HYDRAULIC EXCAVATOR

SHOP MANUAL model SK310 SK310LC

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

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

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

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

INDEX

KOBELCO

Book code No. S5LC0005E

⚠ WARNING

SAFETY

⚠ WARNING

The proper and safe lubrication and maintenance for this machine, recommended by KOBELCO are outlined in the OPERATION & MAINTENANCE GUIDE for this machine.

Improper performance of lubrication or maintenance procedures is dangerous and could result in injury or death. Read and understand the OPERATION & MAINTENANCE GUIDE 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.

Following is a list of basic precautions that should always be observed.

1. Read and understand all Warning plates and labels on the machine before operating, lubricating or repairing this product.

2. Always wear protective glasses and protective shoes when working around machines. In particular, wear protective glasses when pounding on any part of the machine or its attachments with a hammer or sledge. Use welders gloves, hood/goggles, apron and other protective clothing appropriate to the welding job being performed. Do not wear loose-fitting or torn clothing. Remove all rings from fingers when working on machinery.

3. Disconnect battery and discharge any capacitors before starting to work on machine. Hang "Do Not Operate" tag in the Operator's Compartment
4. If possible, make all repairs with the machine parked on a level, hard surface. Block machine so it does not roll while working on or under machine.

5. Do not work on any machine that is supported only by lift jacks or a hoist. Always use blocks or jack stands to support the machine before performing any disassembly.

⚠ WARNING

Do not operate this machine unless you have read and understand the instructions in the OPERATORS MANUAL. Improper machine operation is dangerous and could result in injury or death.

6. Relieve all pressure in air, oil or water systems before any lines, fittings or related items are disconnected or removed. Always make sure all raised components are blocked correctly and be alert for possible pressure when disconnecting any device from a system that utilizes pressure.

7. Lower the bucket, blade, ripper or other attachments to the ground before performing any work on the machine. If this cannot be done, make sure the bucket, blade, ripper or other attachments is blocked correctly to prevent it from dropping unexpectedly.

8. Use steps and grab handles when mounting or dismounting a machine. Clean any mud or debris from steps, walkways or work platforms before using. Always face machine when using steps, ladders and walkways. When it is not possible to use the designed access system, provide ladders, scaffolds, or work platforms to perform safe repair operations.

9. To avoid back injury, use a hoist when lifting components which weigh 23 kg (50 lbs) or more. Make sure all chains, hooks, slings, etc., are in good condition and are in the correct capacity. Be sure hooks are positioned correctly. Lifting eyes are not to be side loaded during a lifting operation.

10. To avoid burns, be alert for hot parts on machines which have just been stopped and hot fluids in lines, tubes and compartments.

11. Be careful when removing cover plates. Gradually back off the last two bolts or nuts located at opposite ends of the cover or device and pry cover loose to relieve any spring or other pressure, before removing the last two bolts or nuts completely.

12. Be careful when removing filler caps, breathers and plugs on the machine. Hold a rag over the cap or plug to prevent being sprayed or splashed by liquids under pressure. The danger is even greater if the machine has just been stopped because fluids can be hot.

⚠ WARNING

13. Always use tools that are in good condition and be sure you understand how to use them before performing any service work.

14. Reinstall all capscrews with same part number. Do not use a lesser quality capscrew if replacements are necessary.

15. Repairs which require welding should be performed only with the benefit of the appropriate reference information and by personnel adequately trained and knowledgeable in welding procedures. Determine type of metal being welded and select correct welding procedure and electrodes, rods or wire to provide a weld metal strength equivalent at least to that of parent metal. Always disconnect battery during welding operations to protect sensitive electric equipment.

16. Do not damage wiring during removal operations. Reinstall the wiring so it is not damaged nor will it be damaged in operation by contacting sharp corners, or by rubbing against some object or hot surface. Do not connect wiring to a line containing fluid.

17. Be sure all protective devices including guards and shields are properly installed and functioning correctly before starting a repair. If a guard or shield must be removed to perform the repair work, use extra caution.

18. Loose or damaged fuel, lubricant and hydraulic lines, tubes and hoses can cause fires. Do not bend or strike high pressure lines or install ones which have been bent or damaged. Inspect lines, tubes and hoses carefully. Do not check for leaks with your hands. Pin hole (very small) leaks can result in a high velocity oil stream that will be invisible close to the hose. This oil can penetrate the skin and cause personal injury. Use cardboard or paper to locate pin hole leaks.

19. Tighten connections to the correct torque. Make sure that all heat shields, clamps and guards are installed correctly to avoid excessive heat, vibration or rubbing against other parts during operation. Shields that protect against oil spray onto hot exhaust components in event of a line, tube or seal failure must be installed correctly.

20. Do not operate a machine if any rotating part is damaged or contacts any other part during operation. Any high speed rotating component that has been damaged or altered should be checked for balance before reusing.

21. On track-type machines, be careful when servicing or separating tracks. Chips can fly when removing or installing a track pin. Wear safety glasses and long sleeve shirts. Track can unroll very quickly when separated. Keep away from front and rear of machine. The machine can move unexpectedly when both tracks are disengaged from the sprockets. Block the machine to prevent it from moving.

22. Caution should be used to avoid breathing dust that may be generated when handling components containing asbestos fibers. If this dust is inhaled, it can be hazardous to your health. Components in KOBELCO products that may contain asbestos fibers are brake pads, brake band and lining assemblies, clutch plates and some gaskets. The asbestos used in these components is usually bound in a resin or sealed in some way. Normal handling is not hazardous as long as airborne dust which contains asbestos is not generated.

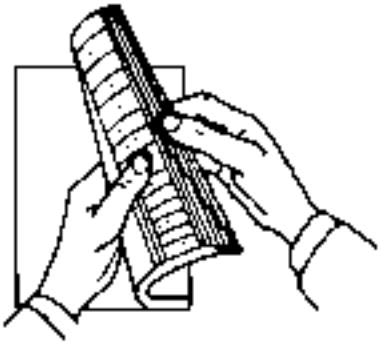
If dust which may contain asbestos is present, there are several common sense guidelines that should be followed.

a. Never use compressed air for cleaning.
b. Avoid brushing or grinding of asbestos containing materials.
c. For clean up, use wet methods or a vacuum equipped with a high efficiency particulate air (HEPA) filter.
d. Use exhaust ventilation on permanent machining jobs.
e. Wear an approved respirator if there is no other way to control the dust.
f. Comply with applicable rules and regulations for the work place.
g. Follow environmental rules and regulations for disposal of asbestos.
h. Avoid areas where asbestos particles may be in the air.

SHOP MANUAL model SK310 SK310LC

TABLE OF CONTENTS

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



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GENERAL

SK310Ⅲ SK310LCⅢ List of Shop Manual GENERAL Section

Index No.	Title	Book Code No. / Distribution Year-Month		
LC01	SPECIFICATION	S5LC0106E 1995-03		
—	OPERATION	S2LC1012E Refer to Operators manual		
LC03	LOCATION AND WEIGHT OF COMPONENTS	S5LC0305E 1995-03		
LC04	MAINTENANCE STANDARDS AND TEST PROCEDURES	S5LC0405E 1995-03		
—	PREVENTIVE MAINTENANCE	S2LC1012E Refer to Operators manual		
LC07	WORKING STANDARDS	S5LC0705E 1995-03		
LC08	STANDARD MAN-HOUR TABLE	S5LC0802E 1995-03		
	Applicable Machines	LC03801~ YC01101~		

Book code No. S5LC0105E

KOBELCO

SHOP MANUAL

SK310
SK310LC

LC01

SPECIFICATION

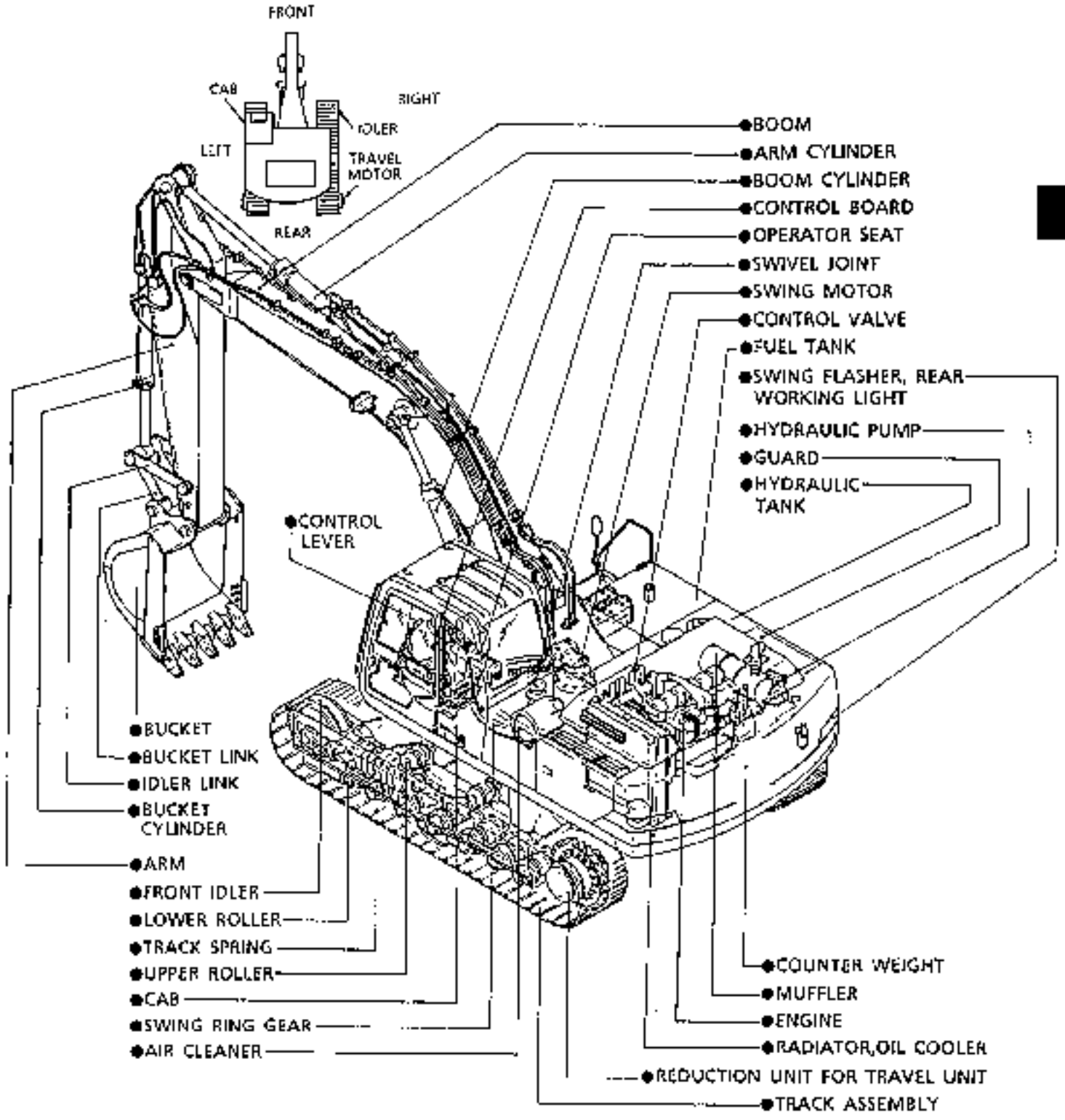
TABLE OF CONTENTS

KOBE STEEL, LTD.

Applicable Machines
LC03801~
YC01101~

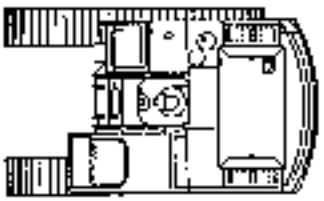
Revision	Date of Issue	Remarks
First edition	March, 1995	S5LC0105E K

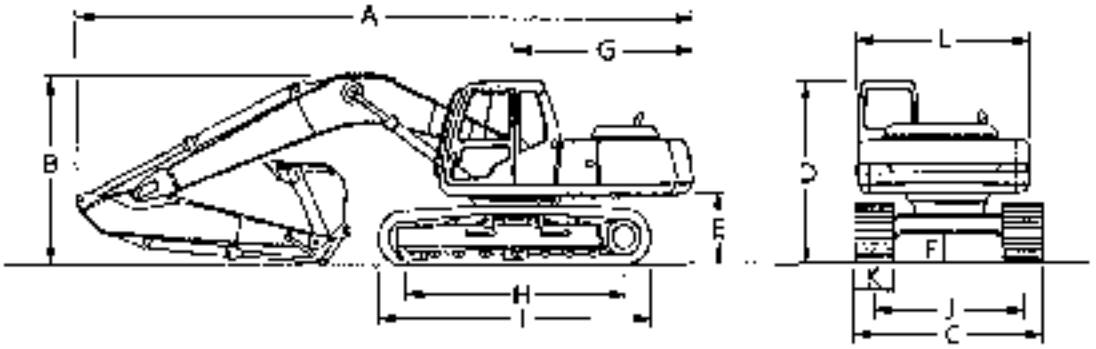
1. LOCATION OF COMPONENTS



2. GENERAL DIMENSIONS

SK310□



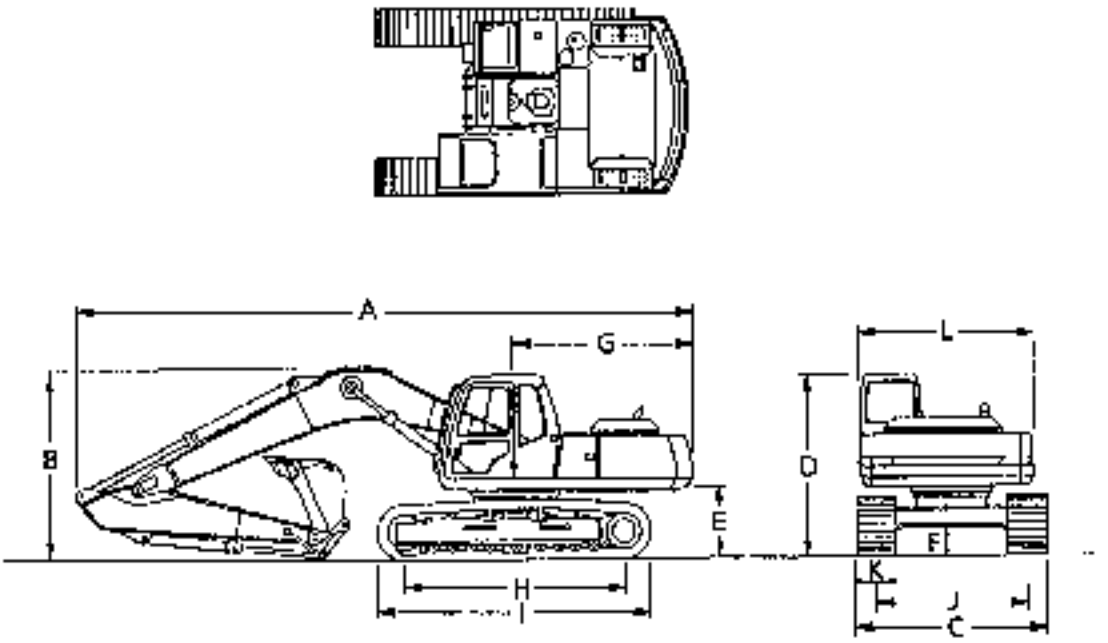


Unit : m (ft)

	Arm length	2.55 (8-4)	3.14 (10-4)	4.1 (13-5)
A	Overall length	10.94 (35-11)	10.85 (35-7)	10.88 (35-8)
B	Overall height (to top of boom)	3.52 (11-6)	3.25 (10-8)	3.36 (11-0)
C-1	Overall width (800mm (31.5in))	3.40 (11-2)	3.40 (11-2)	3.40 (11-2)
C-2	Overall width (600mm (23.6in))	3.20 (10-6)	3.20 (10-6)	3.20 (10-6)
D	Overall height (to top of cab)	3.06 (10-0)	3.06 (10-0)	3.06 (10-0)
E	Ground clearance of rear end*	1.17 (3-10)	1.17 (3-10)	1.17 (3-10)
F	Ground clearance*	470mm (18.5in)	470mm (18.5in)	470mm (18.5in)
G	Tail swing radius	3.20 (10-6)	3.20 (10-6)	3.20 (10-6)
H	Tumbler distance	3.705 (12-2)	3.705 (12-2)	3.705 (12-2)
I	Overall length of crawler	4.645 (15-3)	4.645 (15-3)	4.645 (15-3)
J	Track gauge	2.60 (8-6)	2.60 (8-6)	2.60 (8-6)
K-1	Shoe width	800mm (31.5in)	800mm (31.5in)	800mm (31.5in)
K-2	Shoe width	600mm (24in)	600mm (24in)	600mm (24in)
L	Overall width of upper structure	3.06 (10-0)	3.06 (10-0)	3.06 (10-0)

NOTE : Figure of asterisk (*) apply to value without shoe lug.

SK310LC III



Unit : m (ft)

	Arm length	2.55 (8-4)	3.14 (10-4)	4.1 (13-5)
A	Overall length	10.94 (35-11)	10.85 (35-7)	10.88 (35-8)
B	Overall height (to top of boom)	3.54 (11-7)	3.25 (10-8)	3.39 (11-1)
C-1	Overall width (800mm (31.5in))	3.40 (11-2)	3.40 (11-2)	3.40 (11-2)
C-2	Overall width (600mm (23.6in))	3.20 (10-6)	3.20 (10-6)	3.20 (10-6)
D	Overall height (to top of cab)	3.06 (10-0)	3.06 (10-0)	3.06 (10-0)
E	Ground clearance of rear end*	1.17 (3-10)	1.17 (3-10)	1.17 (3-10)
F	Ground clearance*	470mm (18.5in)	470mm (18.5in)	470mm (18.5in)
G	Tail swing radius	3.20 (10-6)	3.20 (10-6)	3.20 (10-6)
H	Tumbler distance	4.01 (13-2)	4.01 (13-2)	4.01 (13-2)
I	Overall length of crawler	4.95 (16-3)	4.95 (16-3)	4.95 (16-3)
J	Track gauge	2.60 (8-6)	2.60 (8-6)	2.60 (8-6)
K-1	Shoe width	800mm (31.5in)	800mm (31.5in)	800mm (31.5in)
K-2	Shoe width	600mm (24in)	600mm (24in)	600mm (24in)
L	Overall width of upper structure	3.06 (10-0)	3.06 (10-0)	3.06 (10-0)

NOTE : Figure of asterisk (*) apply to value without shoe lug.

3. SPECIFICATIONS AND PERFORMANCE

■ SPEED AND CLIMBING ABILITY

Item \ Model	SK310III · SK310LC-III
Swing speed	10.5rpm
Travel speed	5.5 / 3.7km / h (3.4 / 2.3 mph)
Gradeability	35° (70%)

■ ENGINE

Model		Mitsubishi 6D22-T
Type		Water-cooled 4-cycle, direct injection type diesel engine with turbo-charger
Number of cylinder−Bore×Stroke		6−130mm(5.11in)×140mm(5.51in)
Total displacement		11,149c.c. (680cuin)
Rated output power/revolution	JISD 1005 NET	230 HP / 1,750rpm
	ISO 9249 NET	169 KW / 1,750rpm
Maximum torque/revolution	JISO 1005 NET	106 kgf-m / 1,400rpm
	ISO 9249 NET	1,040 N-m / 1,400rpm

■ HYDRAULIC COMPONENTS

Hydraulic pump	Double-pump variable displacement, axial piston + gear pump
Hydraulic motor (swing)	Axial piston motor
Hydraulic motor (travel)	Axial piston motor
Control valve	6-spool multiple control valve + 1-spool control valve (swing)
Cylinders (boom, arm, and bucket)	Double acting cylinder
Return filter	Safety valve containing filter type
Oil cooler	Air-cooled type

■ WEIGHT

Unit : kg (lbs)

Item \ Model		SK310III		SK310LC-III	
Fully-equipped weight		30,100 (66,400)	31,000 (68,400)	30,700 (67,700)	31,700 (69,900)
Upper machinery		13,400 (29,500)	←	←	←
Lower machinery with grouser shoe	600 (24")	11,000 (24,100)	——	11,500 (25,400)	——
	800 (32")	——	11,800 (26,100)	——	12,500 (27,600)
Attachment (10ft-4in) arm + [illegible]	6.47m(21ft-3in) boom + 3.14m [illegible] (cuyd) bucket	5,800 (12,800)	←	←	←

4. TYPE OF SHOES

Shape	Model	Width of track shoe (mm(in))	Overall width of crawler (mm(ft-in))	Ground pressure [kg /cm²(psi)]
Grouser(equal height)  YNK-0-3	SK310IIIC 48 link	600(24")	3,200(10'6")	0.63(8.96)
		800(32")	3,400(11'2")	0.48(6.83)
	SK310LCIII 51 link	600(24")	3,200(10'6")	0.59(8.39)
		800(32")	3,400 (11'2")	0.46(6.54)

NOTE : The 800mm (32") shoes is applied for general civil work, one is used for soft ground operation Do not use them in rough operations, such as gravel and rock digging.

5. TYPES AND COMBINATIONS OF ATTACHMENTS

HOE BUCKET  YNC-5-8

SAE.JIS Heaped capacity m³(cuyd)	Outside width of bucket mm (ft-in)		No. of teeth	Equipped with side cutter	Possibility of turnover	Weight kg (lbs)
	With side cutter	Without side cutter				
1.20 (1.57)	1,240(4'1")	1,120(3'8")	4	Yes	Yes	950 (2,090)
1.40 (1.83)	1,430(4'8")	1,310(4'4")	5	Yes	Yes	1,070 (2,360)
1.60 (2.09)	1,610(5'3")	1,490(4'11")	5	Yes	Yes	1,160(2,600)
1.80 (2.35)	——	1,680(5'6")	5	Yes	Yes	1,200 (2,650)

■COMBINATIONS OF ATTACHMENTS

Bucket			Applicable arm		
Type	SAE·JIS heaped capacity m³(cuyd)	JIS·SAE struck capacity m³(cuyd)	2.55m (8ft-4in) arm	3.14m (10ft-4in) arm	4.1m (13ft-5in) arm
Hoe bucket	1.20 (1.57)	0.84 (1.10)	○	○	◎
	1.40 (1.83)	1.00 (1.31)	○	◎	△
	1.60 (2.09)	1.20 (1.57)	◎	△	×
	1.80 (2.35)	1.40 (1.83)	△	×	×
	——	——	——	——	——

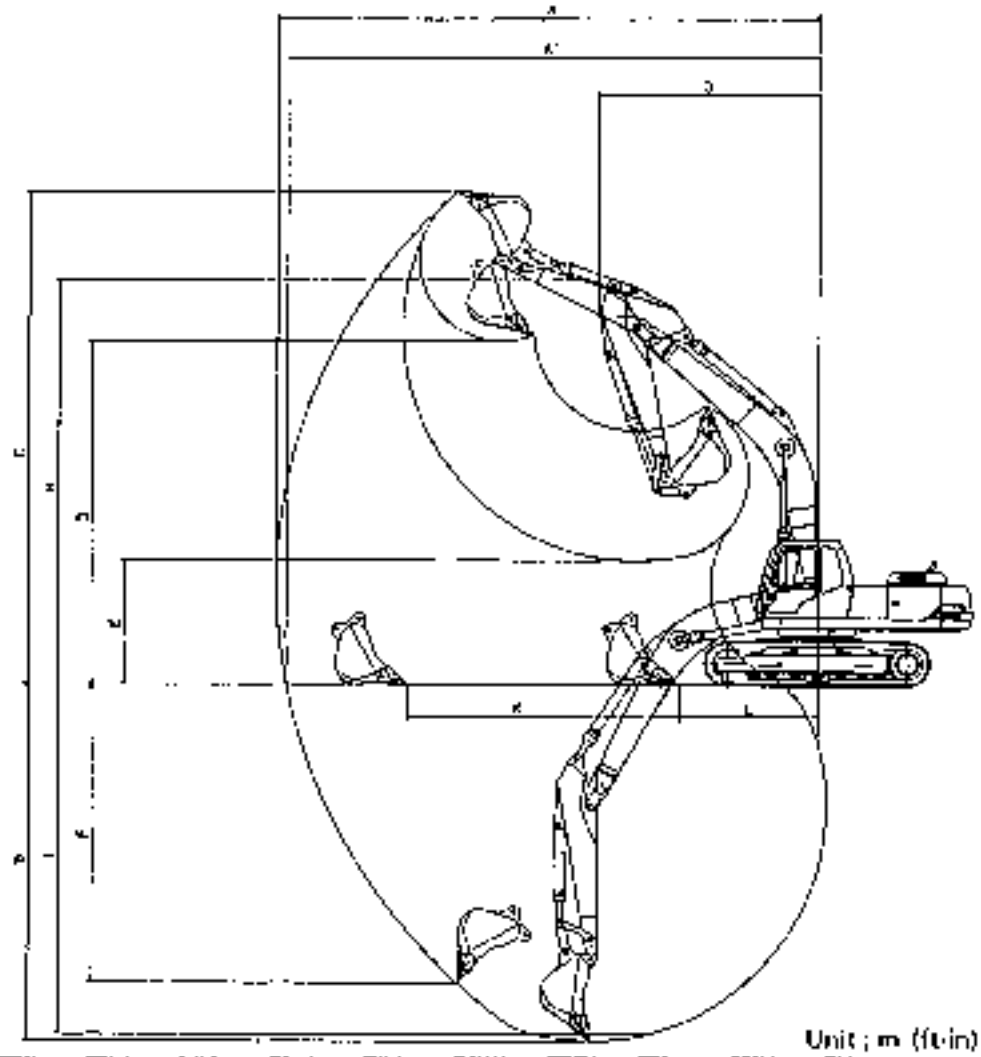
NOTE : ◎ Standard combinations
○ General operation : Digging and loading of sand, gravels and clay-mixed soil
△ Light operation : Operations mainly consisting of loading of loose sand and soil (for instance, operations in paddy fields and loading of sand and gravels)
× Not usable : Do not operate in such combinations as guarantee does not cover them.

⚠ CAUTION

- **If a bucket other than a hoe bucket is used to execute face shovel operation, it will cause damage to the arm and the bucket.**
- **The combinations other than those mentioned in the above table cannot be used in principle. For further details, contact KOBELCO.**

6. WORKING RANGES OF ATTACHMENTS

■ **BACKHOE ATTACHMENT**

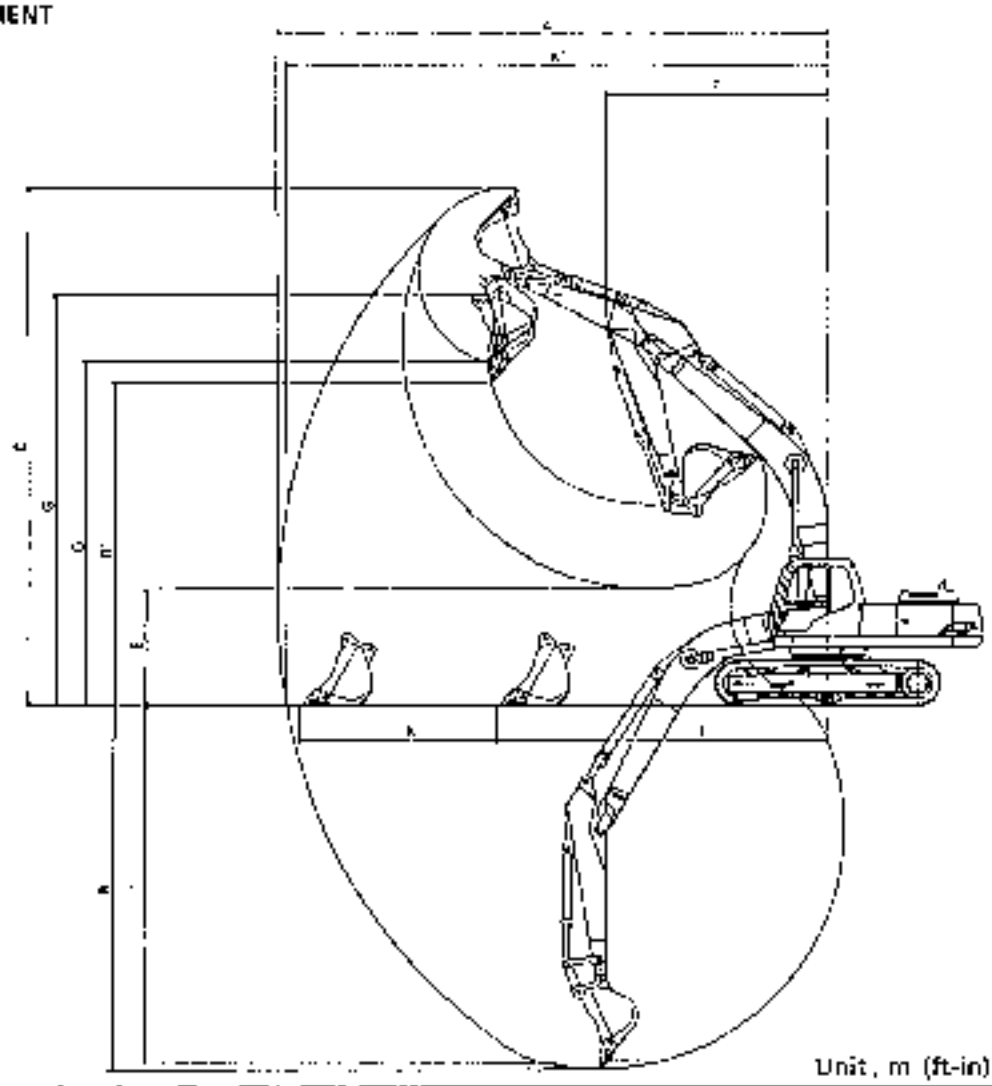


Unit ; m (ft·in)

Item \ Type of attachment			2.55m (8ft4in) arm with 1.60m³ (2.09cuyd) bucket	3.14m (10ft4in) arm with 1.40m³ (1.83cuyd) bucket	4.1m (13ft5in) arm with 1.20m³ (1.57cuyd) bucket
A	Max digging reach		10.60 (34'9")	11.13 (36'6")	11.98 (39'4")
A'	Max. reach at ground level		10.40 (34'1")	10.94 (35'11")	11.80 (38'9")
B	Max. digging depth		6.79 (22'3")	7.38 (24'3")	8.34 (27'4")
C	Max. digging height		10.09 (33'1")	10.27 (33'8")	10.51 (34'6")
D	Max. dumping clearance		6.95 (22'10")	7.15 (23'5")	7.40 (24'3")
E	Min. dumping clearance		3.17 (10'5")	2.59 (8'6")	1.62 (5'4")
F	Max. Vertical digging depth		5.39 (17'8")	6.19 (20'4")	6.98 (22'11")
G	Min. swing radius		4.61 (15'2")	4.53 (14'10")	4.54 (14'11")
H	Height at min. swing radius		8.62 (28'3")	8.43 (27'8")	8.43 (27'8")
I	Digging depth at 8'-flat bottom		6.61 (21'8")	7.22 (23'8")	8.21 (26'11")
K	Horizontal digging stroke	Stroke	4.26 (14'0")	5.60 (18'4")	7.28 (23'11")
L		At min.	3.64 (11'11")	2.82 (9'3")	2.00 (6'7")

NOTE : The figures in this table do not include the grouser of shoes (30mm (1.18in)) .

■ FACE SHOVEL ATTACHMENT



Unit, m (ft-in)

Item / Range			Type of attachment: 2.55m (8ft4in) arm with 1.60m³ (2.09cuyd) bucket	3.14m (10ft4in) arm with 1.40m³ (1.83cuyd) bucket	4.1m (13ft5in) arm with 1.20m³ (1.57cuyd) bucket
A	Max. digging reach		10.74 (35'3")	11.30 (37'1")	12.12 (39'9")
A'	Max. reach at ground level		10.54 (34'7")	11.11 (36'5")	11.94 (39'2")
B	Max. digging depth		6.92 (22'8")	7.55 (24'9")	8.47 (27'9")
C	Max. digging height		10.46 (34'4")	10.70 (35'1")	10.92 (35'10")
D	Max. dumping clearance		6.91 (22'8")	7.03 (23'1")	7.34 (24'1")
D'	Max. dumping clearance (45°)		6.35 (20'10")	6.62 (21'9")	6.63 (21'9")
E	Min. dumping clearance		3.04 (10")	2.42 (7'11")	1.49 (4'11")
F	Min. swing radius		4.61 (15'1")	4.53 (14'10")	4.54 (14'11")
G	Height at min. swing radius		8.52 (27'11")	8.43 (27'8")	8.43 (27'8")
I	Digging depth at 8'-flat bottom		6.75 (22'2")	7.39 (24'3")	8.35 (27'5")
K	Horizontal digging stroke	Stroke	3.01 (9'11")	4.06 (13'4")	5.43 (17'10")
L		At min.	7.30 (23'11")	6.80 (22'4")	6.26 (20'6")

NOTE : The figures in this table do not include the grouser of shoes [30mm (1.18in)].

7. LIFTING—UP ABILITY DIAGRAM

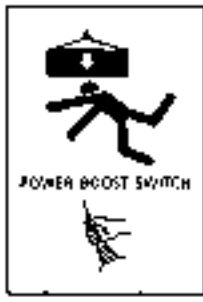
(1) Calculation condition

The lifting-up ability of this drawing is indicated by pound standard. The indicated figures fall within 87% of a set pressure of the main relief valve used in the arm and the boom cylinder and 75% of static tilting load.

1) The load point is the fulcrum of the bucket and the bucket position is an embraced posture.

2) The figures on the upper stage indicate the lifting-up ability of a machine facing sideways, while the figures at the bottom stage represent a machine facing longitudinally.

⚠ Do not use the power boost switch while lifting a load.



⚠ WARNING

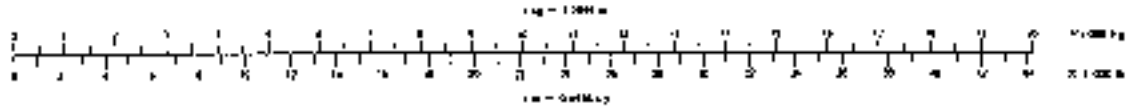
Releasing power boost switch while lifting a load can cause unexpected lowering of load, resulting in severe injury or death.
Never use power boost switch for lifting a load.

YN20T0100491

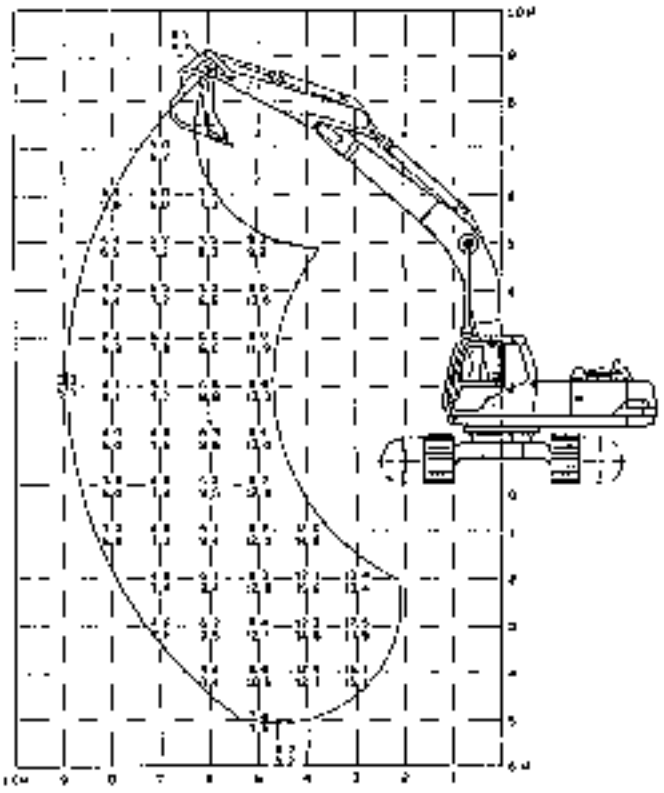
Attached to the right side of the cab interior

(2) Lifting-up ability diagram Item No. table

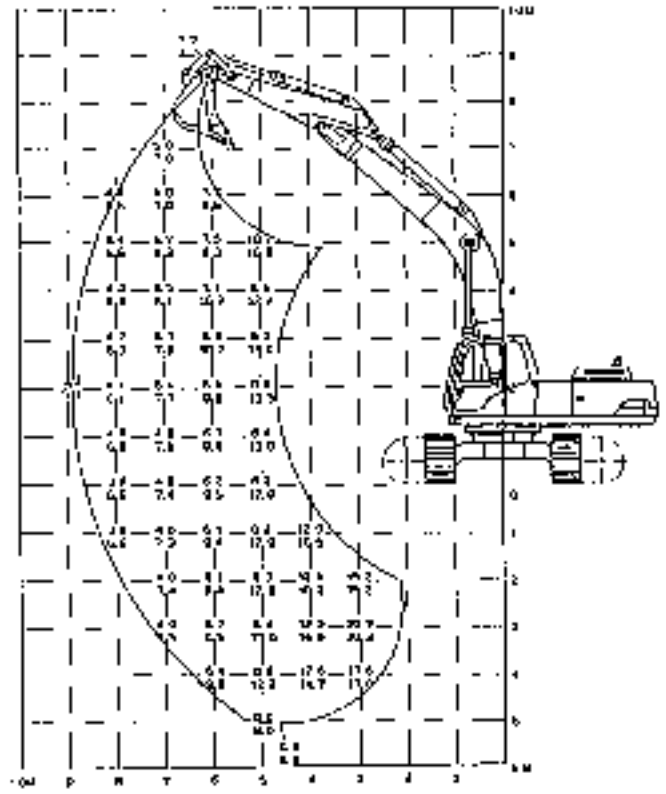
Model	Pressure kgf/cm² (psi)	Arm length (M) + bucket capacity (M³)					
		2.55M+1.60M³ (8ft-4in+2.09cu·yd)		3.14M+1.40M³ (10ft-4in−1.83cu·yd)		4.1M+1.16M³ (13ft-5in+1.52cu·yd)	
		600 (24")	800 (32")	600 (24")	800 (32")	600 (24")	800 (32")
SK310III	300 (4270)	1	5	9	13	17	19
	Heavy lift 335 (4760)	2	6	10	14	—	—
SK310LcIII	300 (3270)	3	7	11	15	18	20
	Heavy lift 335 (4760)	4	5	12	16	—	—



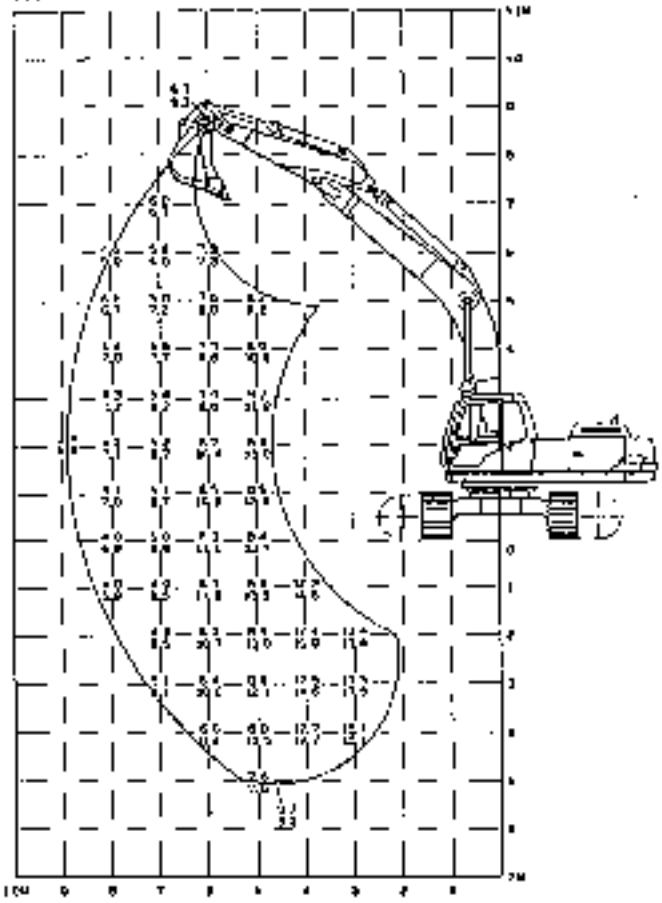
(1) Unit : ton



(2) Unit : ton



(3) Unit : ton



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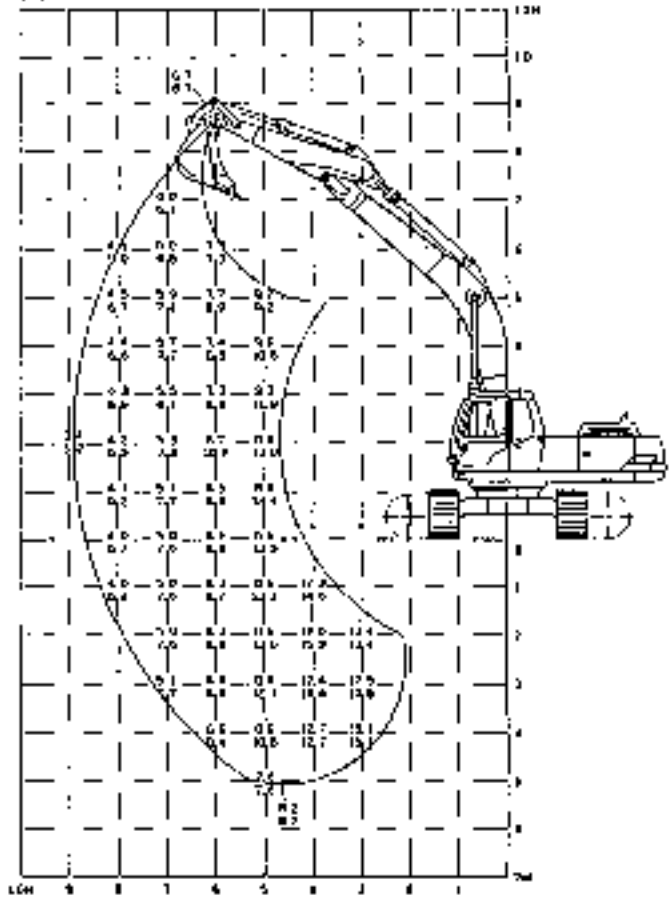

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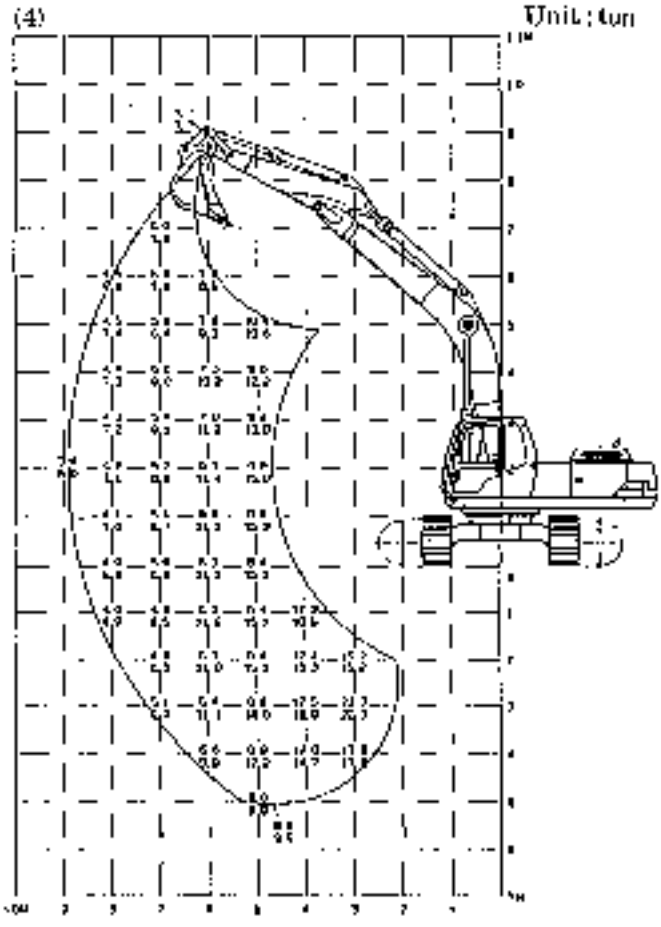
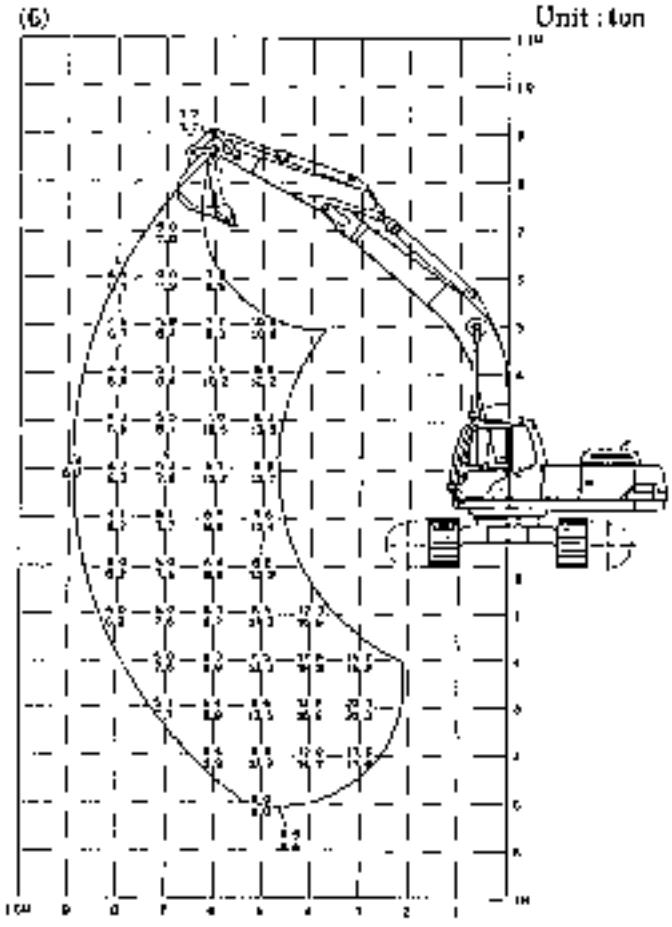


(6) Unit : ton



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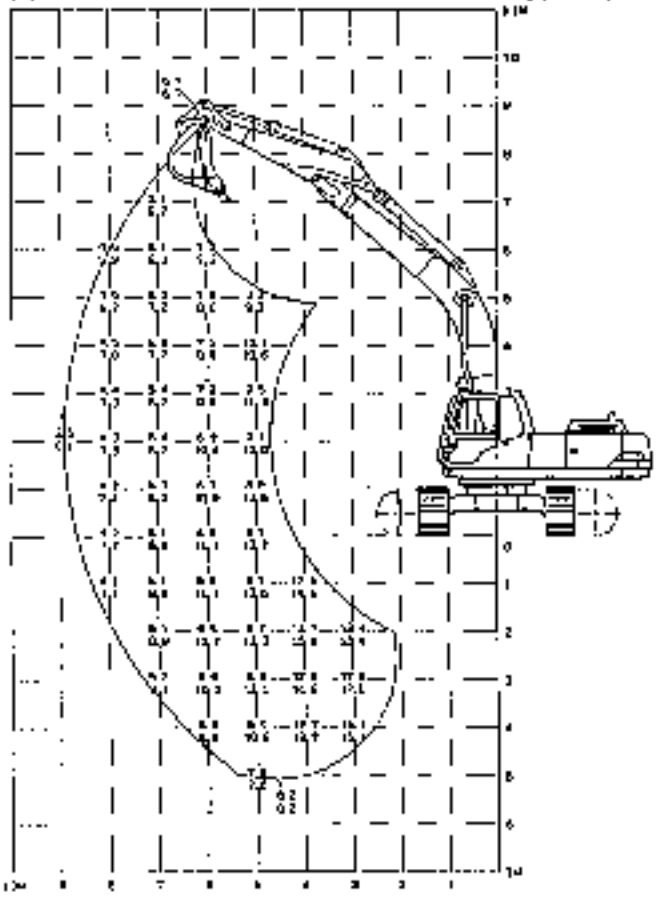

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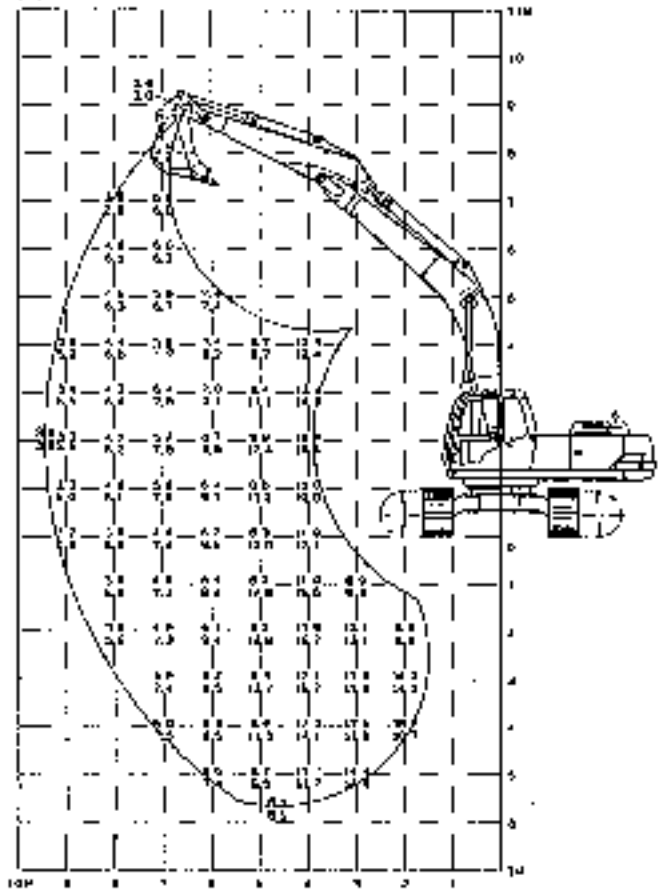
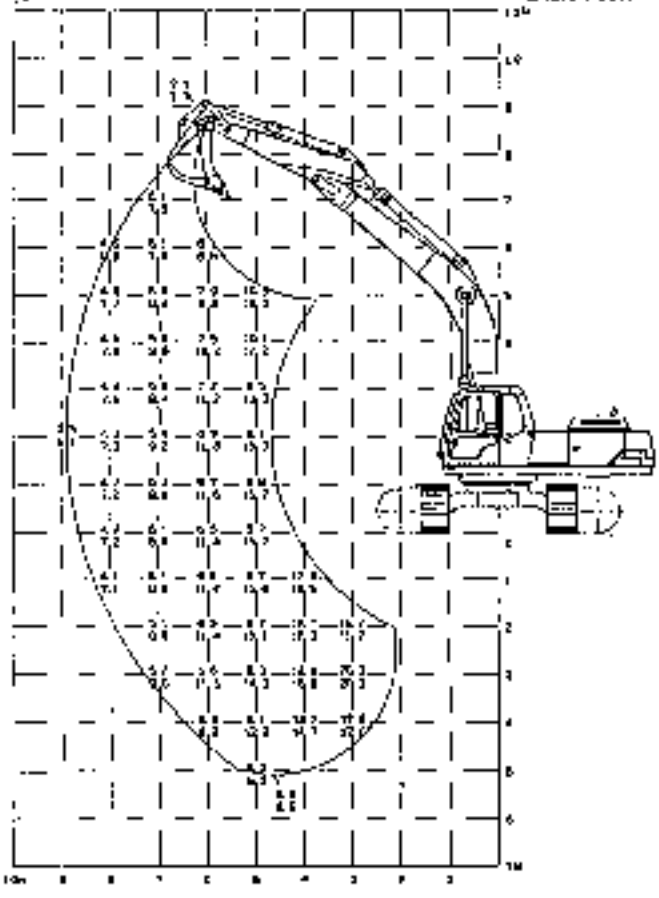
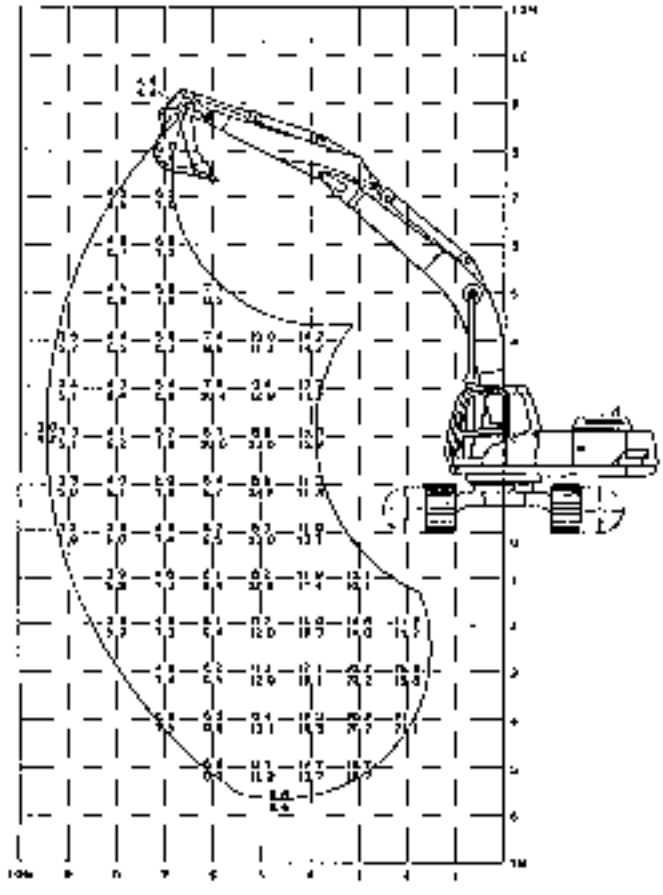


(8) Unit : ton



(10) Unit : ton



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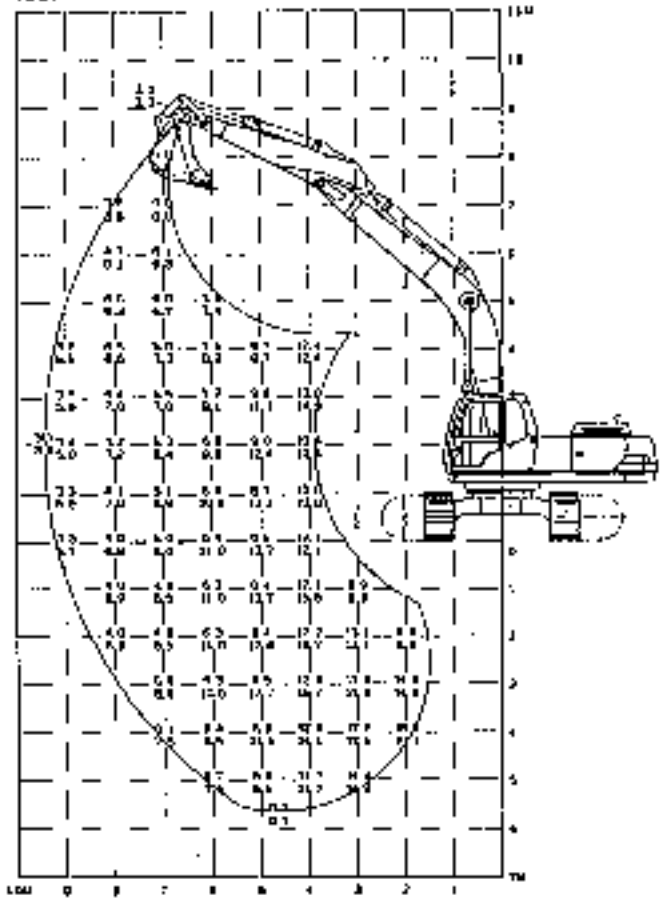

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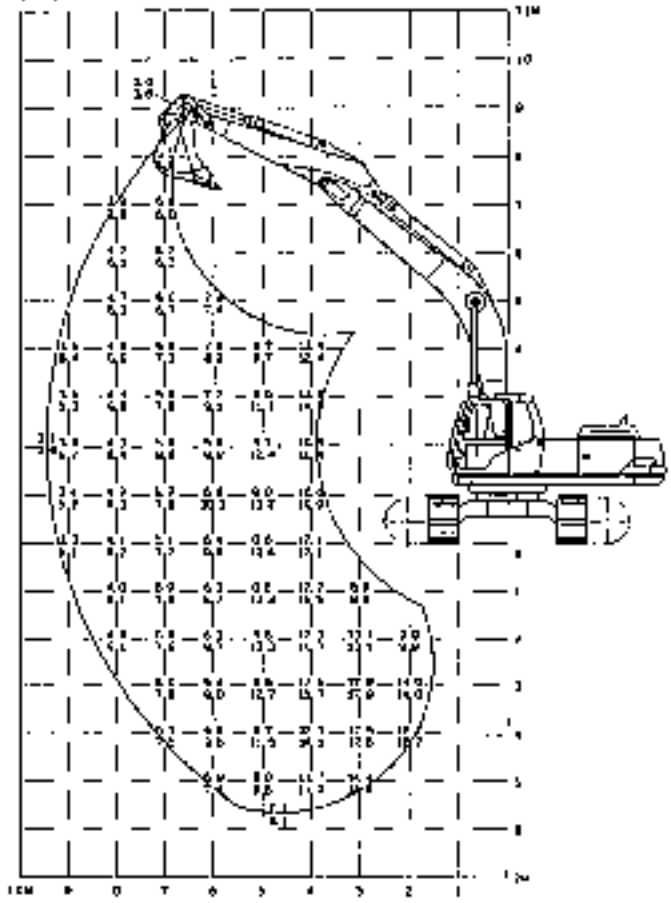
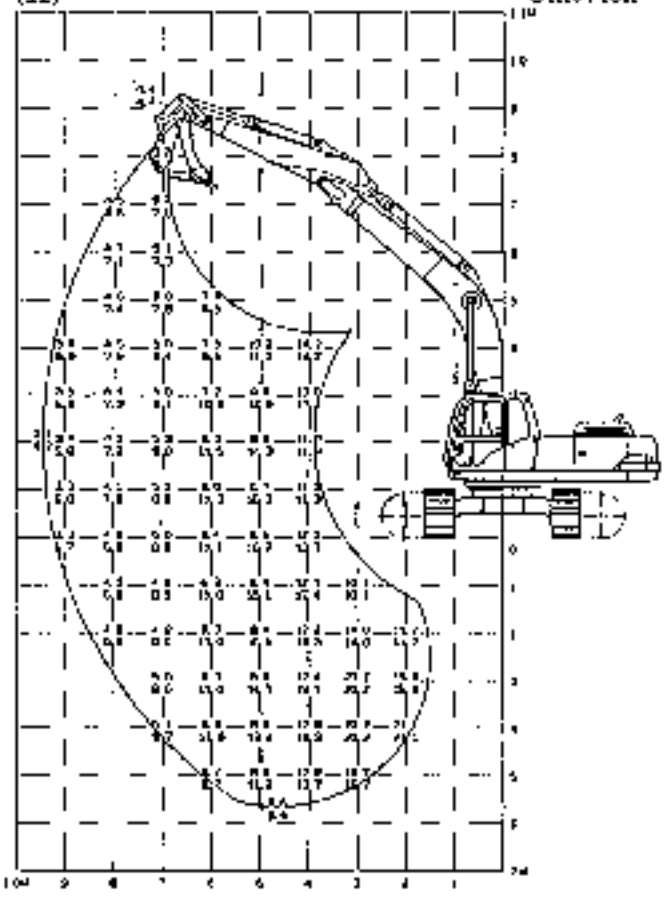
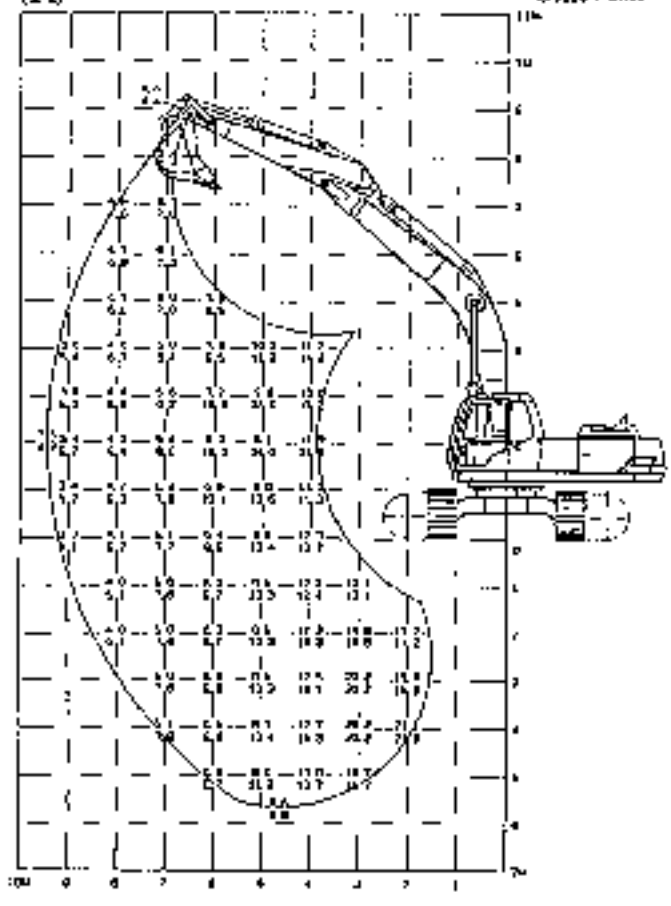


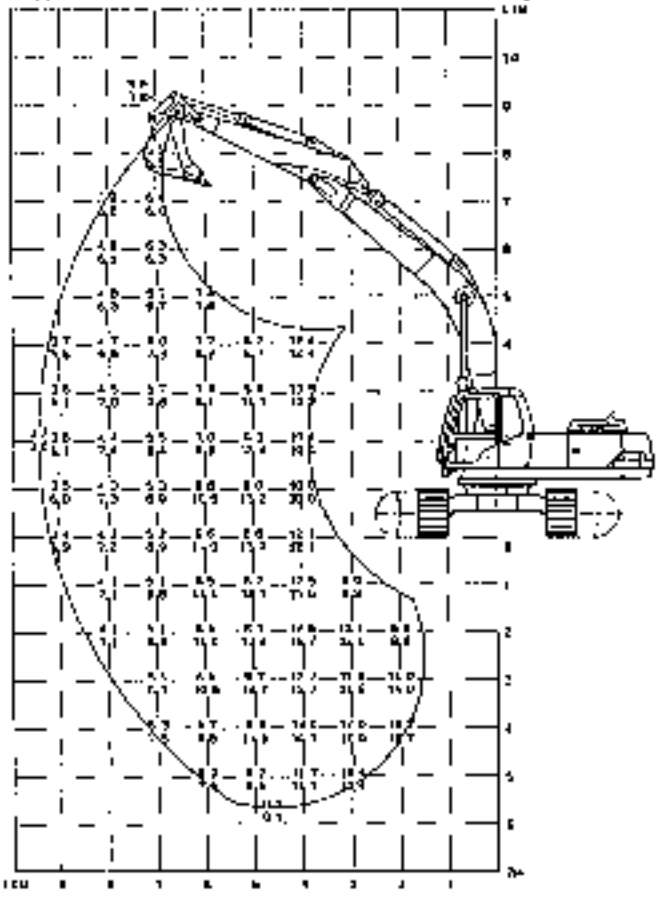
(12) Unit : ton



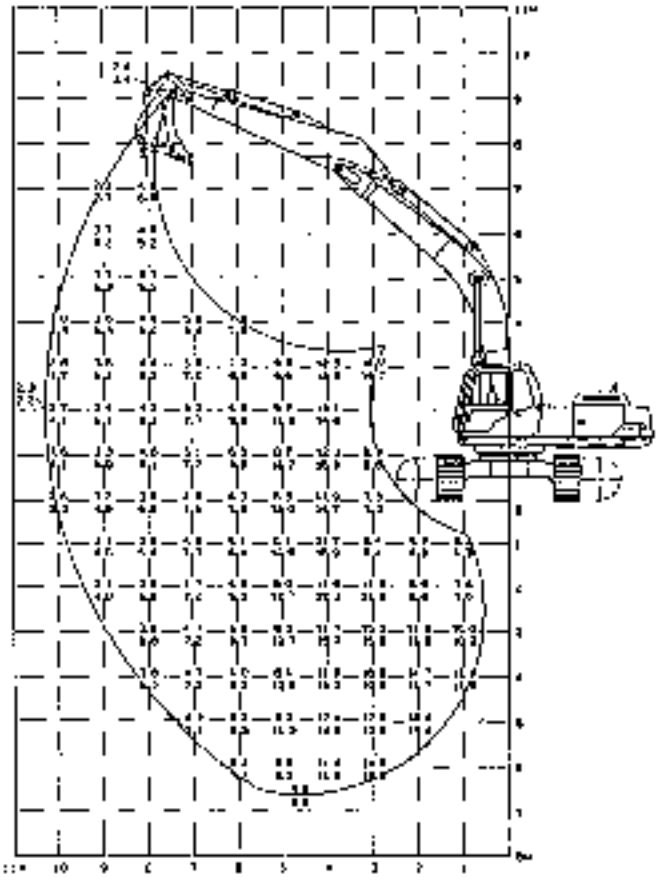
(14) Unit : ton



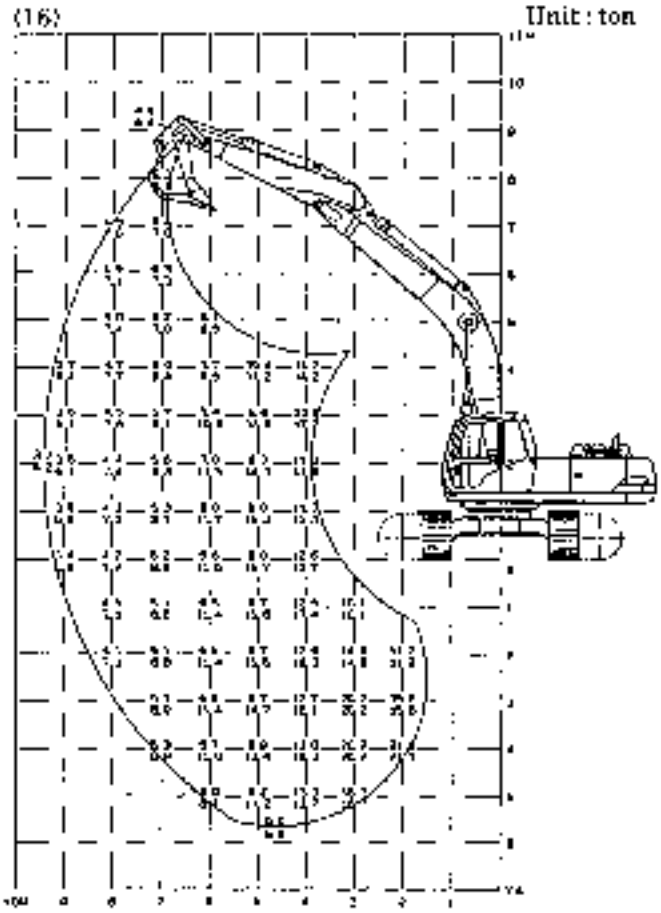
(15) Unit : ton



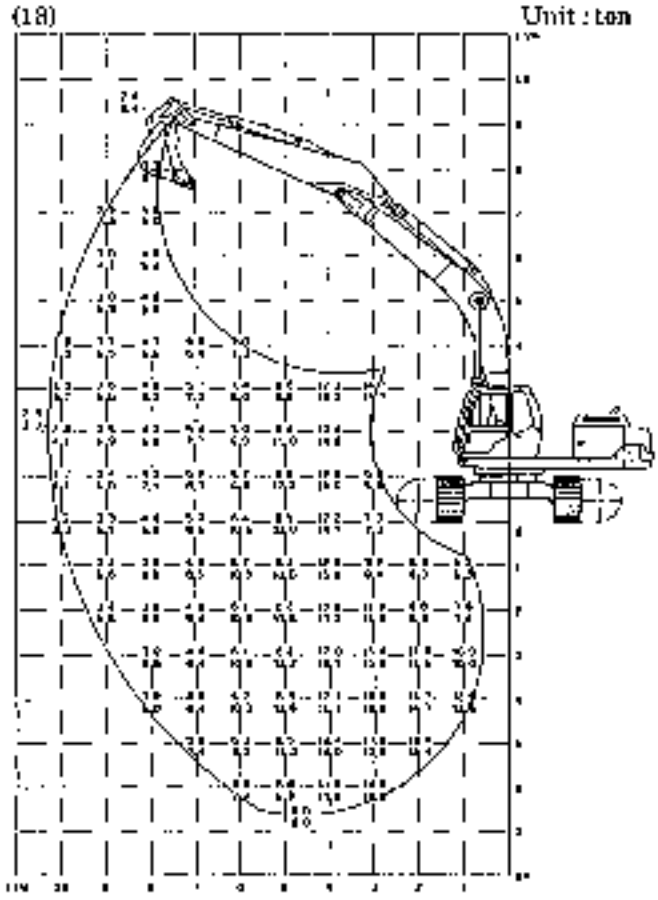
(17) Unit : ton



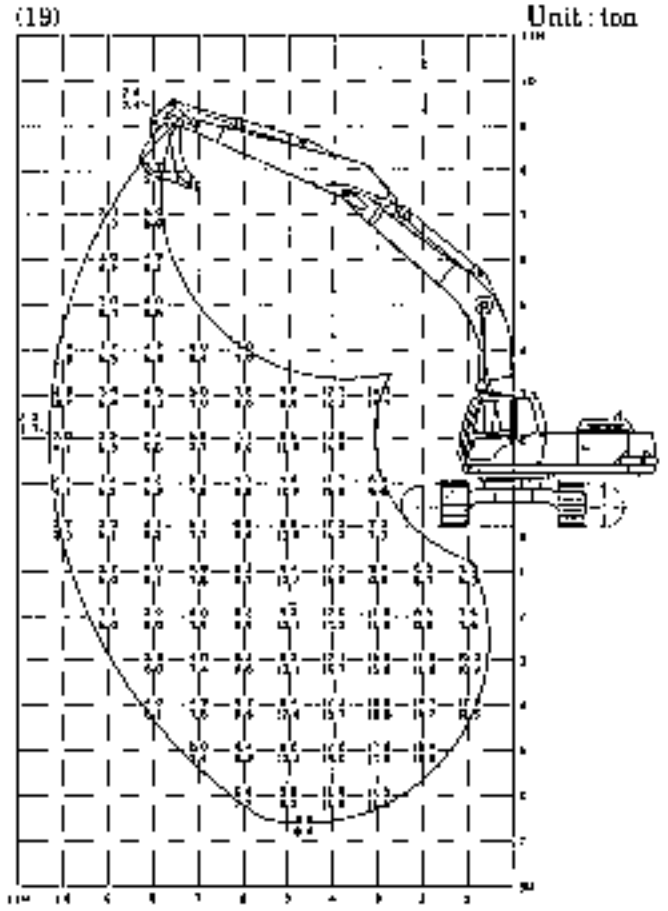
(16) Unit : ton



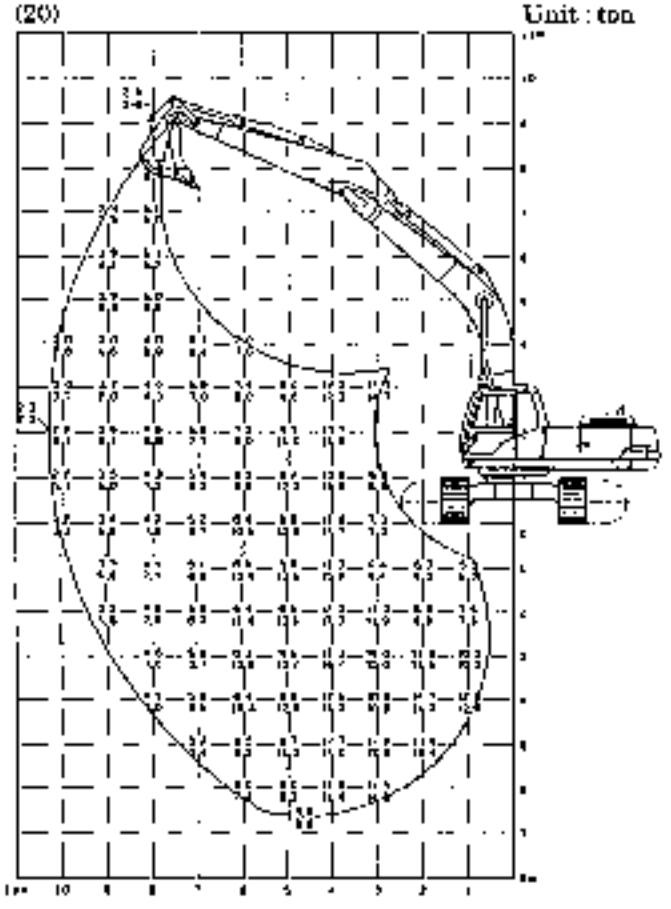
(18) Unit : ton



(19) Unit : ton



(20) Unit : ton



8. ENGINE SPECIFICATIONS

SPECIFICATIONS

SK910Ⅲ , SK910LC-Ⅲ

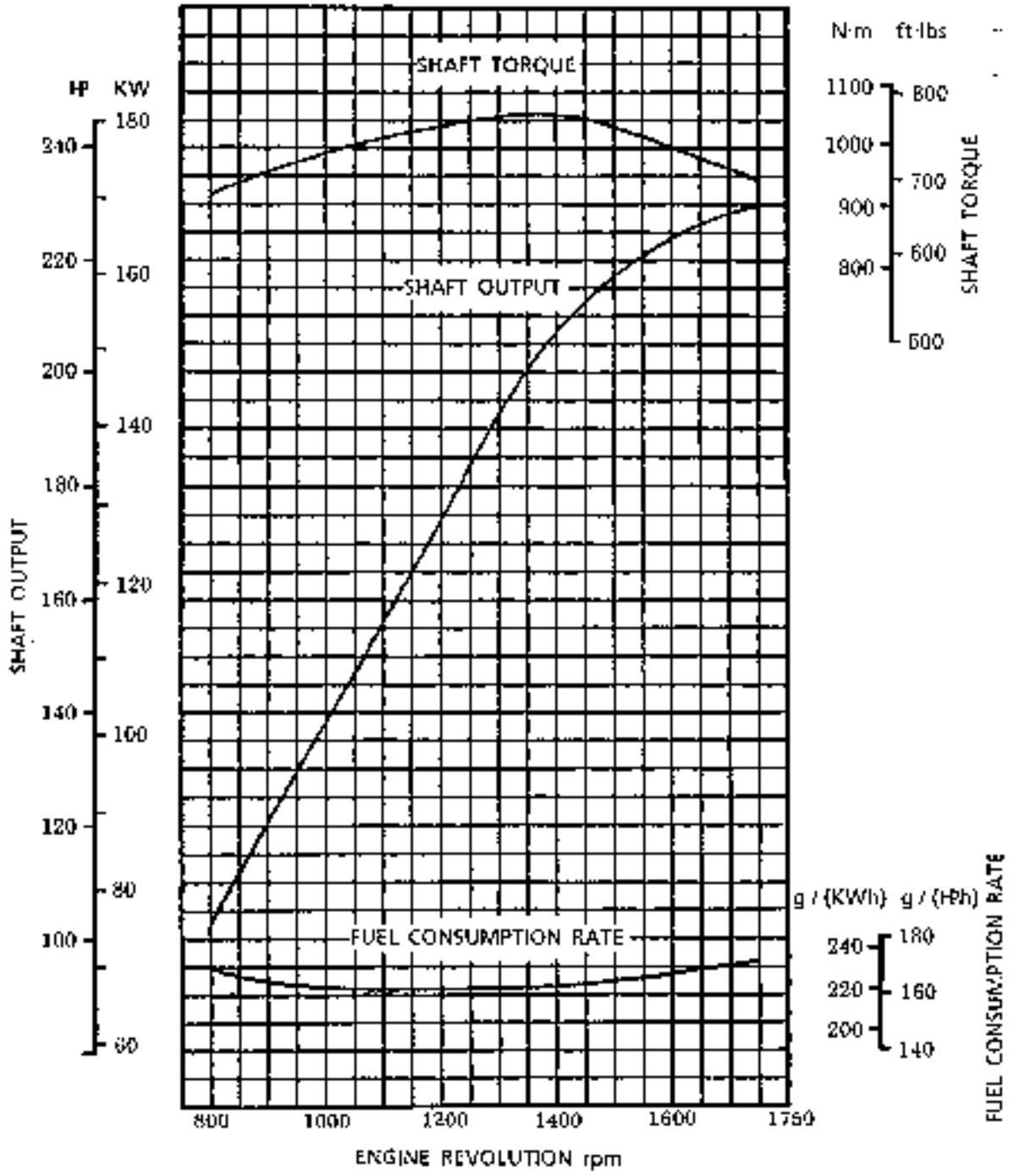
Type		Mitsubishi 6D22-T Diesel engine		
No. of cylinders-Bore×Stroke		6-150mm×140mm (5.12 in×5.51 in)		
Total displacement		11,149cc (680 cuin)		
Compression ratio		16.0		
Output rating		230PS / 1,750 rpm (169kw/ 1,750 rpm)		
Max. torque		101kgf·m (731ft·lbs) / 1,200 rpm		
High idling		1,960±20 rpm		
Low idling		850±30 rpm		
Injection start pressure		180kgf / cm² (2,560psi)		
Thermostat action		Opening 76.5°C Full open 90°C		
Ignition order		1-5-3-6-2-4		
Compression pressure		28kgf / cm² (396psi) at 200 rpm		
Lube oil preseure		Rating 1.5~5kgf/cm² (21.3~71.1psi)		
Fuel injection timing		17°C before the top dead point		
Valve clearance, valve action timing		Valve clearance	Open	Close
	Intake valve	In cold state, in cold condition 0.4mm (0.016")	18° before the top dead point	50° before the bottom dead point
	Exhaust valve	In cold state, in cold condition 0.6mm (0.024")	60° before the bottom dead point	18° before the top dead point
Starter capacity		5.5kw		
Alternator capacity		800W (30A)		
Super Charging type		Turbo type		
Cooling fan drive method		∅700 (∅28in)suction type Belt drive pulley ratio:0.95		
Engine oil volume		Engine body 34ℓ (8.98gal)		
Dry weight		990kg (2,180 lbs)		
Fuel consumption rate		172±3% g/(ps·h)/ 1,750rpm		
Allowable tilting angles		Back and forth, right and left 35°		
Engine dimension L×W×H mm (in)		1,635×901×1,196 (64.3×35.5×47.2)		
Rotating direction		Counterclockwise as seen from flywheel side		

ENGINE CHARACTERISTIC CURVE

(MITSUBISHI 6D22-T)

Atmospheric condition: JIS D1005-1989
Standard atmospheric temperature 298°K (25°C)
Standard dry atmospheric pressure 743mmHg (99kpa)
(Atmospheric pressure 750mmHg (100kpa)
Partial pressure of water steam 7.5mmHg (1kpa));

Auxiliary device: Fan, air cleaner, with alternator, without silencer



$$\text{FUEL CONSUMPTION VOLUME} = \frac{\text{FUEL CONSUMPTION RATE}}{0.835 \times 1000} \times PS \times \text{LOAD RATIO } (\alpha)$$

$$= \frac{172\text{g/HP-h}}{0.835 \times 1000} \times 230\ \text{HP} \times \alpha$$

$$= 47.4\,\alpha\text{-}\ell / \text{h}$$

Book code No. S5LC0305E

KOBELCO

SHOP MANUAL

SK310
SK310LC

LOCATION AND WEIGHT OF COMPONENTS

LC03

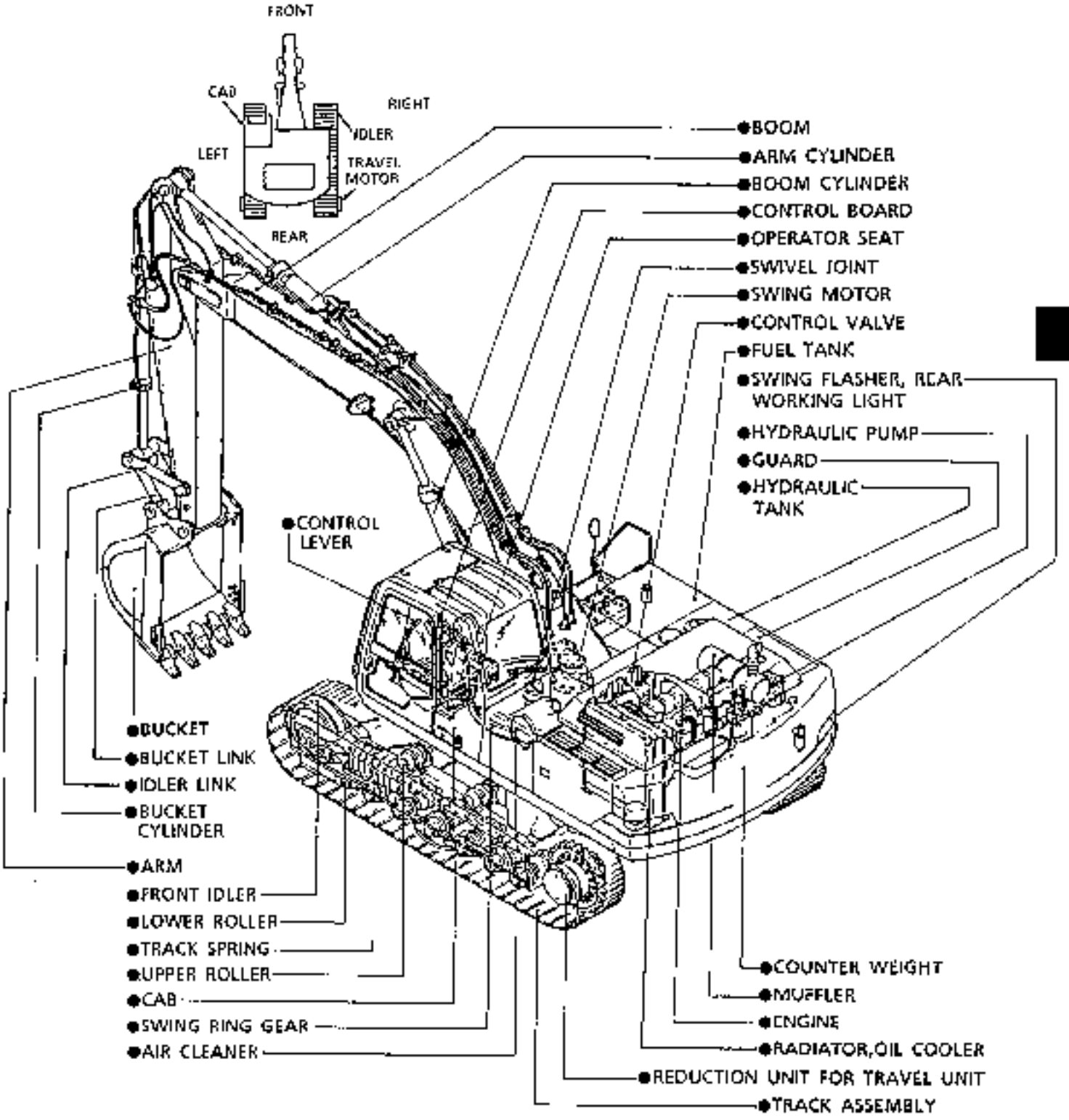
TABLE OF CONTENTS

KOBE STEEL, LTD.

Applicable Machines
LC03801~
YC01101~

Revision	Date of Issue	Remarks
First edition	March, 1995	SMLC0305E K

1. LOCATION OF COMPONENTS



2. WEIGHT OF COMPONENTS

Unit : kg (lbs)

Item \ Model		SK310□□	SK310LC□□
Complete Machine [Std Export 600mm (24") shoe]		30,100(66,400)	30,700(67,700)
Complete Machine [Opt Export 800mm (32") shoe]		31,000(68,400)	31,700(69,900)
1	Upper Frame Assy (incl. 1.1~1.10)	13,400(29,500)	←
1.1	· Counter-weight	6,150(13,560)	←
1.2	· Cab	240(530)	←
1.3	· Boom cylinder	※ 260(570)×2	←
1.4	· Engine	※ 990(2,180)	←
1.5	· Radiator	※ 120(260)	←
1.6	· Pump assy	175(380)	←
1.7	· Control valve	130(290)	←
1.8	· Fuel tank	※ 190(420)	←
1.9	· Hydraulic tank	※ 230(510)	←
1.10	· Swing motor & reduction unit	※ 470(1,040)	←
2	Lower frame assy (incl. 2.1~2.10)	11,000(24,100)	11,500(25,400)
2.1	· Slewing ring	570(1,260)	←
2.2	· Travel motor & reduction unit	640(1,410)×2	←
2.3	· Idler assy	170(370)×2	←
2.4	· Lower roller assy	60(130)×14	60(130)×18
2.5	· Upper roller assy	20(44)×4	←
2.6	· Track tension assy	170(370)×2	←
2.7	· Sprocket	80(180)×2	←
2.8	· Swivel joint	26(57)	←
2.9	· Track gulde	25(55)×2	←
2.10	· Track link with 600mm (24") shoe assy	1,740(3,840)×2	1,850(4,080)×2
	· Track link with 800mm (32") shoe assy	2,190(4,830)×2	2,320(5,120)×2
2.10.1	· · Track link	750(1,650)×2	790(1,750)×2
3.	Attachment (incl. 3.1~3.3)	5,800(12,800)	←
3.1	· Bucket assy [1.40 m^3 (1.83cu yd) STD]	1,060(2,340)	←
3.2	· Arm assy [3.14m (10ft-4in) STD] (incl. following)	1,610(3,550)	←
3.2.1	· · Arm	1,070 (2,360)	←
3.2.2	Bucket cylinder	※ 250(550)	←
3.2.3	· · Idler link	61(130)	←
3.2.4	· · Bucket link	123(270)	←
3.2.5	· · Pin (2 pcs for mounting the arm cylinder and the bucket)	110(240)	←
3.3	· Boom assy (includes the following :)	3,280(7,230)	←
3.3.1	· · Boom	2,742(6,043)	←
3.3.2	· · Arm cylinder	※ 500(1,100)	←
3.3.3	· · Pin (mounting the arm)	38(86)	←
4.	Oil, grease, water, etc. (incl. 4.1~4.4)	900(1,980)	←
4.1	· · Hydraulic oil	350(770)	←
4.2	· Fuel	480(1,060)	←
4.3	· · Water	43 (95)	←
4.4	· · Engine oil	28(60)	←

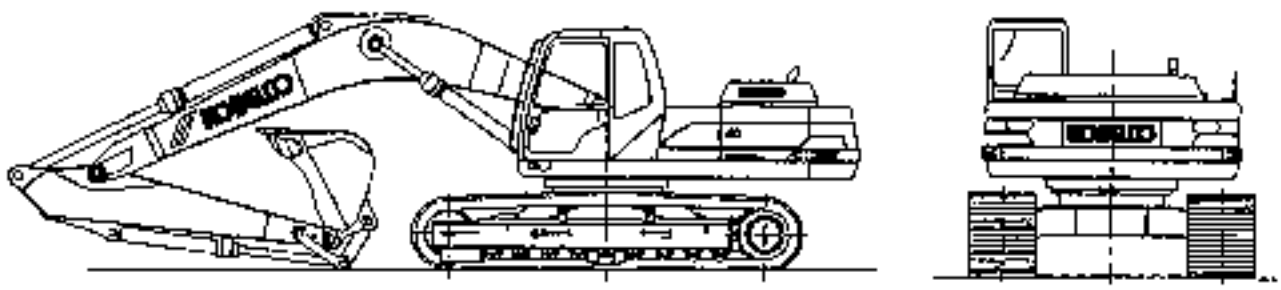
※ Mark dry weight.

3. TRANSPORTATION WEIGHT

● **OVERALL SPECIFICATIONS OF A FULLY-ASSEMBLED MACHINE ON A TRAILER**

Model	SK310□		SK310LC□	
Shoe of type	Width of shoe 600mm (24")	Width of shoe 800mm (32")	Width of shoe 600mm (24")	Width of shoe 800mm (32")
Total width	3,200mm (10ft-6in)	3,400mm (11ft-2in)	3,200mm (10ft-6in)	3,400mm (11ft-2in)
Weight	30.1ton (66,400lbs)	31.0ton (68,400lbs)	30.7ton (67,700lbs)	31.7ton (69,900lbs)

NOTE : With 3.14M (10ft-4in) Arm



● **MACHINE LIFTING**

⚠ CAUTION

Improper lifting can allow load to shift and cause injury or damage.

1. Weight and instructions given herein apply to machine as manufactured by KOBELCO Inc.

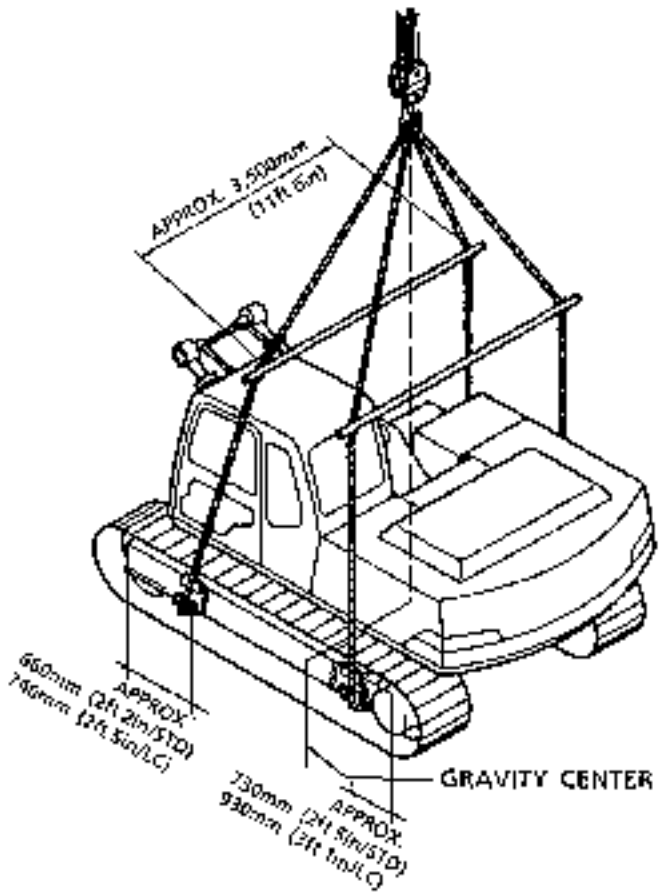
● **LIFTING THE WEIGHT**

Model	SK310□	SK310LC□
Shoe of type	Width of shoe 600mm (24")	Width of shoe 600mm (24")
Width	3,200mm (10ft-6in)	3,200mm (10 ft-6in)
Weight	24.4 ton (53,800 lbs)	24.9ton(54,900 lbs)

2. Use proper rated cables and slings for lifting. Position crane for level machine lift.

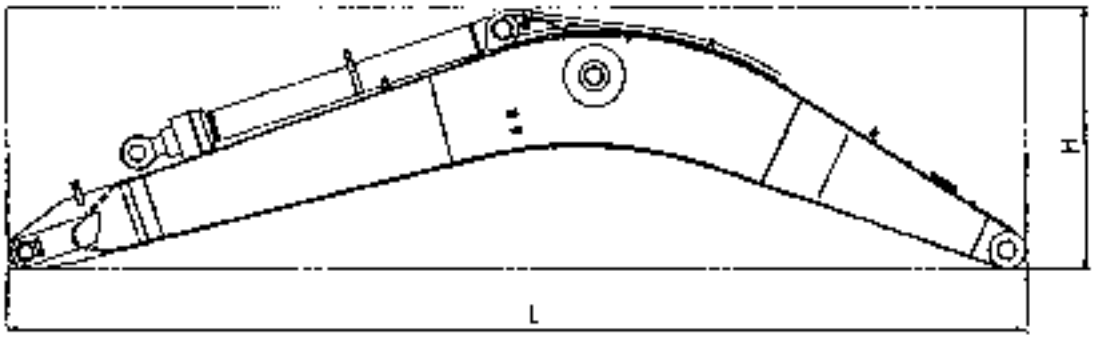
3. Lifting cables should have sufficient length to prevent contact with machine.

4. Use the rear and front eyes on lower frame provided for lifting.



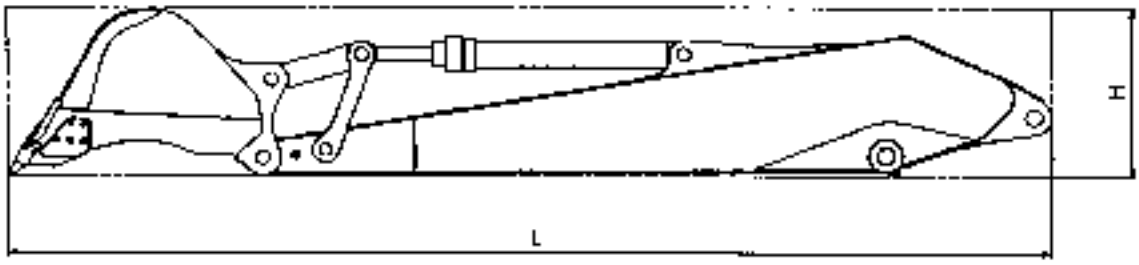
● OVERALL SPECIFICATIONS OF BOOM

	6.47m (21ft-3 in) boom
Total length × total height × total width L×H×W m (ft-in)	6.72×1.72×0.94 (22'1"×5'8"×3'1")
Weight kg (lbs)	2,970 (6,500)



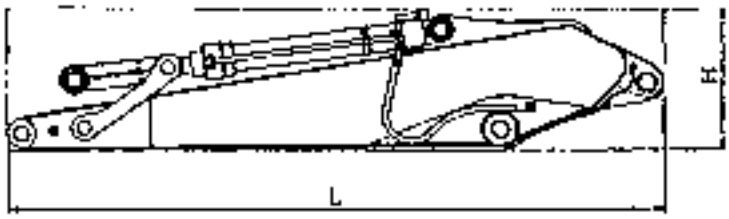
● OVERALL SPECIFICATIONS OF ARM AND BUCKET

Combination	2.55m(8ft-4 in) arm + 1.60m³ (2.09cuyd) bucket	3.14m(10ft-4 in) arm + 1.40m³ (1.83cuyd) bucket	4.1m(13ft-5 in) arm + 1.20m³ (1.57cuyd) bucket
Total length × total height × total width L×H×W m (ft-in)	5.33×1.13×1.61 (17.6"×3'8"×5'3")	5.92×1.13×1.43 (19'5"×3'8"×4'8")	6.89×1.12×1.24 (22'7"×3'8"×4'1")
Weight kg (lbs)	2,690 (5,930)	2,700 (5,950)	2,650 (5,840)



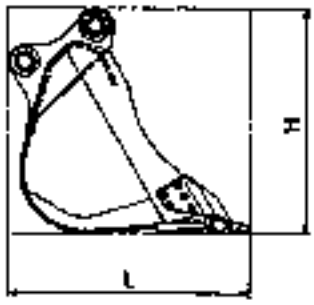
● OVERALL SPECIFICATIONS OF ARM

Length of arm	2.55m(8ft-4in)	3.14m(10ft-4 in)	4.1m(13ft-5 in)
Total length × total height × total width L×H×W m (ft-in)	3.74×1.06×0.55 (12'3"×3'6"×1'10")	4.32×0.95×0.55 (14'2"×3'1"×1'10")	5.30×0.95×0.55 (17'5"×3'1"×1'10")
Weight kg (lbs)	1,540 (3,400)	1,630 (3,590)	1,700 (3,750)



● OVERALL SPECIFICATIONS OF BUCKET

Type	Hoe bucket			
Total length × total height × total width L×H×W m (ft-in)	1.60×1.49×1.24 (5'3"×4'11"×4'1")	1.60×1.49×1.43 (5'3"×4'11"×4'8")	1.60×1.49×1.61 (5'3"×4'11"×5'3")	1.60×1.49×1.68 (5'3"×4'11"×5'6")
Weight kg (lbs)	950 (2,090)	1,070 (2,360)	1,160 (2,540)	1,200 (2,650)
SAE(JIS) Bucket capacity m^3 (cuyd)	1.20 (1.57)	1.40 (1.83)	1.60 (2.09)	1.80 (2.35)



Book code No. 55LC0405E

KOBELCO

SHOP MANUAL

SK310
SK310LC

MAINTENANCE STANDARDS AND TEST PROCEDURES

TABLE OF CONTENTS

LC04

KOBE STEEL, LTD.

Applicable Machines
LC03801~
YC01101~

Revision	Date of Issue	Remarks
First edition	March, 1995	S5LC0405E K

1. HOW TO USE THE MAINTENANCE STANDARD AND CAUTIONS TO BE EXERCISED

(1) Application

1) When the machine is new ;
Confirm that the performances are in accordance with standard specifications as compared to the performance standards

2) At specific self inspection ,
Use the data for the criterion, for the purpose of correction, adjustment and replacement

3) When performances are deteriorated ;
Determine whether it is caused by a fault or end of service life after long hours of operation, to be used for safety and economical considerations.

4) When main components are replaced :
For example, use data to restore performances of pumps and others.

(2) Terminology

1) Standard values ;
Values to be used to condition or assemble a new machine. Where special notes are not given, these values represent standard specifications (machine with standard attachments and standard shoes)

2) Reference values for remedy ;
Values at which readjustment is required. Adjust immediately if the value is close to the service limit value.

3) Serviceability limit ;
This is the limit value at which reconditioning is impossible without replacement of parts. If the value is expected to exceed the service limit before next inspection and correction are performed, replace the parts immediately. If the part is used beyond the limit, chances of trouble increase, ultimately resulting in a breakdown of the machine. Avoid operating the machine beyond this service limit.

(3) Cautions to be Exercised at Judgment

1) Evaluation of measured data ;
Disagreement of measuring conditions, variations of data peculiar to a new machine, and measuring errors are to be evaluated. Determine generally at what levels measured values are located, instead of determining whether or not values fall within or run out of the reference values.

2) Determining correction, adjustment or replacement ;
Machine performances deteriorate with time as parts wear and some deterinrated performances may be restored to new levels of machine. Therefore, determine correction, adjustment or replacement, depending upon the operating hours, kind of work and circumstances in which the machine is placed, and condition the machine performances to its most desirable levels.

(4) Other Cautions to be Exercised

1) Parts liable to degrade ;
Rubber products, such as, hydraulic hoses, O rings, and oil seals deteriorate with time ; replace them at regular intervals or at overhauls.

2) Parts requiring regular replacement ;
The hoses that are necessary to secure safety, we designate very important parts (V.I.P) and recommend that they should be replaced regularly.

3) Inspection and replacement of oils and greases :
In performing maintenance, it is necessary for the user to familiarize himself with how to handle the machine safely, cautions to be exercised and inspection / lubrication procedures.
Refer to the operators manuals as well.

2. MEASURING HYDRAULIC PRESSURE

2.1 PERFORMANCE INSPECTION STANDARD (SK310-III, SK310LC-III)

Table 1

(NOTE ; Take measurement in the H mode, unless otherwise specified.
The standard tolerance shall be an allowable range in field measurements.)

Inspection item				Pressure measurement: Position	Site	Port	Specification		Unit	Adjusting point	Measuring Condition, Function
Standard measuring condition	Cleanliness of hydraulic oil			Hydraulic oil tank			NAS 7 – 9		Class	–	Sampling
	Temperature of hydraulic oil			Tank surface			45 ~ 55	(113 ~ 131)	°C (°F)	–	Ambient temperature -10°C ~ 50°C (14°F ~ 122°F)
	Coolant temperature			Radiator surface			80 ~ 90	(140 ~ 194)		–	
	Engine controller	Low idle		Multi display			850 ~ 900		rpm	No Adjustment	Full throttle
		H or S mode Hi idle					1980 ~ 1970				
		S Mode					1650 ~ 1750				
		PT mode					1350 ~ 1450				
		Auto-accel					1000 ~ 1500				
Pilot circuit	Primary pressure			Gear pump		PP	50 ~ 53	(710 ~ 750)	kgf/cm² (psi)	PR1	H Mode, E/G Hi idle
High pressure circuit	Main relief pressure	Travel					350 ~ 355	(4980 ~ 5050)		TR1	H Mode, E/G Hi idle
										TR2	Simultaneous RH/LH
		Attachment	Boost Pressure				340 ~ 345	(4830 ~ 4910)		MR1	Bucket digging
										MR2	Boom raising
							330 ~ 335	(4270 ~ 4340)		MR1	Bucket digging
										MR2	Boom raising
	Port relief pressure	Bucket					320 ~ 325	(4550 ~ 4760)		BV8	Bucket discharge
							330 ~ 340	(4550 ~ 4860)		BV7	Bucket digging
		Boom					320 ~ 325	(4550 ~ 4760)		BV6	Boom lowering
							330 ~ 336	(4550 ~ 4690)		BV5	Boom raising
		Arm					320 ~ 330	(4550 ~ 4690)		BV10	Arm retracting
							330 ~ 335	(4550 ~ 4760)		BV9	Arm digging
		Swing					285 ~ 295	(4190 ~ 4020)		BV11 BV12	Bucket fuck
		Travel	R.H.				350 ~ 360	(4980 ~ 5120)		BV14 BV13	H Mode, E/G Hi idle Simultaneous RH/LH
			L.H.				350 ~ 360	(4950 ~ 5120)		BV13 BV14	
	–	–					–	–		–	–
										–	
Low pressure relief	–	–					–	–		–	–
										–	
	Negative control pressure	–					P11 P12	32 ~ 42	(455 ~ 570)	–	H Mode, E/G Hi idle
		–					–	–		–	–
Proportional solenoid valve	Variable loading mode						P2	17 ~ 18	(240 ~ 255)		S Mode, E/G Hi idle volume switch up & low
								11.5 ~ 12.5	(165 ~ 180)		
	KDSS	H-S-BC-B		Gear pump			a1	0 ~ 3	(0 ~ 43)	–	E/G Hi idle
		Release						10.3 ~ 16.3	(145 ~ 230)	–	
		Boost						32 ~ 40	(455 ~ 570)	–	

3. MECHATRONIC ADJUSTMENTS

3.1 MECHATRONIC ADJUSTMENTS

If part is to be replaced	Perform	
	Adjust A	Adjust B
Mechatronic controller (KPSS)	○	○
Stepping motor	○	—
Electromagnetic proportional reducing valve for loading mode	—	○

When the above-mentioned parts have been replaced, do not fail to perform mechatronic adjustment. That is to say, adjustment A refers to the adjustment of engine revolution, while adjustment B represents the adjustment of the loading mode. These adjustments consist of adjustment procedure, adjustment timing, etc. Always observe the following procedures for adjustment.

3.2 PREPARATION

1) Warm up the engine.
2) Stop the engine and place the key to "OFF" position.

NOTE : Confirm the E/G manual stop knob is pushed in.

⚠ The power supply turns off four seconds after the engine key is turned to "OFF". Be careful if the engine key is set to "OFF" while performing mechatronic adjustment. If the internal adjusting switch (3 of Fig. 2) is moved over when the power is on, adjustment data may be lost.

3) Remove the cover from KPSS controller.
4) Before performing each adjustment, turn the switch on the mechatronic controller toward "TEST" with the engine key switch OFF.
This is common to both the A and B adjustments.
If you turn on the engine key switch with the engine stopped and the controller switch at "TEST", the auto accel lamp (LED on the cluster gauge) lights continuously. Lighting of the lamp confirms that the switch is at "TEST".

A. ADJUSTMENT START CONDITIONS (1)

① Internal adjustment switch	Test.
② Working mode	H mode
③ Auto accel	ON
④ Accel potentiometer	Low idling
⑤ Engine	Stop (Key ON position)

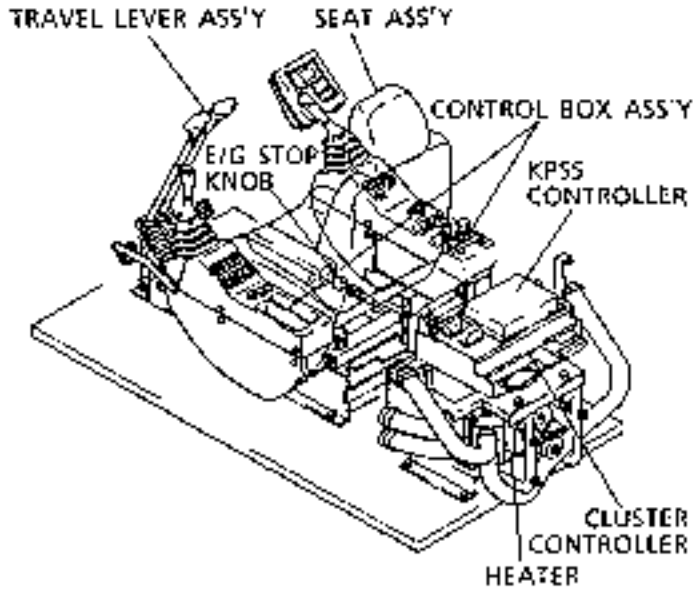


Fig. 1 Location of KPSS controller

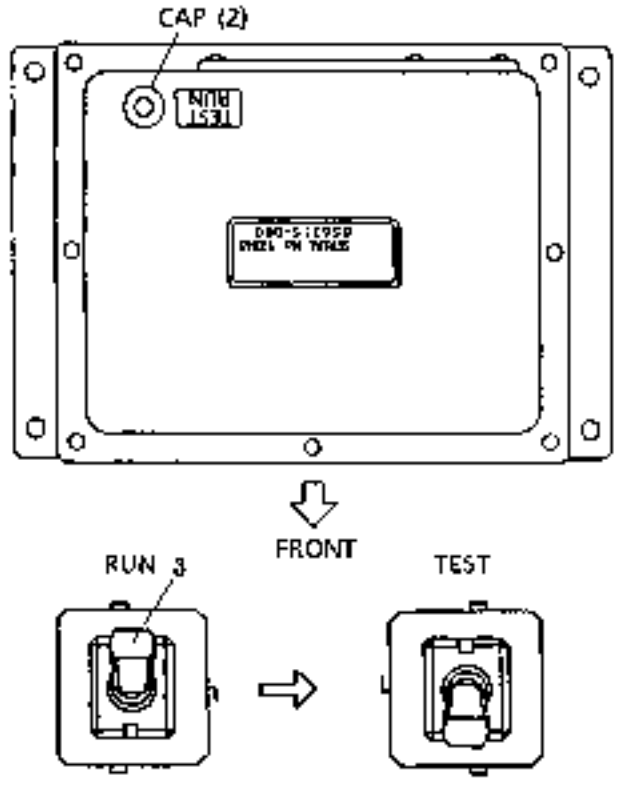


Fig. 2 KPSS controller

3.3 A ADJUSTMENT PROCEDURE

<Positioning E/G Low idle>

1) Draw out the 1P coupler of the controller.
2) Joint the adjust harness with the coupler.
3) Set the adjustment start condition.
4) Press the adjust harness switch for 3 to 5 seconds and let it free.
   If the adjust harness switch is not equipped, pull out 1P coupler and reconnect after 3 to 5 seconds.
5) On that occasion, CPU is displayed on the multi display.
   At the same time, the governor motor is fixed in the E/G Low idle position.
6) If the switch is pressed for more than five seconds or where the adjustment condition is wrong, the display returns to the clock display. In that case, set the adjustment condition correctly once again.
7) Adjust dimension A of the governor motor
   Tighten the locknut when the clearance between the governor lever and the engine stop bolt is 0.1mm (0.004in). After tightening the locknut, make sure of the clearance again. In case the clearance is not 0.1mm (0.004in), loosen and adjust the locknut once again.

7	Governor
8	Stepping motor lever
9	Adjusting rod
10	Stepping motor
11	Emergency stop cable
12	High idle set screw
13	Engine stop setscrew

This completes the positioning of the E/G Low idle position.

<Positioning E/G High idle>

1) Push the adjusting harness pushbutton or pull out 1P coupler, electric power to the stepping motor is cut off, making the stepping motor free.
2) Put a 0.2mm (0.008in) feeler gauge between the high idle setscrew. Move the now freed governor lever and press it hard against the feeler gauge so the lever contacts the setscrew.

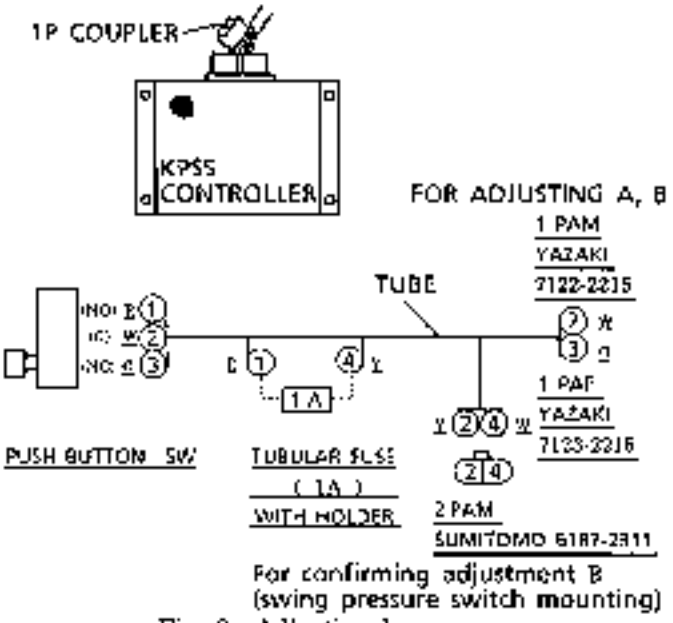


Fig. 3 Adjusting harness

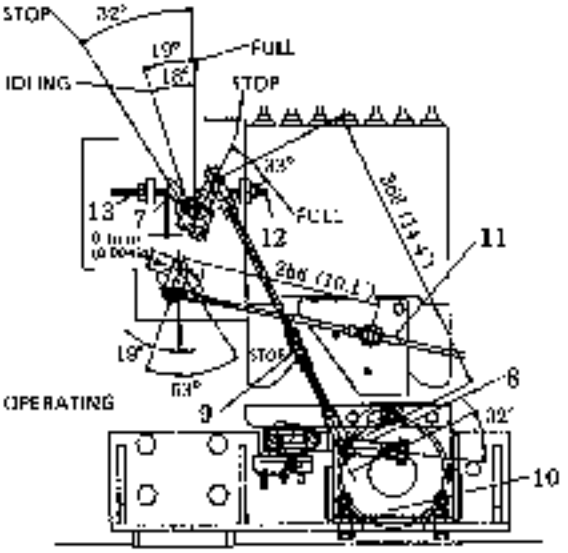


Fig. 4 Engine stop position

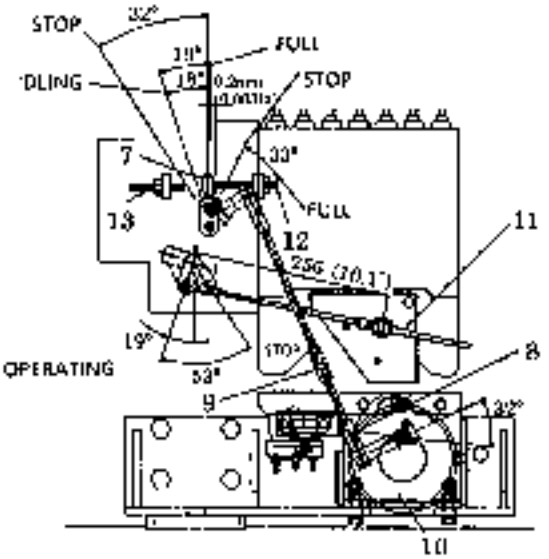


Fig. 5 Engine high idle position

3) With the governor lever pressed, push the adjusting harness pushbutton. (Momentary switch) on pull out 1P coupler. So electric power is now supplied to the stepping motor whereby it is fixed in the high idle position.
4) After the lever is fixed in the high idle position, make sure of the clearance of 0.2mm (0.008in)
5) If the clearance is out of the clearance standard, clearance adjustment may be carried out, as follows :
   When the clearance is large ;
   If the auto accel switch is turned on and the buzzer stop switch is pressed one time, the clearance decreases by about 0.04mm (0.002in).
   When the clearance is small ;
   If the auto accel switch is turned off and the buzzer switch is pressed once, the clearance increases by about 0.04mm (0.002in).
6) If the adjusting harness pushbutton is pushed or 1P coupler pulled out after the clearance adjustment, the stepping motor memorizes the high idle position and returns to the start position.
7) Memorization is complete when the indication on the multi display has changed from [CPU] to [Time].

This completes the positioning of the E/G High idle position.

※ The adjust harness switch is of momentary type with a normally closed contact; it is opened if the switch is pressed and it is shorted if the switch is let free.
   Where there is no adjust harness provided, disjoint the 1P coupler, instead of pressing the switch. Joint the 1P coupler instead of turning off the switch.

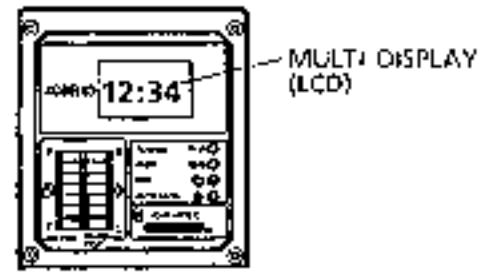


Fig. 6 Time indication on multi display

Fig. 7 CPU indication on multi display


Fig. 8 Auto accel select switch

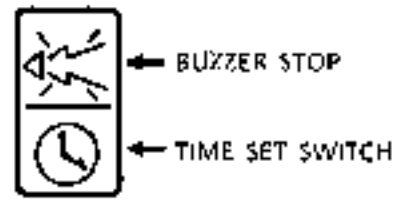


Fig. 9 Buzzer stop switch

(3) Setting (matching) the engine revolutions.

1) Run the engine until, the E/G coolant temperature rises to the standard 75±15°C (167±27°F).

2) Reset the adjustment A start condition (2).

3) Depress the adjustment harness pushbutton and release it after 3 to 5 seconds when CPU is displayed.

4) It takes about three minutes for the stepping motor to increase from a speed range lower than low idle to the high idle automatically. The controller reads the change in revolution and stores it.

- [CPU] is indicated on the multi display when the stepping motor is running itself. If [Time] is indicated, the adjustment condition may be wrong or the pushbutton adjustment timing is out of standard. Repeat the engine revolution setting procedure once again.

5) This completes adjustment A. Turn the engine key to OFF, disconnect the 1P coupler for the adjusting harness and reconnect the 1P coupler for the controller.

6) Last return the internal adjustment switch in the controller to the "RUN" side without fail and refit controller cap (2) (Fig. 2).

3.4 B ADJUSTMENT PROCEDURE

(1) Procedure for setting the secondary pressure of loading mode electromagnetic proportional reducing valve.

1) Raise the temperature of the hydraulic oil to 50±5°C (122±9°F).

2) Remove plug a4 at the secondary pressure port PZ of the loading mode electromagnetic proportional reducing valve attached to the main pump. Then install a 70kgf/cm² (1000psi) pressure gauge. (Fig.15)

3) After making sure that the engine key is "OFF", pull out the 1P coupler of the KPSS controller and connect the 1P coupler for the adjusting harness.

4) Set the internal adjusting switch of the KPSS controller to the test side. (Fig. 2)

5) Set the adjustment B start condition.

6) Depress the adjustment harness pushbutton and release it after 3 to 5 seconds.

- If [CPU] is indicated on the multi display, it means that the ADJ. mode has been entered. If [Time] is indicated instead of [CPU], the adjustment condition is wrong or pushbutton adjustment timing is off. Repeat the adjustment procedure once again.

A. Adjustment start conditions (2)

Internal adjustment switch	Test
Working mode	II mode
Auto accel	OFF
Accel potentiometer	Low idle
Engine	Running

Self run (about three minutes)

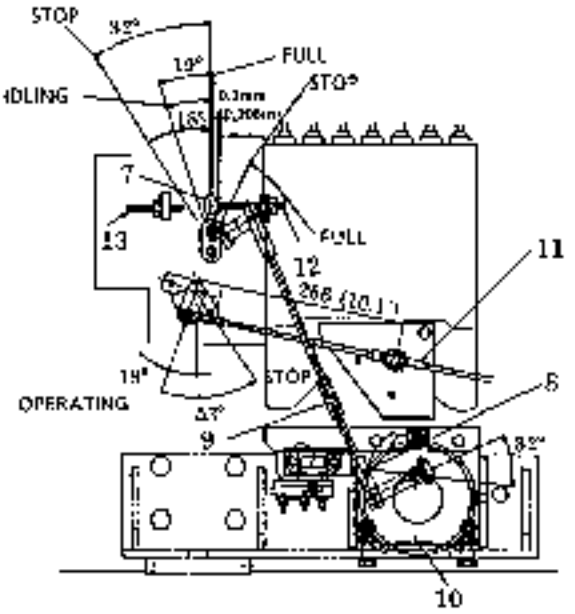


Fig. 10 Self running of stepping motor

B. Adjustment start conditions

Internal adjustment switch	Test
Work mode	S mode
Auto accel	OFF
Accel potentiometer	Hi idle
Engine	Running

Fig. 11 Secondary port PZ of electromagnetic proportional reducing valve for loading mode

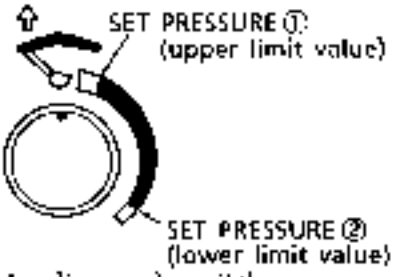


Fig. 12 Loading mode switch

7) Raise the boom fully and hold in this position (operating lever at full stroke).

8) Turn the loading mode switch from the upper limit to the lower limit (little by little) and read on the pressure gauge, the change in the secondary pressure of the electromagnetic proportional reducing valve. (Pressure decreases by clockwise turning and increases by counter-clockwise turning.

9) When the secondary pressure has reached the upper standard set value (close to the black mark of the upper limit), press the adjusting harness pushbutton. The upper limit value is stored now.

10) Then, turn the loading mode switch close to the lower limit block mark and when the secondary pressure arrives at the standard lower limit set value, push the adjusting harness pushbutton.
This stores the lower limit value.

- The indication on the multi display changes form [CPU] to [Time].

11) This completes adjustment B. Turn the engine key to [OFF]. Disconnect the 1P coupler for the adjusting harness and reconnect the 1P coupler for the controller.

12) Lastly, pull the internal adjusting switch in the controller to this side (RUN) and refit the controller cap (2) back in place with the key in the off position. (Fig. 3)

Set standard pressure of electromagnetic proportional reducing valve

Model	Set pressure ①	Set pressure ②
SK210Ⅲ	17.5 (249)	12.0 (171)
SK430Ⅲ	19.0 (270)	14.0 (199)

Units : kg/cm² (psi)

Book code No. S5LC0705E

KOBELCO

SHOP MANUAL

SK310
SK310LC

WORKING STANDARD

TABLE OF CONTENTS

LC07

KOBE STEEL, LTD.

Applicable Machines
LC03801~
YC01101~

Revision	Date of Issue	Remarks
First edition	March, 1995	S5LC0705E K

1. TIGHTENING TORQUES FOR CAPSCREWS AND NUTS

Tables 1 and 2 indicate tightening torques applicable to cases where no special note is given.

Overtightening of bolts may result in a twist-off and a fracture under load.

Undertightening may lead to a loosening or loss of bolts. Always tighten bolts to proper torques.

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

Classification	4	T	7	T	10	T
Nominal size	No lubrication	Oil lubrication	No lubrication	Oil lubrication	No lubrication	Oil lubrication
M 6 P=1	0.45±0.05 (3.3±0.4)	0.36±0.04 (2.7±0.3)	0.98±0.1 (7.1±0.7)	0.83±0.06 (6.0±0.6)	1.77±0.18 (13±1)	1.5±0.15 (11±1)
M 8 P=1.25	1.09±0.11 (7.9±0.8)	0.92±0.09 (6.7±0.7)	2.4±0.2 (17±1)	2.0±0.2 (14±1)	4.3±0.4 (32±3)	3.6±0.4 (26±3)
M10 P=1.5	2.2±0.2 (16±1)	1.88±0.18 (13±1)	4.7±0.5 (34±4)	4.0±0.4 (29±3)	8.5±0.9 (61±7)	7.2±0.7 (52±5)
M12 P=1.75	3.7±0.4 (27±3)	3.2±0.3 (23±2)	8.1±0.8 (59±6)	6.8±0.7 (49±5)	14.6±1.5 (110±11)	12.3±1.2 (89±9)
M14 P=2	5.9±0.6 (43±4)	5.0±0.5 (36±4)	12.8±1.3 (93±9)	10.8±1.1 (78±8)	23±2 (170±14)	19.5±1.9 (140±14)
M16 P=2	9.0±0.9 (66±7)	7.6±0.7 (55±5)	19.5±2.0 (140±14)	16.4±1.6 (120±12)	35±4 (250±29)	29±3 (210±22)
M18 P=2.5	12.4±1.2 (90±9)	10.5±1.0 (76±7)	27±3 (200±22)	23±2 (170±14)	49±5 (350±36)	41±4 (300±29)
M20 P=2.5	17.5±1.7 (130±12)	14.7±1.4 (110±10)	38±4 (270±29)	32±3 (230±22)	68±7 (490±51)	57±6 (410±43)
M22 P=2.5	23±2 (170±14)	19.6±2.0 (140±14)	51±5 (370±36)	43±4 (310±29)	92±9 (670±65)	77±8 (560±58)
M24 P=3	30±3 (220±22)	24±3 (170±22)	65±7 (470±51)	53±5 (380±36)	115±12 (850±87)	96±10 (690±72)
M27 P=3	44±4 (320±29)	36±3 (260±22)	96±10 (690±72)	78±8 (560±58)	173±17 (1300±120)	140±14 (1000±100)
M30 P=3.5	60±6 (430±43)	50±5 (360±36)	131±13 (960±94)	110±11 (800±80)	235±24 (1700±170)	196±20 (1400±140)
M33 P=3.5	81±8 (590±58)	68±7 (490±51)	176±16 (1300±130)	145±15 (1100±110)	317±32 (2300±230)	266±27 (1900±200)
M36 P=4	105±10 (760±72)	88±9 (640±65)	227±23 (1600±170)	190±19 (1400±140)	409±41 (3000±300)	343±34 (2500±250)

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

Classification	4	T	7	T	10	T
Nominal size	No lubrication	Oil lubrication	No lubrication	Oil lubrication	No lubrication	Oil lubrication
M 8 P=1	1.15±0.11 (8.3±0.8)	0.97±0.1 (7.0±0.7)	2.5±0.2 (18±1)	2.1±0.2 (15±1)	4.5±0.4 (33±3)	3.8±0.4 (27±3)
M10 P=1.25	2.3±0.2 (17±1)	1.91±0.19 (14±1)	4.9±0.5 (35±4)	4.2±0.4 (30±3)	8.9±0.9 (64±7)	7.5±0.7 (54±5)
M12 P=1.25	4.0±0.4 (29±3)	3.4±0.3 (25±2)	8.7±0.9 (63±7)	7.3±0.7 (53±5)	15.7±1.6 (114±12)	13.2±1.3 (96±9)
M16 P=1.5	9.4±0.9 (68±7)	7.9±0.8 (57±6)	20±2 (140±14)	17.2±1.7 (120±12)	37±4 (270±29)	31±3 (220±22)
M20 P=1.5	19±1.9 (140±14)	15.8±1.6 (110±12)	41±4 (300±29)	34±3 (250±22)	74±7 (540±51)	62±6 (450±43)
M24 P=2	32±3 (230±22)	27±3 (200±22)	70±7 (510±51)	58±6 (420±43)	126±12 (910±87)	105±10 (760±72)
M30 P=2	65±6 (470±43)	54±5 (390±36)	142±14 (1000±100)	118±12 (850±87)	255±26 (1800±190)	212±21 (1500±150)
M36 P=3	109±11 (790±80)	91±9 (660±65)	238±23 (1700±170)	198±20 (1400±140)	428±43 (3100±310)	357±36 (2600±260)

2. TIGHTENING TORQUES FOR NUTS AND SLEEVES

Table 3 indicates standard tightening torques applicable to cases where no particular note is given.

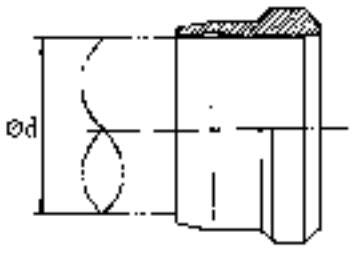
Overtightening or undertightening of nuts and sleeves in bite type tube fittings may develop oil leaks through pipe connections. Always tighten nuts and sleeves to proper torques.

Table 3

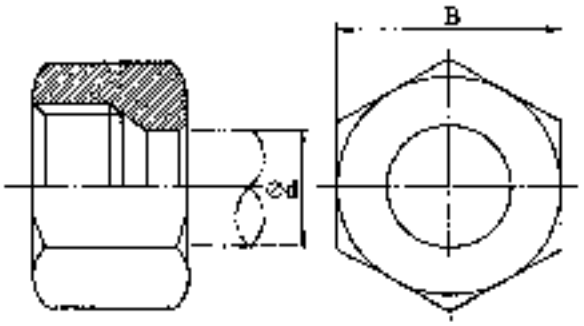
Manufacturer's name	Working pressure kgf/cm² (psi)	Tube size OD×thickness mm (in)	Opposing flats	Tightening torque kgf·m (ft-lbs)
Nippon A.M.C.	300 (4270)	10×1.5 (0.394×0.059)	19	5±1 (36±7)
		15×2.0 (0.591×0.079)	27	12±1.2 (87±9)
		18×2.5 (0.709×0.098)	32	15±1.5 (108±11)
		22×3.0 (0.866×0.118)	36	22±2.2 (159±16)
		28×4.0 (1.10×0.157)	41	28±2.8 (203±20)
Ihara Koatu	300 (4270)	35×5.0 (1.38×0.197)	55	45±4.5 (325±33)

Table 4

SLEEVE



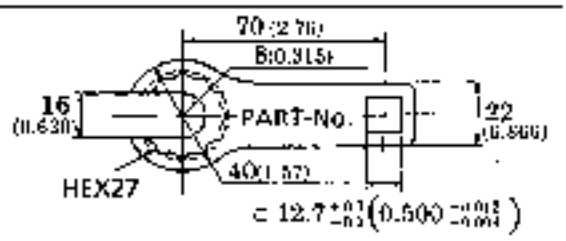
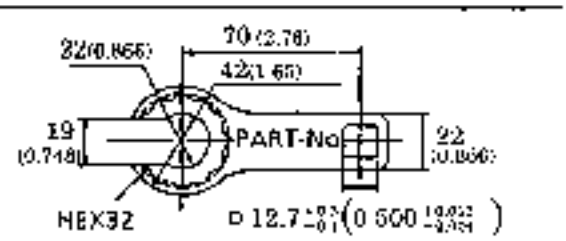
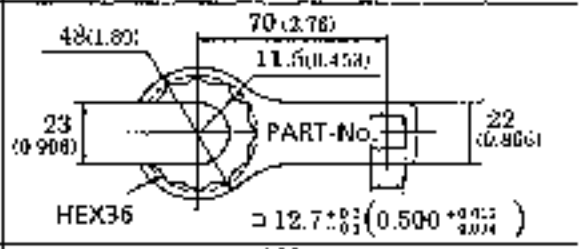
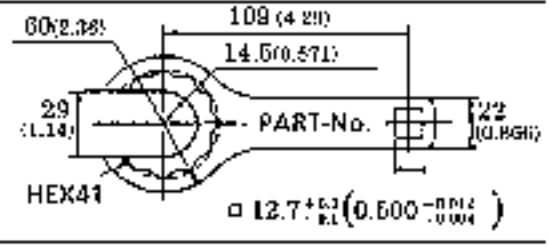
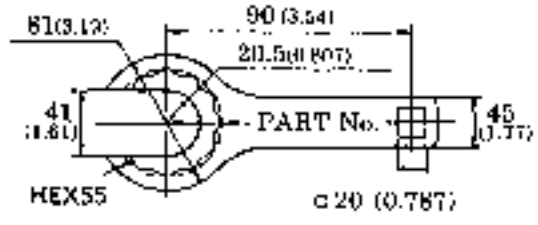
NUT



Tube size Ød	Parts No.		Tube size Ød	Opposing flats h	Parts 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	–

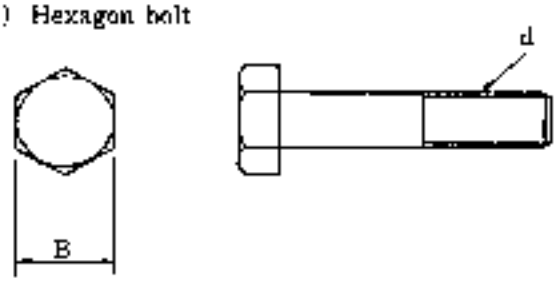
3. SPECIAL SPANNER FOR TUBE

Table 5

Applicable tube diameter mm (in)	Part No	Opposing flats of a hexagon nut mm	Drawing of a special spanner mm (in)
15 (0.591)	2421T160	27	
19 (0.709)	2421T136	32	
22 (0.866)	2421T130	36	
28 (1.10)	2421T115	41	
36 (1.38)	2421T314	55	

4. SCREW SIZE AND TIGHTENING TOOL SIZE

(1) Hexagon bolt



(2) Socket bolt

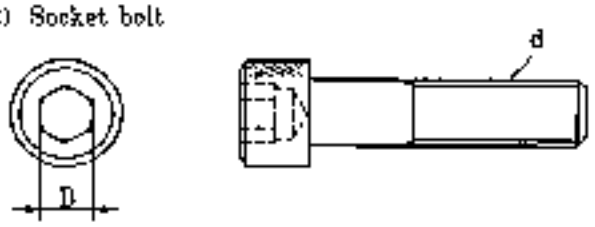


Table 6-1

NOMINAL SCREW SIZE	B mm
(d)	STANDARD DIMENSION
M6	10
M8	13
M10	17
M12	19
(M14)	(22)
M16	24
(M18)	(27)
M20	30
(M22)	32
M24	36
(M27)	(41)
M30	46
M36	55
M42	65
M45	70

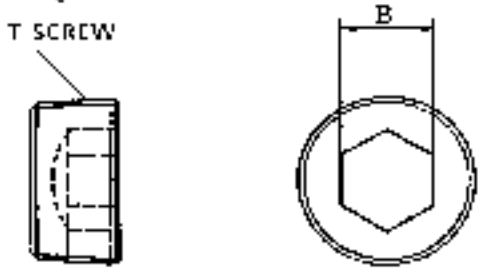
Table 6-2

NOMINAL SCREW SIZE	B mm
(d)	STANDARD DIMENSION
M48	75
M56	85
(M60)	90
M64	95
(M68)	100
M72	105
M76	110
M80	115

Table 7

NOMINAL SCREW SIZE	B mm
(d)	STANDARD DIMENSION
M6	5
M8	6
M10	8
M12	10
M14	12
M16	14
(M18)	14
M20	17
M24	19
M30	22
M36	27
M42	32
M48	36

(3) Plug



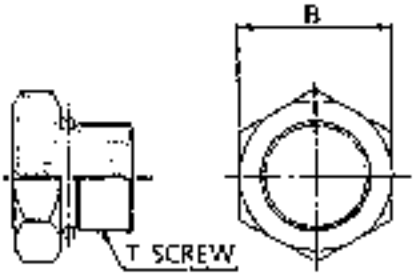


Table 8

T SCREW	B mm
PT 1/8	5
PT 1/4	6
PT 3/8	8
PT 1/2	10
PT 3/4	14
PT 1	17
PT1 1/4	22
PT1 1/2	22

Table 9

T SCREW	B mm	O RING PART NO
PF 1/4	19	ZD12P01400
PF 3/8	22	ZD12P01409
PF 1/2	27	ZD12P01800
PF 3/4	36	ZD12P02400
PF 1	41	ZD12P02900

5. INTERNATIONAL UNIT SYSTEM

Introduction

Although this manual uses the JIS unit system, we will introduce the international unit system in the following as there are Iron and Steel Association and other organizations which adopted the international unit system.

