KOBELCO

SERVICE MANUAL

HYDRAULIC EXCAVATOR

SK45SR-2

Applicable: SK45SR-2 PJ02-00101~

S5PJ0001E-00 04/01

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 releasing 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

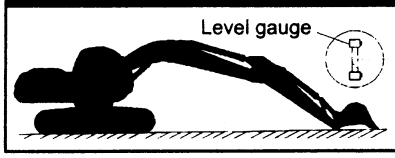
⚠ Operation of the hydraulic equipment without filling hydraulic oil or lubricant or without performing air releasing will result in damage to the equipment.

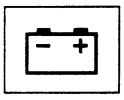
3) Perform air releasing after loosening the upper drain plug, starting the engine and keep it in low idle condition. Complete the air releasing when seeping of hydraulic oil is recognized, and tightly plug.
4) Perform air releasing of the travel motor and the hydraulic cylinders by running the engine 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 releasing 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.

Checking hydraulic oil level





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 when handling tools around the battery or its relay.
(8) Do not splash water on the electrical equipment and connectors during machine washing.

(9) Check for moisture adhesion inside the waterproof connector after pulling it out, since it is hard to remove moisture from the connector. If moisture adhesion is found, dry it completely before the connection.

3. SPECIFICATIONS AND PERFORMANCE

■ SPEED AND GRADEABILITY

Model		SK45SR-2 (with Rubber Shoe)	
Serial No		PJ02-00101~	
Item			
Slewing Speed	min^{-1} {rpm}	9.5 {9.5}	
Travel Speed	km/h (mph)	Low (1st.)	High (2nd.)
		2.6 (1.6)	4.6 (2.9)
Gradeability	%(degree)	58 (30)	

■ ENGINE

Model (YANMAR)		4TNE88-NYBB (EU), 4TNE88-EYBD (KAI)
Type		Vertical,4-cycle,water cooled diesel engine
Number of cylinders-Bore X Stroke		4-ø88mm X 90mm
Total Displacement	L	2.18
Rated Output	kW/min^{-1} {PS/rpm}	27.2 / 2,200 {37.0 / 2,200}
Maximum Torque	N·m/min^{-1} {kgf·m/rpm}	147 /1,400 {15 /1,400}
Starter	V X kW	12 X 2.0
Generator (Dynamo)	V X A	12 X 40

■ HYDRAULIC COMPONENTS

Hydraulic Pump	Variable displacement axial piston + gearpump
Slewing Motor	Axial piston
Travel Motor	Axial psiton, 2 speed motor
Control Valve	10 spool multiple control valve
Cylinder (Boom,Arm,Swing Bucket,Dozer)	Double acting cylinder
Return filter	Paper filter with safety valve (30μ)

■ OFFSET DIGGING · DOZER

Mechanism		Boom swing operation by cylinder stroke
Boom swing angle degree	Right	Approx.58
	Left	Approx.83 (Cab spec : 73)
Stroke of dozer (Up / Down)	mm	360 /380 (14.2 / 15.0)

Unit:kg (lb)

■ WEIGHT	EU	KAI
Machine Weight	Rubber shoe, Canopy	←
	4,630 (10,210)	←
Upper slewing body	2,100 (4,630)	←
Travel system	1,870 (4,120)	←
Attachment (Boom+STD Arm+STD Bucket)	600 (1,260)	← (In case of Japanese STD bucket)
Oil & Water	109 (240)	←

Note : This figure is calculated with Japanese standard bucket.
Bucket weight 47 kg (104 lb)

3.2 DETAIL DIMENSION OF LUG SECTION

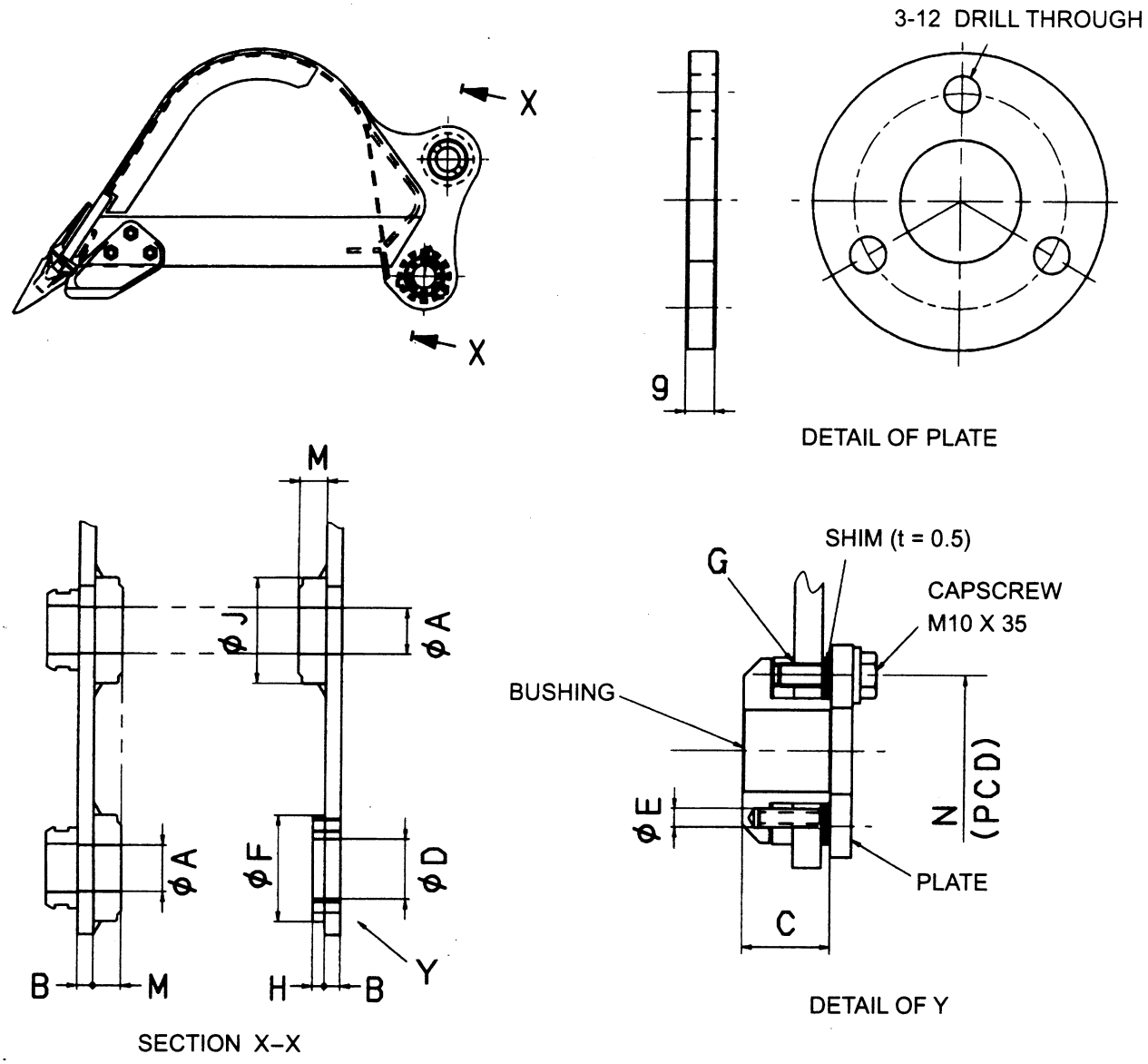


Fig. 3-2 Dimension of lug section

Table 3-2

Unit : mm (in)

Portion	Pin bore dia.	Lug plate thickness	Bushing length.	Bore.	Spring pin dia.	Plate outer dia.	Thread size.	Plate thickness.	Boss outer dia.	Boss thickness.	Screw hole P.C.D.
Code	øA	B	C	øD	øE	øF	G	H	øJ	M	øN
Dimension	$45^{+0.10}_{0}$ ($1.768^{+0.004}_{0}$)	14 (0.55)	44 (1.73)	60 (2.36)	8 (0.31)	108 (4.24)	M10	8 (0.31)	95 (3.37)	23 (0.90)	85 (3.34)

Note : Japanese standard bucket.

Applicable Machines

SK45SR-2 : PJ02-00101~

Revision	Date of Issue	Remarks
First edition	April, 2001	S5PJ1101E K·E

Applicable Machines

SK45SR-2 : PJ02-00101~

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	April, 2001	S5PJ1201E K·E

2. PERFORMANCE INSPECTION STANDARD TABLE

2.1 STANDARD VALUE

Table. 1 (1 / 2)

Model					SK45SR-2	
Applicable machine					PJ02-00101~	
Div.	ITEM			Unit	Standard value	Repairable level
Measuring Condition	Hyd. oil Cleanliness			Class	8 ± 1	—
	Hyd. oil Temperature (Tank surface)			°C (°F)	50~60 (122~140)	—
	Coolant Temperature (Radiator surface)				60~90 (140~194)	—
Engine Speed	Low idle			rpm	1025 ± 50	—
	High idle				2350 ± 50	—
	Deceleration (Option)				1025 ± 50	—
Main relief valve pressure	P1	Bucket	H	kgf/cm² (psi)	230^{+5}_{0} (3270^{+70}_{0})	—
	P2	Arm	R		230^{+5}_{0} (3270^{+70}_{0})	—
		Travel	R		200^{+10}_{0} (2840^{+140}_{0})	—
	P3	Dozer	R		200^{+10}_{0} (2840^{+140}_{0})	—
	P4	Pilot			35 ± 3 (500 ± 43)	—
Over load relief valve pressure	Boom		R	kgf/cm² (psi)	280^{0}_{-50} (3980^{0}_{-710})	—
			H		280^{0}_{-50} (3980^{0}_{-710})	—
	Bucket		—			—
			H		260^{+5}_{-30} (3700^{+70}_{-430})	—
	Arm		R		260^{0}_{-30} (3700^{0}_{-430})	—
			H		260^{0}_{-30} (3700^{0}_{-430})	—
	Dozer		H		260^{0}_{-60} (3700^{0}_{-850})	—
	Slew		RH		165^{+30}_{0} (2350^{+430}_{0})	—
			LH		165^{+30}_{0} (2350^{+430}_{0})	—
Travel	Crawler speed (5 rev)	Rubber crawler	Low	sec.	36.1 ± 2.0	46
			High		20.9 ± 1.1	27
		Iron crawler	Low		38.1 ± 2.1	49
			High		22.0 ± 1.1	28
	Travel speed 10m (33ft)	Rubber crawler	Low	sec.	13.8 ± 0.7	18
			High		8.0 ± 0.5	10
		Iron crawler	Low		14.8 ± 0.7	19
			High		8.0 ± 0.5	11
	Travel deviation			mm (in)	140^{0}_{-140} ($5.51^{0}_{-5.51}$)	290 (11.42″)
	Drift due to gravity				0^{+120}_{0} ($0^{+4.7}_{0}$)	180 (7.09″)

Note) Ext : Extension R : Rod side
Ret : Retraction H : Head side

7. MEASURING ATTACHMENT OPERATING PERFORMANCES

- **TEST PROCEDURES**

  Measure 3-times 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 position : 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.)

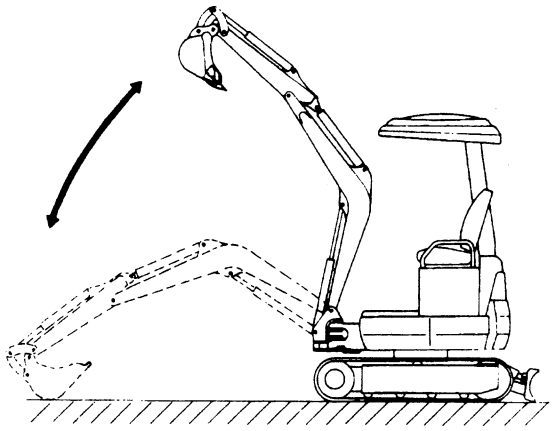


Fig. 7-1

(2) Arm Cylinder Speed

- Engine : High idle
- Hydraulic Oil Temp. : 50 ~ 60 °C (122 ~ 140 °F)
- Measurement position : 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).

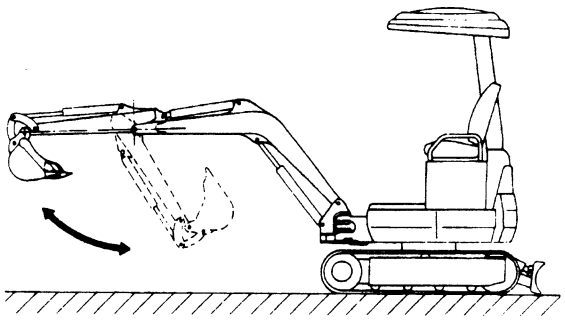


Fig. 7-2

(3) Bucket Cylinder Speed

- Engine : High idle
- Hydraulic Oil Temp. : 50 ~ 60 °C (122 ~ 140 °F)
- Measurement position : 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).

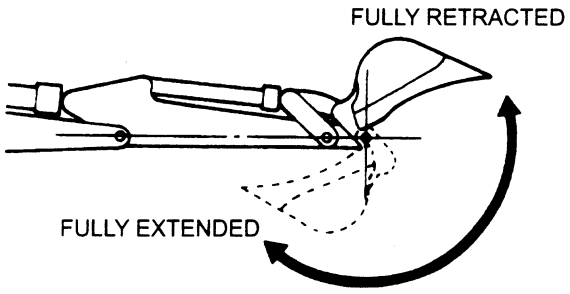


Fig. 7-3

(4) Swing Cylinder Speed

- Engine : High idle
- Hydraulic Oil Temp. : 50 ~ 60 °C (122 ~ 140 °F)
- Measurement position : 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.)

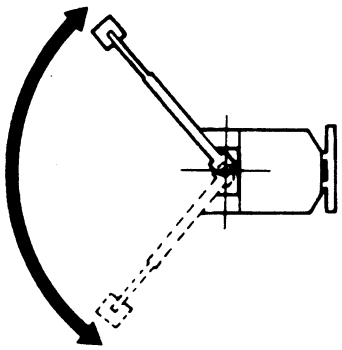


Fig. 7-4

3. HYDRAULIC CIRCUIT OPERATION

This explanation is described as KAI specifications.
The difference between KAI and EU are shown in following table.

No.	Item	EU	KAI
1	Boom swing section of control valve (2)	Direct pulling with cable of pedal	Hydraulic pilot type
2	John deere pattern multi-control valve (15)	Without	With in option
3	Solenoid valve (21)	Without	With

3.1 COLOR CODING STANDARDS

Blue	: Supply/Drain circuit 3.5 kgf/cm² (50 psi)
Green	: Return/Make-up circuit 3.5~6 kgf/cm² (50~85 psi)
Purple	: Secondary pilot pressure 6.0~35 kgf/cm² (85~500 psi)
Red	: Primary pilot pressure 35~40 kgf/cm² (500~570 psi)
Orange	: Main pump drive pressure 50~280 kgf/cm² (710~3980 psi)

Blue tone	: Shifted condition of valve (spool)
Red valve	: Indication for opened condition on valve

Red solenoid : Energized condition

Displaying the flow circuit and standby circuit when operating.
Regarding the electrical symbols in this manual,refer to the electric circuit diagram.

3.2 NEUTRAL CIRCUIT

(1) Pilot circuit

1) Pilot primary pressure circuit

The delivery oil from A4 port of pump Assy (1) flows into solenoid valve (13) through line filter (19).

The delivery pressure from A2 port of solenoid valve (13) is led to pilot valve (11) for attachments and P port of pilot valve (12) and Pp port of solenoid valve (21) for travel by releasing the lever lock(operating condition).

Since the control circuit is completely closed at neutral position,the delivery oil, having nowhere to flow, is released by the relief valve(set pressure 35kgf/cm² (500psi) built in solenoid valve (13) and returns into hydraulic oil tank (25).

■ The solenoid valve (21) is installed on only machines in KAI specification to switch operating circuits of slewing and boom swing motions.

2) Pilot secondary pressue circuit

While the pilot valve (11),(12) are being in neutral,the pilot secondary pressure is not generated.By means of operating the operating lever,the secondary pressure is generated in accordance with its motion and led to the control valve (2) from the pilot valve to shift each spool of valve.

(2) Main circuit

1) Variable displacement pump circuit

The delivery oil from A1 and A2 ports of the pump is led to P1 and P2 ports of control valve (2).

The oil in P1 port flows through each valve for travel straight, travel left, boom and bucket operations, and the oil in P2 port flows through each valve for travel straight, travel right, arm, swing and breaker / nibbler operations, and all oil from P1 and P2 ports returns in hydraulic oil tank (25) from T2 port through oil cooler (26).

2) The 3rd pump circuit

The delivery oil from A3 port of the 3rd pump flows into P3 port of control valve (2). The oil led to P3 port flows through valve for slewing and dozer, confluxes with the oil led to P2 port in breaker/nibbler valve, and the oil returns into hydraulic oil tank (25) through T2 port.

Notes:

A part of return oil from control valve (2) returns into hydraulic oil tank (25) through check valve (20), which made up the slewing boost circuit.

3.7 ARM OPERATION CIRCUIT

Pilot hydraulic system by means of control lever
When digging in the light load, with a function of the return oil recirculation,

3.7.1 Arm in operation circuit

(1) Pilot circuit

1) Switching arm spool

With the arm in operation, pilot valve (11) delivers the pilot secondary pressure. And the pressure oil flows into Pa5 port of control valve (2) and switches the spool of the arm valve.
And the pilot secondary pressure acts on the SH port of the slewing motor delay valve by way of shuttle valve (14), and releases the swing parking brake.

(2) Main circuit

1) Supply circuit to cylinder (6)

Supply oil from A2 port of the main pump flows into P2 port of control valve (2).
The pressure oil from A5 port through the arm valve is supplied into the H side of arm cylinder (6) and carries out the arm operation.

2) Return circuit from cylinder (6)

The return oil from the R side of the arm cylinder flows into B5 port of control valve (2), is led into the return circuit from T2 port through the arm valve, and returns into the tank. When operating in the light load, the pressure of the return oil from the cylinder rises taking advantage of the throttling effect of the arm valve, and opens the check valve leading to the supply circuit of a part of the return oil, and is recirculated. Consequently the arm in speed rises.

3.7.2 Arm out operation circuit

(1) Pilot circuit

With the arm out operation, pilot valve (11) delivers the pilot secondary pressure, and the pressure oil is led to Pb5 port of control valve (2) and switches the spool of the arm valve.

(2) Main circuit

Similar to the arm in operation, the pressure oil led into B5 port of control valve (2) is supplied from the B5 port into the R side of the arm cylinder and carries out the arm out operation.

3.12 NIBBLER/BREAKER OPERATION CIRCUIT

Cable drive type with control pedal
Link drive type in EU

3.12.1 Nibbler "close" operation

(1) Nibbler operation

Press the left side of the control pedal, and the cable is pulled and consequently the nibbler/ breaker valve spool of control valve (2) is switched. The nibbler can be operated regardless of the lever lock, like dozer.
For link drive in EU, press the front side of the pedal, and the similar operation can be obtained.

(2) Main circuit

1) Supply circuit to nibbler cylinder

The delivery oil from the A2 port of the 2nd pump of pump assy (1) flows in the P2 port of control valve (2) and is fed in the B3 port through nibbler / breaker valve. And it is fed in the H side of the nibbler cylinder and consequently the nibbler "close" operation is executed.

3.12.2 Breaker ON operation

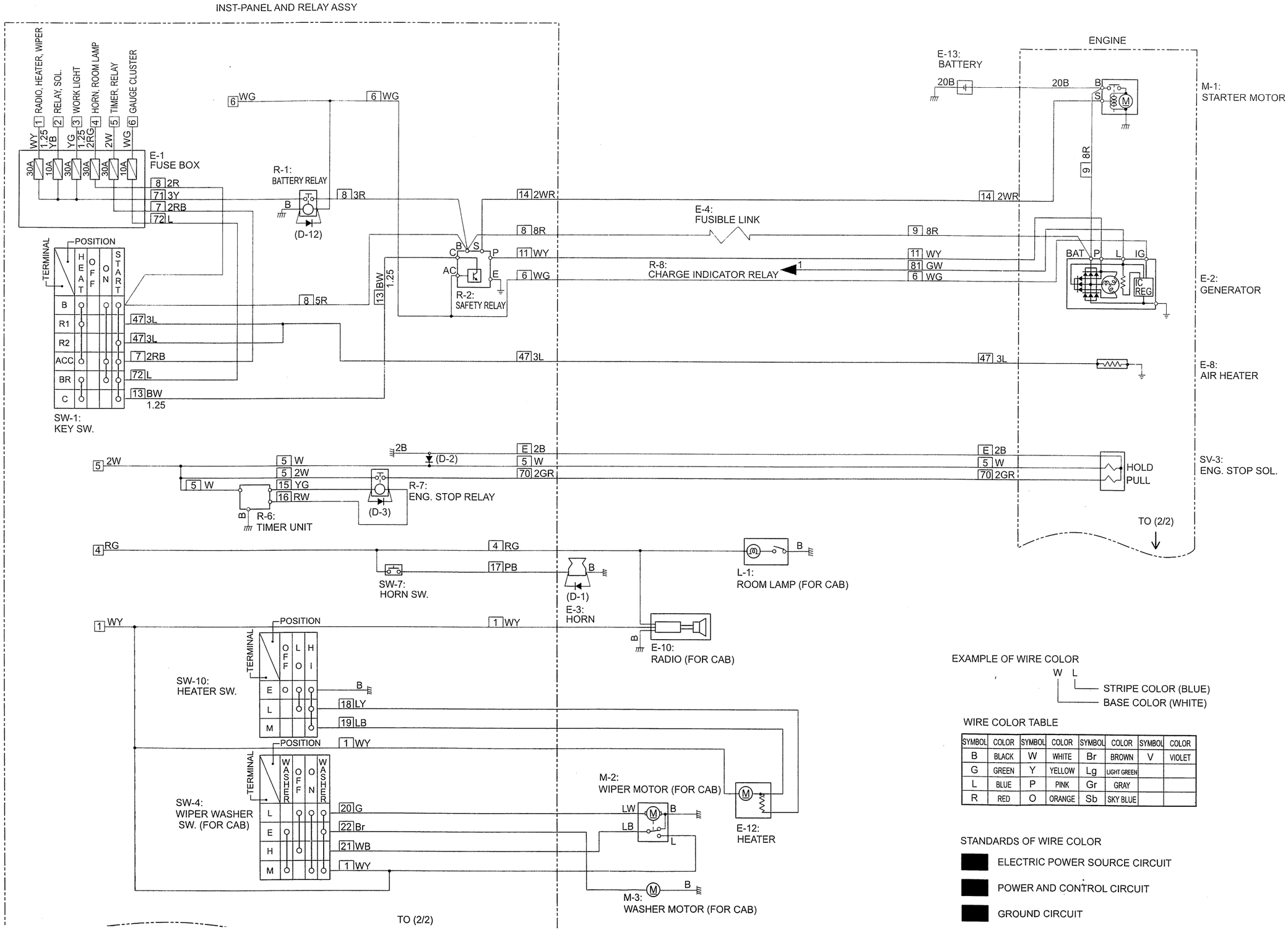
(1) Breaker operation

Press the right side of the control pedal, and the cable is pushed and consequently the nibbler/breaker valve spool of control valve (2) is switched. The breaker can be operated / regardless of the lever lock, like dozer.
For link drive in EU, press the rear side of the pedal, and the similar operation can be obtained.

(2) Main circuit

The delivery oil from the A2 port of the 2nd pump of pump assy (1) flows in the P2 port of control valve (2) and is fed in the A3 port through nibbler/ breaker valve. And it is fed in the breaker inlet and the breaker starts operating. Then, selector valve (23) of the return circuit is switched to the breaker side, consequently the return oil returns in hydraulic oil tank (25) directly.

