 bypass cut spool is scored.
YES
Replace P2 bypass cut spool assy.
NG
YES
NO
Replace control valve.
In case of a machine with a multi control valve, check if the condition returns normal by moving back and forth with slewing lever.
Secondary pilot pressure for slewing motion is approx. 35kgf/cm² (500psi) when lever is turned to the full in either direction.
NO
Inspect or replace pilot valve.
Inspect or replace slewing pilot shuttle valve of control valve.
YES
Slewing relief pressure is approx. 250kgf/cm² (3560psi).
NO
Inspect or replace slewing motor relief.
YES
NG
Machine drifts very much when slewing parking is released (arm in action) on a slope.
YES
Inspect or replace slewing motor.
NO
Return spring of slewing spool is broken.
YES
Inspect or replace slewing spool assy and pilot cover.
NO
Slewing spool moves smoothly.
NO
Outer circumference of slewing spool is scored.
YES
Replace slewing spool assy.
NG
YES
NO
Replace control valve.
Replace control valve.


Continued from Page 7.
YES
Error code E18 is shown on C-1 controller.
YES
Harness between C-1 controller and P2 bypass cut proportional valve (PSV-B) is disconnected or shorted.
YES
Inspect harness between C-1 controller and P2 bypass cut proportional valve (PSV-B).
NO
(Hard check SW30)
Command current for travel straight proportional valve (PSV-C) is more than approx. 350mA only when boom raise lever is shifted to the full.
NO
To hydraulic troubleshooting
YES
Travel right sensor (SE-9) shows approx. 1.3V when travel right lever is at neutral.
NO
C-1 controller is faulty.
YES
Trouble disappears if travel right sensor (SE-9) is replaced.
YES
Travel right sensor (SE-3) is faulty.
NO
Travel right pilot pressure is more than 6kgf/cm² (85psi) when lever is at neutral.
NO
Inspect harness between travel right sensor (SE-9) and C-1 controller.
YES
Inspect travel pilot valve.

(2)-3


Only boom raise and arm in motions are slow.
YES
(Hard check SW30); controller service diagnosis 30
Command current for travel straight proportional valve is approx. 350mA or over at boom raise or arm in motions.
NO
To hydraulic troubleshooting
YES
(Hard check SW21)
(Hard check SW22)
Travel right sensor (SE-9) shows more than 1.3V when travel right lever is at neutral.
NO
Travel left sensor (SE-10) shows approx. 1.3V or over when travel left lever is at neutral.
NO
Replace C-1 controller.
YES
YES
Trouble disappears if travel left sensor (SE-10) is replaced.
NO
Travel left pilot pressure is more than 6kgf/cm² (85psi) when lever is at neutral.
NO
Inspect harness between travel left sensor (SE-10) and C-1 controller.
YES
YES
Inspect travel pilot valve.
Replace travel left sensor (SE-10).
Trouble disappears when travel right sensor (SE-9) is replaced.
NO
Travel right pilot pressure is more than 6kgf/cm² (85psi) when lever is at neutral.
NO
Inspect harness between travel right sensor (SE-10) and C-1 controller.
YES
YES
Inspect travel pilot valve.
Replace travel right sensor (SE-9).


Continued from Page 17.
YES
Error code E18 is indicated.
NO
Replace C-1 controller.
YES
Inspect harness between P2 bypass cut proportional valve (PSV-B) and C-1 controller.
Slewing motion can not be held on a slope.
YES
24V is alive across pink/black and black wires of connector for slewing parking solenoid (SV-1).
YES
To hydraulic troubleshooting
NO
Slewing parking release switch (SW-4) is at NORMAL.
NO
Turn to NORMAL.
YES
(Hard check SW19)
Slewing right sensor (SE-6) reads more than 1.3V when lever is at neutral.
YES
Trouble gets normal if slewing right sensor (SE-6) is replaced.
YES
Slewing right sensor (SE-6) is faulty.
NO
Slewing right pilot pressure is more than 6kgf/cm² (85psi) when lever is at neutral.
NO
Inspect harness between slewing right sensor (SE-6) and C-1 controller.
YES
Inspect ATT pilot valve.
NO
(Hard check SW20)
Slewing left sensor (SE-5) reads more than 1.3V when lever is at neutral.
YES
Trouble gets normal if slewing left sensor (SE-5) is replaced.
YES
Slewing left sensor (SE-6) is faulty.
NO
Slewing left pilot pressure is more than 6kgf/cm² (85psi) is when lever is at neutral.
NO
Inspect harness between slewing left sensor (SE-5) and C-1 controller.
YES
Inspect ATT pilot valve.
NO
Arm in sensor (SE-7) reads more than 1.3V when lever is at neutral.
YES
Trouble gets normal if arm in sensor (SE-7) is replaced.
YES
Arm in sensor (SE-7) is faulty.
NO
Arm in pilot pressure is more than 6kgf/cm² (85psi) when lever is at neutral.
NO
Inspect harness between arm in sensor (SE-7) and C-1 controller.
YES
Inspect ATT pilot valve.
NO
If slewing right (or slewing left, or arm in) lever is operated, error E15 is indicated.
YES
Inspect that harness (pink / black) between slewing parking brake solenoid (SV-1) and C-1 controller is not disconnected.
NO
Replace C-1 controller.

(11)

E/G does not stop when starter key is turned off.
→ Confirm governor lever stop bolt position.
→ Check if governor motor is not faulty mechanically.
→ Check that governor motor link connecting bolts are not loose.

OK

Check that terminal M of starter key switch shows 0V.
→ Wire number 60 of instrument panel harness CN-43F shows 0V.
NG → Check resistance across terminals M and B on starter key.
→ Replace starter key if resistance across M and B is 0Ω.
See Fig.3.

OK

Check that battery relay terminal B2 measures 0V four seconds after key is turned off.
→ Wire No.857 of main harness CN-150F measures 0V.
NG → Check C1 controller.
→ Does resistance across C1 controller terminals 11-1 and 14-22 measure 72Ω?

OK

(12)

When starter key is turned off, power is cut off but engine does not stop.
→ Check that battery relay operates.
→ Does battery terminals A and B measure 0Ω?
NG → Replace battery relay.
→ Replace C1 controller if resistance measures 0Ω.
See Fig.2.

Checking condition ; Starter key is off.

