3. SPECIFICATIONS AND PERFORMANCE

1. SPEED AND GRADEABILITY

Item \ Model	SK15MSR		SK16MSR	
	Rubber crawler shoe		Rubber crawler shoe	
Slewing Speed	10.7 rpm		10.7 rpm	
Travel Speed	Low (1st)	High (2nd)	Low (1st)	High (2nd)
	2.0km/h (1.2mph)	3.5km/h (2.2mph)	2.0km/h (1.2mph)	3.5km/h (2.2mph)
Gradeability % (degree)	58 % (30°)		58 % (30°)	

2. SIDE DIGGING & DOZER

Type		Boom swing by hydraulic cylinder	Boom swing by hydraulic cylinder
Boom Swing Angle	Right	50°	50°
	Left	80°	80°
Stroke of Dozer(above/below) mm(in)		230 / 280 (9.1 / 11.0)	230 / 280 (9.1 / 11.0)

3. ENGINE

Model	YANMAR 3TNE68 - YB
Type	Water-cooled, 4-cycle type Swirl chamber type diesel engine
Number of cylinders-Bore x Stroke	3 - 68mm X 72mm (2.68in X 2.83in)
Total Displacement	0.784 liters (47.8 cu.in)
Output Rating	12.1PS / 2,000rpm (8.9kW / 2,000min^{-1})
Maximum Torque	4.7kgf·m / 1,500rpm (34ft·lbs/1,500rpm)
Starting Motor	12V / 0.9 kW
Generator	12V / 20 A

4. HYDRAULIC COMPONENTS

Hydraulic Pump	Variable displacement axial piston + gear pump
Hydraulic Motor	Orbit motor
Hydraulic Motor w/Reducer (Travel)	Axial piston, 2-Speed motor
Control Valve	9-function multiple control valve
Cylinder (Boom, Arm, Swing, Bucket, Dozer, Frame width)	Double action cylinder
Return Filter	Safety valve containing/Filter Type (30μ)

5. NOISE LEVEL

Sound Power Level	88dB (A)

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3.2 NEUTRAL CIRCUIT

(1) Pilot Circuit

1) Pilot Primary Pressure Circuit

The oil discharged from the P3 pump on pump assy (2) enters into the solenoid valve (13) through the line filter (20).

By unlocking the safety lock lever (operating conditions), the pressuized oil discharged from the A1 port on solenoid valve (13) directs to P ports on Pilot valves (14) and (29), as primary pilot pressure.

While the operating circuit is closed at neutral position, the discharged oil from the pump loses its flowing passage, and returns to the hydraulic oil tank through the relief valve [setting pressure: 35 kg/cm² (500 psi)] in the solenoid valve (13).

2) Pilot Secondary Pressure Circuit

While the pilot valves (14) and (29) 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 from the pilot valve to shift each spool of shifting valve.

(2) Main Circuit

1) Variable Pump Circuit

The discharged oil from P1 and P2 ports on variable pump enters into P1 and P2 ports on control valve respectively. All the discharged oil from these two ports finally joins together in the service valve and returns to the hydraulic oil tank, through each valve of bucket, boom, swing, right travel and dozer for the P1 oil, and through each valve of arm, slew and left travel for the P2 oil.

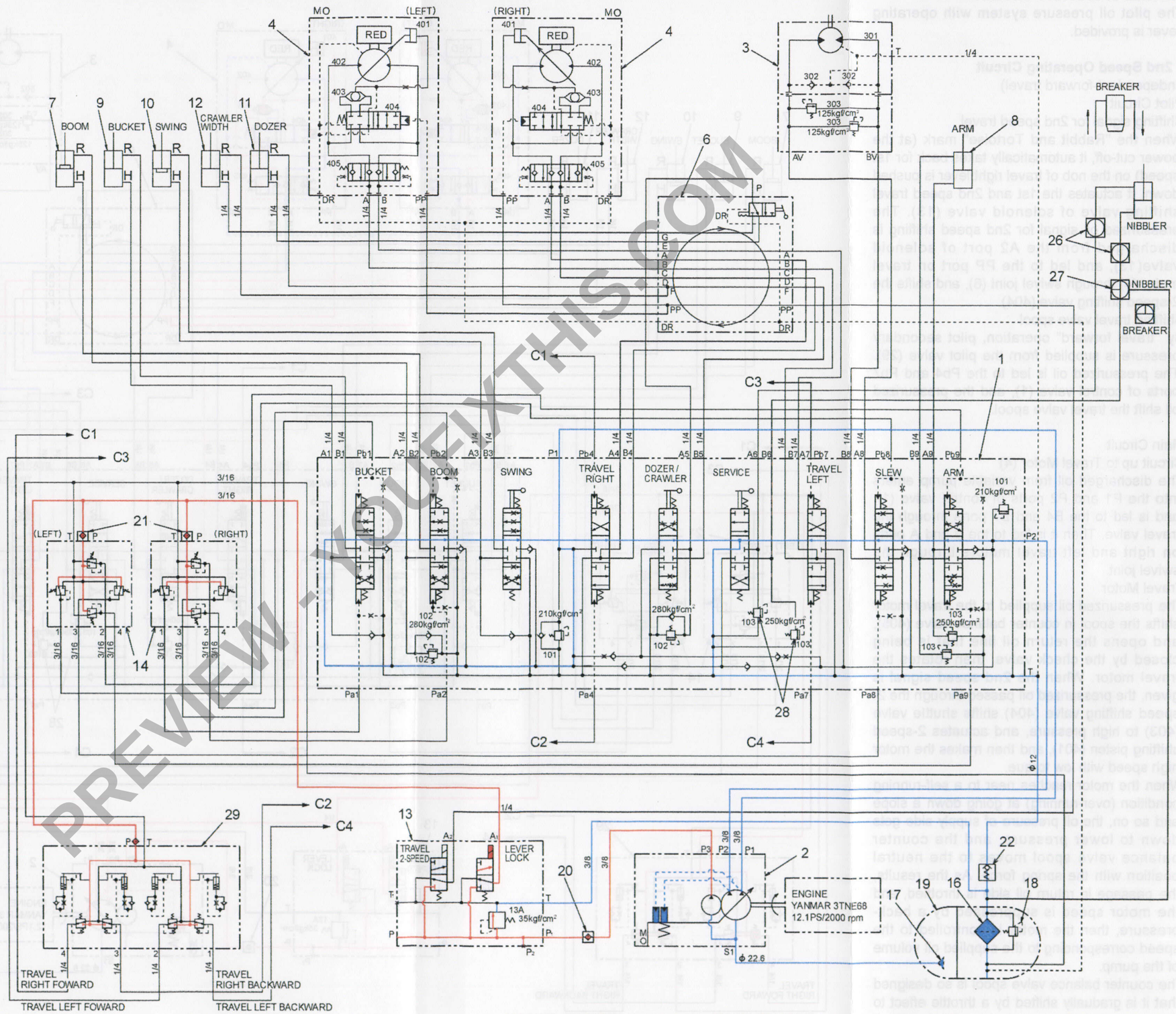
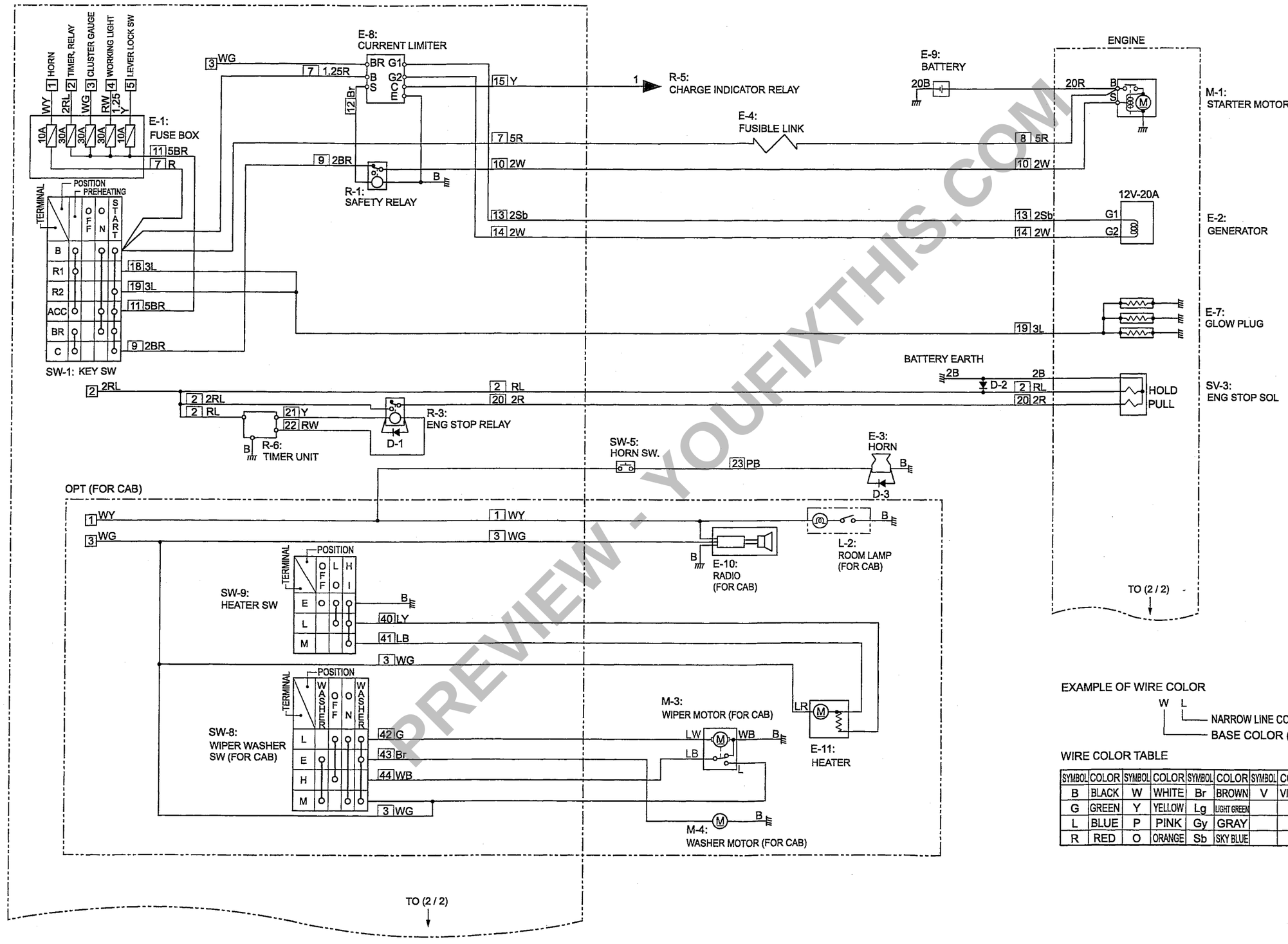