2. ELECTRIC CIRCUIT DIAGRAM (1/2)



EXAMPLE OF WIRE COLOR

W L
- W: BASE COLOR (WHITE)
- L: STRIPE COLOR (BLUE)

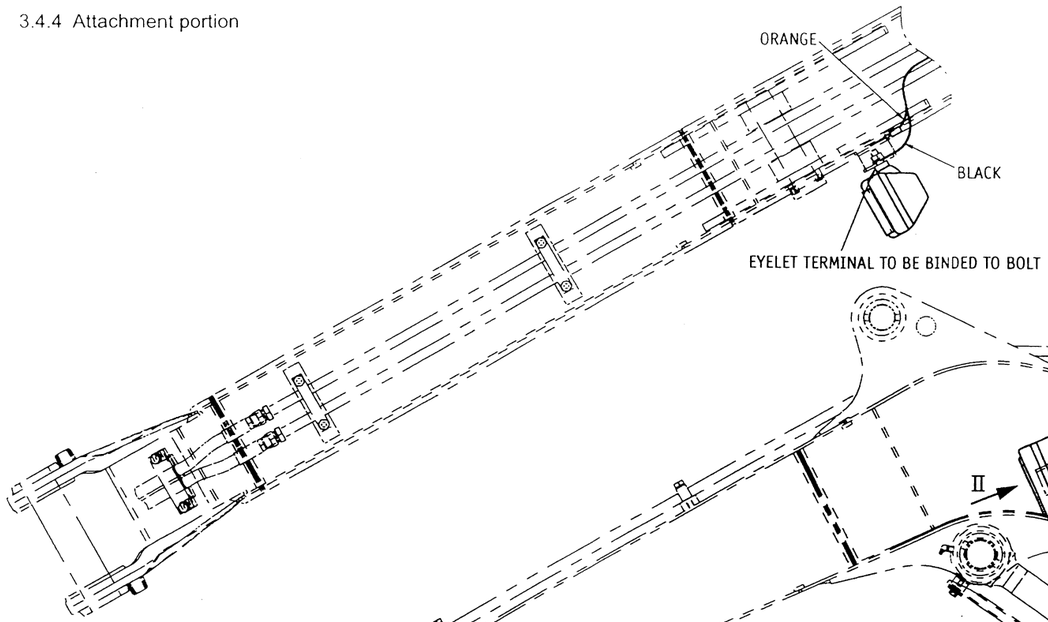
WIRE COLOR TABLE

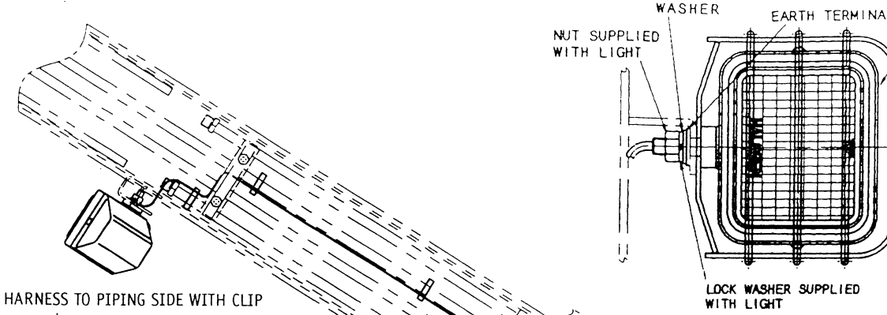
SYMBOL	COLOR	SYMBOL	COLOR	SYMBOL	COLOR	SYMBOL	COLOR
B	BLACK	W	WHITE	Br	BROWN	V	VIOLET
G	GREEN	Y	YELLOW	Lg	LIGHT GREEN		
L	BLUE	P	PINK	Gr	GRAY		
R	RED	O	ORANGE	Sb	SKY BLUE		

STANDARDS OF WIRE COLOR

- ELECTRIC POWER SOURCE CIRCUIT
- POWER AND CONTROL CIRCUIT
- GROUND CIRCUIT

3.4.4 Attachment portion

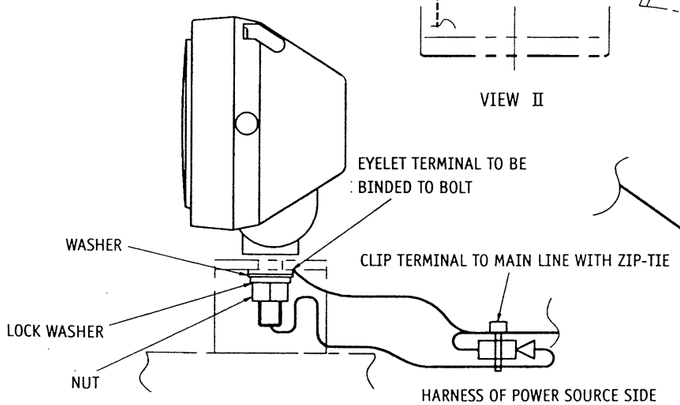




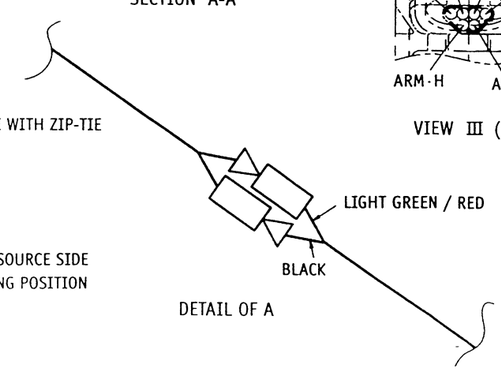
VIEW II KAI

VIEW II

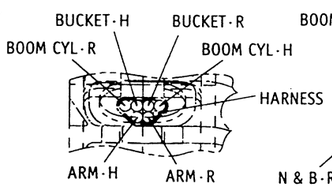
SECTION A-A



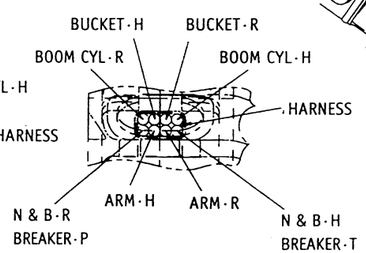
VIEW I



DETAIL OF A



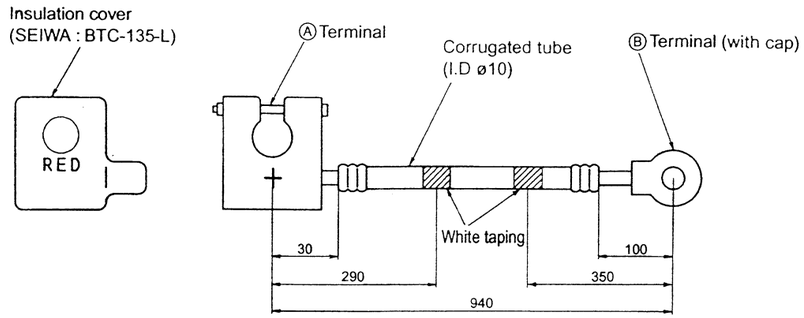
VIEW III (STD.)



VIEW III (B, N & B SPEC.)

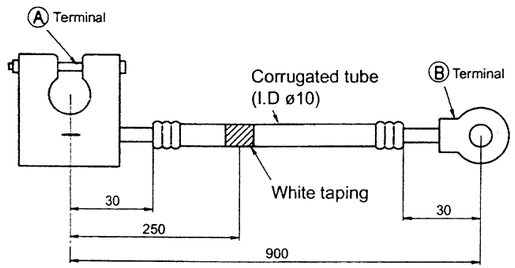
FROM	CONNECTION	TO
BOOM HARNESS (ORANGE)	⟷	MAIN HARNESS (LIGHT GREEN / RED)
BOOM HARNESS (BLACK)	⟷	MAIN HARNESS (BLACK)

3.5.4 Battery cable ⊕ (Code H-4)



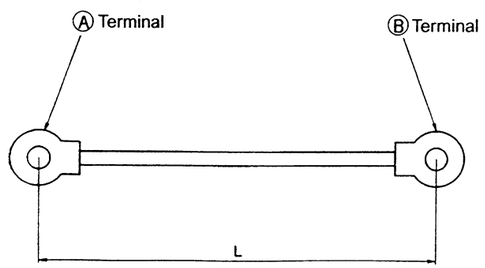
Ⓐ TERMINAL JIS D5403	Ⓑ TERMINAL JIS D5403	CAP	LENGTH (mm)	FUNCTION
BC618	BA508	SEIWA SLC30-R	940	BATTERY ⊕ ⟷ STARTER Ⓑ TERMINAL

3.5.5 Battery cable ⊖ (Code H-5)



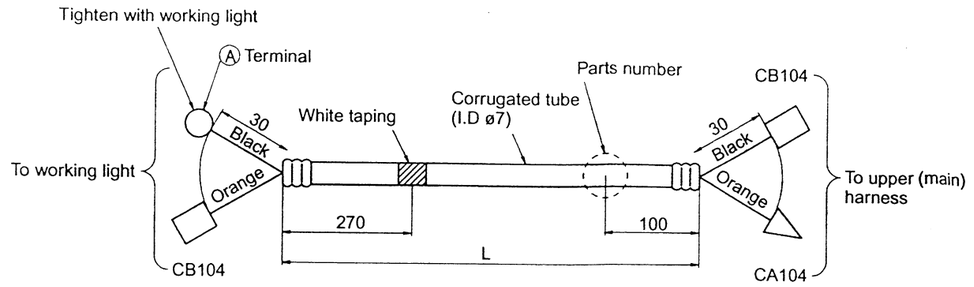
Ⓐ TERMINAL JIS D5403	Ⓑ TERMINAL JIS D5403	CAP	LENGTH (mm)	FUNCTION
BC616	BA510		900	BATTERY ⊖ ⟷ BODY GROUND

3.5.6 Engine ground (Code H-6)



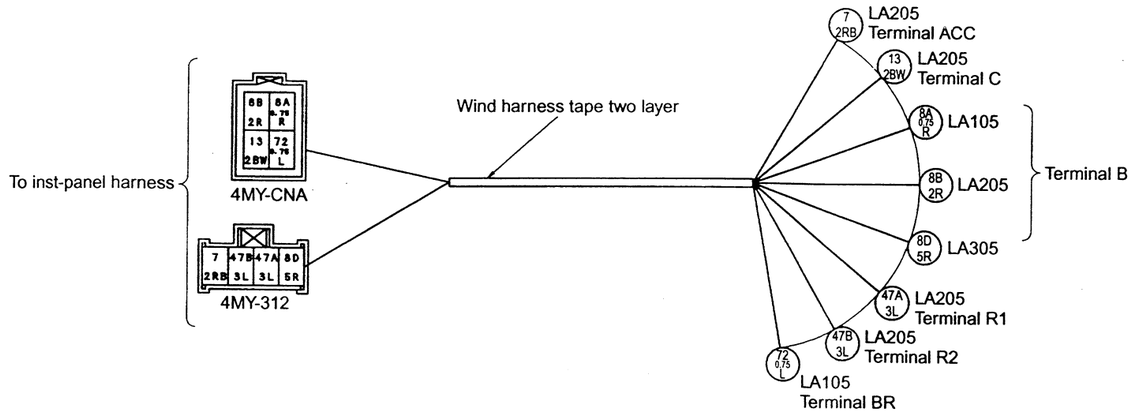
Ⓐ TERMINAL JIS D5403	Ⓑ TERMINAL JIS D5403	CAP	L (mm)	FUNCTION
BA510	BA510		280	ENGINE GROUND

3.5.7 Boom harness (Code H-7)



A TERMINAL	L (mm)
LA312	2050

3.5.8 Key switch harness (Code H-8)



CONNECTORS SELECTION TABLE

CONNECTOR (PIN NUM.)	MANUFUC.	PART.NUMBER	
		HOUSING	TERMINAL
4MY-CNA	YAZAKI	7122-2446	7114-2020
4MY-312	YAZAKI	7282-3040	7114-5041
			7114-6042

2) Control

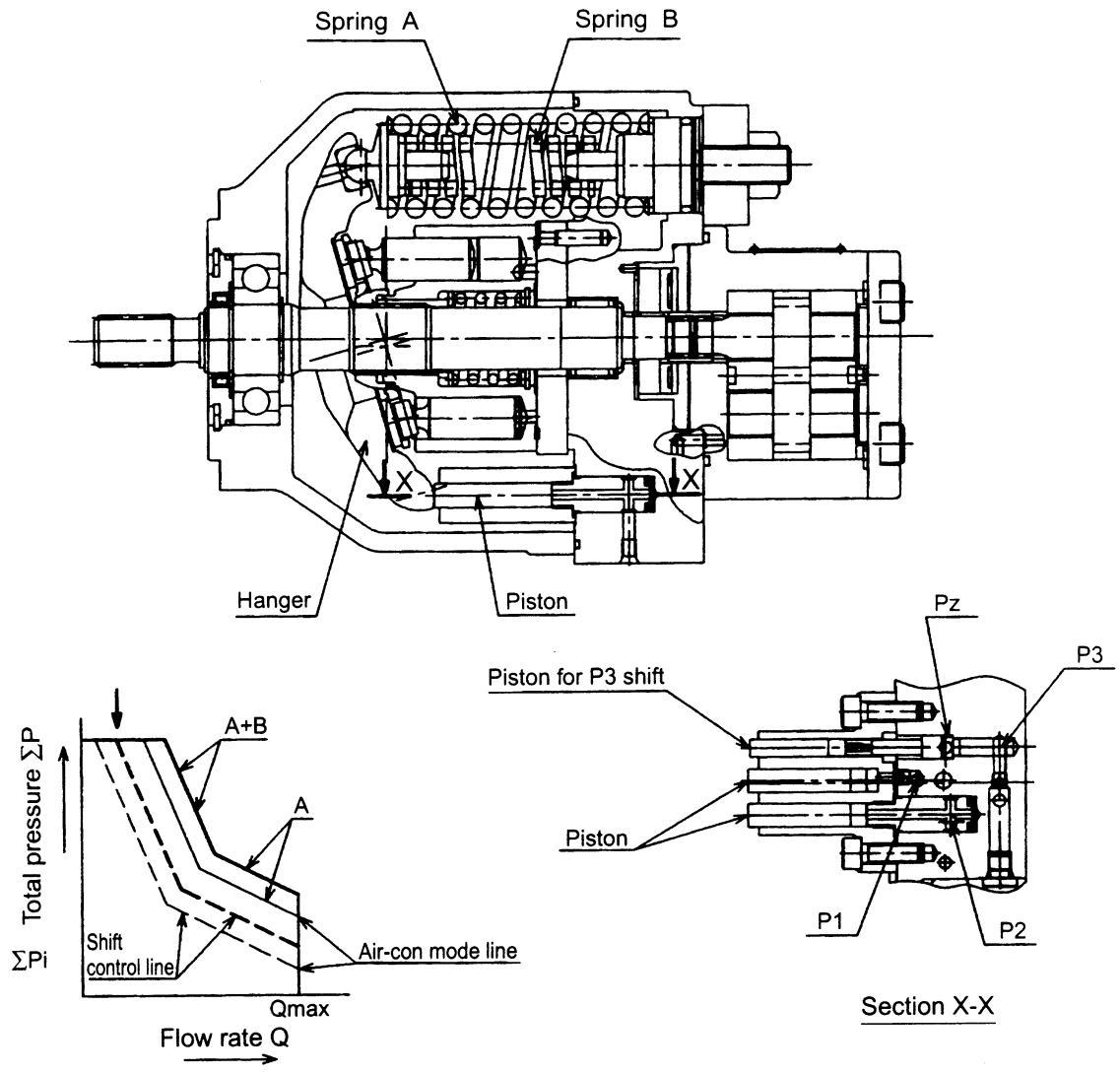


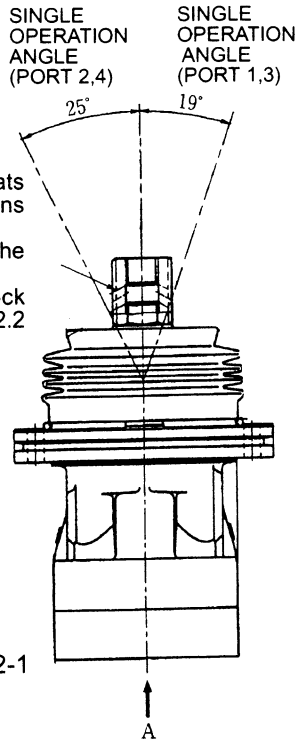
Fig. 1-4

- Delivery oil pressure P1 and P2 act on hanger through pistons that have same sectional area.
- The spring is located in the form which is in opposition to the delivery oil pressure.
- When the hydraulic pressure acting on the hanger through the piston goes below the setting load of the spring, the hanger is fixed at the maximum tilt angle.
- When the hydraulic pressure acting on the hanger through the position exceeds the setting load of the spring A, the hanger is tilted and held tilting at the position where the hydraulic pressure balances the spring pressure. (Control line, Area A)
- The control line is shifted after the hydraulic pressure P3 acts on the shift piston.

2. PILOT VALVE (ATT)

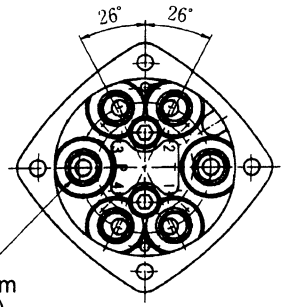
2.1 SUMMARY

(1) General view



The adjust nut (opposing flats : 22) : Fix adjust nut by means of spanner (opposing flats : 22) when the lever is installed.
Then tighten the mating lock nut to 4.2 ± 0.3 kgf·m (30 ± 2.2 lbf·ft)

Fig. 2-1



6-PF1/4
T=3.0 ± 0.2kgf·m
(21.7 ± 1.4lbf·ft)

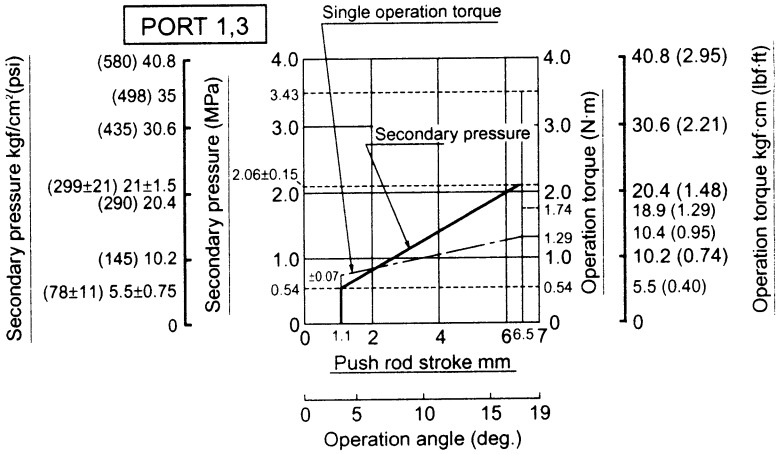
VIEW A

T=Tightening torque

(2) Specifications

ITEM	SPECIFICATIONS
Parts number	PA30V00002F2
Model (Type)	PV48M1032B
Max. primary pressure	70 kgf / cm² (1,000 psi)
Rated flow	15/min (4.0 gal / min)
Weight	1.6 kg (3.5 lb)

(3) Performance Characteristics



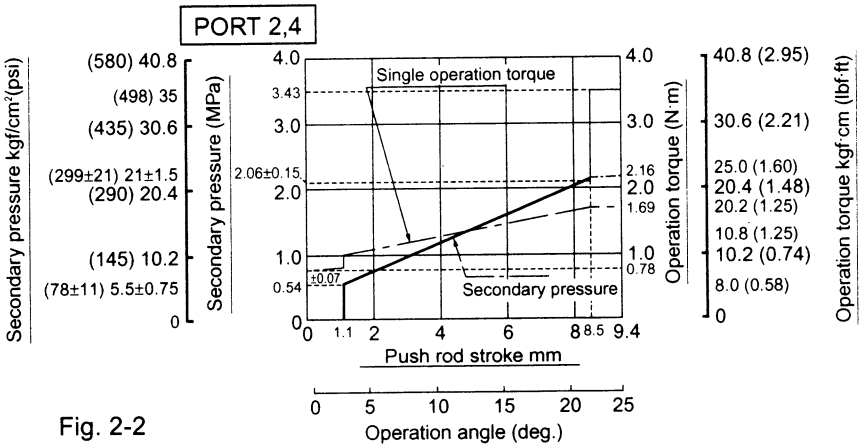


Fig. 2-2

4. CONTROL VALVE

4.1-1 GENERAL VIEW AND PORTS NO. EU

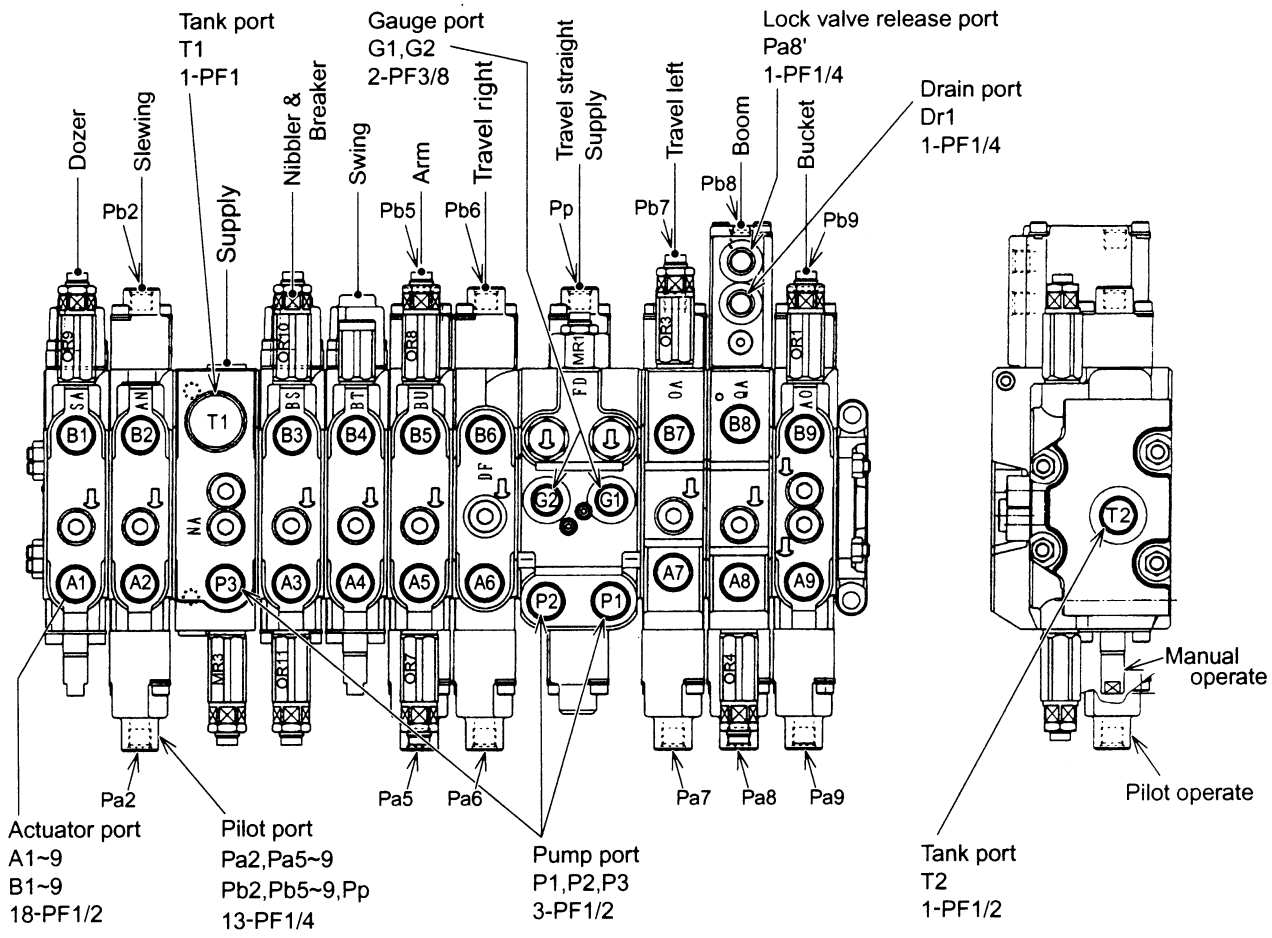


Fig. 4-1-1

4.2-1 SPECIFICATIONS. EU

Table. 4-1-1

ITEM		SK45SR-2
Model (Type)		BCV65-AF10
Valve operation	Manual	Swing, Nibbler & Breaker, Dozer blade
	Pilot	Travel straight, Travel left, Travel right, Boom, Arm, Bucket, Slewing
Flow rate		P1, P2 : 52.4 L/min, P3 : 40.3 L/min
Setting pressure of main relief valve P1, P2, P3		P1, P2···230^{+5}_{0} kgf/cm² (3270^{+71}_{0} psi) at 52.4 L/min (13.8 gal/min) : MR1 P3 ·····200^{+5}_{0} kgf/cm² (2840^{+71}_{0} psi) at 40.3 L/min (10.6 gal/min) : MR3
Setting pressure of over load relief valve		B1, A3, B3, A5, B5, B9 port (OR1, OR7, OR8, OR9,OR10, OR11) 260^{+5}_{0} kgf/cm² (3700^{+71}_{0} psi) at 5L/min (1.3 gal/min) B8, A8 port (OR3, OR4) 280^{+5}_{0} kgf/cm² (3980^{+71}_{0} psi) at 5L/min (1.3 gal/min)

(2) Pilot operating section

1) Operating boom raise

With the boom raise operation, the pilot secondary pressure enters into the Pb8 port, and moves the spool for the boom operation. And with the movement of the spool, as the by-pass circuit is cut at the boom switching section, the oil received through the P1 port flows from the parallel circuit through the check valve installed on the upper part of the spool by-pass circuit for the travel operation into the parallel circuit on the boom switching section.

