

KOBELCO

SERVICE MANUAL

**HYDRAULIC EXCAVATOR
SK13SR**

Applicable: SK013SR PE0100101~

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- 5) Use the special jig and tools without fail if they are specified.
- 6) If it is hard to remove a part according to the procedure, do not try it by force but investigate the cause.
- 7) Place the removed parts in order and attach tags to facilitate the reassembling.
- 8) Note the location and quantity of parts commonly applied to multiple locations.

(3) Inspecting parts

- 1) Ensure that the disassembled parts are free from seizure, interference and uneven contact.
- 2) Measure and record wear condition of parts and clearance.
- 3) If the problem is found in a part, repair or replace it with a new one.

(4) Reassembling hydraulic equipment

- 1) Turn ON the ventilation fan or open windows to maintain good ventilation prior to starting the cleaning of parts.
- 2) Perform rough and finish cleaning before assembling.
- 3) Remove washing oil by air and apply clean hydraulic or gear oil for assembling.
- 4) Always replace the removed O-rings, backup rings and oil seals with new ones by applying grease in advance.
- 5) Remove dirt and moisture from and perform degreasing on the surface where liquid gasket to be applied.
- 6) Remove rust preventive agent from the new parts before use.
- 7) Fit bearings, bushings and oil seals using special jigs.
- 8) Assemble the parts utilizing matching marks.
- 9) Ensure all the parts are completely assembled after the work.

(5) Installing hydraulic equipment

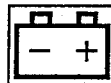
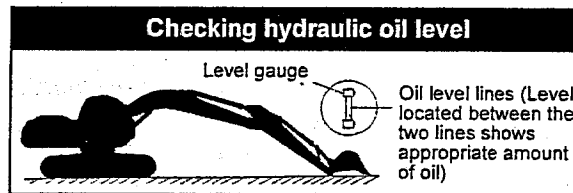
- 1) Ensure hydraulic oil and lubricant are properly supplied.
- 2) Perform air bleeding when:
 - a. Hydraulic oil changed
 - b. Parts of suction side piping replaced
 - c. Hydraulic pump installed
 - d. Slewing motor installed
 - e. Travel motor installed
 - f. Hydraulic cylinder installed

- ⚠ • Operation of the hydraulic equipment without filling hydraulic oil or lubricant or without performing air bleeding will result in damage to the equipment.

- 3) Perform air bleeding of the hydraulic pump and slewing motor after loosening the upper drain plug, starting the engine and keep it in low idle condition. Complete the air bleeding when seeping of hydraulic oil is recognized, and tightly plug.
- 4) Perform air bleeding of the travel motor and the hydraulic cylinders by running the engine for more than 5 minutes at low speed without load.

- ⚠ • Do not allow the hydraulic cylinder to bottom on the stroke end just after the maintenance.

- 5) Perform air bleeding of pilot line by performing a series of digging, slewing and travel.
- 6) Check hydraulic oil level after placing the attachment to the oil check position, and replenish oil if necessary.



1.4 ELECTRICAL EQUIPMENT

- (1) Do not disassemble electrical equipment.
- (2) Handle it carefully not to drop and give a shock.
- (3) Turn the key OFF prior to connecting and disconnecting work.
- (4) Disconnect the connector by holding it and pressing the lock. Do not pull the wire to apply force to the caulking portion.
- (5) Connect the connector and ensure it is completely locked.
- (6) Turn the key OFF prior to touching the terminal of starter or generator.
- (7) Remove the ground (earth) terminal of battery

4. MACHINE & COMPONENTS WEIGHT (DRY)

	Unit : kgf (lbs)	
MODEL	SK13SR	
COMPLETE MACHINE	1,390	(3,060)
UPPER FRAME ASSEMBLY (ASSY OF FOLLOWINGS)	600	(1,320)
UPPER FRAME	141	(311)
ENGINE	82	(181)
RADIATOR	8	(18)
HYDRAULIC PUMP	10	(22)
-----	-----	-----
HYDRAULIC TANK	21	(46)
FUEL TANK	3	(7)
CONTROL VALVE	17	(37)
SLEWING MOTOR	15	(33)
SWING BRACKET	21	(46)
-----	-----	-----
SWING CYLINDER	19	(42)
COUNTER WEIGHT	80	(176)
CANOPY	93	(205)
LOWER FRAME ASSEMBLY (ASSY OF FOLLOWINGS)	554	(1,220)
LOWER FRAME	190	(419)
SWIVEL JOINT	12	(26)
SLEWING BEARING	17	(37)
RUBBER CRAWLER SHOE	58 X 2	(128 X 2)
-----	-----	-----
TRAVEL MOTOR	18 X 2	(40 X 2)
LOWER ROLLER	4 X 6	(9 X 6)
IDLER	14 X 2	(31 X 2)
SPROCKET	5 X 2	(11 X 2)
IDLER ADJUSTER	8 X 2	(18 X 2)
-----	-----	-----
DOZER	66	(146)
DOZER CYLINDER	9 X 2	(20 X 2)
CRAWLER WIDTH CYLINDER	8	(18)
HOE ATTACHMENT (ASSY OF FOLLOWINGS)	195	(430)
BOOM	44	(97)
ARM	29	(64)
BUCKET	33	(71)
BOOM CYLINDER	12	(26)
-----	-----	-----
ARM CYLINDER	10	(22)
BUCKET CYLINDER	9	(20)
FLUIDS	37	(82)
HYDRAULIC OIL	17 liters	(4 gal)
COOLING WATER	3 liters	(1 gal)
ENGINE OIL	3 liters	(1 gal)
FUEL	15 liters	(4 gal)

Note : Bucket weight is shown with Japanese standard bucket weight.

Applicable Machines

SK13SR:PE01-00101~

PREFACE

(1) Working Conditions

- 1) Technicians : One or more technicians qualified by KOBELCO Construction Machinery Co., Ltd. as a first class service technician (with five years or more of field experience and having completed the training in the operation of vehicle type construction machinery) to be provided.
- 2) Facilities : General jigs, tools, apparatus, testers to be provided.
The maintenance workshop to be equipped with a good enough capacity of building with crane and inspection instruments necessary for specific self inspection activities.
- 3) Place : The workshop to be located on a flat land at which the work is able to perform and to which a service car or truck crane is accessible.

(2) Applicable Range of Standard Maintenance Time

- 1) Standard maintenance time : Direct maintenance time plus spare time.
- 2) Direct maintenance time : Net time actually spent for maintenance.
- 3) Spare time : Time for transportation of the machine for maintenance, preparation for safety work, meeting for the work and physiological time for the needs of body.

(3) Excluded Time (not included in the standard maintenance time)

- 1) Repairing time : Time for machining, sheet metal processing, welding, gas cutting, removing broken screw, taking care of parts and painting.
- 2) Items excluded from maintenance time because of uncertainly in time : Receiving the vehicle into shop, transportation, delivery, final inspection and investigation of causes for trouble, diagnosis and inspection.
- 3) Indirect time : Time for field work, preparation of required parts, etc., before starting work, going to and from the site, waiting due to user's convenience at the site and paper work for reports, bills, etc.
- 4) Special time : Working time at early morning, at mid night and on holidays shall be separately calculated.
- 5) Separate calculation : The cost for service cars, trucks with crane and truck cranes shall be separately calculated.

(4) Applicable Machine for Estimation of Standard Maintenance Time

- 1) Standard machine.
- 2) A well maintained machine combined with standard attachments which has operated in a normal circumstances.

Revision	Date of Issue	Remarks
First edition	September, 2000	S5PE1201E

2. PERFORMANCE INSPECTION STANDARD TABLE

2.1 STANDARD VALUE TABLE

Model			SK13SR		
Applicable machines			PE01-00101~		
Div.	Item	Unit	Standard value	Standard value for repair	
Measuring Condition	Hyd. oil cleanliness	Class	8 ± 1		
	Hyd. oil temperature (Tank surface)	°C	50 ~ 60 (122 ~ 140)		
	Coolant temperature (Radiator surface)	(°F)	60 ~ 90 (140 ~ 194)		
Engine Speed	Low idle	rpm	1280 ± 50		
	High idle		2,180 ± 50		
Main relief valve pressure	Boom-Bucket-Swing-Travel(RH) P1	kgf/cm ² (psi)	210 ⁺¹⁰ / ₀ (2990 ⁺¹⁴⁰ / ₀)		
	*1 Arm-(Slew)-Travel(LH) P2		210 ⁺¹⁰ / ₀ (2990 ⁺¹⁴⁰ / ₀)		
	Dozer/Crawler width, Service P1 P2		210 ⁺¹⁰ / ₀ (2990 ⁺¹⁴⁰ / ₀)		
Pilot relief valve pressure	Pilot Line P3		35 ⁺⁵ / ₋₃ (500 ⁺⁷⁰ / ₋₄₀)		
Port (Over load) relief valve pressure	Boom	Rod	280 ⁺¹⁰ / ₀ (3980 ⁺¹⁴⁰ / ₋₃₀)		
	Dozer (Crawler width)	Head	280 ⁺¹⁰ / ₀ (3980 ⁺¹⁴⁰ / ₋₃₀)		
	Arm	Head	250 ⁺¹⁰ / ₀ (3560 ⁺¹⁴⁰ / ₋₃₀)		
	*1 Slew	LH·RH	135 ⁺¹⁰ / ₋₄ (1920 ⁺¹⁴⁰ / ₋₆₀) [125 (1780)]		
Travel	Travel Speed (5 rev.)	Rubber crawler	Low	31.9 ± 1.6	41
			High	17.1 ± 0.8	22
		Steel crawler	Low	34.2 ± 1.7	44
			High	17.7 ± 0.7	23
	Travel Speed 10m (32.8ft)	Rubber crawler	Low	18.5 ± 0.9	24
			High	10.5 ± 0.5	13
		Steel crawler	Low	19.6 ± 1.0	25
			High	11.1 ± 0.5	14
	Travel deviation		mm (in)	180 ⁰ / ₋₁₈₀ (7.1 ⁰ / _{-7.1})	360 (14.2)
	Drift due to gravity	w / P.B.		0	-
(w/o P.B.)		96 ⁰ / ₋₉₆ (3.8 ⁰ / _{-3.8})		190 (7.5)	
Slew	Slew time per 2-revolution		sec.	13.0 ± 0.6	16
	Overrun when slewing stops		mm (in)	78 ⁰ / ₋₆₀ (3.1 ⁰ / _{-2.4})	86 (3.4)
	Drift due to gravity			36 ⁰ / ₋₃₆ (1.4 ⁰ / _{-1.4})	72 (2.8)

*1 The pressure for slew is controlled by the relief valve attached to the slew motor.
The figures in [] show the setting pressure on single body of slew motor relief valve.

7. MEASURING ATTACHMENT OPERATING PERFORMANCES

•TEST PROCEDURES

Measure 3-time each.

Apply average data of the above for judgement.

7.1 CYLINDER SPEED

(1) Boom Cylinder Speed

- Engine : High Idle
- Hydraulic Oil Temp. : 50 ~ 60 °C
(122 ~ 140 °F)
- Measurement Posture : Completely retract the arm cylinder, fully extend the bucket cylinder and place the dozer blade on the ground.
- Then measure the time required for the bucket to reach its highest point (lowest point) from its lowest point (highest point) placing on the ground. (Do not include the cushioning time.)

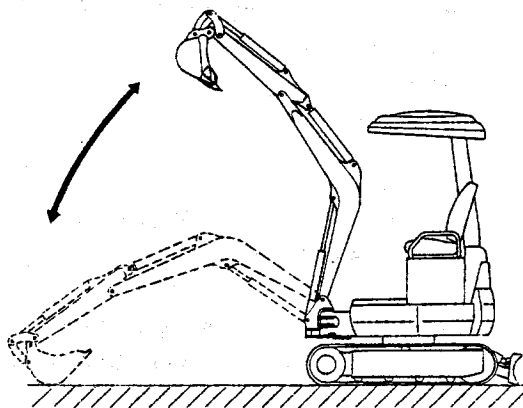


Fig. 7-1

(2) Arm Cylinder Speed

- Engine : High Idle
- Hydraulic Oil Temp. : 50 ~ 60 °C
(122 ~ 140 °F)
- Measurement Posture : Completely retract the arm cylinder, fully extend the bucket cylinder, position the arm horizontally and place the dozer blade on the ground.
- Then measure the time required for the arm cylinder to completely retract (extend) from a fully extended state (retracted state).

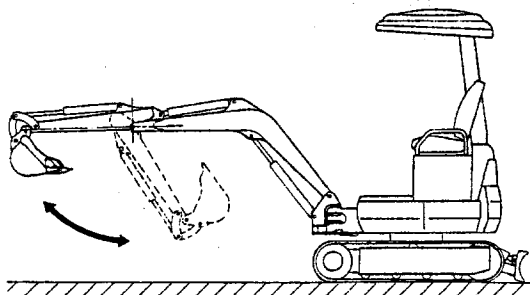


Fig. 7-2

(3) Bucket Cylinder Speed

- Engine : High Idle
- Hydraulic Oil Temp. : 50 ~ 60 °C
(122 ~ 140 °F)
- Measurement Posture : Completely retract the arm cylinder, position the arm horizontally and place the dozer blade on the ground.
- Then measure the time required for the bucket cylinder to completely retract (extend) from a fully extended state (retracted state).

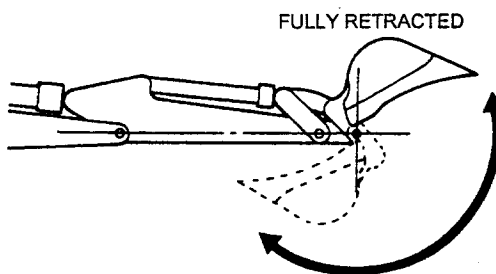


Fig. 7-3

(4) Swing Cylinder Speed

- Engine : High Idle
- Hydraulic Oil Temp. : 50 ~ 60 °C
(122 ~ 140 °F)
- Measurement Posture : Same as that for measuring slew time.
- While swinging the boom left (right) to right (left), measure the time required for a full stroke each way. (Do not include the cushioning time.)

