EEBM001304

SHOP MANUAL

KOMATSU

PC450, 450LC-6K

MACHINE MODEL	SERIAL NUMBER
PC450-6K	**K30001 and up**
PC450LC-6K	**K30001 and up**

- This shop manual may contain attachements and optional equipment that are not available in your area. Please consult your local Komatsu distributor for those items you may require. Materials and specifications are subject to change without notice
- PC450-6k mounts the MTA 11 engine

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SAFETY
SAFETY NOTICE

IMPORTANT SAFETY NOTICE

Proper service and repairs extremely important for safe machine operation. The service and repair techniques recommended by Komatsu and described in this manual are both sepcially designed by Komatsu for the specific purpose.

To prevent injury to workers, the symbol ⚠ is used to mark safety precautions in this manual. The cautions accompaning these symbols should always be followed carefully. If any dangerous situation arises or may possibly arise, first consider safety, and take the necessary actions to deal with the situation.

GENERAL PRECAUTIONS

Mistakes in operation are extremely dangerous. Read the Operation and Maintenance carefully BEFORE operating the machine.

1. Before carrying out any greasing or repairs, read all the precautions given on the decals which are fixed to the machine.

2. When carrying out any operation, always wear safety shoes and helmet. Do not wear loose work clothes, or clothes with buttons missing.
   - Always wear safety glasses when hitting parts with a hammer.
   - Always wear safety glasses when grinding parts with a grinder, etc.

3. If welding repairs are needed, always have a trained, experienced welder carry out the work. When carrying out welding work, always wear welding gloves, apron, glasses, cap and other clothes suited for welding work.

4. When carrying out any operation with two or more workers, always agree on the operating procedure before starting. Always inform your fellow workers before starting any step of the operation. Before starting work, hang UNDER REPAIR signs on the controls in the operator's compartment.

5. Keep all tools in good condition and learn the correct way to use them.

6. Decide a place in the repair workshop to keep tools and removed parts. Always keep the tools and parts in their correct places. Always keep the work area clean and make sure that there is no dirt or oil on the floor. Smoke only in the areas provided for smoking. Never smoke while working.

PREPARATIONS FOR WORK.

7. Before adding the oil or making any repairs park the machine on hard, level ground, and block the wheels or tracks to prevent the machine from moving.

8. Before starting work, lower blade, ripper, bucket or any other work equipment to the ground. If this is not possible, insert the safety pin or use blocks to prevent the wrok equipment from falling. In addition, be sure to lock all the control levers and hang warning signs on them.

9. When disassembling or assembling, support the machine with blocks, jacks or stands before starting work.

10. Remove all mud and oil from the steps or other paces used to get on and off the machine. Always use the handrails, ladders or steps when getting on or off the machine. Never jump on or off the machine. If it is impossible to use the handrails, ladders or steps, use a stand to provide safe footing.

PRECAUTIONS DURING WORK

11. When removing the oil filter cap, drain plug or hydraulic pressure measuring plugs, loosen them slowly to prevent the oil from spurting out. Before disconnecting or removing components of the oil, water or air circuits, first remove the pressure completely from the circuit.

12. The water and oil in the circuits are hot when the engine is stopped, so be careful not to get burned.
    Wait for the oil and water to cool before carrying out any work on the oil or water circuits.

13. Before starting work, remove the leads from the battery. Always remove the lead from the negative (-) terminal first.

14. When raising heavy components, use a hoist or crane.
    Check that the wire rope, chains and hooks are free from damage.
    Always use lifting equipment which has ample capacity.
    Install the lifting equipment at he correct places.
    Use a hoist of crane and operate slowly to prevent the component from hitting any other part.
    Do not work with any part still raised by the hoist or crane.

15. When removing covers which are under internal pressure or under pressure from a spring, always leave two bolts in position on opposite sides. Slowly release the pressure, then slowly loosen the bolts to remove.

16. When removing components, be careful not to break or damage the wiring. Damaged wiring may cause electrical fires.

17. When removing piping, stop the fuel or oil from spilling out. If any oil or fuel drops onto the floor, wipe it up immediately. Fuel or oil on the floor can cause you to slip, or can even start fires.

18. As a general rule, do not use gasoline to wash parts. In particular, only use the minimum of gasoline when washing electrical parts.

19. Be sure to assemble all parts again in their original places.
    Replace any damaged parts with new parts.
    - When installing hoses and wires, be sure that the will not be damaged by contact with oter parts when the machine is being operated.

20. When installing high pressure hoses, make sure that they are not twisted. Damaged tubes are dangerous, so be extremely careful when installing tubes for high pressure circuits. Also, check that connecting parts are correctly installed.

21. When assembling or installing parts, always use the specified tightening torques. When installing protective parts such as guards. or parts which vibrate violently or rotate at high speed, be particulary careful to check that they are installed correctly.

22. When aligning two holes, never insert your fingers or hand. Be careful not to get your fingers caught in a hole.

23. When messuring hydraulic pressure, check that the messuring tool is correctly assembled for taking any measurements.

24. Take care when removing or installing the tracks of track-type machines. When removing the track, the track separates suddenly, so never let anyone stand at either end of the track.

FOREWORD
GENERAL

This shop manual has been prepared as an aid to improve the quality of repairs by giving the serviceman an accurate understanding of the product and by showing him the correct way to perform repairs and make judgements. Make sure you understand the contents of this manual and use it to full effect at every opportunity.

This shop manual mainly contains the necessary technical information for operations performed in a service workshop. For ease of understanding, the manual is divided into the following chapters: these chapters are further divided into the each main group of components.

STRUCTURE AND FUNCTION

This section explains the structure and function of each component. It serves not only to give an understanding of the structure, but also serves as reference material for troubleshooting.

TESTING AND ADJUSTING

This section explains checks to be made before and after performing repairs , as well as adjustments to be made at completion of the checks and repairs. Troubleshooting charts correlating "problems" to "Causes" are also included in this section.

DISASSEMBLY AND ASSEMBLY

This section explains the order to be followed when removing, installing, disassembling or assembling eachr component, as well as precautions to be taken for these operations.

MAINTENANCE STANDARD

This section gives the judgement standards when inspecting disassembled parts.

NOTICE

The specifiactions contained in this shop manual are subject to change at any time and without any advance notice. Use the specifications given in the book with the latest date.

HOW TO READ THE SHOP MANUAL

VOLUMES

Shop manuals are issued as a guide to carrying out repairs. They are devided as follows:

Chassis volume: Issued for every machine model
Engine model: Issued for each engine series

Electrical volume:
Attachments volume: } Each issued as one volume to cover all models

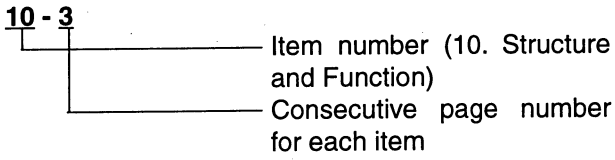
These various volumes are designed to avoid duplicating the same information. Therefore, to deal with all repairs for any model, it is necessary that chassis, engine , electrical and attachement volumes be available.

DISTRIBUTION AND UPDATING

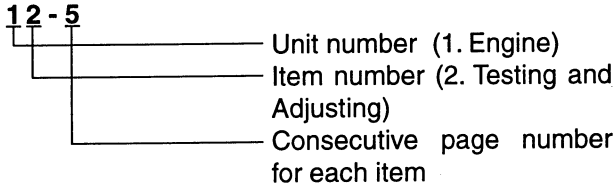
Any additions, amendments or other changes will be sent to KOMATSU distributors. Get the most up-to-date information before you start any work.

FILING METHOD

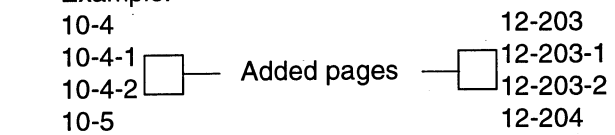
1. See the page number on the bottom of the page. File the pages in correct order.
2. Following examples show how to read the page number
   Example 1 (Chassis volume:)



Example 2 (Engine Volume:)



3. Additional pages: Additional pages are indicated by a hyphen (-) and number after the page number. File as in the example.
   Example:



REVISED EDITION MARK

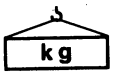
When a manual is revised, an edition mark (1,2,3,...) is recorded on the bottom of the pages.

REVISIONS

Revised pages are shown in the LIST OF REVISED PAGES next to the CONTENTS page.

SYMBOLS

So that the shop manual can be of ample practical use, important safety and quality portions are marked with the following symbols.

Symbol	Item	Remarks
	Safety	Special safety precautions are necessary when performing the work.
★	Caution	Special technical precautions or other precautions for preserving standards are necessary when performing the work.
	Weight	Weight of parts of systems. Caution necessary when selecting hoisting wire, or when working posture is important, ect.
	Tightening torque	Places that require special attention for the tightening torque during assembly.
	Coat	Places to be coated with adhesives and lubricants, etc.
	Oil, water	Places where oil, water or fuel must be added, and the capacity.
	Drain	Places where oil or water must be drained, and quantity to be drained.

HOISTING INSTRUCTIONS

HOISTING

> ⚠ Heavy parts (25 kg or more) must be lifted with a hoist, etc. In the **DISASSEMBLY AND ASSEMBLY** section, every part weighing 25 kg op mroe is indicated with the symbol

- If a part cannot be smootlhy removed from the machine by hoisting, the following checks should be made:
  1) Check for removal of all bolts fastening the part to the relative parts.
  2) Check for existence of another part causing interference with the part to be removed.

WIRE ROPES

1) Use adequate ropes depending on the weight of parts to be hoisted, referring to the table below:

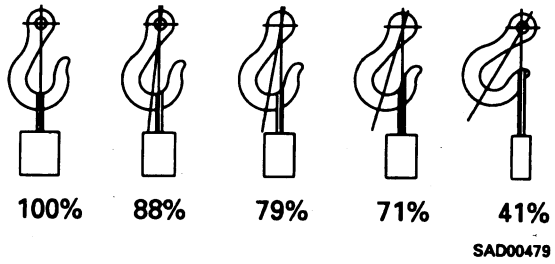
Wire ropes
(Standard "Z" or "S" twist ropes
without galvanizing

Rope diameter (mm)	Allowable load (tons)
10	1.0
11.2	1.4
12.5	1.6
14	2.2
16	2..8
18	3.6
20	4.4
22.4	5.6
30	10.0
40	18.0
50	28.0
60	40.0

★ The allowable load value is estimated to be one-sixth or one-seventh of the breaking strength of the rope used.

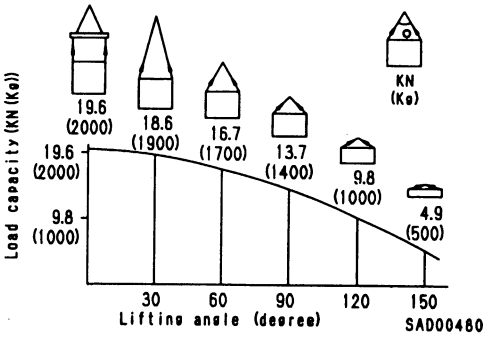
2) Sling wire ropes from the middle portion of the hook.

Slinging near the edge of the hook may cause the rope to slip off the hook during hoisting, and a serious accident can result. Hooks have a maximum strength at the middle portion.



3) Do not sling a heavy load with one rope alone, but sling with two or more ropes symmetrically wound onto the load.
   ⚠ Slinging with one rope may cause turning of the load during hoisting, untwisting of the rope, or slipping of the rope from its original winding position on the load, which can result in a dangerous accident.

4) Do not sling a heavy load with ropes forming a wide hanging angle from the hook. When hoisting a load with two or more ropes, the force subjected to each rope will increase with the nahging angles. The table below shows the variation of allowable load (kg) when hoisting is made with two ropes, each of which is allowed to sling up to 1000 kg vertically, at various hanging angles.
   When two ropes sling a load vertically, up to 2000 kg of total weight can be suspended. This weight becomes 1000 kg when two ropes make a 120° hanging angle. On the other hand, two ropes are subjected to an excessive force as large as 4000 kg if they sling a 2000 kg load at a lifting angle of 150°.



COATING MATERIALS

The recommended coating materials prescribed in Komatsu Shop Manuals are listed below.

Category	Komatsu code	Part No.	Q'ty	Container	Main applications, features
Adhesive	LT-1A	790-129-9030	150 g	Tube	• Used to prevent rubber gaskets, rubber cushions, and cork plugs from coming out
	LT-1B	790-129-9050	20 g (x2)	Plastic container	• Used in places requiring an immediately effective, strong adhesive. Used for plastics (except polyethylene, polyprpylene, tetrafluoroethylene and vinyl chloride), rubber, metal, and non-metal.
	LT-2	09940-00030	50 g	Plastic container	• Features: resistance to heat, chemicals • Used for anti-lossening and sealant purposes for bolts and plugs
	LT-3	790-129-9060 (Set of adhesive and hardening agent)	Adhesive : 1 kg Hardening agent : 500 g	Can	• Used as adhesive or sealant for metal, glass, plastic
	LT-4		250 g	Plastic container	• Used as sealant for machined holes
	(Loctite 648-50)	790-129-9040	50 cc	-	• Features: Resistance to heat, chemicals • Used at joint portions subject to high temperature
Gasket sealant	LG-1	79A-129-9110	200 g	Tube	• Used as adhesive or sealant for gaskets and packings of power train case, etc.
	LG-3	790-129-9070	1kg	Can	• Features: Resistance to heat • Used as sealant for flange surfaces and bolts at high temperature locations, used te prevent seizure • Used as sealant for heat resistant gasket for high temperature locations such as engine precombustion chamber, exhaust pipe
	LG-4	790-120-9020	200 g	Tube	• Features: Resistance to water, oil • Used as sealant for flange surface, thread • Aiso possible to use as sealant for flanges with large clearance • Used as sealant for mating surfaces of final drive case, transmission case.
	LG-5	790-129-9080	1 kg	Plastic container	• Used as sealant for various threads, pipe joints, flanges • Used as sealant for tapered plugs, elbows, nipples of hydraulic piping
	LG-6	09940-00011	250 g	Tube	• Features: Silicon based, resistance to heat, cold • Used as sealant for flange surface, thread • Used as sealant for oil pan, final drive case, etc.
	LG-7	09920-00150	150 g	Tube	• Features: Silicon based, quick hardening type • Used as sealant fo rflywheel housing, intake manifold, oil pan, thermostat housing, etc.
Rust prevention lubricant	-	09940-00051	60 g	Can	• Used as lubricant for sliding parts (to prevent squeaking)
Molybdenum disulphide lubricant	-	09940-00040	200 g	Tube	• Used to prevent seizure or scuffing of the thread when presss fitting or shrink fitting • Used as lubricant for linkage, bearings, etc.
Lithium grease	G2-LI	SYG350LI SYG-400LI SYG-400LI-A SYG-160LI SYGA-160CNLI	Various	Various	• General purpose type
Calcium grease	G2-CA	SSG2-400CA SYG2-350CA SYG2-400CA-A SYG2-160CA SYGA-16NCA	Various	Various	• Used for normal temperature, light load bearing at places in contact with water or steam
Molybdenum disulphide grease	-	SYG2-400M	400 g (10 per case)	Bellows type	• Used for places with heavy load

STANDARD TIGHTENING TORQUE

STANDARD TIGHTENING TORQUES OF BOLTS AND NUTS

The following charts give the standard tightening torques of bolts and nuts. Exceptions are given in section of **DISASSEMBLY AND ASSEMBLY.**

1 Kgm = 9.806 Nm

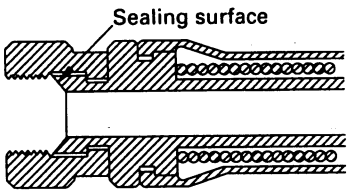
Thread diameter of bolt	Width across flats	 SAD00481	 SAD00482
mm	mm	kgm	Nm
6	10	1.35 ± 0.15	13.2 ± 1.4
8	13	3.2 ± 0.3	31.4 ± 2.9
10	17	6.7 ± 0.7	65.7 ± 6.8
12	19	11.5 ± 1.0	112 ± 9.8
14	22	18.0 ± 2 .0	177 ± 19
16	24	28.5 ± 3	279 ± 29
18	27	39 ± 4	383 ± 39
20	30	56 ± 6	549 ± 58
22	32	76 ± 8	745 ± 78
24	36	94.5 ± 10	927 ± 98
27	41	135 ± 15	1320 ± 140
30	46	175 ± 20	1720 ± 190
33	50	225 ± 25	2210 ± 240
36	55	280 ± 30	2750 ± 290
39	60	335 ± 25	3280 ± 340

★ This torque table does not apply to the bolts with nylon packaging or other nonferrous metal washers are to be used, or which require tightening to otherwise specified torque.

TIGHTENING TORQUE OF SPLIT FLANGE BOLTS

Use these torques for split flange bolts.

Thread daimeter of bolt	Width across flats	Tightening torque	
mm	mm	kgm	Nm
10	14	6.7 ± 0.7	65.7 ± 6.8
12	17	11.5 ± 1	112 ± 9.8
16	22	28.5 ± 3	279 ± 29



SAD00483

TIGHTENING TORQUE FOR FLRED NUTS

Use these torques for flared part of nut.

Thread daimeter of bolt	Width across flats	Tightening torque	
mm	mm	kgm	Nm
14	19	2.5 ± 0.5	24.5 ± 4.9
18	24	5 ± 2	49 ± 19.6
22	27	8 ± 2	78.5 ± 19.6
24	32	14 ± 3	137.3 ± 29.4
30	36	18 ± 3	176.5 ± 29.4
33	41	20 ± 5	196.1 ± 49
36	46	25 ± 5	245.2 ± 49
42	55	30 ± 5	294.2 ± 49

ELECTRIC WIRE CODE

In the wiring diagrams, various colors and symbols are employed to indicate the thickness of wires. This wire code table will help you understand WIRING DIAGRAMS.
Example: 5WB indicates a cable having a nominale number 5 and white coating with black stripe.

CLASSIFICATION BY THICKNESS

Nominal number	Copper wire			Cable O.D. (mm)	Current rating (A)	Applicable circuit
	Number of strands	Dia. of strands (mm)	Cross section (mm2)			
0.85	11	0.32	0.88	2.4	12	Starting, lighting, signal etc.
2	26	0.32	2.09	3.1	20	Lighting, signal etc.
5	65	0.32	5.23	4.6	37	harging and signal
15	84	0.45	13.36	7.0	59	Starting (Glow plug)
40	85	0.80	42.73	11.4	135	Starting
60	127	0.80	63.84	13.6	178	Starting
100	217	0.80	109.1	17.6	230	Starting

CLASSIFICATION BY COLOR AND CODE

Priority	Classification \ Circuits		Charging	Ground	Starting	Lighting	Instrument	Signal	Other
1	Primary	Code	W	B	B	R	Y	G	L
		Color	White	Black	Black	Red	Yellow	Green	Blue
2	Auxiliary	Code	WR	-	BW	RW	YR	GW	LW
		Color	White & Red	-	Black & White	Red & White	Yellow & Red	Green & White	Blue & White
3		Code	WB	-	BY	RB	YB	GR	LR
		Color	White & Black	-	Black & Yellow	Red & Black	Yellow & Black	Green & Red	Blue & Red
4		Code	WL	-	BR	RY	YG	GY	LY
		Color	White & Blue	-	Black & Red	Red & Yellow	Yellow & Green	Green & Yellow	Blue & Yellow
5		Code	WG	-	-	RG	YL	GB	LBB
		Color	White & Green	-	-	Red & Green	Yellow & Blue	Green & Black	Blue & Black
6		Code	-	-	-	RL	YW	GL	-
		Color	-	-	-	Red & Blue	Yellow & White	Green & Blue	-

CONVERSION TABLE

METHOD OF USING THE CONVERSION TABLE

The Conversion Table in this section is provided to enable simple conversion of figures. For details of the method of using the Conversion Table, see the example given below.

EXAMPLE

- Method of using the Conversion Table to convert from millimeters to inches

1. Convert 55 mm to inches
   (1) Locate the number 50 in the vertical column at the left side, take this as Ⓐ, then draw a horizontal line from Ⓐ.
   (2) Locate the number 5 in the row across the top, take this as Ⓑ, then draw a perpendicular line down from Ⓑ.
   (3) Take the point where the two lines cross as Ⓒ. This pint Ⓒ gives the value when converting from millimeters to inches. Therefore, 55mm = 2.165 inches.

2. Convert 550 mm into inches.
   (1) The nuber 550 does not appear in the table, so divide by 10 (move the decimal point one place to the left) to convert it to 55 mm.
   (2) Carry out the same procedure as above to convert 55 mm to 2.165 inches.
   (3) The original value (550 mm) was divided by 10, so multiply 2.165 inches by 10 (move the decimal point one place to the right) to return to the orginal value. This gives 550 mm = 21.65 inches.

Millimeters to inches 1 mm = 0.03937 in

	0	1	2	3	4	5 Ⓑ	6	7	8	9
0	0	0.039	0.079	0.118	0.157	0.197	0.236	0.276	0.315	0.354
10	0.394	0.433	0.472	0.512	0.551	0.591	0.630	0.669	0.709	0.748
20	0.787	0.827	0.866	0.906	0.945	0.984	1.024	1.063	1.102	1.142
30	1.181	1.220	1.260	1.299	1.339	1.378	1.417	1.457	1.496	1.536
40	1.575	1.614	1.654	1.693	1.732	1.772	1.811	1.850	1.890	1.929
Ⓐ 50	1.969	2.008	2.047	2.087	2.126	Ⓒ 2.165	2.205	2.244	2.283	2.323
60	2.362	2.402	2.441	2.480	2.520	2.559	2.598	2.638	2.677	2.717
70	2.756	2.795	2.385	2.874	2.913	2.953	2.992	3.032	3.071	3.110
80	3.150	3.189	3.228	3.268	3.307	3.346	3.386	3.425	3.465	3.504
90	3.543	3.583	3.622	3.661	3.701	3.740	3.780	3.819	3.858	3.898

Millimeters to Inches

1 mm = 0.03937 in

	0	1	2	3	4	5	6	7	8	9
0	0	0.039	0.079	0.118	0.157	0.197	0.236	0.276	0.315	0.354
10	0.394	0.433	0.472	0.512	0.551	0.591	0.630	0.669	0.709	0.748
20	0.787	0.827	0.866	0.906	0.945	0.984	1.024	1.063	1.102	1.142
30	1.181	1.220	1.260	1.299	1.339	1.378	1.417	1.457	1.496	1.536
40	1.575	1.614	1.654	1.693	1.732	1.772	1.811	1.850	1.890	1.929
50	1.969	2.008	2.047	2.087	2.126	2.165	2.205	2.244	2.283	2.323
60	2.362	2.402	2.441	2.480	2.520	2.559	2.598	2.638	2.677	2.712
70	2.756	2.795	2.835	2.874	2.913	2.953	2.992	3.032	3.071	3.110
80	3.150	3.189	3.228	3.268	33.07	3.346	3.386	3.425	3.465	3.504
90	3.543	3.583	3.622	3.661	3.701	3.740	3.780	3.819	3.858	3.898

Kilogram to Pound

1kg = 2.2046 lb

	0	1	2	3	4	5	6	7	8	9
0	0	2.20	4.41	6.61	8.82	11.02	13.23	15.43	17.64	19.84
10	22.05	24.25	26.46	28.66	30.86	33.07	35.27	37.48	39.68	41.89
20	44.09	46.30	48.50	50.71	51.91	55.12	57.32	59.53	61.73	63.93
30	66.14	68.34	70.55	72.75	74.96	77.16	79.37	81.57	83.78	85.98
40	88.18	90.39	92.59	94.80	97.00	99.21	101.41	103.62	105.82	108.03
50	110.23	112.44	114.64	116.85	119.05	121.25	123.46	135.66	127.87	130.07
60	132.28	134.48	136.69	138.89	141.10	143.30	145.51	147.71	149.91	152.12
70	154.32	156.53	158.73	160.94	163.14	165.35	167.55	169.76	171.96	174.17
80	176.37	178.57	180.78	182.98	185.19	187.39	189.60	191.80	194.01	196.21
90	198.42	200.62	202.03	205.03	207.24	209.44	211.64	213.85	216.05	218.26

Litre to U.S. Gallon

1ℓ = 0.2642 U.S. Gal

	0	1	2	3	4	5	6	7	8	9
0	0	0.264	0.528	0.793	1.057	1.321	1.585	1.849	2.113	2.378
10	2.642	2.906	3.170	3.434	3.698	3.963	4.227	4.491	4.755	5.019
20	5.283	5.548	5.812	6.076	6.3340	6.604	6.869	7.133	7.397	7.661
30	7.925	8.189	8.454	8.718	8.982	9.246	9.510	9.774	10.039	10.303
40	10.567	10.831	11.095	11.359	11.624	11.888	12.152	12.416	12.680	12.944
50	13.209	13.473	13.737	14.001	14.265	14.529	14.795	15.058	15.322	15.586
60	15.850	16.115	16.379	16.643	16.907	17.171	17.435	17.700	17.964	18.228
70	18.492	18.756	19.020	19.285	19.549	19.813	20.077	20.341	20.605	20.870
80	21.134	21.398	21.662	21.926	22.190	22.455	22.719	22.983	23.247	23.511
90	23.775	24.040	24.304	24.568	24.832	25.096	25.361	25.625	25.889	26.153

Litre to U.K. Gallon

1ℓ = 0.21997 U.K. Gal

	0	1	2	3	4	5	6	7	8	9
0	0	0.220	0.440	0.660	0.880	1.100	1.320	1.540	1.760	1.980
10	2.200	2.420	2.640	2.860	3.080	3.300	35.20	3.740	3.950	4.179
20	4.399	4.619	4.839	5.059	5.279	5.499	5.719	5.939	6.159	6379
30	6.599	6.819	7.039	7.259	7.479	7.969	7.919	8.139	8.359	8.579
40	8.799	9.019	9.239	9.459	9.679	9.899	10.119	10.339	10.559	10.778
50	10.998	11.281	11.438	11.658	11.878	12.098	12.318	12.528	12.758	12.978
60	13.198	13.418	13.638	13.858	14.078	14.298	14.518	14.738	14.958	15.178
70	15.398	15.618	15.838	16.058	16.278	16.498	16.718	16.938	17.158	17.378
80	17.598	17.818	18.037	18.257	18.477	18.697	18.917	19.137	19.357	19.577
90	19.797	20.017	20.237	20.457	20.677	20.897	21.117	21.337	21.557	21.777

kgm to ft. lb

1 kgm = 7.233 ft. lb

	0	1	2	3	4	5	6	7	8	9
0	0	7.2	14.5	21.7	28.9	36.2	43.4	50.6	57.9	65.1
10	72.3	79.6	86.8	94.0	101.3	108.5	115.7	123.0	130.2	137.4
20	144.7	151.9	159.1	166.4	173.6	180.8	188.1	195.3	202.5	209.8
30	217.0	224.2	231.5	238.7	245.9	253.2	260.4	267.6	274.9	282.1
40	289.3	296.6	303.8	311.0	318.3	325.5	332.7	340.0	347.2	354.4
50	361.7	368.9	376.1	383.4	390.6	397.8	405.1	412.3	419.5	426.8
60	434.0	441.2	448.5	455.7	462.9	470.2	477.4	484.6	491.8	499.1
70	506.3	513.5	520.8	528.0	535.2	542.5	549.7	556.9	564.2	571.4
80	578.6	585.9	593.1	600.3	607.6	614.8	622.0	629.3	636.5	643.7
90	651.0	658.2	665.4	672.7	679.9	687.1	694.4	701.6	708.8	716.1
100	723.3	730.5	737.8	745.0	752.2	759.5	766.7	773.9	781.2	788.4
110	795.6	802.9	810.1	817.3	824.6	831.8	839.0	846.3	853.5	860.7
120	868.0	875.2	882.4	889.7	896.9	904.1	911.4	918.6	925.8	933.1
130	940.3	947.5	954.8	962.0	969.2	976.5	983.7	990.9	998.2	1005.4
140	1012.6	1019.9	1027.1	1034.3	1041.5	1048.8	1056.0	1063.2	1070.5	1077.7
150	1084.9	1092.2	1099.4	1106.6	1113.9	1121.1	1128.3	1135.6	1142.8	1150.0
160	1157.3	1164.5	1171.7	1179.0	1186.2	1193.4	1200.7	1207.9	1215.1	1222.4
170	1129.6	1236.8	1244.1	1251.3	1258.5	1265.8	1273.0	1280.1	1287.5	1294.7
180	1301.9	1309.2	1316.4	1323.6	1330.9	1338.1	1245.3	1352.6	1359.8	1367.0
190	1374.3	1381.5	1388.7	1396.0	1403.2	1410.4	1417.7	1424.9	1432.1	1439.4

kg/cm² to lb/in²

1 kg/cm² = 14.2233 lb/in²

	0	1	2	3	4	5	6	7	8	9
0	0	14.2	28.4	42.7	56.9	71.1	85.3	99.6	113.8	128.0
10	142.2	156.5	170.7	184.9	199.1	213.4	227.6	241.8	256.0	270.2
20	284.5	298.7	312.9	327.1	341.4	355.6	369.8	384.0	398.3	412.5
30	426.7	440.9	455.1	469.4	483.6	497.8	512.0	526.3	540.5	554.7
40	568.9	583.2	597.4	611.6	625.8	640.1	654.3	668.5	682.7	696.9
50	711.2	725.4	739.6	753.8	768.1	782.3	796.5	810.7	825.0	839.2
60	853.4	867.6	881.8	896.1	910.3	924.5	938.7	953.0	967.2	981.4
70	995.6	1010	1024	1038	1053	1067	1081	1095	1109	1124
80	1138	1152	1166	1181	1195	1209	1223	1237	1252	1266
90	1280	1294	1309	1323	1337	1351	1365	1380	1394	1408
100	1422	1437	1451	1465	1479	1493	1508	1522	1536	1550
110	1565	1579	1593	1607	1621	1636	1650	1664	1678	1693
120	1707	1721	1735	1749	1764	1778	1792	1806	1821	1835
130	1849	1863	1877	1892	1906	1920	1934	1949	1963	1977
140	1991	2005	2020	2034	2048	2062	2077	2091	2105	2119
150	2134	2148	2162	2176	2190	2205	2219	2233	2247	2262
160	2276	2290	2304	2318	2333	2347	2361	2375	2389	2404
170	2418	2432	2446	2460	2475	2489	2503	2518	2532	2546
180	2560	2574	2589	2603	1617	2631	2646	2660	2674	2688
190	2702	2717	2731	2745	2759	2773	2788	2802	2816	2830
200	2845	2859	2873	2887	2901	2916	2930	2944	2958	2973
210	2987	3001	3015	3030	3044	3058	3072	3086	3101	3115
220	3129	3143	3158	3172	3186	3200	3214	3229	3243	3257
230	3271	3286	3300	3314	3328	3343	3357	4471	3385	3399
240	3414	3428	3442	3456	3470	3485	3499	3513	3527	3542

Temperature

Fahrenheit-Centigrade Conversion; a simple way to convert a Fahrenheit temperature reading into a Centigrade temperature reading or vice is to enter the accompanying table in the center or boldface column of figures. These figures refer to the temperature in either Fahrenheit or Centigrade degrees.

If it desired to convert from Fahrenheit to Centigrade degrees, consider the center column as a table of Fahrenheit temperatures and read the corresponding Centigrade temperature in the column at the left.

If it is desired to convert from Centigrade to Fahrenheit degrees, consider the center column as a table of Centigrade values, and read the corresponding Fahrenheit temperature on the right.

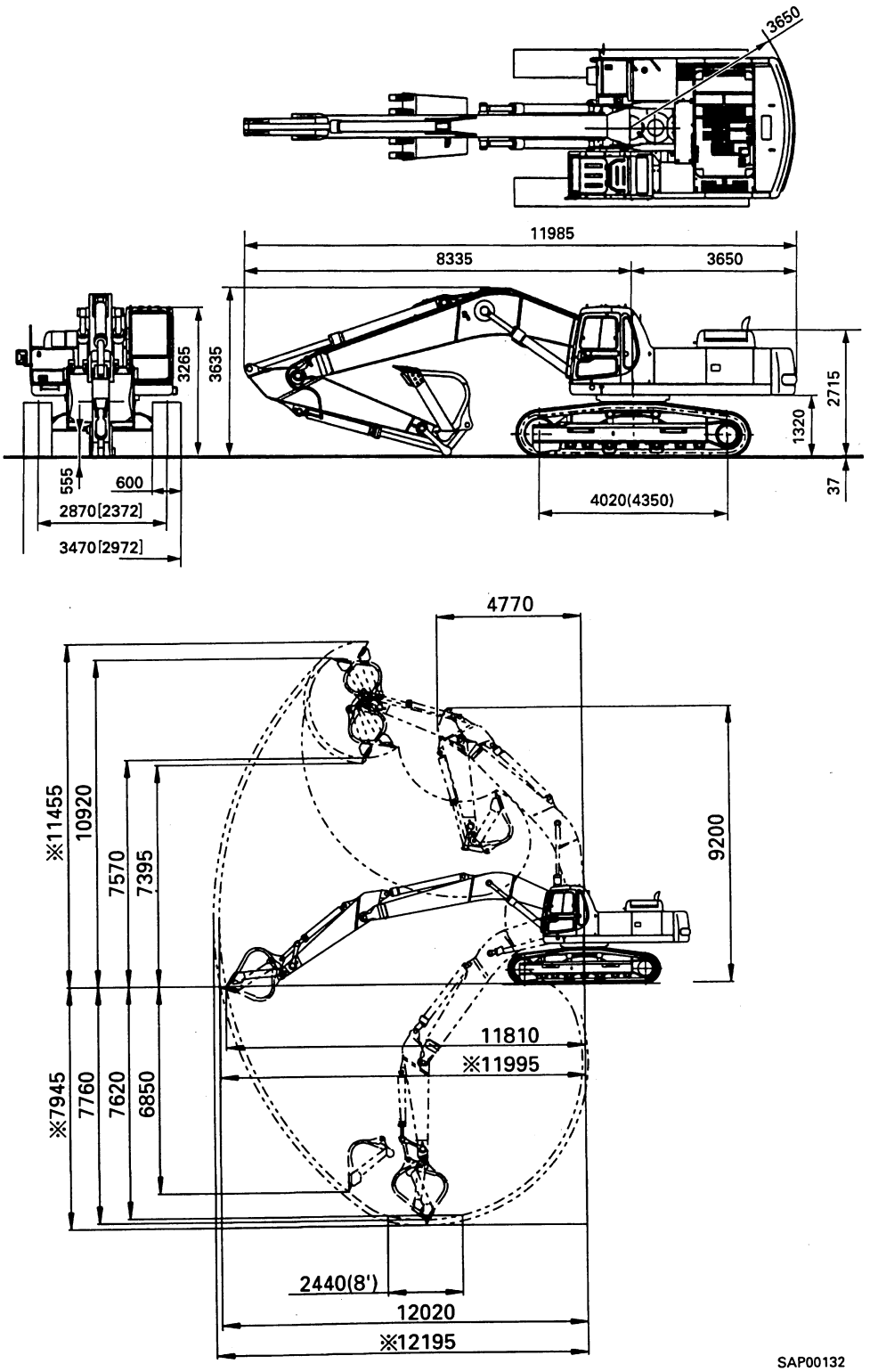
1°C = 33.8°F

°C		°F	°C		°F	°C		°F	°C		°F
-40.4	-40	-40.0	-11.7	11	51.8	7.8	46	114.8	27.2	81	117.8
-37.2	-35	-31.0	-11.1	12	53.6	8.3	47	116.6	27.8	82	179.6
-34.4	-30	-22.0	-10.6	13	55.4	8.9	48	118.4	28.3	83	181.4
-31.7	-25	-13.0	-10.0	14	57.2	9.4	49	120.2	28.9	84	183.2
-28.9	-20	-4.0	-9.4	15	59.0	10.0	50	122.0	29.4	85	185.0
-28.3	-19	-2.2	-8.9	16	60.8	10.6	51	123.8	30.0	86	186.8
-27.8	-18	-0.4	-8.3	17	62.6	11.1	52	125.6	30.6	87	188.6
-27.2	-17	1.4	-7.8	18	64.4	11.7	53	127.4	31.1	88	190.4
-26.7	-16	3.2	-7.2	19	66.2	12.2	54	129.2	31.7	89	192.2
-26.1	-15	5.0	-6.7	20	68.0	12.8	55	131.0	32.2	90	194.0
-25.6	-14	6.8	-6.1	21	69.8	13.3	56	132.8	32.8	91	195.8
-25.0	-13	8.6	-5.6	22	71.6	13.9	57	134.6	33.3	92	197.6
-24.4	-12	10.4	-5.0	23	73.4	14.4	58	136.4	33.9	03	199.4
-23.9	-11	12.2	-4.4	24	73.4	15.0	59	138.2	34.4	94	201.2
-23.3	-10	14.0	-3.9	25	75.2	15.6	60	140.0	35.0	95	203.0
-22.8	-9	15.8	-3.3	26	77.0	16.1	61	141.8	35.6	96	204.8
-22.2	-8	17.6	-2.8	27	78.8	16.7	62	143.6	36.1	97	206.6
-21.7	-7	19.4	-2.2	28	80.6	17.2	63	145.4	36.7	98	208.4
-21.1	-6	21.2	-1.7	29	82.4	17.8	64	147.2	37.2	99	210.2
-20.6	-5	23.0	-1.1	30	86.0	18.3	65	149.0	37.8	100	212.0
-20.0	-4	24.8	-0.6	31	87.8	18.9	66	150.8	40.6	105	221.0
-19.4	-3	26.6	0	32	89.6	19.4	67	152.6	43.3	110	230.0
-18.9	-2	28.4	0.6	33	91.4	20.0	68	154.4	46.1	115	239.0
-18.3	-1	30.2	1.1	34	93.2	20.6	69	156.2	48.9	120	248.0
-17.8	0	32.0	1.7	35	95.0	21.1	70	158.0	51.7	125	257.0
-17.2	1	33.8	2.2	36	96.8	21.7	71	159.8	54.4	130	266.0
-16.7	2	35.6	2.8	37	98.6	22.2	72	161.6	57.2	135	275.0
-16.1	3	37.4	3.3	38	100.4	22.8	73	163.4	60.0	140	284.0
-15.6	4	39.2	3.9	39	102.2	23.3	74	165.2	62.7	145	293.0
-15.0	5	41.0	4.4	40	104.0	23.9	75	167.0	65.6	150	302.0
-14.4	6	42.8	5.0	41	105.8	24.4	76	168.8	68.3	155	311.0
-13.9	7	44.6	5.6	42	107.6	25.0	77	170.6	71.1	160	320.0
-13.3	8	46.4	6.1	43	109.4	25.6	78	172.4	73.9	165	329.0
-12.8	9	48.2	6.7	44	111.2	26.1	79	174.2	76.7	170	338.0
-12.2	10	50.0	7.2	45	113.0	26.7	80	176.0	79.4	175	347.0

01 GENERAL

SPECIFICATION DRAWINGS

PC450, 450LC-6k



- The figures in ( ) indicate the PC450LC.
- The values marked ※ are for shovel operations.
- The figures in [ ] indicate the transport dimensions.

SPECIFICATIONS

				PC450-6k	PC450LC-6k
Machine model				PC450-6k	PC450LC-6k
Serial Number				K30001 and up	K30001 and up
Bucket capacity			(m3)	1.6	1.6
Operating weight			(kg)	43,060	44,200
Performance	Working ranges	Max. digging depth	(mm)	7,760	7,760
		Max. vertical wall depth	(mm)	6,850	6,850
		Max. digging reac	(mm)	12,020	12,020
		Max. reach at ground level	(mm)	11,810	11,810
		Max. digging height	(mm)	10,920	10,920
		Max. dumping height	(mm)	7,570	7,570
	Max. digging force (using power max. function)		(kN(kg))	224.4 (22,900)	224.4 (22,900)
	Swing speed		(rpm)	9.1	9.1
	Swing max. slope angel		(deg.)	20.0	20.0
	Travel speed		(km/h)	Lo: 3.2 Mi: 4.5 Hi: 5.5	Lo: 3.2 Mi: 4.5 Hi: 5.5
	Gradeability		(deg.)	35	35
	Ground pressure [standard triple grouser shoe width]		(MPa(kg/cm²))	0.079 (0.81) [600 mm]	0.064 (0.65) [700 mm]
Dimensions	Overall lenght (for transport)		(mm)	11,985	11,985
	Overall width		(mm)	3,470	3,470
	Overall width (for transport)		(mm)	2,995	2,995
	Overall width of track		(mm)	3,340	3,340
	Overall height (for transport)		(mm)	3,635	3,635
	Overall height to top of cab		(mm)	3,265	3,265
	Ground clearance of counterweight		(mm)	1,320	1,320
	Min. ground clearance		(mm)	555	555
	Tail swing radius		(mm)	3,650	3,650
	Min. swing radius of work equipment		(mm)	4,770	4,770
	Height of work equipment at min. swing radius		(mm)	9,200	9,200
	Length of track on ground		(mm)	4,020	4,350
	Track gauge		(mm)	2,870	2,870
	Track gauge (for transport)		(mm)	2,372	2,372
	Height of machine cab		(mm)	2,715	2,715

Machine model				PC450-6k	PC450LC-6k
Serial Number				K30001 and up	K30001 and up
Engine		Model MTA 11 Type		4-cycle, water-cooled, in-line, vertical, direct injection, with turbocharger and aftercooler (water cooled)	
		No. of cylinders - bore x stroke	(mm)	6 - 125 x 147	
		Piston displacement	(cc)	10,800	
	Performance	Flywheel horsepower	(kW(HP)/rpm)	228 (305.7)/1,900	
		Max. torque	(Nm(kgm)/rpm)	990 (100.9)/1,400	
		Max. speed at no load	(rpm)	2,100	
		Min. speed at no load	(rpm)	700	
		Min. fuel consumption	(g/kW.h(g/HP.h))	202 (149)	
	Starting motor			24V, 7.5 kW	
	Alternator			24V, 45A	
	Battery			12V, 160Ah x 2	
	Radiator core type			CWX-4	
Undercarriage	Carrier roller			2 on each side	2 on each side
	Track roller			7 on each side	7 on each side
	Track shoe			Assembly-type triple grouser	Assembly-type triple grouser
Hydraulic system	Hydraulic pump	Type x No.		Variable displacement piston type x 2; gear type x 1	
		Delivery	(ℓ/min)	Piston type: 315 x 2, gear type: 34	
		Set pressure	(MPa(kg/cm²))	Piston type: 34.8 (355), gear type: 2.9 (30)	
	Contral valve	Type x No.		6-spool + 1-spool type x 1	
		Control method		Hydraulic	
	Hydraulic motor	Travel motor		Piston type (with brake valve, shaft brake): x 2	
		Swing motor		Piston type (with safety valve, shaft brake): x 1	
	Hydraulic cylinder			Double-acting piston	
	Hydraulic tank			Box-shaped, sealed	
	Hydraulic filter			Tank return side	
	Hydraulic cooler			Air cooled	

WEIGHT TABLE

Unit: kg

Machine model	PC450-6	PC450LC-6
Serial Number	K30001 and up	K30001 and up
Engine assembly	1,429	1,429
• Engine	981	981
• Damper	14.7	14.7
• Hydraulic pump	210	210
Radiator, oil cooler assembly	185	185
Hydraulic tank, filter assembley (excl. hydraulic oil)	254	254
Fuel tank (excl. fuel)	235	235
Revolving frame	3,111	3,111
Operator's cab	287	287
Operator's seat	29	29
Counterweight	8,890	8,890
Swing machinery	535	535
Control valve (standard)	256	256
Swing motor	80	80
Travel motor	252 x 2	252 x 2
Center swivel joint	38	38
Track frame assembly:-		
600 mm shoe	15,180 (std)	15,520
700 mm shoe	16,358	16,698 (std)
800 mm shoe	16,808	17,148
• Track frame:-	6,905	7,209
Center frame	3,433	3,433
Frame (L.H.)	1,736	1,888
Frame (R.H.)	1,736	1,888
• Swing circle	605	605
• Idler	235	235
• Idler cushion	370 x 2	370 x 2
• Carrier roller	31 x 4	31 x 4
• Track roller	72 x 14	72 x 16
• Final drice (incl. travel motor)	788 x 2	788 x 2

Unit: kg

Machine model	PC450-6k	PC450LC-6k
Serial Number	K30001 and up	K30001 and up
Track shoe assembly		
Standard triple grouser shoe (600 mm)	4,420	4,720
Standard triple grouser shoe (700 mm)	4,840	5,160
Wide triple grouser shoe (800 mm)	5,280	5,620
Boom assembly	3,264	3,264
Arm assembly (with bucket cylinder and linkage)	2,120	2,120
Bucket assembly	1,300	1,300
Boom cylinder assembly	390 x 2	390 x 2
Arm cylinder assembly	555	555
Bucket cylinder assembly	345	345
Link assembly	394	394
Boom pin	92 + 20 x 2 + 86 + 27 + 54	92 + 20 x 2 + 86 + 27 + 54
Arm pin	17 + 23	17 + 23
Bucket pin	38 x 2	38 x 2
Link pin	34 x 2	34 x 2

FUEL, COOLANT AND LUBRICANTS

RESERVOIR Add antifreeze	KIND OF FLUID	AMBIENT TEMPERATURE -22 -4 -14 32 50 68 86 104°F -30 -20 -10 0 10 20 30 40°C	CAPACITY (ℓ)	
			Specified	Refill
Engine oil pan	Engine oil	SAE 30 SAE 10W SAE 10W-30 SAE 15W-40 SYNTHETIC 5W-30	44.7	42
Swing machinery case			21.5	21.5
Final drive case (each side)			12	11.5
Damper case			1.25	-
Idler (1 each)		SAE 30	0.34 - 0.36	0.34 - 0.36
Track roller (1 each)			0.28 - 0.31	0.28 - 0.31
Carrier roller (1 each)			0.45 - 0.50	0.45 - 0.50
Hydraulic system		SAE 10W SAE 10W-30 SAE 15W-40	370	270
	Hydraulic oil	H046-HM (★)		
Fuel tank	Diesel fuel	ASTM DG75 No. 2 ASTM D975A No. 1	605	-
Cooling system	Coolant	Add antifreeze	42.3	-

NOTE:

(1) When fuel sulphur content is less than 0.5%, change oil in the oil pan every periodic maintenance hours described in this manual.
Change oil according to the following table if fuel sulphur content is above 0.5%

Fuel sulphur content	Change interval of oil in engine oil pan
0.5 to 1.0%	1/2 of regular interval
Above 1.0%	1/4 of regular interval

(2) When starting the engine in an atmospheric temperature of lower than 0°C, be sure to use engine oil of SAE10W-30 and SAE15W-40, even though an atmospeheric temperature goes up to 10°C more or less in the day time.
(3) Use API classification CD as engine oil and if API classification CC, reduce the engine oil change interval to half.
(4) There is no problem if single grade oil is mixed with multigrade oil (SAE10W-30, 15W-40), but be sure to add single grade oil that matches the temperature in the table on the left.
(5) We recommende Komatsu genuine oil which has been specifically formulated and aproved for use in engine and hydraulic work equipment applications.

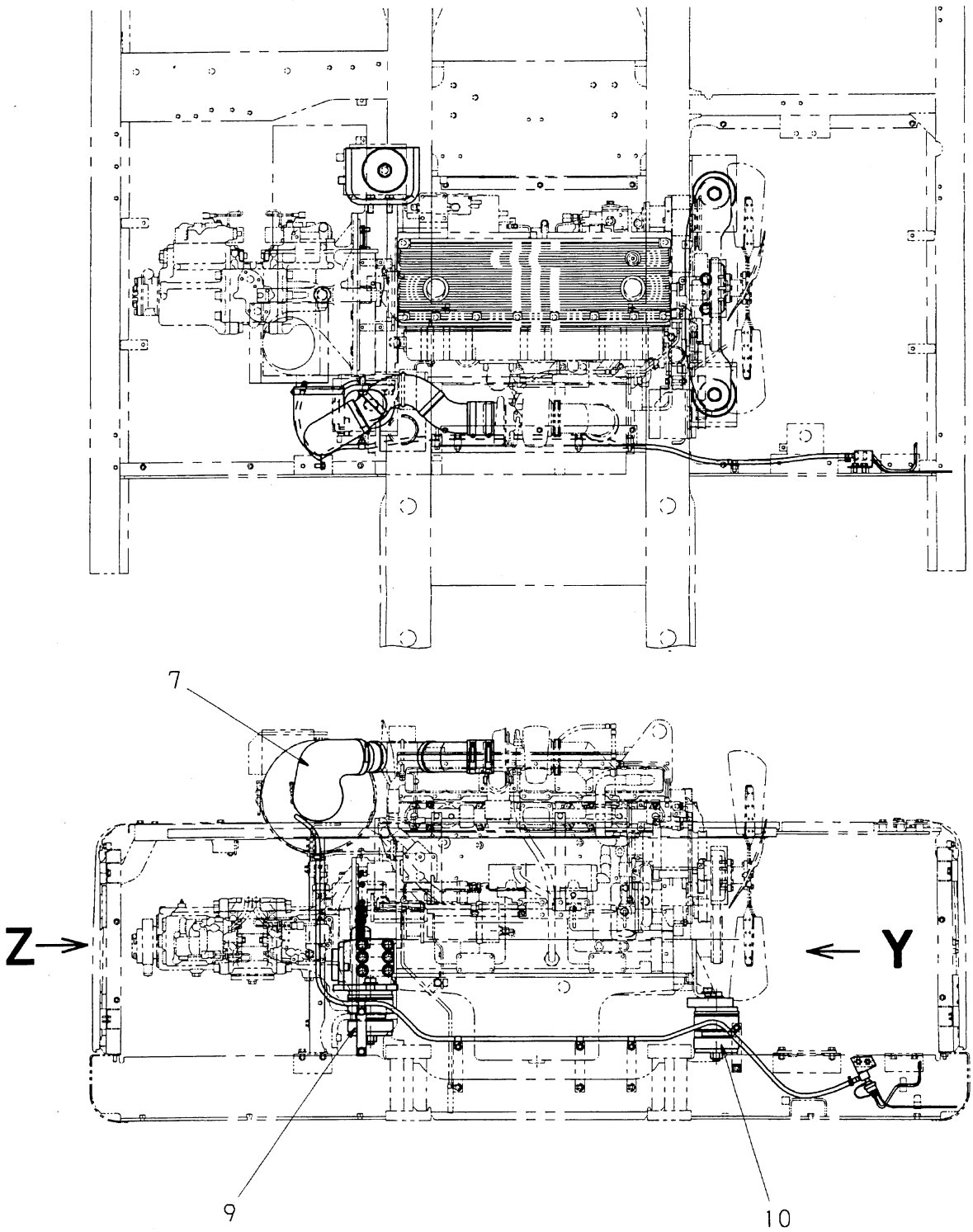
★ For the HO46-HM, use the oil recommended by Komatsu.

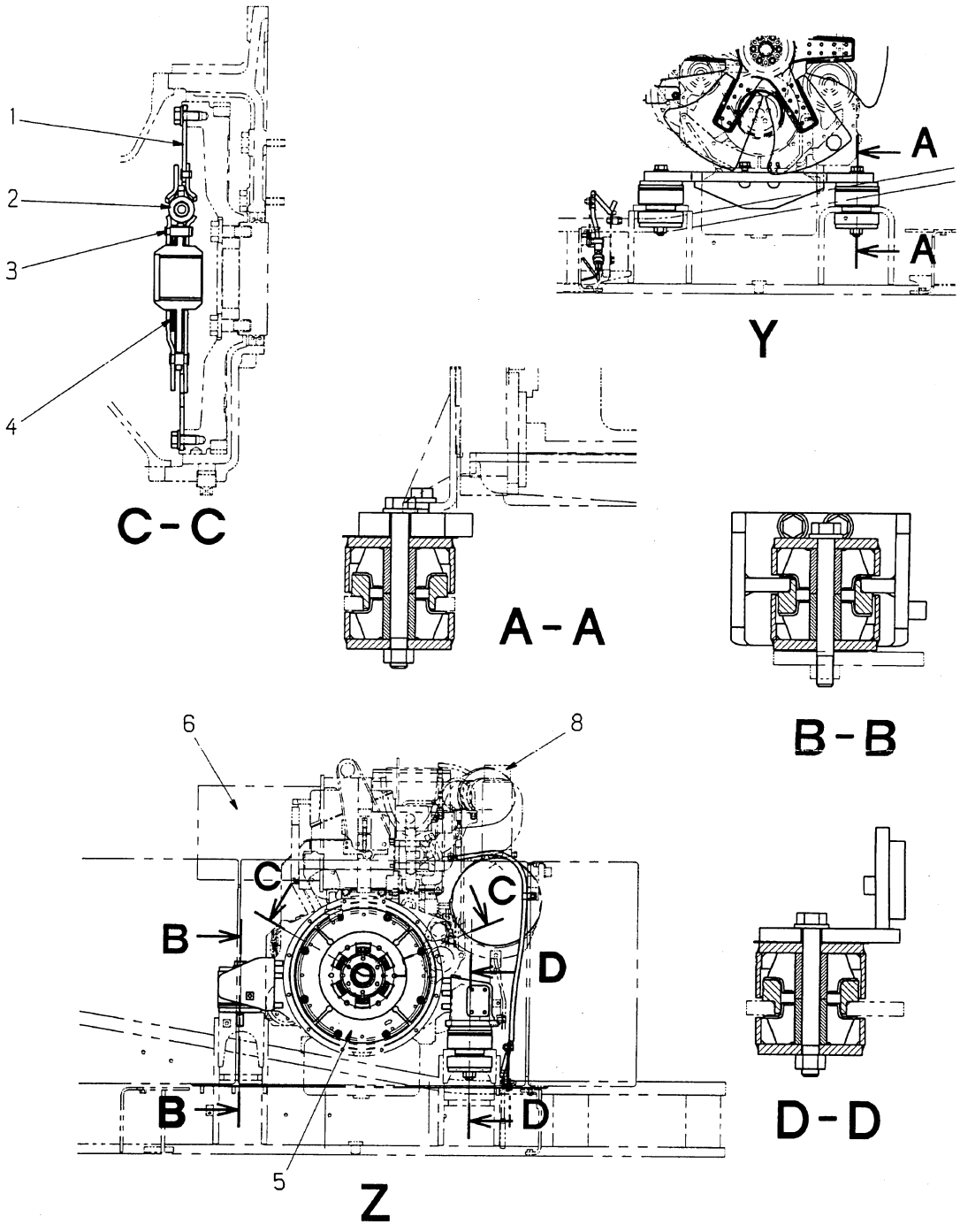
ASTM: American Society of Testing and Material
SAE: Society of Automotive Engineers
APA: American Petroleum Institute

Specified capacity: Total amount of oil including oil for components and oil in piping.
Refill capacity: Amount of oil needed to refill system during normal inspection and maintenance.

10 STRUCTURE AND FUNCTION

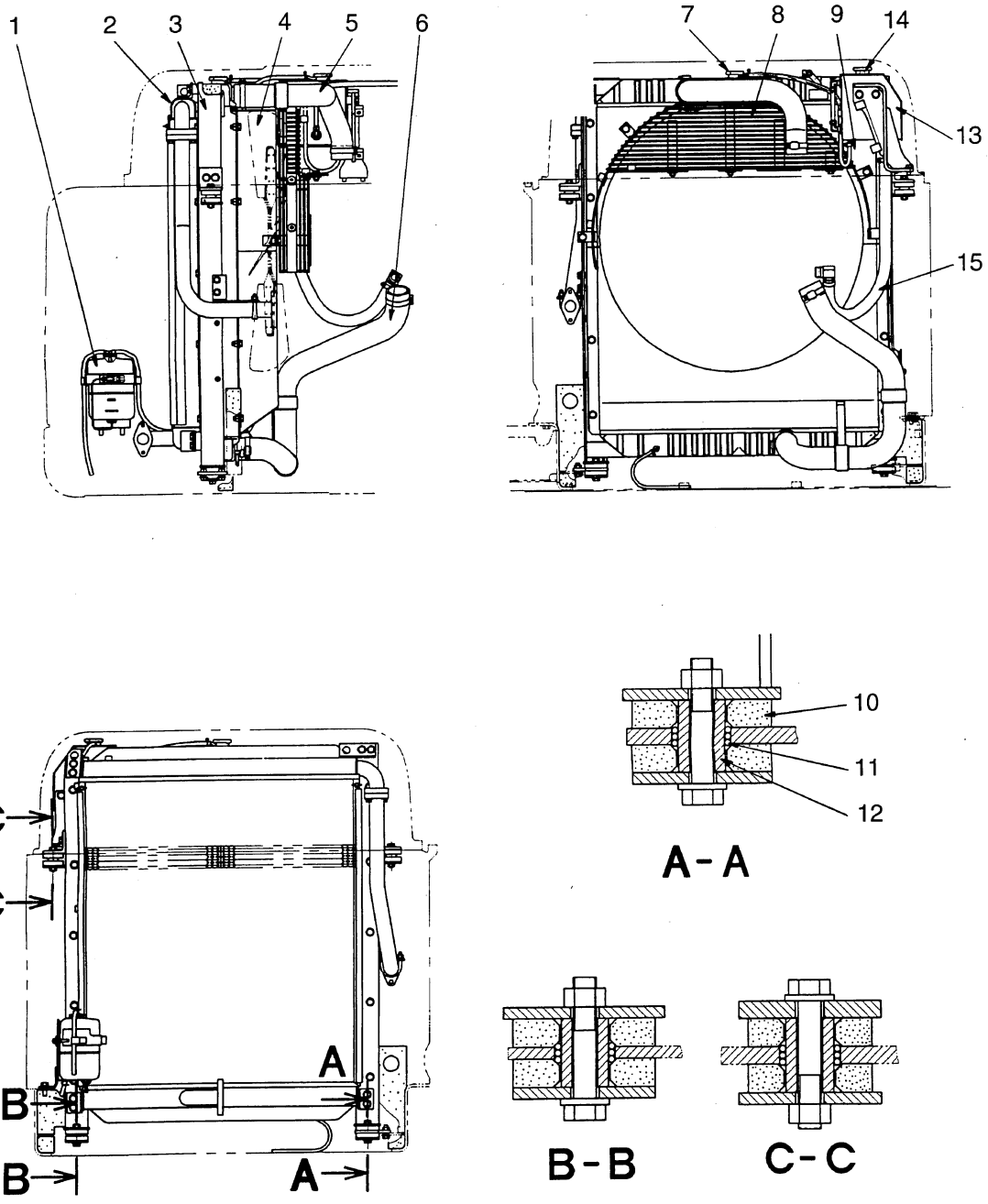
PARTS RELATED TO ENGINE





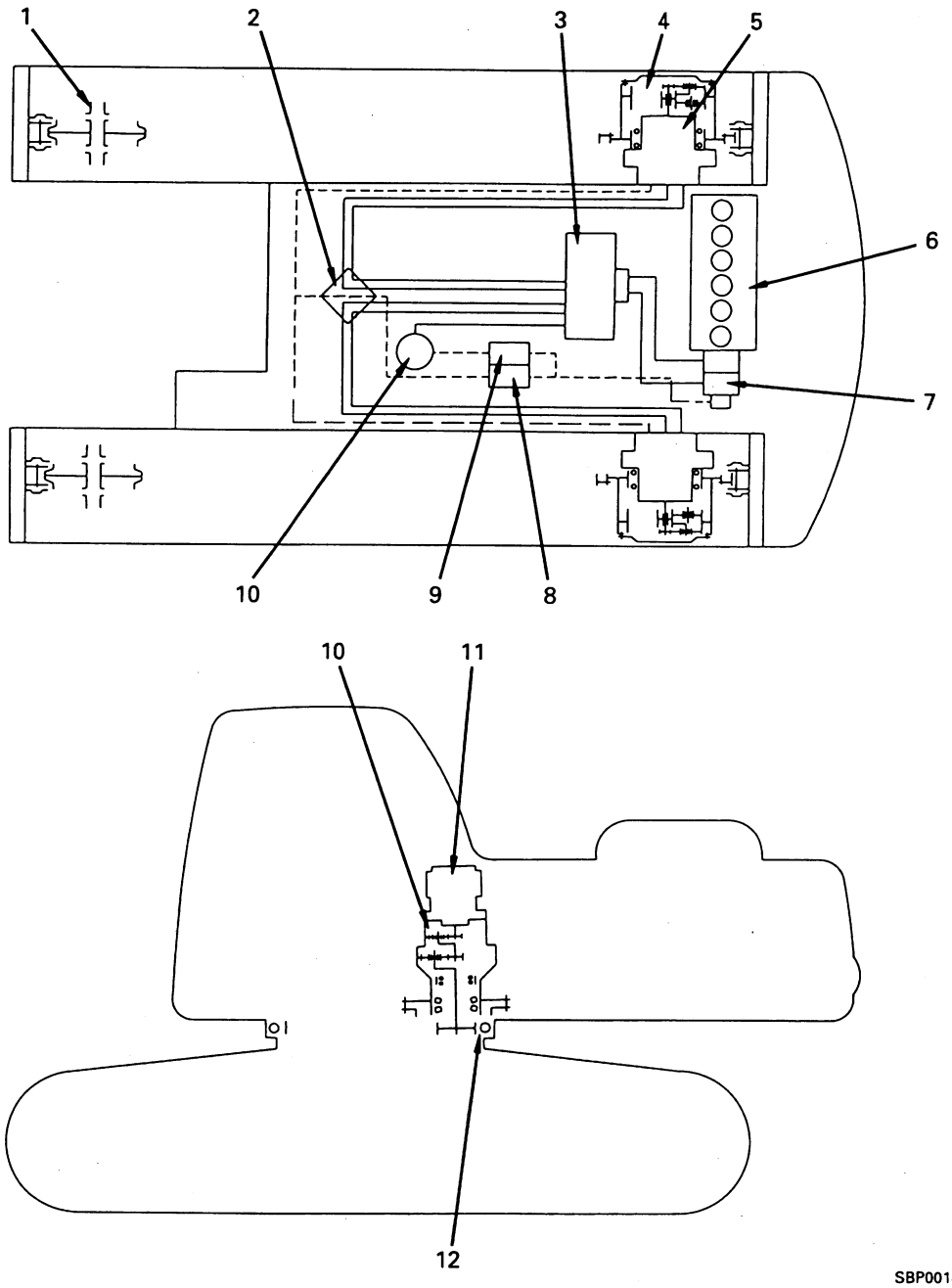
1. Drive plate
2. Torsion spring
3. Stopper spring
4. Friction plate
5. Damper assembly
6. Air cleaner
7. Intake connector
8. Muffler
9. Rear engine mount
10. Front engine mount

RADIATOR, OIL COOLER



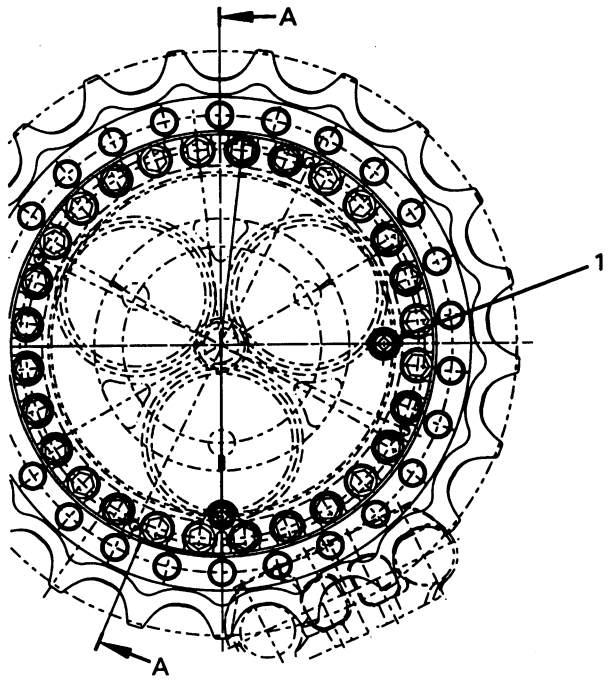
1. Reservoir tank
2. Oil cooler
3. Radiator
4. Fan
5. Radiator inlet hose
6. Radiator outlet hose
7. Radiator cap
8. Net
9. Shroud
10. Cushion
11. O-ring
12. Collar
13. Upper tank
14. Pressure cap
15. Make-up line

POWER TRAIN



1. Idler
2. Center swivel joint
3. Control valve
4. Final drive
5. Travel motor
6. Engine
7. Hydraulic pump
8. Travel speed solenoid valve
9. Swing brake solenoid valve
10. Swing machinery
11. Swing motor
12. Swing circle

FINAL DRIVE

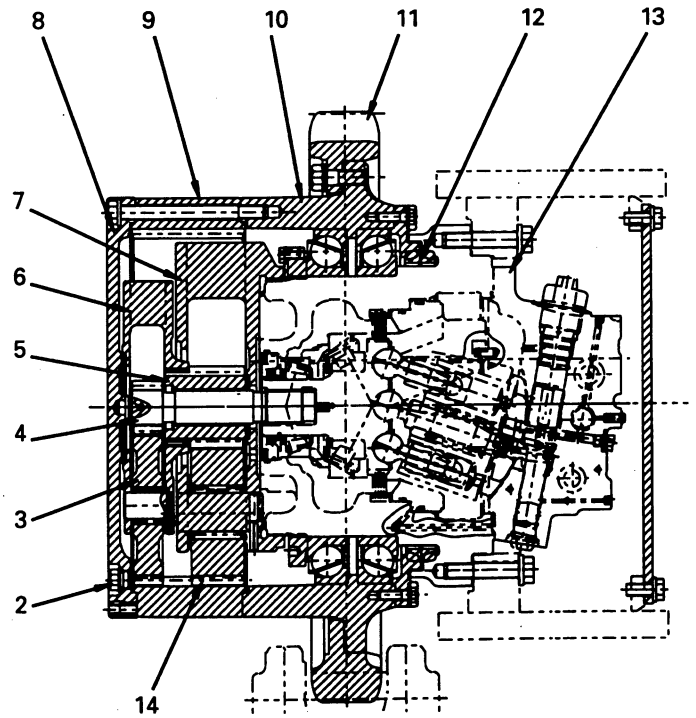


1. Level plug
2. Drain plug
3. No. 1 planetary gear (No. of teeth: 38)
4. No. 1 sun gear (No. of teeth: 10)
5. No. 2 sun gear (No. of teeth: 17)
6. No. 1 planetary carrier
7. No. 2 planetary carrier
8. Cover
9. Ring gear (No. of teeth: 83)
10. Hub
11. Sprocket
12. Floating seal
13. Travel motor
14. No. 2 planetary gear (No. of teeth: 32)

Specifications

Reduction ratio: $-\left(\frac{10+83}{10}\right) \times \left(\frac{17+83}{17}\right) +1$

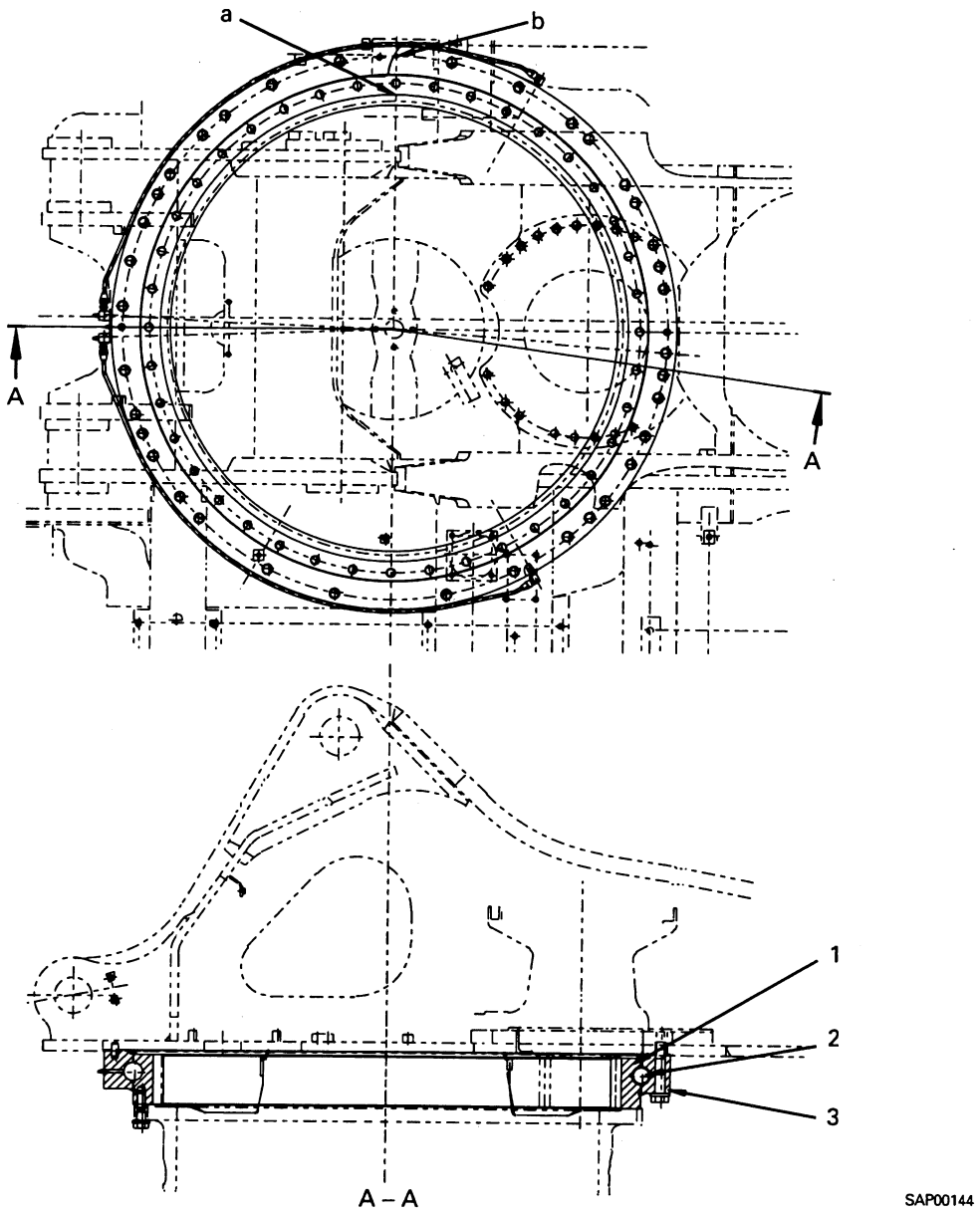
$= -53.706$



A–A

SAP00142

SWING CIRCLE



1. Swing circle inner race (No. of teeth: 90)
2. Ball
3. Swing circle outer race

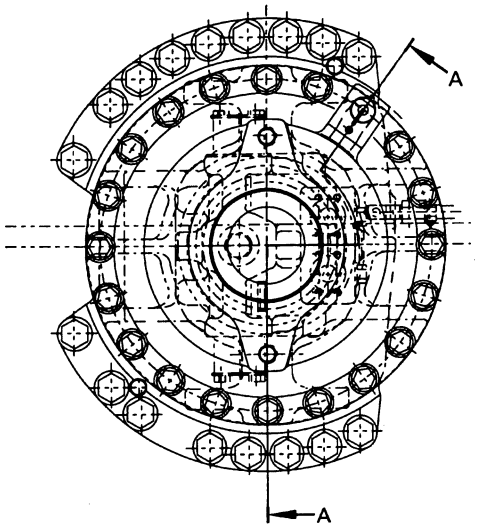
a. Inner race soft zone "S" position
b. Outer race soft zone "S" position

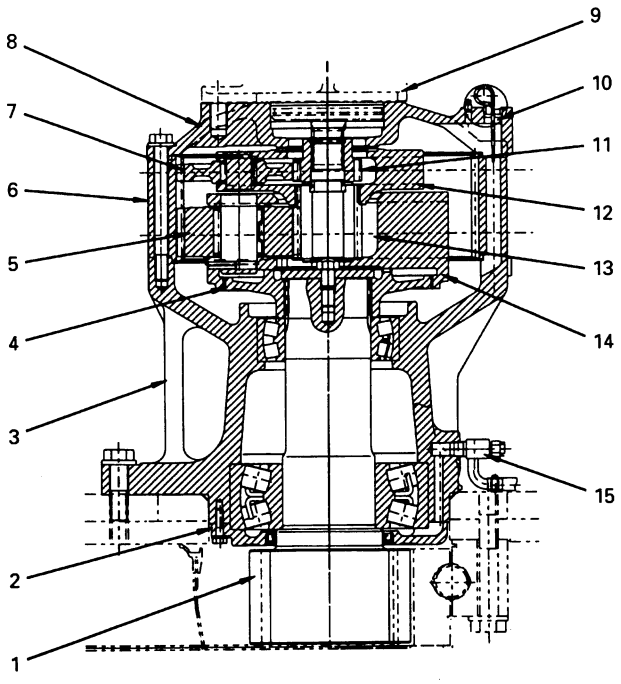
Specifications

Reduction ration: $-\frac{84}{13} = -6.462$

Amount of grease: 33 ℓ (G2-LI)

SWING MACHINERY





A–A

SAP00146

1. Swing pinion (No. of teeth: 13)
2. Cover
3. Case
4. Coupling
5. No. 2 planetary gear (No. of teeth: 35)
6. Ring gear (No. of teeth: 92)
7. No 1 planetary gear (No. of teeth: 35)
8. Cover
9. Swing motor
10. Oil level gauge
11. No. 1 sun gear (No. of teeth: 19)
12. No. 1 planetary carrier
13. No. 2 sun gear (No. of teeth: 19)
14. No. 2 planetary carrier
15. Drain plug

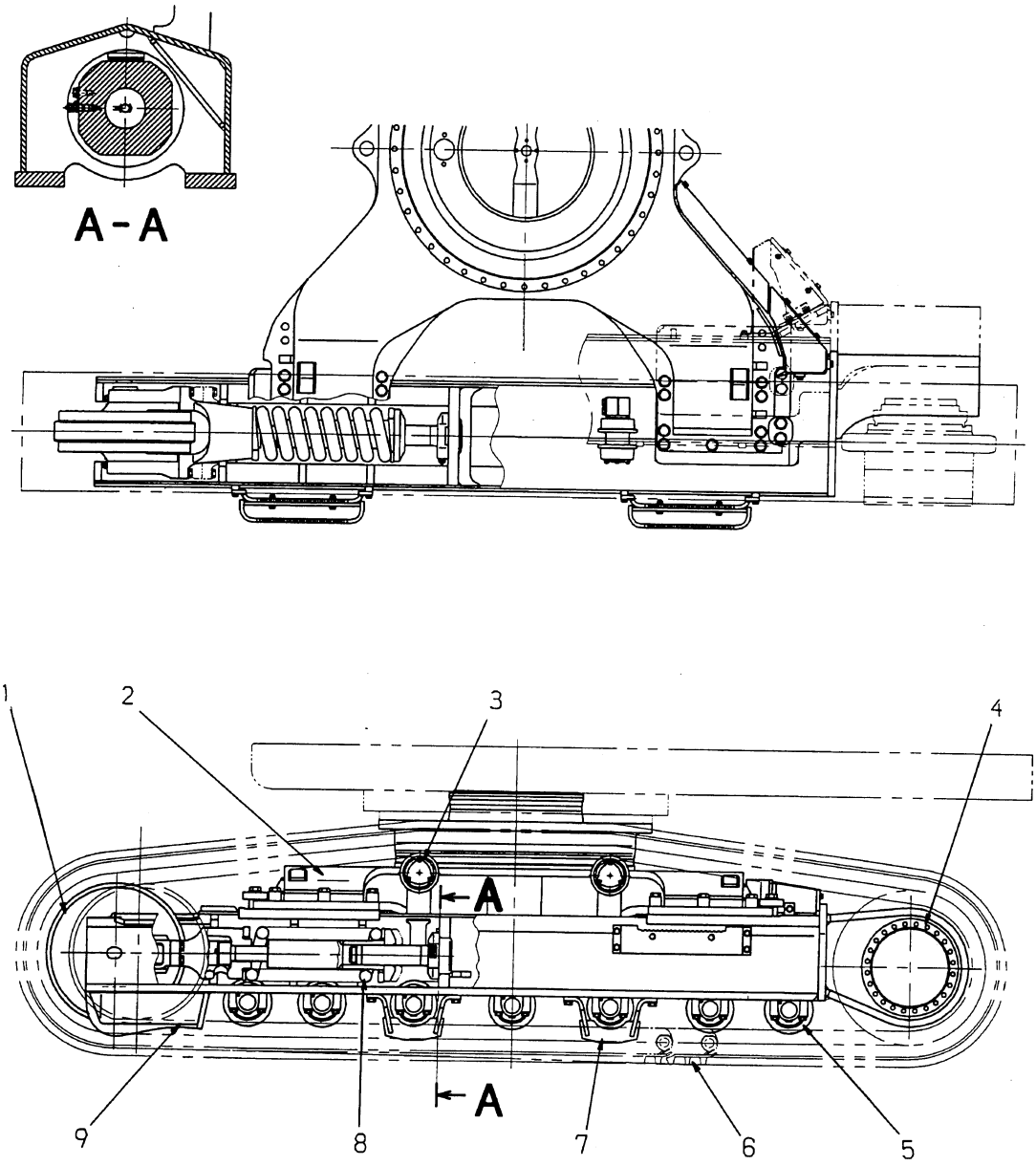
Specifications

Reduction ration: $\frac{19 + 92}{19} \times \frac{19+92}{19}$

= 34.130

TRACK FRAME, RECOIL SPRING

★ The diagram shows the PC450-6k



1. Idler
2. Track frame
3. Carrier roller
4. Final drive
5. Track roller
6. Track shoe
7. Center guard
8. Recoil spring
9. Front guard

- The dimensions and number of track rollers may differ according to the model, but the basic structure is the same.
- No. of track rollers.