Fig.5 Neutral circuit

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2. ELECTRIC CIRCUIT DIAGRAM (1/2)



EXAMPLE OF WIRE COLOR

W L
- L — NARROW LINE COLOR (BLUE)
- W — BASE COLOR (WHITE)

WIRE COLOR TABLE

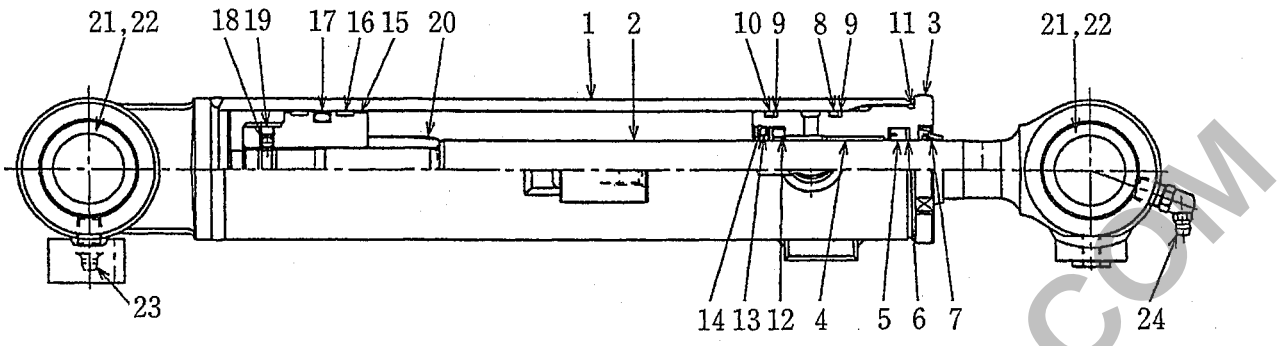
SYMBOL	COLOR	SYMBOL	COLOR	SYMBOL	COLOR	SYMBOL	COLOR
B	BLACK	W	WHITE	Br	BROWN	V	VIOLET
G	GREEN	Y	YELLOW	Lg	LIGHT GREEN		
L	BLUE	P	PINK	Gy	GRAY		
R	RED	O	ORANGE	Sb	SKY BLUE		

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1.3 CYLINDER CONSTRUCTION (EXAMPLE OF BOOM CYLINDER)

- See [24-I-7] CYLINDER for the others.



No.	NAME	Q'TY	No.	NAME	Q'TY	No.	NAME	Q'TY
1	CYLINDER TUBE ASSY	1	9	BACK-UP RING	2	17	SEAL RING ASSY	1
2	PISTON ROD ASSY	1	10	O-RING	1	18	STEEL BALL	1
3	CYLINDER HEAD	1	11	O-RING	1	19	SETSCREW	1
4	BUSHING	1	12	CUSHION RING	1	20	CUSHION BEARING	1
5	U-RING	1	13	SPACER	1	21	PIN BUSHING	2
6	BACK-UP RING	1	14	STOPPER	1	22	DUST SEAL	4
7	WIPER RING	1	15	PISTON	1	23	GREASE NIPPLE	1
8	O-RING	1	16	SLIDE RING	2	24	GREASE NIPPLE	1

Fig. 1-1 Construction of boom cylinder

1.4 DISASSEMBLY

- The numbers in ( ) following to each part name are the numbers corresponding to those in Fig. 1-1 "Boom cylinder" except for notes.

(1) Disassembly of cylinder assy

1) Fix the clevis portion of tube with a vice, and hold the other end with a wooden stand to hold the cylinder in level.
2) Drain hydraulic oil remained in the cylinder.
   - Slowly move the piston rod so that the hydraulic oil does not spout out.

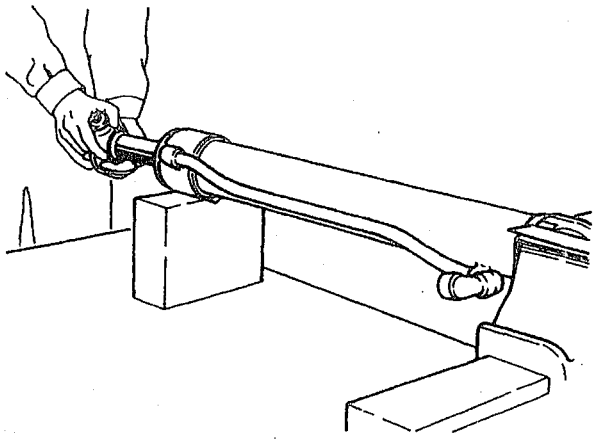


Fig. 1-2 Disassembling cylinder assy

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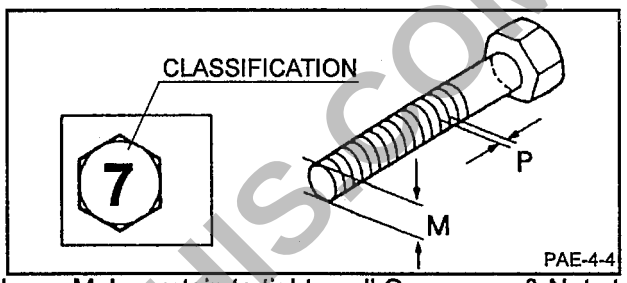
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1. TORQUE SPECIFICATIONS FOR CAPSCREWS & NUTS

The following Torque Specifications are provided for use when actual torque value of a fastener is not known. Check the capscrews and nuts for their looseness and dropping off before the start of daily work and at the periodical maintenance. Retighten the loosened ones, and install new ones for the dropped off. For the new machine, the check and retightening of them must be carried out at first 50 hours operation. For the replacement of them, make sure to use the same size of KOBELCO genuine parts.

Refer to the table below for the tightening and retightening of capscrews.

- The table below is not applicable for the capscrews to fix the cover, etc., made of plastic. For the tightening torque for such capscrews, consult with an authorized KOBELCO Distributor. Over-tightening may cause damages on the parts to be fixed.
- In case that the tightening torque is specified in the manual, use such torque values regardless to the table below.
- Numerical indication on the capscrew head shows the classification for strength (e.g., 7 = 7 T). No indication is provided for smaller size of capscrews, M 5 or less.



1. Metric Coarse Thread Standard Tightening Torque Values. Make certain to tighten all Capscrews & Nuts to proper torque values.

Classification	4.8 T		7 T		10.9 T	
NOMINAL SIZE	NO LUBRICATION	OIL LUBRICATION	NO LUBRICATION	OIL LUBRICATION	NO LUBRICATION	OIL LUBRICATION
M6 P=1	0.45±0.05(3.2±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(12.8±1.3)	1.5±0.15(10.8±1.1)
M8 P=1.25	1.09±0.11(7.9±0.8)	0.92±0.09(6.6±0.7)	2.4±0.2(17.3±1.4)	2.0±0.2(14.4±1.4)	4.3±0.4(31±2.9)	3.6±0.4(26±2.9)
M10 P=1.5	2.2±0.2(15.9±1.4)	1.83±0.18(13.2±1.3)	4.7±0.5(34±3.6)	4.0±0.4(29±2.9)	8.5±0.9(61±6.5)	7.2±0.7(52±5.1)
M12 P=1.75	3.7±0.4(27±2.9)	3.2±0.3(23±2.2)	8.1±0.8(59±5.8)	6.8±0.7(49±5.1)	14.6±1.5(105±10.8)	12.3±1.2(89±8.7)
M14 P=2	5.9±0.6(43±4.3)	5.0±0.5(36±3.6)	12.8±1.3(93±9.4)	10.8±1.1(78±7.9)	23±2(166±14.5)	19.5±1.9(140±13.7)
M16 P=2	9.0±0.9(65±6.5)	7.6±0.7(55±5.1)	19.5±2(140±14.4)	16.4±1.6(118±11.5)	35±4(252±29)	29±3(209±22)
M18 P=2.5	12.4±1.2(90±8.7)	10.5±1.0(76±7.2)	27±3(195±22)	23±2(166±14.5)	49±5(354±36)	41±4(296±29)
M20 P=2.5	17.5±1.7(126±12.3)	14.7±1.4(106±10.1)	38±4(274±29)	32±3(231±22)	68±7(491±51)	57±6(412±43)
M22 P=2.5	23±2(166±14.5)	19.6±2(142±14.5)	51±5(368±36)	43±4(310±29)	92±9(665±65)	77±8(557±58)
M24 P=3	30±3(217±22)	24±3(173±22)	65±7(470±51)	53±5(383±36)	118±12(852±87)	93±10(673±72)
M27 P=3	44±4(318±29)	36±3(260±22)	96±10(694±72)	78±8(563±58)	173±17(1250±123)	140±14(1010±100)
M30 P=3.5	60±6(433±43)	50±5(361±36)	131±13(948±94)	110±11(796±79)	235±24(1700±174)	198±20(1430±145)
M33 P=3.5	81±8(585±58)	68±7(491±51)	176±18(1270±130)	148±15(1070±110)	317±32(2290±230)	266±27(1920±195)
M36 P=4	105±10(758±72)	88±9(636±65)	227±23(1640±170)	190±19(1370±140)	409±41(2960±300)	343±34(2480±250)

TORQUE VALUE UNIT-kgf·m (ft·lbs.)

2. Metric Fine Thread Standard Tightening Torque Values. Make certain to tighten all Capscrews & Nuts to proper torque values.