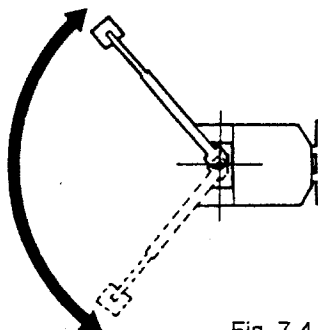


Fig. 7-4

3.5 BUCKET OPERATING CIRCUIT

The pilot oil pressure system with operating lever is provided.

3.5.1 Bucket Digging Operation Circuit

(1) Pilot Circuit

1) Bucket Spool Shifting

When the lever is put at bucket digging position, the pilot secondary pressure oil is discharged from the pilot valve (14). The pressurized oil entered into the Pa1 port on control valve (1) shifts the bucket valve spool to connect the circuits of variable pump and bucket cylinder.

(2) Main Circuit

1) Supply Circuit for Cylinder (9)

The oil discharged from P1 port on variable pump of pump assy (2) enters into P1 port on control valve (1). The pressurized oil discharged from A1 port through bucket valve is supplied to the head side of bucket cylinder (9) to activate the digging work. The return oil from the rod side of cylinder (9) enters into B1 port on control valve (1) and returns into the tank through bucket valve.

3.5.2 Bucket Dumping Operating Circuit

(1) Pilot Circuit

1) Bucket Spool Shifting

When the operating lever is put at bucket dumping position, the pilot secondary pressure oil is discharged from pilot valve (14) and enters into Pb1 port on control valve (1) to shift the bucket valve spool.

(2) Main Circuit

1) Supply Circuit for Cylinder (9)

Similar to the case for bucket digging, the pressurized oil discharged from P1 port on variable pump enters into P1 port on control valve (1). The oil discharged from B1 port through bucket valve is supplied to the rod side of bucket cylinder (9) to activate the bucket dumping.

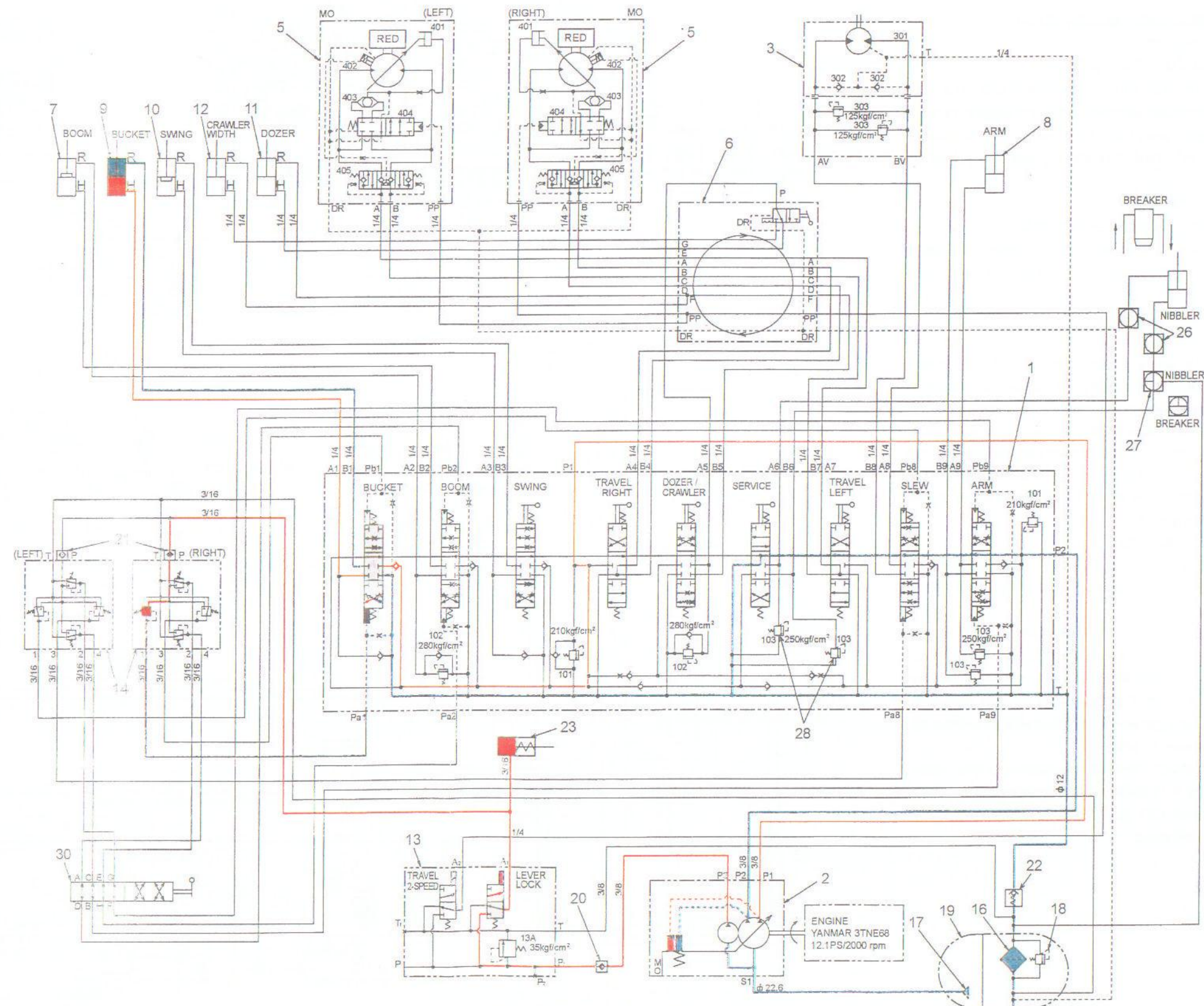
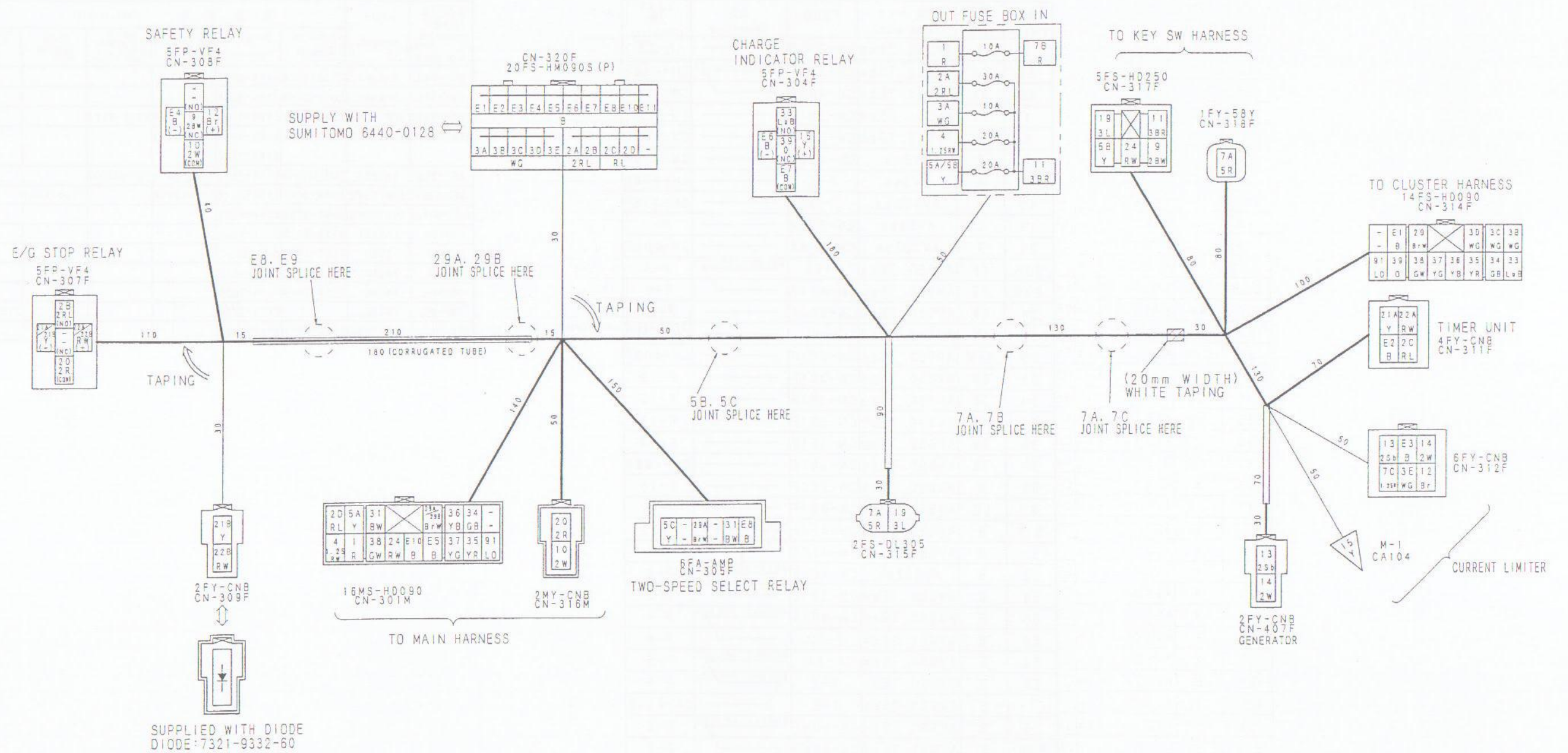


Fig.8 Bucket digging operation circuit

3.5.2 Relay Harness : (No.H-2)



(2) Constant Power Control

The constant power/variable discharge mechanism is achieved by changing the slant angle of swash plate. The variable mechanism to change the slant angle is of a simple direct acting type using a spring.

The rotating center of the swash plate is located on the ball of back side. The direction of load F_1 due to piston side is shown in the right sketch, which generates clock-wise turning moment against the swash plate. Opposing to this force, a spring with proper spring force (F_2) is provided for the opposite direction.

Along with increasing pressure, the clock-wise turning moment is also increased. When it overcomes the spring force, the slant angle becomes less decreasing the discharge volume. Thus the power is kept at constant.