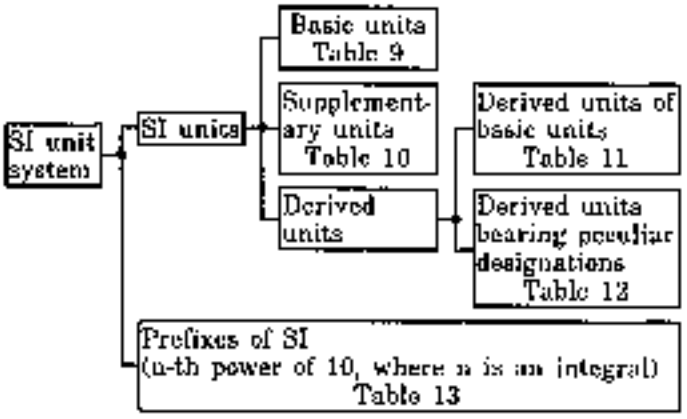
Given here in under are an except of the units that are related to this manual :

1. Etymology of SI Units

   French : Le Systeme International d' Unites

   English : International System of Units

2. Construction of SI Unit System



(1) Basic Units

Table 10

QUANTITY	DESIGNATION	SIGN
Length	Meter	m
Mass	Kilogram	kg
Time	Second	s
Current	Ampere	A
Thermodynamic temperature	Kelvin	K
Gram molecule	Mol	mol
Luminous intensity	Candela	cd

(2) Supplementary Units

Table 11

QUANTITY	DESIGNATION	SIGN
Plane angle	Radian	rad
Solid angle	Steradian	sr

(3) Derived Units of Basic Units

Table 12

QUANTITY	DESIGNATION	SIGN
Area	Square meter	m^2
Volume	Cubic meter	m^3
Velocity	Meter per second	m/s
Acceleration	Meter per second / second	m/s^2
Density	Kilogram per cubic meter	kg/m^3

(4) Derived Units bearing Peculiar Designations

Table 13

QUANTITY	DESIGNATION	SIGN	DERIVED UNIT
Frequency	hertz	Hz	$1Hz = 1s^{-1}$
Force	newton	N	$1N = 1kgf \cdot m/s^2$
Pressure, Stress	pascal	Pa	$1Pa = 1N/m^2$
Energy Work, Quantity of heat	joule	J	$1J = 1N \cdot m$
Power Motive power, Electric power	watt	W	$1W = 1J/s$
Charge, Quantity of electricity	coulomb	C	$1C = 1A \cdot s$
Potential Voltage, Electromotive force	bolt	V	$1V = 1J/C$ $(1W/A)$
Quantity of static electricity Capacitance	farad	F	$1F = 1C/V$
Electric resistance	ohm	Ω	$1\Omega = 1V/A$
Celcius temperature	celcius degree or degree	℃	
Illuminance	lux	ℓX	$1\ell X = 1\ell m/m^2$

(5) Prefixes of SI

Table 14

PREFIX		POWER
DESIGNATION	SIGN	
Giga-	G	10^9
Mega-	M	10^6
Kilo-	k	10^3
Hecto-	h	10^2
Deca-	da	10
Deci-	d	10^{-1}
Centi-	c	10^{-2}
Milli-	m	10^{-3}
Micro-	μ	10^{-6}
Nano-	n	10^{-9}
Pico-	p	10^{-12}

3. Unit Conversion Table

Table 15

QUANTITY	JIS	SI	REMARKS
Mass	kg	kg	
Force	kgf	10N	9.807N
Torque	kgf·m	10N·m	9.807N·m
Pressure	kgf/cm^2	0.1MPa	0.098MPa
Motive power	PS	0.7355kw	
Revolution	rpm	min^{-1}	r/min

6. DETAILS OF SUCTION STOPPER

6.1 COMPONENTS OF SUCTION STOPPER

No.	NAME	PARTS No.	Q'ty
	SUCTION STOPPER ASSY	24100P973FS	
1	ROD	2420T4660D1	1
2	NUT	ZN16C08007	1
3	COVER	2414T2123D3	1
4	O RING	46Z01D7	1

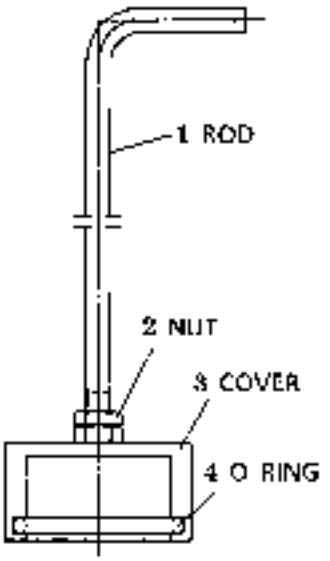


Fig. 20 Components of suction stopper

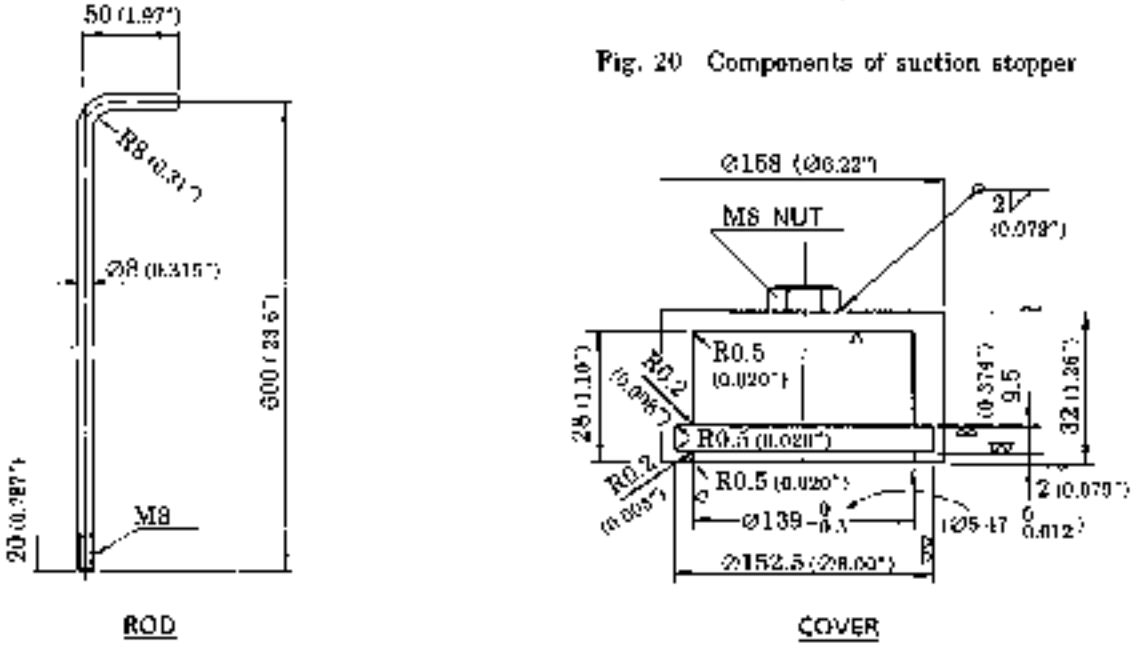


Fig. 36 Dimension of suction stopper

6.2 MACHINE MODELS TO WHICH SUCTION STOPPER IS APPLICABLE

Table 16

Part No. of suction stopper	Applicable model
	SK Series
24100P973FS	SK300, SK400 SK300-2, SK400-2 SK310II, SK430II

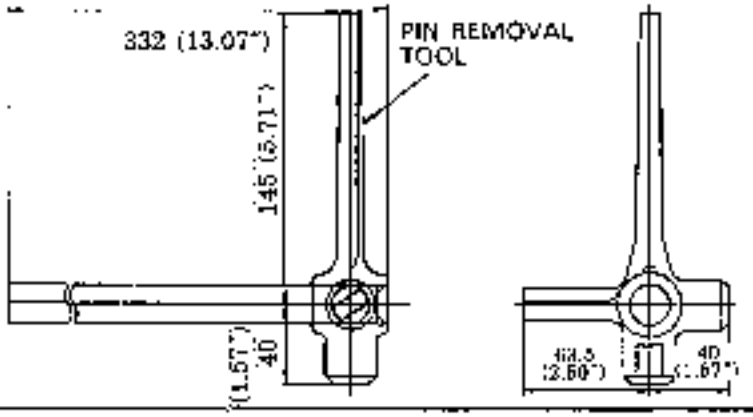
7. TABLE OF THREAD LOCK AND SEALANT

Table 17

SERVICE	MANUFACTURER		FEATURES
	LOCKTITE	THREE-BOND	
Screw locking compound	#242	1360K	Low strength
	#271	1305	High strength
Sealing compound	#515	1215	Sealing

8. SPECIAL TOOL FOR BUCKET TOOTH

Table 18

Applicable	Part No.	Special Tool
Tooth S18 over	2421N225	

Book code No. S5LC0802E

KOBELCO

SHOP MANUAL

SK310
SK310LC

STANDARD MAN-HOUR TABLE

TABLE OF CONTENTS

LC08

KOBE STEEL, LTD.

Applicable Machines

LC03801~
YC01101~

(1) Standard Man-Hour

1) The standard man-hour apply where the serviceman with about five year's experience with general construction machinery performs maintenance operation at normal speed, using an appropriate number of personnel and jigs/tools.
2) The standard man-hour does not include the setup time for repair, the time necessary to explain to the customer and painting, but those times may be added depending upon the contents of work.

(2) How to Look at Man-Hour Table

1) Units of working time
   The working time is indicated in decimal numbers; 6min.=0.1hour.
2) Formula for calculating man-hour
   Man-hour=working hour×the number of workers, (working time=man-hour÷the number of workers)
3) Where more than one operation is performed at the same time, the standard man-hour for each of the operations shall be added.

Revision	Date of Issue	Remarks
First edition	March, 1995	SGLC0802E K

1. STANDARD MAN-HOUR TABLE

No.	UPPER	LOCATION	WORK TO BE DONE	UNIT	REMARK	SK310III SK310LC-III	SK400III SK400LC-III
00	1	Swing motor (reduction gear) ASSY	Detach/attach	1 pc.		7.0	9.0
	– 2	Swing reduction gear	O/H	1 pc.	Excl. removal.	6.0	8.0
	– 3	Swing motor (single)	O/H	1 pc.	Excl. removal.	5.0	6.0
	– 4	Swing bearing	Detach/attach	1 pc.		32.0	38.0
	– 5	Counterweight	Detach/attach	1 pc.	Lifting jig and tool required.	3.0	4.0
	– 6	Under cover	Detach/attach	1 pc.		0.8	0.9
	– 7	Left side cover	Detach/attach	1 pc.		0.5	0.6
	– 8	Fuel tank ASSY	Detach/attach	1 pc.	Incl. emptying fuel.	3.0	4.0
	– 9	Water separator	Replace	1		0.3	←
	– 10	Sending unit	Replace	1		0.6	←
	– 11	Hydraulic oil tank ASSY	Detach/attach	1 pc.	Incl. emptying Hydraulic oil.	5.0	6.0
	– 12	Suction strainer	Replace	1		0.3	←
	– 13	Return filter element	Replace	1		0.6	←
	14	Hydraulic oil	Replace	1 pc.	Incl. cleaning in tank	3.0	4.0
	– 15	Level gauge	Replace	1		0.3	←
	– 16	Drain plug	Replace	1		0.3	←
	– 17	Upper frame ASSY	Detach/attach	1 pc.		26.0	34.0
	– 18	Engine oil	Replace	1 pc.		0.5	←
No.	CAB & GUARD						
01	– 1	Cab ASSY	Detach/attach	1 pc.	Fix with eight bolts.	4.0	←
	– 2	Door	Detach/attach	1 pc.		1.0	←
	– 3	Door lock	Replace	1		1.0	←
	– 4	Washer washer tank	Replace	1		0.5	←
	– 5	Operator seat	Detach/attach	1		1.0	←
	– 6	Guard ASSY	Detach/attach	1 set	#0,11,12,13	3.0	4.0
	– 7	Engine guard (rear cover)	Detach/attach	1		0.8	0.9
	– 8	Front guard (Incl. battery cover)	Detach/attach	1		0.8	0.9
	– 9	Right side cover	Detach/attach	1		0.3	0.9

No	CONTROL	LOCATION	WORK TO BE DONE	UNIT	REMARK	SK310-III SK310LC-III	SK400-III SK400LC-III
02	– 1	Operating lever stand	Detach/attach	One side		2.0	←
	– 2	Pilot valve (ATT swing)	Detach/attach	1		1.0	←
	3	Travel pilot valve	Detach/attach	1		1.0	←
	– 4	Operating lever	Replace	1		0.3	←
	– 5	Travel lever	Replace	1		0.3	←
	– 6	Solenoid valve	Detach/attach	1	Lever lock, EC, Travel 2-speed, Travel deflection, ATT boost pressure, Swing P/B	1.0	←
	– 7	Proportionate valve	Replace	1	QMIN, Travel straight valve, QMAX, cut valve P1, Cut valve P2	1.0	←
	– 8	Accumulator/pilot relief manifold	Adjust	1 set		0.5	←
	– 9	Multi control valve	Detach/attach	1 pc.		3.0	←
	– 10	Multi control valve	Oil	1 set	Each detachment/attachment	2.0	←
	– 11	Controller	Detach/attach	1 pc.	Top stage (for mechatronic control) Middle stage (for cluster gauge) Bottom stage (for power window)	0.5 2.0	← ←
No.	HYDRAULIC LINE						
03	– 1	Hydraulic pump ASSY	Detach/attach	1 pc		6.0	←
	– 2	Pump coupling	Replace	1 set		1.5	←
	– 3	Suction hose	Replace	1		2.0	←
	– 4	Delivery hose	Replace	1		1.0	←
	– 5	Pilot valve	Detach/attach	1 pc.		1.0	←
	– 6	Filter element (line filter)	Replace	1	SK60 is direct coupled with return filter.	0.5	←
	– 7	Main control valve	Detach/attach	1 pc		10.0	11.0
	– 8	Main relief valve	Replace	1		1.0	←
	– 9	Overload relief valve	Replace	1		1.0	←
	– 10	Option valve	Detach/attach	1 pc		3.0	←
	– 11	Main relief valve	Replace	1		1.0	←
	– 12	Overload relief valve	Replace	1		1.0	←

No.	POWER PLANT	LOCATION	WORK TO BE DONE	UNIT	REMARK	SK310III SK310LCIII	SK430III SK430LCIII
04	– 1	Engine ASSY	Detach/attach	1 pc.		12.0	←
	– 2	Injection pump	Detach/attach	1 pc		3.0	←
	– 3	Valve clearance	Adjust	1 pc.		2.0	←
	– 4	Nozzle	Replace	1		1.5	←
	– 5	Fuel hose	Replace	1		1.0	←
	– 6	Radiator ASSY	Detach/attach	1 pc		6.0	←
	– 7	Radiator hose (upper)	Replace	1		0.8	←
	– 8	Radiator hose (lower)	Replace	1		1.5	←
	– 9	Sub tank	Replace	1		0.5	←
	– 10	Fan belt	Replace	1 pc		2.0	←
	– 11	Radiator fan	Replace	1		1.5	←
	– 12	Radiator cooling water	Replace	1 pc		0.8	←
	– 13	Oil cooler	Detach/attach	1 pc		3.0	←
	14	Muffler	Replace	1		3.0	←
	– 15	Air cleaner	Replace	1		1.5	←
	– 16	Fuel element	Replace	1		0.5	←
	– 17	Oil element	Replace	1		0.5	←
	– 18	Turbocharger	Detach/attach	1 pc		1.0	←
No.	Electric						
05	– 1	Battery	Replace	1		0.5	←
	– 2	Battery cable	Replace	1		0.2	←
	– 3	Battery relay	Replace	1		0.6	←
	– 4	Relay ASSY	Replace	1 pc.	Horn, work lamps (front), (rear), Swing flasher	0.5	←
	– 5	Relay	Replace	1	Heater, starter, Key switch, Safety relay	0.5	←
	– 6	Water temp. sensor	Replace	1		0.5	←
	– 7	Oil pressure switch	Replace	1		0.5	←
	– 8	Swing flasher	Replace	1		0.5	←
	– 9	Boom work lamp	Replace	1		0.8	←
	– 10	Upper frame work lamp	Replace	1		0.5	←
	– 11	Cluster gauge	Detach/attach	1 pc.		1.0	←
	12	Heater	Detach/attach	1 pc.		2.0	←
	– 13	Governor motor	Replace	1 pc.		1.0	←
	– 14	Alternator	Detach/attach	1 pc.		1.0	←
	– 15	Starter motor	Detach/attach	1 pc.		1.0	←
	– 16	Air-conditioner ASSY	Detach/attach	1 pc.		6.0	←
	– 17	Compressor	Detach/attach	1 pc.		1.0	←
	– 18	Condenser	Detach/attach	1 pc.		1.0	←
	– 19	Evaporator	Detach/attach	1 pc.		2.0	←

No.	LOWER	LOCATION	WORK TO BE DONE	UNIT	REMARK	SK310III SK310LCIII	SK430III SK430LCIII
06	– 1	Track link ASSY (with shoe)	Detach/attach	One side	Incl. adjustment of tension	2.0	3.0
	– 2	Track link ASSY	Replace	One side	Disassembly and assembly of shoe and link	4.0	5.0
	– 3	Master pin	Replace	One side		0.8	1.0
	– 4	Track link	Replace	1 link		2.5	3.0
	– 5	Shoe plate	Replace	1 pc	Incl. cutting off of shoe bolts	0.5	←
	– 6	Upper roller	Detach/attach	1		0.8	1.0
	– 7	Upper roller	O/H	1	Where upper roller is removed.	1.5	←
	– 8	Lower roller	Detach/attach	1		1.0	←
	– 9	Lower roller	O/H	1	Where upper roller is removed	1.0	←
	– 10	Front idler	Detach/attach	One side		4.0	4.5
	– 11	Front idler	O/H	One side	Where upper roller is removed.	2.0	2.5
	– 12	Track spring ASSY	Detach/attach	One side		4.0	4.5
	– 13	Grease cylinder	O/H	One side	Where upper roller is removed.	0.5	1.0
	– 14	Spring	Replace	One side	Where upper roller is removed.	3.0	3.5
	– 15	Travel motor reduction gear ASSY	Detach/attach	One side	Incl. detaching and attaching piping and cover	6.0	7.0
	– 16	Reduction gear ASSY	O/H	1	Incl. detaching and attaching pipings	8.0	9.0
	– 17	Drive sprocket	Replace	One side		3.0	3.5
	– 18	Travel motor (single) ASSY	Detach/attach	One side		5.0	5.5
	– 19	Travel motor	O/H	1	Incl. detaching and attaching pipings	5.0	6.5
	– 20	Swivel joint	Detach/attach	1 pc.		5.0	5.5
	– 21	Swivel joint	O/H	1	Incl. detaching and attaching pipings	2.0	3.0
	– 22	Lower piping (tube)	Replace	1	Incl. detaching and attaching cover	1.5	2.0

No.	ATTACHMENT	LOCATION	WORK TO BE DONE	UNIT	REMARK	SK310Ⅲ SK310LC-Ⅲ	SK400Ⅲ SK400LC-Ⅲ
407	− 1	Bucket ASSY	Detach/attach	1 pc.		1.5	2.0
	− 2	Bucket mounting pin	Replace	1		0.8	1.0
	− 3	Side cutter	Replace	One side		0.8	1.0
	− 4	Tooth	Replace	1		0.5	—
	− 5	Arm ASSY	Detach/attach	1 set	Incl. bucket cylinder and link	3.0	4.0
	− 6	Arm (single)	Replace	1 pc		4.0	5.0
	− 7	Arm bushing	Replace	1	Single arm condition	1.5	2.0
	− 8	Bucket cylinder ASSY	Detach/attach	1		1.5	2.0
	− 9	Bucket cylinder	O/H	1	Not incl. replacement of bushing	5.0	6.0
	− 10	Bucket link	Replace	1 set		0.8	1.0
	11	Bucket link bushing	Replace	1	Incl. idler link	1.5	2.0
	− 12	Idler link	Replace	1		0.8	1.0
	− 13	Arm cylinder ASSY	Detach/attach	1		3.0	4.0
	− 14	Arm cylinder	O/H	1	Not incl. replacement of bushing	5.0	6.0
	− 15	Arm ASSY	Detach/attach	1 pc	Incl. arm cylinder	6.0	7.0
	− 16	Boom foot pin	Replace	1	Draw out SKGB by sliding the seal toward from the out side.	2.0	3.0
	− 17	Boom cylinder ASSY	Detach/attach	1		3.0	4.0
	− 18	Boom cylinder	O/H	1	Not incl. replacement of bushing	5.0	6.0
	19	Boom cylinder bushing	Replace	1		0.8	1.0
	− 20	Boom cylinder hose	Replace	1		0.8	1.0
	− 21	Arm cylinder hose	Replace	1		1.5	2.0
	− 22	Bucket cylinder hose	Replace	1		1.5	2.0

2. STANDARD WORKING TIME TABLE FOR THE MAINTENANCE OF ENGINE

Introduction

This standard working time table provides time required for maintenance (if the work is carefully carried out) under the following condition :

- ○ Tools designated by us are used.
- ○ Genuine parts are prepared.
- ○ Correct working procedures are observed.
- ○ The engine is mounted correctly to the machine.

However, construction machines of different manufacturers vary in construction, as follows :

1. The working hours given in this table can not be applied because of special machine construction.
2. Special equipments not listed in this table may be used for operation.

If such operations are performed, fill out reasons in the Claim Application Sheet in detail and submit it to us.

(Note 1) Unit of working time

The working time is given in 6 minutes=0.1 hour in the decimal system.

(Note 2) Contents

The group numbers and the titles are in common with the Standard Working Time for Trucks and Buses, and only those items applicable to industrial engines are stated.

(Note 3) Applicable models :

6D31－T ……SK200V, SK200□V
6D15－T……SK220V, SK220LCV
6D22－T ……SK300-2, SK300LC-2
6D22・TC ……SK400-2, SK400LC-2
6D22－T……SK310□, SK310□LCIII
6D22－TC……SK430□, SK430□LCIII

2.1 COOLING SYSTEM

NAME OF WORK	NAME OF TROUBLE	MODEL		
		6DS (6DS1-T)	6D1 (6D15-T)	6D2 (6D22-T, 6D22-TC)
Cooling system 01—00				
Cleaning of cooling system.	Cooling water of cooling system is rusty	1.0	1.0	1.5
Replacing water outlet pipe and packings.	Water leaks from water pipe. Rupture of water pipe or other fault.	1.0	1.0	1.3
Replacing bypass hose.	Water hose is attached improperly. Rupture of water hose or other fault.	0.4	0.4	0.4
Replacing radiator upper (inlet) hose.	Water hose is attached improperly. Rupture of water hose or other fault.	0.3	0.3	0.4
Replacing radiator lower (outlet) hose.	Water hose is attached improperly. Rupture of water hose or other fault.	0.7	0.7	0.8
Replacing radiator hose clip. (1 pc.)	Water hose is installed improperly. Radiator hose system in general is faulty.	0.3	0.3	0.3
Cooling fan 01—20				
Attaching and detaching or replacing fan.	Cooling fan is broken. Cooling fan makes an abnormal sound. Cooling fan parts are defective.	0.6	0.6	0.8
Replacing belts (2 pcs.) Note : Where two or more belts are used, increase 0.4hr. for each belt increased.	Fan belt is damaged. Fan belt squeaks.	0.3	0.3	0.5
Adjusting belts.		0.2	0.2	0.3
Idler pulley overhaul Incl. : detaching and attaching pt.	Refer to Power Train Table.	—	—	—
Detaching and attaching or replacing fan coupling.		0.7	0.7	1.0
Radiator 01—30				
Replacing radiator assy.	Radiator is broken. Radiator is clogged up. Water leaks from radiator. Radiator system in general is out of order.	3.5	3.5	4.5
Replacing radiator drain cock.	Water leaks from drain cock.	0.2	0.3	0.3
Replacing pressure valve.	Radiator cap does not work properly.	—	—	—
Replacing surge tank.	Surge tank parts are faulty.	—	—	—
Replacing radiator shroud.	Radiator shroud parts are defective.	0.8	0.8	0.8
Replacing radiator support. (one side)	Radiator support stay parts are defective.	—	—	—
Detaching and attaching or replacing radiator support stay and bracket. Note : Add 0.4hr. for auto grease with distributor.	Radiator support stay parts are defective.	—	—	—
Replacing radiator mounting rubber. (one side)	Radiator support cushion parts are faulty.	—	—	—
Detaching and attaching or replacing condensation tank.	Condensation tank parts are faulty.	—	—	—
Detaching and attaching or replacing radiator filler set.	Radiator in general are out of order.	—	—	—
Thermostat 01—40				
Inspecting or replacing thermostat. (1 pc.)	Thermostat functions incorrectly. Thermostat remains open. Thermostat remains closed. Thermostat system in general is out of order.	0.6	0.8	0.8
Inspecting or replacing thermostat. (RH one)	Thermostat functions improperly. Thermostat remains open. Thermostat remains closed. Thermostat system in general is out of order.	—	—	—
Inspecting or replacing thermostat. (LH one)	Thermostat functions improperly. Thermostat remains open. Thermostat remains closed. Thermostat system in general is out of order.	—	—	—

NAME OF WORK	NAME OF TROUBLE	MODEL		
		6D5 (6D31-T)	6D1 (6D15-T)	6D2 (6D22-T, 6D22-TC)
Water pump 01 – 50				
Replacing water pump (Not is mounted to the machine). Incl. : (1) Detaching and attaching V-belt. (2) Detaching and attaching idle pulley assy.	Water pump squeaks. Water leaks from water pump. Pump bearing is broken. Pump shaft is damaged. Water pump parts are faulty. Water pump in general are out of order.	2.0	2.3	3.0
Water pump overhaul. Excl. : detaching and attaching.	Water pump squeaks. Water leaks from water pump. Pump bearings are damaged. Pump shaft is damaged. Water pump parts are faulty. Water pump in general is out of order.	0.9	0.8	1.0
Engine oil cooler 01 – 70				
Replacing oil cooler.	Oil cooler parts are faulty. Oil cooler in general is out of order.	3.0	5.0	5.0

2.2 ELECTRICAL SYSTEM

NAME OF WORK	NAME OF TROUBLE	MODEL		
		6D5 (6D31-T)	6D1 (6D15-T)	6D2 (6D22-T, 6D22-TC)
Battery 02 – 03				
Replacing battery. (mount)	Battery is cracked. Battery is distorted by heat. Battery is discharged. Battery in general is out of order.	0.4	0.4	0.5
Replacing battery box.	Battery support parts are faulty. Battery in general is out of order.	1.0	1.0	1.0
Detaching and attaching battery cover.	Battery in general is out of order.	—	—	—
Generator 02 – 05				
Replacing generator assy.	Generator functions improperly. Generator makes an abnormal sound. Generator is burnt. Generator bearing parts are faulty. Generator pulley is broken. Generator mounting bracket is broken.	1.0	1.0	1.0
Overhaul of generator Incl. : Detaching and attaching generator.	Generator functions improperly. Generator makes an abnormal sound. Generator burnt out. Generator bearing parts are faulty. Generator pulley are broken. Generator mounting bracket is broken.	—	—	—
Overhaul of generator. (single)	Generator functions improperly. Generator makes an unusual sound. Generator burnt out. Generator bearing parts are defective. Generator pulley is broken. Generator mounting bracket is broken.	—	—	—
Starter motor 02 - 10				
Replacing starter.	Starter motor malfunctions. Starter motor rusts from inside. Pinion is broken. Overrunning clutch slips. Overrunning clutch parts are defective. Pinion engagement is no good. Starter motor system in general is out of order.	0.9	0.6	1.0

NAME OF WORK	NAME OF TROUBLE	MODEL		
		6D5 (6D31-T)	6D1 (6D15-T)	6D2 (6D22-T) (6D22-TC)
Overhaul of starter. Incl. : detaching and attaching starter	Starter motor malfunctions. Starter motor rusts from inside. Pinion is broken. Overrunning clutch slips. Overrunning clutch parts are faulty. Pinion meshing is no good Starter motor system in general is out of order.	—	—	—
Overhaul of starter	Starter motor malfunctions. Starter motor rusts from inside. Pinion is broken. Overrunning clutch slips. Overrunning clutch parts are faulty. Pinion meshing is no good Starter motor system in general is out of order.	—	—	—
Replacing starter switch assy	Magnetic switch contacts are no good. Magnetic switch burnt out. Starter motor system as a whole is out of order	1.0	1.3	1.3
Safety (starter) relay 02—12				
Detaching/attaching or replacing starter relay.	Relay malfunctions Relay system as a whole is out of order	0.4	0.4	0.4
Voltage regulator 02—20				
Replacing relay (regulator) assy	Voltage regulator malfunctions Voltage regulator system as a whole is out of order.	0.5	0.5	0.5
Glow plug 02—33				
Inspecting and replacing glow plugs. (all)	Glow plug parts are faulty. Glow plug system as a whole is out of order.	1.0	1.2	1.2
Intake air heater 02—34				
Detaching/attaching or replacing intake air heater assy. (one side)	Intake heater parts are faulty Intake heater system as a whole is out of order.	—	—	—
Replacing resistor	Resistor parts are faulty.	—	—	—
Detaching/attaching or replacing magnet valve.	Magnet valve parts are faulty.	—	—	—
Switch (unit) 02—35				
Replacing starter switch	Starter switch does not return well Starter switch is broken or developed other fault.	0.4	0.4	0.6
Replacing starter switch. (in switch box)	Starter switch does not return well. Starter switch is broken or developed other fault.	—	—	—
Replacing water temperature gauge unit	Water temperature gauge unit malfunctions.	0.3	0.3	0.3
Detaching/attaching or replacing fuel tank gauge unit	Fuel gauge unit malfunctions.	—	—	—
Replacing oil bypass alarm.	Oil leaks from oil bypass alarm Oil bypass alarm is broken or developed other fault.	0.3	0.3	0.3
Replacing battery switch.	Battery switch malfunctions.	0.3	0.3	0.3
Replacing turn signal and dimmer switch.	Turn signal switch malfunctions. Dimmer switch malfunctions.	—	—	—
Meters 02—50				
Replacing speedometer assy.	Speedometer malfunctions.	0.7	0.7	0.9
Replacing tachometer cable. (unit)	Speedometer cable is broken Tachograph cable is broken. Tachometer cable is broken.	0.5	0.5	0.5
Replacing temperature gauge.	Temperature gauge gives incorrect readings.	0.5	0.5	0.5
Replacing fuel gauge	Fuel gauge gives incorrect readings.	0.5	0.5	0.5
Replacing oil pressure gauge.	Oil pressure gauge gives incorrect readings.	0.5	0.5	0.5
Replacing air pressure gauge	Air pressure gauge gives incorrect readings.	—	—	0.7
Replacing ammeter	Ammeter gives incorrect readings.	0.5	0.5	0.5

2.3 ENGINE

NAME OF WORK	NAME OF TROUBLE	M/UNIT.		
		6D1 (6D31-T)	6D1 (6D15-T)	6D2 (6D22-T) (6D22-TC)
Replacing tachograph assy	Tachograph malfunctions.	—	—	—
Engine 03—00				
Detaching/attaching or replacing engine assy.	Refer to fault code table.	14.0	15.0	19.0
Overhaul of engine assy Incl. : (1) Detaching/attaching engine. (2) Running-in of engine (3) Conditioning engine. (B) Excl. : (1) Overhauling starter, dynamo and injection pump. (2) Grinding crankshaft. (3) Boring and honing of cylinder liner.	Refer to fault code table.	68.0	73.0	80.0
Semi overhaul of engine. Incl. : (1) Semi overhaul of cylinder head (2) Replacing piston and piston ring. (3) Replacing cylinder liners. (4) Adjusting engine. (A) (5) Adjusting nozzle	Refer to fault code table. For each set of piston liners decreased 1.0hr. Each time one line decreases 0.8hr. Each time one piston decreases 0.5hr	28.0	30.0	35.0
Adjusting engine. (A) Incl. : (1) Adjusting valve clearance. (2) Inspecting nozzle. (3) Adjusting injection timing. (4) Cleaning air cleaner element. (5) Cleaning fuel filter element. (6) Inspecting cooling water hose (7) Adjusting fan belt. (8) Retightening all parts.		3.0	3.2	3.5
Adjusting engine (present vehicle). (B) Incl. : (1) Retightening cylinder head. (2) Cleaning air cleaner (3) Measuring compressive pressure. (4) Inspecting cooling water hose (5) Inspecting fan belt for slackening and adjusting it. (6) Checking the max. and min. revolutions. (7) Inspecting glow plug (8) Inspecting and adjusting nozzle. (9) Adjusting injection timing. (10) Cleaning oil and fuel filter elements (11) Adjusting valve clearance. (12) Retightening other parts		6.5	6.8	7.5
Measuring compressive pressure.		2.0	2.0	2.3
Adjusting injection timing.	Climbing power of vehicle is deficient. Max. speed of vehicle is deficient. Accelerating power of vehicle is deficient. Engine starting is faulty. Engine output is deficient. Engine fuel is no good.	0.8	0.8	0.8
Adjusting valve clearance		1.0	1.0	1.2
Measuring block setscrew		0.6	0.6	0.6
Cylinder head 03—10				
Replacing cylinder head assy (1 unit) Incl. : (1) Adjusting engine (A) (2) Adjusting nozzle.	Cylinder head cracked. Cylinder head is distorted. Cylinder head is corroded. Cylinder head is porous. Area between cylinder head and valve is cracked. Cylinder head system in general is out of order.	8.0	9.0	10.5

NAME OF WORK	NAME OF TROUBLE	MODEL		
		6D5 (6D31-T)	6D1 (6D15-T)	6D2 (6D22-T) (6D22-TC)
Overhauling cylinder head assy. (1 set) Incl. : (1) Detaching/attaching cylinder head. (2) Replacing combustion chamber. (3) Correcting valve seat ring (4) Replacing valve guide. (5) Lapping valve. (6) Adjusting engine (A) (7) Adjusting nozzle.	Cylinder head is cracked. Cylinder head is distorted. Cylinder head is corroded. Cylinder head is porous. Area between cylinder head and valve is cracked. Cylinder head system in general is out of order.	10.5	11.5	13.5
Replacing cylinder head assy. (one side) Incl. : (1) Adjusting engine (A) (2) Adjusting nozzle.	Cylinder head is cracked. Cylinder head is distorted. Cylinder head is corroded. Cylinder head is porous. Area between cylinder head and valve is cracked. Cylinder head system in general is out of order.	—	—	—
Overhauling cylinder head assy. (1 set) Incl. : (1) Detaching/attaching cylinder head (2) Correcting seat face (3) Replacing valve guide. (4) Replacing combustion chamber (5) Lapping valve (6) Adjusting engine (A). (7) Adjusting nozzle	Cylinder head is cracked. Cylinder head is distorted. Cylinder head is corroded. Cylinder head is porous. Area between cylinder head and valve is cracked. Cylinder head system in general is out of order.	—	—	—
Hydrostatic test of cylinder head (1 set) (single)	Cylinder head is cracked. Cylinder head is porous. Cylinder head system in general is out of order.	1.5	1.6	1.5
Replacing cylinder gasket (1 pc.)(present machine) Incl. Adjusting engine (A)	Water leaks from cylinder head. Oil leaks from cylinder head. Gas leaks from cylinder head. Cylinder head system in general is out of order.	6.5	7.0	8.0
Replacing cylinder head gasket (one side) (present machine) Incl. Adjusting engine (A)	Water leaks from cylinder head gasket. Oil leaks from cylinder head gasket. Gas leaks from cylinder head gasket.	—	—	—
Retightening cylinder head bolts. (1 unit) (present machine) Incl. : Adjusting valve clearance.		2.0	2.3	2.5
Replacing pre-combustion chamber, (1 pc.) Excl. : Detaching/attaching head. Incl. : (1) Detaching/attaching and cleaning glow plug (1 pc.). (2) Adjusting nozzle (1 pc.) for each nozzle increased : Medium size 0.4hr. Large size 0.5hr.	Pre-combustion chamber is broken. Water leaks from pre-combustion chamber gasket.	1.0	1.0	1.5
Locker cover 03 – 15				
Replacing locker cover packing (1 pc.) Increase 0.1hr. as one direct injection increases.	Locker cover packing is cracked. Oil leaks from locker cover packing.	0.5	0.6	0.6
Replacing locker casing packing (1 unit) Incl. : (1) Adjusting valve clearance. (2) Detaching/attaching locker casing	Oil leaks from locker casing packing.	—	—	—
Cylinder Block 03 – 20				
Replacing cylinder block Incl. : (1) Detaching and attaching engine. (2) Conditioning engine (B) and travel test Excl. : Replacing associated parts.	Refer to fault code table.	50.0	65.0	65.0
Replacing cylinder liners (all Q'ty on present vehicle) Incl. : (1) Conditioning engine (A). (2) Adjusting nozzle.	Refer to fault code table.	25.0	27.0	31.0
Replacing side cover packing. (front side)	Oil leaks from side cover gasket.	—	0.4	0.4
Replacing side cover packing. (left)	Oil leaks from side cover gasket.	—	—	—

NAME OF WORK	NAME OF TROUBLE	MODEL		
		6D5 (6D31-T)	6D1 (6D15-T)	6D2 (6D22-T) (6D22-TC)
Replacing side cover packing (right) Increase: 2.0hr. where injection pump is tilted.	Oil leaks from side cover gasket.	—	—	—
Replacing side cover packing (rear side)	Oil leaks from side cover gasket.	—	0.5	0.4
Detaching/attaching or replacing rear plate.	Rear plate is cracked	—	—	—
Cam shaft 03−31				
Detaching/attaching or replacing cam shaft. Incl. : Detaching and attaching engine. (1) Conditioning engine (2) Travel test.	Cam shaft is worn. Cam shaft is broken. Cam shaft bushing is worn. Cam shaft bushing seized. Cam shaft system in general is out of order.	18.0	23.0	24.6
Replacing cam shaft bushing Incl : (1) Detaching/attaching engine. (2) Conditioning engine	Cam shaft bushing worn Cam shaft bushing seized.	19.0	24.0	25.6
Push Rod 03−32				
Detaching/attaching or replacing push rod. (All) (present machine) Incl. : Adjusting valve clearance.	Push rod is broken. Push rod is bent. Push rod system in general is out of order.	2.5	2.5	3.5
Detaching/attaching or replacing push rod. (1−6,1−8) (present machine) Incl. : Adjusting valve clearance.	Push rod is broken. Push rod is bent. Push rod system in general is out of order.	—	—	—
Locker arm 03−33				
Detaching/attaching or replacing valve locker assy. (all) Incl. : Adjusting valve clearance.	Locker arm is worn. Locker arm is broken. Bushing is worn. Locker arm system in general is out of order. Locker arm ball makes an unusual sound.	2.5	2.5	3.5
Detaching, attaching and disassembling locker arm and shaft. (1 unit) Incl. : Adjusting valve clearance	Locker arm is worn. Locker arm is broken. Bushing is worn. Locker arm system in general is out of order. Locker arm ball makes an unusual sound.	—	—	—
Detaching, attaching and disassembling locker assy. (one side) Incl. : Adjusting valve clearance	Locker arm is worn. Locker arm is broken. Bushing is worn. Locker arm system in general is out of order. Locker arm ball makes an unusual sound	—	—	—
Detaching, attaching and disassembling valve locker and shaft. (one shaft) Incl : Adjusting valve clearance.	Locker arm is worn. Locker arm is broken. Bushing is worn. Locker arm system in general is out of order.	—	—	—
Replacing valve locker adjusting screws (all) Incl. : Adjusting valve clearance.	Locker arm system in general is out order.	2.0	2.0	3.3
Replacing valve locker adjusting screws. (one side) Incl. : Adjusting valve clearance.	Locker arm system in general is out of order.	—	—	—
Tappet 03−34				
Replacing tappet. (all) Incl. : (1) Detaching and attaching engine (6D5). (2) Conditioning engine. Increase: 10.0hr. for old tappets (6D).	Tappet worn. Tappet is broken. Tappet system in general is out of order.	16.6	9.0	4.0
Valve 03−35				
Replacing valves. (all) (present condition) Incl. : (1) Detaching and attaching cylinder head (2) Correcting and lapping valve seat (3) Conditioning engine (A)	Inlet valve is broken. Exhaust valve is broken.	10.0	11.0	12.5
Lapping valve seat surface (all) Incl : (1) Detaching and attaching cylinder head. (2) Conditioning engine (A)	Valve seat worn. Contact of valve seat with valve is no good. Valve seat fell off.	—	—	—

NAME OF WORK	NAME OF TROUBLE	MODEL		
		6D6 (6D31-T)	6D1 (6D15-T)	6D2 6D22-T 6D22-TC
Replacing valves (6 or 8 pcs.) Incl. : (1) Detaching and attaching cylinder head. (2) Correcting and lapping valve seat. (3) Conditioning engine (A).	Inlet valve is broken. Exhaust valve is broken.	—	—	—
Replacing valve guides (all) Incl. : (1) Detaching and attaching cylinder head. (2) Conditioning engine (A). (3) Correcting and lapping valve seat.	Valve guide is worn. Valve is seized. Oil level on valve guide fall. Valve guide fell off	10.9	11.7	13.3
Replacing valve guides (one side) Incl. : (1) Detaching and attaching cylinder head. (2) Conditioning engine (A). (3) Correcting and lapping vale seat.	Valve guide is worn. Valve guide is sized. Oil level on valve guide fall. Valve guide fell off	—	—	—
Replacing valve springs. (all) Incl. : Adjusting valve clearance. Excl. : Detaching and attaching cylinder head.	Valve spring is broken. Valve spring is fatigued	3.4	3.8	4.8
Replacing valve spring (1 cylinder) (present machine) Incl. : Adjusting valve clearance Excl. : Detaching and attaching cylinder head Add 0.3hr. for medium size and 0.6hr for large size as one cylinder increases.	Valve spring is broken. Valve spring is fatigued.	—	—	—
Timing gear (chain) casing 08 – 40				
Detaching/attaching or replacing timing gear casing	Timing gear (chain) casing makes an unusual sound. Timing gear (chain) casing parts are faulty. Oil leaks from gasket. Timing gear casing system in general is out of order	4.5	—	—
Replacing timing gear casing packing.	Oil leaks from gasket.	4.5	—	—
Detaching, attaching and replacing timing gear casing cover.	Timing gear casing in general is out of order.	—	—	—
Replacing cam shaft gear and idle gear.	Idle gear parts are defective. Cam shaft gear is installed incorrectly. Cam shaft gear parts are defective.	5.3	—	—
Replacing idle gear bushing Note : Flywheel housing is dismantled.	Timing gear casing in general is out of order.	—	0.8	0.9
Crank shaft 09 – 51				
Detaching/attaching or replacing crank shaft. Incl. : (1) Detaching/attaching engine. (2) Adjusting idling.	Refer to Fault Code Table.	24.0	30.0	35.0
Replacing crank shaft rear oil seal. (present machine) Incl. : Detaching and attaching transmission and flywheel	Oil leaks from rear oil seal.	7.0	7.5	8.5
Detaching/attaching or replacing crank pulley. (present machine) Incl. : Detaching and attaching radiator shroud and fan	Crank shaft pulley parts are faulty. Crank shaft pulley nuts are slackened	3.0	3.5	4.0
Detaching/attaching or replacing flywheel Incl. : Detaching and attaching transmission.	Flywheel mounting bolts are broken. (incl. loosening)	6.5	7.0	8.0
Detaching/attaching or replacing flywheel ring gear. (single body)	Flywheel ring gear is worn. Flywheel ring gear is broken.	0.5	0.5	0.6
(Replacing flywheel pilot bearing. (single)	Flywheel pilot bearing parts are faulty.	0.2	0.2	0.2
Replacing crank shaft front oil seal. (present machine) Incl. : (1) Detaching and attaching fan and front cover. (2) Detaching and attaching radiator shroud (lower)	Oil leaks from front oil seal	5.0	4.5	4.8

NAME OF WORK	NAME OF TROUBLE	MODEL		
		6D5 (6D31-T)	6D1 (6D15-T)	6D2 (6D22-—) (6D22-TC)
Replacing crank shaft gear. (present vehicle)	Crank shaft gear is worn. Crank shaft gear is broken.	—	—	—
Connecting rod 03 – 52				
Correcting curvature of connecting rod. (1 pc. single)	Connecting rod is bent.	—	—	—
Replacing connecting rod bearings. (all)	Bearings are worn. Bearings are seized	4.8	5.0	6.5
Replacing connecting rod bearings. (1 set) Add 0.4hr. at one pc. increases.	Bearing is worn. Bearing is seized	—	—	—
Replacing small end bushing. (set by set)	Small end bushing is worn. Small end bushing is seized.	—	—	—
Piston 03 – 68				
Detaching/attaching or replacing pistons. (all) (present vehicle) Incl. : (1) Conditioning engine (A). (2) Adjust nozzle. Add 0.5hr. each time one pc. decreases	Piston is broken. Piston is seized. Oil consumption of engine is large. Piston system in general is out of order. Piston and piston pin make abnormal sound	17.0	18.0	19.0
Detaching/attaching or replacing piston rings. (all) (present vehicle) Incl. : (1) Detaching/attaching cylinder head oil pan. (2) Checking and correcting nut. (3) Scraping off carbon. (4) Conditioning engine (A). (5) Adjusting nozzle.	Engine consumes much oil. Piston rings wore off. Piston rings is broken. Oil dried out of piston ring. Piston system in general is out of order.	16.0	16.5	17.0
Intake manifold 03 – 60				
Detaching/attaching or replacing inlet manifold. (1 pc) Incl. : Replacing gasket.	Intake manifold is broken. Intake manifold is porous. Gas leaks from intake manifold gasket. Intake manifold system in general is out of order.	1.5	1.5	2.0
Detaching/attaching or replacing inlet manifold. (one side) Incl. : Replacing gasket	Intake manifold is broken. Intake manifold is porous. Gas leaks from intake manifold gasket. Intake manifold system in general is out of order.	—	—	—
Air cleaner 03 – 61				
Replacing and cleaning air cleaner.	Air cleaner bracket is broken. Air cleaner casing parts are defective. Air cleaner system in general is out of order.	—	—	—
Cleaning or replacing air cleaner element.	Element is failed. Element is in trouble or other fault is the cause.	—	—	—
Retightening hose clamps. (7 places)	Air cleaner system in general is out of order.	—	—	—
Exhaust manifold 03 – 65				
Detaching/attaching or replacing exhaust manifold. Incl. : Replacing gasket.	Exhaust manifold is broken. Gas leaks from exhaust manifold gasket. Exhaust manifold system in general is out of order.	1.2	1.5	1.5
Detaching/attaching or replacing exhaust manifold. (one side) Incl. : Replacing gasket.	Exhaust manifold is broken. Gas leaks from exhaust manifold gasket. Exhaust manifold system in general is out of order.	—	—	—
Oil 03 – 70				
Replacing engine oil.		0.5	0.6	0.6
Oil filter 03 – 71				
Replacing oil filter assy	Oil leaks from oil filter. Oil filter casing is damaged. Oil filter head is scored. Oil filter system in general is out of order.	1.0	1.0	1.0
Cleaning or replacing oil filter ass'y. (1 set)		0.5	0.5	0.5

NAME OF WORK	NAME OF TROUBLE	MODEL		
		6DS (6D31-T)	6D1 (6D15-T)	6D2 (6D22-T) (6D22-TC)
Inspecting or replacing relief valve. Excl. : Detaching and attaching oil filter ass'y.	Relief valve parts are faulty.	0.4	0.4	0.4
Turbocharger 03−62				
Detaching/attaching or replacing turbocharger ass'y		—	2.7	2.8
Overhauling turbocharger. (Staplet Incl. : Cleaning (1 pc.).		—	1.9	1.9
Detaching/attaching or replacing 2-stock oil filter ass'y	Oil leaks from oil filter. Oil filter casing is damaged. Oil filter head is damaged. Oil filter system in general is out of order.	—	—	—
Oil pan 03−72				
Detaching and attaching oil pan and replacing gasket.	Oil leaks from oil pan gasket. Oil pan parts are faulty. Oil pan system in general is out of order.	2.5	2.8	3.3
Retightening oil pan fastening bolts		0.5	0.5	0.7
Replacing oil level gauge guide or packing.	Oil level gauge parts are defective.	—	—	—
Oil piping 03−74				
Replacing oil piping. (between filter and cooler)	Oil leaks from oil piping. Oil piping system in general is out of order.	0.3	—	—
Replacing breather pipes. (2 pcs.)	Oil piping system in general is out of order.	0.3	0.5	0.8
Oil pump 03−75				
Detaching/attaching or replacing oil pump.	Refer to fault code table.	1.0	4.3	4.5
Overhauling oil pump ass'y. Incl. : Detaching/attaching oil pump.	Refer to fault code table.	—	—	—
Overhauling oil pump. Excl. : Detaching and attaching oil pump.	Refer to fault code table.	1.0	1.0	1.0
Detaching/attaching or replacing oil strainer	Oil screen is installed incorrectly. Oil screen is broken. Oil screen is clogged. Oil screen stay is broken. Oil pump system in general is out of order.	3.3	3.5	3.8
Engine support 03−80				
Replacing front cushion rubber. (one side)	Front mount bracket rubber is broken. Engine support in general is out of order.	0.3	0.7	1.2
Replacing rear cushion rubber. (one side)	Rear mount bracket rubber is broken. Engine support in general is out of order.	0.9	0.9	1.5

2.4 EXHAUST SYSTEM

NAME OF WORK	NAME OF TROUBLE	MODEL		
		6DS (6D31-T)	6D1 (6D15-T)	6D2 (6D22-T) (6D22-TC)
Main muffler 04−20				
Replacing muffler ass'y.	Main muffler (rear muffler) is broken. Main muffler or other part is in trouble.	—	—	—
Tail pipe 04−40				
Detaching/attaching or replacing rear exhaust pipe.	Gas leaks from pipe flange gasket. Tail pipe parts are faulty.	—	—	—
Support 04−50				
Replacing pipe stay.	Muffler hanger parts are faulty. Pipe hanger parts are faulty. Support system in general is out of order.	—	—	—
Replacing pipe bracket.	Muffler hanger parts are faulty. Pipe hanger parts are faulty. Support system in general is out of order.	—	—	—

2.5 FUEL SYSTEM

NAME OF WORK	NAME OF TROUBLE	MODEL		
		6D5 (6D31-T)	6D1 (6D15-TI	6D2 (6D22-T 6D22-TC)
Engine control 05 – 10				
Replacing return spring.	Engine control system in general is out of order.	—	—	—
Replacing flexible wire.	Metal wire parts are faulty. Engine control system in general is out of order	—	—	—
Replacing fuel button.	Fuel button (throttle wire)parts are defective Engine control system in general is out of order.	—	—	—
Replacing engine stop wire & button.	Fuel stop wire parts are faulty. Engine control system in general is out of order	—	—	—
Replacing decomp lever assy.	Engine control system in general is out of order.	—	—	—
Detaching/attaching or replacing decomp shaft.	Engine control system in general is out of order.	—	—	—
Replacing return spring.	Engine control system in general is out of order.	—	—	—
Fuel injection pump 05 – 30				
Detaching and attaching or replacing injection pump. Incl. : (1) Adjusting injection timing. (2) Adjusting idling.	Fuel injection pump malfunctions. Fuel injection pump develops leakage. Fuel injection pump system in general is out of order	4.0	2.5	2.5
Overhauling injection pump. (single) Incl. : Disassembling fuel feed pump Excl. : Disassembling auto timer.	Fuel injection pump malfunctions. Fuel injection pump develops leakage. Fuel injection system in general is out of order.	—	—	—
Injection pump test	Refer to Fault Code Table.	—	—	—
Overhauling auto timer assy. (single)		—	—	—
Replacing injection pump coupling. Incl. : Detaching/attaching injection pump	Pump coupling parts are faulty.	—	—	—
Detaching/attaching or replacing injection pump.	Fuel injection pump malfunctions.	—	—	—
Replacing delivery valve gaskets (all)	Oil leaks from fuel injection pump	—	—	—
Fuel injection pipe 05 – 35				
Replacing injection pipe. (1 pc.) Add 0.2hr. each time one pc. increases.	Injection pipe is cracked. Injection pipe system in general is out of order.	0.5	0.5	0.5
Nozzle holder 05 – 40				
Detaching/attaching or replacing nozzle holders. (all) Incl. : Nozzle test	Nozzle malfunctions. Nozzle holder system in general is out of order.	1.8	2.1	2.5
Detaching/attaching or replacing nozzle holder. (1 pc.) 0.2hr. for medium and 0.3hr. for large size each time one pc. increases. Incl. : Nozzle test.	Nozzle malfunctions. Nozzle holder system in general is out of order	0.8	1.1	1.3
Detaching/attaching or replacing nozzles. (all) Incl. : Nozzle test.	Nozzle malfunctions Nozzle holder system in general is out of order	—	—	—
Replacing nozzle. (1 pc.) Add 0.3hr. and 0.4hr. for large size each time one pc. increases. Incl. : Nozzle test.	Nozzle malfunctions. Nozzle holder system in general is out of order.	—	—	—
Detaching/attaching or replacing nozzle tube. Excl. : Detaching and attaching head. Incl. : Detaching and attaching nozzle. Add 0.2hr. for an increase of one pc.	Nozzle tube is damaged. Water leaks from nozzle tube. Nozzle holder system in general is out of order.	—	—	—
Fuel pump 05 – 45				
Replacing fuel feed pump. Incl. : Venting air.	Fuel pump makes an unusual sound. Fuel leaks from fuel pump. Oil leaks from fuel pump. Fuel pump parts are faulty. Fuel pump system in general is out of order.	0.8	0.8	0.8

NAME OF WORK	NAME OF TROUBLE	MODEL		
		6D5 (6D31-T)	6D1 (6D15-T)	6D2 (6D22-T) (6D22-TC)
Overhauling fuel feed pump (Engine)	Fuel pump makes an unusual sound. Fuel leaks from fuel pump. Oil leaks from fuel pump. Fuel pump parts are faulty Fuel pump system in general is out of order.	1.0	1.0	1.0
Cleaning fuel pump gauze filter.		0.4	0.4	0.4
Fuel Filter 05–50				
Replacing fuel filter ass'y.	Fuel filter is broken Fuel filter is clogged. Fuel filter system in general is out of order.	0.6	0.6	0.8
Replacing or cleaning fuel filter element.	Fuel filter broken. Fuel filter is clogged Fuel filter system in general is out of order.	0.5	0.6	0.5
Fuel piping 05–55				
Replacing engine fuel pipe. (1 pc.)	Sections related to fuel pipe (incl. hose) and engine are damaged. Leakage occurs on sections related to fuel pipe (incl. hose) and engine. General trouble with fuel pump (incl. hose) and engine.	0.5	0.5	0.5

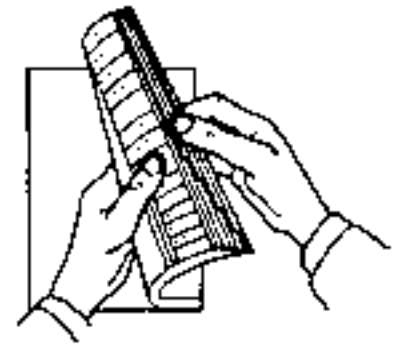
2.6 AUXILIARY EQUIPMENT (COMPRESSOR)

NAME OF WORK	NAME OF TROUBLE	MODEL		
		6D5 (6D31-T)	6D1 (6D15-T)	6D2 (6D22-T) (6D22-TC)
Compressor 05–10				
Detaching/attaching or replacing air compressor ass'y.	Refer to their each table.	—	—	4.0
Overhauling air compressor ass'y. Excl. : Detaching and attaching. Add 1.2hr for 2-cycle one	Compressor related trouble in general.	—	—	2.0
Replacing air compressor valve.	Compressor related trouble in general.	—	—	1.0
Replacing air compressor unloader valve.	Air leaks from compressor. Compressor related trouble in general.	—	—	0.6
Replacing oil seal of air compressor crank shaft.	Compressor related trouble in general.	—	—	3.6
Replacing air compressor bearing	Compressor related trouble in general.	—	—	5.0

SHOP MANUAL model SK310 SK310LC

TABLE OF CONTENTS

○How to Index each Shop Manual Section
The SYSTEMS of this shop manual consists of 9 headings as shown above. Each section can be easily referred to by indexes appended to the margin of the page as indicated on the right. Please use the indexes for speedy reference.



KOBELCO

SYSTEMS

Book code No. S5LC1005E

SK310III
SK310LCIII List of Shop Manual SYSTEMS Section

Index No.	Title	Book Code No. / Distribution Year-Month		
LC12	HYDRAULIC SYSTEM	S5LC1205E 1995-03		
LC15	SWING FRAME	S5LC1506E 1995-03		
LC18	TRAVEL SYSTEM	S5LC1806E 1995-03		
LC21	ATTACHMENTS	S5LC2106E 1995-03		
LC22	CONTROL SYSTEM	S5LC2205E 1995-03		
LC25	ELECTRICAL SYSTEM	S5LC2505E 1995-03		
LC26	AIR-CONDITIONER SYSTEM	S5LC2605E 1995-03		
LC29	TROUBLE SHOOTING	S5LC2901E 1995-03		
	Applicable Machines	LC03801~ YC01101~		

Book code No. S5LC1205E

KOBELCO

SHOP MANUAL

SK310
SK310LC

HYDRAULIC SYSTEM

LC12

TABLE OF CONTENTS

KOBE STEEL, LTD.

Applicable Machines

LC03801~

YC01101~

Revision	Date of Issue	Remarks
First edition	March, 1995	S5LC1205E K

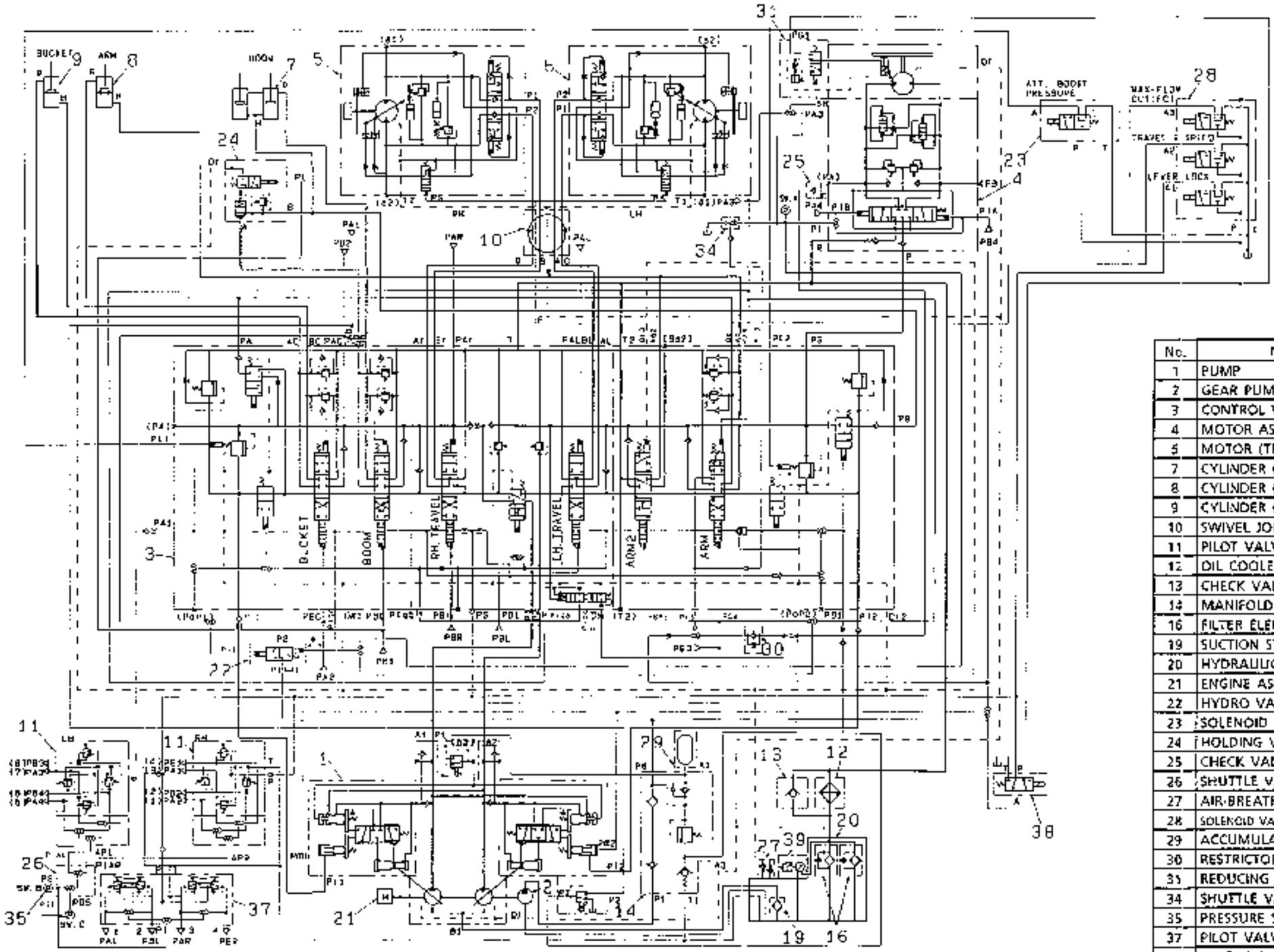
1. SUMMARY

This machine is featured by the following functions embodied in its hydraulic circuits, aiming at easy operation, safety, handling of large masses of material and reduced fuel consumption.

Table 1

Performance	Device	Function	Features
Easy operation and safety	Travel	• Travel straight • Boost pressure for travel • Travel pilot operation • Automatic parking brake	• Straight travel at composite operation • Maximum travel relief pressure attainable • Lever stopper adjustment not required • Mechanical brake built in the travel motor
	Swing	• Swing flasher lights • Swing control valve provided separately • Swing priority circuit (at simultaneous operation of arm digging/swing motions) • Automatic swing parking brake • Delay brake operated by reducing valve • Anti-turnover function by swing-reactionless valve	• Warns the people around the machine at swing motion • Promotes operability in swing motion • Ease in oblique pulling by the arm and in digging by pressing force of the swing unit • Prevents drift in the swing motion on a slope • Delays the action of the parking brake when swing inertia force occurs • Ease in positioning the machine by preventing swing-reaction that occurs when swing inertia stops
	Attachment	• Pilot control method • Variable loading mode • Holding valve (Boom lock) • ATT boost pressure • Operation patterns changeable	• Only minimal force required in manipulation • Boom and swing speeds variable according to loading condition • Prevents natural fall resulting from internal leakage of the boom cylinder when the attachment stops • Creates power when you need extra power • Operating pattern which may be selected by terminal connection
	Other	• Enclosed semi-automatic pressurized hydraulic oil tank • Suction side : suction strainer • Return side : filter element and drain filter • Pilot circuit : line filter in manifold block • Cooling of hydraulic oil by oil cooler	• Prevents contamination of hydraulic oil and promotes self-suction capacity of the pump • Prevents hydraulic components from failing • Prevents contamination of hydraulic oil • Prevents malfunctioning of pilot operating circuit • Prevents deterioration of hydraulic oil
Handling of large masses of material	Pump	• Full horsepower control	• Effective use of engine power by two variable displacement pumps
	Travel	• 2-speed travel	• Travel speed as fast as 5.5km / hr (3.4MPH)
	Attachment	• Conflux for boom raising • Fixed re-circulation circuit for boom lowering • Conflux circuit at heavy-duty arm digging • Variable re-circulation circuit at light-duty arm digging • Conflux circuit for arm extending • Bucket conflux circuit	• Speed increase for boom raising • Bucket manipulation is positive in combined operation with bucket • Speed increase at heavy-duty arm digging • Speed increase at light-duty arm digging • Speed increase at arm extending • Speed increase at arm extending • Speed increase at bucket digging and extending
Low fuel consumption	Pump	• Negative flow control • Negative control relief cut • Max. flow cut	• Minimum flow at neutral • Minimum flow by relieving the main relief valve • Maximum flow cut of pump in EC mode
	Micro-computer	• Selection of KPSS work mode switch • Automatic accel	• An engine revolution suited for an work mode • Repeated changes in the engine revolution during waiting for a dump truck and reduction in fuel consumption and noise levels

2. HYDRAULIC CIRCUIT DIAGRAM AND DESCRIPTION OF COMPONENTS



No.	NAME	TYPE
1	PUMP	2437U502F3
2	GEAR PUMP	2437U469F1
3	CONTROL VALVE	2436U2885F1
4	MOTOR ASSY (SWING)	2441U947F2
5	MOTOR (TRAVEL)	2441U787F3
7	CYLINDER (BOOM)	KYBØ150×Ø100-1515
8	CYLINDER (ARM)	KYBØ170×Ø120-1835
9	CYLINDER (BUCKET)	KYBØ150×Ø100-1204
10	SWIVEL JOINT	24100J15939F1
11	PILOT VALVE (O/P)	LE30V00002F1
12	OIL COOLER	—
13	CHECK VALVE	2436R394S4
14	MANIFOLD BLOCK	2436R914F2
16	FILTER ELEMENT (RETURN)	YN50V00001P1
19	SUCTION STRAINER	2446R347F2
20	HYDRAULIC TANK ASSY	—
21	ENGINE ASSY	6D22-T
22	HYDRO VALVE	2436U2675F1
23	SOLENOID VALVE (ATT:B)	YN35V00010F1
24	HOLDING VALVE (LOCK)	2436U2623F4
25	CHECK VALVE	2436U1171D31
26	SHUTTLE VALVE	2436U2887F2
27	AIR-BREATHER	2446U260F1
28	SOLENOID VALVE (LEVER LOCK)	YN35V00009F1
29	ACCUMULATOR	2445R373F1
30	RESTRICTOR VALVE	2436U1282D2106
31	REDUCING VALVE	—
34	SHUTTLE VALVE	2444R1111F7
35	PRESSURE SWITCH a, b, c	2437U1378
37	PILOT VALVE (TRAVEL)	2436U2888F1
38	SOLENOID VALVE	2436U1314F2
39	HYD OIL INDICATOR	24100U1436F1

3. FUNCTIONAL EXPLANATION OF HYDRAULIC CIRCUIT

(1) Color Coding Standard for Hydraulic Circuits

Bold black	6kgf/cm²(85 psi) or below	Toned black	Valve changed over
Green	7~32kgf/cm²(100~455 psi)	Red valve	Pressure acting
Red	32~50kgf/cm²(455~711 psi)	Red	
Orange	50kgf/cm²(711 psi) or over	solenoid valve	Solenoid valve electrified

NOTE :
The only flow and stanby circuit were displayed with coloring.

4. NEUTRAL CIRCUIT

We will explain the following functions here:

1) Negative flow control circuit (negative control circuit)
2) Relief cut circuit
3) ATT boost pressure circuit
4) FC mode circuit (max. flow cut)

4.1 NEGATIVE FLOW CONTROL CIRCUIT (HEREUNDER CALLED NEGA-CON)

Objective ; To save unwanted power consumption in neutral operation

Principle ; At neutral operation, the flow of the main pump passes through the control valve (hereunder shorten as C/V) and then the low pressure relief valve in the lowermost stream. This makes the pressure upstream of the low pressure relief valve more than 32kgf/cm² (455 psi), it is judged to be neutral.

Function ; 32kgf/cm² (455 psi) pressurized oil enters from the Pi1 and Pi2 ports of C/V to the Pi1 and Pi2 ports of the pump and pushes the pilot piston (643). Then it compresses the pilot spring (646) which causes the lever to press the spool (652) and compresses the return spring (654). The discharge pressure P1 is then admitted to the larger diameter part of the servo piston via port C1. The areal difference of the piston actuates the pump tilting pin (681) so as to decrease the delivery rate of the pump.

4.2 RELIEF CUT CIRCUIT

Objective ; To save energy at relief action

Principle ; The flow at main relief action enters the negative control circuit.

Function ; The same function as para. 4.1 Nega-Con is displayed.

4.3 ATT BOOST PRESSURE CIRCUIT

Objective ; To exert extra power when needed.

Principle ; The main relief pressure increase by about 10%.

Function ; The circuit is activated electrically if the button switch in the bucket operating lever grip is kept pressed. This causes the primary pilot pressure to enter ports PLL, PL2 of C/V from the AS port of the solenoid selector valve (23) and to raise the relief pressure.

4.4 FC MODE CIRCUIT (MAX-FLOW CUT CONTROL)

Objective ; If the button switch is changed over, the speed is decreased to 65% of normal speed when fine delicate operation is needed.

Principle ; The max. flow of the pump is cut to 65%.

Function ; If the FC mode is selected, the primary pilot pressure enters ports Pm1, Pm2 of the pump through port A3 of the solenoid valve (28), pushes the piston (648) and reduces the flow the same way as Nega-Con.

Fig. 2 Neutral circuit, lever lock release, ATT boost or heavy lift, FC mode (MAX FLOW CUT)

5. TRAVEL CIRCUIT

The following are explained in this section :

1) Travel pilot circuit
2) Travel (AUTO) 2-speed selection
3) Auto accel
4) Travel speed 5.5km/h

5.1 TRAVEL PILOT CIRCUIT

Objective ; For slow start, slow stop.

Principle ; To operate the travel spool of C/V by the secondary proportionate pilot pressure of the travel pilot valve.

Function ; <Pilot circuit>

The travel lever and the travel pedal actuate the pilot valve (37) directly. For instance, if advance action is performed, secondary proportionate pilot pressure PAL, PAR come out of the pilot valve (37), enter ports PAL, PAr of C/V, and actuate the travel spool (301).

<Main circuit>

The hydraulic pressure of the No.1 pump (engine side) actuates the RH travel motor via the RH travel spool (301), while the hydraulic pressure of the No.2 pump operates the LH travel motor by way of the LH travel spool.

5.2 TRAVEL 2-SPEED SELECTION

Objective ; To select a low-speed high-torque mode or a high-speed low-torque mode by the switch.

Principle ; The primary pilot pressure alter the tilting angle of the swash plate of the variable displacement 2-speed motor.

Function ; If you depress the momentary switch with a rabbit and tortoise mark the solenoid the primary pilot pressure goes out of port A2, enters port PS of both the RH and LH travel motors (5) and changes over the variable displacement motors to the 2nd speed.

5.3 AUTO ACCEL

Objective ; If the travel and the ATT actions are performed with the auto accel select switch on, the engine takes decel action.

Principle ; If the secondary pilot pressure takes up the auto accel.

Function ; If the auto accel select switch is depressed (E/G mark), the secondary select pressure goes out of the travel pilot valve (37) and the pilot valve (11) and turns on the pressure switch PSW C of the shuttle valve (26). If the pressure switch on, takes up the auto accel.

5.4 TRAVEL SPEED 5.5km/h

Objective ; Travel speed as fast as 5.5km/h.

Principle ; The secondary pressure that selects travel operation turns off the PSW B (normally on), releases the solenoid valve (38) and permits the machine to travel in the FC mode.

Function ; The solenoid valve (38) is normally on except at travel :
The secondary pilot pressure is blocked at the inlet of the valve. Therefore, the solenoid valve operates in the select mode during ATT operation.

Fig. 3 Travel (forward) circuit at 2-speed selected

6. SWING CIRCUIT

The following are explained in this section :

1) Swing pilot circuit
2) Parking auto brake for swing
3) Delay brake by reducing valve
4) Anti-cavitation circuit to dampen inertia force in swing action
5) Swing flasher lights in swing action
6) Prevention of reaction by the swing-reactionless valve

6.1 SWING PILOT CIRCUIT

Function : If swing action is taken, the secondary proportionate pilot pressure PA4 or PB4 comes out of the pilot valve (11) and actuates the swing spool.

6.2 AUTO SWING PARKING BRAKE

Objective ; To prevent swing drift when operation is neutral.

Principle ; When swing action is performed, the spring action is released by primary pilot pressure.

Function ; In both the swing action and the arm digging, the secondary pilot pressure enters port SH of the reducing valve and changes over the spool. Then the primary pilot pressure releases the parking brake by way of port PG1.

6.3 DELAY BRAKE BY REDUCING VALVE

Objective ; To prevent the parking brake when swing inertia occurs.

Principle ; The release oil is throttled to delay braking.

Function ; If operation is brought to neutral, the oil returned from the brake release cylinder is delayed 5~8 seconds afterwards.

6.4 ANTI-CAVITATION CIRCUIT WHEN SWING INERTIA OCCURS

Objective ; To prevent anti-cavitation when swing action is decelerated of stopped.

Principle ; If the operating lever is at deceleration or at neutral when swing inertia occurs, the relieved pilot pump oil is replenished to prevent anti-cavitation

Function ; The boost oil of 7kgf/cm² (100 psi) comes out of port A3 of the manifold block, passes through the check valve (25) and enters port C of the swing control valve to replenish oil.

6.5 LIGHTING OF SWING FLASHER AT SWING ACTION

Objective ; To warn around the swing action is being performed.

Principle ; The selected secondary proportionate pilot pressure causes the swing flasher to flash alternately during swing action.

Function ; If the pressure switch PSW.A is turned on by secondary swing proportionate pilot pressure, the oscillator in the flasher unit is turned on which turns on the swing flasher.

6.6 PREVENTION OF SWING REACTION BY SWING-REACTIONLESS VALVE

Objective ; To prevent swing reaction within 1 time after swing action stops.

Principle ; While the motor is being reversed, high pressure oil is bypassed from A to B and visa versa, thereby preventing reversing pressure from occurring.

Function ; Reversing prevention is performed in the swing-reactionless valve of the swing motor.

Fig. 4 Swing (LH) circuit at preventing swing reaction

7. BUCKET CIRCUIT

The following are explained in this section:

1) Pilot circuit for bucket digging
2) Bucket digging
3) Pump flow increase action
4) Power shift control (reduced power control)
5) Pilot circuit for bucket discharge
6) At bucket discharge
7) Simultaneous full-power control (overload prevention)

7.1 BUCKET DIGGING

<Pilot circuit>

If bucket digging operation is performed, the pilot secondary proportionate pressure PA2 comes out of the pilot valve (11), enters port PBC of C/V and controls the bucket spool.

7.2 CONFLUX 2-PUMP IN VALVE AT BUCKET DIGGING

Objective; To speed up the bucket digging motion

Principle; The secondary proportionate pilot pressure switches over the hydro valve (22), causes the primary pilot pressure to enter the side bypass circuit in the control valve, changes over the travel priority valve in the control valve, thereby combining oil streams of the two pumps.

Function; <Pilot circuit>

The secondary proportionate pilot pressure PA2 enters port Pi1 the hydro valve (22) and changes it over. The primary pilot pressure flows to P1 and P2, in that order, passes through port Pigd of the control valve and then the side bypass circuit (63), and changes over the travel priority valve (305) and the neutral cut valve (306).

<Main circuit>

Pressure oil which enters P1 and P2 of the control valve is combined with the oil in the control valve, comes out of port BC, and is supplied to port H of the cylinder.

7.3 PUMP FLOW INCREASE ACTION

Objective; To increase the pump flow in operation.

Principle; If the oil of the No.1 and No.2 pumps stop to flow to the low-pressure relief valve and when the negative control pressure falls below 6kgf/cm²(85psi), the controller judges that operation is underway.

Function; If port Pi1 and Pi2 of the pump falls below 6kgf/cm²(85psi), the pilot spring (646) extends. This pushes back the spool (652) by the action of the return spring (654). The pressured oil of the larger diameter part of the servo piston (532) returns to tank from port C1. The servo piston (532) is pushed to the larger diameter side by the pressure on the smaller diameter part. This causes the tilting pin (531) of the pump to increase the tilting angle of the pump, in order to increase the delivery rate of the pump.

7.4 POWER SHIFT CONTROL (REDUCED POWER CONTROL)

Objective; To control the pump power so the engine does not fail by overriding the engine power.

Principle; Secondary proportionate pressure Pf for solenoid (power shift pressure) by commands current enters the compensation piston to perform reduced power control.

Function; In the H, S or EC mode, the electromagnetic proportionate valve attached to the No.1 pump controls the electromagnetic proportionate secondary pressure Pf by command current from the KPSS controller. Then the secondary pressure Pf enters the compensation piston (621) decreases the delivery rate of the pump to perform reduced power control.

Fig. 5 Bucket circuit at digging conflux

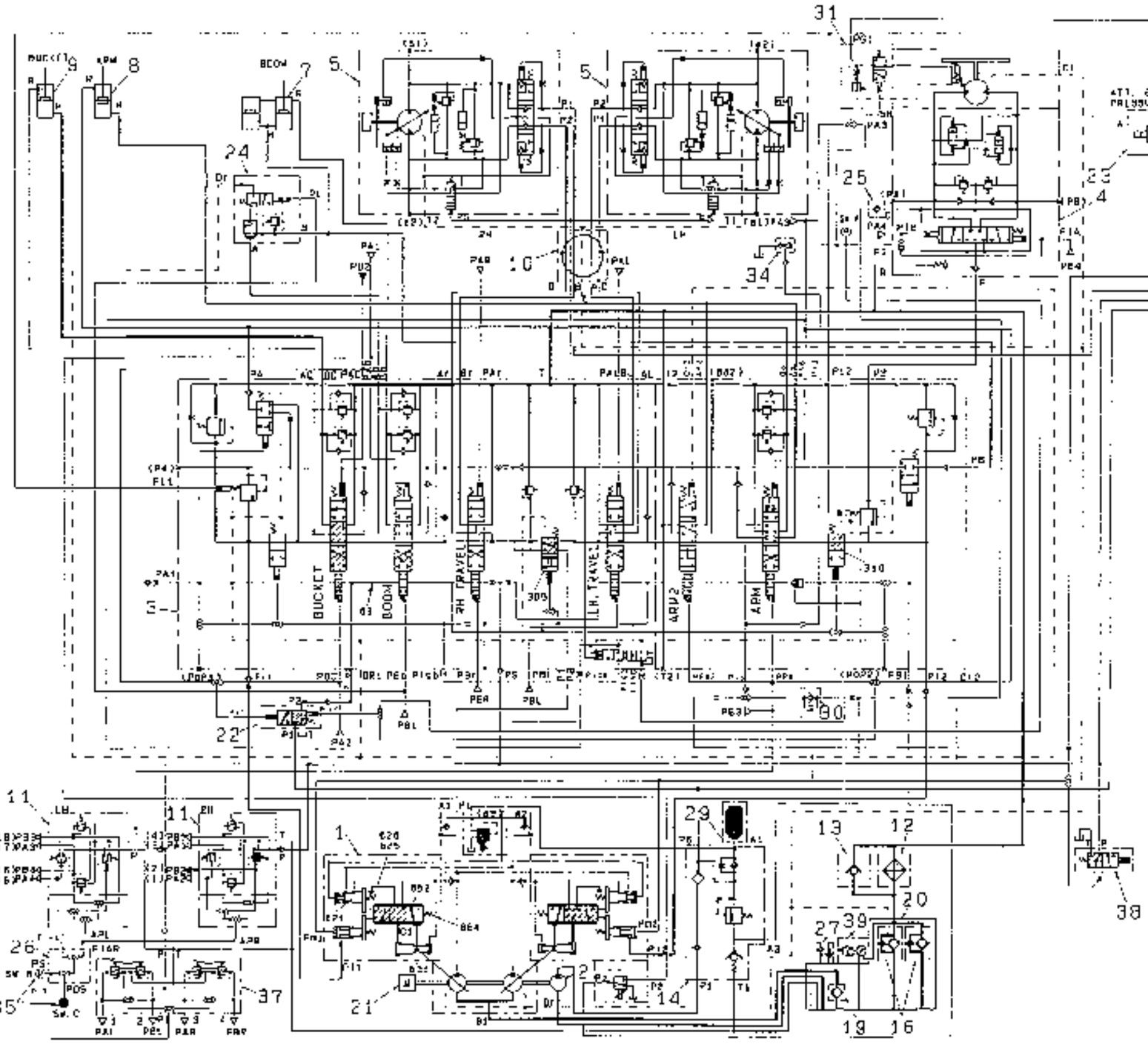


Fig. 6 Bucket circuit at discharge conflux

7.5 BUCKET DISCHARGE

<Pilot circuit>

If bucket operation is performed, the pilot secondary proportionate pressure PB2 comes out of the pilot valve (11), enters port PAC of C/V and controls the bucket spool.

7.6 CONFLUX 2-PUMP IN VALVE AT BUCKET DISCHARGE

Objective ; To speed up the bucket discharge motion

Principle ; The secondary proportionate pilot pressure switches over the hydro valve (22), causes the primary pilot pressure to enter the side bypass circuit in the control valve, changes over the travel priority valve in the control valve, thereby combining oil streams of the two pumps

Function ; <Pilot circuit>

The secondary proportionate pilot pressure PB2 enters port Pi1 the hydro valve (22) and changes it over. The primary pilot pressure flows to P1 and P2, in that order, passes through port Pigd of the control valve and then the side bypass circuit (63), and changes over the travel priority valve (305) and the neutral cut valve (306).

<Main circuit>

Pressure oil which enters P1 and P2 of the control valve is combined with the oil in the control valve, comes out of port AC, and is supplied to port R of the cylinder.

7.7 SIMULTANEOUS FULL-POWER CONTROL (OVERLOAD PREVENTION)

Objective ; To prevent the engine from being stopped due to overloads.

Principle ; The tilting angles of two pumps are controlled to the same value by $\frac{(P1 \div P2) \cdot q}{2\pi}$

Function ; If the discharge pressure Pd (P1) of the self pump or the discharge pressure P2 of the mating pump rises, P1 and P2 act upon the stepped part of the compensating piston (621). The compensating rod is thus pushed and moves till the outer spring (625) and the inner spring (626) balance with the hydraulic pressure. The compensating rod then pushes the spool (652) via the lever and compresses the return spring (654). The discharge pressure P1 is admitted to the larger diameter part of the servo piston by way of port C1, actuates the tilting pin (591) of the pump due to the areal difference of the piston and reduces the delivery rate of the pump.

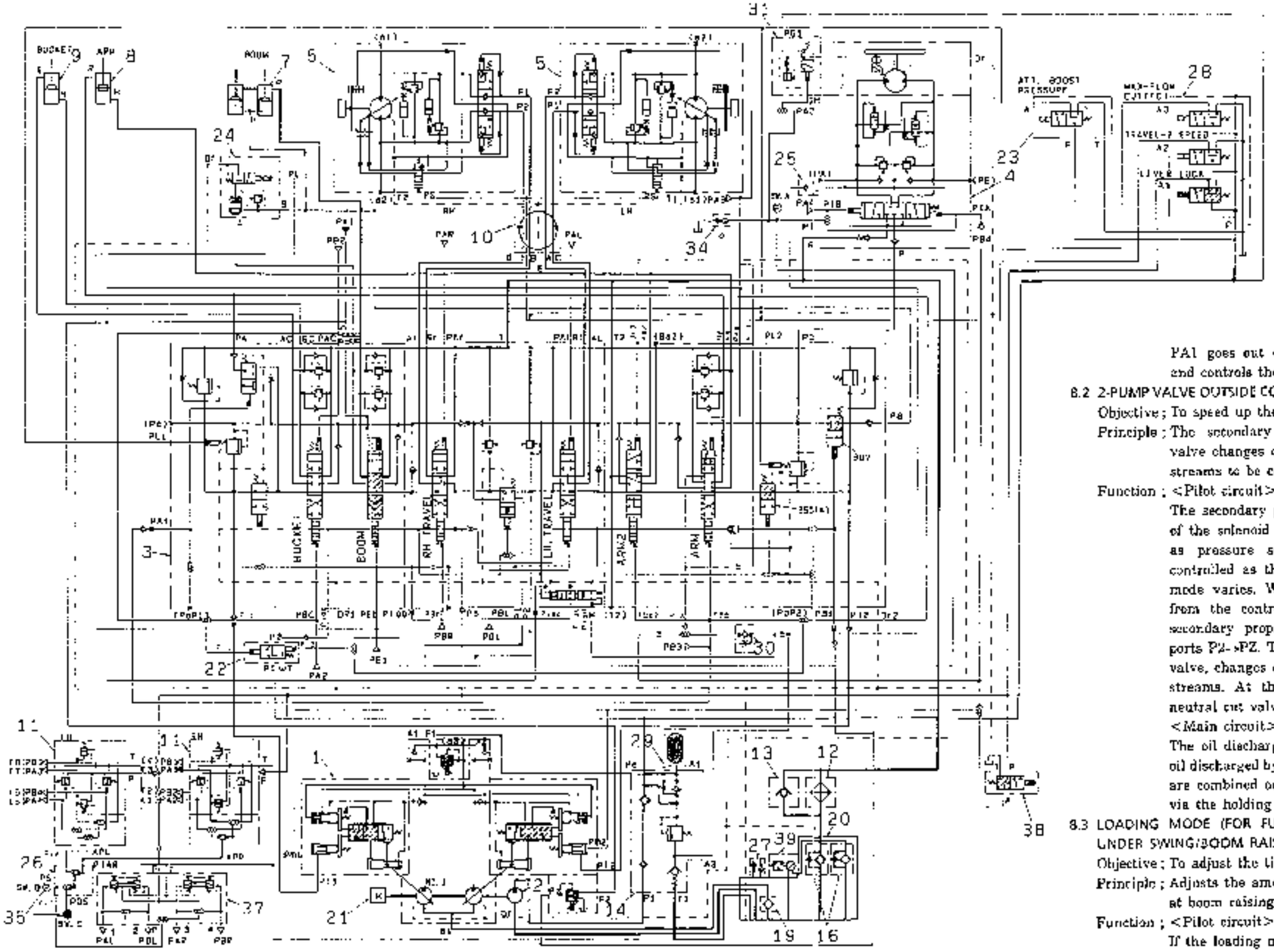


Fig. 7 Boom circuit at boom up conflux

8. BOOM CIRCUIT

The following are explained in this section:

1) Pilot pressure for boom raising
2) 2-pump conflux for boom raising (at max. boom raising)
3) Simultaneous full-power control (overload prevention)
4) Pilot operation for boom lowering
5) Boom stop by holding valve, prevention of natural fall at neutral position
6) Fixed recycle circuit for boom lowering

8.1 PILOT CIRCUIT FOR BOOM RAISING

Function ; If boom raising operation is performed, secondary proportionate pilot pressure PA1 goes out of the pilot valve (11), enters port PAb of C/V and controls the boom spool.

8.2 2-PUMP VALVE OUTSIDE CONFLUX FOR BOOM RAISING (AT MAX BOOM UP)

Objective ; To speed up the boom raising motion.

Principle ; The secondary pressure of the electromagnetic proportionate valve changes over the boom conflux spool (307) and allows oil streams to be combined outside the valve.

Function ; <Pilot circuit>

The secondary proportionate pilot pressure PA1 enters port P2 of the solenoid proportionate valve attached to the No.2 pump as pressure source. The solenoid proportionate valve is controlled as the voltage of the potentiometer for the loading mode varies. With the boom raising at MAX, the amperage from the controller is maximized which also maximizes the secondary proportionate pressure (for the solenoid valve) to ports P2-sPZ. The pressure then enters port PB1 of the control valve, changes over the boom conflux spool (307) to combine oil streams. At the same time, the pressure changes over the neutral cut valve (306).

<Main circuit>

The oil discharged by the No.1 pump goes out of port Ab. The oil discharged by the No.2 pump goes out of port PB. Both streams are combined outside the valve and fed to the boom cylinder H via the holding valve (24).

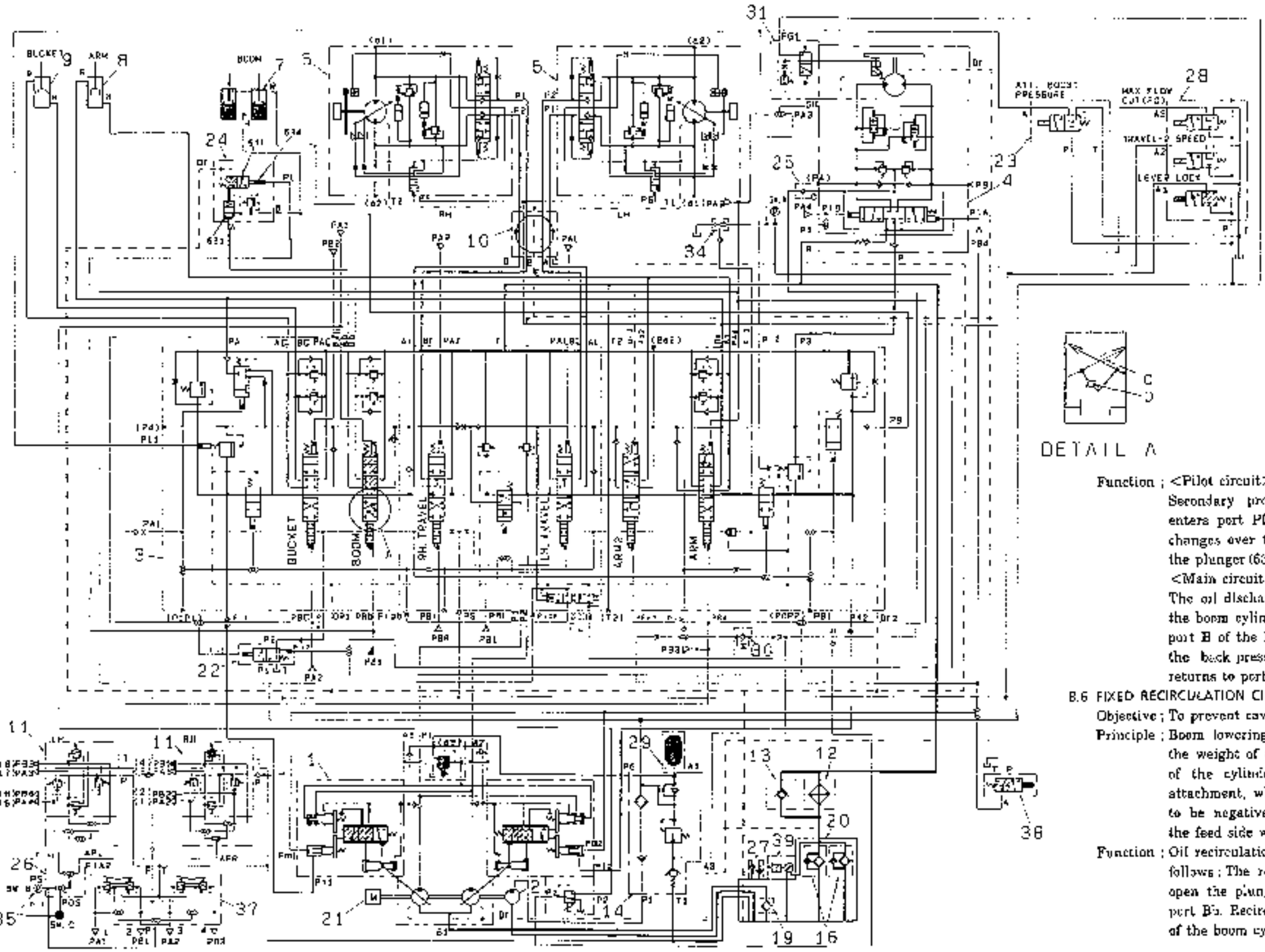
8.3 LOADING MODE (FOR FUNCTIONS, REFER TO THE COMPOSITE CIRCUIT UNDER SWING/BOOM RAISING.)

Objective ; To adjust the timing for loading onto dump trucks

Principle ; Adjusts the amount of oil streams combined outside two pumps at boom raising action.

Function ; <Pilot circuit>

If the loading mode switch is turned clockwise under para. 8.2, the voltage of the potentiometer falls. This decreases the secondary proportionate valve (for solenoid) to ports P2→PZ which in turn decreases the stroke of the boom conflux spool (307). This decreases the amount of oil combined in the main circuit for boom action.



DETAIL A

B.4 PILOT CIRCUIT FOR BOOM LOWERING

Function ; If boom lowering operation is performed, secondary proportionate pilot pressure PB1 goes out of the pilot valve (11), enters port PBb of C/V and controls the boom lowering.

B.5 PREVENTION OF NATURAL FALL OF BOOM AT STOP OR NEUTRAL POSITION

Objective ; To prevent natural fall when operation is neutral.

Principle ; Fall of the cylinder is prevented at neutral position by the valve seat of the holding valve.

Function ; <Pilot circuit>

Secondary proportionate pilot pressure for boom lowering enters port PL of holding valve (24), pushes the piston (634), changes over the spool (611) and removes the back pressure of the plunger (631).

<Main circuit>

The oil discharged by the No.1 pump is supplied to port R of the boom cylinder from port Bb of C/V. The returned oil enters port B of the holding valve (24) from port H of the cylinder. If the back pressure is let off from the plunger (631), the oil returns to port Ab of C/V past B and A in that order.

B.6 FIXED RECIRCULATION CIRCUIT FOR BOOM LOWERING

Objective ; To prevent cavitation when lowering the boom.

Principle ; Boom lowering action tends to speed up as oil is supplied by the weight of the attachment. The pressure on the return side of the cylinder is sufficiently high by the weight of the attachment, whereas the pressure on the feed side of it tends to be negative. Therefore, the returned oil is recirculated to the feed side within C/V.

Function ; Oil recirculation to port R of the boom cylinder is performed as follows ; The returned oil which enters port Ab of C/V pushes open the plunger (D) in the boom spool and is recirculated to port Bb. Recirculation stops as the pressure on the port R side of the boom cylinder becomes higher than that on the H side.

Fig. 8 Boom circuit at boom down recirculation

9. ARM CIRCUIT

The following are explained in this section :

1) Pilot circuit for arm digging
2) Variable recirculation circuit for light-duty arm digging
3) Sequence conflux circuit for heavy-duty arm digging
4) Pilot circuit for arm extending
5) 2-pump valve outside conflux circuit for arm digging

9.1 PILOT CIRCUIT FOR ARM DIGGING

Function ; If arm digging operation is performed, secondary proportionate pilot pressure PA3 goes out of the pilot valve (11), enters port PAa of C/V and actuates the arm spool

DETAIL C

9.2 VARIABLE RECIRCULATION CIRCUIT AT LIGHT DUTY ARM DIGGING

Objective ; To prevent cavitation at light duty operation and to speed up the digging operation.

Principle ; In light-duty arm digging operation in the air and on the ground, the pressure on the R side of the cylinder is sufficiently higher while that on the feed side is lower. The sub spool (recycle spool) in the arm spool throttles the returned oil to execute variable recirculation

Function ; <Pilot circuit>
7kgf/cm² (100 psi) pressure which enters port Pis of C/V acts on the sub spool of the arm spool, throttles the returned oil that enters port Ba of C/V from port R of the cylinder and reduces the opening area of (A).
<Main circuit>
The oil returned from port R of the cylinder is throttled by the 7kgf/cm² (100 psi) pilot pressure in the arm spool of C/V. The oil is variably recirculated to port Aa of C/V to decrease the oil returning to the tank.

Fig. 9 Arm circuit at light duty arm digging variable recirculation

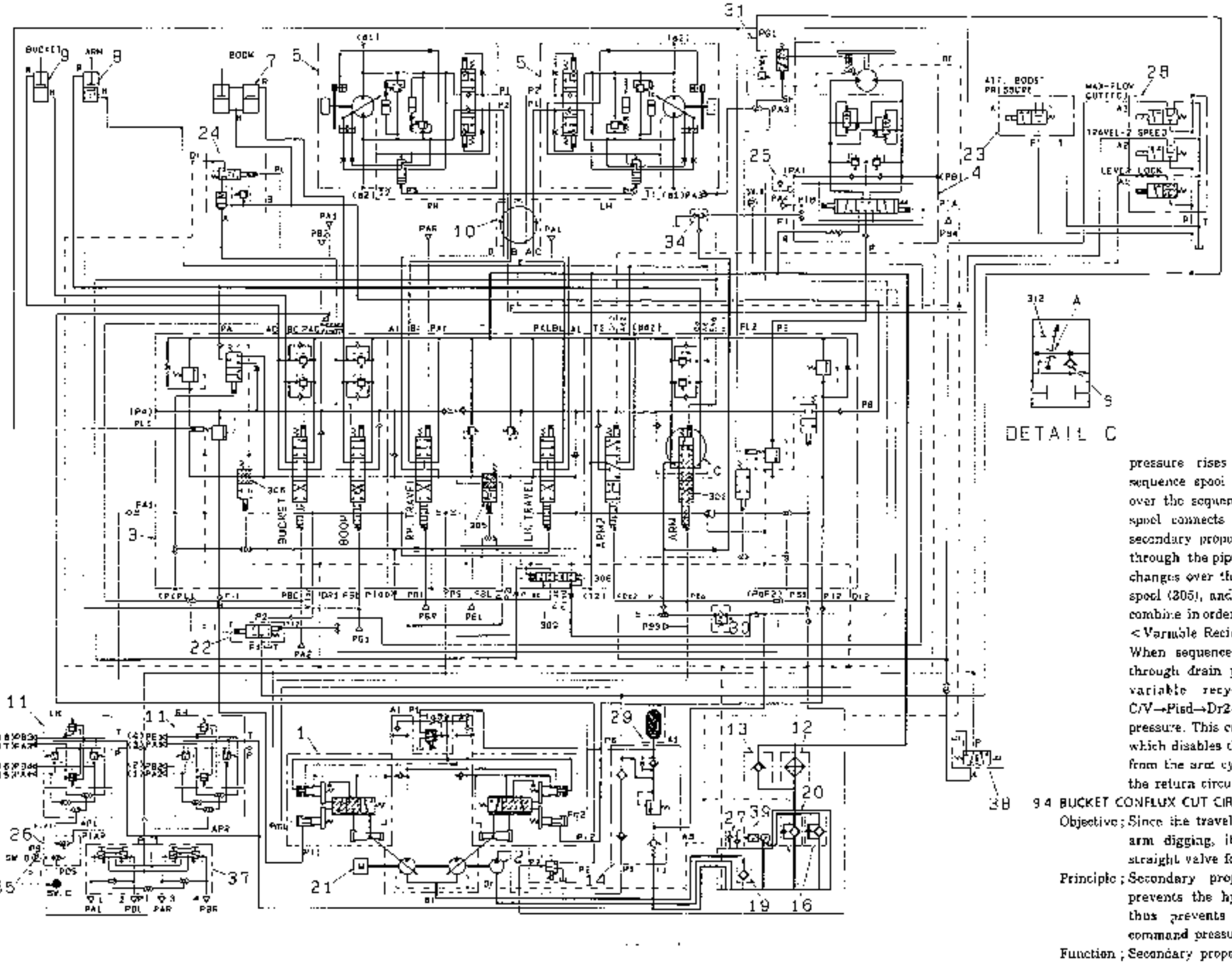


Fig. 10 Arm circuit at heavy duty digging sequence conflux

9.3 SEQUENCE CONFLUX CIRCUIT IN HEAVY DUTY ARM DIGGING

Objective : To speed up the heavy duty arm digging operation, and to increase digging power.

Principle ; The combination of a rise in the arm digging circuit pressure and the secondary proportionate pilot pressure for arm digging changes over the sequence valve. When the valve is changed over, oil streams by the two pumps are combined in the valve.

Function ; Sequence conflux action

When the pump P2 circuit pressure rises about 147kgf/cm² (2090 psi), it pushes the sequence spool (308), overcomes the spring force and changes over the sequence valve spool (308). The changing over of the spool connects port Pi9a with port Pi9c that is subject to secondary proportionate pilot pressure PA3 re-enters port Pi9b through the piping. The pilot pressure which enters port Pi9b changes over the bypass cut spool (306) and the travel straight spool (305), and causes the oil streams of pumps P1 and P2 to combine in order to speed up the action.

<Variable Recirculation Cut Function>

When sequence spool (308) is changed over, port Pi8d gets through drain port Dr. Consequently, the oil pressure of the variable recycle command circuit flows to Pi8 of C/V→Pi8d→Dr2→tank, in that order, to decrease the hydraulic pressure. This ceases to press sub spool (312) in arm spool (302) which disables the variable recycle function. All the oil returned from the arm cylinder head returns to the tank. This decreases the return circuit pressure and increases the digging power.

9.4 BUCKET CONFLUX CUT CIRCUIT AT ARM DIGGING

Objective ; Since the travel straight valve (305) has been changed over at arm digging, it is not necessary to change over the travel straight valve for conflux at bucket digging.

Principle ; Secondary proportionate pilot pressure for arm digging prevents the hydro valve (22) from being changed over and thus prevents bucket conflux by bucket conflux circuit command pressure.

Function ; Secondary proportionate pilot pressure PA3 for arm digging is admitted to port Pi2 of the hydro valve (22) and performs bucket digging conflux cut and bucket discharge conflux cut functions.

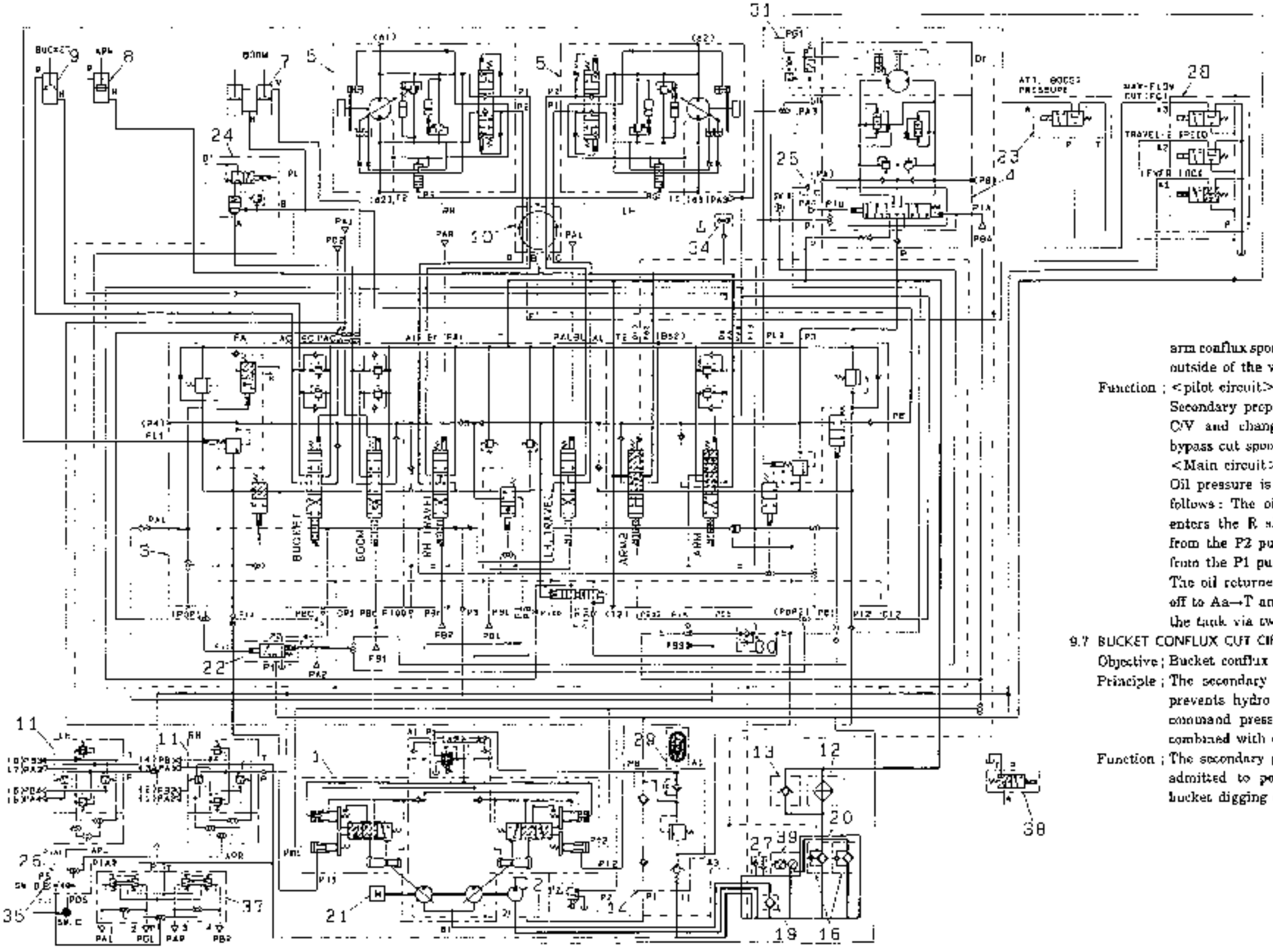


Fig. 11 Arm circuit at arm extend valve outside conflux

9.5 PILOT CIRCUIT FOR ARM EXTENDING

Function : If arm extending operation is executed, secondary proportionate pilot pressure PB3 goes out of the pilot valve (11), enters port PBa and PBa2 of C/V and actuates the arm spool and arm spool 2.

9.6 2-PUMP VALVE OUTSIDE CONFLUX CIRCUIT FOR ARM EXTENDING

Objective ; To speed up the arm extending motion

Principle ; The secondary proportionate pilot pressure for arm extending changes over the arm conflux spool and combines the oil streams by the two pump outside of the valve.

Function ; <pilot circuit>

Secondary proportionate pilot pressure PB3 enters port PA1 of C/V and changes over the arm conflux spool (391) and the bypass cut spool (306).

<Main circuit>

Oil pressure is supplied to the R side of the arm cylinder, as follows : The oil from the P1 pump gets out of port PA, and enters the R side of the cylinder directly. Meanwhile, the oil from the P2 pump comes out of port Ba combines with the oil from the P1 pump, and enters the R side of the cylinder.

The oil returned from the H side of the arm cylinder branches off to Aa→T and T2, and to Aa2→T and T2. The oil returns to the tank via two spools.

9.7 BUCKET CONFLUX CUT CIRCUIT AT ARM DISCHARGE

Objective ; Bucket conflux is unnecessary at arm discharge.

Principle ; The secondary proportionate pilot pressure for arm discharge prevents hydro valve (22) from being changed over, while the command pressure of the bucket conflux circuit ceases to be combined with other oil.

Function ; The secondary proportionate pilot pressure for arm discharge is admitted to port Pi2 of hydro valve (22), and cuts off the bucket digging conflux and the bucket discharge conflux.

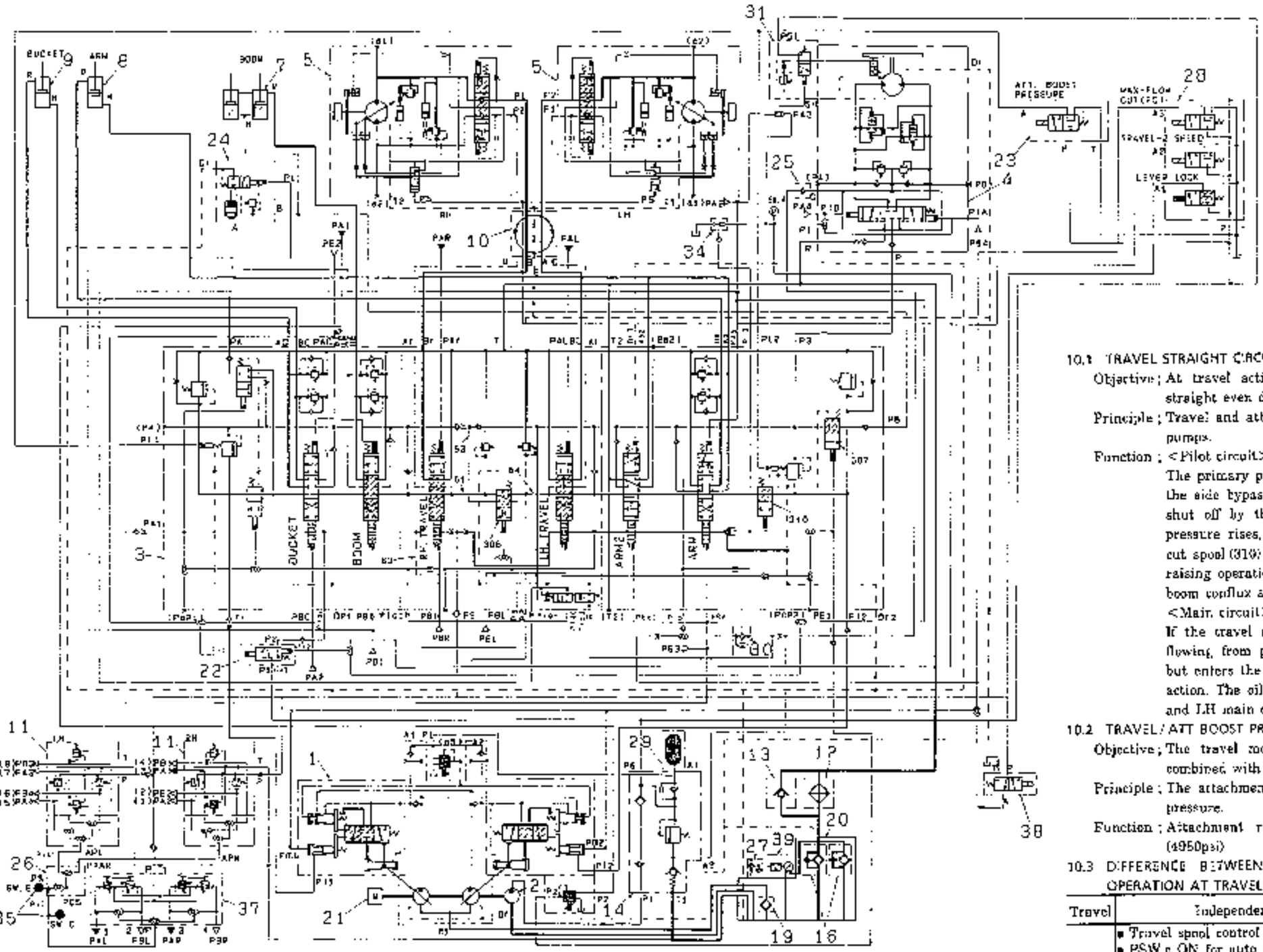


Fig. 12 Simultaneous operation circuit at boom raising / travel (forward 1-speed), travel straight

10. SIMULTANEOUS OPERATION

The following are explained in this section :

1) Travel straight circuit at travel/boom raising action
2) Travel/ATT boost pressure circuit
3) Difference between composite operation and independent operation at travel / boom raising action
4) Swing priority circuit at swing / arm digging
5) Difference between composite operation and independent operation at swing / arm digging action
6) Swing / Boom raise ; loading mode circuit

10.1 TRAVEL STRAIGHT CIRCUIT AT TRAVEL/BOOM RAISING ACTION

Objective ; At travel action, the circuit enables the machine to travel straight even during attachment operation.

Principle ; Travel and attachment motions may by operated by separate pumps.

Function ; <Pilot circuit>

The primary pilot pressure which enters port PS of C/V enters the side bypass circuit (63), passes through the travel spool, is shut off by the boom spool. As the shut off bypass circuit pressure rises, the travel straight spool (305) and the bypass cut spool (310) are changed over. Secondary pressure for boom raising operation enters port PBL of C/V and changes over the boom conflux spool (307).

<Main circuit>

If the travel straight spool is changed over, the oil pressure flowing, from pump P1 into the main circuit (51) is shut off, but enters the parallel circuit (53) to perform the boom raising action. The oil pressure from pump P2 enters both of the RH and LH main circuits (51, 54) and is led to the travel motor.

10.2 TRAVEL / ATT BOOST PRESSURE CIRCUIT

Objective ; The travel motor moves to the fast at composite operation combined with travel action.

Principle ; The attachment relief pressure is higher than the travel relief pressure.

Function ; Attachment relief : 300kgf/cm² (4270psi), travel : 350kgf/cm² (4950psi)

10.3 DIFFERENCE BETWEEN COMPOSITE OPERATION AND INDEPENDENT OPERATION AT TRAVEL / BOOM RAISING ACTION

Travel	Independent	Simultaneous
Pilot circuit	• Travel spool control • PSW.c ON for auto accel • PSW.h OFF for travel 5.5km/h	• Travel straight spool (305) changed over • Bypass cut spool (310) changed over
Main circuit	• P1 pump drives RH motor. • P2 pump drives LH motor.	• P1 pump drives RH and LH motor.

10.4 SWING PRIORITY CIRCUIT AT SWING/ARM DIGGING

Objective ; To stabilize the swing speed.

Principle ; The oil flow for arm digging is reduced and fed preferentially to the swing side.

Function ; <Pilot circuit>

In the swing operation and in the arm digging operation, the secondary proportionate pilot pressure enters port PiA or PiB of the swing control valve and actuates the swing spool. At the same time, the pressure goes out of the Pi port and turns on the swing pressure switch PSW. a. At the same time, the pressure re-enters port SH of the reducing valve for the swing parking brake, then enters port Pi3 of C/V, changes over the bypass cut valve (310), and acts upon the back pressure of the logic valve (612) and the sub spool in the arm spool. When the pressure acts upon the sub spool, it is restricted more as it is higher than the servo pressure 7kgf/cm² (100psi) that comes from PIS.

<Main circuit>

Pressurized oil for the swing motor and the arm digging motion is supplied by the No.2 pump i.e. by a parallel circuit. when arm digging and swing motions are operated at the same time, the pressure flows toward the lower load pressure. Since the oil returned from the cylinder is restricted by the above-mentioned sub-spool, the load pressure fed to the cylinder rises. Therefore, the oil is fed preferentially to the swing motor to stabilize the swing speed.

10.5 DIFFERENCE BETWEEN SIMULTANEOUS OPERATION AND INDEPENDENT OPERATION AT SWING/ARM DIGGING

Swing	Independent	Simultaneous
Pilot circuit	• Control of swing control valve • Auto accel pressure PSW.b ON • Swing pressure switch PSW.a ON • Swing parking brake release • Bypass cut spool (310) changed over • Bucket conflux cut	• Arm sub spool restrictor forced
Main circuit	• Swing motor is driven by P2 pump.	• Swing and arm digging by P2 pump
Arm digging	**Independent**	**Simultaneous**
Pilot circuit	• Arm spool control • Swing parking brake release • Variable recirculation at light load	• Forced recirculation at light load
Main circuit	• Variable arm digging recirculation at light load	• Forced arm digging recirculation at light load

Fig. 13 Simultaneous circuit, swing priority at swing (LH) & arm digging

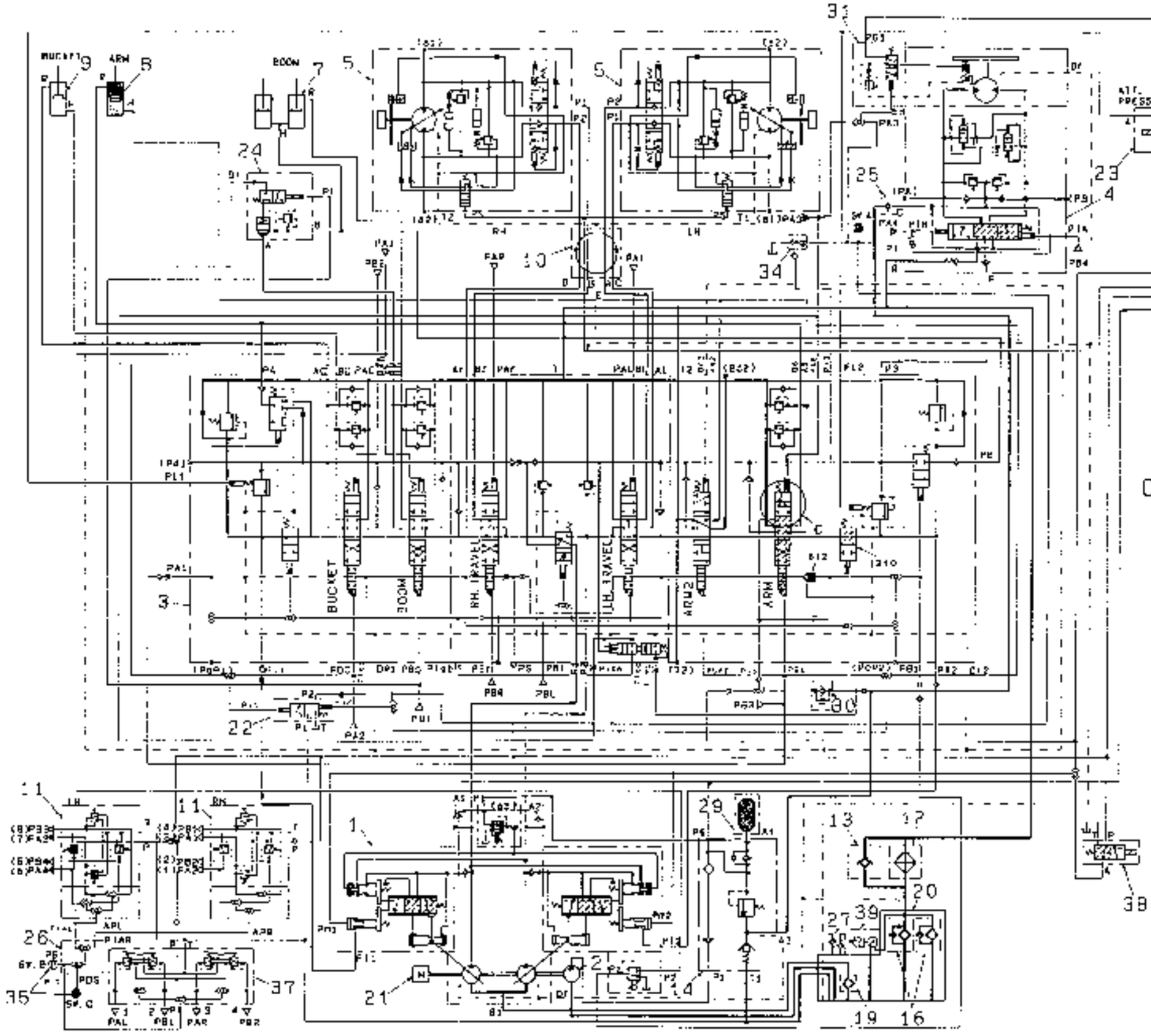


Fig. 14 Simultaneous circuit at slewing (LH) / boom up, loading mode

10.6 LOADING MODE CIRCUIT AT SWING BOOM RAISING

Objective ; To adjust the dump loading timing.

Principle ; The circuit changes the boom raising conflux flow (reduction from the max flow) and adjusts (increases) the swing flow.

Function ; <Pilot circuit>

If the loading potentiometer on the control board is turned clockwise, the voltage falls. This decreases the current reading of the electromagnetic proportionate valve attached to the No.2 pump which in turn decreases the electromagnetic proportionate secondary pressure at port PZ.

If the PZ port pressure falls, the PB1 port pressure of C/V falls. The spring action of boom conflux spool (307) then overcomes the pressure and decreases the stroke of the spool for boom conflux. If the loading mode switch is turned to the right end, the boom conflux pressure becomes 0kgf/cm². This makes the boom conflux spool unable to change over.

<Main circuit>

Since the No.2 pump circuit has the boom raising circuit and the swing motor drive circuit connected in parallel, the pressure flows toward a lower pressure side. Usually since the pressure on the swing motor side is lower, more oil flows to the swing motor. Speed of the swing motor in composite operation does not vary much. The more the loading mode switch is turned to the right end, the less the amount of conflux by the No.2 pump becomes. This makes the operating speed of the single boom raising motion slow.