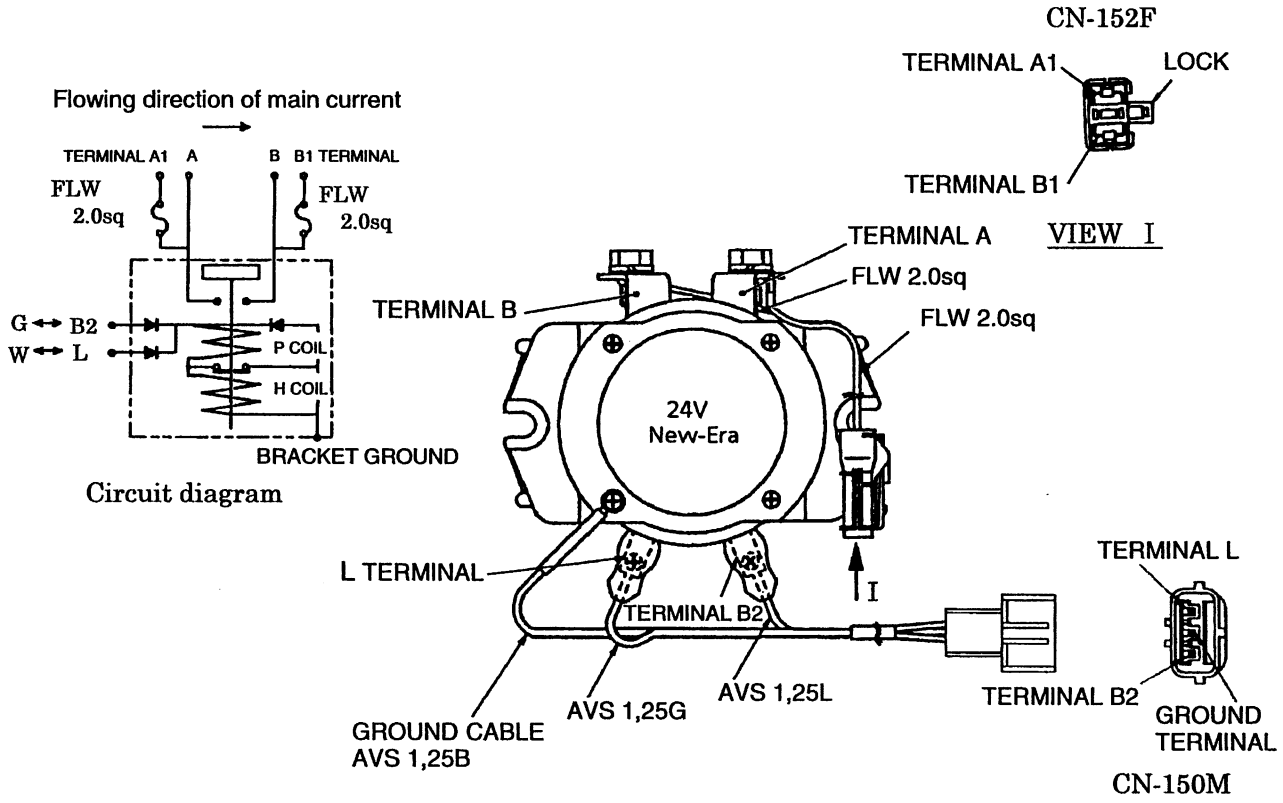


Fig. 2 Battery relay

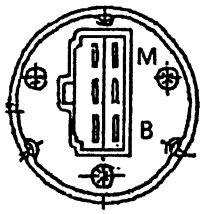
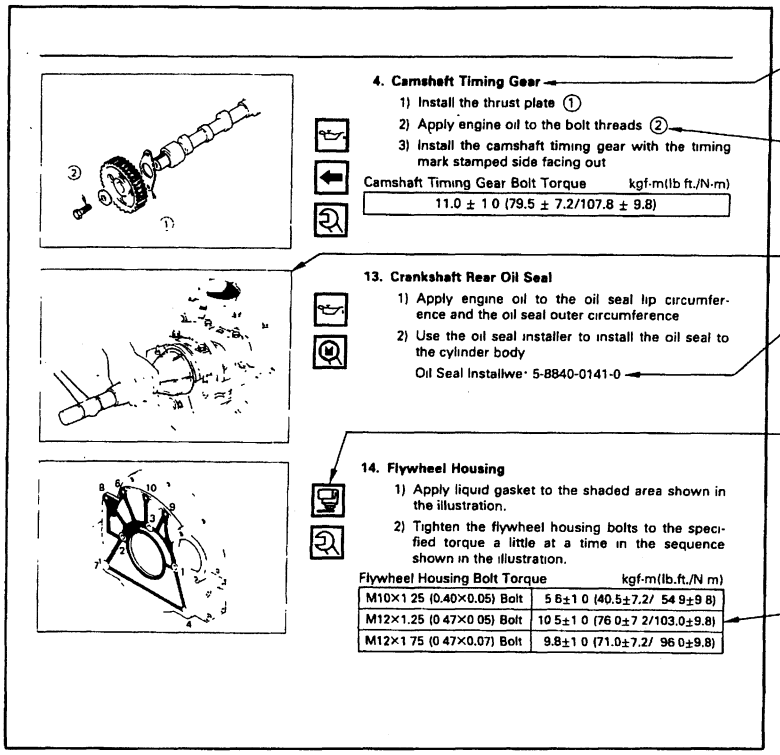


Fig. 3 Key SW. terminal

7. Below is a sample of the text of the Workshop Manual.



4. Camshaft Timing Gear

1) Install the thrust plate ①
2) Apply engine oil to the bolt threads ②
3) Install the camshaft timing gear with the timing mark stamped side facing out

Camshaft Timing Gear Bolt Torque kgf-m(lb ft./N-m)

11.0 ± 1.0 (79.5 ± 7.2/107.8 ± 9.8)

13. Crankshaft Rear Oil Seal

1) Apply engine oil to the oil seal lip circumference and the oil seal outer circumference
2) Use the oil seal installer to install the oil seal to the cylinder body

Oil Seal Installwe· 5-8840-0141-0

14. Flywheel Housing

1) Apply liquid gasket to the shaded area shown in the illustration.
2) Tighten the flywheel housing bolts to the specified torque a little at a time in the sequence shown in the illustration.

Flywheel Housing Bolt Torque kgf-m(lb.ft./N m)

M10×1.25 (0.40×0.05) Bolt	5.6±1.0 (40.5±7.2/ 54.9±9.8)
M12×1.25 (0.47×0.05) Bolt	10.5±1.0 (76.0±7.2/103.0±9.8)
M12×1.75 (0.47×0.07) Bolt	9.8±1.0 (71.0±7.2/ 96.0±9.8)

This is the item shown in the illustration. It is marked with a triangle (▲) on the Major Components page.

Letters and numbers contained in a circle refer to the illustration.

Special tools are identified by the tool name and/or number.

The illustration shows how the special tool is to be used.

Symbols indicate the type of service operation or step to be performed. A detailed explanation of these symbols follows.

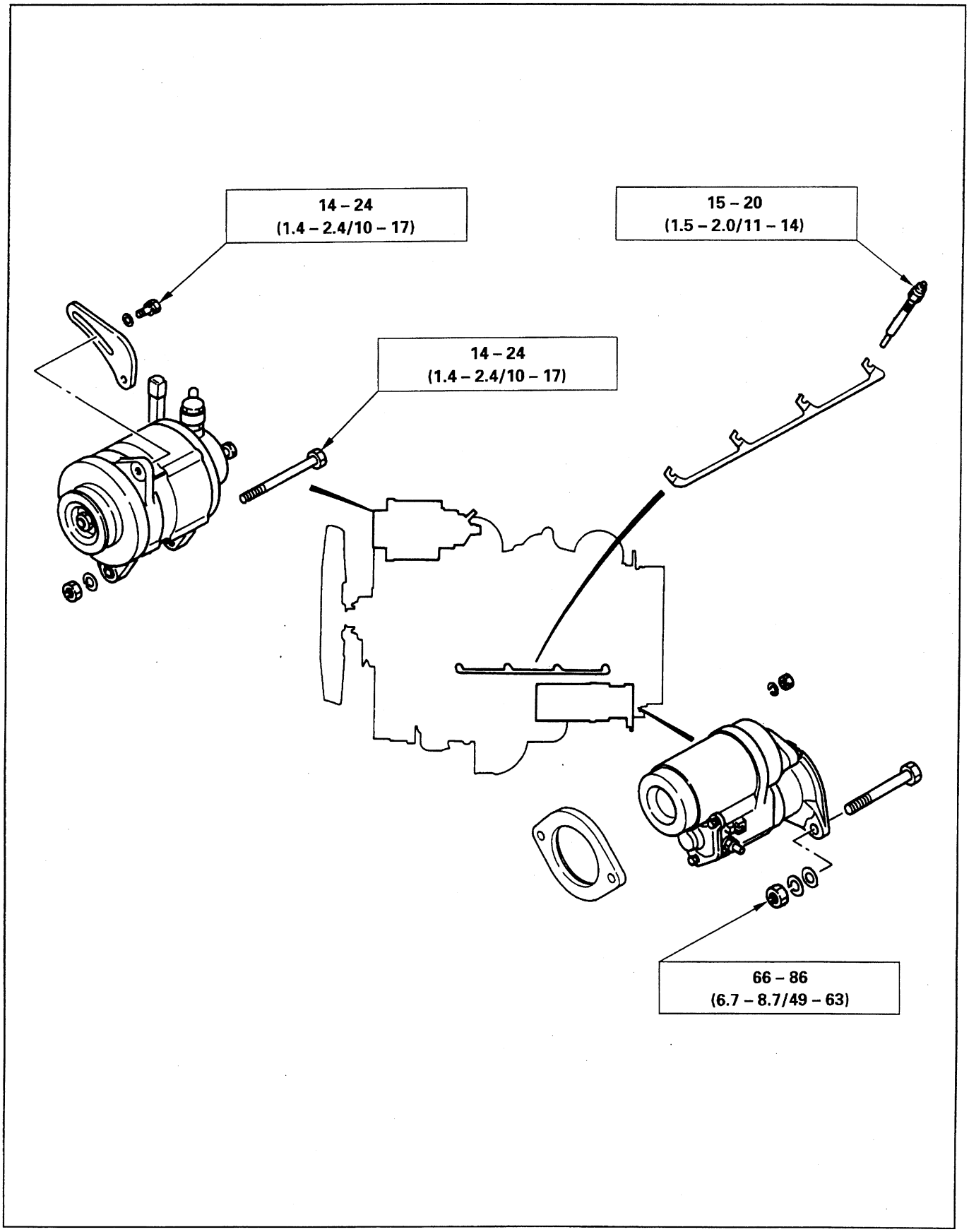
Service data and specifications are given in this table.

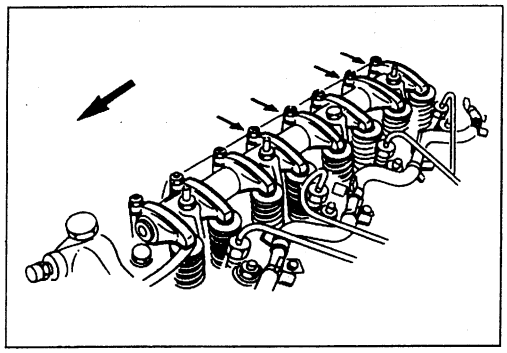
8. The following symbols appear throughout this Workshop Manual. They tell you the type of service operation or step to perform.

....	Removal	....	Adjustment
....	Installation	....	Cleaning
....	Disassembly	...	Important operation requiring extra care
....	Reassembly	....	Specified torque (tighten)
....	Alignment (marks)	....	Special tool use required or recommended(Isuzu tool or tools)
....	Directional indication	....	Commercially available tool use required or recommended
....	Inspection	....	Lubrication (oil)
....	Measurement	....	Lubrication (grease)
		....	Sealant application

Engine Electrical

N·m (kgf·m/lb.ft)

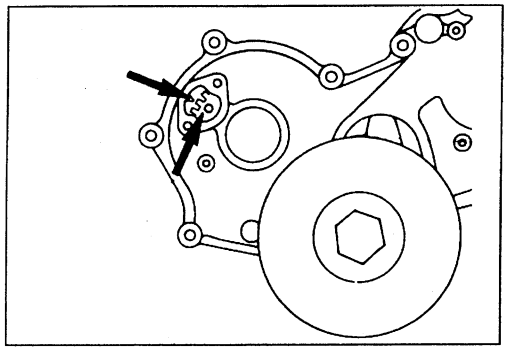




Rotate the crankshaft 360°.