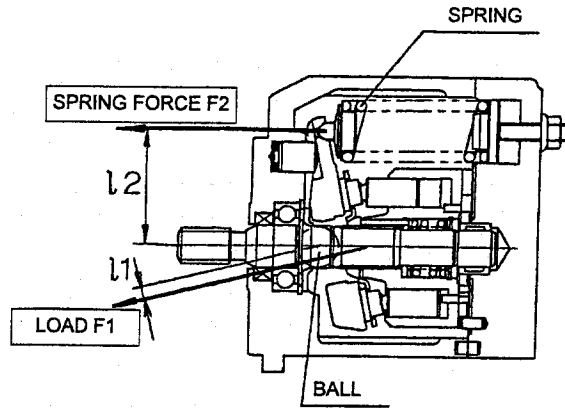


Fig. 1-5

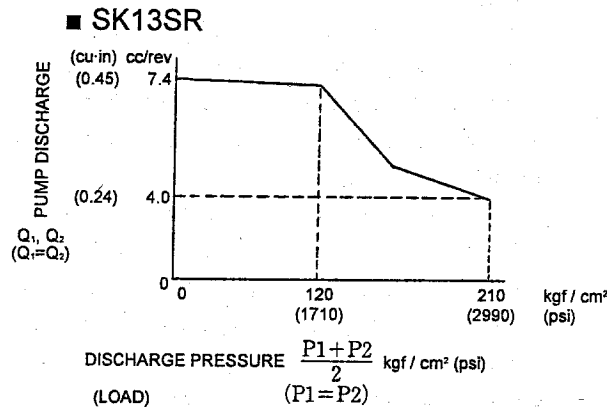


Fig. 1-6

3.3 HYDRAULIC CIRCUIT DIAGRAM

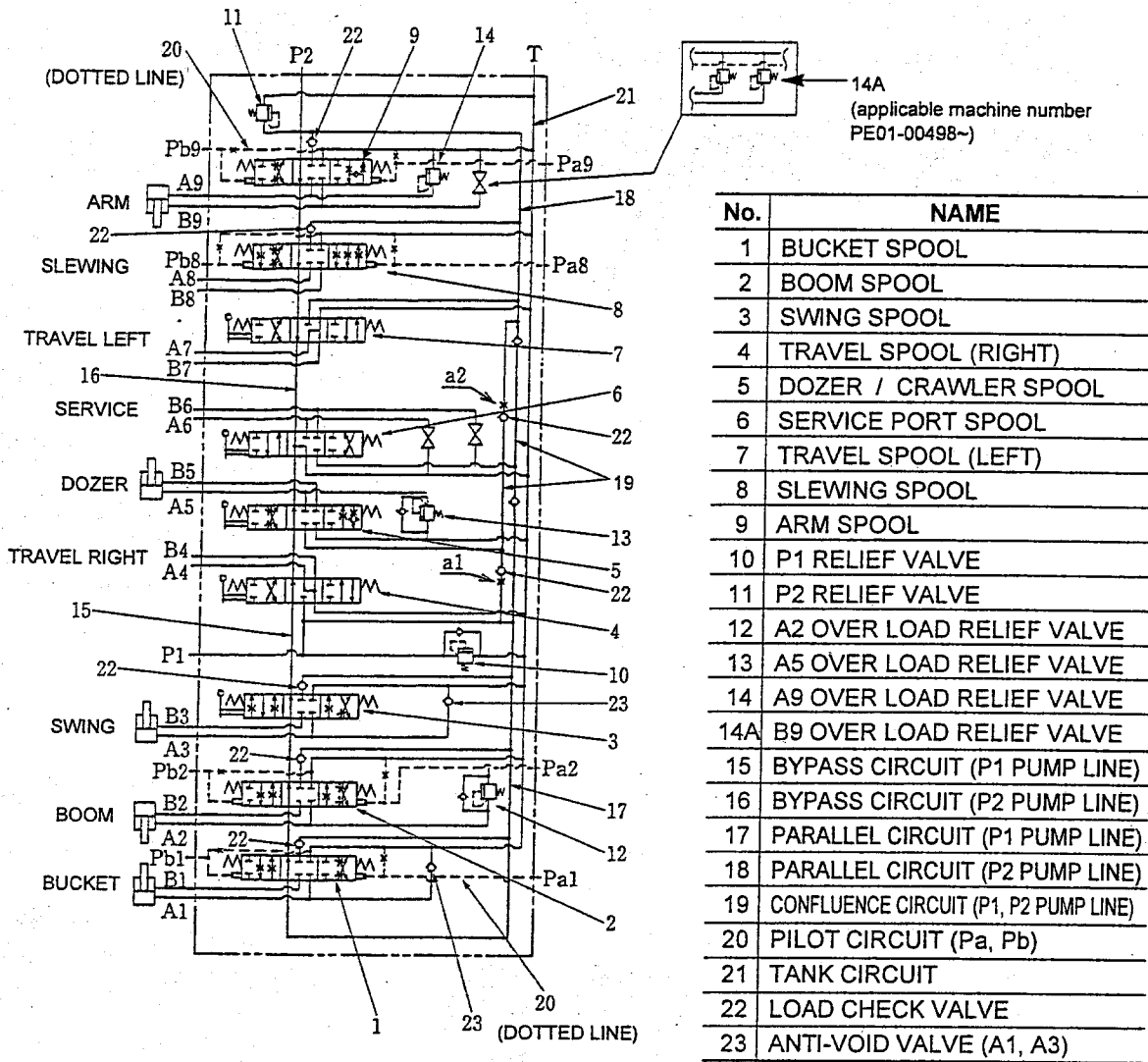


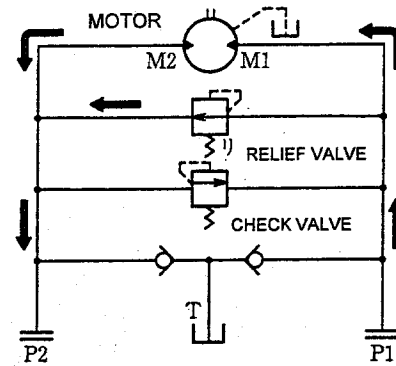
Fig. 3-10

(2) Operating of Relief Valve : Part-1

1) When the motor is started

When the motor is started, since the inertia load is great, the pressure of the oil required to accelerate it rises. If this pressure reached the relief valve set pressure, the relief valve operates and oil returns to port M2.

In this way, the motor begins to turn relieving oil from the relief valve, and as the speed increases, the amount of relief decreases until it stops. In this way, the shock during starting is absorbed.



2) When the motor is stopped

When the motor is stopped, the return circuit is closed off. However, since the motor tends to continue rotating due to inertia energy, the pressure in port M2 rises. When this pressure reaches relief valve's pressure, the relief valve operates and oil flows to port M1. On the other hand, a vacuum is generated at port M1. For this reason, oil flows into port M1 from the tank (T). In this way, the flow of oil to port M1 prevents cavitation from occurring as it absorbs the shock during stopping.

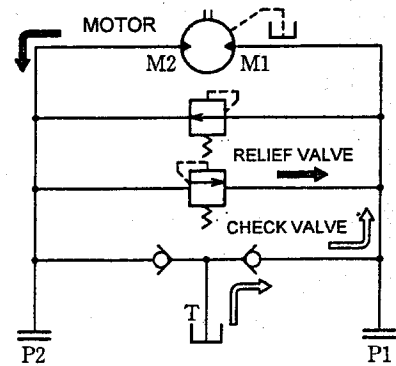


Fig. 4-5

(3) Operating of Relief Valve : Part-2

Pressure in the circuit is introduced into chamber (A). This pressure is transmitted to chamber E via the orifice (1) and acts as a force to push the needle valve (2) to the right. When the pressure acting on the needle valve (2) is higher than the force of the spring (3), the needle valve (2) moves to the right and port M1 and port M2 are connected.

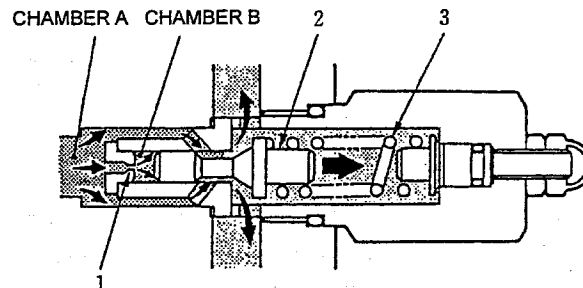
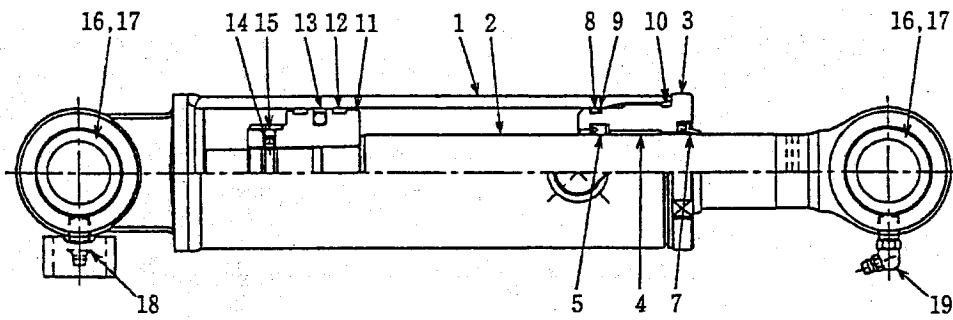


Fig. 4-6

(5) Dozer cylinder



No.	NAME	Q'TY	No.	NAME	Q'TY	No.	NAME	Q'TY
1	CYLINDER TUBE ASSY	1	8	O-RING	1	15	SETSCREW	1
2	PISTON ROD ASSY	1	9	BACK-UP RING	1	16	PIN BUSHING	2
3	CYLINDER HEAD	1	10	O-RING	1	17	DUST SEAL	4
4	BUSHING	1	11	PISTON	1	18	GREASE NIPPLE	1
5	U-RING	1	12	SLIDE RING	2	19	GREASE NIPPLE	1
-	-	-	13	SEAL RING ASSY	1			
7	WIPER RING	1	14	STEEL BALL	1			

Fig. 7-6 Construction of dozer cylinder

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3. ARM

3.1 REMOVAL OF ARM

(1) Making the arm cylinder and bucket cylinder to the most contracting conditions, get touch the arm tip with the ground.

(2) Loosing the air plug on the hydraulic oil tank, release the pressure in the tank.


 : 22 mm

(3) Disconnect the 2 hoses connected to the bucket cylinder. Then apply a blinding plug to the openings.

 : 19mm, 22 mm

(4) Lift up the arm cylinder body with a nylon sling in order not to exert any load to the pin (E).

(5) Remove the capscrew and nuts that are preventing the pin (E) from coming out. Then remove the pin (E) and shims.

 : 17mm

(6) Placing a square timber under the arm cylinder, get down the cylinder.

(7) Install the pin (E) to the original position, and install the capscrew and nuts that prevents the pin (E) from coming out. Applying a rope to the pin (E) and the arm tip, slightly lift it up in order not exert any load to the pin (F).

(8) Remove the capscrew that is preventing the pin (F) connecting the arm and boom, from coming out. Then pull off the pin (F).

 : 17mm

(9) Remove the arm assy paying attention to the stability of arm.

Weight of arm assy: SK13SR ; 61 kgf (135 lbs)

(10) Removal of Bucket Cylinder

1) Remove the capscrew that is preventing the rod pin (H) from coming out, then pull off the pin (H).

 : 19mm

2) Remove the capscrew and nuts that are preventing the head pin (G) from coming out, then pull off the pin (G).

 : 17mm

3) Apply a nylon sling to the tube of bucket cylinder, and remove the cylinder.

Weight ; 9 kgf (20 lbs)

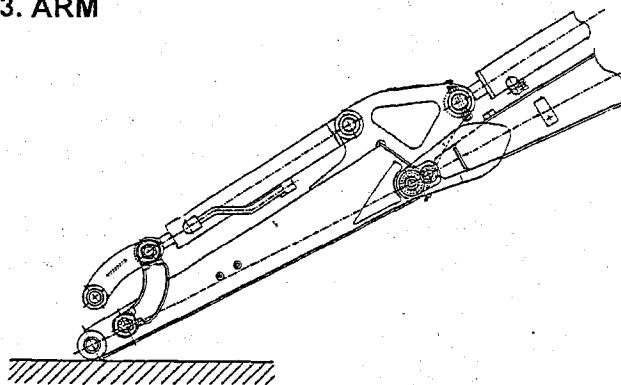
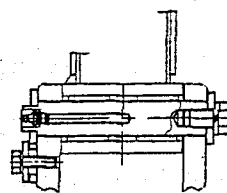
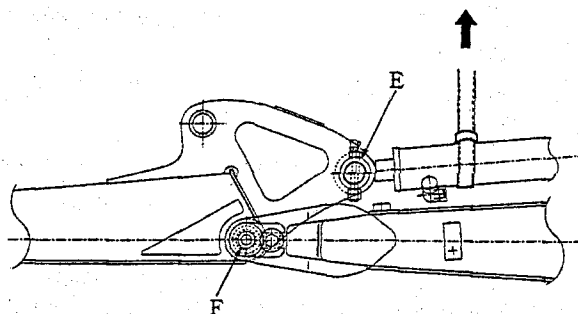
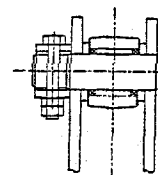


Fig. 2-5 Arm removing Posture



PIN (F) PORTION



PIN (E) PORTION

Fig. 2-6 Sectional view of Installing Pin

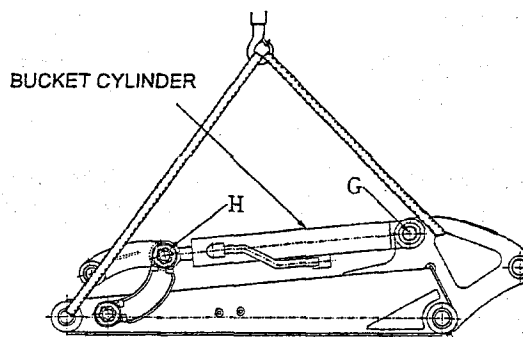


Fig. 2-7 Removal of Arm assy

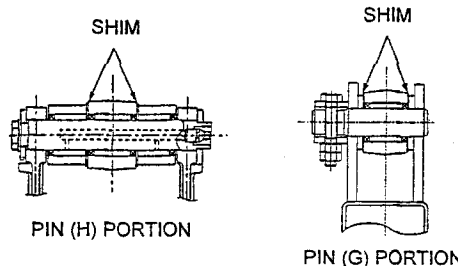


Fig. 2-8 Sectional view of Installing Pin

« For Swing Cylinder »

- a. Remove the bolt (19) and washer (18), then remove the cushion bearing (17).
- b. Remove the setscrew (16), then remove the steel ball (15).
- c. Remove the piston assy (12).

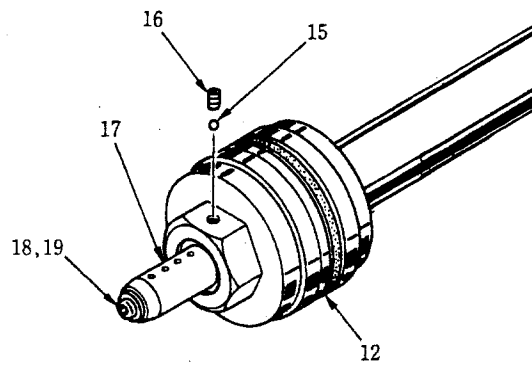


Fig. 1-7 Removing piston assy

- 3) Remove the cylinder head assy.

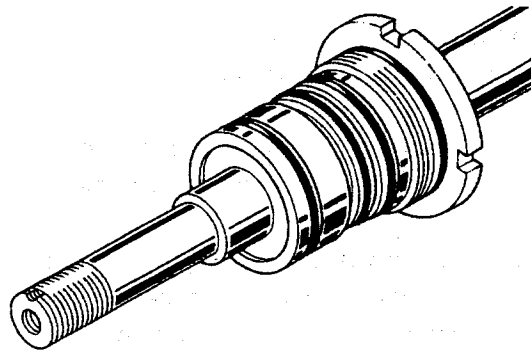


Fig. 1-8 Removing cylinder head assy

(3) Disassembly of piston assy:

- 1) Remove the slide ring (16) from the piston (15).
 - Expand the split on the slide ring (16) as minimum as required to pull it off for axial direction.
- 2) Remove the seal ring assy (17).
 - Cut off the seal ring (17) or remove it using a minus screw driver.

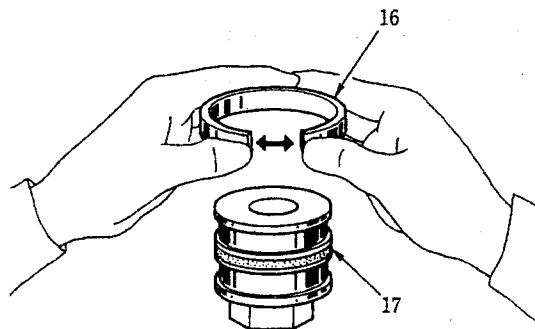


Fig. 1-9 Disassembling piston assy

(4) Disassembly of cylinder head assy:

- 1) Remove the O-rings (8) (11) and back-up ring (9) from the outer periphery of cylinder head (3). Then remove the O-ring (10) and back-up ring (9) [for Boom Cylinder only].