With the movement of the spool, as the circuit from the passage leading to the boom lock valve section to the bridge passage is opened, the oil entered in the parallel circuit passes through the load check valve on the boom switching section and flows into the B8 port through the bridge passage and open the boom lock valve (free flow) and is fed into the boom cylinder head side.

On the other hand, the return oil from the boom cylinder rod side flows into the A8 port, and with the movement of the spool the oil flows out into the tank circuit.

Consequently, the boom cylinder extends and raises the boom.

(See page 11 and 12 for lock valve)

The oil from the Pp port passes through the orifice provided on the P1 and P2 supply section and flows into the pilot circuit.

The oil entered into the pilot circuit flows from the travel switching section to the tank circuit, and the pilot circuit pressure becomes equal to the tank pressure, consequently the travel spool is not switched.

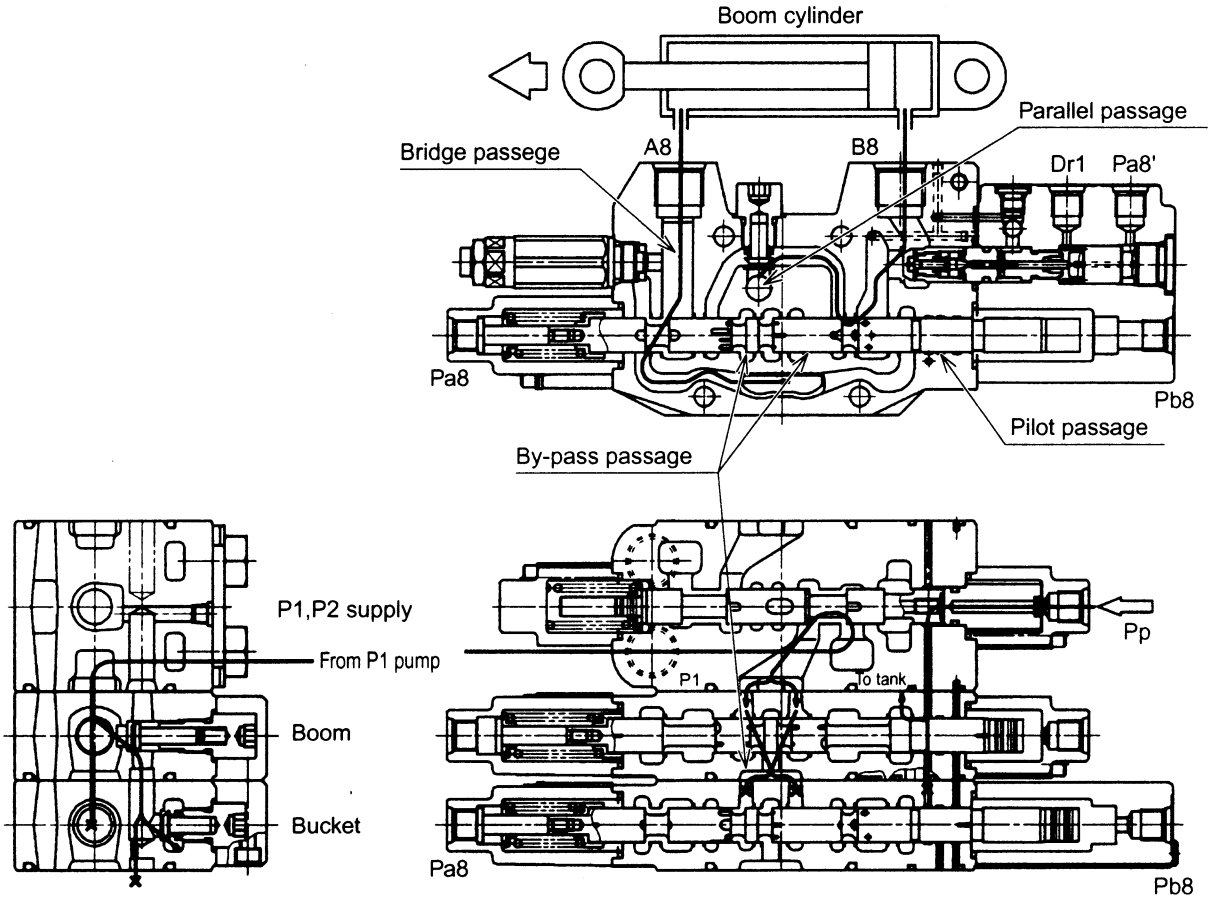
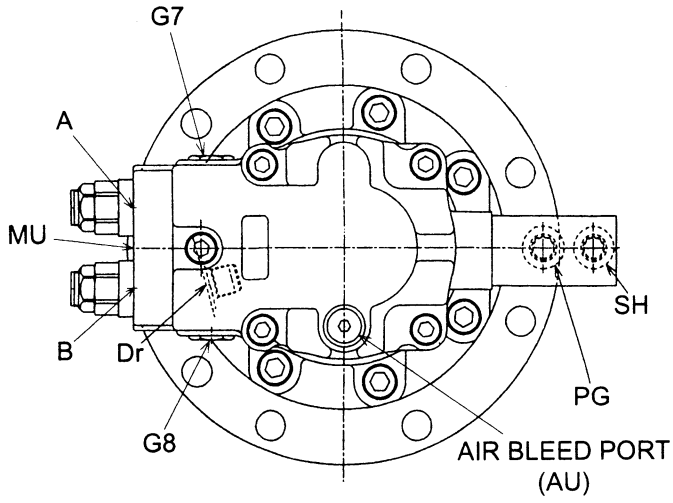
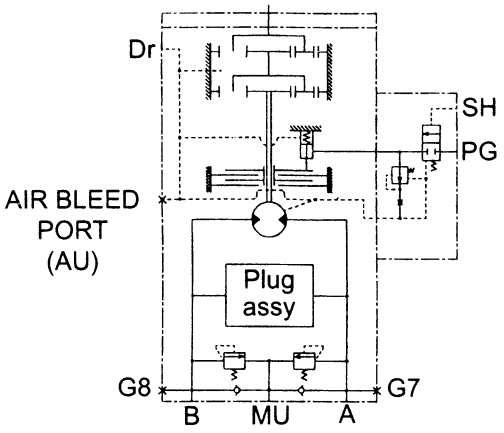


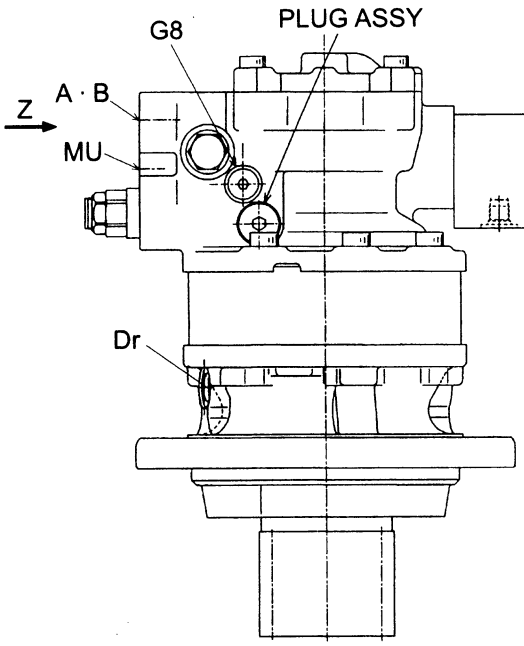
Fig. 4-11 Operation at boom raising

5. SLEWING MOTOR

5.1 GENERAL VIEW







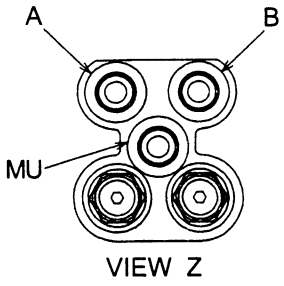


Fig. 5-1

Code	Port	Size
A	Main port	PF1/2
B	Main port	
MU	Make up port	
Dr	Drain port	PF3/8
PG	Slewing parking brake release port	PF1/4
SH	Slewing parking brake pilot port	
G7	Gauge port	PF1/4
G8		

Rotational direction : Inlet A port : CCW
Inlet B port : CW
(View from shaft end)

5.2 SPECIFICATIONS

Table. 5-1

Applicable model			SK45SR-2
Model			SG015E-502A
Hydraulic motor	Displacement	cc/rev (in³/rev)	27.2 (1.66)
	Rated flow	L/min (gal/min)	40.3 (10.6)
	Parking brake torque	kgf·m (lbf·ft)	8 (58)
	Parking brake releasing pressure	kgf/m² (psi)	Cracking 6 (85) Max.50 (710)
	Parking brake timing	sec	6 ± 1.5
Relief valve	Set pressure	kgf/m² (psi)	180 (2560) at 40.3 L (10.6 gal) /min
Reduction	Reducing ratio		1/17.01
Weight		kg (lb)	43 (95)

6.4 CONSTRUCTION

(1) Composition

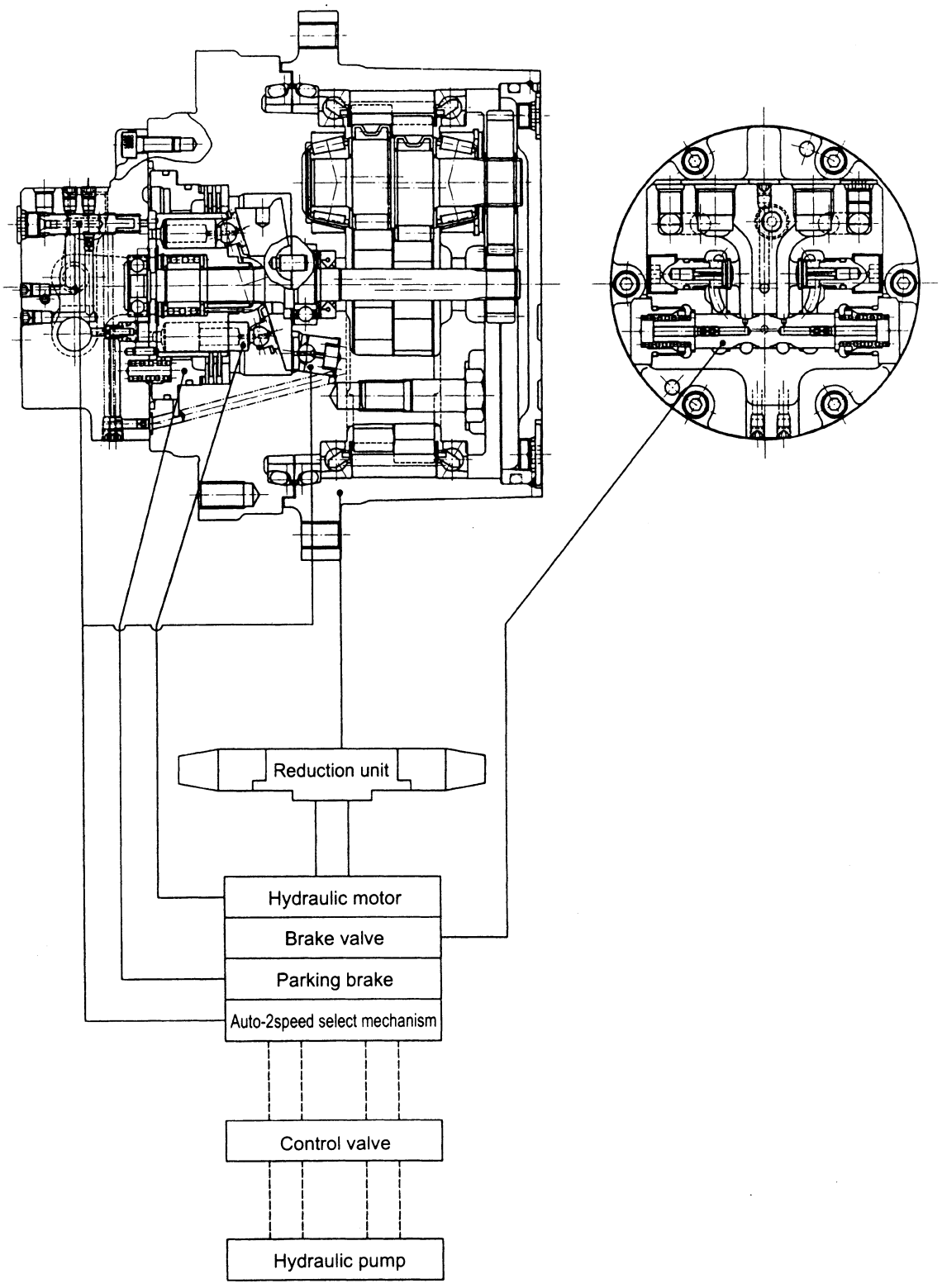


Fig. 6-3

2-3 Parking brake

(1) Machine is running :

If the pressure from the pump is supplied to port (A) or (B), the spool (223) of the brake valve moves to the right or the left. Port (E) opens, and the pressure is led from port (E) to cylinder chamber ⓐ .

When the pressure reaches 9.1 kgf/cm² (130 psi) or over, the thrust of piston (113). The piston (112) moves toward rear flange (201). If the piston (112) loses its pressing force against separator plate (116) and friction plate (115), the friction plate (115) is let free. The friction plate (115) is engaged with cylinder block (104) of the hydraulic motor. The result is that cylinder block (104) is freed from the braking force. The hydraulic motor is freed to run.

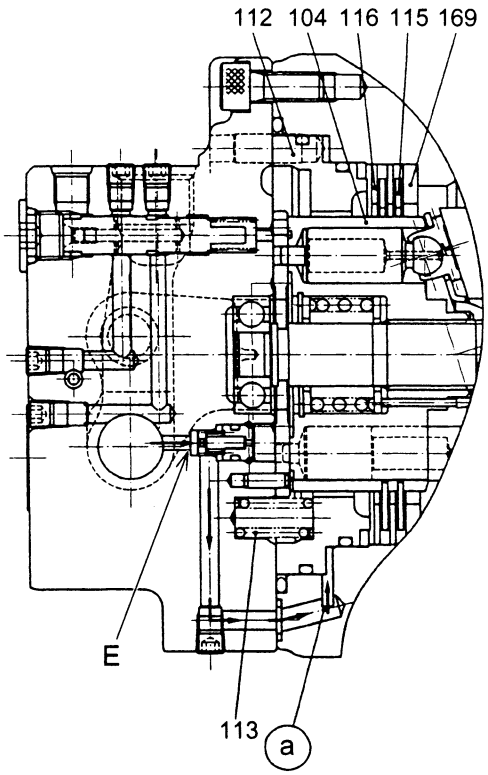


Fig. 6-14

(2) Machine is not running :

If the pressure to port (A) or (B) is suspended, the spool (223) of the brake valve moves to neutral.

Port (E) is shut off, and the pressure in cylinder chamber ⓐ falls. When the pressure falls below 9.1 kgf/cm² (130 psi), the hydraulic force of piston (112) decreases below the force of spring (113). Then the action of spring (113) causes the piston (112) to be pressed against the separator plate (116), plate (169) and the friction plate (115). This pressing force creates frictional force that acts braking torque 6.6 kgf·m (48 lbf·ft).

The friction plate (115) meshes with the cylinder block (104) of the hydraulic motor. The cylinder block (104) meshes with shaft (102) of the hydraulic motor.

In this way, the hydraulic motor undergoes braking torque while the machine is at parking.

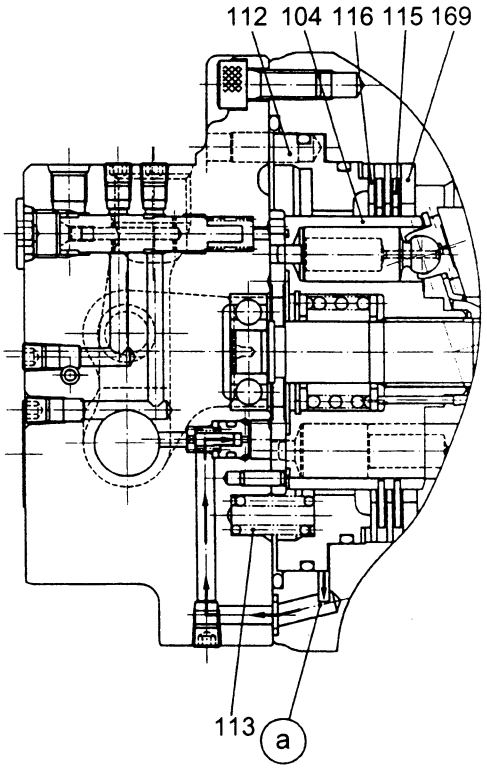


Fig. 6-15

(4) Dozer cylinder

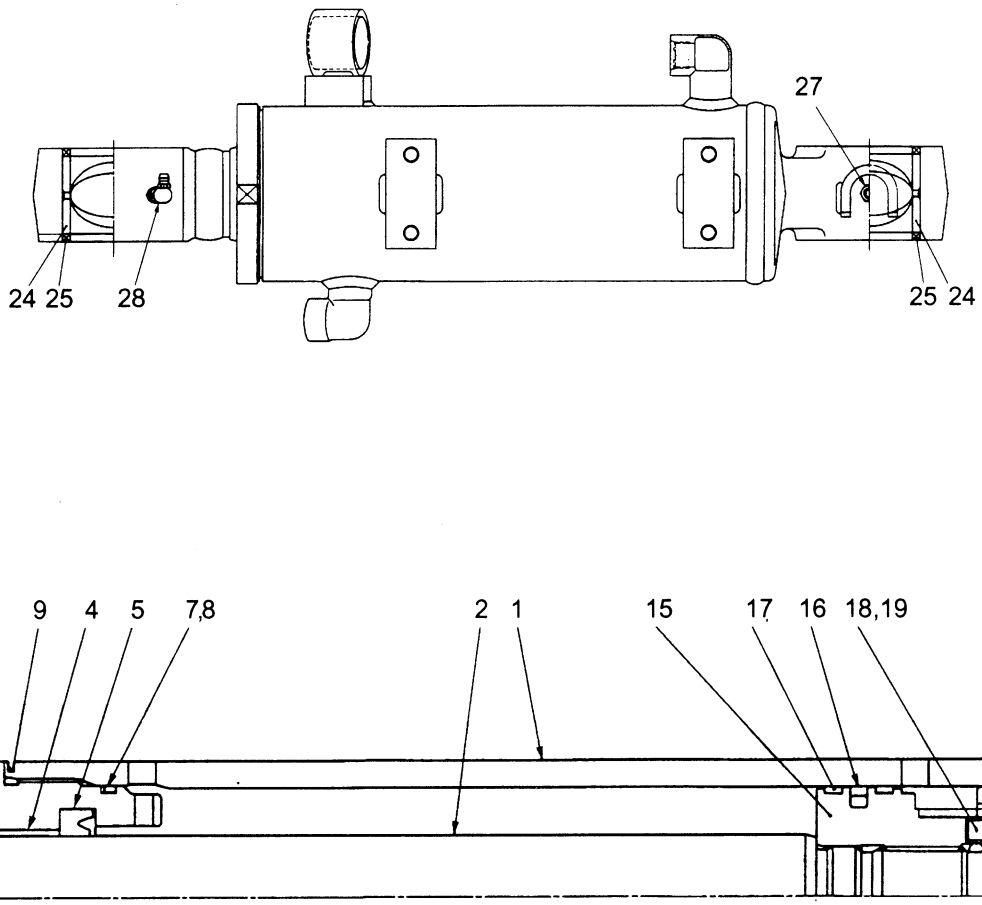
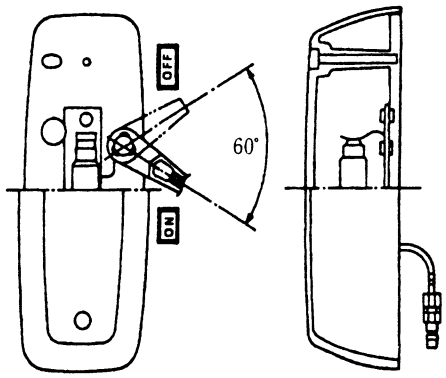
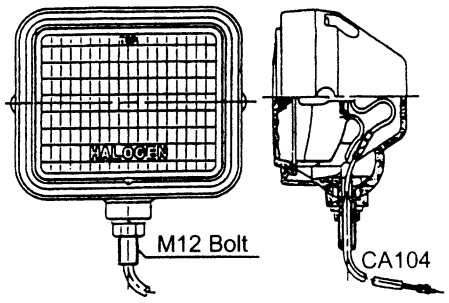
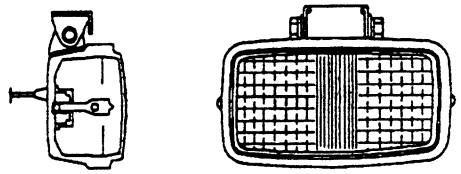


Fig. 8-5 Construction

No.	Parts name	Q'ty	No.	Parts name	Q'ty	No.	Parts name	Q'ty
1	Cylinder tube	1	7	O-ring	1	18	Setscrew	1
2	Piston rod	1	8	Back-up ring	1	19	Steel ball	1
3	Cylinder head	1	9	O-ring	1	24	Pin bushing	2
4	Bushing	1	15	Piston	1	25	Wiper ring	4
5	U-ring	1	16	Seal ring assy	1	27	Grease nipple	1
6	Wiper ring	1	17	Slide ring	2	28	Grease nipple	1

Code No. Parts Name Parts No. Use Applicable Machine	Specifications	Description
L-1 Light 2456U114 Dome light (Cab only) PM05-05001~ PV08-20001~ PW08-20001~ PX09-08001~ PH03-02001~ PJ02-00101~	Model: 17030-01700 Rated voltage: 12V Bulb: 12V10W	
L-2 Light 2456R243F2 Boom working light (L.H.) PM05-05001~ PV08-20001~ PW08-20001~ PX09-08001~ PH03-02001~ PJ02-00101~	Maker's P/No.: DS U023 Effective area of lens: 102cm² Bulb: Halogen12V-55W	
L-3, 4 Light PY80S00002F1 Working light (OPT) (Cab spec.) PV10001~ PW07001~ PX05001~ PW08-20001~ PX09-08001~ PJ02-00101~	Bulb: 12V-55W	

KOBELCO

Book Code No. S5PJ3101E

SHOP MANUAL SK45SR-2

WHOLE DISASSEMBLY & ASSEMBLY

TABLE OF CONTENTS

PJ3

KOBELCO CONSTRUCTION MACHINERY CO., LTD.

