HYDRAULIC EXCAVATOR

SHOP MANUAL model SK15SR SK20SR

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

*GENERAL

PM01.	SPECIFICATION	PM04.	MAINTENANCE STANDARD AND TEST PROCEDURE
—	OPERATION AND CONTROLS (Refer to Operators Manual)	—	PREVENTIVE MAINTENANCE (Refer to Operators Manual)
PM03.	LOCATION AND WEIGHT OF COMPONENTS	PM07.	WORKING STANDARD

*SYSTEMS

PM12.	HYDRAULIC SYSTEM	PM22.	CONTROL SYSTEM
PM15.	UPPER STRUCTURE	PM25.	ELECTRIC SYSTEM
PM18.	TRAVEL SYSTEM		
PM21.	ATTACHMENTS	PM29.	TROUBLE SHOOTING

*COMPONENTS

12.	HYDRAULIC PUMP	16.	SWIVEL JOINT
13.	CONTROL VALVE	17.	HYDRAULIC CYLINDER
14.	OTHER VALVES		
15.	HYDRAULIC MOTOR	50.	ENGINE

*PROCEDURE

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

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

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

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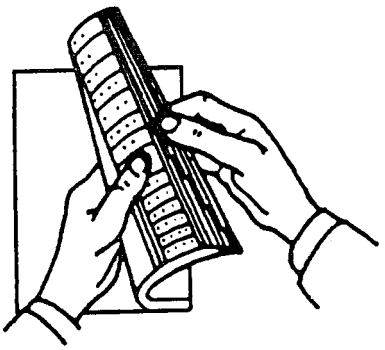
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SHOP MANUAL model SK15SR SK20SR

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○How to Index each Shop Manual Section
The GENERAL of this shop manual consists of 8 headings as shown above. Each section can be easily referred to by indexes appended to the margin of the page as indicated on the right. Please use the indexes for speedy reference.



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GENERAL

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1. CANOPY OR CAB (OPT)

1.1 REMOVAL AND INSTALLATION OF CANOPY ASSY

Fig. 1-1 shows the constitution of canopy assy.
Carry out the removal and installation referring to Fig. 1-1 and Table 1-1.
Weight of canopy : 40kg (88lbs)

Major component parts
(related to removal and installation)

No.	NAME	Q'TY	No.	NAME	Q'TY
1	CANOPY	(1)1	4	SEMS BOLT	(4)4
2	SUPPORT	(1)1	5	CAPSCREW	(–)4
3	SEMS BOLT	(10)5	6	HOOK	(–)1

※Figures in ( ) are applicable for machine numbers;
PU06001~PU06393
PM02001~PM02739

Table 1-1 Tightening torque

No.	Hex. (㎜)	Torque : kgf·m (ft·lbs)
3	17	3.5±0.4(25±3)
4	19	6.1±0.6(44±4)

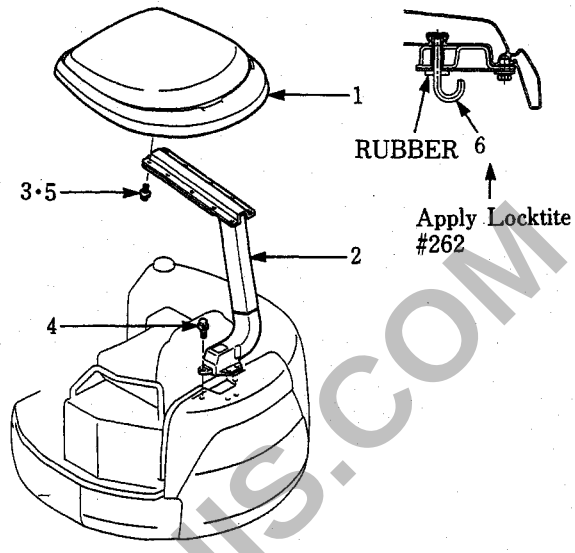


Fig. 1-1 Removal and installation of canopy assy

1.2 REMOVAL AND INSTALLATION OF CAB ASSY

1.2.1 Preparation for Removal and Installation of Cab Assy

(1) Remove the floor mat.
(2) Disconnection of harness connector
1) Disconnect the harness for cab at the behind of operator seat.

1.2.2 Removal and Installation of Cab

(1) Removal of cab fixing bolts
1) Remove capscrews (9) (10)(13) that are fixing the cab.
: 19㎜, 24㎜
(2) Lifting up cab
Apply a wire rope sling to the sling fitting provided on the ceiling of cab, and lift it up to remove.
Weight of cab : 140kg (310lbs)

⚠ While lifting up/down the cab, pay special attention not to get touch it with the control boxes of left and right, each kind of levers, etc.

(3) Installation of cab
The installation is the reverse order of the removal.
1) Install the capscrews (9), (10) and (13) to fix the cab.
• Confirm the proper positioning for each kind of sheets and rubbers.

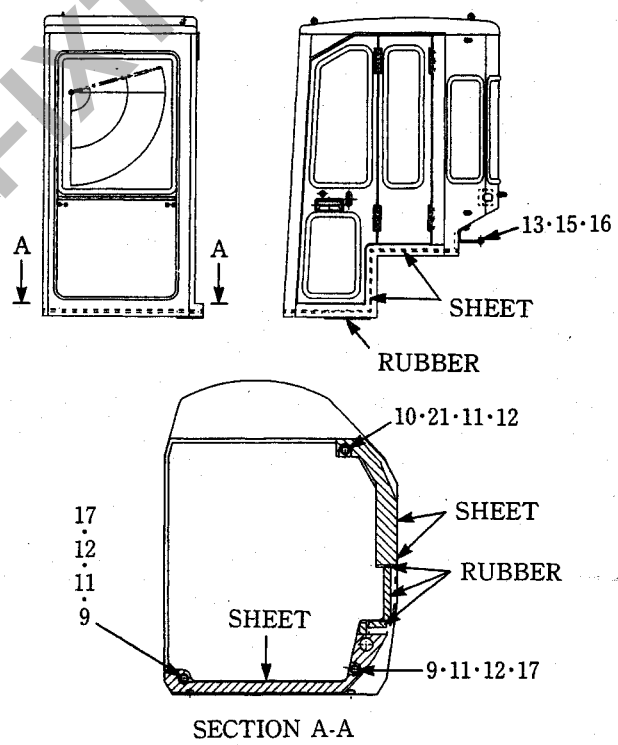


Fig. 1-2 Removal and installation of cab assy

Major component parts
(related to removal and installation)

No.	NAME	Q'TY	No.	NAME	Q'TY
1	CAB ASSY	1	13	CAPSCREW	2
9	CAPSCREW	2	15	WASHER	2
10	CAPSCREW	1	16	LOCK WASHER	2
11	WASHER	3	17	BOSS	2
12	LOCK WASHER	3	21	SPACER	1

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2. HYDRAULIC CIRCUITS AND COMPONENT MODELS

2.1 STANDARD SPECIFICATION

■SK15SR Applicable machines : PU06001～PU07000
: PU07001～

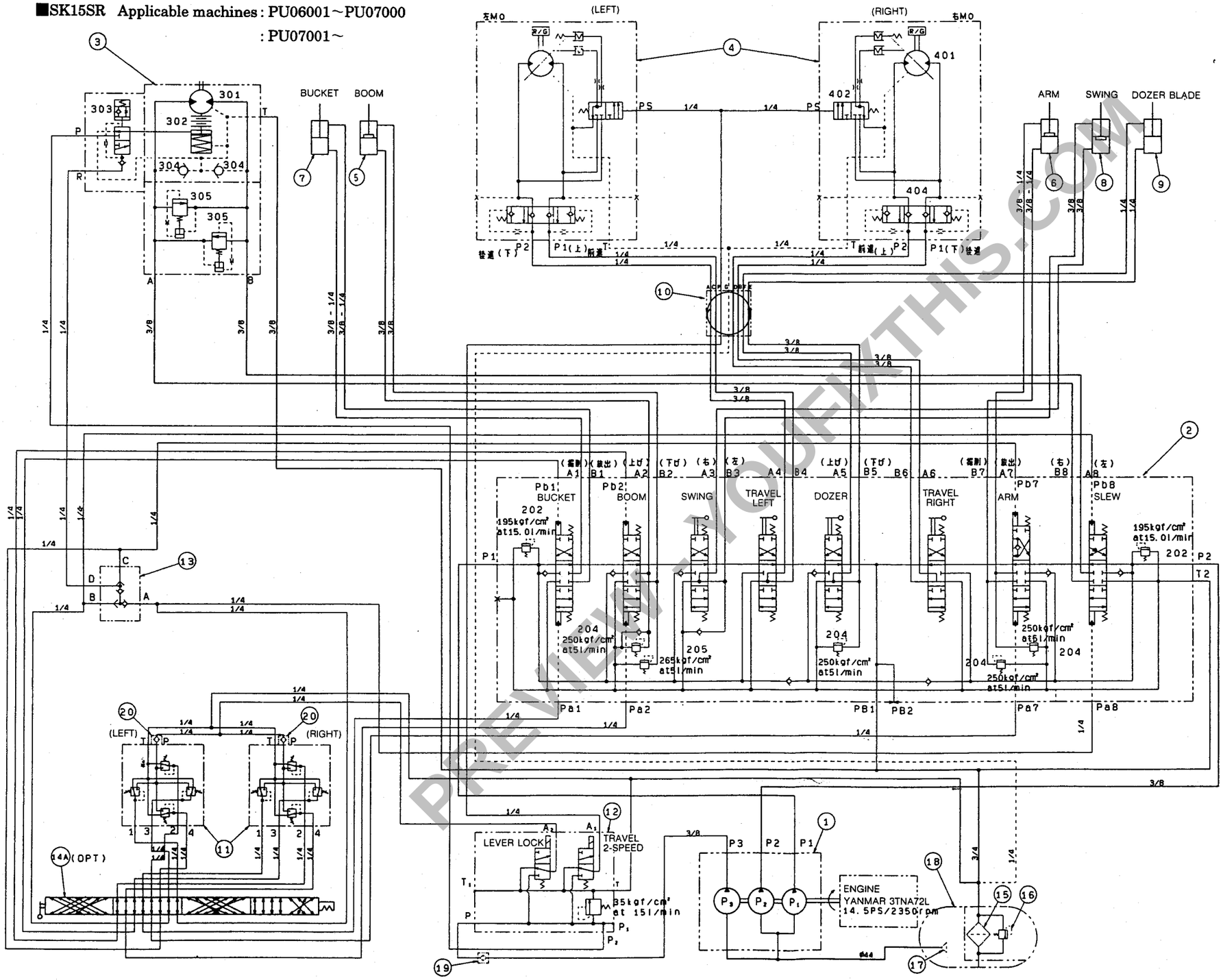


Fig. 1 Hydraulic diagram

No	NAME	MODEL No.	PART No.
1	PUMP	KFP1161-61-30	PU10V00002F1
2	CONTROL VALVE	KVS31-8	PU30V00006F1
3	SLEW MOTOR	2PB20CO107-A	PU15V00005F1
4	TRAVEL MOTOR	MAG10V-100-1 [MAG10V-100-2]	PU15V00003F1 [PU15V00006F1]
5	BOOM CYLINDER	ϕ30× ϕ55×435	PU01V00013F1
6	ARM CYLINDER	ϕ30× ϕ55×450	PU01V00007F1
7	BUCKET CYLINDER	ϕ30× ϕ50×340	PU01V00008F1 [PU01V00017F1]
8	SWING CYLINDER	ϕ35× ϕ65×410	PU01V00010F1
9	DOZER BLADE CYLINDER	ϕ35× ϕ70×108	PU01V00009F1
10	SWIVEL JOINT	YV-7104	PV55V00001F1
11	PILOT VALVE	TH40M	PH30V00002F1 [PW30V00018F1]
12	SOLENOID VALVE	2KWE5A-20	PH35V00001F1
13	SHUTTLE VALVE	—	PH26V00001F1
※14A	MULTI CONTROL VALVE	K16AR6-11	2436U2621F1
15	RETURN FILTER	Y-464900	PM50V00012F1
16	RELIEF VALVE	Y-148300	PM50V00013F1
17	SUCTION STRAINER	Y-1405	2446R344F1
18	HYDRAULIC TANK	—	PM33H00003P1
19	LINE FILTER	Y-410200	PY50V00001F1
20	FILTER	—	HH25R04004G2

※marked item is option.