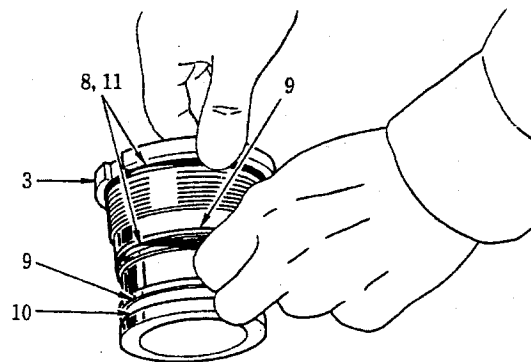


Fig. 1-10 Disassembling cylinder head assy

(5) Inspection after installation

■ Unloaded performance test

- 1) Put the cylinder horizontally at unloaded condition.
- 2) Apply pressure slowly and alternately through the ports at both ends to operate the piston rod 5 or 6 times.
- 3) Check that the cylinder operates normally.

■ Leakage test

• External leakage

- 1) Apply test pressure for 3 minutes each to the rod retraction side and to the rod extension side of the cylinder.
- 2) Confirm that rod seals, cylinder head tightening part, and each weld are free from abnormalities, such as external leakage and permanent deformation.

• Internal leakage

- 1) Disconnect the hose from the rod extension side of the cylinder.
- 2) Apply test pressure to the rod retraction side of the cylinder for 3 minutes.
- 3) Measure the leakage from the rod extension side.
 - Leakage should be below 1 cc (0.06 cu·in) / 3 min.

(6) Bleeding air from hydraulic cylinder

Bleed air from the cylinder after removing or installing it, or after disconnecting a hydraulic pipe.

- 1) Start the engine, and let it idling for about 5 minutes.
- 2) Repeat the step of extending and retracting the cylinder 4 or 5 times at slow speed of engine.
 - Move the piston rod 50 ~ 100 mm (2.0 ~ 3.9 in) short of its stroke end.
 - Take care never to operate the relief valve.
- 3) Perform the above 2) procedures at high idling speed, then move the piston rod to its stroke end at low idling speed to operate the relief valve.

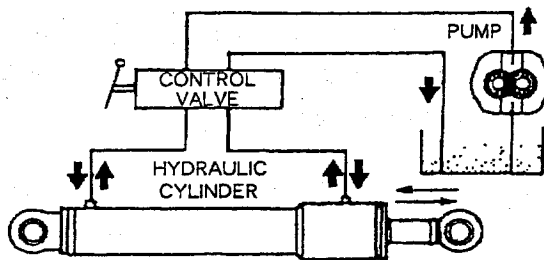


Fig. 1-34 Unloaded test

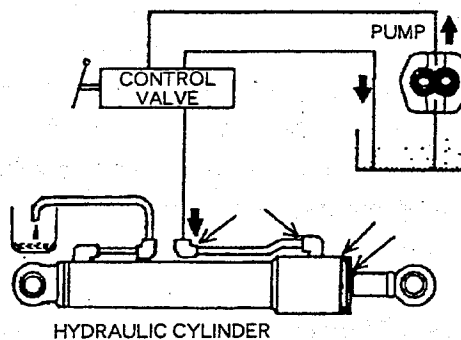


Fig. 1-35 Leakage test


2. GUARD (COVER AND SUPPORT)

2.1 COVER


2.1.1 Disassembly

(1) Disassembling upper side covers (1) (2)

1) Remove the SEMS bolts (23).

 : 13mm

2) Open the hinged side covers, and remove the each two SEMS bolts (25).


 : 13mm

3) Remove the side covers (1) and (2).

(2) Disassembling lower side covers (3), (4)

1) Remove the floor plate in advance (See item 1).

2) Remove each four SEMS bolts (23).

 : 13mm


3) Remove the side covers (3) and (4).

(3) Disassembling front side cover (9)

1) Loosen the knobs (25).

- Since the cover is attached by hinges, it falls down to near side when the knobs loosened.


2) Remove two SEMS bolts (16).

 : 13mm

3) Remove the cover assy (9).

(4) Disassembling bonnet

1) Remove two SEMS bolts (5-10).

 : 13mm

2) Remove the brackets (5-8) and (5-9), and the bonnet assy (5).

2.1.2 Assembly

Assemble in reverse order of the removal.

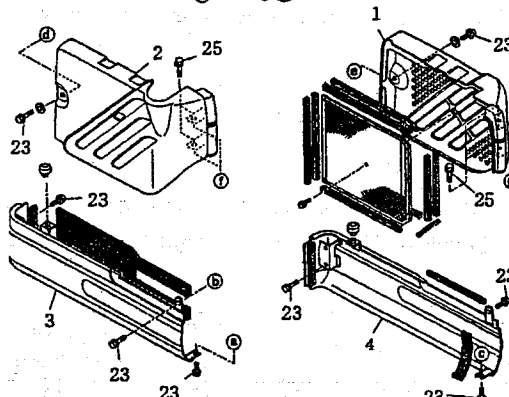
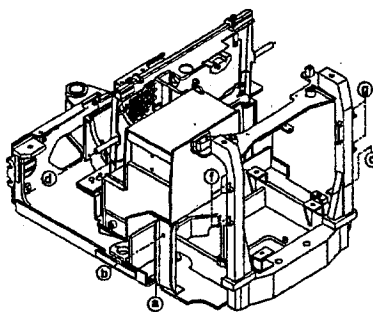


Fig. 2-1 Upper and lower cover disassembly

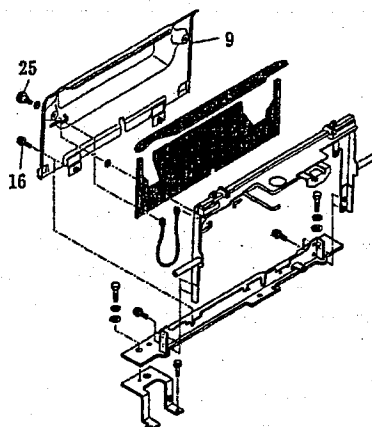


Fig. 2-2 Front cover disassembly

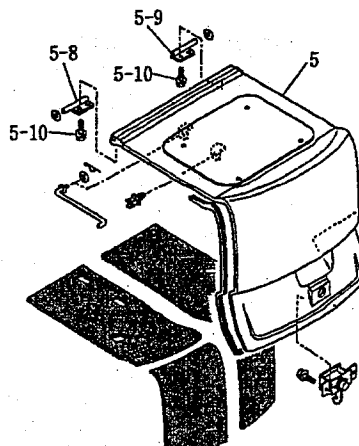


Fig. 2-3 Bonnet disassembly

12. HYDRAULIC OIL TANK

12.1 Disassembly preparation

- (1) Prepare removal of the hydraulic oil tank in the method similar to the fore-mentioned fuel tank.
- (2) Remove the front support and the lower support (See item 2.2).
- (3) Remove the battery (See item 3).

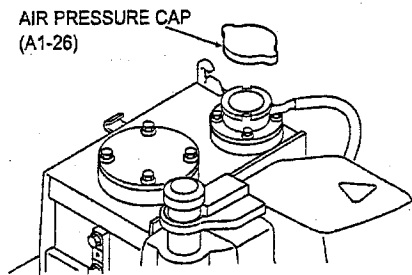



Fig. 12-1 Depressurizing tank

12.2 Disassembly

(1) Depressurizing tank

The hydraulic tank is pressurized. Loosen the air pressure cap (A1-26) slowly to release air and depressurize.


(2) Remove the plug (A1-10) to drain hydraulic oil.

 : 22 mm.

Tank capacity: Approx. 11 liters (2.9 gal)

(3) Disconnecting suction hose

1) Remove the clip (18).


 : Minus screw driver

2) Remove the hose (19).

 : Minus screw driver

(4) Suction tube

Remove the capscrew (A1-5) and the suction tube (A1-11) with the strainer (A1-2), if necessary.

 : 13 mm

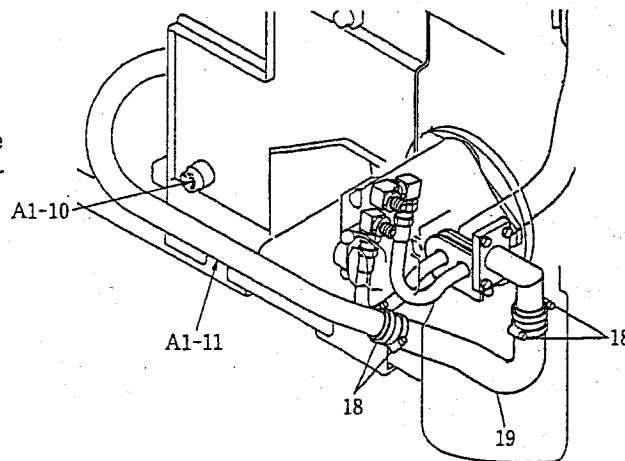


Fig. 12-2 Suction hose removal

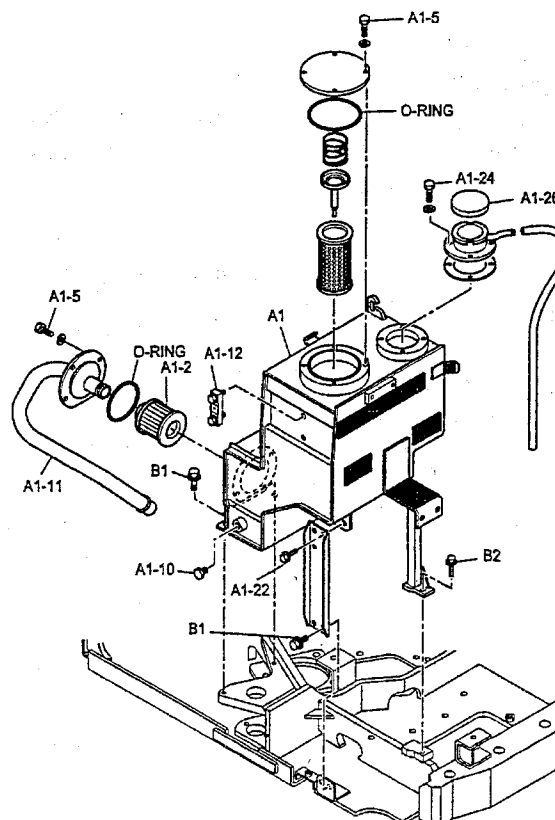



Fig. 12-3 Hydraulic oil tank disassembly

(3) Removing control valve


- 1) Remove three capscrews (7) with the washers (5).

 : 13 mm

- 2) Remove the control valve (1) with the brackets (2) and (3).

Weight : Approx. 18 kgf (40 lbs)

- 3) Remove each two capscrews (4) and (7) for fixing the bracket.

 : 13 mm

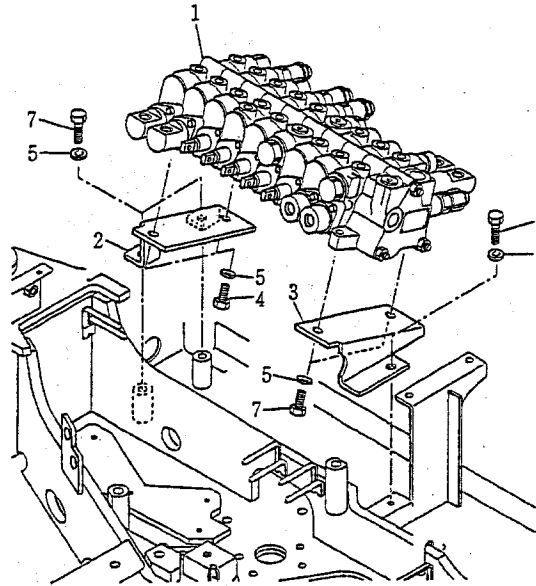



Fig. 16-4 Control Valve Removal


16.3 INSTALLATION

- (1) Perform installation in reverse order of the removal.

- (2) Install the capscrews (4) and (7).

 : 13 mm

T=3.4 kgf · m (25 ft · lbs)

-  • Clean the mounting surface and take care to prevent deformation of the valve.

- (3) Tighten hoses and so on with the following torque:

		Torque kgf·m (ft·lbs)	
Thread size (PF)	Spanner (mm)	30° flare metal joint	O-ring type fitting
1/4	19	3.0 ± 0.5(22 ± 4)	3.7 ± 0.2(27 ± 2)
3/8	22	5.0 ± 0.5(36 ± 4)	7.5 ± 0.5(54 ± 4)
1/2	27	8.0 ± 0.5(58 ± 4)	11 ± 1.0(80 ± 7)

- (4) Pressurize the hydraulic oil tank (See item 12.3).

- (5) Operate the attachment and check the performance.

- (6) Check oil leakage and hydraulic oil level.

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10) Remove the spring guide (19) and valve plate (5) from the body H(2).

- Screw up the pressure adjusting setscrew into the bore for to remove the spring guide (19).

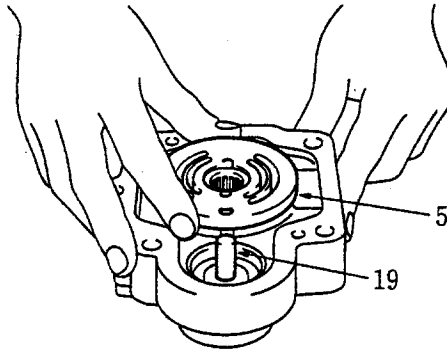


Fig. 1-9

11) Disassembling cylinder barrel (4) assy

- Remove the shoe holder (8) with piston shoe assy (6) (7) and barrel holder (9) from the cylinder barrel (4) assy.
- Remove the piston shoe assy (6) (7) and barrel holder (9) from shoe holder (8).