Realign the crankshaft damper pulley TDC line with the timing pointer.

Adjust the clearances for the remaining valves as shown in the illustration. (At TDC on the compression stroke of the No. 4 stroke)



INJECTION TIMING

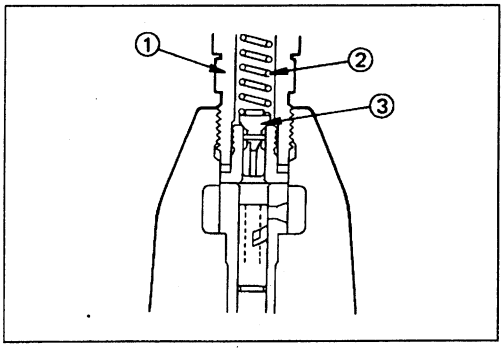
Injection Timing Confirmation Procedure

1. In-line type injection pump

1) Rotate the crankshaft clockwise to align the camshaft gear timing mark "O" with the timing gear case cover pointer.

   The No. 1 cylinder will now be at the point where nearly injection timing.

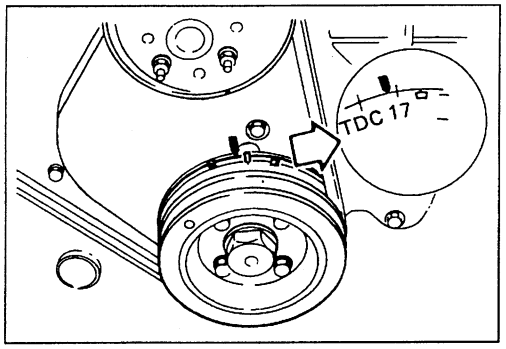
2) Remove the No. 1 fuel injection pipe.



3) Remove the delivery valve holder ① , the delivery valve spring ② , and the delivery valve ③ .

4) Tighten the delivery valve holder to the specified torque.

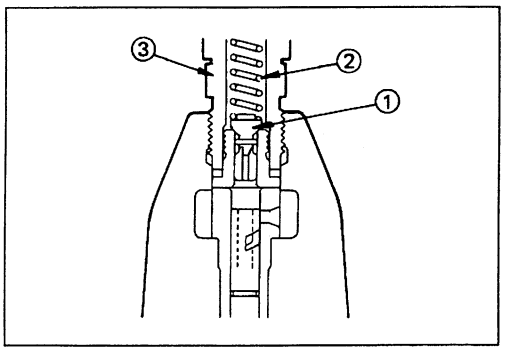
Delivery Valve Holder Torque	N·m (kgf·m/lb.ft)
39 – 44 (4.0 – 4.5/29 – 33)	



5) Operate the injection pump priming pump while slowly rotating the crankshaft until fuel stops flowing from the delivery valve holder.

6) Conform that the crankshaft damper pulley notched line is aligned with the timing gear case cover pointer.

Injection Timing (Static BTDC)
16°



7) Remove the delivery valve holder.

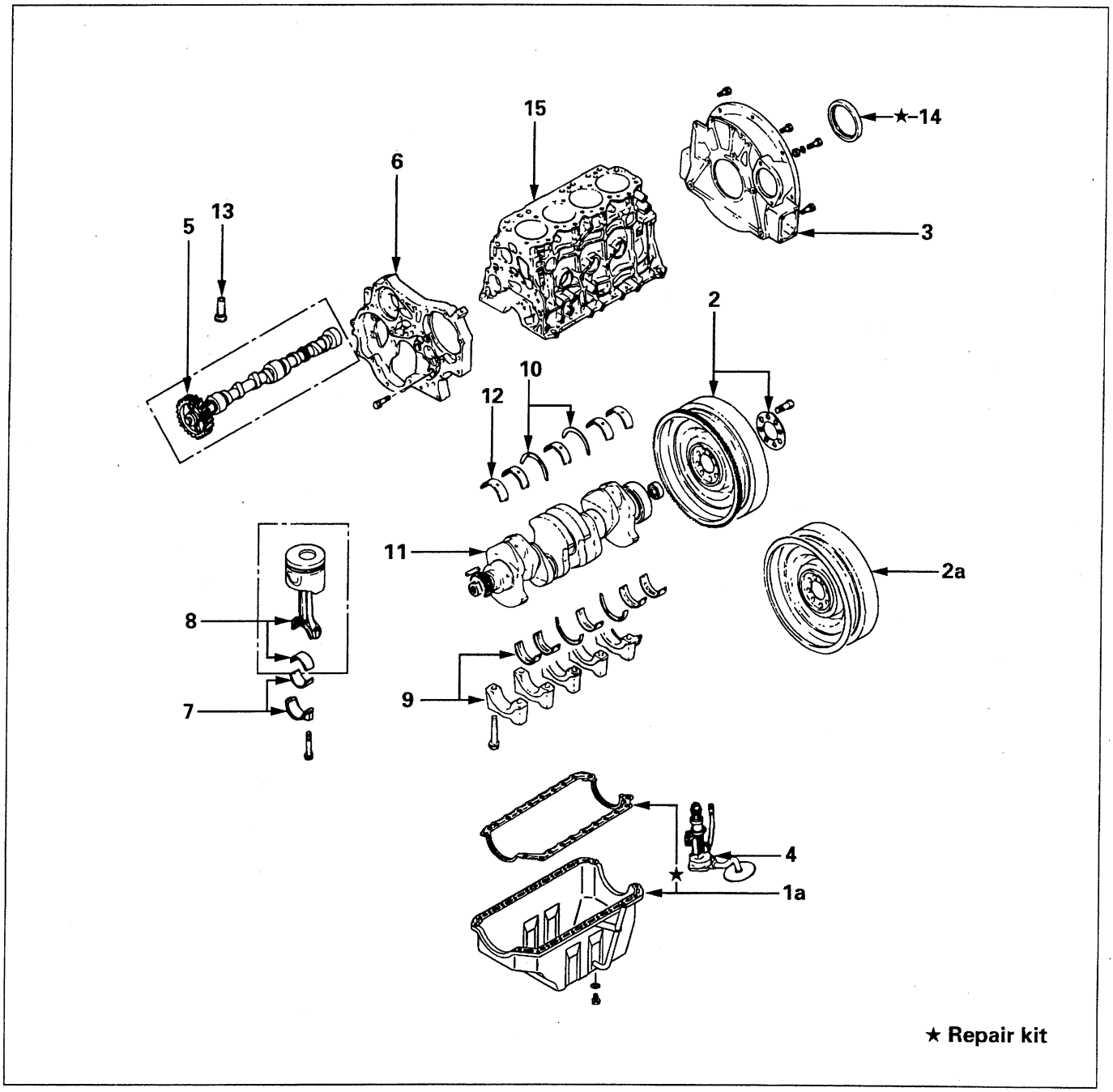
8) Install the delivery valve ① , the delivery valve spring ② , and the delivery valve holder ③ .

9) Tighten the delivery valve holder to the specified torque.

10) Install the fuel injection pipes and tighten them to the specified torque.

Fuel Injection Pipe Torque	N·m (kgf·m/lb.ft)
20 – 39 (2 – 4/15 – 29)	

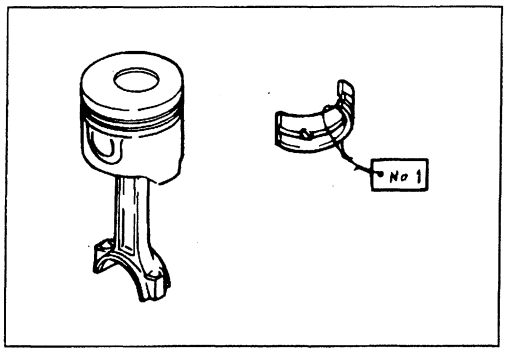
11) Operation to air breeding.



Disassembly Steps - 3

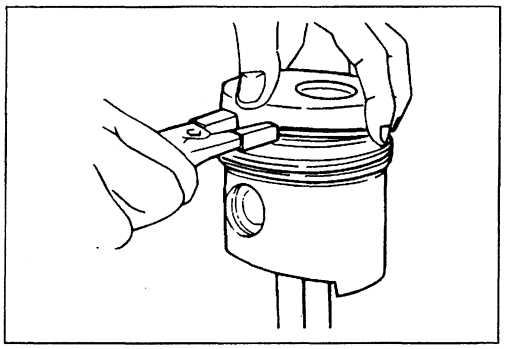
1. Oil pan
▲ 2. Flywheel
2a. Rear flywheel (If so equipped)
3. Flywheel housing
4. Oil pump with oil pipe
▲ 5. Camshaft with camshaft timing gear and thrust plate
6. Timing gear case
▲ 7. Connecting rod cap with lower bearing
▲ 8. Piston and connecting rod with upper bearing
▲ 9. Crankshaft bearing cap with lower bearing
10. Crankshaft thrust bearing
11. Crankshaft with crankshaft timing gear
▲ 12. Crankshaft upper bearing
▲ 13. Tappet
14. Crankshaft rear oil seal
15. Cylinder body

Important Operations



1. Connecting Rod Bearing

If the connecting rod bearings are to be reinstalled, mark their fitting positions by tagging each bearing with the cylinder number from which it was removed.