Note : This is for reference only, because the model number might be changed due to improvement.

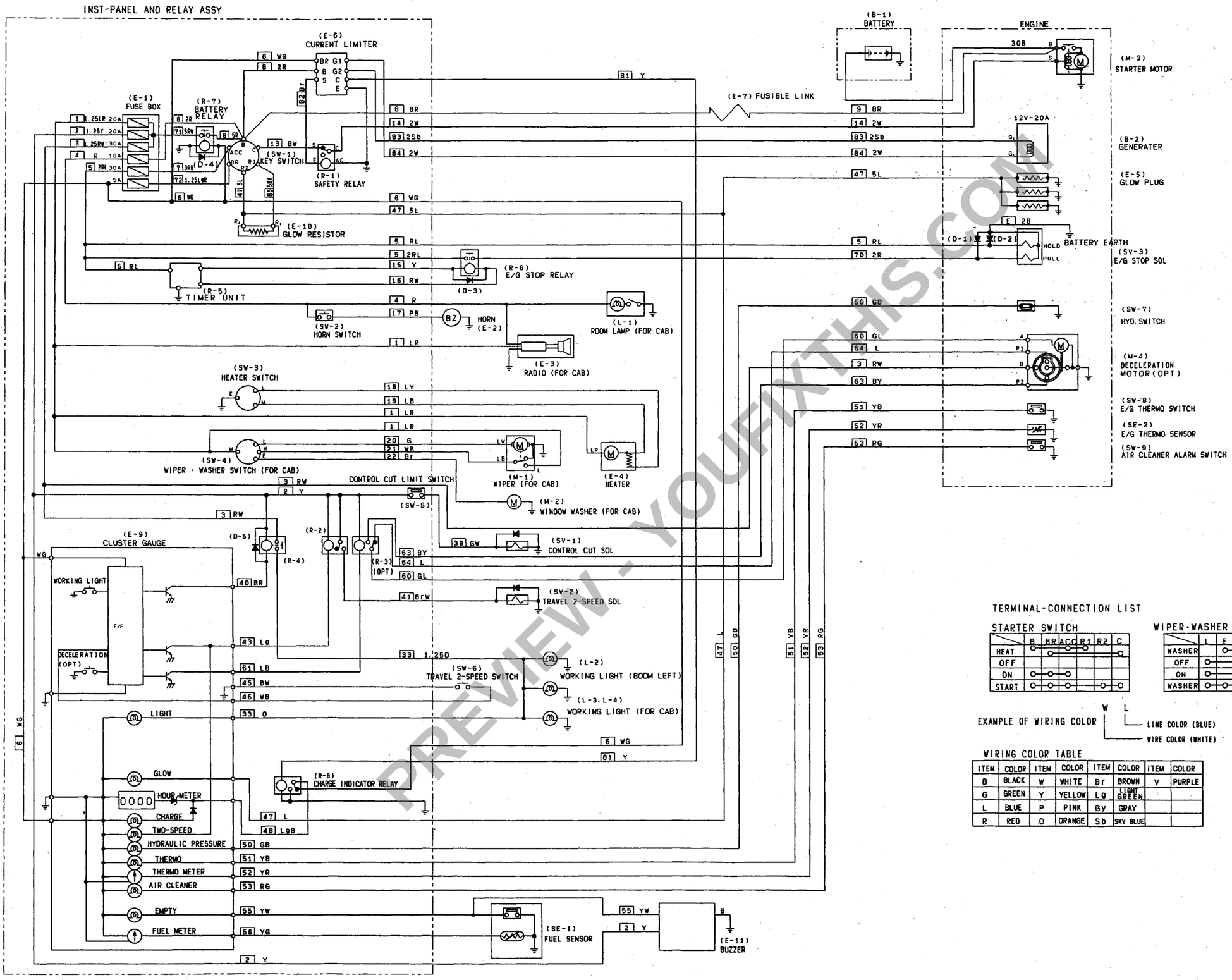
- The model numbers and part numbers in [ ] are applicable for and after the machine number PU07001.

No	PART NAME	No	PART NAME
202	MAIN RELIEF VALVE	304	CHECK VALVE
204	PORT RELIEF VALVE	305	RELIEF VALVE
205	PORT RELIEF VALVE	401	HYDRAULIC MOTOR
301	HYDRAULIC MOTOR	402	2-SPEED CONTROL VALVE
302	PARKING BRAKE	404	COUNTERBALANCE VALVE
303	TIME DELAY VALVE		

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2. ELECTRIC CIRCUIT DIAGRAM



TERMINAL-CONNECTION LIST

STARTER SWITCH

	B	BR	ACC	R1	R2	C
HEAT	○		○			○
OFF						
ON	○		○			
START	○		○		○	○

WIPER·WASHER SWITCH

	L	F	H	M
WASHER		○	○	○
OFF	○		○	
ON	○	○		
WASHER	○	○	○	○

HEATER SWITCH

	E	L	M
OFF	○		
LO	○		○
HI	○	○	○

EXAMPLE OF WIRING COLOR — W L — L: LINE COLOR (BLUE); W: WIRE COLOR (WHITE)

WIRING COLOR TABLE

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

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1. TIGHTENING TORQUES FOR CAPSCREWS AND NUTS

Tables 1 and 2 indicate tightening torques applicable to cases where no special note is given.
Overtightening of bolts may result in a twist-off and a fracture under load.
Insufficient tightening may lead to a loosening or loss of bolts. Always tighten bolts to proper torques.

Table 1 Standard tightening torques for metric coarse screw threads unit : kgf·m (ft·lbs)

Classification	4	T	7	T	10	T
Nominal size	No lubrication	Oil lubrication	No lubrication	Oil lubrication	No lubrication	Oil lubrication
M 6 P=1	0.45±0.05 (3.3±0.4)	0.38±0.04 (2.7±0.3)	0.98±0.1 (7.1±0.7)	0.83±0.08 (6.0±0.6)	1.77±0.18 (13±1)	1.5±0.15 (11±1)
M 8 P=1.25	1.09±0.11 (7.9±0.8)	0.92±0.09 (6.7±0.7)	2.4±0.2 (17±1)	2.0±0.2 (14±1)	4.3±0.4 (32±3)	3.6±0.4 (26±3)
M10 P=1.5	2.2±0.2 (16±1)	1.83±0.18 (13±1)	4.7±0.5 (34±4)	4.0±0.4 (29±3)	8.5±0.9 (61±7)	7.2±0.7 (52±5)
M12 P=1.75	3.7±0.4 (27±3)	3.2±0.3 (23±2)	8.1±0.8 (59±6)	6.8±0.7 (49±5)	14.6±1.5 (110±11)	12.3±1.2 (89±9)
M14 P=2	5.9±0.6 (43±4)	5.0±0.5 (36±4)	12.8±1.3 (93±9)	10.8±1.1 (78±8)	23±2 (170±14)	19.5±1.9 (140±14)
M16 P=2	9.0±0.9 (65±7)	7.6±0.7 (55±5)	19.5±2.0 (140±14)	16.4±1.6 (120±12)	35±4 (250±29)	29±3 (210±22)
M18 P=2.5	12.4±1.2 (90±9)	10.5±1.0 (76±7)	27±3 (200±22)	23±2 (170±14)	49±5 (350±36)	41±4 (300±29)
M20 P=2.5	17.5±1.7 (130±12)	14.7±1.4 (110±10)	38±4 (270±29)	32±3 (230±22)	68±7 (490±51)	57±6 (410±43)
M22 P=2.5	23±2 (170±14)	19.6±2.0 (140±14)	51±5 (370±36)	43±4 (310±29)	92±9 (670±65)	77±8 (560±58)
M24 P=3	30±3 (220±22)	24±3 (170±22)	65±7 (470±51)	53±5 (380±36)	118±12 (850±87)	96±10 (690±72)
M27 P=3	44±4 (320±29)	36±4 (260±29)	96±10 (690±72)	78±8 (560±58)	173±17 (1300±120)	140±14 (1000±100)
M30 P=3.5	60±6 (430±43)	50±5 (360±36)	131±13 (950±94)	110±11 (800±80)	235±24 (1700±170)	198±20 (1400±140)
M33 P=3.5	81±8 (590±58)	68±7 (490±51)	176±18 (1300±130)	148±15 (1100±110)	317±32 (2300±230)	266±27 (1900±200)
M36 P=4	105±10 (760±72)	88±9 (640±65)	227±23 (1600±170)	190±19 (1400±140)	409±41 (3000±300)	343±34 (2500±250)

Table 2 Standard tightening torques for metric fine screw threads unit : kgf·m (ft·lbs)

Classification	4	T	7	T	10	T
Nominal size	No lubrication	Oil lubrication	No lubrication	Oil lubrication	No lubrication	Oil lubrication
M 8 P=1	1.15±0.11 (8.3±0.8)	0.97±0.1 (7.0±0.7)	2.5±0.2 (18±1)	2.1±0.2 (15±1)	4.5±0.4 (33±3)	3.8±0.4 (27±3)
M10 P=1.25	2.3±0.2 (17±1)	1.91±0.19 (14±1)	4.9±0.5 (35±4)	4.2±0.4 (30±3)	8.9±0.9 (64±7)	7.5±0.7 (54±5)
M12 P=1.25	4.0±0.4 (29±3)	3.4±0.3 (25±2)	8.7±0.9 (63±7)	7.3±0.7 (53±5)	15.7±1.6 (110±12)	13.2±1.3 (95±9)
M16 P=1.5	9.4±0.9 (68±7)	7.9±0.8 (57±6)	20±2 (140±14)	17.2±1.7 (120±12)	37±4 (270±29)	31±3 (220±22)
M20 P=1.5	19±1.9 (140±14)	15.8±1.6 (110±12)	41±4 (300±29)	34±3 (250±22)	74±7 (540±51)	62±6 (450±43)
M24 P=2	32±3 (230±22)	27±3 (200±22)	70±7 (510±51)	58±6 (420±43)	126±12 (910±87)	105±10 (760±72)
M30 P=2	65±6 (470±43)	54±5 (390±36)	142±14 (1000±100)	118±12 (850±87)	255±26 (1800±190)	212±21 (1500±150)
M36 P=3	109±11 (790±80)	91±9 (660±65)	238±23 (1700±170)	198±20 (1400±140)	428±43 (3100±310)	357±36 (2600±260)

