SHOP MANUAL

CASE CX25

INDEX

1	SPECIFICATIONS
2	MAINTENANCE
3	SYSTEM
4	DISASSEMBLING
5	TROUBLESHOOTING
6	ENGINE
7	INSTALLATION PROCEDURES FOR OPTIONAL ATTACHMENTS

CASE

Book Code No. **S5PV001E** ①

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⚠ • Battery electrolyte is hazardous.
Battery electrolyte is dilute sulfuric acid. Exposure of skin or eyes to this liquid will cause burning or loss of eyesight. If the exposure occurs, take the following emergency measures and seek the advice of a medical specialist.

- When skin exposed: Wash with water and soap sufficiently.
- When eyes exposed: Immediately wash away with city water continuously for more than 10 minutes.
- When a large amount of the liquid flows out: Neutralize with sodium bicarbonate or wash away with city water.
- When swallowed: Drink a large amount of milk or water.
- When clothes exposed: Immediately undress and wash.

1.5 HYDRAULIC PARTS

1) O-ring
   - Ensure O-rings have elasticity and are not damaged before use.
   - Use the appropriate O-rings. O-rings are made of various kinds of materials having different hardness to apply to a variety of parts, such as the part for moving or fixed portion, subjected to high pressure, and exposed to corrosive fluid, even if the size is same.
   - Fit the O-rings without distortion and bend.
   - Always handle floating seals as a pair.
2) Flexible hose (F hose)
   - Use the appropriate parts. Different parts are used depending on the working pressure even the size of fitting and the total length of the hose is same.
   - Tighten the fitting at the specified torque. Ensure no kink, tension, interference nor oil leakage is recognized.

1.6 WELDING REPAIR

(1) Refer repair welding to qualified personnel according to the appropriate procedure.

(2) Disconnect the ground (earth) cable of the battery before starting the repair. Failure to do so will cause damage to the electrical equipment.

(3) Move away the articles in advance that may cause fire if exposed to sparks.

(4) Before starting the repair of the attachment, do not fail to cover the plated surface of the piston rod with flameproof sheet to prevent it from being exposed to sparks.

1.7 ENVIRONMENTAL MEASURE

(1) Run the engine at the place that is sufficiently ventilated.

(2) Industrial waste disposal
Dispose of the following parts according to the relevant regulations:
Waste oil and waste container
Battery

(3) Precautions for handling hydraulic oil
Exposure of eyes to hydraulic oil will cause inflammation. Wear protective glasses before handling to avoid an accident. If an eye is exposed to the oil, take the following emergency measures:
   - When an eye exposed: Immediately wash away with city water sufficiently till stimulative feeling vanishes.
   - When swallowed: Do not let vomit, and receive medical treatment immediately.
   - When skin exposed: Wash with water and soap sufficiently.

(4) Others
Use replacement parts and lubricants

5. TRANSPORTATION

■ LOADING MACHINE ON A TRAILER

1.Keep trailer bed clean.Put chocks against truck wheels.

2.Use a ramp or loading dock. Ramps must be strong enough, have a low angle, and correct height. Load and unload machine on a level surface.

3.Travel machine onto ramps slowly. Center the machine over the trailer.

4.Lower all attachment.

5.Stop engine. Remove key from switch.

⚠ **Do not put chains over or against hydraulic lines or hoses.**

6.Fasten machine to trailer with chains or cables.

During transportation, the bucket or attachments may hit the canopy or the cab. Therefore, set the machine in the transporting position by observing following points:

1.Extend the bucket cylinder fully.

2.Extend the arm cylinder fully.

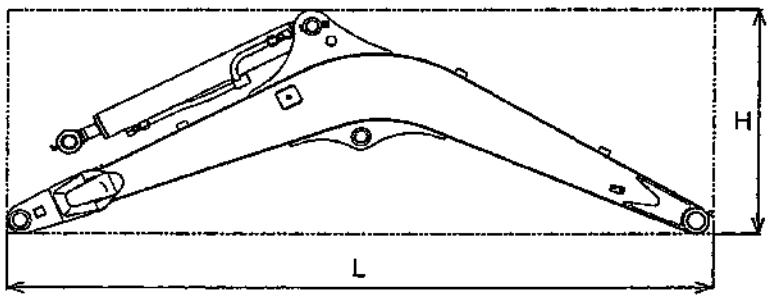
3.Lower the boom.

4.If machine cannot be transported with arm cylinder fully
extended, remove bucket or attachment and extend arm cylinder.

(2)Tramsportation Dimention and Weight of Attachment

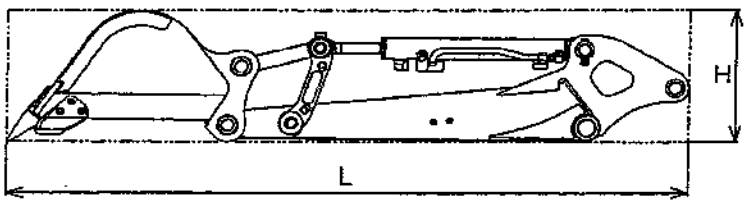
(1) Boom

Length X Height X Width mm (ft·in)	2300X650X215 (7'7" X 2'2" X 8.5")
Weight kg (lb)	120 (265)



(2) 1,15m Arm and 0.08m³ Bucket (Japanese standard bucket)

Length X Height X Width mm (ft·in)	2070X395X495 (6'10"X1'4"X1.7")
Weight kg (lb)	120 (265)



Book Code No. S5PV03 01E ①

CASE CX25

PV03

See next page for model cross reference.

ATTACHMENT DIMENSIONS

TABLE OF CONTENTS

1. BOOM
   - 1.1 Boom dimension 1-1
   - 1.2 Boom maintenance standards 1-2
2. ARM
   - 2.1 Arm dimension 1-4
   - 2.2 Arm maintenance standards 1-5
3. BUCKET
   - 3.1 Bucket dimension 1-7
   - 3.2 Detail dimensional drawings of lug section 1-8
   - 3.3 Detail dimensional drawings of boss section 1-9
4. DOZER
   - 4.1 Dozer dimension 1-10
   - 4.2 Dozer maintenance standards 1-11
5. SWING
   - 5.1 Swing bracket dimension 1-12
   - 5.2 Swing maintenance standards 1-13

3.3 DETAIL DIMENSION OF BOSS SECTION

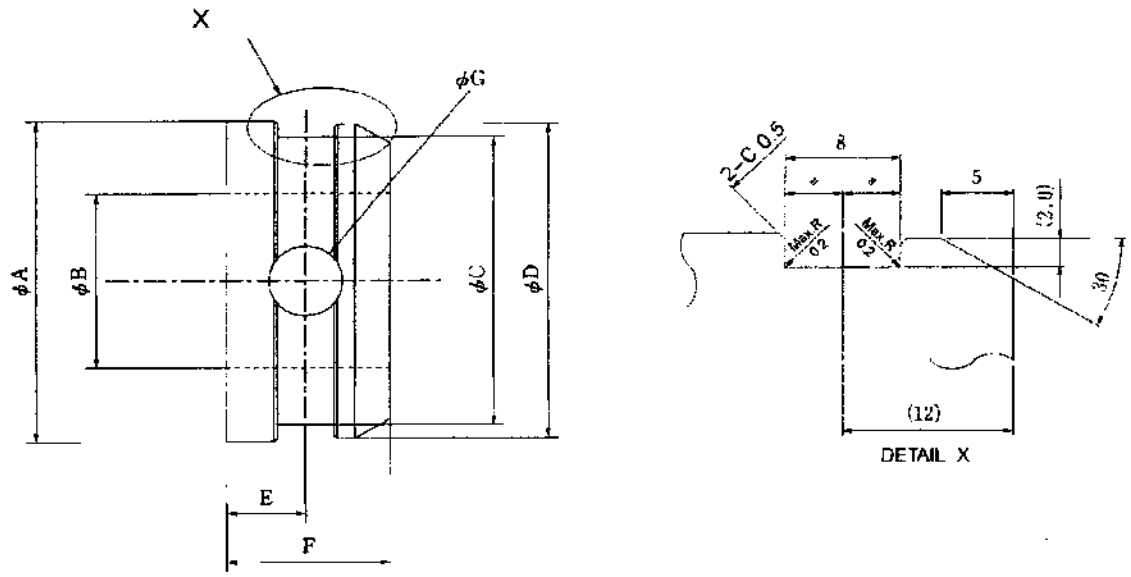


Fig. 3-3 Dimension of boss section

Table 3-3 Unit : mm (in)

Code	øA	øB	øC	øD	E	F	øG
Dimension	60.5 (2.382)	36.5 (1.437)	54.5 (2.146)	58.5 (2.303)	12 (0.472)	24 (0.945)	11 (0.433)

4. TORQUE SPECIFICATIONS FOR SLEEVE TYPE TUBE FITTINGS

A. SLEEVE TYPE TUBE FITTINGS

Tube size OD X Thickness (mm)	Spanner size (mm)	Tightening torque kgf·m (lbf·ft)
10X1.5	19	5 ± 1 (36 ± 7)
15X2.0	27	12 ± 1.2 (87 ± 9)
18X2.5	32	15 ± 1.5 (108 ± 11)
22X3.0	36	22 ± 2.2 (159 ± 16)
28X4.0	41	28 ± 2.8 (203 ± 20)
35X5.0	55	45 ± 4.5 (325 ± 33)

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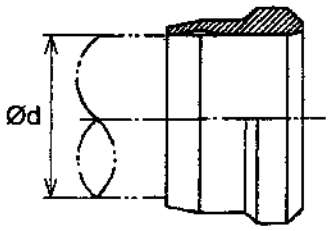
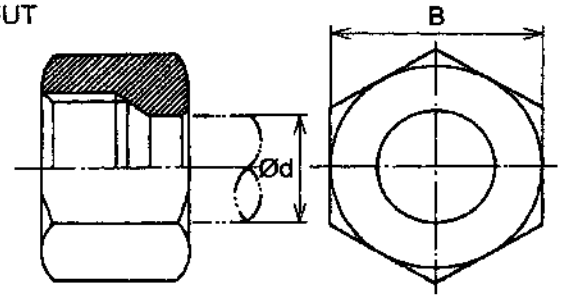
B. PART NO.

SLEEVE



NUT



Tube size ød	Part NO.		Tube size ød	Opposing flats(HEX) B	Part NO.	
	Ihara Koatu	Nippon A.M.C			Ihara Koatu	Nippon A.M.C
6	ZF93S06000	—	6	14	ZF93N06000	—
8	ZF93S08000	—	8	17	ZF93N08000	—
10	ZF93S10000	ZA93S10000	10	19	ZF93N10000	ZA93N10000
12	ZF93S12000	—	12	22	ZF93N12000	—
15	ZF93S15000	ZA93S15000	15	27	ZF93N15000	ZA93N15000
18	ZF93S18000	ZA93S18000	18	32	ZF93N18000	ZA93N18000
22	ZF93S22000	ZA93S22000	22	36	ZF93N22000	ZA93N22000
28	ZF93S28000	ZA93S28000	28	41	ZF93N28000	ZA93N28000
32	ZF93S32000	—	32	50	ZF93N32000	—
35	ZF93S35000	ZA93S35000	35	55	ZF93N35000	ZA93N35000
38	ZF93S38000	—	38	60	ZF93N38000	—

GROUP No.		EQUIPMENT PORTION	WORK TO BE DONE	UNIT	REMARK	UNIT : HOUR
02 Canopy & Guard	25	Bonnet assy (5)	Removal / Inst.	1 pc.		0.1
	26	Cover assy (6)	Removal / Inst.	1 pc.		0.2
	27	Cover assy (7)	Removal / Inst.	1 pc.		0.2
	28	Cover assy (8)	Removal / Inst.	1 pc.		0.1
	29	Cover (36)	Removal / Inst.	1 pc.		0.1
	30	Bracket assy (9)	Removal / Inst.	1 pc.		0.1
	31	Cover assy (17)	Removal / Inst.	1 pc.		0.1
	32	Suport (10)	Removal / Inst.	1 pc.		0.2
	40	Floor plate portion			Refer to 33-1 item3	
	41	Floor plate assy	Removal / Inst.	1 set		0.5
		Othen necessary works	Removal / Inst.	1 pc.	Canopy removal/inst	0.2
	50	Counter weight portion			Refer to 33-I item 6	
	51	Counter weight ASSY	Removal / Inst.	1 pc.		0.4
	52	• Lifting tools	Preparation	1set		0.1
	53	• Slinging	Removal / Inst.	1 pc.		0.1
	54	• Counter weight fixing bolt	– ditto –	1 set		0.1
		Other necessary works	– ditto –	3 pcs.	Guard	0.3
03 Upper structure	00	Control portion				
	01	E / G control cable	Removal / Inst.	1 pc.		0.2
	02	Dozer yoke	– ditto –	1 pc.		0.1
	03	Dozer cable	– ditto –	1 pc.		0.1
	04	Swing yoke	– ditto –	1 pc.		0.1
	05	Swing cable	– ditto –	1 pc.		0.1
		Other necessary works	– ditto –	1 set.	Cover,Hose	0.4
	10	Intake portion			Refer to 33-I item 9	
	11	Air cleaner ASSY	Removal / Inst.	1 pc.		0.4
	12	• Hose (1)	- ditto -	1 pc.		0.1
	13	• Hose (2)	- ditto -	1 pc.		0.1
	14	• Element	Replace	1 pc.		0.1
	20	Exhaust portion			Refer to 33-I item 12	
	21	Muffler ASSY	Removal / Inst.	1 pc.		0.4
	22	• Muffler attaching bolts (13) (14)	– ditto –	3 pcs.		0.1
	23	• Clamp	– ditto –	2 pcs.		0.1
		Other necessary works	– ditto –	1 pc.	Under cover	0.1
	20	E / G Accessory portion			Refer to 33-I item 10 & 11	
	21	Dynamo	Removal / Inst.	1 pc.		0.6
	22	• Connector	- ditto -	1 pc.		0.1
	22	• Dynamo fixing bolt	- ditto -	2 pcs.		0.1
	23	• V-bolt	- ditto -	1 pc.	Include tension adjusting	0.3
		Other necessary works	- ditto -	1 set	Covers	0.4
			- ditto -	1 pc.	Negative terminal of battery	0.1
	26	Starter	- ditto -	1 pc.		0.5
	27	• B-terminal	- ditto -	1 pc.		0.1
	28	• S-terminal connector	- ditto -	1 pc.		0.1
	29	• Starter fixing bolt	- ditto -	2 pcs.		0.2
		Other necessary works	- ditto -	1 set	Cover,Floor plate	0.3
			- ditto -	1 pc.	Negative terminal of battery	0.1

4. MEASURING HYDRAULIC OIL PRESSURE

4.1 STANDARD FOR OIL PRESSURE MEASUREMENT

(1) Hydraulic Instruments

70 kgf/cm² (1000 psi) pressure gauge .....1 set
500 kgf/cm² (7110 psi) pressure gauge ...3 sets
Surface Thermometer .....1 set
Pressure Measuring Kit and
Oil Analyzing Equipment .....1 set

(2) Measuring cleanliness of hydraulic oil

⚠ After releasing air in the hydraulic oil tank, open the cover and sample oil in the hydraulic tank, and measure with the instrument for analysis. If the measured value is over the standard value, replace the return filter and/or change the hydraulic oil.

4.2 PRESSURE MEASUREMENT AND ADJUSTMENT

4.2.1 Main Circuit Pressure

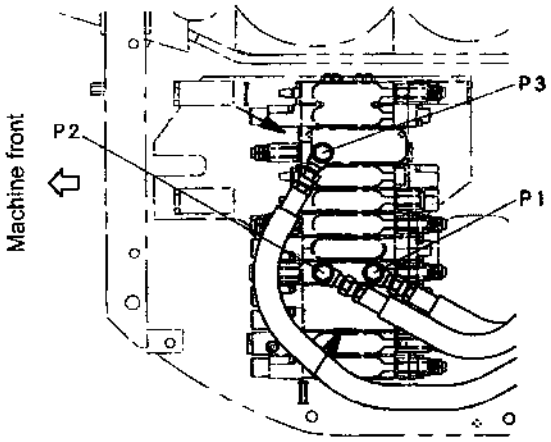
(1) Measuring Conditions

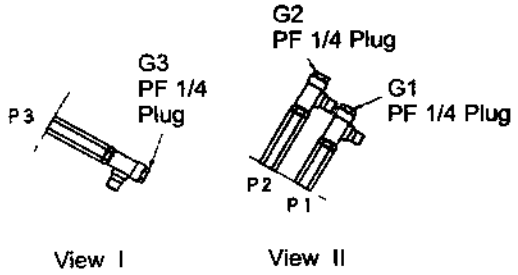
Engine speed : High idling
Hydraulic oil temperature: 50 ~ 60 °C (122 ~ 140 °F)
Coolant temperature (on radiator surface) : 60~90 °C (140 ~ 194 °F)

(2) Pressure Measuring Procedures

1) Set the pressure gauge to the pressure detecting port (plugged G1,G2,G3), and operate the circuit to be measured to measure the relief pressure.
2) When the main relief pressure is being within the standard range, the measurement for the over load relief pressure may be omitted.
3) If the main relief pressure is lower than the standard range, tighten up the main relief valve by half turn [pressure increase by 125 kgf/cm² (1780 psi)], then measure the pressure at over lode relief valve.
4) After adjustment for the over load relief pressure, return back the main relief pressure within the standard range.

Operating Circuit	Press. Detecting Port		Relief Valve
	Port Location	Size	
Boom, Bucket, Swing & Travel (left)	G1	PF1/4	MR1
Arm & Travel (right)	G2		MR2
Dozer, N & B Slew	G3		MR3





View I View II

Remove PF 1/4 plug and install press.gauge.

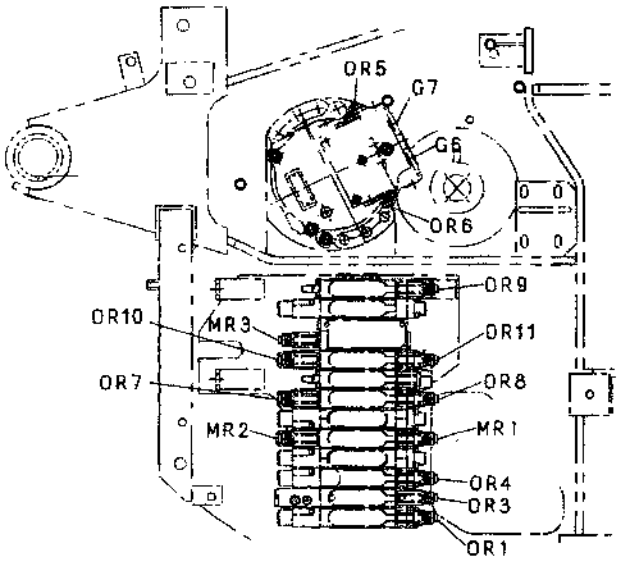


Fig. 4-1 Main hyd. oil pressure measurement

Location of over load relief valve

OR1	Bucket in	OR7	Arm in
OR3	Boom up	OR8	Arm out
OR4	Boom down	OR9	Dozer down
OR5	Slewing left	OR10	Nibbler close
OR6	Slewing right	OR11	Nibbler open

Book Code No. S5PV2201E ①

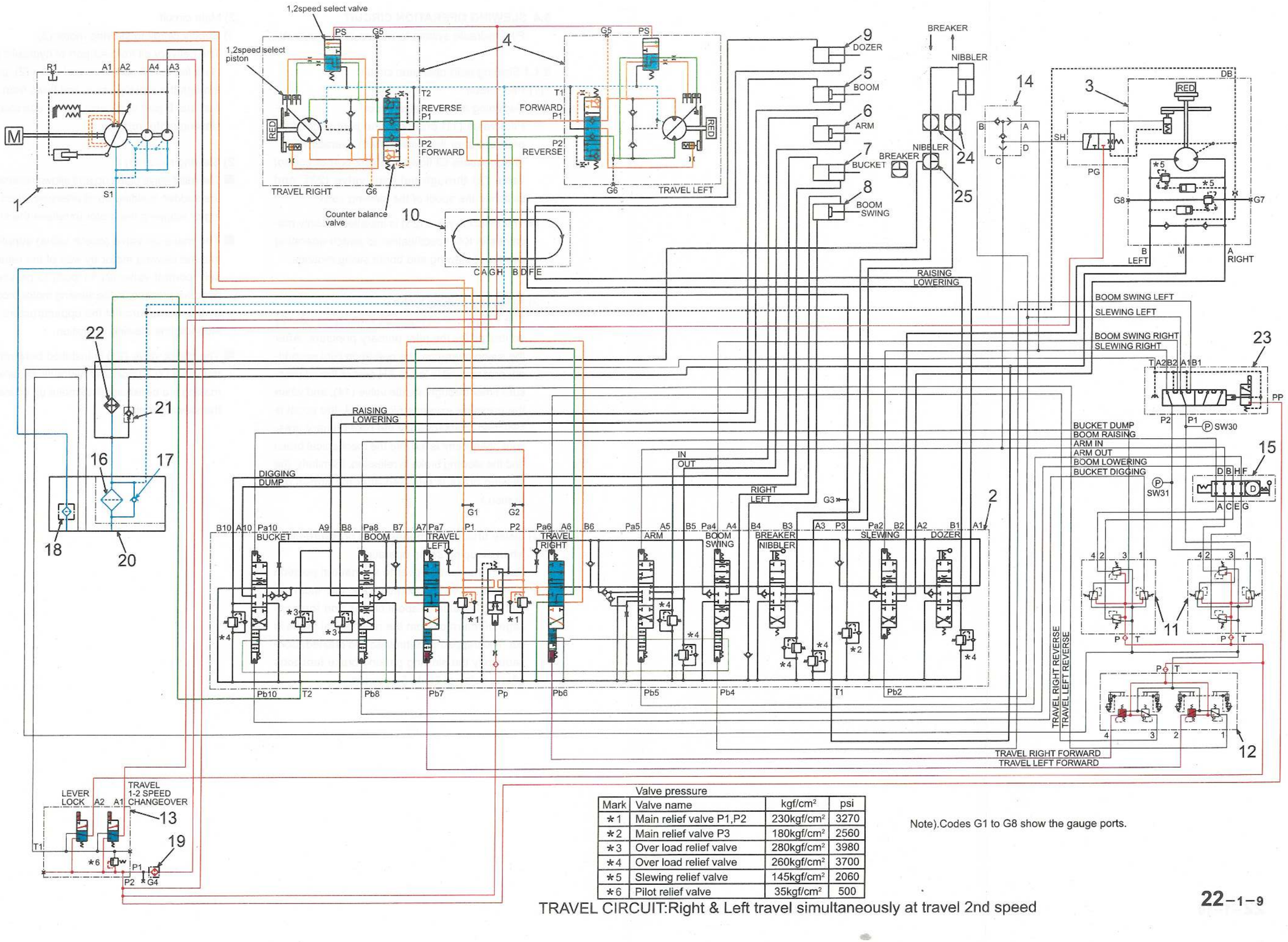
CASE CX25

See next page for model cross reference.