10.7 DIFFERENCE BETWEEN COMPOSITE OPERATION AND SINGLE OPERATIONS IN SWING / BOOM RAISING MOTION

Swing	Independent	Simultaneous
Pilot circuit	• Swing control valve operation • Auto accel pressure SW.C, ON • Swing pressure SW.A, ON • Swing parking brake release • Neutral cut spool (310) select	←
Main circuit	• Swing motor is driven by P2 pump	←

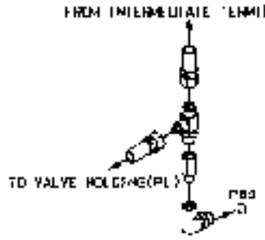
Boom raising	Independent	Simultaneous
Pilot circuit	• Boom spool operation • Auto decel pressure SW.C, ON • Neutral cut spool (310) changeover • Boom conflux spool (307) changeover variable	←
Main circuit	• Conflux flow by P2 pump is much	• Conflux flow by P2 pump is few

11. PILOT PIPING

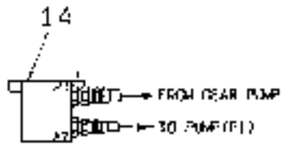
No.	COMPONENT NAME	No.	COMPONENT NAME	No.	COMPONENT NAME
1	MAIN PUMP ASSY	22	HYDRO VALVE	33	TERMINAL BRACKET (T/B)
2	GEAR PUMP ASSY	23	SOLENOID VALVE (S/V)	34	SHUTTLE VALVE
3	CONTROL VALVE (C/V)	24	HOLDING VALVE	35	PRESSURE SWITCH (A,B,C)
4	SLEWING (SWING) MOTOR (S/M)	25	CHECK VALVE	36	PT BLOCK
5	TRAVEL MOTOR (T/M)	26	SHUTTLE VALVE	37	TRAVEL PILOT VALVE (T.P/V)
10	SWIVEL JOINT	28	SOLENOID VALVE	38	SOLENOID VALVE (S/V)
11	OPERATING PILOT VALVE (O.P/V)	29	ACCUMULATOR	39	INDICATOR
14	MANIFOLD BLOCK	30	RESTRICTOR VALVE		
20	HYDRAULIC TANK	31	REDUCING VALVE		

Piping No. and pressure class			COMPONENT No. & CONNECTING PORT FROM	TO	REMARKS
50			2-OUT	14-Pi	Primary pilot pressure delivery
51			14-P6	31-PGi	For automatic slewing parking release pressure source
52-1			31-PG1	23-P	For solenoid valve (23)
52-2			28-P	23-P	For solenoid valve (23)
53-1			28-A1	36-P	For PT block (36)
53-2			36-P	38-P	For solenoid valve (38)
54-1			36-P	11-P	For RH operating pilot valve (11)
54-2			36-P	11-P	For LH operating pilot valve (11)
55			36-P	37-P	For travel pilot valve (37)
56			3- PG1	22-P1	For hydro valve (22)
57	Red color	Primary pilot pressure circuit	22-P2	3-Pigd	Bucket conflux command
58			14-A2	1-Pi	For power shift solenoid valve at pump (1)
59			28-A2	10-F	Traveling motor 2-speed changeover
60			38-A3	3-Pin	Force re-circulation in FC mode Arm digging
61			3-Pis	1-Pm1	Max. flow cut for No.1 pump in FC mode
62			1 Pm1	1-Pm2	Max. flow cut for No.2 pump in FC mode
63			23-A	3-PL2	Attachment boost pressure command
64			3-PL2	3-PL1	Attachment boost pressure command
65			36-P	3-PS	Servo pressure for side bypass
66			38-A	3-Pis	Max. flow cut for No.1 and No.2 pump in Travel
71			37-1	3-PAL	Travel LH Advance
72			37-2	3-PBL	Travel LH Retract
73			37-3	3-PAr	Travel RH Advance
74			37-4	3-PBr	Travel RH Retract
75	Violet color	Secondary pilot pressure circuit	37-Pi	26-PiT	Auto accel PSW.C on and 5.5km/h PSW.B ON
51-1			11-1	33-1	Bucket digging (PA2)
51-2			33-③	3-PBC	Bucket digging
52-1			11-2	33-2	Bucket discharge (PB2)
52-2			33-②	3-PAC	Bucket discharge
53-1			11-3	33-3	Boom up (PA1)
53-2			33-③	3-PAb	Boom up

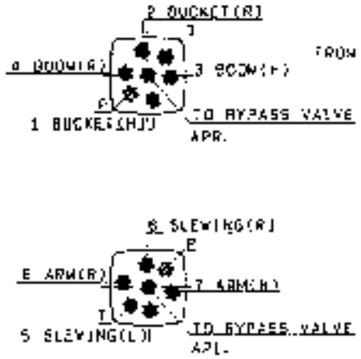
Piping No. and pressure class			COMPONENT No. & CONNECTING PORT FROM	TO	REMARKS
84-1			11-4	33-4	Boom down (PB1)
84-2			33-④	3-PBb	Boom down
85-1			11-5	33-5	Slewing LH (PA4)
85-2			33-⑤	4-PiB	Slewing LH
86-1			11-6	33-6	Slewing RH (PB4)
86-2			33-⑥	4-PiA	Slewing RH
87-1			11-7	33-7	Arm digging (PA3)
87-2			33-⑦	3-PAa	Arm digging
88-1			11-8	33-8	Arm extending (PB3)
88-2			33-⑧	3-PBa	Arm extending
90			3-Pi1	1-Pi1	Negative control for No.1 pump
92			3-Pi2	1-Pi2	Negative control for No.2 pump
94			37-Pi	26-PiT	Auto accel and travel alarm pressure sw. cir. on Travel
95			11-APL	26-PiAL	Auto accel pressure sw. cir. in Arm and Slewing
96			11-APR	26-PiAR	Auto accel pressure sw. cir. on Boom and Bucket
100			3-PAC	22-Pi1	Bucket extending conflux in hydro valve
101			3-PBC	22-Pi1	Bucket digging conflux in hydro valve
103			3-PBb	24-PL	Release holding valve in Boom down
104			3-PAb	1-P2	Variable loading mode for proportionate solenoid valve
105			1-P2	3-PB1	Variable loading mode command
106			3-PAa	3-Pigb	Changeover sequence valve in Arm heavy digging
107			3-Pigc	3-Pigb	Sequence confluent in Arm heavy digging
108			3-PAa	3-PBa	Bucket conflux cut in Arm digging
109			3-PBa	22-Pi2	Bucket conflux cut in Arm digging or extending
110			4-Pi	31-SH	Release slewing parking brake in Slewing
111			3-PAa	31-SH	Release slewing parking brake in Arm digging
112			31-SH	22-Pi2	Bucket conflux cut in Slewing
113			4-Pi	3-Pi3	Slewing priority & Slewing pressure switch A circuit
120			30	2-IN	To gear pump
121			14-A3	4 C	For slewing motor boost pressure
122			4-C	3-Pis	For arm variable recirculation boost pressure
123			37-T	36-T	From Travel pilot valve (37)
124			11-T	36-T	From RH operating pilot valve (11)
125			11-T	36-T	From LH operating pilot valve (11)
126			24-Dr	20-T	From holding valve (24)
127			22-T	20 T	From hydro valve (22)
128			20-T	39	Filter element indicator circuit
129			3-Dr3	20-T	From arm spool 3
130	Blue color	Drain or Servo circuit	14-T1	Pump	From manifold block (14)
131			23-T	23-T	From solenoid valve (23)
132			23-T	36-T	From solenoid valve (23)
133			36-T	3-Dr2	From PT block (36)
134			3 Dr2	3-Dr1	From Control valve (3)
135			3-Dr1	20-T	From Control valve (3)
136			3-Pi3	20-T	From arm variable recirculation boost pressure drain
137			3-Pis	3-Pisd	Variable recirculation cut in Arm heavy digging
138			38-T	36-T	From solenoid valve (38)



DETAIL B

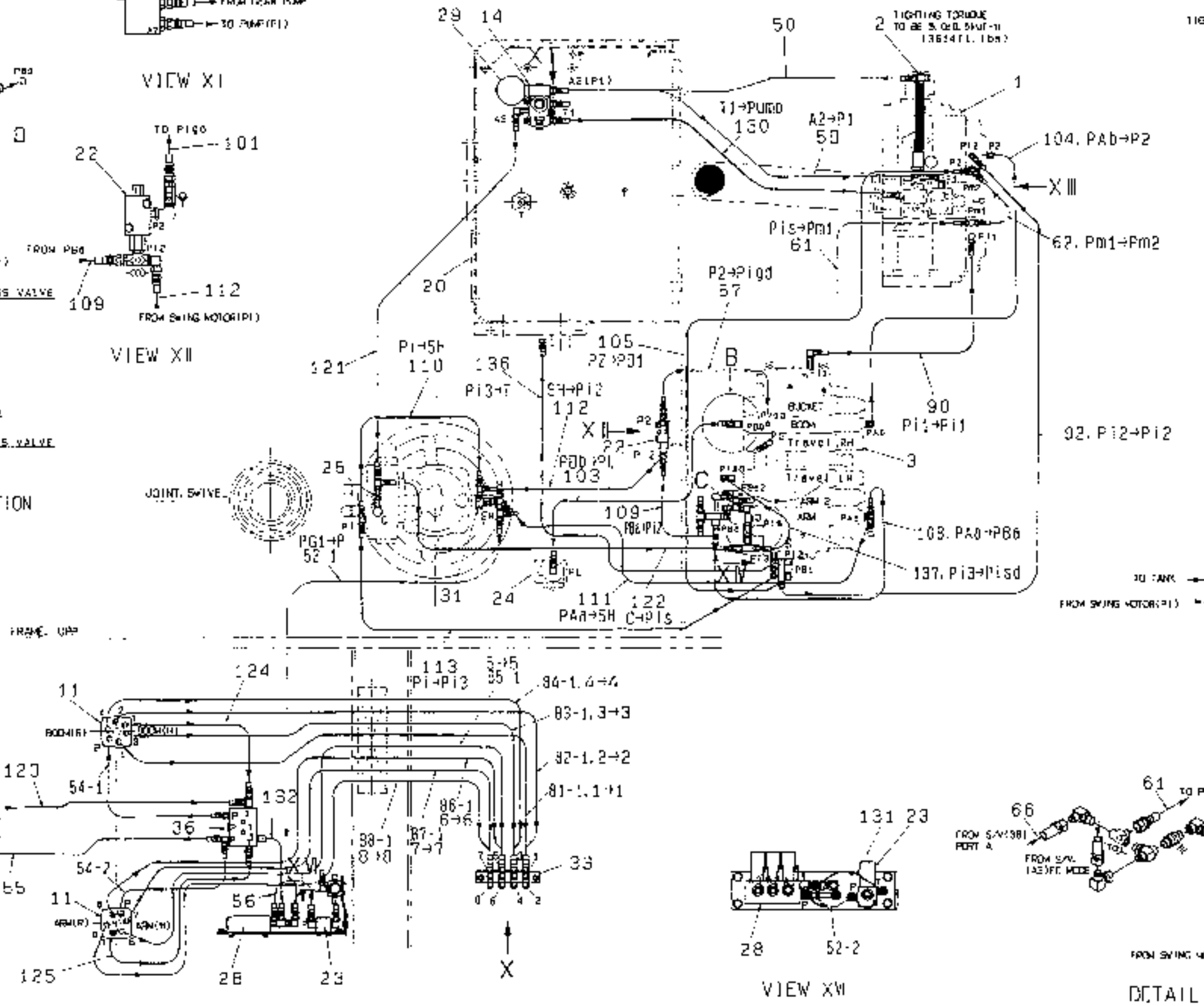


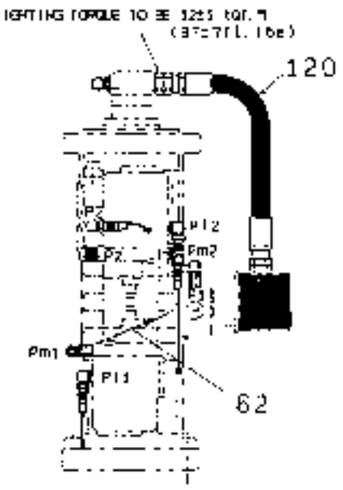
VIEW XI



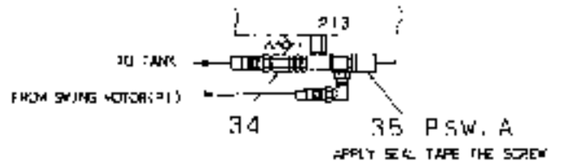
VIEW XII

PILOT VALVE PORT POSITION



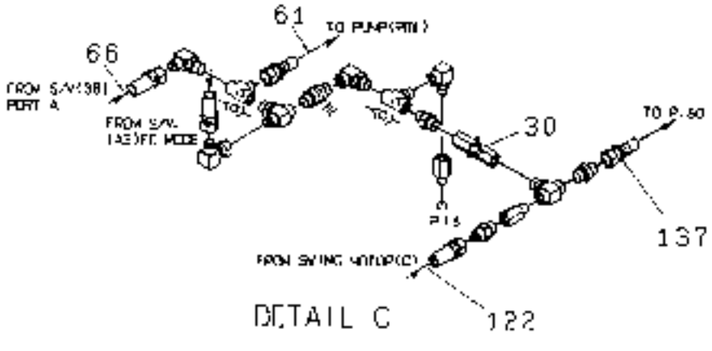


VIEW XIII



VIEW XIV

VIEW XVI



DETAIL C

Fig. 15 Pilot piping (1/2)

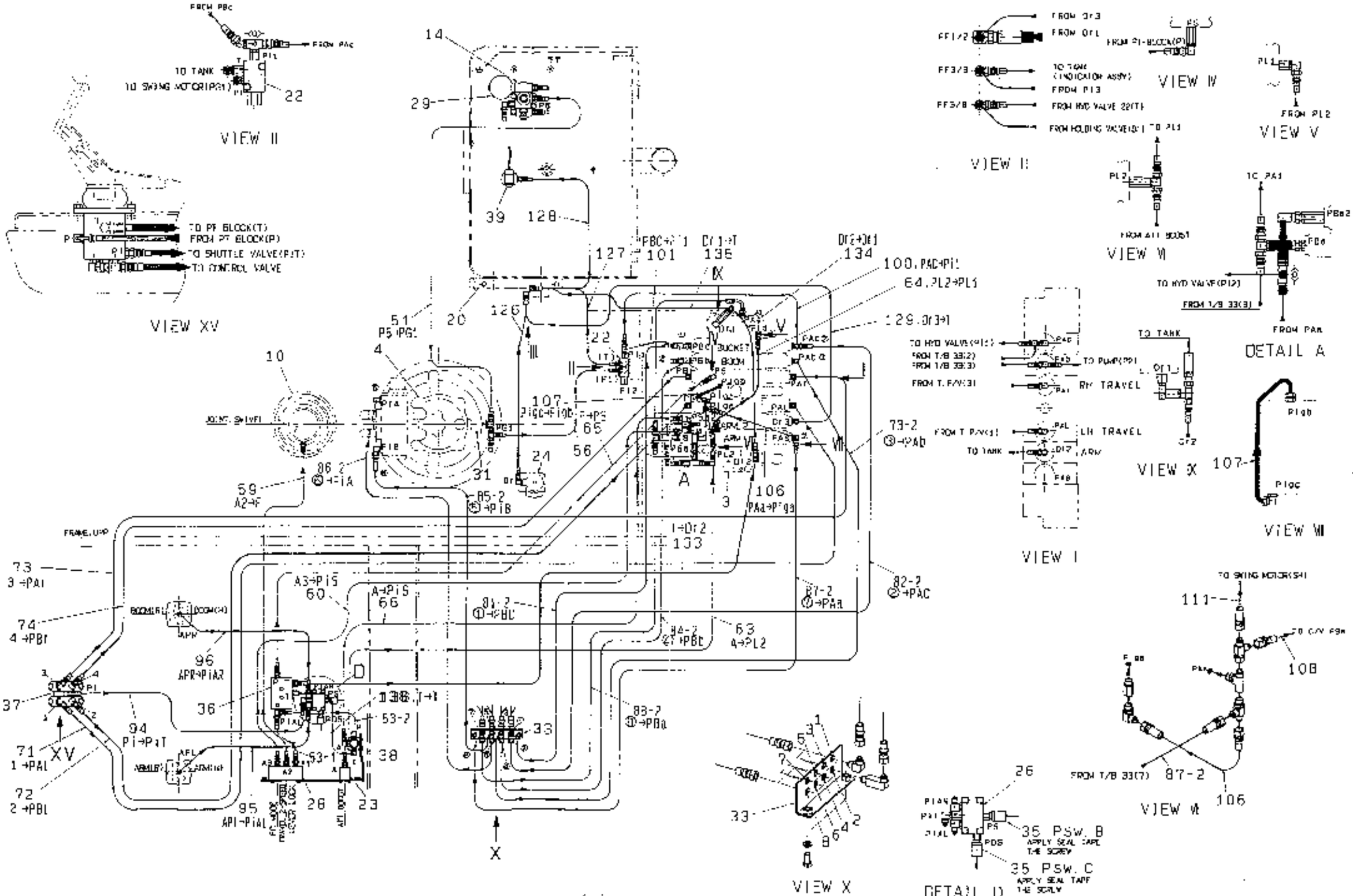
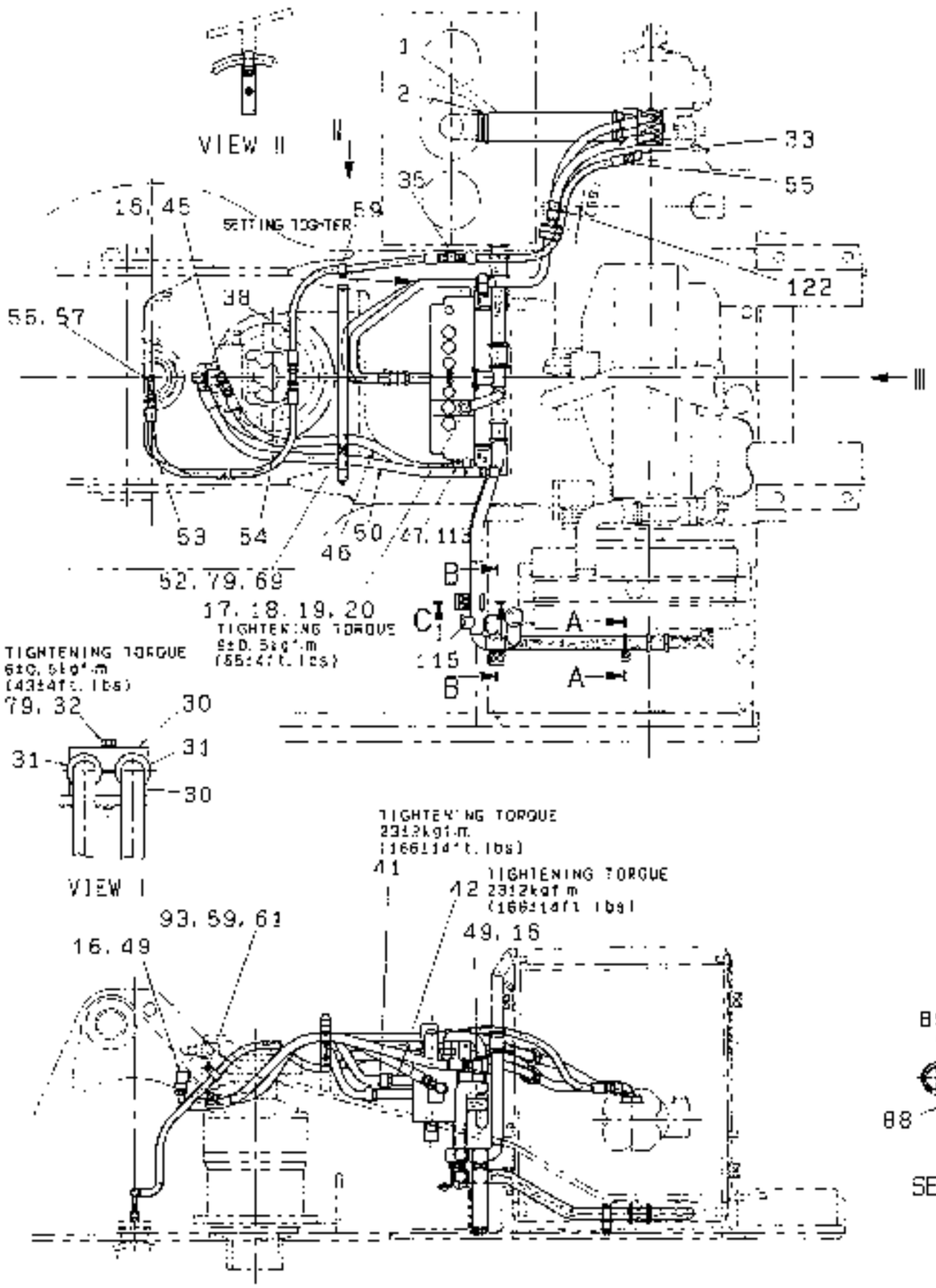
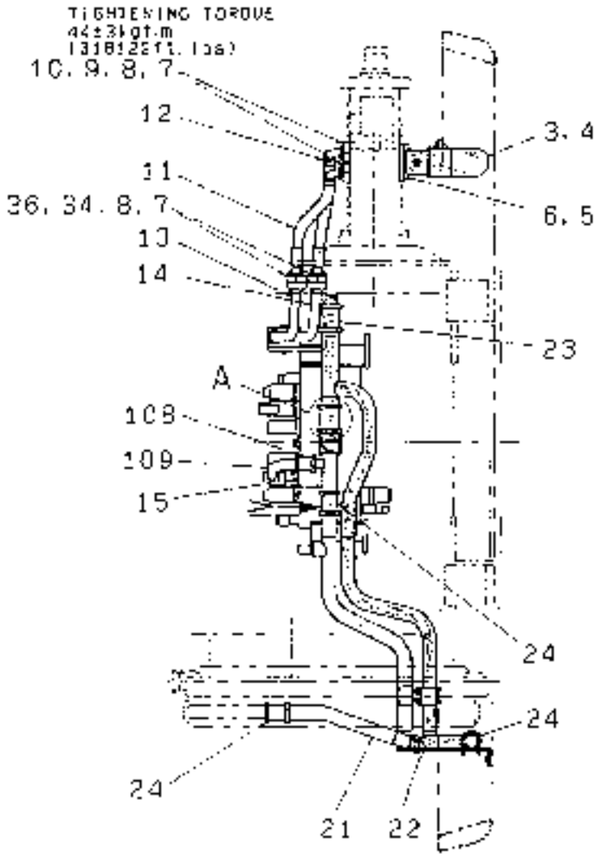
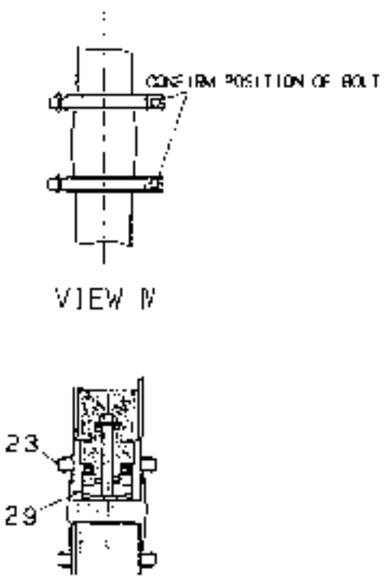


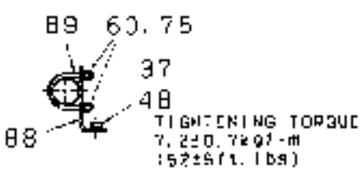
Fig. 16 Pilot piping (2/2)

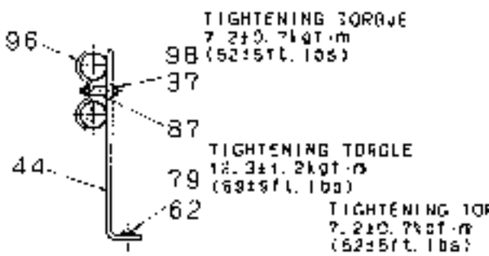
ITEM	NAME OF PARTS	Q'TY	REMARKS	ITEM	NAME OF PARTS	Q'TY	REMARKS	ITEM	NAME OF PARTS	Q'TY	REMARKS	ITEM	NAME OF PARTS	Q'TY	REMARKS
1	HOSE	1	SUCTION	30	CLAMP	2		58	CAPSCREW	4	M12×110	87	SPACER	4	
2	CLIP	4		31	BUSHING	2		59	CLIP	2		88	BRACKET	1	
3	TUBE	1		32	CAPSCREW	3	M12×100	60	NUT	4	M8	89	U-BOLT	1	M8
4	O RING	1	G85, 1B	33	ELBOW	1	PF3/4, HEX.36	61	WASHER	1		90	TUBE	1	LH TRAVEL FORWARD
5	CAPSCREW	4	M16×40	34	CAPSCREW	3	M12×45	62	TUBE	4	M12×25	91	TUBE	1	LH TRAVEL BACKWARD
6	LOCK WASHER	4		35	TEE	1	PF1, HEX.41	63	CAPSCREW	2	M12×85	92	TUBE	1	
7	HALF CLAMP	8		36	LOCK WASHER	8		64	CAPSCREW	2	M12×80	93	NUT	1	M10
8	O RING	4	P34, 1B	37	WASHER	5		65	BRACKET	1		94	HOSE	4	L=1400 (55.1")
9	CAPSCREW	8	M12×45	38	HOSE	1	L=1000 (39.4")	66	CAPSCREW	6	M16×50	96	CLAMP	2	
10	LOCK WASHER	8		40	ELBOW	1	PF1, HEX.41, 55	67	WASHER	6		97	CLAMP	2	
11	HOSE	1	DELIVERY L=670 (26.4")	41	CONNECTOR	1	PF1, HEX.46	68	CAPSCREW	3		98	CAPSCREW	4	M10×60
12	HOSE	1	DELIVERY L=730 (28.7")	42	CONNECTOR	4	PF1, HEX.46	69	NUT	20	M12	99	CAPSCREW	2	M12×90
13	TUBE	1	DELIVERY No.1	43	CONNECTOR	2	PF3/4, HEX.41	70	CAPSCREW	4	M12×35	103	CLAMP	2	
14	TUBE	1	DELIVERY No.2	44	BRACKET	1		71	TUBE	1	BOOM (R)	104	TUBE	1	RH TRAVEL FORWARD
15	CONNECTOR	10	PF1, HEX.46, 55	45	ELBOW	1	PF1, HEX.41	72	TUBE	1	BOOM (H)	107	CLAMP	2	
16	O RING	17	P29, 1B	46	HOSE	1	SWING L=1210 (47.6")	73	TUBE	1	ARM (H)	108	COUPLING	1	
17	TUBE	1	RETURN	47	ELBOW	1	PF3/4, HEX.36, 41	74	TUBE	1	ARM (R)	109	TUBE	1	
18	O RING	1	G60, 1A	48	CAPSCREW	1	M10×25	75	WASHER	2		112	TUBE	1	RH TRAVEL BACKWARD
19	CAPSCREW	4	M10×30	49	ELBOW	2	PF1, HEX.41	76	BRACKET	1		113	O RING	1	P24, 1B
20	LOCK WASHER	4		50	HOSE	1	SWING L=1400 (55.1")	77	BRACKET	1		115	PLUG	1	PF1 1/4, HEX 50
21	TUBE	1		51	CAPSCREW	4	M12×60	79	WASHER			117	CLAMP	2	
22	TUBE	1		52	CLIP	2		80	CLAMP	39		118	CLAMP	2	
23	COUPLING	2		53	HOSE	1	TRAVEL DRAIN L=1400 (55.1")	81	BRACKET	2		119	CLAMP	1	
24	COUPLING	3		54	TEE	1	PF1/2, HEX.27	82	TUBE	1	BUCKET (H)	122	CLIP	1	
25	BRACKET	1		55	HOSE	1	DRAIN L=1200 (47.2")	53	TUBE	1	BUCKET (R)				
26	BRACKET	1		56	TUBE	1		84	CONTROL VALVE	1					
29	BYPASS VALVE	1		57	O RING	1	P18, 1B	85	HOLDING VALVE	1					











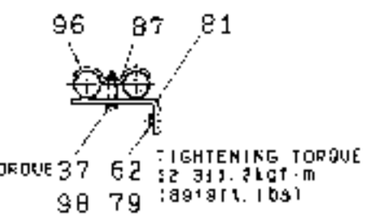
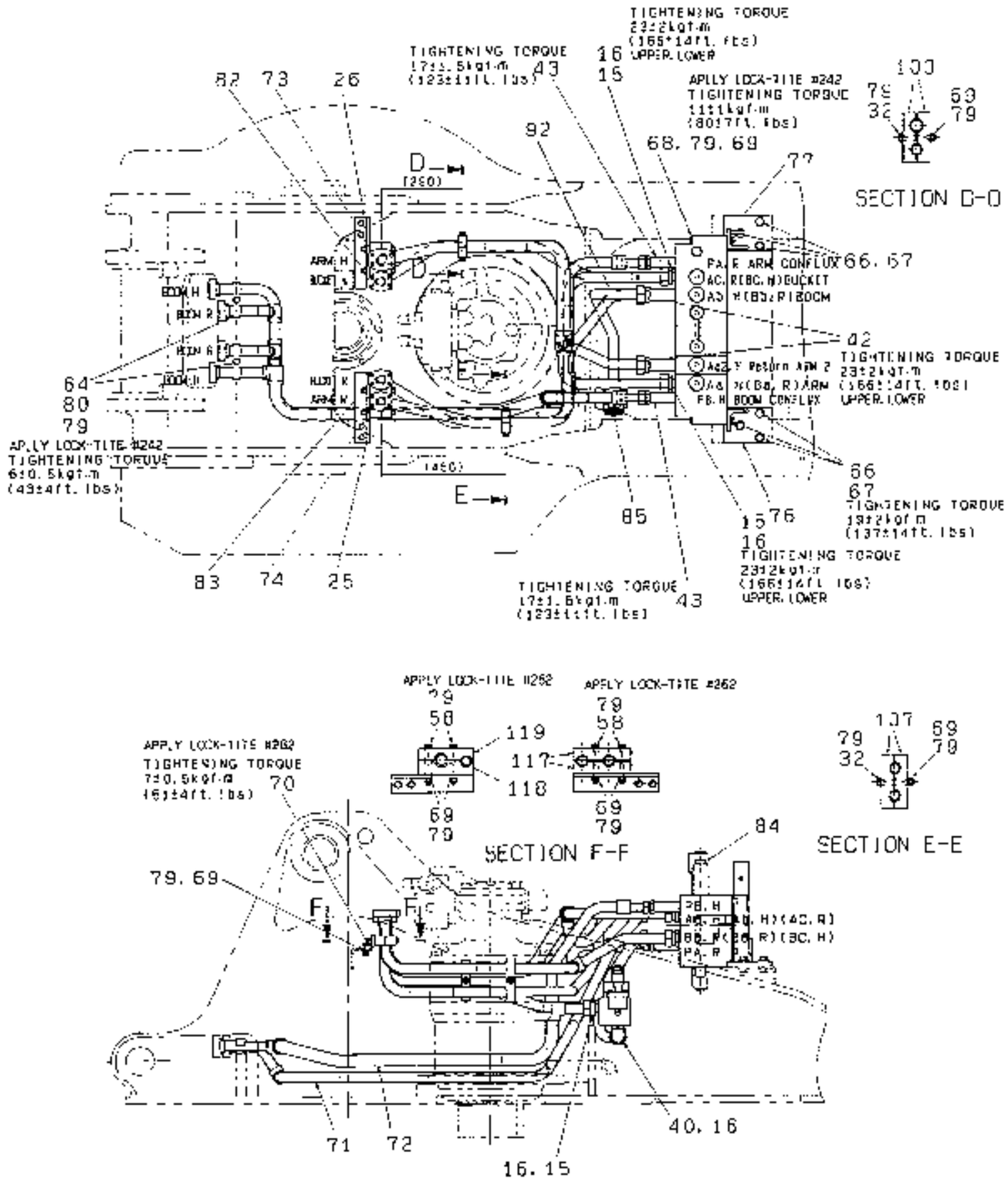


Fig. 17 Main piping (1/3)

(2) Att (Boom & arm & bucket)



(3) Travel

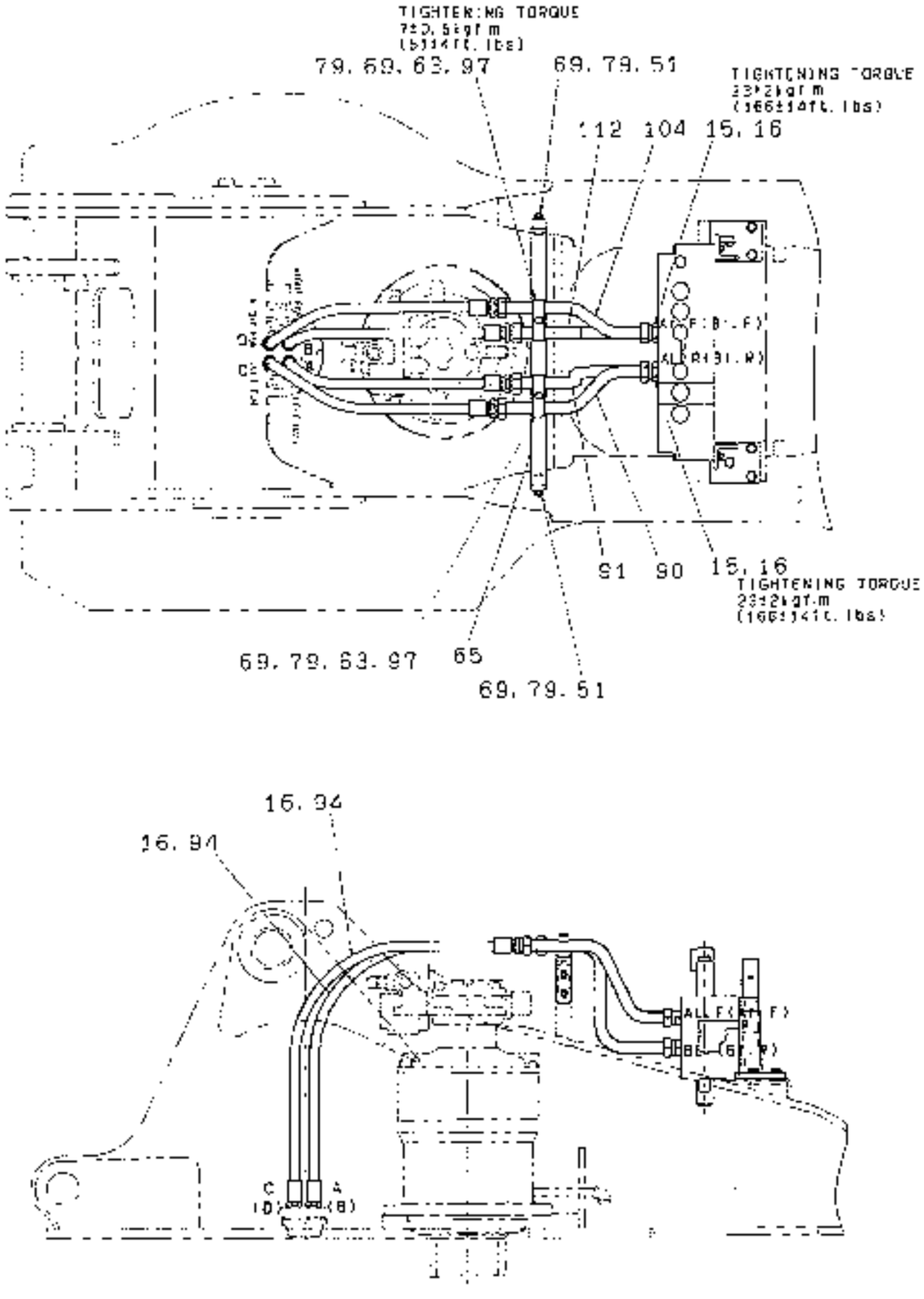
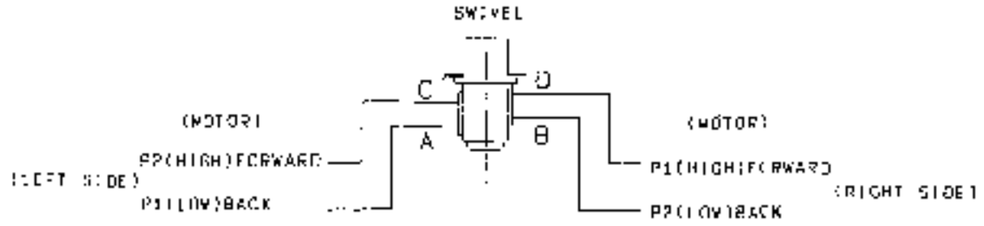
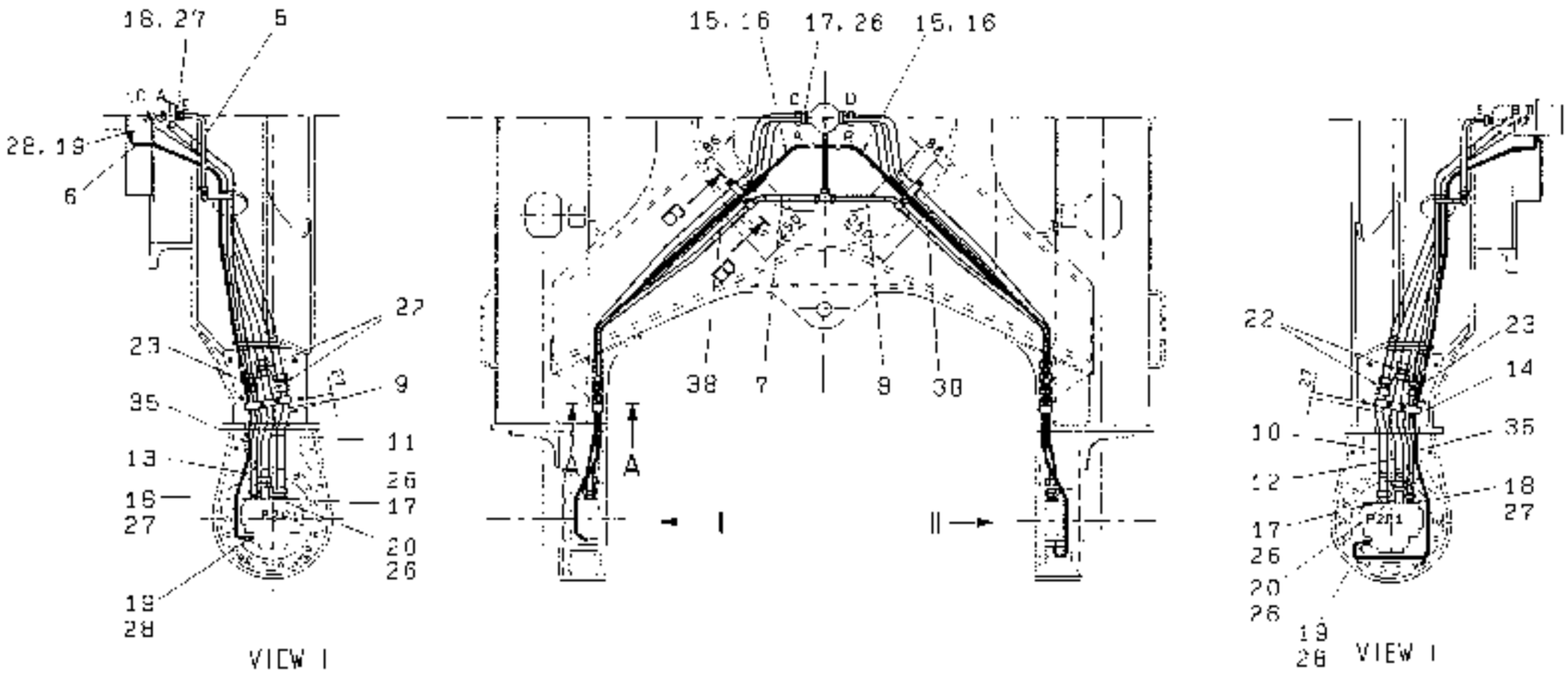
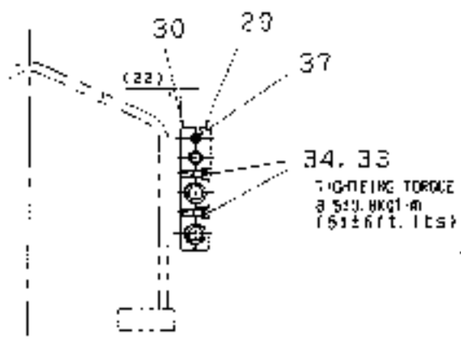
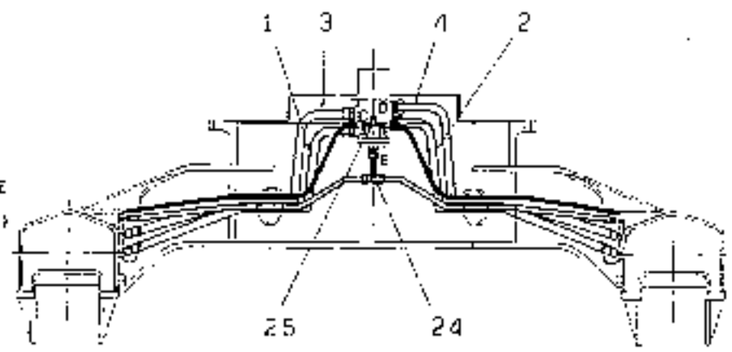


Fig. 16 Main piping (2/3)









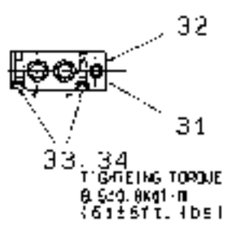


Fig. 19 Main piping (3/3)

List of tightening torque for connector and elbow

ITEM	CONNECTION	JOINT
19	5±1kgf·m (36±7ft·lbs)	3.7±0.2kgf·m (27±1ft·lbs)
18	22±2.2kgf·m (159±16ft·lbs)	11±1kgf·m (80±7ft·lbs)
17,20	45±4.5kgf·m (325±33ft·lbs)	25^{+1}_{0} kgf·m (181^{+7}_{0} ft·lbs)
22	45±4.5kgf·m (325±33ft·lbs)	
33	22±2.2kgf·m (159±16ft·lbs)	

No.	NAME	Q'TY	REMARKS
1	TUBE	1	
2	TUBE	1	
3	TUBE	1	
4	TUBE	1	
5	TUBE	1	
6	TUBE	1	
7	TUBE	1	
8	TUBE	1	
9	TUBE	1	
10	TUBE	1	
11	TUBE	1	
12	TUBE	1	
13	TUBE	1	
14	TUBE	1	
15	CLIP	16	
16	HOSE	2	
17	CONNECTOR	6	PF1, HEX.46×54
18	CONNECTOR	3	PF1/2, HEX.32×36
19	CONNECTOR	3	PF1/4, HEX.19×19
20	CONNECTOR	2	PF1, HEX.46
22	CONNECTOR	4	ø35, HEX.46×55
23	CONNECTOR	2	ø22, HEX.32×36
24	TEE	1	ø22, HEX.32×36
25	TEE	1	ø10, HEX.17×19
26	O RING	8	P29, 1B
27	O RING	3	P18, 1B
28	O RING	9	P11, 1B
29	CLAMP	2	
30	CLAMP	2	
31	CLAMP	2	
32	CLAMP	2	
33	CAPSCREW	8	M12×40
34	LOCK WASHER	8	M12
35	TUBE	1	
36	TUBE	1	
37	RUBBER	2	
38	HOSE GUARD	2	

Book code No. S5LC1505E

KOBELCO

SHOP MANUAL

SK310
SK310LC

SWING FRAME

LC15

TABLE OF CONTENTS

KOBE STEEL, LTD.

Applicable Machines
LC03801~
YC01101~

Revision	Date of Issue	Remarks
First edition	March, 1996	S6LC1605E K

1. CAB

1.1 PREPARATION FOR MOUNTING AND DISMANTLING CAB

(1) Removing floor mat

(2) Removing instrument panel

In order to prepare for removing the instrument panel cover (14) at the back of the Conditioner cover, remove six fasteners (37). Then remove the instrument panel cover (14).

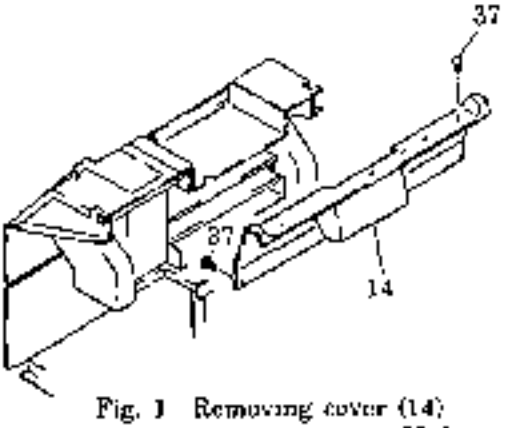


Fig. 1 Removing cover (14)

(3) Removing cover assy (32)

Remove the fastener (23), loosen and take off screws (32-4), (32-5), and remove the cover assy (32).

⊕ Screwdriver

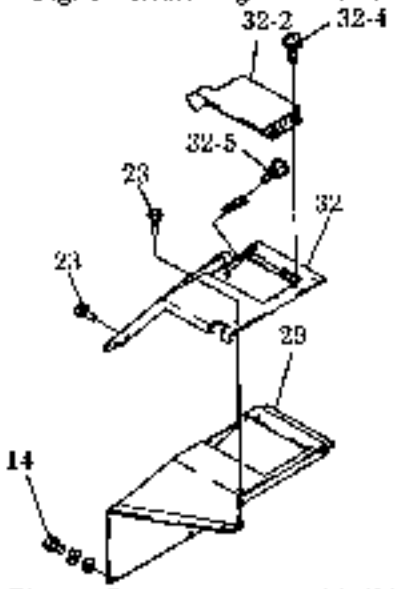


Fig. 2 Removing cover (29) (32)

(4) Removing cover (29)

Loosen and remove capscrews (14) and separate cover (29).

: 13mm

(5) Removing cover (10), (11)

Remove fastener (23). Loosen and take off sems bolts (30) and remove covers (10), (11).

⊕ Screwdriver

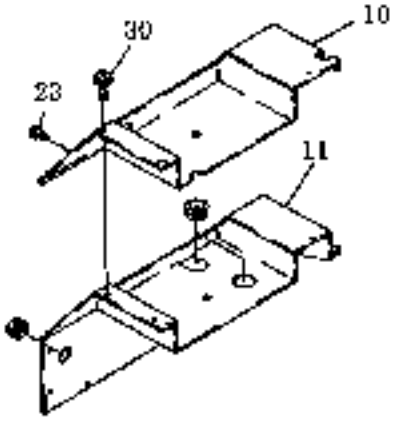


Fig. 3 Removing cover (10) (11)

(6) Removing cover assy (3)

Loosen and take off capscrew (14). Then remove cover assy (3).

: 13mm

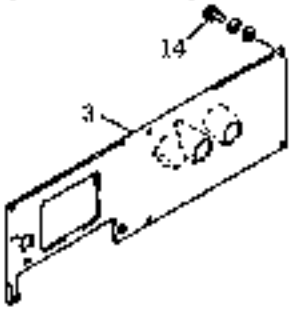


Fig. 4 Removing cover assy (3)

(7) Removing cab harness connector
Remove the 6P coupler for the wiper.

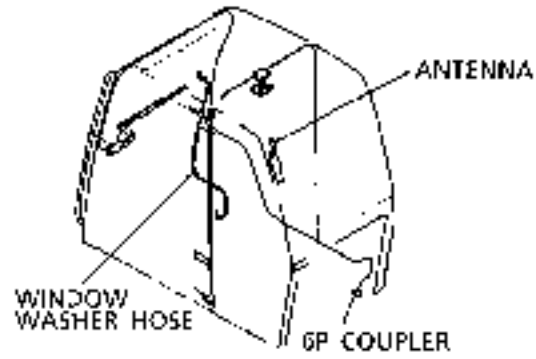


Fig. 5 Removing cab harness connector

(8) Removing under cover
Loosen and remove 13 sems bolts (9). Then remove cover (1), (2).
: 19mm

(9) Pulling out washer hose
Pull out the window washer hose on the washer tank side.

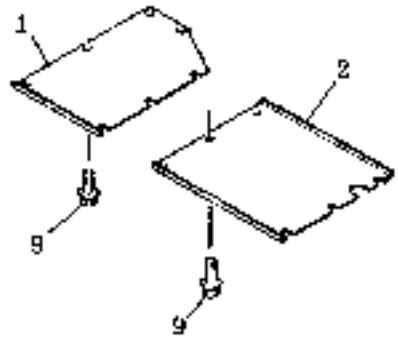


Fig. 6 Removing under cover

1.2 MOUNTING AND DISMANTLING CAB

(1) Removing cab-mounting bolts
Remove cab-mounting capscrew (1)×3 pcs, sems bolt (2)×1 pcs, and nuts (3)×2 pcs.
: 17mm, 24mm

(2) Lifting up cab
Place a wire sling in two lifting hooks at the top of the cab and lift it up slowly so it does not interfere with the control unit.
Weight of cab : about 260 kg (650 lbs)

(3) Mounting cab
Mounting is done in the reverse order of dismantling.
: 19mm, 24mm
Tightening torque :
Capscrew (1) : 11±1.5kgf·m (80±11ft·lbs)
Sems bolt (2) : 11±1.5kgf·m (80±11ft·lbs)
Nut (3) : 19±2kgf·m (137±14ft·lbs)
Apply Locktite #242.

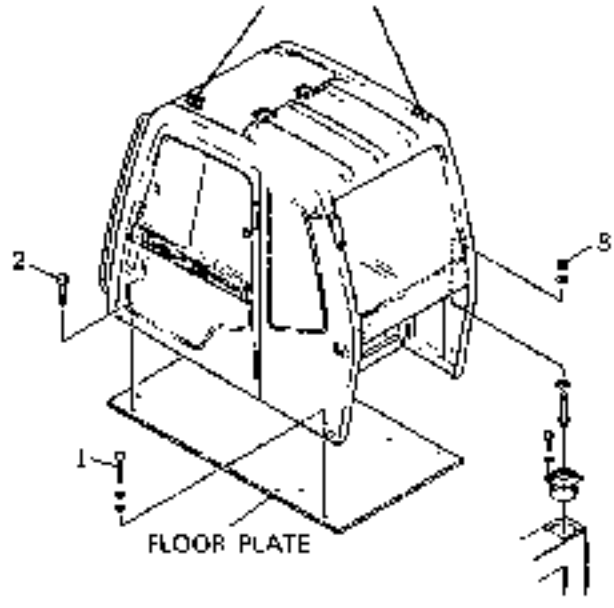


Fig. 7 Mounting and dismantling cab

2. FLOOR PLATE

The floor plate consists of the following devices:
Travel lever assy & travel pilot valve,
Control box assy,
Operator seat assy,
Controller & relay assy,
Pilot piping block (at the bottom face of floor),
Washer tank for window wiper (at the bottom face of floor)

The following explains how to dismantle and install the floor plate assy.

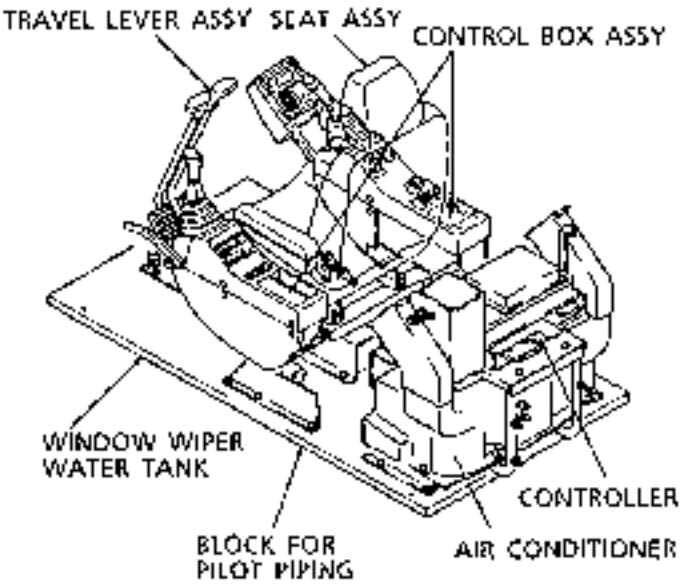


Fig. 8 Floor plate assy

2.1 PREPARATION FOR DISMANTLING AND MOUNTING FLOOR PLATE

(1) Removing cab and under cover (1, 2)
(Refer to Sect. 1 Cab.)

(2) Removing cover assy (66), guard assy (12) and air cleaner.
(Refer to Sect. 3 Guard and Sect. 8 Air Cleaner.)

(3) Disconnecting pilot piping.
Arrange pilot piping so it is divided on the floor plate side and on the upper frame side, in order to enable lifting it as a floor plate assy.

1) Disconnecting pilot piping for operating lever
Disconnect the hoses ① ~ ⑧ on the pilot valve side of operation changeover terminal bracket.

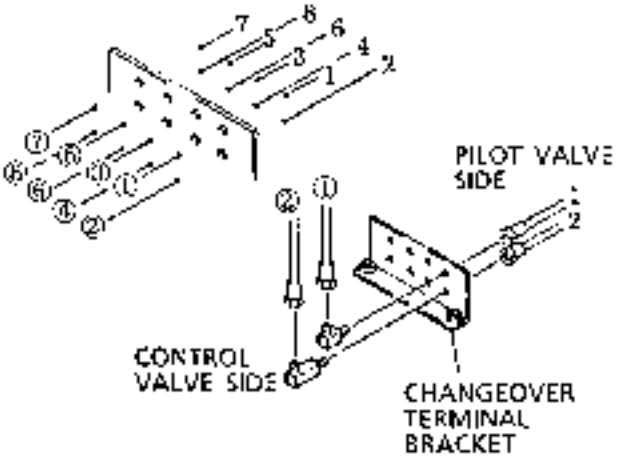


Fig. 9 Disconnecting pilot piping for operating lever (at bracket)

2) Disconnecting travel pilot valve piping
Disconnect the hoses for travel operation pilot piping on the pilot valve side of ports 1, 2, 3, 4.

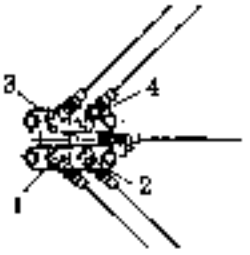


Fig. 10 Removing travel pilot valve piping

3) Disconnecting pipes for 3-spool solenoid valve (5)
Disconnect the pilot pipe hoses at port A1,A2 and A3.

4) Disconnecting pipe for 1-spool solenoid valve (7)
Disconnect the pilot pipe hose at port A.

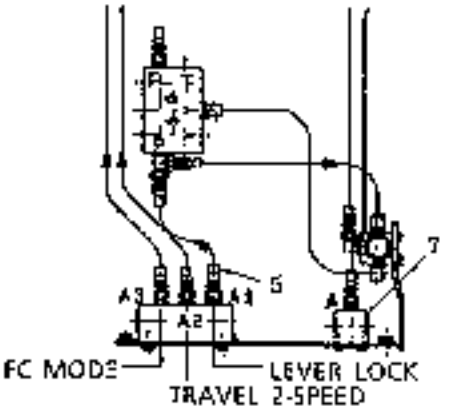


Fig. 11 Disconnecting 3-spool solenoid valve piping

5) Disconnecting piping for block (4)
Disconnect the pilot pipe hose at port T of the block side.

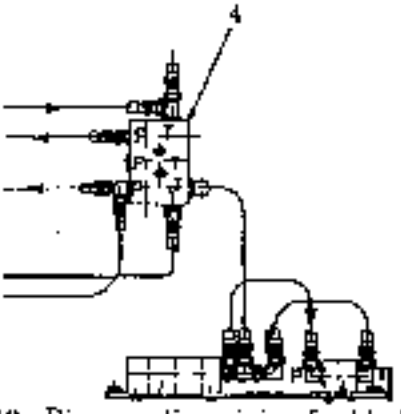


Fig. 12 Disconnecting piping for block (4)

(4) Disconnecting harnesses
1) Separate the harnesses under the floor.
2P coupler for diesel pressure switch
2P coupler for washer tank

2) Separate the connector for harnesses running from under the floor to the top of the floor.
Separate them at the jointed part of the connector. (Refer to Instrument Panel for Electric System)

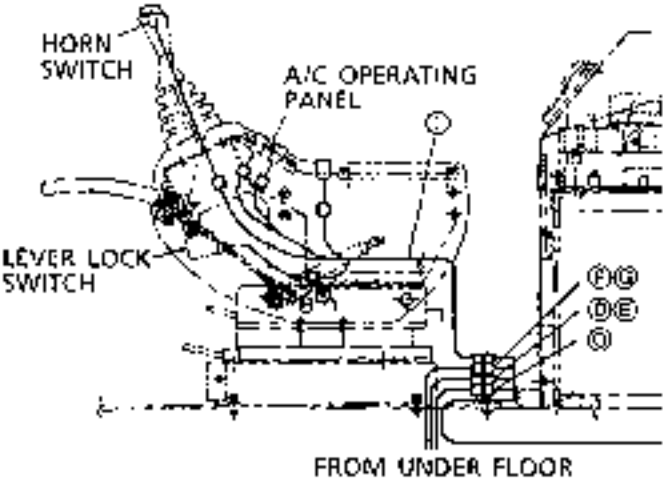


Fig. 13 Separating harness connectors

(5) Disconnecting air conditioner piping
Disconnect two pipes on the air conditioner side.

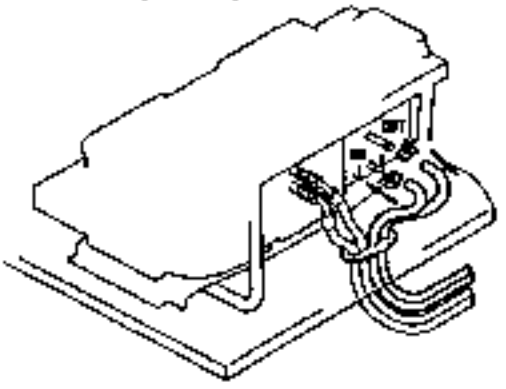


Fig. 14 Disconnecting air conditioner pipes

(6) Disconnecting cable (3) for the emergency stop of engine
Disconnect the E/G emergency stop cable (3) at rod end (11) of the engine stop lever.

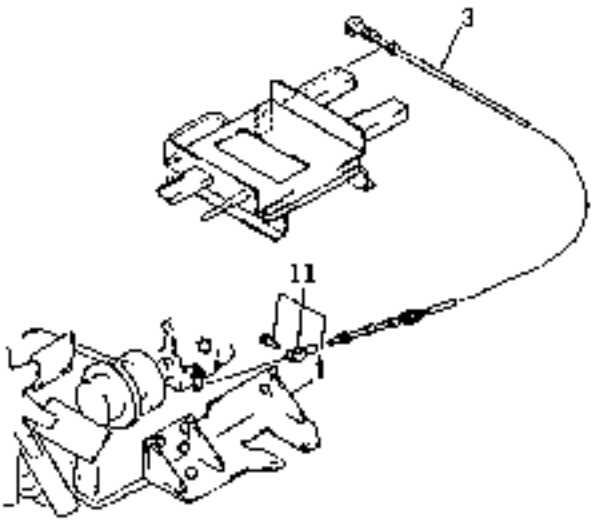


Fig. 15 Disconnecting the engine emergency stop cable

2.2 DISMANTLING AND INSTALLING FLOOR PLATE ASSY

(1) Removing rubber cushion mounting capscrews
Remove four capscrews (28) that mount rubber cushion (13) to the bottom face of the floor plate.
: 24mm

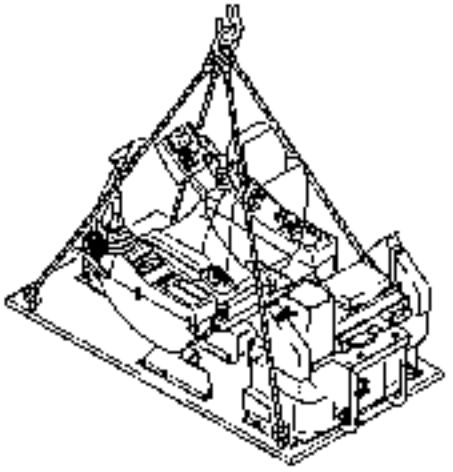


Fig. 16 Lifting floor plate assy

(2) Dismantling floor plate
Put an eye bolt M12 into each of the four cab mounting holes (※2) and lift them with the air conditioner assy.

(3) Installation
Installation of the floor plate is performed in the reverse order of dismantling
Rubber cushion mounting capscrew (28)
: 24mm,
Tightening torque : 19±2kgf·m
(137±14ft·lbs)
Apply Locktite #242.

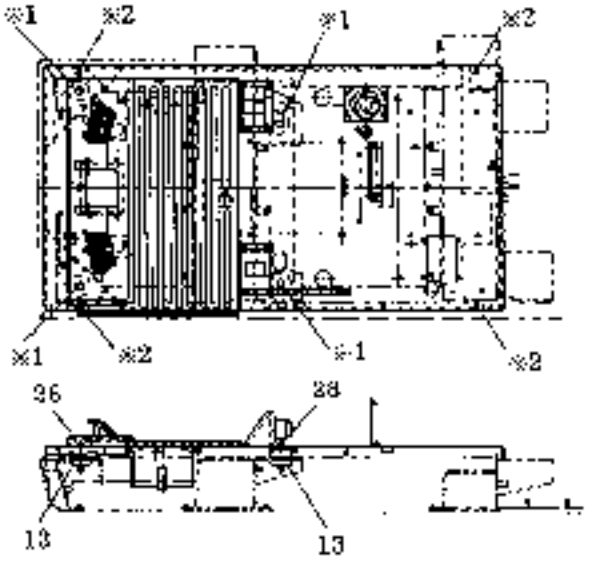


Fig. 17 Dismantling floor plate

3. GUARD

3.1 PREPARATION FOR DISMANTLING AND INSTALLING GUARDS

(1) Removing engine cover assy (60)
Unlock catches (28, 29), open cover assy (60), remove nut (36) and separate cover (60) from bracket (91).
Remove capscrew (33) and take off spring assy (23).
: 19mm

(2) Separate the harnesses for the swing flasher and the back light.

(3) Dismantle the counterweight.
(Refer to para. 4. Counterweight.)

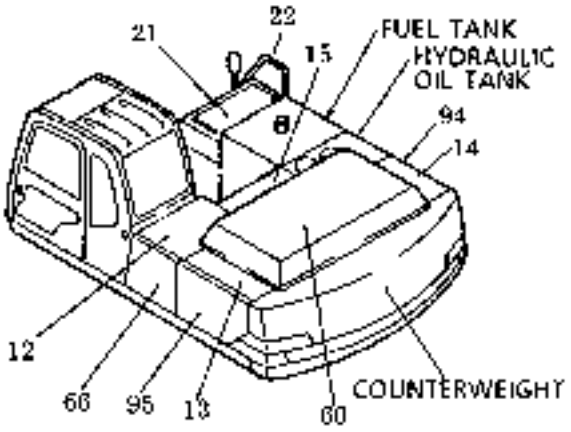


Fig. 18 Cover assy and guard assy

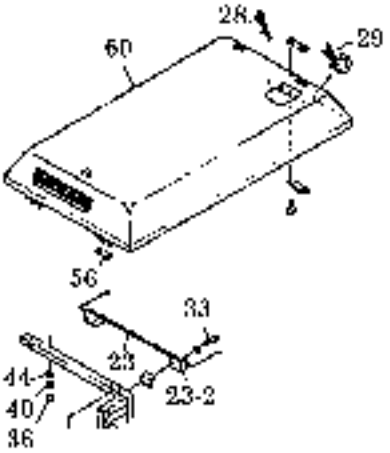


Fig. 19 Removing engine cover assy (60)

3.2 REMOVING COVER ASSY AND GUARD ASSY

(1) Removing cover assy (95)
Unlock lock (95-1H), open cover (95), remove nut (37) and dismantle cover assy (95).
: 17mm

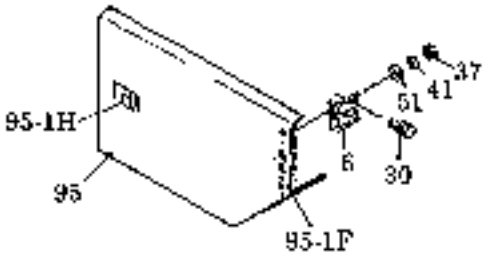


Fig. 20 Removing cover assy (95)

(2) Removing cover assy (66)
Open cover assy (66), remove capscrew (63) for hinge (66-1C) and separate cover assy.
: 17mm

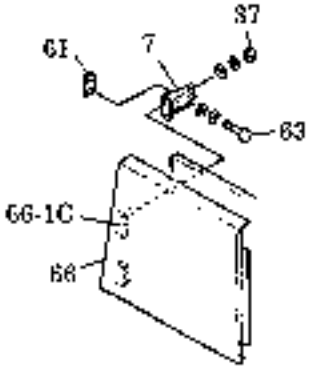


Fig. 21 Separating cover assy (66)

(3) Removing cover assy (94)
Unlock lock (94-1F), open cover (94), remove nut (37) and separate cover assy (94).
: 17mm

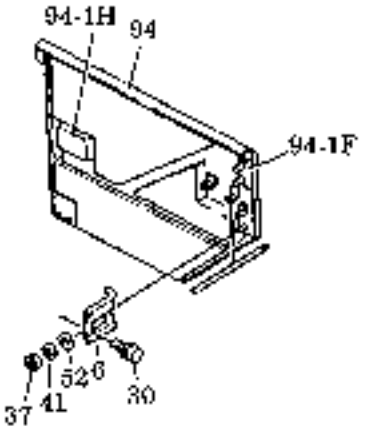


Fig. 22 Removing cover assy (94)

(4) Removing guard (14)
Remove sems bolt (31) and separate guard (14) with catches (28, 29).
: 19mm

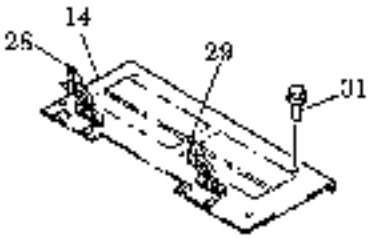


Fig. 23 Removing guard (14)

(5) Removing guard assy (12)
Remove sems bolt (31) and separate guard assy (12).
: 19mm

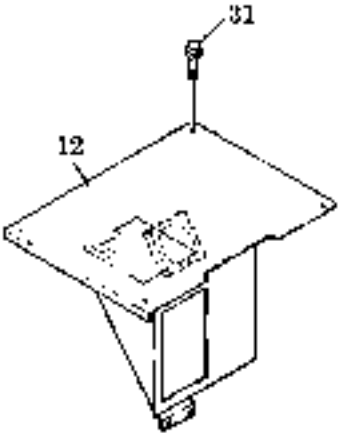


Fig. 24 Removing guard assy (12)

(6) Removing cover assy (15)
Open cover assy (15) by hinge (15-1D), remove nut (37) and separate cover assy (15) from bracket (4).
: 17mm

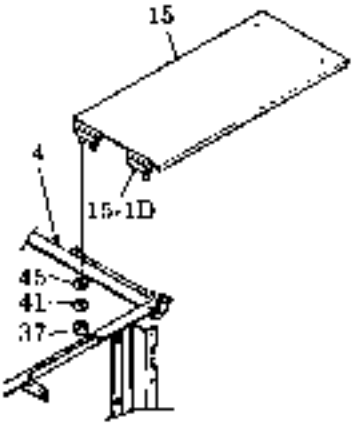


Fig. 25 Removing cover assy (15)

(7) Removing bracket (13)
Remove sems bolt (30) and separate bracket (13).
: 19mm

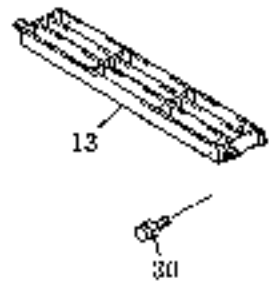


Fig. 26 Removing bracket (13)

(8) Removing handrail (22)
Remove sems bolt (31) and separate the handrail.
: 19mm

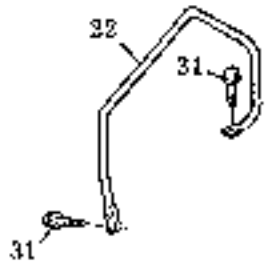


Fig. 27 Removing handrail (22)

(9) Removing box assy (21)
Unlock lock (21-2D), open cover (21-2) by hinge (21-2E), remove sems bolt (30) and separate box assy (21).
: 19mm

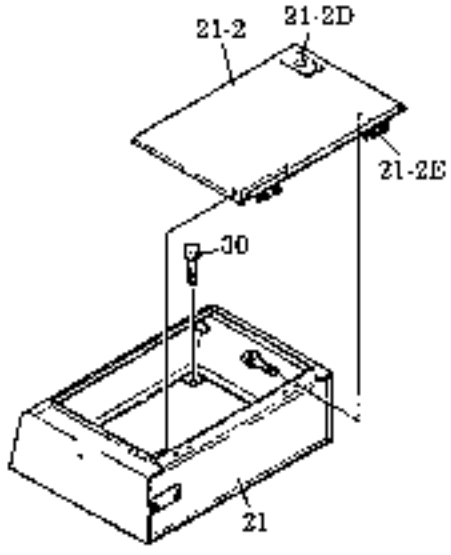


Fig. 28 Removing box assy (20)

(10) Remove bracket (91) (See Fig. 29.)
Remove sems bolt (30) and separate bracket (91).
: 19mm

(11) Removing guard assy (10)
Remove sems bolt (31) and separate guard assy (10).
: 19mm

(12) Removing guard assy (57)
Remove sems bolt (31) and separate guard assy (57).
: 19mm

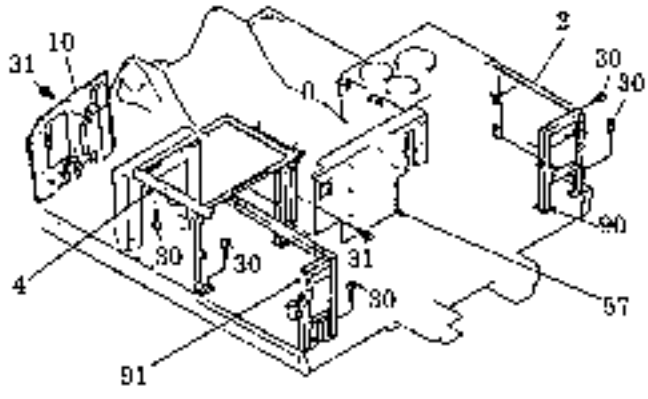


Fig. 29 Guard assy and brackets

(13)Removing brackets (90), (2)

Remove sems bolt (30) and dismantle brackets (90), (2).

: 19mm

3.3 MOUNTING

When attaching the brackets, cover assy, guard assy. etc , use capscrews, sems bolt or parts of the same part numbers and tighten them to the torques given in Table 1

Table 1

Tightening torque Unit kgf·m (ft·lbs)

Size	Sems bolts	Cap screw	Machine screw
M5	–	–	0.81±0.08 (5.86±0.56)
M8	–	3.6±0.4 (26±2.9)	2±0.2 (14.47±1.45)
M10	$5.0^{+3.9}_{-0}$ (36^{+16}_{-0})	7.2±0.7 (52.1±5.1)	–
M12	8.5±0.5 (61±3.6)	11±1 (80±7.2)	–

4. COUNTERWEIGHT

4.1 PREPARATION FOR DISMANTLING AND INSTALLING COUNTERWEIGHT

To prepare to dismantle the counterweight assy, remove the engine cover assy at the back of the upper swing body and the cover assy (4), and separate the harness connector of the rear work light.

4.2 DISMANTLING AND INSTALLING COUNTERWEIGHT

(1) Dismantling

1) Remove plug (5) on the top face of the counterweight assy. Attach a lifting jig to the tapped holes (M48) and lift the assy so it is tensioned slightly.
2) Adjust the tension of the wire sling by loosening four capscrews (M36×240), (9) that fasten the counterweight assy from its bottom side and draw out the capscrews.
   : 55mm
3) Separate the counterweight assy from the swing frame by means of the wire sling that was used to lift the assy.
   Weight of counterweight assy:
   about. 6.12 tons (13,460 lbs)

⚠ Make sure that the insulation is plastered securely and that protectors (2, 3) are fixed firmly.
Note that adjusting shims (6, 7, 8) are placed on the mount. Take a record of these locations when removing the shims.

(2) Mounting

1) Mounting is performed in the reverse order of dismantling. Prepare the shims (6, 7, 8) that were recorded before.
2) Place a wire sling in the lifting jig that was attached to the counterweight assy, and lift and bring the assy close to a fixed place.
3) Insert shims (6, 7, 8). Put capscrews (9) coated with Locktite #242 and washers (13) in place, and temporarily fasten.
4) Check that the counterweight assy is placed in correct position. Then fasten the screws to a torque of 300±30 kgf·m (2170±217 ft-lbs).
   Remove the lifting jig and attach plug (5).
   : 55mm

⚠ The clearance between the guard and the counterweight shall be 10mm (0.39"), and the vertical difference shall be within 6mm (0.24").

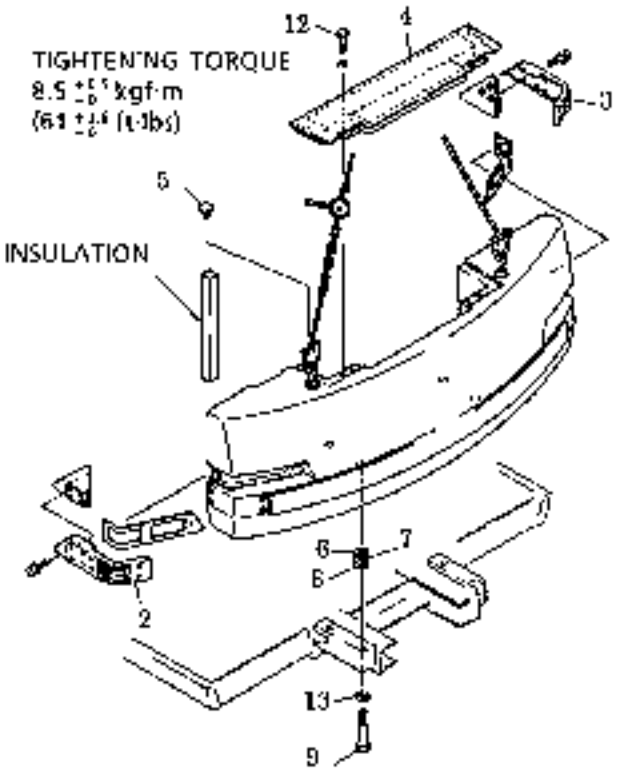


Fig. 30 Counterweight assy

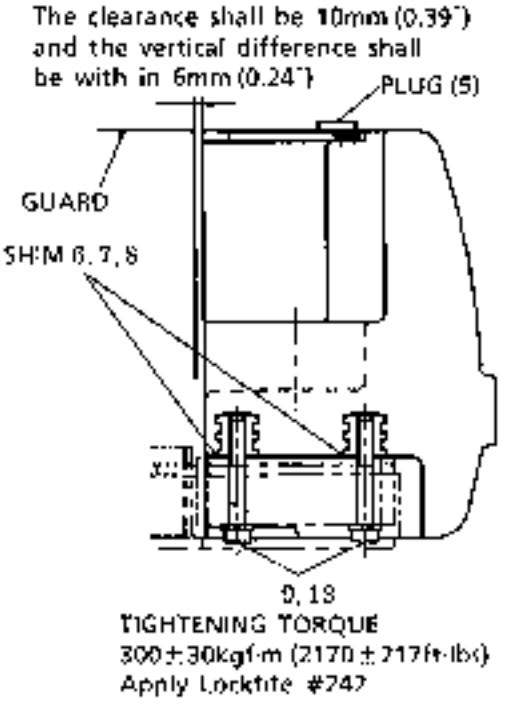


Fig. 31 Detaching and attaching counterweight

5. FUEL TANK

5.1 PREPARATION FOR DISMANTLING AND INSTALLING FUEL TANK

Before dismantling or installing the fuel tank, take off the surrounding covers and guards in order to facilitate the operation.

5.2 DISMANTLING AND INSTALLING FUEL TANK

(1) Dismantling

1) Loosen the cock (9) under the fuel tank to discharge the remaining oil. Disconnect the hoses on the feed and return sides of the fuel pipe and plug the openings of the pipe so as not to allow entry of dust and other foreign matter.
2) Disconnect the wiring on the connector side of sending unit (5).
3) Loosen six mounting capscrews (10) at the bottom of fuel tank (1) and remove them with washers (11).
   : 30mm
4) Place a wire sling in fuel tank (1).
   Weight of fuel tank assy . 210kg (465 lbs)

(2) Mounting

1) Mounting is performed in the reverse order of dismantling. Place a wire sling in fuel tank (1) and lift it onto a fixed position.
2) Coat capscrews (10) with Locktite #271 and tighten them with washers (11).
   : 30mm,
   Tightening torque : 55 ± 5 kgf-m
   (398 ± 36 ft-lbs)
3) Refit the removed fuel pipes back in place.
4) Connect the connector for the wiring for sending unit (5).
5) Attach the removal covers and guards.
6) Close cock (9), remove filler cap (3), fill in fuel and check the fuel level on the fuel gauge of the gauge cluster.

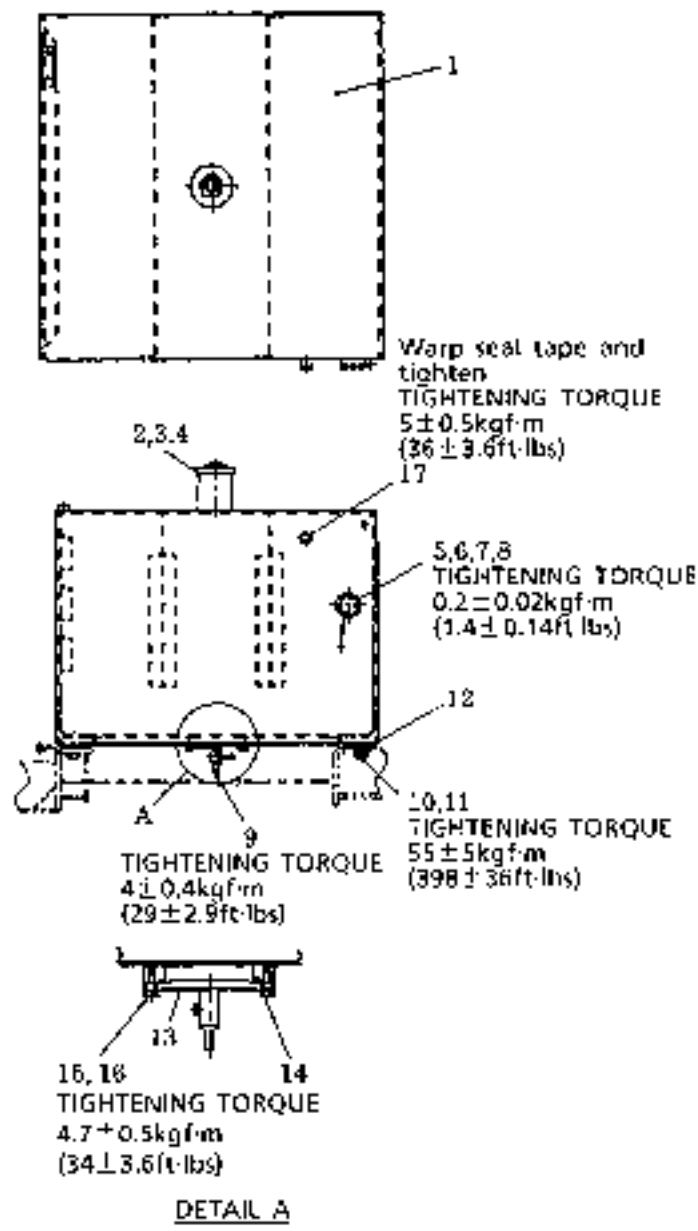


Fig. 32 Fuel tank

5.3 COMPONENT PARTS

Item	NAME	Q'ty	Item	NAME	Q'ty
1	FUEL TANK	1	10	CAPSCREW	6
2	STRAINER	1		(M20×45)	
3	FILLER CAP	1	11	WASHER	6
4	KEY	1	12	SHIM (t=1.0)	5
5	SENDING UNIT	1	13	FLANGE	1
6	PACKING	1	14	O RING	1
7	MACHINE SCREW	5	15	CAPSCREW	4
	(M5×12)			(M10×25)	
8	LOCK WASHER	5	16	LOCK WASHER	4
9	COCK	1	17	PLUG (PT 1/2)	1

6. HYDRAULIC TANK

6.1 PREPARATION FOR DISMANTLING AND MOUNTING HYDRAULIC TANK

(1) Before dismantling or mounting the hydraulic tank, take off the surrounding guards and disjoint brackets
(2) Since the hydraulic tank is pressurized, remove the cap nut at the top of air breather (22) on top of tank (28) and press the plunger in the center.
(3) After venting, remove plunger (4).

6.2 DISMANTLING AND MOUNTING HYDRAULIC TANK

(1) Dismantling
1) Place a clean container of more than 300 ℓ (80 gal) capacity under the hydraulic tank, take off plug (19) with O ring, and discharge hydraulic oil. Disconnect the suction hose, return hose and drain hose and cover the connections with a proper means to prevent entry of dust and other foreign matters.
   ⑨ : 36mm
2) Separate the connector of level switch (10) and the manifold block.
   ⑤ : 10mm, 17mm
3) Loosen four capscrews (12) located at the bottom of hydraulic tank and remove them with washers (13).
   ⑨ : 30mm
4) Lift up hydraulic tank (28) by crane.
   Weight of hydraulic tank assy :
   about. 240kg (528 lbs)

(2) Installation
1) Installation is performed in the reverse order of dismantling ; Place a wire sling in hydraulic tank (28) and lift it onto a fixed position.
2) Make sure that plug (19) with O ring is fastened tight.
   ⑨ : 36mm.
   Tightening torque 16.5±1.5kgf·m
   (119±11ft·lbs)
3) Adjust the gap using shim in case of the gap between the tank mount and the frame is more than 1mm (0.04").
4) Screw in capscrews (12) coated with Locktite #271, and washers (13) into the tapped holes in the bottom of hydraulic tank (28).
   ⑨ : 30mm,
   Tightening torque 55±5kgf·m
   (398±36ft·lbs)
5) Reconnect the disconnected suction hose, return hose and drain hose back in position.
6) Fit the connector and manifold block of the level switch.
   ⑤ : 10mm.
   Tightening torque 0.45±0.05kgf·m
   (3.3±0.4ft·lbs)
7) Connect the tank with brackets and attach the surrounding guards.
8) Fill in a designated hydraulic oil from flange (4) (Flange (4) is already removed under 6.1 (3).), and confirm the oil level on level gauge (11).
9) Attach flange (4).

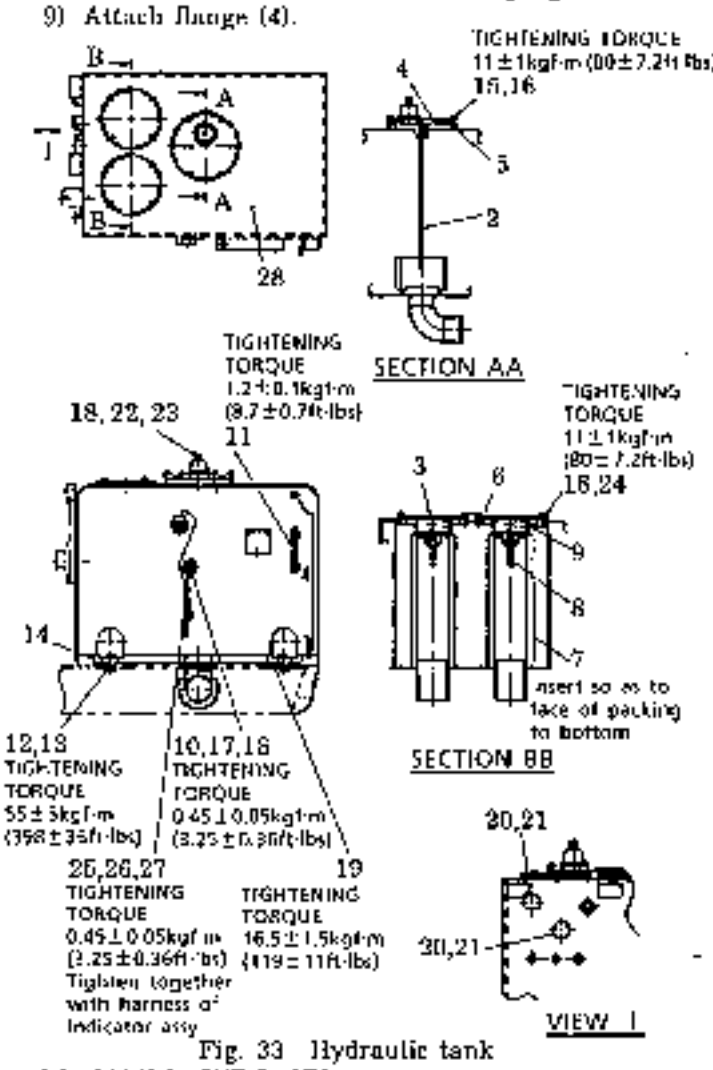


Fig. 33 Hydraulic tank

6.3 COMPONENT PARTS

Item	NAME	Q'ty	Item	NAME	Q'ty
2	SUCTION STRAINER	1	17	CAPSCREW (M6×10)	8
3	FLANGE	2			
4	FLANGE	1	18	LOCK WASHER	7
5	O RING	1	19	PLUG (PF 3/4)	1
6	O RING	2	20	PLUG	2
7	RETURN FILTER	2	21	O RING	2
8	BYPASS VALVE	2	22	BREATHER	1
9	SPRING	2	23	CAPSCREW (M6×60)	4
10	LEVEL SWITCH	1			
11	LEVEL GAUGE	1	24	CAPSCREW (M12×22)	8
12	CAPSCREW (M20×45)	4	25	CLIP	1
13	WASHER	4	26	CAPSCREW (M8×16)	1
14	SHIM	3			
15	CAPSCREW (M12×30)	6	27	LOCK WASHER	1
16	LOCK WASHER	14	28	HYDRAULIC TANK	1

7. HYDRAULIC PIPING

7.1 GENERAL PRECAUTIONS TO BE EXERCISED WHEN DETACHING AND ATTACHING HYDRAULIC PIPING.

(1) Before detaching and attaching the hydraulic piping, bleed off the pressure of the hydraulic oil tank and drain out all hydraulic oil through the drain plug.

(2) When disconnecting the tubes and hoses from the joints, make sure that they are not internally pressurized and then loosen the nuts of the joints.

(3) Prepare an oil container in order to receive hydraulic oil flowing out of the tubes and hoses when joints are removed.

⚠ It becomes a public nuisance to pour hydraulic oil onto the ground. Take care so as not to let oil out.

(4) Always put a blind plug to both ends of the removed joints so as to prevent entry of foreign matter. Further, when temporarily placing tubes, hoses and joints independently, place them on a clean stand and put a cover on them to protect them from foreign matter.

(5) When removing them, put a tag or something to each of them, considering re-installation.

(6) Always tighten the joints to a specified torque.
Joints come in the following three types. Different tightening torques are produced even if spanners of the same size are used. Therefore, refer to the graph and the tables in the following : Regarding the main piping and the pilot piping, refer to Hydraulic System.

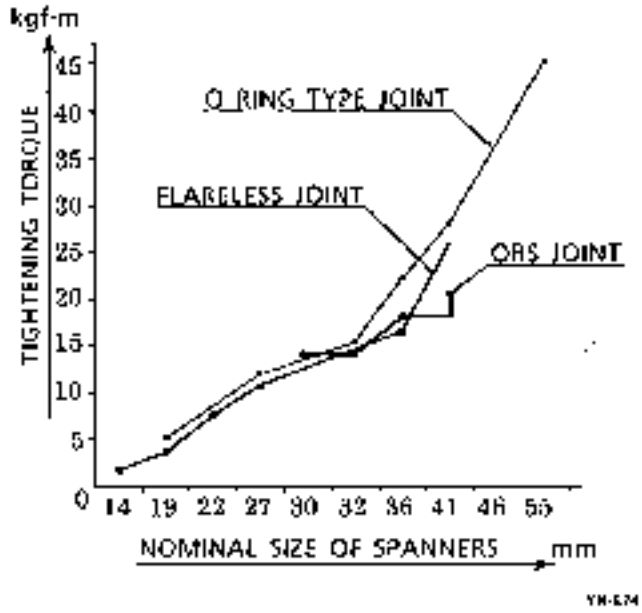
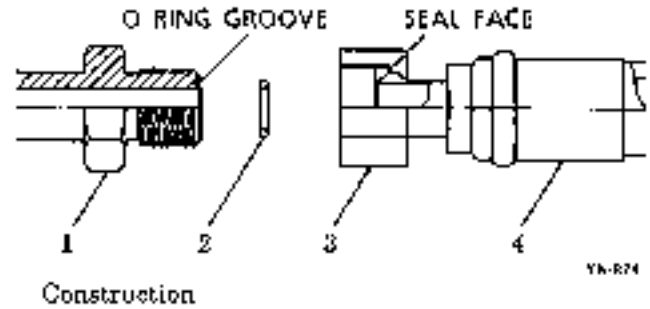


Fig. 34 Kinds of Joints and tightening torques



Construction
1. Joint 2. O ring
3. Union nut 4. Hose and tube

Fig. 35 ORS joint

• ORS joint (O ring seal type)

	SIZE	SPANNER USED mm	TIGHTENING TORQUE kgf·m (ft·lbs)
HOSE AND JOINT	1—14	30 32	14±1.4 (101±10)
	1—3/ 16—12	36 41	18±1.8 (130±13)
	1—7/ 16—12	41 46	21±2.1 (152±15)

• Flareless joint

Tube size O.D.×Thickness mm	SPANNER USED mm	TIGHTENING TORQUE kgf·m (ft·lbs)
10×1.5	19	5±1 (36±7)
15×2.0	27	12±1.2 (87±9)
18×2.5	32	15±1.5 (108±11)
22×3.0	36	22±2.2 (159±16)
28×4.0	41	28±2.8 (202±20)
35×5.0	55	45±4.5 (325±33)

• O ring type joint

SCREW DIA. (PF)	SPANNER USED mm	TIGHTENING TORQUE kgf·m (ft·lbs)
1/8	14	1.7±0.2 (12±1)
1/4	19	3.7±0.2 (27±1)
3/8	22	7.5±0.5 (54±4)
1/2	27	11±1 (80±7)
3/4	36	16.5±1.5 (119±11)
1	41	26±1 (188±7)

8. AIR CLEANER

The intake air sucked from the side and top of the radiator is purified by the air cleaner element and used for the intake air of the engine via hoses (25), (29). Switch assy (7-11) is installed to the air cleaner and warns of clogging of the element on the multi display of the operator's cab.

8.1 DISMANTLING AND MOUNTING AIR CLEANER

(1) Dismantling

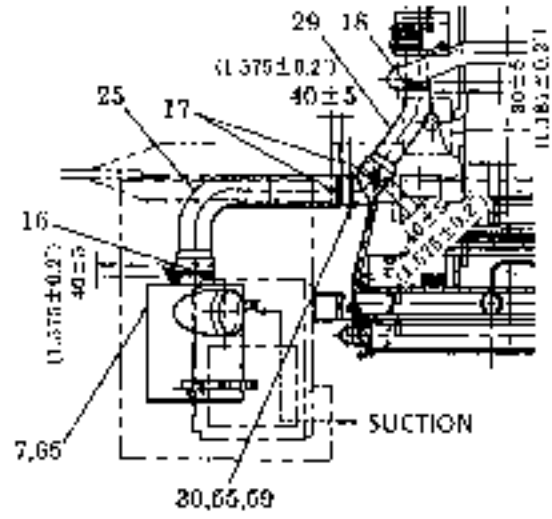
⚠ Areas heated hot exist nearby while the engine is running. Proceed to disassembly operation after the engine has cooled of sufficiently.

1) Separate the engine cover assy and the cover assy in the neighborhood of the air cleaner.
2) Remove clip (16), (17) and separate hose (25) from air cleaner (7).
3) Remove sems bolt (47) and separate air cleaner (7) from the guard. On that occasion, make sure that the insulation is plastered securely to the box.
   : 19mm
4) Remove clip (17), (18) and separate hose (29) from the turbo and tube (30).
5) Remove capscrew (59) and separate tube (30) from the guard.
   : 17mm

(2) Mounting

The mounting of the air cleaner is performed in the reverse order of dismantling.

1) Install air cleaner (7) to the guard, using sems bolt (47).
   : 19mm
2) Install tube (30) to the guard by means of capscrews (59).
   : 12mm
3) Inserting dimension into the both side of hose (25) and tube (30) side of hose (29) are 40±5mm (1.575±0.2").
   Inserting dimension into turbo side of hose (29) is 30±5mm (1.181±0.2")
4) Switch assy (7-11) is screwed on the air cleaner. When replacing or removing switch assy, beforehand tighten it by the specified torque.
   Tightening torque : 0.1~0.2kgf·m
   (0.72~1.45ft·lbs)



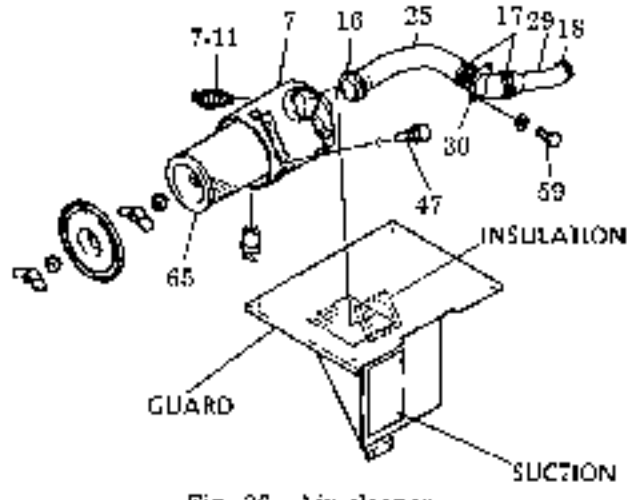


Fig. 36 Air cleaner

8.2 COMPONENT PARTS

Item	NAME	Q'ty	Item	NAME	Q'ty
7	AIR CLEANER	1	30	TUBE	1
7-11	SWITCH ASSY	1	47	SEMS BOLT	8
16	CLIP	1		(M12×30)	
17	CLIP	2	55	WASHER	4
18	CLIP	1	59	CAPSCREW	4
25	HOSE	1		(M10×20)	
29	HOSE	1	65	FILTER ELEMENT	1

9. POWER TAKEOFF ASSY

The power takeoff assy consists of hydraulic pump (1), gear pump (11), bracket (3) and coupling (12). The power takeoff assy is fixed to the engine flywheel housing via bracket (3). The drive shaft (input shaft) is connected with the flywheel of the engine by means of coupling assy (12) so as to absorb jerky load variations between the engine and the hydraulic pump.

9.1 PREPARATION FOR DISMANTLING AND INSTALLATION OF POWER TAKEOFF ASSY

(1) Removing covers
After the engine stops, remove the engine cover assy, guards and muffler so the pump can be drawn out

(2) Mounting hydraulic suction stopper
Vent air through air breather (22) on the hydraulic tank, separate flange (4), and draw out suction strainer (2). After drawing out the suction strainer, install the suction stopper to prevent the hydraulic oil from flowing out.

9.2 DISMANTLING AND INSTALLATION OF POWER TAKEOFF ASSY

(1)Installation

1) Place a wire sling in the eye bolt at the top center of the hydraulic pump, give it slight tension, and remove capscrews (9).
: 17mm, weight : 219 kg (482 lbs)
However, when separating the bracket from pump (1), loosen capscrew (4) about half turn before loosening capscrews (9).

2) Draw out the power takeoff assy from the flywheel housing assy slowly, while adjusting the tension of the wire sling
On that occasion, coupling (12) is separated, insert (12-2) and hub (12-9) are on the hydraulic pump, insert (12-8) and flange (13) are on the flywheel side, and element (12-1) is fixed on either side.

3) Remove capscrews (12-4) attached insert (12-3) and flange (13) to the flywheel.
Then take off insert (12-3), flange (13) and four spring pin (12-7).
: 17mm

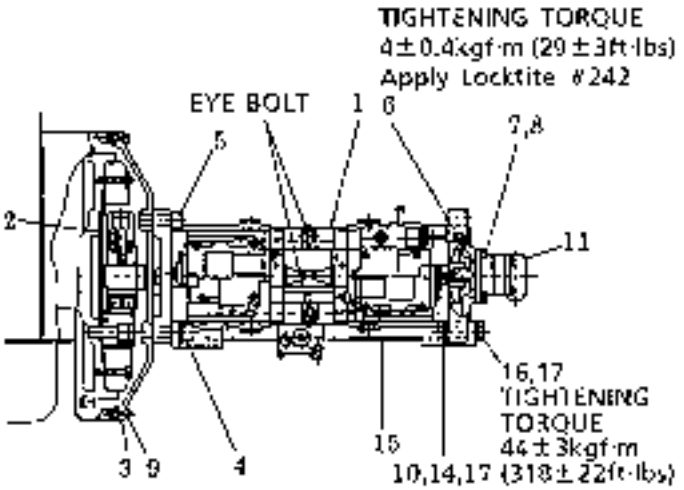


Fig. 37 Power takeoff assy

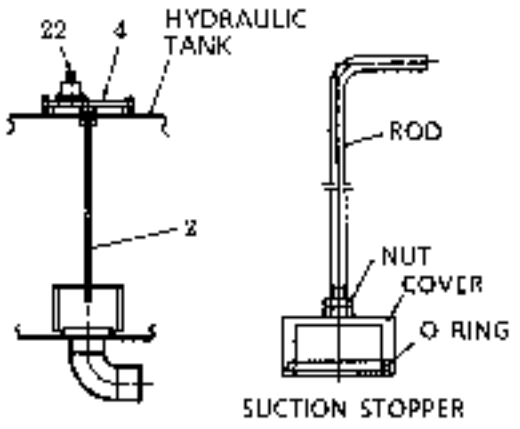


Fig. 38 Installing suction stopper

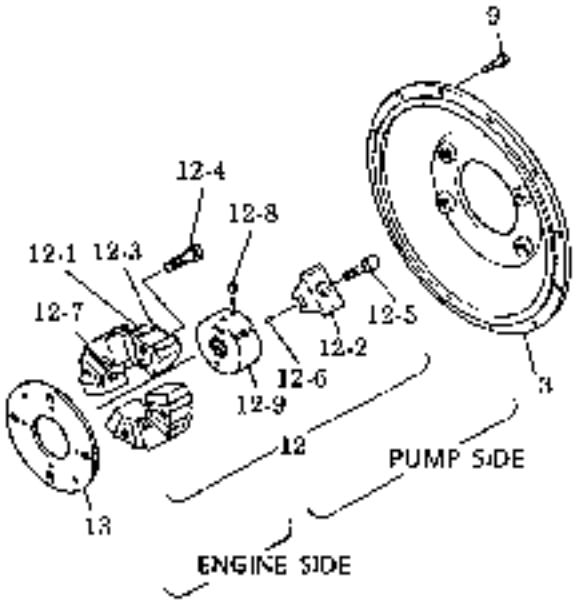


Fig. 39 Detaching and attaching coupling

4) When removing insert (12-2), remove capscrews (12-5) attached to hub (12-9). Then take off four inserts (12-2) and eight spring pins (12-6).
: 17mm

5) Loosen setscrew (12-8) and draw out hub (12-9) from the shaft of the hydraulic pump.
: 10mm

6) When replacing the pump, remove capscrews (4,5) and separate bracket (3) from hydraulic pump (1).
: 17mm

(2) Installation

1) Coat capscrews (4,5) with Locktite #242 and install bracket (3) to the hydraulic pump. On that occasion, coat the mounting face of the pump with Locktite #515
: 17mm,
Tightening torque : 44 ± 3 kgf·m
(318 ± 22 ft·lbs)

2) Insert hub (12-9) in the shaft of the hydraulic pump, protrude the end of shaft 5mm (0.2") from the face of the hub (12-9) and fix the assy to the shaft by means of setscrew (12-8) coated with Locktite #242.
: 10mm,
Tightening torque : 21 ± 1 kgf·m
(152 ± 7 ft·lbs)

3) Drive eight spring pins (12-6) into hub (12-9), and fix four inserts (12-2) to hub (12-9) by means of capscrews (12-5).
: 20mm,
Tightening torque : 46 ± 3 kgf·m
(333 ± 22 ft·lbs)

4) Drive four spring pins (12-7) into flange (13), and fix inserts (12-3) to flange (13).

5) Fix flange (13) and inserts (12-3) assembled in the foregoing paragraph to the flywheel.
: 17mm,
Tightening torque : 46 ± 3 kgf·m
(333 ± 22 ft·lbs)

6) Assemble element (12-1) to insert (12-3) on the engine side.

7) Lift the hydraulic pump assy horizontally, engage insert (12-2) on the hydraulic pump with element (12-1) on the flywheel side, and push in the hydraulic pump assy.

8) Install bracket (3) to the flywheel housing and fasten them with capscrews (9) coated with Locktite #242.

On that occasion, apply Locktite #515 to the mating faces between the flywheel housing and bracket (3)
: 8mm,
Tightening torque : 7 ± 0.7 kgf·m
(51 ± 5 ft·lbs)

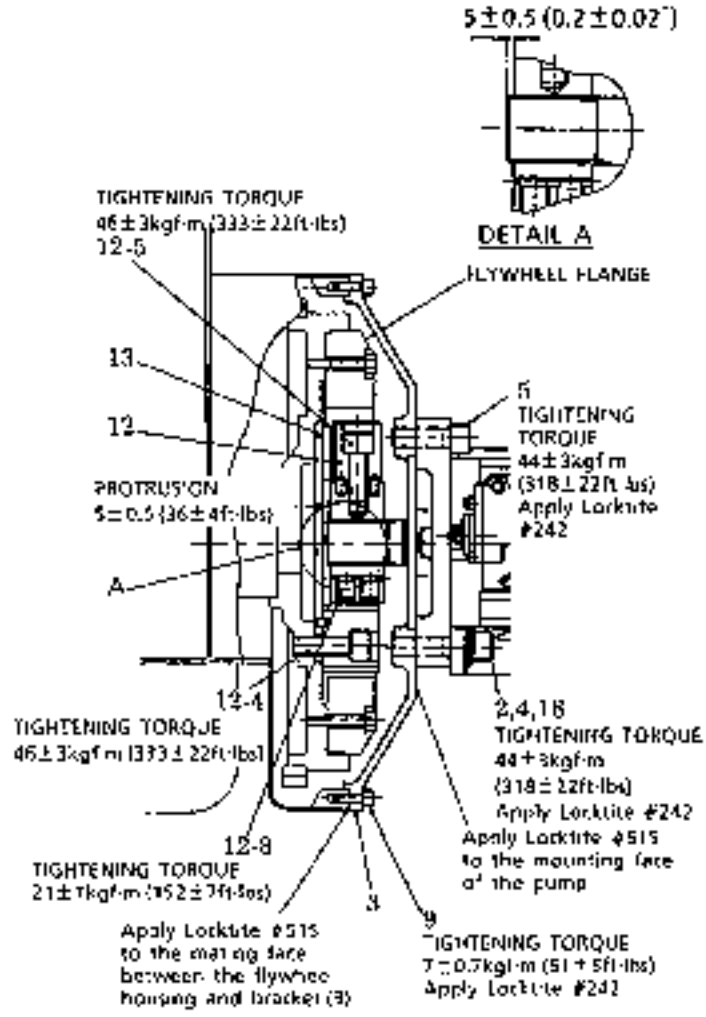


Fig. 40 Power takeoff assy

9.3 COMPONENT PARTS

Item	NAME	Q'ty	Item	NAME	Q'ty
1	HYDRAULIC PUMP	1	12-3	INSERT	4
2	LOCK WASHER	1	12-4	CAPSCREW (M20×60)	4
3	BRACKET	1			
4	CAPSCREW (M20×85)	1	12-5	CAPSCREW (M20×50)	4
5	CAPSCREW (M20×60)	3	12-6	SPRING PIN	8
6	O RING	1	12-7	SPRING PIN	4
7	CAPSCREW (M10×25)	2	12-8	SET SCREW (M20×25)	2
8	WASHER	2	12-9	COUPLING HUB	1
9	CAPSCREW (M10×30)	12	13	FLANGE	1
10	LOCK WASHER	2	14	NUT	2
11	GEAR PUMP	1	15	BRACKET	1
12	COUPLING	1	16	CAPSCREW (M20×100)	2
12-1	ELEMENT	4	17	WASHER	4
12-2	INSERT	4	18	WASHER	1

10. AIR CONDITIONER

The structure, operation, disassembly, assembly, etc of the air-conditioning system are described fully in a separate volume. This section describes how to remove and install the air-conditioning system in the cab.

⚠
- The new refrigerant R134a is used for the air conditioner of this machine. The specification differs from the conventional fleon-gas-used air conditioner.
- Electric fittings including a controller are mounted on the air-conditioner and electric fittings.

10.1 PREPARATORY ARRANGEMENTS FOR REMOVING AND INSTALLING AIR-CONDITIONING UNIT

(1) Remove 18 fasteners (23) to remove cover (10).
(2) Remove cab. (Refer to para. 1 cab.)

10.2 REMOVING AND INSTALLING AIR-CONDITIONING UNIT

(1) Removing
1) Draw out the grill hose band from part A on the air-conditioner side.
2) A controller, and other electric fittings are placed on the air-conditioner. Separate the connectors connecting the instrument panel harness with other harnesses from parts D, E, F, G, H, I, J, k, L, M and N.
3) Remove the cooler hose and the heater hose from the air-conditioner unit.
4) Loosen and remove six capscrews (17) that fasten the air-conditioner, and lift up the air-conditioner unit.
   : 17mm, weight of air-conditioning unit : 30kg (66 lbs)

(2) Installing
Install air-conditioning unit by reversing the procedure of removal.
1) Install the air-conditioner unit to the floor plate.
   : 17mm,
2) Fasten the heater hose with a hose band. Tighten the cooler hose to a designated torque.
3) Reconnect all harness connectors.
4) Insert the grill hose.
5) Mount the cab. (Refer to para. 1 cab.)
6) Install cover (10) with fastener (23).

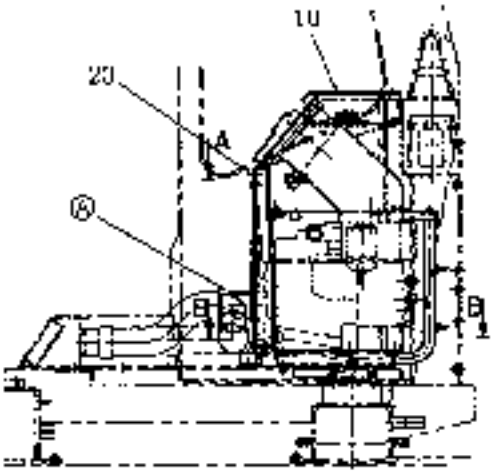


Fig. 41 Outside view of air-conditioner

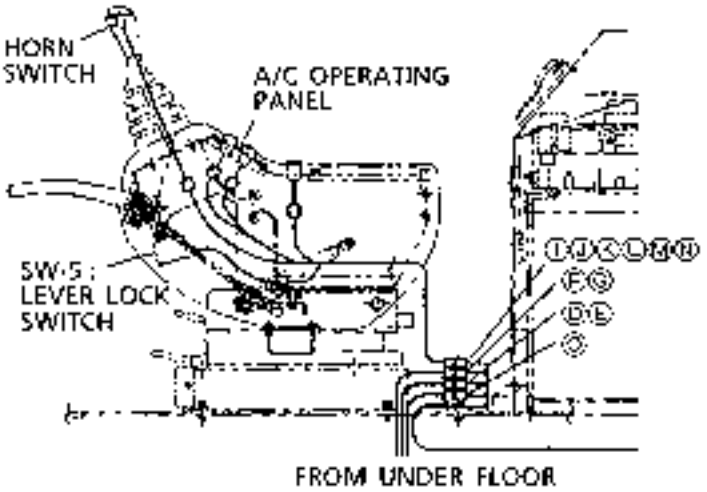


Fig. 42 Inst-panel harness connector

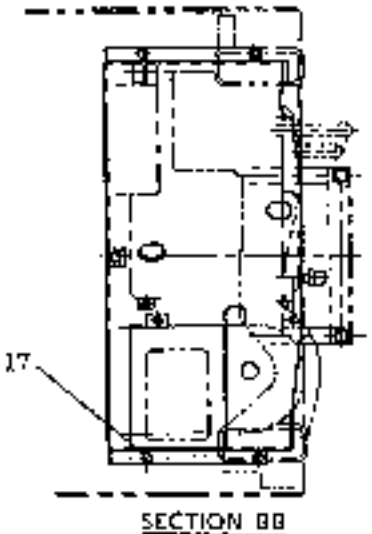


Fig. 43 Air-conditioner mounting bolts (17)

11. AIR CONDITIONER PIPING

11.1 CONSTRUCTION AND FUNCTION

1) Cooler section

The cooler section of the air-conditioner consists of an air-conditioner unit, a receiver tank, and a compressor.

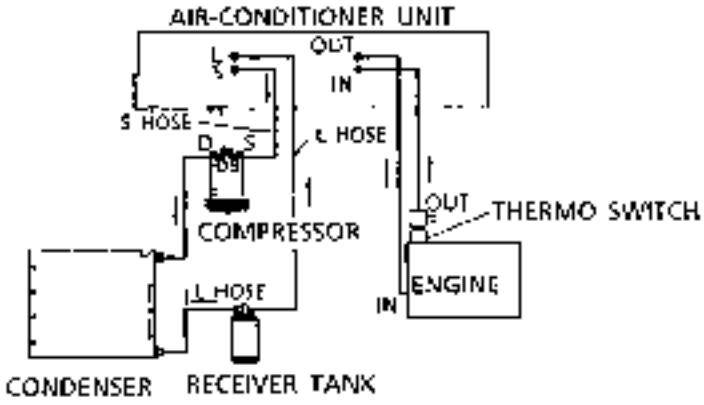
Both IN and OUT hoses connected with the receiver tank are called L hose, while the hose connecting with the suction side of the compressor is called S hose. Also the hose connecting with the delivery side of the compressor is called D hose.

2) Heater section

The heater section of the air-conditioner consists of an air-conditioner unit, and an engine cooling water block.

AC unit side IN ——— OUT
OUT ——— IN

Connect hoses so they are located on the engine side.



11.2 DETACHING AND ATTACHING AIR-CONDITIONER

Regarding the attaching and detaching of the air-conditioner piping, refer to the figure below.

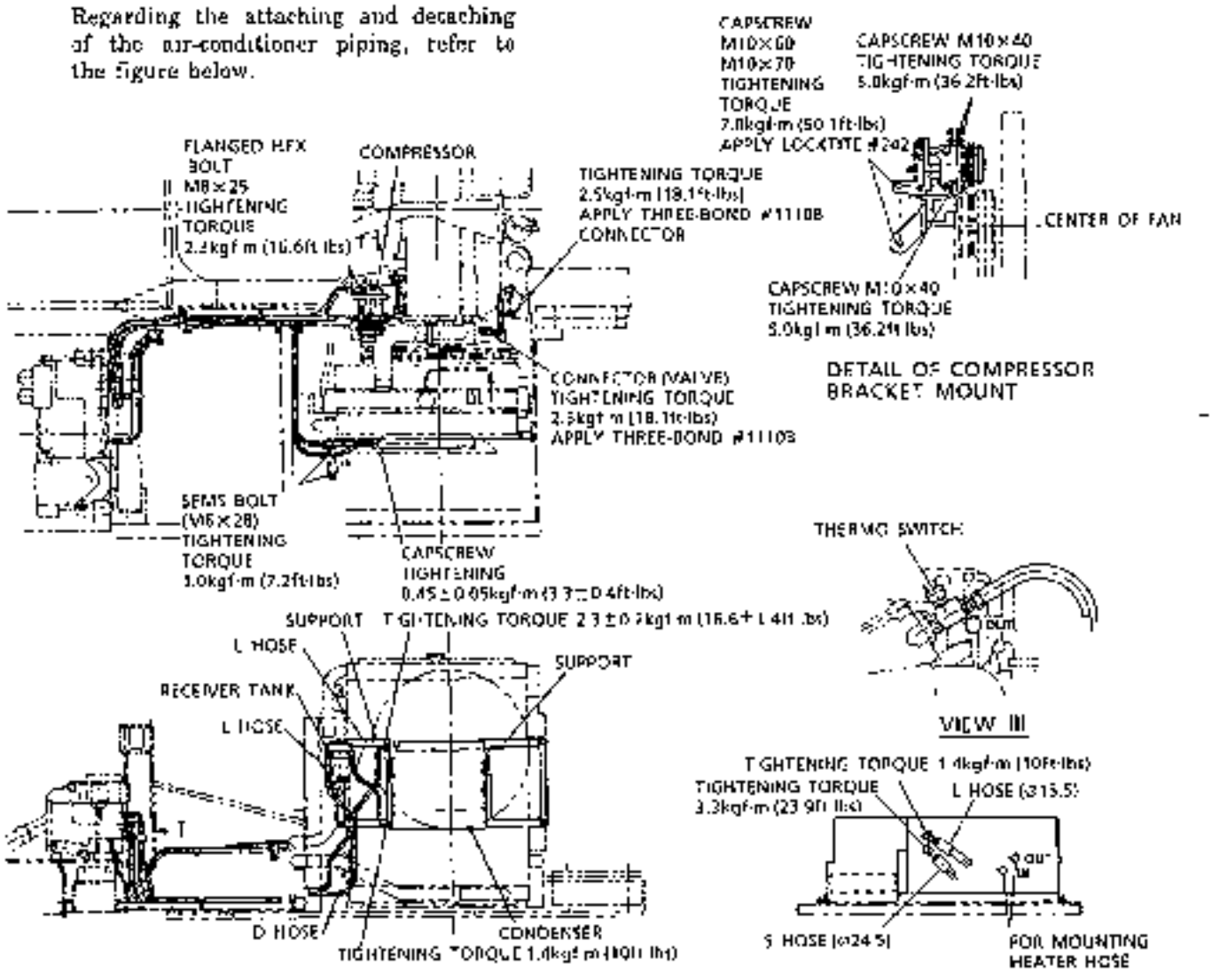


Fig 44 Air conditioner piping

12. RADIATOR

The radiator assy consists of a cooling water radiator, an oil cooler and a sub tank.

12.1 PREPARATION FOR DISMANTLING AND INSTALLING RADIATOR

1) Dismantle the engine cover, guards, air cleaner hoses around the radiator. (Refer to Dismantling and Installation of Guards and Air Cleaner.)
2) Open the cock under the radiator and drain out the water from inside the radiator.
3) Attach the suction stopper to the hydraulic tank and draw out the hydraulic oil of the oil cooler. (Refer to Dismantling and Installation of Power Take off Assy.)

12.2 DISMANTLING AND INSTALLATION OF RADIATOR ASSY

(1) Dismantling

1) Disconnect all hoses connected to the radiator and the oil cooler.
2) Remove fan guard.
3) Remove capscrews (45,46) that fasten stays (10), (11).
   : 19mm
4) Attach an eye bolt M12 to each of the tapped holes to which the stays were installed. Place a wire sling in them and tension the wire sling so it will not get loose.
5) Loosen and draw out capscrews (44) that fix the legs of the radiator assy to the frame. Then remove the radiator assy so as to prevent the shroud from interfering with the fan.
   : 30mm
   Weight of radiator assy : 123 kg (270 lbs)

(2) Installation

1) Place a wire sling in the radiator, install it, and temporarily fasten it with capscrews (44).
   : 30mm

⚠ Confirm that insulators (37,38) are not damaged.

2) Temporarily fasten stays (10), (11) by means of capscrews (45,46).
   : 19mm
3) Adjust the clearance between the fan and the radiator shroud 22.5^{+5}_{+2} mm ($0.89^{+0.2}_{+0.1}$") throughout all circumference. Also adjust so the fan is inserted axially 64±5 mm (2.52±0.2") into the shroud. Then coat capscrews (44) with Locktite #242 and tighten them.
   : 30mm
4) Fix all hoses, and adjust so the dimension of the inserting hose is 40 mm (1.575"). Also, adjust so the clearance between the radiator hose (23) and the center section plate of the upper frame is 29±5 mm (1.142±0.2").
5) Fill in cooling water to a designated level.
6) Run the engine for about ten minutes and confirm no water leakage.
7) Fill sub tank (6) with cooling water.

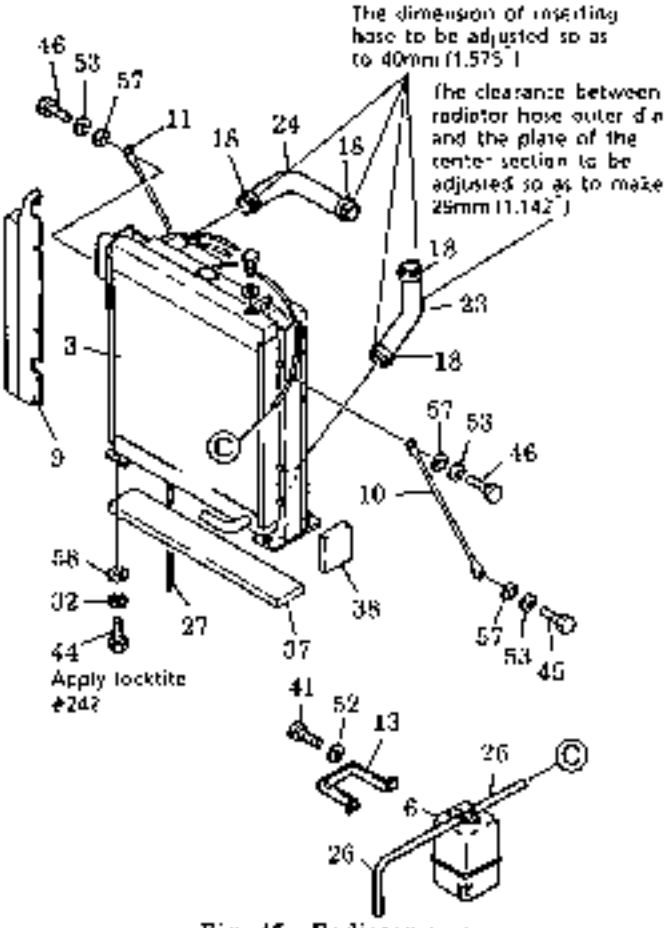


Fig. 45 Radiator assy

12.3 COMPONENT PARTS

Item	NAME	Q'ty	Item	NAME	Q'ty
3	RADIATOR ASSY	1	41	CAPSCREW (M10×25)	2
6	WATER TANK	1			
9	PLATE ASSY	1	44	CAPSCREW (M20×45)	4
10	STAY	1			
11	STAY	1	45	CAPSCREW (M12×25)	2
13	SUPPORT	1			
16	CLIP	4	46	CAPSCREW (M12×30)	2
23	HOSE	1			
24	HOSE	1	48	CAPSCREW (M6×14)	1
26	HOSE	1			
27	HOSE	1	52	LOCK WASHER	2
32	LOCK WASHER	4	53	LOCK WASHER	4
37	INSULATOR	1	57	WASHER	4
38	INSULATOR	1	58	WASHER	4
39	CLIP	1	64	WASHER	1

13. FUEL LINE

The fuel from the fuel tank passes through the separately installed filter (5), and is separated and removed the water mixed in the fuel.
The fuel which coming out from the separator (5) is supplied to the fuel filter installed on the engine by way of the separately installed filter (73) and the feed pump installed on the fuel injection pump, and remove the impurities mixed in the fuel.
The fuel from the fuel filter is supplied to the fuel injection pump and inject from the nozzles.
The oil returned from the engine is brought back directly to the fuel tank.

13.1 PREPARATION FOR DISMANTLING AND INSTALLATION OF FUEL LINE

1) Engine stop
2) Discharging fuel
   Loosen the cock under the fuel tank and discharge the remaining fuel.
3) Dismantle parts necessary for detaching and attaching the fuel line such as the engine cover, guard and muffler.

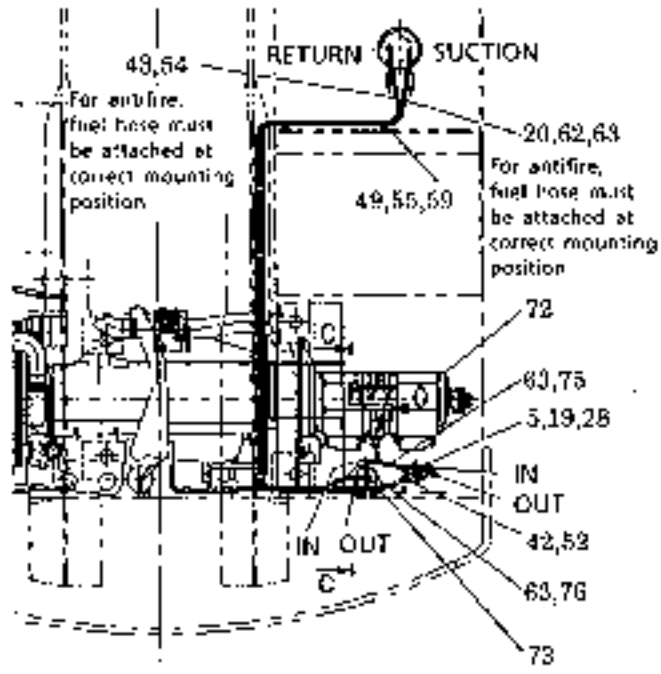
13.2 DETACHING AND ATTACHING FUEL LINE

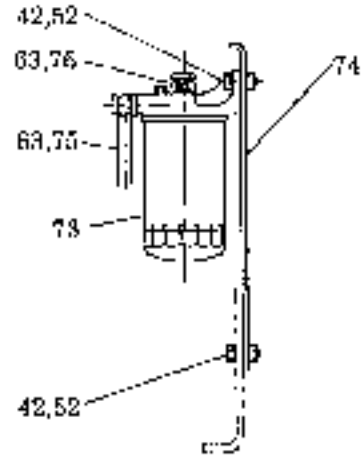
(1) Detaching

1) Loosen the drain cock of the water separator and drain out water.
2) Take off clips (20, 22, 49, 63) and disconnect hoses.

(2) Attaching

1) Attach hoses with clips (20, 22, 49, 63).
   ⚠ For antifire, fuel hose must be attached at correct mounting position.
2) Replace the fuel filter element where necessary.
3) Close the cock at the bottom face of the fuel tank and fill with fuel.
4) Loosen the overflow valve of the distributor, the air venting plug of the fuel filter and the air plug of the water separator. Operate the fuel feed pump to vent air.
5) Start the engine and run it at low idle revolution for more than one minute to confirm operation.
6) Make sure of no fuel leakage.
7) Install the engine cover, guard and muffler that were removed before.





SECTION CC

Fig. 46 Fuel line

13.3 COMPONENT PARTS

Item	NAME	Q'ty	Item	NAME	Q'ty
5	FILTER (WATER SEPARATING)	1	55	WASHER	3
			59	CAPSCREW (M10×20)	3
19	CLIP	1			
20	CLIP	6	60	NUT (M10)	1
22	CLIP	1	62	HOSE	1
28	HOSE	1	63	CLIP	6
42	CAPSCREW (M10×30)	2	73	FILTER ASSY	1
			74	BRACKET	1
49	CLIP	3	75	HOSE	1
52	LOCK WASHER	6	76	HOSE	1
54	HOSE	1			

14. ENGINE

14.1 PREPARATION FOR DISMANTLING AND INSTALLATION OF ENGINE

Before the engine is dismantled, the following operations must be completed. When installation has been completed, reassemble the engine by doing the same operations.

1) Discharge the oil of the fuel tank and the hydraulic oil tank.
2) Dismantle the guards, counterweight, radiator assy, air cleaner and muffler assy. (Refer to the Dismantling and Installation Procedures for each equipment.)
3) Disconnect the fuel hoses.
4) Disconnect the piping to the pump.
5) Disconnect the connectors for the harnesses for sensors.

⚠ Prepare a support which withstands the weight of the engine assy and on which the dismantled engine may be placed securely.

14.2 DISMANTLING AND INSTALLING ENGINE

(1) Dismantling

1) Removing engine mounting nuts
   Loosen and remove four engine mounting nuts (12) and draw out capscrews (10).
2) Lifting engine
   Place a wire sling in the lifting metal at the top of the engine and lift it up
   Weight of engine : about 900 kg (2180 lbs)
3) After dismantling of engine
   Remove the rubber mounts (1), (2) and cover (8) on the engine mounting frame.

(2) Installation

Coat the following parts with Locktite or ThreeBond and tighten the parts to the tightening torques of the following table.

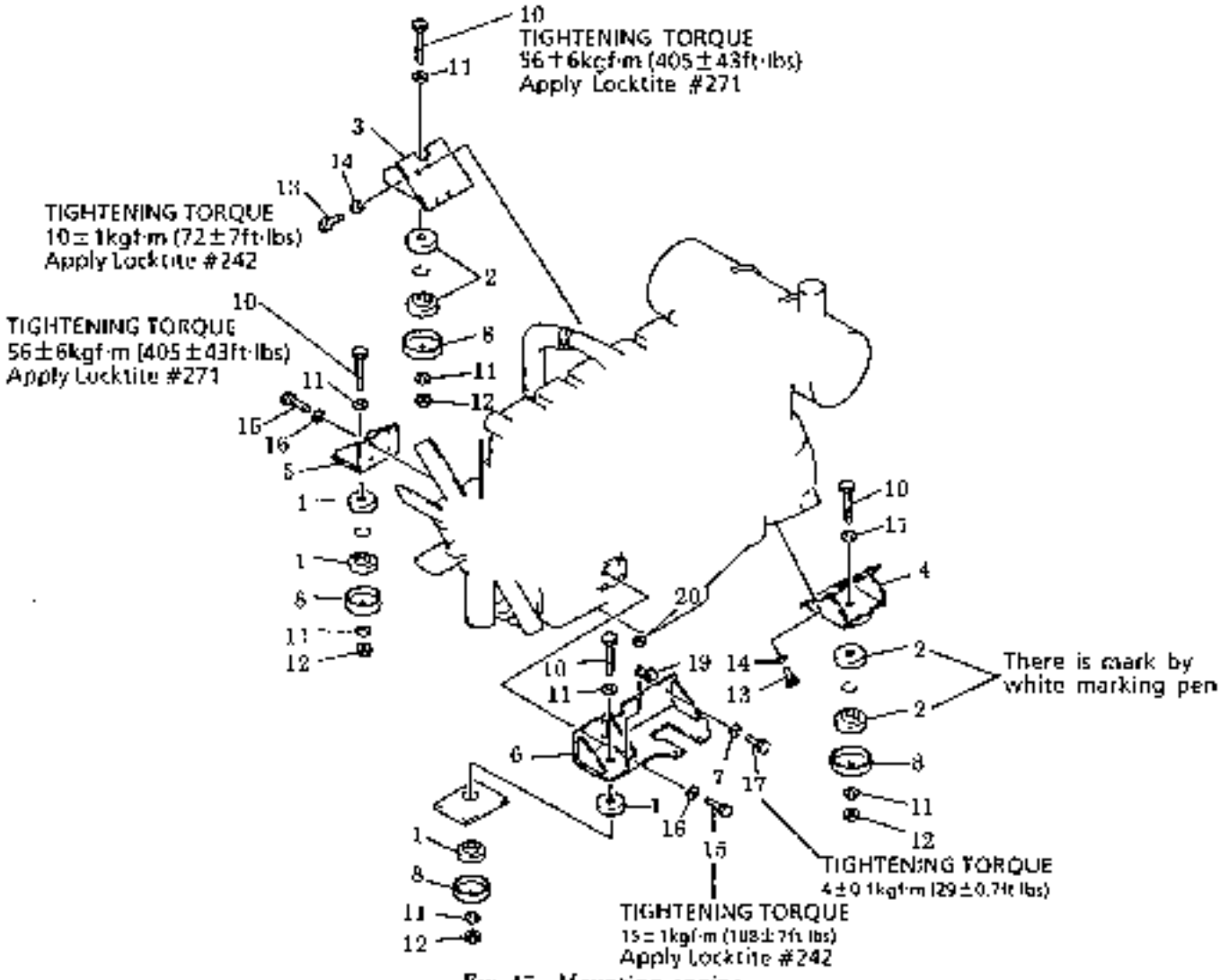


Fig. 47 Mounting engine

14.3 TIGHTENING TOOLS

NAME	Size	Width across flat
	M10	17
Spanner	M12	19
	M14	22
Socket	M16	27

14.4 COMPONENT PARTS

Tightening Torque	Item	NAME	Q'ty	Tightening Torque	Item	NAME	Q'ty
	1	RUBBER MOUNT	4	10±1kgf·m (72±7 ft·lbs) Locktite #242	13	CAPSCREW (M12×35)	8
	2	RUBBER MOUNT	4				
	3	BRACKET	1		14	WASHER	8
	4	BRACKET	1	15±1kgf·m (105±7 ft·lbs) Locktite #242	15	CAPSCREW (M14×35)	8
	5	BRACKET	1				
	6	BRACKET	1		16	WASHER	8
	7	LOCK WASHER	2	4±0.4kgf·m (29±2.9 ft·lbs)	17	CAPSCREW (M10×30)	1
	8	COVER	4				
56±6kgf·m (405±43 ft·lbs) Locktite #271	10	CAPSCREW (M20×130)	4		19	CLIP	1
					20	NUT	1
	11	WASHER	8				
	12	NUT (M20)	4				

15. SWING REDUCTION GEAR

The swing motor is installed at the top of the swing reduction gear. In order to install the swing reduction gear to the swing frame or dismantle the reduction gear from the swing frame, dismantle or install the swing unit that integrates the reduction gear with the motor.

15.1 PREPARATION FOR DISMANTLING AND INSTALLING SWING REDUCTION GEAR

1) Remove guards. (Refer to the procedure for dismantling and installation of guards.)
2) Vent air from the hydraulic tank.
3) Attach the suction stopper to the hydraulic tank.
4) Disconnect the pipes and install caps and plugs to prevent entry of foreign matter.

15.2 DISMANTLING AND INSTALLING SWING REDUCTION GEAR

(1) Dismantling

1) Removing capscrews
Loosen and remove fourteen capscrews (1) that fasten the flange of the swing reduction gear.
: 36mm

2) Lifting swing unit
Put an eye bolt into each of the tapped holes for the lifting screw (M12×1.75) located at the top of the swing motor assy. Place a wire sling in the swing unit, lift it up and bring it down on a prepared stand.
Weight of swing unit : about 490 kg (1080 lbs)

(2) Installation

1) Checking the mounting face
Installation is performed in the reverse order of dismantling. Before entering installation operation, make sure that the mating faces of the flanges of the upper frame and of the swing reduction gear are free from burrs and stain.

2) Coating the mounting faces with Locktite
Coat the mounting face of the swing reduction gear of the upper frame with Locktite #515.

3) Lifting and placing swing unit
Using the same lifting jig that was used to dismantle the swing unit, lift it and install it in place, while checking the faucet joint of the flange, the meshing of the pinion at the end of the reduction gear shaft, the mounting holes for the capscrews and the orientation of the swing reduction gear.

4) Attaching capscrews
Coat the threaded part of capscrews (1) with Locktite #242, screw them in and tighten them to install the swing reduction gear to the upper frame.
: 36mm,
Tightening torque : 95±9.5 kgf·m
(687±69 ft·lbs)

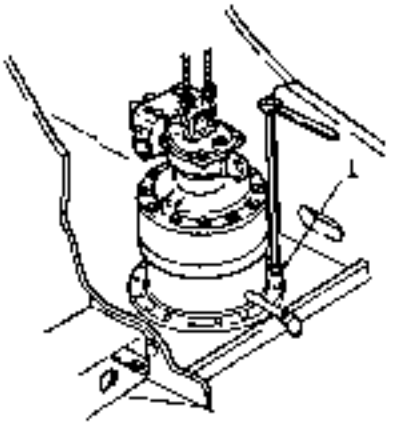


Fig. 48 Dismantling and installing swing reduction gear

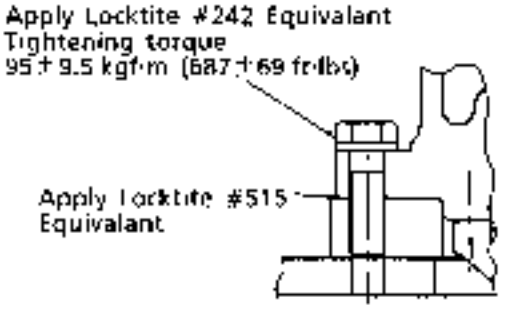


Fig. 49 Mounting part of swing reduction gear

15.3 COMPONENTS TO BE INSTALLED

No.	Nomenclature	Q'ty
0	SWING UNIT	1
1	CAPSCREW (M24×75)	14

16. UPPER FRAME

Methods of dismantling and installing the upper frame vary with disassembly condition and crane capacity. Methods may be classified as below :

Upper swing body − cab = about. 14 tons (30800 lbs)

Upper swing body − (cab + counterweight)
− about. 8 tons (17600 lbs)

However, since the attachment is left detached, prepare a crane having a capacity sufficiently safe for the above weights.

16.1 PREPARATION FOR DISMANTLING AND INSTALLING UPPER FRAME

(1) Dismantling cab (Refer to Sect. 1 Cab.)

(2) Prevention of hydraulic oil leakage (Refer to Sect. 6 Hydraulic Tank.)

1) Discharge the pressure out of the hydraulic tank.

2) Install the suction stopper to the hydraulic tank.

(3) Disconnecting piping

1) Disconnect the pipes to the boom, arm and bucket at the boom foot.

2) Plug the hose ends and tag the hoses so they are not mixed up at reassembly operation.

3) Disconnect the harness for the boom work light. Then remove the attachment and the boom cylinder.

4) Disconnect the piping to the travel system at the top of the swivel joint.

5) plug and tag the hoses so they are not mixed up at reassembly.

6) Remove the capscrews that lock the swivel joint and take off cover (18) and dust cover (2).

16.2 DISMANTLING AND INSTALLING UPPER FRAME

(1) Dismantling

1) Lifting upper frame

- With counterweight :
  Take off the engine cover and put eye bolts (M48) in the two tapped holes in the counterweight, and attach two chain hoists to the eye bolts.
  Regarding the front, put two wire slings in the lifting holes at the back of the boom foot pin holes.
- Without counterweight :
  Take off the engine cover and leave the counterweight removed.
  Attach two chain hoists to the frame at the mount of the counterweight, using the jig shown in the figure (next page).

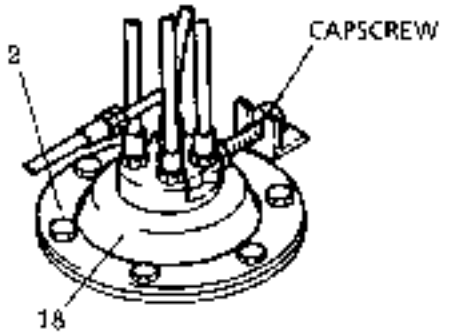


Fig. 50 Upper part of swivel joint

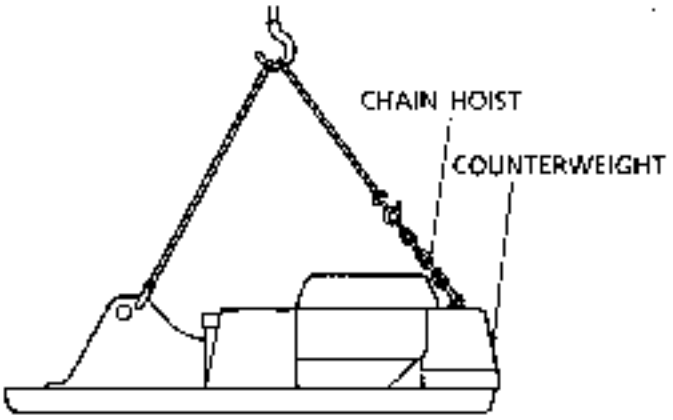


Fig. 51 Lifting method (with counterweight)

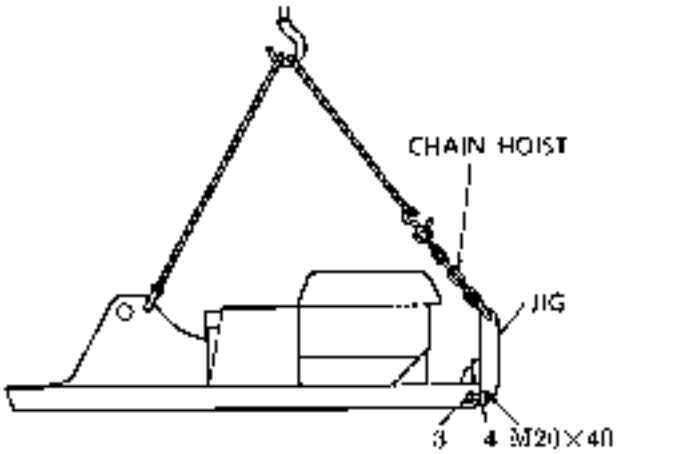


Fig. 52 Lifting method (without counterweight)

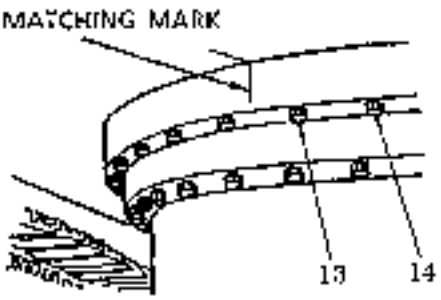


Fig. 53 Matching marks on swing bearing and upper frame

Regarding the front, attach two wire slings, utilizing the lifting holes of the frame the same way as mentioned above

2) Removing swing outer race mounting bolts.
   Put a matching mark to the swing bearing and the upper frame.
3) Tension the wire slings so they do not get slack and remove capscrews (17) and reamer bolt (14)

(2) Installation

1) Installation is done in the reverse order of dismantling. First of all, clean the swing bearing mounting surface at the bottom of the upper frame and the top surface of the outer race so the surfaces are free from dust, dirt and oily matter.
2) Apply Locktite #515 over the entire surface of the top face of the outer race from inside the capscrews.
3) Lifting method
   Lift the upper frame level and lower it slowly, while matching the matching marks left at disassembly and confirming the meshing of the swing pinion with the internal gear on the inner circumference of the inner race of the swing bearing.
4) Installing swing bearing to upper frame
   Apply Locktite #242 to reamer bolts (14) that mount the outer race of the swing bearing, and attach reamer bolts (14). After fastening it temporarily, coat capscrews (17) with Locktite #242 and temporarily fasten all of them.
5) Tighten all capscrews (17) and reamer bolts (14) back-and-forth, and right-and-left, alternately at 180° intervals, to specified torques.

   ⬢ : 80mm,
   Tightening torque : 50±5 kgf-m
   (362±36 ft-lbs)

16.3 JIG FOR LIFTING REAR OF UPPER FRAME

Insert the counterweight mounting bolts from underneath, attach eye nuts and make a lifting jig using a wire sling of about 2.5 m (9 ft) and shackles.

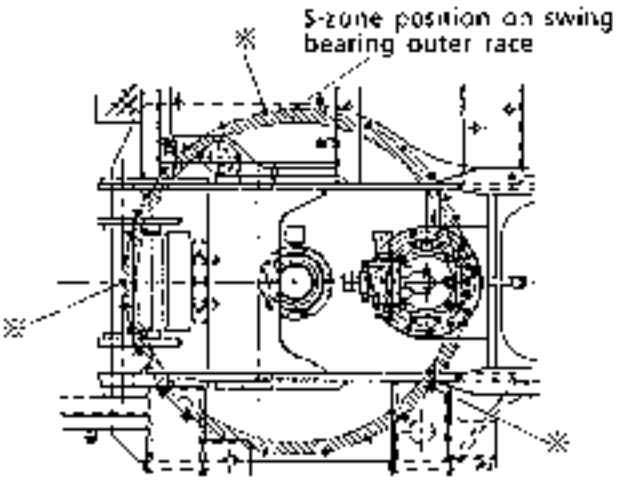


Fig. 54 Location of reamer bolts (※ mark)

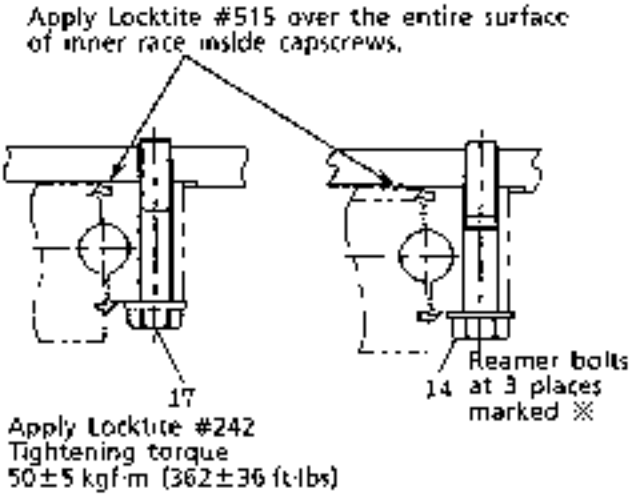
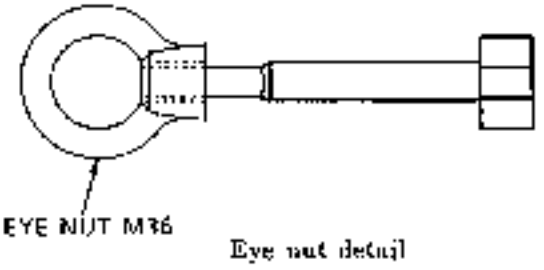


Fig. 55 Installing swing bearing to upper frame



Eye nut detail

Fig. 56 Upper frame lifting jig

Book code No. S5LC1805E

KOBELCO

SHOP MANUAL

SK310
SK310LC

TRAVEL SYSTEM

LC18

TABLE OF CONTENTS

KOBE STEEL, LTD.

Applicable Machines
LC03801~
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Revision	Date of Issue	Remarks
First edition	March, 1995	S5LC1805F K

1. CRAWLER

1.1 DISMANTLING AND MOUNTING PROCEDURE

(1) Dismantling

1) One master pin (6) is fixed in the track link of the crawler. Turn the crawler so the master pin is located ahead of the front idler.

2) Put square wooden blocks A and B under the shoe at the tip of the crawler and in the gap with the link above the track frame, in order to relieve the load of master pin.

3) Loosen the grease nipple for the track spring adjuster to let the grease in the cylinder out and slacken the tension of the crawler.
   : 19mm

⚠
- When loosening the grease nipple of the adjuster, do not loosen it more than one turn.
- Where grease does not come out well, move the machine back and forth.
- Take care as grease may jet out.

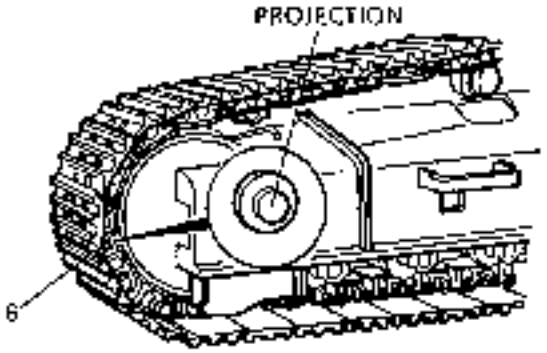


Fig. 1 Location of master pin

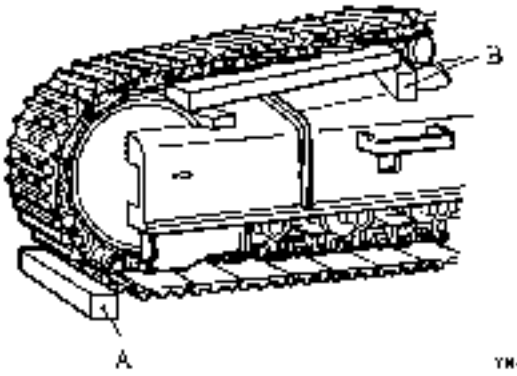


Fig. 2 Removing shoe

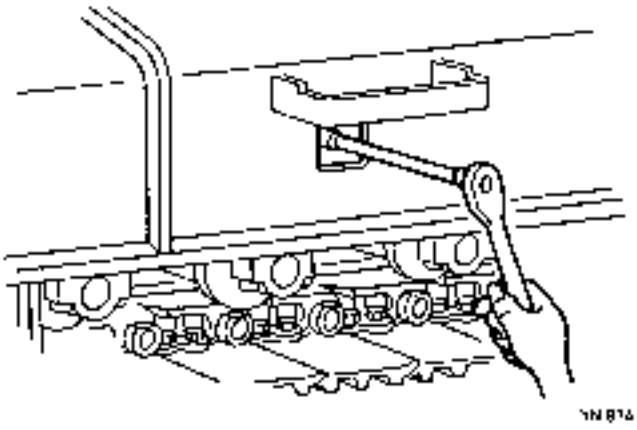


Fig. 3 Slackening the tension of crawler

4) Remove master pin (6) by knocking it with the master pin drawing jig (a).

⚠
- Use care as the front idler may pop out of the front idler by spring action if the master pin is drawn out where the front idler parts are broken.
- If you use a big hammer, wear a long-sleeved garment and protective goggles to protect yourself from flying objects.
- Unless you knock on the master pin by attaching the shoe plate to it, it gets hard to draw out the master pin as the link is distorted.

5) Remove the crawler by stretching it over the ground, while moving back the machine slowly by operating the travel lever.

⚠ When the master pin has been draw out and crawler has been separated, the end of the shoe plate may fall down. Therefore, do not get your feet close to the point where the end of the shoe plate may drop.

(2) Mounting

1) Set the crawler so it is directed correctly to the machine body.
Namely, place the track links on the ground so they converge, facing the front idler, as shown in the figure on the right.
2) Jack up the machine body and place it in a position at which the end of the track links engage with the sprocket. Move back the machine slowly over the track links till it comes at the position of Fig. 5.
3) Move the machine forward slowly, while assisting the crawler being coiled around the sprocket by inserting a crowbar in the master pin hole, till the crawler passes the regular position and engaged with the front idler. Finally set the crawler in the position of Fig. 5 by assisting it with a crowbar.
Protect the lower frame properly so it is not damaged as the track link may get slack and scratch the lower frame.

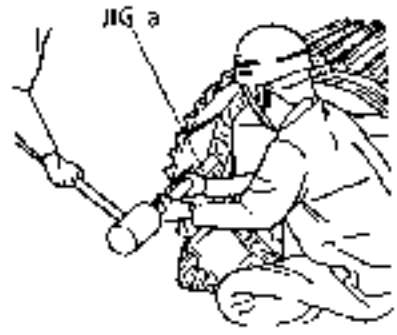


Fig. 4 Removing master pin

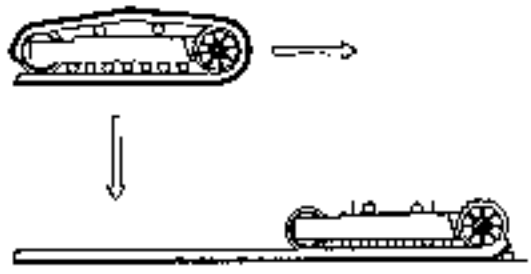


Fig. 5 Dismantling crawler

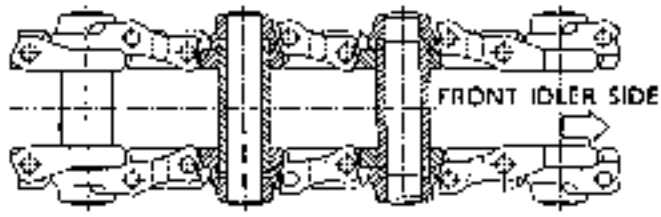


Fig. 6 Mounting direction of crawler

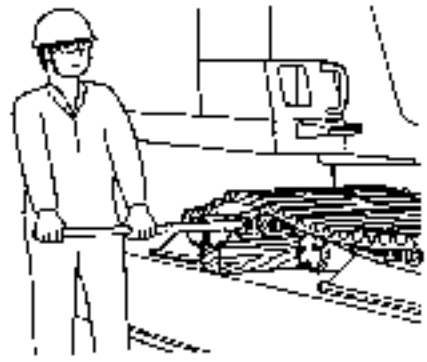


Fig. 7 Coiling crawler

4) Hook a chain block in the upper shoes plate and lower shoe plate in order to fasten the crawler. Then correctly align the master pin holes at both ends of the track link.

⚠ Place a square wooden block (A) under the shoe plate so the end of the shoe plate does not fall and press your foot when setting the master pins.

5) Install the collar (7).
Put the master pin drawing jig (a) which was used when master pin was removed against the master pin and knock it in with a hammer.

⚠ • Be careful for flying object when using a big hammer. Always use safety glasses and long sleeve shirt.

• Coat the master pin with molybdenum disulfide grease, before pressing it in.

6) After mounting work has been completed, grease the grease nipple for the track spring adjuster and adjust the crawler tension.