Model	No. of rollers (each side)
PC450-6k	7
PC450LC-6k	8

TRACK SHOE

Standard shoe

Item \ Model	PC450-6k	PC450LC-6k
Shoe width (mm) (triple shoe)	600	700
Link pitch (mm)	228.6	228.6
No. of shoes (each side)	46	49

Selection of track shoe

- Select the most suitable track shoe from the following table

	PC450-6k		PC450LC-6k	
	Specifications	Category	Specifications	Category
Standard	600 mm triple	A	700 mm triple	B
Option	700 mm triple	B	600 mm triple	A
Option	800 mm triple	B	800 mm triple	B

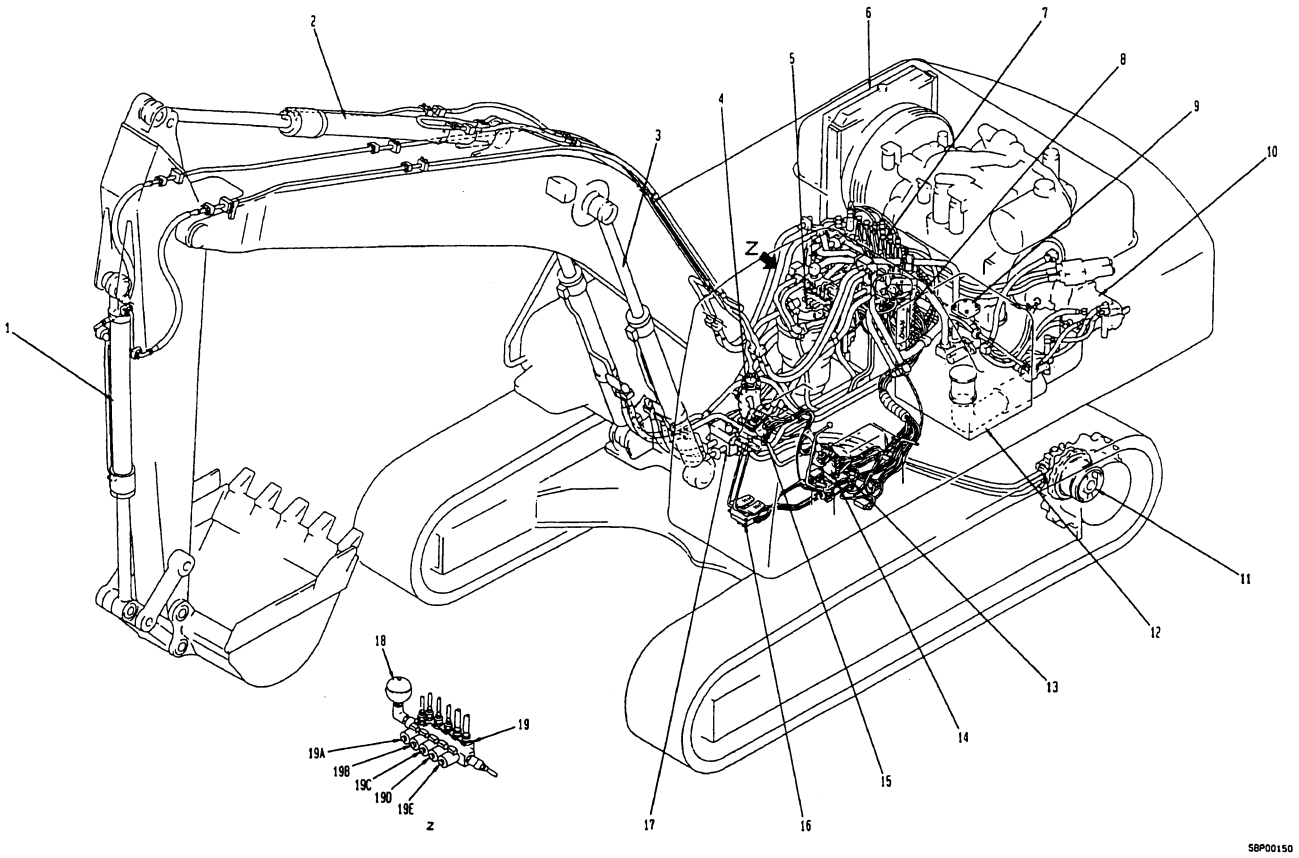
Category	Use	Precautions when using
A	Rocky ground, normal river soil	• Travel in Lo speed when traveling on rough ground with obstacles such as large boulders and fallen trees.
B	Normal soil, soft land	• Cannot be used on rough ground where there are large obstacles such as boulders and fallen trees. • Travel in Hi speed only on flat ground; when it is impossible to avoid traveling over obstacles, lower the travel speed to approx. half of Lo speed.
C	Extremely soft ground (swampy ground)	• Use only for ground wher "A" and "B" sink and are impossible to use. • Cannot be used on rough ground where ther are large obstacles such as boulders and fallen trees. • Travel in Hi speed only on flat ground; when it is impossible to avoid traveling over obstacles, lower the travel speed to approx. half of Lo speed.
D	Daved surface	• The shoes are flat, so they have low gradeability.
E	Paved surface	• The shoes are made of rubber, so be careful when traveling on rough ground.

★ Categories "B" and "C" are wide shoes, so there are restrictions on their use. Therefore, before using, check the restrictions and consider carefully the conditions of use before recommending a suitable shoe width. If necessary, give the customer guidance in their use.

★ When selecting the shoe width, select the narrowest shoe possible within the range that will give no problem with flotation and ground pressure.
If a wider shoe than necessary is used, there will be a large load on the shoe, and this may lead to bending of the shoe, cracking of the links, breakage of the pins, loosening of the shoe bolts, or other problems.

HYDRAULIC PIPING DRAWING

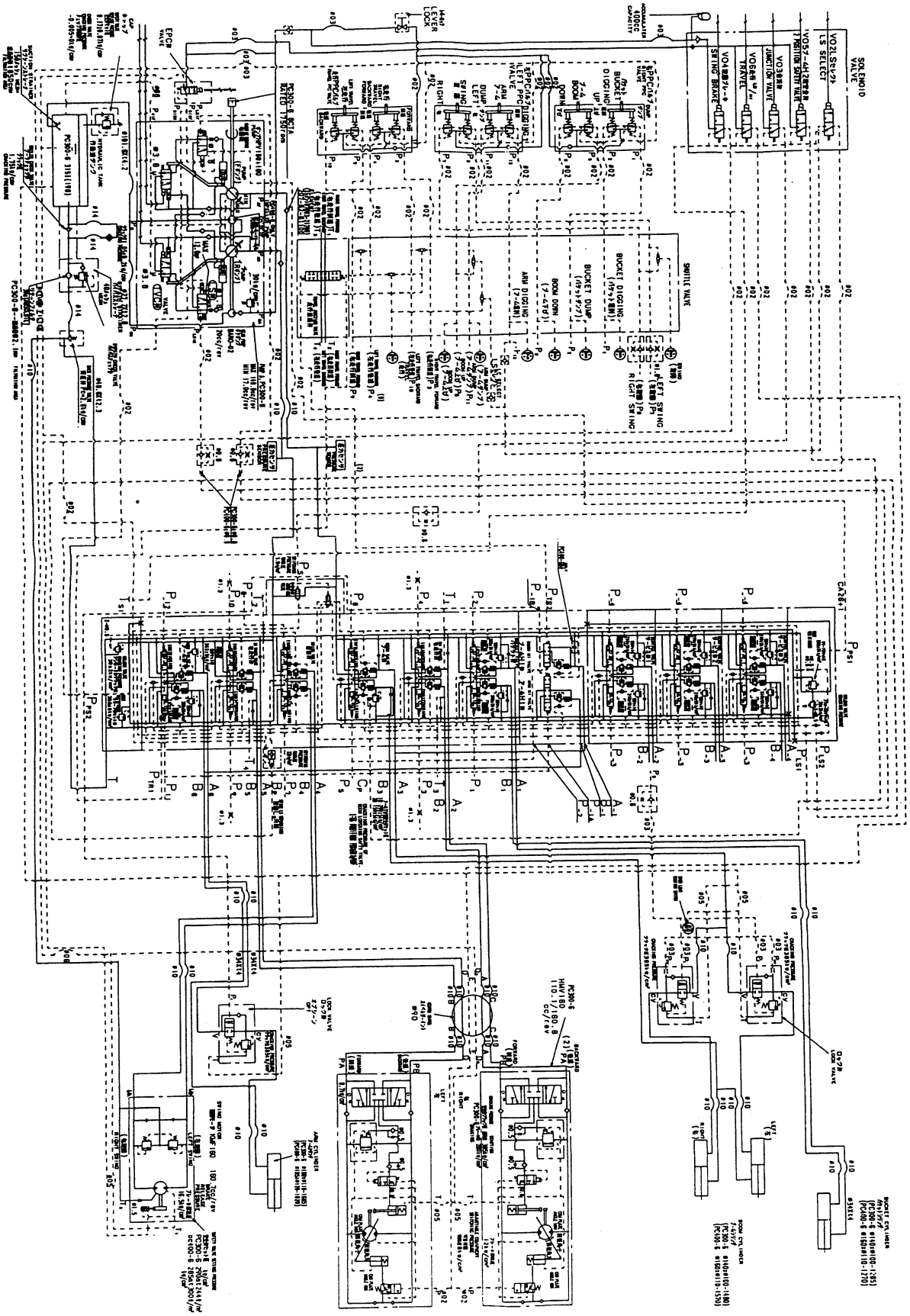
★ For details of this page, see Section 90.



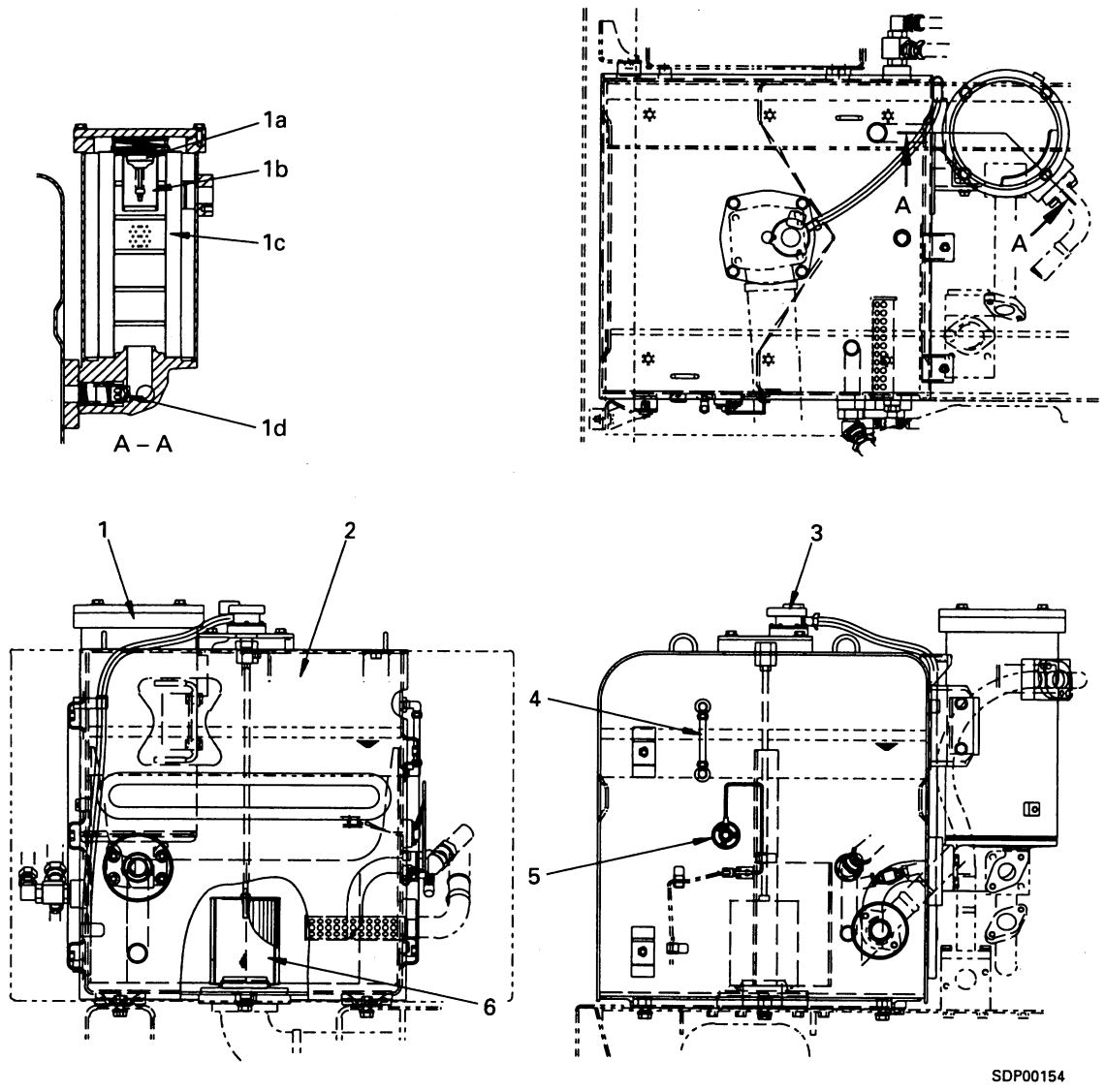
1. Bucket cylinder
2. Arm cylinder
3. Boom cylinder
4. Center swivel joint
5. Swing motor
6. Oil cooler
7. Control valve
8. PPC shuttle valve
9. Hydraulic filter
10. Hydraulic pump
11. L.H. travel motor
12. Hydraulic tank
13. PPC safety lock valve
14. L.H. PPC valve
15. R.H. PPC valve
16. Travel PPC valve
17. Boom holding valve
18. Accumulator
19. Solenoid valve assembly
    - 19A. LS selected solenoid valve
    - 19B. Boom Hi 2-stage safety solenoid valve
    - 19C. Pump merge/flow divider solenoid valve
    - 19D. Travel speed solenoid valve
    - 19E. Swing brake solenoid valve

HYDRAULIC CIRCUIT DIAGRAM

★ For details of this page, see Section 90.



HYDRAULIC TANK, HYDRAULIC FILTER



1. Hydraulic filter
   1a. Bypass valve
   1b. Strainer
   1c. Element
   1d. Cooler check valve
2. Hydraulic tank
3. Oil filter cap
4. Sight gauge
5. Hydraulic oil level sensor
6. Suction strainer

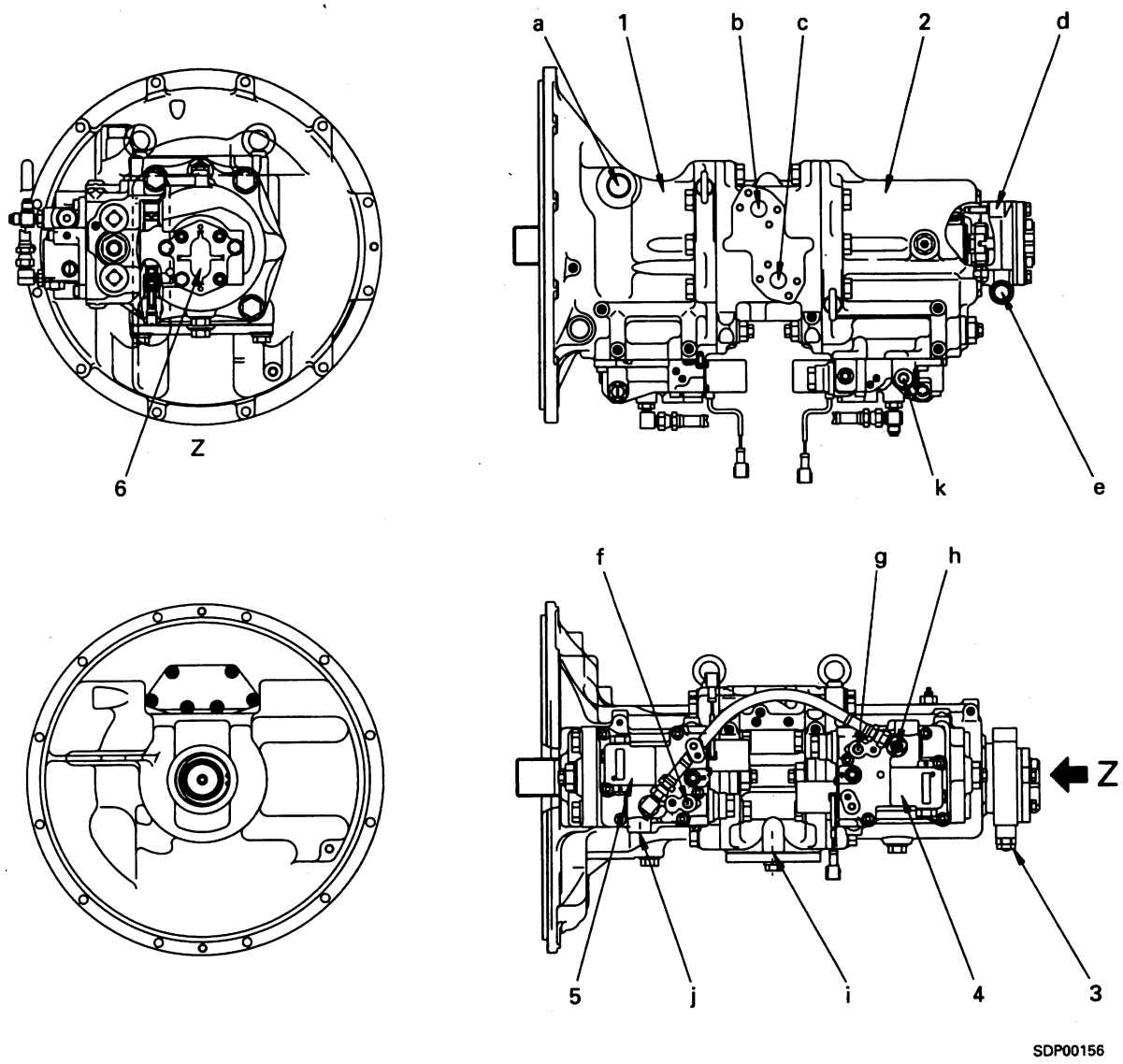
Specifications

Tank capacity: 358 ℓ
Amount of oil inside tank: 273 ℓ (at H level)

Safety valve

- Relief cracking pressure: 0.017 ± 0.007 MPa (0.17 ± 0.07 kg/cm²)
- Suction cracking pressure: 0 - 0.0005 MPa (0 - 0.005 kg/cm²)
- Bypass valve set pressure: 0.103 ± 0.02 MPa (1.05 ± 0.2 kg/cm²)

HYDRAULIC PUMP

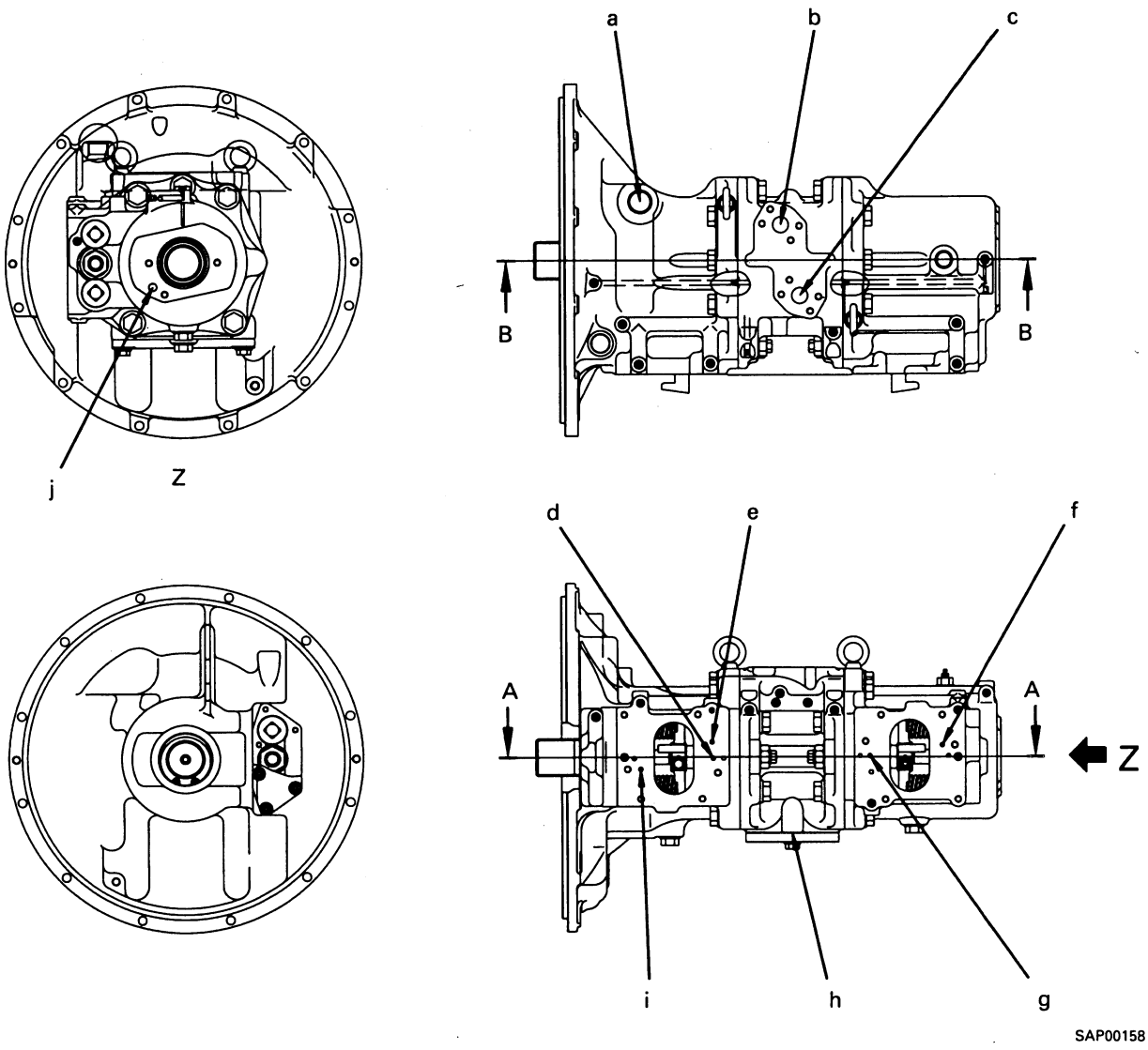


1. Front main pump
2. Rear main pump
3. Relief valve
4. Rear TVC, LS valve
5. Front TVC, LS valve
6. Control pump

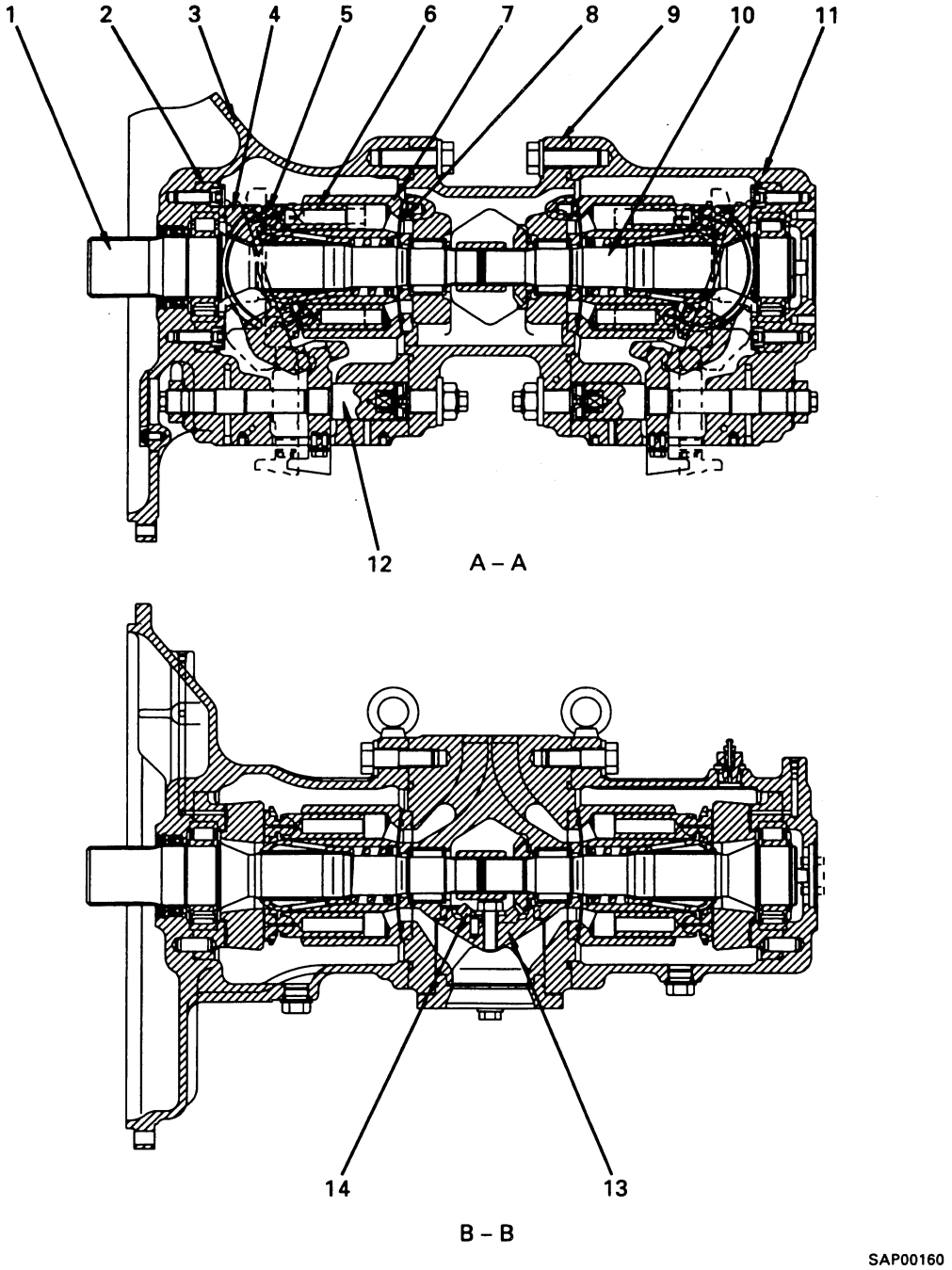
Outline
This pump consists of two variable displacement swash plate type piston pumps, TVC, LS valves, impeller pump, control pump, and relief valve.

a. Port P_{d1F} (pump drain)
b. Port P_{AF} (front delivery)
c. Port P_{AR} (rear delivery)
d. Port P_{GS} (control pump suction)
e. Port P_{GA} (control pump delivery)
f. Port P_{LS1F} (front LS pressure)
g. Port P_{LS1R} (rear LS pressure)
h. Port P_{sig} (LS control pressure EPC pressure)
i. Port P_S (pump suction)
j. Port P_{P2F} (front No. 2 pump delivery pressure)
k. Port P_{P2R} (rear No. 2 pump delivery pressure)

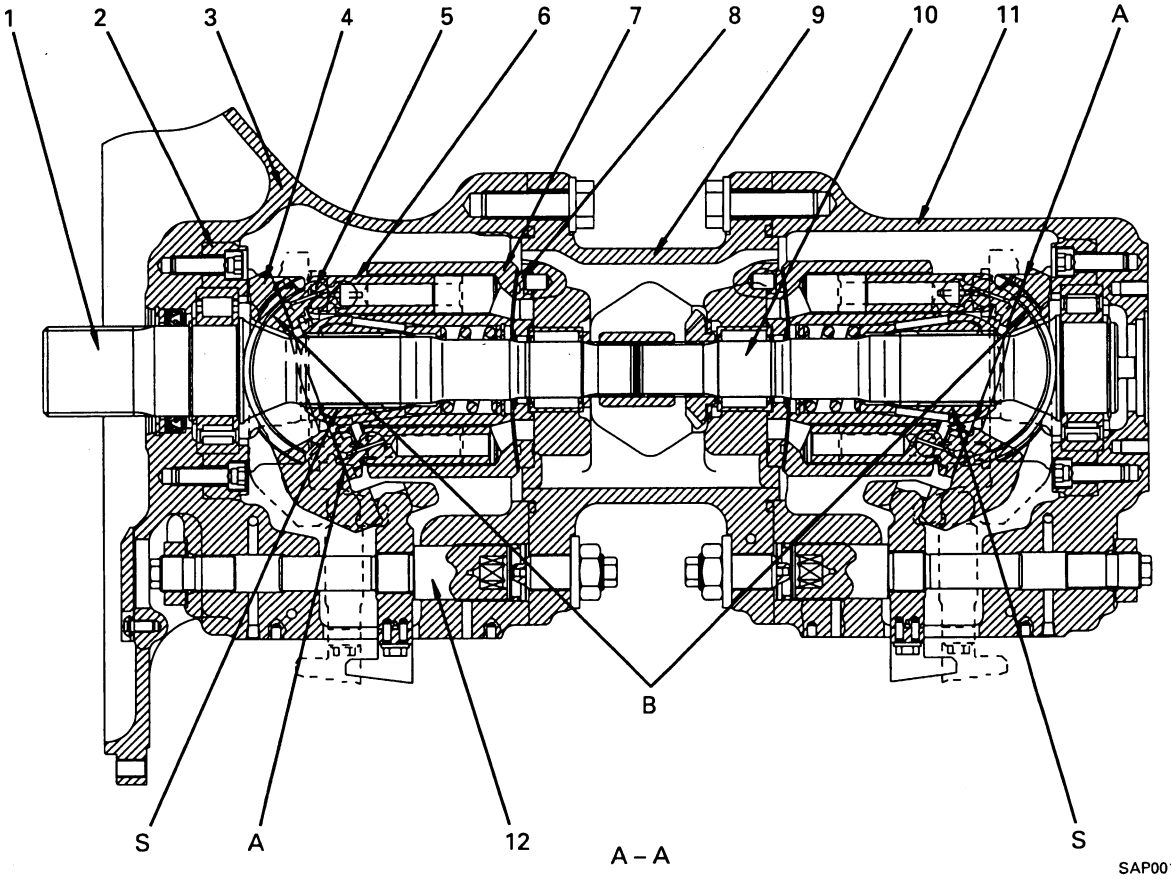
1. MAIN PUMP (HPV160 + 160)



a. Port P_{D1F} (pump drain)
b. Port P_{AF} (front pump delivery)
c. Port P_{AR} (rear pump delivery)
d. Port P_{en1F} (front contronl pressure)
e. Port P_{ARF} (rear delivery pressure)
f. Port P_{ARR} (rear delivery pressure)
g. Port P_{en1R} (rear control pressure)
h. Port P_S (suction)
i. Port P_{AFF} (front delivery pressure)
j. Port P_{SVd} (control pump drain)



1. Shaft (front)
2. Cradle
3. Case (front)
4. Rocker cam
5. Shoe
6. Piston
7. Cylinder block
8. Valve plate
9. End cap
10. Shaft (rear)
11. Case (rear)
12. Servo piston
13. Impeller pump
14. Bevel gear



Function

- The rotation and torque transmitted to the pump shaft is converted into hydraulic energy, and pressurized oil is discharged according to the load.
- It is possible to change the delivery amount by changing the swash plate angle.

Structure

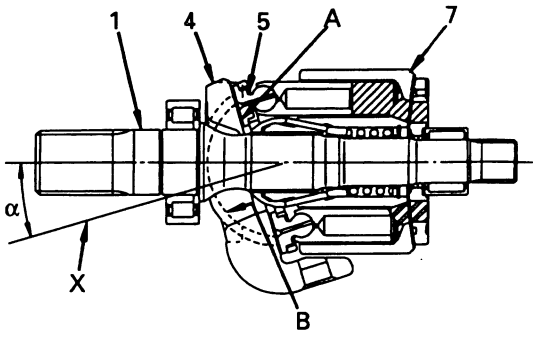
- Cylinder block (7) is supported to shaft (1) by spline **S**, and shaft (1) is supported by the front and rear bearings.
- The tip of piston (6) is a concave ball, and shoe (5) is caulked to it to form one unit.
  Piston (6) and shoe (5) form a spherical bearing.
- Rocker cam (4) has flat surface **A**, and shoe (5) is always pressed against this surface while sliding in a circular movement.
  Rocker cam (4) brings high pressure oil at cylindrical surface **B** with cradle (2), which is secured to the case, and forms a static pressure bearing when it slides.
- Piston (6) carries out relative movement in the axial direction inside each cylinder chamber of cylinder block (7).
- The cylinder block seals the pressure oil to valve plate (8) and carries out relative rotation. This surface is designed so that the oil pressure balance is maintained at a suitable level. The oil inside each cylinder chamber of cylinder block (7) is sucked in and discharged through valve plate (8).
- Impeller (13) is connected with shaft (1) through bevel gear (14) and rotates together with the shaft. The oil sucked in from the suction port is sent into the cylinder chamber by centrifugal force to make it easier to suck in.

Operation

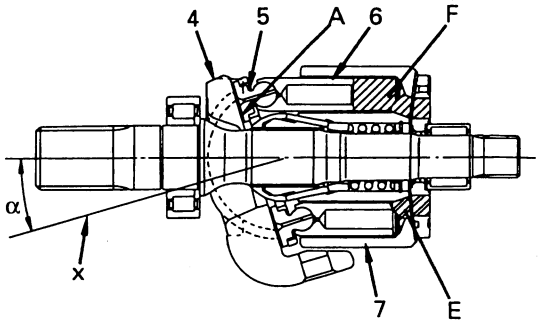
1. Operation of pump

- Cylinder block (7) rotates together with shaft (1), and shoe (5) slides on flat surface **A**.
  When this happens, rocker cam (4) moves along cylindrical surface **B**, so angle (α) between center line **X** of rocker cam (4) and the acial direction of cylinder block (7) changes. (Angle α is called the swash plate angle.)

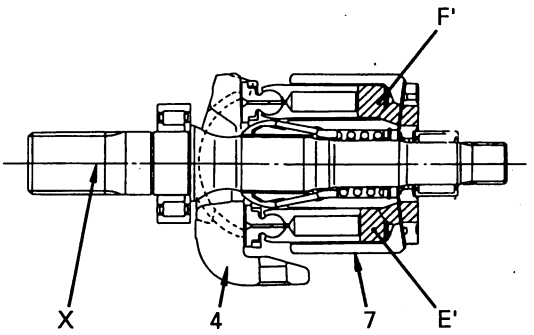
1) Center line **X** of rocker cam (4) maintains swash plate angle α in relation to the axial direction of cylinder block (7), and flat surface **A** moves as a cam in relation to shoe (5). In this way, piston (6) slides on the inside of cylinder block (7), so a difference between volume **E** and **F** is created inside cylinder block (7). The suction and discharge is equal to this difference **F**-**E**.
   In other words, when cylinder block (7) rotates and the volume of chamber **E** becomes smaller, the oil is discharged during that stroke. On the other hand, the volume of chamber **F** becomes larger, and as the volume becomes bigger, the oil is sucked in.
2) If center line **X** of rocker cam (4) is in line with the axial direction of cylinder block (7) (swash plate angle = 0), the difference between volumes **E'** and **F'** inside cylinder block (7) becomes 0, so the pump does not carry out any suction or discharge of oil.



SLP00163

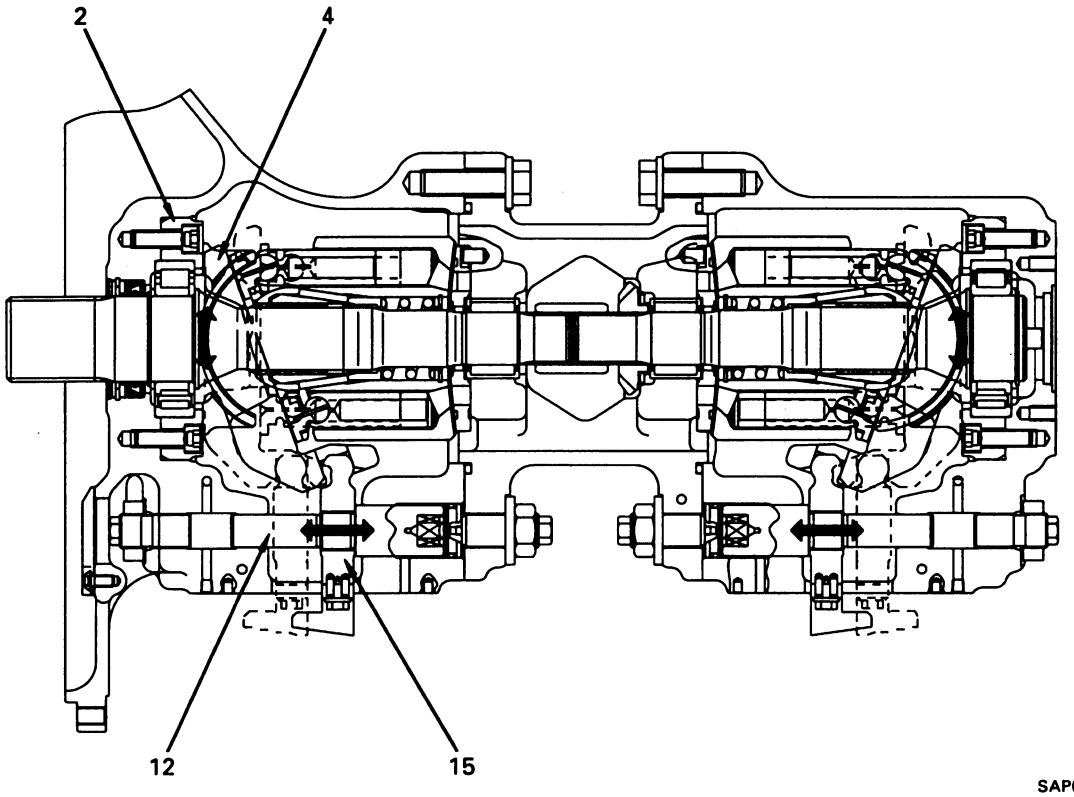


SLP00164



SLP00165

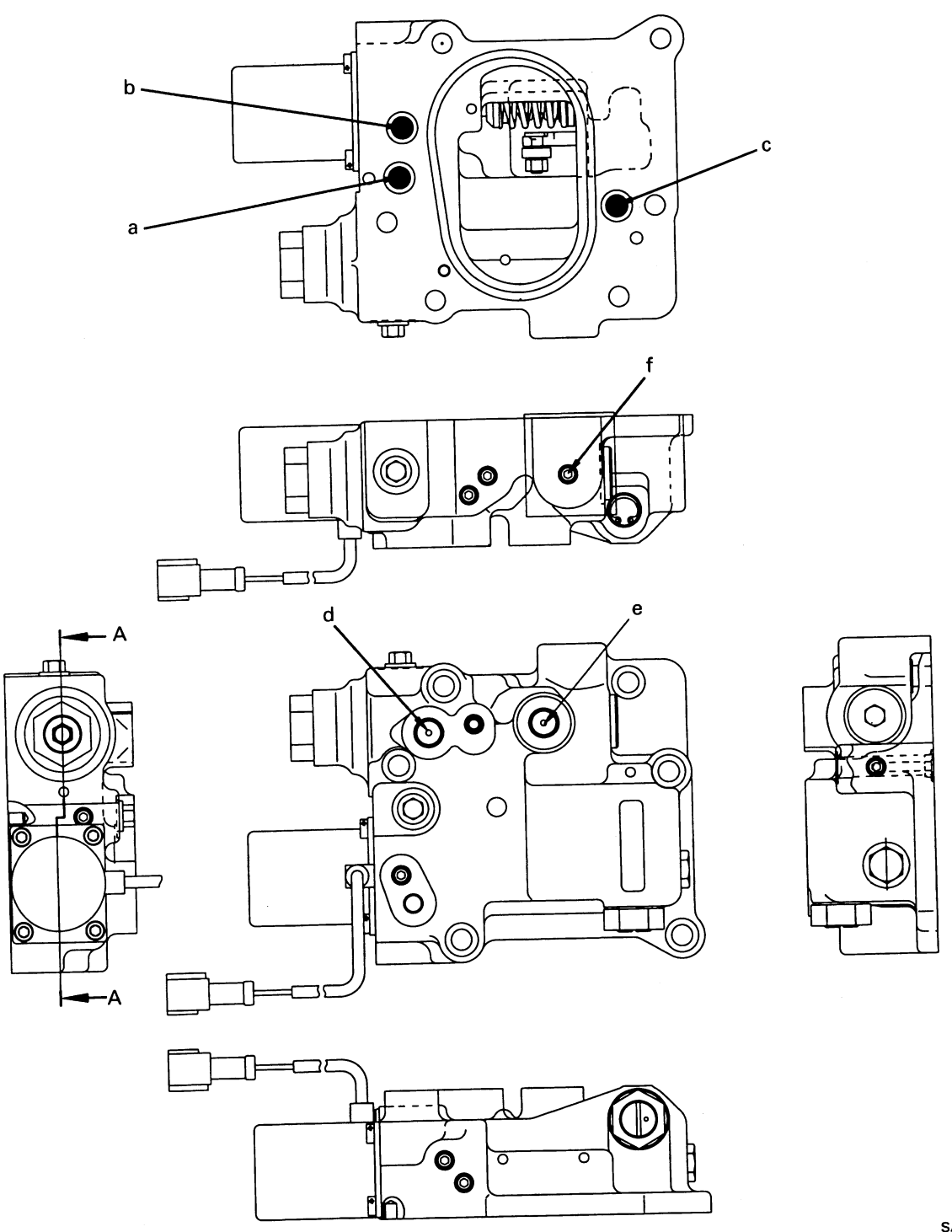
2. Control of discharge amount



SAP00167

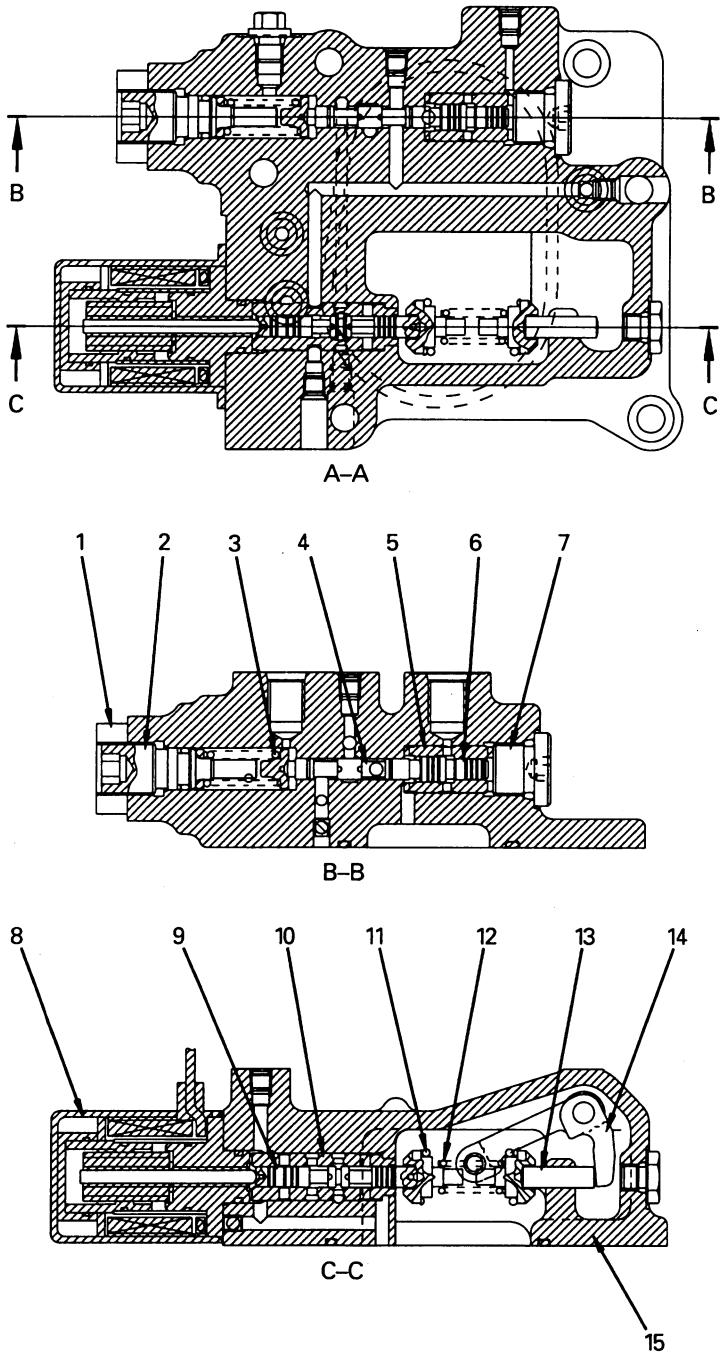
- If swash plate angle α becomes larger, the difference in volumes **E** and **F** becomes larger and discharge volume **Q** increases.
- Swash plate angle α is changed by servo piston (12).
- Servo piston (12) moves in a reciprocal movement (↔) according to the command from the control valve.
- This straight line movement is transmitted through rod (15) to rocker cam (4), and rocker cam (4), which is supported by the cylindrical surface to cradle (2), moves in a rocking movement on the cylindrical surface in (↕ direction).
- With servo piston (12), the area receiving the pressure is different on the left and right, so main pump discharge pressure (self pressure) **PP** is always connected to the chamber receiving the pressure on the small diameter piston side (the self-pressure is brought in). Output pressure **Pen** of the LS valve is brought to the camber receiving the pressure at the large diameter piston end. The relationship in the size of self-pressure **PP** and the pressure at the small diameter piston end, and the ratio between the area receiving the pressure at the small diameter piston end and the large diameter piston end controls the movement of servo piston (12).

2. TVC, LS VALVE



SAP00168

a. Port Pen1 (signal pressure output)
b. Port Pa2 (rear pump delivery pressure inlet port)
c. Port Pa1 (front pump delivery pressure inlet port)
d. Port PLS1 (control valve LS pressure inlet port)
e. Port P sig1 (Ls control EPC pressure inlet port)
f. Port PP2 (pump pressure No. 2 port)



LS valve

1. Locknut
2. Plug
3. Spring
4. Spool
5. Sleeve
6. Piston
7. Plug

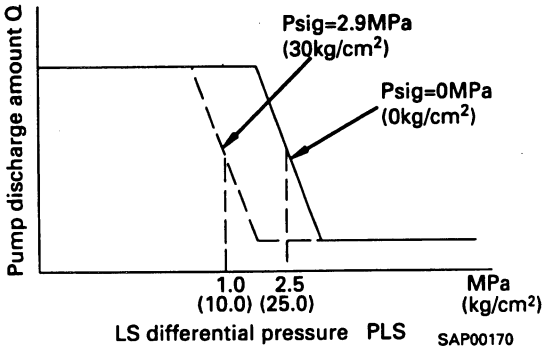
TVC valve

8. Solenoid
9. Piston
10. Sleeve
11. Spring
12. Spring
13. Piston
14. Lever
15. Valve body

Function

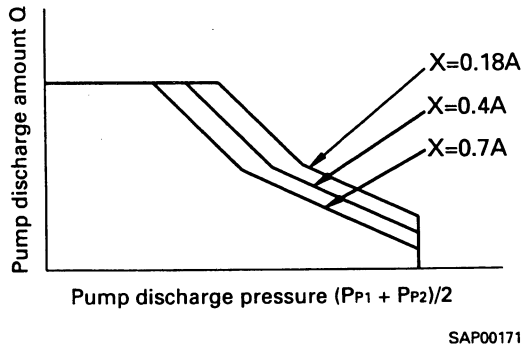
1. LS valve

- The LS valve detects the load and controls the discharge amount.
- This valve controls main pump discharge amount **Q** according to differential pressure **ΔPLS** (=**P2P**-**PLS**) (the difference between main pump pressure **P2P** and control valve outlet port pressure **PLS**) (called the LS differential pressure).
- Main pump pressure **P2P** coming from the control valve inlet port, pressure **PLS** (called the LS pressure) coming from the control valve output, and pressure **Psig** (called the LS selector pressure) from the proportional solenoid valve enter this valve. The relationship between discharge amount **Q** and differential pressure **ΔPLS**, (the difference between main pump pressure **P2P** and LS pressure **PLS**) (=**P2P**-**PLS**) changes as shown in the diagram on the right according to LS selector pressure **Psig**.
- When **Psig** changes between 0 - 2.9 MPa (0 - 30 kg/cm²), the spring load changes according to this, and the point for switching the pump discharge amount changes at the rated central value between 1.0 - 2.5 MPa (10.0 - 25.0 kg/cm²).



2. TVC valve

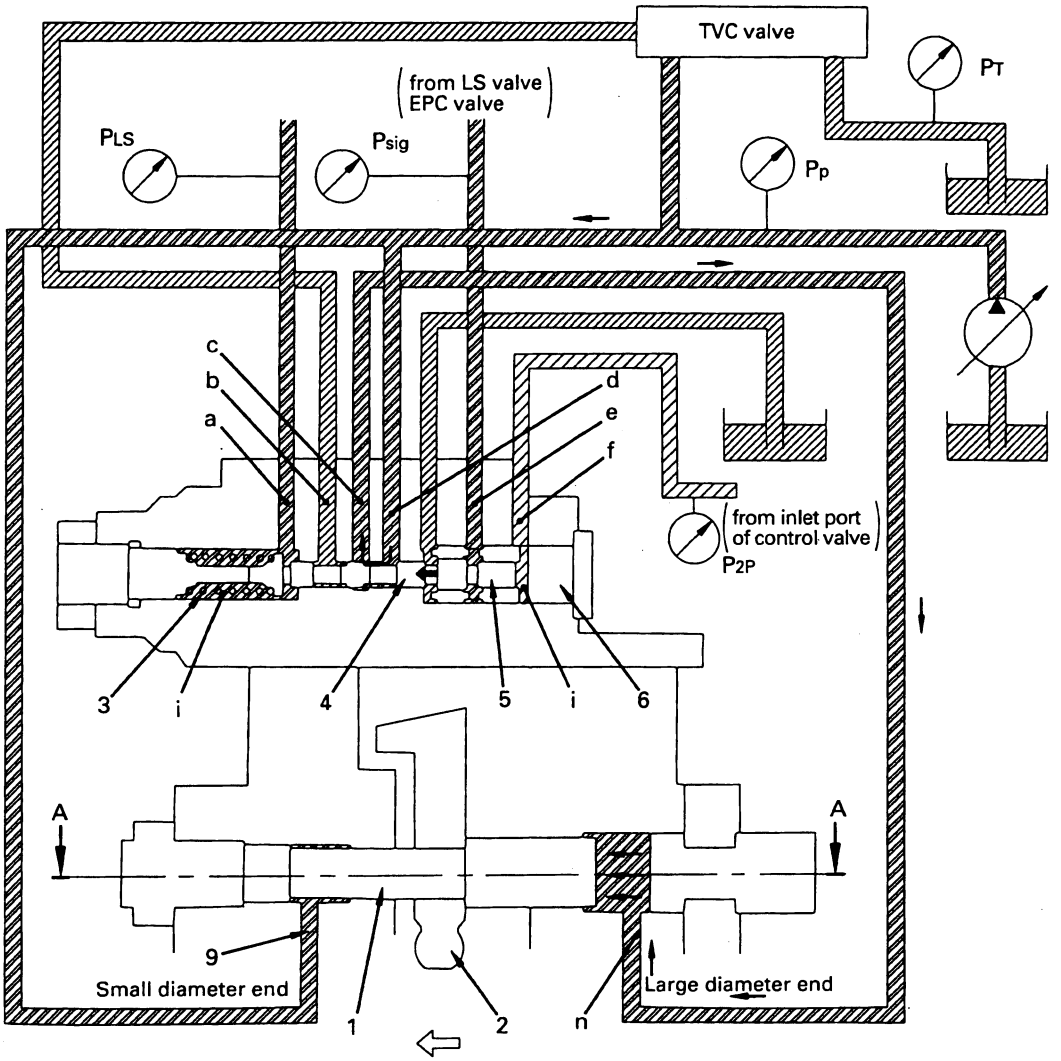
- When pump discharge pressure **PP1** (self-pressure) and **PP2** (other pump pressure) are high, the TVC valve controls the pump so that no more oil than the constant flow (in accordance with the discharge pressure) flows even if the stroke of the control valve becomes larger. In this way it carries out equal horsepower control so that the horsepower absorbed by the pump does not exceed the engine horsepower.
- In other words, if the load during the operation becomes larger and the pump discharge pressure rises, it reduces the discharge amount from the pump; and if the pump discharge pressure drops, it increases the discharge amount from the pump. The relationship between the average of the front and rear pump discharge pressure (**PP1** + **PP2**)/2 and pump discharge amount **Q** is shown on the right, with the current given to the TVC valve solenoid shown as a parmeter.
  However, in the heavy-duty operation mode, there are cases where it is given the function of sensing the actual speed of the engine, and if the speed drops becaus of an increase in the load, it reduces the pump discharge amount to allow the speed to recover. In other words, when the load increases and the engine speed drops below the set value, the command to the TVC valve solenoid from the controller increases according to the drop in the engine speed to reduce the pump swash plate angle.



Operation

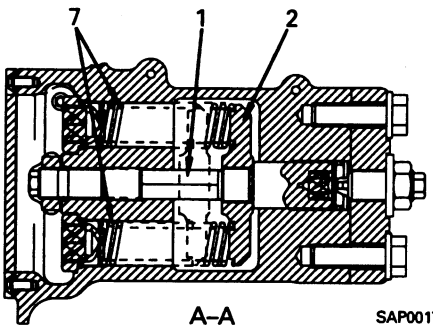
1. LS valve

1) When control valve is at NEUTRAL postion



SLP00172

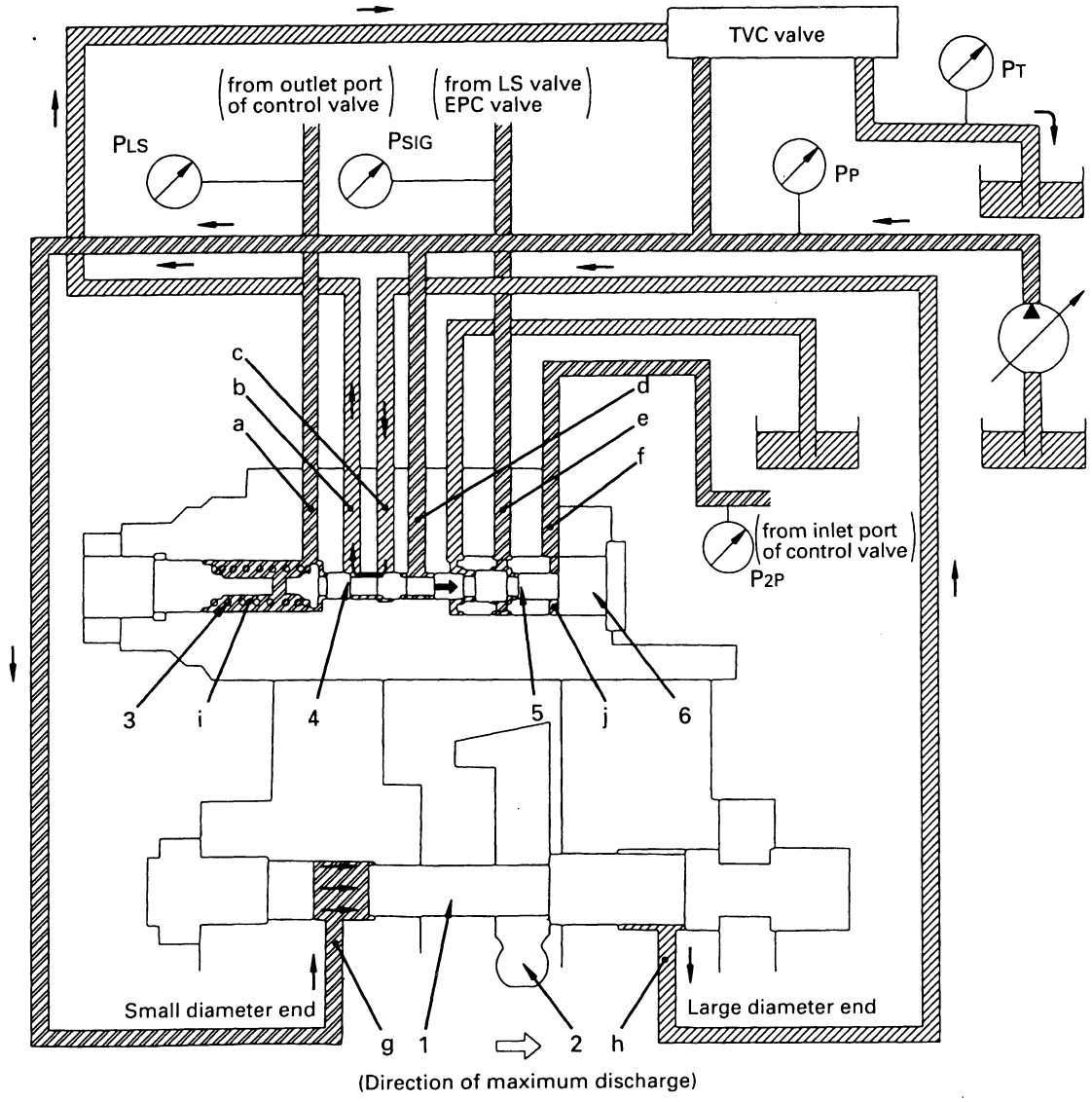
- The LS valve is a three-way selector valve, with pressure **PLS** (LS pressure) from the outlet port of the control valve brought to spring chamber **i**, and main pump discharge pressure **P2P** brought to chamber **j** of plug (6).
- The size of the force of this LS pressure **PLS** + force **F** of spring (3) and the main pump pressure (self pressure) **P2P** determines the position of spool (4). However, the size of the output pressure **Psig** (the LS valve entering port **e** also changes the position of spool (4). (The set pressue of the spring changes.)
- Before the engine is started, servo piston (1) is pushed to the right by spring (7) installed to rod (2). (See the diagram on the right)
- When the engine is started and the control lever is at the NEUTRAL POSITION, LS pressue **PLS** is 0 MPa (0 kg/cm^2). (It is interconnected with the drain circuit through the control valve



SAP00173

spool.) At this point, spool (4) is pushed to the left, and port **d** and port **c** are connected. Pump pressure **PP** enters the large diameter end of the piston from port **h**, and the same pump pressure **PP** also enters the small diameter end of the piston, so the swash plated is moved to the minimum angle by the difference in area of piston (1).

2) Operation in maximum direction for pump discharge amount

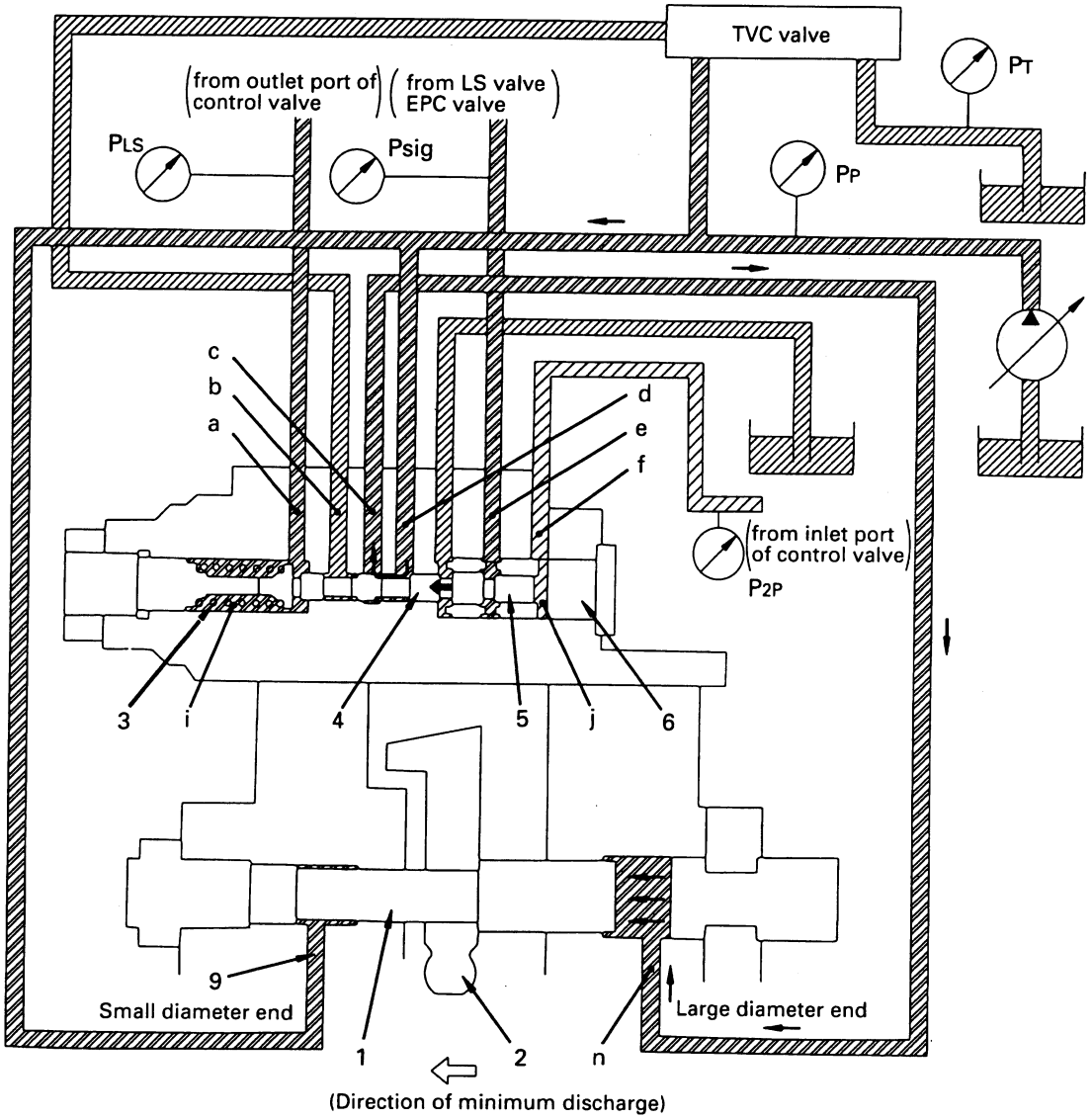


(Direction of maximum discharge)

SLP00174

- When the difference between main pump pressure **P2P** and LS pressure **PLS**, in other words, LS differential pressure **ΔPLS**, becomes smaller (for example, when the area of opening of the control valve becomes larger and pump pressure **PP** drops), spool (4) is pushed to the right by the combined force of LS pressure **PLS** and the force of spring (3).
- When spool (4) moves, port **b** and port **c** are joined and connected to the TVC valve. When this happens, the TVC valve is connected to the drain port, so circuit **c** - **h** becomes drain pressure **PT**. (The operation of the TVC valve is explained later).
- For this reason, the pressure at the large piston diameter end of servo piston (1) becomes drain pressure **PT**, and pump presure **PP** enters the small diameter end, so servo piston (1) is pushed to the right. Therefore, rod (2) moves to the right and moves the swash plate in the direction to make the discharge amount larger.
- If the output pressure **Psig** of the EPC valve for the LS valve enters port **e**, this pressure creates a force to move piston (5) to the left.
  If piston (5) is pushed to the left, it acts to make the set pressure of spring (3) weaker, and the difference between **PLS** and **P2P** changes when ports **b** and **c** of spool (4) are connected.

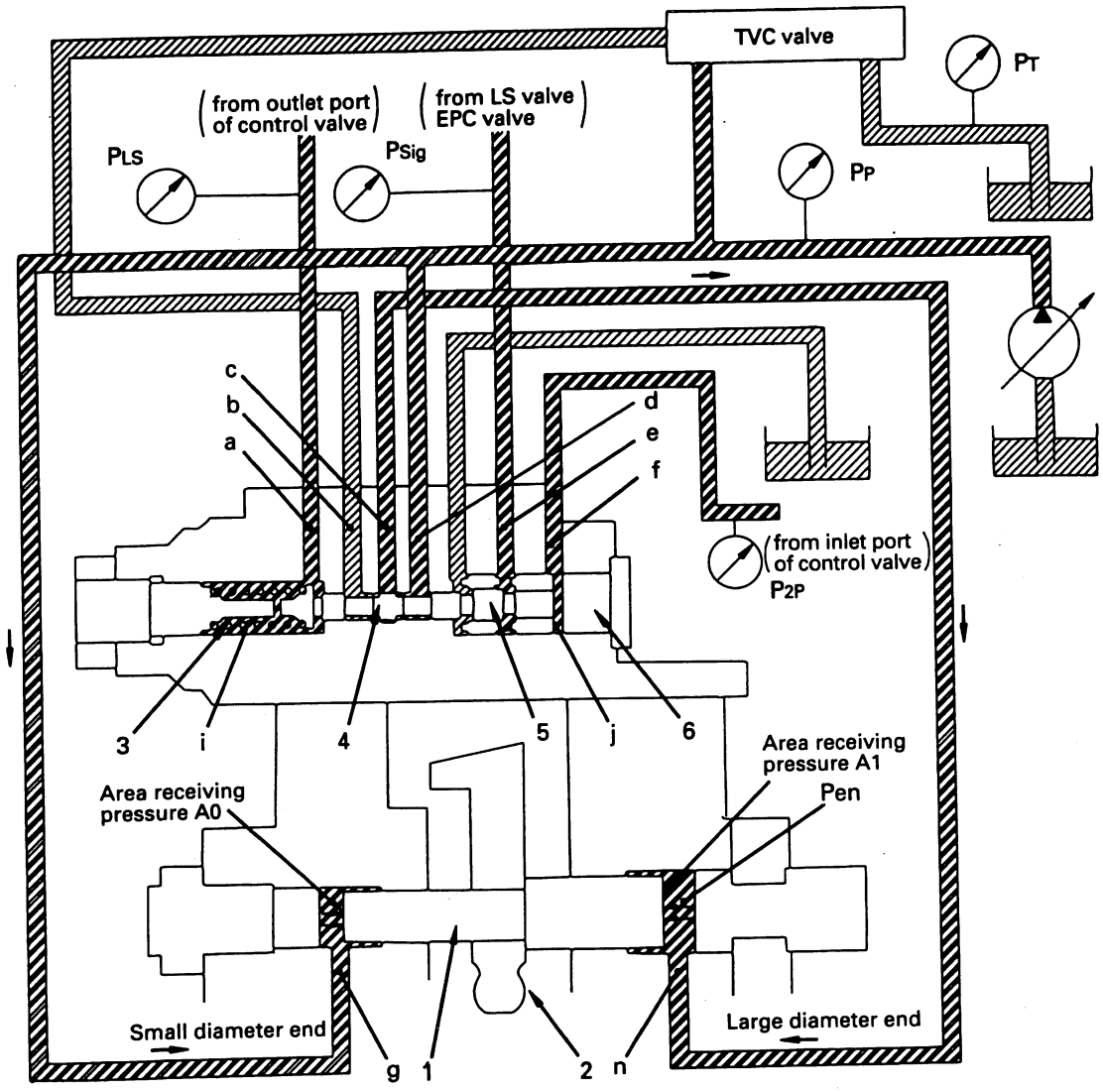
3) Operation in minimum direction for pump discharge amount



SLP00175

- The following explains the situation if servo piston (1) moves to the left (the discharge amount becomes smaller). When LS differential pressure **ΔPLS** becomes larger (for example, when the area of opening of the control valve becomes smaller and pump pressure **PP** rises), main pump discharge pressure **P2P** pushes spool (4) to the left.
- When spool (4) moves, main pump pressure **PP** flows from port **d** to port **c**, and from port **h**, it enters the large piston diameter end.
- Main pump pressure **PP** also enters the small piston diameter end, but because of the difference in area between the large piston diameter end and small piston diameter end of servo piston (1), servo piston (1) is pushed to the left.
  As a result, rod (2) moves in the direction to make the swash plate angle smaller.
- If LS selection pressure **Psig** enters port **e**, it acts to make the set pressure of spring (3) weaker.