HYDRAULIC SYSTEM

TABLE OF CONTENTS

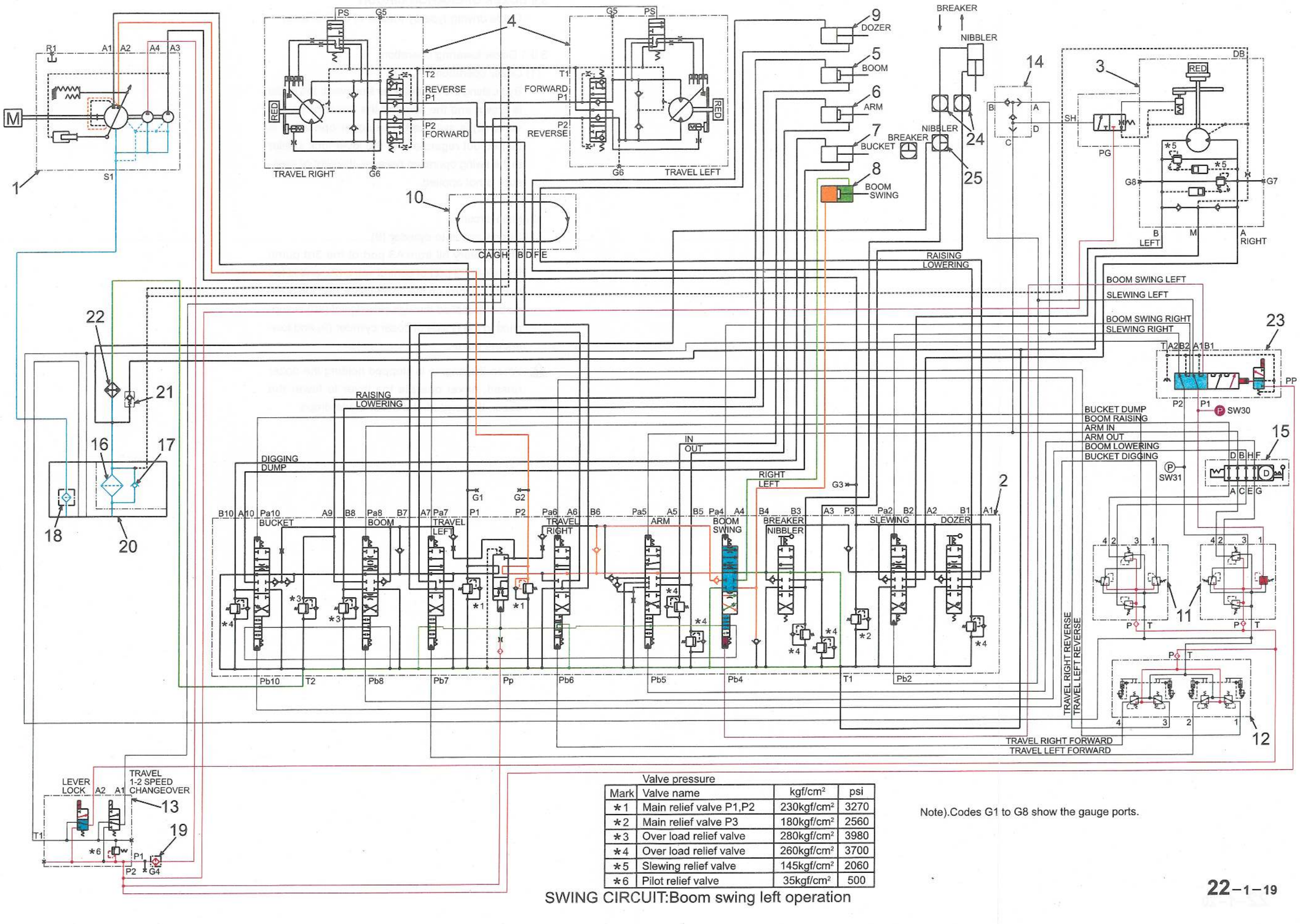
1. SUMMARY 1-1
2. HYDRAULIC CIRCUITS AND COMPONENTS .....
   2.1 Standard Circuit Diagram 1-3
3. HYDRAULIC CIRCUIT OPERATION
   3.1 Outline of Hydraulic Circuit Explanation 1-6
   3.2 Neutral Circuit 1-7
   3.3 Travel Operating Circuit 1-10
   3.4 Slew Operating Circuit 1-12
   3.5 Bucket Operating Circuit 1-14
   3.6 Boom Operating Circuit 1-16
   3.7 Arm Operating Circuit 1-20
   3.8 Swing Operating Circuit 1-22
   3.9 Dozer and Adjustable Crawler Frame Width Operating Circuit 1-24
   3.10 Travel / Dozer Combined Operating Circuit 1-26
4. SCHEMATIC PIPING FOR HYDRAULIC SYSTEM 1-28



Valve pressure			
Mark	Valve name	kgf/cm²	psi
*1	Main relief valve P1,P2	230kgf/cm²	3270
*2	Main relief valve P3	180kgf/cm²	2560
*3	Over load relief valve	280kgf/cm²	3980
*4	Over load relief valve	260kgf/cm²	3700
*5	Slewing relief valve	145kgf/cm²	2060
*6	Pilot relief valve	35kgf/cm²	500

Note).Codes G1 to G8 show the gauge ports.

TRAVEL CIRCUIT:Right & Left travel simultaneously at travel 2nd speed



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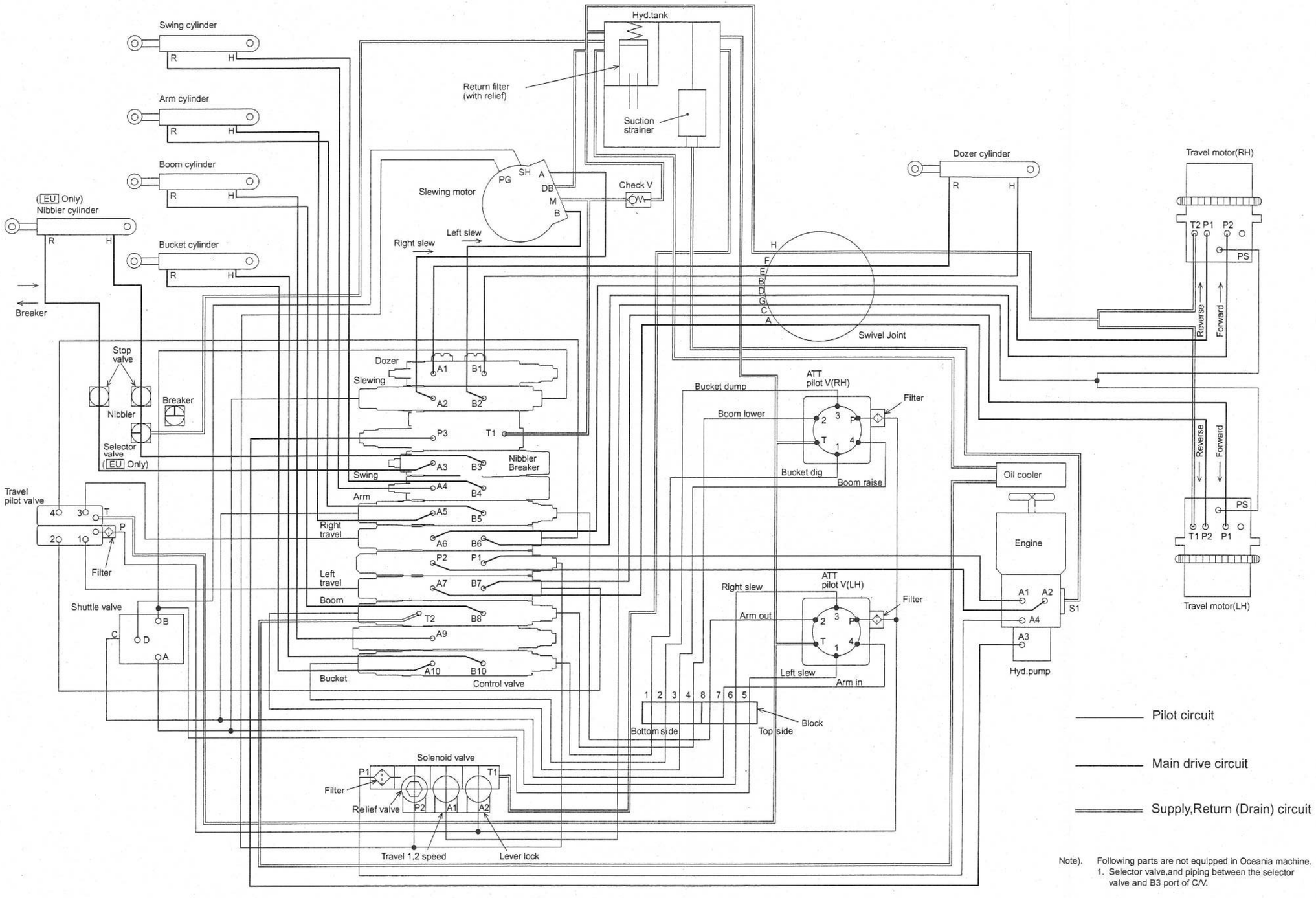
＊4	Over load relief valve	260kgf/cm²	3700
＊5	Slewing relief valve	145kgf/cm²	2060
＊6	Pilot relief valve	35kgf/cm²	500

Note).Codes G1 to G8 show the gauge ports.

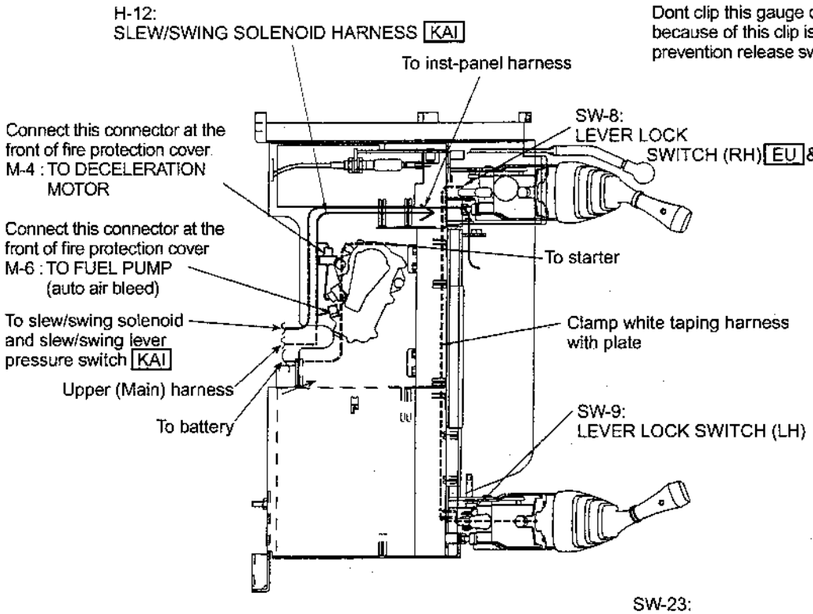
SWING CIRCUIT:Boom swing left operation

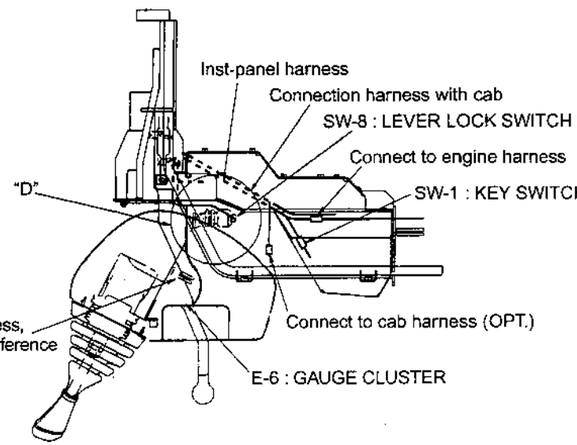
4.2 SCHEMATIC PIPING FOR HYDRAULIC SYSTEM [EU] & [OCEANIA]

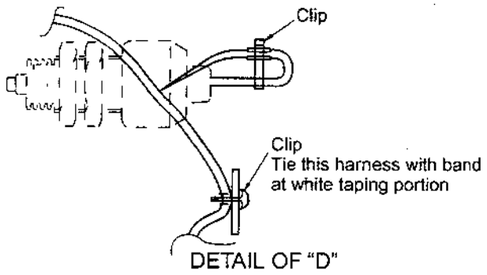


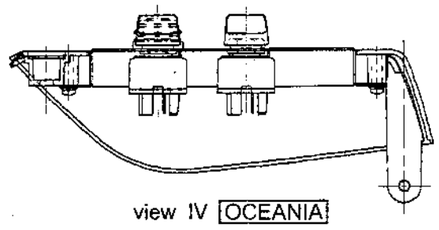
Note). Following parts are not equipped in Oceania machine.
1. Selector valve,and piping between the selector valve and B3 port of C/V.

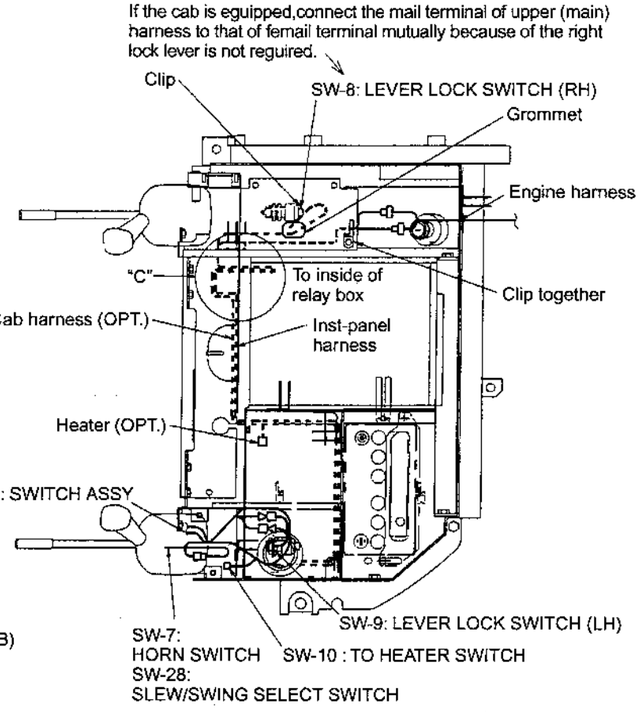
3.4.1 Upper frame portion (2 / 3)