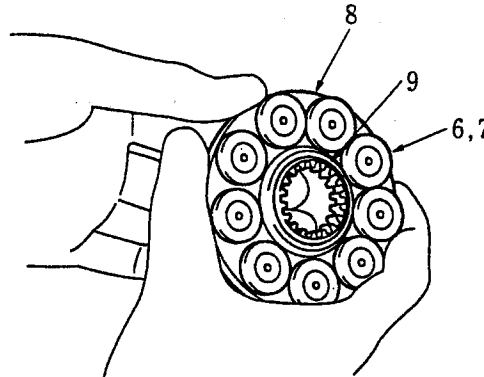


Fig. 1-10

- Remove the needle pins (11) from the cylinder barrel (4).

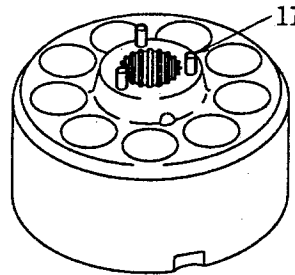


Fig. 1-11

- Remove the snap ring (35), and remove the outer retainer (24), spring (14) and inner retainer (24) from cylinder barrel (4).

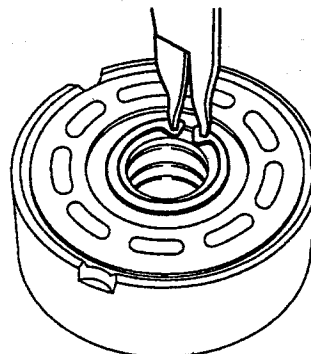
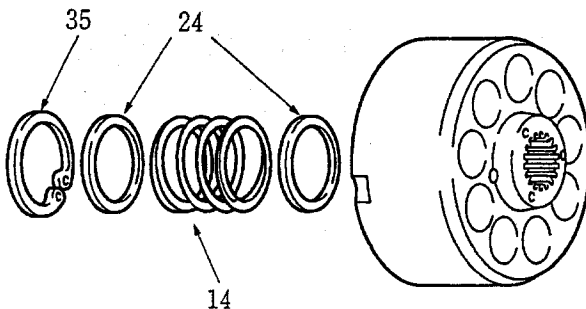


Fig. 1-12

(6) Travel (Right) Block (No.7)

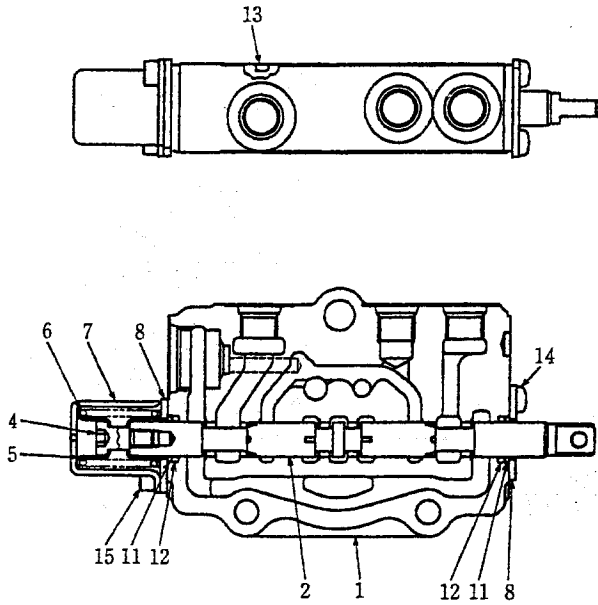


Fig. 2-6

No.	NAME	Q'TY
1	VALVE HOUSING	1
2	SPOOL	1
3	-	-
4	CAPSCREW	1
5	SPRING SEAT	2
6	SPRING (SPOOL)	1
7	CAP	1
8	SEAL PLATE	2
9	-	-
10	-	-
11	WIPER	2
12	O-RING	2
13	O-RING	1
14	SCREW	2
15	SOCKET BOLT	2

(7) Dozer / Adjustable Crawler Frame Width Block (No.8)

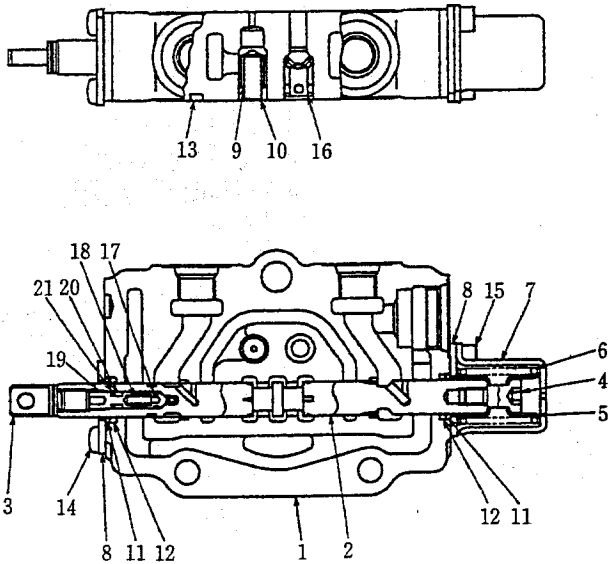



Fig. 2-7

No.	NAME	Q'TY
1	VALVE HOUSING	1
2	SPOOL	1
3	SPOOL HEAD	1
4	CAPSCREW	1
5	SPRING SEAT	2
6	SPRING (SPOOL)	1
7	CAP	1
8	SEAL PLATE	2
9	LOAD CHECK VALVE	1
10	SPRING (CHECK VALVE)	1
11	WIPER	2
12	O-RING	2
13	O-RING	1
14	SCREW	2
15	SOCKET BOLT	2
16	POPPET	1
17	POPPET	1
18	SPRING	1
19	SPACER	1
20	O-RING	1
21	BACK UP RING	1

- c) Install the spool assy to the valve housing (1) at the same position and direction as before disassembling, and install the cap (7) with the socket capscrew (15).

 : 4 mm

T=0.74 ~ 1.0 kgf·m (5.4 ~ 7.2 ft·lbs)

- d) Install the O-ring (12), wiper (11) and seal plate (8) in turn to the spool head side, and tighten them up with the screw (14)

T=0.25 ~ 0.30 kgf·m (1.8 ~ 2.2 ft·lbs)

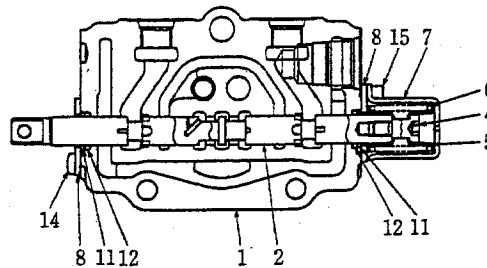




Fig. 2-31 Swing Block

-  • Slowly insert the spool in straight against the bore.
- After insertion, slide the spool with fingers. If some resistance is felt to the fingers for the sliding, it may cause malfunction of the spool.

[B] Pilot Operating Blocks (Boom, Arm, Bucket and Slew)

- 1) Remove oil adhered on the threaded portions of spool (2) and socket capscrew (4), apply adhesive (loctite # 271 + hardening agent to hasten going solid), put the spring (6) between the spring seats (5), and then install them to the spool with the socket capscrew (4).

 : 5 mm

T= 0.49 ~ 0.73 kgf·m(3.5 ~ 5.3 ft·lbs)

- To assemble the spool, put the spool between wooden hard blocks (see Fig. 2-24) and hold the wooden blocks (putting the spool into) with a vice.

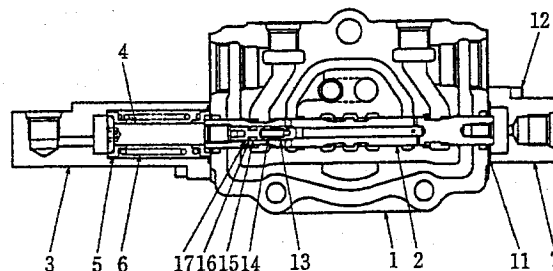


Fig. 2-32 Arm Block

2) In case of Arm Block

- a) Install the poppet (13) and spring (14) to the spool (2), then assemble the spacer (17) with the O-ring (15) and backup ring (16) to the spool (2).

- b) Remove oil adhered on the threaded portion of socket capscrew (4), then apply adhesive (Loctite # 271 + hardening agent to hasten going solid). Put the spring (6) between the spring seats (5), and then tighten up them with the capscrew (4).

T=0.3 ~ 0.5 kgf·m(2.2 ~ 3.6 ft·lbs)

1.6.5 Anti-Void Valve

(1) Disassembling

- 1) Take the valve assy consisting of the sleeve (1), poppet (2), spring seat (4), spring (3) and snap ring (6) out of the plug (5).
- 2) Remove the snap ring (6) pushing the spring seat (4).

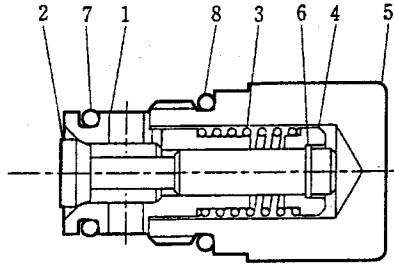


Fig. 2-44 Anti-Void Valve

(2) Cleaning and Inspection

- 1) The seat faces on the tip end of poppet (2) and sleeve (1) are to be evenly contacted with each mating face without any defects.
 - 2) The poppet (2) and sleeve (1) are to slide smoothly and lightly.
There should be no scratches and scores on the outer periphery of poppet and inner periphery of sleeve.
 - 3) The spring should have no snapping off, deformation and abrasion.
- Through the inspection of the above, when some slight scratches or scores are found out, remove them with lapping. For the defective parts, replace them as assembly.

(3) Assembling

- 1) Insert the poppet (2), spring (3) and spring seat (4) into the sleeve (1) in turn.
- 2) Install the snap ring (6) pushing down the spring seat (4).
- 3) Install the above valve assy to the plug (5).

Table 4-1

No.	NAME	Q'TY	No.	NAME	Q'TY	No.	NAME	Q'TY
1	BEARING HOUSING	1	18	INNER FACE SEAL	1	35	SPRING GUIDE	2
2	PINION GEAR	1	19	PIN	2	36	ORIFICE PLUG	2
3	BALL BEARING	1	20	OUTER FACE SEAL	1	37	PACKING	2
4	BALL BEARING	1	21	2K (MAIN)DRIVE	1	38	SPRING	2
5	PLUG	2	22	GEROLLER	1	39	O-RING (P5)	2
6	X-RING	1	23	VALVE DRIVE	1	40	O-RING (P20)	2
7	RETAINING RING	1	24	O-RING	3	41	SETSCREW	2
8	O-RING	1	25	VALVE HOUSING	1	42	NUT	2
-	-	-	26	STEEL BALL	2	43	CAP NUT	2
10	SHAFT FACE SEAL	1	27	PLUG	2	44	CAPSCREW	4
11	WEAR PLATE	1	28	O-RING (P14)	2	45	NAME PLATE	1
12	O-RING	2	29	SPRING	2	46	RIVET	2
13	VALVE PLATE	1	30	PLUG	3			
14	O-RING	1	31	CARTRIDGE	2			
15	VALVE	1	32	VALVE SEAT	2			
16	BALANCING PLATE	1	33	NEEDLE VALVE	2			
17	SPRING	2	34	SPRING SEAT	2			

4.3 MAINTENANCE STANDARDS

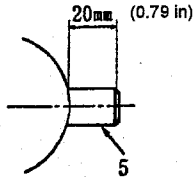
Portion	Judgement Criteria	Remedy
Body	<ul style="list-style-type: none"> • Deep scores and/or rough surface on each sliding surface • Scratches or scores causing oil leakage 	<ul style="list-style-type: none"> • Replace • Replace
Shaft	<ul style="list-style-type: none"> • Pitching or peeling off on gear tooth face • Flaking or pitching on contact surface 	<ul style="list-style-type: none"> • Replace • Replace
Ball bearing	<ul style="list-style-type: none"> • Abnormal rotation (abnormal noise, not smooth rotation, etc.) • Flaking or peeling off on contact surface 	<ul style="list-style-type: none"> • Replace • Replace
Valve drive	<ul style="list-style-type: none"> • Pitching or peeling off on gear tooth face 	<ul style="list-style-type: none"> • Replace
Drive	<ul style="list-style-type: none"> • Much abrasion on spline 	<ul style="list-style-type: none"> • Replace
Inner face seal	<ul style="list-style-type: none"> • Scratches or scores causing oil leakage 	<ul style="list-style-type: none"> • Replace
Outer face seal		
Steel ball	<ul style="list-style-type: none"> • Scratches or scores causing oil leakage 	<ul style="list-style-type: none"> • Replace
Geroller	<ul style="list-style-type: none"> • Pitching or peeling off on gear tooth face • Abnormal rotation (abnormal noise, not smooth rotation, etc.) 	<ul style="list-style-type: none"> • Replace • Replace
Relief valve assy	<ul style="list-style-type: none"> • Abnormal lowering of setting pressure • Unstable setting pressure causing vibration • Much leak due to defective seat 	<ul style="list-style-type: none"> • Replace • Replace • Replace
Spring	<ul style="list-style-type: none"> • Breakage or deformation 	<ul style="list-style-type: none"> • Replace
Oil seal	<ul style="list-style-type: none"> • Score on lip • At every 3000 hours operation, even if normal • At every disassembling 	<ul style="list-style-type: none"> • Replace • Replace • Replace
O-ring	<ul style="list-style-type: none"> • Score • At every 3000 hours operation, even if normal • At every disassembling 	<ul style="list-style-type: none"> • Replace • Replace • Replace
Backup ring	<ul style="list-style-type: none"> • At every disassembling 	<ul style="list-style-type: none"> • Replace

5.2.4 Assembling

[A] Assembling Swivel Joint


(1) Installing pin (5):


When the pin (5) has been removed, tap it into the shaft (1) with a plastic hammer paying attention to the installing length.