Classification	4.8 T		7 T		10.9 T	
NOMINAL SIZE	NO LUBRICATION	OIL LUBRICATION	NO LUBRICATION	OIL LUBRICATION	NO LUBRICATION	OIL LUBRICATION
M8 P=1.0	1.15±0.11(8.3±0.8)	0.97±0.1 (7.0±0.7)	2.5±0.2 (18.0±1.4)	2.1±0.2 (15.2±1.4)	4.5±0.4 (33±2.9)	3.8±0.4 (27±2.9)
M10 P=1.25	2.3±0.2 (16.6±1.4)	1.91±0.19(13.8±1.4)	4.9±0.5 (35±3.6)	4.2±0.4 (30±2.9)	8.9±0.9 (64±6.5)	7.5±0.7 (54±5.1)
M12 P=1.25	4.0±0.4 (29±2.9)	3.4±0.3 (25±2.2)	8.7±0.9 (63±6.5)	7.3±0.7 (53±5.1)	15.7±1.6 (114±11.6)	13.2±1.3 (95±9.4)
M16 P=1.5	9.4±0.9 (68±6.5)	7.9±0.8 (57±5.8)	20±2 (144±14.5)	17.2±1.7 (124±12.3)	37±4 (268±29)	31±3 (224±22)
M20 P=1.5	19±1.9 (137±13.7)	15.8±1.6 (114±11.6)	41±4 (296±29)	34±3 (246±22)	74±7 (535±51)	62±6 (448±43)
M24 P=2	32±3 (231±22)	27±3 (195±22)	70±7 (506±51)	58±6 (420±43)	126±12 (911±87)	105±10 (759±72)
M30 P=2	65±6 (470±43)	54±5 (391±36)	142±14(1030±100)	118±12 (852±87)	255±26 (1840±188)	212±21 (1530±150)
M36 P=3	109±11 (788±79)	91±9 (658±65)	238±23(1720±166)	198±20 (1430±145)	428±43 (3100±310)	357±36 (2580±260)

TORQUE VALUE UNIT-kgf·m (ft·lbs.)

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

Note : (*) Marked items are not applied for SK15MSR and SK16MSR which provide Pilot Valve instead of travel lock cylinder.

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INDEX

SK15MSR
SK16MSR

Book Code No.				Title	Index No.
S5PF0102E 2000-7	S5PF0102E ① 2001-7		SPECIFICATIONS	PRELIMINARY REMARKS	PF01
S5PF0202E 2000-7	S5PF0202E ① 2001-7			SPECIFICATIONS	PF02
S5PF0302E 2000-7	S5PF0302E ① 2001-7			ATTACHMENT DIMENSIONS	PF03
S5PF1102E 2000-7	S5PF1102E ① 2001-7		MAINTENANCE	TOOLS	PF11
S5PF1202E 2000-7				STANDARD MAINTENANCE TIME TABLE	PF12
S5PF1302E 2000-7	S5PF1302E ① 2001-7			MAINTENANCE STANDARDS AND TEST PROCEDURES	PF13
—			SYSTEM		
S5PF2202E 2000-7	S5PF2202E ① 2001-7			HYDRAULIC SYSTEM	PF22
S5PF2302E 2000-7	S5PF2302E ① 2001-7			ELECTRICAL SYSTEM	PF23
S5PF2402E 2000-7	S5PF2402E ① 2001-7			COMPONENTS SYSTEM	PF24
—					
—					
S5PF3102E 2000-7			DISASSEMBLING	WHOLE DISASSEMBLING & ASSEMBLING	PF31
S5PF3202E 2000-7	S5PF3202E ① 2001-7			ATTACHMENTS	PF32
S5PF3302E 2000-7	S5PF3302E ① 2001-7			UPPER SLEWING STRUCTURE	PF33
S5PF3402E 2000-7	S5PF3402E ① 2001-7			TRAVEL SYSTEM	PF34
—			TROUBLESHOOTING		
S5PF4202E 2000-7				HYDRAULIC SYSTEM	PF42
S5PF4302E 2000-7				ELECTRICAL SYSTEM	PF43
S5PF4402E 2000-7				ENGINE	PF44
S5PF5102E 2000-7			E/G	ENGINE	PF51
			OPT		

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1.1 GENERAL SAFETY INFORMATION

WARNING

Do Not operate or perform any maintenance on this machine until all instructions found in the OPERATION & MAINTENANCE MANUAL have been thoroughly read and understood.
Improper operation or maintenance of this machine may cause accidents and could result in serious injury or death.
Always keep the manual in the operator's seat pocket.
If it is missing or damaged, place an order with an authorized KOBELCO Distributor for a replacement.
If you have any questions, please consult an authorized KOBELCO Distributor.

1. Most accidents, which occur during operation, are due to neglect of precautionary measures and safety rules. Sufficient care should be taken to avoid these accidents. Erroneous operation, lubrication or maintenance services are very dangerous and may cause injury or death of personnel. Therefore all precautionary measures, NOTES, DANGERS, WARNINGS and CAUTIONS contained in the manual and on the machine should be read and understood by all personnel before starting any work with or on the machine.

2. Operation, inspection, and maintenance should be carefully carried out, and safety must be given the first priority. Messages of safety are indicated with marks. The safety information contained in the manual is intended only to supplement safety codes, insurance requirements, local laws, rules and regulations.

3. Messages of safety appear in the manual and on the machine : All messages of safety are identified by eighter word of "DANGER", "WARNING" and "CAUTION".
   a. **DANGER-** Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury and is represented as follows:

DANGER

   b. **WARNING-** Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury and is represented as follows:

WARNING

   c. **CAUTION–** Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against possible damage to the machine and its components and is represented as follows:

CAUTION

4. It is very difficult to forecast every danger that may occur during operation. However, safety can be ensured by fully understanding proper operating procedures for this machine according to methods recommended by KOBELCO.

5. While operating the machine, be sure to perform work with great care, so as not to damage the machine, or allow accidents to occur.

6. Continue studying the manual until all Safety, Operation and Maintenance procedures are completely understood by all persons working with the machine.

1.2 SAFETY PRECAUTIONS

WARNING

The proper and safe lubrication and maintenance for this machine, recommended by KOBELCO, are outlined in the OPERATOR'S MANUAL for the machine.
Improper performance of lubrication or maintenance procedures are dangerous and could result in injury or death. Read and understand the MANUAL before performing any lubrication or maintenance.

The serviceman or mechanic may be unfamiliar with many of the systems on this machine. This makes it important to use caution when performing service work. A knowledge of the system and or components is important before the removal or disassembly of any component.

Because of the size of some of the machine components, the serviceman or mechanic should check the weights noted in this manual. Use proper lifting procedures when removing any components. Weight of components table is shown in the section ; SPECIFICATIONS.

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(2) Clearance in thrust direction on boom and cylinder installation section [Fig. 1-3]

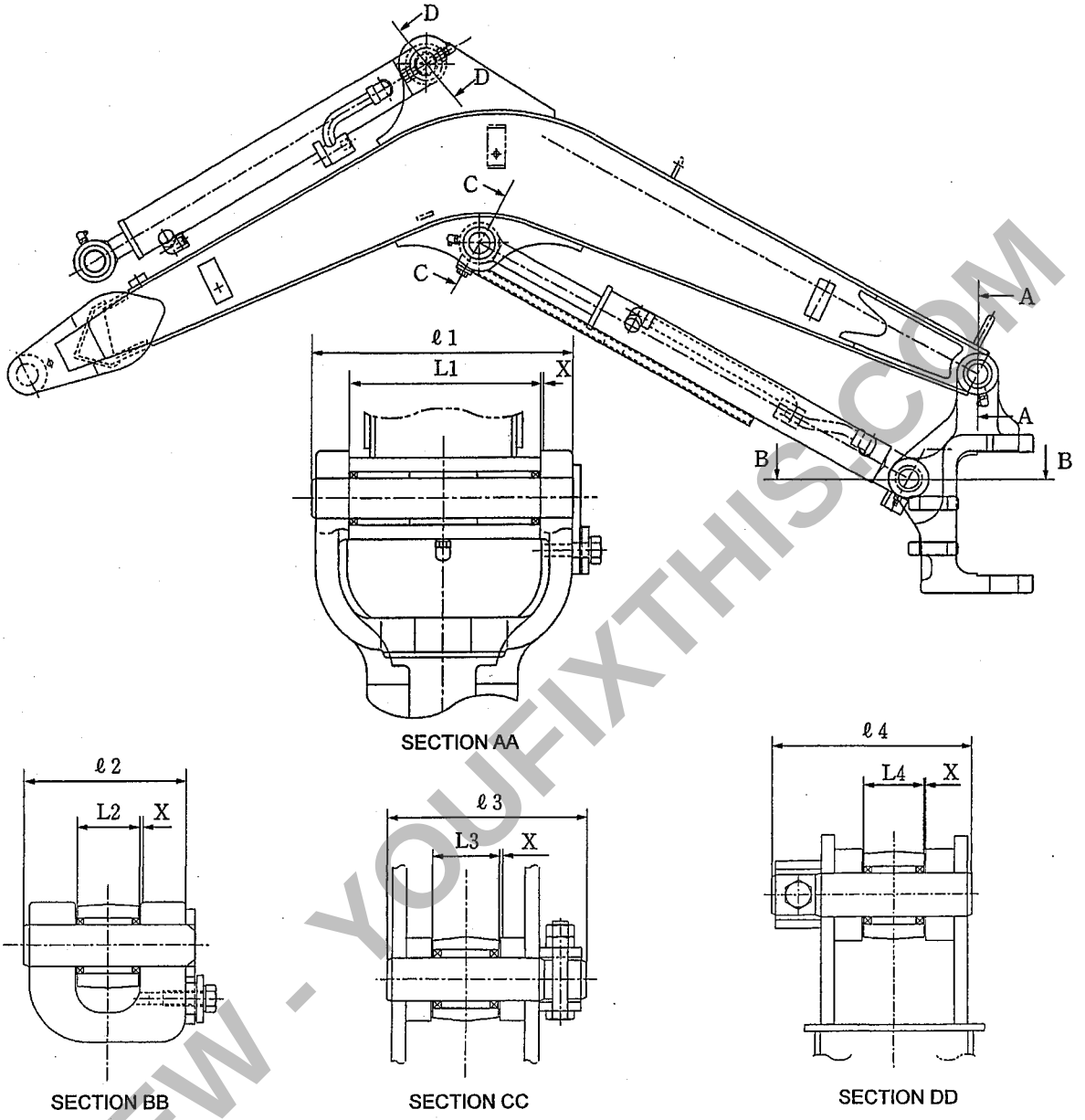


Table 1-3 Unit : mm (in)