2. Piston Ring

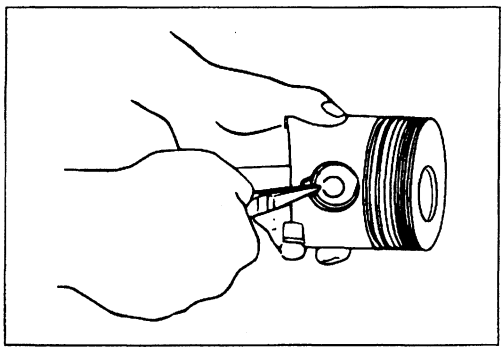
1) Clamp the connecting rod in a vise.

   Take care not to damage the connecting rod.

2) Use a piston pin replacer to remove the piston rings.

   Piston Ring Replacer

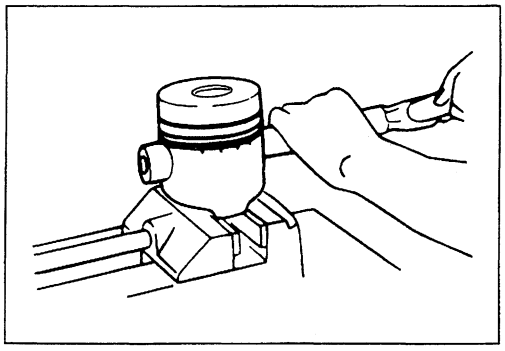
   Do not attempt to use some other tool to remove the piston rings. Piston ring stretching will result in reduced piston ring tension.



3. Piston Pin Snap Ring

4. Piston Pin Snap Ring

Use a pair of snap ring pliers to remove the piston pin snap rings.

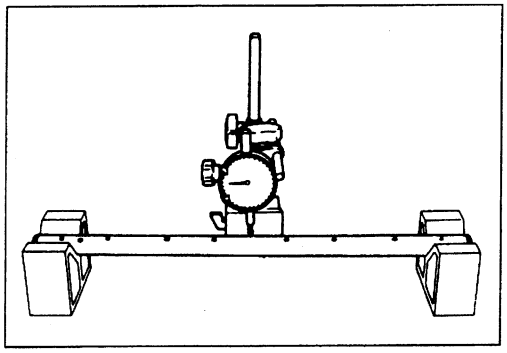


5. Piston Pin

7. Piston

Tap the piston pin out with a hammer and a brass bar.

If the pistons are to be reinstalled, mark their installation positions by tagging each piston with the cylinder number from which it was removed.



ROCKER ARM SHAFT AND ROCKER ARM

Rocker Arm Shaft Run-Out

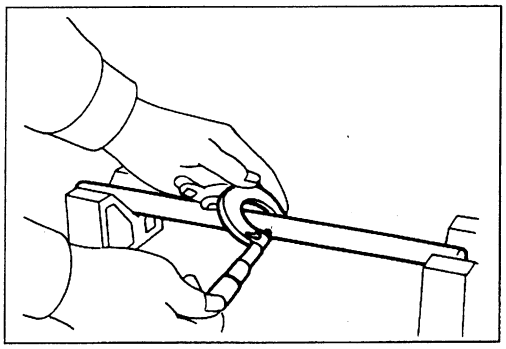
1. Place the rocker arm shaft on a V-block.
2. Use a dial indicator to measure the rocker arm shaft central portion run-out.

   If the run-out is very slight, correct the rocker arm shaft run-out with a bench press. The rocker arm must be at cold condition.

   If the measured rocker arm shaft run-out exceeds the specified limit, the rocker arm shaft must be replaced.

Rocker Arm Shaft Run-Out mm(in)

Standard	Limit
0.2 (0.008)	0.6 (0.024)



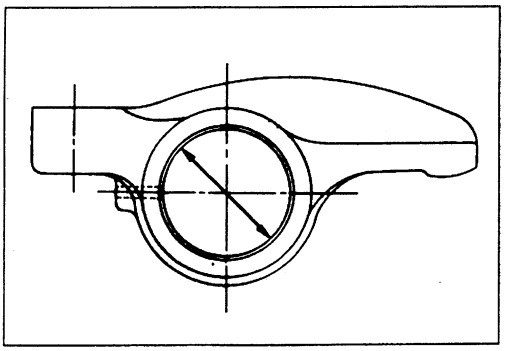
Rocker Arm Shaft Outside Diameter

Use a micrometer to measure the rocker arm fitting portion outside diameter.

If the measured value is less than the specified limit, the rocker arm shaft must be replaced.

Rocker Arm Shaft Outside Diameter mm(in)

Standard	Limit
18.98 – 19.00 (0.747 – 0.748)	18.85 (0.742)



Rocker Arm Shaft and Rocker Arm Clearance

1. Use either a vernier caliper or a dial indicator to measure the rocker arm bushing inside diameter.

Rocker Arm Bushing Inside Diameter mm(in)

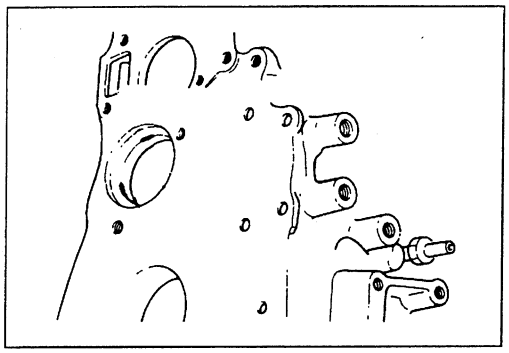
Standard	Limit
19.01 – 19.03 (0.748 – 0.749)	19.05 (0.750)

2. Measure the rocker arm shaft outside diameter.

   If the measured value exceeds the specified limit, replace either the rocker arm or the rocker arm shaft.

Rocker Arm and Rocker Arm Shaft Clearance mm(in)

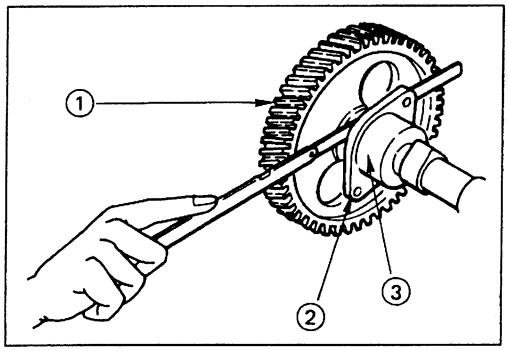
Standard	Limit
0.01 – 0.05 (0.0004 – 0.002)	0.2 (0.008)



Camshaft Bearing Installation

1. Align the bearing oil holes with the cylinder body oil holes.
2. Use the camshaft bearing replacer installer to install the camshaft bearing.

   Bearing Replacer: 5-8840-2038-0

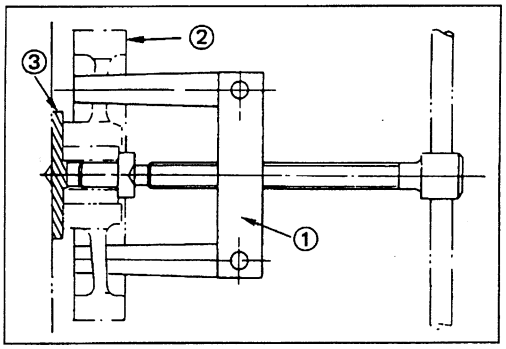


Camshaft End Play

1. Before removing the camshaft gear ①, push the thrust plate ② as far as it will go toward the camshaft gear ③.
2. Use a feeler gauge to measure the clearance between the thrust plate and the camshaft journal. If the measured value exceeds the specified limit, the thrust plate must be replaced.

Camshaft End Play mm(in)

Standard	Limit
0.050 – 0.114 (0.002 – 0.0044)	0.2 (0.008)

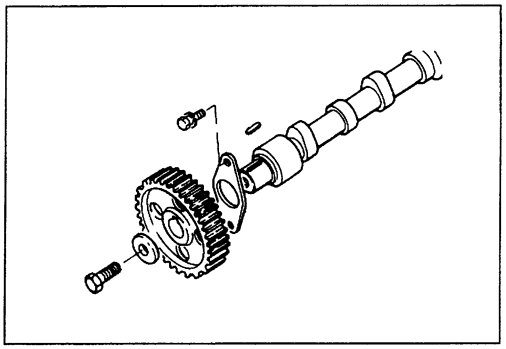


Thrust Plate Replacement

Thrust Plate Removal

1. Use the universal puller ① to remove the camshaft timing gear ② .

   Universal Puller: 5-8840-0086-0
2. Remove the thrust plate ③ .



Thrust Plate Installation

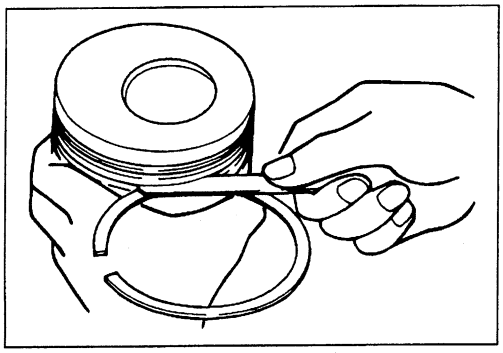
1. Install the thrust plate.
2. Apply engine oil to the bolt setting face and the bolt threads.
3. Install the camshaft gear.