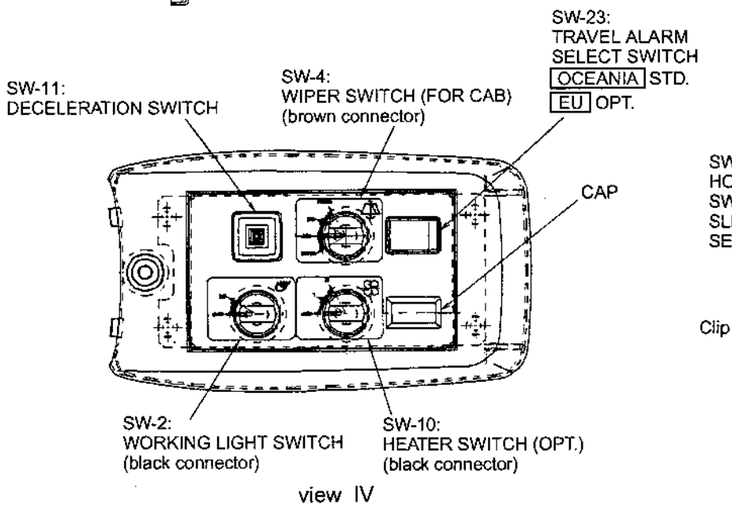


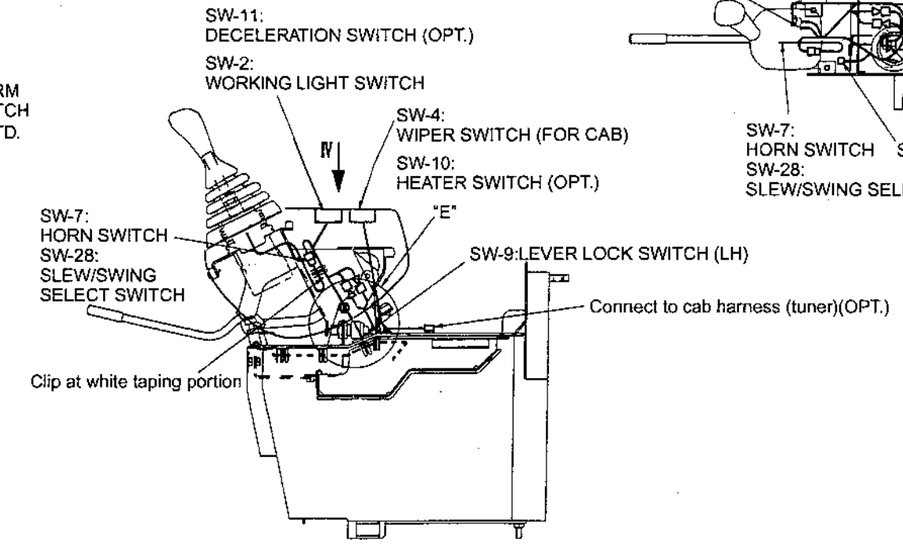


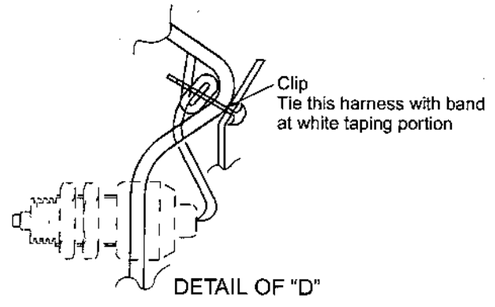


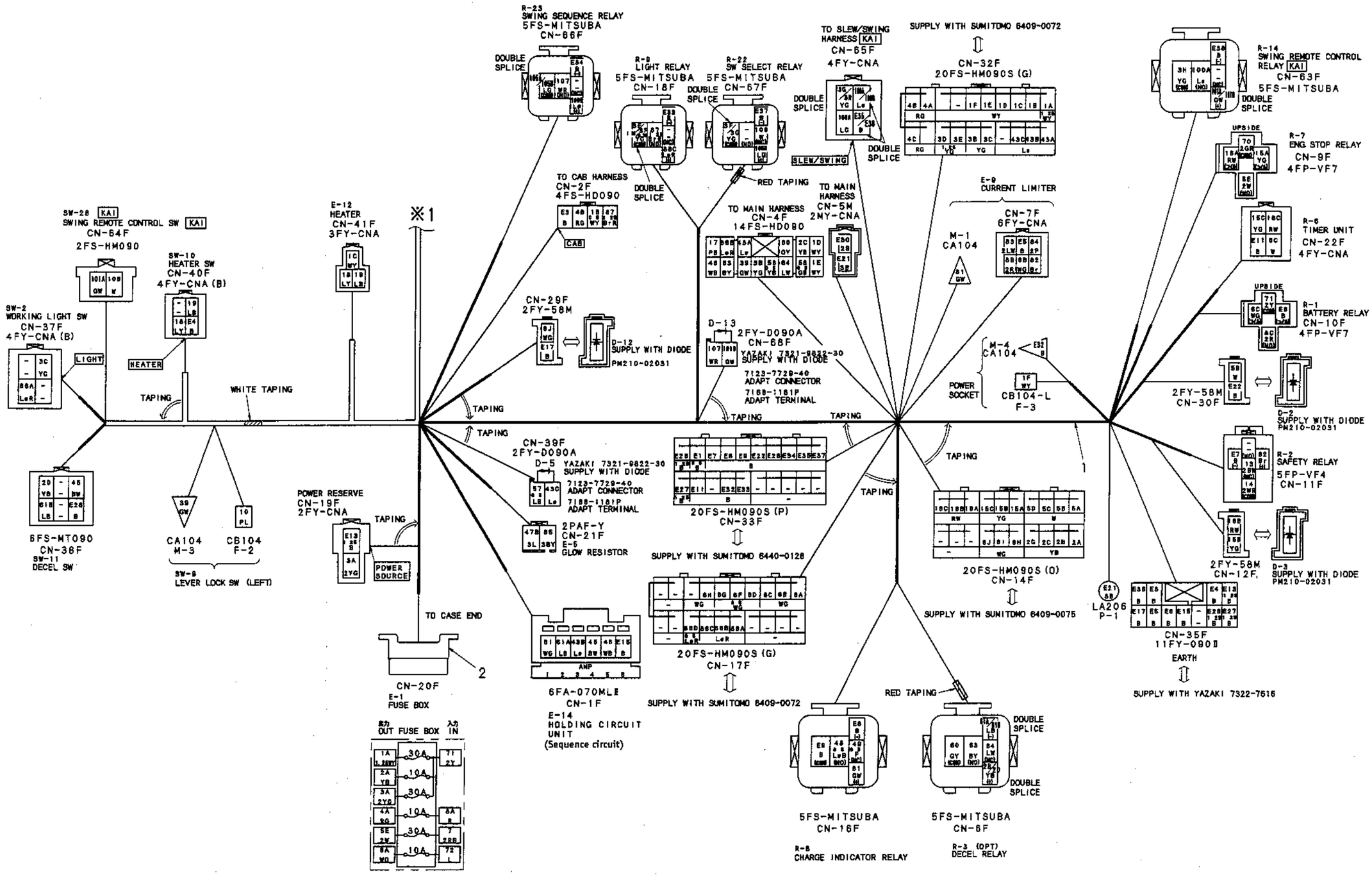











R-23
SWING SEQUENCE RELAY
5FS-MITSUBA
CN-66F
DOUBLE SPLICE
R-9
LIGHT RELAY
5FS-MITSUBA
CN-18F
R-22
SW SELECT RELAY
5FS-MITSUBA
CN-67F
TO SLEW/SWING HARNESS KAI
CN-65F
4FY-CNA
SUPPLY WITH SUMITOMO 6409-0072
CN-32F
20FS-HM090S (G)
R-14
SWING REMOTE CONTROL RELAY KAI
CN-63F
5FS-MITSUBA
SW-28 KAI
SWING REMOTE CONTROL SW KAI
CN-64F
2FS-HM090
SW-10
HEATER SW
CN-40F
4FY-CNA (B)
E-12
HEATER
CN-41F
3FY-CNA
※1
TO CAB HARNESS
CN-2F
4FS-HD090
CAB
TO MAIN HARNESS
CN-4F
14FS-HD090
TO MAIN HARNESS
CN-5M
2MY-CNA
E-9
CURRENT LIMITER
CN-7F
6FY-CNA
M-1
CA104
R-7
ENG STOP RELAY
CN-9F
4FP-VF7
UPSIDE
R-6
TIMER UNIT
CN-22F
4FY-CNA
R-1
BATTERY RELAY
CN-10F
4FP-VF7
SW-2
WORKING LIGHT SW
CN-37F
4FY-CNA (B)
LIGHT
HEATER
TAPING
WHITE TAPING
CN-29F
2FY-58M
D-12
SUPPLY WITH DIODE
PM210-02031
D-13
2FY-D090A
CN-68F
YAZAKI 7321-8822-30
SUPPLY WITH DIODE
7123-7729-40
ADAPT CONNECTOR
7188-1161P
ADAPT TERMINAL
M-4
CA104
POWER SOCKET
CB104-L
F-3
2FY-58M
CN-30F
D-2
SUPPLY WITH DIODE
PM210-02031
CN-39F
2FY-D090A
D-5
YAZAKI 7321-8822-30
SUPPLY WITH DIODE
7123-7729-40
ADAPT CONNECTOR
7188-1161P
ADAPT TERMINAL
20FS-HM090S (P)
CN-33F
SUPPLY WITH SUMITOMO 6440-0128
R-2
SAFETY RELAY
5FP-VF4
CN-11F
2FY-58M
CN-12F
D-3
SUPPLY WITH DIODE
PM210-02031
6FS-MT090
CN-38F
SW-11
DECEL SW
CA104
M-3
CB104
F-2
SW-9
LEVER LOCK SW (LEFT)
POWER RESERVE
CN-19F
2FY-CNA
POWER SOURCE
2PAF-Y
CN-21F
E-5
GLOW RESISTOR
TO CASE END
CN-20F
E-1
FUSE BOX
OUT FUSE BOX
IN
20FS-HM090S (O)
CN-14F
SUPPLY WITH SUMITOMO 6409-0075
LA206
P-1
CN-35F
11FY-090II
EARTH
SUPPLY WITH YAZAKI 7322-7616
6FA-070MLE
CN-1F
E-14
HOLDING CIRCUIT UNIT
(Sequence circuit)
20FS-HM090S (G)
CN-17F
SUPPLY WITH SUMITOMO 6409-0072
5FS-MITSUBA
CN-16F
R-8
CHARGE INDICATOR RELAY
5FS-MITSUBA
CN-6F
R-3 (OPT)
DECEL RELAY
RED TAPING
DOUBLE SPLICE

Shop Manual Model Number Cross Reference:
SK25SR-2 is CASE Model CX25

(7) Housing

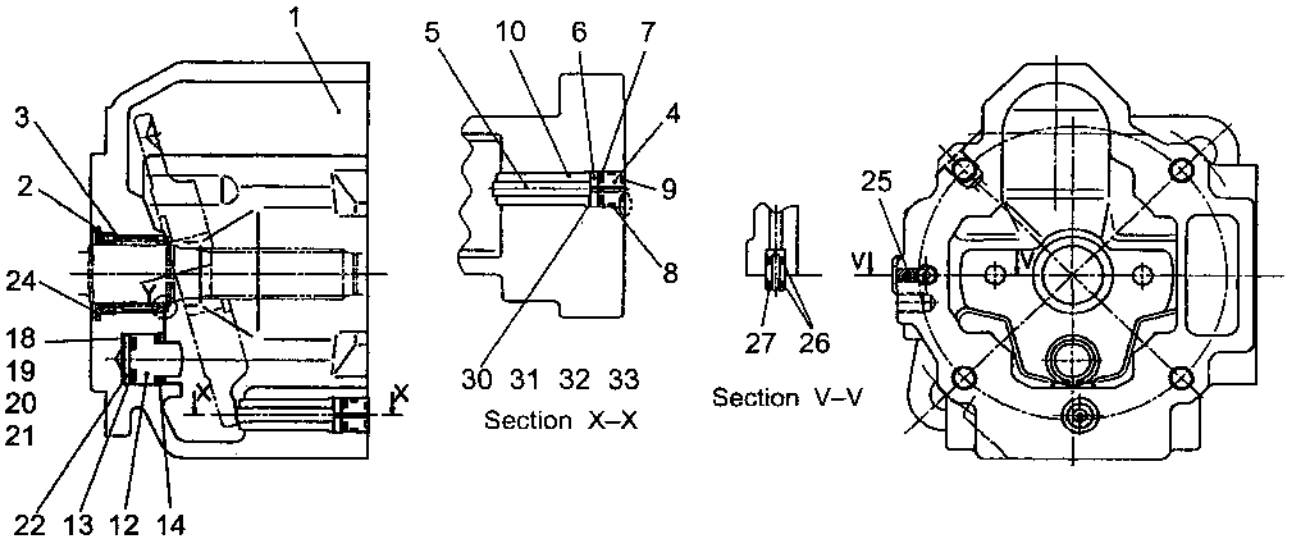


Fig. 1-12

No.	NAME	Q'TY	No.	NAME	Q'TY	No.	NAME	Q'TY
1	Housing	1	10	Sleeve	1	24	Retaining ring (for hole)	1
2	Oil seal	1	12	Guide	1	25	Plug	1
3	Bearing	1	13	Disk spring	2	26	O-ring	2
4	Piston	1	14	Retaining ring	1	27	Sleeve	1
5	Parallrl pin	1	18	Shim	1	30	Shim	1
6	Distance piece	1	19	Shim	1	31	Shim	1
7	Disk spring	3	20	Shim	1	32	Shim	1
8	O-ring	1	21	Shim	1	33	Shim	1
9	O-ring	1	22	Distance piece	1			

(2) Dumping mechanism

1) In case of neutral position,

Push rod (214) is pushed up by dumping spring(336) through piston(224), and holds at the position shown in Fig. 3-3.

2) Where the control section is inclined from the neutral position,

By rotating the cam clockwise, the push rod on the port 1 side is pushed down, and the piston also moves down.

Then, the oil in the dumping piston chamber is discharged through the orifice, and the simultaneously generated pressure produces dumping force.

On the other hand, the push rod on the port 2 side moves up by the dumping spring through the piston. Then, oil is sucked from the tank into the dumping piston chamber through three ball check valves. The oil outside of the piston chamber flows out through the passage leading to port T on the casing top end.

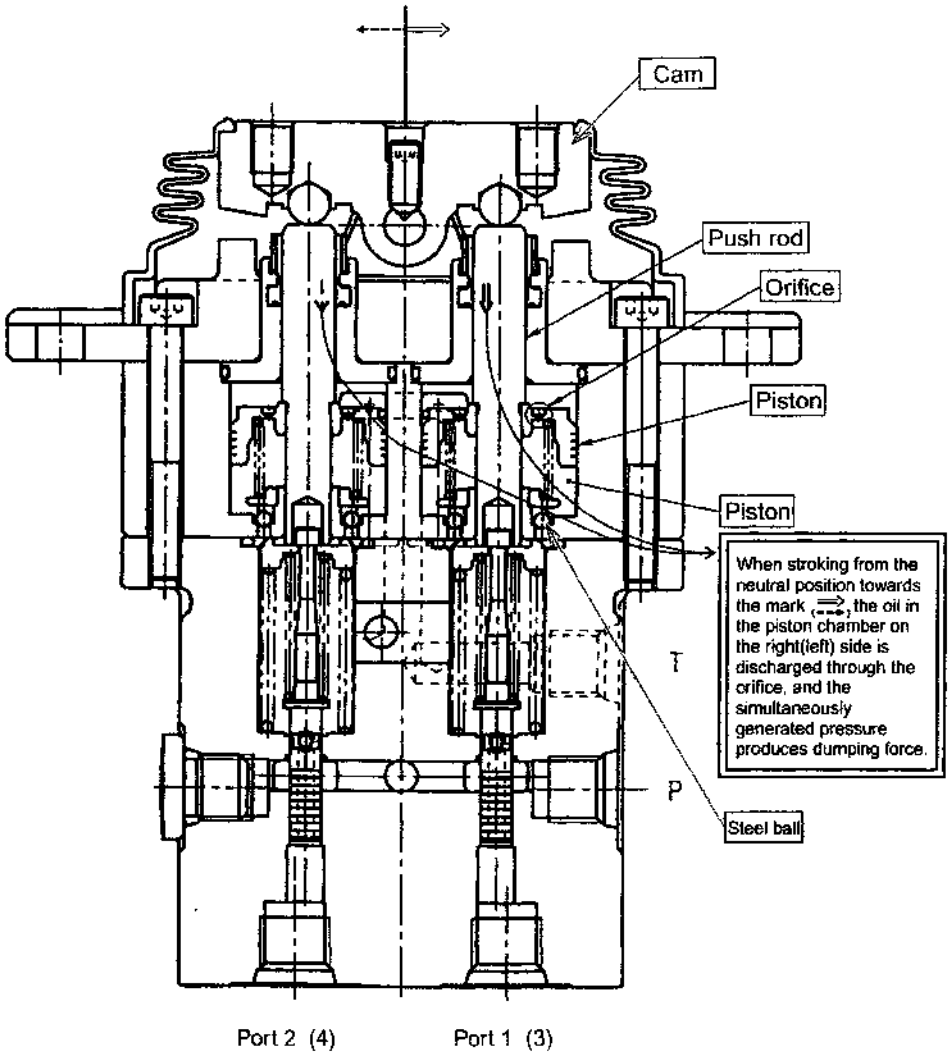


Fig. 3-6 Operation when the lever is stroked from the neutral position

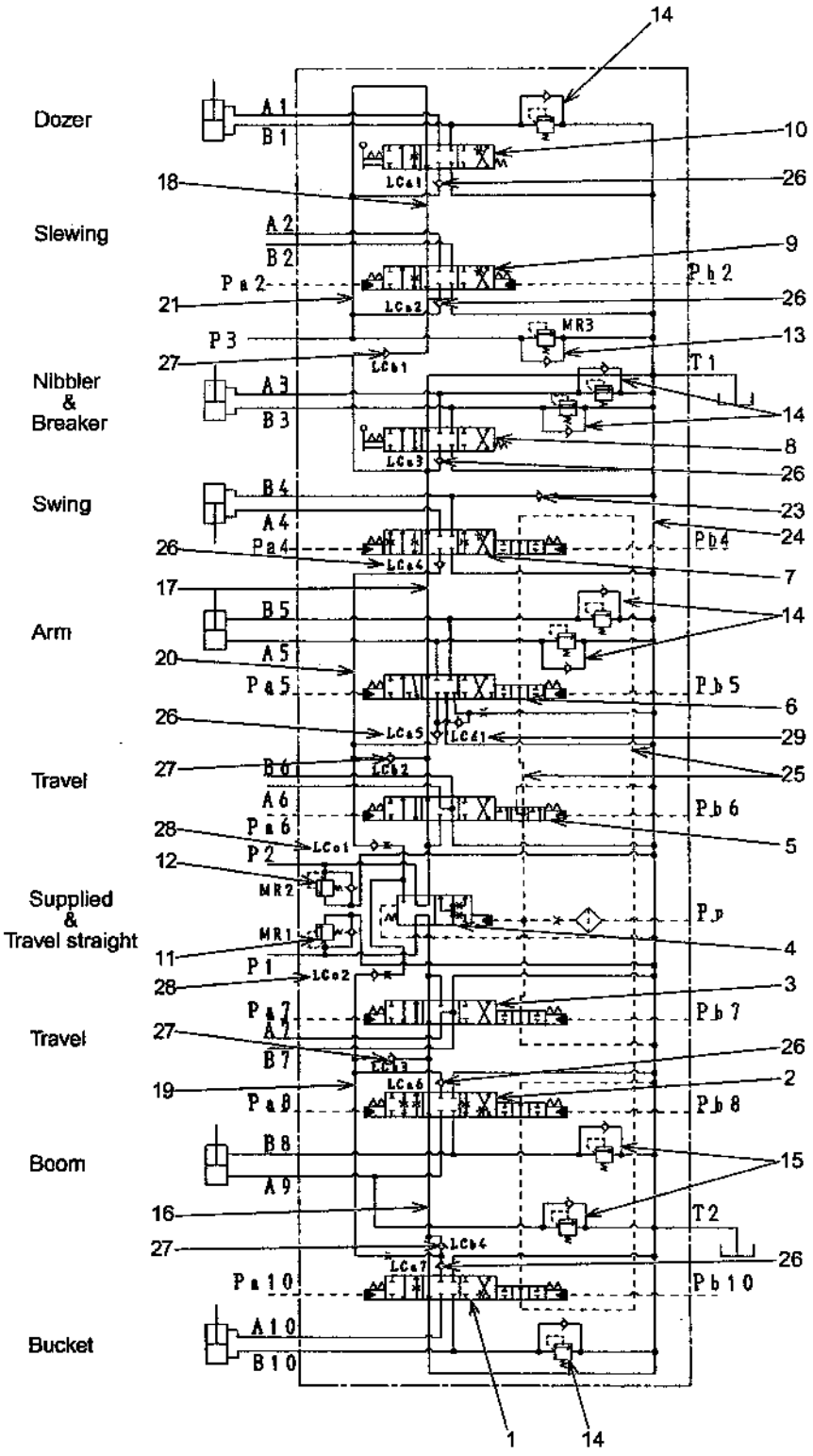
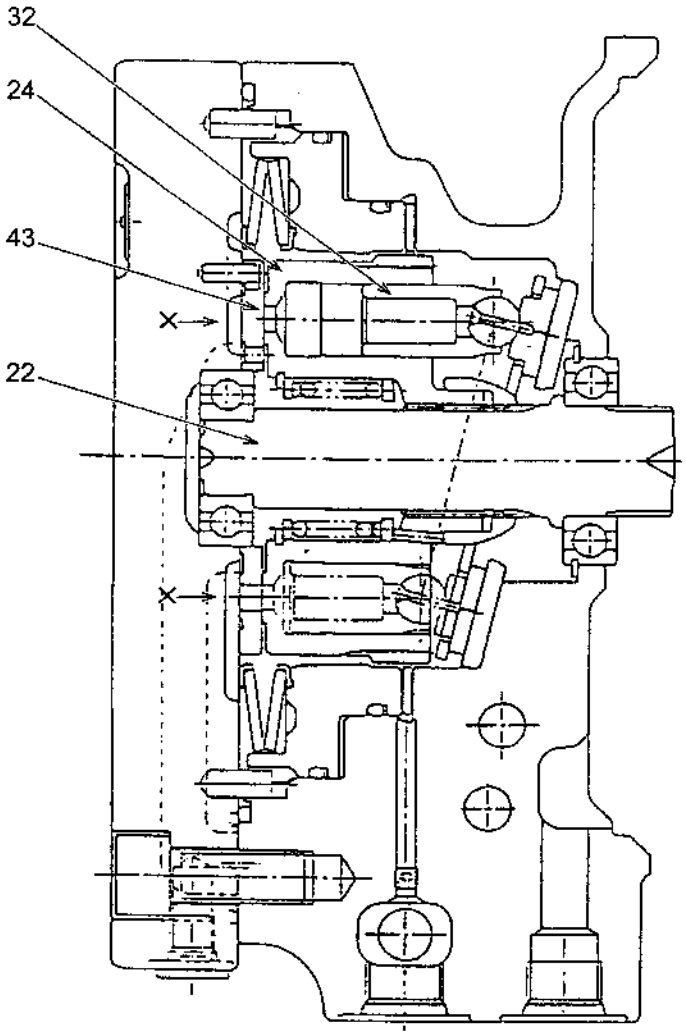


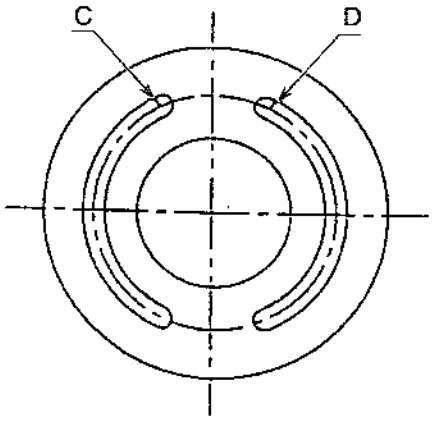
Fig. 4-7-2

Table. 4-7-2

No.	NAME
1	Bucket spool
2	Boom spool
3	Travel left spool
4	Travel straight spool
5	Travel right spool
6	Arm spool
7	Swing spool
8	Nibbler & Breaker spool
9	Slewing spool
10	Dozer spool
11	P1 main relief valve
12	P2 main relief valve
13	P3 main relief valve
14	B1, A3, B3, A5, B5, B10 Over load relief valve
15	B8,A9 Over load relief valve
16	P1 by-pass circuit
17	P2 by-pass circuit
18	P3 by-pass circuit
19	P1 parallel circuit
20	P2 parallel circuit
21	P3 parallel circuit
23	Anti cavitation
24	Tank circuit
25	Pilot passage
26	Load check valve
27	Load check valve
28	Load check valve
29	Load check valve

Construction of slewing motor





Valve plate , Viewed from X–X (Outline)

Fig. 5-5

6.3 SPECIFICATIONS

Table. 6-2

Machine model			EU model	KAI model
Model (Type)	Hydraulic motor		MAG-18V-190E-2	MAG-18V-200E
	Reduction unit		RGC-18V-34E-1	←
Hydraulic motor	Displacement 1st/2nd	cc/rev(in³/rev)	17.3/10.02 (1.1/0.61)	←
	Rated flow	L/min(gal/min)	24 (6.3)	←
	Set pressure	kgf/cm²(psi)	230 (3270)	←
	Output torque	kgf·m(lbf·ft)	215.2/124.4 (3060/1770)	158.9/92.1 (2260/1310)
	Drain pressure	kgf/cm²(psi)	Normal 2 (28) Max 5 (71)	←
	Revolution speed 1st / 2nd	min⁻¹{rpm}	40.8 / 70.6 at 24 (6.3gal) L/min	38.0 / 65.7 L/min
Counter balance valve	Spool switching pressure kgf/cm²(psi)	Cracking	2.3 (3.3)	←
		Full stroke	4.9 (70)	←
	Check valve cracking pressure	kgf/cm²(psi)	0.3 (4.3) or less	←
Anti cavitation valve	Check valve cracking pressure	kgf/cm²(psi)	0.2 (2.8)	←
Reduction unit	Reduction ratio		33.980	36.474
1,2speed select valve	Switching pressure	{kgf/cm²}	6.1 (87)	←
Lubricant	GL-4 #90	L(gal)	0.35 (0.09)	←
Weight		kg(lb)	28 (62)	←

Note).