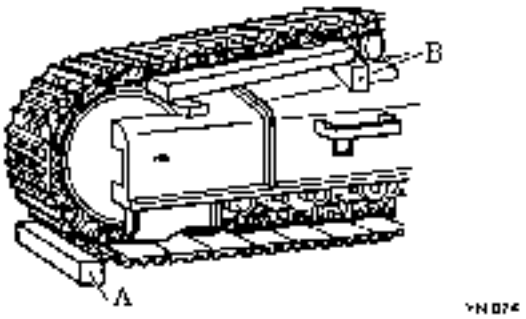


Fig. 8 Aligning master pin holes

Fig. 9 Pressing in master pins

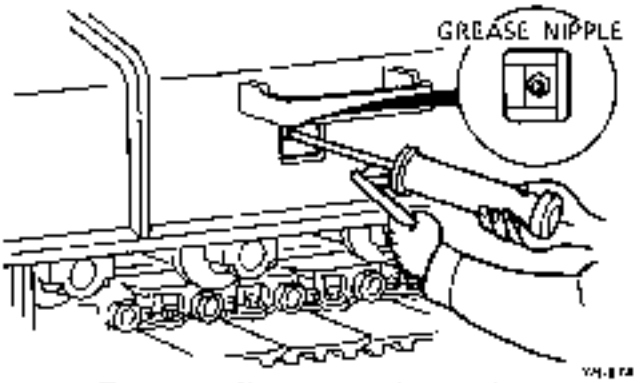


Fig. 10 Adjusting crawler tension

1.2 CONSTRUCTION

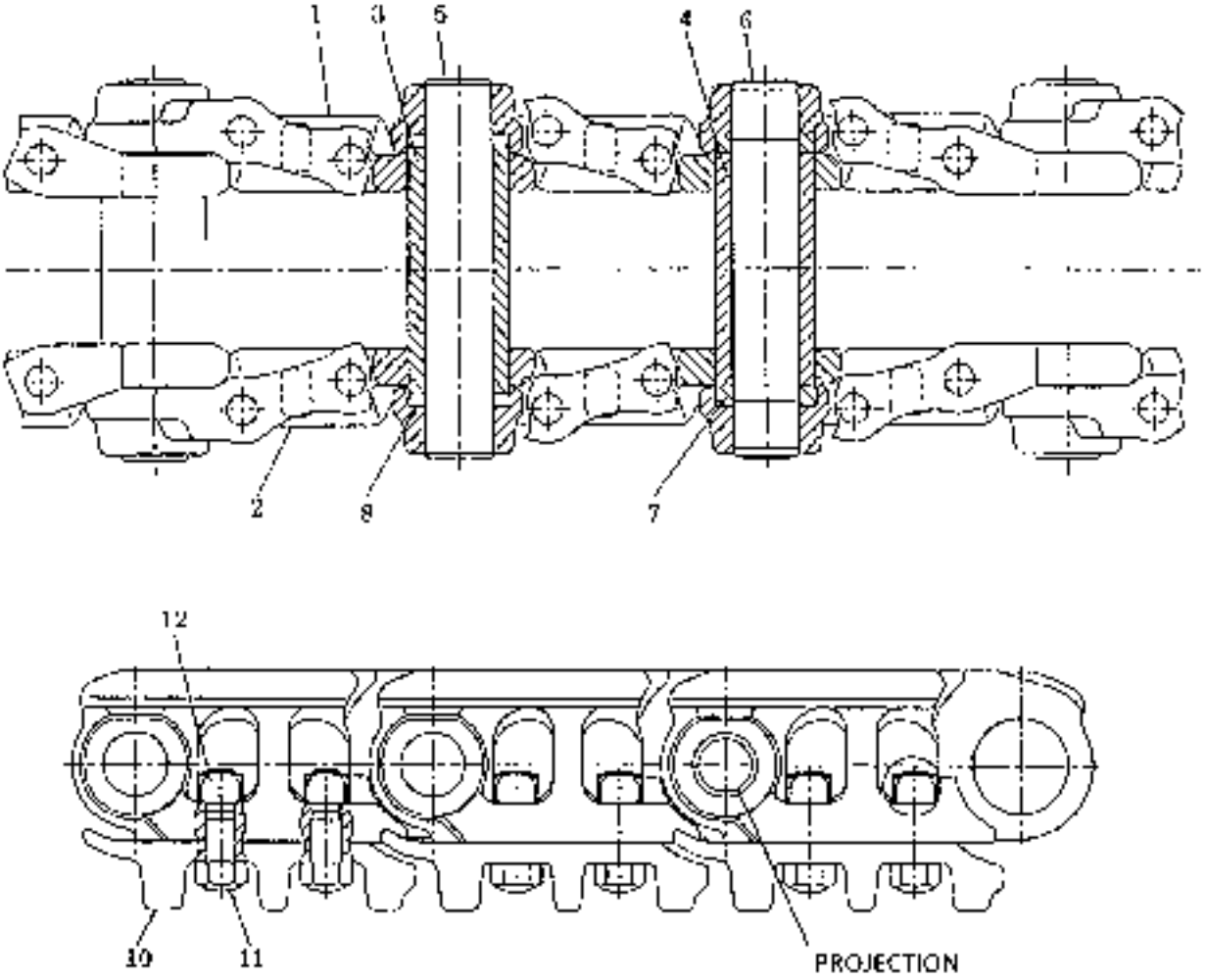


Fig. 11

No.	NAME	Q'TY	
		NOT LC	LC TYPE
1	TRACK LINK (RH)	48	51
2	TRACK LINK (LH)	48	51
3	TRACK BUSHING	46	49
4	MASTER BUSHING	2	2
5	TRACK PIN	46	49
6	MASTER PIN	2	2
7	COLLAR	4	4
8	SEAL	92	98
10	SHOE	48	51
11	BOLT	192	204
12	NUT	192	204

1.3 MAINTENANCE STANDARD

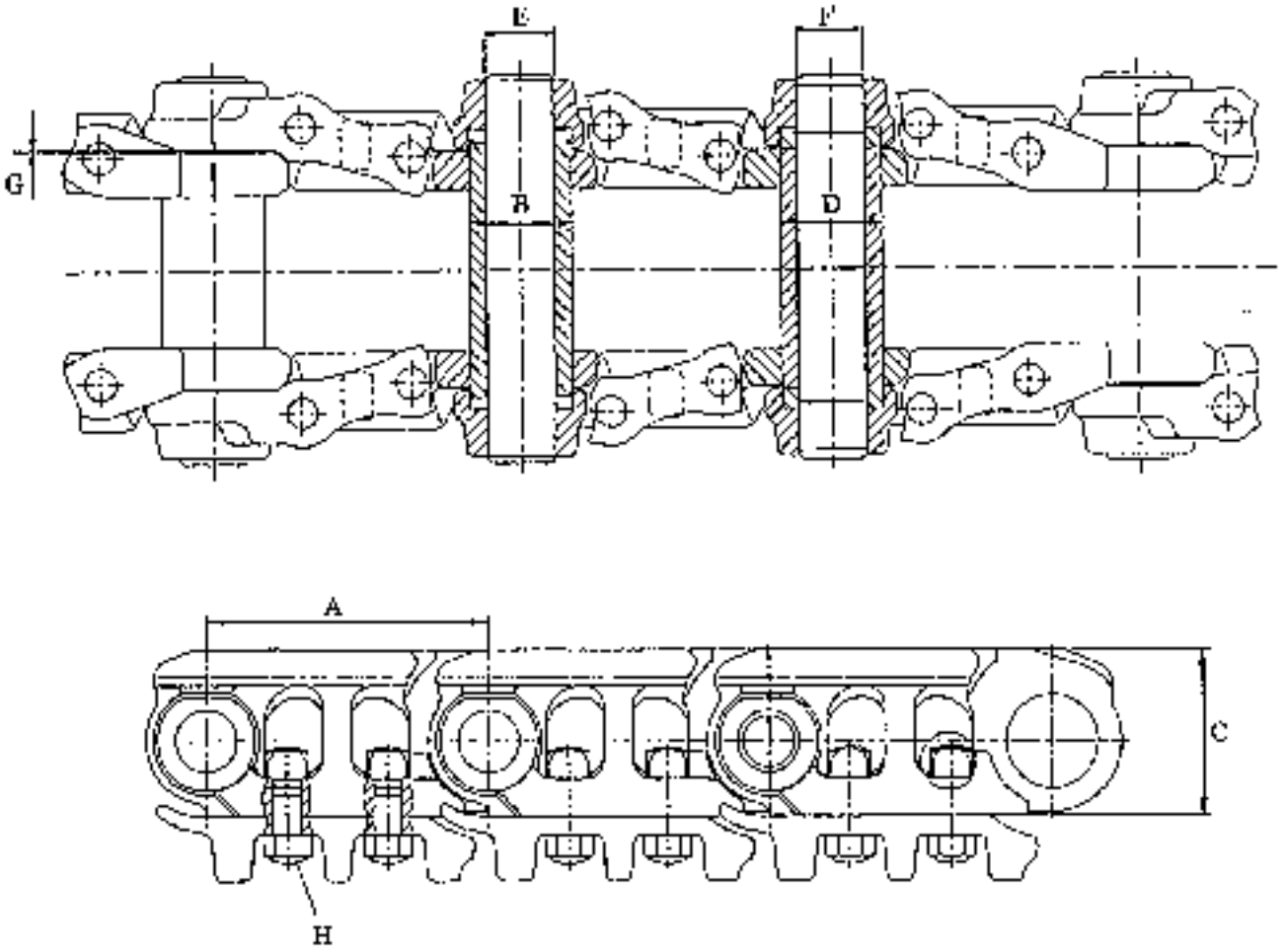


Fig. 12

Table 1 Unit : mm (in)

No.	ITEM	STANDARD VALUE			REFERENCE VALUE FOR REMEDY	SERVICEABILITY LIMIT	REMEDY
A	Link pitch	203.2±0.1 (8.000±0.004)			207.5 (8.169)	211 (8.307)	Replace
B	O.D. of bushing	$\varnothing 66.65^{+0.25}_{0}$ ($\varnothing 2.624^{+0.002}_{0}$)			⌀63 (⌀2.480)	⌀51 (⌀2.008)	
C	Height of link	117.6±0.2 (4.630±0.008)			114 (4.488)	110 (4.331)	
D	Interference between bushing and link	Basic dimension	Tolerance		Interference	Interference	
		⌀66.65 (⌀2.624)	Shaft	$^{+0.05}_{0}\left(^{-0.002}_{0}\right)$	0.10 (0.0039)	0	
E	Interference between track pin and link	⌀44.50 (⌀1.752)	Shaft	$^{+0.05}_{0}\left(^{-0.002}_{0}\right)$	0.25 (0.0098)	0	
F	Interference between master pin and link	⌀44.27 (⌀1.743)	Shaft	$^{+0.03}_{0}\left(^{-0.001}_{0}\right)$	0.16 (0.0063)	0	
G	Clearance between links (both sides)	1.2 (0.047)			4 (0.157)	6 (0.236)	
H	Tightening torque of shoe bolt	95±9.5 kgf·m (687±69ft·lbs)					Retighten

1.4 TOOLS AND JIGS

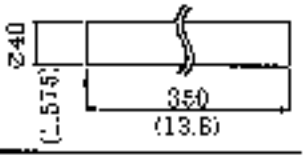
(1) Tightening tool

Unit : mm

NAME	WIDTH ACROSS FLATS
Socket.	19, 30

(2) Jig

Unit : mm (in)

No.	NAME	SHAPE
a	Master pin drawing rod	

2. UPPER ROLLER

2.1 DISMANTLING AND MOUNTING PROCEDURE

(1) Dismantling

1) Stretch the crawler by referring to "1.Crawler 1.1 Dismantling and Mounting Procedure".

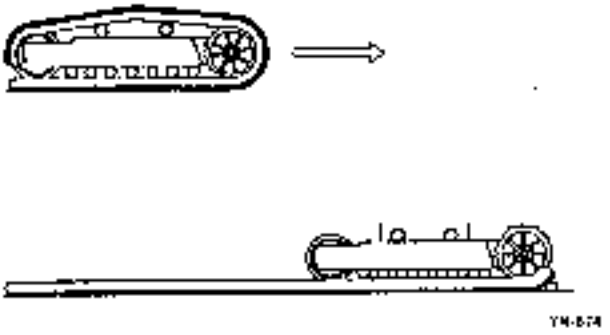


Fig. 14 Stretching crawler

2) Remove capscrews (2) that fasten the upper roller and separate upper roller ass'y (1) from the bracket.

: 30mm,

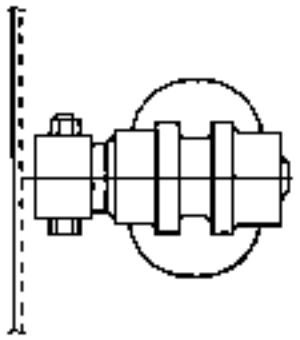
Weight of upper roller : 18.5kg (40.7 lbs)

(2) Mounting

Before mounting the upper roller, make sure that sufficient oil is filled in and that the upper roller rotates smoothly by hand. If the oil volume is insufficient, the upper roller does not rotate smoothly or oil is leaking, refill oil or check the O ring and the floating seals and replace them where necessary

Oil : Engine oil API CD grade #30 (SHELL RIMURA CT#30)

Volume : 50cc (3cu·in)



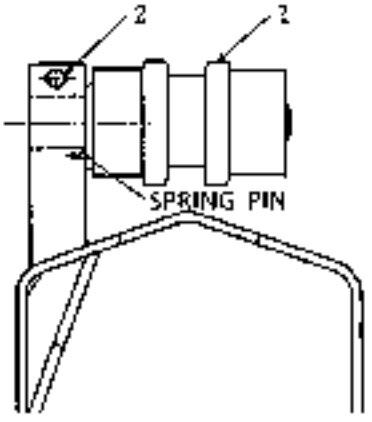


Fig. 15 Upper roller ass'y

1) Insert the shaft of the upper roller ass'y into the bracket, matching the spring pin on the collar of the upper roller with pin hole of the bracket.

2) Coat mounting capscrews (2) with Locktite #242 and attach them.

: 30mm,

Tightening torque : 55±5.5kgf.m (400±40ft·lbs)

3) Install the crawler by referring to "1.Crawler 1.1 Dismantling and Mounting Procedure".

2.2 CONSTRUCTION

No.	NAME	Q'TY
1	ROLLER	1
2	SHAFT	1
3	COLLAR	1
4	PLATE	1
5	COVER	1
6	BUSHING	2
7	FLOATING SEAL	1
8	O RING	1
9	CAPSCREW M10×20	2
10	PLUG PT1/4	1
11	O RING	1
12	SPRING PIN	1
13	SNAP RING	1

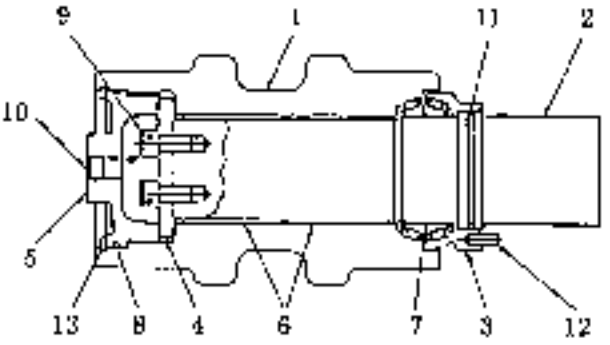


Fig. 16 Construction of upper roller

2.3 DISASSEMBLY AND REASSEMBLY

(1) Disassembly

1) Remove plug (10) and drain out oil.
: 6mm

2) Mount the end face inside upper roller (1) on stand jig (f) and separate snap ring (13), using snap ring pliers.

3) Take off cover (5) using a spanner.
(width across flat : 36mm)

4) Separate O ring (8) from cover (5).

5) Loosen two capscrews (9) and draw out plate (4) from upper roller (1).
: 8mm

6) Put the extrusion jig (h) against the end face of shaft (2) and lightly extrude shaft (2) with collar (3) for floating seal (7), using a press or hammer

7) Take out floating seal (7) from upper roller (1).

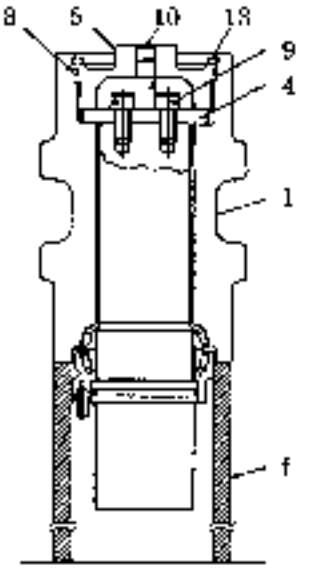


Fig. 17 Preparation for disassembly

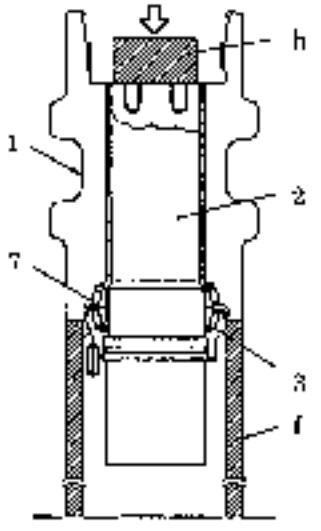


Fig. 18 Extruding shaft

8) Take out, from collar (3), floating seal (7) that is located on the side from which shaft (2) was disported.

9) Remove collar (3) and O ring (11).

10) Take out spring pin (13) from collar (3) using a pliers.

11) When extruding bushing (6), mount upper roller(1) on the stand jig (f) with its floating seal inserting side up, put the extrusion jig (g) against the end face of bushing (6) and extrude it by means of a press.

(2) Reassembly

Reassembly of the upper roller is performed in the reverse order of disassembly.

1) Mount upper roller (1) on the top end face of the stand jig (f) with the floating seal inserting side down
2) Make sure that the outer circumference of bushing (6) is not galled and coat the inserting area of the bushing with molybdenum disulfide grease.
3) Insert the jig (i) into bushing (6) and press in the bushing with the bore of the bushing and the bore of the roller as a guide.
   As bushing (6) divides into two, repeat the same work as above.

⚠ If you fail in this operation by pressing the bushing unevenly, the bushing is distorted and gets unserviceable. In that case, do not re-use the bushing as it may develop malfunctioning after assembly.

4) Install spring pin (13) to collar (3).
5) Install collar (3) and O ring (11) with thinly grease coated to shaft (2).
6) Two floating seals (7) make a pair. Attach one floating seal to collar (3) fixed in shaft (2), and another to the inside of upper roller (1).

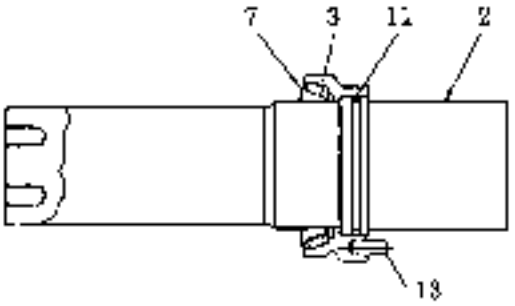


Fig. 19 Taking out floating seal, collar and O ring

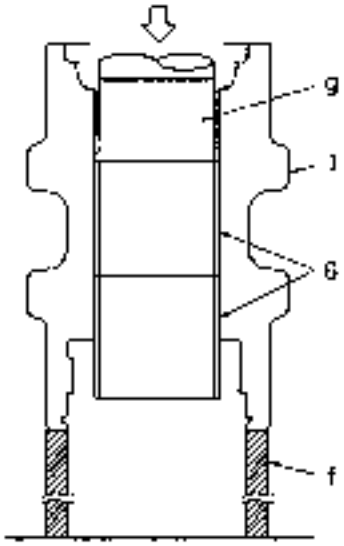


Fig. 20 Extruding bushing

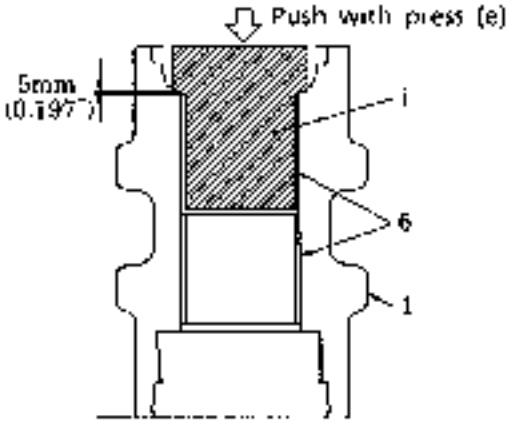


Fig. 21 Pushing in bushing

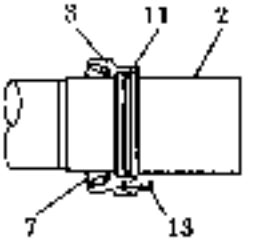


Fig. 22 Fixing spring pin, collar, O ring

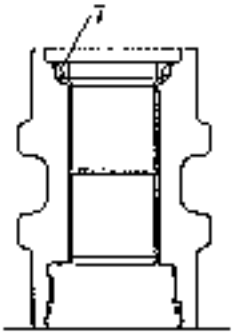


Fig. 23 Fixing floating seal

7) Coat shaft (2) with a thin film of oil and insert it into upper roller (1).

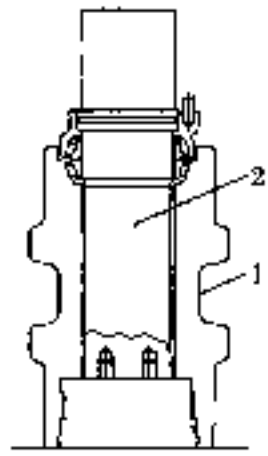


Fig. 24 Inserting shaft

8) Mount upper roller (1) on the stand jig (6) and attach plate (4) to the end face of the shaft with capscrews (9). In that case, coat the screwed part of capscrews (9) with Locktite #242 beforehand.

: 8mm,

Tightening torque : 6.7±0.7kgf·m
(48.5±5ft·lbs)

9) Coat O ring (8) with grease and fix it in the groove of cover (5).

10) Tighten cover (5) to upper roller (1), using spanner.

11) Fix snap ring (13) into upper roller (1), using snap ring pliers.

12) Fill in 50cc (3cu·in) of engine oil API grade CD#30 (SHELL RIMURA CT#30) through the plug hole in the center of cover (5).

13) Place seal tape around plug (10) and screw it into the plug hole of cover (5).

. 6mm,

Tightening torque : 2.2~2.5kgf·m
(16~18ft·lbs)

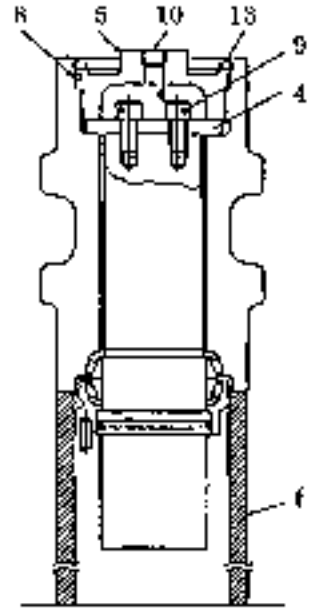


Fig. 25 Installing cover

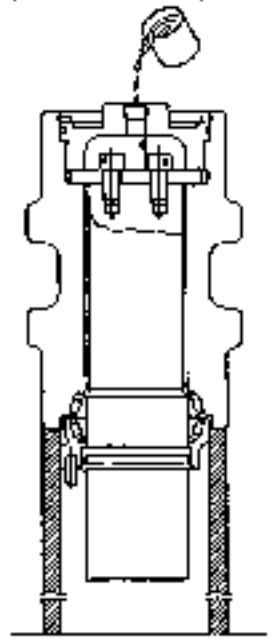


Fig. 26 Filling oil

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

2.4 MAINTENANCE STANDARD

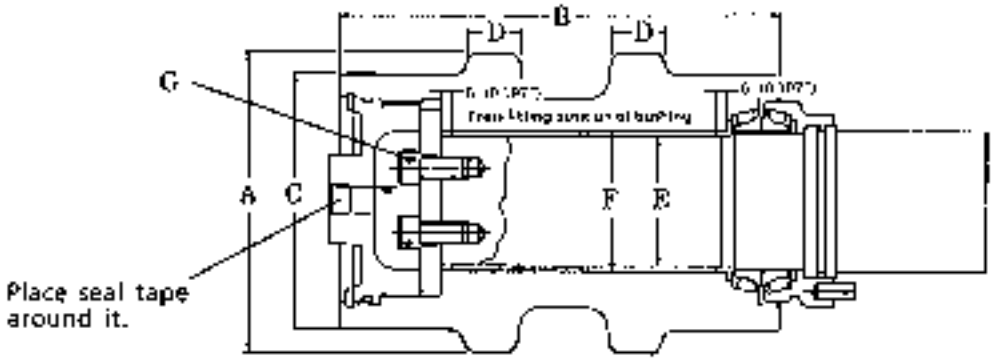


Fig. 27 Cross-sectional view of upper roller

Table 2 Unit : mm (in)

No.	ITEM	STANDARD VALUE			REFERENCE VALUE FOR REMEDY	SERVICEABILITY LIMIT	REMEDY
A	O.D.	⌀140 (⌀5.51)			—	—	Padding weld, repair or replace.
B	Width	205 (8.071)			—	—	
C	Tread dia.	⌀120 (⌀4.72)			⌀110 (4.33)	⌀108 (4.25)	
D	Flange width	27.5 (1.083)			—	13 (0.709)	
E	Clearance between shaft and bushing	Basic dimension	Tolerance		Fit	Fit	Replace bushing.
		⌀60 (⌀2.362)	Shaft	$\begin{matrix}-0.025\\-0.050\\(-0.00098\\-0.002)\end{matrix}$	Clearance 0.7 (0.028)	Clearance 1.0 (0.04)	
F	Interference between roller and bushing	⌀65 (⌀2.559)	Hole	$\begin{matrix}+0.030\\0\\(+0.00118\\0)\end{matrix}$	Interference 0	Clearance 0.03 (0.0004)	
G	Tightening torque of capscrew	6.7±0.7 kgf·m (48.5±5 ft·lbs)					Apply Locktite #242
	Oil	Engine oil API grade CD #30 (SHELL RIMURA CT #30), 50cc (3.1cu·in)					Replenish.
	Roller rotation	Roller rotates smoothly by hand.					Reassembly.

2.5 TOOLS AND JIGS

(1) Tightening tools Unit : mm (in)

NAME	WIDTH ACROSS FLATS
Socket	30
Allen key wrench	6, 8
Spanner	36

(2) Jig Unit : mm (in)

No.	NAME	SHAPE
f	Stand jig	⌀120 (4.72), ⌀80 (3.64), 130 (5.13)
g	For extruding bushing	⌀64 (2.520), 30 (1.18)
h	For extruding shaft	⌀50 (2.323), 30 (1.18)
i	Bushing fixing jig	⌀75 (2.953), ⌀58.6 +0.1 0, ⌀96.5 +0.1 0, 12.346 +0.004 0, 12.520 +0.004 0, (1.26), 32, 5, (0.197), (1.46), 37, 60 (2.362), 97 (3.819)

3. LOWER ROLLER

3.1 DISMANTLING AND MOUNTING PROCEDURE

(1) Dismantling

1) Slightly loosen capscrews (3), (4) fasten lower roller assy (1) and track guide (2) with the crack frame.
   : capscrews (3) : 32mm
   capscrews (4) : 36mm

2) Loosen the grease nipple of the crawler adjuster and slacken the crawler tension.
   : 19mm

3) Lift the track frame to an extent that the lower roller can be taken out, using the front attachment.

4) After lifting the track frame to flat firm roadbed, place square wooden blocks under the lower frame to stabilize the machine body.

⚠ Always place square wooden blocks so they support the front and back lower frames, in order to stabilize the machine body. Lower the front attachment down to the ground, stop the engine and proceed to work.

5) Remove the capscrews fastening the lower roller and the track guide and pull out the lower roller and the track guide.
   Weight of lower roller assy : 60.4kg (133 lbs)
   Weight of track guide : 25kg (55 lbs)
   : 32, 36mm

(2) Mounting

1) Coat the mounting capscrews with Locktite #242 beforehand. Match the capscrews to the bolt holes and fasten them temporarily.

2) Bring the machine in full contact with the ground and fasten the capscrews.
   : 32, 36mm,
   Tightening torque :
   capscrews (3) : 74.5±7.5kgf·m (539±54ft·lbs)
   capscrews (4) : 95±9.5kgf·m (687±69ft·lbs)

3) Fasten the grease nipple of the crawler adjuster, fill in grease and adjust the crawler tension.
   : 19mm,
   Tightening torque 6±1kgf·m
   (43±7ft·lbs)

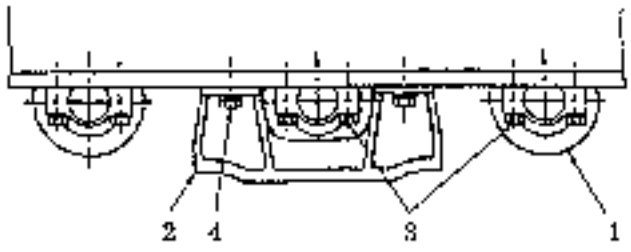


Fig. 28 Lower roller assy and track guide

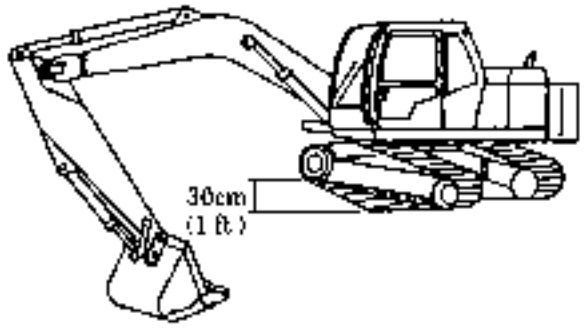


Fig. 29 Preparation for dismantling and mounting

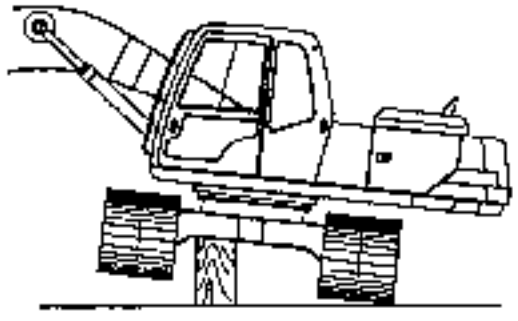


Fig. 30 Supporting track frame

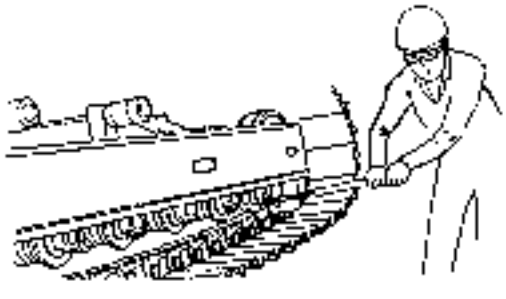
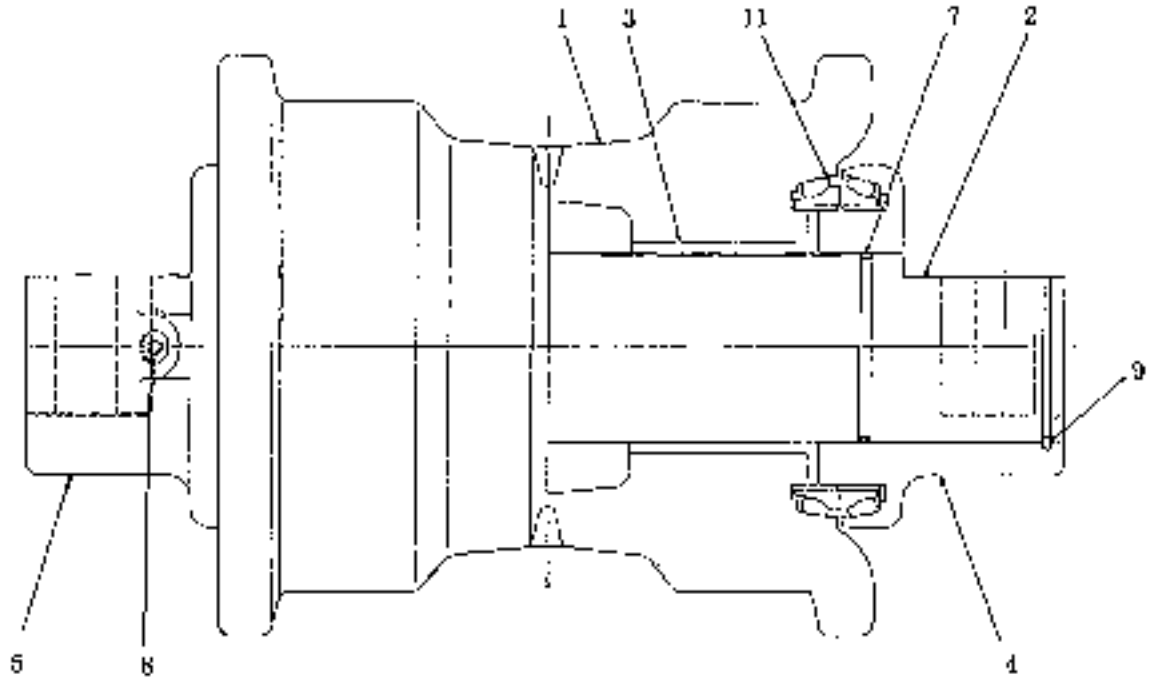


Fig. 31 Dismantling and mounting lower roller assy

3.2 CONSTRUCTION



No.	NAME	Q'TY	No.	NAME	Q'TY
1	ROLLER	1	7	O RING	2
2	SHAFT	1	8	PLUG	2
3	BUSHING	2	9	LOCK RING	4
4	COLLAR	1	11	FLOATING SEAL	2 Set
5	COLLAR	1			

Fig. 32 Construction of lower roller ass'y

3.3 DISASSEMBLY AND REASSEMBLY

(1) Disassembly

1) Remove the plug (8), and drain out the oil.

2) Insert the lock ring puller jig (6) into the collar mounting cap screw hole in the collars (4, 5), rotate the collar by tapping the jig with a mallet, and drive out the lock ring (9) using a chisel and mallet.

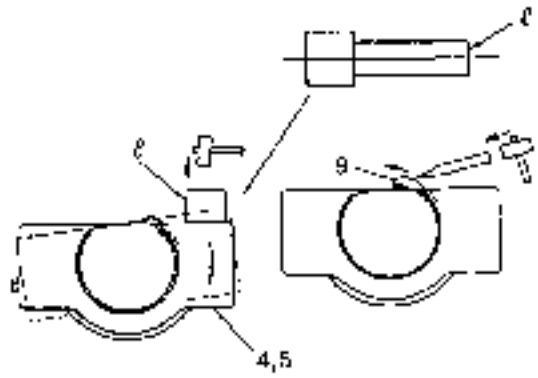


Fig. 33 Drawing out lock ring

3) Mount the lower roller so shaft (2) stands perpendicular to the top end face of the stand jig (m). Put the extrusion jig (p) against the shaft end and extrude the shaft with a press or a mallet.

⚠ The shaft (2) extrusion operation may cause the remaining lube oil to flow out and contaminate the working floor. Prepare an oil container beforehand.

Push with a press or mallet.

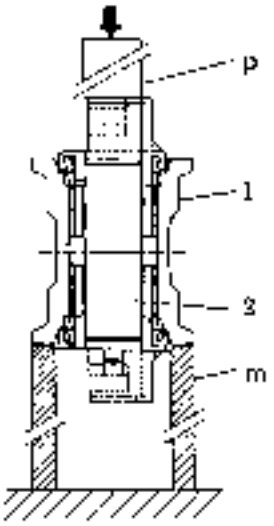


Fig. 34 Taking out shaft

4) Take out floating seal (11) from collar (4), (5).

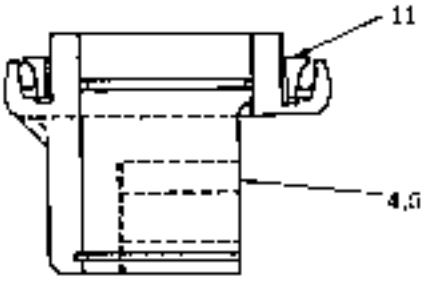


Fig. 35 Taking out floating seal

5) Take out floating seal (11) from roller (1).

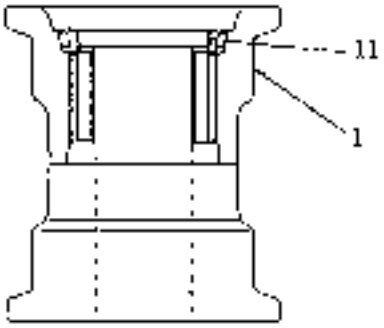


Fig. 36 Taking out floating seal

6) Mount roller (1) on the stand jig (m), put the tip of the extrusion jig (n) against the end face of bushing (3).

⚠ Hammer the inside surface of roller lightly so as not to damage the surface. Put the extrusion jig (n) fractionally over the circumference of bushing (3) and extrude it little by little.

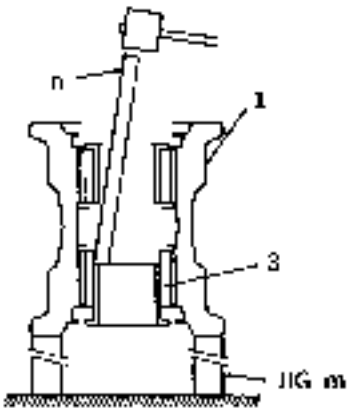


Fig. 37 Extruding bushing

7) Separate O ring (7) from shaft (2).

(2) Assembly

1) Coat O ring with grease and fit it in the shaft groove.

⚠ At reassembly, always use a new O ring.

2) Make sure that the outer circumference of bushing (3) is not galled and put the jig (q) into bushing (3).

3) Press bushing (3) vertically into roller, using the bore of the bushing and the bore of the roller as a guide.

⚠ • Coat the fitting part of the bushing with molybdenum disulfide grease.

• If you have failed the above-mentioned operation by uneven pressing or something, do not use the failed bushing again.

4) Insert the shaft (2) into the roller (1) using the press or hammer.

5) Install the floating seal (11) in the roller (1)

6) Install the floating seal (11) in the collars (4, 5)

7) Install the collar (4, 5) on the shaft (2).

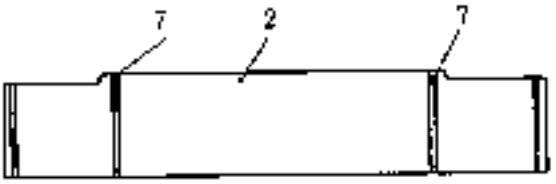


Fig. 38 Taking out O ring

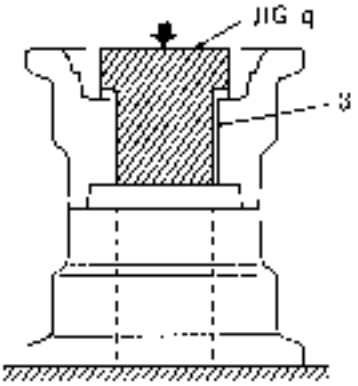


Fig. 39 Pressing in bushing

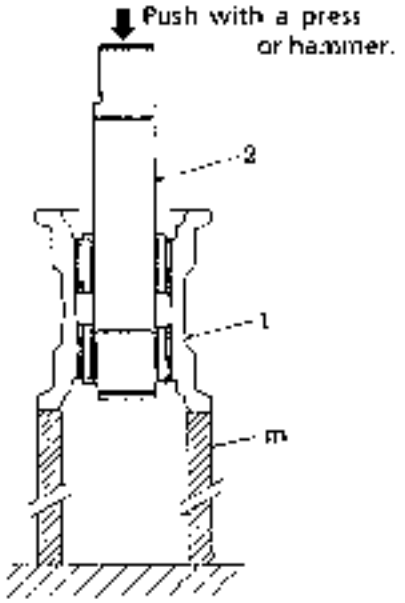


Fig. 40 Inserting shaft

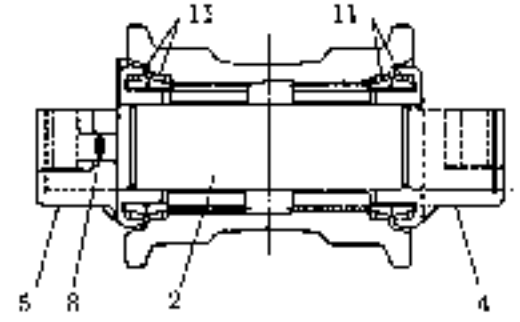


Fig. 41 Inserting floating seals and collars

8) Drive the lock ring (9) onto the collars (4,5).

9) Remove the plug (6), and add 250 cc (15.3 cu-in.) of engine oil #30, grade CD, API classification (SHELL RIMURA CT#30).
After filling, wind sealing tape around the plug (6), and tighten the plug with a hex key.

: 6mm,
Tightening torque 2.2~2.5kgf·m
(16~18ft·lbs)

⚠ After assembling the lower roller, confirm that oil is not leaking and that the roller rotates smoothly by hand.

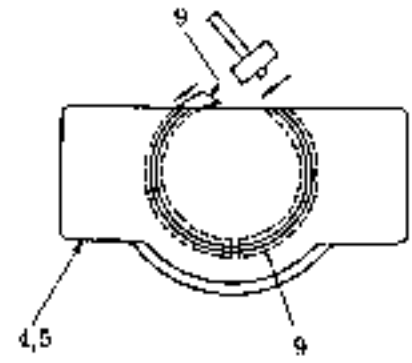


Fig. 42 Installing lock ring

3.4 MAINTENANCE STANDARD

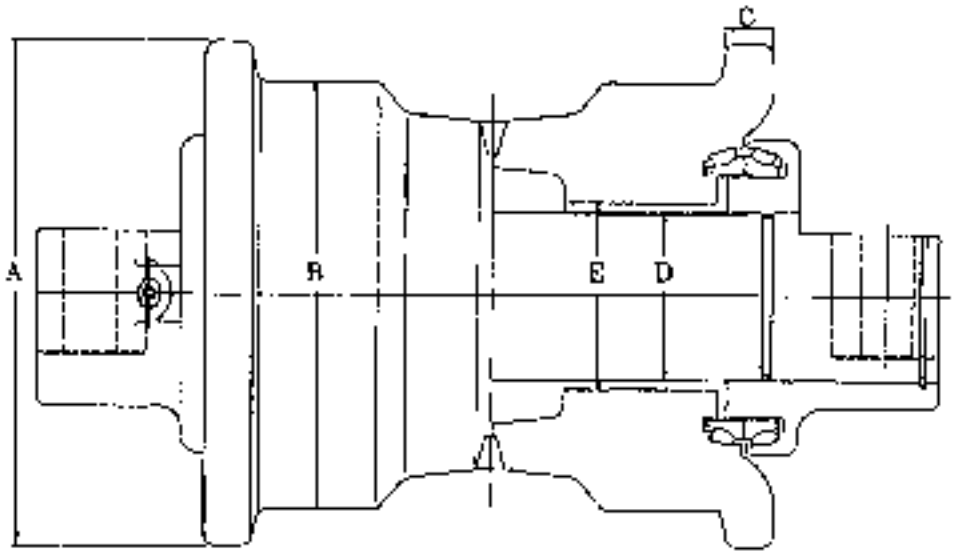


Fig 43 Lower roller

Table 3 Unit : mm (in)

No	ITEM	STANDARD VALUE			REFERENCE VALUE FOR REMEDY	SERVICEABILITY LIMIT	REMEDY
A	O.D. of flange	ø220 (ø8.661)			—	—	Padding weld, repair or replace.
B	Tread dia.	ø185 (ø7.283)			ø175 (ø6.890)	ø170 (ø6.693)	
C	Flange width	24 (0.945)			18 (0.709)	16.5 (0.650)	
D	Clearance between shaft and bushing (coiled bushing)	Basic dimension	Tolerance		Fit	Fit	Replace bushing
		ø75 (ø2.953)	Shaft	$\begin{matrix}-0.03\\-0.06\\(-0.0012\\-0.0024)\end{matrix}$	Clearance 0.7 (0.0276)	Clearance 1.0 (0.04)	
E	Interference between the bore of roller and bushing	ø83 (ø3.268)	Hole	$\begin{matrix}+0.035\\0\\(+0.0014\\0)\end{matrix}$	Interference 0	Clearance 0.01 (0.0004)	
F	Oil	Engine oil API grade CD #30 (SHELL RIMURA CT #30), 250cc (15.3cu·in)					Replenish
	Roller rotation	Rotates smoothly by hand					Reassemble

3.5 TOOLS AND JIGS

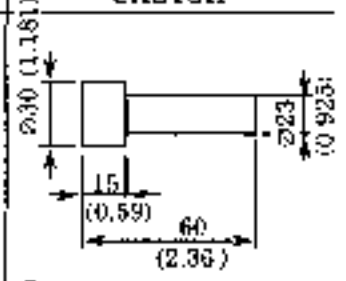
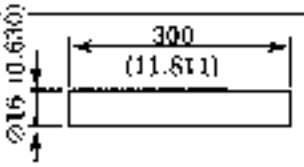
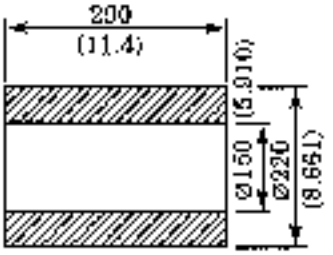
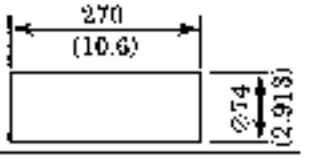
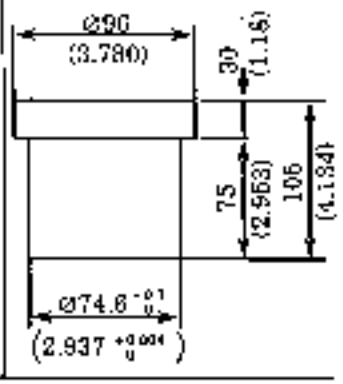
(1) Tightening tools

Unit: mm

NAME	WIDTH ACROSS FLATS
SOCKET	19, 32, 36
ALLEN KEY WRENCH	6

(2) Jigs

Unit: mm (in)

No.	NAME	SKETCH
ℓ	Lock ring drawing jig	
n	Bushing extrusion rod	
m	Stand jig	
p	Shaft extrusion jig	
q	Bushing fixing jig	

4. FRONT IDLER

4.1 DISMANTLING AND MOUNTING PROCEDURE

(1) Dismantling

1) Dismantle the crawler ass'y.

2) Take out idler (1) forward idler adjuster ass'y (2) from the track frame, using a crowbar or by placing a wire sling in it

3) Loosen capscrews (4) and separate idler ass'y (1) idler adjuster ass'y (2).

: 36mm

Idler	;	171.5kg (377 lbs)
+ Adjuster	;	173kg (381 lbs)
Front Idler Adjuster	;	344.5kg (758 lbs)

⚠ The separated idler ass'y (1) is easy to fall down : Lay it down so it will not fall down on your feet, utilizing square wooden blocks.

(2) Mounting

1) Attach idler ass'y (1) to the top of idler adjuster ass'y (2) by means of capscrews (4) in the reverse order of dismantling the idler ass'y. In that case, coat the screwed part of capscrews (4) with Locktite #242 beforehand.

: 36mm,
Tightening torque : 95kgf·m (687ft·lbs)

2) Fit the idler to the track frame so the grease nipple (3) comes outside of it.

: 19mm,
Tightening torque : 6±1kgf·m (43±7ft·lbs)

In that case, make sure that the tip of the idler adjuster ass'y is correctly set in the support of the track frame.

3) Fit the crawler ass'y, adjust the crawler tension, according to the mounting procedure of the crawler.
On that occasion, make certain that lubrication through the grease nipple is normal and that grease is not leaking from the grease cylinder.

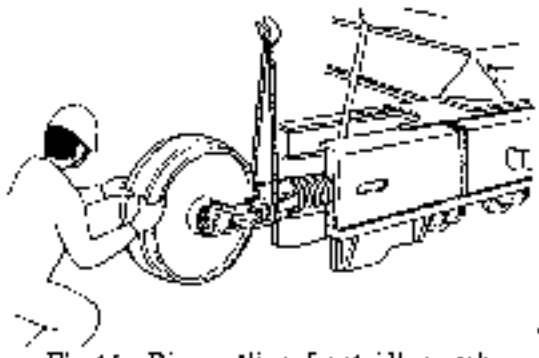


Fig. 44 Dismantling front idler ass'y

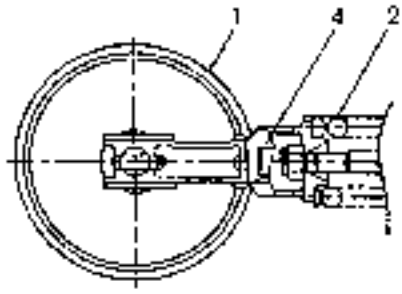


Fig. 45 Removing idler ass'y

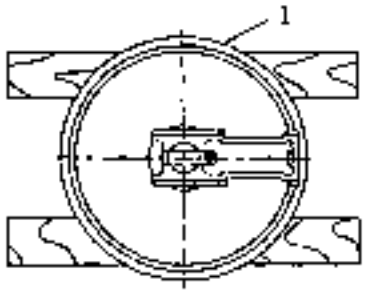


Fig. 46 Storing idler ass'y

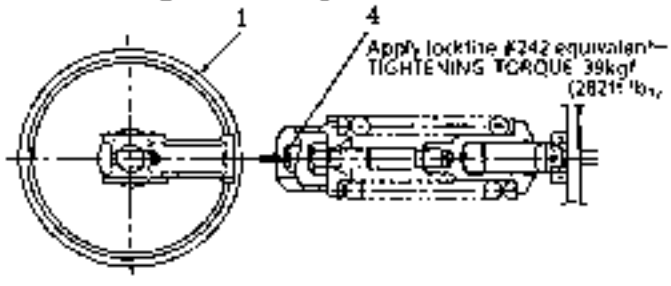


Fig. 47 Fitting idler ass'y

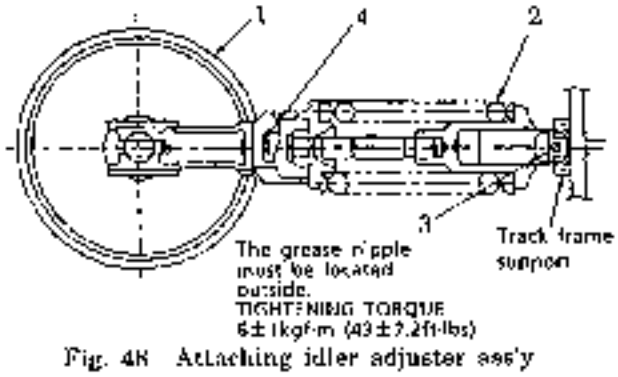


Fig. 48 Attaching idler adjuster ass'y

4.2 CONSTRUCTION

No.	NAME	Q'TY	No.	NAME	Q'TY
1	IDLER	1	5	SHAFT	1
2	BUSHING	2	6	PIN	2
3	FLOATING SEAL	2	7	O RING	2
4	SLIDE BLOCK	2	8	PLUG	1

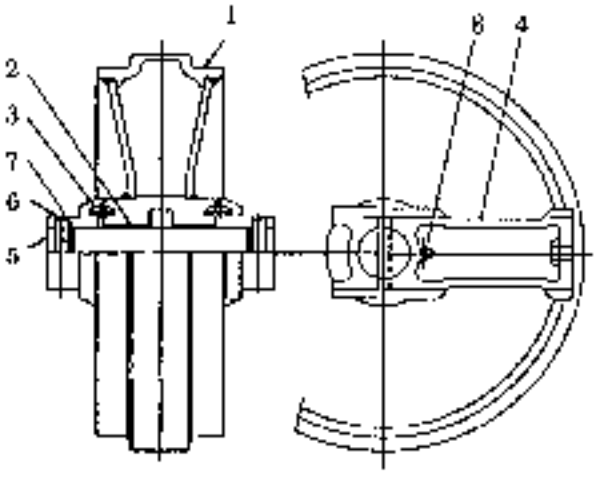


Fig. 49 Construction of idler ass'y

4.3 DISASSEMBLY AND REASSEMBLY

(1) Disassembly

1) Remove plug (8) located on one side of slide block (4) and discharge oil.

: 5mm

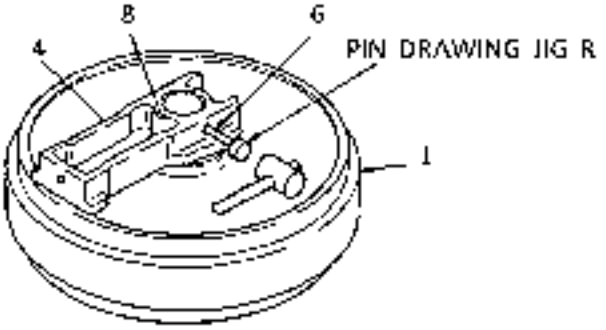


Fig. 50 Drawing out pin

2) Place the pin drawing jig (R) on the top of pin (6) and draw it out, tapping it with a hammer.

3) Mount idler (1) on stand (U), place the shaft extrusion jig (S) against shaft (5) extrude it by press.

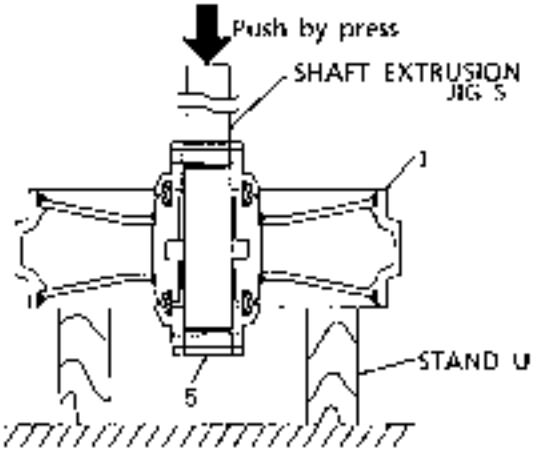


Fig. 51 Extruding shaft

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

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

6) Separate O ring (7) from shaft (5).

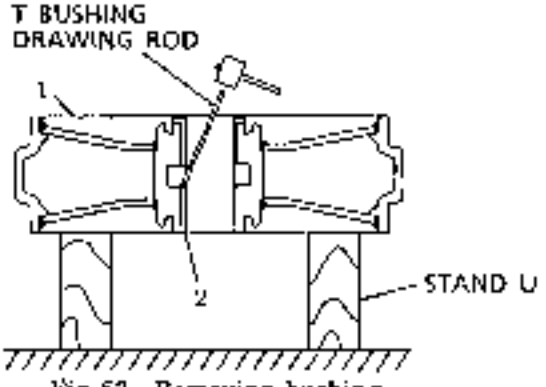


Fig 52 Removing bushing

(2) Assembly

1) Press bushing (2) into the embossed hole in the center of idler (1), using the bushing fixing jig (V).

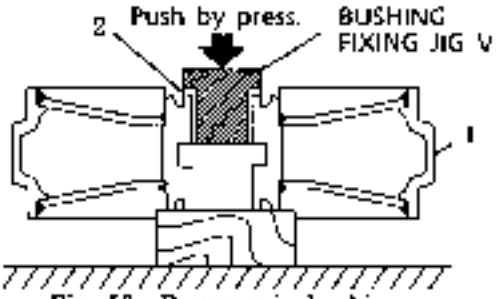


Fig. 53 Pressing in bushing

2) Fit grease-coated O ring (7) to the O ring groove of shaft (5).

3) Match the pin (6) hole in shaft (5) with the pin hole in slide block. Press shaft (5) into slide block (4) from the O ring (7) inserted side.

4) Knock in pin (6).

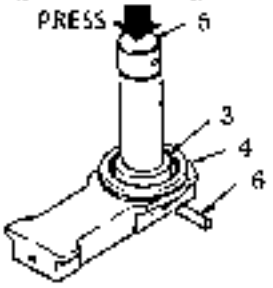


Fig 54 Pressing in shaft

5) Fix a pair of floating seals (3) to one side of slide block (4) and idler (1).

6) Coat shaft (5) with a thin film of oil and insert idler (1) in place.

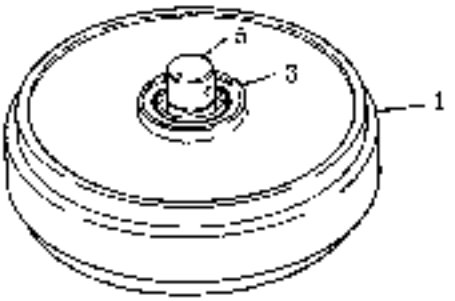


Fig. 55 Inserting idler

7) Fix a pair of floating seals (3) to idler (1) and other slide block (4).

8) Attach O ring (7) to the O ring groove of shaft (5)

9) Match the pin (6) hole in shaft (5) with the pin hole in slide block (4). Then press slide block (4) into shaft (5), using the collar fixing jig (W).

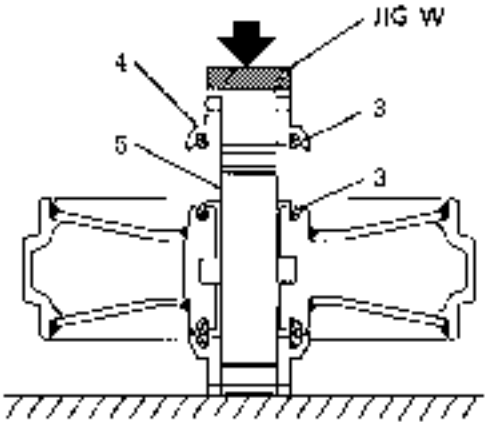


Fig. 56 Pressing in slide block

10) Knock in pin (6), using a hammer.

11) Fill in 300cc (18.3cu·in) of engine oil API grade CD #30 (SHELL RIMURA CT #30) through the plug hole of slide block, place the screwed part of plug (8) with seal tape and put in plug (8).
: 5mm

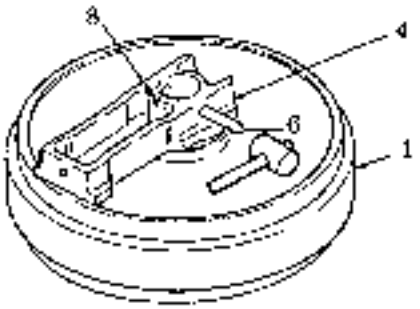


Fig 57 Knocking in pin

⚠ After mounting the idler ass'y to the idler adjuster ass'y, make certain that no oil leaks from floating seal (3) and plug (8) and that idler (1) rotates smoothly.

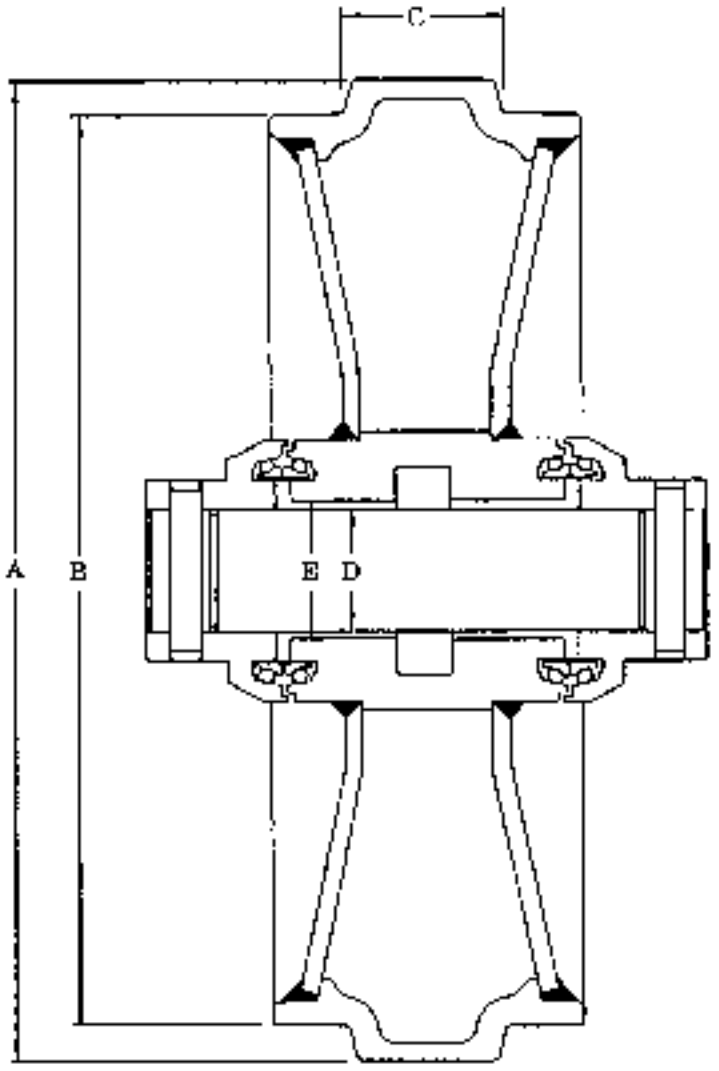


Fig. 58 Front idler

Table 4 Unit : mm (in)

No.	ITEM	STANDARD VALUE			REFERENCE VALUE FOR REMEDY	SERVICEABILITY LIMIT	REMEDY
A	Dia. of idler projection	∅640 (∅25.197)			—	—	Padding weld, repair or replace.
B	Tread dia.	∅595±1.5 (∅23.425±0.059)			∅585 (∅23.150)	∅585 (∅23.031)	
C	Flange width	102±0.8 (4.016±0.031)			96 (3.780)	94 (3.701)	
D	Clearance between shaft and bushing	Basic dimension	Tolerance		Fit	Fit	Replace bushing.
		∅80 (∅3.150)	Shaft	$\begin{matrix}-0.030\\-0.060\\(-0.0012\\-0.0024)\end{matrix}$	Clearance 1.0 (0.039)	Clearance 1.5 (0.059)	
E	Interference between roller and bushing	∅90 (∅3.543)	Bore	$\begin{matrix}0.035\\0\\(0.0014\\0)\end{matrix}$	Interference 0	Clearance 0.01 (0.0004)	
	Oil	Engine oil API grade CD#30 (SHELL RIMURA CT#30), 300cc (18.3cu·in)					Replenish
	Idler rotation	Rotates smoothly by hand.					Reassemble

4.5 TOOLS AND JIGS

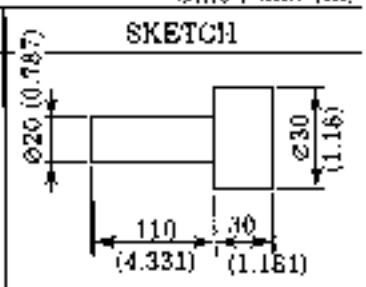
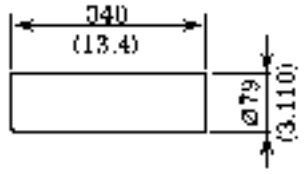
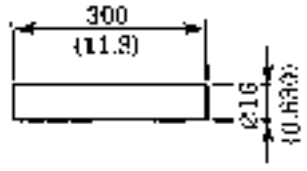
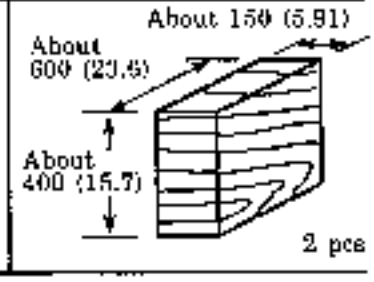
(1) Tightening tools

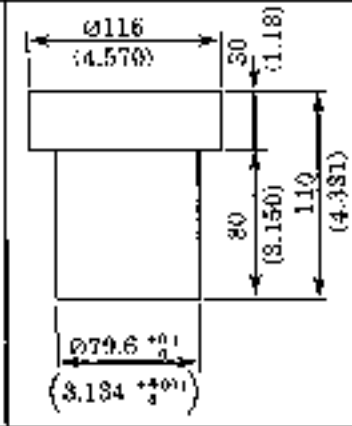
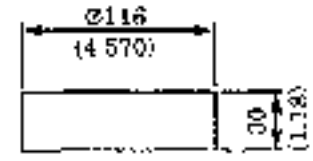
Unit : mm

NAME	WIDTH ACROSS FLATS
SOCKET	36
SPANNER	19
ALLEN KEY WRENCH	5

(2) Jigs

Unit : mm (in)

No.	NAME	SKETCH
R	Pin drawing jig	
S	Shaft drawing jig	
T	Bushing drawing rod	
U	Stand	

No	NAME	SKETCH
V	Bushing fixing jig	
W	Slide block fixing jig	

5. IDLER ADJUSTER

5.1 DISMANTLING AND MOUNTING PROCEDURE

(1) Dismantling

1) Idler adjuster ass'y (2) is drawn out of the crawler frame, integrated with idler ass'y (1). Do this job by referring to "4.1.(1)" Dismantling front idler.

2) Loosen capscrews (4) and separate idler ass'y (1) from idler adjuster ass'y (2).
Weight of idler adjuster ass'y : 173kg (381 lbs)
(1) + (2) = 344.5kg (758 lbs)
: 36mm

(2) Mounting

1) Mounting is done in the reverse order of dismantling :
First of all, mount idler ass'y (1) to idler adjuster ass'y (2) and fasten them together with capscrews (4).
: 36mm,
Tightening torque : 95kgf-m
(687ft-lbs)

2) Before mounting the idler adjuster to the track frame, assemble it with the idler ass'y. For the procedure, refer to "4.1.(2)" Mounting Front Idler.

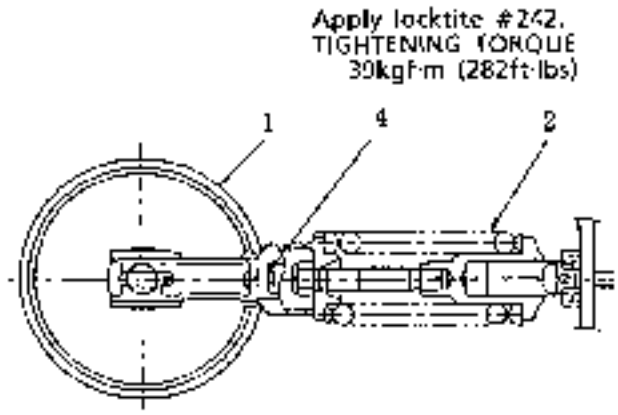


Fig. 59 Crawler idler ass'y

5.2 CONSTRUCTION

No.	NAME	Q'TY
1	GREASE CYLINDER	1
2	BRACKET	1
3	NUT M56×P3	1
4	SPRING PIN	1
5	SPRING	1
6	CAPSCREW	2
7	GREASE NIPPLE	1
8	PISTON	1
9	OIL SEAL	1
10	O RING	1
11	PIN	2

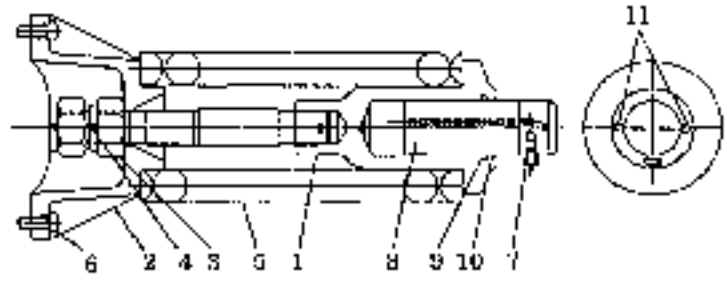


Fig. 60 Idler adjuster ass'y

5.3 DISASSEMBLY AND REASSEMBLY

(1) Disassembling Idler Adjuster Ass'y

1) Before disassembling and reassembling the idler adjuster ass'y, prepare spring setting jig (V).

Capacity of hydraulic jack : more than 20 tons (44000 lbs)

: 46mm

Large power is needed to set the spring. Prepare a special jig before disassembly and reassembly.

2) Place a hydraulic jack between the jig base and the stand.

3) Loosen the holding-down nuts of the jig and draw out the retainer plate upward.

: 46mm

4) Draw out piston (8) from grease cylinder (1) of the idler adjuster ass'y.

5) Taken out oil seal (9) and O ring (10) from grease cylinder (1).

6) Set the idler adjuster ass'y thus disparted on the stand of the jig (V), with its bracket side (2) facing up.

7) Put the retainer plate over bracket (2) and confirm that the center hole is aligned with the center of nuts (3). Fasten the holding-down nuts by turns and fix the idler adjuster ass'y.

: 46mm

8) Compress spring (5) till nuts (3) at the tip of grease cylinder (1) can be turned freely by a hydraulic jack. Then take off spring pin (4) and nuts (3).

: 46mm

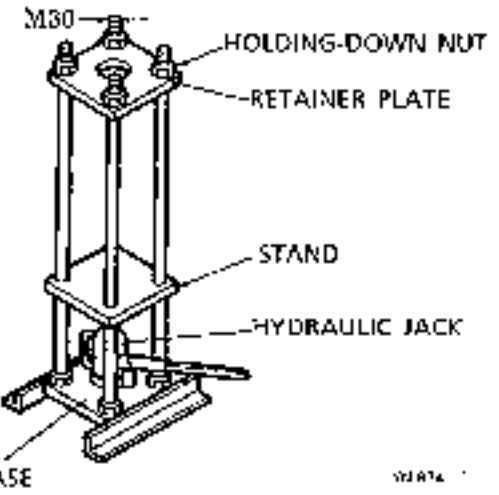


Fig. 61 Disassembly/assembly jig V

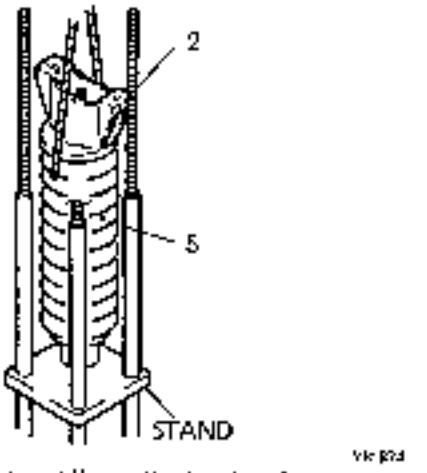


Fig. 62 Lifting idler adjuster in place

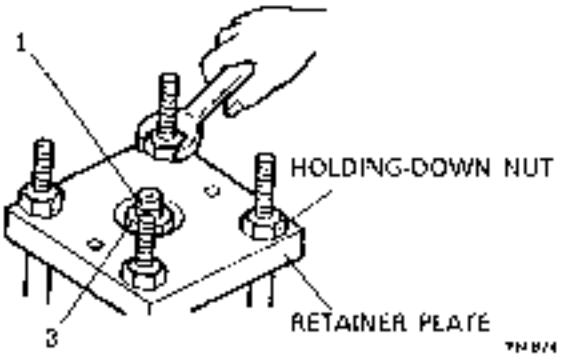


Fig. 63 Mounting retainer plate

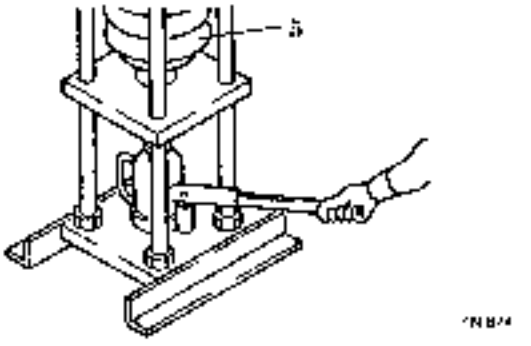


Fig. 64 Compressing spring by hydraulic jack

9) Allow the hydraulic jack to shrink slowly till the spring is extended to its free length. Remove the retainer plate and take off bracket (2). Measure the free length of the spring and check it with the value given in the maintenance standard. About 627.3mm (24.7in)
: 46mm

10) Attach lifting nut (W) to the screw M56 at the tip of grease cylinder (1), place a wire sling to it and lift it by crane. Remove grease cylinder (1) and spring (5) in pairs.

11) Draw out grease cylinder (1) from spring (5).

(2) Reassembly
Reassembly is done in the reverse order of disassembly

1) Insert grease cylinder (1) into spring (5) and attach lifting nut (w) to screw M56 at the tip of the grease cylinder. Lift the grease cylinder by crane and erect it in the center of the jig stand upright.

2) Install bracket (2) on top of spring (5). Center the rod of grease cylinder (1) and the holes in bracket (2). Attach the retainer plate and four holding-down nuts. Fasten the nuts evenly all round and fix the idler adjuster ass'y to the jig body.
: 46mm

3) Extend the hydraulic jack, compress spring (5) to a set length and screw in nut (3) to the screwed part at the tip of grease cylinder (1).
Set length : 852.5mm (33.563")

4) Screw in nut (3) till the holes for locking spring pins (4) are aligned. Then fit spring pin (4).
: 46mm
: 85mm

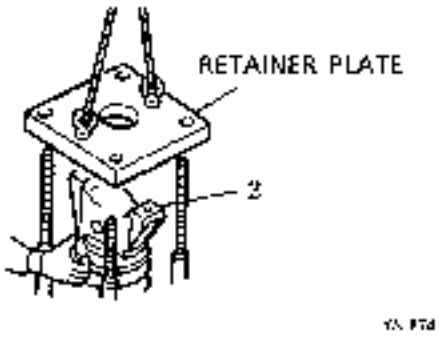


Fig. 65 Removing retainer plate

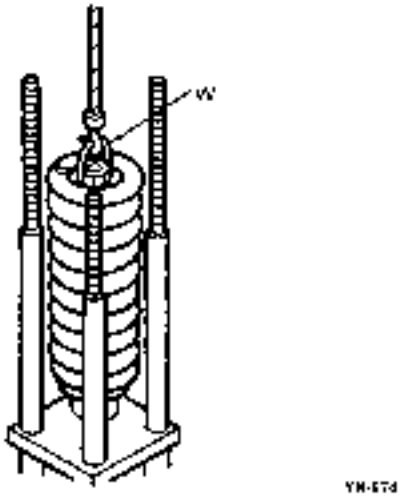


Fig. 66 Removing and attaching idler adjuster ass'y

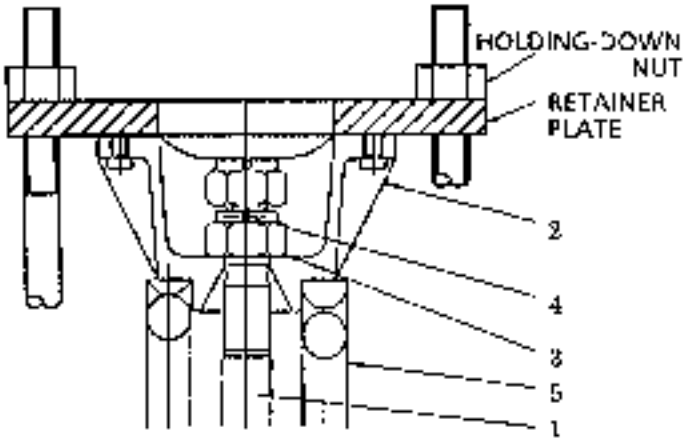


Fig. 67 Attaching idler adjuster ass'y to jig body

5) Take out the idler adjuster ass'y from the jig.

6) Attach oil seal (9) and O ring (10) coated with grease, to grease cylinder (1).

7) Fill up grease in grease cylinder (1), separate the grease nipple from piston (7) and discharge the entrapped air through the grease nipple mounting hole, while pushing in the piston (8) by hand. In that case, the entrapped air is easy to escape if the piston is pushed in with the grease nipple hole facing down.

8) Screw in a grease nipple into piston (6)
   : 19mm,
   Tightening torque : 6±1kgf·m
   (43±7ft-lbs)

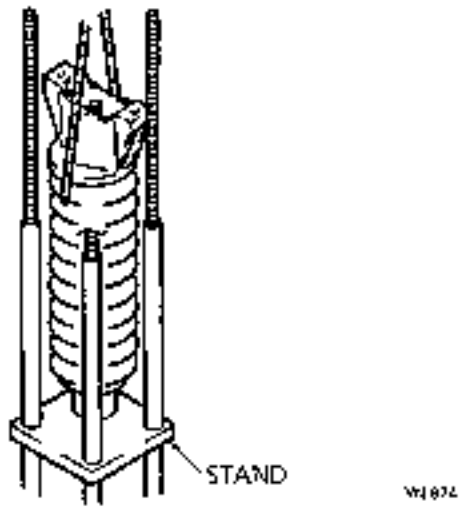


Fig. 68 Taking out idler adjuster ass'y

5.4 MAINTENANCE STANDARD

Table 5

No.	ITEM		STANDARD VALUE
A	Installed length of spring	mm	527.5 (20.8")
B	Free length of spring	mm	About 627.3 (24.7")
C	Stroke	mm	64 (2.520")
D	Set length	mm	852.5 (33.563")
E	Outer circumference of piston		Nor surging and rusting
F	Tightening torque of grease nipple		6±1kgf·m (43±7ft-lbs)

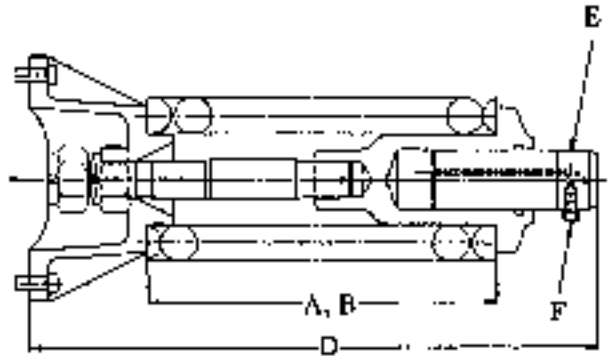


Fig. 69 Idler adjuster

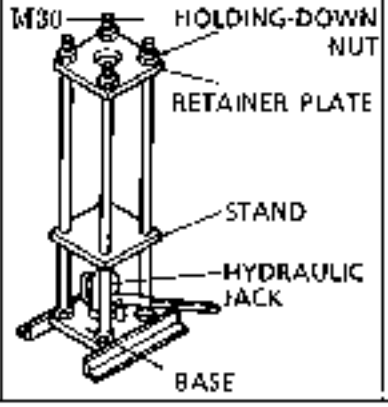
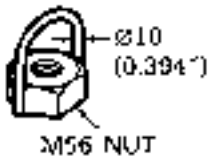
5.5 TOOLS AND JIGS

(1) Tightening Tools

Unit : mm

NAME	WIDTH ACROSS FLATS
SPANNER	46, 85
SOCKET	19, 36

(2) Jigs

No.	NAME	SKETCH	No.	NAME	SKETCH
V	Spring setting jig		W	Lifting nut	

6. SPROCKET

6.1 DISMANTLING AND MOUNTING PROCEDURE

(1) Dismantling

1) Remove the crawler ass'y
2) Place square wooden blocks under the track frame so the sprocket is off the ground.
3) Loosen 26 capscrews (C) (M20) for the mounting of the sprocket by means of a socket and dismantle the sprocket.

Single weight of sprocket . 82kg (180 lbs)

: 30mm

(2) Mounting

1) Check the jointing parts of the travel reduction gear and the sprocket, eliminate burrs and contamination thoroughly and install the sprocket.
2) Coat the sprocket mounting capscrews with Locktite #242 and fasten the sprocket temporarily.
3) Remove the square wooden blocks placed under the track frame and tighten the sprocket against the travel reduction gear with the capscrews.

: 30mm,

Tightening torque : 55 ± 5.5kgf·m

(397 ± 40ft·lbs)

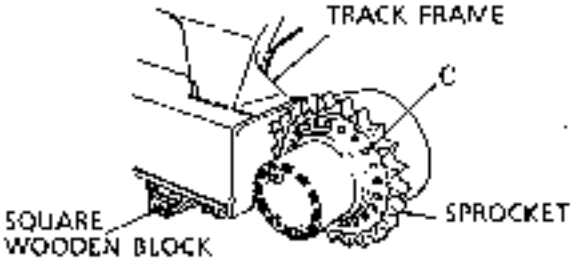


Fig. 70 Lifting the sprocket

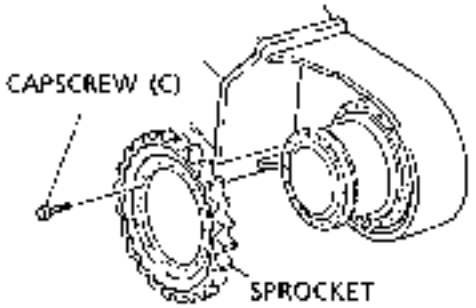


Fig. 71 Separating sprocket

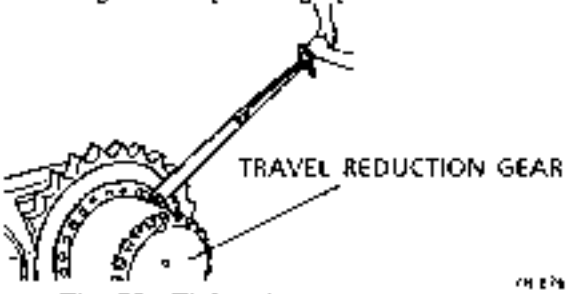


Fig. 72 Tightening capscrews

6.2 MAINTENANCE STANDARD

Table 6

SPECIFICATIONS	LINK PITCH	203.2mm (8 in)	NUMBER OF TEETH	28
	ROLLER DIA.	⌀66.6 (2.622 in)	PITCH DIA.	⌀753.16 (29.652 in)

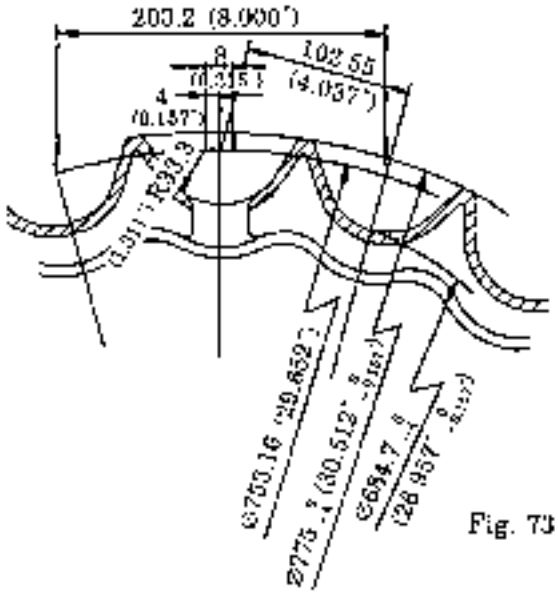


Fig. 73

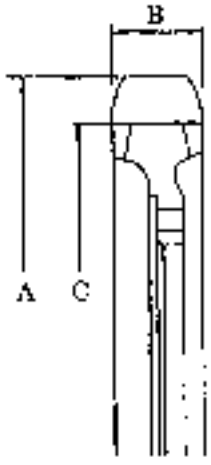


Table 7 Unit : mm (in)

No.	NAME	STANDARD VALUE	REFERENCE VALUE FOR REMEDY	SERVICEABILITY LIMIT	REMEDY
A	O.D. of sprocket	⌀775.4 (30.512 -0.157)	⌀767 (30.197)	⌀765 (30.118)	Padding weld, repair or replace.
B	Width of sprocket teeth	88 ±0.15 (3.465 -0.059 -0.169)	82 (3.228)	80 (3.150)	Replace.
C	Dia. of sprocket teeth bottom	⌀684.7 (26.957 -0.157)	⌀677 (26.653)	⌀675 (26.575)	Padding weld, repair or replace.

6.3 TOOLS AND JIGS

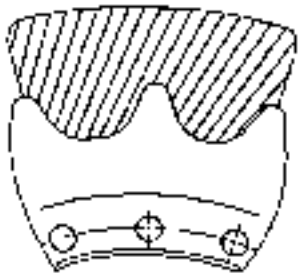
(1) Tightening Tools

Unit : mm

NAME	WIDTH ACROSS FLATS
SOCKET	80

(2) Jigs

Table 8

No.	NAME	SKETCH
W	Tooth profile gauge	

7. TRAVEL REDUCTION GEAR

7.1 DISMANTLING AND MOUNTING PROCEDURE

(1) Dismantling

1) Dismantle the crawler ass'y.

2) Place square wooden blocks under the track frame and float the sprocket off the crawler.

3) Loosen the capscrews that mount the cover inside the track frame and take off the cover.

⑨ : 19mm

4) Vent air out of the hydraulic oil tank beforehand, place the suction stopper, disconnect the hydraulic piping connected with the travel motor from the joints and plug the tubes and joints in order to prevent outflow of oil and intrusion of duet and other foreign matter.

: 19mm – Ø10 pipe dia
27, 32mm – Ø18 pipe dia
41mm – Ø26 pipe dia

5) Loosen 18 capscrews that fasten the track frame to the travel reduction gear. On that occasion, put a matching mark between the track frame and the travel reduction gear.

⑨ : 36mm

6) Place a wire sling in an area near the sprocket of the travel reduction gear and extrude the unit out of the track frame.
Weight of travel reduction gear :
320kg (704 lbs) (with brake valve)
402kg (884 lbs) (with sprocket)

⑫ : 36mm

(2) Mounting

1) If there are burrs and contamination in the fitting part and the joints with which the travel reduction gear are fastened, service it beforehand, place a wire sling in the travel reduction gear the same way as in the dismantling, and install it to the track frame.

2) Coat the threaded part of the mounting capscrews with LocktiteⓇ #242 and tighten them.

⑨ : 36mm,
Tightening torque : 95±9.5kgf·m
(687±69ft·lbs)

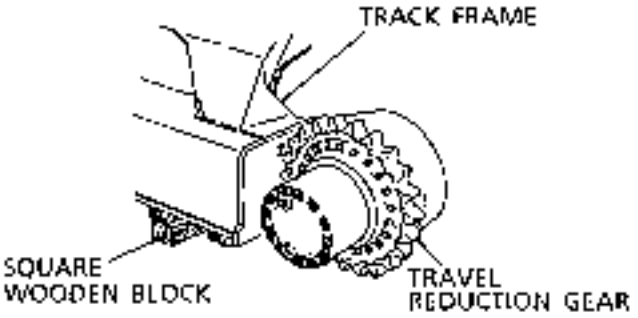


Fig 74 Lifting sprocket

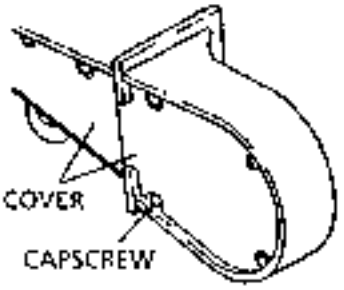


Fig. 75 Removing cover

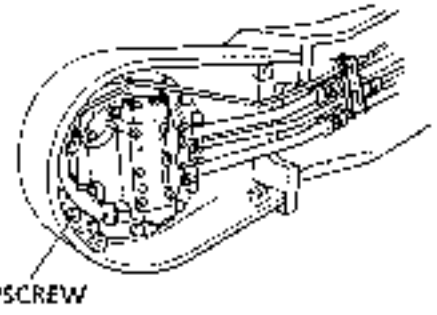


Fig. 76 Removing piping and capscrews

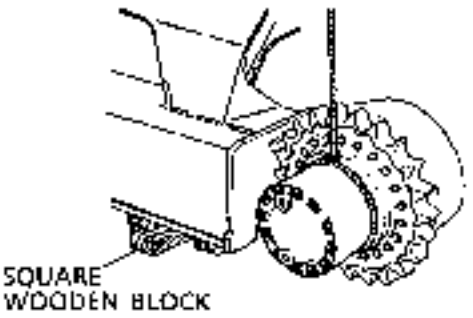


Fig. 77 Dismantling and mounting travel reduction gear

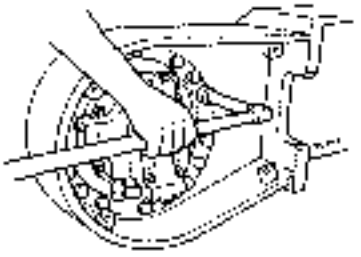


Fig. 78 Tightening capscrews

3) Reconnect the hydraulic piping separated during dismantling, tighten the joints to a specified torque and install the cover to the inside of the crawler frame, using capscrews.

No.	SCREW SIZE	TIGHTENING TORQUE kgf·m (ft-lbs)	
1	PF 1	25.0 ± 2.5 (180 ± 18)	41mm, ⌀26
2	PF 1/2	11.0 ± 1.0 (80 ± 7)	32mm, ⌀18
3	PF 1/4	3.7 ± 0.2 (27 ± 1)	19mm, ⌀10

4) Remove the square wooden blocks supporting the track frame and install the crawler.

5) Check the engine oil level in the reduction gear and replace or replenish oil as required.
Capacity of engine oil: 8.5 ℓ (2.25gal)
Kind of oil: Extreme-pressure gear oil #90 grade GL-4 by API classification
: 6mm, 14mm

6) Checking oil level in travel reduction gear
a) Stop the machine so the drain plug comes right under the machine.
b) Remove the level plug and check the oil level and fouling. The oil level is proper if it is at the tip of the plug. Replenish oil when deficient.

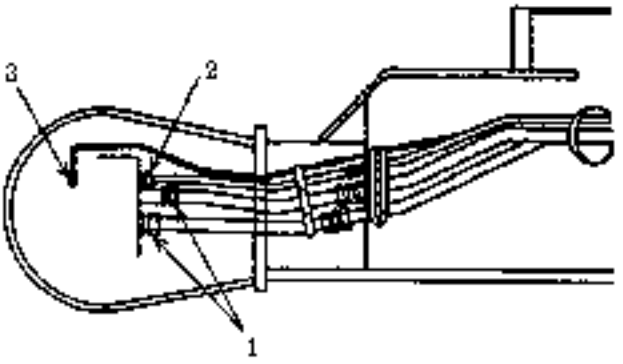


Fig. 79 Attaching hydraulic pipe joints

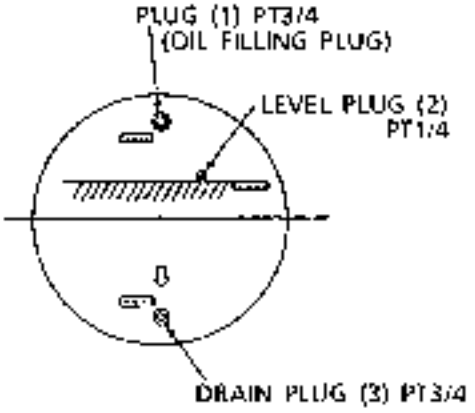


Fig. 80 Checking oil level

7.2 MAINTENANCE STANDARD

Table 9

	ITEM	STANDARD VALUE
Tightening torque	Travel reduction gear mounting bolt	Apply Locktite #242. 95 ± 9.5kgf-m (687 ± 69ft-lbs)
Oil	Kind	Extreme-pressure gear oil #90 grade GL-4 by API classification
	Capacity	8.5ℓ (2.25gal)

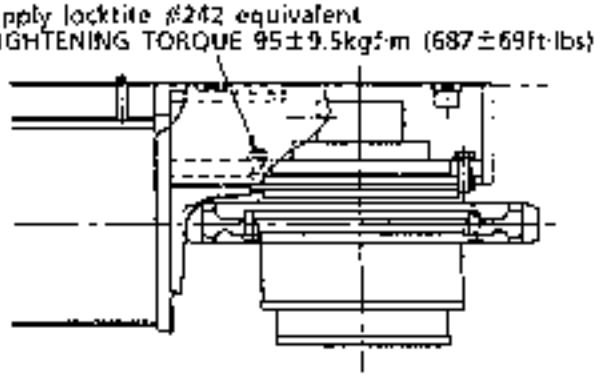


Fig. 81 Installing travel reduction gear

7.3 TOOLS AND JIGS

(1) Tightening tools

Unit : mm

NAME	WIDTH ACROSS FLATS
SPANNER	19,27,32,41
SOCKET	36
ALLEN KEY WRENCH	6,14

8. SWIVEL JOINT

8.1 DISMANTLING AND MOUNTING PROCEDURE

(1) Dismantling

1) When disconnecting pipings, stop the engine, vent air from the hydraulic pipings and install the suction stopper.

2) Separate all the hydraulic pipes connected with the swivel joint. In that case, attach a tag to each pipe showing to what port it should be connected.

: 19mm ⌀10 pipe dia
27mm,32mm ⌀18 pipe dia.
41mm ⌀28 pipe dia.

3) Put a plug to each of the connecting ports and pipes.

4) Loosen locknut(29) and remove capscrews (20)
: 24mm

5) Loosen swivel joint fastening capscrews (21) and take out the washers (27).
: 19mm

6) Attach eye bolts to the swivel joints, place a wire sling in the eye joints. lift it by crane and lower it.

(2) Mounting

1) Mounting is performed in the reverse order of dismantling. Lift the swivel joint so the swivel joint mounting bracket comes in contact with the bottom surface in the center of the lower frame and match the mounting holes.

2) Coat the threads of the capscrews (21) with Locktite #242 and tighten them up.
: 19mm,
Tightening torque : 11±1kgf·m
(80±7ft·lbs)

8.2 MAINTENANCE STANDARD

Table 10

No.	SCREW SIZE	TIGHTENING TORQUE kgf·m (ft·lbs)
1	PF1	25.0 $^{+3}_{-1}$ (180 $^{+14}_{0}$)
2	PF1/4	3.7±0.2 (27±1)
3	PF1/2	11.0±1.0 (80±7)

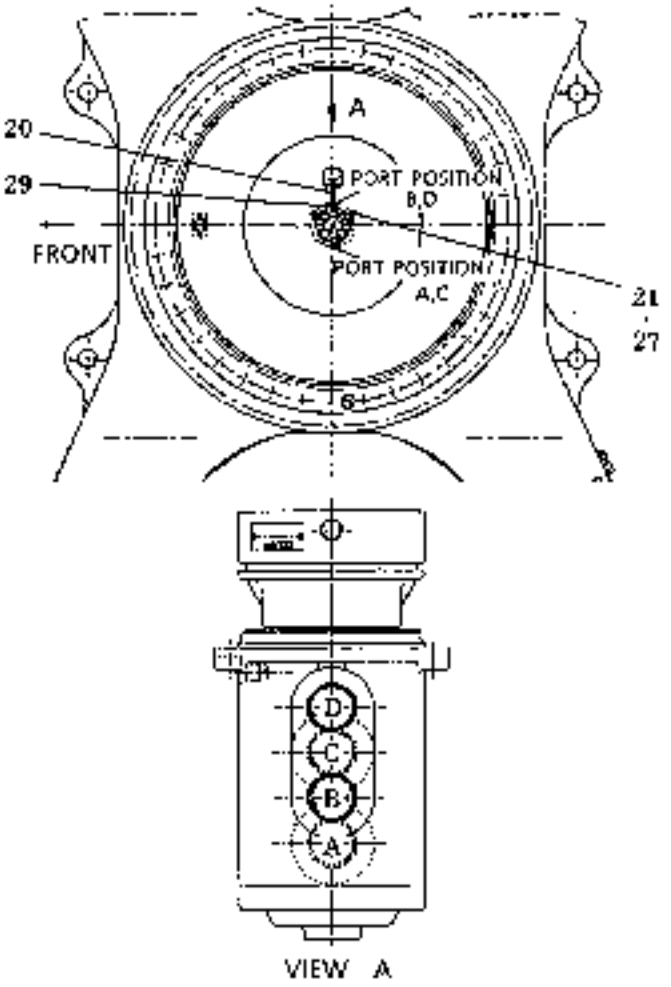


Fig. 82 Swivel joint

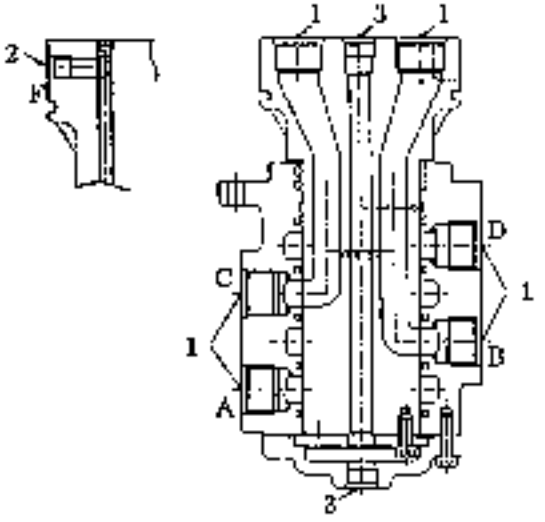


Fig. 83 Hydraulic piping for swivel joint

9. SWING BEARING

9.1 DISMANTLING AND MOUNTING PROCEDURE

(1) Dismantling

1) With the upper frame removed, loosen capscrews (15) that fix the inner race of swing bearing (5) to the stand of the lower frame, and take off all of them.
   : 36mm

2) Let out the grease in the swing bearing inner race.

3) Attach T-bolts to swing bearing (5), lift it by crane, separate it from the lower frame and lift it down.
   Weight of swing bearing : 570kg (1,257 lbs)

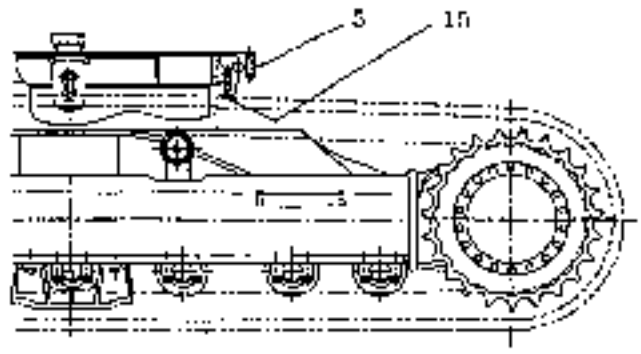


Fig. 84 Swing bearing

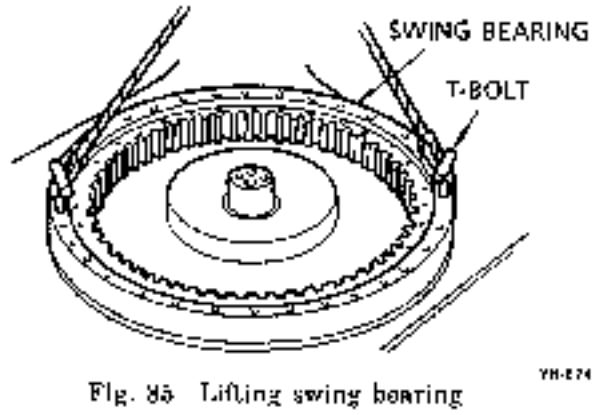


Fig. 85 Lifting swing bearing

(2) Mounting

1) Before mounting the swing bearing, clean thoroughly the swing bearing and the matching surface of the swing bearing base on the lower frame to be free from dirt, oil and other foreign substance.

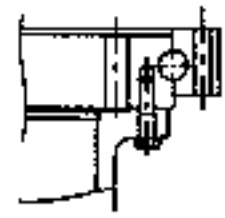
2) Lift the swing bearing onto the base so the S mark stamped on the inner race of the swing bearing is located on the left hand side (See the figure on the right.) of the lower frame.

3) Coat the threads of the capscrews with Locktite #242 and screw in all the capscrews (36 pcs) to an extent that they are fastened temporarily.

4) Fasten the capscrews at 180° intervals alternately and tighten them up to a specified torque
   : 36mm,
   Tightening torque : 95±9.5kgf·m
   (687±69ft-lbs)

5) Before installing the upper frame, mount the swing bearing to the base of the lower frame according to the mounting procedure of the swing bearing.

6) Fill in 14kg (31 lbs) of SHELL RETINAX AM grease equivalent into the grease bath.



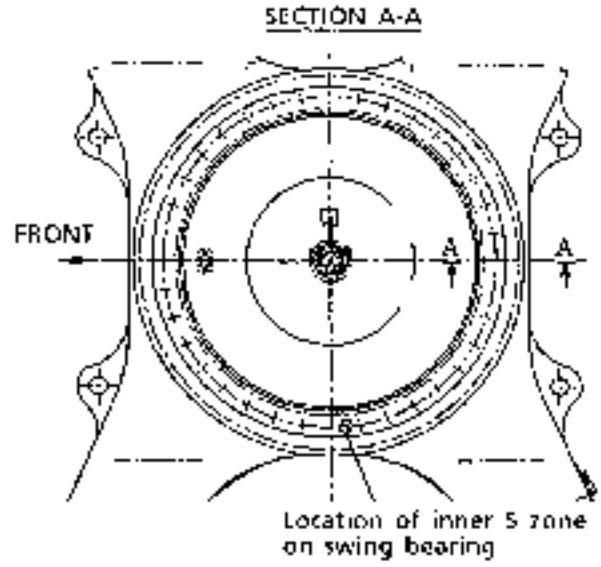


Fig. 86 Location of S mark on swing bearing

9.2 CONSTRUCTION

No.	NAME	Q'TY	No	NAME	Q'TY
1	OUTER RACE	1	7	SEAL	1
2	INNER RACE	1	8	GREASE NIPPLE	1
3	BALL	64	9	PLUG	1
4	RETAINER	64	10	TAPER PIN	2
5	SEAL	1	11	O RING	1
6	SEAL	1			

9.3 DISASSEMBLY AND REASSEMBLY

(1) Disassembly

1) Take out seal (6) fitted in the groove of inner race (2) and seal (5) fitted in the groove of outer race (1) and place them level on a square wooden block or something.
2) Draw out taper pin (10), using a hammer and an extrusion rod.
3) Draw out plug (9), utilizing an pull bolt inserted in the screwed hole (M6) of the plug and using a puller
4) After drawing out plug (9) while rotating outer race (1) little by little, take out ball (3) and retainer (4) from the hole in sequence.
5) Separate outer race (1) from inner race (2), using a crane.
6) Remove seal (7) from outer race (1).

(2) Reassembly

1) Install seal (7) to outer race (1).
2) Degrease thoroughly the groove for seal (5) located in the inner circumference of outer race (1) and the groove for seal (6) located in the outer circumference of inner race (2). Coat the grooves with adhesive Cyano Bond PO 1, fit seal (6), and place inner race (2) on a surface plate.
3) Lift and lower outer race (1) slowly till the top surface of inner race (2) matches the bottom of the sealing groove of outer race (1). Place an adjusting washer under outer race (1) so the track surface of ball (3) is aligned, in order to support the outer race.
4) Insert, through the hole for plug (9) in outer race (1), ball (3) and retainer (4) coated with grease (Shell Albania EP#2) alternately.

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

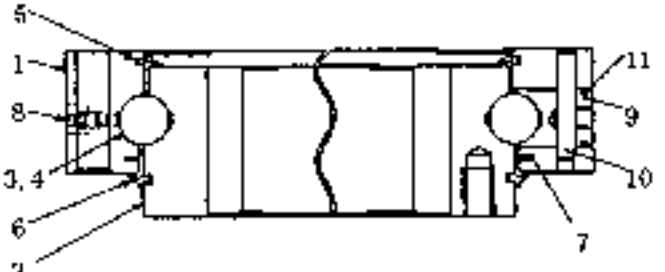


Fig. 87 Cross-sectional view of swing bearing

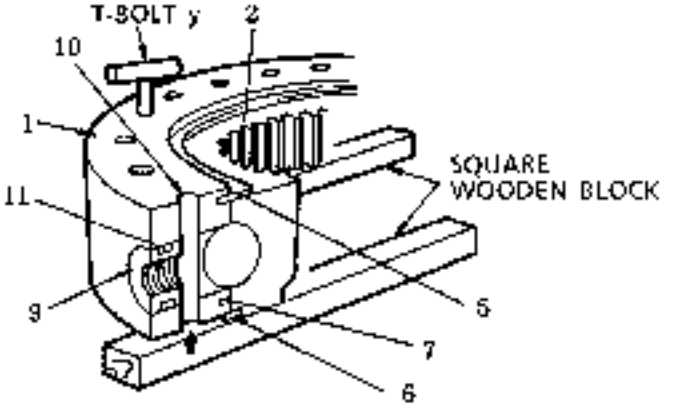


Fig. 88 Disassembling swing bearing

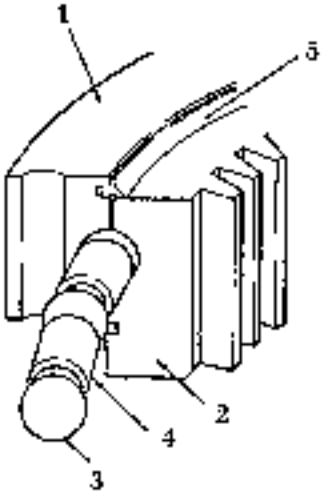


Fig. 89 Removing balls and retainers

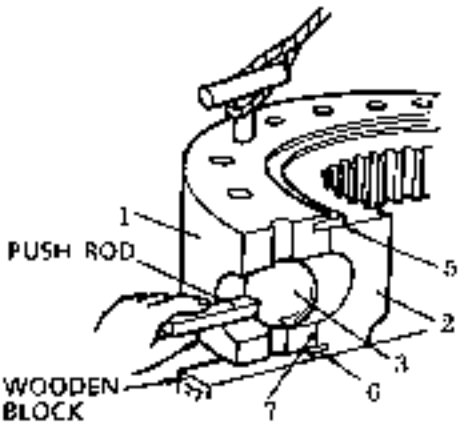


Fig. 90 Fitting balls

4) Push in outer race (1) and plug (9), confirming the orientation and the position of the hole for taper pin (10).

5) Knock in taper pin (10) and caulk the head of the taper pin with a punch.

6) Coat seal (5) with adhesive Cyano Bond PO–1 and fit it into outer race (1).

7) Confirm that grease nipple (8) is normal. Inject grease (Shell Albania EP#2) and confirm that the outer race rotates smoothly and that the lip of the seal is not scored.

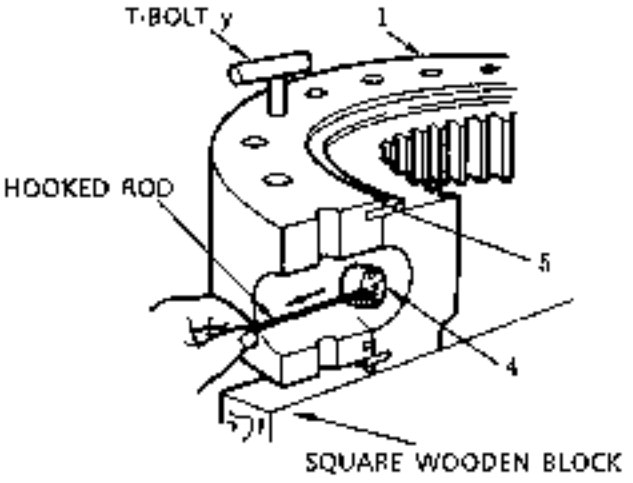


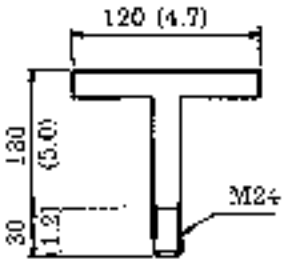
Fig. 91 Fitting retainer

9.4 MAINTENANCE STANDARD

Regarding the maintenance standard for the wear of the swing bearing, refer to Maintenance Standard and Measurement of Swing Performances under Test Procedure that are explained in a separate manual.

9.5 TOOLS AND JIGS

Unit : mm (in)

No.	NAME	SKETCH
y	T-bolt and nut	

Book code No. S5LC2105E

KOBELCO

SHOP MANUAL

SK310
SK310LC

ATTACHMENT

TABLE OF CONTENTS

LC21

KOBE STEEL, LTD.

Applicable Machines
LC03801~
YC01101~

Revision	Date of Issue	Remarks
First edition	March, 1995	S5LC2105E K

1. BUCKET

1.1 DISMANTLING AND MOUNTING PROCEDURE

(1) Dismantling bucket

1) Operate the operating lever and bring the bucket down to the ground so the bucket and arm connecting pins are not loaded.

2) Remove the ring and the pin by means of a flat-bladed screwdriver and draw out pin (A), in order to remove pin (A) in the embossment of the bucket. (Fig. 1)

⚠
- If the pin is hard to come off, the pin is loaded: Adjust it by manipulating the operating lever
- Exercise care so the dust seal between the arm and the bucket embossment is not scored.

3) Adjust the bucket by manipulating the operating lever so the pin (B) between the bucket link and the bucket is not loaded.

4) Remove the pin securing ring and the pin in the bucket embossment, using a flat-bladed screwdriver and draw out pin (B). (See Fig. 2)

(2) Mounting bucket (See Fig. 3)

Mounting is performed in the reverse order of dismantling, including the following operations:

1) Clean the welds of the structures and check that there is no crack on the welds

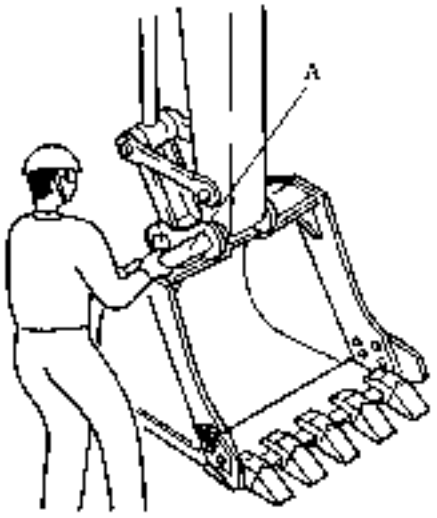
2) Check the bushing in the bucket embossment to see if it is not worn nor damaged, according to "Maintenance Standard" which will be explained later. Replace it where necessary.

3) Check that the dust seal is not scored and replace a faulty one if necessary.

4) When inserting the pin, coat the shaft with grease.

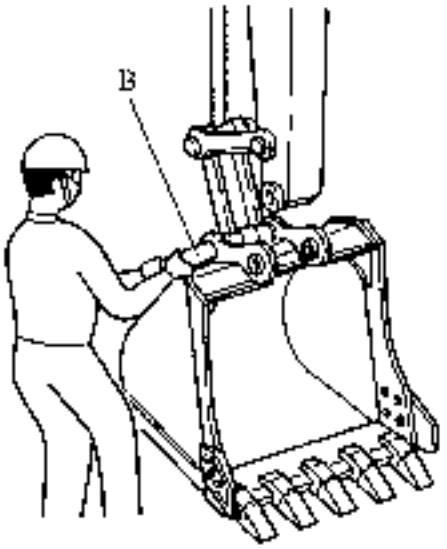
⚠
- The bucket can be mounted easily if the bucket link is installed in the beginning.
- When aligning the pin holes, do not put your finger in the pin holes in any circumstances, but align them visually.

5) Adjust the clearance between the bucket and the arm by referring to "Maintenance Standard" which will be dealt with later.



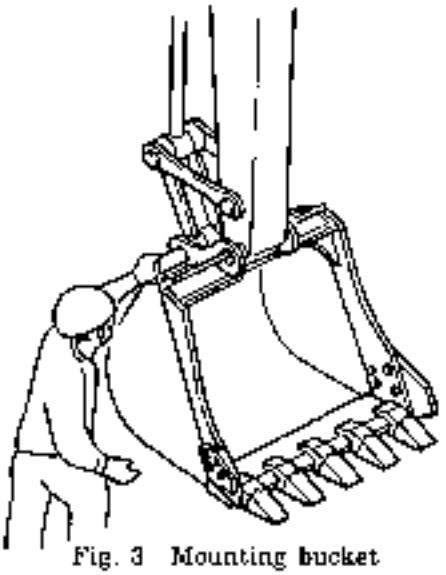
YM 31a

Fig. 1 Removing bucket pin



YM-874

Fig. 2 Removing link pin



YM 31a

Fig. 3 Mounting bucket

1.2 CONSTRUCTION

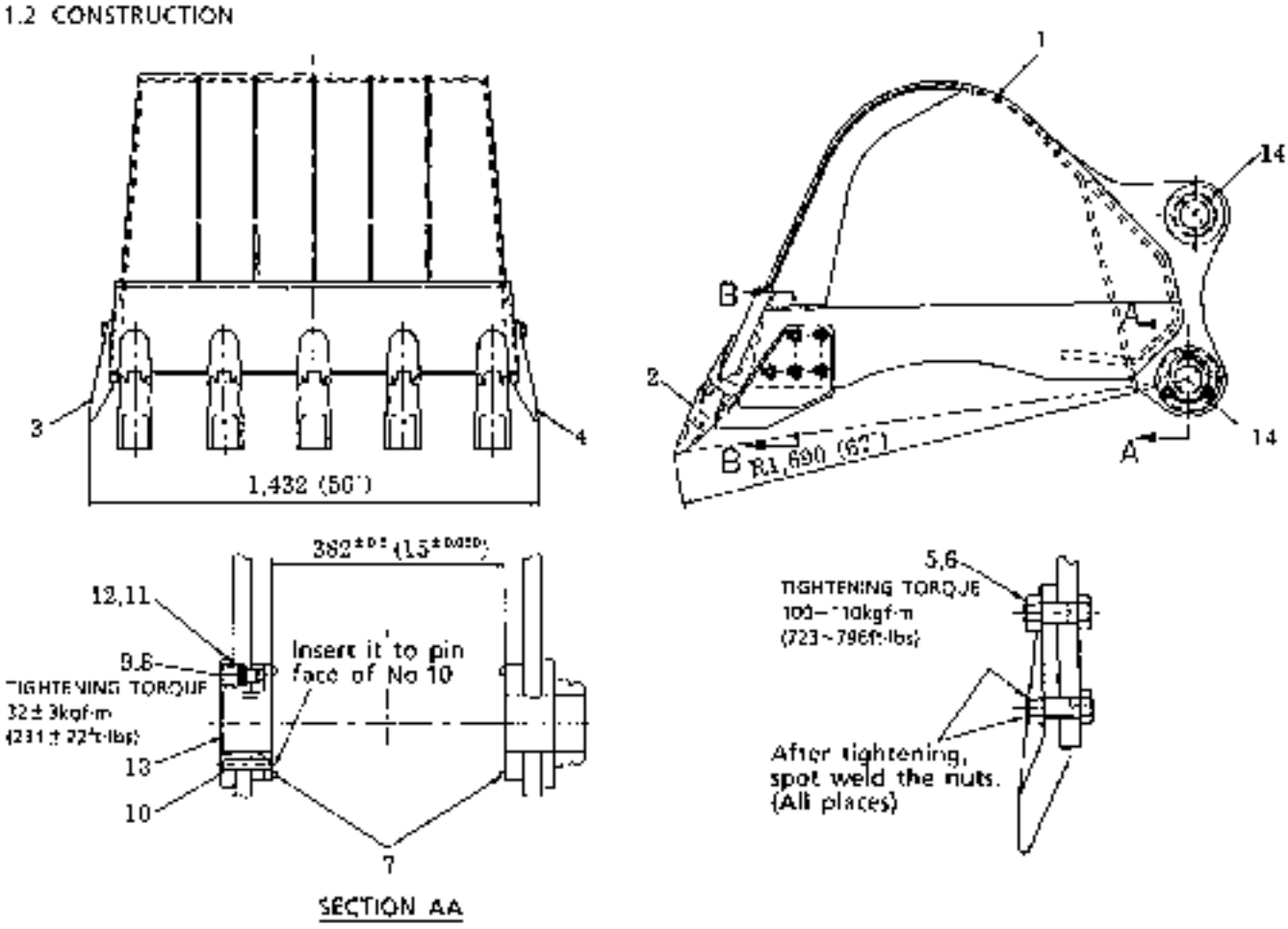


Fig. 4 Construction of bucket

No	NAME	Q'ty	No.	NAME	Q'ty	No.	NAME	Q'ty
1	BUCKET	1	6	NUT	10	11	SHIM	3
2	TOOTH ASSY	5	7	O RING	4	12	SHIM	30
3	SIDE CUTTER (RH)	1	8	CAPSCREW (M20)	3	13	BUSHING	1
4	SIDE CUTTER (LH)	1	9	LOCK WASHER	3	14	SPRING PIN	2
5	CAPSCREW (M24)	10	10	PIN	1			

1.3 MAINTENANCE STANDARD

(1) Tightening torque

Table 1 Unit: kgf-m (ft-lbs)

No.	NAME	TIGHTENING TORQUE	REMARK
6	Side cutter fastening nut	100~110 (723~796)	After fastening nuts, spot weld.
8	Capscrew	32±3 (231±22)	For adjusting bucket mounting clearance ⌐ : 17mm

(2) Procedure for adjusting clearance
Adjustment of clearance between bucket and arm

1) Shift O ring (3) toward the bucket embossment, using a spatula.
2) When adjusting clearance (B), bring the non-adjusting side of the bucket in contact with the arm.
3) Measure clearance (B) and check that it is within 1.2mm (0.05in).
4) Adjust clearance (B) where it is more than 1.2mm (0.05in).
5) An average of 10 shims of 1mm (0.04in) thickness are set in each of the three socket head capscrews (1). The clearance can be adjusted by 1mm (0.04in) if one shim is removed.
   : 17mm
6) After adjustment, tighten the socket head capscrews evenly.
7) Operate the bucket and confirm that the total sum of both clearances are within 1.2mm (0.05in)
8) Refit O ring (3) to its original position.

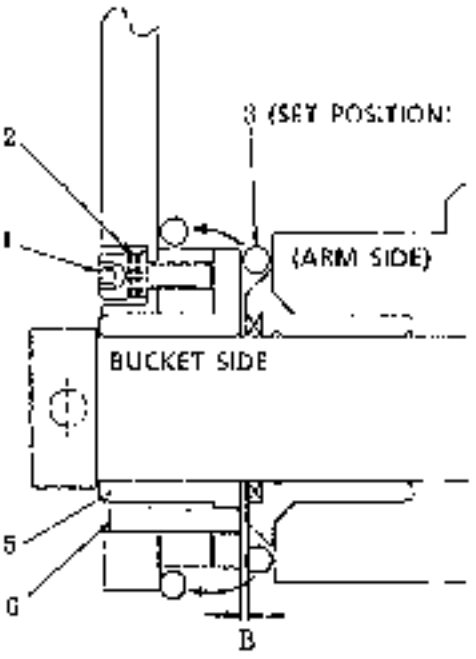


Fig. 5 Adjusting clearance between bucket and arm

- When shifting O ring (3) by means of a spatula, use care so as not to score O ring (3).
- Remove shims (2), push out bushing (5) rightwards by means of three socket head capscrews (1) and adjust clearance (B) so it falls within the standard value evenly all round.
- Check the clearance at 120 hours' intervals in normal operation. Shorten these intervals in special operation. Adjust the intervals as necessary.

2. ARM

2.1 DISMANTLING AND MOUNTING PROCEDURE

Here in under is explained how to dismantle and mount the arm that is fixed to the bucket cylinder.

(1) Dismantling

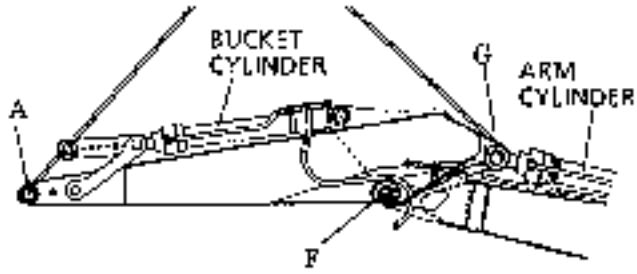
1) Retract the rod of the bucket cylinder most and fix the bucket cylinder and the bucket link to the arm.
2) Stop the engine and discharge the remaining air from inside the hydraulic oil tank. Remove the hoses connected to the bucket cylinder and plug the connections.
3) Place a nylon sling in the body of the arm cylinder and lift it so pin (G) is not loaded.
4) Remove capscrews (26) fixing pin (G) and draw out pin (G).
   : 30mm
5) Place wooden blocks under the arm cylinder and support the arm cylinder.
6) Insert pin (G) into the original position of the arm and attach capscrews (26).
7) Place a wire sling in pin (G) and the tip (A) of the arm and lift the arm slightly so pin (F) connecting the arm with the boom is not loaded.
8) Remove capscrew (50), plate (49) fixing pin (F) and draw out pin (F).
   : 24mm
9) Dismantle the arm with the bucket cylinder.
   Weight of arm assy : 1000kg (3520 lbs).

(2) Mounting

1) Before installing the arm, check the thrust clearance of the pin (G) and the pin (F) and decide the thickness of shims (※47) & (※93) by referring to "Maintenance Standard" which will be described later.
   Also check dust seal (17) and replace it if necessary.
2) Place a wire sling at pin (G) and the tip (A) of the arm, lift the arm and align the pin holes in the arm and in the boom.
3) Install shims (※93) decided under 1) and the grease-coated pin (F) and plate (49) and attach fastening capscrew (50) coated with Locktite #242.
   : 24mm
4) Align the pin holes in the rod side of the arm cylinder and in the arm and insert pin (G) and shims (※47).
5) Put capscrew (26) fixing pin (G) through pin (G), locknut (28) with Locktite #242 and tighten it up.
   On that occasion, set the clearance between the tip of the capscrew and the nut face to 0~0.5mm (0.02in). (See Fig. 7)
   : 30mm
6) Attach the hydraulic hoses to the bucket cylinder.

⚠ Tightening torque

Item	Size	Tightening torque kgf·m (ft·lbs)
Tube clamp	M12	12.3±1.2 (89±8.7)
Band of cylinder	M10	3.2±0.6 (23±4.3)
Nut and sleeve in bite type tube fitting	Tube ø35×5.0	45±4.5 (325±33)



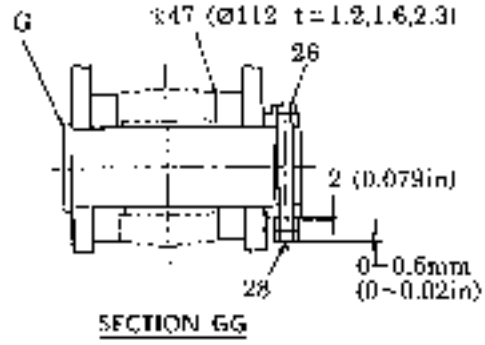


Fig. 6 (1/2) Dismantling and mounting arm

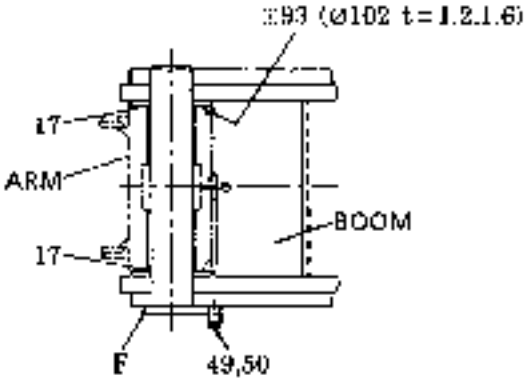


Fig. 6 (2/2) Dismantling and mounting arm

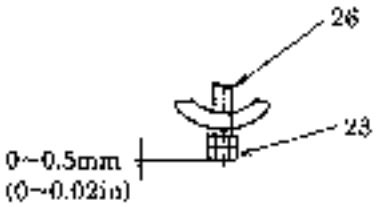
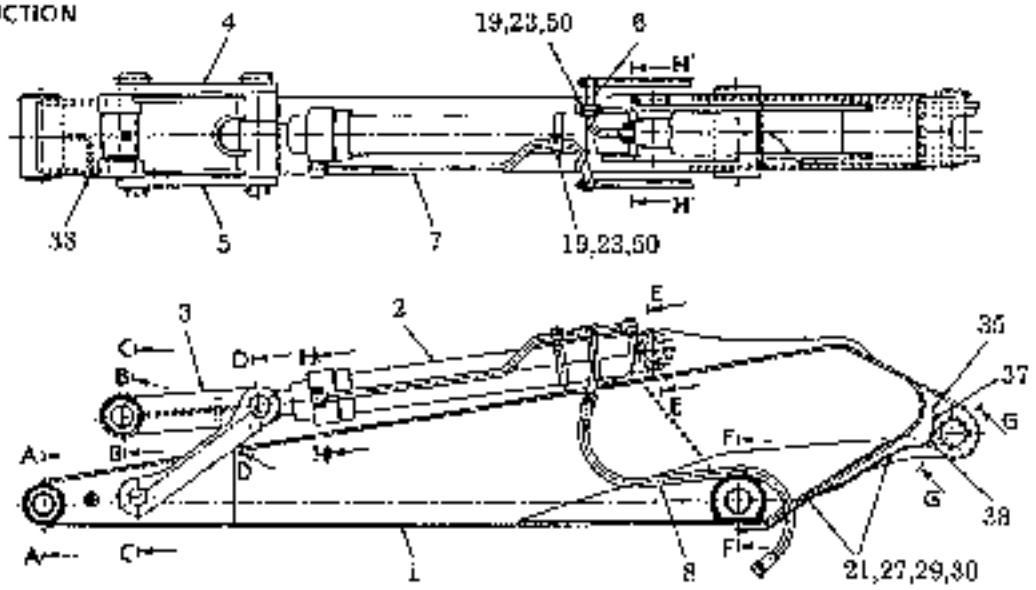
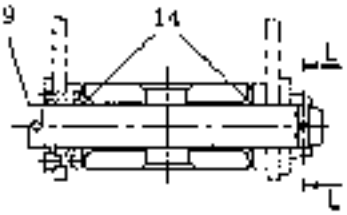


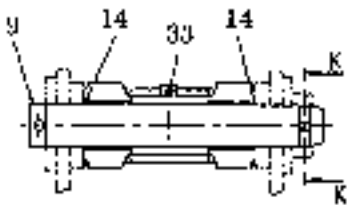
Fig. 7 Tightening locknut

2.2 CONSTRUCTION





SECTION AA



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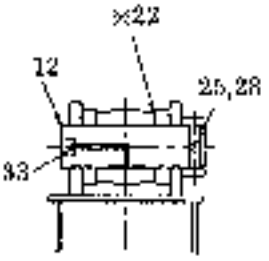

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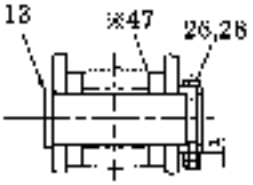

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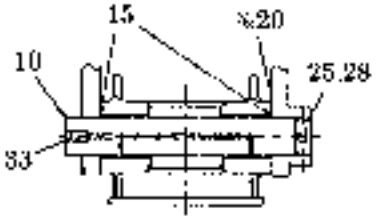

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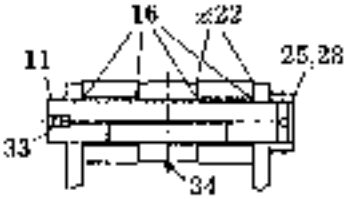

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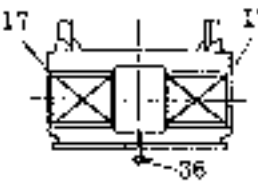
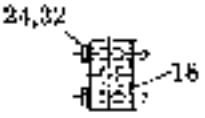
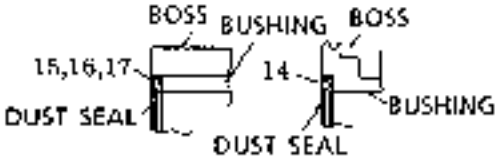


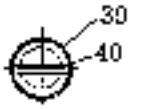
SECTION FF



SECTION HH,H'H



Assembling procedure of dust seal



SECTION KK,LL

Fig. 8 Arm

※ : Only necessary number of shims must be selected.

No.	NAME	QTY	No.	NAME	QTY	No.	NAME	QTY
1	ARM	1	16	DUST SEAL	4	29	LOCK WASHER	2
2	CYLINDER	1	17	DUST SEAL	2	30	WASHER	2
3	BUCKET LINK	1	18	O RING	2	32	WASHER	8
4	IDLER LINK (RIGHT)	1	19	CLAMP	2	33	GREASE NIPPLE	5
5	IDLER LINK (LEFT)	1	※20	SHIM Ø82 (Selected)	1S	34	GREASE NIPPLE	1
6	TUBE	1		(t=0.5,0.9,1.2,1.6,2.3)		35	GREASE NIPPLE	1
7	TUBE	1	21	CLIP	2	36	CONNECTOR	1
8	HOSE	2	※22	SHIM Ø92 (Selected)	3S	37	CONNECTOR	1
9	PIN	2		(t=0.5,0.9,1.2,1.6,2.3)		38	HOSE	1
10	PIN	1	23	CAPSCREW (M12×60)	4	39	RING	2
11	PIN	1	24	CAPSCREW (M12×75)	8	40	PIN	2
12	PIN	1	25	CAPSCREW (M20×160)	3	※47	SHIM Ø112 (Selected)	1S
13	PIN	1	26	CAPSCREW (M20×150)	1		(t=1.2,1.6,2.3)	
14	DUST SEAL	4	27	CAPSCREW (M6×12)	2	50	WASHER	4
15	DUST SEAL	2	28	NUT	8			

2.3 MAINTENANCE STANDARD

(1) Clearance between pin and bushing

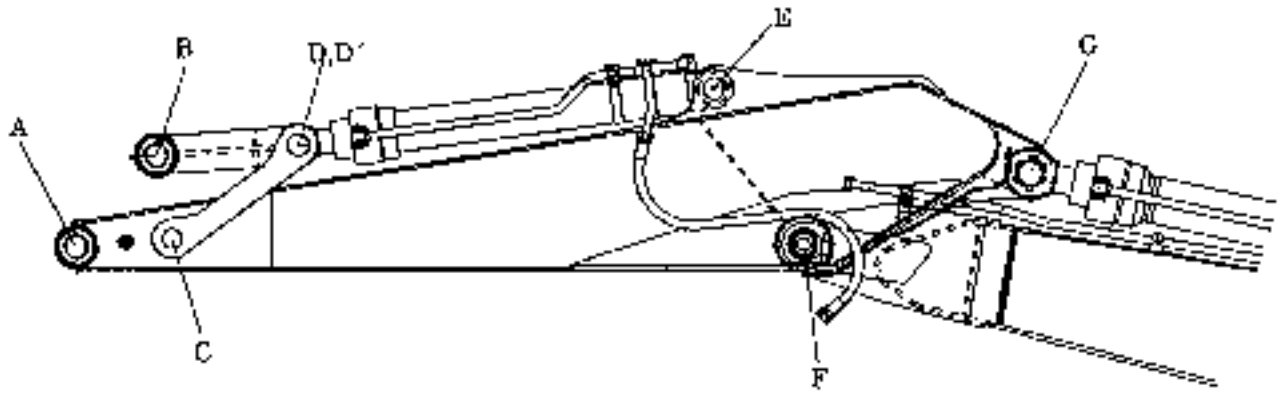


Fig 9 Clearance between pin and bushing of arm section

Table 2 Unit : mm (in)

No.	Item	Standard dimension			Clearance			Remedy
		Pin dia	Tolerance on pin dia	Tolerance on bushing bore dia	Standard value	Reference value for remedy	Serviceability limit	
A	Arm cylinder (arm side)	ø90 (ø3.5433)	−0.070 (−0.0028) −0.130 (−0.0051)	+0.375 (0.0148) +0.320 (+0.0126)	0.39 (0.015) \ 0.51 (0.020)	2.5 (0.098)	3.0 (0.118)	Replace bushing or pin
B	Bucket link (bucket side)							
C	Idler link (connected part of arm)	ø80 (ø3.1496)		+0.279 (+0.0110) +0.194 (+0.0076)	0.26 (0.010) \ 0.41 (0.016)			
D	Bucket cylinder (rod side)	ø90 (ø3.5433)		+0.250 (+0.0098) +0.050 (+0.0020)	0.12 (0.004) \ 0.38 (0.015)			
D'	Bucket link (cylinder side)			−0.075 (+0.0148) +0.320 (+0.0126)	0.39 (0.015) \ 0.51 (0.020)			
E	Bucket cylinder (arm side)			+0.250 (0.0098) +0.050 (+0.0020)	0.12 (0.005) \ 0.38 (0.015)			
G	Arm cylinder (arm side)	ø110 (ø4.3307)						
F	Connecting part of arm and boom	ø100 (ø3.9370)	±0.02 (±0.0008)	+0.375 (+0.0148) +0.320 (+0.0126)	0.30 (0.012) \ 0.40 (0.016)			

(2) Thrust clearance between arm and cylinder mounting

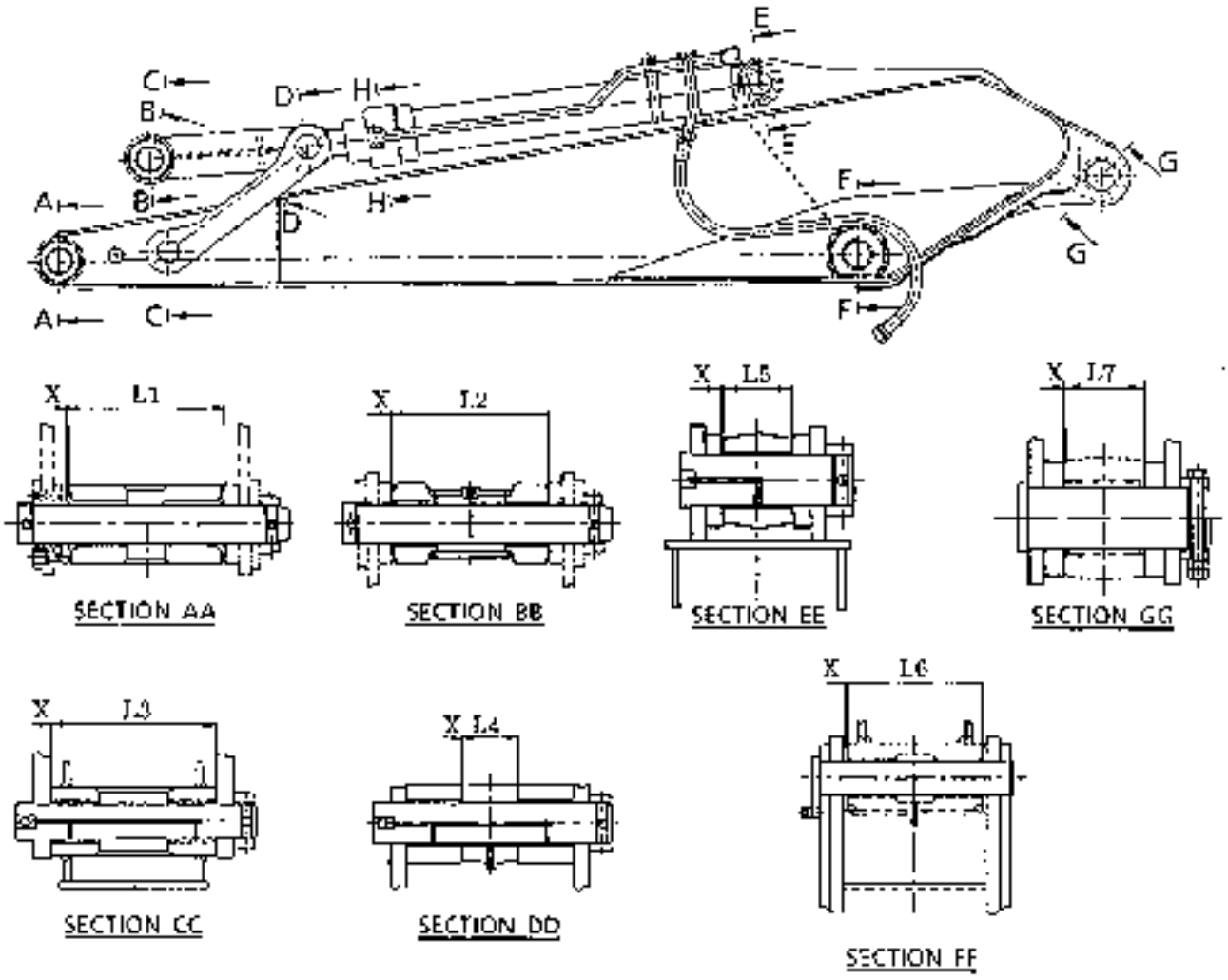


Fig. 10 Thrust clearance between arm and cylinder mounting

Table 3 Unit: mm (in)

Section	Item		Standard dimension		Shim adjusted clearance X (total of both sides)			Remedy
			Code	Dimension	Standard value	Reference value for remedy	Serviceability limit	
A	Arm tip (bucket mounting part)	Arm	L1	380 +0.1 (14.961 +0.004)	Less than 1.2 (0.047)	2.5 (0.098)	3.0 (0.118)	Shim adjustment
		Bucket		382 +0.5 (15.039 +0.020)				
B	Bucket link (bucket side)	Link side	L2	(380 (14.961))				
		Bucket		382 +0.1 −1.1 (15.039 +0.004 −0.043)				
C	Idler link (arm connecting part)	Arm	L3	380 +0.5 (14.961 +0.012)				
		Link side		—				
D	Bucket link (cylinder side)	Rod side	L4	128 −0.5 (5.039 −0.020)				
		Link side		330 +0.7 (5.118 +0.028)				
E	Bucket cylinder mounting part (arm side)	Bottom side	L5	128 −0.5 (5.039 −0.020)	Less than 2.0 (0.079)	3.0 (0.118)	4.0 (0.157)	
		Arm		130 +1.7 +1.0 (5.118 +0.043 +0.039)				
F	Connecting part between arm and boom	Arm	L6	400 ±0.2 (15.748 ±0.008)	Less than 1.2 (0.047)	2.5 (0.098)	3.0 (0.118)	
		Boom		401.8 −0.2 (15.819 −0.008)				
G	Arm cylinder mounting part (arm side)	Rod side	L7	140 −0.5 (5.512 −0.020)	Less than 2.0 (0.079)	3.0 (0.118)	4.0 (0.157)	
		Arm		142 +1.1 +0.6 (5.591 +0.024 +0.020)				

3. BOOM

3.1 PREPARATION FOR DISMANTLING AND MOUNTING

1) Retract the arm cylinder most. Support it by wooden blocks and fix it to the boom.
2) Bring down the boom and support the top end by an appropriate stand.
3) Stop the engine and lock the operating lever.
4) Disconnect the electric wiring for the working light.
5) Vent the remaining air in the hydraulic oil tank and separate the hydraulic pipes of the upper frame side and those of the attachment side. Plug the joints.

3.2 DISMANTLING AND MOUNTING PROCEDURE

(1) Dismantling

1) Dismantle the arm cylinder and the boom cylinder by referring to "4.1 Dismantling and Mounting Hydraulic Cylinder" which will be dealt with later.
2) Temporarily lift the boom lightly by crane so boom foot pin (53) will not be loaded.
3) Separate capscrew (57) fastening boom foot pin (53) and plate (56). Then draw out boom foot pin (53).
4) Lift the boom by crane and remove it with shims (※87).

⚠ Put a tag to each shim showing the location and keep it so it will not be lost.