4) When servo piston is balanced

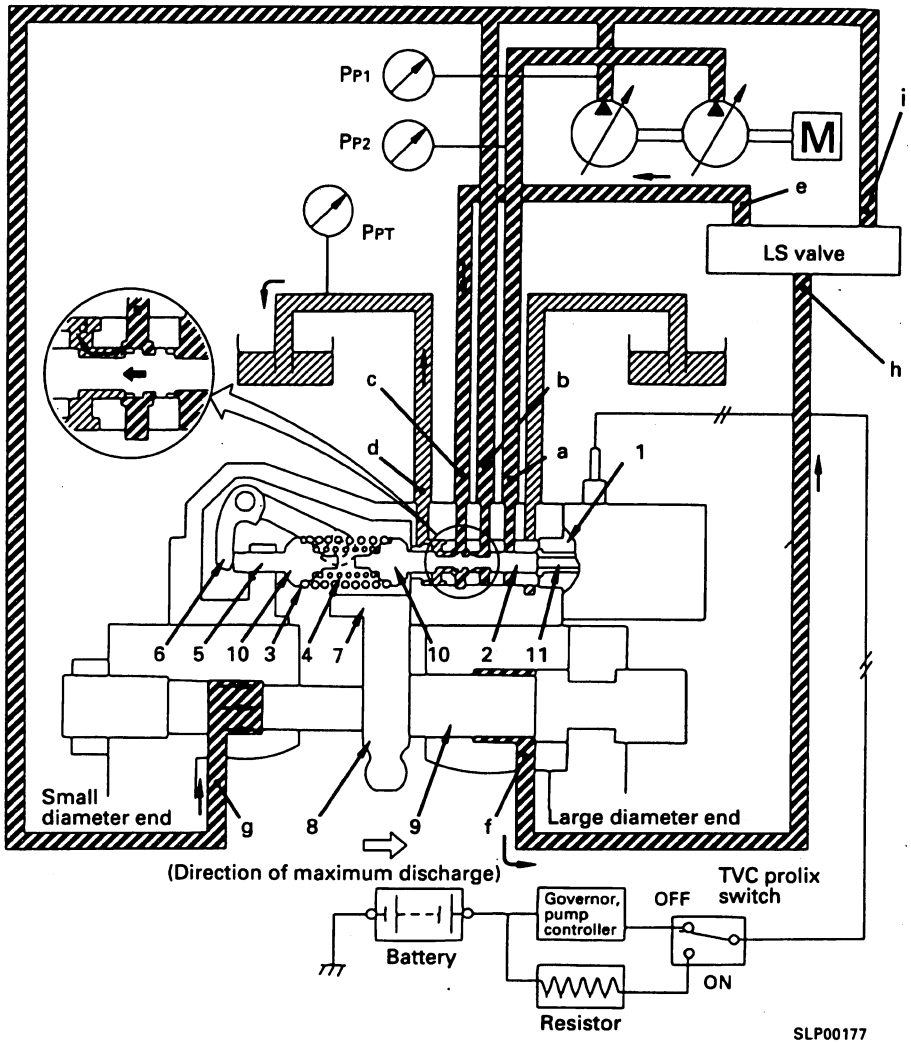


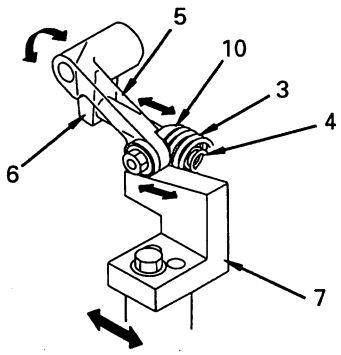
SLP00176

- Let us take the area receiving the pressure at the large piston diameter end as A1, the area receiving the pressure at the small diameter end as A0, and the pressure flowing into the large piston diameter end as **Pen**. If main pump discharge pressure **P2P** of the LS valve and the combined force of force **F** of spring (3) and LS pressure **PLS** are balanced, and the relationship is A0 x **PP** = A1 x **Pen**, servo piston (1) will stop in that postion, and the swash plate will be kept at an intermediate position. (It will stop at a postion where the opening of the throttle between port **b** and port **c** and between port **d** and port **c** of spool (4) is approximately the same. At this point, the pressure of port **c** is approx. 1/2 pump pressure **PP**.)
- At this point, the relationship between the area receiving the pressure at both ends of piston (1) is A0 : A1 = 1 : 2, so the pressure applied to both ends of the piston when it is balanced becomes **PP** : **Pen** = 2 : 1.
- The postion where spool (4) is balanced and stopped is the standard center, and the force of spring (3) is adjusted so that it is determined when **P2P** - **PLS** = 2.5 MPa (25 kg/cm^2). However, if **Psig** (the output pressure of 0 - 2.9 MPa (0 - 30 kg/cm^2) of the EPC valve of the LS valve) is applied to port **e**, the balance stop position will change in proportion to pressure **Psig** between **P2P** - **PLS** = 2.5-1.0 MPa (25-10 kg/cm^2).

2. TVC valve

1) When governor, pump controller are normal





★ Other pump pressure
This is the pressure of the pump at the opposite end. For the front pump, it is the rear pump pressure .
For the rear pump, it is the front pump pressure.

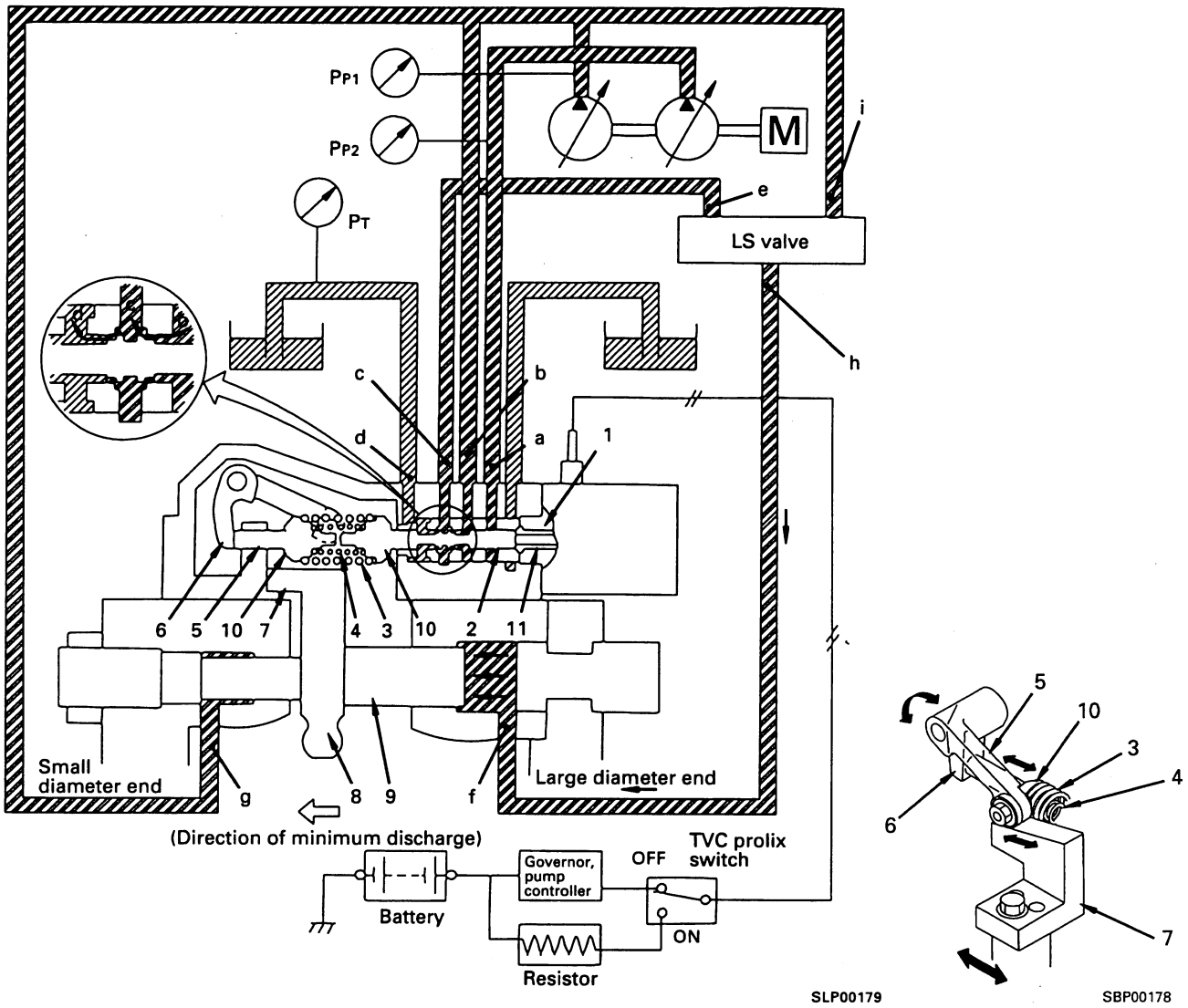
a. When the load on the actuator is small and pump pressures PP1 and PP2 are low

① Action of solenoid (1)

- Command current **x** from the governor, pump controller flows to solenoid (1). This command current changes the internal force pushing solenoid push pin (11).
- On the opposite side to the force pushing this solenoid push pin (11) is the spring set pressure of springs (3) and (4) and pump pressure **PP1** and other pump pressure **PP2** (see ★). Piston (2) stops at a position where the combined force pushing piston (2) is balanced, and the pressure (pressure of port **c**) output from the TVC valve changes according to this position.
- The size of command current **x** is determined by the nature of the operation (lever operation), the selection of the working mode, and the set value and actual value for the engine speed.

② Action of spring

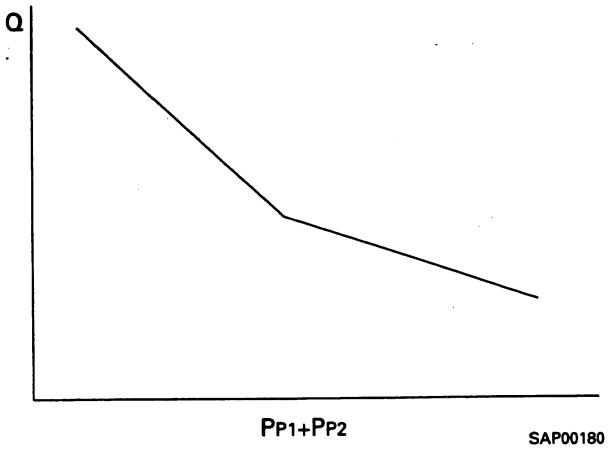
- The spring load of springs (3) and (4) in the TVC valve is determined by the position of the swash plate.
- When servo piston (9) moves, cam (7), which is connected to rod (8), also moves. When this happens, lever (6) is rotated by the angle of cam (7), and piston (5) moves to the right or left.
- If piston (5) moves to the right, spring (3) is compressed; and if it moves further to the right, spring (4) contacts seat (10), so both spring (3) and spring (4) function. In other words, the spring load is changed by piston (5) extending of contracting springs (3) and (4).
- If command current **x** input to solenoid (1) changes further, the pushing force of solenoid push pin (11) changes, and the spring load of springs (3) and (4) also changes according to the value of the solenoid command current.
- Port **c** of the TVC valve is connected to port **e** of the LS valve (see 1. LS valve).
  Self pressure **PP1** enters port **b** and the small piston diameter end of servo piston (9), and the other main pump pressure **PP2** enters port **a**.
- When pump pressures **PP1** and **PP2** are small, piston (2) is on the right. At this point, port **c** and port **d** are connected, and the pressure entering the LS valve becomes drain pressure **PT**.
  If port **h** and port **e** of the LS valve are connected (see 1. LS valve), the pressure entering the large piston diameter end from port **f** becomes drain pressure **PT**, and servo piston (9) moves to the right. In this way, the pump discharge amount moves in the direction of increase.
- As servo piston (9) moves further, piston (5) is moved to the left by rod (8), cam (7), and lever (6). Springs (3) and (4) expand and the spring force becomes weaker. When the spring force becomes weaker, piston (2) moves to the left, so the connection between port **c** and **d** is cut, and the pump discharge pressure port **b** is connected to port **c**. As a result, the pressure at port **c** rises, and the pressure at the large piston diameter end also rises, so the movement of piston (9) to the right is topped. In other words, the stop position for piston (9) (=pump discharge amount) is decided at the point where the force from the solenoid and the pushing force created by pressures **PP1** and **PP2** acting on piston (2) are in balance.



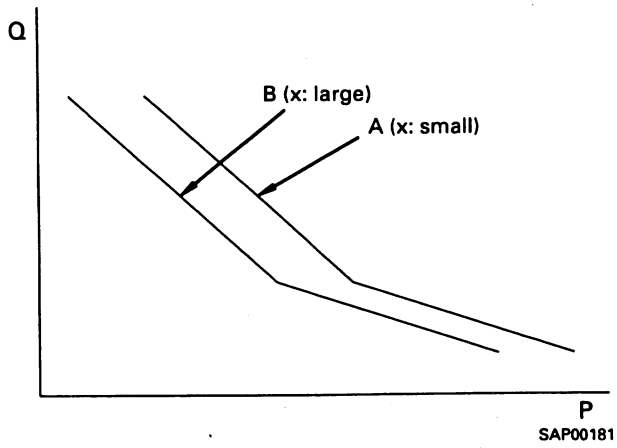
b. When load on actuator is small and pump discharge pressure is high

- When the load is large and pump discharge pressures **PP1** and **PP2** are high, the force pushing piston (2) to the left becomes larger and piston (2) moves to the position shown in the diagram above. When this happens, as shown in the diagram above, with the pressurized oil flowing from port **c** to the LS valve, part of the pressurized oil from port **b** flows out to port **d** and becomes approximately half of main pump pressure **PP1**.
- When port **h** and port **e** of the LS valve are connected (see 1. LS valve), the pressure from port **f** enters the large piston diameter end of servo piston (9), and servo piston (9) stops.
- If main pump pressures **PP1** and **PP2** increase further and piston (2) moves further to the left, main pump pressure **PP1** flows to port c and acts to make the discharge amount the minimum. When piston (9) moves to the left, piston (5) is moved to the right by cam (7) and lever (6). For this reason, springs (3) and (4) are compressed and push back piston (2). Because of this force, piston (2) cuts off the connection from port **b** to port **c**, and port **c** and port **d** are connected. As a result, the pressure at port **c** (=**f**) drops, and piston (9) stops moving to the left. The position in which piston (9) stops when this happens is further to the left. The position in which piston (9) stops when this happens is further to the left than the position when main pump pressures **PP1** and **PP2** are low.

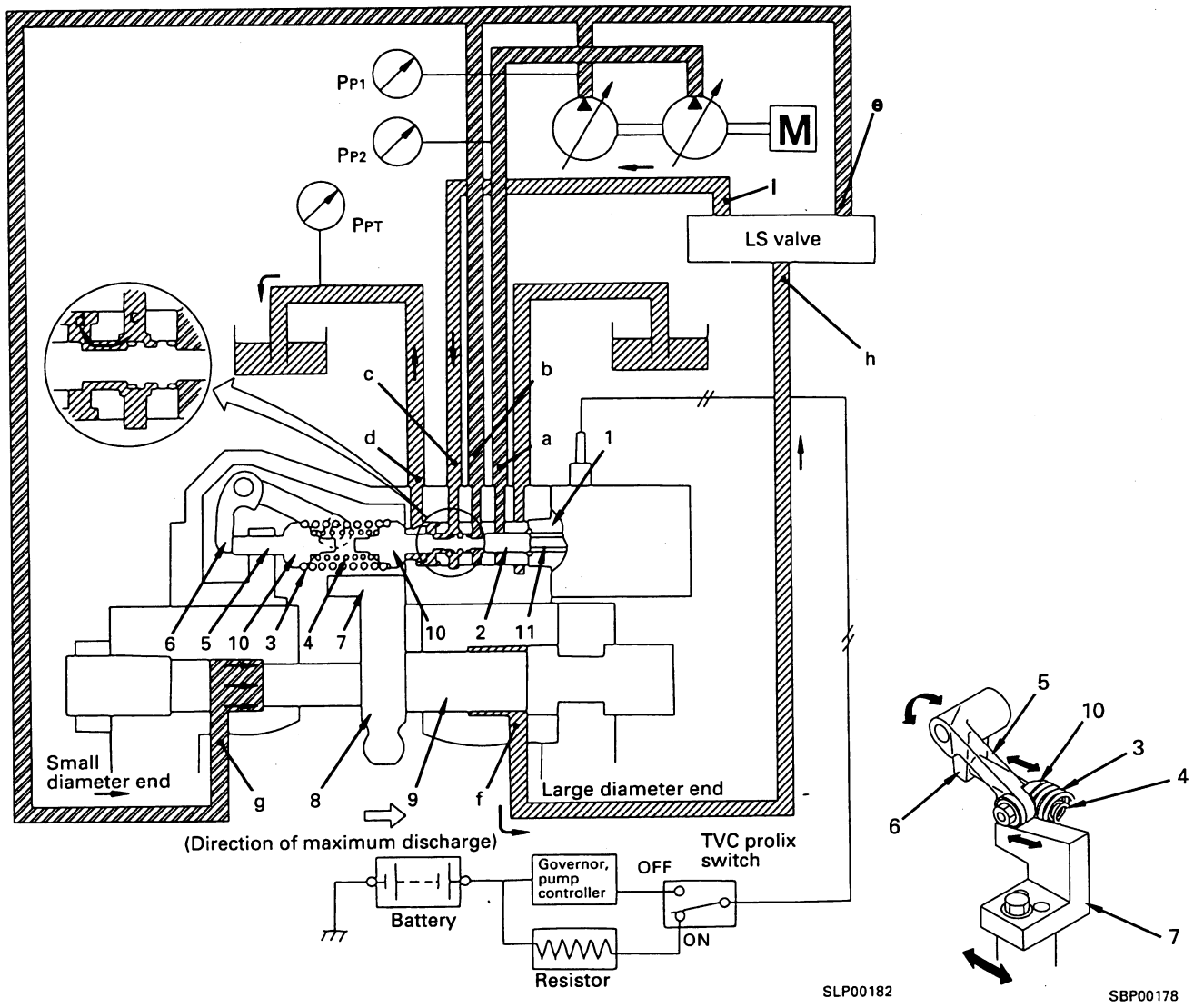
- The relation of pump pressures **PP1** + **PP2** and the position of servo piston (9) forms a bent line because of the double-spring effect of springs (3) and (4). The relationship between pump pressures **PP1** + **PP2** and pump discharge amount **Q** is shown in the figure on the right.



- If command current **x** sent to solenoid (1) increases further, the relationship between pump pressures **PP1** and **PP2**, and pump discharge amount **Q** is proportional to the pushing force of the solenoid and moves in parallel. In other words, if the pushing force of solenoid (1) is added to the force pushing to the left because of the pump pressure applied to the piston (2), the relationship between **P** and **Q** moves from **A** to **B** in accordance with the increasse in **X**.

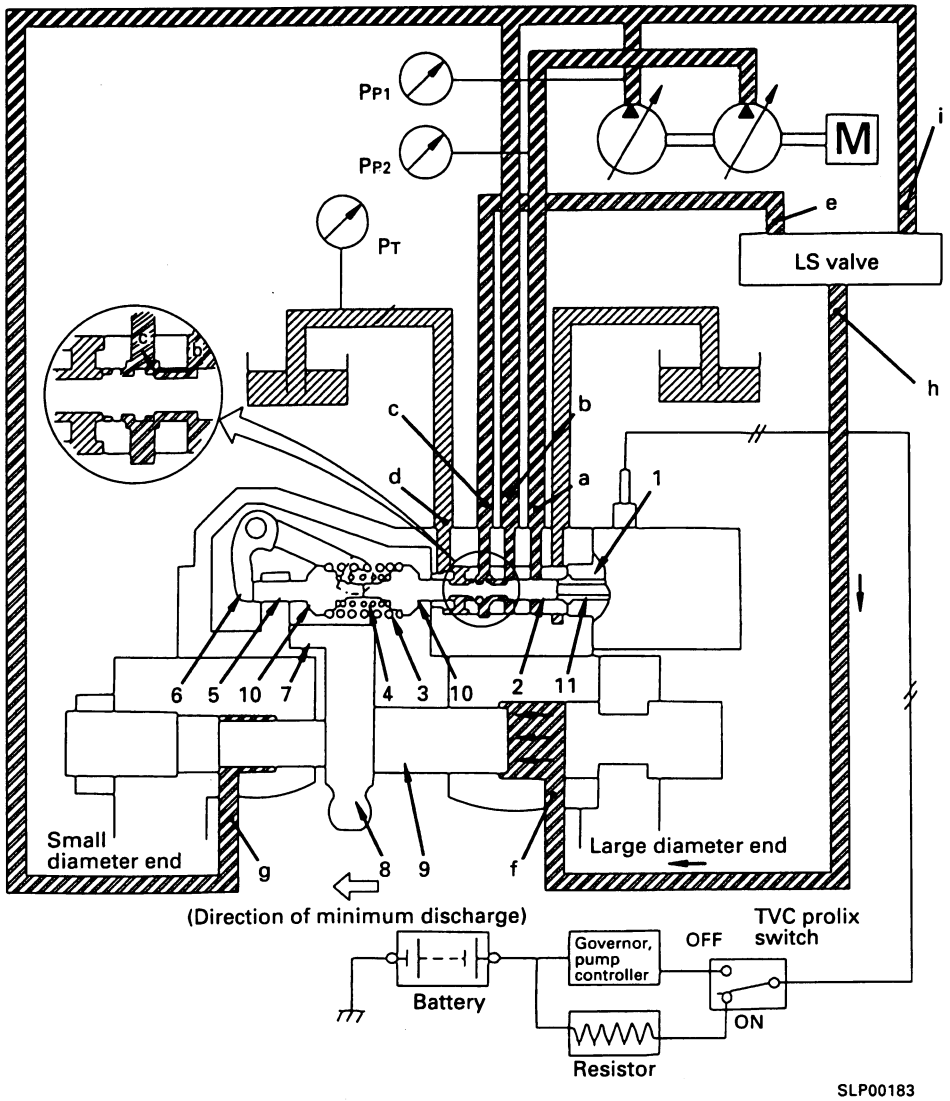


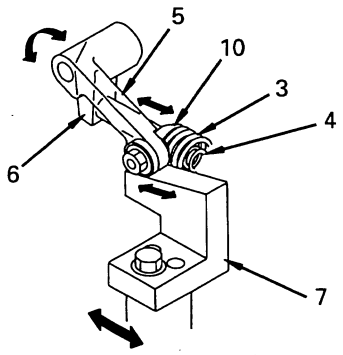
2) When governor, pump controller is abnormal and TVC prolix switch is ON



a. When load on main pump is light

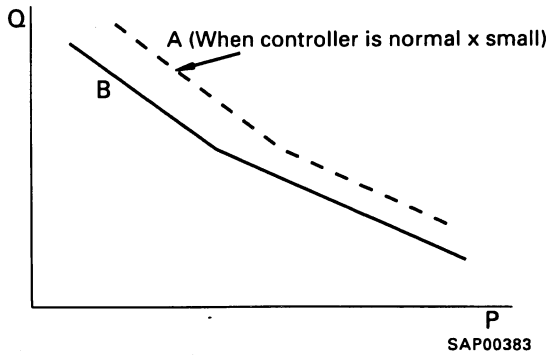
- If there is a failure in the governor, pump controller, turn TVC prolix switch ON to switch to the resistor side. In this case, the power source is taken directly from the battery. But if the current is used as it is, it is to large, so use the resistor to control the current flowing to solenoid (1).
- When this is done, the current becomes constant, so the force pushing solenoid pus pin (11) is also constant.
- If main pump pressures **PP1** and **PP2** are low, the combined force of the pump pressure and the force of solenoid (1) is weaker than the spring set force, so piston (2) is balanced at a position to the right.
- At this point, port **c** is connected to the drain pressure of port **d**, and the large piston diameter end of servo piston (9) also becomes the drain pressure **PT** through the LS valve.
  When this happens, the pressure at the small piston diameter end is large, so servo piston (9) moves in the direction to make the discharge amount larger.



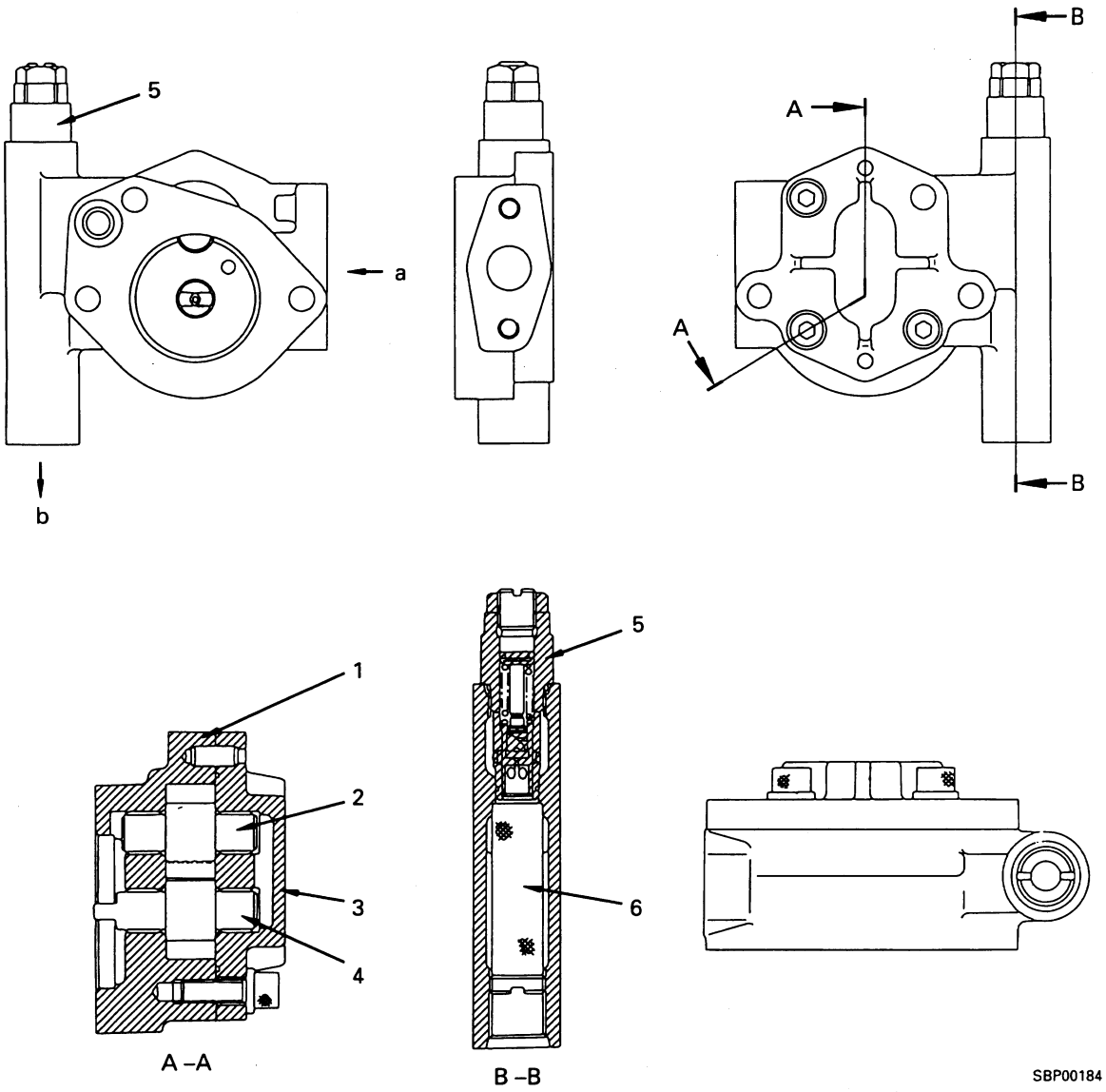


b. When load on main pump is heavy

- In the same way as in the previous item, when the TVC prolix switch is ON, the command current **x** sent to solenoid (1) becomes constant. For this reason, the force of solenoid push pin (11) pushing piston (2) is constant.
- If main pump pressures **PP1** and **PP2** increase, piston (2) moves further to the left than when the main pump load is light, and is balanced at a position towards the left.
- In this case, the pressure from port **b** flows to port **c**, so servo piston (9) moves to the left (to make the discharge amount smaller) by the same mechanism as explained in Item 2.1)-b, and stops at a position further to the left than when the load on the pump is light.
  In other words, even when the TVC prolix switch is ON, the curve for the pump pressure **P** and discharge amount **Q** is determined as shown in the diagram for the value of the current sent to the solenoid through the resistor.
- The curve when the TVC prolix switch is ON is curve **B**, which is to the left of curve **A** for when the governor, pump controller is normal.



3. CONTROL PUMP (BAR-020)

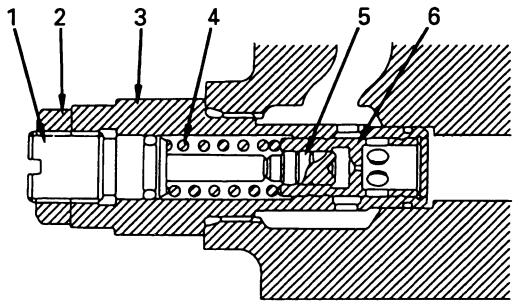


1. Body
2. Driven gear
3. Housing
4. Drive gear
5. Relief valve
6. Filter

a. Suction port
b. Delivery port

Specifications
Type: Bar-020
Theoretical delivery: 20.9 cc/rev
Max. delivery pressure: 3.2 MPa (33 kg/cm^2)

RELIEF VALVE



SBP00185

1. Adjustment screw
2. Locknut
3. Sleeve
4. Main valve spring
5. Pilot piston
6. Main valve

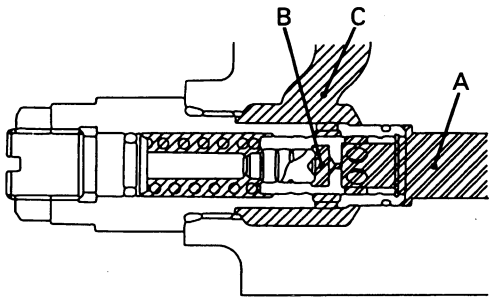
Set pressure:

3.2 $^{0}_{-0.1}$MPa (at 33 ℓ/min)

(33 $^{0}_{-1}$ kg/cm² (at 33 ℓ/min))

Function

The relief valve is assembled in the body of the control pump, and when the PPC valve is at neutral, the oil sent from the pump is relieved through this valve. (It set the maximum pressure in the circuit during opertations.)

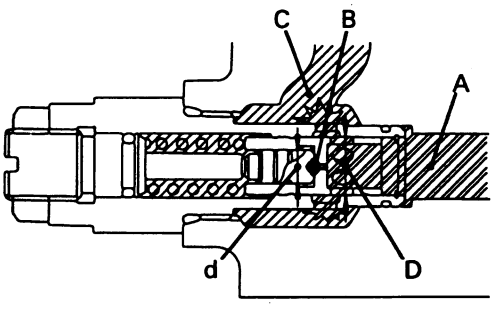


SBP00186

Operation

- Chamber **A** is the pump circuit and chamer **C** is the drain circuit. The oil passes through the orifice in the main valve and fills chamber **B**.

- If any abormal pressure is generated, and the differntial pressure [π/4 (D2 - d2) x pressure of chamber **A**] created by the difference in the area of **d** and diameter **D** reaches the pressure set by the main valve spring, the main valve opens, and the oil in chamber **A** is released to chamber **C**. This suppresses the rise in the pressure in chamber **A**.

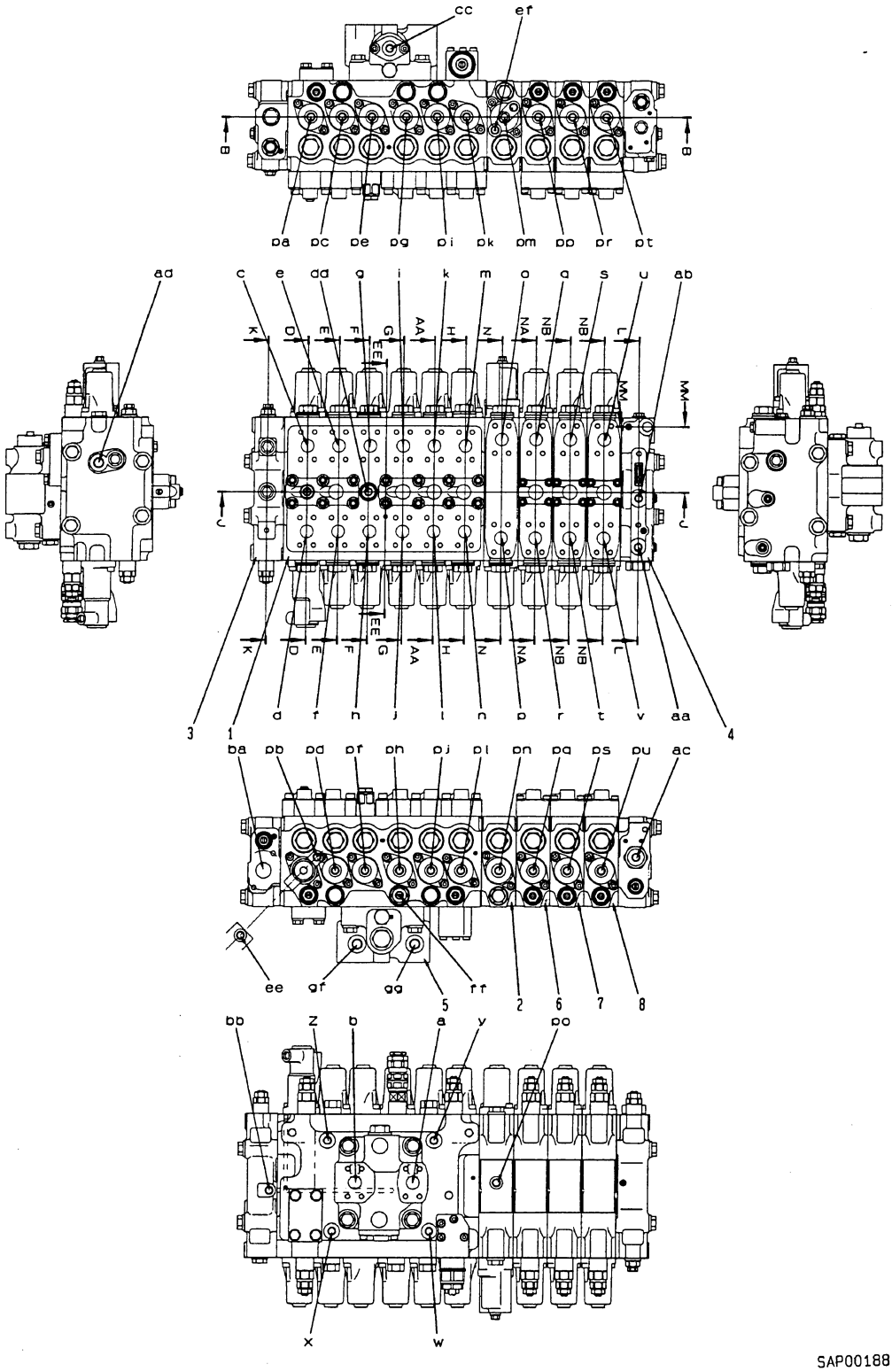


SBP00187

CONTROL VALVE

10-spool valve (STD + service valve x 3)

★ For details of this page, see Section 90.



SAP00188

1. 6- spool valve
2. Boom, arm Hi valve
3. Cover 1
4. Cover 2
5. Merge/flow divider valve
6. Service valve
7. Service valve
8. Service valve

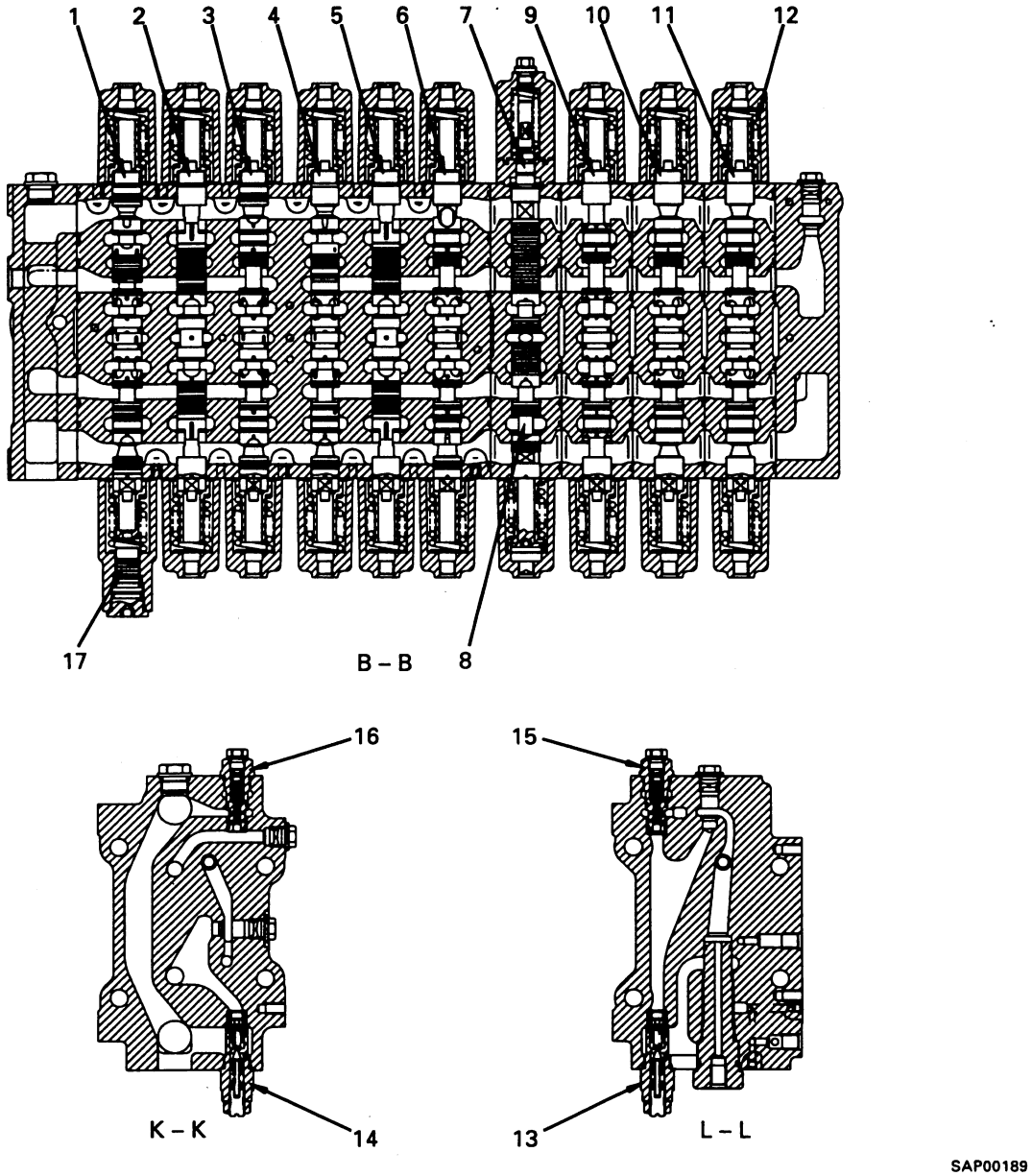
Outline

- This control valve consists of a 7-spool valve (the 6-spool valve + Hi valve) and 3 sets of service valves. The merge/flow divider valve is installed to this. (1 service valve is provided as standard)
- All the valves are connected by a bolt to form one unit, and the passages are internally connected, so the structure is compact and is very easy to service.
- This control valve is designed to assist only the boom and arm valves with their large flow using the Hi valve, so it has a simple structure.

a. Port P_{P1} (from front main pump)
b. Port P_{P2} (from rear main pump)
c. Port A_6 (to arm cylinder head)
d. Port B_6 (to arm cylinder bottom)
e. Port A_5 (to L.H. travel motor)
f. Port B_5 (to L.H. travel motor)
g. Port A_4 (to swing motor)
h. Port B_4 (to swing motor)
i. Port A_3 (to boom cylinder bottom)
j. Port B_3 (to boom cylinder head)
k. Port A_2 (to R.H. travel motor)
l. Port B_2 (to R.H. travel motor)
m. Port A_1 (to bucket cylinder bottom)
n. Port B_1 (to bucket cylinder head)
o. Port A-1 (to boom cylinder bottom)
p. Port B-1 (to arm cylinder bottom)
q. Port A-2 (to attachment)
r. Port B-2 (to attachment)
s. Port A-3 (to attachment)
t. Port B-3 (to attachment)
u. Port A-4 (to attachment)
v. Port B-4 (to attachment)
w. Port T_1 (to travel junction valve)
x. Port T_2 (to travel junction valve)
y. Port T_3 (to travel junction valve)
z. Port T_4 (to travel junction valve)

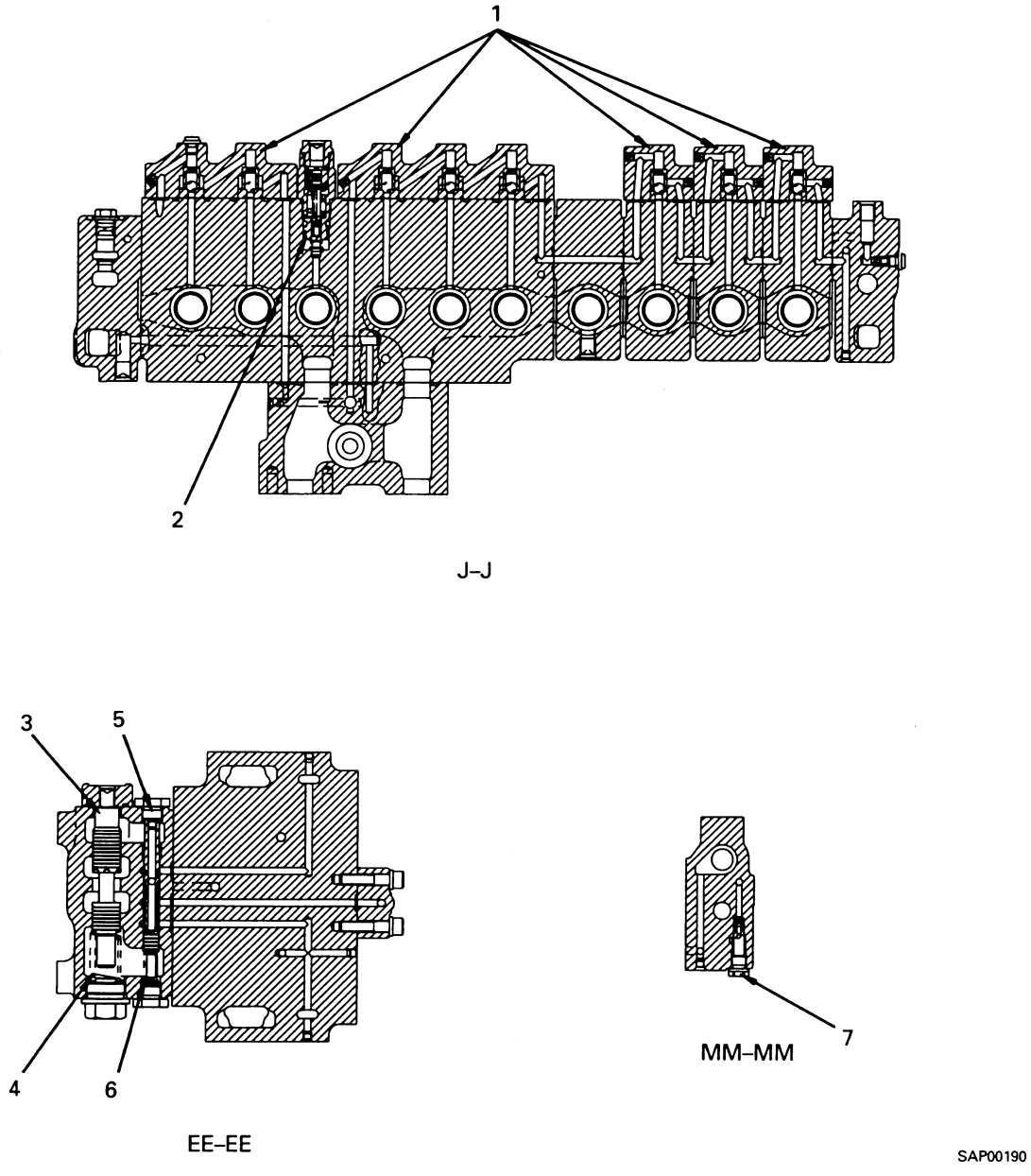
aa. Port P_{LS1} (to front pump control)
ab. Port P_{LS2} (to rear pump control)
ac. Port P_{PS1} (to front pump control)
ad. Port P_{PS2} (to rear pump control)
ba. Port T (to tank)
bb. Port T_S (to tank)
cc. Port P_S (from merge/flow divider solenoid valve)
dd. Port B_P (from LS select solenoid valve)
ee. Port P_{TR1} (to travel junction valve)
ef. Port P_{TR2} (to travel junction valve)
ff. Port C_P (from 2-stage safety valve selector solenoid valve)
pa. Port P_{12} (from arm PPC valve)
pb. Port P_{11} (from arm PPC valve)
pc. Port P_{10} (from L.H. travel PPC valve)
pd. Port P_9 (from L.H. travel PPC valve)
pe. Port P_8 (from swing PPC valve)
pf. Port P_7 (from swing PPC valve)
pg. Port P_6 (from boom PPC valve)
ph. Port P_5 (from boom PPC valve)
pi. Port P_4 (from R.H. travel PPC valve)
pj. Port P_3 (from R.H. travel PPC valve)
pk. Port P_2 (from bucket PPC valve)
pl. Port P_1 (from bucket PPC valve)
pm. Port P-2 (from boom PPC valve)
pn. Port P-1B (from arm PPC valve)
po. Port P-1a (from arm PPC valve)
pp. Port P-4 (from service PPC valve)
pq. Port P-3 (from service PPC valve)
pr. Port P-6 (from service PPC valve)
ps. Port P-5 (from service PPC valve)
pt. Port P-8 (from service PPC valve)
pu. Port P-7 (from service PPC valve)
gf. Port S_A (pressure sensor mount port)
gg. Port S_B (pressure sensor mount port)

Main structure of 10-spool valve (1/3)



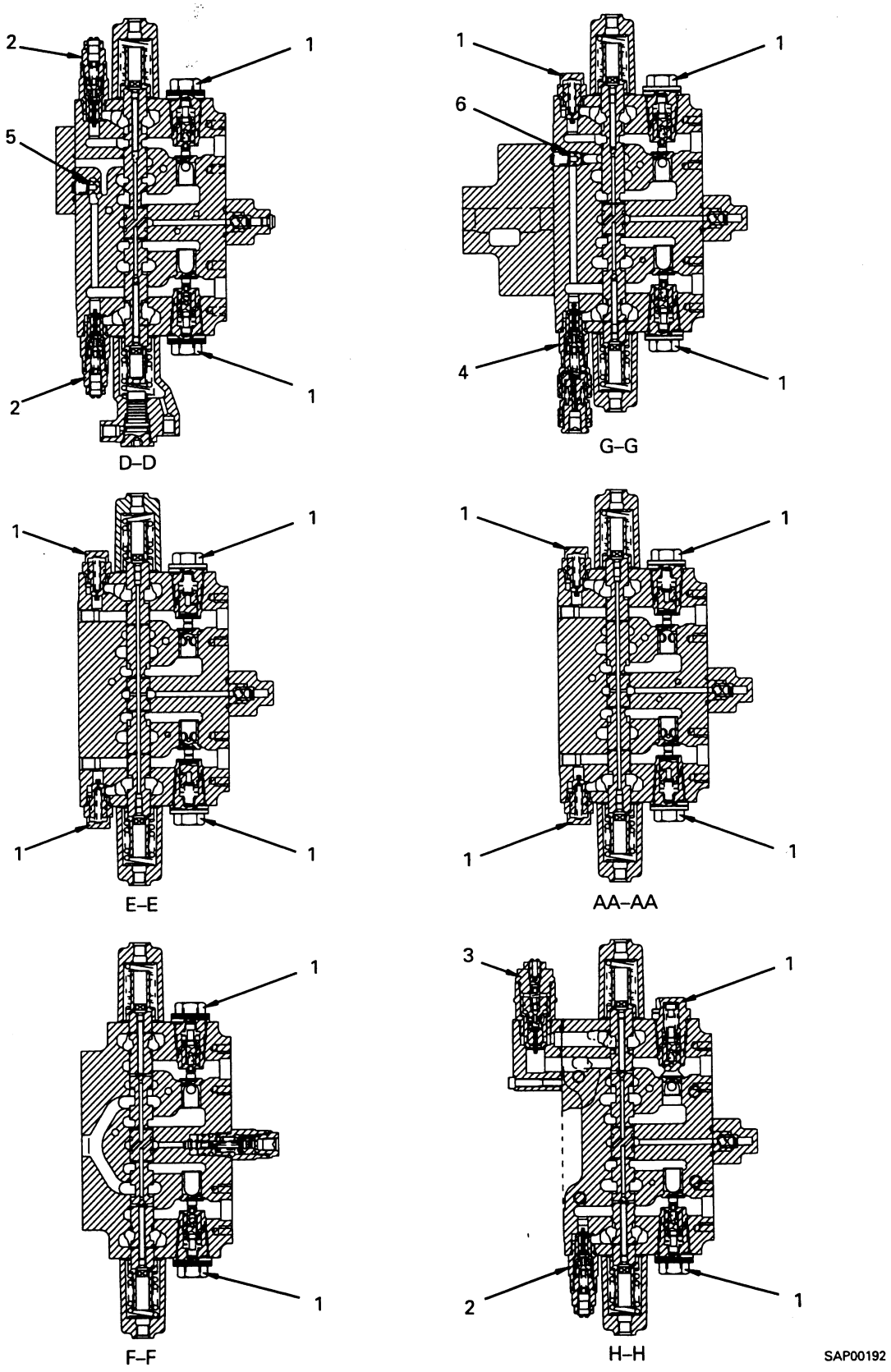
1. Spool (arm-Lo)
2. Spool (L.H. travel)
3. Spool (swing)
4. Spool (boom Lo)
5. Spool (R.H. travel)
6. Spool (bucket)
7. Spool (boom Hi)
8. Spool (arm Hi)
9. Spool (service)
10. Spool (service)
11. Spool (service)
12. Spool return spring
13. Main relief valve (bucket)
14. Main relief valve (arm Lo)
15. Unload valve (bucket)
16. Unload valve (arm Lo)
17. Piston (arm Lo stroke control)

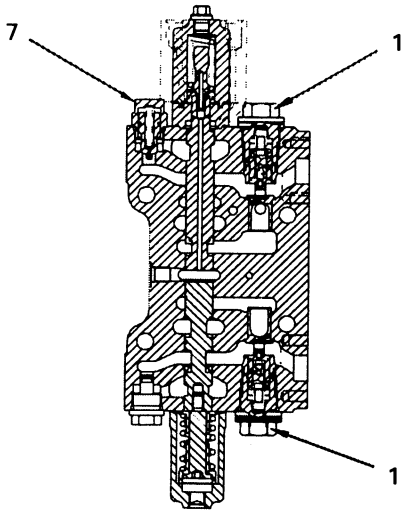
(2/3)



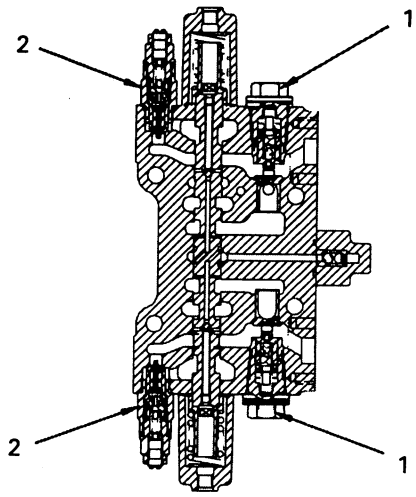
1. LS shuttle vlave
2. LS select valve
3. Merge/flow divider valve (main)
4. Return spring
5. Merge/flow divider valve (for LS)
6. Return spring
7. LS bypass valve

(3/3)

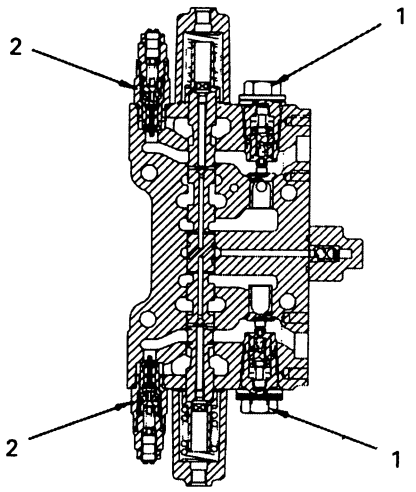




N–N



NA–NA



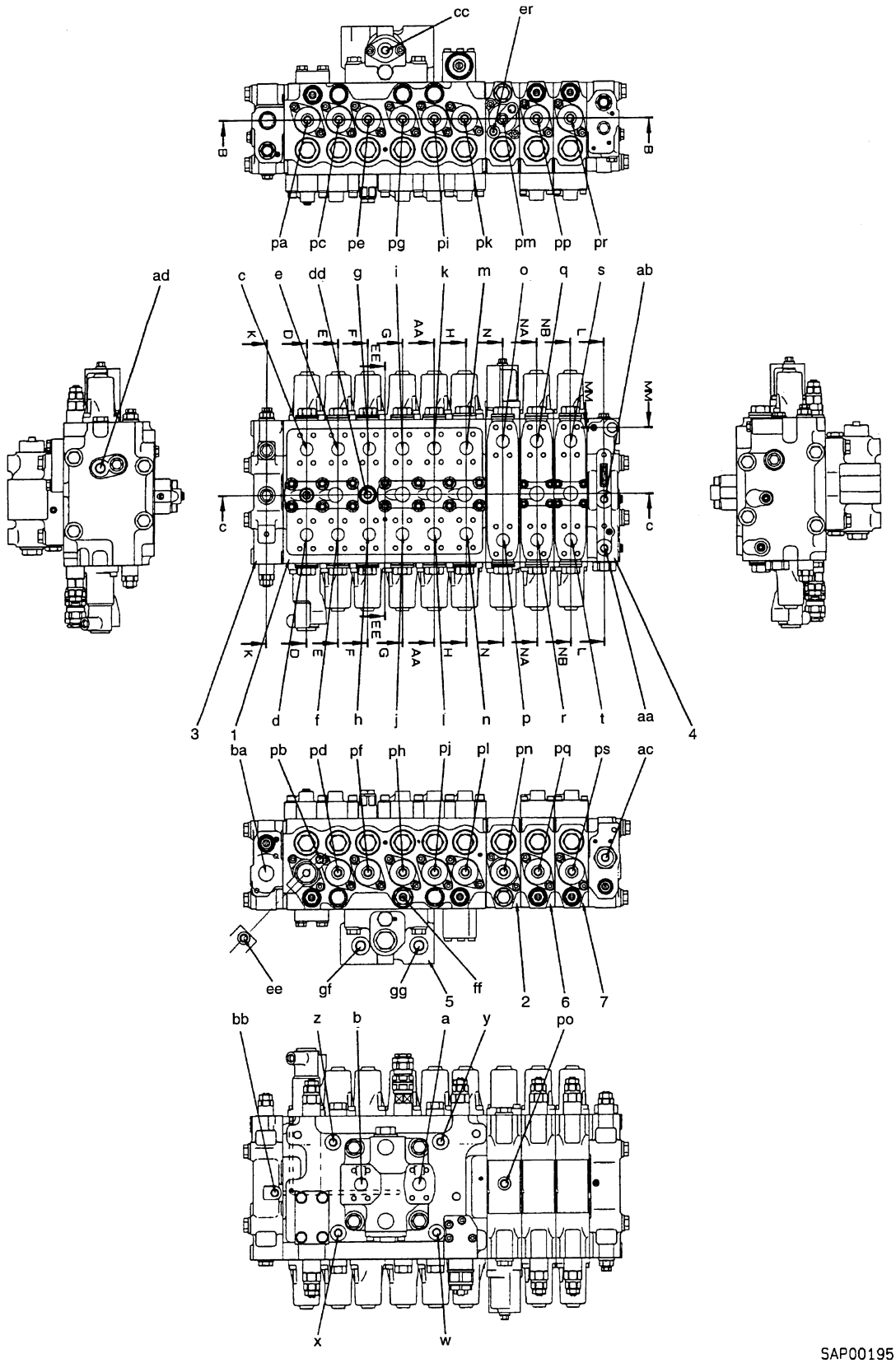
NB–NB

SAP00194

1. Pressure compensation valve
2. Safety-suction valve
3. Safety-suction valve (for large flow)
4. Safety-suction valve (2-stage)
5. Check valve for regeneration circuit (arm)
6. Check valve for regeneration circuit (boom)
7. Suction valve

9-spool valve (STD + service valve x 2)

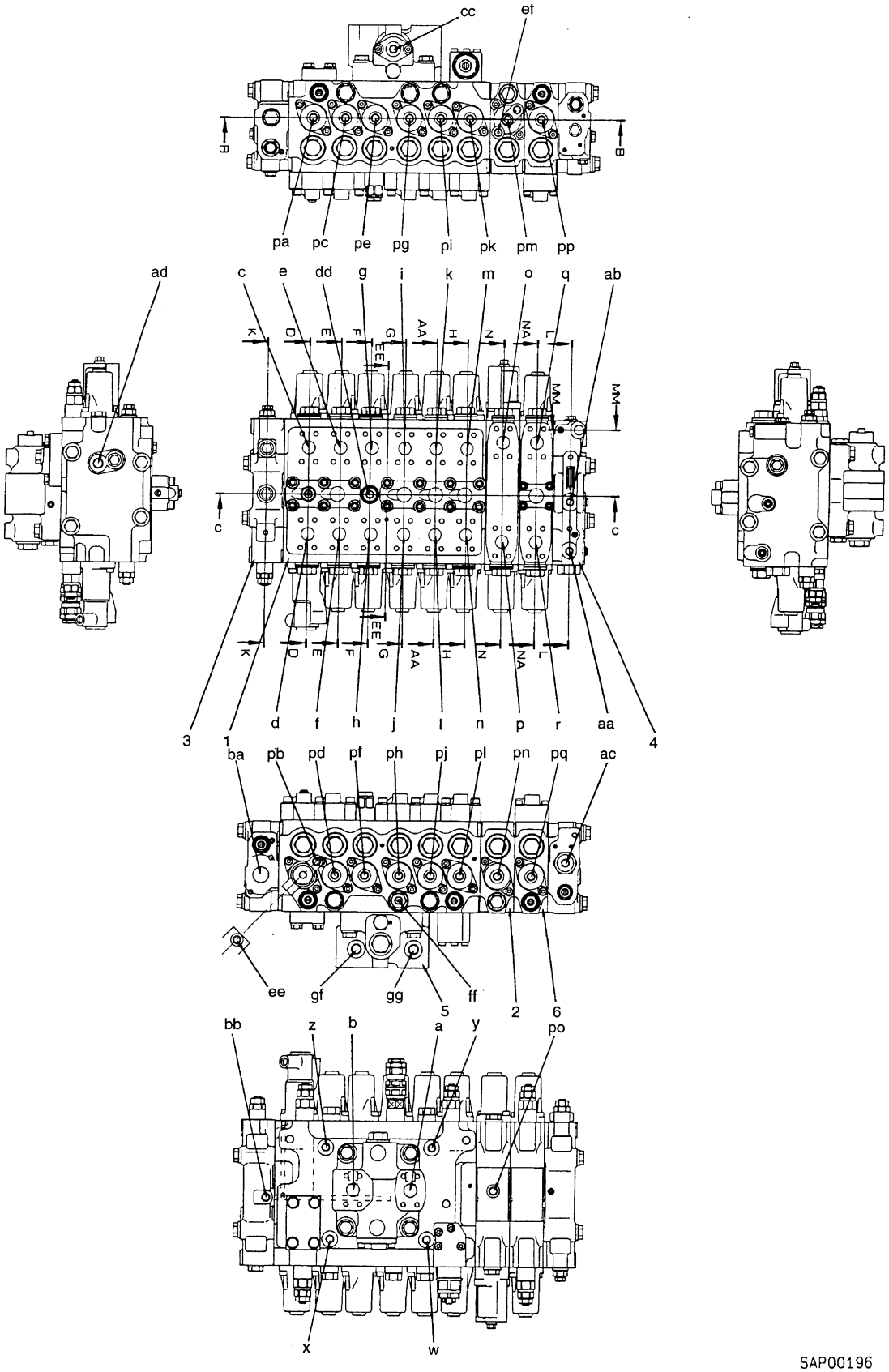
★ For details of the names of the port and the main structure, see 10-SPOOL VALVE
★ For details of this page, see Section 90.



SAP00195

8-spool valve (STD + service valve x 1)

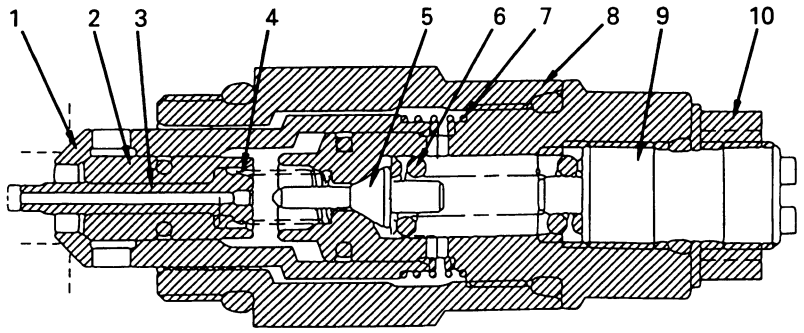
★ For details of the names of the ports and the main structure, see 10-SPOOL VALVE
★ For details of this page, see Section 90.



SAP00196

SUCTION SAFETY VALVE

FOR SERVICE VALVE



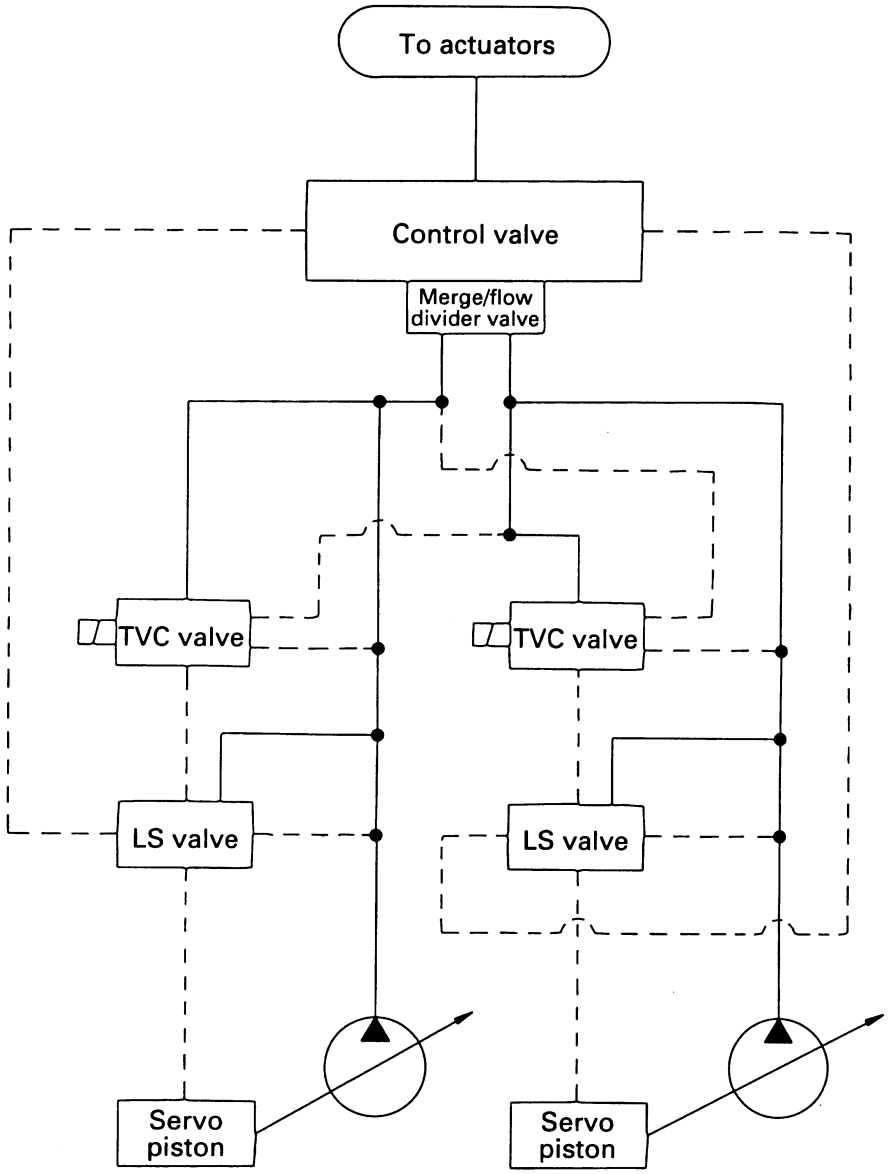
SBP00198

1. Suction valve
2. Main valve
3. Piston
4. Piston spring
5. Poppet
6. Poppet spring
7. Suction valve spring
8. Sleeve
9. Adjustment screw
10. Locknut

Part No.	Set pressure	Use
709-70-74800	20.6 MPa (210 kg/cm²) at 190 ℓ/min	For breaker
709-70-75100	20.1 MPa (205 kg/cm²) at 5 ℓ/min	For breaker
709-70-75300	16.7 MPa (170 kg/cm²) at 190 ℓ/min	For breaker
709-70-74600	24.5 MPa (250 kg/cm²) at 5 ℓ/min	For crusher

CLSS

Outline of CLSS



SBP00199

Outline

- CLSS stands for Closed center Load Sensing System, and has the following features.

Features

- Fine control not influenced by load.
- Control enabling digging even with fine control.
- Ease of compound operation ensured by flow divider function usting area of opening of spool during compound operations.
- Energy saving using variable pump control.

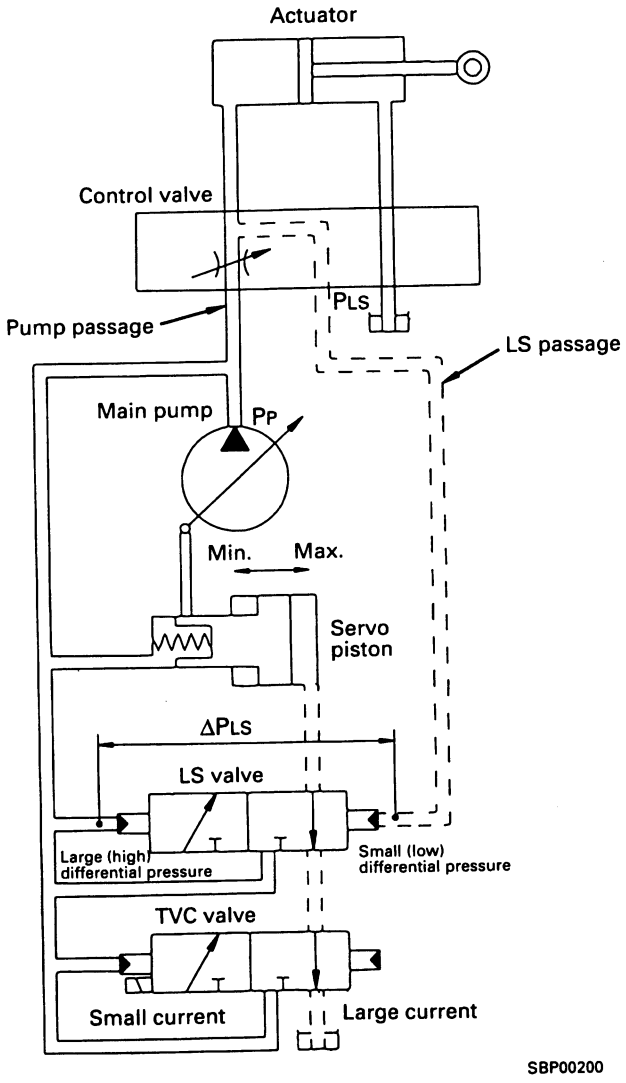
Structure

- The CLSS consists of a main pump (2 pumps), control valve, and actuators for the work equipment.
- The main pump consists of the pump itself, the TVC valve and LS valve.

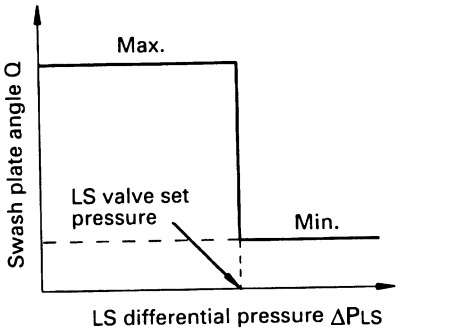
Basic principle

1) Control of pump swash plat angle

- The pump swash plate angle (pump discharge amount) is controlled so that LS differential pressure ΔPLS (the difference between pump pressure PP and control valve outlet port LS pressure PLS) (load pressure of actuator) is constant.
  (LS pressure ΔPLS = Pump discharge pressure PP - LS pressure PLS)



SBP00200

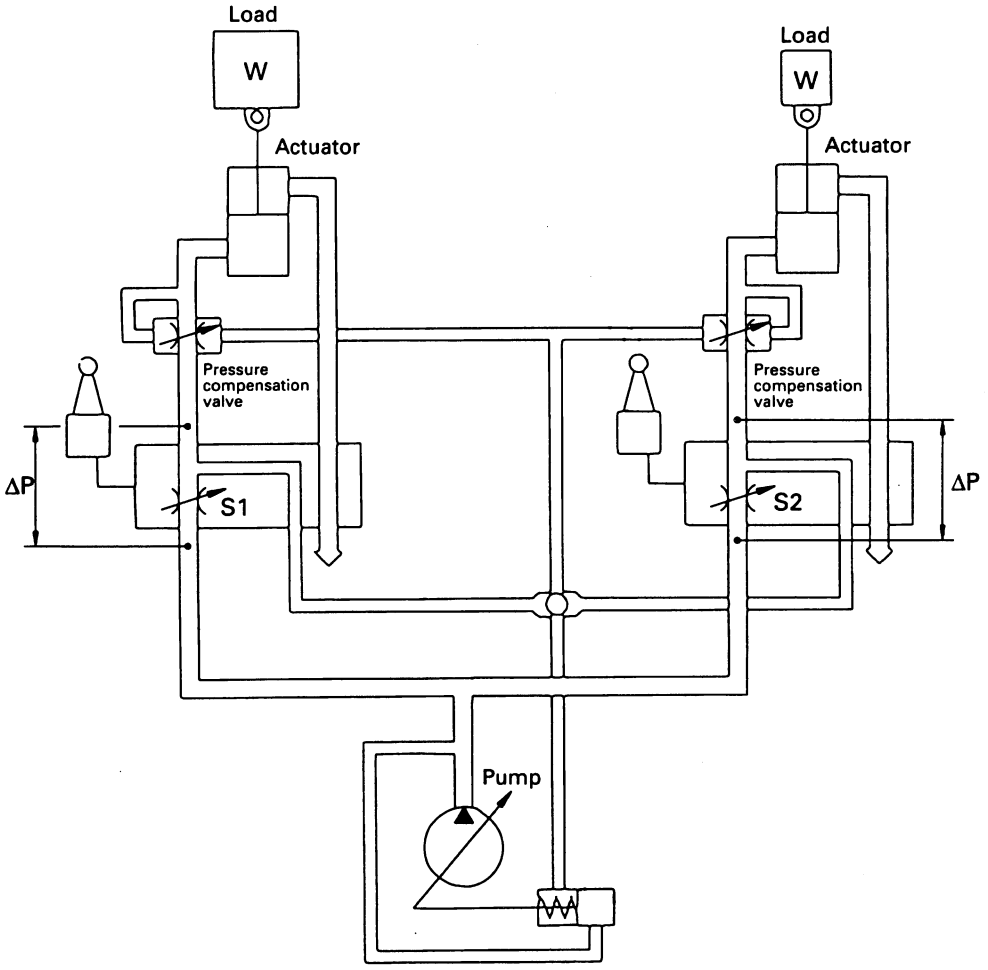


SAP00384

- If LS differential pressure ΔPLS becomes lower than the set pressure of the LS valve (when the actuator load pressure is high), the pump swash plate moves towards the maximum position; if it becomes higher than the set pressure of the LS valve (when the actuator load pressure is low), the pump swash plate moves towards the minimum position.)