Parking brake : Standard specification in KAI.
Optional specifcation in EU.

5-5 Explanation of operation of anti-cavitation valve

When stopping the motor, the motor tries to continue the rotation due to the inertia force, but the hydraulic oil is discharged into P port through the oil passage because the counter balance valve is open.
Then, the supply through P1 port is insufficient, consequently the cavitation is generated at the P1 and M1 ports.
However, this anti-cavitation system returns the hydraulic oil through T1 and T2 ports (drain), TV1.TV2, check valve A, and oil passage M1 when the pressure of P1~M1 lowers to negative pressure (P1~M1<drain pressure) and therefore the anti-cavitation is reduced.

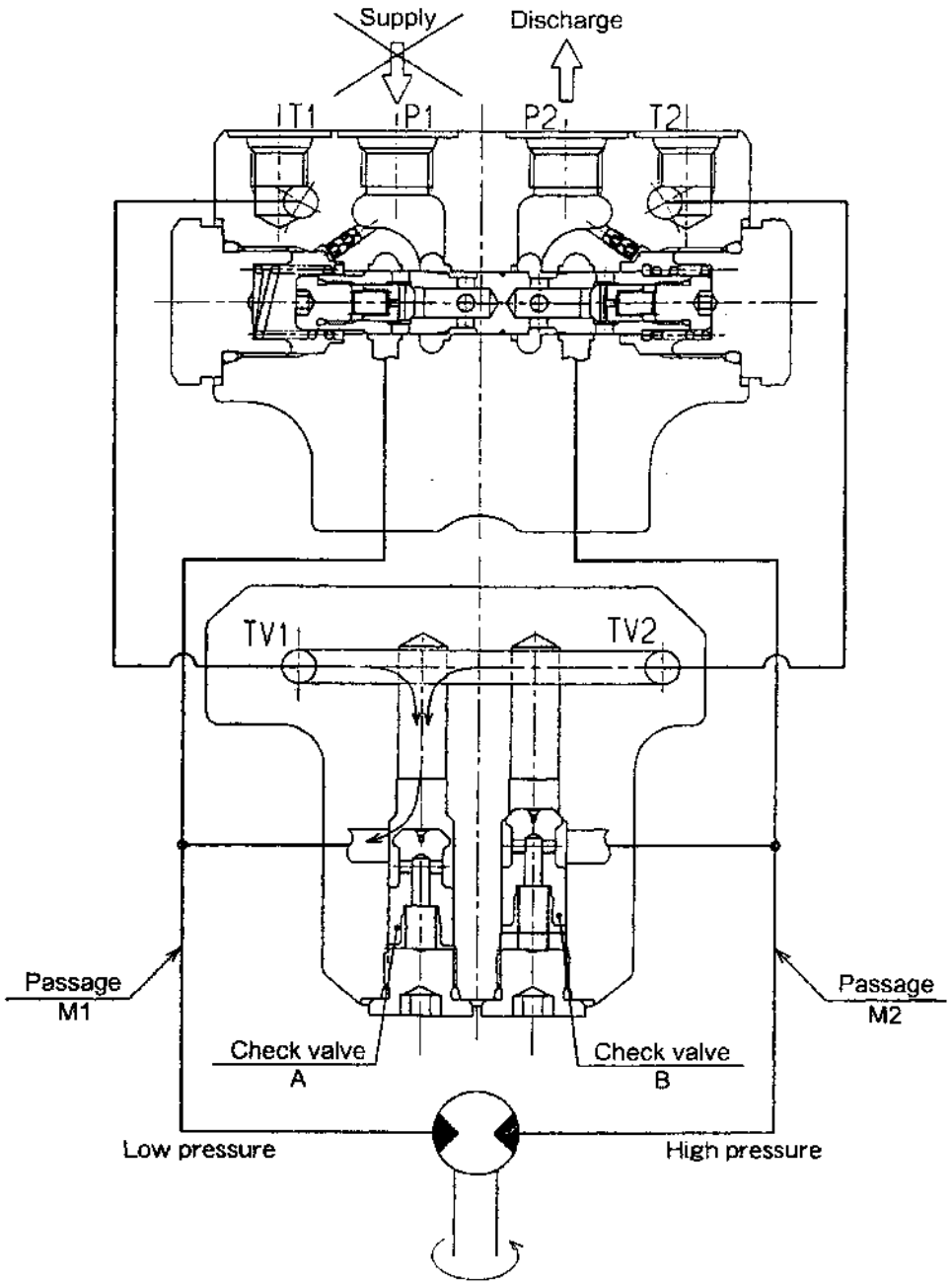


Fig. 6-11

8.2.2 Functions (Example of boom and arm cylinder)

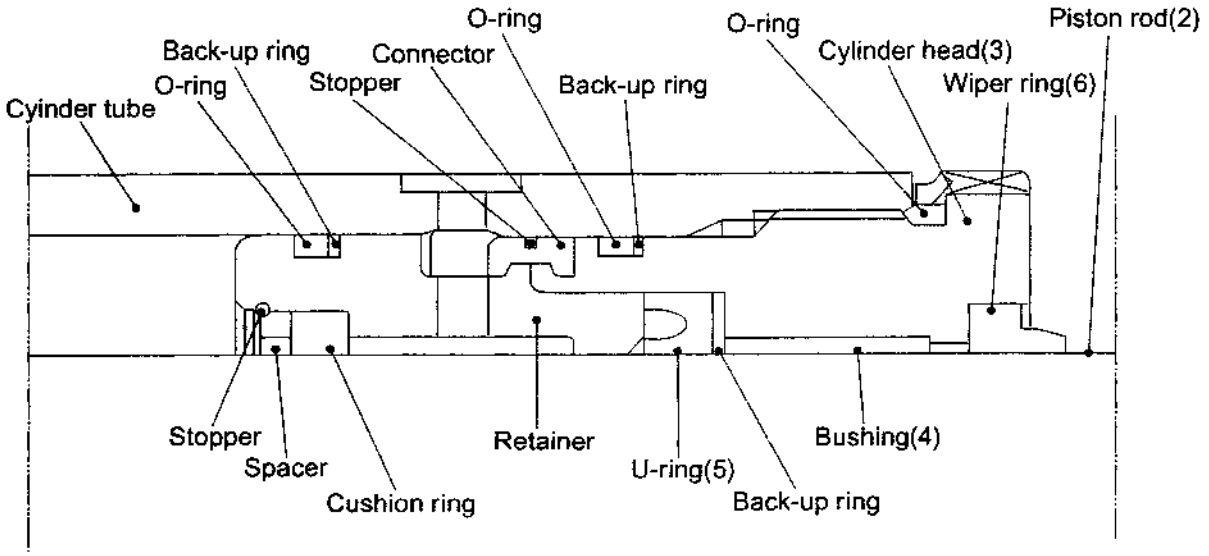


Fig. 8-6 Cylinder head assy

(1) Basic function

This is a kind of hydraulic actuator, which works so that the energy of the hydraulic pressure delivered by the hydraulic pump is transformed into a large force of rectilinear motion by way of the piston, and the operating direction is changed in the extending and retracting direction by operating the valve lever for the pressure oil flowing direction change. These large force and rectilinear motion, and operating direction change are basic functions.

(2) Functions of other sections

The following are described with the boom and arm cylinders.

1) Cylinder head assembly

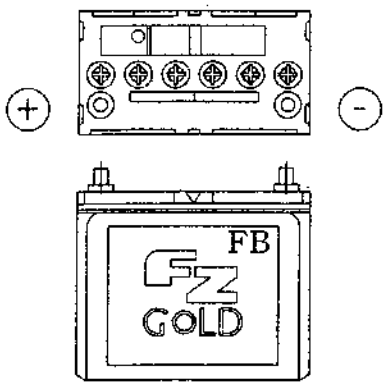
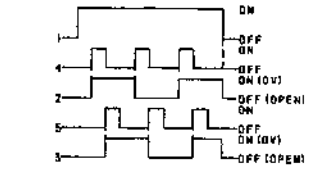
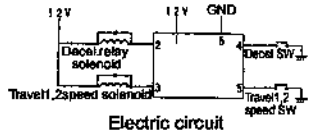
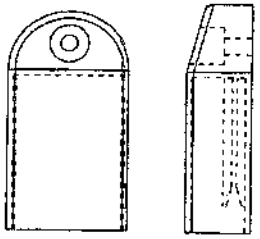
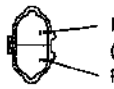
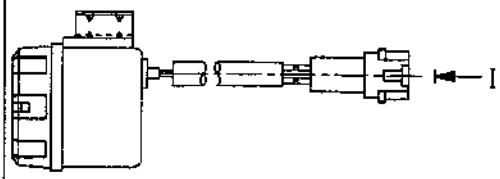
The cylinder head assembly plays a role as a bearing in piston rod (2) by press-fitting bushing(4) in the bore of the cylinder head. U-ring (5) is inserted in the bore of cylinder head to prevent the oil leakage to the outside. And wiper ring (6) is press-fitted in the bore of cylinder head to protect it from dust entry. The high pressure is produced in the cushion room by fitting it with cushion bearing at the position where the boom is almost extended to reduce the shock of the cylinder head at the most extended position. And it has a function to feed and deliver the high pressure oil from the cylinder tube to the port.

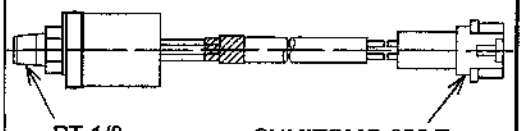
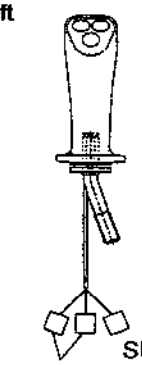
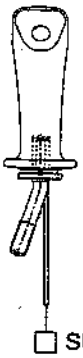
• Bushing (4)

The bushing (4) is press-fitted in the bore of the cylinder head and is in contact with the piston rod. And it shares the lateral load to the cylinder with the slide ring around the piston, moves linearly in high bearing stress to the piston rod, and reduces eccentricity which has a bad effect on the sealing capacity holding an end of the piston rod.

• Wiper ring (6)

The wiper ring is fitted on the mouth where the rod cylinder telescopes from cylinder. The rod seal of U-ring (5) in the cylinder prevents the entry of dust and water and removes mud adhered on the piston rod by the movement of the piston rod.

Code No. Parts Name Parts No. Use Applicable Machine	Specifications	Description
E-13 Battery PU72S00001P1 Power source PU06001~ PM02001~ PM05-05001~ PV08-20001~	Type: FZG-B24R Rated voltage: DC12V Capacity: 38Ah/5HR Amount of electrolyte: 3.2L	
E-14 Relay PA24S00002P2 Holding circuit unit PM05-05001~ PV08-20001~	Rated voltage: DC12V  Input/output operation  Electric circuit	 AMP : 0-175783-1 Mating connector : 0-174923-1 Terminal : 175027-1 Pin arrangement
E-20 Travel alarm PM53S00001F2 Alarm sound PV08-20001~	Reted votage: 12 · 24V DC Rated current: 50mA or less Sound pressure: 90 ± 6dB Frequency: 2400 ± 300Hz Intermittency: 80 ± 10 cycle/min	 View I POWER SOURCE PLUS (PINK) POWER SOURCE MINUS (BLACK) SUMITOMO HOUSING : 6187-2311 TERMINAL : 1500-0105 HARNESS SEAL : 7160-8234 

Code No. Parts Name Parts No. Use Applicable Machine	Specifications	Description
SW-24,25,26,27,30,31 Switch GB50S00049F1 Slew/swing lever,Travel pressure switch PV08-20001~ PJ02-00101~	Contact rating: Voltage : 18~30V Current : 10mA~3.5A Insulation resistance: 100MΩ more/ DC 500V Megger	 PT 1/8 SUMITOMO 090 Type water proof connector Housing : 6187-2311 equivalent
SW-7, 28 KAI Grip & Switch KAI Control lever LF01-00501~ PJ02-00101~ PV08-20001~	Left  Grip assy PV03M01133F2 Handle assy (with switch) LF03M01005F3 SW-28 TAPING SUMITOMO TERMINAL : HM090	Right  Grip assy PV03M01133F1 Handle assy (with switch) LF03M01005F1 SW-7 SUMITOMO TERMINAL : HM090

3. ARM

3.1 REMOVAL OF ARM

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

(2) Depressing the air breather on the hydraulic oil tank, release the pressure in the tank.

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

: 22 mm

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

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

: 17mm

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

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

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

: 24mm

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

Weight of arm assy: approx. 68kg (150lb)

(10) Removal of bucket cylinder

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

: 24mm

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

: 17mm

3) Apply a nylon sling to the tube of bucket cylinder, and remove the cylinder.
Weight ; 11kg (24lb)

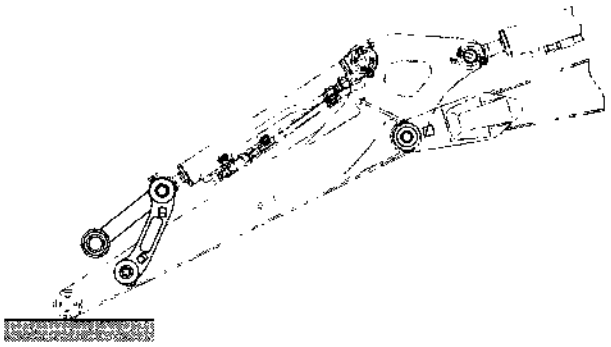


Fig. 2-5 Arm removing posture

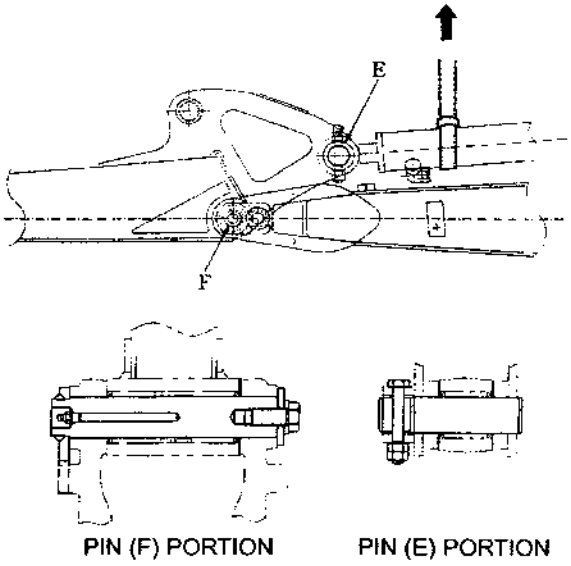


Fig. 2-6 Sectional view of Installation pin

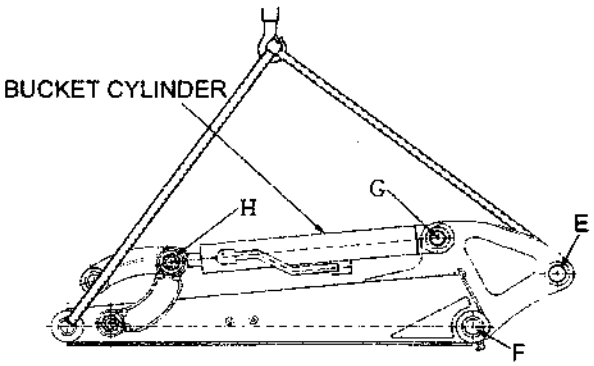


Fig. 2-7 Removal of arm assy

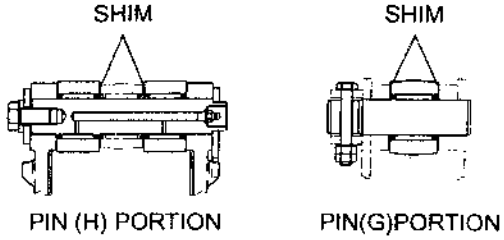


Fig. 2-8 Sectional view of Installation pin

3) Remove the cylinder head assy.

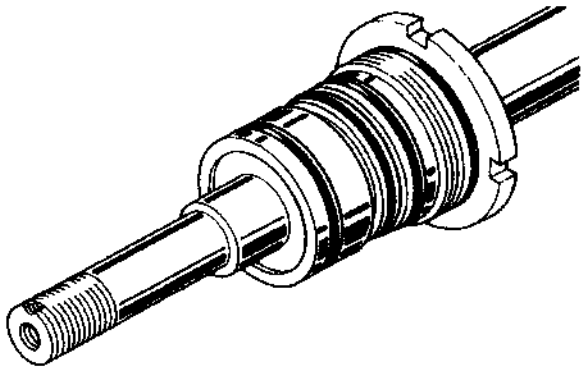


Fig. 1-7 Removing cylinder head assy

(3) Disassembly of piston assy:

1) Remove the slide ring (20) from the piston (19).

- Expand the split on the slide ring (20) as minimum as required to pull it off for axial direction (2 places).

2) Remove the seal ring assy (21).

- Cut off the seal ring (21) or remove it using a straight screw driver.

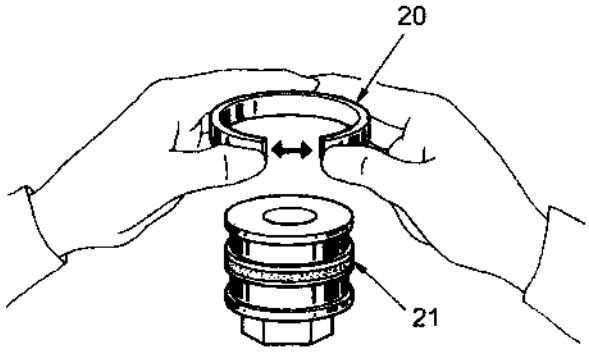


Fig. 1-8 Disassembling piston assy

(4) Disassembly of cylinder head assy:

1) Remove the O-rings (8) (10) and back-up ring (9) from the outer periphery of cylinder head (3). Then remove the O-ring (14) and back-up ring (15) [for Boom,Arm and swing cylinder].

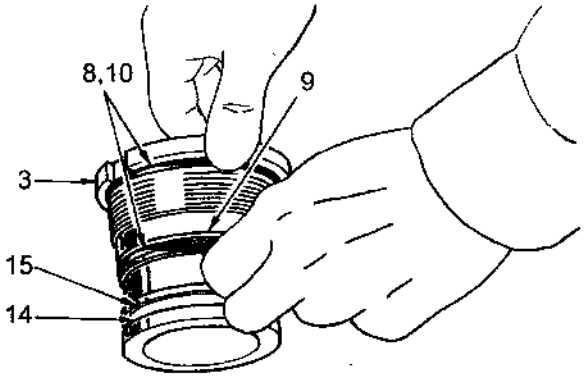


Fig. 1-9 Disassembling cylinder head assy

« For Boom and Arm Cylinder »

a. Remove stopper (18)
b. Remove spacer (17)
c. Remove cushion ring (16)
d. Remove stopper (12)
e. Remove connector(11)

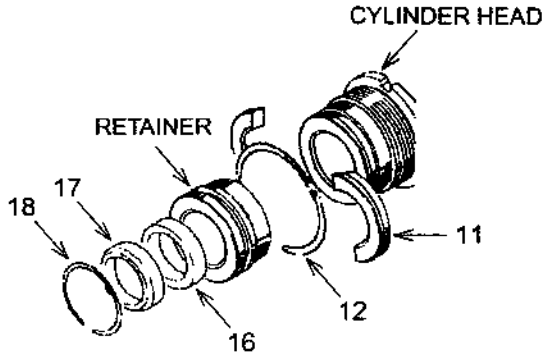


Fig. 1-10 Disassenbling retainer assy

(5) Inspection after assembly

Idling test

1) Place the cylinder level in idling condition.
2) Pressurize it through alternate ports on both sides softly, and operate the piston rod 5 or 6 times.
3) Be sure that the piston rod moves smoothly without abnormalities.