Camshaft Gear Torque N·m(kgf·m/lb.ft)

98 – 118 (10 – 12/72 – 87)

Piston Ring Gap mm(in)

	Standard	Limit
1st Compression Ring	0.2 – 0.35 (0.008 – 0.014)	1.5 (0.059)
2nd Compression Ring	0.37 – 0.52 (0.015 – 0.020)	
Oil Ring	0.2 – 0.4 (0.008 – 0.016)	



Piston Ring and Piston Ring Groove Clearance

Use a feeler gauge to measure the clearance between the piston ring and the piston ring groove at several points around the piston.

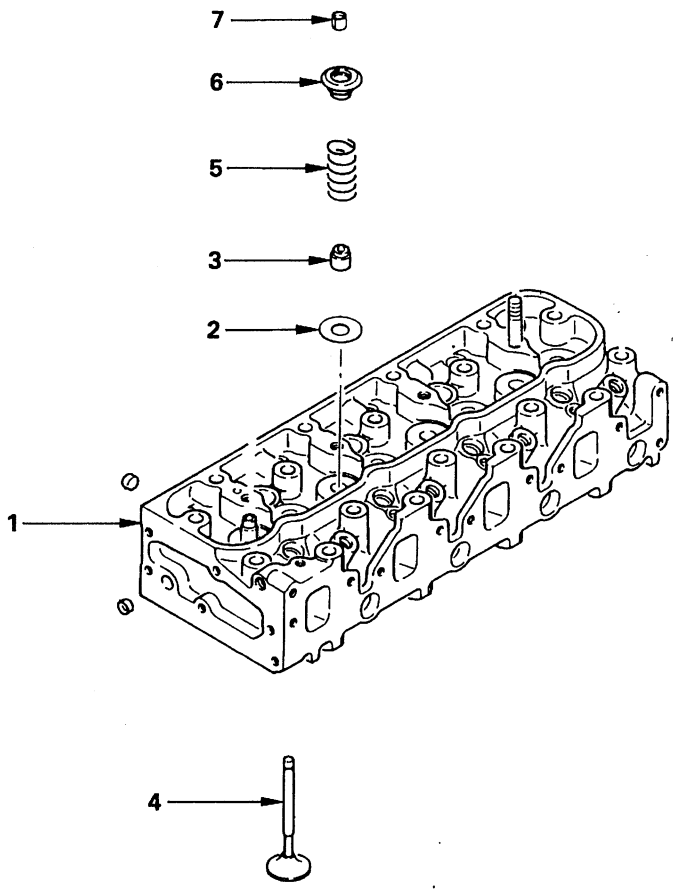
If the clearance between the piston ring and the piston ring groove exceeds the specified limit, the piston ring must be replaced.

Piston Ring and Piston Ring Groove Clearance mm(in)

	Standard	Limit
1st Compression Ring	0.09 – 0.130 (0.0035 – 0.0051)	0.15 (0.006)
2nd Compression Ring	0.05 – 0.090 (0.002 – 0.0035)	
Oil Ring	0.03 – 0.07 (0.0012 – 0.0028)	

Visually inspect the piston. If a piston ring groove is damaged or distorted, the piston must be replaced.

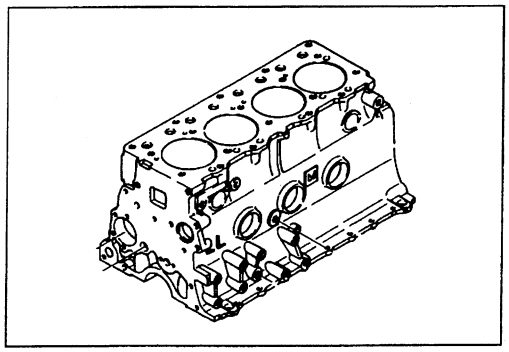
CYLINDER HEAD



Reassembly Steps

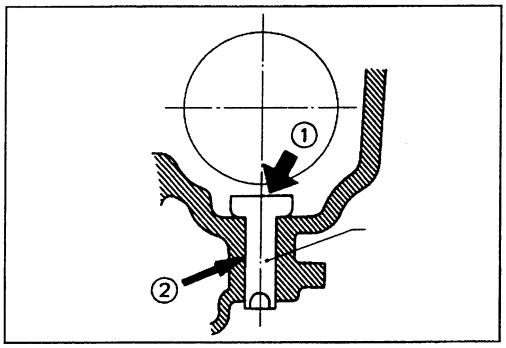
1. Cylinder head
2. Valve spring lower washer
▲ 3. Valve stem oil seal
▲ 4. Intake and exhaust valve
▲ 5. Valve spring
6. Valve spring upper seat
▲ 7. Split collar

Important Operations (Reassembly Steps-1)



1. Cylinder Body

Use compressed air to thoroughly clean the inside and outside surfaces of the cylinder body, the oil holes, and the water jackets.

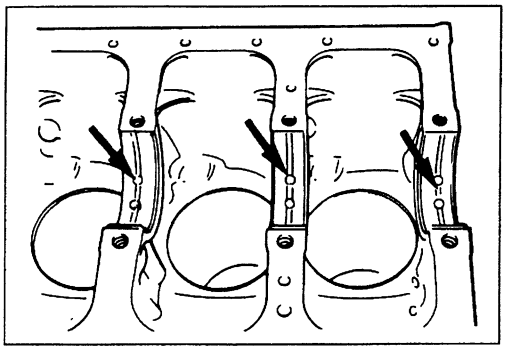


2. Tappet

1) Apply a coat of engine oil to the tappet ① and the cylinder body tappet insert holes ② .
2) Locate the position mark applied at disassembly (if the tappet is to be reused).

Note:

The tappet must be installed before the camshaft.



3. Crankshaft Upper Bearing

The crankshaft upper bearings have an oil hole and an oil groove. The lower bearings do not.

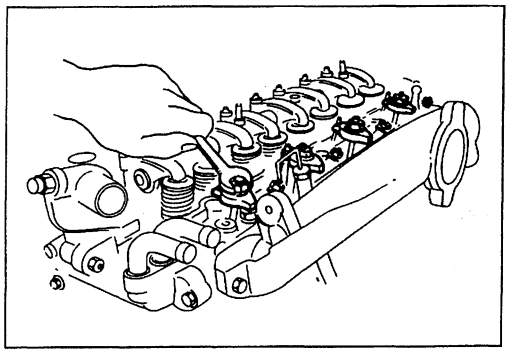
1) Carefully wipe any foreign material from the crankshaft upper bearing and the crankshaft upper bearing fitting surfaces.
2) Locate the position mark applied at disassembly if the removed crankshaft upper bearings are to be reused.

4. Crankshaft with Crankshaft Timing Gear

Apply an ample coat of engine oil to the crankshaft journals and the crankshaft bearing surfaces before installing the crankshaft.

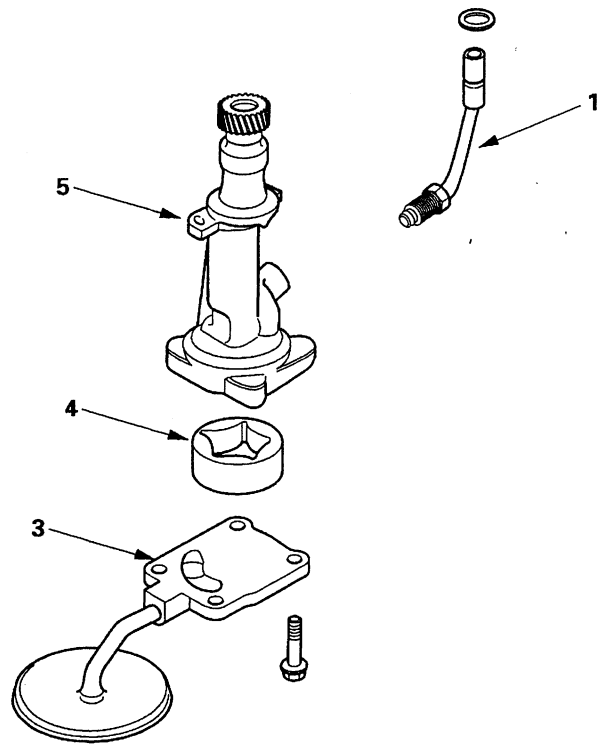
Note:

Do not apply engine oil to the bearing back faces and the cylinder body bearing fitting surfaces.