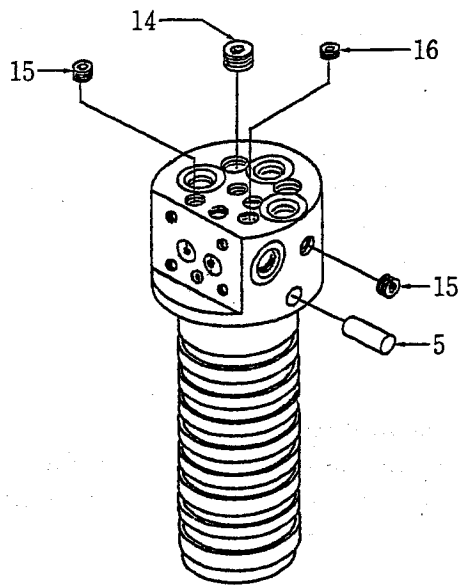
(2) Installing plugs:

When plugs (14), (15) and (16) have been removed, install them with each specified tightening torque.

Plug (14):  = 6 mm,
T = 3.0 kgf·m(22 ft·lbs)

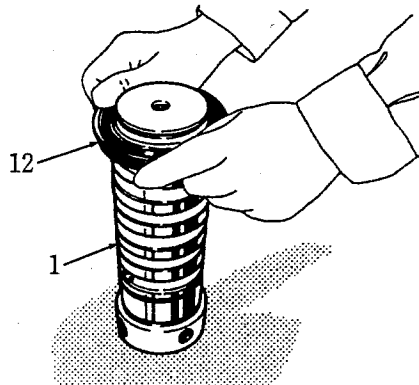
Plug (15):  = 5 mm,
T = 1.9 kgf·m(14 ft·lbs)

Plug (16):  = 4 mm,
T = 1.0 kg·m(7.2 ft·lbs)



(3) Install the dust seal (12) to the shaft (1).

- Apply grease in plenty to the lip portion of dust seal (12).



(4) Installing seals:

Install the O-ring (7), backup ring (11) and slipper seal (6) into each groove on the body (2).

- Ensure each positioning of the seals referring to the structural drawing.
- Pay attention not to give any damages, scores and twisting to the seals.



Applicable Machines

SK13SR:PE01-00101~

PREFACE

1. This manual covers all the procedures required for the dis/re-assembling of the machine in compilation by items.
2. This manual consists of Part I ; REMOVING AND INSTALLING ASSY, and Part II ; DISASSEMBLING AND ASSEMBLING COMPONENTS.
3. Though general dis/re-assembling procedures are able to carry out nearly in the order of Table of Contents, some items may be omitted because of the circumstances at the actual repair work or the purpose of time saving.
4. Please understand that it is impossible to accord the descriptions with all cases of the actual process for the removal/installation of the assembled components, because of difference in the field conditions or defective section and the convenience in compilation of this manual.
5. Please be aware the importance to establish the working order.
Prior to carry out the removal/installation and dis/re-assembling works, select the sections presumably required, fully understand the description, and itemize the working procedures, then start up the work.

Revision	Date of Issue	Remarks
First edition	September, 2000	S5PE3401E A
First revision	July, 2001	S5PE3401E① A

4.3.2 Assembling

(1) Apply molybdenum grease to the shaft (2), and install the bearings (3).

- In case of re-use of the bearing, check its smooth rotation, and no defect and rust on them.

(2) Apply molybdenum grease to the lower roller (1), and press the shaft (2) together with the bearings into the place.

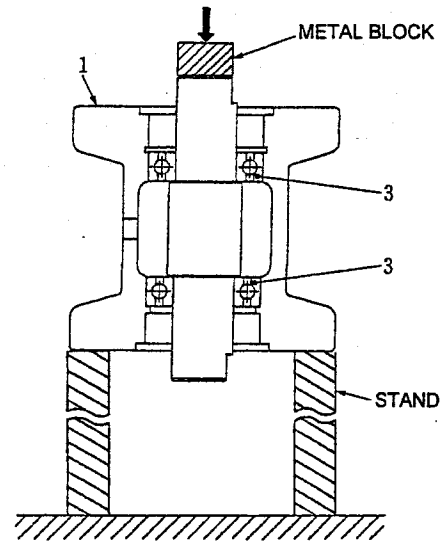


Fig. 4-7 Installing shaft / bearing

(3) Install the snap ring (6).

(4) For the seal (5), first enclose grease into the lip portion of the seal body (5a). Then push the seal body (5a) and sleeve (5b) into the place evenly with the specialized pushing jig paying attention not to give any distortion on the lip.

- Replace the seal with new one at reassembly.
- When the seal is not installed properly due to one-sided pressing etc, replace it with new one.

(5) With the same procedure of the above, install the seal (5) of the opposite side.

(6) Fill in 60 cc (3.7 cu-in) of the gear oil SAE #90 through the bore of plug on the roller (1).

(7) Tighten up the plug (7).

↖ : 5 mm

- After assembling the lower roller, check its smooth rotation with hands and no leakages on it.

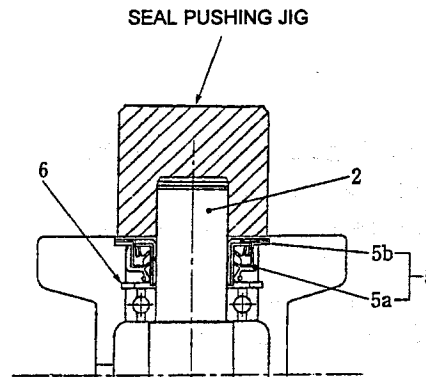


Fig. 4-8 Installing seal

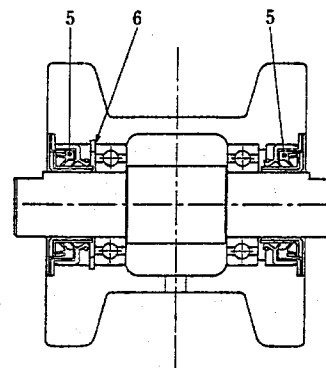



Fig. 4-9 Assembling lower roller

- (9) Lower the hydraulic jack slowly till the spring returns to its free length. Then remove the retainer plate.

 : 30mm

- (10) Remove the bracket (4) and spring (3).

- Check that there are no scratches and rust on the inner surface of grease cylinder (2) and outer surface of piston (1), and that the free length of spring (3) is being within the tolerance.

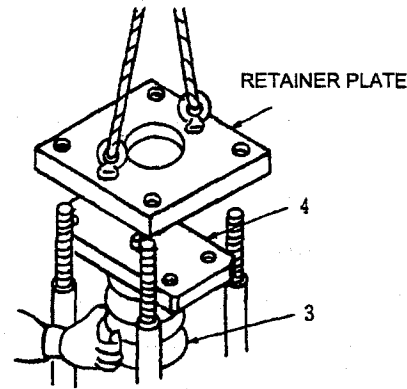



Fig. 6-5 Removal of retainer plate

6.3.2 Assembly

- (1) Carry out the assembly in reverse order of the disassembly. At first, set the grease cylinder (2) to the center of supporter stand of the jig.

- (2) Install the spring (3) and bracket (4).


- (3) Put the retainer plate over the bracket (4), fix the retainer plate with the nuts, ensuring that the hole on retainer plate is aligned with the center of grease cylinder (2).

 : 30mm


- (4) Drive the hydraulic jack to compress the spring (3) up to the set length, and install the nut (5) to the grease cylinder (2).

- (5) Tighten up the nut (5) up to the position at which both bores for split pin are aligned with each other.

Then insert the split pin (7).

 : 30mm

- (6) Lower the hydraulic jack slowly, and remove the nuts and retainer plate.

 : 30mm

- (7) Take out the idler adjuster assy from the jig.

- (8) Install the backup ring (12), O-ring (11) and oil seal (10) to the grease cylinder (2), thinly applying grease on these parts.

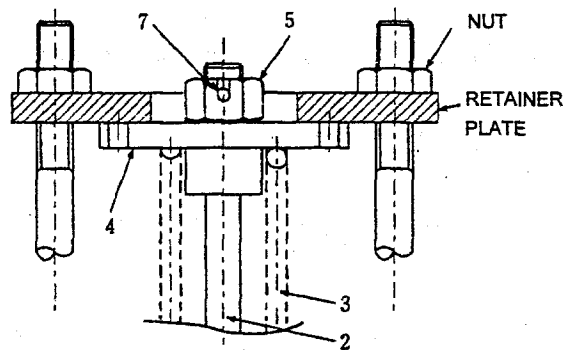


Fig. 6-6 Compressing spring and installing nut

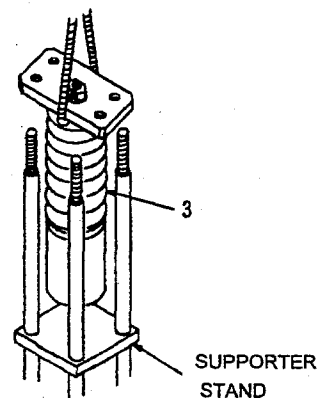



Fig. 6-7 Taking out idler adjuster assy

(3) Check the installing length of stopper bolts for both left and right. (Refer to Fig. 10-9)

Nuts (10) & (15) : M16

 : 24 mm


T=16 kgf-m(116 ft-lbs)

(4) Apply grease to the pin (A2).

Grease : Shell Lenatecs AM Grease or equivalent

(5) Installation of Capscrew (A4)

●Apply loctite #262.

 : 19 mm

T=11.7 kgf-m(85 ft-lbs)

(6) Re-connect the hydraulic pipings for the adjusting cylinder and hydraulic pump as they had been, and tighten them with the specified torque.

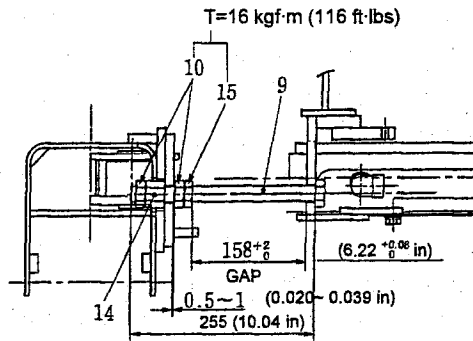


Fig. 10-9 Installing stopper bolts (9)

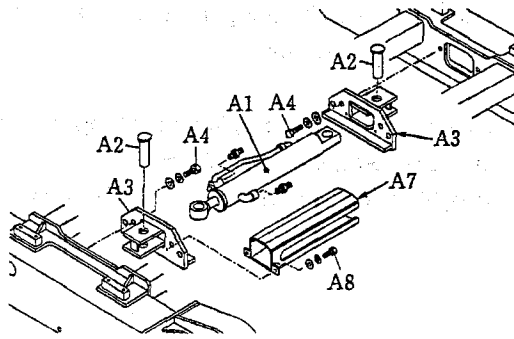




Fig. 10-10 Installing adjustable crawler frame width

Tightening Torque of Joint Unit:kgf-m(ft-lbs)

Thread size	Spanner (mm)	30° Flare Metal Joint	O-Ring Type
PF 1/8	14	1.5 ± 0.2(11 ± 1)	1.7 ± 0.2 (12 ± 1)
PF 1/4	19	3.0 ± 0.5(22 ± 4)	3.7 ± 0.2 (27 ± 1)

(7) Pressurize the hydraulic oil tank, then check the smooth operation of adjusting cylinder and travel motor without any leakages.

10.2 MAINTENANCE STANDARDS

	ITEM	STANDARDS
TIGHTENING TORQUE	Nuts (10)&(15) for Stopper bolt (9)	 : 24 mm 16 kgf-m(116 ft-lbs)
	Capscrew (A4)	Apply loctite # 262  : 19 mm 11.7 kgf-m(85 ft-lbs)
INSTALLING DIMENSION	Installed Dimension for Stopper bolt (9) Clearance for Double Nuts	} Refer to Fig. 10-9

2-7) Pull out the cylinder barrel (204) assy from the body 2 (202).

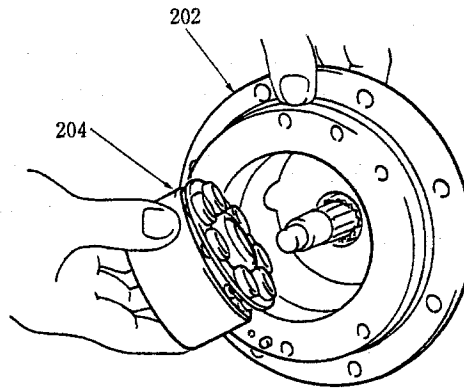


Fig. 1-22 Removing cylinder barrel (204) assy

2-8) Disassembling cylinder barrel assy

- a) Remove the piston shoe assy (206) and (207).
 - The piston (206) and the shoe (207) cannot be disassembled because they are caulked together.
- b) Remove the shoe holder (208), the barrel holder (209) and the pin (212).

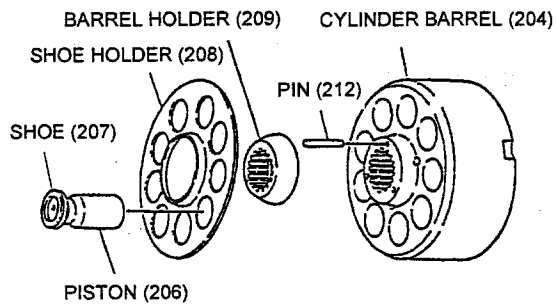


Fig. 1-23 Disassembling cylinder barrel (204) assy

2-9) Remove the snap ring (221) from the cylinder barrel (204), and the retainer (214) and the spring (213) are removed.