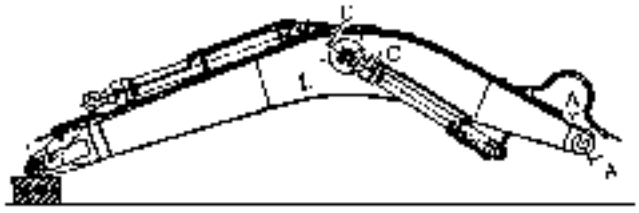
(2) Mounting

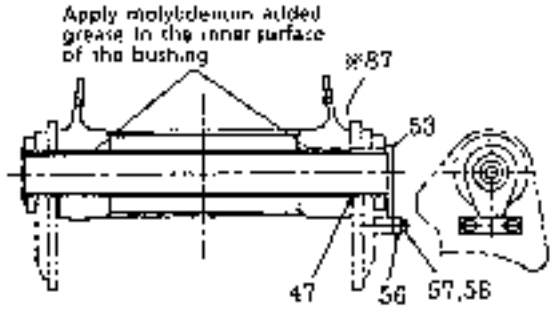
Mounting of the boom is done in the reverse order of dismantling, but pay attention to the following points:

1) Replace the worn pin and bushing and dust seal (47) by referring to "Maintenance Standard" which will be described later.
2) In installing the boom and the cylinders, check the thrust-wise clearance in the mounting part and decide the thickness of shims by referring to "Maintenance Standard" which will be explained later.
3) When installing pins (53), (29), (34), and (28), coat the inner surface of the bushing with molybdenum-added grease.
4) Before tightening locknut (40) of the locking capscrews for the boom cylinder rod pin (29) and the arm cylinder head pin (28), coat them with Locktite #242. Set the distance between the tip of the capscrew and the nut face to 0−0.5mm (0−0.02in)

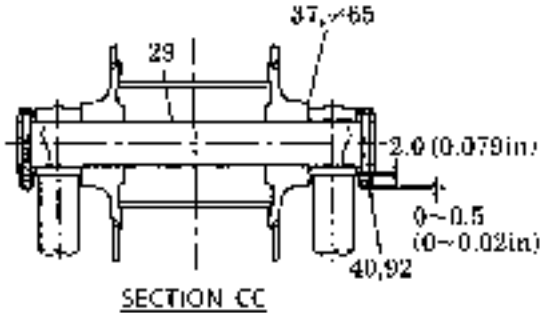
⚠ Tightening torque

Item	Size	Tightening torque kgf·m (ft·lbs)
Tube clamp	M12	12.3±1.2 (89±8.7)
Band of cylinder	M10	3.2±0.6 (23±4.3)
Nut and sleeve in bite type tube fitting	Tube ø35×5.0	46±4.6 (325±33)





SECTION AA



SECTION CC

Fig. 11 Dismantling and mounting boom

3.3 CONSTRUCTION

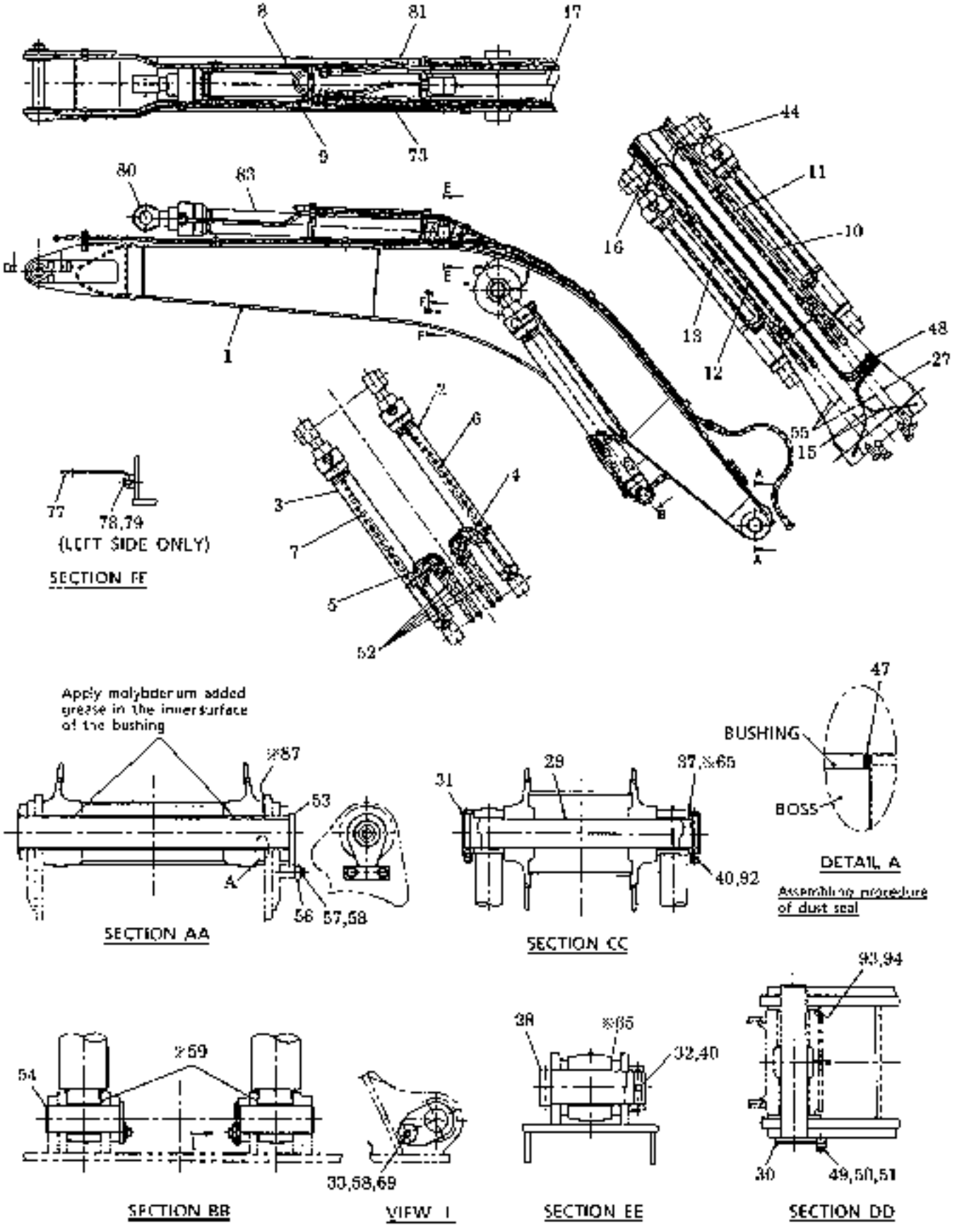


Fig. 12 Boom

NOTE : Only necessary number of shims must be selected.

No	NAME	Q'TY	No.	NAME	Q'TY	No.	NAME	Q'TY
1	BOOM	1	29	PIN	1	58	WASHER	4
2	BOOM CYLINDER (LH)	1	30	PIN	1	※59	SHIM	2S
3	BOOM CYLINDER (RH)	1	31	COLLAR	2		(t=0.5,0.9,1.2,1.6,2.3)	
4	TUBE	1	32	CAPSCREW (M20×180)	1	※65	SHIM	3S
5	TUBE	1	33	CAPSCREW (M20×35)	2		(t=0.5,0.9,1.2,1.6,2.3)	
6	TUBE	1	37	SHIM t=3.2	2	69	PLATE	2
7	TUBE	1	40	NUT	6	73	HOSE	1
8	TUBE	1	44	HOSE	1	77	BRACKET	1
9	TUBE	1	47	DUST SEAL	2	78	CAPSCREW (M10×20)	1
10	TUBE	1	48	GREASE NIPPLE	7	79	WASHER	1
11	TUBE	1	49	PLATE	1	80	GREASE NIPPLE	1
12	TUBE	1	50	CAPSCREW (M16×35)	2	81	HOSE	1
13	TUBE	1	51	WASHER	2	83	ARM CYLINDER	1
14	TUBE	2	52	HOSE	4	※87	SHIM	1S
15	HOSE	2	53	PIN	1		(t=0.5,0.9,1.2,1.6,2.3)	
16	HOSE	1	54	PIN	2	92	CAPSCREW (M20×190)	2
17	HOSE	1	55	HOSE	3	※93	SHIM (t=1.2,1.6)	1S
27	HOSE	1	56	PLATE	1			
28	PIN	1	57	CAPSCREW (M20×55)	2			

3.4 MAINTENANCE STANDARD

(1) Clearance between pin and bushing

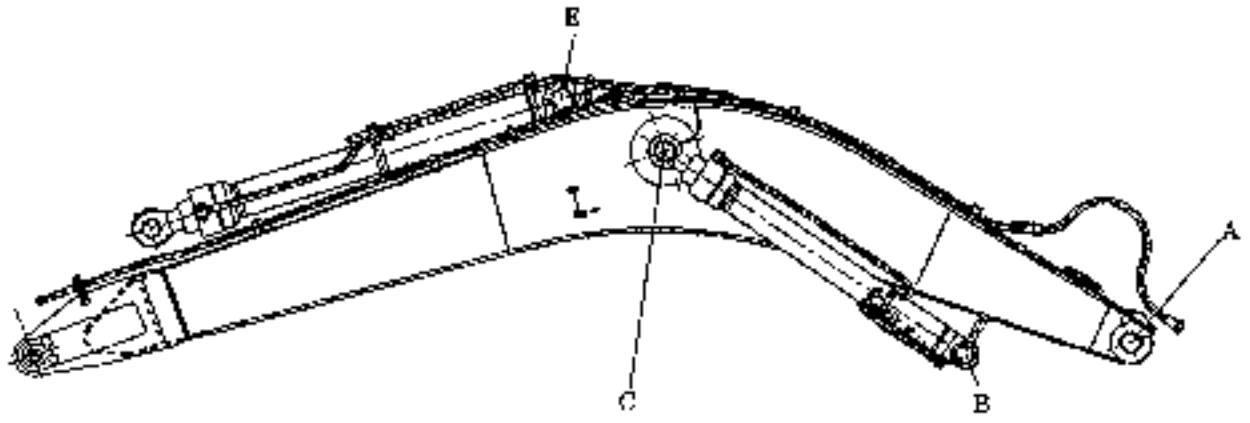


Fig. 13 Clearance between boom pin and bushing

Table 4 Unit: mm (in)

No.	Item	Standard dimension			Clearance			Remedy
		Pin dia	Tolerance on pin dia	Tolerance on bushing bore dia	Standard value	Reference value for remedy	Serviceability limit	
A	Boom foot	⌀110 (⌀4.3307)	±0.02 (±0.0008)	+0.295 (+0.0116) +0.240 (+0.0094)	0.22 (0.009) \ 0.32 (0.013)	2.5 (0.098)	3.0 (0.12)	Replace bushing or pin
B	Boom cylinder (Head side)	⌀100 (⌀3.9370)		+0.250 (+0.0098) +0.050 (+0.0020)	0.07 (0.003) \ 0.27 (0.011)			
C	Boom cylinder (Rod side)	⌀110 (⌀4.3307)						
E	Arm cylinder (Head side)		−0.070 (−0.0028) −0.180 (−0.0051)		0.12 (0.005) \ 0.36 (0.015)			

(2) Thrust-wise clearance between boom and cylinder mounting

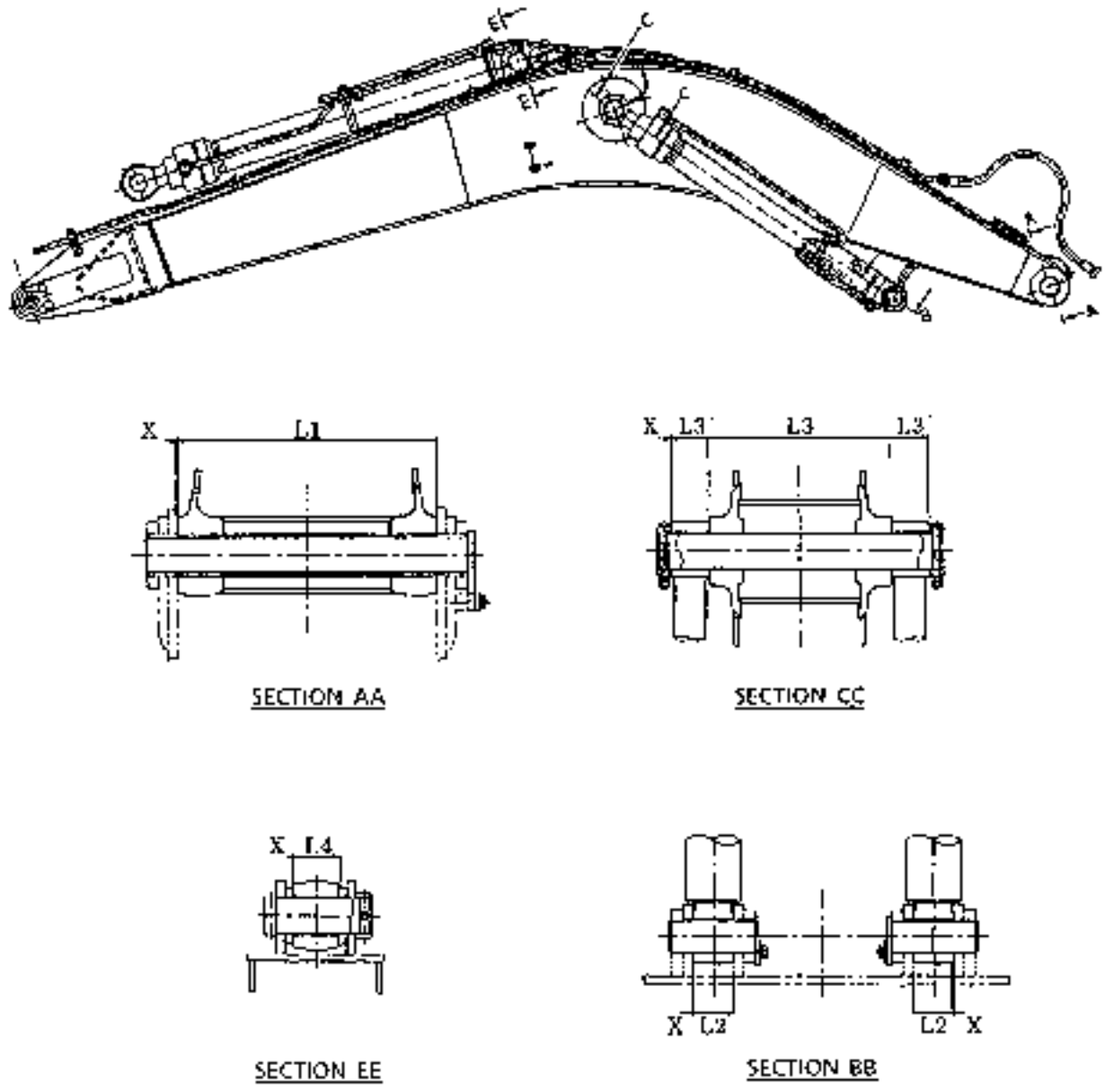


Fig. 14 Thrust-wise clearance between boom and cylinder mounting

Table 5

Unit : mm (in)

Section	Item		Standard dimension		Shim adjusted clearance X (total of both sides)			Remedy
			Code	Dimension	Standard value	Reference value for remedy	Serviceability limit	
A	Boom foot	Boom	L1	830 $^{0}_{-0.5}$ (32.677 $^{0}_{-0.020}$)	Less than 0.6 (0.024)	2.5 (0.098)	3.0 (0.118)	Shim adjustment
		Upper frame		832 $^{+0.5}_{+0.2}$ (32.756 $^{+0.020}_{+0.008}$)				
B	Boom cylinder (Head side)	Boom cylinder	L2	130 $^{0}_{-0.5}$ (5.118 $^{0}_{-0.020}$)				
		Upper frame		131 $^{+0.5}_{+0.2}$ (5.157 $^{+0.020}_{+0.008}$)				
C	Boom cylinder (Rod side)	Boom cylinder	L3'	120 $^{0}_{-0.5}$ (4.724 $^{0}_{-0.020}$)	Less than 1.2 (0.047)	3.0 (0.12)	4.0 (0.16)	
		Boom	L3	581 (22.874)				
E	Arm cylinder (Head side)	Arm cylinder	L4	140 $^{0}_{-0.5}$ (5.512 $^{0}_{-0.020}$)	Less than 0.6 (0.024)	2.5 (0.098)	3.0 (0.118)	
		Boom		142 $^{+0.7}_{+0.2}$ (5.591 $^{+0.028}_{+0.008}$)				

4. HYDRAULIC CYLINDER

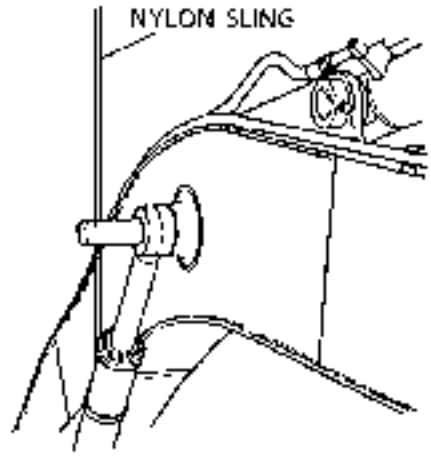
4.1 DISMANTLING AND MOUNTING HYDRAULIC CYLINDER

(1) Dismantling hydraulic cylinder

1) Lift the cylinder lightly so the rod side pin is not loaded.
   Then remove the rod side pin and the shims.
   But, when it is difficult to remove the rod side pin of the boom cylinder, firstly remove the head side pin by referring to 4) which will be described later.
   Put a tag to each of the shims showing location or attach each shim to its removed position by means of a string.
2) Retract the cylinder rod.
3) Disconnect the joints of the hydraulic hoses and plug those joints to prevent entry of foreign matter.
4) Lift the cylinder lightly so the head pin is not loaded.
   Then remove the head pin and the shim.

(2) Mounting hydraulic cylinder

1) Mounting the hydraulic cylinder is performed in the reverse order of dismantling.
2) Adjust the clearance in the thrust direction between the rod and head pin mount, using iron shims, so that the clearance falls within the standard dimension.
3) Before inserting pins, coat the shaft with grease.
4) Coat the pin locking capscrew and the nut with Locktite #242 and set the gap between the tip of the capscrew and the nut face to less than 0.5mm (0.02in)
   : 30mm



YH-ET4

Fig. 15 How to dismantle and mount boom cylinder

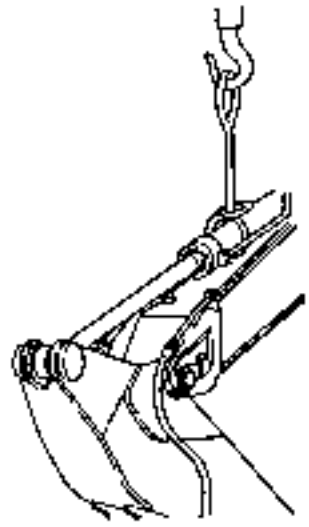


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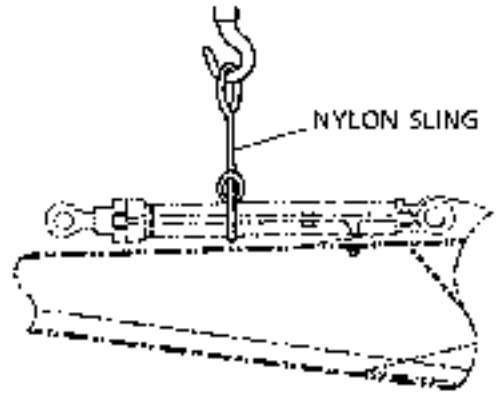
Fig. 16 How to dismantle and mount arm cylinder



YH-ET4

Fig. 17 How to dismantle and mount bucket cylinder

Book code No. SSLC2205E

KOBELCO

SHOP MANUAL

SK310 SK310LC

CONTROL SYSTEM

TABLE OF CONTENTS

LC22

KOBE STEEL, LTD.

Applicable Machines

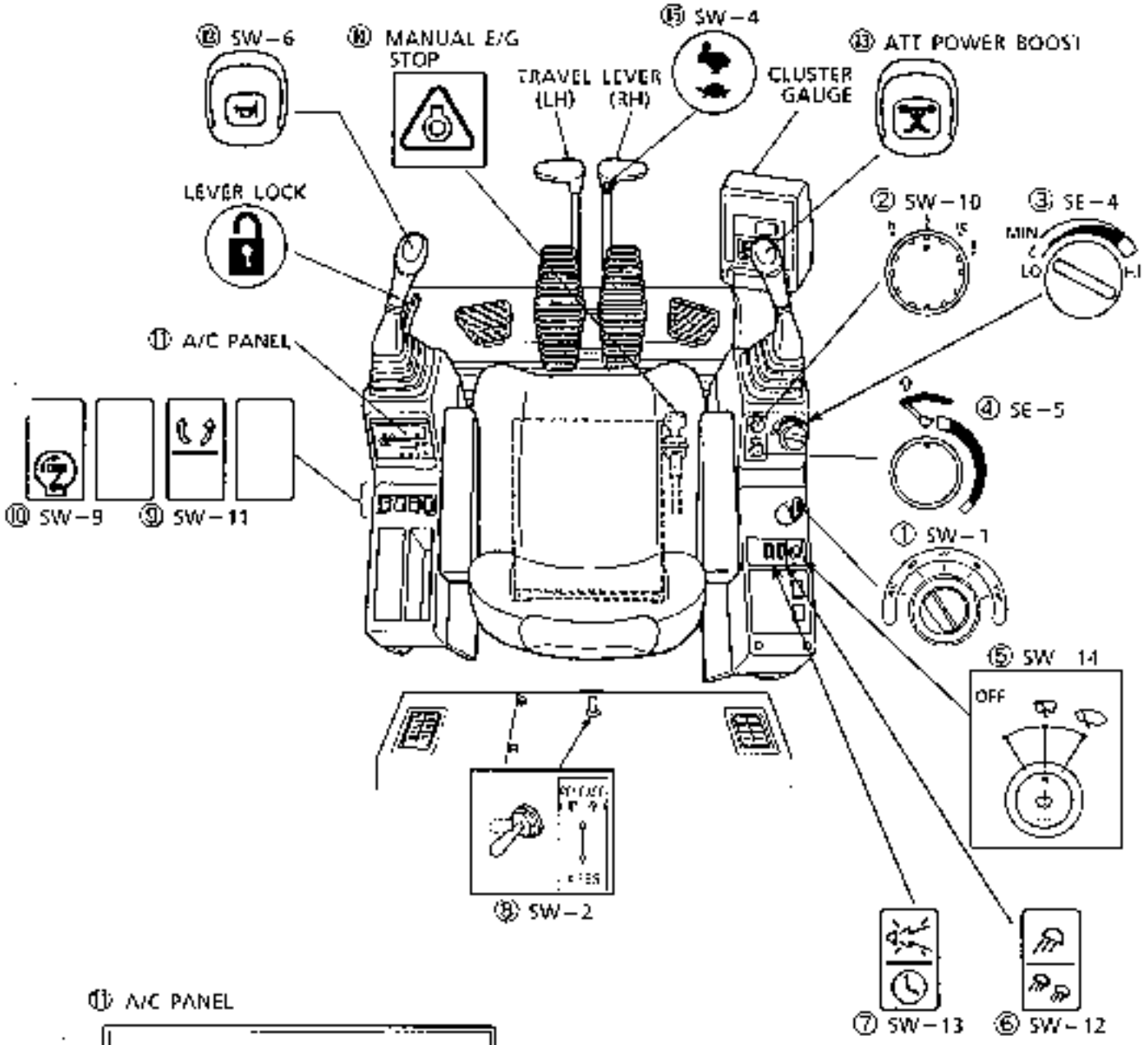
LC03801~

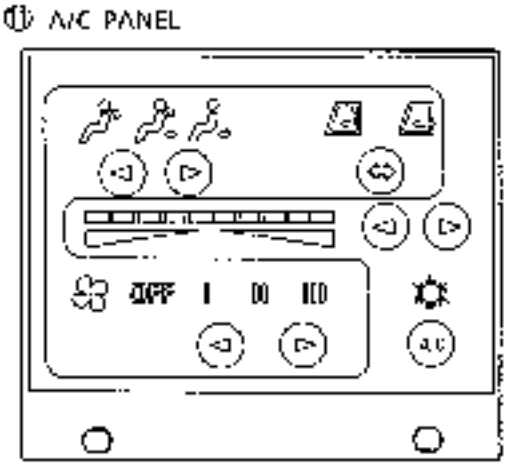
YC01101~

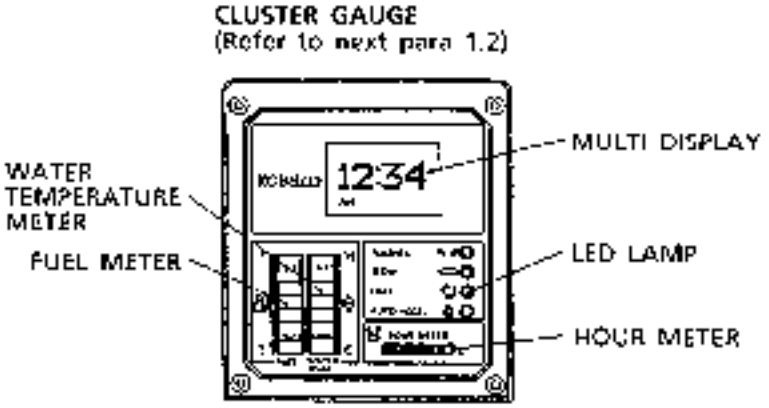
Revision	Date of Issue	Remarks
First relation	March, 1995	S5LC2206E K

1. OPERATING CONTROLS

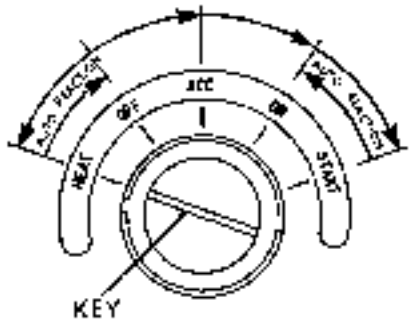
1.1 OPERATING SWITCHES OF CONTROL BOAD





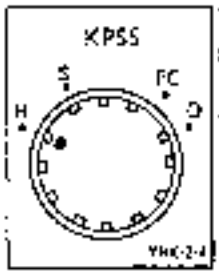


(1) Starter key switch



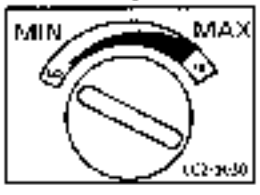
HEAT ; No function (Use other injection switch)
OFF ; E/G stop position
Key pull out position
ACC ; Accessory usable position
Cigarette lighter
12V socket
ON ; E/G running position
START ; E/G start position

(2) K.P.S.S. work mode switch



H ; For heavy digging operation.
S ; For light duty operation.
FC ; For fine manipulation.
D ; Independent travel.

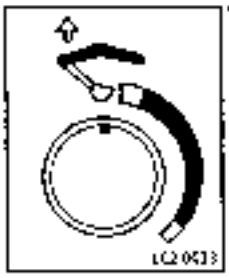
(3) Accel potentio meter



LO ; Low idling
(Minimum revolution)

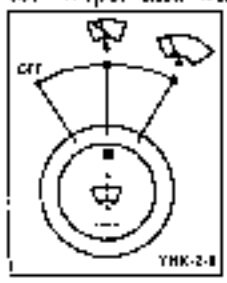
HI ; High idling
(Maximum revolution)

(4) Variable loading mode switch



This variable speed switch allows the operator to adjust the raise speed of the boom in relation to the swing speed when these functions are performed at the same time. If the dial is turned clockwise, the speed of the boom is decreased while the swing speed is increased. Turning the dial counterclockwise, increases the speed of the boom and decreases the swing speed. This allows you to adjust the boom and swing speeds to match your needs

(5) Wiper and washer switch)



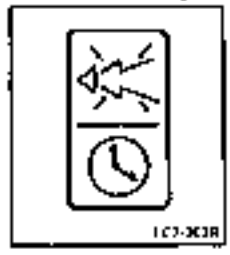
OFF ; Wiper switch off
One notch ; Intermittently
Two notch ; Continuously
Press ; Washer fluid sprays out

- Do not press the switch if the washer fluid is empty. Otherwise the motor may be damaged.
- The washer tank is located at the lower right-hand side of the floor mat by the operator's seat.

(6) Working light F/R select switch

- Boom & Frame working light
- OFF
- Boom & Frame & Rear working light

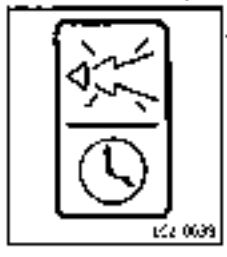
(7) Buzzer stop/Time set (Oil supply reset) switch



- Buzzer stop
- OFF
- Time set

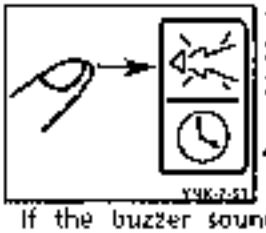
1) Buzzer sound included next function
- E/G Oil pressure
- E/G Air filter restriction
- E/G Water temperature
- E/G Oil filter restriction
- Time correct (Every 250Hr E/G oil)

2) Buzzer stop / Time set / Oil change reset switch



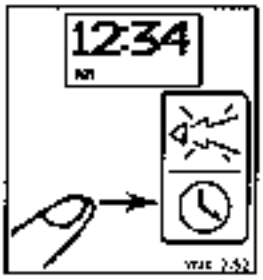
BUZZER STOP
pressing the top of the switch will turn OFF the buzzer on the instrument panel.

NOTE : The buzzer sounds under the following conditions;



1. Air cleaner clogged
2. Oil level low
3. Abnormal rise in coolant temperature
4. Engine oil change reminder

If the buzzer sounds, then inspect and correct any problems that may exist.



TIME SET

Pressing and holding the bottom of the switch will change the reading of the clock display.

OIL CHANGE RESET

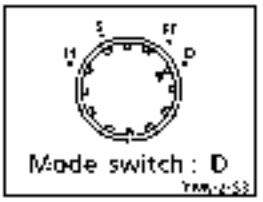
At a regular 500 hour interval the gauge cluster will display a reminder to change the engine oil

The buzzer will also sound.

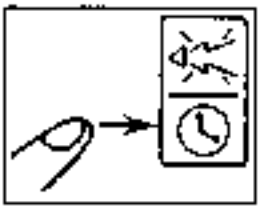
Change the engine oil at this time.

NOTE :

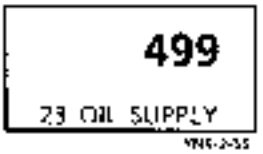
- **To remove the display and to stop the buzzer, press the top of the buzzer stop switch two times.**
- **If you want to change your engine oil at an interval of less than 500 hours, then you can reset the reminder through the Following procedure**



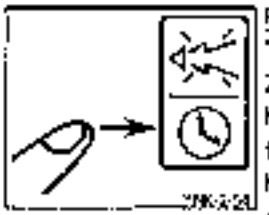
1. Turn the work mode selector switch to the "D" mode.



2. Press the bottom of the buzzer stop switch and the gauge cluster will display the number of hours your machine has operated since the last oil change.

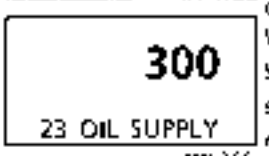


3. The oil change reminder will be displayed only at the 500 hour interval, so to receive the reminder sooner, you must make the gauge cluster believe that 500 hours have elapsed.

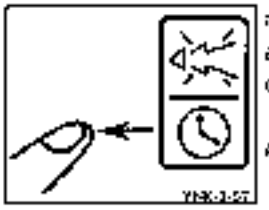


FOR EXAMPLE

To reset the reminder to a 200 hour interval; press and hold the buzzer stop switch for 30 seconds, the elapsed hours display will begin to count upwards automatically

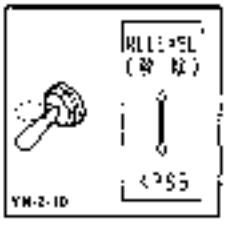


When you reach the 300 hour mark, then release the switch. The gauge cluster will now believe that 300 hours have elapsed, and the reminder will be displayed after 200 more hours of operation. (300 + 200 = 500)



4. The oil change reset procedure must be performed each time after the reminder is displayed. (If you want an interval of less than 500 hours)

(8) K.P.S.S work mode release switch

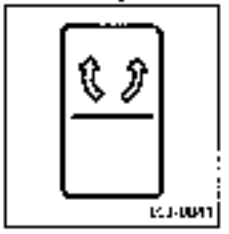


RELEASE ; S mode E/G rpm in CPU trouble

KPSS ; Normal operation

⚠ ● Remove the rubber cap but do not touch this switch unless CPU trouble is displayed.

(9) Swing flasher select switch



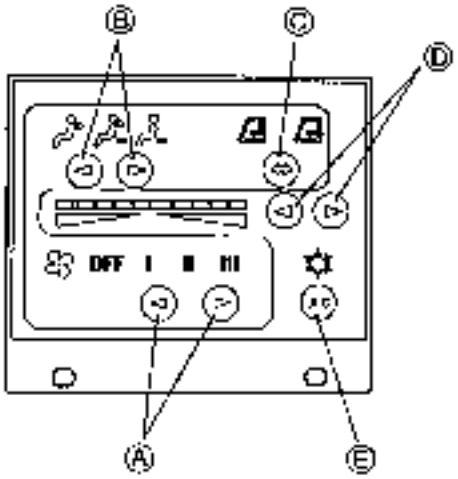
- Swing flashers light in Swing operating
- Swing flashers do not flash

(10) Auto accel select switch

ON ; E/G auto accel in operating lever and neutral lever continues for four seconds E/G decel revolution

OFF ; Auto accel released position

(11) Air conditioner



Ⓐ FAN SWITCHES

The switches control the air conditioner ON/OFF function and the blower speed.

I position ..... Low
II position ..... Medium
III position ..... High (Maximum)

Ⓑ AIR VENT SELECTION SWITCH

These switches control the open/close position of each air vent. Select the desired air flow mode from the three mode position. The selected position is always shown by a lamp.

Ⓒ AIR INLET SELECTION SWITCH

This switch selects the open or close position of air inlet.

Ⓓ TEMPERATURE CONTROL SWITCHES

These switches control the temperature of air coming out of the air vents to any of five levels during heating (red lavel) and cooling (blue lavel).

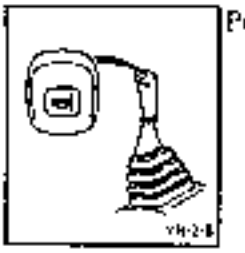
1) Push the right switch (⊖), and the range of the LED lights decrease and the air temperature goes down.

2) Push the left switch (⊕), and the range of the LED lights increase and the air temperature goes up.

Ⓔ AIR CONDITIONER SWITCH

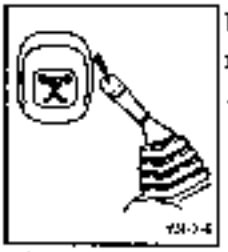
This is used to turn ON and OFF the cooling function during cooling or dehumidification heating, or while the cool box is being used.
Push once to change over from ON/OFF to OFF/ON.
When the switch is turned ON, the ✡ lamp on the upper part of the switch lights up.

(12) Horn switch



Push on horn mark

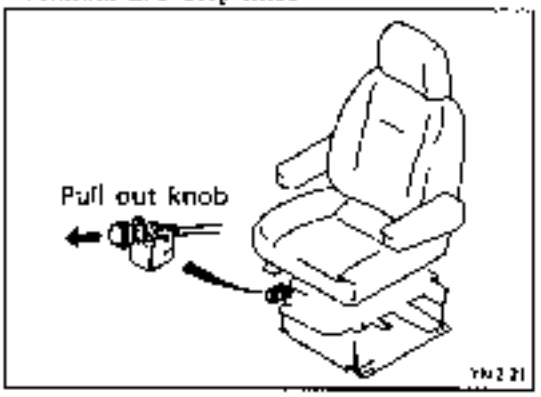
(13) Power boost switch



During pushing on power boost mark digging force increases 12%

⚠ Never use power boost switch during lifting operations. Unexpected implement speed changes could result in injury to personnel.

(14) Manual EG stop knob



⚠ Only use to stop the engine in an emergency

(15) Travel speed select switch

- High speed Max. 5.5km/h
- Low speed Max. 3.5km/h

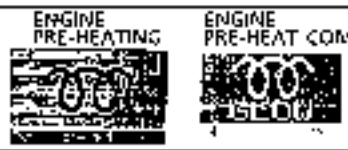
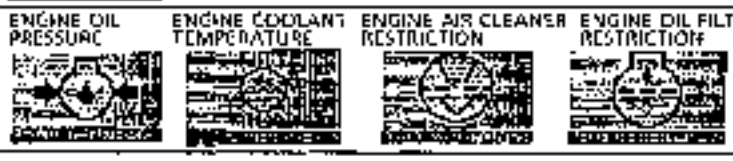
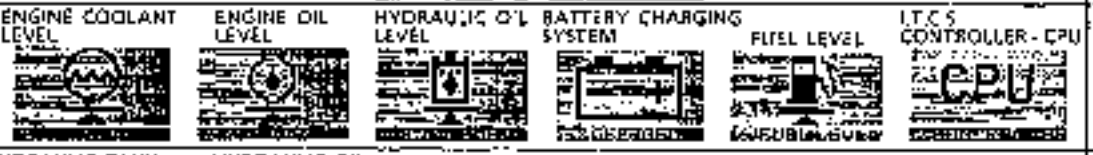
1.2 DISPLAY FUNCTION

(1) OK MONITOR FUNCTIONS BY MULTI DISPLAY

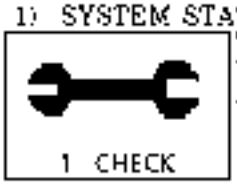
Priorities given to displays are as listed in Tables. Displays with higher priorities are displayed first. For instance, if the engine oil pressure (priority 3) and the fuel level (priority 5) are both abnormal, the engine oil pressure alarm having a higher priority is displayed. Where alarms of equal priority, the radiator water level and the engine oil level faults occur, for instance the radiator water level alarm and the engine oil level alarm displayed in sequence.

PRIORITY DISPLAYS TABLE

Table 1

Priority	Service diagnosis function	Buzzer
1		—
2		—
3		Buzzer
4		—
5		—
		—
6		—
7		—
8		—

12) SYSTEM
● NG DISPLAY ON MULTI DISPLAY
1) SYSTEM STATUS DISPLAY



This symbol is displayed when the controller for the clusters gauge and warning lamp. Monitoring system is not functioning properly.

2) SYSTEM STATUS DISPLAY

This symbol is displayed if all systems and components are normal.

3) ENGINE PRE-HEATING

This symbol is displayed when key switch is turned to heat position and the engine preheat circuit is activated.
This display lasts about 25 seconds and then goes out at completion of pre-heating, at which time GLOW is displayed.

4) ENGINE PRE-HEAT COMPLETE

This symbol is displayed when engine pre-heating is complete.

⚠ Stop preheating immediately after preheat complete is displayed to prevent damaging the air heater.

5) ENGINE OIL PRESSURE

This symbol is displayed, and the warning buzzer is sounded, when engine oil pressure is too low. Stop the engine immediately and check the engine oil level.

6) ENGINE COOLANT TEMPERATURE

This symbol is displayed, and the warning buzzer is sounded, if the engine coolant temperature becomes abnormally high. If this symbol is displayed, reduce engine speed to idle until the coolant temperature is reduced.

7) ENGINE AIR CLEANER RESTRICTION

This symbol is displayed, and the warning buzzer is sounded, if the engine air cleaners become too restricted to allow proper air flow.
Replace or clean the air cleaner if this symbol is displayed.

8) ENGINE OIL FILTER RESTRICTION

This symbol is displayed, and the warning buzzer is sounded, if the engine oil filter becomes too restricted due to contamination
This symbol is only displayed when the alternator is charging.
If this symbol is displayed,replace the engine oil filters immediately.

9) 10) 11) NO FUNCTION

12) ENGINE COOLANT LEVEL

This symbol is displayed when engine coolant level is low. This is only shown when key switch is turned to the ON position, before engine startup.
If this symbol is displayed, check radiator and surge tank coolant levels

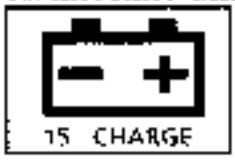
13) ENGINE OIL LEVEL

This symbol is displayed when engine oil level in the engine oil pan is low. This symbol is only shown when the key switch is turned to the on position, before engine start up. This symbol will not display if the alternator is charging and engine oil level drops during operation. If this symbol is displayed, check engine oil level immediately before starting engine.

14) HYDRAULIC OIL LEVEL

This symbol is displayed when hydraulic oil level is low. The attachment must be in the proper check position to accurately determine hydraulic oil level. If this symbol is displayed, place machine in proper check position, verify with hydraulic tank sight gauge, and add oil if required.

15) BATTERY CHARGING SYSTEM



This symbol is displayed when a problem occurs in the electrical charging system during engine operation. A problem occurs in the charging system.

16) FUEL LEVEL

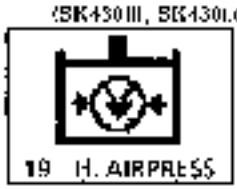
This symbol is displayed when the fuel level in the fuel tank has reach 50ℓ 13.2 gallons or less.
It also will be displayed if fuel level drops to a low level during operation. Add fuel if this symbol is displayed

17) I.T.C.S. CONTROLLER-CPU

This symbol is displayed when a problem exists with the I. T. C. S.-Intelligent Total Control System. This display will indicate a problem with the main I.T.C.S. Controller-CPU.
The CPU programing may just be temporarily out of order if this symbol is displayed, try turning off the key switch and back to the ON position. If machine operation is necessary, turn the KPSS release switch to the release position and machine operation will be possible until repairs can be completed.

18) NO FUNCTION

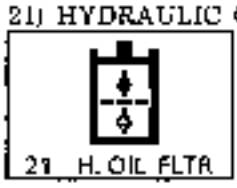
19) HYDRAULIC TANK AIR PRESSURE
(SK430III, SK430LcIII ONLY)



This display occurs when the inner air pressure of the hydraulic tank is below 0.25kgf/cm² (3.6psi). Machine operation is not possible when this display is ON. If this symbol is displayed, contact your authorized KOBELCO Dealer Service Dept.

20) NO FUNCTION

21) HYDRAULIC OIL FILTER



This symbol is displayed when the hydraulic oil filters are clogged and the hydraulic oil temperature is normal. Replace the filter elements. Examine the filters for the cause of the contamination.

22) ATTACHMENT BOOST PRESSURE

This symbol is displayed when the attachment power boost switch in the right operating lever button is pushed.
The symbol displayed is only to show when this system is activated. no problem exists when this symbol appears.

23) REPLACE ENGINE OIL

This symbol is displayed every 250 hours of machine operation time. It appears every 250 hours to remind the operator that the engine oil needs changed.

- Replace the engine oil filter elements at the same time
- To reset this display, press buzzer stop switch twice.

24) ENGINE STOPPED

If engine oil pressure is not correct for three seconds during engine running, or 13 seconds after starting of engine rotation, the engine is automatically stopped.
On that occasion, the display on the left appears followed by a circle ⓪. The display continues for about ten seconds, and during this period the engine can not be restarted.
Check the engine oil level and for oil leakage.

25) STEPPING (GOVERNOR) MOTOR FAIL

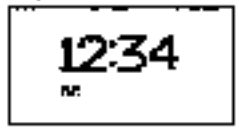
This symbol is displayed when a problem exists in the electrical circuit for the E/G accel stepping motor assy (governor motor).
The symbol will be displayed when the stepping motor does not automatically index, or move, the engine throttle back to its starting point within 40 seconds after turning the key switch off and then back on. If the stepping motor does not index back to the starting point, it indicates a possible failure of the stepping motor limit switch or a fault in the wiring harness. When the motor fail symbol is displayed, engine throttle control via the mechatronics system and stepping motor will not be possible. The engine accel potentio can be positioned manually to allow machine operation. The manual engine stop knob must be used then to shut down the engine. The following functions do not work when the motor fail symbol is displayed:

1. KPSS mode selection-H, S, FC, and B modes
2. Auto accel
3. Engine shut down via the key switch
4. Variable loading mode

26) STEPPING (GOVERNOR) MOTOR OFF

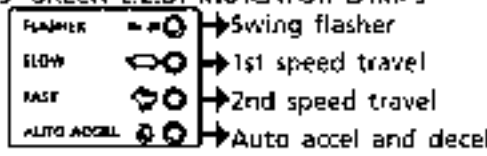
This symbol is displayed when the electrical current to the stepping motor is stopped. The current supply is stopped if less than 1amp or more than 2amps is supplied to the stepping motor the coil for more than 13 seconds after the stepping motor fails to index, or move, back to the starting point. The current supply to the stepping motor is also stopped if 6amps or more is supplied for 3 seconds. If this button condition occurs, turn off key switch to prevent damage to the controller.

27) TIME DISPLAY



This mark is indicated for items to which no specific mark is assigned.
The normal mark when the key is on. It is displayed about two seconds after the OK monitor mark disappears.

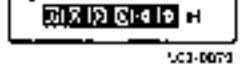
1.3 GREEN L.E.D. INDICATOR LAMPS



⚠ The swing flasher L.E.D. flashes when swing is engaged the swing flasher switch is on. If a swing flasher bulb is burnt out the swing flasher L.E.D lamp will stay on steady.

● GAUGE

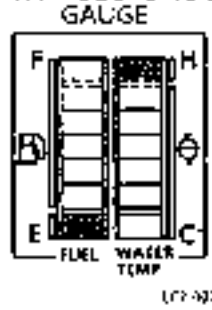
28) HOUR METER



H indicates cumulative operating hours of the engine.

The last two digits indicate 1/10H and 1/100H, respectively.

1.4 FUEL GAUGE AND WATER TEMPERATURE GAUGE

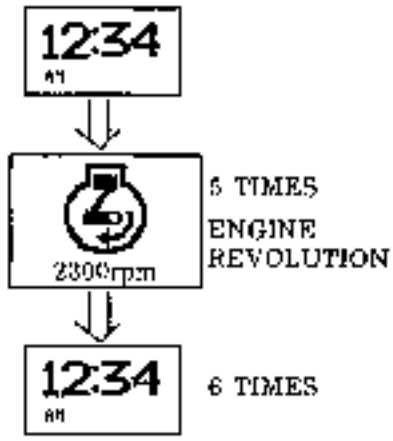


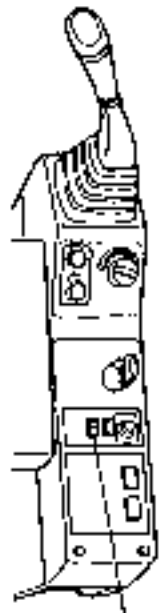
Fuel gauge
····· The fuel level is indicated by the position of the indicator lights.
Water temp. gauge
···· A water temperature range of 62~105°C (144°~221°F) is indicated by the position of the indicator lights.

(3) ENGINE REVOLUTION DISPLAY

The multipurpose display can display the engine revolution.

1) Press buzzer stop switch 5 times to display the engine speed.
2) By pressing one more time, the display changes to CLOCK.
3) And by pressing the switch one more time the engine revolution is displayed.
4) Then repeat this procedure.





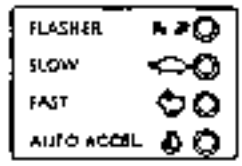
BUZZER STOP SWITCH

(4) SERVICE DIAGNOSIS (By auto accel lamp)

The service diagnosis of mechatronics system can be performed by checking the flickering condition of auto accel lamp.

1) Engine start
2) By continuously pressing the buzzer stop switch, the failure contents are displayed with flickering of lamp on and after 6 of 10 seconds.
3) If the lamp is continuously lit, the operation is normal.
4) The lamp goes off by releasing the switch.

And in case failures simultaneously occur on two or more places, the flickering of lamp will be continued.



AUTO ACCEL LAMP

SERVICE DIAGNOSIS TABLE

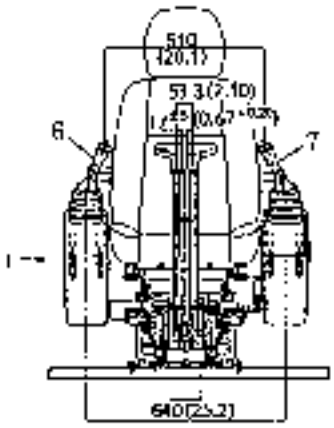
Table 2

Code	Contents	Lamp ON / OFF state table ■ ON □ OFF	Checking and corrective action
0	Engine stops or the speed is less than 420rpm.		Check the wiring up to the revolution sensor.
1	Error data or not adjusted in ROM.		Perform A adjustment and B adjustment.
2	In indexing stepping (governor) motor starting point or impossible to index		Check the stepping (governor) motor limit switch and also the wiring.
3	Judged engine rotates in reverse direction.		Check (1) oil pressure switch, (2) water temperature switch and wiring
4	Failed to adjust the mechatronics controller.		Perform A adjustment and B adjustment.
5	Incorrect current applied to solenoid valve (Power shift) (Load mode)		Check the wiring up to the solenoid valve.
6	Incorrect current on stepping motor (Less than 1A or 2A or more)		Check the wiring up to the stepping motor.
7	Stepping (governor) motor abnormally rotated		Check the mounting state of stepping motor, link, rod, etc.
	In normal state		

0.32sec.

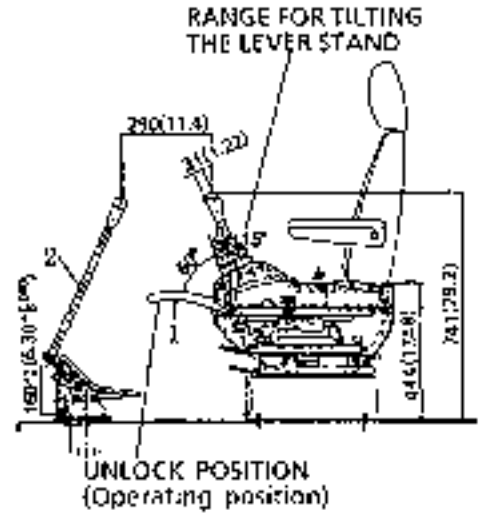
5.12sec.

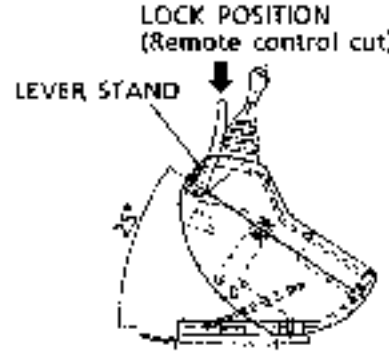
1.3 CONTROL LEVER OPERATION

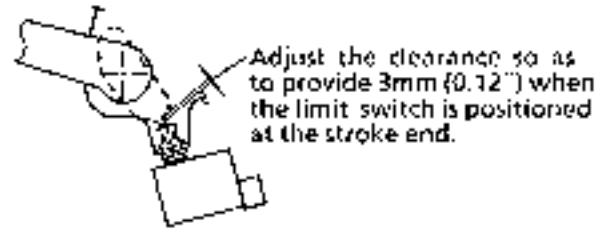


(1) Lever Lock (Remote Control Cut Lever) Operation.
If the rod lever of lever lock (1) is pulled up, the limit switch is turned off. This cuts off the lever lock of the electromagnetic selector valve electrically which cuts off the primary pilot pressure of the remote control valve of the attachment. This serves as a safety unit that does not actuates the machine by lever action. Furthermore, if the lever is pulled up jerkily, the striker is disengaged which in turn causes the control box to spring up 25°, thereby making access to the machine easier.

(2) Travel Operation
Traveling forward means where the forward movement of the front idler of lower travel body accords with the forward direction of the operator :
Lever (2) push forward — Advance
Lever (2) pull toward yourself — Retreat
However, Where the moving direction of the front idler of the lower travel body does not accord with the forward movement of the operator, the lever operation must be reversed.



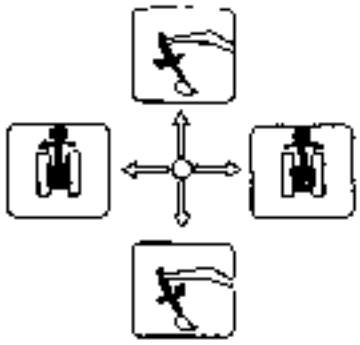
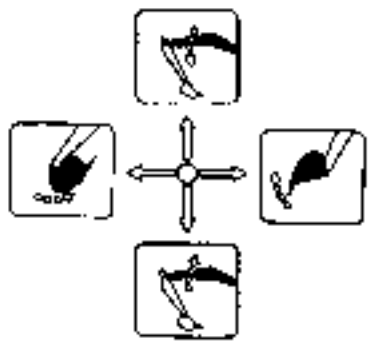




Procedure for adjusting the limit switch

Fig. 2

(3) Attachment Operation (ISO operating method)

LEFT OPERATING LEVER (7)	RIGHT OPERATING LEVER (6)
	
Arm and swing lever	Boom and bucket lever

1.4 ENGINE CONTROL

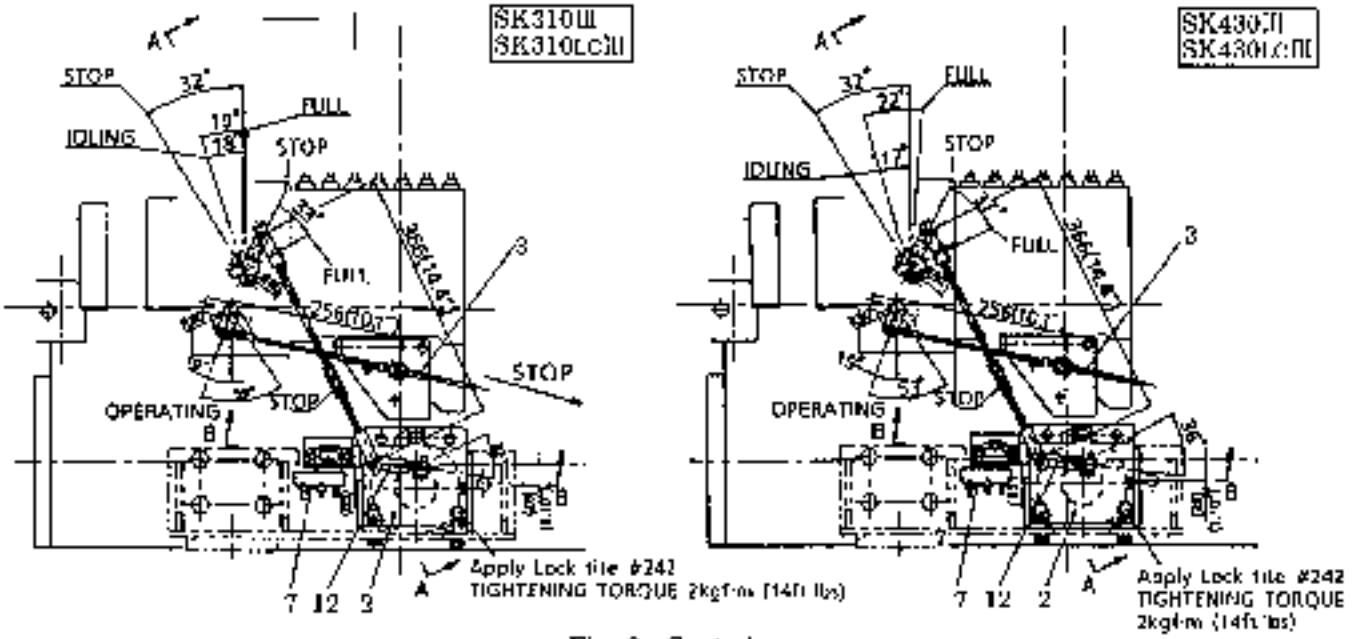


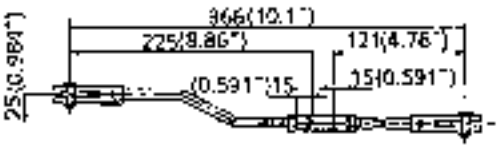
Fig. 3 Control

(1) Starting and Stopping the Engine
(Refer to Operation of Switches.)
The engine can be started and stopped with the engine key.
To start the engine, turn the engine key to START. Let your hand off from the key after the engine starts.
To stop the engine, turn the engine key to OFF. The engine stops about four seconds later.

(2) Engine Revolution Control
(Refer to Operation of Switches.)
The accel potentiometer which is of dial rotary switch type holds a set revolution.
The operating sequence is: Change the rotary switch. → Electric resistance of potentiometer changes. → Controller → Governor motor (2) (accelerator) Control → Governor lever (12) rotates → Rod end assy operates. → E/G governor control → E/G revolution changes.

(3) Auto Accel Control
(Refer to Operation of Switches.)
When the auto accel select switch is on, a set decel revolution and a set rotation time of the accel potentiometer are repeated, depending upon whether or not the auto accel is neutral.

(4) Manual Engine Stop (3)
Pull manual engine stop knob.
——Engine stops.
Return manual engine stop knob
——Returns after engine stops.
In case the engine does not stop even if the engine key is brought to OFF, pull the manual engine stop knob located under the lower righthand side of the seat stand. This pulls the engine stop lever directly to the stop side, consequently stopping the engine.



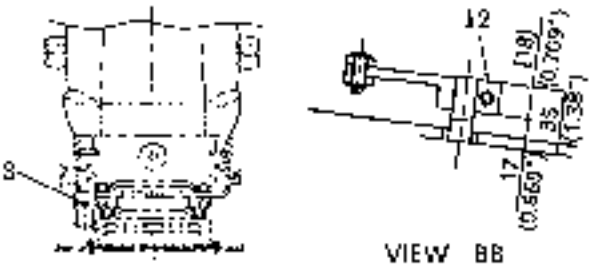


Fig. 4 Operator seat

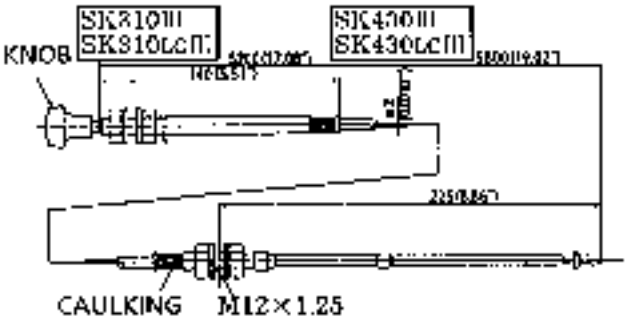


Fig. 5 Detail of emergency E/G stop knob control cable (3)

2. MECHATRONIC CONTROL

2.1 KPSS CONTROLLER (C – 1)

(1) Mechatronic Adjustment

Where any of the components listed in the table below is replaced, always perform Mechatronic Adjustment A or B. (marked ○)

Parts to be replaced	Adjustment A	Adjustment B
Mechatronic controller	○	○
Governor motor	○	—
Solenoid proportionate reducing valve for loading mode	—	○

Conditions Common to Mechatronic Adjustments A and B

Keep the engine key OFF when turning the controller switch in the mechatronic controller (C – 1) to either Adjust Prohibit or Permit.

If you turn the controller switch to Permit and turn the engine key to ON, the auto accel lamp lights continuously. After confirming that the lamp is on, execute the following steps:

1) Adjustment A (Setting E/G revolution)
Refer to Maintenance Standard and Test procedure.

2) Adjustment B (Set the loading mode).
Refer to Maintenance Standard and Test procedure.

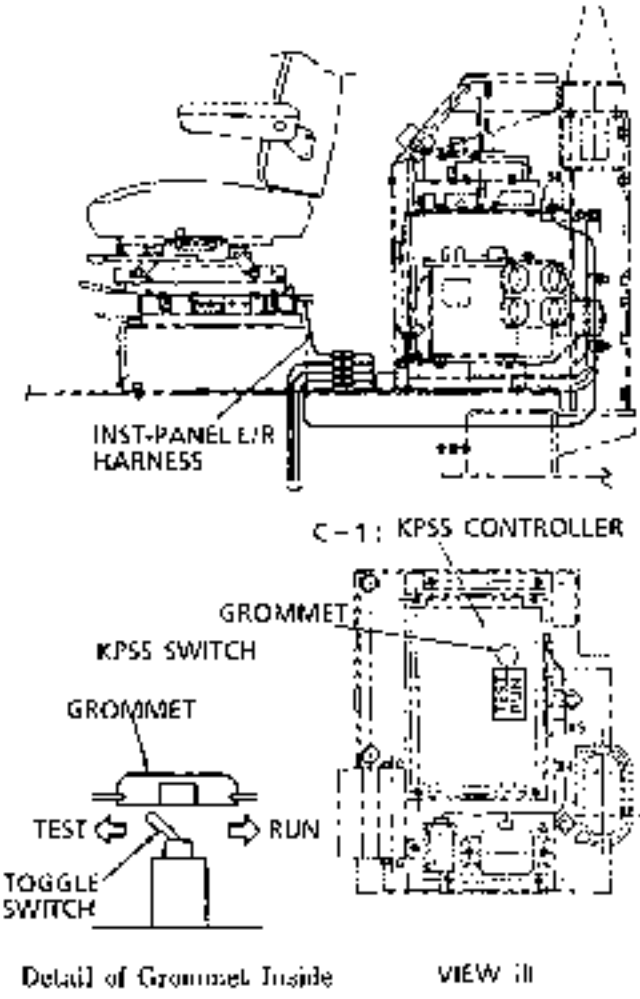
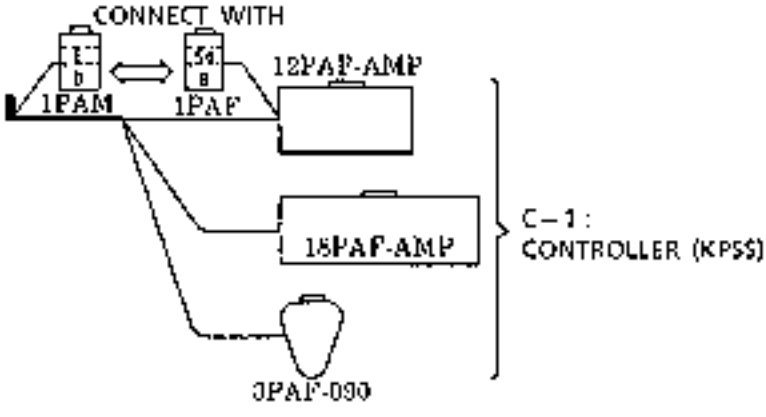


Fig. 6 Mounting position of mechatronic controller (C – 1)

(2) Harness



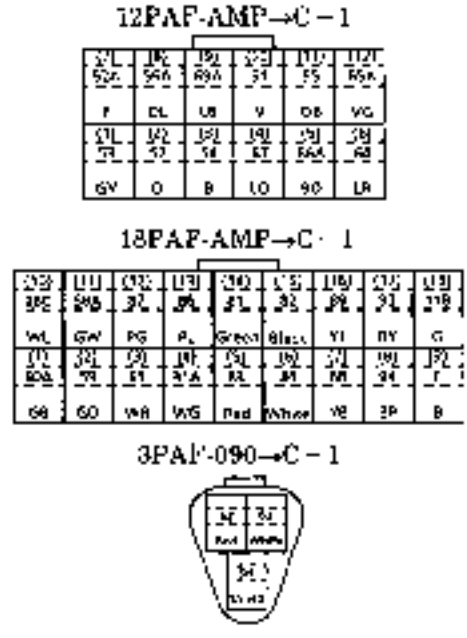


Fig. 7 C – 1 Controller harness and connector
However, see the connector from the engaged surface.

(3) Mechatro (KPSS) Controller IN/OUT Diagram :N

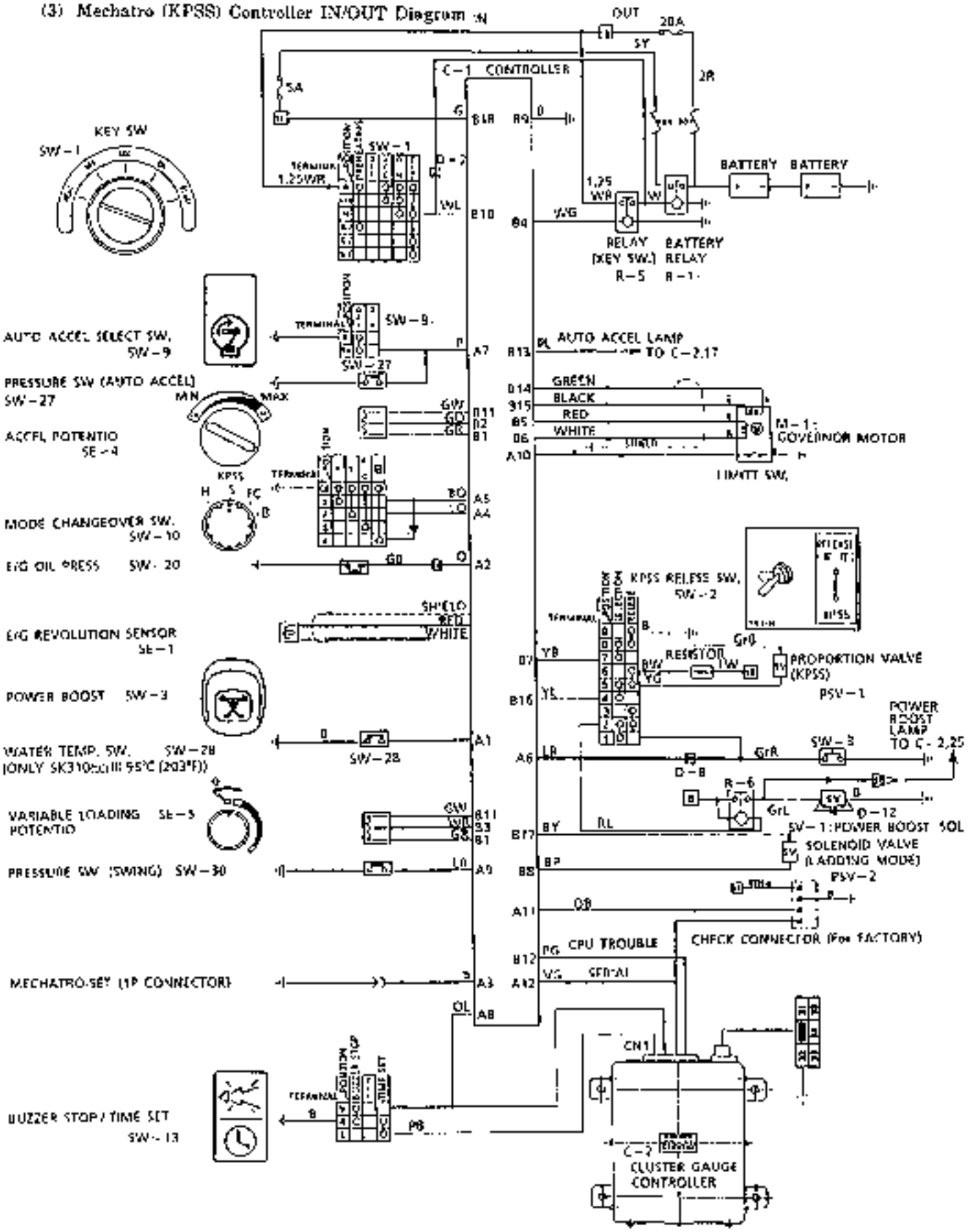
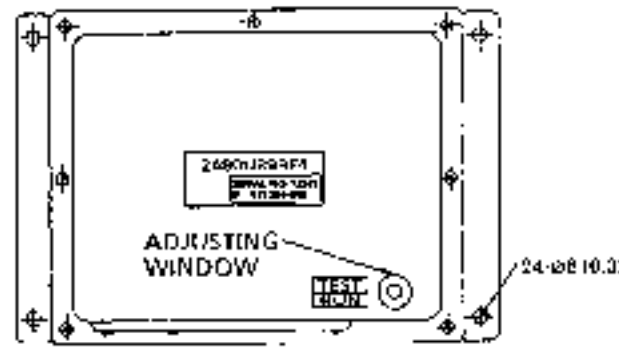


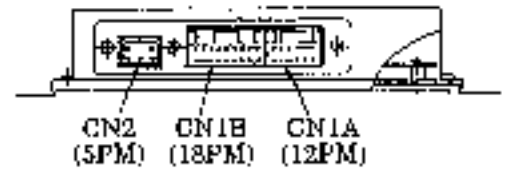
Fig. 8

(4) KPSS Controller and I/O Signals

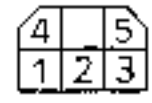
No.	Wire color	Signal Name	In / Out
A 1	GY	Radiator coolant temperature signal	In
A 2	O	E/G oil pressure	In
A 3	B	Mechatronics adjustment start signal	In
A 4	LO	S mode signal	In
A 5	BO	H mode signal	In
A 6	LR	ATT boost signal & Heavy lift signal	In
A 7	P	Auto accel signal	In
A 8	OL	Buzzer stop signal	In
A 9	LB	Slewing pressure signal	In
A 10	V	Stepping (governor) motor (Starting point of limit switch)	In
A 11	OB	Cluster gauge receiving (Serial communication)	In
A 12	VG	Cluster gauge sending (Serial communication)	Out
B 1	GR	Throttle and Loading (Potentiometer power source ⊕)	Out
B 2	GO	Throttle lever position signal	In
B 3	WR	Loading mode position signal	In
B 4	1.25WG	Battery relay drive signal	Out
B 5	Red	Stepping motor coil B phase	Out
B 6	White	Stepping motor coil B phase	Out
B 7	YR	KPSS release solenoid valve grounding ⊖	Out
B 8	BP	Loading mode solenoid valve grounding ⊖	Out
B 9	B	Controller grounding ⊖	Out
B 10	1.25WL	Key switch (M) terminal signal	In
B 11	GW	Throttle and Loading (Potentiometer grounding ⊖)	In
B 12	PG	Cluster gauge signal (CPU trouble)	Out
B 13	PL	Cluster gauge signal (Auto accel)	Out
B 14	Green	Stepping motor coil A phase	Out
B 15	Black	Stepping motor coil A phase	Out
B 16	YL	KPSS release solenoid valve power source ⊕	Out
B 17	BY	Loading mode solenoid valve power source ⊖	Out
B 18	G	KPSS controller power source ⊕	In



KPSS CONTROLLER CONNECTOR AND I/O SIGNALS



CN 1B (18 PAM)									CN 1A (12 PAM)					
18	17	16	15	14	13	12	11	10	⑫	⑪	⑩	⑨	⑧	⑦
9	8	7	6	5	4	3	2	1	⑥	⑤	④	③	②	①



Connector CN2

CN2

No.	Wire color	Signal Name	In / Out
C 1	Red	Revolution sensor	Out
C 2	White	Revolution sensor	In
C 3	Gr-R	Shield ⊖	In
C 4	—	—	—
C 5	—	—	—

(5) Controller Resistance Value Measuring Procedure

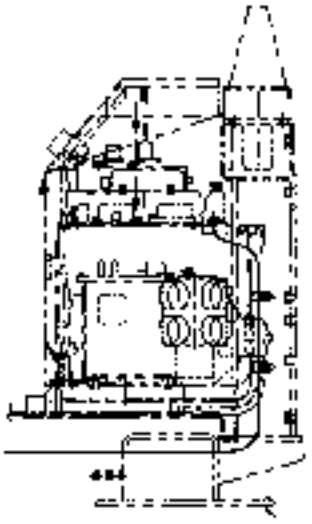
After replacing controller, check the resistance value without fail before turning it on again

After turning key switch OFF, remove the CN1B and perform measurement on the harness side.

	(Standard value)	(Situation at 0Ω)
CN1B Between 1 and 11	1KΩ	(Potentiometer / Short circuit)
CN1B Between 1 and 9	1MΩ or more	(Potentiometer / Grounding)
CN1B Between 4 and 9	250Ω (~100Ω)	(Relay / Grounding)
CN1B Between 5 and 6	5.7Ω±10%	(Stepping motor / Short circuit)
CN1B Between 14 and 15	5.7Ω±10%	(Stepping motor / Short circuit)
CN1B Between 5 and 9	1MΩ or more	(Stepping motor / Grounding)
CN1B Between 14 and 9	1MΩ or more	(Stepping motor / Short circuit)
CN1B Between 7 and 16	13.5Ω±0.7Ω	(Solenoid valve / Short circuit)
CN1B Between 8 and 17	13.5Ω±0.7Ω	(Solenoid valve / Short circuit)
CN1B Between 7 and 9	1MΩ or more	(Solenoid valve / Grounding)
CN1B Between 8 and 9	1MΩ or more	(Solenoid valve / Grounding)
CN1B Between 18 and 9	4Ω	(Power source / Grounding)

2.2 CLUSTER GAUGE CONTROLLER (C−2)

(1) Location of controller



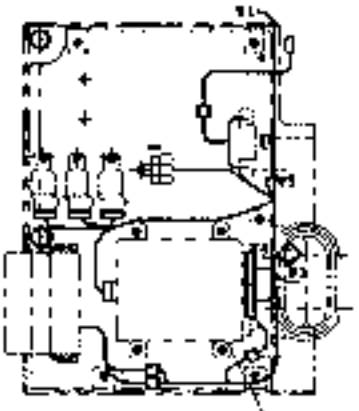


Fig. 10 Fitting place of controller (C−2)

(2) Harness

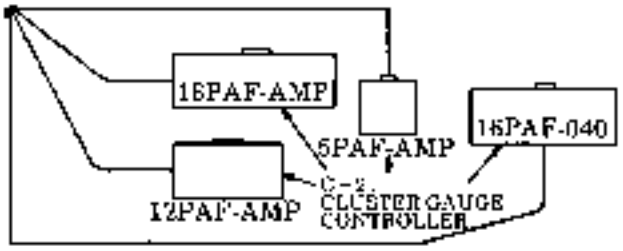


Fig. 11 C−2 Controller harness

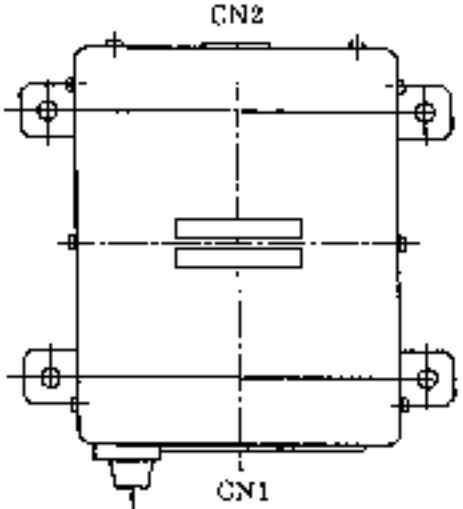
16PAF-040→C-2

208	207	206	205	204	203	202	201
G	Y	BL	O	BG	L	R	BW
216	215	214	213	212	211	210	209
W	GR	BR	BW	VW	V	LB	I

CN2

16	15	14	13	12	11	10	9
8	7	6	5	4	3	2	1

CN2

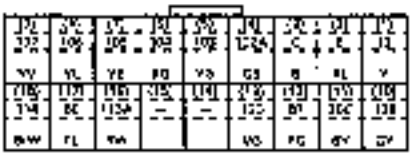


1	2	3	4	5	6	7	8	9	13	20	21	22	23	24
10	11	12	13	14	15	16	17	18	25	26	27	28	29	30

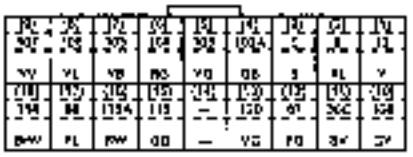
CN1

5PAF-AMP→C-2

(For SK310III, SK310LCIII)
16PAF-AMP→C-2



(For SK430III, SK430LCIII)
16PAF-AMP→C-2



12PAF-AMP→C-2

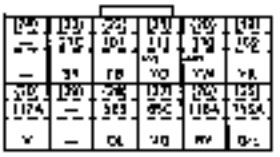


Fig. 12 C−2 Controller connector pin location and harness connector
However, see the connector from the engaged surface.

(3) Cluster Gauge Controller IN/OUT

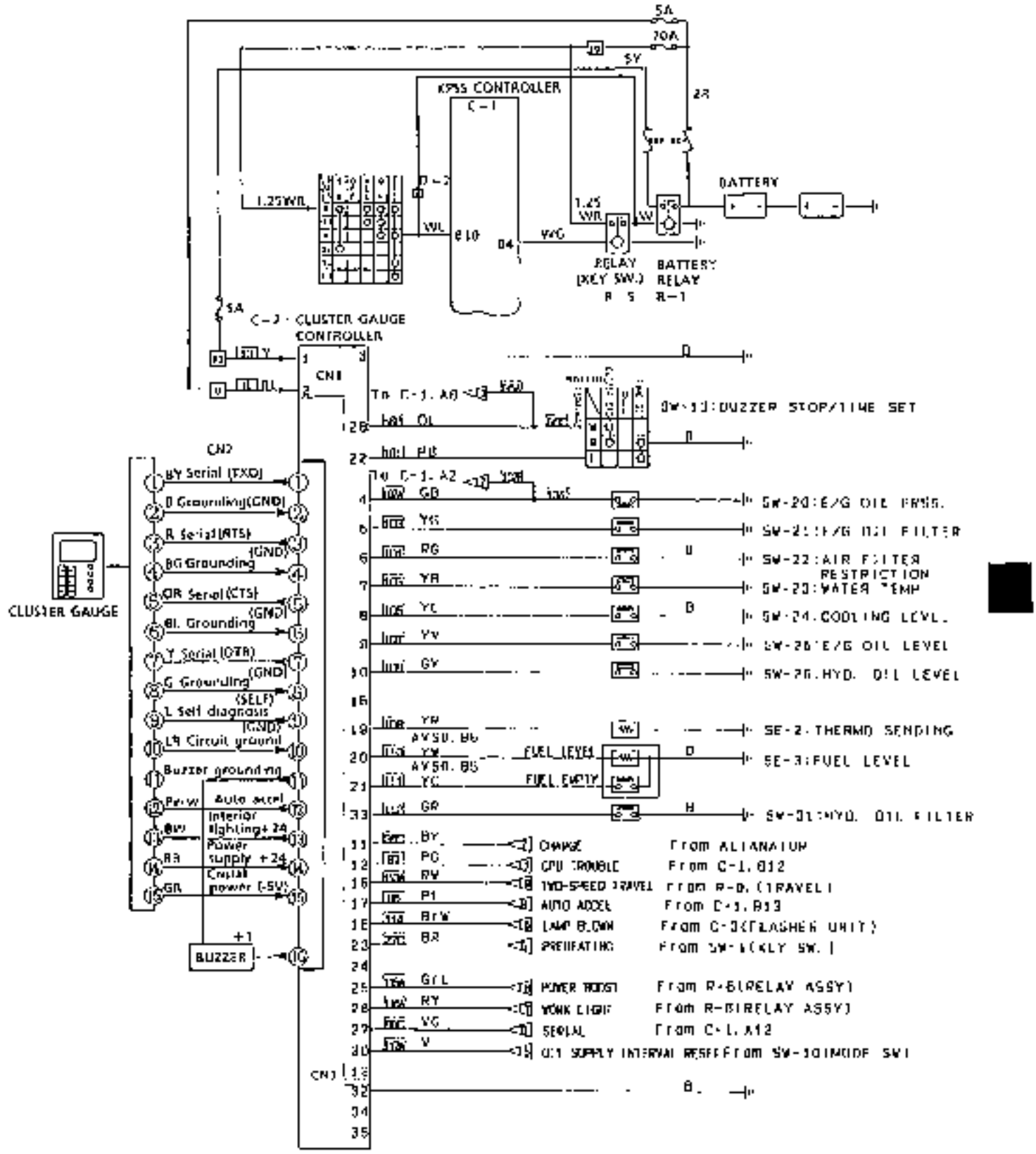
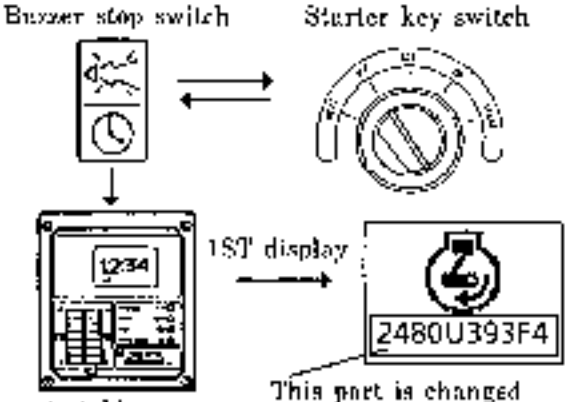


Fig. 16 Cluster gauge controller wiring diagram

(4) Service Diagnostic Check by Multi Display

It is possible to diagnose the operating status of mechatronics system, and then display the status on the multi-purpose display.

1) Keep the buzzer stop switch pressed and turn key switch ON.
2) Press the buzzer stop switch 5 times to display.
3) And later, the status of 24 items are displayed in order, each time switch is pressed.
4) By turning key switch OFF, the display is cleared.



H mode, in engine rotation

The display shown with a range means that the display is not stable.

The figure shows the target value, so, it differs depending on models.

※ Figures are displayed, but the data has no relation.

No.	DIAGNOSIS DISPLAY	CONTENTS OF DISPLAYS	SK310III SK310LCIII	SK430III SK430LCIII	REMARKS
1	P/No	Controller P/No	2480U393F4	2480U393F5	
2	S1 wtmp	Thermo switch temperature	OPEN	←	
3	S2 oprs	E/G Oil pressure switch	OPEN	←	
4	S3 cpu	Mechatro 1P connector	CLOS	←	
5	S4 smod	S mode select switch	CLOS	←	S mode
			OPEN	←	H,FC,D mode
6	S5 hmod	H mode select switch	CLOS	←	H mode
			OPEN	←	S,FC,D mode
7	S6 att	ATT Boost switch	OFF OPEN	OPEN	
			ON CLOS		
8	S7 des	Auto accel pressure switch	OPEN	←	Decel SW. ON
			CLOS	←	Decel SW. OFF
			CLOS	←	Lever operating
9	S8 bzsp	Buzzer stop switch	OPEN	←	
10	S9 jpin	Controller inside switch	OPEN	←	
11	S10 keys	Key switch BR terminal	CLOS	←	
12	S11 limx	Stepping motor limit switch	OPEN	←	
13	S12 boom	Slewing pressure switch	OPEN	←	Lever neutral
			OPEN	←	Slewing
14	AD1 accl	Accel potentiometer	40	40	Low
			215	215	High
15	AD2 boom	Loading potentiometer	2	1	Up
			96	97	In
			255	255	Down
16	AD3 motA	Stepping motor A phase current value	33~38	33~38	
17	AD4 motB	Stepping motor B phase current value	33~38	33~38	
18	AD5 isvP	KPSS solenoid valve current value (Current value measured by controller)	10~12	10~12	E/G Low no load
			29~32	29~32	E/G Low arm relief
			7~8	7~8	E/G High no load
			7~8	7~5	E/G High arm relief
19	AD6 isvB	Loading solenoid current value (Current value measured by controller)	38~47	38~47	
20	I1 pump	KPSS solenoid valve current value mA (Controller instructed value)	215~230mA	215~230mA	E/G Low no load
			590~640mA	590~640mA	E/G Low arm relief
			150mA	150mA	E/G High no load
			150mA	150mA	E/G High arm relief
21	I2 boom	Loading solenoid current value mA (Controller instructed value)	100mA (800mA)	100mA (800mA)	
22	POS	Stepping motor position	205	210	Low idle
			405	420	High idle
23	r.p.m	E/C revolution	862, 866	862, 508	Low idle
			1926, 1930	2186, 2190	High idle
24	18V	Source voltage 18V or more	OVER	←	

(5) Explanation of mechatronic system circuit and service diagnosis monitor displays
(Refer to I/O Chart on page 12 and Service Diagnosis Table on page 16.)

■KEY SWITCH

1) If the key switch (SW−1) is turned off, the voltage between the key terminal M and the C−1 controller terminal B10 becomes OV.
2) The C−1 controller is capable of holding voltage for four seconds after the key switch is turned OFF.
3) Therefore, the key switch relay R−5 and the battery relay (R−1) are excited for four seconds via terminal B4; the power is held for four seconds after the key switch is turned OFF.
4) "S10 kwys of eleven monitor items" indicates confirmation of the harness between the key switch terminal M and B10.

■AUTO ACCEL

1) The auto accel is turned off if the auto accel switch (SW−9) is released. As the result, the switch terminal RV and the C−1 controller terminal A7 put out negative signals. The controller judges by a negative signal that operation is underway.
2) If the auto accel switch is turned to the switch mark side, it is turned ON. If the operating lever is in neutral position and the pressure switch (SW−27) is off, the terminal A7 becomes open by which the decel revolution is set at 1050rpm.
3) If the operating lever is operated, the pressure switch is turned on. This turns out a negative signal from the terminal A7; the controller judges by a negative signal that operation is underway. As the result, the auto accel function operates. If the operating lever is in neutral position, a decel revolution is attained four seconds after the operating lever is brought to neutral.
4) With "S7 des" of the eight monitor items, the condition of the harness between the auto accel switch and the terminal A7 is displayed.

■ACCEL POTENTIOMETER AND GOVERNOR MOTOR

1) If the accel dial is operated, the potentiometer (SE−4) rotates. The C−1 controller senses input voltage variations through the terminal B2 of the C−1 controller.
2) The controller computes the input voltage at B2 and causes the governor motor (M−1) to rotate. It determines the rotating angle of the governor motor by giving a fixed 1.5A current (as pulse signals) to phase A (B14 terminal), phase $\bar{A}$ (B15 terminal), phase B (B5 terminal) and phase $\bar{B}$ (B6 terminal). This provides a rotating angle according to an accel dial position.
3) The limit switch in the governor motor serves as the basis of an angle at which the governor motor changes from an off to on condition.
4) Fault code 2 indicates that the limit switch has operated.
Fault code 6 indicates that the governor motor is loaded with fixed current.
Fault code 7 indicates that the governor motor is rotating.
5) "S11 lims" of twelve monitor items indicates the condition of the harness between the limit switch and terminal A10.
6) "AD1 accl" of fourteen monitor items indicates confirmation of operation of the accel potentiometer.
7) "AD3 motA" of sixteen monitor items indicates confirmation of the fixed current load at phase A of the governor motor.
8) "AD4 motB" of seventeen monitor items indicates confirmation of the fixed current load at phase B of the governor motor.
9) "POS" of twenty-two items indicates confirmation of the rotating angle of the governor motor.
10) "rpm" of twenty-three monitor items indicates confirmation of the engine revolution.

■OPERATION MODE SELECT SWITCH AND GOVERNOR MOTOR

1) If the operation mode select switch (SW−10) is in the H-mode, terminal A5 of the C−1 controller senses a negative signal. The controller judges the negative signal as H-mode.
2) The governor motor (M−1) drives the governor lever to a position 0.2mm ahead of the Hi idle set bolt.
3) In the S-mode, the A4 terminal senses a negative signal by which the governor motor is driven at the S-mode revolution.
4) In the FC-mode, terminals A4 and A5 cease to sense the negative signal by which the governor motor is driven at the FC mode revolution.

5) In the D-mode, terminal A5 senses a negative signal via a diode, so that the C−1 controller provides the same recognition as the H-mode.
6) "S5 smod" of six monitor items indicates confirmation of the harness between terminal 1 of the mode select switch and terminal A5 of the C−1 controller.
7) "S4 smod" of five monitor items indicates the confirmation of the harness between terminal 2 of the mode select switch and terminal A4 of the C−1 controller.
However, where different types of control are performed on revolutions, control is performed to select the lower of the revolutions.

■ATT BOOST PRESSURE

1) If the ATT boost pressure switch (SW−3) is depressed the ATT boost pressure relay (R−6) is excited. At the same time the terminal A6 of the C−1 controller senses a negative signal.
2) The moment the ATT boost relay (R−6) is changed over, the ATT boost pressure mark is displayed on the multi display.
3) If terminal A6 of the C−1 controller senses a negative signal. 715mA is put out from terminal B16.
4) The 715mA drives the solenoid proportionate reducing valve (PSV-1) by way of the YL harness, the KPSS release switch and the YG harness, thereby providing power shift action (reduced horsepower) of the pump.
5) The return harness GrB and the harness YB of the solenoid proportionate reducing valve (PSV−1) are fed back to terminal B7.
6) The fault code 5 indicates that the operation of the solenoid proportionate reducing valve has been confirmed.
7) "S6 att" of seven monitor items indicates that the harness between the ATT boost pressure switch and terminal A6 has been confirmed.
8) "I1 pump" of twenty monitor items indicates a command current value from terminal B16 and the solenoid proportionate reducing valve (PSV−1).
9) "AD5 isvp" of eighteen monitor items indicates the feedback current value from the solenoid proportionate reducing valve to terminal B7.

■KPSS RELEASE SWITCH, POWER SHIFT AND ATT BOOST PRESSURE

1) If the KPSS release switch (SW−2) is released, the power source 15 arrives at the solenoid proportionate reducing valve (PSV−1) via the resister (62Ω) to give it a S-mode current value of 330mA.
2) The current is reduced to an earth level by way of the solenoid proportionate reducing valve, the GrD harness and the KPSS release switch.
3) If the KPSS is not released, the C−1 controller computes a set revolution from the rotating angle of the governor motor.
4) In the meantime, an actual revolution value is read from the engine revolution sensor.
5) The C−1 controller compares a set revolution with an actual revolution and computes the difference.
6) A current value according to the difference is put out from terminal B16 to perform power shift action. If the KPSS is released. Power is shifted to the S-mode current level, thereby ceasing to feed back to terminal B7.
7) Also, if the KPSS is released, current ceases to flow from the ATT boost pressure relay (R−6) to the earth side, thereby disabling the ATT boost pressure action.

■LOADING MODE POTENTIOMETER (OPTION)

1) If swing action is performed, the pressure switch (SW−30) operates which causes terminal A9 of the C−1 controller to sense a negative signal.
2) The C−1 controller senses, at terminal B3, an output voltage of the loading mode potentiometer (SE−6).
3) The output voltage increases if the potentiometer dial is turned clockwise.
4) The C−1 controller computes the input voltage and puts out a control current from terminal B17 so it acts upon the solenoid proportionate reducing valve (PSV−2).
5) Also, the control current is fed back to terminal B8 by way of the solenoid proportionate reducing valve and the BP harness.
6) "S12 boom" of thirteen monitor items indicates that the harness between the pressure switch and terminal A9, has been confirmed.

7) "AD2 boom" of fifteen monitor items indicates that the potentiometer (SE−5) operates.
8) "12 boom" of twenty-one monitor items confirms a command current value from terminal B17
9) "AD6 invB" of nineteen monitor items indicates confirmation of the feedback current value to terminal B8.

■WATER TEMPERATURE SWITCH AND POWER SHIFT (SK310Ⅲ SERIES ONLY)

1) When the water temperature of the radiator rises at 95℃ (203.0℉), the water temperature switch (SW−28) operates. This causes the C−1 controller detects a negative signal at terminal A1. Announcing that a fault has occurred.
2) The C−1 controller puts out 330mA from terminal B16. The signal acts upon the electromagnetic proportionate reducing valve (PSV−1) by way of the KPSS release switch and the YR harness and causes power to shift to pick up the S-mode.
3) If the monitor item No.2 "S1 wtmp" is indicated, it means that the harness between the water temperature switch and terminal A1 have been confirmed.

3 . MAIN ELECTRIC EQUIPMENT

3.1 SUMMARY OF MAIN ELECTRIC EQUIPMENT

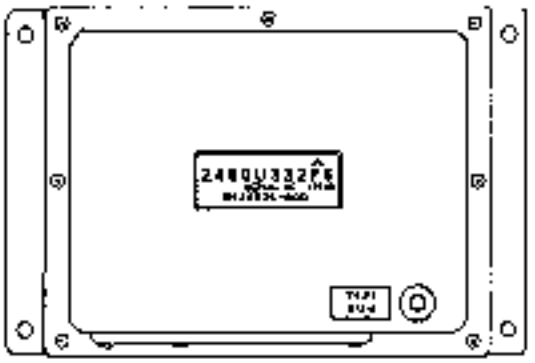
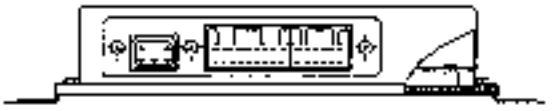
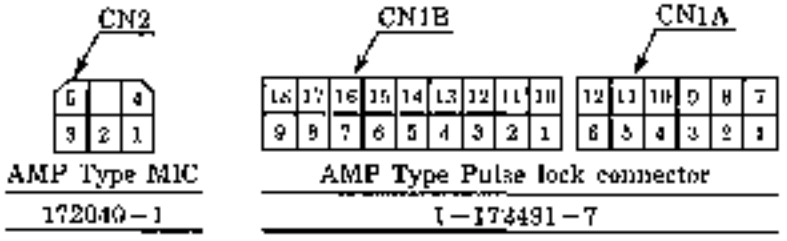
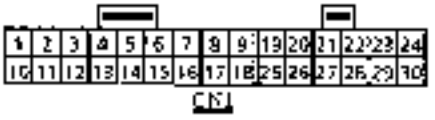
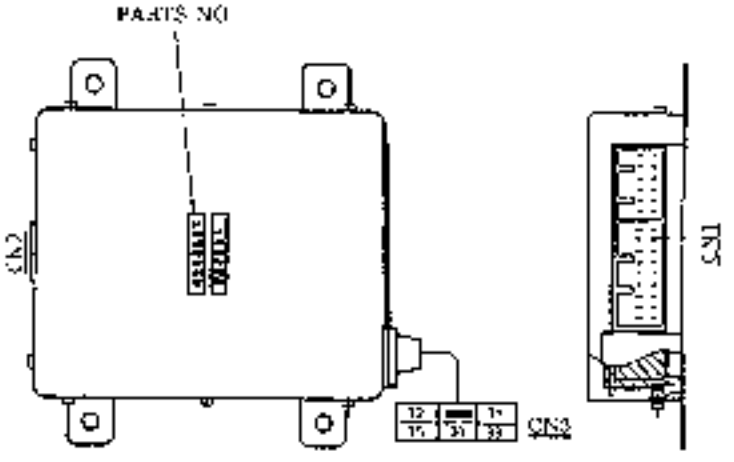
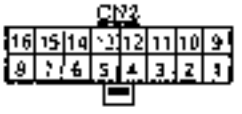
The main electric equipment are classified into the following ten groups in alphabetical order.

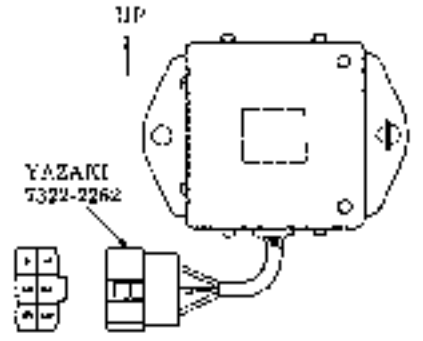
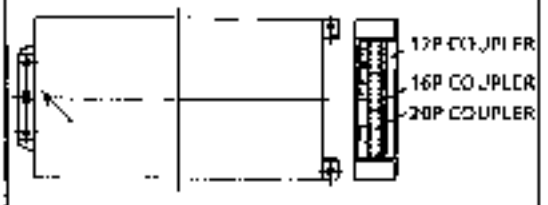
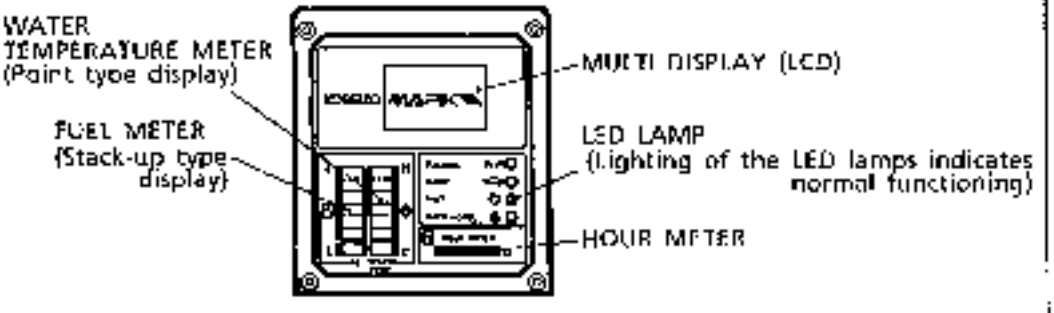
1) Controller	4) Light	7) Sensor	10) Pressure switch
2) Diode	5) Motor	8) Solenoid	
3) Electric Equipment	6) Relay	9) Switch	

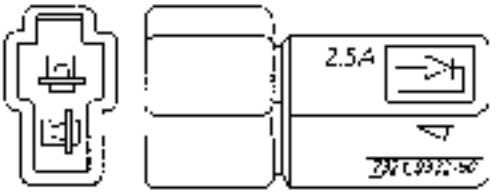
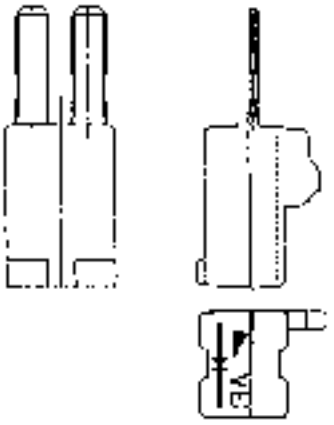
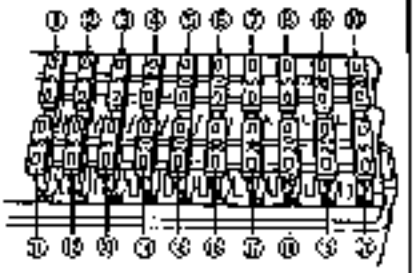
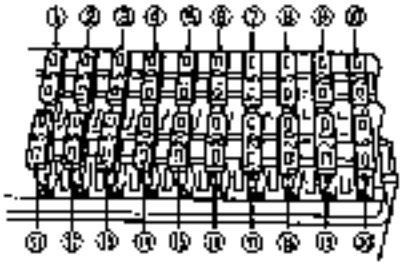
class	Item	Name	Part No.	
Controller	C−1	KPSS Controller	2480U302F4 (SK210) F5 (SK400)	
	C−2	Cluster Controller	2480U371F2	
	C−3	Flasher Unit	2480U306	
	C−4	A/C Amp.	YN22E00014F1	
	C−5	Guage Cluster	2489U276F5	
Diode	D−1	Diode	YN02D01001F1	
	D−2	Diode	↑	
	D−3	Diode	↑	
	D−4	Diode	↑	
	D−5	Diode	2475R132	
	D−6	Diode	↑	
	D−7	Diode	YN02D02001F1	
	D−8	Diode	↑	
	D−9	Diode	↑	
	D−10	Diode	↑	
	D−11	Diode	2475R132	
	D−12	Diode	↑	
	D−13	Diode	↑	
	D−14	Diode	↑	
Electric Equipment	E−1	Fuse Box	YN53E00001F2	
	E−5	Horn (High)	2479U1009F1	SK210 ONLY
	E−6	Horn (Low)	2479U1009F2	↑
	E−7	Resister	2484R166D1	
	E−14	Air Horn	2447U2	SK400 ONLY
	E−15	Battery	2484U178	STD
Light	L−1	Swing Flasher (L)	2456U104F4	
	L−2	Swing Flasher (R)	2456U104F3	
	L−3	Boom Work Light (L)	2456U74F3	
	L−4	Boom Work Light (R)	↑	
	L−5	Work Light (L)	2456U116F1	
	L−6	Work Light (R)	↑	
	L−7	Rear Work Light (L)	2456U105F4	

class	Item	Name	Part No.	
Light	L−8	Rear Work Light (R)	2456U105F3	
	L−9	Room Light	2456Z22F1	
Motor	M−1	Governor Motor	2406U197F4	
	M−2	Wiper Motor	2475R704	
	M−3	Washer Motor	2427U900	
	M−4	Starter Motor	ME057990	STD
	M−5	Alternator	ME049177	
Relay	R−1	Battery Relay	2479U1470F1	
	R−2	Starter Relay	YN24S01002F1	
	R−3	Heater Relay	ME067624	
	R−4	Safety Relay	ME049231 YN24S00001F1	
	R−5	Key Switch Relay	YN24S00011F1	
	R−6	Relay Assy	YN24E00001F1	
	R−7	Heater Cut Relay	YN24S00001F1	
	R−8	Intermit Relay	2479R1306	
	R−9	2-speed Relay	2479U1290	
Sensor	SE−1	Revolution Sensor	ME049235 YN52S00002F1	
	SE−2	Thermo Sending Unit	2489U258F1	
	SE−3	Fuel Sensor	2469U275	
	SE−4	Accel Lever Potentio	2480R430	
	SE−5	Variable Loading Potentio	2480U376F1	
Solenoid	SV−1	Power Boost Solenoid	2436U1314F3	
	SV−2	PC Mode Solenoid	YN35V00009F1	
	SV−3	2-speed Travel Solenoid	↑	
	SV−4	Lever Lock Solenoid	↑	
	SV−5	Travel Flow Cut	2436U1314F2	SK210 ONLY
PSV	PSV−1	P.S.V. (KPSS)	2436R804F2	
	PSV−2	P.S.V. (Variable Loading)	↑	

class	Item	Name	Part No.		class	Item	Name	Part No.	
Switch	SW-1	Key SW	YN50S00002P1						
	SW-2	Release SW (3OPSS)	2479Z1447						
	SW-3	ATT Boost SW	YN03M01164P1						
	SW-4	2-speed Travel SW	YN03M01039P1						
	SW-5	Lever Lock SW	YN50S01001P1						
	SW-6	Horn SW	YN03M01155P1						
	SW-7	A/C SW	2410U275S3						
	SW-8	Heater SW	2479U326	OPT					
	SW-9	Auto Accel SW	2479U1190F7						
	SW-10	Mode Select SW	2479U1348F2						
	SW-11	Swing Flusher SW	2479U1190F19						
	SW-12	Work Light SW	2479U1578F1						
	SW-13	Buzzer Stop/Time Adjust SW	2479U1591F1						
	SW-14	Wiper & Washer SW	2479U1276F2						
	SW-15	Buzzer Stop (Travel Alarm SW)	2479U1190F16						
	SW-20	E/G Oil press.SW	MC840819						
	SW-21	E/G Oil filter SW	ME054565						
	SW-22	Air filter SW	2446R353S11						
	SW-23	E/G coolant Temp (105℃)	ME039907						
	SW-24	E/G coolant level	2427U203S6						
	SW-25	E/G Oil level SW	MC840577						
	SW-26	Hyd. Oil Level	2485R302F1						
	SW-27	Press.SW(Auto Accel)	2479U1378						
	SW-28	E/G coolant Temp (96℃)	ME049263						
	SW-29	Press.SW(Breaker)	2479U1378						
	SW-30	Press.SW(Swing)	〃						
	SW-31	Hyd. Oil Filter SW	2410U1403F1						
	SW-33	Hyd. tank Air Press SW	2479U2207						

File No. Name of part Part No. Use Applicable Machine	Specification	Description
C－1 KPSS Controller 2480U393F4 KPSS LC03601～ YC01101～		
C－1 KPSS Controller 2480U393F5 KPSS LS00701～ YS00601～	  AMP Type MIC 172040－1 AMP Type Pulse lock connector 1－174491－7	
C－2 Cluster controller 2480U371F2 Cluster gauge LC03801～ YC01101～ LS00701～ YS00601～	  	

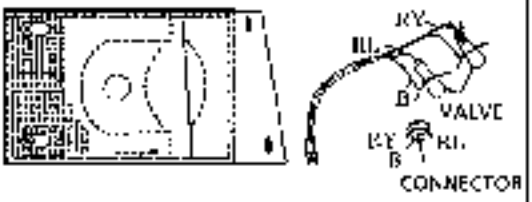
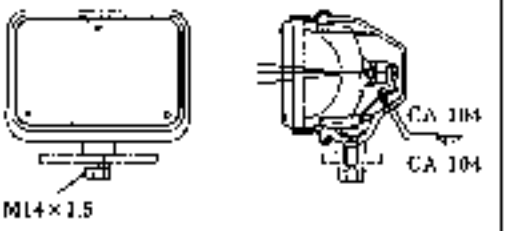
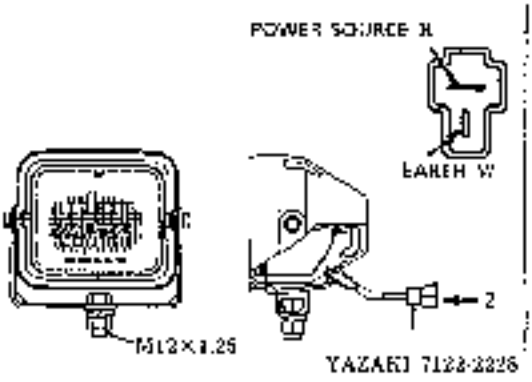
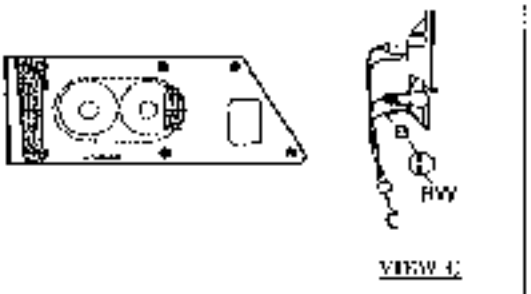
File No. Name of part Part No. Use Applicable Machine	Specification	Description
C—3 Controller 2480U806 Flasher Unit LC03801~ YC01101~ LS00701~ YS00601~	Rated voltage: DC 24V Operating temp. range: 30°C~60°C Flashing frequency: 90±30 c/min	
C—4 Controller YN22E00014P1 Amplifier for air-conditioner LC03801~ YC01101~ LS00701~ YS00601~		
C—5 Controller 2480U276F5 Gauge cluster LC03801~ YC01101~ LS00701~ YS00601~	Rated voltage: 24V DC Working Voltge Range: DC20V~30V Working Temp Range: 20~60°C	  VIEW I

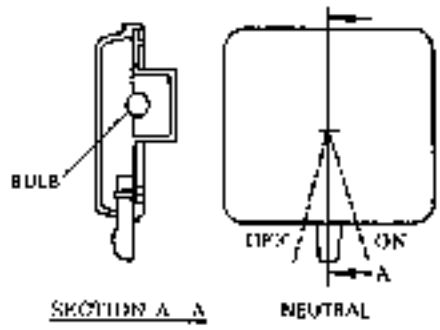
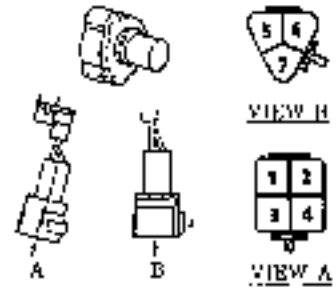
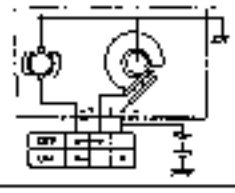
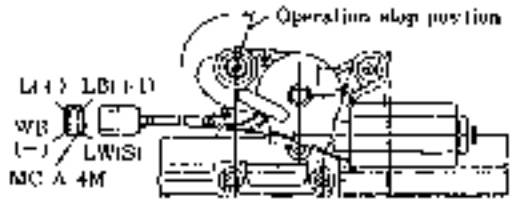
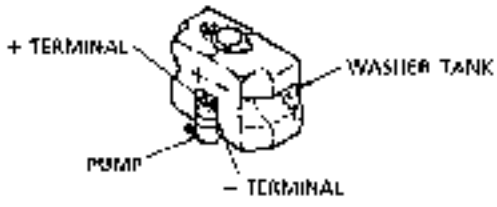
File No. Name of part Part No. Use Applicable Machine	Specification	Description
D—1~4,7~10 Diode YN02D01001P1 LC03601~ YC01101~ LS00701~ YS00601~	Type: 7321-9332-60 Rated current: 2.5A	
D—5,6,11~14 19,20,21 Diode 2475R132 LC03801~ YC01101~ LS00701~ YS00601~	Type: 7321-9322 Peak reverse voltage: 400V Forward current: 3A Surge current: 200A	
E—1 Fuse box YN73E00001P2 Fuse (Main) LC03801~ YC01101~	Type: 7124-8060 ※ Fuse capacities and names of circuits	
E—1 Fuse box YN73E00001P2 Fuse (Main) LS00701~ YS00601~	Type: 7124-8043 ※ Fuse capacities and names of circuits	

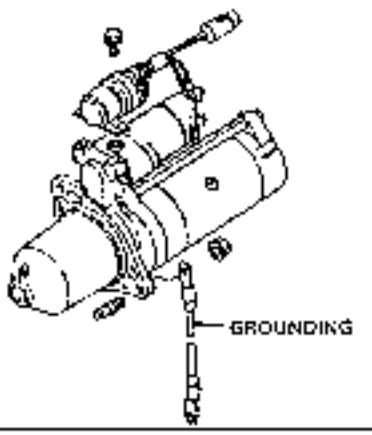
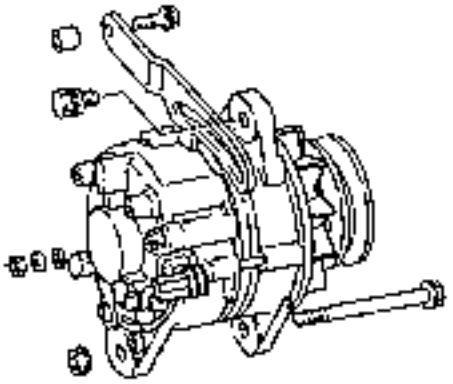
No.	CAPACITY	NAME OF CIRCUIT	No.	CAPACITY	NAME OF CIRCUIT
1	5A	Nothing	12	5A	Swing flasher
2	5A	Heating	13	5A	Controller (cluster)
3	5A	Nothing	14	20A	Wiper, washer
4	10A	Reverse	15	10A	Solenoid
5	10A	Hazard	16	20A	Rear work light
6	10A	Horn	17	20A	Work light (right & left)
7	5A	Back up	18	20A	Air-conditioner, heater (option)
8	5A	Cluster (backup)			
9	20A	Room lamp	19	10A	Spare (24V)
10	20A	Starter switch	20	5A	Spare (24V)
11	5A	Controller (engine rpm adjustment)			

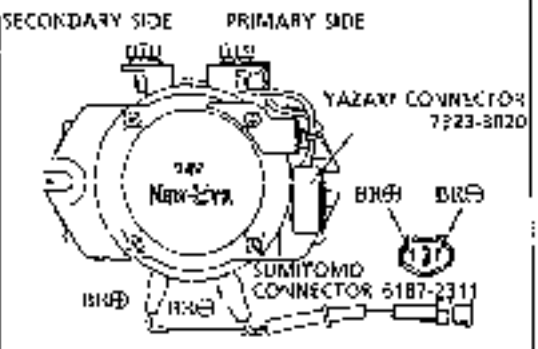
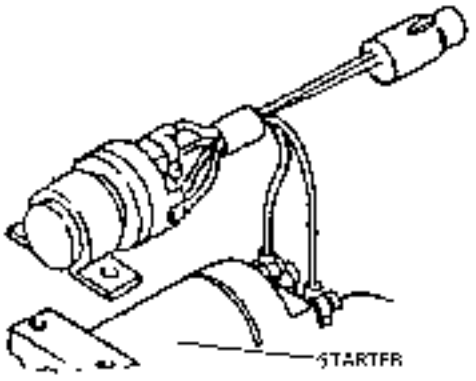
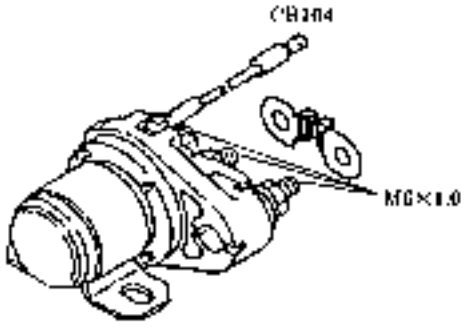
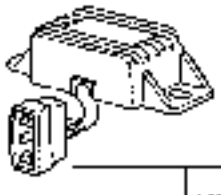
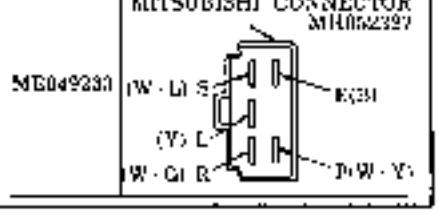
No.	CAPACITY	NAME OF CIRCUIT	No.	CAPACITY	NAME OF CIRCUIT
1	5A	Nothing	12	5A	Swing flasher
2	5A	Nothing	13	5A	Controller (cluster)
3	5A	Nothing	14	20A	Wiper, washer
4	10A	Nothing	15	10A	Solenoid
5	10A	Nothing	16	20A	Rear work light
6	10A	Horn	17	20A	Work light (right & left)
7	5A	Air conditioner, evaporator (option)	18	20A	Air-conditioner, heater (option)
8	5A	Cluster (backup)	19	10A	Spare (24V)
9	10A	Room lamp	20	5A	Nothing
10	20A	Starter switch			
11	5A	Controller (engine rpm adjustment)			

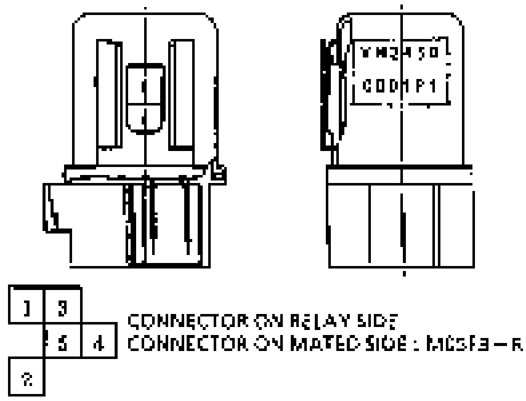
File No. Name of part Part No. Use Applicable Machine	Specification	Description
E－5,6 Horn 2479U1009F1(High) 2479U1009F2(Low) Alarm LC03801～ YC01101～	Type Rated voltage: DC 24V Operated voltage range: DC22～28A Sound volume: 110±5 dB Basic frequency: 390±20 HZ (High) 350±20 HZ (Low) Insulation resistance: 1MΩ/DC 500V	Drill 2-Hole STAMP H High sound (2479U1009F3)F1 L Low sound (2479U1009F4)F2
E－7 Resister 2484R166D1,D2 Resister LC03801～ YC01101～ LS00701～ YS00601～	Type: CRV MA 30W Nominal resistance value D1: 62Ω D2: 51Ω	
E－14 Air Horn 2447U2 Alarm LS00701～ YS00601～	Rated Air-pressure: 3～9kgf/cm² Sound volume: 116dB Operated temperature range: −40～+80°C Basic frequency: 555±10HZ 430±10HZ	2-11×16 hole Apply sealant
E－15 Battery 2484U178(STD) Power source LC03801～ YC01101～ LS00701～ YS00601～	Parts No.: 2484U178 Type: 130F51 (F160-12) Capacity: 104Ah/5HR 130Ah/20HR	FB

File No. Name of part Part No. Use Applicable Machine	Specification	Description
L—1,2 Light 2456U104F4 (L.H) 2456U104F3 (R.H) Swing flasher LC03801— YC01101~ LS00701— YS00601~	Type Rated voltage: 24V Bulb: 25W×2×2 pairs/machine	
L—3,4 Light 2456U74F3 Boom working light LC03801~ YC01101~ LS00701~ YS00601~	HALOGEN SEALED BEAM DATA Watts: 70 Volts: 24	
L—5,6 Light 2456U116F1 Working light LC03801~ YC01101~ LS00701~ YS00601~	HALOGEN SEALED BEAM DATA Watts: 70 Volts: 24	
L—7,8 Light 2456U105F4 (L.H) 2456U105F3 (R.H) Rear working light LC03801~ YC01101~ LS00701~ YS00601~	Type Rated voltage: DC 24V Bulb: 25W×2×2 pairs/machine	

File No. Name of part Part No. Use Applicable Machine	Specification	Description
L－9 Light 2456Z322F1 Room light LC03801～ YC01101～ LS00701～ YS00601～	voltage: DC 24V Bulb: 5W×1	
M－1 Motor 2406U197F4 Governor LC03801～ YC01101～ LS00701～ YS00601～	Drive voltage: DC24V Current: 1.5A / Phase Number of phases: 4 Phases Excitation method: 2-phase excitation Step angle: 0.036° (output shaft) DH resistance of coil: 5.72Ω±10% (at 25°C)	
M－2 Motor 2479R704 Wiper LC03801～ YC01101～ LS00701～ YS00601～	Type: Motor OFF Rated voltage: 24V Connection diagram: 	
M－3 Motor 2427U900S2 Washer LC03801～ YC01101～ LS00701～ YS00601～	Rated voltage: 24V Tank capacity: 2.2ℓ (0.581 gal)	

File No. Name of part Part No. Use Applicable Machine	Specification	Description
M－4 Motor (5.5KW) ME057990 Starter (STD) LC09801～ YC01101～ LS00701～ YS00601～	Maker P/No: ME057990 Rated Voltage: 24V Output: 5.5KW	
M－5 Alternator ME049177 Generator LC03801～ YC01101～ LS00701～ YS00601～	Type: Alternating current Rated Voltage: 24V Output: 30A (600W)	

File No. Name of part Part No. Use Applicable Machine	Specification	Description
R－1 Relay 2479R1470F1 Battery LC03801～ YC01101～ LS00701～ YS00601～	Rated voltage / current: Ac start 24V 110A (30sec.) At charge 28V 120A (continuous) Exciting current: 0.4A or below / 24V Contact pressure: 2kg or over Closing voltage: 18V or over Opening voltage: 4V or over Insulation resistance: 2MΩ or over / 500V megger	
R－2 Relay ME050939 YN24SU1002P1 Starter LC03801－ YC01101～ LS00701－ YS00601～	Maker P/No.: ME050939	
R－3 Relay ME007624 Heater LC03801～ YC01101～ LS00701－ YS00601～	Maker P/No.: ME007624 Rated voltage & current: DC24V 2.3A Fuse: 5A	
R－4 Relay ME049233 YN24SU1001P1 Voltage sensing (Safety relay) LC03801－ YC01101～ LS00701～ YS00601～	Maker P/No.: ME049233 Rated voltage: DC 24V	 

<table>
<tr><th>File No.
Name of part
Part No.
Use
Applicable Machine</th><th>Specification</th><th>Description</th></tr>
<tr><td>R−5,7
Relay
YN24S00001P1
Key switch
Heater cut
LC03601~
YC01101~
LS00701~
YS00601~</td><td>Maker's part No.: 468 306 6010
Rated voltage: DC 24V / 10A
Insulation resistance: More than 1MΩ / 500V megger</td><td> 
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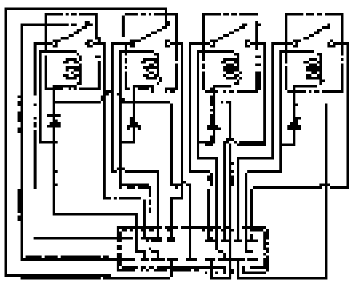
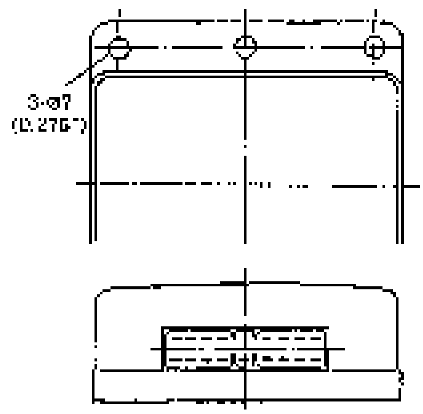
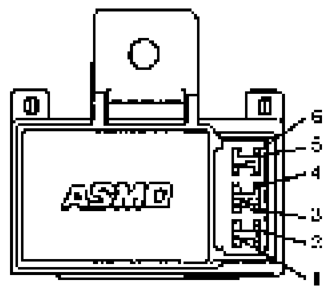
<tr><td>R−6
Relay
YN24E00001F1
Relay Assy.
LC03801~
YC01101~
LS00701~
YS00601~</td><td>Rated voltage: DC 24V
CIRCUIT DIAGRAM
  </td><td> 
</td></tr>
<tr><td>R−8
Relay
2479R1366
Intermit relay
LC03801~
YC01101~
LS00701~
YS00601~</td><td>Manufacturers mfg. No: 0-060010-0 [illegible]
Rated voltage: 24V
Intermittent action: Wiper action ; 1 cycle, 5 second pause
Continuous action: ——</td><td> 
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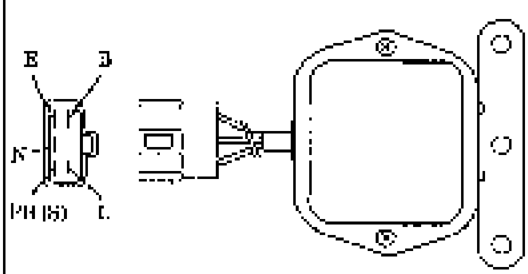
<tr><td>R−9
Relay
2479U1290
2 speed travel
LC03801~
YC01101~
LS00701~
YS00601~</td><td>Type:
Operating voltage range: 20~36V
Relay capacity: A</td><td> 
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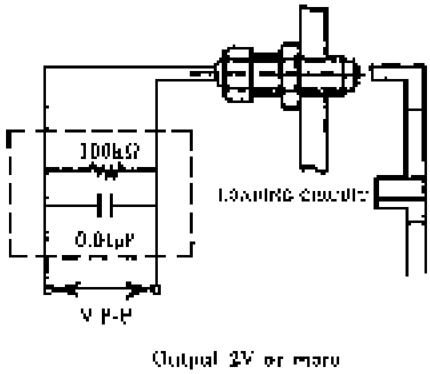
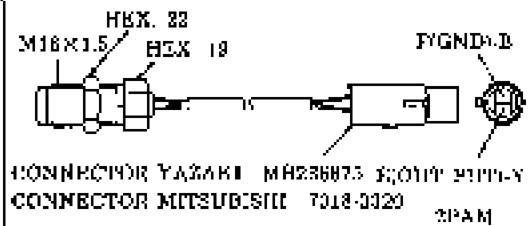
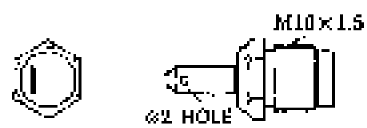
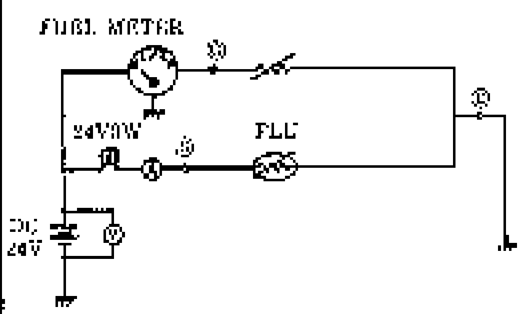
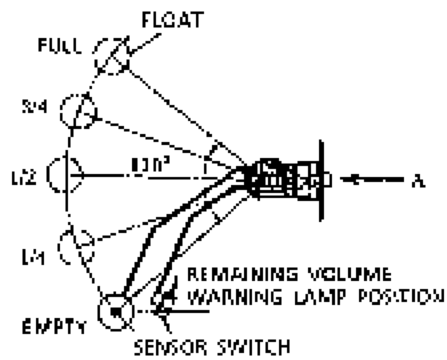
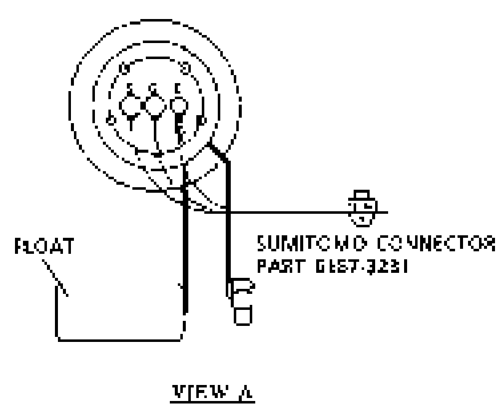
File No. / Name of part / Part No. / Use / Applicable Machine	Specification	Description
SE-1 Sensor MC845235 E/G revolution LC03801~ YC01101~ LS00701~ YS00601~		
SE-2 Sensor 2489U266F1 Thermo sending unit LC03801~ YC01101~ LS00701~ YS00601~	see table SE-2 below	
SE-3 Sensor 2489U275 Fuel level LC03801~ YC01101~ LS00701~ YS00601~	see table SE-3 below 	 

SE-2 Specification

Type	51400 KW0100	
Type	Thermister element	
Electric performance		
Temperature (°C)	65±0.2 (149.0±0.4°F)	115±0.3 (239.0±1.1°F)
Resistance value (Ω)	1740±204	382±15

SE-3 Specification

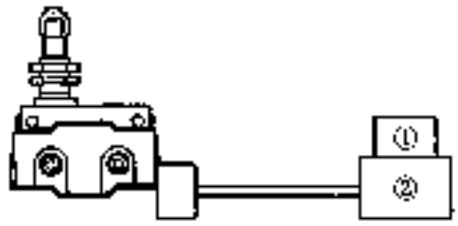
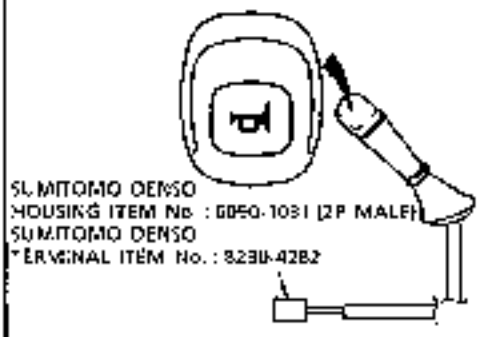
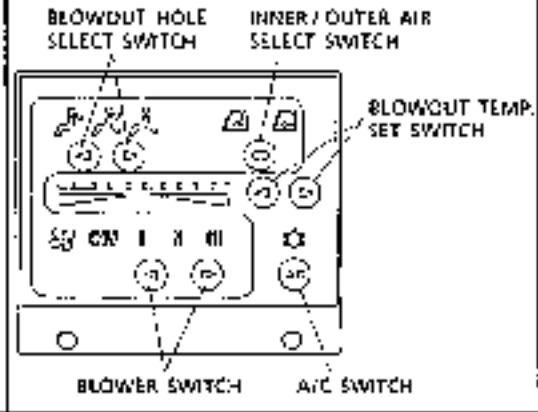
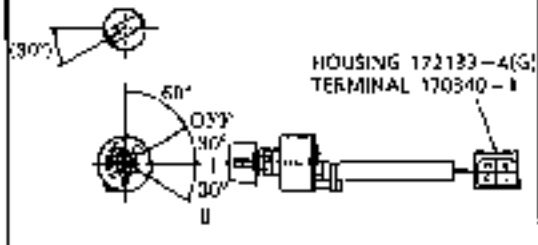
Float operating standard

Float	Resistance value Ω
FULL	$10^{+0.1}_{-0.5}$
3/4	(19)
1/2	32±3
1/4	(49.5)
EMPTY	90^{+12}_{-7}

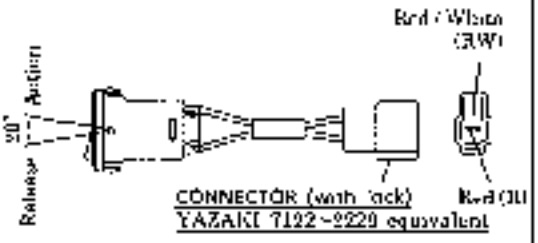
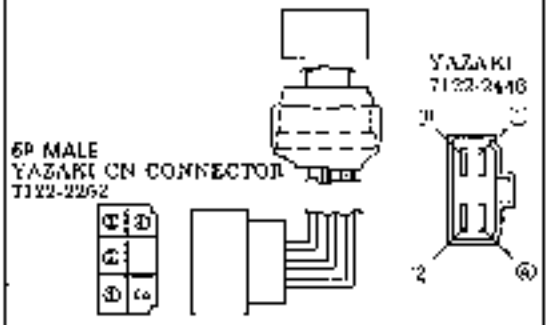
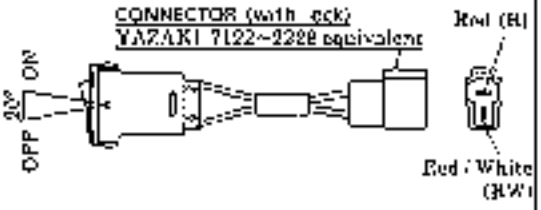
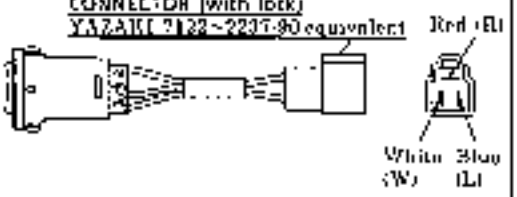
File No. Name of part Part No. Use Applicable Machine	Specification	Description
SE－4 Sensor 2486R430 Accel lever potentio LC03801～ YC01101～ LS00701～ YS00601～	Rated voltage: 5V Total resistance: 2KΩ Effective electric angle: 90° Number of Notch: 11 VOLTAGE (①-②)	SEAL, NOTCH, BRACKET, POTENTIO, AV×0.5sq 3PAM-090 SUMITOMO 6187-3231 TERMINAL 1500-0105 WIRESEAL 7160-8231
SE－5 Sensor 2486U376F1 Variable loading potentio LC03801～ YC01101～ LS00701～ YS00601～	Type: WA1.5W 2KΩK Power rating: 0.75W Mechanical rotating angle: 150°±5° Electrical rotating angle: 140°±5° Insulation resistance: 100MΩ or more / DC 500V megger	CLICK MECHANISM (11 STEPS), CONNECTOR SUMITOMO 6187-3231, STARTING POINT 1: GND AV×0.5 B 2: OUT AV×0.5 1.Y 3: VCC AV×0.5 LR VIEW A
SV－1 Solenoid 2486U1314F3 Power boost LC03801～ YC01101～ LS00701～ YS00601～	Rated voltage: DC 24V Power consumption: 12W Working pressure: 140 kgf/cm² Max. flowrate: 16ℓ/min (at P port) Circuit	P, T, O RING SEAL SUMITOMO 090 CONNECTOR M(2P) HOUSING M(6187-2311) TERMINAL (150D-0105)
SV－2,3,4 Solenoid YN35V00009F1 PC Mode 2-speed travel Lever lock LC03801～ YC01101～ LS00701～ YS00601～	Rated voltage: DC 24V Working pressure: 35 kgf/cm² SYMBOL	

File No. Name of part Part No. Use Applicable Machine	Specification	Description
SV – 5 Solenoid 2436U1314F2 Travel Flow Cut LC03801 – YC01101 ~	Rated voltage: DC 24V Power consumption: 12W Working pressure: 140 kgf/cm² Max. flowrate: 16ℓ/min (at P port) Circuit: A, P, T	P, T SUMITOMO 090 CONNECTOR M(2P) HOUSING M(6187-2311) TERMINAL 1500-0105 O RING SEAL
PSV – 1,2 PSV 2436R584F2 KPSS Variable Loading LC03801 ~ YC01101 ~ LS00701 ~ YS00601 ~	Type: KDRE-5K Max. working pressure (P port): 140 kg/cm² Max. secondary pressure (A port): 40 kg/cm² Max. flow: 6ℓ/min Rated current: 0.8A Coil resistance: 13.6Ω (20°C) SYMBOL: P, T, A	P A T SUMITOMO HW090 CONNECTOR (water proof) M(2P) HOUSING 6181-0070 TERMINAL 1500-0105

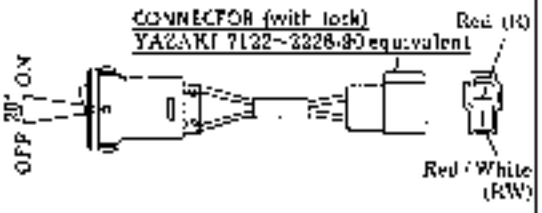
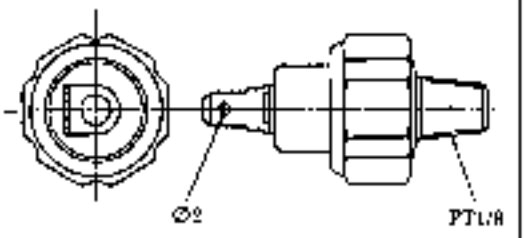
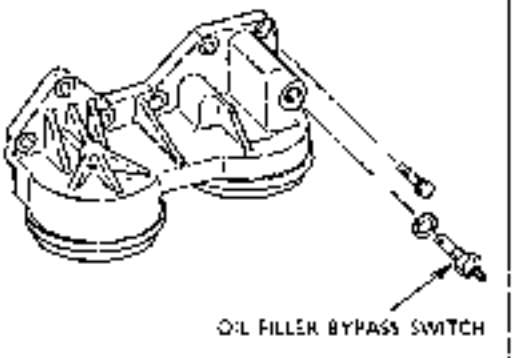
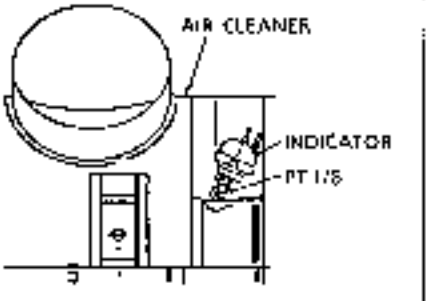
File No. Name of part Part No. Use Applicable Machine	Specification	Description
SW—1 Switch YN50S00002P1 Key LC03501~ YC01101~ LS00701~ YS00601~	Connection table T / P: B, G1, G2, ACC, M, ST H: B, G1 OFF: ACC: B, ACC ON: B, ACC, M START: B, G2, M, ST	AUTO RETURN OFF HO S AUTO RETURN VIEW A A "K250" STAMPED ACC G2 ST M G1 B TERMINAL ARRANGEMENT
SW—2 Switch 2479Z1447 KPSS Release LC03801~ YC01101~ LS00701~ YS00601~	Type: S-32	GAUGE CONTROLLER M12PI HOLE Ø2.4 9PAM 1 4 7 2 5 8 3 6 9
SW—3 Switch YN03M01164P1 ATT. boost LC03801~ YC01101~ LS00701~ YS00601~	Type: Buried in right grip	SUMITOMO DENSO, HOUSING ITEM No : 6090-1031 (2P MALE) SUMITOMO DENSO, TERMINAL ITEM No 8230-1282
SW—4 Switch YN03M01089P1 Travel 1,2-speed LC03801~ YC01101~ LS00701~ YS00601~	Type: Buried in travel lever	MARKS ON SWITCH PORTION CA106

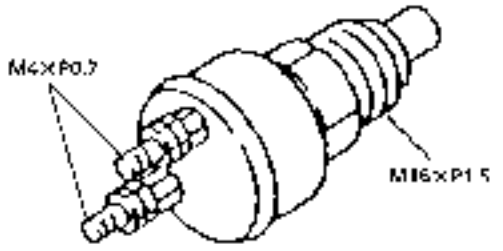
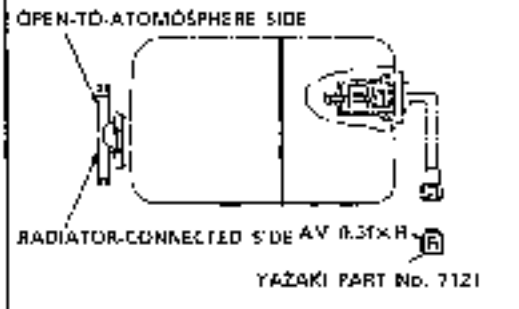
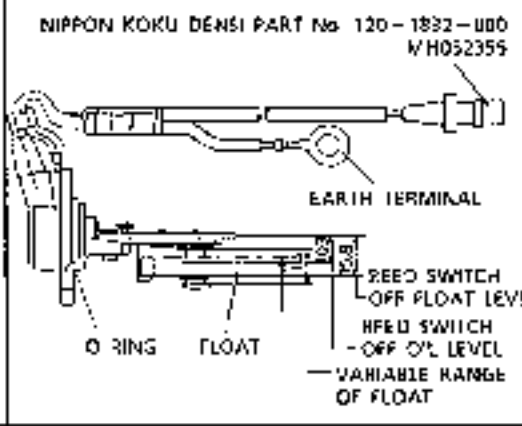
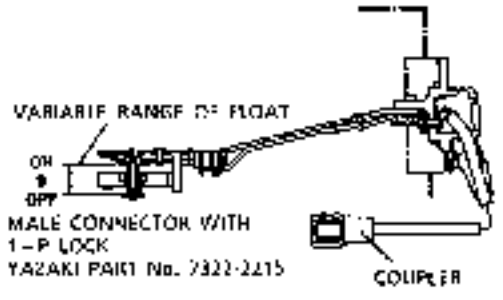
File No. Name of part Part No. Use Applicable Machine	Specification	Description
SW—5 Switch YN50S01001P1 Lever lock LC03601~ YC01101~ LS00701~ YS00601~	Type: Omron D4MC-5021 CONNECTION TABLE ① NO ② COM NC	 YAZAKI 2P HOUSING 7122-2228 TERMINAL 7114-2020
SW—6 Switch YN03M01165P1 Horn LC03601~ YC01101~ LS00701~ YS00601~	Type: Buried in left grip	
SW—7 Air-conditioner switch 24100Z75S3 (YN20M01068P1) Air-conditioner LC03601~ YC01101~ LS00701~ YS00601~	Type: 58580-40160	
SW—8 Heater switch 2479U325 Heater Option LC03601~ YC01101~ LS00701~ YS00601~	Rated voltage: DC 24V Load used: 135W DC motor CONNECTION TABLE	

	B	C	Lo	Hi
		80W	52W	135W
OFF	○			
I	○	○	○	
II	○	○		○

File No. Name of part Part No. Use Applicable Machine	Specification	Description
SW－9 Switch 2479U1190F7 Auto accel LC03801～ YC01101～ LS00701～ YS00601～	Switch mechanism: Center spring return Rated voltage: DC 24V Insulation resistance: 1MΩ or below / DC 500V megger Switch mark: Auto accel action / Auto accel release	
SW－10 Switch 2479U1348F2 Mode select LC03801～ YC01101～ LS00701～ YS00601～	Type: 2479U1348F2 Number of select positions: 4 (E,S,P,C,D) Full rotation angle: 135° Mode position: KPSS E S P C	
SW－11 Switch 2479U1190F19 Swing flasher LC03801～ YC01101～ LS00701～ YS00601～	Switch mechanism: Alternate Rated voltage: DC 24V Insulation resistance: 1MΩ or more / DC 500V megger Switch mark: Swing flasher	
SW－12 Switch 2479U1578F1 Working light LC03801～ YC01101～ LS00701～ YS00601～	Type: Alternate Rated voltage: 24V Switch mark: Working lamp ON (Dump, right, left, boom) Neutral : OFF Working lamp ON, Rear working lamp ON	

File No. Name of part Part No. Use Applicable Machine	Specification	Description
SW—13 Switch 2479U1191F1 Buzzer stop Time adjust LC03801~ YC01101~ LS00701~ YS00601~	Type: Center spring return Rated voltage: DC 24V Insulation resistance: 1MΩ or over / DC 500V megger Switch mark: ① Buzzer stop ② Clock	CONNECTOR (with lock) YAZAKI 7122-2237 equivalent Red (R) White (W) Blue (L) OFF ON
SW—14 Switch 2479U1278F2 Wiper & Washer LC03801~ YC01101~ LS00701~ YS00601~	Type: Rated voltage: 24V Voltage drop: 0.1V or below (under rated condition) Insulation resistance: 200MΩ / DC 500V megger (between insulated terminals and between insulated terminals and frame) Rotating torque: 0.8±0.5kgf·cm (0.0579±0.0362 ft·lbs) Rated load: Between P and L; Between B and L; intermittent relay input Between B and H; Between B1 and W; washer motor	Blue / White (L) B1 Red / White (R) Blue / Black (L) Blue (L) Blue / Red (W) Red (R) CONNECTOR (with lock) YAZAKI 7122-2262 equivalent
SW—15 Switch 2479U1190F16 Buzzer stop (Travel alarm) LC03801~ YC01101~ LS00701~ YS00601~	Type: Alternate Rated voltage: DC 24V Insulation resistance: 1MΩ or more / 500V megger CONNECTION Switch \ Terminal: L, RW OFF ON	CONNECTOR (with lock) YAZAKI 7122-2236 equivalent Red (R) Red / White (RW)

File No. Name of part Part No. Use Applicable Machine	Specification	Description
SW-18 (OPT.) Switch 2479L1190F21 Extra breaker LC03801~ YC01101~ LS00701~ YS00601~	Type: Alternate Rated voltage: DC 24V Insulation resistance: 1MΩ or over/DC 500V megger Switch mark: EXTRA	
SW-20 Switch MC840219 E/G oil pressure LC03801~ YC01101~ LS00701~ YS00601~	Maker P/No: MC840219 Rated voltage: 24V Open circuit oil press.: 0.5kg/cm² MIN Contact type: Normally closed	
SW-21 Switch ME054661 E/G oil filter LC03801~ YC01101~ LS00701~ YS00601~	Maker P/No: ME054661	
SW-22 Switch 2446R336S11 Air filter LC03801~ YC01101~ LS00701~ YS00601~	Maker parts No: 6000L-141	

File No. Name of part Part No. Use Applicable Machine	Specification	Description
SW – 23 Switch YN02PU1003P1 E/G water Temp. (105°C (221.0°F)) LC03801~ YC01101~ LS00701~ YS00601~	Maker P/No. : MR039810	
SW – 24 Switch 2427U203S6 E/C coolant level LC03801~ YC01101~ LS00701~ YS00601~	Sub tank: Tntn'. water volume 3.6ℓ (0.80gal) HIGH 1.8ℓ (0.40gal) LOW level 0.43ℓ (0.11gal) Switch function: Remaining liquid level 0.43±0.1ℓ (0.11 – 0.026gal) Contact type: Normally closed	
SW – 25 Switch MC840577 E/G oil level LC03801~ YC01101~ LS00701~ YS00601~	Mitsubishi part No.: MC840577 Rated voltage: 24V Rated current: 0.3A or below Contact type: Normally closed	
SW – 26 Switch 2459R302P1 Hyd. oil level LC03801~ YC01101~ LS00701~ YS00601~	Type: 07191-2089 Contact resistance: Less than 500mΩ (Between connector terminal and body) Insulation resistance: 1MΩ More than (DC 250V when switch is OFF) Switch capacity: Less than 0.3A Other: Do not use one that dropped.	