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2. TROUBLE DIAGNOSTIC LIST

Class	Ref. No.	Malfunction condition		Engine				Electric unit														Hydraulic unit												
		Parts						Power supply system				Power generation and stop system							Operation system and others					Pump			Valve							Actuator		
				Fuel system	Cooling system	Lubrication system	Suction exhaust system and others	Battery	Fusible link	Fuse	Key switch	Safety Relay	Starter motor	Alternator & Air heater	Battery relay	Timer unit	E/G Stop relay	E/G Stop SOL	Gauge cluster	Control cut Limit switch	Control cut SOL	Travel 1,2-speed SW&SOL	Travel lock motor & relay	Main pump	Trochoid pump	Gear pump	Travel & ATT main R/V	Main gear pump R/V	Ports R/V	Travel straight valve (SK20SR ONLY)	Travel spool	ATT spool	Check valve	Shuttle valve	Slewing motor unit	Travel motor unit	Hydraulic cylinder
Engine	1	Not start.	Starter doesn't rotate.	○				○	○	○	○	○	○	○	○																				
			Starter rotate.	○				○								○	○	○																	
	2	Starts, but stops.		○												○																			
	3	Not stop.														○	○	○																	
	4	The engine malfunctions.		○	○		○																												
Pump	5	The engine revolution falls when loaded.																						○											
	6	The pump malfunctions.																						○	○	○									
Travel	7	Travel operations is unavailable.								○										○	○		○							○				○	
	8	Travel speed is slow.					○												○			○	○	○						○				○	
	9	Travel power is poor.																	○			○					○		○					○	
	10	Travel motion deflects.																						○						○	○				○	
Slewing	11	Slewing operation unavailable.																		○	○										○			○	
	12	Slewing speed is slow.					○																	○											
	13	Slewing power is poor.																										○	○					○	
	14	Slewing operations is unavailable.																													○		○	○	
Attachment	15	Attachment is unoperatable.																		○	○			○						○					
	16	Attachment speed is slow.				○																		○							○				○
	17	Attachment power is poor.																									○		○						○
	18	Attachment operation is unavailable.																												○		○			○

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Table of abbreviations

E/G : ENGINE
SOL : SOLENOID
SW : SWITCH
ATT : ATTACHMENT
C/V : CONTROL VALVE
R/V : RELIEF VALVE
V : VALVE

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3. SPECIFICATIONS AND PERFORMANCE

● SPEED AND GRADABILITY

Model	SK15SR							
Applicable Machines	PU06001~PU07000				PU07001~			
Item \ Shoe Type	Rubber		Steel		Rubber		Steel	
Slewing Speed rpm	9.4							
Travel Speed km/h (mph)	Low	High	Low	High	Low	High	Low	High
	2.1 (1.3)	4.2 (2.6)	2.0 (1.2)	4.0 (2.5)	2.2 (1.4)	4.0 (2.5)	2.0 (1.2)	3.7 (2.3)
Gradability	30°(58%)							

● ENGINE

Item \ Model	SK15SR
Model	3TNE72A-UYBB
Type	4-Cycle, vertical, water-cooled, 3-cylinder
Number of Cylinders-Bore×Stroke	3−72㎜×72㎜ (2.83in×2.83in)
Total Displacement cc (cu.in)	879 (53.64)
Rated Output/Rotation Speed Ps/rpm	14.5/2,350
Maximum Torque/Rotation kgf·m (ft·lbs)/rpm	5.2 (38) /1,700
Starter	12V/1.0kW
Alternator	12V/20A

● HYDRAULIC COMPONENTS

Item \ Model	SK15SR
Hydraulic Pump	Gear pump
Hydraulic Motor (Slewing)	Orbit motor
Hydraulic Motor (Travel)	Axial piston, 2-speed motor
Control Valve	8-functions multiple control valve
Cylinder (Boom, Arm, Bucket, Swing, Dozer blade)	Double action cylinder
Return filter	Safety valve containing filter type (10 μ)

● SIDE DIGGING

Item \ Model		SK15SR
Type		Boom swing by hydraulic cylinder
Boom Swing Angle	Canopy	55°(Right) / 85°(Left)
	Cab	55°(Right) / 70°(Left)

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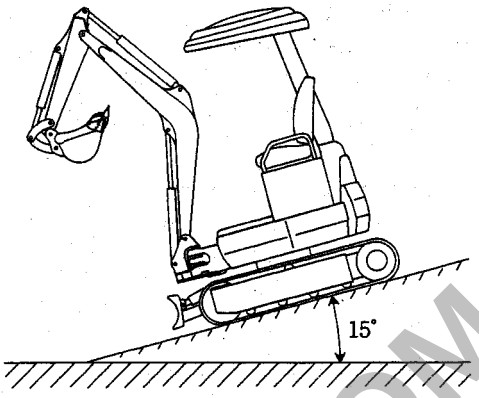
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(4) Natural Travel Drop

- Engine : Stopped
- Hydraulic Oil Temp. : 50~60°C (122~140°F)
- Grade : 15°
- Measurement Posture : Fully extend the boom, arm and bucket cylinders and completely retract the dozer blade cylinder.

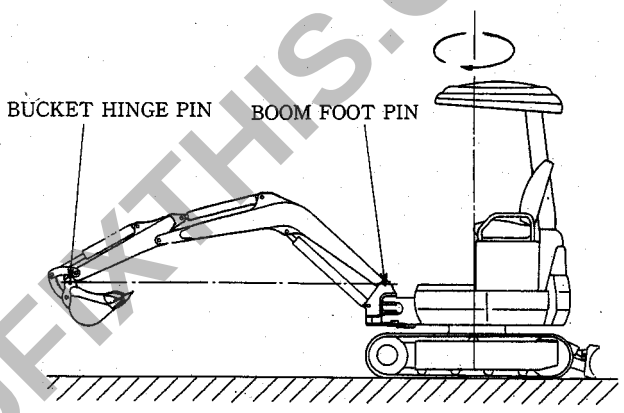
• With the excavator parked at angle for 5 minutes, measure the extent of natural drop.



2.2.4 Slew

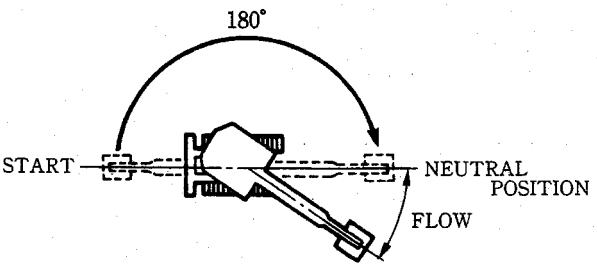
(1) Slew Time

- Engine : Rated R.P.M.
- Hydraulic Oil Temp. : 50~60°C (122~140°F)
- Measurement Posture : Completely retract the arm cylinder, fully extend the bucket cylinder and adjust so that boom foot pin and bucket pin are at matching height. Rest the dozer blade on the ground.
- With the hoe attachment in a no-load state, wait 1 rotation, then measure the time required for the next 2 rotations.



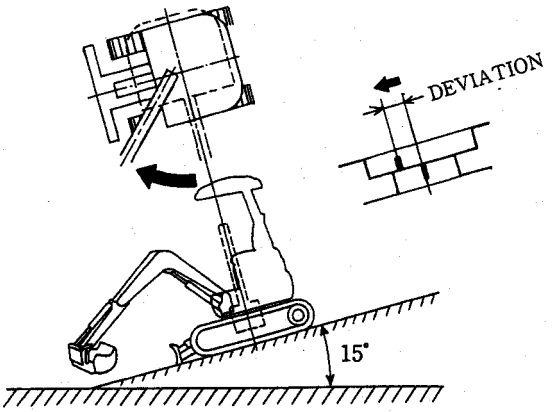
(2) Overrun When Slewing Stops

- Engine : Rated R.P.M.
- Hydraulic Oil Temp. : 50~60°C (122~140°F)
- Measurement Posture : Same as that for measuring slew time.
- Draw matching marks on the outer race of the slew bearing and lower frame at an exactly 180 degrees rotation from the starting point. With the hoe attachment in a no-load state, rotate 180 degrees, at which point return the operation lever to neutral. Measure the differential between the position marks and the point the hoe attachment stops.



(3) Natural Slew Drop

- Engine : Stopped
- Hydraulic Oil Temp. : 50~60°C (122~140°F)
- Grade : 15°
- Measurement Posture : Same as that for measuring slew time.
- Rotate the upper machinery so that it is directly abeam of the grade, then draw positional marks on the slew bearing's outer race and the lower frame. Then measure the distance that develops between the marks after 5 minutes.



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3. GUARD · COVER

3.1 UPPER COMPONENTS

3.1.1 REMOVAL

(1) Removal of Bonnet Assy (8)
This is to cover the engine portion.
1) Unlock the bonnet assy (8) with the door key to open it.
2) Remove the sems bolts (35) that are fixing the hinge (8-2), and remove the bonnet assy.
: 13㎜

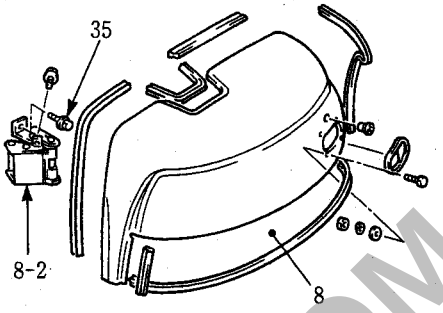


Fig. 3-1 Removal of bonnet assy (8)

(2) Removal of Cover Assy (18)
This is to cover the radiator portion.
1) Open the cover assy (18) and hold it with the rod (22).
2) Remove the sems bolts (18-12), and remove the cover assy (18) from the hinge (18-2).
: 13㎜

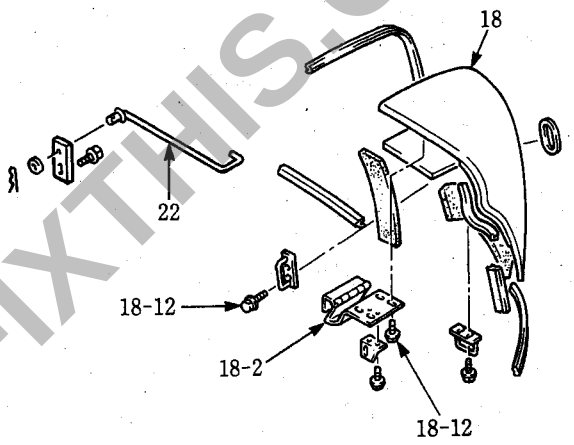


Fig. 3-2 Removal of cover assy (18)

(3) Removal of Cover Assy (28)
This is to cover the tank assy.
1) Remove the sems bolt (35) (39), and remove the cover assy (28).
: 13㎜

(4) Removal of Cover Assy (3)
Remove the capscrews (40) and remove the cover assy (3).
: 13㎜

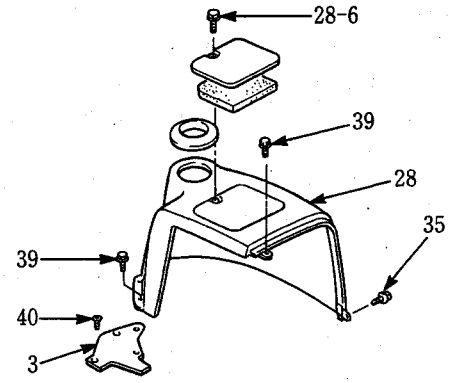


Fig. 3-3 Removal of cover assy (28) (3)

3.1.2 Installation

To install the cover, use each kind of the same bolts that were removed at the removal or the new bolts of the same size. Table 3 shows their tightening torques.