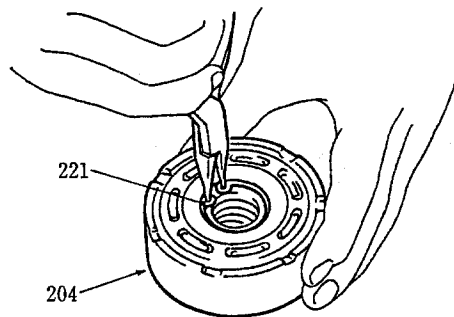


Fig. 1-24 Snap ring (221) removal

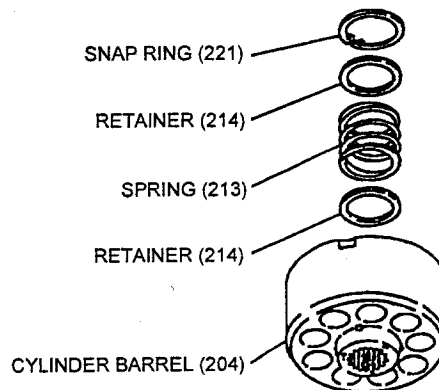


Fig. 1-25 Cylinder barrel (204) disassembly

(2) Assembling reduction unit

2-1) Install the floating seat (118) and the O-ring (119) to the hydraulic motor body 2 (202).

- Apply grease on the O-ring (119) to facilitate the installation.

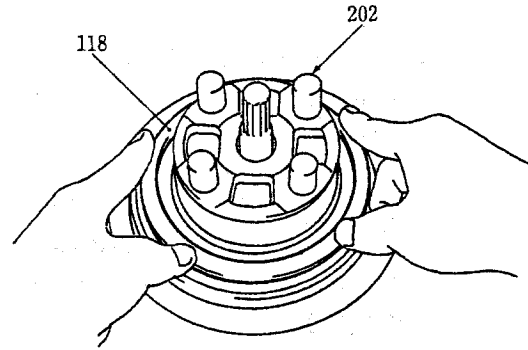


Fig. 1-60 Floating seat (118) installation

2-2) Install the inner race of the bearing (120) and the steel balls with the retainer to the body 2 (202) in this order.

- Do not mistake the direction of the inner race and the retainer when installing (See sectional drawing).
- Be careful not to loss steel balls because they may come off from the retainer.

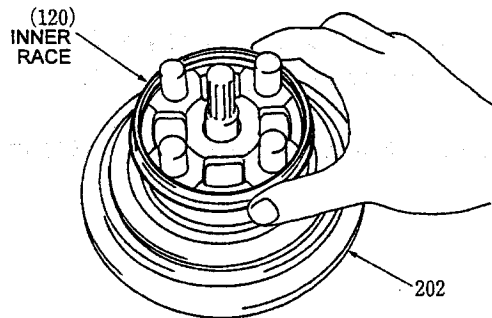


Fig. 1-70 Bearing (120) inner race installation

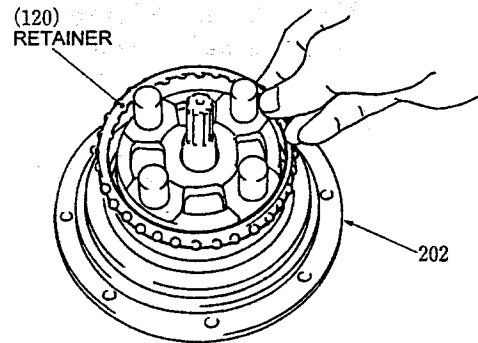


Fig. 1-71 Bearing (120) retainer installation

1. TROUBLE DIAGNOSIS : HYDRAULIC

Classification	Group No.	Probable Cause/ Component Trouble	Pump				Control valve					Slewing motor	Travel motor				Cylinder				Other valves			Filter			Relief valve									
			Engine speed	Pump P1	Pump P2	Pump P3	Pilot relief valve	Travel spool	Slewing spool	Boom spool	Arm spool	Bucket spool	Load check valve	Motor	Motor	Counter balance valve	Check valve for counter balance valve	1st/2nd speed shifting valve	Boom cylinder	Arm cylinder	Bucket cylinder	Travel lock cylinder	Swivel joint	Pilot valve	1st / 2nd travel speed solenoid valve	Lever lock solenoid valve	Inline filter	Suction strainer	Bypass check valve	Return filter	Main relief valve	Boom down	Arm digging	Slewing		
Attachment operation	1	(1) Incapable of attachment operation				<input type="radio"/>	<input type="radio"/>			<input type="radio"/>	<input type="radio"/>								<input type="radio"/>	<input type="radio"/>			<input type="radio"/>	<input type="radio"/>							<input type="radio"/>					
		(2) Attachment force small	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>			<input type="radio"/>	<input type="radio"/>	<input type="radio"/>							<input type="radio"/>	<input type="radio"/>	<input type="radio"/>			<input type="radio"/>	<input type="radio"/>						<input type="radio"/>	<input type="radio"/>	<input type="radio"/>			
		(3) Attachment speed low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>			<input type="radio"/>	<input type="radio"/>	<input type="radio"/>							<input type="radio"/>	<input type="radio"/>	<input type="radio"/>			<input type="radio"/>	<input type="radio"/>						<input type="radio"/>	<input type="radio"/>	<input type="radio"/>			
Travel operation	2	(1) Incapable of travel operation				<input type="radio"/>	<input type="radio"/>			<input type="radio"/>				<input type="radio"/>	<input type="radio"/>	<input type="radio"/>					<input type="radio"/>															
		(2) Traction force small	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>					<input type="radio"/>					<input type="radio"/>	<input type="radio"/>	<input type="radio"/>					<input type="radio"/>										<input type="radio"/>				
		(3) Travel speed low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>					<input type="radio"/>					<input type="radio"/>	<input type="radio"/>	<input type="radio"/>					<input type="radio"/>										<input type="radio"/>				
		(4) Incapable of shifting 1st / 2nd speed				<input type="radio"/>	<input type="radio"/>								<input type="radio"/>	<input type="radio"/>	<input type="radio"/>					<input type="radio"/>		<input type="radio"/>												
		(5) Deviation in single (independent) operation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>					<input type="radio"/>					<input type="radio"/>	<input type="radio"/>	<input type="radio"/>					<input type="radio"/>														
Slewing operation	3	(1) Incapable of slewing operation				<input type="radio"/>	<input type="radio"/>			<input type="radio"/>		<input type="radio"/>											<input type="radio"/>													
		(2) Slewing speed low	<input type="radio"/>		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>					<input type="radio"/>		<input type="radio"/>									<input type="radio"/>												<input type="radio"/>	<input type="radio"/>
		(3) Slewing force small	<input type="radio"/>		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>					<input type="radio"/>		<input type="radio"/>									<input type="radio"/>												<input type="radio"/>	<input type="radio"/>
Pump	4	(1) Malfunction of pump		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>																					<input type="radio"/>									

Applicable Machines

SK13SR:PE01-00101~

Revision	Date of Issue	Remarks
First edition	September, 2000	S5PE4301E

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1-10. 4TNE84

* Output conditions: Intake back pressure ≤ 250 mmAq, Exhaust back pressure ≤ 550 mmAq, other conditions complying with JIS D 1005-1986. After minimum 30 hour's run-in.

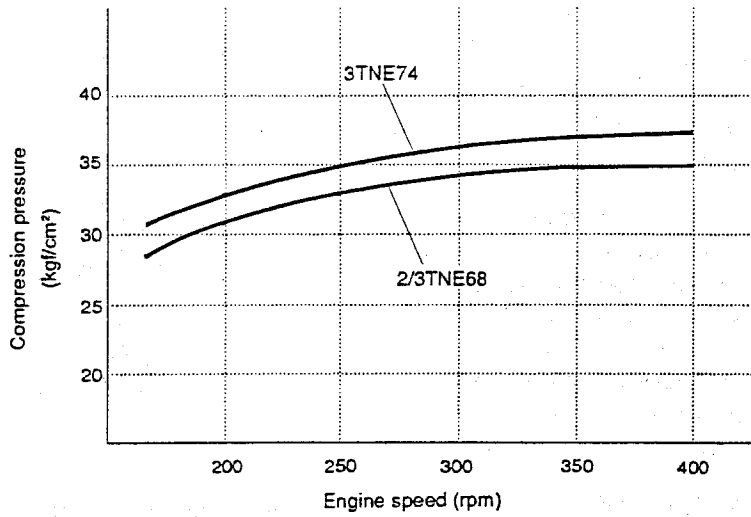
Item		Model		4TNE84												
		Unit														
Application		—	CL	VM						CH		VH				
Type		—	Vertical, 4-cycle water-cooled diesel engine													
Combustion system		—	Direct injection system													
No. of cylinders – Bore × Stroke		mm	4 – 84 × 90													
Displacement		ℓ	1.995													
Firing order		—	1 – 3 – 4 – 2 – 1													
Revolution speed		rpm	1500	1800	2000	2200	2400	2600	2800	3000	3000	3600	3200	3400	3600	
Output*	Continuous rating	kW(HP)	14.9 (20.0)	17.7 (23.7)	—	—	—	—	—	—	29.9 (40.1)	34.7 (46.5)	—	—	—	
	Max. rating	kW(HP)	16.4 (22.0)	19.5 (26.1)	21.9 (29.4)	24.1 (32.3)	26.3 (35.3)	28.5 (38.2)	30.7 (41.2)	32.9 (44.1)	32.9 (44.1)	38.2 (51.2)	33.9 (45.5)	35.8 (48.0)	38.2 (51.2)	
Max. revolution speed at no load		rpm	1575 ⁺⁵⁰ ₀	1870 ⁺⁵⁰ ₀	2180 ⁺⁵⁰ ₀	2400 ⁺⁵⁰ ₀	2590 ⁺⁵⁰ ₀	2810 ⁺⁵⁰ ₀	2995 ⁺⁵⁰ ₀	3210 ⁺⁵⁰ ₀	3150 ⁺⁵⁰ ₀	3745 ⁺⁵⁰ ₀	3455 ⁺⁵⁰ ₀	3670 ⁺⁵⁰ ₀	3890 ⁺⁵⁰ ₀	
Min. revolution speed at no load			≤1200	≤800						≤1500		≤800				
Direction of rotation		—	Counterclockwise (viewed from flywheel)													
Power take off		—	Flywheel													
Compression ratio		—	18.0													
Fuel injection timing (FID, b.T.D.C.)		deg	10±1	12±1		14±1		16±1		24±1		18±1	20±1	24±1		
Compression pressure		MPa (kgf/cm ²)	3.24±0.1 (33±1), at 250 rpm													
Fuel injection pressure		MPa (kgf/cm ²)	19.6 ^{+1.0} ₀ (200 ⁺¹⁰ ₀)						19.6 ^{+1.0} ₀ (200 ⁺¹⁰ ₀)							
Recommended diesel gas oil		—	ISO 8217 DMA, BS 2869 A1 or A2 (Cetane No. 45 min.)													
Lubrication system		—	Forced lubrication with trochoid pump													
Lubricating oil capacity Max/Effective		ℓ	5.8/2.3						7.9/2.5							
Recommended lubricating oil		—	API grade CC class or higher													
Cooling system		—	Liquid cooling/Radiator													
Cooling water capacity		ℓ	2.7 (for engine only)													
Cooling fan No. of blade × dia.		mm	Pusher type, 6 × φ370													
Crank V-pulley dia./ Fan V-pulley dia.		mm	φ120/φ90			φ110/φ110										
Governor		—	Mechanical centrifugal governor (All speed type)													
Starting system		—	Electrical													
*1 Dimensions L × W × H		mm	683 × 498.5 × 618			632 × 498.5 × 618/658 × 498.5 × 618					658 × 498.5 × 618		650 × 498.5 × 618/658 × 498.5 × 618			
*1 Dry weight		kg	184			160/170					170		160 / 170			
PERFORMANCE	Governing performance (full speed range)	Transient speed difference	%	≤10	≤8	≤12					≤10	≤8	≤12			
		Steady state speed band	%	≤5	≤4	≤9	≤8	≤7	≤5	≤4	≤8					
		Recovery time	sec	≤5			≤6					≤5		≤6		
		Fluctuation of revolution	rpm	≤15			≤25					≤30				
L.O. press.	Rated operation	MPa (kgf/cm ²)	0.29±0.05 (3.0±0.5)			0.34±0.05 (3.5±0.5)										
	Idling		≥0.06 (≥0.6)													

*1. Designation of engine dimension and dry weight in numerals.
 CL/CH application: engine with flywheel housing
 VM/VH application: engine with back plate/with flywheel housing

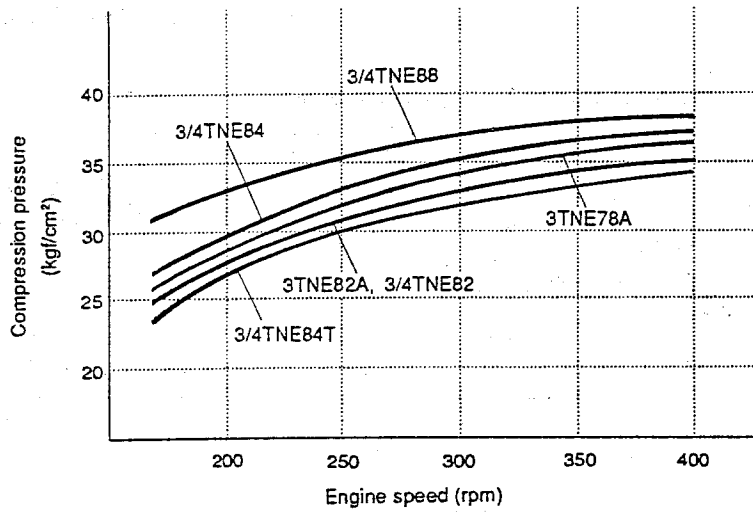
NOTES

Reference: Variation of Compression Pressure with Engine Speed

(1) Indirect injection system



(2) Direct injection system



2. Action to be taken when the measured compression pressure is below the limit value.

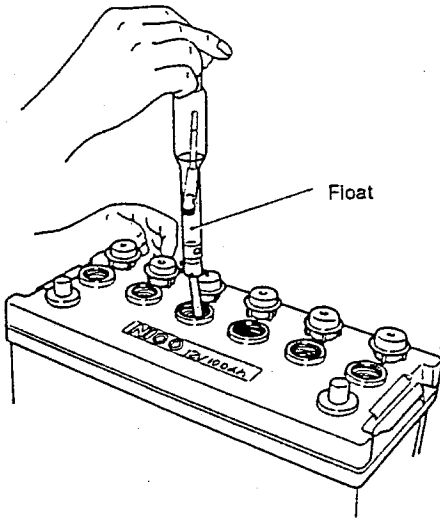
Trouble occurs in a part of the engine. For troubleshooting, refer to Chapter 4, 4-2 trouble diagnosis through measurement of compression pressure.