3.2 INSTALLATION OF ARM

Installation is performed in the reverse order of removal, including the following work.

⚠ • At the alignment of pin bore, never insert your finger into the bore.

• Make sure to align them with visual check.

(1) Make the welded area clean to inspect any cracks there.

(2) Check the dust seal for damages, and replace the faulty dust seal to new one (referring to Fig. 2-9 for the installing procedures).

(3) Referring to the Chapter "ATTACHMENT DIMENSIONS" of Specifications, replace the worn-out pin and bushing to new ones.

(4) Before installing the pin, apply grease to the shaft area.

(5) Referring to Fig. 2-10, install the capscrew and nuts to prevent the pin from coming out.

: 17 mm

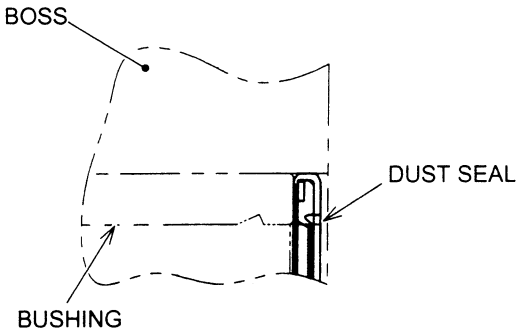


Fig. 2-9 Dust seal installation

(6) Make sure to provide an appropriate clearance for thrust direction at the installation of pin referring to Fig. 2-10.

(7) For the adjustment for clearance, insert plastic shim first, then adjust the clearance with steel shims.

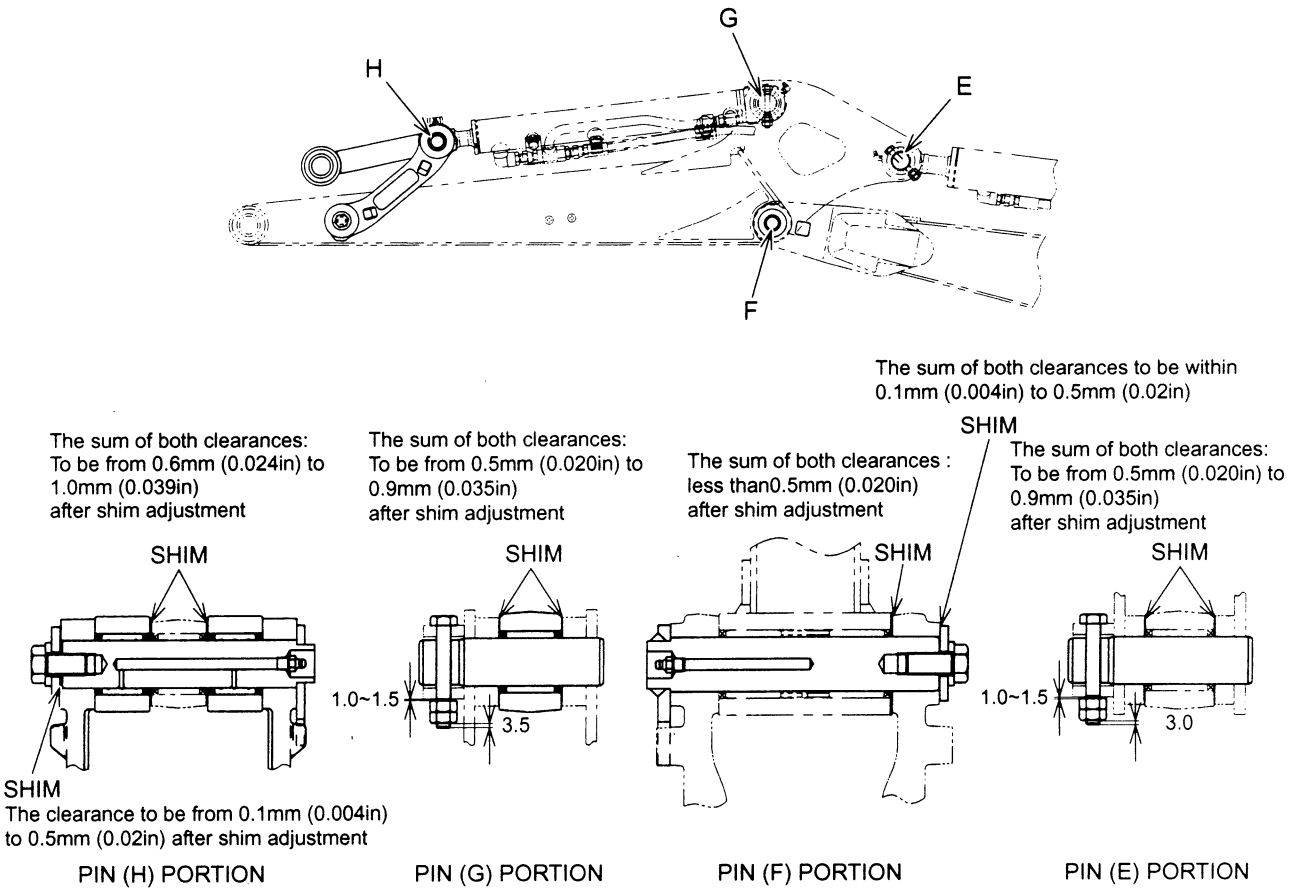


Fig. 2-10 Sectional view of Installing pin

2) Disassembly of holder
(Boom and swing cylinder)

a. Remove collar (12).
b. Remove cushion seal (11).
c. Remove spacer (32).
d. Remove O-ring (7) and back-up ring (13).

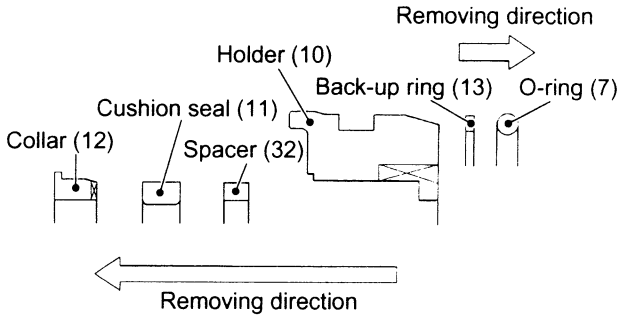


Fig. 1-11 Disassembling holder

3) Remove the U-ring (5).

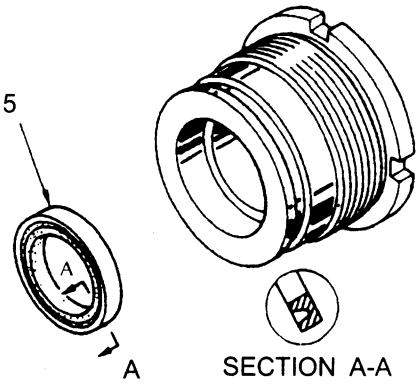


Fig. 1-12 Removing U-ring

4) Remove the wiper ring (6).

- Alternately tap inside of the metal ring of wiper ring at several positions, as shown in the figure, to push it out step by step from the cylinder head.

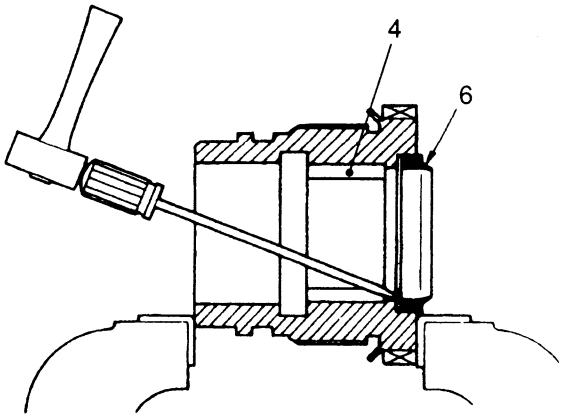


Fig. 1-13 Removing Wiper ring

5) Remove the bushing (4) using a removal jig.

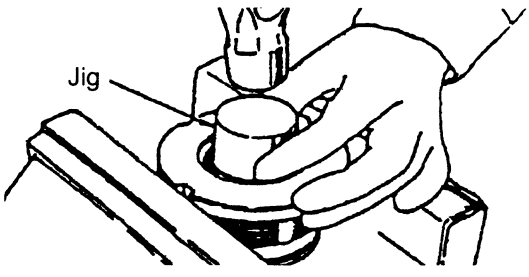
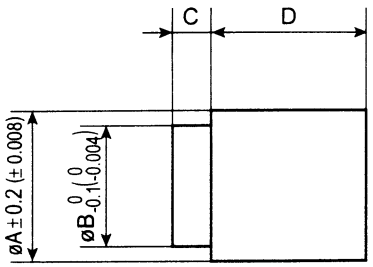


Fig. 1-14 Removing bushing

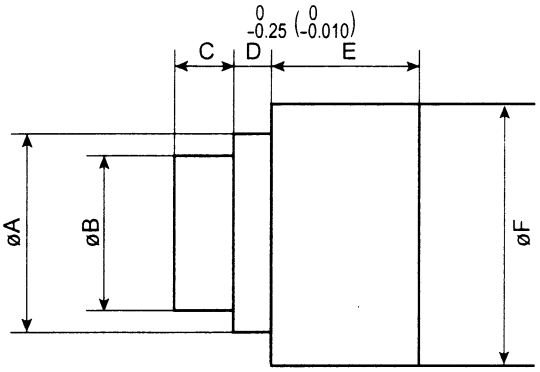
1.7 JIG LIST

1) Installing Jig (A) for press fitting of head bushing (4).



Material : Steel

2) Installing Jig (B) for press fitting of pin bushing (24).



Material : Steel

Unit:mm (in)

Applicable cylinder		Dimension	
SK45SR-2			
(Rod dia ø 40)		A	49.5 (1.95)
		B	39.5 (1.56)
Bucket		C	25.0 (0.98)
		D	67.0 (2.64)
(Rod dia ø 50)		A	59.5 (2.34)
		B	49.5 (1.95)
Arm		C	25.0 (0.98)
Swing		D	67.0 (2.64)
(Rod dia ø 55)		A	64.5 (2.54)
		B	54.5 (2.15)
Boom		C	25.0 (0.98)
Dozer		D	67.0 (2.64)

Unit:mm (in)

Applicable cylinder		Dimension	
SK45SR-2			
(Rod dia ø 45)		A	54.0 (2.13)
		B	44.5 (1.75)
Arm		C	10.0 (0.39)
Bucket		D	5.0 (0.20)
		E	30.0 (1.18)
		F	65.0 (2.56)
(Rod dia ø 50)		A	59.0 (2.32)
		B	49.5 (1.95)
Boom		C	10.0 (0.39)
Swing		D	5.0 (0.20)
		E	30.0 (1.18)
		F	70.0 (2.76)
(Rod dia ø 55)		A	64.0 (2.52)
		B	54.5 (2.15)
		C	10.0 (0.39)
Dozer		D	5.0 (0.20)
		E	30.0 (1.18)
		F	75.0 (2.95)

(8) Removing cover assy (8)

Loosen and remove 4 sems bolts (22) M8 X 20 (green).

: 13 mm

(9) Removing cover (36)

Loosen and remove 5 sems bolts (22) M8 X 20 (green).

: 13 mm

(10) Removing bracket assy (9)

Loosen and remove 3 sems bolts (22) M8 X 20 (green), 1 capscrew (23) and 1 sems bolt (24) M10 X 25 (yellow).

: 13, 17 mm

Weight : 16 kg (35 lb)

(11) Removing cover assy (17)

Loosen and remove 3 sems bolts (50) M8 X 20 (yellow).

: 13 mm

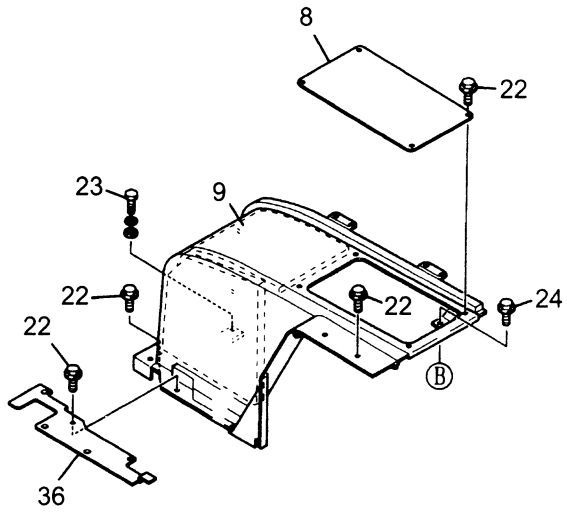


Fig. 2-6
Removing cover assy (8), cover (36) and bracket assy (9)

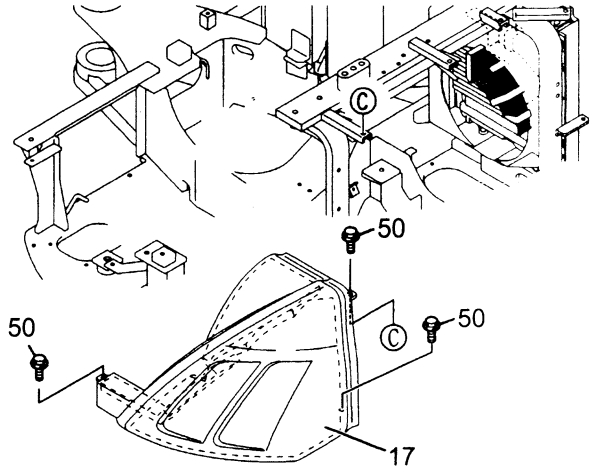


Fig. 2-7 Removing cover assy (17)

(12) Removing support (10)

Loosen and remove 4 capscrews (21) M12 X 45.

: 19 mm

Weight : 47 kg (104 lb)

- Removing seat stand and counterweight is required to disassemble this support (10). (See par. 5 and 6.)

2.2 INSTALLATION

Install the cover by the procedure reverse of the removal.

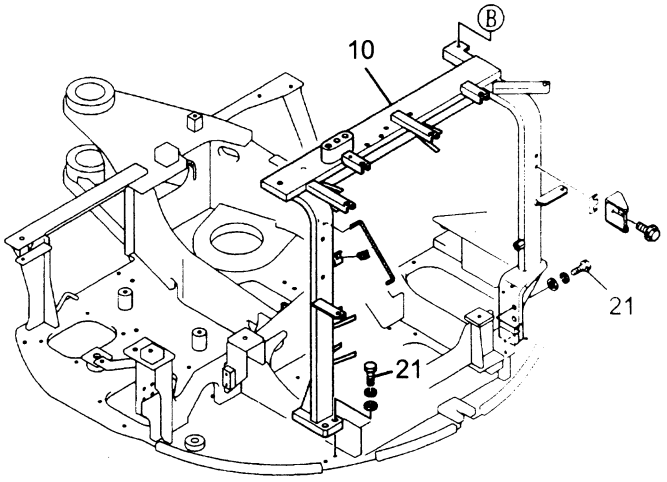


Fig. 2-8 Removing support (10)

(5) Disconnecting return oil hose

Disconnect every hose at the * marked position.

: 22, 27, 36 mm

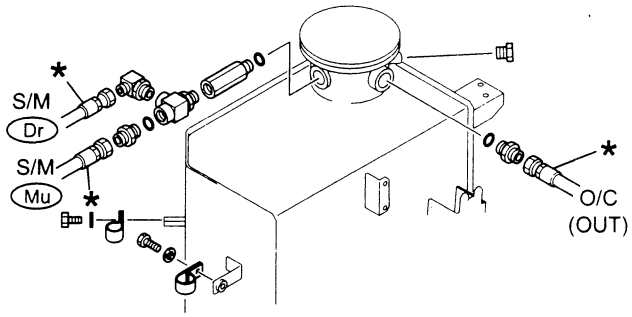


Fig. 8-3 Disconnection of return oil hose

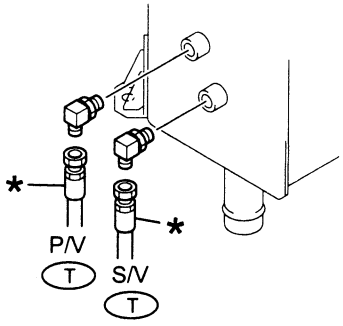


Fig. 8-4 Disconnection of return oil hose

(6) Removing hydraulic tank

Loosen 3 capscrews (B1) M 10 X 25 and remove hydraulic tank (A1).

: 17 mm

Weight : Approx.36 kg (80 lb)

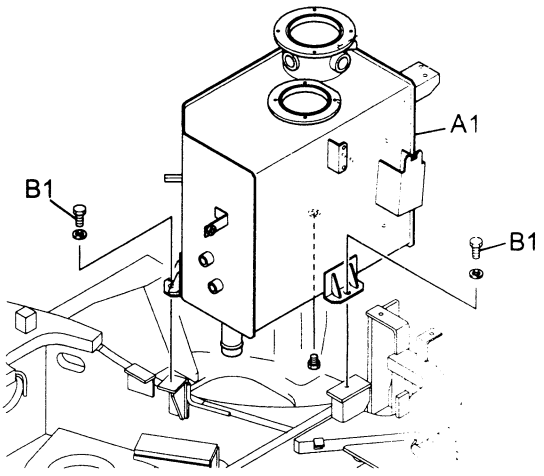


Fig. 8-5 Removing hydraulic tank

(5) Removing support (10)
Loosen 4 capscrews (21) M12 X 45, and remove support (10) and the air cleaner together.

: 19 mm

(6) Disconnecting harness·cable.
(For details, Refer to the Chapter 23 "Electric System".)
1 Disconnect B terminal of starter motor (M-1) of the battery cable on the positive side.
(See section 11.)
2) Remove the engine grounding cable.

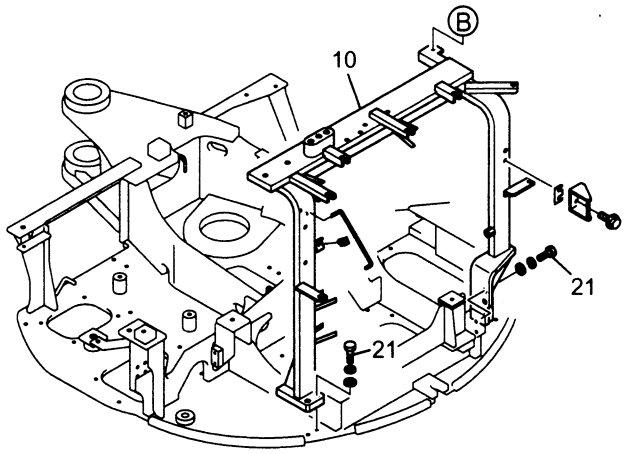


Fig. 15-4 Removing support (10)

⚠ Prepare the stand on which the engine assembly can be placed.

(7) Removing engine
1) Removing engine attaching capscrew (9), (15)
Loosen 2 capscrews (9) M12 X 115 and 2 capscrews (15) M12 X 120 that the capscrews fix the engine to 3 rubber mounts (5) and to one rubber mount (6).
2) Hanging engine
Sling and hang the engine from 2 hooks on the top of the engine.
Weight : Approx.180 kg (400 lb)
3) Place the engine on the stand in the stable condition.

15.3 INSTALLATION

(1) Install the engine by the procedure reverse of the removal. For the tightening torque and Loctite, refer to figure below.

Code	Parts	Tool (mm)	Torque (lbf·m)
8	Capscrew (M10)	17	4.7 (34) Apply Loctite #262
9,15	Capscrew (M12)	19	8.1 (59) Apply Loctite #262

- Use mount rubber marked [A] to identify with mount rubber (5). (3 places)
- Use mount rubber marked [C] to identify with mount rubber (6). (1 place)

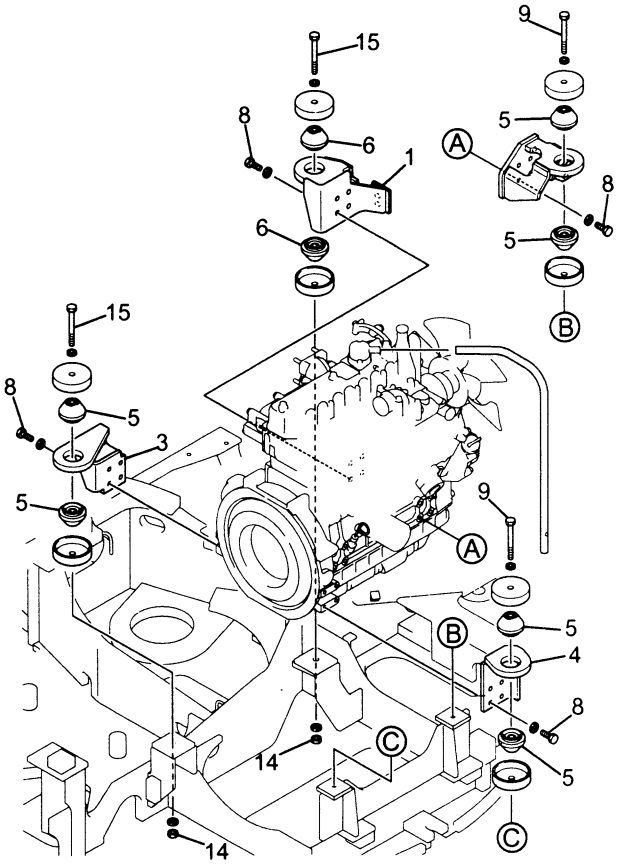


Fig. 15-5 Removing engine

21. UPPER FRAME

21.1 PREPARATION FOR REMOVAL

(1) Remove the floor plate assy. (See Section 3.)

(2) Remove the guard, etc. (See Section 2)

(3) Remove the counterweight. (See Section 6.)

(4) Drain oil from the hydraulic tank.
(See Article 8-2.)

(5) Disconnect the hose on the upper side of the swivel joint.
(See Article 20-2.)

(6) Remove the stopper for the swivel joint.
(See Fig. 20-5.)

(7) Remove the attachment.
(See Section "Boom" of Chapter "ATTACHMENT".)

(8) Remove the swing bracket.
(See Section "Swing" of Chapter "ATTACHMENT".)

21.2 REMOVAL

(1) Putting a match mark on the slewing bearing
Put a match mark on the upper frame and the slewing bearing outer race.

(2) Hanging upper frame temporarily.
Sling the upper frame at three points, a swing bracket attaching hole position on the front side and two positions on the support (10) of rear side of the upper frame.

(3) Removing upper frame installing bolt
Remove 19 capscrews (7) for securing the slewing bearing and the outer race and one reamer bolt (8).