3.2 LOWER COMPONENTS

(1) Under Cover
Taking easiness for the works into consideration, some under covers are provided to the lower face of upper frame.
Remove and install them as required for the removal and installation or the maintenance.
: 17㎜, Tightening torque : 4.7kgf·m (34ft·lbs)

Table 3 Tightening torque

No.	NAME	Hex.(㎜)	Torque : kgf·m (ft·lbs)
18-12	SEMS BOLT M8	13	0.83±0.08 (6.0±0.6)
28-6	SEMS BOLT M8	13	1.03±0.11 (7.4±0.8)
39,40	SEMS BOLT M8	13	2.0±0.2 (14.5±1.4)

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9.2 CONSTRUCTION ■SK15SR

No.	NAME	Q'TY	No.	NAME	Q'TY
1	OUTER RACE	1	5	SEAL	1
2	INNER RACE	1	6	SEAL	1
3	BALL	68	7	GREASE NIPPLE	1
4	SPACER	68	8	TAPER PIN	1
4A	SPACER(ADJUSTING)	3	9	PLUG	1

9.2.1 REMOVAL AND INSTALLATION

(1) Removing

1) Remove seal (5) fitted in the groove in the outer circumference under inner race (2) and seal (6) fitted in the groove in the inner circumference on top of outer race (1) and place them level on a square wooden block.
2) Remove taper pin (8), using a hammer and an extrusion rod.
3) Remove plug (9), using an puller inserted in the threaded hole in the center of the plug.
4) After removing plug (9) while rotating outer race (1) little by little, take out ball (3) and spacer (4) (4A) from the hole in sequence.

(2) Installing

1) Degrease thoroughly the groove for seal (6) located in the inner circumference of outer race (1) and the groove for seal (5) located in the outer circumference of inner race (2). Coat the grooves with adhesive Cyano Bond PO−1, fit seal (5), and place inner race (2) on a surface plate.
2) Lift and lower outer race (1) slowly till the top surface of inner race (2) matches the bottom of the sealing groove of outer race (1). Place an adjusting washer under outer race (1) so the track surface of ball (3) is aligned, in order to support the outer race.
3) Insert, through the hole for plug (9) in outer race (1), ball (3) and spacer (4) (4A) coated with grease (NLGI−2) alternately.

⚠ When inserting ball (3) spacer (4) (4A), the raceways must be aligned completely. To achieve it, outer race (1) should be adjusted. It is very dangerous to put your finger into the plug hole directly ; always use a push rod or a hooked rod.

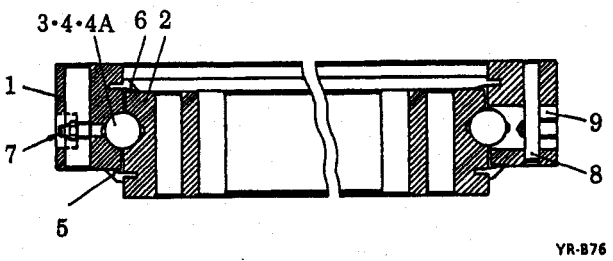


Fig. 72 Cross-sectional view of slewing bearing

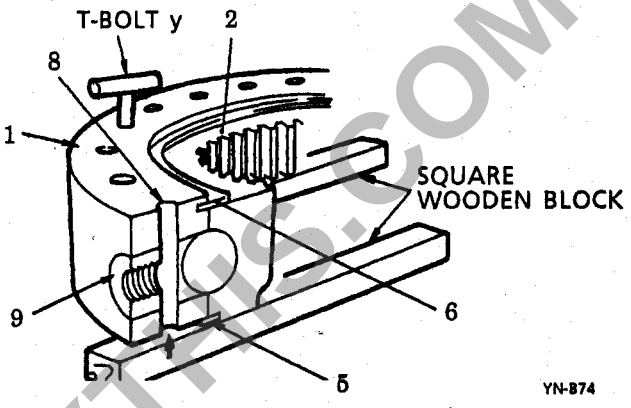


Fig. 73 Removing slewing bearing

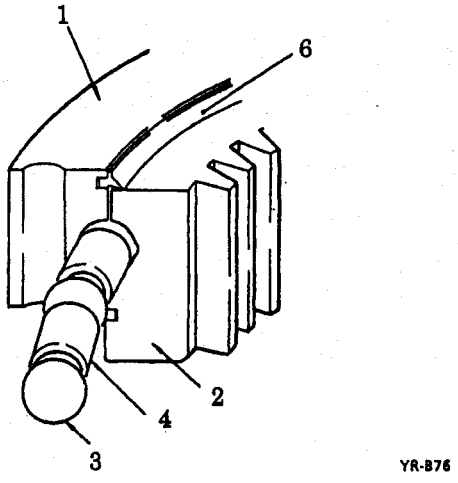


Fig. 74 Removing balls and spacer

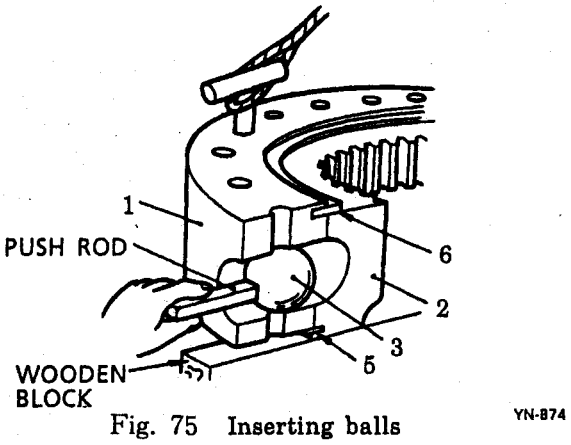


Fig. 75 Inserting balls

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6.2 REMOVAL AND INSTALLATION OF CYLINDER

(1) Preparation for Works

1) Make the attachment stable and easy for works putting the machine on a solid and level ground.
2) Stop the engine, and make the safety lock lever to lock position.
3) Loosen the air bleeding plug on hydraulic oil tank to release the pressure in tank.
   : 22㎜
4) Before the removal of swing cylinder, remove the floor cover and under cover.
   : 13㎜

(2) Removal of Cylinder

1) Disconnect the hydraulic hose connection, then plug the connecting portion.
   : 19㎜, 22㎜
   ⚠ Install the plug securely.
2) Lightly lift up the cylinder not to load on the pin of rod side, then remove the loose-out prevention capscrew of rod side and nuts, and pull off the pin and shim.
   : 17㎜
3) Retract the cylinder rod, then support the cylinder with a wooden pillow.
4) Lightly lift up the cylinder not to load on the pin of head side, then remove the capscrew and nuts of head side, and pull off the pin and shim.
   For the swing cylinder of head side, remove two capscrews, and take off the loose-out prevention plate.
   : 17㎜, 19㎜
5) Lift up the cylinder at the center of gravity, and remove the cylinder.

Weight of cylinder : Unit : kg (lbs)

	SK15SR	SK20SR
Bucket	10(22)	12(26)
Arm	13(29)	18(40)
Boom	13(29)	19(42)
Swing	18(40)	22(49)
Dozer blade	15(33)	15(33)

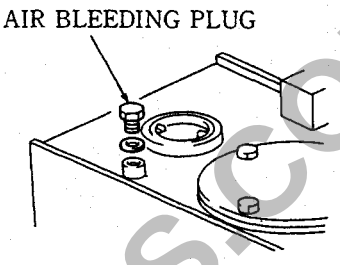


Fig. 37 Air bleeding in hydraulic oil tank

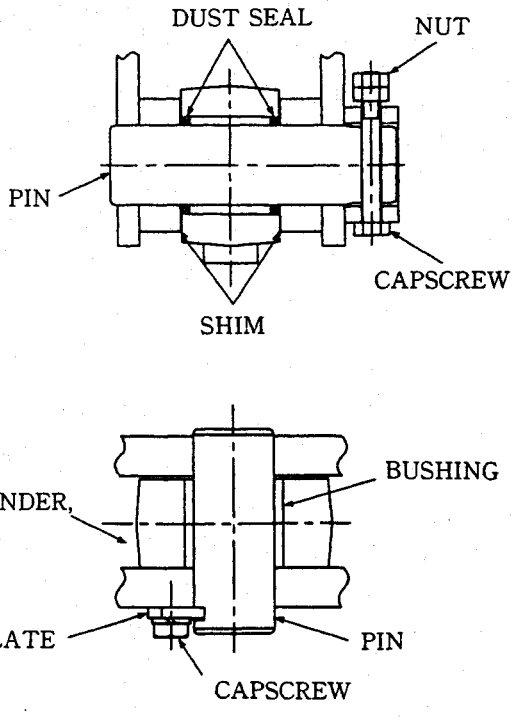


Fig. 38 Section at cylinder installing portion

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INSTRUMENT HARNESS CONNECTION TABLE