File No. Name of part Part No. Use Applicable Machine	Specification	Description
SW−27,29,30 Pressure switch 2479U1378 Auto accel Swing 1 Pedal Lever LC03801~ YC01101~ LS00701~ YS00601~	Contact type: Normal open Medium used: Hydraulic oil Operating pressure range: 0~60 kgf/cm² (0~711 psi) Operating temperature range: −30~130°C (−22~266°F) Contact open/close capacity (DC): Voltage 10~30V, Current 10mA~3.5A (provided power is 50W or below) Insulation resistance: Between terminals (when open), body: 10MΩ or more / DC 500V megger Operating pressure: 6.0±0.6 kgf/cm² (85±7 psi) Reset pressure: 4.0±0.4 kgf/cm² (57±6 psi)	2 AV 0.85 B 1 AV 0.85 Y PT 1/8 SUMITOMO DENSO CONNECTOR (MODEL 090 WATERPROOF CONNECTOR) 2-POLE MALE HOUSING 6187-2311 equivalent
SW−28 Switch ME049263 2479R2348 Hyd. oil temp [95°C (203°F)] LC03801~ YC01101~ LS00701~ YS00601~	Operating temperature: ON 5°C (38°F), OFF 10°C (50°F)	PT 3/8 CA104 Lot No. BLUE PAINT
SW−31 Switch 24109U1436F1 Hyd. oil filter LC03801~ YC01101~ LS00701~ YS00601~	Rated voltage: DC 24V 8A Circuit press: 140kgf/cm² Differential press: 1.05kgf/cm² Oil Temp: −50~120°C (−58~248°F) Contact point: Normal open	(Black) AEX 1.25mm² (Black) (Red) AVS Housing (M): 7122-2229 (YAZAKI) Terminal (M): 7144-2020 (YAZAKI)
SW−33 Switch 2479R2287 Hyd. Tank Air Press. SW. LS00701~ YS00601~	Rated voltage: DC 24V 4A Set pressure: 0.25±0.05kgf/cm² Max. working press.: 10.5kgf/cm² Contact point: Normal close	CA104 1/8 PT

Book code No. 55LC2505E

KOBELCO

SHOP MANUAL

SK310
SK310LC

ELECTRIC SYSTEM

TABLE OF CONTENTS

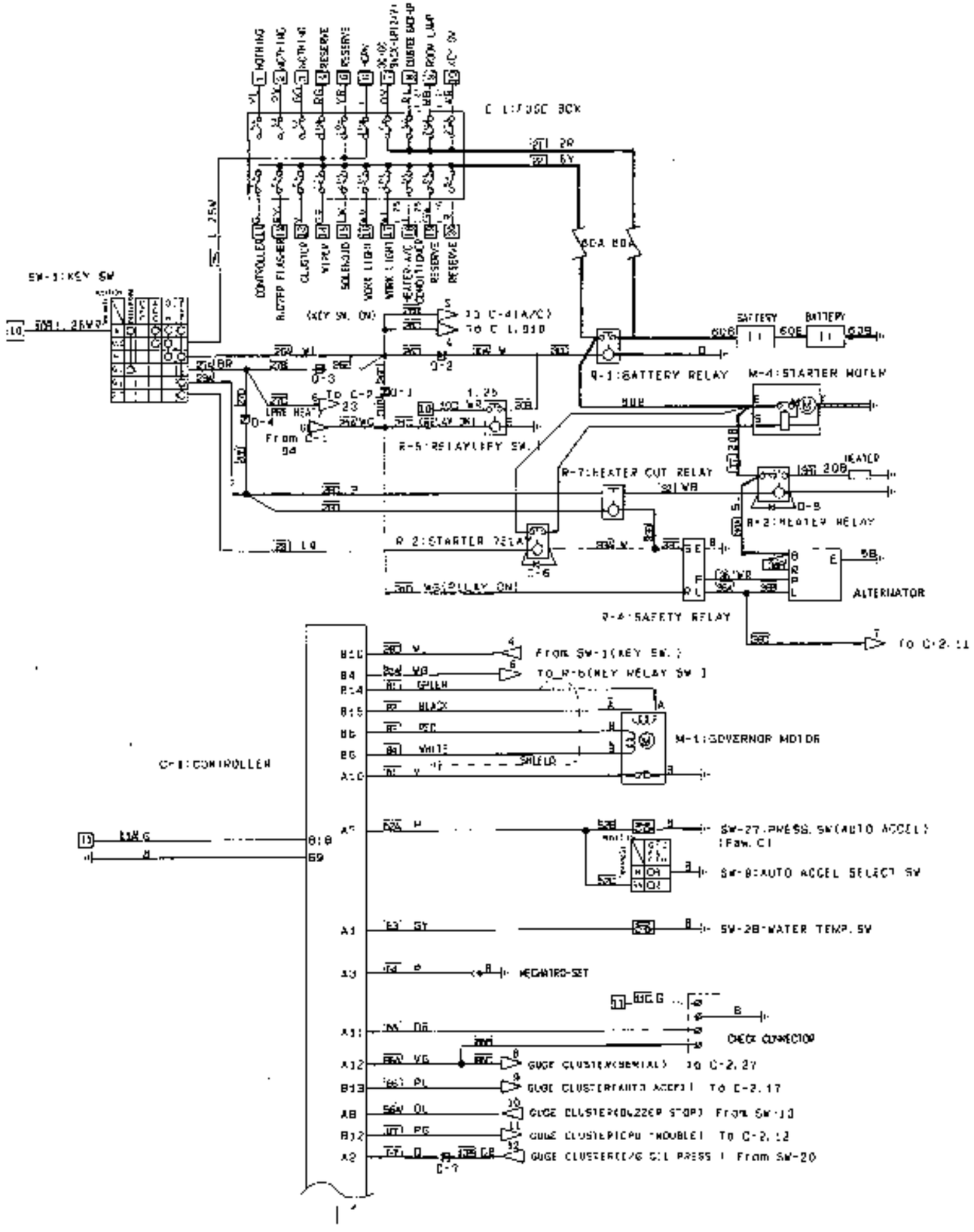
LC25

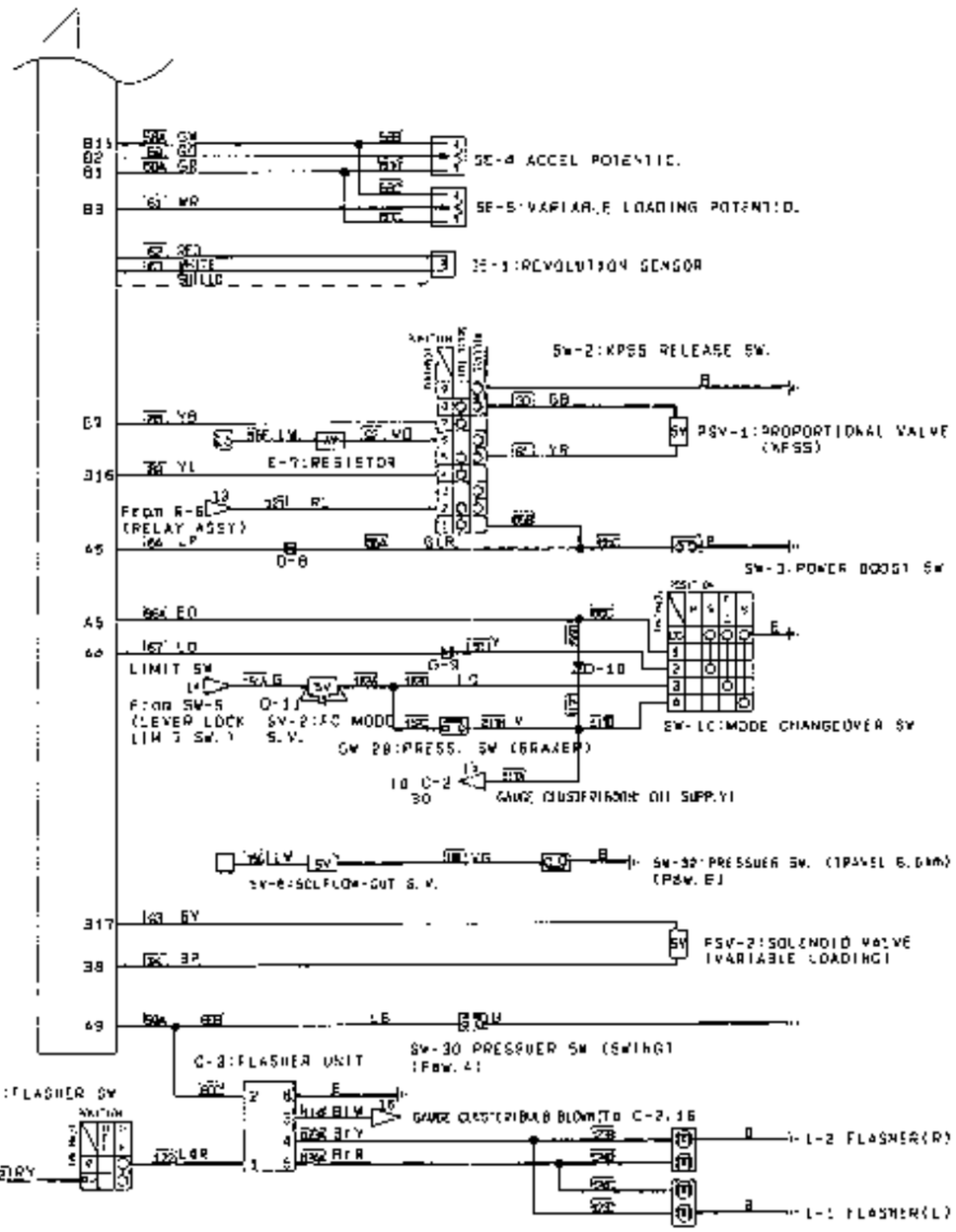
KOBE STEEL, LTD.

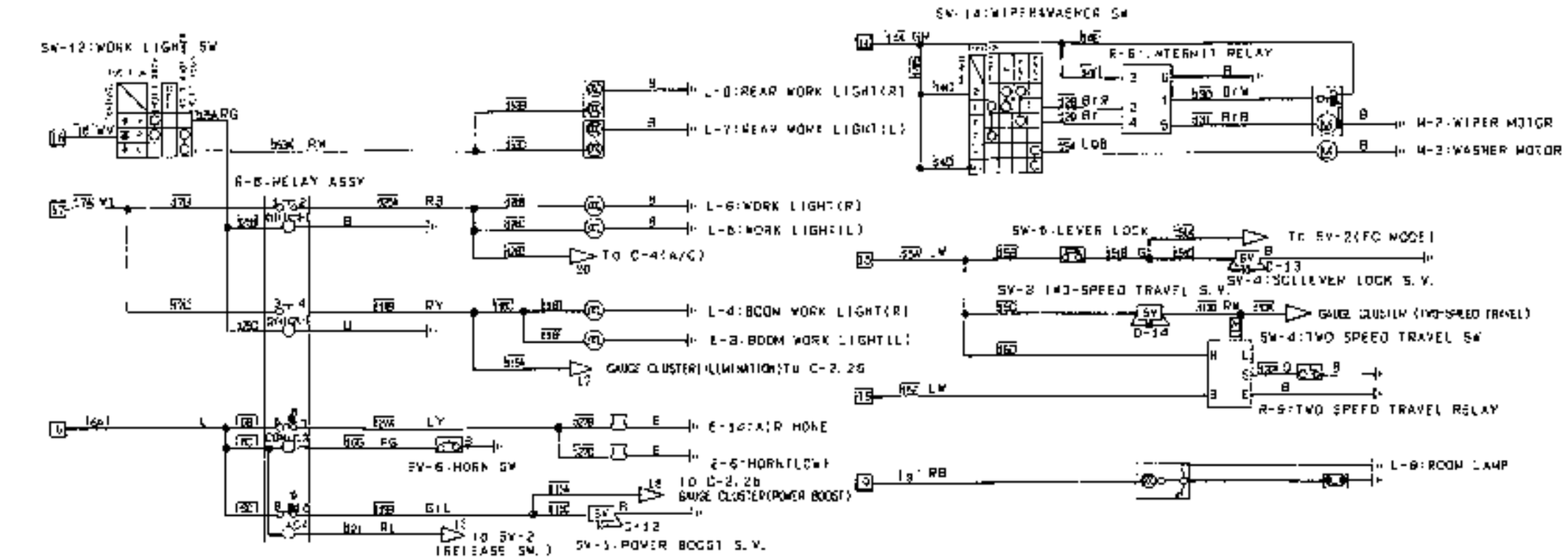
Applicable Machines
LC03801~
YC01101~

Revision	Date of Issue	Remarks
First edition	March, 1995	S5LC2505E K

1. ELECTRIC CIRCUIT DIAGRAM







NOTES

1. WIRES USED TO BE

   1) "AVSS" OR "AVSF" FOR 0.75mm² AND 1.25mm².

   2) "AVS" FOR 2mm, 3mm

   3) "AV" FOR OTHERS.

2. WIRES TO BE 0.75mm² UNLESS OTHERWISE SPECIFIED

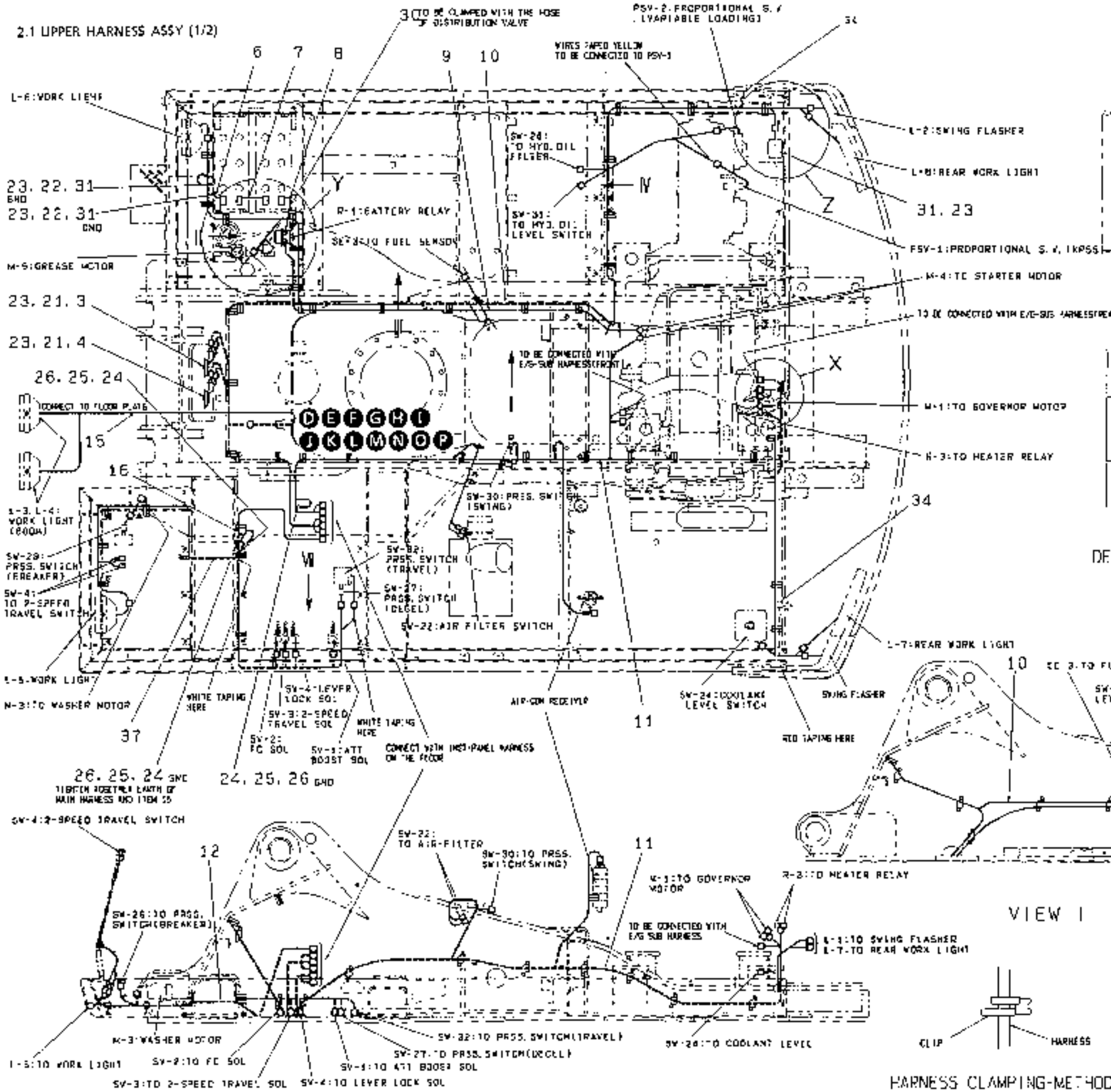
3. GROUND AS FOR WHICH WIRE COLOR IS NOT SHOWN TO BE

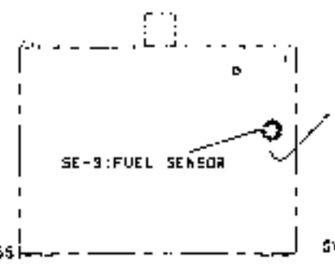
   PERFORMED WITH COMPONENT CASE.

4. NUMBER IN SQUARE SHOWS LINE NO.

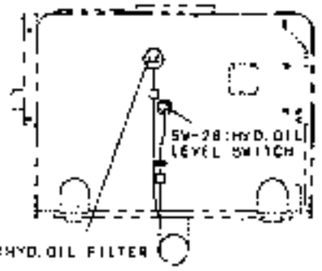
2. HARNESS

2.1 UPPER HARNESS ASSY (1/2)



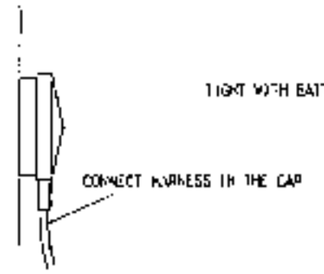


DETAIL OF VIEW III (FUEL TANK)

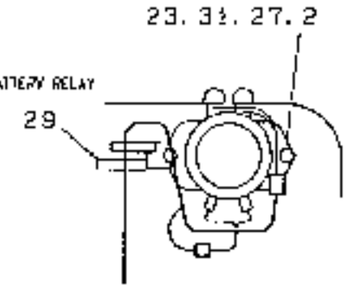


DETAIL OF VIEW IV (HYD. OIL TANK)

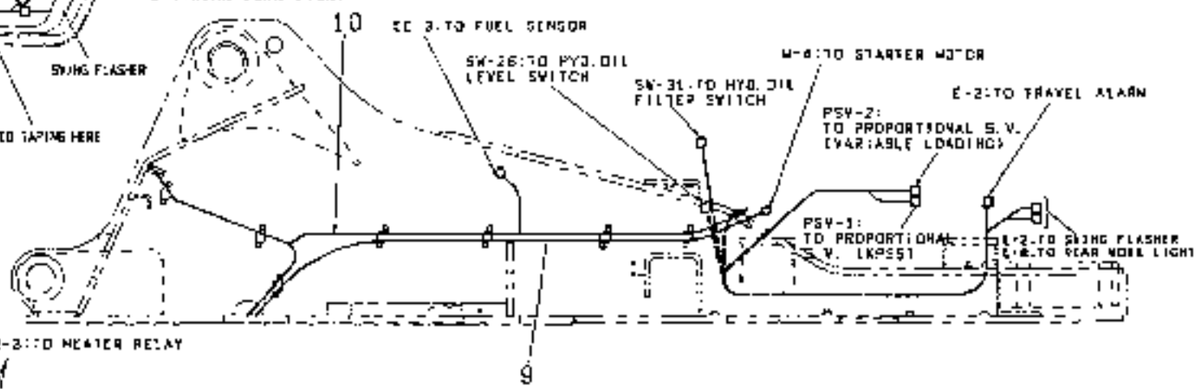
TIGHTENING TORQUE TO BE 0.7±0.1kgf·m



DETAIL OF FUEL SENSOR



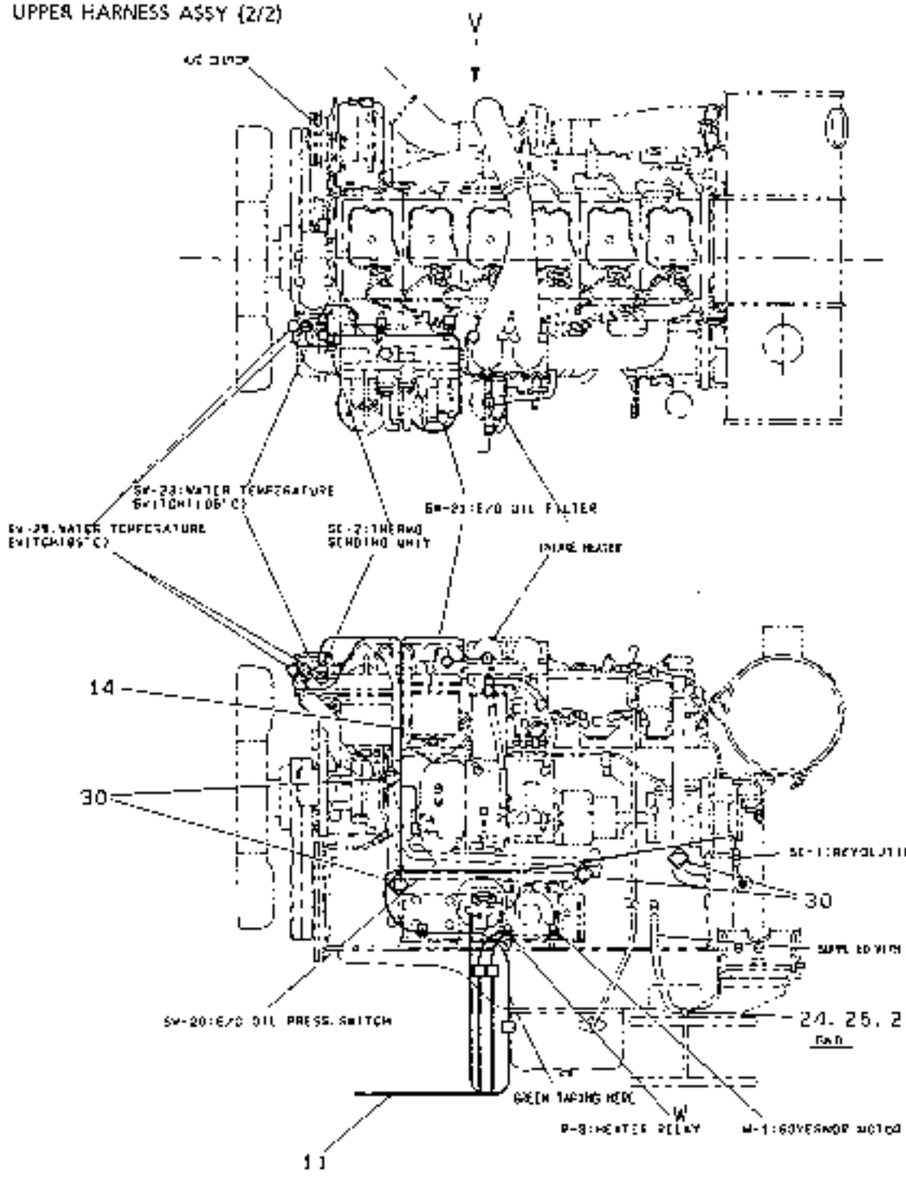
DETAIL OF VIEW II (BATTERY RELAY)



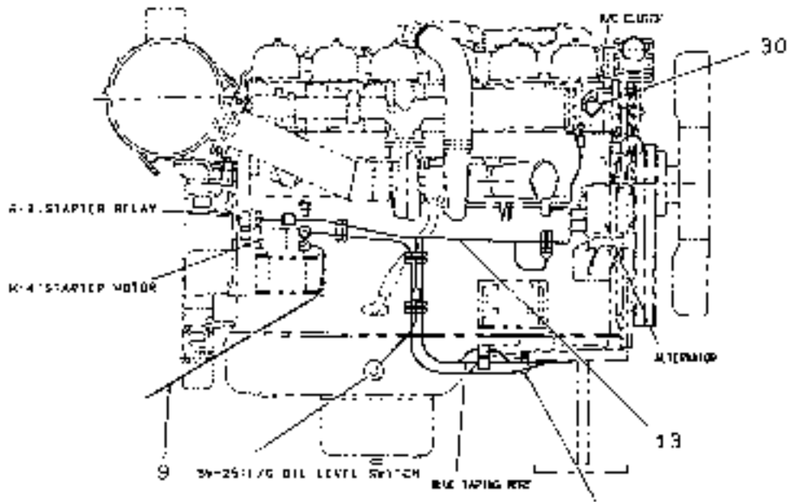
VIEW I

HARNESS CLAMPING-METHOD

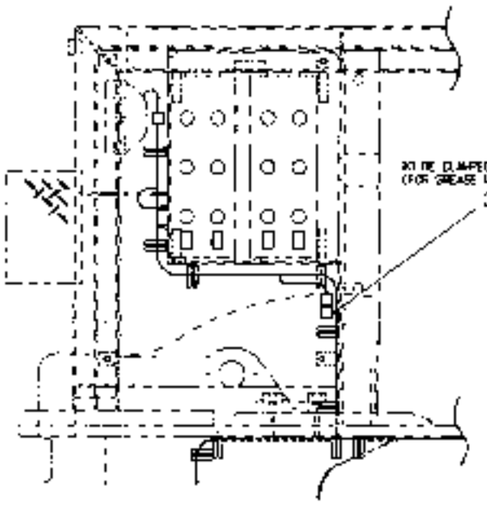
UPPER HARNESS ASSY (2/2)



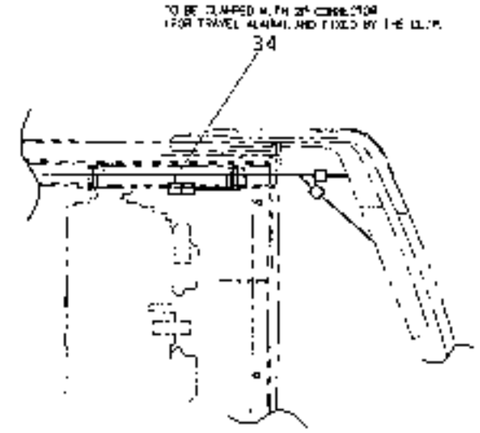
DETAIL OF ENGINE



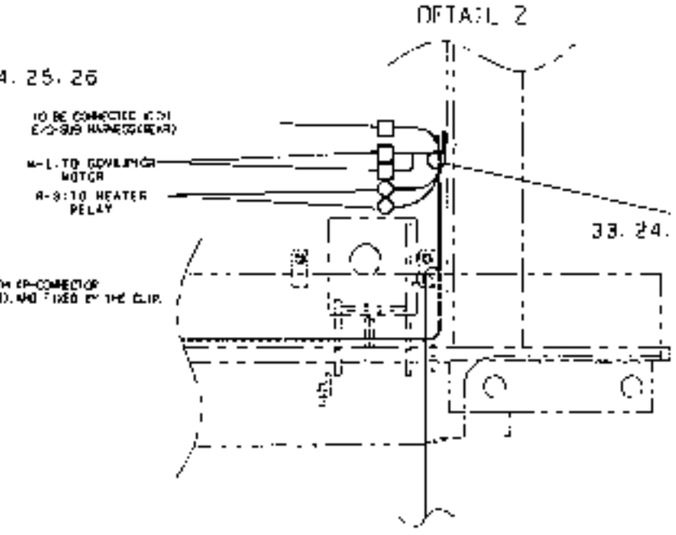
VIEW V



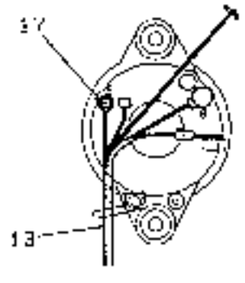
DETAIL Y



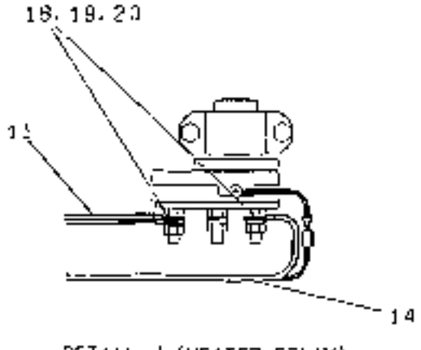
DETAIL Z



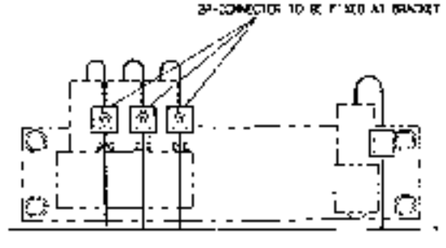
DETAIL X



VIEW W (DETAIL OF ALTANATOR)



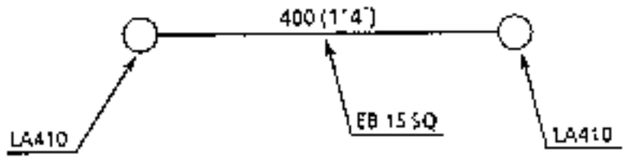
DETAIL W (HEATER RELAY)



VIEW W

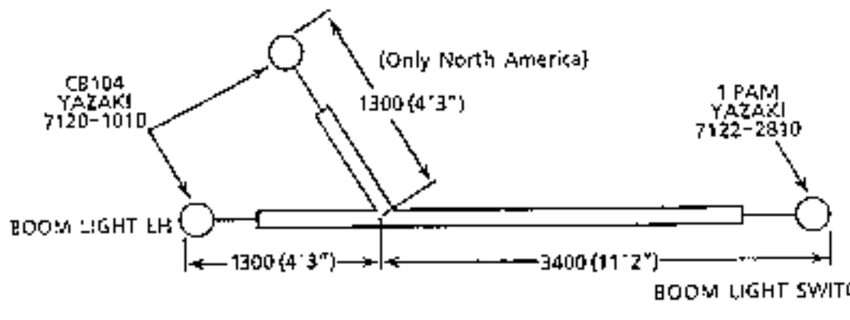
No.	NAME	Q'TY	No.	NAME	Q'TY
2	BATTERY RELAY	1	19	LOCK WASHER	2
3	HORN ASSY (HIGH)	1	20	WASHER	2
4	HORN ASSY (LOW)	1	21	CAPSCREW	2
6	BATTERY CABLE	1	22	NUT	2
7	BATTERY CABLE	1	23	LOCK WASHER	6
8	BATTERY CABLE	1	24	NUT	6
9	BATTERY CABLE	1	25	LOCK WASHER	6
10	HARNESS : RIGHT SIDE	1	26	WASHER	6
11	HARNESS : LEFT SIDE	1	27	CAPSCREW	2
12	HARNESS : UNDER FLOOR	1	29	CLIP	1
13	HARNESS : E/G FRONT	1	30	CLIP	6
14	HARNESS : E/G REAR	1	31	WASHER	4
15	HARNESS . 2 LIGHT	1	32	CLIP	1
16	HARNESS : GROUNDING	1	33	CLIP	1
17	SEMS BOLT	1	34	PLUG	1
18	NUT	2	36	PLUG	1

2.1.1 GROUNDING HARNESS (2-16)



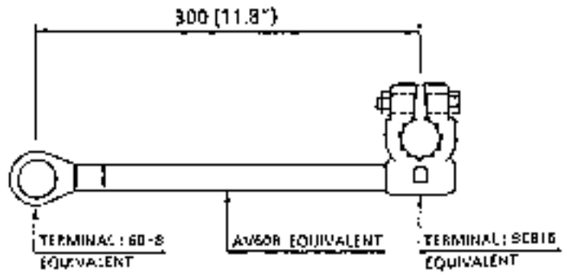
2.1.2 BOOM WORKING LIGHT HARNESS (2-15)

(1) Two Light Harness

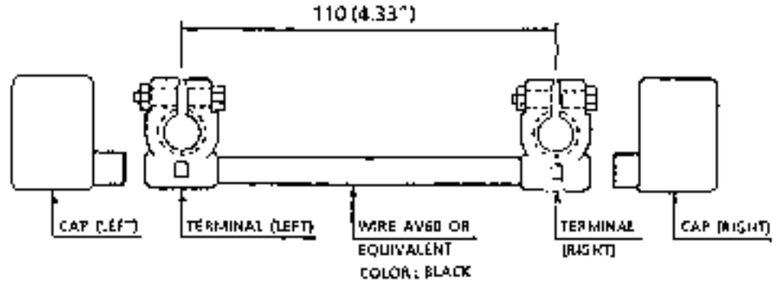


2.1.3 BATTERY CABLE

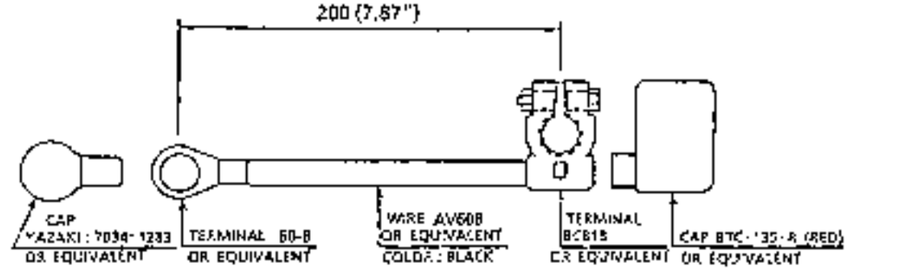
(1) Battery Cable (2-6)



(2) Battery Cable (2-7)

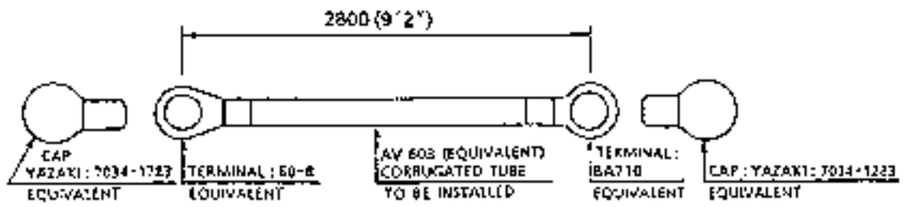


(2) Battery Cable (2-8)

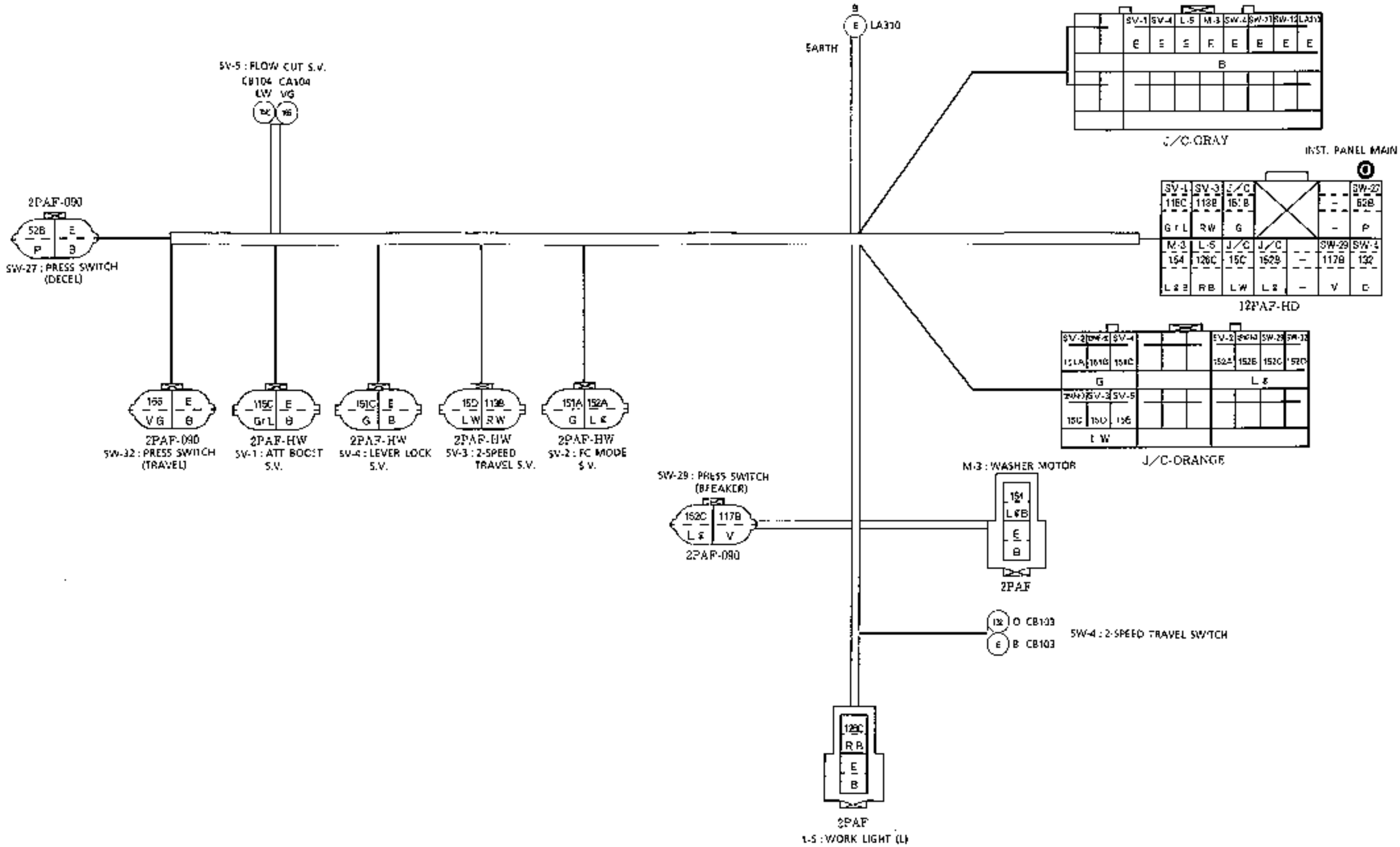


2.1.4 CABLE

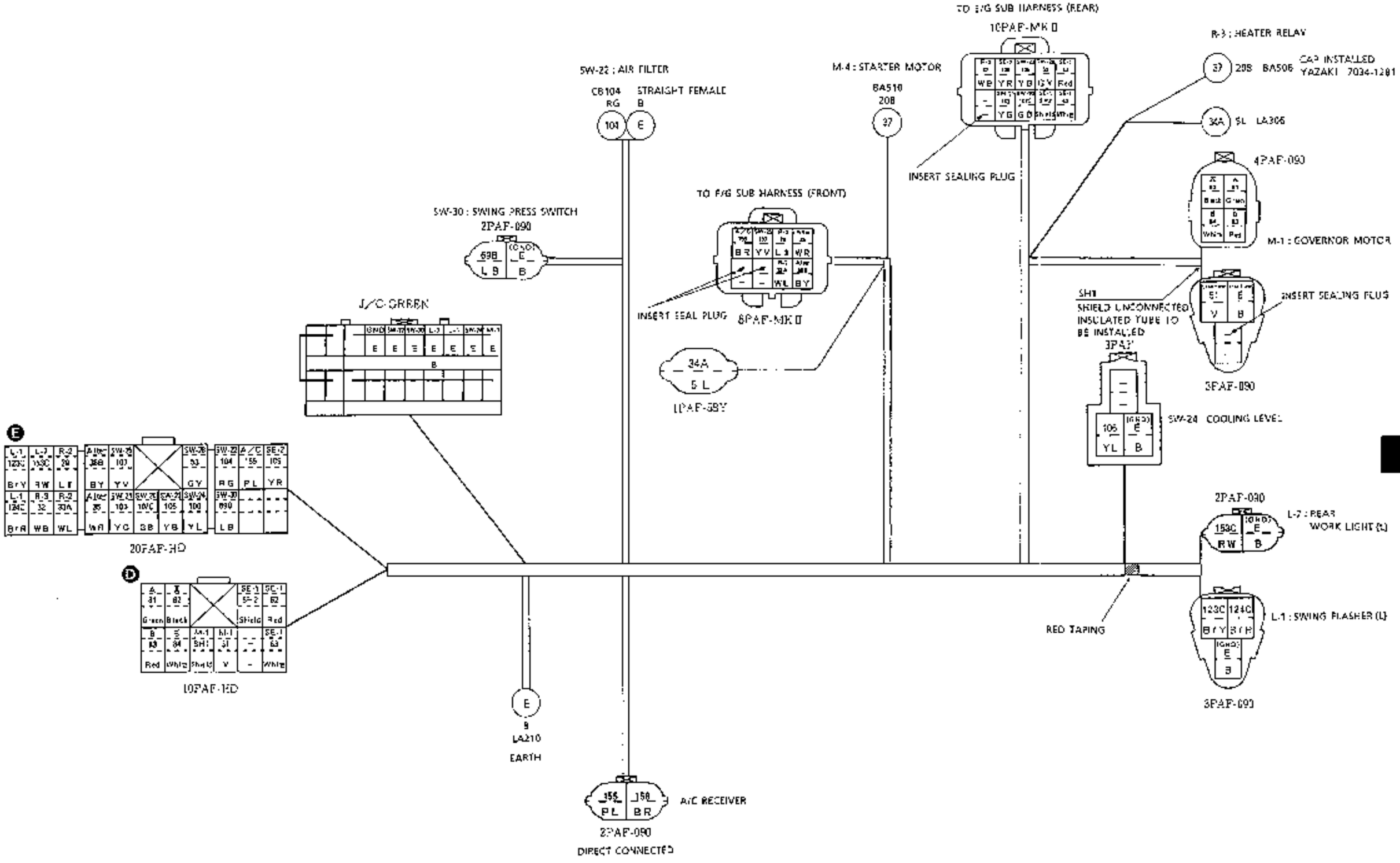
(1) Battery ~Starter motor (2-9)



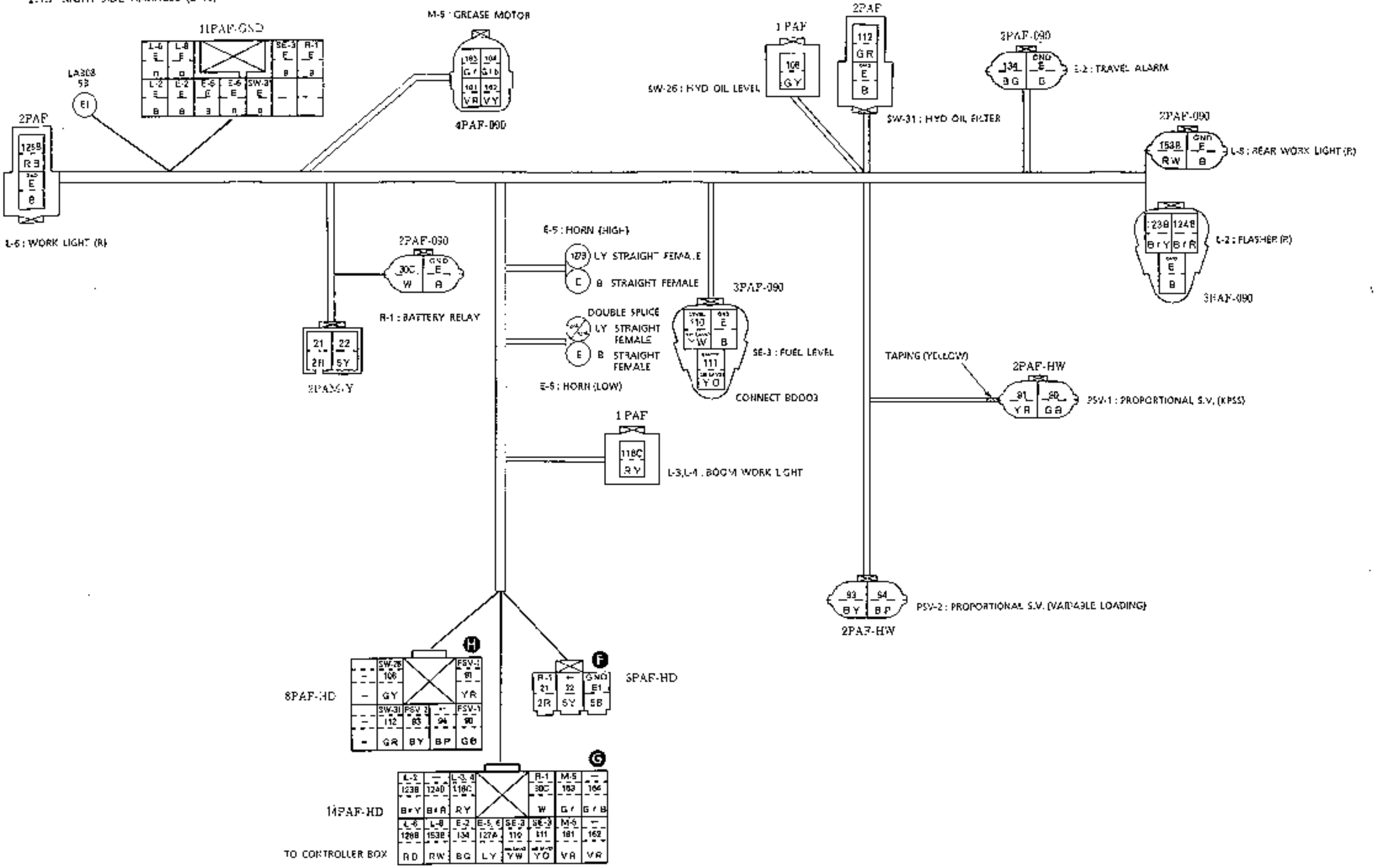
2.1.5 UNDER FLOOR HARNESS (2-12)



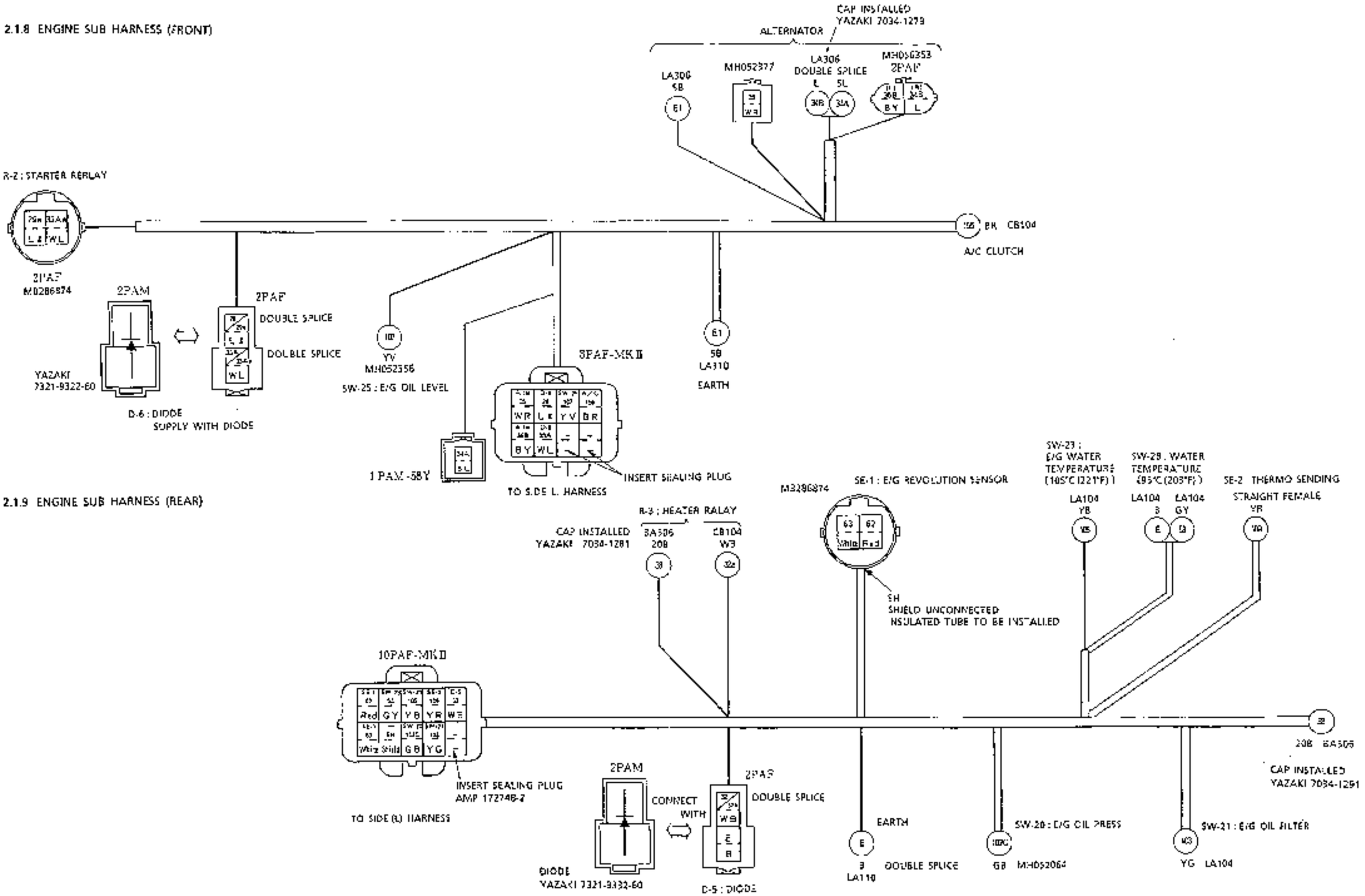
2.1.6 LEFT SIDE HARNESS (2-11)



2.1.7 RIGHT SIDE HARNESS (2-10)

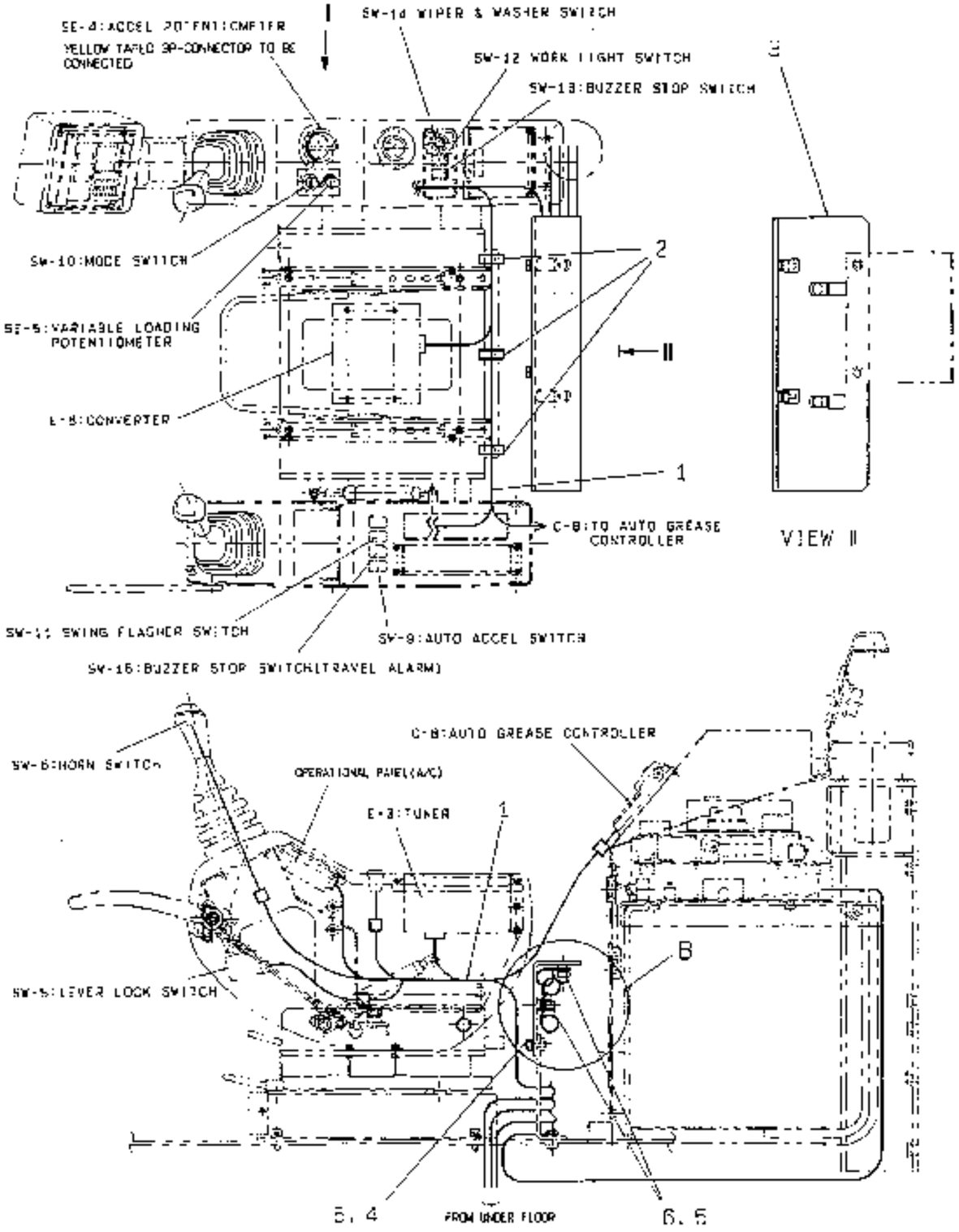


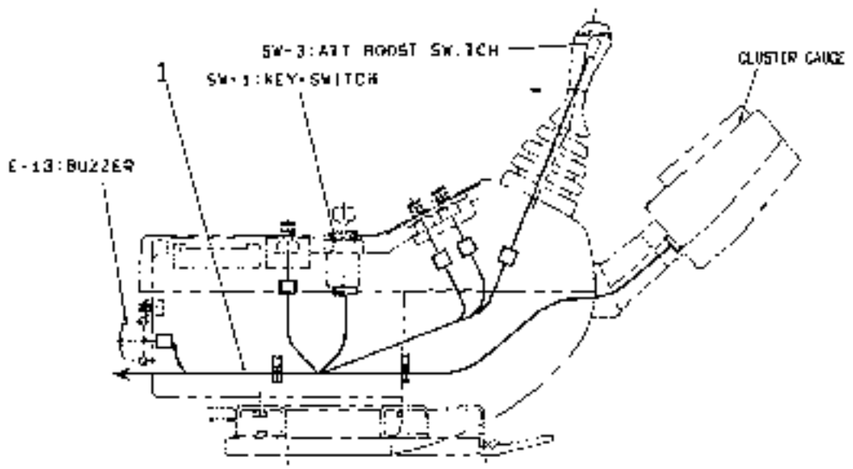
2.1.8 ENGINE SUB HARNESS (FRONT)

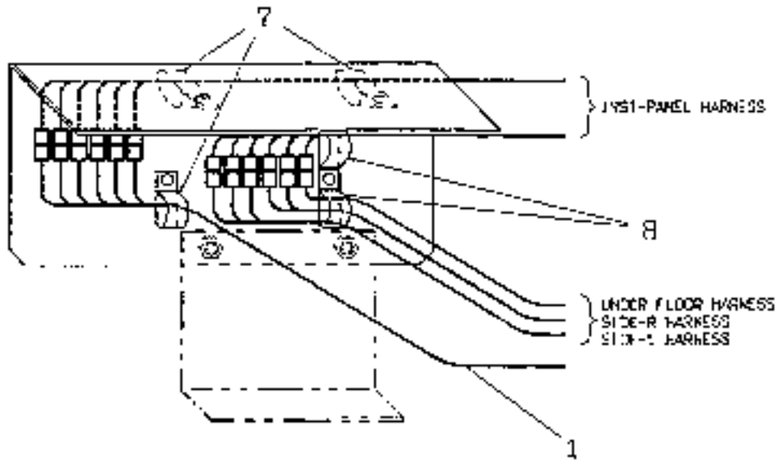


2.1.9 ENGINE SUB HARNESS (REAR)

2.2 INSTRUMENT PANEL HARNESS ASSY RIGHT AND LEFT



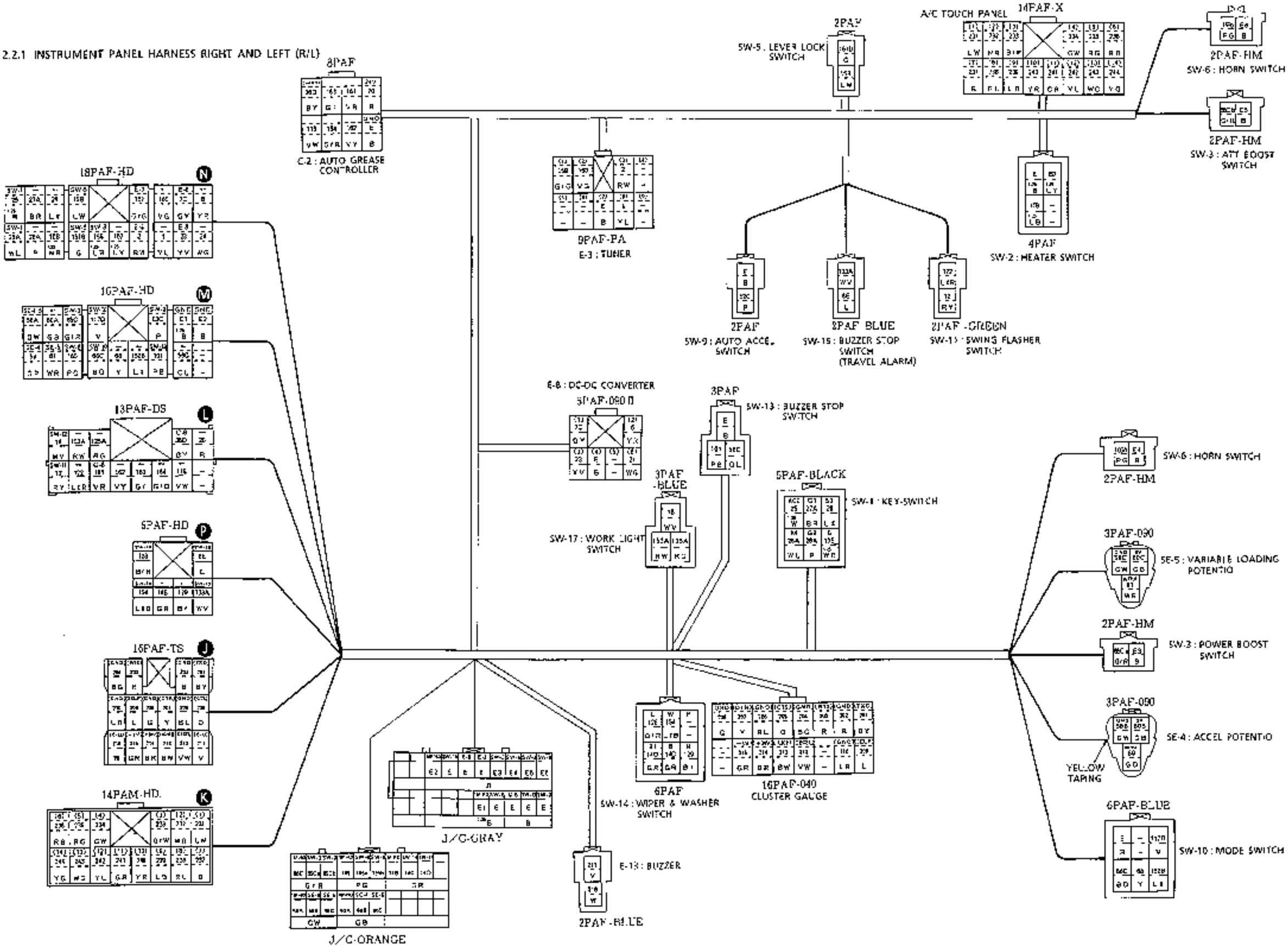




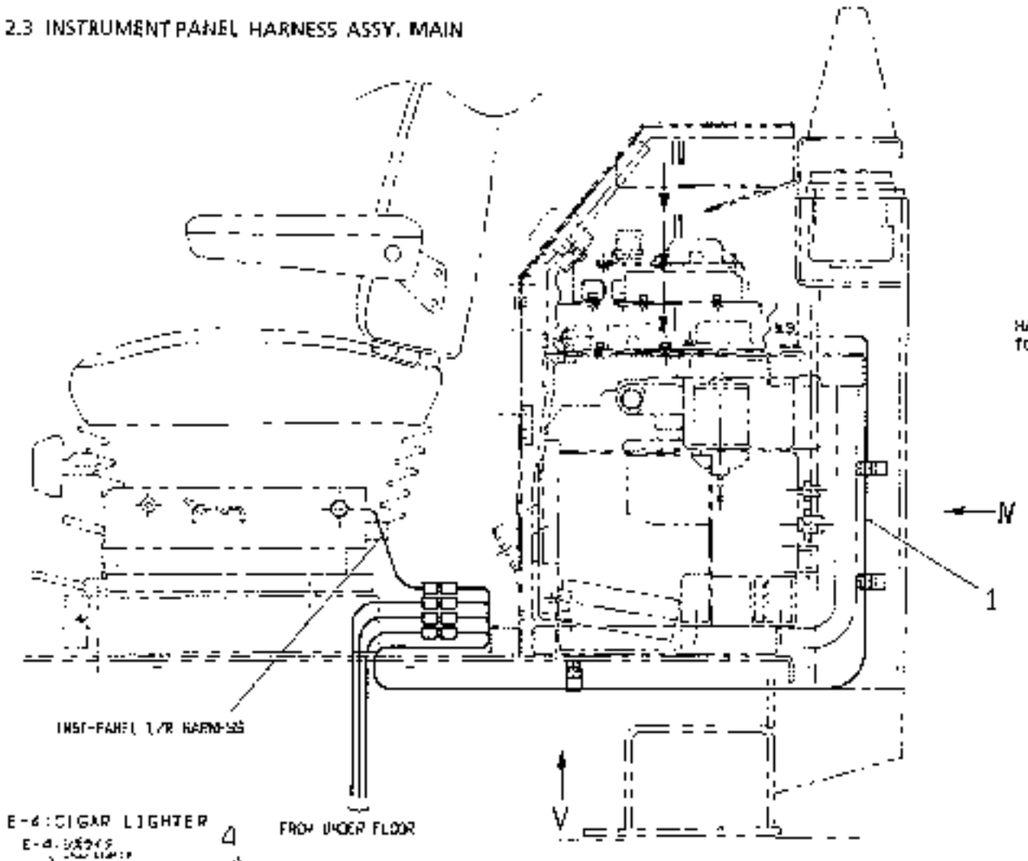
DETAIL OF B(HOW TO CLAMP HARNESS)

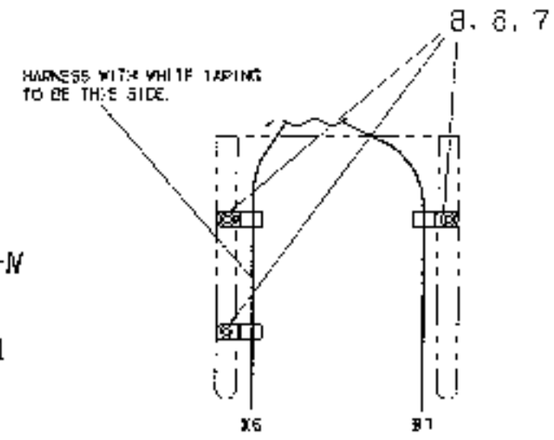
No.	NAME	QTY
1	HARNESS:INST PANEL R/L	1
2	CLIP	3
3	PLATE	1
4	CAPSCREW	2
5	LOCK WASHER	6
6	NUT	4
7	CLIP	3
8	CLIP	2

2.2.1 INSTRUMENT PANEL HARNESS RIGHT AND LEFT (R/L)

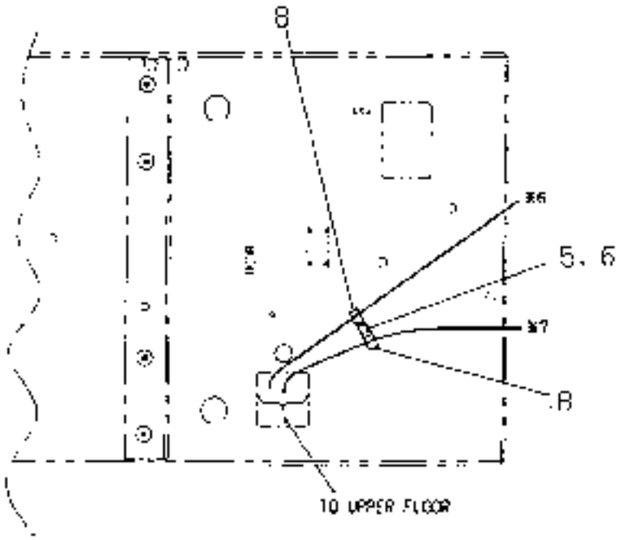


2.3 INSTRUMENT PANEL HARNESS ASSY. MAIN

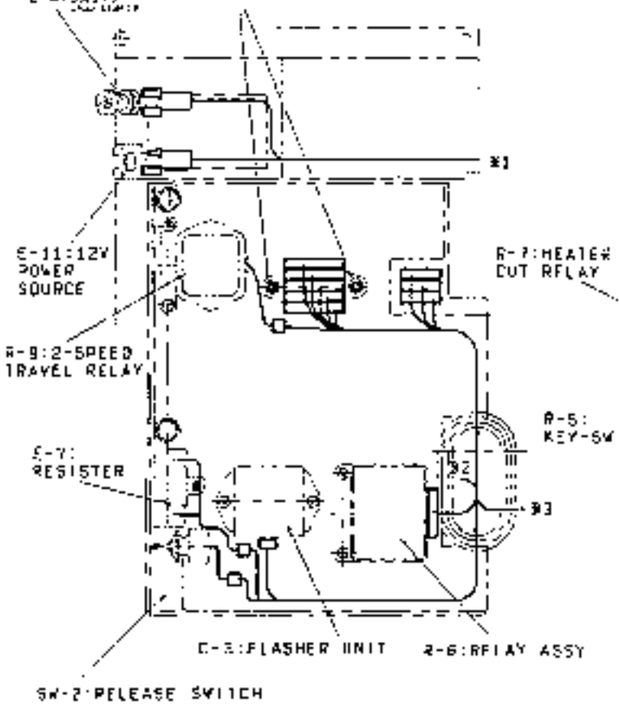




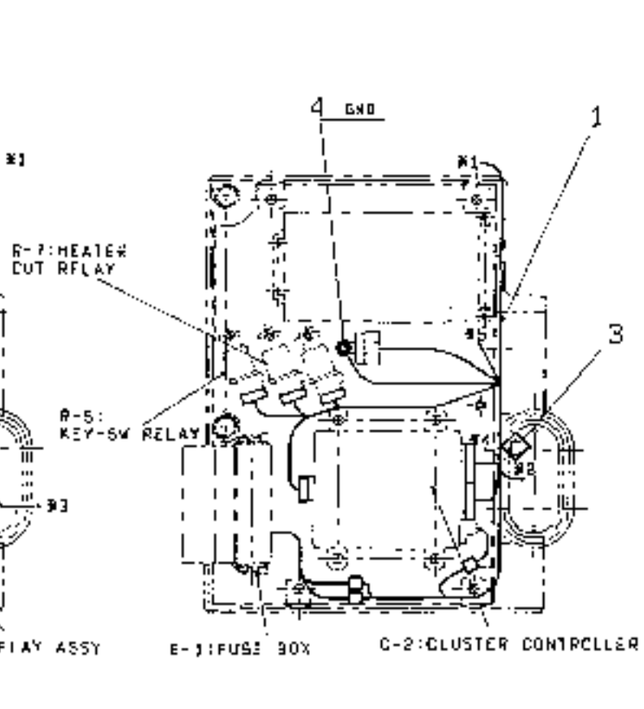
VIEW IV
DETAIL OF THE WAY TO CLAMP HARNESS



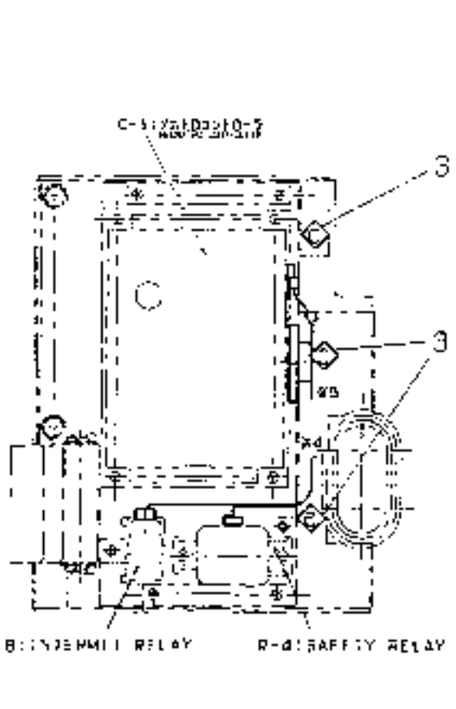
VIEW V
DETAIL OF THE WAY TO CLAMP HARNESS



VIEW I



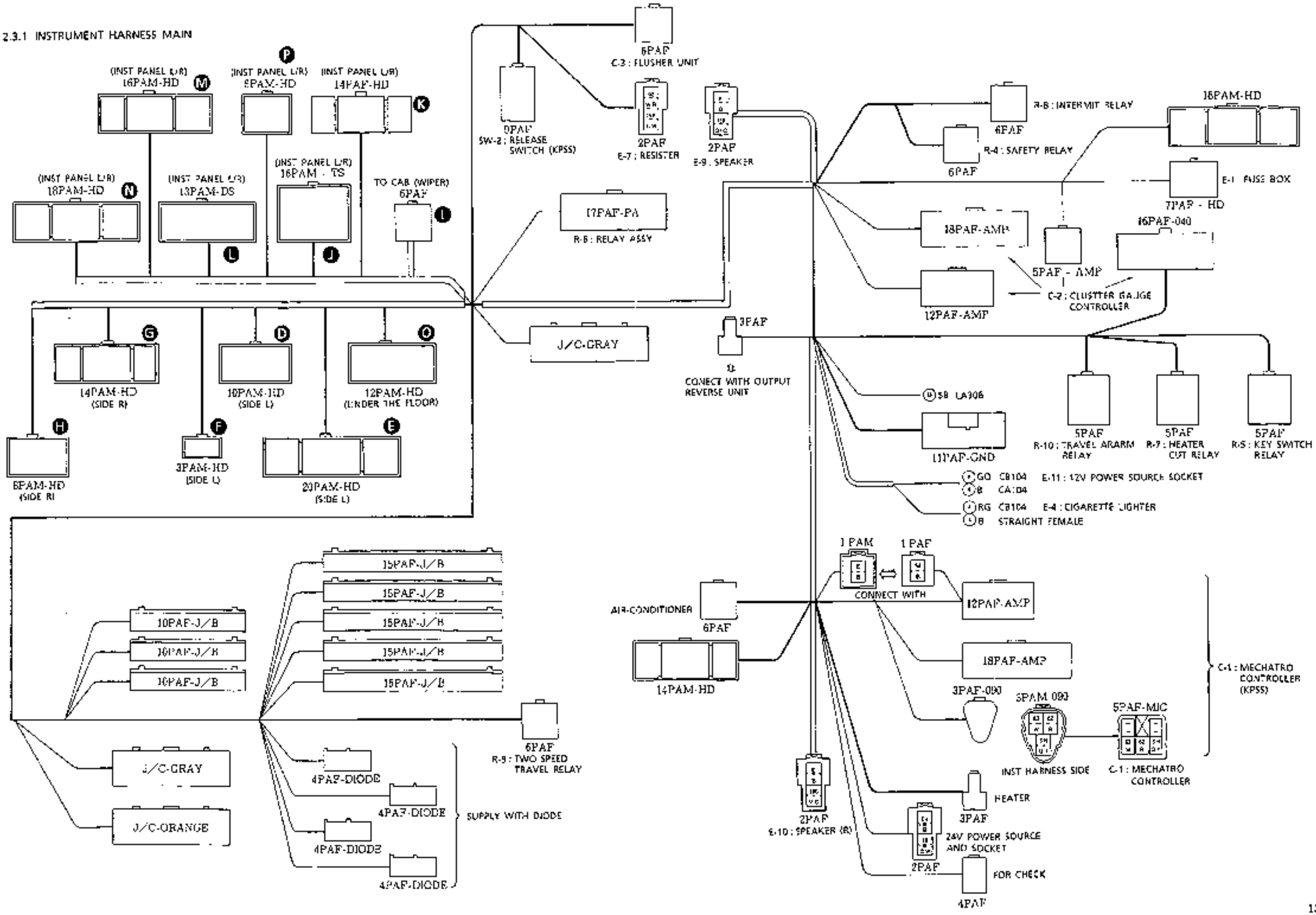
VIEW II

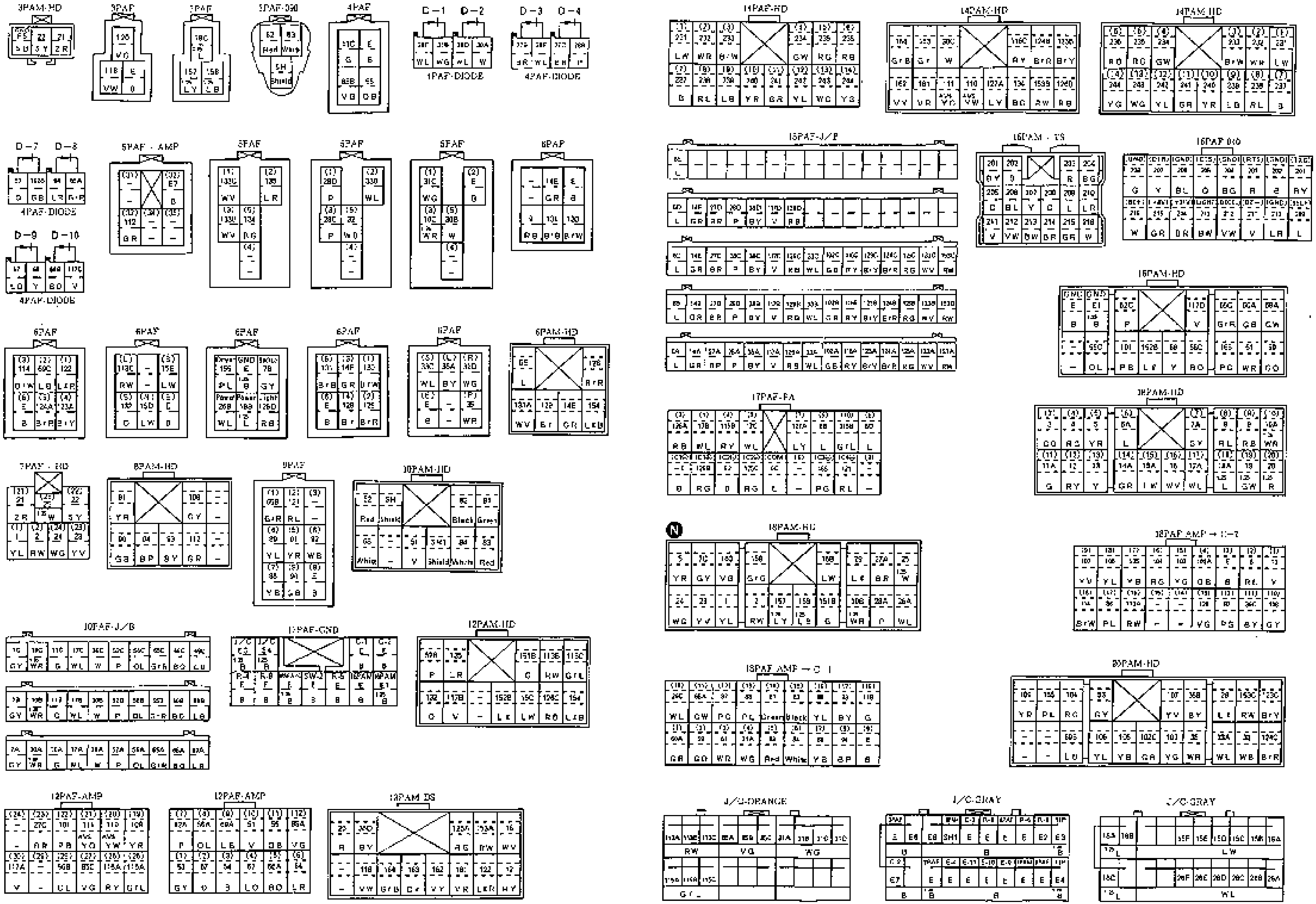


VIEW III

No.	NAME	Q'TY
1	HARNESS:INST-PANEL	1
3	CLIP	4
4	SEMS BOLT	3
5	CAPSCREW	1
6	LOCK WASHER	4
7	NUT	3
8	CLIP	5

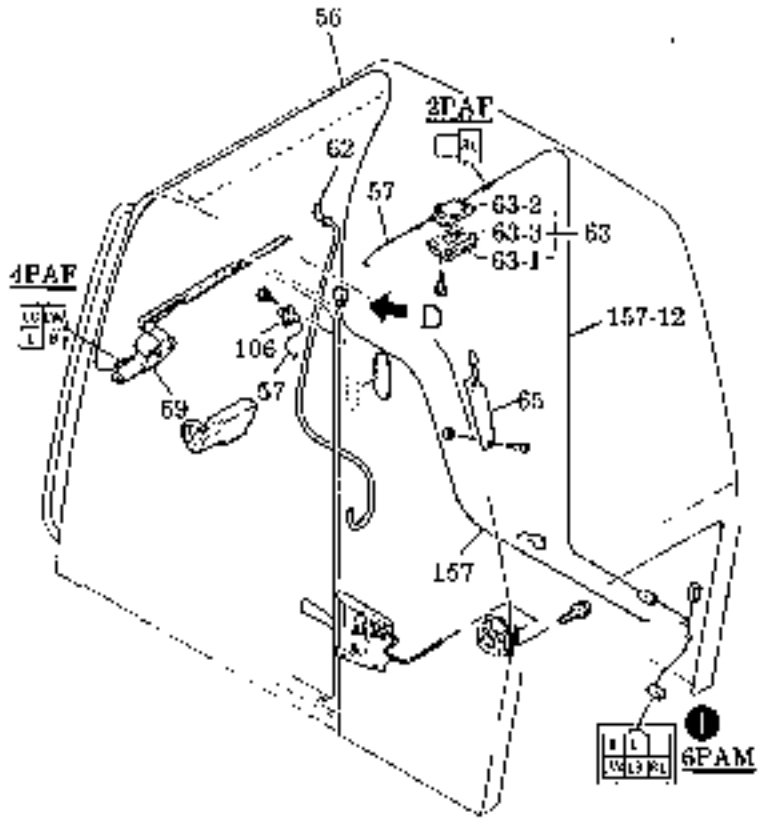
2.3.1 INSTRUMENT HARNESS MAIN



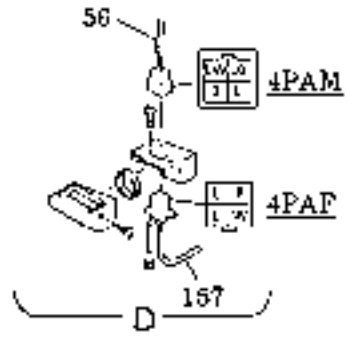


3PAM-HD
3PAF
4PAF
D-1
D-2
1PAF-DIODE
D-3
D-4
4PAF-DIODE
D-7
D-8
D-9
D-10
5PAF-AMP
5PAF
6PAF
6PAM-HD
7PAF-HD
8PAM-HD
9PAF
10PAM-HD
10PAF-J/B
12PAM-HD
12PAF-AMP
13PAM-DS
14PAF-HD
14PAM-HD
15PAF-J/B
16PAM-TS
16PAF-DIO
16PAM-HD
17PAF-FA
18PAM-HD
18PAM-HC
19PAF-AMP
20PAM-HD
J/C-ORANGE
J/C-GRAY

2.4 CAB HARNESS



No	NAME	QTY
56	HARNESS : WIPER	1
57	HARNESS : DOOR SW.	1
59	WIPER MOTOR	1
63	ROOM LAMP	1
65	ANTENNA	1
106	DOOR SWITCH	1
157	HARNESS	1
157-12	HARNESS : ROOM LAMP	1



3. CONNECTION TABLE OF HARNESSES ACCORDING TO WIRE NUMBERS

(1) HOW TO USE CONNECTION TABLE OF HARNESS

1) Search a number wiring

Search the failed electric device in the electric diagram and find the number of wiring.

2) Search a harness name and connector name

Find the number of wiring in Connection Table of Harness.

Then search the name of harness and connector.

3) Search the location of a wiring number

4) Conform the color of wire and gauge on the actual machine.

No.	Gauge& Color of wire	From		Connector at inst. Panel	To.	
		Equipment	No.	Name of connector	No.	Equipment
1	0.75YL	Fuse box	E-1	7PAF HD —— 18PAM-HD		Inst Panel L/R
2	0.75DW	"	E-1	7PAF-HD —— 18PAM-HD		"
3	0.75GO	"	E-1	18PAM-HD —— CB104	(R-11)	12V power source
4	0.75RG	Fuse box	E-1	18PAM-HD —— CB104	(R-4)	(Cigarette lighter)
5	0.75YR	"	E-1	18PAM-HD —— 18PAM-HD		Inst. Panel L/R
6A	0.75L			J/B-15PAF —— 18PAM-HD	E-1	Fuse box
6B	"			• 17PAF-FA	R-6	Relay assy.
6C	"			• 17PAF-FA	R-6	"
6D	"			• 17PAF-FA	R-6	"
6E	"			• 6PAM-HD		Inst. Panel L/R
7A	0.75GY			J/B-10PAF —— 18PAM-HD	E-1	Fuse box
7B	"			• 8PAF		A/C
7C	"			• 18PAM-HD		Inst Panel L/R
8	0.75RL	Fuse box	E-1	18PAM-HD —— 18PAF-AMP	C-2	Cluster gauge
9	0.75RB	"	E-1	18PAM-HD —— 6PAF		To Cab
10A	1.25WR			J/B-10PAF —— 18PAM-HD	E-1	Fuse box
10B	"			• 18PAM-HD		Inst. Panel L/R
10C	"			• 5PAF	R-5	Key Switch Relay
11A	0.75G			J/B-10PAF —— 18PAM-HD	E-1	Fuse box
11B	"			• 18PAF-AMP	C-1	Controller
11C	"			• 4PAF		For Check
12	0.75RY	Fuse box	E-1	18PAM-HD —— 13PAM-TS		Inst Panel L/R
13	0.75Y	Fuse box	E-1	18PAM-HD —— 18PAF-AMP	C-2	Cluster gauge

No.	Gauge & Color of wire	From		Connector at Inst. Panel	To.	
		Equipment	No.	Name of connector	No.	Equipment
14A	0.75GR			J/B-15PAF — 13PAM-HD	E−1	Fuse box
14B	↑			6PAM-DS		Inst. Panel L/R
14E	↑			6PAF		Cab
14F	↑			6PAF	R−8	Intermit relay
15A	0.75LW			J/C-GRAY — 18PAM-HD	E−1	Fuse box
15B	↑			18PAM-HD		Inst. Panel L/R
15C	↑			12PAM-HD		Under floor
15D	↑			6PAF (N)	R−9	2-speed relay
15E	↑			6PAF (B)	R−9	〃
15F	↑			2PAF	E−7	Resistor
16	0.75WV	Fuse box	E−1	18PAM-HD — 13PAM-DS		Inst Panel L/R
17A	0.75WL			J/B-10PAF — 18PAM-HD	E−1	Fuse box
17B	↑			17PAF-PA	R−6	Relay assy.
17C	↑			17PAF-PA	R−6	↑
18A	1.25L			J/C-GRAY — 18PAM-HD	E−1	Fuse box
18B	↑			6PAF		A/C
18C	〃			3PAF		Heater
19	1.25GW	Fuse box	E−1	18PAM-HD — 2PAF		24V Power reserve
20	0.75R	↑	E−1	18PAM-HD — 13PAM-DS		Inst. Panel L/R
21	2R	↑	E−1	7PAF-HD — 3PAM-HD		Side R
22	5Y	↑	E−1	7PAF-HD — 3PAM-HD		〃
23	0.75YV	↑	E−1	7PAF-HD — 18PAM-HD		Inst. Panel L/R
24	0.75WG	↑	E−1	7PAF-HD — 18PAM-HD		↑
25	1.25W	↑	E−1	7PAF-HD — 18PAM-HD		↑
26A	0.75WL			J/C GRAY — 18PAM-HD		↑
26B	↑			6PAF		A/C
26C	↑			18PAF-AMP	C−1	Controller
26D	↑			4PAF	D−2	Diode
26E	↑			4PAF	D−3	〃
26F	↑			4PAF	D−1	↑
27A	0.75BR			J/B-15PAF — 18PAM-HD		Inst. Panel L/R
27B	↑			4PAF	D−3	Diode
27C	↑			12PAF-AMP	C−2	Cluster gauge
27D	↑			4PAF	D−4	Diode

No.	Gauge& Color of wire	From		Connector at inst. Panel		To	
		Equipment	No.	Name of connector		No.	Equipment
28A	0.75P			J/B-15PAF	18PAM-HD		Inst. Panel L/R
28B	†				4PAF	D-4	Diode
28C	†				5PAF	R-7	Heater cut relay
28D	†				5PAF	R-7	"
29	0.75Lg	Inst Panel L/R		18PAM-HD	20PAM HD		Side L
30A	0.75W			J/B-10PAF	4PAF	D-2	Diode
30B	†				5PAF	R-5	Key switch relay
30C	†				14PAM-HD		Side R
31A	0.75WG			J/C-ORANGE	18PAF-AMP	C-1	Controller
31B	"				4PAF	D-1	Diode
31C	†				5PAF	R-5	Key switch relay
31D	†				6PAF	R-4	Safety relay
32	0.75WB	Side L		20PAM-HD	5PAF	R-7	Heater Cut relay
33A	0.75WL			J/B-15PAF	20PAM-HD		Side L
33B	†				5PAF	R-7	Heater Cut relay
33C	"				6PAF	R-4	Safety relay
35	0.75WR	Side L		20PAM-HD	6PAF	R-4	†
36A	0.75BY			J/B-15PAF	6PAF	R-4	†
36B	†				20PAM-HD		Side L
36C	†				18PAF-AMP	C-2	Cluster gauge
36D	†				18PAM-DS		Inst. Panel L/R
51	0.75V	Controller	C-1	12PAF-AMP	10PAM-HD		Side L
52A	0.75P			J/B-10PAF	12PAF AMP	C-1	Controller
52B	"				12PAM-HD		Under Floor
52C	"				16PAM-HD		Inst. Panel L/R
53	0.75GY	Controller	C-1	12PAF-AMP	20PAM-HD		Side L
54	0.75R	†	C-1	12PAF-AMP	1PAF		
55	0.75OR	†	C-1	12PAF-AMP	4PAF		For Check
56A	0.75OL			J/B-10PAF	12PAF-AMP	C-1	Controller
56B	†				12PAF AMP	C-2	Cluster gauge
56C	†				16PAM-HD		Inst. Panel L/R
57	0.75O	Controller	C-1	12PAF AMP	4PAF	D-7	Diode
58A	0.75GW	†	C-1	18PAF-AMP	16PAM-HD		Inst. Panel L/R
59	0.75GO	†	C-1	18PAF-AMP	16PAM-HD		†
60A	0.75GB	†	C-1	18PAF-AMP	16PAM-HD		†
61	0.75WR	†	C-1	18PAF-AMP	16PAM-HD		†

No.	Gauge & Color of wire	From		Connector at Inst. Panel	To	
		Equipment	No.	Name of connector	No.	Equipment
62	2-Shield Red	Controller	C−1	3PAF-090 —— 20PAM-HD		Side L
63	2-Shield White	†	C−1	3PAF-090 —— 16PAM-HD		†
64	0.75LR	†	C−1	12PAF-AMP —— 4PAF	D−6	Diode
65A	0.75GR			J/S-16PAF — 4PAF	D−8	†
65B	†			— 9PAF	SW−2	Release SW
65C	†			— 16PAM-HD		Inst. Panel L/R
66A	0.75LO			J/S-16PAF — 12PAF-AMP	C−1	Controller
66B	†			— 4PAF	D−10	Diode
66C	†			— 16PAM-HD		Inst. Panel L/R
67	0.75LO	Controller	C−1	12PAF-AMP —— 4PAF	D−9	Diode
68	0.75Y	Inst. Panel L/R		16PAM-HD —— 4PAF	D−9	†
69A	0.75LB			J/S-16PAF — 12PAF-AMP	C−1	Controller
69B	†			— 20PAM-HD		Side L
69C	†			— 6PAF	C−3	Flasher unit
81	4-Shield Green	Controller	C−1	18PAF-AMP — 20PAM-HD		Side L
82	4-Shield Black	†	†	18PAF-AMP — 20PAM-HD		Side L
83	4-Shield Red	†	†	18PAF-AMP — 20PAM-HD		Side L
84	4-Shield White	†	†	18PAF-AMP — 16PAM-HD		Side L
85A	0.75VG			J/C-ORANGE — 12PAF-AMP	C−1	Controller
85B	†			— 4PAF		For Check
85C	†			— 12PAF-AMP	C−2	Cluster gauge
86	0.75PL	Controller	C−1	18PAF-AMP — 18PAF-AMP	C−2	†
87	0.75PG	†	C−1	18PAF-AMP — 18PAF-AMP	C−2	†
88	0.75YB	†	C−1	18PAF-AMP — 9PAF	SW−2	Release SW
89	0.75YL	†	C−1	18PAF-AMP — 9PAF	SW−2	†
90	0.75GB	Side R		8PAM-HD —— 9PAF	SW−2	†
91	0.75YR	†		8PAM-HD —— 9PAF	SW−2	†
92	0.75WB	Resister	E−7	2PAF —— 9PAF	SW−2	†
93	0.75BY	Controller	C−1	18PAF-AMP — 8PAM-HD		Side R
94	0.75BP	†	C−1	18PAM-AMP — 8PAM-HD		†
101	0.75PB	Cluster gauge	C−2	12PAF-AMP — 16PAM-HD		Inst. Panel L/R
102A	0.75GA			J/S-16PAF — 18PAF-AMP	C−2	Cluster gauge
102B	†			— 4PAF	D−7	Diode
102C	†			— 20PAM-HD		Side L
103	0.75YG	Cluster gauge	C−2	18PAF-AMP — 20PAM-HD		†
104	0.75RG	†	C−2	18PAF-AMP — 20PAM-HD		†

No.	Gauge & Color of wire	From		Connector at inst. Panel	To	
		Equipment	No.	Name of connector	No.	Equipment
105	0.75YB	Cluster gauge	C 2	18PAF-AMP — 20PAM-HD		Side L
106	0.75YL	〃	C-2	18PAF-AMP — 20PAM-HD		〃
107	0.75YW	〃	C 2	18PAF-AMP — 20PAM-HD		〃
108	0.75GY	〃	C-2	18PAF-AMP — 8PAM-HD		Side R
109	0.75YR	〃	C-2	12PAF-AMP — 20PAM-HD		Side L
110	AVS0.85YW	〃	C-2	12PAF-AMP — 14PAM-HD		Side R
111	AVS0.85YO	〃	C-2	12PAF-AMP — 14PAM-HD		〃
112	0.75GR	〃	C-2	5PAF-AMP — 8PAM-HD		〃
113A	0.75BW			J/C-ORANGE — 18PAF-AMP	C- 2	Cluster gauge
113B	〃			— 12PAM-HD		Under floor
113C	〃			— 6PAF	R-2	2 speed relay
114	0.75BrW	Cluster gauge	C-2	18PAF-AMP — 6PAF	C-3	Flasher unit
115A	0.75GL			J/C-ORANGE — 12PAF-AMP	C 2	Cluster gauge
115B	〃			— 17PAF-PA	R 6	Relay Assy.
115C	〃			— 12PAM-HD		Under floor
116A	0.75RY			J/B-15PAF — 12PAF-AMP	C-2	Cluster gauge
116B	〃			— 17PAF-PA	R-6	Relay Assy.
116C	〃			— 14PAM-HD		Side R
117A	0.75V			J/B 15PAF — 12PAF AMP	C-2	Cluster gauge
117B	〃			— 12PAM-HD		Under floor
117C	〃			— 4PAF	D-10	Diode
117D	〃			— 16PAM-HD		Inst. Panel L/R
118	0.75VW	Signal reverse unit		3PAF — — — 13PAM-DS		〃
120	0.75VG	Cluster gauge	C 2	18PAF-AMP — 3PAF		Signal reverse unit
121	0.75RL	Relay Assy.	R-6	17PAF-PA — 9PAF	SW-2	Release SW
122	0.75LgR	Inst. Panel L/R		13PAM-DS — 6PAF	C-3	Flasher unit
123A	0.75BrY			J/B-15PAF — 6PAF	C-3	〃
123B	〃			— 14PAM-HD		Side R
123C	〃			— 20PAM-HD		Side L
124A	0.75BrR			J/B 15PAF — 6PAF	C-3	Flasher unit
124B	〃			— 14PAM-HD		Side R
124C	〃			— 20PAM-HD		Side L
125A	0.75RG			J/B-15PAF — 13PAM-DS		Inst. Panel L/R
125B	〃			— 17PAF-PA	R 6	Relay Assy.
125C	〃			— 17PAF-PA	R-6	〃

No.	Gauge & Color of wire	From		Connector at Inst. Panel	To	
		Equipment	No.	Name of connector	No.	Equipment
126A	0.75RB			J/B-15PAF — 17PAF-PA	R−6	Relay Assy.
126B	"			14PAM-HD		Side R
126C	"			12PAM-HD		Under floor
126D	"			6PAF		A/C
127A	0.75LY	Side R		14PAM-HD — 17PAF-PA	R−5	Relay Assy.
128	0.75BrR	Inst. Panel L/R		6PAM-HD — 6PAF	R−8	Intermit Relay
129	0.75B	"		6PAM-HD — 6PAF	R−8	"
130	0.75BrW	Cab		6PAF — 6PAF	R−8	"
131	0.75BrB	"		6PAF — 6PAF	R−8	"
132	0.75O	Under floor		12PAM-HD — 6PAF	R 9	2-speed travel relay
133A	0.75WV			J/B-15PAF — 6PAM-HD		Inst. Panel L/R
133B	"			5PAF	(R−10)	(Travel Alarm relay)
133C	"			5PAF	(R−10)	"
134	0.75BG	Side R		4PAM-HD — 5PAF	(R−10)	"
135	0.75LR	Under floor		12PAM-HD — 5PAF	(R−10)	"
151B	0.75G	"		12PAM-HD — 18PAM-HD		Inst. Panel L/R
152B	0.75LR	"		12PAM-HD — 16PAM-HD		"
153A	0.75RW			J/B-15PAF — 13PAM-DS		"
153B	"			14PAM-HD		Side R
153C	"			20PAM-HD		Side L
154	0.75LgB	Inst. Panel L/R		6PAM-HD — 12PAM-HD		Under floor
155	0.75PL	Side L		20PAM-HD — 6PAF		A/C
157	1.25LY	Inst. Panel L/R		18PAM-HD — 3PAF		Heater
158	1.25LB	"		18PAM-HD — 3PAF		"
159	0.75GrG	"		18PAM-HD — 2PAF	(E−9)	(Speaker L)
160	0.75VG	"		18PAM-HD — 2PAF	(E−10)	(Speaker R)
161	0.75VR	Side R		14PAM-HD — 13PAM-DS		Inst. Panel L/R
162	0.75VY	"		14PAM-HD — 13PAM-DS		"
163	0.75Gr	"		14PAM-HD — 13PAM-DS		"
164	0.75GrB	"		14PAM-HD — 13PAM-DS		"
165	0.75PG	Inst. Panel L/R		16PAM-HD — 17PAF-PA	R−6	Relay Assy.

No.	Gauge & Color of wire	From		Connector at Inst. Panel	To.	
		Equipment	No.	Name of connector	No	Equipment
201	0.50BY	Inst. Panel L/R		16PAM-TS — 16PAF-040	C-2	Cluster gauge
202	0.50Z	"		16PAM-TS — 16PAF-040	C-2	"
203	0.50R	"		16PAM-TS — 16PAF-040	C-2	"
204	0.50BG	"		16PAM-TS — 16PAF-040	C-2	"
205	0.50O	"		16PAM-TS — 16PAF-040	C-2	"
206	0.50BL	"		16PAM-TS — 16PAF-040	C-2	"
207	0.50Y	"		16PAM-TS — 16PAF-040	C-2	"
208	0.50G	"		16PAM-TS — 16PAF-040	C-2	"
209	0.50L	"		16PAM-TS — 16PAF-040	C-2	"
210	0.50LR	"		16PAM-TS — 16PAF-040	C-2	"
211	0.50V	"		16PAM-TS — 16PAF-040	C-2	"
212	0.50VW	"		16PAM-TS — 16PAF-040	C-2	"
213	0.50BW	"		16PAM-TS — 16PAF-040	C-2	"
214	0.50BR	"		16PAM-TS — 16PAF-040	C-2	"
215	0.50GR	"		16PAM-TS — 16PAF-040	C-2	"
216	0.50W	"		16PAM-TS — 16PAF-040	C-2	"
231	0.50LW	A/C		14PAM-HD — 14PAF-HD		Inst. Panel L/R
232	0.50WR	"		14PAM-HD — 14PAF-HD		Inst. Panel L/R
233	0.50BrW	"		14PAM-HD — 14PAF-HD		Inst. Panel L/R
234	0.50GW	"		14PAM-HD — 14PAF-HD		Inst. Panel L/R
235	0.50RG	"		14PAM-HD — 14PAF-HD		Inst. Panel L/R
236	0.50RB	"		14PAM-HD — 14PAF-HD		Inst. Panel L/R
237	0.50B	"		14PAM-HD — 14PAF-HD		Inst. Panel L/R
238	0.50RL	"		14PAM-HD — 14PAF-HD		Inst. Panel L/R
239	0.50LB	"		14PAM-HD — 14PAF-HD		Inst. Panel L/R
240	0.50YR	"		14PAM-HD — 14PAF-HD		Inst. Panel L/R
241	0.50GR	"		14PAM-HD — 14PAF-HD		Inst. Panel L/R
242	0.50YL	"		14PAM-HD — 14PAF-HD		Inst. Panel L/R
243	0.50WG	"		14PAM-HD — 14PAF-HD		Inst. Panel L/R
244	0.50YG	"		14PAM-HD — 14PAF-HD		Inst. Panel L/R

No.	Gauge& Color of wire	From		Connector at Inst. Panel	To.	
		Equipment	No.	Name of connector	No.	Equipment
E01	1.25B			11PAF-GND — 16PAM-HD		Inst. Panel L/R
E02	0.75B			J/C-GRAY — 17PAF-PA	R−6	Relay Assy
E03	1.25B			11PAF-GND — J/C-GRAY		
E04	↑			11PAF-GND — J/C-GRAY		
E05	5B	Side R		3PAM-HD — LA306		
E06	0.75B			J/C-GRAY — J/C-GRAY		
E07	↑			J/C-GRAY — 5PAF-AMP	C−2	Cluster gauge
E	0.75B			18PAF-GND — 18PAF-AMP	C−1	Controller
E	↑			18PAF-GND — 18PAF-AMP	C−2	Cluster gauge
E	↑			11PAF-GND — 6PAF	R−4	Safety relay
E	↑			11PAF GND — 6PAF	R−9	2-speed relay
E	1.25B			11PAF-GND — 6PAF		A/C
E	0.75B			11PAF-GND — 9PAF	SW 2	Release SW
E	↑			11PAF-GND — 5PAF	R−5	Key SW relay
E	↑			11PAF-GND — 16PAM-HD		Inst Panel L/R
E	↑			J/C-GRAY — 6PAF	C−3	Flasher controller
E	↑			— 6PAF	R−8	Intermit relay
E	↑			— 4PAF		For check
E	↑			— 17PAF-PA	R−6	Relay Assy
E	1.25B			— 2PAF		Power source
E	0.75B			— FEMALE	(E−4)	Cigarette Lighter
E	↑			— CA101	(E−11)	12V power source
E	↑			— 2PAF	(E−10)	(Speaker R)
E	↑			— 2PAF	(E−9)	(Speaker L)
E	↑			— 1PAM		
E	↑			— 6PAF		Cab
E	↑			— 3PAF		Signal reverse unit
SH		Side L		10PAM-HD — 3PAF-090	C−1	Controller
SH1		↑		10PAM-HD — J/C-GRAY		

Book code No. S5LC2605E

KOBELCO

SHOP MANUAL

SK310
SK310LC

AIR-CONDITIONER SYSTEM

TABLE OF CONTENTS

LC26

KOBE STEEL, LTD.

Applicable Machines

LC03801~

YC01101~

PREFACE

In place of a conventional special air-conditioner using refrigerant R12, we have developed a special air-conditioner using a new refrigerant R134a that has little effect upon global environment and does not destroy the ozone layer of the earth. Since R134a differs from conventional R12 in terms of characteristics, it can not be applied to conventional air-conditioners. This manual summarizes basic knowledge and precautions to be exercised in servicing the R134a special air-conditioner.

Revision	Date of Issue	Remarks
First edition	March, 1995	S5LC2605E K

1. CONSTRUCTION

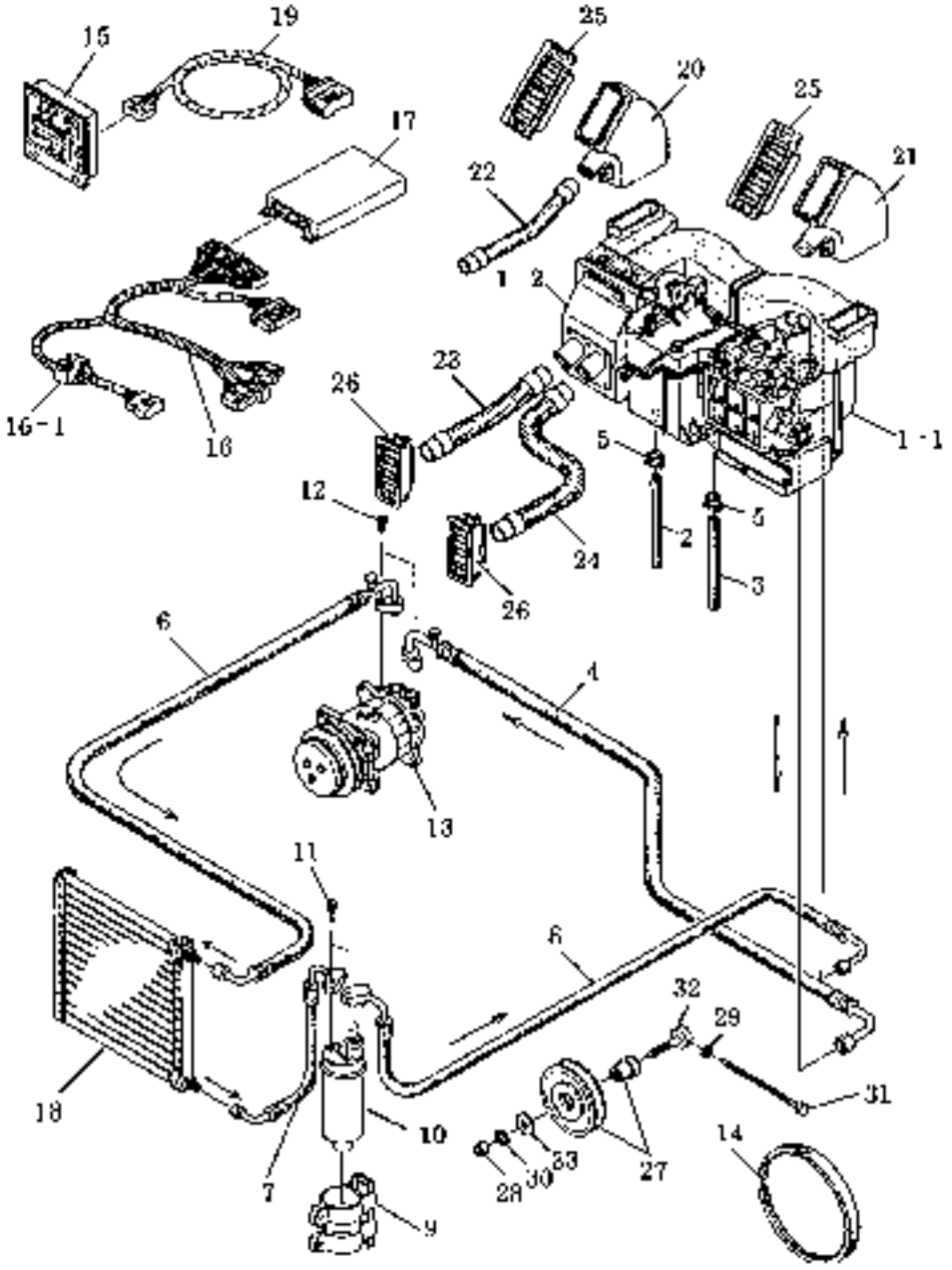


Fig. 1

No.	NAME	Q'ty	No.	NAME	Q'ty	No.	NAME	Q'ty
1-1	INTAKE UNIT	1	11	SEMS BOLT M6	2	23	DUCT HOSE A	1
1-2	AIR-CONDITIONER UNIT	1	12	SEMS BOLT M8	2	23	DUCT HOSE B	1
2	DRAIN HOSE	1	13	COMPRESSOR	1	24	DUCT HOSE C	1
3	DRAIN HOSE	1	14	V-BELT	1	25	GRILL	2
4	S HOSE	1	15	PANEL	1	26	GRILL	2
5	HOSE CLAMP	2	16	HARNESS A	1	27	PULLEY	1
6	D HOSE	1	16-1	FUSE 1A	3	28	NUT M10	1
7	L HOSE	1	17	CONTROL AMP.	1	29	SPRING WASHER	1
8	L HOSE	1	18	CONDENSER	1	30	SPRING WASHER	1
9	RECEIVER DRYER	1	19	HARNESS B	1	31	BOLT	1
	FASTENING METAL		20	DUCT A	1	32	SLIDE SHAFT	1
10	RECEIVER DRYER	1	21	DUCT B	1	33	PULLEY STOPPER	1

2. CONSTRUCTION OF MAIN COMPONENTS

2.1 INTAKE UNIT

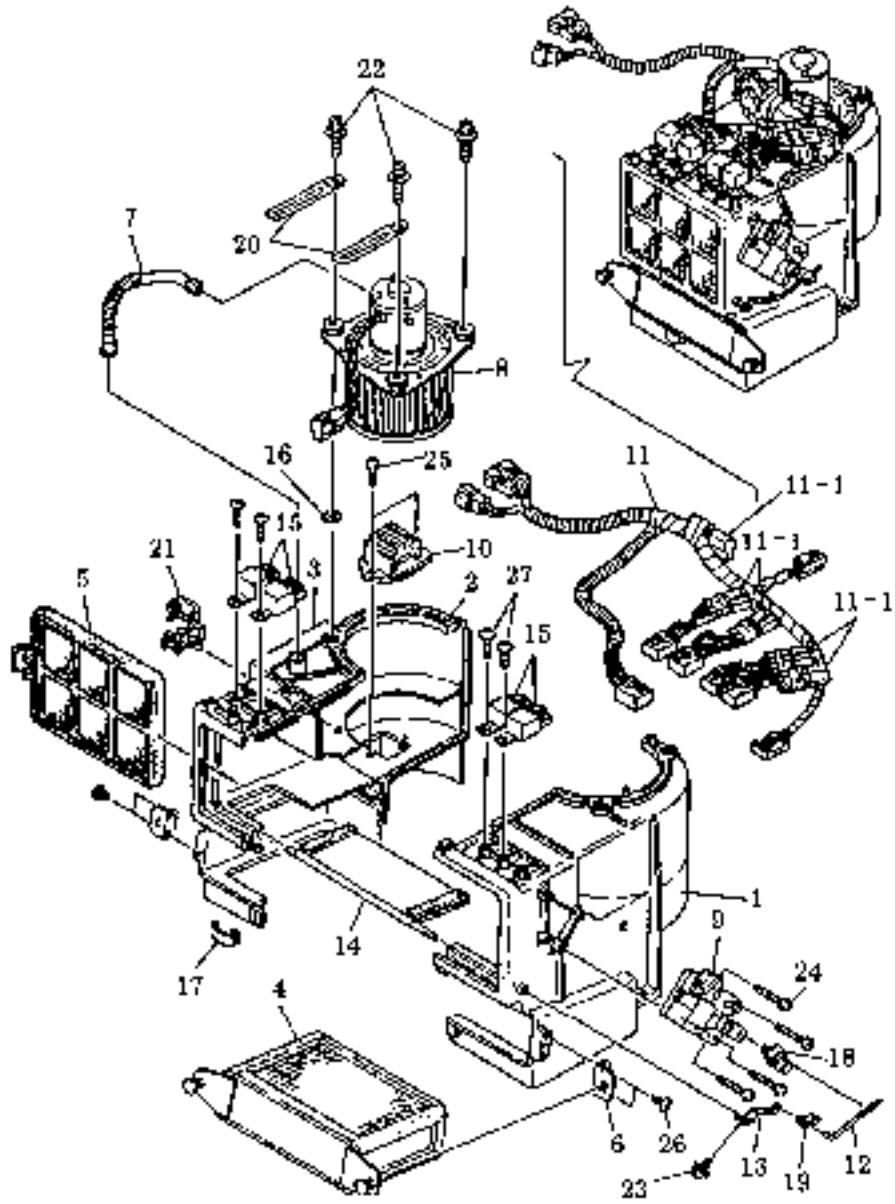


Fig. 2

No.	NAME	Q'ty	No.	NAME	Q'ty	No	NAME	Q'ty
1	FAN CASING LH	1	11	HARNESS	1	20	CLAMP	2
2	FAN CASING RH	1	11-1	DIODE 1B	5	21	HARNESS CLAMP	1
3	CONNECTING OPENING	1	12	LINK ROD	1	22	SEMS BOLT	3
4	OUTER AIR FILTER	1	13	DAMPER LEVER	1	23	SEMS BOLT	1
5	INNER AIR FILTER	1	14	INTAKE DAMPER	1	24	MACHINE SCREW	4
6	HOLDER	2	15	RELAY	4	25	MACHINE SCREW	2
7	COOLING HOSE	1	16	WASHER	3	26	MACHINE SCREW	4
8	BLOWER MOTOR	1	17	CLAMP	9	27	MACHINE SCREW	4
9	ACTUATOR	1	18	ROD CLAMP	1			
10	RESISTER	1	19	ROD HOLDER	1			

2.2 AIR-CONDITIONER UNIT

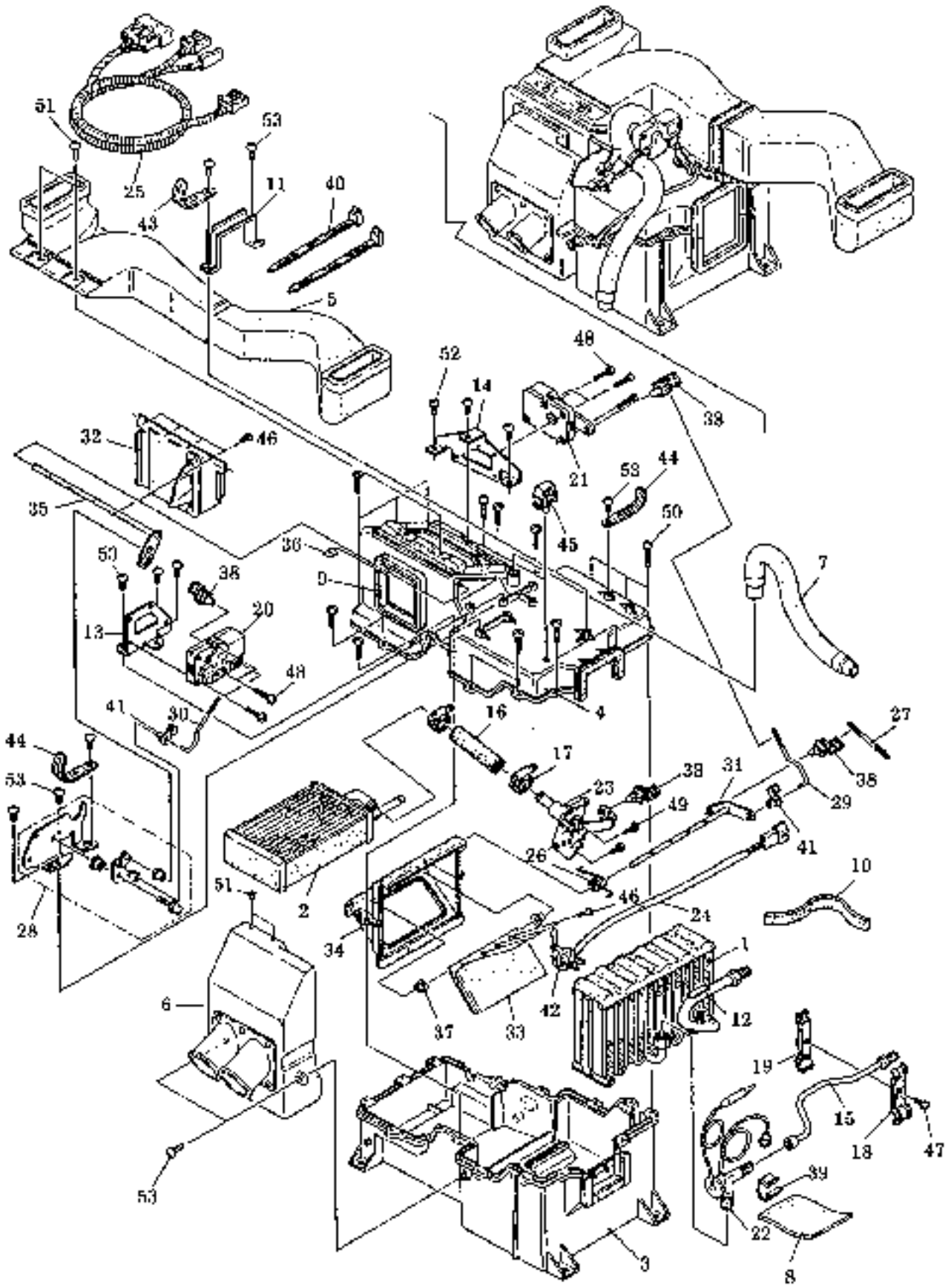
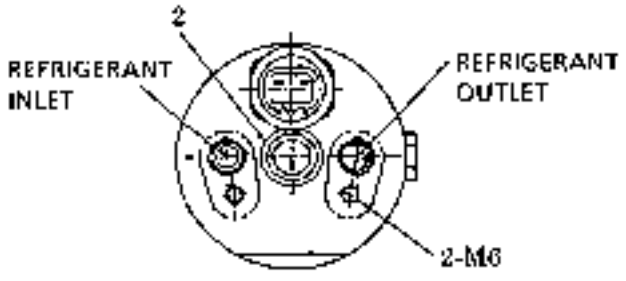


Fig. 3 (1/2)

No.	NAME	Q'ty	No.	NAME	Q'ty	No.	NAME	Q'ty
1	EVAPORATOR	1	18	PIPE RETAINER	1	36	NUT	2
2	HEATER COVER	1	19	PIPE RETAINER	1	37	SPACER	2
3	UNIT CASING LOWER	1	20	ACTUATOR	1	38	ROD CLAMP	4
4	UNIT CASING UPPER	1	21	ACTUATOR	1	39	THERMOWELL STAY	1
5	UPPER DUCT	1	22	VALVE	1	40	BAND	2
6	LOWER DUCT	1	23	VALVE	1	41	ROD HOLDER	2
7	DUCT HOSE	1	24	THERMISTOR	1	42	SENSOR HOLDER	1
8	THERMAL INSULATION	1	25	HARNESS	1	43	CLAMP	1
	MATERIAL		26	SPRING	1	44	CORD RETAINER	2
9	GASKET	1	27	VALVE ROD	1	45	HARNESS CLAMP	1
10	GASKET	1	28	MODE LINK	1	46	BIND SCREW M3	8
11	DUCT RETAINER	1	29	LINK ROD	1	47	BIND SCREW M4	1
12	THERMOWELL	1	30	LINK ROD	1	48	BIND SCREW M4	8
13	ACTUATOR BRACKET	1	31	DAMPER SHAFT	1	49	MACHINE SCREW	3
14	ACTUATOR BRACKET	1	32	MODE DAMPER	1	50	MACHINE SCREW	15
15	INLET PIPE	1	33	AIR MIX DAMPER	1	51	MACHINE SCREW	4
16	HEATER HOSE	1	34	DAMPER BASE	1	52	MACHINE SCREW	3
17	HOSE BAND	2	35	DAMPER SHAFT	1	53	MACHINE SCREW	11

Fig. 3 (2/2)

2.3 RECEIVER DRYER



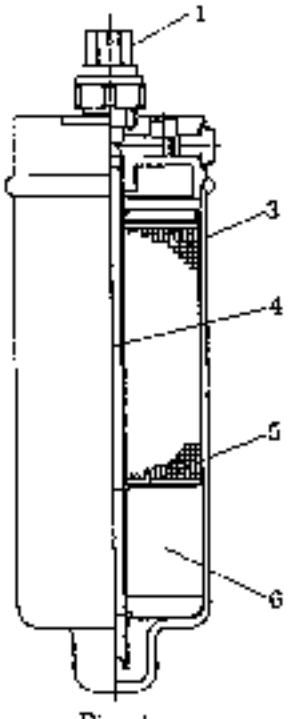


Fig. 4

No	NAME	Q'ty
1	PRESSURE SWITCH	1
2	SIGHT GLASS	1
3	DESICCANT	1
4	SUCTION PIPE	1
5	FILTER	1
6	RECEIVER TANK	1

3. FUNCTION

3.1 MECHANISM OF COOLING CIRCUIT

(1) Mechanism of Cooling

In the cooling process, the refrigerant that flows through the cooling circuit changes its phases from liquid to gas and vice versa during which process heat is transferred from the low temperature part (compartment) to the high temperature part (outside of the vehicle).

1) Kind of Refrigerant

Many kinds of refrigerants that change in that way are available, but the following requirements are needed for use in such applications:

- Latent heat of vaporization (heat of vaporization) is large.
- It is easy to liquefy (condense). (It dose not require very high pressure for condensation.)
- It is easy to gasify (evaporate). (It evaporates sufficiently at not too low pressure, i.e. cools down an object.)
- It has small specific heat. (Since the refrigerant itself is cooled by the expansion valve, the loss resulting from it must be held down to a minimum.)
- It has a high critical temperature and a low solidification point.
- It is stable chemically and does not corrode and permeate into the circuit parts.
- It is free from toxicity, objectionable odor, flammability and explosiveness and excels in thermal conductivity and electric insulation.
- It has small specific volume.
- It is easy to find out leakage.

Out of refrigerants meeting the above-mentioned requirements, ones having characteristics that suit the intended cooling unit are chosen and used. If a refrigerant other that those designated is used, sufficient refrigeration will not be performed or the equipment in which the refrigerant is used may be broken. Therefore, always use a designated refrigerant for the cooling unit.

Table 1 shows the principal characteristics of the R134a refrigerant that is used in this machine.

Table 1

Item	R143a
Chemical formula	CH_2FCF_3
Molecular weight	102.03
Boiling point	-26.19°C (-15.14°F)
Critical temperature	101.14°C (214.05°F)
Critical pressure	4.065MPa (41.45kgf/cm^2*1)
Critical density	511kg/m^3 (31.9lb/ft^3)
Density of saturated liquid [25°C (77.0°F)]	1206kg/m^3 (75.3 lb/ft^3)
Specific volume of saturated vapor [25°C (77°F)]	0.0310m^3/kg (0.496ft^3/lb)
Latent heat of vaporization [0°C (32°F)]	197.5KJ/kg (47.19kcal/kg)
Flammability	Nonflammable
Ozone destruction coefficient	0

*1 : 1MPa (mega pascal) equals 10.1972kgf/cm^2 (145psi)

(2) Characteristics of Refrigerant (See Fig.6.)
In general, the fluid (general term of gas and liquid) has the following qualities:

1) As a gas under certain pressure is cooled down, it begins to condensate at a certain temperature to take a liquid state. The temperature at which condensation begins is unique to each substance (fluid) at a given pressure. The temperature determined by a given pressure is called saturation temperature.

2) Inversely to 1) above, the pressure at which a gas condenses for a temperature is determined. This pressure is called saturation pressure.

Fig.5 illustrates the relationships between the saturation temperature and the saturation pressure in the case of refrigerant R134a used in the air-conditioner. At the temperature and the pressure on the lower righthand side of the curve in Fig.5, the refrigerant take a gaseous state, while at the temperature and the pressure on the upper lefthand side of the curve, the refrigerant takes a liquid state.

Let us think of a case where an air-conditioner is operated in the midst of summer. As the refrigerant evaporates, it absorbs evaporation heat from the air of the compartment. In order to cool the inside of the compartment down to 25°C (77°F), the refrigerant must transform (evaporate) from a liquid to a gaseous state at a lower temperature. It can be seen from Fig.5 that R134a under a pressure above the atmospheric pressure is capable of cooling the inside of the compartment sufficiently. (If a refrigerant that requires a pressure below the atmospheric pressure to cool it to a required temperature is used, air is mixed into the circuits, thereby deteriorating the performance of the cooling unit.) In the process in which gaseous refrigerant is brought back to a liquid state, the refrigerant is cooled and condensed by the outer air exceeding 35°C (95°F).

Accordingly the refrigerant is capable of condensing at a pressure exceeding 10.2kgf/cm²G (145psi·G), as seen from Fig.5.

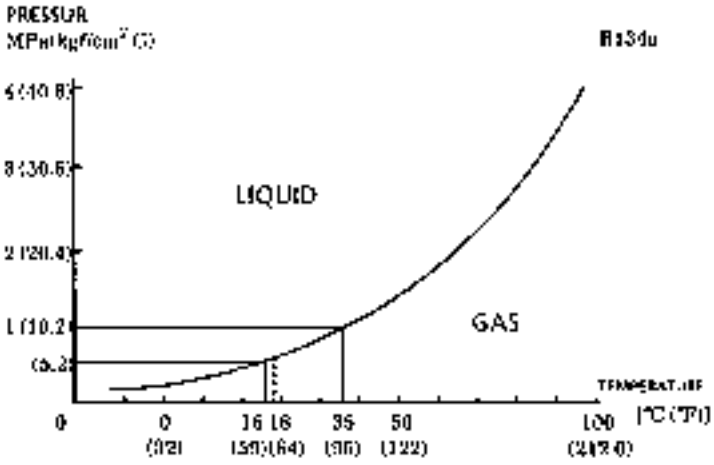


Fig. 5 Pressure-temperature characteristics of R134a

Note ; 1PMa=145psi

3.2 COOLING CIRCUIT

Fig.6 illustrates the cooling circuit of the car air-conditioner.

In this circuit diagram, the portion that cools the air of the compartment is the evaporator. The object air is cooled off by utilizing the fact that the refrigerant takes heat off the surrounding area as evaporation heat as it evaporates in the cooling circuit. Since the part at which vaporization of the refrigerant takes place is the evaporator, cooled air is constantly delivered to the circumference of the evaporator by the blower fan. In the meantime, liquid refrigerant (slightly wet vaporized refrigerant) is fed into the evaporator, when "cooling" effect is attained. For instance, in order to cool the air to 15°C (59°F), the refrigerant can not absorb evaporation heat from the air unless it evaporates at a temperature lower that 15°C (59°F). For that purpose, it can be seen from Fig.5 that the pressure of the refrigerant in the evaporator must be less than 5.2kgf/cm²G (74psi-G).

Furthermore, the cooling effect deteriorates unless the feed rate of the refrigerant is controlled so that all of the refrigerant supplied to the evaporator vaporizes and turns into dry vapor.

Consequently, the cooling circuit is so constructed that the evaporator can cool down an object (air in this case) sufficiently (i.e. so as to decrease the pressure in the evaporator) and that an adequate amount of refrigerant can be fed to the evaporator.

The feed rate of the refrigerant is controlled by the expansion valve, but the pressure in the evaporator is held low by the throttling action of the expansion valve and the suction action of the compressor. The compressor acts as a pump that allows the refrigerant to circulate. The compressive action of the compressor and the heat exchange (heat radiation) action of the condenser transform the refrigerant in a dry vapor state back to a liquid state.

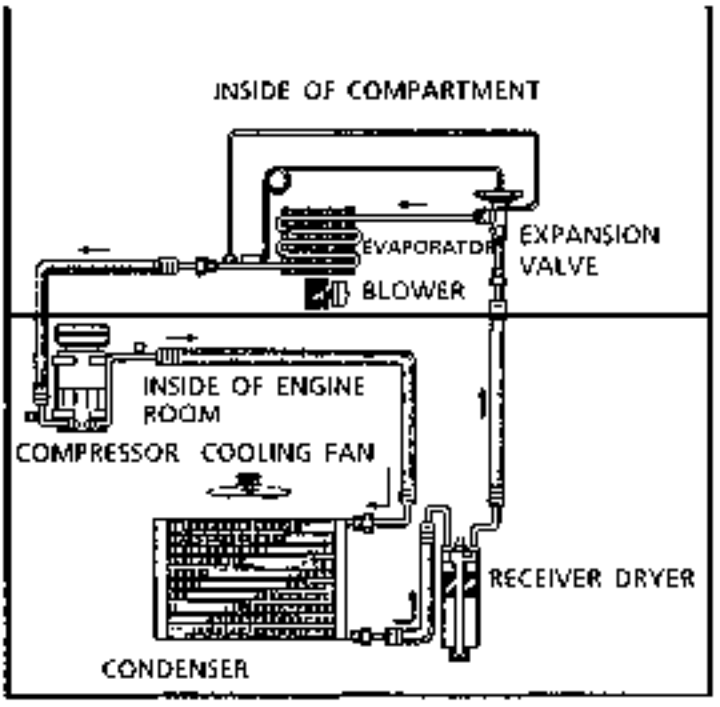


Fig. 6 Construction of cooling circuit

3.3 COMPONENT PARTS

(1) Evaporator (See Fig.7.)

The evaporator is an important heat exchanger that absorbs the heat of the compartment air (object) by the utilization of the latent vaporization heat of the low-temperature, low-pressure liquid-state refrigerant. Therefore, it is necessary that satisfactory heat transfer between the object and the refrigerant take place in the evaporator.

To that end, the evaporator is equipped with fins on the air side in order to increase the heat transfer area of the air side and thereby perform excellent thermal transfer between the refrigerant and the air.

The humidity in the air condenses as the air cools down and adheres to the outside of the evaporator as water drops. The cooling effect deteriorates if the water drops freeze. Therefore, how to discharge water is an important point.

The amount of refrigerant supplied to the evaporator is controlled by the expansion valve which is described in the following. In order to attain proper control, it is necessary to reduce the pressure drop of the refrigerant of the evaporator. Accordingly, reducing the pressure drop is one element that makes the evaporator attain its full performances.

(2) Expansion Valve

In order for the evaporator to fulfill its performances, a proper amount of low-pressure low-temperature liquid refrigerant must be fed to the evaporator.

If the feed rate is too low, the refrigerant completes vaporization early in the evaporator which results in deterioration of the cooling effect. If the feed rate is too high, unvaporized liquid refrigerant returns to the compressor (liquid back). This not only deteriorates the cooling effect, but also damages the compressor valves.

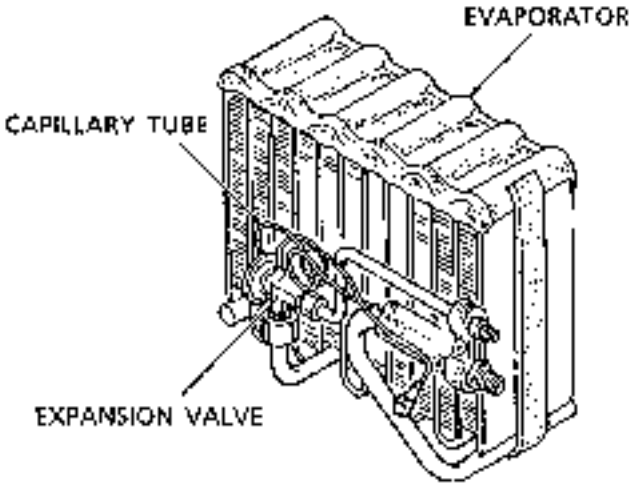


Fig. 7 Evaporator

The expansion valve feeds the flowing high-pressure high-temperature liquid refrigerant to the evaporator as low-pressure low-temperature liquid refrigerant (damp vapor of low dryness). The expansion valve controls the feed rate of the refrigerant at the same time.