: 22 mm

(4) Removing upper frame
Raise the upper frame slightly, and remove and place it on the stand after being sure that it is safe.
Weight : Approx.1150 kg (2540 lb)

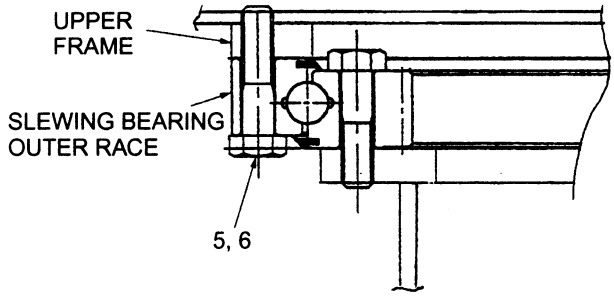


Fig. 21-1 Slewing bearing and upper frame

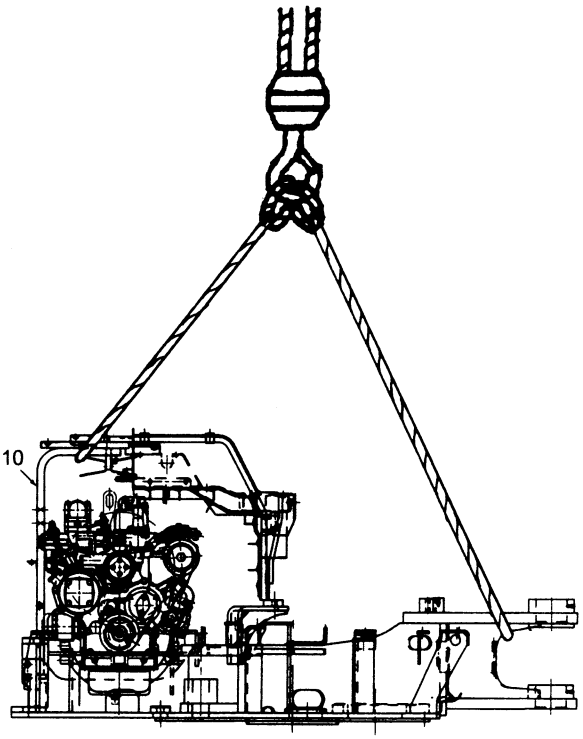
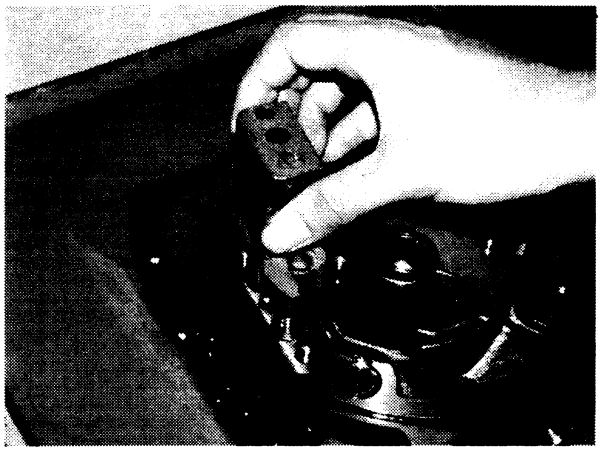
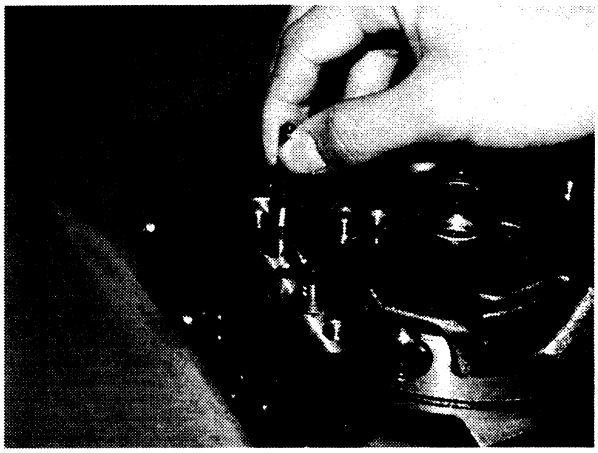


Fig. 21-2 Hanging upper frame temporarily

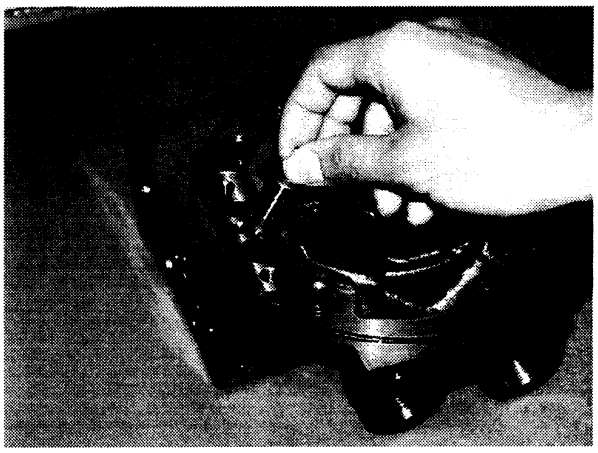
17. Remove cylinder and parallel pin.
    - Take care not miss those O-ring fitted on cylinder section. (2 pcs)



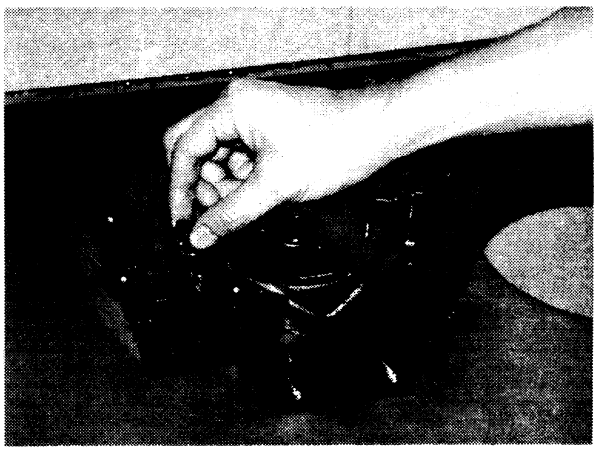
18. If equipped, remove piston for air-conditioner mode.



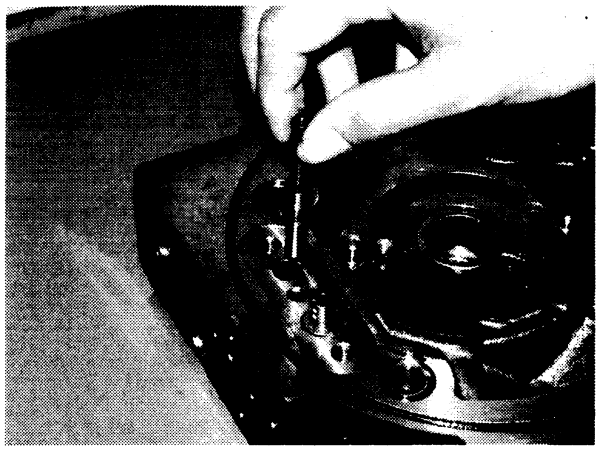
19. Remove piston.



20. Remove three disk springs and spring seat.

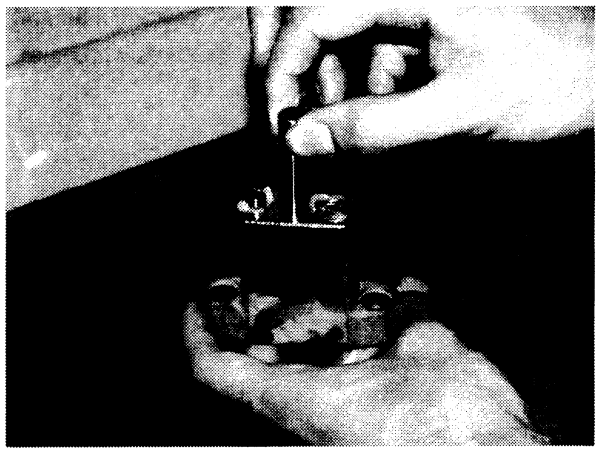


19. If equipped, install piston for air-conditioner mode.



20. Apply grease on O-rings, and fit them to cylinder.

21. Apply grease on two parallel pins (ø10) and one parallel pin (ø7.5) and install them to cylinder.

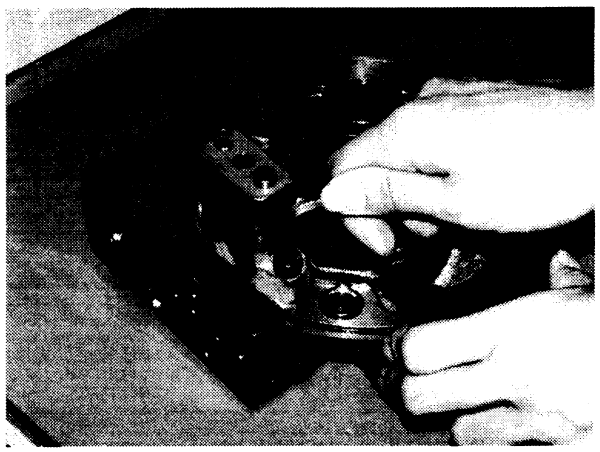


22. Install cylinder with two socket bolts (M8 X 25).

- Apply Loctite to thread portion.

: 6 mm

Torque : 3.25 kgf·m (23.5 lbf·ft)



2.5 PRECAUTIONS WHEN ASSEMBLING

1) The unevenness of tightening torque and the contamination of dust during assembly may cause a failure. And observe the tightening torque specified in the description.
2) When assembling, check up on the valve construction drawing, identify the quantity of part, and pay attention that there is no installation error and omission of part,etc.
3) After cleaning the parts required to use with cleaning solvent, immerse them in hydraulic oil as required and reassemble them.
4) Before applying Loctite, clean and degrease the surface sufficiently, and apply it to two threads. (Overapplication may cause a malfunction due to the squeezing out.)

⚠ PRECAUTIONS (OBSERVE THE FOLLOWING FOR SAFETY.)

2.6 PRECAUTIONS WHEN FITTING SEALS

1) Replace seals with new ones when assembling.
2) Pay attention to seals that they are free from deformation and flaw coming about when handling them.
3) Apply grease or hydraulic oil to the seals and seal fitting section to make the sliding smooth, unless otherwise specified.
4) Don't stretch the seals until it will be deformed permanently.
5) Pay attention not to roll the O-ring when fitting. Because it is difficult for the twisted O-ring to be restored naturally after fitting, and it may cause oil leakage.

11) Disassemble the spool (201-1, 201-2), spring seat (216-1, 216-2), spring (241-1, 242-2) and washer 2 (217).

- These parts to be treated as assy until assembling.

12) Loosen disk (302), adjusting nut (312) and lock nut on the handle operating parts, using spanner, and disassemble joint (301).

: 22mm

(4) Assembling

1) Before assembling, wash parts with cleaning solvent and dry them with compressed air, Avoid using cloth if possible.

- Before assembling correct all defects made during disassembling, clean parts, coat moving parts with oil and refit parts back in original place.

2) Replace O-rings with new ones.
Replace seal washers (121) with new ones, also.

3) Fit O-rings (122) into valve body (101).

4) Install port plate (111) to valve body (101).
In that case, beware of the mounting position so that spring pin (126) can be set in the hole of valve body (101) side.

5) Tighten slowly, with specified torque, two socket bolts (125) with seal washers (121).

: 6mm

T=3 ± 0.3 kgf·m (22 ± 2 lbf·ft)

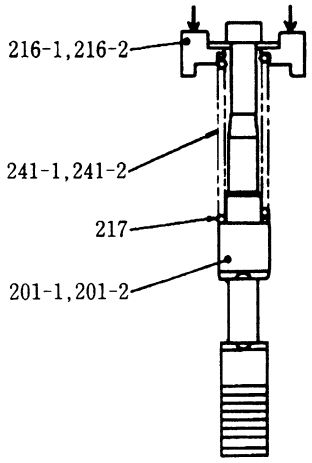


Fig. 3-4 Spool assy

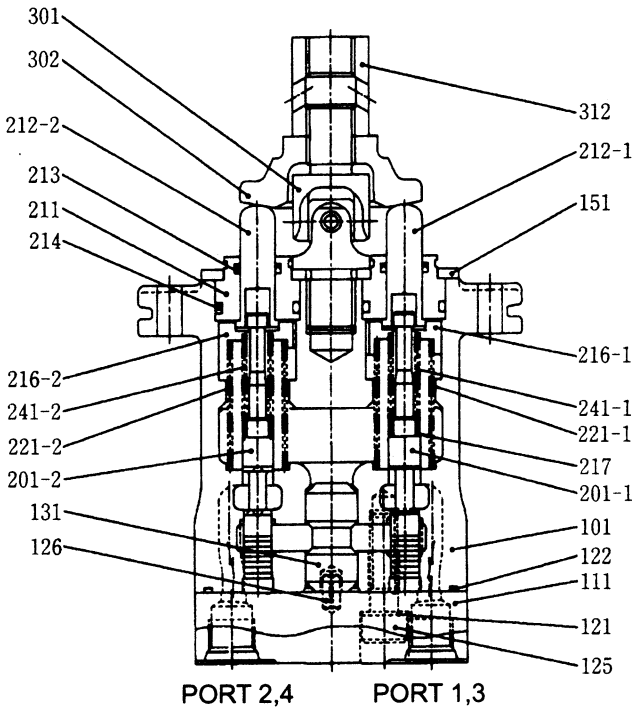
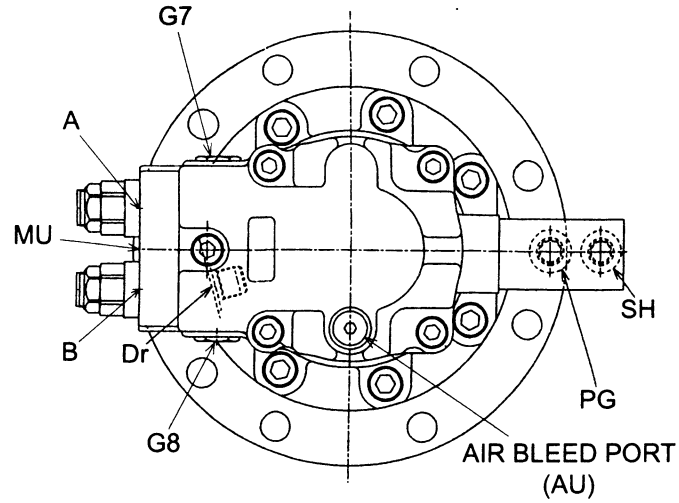
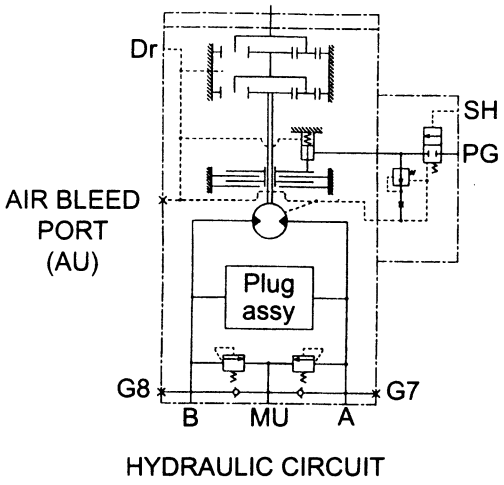


Fig. 3-5 Assembling

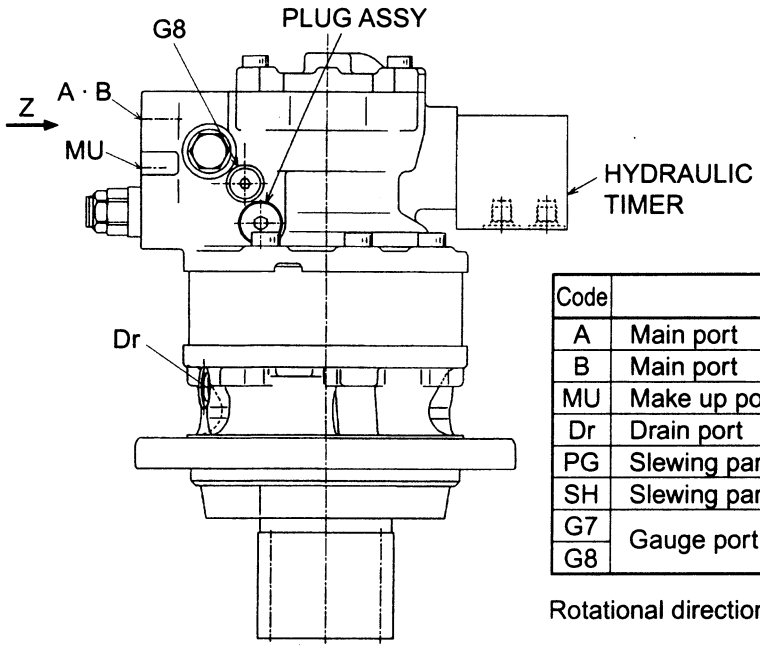
5. SLEWING MOTOR

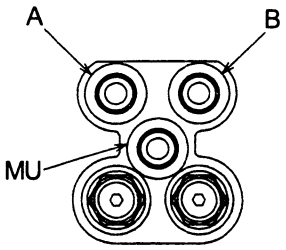
5.1 GENERAL VIEW





HYDRAULIC CIRCUIT





VIEW Z

Fig. 5-1

Code	Port	Size
A	Main port	PF1/2
B	Main port	
MU	Make up port	
Dr	Drain port	PF3/8
PG	Slewing parking brake release port	PF1/4
SH	Slewing parking brake pilot port	
G7	Gauge port	PF1/4
G8		

Rotational direction : Inlet A port : CCW
Inlet B port : CW
(View from shaft end)

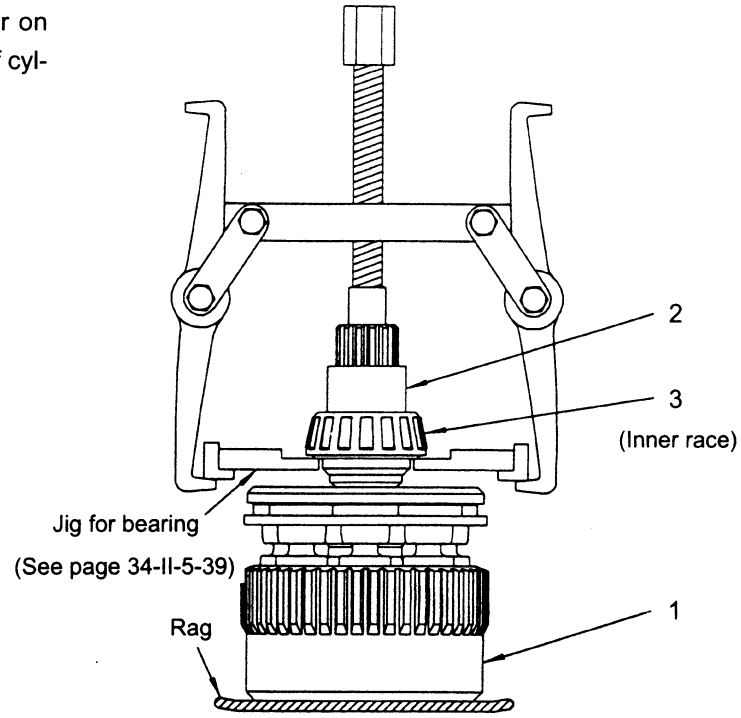
5.2 SPECIFICATIONS

Table. 5-1

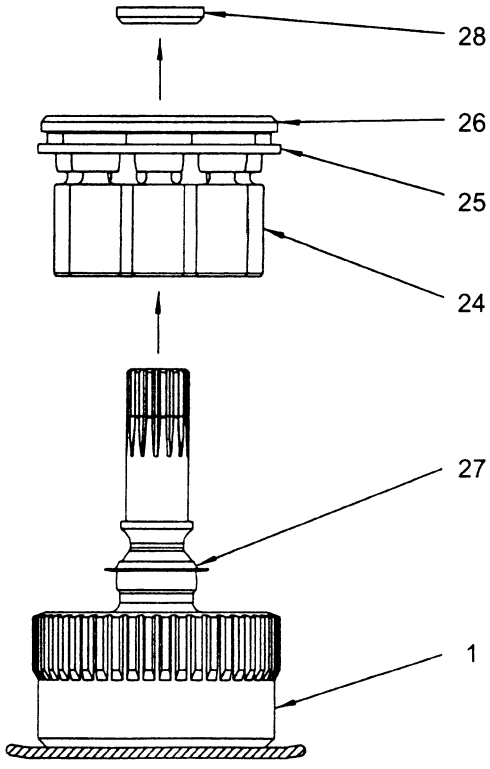
Applicable model			SK45SR-2
Model			SG015E-502A
Hydraulic motor	Displacement	cc/rev (in³/rev)	27.2 (1.66)
	Rated flow	L/min (gal/min)	40.3 (10.6)
	Parking brake torque	kgf·m (lbf·ft)	8 (58)
	Parking brake releasing pressure	kgf/m² (psi)	Cracking 6 (85) Max.50 (710)
	Parking brake timing	sec	6 ± 1.5
Relief valve	Set pressure	kgf/m² (psi)	180 (2560) at 40.3 L (10.6 gal) /min
Reduction	Reducing ratio		1/17.01
Weight		kg (lb)	43 (95)

11) Disassemble cylinder assy.

1. (Pull inner race, taper roller bearing out.)
   Attach a jig for removal under the inner race of taper roller bearing (3), hook a gear puller on two parts of jig and the spline end section of cylinder (1), and pull them out together.



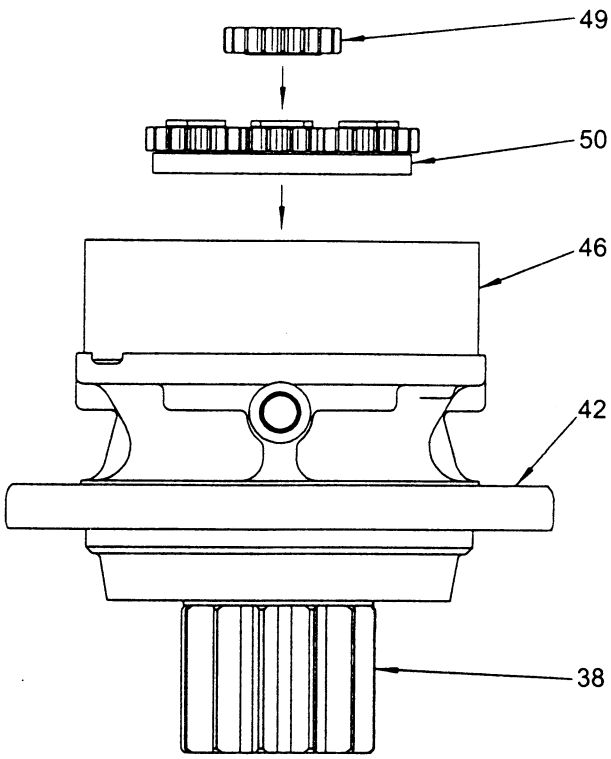
2. Pull collar (28) out, and then pull cam plate (26), return plate (25), piston assy (24) out of cylinder (1) together.



12) Install holder 1 assy and sun gear.

Place holder 1 assy (50) in ring gear (46) moving it in mesh with the internal tooth softly, and also rotating holder 1 assy (50) so that the tooth of holder 1 (51) engages with the tooth of spur gear 4 (47).

Place it in moving sun gear (49) in mesh with spur gear 2 (52) softly.



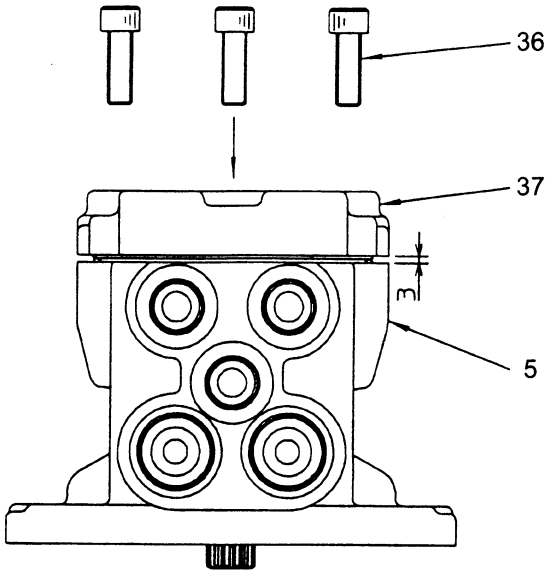
13) Check assembly.

Turn holder 1 assy (50) by hand and check that the output shaft rotates smoothly.

This completes the assembly of reduction unit.