線番 WIRE NO	線色 WIRE COLOR	線番・サイズ WIRE SIZE	FROM	接続 CONNECTION	TO	機能 FUNCTION
1	R	AVS1.25sq	CN-314F		CN-303M	FUSE BOX → CAB
2A	Y	AVSS0.75sq	CN-309F		CN-341F	TRAVEL 2-SPEED RELAY → J/C-BLUE
2B	Y	AVSS0.75sq	CN-309F		CN-341F	TRAVEL 2-SPEED RELAY → J/C-BLUE
2C	Y	AVSS0.75sq	CN-301M		CN-341F	CONTROL CUT LS → J/C-BLUE
2D	Y	AVSS0.75sq	CN-313F		CN-341F	DECELE RELAY → J/C-BLUE
2E	Y	AVS0.75sq	CN-330F		CN-341F	BUZZER → J/C-BLUE
2F	Y	AVS1.25sq	CN-314F		CN-341F	FUSE BOX → J/C-BLUE
2G	Y	AVSS0.75sq	CN-320F		-	DIODE ← JOINT SPLICE
2H	Y	AVSS0.75sq	CN-320F	DOUBLE SPLICE	CN-310F	LIGHT RELAY ← DIODE
3A	RW	AVSS0.75sq	CN-310F		CN-341F	LIGHT RELAY → J/C-BLUE
3B	RW	AVSS0.75sq	CN-301M		CN-341F	DECELE MOTOR → J/C-BLUE
3C	RW	AVS1.25sq	CN-314F		CN-341F	FUSE BOX → J/C-BLUE
4	R	AVSS0.75sq	CN-314F		CN-301M	FUSE BOX → HORN SWITCH
5A	RL	AVSS0.75sq	CN-306F		CN-341F	TIMER UNIT → J/C-BLUE
5B	RL	AVSS0.75sq	CN-301M		CN-341F	E/G STOP SOL → J/C-BLUE
5C	RL	AVSS2sq	CN-308F		CN-341F	E/G STOP RELAY → J/C-BLUE
5D	RL	AVS2sq	CN-315F		CN-341F	FUSE BOX → J/C-BLUE
6A	WG	AVSS0.75sq	CN-311F		CN-341F	BATTERY RELAY → J/C-BLUE
6B	WG	AVSS0.75sq	CN-318F		CN-341F	CURRENT LIMITER → J/C-BLUE
6C	WG	AVSS0.75sq	CN-312F		CN-341F	CHARGE INDICATER RELAY → J/C-BLUE
6D	WG	AVSS0.75sq	CN-1F		CN-341F	CLUSTER GAUGE → J/C-BLUE
6E	WG	AVSS0.75sq	CN-3M		CN-341F	CLUSTER GAUGE → J/C-BLUE
6F	WG	AVSS0.75sq	CN-314F		CN-341F	FUSE BOX → J/C-BLUE
6G	WG	AVSS0.75sq	CN-314F		-	DIODE → JOINT SPLICE
7	RB	AVS3sq	CN-317F		CN-315F	KEY SWITCH → FUSE BOX
8A	R	AVS2sq	CN-311F		CN-316F	BATTERY RELAY → KEY SWITCH
8B	R	AVS2sq	CN-315F		CN-316F	FUSE BOX → KEY SWITCH
8C	R	AVS2sq	-		CN-318F	JOINT SPLICE → CURRENT LIMITER
8D	R	AVS5sq	CN-302M		CN-317F	KEY SWITCH → FUSIBLE LINK
13	BW	AVSS0.75sq	CN-316F		CN-305F	KEY SWITCH → SAFETY RELAY
14	W	AVS2sq	CN-305F		CN-302M	SAFETY RELAY → STARTER MOTOR
15A	Y	AVSS0.75sq	CN-319F	DOUBLE SPLICE	CN-306F	DIODE → TIMER UNIT
15B	Y	AVSS0.75sq	CN-308F		CN-306F	E/G STOP RELAY → TIMER UNIT
16A	RW	AVSS0.75sq	CN-319F	DOUBLE SPLICE	CN-306F	DIODE → TIMER UNIT
16B	RW	AVSS0.75sq	CN-308F		CN-306F	E/G STOP RELAY → TIMER UNIT
33A	O	AVS1.25sq	CN-310F		CN-340F	LIGHT RELAY → J/C-BLUE
33B	O	AVSS0.75sq	CN-1F		CN-340F	CLUSTER GAUGE → J/C-BLUE
33C	O	AVS1.25sq	CN-303M		CN-340F	WORKING LIGHT → J/C-BLUE
40A	BR	AVSS0.75sq	CN-2M		CN-310F	DIODE → CLUSTER GAUGE
40B	BR	AVSS0.75sq	CN-310F		CN-320F	DIODE → LIGHT RELAY
41	BrW	AVSS0.75sq	CN-309F		CN-301M	TRAVEL 2-SPEED RELAY → TRAVEL 2-SPEED SOL
43	Lg	AVSS0.75sq	CN-2M		CN-309F	CLUSTER GAUGE → TRAVEL 2-SPEED RELAY
45	BW	AVSS0.75sq	CN-3M		CN-301M	CLUSTER GAUGE → TRAVEL 2-SPEED SWITCH
46	WB	AVSS0.75sq	CN-3M		CN-301M	CLUSTER GAUGE → TRAVEL 2-SPEED SWITCH
47A	L	AVS5sq	CN-307F		-	GLOW RESISTER → JOINT SPLICE
47B	L	AVS5sq	CN-317F	DOUBLE SPLICE	CN-302M	KEY SWITCH → GLOW PLUG
47C	L	AVSS0.75sq	CN-317F		CN-1F	KEY SWITCH → CLUSTER GAUGE
48	LgB	AVSS0.75sq	CN-2M		CN-312F	CLUSTER GAUGE → INDICATER RELAY
50	GB	AVSS0.75sq	CN-1F		CN-301M	CLUSTER GAUGE → HYD SWITCH
51	YB	AVSS0.75sq	CN-1F		CN-301M	CLUSTER GAUGE → E/G THERMO SWITCH
52	YR	AVSS0.75sq	CN-1F		CN-301M	CLUSTER GAUGE → E/G THERMO SENSOR
53	RG	AVSS0.75sq	CN-1F		CN-301M	CLUSTER GAUGE → AIR CLEANER ALARM SWITCH
55A	YW	AVSS0.75sq	CN-301M		CN-340F	FUEL SENSOR → J/C-BLUE
55B	YW	AVSS0.75sq	CN-1F		CN-340F	CLUSTER GAUGE → J/C-BLUE
55C	YW	AVSS0.75sq	CN-330F		CN-340F	BUZZER → J/C-BLUE
56	YG	AVSS0.75sq	CN-1F		CN-301M	CLUSTER GAUGE → FUEL SENSOR
60	GL	AVSS0.75sq	CN-301M		CN-313F	DECELE MOTOR → DECEL RELAY

線番 WIRE NO	線色 WIRE COLOR	線番・サイズ WIRE SIZE	FROM	接続 CONNECTOR	TO	機能 FUNCTION
61	LB	AVSS0.75sq	CN-2M		CN-313F	CLUSTER GAUGE → DECEL RELAY
63	BY	AVSS0.75sq	CN-301M		CN-313F	DECELE MOTOR → DECEL RELAY
64	L	AVSS0.75sq	CN-301M		CN-313F	DECELE MOTOR → DECEL RELAY
70	R	AVS2sq	CN-308F		CN-302M	E/G STOP RELAY → E/G STOP SOL
71	RW	AVS2sq	CN-315F		CN-311F	FUSE BOX → BATTERY RELAY
72	LgR	AVS1.25sq	CN-316F		CN-315F	KEY SWITCH → FUSE BOX
81	Y	AVSS0.75sq	CN-312F		M-1	CHARGE INDICATER RELAY → CURRENT LIMITER
82	Br	AVSS0.75sq	CN-305F		CN-318F	SAFETY RELAY → CURRENT LIMITER
83	Sb	AVS2sq	CN-318F		CN-303M	CURRENT LIMITER → GENERATER
84	W	AVS2sq	CN-318F		CN-303M	CURRENT LIMITER → GENERATER
85	BY	AVS5sq	CN-317F		CN-307F	KEY SWITCH → GLOW RESISTER
E1	B	AVSS0.75sq	CN-305F		CN-340F	SAFETY RELAY → J/C-BLUE
E2	B	AVSS0.75sq	CN-306F		CN-340F	TIMER UNIT → J/C-BLUE
E3	B	AVSS0.75sq	CN-311F		CN-340F	BATTERY RELAY → J/C-BLUE
E4	B	AVSS0.75sq	CN-312F		CN-340F	CHARGE INDICATER RELAY → J/C-BLUE
E5	B	AVSS0.75sq	CN-312F		CN-340F	CHARGE INDICATER RELAY → J/C-BLUE
E7	B	AVSS0.75sq	CN-1F		CN-340F	CLUSTER GAUGE → J/C-BLUE
E8	B	AVSS0.75sq	CN-3M		CN-340F	CLUSTER GAUGE → J/C-BLUE
E9	B	AVSS0.75sq	CN-318F		CN-340F	CURRENT LIMITER → J/C-BLUE
E10	B	AVS1.25sq	CN-303M		CN-340F	BODY EARTH → J/C-BLUE
E11	B	AVS1.25sq	CN-303M		CN-340F	BODY EARTH → J/C-BLUE
E12	B	AVS1.25sq	CN-330F		CN-340F	BUZZER → J/C-BLUE
E13	B	AVS1.25sq	CN-321F		CN-340F	DIODE → J/C-BLUE

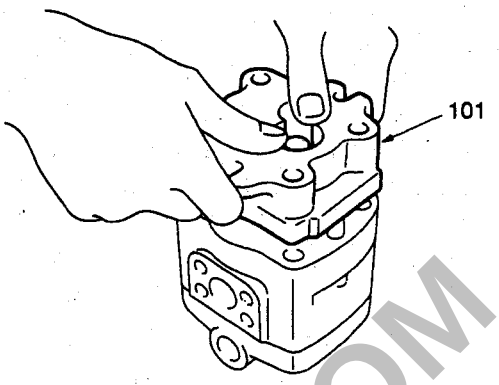
CONNECTORS SELECTION TABLE

コネクタ名（ピン数） CONNECTOR NAME (PINE NUM.)	メーカー MANUFUC.	部品番号 (PART. NUMBER) ハウジング HOUSING	ターミナル TERMINAL	ハーネスシール HARNESS SEAL	リテーナ RETAINER ロックプレート LOCK PLATE	ワメ板	クリップ CLIP
2PAF-D	YAZAKI	7116-3250	7116-3250	7157-6421-80			
2PAF-Y	YAZAKI	7123-3020	7116-3060				
3PAF	YAZAKI	7123-2237	7116-2090				
4PAF	YAZAKI	7123-2446	7116-2090				
4PAM-312	YAZAKI	7282-3040	7114-6041 7114-6042				
4PAF-312	YAZAKI	7283-3040	7116-6041 7116-6042				
4PAF-P&B	P&B	YCF7-1000					
	AMP		42281-1				
5PAF-P&B	P&B	YCF4-1003					
	PACKARD		12015865				
5PAM-MIC (BLACK)	AMP	172494-2	172777-1				
5PAM-MIC	AMP	172504-1	172777-1				
6PAF	YAZAKI	7123-2262	7116-2090				
11PAF-MIC	AMP	172497-1	172773-1				
CA104	YAZAKI	7120-8012	7113-1020				
J/C-BLUE	SUMITOMO	6400-0014 6409-0073	8240-4422				
20PAM	SUMITOMO	6240-1035	8230-4502				

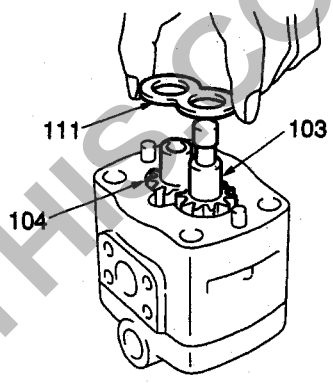
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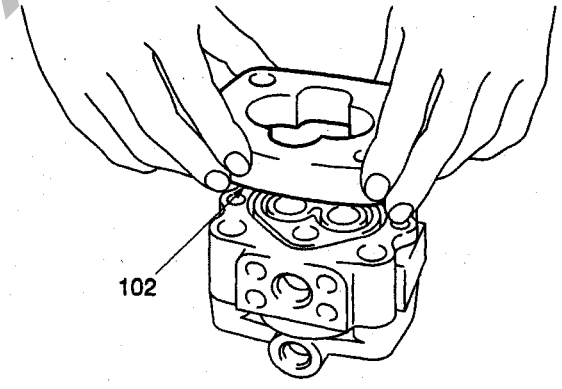
b. Remove the front cover (101).