2) Pressure compensation

- A pressure compensation valve is installed to the outlet port side of the control valve to balance the load. When two actuators are operated together, this valve acts to make pressure difference **ΔP** between the upstream (inlet port) and downstream (outlet port) of the spool of each valve the same regardless of the size of the load (pressure).
  In this way, the flow of oil from the pump is divided (compensated) in proportion to the area of openings **S1** and **S2** of each valve.

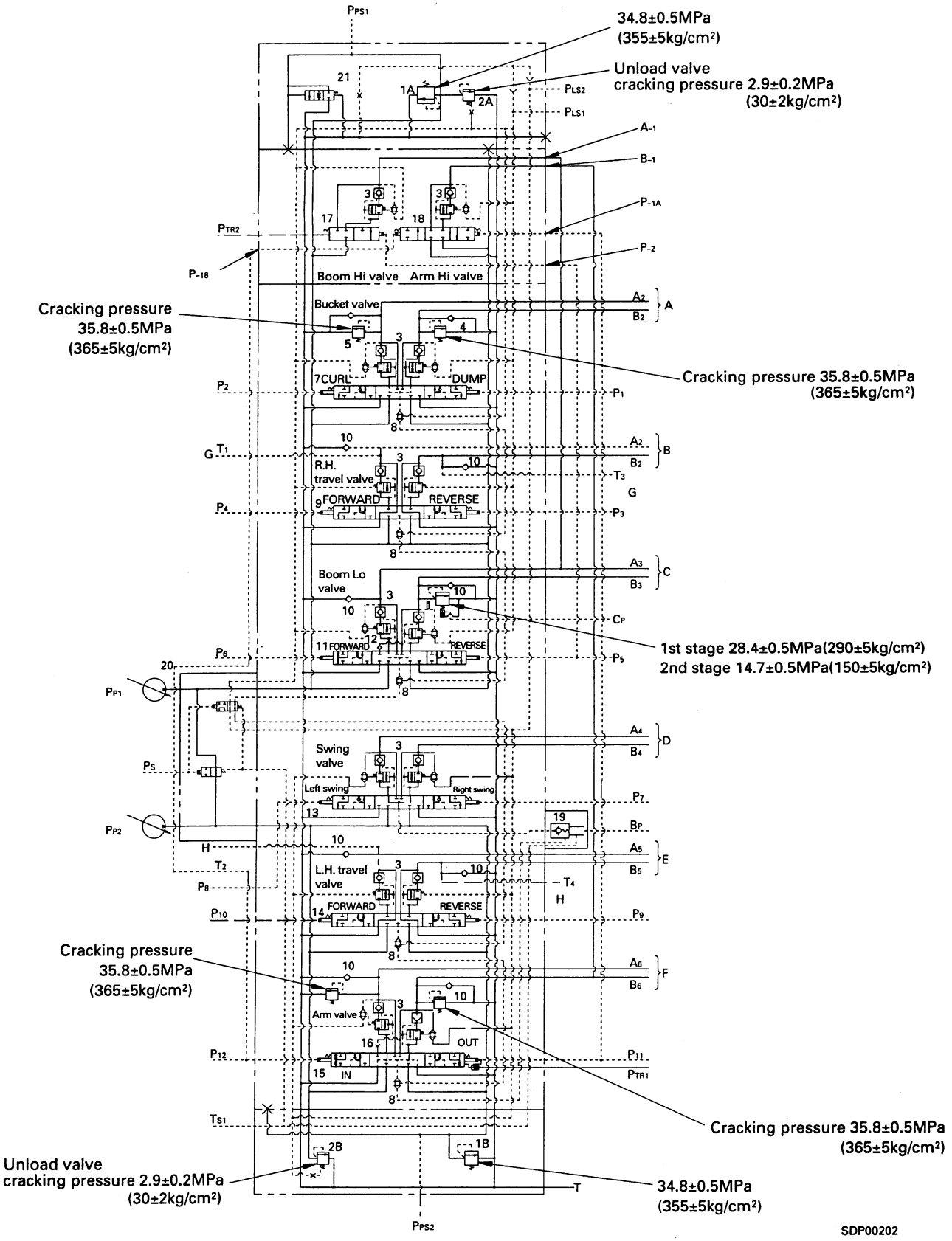


SBP00201

Operation for each function of CLSS

Hydraulic circuit diagram for system

★ For details of this page, see Section 90.

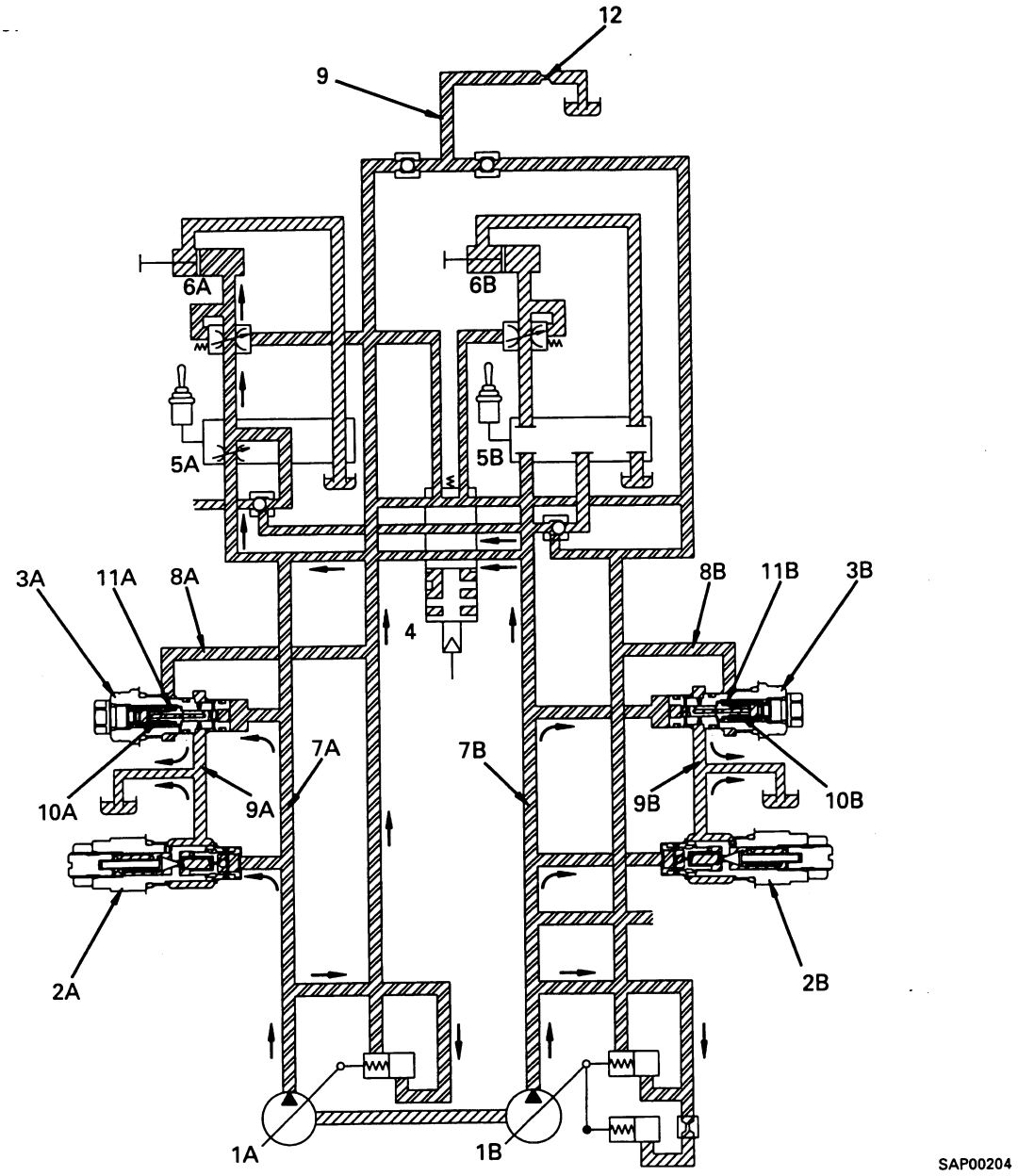


1A. Main relief valve (bucket group)
1B. Main relief valve (arm group)
2A. Unload valve (bucket group)
2B. Unload valve (arm group)
3. Pressure compensation valve
4. Safety-suction valve
5. Safety-suction valve (for large flow)
6. Safety-suction valve (2-stage)
7. Bucket spool
8. LS shuttle valve
9. R.H. travel spool
10. Suction valve
11. Boom Lo spool
12. Check valve (for boom regeneration circuit)
13. Swing spool
14. L.H. travel spool
15. Arm Lo spool
16. Check valve (for arm regeneration circuit)

17. Boom Hi spool
18. Arm Hi spool
19. LS select valve
20. Merge/flow divider valve
21. LS bypass valve
A. To bucket cylinder
B. To R.H. travel motor
C. To boom cylinder
D. To swing motor
E. To L.H. travel motor
F. To arm cylinder
G. To travel junction valve

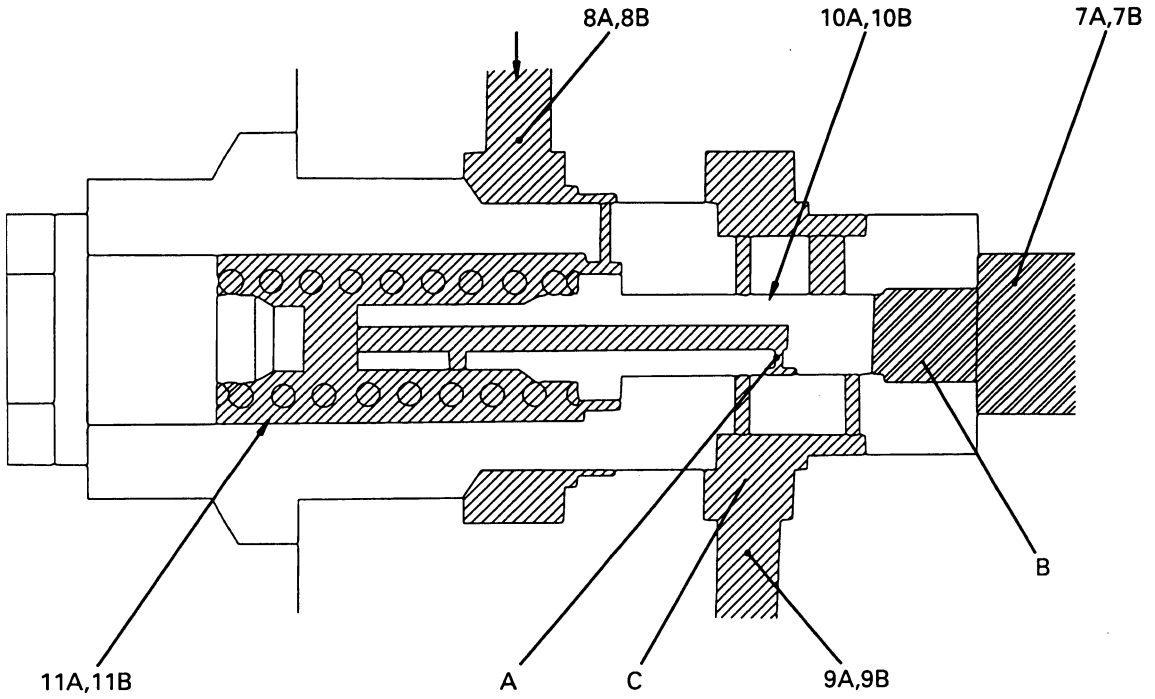
SYSTEM DIAGRAM

★ This shows actuator (6A) at stroke end relief in the merge mode.



1A. Main pump
1B. Main pump
2A. Main relief valve
2B. Main relief valve
3A. Unload valve
3B. Unload valve
4. Merge/flow divider valve
5A. Control valve
5B. Control valve
6A. Actuator
6B. Actuator
7A. Pump passage
7B. Pump passage
8A. LS circuit
8B. LS circuit
9A. Tank passage
9B. Tank passage
10A. Valve
10B. Valve
11A. Spring
11B. Spring
12. LS bypass valve

1. When unload valve is actuated



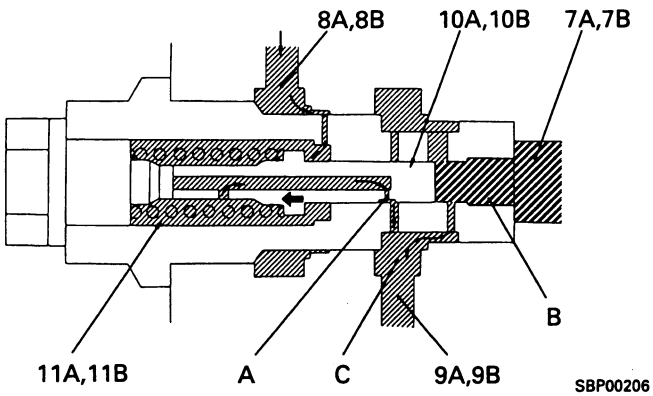
SBP00205

Function

- When all the control valves are at neutral, the oil discharged when the pump is at the minimum swash plate angle is drained. When this happens, the pump pressure becomes a pressure that matches the set load of springs (11A, 11B) inside the valve (**P1** pressure). The **LS** pressure is drained from **LS** bypass valve (12), so **LS** pressure ≒ tank pressure ≒ 0 MPa (0 kg/cm²).
- When operated (for operations in the discharge range for the minimum swash plate angle), the discharge pressure of the oil discharged with the pump at the minimum swash plate angle is **LS** pressure + **P1** pressure. In other words, the LS control differentail pressure (**ΔPLS**) of the oil discharged at the minimum swash plate angle is the **P1** pressure.

Operation

- The pressure in pump passages (7A, 7B) is received by the end face of valves 10A, 10B). The control valve is at neutral, so the pressure in LS circuits (8A, 8B) is 0 MPa (0 kg/cm²).
- The pressurized oil in pump passages (7a, 7b) is stopped by valves (10A, 10B). There is no way for the pressurized oil discharged by the pump to escape, so the pressure rises.
  When this pressure becomes larger than the force of springs (11A, 11B), valves (10A, 10B) move to the left, ports **B** and **C** are connected and the pump pressure flows to tank passages (9A, 9B). In addition, the pressurized oil in LS circuits (8A, 8B) passes from orifice **A** through port **C**, and is drained to tank passages (9A, 9B). Therefore, when the valve is actuated, **LS** pressure ≒ tank pressure.
- When the unload operation is carried out, the differential pressure (pump discharge pressure - LS circuit pressure) is greater than the pump LS control pressure, so a signal is sent to move the pump swash plate to the minimum angle.



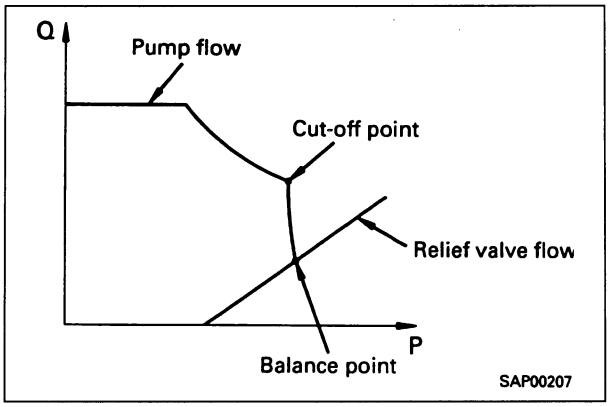
SBP00206

2. At LS relief

(1) Cut-off control actuated

Function

- When cut-off control is being carried out on the pump by the TVC valve, the pump swash plate angle is at the minimum.
- The relief valve acts to relieve the oil flow when the pump is at the minimum swash plate angle in order to maintain the overall balance.



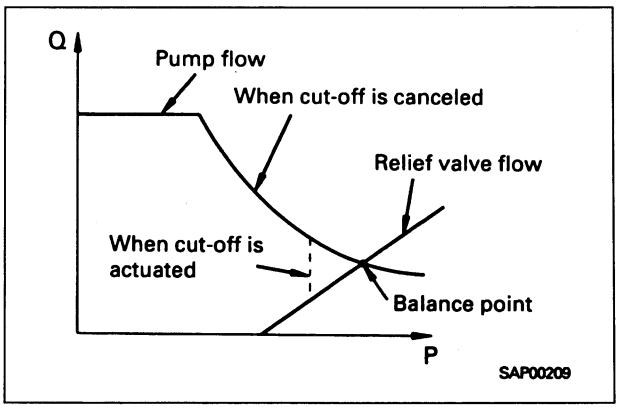
Operation

- When the cylinder reaches the end of its stroke, main relief valves (2A, 2B) open and pump discharge amount **Q** is relieved to tank passages (9A, 9B).
- When pump delivery pressure **PP** comes close to the relief pressure, the governor, pump controller sends a signal to the solenoid of the TVC valve and carries out the cut-off function to make pump discharge amount **Q** the minimum.
- The spool is at the end of its stroke, so there is no flow of oil upstream or downstream from the spool. As a result, pump delivery pressure **PP** and LS pressure **PLS** are almost the same pressure, and LS differential pressure **ΔPLS** becomes 0.
- LS differential pressure **ΔPLS** is lower than the LS set pressure of the LS valve, so the Ls valve acts to try to move the pump swash plate angle to the maximum. However, because of the structure, the action of the TVC valve is given priority over the action of the LS valve, so the pump is held at the minimum swash plate angle by the cut-off function of the TVC valve.

(2) Cut-off canceled (power max. mode, fine control mode, travel)

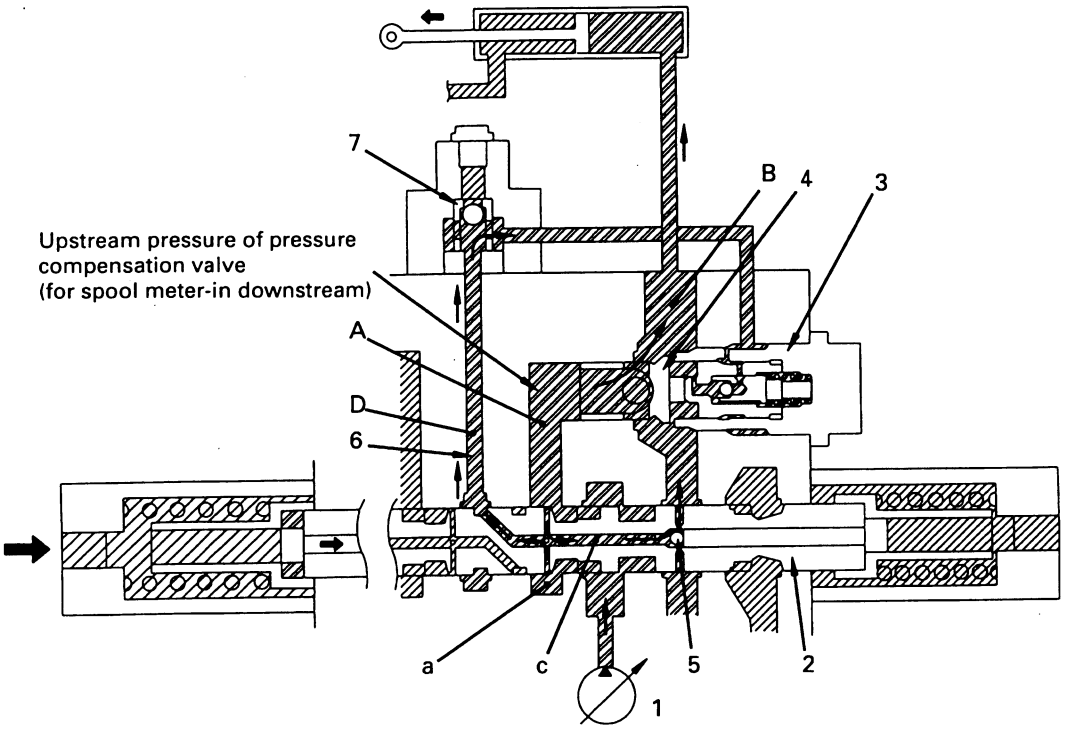
Function, operation

- In the power max. mode, fine control mode, or travel mode, the torque cut-off signal is not given, so the torque moves on the pump output curve.
- When this happens, the pump discharge amount is relieved from the relief valve, so the overall balance is maintained.



3. Introduction of LS pressure

★ The diagram shows the condition for arm IN.



SLP00210

1. Main pump
2. Main spool
3. Pressure compensation valve
4. Valve
5. Ball valve
6. LS circuit
7. LS shuttle valve

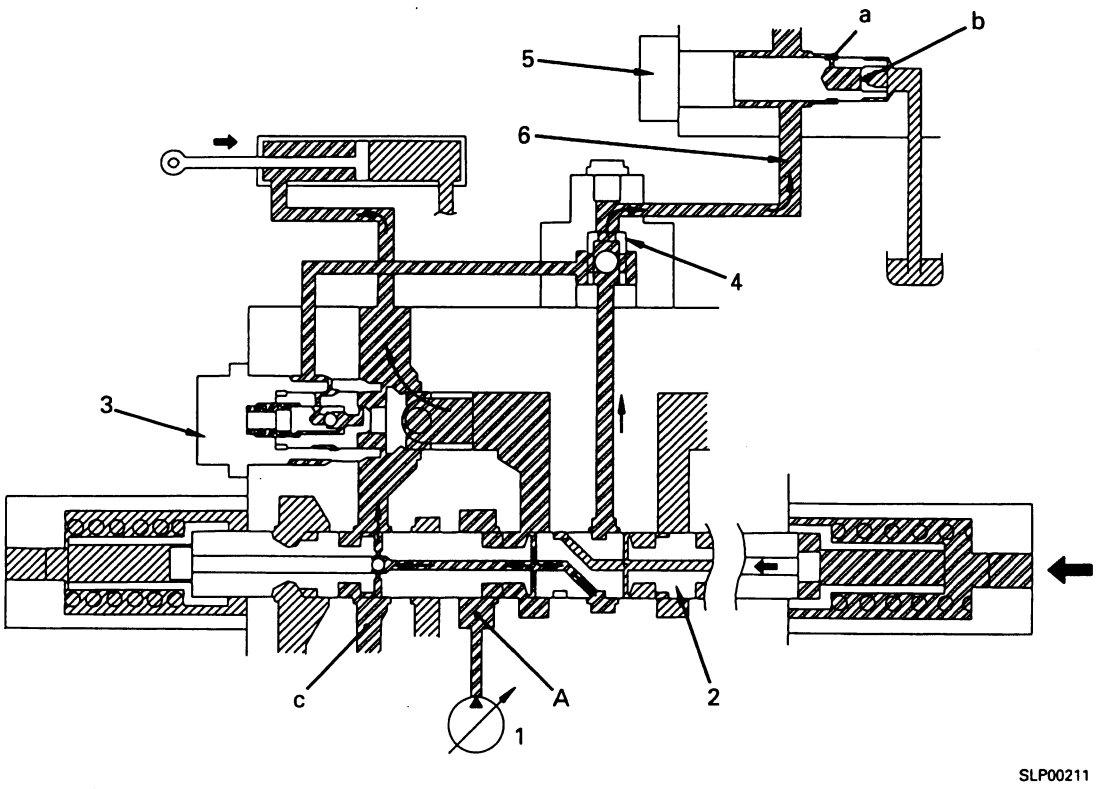
Function

- The upstream pressure (= spool meter-in downstream pressure) of pressure compensation valve (3) is introduced and goes to shuttle valve (7) as the **LS** pressure. When this happens, it is connected to port **B** of the actuator through valve (4), and **LS** pressure ≒ actuator load pressure. Introduction hole **a** inside the spool has a small diameter, so it also acts as a throttle.

Operation

- When spool (2) is operated, the pump pressure passes through introduction hole **a**, enters port **C**, and is taken to the LS circuit. When the pump pressure rises and reaches the load pressure of port **B**, ball valve (5) opens.

4. LS bypass valve

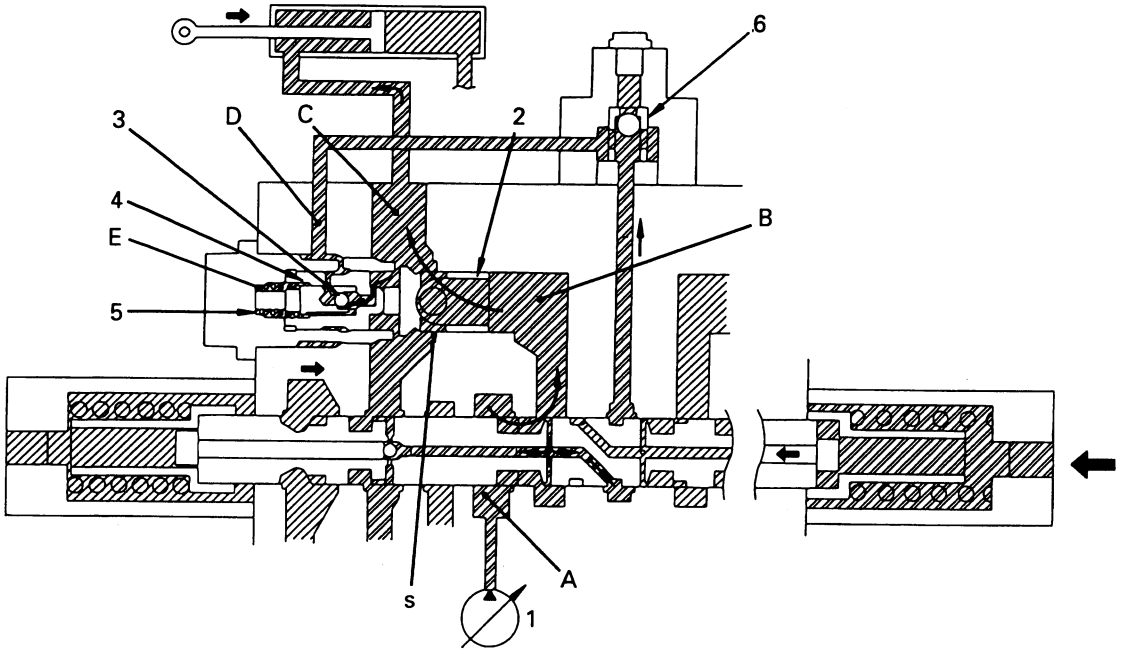


1. Main pump
2. Main spool
3. Pressure compensation valve
4. LS shuttle valve
5. LS bypass valve
6. LS circuit

Function

- The residual pressure in LS circuit (6) is released from orifices **a** and **b**.
- This reduces the speed of the rise in the LS pressure, and pevents any sudden change in the oil pressure. Furthermore, a pressure loss is generated by the circuit resistance between throttle **c** of main spool (2) and LS shuttle valve (4) according to the bypass flow from LS bypass valve (5). As a result, the effective LS differential pressure drops, and the dynamic stability of the actuator is increased.

5. Pressure compensation valve



SLP00212

1. Main pump
2. Valve
3. Shuttle valve
4. Piston
5. Spring
6. LS shuttle valve

Function

1) During independent operation and at maximum load pressure (during compound operations, when load pressure is higher than other work equipment)

- The pressure compensation valve acts as a load check valve.

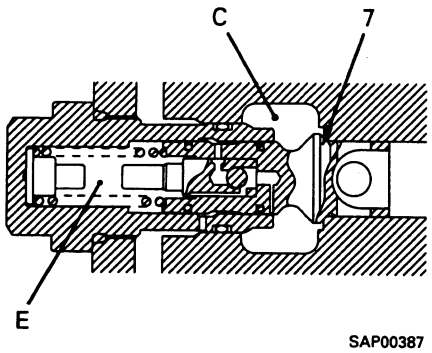
Operation

- If the pump pressure (LS pressure) is lower than the load pressure at port **C**, shuttle valve (3) inside pressure compensation valve piston (4) moves to interconnect spring camber **E** and port **C**.
  From this condition, the force of spring (5) acts to move piston (4) and valve (2) in the direction of closing.

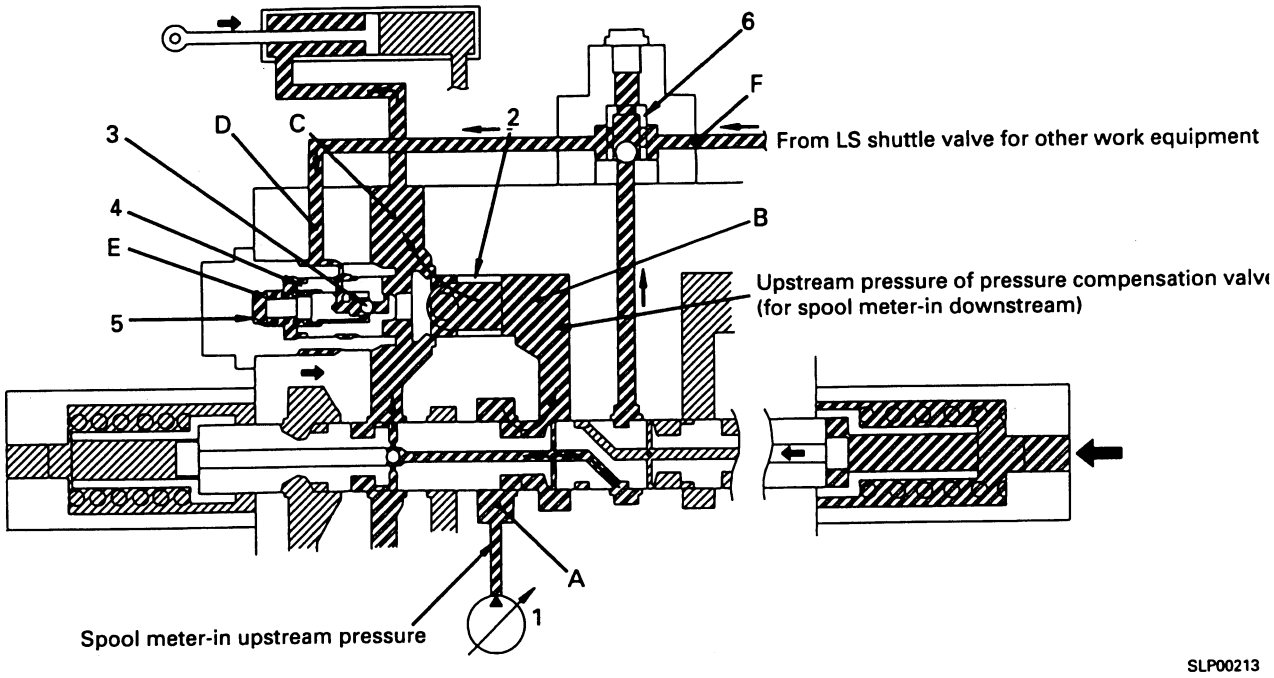
Reference: Integrated pressure compensation valve

- When high peak pressure is generated in the actuator circuit or when peak pressure is generated repeatedly over a continuous period (such as when using a breaker), valve (2) may hit valve chamber seat s and generate a high stress. To prevent this, an intergrated pressure compensation valve combining valve (2) and piston (4) is used. On this machine, this is employed for the bucket valve (at the cylinder bottom) and service valve.

With the integrated compensation valve, as a basic rule, port **C** and spring chamber **E** are not interconnected, so even if a high peak pressure is generated at port **C**, valve (7) does not hit the valve chamber.
(However, the system is designed so that port **C** and spring chamber **E** are interconnected just before the bucket valve is seated.)



SAP00387



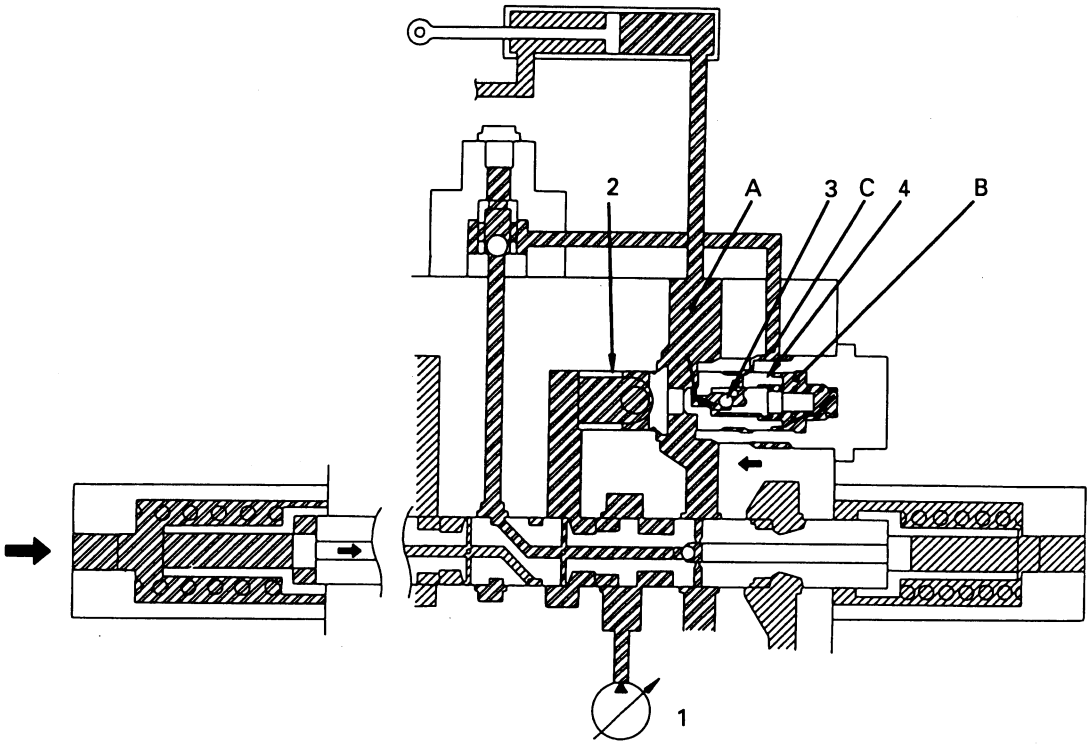
2) When receiving compensation (during compound operations, when load pressure is lower than other work equipment)

- The pressure compensation valve is closed by the LS pressure of port **D**, and the spool meter-in downstream pressure of port **B** becomes the same as the maximum pressure of the other work equipment. The spool meter-in upstream pressure of port **A** is the pump pressure, so spool meter-in differential pressure (upstream pressure (pressure of port **A**) - downstream pressure (pressure of port **B**)) becomes the same for all spools that are being operated. In this way, the pump flow is divided in proportion to the area of the meter-in opening.

Operation

- Spring chamber **E** is interconnected with port **D**. Piston (4) and valve (2) are actuated by the LS circuit pressure from the other work equipment at port **F** in the direction of closing (to the right). In other words, the valve upstream pressure of port **B** (=spool meter-in downstream pressure) is controlled by the **LS** pressure.

6. Shuttle valve inside pressure compensation valve



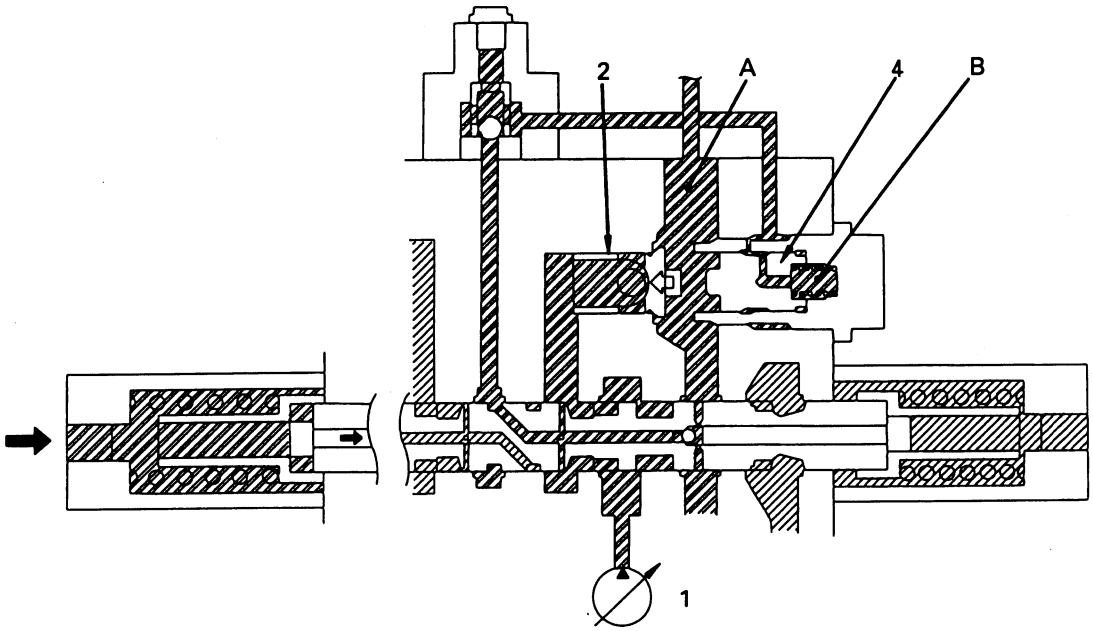
SLP00214

1. Main pump
2. Valve
3. Shuttle valve inside pressure compenstion valve
4. Piston

Function

When holding pressure at port A > LS pressure in spring chamber B.

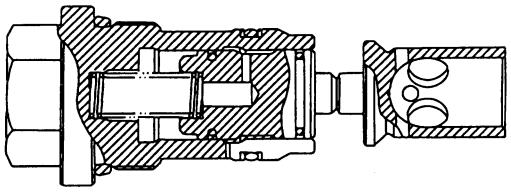
- Shuttle valve (3) is pushed to the right by the pressure of port **A**, and the circuit between ports **A** and **C** is shut off. In this condition, the holding pressure at port **A** is taken to spring chamber **B**, and pushes piston (4) to the left to prevent piston (4) and valve (2) from separating.



SLP00215

<For travel>

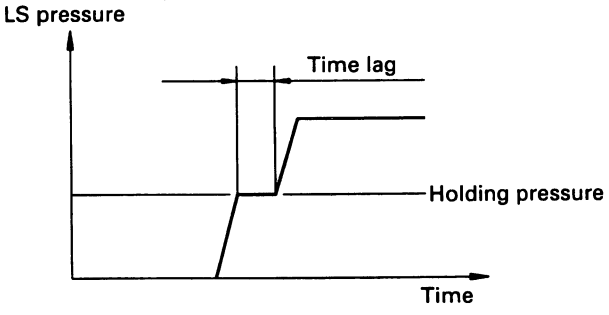
- No holding pressure is generated at port **A** in the travel circuit, so a pressure compensation valve without a shuttle valve is used.



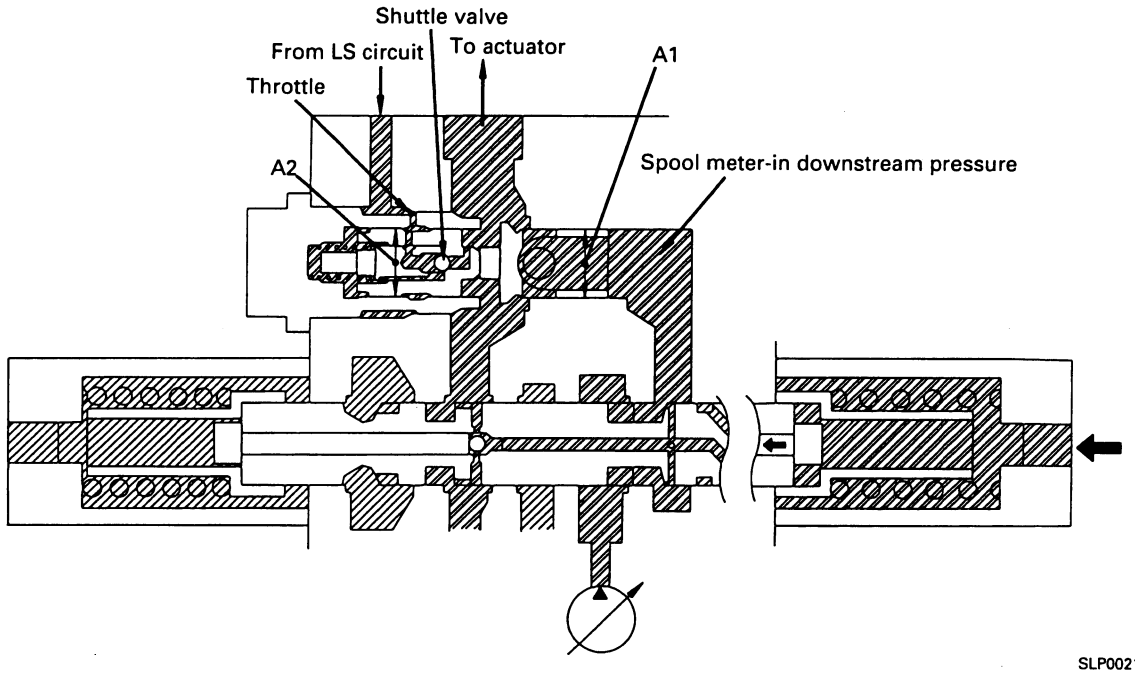
SBP00216

Reference: When there is no shuttle valve

- If there is no shuttle valve, piston (4) and valve (2) will seperate. In this condition, if another actuator is operated, the piston acts as an accumulator, so there is a time lag.



SAP00217



<Area ratio of pressure compensation valve>
The condition of the flow division changes according to the ratio of the areas of portion **A1** and portion **A2** of the pressure compensation valve.
Area ratio = **A2/A1**

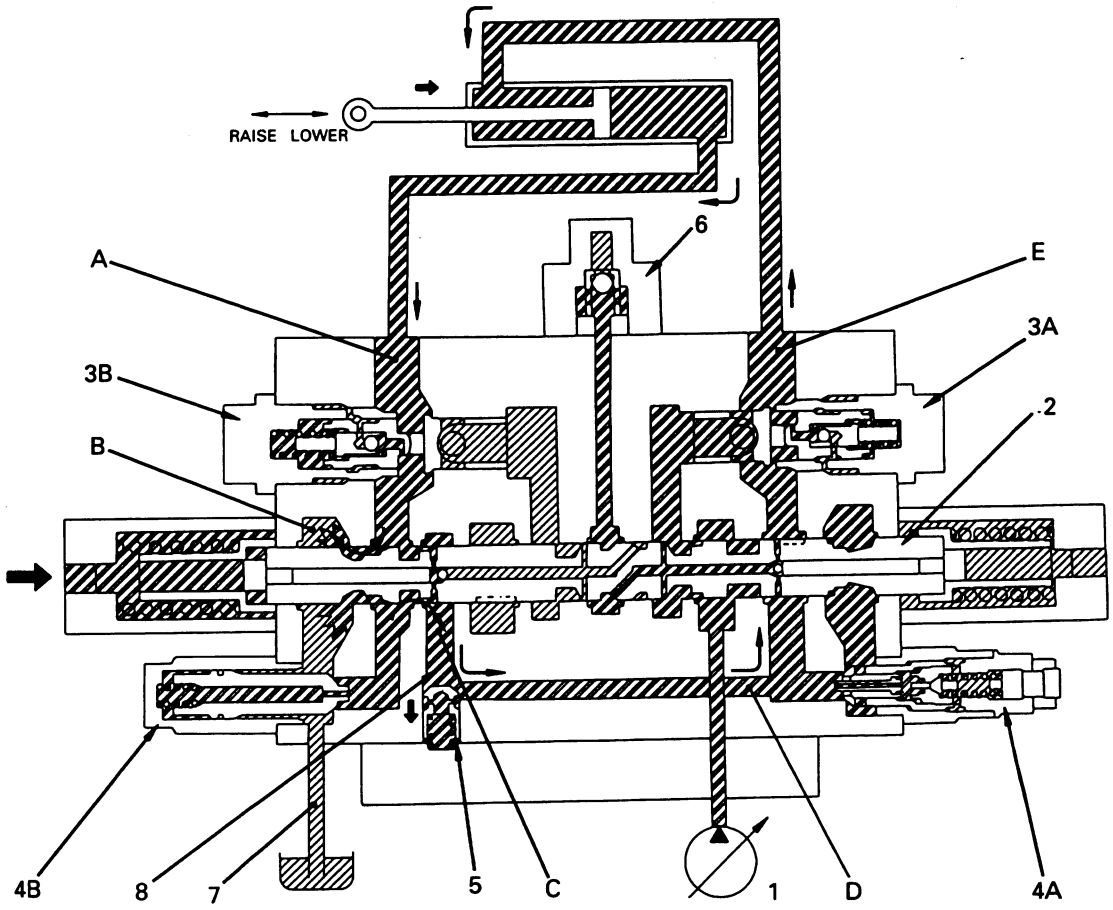
- When area ratio = 1: Spool meter-in downstream pressure = max. load pressure, and oil flow is divided in proportion to area of opening.
- When ratio is more than 1: Spool meter-in downstream pressure > Max. load pressure, and a smaller oil flow is divided than proportion between the areas of opening.
- When ratio is less than 1: Spool meter-in downstream pressure < Max. load pressure, and a larger oil flow is divided than the proportion between the areas of opening.

Area ratio for each part of work equipment

	Port A		Port B	
	Area ratio	Throttle diameter (mm)	Area ratio	Throttle diameter (mm)
Bucket	★ 0.88 (CURL)	ø2.0	0.88 (DUMP)	ø2.0
L.H./R.H. travel	0.98	ø1.0	0.98	ø1.0
Boom	0.98 (RAISE) (both Lo and Hi valves)	ø1.0	0.98 (LOWER)	ø2.0
Swing	0.88	ø2.0	0.88	ø2.0
Arm	0.90 (OUT)	ø2.0	0.98 (IN) (both Lo and Hi valves)	ø2.0
Service (for 2-spool valve)	★ 0.94	ø2.0	★ 0.94	ø2.0
Service (for 1-spool valve)	★ 0.98	ø2.0	★ 0.98	ø2.0

★ Intergrated pressure compensation valve

7. Boom regeneration circuit



SLP00220

1. Main pump
2. Main spool
3A. Pressure compensation valve
3B. Pressure compensation valve
4A. Suction valve (with safety)
4B. Suction valve
5. Check valve
6. LS shuttle valve
7. Drain circuit
8. Regeneration circuit

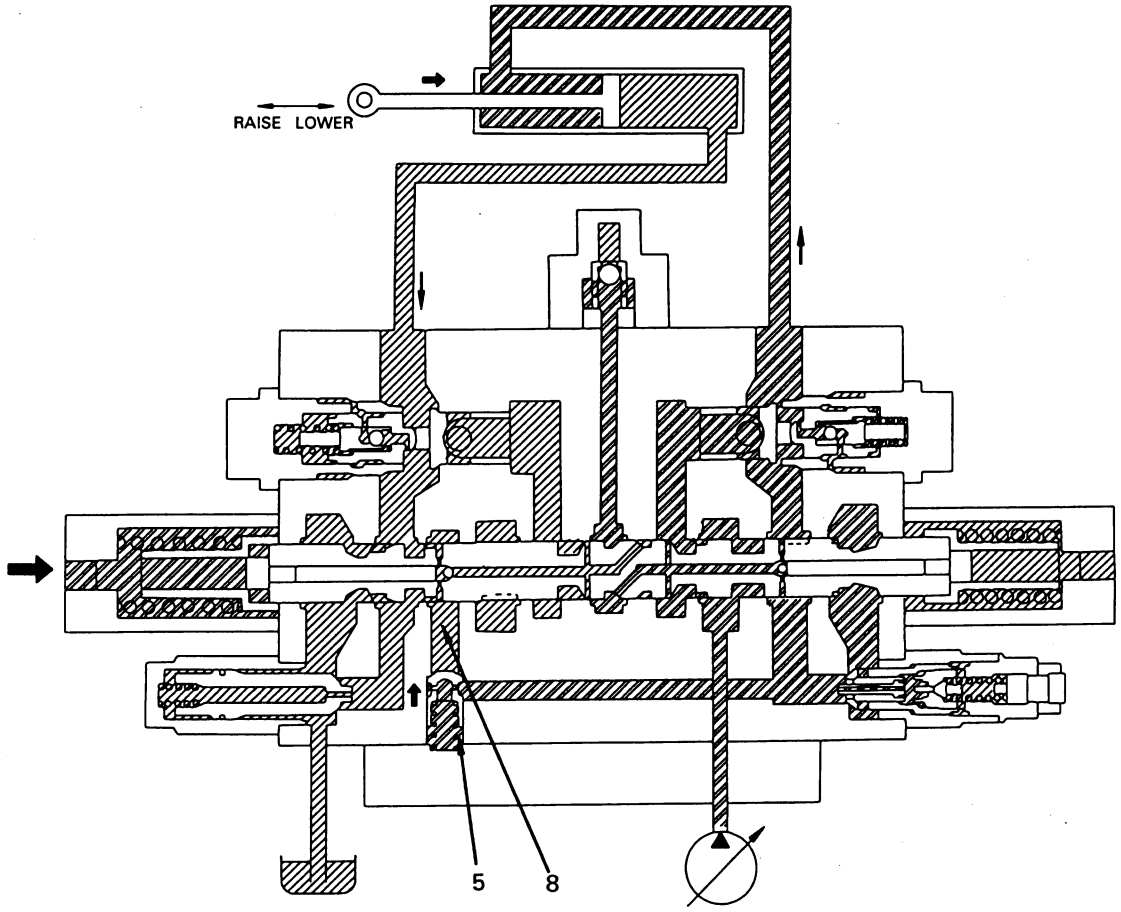
Function

1) Cylinder head pressure < cylinder bottom pressure (free fall, etc.)

- A return flow circuit is provide from the cylinder bottom to the cylinder head so that when the boom is lowered, the return flow can be used to increase the flow of oil from the pump to the cylinder bottom.

Operation

- When the cylinder head pressure < cylinder bottom pressure, part of the pressurized oil from the cylinder bottom passes through the notch in spool (2), goes through port **B**, and enters drain circuit (7). The rest of the oil goes from port **C**, enters regeneration circuit (8), opens check valve (5), and passes through ports **C** and **D** to flow back to the cylinder head.

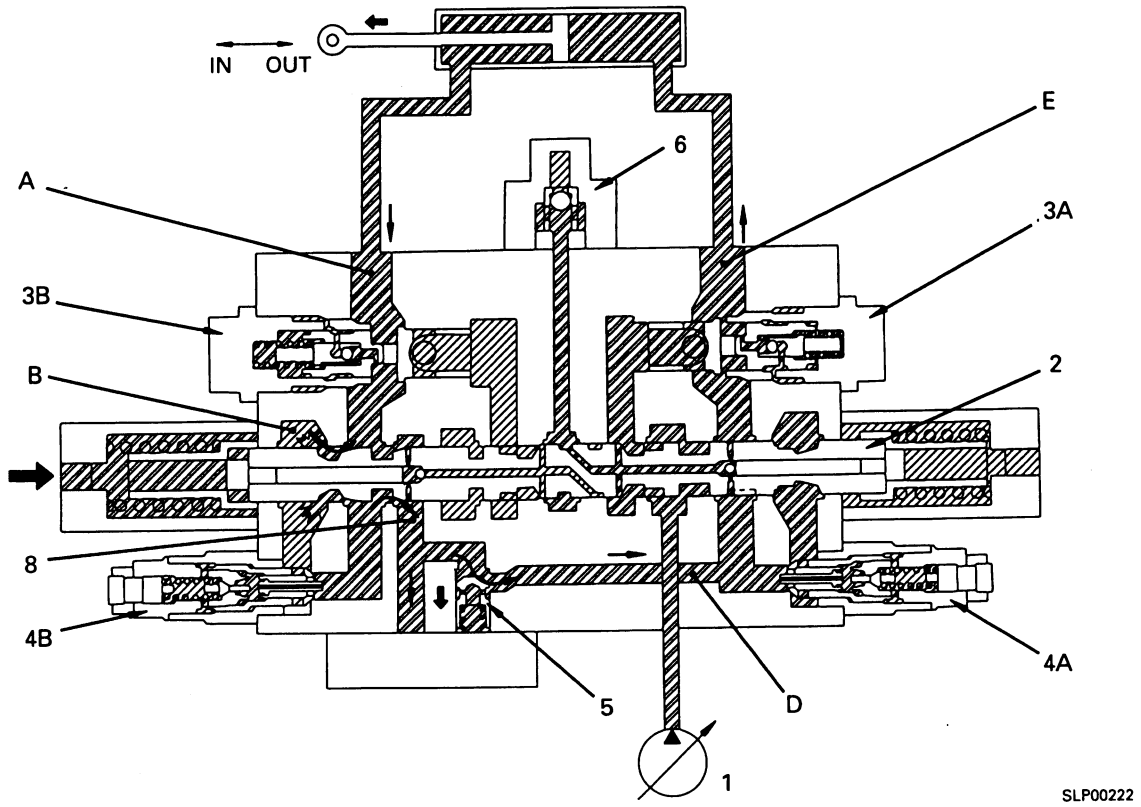


S LP00221

2) Cylinder head pressure > Cylinder bottom pressure (digging operations, etc.)

- Check valve (5) in regeneration circuit (8) acts to shut off the flow from the cylinder head to the cylinder bottom.

8. Arm regeneration circuit



1. Main pump
2. Main spool
3A. Pressure compensation valve
3B. Pressure compensation valve
4A. Safety valve
4B. Safety valve
5. Check valve
6. LS shuttle valve
7. Drain circuit
8. Regeneration circuit.

Function

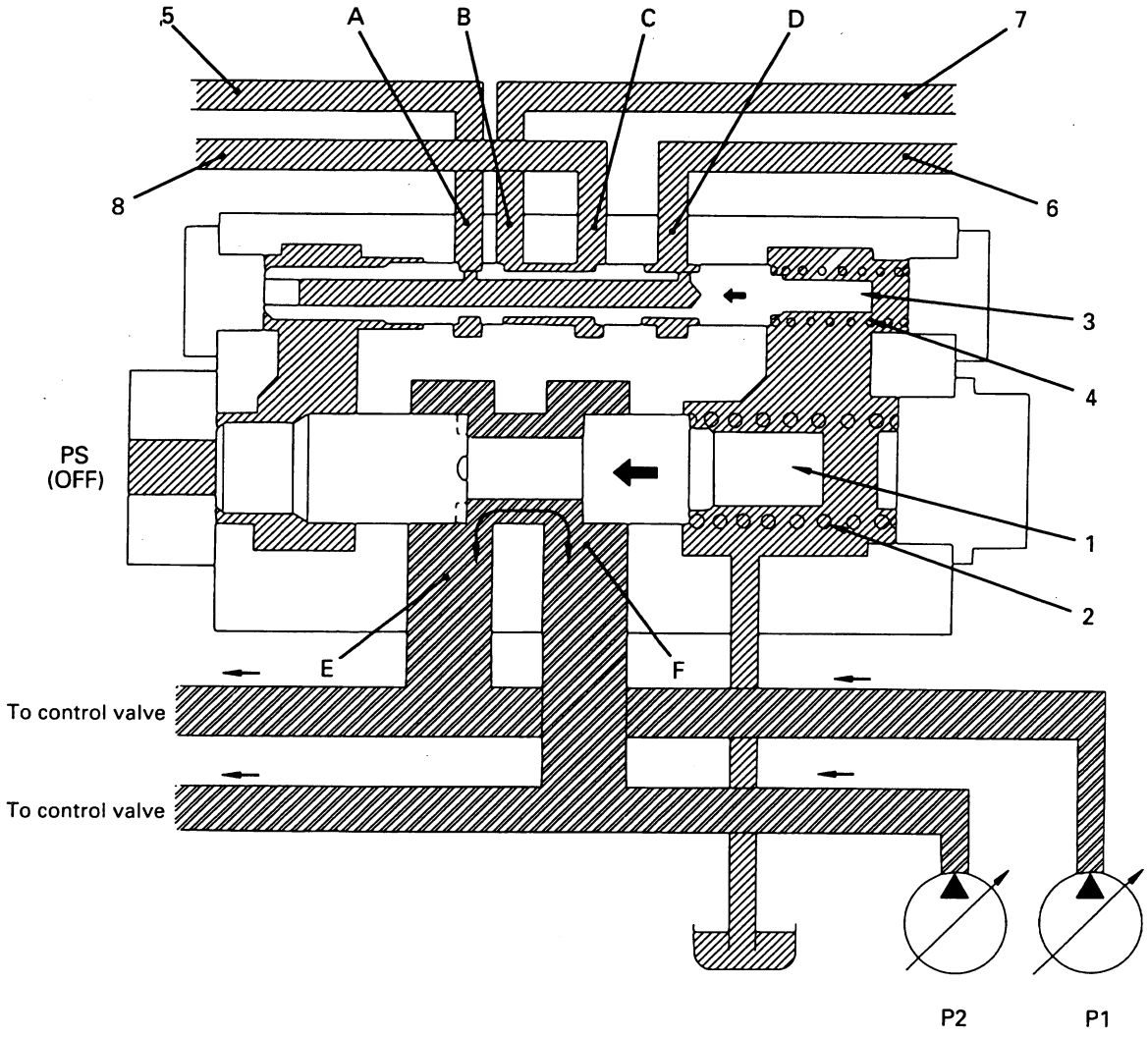
Cylinder head pressure > cylinder bottom pressure

- A return flow circuit is provide from the cylinder head to the cylinder bottom so that when the arm is moved IN, the flow of oil to the cylinder becomes the pump discharge amount + the return flow. This covers for any negative pressure at the cylinder bottom, and, as a result, increases the cylinder speed.

Operation

- When the cylinder head pressure > cylinder bottom pressure, the pressurized oil from the cylinder head passes through the notch in spool (2), enters port **C** and opens check valve (8), then passes through ports **D** and **E** to flow back to the cylinder bottom.

9. Merge/flow divider valve



1. Main spool
2. Spring
3. LS spool
4. Spring
5. LS circuit (bucket)
6. LS circuit (arm)
7. LS circuit (arm)
8. LS circuit (bucket)

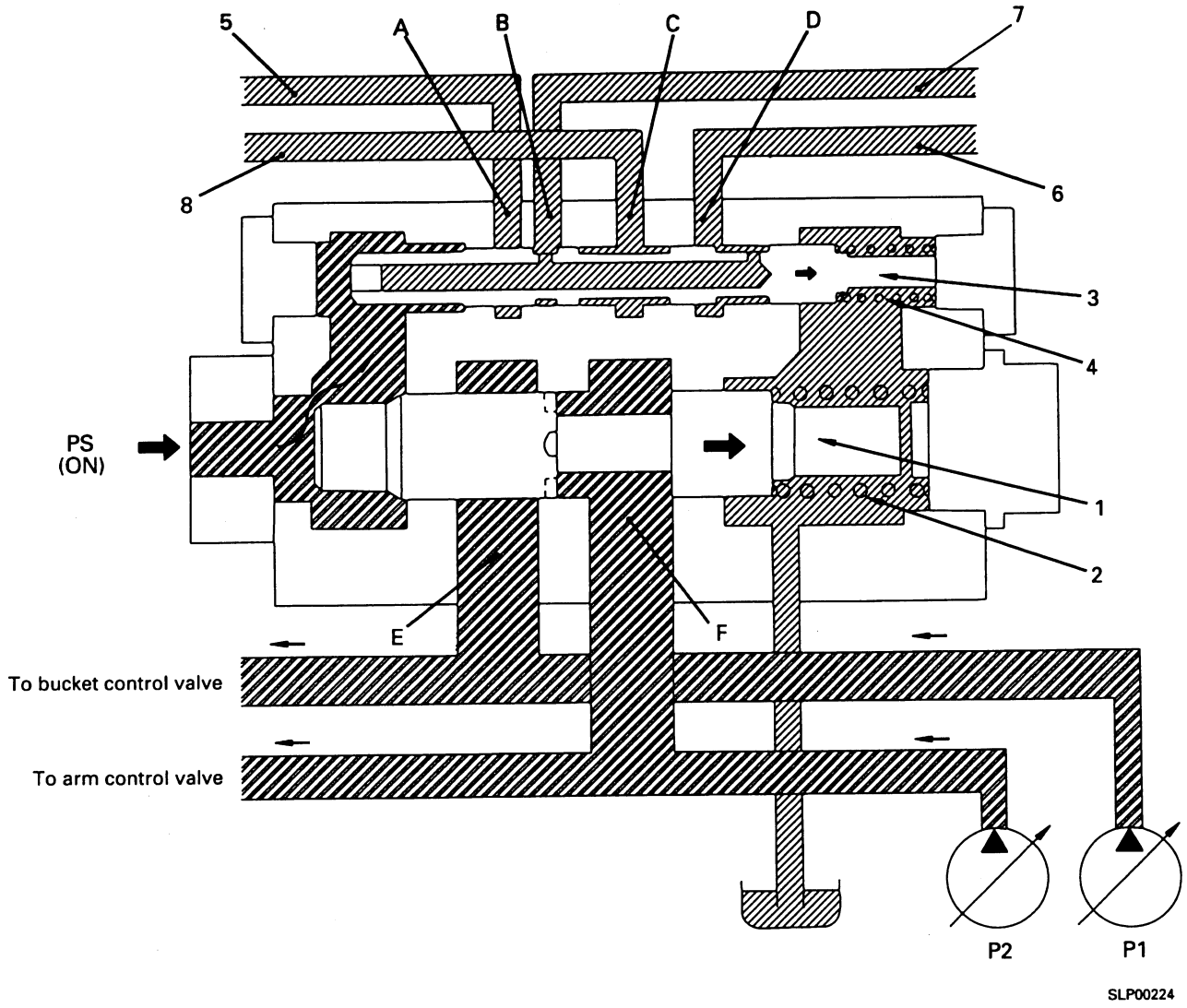
Function

- This acts to merge or divide (send each to its own control valve group) oil flows **P1** and **P2** of pressurized oil discharged from the two pumps.
- At the same time, it also carries out merging and dividing of the LS circuit pressure.

Operation

1) When merging pump flow (when pilot pressure PS is OFF

- Pilot pressure **Ps** is OFF, so main spool (1) is pushed fully to the left by spring (2), and ports **E** and **F** are interconnected.
  Therefore, pressurized oil flows **P1** and **P2** discharged from the two pumps are merged at ports **E** and **F**, and are sent to the control valve that demands the oil.
- In the same way, LS spool (3) is also pushed fully to the left by spring (4), so the ports are connected as follows.
  Connected ports: **A** ⟷ **D**, **B** ⟷ **C**
- Therefore, the **LS** pressure supplied from the spools of each control valve to LS circuits (5), (6), (7), and (8) is all sent to the pressure compensation valve and other valves.

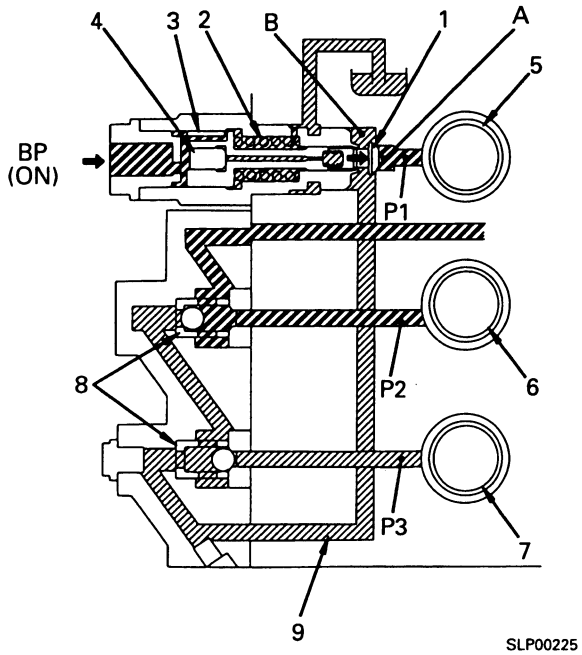


2) When dividing pump flow (when pilot pressure PS is ON)

- When pilot pressure **PS** is ON, main spool (1) is moved to the right by the **PS** pressure, and ports **E** and **F** are disconnected.
  Therefore, the pressurized oil discharged from each pump is sent to its own control valve group.
  Pressure **P1**: To bucket, R.H. travel, boom group
  Pressure **P2**: To swing, L.H. travel, arm group
- In the same way, LS spool (3) is also moved to the right by the **PS** pressure, and the ports are connected as follows.
  Connected ports: **B** ⟷ **D**, others are not connected as follows.
  Therefore, LS circuits (5), (6), (7), and (8) are all connected to their own control valve group.

10. LS select valve

★ The diagram shows the situation when the swing and left travel are operated at the same time. (BP pressure ON)



SLP00225

1. Valve
2. Spring
3. Piston
4. Piston
5. Swing spool
6. L.H. travel spool
7. Arm spool
8. LS shuttle valve
9. LS circuit

Function

- This valve is used to increase the ease of operating the work equipment prevents high pressure from being generated when the swing is operated. It also prevents the high **LS** pressure from the swing circuit from flowing into any other **LS** circuit when the swing is operated together with the work equipment.

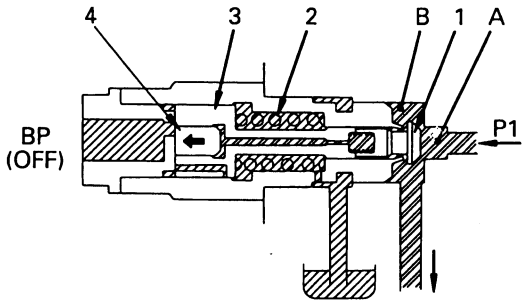
Operation

1) When pilot pressure BP is OFF

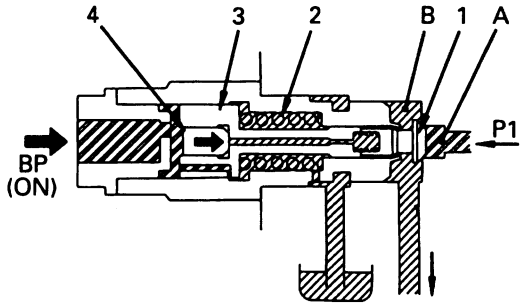
- Pilot pressure **BP** is OFF, so piston (3) is pushed to the left by spring (2). If the swing is then operated, swing LS pressure **P1** passes through swing spool (5) and enters port **A**. It pushes valve (1) to the left and connects ports **A** and **B**.
  Therefore, swing LS pressure **P1** flows to LS shuttle valve (8).

2) When pilot pressure BP is ON

- When pilot pressure **BP** is ON, piston (3) is moved to the right against spring (2) by the **BP** pressure. It pushes valve (1) to the right and closes the circuit between ports **A** and **B**. As a result, swing LS pressure **P1** stops flowing to LS shuttle valve (8), and even if swing LS pressure **P1** rises to a high pressure, it does not influence any other LS circuit.

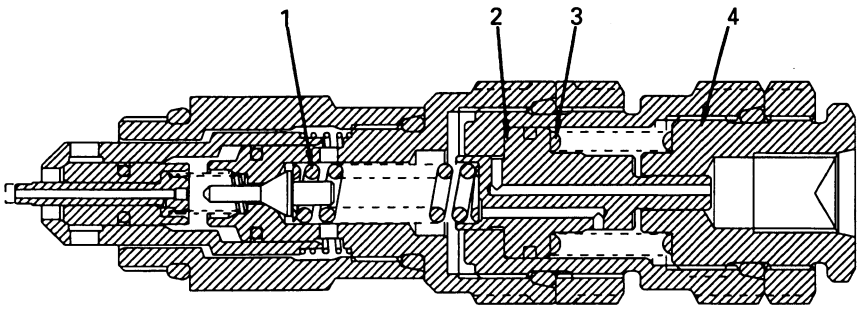


SLP00226



SLP00227

11. 2-stage safety valve (installed to boom cylinder head)



SAP00228

1. Spring
2. Piston
3. Spring
4. Holder

Function

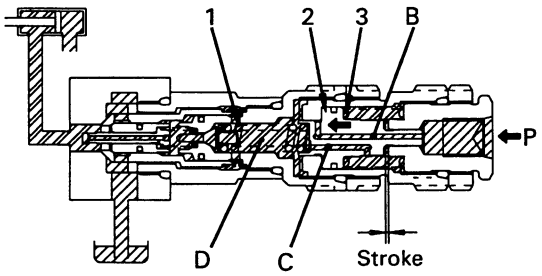
- The set pressure of the safety valve can be set to two stages and the low pressure setting can be made smaller. Because of this, when digging with boom, even if high pressure is brought to bear on the boom cylinder, it is possible to let the boom escape without operating the control lever. This makes it possible to carry out operations with high efficiency and with little vibration of the chassis.

Operation

- The set pressure of the safety valve is determined by the load pressure of spring (1).

1) When pilot pressure P is OFF: high pressure setting

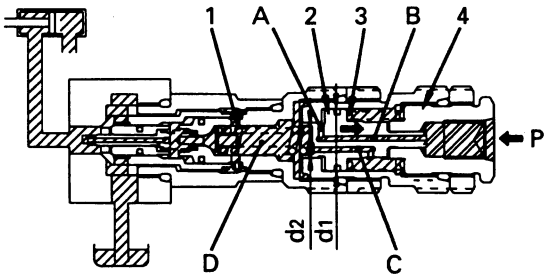
- Pilot pressure **P** is OFF, so piston (2) is pushed to the left by spring (3). (Installed load of spring (1) < installed load of spring (3)).
  When this happens, the installed load of spring (1) becomes the maximum, and the set pressure is set to high pressure.
  In addition, passage **B** is connected to the drain circuit through passage **C** and chamber **D**.



SAP00229

2) When pilot pressure P is ON: low pressure setting

- When pilot pressure **P** is ON, the pilot pressure goes to portion **A** through passage **B**, and piston (2) acts on the diameter of portion **A** receiving the pressure (**d2** - **d1**). Piston (2) is moved to the right against spring (3) by this pilot pressure.
  It moves the full stroke until it contacts holder (4). As a result, spring (1) extends, the installed load becomes the minimum, and the set pressure is set to low pressure.
  In addition, and amount of oil equivalent to the piston stroke passes through passage **C** and chamber **D**, and is drained.