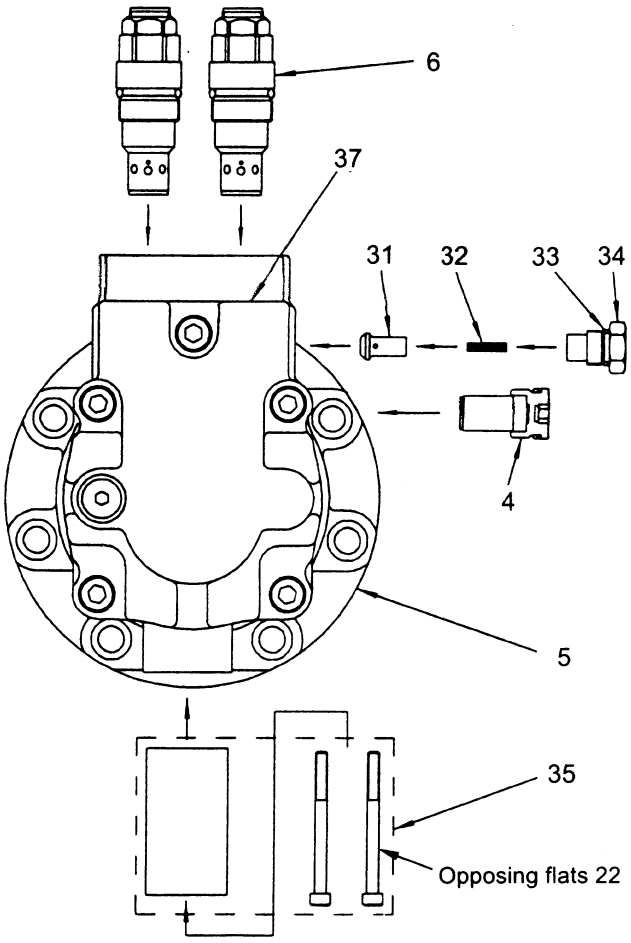
14) Tighten bolt.
[Clamping between cover (37) and housing (5)]
Tighten socket bolt (36) (Opposing flats 8) to 6.6 kgf·m (48 lbf·ft).

⚠ Then, tighten 4 socket bolts (36) evenly so that housing (5) and cover (37) are installed face to face in parallel.



15) Install relief valve, etc.
Install relief valve (6) [Opposing flats 27] on housing (5) and torque to 6 kgf·m (43 lbf·ft).
Place check valve (31) and spring (32) in housing (5), place cap (34) [Opposing flats 22] in housing and torque to 6.6kgf·m (48 lbf·ft).
Install hydraulic timer (35) [Opposing flats 5] in housing (5) and torque 1.2 kgf·m (8.7 lbf·ft).
Install plug assy (4) [Opposing flats 8] on housing (5) and torque to 6 kgf·m (43 lbf·ft)

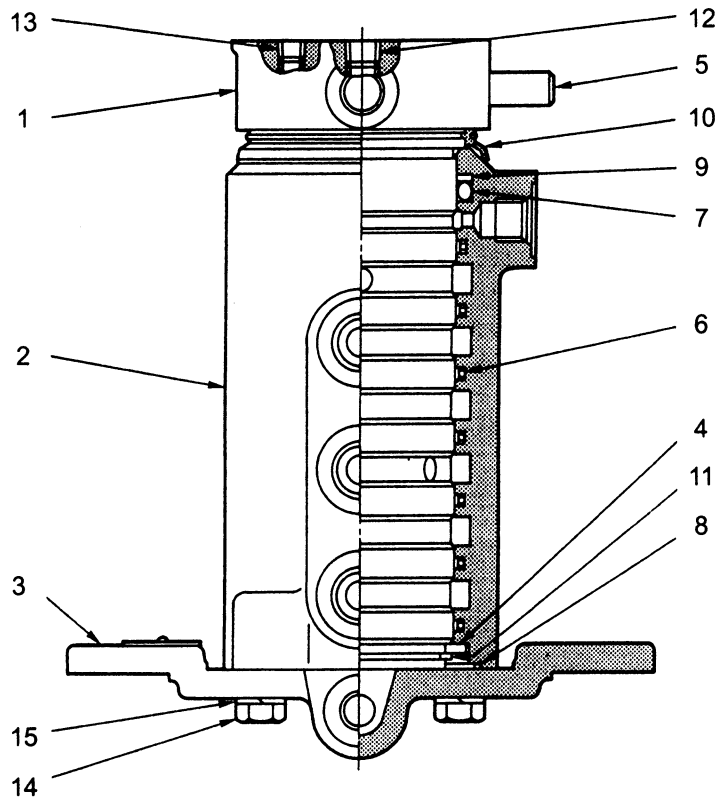
⚠ Be sure to install the removed relief valve (6), cap (34), spring (32), check valve (31), hydraulic timer (35) and plug assy (4) on the positions where they were installed before disassembly.



6. SWIVEL JOINT

6.1 CONSTRUCTION

T=Torque
kgf·m(lbf·ft)



T = 1.0 ~ 2.0 (7.2 ~ 14)

Table. 6-1 Construction

No.	NAME	Q'TY	No.	NAME	Q'TY
1	SHAFT	1	9	BACK-UP RING	1
2	BODY	1	10	DUST SEAL	1
3	FLANGE	1	11	SNAP RING	1
4	THRUST RING	1	12	PLUG	2
5	PIN	1	13	PLUG	1
6	SLIPPER SEAL	7	14	BOLT	4
7	O-RING	1	15	SPRING WASHER	4
8	O-RING	1			

Part I : REMOVING AND INSTALLING

1. TRAVEL SYSTEM'S PARTS

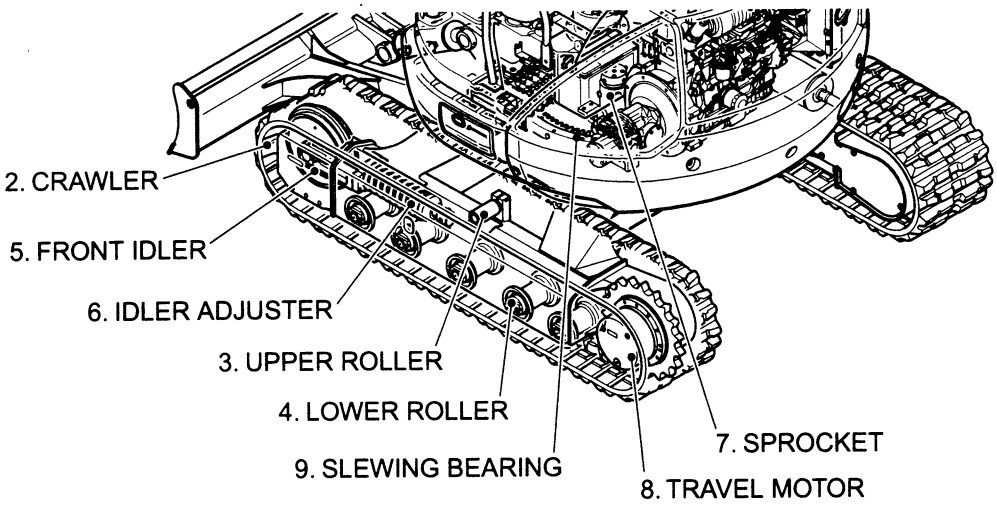


Fig. 1-1 Name and location of parts

2. CRAWLER

2.1 REMOVAL AND INSTALLATION (Rubber)

2.1.1 Removing Rubber Crawler

(1) Lift the one side of machine with attachment, as shown in Fig. 2-1, and place support under lower frame to support machine.

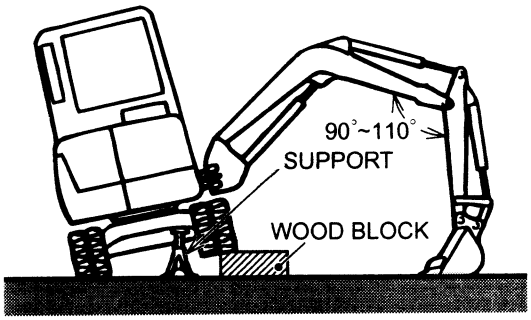


Fig. 2-1 Crawler removing position

(2) Loosen grease nipple for crawler adjuster, discharging grease in cylinder, and release tension of crawler.

: 19 mm

⚠ When loosening the grease nipple of the adjuster, do not loosen it more than one turn.

Where grease does not come out well, drive the crawler forward / reverse. The over loosening of grease nipple will cause it to jump out incurring danger of injury. So be careful not to over loosen the grease nipple. Keep body and face away from the grease nipple for safety.

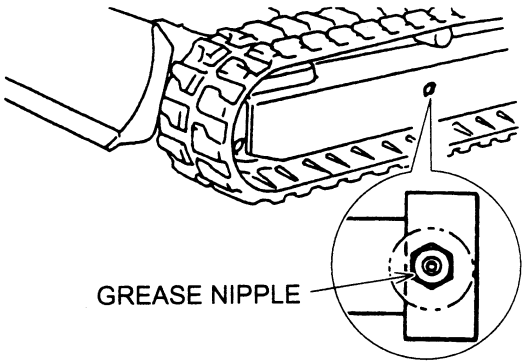


Fig. 2-2 Loosening crawler tension

(4) Place upper roller (1) on the stand jig (f) and attach plate (3) to the end face of the shaft with socket bolts (8). In that case, coat the threaded part of socket bolts (8) with Loctite #242 beforehand.

: 6 mm
Tightening torque : 3.4 kgf·m (25 lbf·ft)

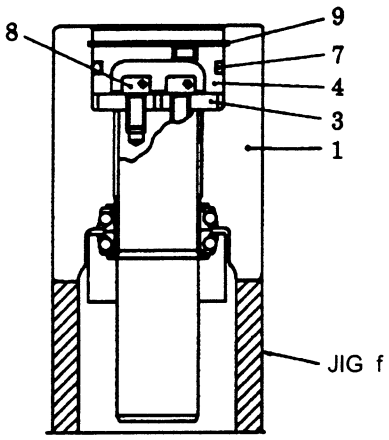


Fig. 3-13 Installing cover

(5) Fix O-ring (7) in the groove of cover (4).

- Coat grease to O-ring.

(6) Install cover (4) to upper roller (1). Use a press in this operation as a press fit is used.

(7) Fix snap ring (9) into upper roller (1).

(8) Fill in 20cc of engine oil API grade CD #30 through the plug hole of cover (4).

(9) Place seal tape around plug (10) and tighten it into the plug hole of cover (4).

: 5 mm
Tightening torque : 2.3 kgf·m (17 lbf·ft)

- After assembling the upper roller, confirm that oil is not leaking from it and that it rotates smoothly by hand.

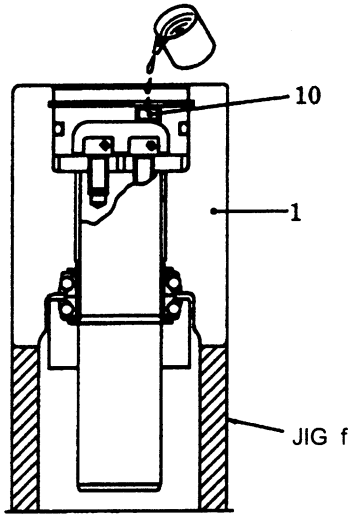


Fig. 3-14 Filling oil

5.2 CONSTRUCTION

No.	Part name	Q'ty	No.	Part name	Q'ty
1	Idler	1	5	Pin	2
2	Bushing	2	6	Shaft	1
3	Collar	2	7	O-ring (1A G 40)	2
4	Seal	2	8	Plug : PT1/8	2

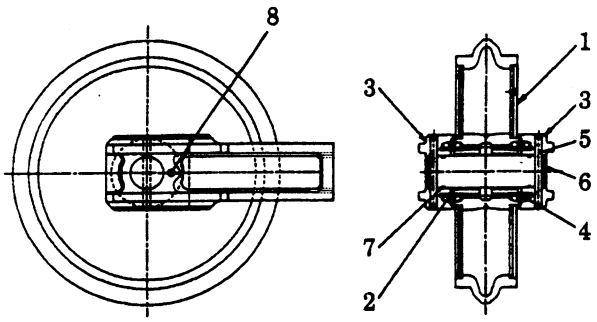


Fig. 5-4 Constuction

5.3 DISASSEMBLY AND ASSEMBLY

5.3.1 Removing

(1) Remove plug (8) on the side of collar (3) and drain oil.

: 5 mm

(2) Apply pin push bar (jig R) to the top of pin, and take out striking lightly by hammer.

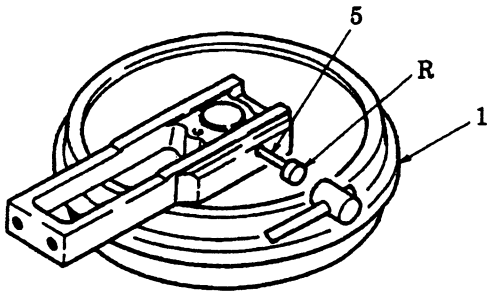


Fig. 5-5 Extruding pin

(3) Put idler (1) on repair stand (U), apply pushout jig (S) on shaft (6), push out shaft (6) with collar (3), then remove collar (3).

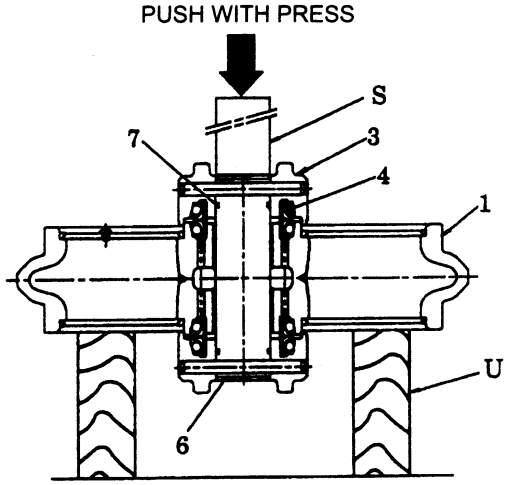


Fig. 5-6 Extruding shaft

(4) With idler (1) placed on the stand, tap bushing (2) lightly by hammer, while placing the bushing extruding rod (T) against the end face of bushing (2) evenly all round, till it comes out.

(5) Take out floating seals (4) from idler (1), collar (3). If you intend to re-use floating seals (4), confirm that there is no scoring and rusting on the contact surface and store the floating seals in pairs by placing thick paper between the sealing faces.

(6) Remove O-ring (7) from shaft (6).

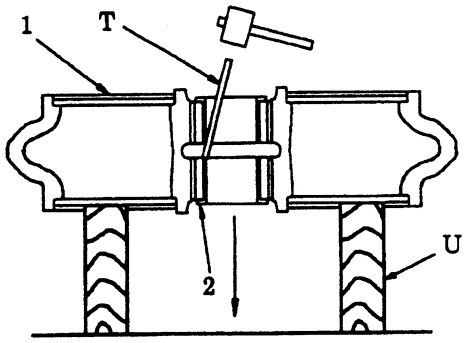


Fig. 5-7 Removing bushing

9. SLEWING BEARING

9.1 REMOVAL AND INSTALLATION

9.1.1 Removing

(1) Remove the upper slewing structure. (See Chapter PJ33 "Upper Slewing Structure")

(2) Remove capscrews (B) that fix the inner race of slewing bearing (A)

: 22 mm

(3) Remove the grease in the inner race of slewing bearing.

(4) Fix lifting-bolts to slewing bearing (A), and lift it by crane.
Weight of slewing bearing assy : 76 kg (168 lb)

9.1.2 Installing

(1) Before installing the slewing bearing, clean thoroughly the bearing and the mating surface of the lower frame to be free from dirt, oil and other foreign materials.

(2) Lift up the bearing and place it on the lower frame, aligning the "S" mark stamped on the inner race as shown in Fig. 9-3.

(3) Coat the threads of the capscrews (B) with Loctite #262 and tighten all capscrews temporarily.

(4) Tighten the capscrews at 180° intervals alternately, and tighten them up to a specified torque.

: 19 mm
T= 18.5 kgf·m (134 lbf·ft)

(5) After installing the slewing bearing on the lower frame, install upper slewing structure.

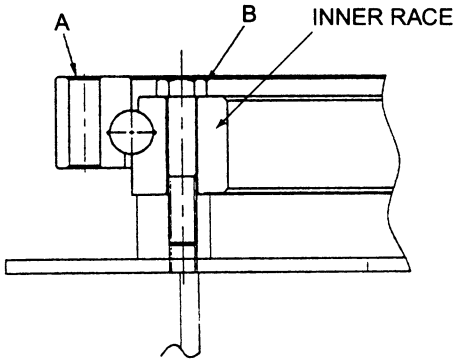


Fig. 9-1 Slewing bearing

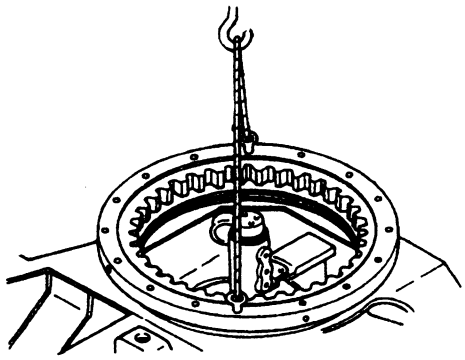


Fig. 9-2 Lifting slewing bearing

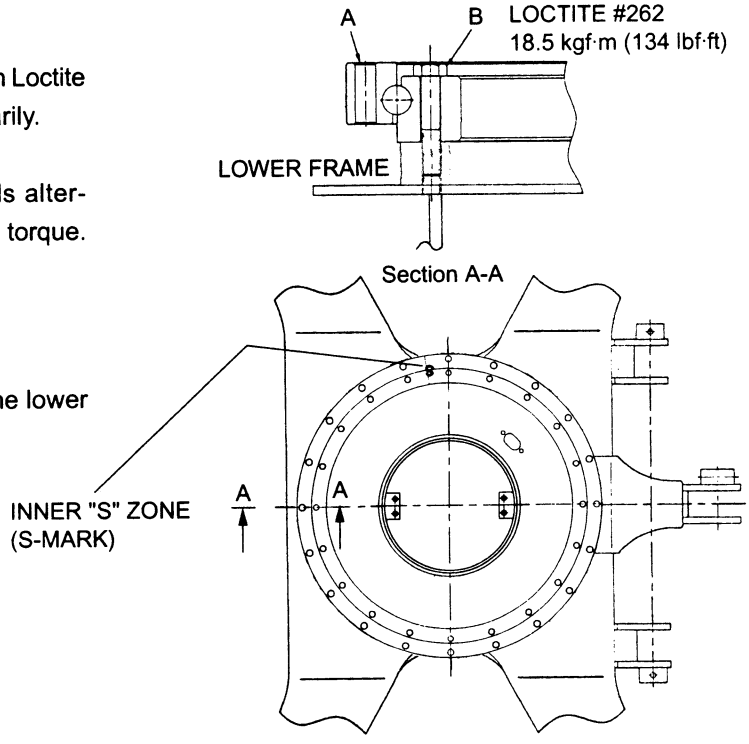
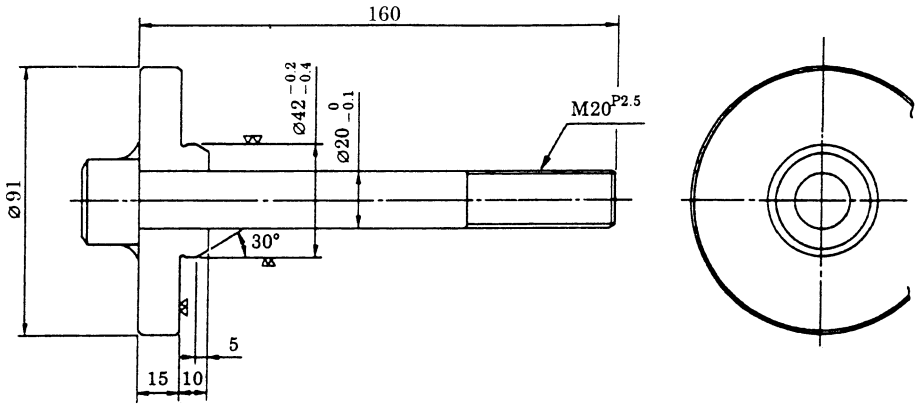
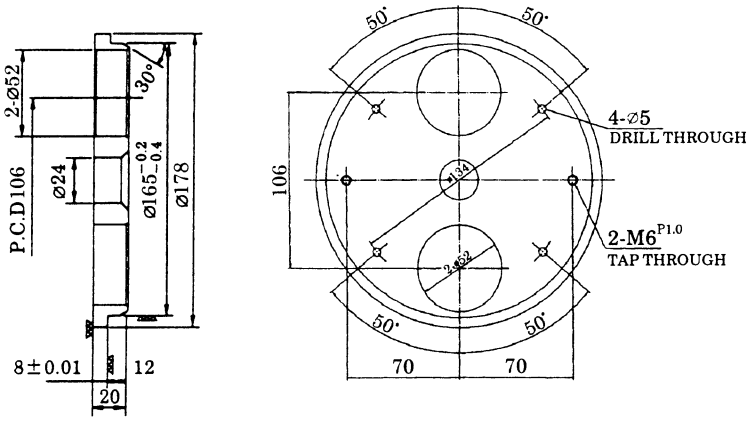


Fig. 9-3 Location of "S" mark to install slewing bearing

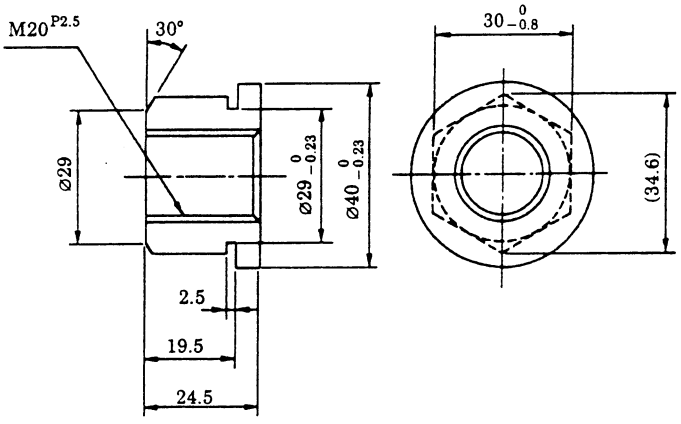
1 FLANGE BOLT



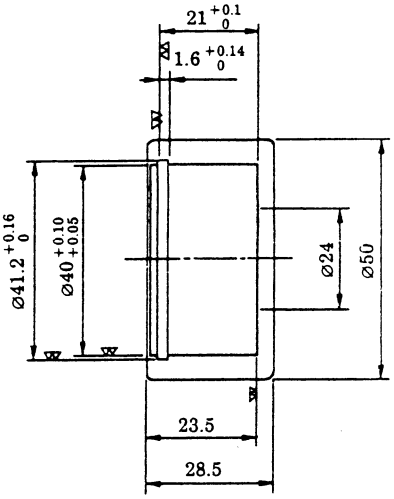
3 STANDARD HOLD FLANGE



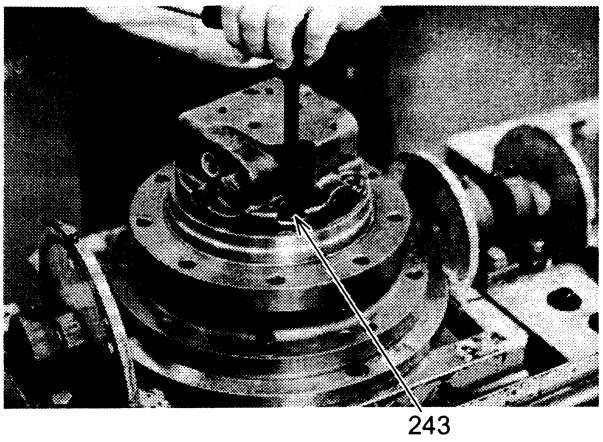
4 SPECIAL NUT



8 GUIDE RING

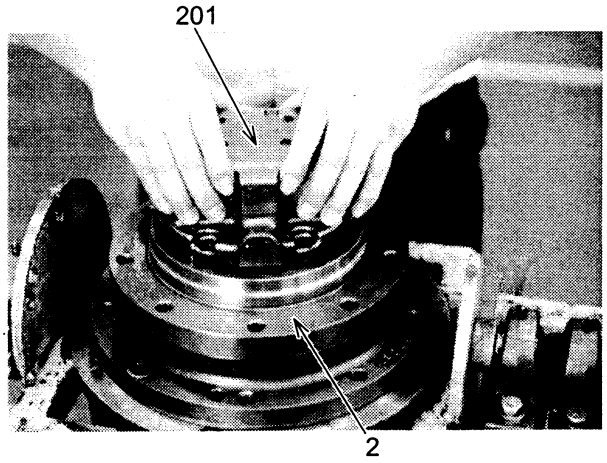


④ Loosen six socket bolts (243) from rear flange (201).