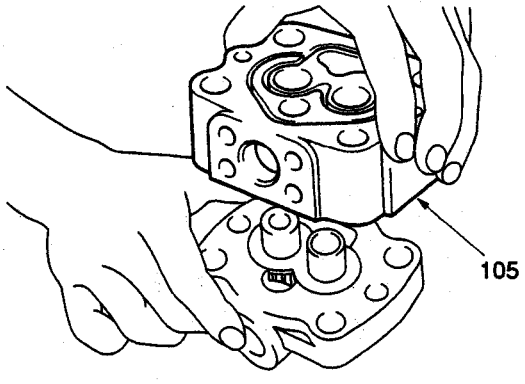
c. Remove the bushing (111).
d. Remove the drive gear (103) and driven gear (104).



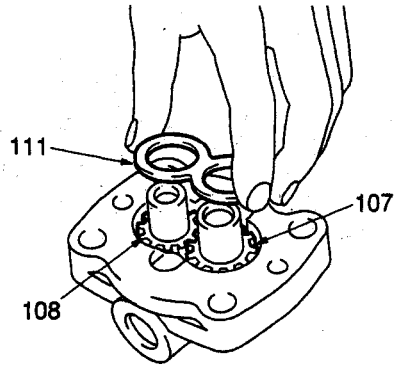
e. Remove the gear case (102).



f. Remove the gear case (105).



g. Remove the bushing (111), drive gear (107) and driven gear (108).



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2) When the pressurized oil at the port P reaches up to the setting pressure on spring, it pushes up the piston to open the needle valve.
At that time, the pressurized oil flows through inside the piston, choke B, chamber A, choke C and drilled hole D in turn, then is led to the tank passage through the outer periphery of socket.

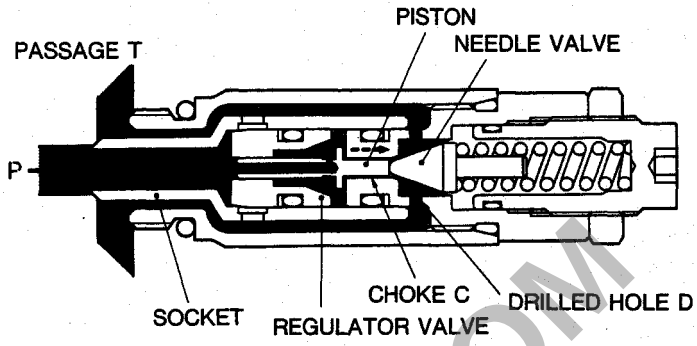


Fig. 21

3) Because of opening of the needle valve, the pressure in the chamber A is lowered. Then the pressurized oil at the port P flows directly back to the tank passage through the drilled hole E.

4) When the pressure at the port P is lowered down to the setting pressure on the spring, the regulator valve is pushed back to the seat due to the spring force, resulting the pressure in the chamber A becoming equal to that at the port P. So the regulator valve is also pushed back to the seat. Then it returns to the original position shown in Fig. 20.

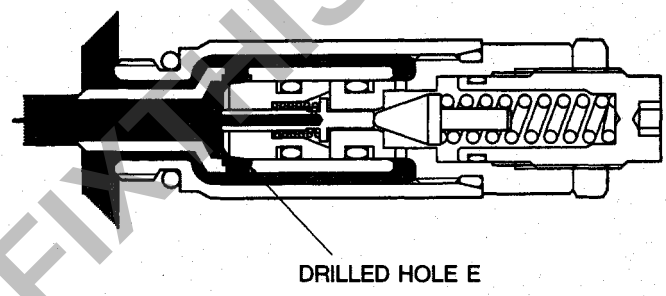


Fig. 22

2.2.4 Port Relief Valve

The port relief valve is incorporated between the cylinder port and the low pressure passage of tank side, and concurrently acts as a relief valve and anti-cavitation valve.
(Refer to section 2.2.3 for the function of relief valve.)

1) Function for Anti-cavitation
When a negative pressure is generated at the port P, it supplies oil from the tank passage.
When the pressure in the tank passage becomes higher than that at the port P, a pushing up force acts to the socket, resulting opening between the body seat and the socket allowing oil flowing in from the tank passgae to the port P to prevent it from cavitation by means of filling up the space with oil.

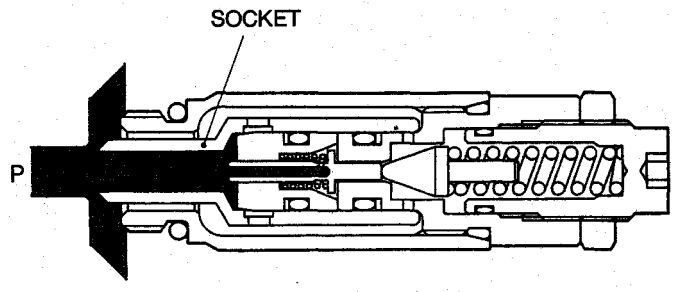


Fig. 23

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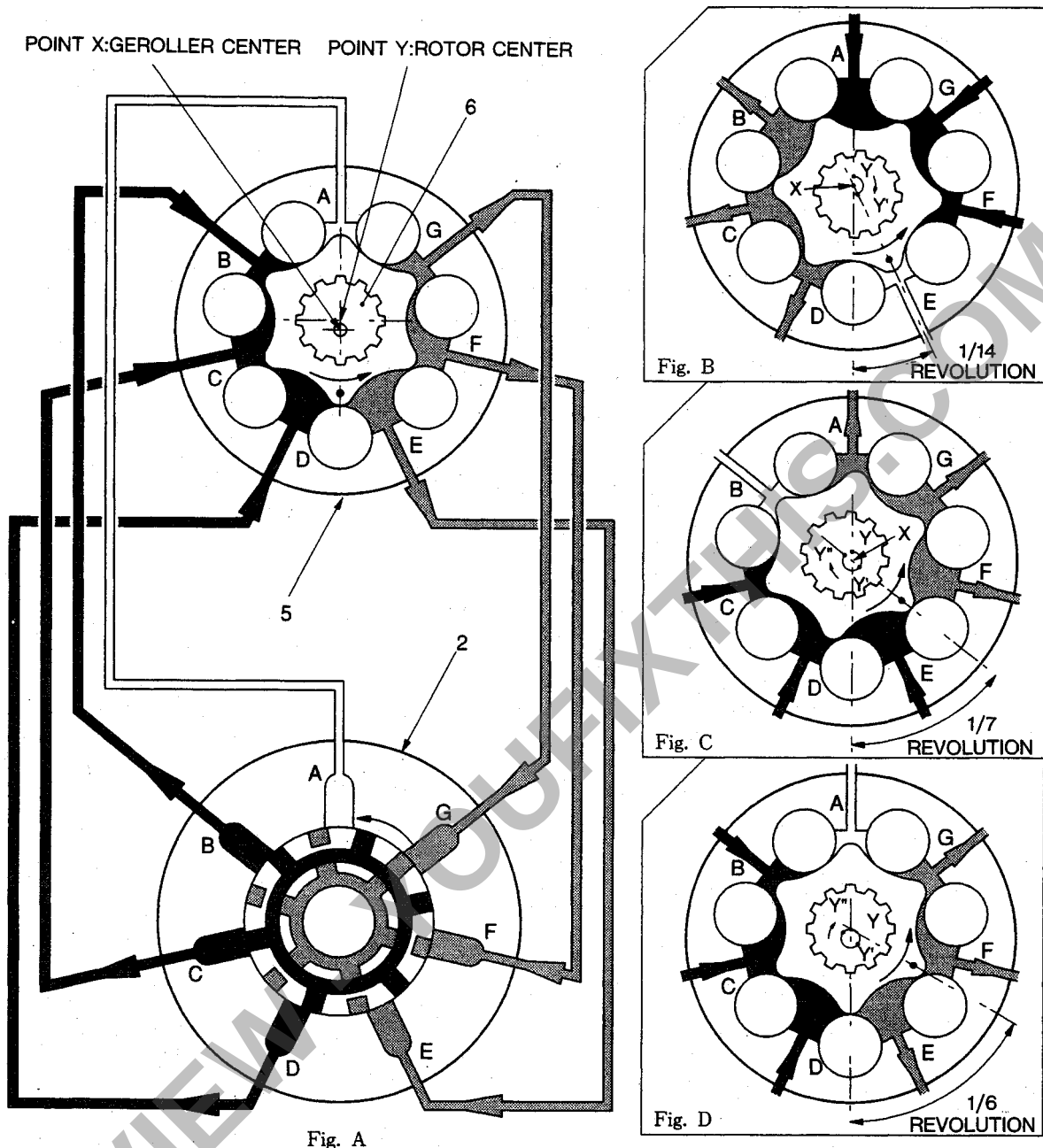


Fig. 6 Operational principle

In Fig. A, when high pressure oil is introduced into chambers B, C and D, the rotor (6) rotates in the arrow direction while making contact with the inside of the stator. The valve (2) rotates along with this, so the chambers in which high pressure oil is introduced also shift sequentially, but in the direction opposite the arrow direction. in Fig. B the rotor (6) has turned 1/14 revolution. This causes the chambers where high pressure oil is introduced to shift to A, G and F. At this time, the center of the rotor Y shifts in a circle about point X to pointed Y'. In Fig. C, Y' shifts to Y".

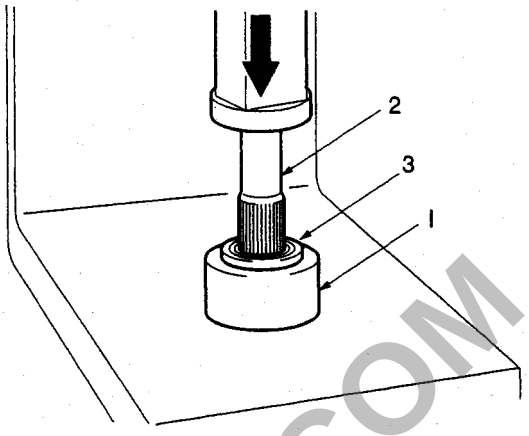
That is, the center of the rotor (6) rotates in a circle around point X, 6/7 revolution, from Y to Y' to Y". In Fig. D, point Y" has returned to point Y, making 1 cycle of shifting the chambers where high pressure oil is introduced.

At this time, the • mark on the rotor (6) rotates 1/6 revolution in the reverse direction.

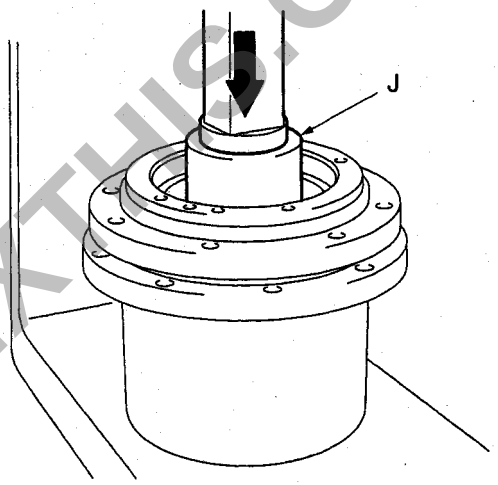
From this, we can see that 1 revolution of the output shaft is achieved by introduction of high pressure oil into 42 chambers, that is, 7 chambers $\times$6 cycles = 42 chambers.