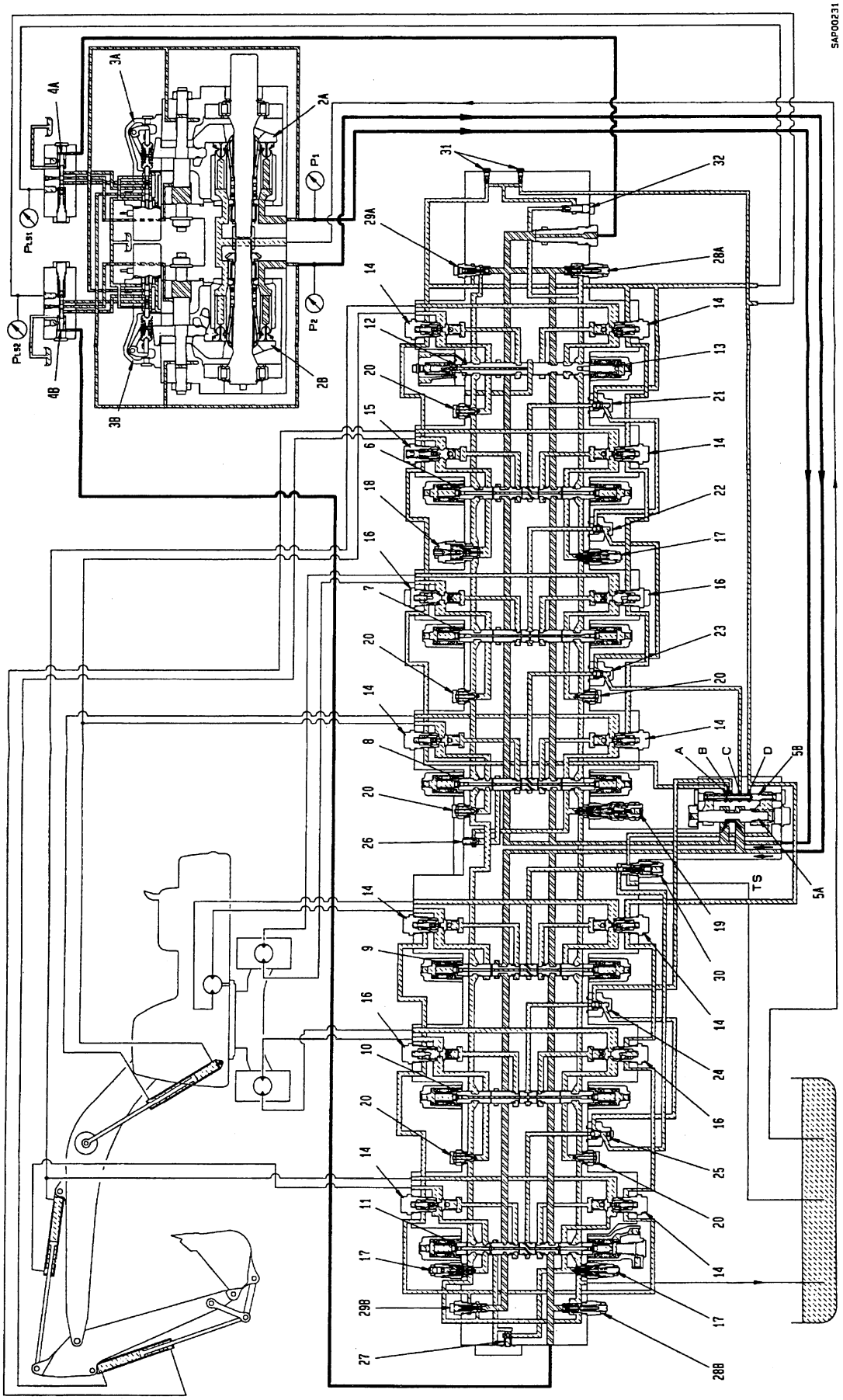


SAP00230

OPERATION OF CLSS SYSTEM AS A WHOLE

1. When all work equipment is at neutral

★ The diagram shows the situation when all work equipment is at neutral.
★ The valves and circuits that are not connected with the explanation of the operation of the CLSS hydraulic system have been omitted.
★ For details of this page, see Section 90.



1. Hydraulic tank
2A. Main pump (front)
2B. Main pump (rear)
3A. TVC valve (front)
3B. TVC valve (rear)
4A. LS valve (front)
4B. LS valve (rear)
5A. Merge/flow divider valve (main)
5B. Merge/flow divider valve (for LS)
6. Bucket spool
7. R.H. travel spool
8. Boom Lo spool
9. Swing spool
10. L.H. travel spool
11. Arm Lo spool
12. Boom Hi spool
13. Arm Hi spool
14. Pressure compensation valve (with shuttle valve)
15. Pressure compensation valve (with shuttle valve, integrated type) (bucket CURL)
16. Pressure compensation valve (without shutle valve) (travel)
17. Safety-suction valve
18. Safety-suction valve (bucket CURL)
19. 2-stage safety-suction valve (boom LOWER)
20. Plug
21. LS shuttle valve (bucket)
22. LS shuttle valve (R.H. travel)
23. LS shuttle valve (boom)
24. LS shuttle valve (L.H. travel)
25. LS shuttle valve (arm)
26. Check valve (for boom regeneration circuit)
27. Check valve (for arm regeneration circuit)
28A. Main relief valve (bucket group)
28B. Main relief valve (arm group)
29A. Unload valve (bucket group)
29B. Unload valve (arm group)
30. LS select valve
31. LS check valve
32. LS bypass valve

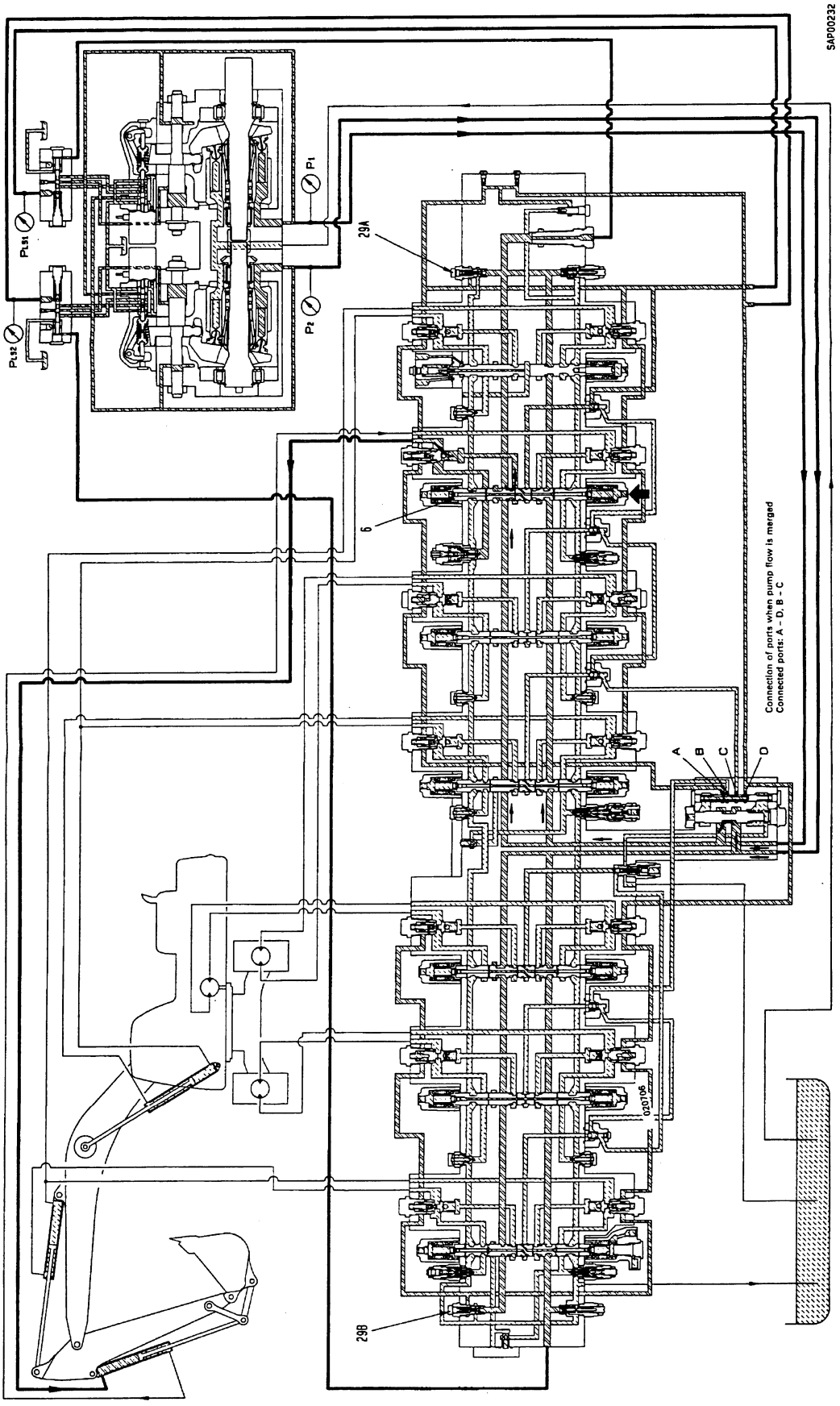
Note: Groups of control valves by main pump circuit
Bucket group: Bucket, R.H. travel, boom Lo, boom Hi, Arm Hi
Arm group: Swing, L.H. travel, arm Lo

Operation

- When the levers are at neutral, the pump is at the minimum swash plate angle, and the oil flow is drained from unload valves (29A, 29B).
- The LS pressure is connected to hydraulic tank (1) by LS bypass valve (32). The LS differential pressure ΔP_{LS} (unload pressure - tank pressure) at this point is ΔP_{LS} > pump LS control pressure, so the pump swash plate angle is the minimum.

2. Pump flow merged, bucket CURL operated independently

★ For details of this page, see Section 90.



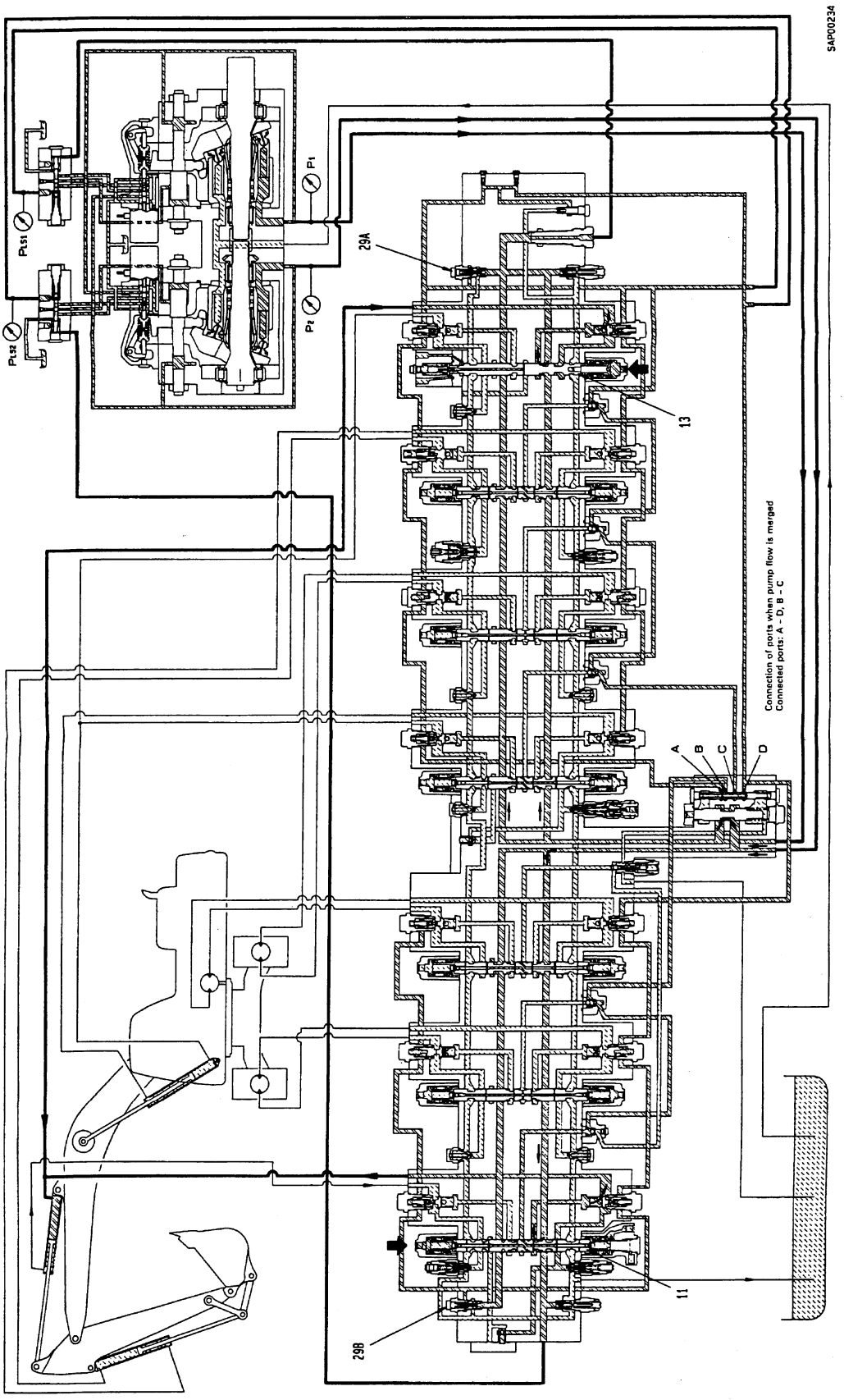
Operation

- When the bucket CURL is operated, unload valves (29A, 29B) are closed.
- The swash plate of the main pump is controlled (LS control) to match the area of the meter-in opening of bucket spool (6), so the pump swash plate is balanced at a position which matches the oil flow demande by the spool meter-in.

(Δ**PLS** = pump LS control pressure)

4. Pump flow merged, arm IN operated independently (Arm Lo valve + arm Hi valve)

★ For details of this page, see Section 90.

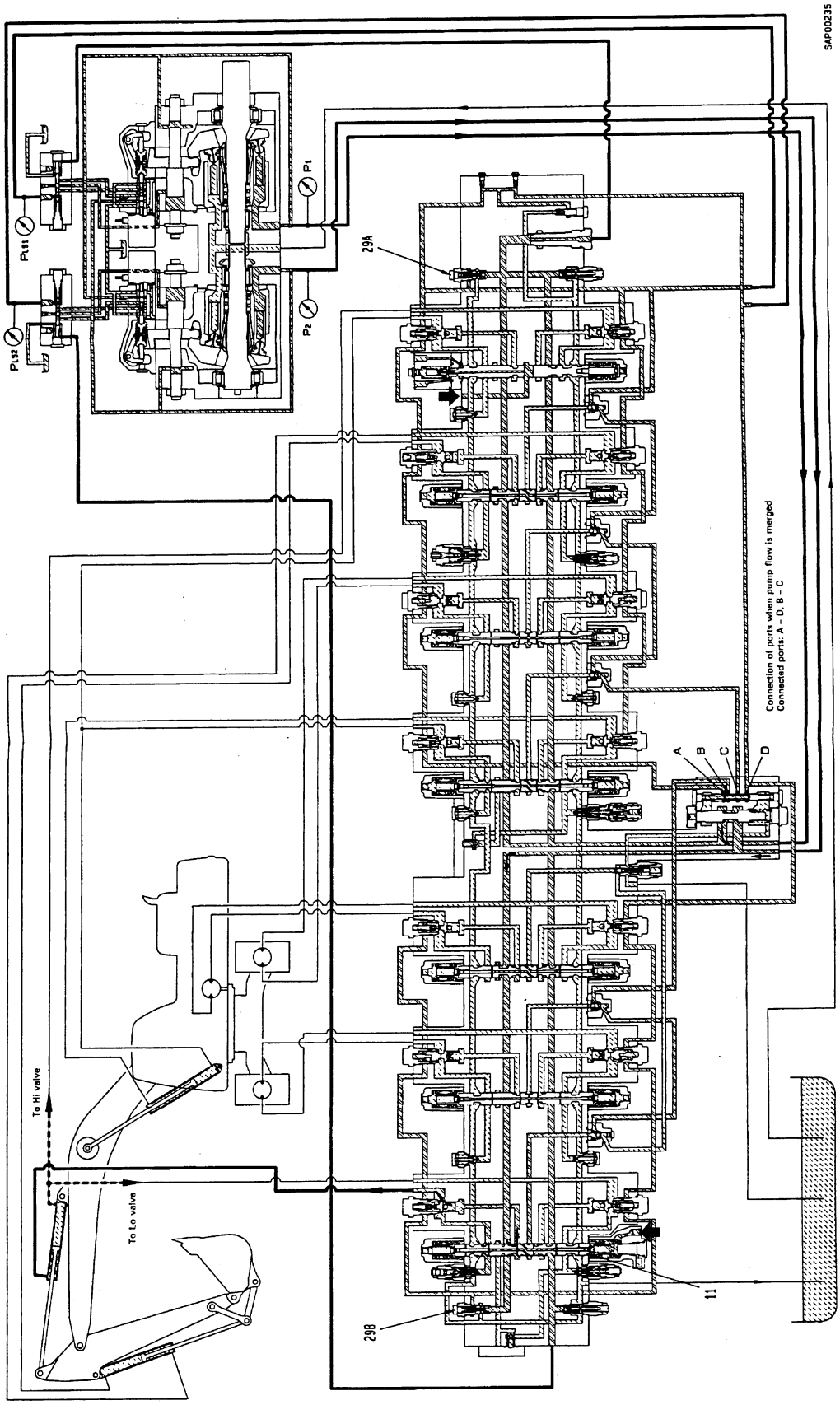


Operation

- When the arm IN is operated, unload valves (29A, 29B) are closed.
- The swash plate of the main pump is controlled (LS control) to match the total area of the meter-in opening of arm Lo spool (11) and arm Hi spool (13).
  (ΔP_{LS} = pump LS control pressure)
- When the spool meter-in opening comes near the maximum, both pumps are at the maximum swash plate angle.
  (When the pump discharge is the maximum, the maximum area of opening of the spool is also large, so the LS differential pressure is smaller than the LS control pressure and the swash plate angle is always at the maximum.)
  (ΔP_{LS} < pump LS control pressure)

5. Pump flow merged, arm OUT operated independently (Return circuit arm Lo + arm Hi)

★ For details of this page, see Section 90.



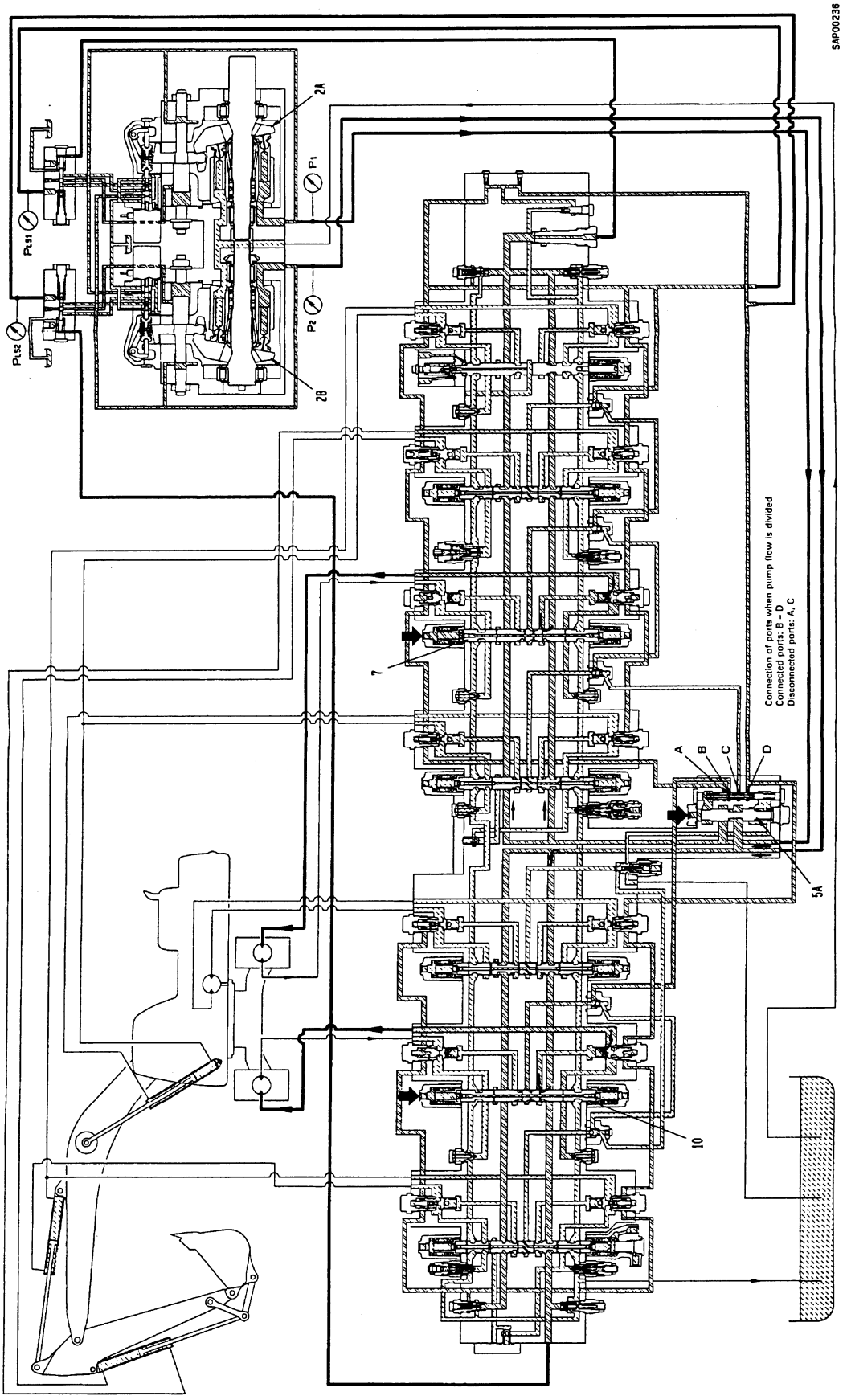
Operation

- When the arm OUT is operated, unload valves (29A, 29B) are closed.
- The swash plate of the main pump is controlled (LS control) to match the area of the meter-in opening of arm Lo spool (11), so the pump swash plate is balanced at a position which matches the oil flow demanded by the spool meter-in.

  (ΔP_{LS} = pump LS control pressure)
- When this happens, the oil from the cylinder bottom is divided, sent to the Lo and Hi spools, and then returned, so it is possible to keep the pressure loss in the circuit small.

6. Pump flow divided, travel operated independently

★ For details of this page, see Section 90.



Operation

- Pilot pressure **PA** of merge/flow divider valve (5A) ON

1)

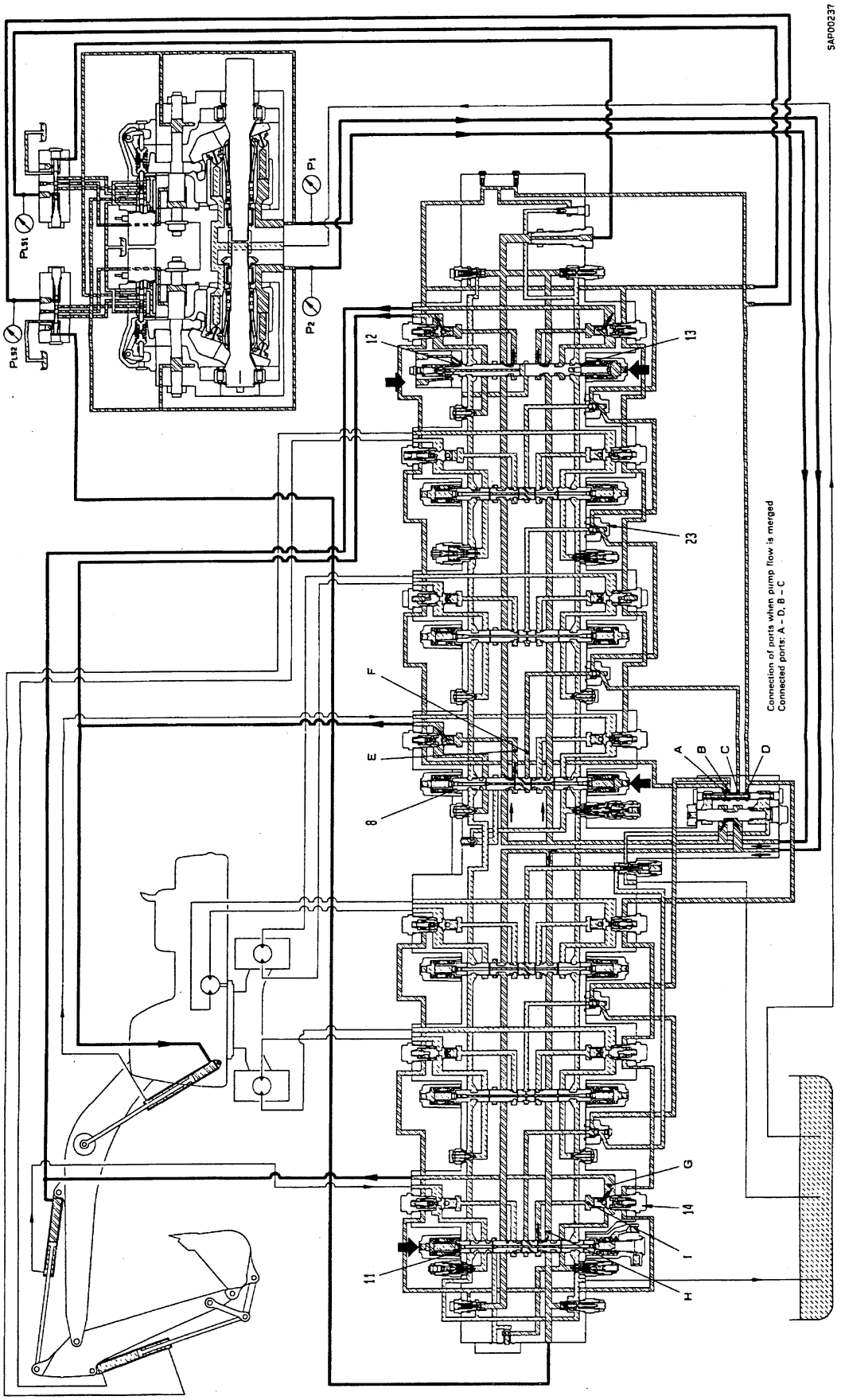
- When the STRAIGHT TRAVEL is operated, a flow of oil is supplied from the main pump to match the stroke of the left and right travel spools (10) and (7).
  Flow of oil from main pump (2A):
  To L.H. spool (10) (arm group)
  Flow of oil from main pump (2B):
  To R.H. spool (7) (bucket group)
- The straight travel is compensated by the travel junction valve.

2)

- From the condition in 1) above, if the lever on the side being steered is returned (the oil flow becomes small) or the lever on the other side is operated in the opposite direction (the direction of travel is reversed), the oil flow from the pump is being divided, so the left and right travel circuits are controlled independently and the machine is steered.

7. Pump flow merged, arm IN + boom RAISE operated simultaneously

★ For details of this page, see Section 90.



Operation

1)

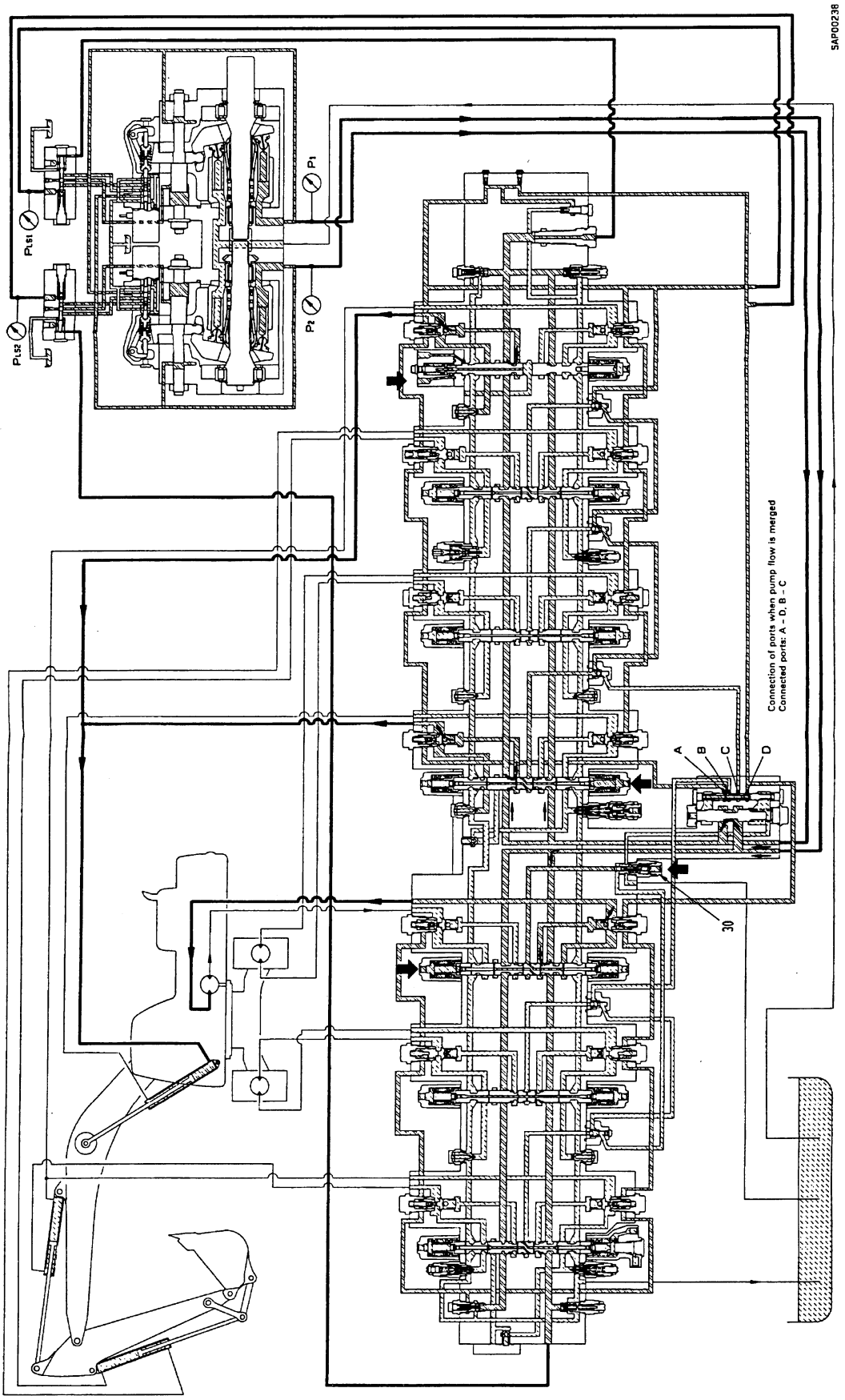
- When the arm and boom are operated simultaneously, the swash plate angle for both pumps becomes the maximum.
- When this happens, the load pressure at the boom RAISE side is higher than at the arm side, so the LS pressure passes through ports **E** and **F** of boom Lo spool (8), enters boom LS shuttle valve (23) and is sent to the LS circuit. This LS pressure is transmitted to port **G** of pressure compensation valve (14), and acts to increase the set pressure of the pressure compensation valve. Because of this, the pressure between port **H** of arm Lo spool (11) and port **I** of pressure compensation valve (14) rises, and the spool meter-in LS differential pressure (pump pressure - LS pressure = ΔP_{LS}) becomes the same as that at the boom end.

2)

- Because of the above operation, the oil flow is divided in proportion to the total area of opening of boom Lo spool (8) and boom Hi spool (12), and the total area of opening of arm Lo spool (11) and arm Hi spool (13).
- Meter-in LS differential pressure ΔP_{LS} during boom RAISE + arm IN ΔP_{LS} < pump LS control pressure, so the main pump swash plate angle is set to maximum.

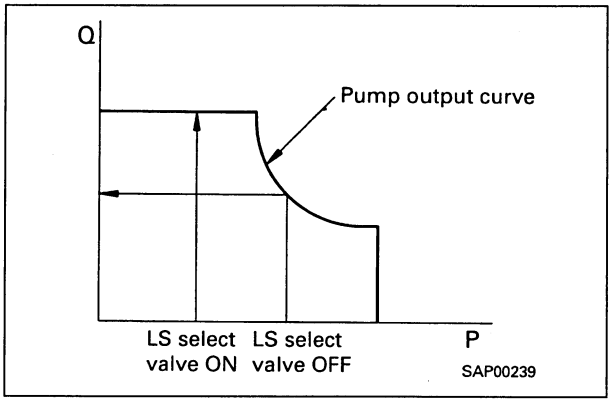
8. Pump flow merged, swing + boom RAISE operated simultaneously

★ For details of this page, see Section 90.



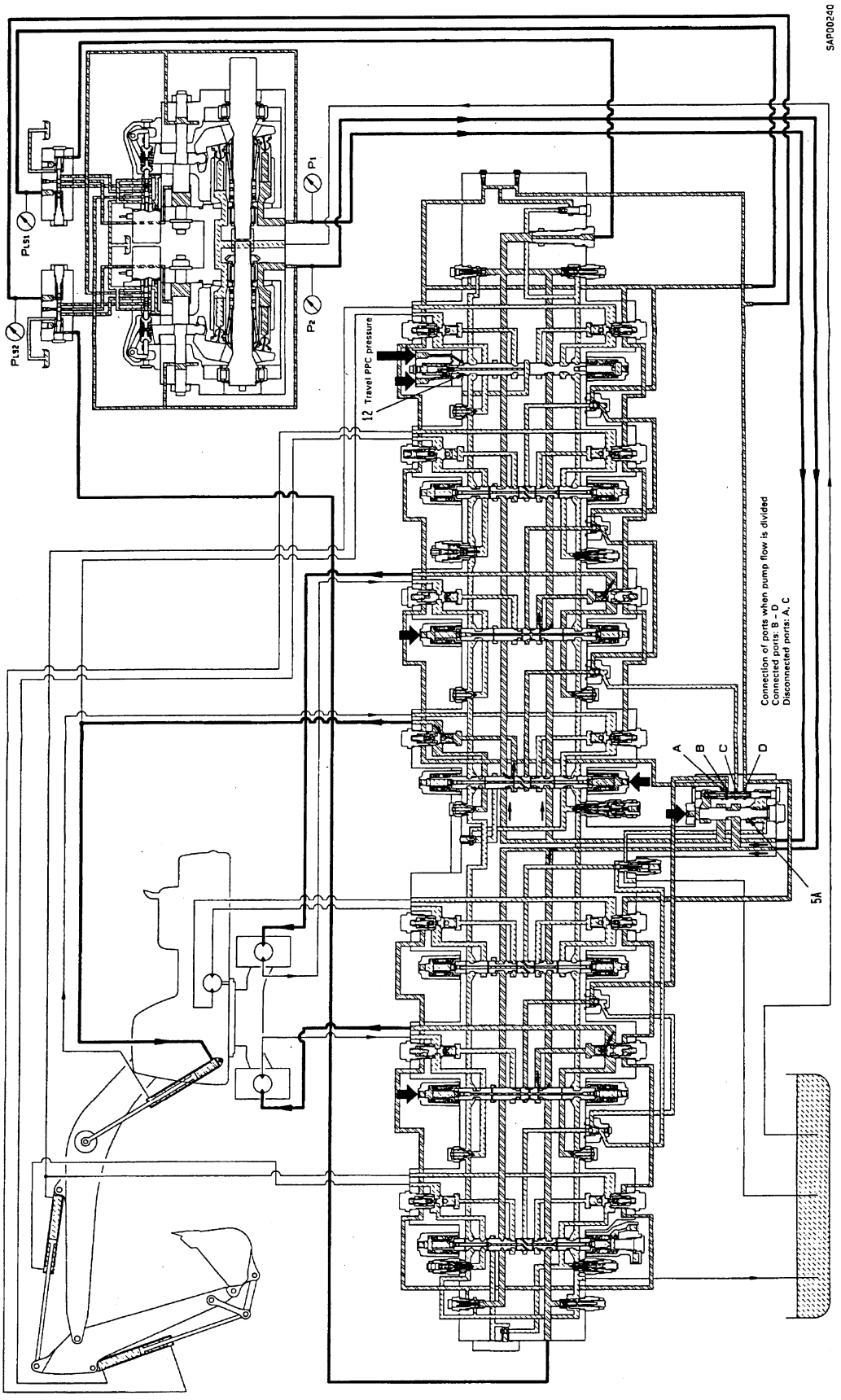
Operation

- When the boom RAISE is being operated in the heavy-duty digging mode the swing is operated simultaneously, the pilot pressure of LS select valve (3) is turned ON.
- When this happens, the LS select valve is shut off, and the high pressure generated when the swing is operated does not flow to the LS circuit, so the LS circuit pressure becomes the boom pressure.
  The swash plate of the main pump is controlled (LS control) by the difference in pressure between the boom and LS pressure.
- In addition, the pump pressure is determined by the boom pressure, so even if the swing drive pressure is high, the pump can deliver an ample flow of oil regardless of the pump output curve.



9. Pump flow divided (pump pressure: 19.6 MPa (200 kg/cm²) or above), travel + boom RAISE operated simultaneously

★ For details of this page, see Section 90.

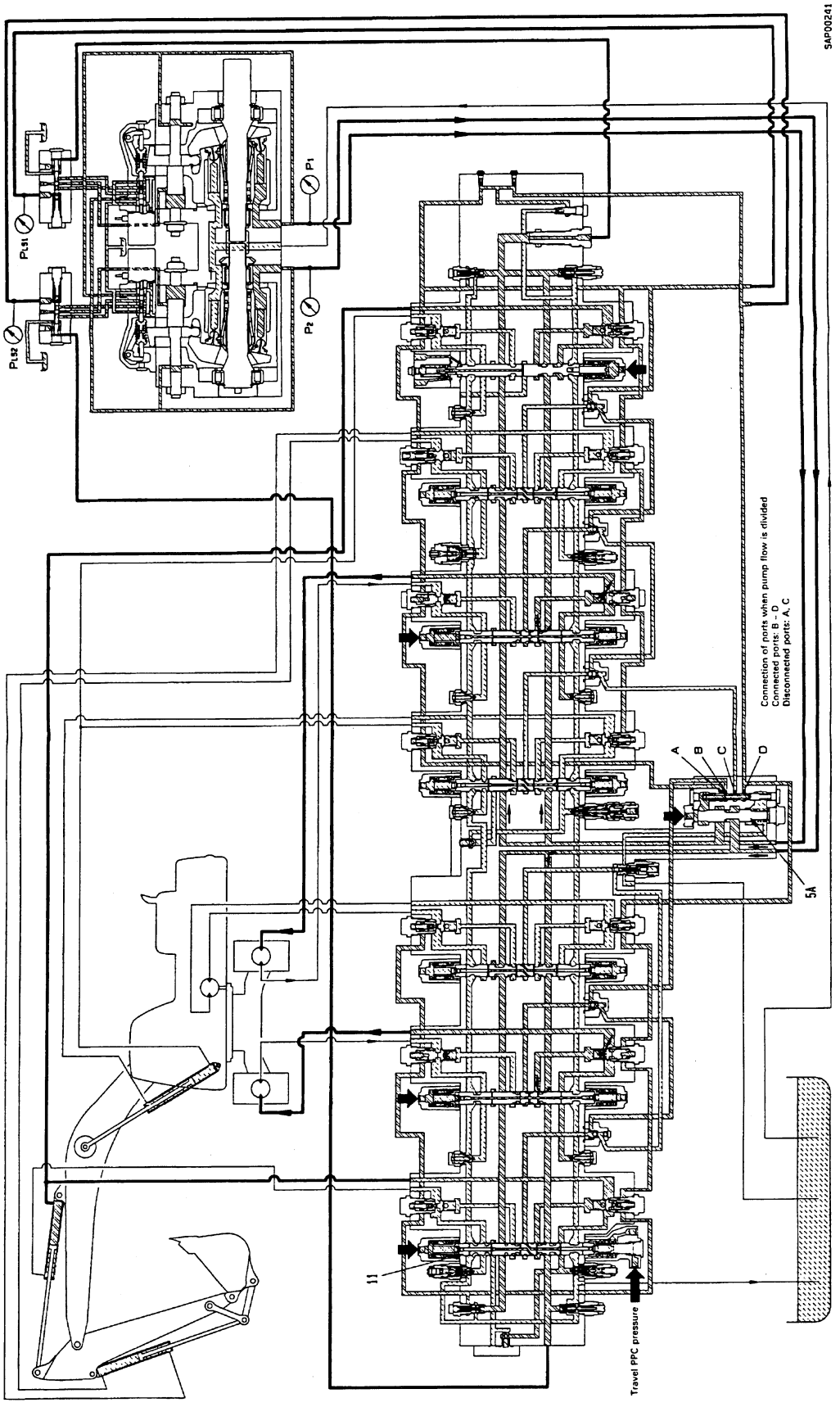


Operation

- When the travel and boom RAISE are operated simultaneously (such as when raising the boom before traveling up a steep slope), if the pump pressure rises to 19.6 MPa (200 kg/cm^2), the merge/flow divider valve pilot is turned ON and the pump flow is divided.
- In addition, the boom Hi spool does not move because of the travel **PPC** pressure. The flow of oil to the boom at this point is restricted, so the travel pressure is maintained and it is possible to carry out compound operations easily.

10. Pump flow divided (pump pressure: 19,6 MPa (200 kg/cm²) or above), travel + arm IN operated simultaneously

★ For details of this page, see Section 90.

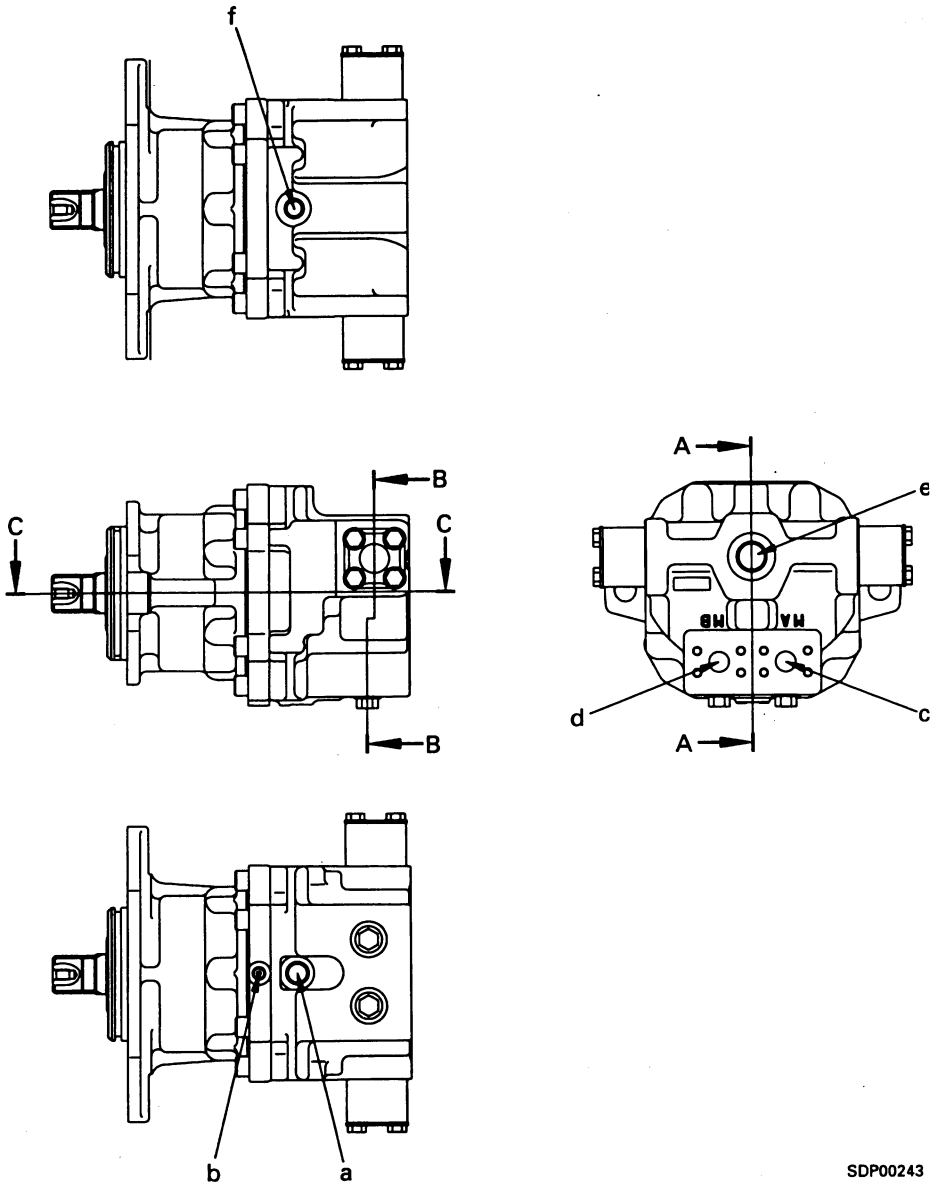


Operation

- When the travel and arm IN are operated simultaneously (such as when using the digging action of the arm to help the machine travel up a steep slope), if the pump pressure rises to 19.6 MPa (200 kg/cm^2), the merge/flow divider valve pilot is turned ON and the pump flow is divided.
- In addition, the stroke of the arm Lo spool is restricted by the travel **PPC** pressure. The flow of oil to the arm at this point is restricted, so the travel pressure is maintained and it is possible to carry out compound operations easily.

SWING MOTOR

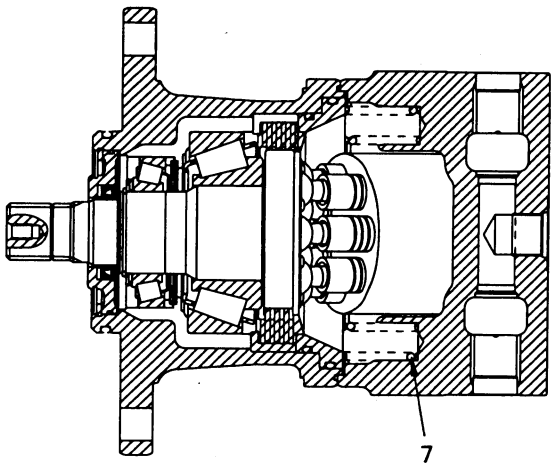
KMF160AB-3



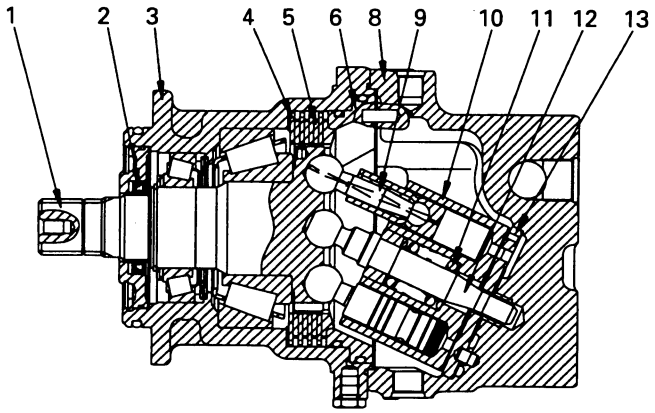
a. Port T1 (to tank)
b. Port B (from swing brake solenoid valve)
c. Port MA (from control valve)
d. Port MB (from control valve)
e. Port S (from lift check valve)
f. Port T2 (to port S)

Specifications

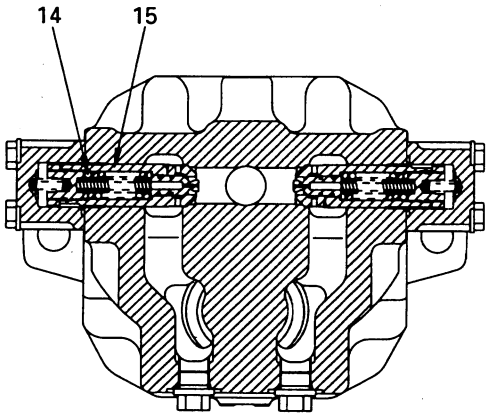
Model:	KMF160AB-3
Theoretical delivery:	160.7 cc/rev
Safety valve set pressure:	27.9 $^{+0.5}_{0}$ MPa at 300 l/min
	(285 $^{+5}_{0}$ kg/cm^2 at 300 l/min)
Rated speed:	1.925 rpm (2.120 rpm max.)
Brake releasing pressure:	1.8 ± 0.4 MPa
	(18.4 ± 4 kg/cm^2)



C – C



A – A



B – B

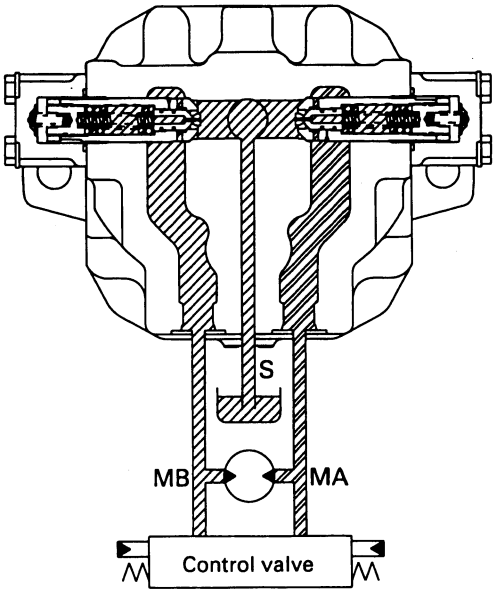
SDP00244

1. Output shaft
2. Oil seal
3. Case
4. Plate
5. Disc
6. Brake piston
7. Spring
8. Housing
9. Piston assembly
10. Cylinder block
11. Spring
12. Center shaft
13. Valve plate
14. Suction valve spring
15. Suction-safety valve

SUCTION-SAFETY VALVE

Function

- When the swing is stopped, the outlet port circuit of the motor is closed by the control valve, but the motor continues to be turned by the inertia of the swing. As a result, the pressure at the outlet port of the motor becomes abnormally high and there is danger that the motor will be damaged.
- The safety valve is installed to prevent this problem. It acts to release the abnormally high pressure oil from the outlet port of the motor to port **S**, and also functions as a swing brake.
- The suction valve supplies an amount of oil equivalent to the amount of oil released by the safety valve. It sends this oil from port S to the inlet port of the motor to prevent any cavitation.



SAP00245

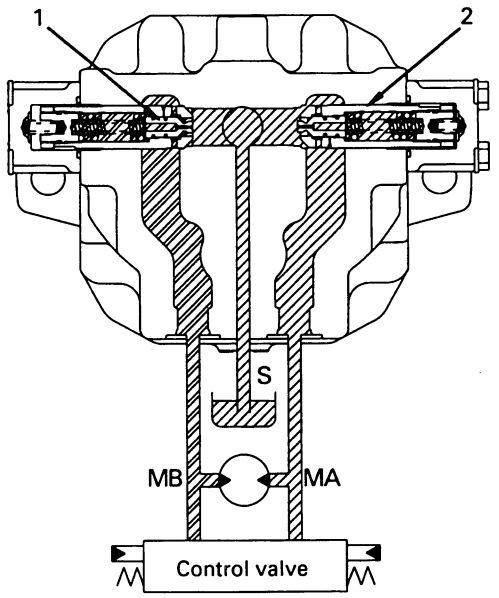
Operation

1. When starting swing

- If the swing control lever is operated to swing to the right, the pressurized oil from the pump passes throug the control valve and it supplied to port **MA**.
- When this happens, the pressure at port **MA** rises and the starting force is generated in the motor, so the motor starts to turn.
  The oil from the outlet port of the motor flows from port **MB** through the control valve and returns to the tank.

2. When stopping swing

- When the swing control lever is returned to the neutral position, no more pressurized oil is supplied from the pump to port **MA**.
  At the same time, the oil from the outlet port of the motor returns from the control valve to the tank, and the circuit is closed.
- The pressure at port **MB** rises, and rotating resistance to the motor is generated, so the brake starts to take effect.
  If the pressure at port **MB** rises to the set pressure of safety valve (1) opens and releases the pressurized oil at port **MB** to port **S**.
- No pressurized oil is supplied at port **MA**, but the swing continues, so negative force is generated.
  When this negative pressure drops to the set pressure of suction valve (2), suction valve (2) opens and oil supplied from port **S** to prevent cavitation.



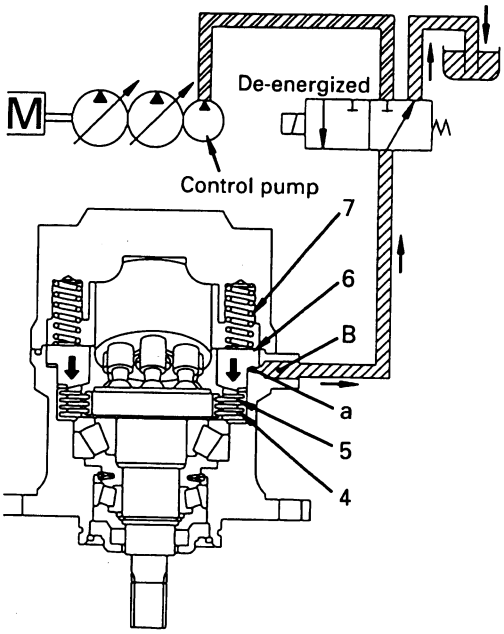
SAP00246

Operation of swing brake

1) Swing brake solenoid valve de-energized

If the swing brake solenoid valve is de-energized, the flow of pressurized oil from the control pump is shut off, and port **B** is connected to the tank circuit.

As a result, brake piston (6) is pushed down by brake spring (7), pushes disc (5) and plate (4) together, and the brake is applied.

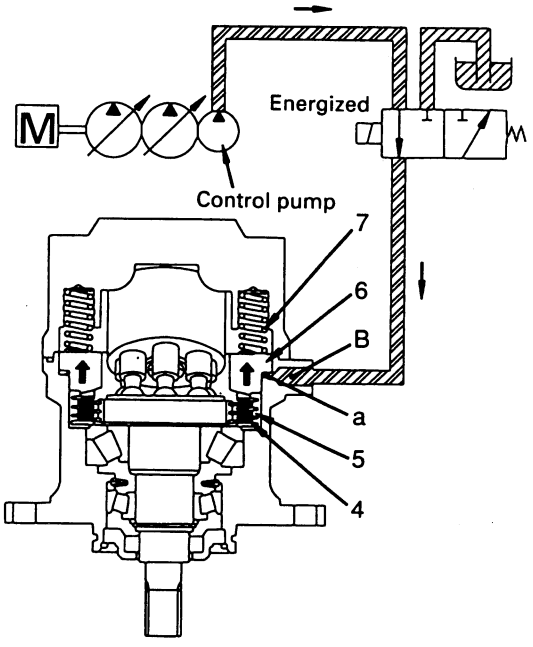


SBP00247

2) Swing brake solenoid valve energized

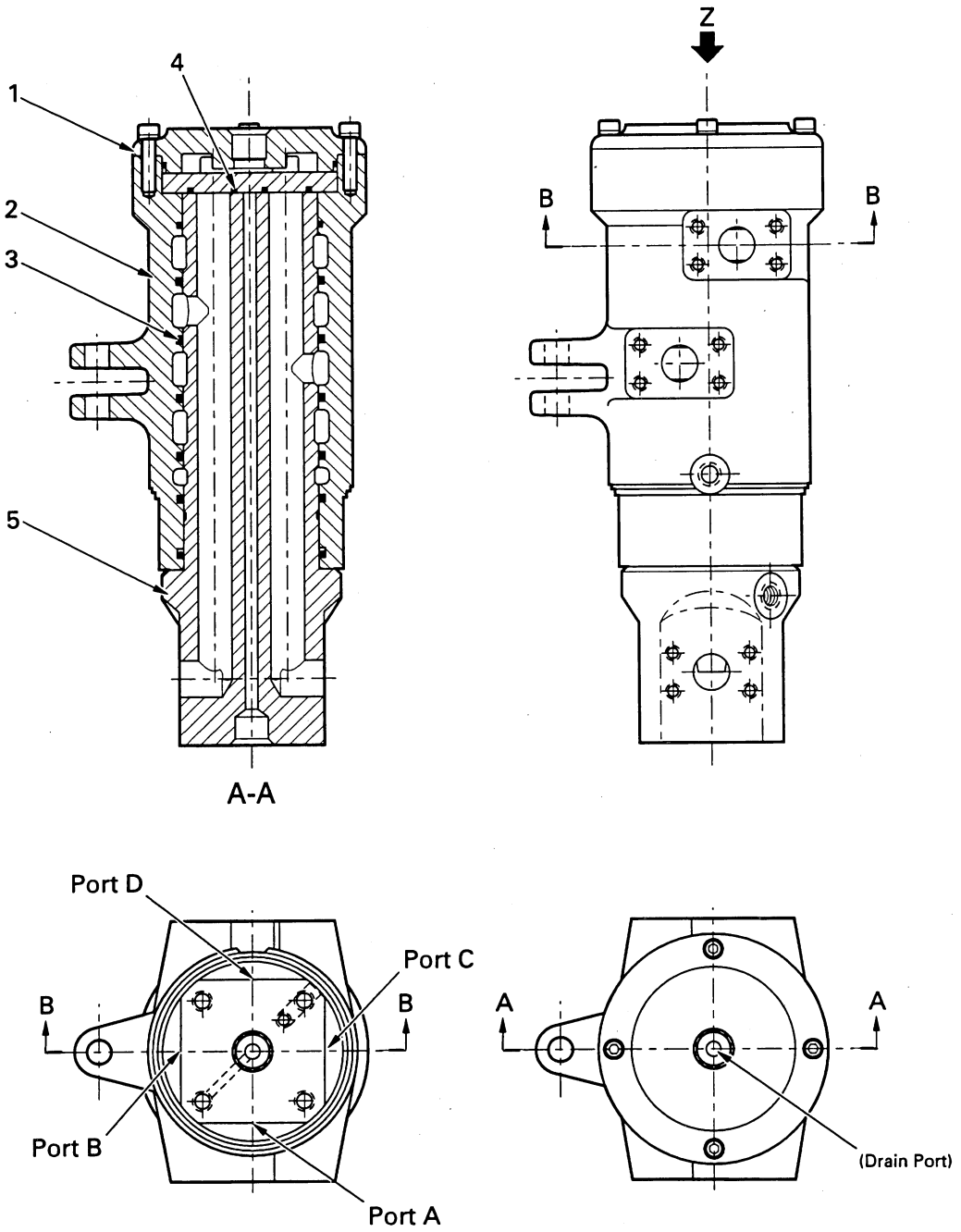
When the swing brake solenoid valve is energized, the valve is switched, and pressurized oil from the control valve enters port **B** and flows to brake chamber **a**.

The pressurized oil entering chamber **a** overcomes brake spring (7) and pushes brake piston (6) up. As a result, disc (5) and plate (4) are separated and the brake is released.



SBP00248

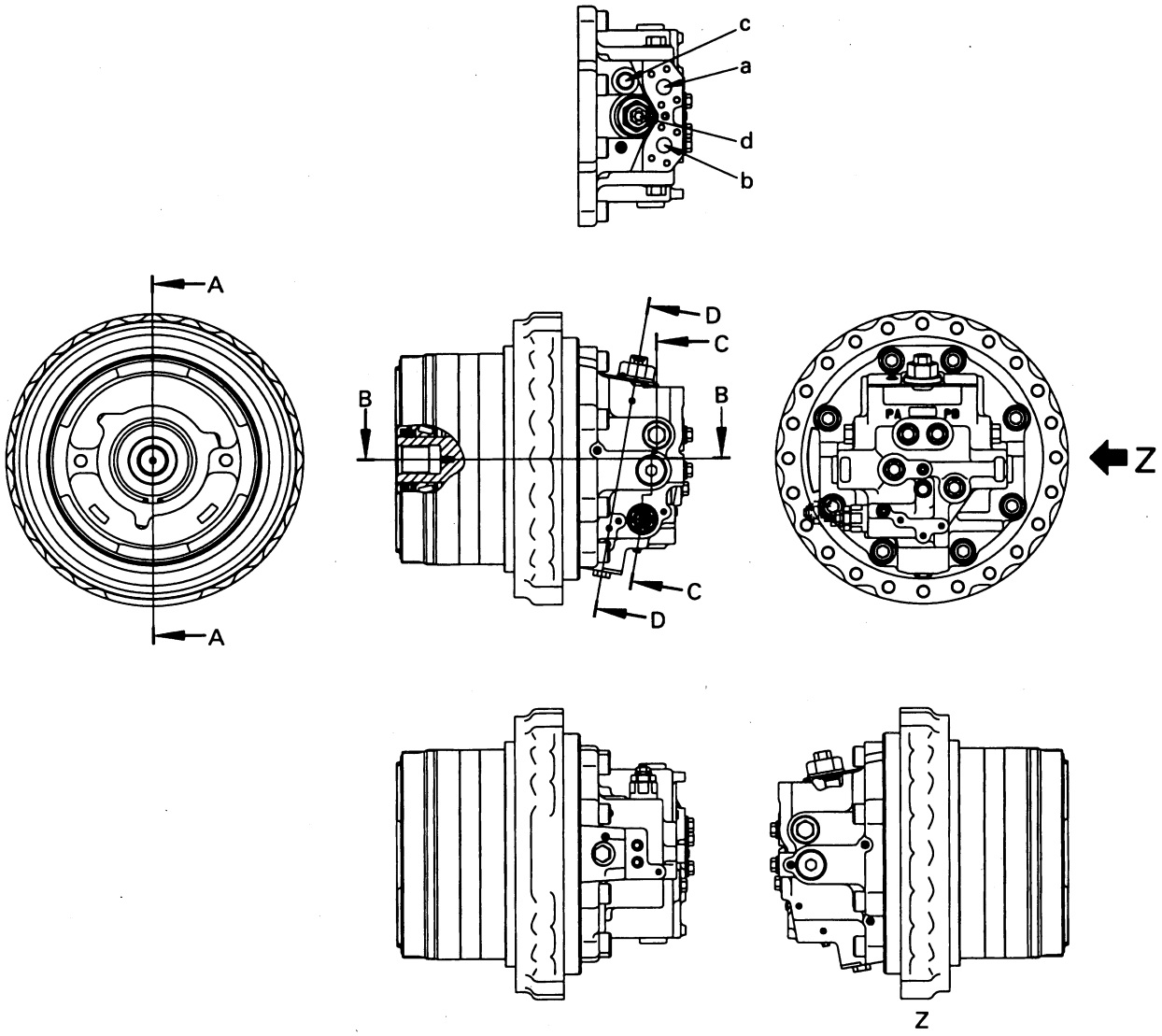
CENTER SWIVEL JOINT



1. Cover
2. Body
3. Slipper seal
4. O-ring
5. Shaft

A1. From control valve port B2
A2. To R.H. travel motor port PB
B1. From control valve port B5
B2. To L.H. travel motor port PA
C1. From control valve port A2
C2. To R.H. travel motor port PA
D1. From control valve port A5
D2. To L.H. travel motor port PB
E1. From travel speed EPC valve
E2. To L.H. and R.H. travel motors port P
T1. To tank
T2. From L.H. and R.H. travel motors port T.

TRAVEL MOTOR
KMV280ADT

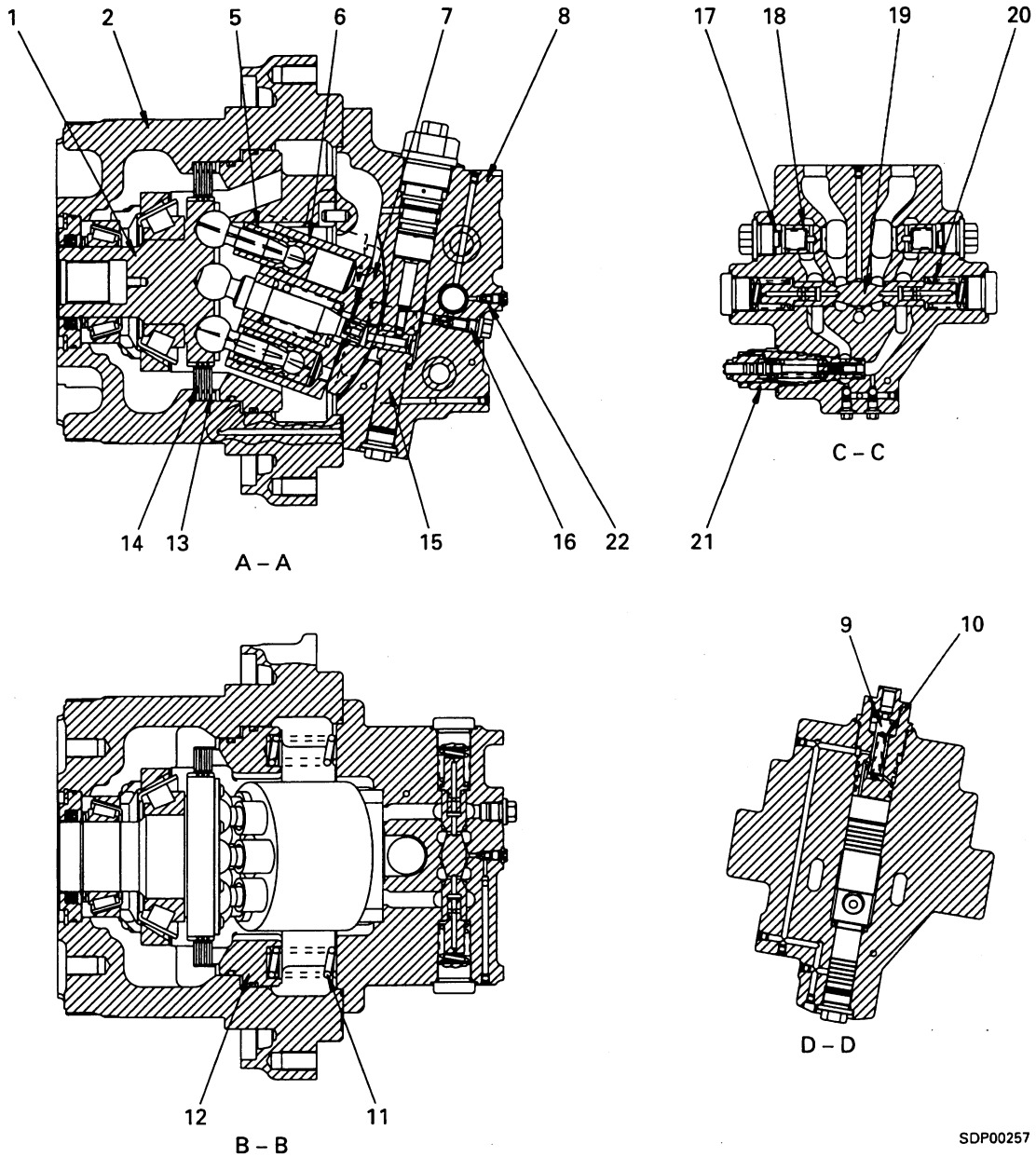


SDP00256

a. Port **PB** (from control valve)
b. Port **PA** (from control valve)
c. Port **T** (to tank)
d. Port **P** (from travel speed solenoid valve)

Specifications

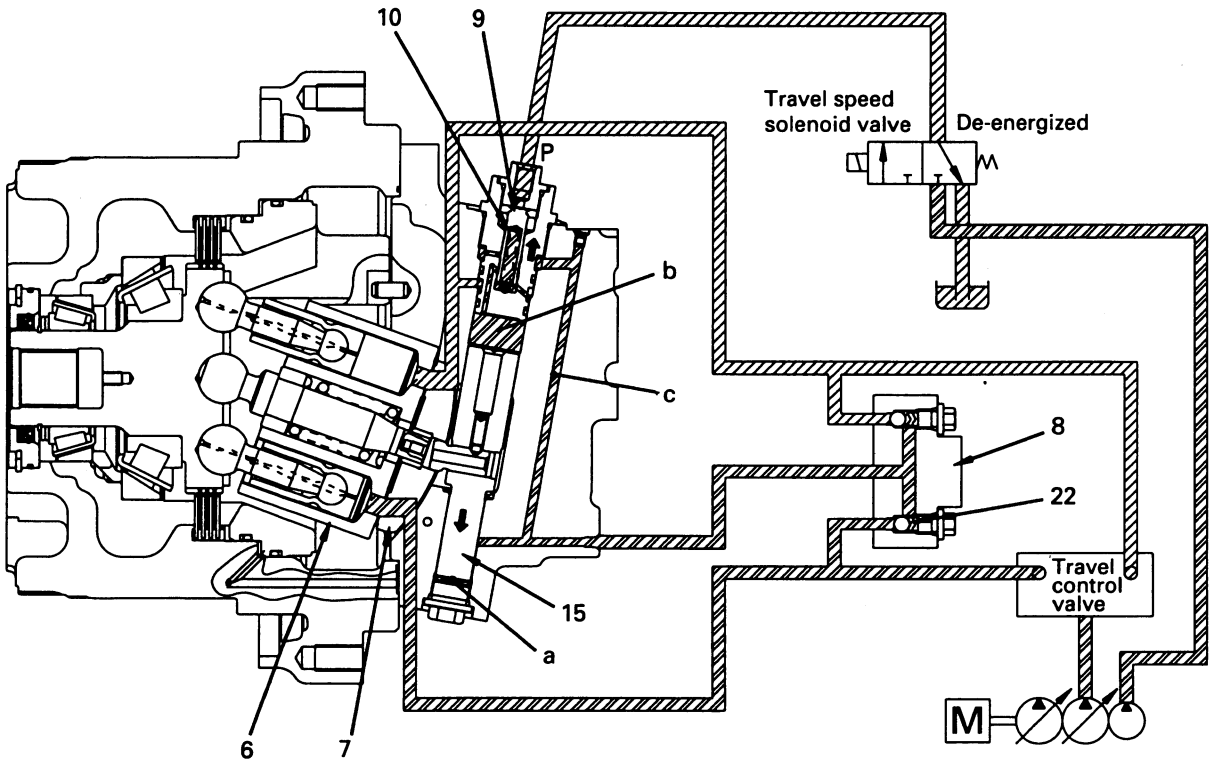
Model:	KMV280ADT
Theoretical delivery:	Min 158 cc/rpm Max 270 cc/rpm
Set pressure:	34.8 MPa (355 kg/cm²)
Rated speed:	Min. capacity 1,943 rpm Max. capacity 1,137 rpm
Brake releasing pressure:	1.3 ± 0.4 MPa (13 ± 4 kg/cm²)
Travel speed switching pressure:	$0.8^{+0.4}_{-0.1}$ MPa (Differential pressure) (8^{+4}_{-1} kg/cm²) (Differential pressure)



1. Output shaft
2. Motor case
3. -
4. -
5. Piston
6. Cylinder
7. Valve plate
8. End cover
9. Regulator valve
10. Spring
11. Brake spring
12. Brake piston
13. Plate
14. Disc
15. Regulator piston
16. Plug
17. Check valve spring
18. Check valve
19. Counterbalance valve
20. Spool return spring
21. Safety valve
22. Slow return valve

Operation of motor

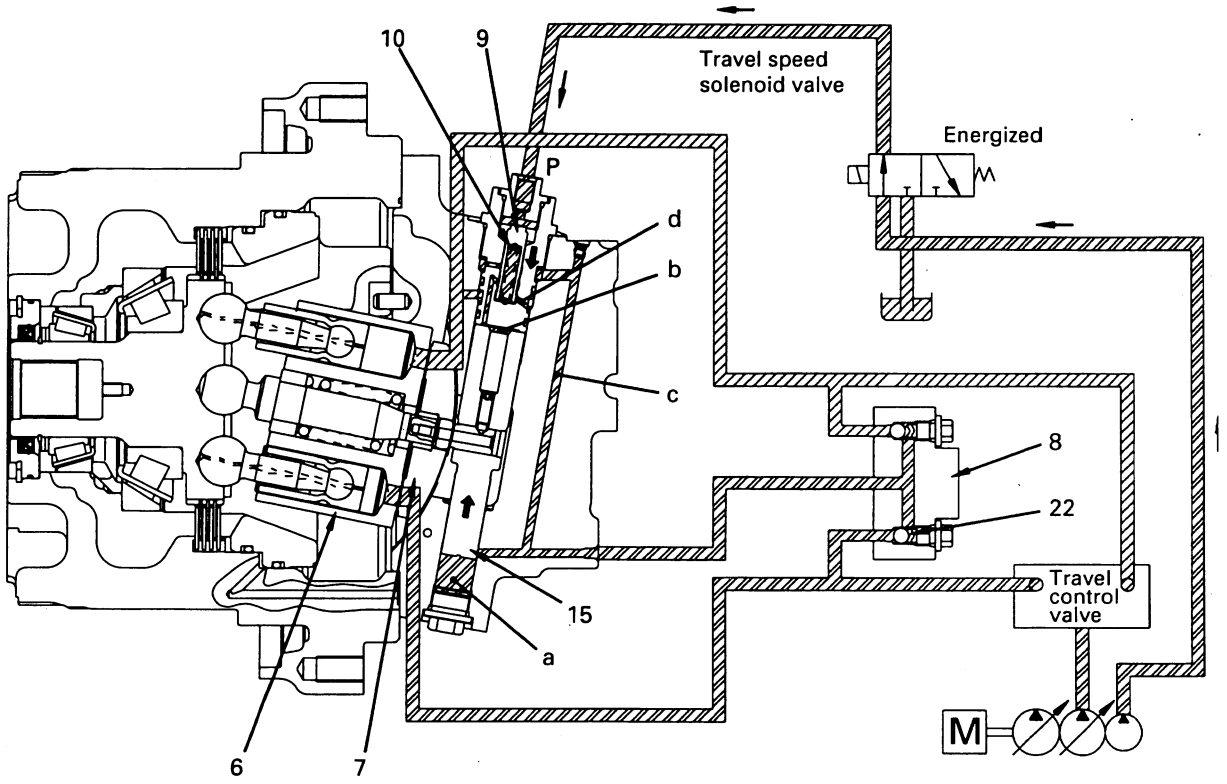
1) At low speed (motor swash plate angle at maximum)



SAP00258

- The solenoid valve is de-energized, so the pilot pressure oil from the control pump does not flow to port **P**.
  For this reason, regulator valve (9) is pushed up by spring (10).
- The main pressure oil from the control valve pushes slow return valve (22), goes to end cover (8), and acts on chamber **a** of regulator piston (15).
- At the same time, the main pressure oil passes through orifice **c** in regulator valve (9) and acts also on chamber **b**.
- When this happens, the propulsion force of differential (**Ab** - **Aa**) between the aera of chambers **a** and **b** of regulator piston (15) acts in a downward direction.
- As a result, valve plate (7) and cylinder block (6) move in the maximum swash plate angle direction, the motor capacity becomes maximum, and the system is set to low speed.