Fig.8 illustrates how the external temperature sensing expansion valve is constructed. The thermowell in this illustration is installed on the surface of the outlet tube of the evaporator and senses indirectly the temperature of the refrigerant at the outlet of the evaporator. The thermowell and the capillary are filled with R134a in saturated state. The internal pressure of the R134a varies with temperature being sensed. This pressure variation changes the force acting upon the diaphragm.

The high-pressure high-temperature liquid refrigerant that is fed from the receiver side reduces the pressure abruptly as it passes through the valve (throttling action). On that occasion, part of the refrigerant evaporates by the very heat of the refrigerant and cooled off. The result is that low-pressure low-temperature damp refrigerant vapor is fed to the evaporator.

The opening of the valve is determined by the equilibrium between the pressure (low) of the evaporator side, the action of the adjust spring and the pressing force of the diaphragm (the temperature of the refrigerant at the outlet of the evaporator to be sensed by the thermowell). The feed rate is controlled automatically so that under the pressure in the evaporator, the refrigerant is properly overheated (3–8 degrees) and goes out of the evaporator. This action is carried out by sensing the refrigerant temperature at the outlet of the evaporator as against the inlet pressure of the evaporator and consequently controlling the feed rate of the refrigerant.

This means that if the refrigerant pressure drop in the evaporator is excessive, it is difficult to control the overheating or the feed rate of the refrigerant. For this reason, the smaller the pressure drop of the evaporator, the better.

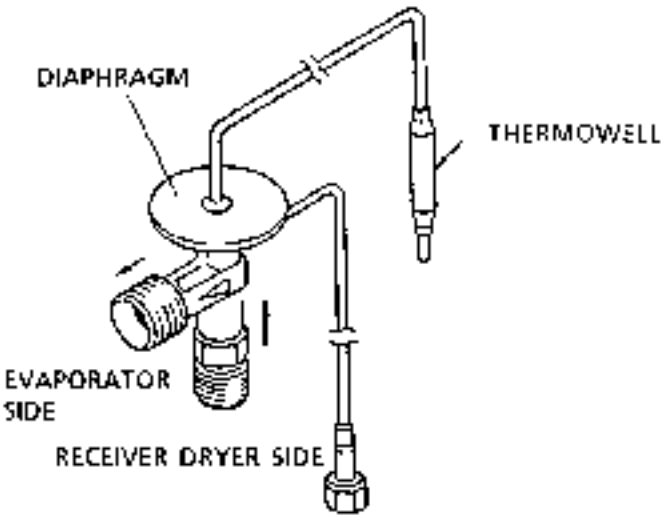


Fig. 8 Expansion valve

It is the temperature sensing expansion valve with an external pressure equalizer that controls more positively the overheat of the refrigerant and the feed rate of the refrigerant to the evaporator by sensing the pressure and the temperature at the outlet of the evaporator. The air-conditioner of this machine employs such a temperature sensing expansion valve with an external pressure equalizer.

(3) Compressor (See Fig.9.)

The compressor performs the following three functions in the cooling circuit:

1) Suction action
2) Pumping action
3) Compressive action

1) The suction action, as combined with the throttling action, works to decrease the refrigerant pressure in the evaporator. This permits the refrigerant to vaporize at low temperature in order to perform cooling effect.
2) The pumping action serves to cause all the refrigerant to circulate in the cooling circuit. This enables enables continuous cooling.
3) The compressive action, as combined with the action of the condenser which is mentioned hereunder, transforms vaporized refrigerant back to a liquid state again.

The saturation temperature gets higher as the pressure increases. For instance, it becomes possible to cool down the refrigerant by the use of an outer air of 35°C (95°F) and liquefy it. The compressive action of the compressor works to turn low pressure vaporized refrigerant to high pressure vapor refrigerant. The condenser then serves to cool down the refrigerant. However, since the compressive action takes place only for a short period, the refrigerant hardly exchanges heat with outer air. That is to say, it takes a near form of thermally insulated compression, so that the refrigerant discharged by the compressor turns into high-temperature high-pressure vapor and is delivered to the condenser.

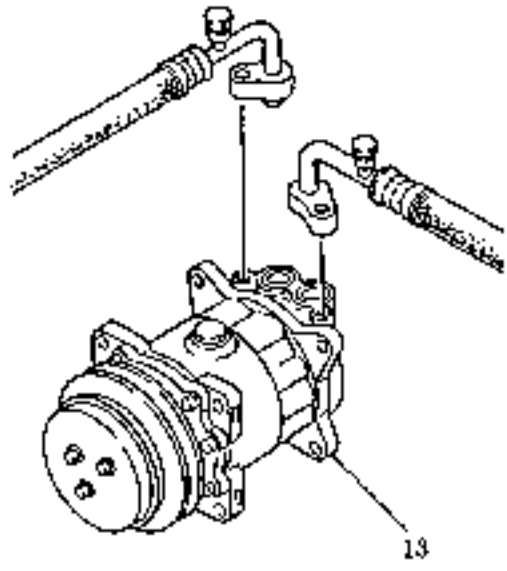


FIg. 9 Compressor

(4) Condenser (See Fig 10)

This is a heat exchanger that cools the vaporized refrigerant at high temperature and high pressure by the use of outer air and condenses the refrigerant. The direction in which heat moves is from the refrigerant to air, the opposite to the case of the evaporator. Fins are equipped on the outer air side to improve thermal transfer. If the refrigerant is not cooled well by the condenser, the air in the compartment can not be cooled sufficiently by the evaporator. For that purpose, it is necessary to secure ventilation required for the cooling of the refrigerant.

(5) Receiver Dryer (See Fig.11.)

1) Receiver Tank

On the air-conditioner, the revolution of the compressor varies greatly which causes the proper flow of refrigerant in the cooling circuit to vary. It is the receiver tank that receives the variations. When the cooling circuit does not need much refrigerant, the receiver tank stores extra refrigerant temporarily and supplies it when the cooling circuit needs much refrigerant. The receiver tank also stores an extra amount of refrigerant to be used for filling balance and supplement small amounts of leakage of the refrigerant through penetration into rubber hoses.

2) Dryer

If water is mixed in the cooling circuit, it deteriorates the compressor valves and oil, corrodes the metallic parts of the circuit or clogs the circuit as the water freezes in the expansion valve. It is desirable that the amount of water mixed in the refrigerant should be held below a concentration of 30ppm. The air-conditioner uses a molecular sieve as desiccant suited for the circuit, in order to absorb water content that intrudes into the circuit when the dryer is installed or when refrigerant is charged.

3) Sight Glass

This is a peep window with which the refrigerant level in the circuit is determined, the only means of confirming the inside of the circuit visually.

4) Filler

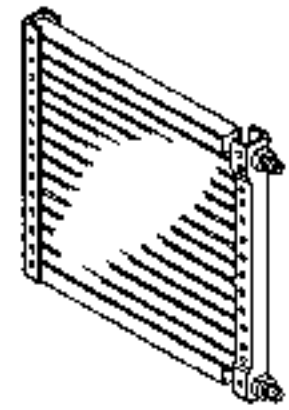


Fig. 10 Condenser

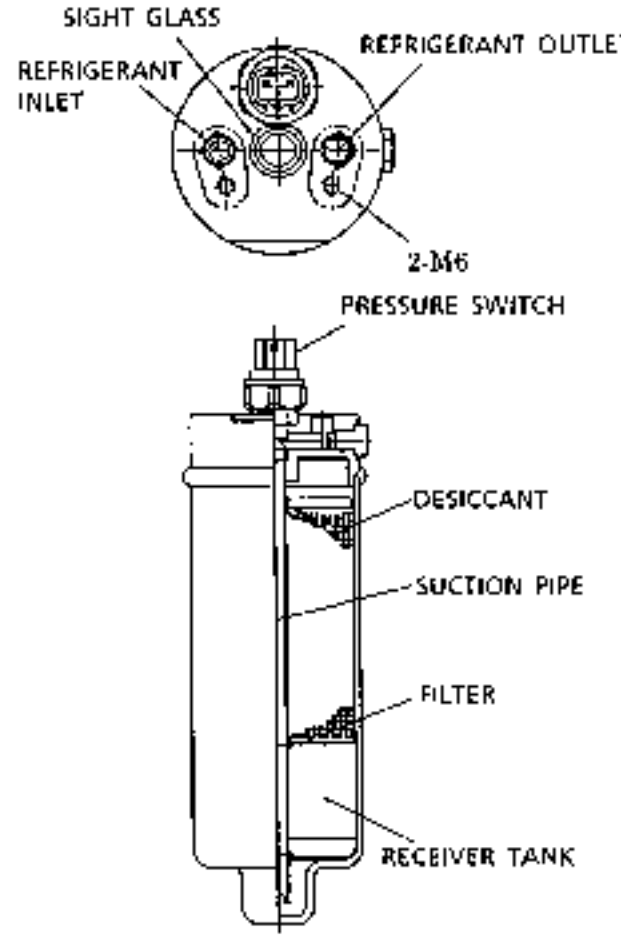


Fig. 11 Receiver dryer

6) Pressure Switch

This machine employs pressure switches of high/low pressure type.

The pressure switch protects the circuit by cutting off the power supply to the compressor when high pressure increases abnormally high (more than 32kgf/cm^2 (460psi)).

The pressure switch also detects the leakage of refrigerant by cutting the power supply to the compressor when the pressure of the circuit falls below 2kgf/cm^2 (28psi).

4. DISASSEMBLY AND REASSEMBLY

4.1 Precautions to be Exercised in Operation

(1) Special Refrigerater Oil

This air-conditioner uses special refrigerater oil SP20 for use with new refrigerant R134a. Oils other than SP20 may not be used. Since SP20 tends to absorb moisture and may corrode paint and resin, the following points must be noted:

1) Keep open all pipe connections on a new compressor and the component parts of the installed refrigeration circuit.
(Remove valves and caps at the pipe openings of the compressor, just before connecting pipes. If you have removed a pipe joint for repair, put a cap to both ports immediately.)

2) Use care so SP20 does not adhere to the painted surface and resin parts. In case SP20 has adhered to such surfaces, wipe it off immediately.

(2) The receiver dryer is filled with desiccant to absorb moisture in the circuit. Therefore, remove the valve at the pipe port immediately before connecting pipes.

(3) Tightening Torque

1) Pipe Joints (See Table 2.)
When connecting pipe joints, coat the O ring with special oil (SP20) and fasten to the tightening torque indicated in the table, using a double spanner.

2) Screws and Bolts (See Table 3.)

(4) Amount of Oil for Compressor (See Table 4.)
The compressor SD7H (HD type) is filled with 240cc (15cu·in) of oil. If the oil volume is small, seizure at high revolution and shortening of service life will occur. If the oil volume is large, the cooling ability will be deteriorated.
Once the air-conditioner is operated, part of the oil is dispersed in the refrigeration circuit. Therefore, when replacing the parts in Table 4, adjust the oil level to that of table.

(5) Before performing operation, stop the engine and turn off all power supplies to the equipment related to the air-conditioner.

(6) After the operation is over, confirm that all faults have been repaired completely, by operating the air-conditioner.

Table 2 Unit: kgf·cm (ft·lbs)

Pipe Fastening Part	Tightening Torque
D hose and compressor (M8 bolt)	200~250 (14~18)
D hose and condenser	200~250 (14~18)
L hose and condenser	120~150 (8.7~11)
L hose and receiver dryer (M6 bolt)	80~120 (5.8~8.7)
L hose and air-conditioner unit	120~150 (8.7~11)
S hose and air-conditioner unit	300~350(22~25)
Inlet of expansion valve	120~150 (8.7~11)
Outlet of expansion valve	200~250 (14~18)
Pressure sensing part of expansion valve	70~90 (5.0~6.5)

Table 3 Unit: kgf·cm (ft·lbs)

Screw Size	Tightening Torque
N4, T4 machine screw, M4	8~12 (0.58~0.87)
N5, T5 machine screw, M5	20~25 (1.4~1.8)
M6 (mounting part of L hose joint)	80~120 (5.8~8.7)
M6 (except mounting part of L hose joint)	100~120 (7.2~8.7)
M8 (mounting parts of S, D hose joints)	200~250 (14~18)
M8 (mounting part of A/C unit)	100~120 (7.2~8.7)
M8 (other than those mentioned above)	120~160 (8.7~12)
M10	400~550 (29~40)

Table 4

Part to be Replaced	Amount to be filled in
Evaporator	40cc (2.4cu·in)
Condenser	40cc (2.4cu·in)
Compressor	Drain out the volume of oil left in the compressor to be replaced, from the new compressor.

4.2 DISASSEMBLY AND REASSEMBLY OF UNIT CASING (SEE FIG.12 AND 13.)

The figures in parentheses after the part names correspond to those in the structural drawings.

(1) Dismantling Upper Duct

Remove two M4 machine screws (51) and two M5 machine screws (53). Then separate duct retainer (11) and upper duct (5).

(2) Dismantling the Upper Casing of Air-Conditioner Unit.

1) Dismantle the upper duct according to para. (1) above.
2) Remove two M4 machine screws (51) and two M5 machine screws. The separate lower duct (6).
3) Separate rod (29) from rod holder (41).

⚠ On that occasion, do not remove rod clamp (38). In case it is taken off by mistake, adjust it according to para. 4.7.

4) Remove air mix actuator connector (15-1) and thermistor connector (24-1).
5) Remove four M4 screws (48) and dismantle motor actuator (21).
6) Remove 15 M5 machine screws (50) and then separate casing upper (4).

(3) Mounting

Mounting should be done in the reverse order of dismantling.

⚠ Use care so as not to pinch thermistor cord (24-1) between the casing and other object.

4.3 REPLACING THERMISTOR (SEE FIG. 14.)

(1) Dismantling

1) Dismantle the casing upper of the air-conditioner unit according to para 4.2.(2).
2) Remove thermistor cord (24-2) from the groove (a) on the unit casing
3) Draw out sensor holder (42) from evaporator (1).
4) Remove thermistor (24) from sensor holder (42).

(2) Mounting

Mounting is done in the reverse order of dismantling, with attention paid to the following.

1) When installing thermistor (24) to sensor holder (42), place them so only the sensor part (24-3) stands out as shown in the illustration. Use care so air mix damper (30) does not interfere with others.
2) Take care so the cord of thermistor (24) is not pinched between casing (3) and other object.

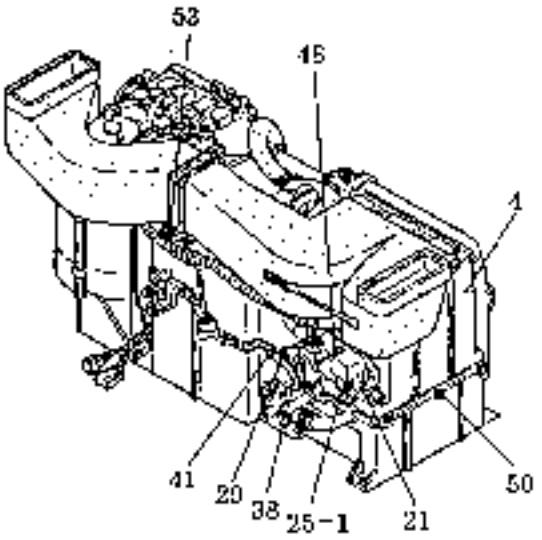


Fig. 12 Air-conditioner unit

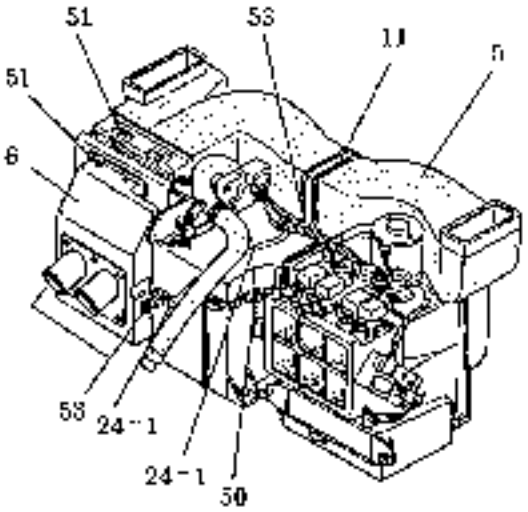


Fig. 13 Air-conditioner unit

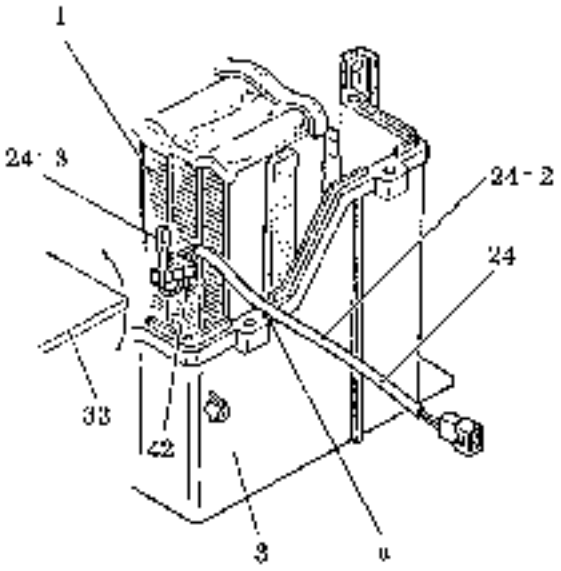


Fig. 14 Replacing thermistor

4.4 REPLACING EVAPORATOR AND EXPANSION VALVE (SEE FIG.15 AND 16.)

(1) Dismantling Expansion Valve.

1) Remove the casing upper of the air-conditioner unit according to para 4.2 (2).

2) Dismantle the assembly of evaporator (1) and expansion valve (22) from the casing, as shown in Fig.15.

3) Peel off thermal insulation material (8) of the temperature sensing part and separate thermowell stay (39). (See Fig.16.)

4) Loosen nuts (a), (b) and (c) and remove each of the pipes.

(2) Dismantling Evaporator

1) Perform Para. (1) above.

2) Remove M4 screw (47) and separate retainer (18).

(3) Mounting

Mounting should be done in the reverse order of dismantling, with attention paid to the following:

1) Install thermowell (22-1) as shown in the cross-sectional drawing (A-A)

2) Round off extra length of capillary tube (22-2) to about ⌀20 (0.787in.) beforehand.

3) When installing the assembly of the evaporator and the expansion valve to the casing, place them so retainer (18) is fixed to the casing

4) Since thermal insulation material (8) can not be re-used, replace it with the expansion valve at the same time.

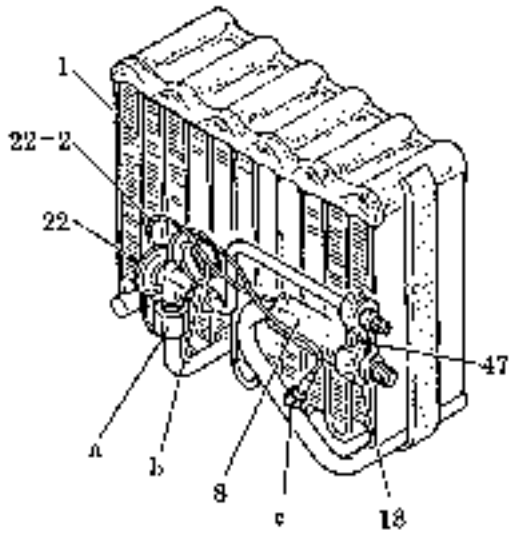


Fig. 15 Replacing expansion valve

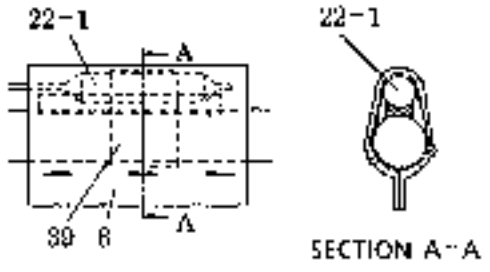


Fig. 16

4.5 REPLACING WATER VALVE (SEE FIG.17.)

(1) Dismantling

1) Turn the fan switch "ON" and bring the temperature control to COOL MAX (Only one LED on the operation panel lights.).

2) Release rod clamp (38-a).

3) Remove three M5 machine screws (49) and then dismantle water valve (23).

(2) Mounting

Mounting is performed in the reverse order of dismantling, with attention paid to the following:

1) Attach valve rod (27) to rod clamp (38-a) and turn lever (23-1) toward (A) till spring (27-1) is bent about 1mm (0.04in) Then install valve rod (27) to rod clamp (38-b).

2) Replace heater hose (16) at the same time.

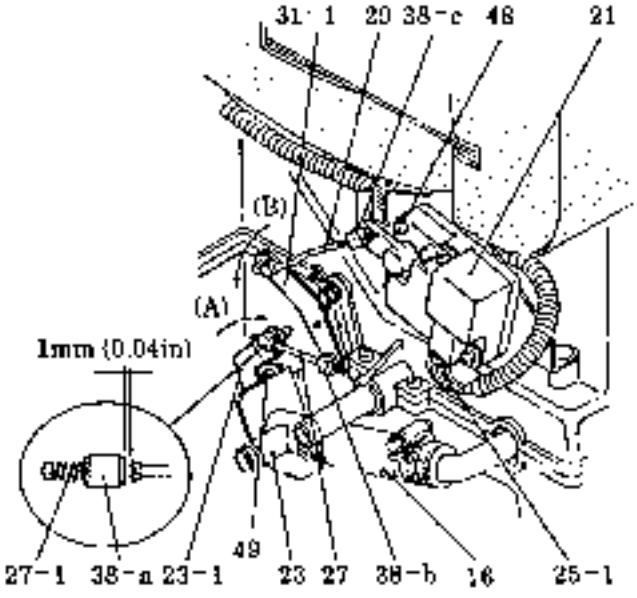


Fig. 17 Replacing water valve

4.6 REPLACING AIR MIX MOTOR ACTUATOR (SEE FIG.17.)

(1) Dismantling

1) Release rod clamp (38-C).
2) Remove connector (15-1).
3) Remove four M4 machine screws (48) and separate motor actuator (21).

(2) Mounting

Mounting should be performed in the reverse order of dismantling, with attention paid to the following:

1) Turn damper lever (31-1) in the direction of (B) and mount rod (29) to rod clamp (38-C), while pressing the damper lever.
2) Make sure that the actuator lever has no play and that spring (27-1) is deflected about 1mm (0.04in).

⚠ When replacing a new motor actuator, do not remove rod clamp (38-C) in any circumstances. In case you have removed the rod clamp by mistake, turn the fan switch to [I], [II] or [III], set the temperature control to COOL MAX (Only one LED on the operation panel lights.) and install it according to para. (2) above.

4.7 REPLACING MODE MOTOR ACTUATOR (SEE FIG.18.)

(1) Dismantling

1) Release rod clamp (38).
2) Remove connector (25-2).
3) Remove four M4 machine screws (48) and dismantle motor actuator (21).

(2) Mounting

Mounting is performed in the reverse order of dismantling, with attention paid to the following:

1) Turn the link (28-1) of mode link ass'y (28) to the position in Fig.16. (So the mode damper closes the lower blowoff port.)
2) Attach mode link rod (29) by pulling it toward (A).

⚠ Never remove rod clamp (38) except when replacing the motor actuator with a new one. In case you have removed it by mistake, turn the fan switch to [I], [II] or [III], set the blowoff mode to FACE [ ] and installed it according to para. (2) above.

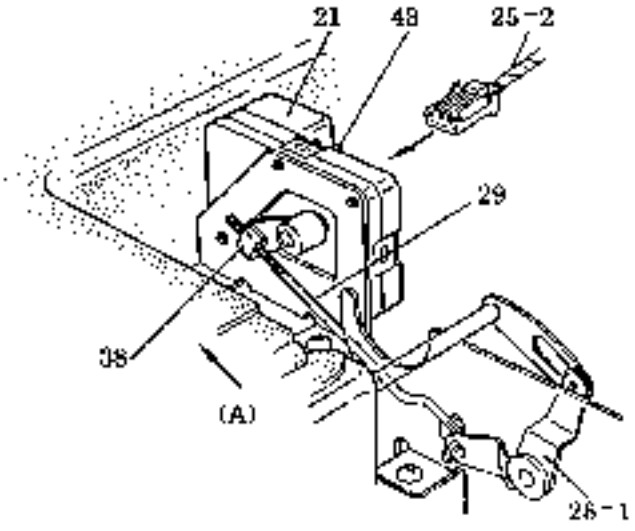


Fig 18 Replacing motor actuator

4.8 REPLACING MODE LINK (SEE FIG.19)

(1) Dismantling

1) Turn the fan switch to [I], [II] or [III] and set the blowoff mode to FACE [ ].

2) Remove three M5 small screws (53) and separate mode link (28).

(2) Mounting

Perform mounting in the reverse order of dismantling, with attention paid to the following:

1) Tighten the M5 small screws to torques of 10~15kgf·cm (0.72~7.8ft·lbs).

2) After mounting, make sure that the link rotates smoothly.

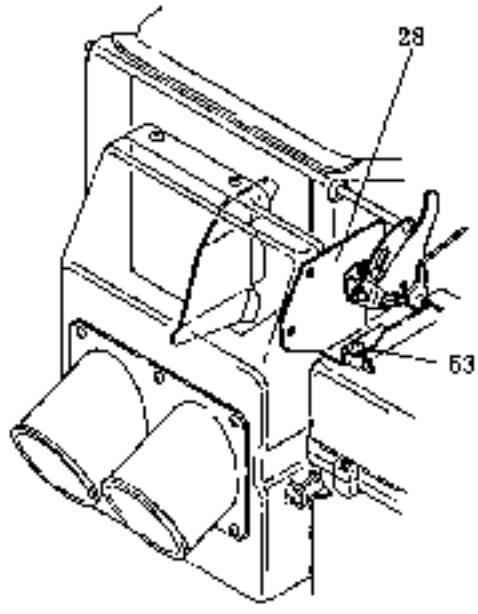


Fig. 19 Replacing mode link

4.9 REPLACING INTAKE MOTOR ACTUATOR (SEE FIG.20.)

(1) Dismantling

1) Release rod clamp (18).

2) Remove connector (11-1)

3) Remove four M4 machine screws (24) and separate motor actuator (9).

(2) Mounting

Perform mounting in the reverse order of dismantling, with attention paid to the following:

1) Turn damper lever (13) toward (A) and install rod (12) to rod clamp (18) while pressing the damper lever.

⚠ Never dismantle rod clamp (18) except when replacing the motor actuator with a new one. In case you have removed the rod clamp by mistake, turn the fan switch to [I], [II] or [III], set the blowoff mode to inner air circulation [ ] and install the motor actuator according to para. (2) above.

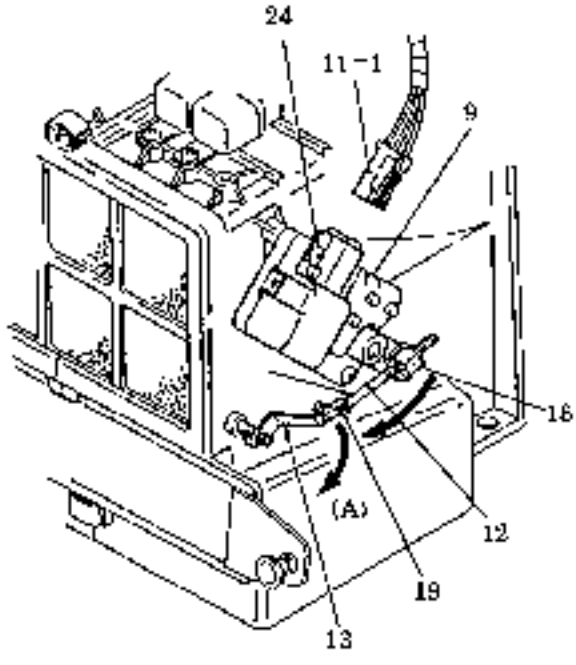


Fig. 20 Replacing actuator

4.10 REPLACING BLOWER MOTOR (SEE FIG.21.)

(1) Dismantling

1) Remove the upper duct according to para. 4.2 (1).
2) Remove connecter (8-1).
3) Separate cooling hose (7) from blower motor (8).
4) Take off three M6 small screws (22).

⚠ On that occasion, exercise care so as not to lose two harness clamps (20) that are fastened together with the blower motor.

5) Remove blower motor (8) upwards. Do not separate fan (8-1) from the blower motor.

(2) Mounting

Mounting should be done in the reverse order of dismantling.

⚠ If foreign matter enters the fan casing, the motor or the resister may be broken. Use sufficient care so such trouble does not occur.

4.11 REPLACING RESISTER (SEE FIG.22)

(1) Dismantling

1) Dismantle blower motor (8) according to para. 4.10.
2) Take off two M5 machine screws (25).
3) Lift up resister (10) upward a little, remove connector (11-2) and take it out.

(2) Mounting

Mounting is done in the reverse order of dismantling.

⚠ Never disassemble the resister. Replace it if the fuse is blown.

⚠ The resister gets very hot. If foreign matter is put between the resister and the heat sink, ignition may occur. Use care so such an accident does not occur.

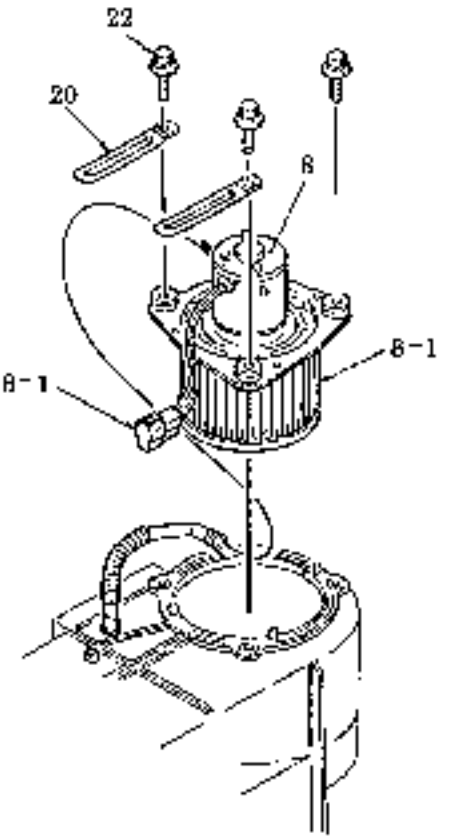


Fig. 21 Replacing blower motor

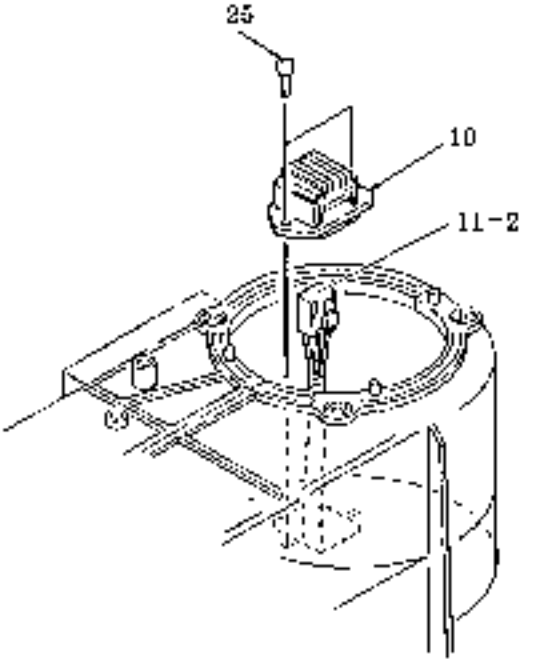


Fig. 22 Replacing resister

5. CHARGING REFRIGERANT

5.1 PRECAUTIONS TO BE EXERCISED IN OPERATION

(1) Always assign a person in charge of handing refrigerant.

Refrigerant charge operation involves dangers as it handles high pressure gas. Always assign a person familiar with how work is done for handing refrigerant.

⚠
- Always wear protective goggles. (You may lose your sight if the refrigerant gets in your eyes.)
- The refrigerant in liquid state is at very low temperature [approx. -26°C (-15°F)]. Therefore, handle it with care. (You may get a frosthite if the refrigerant is sprayed over your skin.)

(2) Storage and Transportation

1) Hold the service can (hereinafter called can) less than 40°C (104°F). Since high pressure gas of R134a is filled in the can in a saturated liquefied state, the pressure in the can increases sharply as temperature rises. The can may blast as the result.

It is for this reason why the can temperature must be kept below 40°C (104°F).

2) For storage, choose a cold bark place not exposed to direct sunlight.

3) If the can is placed near a fire source, it is subject to radiation heat and gets hot. This causes the inside pressure to rise and may cause the can to blow out. Therefore, never bring the can close to a fire.

4) The inside of the closed compartment gets very hot as the radiation heat of the sunlight enters the compartment. The areas of the compartment which are exposed to direct sunlight may rise to a dangerous temperature level. Therefore, do not bring the can into the compartment. Also, the inside of the trunk room may rise to a dangerous temperature level even in the summer time. Use sufficient care, therefore, taking the above into account.

5) Note that if the can has scratches, marks and distortion, the strength of the can will deteriorate.

1. Do not drop or knock on the can.
2. When transporting, loading or unloading cases and packages containing cans, do not throw or drop them.

6) Store cans beyond the reach of children.

(3) Charging

1) When warming the can in which refrigerant is charged, do not fail to open the service can valve and the low pressure valve of the gauge manifold and warm the can in warm water of 40°C (104°F) or below (to an extent that you do not feel hot when you put your hand in the water.) If the can is put in hot water or heated by a direct fire, the pressure of the can may rise sharply, thereby blowing off the can.

2) When charging refrigerant while running the engine, do not open the high pressure valve (HI) of the gauge manifold in any case.

(4) Others

Re-use of service cans is prohibited by law; never use them again. Do not allow foreign matter to enter the air-conditioner circuit. Air, water and dust are detrimental to the refrigeration cycle. Install the components of the air-conditioner correctly and speedily. Pay full attention to the entry of water and dust.

⚠
- Be careful about overcharge of gas.
- Fasten pipes to a specified torque.

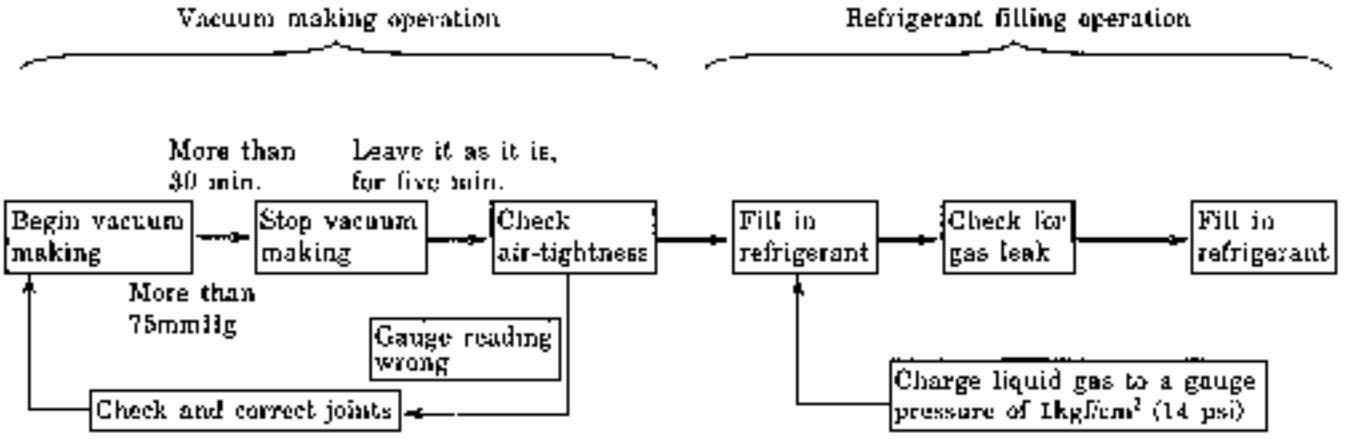
5.2 OPERATING PROCEDURE

(1) Refrigerant charge into the air-conditioner consists mainly of "vacuum making operation", and "gas charge operation".

1) The "vacuum making operation" consists of removing water in the air-conditioner circuit. If only a little water remains in the circuit, the small holes of the expansion valve are frozen during operation. This causes the circuit to clog up or rust, resulting in a variety of malfunctions. Therefore, before filling refrigerant in the circuit, make vacuum and allow the water in the circuit to boil and vaporize. Water in the circuit is thus eliminated.

2) The "gas charging operation" consists of filling refrigerant in the circuit after forming vacuum. Filling gas not only depends upon the cooling performances of the air-conditioner, but also affects the service life of the component parts of the circuit. Extreme overcharge will make the circuit pressure extremely high and causes the cooling performance to deteriorate. On the contrary, undercharge causes poor circulation of the lubricating oil of the compressor and causes seizure of the moving parts of the compressor. The gas filling operation involves handling of high pressure gas; filling gas according to incorrect operation procedure is dangerous. Fill refrigerant correctly following the operation procedures and cautions stated in this manual.

(2) Operation Chart



(3) Tools

Table 5

unit : mm

No.	Name of Part	Q'ty	Sketch	Service	No.	Name of Part	Q'ty	Sketch	Service
1	Gauge manifold	1			4	Quick joint	1		Low pressure side
					5	T joint	1		For service can valve
2	Charging hose	3		Red : high pressure side Blue : low pressure side Yellow : vacuum pump side	6	Service can valve	2		For service can
3	Quick joint	1		High pressure side	7	Vacuum pump adapter	1		For vacuum pump

5.3 CHARGING PROCEDURE

5.3.1 VACUUM MAKING OPERATION

(1) Connecting Gauge Manifold (See Fig.23.)

1) Close the high pressure valve (HI) and the low pressure valve (LO) of the gauge manifold.

2) Connect the charging hoses (red and blue) with the service valves of the compressor.

Red hose : High pressure side (HI) of the gauge manifold →high pressure side (DIS) of compressor

Blue hose : Low pressure side (LO) of gauge manifold →low pressure side (SUC) of compressor

⚠ • Take care so as not to mistake the high pressure side for low pressure side and push it in till a click is heard.

• Connect the end bent like "L" of the charging hose with the service valve of the compressor. If the charging hose is connected the opposite way, the mini valve of the compressor does not open. (See Fig.24.)

3) Connect the middle valve of the gauge manifold with the charging hose of the vacuum pump.

⚠ Some kinds of gauge manifolds are not equipped with an open/close valve in the center.

(2) Vacuum Making (See Fig.25.)

1) Open the high pressure valve (HI) and the low pressure valve (LO) of the gauge manifold.

2) Turn on the switch of the vacuum pump and make vacuum for more than 30 minutes.

3) When vacuum making for a specified duration is over (degree of vacuum : less than −750mmHg), close the high pressure valve and the low pressure valve of the gauge manifold

4) Then turn off the vacuum pump.

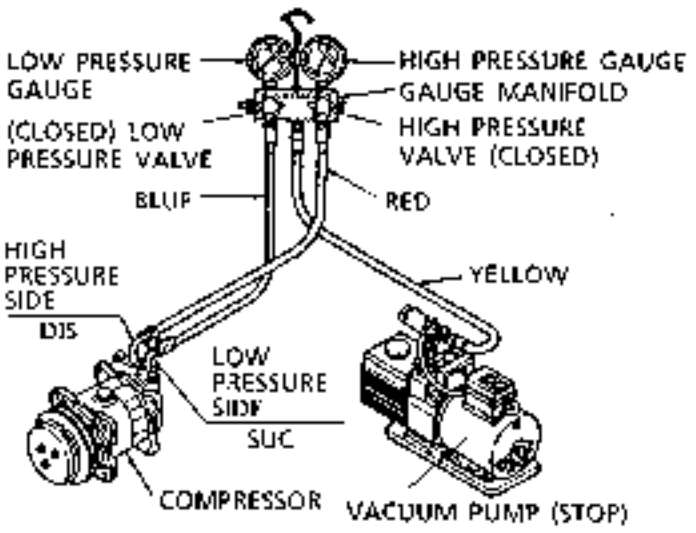


Fig. 23 Connecting gauge manifold

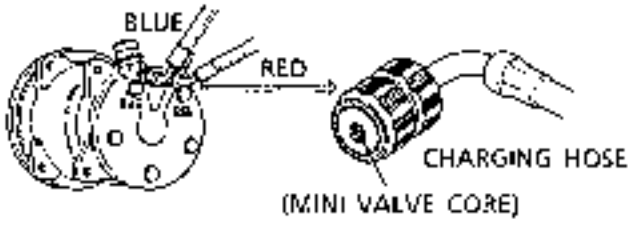


Fig. 24 Connecting piping with compressor

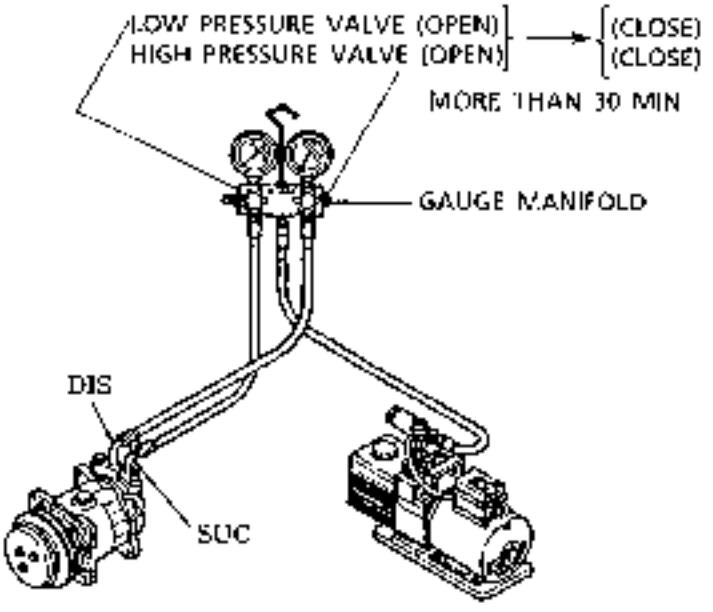


Fig. 25 Vacuum making operation

(3) Air-tightness Check
Close the high pressure valve and the low pressure valve of the gauge manifold, leave it as it is for more than five minutes and make sure that the gauge indication does not return toward 0.

⚠ If the gauge indication swings toward 0, there is somewhere that is leaking. Retighten pipe joints, make vacuum again and make sure of no leakage.

5.3.2 GAS FILLING OPERATION

(1) Filling from High Pressure Side (See Fig.26.)

1) After making vacuum repeatedly, change the charging hose (yellow) of the gauge manifold from the vacuum pump to the service can.

2) Air purge
Open the service can valve. (However, close the high and low pressure valves of the gauge manifold.) Then push the mini valve of the side service port on the low pressure side of the gauge manifold, using a screwdriver or something, in order to let out the air in the charging hose by the pressure of the refrigerant. (See Fig.26.) (The operation ends when a hissing sound is heard.)

3) Open the high pressure valve of the gauge manifold and fill in refrigerant. (Fill in gaseous refrigerant to a gauge pressure of 1kgf/cm2 (14psi).)
After charging, close the high pressure valve of the gauge manifold and the service and valve. (See Fig.27.)

⚠ Do not run the compressor in any case. (Otherwise the refrigerant flow in reverse direction which causes the service can and the hoses to rupture. This is very dangerous.)

(2) Checking for Gas Leakage
Check for gas leakage in the cycle, using a gas leak detector (electric type). Retighten and correct leaking points.

⚠ Always use R134a for the leak tester. (The presently used fron gas affects the sensitivity adversely.)

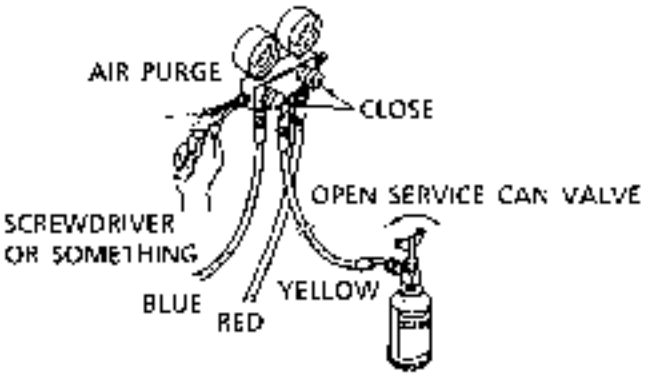


Fig. 26 Gas filling operation

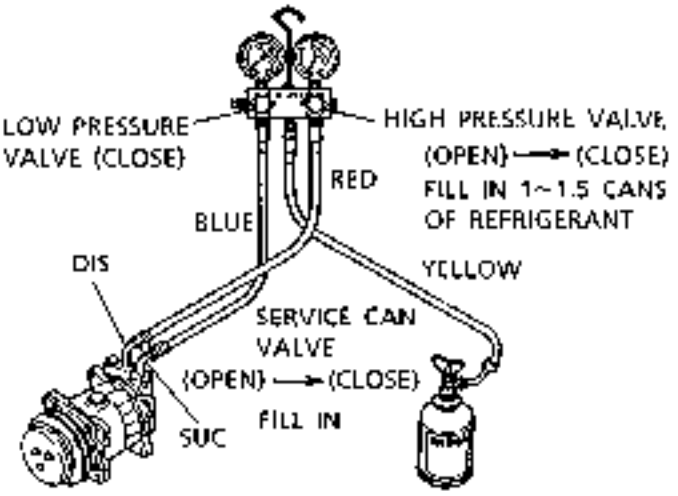


Fig 27 Gas filling operation (High pressure side)

(3) Filling from Low Pressure Side (See Fig.28.)

1) Make sure that the high-pressure and low-pressure valves of the gauge manifold and the service can valve are closed.
2) Start the engine and run the revolution to 1500±100rpm and fully open the cab door and the windows
3) Turn on the air-conditioner switch, set the fan switch to Max and the temperature control switch to cool Max.
4) When filling gas, set the discharge pressure of the compressor to 14-16kgf/cm² (200-230psi).
5) Open the low pressure valve of the gauge manifold and the service can valve and fill in refrigerant till air bubbles of the sight glass of the receiver go away (See Fig.29 ;
[Total amount of gas to be charged : 1000±50g (2.2±0.1lbs.)]
6) When refrigerant charge is over, close the low pressure valve of the gauge manifold and the service can valve.

⚠

- Do not open the high pressure valve of the gauge manifold in any circumstances.
- Never place the service can upside down. (The compressor valve may be scored because the refrigerant is sucked in a liquid state.)

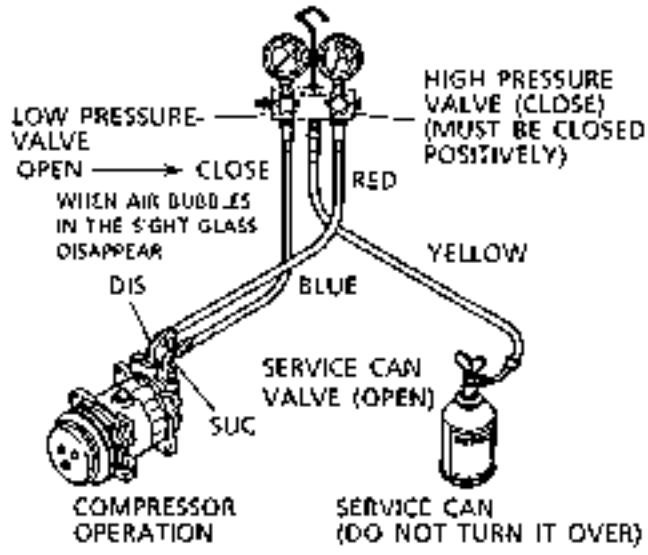


Fig. 28 Gas filling operation (Low pressure side)

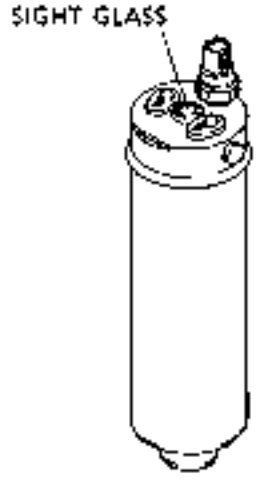


Fig. 29 Receiver dryer

(4) Criterion for Checking the Amount of Refrigerant Filled in

Judgment of refrigerant level through the sight glass of receiver dryer

Proper level	After A/C is turned on, only a little bubbles are seen and thereafter light milky white is seen.	
Overcharge	After A/C is turned on, no air bubbles are seen.	
Undercharge	After A/C is turned on, continuous air bubbles are seen.	

⚠
- If the air-conditioner is run with scant refrigerant R134a, it has adverse effect on the compressor.
- If the refrigerant is charged too much (overcharged), the cooling performance is deteriorated. Moreover, the circuit pressure gets abnormally high : Always keep a proper level.

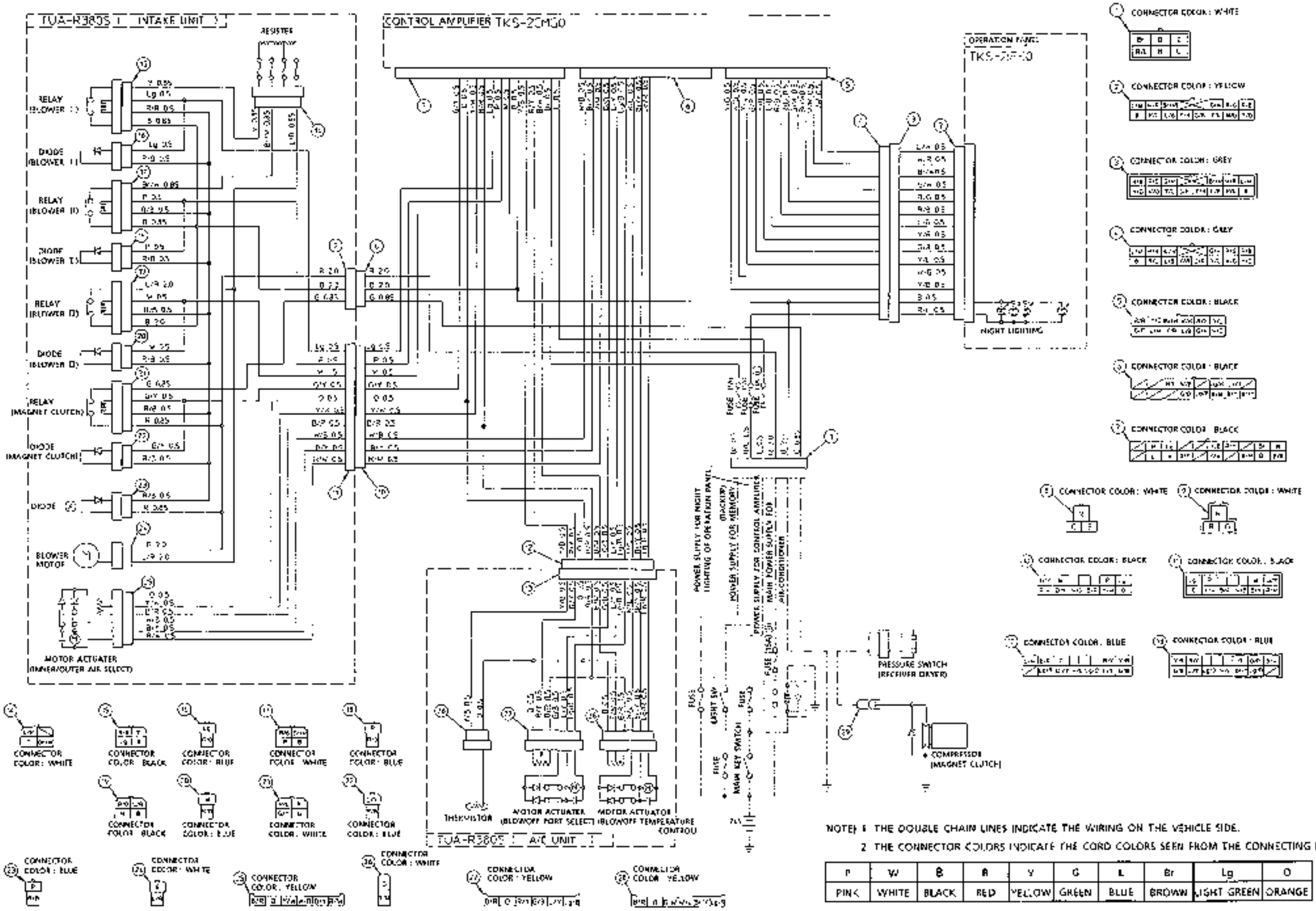
(5) Diamantling Gauge Manifold

When the refrigerant level has been checked, disconnect the charging hoses from the compressor in the following manner:

1) Press the "L" shape metal fitting of the charging hose (blue) on the low pressure side against the service valve of the compressor so the refrigerant does not leak out and loosen the nut. As soon as the nut has been removed, disconnect the charging hose from the service valve.
2) Leave the high pressure side as it is till the high pressure gauge reading falls. [below 10kg/cm²G (140psi·G)].
3) Disconnect the charge hose (red) on the high pressure side the same way as on the low pressure side.

6. ELECTRIC CIRCUIT

6.1 WIRING DIAGRAM AND CONNECTORS



NOTE) 1 THE DOUBLE CHAIN LINES INDICATE THE WIRING ON THE VEHICLE SIDE.

2 THE CONNECTOR COLORS INDICATE THE CORD COLORS SEEN FROM THE CONNECTING PART.

P	W	B	R	Y	G	L	Br	Lg	O
PINK	WHITE	BLACK	RED	YELLOW	GREEN	BLUE	BROWN	LIGHT GREEN	ORANGE

6.2 CHECKING FUNCTIONAL PARTS

(1) Relays (24P-4PA)

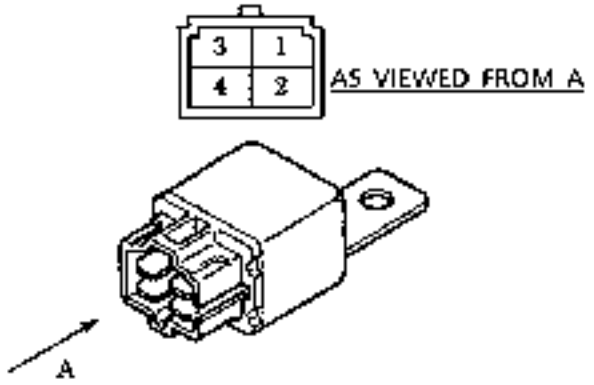
1) Contents of checking

a. Coil resistance: 400Ω (across 1-2)

b. Action: Check for continuity across 3-4 under the following condition.

Apply 20~30V across terminals 1-2 : through

No voltage applied across terminals 1-2 : not through



2) Functions

The power supplies for the following lines are turned on and off by the control of the control amplifier:

- Compressor clutch
- Blower I
- Blower II
- Blower III

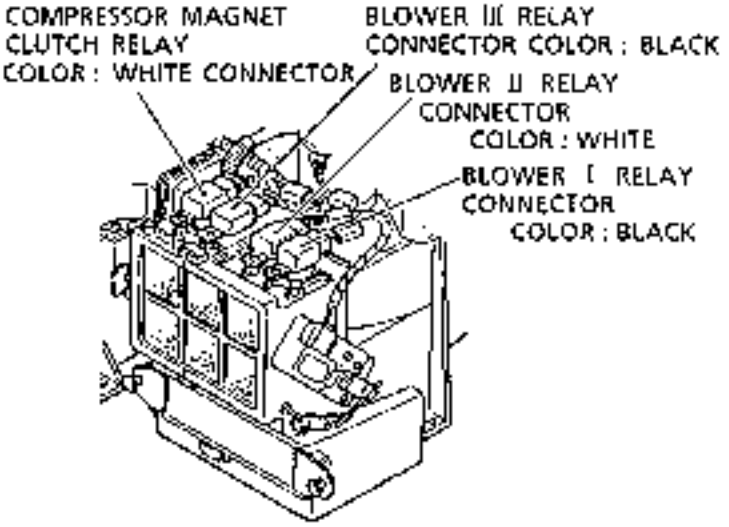


Fig. 30 Relay

(2) Diode (1B)

1) Contents of checking

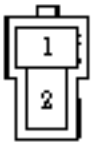
Check the following, using the diode test mode of a circuit tester or other instrument.

Forward direction

(⊕ to terminal 1, COM to terminal 2) : Through

Reverse direction

(COM to terminal 1, ⊕ to terminal 2) : not through



2) Functions

Backflow prevention or surge voltage absorption of relay coils

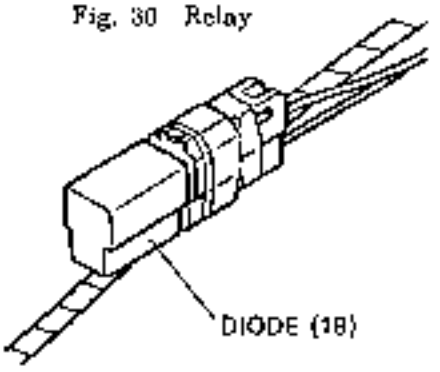


Fig. 31 Diode

(3) Blade Fuse (1A)

1) Contents of checking

Checking for continuity

2) Functions

Protecting the leads of the main power supply for the control amplifier, for the power supply for memory and for the night lighting of the operation panel are shorted to the ground.

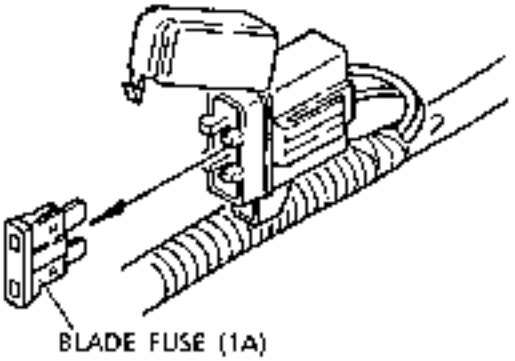


Fig. 32 Blade fuse

(4) Pressure Switch (Attached to Receiver Dryer)

1) Contents of checking (specification)

Low pressure side off pressure :
$2.0 \pm 0.2 kgf/cm^2 \cdot G$ ($28 \pm 3 psi \cdot G$)

Low pressure side return pressure :
OFF pressure $+0.3 kgf/cm^2$ (4.3psi) or below

High pressure side off pressure :
$32 \pm 2 kgf/cm^2 \cdot G$ ($455 \pm 28 psi \cdot G$)

High pressure side return pressure :
off pressure $-6 \pm 2 kgf/cm^2$ ($-85 \pm 28 psi$)

2) Performance

Low pressure side : To prevent actuation of the compressor clutch where refrigerant is deficient

High pressure side : To prevent actuation of the compressor clutch where pressure rises abnormally because of the clogging of the refrigeration circuit, etc.

(5) Thermistor (C18)

1) Contents of checking (specification)

Resistance across terminals
at 0°C (32°F) : 7.2kΩ
at 25°C (77°F) : 2.2kΩ

Note : Normally check that there is no shortcircuit or disconnection.

2) Performance

In order to prevent freezing of the evaporator, the blowoff air temperature of the evaporator is controlled by turning the compressor clutch on and off. The thermistor operates as the sensor of the control.

(6) Resister

1) Contents of checking

Resistance across terminals 1-2 :
8.0Ω (blower 1)

Resistance across terminals 1-4 :
2.5Ω (blower 2)

Resistance across terminals 1-3:
1.0Ω (not used)

2) Function

Lower the terminal-to-terminal voltage of the blower motor and adjust the revolution of the blower motor.

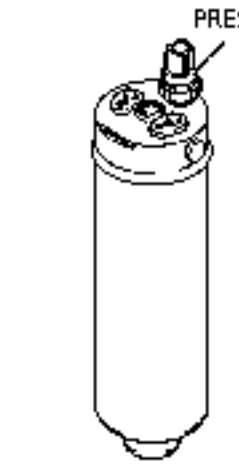


Fig. 33 Pressure switch

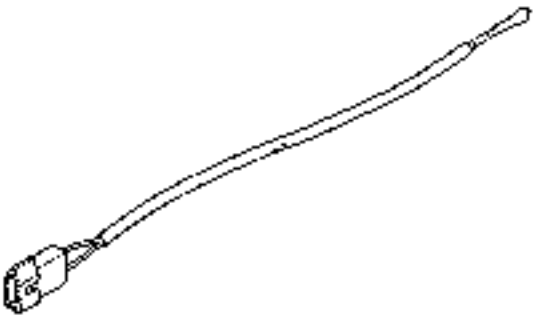


Fig. 34 Thermistor

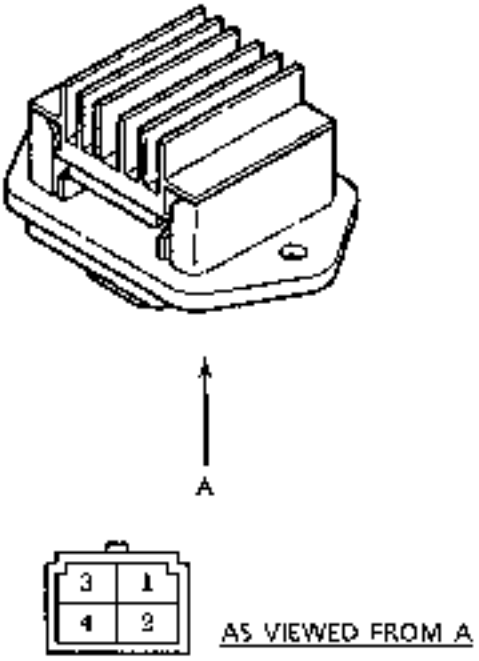


Fig. 35 Resister

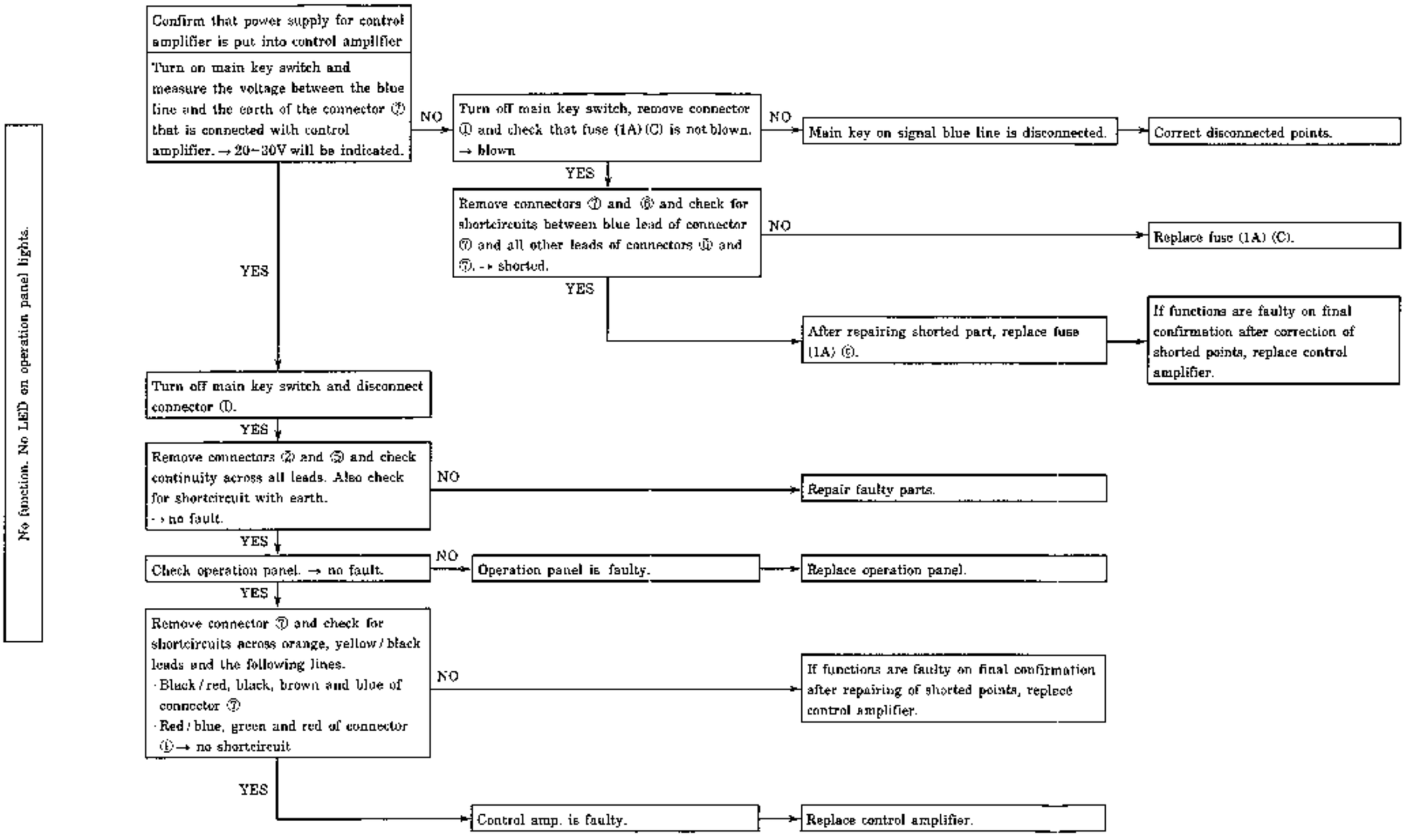
7. TROUBLESHOOTING

7.1 COOLING CIRCUIT

Symptom and Diagnosis			Cause	Remedy and Disposition
Poor cooling	Both high and low pressures are high.	Air bubbles are seen through sight glass.	Oil oozes out of pipes and parts. Gas detecter reacts.	Gas leaks from pipe joints and parts.	Retighten or replace faulty parts with new ones.
			No oozing of oil and on gas reaction. Gas has not been charged for more than one season.	Natural leaks from hose.	Charge gas.
		No air bubbles seen through sight glass.		Expansion valve is not conditioned well. (Too much throttling)	Recondition or replace.
				Expanston valve clogged.	Remove clogged stuff, replace receiver or expansion valve.
				Low pressure circuit and evaporator clogged.	Remove clogged stuff, or replace faulty parts.
			Cooling performance deteriorates at high speed continuous run. Air flow dose not change	Expansion valve is frozen. Water entered.	After vacuum making, refill refrigerant and replace receiver.
			Air flow is small.	Air leaks from casing.	Clog with vinyl tape or packing compound.
	Low pressure is high.	Air bubbles are seen through sight glass	Cylinder of compressor does not get hot. (liquid pack)	Thermowell of expansion valve is in poor contact.	Improve contact. Replace thermowell stay
				Expansion valve is condition poorly. (too much open)	Readjust or replace.
		High pressure is low.	Cylinder of compressor geest very hot. Objectionable odor emitted.	Discharge of compressor is bad. (gasket or valve faulty)	Replace.
		Hot air comes out of heater unit.		Water cock is adjusted poorly or cock is faulty.	Check and readjust or replace.
				Air-tightness of outer air damper is faulty. (outer air intake type)	Repair.
	High pressure is high	Air bubbles seen through sight glass.	Low pressure is low.	High pressure circuit upstream of receiver is clogged.	Remove clogged stuff or replace parts.
		Condenser is fouled or clogged.			Clean condenser.
		Air bubbles are hard to escape even if water is poured over condenser. Receiver temperature is low.		Refrigerant is overcharged.	Discharge refrigerant to a proper level.
				Air is mixed	Refill refrigerant after vacuum making. Replace receiver
	Cooling is poor at high speed continuous run. Air flow is low.	Frost deposited.	Thermistor is not cooled well.	Thermistor position incorrect.	Correct thermistor position.
				Air leaks from casing.	Stuff with vinyl tape or packing compound.
			Thermistor is cooled.	Thermostat faulty. (does not OFF)	Thermistor cord disconnected, etc.
				Performance and functions are normal. If compressor is run for a long time with the air flow level set to M or L, frost deposit may occur.	Get users familiar with how to use it. Increase air flow.

Symptom and Diagnosis	Cause	Remedy and Disposition
Heater is faulty	Blowoff temperature is higher than suction air temperature by 5°C (41°F) when the air-conditioner switch is off and the control is set to COOL MAX.	Heater warm water valve is faulty, valve is conditioned poorly. Heater control wire is adjusted incorrectly.	Replace or adjust valve.
Noise	Compartment side	Blower motor fan	Fan interferes with casing or foreign matter enters casing.	Eliminate foreign matter. Adjust fan motor position.
			Sound of brushes. Metal or thrust washer interferes with others.	Some sound is inevitable. Replace ones making a large sound.
		Gas sound (roaring sound)	Gas vibration sound (discharge of compressor of gas sucking sound of compressor)	No problem functionally
		Expansion valve: hissing sound and gas flowing sound	Sound of expansion valve is unusual. Expansion valve is normal.	Replace expansion valve if blowing sound is heard. Some gas flowing sound is inevitable.
		Sound that is made when the clutch is disengaged.	Clutch bearing or idle pulley bearing is faulty.	Replace.
			Uneven contact of clutch armature, loosened belt or loosened screws.	Repair or replace clutch. Retighten screws.
	Engine room	Sound is made when compressor runs.	Sound of compressor is unusual.	Repair or replace if faulty.
			Oscillation due to slack V-belt or loosened screws	Tension belt. Retighten screws.
Others	Water leaks or splashes.	Heater core is broken or hose ruptured.	Replace.
		Drain hole of casing or drain hose is clogged.	Clean.
	Objectionable odor smells.	Tobacco smoke, dust and odor of the compartment got stuck to evaporator fins and stay there.	Clean evaporator or open door when humidity is high and set air flow to L. Run the compressor for 10 minutes at about 1500rpm and wash down with condensed water.

Note : Re-connect the connectors removed for inspection, after repair is over.



Note : Reconnect connectors removed for inspection securely after repair.

Blowoff hole can not be changed.

Confirm in dication (LED) of blowoff hole changeover.

Turn on main key switch and turn on fan switch (Ⅰ, Ⅱ or Ⅲ). Confirm that LEDs , , , light correctly be the blowoff select switch. → Either of the LEDs remains flashing.

NO → Motor actuator or link is out of order. → Repair or replace troubled part

YES

Turn off main key switch and remove connectors ⑪, ⑰ and ㉖.

Check that there is nothing that obstructs the action of the link or actuator. → Nothing that interferes with them. Link is not arrested.

NO → Remove things that are interfering, or repair or replace troubled part.

YES

Check continuity between six leads ; orange, red / yellow, black / red, green / black, blue / yellow and light green / black of connector ⑰ and connector ㉖ → Continuous

NO → Repair disconnected points.

YES

Check for shortcircuits across six leads and across the earth and other leads between connector ⑰ and connector . ⑰ → no shortcircuit.

NO → If action is faulty on final functional confirmation after shorted points have been fixed, replace control amplifier.

YES

Connect motor actuator (for inspection) with connector ㉖, reconnect remove connector back in place and confirm function.

NO → Control amplifier is faulty. → Replace control amplifier.

YES

Motor actuator is faulty. → Replace motor actuator.

Inner / outer air selection impossible.

Confirm that inner / outer air select is indicated (LED).

Turn on main key switch and turn on fan switch. (Ⅰ, Ⅱ or Ⅲ). Confirm that LDEs , , light normally by inner / outer air select switch. → Either of them remains flashing.

NO → Motor actuator or link is faulty → Repair or replace troubled part

YES

Turn off main key switch and remove connectors ⑪, ⑰ and ㉖.

Check that link or actuator is not obstructed. → No interference. Link is not arrested.

NO → Remove interference. Repair or replace troubled part.

YES

Check for continuity across six leads ; orange, yellow / white, black / red, white / black, black / yellow and red / white between connector ⑰ and connector ㉖. → Continuous

NO → Repair disconnected parts

YES

Check for shortcircuit across six leads and across earth and six leads, between connector ⑰ and connector ㉖.

NO → If functions are faulty on final confirmation after shorted points have been fixed, replace control amplifier.

YES

Connect motor actuator (for inspection) with connector ㉖, reconnect removed connector and confirm function. → Normal function

NO → Control amplifier is faulty. → Replace control amplifier.

YES

Motor actuator is faulty. → Replace motor actuator.

Blowoff temperature control impossible.

Confirm that blowoff temperature control is indicated. (LED)

Turn on main key switch and turn on fan switch. (Ⅰ, Ⅱ, or Ⅲ). Check that 1~10 LEDs for blowoff temperature indication light normally by temperature control switch. → Remain flashing

NO → Motor actuator, link or water valve is faulty. → Repair or replace troubled parts.

YES ↓

Turn off main key switch and disconnect connectors ⑤, ⑦, and ⑧.

Check the link or actuator action in not obstructed.
→ No interference, Link is not arrested.

NO → Remove interference. Repair or replace troubled parts.

YES ↓

Check for continuity of six leads across orange, black / white, black / red, white / blue, brown / yellow and light green / red, between connector ⑦ connector ⑧. → continuous

NO → Repair disconnected parts.

YES ↓

Check for shortcircuit across six leads and across earth and six leads, between connector ⑦ and connector ⑧.

NO → If functions are faulty on final confirmation after shorted parts have been fixed, replace control amplifier.

YES ↓

Connect motor actuator (for inspection) with connector ⑧. Reconnect removed connector bake in place and confirm functions. → normal function

NO → Control amplifier is faulty → Replace control amplifier.

YES → Motor actuator is faulty → Replace motor actuator.

Compressor clutch does not actuate.

Blower motor rotates.

NO → Go to (Blower motor does not run (Displays Ⅰ, Ⅱ and Ⅲ do not change over.)) → To ※ on page 29

YES ↓

Turn off main key switch and disconnect terminal ⑩ connected with compressor.

Turn on main key switch and turn on fan switch. (Ⅰ, Ⅱ or Ⅲ). Then turn on air-conditioner switch and confirm that LED, ☆ lights normally.
→ remains flashing.

YES → Turn off main key switch, disconnect connectors ①, ⑦ and ⑩ and check for shortcircuit between yellow / black wire and other twelve leads of connector ⑦. → no shortcircuit

YES → Inspected lined may be shorted or control amplifier may be broken → If functions are found faulty on final confiration after shorted points have been repaired, replace control amplifier.

NO ↓

※

Light LED, ☆ and measure voltage between terminal ⑩ and earth. (when thermostat is on)
→ indicates 20~30V.

YES → Compressor clutch is faulty. → Repair or replace compressor.

NO ↓

※

Turn off main switch, disconnect connector ① and check for continuity of pressure switch of receiver dryer.
→ continuius

NO → Pressure switch is faulty → Repair or replace receiver dryer.

YES ↓

Check thermistor. → No fault

NO → Thermistor cord or thermistor is faulty. → Repair thermistor cord. Or replace thermistor.

YES → Control amplifier is faulty. → Replace control amplifier.

Check compressor clutch relay.
→ no fault.

NO → Relay is faulty. → Replace relay.

YES ↓

Check continuity of the contacts of compressor clutch relay and the line connected with coil. → no continuity

NO → Inspected lines are disconnected. → Repair disconnected points.

YES ↓

Disconnect connector ⑳ ~ ㉓ Check shortcircuit between green / yellow line of connector ⑳ and red and red / black lines of connector ㉓. → no shortcircuit

NO → Inspected lines may be shorted or control amplifier may be broken. → If functions are fiund faulty on final confirmation after shorted points have been repaired, replace control amplifier.

Control amplifier is faulty. → Replace control amplifier.

Note 1. Refit the connectors removed for inspection securely after repair.
2. The items marked ※ can not be inspected unless refregerant is filled up and atmospheric temperature is more than 0°C (32°F).

Blower motor does not rotate. (I , II and III displays are changed over.)

Blower motor does not run by any of the air flow settings I , II and III .
NO → Check the rotation of blower motor when fan switch is set to III. → run normally
YES

Turn off main key, remove blower motor and check for foreign matter that obstructs blower fan from rotating. → No foreign matter
NO → Blower motor is locked by foreign matter → Remove foreign matter.
YES

Turn ON main key and fan switch (I , II or III) However, the inner / outer air indicating LED does not flash.
NO → 10 P connectors Ⓕ and Ⓓ are disconnected. → Connect connectors.
YES

Notes : 1. If the fault of blower motor is clear, check it beforehand.
2. Reconnect those connectors removed for inspection securely after repair.

Disconnect connector Ⓜ, turn on main key again, and measure vaotage between red of connector Ⓚ and earth. → 20~30V are indicated.
YES

Turn off main key, disconnect connectors Ⓓ, Ⓔ, Ⓕ and Ⓖ and check diode Ⓐ. → no fault.
NO → Diode Ⓐ is fulty. → Remove connectors Ⓓ and Ⓕ. (Diode Ⓐ needs replacement.)
YES

Disconnect connectors Ⓒ and Ⓔ and check for continuity across black terminals. → continuous
NO → Check for disconnection across black line between connectors Ⓓ and Ⓑ. → Repair disconnected points.
YES

Disconnect connectors Ⓘ, Ⓖ and Ⓛ. Short blue / red and black terminals of connector Ⓖ and check continuity between black and blue / red terminals of connector Ⓛ. → cintinuous
NO → Check for disconnection across black or blue / red line between connectors Ⓖ and Ⓛ. → Repair disconnected points.
YES

Check for continuity across red line between connector Ⓜ and connector Ⓚ. Check also for continuity across red/black line between connector Ⓗ and connector Ⓙ. → continuous
NO → Inspected points are disconnected. → Repair disconnected points.

Connect connectors Ⓔ and Ⓘ.

Disconnect connectors Ⓔ and Ⓙ. Check for shortcircuit between yellow and brown/white linws of connector Ⓗ and between red and red/black lines of connector Ⓙ. →no shortcircuit
NO → Resister fuse is blown as inspected points are shorted. → Replace resister after shorted points have been repaired. Note : Do not repair in any case.
YES → Resister is faulty. → Replace resister. Note : Do not repair in any case.

Turn off main key switch and disconnect connector Ⓘ.
YES

Check resister. → no fault
NO
YES

Check air flow relay (I , II or III) that prevents blower motor from running. → No fault.
NO → Relay is faulty. → Replace faulty relay.
YES

Check contacts of air flow erlay and continuity of coil line that prevents blower relay from runninng. → No faule
NO → Inspected lines are disconnected. → Repair disconnected points.
YES

Disconnect air relay connector and diode that prevent blower relay from running. Check for shortcircuit between coil leads (light green, pin or white) and red and red / black of connector Ⓙ. → No fault
NO → Inspected lines may be shorted or control amplifier may be broken. → If functions are found faulty on final confirmation after shorted points have been repaird, replace control amplifier.
YES → Control amplifier is faulty. → Replace control amplifier.

Remove connector Ⓘ and connectors Ⓑ and Ⓕ.

Inspect that fuse (15A) Ⓑ is not blown. → blown
NO → Red lines between connectors Ⓘ ans Ⓐ are disconnected. → Repair disconnected points.
YES

Check for shortcircuit across black line between connector Ⓑ and connector Ⓘ. Also check for shortcircuit across red line and body earth of connector Ⓑ. → No shortcircuit
NO → Shortcircuit exisits across red and black leads or earth between connector Ⓘ and Ⓑ. → After repairing shorted points, replace fuse (15A) Ⓑ.
YES

Disconnect connectors Ⓑ~Ⓚ and check for shortcircuit between red or red/black and each of the following leads of connector Ⓑ.

Light green, pink, white, green / yellow and black / red of connector Ⓣ and leads of all colors of connector Ⓑ	No shortcircuit

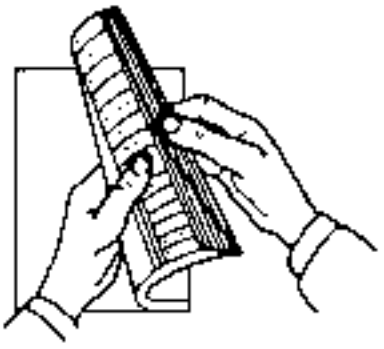
NO → Shortcircuit may exist across red or red / black leads and checked color leads. Or control amplifier and diode Ⓐ may be broken. → After repairing shorted points, replace fuse (15A) Ⓔ (if blown). If functions are faulty on final confirmation, replace control amplifier or diode Ⓐ.
YES

Blower motor is faulty → Replace blower motor. Replace fuse (15A) Ⓔ if blown.

SHOP MANUAL model SK310 SK310LC

TABLE OF CONTENTS

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



KOBELCO

COMPONENTS

Book code No. S5LC3005E

SK310III SK310LCIII List of Shop Manual COMPONENTS Section

Index No.	Title	Book Code No. / Distribution Year-Month			
12	HYDRAULIC PUMP	~~S5120405E①~~ 1995-08	S5120405E Refer to II		
	REGULATOR	~~S5120406E①~~ 1995-08	S5120406E Refer to II		
	HYDRAULIC GEAR PUMP	~~S5120411E①~~ 1995-08	S5120411E Refer to II		
13	PILOT VALVE (TH40K)	~~S5130457E③~~ 1995-08	S5130457E① Refer to II		
	CONTROL VALVE (SWING)	~~S5130751E①~~ 1995-08	S5130751E Refer to II		
	CONTROL VALVE	S5130767E 1995-03			
	PILOT VALVE (TRAVEL)	S5130777E 1995-03			
14	HOLDING VALVE (BOOM LOCK)	~~S5140711E②~~ 1995-08	S5140711E① Refer to II		
	MANIFOLD BLOCK	~~S5140731E②~~ 1995-08	S5140731E Refer to II		
15	HYDRAULIC MOTOR (TRAVEL)	~~S5150233E③~~ 1995-08	S5150233E② Refer to II		
	HYDRAULIC MOTOR (SWING)	~~S5150437E①~~ 1995-08	S5150437E Refer to E		
16	SWIVEL JOINT	S5160122E② 1995-03			
17	HYDRAULIC CYLINDER	~~S5170148E①~~ 1995-08	S5170148E Refer to II		
21	REDUCTION UNIT (TRAVEL)	~~S5210203E②~~ 1995-08	S5210203E① Refer to II		
	REDUCTION UNIT (SWING)	~~S5210327E①~~ 1995-08	S5210327E Refer to II		
50	ENGINE	~~S5600023E~~ 1995-08	S4LC5001E Refer to II		
	Applicable Machines	LC03801— YC01101~			

Book code No. S5 13076 7E

KOBELCO

SHOP MANUAL

CONTROL VALVE

13

TABLE OF CONTENTS

KOBE STEEL, LTD.

PREFACE

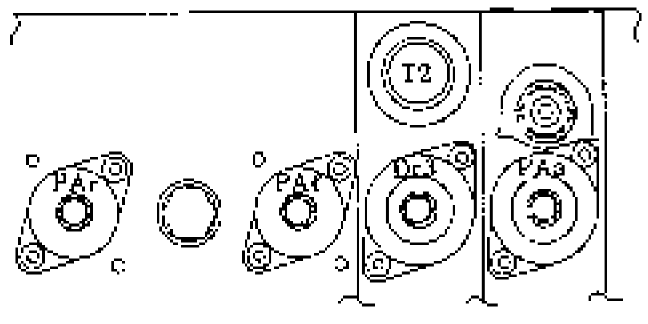
This valve is an integral multi-function structure containing direction control valves to control actuator motion by switching between circuits, relief valves to maintain circuit pressure within a safe pressure range, and port relief valves to prevent negative pressure.

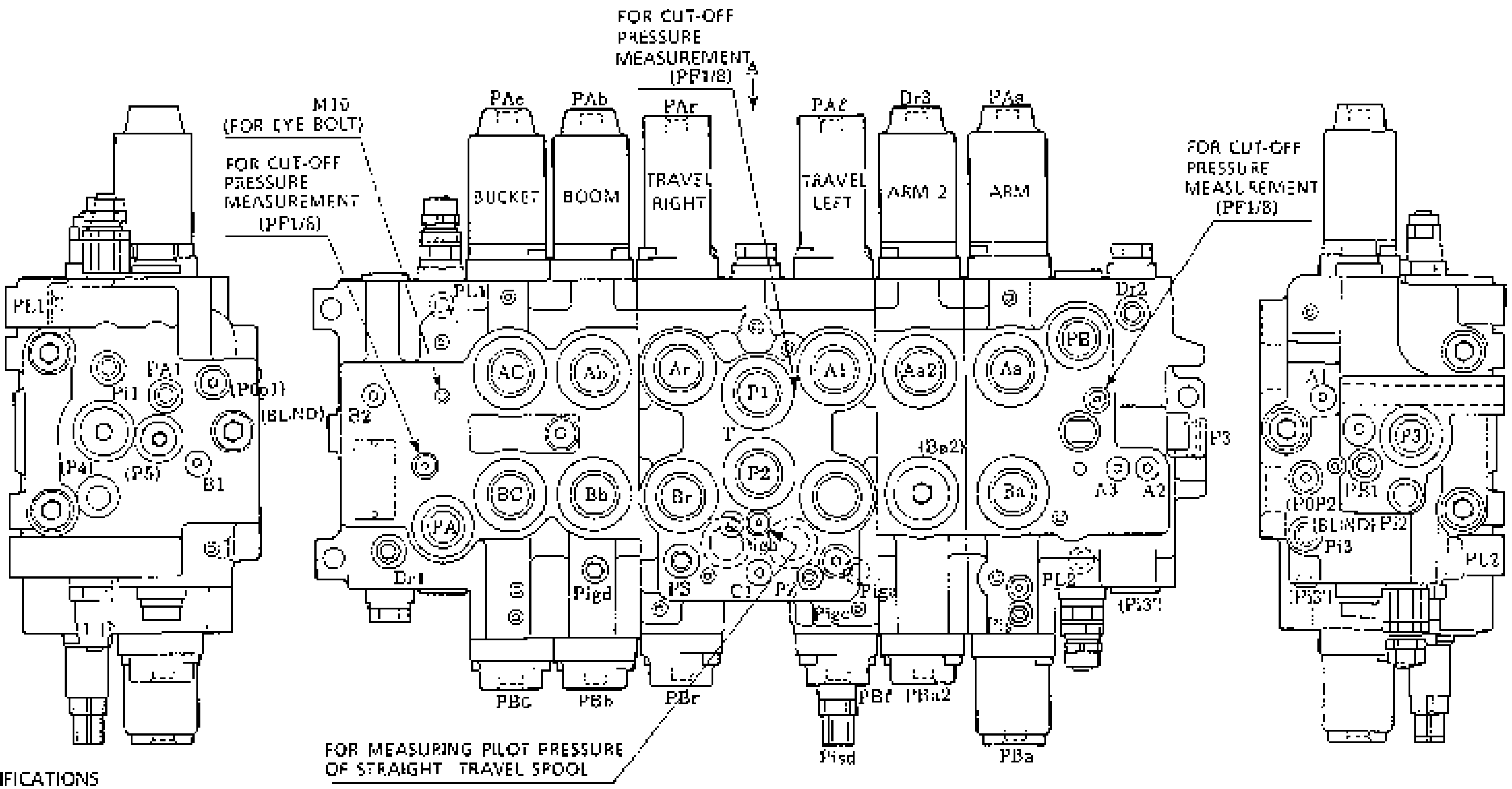
Models	Applicable Machines	Notes	Models	Applicable Machines	Notes
SK310DH	LC03801~				
SK310DLH	YC01101~				

Revision	Date of Issue	Remarks
First edition	March, 1995	S5130767E K

1. SPECIFICATIONS

1.1 EXTERNAL VIEWS





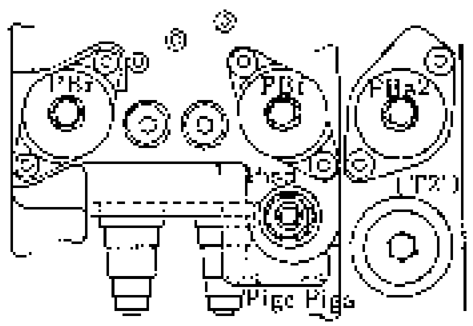


Fig. 1 External views of Control valve

1.2 SPECIFICATIONS

Table 1

Item	Specification
Model	KMX15RB/30041 (2436U2885F1)
Flow rate ℓ/min (gal/min)	315×2 (83.2×2)
Max. pressure kgf/cm² (psi)	350 (4980)
Main relief valve set pressure kgf/cm² (psi)	300±5 (4270±70) / 335±5 (4760±70) at 206ℓ/min (5.2gal/min)
Port relief valve set pressure kgf/cm² (psi) (Boom head, bucket head)	350±5 (4970±70) at 30ℓ/min (7.92gal/min)
Miscellaneous set pressure kgf/cm² (psi) (for 4 locations)	335±5 (4760±70) at 30ℓ/min (7.92gal/min)
Travel relief valve set pressure kgf/cm² (psi)	350±5 (4970±70) at 120ℓ/min (31.7gal/min)
Low pressure relief valve set pressure kgf/cm² (psi)	32^{+5}_{0} (455^{+70}_{0}) at 40ℓ/min (10.6gal/min)

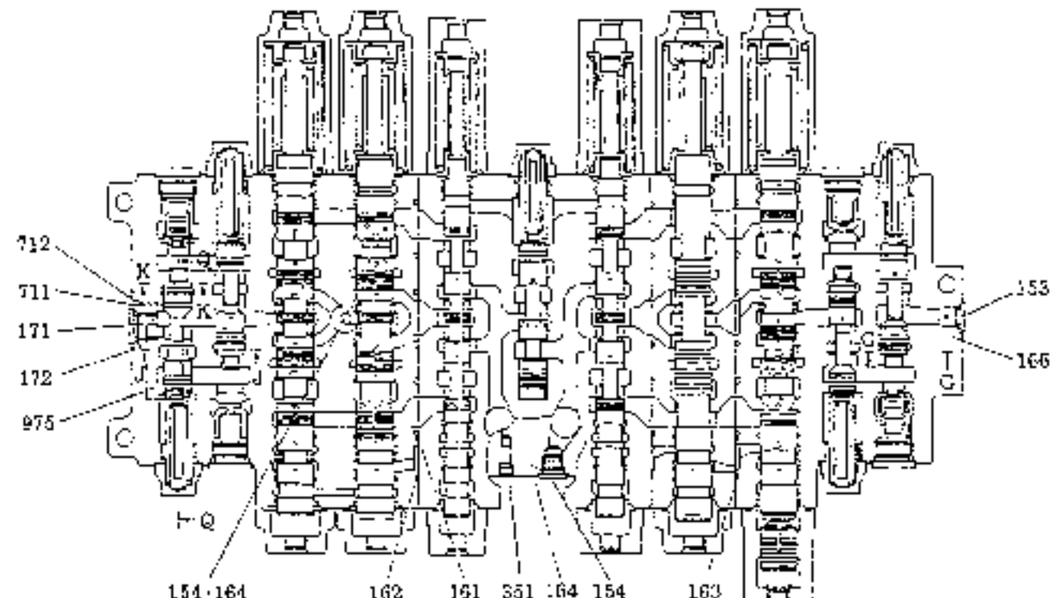
Table 2

Port size	Tightening torque kgf·cm (ft·lbs)	Port name	Description
PF1	2250±250 (162±18)	P1	Pump P1 port
		P2	Pump P2 port
		Ab	Boom raise port
		Bb	Boom lower port
		Ac	Bucket dump port
		Bc	Bucket digging port
		Ar	Right travel port (forward)
		Br	Right travel port (reverse)
		Aℓ	Left travel port (forward)
		Bℓ	Left travel port (reverse)
		Aa	Arm digging port
		Ba	Arm extend port
		Aa2	Arm discharge return port
		T2	Arm discharge return tank port
PF3/4	1650±150 (119±11)	P3	Swing port
		PA	Arm conflux port
		PB	Boom conflux port
		(P4)	Option port
PF3/8	750±50 (54.2±3.6)	PAa	Arm digging pilot port
		PAb	Boom raise pilot port
		PAc	Bucket dump pilot port
		PBa	Arm extend pilot port
		PBb	Boom lower pilot port
		PBc	Bucket digging pilot port
		PAr	Right travel pilot port (forward)
		PBr	Right travel pilot port (reverse)
		PAℓ	Left travel pilot port (forward)
		PBℓ	Left travel pilot port (reverse)
		PBa2	Return pilot port for arm stretching
		Dr3	Drain port
PF1/4	370±20 (26.7±1.4)	PA1	Arm extend conflux signal port
		PB1	Boom raise conflux signal port
		Dr1	Drain port
		Dr2	Drain port
		Ps	Servo pressure port
		Pisd	Variable recirculation cut in Arm heavy digging
		POp1	Option pilot port
		POp2	Option pilot port
		Pi1	Negative control signal port
		Pi2	Negative control signal port
		Pi3	Swing pilot port
PF1/8	170±20 (12.3±1.4)	Pis	Arm loading recirculation command port
		Piga	Arm conflux sequence port (primary)
		Pigb	Arm conflux sequence port (secondary)
		Pigc	Arm conflux sequence port (secondary)
		PL1	Attachment boost pressure port
		PL2	Attachment boost pressure port
		Pigd	Bucket conflux command port
M10	580±10 (41.9±0.7)	T	Tank port

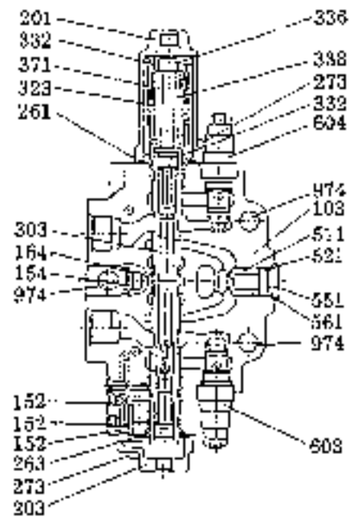
2. CONSTRUCTION AND OPERATION

2.1 CONSTRUCTION

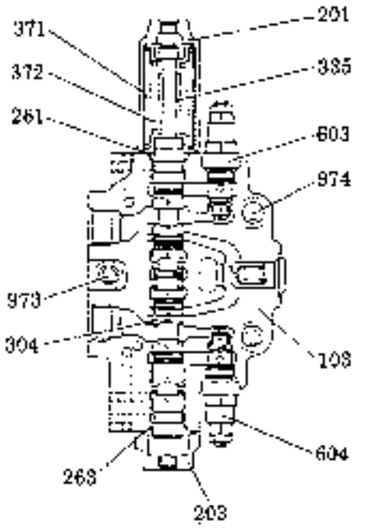
(1) Control valve



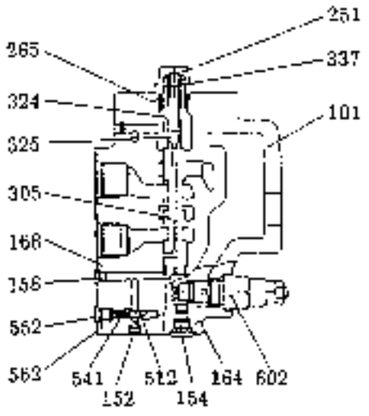
BUCKET BOOM TRAVEL RIGHT TRAVEL LEFT ARM T2 ARM



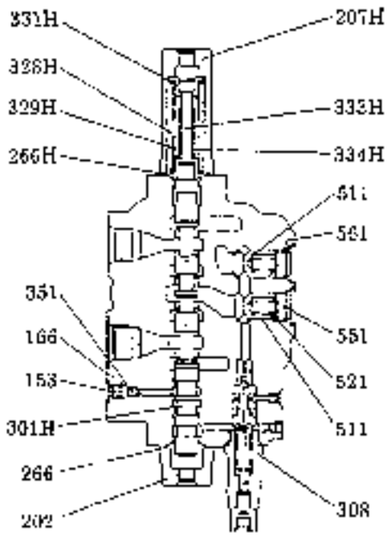
SECTION A-A
BOOM



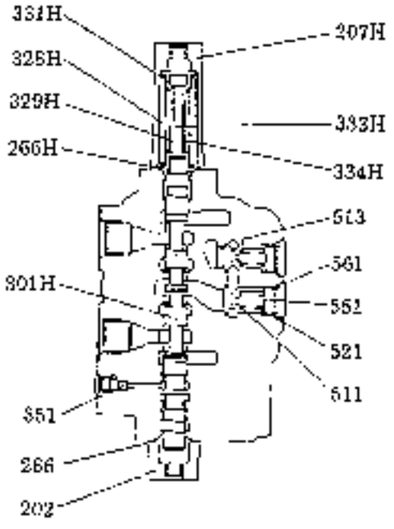
SECTION A'-A'
BUCKET



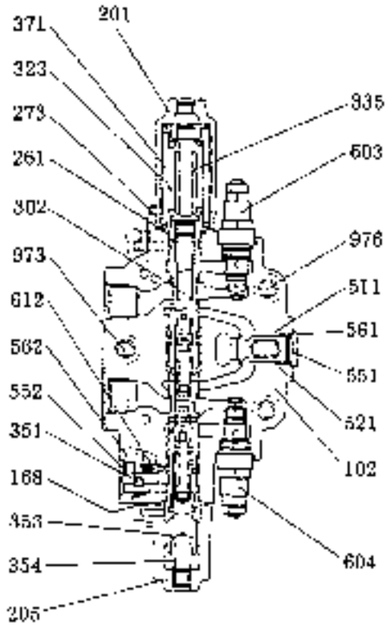
SECTION B-B
TRAVEL STRAIGHT VALVE



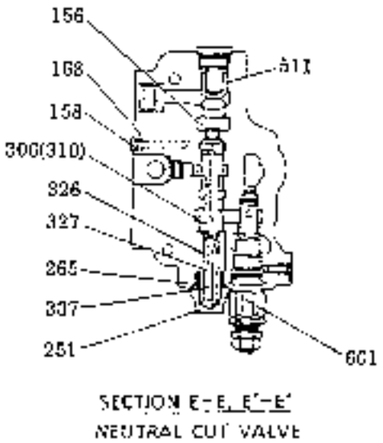
SECTION C-C
TRAVEL LEFT



SECTION C'-C'
TRAVEL RIGHT

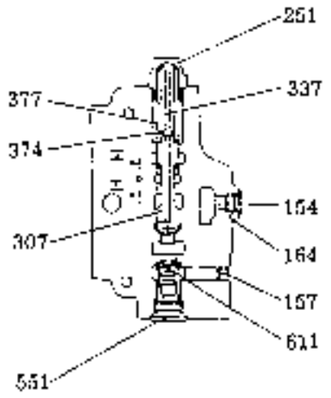


SECTION D-D
ARM

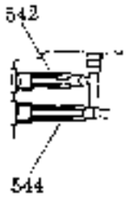


SECTION E-E, E'-E'
NEUTRAL CUT VALVE

Fig 2 (1/2) Sectional views of control valve

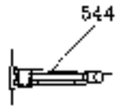


SECTION F-F
BOOM CONFLUX CHANGEOVER VALVE

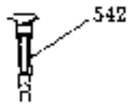


SECTION G-G

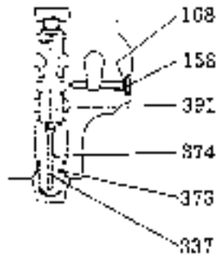
SECTION H-H



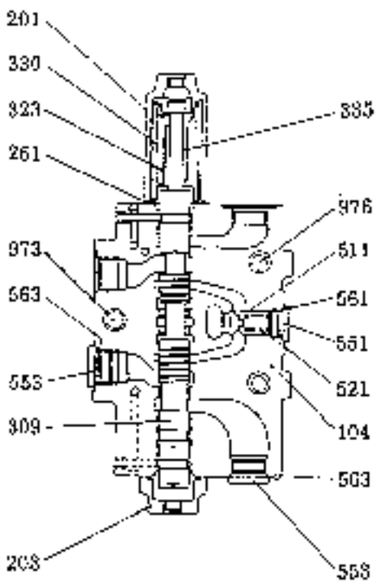
SECTION I-I



SECTION K-K



SECTION Q-Q
ARM CONFLUX CHANGEOVER VALVE



SECTION R-R
ARM T2

Fig. 2 (2/2) Sectional views of control valve

Table 3

Tightening torque kgf·cm (ft-lbs)	No.	NAME	Q'ty	Tightening torque kgf·cm (ft-lbs)	No.	NAME	Q'ty
	101	TRAVEL BLOCK	1		331H	SPRING SEAT (TRAVEL)	4
	102	CASING (A)	1		332	SPRING SEAT (ARM, BOOM, BUCKET)	6
	103	CASING (B)	1				
	104	CASING (T2)	1	170±20 (12.3±1.4)	333H	SPACER BOLT (TRAVEL)	2
100±15 (7.2±1.0)	152	PLUG	39		334H	STOPPER (TRAVEL)	2
375±25 (27.1±1.8)	153	PLUG	3		335	STOPPER (ARM, BUCKET)	3
750±50 (54.2±3.6)	154	PLUG	6	170±20 (12.3±1.4)	336	SPACER BOLT (ARM, BOOM, BUCKET)	4
275±25 (19.9±1.8)	156	PLUG	4				
220±20 (15.9±1.4)	157	PLUG	2		337	ROD (CONFLUX, BYPASS CUT)	5
88±12 (6.4±0.8)	158	PLUG	6		338	STOPPER (BOOM)	1
	161	O RING	12	170±20 (12.3±1.4)	351	ORIFICE (ø0.7(0.028"))	4
	162	O RING	9		353	PISTON (ARM COVER)	1
	163	O RING	3		354	SPRING (ARM COVER)	1
	164	O RING	6		371	SPRING (ARM, BOOM, BUCKET)	3
	166	O RING	3				
	168	O RING	6		372	SPRING (BUCKET)	1
1250±250 (90.4±18.1)	171	PLUG	1		373	SPRING (ARM CONFLUX)	1
	172	O RING	1		374	SPRING (ARM CONFLUX)	2
	201	SPRING COVER	4		377	SPRING (BOOM CONFLUX)	1
	202H	SPOOL COVER (TRAVEL)	2		391	SPOOL (ARM CONFLUX)	1
	203	SPOOL COVER	3		511	POPPET (LOAD CHECK VALVE)	9
	205	ARM COVE	1				
	207H	SPRING COVER (TRAVEL)	2		512	BALL (SHUTTLE VALVE)	6
750±50 (54.2±3.6)	251	PLUG	5		513	POPPET	1
	261	O RING	4		521	SPRING	10
	263	O RING	4			(LOAD CHECK VALVE)	
	264	O RING	4		541	SEAT L=16.7(SHUTTLE VALVE)	1
	265	O RING	5		542	SEAT L=27.7(SHUTTLE VALVE)	2
	266H	O RING	4		543	SEAT L=33.7(SHUTTLE VALVE)	1
275±25 (19.9±1.8)	273	SOCKET BOLT	24		544	SEAT L=37.7(SHUTTLE VALVE)	2
	301H	SPOOL (TRAVEL)	2	1650±150 (119±11)	551	PLUG RO M27×1.5	12
	302	SPOOL (ARM)	1	113±12 (8.2±0.9)	552	PLUG RO M12×1.5	7
	303	SPOOL (BOOM)	1	2250±250 (163±18)	553	PLUG RO 1	2
	304	SPOOL (BUCKET)	1		561	O RING	12
	305	SPOOL (TRAVEL STRAIGHT)	1		562	O RING	7
	306	SPOOL (BYPASS CUT)	1		563	O RING	2
	307	SPOOL (BOOM CONFLUX)	1	750±50 (54.2±3.6)	601	MAIN RELIEF VALVE	2
	308	ARM CONFLUX SEQUENCE	1	750±50 (54.2±3.6)	602	TRAVEL RELIEF VALVE	2
				750±50 (54.2±3.6)	603	PORT RELIEF VALVE	3
	309	SPOOL (ARM T2)	1	750±50 (54.2±3.6)	604	PORT RELIEF VALVE	3
	310	BYPASS CUT SPOOL	1		611	LOW PRESSURE RELIEF VALVE (NEGATIVE CONTROL)	2
	323	SPRING (ARM, BOOM T2)	3				
	324	SPRING (TRAVEL STRAIGHT)	1		612	POPPET	1
	325	SPRING (TRAVEL STRAIGHT)	1	1650±150 (119±11)	711	PLUG RO 3/4	1
	326	SPRING (BYPASS CUT)	2		712	O RING	1
	327	SPRING (BYPASS CUT)	2	3200±200 (231±14)	973	SOCKET BOLT M18×1.5×235	2
	328H	SPRING (TRAVEL)	2	3200±200 (231±14)	974	SOCKET BOLT M18×1.5×145	2
	329H	SPRING (TRAVEL)	2		975	NAMEPLATE	1
	330	SPRING (ARM T2)	1	3200±200 (231±14)	976	SOCKET BOLT M18×1.5×150	2

(2) Arm spool

Fig. 3

Tightening torque kgf·cm (ft·lbs)	No.	NAME	Q'ty	Tightening torque kgf·cm (ft·lbs)	No	NAME	Q'ty
	302	SPOOL	1		339	O RING	1
	312	SUB SPOOL	1		341	BUSHING	1
	313	PISTON	1		342	SLEEVE (1)	1
	314	SLEEVE (2)	1		343	SPACER BOLT	1
	328	SPRING	1		348	STOPPER (1)	1
	329	SPRING	1		358	SPRING SEAT	1
	338	SPRING	1		359	PLUG	2

(3) Boom spool

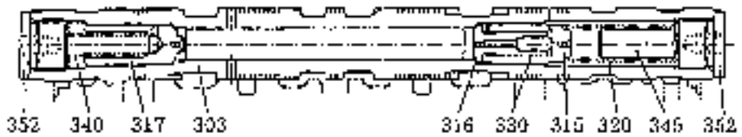


Fig. 4

Tightening torque kgf·cm (ft·lbs)	No	NAME	Q'ty	Tightening torque kgf·cm (ft·lbs)	No.	NAME	Q'ty
	303	SPOOL	1		330	SPRING	1
	315	PLUNGER 1	1		340	SPRING	1
	316	PLUNGER 2	1		345	ROD	1
	317	PLUNGER 3	1		352	PLUG	2
	320	SPRING	1				

(4) Recirculation cut sequence valve

Fig. 5

Tightening torque kgf·cm (ft·lbs)	No.	NAME	Q'ty	Tightening torque kgf·cm (ft·lbs)	No.	NAME	Q'ty
	440	O RING	1		446	SPOOL	1
	441	O RING	1	750±50 (54.2±3.6)	447	PLUG	1
	442	SPOOL	1		448	SPRING	1
	443	PISTON	1	350±50 (25.3±3.6)	449	STOPPER	1
	444	SLEEVE	1		450	O RING	1
	445	BUSHING	1				

(5) Main relief valve (two-step relief) (601)

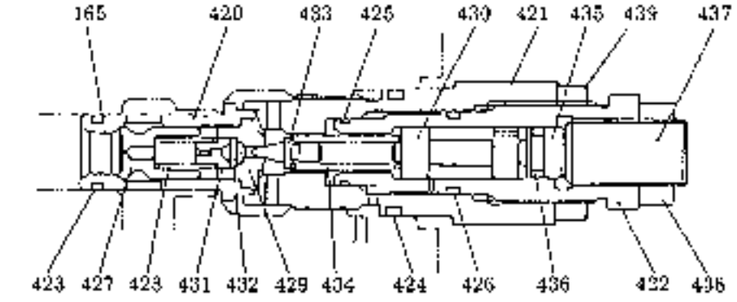


Fig. 6

Tightening torque kgf·cm (ft·lbs)	No.	NAME	Q'ty	Tightening torque kgf·cm (ft·lbs)	No.	NAME	Q'ty
	165	BACKUP RING	1		430	PISTON	1
	420	BODY	1		431	SPRING SEAT	1
750±50 (54.2±3.6)	421	PLUG	1		432	FILTER	1
	422	ADJUSTING SCREW	1		433	POPPET	1
	423	O RING	1		434	SPRING	1
	424	O RING	1		435	SPRING SEAT	1
	425	O RING	1		436	O RING	1
	426	O RING	1	280±30 (20.3±2.2)	437	ADJUSTING SCREW	1
	427	PLUNGER	1		438	LOCK NUT	1
	428	SPRING	1	280±30 (20.3±2.2)	439	LOCK NUT	1
	429	SEAT	1				

(6) Travel relief valve (602)

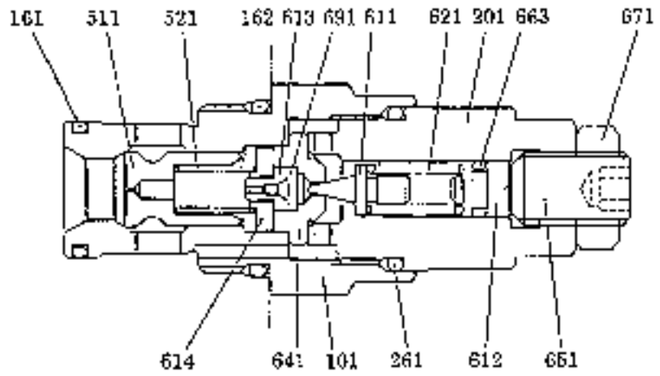


Fig. 7

Tightening torque kgf-cm (ft-lbs)	No.	NAME	Q'ty
750±50 (54.2±3.6)	101	BODY	1
	161	O RING	1
	162	O RING	1
750±50 (54.2±3.6)	201	PLUG	1
	261	O RING	1
	511	PLUNGER	1
	521	SPRING	1
	611	POPPET	1
	612	SPRING SEAT	1
	613	SPRING SEAT (2) ※	1
	614	SPRING SEAT	1
	621	SPRING	1
	641	SEAT	1
	651	ADJUSTING SCREW	1
	663	O RING	1
300±20 (21.7±1.4)	671	LOCK NUT	1
	691	FILTER	1

(7) Port relief valve (603, 604)

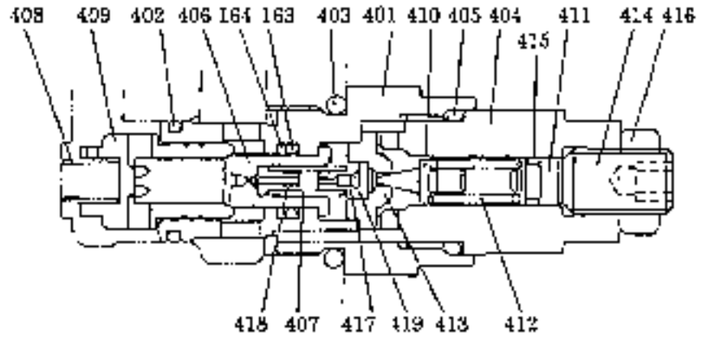


Fig. 8

Tightening torque kgf-cm (ft-lbs)	No.	NAME	Q'ty
	163	O RING	1
	164	BACKUP RING	1
750±50 (54.2±3.6)	401	BODY	1
	402	O RING	1
	403	O RING	1
750±50 (54.2±3.6)	404	PLUG	1
	405	O RING	1
	406	PLUNGER	1
	407	SPRING	1
	408	SPRING	1
	409	SEAT 1	1
	410	POPPET	1
	411	SPRING SEAT	1
	412	SPRING	1
	413	SEAT 2	1
	414	ADJUSTING SCREW	1
	415	O RING	1
300±20 (21.7±1.4)	416	LOCK NUT	1
	417	SPRING SEAT	1
	418	SPRING SEAT	1
	419	FILTER	1

(8) Negative control (low pressure) relief valve (611)

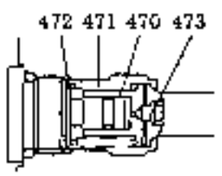


Fig. 9

Tightening torque kgf-cm (ft-lbs)	No.	NAME	Q'ty
	470	POPPET	1
	471	SPRING	1
	472	BUSHING	1
	473	FILTER	1

(9) Hydraulic circuit diagram

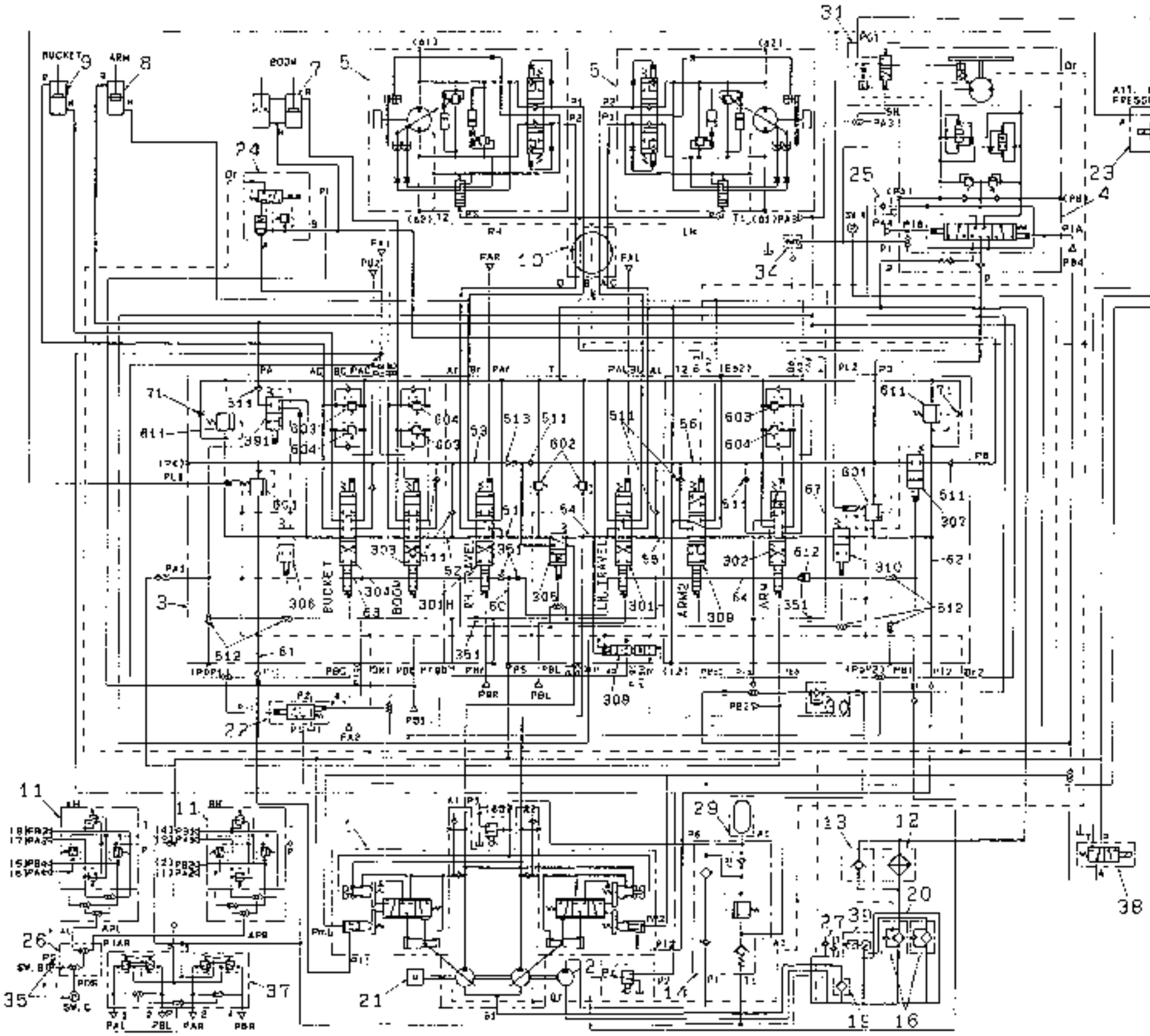


Table 4

No.	Item
23	SOLENOID VALVE
28	SOLENOID VALVE
51	MAIN PASSAGE (RIGHT)
52	BYPASS CIRCUIT (RIGHT)
53	PARALLEL CIRCUIT (RIGHT)
54	MAIN PASSAGE (LEFT)
55	BYPASS CIRCUIT (LEFT)
56	PARALLEL CIRCUIT (LEFT)
60	SERVO PRESSURE CIRCUIT
61	NEGATIVE CONTROL SIGNAL CIRCUIT (P1)
62	NEGATIVE CONTROL SIGNAL CIRCUIT (P2)
63	SIDE BYPASS CIRCUIT (LEFT)
64	SIDE BYPASS CIRCUIT (RIGHT)
66	BOOM CONFLUX SIGNAL CIRCUIT
67	SWING SIGNAL CIRCUIT
71	NEGATIVE CONTROL ORIFICE
301H	TRAVEL SPOOL
302	ARM SPOOL
303	BOOM SPOOL
304	BUCKET SPOOL
305	TRAVEL STRAIGHT CHANGEOVER SPOOL
306	BYPASS NEUTRAL CUT SPOOL
307	BOOM CONFLUX SPOOL
308	ARM CONFLUX SEQUENCER
309	ARM T2 SPOOL
310	BYPASS NEUTRAL CUT SPOOL
351	ORIFICE
391	ARM CONFLUX SPOOL
511	POPPET (LOAD CHECK VALVE)
512	BALL
513	POPPET (FOR TRAVEL STRAIGHT RESTRICTION)
601	MAIN RELIEF VALVE
602	TRAVEL RELIEF VALVE
603	PORT RELIEF VALVE
604	PORT RELIEF VALVE
611	NEGATIVE CONTROL RELIEF VALVE
612	POPPET (LOGIC VALVE)

Fig. 10 Hydraulic circuit diagram

2.2 FUNCTION

2.2.1 AT NEUTRAL

(1) Minimum flow by negative control signal

1) Main circuit in H, S, PC modes

When all spools are at neutral, the oil discharged by the hydraulic pump (P1) passes through the main path (51), the bypass circuit (52) that goes through the RH travel and boom, bucket spools and negative control relief (611) and returns to the hydraulic tank via the tank port (T).

The pressure upstream of negative control relief (611) rises to this set relief pressure. The pressure from the port Pi1 is admitted to the regulator (Pi1) of the hydraulic pump in order to control the minimum flow of the oil discharged by the hydraulic pump. (negative flow control)

Likewise, the oil discharged by hydraulic pump (P2) passes through the main path (54), the bypass circuit (55) that goes through the arm T2 and arm spools and the negative control relief valve (611) and is brought back to the hydraulic tank via the tank port (T).

The increased port Pi2 pressure by negative control relief (611) enters the pump regulator Pi2 and controls negative flow.

<Pilot circuit>

The oil discharged by gear pump (P3) enters port PS (Refer to section F-F.) and runs to the side bypass circuit (63, 64) by way of orifice (351), but is shut off to the lower stream as the travel spool circuit located in the uppermost stream is closed.

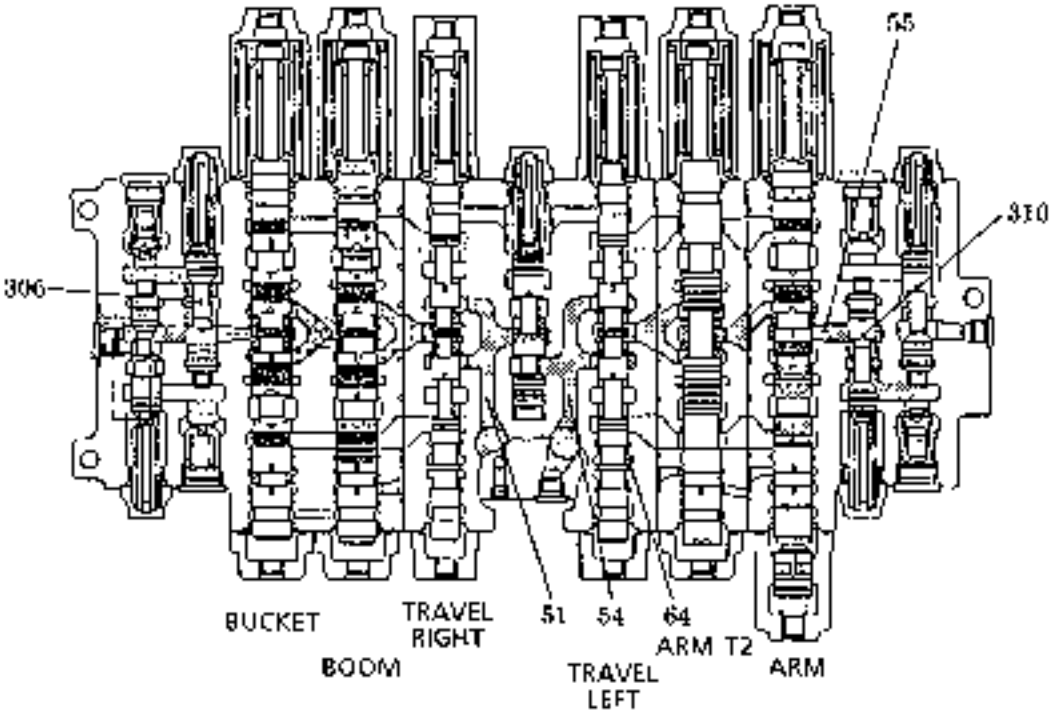


Fig. 11

2.2.2 TRAVEL

(1) Travel independent (forward) by two pumps

1) Main circuit

If pilot port PAr of the right travel spool is pressurized, bypass circuit (52) is shut off. The oil delivered by pump (P1) runs to the right travel motor from port (Ar).

Meanwhile, the oil returned from the right travel motor passes through port (Br), low pressure circuit (D) and tank port (T) and returns to the hydraulic tank.

In this case, since the negative control relief valve is located in the lowermost stream, shift of an upstream spool shuts off oil stream, i.e. negative flow control is cut off.

2) Pilot circuit

Shift of travel spool (301II) allows servo pressure (60) to pass port (PS) and orifice (351) and connect with port (E). However, since the oil downstream is connected with the drain circuit, pressure does not rise and the travel straight changeover spool (305) does not change over. (See section B-B.)

If the pilot port PBr of the spool is pressurized, the oil runs in the opposite direction. The pump (P2)-left travel spool side falls in the same condition.

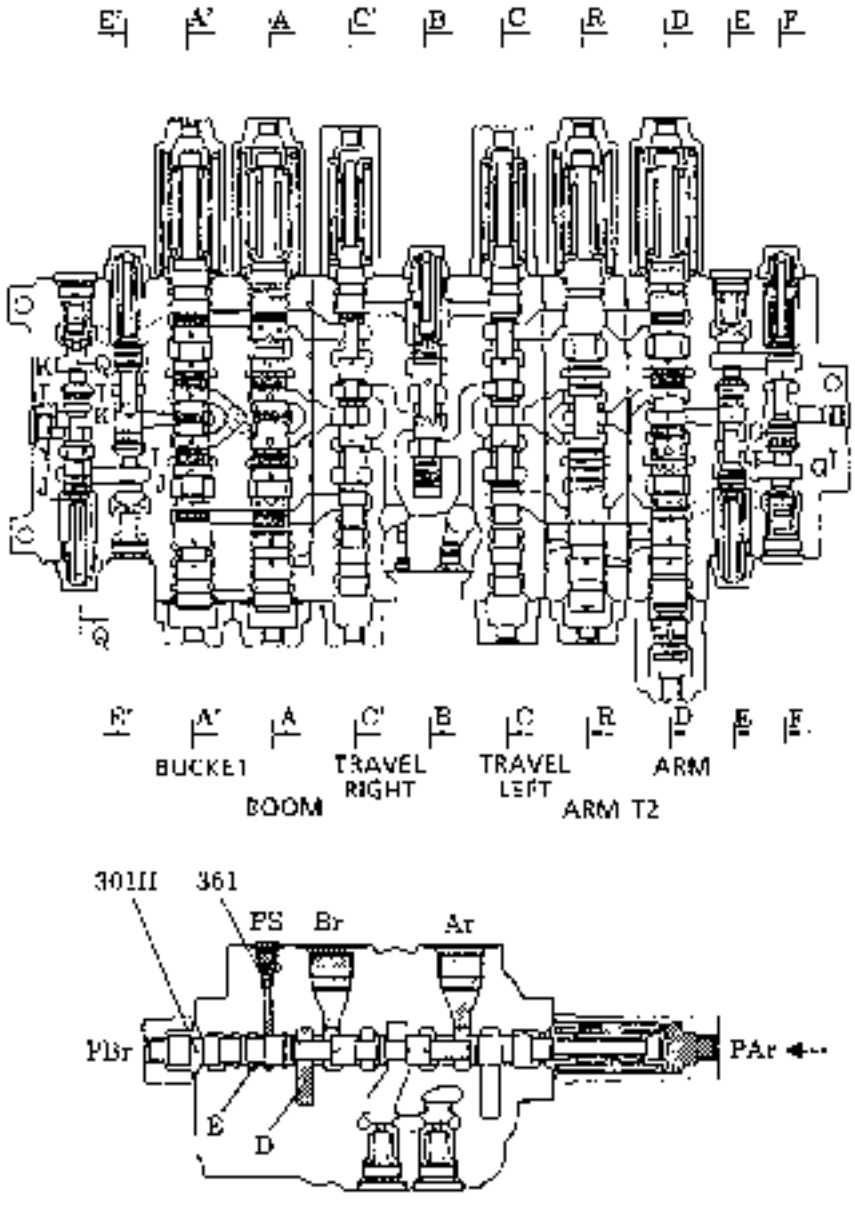


Fig. 12

(2) Travel straight in composite operation

1) Travel / Attachment

Travel straight action in composite operation is effected by pump (P2). Pump (P1) actuates the attachment by changing over the travel straight spool (305).

For instance, the boom and travel spools change over when travel forward and boom raising motions are performed.

The increased pressure of the side bypass circuit (63, 64) enters chamber E of section B–B and actuates spool (305).

<Pilot circuit>

The path from the bypass circuit to tank port T is shut off by shifting the neutral cut spool (306), (310). The increased neutral cut spool changeover pressure is admitted to port PS of the control valve.

The primary pilot pressure passes through the travel spool of the side bypass circuit and is shut off by the boom spool. The bypass circuit pressure thus raised by the shutoff enters chamber E, E' of section E–E, E'–E' and changes over neutral cut spool (306), (310)

<Main circuit>

When the travel straight spool is changed over, the hydraulic pressure discharged by pump (P1) is prevented from flowing into the main circuit and connects with the parallel circuit (53). (See section B–B.)

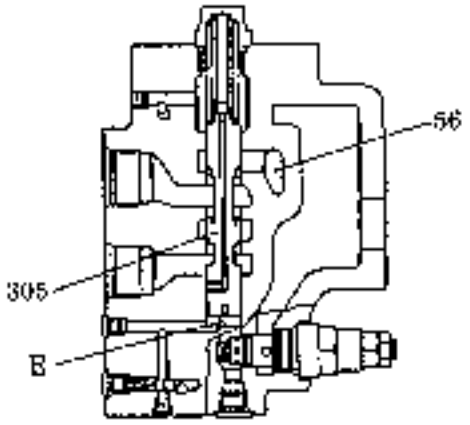
In the meantime, the pressure from pump (P2) is connected with the RH and LH main circuits. Pump (P1) actuates the attachment to perform boom raising action, while pump (P2) operates the RH and LH travel motors.

2) Travel and swing

If travel and swing motions are executed at the same time, swing signal pressure closes poppet (612) of the logic valve and raises the side bypass circuit pressure.

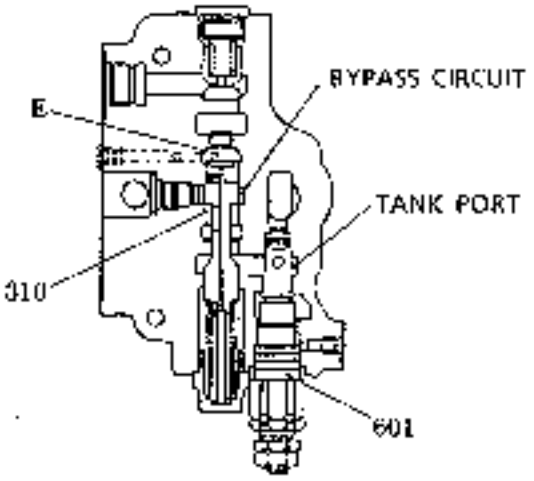
In the same way that occurs in the travel and attachment operation, the increased side bypass circuit pressure changes over neutral cut spool (306), (310) and travel straight spool (305).

Shift of the travel straight spool causes pump (P1) to operate the swing motor and causes pump (P2) to actuate the RH and LH travel motors.



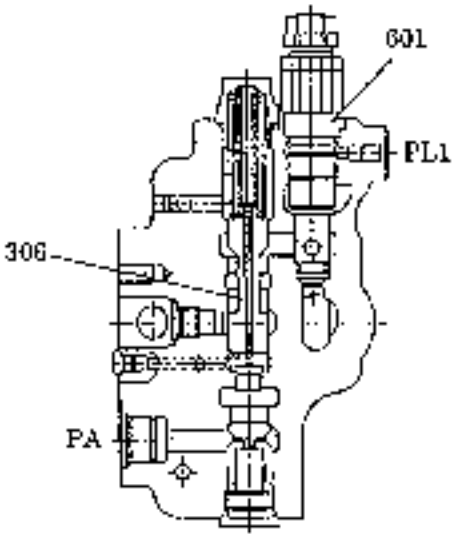
SECTION B–B

Fig. 13



SECTION E–E

Fig. 14



SECTION E'–E'

Fig. 15

(3) Function of travel straight valve in Fig. 16, travel straight spool (305) is pressed down to the bottom end by spring (324), (325). When only attachment or travel motion is performed, spool (305) is fixed by position [I].
If attachment and travel motions are carried out at same time, spool (305) shifts to take position [II] as the side bypass circuits (63), (64) pressure is increased

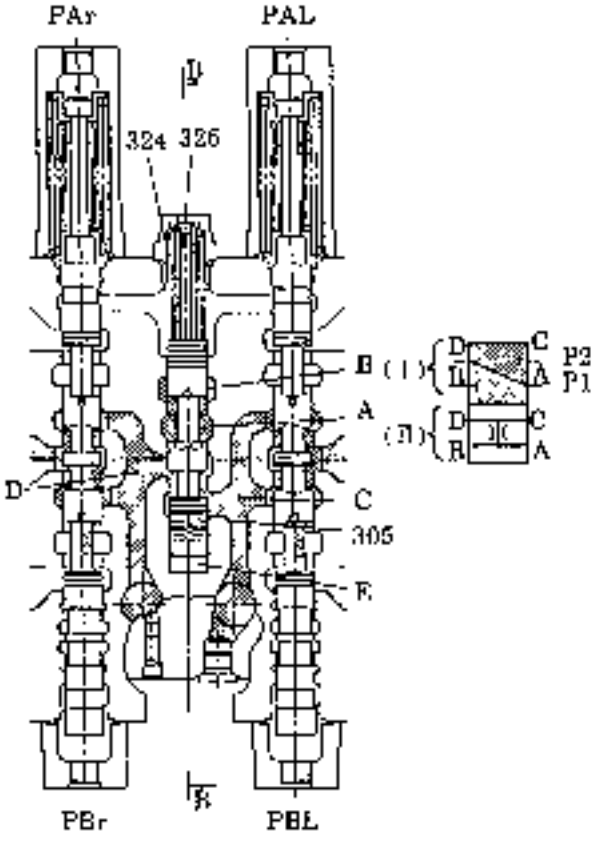
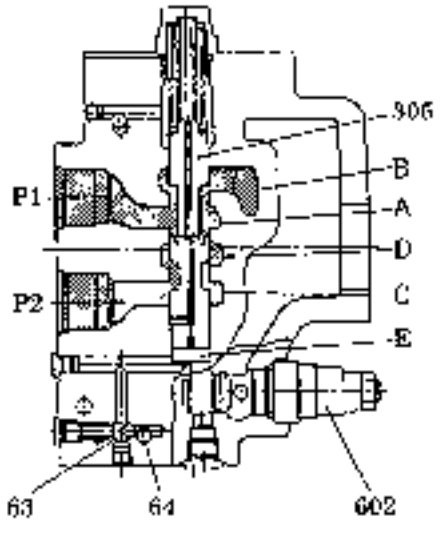


Fig. 16 Function of travel straight valve



SECTION B-B

Fig. 17

2.2.3 BUCKET ACTION

(1) Bucket digging action

If bucket digging motion is performed, secondary proportionato pilot pressure PA2 enters port (PBC) and transfers bucket spool (304) to the right.

When spool (304) is shifted, the oil discharged by pump (P1) enters parallel circuit (53) from bypass circuit (52), pushes check (511) open, goes out to port BC and is supplied to cylinder head (H).

In the meantime the oil which returns from the cylinder head passes through port (AC) and the notch in the outer circumference of the spool and returns to the hydraulic circuit by way of low pressure circuit (D) and tank port (T).

(2) Bucket discharge motion

In the same way as bucket digging motion, if bucket discharge motion is performed, secondary proportionate pilot pressure PB2 enters port (PAC) and shifts spool (304) to the left.

The oil discharged by pump (P1) enters parallel circuit (53), pushes poppet (511) open and is supplied to cylinder rod (R) from port (AC).

Meanwhile, the oil which returns from the cylinder head passes through port (BC) and the notch in the outer circumference of the spool and is brought back to the hydraulic tank from low pressure circuit (D) and tank port (T).

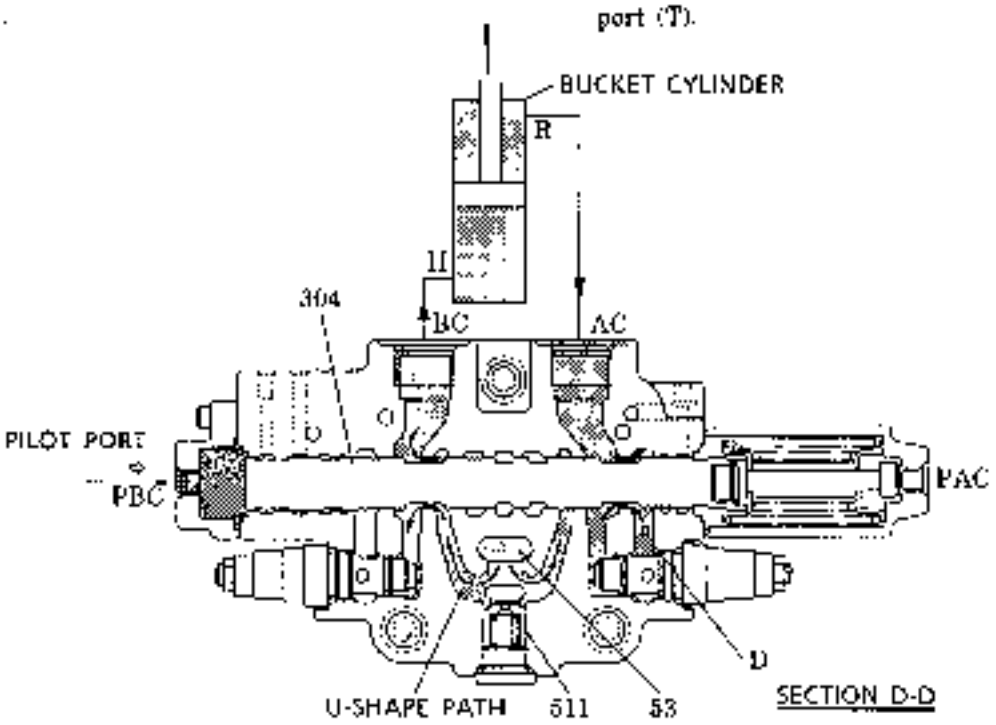


Fig. 18

(3) Bucket conflux

To speed up the bucket motion, the travel straight spool is changed over in single bucket operation to combine the pressure from P2.