OIL PUMP

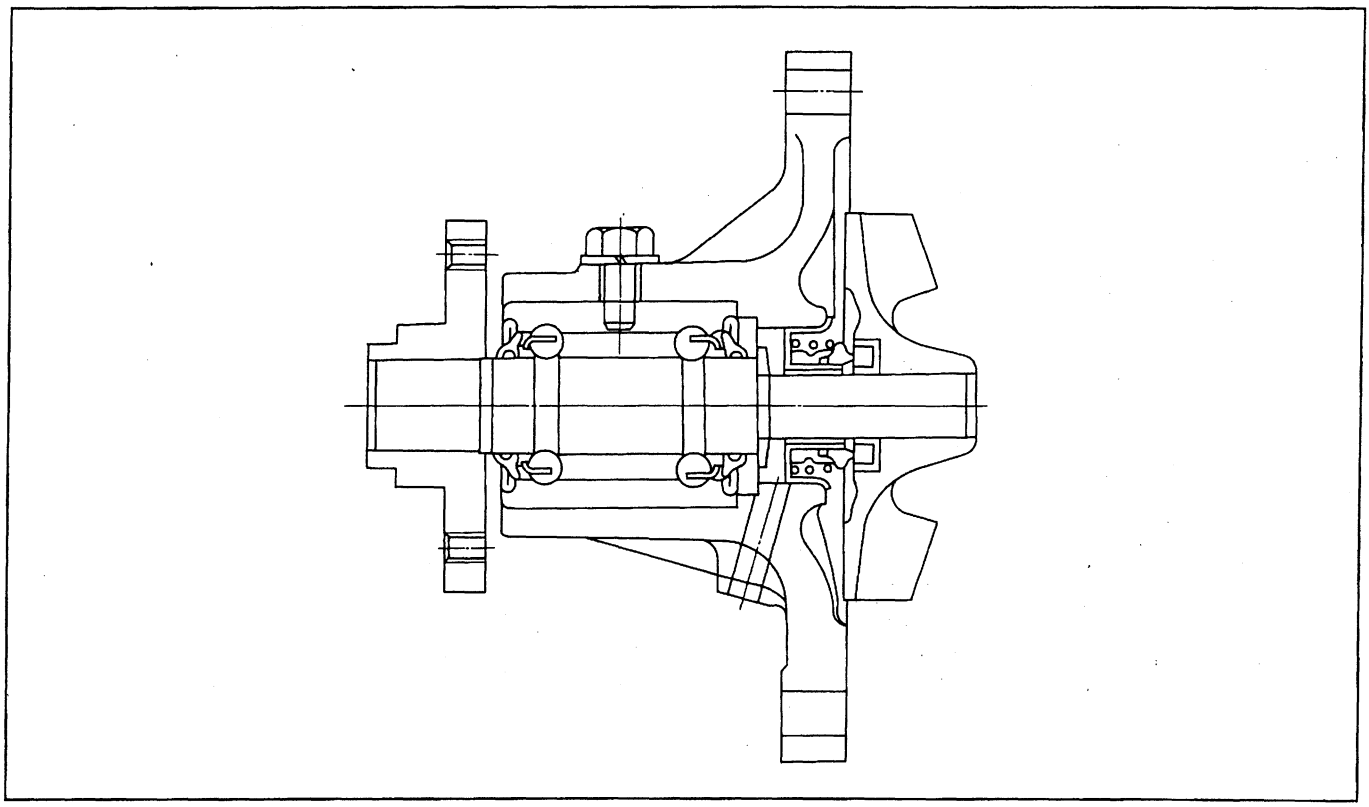
DISASSEMBLY



Disassembly Steps

1. Oil pipe
2. Strainer case
3. Pump cover
4. Vane
▲ 5. Pump body with rotor and pinion

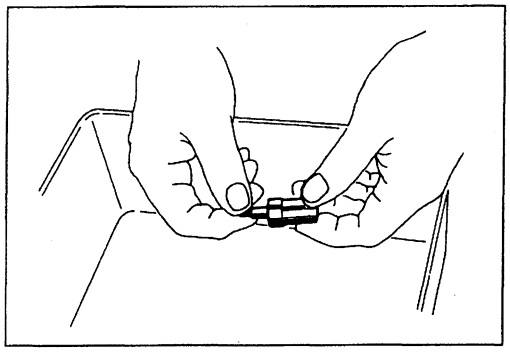
WATER PUMP



A centrifugal type water pump forcefully circulates the coolant through the cooling system.

INSPECTION AND REPAIR

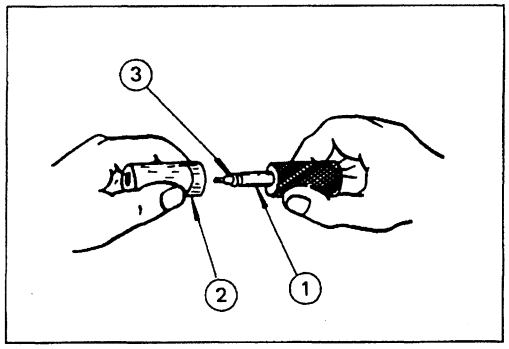
Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.



Injection Nozzle Needle Inspection

1. Remove the nozzle needle from the nozzle body.
2. Carefully wash the nozzle needle and the nozzle body in clean diesel fuel.
3. Check that the nozzle needle moves smoothly inside the injection nozzle body.

   If the nozzle needle does not moves smoothly, it must be repaired (See "Nozzle Lapping Procedure" below.)



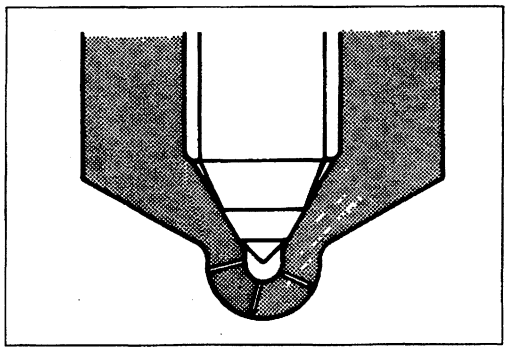
Nozzle Lapping Procedure

1. Lap the nozzle needle ① and the nozzle body ② by applying a compound of oxidized chrome and animal oil ③.

Note:

Do not apply an excessive amount of the oxidized chrome and animal oil compound to the injection needle valve seat area.

2. Carefully wash the needle valve and the nozzle body in clean diesel fuel after lapping.

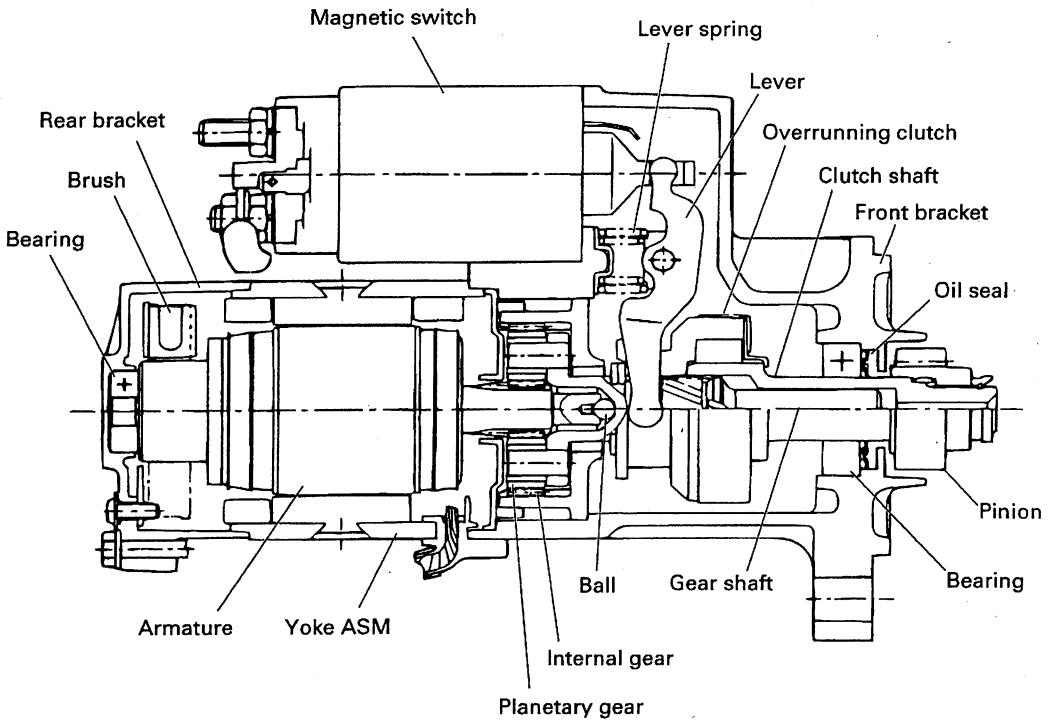


Nozzle Body and Needle Valve Inspection

Check the nozzle body and the needle valve for damage and deformation.

The nozzle and body must be replaced if either of these two conditions are discovered during inspection.

GENERAL DESCRIPTION



ASSEMBLY

Although assembly is done in the reverse procedure to disassembly, some points need to be explained.

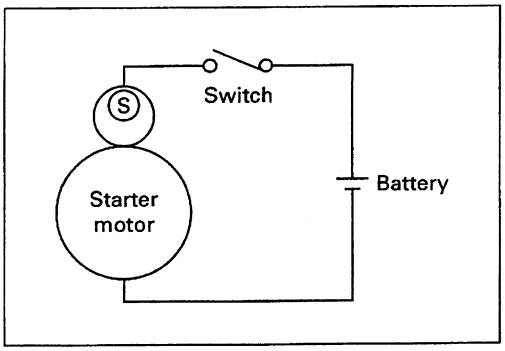
1. Oiling section and tightening torque

Refer to the specifications attached. (P.155)

- Recommended grease is MUL TEMP#6129 (Kyodo Yushi), Molykote RAG-650 (Dow Corning) or equivalent.