2) At high speed (motor swash plate angle at minimum)



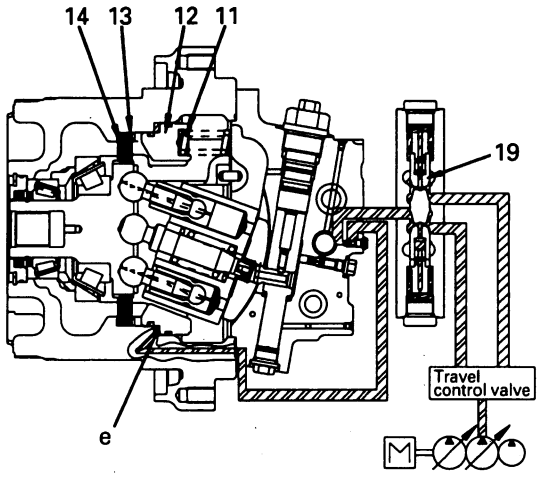
SAP00259

- When the solenoid valve is energized, the pilot pressure oil from the control pump flows to port **P**, and pushes regulator valve (9) down.
- When this happens, chamber **b** and the main pressure oil are shut off at regulator valve (9), and the oil at chamber **b** is drained inside the case.
- Because of this, the propulsion force of the pressure oil at chamber **a** of regulator piston (15) acts in a upward direction.
- As a result, valve plate (7) and cylinder block (6) move in the minimum swash plate angle direction, the motor capacity becomes minimum, and the system is set to high travel speed.

Operation of parking brake

1) When starting to travel

When the travel lever is operated, the pressurized oil from the pump actuates counterbalance valve spool (19), opens the circuit to the parking brake, and flows into chamber **e** of brake piston (12). It overcomes the force of spring (11), and pushes piston (12) to the right. When this happens, the force pushing plate (13) and disc (14) together is lost, so plate (13) and disc (14) separate and the brake is released.



SAP00260

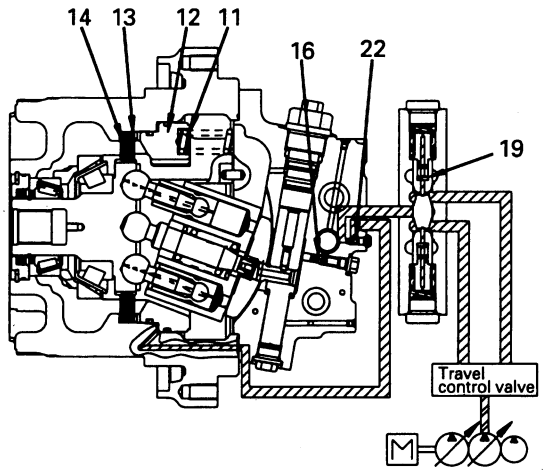
2) When stopping travel

When the travel is placed in neutral, counterbalance valve spool (19) returns to the neutral position and the circuit to the parking brake is closed.

The pressurized oil in chamber **e** of brake piston (12) passes through the throttle in slow return valve (22), is drained to the case from the orifice in plug (16), and brake piston (12) is pushed fully to the left by spring (11).

As a result, plate (13) and disc (14) are pushed together, and the brake is applied.

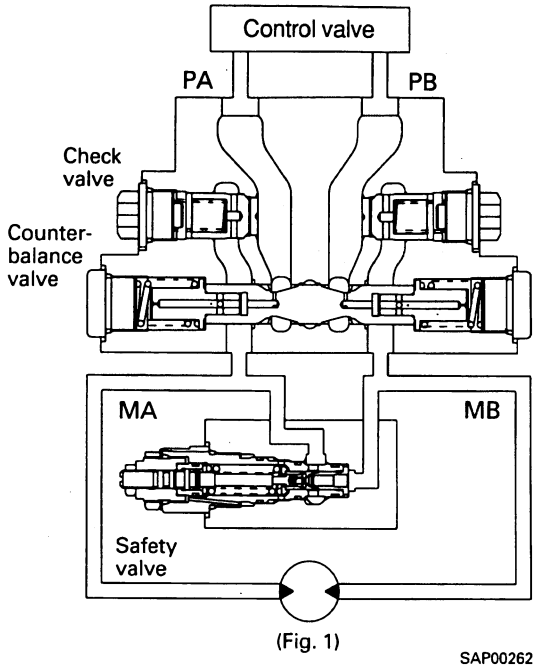
A time delay is provided by having the pressurized oil pass through a throttle in slow return valve (22) when the brake piston returns, and this ensures that the brake is applied after the machine stops.



SAP00261

Operation of brake valve

- The brake valve consists of a check valve, counterbalance valve, and safety valve in a circuit as shown in the diagram on the right. (Fig. 1)
- The function and operation of each component is as given below.



(Fig. 1)

SAP00262

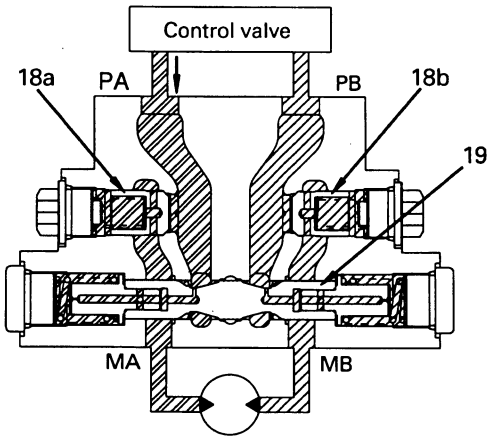
1) Counterbalance valve, check valve

Function

- When traveling downhill, the weight of the machine makes it try to travel faster than the speed of the motor.
  As a result, if the machine travels with the engine at low speed, the motor will rotate without load and the machine will run away, wich it extremely dangerous.
  To prevent this, thes valves act to make the machine travel according to the engine speed (pump discharge amount).

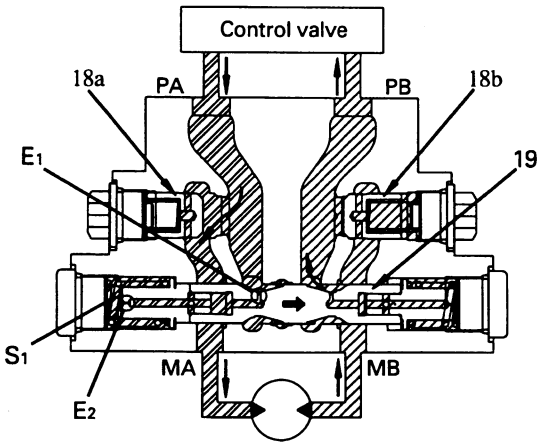
Operation when pressurized oil is supplied

- When the travel lever is operated, the pressurized oil from the control valve is supplied to port **PA**. It pushes open check valve (18a) and flows from motor inlet port **MA** to motor outlet port **MB**.
  However, the motor outlet port is closed by check valve (18b) and spool (19), so the pressure at the supply side rises. (Fig. 2)
- The pressurized oil at the supply side flows from orifice E1 in spool (19) and orifice **E2** in the piston ot chamber **S1**. When the pressure in chamber **S1** goes above the spool switching pressure, spool (19) is pushed to the right. As a result, port **MB** and port **PB** are connected, the outlet port side of the motor is opened, and the motor starts to rotate. (Fig. 3).



(Fig. 2)

SAP00263

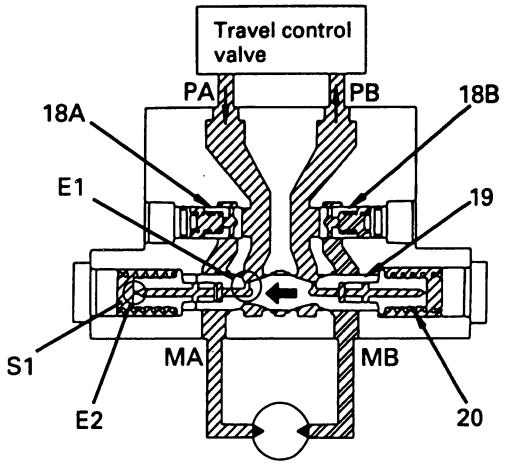


(Fig. 3)

SAP00264

Operation of brake when traveling downhill

- If the machine tries to run away when traveling downhill, the motor will turn under no load, so the pressure at the motor inlet port will drop, and the pressure in chamber **S1** through orifices **E1** and **E2** will also drop.
  When the pressure in chamber **S1** drops below the spool switching pressure, spool (19) is returned to the left by spring (20), and outlet port **MB** is throttled.
  As a result, the pressure at the outlet port side rise, resistance is generated to the rotation of the motor, and this prevents the machine from running away.
  In other words, the spool moves to a position where the pressure at the outlet port **MB** balances the pressure at the inlet port and the force generated by the weight of the machine. It throttles the outlet port circuit and controls the travel speed according to the amount of oil discharged from the pump.
  (Fig. 4)



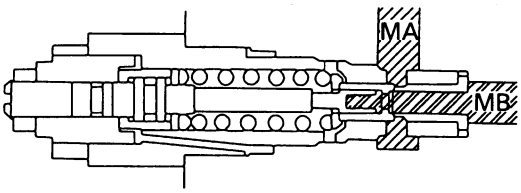
(Fig. 4)

SBP00265

2) Safety valve (2-direction operation, 2-stage set safety valve)

Function

- When travel is stopped (or when traveling downhill), the circuits at the inlet and outlet ports of the motor are closed by the counterbalance valve. However, the motor is rotated by inertia, so the pressure at the outlet port of the motor will become abnormally high and will damage the motor or piping. The safety valve acts to release this abnormal pressure and sent it to the inlet port side of the motor to prevent damage to the equipment.



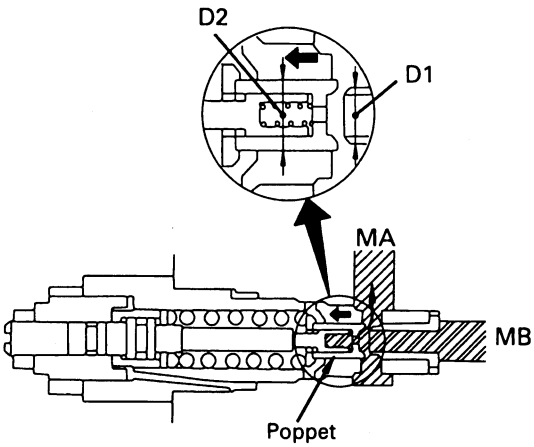
(Fig. 5)

SBP00266

Operation in both directions

1) When pressure in chamber MB has become high (when rotating clockwise)

- When the travel is stopped (or when traveling downhill), chamber **MB** in the outlet port circuit is closed by the check valve of the counterbalance valve, but the pressure at the outlet port rises because of inertia. (Fig. 5)
- If the pressure goes above the set pressure, the force produced by the difference in area between **D1** and **D2** [$\pi 4(D1^2 - D2^2)$ x pressure} overcomes the force of the spring and moves the poppet to the left, so the oil flows to chamber **MA** in the circuit on the opposite side. (Fig. 6).

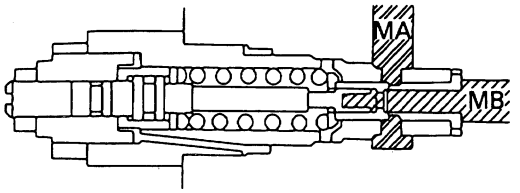


(Fig. 6)

SBP00267

2) When pressure in chamber MA has becom high (when rotating counterclockwise)

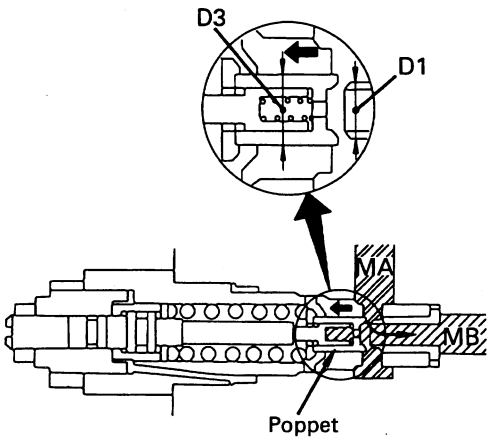
- When the travel is stopped (or when traveling downhill), chamber **MA** in the outlet port circuit is closed by the check valve of the counterbalance valve, but the pressure at the outlet port rises because of inertia. (Fig. 7)



(Fig. 7)

SBP00268

- If the pressure goes above the set pressure, the force produced by the difference in area between **D1** and **D3** [$\pi/4(D3^2 - D1^2)$ x pressure] overcomes the force of the spring and moves the poppet to the left, so the oil flows to chamber **MB** in the circuit on the opposite side. (Fig. 8)



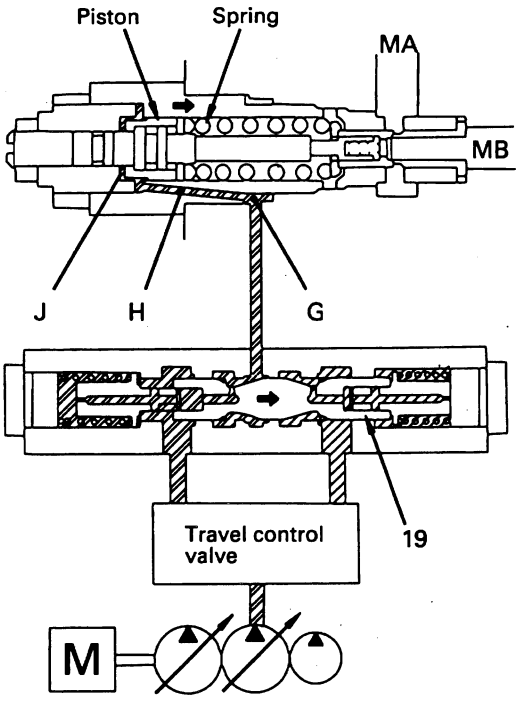
(Fig. 8)

SBP00269

Operation of mechanism for varying set pressure

1) When starting travel (high-pressure setting)

- When the travel lever is operated, the pressurized oil from the pump actuates counterbalance valve spool (19), and opens the pilot circuit to the safety valve. The oil passes from chamber **G** to passage **H** and flows into chamber **J**, pushes the piston to the right, and compresses the spring to make the set load larger. Because of this, the set pressure of the safety valve is switched to the high pressure setting, and a large drawbar pull is made available.



(Fig. 9)

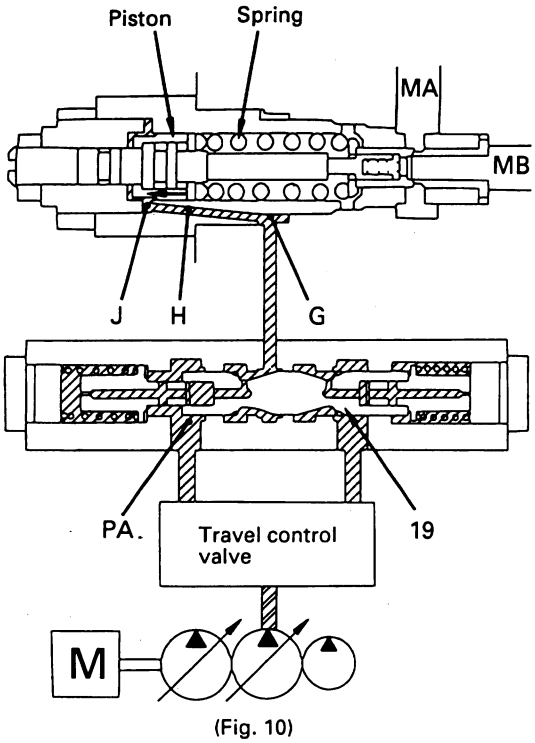
SBP00270

2) When stopping travel (low-pressure setting)

- When the travel lever is placed at neutral, the pressure in chamber **PA** drops and counterbalance valve spool (19) returns to the neutral position. While the counterbalance valve spool is returning to the neutral position, the pressurized oil in chamber **J** passes through passage **H**, and escapes to chamber **PA** from chamber **G**. The piston moves to the left, and the set load becomes smaller. Because of this, the set pressure of the safety valve is switched to the low-pressure setting and relieves the shock when reducing speed.

[Set pressure of safety valve]

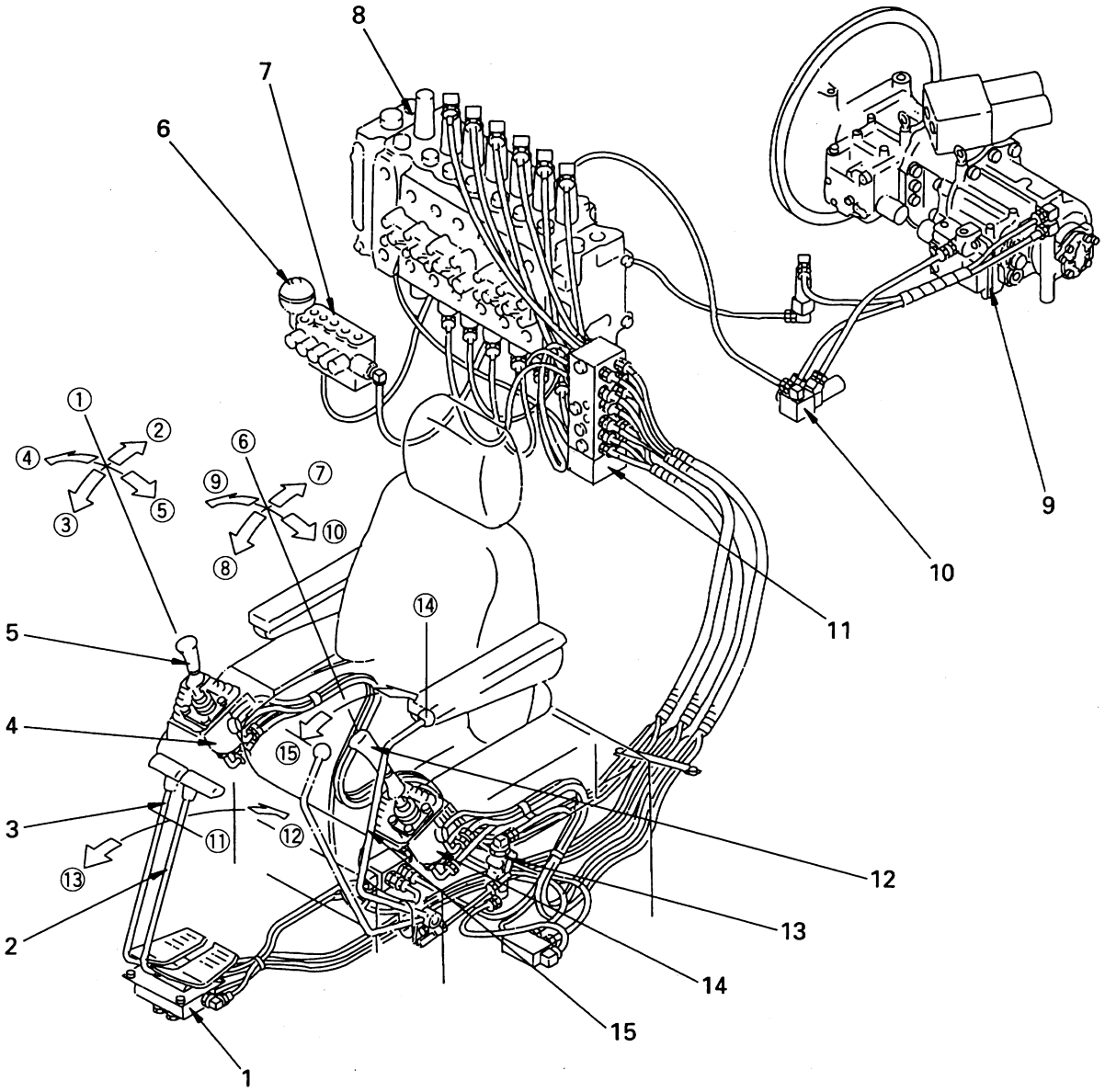
When starting / When traveling : High-pressure setting	When stopping: Low-pressure settings
37.7 MPa (385 kg/cm²)	27.4 MPa (280 kg/cm²)



(Fig. 10)

SBP00271

VALVE CONTROL



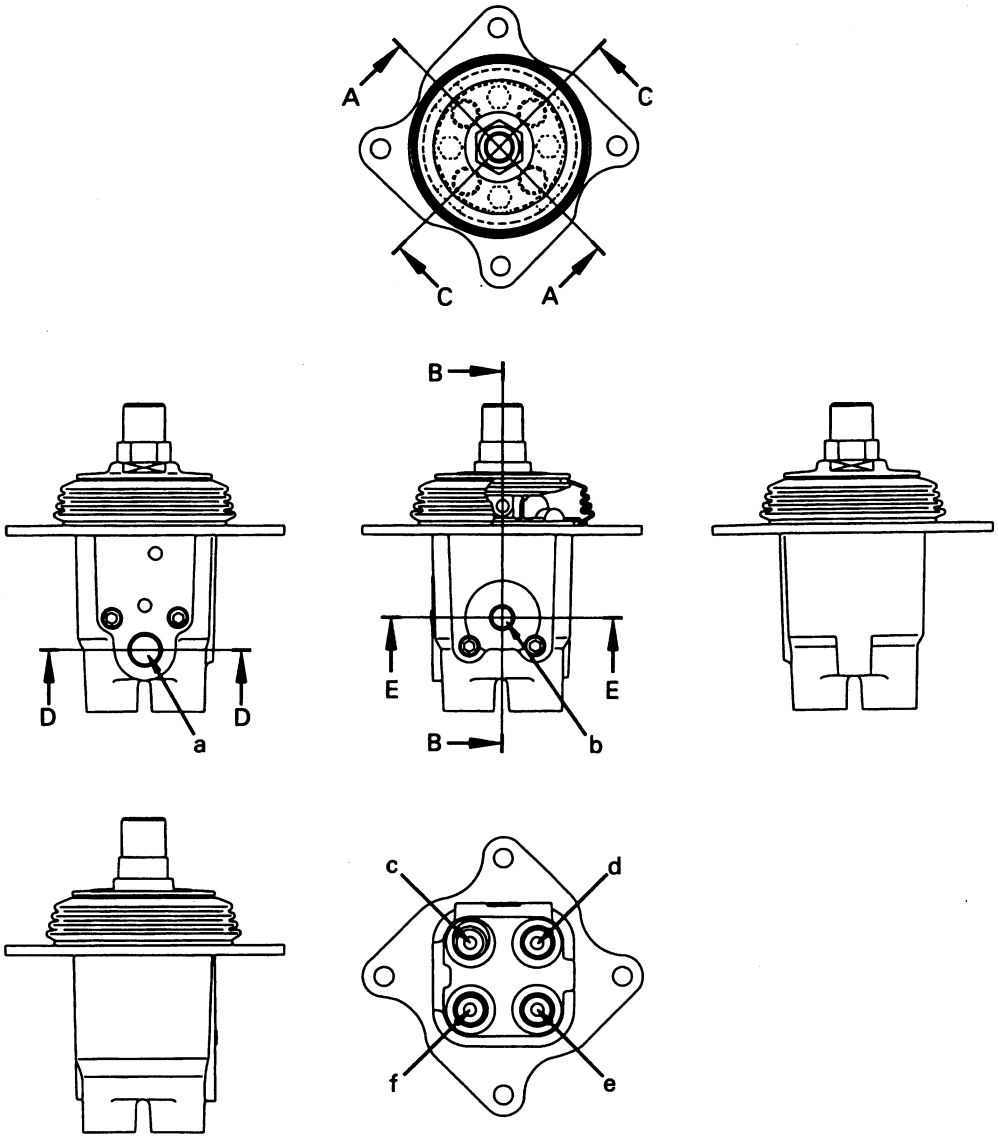
SBP00272

1. Travel PPC valve
2. L.H. travel lever
3. R.H. travel lever
4. Right PPC valve
5. Right work equipment lever
6. Accumulator
7. Solenoid block
8. Control valve
9. Hydraulic pump
10. LS control EPC valve
11. PPC shuttle valve
12. Left work equipment lever
13. PPC safety lock lever
14. Left PPC valve
15. Safety lock lever

Lever postions

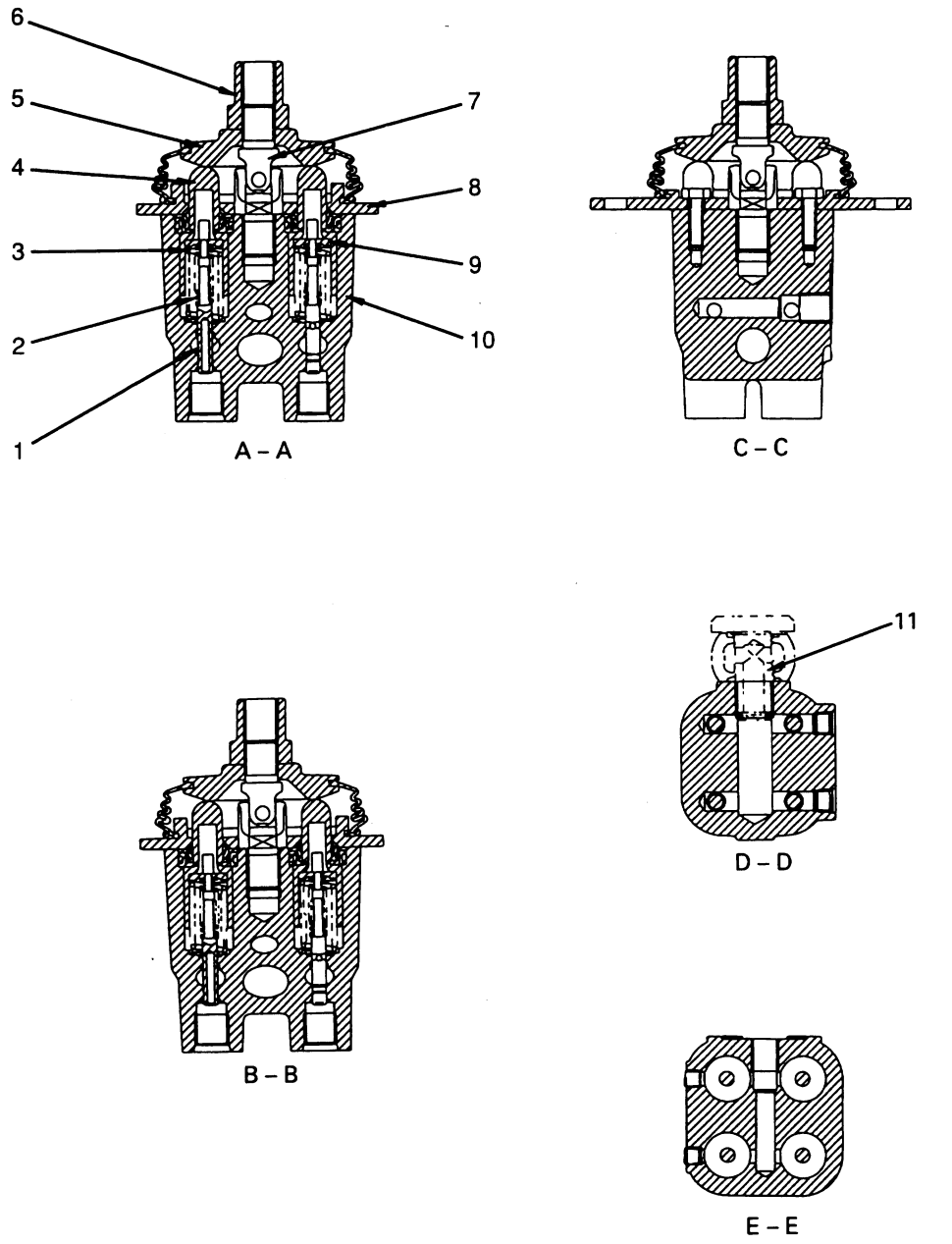
① NEUTRAL
② Boom RAISE
③ Boom LOWER
④ Bucket DUMP
⑤ Bucket CURL
⑥ NEUTRAL
⑦ Arm IN
⑧ Arm OUT
⑨ Swing right
⑩ Swing left
⑪ NEUTRAL
⑫ Travel REVERSE
⑬ Travel FORWARD
⑭ LOCK
⑮ FREE

WORK EQUIPMENT, SWING PPC VALVE



SBP00273

a. Port P (from control pump)
b. Port T (from tank)
c. Port P_2 (L.H.: Arm IN/R.H.: Boom RAISE)
d. Port P_4 (L.H.: Left swing/R.H.: Bucket DUMP)
e. Port P_1 (L.H.: Arm OUT/R.H.: Boom LOWER)
f. Port P_3 (L.H.: Right swing/R.H.: Bucket CURL)

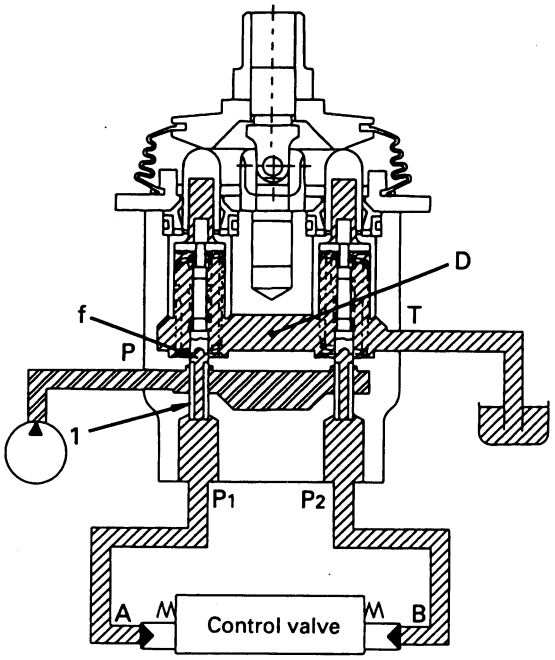


1. Spool
2. Metering spring
3. Centering spring
4. Piston
5. Disc
6. Nut (for connecting lever)
7. Joint
8. Plate
9. Retainer
10. Body
11. Filter

Operation

1) At neutral

Ports **A** and **B** of the control valve and ports **P1** and **P2** of the PPC valve are connected to drain chamber **D** through fine control hole **f** in spool (1). (Fig. 1)



(Fig. 1)

SBP00275

2) Fine control (neutral → fine control)

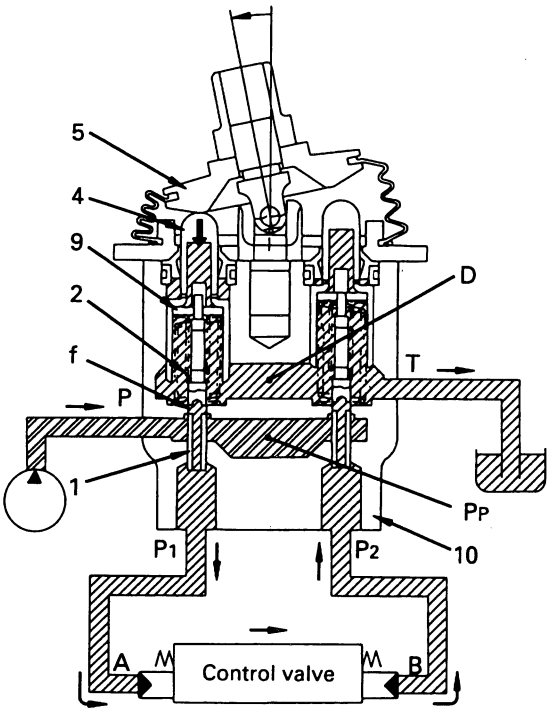
When piston (4) starts to be pushed by disc (5), retainer (9) is pushed. Spool (1) is also pushed by metering spring (2) and moves down.

When this happens, fine control hole **f** is shut off from drain chamber **D**. At almost the same time, it is connected to pump pressure chamber **PP**, and the pilot pressure of the control pump is sent from port **A** through fine control hole **f** to port **P1**.

When the pressure at port **P1** rises, spool (1) is pushed back. Fine control hole **f** is shut off from pump pressure chamber **PP**. at almost the same time, it is connected to drain chamber **D**, so the pressure at port **P1** escapes. As a result, spool (1) moves up and down until the force of metering spool (2) is balanced with the pressure of port **P1**.

The relationship of the positions of spool (1) and body (10) (fine control hole **f** is in the middle between drain hole **d** and pump pressure chamber **PP**) does not change until retainer (9) contacts spool (1).

Therefore, metering spring (2) is compressed in proportion to travel of the control lever, so the pressure at port **P1** also rises in proportion to the travel of the control lever. In this way, the spool of the control valve moves to a position where the pressure of chamber **A** (same as pressure at port **P1**) and the force of the return spring of the control valve spool are balanced. (Fig. 2)



(Fig. 2)

SBP00276

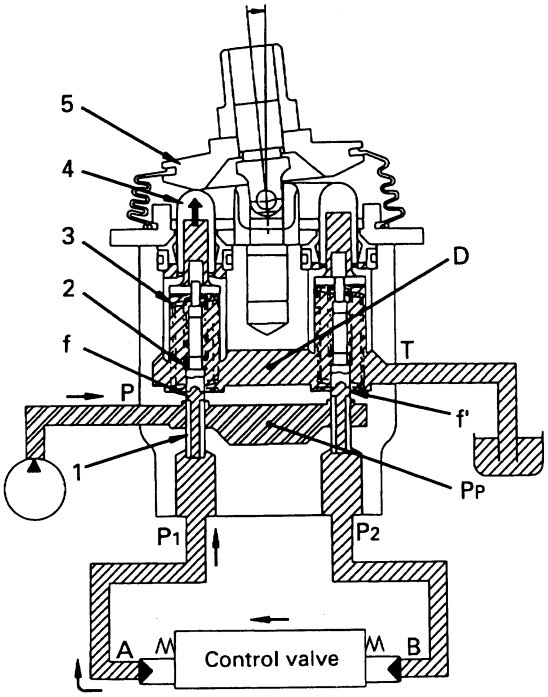
3) Fine control (Control lever returned)

When disc (5) starts to be returned, spool (1) is pushed up by the force of centering spring (3) and the pressure at port **P1**.

Because of this, fine control hole **f** is connected to drain chamber **D**, and the pressurized oil at port **P1** is released.

If the pressure at port **P1** drops to much, spool (1) is pushed down by metering spring (2), so fine control hole **f** is shut off from drain chamber **D**. At almost the same time, it is connected to pump pressure chamber **PP**, so the pressure at port **P1** supplies the pump pressure until the pressure recovers to a pressure equivalent to the position of the lever.

When the control valve returns, oil in drain chamber **D** flows in from fine control hole **f'** of the valve on the side that is not moving. It passes through port **P2** and goes to chamber **B** to charge the oil. (Fig. 3)



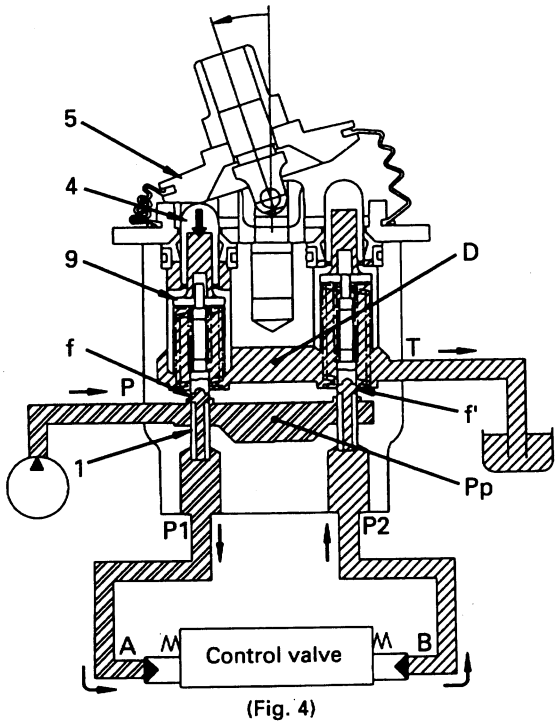
(Fig. 3)

SBP00277

4) At full stroke

Disc (5) pushes down piston (4), and retainer (9) pushes down spool (1). Fine control hole **f** is shut off from drain chamber **D**, and is connected to pump pressure chamber **PP**. Therefore, the pilot pressure oil from the control pump passes through fine control hol **f** and flow to chamber **A** from port **P1** to push the control valve spool.

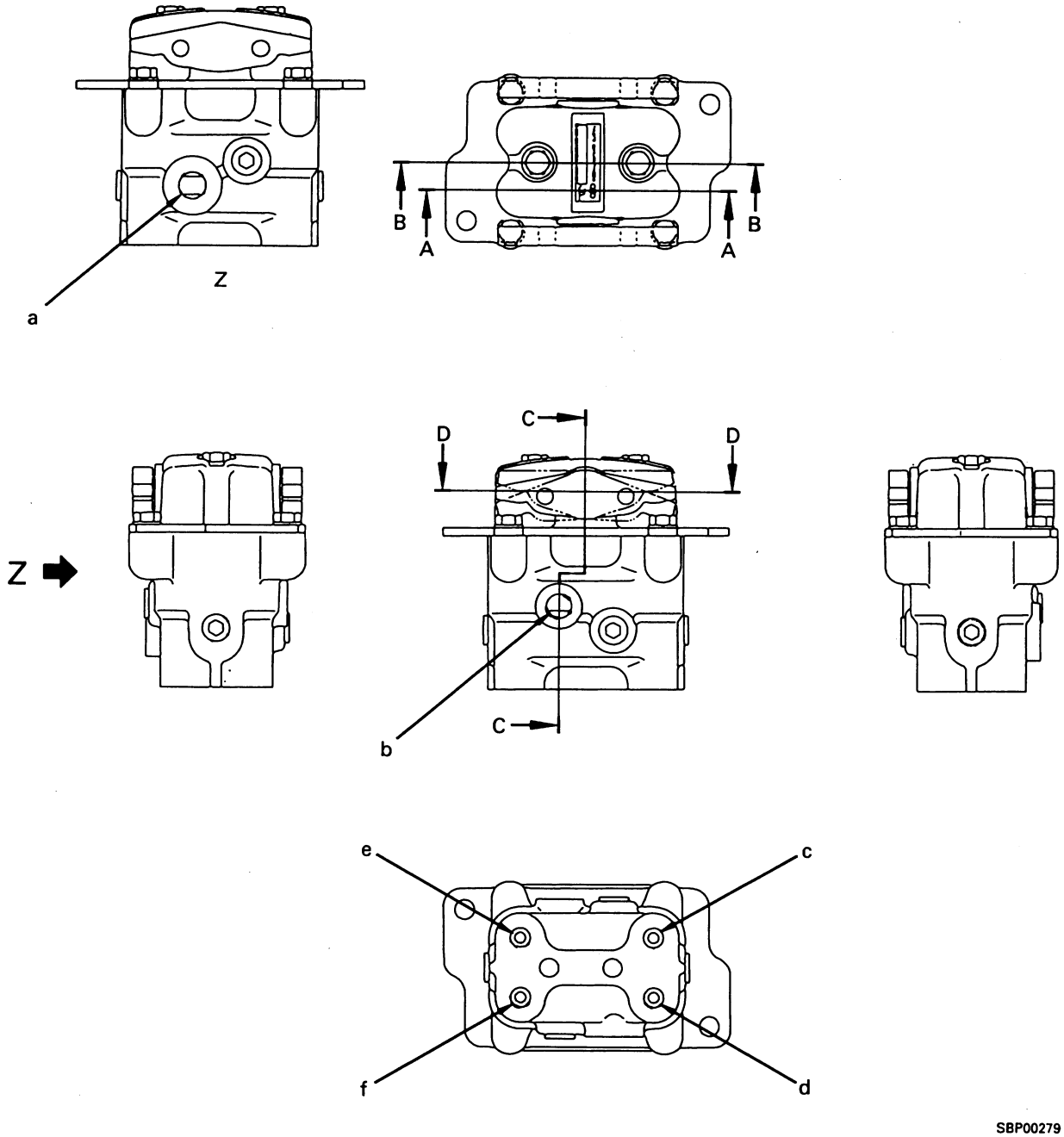
The return oil from chamber **B** passes from port **P2** through fine control hol **f'** and flows to drain chamber **D**. (Fig. 4)



(Fig. 4)

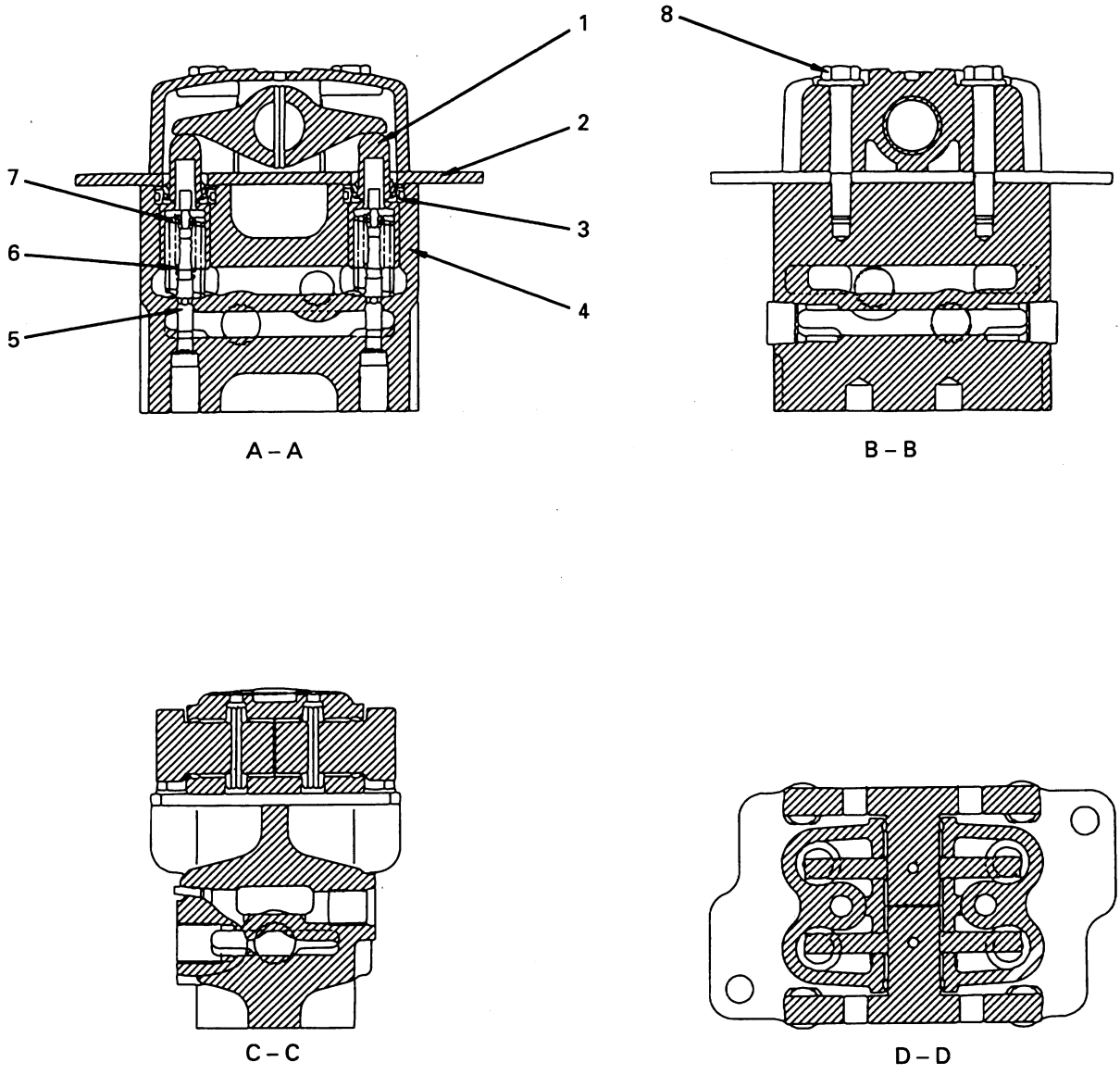
SBP00278

TRAVEL PPC VALVE



SBP00279

a. Port P (from control pump)
b. Port T (to tank)
c. Port P1 (L.H. travel FORWARD)
d. Port P3 (R.H. travel FORWARD)
e. Port P2 (L.H. travel REVERSE)
f. Port P4 (R.H. travel REVERSE)

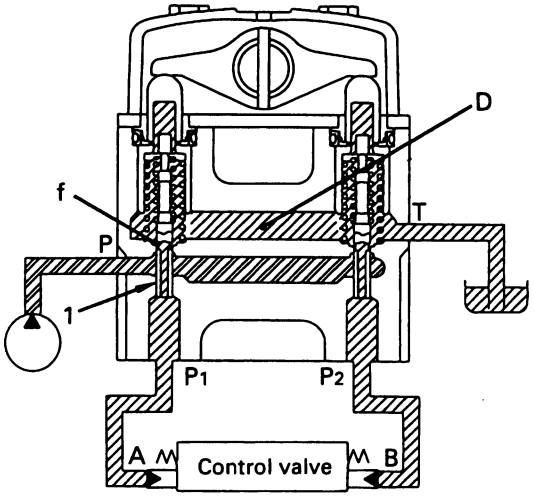


1. Piston
2. Plate
3. Collar
4. Body
5. Valve
6. Metering spring
7. Centering spring
8. Bolt.

OPERATION

1) At neutral

Ports **A** and **B** of the control valve and ports **P1** and **P2** of the PPC valve are connected to drain chamber **D** through fine control hole **f** in spool (1). (Fig. 1)



(Fig. 1)

SBP00281

2) Fine control (neutral → fine control)

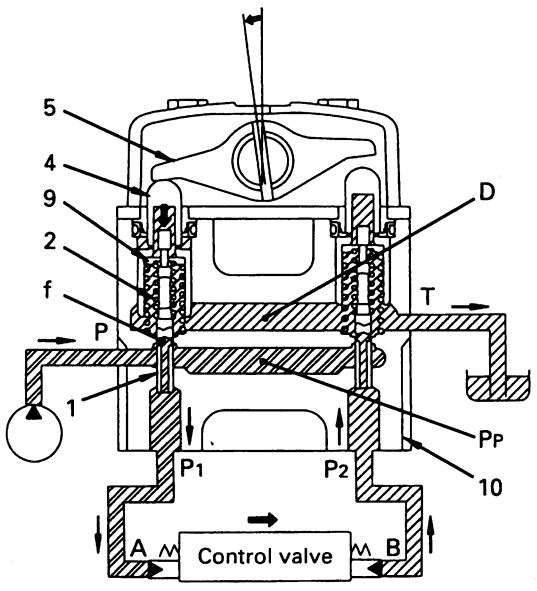
When piston (4) starts to be pushed by disc (5), retainer (9) is pushed. Spool (1) is also pushed by metering spring (2) and moves down.

When this happens, fine control hole **f** is shut off from drain chamber **D**. At almost the same time, it is connected to pump pressure chamber **PP**, and the pilot pressure of the control pump is sent from port **A** through fine control hole **f** to port **P1**.

When the pressure at port **P1** rises, spool (1) is pushed back. Fine control hole f is shut off from pump pressure chamber **PP**. At almost the same time, it is connected to drain chamber **D**, so the pressure at port **P1** escapes. As a result, spool (1) moves up and down until the force of metering spool (2) is balanced with the pressure of port **P1**.

The relationship of the positions of spool (1) and body (10) (fine control hole f is in the middle between drain hole **D** and pump pressure chamber **PP**) does not change until retainer (9) contacts spool (1).

Therefore, metering spring (2) is compressed in proportion to the travel of the control lever, so the pressure at port **P1** also rises in proportion to the travel of the control lever, so the pressure at port **P1** also rises in proportion to the travel of the control lever. In this way, the spool of the control valve moves to a position where the pressure of chamber **A** (same as pressure at port **P1**) and the force of the return spring of the control valve spool are balanced. (Fig. 2)



(Fig. 2)

SBP00282

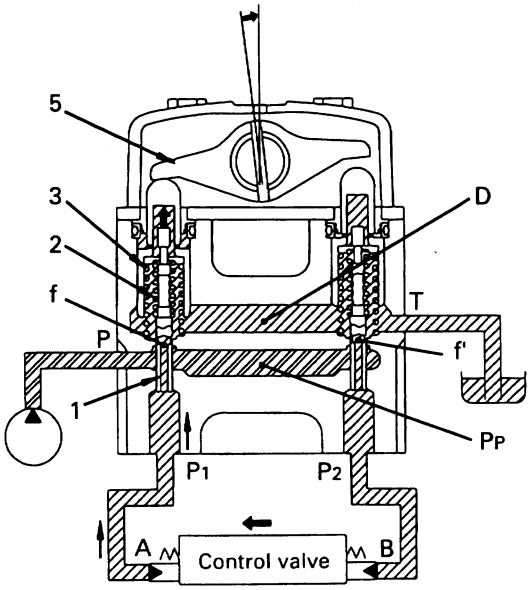
3) Fine control (control lever returned)

When disc (5) starts to be returned, spool (1) is pushed up by the force of centering spring (3) and the pressure at port **P1**.

Because of this, fine control hole **f** is connected to drain chamber **D**, and the pressurized oil at port **P1** is released.

If the pressure at port **P1** drops too much, spool (1) is pushed down by metering spring (2), so fine control hole f is shut off from drain chamber **D**. At almost the same time, it is connected to pump pressure chamber **PP**, so the pressure at port **P1** supplies the pump pressure until the pressure recovers to a pressure equivalent to the position of the lever.

When the control valve returns, oil in drain chamber **D** flows in from fine control hole **f'** of the valve on the side that is not moving. It passes through port **P2** and goes to chamber **B** to charge the oil. (Fig. 3)



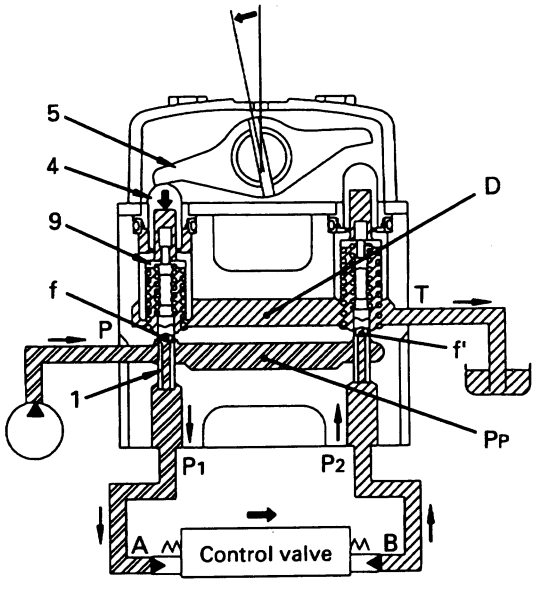
(Fig. 3)

SBP00283

4) At full stroke

Disc (5) pushes down piston (4), and retainer (9) pushes down spool (1). Fine control hole **f** is shut off from drain chamber **D**, and is connected to pump pressure chamber **PP**. Therefore, the pilot pressure oil from the control pump passes through fine control hole f and flows to chamber **A** from port **P1** to push the control valve spool.

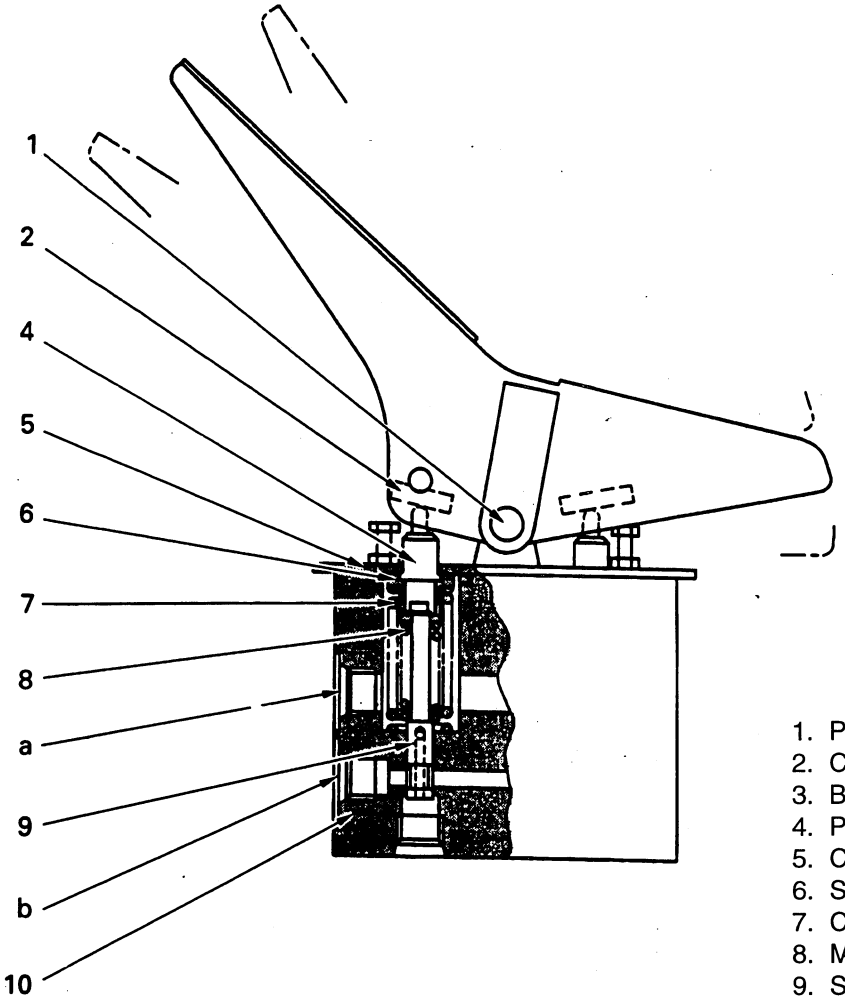
The return oil from chamber **B** passes from port **P2** through fine control hole f' and flows to drain chamber **D**. (Fig. 4)



(Fig. 4)

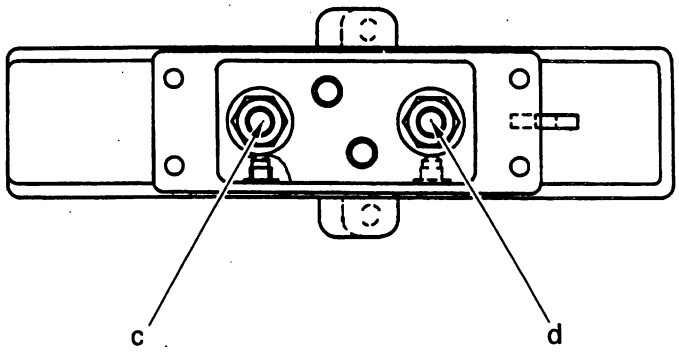
SBP00284

SERVICE PPC VALVE



1. Pin
2. Cam
3. Ball
4. Piston
5. Cover
6. Sleeve
7. Centering spring
8. Metering spring
9. Spool
10. Body

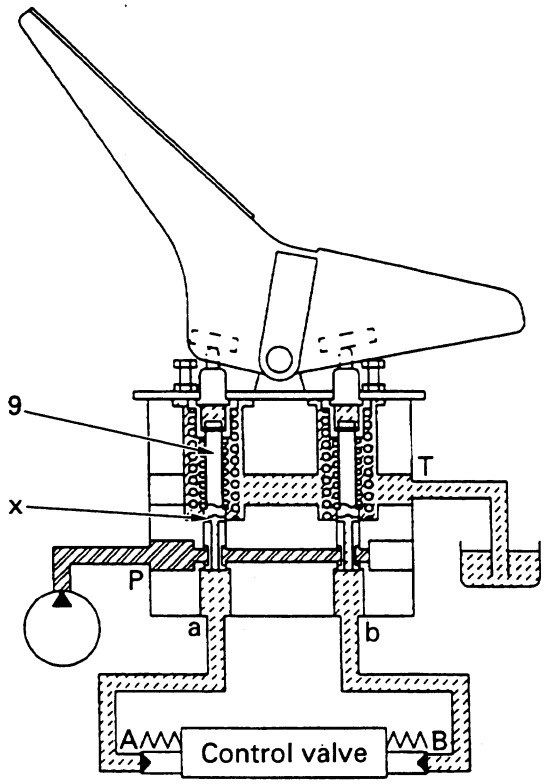
a. Port **T** (to tank)
b. Port **P** (from control pump)
c. Port **A** (to service valve **P1**)
d. Port **B** (to service valve **P2**)



OPERATION

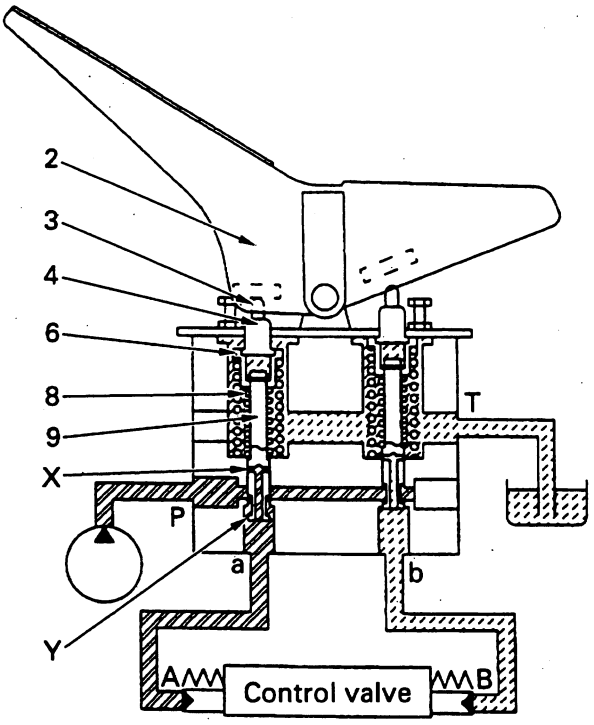
At neutral

- The pressurized oil from the control pump enters from port **P** and is blocked by spool (9).
- Port **A** and **B** of the control valve and port "a" and "**b**" of the PPC valve are connected to drain port **T** through fine control hole **X** of spool (9).

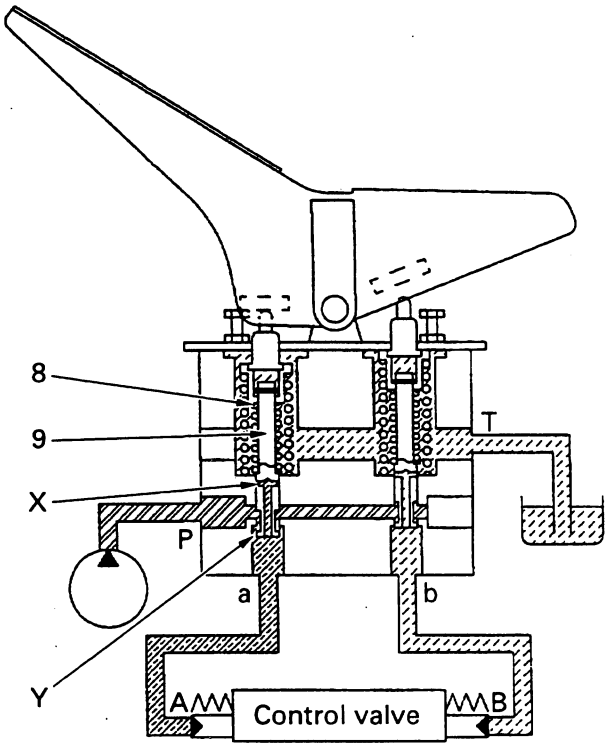


When operated

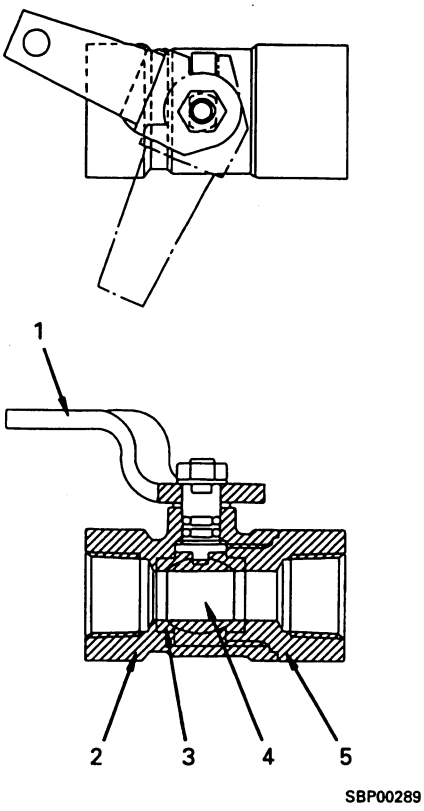
- When cam (2) is moved, metering spring (8) is pushed by ball (3), piston (4), and sleeve (6), and spool (9) is also pushed down by this.
- As a result, fine control hole **X** is shut off from the drain circuit. at almost the same time, fine control portion **Y** is connected with port "**a**", and the pressurized oil from port **P** flows from port "**a**" to port **A** of the control valve.



- When the pressure at port "**a**" becomes higher, spool (9) is pushed back by the force acting on the end of the spool. When fine control portion **Y** closes, fine control hole **X** is connected to the drain circuit at almost the same time.
- As a result, spool (9) moves up and down to balance the force at port "**a**" and the force at metering spring (8).
- Therefore, metering spring (8) is compressed in proportion to the amount the control lever is moved. The spring force becomes larger, so the pressure at port "**a**" also increases in proportion to the amount the control lever is operated.
- In this way, the control valve spool moves to a positon where the pressure of port **A** (the same as the pressure at port "**a**") is balanced with the force of the return spring of the control valve spool.



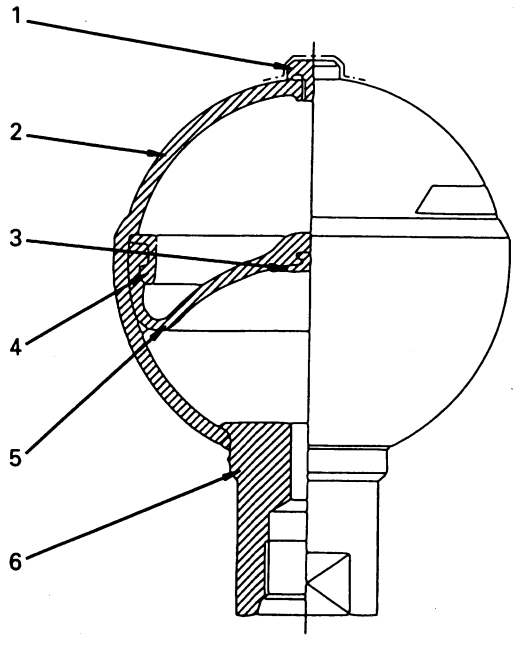
PPC SAFETY LOCK VALVE



SBP00289

1. Lever
2. Body
3. Seat
4. Ball
5. End cap

PPC ACCUMULATOR

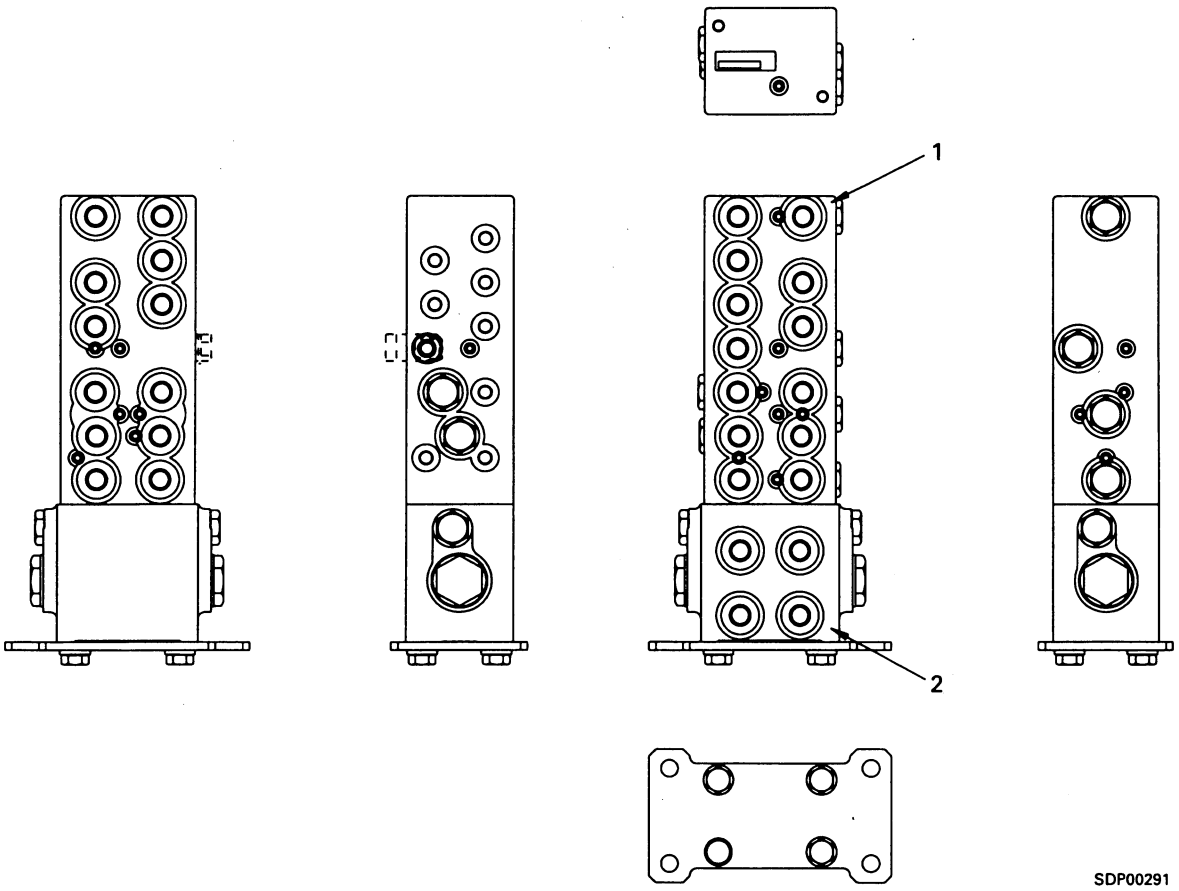


SBP00290

1. Gas plug
2. Shell
3. Poppet
4. Holder
5. Bladder
6. Oil port

Specifications
Actual gas volume: 400 cm^3

PPC SHUTTLE VALVE, TRAVEL JUNCTION VALVE

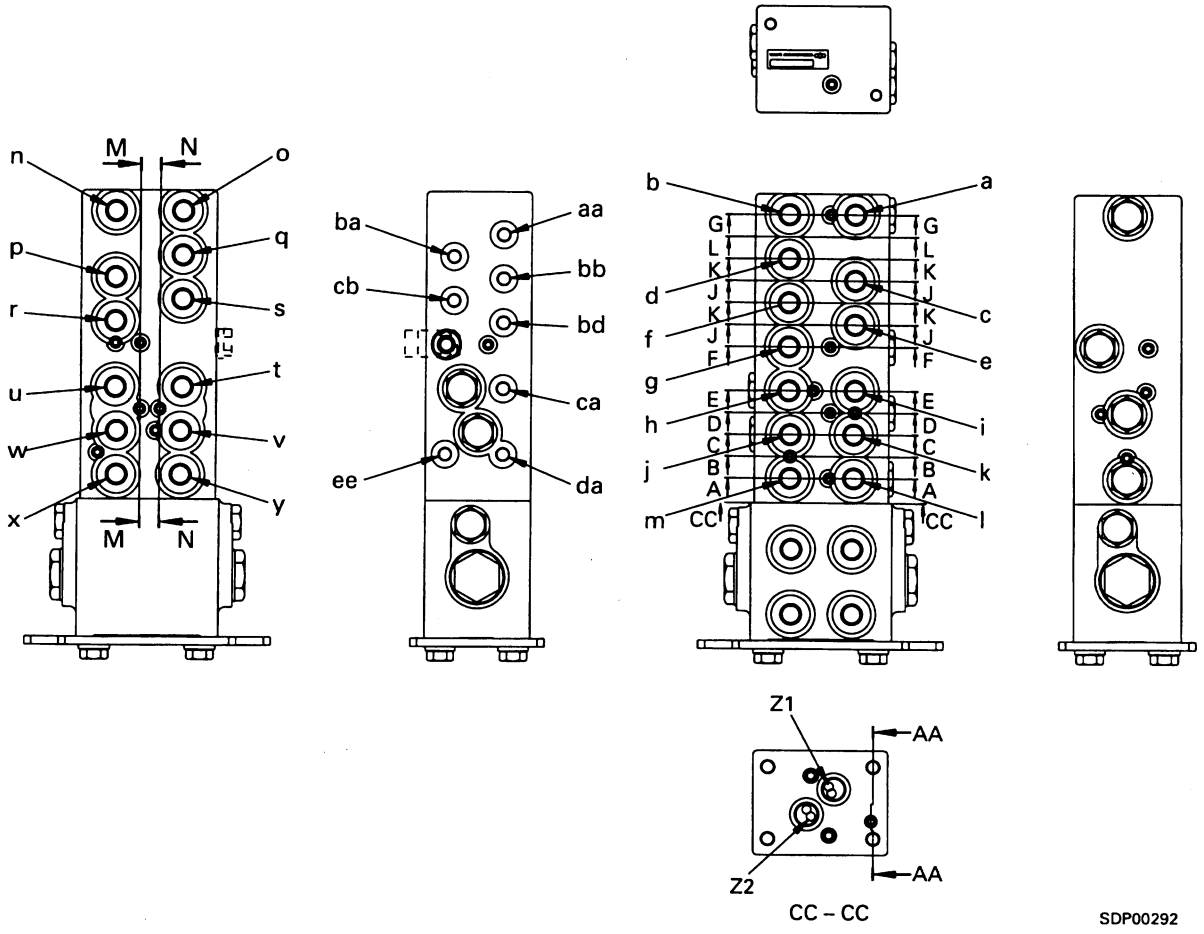


1. PPC shuttle valve
2. Travel junction valve

Outline

- The PPC shuttle valve and travel junction valve form a combined structure.