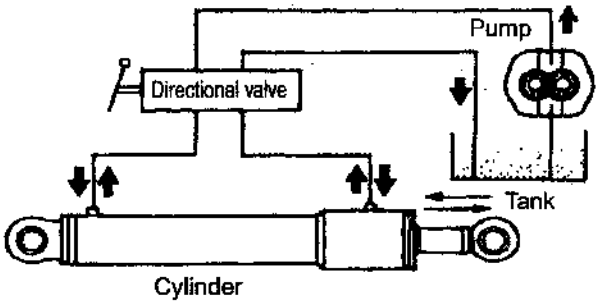


Fig. 1-36 Idling test

Leak test

● Outside leaking

1) Apply test pressure on the extension and retraction sides for 3 minutes.
2) Check on the rod seal section, cylinder head clamping section, every weld zone for possible failures like leaking and permanent set.

● Inside leaking

1) Remove the hose on the extension side.
2) Apply test pressure for 3 minutes on the retraction side alternately.
3) Measure oil leakage on the extension side.
   - Leaking should be 1cc/3min. or less.

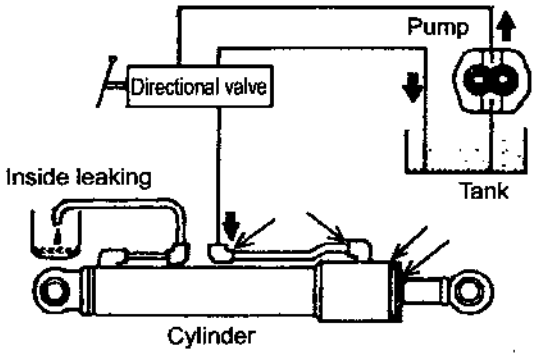


fig. 1-37 Leak test

(6) Bleeding air of hydraulic cylinder

When removing cylinder and hydraulic piping, etc. bleed them of air simultaneously.

1) Start the engine and idle it for approx. 5 minutes.
2) Repeat the extension and retraction of the cylinder 4 or 5 times at engine low idling.
   - Stop the piston rod 100mm short of the stroke end in order not to relieve.
3) Operate the cylinder extension and retraction at the engine high idling as shown in Par. 2), then stroke the piston rod to the stroke end at low idling to relieve it.

(4) Removing bonnet assy (4)

Loosen and remove 2 sems bolts (24) M10 X 25 together with shims (52) (53) (54),unlock and open bonnet assy (4), and remove bonnet (4) from the hinge section.

: 17mm

(5) Removing bonnet assy (5)

Remove 2 grommets (20), and loosen and remove sems bolts (27) M8 X 20.

: 13mm

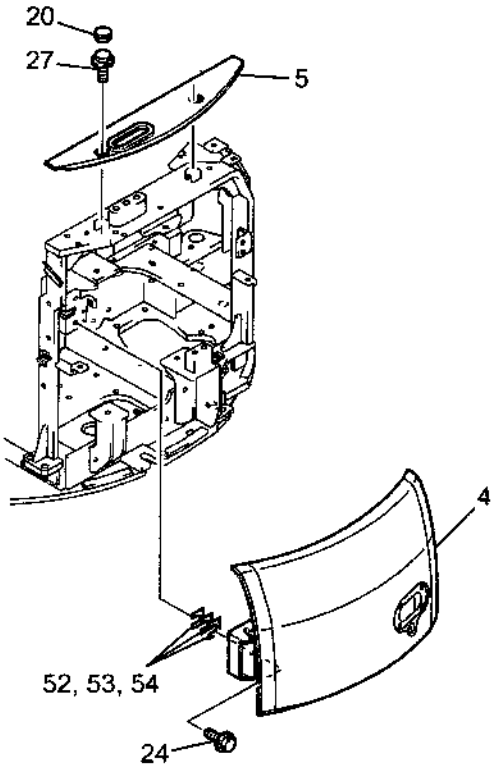


Fig. 2-4 Removing bonnet assy (4) (5)

(6) Removing cover assy (6)

Loosen and remove 2 capscrews (23) M10 X 35 and 3 sems bolts (24) M10 X 25.

: 17mm

(7) Removing cover assy (7)

Loosen and remove 3 capscrews (23) M10 X 35 and 3 sems bolts (24) M10 X 25.

: 17mm

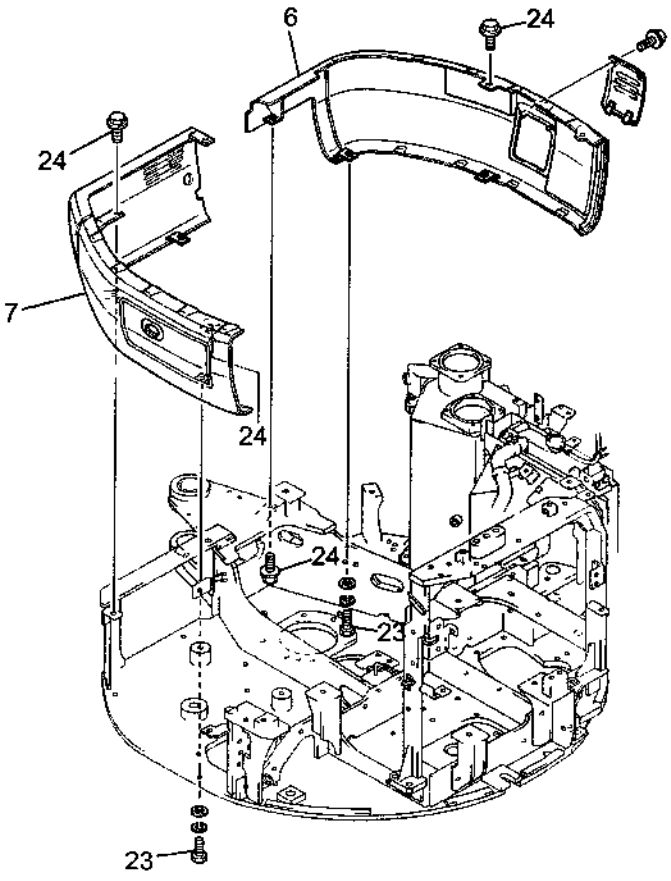


Fig. 2-5 Removing cover assy (6) (7)

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8. HYDRAULIC TANK

8.1 PREPARATION FOR REMOVAL

(1) Slew the upperstructure right about 90 degrees to make the work easy.

(2) Remove the fuel tank according to the procedure in section 7 "Fuel Tank".

(3) Loosen and remove 4 capscrews (B1) M10 X 25 and one capscrew (B3) M10 X 16.
Then remove bracket (B4).
: 17mm

(4) Remove the undercover under the hydraulic tank.
: 17mm,T= 4.7kgf·m (34 lbf·ft)

(5) Remove panel assy (3). (See Article 2.1-(3).)

8.2 REMOVAL

(1) Releasing internal pressure of tank
Release internal pressure by pressing the cap boots of breather assy (A1-9).

⚠ Keep the cap boots pressed until the hissing sound dies out.

(2) Remove plug (A1-14) and drain hydraulic oil.
: 22mm
Tank capacity : Approx. 27L (7.1 gal)

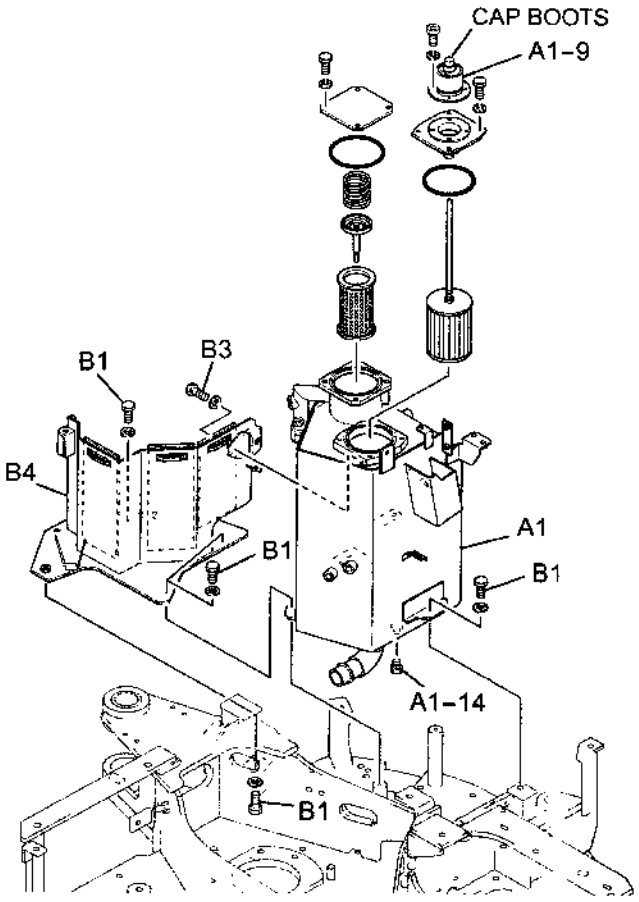


Fig. 8-1
Removing bracket(4)
Releasing internal press.
Draining hyd.oil

(3) Disconnecting suction hose
From the hole under the hydraulic tank,

1) Remove clip (10).
Screwdriver (-)

2) Disconnect hose (5).
Screwdriver (-)

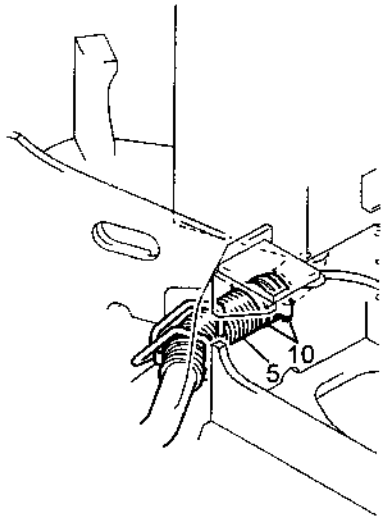


Fig. 8-2 Removing suction hose

15. ENGINE

15.1 PREPARATION FOR REMOVAL

(1) Remove the canopy. (See Section 1.)
(2) Remove the seat stand. (See Section 5.)
(3) Remove the counterweight. (See Section 6.)
(4) Remove the radiator. (See Section 14.)
(5) Remove the pump or disconnect the hose. (See Section 13.)
(6) Remove the battery grounding.(See Section 4).

15.2 REMOVAL

(1) Disconnecting fuel hose
Disconnect every hose at ★ and ★ marks position. However, the ★ mark is only for Auto Air Bleeding (OPT).

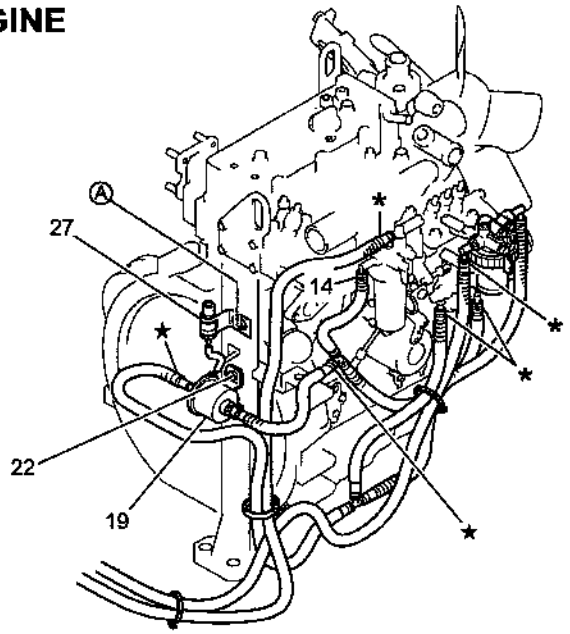


Fig. 15-1 Removing fuel hose, Removing fuel pump

(2) Removing fuel pump (19) (OPT)
1) Pull out connector (2FY-BS) of the harness for auto air bleeding. (For details, refer to the chapter 23 "Electric System".)
2) Loosen capscrew (22) and bolt Ⓐ used together with the cover, and remove fuel pump (19) and clamp (27).
: 10 mm

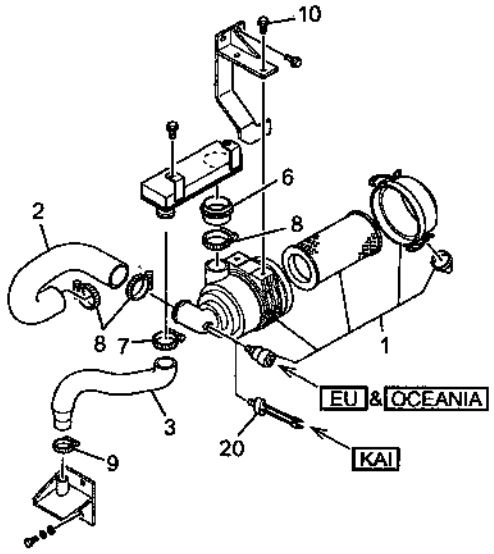


Fig. 15-2 Separating air cleaner (1)

(3) Separating air cleaner (1)
Loosen clamp (8), disconnect hose (2) and air cleaner (1), and pull out the connector for indicator (KAI only) (20).
: Screwdriver (-)

(4) Removing support (10)
Loosen 2 capscrews (21) M12x45 and 2 sems bolts (22) M12 X 30, and remove support (10) and the air cleaner together.
: 19 mm

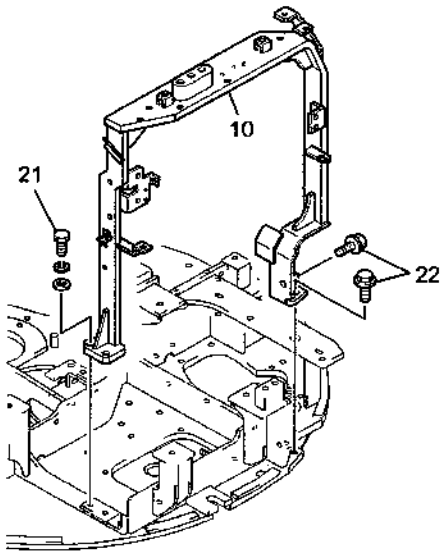


Fig. 15-3 Removing support

(5) Disconnecting cable connector
(For details, Refer to thechapter 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.

20. 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 19-4&5.)

(6) Remove the stopper for the swivel joint.
(See Fig. 19-6.)

(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 14 capscrews (5) for securing the slewing bearing and the outer race and one reamer bolt (6).

: 19 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.840 kg (1850 lb)

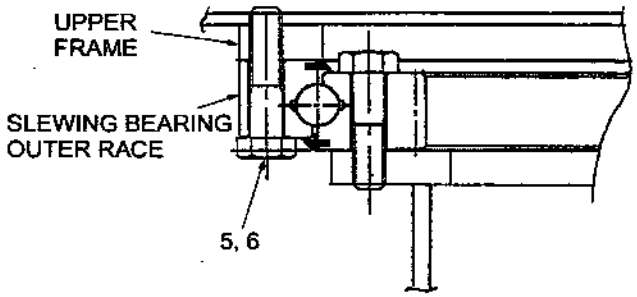


Fig. 20-1 Slewing bearing and upper frame

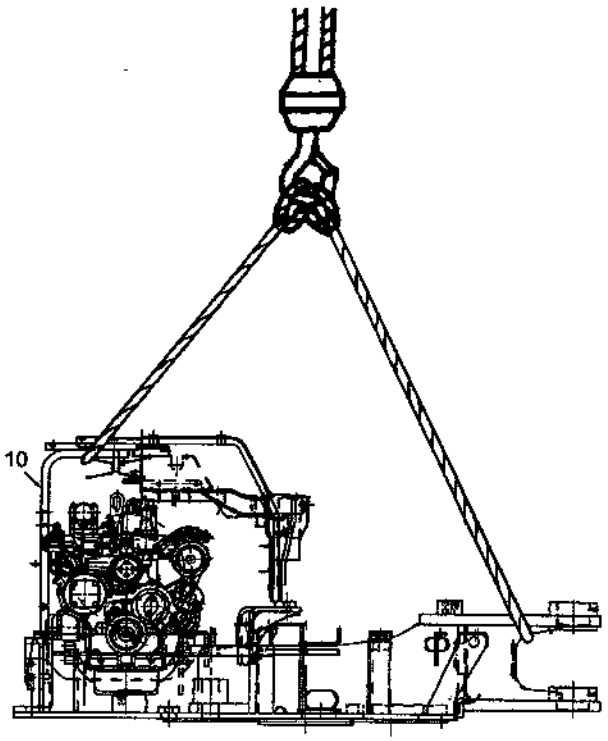
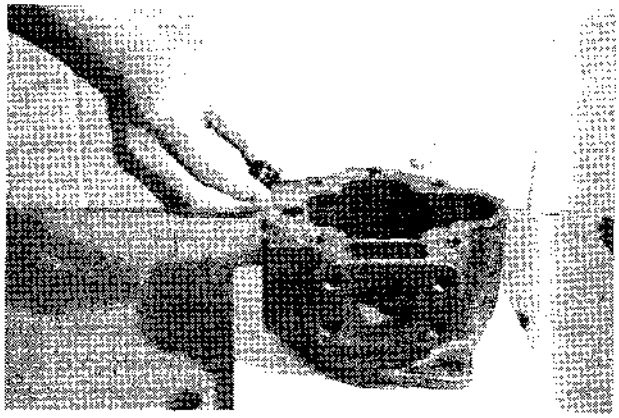


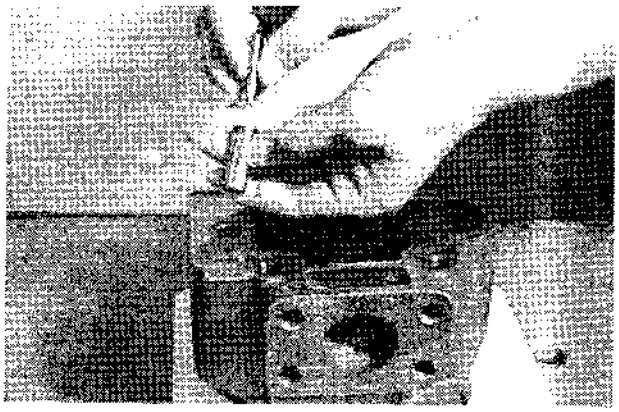
Fig. 20-2 Hanging upper frame temporarily

9. Disassembling housing section

(1) Remove the piston, disk spring and distance piece shim.



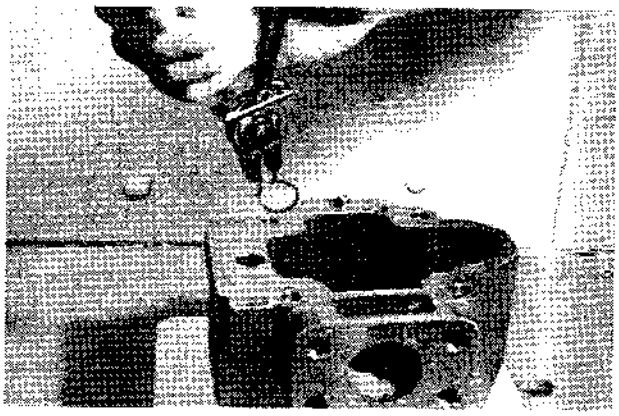
(2) Remove the parallel pin and sleeve (ø5.5).



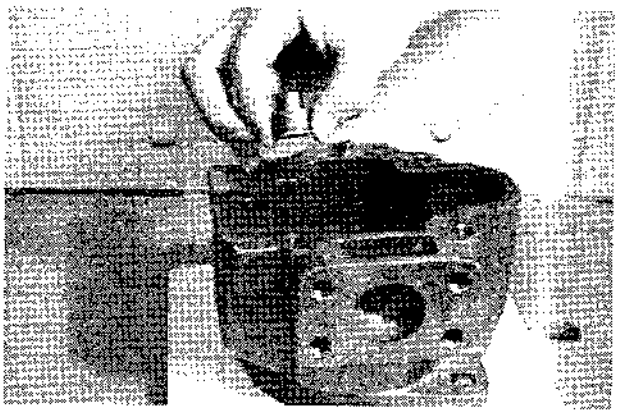
(3) Removing min. flow stopper

Remove C-snap ring (22 for hole), and then remove the min. flow stopper.