○ Measurement with a hydrometer

When using a hydrometer, correct the measured specific gravity according to the temperature. The specific gravity of the electrolyte of the battery is the standard when measured at 20°C. Correct the specific gravity according to the following equation, as it changes by 0.0007 per 1°C.

$$S_{20} = S_t + 0.0007 (t - 20)$$

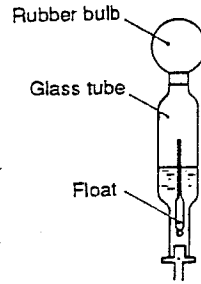
S_{20} — Specific gravity converted to 20°C
 S_t — Measured specific gravity
 t — Measured electrolyte temperature



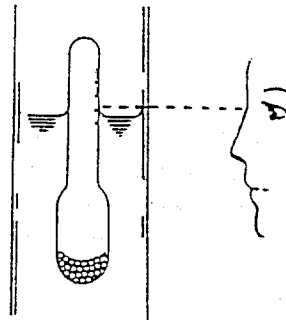
(Measuring the remaining battery charge with hydrometer)

Hydrometer and remaining battery charge

Specific gravity (at 2°C)	Discharged level (%)	Remaining level (%)
1.260	0	100
1.210	25	75
1.160	50	50
1.110	75	25
1.060	100	0



(Hydrometer)



(How to read a hydrometer)

- (3) **Terminals**
Repair or clean the terminals if corroded or soiled.
- (4) **Fittings**
Repair or replace the fittings if corroded. Re-tighten them if loosened.
- (5) **Appearance of the battery**
Replace the battery if cracked or deformed. Clean it using fresh water if contaminated.

7-2. Cylinder block

1. Checking the cylinder block

- (1) Visually check to see if the cylinder block is free from water leak, oil leak and cracks. If any cylinder block is suspected to be cracked, check it by color check.
- (2) Replace the cylinder block if badly damaged and incorrecable.
- (3) Thoroughly clean each oil hole. Make sure that it is not clogged.

2. Measuring the bore and distortion of the cylinder

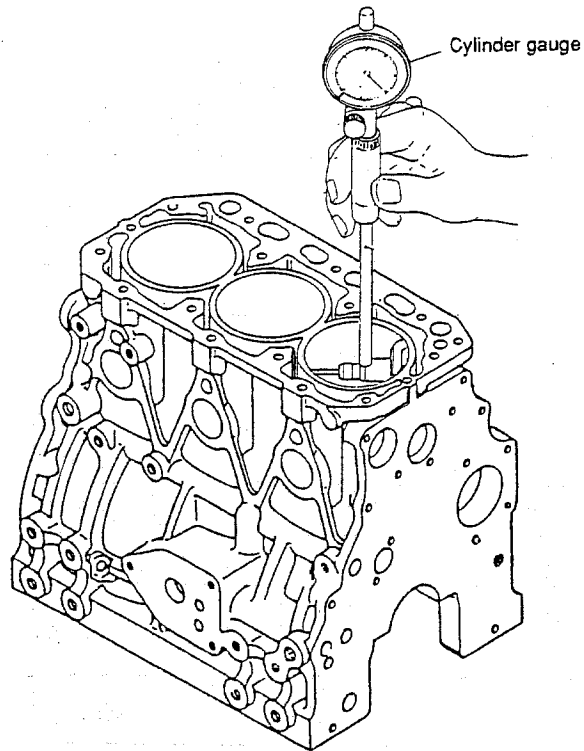
Measure the bore of each cylinder with a cylinder gauge. Measure the cylinder at point a, approx. 20 mm below the crest of the liner, and at points b and c at equal pitch ($a-b = b-c$).

Obtain distortion (roundness and cylindricity of each cylinder) from the measured values as follows:

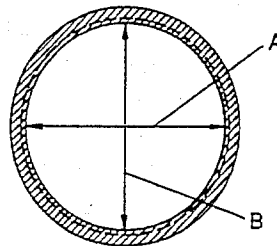
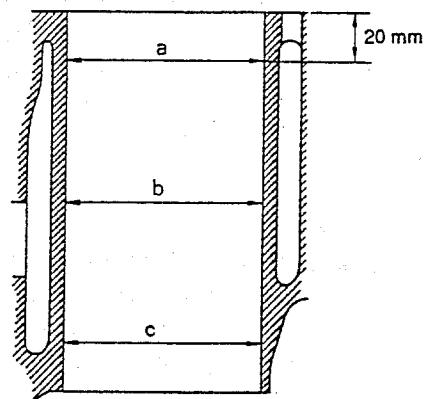
- Roundness:
Difference between max. and min. bore values on the same cross section of each liner.
- Cylindricity:
Difference between max. and min. bore values in the same direction of each liner.

Honing (honing and boring) is required when the measured value exceeds the limit.

* For oversized piston and piston ring, refer to this chapter, 7-4, 8.



(Measuring the cylinder bore)



Note: Measurement should be made at a, b and c in the directions of A and B.

(Cylinder bore measuring positions)

7-5. Connecting rod

1. Visual inspection

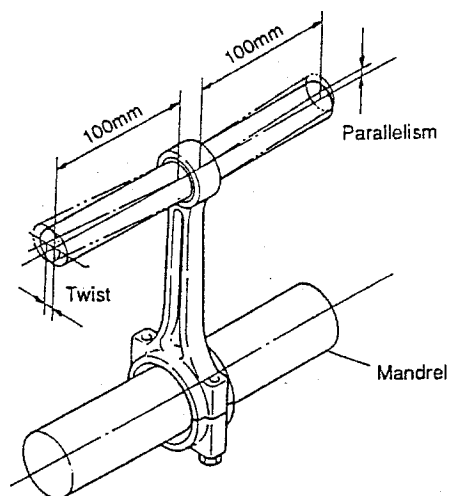
Inspect the portion near the boundary of the chamfered portion and I-beam section of the big and small ends of the connecting rod as well as the portion near the oil hole of the bushing at the small end for cracks, deformation, and discoloration.

2. Measuring the twist and parallelism

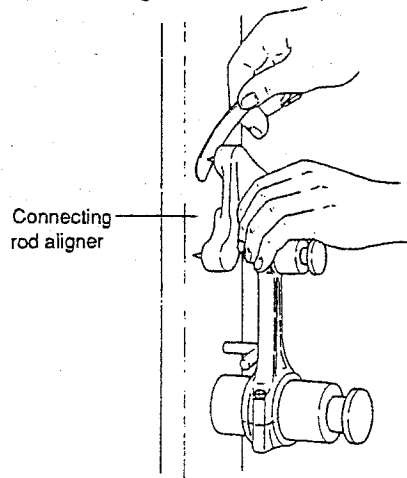
Measure the twist and parallelism by use of the connecting rod aligner.

(mm)

	All models	
	Standard	Wear limit
Twist and parallelism	0.03 or less per 100 mm	0.08



(Measuring the twist and parallelism)



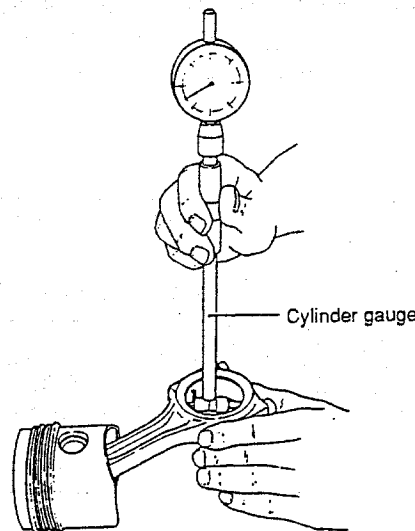
(Measuring the twist with connecting rod aligner)

3. Measuring the crankpin and bushing clearance

To measure the oil clearance of the crankpin and bushing, measure the inside diameter of the crankpin metal and outside diameter of the crankpin, and obtain the difference between them.

If the measured oil clearance exceeds or near the wear limit, replace the crankpin metal. If the crankpin is excessively or unevenly worn, grind the crankpin, and use an oversized crankpin metal.

* To measure the inside diameter of the crankpin metal, reassemble the crankpin metal to the connecting rod and tighten the rod bolt to the specified torque, making sure each metal is fitted on the correct position.



(Measuring the inside diameter of the crankpin metal)

(kgf-m)

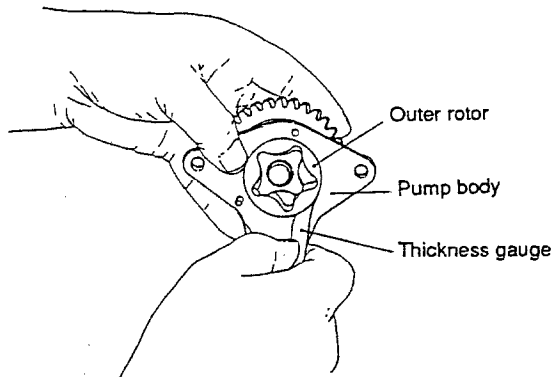
	2/3TNE68 3TNE74	3TNE78A 3TNE82A	3/4TNE82, 3/4TNE84(T), 3/4TNE88
	Specified torque		
Rod bolt tightening torque (Apply lube oil to the rod bolt)	2.3-2.8	3.8-4.2	4.5-5.5

7-9. Trochoid pump

1. Clearance between outer rotor and pump body

Insert a thickness gauge between the outer rotor and pump body to measure the clearance. (mm)

	All models	
	Standard	Wear limit
Clearance between outer rotor and pump body	0.10~0.16	0.25

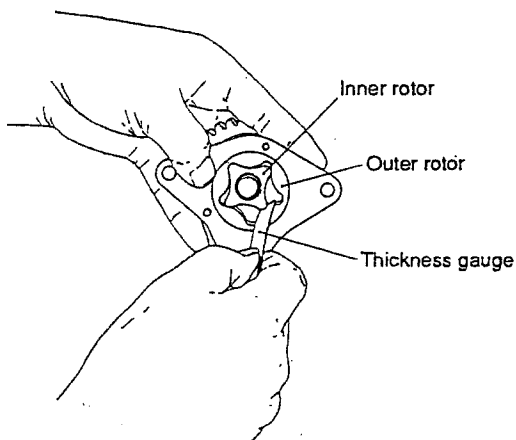


(Measuring the clearance between outer rotor and pump body)

2. Clearance between outer rotor and inner rotor

Insert a thickness gauge between the top of the inner rotor tooth and the top of the outer rotor tooth to measure the clearance. (mm)

	All models	
	Standard	Wear limit
Clearance between outer rotor and inner rotor	—	0.15

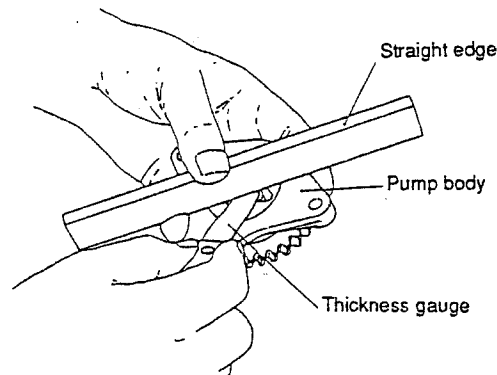


(Measuring the clearance between outer rotor and inner rotor)

3. Side clearance between pump body and inner rotor, outer rotor

Place a straight-edge against the end of the pump and insert a thickness gauge between the straight-edge and the rotors to measure the side clearance. (mm)

	2/3TNE68 3TNE74		3TNE78A 3TNE82A		3/4TNE82, 3/4TNE84(T), 3/4TNE88	
	Standard	Wear limit	Standard	Wear limit	Standard	Wear limit
	Pump body and inner-, outer-rotor side clearance	0.03 ~0.09	0.13	0.05 ~0.10	0.15	0.03 ~0.09



(Measuring the clearance between the pump body and inner-, outer-rotor)

4. Clearance between rotor shaft and side cover hole

Measure the rotor shaft outside diameter and the side cover hole diameter, and calculate the difference between the hole diameter and the outside diameter. (mm)

	All models	
	Standard	Wear limit
Clearance between rotor shaft and side cover hole	0.013 ~0.043	0.2

5. Others

- (1) Check for looseness of drive gear/rotor shaft fitting, and replace the entire assembly if loose or wobbly.
- (2) Push the oil pressure regulating valve piston from the oil hole side, and replace the entire assembly if the piston does not return due to spring breakage, etc. (Engine with oil cooler only)
- (3) Make sure that the rotor shaft rotates smoothly and easily when the drive gear is rotated.

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