Pos.	Item		Standard dimensions		Clearance X reconditioned with shim (total of both sides)			Pin length		Remedy
			No.	Dimensions	Standard value	Standard value for repair	Serviceability limit	No.	Dimensions	
A	Boom foot	Boom	L1	$140^{-0.1}_{-0.2}(5.512^{-0.004}_{-0.008})$	Less than 0.2 (0.008)	0.7 (0.028)	1.0 (0.039)	ℓ1	[189 (7.44)] 206 (8.11)	Reconditioned with shim
		Swing bracket		$140^{+0.3}_{0}(5.512^{+0.012}_{0})$						
B	Boom cylinder (Head side)	Boom cylinder	L2	$45^{0}_{-0.5}(1.772^{0}_{-0.020})$	Less than 0.5 (0.020)	1.0 (0.039)	1.5 (0.059)	ℓ2	111 (4.37)	
		Swing bracket		$46^{+2.0}_{0}(1.811^{+0.079}_{0})$						
C	Boom cylinder (Rod side)	Boom cylinder	L3	$45^{0}_{-0.5}(1.772^{0}_{-0.020})$				ℓ3	139 (5.47)	
		Boom		$47^{+1.0}_{0}(1.850^{+0.039}_{0})$						
D	Arm cylinder (Head side)	Arm cylinder	L4	$45^{0}_{-0.5}(1.772^{0}_{-0.020})$				ℓ4	139 (5.47)	
		Boom		$47^{+1.0}_{0}(1.850^{+0.039}_{0})$						

(Note) ● The dimensions in [ ] are applicable to the machine numbers PF02-02001~02203.

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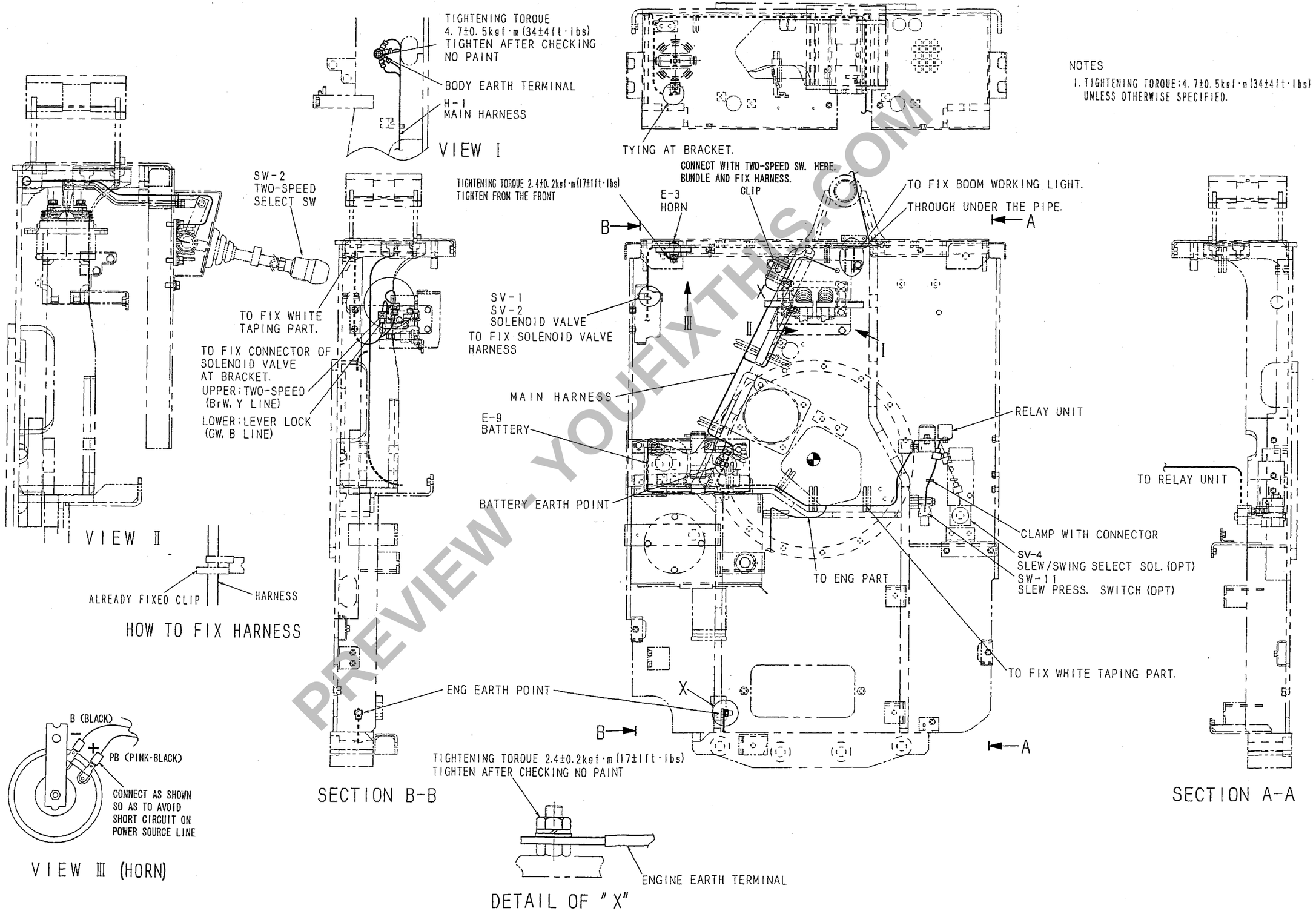
Model						SK15 & 16MSR	
Applicable machines						PF02-02001~	
Div.	Item				Unit	Standard value	Standard value for repair
Cylinders	Cylinder speed	Boom	Canopy	Ext.	sec.	2.4 ± 0.3	3.1
				Ret.		2.4 ± 0.3	3.1
			Cab	Ext.		2.2 ± 0.3	2.8
				Ret.		2.1 ± 0.3	2.7
		Arm		Ext.		3.9 ± 0.6	5.0
				Ret.		$3.1^{+0.2}_{-0.6}$	4.0
		Bucket		Ext.		2.9 ± 0.4	3.7
				Ret.		2.0 ± 0.4	2.6
		Swing		Ext.		5.7 ± 0.8	7.3
				Ret.		4.9 ± 0.8	6.3
		Dozer		Ext.		1.5 ± 0.4	1.9
				Ret.		1.5 ± 0.4	1.9
		Crawler width		Ext.		4.4 ± 0.6	5.6
				Ret.		3.7 ± 0.5	4.7
	Cylinder Gravity move	Boom			mm (in)	12^{0}_{-12} ($0.47^{0}_{-0.47}$)	24(0.94)
		Arm				$8.4^{0}_{-8.4}$ ($0.33^{0}_{-0.33}$)	17(0.67)
		Bucket				$3.6^{0}_{-3.6}$ ($0.14^{0}_{-0.14}$)	7.2(0.28)
		Swing				$3.6^{0}_{-3.6}$ ($0.14^{0}_{-0.14}$)	7.2(0.28)
		Dozer				$3.6^{0}_{-3.6}$ ($0.14^{0}_{-0.14}$)	7.2(0.28)
		Bucket tip				195^{0}_{-195} ($7.7^{0}_{-7.7}$)	390(15.4)
Slew bearing	Bucket tip play				mm (in)	42^{0}_{-25} ($1.7^{0}_{-1.0}$)	84(3.3)
	Slew bearing play					1.4±0.4(0.06± 0.02)	2.6(0.10)
Crawler	Crawler tension	Rubber			mm (in)	35~45(1.38~1.77)	—
		Steel				75~80(2.95~3.15)	—

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3.3 COMPONENTS & HARNESS ARRANGEMENT

3.3.1 Upper Frame Portion



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2) Boom (Rod Side) / Dozer (Head Side) Valve

(A) Relieving Operation

(a) When the pressure in the circuit is low with respect to the set value, the relief valve is maintained at equilibrium. Pressure from the pump passes from chamber (B) to the orifice in piston(4), then reaches chamber (C) and needle valve (poppet) (5). On the other hand, forces F and F1 are acting in the arrow direction on both sides of the main poppet (6).

$F = P \times A$ $F1 = P \times A1$

P : Pressure A, A1 : Sectional Area

Since the sectional area of A is less than that of A1, the main poppet (6) is pushed by the force "F1 - F" to the seat surface on the left side.

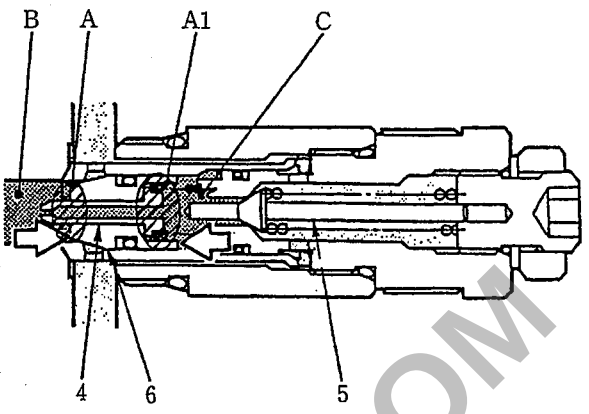


Fig. 3-17

(b) If the pressure in the circuit become higher than the force of the spring (7), the needle valve (poppet) (5) is pushed to the right by hydraulic pressure, opening passage. Oil then flows around the circumference of the needle valve (poppet) (5) and passes through the drill hole, flowing into the tank passage (T).

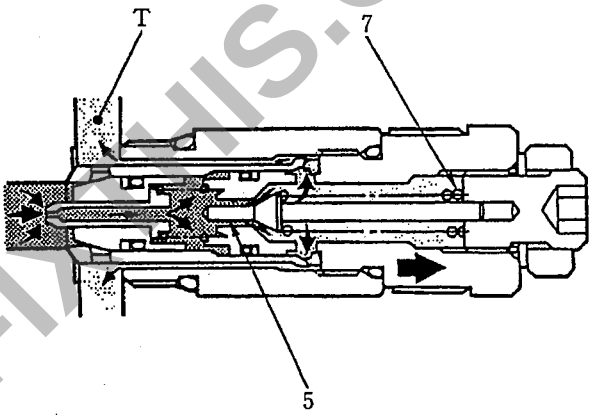


Fig. 3-18

(c) When the needle valve (poppet) (5) opens, the pressure drops on the back side of the piston (4), and the piston (4) is pushed to the right, seating with the needle valve (poppet) (5). This shuts off the flow of hydraulic oil to the rear of the main poppet (6). As a result, the pressure in chamber C on the inside drops.