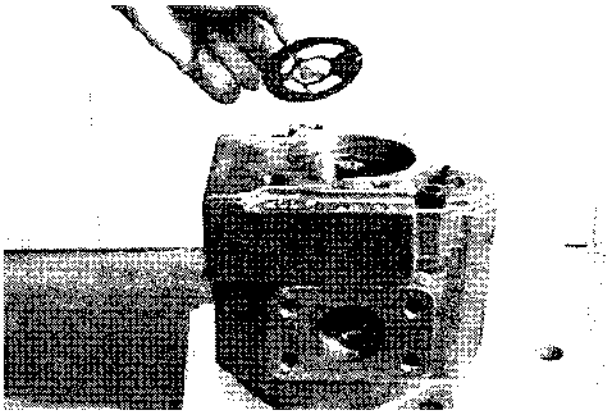
Snap ring plier (for snap ring 22 for hole)



(4) Remove the guide, disk spring, distance piece and shim sleeve.

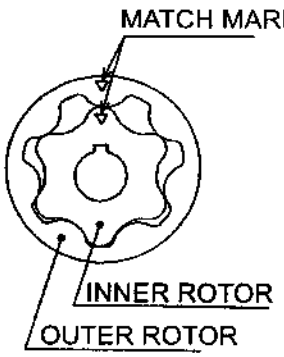


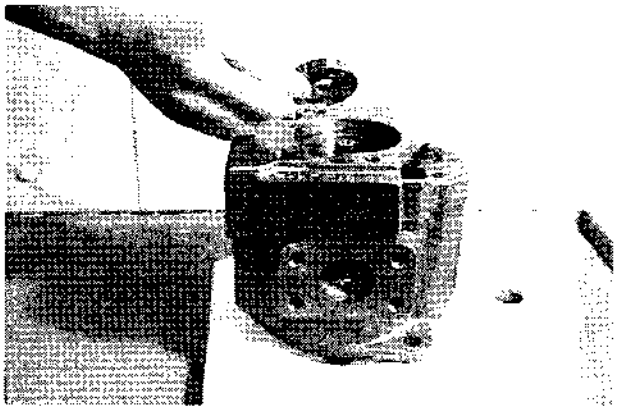
2. Install side plate (B) on the cover.



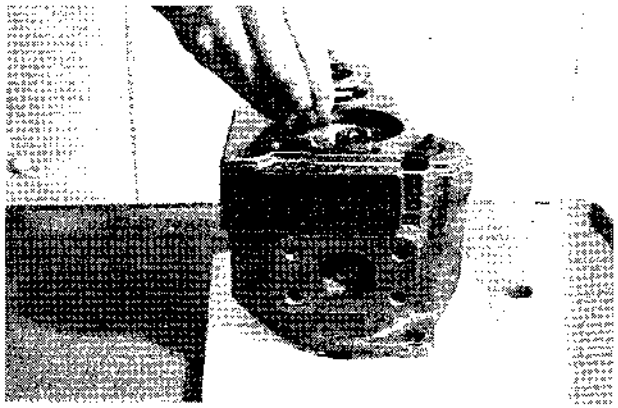
3. Fit the ring on the cover.

4. Place the gear in the cover.
   - Install directing the match mark face to side plate (B) side.





5. Install plate (A) and the plate on the cover.



2.4 DISASSEMBLING

(1) Drawing the spool out

Place the control valve on work bench directing the actuator port upward.

1) In case of hydraulic pilot switching type,how to take out the spool for slewing is as follows.
(Refer to Fig. 2-3 and 2-6.)
First, loosen and remove 2 socket bolts (10) with allen wrench of 4mm. Then, remove pilot cover (9).
The spring section of the slewing spool is disposed, so draw out and take out spool assy (2a-2e) slightly and horizontally(parallel to the spool hole) from the body holding the spring section.
Other pilot spools can be taken out from the same face by the same procedure. Then, check that the O-ring (7) on the flange bottom installing the pilot cover on the body side is not separated.

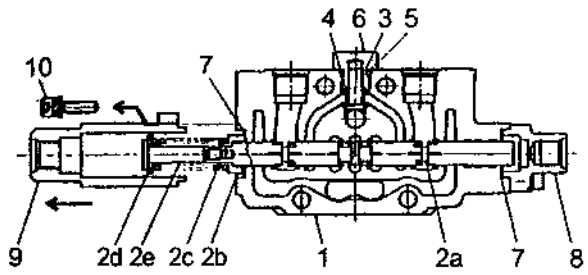


Fig. 2-6 Hydraulic pilot switching type

2) In case of manual switching type,How to take out this type as an example of the swing spool is as follows. (In KAI ,swing controlled by hyd.pilot system)
(Refer to Figures 2-2 and 2-7.)
First, loosen and remove 2 socket bolts (12) with allen wrench of 4mm.
Then, remove end cover (11).
The spring section of the swing spool is disposed, so draw out and take out spool assy (2a-2g) slightly and horizontally(parallel to the spool hole) from body (1) holding the spring section.
Then, pull the spool assy carefully, or the spool seal[dust wiper (2c) and O-ring (2b)] moves to the edge section of the spool and the lip section may be damaged.
Replace the removed O-ring with new one.
If it absolutely has to be used, check that it is free from flaw, deformation and foreign matter adhered.

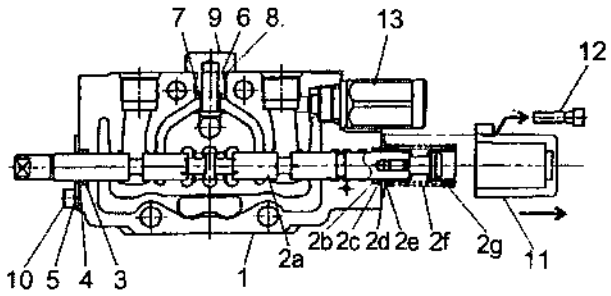


Fig. 2-7 Manual switching type

3) Precautions when replacing spool,
When replacing the spool, in no case should the spool be disassembled, but replace it by the spool assy.

(2) Relief valve

The relief valve is essential for the performance and the safety, and it is difficult to reset the pressure other if there is no facility in service shop, so when abnormality occurs, don't fail to replace the assy. The handling method is for reference, replace the assy as a rule.

Phenomenon	Cause	Corrective action
1. Pressure does not rise.	The pressure adjusting valve of each relief valve, poppet and piston are stuck, kept open, or got caught dust in the seat section of the valve.	• Check that the engagement valve of respective valve doesn't get matters caught in it. • Each part slides freely. • Clean all parts completely.
2. Relief pressure is unstable.	The adjusting valve of respective valve is damaged, or the piston is stuck to the poppet.	• Replace the damaged part. • Clean all parts completely. • Remove flaw on the surface.
3. The relief pressure is not within the limit of set values.	1) Wear due to dust 2) Lock nut and adjusting screw are loose. • Breakage and permanent set in fatigue of spring 3) Malfunction of RV and ORV	1) Disassemble and clean 2) Adjusting pressure • Replace spring. 3) Measure the pressure of RV and ORV.
4. Oil leakage	1) Damage on each seat section Wear of O-ring 2) Respective part is stuck due to dust entered.	1) Replace the worn or damaged part. Check that respective part move smoothly before installing. 2) Check that it is free from scratch, score and foreign matter before installing.

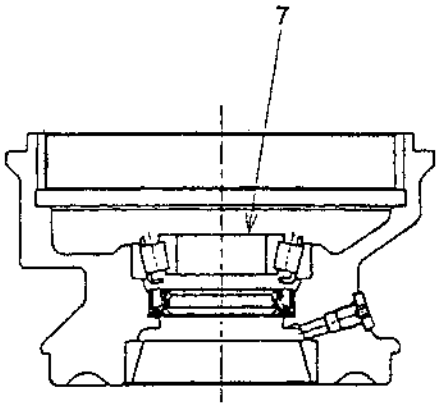
22) Apply Loctite #241 or equivalent to the thread of socket bolt.

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

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

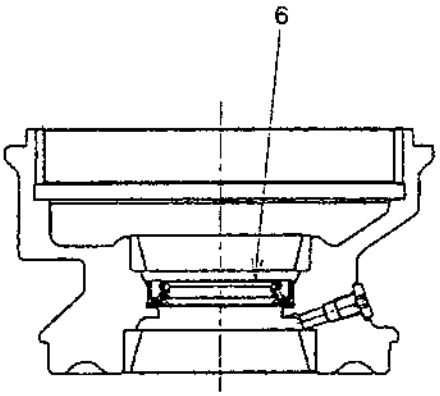
25) After fitting the top end of bellows (501) in cam (402), fit the lower side in the groove of cover (201).

3-4. Separate the inner race from taper roller bearing (7).

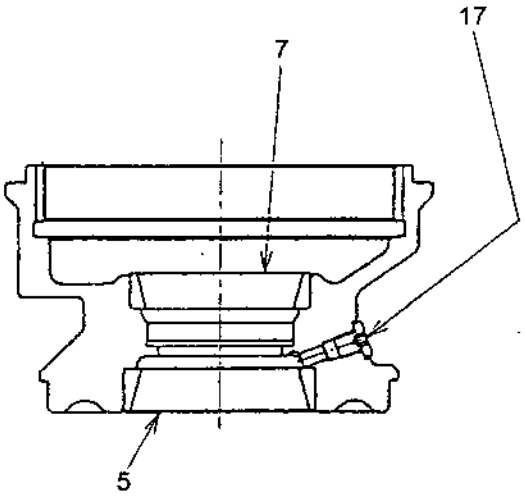


3-5. Break oil seal (6) and take out it.

[Note] : Don't use the removed oil seal. When removing, pay attention not to damage the outer race of taper roller bearing (5) (7).



3-6. Remove taper roller bearing (7), outer race and plug' (17). The disassembly is now completed.



5.5 MAINTENANCE STANDARD

Replace all parts referring to the list shown below.

(1) Motor

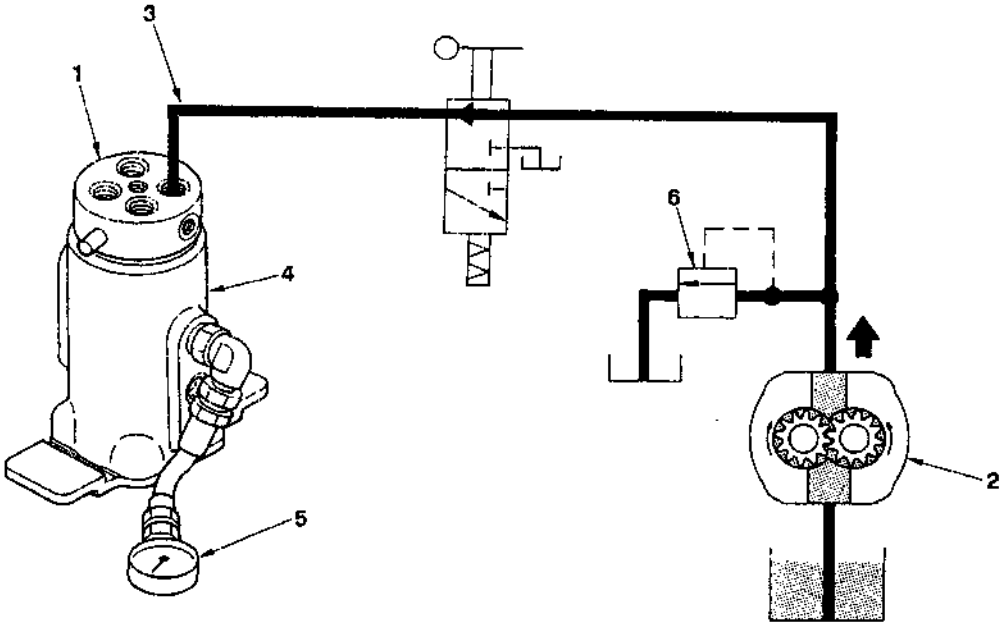
Part name	Maintenance standard
Piston assy (32)	1. Severe flaw and roughness of each sliding surface 2. Too large gap from the assy to cylinder block bore Upper limit of diameter clearance : 0.04mm (0.0016˝) 3. Large looseness of shoe ball Max. looseness(moving range) : 0.4mm (0.016˝)
Thrust plate (23) Retainer holder (30) Retainer plate (31) Valve plate (43) Brake piston (32)	1. Sever flaw and roughness of each sliding surface
Cylinder block (24)	1. Severe flaw and roughness of each sliding surface 2. Severe wear or breakage of the mating surface
Disk (33)	1. Severe flaw or peeling of each sliding surface (Friction plate) 2. Severe wear and peeling of mating surface
Ball bearing (21,41)	1. Flaking and peeling of rolling contact surface 2. Indentation of rolling contact surface 3. Abnormality of bearing rotation(Noise, unsmooth rotation)
Spring (26)	1. Sever breakage and deformation
O-ring (35,36,39,45,57,59,61)	1. Flaw causing oil leakage, flaw causing insufficient sealing, and permanent set

(2) Reduction unit

Part name	Maintenance standard
Pinion shaft (2)	1. Severe flaw, wear and flaking of gear tooth surface
Plate (4)	1. Severe flaw and wear
Taper roller bearing (5,7)	1. Severe flaw, indentation and flaking of roller and race section 2. Unsmooth rotation with noise ●Replace the body assy when required to replace the taper roller bearing.
Oil seal (6)	1. Severe flaw, deformation and wear of lip section 2. Hardening of lip section
Housing (1) Holder (10) Drive gear (16) Planetary gear (14)	1. Severe flaw, wear and flaking of gear tooth surface ●Replace the body assy when it is necessary to replace the housing.
Inner race (12)	1. Severe flaw, wear and flaking of needle bearing rolling surface
Needle bearing (13)	1. Severe flaw, wear and flaking of needle bearing surface
Planetary gear (14)	1. Severe flaw, wear and flaking of gear tooth surface 2. Severe flaw, wear and flaking of rolling surface in contact with needle bearing
Thrust plate (15,23)	1. Severe flaw, wear and seizure of sliding surface

6.3.3 Inspection After Assembly

After assembly is completed, check for leakage of oil in each circuit using the equipment shown below.



(1) Connect a pipe (3) between the hydraulic pump (2) and the shaft (1) side port.

(2) Connect a pressure gauge to the body (4) side.

(3) Increase the pressure gradually to 210 kgf/cm² (2990 psi) adjusting the relief valve (6), then perform 1 minute leak test.

- Open the neighboring ports on both sides and check visually for leakage from the ports.
- Check for external leakage, etc. by a color check.

2.3 CONSTRUCTION

(1) Construction of rubber crawler

No.	NAME	Q'TY per machine
1	RUBBER CRAWLER ASSY	2

● Standard machine is provided rubber crawler.

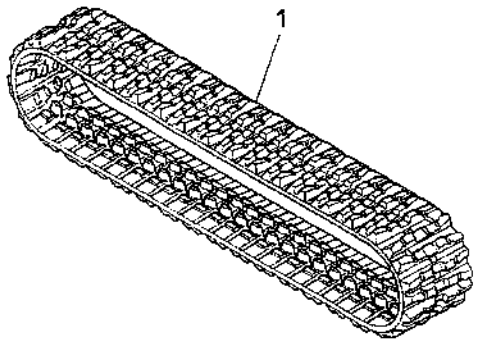


Fig. 2-18 Rubber crawler assy

(2) Construction of iron crawler

No.	Parts	Q'TY (for one side)
	Shoe assy	
	•Track link assy	1
1	•Track link (LH)	38
2	•Track link (RH)	38
3	••Master link (LH)	1
4	••Master link (RH)	1
5	••Track pin	38
6	••Master pin	1
7	••Bushing	39
8	••Pin	1
9	••Shoe	39

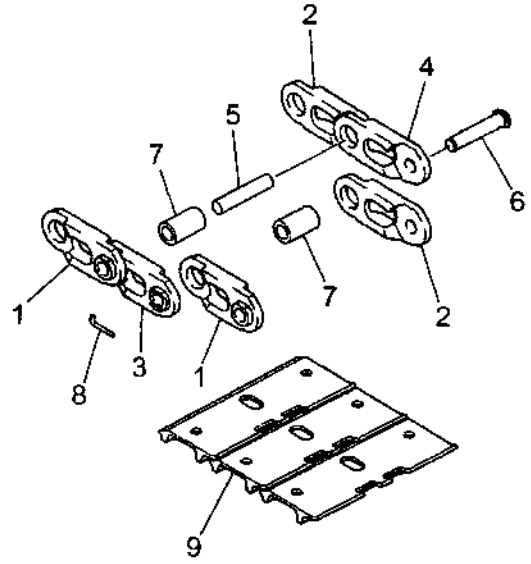


Fig. 2-19 Construction (Example of pad shoe)

2.4 MAINTENANCE STANDARDS

(1) Rubber crawler

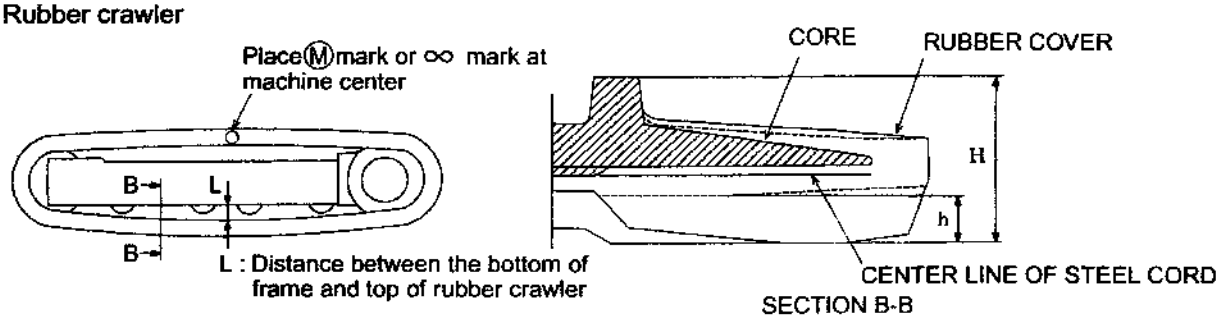


Fig. 2-20 Rubber crawler shoe

Table. 1

Unit : mm (in)

ITEM	STANDARD VALUE	REPAIRABLE LEVEL	SERVICE LIMIT	REMEDY
Slack of rubber crawler L	55~65 (2.2~2.6)	—	—	Adjustment
Cracks and cuts on rubber crawler	None	Where the depth of them does not reach to the steel cords.	Where the depth of them reachs to the steel cords.	Replace
Breakage of steel cords	None	None	Exist	Replace
Contact surface of rubber crawler and lower roller	None	Where 10 percent of core is visible from outside.	Where a half of core is visible from outside.	Replace
Height (H)	78 (3.1)	—	63 (2.5)	Replace
Lug projection (h)	15 (0.6)	—	0 (0)	Replace

5.4 MAINTENANCE STANDARDS

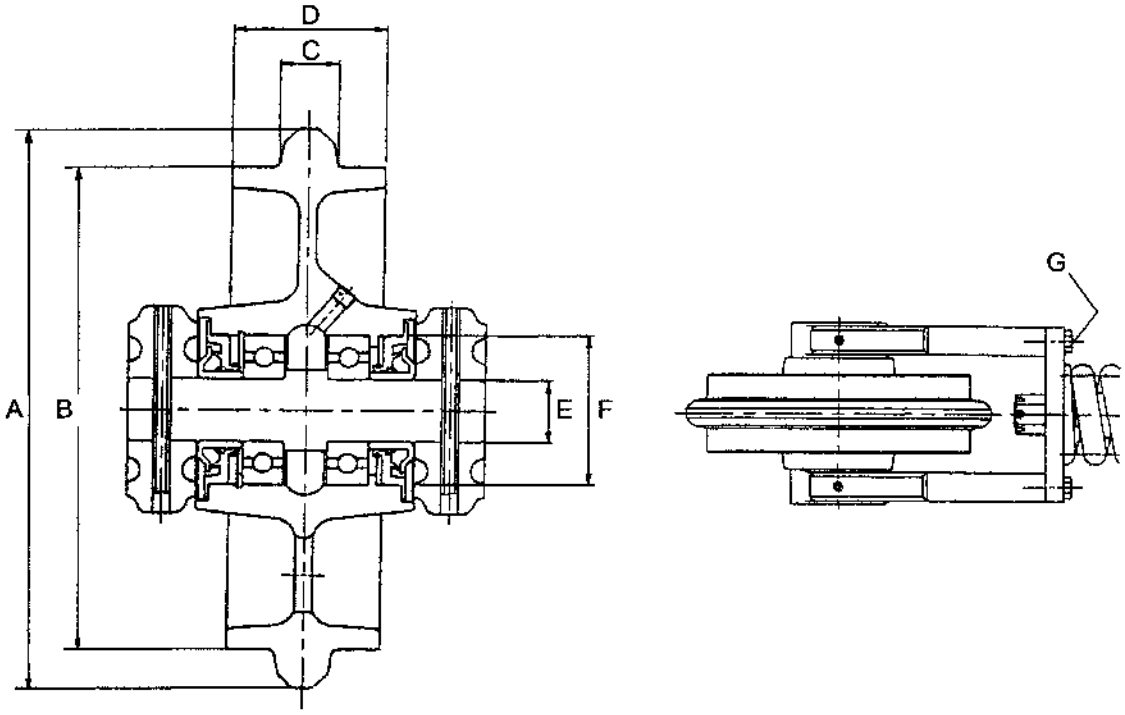


Fig. 5-11 Idler assy

Unit : mm (in)

Code	ITEM	STANDARD VALUE				REPAIRABLE LEVEL	SERVICE LIMIT	REMEDY
A	Dia.of idler projection	ø271 (10.7)				—	—	Replace
B	Tread O.D	ø233 (9.17)				ø229 (9.02)	ø227(8.94)	
C	Flange width	27 (1.06)				—	—	
D	Tread width	71 (2.80)				—	—	
E	Fitting shaft / bearing	Basic dimension	Tolerance		Fitting	Fitting	Fitting	Replace of shaft or bearing
		ø30 (1.18)	Shaft	+0.018 (0.00070) +0.002 (0.00008)	Interference 0.002 (0.00008) ~ 0.024 (0.00096)	Interference 0.002 (0.00008)	—	
			Bore	0(0) −0.006 (0.00024)				
F	Fitting idler / bearing	ø72 (2.83)	Shaft	0 (0) −0.009 (0.00035)	Clearance 0 (0) ~ Interference 0.039 (0.00154)	Clearance 0 (0)	—	Replace of idler or bearing
			Bore	−0.009 (0.00035) −0.039 (0.00154)				
–	Oil	Gear oil SAE #90 45cc (2.7 cu·in)						Replenish
–	Idler rotation	Idler rotates smoothly by hand						Reassembly
G	Tightening torque (Capscrew M10)	T = 6.7 kgf·m (48 lbf·ft) : 17mm Apply Loctite #262				—		Retightening

(4) Install plug (6) to outer race (2), confirming the direction and the position of the bore for taper pin (7).