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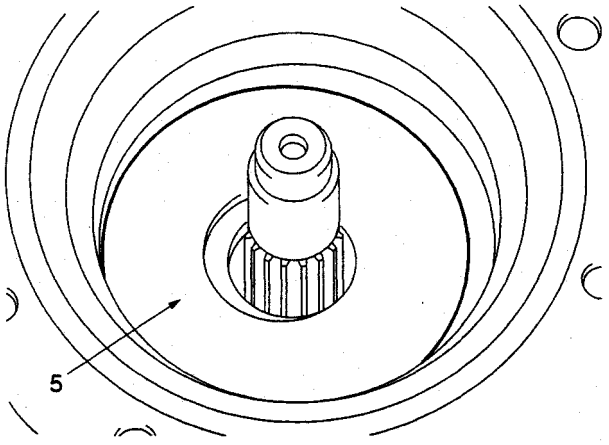
(18) Install the ball bearing (3) to the shaft (2).
- Use the pressure fitting jig (I).



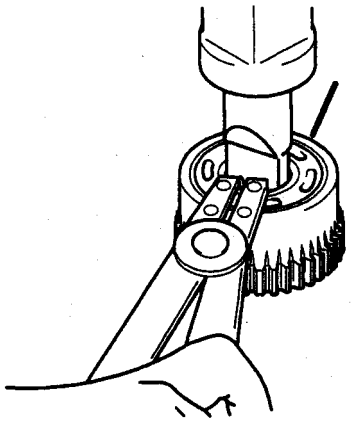
(19) Install the shaft assy to the flange holder (101).
- Use the pressure fitting jig (J).



(20) Install the steel ball (6), spring (20), piston assy (19) and swash plate (5).
- Apply hydraulic oil to the sliding surface on the swash plate.

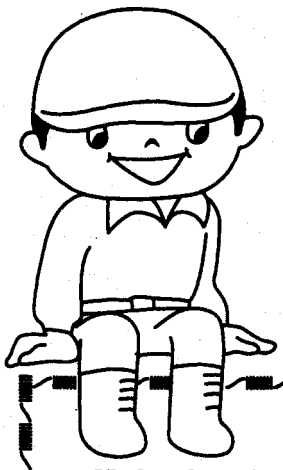


(21) Installation of cylinder block:
a. Install the spring seat (8), spring (9) and washer (10) to the cylinder block (7).
b. Install the snap ring (11).
- Use the installation jig (K).



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PREFACE

Hydraulic cylinders are equipments that convert the energy of the pressurized oil fed by the pump to reciprocating motions. The cylinder is composed of a cylinder head, cylinder tube, piston, piston rod and others. Hydraulic cylinders vary in the piston diameter, rod diameter, stroke, sealing method and cylinder bearing method, depending upon their service conditions, but are identical in terms of fundamental construction.

Models	Applicable Machines	Notes	Models	Applicable Machines	Notes
SK20SR	PM02001~				

Revision	Date of Issue	Remarks
First edition	July, 1997	S5170221E S
First revision	March, 1998	S5170221E① S

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5.1.3 Modifilation of Arm

Attach the additional parts shown in the Table 24 to the arm of standard specification by means of welding in accordance with the Fig. 33.

Note : • Use the welding rod with the weld symbol B (for mild steel 50 kg grade).

Symbol for Q'ty	Arm Part No.	Applicable Machine No.
A	PU12B00013F1	PU06001～07000
B	PU12B00013F2	PU07001～

Table 24 Additional Parts for Arm Modification

No.	PART NO.	NAME	Q'TY A	Q'TY B	No.	PART NO.	NAME	Q'TY A	Q'TY B
2	PV12B01152P1	PLATE	2	2	4	PU12B01049P1	PLATE	1	1
	(PV46H01004P1)	(before Modification)	(2)	—	5	PU12B01050P1	PLATE	1	1
3	PU12B01048P1	PLATE	2	2					

Note : The part numbers are subject to change due to improvement or modification. Use them for your reference only.

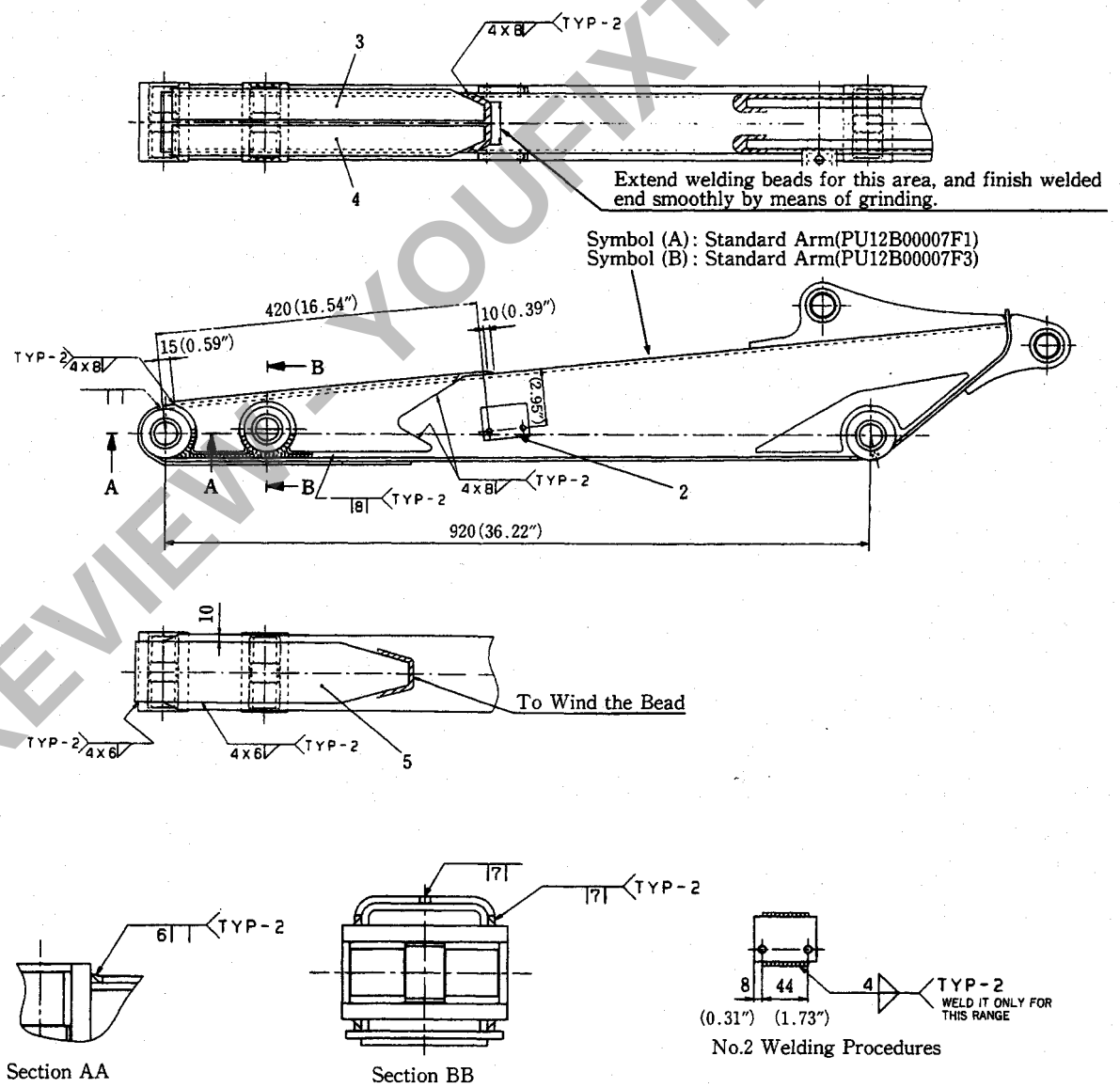


Fig. 33 Arm Modification (SK15SR)

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MEMO:

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CHAPTER 3

FUEL INJECTION EQUIPMENT

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2. Disassembly, Reassembly and Inspection of Governor 3-13
3. Disassembly, Reassembly and Inspection of Fuel Injection Pump 3-23
4. Adjustment of Fuel injection pump and Governor 3-38
5. Fuel feed pump 3-47
6. Fuel injection nozzle 3-49
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8. Tools 3-57
9. Fuel filter 3-59
10. Air venting system 3-59
11. Service data 3-60

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(3) When the plunger top clearance is larger than the prescribed value, remove the plunger guide and insert plunger shims between the plunger spring lower retainer and the plunger guide. Adjust each pump in the same manner.

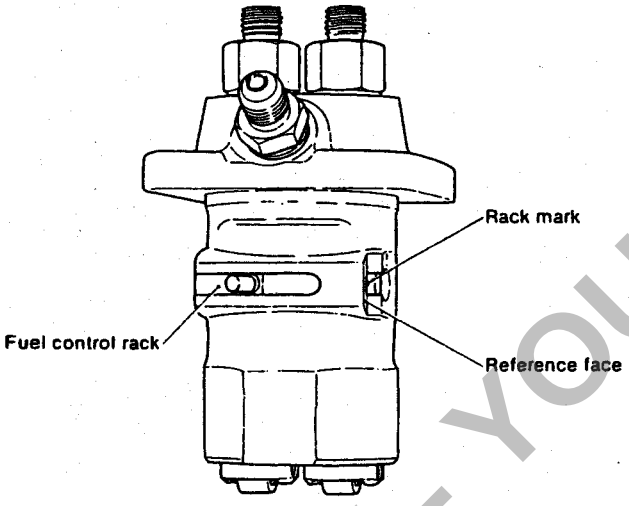
Plunger shim thickness	0.1mm (0.004in.)	119620-51250
	0.2mm (0.008in.)	
	0.3mm (0.012in.)	

(4) After rechecking adjustment, install the delivery valve.

Delivery valve holder tightening torque	4.0 ~ 4.5 kg-m (29 ~ 32.6 lb-ft)

4-8.4 Checking the cylinder injection interval

(1) Align the control rack punch mark with the pump reference face.



(2) Turn the pump by hand to check the No.1 cylinder injection timing.
(3) Turn the pump in the prescribed direction and check the No.2/3 cylinder injection timing.
(4) Using the plunger shims, adjust each cylinder injection timing interval.