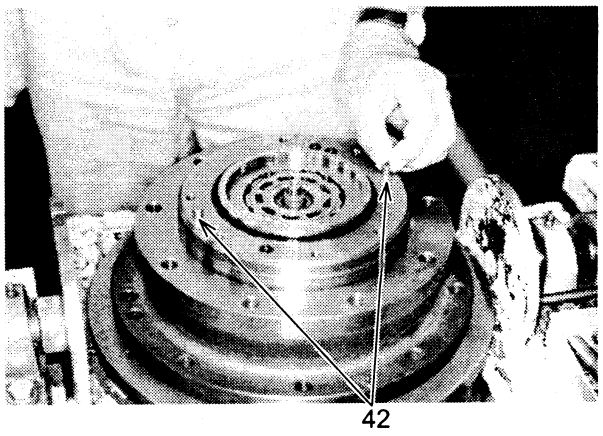
⑤ Remove rear flange (201) from spindle (2).

⚠ Hold the rear flange by both hands, hold it up gently upright and remove it.
Forced prying or striking it may cause timing plate (109) to fall and damage it.



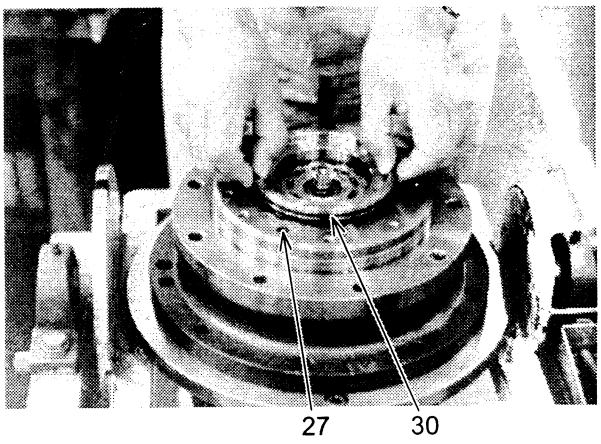
⑥ Remove parallel pins (42) from spindle (2).

⑦ Remove eight springs (113) from spindle (2).



⑧ Remove O ring (27),(30) from spindle (2).

- Do not reuse removed O ring (27), (30).

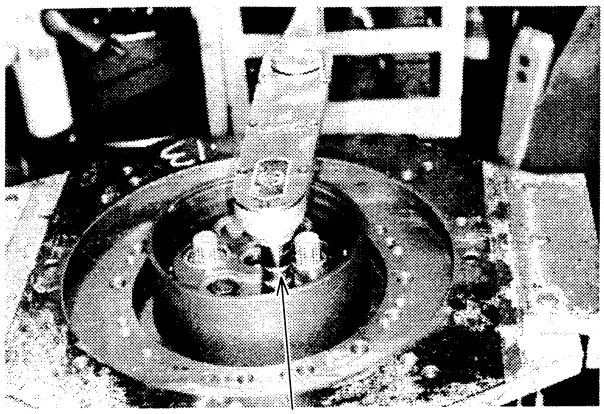


⑥ Turn over the travel motor.

⑦ Loosen two reamer bolts (19).

: 24mm

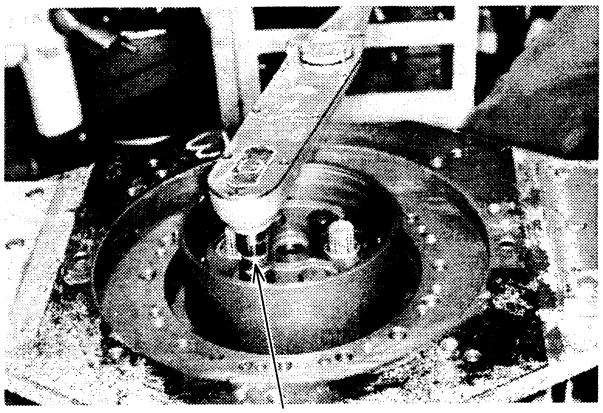
- The threaded portion of reamer bolt (19) is provided with adhesive agent and may cause the seizure on the reamer portion where the adhesive agent is applied, leading to the difficulty of disassembling. Therefore loosen reamer bolt (19) slowly. If it is hard to turn in the middle way, tighten it one more time, then loosen it again.
- The tightening torque is 25.7kgf·m (186 lbf·ft). A torque more than it is needed to loosen the bolt because of adhesive.



⑧ Loosen two capscrews (35).

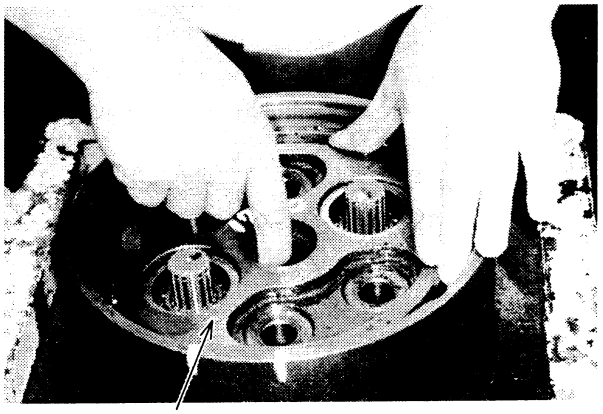
: 24mm

- The threaded portion of capscrew (35) is provided with adhesive agent and may cause the seizure on the thread portion where the adhesive agent is applied, leading to the difficulty of disassembling. Therefore loosen capscrew (35) slowly. If it is hard to turn in the middle way, tighten it one more time, then loosen it again.
- The tightening torque is 25.7kgf·m (186 lbf·ft). A torque more than it is needed to loosen the bolt because of adhesive.



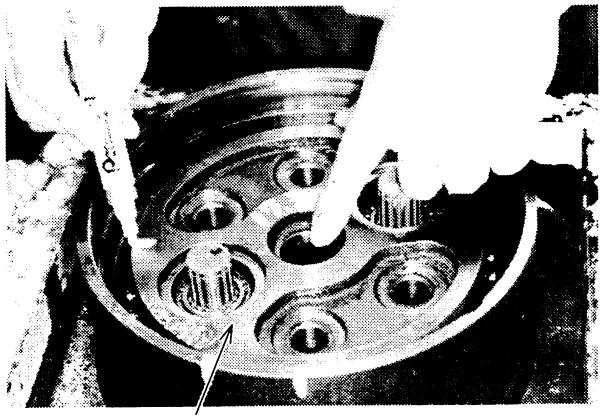
⑨ Turn over the travel motor again.

⑩ Remove hold flange (3) from spindle (2).



⑪ Put matchmarks on hold flange (3) and spindle (2) with paint marker.

- This is intended to install the hold flange (3) in the same position as the spindle (2).
- The two holes for reamer bolts (19) and two holes for capscrew in the spindle (2) are machined together. In case of they must be replaced, replace the spindle (2) and the hold flange (3) together as a set (assy). [Hereafter called spindle assy]



② Tighten two reamer bolts (19) until hold flange (3) is fitted into bearing (21) evenly.

③ Tighten two reamer bolts (19) to the specified torque.

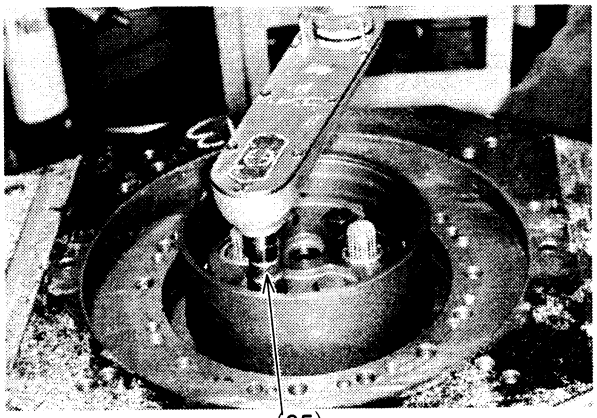
: 24mm,
Torque : 25.7kgf·m (186 lbf·ft)

④ Coat the threaded part of capscrew with adhesive.

- In case oily matter is stuck to the capscrew, degrease it and after cleaning, dry them in natural condition. Coat the capscrew with adhesive.

⑤ Tighten two capscrews (35) to the specified torque.

: 24mm,
Torque : 25.7kgf·m (186 lbf·ft)

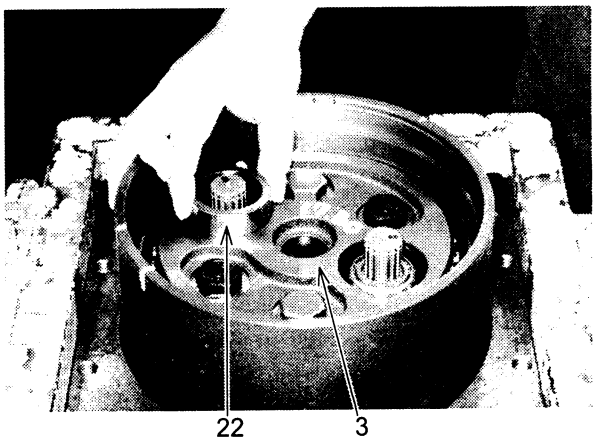


⑥ Turn over the travel motor.

⑦ Remove (two) fixing metal.

⑧ Turn over the travel motor.

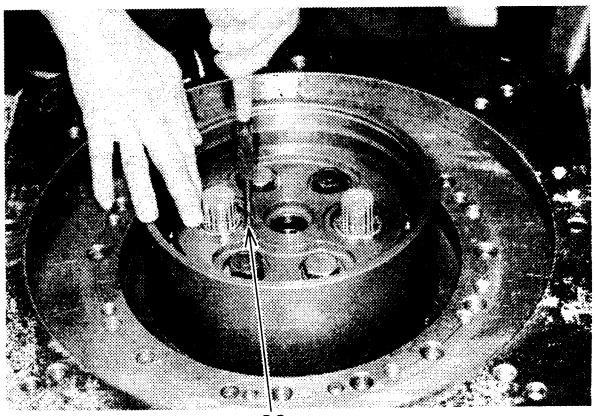
⑨ Fit the outer race of bearing (22) to hold flange (3).



6) Fixing snap ring.

① Check that spindle (2), hold flange (3), crankshaft (9), bearing (22) and spacer (12) are not replaced.

- Go to next process ② if nothing is replaced.
- Even if one of them is replaced, adjust clearance in shaft direction of bearing (22) and proceed to next process.
  (Refer to Article "Clearance adjustment procedure of bearing (22) in shaft direction" in page 34- II -1-51.)
- When replacement of snap ring (20) only is required, use the same snap ring as the removed snap ring (20) or select one equivalent to the removed one from 15 types.



17) Installing cover (8)

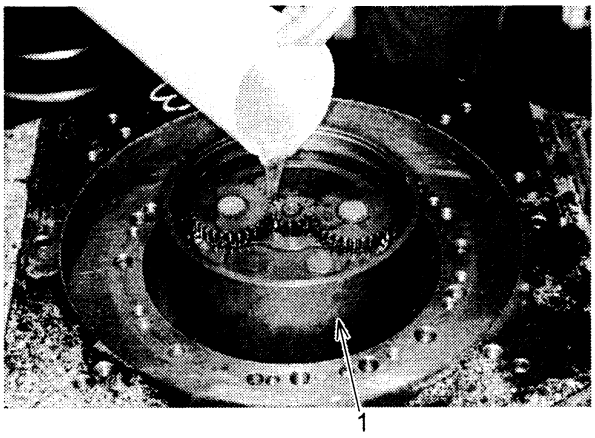
① Fill gear oil in hub (1).

Oil volume : 1.0 ℓ (0.26gal)

Type of oil : SAE#90 GL4

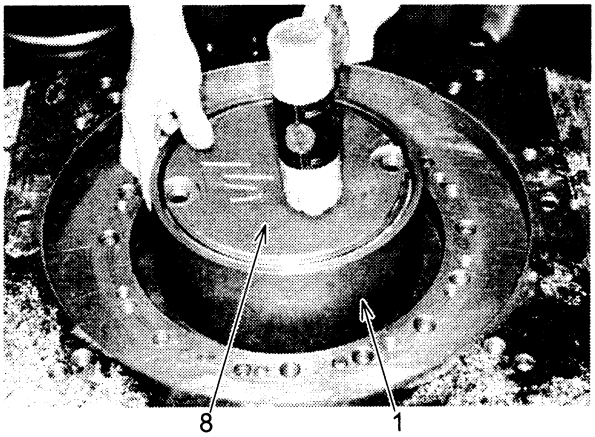
② Fit O ring (29) into the O ring groove of cover (8).

- Apply grease to O ring (29).

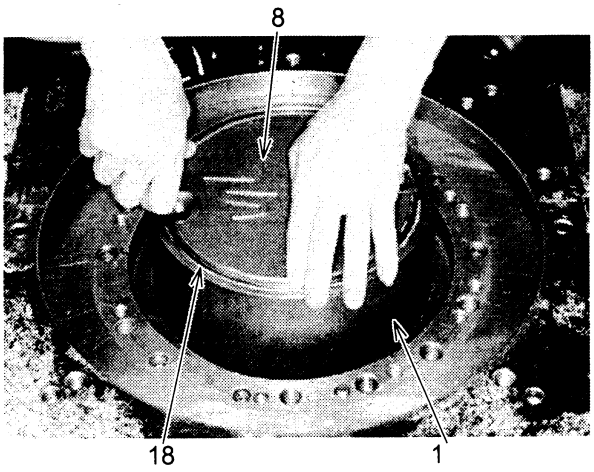


③ Install hub (1) to cover (8).

- Align the matching marks on cover (8) and hub (1) and install them.
- Install cover (8) in hub (1), tapping the outer circumference of cover (8) lightly by means of a plastic mallet. Use care that if the cover is fixed jerkily by striking it hard, the O ring is scored and brings about an oil leakage.



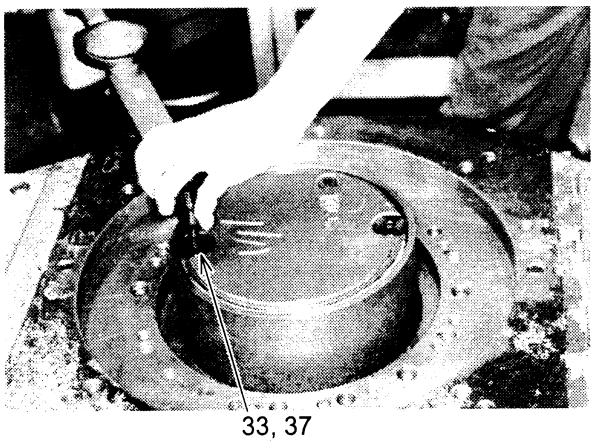
④ Fix ring (18) into the ring groove of hub (1).



⑤ Wind seal tape on two plugs (33) and install it on cover (8).

: 8mm,

Torque : 6kgf·m (43 lbf·ft)



KOBELCO

Book Code No. S5PJ4201E

SHOP MANUAL SK45SR-2

TROUBLESHOOTING
(HYDRAULIC SYSTEM)

TABLE OF CONTENTS

PJ4

KOBELCO CONSTRUCTION MACHINERY CO., LTD.

KOBELCO

Book Code No. S5PJ4301E

SHOP MANUAL SK45SR-2

TROUBLESHOOTING
(ELECTRICAL SYSTEM)

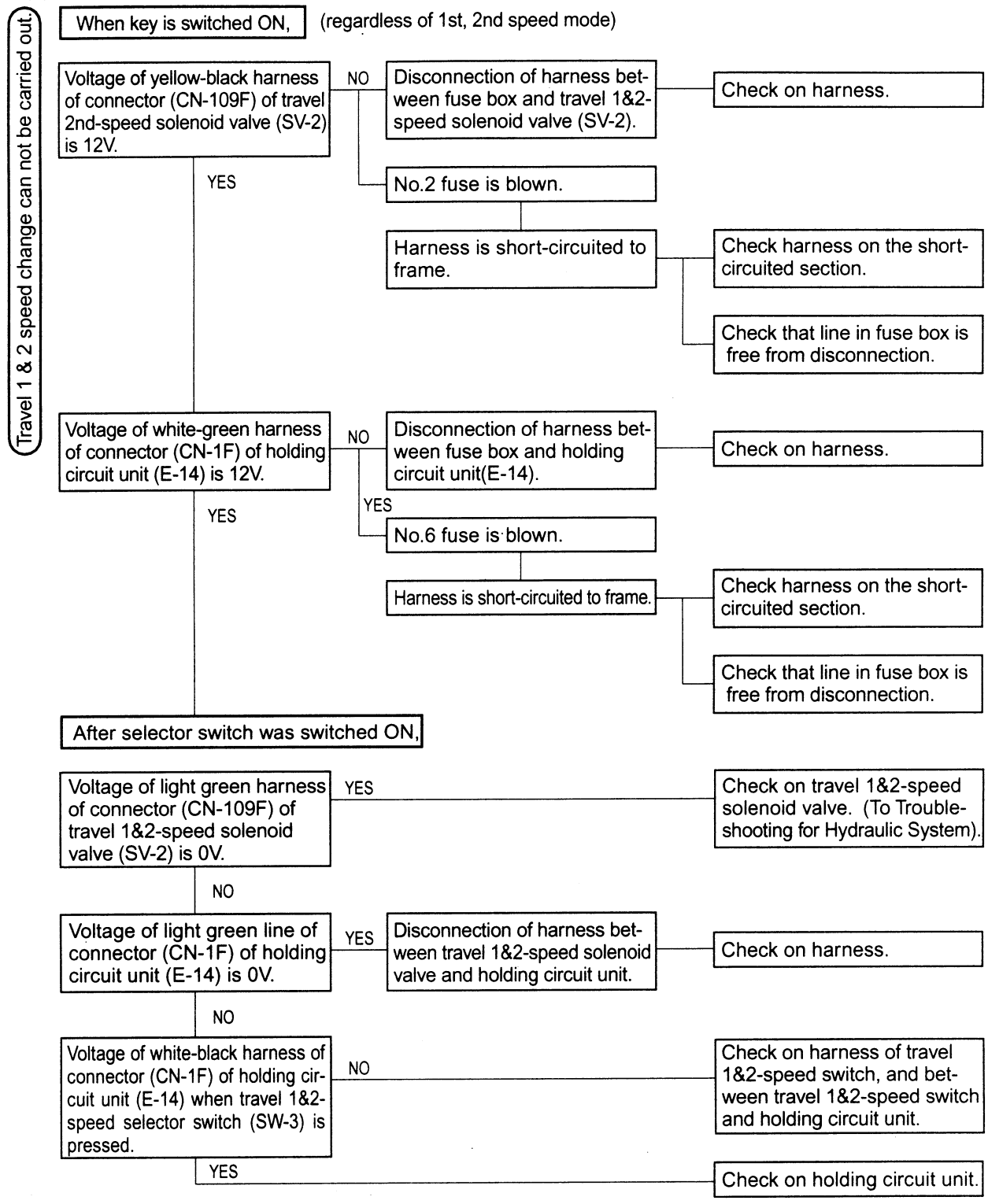
TABLE OF CONTENTS

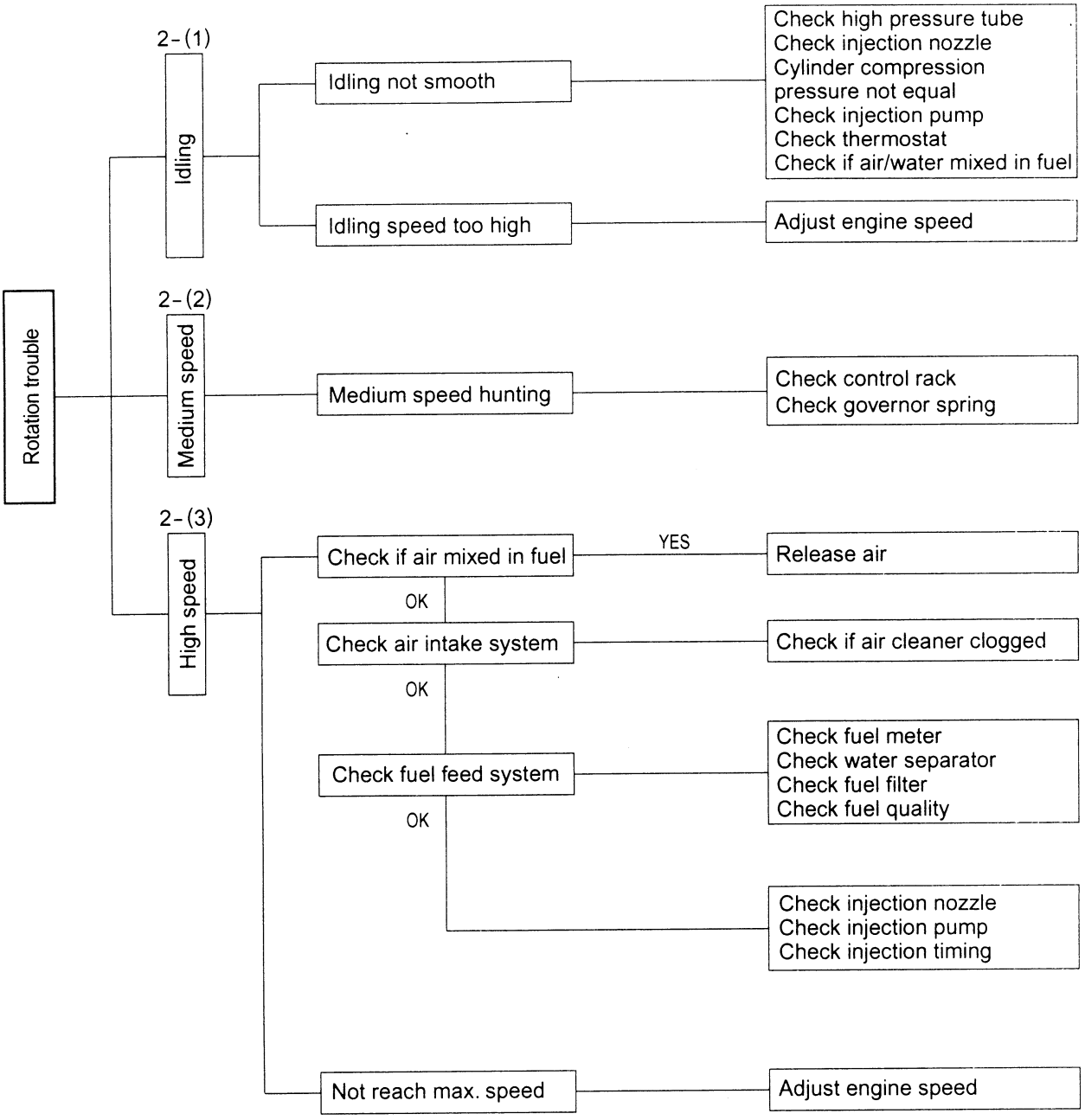
PJ4

KOBELCO CONSTRUCTION MACHINERY CO., LTD.

3-(1)

Travel 1 & 2 speed change can not be carried out.