(5) Push taper pin (7) into bore, and caulk the head of the taper pin with a punch.

(6) Coat seal A (8) with adhesive (Cyano Bond PO-1) and place it into groove of outer race (2).

(7) Confirm that grease nipple (10) is useful. Apply grease (NLGI-2 EP type) and confirm that the outer race rotates smoothly and that the lip of the seal is not scored.

Grease amount : 90g (3.2oz)

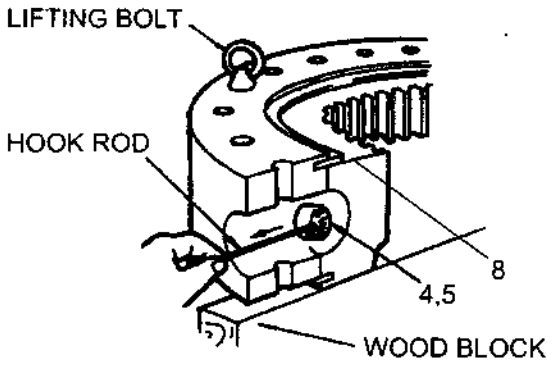
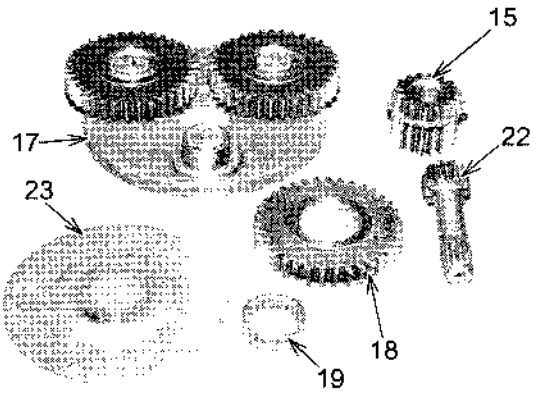


Fig. 9-8 Installing spacer

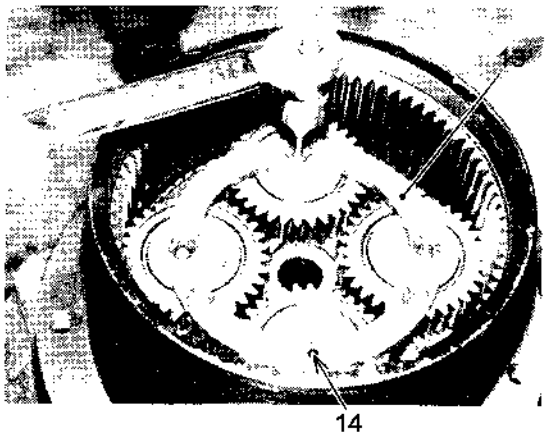
9.4 MAINTENANCE STANDARDS

Regarding the maintenance standards for the wear of the slewing bearing, refer to the section PV13 Maintenance Standards and Test Procedures, Article Measuring Slewing Performances.

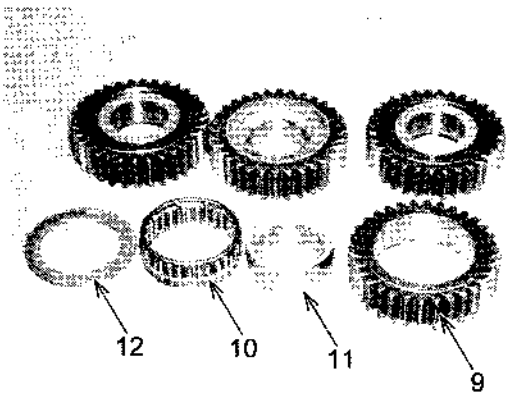
3) Remove sun gear assy (15), holder (17), planetary gear A (18), cage & roller (19), inner race (20), drive gear (22) and thrust plate (23).



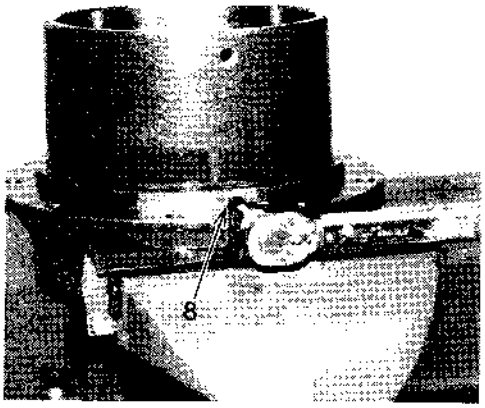
4) Remove thrust plate (13) and screw (14).
: 4mm



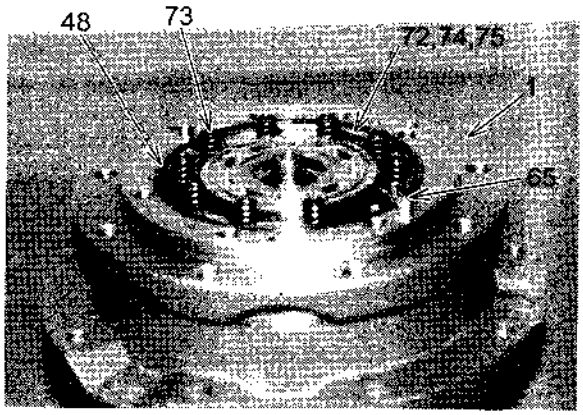
5) Remove planetary gear B (9), needle bearing (10), inner race (11) and thrust washer (12).
Be careful not to damage the tooth surface of gear and the rolling section of the collar.



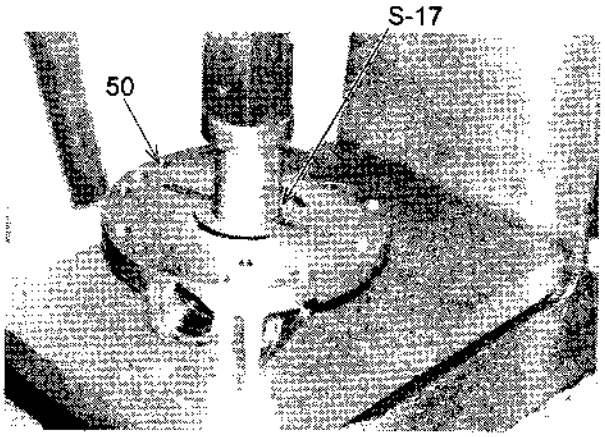
6) Remove socket plug PT1/8 (8).
: 5mm



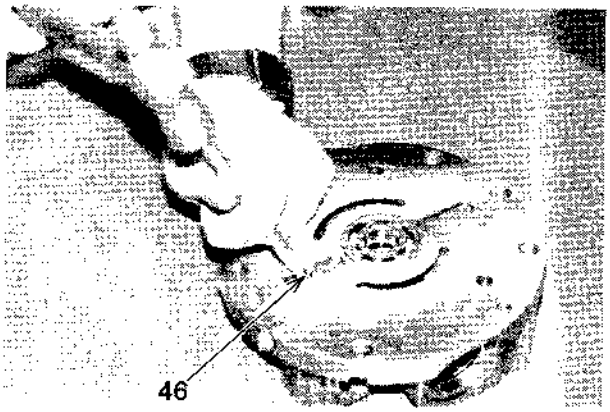
5) Install brake piston (72) with O-ring to flange holder (1).
Install spring (73), pin (65) and O-ring (48) to flange holder.
Apply small amount of gnease to O-ring.
Tool : Plastic mallet



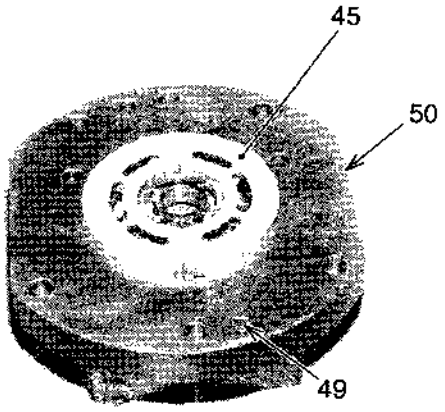
6) Press fit ball bearing (47) on the base plate (50).
Jig: S-17



7) Fit pin (46) and caulk 2 places.



8) Apply grease to the back side of valve plate (45), and install it on base plate (50).
Fit O-ring (49) on base plate (50). Apply a slight grease to the O-ring.



2. TROUBLE DIAGNOSIS: HYDRAULIC

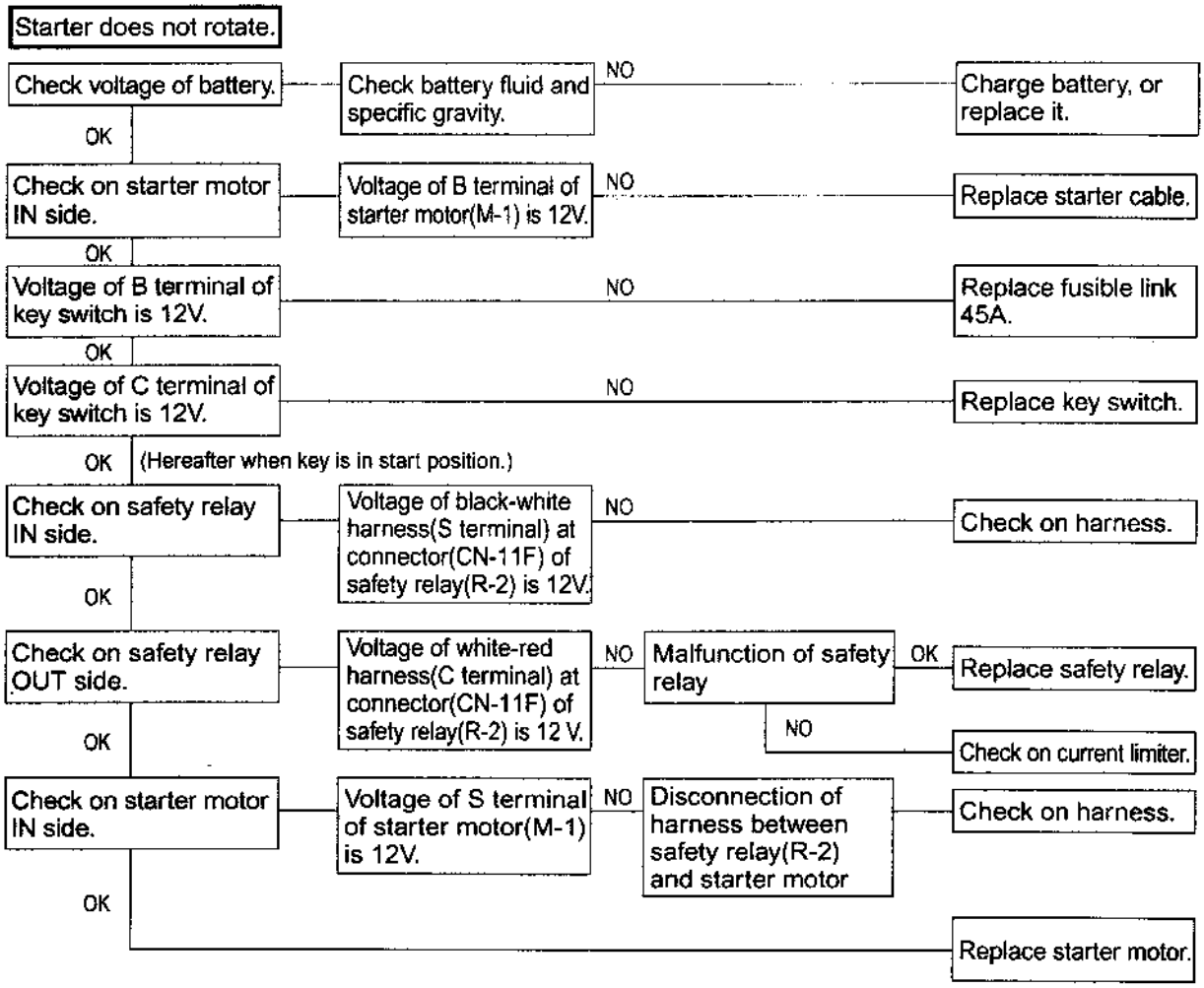
Classification	Reference No.		Causes / Phenomenon	Pump			Valve								Actuator		
				Main pump	Trochoid pump	Gear pump	Travel & ATT main R/V	Main gear pump R/V	Each over load R/V	Travel straight valve	Travel spool	Attachment spool	Check valve	Shuttle valve	Slewing motor unit	Travel motor unit	Hydraulic cylinder
Attachment	1	(1)	Attachment operational failure (excluding swing and dozer operation)	○							○	○					
		(2)	Travel speed is slow.	○								○					○
		(3)	Attachment operating power is low.				○		○								○
		(4)	Malfunction of attachment							○		○					○
Travel operation	2	(1)	Travel operational failure								○					○	
		(2)	Travel speed is slow.	○							○					○	
		(3)	Travel operating power is low.				○									○	
		(4)	It deviates in travel independent operation.	○						○	○					○	
Swing operation	3	(1)	Slewing operational failure									○			○		
		(2)	Slewing speed is slow.	○													
		(3)	Slewing operating power is low.					○	○						○		
		(4)	Malfunction of slewing operation									○		○	○		
Pump	4	(1)	Engine speed is reduced due to pump load.	○													
		(2)	Malfunction of pump	○	○	○											

Abbreviation

E/G : Engine
SOL : Solenoid
SW : Switch
ATT : Attachment
C/V : Control valve
R/V : Relief valve
V : Valve

1-(1)

Engine does not start.



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1-8 3TNE88

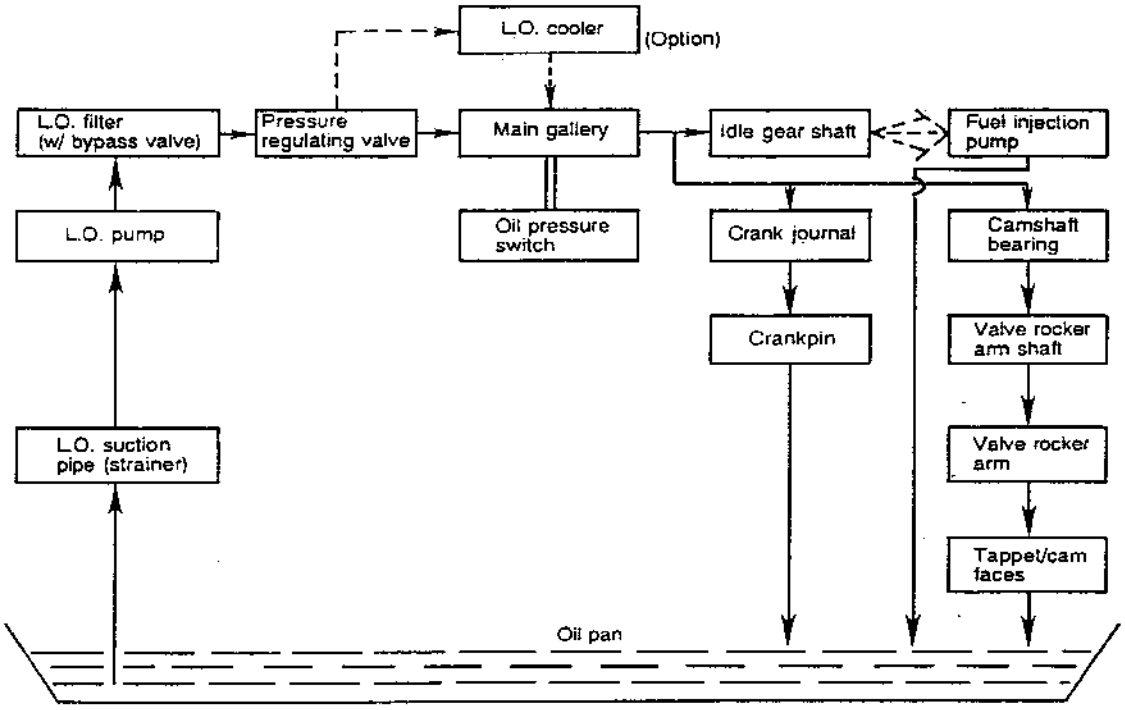
* **Output conditions:** Intake back pressure ≤ 250 mmAq, Exhaust back pressure ≤ 550 mmAq, other conditions complying with JIS D 1005–1986. After minimum 30 hour's run-in.