2. Tightening torque

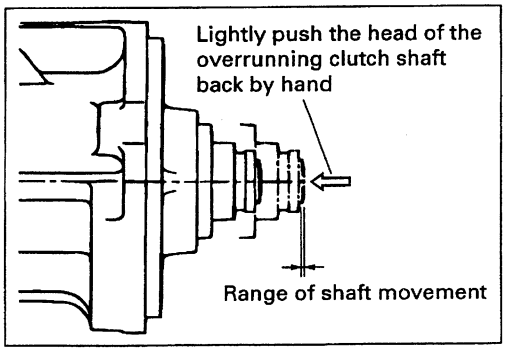
Refer to the specifications attached. (P.155)



3. Inspection of the projection position of the pinion

After reassembling the cranking motor, inspect the projection position of the pinion.

Projection Position of the Pinion	mm(in.)
0.5 – 2.0	



Measuring method

As shown in the diagram, connect the starter motor to the battery.

- When the switch is turned on, the pinion will move forward to the cranking position. At this time, the armatures may also turn, so care is needed.
- Lightly push the head of the overrunning clutch shaft by hand and measure the movement (return) of the clutch shaft.

  If the value is within 0.5-2.0, it is in the normal position. If it is outside the limit, replace the lever.

4. Note the circuit tester reading.

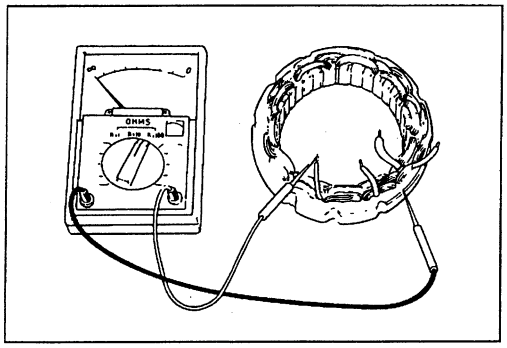
   If the two readings (Steps 2 and 4) are identical, the stator coil has continuity.

   If the two circuit tester readings are different, there is no stator continuity.

5. Check the neutral junction (arrow mark) for breaks.

   If breaks are found, repair and repeat the stator coil continuity test.

   If there is still no stator coil continuity, the stator must be replaced.



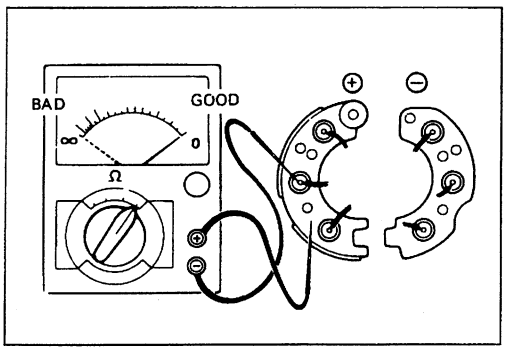
Stator Coil Ground Test

Use an circuit tester to test the stator coil for grounding.

1. Touch one circuit tester probe to the bear metal surface of the stator.
2. Touch the other circuit tester probe to a bare stator lead wire.
3. Note the circuit tester reading.

   The circuit tester should show infinity (no needle movement).

   If the circuit tester shows a value other than infinity (the needle moves), the stator is grounded and must be replaced.



RECTIFIER

Rectifier (Positive Diode) Continuity Test

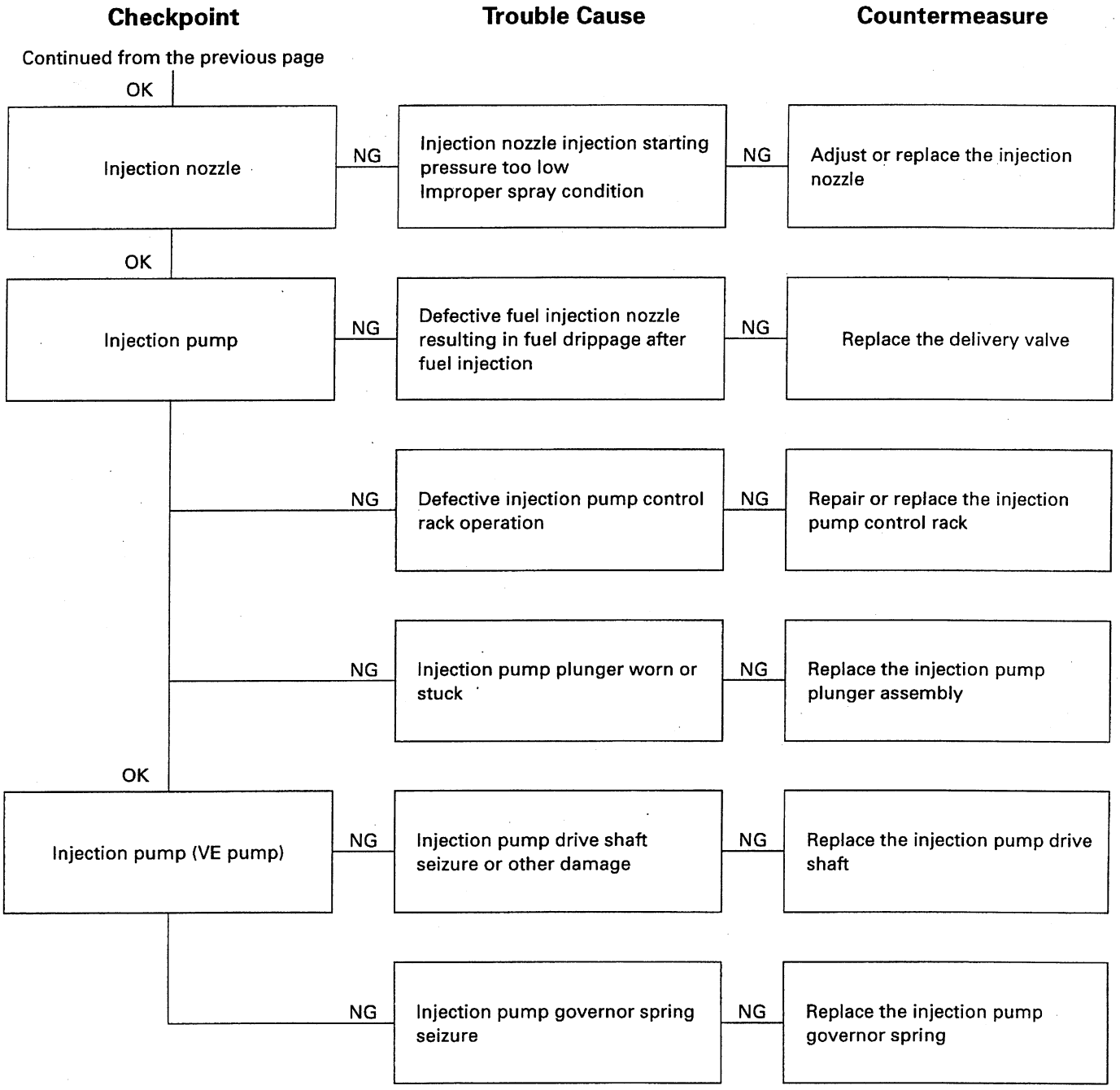
Use an circuit tester to test rectifier continuity.

1. Touch the circuit tester positive probe to the rectifier holder.
2. Touch the circuit tester negative probe to each of the diode terminals in turns.