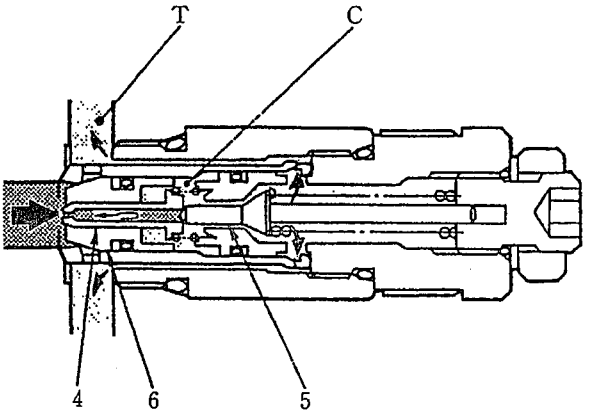


Fig. 3-19

(d) Compared to the chamber (B) side, the pressure in chamber (C) is low and there is no equilibrium in pressure. For this reason, the main poppet (6) opens and pressurized oil flows to the tank passage (T).

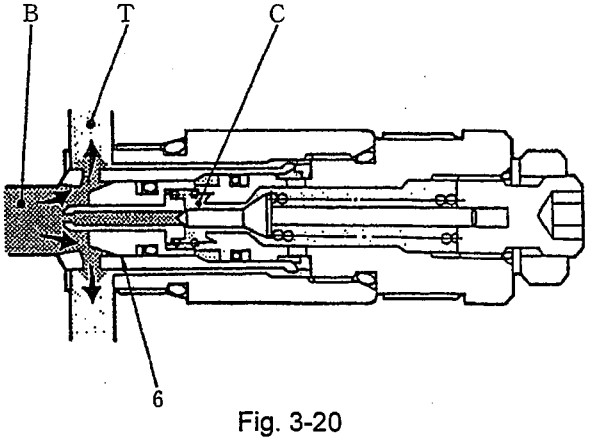
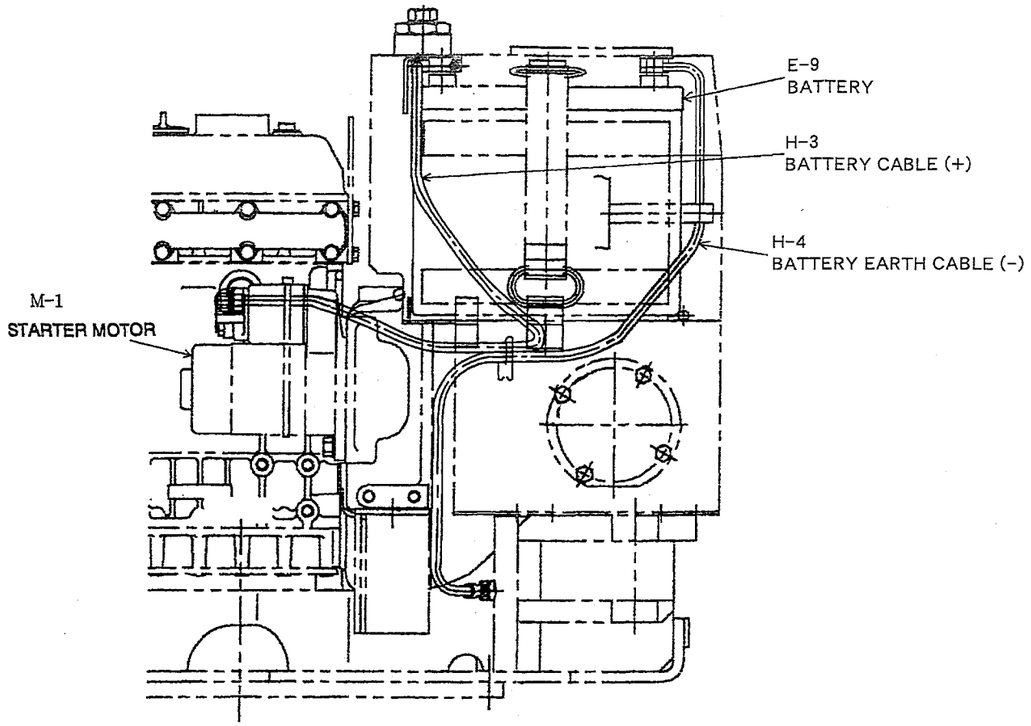


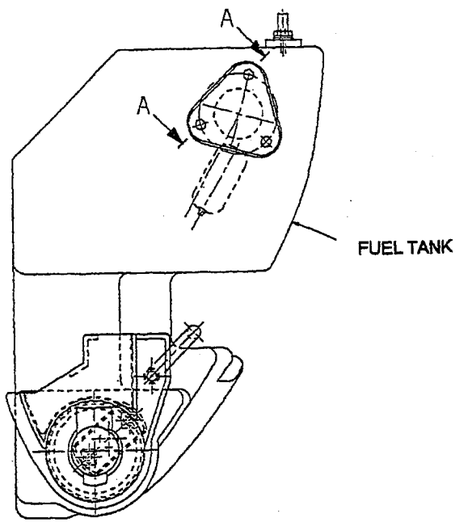
Fig. 3-20

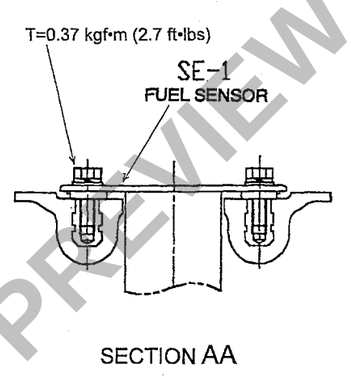
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2.2.4 Battery Portion



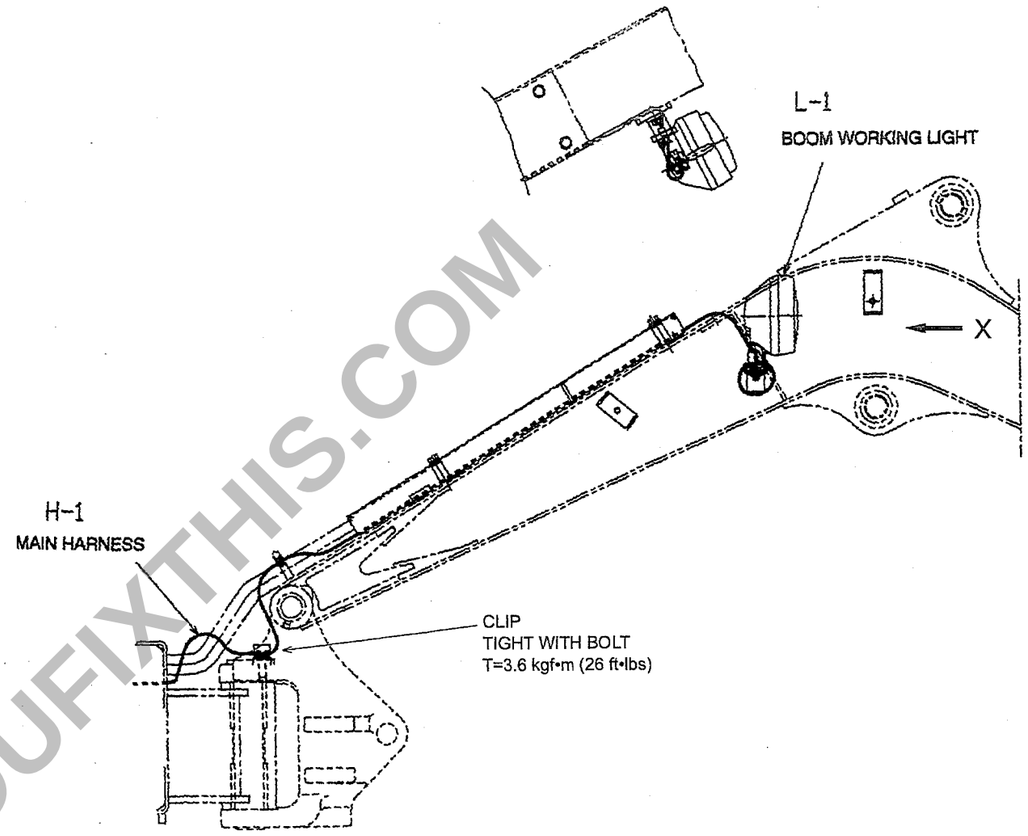
2.2.5 Fuel Tank Portion

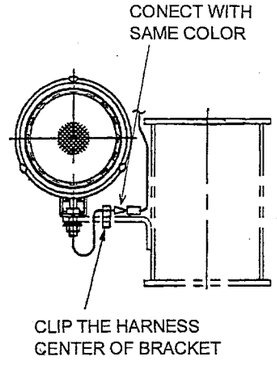




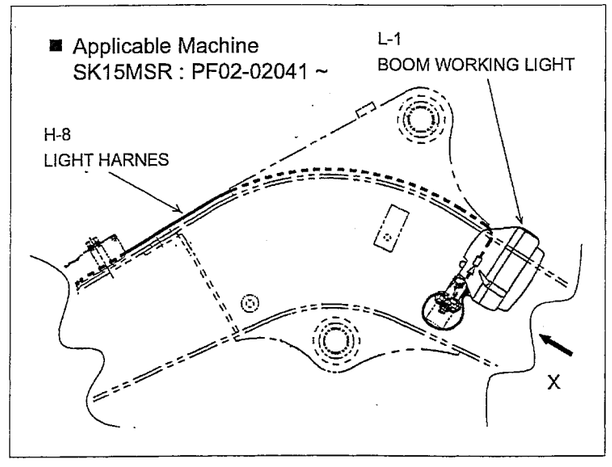
SECTION AA

2.2.6 Attachment Portion





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《 For Swing Cylinder 》

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

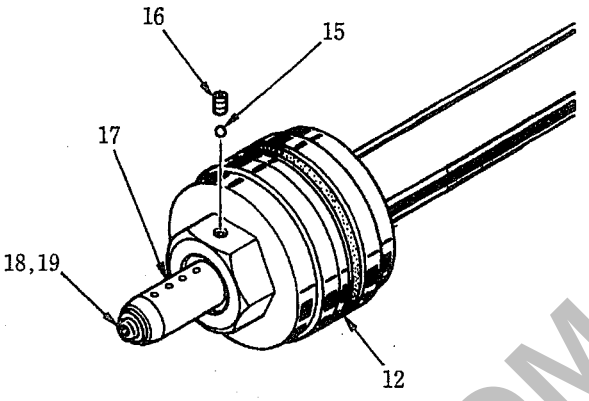


Fig. 1-7 Removing piston assy

3) Remove the cylinder head assy.