If bucket motion is performed in the hydraulic circuit, the pilot pressure 50kg/cm^2 (711psi) is pressurized at port Pigd.

Since Pigd connects with side bypass circuit (63) and the circuit to Dr is shut off during bucket operation, the pilot pressure shifts the travel straight spool.

The result is that the oil discharged from P2 passes through the travel straight spool, connects with the bypass path, enters the parallel circuit via check valve (513) and combines with the oil discharged from the P1 side.

During composite operation of bucket and attachment motions, the pilot pressure, which is not pressurized against port Pigd via the valve on external piping, functions the same way as in normal single operation.

During bucket discharge motion also, conflux function works the same way as in bucket digging motion.

2.2.4 BOOM ACTION

(1) Boom raising 2-pump conflux motion

If boom raising operation is performed, secondary proportionate pilot pressure PA1 acts on port (PAb) and shifts the boom spool (303) to the left and at the same time the pressure passes through the solenoid proportionate reducing valve and acts upon pilot port (PB1) of the LH block end section and changes over LH neutral cut spool (310) via boom conflux changeover spool (307) (section F-F) and shuttle ball (512).

The oil discharged by pump (P1) runs to bypass circuit (52) past main path (51), enters parallel circuit (50), pushes poppet (511) open, enters chamber E in boom spool (303) and chamber F in the boost check valve, presses the boost check valve leftward as illustrated, passes through the notch in the outer circumference of spool (303) and is supplied to boom cylinder head (H) from port (Ab).

Meanwhile, the oil which returns from the cylinder rod passes through port (Bb) and the notch in the outer circumference of spool (303), runs to tank port (T) from low pressure circuit (D) and returns to the hydraulic tank.

On the other hand, the oil discharged pump (P2) runs to bypass circuit (55) of the LR block, but since LH neutral cut valve (306) is closed, the oil pushes check valve (511) open and enters parallel circuit (56).

However, since boom conflux changeover spool (307) is open, the pressure pushes check valve (511) open and is supplied to the cylinder head from boom conflux port (PB). (boom parallel conflux)

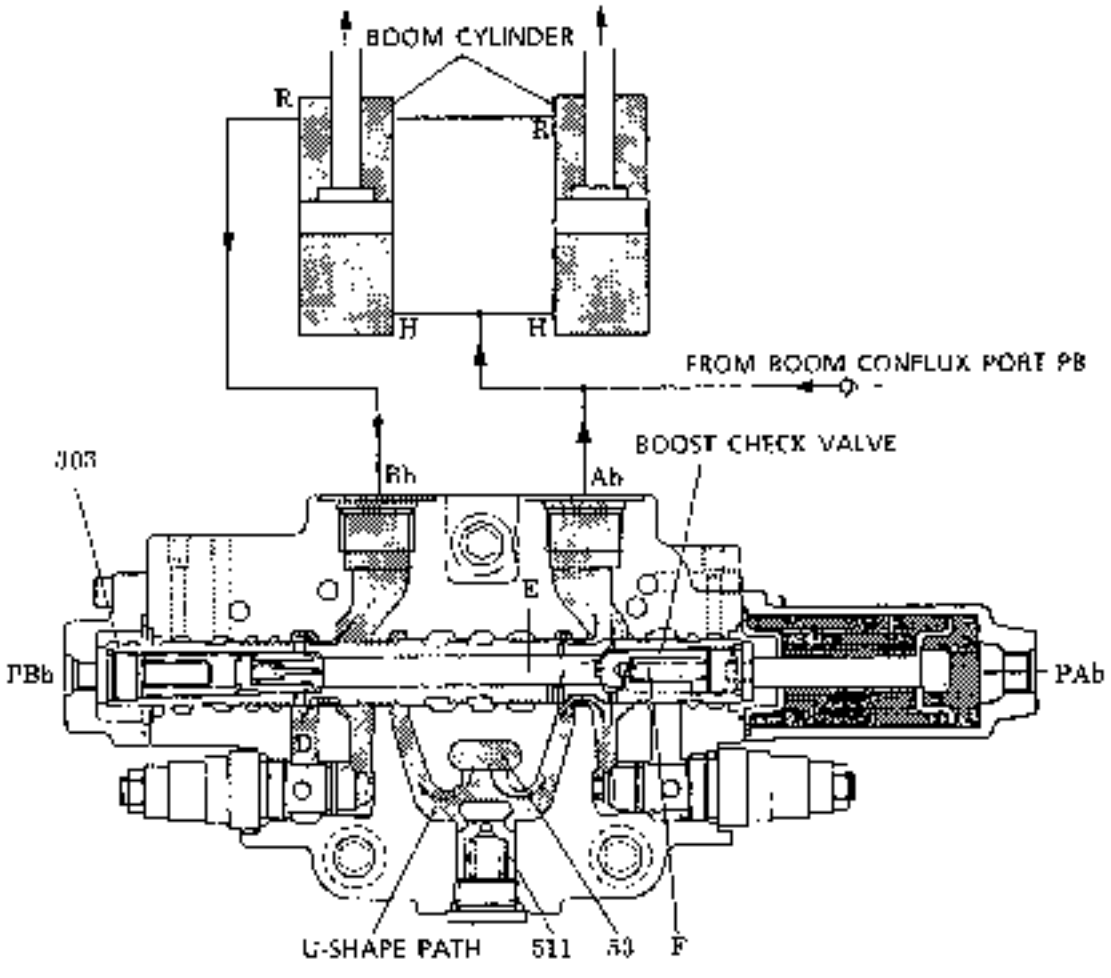


Fig. 19

(2) Fixed recirculation function for boom lowering
If boom lowering motion is performed, the secondary proportionate pilot pressure acts upon port (PBb), transfers boom spool (303) rightwards.
The pressurized oil discharged by pump (P1) enters parallel circuit (53), pushes poppet (511) open, enters the U-shape path, passes through the notch in the outer circumference of spool (303) and is supplied to the cylinder rod from port (Rb).
Meanwhile, the oil which returns from cylinder head (H) runs into spool (303) past port (Ab) and the circular notch of spool (303). Since the oil thus returned is sufficiently pressurized by the weight of the boom, arm, etc., it passes through the inside of the spool, pushes the poppet on the left as illustrated, passes through the outer circumference of the spool and is supplied to the boom cylinder rod as hydraulic oil for boom lowering action. (fixed recirculation function for boom action)
Extra hydraulic oil pushes the boost check valve open and returns to the low pressure circuit (D).

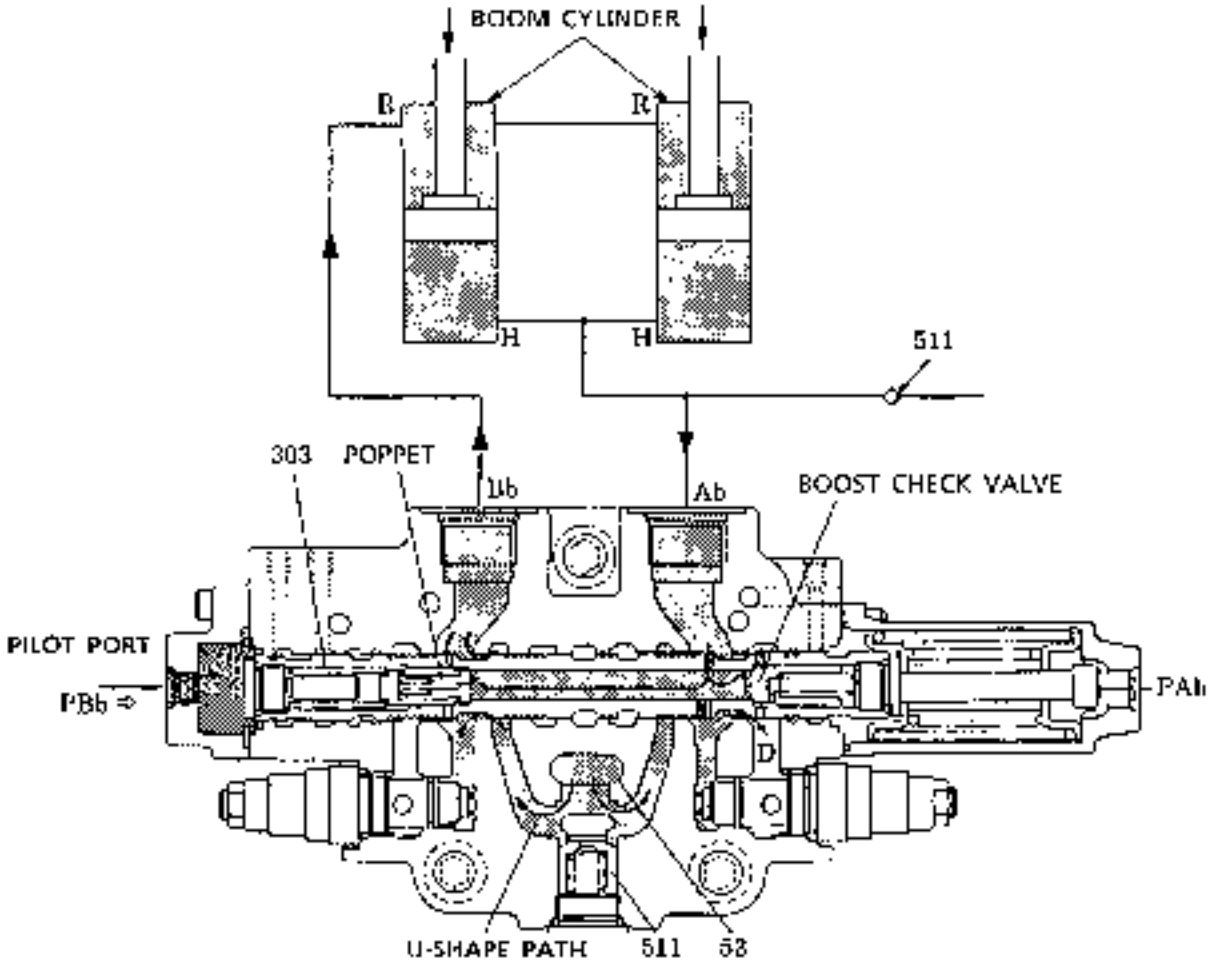


Fig. 20

(4) Variable loading mode operation

Boom raising and swing speeds may be selectively controlled by turning the loading mode potentiometer.

If the loading mode potentiometer is turned clockwise, the electric current of the electromagnetic proportionate reducing valve falls which in turn lowers the PB1 port circuit pressure from the secondary pressure PZ port of the proportionate reducing valve. The amount of oil combined from notch A to B as the stroke of boom conflux spool (307) decreases. If the pressure controlled by the electromagnetic proportionate reducing valve falls, the oil combined from notch A to B is shut off

Consequently, boom conflux action by the secondary pilot pressure of the electromagnetic proportionate reducing valve stops. This brings operating speed to a single swing speed even in simultaneous swing/boom operation.

Fig. 21 Loading mode potentiometer

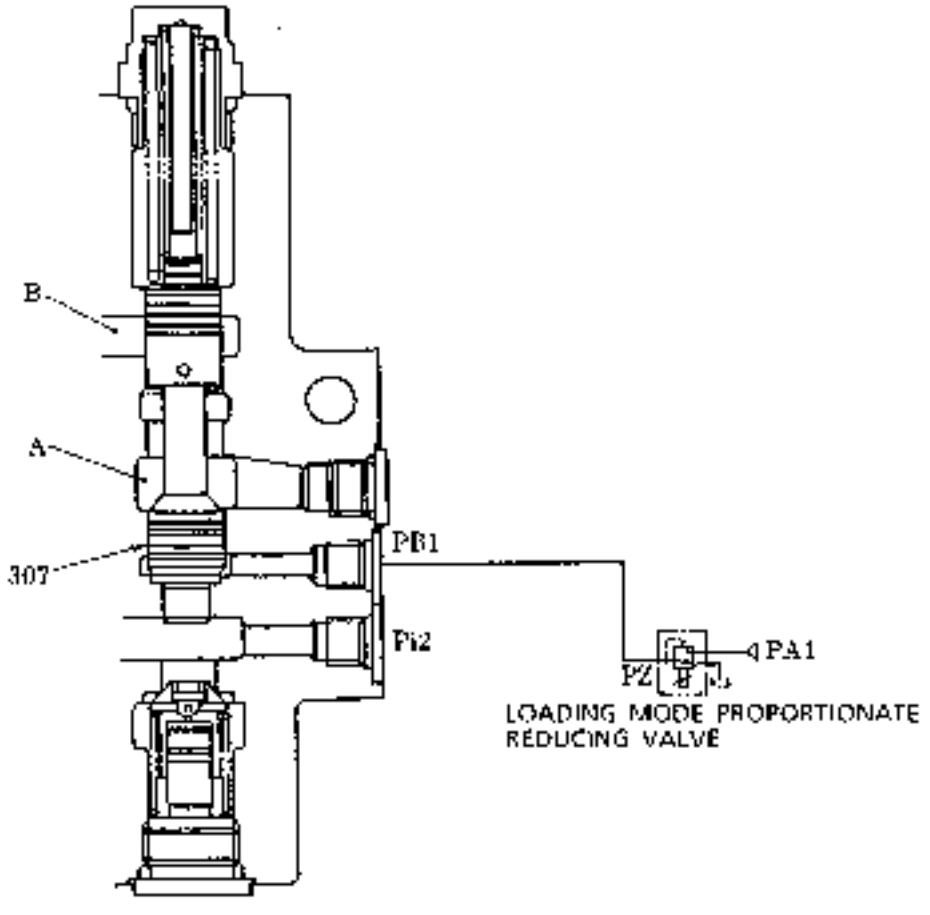


Fig. 22 Boom conflux spool

2.2.5 ARM ACTION

(1) Arm discharge 2-pump conflux function

If arm discharge action is performed, the secondary proportionate pilot pressure PB3 acts upon port (PBa) and port (PBa2) of the arm T2 section and shifts arm spool (302) and arm T2 spool (309) to the right.

At the same time, the secondary pressure acts upon pilot port (PA1) of the RH end section and changes over RH neutral cut spool (306) (section E'−E') via arm conflux changeover spool (391) (section Q−Q) and ball (512).

The pressurized oil discharged by pump (P2) runs to bypass circuit (55) past main path (54), pushes poppet (511) open, runs to parallel circuit (56), pushes poppet (511) open, goes through the notch in the outer circumference of spool (302) and is supplied to the cylinder rod from port (Ba).

The pressurized oil discharged by pump (P1) pushes arm conflux check valve poppet (511) (section E'−E') by way of bypass circuit (52) of the RH block and arm conflux changeover spool (391) and is combined to the cylinder rod from arm conflux port (PA). (arm tandem conflux)

In the meantime, the oil which returns from the cylinder head goes through port (Aa) and the outer circumference of arm spool (302) and returns to port T or the oil passes through port (Aa2) and the outer circumference of arm spool T2 (309), runs to tank port (T2) and returns to the tank.

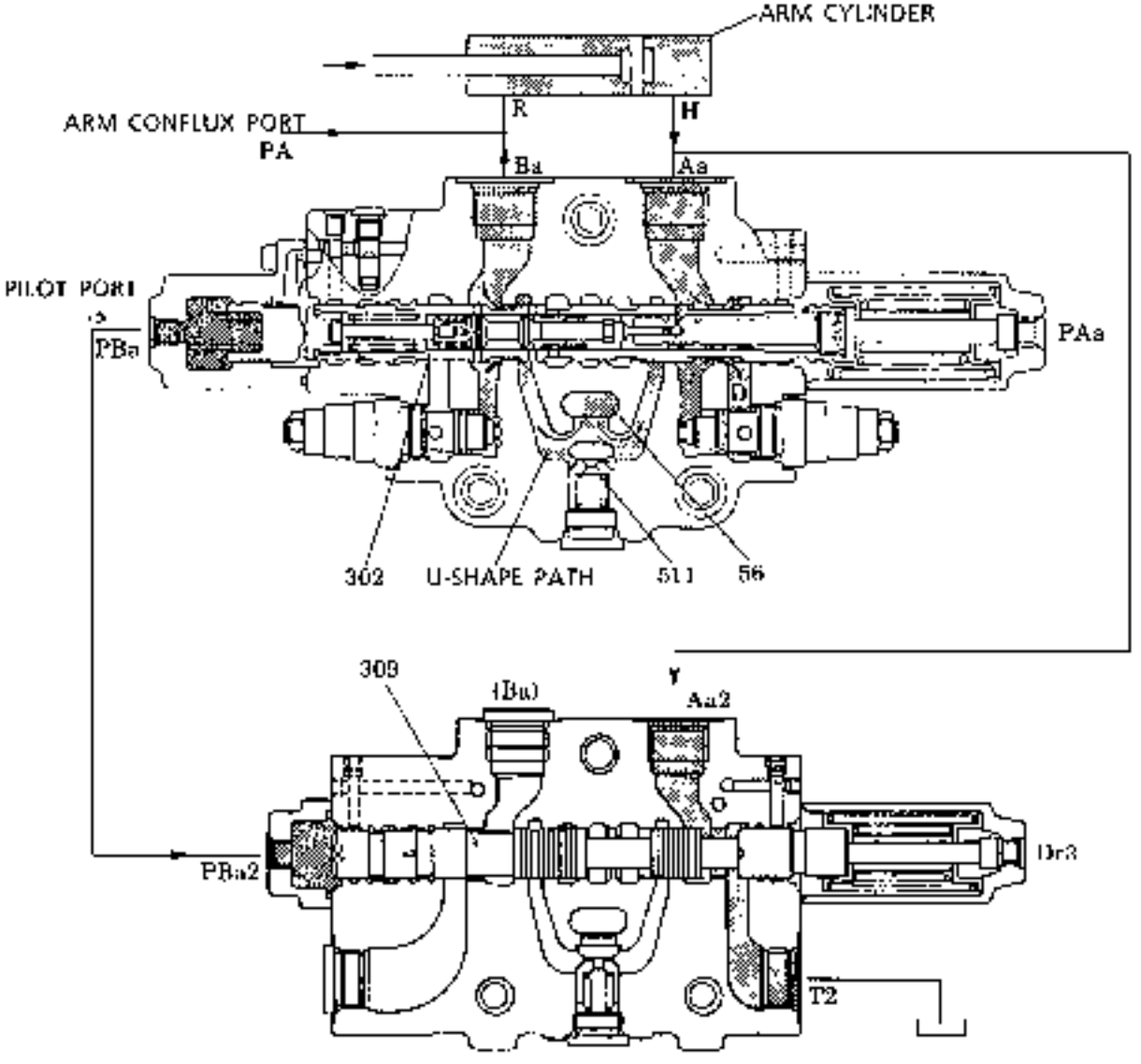


Fig. 23

(2) Variable recirculation action for arm digging (at light load)

If you do arm digging operation, the secondary proportionate pilot pressure PA3 acts upon port (PAa) and moves arm spool (302) to the left. At the same time, a boost pressure of 7kgf/cm^2 (99.5psi) is constantly working on port (PiS). The pressure enters the spring chamber G of sub spool (312) inside arm spool (302) and pushes the arm spool to the left. The pressure also works on the variable restrictor.

The oil discharged by pump (P2) flows into bypass circuit (55) past main path (54), pushes poppet (511) open, runs into parallel circuit (56), pushes peppet (511) open, goes through the U-shape path and the notch in the outer circumference of arm spool (302) and is supplied to the cylinder head through port (Aa).

<Variable recirculation action for arm digging>

In the meantime, since the oil which returns from the cylinder rod is sufficiently pressurized by the weight of the arm, etc , the preasure is admitted to spool (302) from port (Ba) and pushes the arm check poppet righwards via sub spool (312) as illustrated. Therefore the oil passes through the notch in arm spool (302) and the U-shape path and is supplied to the cylinder head once again as hydraulic oil for arm digging operation. This is what is called the variable recirculation function for arm action.

Part of the oil which returns from the cylinder rod passes through the slanted hole in sub spool (312) and is released to the hydraulic tank by way of low pressure circuit (D) and tank port (T). This is to avoid a rise in the cylinder inside pressure.

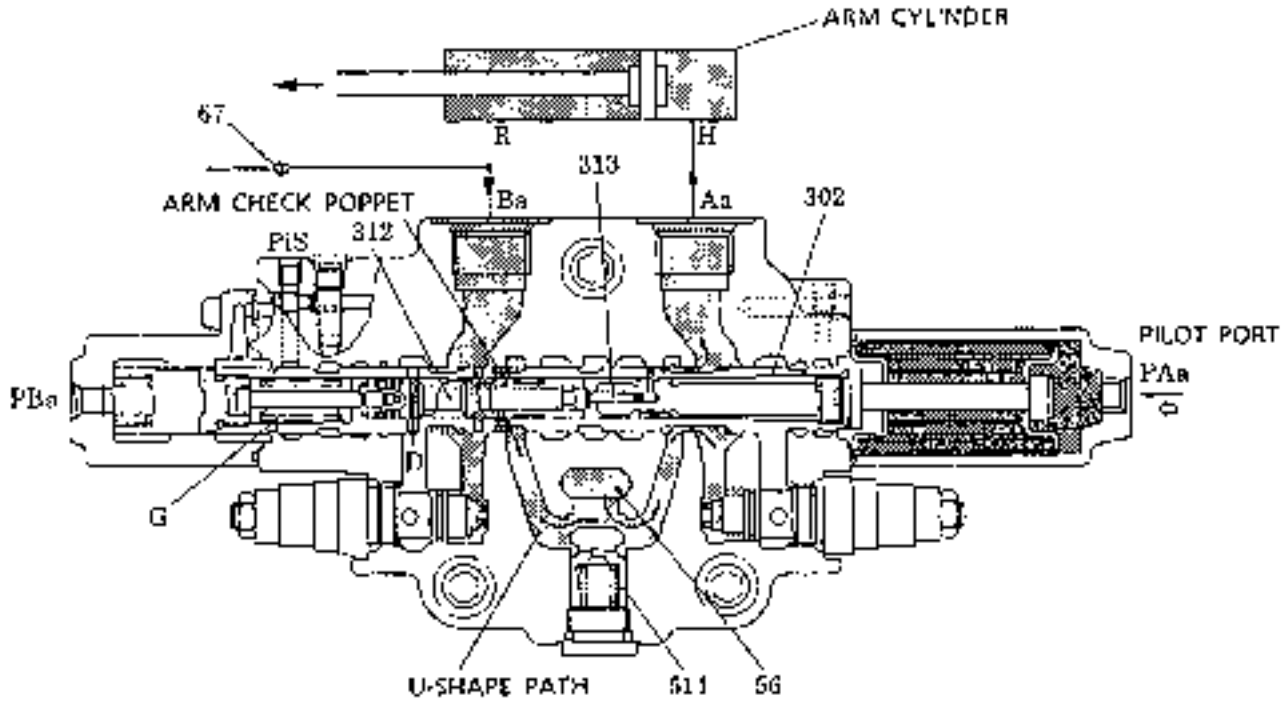


Fig. 24

(3) At arm digging (at heavy load)

The machine needs quick and strong power for arm digging operation. For this reason, oil streams by multiple pumps are combined to dissipate back pressure produced by the arm recirculation function.

First of all, sequence spool (303) is switched over automatically as pump pressure (Pd) on the feed side rises.

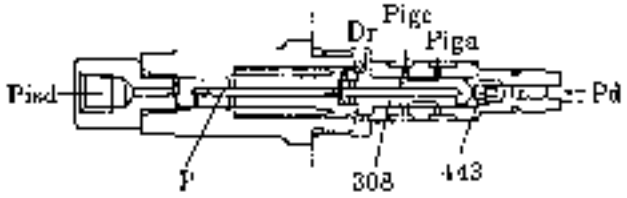
The sequence spool allows the sequence conflux action and the variable recirculation function cut action to work.

<Sequence conflux action>

The pump P2 circuit pressure is admitted to chamber Pd of the recirculation cut sequence valve. The pressure pushes piston (443) to the left as the P2 pump circuit pressure rises till it overcomes the spring action at which spool (308) is switched over.

If the spool is switched over, ports Piga and Pigc that are connected to the secondary proportionate pilot pressure PA3 get through to each other, with the result that the pressure re-enters port Pigb.

The pilot pressure which has entered port Pigb switches over neutral cut spool (306) and travel straight spool (305) to put the streams by pumps P1 and P2 together.



RECIRCULATION CUT SEQUENCE VALVE

<Variable recirculation function cut action>

If the sequence spool is pushed to the left end, port Pisd get through with side hole P and drain port Dr.

Consequently, the pressure of the variable recirculation command circuit flows from control valve port Pis to Pisd in Dr to tank in which process the pressure falls.

Since spring chamber G in the arm spool also gets through with port Pis, the pressure becomes the tank pressure.

Meanwhile, the main circuit pressure acting on the arm head (H) side is admitted to chamber E. It pushes piston (313) and transfers sub spool (312) in arm spool (302) to the left.

If sub spool (312) is transferred, it plugs up the arm recirculation hole in arm spool (302) to nullify the variable recirculation. As the result, all of the oil which returns from the cylinder head is brought back to the hydraulic tank.

<Main circuit>

The combined oil streams by pumps pushes poppet (511) open through parallel circuit (56) and goes out to the U-shape path.

The pressurized oil which has goes out to the U-shape path connects with port Aa on the notch in the outer circumference of spool (302) and is supplied to the cylinder head.

In the meantime, the oil which returns from the cylinder rod (R) side is not subject to variable recirculation and connects port Ba with path D in the notch of the outer circumference of arm spool (302).

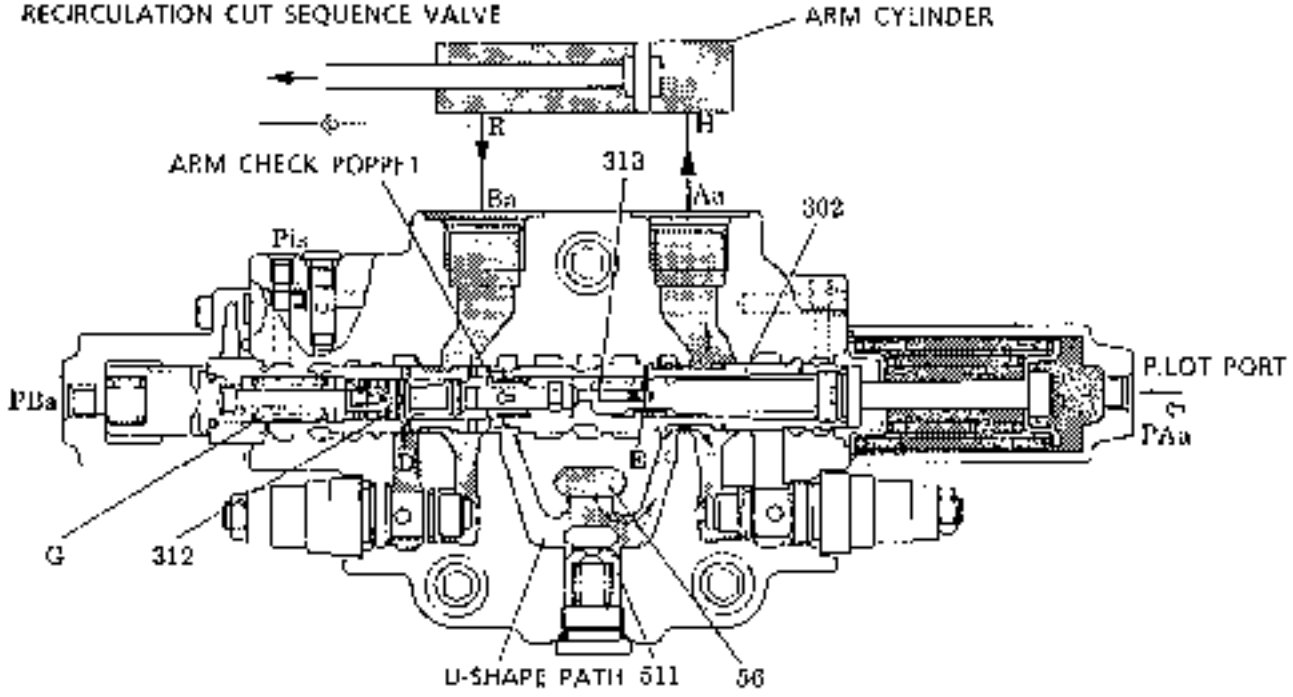


Fig. 25

(4) Swing preferential action at arm digging

The swing control valve is a special valve provided separately. The pump port is connected with control valve port P3 and shares a parallel circuit with the arm operation section.

When arm digging and swing motions are performed at the same time, the proportionate secondary pilot pressure is admitted to chamber G in order to use stabilized oil for swing preferential action and shifts sub spool (312) to the left so as to perform forced recirculation that holds the recirculation circuit even if arm digging pressure rises.

The result is that the P2 pump oil is reduced to the cylinder side and is supplied preferentially for swing motion.

<Pilot circuit action>

Regarding the arm action, refer to the foregoing paragraph.

For arm digging/swing operation, the proportionate secondary pilot pressure is combined with the oil in port PiS through port Pi3.

The proportionate secondary pilot pressure which enters port Pi3 passes through restrictor (351) while pushing logic valve (612), is combined with the boost pressure coming from port PiS and pushes arm sub spool (312) to the right.

At the same time, the secondary pilot pressure which enters port Pi3 switches neutral cut valve (310) over by way of ball (512) in section E–E.

<Main circuit action>

If sub spool (312) is pushed hard to the left end by pilot circuit action, the oil which returns from the arm cylinder rod side passes through the oblique hole in the sub spool, with the result that the pressurized oil which has returned to tank port (T) from low pressure circuit (D) is hard to go back.

The result is that pressurized oil is preferentially supplied to the swing side through the recirculation circuit, even though the pressure on the arm cylinder head side rises above the swing operating pressure.

This is called swing preferential circuit.

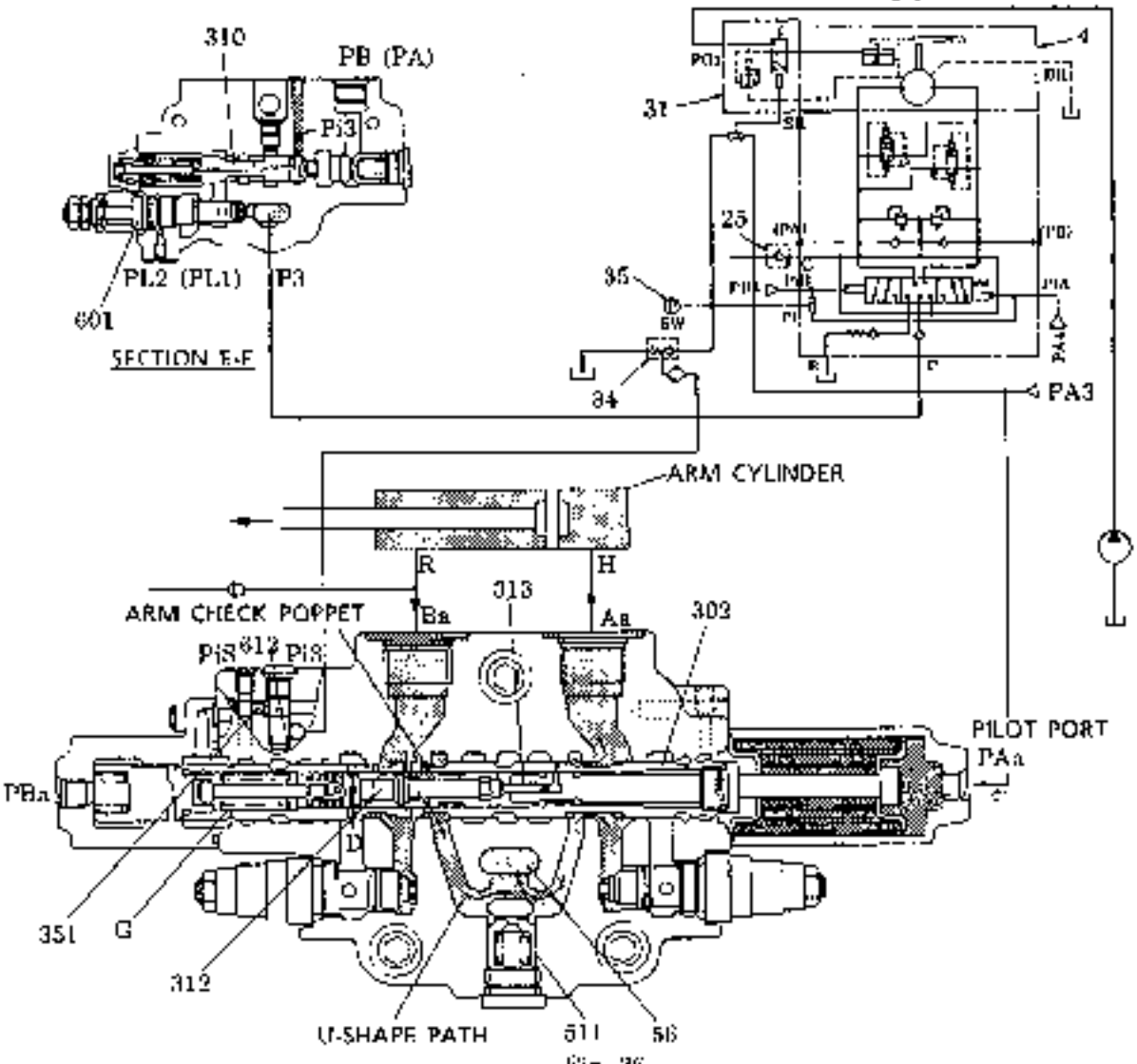


Fig 26

2.2.6 SWING ACTION (SEE FIG.30)

If swing action is performed, the higher of proportionate secondary pilot pressures is selectively chosen in the swing control valve, goes out of port P_4, enters port Pi3 of the control valve, actuates LH neutral cut valve (310) and closes bypass circuit (55).

The pressurized oil discharged by pump (P2) enters bypass circuit (55) past main path (54), but since LH neutral cut spool (310) is closed, the pressure pushes check valve (511) open, enters parallel circuit (58), gets out of port P3 and is supplied to the swing motor via the swing control valve.

In the meantime, the oil which returns from the swing motor goes directly back to the hydraulic tank from the swing control valve and through the return circuit, instead of going through the control valve.

2.2.7 ATTACHMENT BOOST PRESSURE

When the attachment boost pressure button on the grip of the bucket control lever is pressured, the solenoid valve (23) for attachment boost pressure is actuated and pilot pressure flows to ports PL1 and PL2, raising the relief pressure of the main relief valve (601) to increase retraction power.

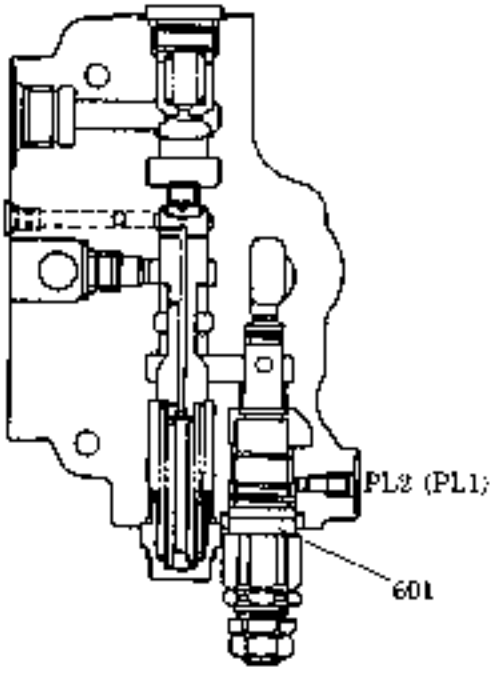


Fig. 27

2.2.8 ACTION OF MAIN RELIEF VALVE AND TRAVEL RELIEF VALVE

(1) Action of main relief valve

The main relief valve is built between the parallel circuit and the low pressure circuit and functions as follows.

1) Pressurized oil is filled up to the inside chamber A through restrictor hole (B) of main poppet (427)

Therefore, plunger (427) is seated securely against body (420).

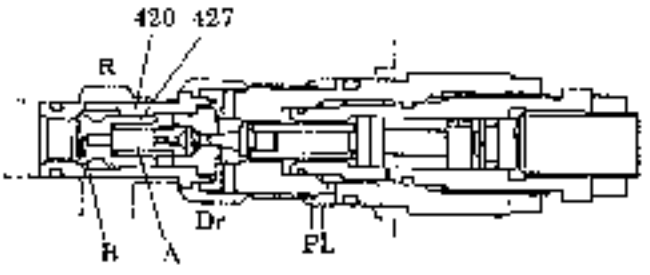


Fig. 28

2) If the pressure in parallel circuit (P) reaches the action of spring (434), it passes through restrictor hole (B), pushes poppet (433) open and flows to low pressure circuit (R) via slit (D).

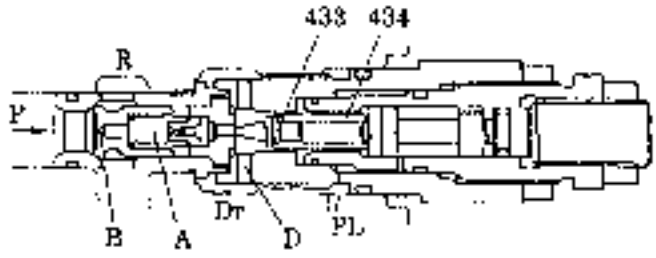


Fig. 29

3) When poppet (433) opens, the pressure in chamber A falls. This opens main poppet (427) and the pressure at port (P) runs directly to low pressure circuit (R). (The relief valve works.)

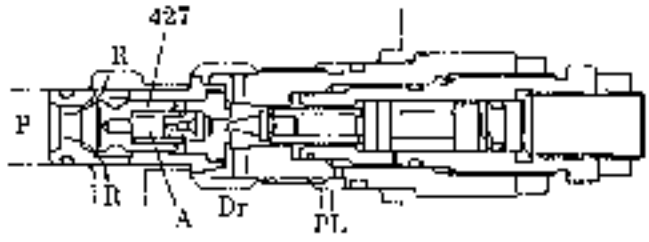


Fig. 30

4) Boost pressure

If you press the attachment boost pressure button, pilot pressure enters the PL1 and PL2 port

The pilot pressure pushes piston (430) to the left to increase the action of spring (434). This change a relief set pressure to high pressure.

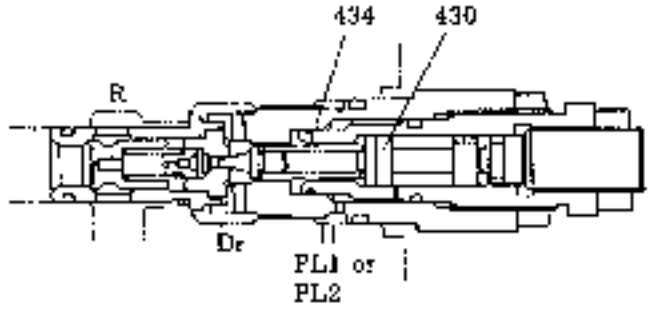


Fig. 31

(2) Action of travel relief valve

The travel relief valve is located between the pump port and the low pressure path.

The function is the same as para. 1) - 8) of the main relief valve and therefore left out herein.

2.2.9 ACTION OF PORT RELIEF VALVE

The port relief valve is located between the cylinder port and the low pressure path and functions as both a relief valve and an anti-cavitation check valve, as mentioned below.

(1) As a relief valve

1) Oil flows through passage A in seat 1 (409), then through throttling passage B in the main poppet (406), and fills interior chamber C, forcing the main poppet (406) securely against seat 1 (409).

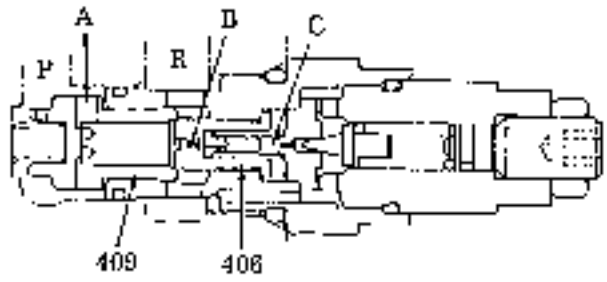


Fig. 32

2) When the pressure at port P overcomes the set force of the spring (412), oil flows through throttling passage D, forcing the poppet (410) open, flows around the poppet (410), passing through passages E and F to the low pressure circuit R.

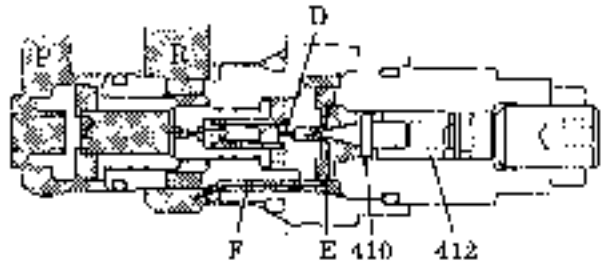


Fig. 33

3) As the poppet (410) opens, the pressure in chamber C drops, and the main poppet (406) opens, allowing oil at port P to flow to the low pressure circuit R.

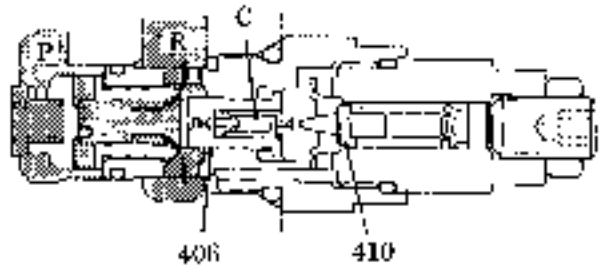


Fig. 34

(2) As an anti-cavitation valve

If cavitation occurs at port P, oil from the low pressure circuit R is supplied to port P.

If the pressure at port P drops below that at low pressure port R, pressure acts on the area between the diameter of the seating portion of the main poppet (406) and the diameter of seat 1 (409), moving seat 1 (409) to the left.

Consequently, enough oil flows out from low pressure port R, passing between the main poppet (406) and seat 1 (409), and enters port P to fill the void.

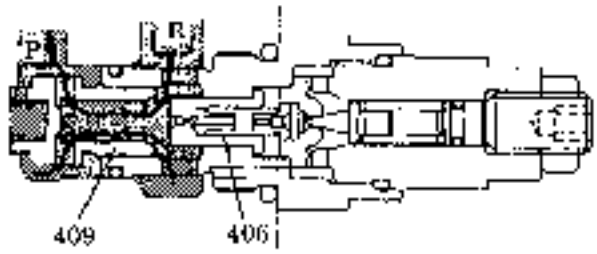


Fig. 35

2.2.10 ACTION OF RECIRCULATION CUT SEQUENCE VALVE

When pump pressure (Pd) rises, piston (443) moves to the left. Spool 1 (442) and spool 2 (446) move to the left also

When spool 1 (442) moves to the left, the arm contracting pilot pressure in port Pigc enters the travel straight valve command pressure port past port Pigc and changes over the travel straight valve spool.

When spool 2 (446) moves to the left, the recirculation signal circuit Pisd port connects with drain port Dr, whereby recirculation signal pressure falls.

2.2.11 LOW PRESSURE RELIEF VALVE (NEGATIVE CONTROL RELIEF VALVE)

A low pressure relief valve is incorporated between the downstream passage from the center bypass, and the low pressure passage. It operates as described below.

1) When pressure at port P is below the set force of the spring (471), poppet (470) is positioned as shown in right figure.
   The poppet (470) has a pressure bearing part ØA and ØB. Part ØA is canceled by damping chamber E. As the result the pressure bearing area equals ØB-ØA.
2) Under this condition, the oil at port P flows through throttling passage C to port R. This throttling passage C does not become clogged because a filter (473) is installed upstream.
3) When the pressure at port P overcomes the set force of the spring (471), the poppet (470) moves to the left; the oil at port P flows past the outer circumference of the poppet (470) to the low pressure circuit (R).

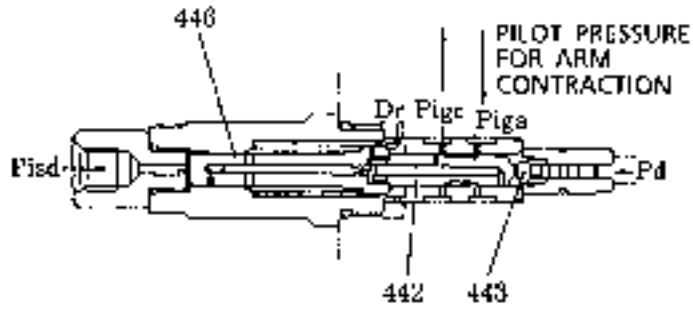


Fig. 36

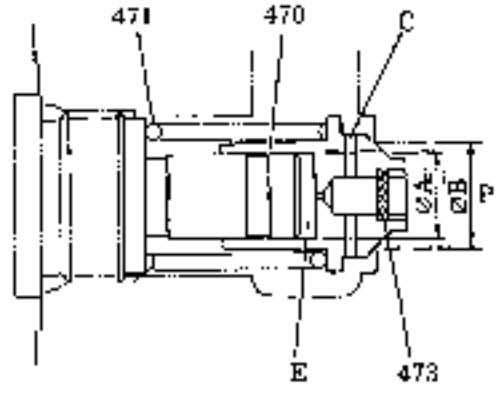


Fig. 37

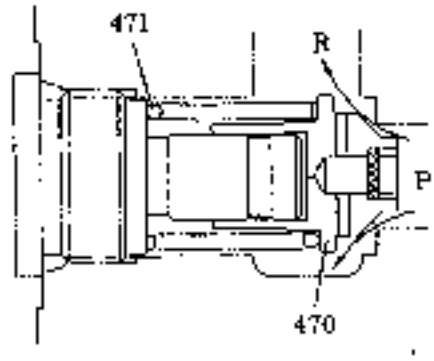


Fig. 38

3. DISASSEMBLY AND REASSEMBLY

3.1 GENERAL PRECAUTIONS

1) As all the hydraulic components are precisely machined, it is essential to carry out disassembly and reassembly in an especially clean location.
2) When handling the control valve, take special care to prevent the entry of foreign matter, such as dust or sand.
3) Cap each port of the control valve before removing the valve from the machine. Before disassembly, confirm that each cap is in place and then clean the exterior of the assembly.
   Use an appropriate workbench. Lay a clean sheet of paper, rubber mat, or the like over the workbench.
4) When carrying or moving the control valve, hold the body, and never put pressure on a lever, an exposed spool, or the end cover. Handle the valve with care.
5) Tests (for relief characteristics, leaks, overload valve setting, flow resistance, etc.) that are desired after disassembly and reassembly require hydraulic testing apparatus.
   For this reason, do not disassemble hydraulic units that you are capable of disassembling but cannot test or adjust.
   Prepare beforehand clean solvent, hydraulic oil, grease, etc. .

3.2 TOOLS

Prepare the following tools before disassembling the control valve.

Table 5

No.	Name	Q'ty	Remarks
a	Vise	1	
b	Box end wrench	1 of each size	22,24,27,30mm
c	Hex key wrench	1 of each size	4,5,6,8,10,12,14,17, 19mm
d	Sealing tape	1	
e	Locktite #241	1	
f	Spatula	1	
g	Tweezers	1	
h	Single-ended wrench	1 of each size	32,41,46mm

3.3 DISASSEMBLY

The numbers in parentheses following each part name in the text correspond to the numbers in the external views in Fig.2,3,4,5,6,7,8 and 9 in Section 2.1.

1) Place the control valve on the workbench with the ports facing upward.

- Disassemble the valve in a clean location, and be careful not to damage flange surfaces or plate mounting surfaces.
- "Top", "Right" and "Front" in the photographic illustrations represent the positions of the machine with valves.

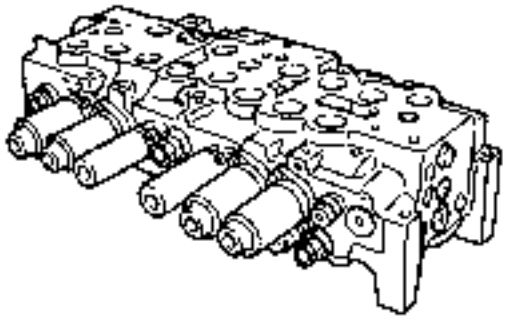


Fig. 39 Outside view from top and front right

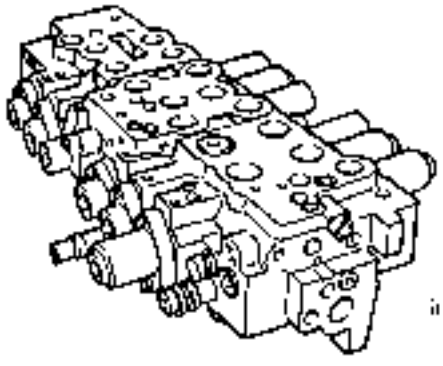


Fig. 40 Outside view from bottom and front left

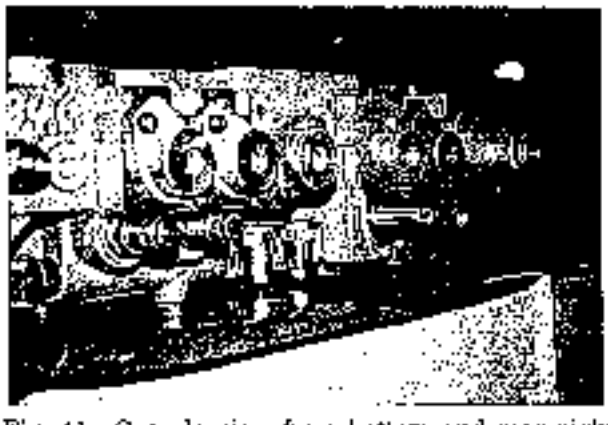


Fig. 41 Outside view from bottom and rear right

3.3.1 BUCKET SPOOL

1) Remove the socket bolts (273) and remove the spring cover (201). Pull the spool assembly made up of the bucket spool (304), spring seat (332), springs (371,372), and stopper (335) from casing B (103).

- Take care not to damage casing B (103) when pulling the spool assembly from the casing.
- Mark the spool with a tag or the like to prevent it from being confused with other spools during reassembly; it differs in shape from the others, and has a particular direction in which it must be reinstalled.

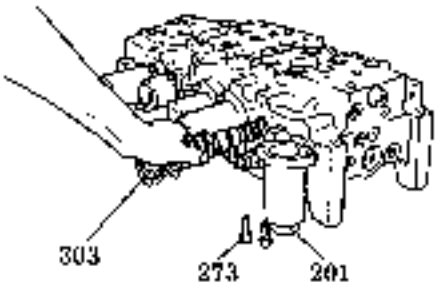


Fig. 42 Drawing the bucket spool

2) Clamp the center of the bucket spool (304) in a soft-jaw vise. Remove the spacer bolt (336), then remove the spring seat (332), springs (371,372), and stopper (335) from the bucket spool (304).

- Take care not to make the vise too tight as it might deform the bucket spool (304).

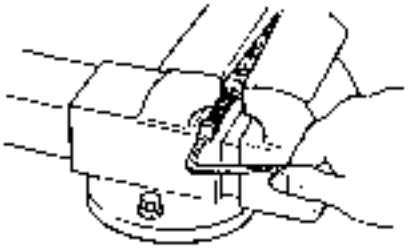


Fig. 43 Removing the spring

3.3.2 BOOM SPOOL

1) Remove the socket bolts (273), then remove the spring cover (201). Pull the spool assembly made up of the boom spool (303), spring seat (332), springs (371,323), and stopper (338), from casing B (103)

- Take care not to damage casing B (103) when pulling the spool assembly from the casing.
- Mark the spool with a tag or the like to prevent it from being confused with other spools during reassembly; it differs in shape from the others, and has a particular direction in which it must be reinstalled.

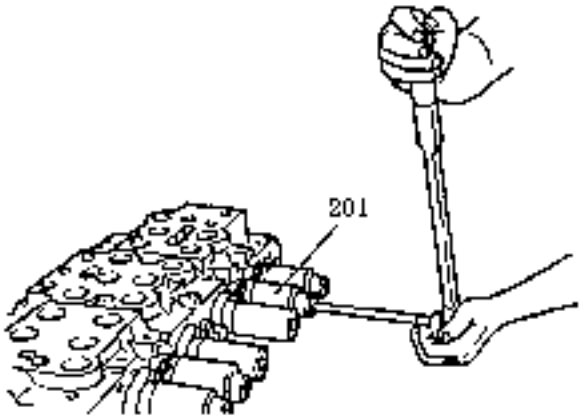


Fig. 44 Drawing out the boom spool

2) Clamp the plug (352), located at the end of the spool assembly, in a vise. Remove the spacer bolt (336), then remove the spring seat (332), springs (371,323) and stopper (338) from the boom spool (303).

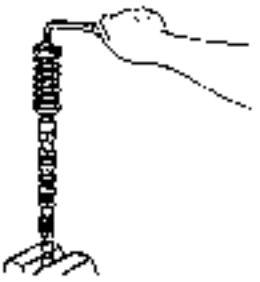


Fig. 45 Removing the spring

3) Do not disassemble the boom spool (303) any further, unless there is a particular problem with the spool.
If it definitely must be disassembled, follow this procedure:
a) Clamp the center of the boom spool (303) in a soft-jaw vise, and using a hex end wrench 24mm (0.9in) across the flats, remove the plug (352)
b) Disassemble plunger 1 (315), plunger 2 (316), plunger 3 (317), spring (boom lower) (320), spring (boom oil recirculation) (330), spring (boost check) (340), and rod (345).

- Take care not to make the vise too tight as it might deform the boom spool (303).

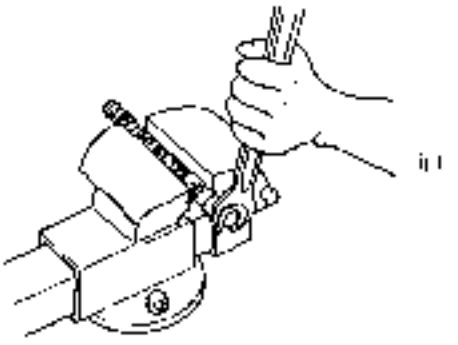


Fig. 46 Disparting the boom spool

3.3.3 ARM SPOOL

1) Remove the socket bolts (273) and remove the spring cover (201). Pull the spool assembly made up of the arm spool (302), spring seat (332), springs (371,323) and stopper (335) from casing A (102).

- Take care not to damage casing A (102) when pulling the spool assembly from the casing.
- Mark the spool with a tag or the like to prevent it from being confused with other spools during reassembly; it differs in shape from the others, and has a particular direction in which it must be reinstalled.

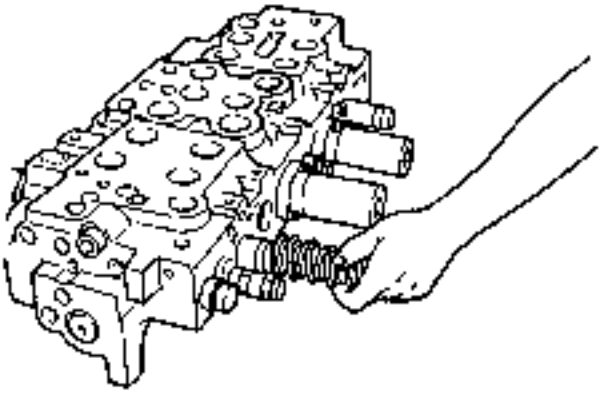


Fig. 47 Drawing out the arm spool

2) Clamp the plug (359), located at the end of the arm spool (302), in a vise. Remove the spacer bolt (336), then remove the spring seat (332), springs (371,323) and stopper (335) from the arm spool (302).
3) Do not disassemble the arm spool (302) any further, unless there is a particular problem with the spool.
If it definitely must be disassembled, follow this procedure:

a) Clamp the center of the arm spool (302) in a soft-jaw vise, and using a box end wrench 24mm (0.9in) across the flats, remove the plug (359) and bushing (341).

- Take care not to make the vise too tight as it might deform the arm spool (302).

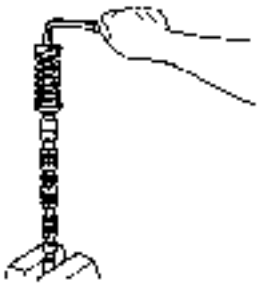


Fig. 48 Removing the spring

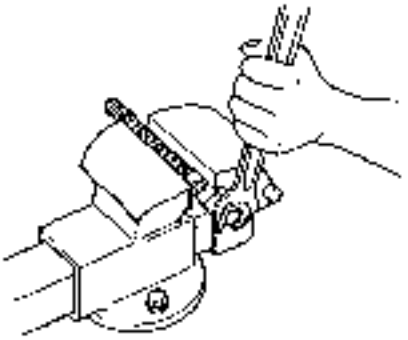


Fig. 49 Disparting the arm spool

b) Remove the plugs (359,341), then pull out the arm spool sub-spool (312) as an assembly. Remove the piston (313) along with the bushing (341).

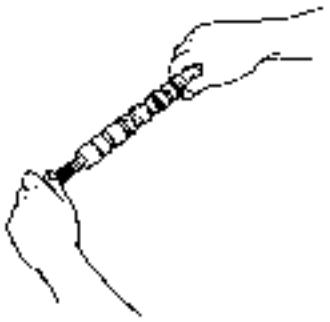


Fig. 50 Drawing out the sub spool

c) Clamp the arm spool sub-spool (arm) (312) in a soft-jaw vise. Remove the spacer bolt (343), then remove the spring (329) and spring seat (358).

- Take care not to damage the arm spool sub-spool (312).

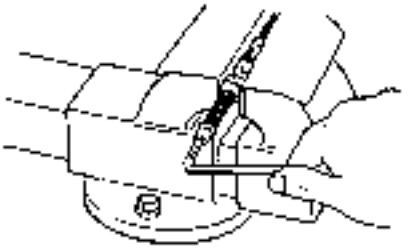


Fig. 51 Drawing out the sub spool

d) The assembly made up of the arm spool sub-spool (312), sleeve 2 (314), spring (arm oil recirculation) (328), sleeve 1 (343), stopper (349), and O ring (339) cannot be disassembled any further.

3.3.4 DISPARTING THE ARM T2 SPOOL

1) loosen socket bolt (273), remove spring cover (201) and draw out from casing T2 (104) the spool assy that consists of spool (arm T2) (309), spring seat (332), springs (323,330) and stopper (335).

- When drawing out the spool assy from casing T2 (104), take care so as not to score casing B (103).
- Mark the spool with a tag or the like to prevent it from being confused with other spools during reassembly; it differs in shape from the others, and has a particular direction in which it must be reinstalled.

3.3.5 DISASSEMBLING THE TRAVEL SPOOL

1) Loosen socket bolt (273), remove spring cover (207H) and draw out from travel block (101) the spool assy that consists of spool (travel) (301H), spring seat (331H), springs (328H,329H) and stopper (334H).

- When drawing out the spool assy from travel block (101), use care so as not to damage travel block (101).
- Mark the spool with a tag or the like to prevent it from being confused with other spools during reassembly; it differs in shape from the others, and has a particular direction in which it must be reinstalled.

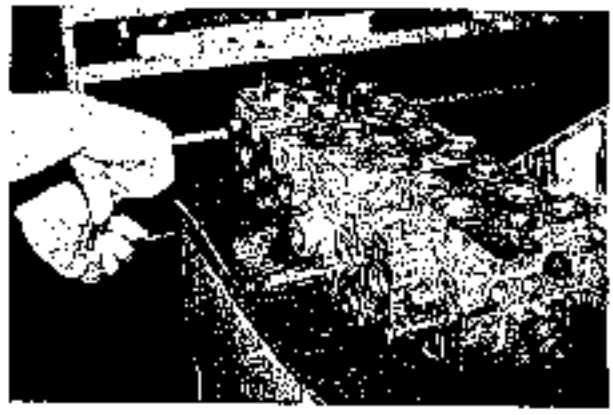


Fig. 52 Removing the travel cover

2) Clamp the center of the travel spool (301H) in a soft-jaw vise. Remove the spacer bolt (333H), then remove the spring seat (331H), springs (328H,329H), and stopper (334H) from the travel spool (301H).

- Take care not to make the vise too tight as it might deform the travel spool (301H).

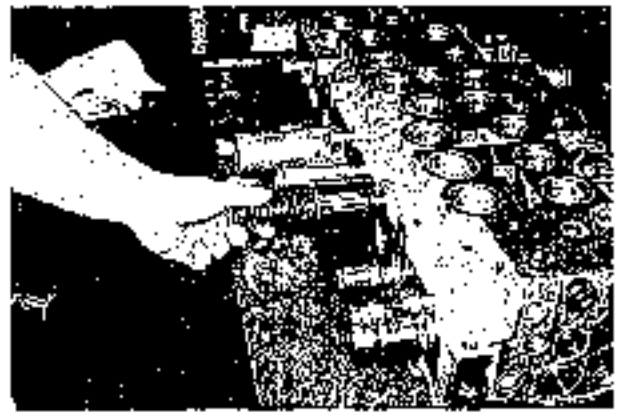


Fig 53 Drawing out the travel spool

3.3.6 DISASSEMBLING THE SEQUENCE VALVE

Draw out arm conflux sequence valve (308).

Fig. 54 Drawing out the sequence valve

3.3.7 DISASSEMBLING THE TRAVEL PREFERENTIAL VALVE NEUTRAL CUT VALVE AND CONFLUX VALVE SPOOLS

1) Remove plug (251) and separate outer spring (324), inner spring (325) (for travel straight valve), outer spring (326), inner spring (327) (for neutral cut valve), outer spring (373) (for arm conflux valve), outer spring (377) (for boom conflux valve), inner spring (374) (for conflux valve), rod (337) (for neutral cut conflux).

- Mark the springs with a tag or the like to prevent them from being confused with the other springs during reassembly, as they differ in shape from the other springs.

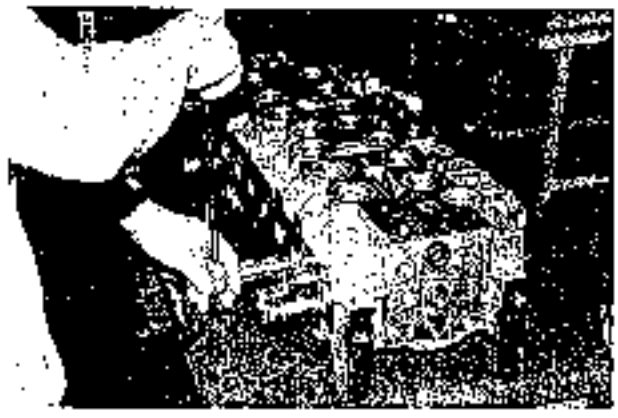


Fig. 55 Drawing out the travel proferential valve

2) Draw out the spool, utilizing the M4 screw at the end of the spool

- Mark the spools with a tag or the like to prevent them form being confused with each other during reassembly, as they differ in shape from each other.

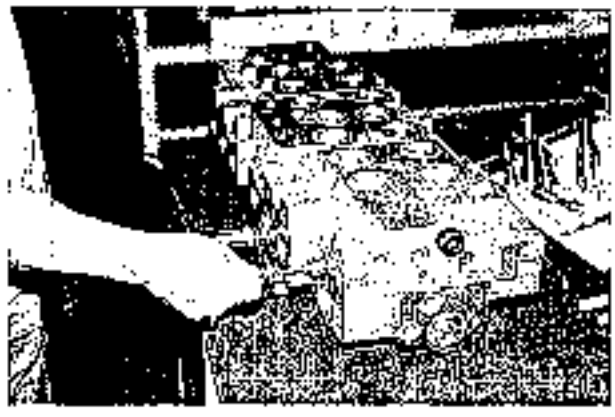


Fig. 56 Drawing out the RH neutral cut spool

Fig. 57 Boom conflux valve

3.3.8 RELIEF VALVE

1) Remove the main relief valve (601), travel relief valve (602) and port relief valve (603), (604) from the casing.

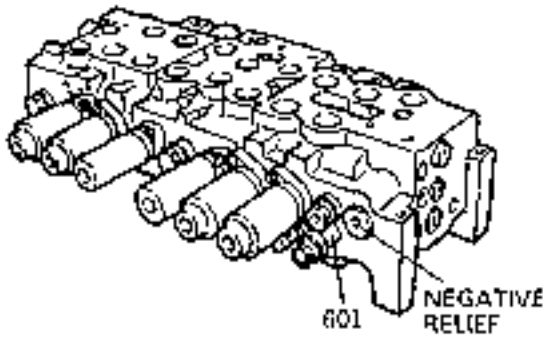


Fig. 58 Removing the upper right main relief valve

- Mark the port relief valve (603), (604) with a tag or the like to prevent them from being confused during reassembly, as they are the same in appearance and shape but differ in pressure setting (adjusted flow rate value).
- When removing the port relief valve (603), take care not to allow seat 1 (409) and spring (408) to slip off.
- Regarding the disassembly of the relief valves themselves, refer to the disassem-bly procedure outlined separately.

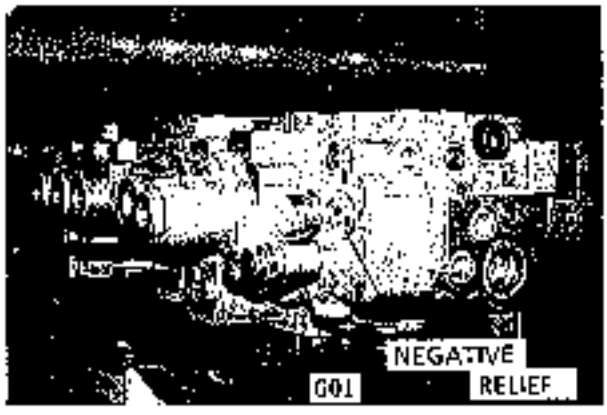


Fig. 59 Removing the lower left main relief valve

3.3.9 NEGATIVE CONTROL RELIEF VALVE (SEE FIG 9)

1) Remove the plug (551), and then remove the bushing (472), spring (471), and poppet (470).

- Take care not to lose the filter (473) installed on the poppet (470).

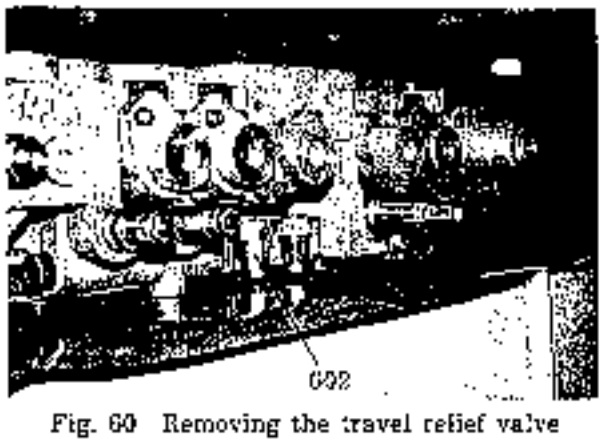


Fig. 60 Removing the travel relief valve

3.3.10 CHECK VALVE

1) Remove the plug (551), and the remove the poppets (511) and the spring (521).

- Remove all the check valves: seven are installed on the underside of the casing, and two on the side.
- The travel check valve is fitted with one special poppets (513). Mark them with a tag or the like to prevent them from being confused with each other.

Fig. 61 Removing poppet (511)

3.3.11 SHUTTLE VALVE

1) Remove the plug (552), and then remove the seats (541,542,543,544) and the ball (512).

- One shuttle valve is installed in the travel block (101), three in casing A (102), and two in casing B (103). Mark the shuttle valves with a tag or the like to prevent them from being confused with each other during reassembly, as their seats (541,542,543,544) differ in length from each other.

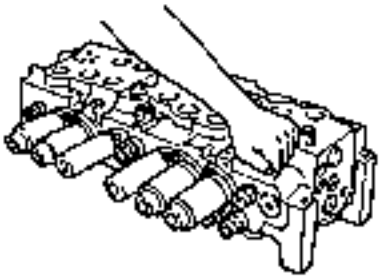


Fig. 62 Removing ball (512)

2) Remove plug (152) in casing A (102) and draw out orifice (351).

- Plug (152) is specially coated. At reassembly, replace it with a new one.

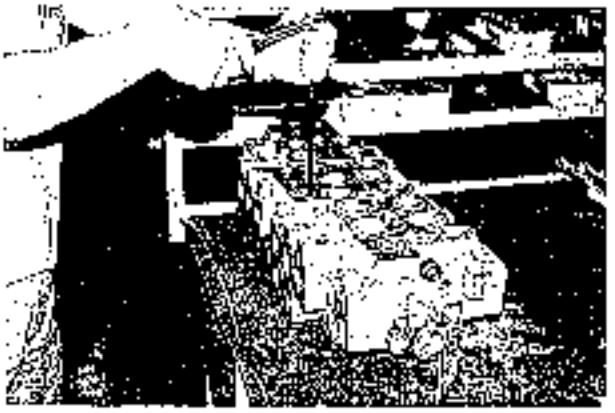


Fig. 63 Taking out the orifice

3) Remove two plugs (153) in travel block (101) and take out orifice (351).

3.3.12 DISASSEMBLING OTHER COMPONENTS

1) Remove plug (552) in casing A (102) and take off poppet (logic valve) (612).
(See section D−D)

- Use tweezers to remove the poppet (612).

Fig. 64 Removing the logic valve

3.3.13 CASING

1) Remove the socket bolts (973,974,976), and disassemble the assembly into travel block (101), casing A (102), casing B (103) and casing T2 (104).

2) Plugs not referred to in the above procedures are blind plugs for use in machining holes and as casting stoppers. Do not disassemble them unless there is a particular need to do so.

Fig. 65 Disassembling the casing

3.3.14 DISASSEMBLING THE MAIN RELIEF VALVE (SEE FIG. 6)

1) Body (420) and plug (421) are tight-fitted. Remove the plug by either pulling it by hand or prying it up with a screwdriver.

    ●The seat (429) and poppet (433) may pop out due to force of the springs (428,434). Be aware of this.

2) Remove the seat (429), spring (428) and plunger (427) from inside the body (420).
3) Loosen lock nut (439), separate adjust plug (422) from plug (421) and then draw out spring (434) and poppet (433).
4) Separate lock nut (438) and adjust screw (437) from adjust plug (422) Then separate spring seat (435) and piston (430).

3.3.15 DISASSEMBLING THE TRAVEL RELIEF VALVE (SEE FIG. 7)

1) With the body (101) in a vise, remove the plug (201).

    ●The poppet (611) and seat (641) may pop out due to the force of the springs (521,621).

2) Remove the seat (641), spring (521), and plunger (511) from inside the body (101)
3) Remove the lock nut (671) on plug (201), and the adjusting screws (651), then take out the spring seat (612), spring (621), and poppet (611).

3.3.16 DISASSEMBLING THE PORT RELIEF VALVE (SEE FIG. 8)

1) Draw out spring (408) and seat (409).
2) Hold body (401) in a vise and take off plug (404).

    ●Take care as poppet (410) and seat 2 (413) will pop up by the action of springs (407,412).

3) Draw out seat (413), spring (407), spring seat (417) and plunger (406) from inside body (401).
4) Separate lock nut (416) and adjust screw (414) from plug (404) and then draw out spring seat (411), spring (412) and poppet (410).

3.3.17 INSPECTION AFTER DISASSEMBLY

Thoroughly clean all disassembled parts with clean mineral oil, and dry them with compressed air. Place each part on a clean sheet of paper or cloth for inspection.

(1) Control valve

1) Inspect the entire surface of each part for burrs, scratches, cuts, and other defects
2) Confirm that the sealing groove surface of the casing or the block is free of foreign matter, dents or rust.
3) If the check valve seat of the casing or the block has dents or damage on its surface, smooth it by lapping.

    ●Take care not leave lapping compound behind in the casing or block.

4) Confirm that the sealing part or the outer circumference of the sliding part of a manual spool is free of scratches, dents, and the like. Remove any small defects with an oil stone or rags moistened with lapping compound.
5) Manually confirm that all sliding and fitted parts move smoothly. Confirm that all grooves and passages are free of foreign matter.
6) Replace any broken or deformed spring with a new one.
7) If a relief valve malfunctions, repair it by following the relief valve disassembly and reassembly procedures.
8) Replace all seals and O rings with new ones.

(2) Relief valve

1) Confirm that the seating face of each poppet and each seat edge is free of defects and is a uniform contact surface.
2) Manually confirm that the main poppet slides smoothly onto and off the seat.
3) Confirm that the outer circumference of the main poppet and the inner circumference of its seat are free of defects such as scratches.

4) Confirm that each spring is free of breakage, deformation, and excessive wear.
5) Confirm that the orifices of the main poppet and its seat are not clogged.
6) Replace all O rings with new ones.
7) Remove any slight defects found during the above inspection by lapping.
8) If any abnormal part is found, replace the relief valve as an assembly.

3.4 REASSEMBLY

(1) Here, only the reassembly procedures are described. Regarding drawings, refer to the disassembly procedures.
(2) The numbers in parentheses following each part in the descriptions correspond to those in the views in Fig.2,3,4,5,6,7,8 and 9 in section 2.1.
(3) Precautions on reassembling seals
1) Confirm that seals are free of forming defects or defects caused by poor handling.
2) Apply an adequate coat of grease or hydraulic oil to seals and their mating parts.
3) Do not stretch seals to the extent that they become permanently set.
4) When installing O rings, do not roll them into place. Twisted O rings do not easily untwist by themselves after installation, and can cause oil leaks.
5) Regarding the mounting bolts in various sections, tighten them to the tightening torques given in the sectional view of control valve (Fig. 2), using a torque wrench.

3.4.1 CASING

1) Put O rings (161,162,163) on casing A (102), casing T2 (104) and casing B (103), and then join the casings to the travel block (101) with socket bolts (973,974,976) and tighten to the specified torque.

- Confirm that the mating surface is free of foreign matter such as dust, and that each O ring is securely installed in its O ring groove.

3.4.2 PLUGS AND ORFICES

1) Install the two orifices (351) in the travel block (101), and tighten the plug (153) to the specified torque.
2) Install the orifice (351) in the casing (102), and tighten the plug (152) to the specified torque.

- Since plug (152) is specially coated, be sure to install a new one at reassembly. As a stopgap measure, a commercial PT1/8" plug with 1.5 turns of sealing tape around it may be used. In that case, take care not to let any pieces of the sealing tape enter the casing.
- Use of sealing tape may cause the control valve to malfunction. Try as much as possible not to use tape.

3) Install the poppet (612) in casing A (102). Put an O ring (166) on the plug (153), and tighten the plug to the specified torque.

3.4.3 RELIEF VALVE

1) Tighten the main relief valve (601), travel relief valve (602), and port relief valve (603), (604) to their respective casings to the specified torque.

- As the port relief valve (603), (604) are the same in appearance and shape, look at the tags attached at disassembly and take care not to confuse them at reassembly.
- Regarding the reassembly of the relief valves themselves, refer to the disassembly procedures in the preceding section.

3.4.4 SHUTTLE VALVES

1) Insert a ball (512) in each casing, install the seats (541,542,543,544), put an O ring (562) on the plug (552) and tighten the plug to the specified torque.

- There is one shuttle valve in the travel block (101), three in casing A (102), and two in casing B (103). Their seats (541,542,543,544) differ in length.
  Take care not to confuse them.

3.4.5 CHECK VALVES

1) Install the poppet (511) and spring (521,), put an O ring (561) on the plug (551), and tighten the plug to the specified torque.

- Note that there are seven check valves on the underside of the casing, and two on the side.

3.4.6 NEGATIVE CONTROL RELIEF VALVE

Install the poppet (470), spring (471) and bushing (472) in casing A (102) and casing B (103), put an O ring (561) on the plug (551) and tighten the plug to the specified torque.

3.4.7 ASSEMBLING TRAVEL STRAIGHT VALVE SPOOL, BYPASS CUT VALVE SPOOL AND CONFLUX VALVE SPOOL

1) Place spools (305,306,307,310,391) in designated positions, insert springs (324, 326, 326, 327, 373, 374, 377) and rod (337) fit O ring (265) to plug (251) and tighten them to specified torques

- Place conflux valve spools (307,391) and bypass cut valve spool (306,310) in correct positions.

3.4.8 BUCKET SPOOL

1) Clamp the center of the bucket spool (304) in a soft-jaw vise, put the spring seat (332), springs (371,372) and stopper (335) in the spool, and tighten the spacer bolt (336) to the specified torque.

- Apply locktite #241 to the spacer bolt (336) before tightening it.
- Take care not to make the vise too tight as it might deform the bucket spool (304).

2) Install the spool assembly reassembled in step 1) above in casing B (103).

- Install the spool assembly in casing B (103) slowly and carefully. Never force the assembly in.

3.4.9 ASSEMBLING THE ARM T2 SPOOL

1) Pinch the center of spool (arm T2) (309) in a mouth-piece attached vise, place spring seat (332), springs (323, 330) and stopper (335) in place and tighten spacer bolt (336) to a specified torque.

- Apply locktite #241 to the spacer bolt (336) before tightening it. Take care not to make the vise too tight as it might deform the arm T2 spool (309).

2) Install the spool assembly reassembled in steps 1) above in casing T2 (104).

- Install the spool assembly in casing T2 (104) slowly and carefully. Never force the assembly in.

3.4.10 BOOM SPOOL (SEE FIG. 4)

1) Install plunger 1(315), plunger 2 (316),plunger 3 (317), spring (boom lower) (320), spring (boom oil recirculation) (330), spring (boost check) (340), and the rod (343) in the boom spool (303), and tighten the plug (352).

- Take care that each part is installed in the correct location. Confirm that each plunger moves smoothly in the boom spool (303).

2) Clamp the plug (352) at the end of the boom spool (303) in a vise, then put the spring seat (332), springs (371,372) and stopper (338) in the spool, and tighten the spacer bolt (336) to the specified torque

- Apply locktite #241 to the spacer bolt (336) before tightening it.

3) Install the spool assembly reassembled in step 1) and 2) above in casing B (103).

- Install the spool assembly in casing B (103) slowly and carefully. Never force the assembly in.

3.4.11 ARM SPOOL (SEE FIG. 3)

1) Clamp the arm spool sub-spool (312) in a soft-jaw vise, install the spring (329) and spring seat (358) in the spool, and tighten the spacer bolt (343) to the specified torque.

- Apply locktite #241 to the spacer bolt (343) before tightening it.

2) Confirm that the piston (013) is in the arm bushing (341), insert the arm spool sub-spool (312) assembly in the arm spool (302) in the correct direction, and tighten the plug (359) to the specified torque.

- Confirm that the arm spool sub-spool (312) moves smoothly in the arm spool (302).

3) Clamp the plug (359) at the end of the arm spool (302) in a vise, set the spring seat (372), springs (371,328) and stopper (335) in the spool, and tighten the spacer bolt (336) to the specified torque.

- Apply locktite #241 to the spacer bolt (356) before tightening it.

4) Install the spool assembly reassembled in steps 1) and 2) above in casing A (102).

- Install the spool assembly in casing A (102) slowly and carefully. Never force the assembly in.

3.4.12 TRAVEL SPOOL

1) Clamp the center of the travel spool (301H) in a soft-jaw vise, put the spring seat (331H), springs (328H,329H) and stopper (334H) in the spool, and tighten the spacer bolt (333H) to the specified torque.

- Apply locktite #241 to the spacer bolt (333H) before tightening it.
- Take care not to make the vise too tight as it might deform the travel spool (301H).

2) Install the spool assembly reassembled in step 1) above in travel block (101).

- Install the spool assembly in travel block (101) slowly and carefully. Never force the assembly in.

3.4.13 COVERS

1) Install spool cover (203) on the opposite side of the boom, bucket, arm T2 spool springs and attach spool cover (202H) on the opposite side of the travel spool spring. Then tighten socket head capscrews (278) to a specified torque.

- Confirm that the O rings (263,266H) are installed.

2) Mount the spring caps (301) on the spring side of the bucket, arm and arm T2 spools, and tighten the socket bolts (273) to the specified torque.

- Confirm that the O ring (261) is installed

3) Install the arm cover (205), piston (353) and spring (354) on the side of the arm spool opposite the spring side, and tighten the socket bolts (273) to the specified torque.

- Confirm that the piston (353) moves smoothly in the arm cover (205). Confirm that the O ring (253) is installed.

3.4.14 MAIN RELIEF VALVE (SEE FIG. 6)

1) Fix piston (430) and spring seat (435) to adjust screw (422) and then attach adjust screw (437) and lock nut (438).
2) Fit spring (434) and poppet (433) to plug (421). Then install the assembly in para. 1) above and lock nut (439).
3) Attach plunger (427), spring (428) and seat (429) to body (430).
4) Force-fit the assemblies reassembled in steps 2) and 3) above.

- Confirm that the seat (429) and the poppet (433) are securely inserted.
- Use a bearing puller or the like to force-fit the assembly, as only a little force is required.

5) Fit O rings (423,424) and backup ring (165).
6) Pressure adjustment is performed by referring to "service standard and test procedure". Adjust screw (422) and adjust screw (437) may be in a temporarily assembled state for this operation.

3.4.15 ASSEMBLING THE TRAVEL RELIEF VALVE (SEE FIG. 7)

1) Fit spring seat (612), spring (621) and poppet (611) to plug (201) and then fix adjust screw (651) and lock nut (671)
2) Fit plunger (511), spring (521) and seat (641) to body (101).
3) Tighten each of the assemblies under para. 1) and 2) above to specified torques.

- Make sure that seat (641) and poppet (611) are set in place.

3.4.16 ASSEMBLING THE PORT RELIEF VALVE (SEE FIG. 8)

1) Fix plunger (406), spring seat (417), spring (407) and seat 2 (413) to body (401).
2) Fit O ring (405) to plug (404). Fit O ring (415) to spring seat (411) as well.
3) Put spring seat (411) assy, spring (412) and poppet (410) into plug (404). Then tighten adjust screw (414) and lock nut (416).
4) Tighten each of the assemblies under para. 1) and 3) to specified torques.
5) Fix seat (409) and spring (408). Then attach O rings (402,403).
6) Pressure adjustment is performed by referring to "service standard and test procedure". Adjust screw (414) may be in a temporarily assembled condition.

4. MAINTENANCE STANDARDS

4.1 INSPECTION OF COMPONENTS

Part name	Inspection item	Criterion and remedy
Casing	1) Look for scratches, rusting, corrosion.	1) If any of the following parts are damaged, replace the component as a unit. • Sliding part of casing hole and spool, particularly the land, to which holding pressure is applied. • Part of sealing pocket through which spool is inserted. • Area of sealing part that is in contact with O ring. • Sealing part of main, travel, or port relief valve. • Defects of other parts that seem to prevent normal function.
Spool	1) Look for scratches, galling, rusting, corrosion. 2) Inspect ends that are sealed with an O ring. 3) Insert the spool in the casing bore, and move it while turning it.	1) If a defect detectable with your fingernail is found on the sliding part of the outer circumference (particularly the part that comes into contact with a seal), replace the spool. 2) If the sliding part is damaged, replace the spool. 3) If the spool damages the O ring or does not move smoothly, repair or replace the spool.
Poppet	1) Look for damage on the poppet and the spring. 2) Insert the poppet in the casing, and move it.	1) If sealing is incomplete, replace the seal. 2) If the poppet moves lightly without catching, it is normal.
Spring and associated components	1) Look for rust, corrosion, deformation, and breakage of the spring, spring seat, plug and cover.	1) If damaged heavily, replace.
Spool seal and associated components	1) Look for external oil leak. 2) Look for rust, corrosion and deformation of sealing plate	1) Repair or replace. 2) Repair or replace.
Main relief valve Travel relief valve Port relief valve Low pressure relief valve	1) Look for rust and damage on outer surface. 2) Inspect the contact face of the valve seat. 3) Inspect the contact face of the poppet. 4) Look for spring abnormality. 5) Inspect the O ring, backup ring, and seal.	1) Replace. 2) If damaged, replace. 3) If damaged, replace. 4) Replace. 5) As a general rule, replace all parts with new ones.

5. TROUBLESHOOTING

1) If an abnormal condition is noticed, check to see if the problem is with the control valve itself, one of the main pumps, the No.3 pump, or a circuit. To this end, you will need to measure pilot pressure, pump delivery pressure, load pressure, etc. If any part of the system is to be disassembled for inspection, follow the disassembly and reassembly procedures in this booklet.
2) Dust is the enemy of hydraulic components. Pay strict attention to protection from dust. If any part of the system is to be disassembled, take dust protection measures beforehand.
3) Moving parts must be handled with care. If they are damaged in any way, smooth the damage using an oil stone or the like.
4) Take care not to damage the gasket face of O rings. A damaged gasket face will certainly cause oil leaks.

5.1 CONTROL VALVE

Trouble	Cause	Remedy
1. Travel does not occur. Slow to start up (sluggish). Slow response	1) Malfunctioning travel relief valve. • Foreign matter between main poppet valve and seat. • Foreign matter between poppet and seat. • Sticking main poppet. • Broken or deformed spring. • Clogged main poppet throttle. • Loosened adjusting screw.	1) Measure travel relief valve pressure • Disassemble and clean. If damaged heavily, replace the assembly as a unit. • Same as above. • Smooth sticking part with oil stone. • Replace spring • Remove foreign matter. • Readjust, and tighten lock nut to specified torque.
	2) Clogged orifice in pilot circuit.	2) Remove foreign matter.
2. Machine does not move straight during simultaneous travel and working attachment operation.	1) Malfunctioning travel straight control valve. • Sticking spool. • Broken or deformed spring. • Excessive clearance between travel block and spool. • Clogged small bore in spool.	1) Measure pilot pressure. • Smooth sticking part with oil stone. • Replace spring. • Replace spool or travel block. • Remove foreign matter.
	2) Malfunctioning shuttle valve. • Air in pilot circuit. • Foreign matter between ball and seat. • Damaged seat face	2) Measure pilot pressure. • Bleed air. • Disassemble and clean. • Smooth with oil stone. If heavily damaged, replace seat.
	3) Malfunctioning right or left neutral cut-off valve. • Sticking spool. • Broken or deformed spring. • Excessive clearance between right or left casing, and spool. • Clogged small bore in spool.	3) Measure pilot pressure. • Smooth sticking part with oil stone. • Replace spring. • Replace spool, or right or left casing. • Remove foreign matter.

Trouble	Cause	Remedy
	4) Malfunctioning logic valve • Foreign matter between poppet and seat. • Damaged poppet or seat face. • Broken or deformed spring.	 • Remove foreign matter. • Smooth with oil stone. If heavily damaged, replace seat or poppet. • Replace spring.
	5) Malfunctioning travel relief valve. See item 1. 1) above.	5) Replace spool or casing.
3. Excessive retraction of cylinder under its own weight when spool is in neutral.	1) Excessive clearance between casing and spool.	1) Replace spool or casing.
	2) Spool is not completely in neutral position. • Foreign matter between casing and spool, or sticking spool • Broken or deformed spring. • Clogged pilot circuit.	2) Measure secondary pilot pressure • Disassemble, clean, and smooth sticking part with oil stone. • Replace spring. • Remove foreign matter.
	3) Malfunctioning main relief valve. Refer to item 1. 1) above.	3) Measure main relief valve pressure Refer to item 1. 1) above.
	4) Malfunctioning port relief valve. Refer to item 1. 1) above.	4) Measure port relief valve pressure. Refer to item 1. 1) above.
	5) Malfunctioning anti-cavitation check valve. • Foreign matter between poppet and casing. • Broken or deformed spring.	5) • Disassemble and clean. • Replace spring.
4. When extending cylinder, at first it retracts.	1) Malfunctioning load check valve. • Foreign matter between poppet and casing. • Sticking poppet. • Broken or deformed spring.	1) • Disassemble and clean. If heavily damaged, replace casing. • Smooth sticking part with oil stone. • Replace spring.
5. Bucket, boom or arm alone does not operate. Slow to start up (sluggish). Slow response.	1) Malfunctioning main spool. • Excessive clearance between casing and spool • Foreign matter between casing and spool. • Sticking spool. • Broken or deformed return spring. • Clogged pilot circuit.	1) Measure secondary pilot pressure. • Replace spool or casing. • Disassemble and clean. • Smooth sticking part with oil stone • Replace spring. • Remove foreign matter.
	2) Malfunctioning main relief valve Refer to item 1. 1) above.	2) Measure main relief valve pressure. Refer to item 1. 1) above.
	3) Malfunctioning port relief valve. Refer to item 1. 1) above.	3) Measure port relief valve pressure. Refer to item 1. 1) above.
	4) Malfunctioning pilot valve. Refer to "Control System" manual.	4) Refer to "Control System" manual.

Trouble	Cause	Remedy
6. Swing priority function does not occur.	1) Malfunctioning logic valve. Refer to item 2. 4) above.	1) Refer to item 2. 4) above.
	2) Clogged orifice in pilot circuit.	2) Remove foreign matter.
7. Swing does not occur.	1) Malfunctioning neutral cut-off valve. Refer to item 2. 3) above.	1) Refer to item 2. 3) above.
	2) Malfunctioning shuttle valve. Refer to item 2. 2) above.	2) Refer to item 2. 2) above.
8. Boom or arm oil recirculation does not occur.	1) Malfunctioning conflux valve. Refer to item 2. 3) above.	1) Measure pilot pressure. Refer to item 2. 3) above.
9. Despite lever being in neutral, negative control does not occur, failing to minimize flow.	1) Malfunctioning low pressure relief valve. • Foreign matter between poppet and seat. • Broken or deformed spring. • Clogged poppet throttle. • Damaged filter.	1) Measure low pressure relief valve pressure. • Disassemble and clean. If heavily damaged, replace the assembly as a unit. • Replace spring. • Disassemble and clean. Remove foreign matter. • Disassemble and clean. Replace filter.

5.2 RELIEF VALVE

Trouble	Cause	Remedy
1. No pressure rise whatsoever.	Main or pilot poppet of relief valve is sticking and valve is open, or there is foreign matter on valve seat.	• Check for foreign matter on each poppet. • Confirm that each component slides smoothly. • Clean all components thoroughly.
2. Unstable relief pressure.	Damaged pilot poppet seat of relief valve Pilot piston sticks against main poppet.	• Replace damaged component • Clean all components thoroughly. • Smooth surface damage.
3. Irregular relief pressure.	1) Wear due to foreign matter.	1) Disassemble and clean.
	2) Loosened lock nut or adjusting screw.	2) Adjust pressure.
4. Oil leak.	1) Damaged seat. Worn out O ring.	1) Replace damaged or worn component. Confirm that each component operates smoothly before reassembling.
	2) Sticking component due to foreign matter.	2) Confirm that there are no scratches, nicks, or foreign matter present before reassembling.

Book code No. S5 13077 7E

KOBELCO

SHOP MANUAL

PILOT VALVE (TRAVEL)

13

TABLE OF CONTENTS

KOBE STEEL, LTD.

PREFACE

The pilot valve is used for remote control of the control valve. The pilot valve is of reducing valve type and contains multiple reducing valves that control the secondary proportionate pilot pressure actuated by manual lever action or pedal action. A check ball is provided on the discharge side of each reducing valve so as to select the higher of proportionate secondary pressure thus selected serves as an auto accel signal.

Models	Applicable Machines	Notes	Models	Applicable Machines	Notes
SK310Ⅲ	LC03601~				
SK310LCⅢ	YC01101~				
SK430Ⅲ	LS00701~				
SK430LCⅢ	YS00601~				

Revision	Date of Issue	Remarks
First edition	March, 1995	S5130777E K

1. SPECIFICATION

1.1 GENERAL VIEW

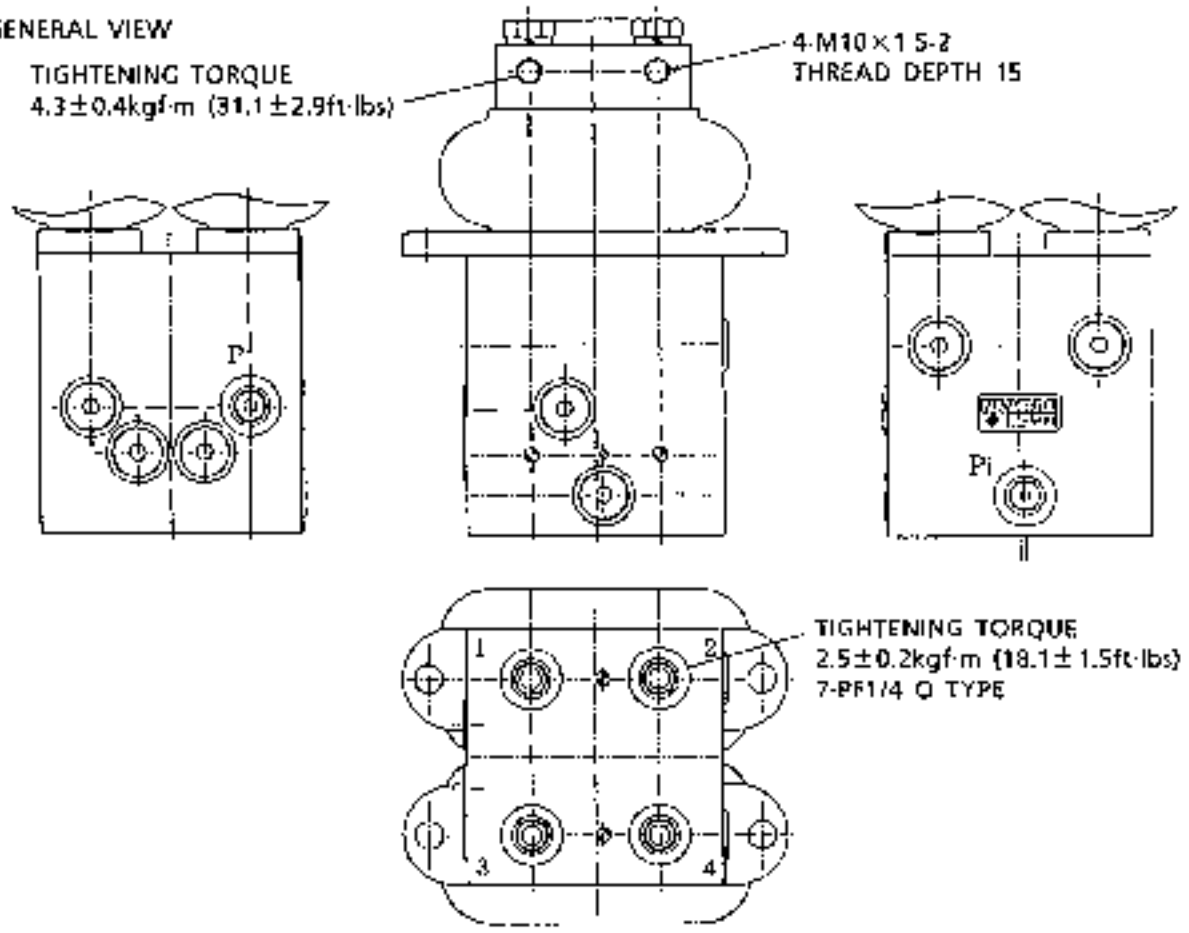


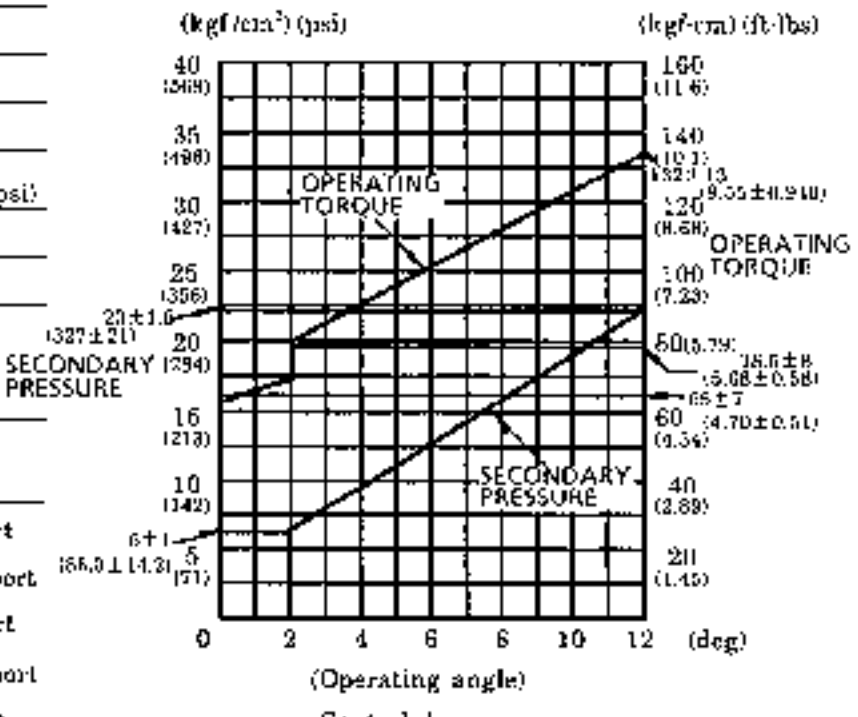
Fig. 1 Outside view of travel pilot valve

1.2 SPECIFICATION

Item	Specification
Dwg No.	2436U2368F1
Primary press	50kgf/cm² (711 psi)
Secondary press	6±1~23±1.5kgf/cm² (85.3±14.1~327±21.3 psi)
Max. pressure of T-port	3kgf/cm² (42.7 psi)
Weight	Approx.11kg (24 lbs)

Port dia.	Tightening torque kgf·m (ft·lbs)	Port Name	Function
PF1/4	2.5±0.2 (18.1±1.4)	1	LH travel forward port
		2	LH travel backward port
		3	RH travel forward port
		4	RH travel backward port
		Pi	Auto accel signal port

1.3 PERFORMANCE CHARACTERISTICS



Control diagram

2. CONSTRUCTION AND FUNCTION

2.1 CONSTRUCTION

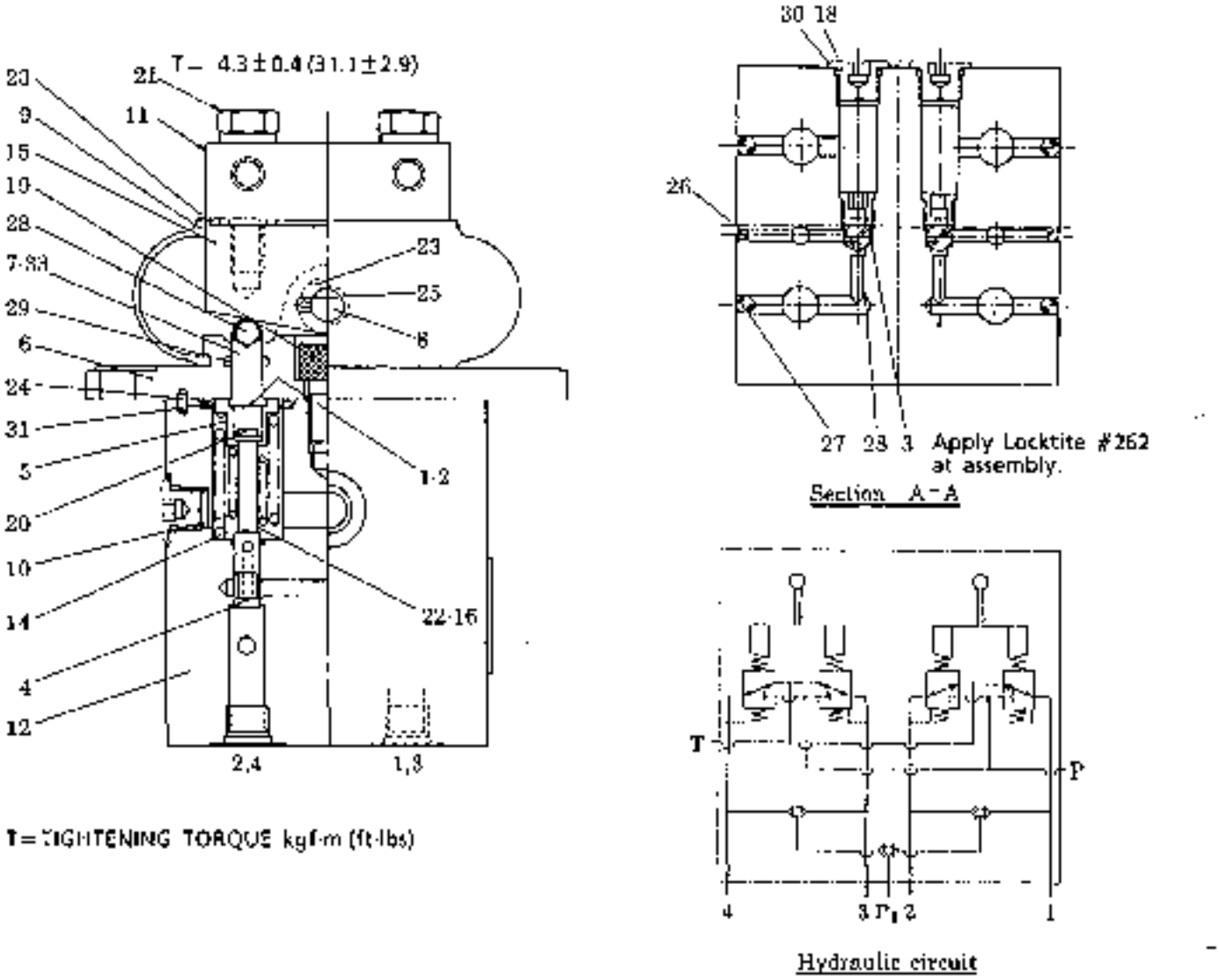


Fig. 2 Construction of travel pilot valve

Tightening torque kgf·m (ft·lbs)	No.	NAME	Q'TY	Tightening torque kgf·m (ft·lbs)	No.	NAME	Q'TY
	1	SHIM	4	8.0±0.8 (14.6±1.45)	18	COLLAR PLUG PPL/4	7
	2	SHIM	4	7.9±0.8 (57.1±5.8)	19	SOCKET HEAD CAPSCREW M12	2
1.5±0.1 (10.8±0.7)	3	SEAT	3	0.5±0.1 (3.62±0.72)	20	FLANGE BOLT M4	4
	4	SPOOL	4	2.2±0.2 (15.9±1.45)	21	SOCKET HEAD CAPSCREW M10	4
	5	SLEEVE	4		22	PLAIN WASHER	4
	6	COVER	2		23	PLAIN WASHER	8
	7	PLUNGER	4		24	PIN	4
	8	PIN	2		26	SPLIT PIN	4
	9	BOOT	2		26	STEEL BALL	2
	10	SPRING	4		27	STEEL BALL	6
	11	PLATE	2		28	STEEL BALL	7
	12	BODY	1		29	O RING	4
	14	SPRING	4		30	O RING	7
	15	CAM	2		31	O RING	4
	16	SHIM	4				

2.2 FUNCTION

(1) Lever neutral (See Fig. 3)

When the lever is neutral, the spool (4) is pushed up by the spring (14) and the output port 2,4 are through with the T port.

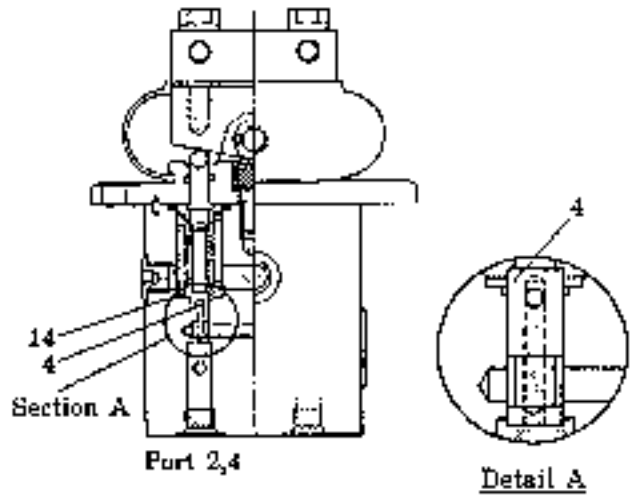


Fig. 3 Lever neutral

(2) Lever tilted (See Fig. 4)

By the tilting operation of lever, plunger (7) is moved down and sleeve (5) is moved down. With the result spring (10) is compressed and spool (4) is pushed down.

Thus the secondary pressure of pilot is decided by spring (10) force.

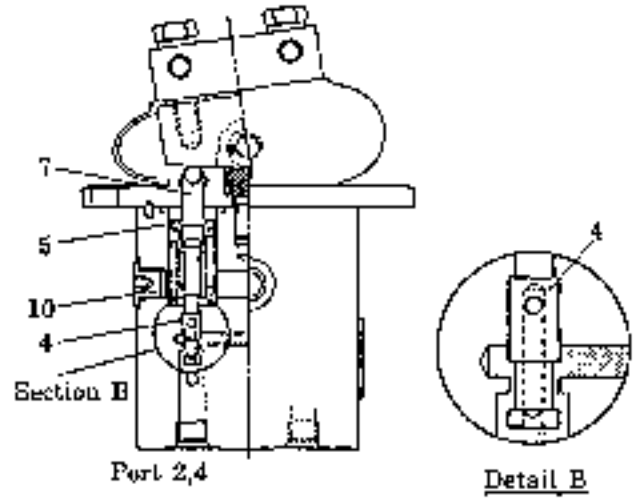


Fig. 4 Lever tilted

(3) Lever hold (See Fig. 5)

If the preasure at ports (2,4) rises to a level equal to the action of the spring (10) set as the lever is tilted, the hydraulic pressure balances with the action of the spring (10) and spool (4) is moved upwards. When the pressure at the ports (2,4) arrives at a set level, the port P closes to hold the secondary pressure constant

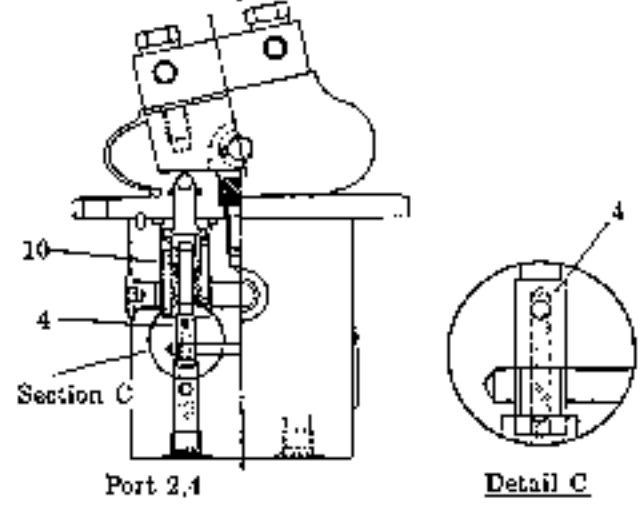


Fig. 5 Lever held

(4) High pressure selector valve

The valve body (12) has ports 1,2,3,4 and Pi in its side surface.

The port Pi is the high pressure select port that takes out the maximum pressure from among the ports 1,2,3 and 4.

Book code No. S5 16012 2E②

KOBELCO

SHOP MANUAL

SWIVEL JOINT

TABLE OF CONTENTS

16

KOBE STEEL, LTD.

PREFACE

The swivel joint is installed in the center part of the rotating body and continuously maintains the connection of the fluid circuit regardless of the swing angle.
Major parts of this swivel joint consist of body and stem which are able to rotate reciprocally and each is provided with ports for the number of fluid circuit on it.

Models	Applicable Machines	Notes	Models	Applicable Machines	Notes
SK150LCⅢ	YM00101~	Spec.1			
SK100V	YW06501~	Spec.1			
SK120V	LP11001~	Spec.1			
SK120LCV	YP02301~	Spec.1			
SK200V	YN18001~	Spec.1			
SK200LCV	YQ02301~	Spec.1			
SK220V	LQ03301~	Spec.1			
SK220LCV	LL02301~	Spec.1			
SK310Ⅲ	LC03801~	Spec.1			
SK310LCⅢ	YC01101~	Spec.1			

Revision	Date of Issue	Remarks	
First edition	February, 1993	S5160122E	K
First revision	April, 1994	S5160122E①	K
Second revision	March, 1995	S5160122E②	K

1. SPECIFICATION

1.1 GENERAL VIEW

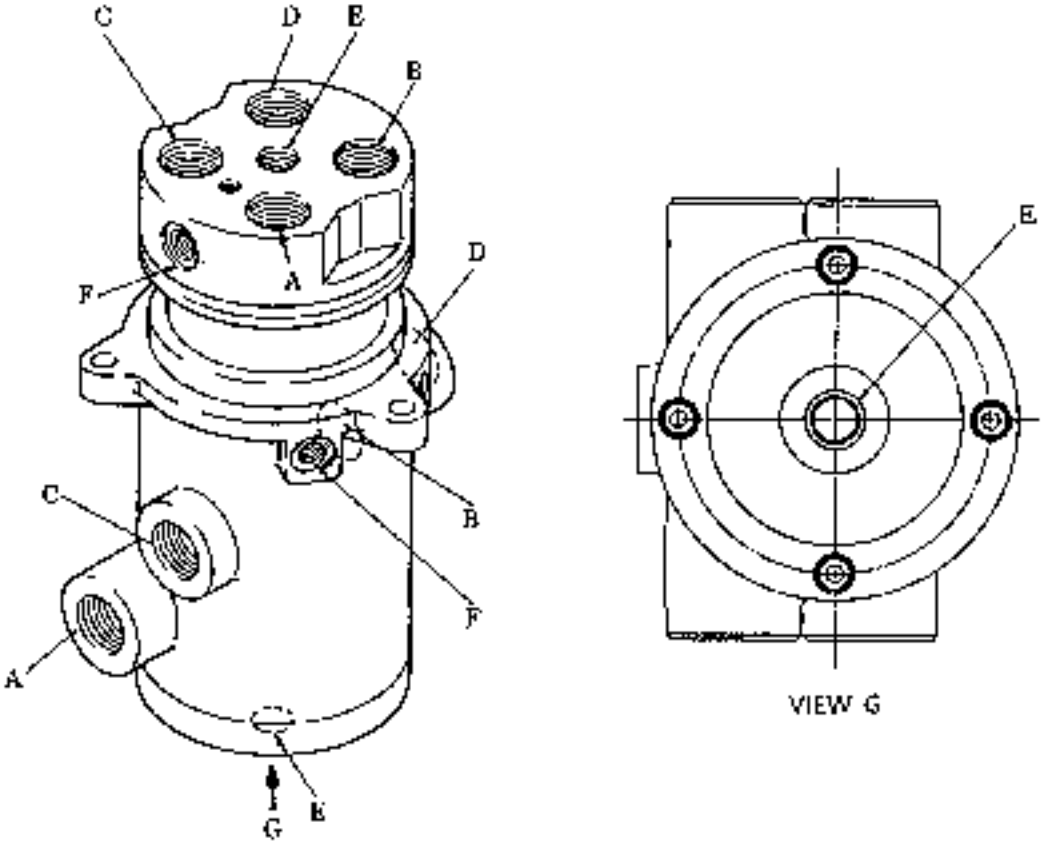


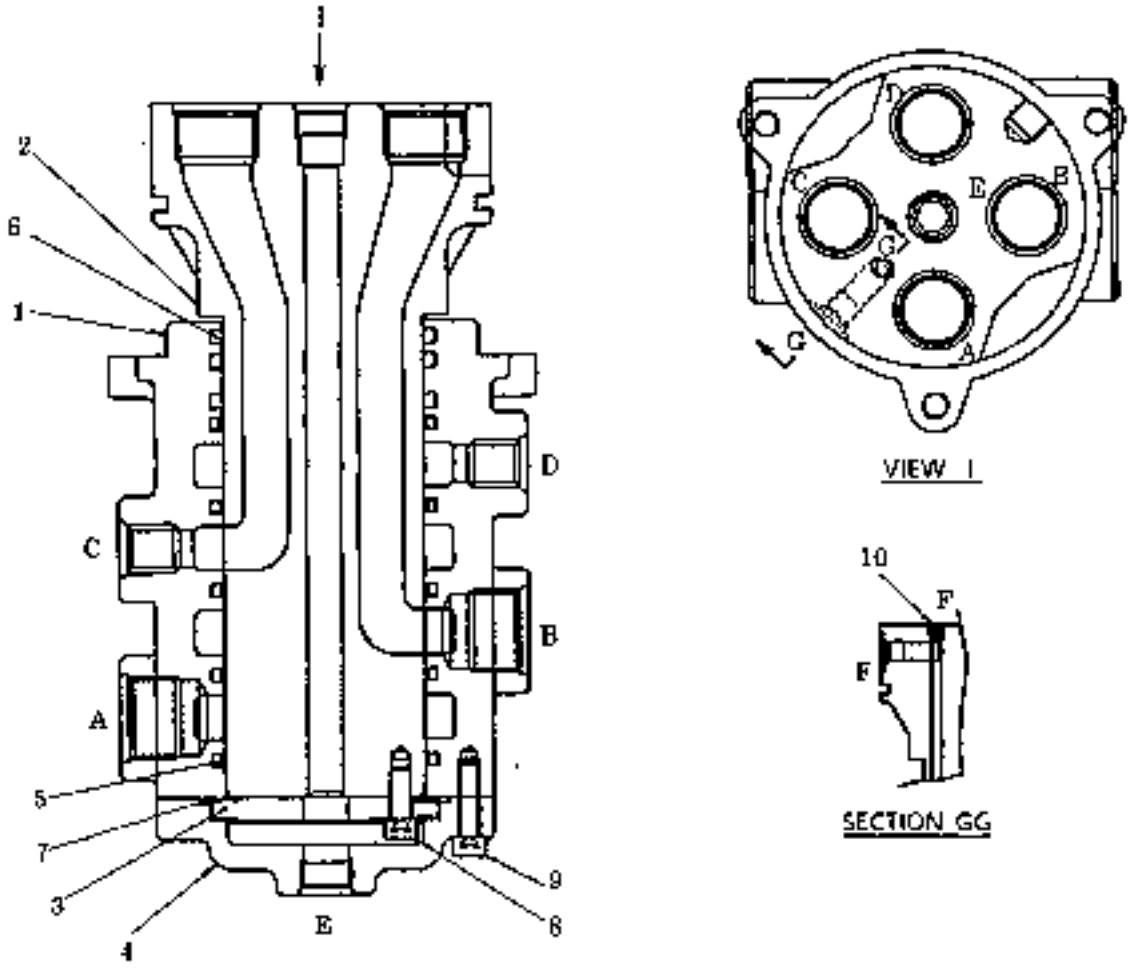
Fig.1 Outside view of swivel joint

1.2 SPECIFICATIONS

Table 1

Item		Spec. 1
High pressure ports A , B , C , D	Working pressure Max. impact pressure (pressure tightness) Rated flow	350kgf/cm² (4980psi) 525kgf/cm² (7470psi) 255ℓ/min (67gal/min)
Low pressure ports E	Working pressure Rated flow	5kgf/cm² (71psi) 50ℓ/min (13gal/min)
Low pressure ports F	Working pressure Rated flow	50kgf/cm² (710psi) 30ℓ/min (8gal/min)
Revolution		15rpm
Port size	A , B , C , D E F	PF1 PF1/2 PF1/4
Total length L		320mm (1 ft 0.6 in)
Weight		27kg (60 lbs)

2. CONSTRUCTION AND FUNCTION



NO.	NAME	Q'TY	NO.	NAME	Q'TY
1	BODY	1	6	O RING	2
2	STEM	1	7	O RING	1
3	THRUST PLATE	1	8	CAPSCREW	2
4	COVER	1	9	CAPSCREW	4
5	SEAL ASS'Y	5	10	PLUG	1

Fig.2 Cross-sectional view of swivel joint

Main portion of the swivel joint consists of body (1) which rotates freely, swivel stem (2), thrust plate (3) which prevents disconnection of body and stem, cover (4) which closes one side of swivel body (1), slipper seal sets (5), which divide circuits, and Orings (6,7), which prevent external oil leakage.

Four ports for the main circuits are provided on body (1) and stem (2), four oil passage grooves are machined on the inner face of the body (1), and seal sets (5) are provided at top and bottom of circumferential grooves

Body (1) and stem (2) rotate freely. Oil from body (1) or stem (2) flows into stem (2) or body (1) through circumferential grooves between body (1) and stem (2) ; Oil flow is thus not obstructed by swiveling. Lubricating oil groove to drain port is also provided to prevent seizure of body (1) or stem (2) by swivelling.

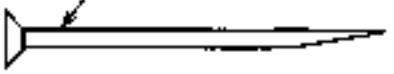
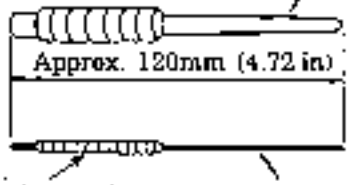
With this construction, swivel joint assures circuit connection between the lower body and the revolving upper body.

3. DISASSEMBLY AND ASSEMBLY

3.1 PREPARATION

3.1.1 TOOLS

Table 2

Symbol	Tool Name	Used for	Remarks
a	Hammer	Disassembly Assembly	1. Steel hammer 2. Wooden or plastic hammer
b	Rubber mat		Not less than 500mm (19.7in) square
c	Wrench		1. Allen wrench 2. Double-ended and single-ended wrench 3. Extension pipe
d	Torque wrench	Assembly	10kgf-m (72ft-lbs)
e	Pin	Disassembly	Grind the tip of "a nail" to shape as a screwdriver. 
f	Spatula	Disassembly Assembly	Made from a hack-saw blade  Approx. 120mm (4.72 in) Vinyl tape Remove the edge completely and make corner round smooth.
g	Vise	Disassembly Assembly	Vises movable over 150mm (5.91in)
h	Three-bond		1360K
i	Lubricating oil		Hydraulic oil or vaseline
j	Cleaning oil		

3.1.2 APPARATUS

(1) Hoist or crane
The lifting device should be capable of lifting the swivel joint assembly.

(2) Work bench
The work bench should have an area of 1.2m × 1.5m (3ft 11in × 4ft 11in).

(3) Others
Also prepare waste cloth, wooden block and oil pan.

3.1.3 CLEANING OUTSIDE

Do not fail to put a plug to each port and clean the swivel joint so it is free from dust and other foreign matter, using steam, cleaning oil, etc.

3.2 DISASSEMBLY

The part numbers used in this disassembly procedure correspond to those of a construction drawing in Fig. 2.

3.2.1 DISMANTLING COVER

1) Mark cover (4) and body (1) with matching marks for convenient re-assembly.

2) Place a V-block on a work bench, mount a swivel joint set on the side, fix it and loosen capscrew (9) by means of a pipe. Alternately, the swivel joint may be fixed by holding stem (2) in a vise.
   : 6mm

3) Remove cover (4) from body (1) and draw out O ring (7) from cover (4).

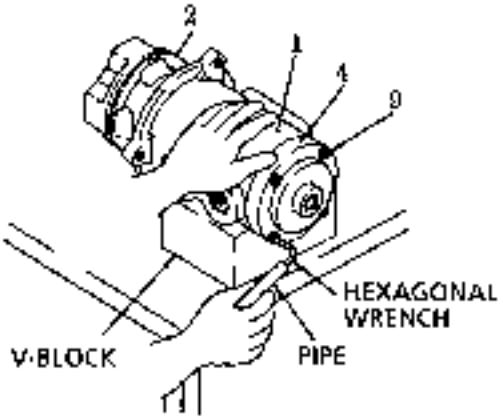


Fig. 3 Removing cover (4)

3.2.2 DISMANTLING THRUST PLATE

Loosen capscrew (8) fastening thrust plate (3), in the same manner as the dismantling of the above-mentioned cover.

⚠ When dismantling thrust plate (3) by fixing body (1), support stem (2) so it may not fall down.
   : 6mm

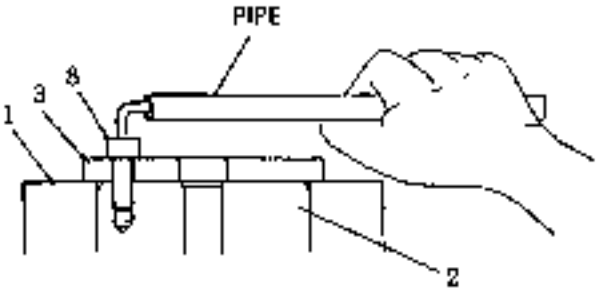


Fig. 4 Removing thrust plate (8)

3.2.3 EXTRACTION OF STEM

Place body (1) on a V-block. Put a wooden block against stem (2) via the body so about half of the stem is covered by the wooden block and knock it out, using a hammer.

By hitting out the stem over about 1/2 from the body, it can be easily pulled out.

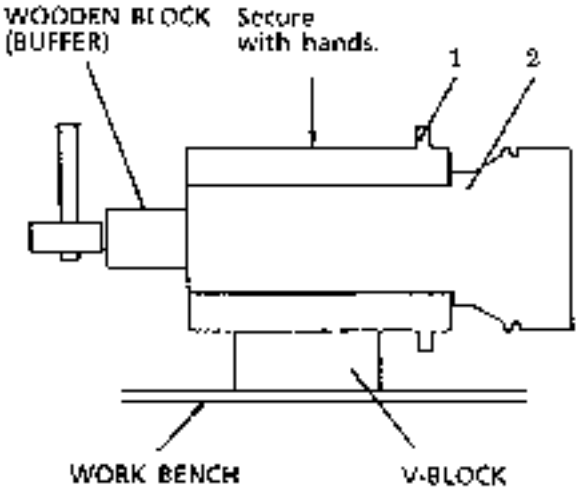


Fig 5 Drawing out stem (2)

3.2.4 REMOVING SEALS

1) Pull out O ring (6) from the O ring groove with the aid of a spatula.

⚠ Use the tip of the spatula taking not to mar the body. Also do not strike the spatula.

2) Pierce pin (e) to seal (5) and extract slipper ring (5). Fig.7 shows the use of one pin, but by using two pins, this can be extracted with more sureness.
As the backup ring is of rubber substance, remove this in the same procedure as O ring (6).

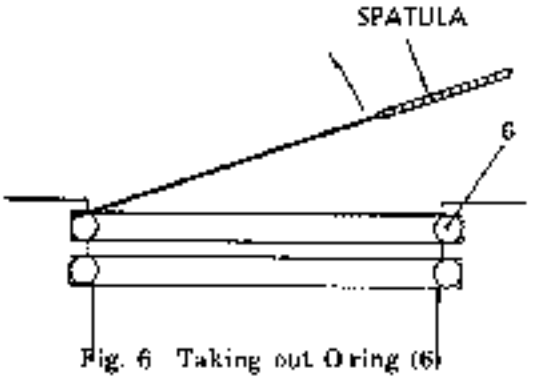


Fig. 6 Taking out O ring (6)

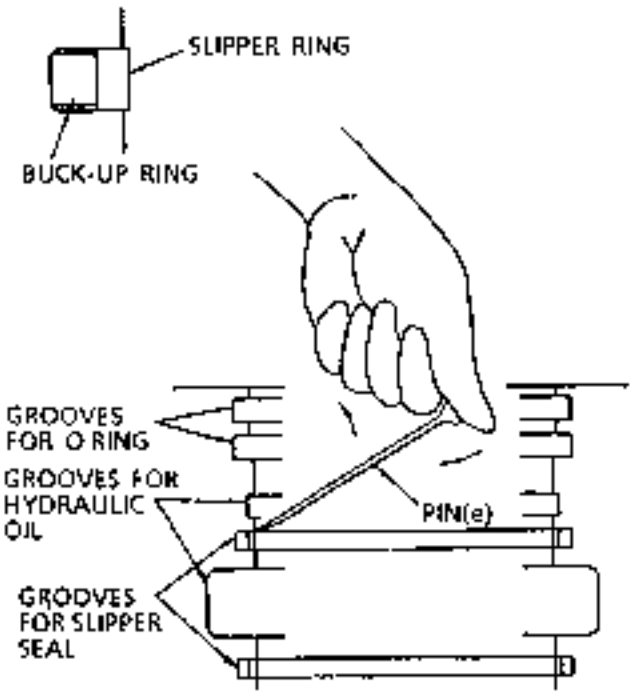


Fig. 7 Taking out seal ass'y (5)

3.3 ASSEMBLY

Prior to assembly, clean each parts (excluding the O ring and slipper ring), and arrange in the sequence of assembly.

3.3.1 ASSEMBLING SEALS TO BODY

1) Coat O ring (6) lightly with vaseline (or hydraulic oil) and install in the O ring groove. Also make sure that the O ring in not distorted after installation
2) Make sure that oiliness, such as vaseline, hydraulic oil and grease, has been completely removed.
3) Slipper ring is assembled, after first inserting the backup ring, by slightly-changing the shape as shown in Fig.8. Also after inserting all of the seals, be certain that these are installed in the seal groove by use of the spatula.

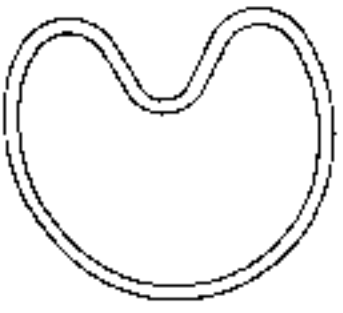


Fig. 8 Inserting seal ass'y (5)

3.3.2 ASSEMBLING STEM

Lightly coat the outer circumference of stem (2) and the inner surface of body (1) with grease or vaseline and slowly insert stem (2) into body (1).

⚠ If stem (2) is pressed in too fast, the seal may be damaged. Do it slowly.
The clearance between body (1) and stem (2) is about 0.1mm (0.004in). Erect stem straight along the shaft center.

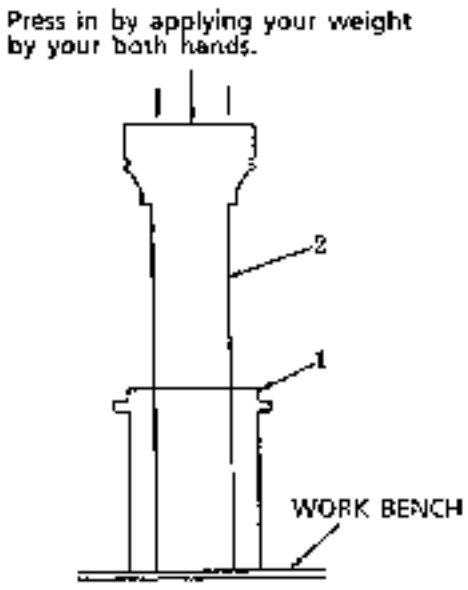


Fig. 9 Inserting stem (2)

3.3.3 ASSEMBLING THRUST PLATE

1) While holding stem (2) and body (1), match the hole of thrust plate (3) and the stem (2) hole.
2) Next, after removing any oil from the thread part of capscrew (8), coat it with three-bond 1360k and tighten to stem (2).

: 6mm,
Tightening torque : 3.1±0.3kgf·m
(22±2ft·lbs)

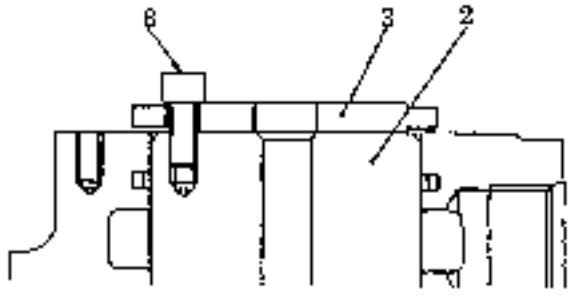


Fig. 10 Tightening capscrew (8)

3.3.4 ASSEMBLING COVER

After installing O ring (7) to cover (4) and aligning the matching marks of the cover (4) and body (1), tighten capscrew (9) which will then complete assembly

: 6mm,
Tightening torque : 3.1±0.3kgf·m
(22±2ft·lbs)

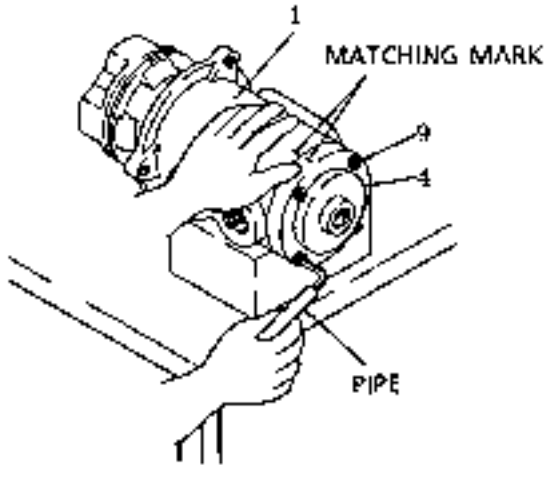


Fig. 11 Tightening capscrew (9)

4. MAINTENANCE STANDARDS

4.1 INSPECTION PROCEDURE AND REMEDY

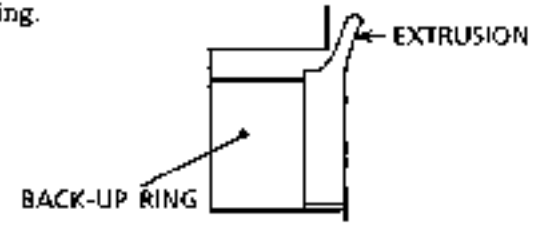
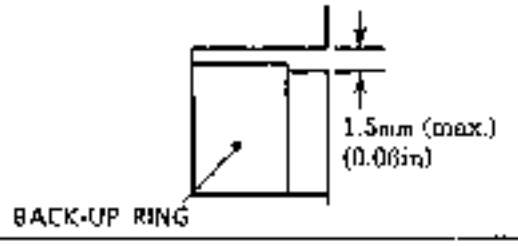
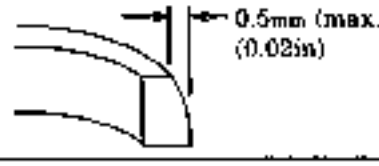
Table 3

Interval	Check Item	Checking Procedure	Remedy
2,000Hrs.	Seal for oil leakage outside	Check oil leakage outside	Replace O ring, if any oil leakage can be found.
4,000Hrs. In principle, disassemble and check regardless of oil leakage or not.	All sealing parts		Replace all sealing parts such as slipper seal with square seal and O ring.
	All rubbing parts	Check abnormal wear, scoring or corrosion caused by foreign particles or burning.	Repair or replace referring to their limit of serviceability.
When disassembled for repair	All parts	Check them for burning, foreign particles, abnormal wear, and defect of seals.	Repair or replace referring to their limit of serviceability. O rings should be replaced.

4.2 USABLE LIMIT OF THE PARTS

Table 4

Parts		Maintenance Standards	Remedy
Body, Stem	Sliding surface with sealing sec-tions	Plating worn or peeled due to seizure or contamination.	Replace
	Sliding surface between body and stem other than sealing sections	1) Worn abnormality or damaged more than 0.1mm (0.004in) in depth due to seizure contamination.	Replace
		2) Damaged more than 0.1mm (0.004in) in depth.	Smooth with oilstone.
	Sliding surface with thrust plate	1) Worn more than 0.5mm (0.02in) or abnor-mality.	Replace
		2) Worn less than 0.5mm (0.02in).	Smooth
		3) Damage due to seizure or contamination remediable within wear limit 0.5mm (0.02in).	Smooth
Cover	Sliding surface with thrust plate	1) Worn more than 0.5mm (0.02in) or abnor-mality.	Replace
		2) Worn less than 0.5mm (0.02in).	Smooth
		3) Damage due to seizure or contamination remediable within wear limit 0.5mm (0.02in).	Smooth

Parts		Maintenance Standards	Remedy
Slipper ring		1) Excruded excessaively from seal groove square ring.  	Replace (With back-up ring)
		2) Slipper ring 1.5mm (0.06in) narrower than seal groove, or narrower than back-up ring.  	Replace (With back-up ring)
		3) Worn more than 0.5mm (0.02in)  	Replace (With back-up ring)

4.3 INSPECTION AFTER ASSEMBLY

After completion of assembly, inspection for oil leakage, pressure resistance, etc., using a device as shown in the figure below.

(1) High pressure port

Install a changeover valve and pressure gauge to the stem side port and body side port respectively, and while watching the pressure gauge (for high pressure) installed on the body side and also by regulating high pressure relief valve (7), gradually increase the pressure and when the pressure has reached 1.5 times the maximum working pressure, close stop valve (3) and lock in the hydraulic oil in the swivel. Keep stop valve (6) on the low pressure relief valve side closed at this time.

(2) Low pressure port

(Drain port, return port, etc.)

Similar to the high pressure port, install a changeover valve and pressure gauge on each port of the stem side and body side.

Open stop valve (6) on the side of low pressure relief valve (5) and while watching the pressure gauge (for low pressure) connected to the body side and also by regulating low pressure relief valve (5), gradually increase the pressure and check for outside leakage with a color check at a pressure of 5 kgf/cm^2 (71 lbs/in^2).

Table 5

Item	Description	Remarks
1	Pressure Gauge	(High and Low Pressures are required.
2	Swivel Joint	
3	Stop Valve	
5	Relief Valve for low pressure	Setting Pressure : 5kgf/cm^2 (71psi)
6	Stop Valve	
7	Relief Valve for high pressure	Setting Pressure : (Working pressure×1.5times)
8	Changeover Valve	
9	Piping, etc.	

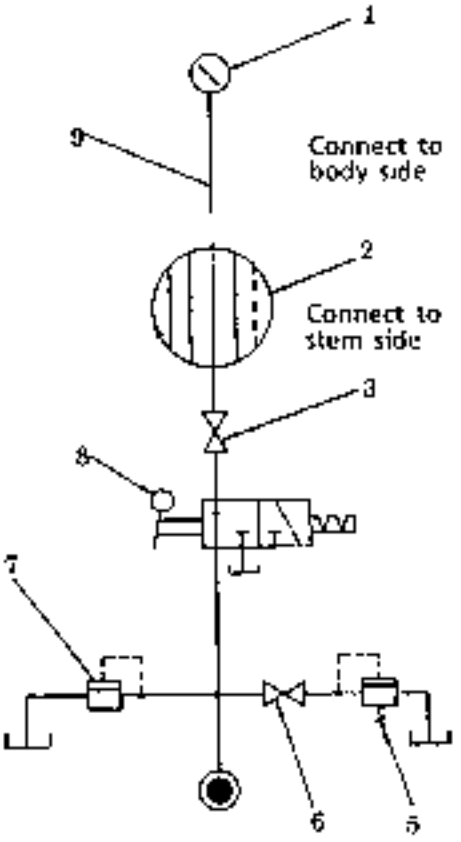


Fig. 12 Hydraulic circuit for inspection equipment

5. TROUBLESHOOTING

Table 6

Trouble	Cause	Remedy
1. External leakage of hydraulic fluid	Defective O ring	Replace all seals.
2. Internal leakage of hydraulic fluid	1) Defective slipper seal 2) Sliding face worn excessively	1) Replace all seals. 2) Replace ass'y.
3. Swivel joint seized	1) Stem and body seized 2) Inappropriate swivel stopper bracket	1) Grind and hone. Replace assembly, if stem and body are too loose and causing oil leakage. 2) Reinstall Secure 2~3mm (0.08~0.12in) allowance for bolt stopper.
4 Loose swivel stem and cover	capscrew tightened insufficiently.	Retighten.