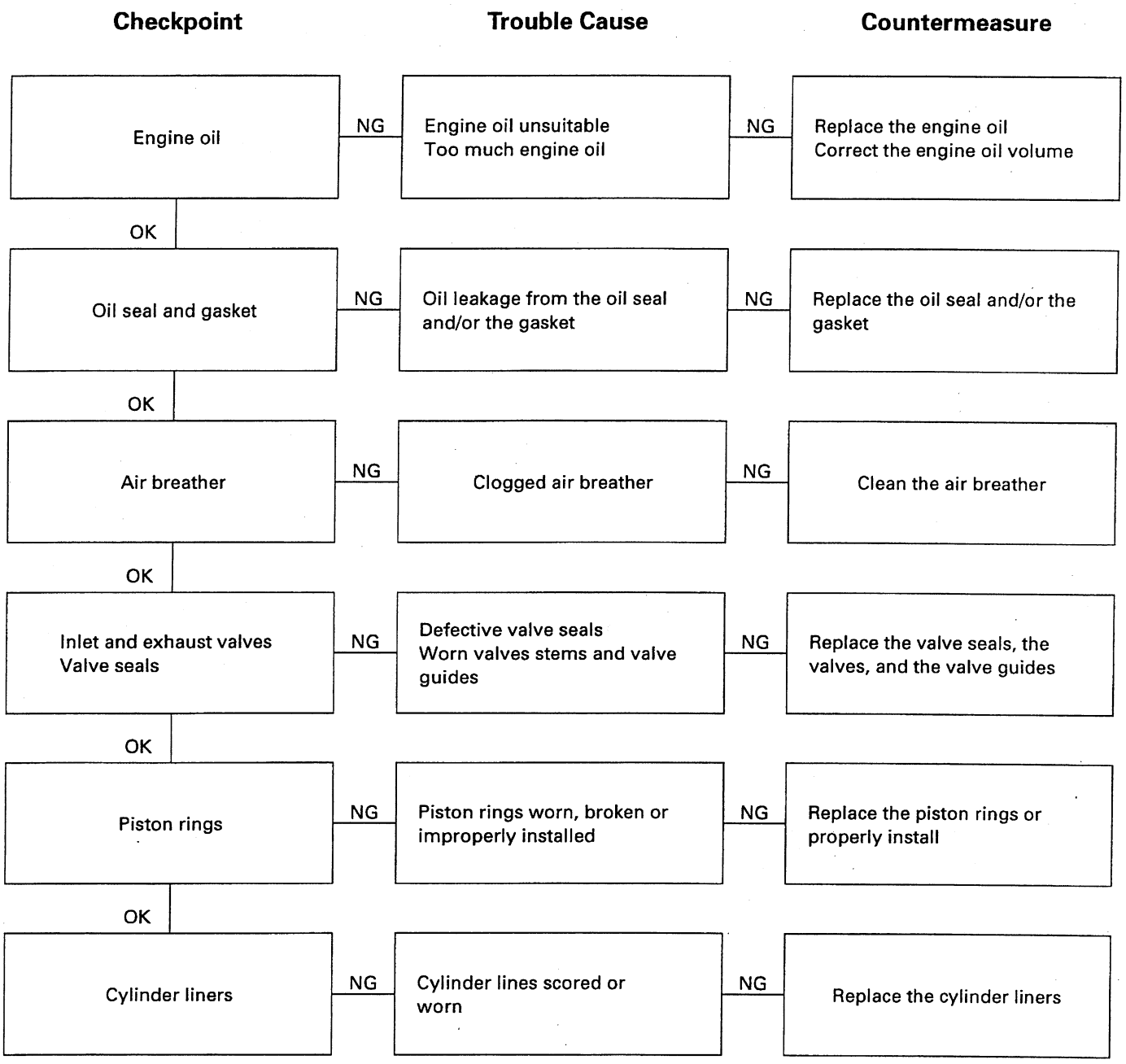
1. HARD STARTING

3. ENGINE TURNS OVER BUT DOES NOT START

FUEL IS BEING DELIVERED TO THE INJECTION PUMP



5. EXCESSIVE OIL CONSUMPTION



MEMO

Major Category	Name of Part	Inspection Item	Nominal Dimension	Assembly Standard Value	Limit	Repair Procedure	Comments
Main Operating Parts	Connecting Rods	Contact between connecting rod bearing and crankpin				Replace parts with poor contact or abrasions	Take special care with crankpin precision
		Clearance between smallend bushing and piston pin		0.008 – 0.020 (0.0003 – 0.0008)	0.05 (0.002)	Replace bushing or pin	Sufficient gap to allow smooth rotation when holding big end
		Connecting rod bearing undersize	Dia. 53 (2.087)				Crank must not be ground (no undersizes available)
		Connecting rod and crankpin end play		0.175 – 0.290 (0.007 – 0.0114)	0.35 (0.0138)	Replace connecting rod	
		Big end to small end hole twist (per 100 mm)		0.05 (0.002) or less	0.20 (0.008)	Repair or replace	
		Big end to small end hole parallelism (per 100 mm)		0.05 (0.002) or less	0.15 (0.006)	Repair or replace	
	Camshaft	Journal uneven wear	Dia. 50 (1.969)		0.05 (0.002)	Replace camshaft	
		Clearance between journal and bearing		0.025 – 0.085 (0.001 – 0.0033)	0.12 (0.0047)	Replace bearing	
		Journal wear	Dia. 50 (1.969)	49.945 – 49.975 (1.9663 – 1.9675)	Dia. 49.60 (1.953)	Replace camshaft	

LENGTH

FEET TO METERS

ft.	0	1	2	3	4	5	6	7	8	9	ft.
	m	m	m	m	m	m	m	m	m	m	
—	—	0.305	0.610	0.914	1.219	1.524	1.829	2.134	2.438	2.743	—
10	3.048	3.353	3.658	3.962	4.267	4.572	4.877	5.182	5.486	5.791	10
20	6.096	6.401	6.706	7.010	7.315	7.620	7.925	8.230	8.534	8.839	20
30	9.144	9.449	9.754	10.058	10.363	10.668	10.973	11.278	11.582	11.887	30
40	12.192	12.497	12.802	13.106	13.411	13.716	14.021	14.326	14.630	14.935	40
50	15.240	15.545	15.850	16.154	16.459	16.764	17.069	17.374	17.678	17.983	50
60	18.288	18.593	18.898	19.202	19.507	19.812	20.117	20.422	20.726	21.031	60
70	21.336	21.641	21.946	22.250	22.555	22.860	23.165	23.470	23.774	24.079	70
80	24.384	24.689	24.994	25.298	25.603	25.908	26.213	26.518	26.822	27.127	80
90	27.432	27.737	28.042	28.346	28.651	28.956	29.261	29.566	29.870	30.175	90
100	30.480	30.785	31.090	31.394	31.699	32.004	32.309	32.614	32.918	33.223	100

METERS TO FEET

m	0	1	2	3	4	5	6	7	8	9	
	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	
—	—	3.2808	6.5617	9.8425	13.1234	16.4042	19.6850	22.9659	26.2467	29.5276	—
10	32.8084	36.0892	39.3701	42.6509	45.9318	49.2126	52.4934	55.7743	59.0551	62.3360	10
20	65.6168	68.8976	72.1785	75.4593	78.7402	82.0210	85.3018	88.5827	91.8635	95.1444	20
30	98.4252	101.7060	104.9869	108.2677	111.5486	114.8294	118.1102	121.3911	124.6719	127.9528	30
40	131.2336	134.5144	137.7953	141.0761	144.3570	147.6378	150.9186	154.1995	157.4803	160.7612	40
50	164.0420	167.3228	170.6037	173.8845	177.1654	180.4462	183.7270	187.0079	190.2887	193.5696	50
60	196.8504	200.1312	203.4121	206.6929	209.9738	213.2546	216.5354	219.8163	223.0971	226.3780	60
70	229.6588	232.9396	236.2205	239.5013	242.7822	246.0630	249.3438	252.6247	255.9055	259.1864	70
80	262.4672	265.7480	269.0289	272.3097	275.5906	278.8714	282.1522	285.4331	288.7139	291.9948	80
90	295.2756	298.5564	301.8373	305.1181	308.3990	311.6798	314.9606	318.2415	321.5223	324.8032	90
100	328.0840	331.3648	334.6457	337.9265	341.2074	344.4882	347.7690	351.0499	354.3307	357.6116	100

MILES TO KILOMETERS

miles	0	1	2	3	4	5	6	7	8	9	
	km	km	km	km	km	km	km	km	km	km	
—	—	1.609	3.219	4.828	6.437	8.047	9.656	11.265	12.875	14.484	—
10	16.093	17.703	19.312	20.921	22.531	24.140	25.750	27.359	28.968	30.578	10
20	32.187	33.796	35.406	37.015	38.624	40.234	41.843	43.452	45.062	46.671	20
30	48.280	49.890	51.499	53.108	54.718	56.327	57.936	59.546	61.155	62.764	30
40	64.374	65.983	67.592	69.202	70.811	72.420	74.030	75.639	77.249	78.858	40
50	80.467	82.077	83.686	85.295	86.905	88.514	90.123	91.733	93.342	94.951	50
60	96.561	98.170	99.779	101.389	102.998	104.607	106.217	107.826	109.435	111.045	60
70	112.654	114.263	115.873	117.482	119.091	120.701	122.310	123.919	125.529	127.138	70
80	128.748	130.357	131.966	133.576	135.185	136.794	138.404	140.013	141.622	143.232	80
90	144.841	146.450	148.060	149.669	151.278	152.888	154.497	156.106	157.716	159.325	90
100	160.934	162.544	164.153	165.762	167.372	168.981	170.590	172.200	173.809	175.418	100

KILOMETERS TO MILES

km	0	1	2	3	4	5	6	7	8	9	
	miles	miles	miles	miles	miles	miles	miles	miles	miles	miles	
—	—	0.621	1.243	1.864	2.485	3.107	3.728	4.350	4.971	5.592	—
10	6.214	6.835	7.456	8.078	8.699	9.321	9.942	10.563	11.185	11.806	10
20	12.427	13.049	13.670	14.292	14.913	15.534	16.156	16.777	17.398	18.020	20
30	18.641	19.262	19.884	20.505	21.127	21.748	22.369	22.991	23.612	24.233	30
40	24.855	25.476	26.098	26.719	27.340	27.962	28.583	29.204	29.826	30.447	40
50	31.069	31.690	32.311	32.933	33.554	34.175	34.797	35.418	36.039	36.661	50
60	37.282	37.904	38.525	39.146	39.768	40.389	41.010	41.632	42.253	42.875	60
70	43.496	44.117	44.739	45.360	45.981	46.603	47.224	47.845	48.467	49.088	70
80	49.710	50.331	50.952	51.574	52.195	52.816	53.438	54.059	54.681	55.302	80
90	55.923	56.545	57.166	57.787	58.409	59.030	59.652	60.273	60.894	61.516	90
100	62.137	62.758	63.380	64.001	64.622	65.244	65.865	66.487	67.108	67.729	100