	For crankshaft angle	For camshaft angle
3TN66E, 3TNA72E	240° 240° 240° 1 ~ 3 ~ 2 ~ 1	120° 120° 120° 1 ~ 3 ~ 2 ~ 1

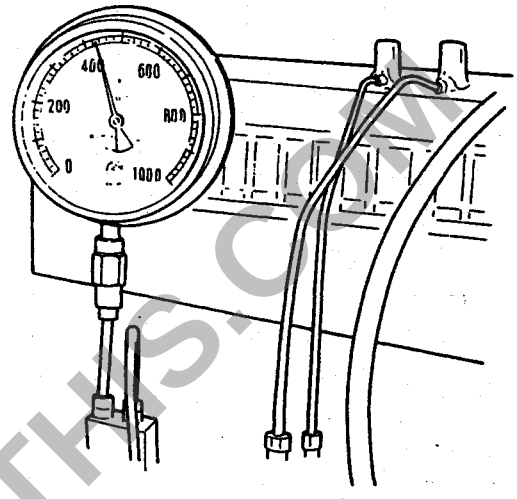
4-8.5 Delivery valve oil-tight test

(1) Install a 1,000 kg/cm² (14,223 lb/in.²) pressure gauge on the delivery valve holder.
(2) Drive the fuel pump to apply a pressure of approximately 120 kg/cm² (1,707 lb/in.²) and measure the time required for the pressure to drop from 100 kg/cm² (1,422 lb/in²) to 90 kg/cm² (1280 lb/in.²)

Pump speed	200 rpm
Pressure drop standard	20 sec. or more
Pressure drop limit	5 sec. or less

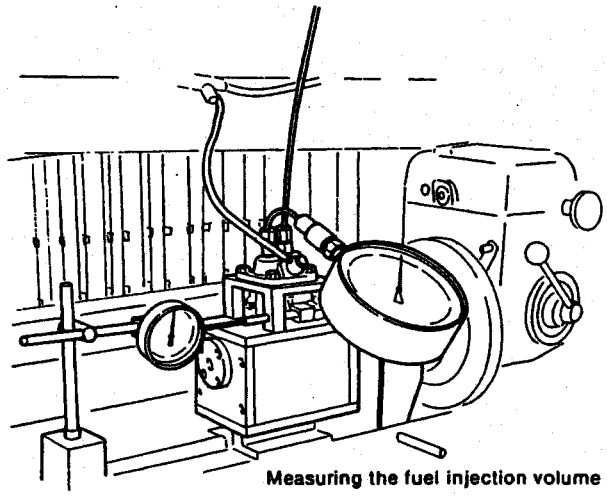
(3) If both the plunger and the delivery valve fail the test, replace them.

4-8.6 Plunger pressure test

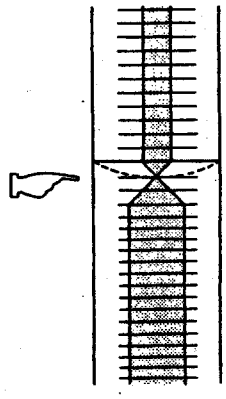


(1) Install a 1,000 kg/cm² (14,223 lb/in.²) pressure gauge on the delivery valve holder.
(2) Check that there is no oil leaking from the delivery valve holder and high pressure pipe mountings, and that the pressure does not drop suddenly when raised to 500 kg/cm² (7,112 lb/in.²) or higher.
Pressure gauge AVT 1/2 × 150 × 1,000 kg/cm²

4-8.7 Measuring the fuel injection volume



Measuring the fuel injection volume



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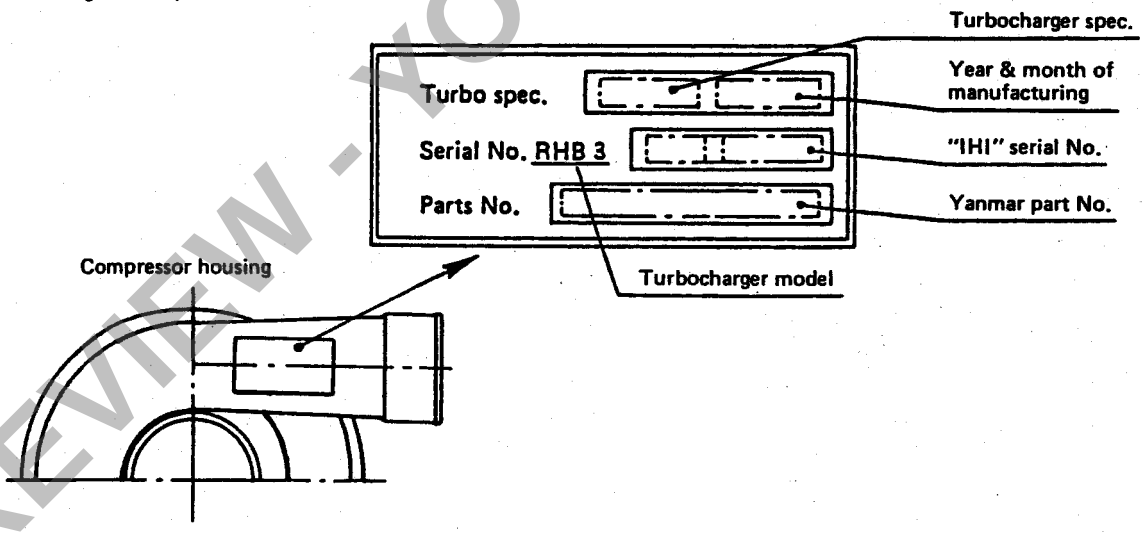
2. Turbocharger

1 Specifications

Turbocharger maker	ISHIKAWAJIMA-HARIMA HEAVY INDUSTRIAL CO.,LTD. (I H I)		
Turbine type	Radial flow	Radial flow, Waste gate	Radial flow, w/Waste gate
Blower type	Centrifugal		
Bearing type	Full floating		
Lubrication method	Forced lubrication from cylinder block main gallery		
Cooling method	Air cooled		
Max. intermittent allowable rpm	250,000		180,000
Max. gas inlet temp. (intermittent allowable)	750°C		
Dry weight, approx.	2.0 kg (4.4 lbs)		3.7 kg (8.2 lbs)
Turbocharger model	RH B31		RH B51
Applicable engine model	3·4TN84TE(CL), 3·4TN82TE-G1	3TN84TE(VM) 3TN82TE-S	4TN82TE-S, 4TN84TE(VM)

Note: The specifications of the turbine and compressor are difference between the turbochargers for the engine models.

Turbocharger name plate



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3-5 Alternator functioning

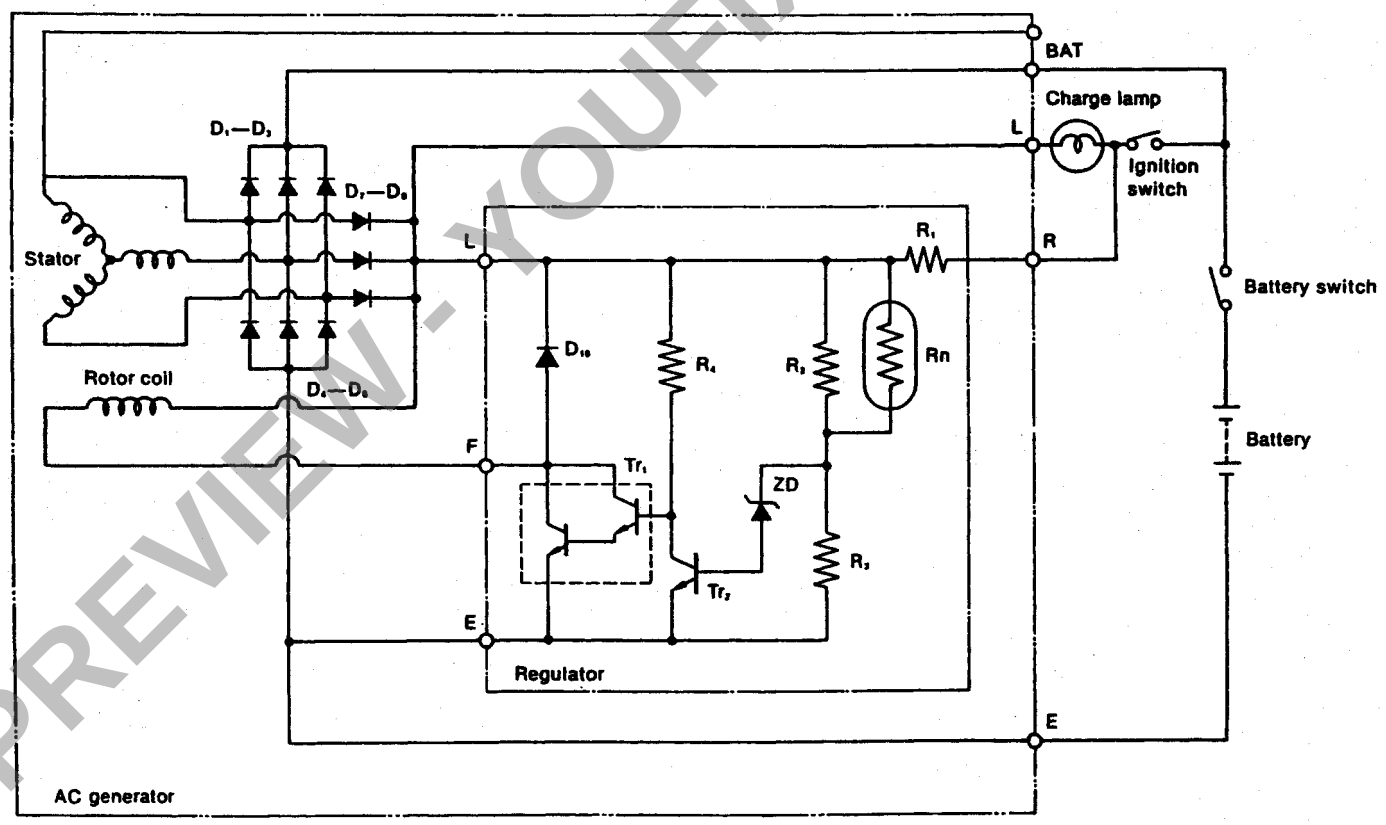
(1) IC regulator
The IC regulator is the transistor (Tr_1) which is series-connected with the rotor. The IC regulator controls the output voltage of the generator by breaking or conducting the rotor coil (exciting) current.
When the output voltage of the generator is within the standard value, the transistor (Tr_1) turns on. When the voltage exceeds the standard value, the Zener diode goes on and the transistor (Tr_1) turns off.
With the repeated turning on and off of the transistor, the output voltage is kept at the standard value. (Refer to the circuit diagram below.)

(2) Charge lamp
When the transistor (Tr_1) is on, the charge lamp key switch is turned to ON, and current flows to R_1, R_4 and to Tr_1 to light the lamp. When the engine starts to run and output voltage is generated in the stator coil, the current stops flowing to this circuit, turning off the charge lamp.

(3) Circuit diagram

3-6 Handling precautions

(1) Be careful of the battery's polarity (+, − terminals), and do not connect the wrong terminals to the wrong cables, or the battery will be short-circuited by the generator diode.
In this case too much current will flow, the IC regulator and diodes burn out, and the wire harness will burn.
(2) Make sure of the correct connection of each terminal.
(3) When quick-charging, etc., disconnect either the battery terminal on the AC generator or the terminal on the battery.
(4) Do not short-circuit the terminals.
(5) Do not conduct any tests using high tension insulation resistance. (The diodes and IC regulator will burn out.)



BAT:	Generator output terminal	D_1—D_6:	Output commutation diode
D_{10}:	IC protecting diode	R_1—R_4:	Resistor
L:	Charge lamp terminal	D_7—D_9:	Auxiliary diode
ZD:	Zener diode	Rn:	Thermistor (Temperature gradient resistance)
E:	Earth		
Tr_1, Tr_2:	Transistor		

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