	Item		Model / Unit	3TNE88							
SPECIFICATIONS	Application		—	CL		VM					
	Type		—	Vertical, 4-cycle water-cooled diesel engine							
	Combustion system		—	Direct injection system							
	No. of cylinders – Bore × Stroke		mm	3 – 88 × 90							
	Displacement		ℓ	1.642							
	Firing order		—	1 – 3 – 2 – 1							
	Revolution speed		rpm	1500	1800	2000	2200	2400	2600	2800	3000
	Output*	Continuous rating	kW(HP)	12.3 (16.5)	14.8 (19.8)	—	—	—	—	—	—
		Max. rating	kW(HP)	13.5 (18.1)	16.3 (21.9)	18.0 (24.1)	19.9 (26.7)	21.6 (29.0)	23.5 (31.5)	25.2 (33.8)	27.1 (36.3)
	Max. revolution speed at no load		rpm	1600^{+50}_{0}	1900^{+50}_{0}	2175^{+50}_{0}	2375^{+50}_{0}	2600^{+50}_{0}	2800^{+50}_{0}	3000^{+50}_{0}	3225^{+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})							
	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	4.7/1.8						6.9/2.1	
	Recommended lubricating oil		—	API grade CC class or higher							
	Cooling system		—	Liquid cooling/Radiator							
	Cooling water capacity		ℓ	2.0 (for engine only)							
	Cooling fan No. of blade × dia.		mm	Pusher type, 6 × ϕ335							
	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	589 × 486 × 623		556 × 486 × 623 / 564 × 486 × 623					
	*1 Dry weight		kg	161		138/155					
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)							

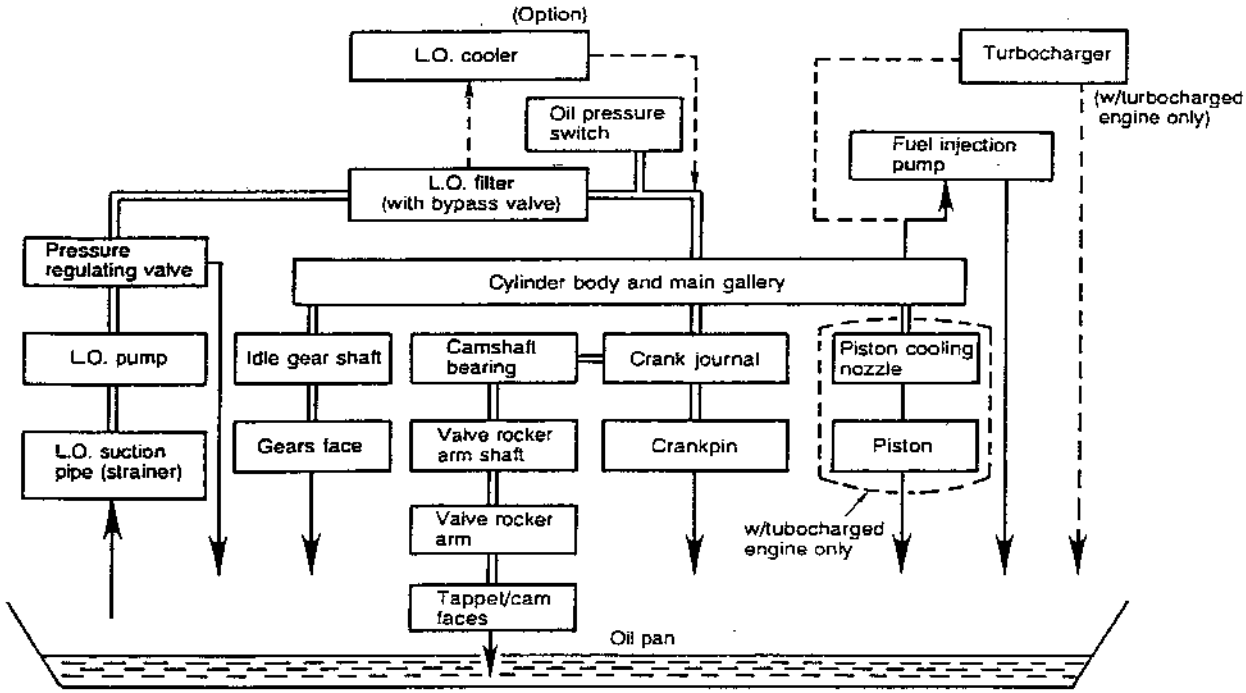
*1. Designation of engine dimension and dry weight in numerals.
CL/CH application: engine with flywheel housing
VM/VH application: engine with back plate/with flywheel hausing

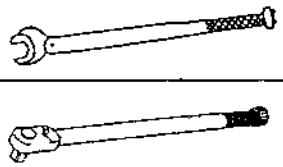
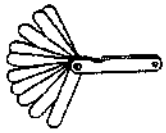
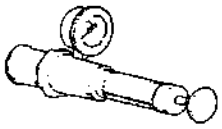
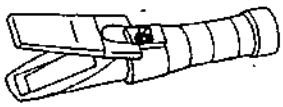
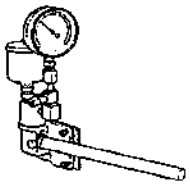
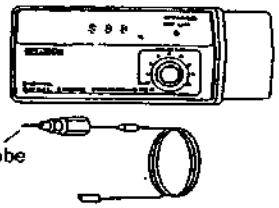
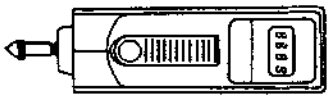
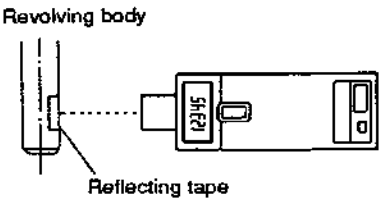
2. Lubrication system diagram

(1) Indirect injection system



(2) Direct injection system

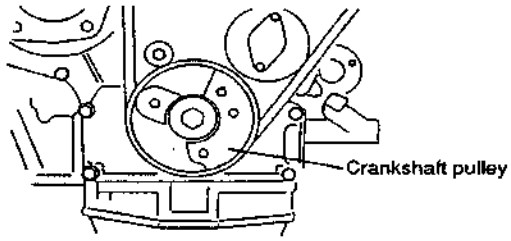


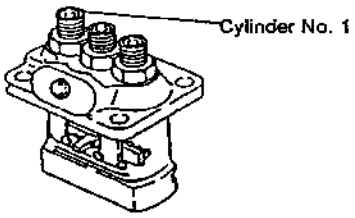
No.	Instrument name	Purpose of use	Illustration
10	Torque wrench	Used for tightening bolts and nuts to the specified torques.	
11	Thickness gauge	Measures gaps between the rings and mating ring grooves and around shaft couplings during installation	
12	Cap tester	Checks the fresh water system for leakage.	
13	Battery coolant tester	Checks the antifreeze for concentration and the battery electrolyte for specific gravity, and charging state.	
14	Nozzle tester	Checks the fuel injection valve for spray patterns and injection pressure.	
15	Digital thermometer	Measures temperature of each part.	
16	Tachometer — Contact type	Measures RPM of the rotary shaft by bringing the gage head into contact with the mortise.	
	Tachometer — Photoelectric type	Applies a reflecting tape on the circumference of the rotating parts to measure RPM.	

6-5. Checking and adjusting the fuel injection timing

1. Indirect injection system

(1) Using the crankshaft pulley, turn the engine in the specified direction. Check the injection timing at the delivery valve of the fuel injection pump for cylinder No.1. (Cylinders are numbered sequentially from cylinder No. 1 from the flywheel side).

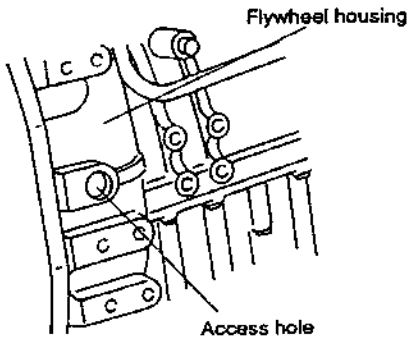


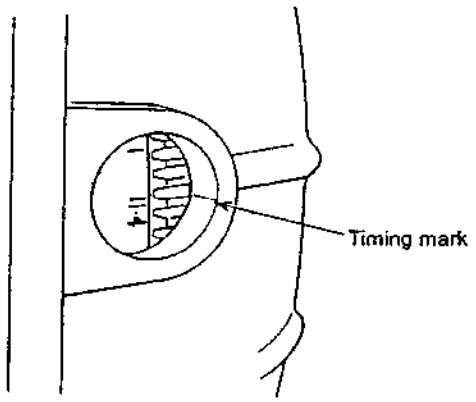


(2) When the crankshaft is turned in the specified direction, oil level rises at the tip of the delivery valve spring holder. At that time, stop the crankshaft.

(3) Identify the timing mark stamped on the flywheel through the access hole of the flywheel housing.

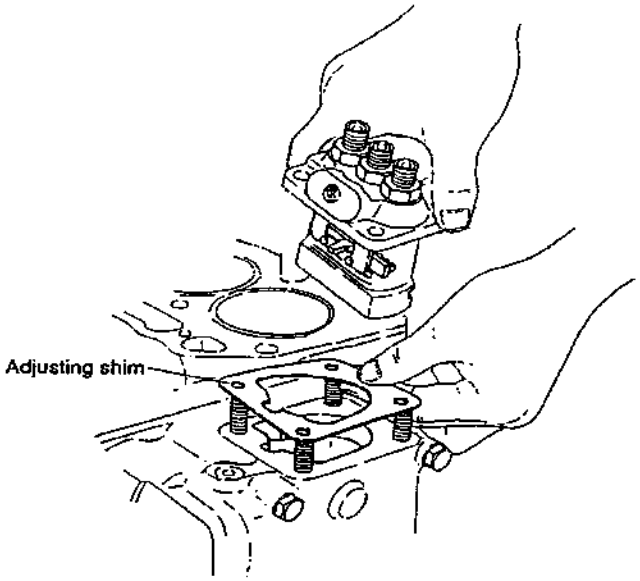
* : *For the fuel injection timing of each engine model, refer to Chapter 1, Specifications and Performance.*

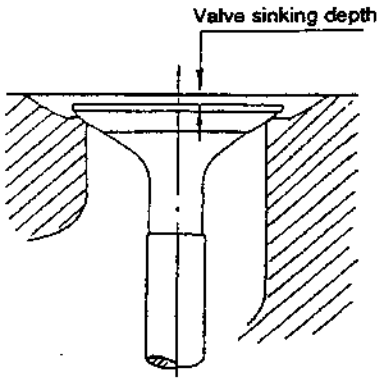




(4) If the present injection timing differs from the specified timing, remove the fuel injection pump, and adjust the timing by increasing or decreasing the adjusting shim thickness between the fuel injection pump and gear case.

- Increase the shim thickness to delay the injection timing.
- Decrease the shim thickness to advance the injection timing.



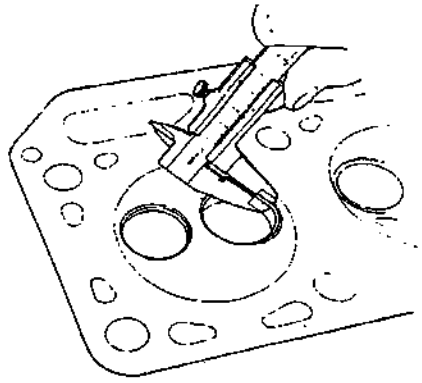


(2) Width and angle of the valve seat
Remove carbon deposits from the seat surface. Measure width and angle of the seat using vernier calipers and an angle gauge.

(mm)

		2/3TNE68		3TNE74	
		Standard	Wear limit	Standard	Wear limit
Valve seat width	Intake	1.15	1.65	1.44	1.98
	Exhaust	1.41	1.91	1.77	2.27
Valve seat angle	Intake	120°	—	120°	—
	Exhaust	90°	—	90°	—

		3TNE78A 3TME82A		3/4TNE82, 3/4TNE84(T), 3/4TNE88	
		Standard	Wear limit	Standard	Wear limit
Valve seat width	Intake	1.36 ~1.53	1.98	1.07 ~1.24	1.74
	Exhaust	1.66 ~1.87	2.27	1.24 ~1.45	1.94
Valve seat angle	Intake	120°	—	120°	—
	Exhaust	90°	—	90°	—

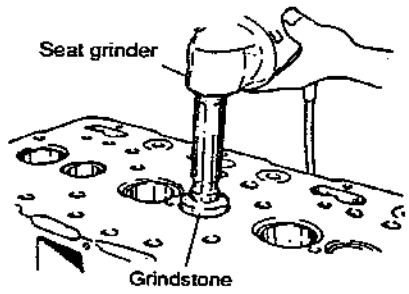


(Measuring the valve seat width)

[Valve Seat Correction Procedure]

(1) When the seat surface is worn or roughened slightly, lap the seat surface with a valve compound mixed with oil to a smooth state.

(2) When the seat surface is worn or roughened heavily, correct seat surface using a seat grinder or seat cutter, and finish it according to step (1).



[Procedure for Using The Seat Grinder and Seat Cutter]

(1) Correct the roughened seat surface with a seat grinder or seat cutter.

Seat grinder	Angle (θ)
Intake valve	30°
Exhaust valve	45°

(2) When the seat width is enlarged from the initial value, correct it by grinding the seat surface with a 70° seat grinder or seat cutter. Then, grind the seat to the standard width with a 15° grinder.

* *When using a seat cutter, evenly apply pressure taking care of avoiding uneven cutting.*

7-4. Piston and piston ring

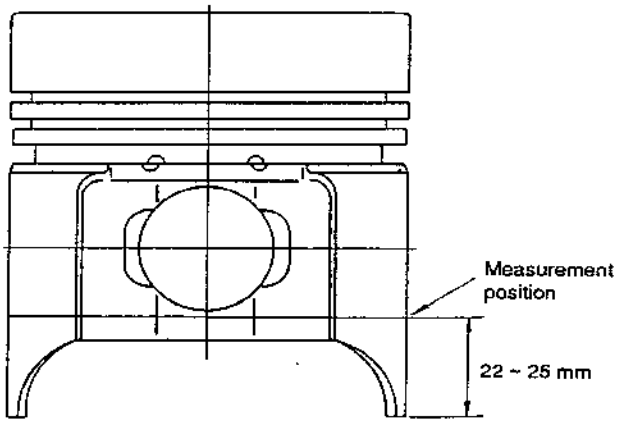
1. Checking the piston

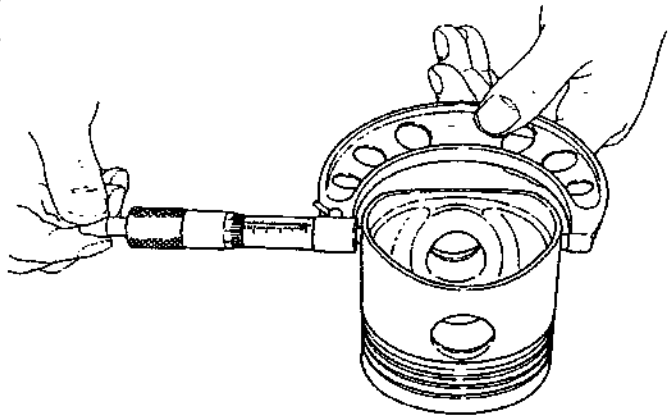
(1) Remove carbon deposits from the head and combustion surface of the piston so as not to impair the piston. Check to see if there is any crack or damage.

(2) Check the circumference and ring groove of the piston, and replace if worn or damaged.

2. Measuring the piston outside diameter

To measure the piston outside diameter, measure the long diameter of the oval hole in vertical direction to the pin hole and at a position 22–25 mm from the lower end of the piston.



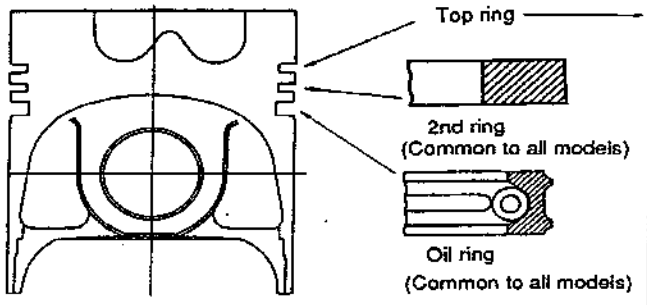


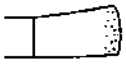
(Measuring the piston outside diameter)

(mm)

	2/3TNE68				3TNE74		3TNE78A		3TNE82A		3/4TNE82		3/4TNE84(T)		3/4TNE88	
	VM, VH		CH													
	Standard	Wear limit	Standard	Wear limit	Standard	Wear limit	Standard	Wear limit	Standard	Wear limit	Standard	Wear limit	Standard	Wear limit	Standard	wear limit
Piston outside diameter	67.960 –67.990	67.90	67.940 –67.970	67.90	73.940 –73.970	73.90	77.950 –77.980	77.90	81.950 –81.980	81.90	81.945 –81.975	81.90	83.945 –83.975	83.90	87.945 –87.975	87.90
Minimum clearance between piston and cylinder	0.025 –0.055	—	0.045 –0.075	—	0.045 –0.075	—	0.035 –0.065	—	0.035 –0.065	—	0.040 –0.070	—	0.040 –0.070	—	0.040 –0.070	—

3. Shapes of piston rings



Model	2/3TNE68, 3TNE74
Application	VM, CH, VH
Top ring	

Model	3TNE78A/82A, 3/4TNE82,	3/4TNE84(T) 3/4TNE88
Application	CL, VM	CH, VH, w/turbocharged
Top ring		

7-7. Crankshaft

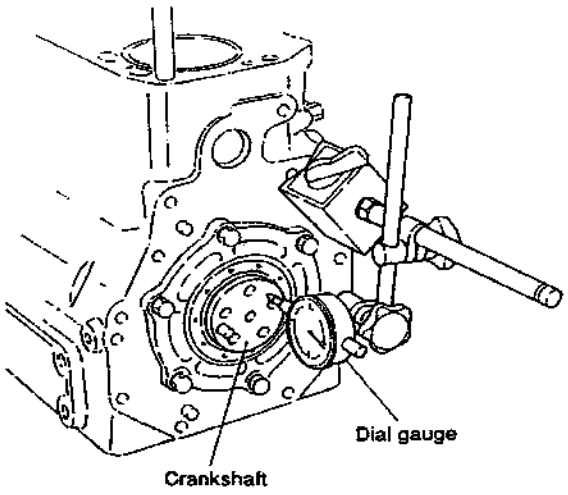
1. Side gap around the crankshaft

Before extracting the crankshaft and when reassembling it, bring a dial gauge into contact to the end of the crankshaft. Force the crankshaft to both sides in the axial direction to measure the thrust gap. Alternatively, insert a thickness gauge directly into a thrust gap between the thrust metal in the standard part and crankshaft to measure the side gap.

If the limit is exceeded, replace the thrust metal with a new one.

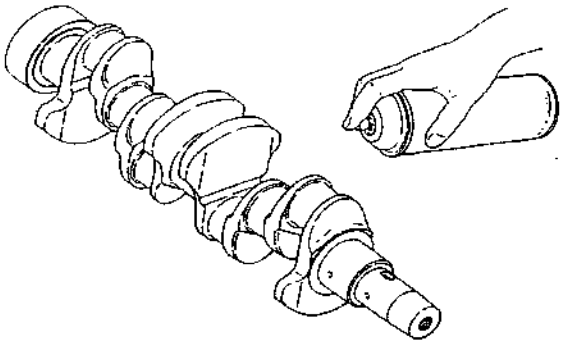
(mm)

	All models
Thrust gap	0.090~0.271



2. Color check of crankshaft

Clean the crankshaft and check it using a color check kit or a magnaflux inspector. Replace the crankshaft if cracked or badly damaged. If the crankshaft is slightly damaged, correct it by re-grinding.



(Color check inspection)

3. Checking the metal

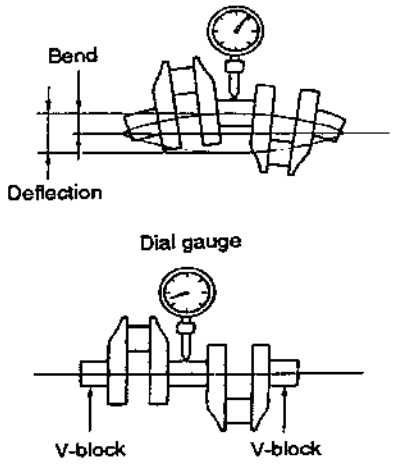
Check the metal for flaking, melting, seizure, and the state of the contact face. Replace the metal if found defective.

4. Bend of the crankshaft

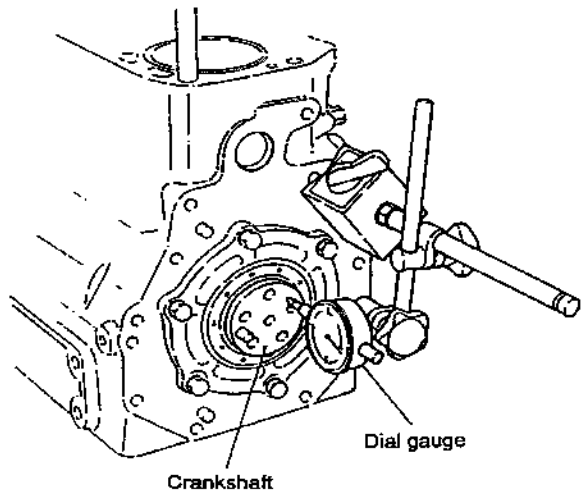
Support the crankshaft with V-blocks at both ends of the journals; measure the runout at the center journal with a dial gauge while rotating the crankshaft to check the extent of crankshaft bend.

(mm)

	All models
	Standard
Bend	0.02 or less



(Measuring the crankshaft bend)

Step	Removal Parts	Remarks
18	1. Remove oil pan ⑥⓪ and spacer ⑥① .	1. Put the cylinder block with the attaching surface of the cylinder head facing down. 2. Carefully protect the combustion surface of the cylinder block from damage. 3. For indirect injection system, be careful to the possibility of the tappet to drop off when the cylinder block is turned upside down, because the tappet is cylindrical in shape.
19	1. Remove idle gear shaft ④⑧ , and then remove idle gear ④⑨ . 2. Remove mounting bolt ⑤② of thrust bearing ⑤① through the hole of the camshaft gear ⑤⓪ . Remove camshaft assembly ⑤③ .	1. Turn the cylinder block aside and carefully prevent tappet ⑤⑨ from jamming on the cam. 2. Preheat camshaft gear ⑤⓪ and camshaft assembly ⑤③ to 180°C ~ 200°C which are shrink fitted, before removing them.
20	1. Remove gear case flange ⑥② .	
21	1. Remove lubricating oil strainer ⑥③ .	
22	1. Remove crankpin side cap ⑥④ of the connecting rod. ○ While turning crankshaft ⑥⑤ , place piston ⑥⑥ in the bottom dead center (BDC).	1. Before extracting piston ⑥⑥ , remove carbon deposits from the upper wall of the cylinder using fine sandpaper, while taking care not to damage the inner surface of the cylinder. 2. Make sure that cap No. of connecting rod ⑥⑦ agrees with cylinder No. 3. Take care not to let crankpin metal ⑥⑧ fall when removing connecting rod crankpin side cap ⑥④ .
23	1. Remove main bearing cap bolt ⑥⑨ . While shaking main bearing cap ⑦⓪ , remove main bearing cap ⑦⓪ together with lower main bearing metal ⑦① . 2. Extract crankshaft ⑥⑤ , taking care not to damage it. 3. Remove upper main bearing metal ⑦② .	1. Before extracting crankshaft ⑥⑤ , measure the side gap around it. 

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