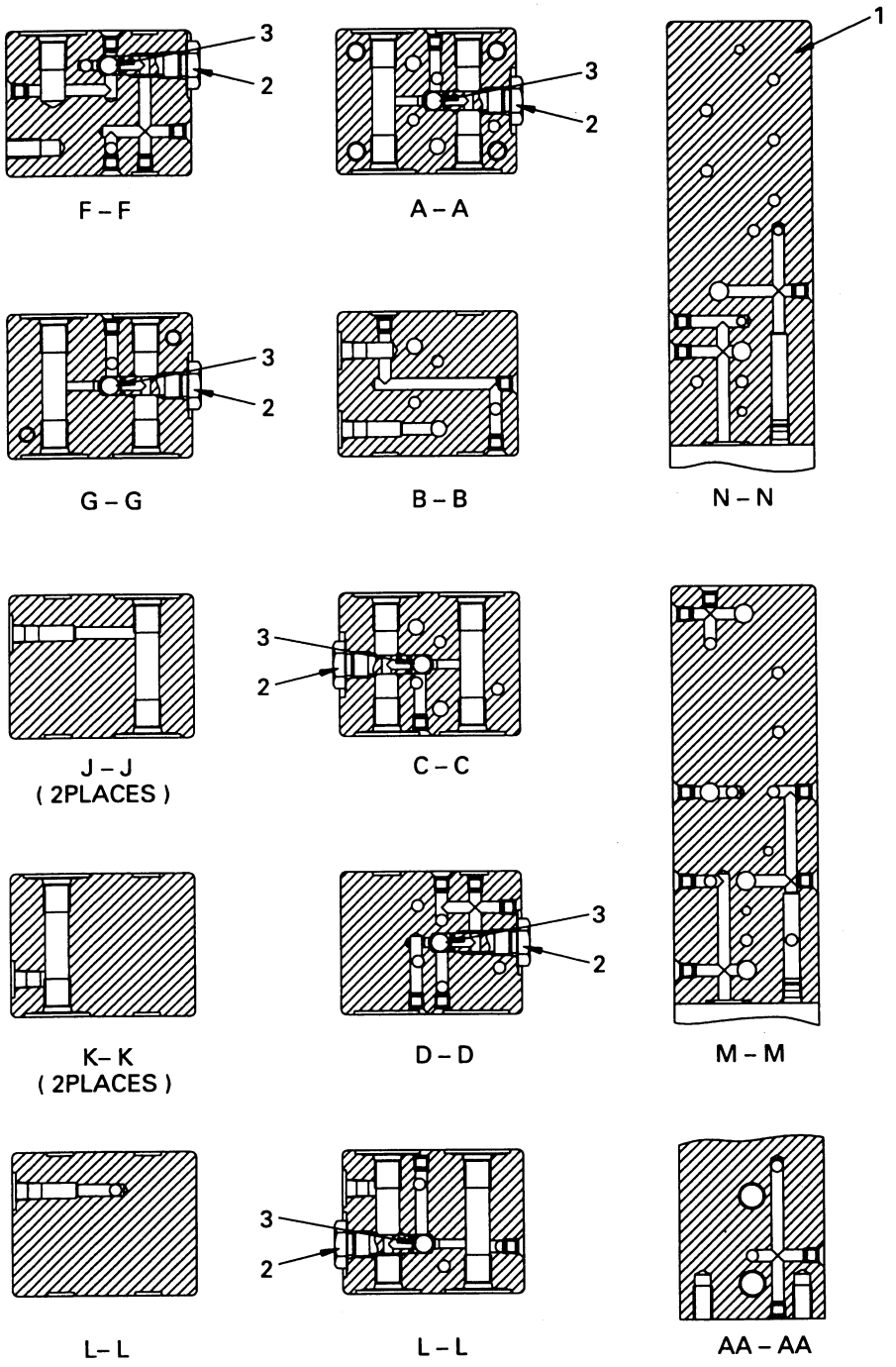
PPC SHUTTLE VALVE



Function

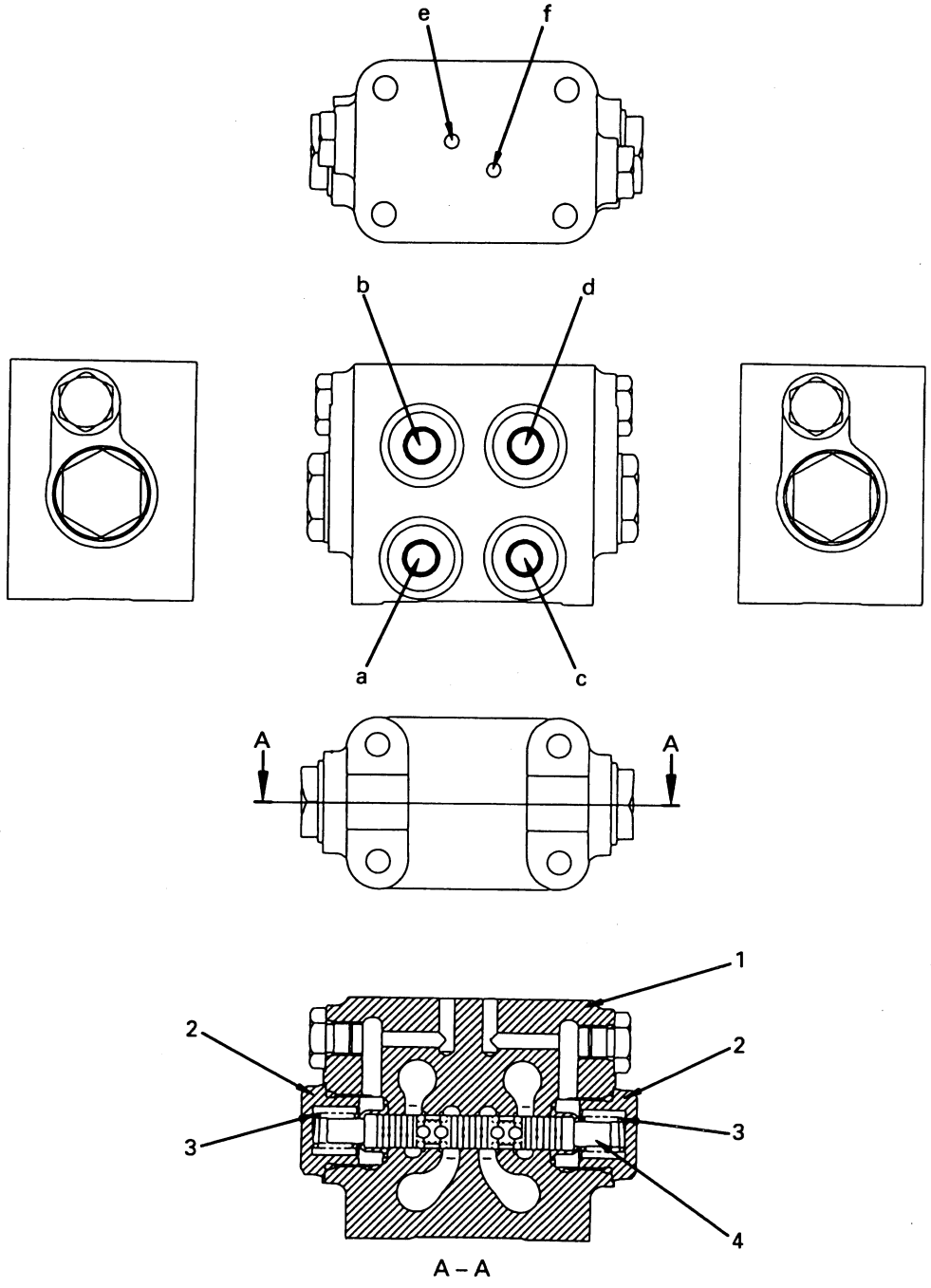
- The PPC shuttle valve sends the PPC valve output pressure to the control valve and travel junction valve. It is provide with a mount port for the pressure switch for detecting the pilot pressure.

a. Port P11 [to control valve (swing)]
b. Port P12 [to control valve (swing)]
c. Port P31 [to control valve (bucket)]
d. Port P41 [to control valve (bucket)]
e. Port P51 [to control valve (boom)]
f. Port P61 [to control valve (arm)]
g. Port PLS (from LS select valve)
h. Port P71 [to control valve (arm)]
i. Port P81 [to control valve (boom)]
j. Port PA1 [to control valve (R.H. travel)]
k. Port PB1 [to control valve (L.H. travel)]
l. Port PC1 [to control valve (L.H. travel)]
m. Port P91 [to control valve (R.H. travel)]
n. Port P12 (from swing PPC valve)
o. Port P22 (from swing PPC valve)
p. Port P32 (from bucket PPC valve)
q. Port P42 (from bucket PPC valve)
r. Port P52 (from boom PPC valve)
s. Port P62 (from arm PPC valve)
t. Port P72 (from arm PPC valve)
u. Port P82 (from boom PPC valve)
v. Port PA2 (from R.H. travel PPC valve)
W. Port PB2 (from L.H. travel PPC valve)
x. Port PC2 (from L.H. travel PPC valve)
y. Port P32 (from R.H. travel PPC valve)
z1. Port PR (to travel junction valve)
z2. Port PF (to travel junction valve)
aa. Port A1 (mount port for swing pressure switch)
ba. Port A8 (mount port for bucket DUMP pressure switch)
bb. Port A2 (mount port for arm CURL pressure switch)
ca. Port A4 (mount port for arm OUT pressure switch)
cb. Port A3 (mount port for arm IN pressure switch)
da. Port A5 (mount port for boom RAISE pressure switch)
db. Port A7 (mount port for boom LOWER pressure switch)
ee. Port A6 (mount port for travel pressure switch)



1. Body
2. Plug
3. Ball

TRAVEL JUNCTION VALVE

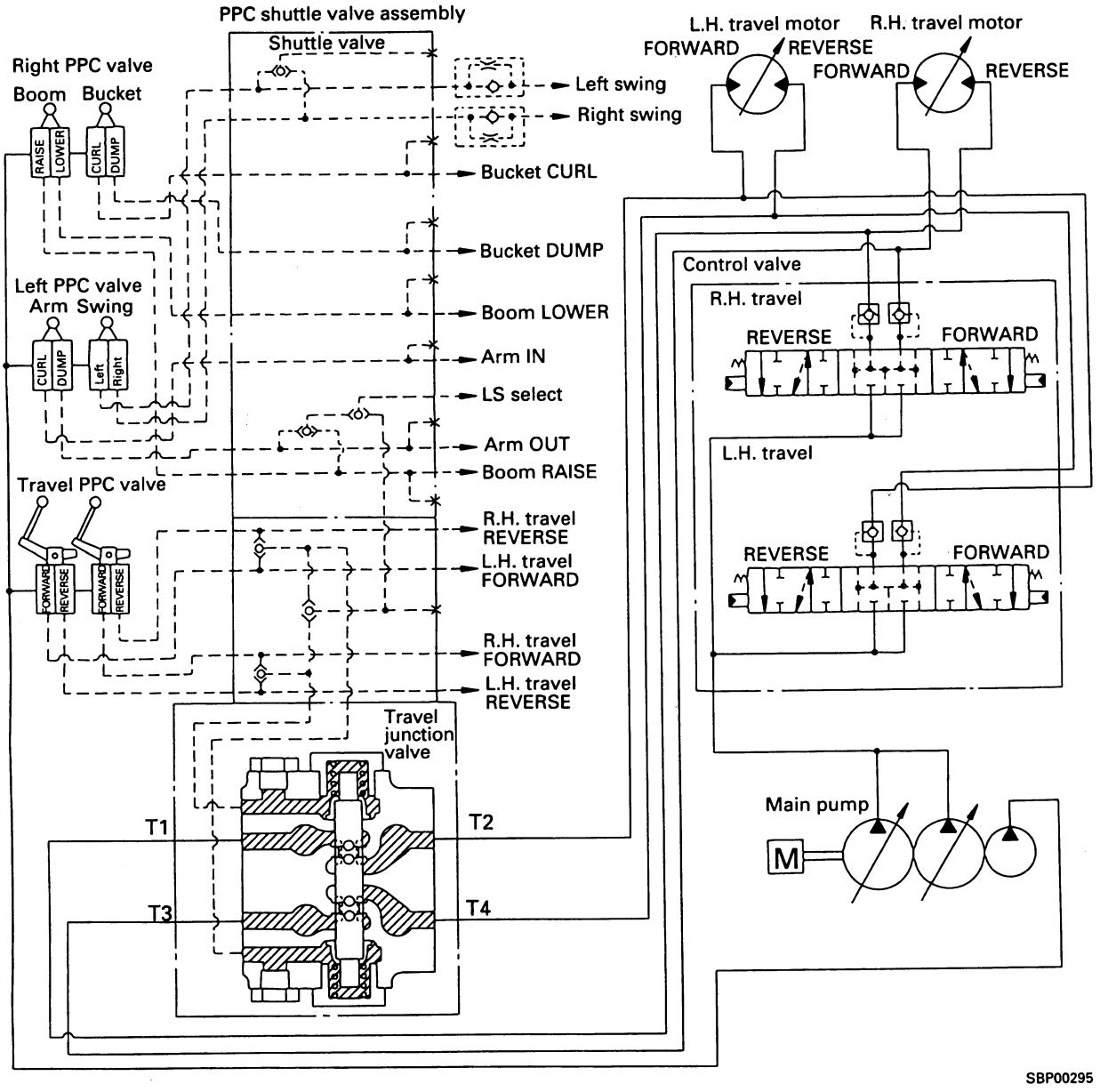


SBP00294

1. Body
2. Plug
3. Spring
4. Spool

a. Port T1 (from L.H. travel control valve)
b. Port T2 (from R.H. travel control valve)
c. Port T3 (from L.H. travel control valve)
d. Port T4 (from R.H. travel control valve)
e. Port PF (from PPC shuttle valve)
f. Port PR (from PPC shuttle valve)

STRAIGHT - TRAVEL SYSTEM



Function

- A travel junction valve is installed between the travel valve and travel motor to compensate for any difference in the oil flow to the left and right travel circuits when traveling in a straight line.
- Because of this, the flow of oil to the left and right travel motors when traveling in a straight line is almost the same, so there is no travel deviation.
- The travel junction valve interconnects the travel circuits when the straight-travel is operated in dependently or when the straight travel + another actuator are operated simultaneously.
- When steering, if the difference in the movement of the travel levers is more than approx. 10 mm, the travel junction valve is switched, and the left and right travel circuits are shut off.

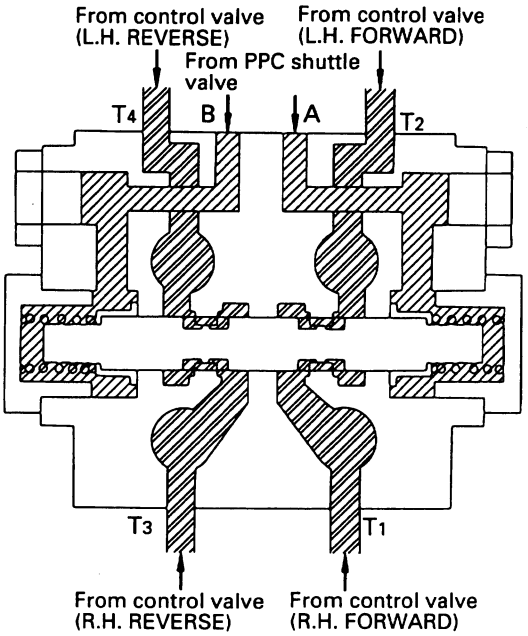
Operation

A: PPC output pressure (R.H. travel REVERSE or L.H. travel FORWARD)

B: PPC output pressure (R.H. travel FORWARD or L.H. travel REVERSE)

When traveling in a straight line in forward or reverse

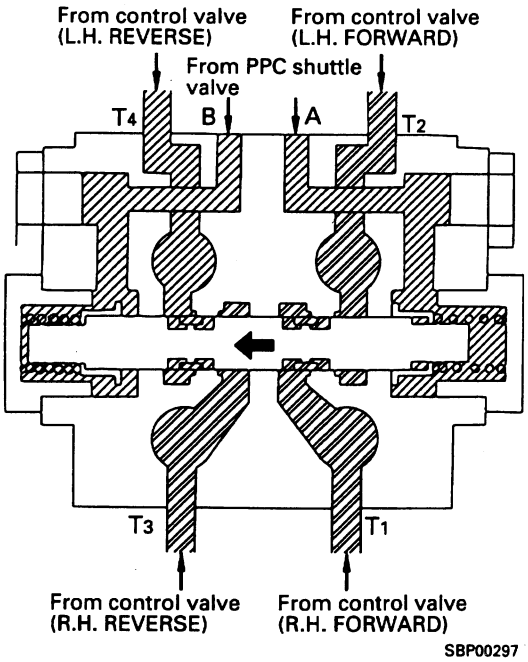
- When traveling forward (or in reverse), there is no difference in the pilot pressure from the PPC shuttle valve (the output pressure of each PPC valve), so the spool is balanced in the middle. In this condition, the R.H. FORWARD and L.H. FORWARD, and R.H. REVERSE and L.H. REVERSE are interconnected through the spool.



SBP00296

When steering in forward or reverse

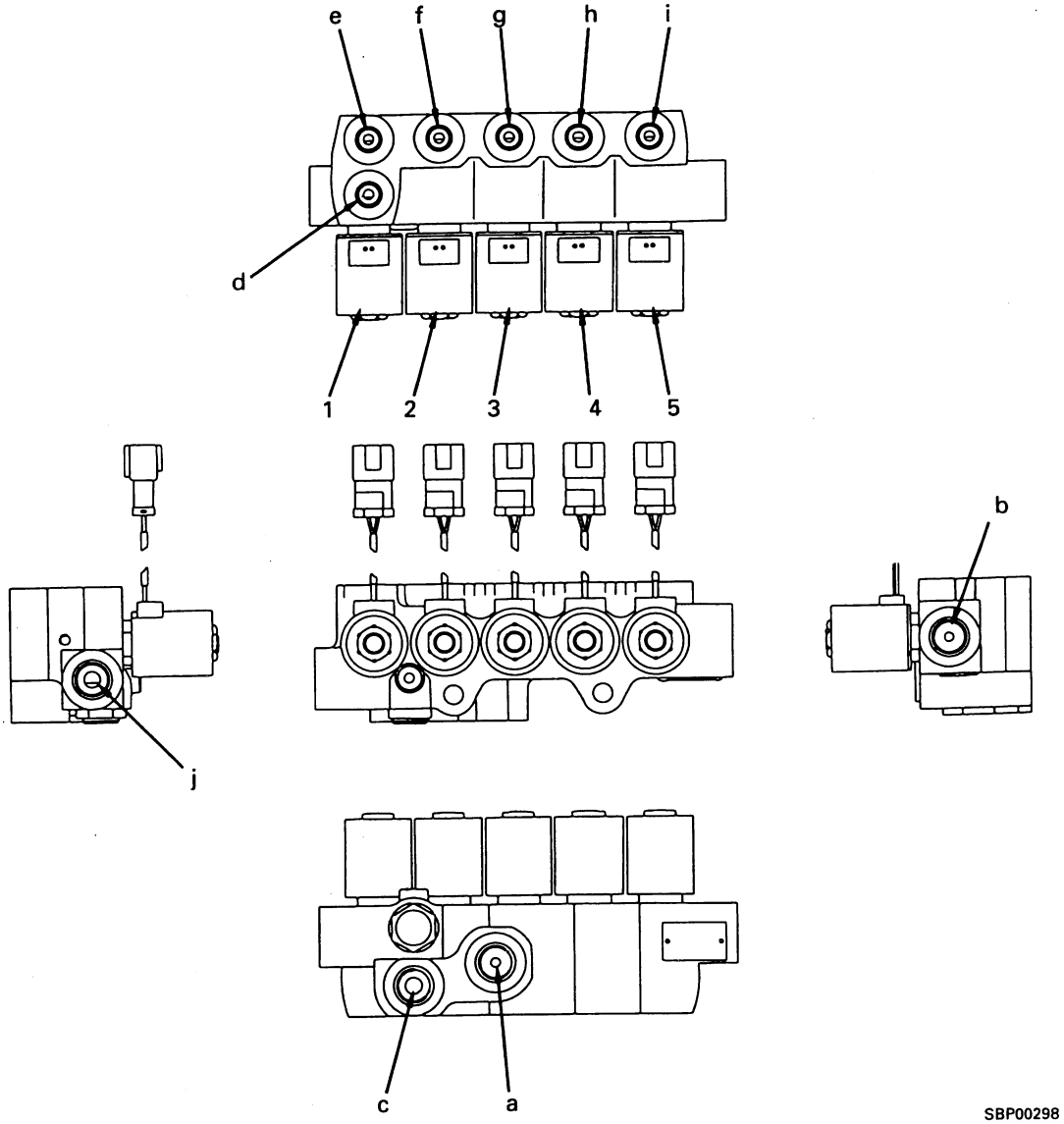
- When the steering is operated in forward (or reverse), if the difference in the pilot pressure from the PPC shuttle valve becomes greater than the switching pressure (spring force), the spool moves to the right forward and left and right reverse passages are separated. Because of this, a difference in pressure is created in the left and right circuits, and the steering can be operated.



SBP00297

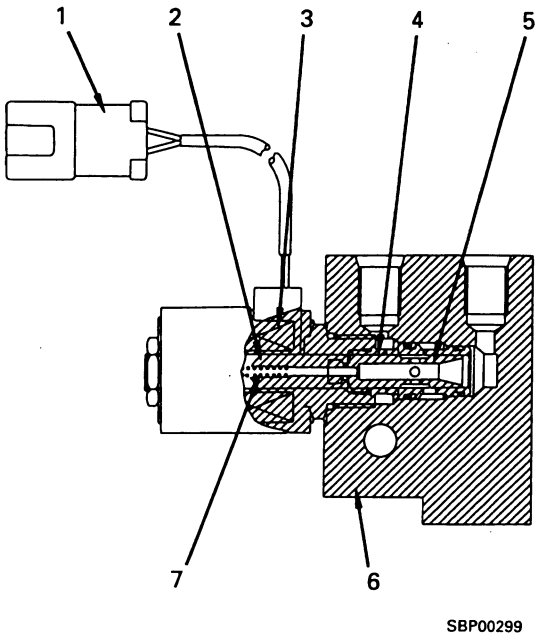
EPC SOLENOID VALVE

For LS select, boom Hi 2-stage safety valve, merge/flow divider, travel speed, swing brake



1. LS select solenoid valve
2. Boom Hi 2-stage safety valve solenoid valve
3. Merge/flow divider solenoid valve
4. Travel speed solenoid valve
5. Swing brake solenoid valve

a. To tank
b. From control pump
c. To PPC valve
d. From shuttle valve
e. To LS select valve
f. To boom control valve
g. To merge/flow divider valve
h. To L.H. and R.H. travel motors
i. To swing motor
j. To accumulator



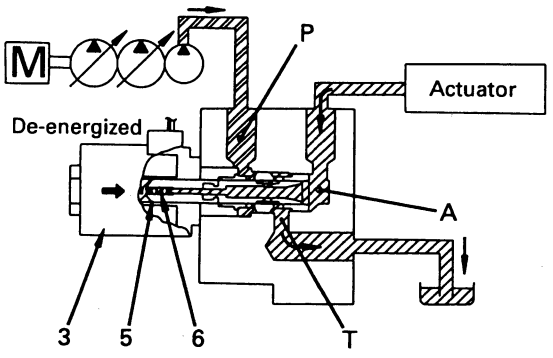
SBP00299

1. Connector
2. Variable core
3. Coil
4. Cage
5. Spool
6. Block
7. Spring

Operation

When solenoid is de-energized

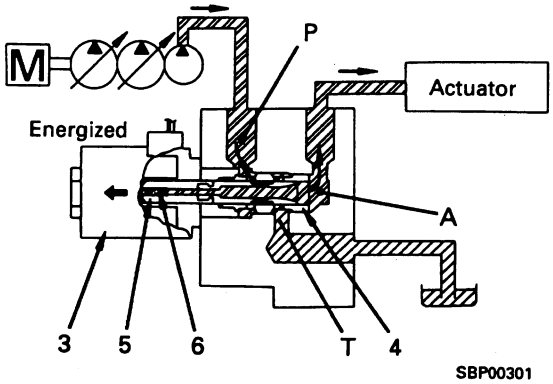
- The signal current does not flow from the controller, so solenoid (3) is de-energized.
  For this reason, spool (5) is pushed to the right by spring (6).
  As a result, the circuit between ports **P** and **A** closes and the pressurized oil from the control pump does not flow to the actuator. At the same time, the pressurized oil from the actuator flows from port **A** to port **T**, and then drained to the tank.



SBP00300

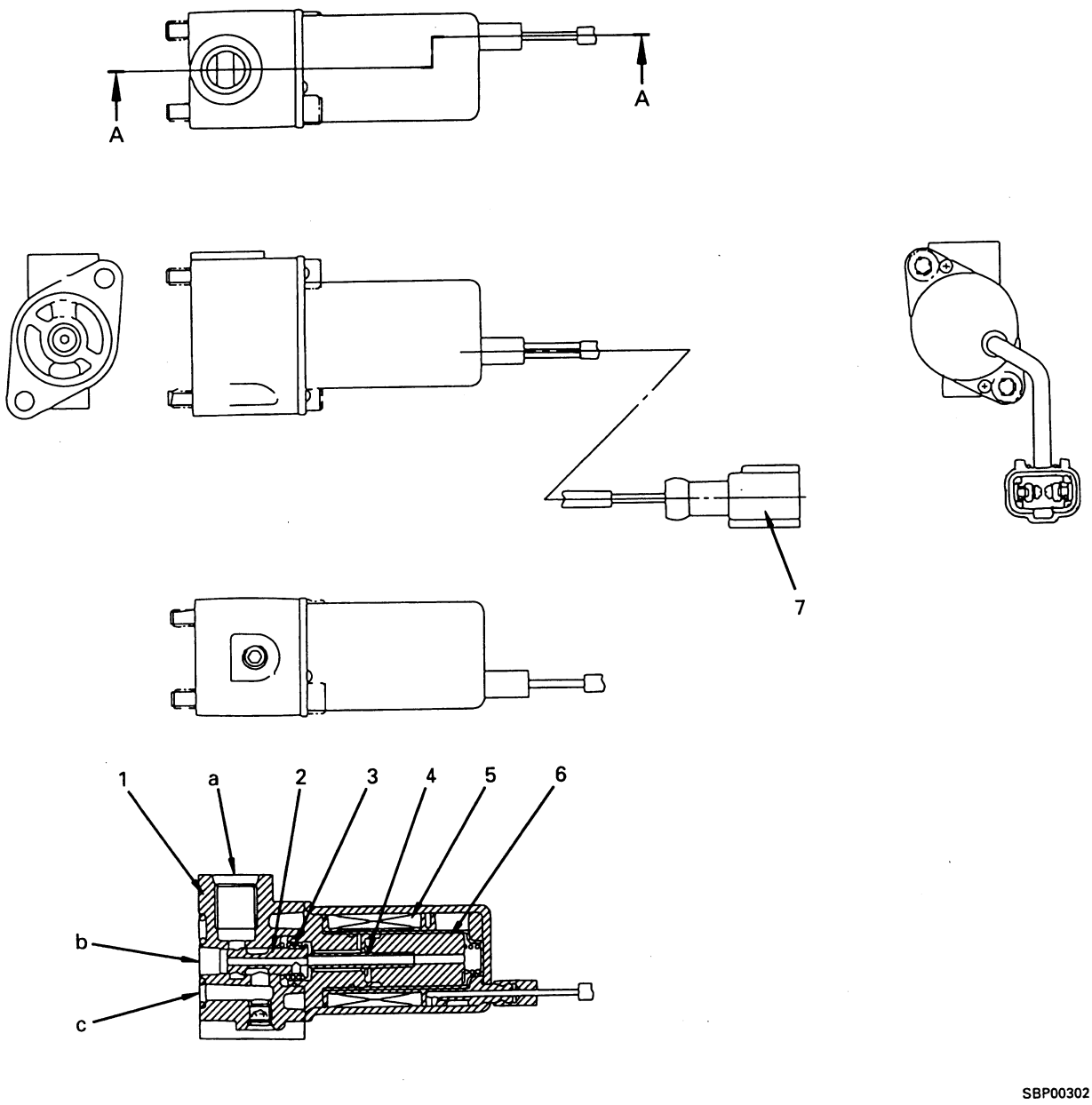
When solenoid is energized

- When the signal current flows from the controller to solenoid (3), solenoid (3) is energized.
  For this reason, spool (5) is pushed to the left.
  As a result, the pressurized oil from the control pump flows from port **P** through the inside of spool (5) to port **A**, and the flows to the actuator.
  At the same time, port **T** is closed, and this stops the oil from flowing to the tank.



SBP00301

FOR LS VAL VE CONTROL



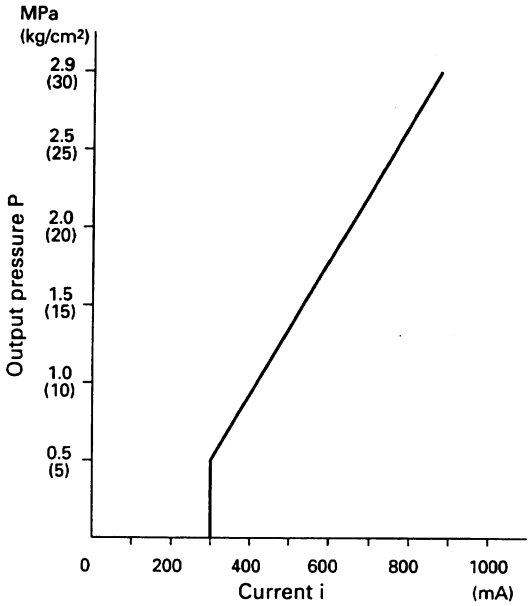
SBP00302

1. Body
2. Spool
3. Spring
4. Push pin
5. Coil
6. Plunger
7. Connector

a. Port C (to LS valve)
b. Port T (to tank)
c. Port P (from control pump)

Function

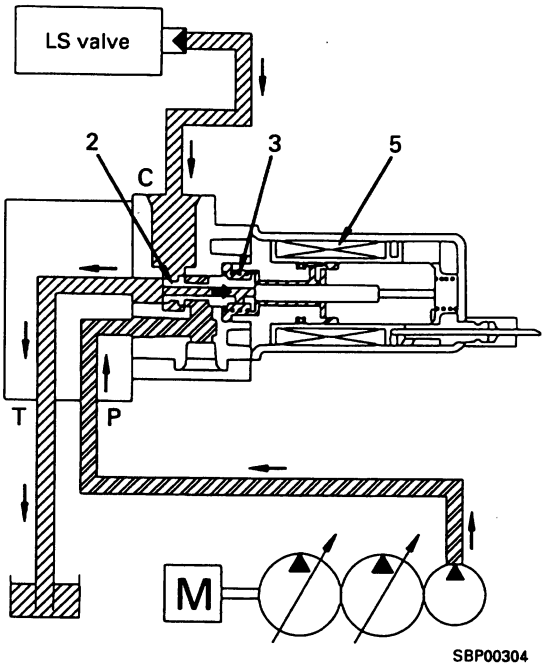
- The EPC valve consists of the proportional solenoid portion and the hydraulic valve portion.
- When it receives signal current i from the governor and pump controller, it generates the EPC output pressure in proportion to the size of the signal, and outputs it to the LS valve.



Operation

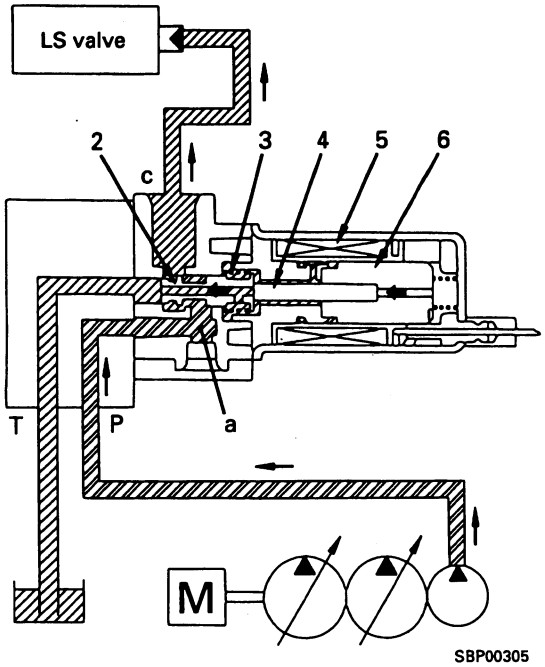
1. **When signal current is 0 (coil de-energized)**

- There is no signal current flowing from the controller to coil (5), coil (5) is de-energized.
- For this reason, spool (2) is pushed to the right by spring (3).
  As a result , port **P** closes and the pressurized oil from the control pump does not flow to the LS valve.
  At the same time, the pressurized oil from the LS valve passes from port **C** through port **T** and is drained to the tank.



2. When signal current is very small (coil energized, fine control)

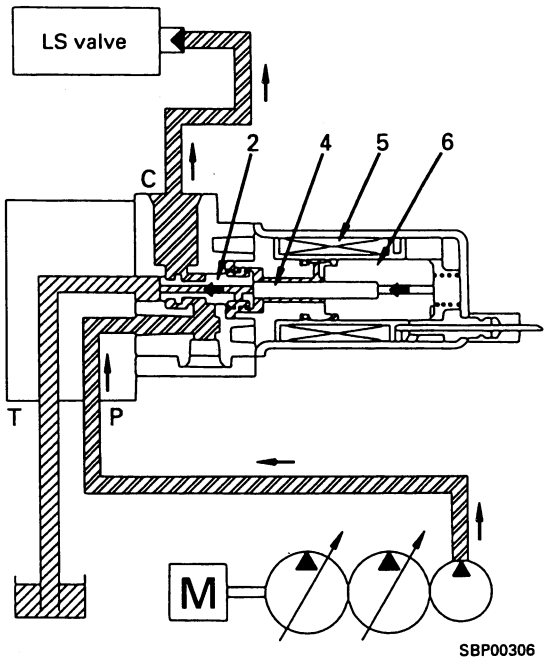
- When a very small signal current flows to coil (5), coil (5) is energized, a propulsion force is generated, and this pushes plunger (6) to the left.
- Push pin (4) pushes spool (2) to the left, and pressurized oil flows from port **P** to port **C**.
- When the pressure at port **C** rises and the load of spring (3) + the force acting on surface a of spool (2) becomes greater than the propulsion force of plunger (6), spool (2) is pushed to the right. The circuit between port **P** and port **C** is shut off, and at the same time, port **C** and port **T** are connected.
- As a result, spool (2) moves up and down so that the propulsion force of plunger (6) is balanced with the load of spring (3) + pressure of port **C**.
- Therefore, the circuit pressure between the EPC valve and the LS valve is controlled in proportion to the size of the signal current.



SBP00305

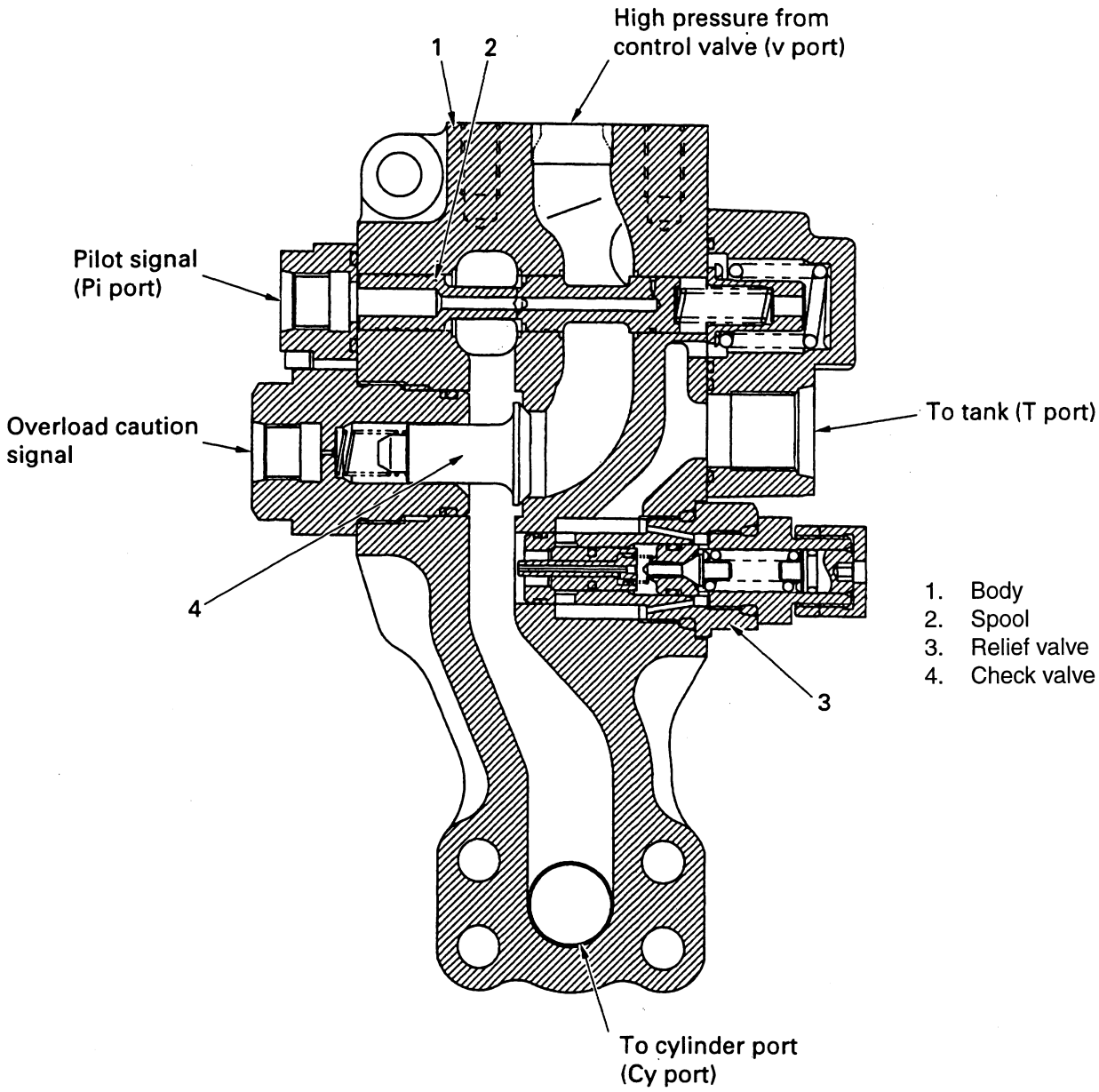
3. When signal current is maximum (coil energized, opeated fully)

- When signal current is maximum (coil energized, operated fully)
- When the signal current flows to coil (5), coil (5) is energized.
- When this happens, the signal current is at its maximum, so the propulsion force of plunger (6) is also at its maximum.
  For this reason, spool (1) is pushed fully to the left by push pin (4).
- As a result, the flow of pressurized oil from port **P** flows at its maximum to port **C**, and the circuit pressure between the EPC valve and LS valve becomes the maximum.
  At the same time, port **T** closes and stops the oil from flowing to the tank.



SBP00306

BOOM SAFETY VALVE



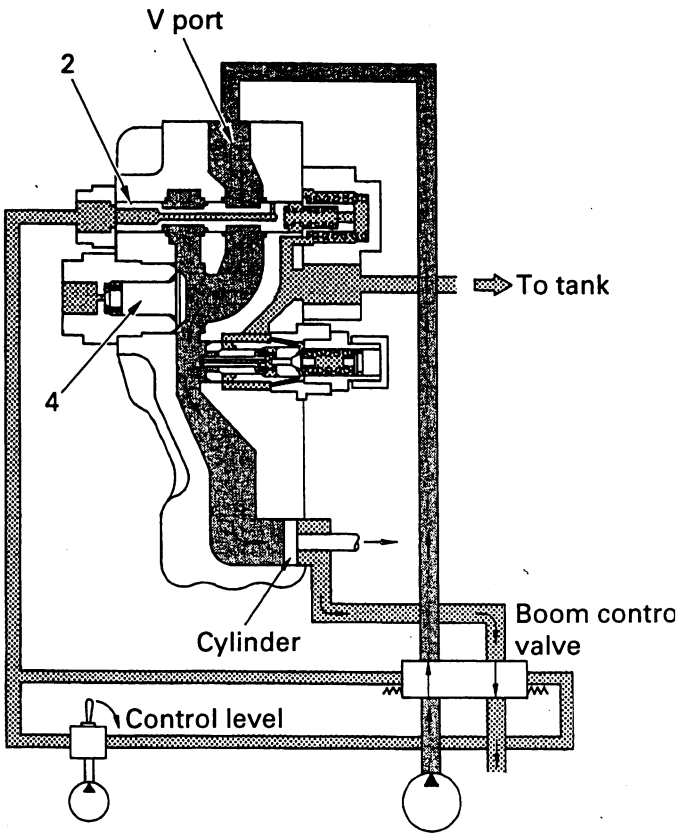
FUNCTION

- This valve prevents sudden uncontrolled lowering of the boom, when lifting, due to the burst of a hose in the boom cylinder line. In such a condition this value will hold the load until operator lowers the boom in a controlled way using the normal wrist control.

OPERATION

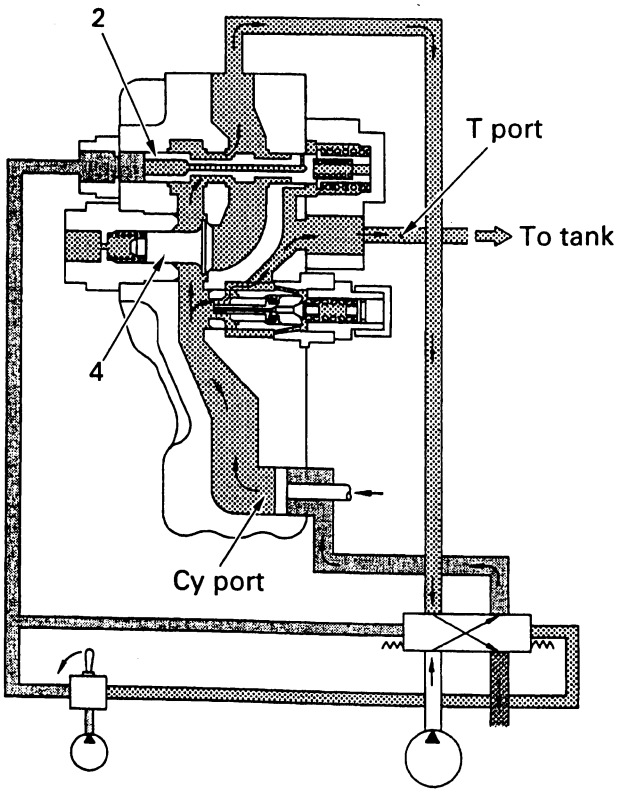
BOOM RAISE

- During boom raising the pilot signal from wrist control operates control valve spool to direct high pressure oil to port **V** of hose burst valve.
- This pressure lifts check valve (4) from seat & high pressure oil flows in the bottom of the cylinder raising the boom.



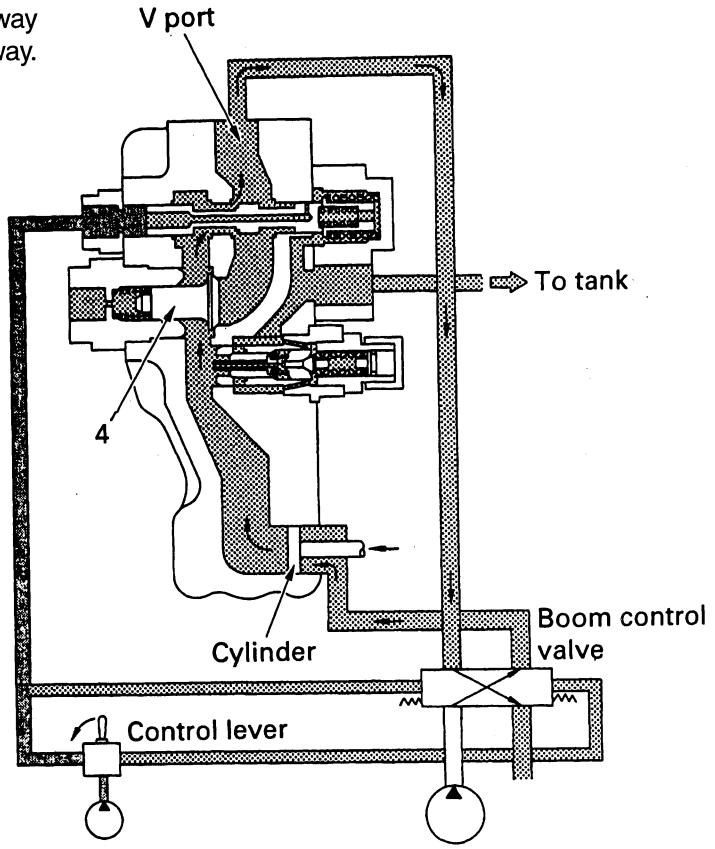
BOOM LOWER

- During boom lowering the pilot signal reverses the flow through the control valve spool. High pressure oil flows to the head side of the cylinder. Oil in the bottom side of the cylinder flows through the port of the valve but cannot flow past the ceck valve. The pilot signal also opens the spool (2) of the hose burst valve and allows oil to flow back to tank.



When hose burst occurs
(Operation to lower safety)

- The sudden loss of pressure at port V will cause check valve (4) to re-seat and so the valve is locked.
- The boom can be lowered in a controlled way by operating the wrist control in the normal way.



HYDRAULIC CYLINDER

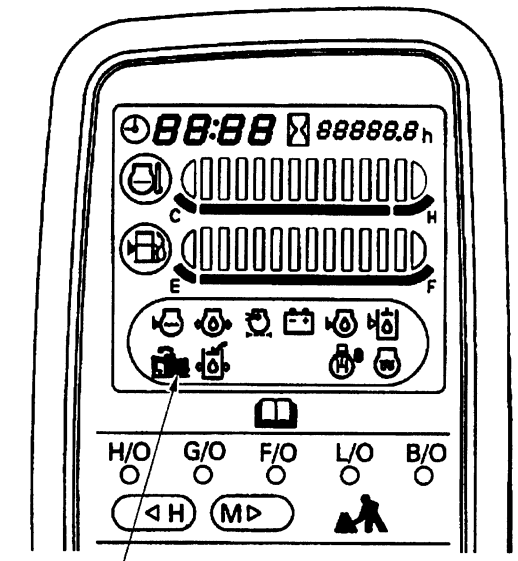
Specifications

Unit: mm

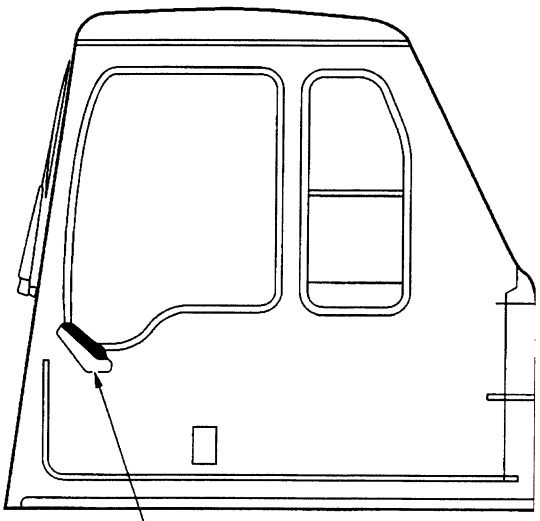
Item	Boom	Arm	Bucket
	PC450-6k	PC450-6k	PC450-6k
Outside diameter of piston rod	110	120	110
Inside diameter of cylinder	160	185	160
Stroke	1,570	1,820	1,270
Max. stroke	3,830	4,410	3,265
Min. stroke	2,260	2,590	1,995

OVERLOAD WARNING DEVICE

1. OUTLINE



Overload warning pilot lamp



Monitor

Function

- This device is installed to prevent the machine from tipping over when it lifts an excessive weight while being used as a crane.

Structure

- When an excessive weight is lifted, the oil pressure goes up at the bottom side of the boom cylinders When this happens, the pressure switch senses the rising pressure, turns the pressure switch on, and lights the monitor lamp to warn the operator. When the monitor lamp lights, immediately lower the weight to the ground or bing the arm closer in to the operator to prevent the machine from tipping over.

Effective from machine s/n K30001 till K30198 (see page 10-133-1 for above K30198)

2. OPERATION

- Hose (2) directs the oil pressure from the bottom side of the boom cylinders to pressure switch (3).

a. When the boom is in the lowest position.

- When boom (50 is in the lowest position, lever (4) takes position A in Fig. 1 and the operating pressure (closed and open) becomes 60 kg/cm^2.

b. When the boom is in the highest position.

- When the boom is in the highest position, lever (4) takes position B in Fig. 2 and the operating pressure becomes 360 kg/cm^2.

c. When the boom is in an arbitrary position.

- When the boom is in a position anywere between the lowest and the highest points, the operating pressure of switch (3) will be somewher between 60 kg/cm2 and 360 kg/cm^2, based on the boom position.
  For instance, when the boom is in a certain position between the lowest and the highest points, lever (4) takes as position which corresponds to that boom position.
  If lever (4) is in the position to make the operating pressure of the pressure switch 150 kg/cm^2 (which is the same pressure as the bottom side of the boom cylinder), the pressure switch will turn on when execessive weight is lifted by the boom and the oil pressure of the bottom of the boom cylinders exceeds 150 kg/cm^2.

⚠ When the machine is performing any kind of operation other than lifting loads, fasten the pressure switch lever (4) with the bolt (6) to prolong the life at the pressure switch.

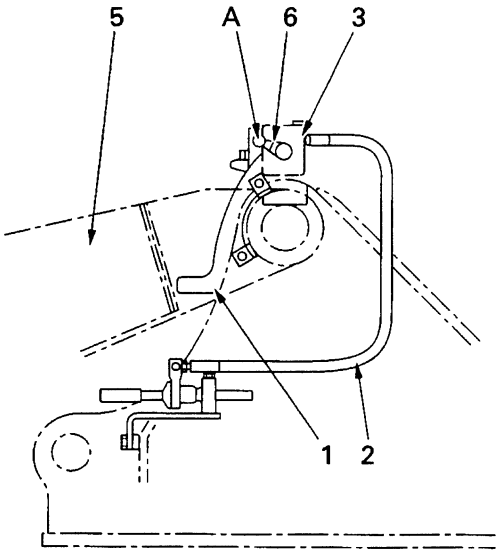


Fig. 1

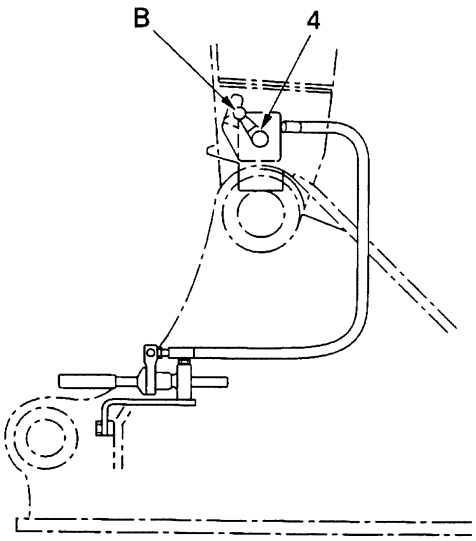
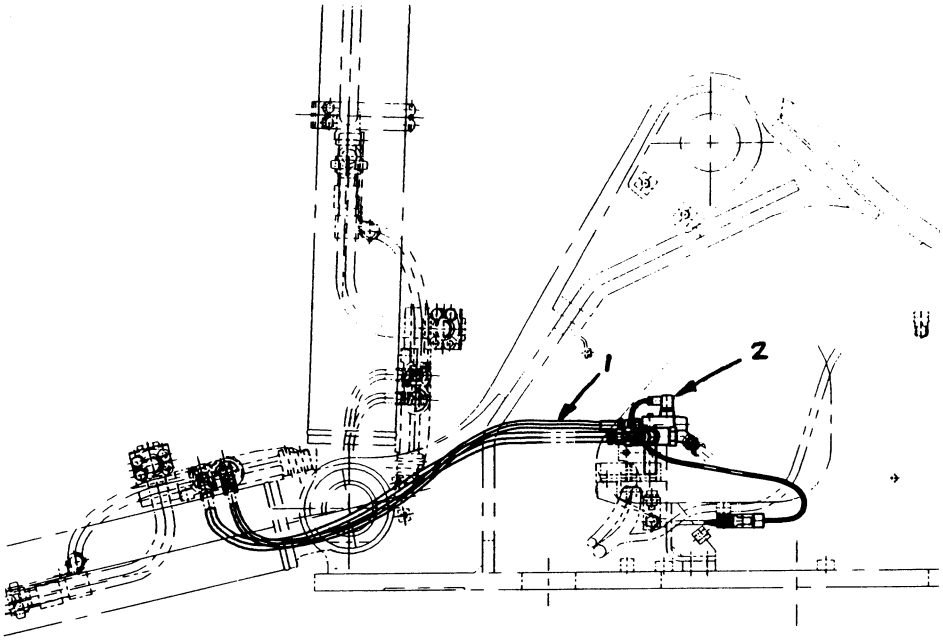


Fig. 2

Effective from machine s/n K30198. The overload warning system will operate as follow:

Mose (1) disects oil pressure from the bottom side of the boom cylinders to pressure switch (2). Pressure switch (2) signals the warning device, but the alarm is only raised when the machine is in LO mode.

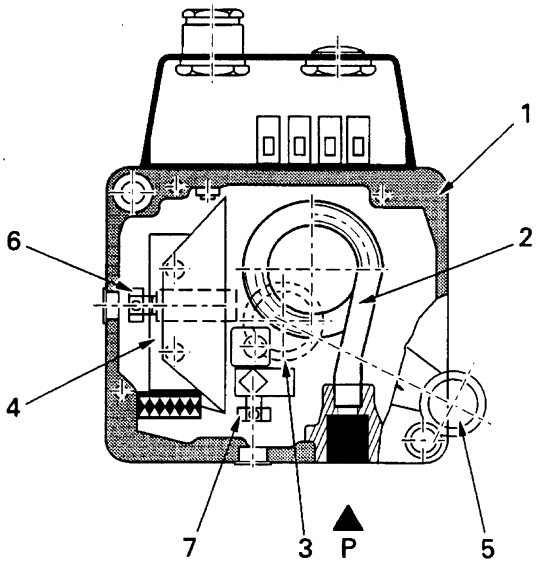


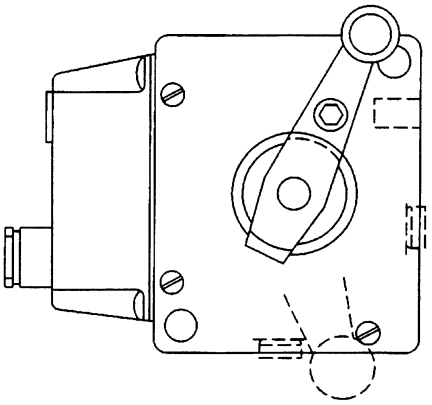
3. ADJUSTING PRESSURE OF THE OIL PRESSURE SWITCH

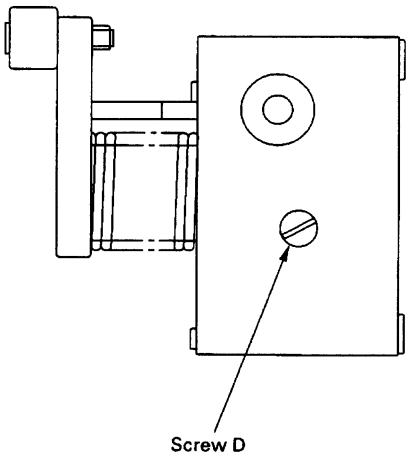
- Screw D: Pressure range adjustment screw
  To make an adjustment so that t oil pressure switch acts normally when checking the operation of the overload warning device.
  Turning to the left makes the pressure range wider.
- Screw E: Zero point adjustment screw
  Turning to the right one complete turn raises the pressure by 57 kg/cm^2.
  Each complete turn to the left lowers the pressure by 57 kg/cm^2.

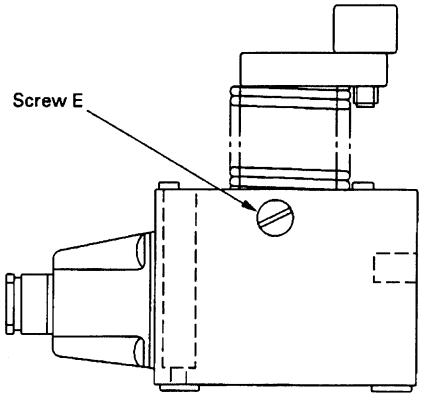
⚠ When an adjustment is required, contact your Komatsu distributor and have him make the adjustment.

1. Body
2. Bourdon tube
3. Eccentric disc
4. Microswitch
5. Lever and roller
6. Adjustment screw (E)
7. Adjustment screw (D)

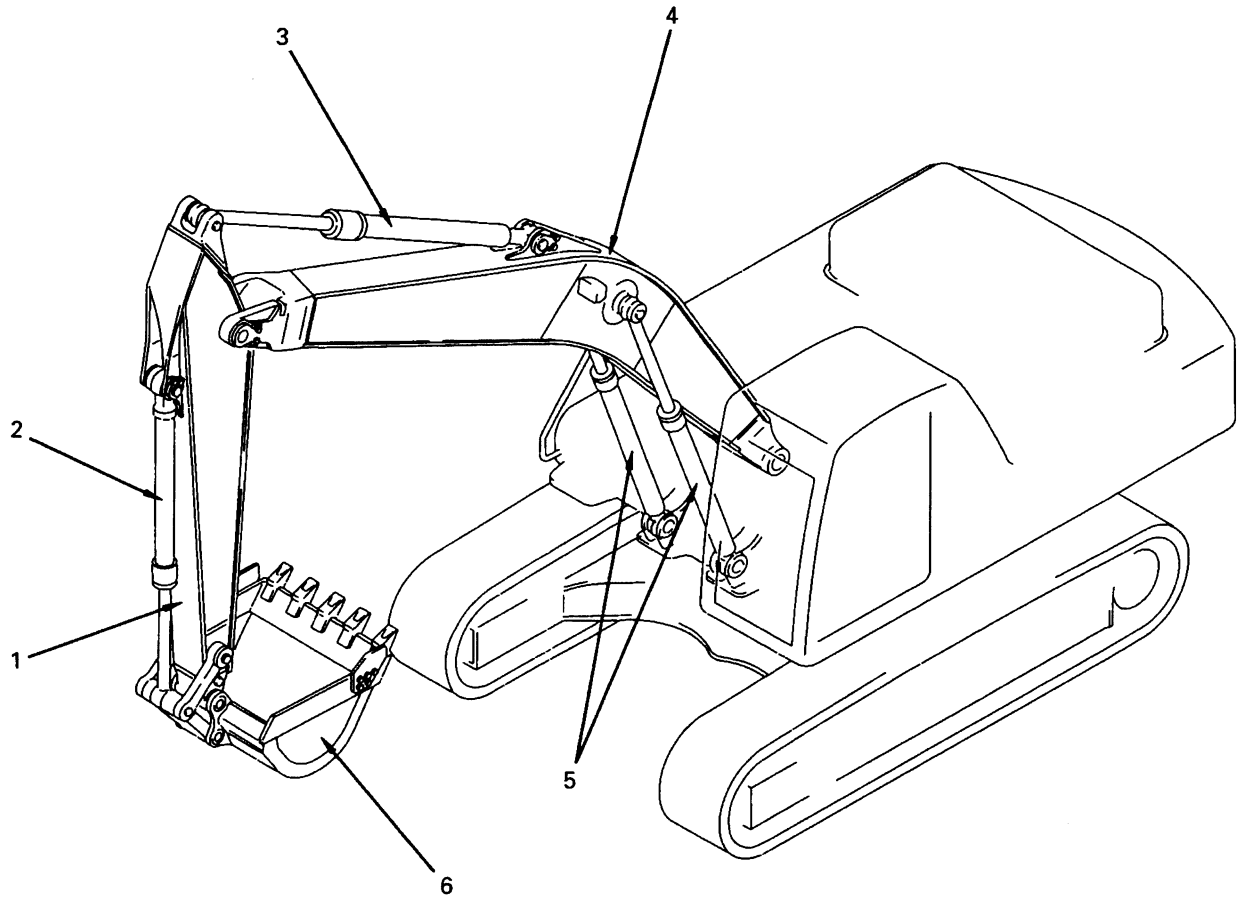








WORK EQUIPMENT

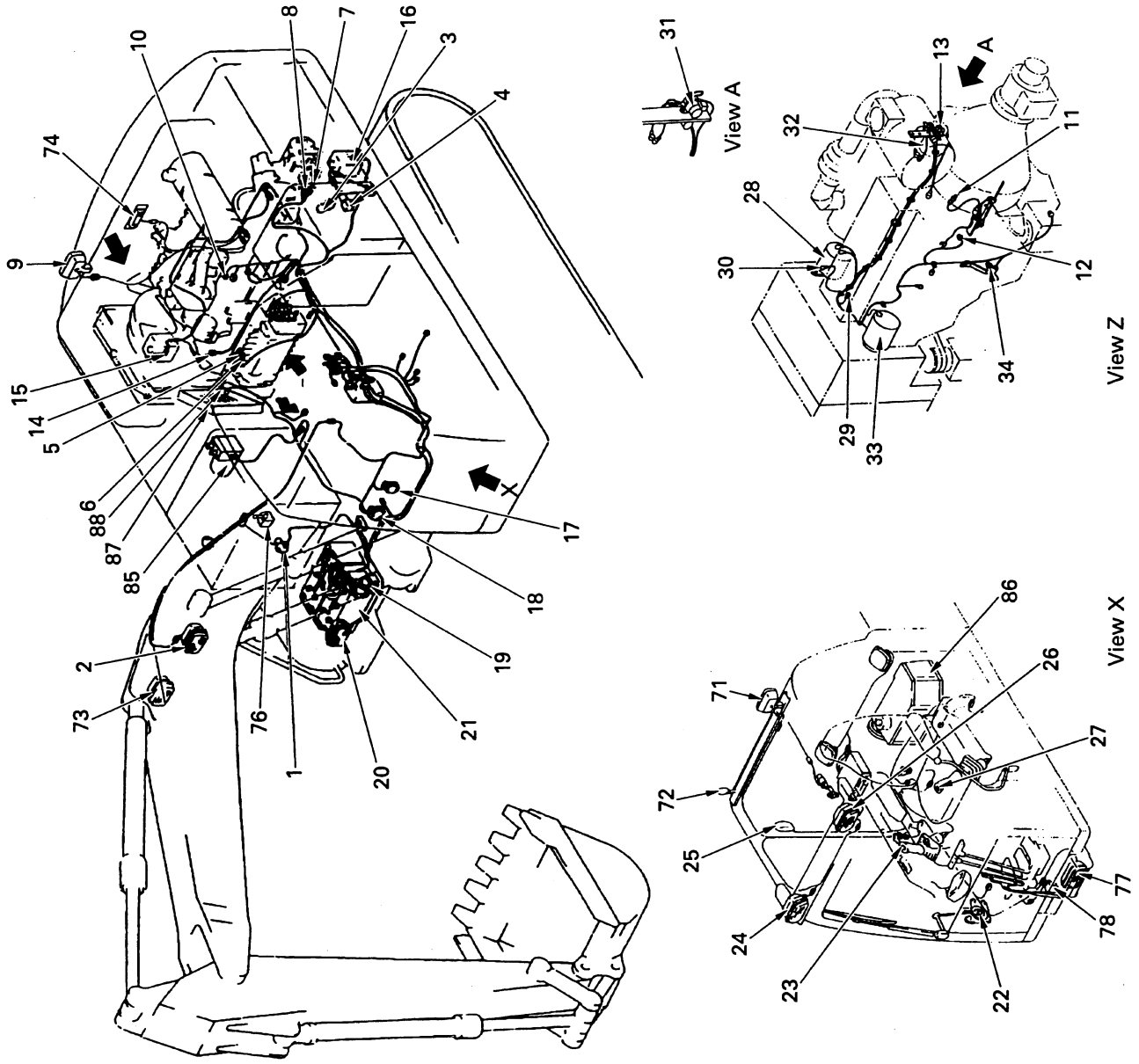


SBP00311

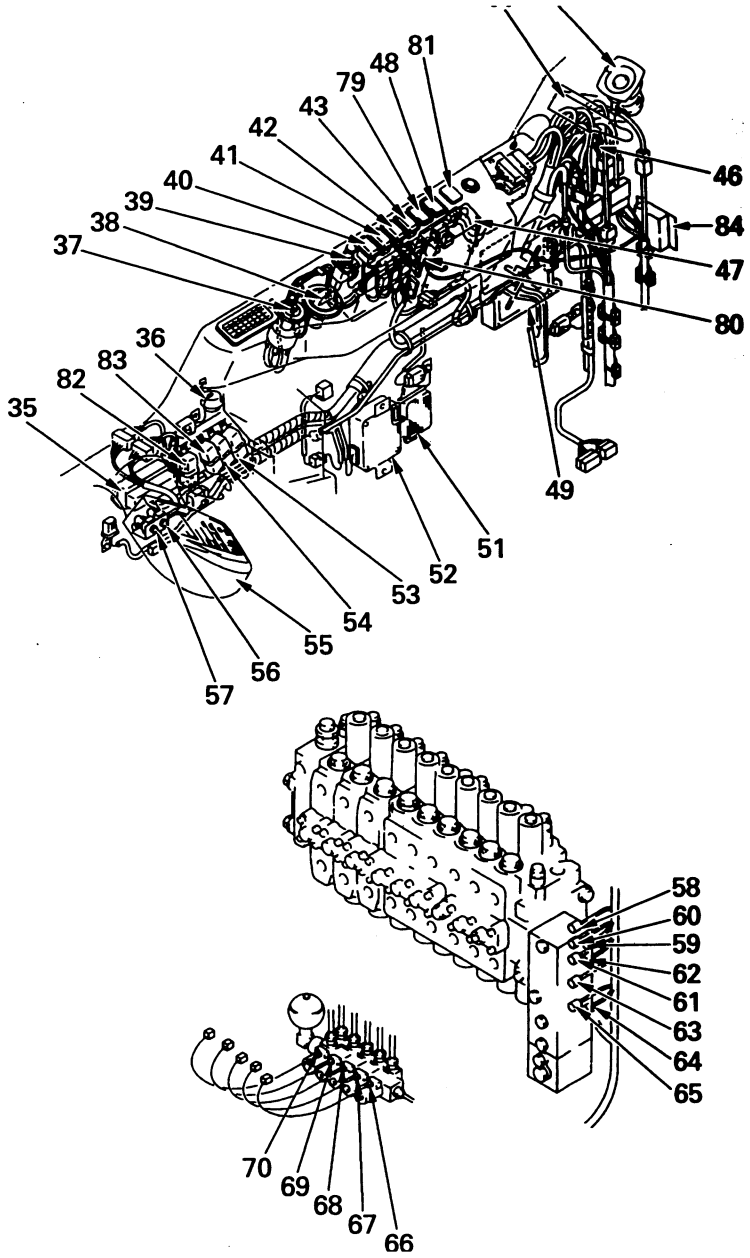
1. Arm
2. Bucket cylinder
3. Arm cylinder
4. Boom
5. Boom cylinder
6. Bucket

ACTUAL ELECTRIC WIRING DIAGRAM

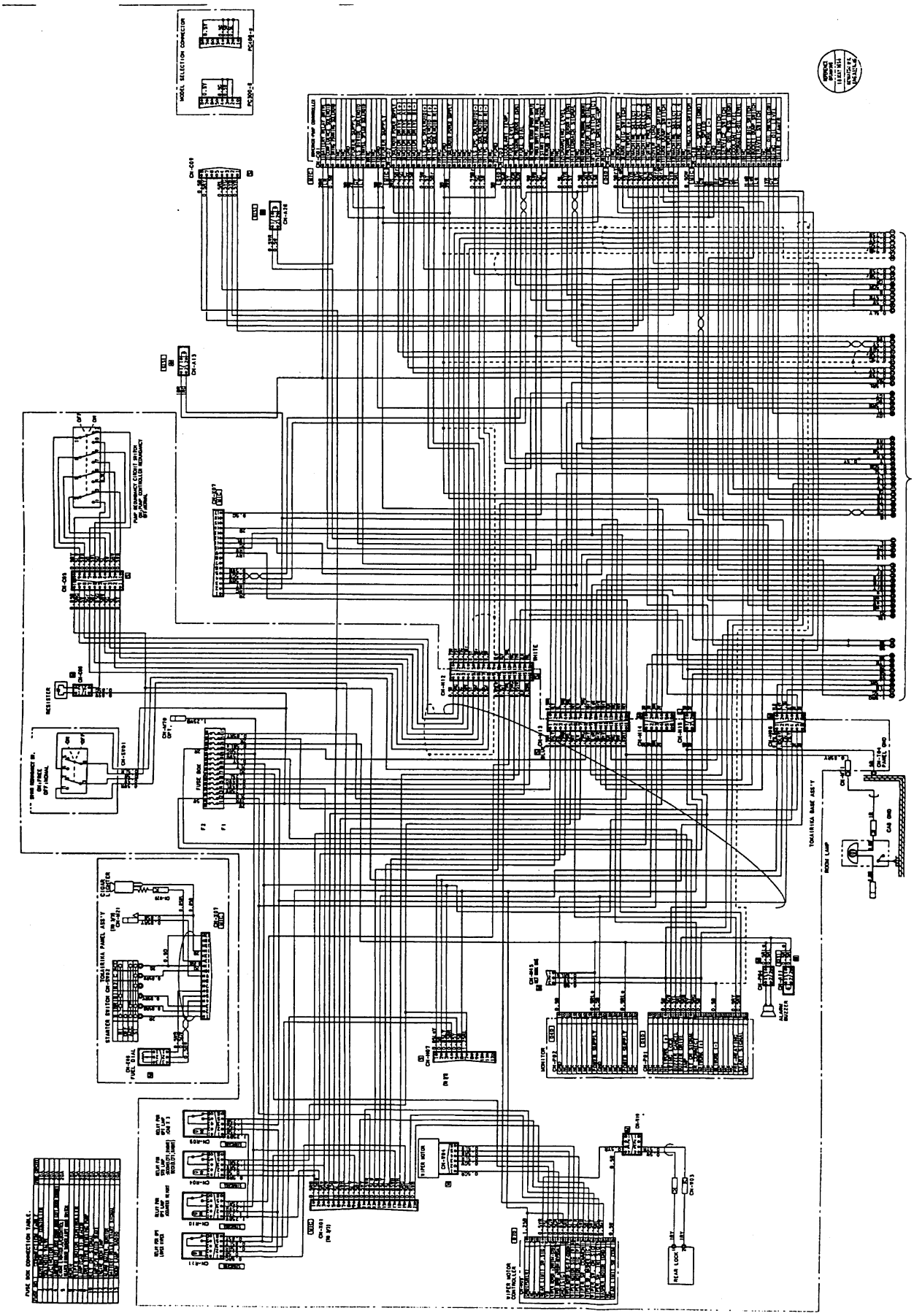
★ For details of this page, see Section 90.