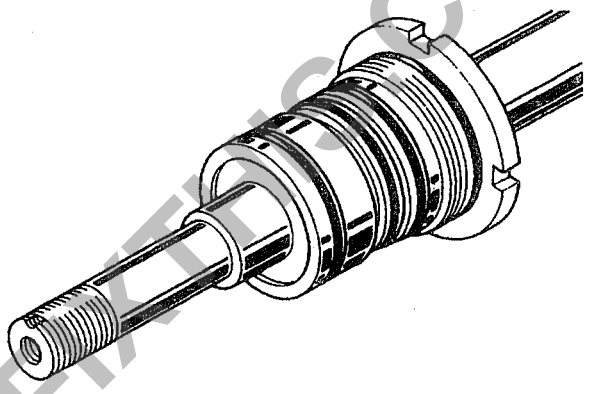


Fig. 1-8 Removing cylinder head assy

(3) Disassembly of piston assy:

1) Remove the slide ring (16) from the piston (15).
   ◦ Expand the split on the slide ring (16) as minimum as required to pull it off for axial direction.

2) Remove the seal ring assy (17).
   ◦ Cut off the seal ring (17) or remove it using a minus screw driver.

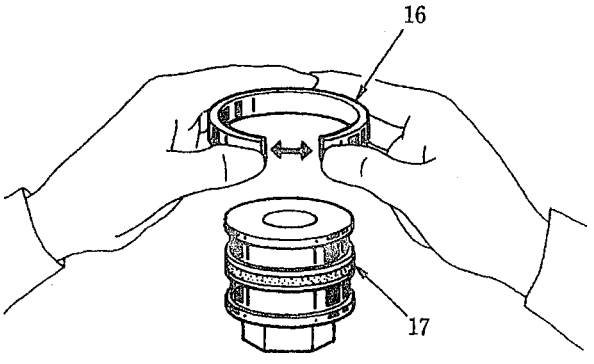


Fig. 1-9 Disassembling piston assy

(4) Disassembly of cylinder head assy:

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

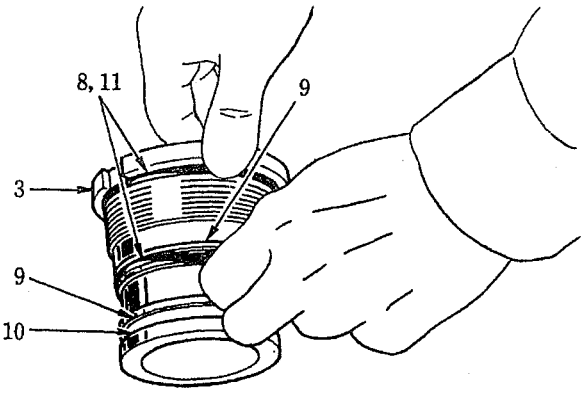


Fig. 1-10 Disassembling cylinder head assy

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13.3 INSTALLATION

Install in the reverse order of the removal according to the tightening torque and sealant instructions.

(1) Apply grease on the spline part of the pump input shaft.
Grease : Shell Retinux AM Grease or equivalent (= Molybdenum sulfide extreme pressure multi-purpose grease)

(2) Insert the pump spline part to the coupling.

(3) Apply sealant on the socket bolts (3B) and install the pump.
Sealant: Loctite #262

30 mm : 10mm
T = 8.7 kgf·m (63 ft·lbs)

(4) Connect the main pump discharge oil hoses (8) and (11), and the pilot discharge oil hose (13A) (See Fig. 13-1 and 13-2).

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

(5) Tighten the capscrew (12) and install the suction tube (16).
: 17 mm

(6) Apply sealant on the tube of insert portion of the suction hose (19) and fix with the clip (18).
Sealant : Permatex
: Minus screw driver
T=0.5 ~ 0.6 kgf·m (3.6 ~ 4.3 ft·lbs)

(7) Restore each equipment removed in the preparation work to the original state.

(8) After feeding hydraulic oil (approx. 11 liters (2.9 gal)), release air and pressurize the tank (See item 12.3).

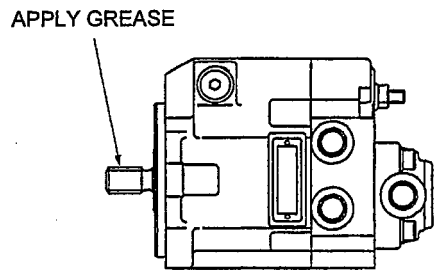


Fig. 13-4 Pump Installation

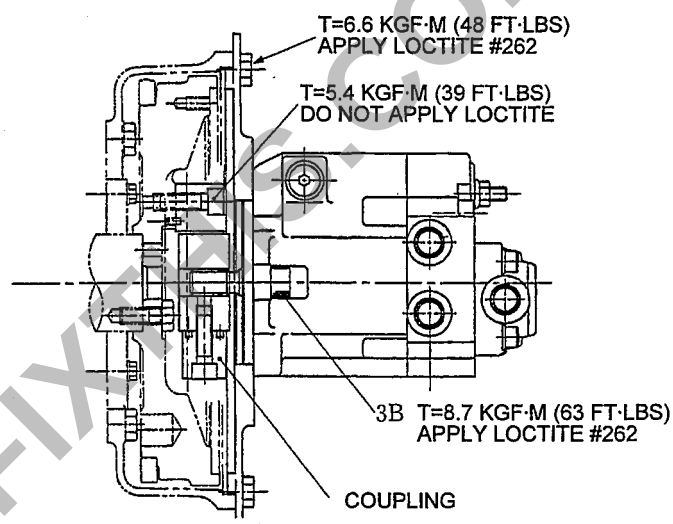


Fig. 13-5 Pump Installation

— NOTE —
Tightening torque for connector to solenoid valves are specified as following table.

		Torque kgf·m (ft·lbs)
Thread size (PF)	**Spanner** (mm)	**O-ring type fitting / 30° flare metal joint**
1/4	19	2.7 ± 0.2(20 ± 1)
3/8	22	5.0 ± 0.5(36 ± 4)

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b) Remove the poppet (16) which is incorporated on the dozer block at its mating face with the service block.

3) Pilot Operating Blocks (Travel, Boom, Arm, Bucket and Slew)
Remove the O-rings (10), springs (9) and load check valves (8) from each valve housing.
- The load check valve (9) and spring (10) are not incorporated in the travel block.
- Remove the poppet (16) which is incorporated on the travel (left) block at its mating face with the service block.

4) Inlet Block
Remove the O-ring (2) from the inlet housing (1).

(Note) Classifying the disassembled parts into each group of blocks, put a tag to every disassembled part to identify the positioning of them at the reassembling.

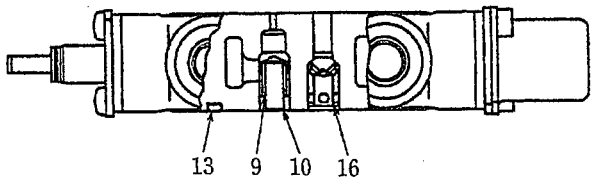


Fig. 2-20 Dozer Block

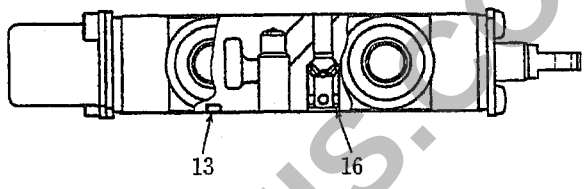


Fig. 2-21 Travel (left) Block

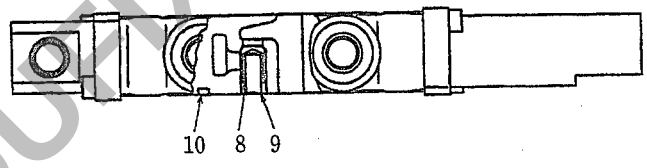


Fig. 2-22 Boom Block

(4) Disassembling Block Assy

[A] Manual Operating Block (Swing, Dozer and Service)

1) Loosening the socket bolt (15), remove the cap (7), and pull the spool (2) out of the valve housing (1) at the sub-assembled conditions with the seal plate (8), wiper (11) and O-ring (12) of cap (7) side.

: 4 mm

2) Then loosen and remove the screw (14) of the opposite side to remove the seal plate (8), wiper (11) and O-ring (12).

⚠
- Pull out the spool in straight not to give any scores on it. Otherwise, it causes difficulty to insert the spool or malfunction even though the spool is able to be inserted.
- Put a tag to each spool disassembled to identify the positioning of them at the reassembling. Erroneous assembling causes dangerous malfunction of the actuator.