Note : Check the above items in the condition of coolant temperature at 50 ± 5 °C. (122 ± 9 °F)

1. Specifications and Performance

1-1 2TNE68

* **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 / Unit	2TNE68										
SPECIFICATIONS	Application		—	VM						CH		VH		
	Type		—	Vertical, 4-cycle water-cooled diesel engine										
	Combustion system		—	Special swirl pre-combustion chamber										
	No. of cylinders – Bore × Stroke		mm	2 – 68 × 72										
	Displacement		ℓ	0.523										
	Firing order		—	1 – 2										
	Revolution speed		rpm	2000	2200	2400	2600	2800	3000	3000	3600	3200	3400	3600
	Output*	Continuous rating	kW(HP)	—	—	—	—	—	—	7.72 (10.5)	9.12 (12.4)	—	—	—
		Max. rating	kW(HP)	5.74 (7.8)	6.25 (8.5)	6.84 (9.3)	7.43 (10.1)	7.94 (10.8)	8.46 (11.5)	8.46 (11.5)	10.0 (13.6)	8.68 (11.8)	9.19 (12.5)	9.64 (13.1)
	Max. revolution speed at no load		rpm	2180^{+50}_{0}	2375^{+50}_{0}	2570^{+50}_{0}	2780^{+50}_{0}	2970^{+50}_{0}	3180^{+50}_{0}	3180^{+50}_{0}	3780^{+50}_{0}	3425^{+50}_{0}	3640^{+50}_{0}	3850^{+50}_{0}
	Min. revolution speed at no load			≤800						≤1500		≤800		
	Direction of rotation		—	Counterclockwise (viewed from flywheel)										
	Power take off		—	Flywheel										
	Compression ratio		—	23.0										
	Fuel injection timing (FID, b.T.D.C.)		deg	14±1						16±1				
	Compression pressure		MPa (kgf/cm²)	3.24±0.1 (33±1), at 250 rpm										
	Fuel injection pressure		MPa (kgf/cm²)	$11.8^{+1.0}_{0}$ (120^{+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	1.6/0.6						2.3/1.0				
	Recommended lubricating oil		—	API grade CC class or higher										
	Cooling system		—	Liquid cooling/Radiator										
	Cooling water capacity		ℓ	0.6 (for engine only)										
	Cooling fan No. of blade × dia.		mm	Discharge type, 5 × ϕ290										
	Crank V-pulley dia./ Fan V-pulley dia.		mm	ϕ95/ϕ85										
	Governor		—	Mechanical centrifugal governor (All speed type)										
	Starting system		—	Electrical										
	*1 Dimensions L × W × H		mm	373.5 × 417 × 498 / 383.5 × 417 × 498						383.5 × 409 × 540		373.5 × 417 × 540 / 383.5 × 417 × 540		
	*1 Dry weight		kg	55 / 65						65		55 / 65		
PERFORMANCE	Governing perform-ance (full speed range)	Transient speed difference	%	≤12						≤10		≤12		
		Steady state speed band	%	≤9	≤8		≤7		≤6	≤5		≤7		
		Recovery time	sec	≤6										
		Fluctuation of revolution	rpm	≤30						≤20		≤30		
	L.O. press.	Rated operation	MPa (kgf/cm²)	0.25±0.05 (2.5±0.5)			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 hausing

1-11. 4TNE88

*** 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 / Unit	4TNE88							
SPECIFICATIONS	Application		—	CL		VM					
	Type		—	Vertical, 4-cycle water-cooled diesel engine							
	Combustion system		—	Direct injection system							
	No. of cylinders – Bore × Stroke		mm	4 – 88 × 90							
	Displacement		ℓ	2.189							
	Firing order		—	1 – 3 – 4 – 2 – 1							
	Revolution speed		rpm	1500	1800	2000	2200	2400	2600	2800	3000
	Output*	Continuous rating	kW(HP)	16.4 (22.0)	19.6 (26.3)	—	—	—	—	—	—
		Max. rating	kW(HP)	18.0 (24.1)	21.6 (29.0)	24.1 (32.3)	26.5 (35.5)	28.8 (38.6)	31.3 (42.0)	33.7 (45.2)	36.0 (48.3)
	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}
	Min. revolution speed at no load			≤1200		≤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	
	Compression pressure		MPa (kgf/cm²)	3.43±0.1 (35±1), at 250 rpm							
	Fuel injection pressure		MPa (kgf/cm²)	$19.6^{+1.0}_{0}$ (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					
	*1 Dry weight		kg	184		160 /170					
PERFORMANCE	Governing performance (full speed range)	Transient speed difference	%	≤10	≤8	≤12					
		Steady state speed band	%	≤5	≤4	≤9		≤8		≤7	
		Recovery time	sec	≤5		≤6					
		Fluctuation of revolution	rpm	≤15		≤25					
	L.O. press.	Rated operation	MPa (kgf/cm²)	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 hausing

4. Troubleshooting

4-1. Trouble causes and remedies

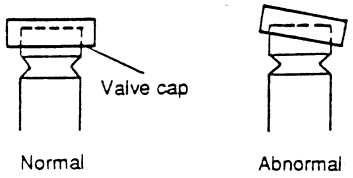
The following table summarizes the symptoms and causes of general troubles. If any symptom of trouble is found, a corrective action shall be taken before the said symptom develops into a serious accident.

Carefully read Chapter 6, Measurement, Inspection and Adjustments, and Chapter 7, Measuring Procedures, Service Data and Countermeasures. Familiarize yourself with Chapter 6 and Chapter 7, which practice is extremely important for extending the service life of the engine.

	Cause \ Symptom of trouble	Fails to start				Insufficient engine output			Poor exhaust color		High knocking sound during combustion	Abnormal engine noise	Uneven combustion sound	Hunting		Large engine vibration	Poor return to low speed	Excessive fuel consumption	Lubricating oil				Much blow-by gas	Cooling water		Air intake		Exhaust temperature rise				Corrective action
		Engine will not start.	Engine starts but stops soon. Exhaust smoke: Nil	Exhaust smoke: Less	Exhaust smoke: More	Exhaust color: Regular	Exhaust color: White	Exhaust color: Black	During work: White	During work: Black				During idling	During work				Excessive consumption	Diluted by fuel oil	Mixture with water	Low L.O. pressure		Overheat	Low water temperature	Pressure drop	Pressure rise					
Engine System	Improper clearance of intake/exhaust valve	○	○			○			○			○													○		○					Adjust valve clearance (Refer to Chapter 6, 6-2.)
	Compression leakage from the valve seat					○		○		○		○						○					○			○		○					Rap valve seat (Refer to Chapter 7, 7-1-2.)
	Seized intake/exhaust valve	○			○	○		○		○		○			○	○				○			○			○						Correct or replace.
	Blowout of cylinder head gasket					○															○			○								Replace the gasket. (Refer to Chapter 8, 8-2-(10))
	Seized or broken piston ring	○			○		○		○			○		○		○			○	○			○	○				○				Replace the piston ring. (Refer to Chapter 7, 7-4-3, 4, (5))
	Worn piston ring, piston and cylinder	○			○		○		○				-						○	○			○									Make honing and use oversize parts. (Refer to Chapter 7, 7-2-3. & 7-4-(8))
	Seized crank pin metal and bearing	○	○									○		○	○	○							○									Repair or replace.
	Improper arrangement of piston ring joints		○			○													○				○									Correct the ring joint positions. (Refer to Chapter 7, 7-4-(5))
	Reverse assembly of the piston ring					○		○											○				○									Properly reassemble. (Refer to Chapter 7, 7-4-(5))
	Worn crank pin and journal metal				○							○		○	○	○					○											Measure and replace . Refer to Chapter 7, 7-5-3. and 7-7-(5))
	Loosened connecting rod bolt											○				○					○											Tighten bolt to the specified torque. (Refer to Chapter 10, 10-1.)
	Foreign matter trapped in combustion chamber	○										○							○				○									Disassemble and repair the combustion chamber. Eliminate foreign matter.
	Excessive gear backlash											○																				Adjust meshing of gears. (Refer to Chapter 7, 7-8-(2))
	Worn valve guide of intake/exhaust valves					○													○				○									Measure and replace. (Refer to Chapter 7, 7-1-(3))
	Poor governor		○											○	○	○	○															Repair and adjust. (Refer to Chapter 13.)
	Improper open/close timing of intake/exhaust valves	○				○	○	○	○			○																				Adjust valve clearance (refer to Chapter 6, 6-2) and check intake/exhaust valve timing (Refer to Chapter 9, 9-1)
Turbocharger	Dirty blower						○		○																	○						Clean the blower.
	Waste gate malfunction						○		○																	○						Disassemble and inspect the waste gate.
	Worn journal bearing					○		○																								Disassemble and inspect the journal bearing.
Cooling Water System	Cooling effect of radiator, excessive							○									○							○								Malfunction of thermostat (kept closed). (Refer to Chapter 6, 6-9)
	Cooling effect of radiator, insufficient						○																○					○				Malfunction of thermostat (kept opened). (Refer to Chapter 6, 6-9) Slipping fan belt (Refer to Chapter 6, 6-3)
	Insufficient cooling water level						○																○					○				Check water leakage from Cooling water system (Refer to Chapter 6, 6-7) and clean cooling water system (Refer to chapter 3, 3-1)
	Cracked water jacket																			○	○		○									Repair and replace.
	Slackened fan belt tension						○																○					○				Adjust fan belt tension. (Refer to Chapter 6, 6-3)
	Poor thermostat						○																○	○								Check or replace. (Refer to Chapter 6, 6-9)

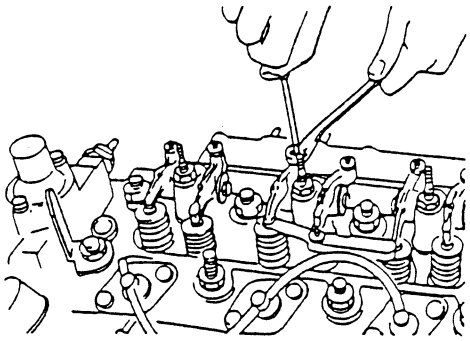
6-2. Adjusting the valve head clearance

(1) Inspect and adjust a valve head clearance while the engine is in cold state.

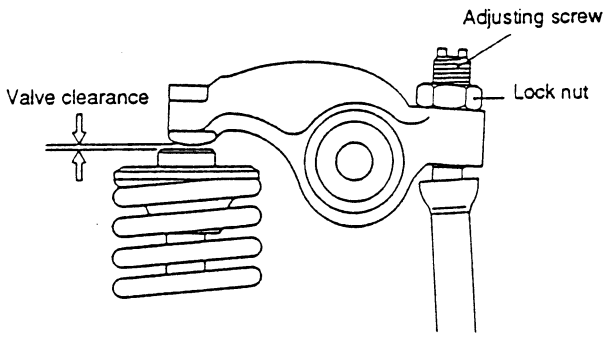


(2) Raise the piston in the cylinder to be measured to the top dead center (TDC) of compression.

(3) Loosen the lock nut and adjusting screw. Make sure that the valve cap is free from inclination or trapped dirt.



(4) Insert a thickness gauge in between the rocker arm and valve cap. Tighten the adjusting screw until the clearance listed below is attained.



(Adjusting the valve head clearance)

(mm)

	All models
Intake/exhaust valve head cleaarance	0.15 ~ 0.25

* : *1. If the valve cap is worn or otherwise damaged on the head, replace it with a new one.*

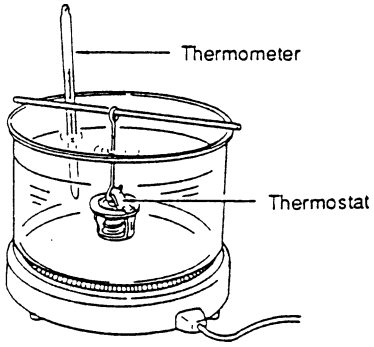
2. Make sure that the valve cap is nested on the head of intake/exhaust valves.

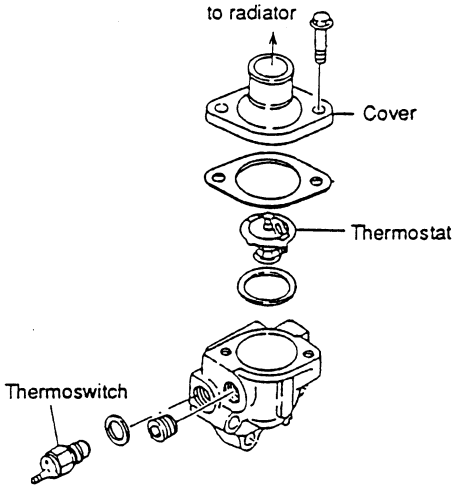
6-9. Checking the sensors

1. Checking the thermostat and thermoswitch

(1) Thermostat

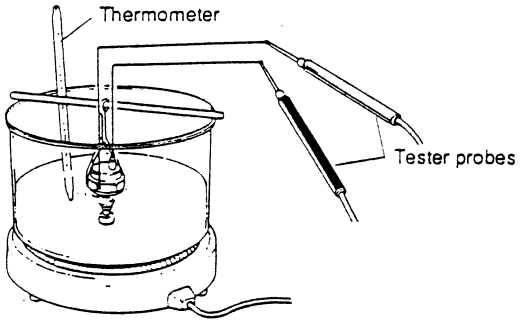
Put a thermostat into water in a container. While measuring water temperature, heat the water. Make sure that the thermostat functions at a temperature of 69.5-72.5°C. (80.5 ~ 83.5°C are used as option parts)





(2) Thermoswitch

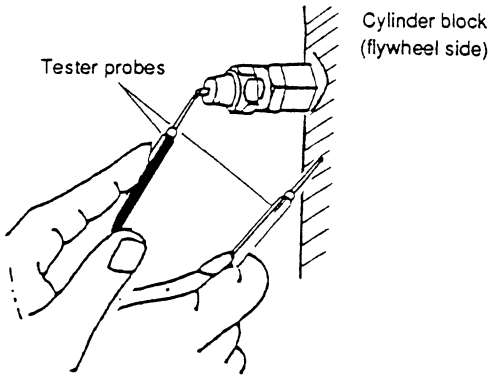
Put a thermoswitch into an antifreeze or oil in a container. While measuring liquid temperature, heat the liquid. If the tester shows continuity at a temperature of 107-113°C, the thermoswitch is acceptable.



2. LO pressure switch

Remove the connector from the LO pressure switch.

While running the engine, bring the tester probes into contact with the switch terminal and cylinder block. If the tester shows continuity, the LO pressure switch is defective.



(Continuity test)

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 incorrectable.

(3) Thoroughly clean each oil hole. Make sure that it is not clogged.

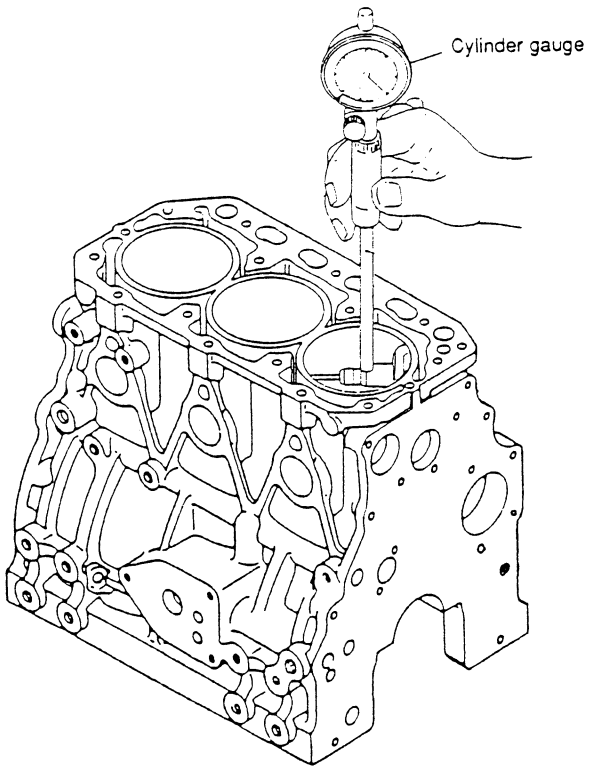
2. Measuring the bore and distortion of the cylinder

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:

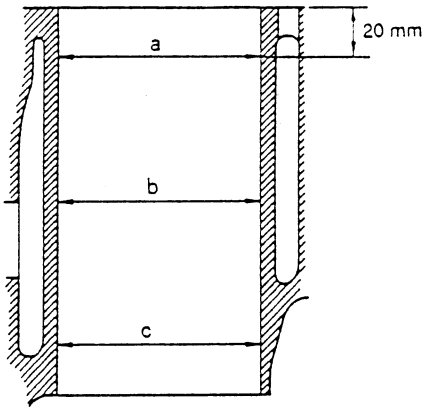
- ○ Roundness:
  Difference between max. and min. bore values on the same cross section of each liner.
- ○ Cylindricity:
  Difference between max. and min. bore values in the same direction of each liner.

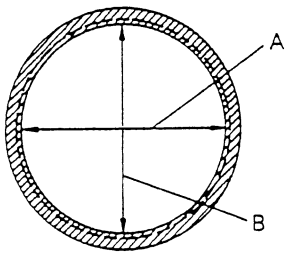
Honing (honing and boring) is required when the measured value exceeds the limit.

* *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

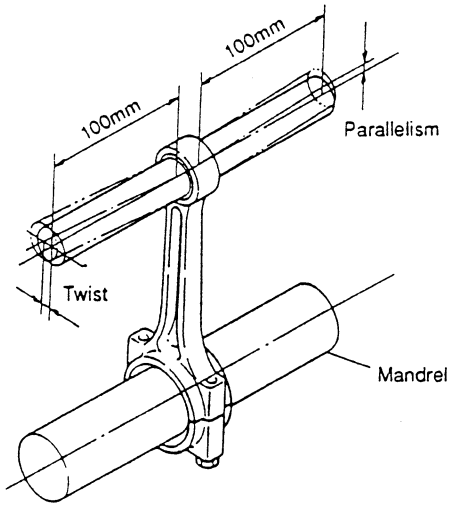
Inspect the portion near the boundary of the chamfered portion and I-beam section of the big and small ends of the connecting rod as well as the portion near the oil hole of the bushing at the small end for cracks, deformation, and discoloration.

2. Measuring the twist and parallelism

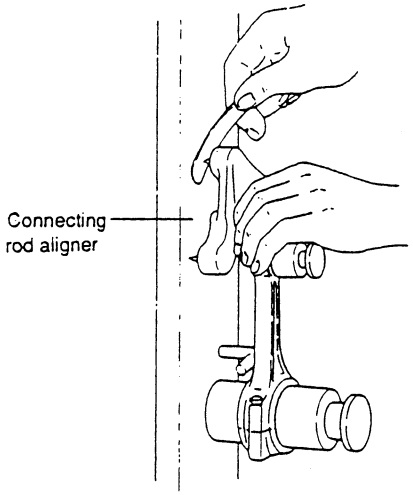
Measure the twist and parallelism by use of the connecting rod aligner.

(mm)

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



(Measuring the twist and parallelism)



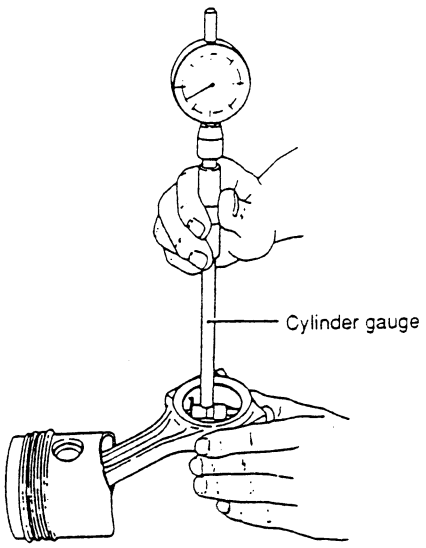
(Measuring the twist with connecting rod aligner)

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

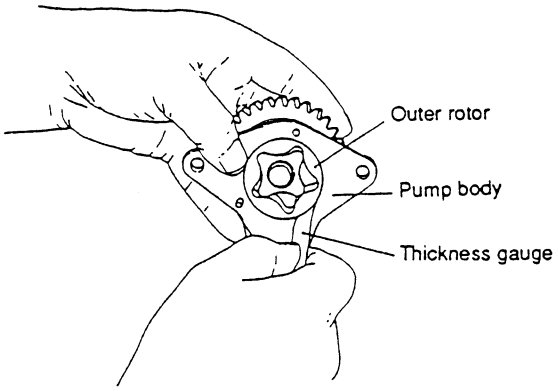
7-9. Trochoid pump

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



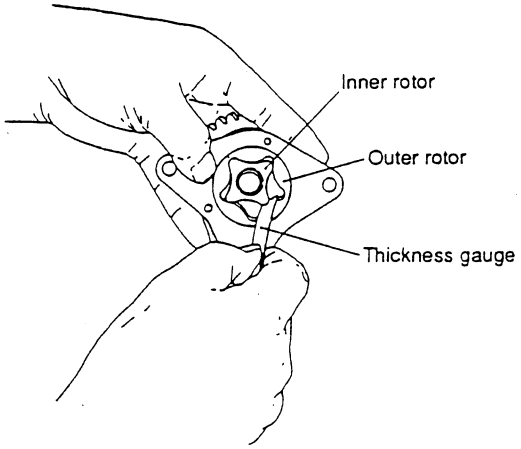
(Measuring the clearance between outer rotor and pump body)

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



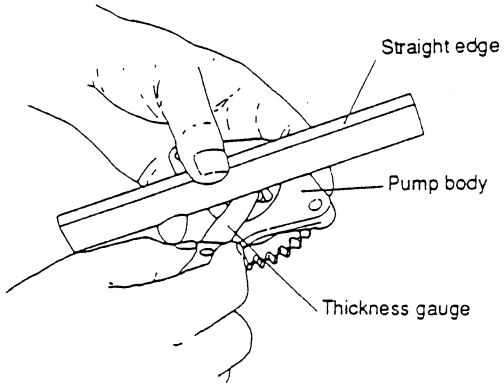
(Measuring the clearance between outer rotor and inner rotor)

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	0.15



(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.

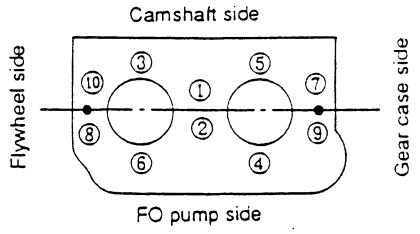
(2) Push the oil pressure regulating valve piston from the oil hole side, and replace the entire assembly if the piston does not return due to spring breakage, etc. (Engine with oil cooler only)

(3) Make sure that the rotor shaft rotates smoothly and easily when the drive gear is rotated.

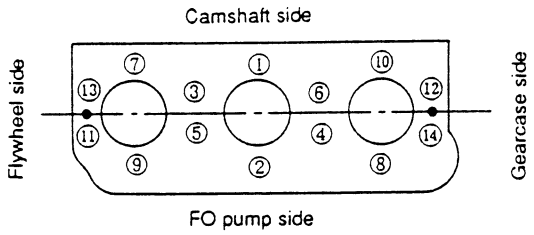
(10) Order of tightening cylinder heads and tightening torque

Tighten cylinder heads in numerical order shown below to the specified torque.

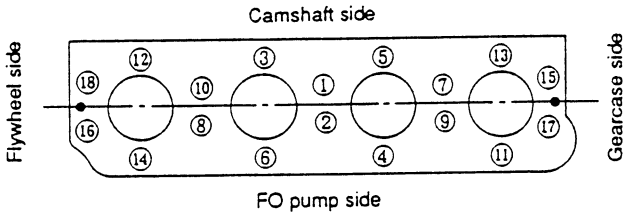
(2 cylinder)



(3 cylinder)



(4 cylinder)



(kgf-m)

	2/3TNE68	3TNE74	3TNE78A 3TNE82A	3/4TNE82 3/4TNE84(T) 3/4TNE88
Tightening torque	3.8 ~4.2	6.0~6.5	6.8~7.2	8.7~9.3

(11) After having reassembled the cylinder heads, carry out confirmation running to see if they are free from leakage of water and oil.