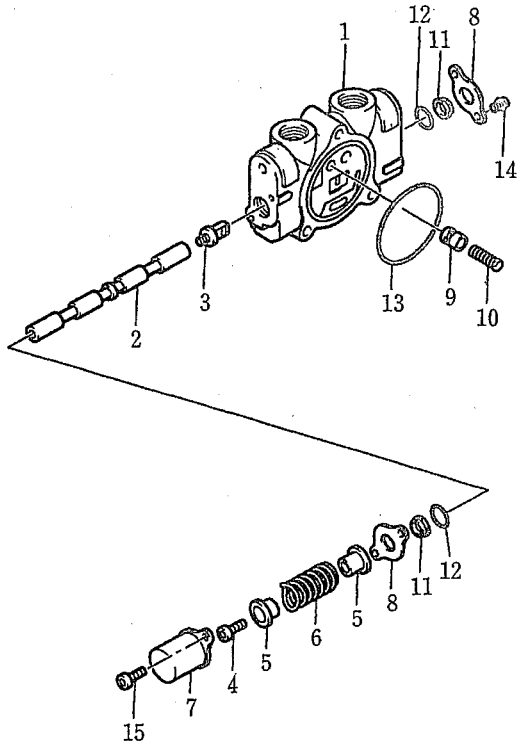


Fig. 2-23 Swing Block

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4.4 TROUBLESHOOTING

Troubles	Possible Causes	Remedy
Motor does not rotate	• Insufficient oil volume in hydraulic oil tank • Failure on hydraulic pump • Failure on relief valve or low setting pressure • Abnormal wear or scuffing on hydraulic motor • Short circuit at inside hydraulic motor	• Replenish tank with hydraulic oil • Replace hydraulic pump • Clean relief valve and set at proper pressure • Disassemble and check hydraulic motor and replace defective parts • Check breakage on face seal, etc., and replace defective parts, if reguired
Unstable rotation	• Low relief setting • Mixing air at suction side of hydraulic pump	• Set relief valve at proper pressure • Check suction side piping, and retighten as required
Reverse rotating direction	• Reverse piping • Reverse valve timing on hydraulic motor	• Correct piping • Reassemble to proper valve timing
Oil leakage at connections	• Loosened fixing capscrews • O-ring is caught by part or damage on O-ring	• Tighten with proper torque • Replace O-ring

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6.3 DISASSEMBLY AND ASSEMBLY

6.3.1 Disassembly

(1) Provide a spring setting jig shown in the Figure or equivalent one in advance of disassembling the idler adjuster assy.,

: 30 mm

Capacity of Hydraulic Jack: 5 tons or more

⚠ Big power is required to set the spring.Provide a special jig for disassembly and assembly.

(2) Set a hydraulic jack between the base and the supporter stand of the jig.

⚠ Set the hydraulic jack at the center of the jig in order not to apply one sided load to the supporter stand.

(3) Remove the nuts of jig and pull off the retainer plate upward.

: 30 mm

(4) Pull out the piston (1) from the grease cylinder (2).

(5) Remove the oil seal (10), O-ring (11) and backup ring (12) from the grease cylinder (2).

(6) Set the idler adjuster assy from which the above parts have been removed, at the center of supporter stand making the bracket (4) side upward.

(7) Put the retainer plate over the bracket (4), and tighten up the nuts by turns to fix the idler adjuster assy to the jig, ensuring that the center hole on the retainer plate is aligned with the center of nut (5).

: 30 mm

(8) Compress the spring (3) with the jack so that the nut (5) at the end of grease cylinder (2) can be freely turned. Then remove the split pin (7) and nut (5).

: 30 mm

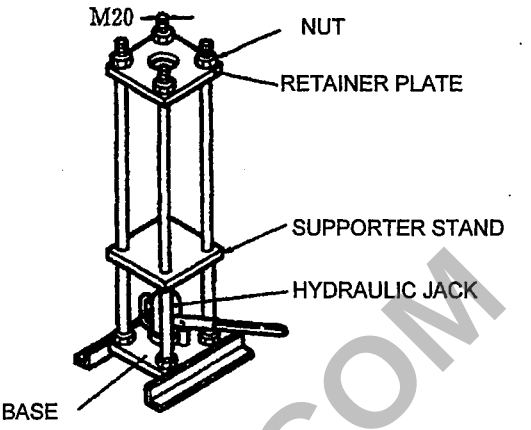


Fig. 6-1 Special Jig for disassembly / assembly

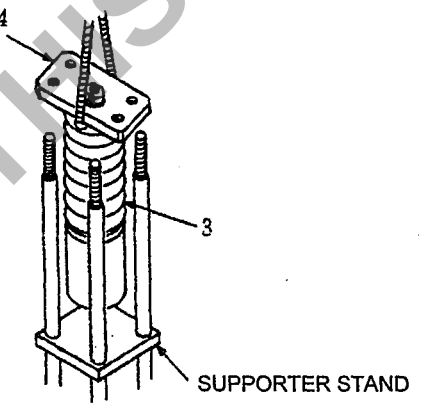


Fig. 6-2 Installation of idler adjuster

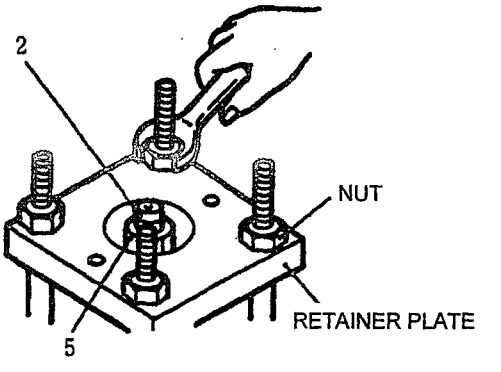


Fig. 6-3 Attachment of retainer plate

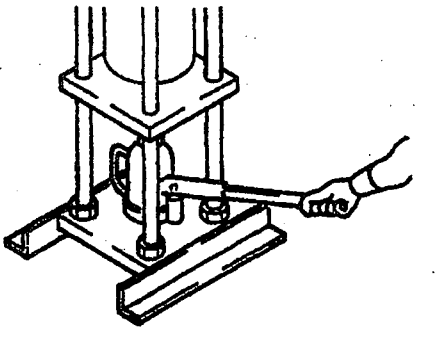


Fig. 6-4 Compressing spring with hydraulic jack

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2-14) Feed 330 cc (20 cu·in) of lubricating oil and install the cover (102).

- Match the characters "DRAIN" of the cover (102) to the recess of the body (101) to assemble.

- Lubricating oil: API Grade CD SAE 30

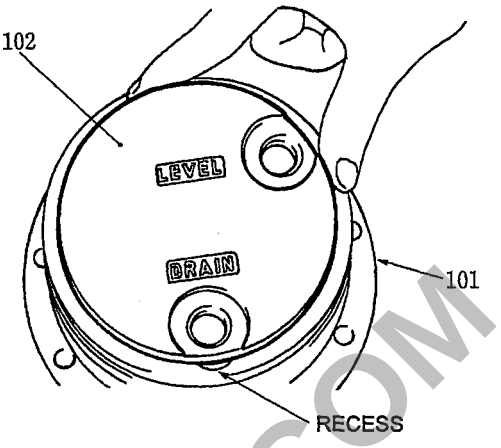


Fig. 1-84 Cover (102) installation

2-15) Install the O-snap ring (113) and fix the cover (102).

- Apply a minus screw driver or the like on the end surface of the snap ring (113) and strike in circumference direction.

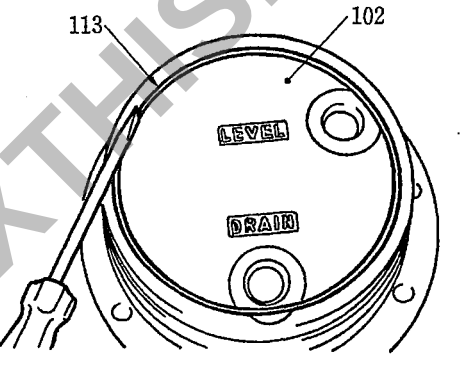


Fig. 1-85 O-snap ring (113) installation

2-16) Tighten the two plugs (131).

- Firstly tighten the plug at the "DRAIN" characters side, and prevent the cover (102) from rotating by the brim.

: 8 mm

T = 4.7 ~ 5.2 kgf·m (34 ~ 38 ft·lbs)

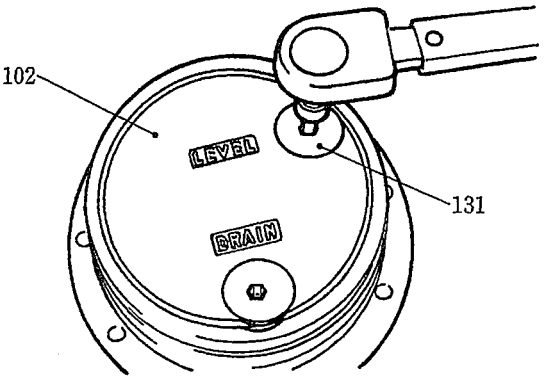


Fig. 1-86 Plug (131) installation

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T-NE

YANMAR

SERVICE MANUAL

INDUSTRIAL DIESEL ENGINE

MODEL TNE series



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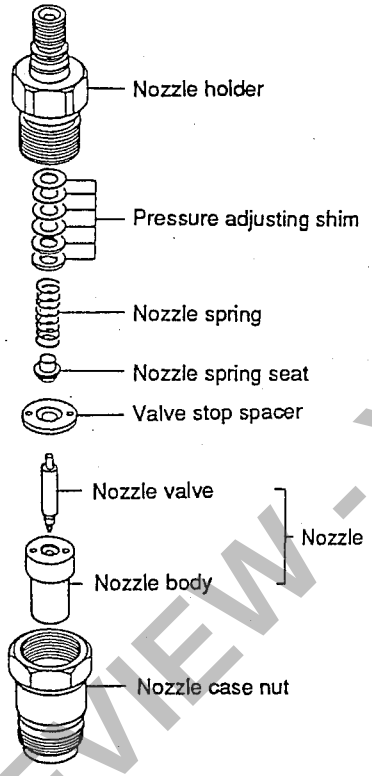
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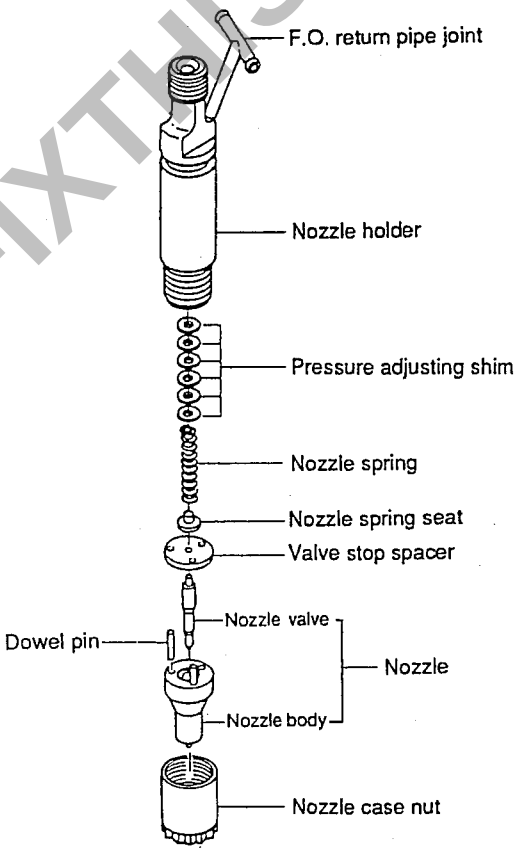
	Type of pressure adjusting shim thickness (mm)	Injection pressure adjustment
Indirect injection system	0.1, 0.2, 0.3, 0.4, 0.5	Increase the pressure adjusting shim the thickness by 0.1 mm and the injection pressure is increased by 7-10 kgf/cm².
Direct injection system	0.13, 0.15, 0.18, 0.4, 0.5, 0.8	Increase the pressure adjusting shim thickness by 0.1 mm and the injection pressure is increased by about 19 kgf/cm².

[Reference: Structure of fuel injection valve]

(Indirect injection system)



(Direct injection system)



2. Checking the spray patterns

While pumping the lever of the nozzle tester 4-6 times per second at the specified injection pressure (Refer to Chapter 1, specifications and performance), check the spray patterns. If the following trouble is found, clean or replace the nozzle.

(1) Make sure that the pattern is neither stream nor sliver.

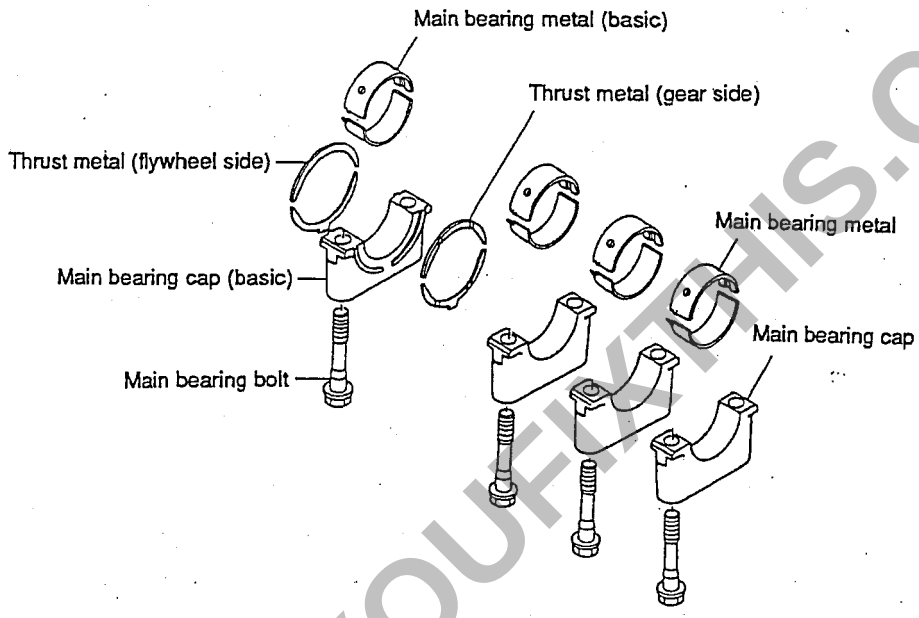
(2) Ensure that fuel is sprayed conically around the nozzle center line and that a fuel injection spreading angle is 5-10° in the indirect injection system or approx. 150° in the direct injection system.

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6. Precautions in mounting the metal cap

(1) The lower metal (cap side) has no oil groove.
(2) The upper metal (cylinder block side) has an oil groove.
(3) Check the cylinder block alignment No.
(4) Place the relief mark "FW" of the cap on the flywheel side.
(5) Place the main bearing metal on the flywheel side.



7. Undersized main metal by 0.25 mm and the oversized thrust metal by 0.25 mm

	Main metal		Thrust metal	
	Part code	Metal thickness (mm) Standard	Part code	Metal thickness (mm) Standard
2/3TNE68	719260—02870	1.625	119260—02940	2.125
3TNE74	719620—02870	2.125	119620—02940	2.125
3TNE78A/82A	119810—02870	2.125	119810—02940	2.125
3/4TNE82 3/4TNE84(T) 3/4TNE88	129150—02870	2.125	129150—02940	2.125

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1-9 4TNE82

*** 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	4TNE82											
SPECIFICATIONS	Application	—	CL		VM						CH		VH	
	Type	—	Vertical, 4-cycle water-cooled diesel engine											
	Combustion system	—	Direct injection system											
	No. of cylinders – Bore × Stroke	mm	4 – 82 × 90											
	Displacement	ℓ	1.901											
	Firing order	—	1 – 3 – 4 – 2 – 1											
	Revolution speed	rpm	1500	1800	2000	2200	2400	2600	2800	3000	3000	3600	3200	3400	3600
	Output* Continuous rating	kW(HP)	14.3 (19.2)	17.1 (22.9)	—	—	—	—	—	—	27.7 (37.1)	32.7 (43.9)	—	—	—
	Output* Max. rating	kW(HP)	15.7 (21.1)	18.8 (25.2)	20.6 (27.6)	22.6 (30.3)	24.5 (32.9)	26.5 (35.5)	28.5 (38.2)	30.5 (40.9)	30.5 (40.9)	36.0 (48.3)	32.4 (43.9)	34.2 (45.9)	36.0 (48.3)
	Max. revolution speed at no load	rpm	1575^{+50}_{0}	1870^{+50}_{0}	2160^{+50}_{0}	2375^{+50}_{0}	2570^{+50}_{0}	2780^{+50}_{0}	2970^{+50}_{0}	3180^{+50}_{0}	3150^{+50}_{0}	3745^{+50}_{0}	3455^{+50}_{0}	3670^{+50}_{0}	3890^{+50}_{0}
	Min. revolution speed at no load	rpm	≤1200		≤800						≤1500		≤800		
	Direction of rotation	—	Counterclockwise (viewed from flywheel)											
	Power take off	—	Flywheel											
	Compression ratio	—	18.0											
	Fuel injection timing (FID, b.T.D.C.)	deg	10±1		12±1		14±1		16±1		24±1		18±1	20±1	24±1
	Compression pressure	MPa (kgf/cm²)	3.04±0.1 (31±1), at 250 rpm											
	Fuel injection pressure	MPa (kgf/cm²)	$19.6^{+1.0}_{0}$ (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 × 448.5 × 618 / 658 × 498.5 × 618						658 × 498.5 × 618		650 × 498.5 × 618 / 658 × 498 × 618	
	*1 Dry weight	kg	184		160/170						170		160/170	
PERFORMANCE	Governing perform-ance (full speed range) Transient speed difference	%	≤10	≤8	≤12						≤10	≤8	≤12	
	Governing perform-ance (full speed range) Steady state speed band	%	≤5	≤4	≤8		≤7		≤6		≤5	≤4	≤8	
	Governing perform-ance (full speed range) Recovery time	sec	≤5		≤6						≤5		≤6	
	Governing perform-ance (full speed range) Fluctuation of revolution	rpm	≤15		≤25						≤30			
	L.O. press. Rated operation	MPa (kgf/cm²)	0.29±0.05 (3.0±0.5)		0.34±0.05 (3.5±0.5)									
	L.O. press. Idling	MPa (kgf/cm²)	≥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

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5. Checking the valve spring

(1) Visually check to see if the valve spring is free from flaws and corrosion.

(2) Measure the free length (length of the spring) and inclination (squareness of the side of the coil).

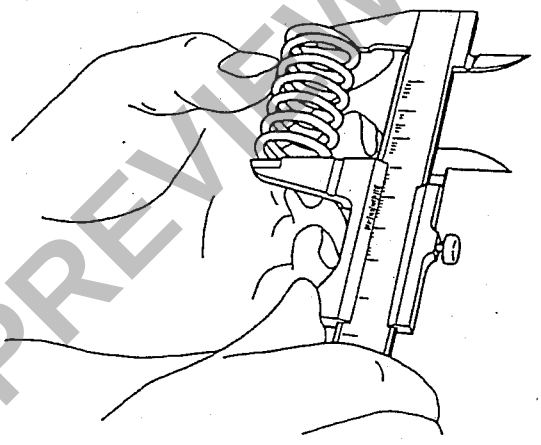
(mm)

		2/3TNE68		3TNE74	
		Standard	Wear limit	Standard	Wear limit
Valve spring	Free length	28	—	37.4	—
	Inclination	—	0.8	—	1.0
	Tension (kg) (when compressed to by 1 mm)	1.14 ~1.40	—	*2.37/ 1.87	—

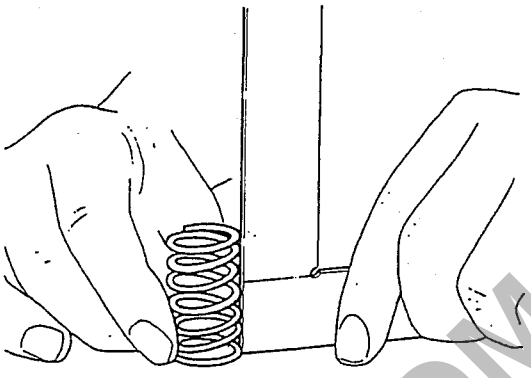
* Tension at variable pitch.

		3TNE78A 3TNE82A		3/4TNE82, 3/4TNE84(T), 3/4TNE88	
		Standard	Wear limit	Standard	Wear limit
Valve spring	Free length	44.4	—	42	—
	Inclination	—	1.1	—	1.1
	Tension (kg) (when compressed to by 1 mm)	*3.61 /2.71	—	*2.36 /3.101	—

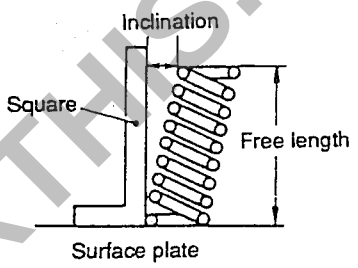
* Tension at variable pitch.



(Measuring the free length)



(Measuring the valve spring inclination)



(Measuring the inclination of valve spring)

6. Checking valve spring holder and cotter

Check contact of the inner surface of the valve spring holder with the circumference of the cotter as well as contact of the inner circumference of the cotter with the notch on the head of the valve stem. If such contact is uneven or if the cotter sinks, replace the cotter with a new one.

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