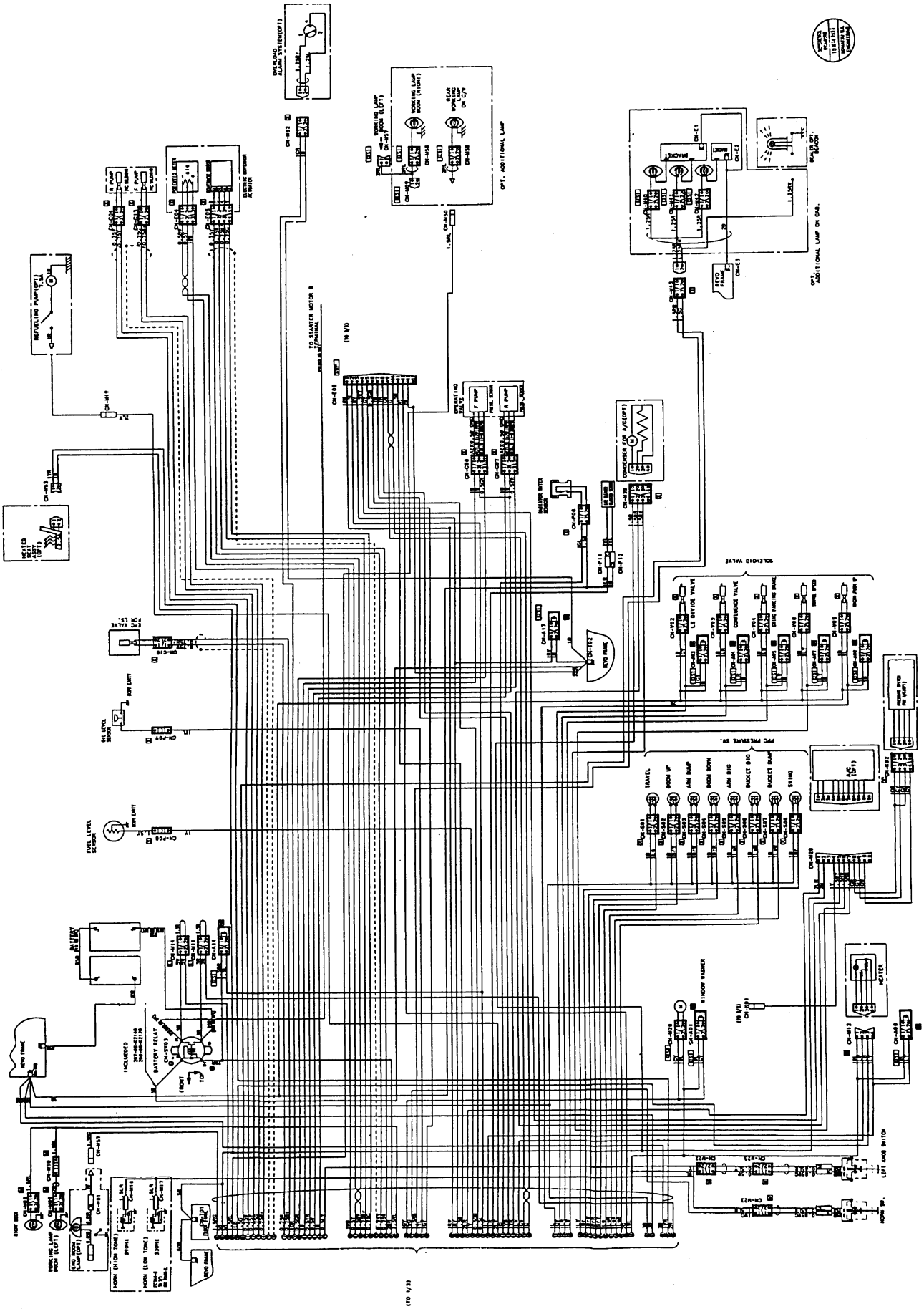


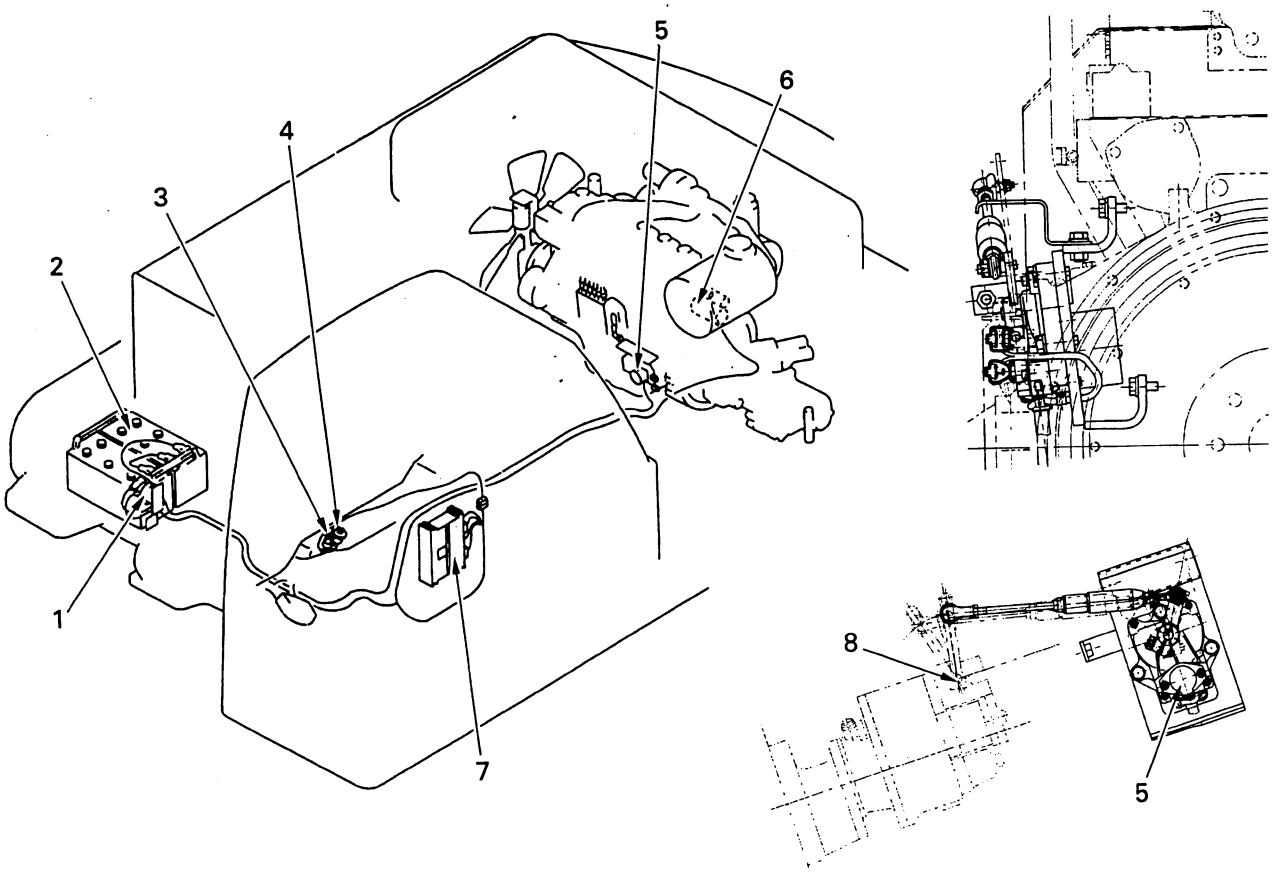
★ For details of this page, see Section 90.



1. Fuel level sensor
2. Working light
3. Hydraulic oil level sensor
4. LS control EPC valve
5. Rear pump pressure sensor
6. Front pump pressure sensor
7. Rear pump TVC valve
8. Front pump TVC valve
9. Rear working light
10. Governor motor
11. Engine speed sensor
12. Engine oil pressure sensor
13. Safety relay
14. Air cleaner clogging sensor
15. Coolant lever sensor
16. Window washer motor
17. Horn (high tone)
18. Horn (low tone)
19. Battery relay
20. R.H. head light
21. Battery
22. Wiper motor
23. Horn switch
24. R.H. additional light
25. Room lamp
26. L.H. additional light
27. L.H. knob switch
28. Alternator
29. Coolant temperature sensor
30. Grid heater
31. Heater relay
32. Starting motor
33. Air conditioner compressor
34. Engine oil level sensor
35. Fuse box
36. Caution buzzer
37. Starting switch
38. Fuel control dial
39. Cigarette lighter
40. Swing lock switch
41. Wiper switch
42. Light switch
43. Buzzer cancel switch
44. (Intergral to monitor panel)
45. Speaker
46. Kerosene mode connector
47. Heater control panel (Air conditioner option)
48. 2-stage pressure relief switch
49. Pump engine throttle controller
50. Radio
51. TVC prolix resistor
52. Wiper motor controller
53. Additional light relay (Cab)
54. Light relay (Boom, R.H. deck, Engine room)
55. Monitor panel
56. Swing lock prolix switch
57. TVC prolix switch
58. Swing oil pressure switch
59. Bucket CURL oil pressure switch
60. Bucket DUMP oil pressure switch
61. Arm IN oil pressure switch
62. Boom LOWER oil pressure switch
63. Arm OUT oil pressure switch
64. Travel oil pressure switch
65. Boom RAISE oil pressure switch
66. Swing brake solenoid valve
67. Travel speed solenoid valve
68. Pump merge-divider solenoid valve
69. 2-stage relief solenoid valve
70. LS select solenoid valve
71. Rear additional lamp
72. Beacon connector
73. R.H. boom working light
74. Engine room lamp
76. Overload caution switch
77. L.H. deck additional lamp
78. Lower wiper motor
79. Lower wiper switch
80. Beacon switch
81. Heated seat switch
82. Lower wiper relay
83. Additional light relay (CWT L.H. deck)
84. Voltage dropper (Rear radio)
85. Re fuelling pump
86. Heater (Air conditioner option)
87. Air conditioner condensor fan
88. Air conditioner condensor switch







1. Battery relay
2. Battery
3. Starting switch
4. Fuel control dial
5. Governor motor
6. Starting motor
7. Governor, pump controller
8. Fuel injection pump

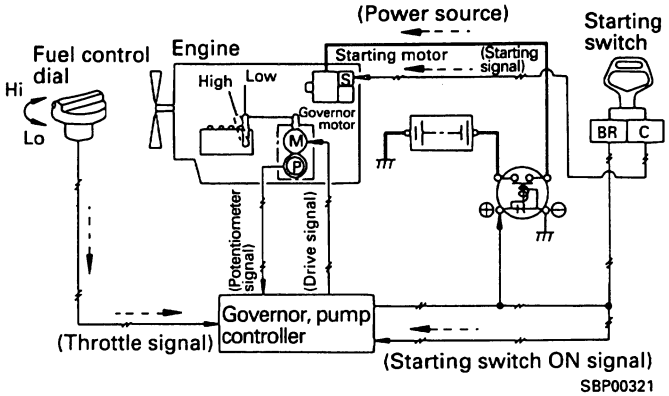
Function

- The engine can be started and stopped simply by using the starting switch.
- A dial-type engine control is used to control the engine speed. The governor, pump controller receives the control signal from the fuel control dial, sends a drive signal to the governor motor, and controles the angle of the governor lever in the fuel injection pump.

1. Operation of system

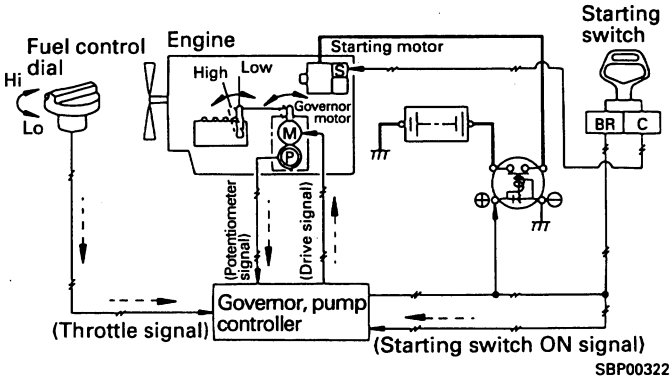
Starting engine

- When the starting switch is turned to the START position, the starting signal flows to the starting motor, and the starting motor turns to start the engine.
  When this happens, the governor and pump controller checks the signal from the fuel control dial and sets the engine speed to the speed set by the fuel control dial.



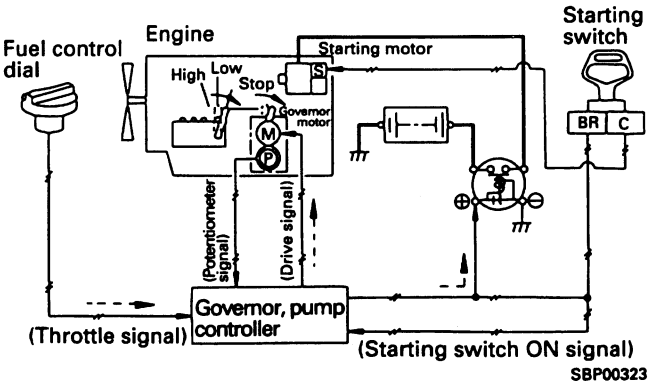
Engine speed control

- The fuel control dial sends a signal to the governor and pump controller according to the position of the dial.
  The governor and pump controller calculates the angle of the governor motor according to this signal, and sends a signal to drive the governor motor so that it is at that angle.
  When this happens, the operating angle of the governor motor is detected by the potentiometer, and feedback is sent to the governor and pump controller, so that is can observe the operation of the governor motor.



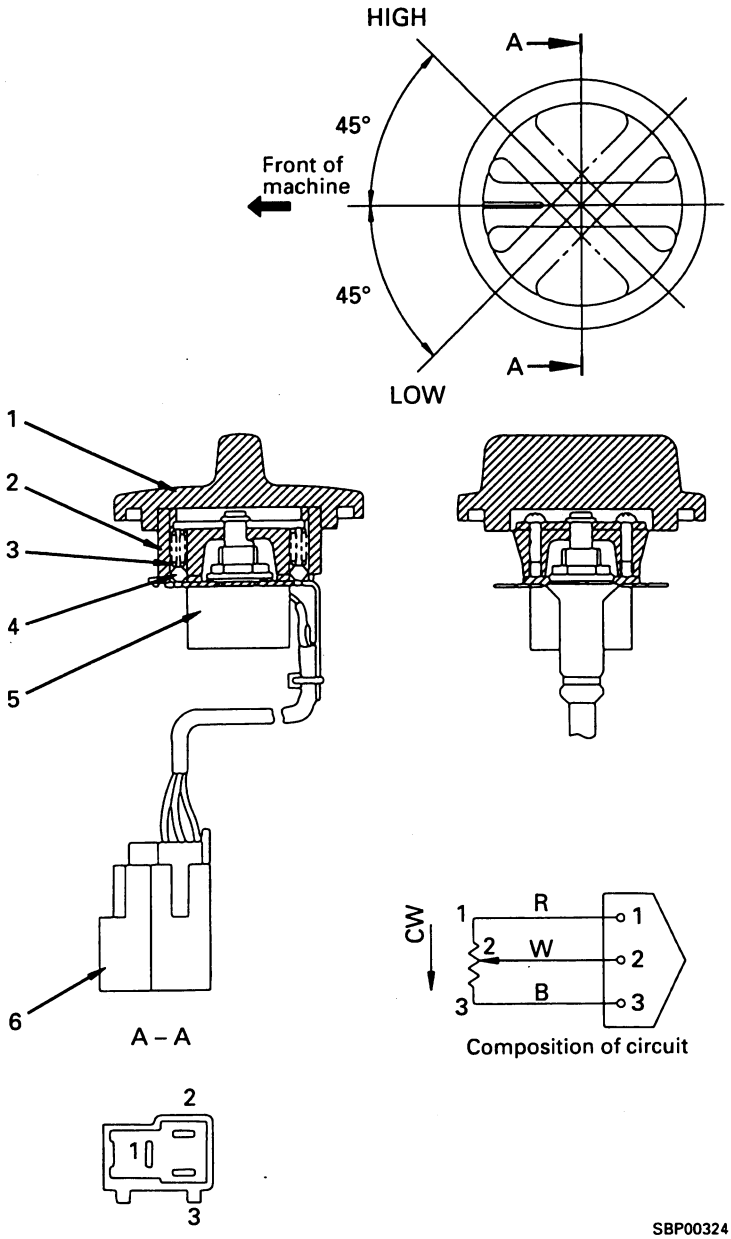
Stopping engine

- When governor and pump controller detects that the starting switch is turned to the STOP position, it drives the governor motor so that the governor lever is set to the NO INJECTION position.
- When this happens, to maintain the electric power in the system until the engine stops completely, the governor and pump controller itself drives the battery relay.



2. Components of system

Fuel control dial

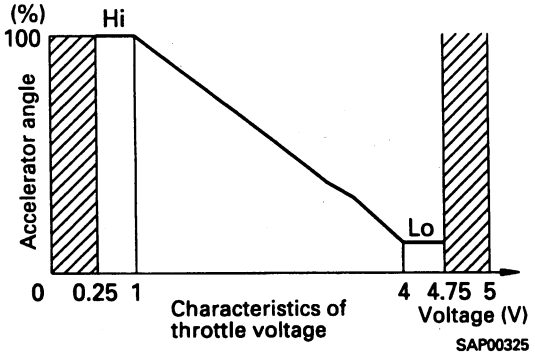


SBP00324

1. Knob
2. Dial
3. Spring
4. Ball
5. Potentiometer
6. Connector

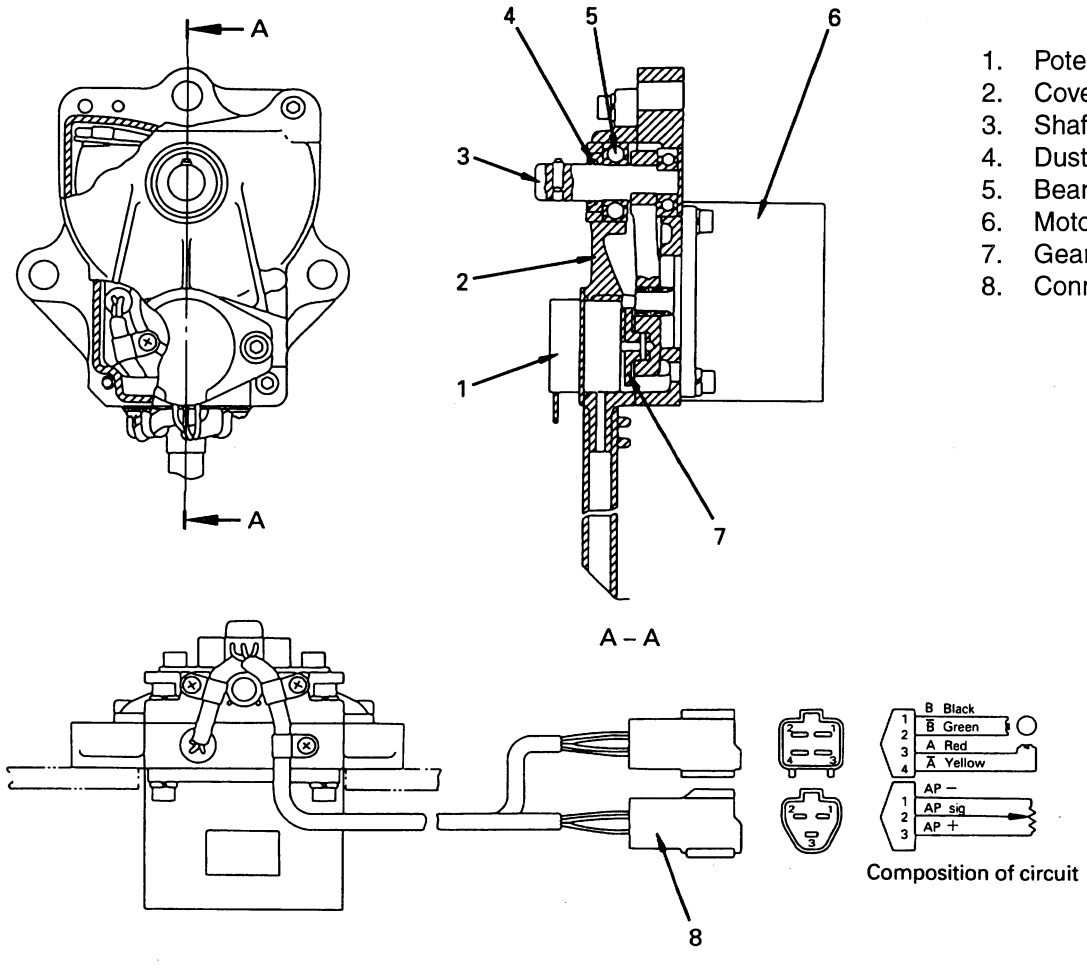
Function

- The fuel control dial is installed at the bottom of the monitor panel. A potentiometer is installed under the knob, and when the knob is turned, it rotates the potentiometer shaft
  When the shaft rotates, the resistance of the variable resistor inside the potentiometer changes, and the desired throttle signal is sent to the governor and pump controller.
  The shaded area in the graph on the right is the abnormality detection area in the graph on the right is the abnormality detection area and the engine speed is set at low idling.



SAP00325

Governor motor



1. Potentiometer
2. Cover
3. Shaft
4. Dust seal
5. Bearing
6. Motor
7. Gear
8. Connector

Function

- The motor is rotated and the governor lever of the fuel injection pump is controlled by the drive signal from the governor and pump controller. A stepping motor is used for the motor which provides the power.
- In addition, a potentiometer for giving feedback is installed to allow observation of the operation of the motor.
- The rotation of the motor is transmitted to the potentiometer through a gear.

Operation

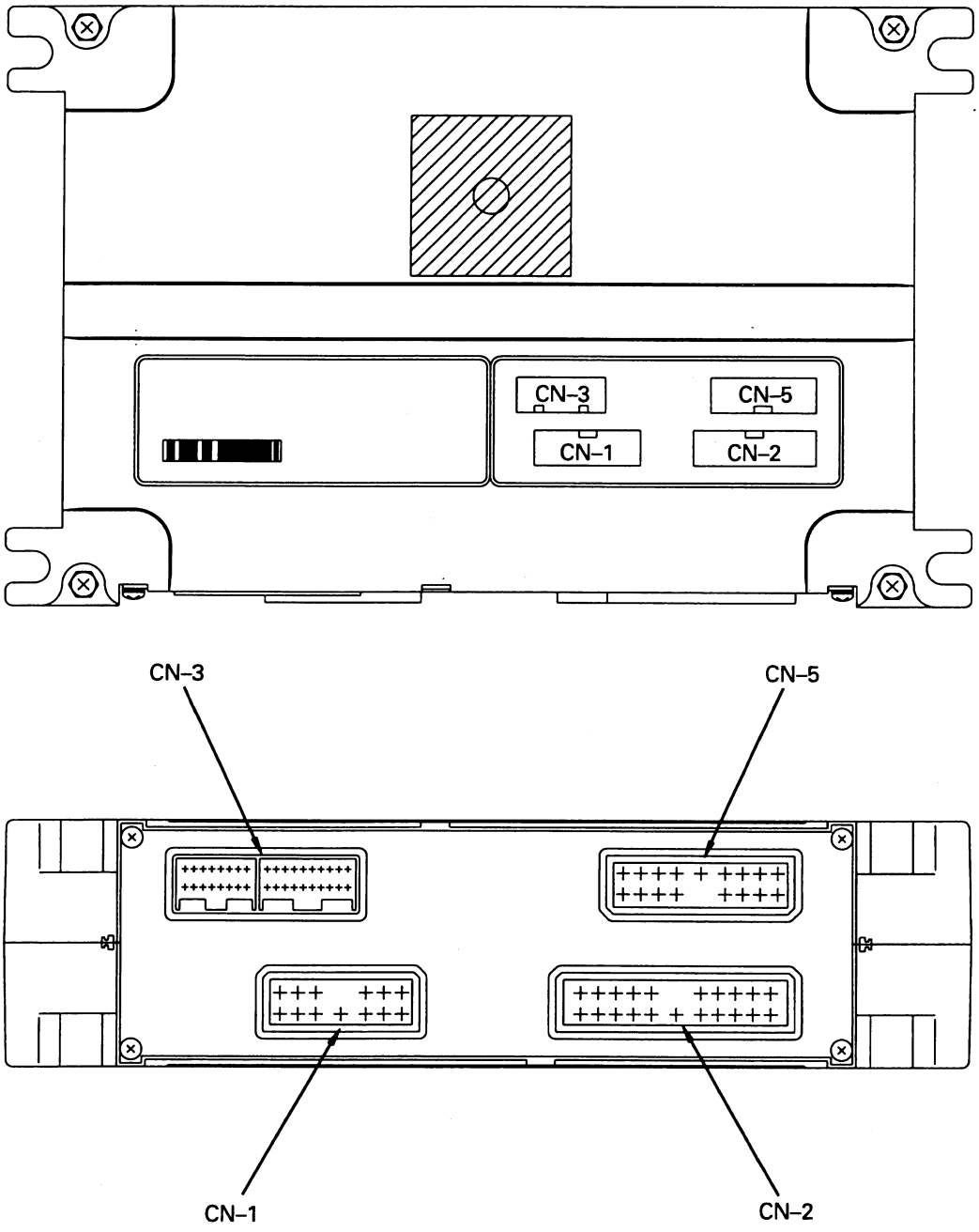
Motor stationary

- Both A phase and B phase of the motor area continuous, and a holding torque is generated in the motor.

Motor rotating

- A pulse current is applied to the A phase and B phase from the governor and pump controller to give synchronous rotation with the pulse.

Governor, pump controller



SAP00327

Input and output signals

CN-1

Pin. No.	Name of signal	Input/ output
1	Battery relay drive output	Output
2	Pump merge/divider solenoid /NC	Output
3	Swing holding brake solenoid	Output
4	NC	
5	NC	
6	GND	Input
7	Power source (+24V)	Input
8	LS divider solenoid/LS cut-off solenoid	Output
9	Travel selector solenoid	Output
10	NC	
11	NC	
12	GND	Input
13	Power source (+24V)	Input

CN-2

Pin. No.	Name of signal	Input/ output
1	Solenoid power source (+24V)	Input
2	Governor motor phase A (+)	Output
3	Governor motor phase A (-)	Output
4	Governor motor phase B (+)	Output
5	Governor motor phase B (-)	Output
6	NC	
7	LS-EPC solenoid (+)	Output
8	TVC solenoid 1 (+)	Output
9	TVC solenoid 2 (+)	Output
10	NC	
11	PGND	Input
12	Solenoid power source (+24V)	Input
13	NC	
14	NC	
15	NC	
16	NC	
17	LS-EPC solenoid (-)	Output
18	TVC solenoid 1 (-)	Output
19	TVC solenoid 2 (-)	Output
20	NC	
21	PGND	Input

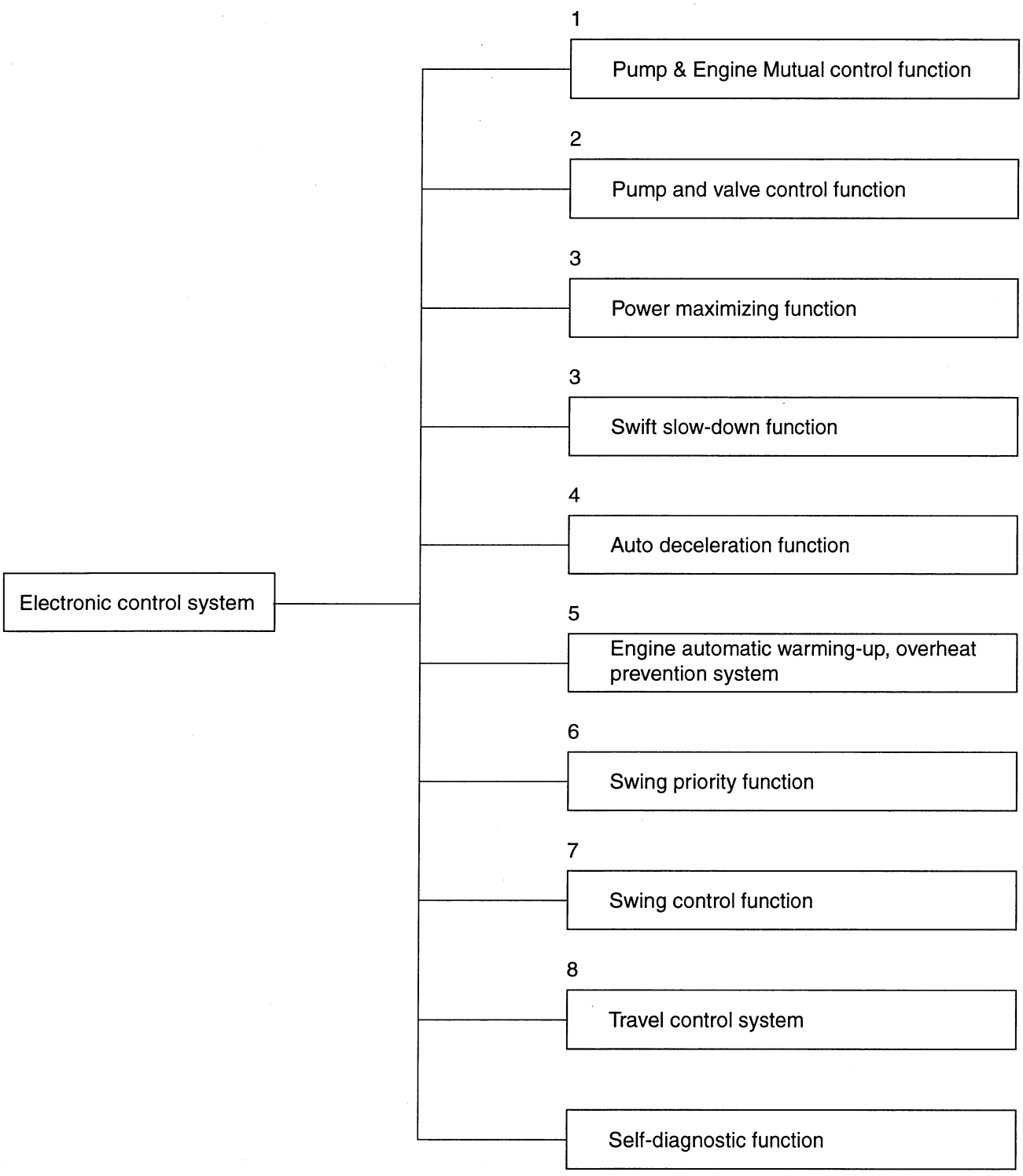
CN-3

Pin. No.	Name of signal	Input/ output
1	Engine water temperature sensor	Input
2	Fuel level sensor	Input
3	Pump F pressure input	Input
4	Throttle potentiometer input	Input
5	NC	
6	Pressure sensor power source (+24V)	Output
7	Potentiometer power source (+5V)	Output
8	Starting switch (ACC)	Input
9	Knob switch	Input
10	NC	
11	NC	
12	Battery charge (alternator terminal R)	Input
13	Pump R pressure input	Input
14	Feedback potentiometer input	Input
15	NC	Input
16	Pressure sensor GND	Input
17	Potentiometer GND	Input
18	Starting switch (terminal C)	Input
19	Automatic greasing controller abnormality	Input
20	NC	
21	NC	
22	Boom RAISE pressure switch	Input
23	Arm IN pressure switch	Input
24	S-NET(+)	Input, output
25	Model selection 1	Input
26	Model selection 3	Input
27	Model selection 5	Input
28	Swing prolix switch	Input
29	Overload sensor	Input
30	Boom LOWER pressure switch	Input
31	Arm OUT pressure switch	Input
32	S-NET(+)	Input, output
33	Model selection 2	Input
34	Model selection 4	Input
35	NC	
36	Swing lock switch	Input

CN-5

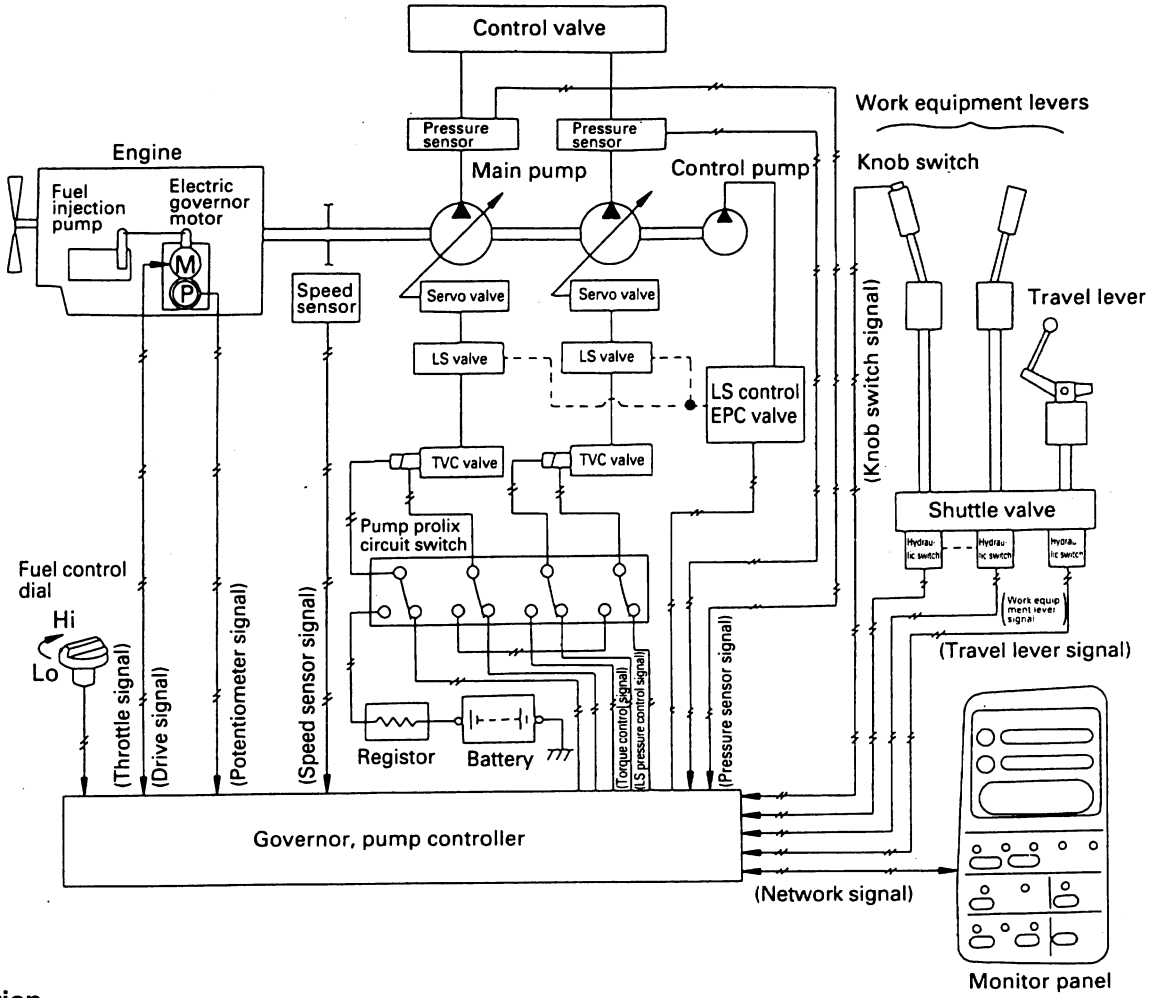
Pin. No.	Name of signal	Input/ output
1	Engine speed sensor GND	Input
2	Engine speed sensor	Input
3	GND	Input
4	GND	Input
5	Swing pressure switch	Input
6	Service valve pressure switch	Input
7	Engine oil pressure sensor H	Input
8	Radiator water level sensor	Input
9	Hydraulic oil level sensor	Input
10	NC	
11	Bucket CURL pressure switch	Input
12	Bucket DUMP pressure switch	Input
13	Travel pressure switch	Input
14	NC	
15	Engine oil pressure sensor L	Input
16	Engine oil level sensor	Input
17	Air cleaner clogging sensor	Input

ELECTRONIC CONTROL SYSTEM
CONTROL FUNCTION



★ For details of the self-diagnostic function, see TROUBLESHOOTING

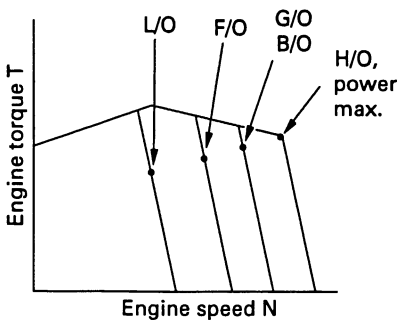
1. Pump & Engine Muntual control system



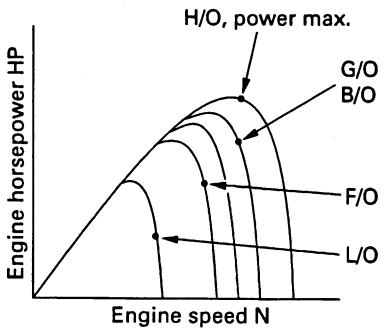
Function

- There are five modes available for selection with the working mode switch on the monitor panel. These modes are the heavy-duty operation mode (H/O), general operation mode (G/O), finishing operation mode (F/O), lifting operation mode (L/O), and the breaker mode (B/O). It is possible to select the most suitable engine torque and pump absorption torque to match the nature of the work.
- The governor and pump controller detects the actual engine speed and the speed set by the engine governor through the fuel control dial in accordance with the pump absorption torque set for each mode, and carries out control so that the pump absorbs all of the torque at each output point of the engine.

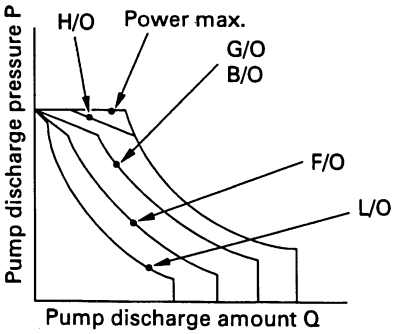
- Engine torque curve



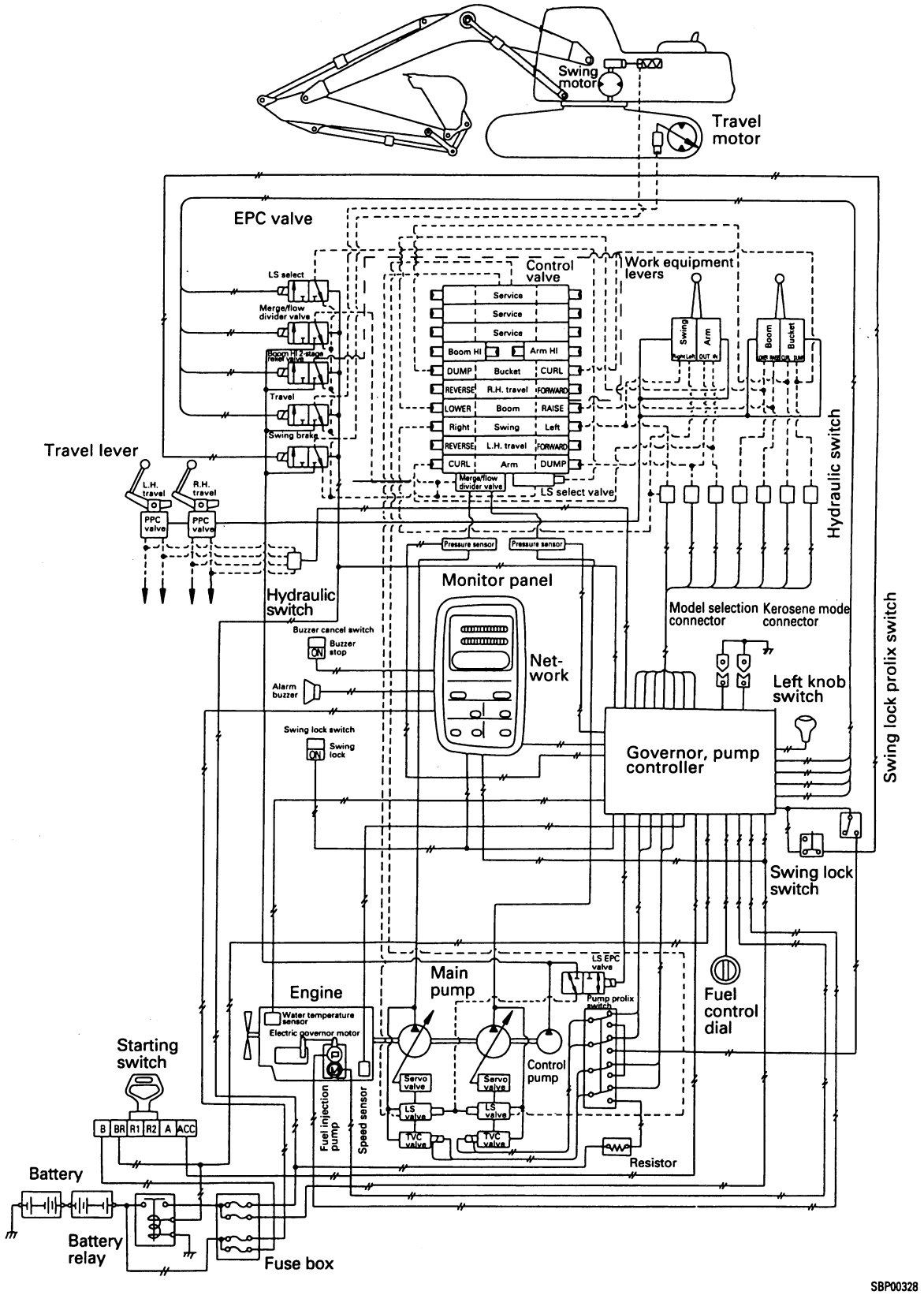
- Engine horsepower curve



- Pump output curve

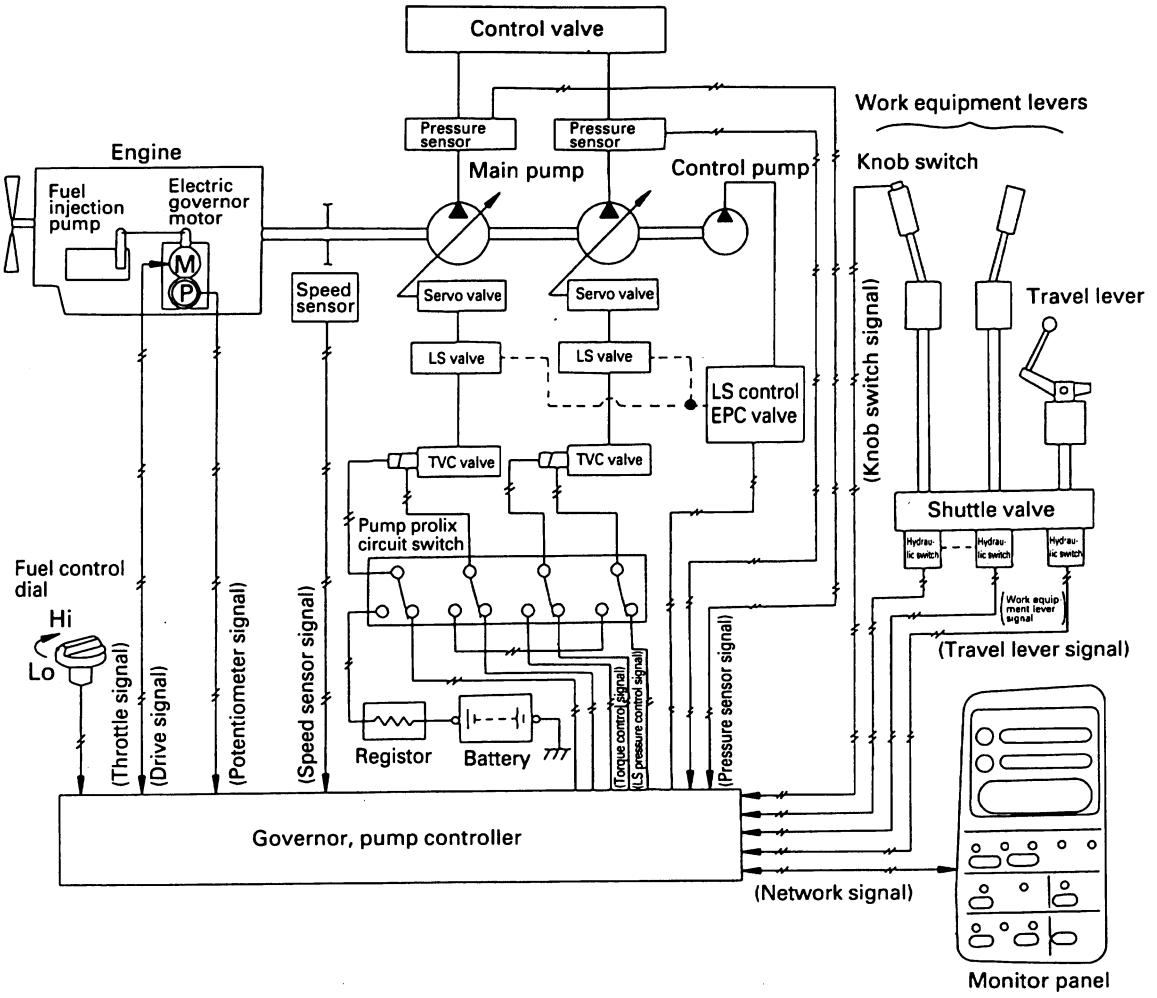


TOTAL SYSTEM DIAGRAM



SBP00328

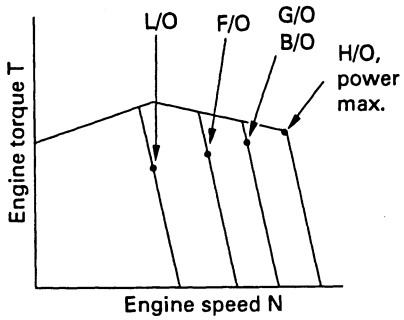
1. Pump & Engine Muntual control system



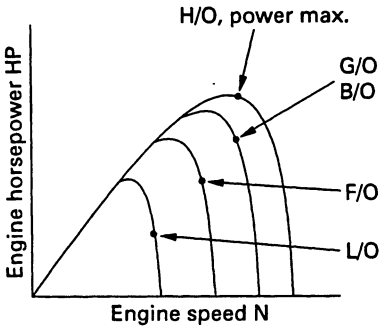
Function

- There are five modes available for selection with the working mode switch on the monitor panel. These modes are the heavy-duty operation mode (H/O), general operation mode (G/O), finishing operation mode (F/O), lifting operation mode (L/O), and the breaker mode (B/O). It is possible to select the most suitable engine torque and pump absorption torque to match the nature of the work.
- The governor and pump controller detects the actual engine speed and the speed set by the engine governor through the fuel control dial in accordance with the pump absorption torque set for each mode, and carries out control so that the pump absorbs all of the torque at each output point of the engine.

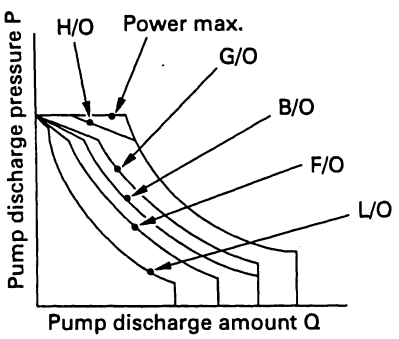
- Engine torque curve



- Engine horsepower curve

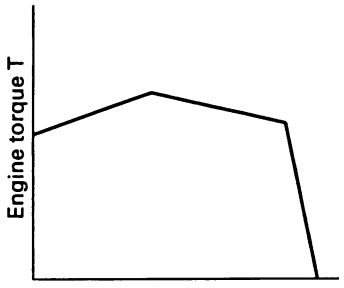


- Pump output curve

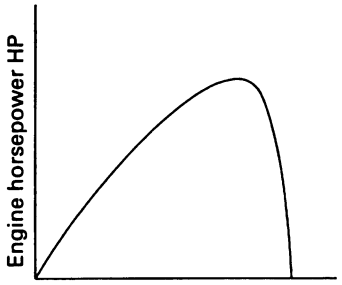


1) Control method in each mode

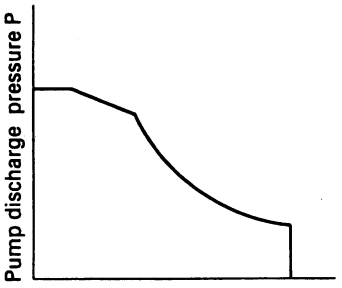
Heavy-duty operation mode



SAP00333



SAP00334



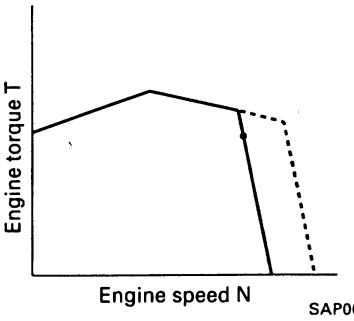
SAP00335

- Matching point in heavy-duty operation mode: Rated output point.

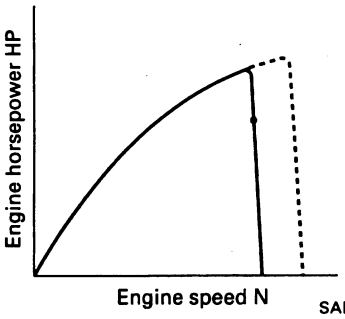
Mode \ Model	PC450-6k, PC450LC-6k
Heavy-duty	228 kW (306 HP)1,900 rpm

- When the load on the pump rise and the pressure rises, the engine speed goes down. When this happens, the pump discharge amount is reduced, and the engine speed is controlled so that it becomes naear the rated output point
  If the reverse happens and the pressure goes down, the system is controlled so that the pump discharge amount is increased until the engine speed becomes near the rated output point.
  By repeating this control, the engine can always be used at near the rated output point.

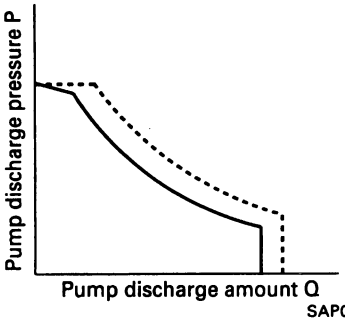
General, breaker, finishing operation mode



SAP00336



SAP00337



SAP00338

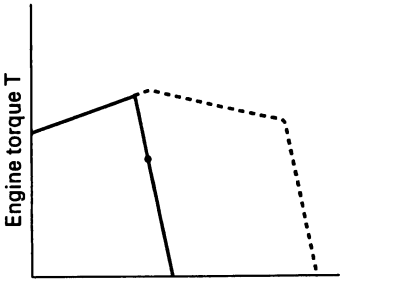
- Matching point

Mode	G/O	B/O	F/O
Partial output point	95%	95%	90%

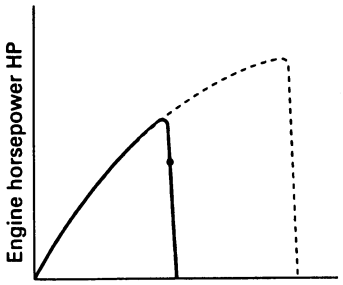
Mode \ Model	PC450-6k, PC450LC-6k
G/0	206 kW (276 HP)/1,800 rpm
B/0	195 kW (261 HP)/1,800 rpm
F/0	184 kW (247 HP)/1,700 rpm

- When the load on the pump rises and the pressure rises, the engine speed goes down. When this happens, mutual control of the engine and pump is used to control the system so that the pump absorption torque follows the equal horsepower curve of the engine, and the engine speed is lowered while keeping the torque constant.
  In this way, the engine is used in a range which provides good fuel efficiency.

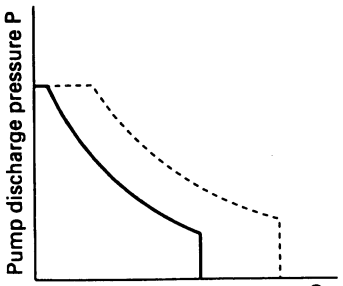
Lifting operation mode



SAP00339



SAP00340



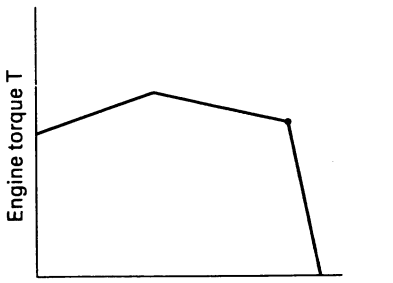
SAP00341

- Matching point lifting operation mode:
  75% partial output point

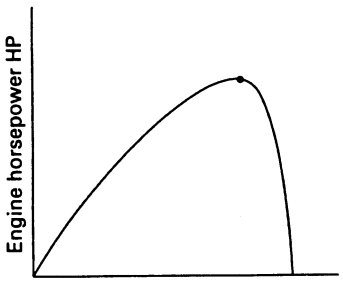
Mode \ Model	PC450-6k, PC450LC-6k
L/O	136 kW (182 HP)/1400 rpm

- When the lifting operation mode is selected, the engine speed is automatically lowered to the partial position.
  In this condition, control is carried out in the same way as for the general operation, finishing, and breaker operation modes to match the load on the pump.
  In this way, the fuel consumption is reduced and the fine control ability is improved.

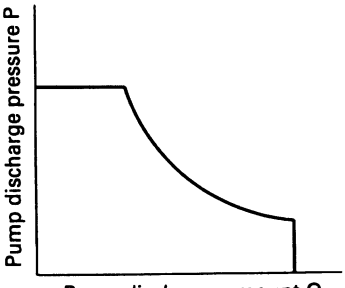
Power max. mode, travel



SAP00342



SAP00343



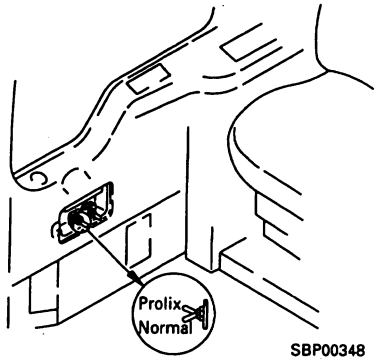
SAP00344

- Matchin point in power max. mode:
  Rated output point

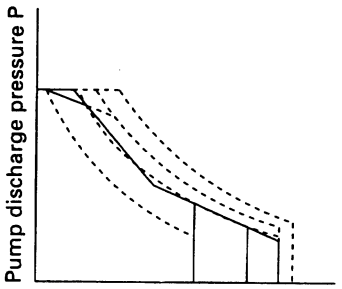
Mode \ Model	PC450-6k, PC450LC-6k
Power max.	228 kW (306 HP)/1900 rpm

- When the pump load increases, the engine speed drops.
  When this happens, the pump discharge is reduced to prevent the engine speed from going down and to ensure that the engine is used at near the rated output point.
  The cut-off at relief is canceled and the oil flow at relief is increased.

2) Control function when TVC prolix switch is ON



SBP00348

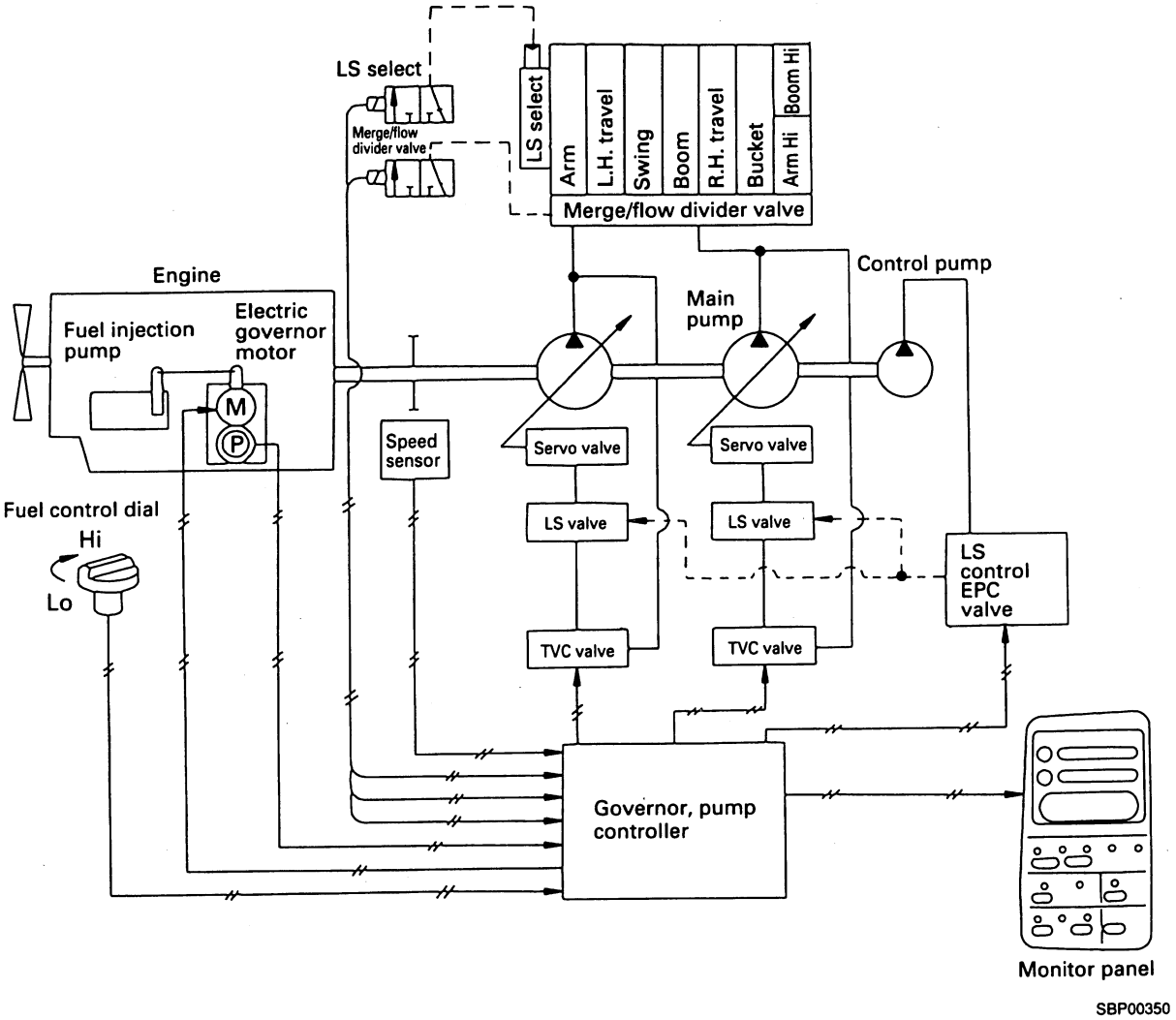


SAP00349

- Even if any abnormality should occur in the controller or sensor, the TVC prolix switch can be turned ON to provide and absorption torque more or less equivalent ot the general operation mode, there by allowing the machine to maintain its functions.

In this case, it is designed to allow a constant current to flow from the battery to the TVC valve, so oil pressure sensing is carried out only by the TVC valve.

2. Pump and valve control function

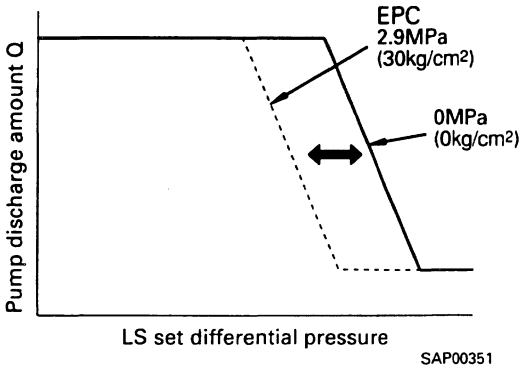


Function

- Optimum matching under various working conditions with the fine control mode function which reduces the hydraulic loss and improves the ease of fine control.

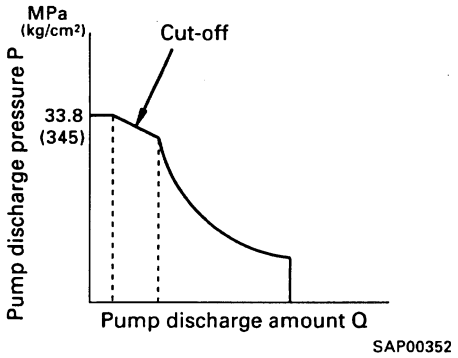
1) LS control function

- The switching point (LS set differential pressure) for the pump discharge amount inside the LS valve is changed by changing the output pressure from the LS EPC valve to the LS valve according to the engine speed and operating condition of the actuator.
- Because of this, the timing for starting the discharge amount from the pump can be optimized, to give excellent ease of compound operation and fine control.



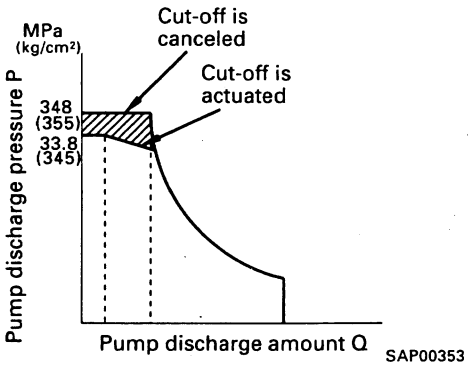
2) Cut-off function

- If the load becomes large during the operation and the pump discharge pressure rises to a point close to the relief pressure, the pump pressure sensor detects this, and the controller sends a signal to the TVC valve to reduce the discharge amount in order to reduce the relief loss.



3) Cut-off function

- The cut-off cancel function stops the actuation of the cut-off function in order to ensure the flow of oil from the pump near the relief pressure, thereby preventing any drop in speed.
- The relief pressure when the cut-off function is actuated is 33.8 MPa (345 kg/cm^2), but when the cut-off is canceled, the relief pressure rises to approx. 34.8 MPa (355 kg/cm^2). Because of this, the hydraulic pressure is increased by one stage.



- Switches and cut-off functions

	Working mode switch		Swing lock switch		Knob switch	
	Heavy digging	Digging	ON	OFF	ON	OFF
Cut-off function	Actuated	Actuated	Canceled	Actuated	Canceled	Actuated

※ When the swing lock switch is set to ON, hydraulic oil is quickly warmed, also when the swing lock switch is set to ON, the function is canceled. Under these conditions, when work equipment is relieved, hydraulic oil temperature goes up more quickly, and warming time is shortened.

4) Fine control function

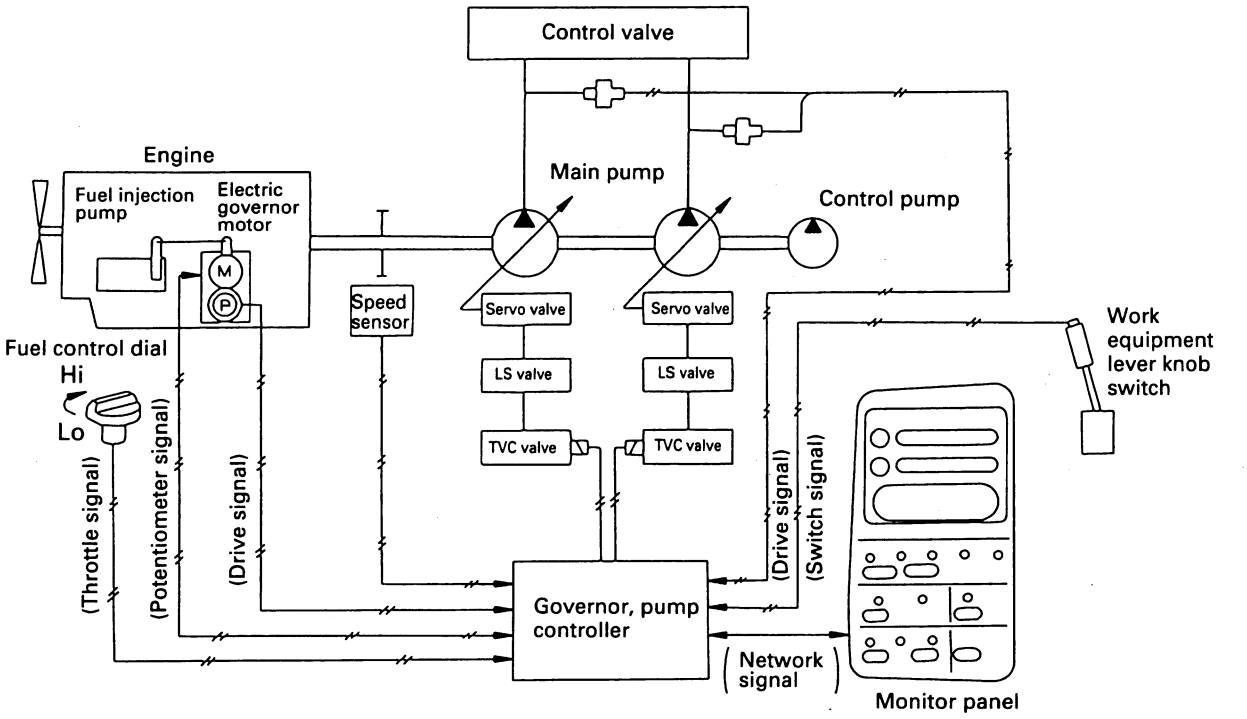
- When the finishing mode is selected as the working mode, the pump LS valve is controlled, and the pump discharge amount is reduced to improve the ease of fine control and the precision when finishing.

- Relationship between working mode and pump discharge amount (for independent operation)

Actuator / Working mode	Boom		Arm	Bucket		Swing	Breaker
	RAISE	LOWER		CURL	DUMP		
Heavy-duty operation (H/O)	100	30	100	75	60	55	-
General operation (G/O)							
Finishing operation (F/O)	83	30	83	60	50	45	-
Lifting mode (L/O)	75		75	55	45	40	-
Breaker (B/O)	100	30	100	75	60	55	45

★ In each working mode, the full flow of the pump at the set engine speed is taken as 100%.

3. Power max. function, swift slow-down function



SBP00354

Function

- This function provides an increase in the digging power for a certain time or switches the working mode to the fine operation to reduce the speed. It is operated using the L.H. knob switch to momentarily match the operating conditions.

★ The power max. function and swift slowdown function are operated with the same switch. Only one of these functions can be selected at any time; they cannot both be operated together.

1) Power max. function

- During digging operations, when that extra bit of digging power is needed (for example, when digging up boulders), the L.H. knob switch can be pressed to raise the hydraulic pressure by approx. 10% and increase the digging force.
- If the L.H. knob switch is pressed ON when the working mode is at H/O or G/O, each function is automatically set as follows.

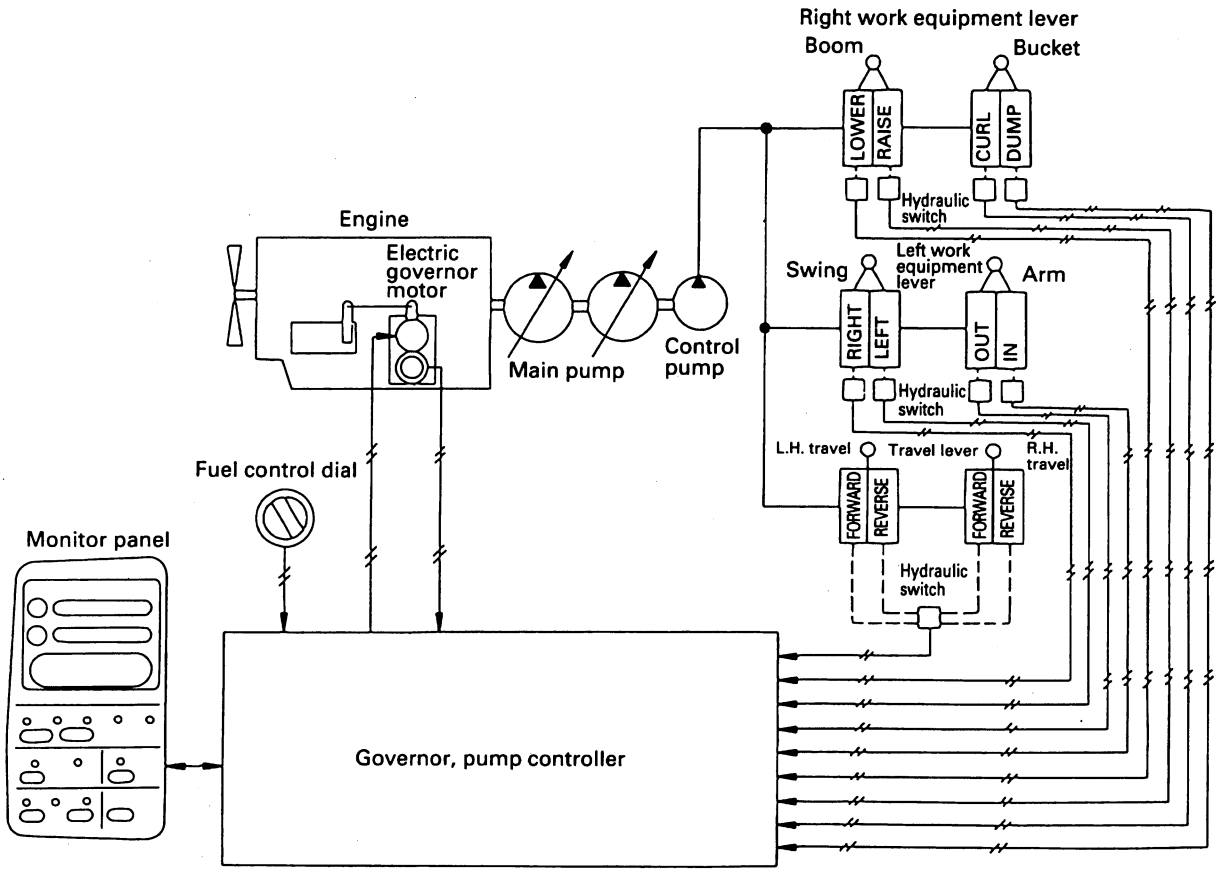
Working mode	Engine, pump control	Cut-off function	Actuating time
Heavy-duty operations	Matching at rated output point	Canceled	Automatically canceled after 8.5 sec

2) Swift slow-down function

- During normal operations, if it is desired to carry out lifting operations or finishing operations for a moment, the working mode can be switched to L/O by operating the L.H. knob switch.
- If the L.H. knob switch is pressed ON when the working mode is at H/O or G/O, each function is automatically set as follows.

Working mode	Actuating time
Lifting operation	While switch is kept pressed

4. Auto deceleration system



Function

- If all the control levers are at neutral when waiting for work or waiting for a dump truck, the engine speed is automatically reduced to a midrange speed to reduce fuel consumption and noise.
- If any lever is operated, the engine speed returns immediately to the set speed.

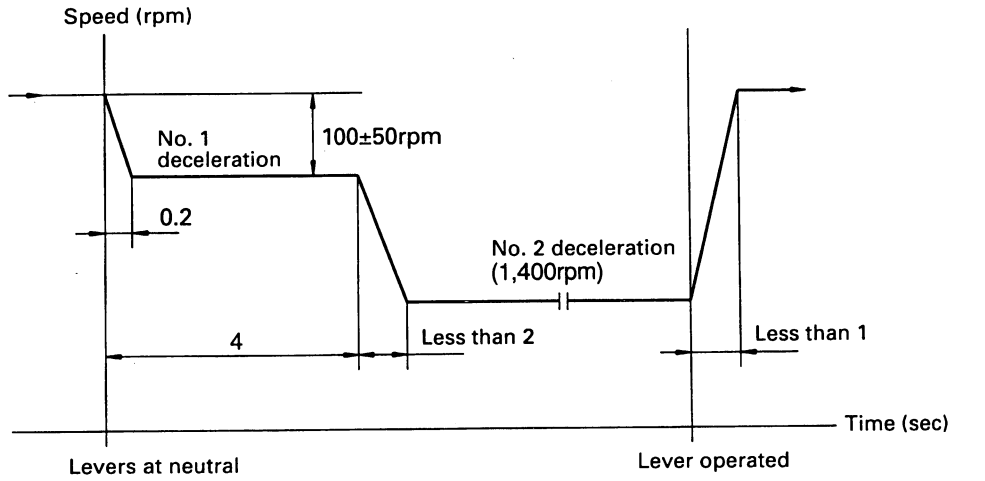
Operation

Control levers at neutral

- If the engine is running at above the deceleration actuation speed (approx. 1400 rpm), and all the control levers are returned to neutral, the engine speed drops immediately to approx. 100 rpm below the set speed to the No. 1 deceleration position.
- If another 4 seconds passes, the engine speed is reduced to the No. 2 deceleration position (approx. 1400 rpm), and is kept at that speed until a lever is operated.

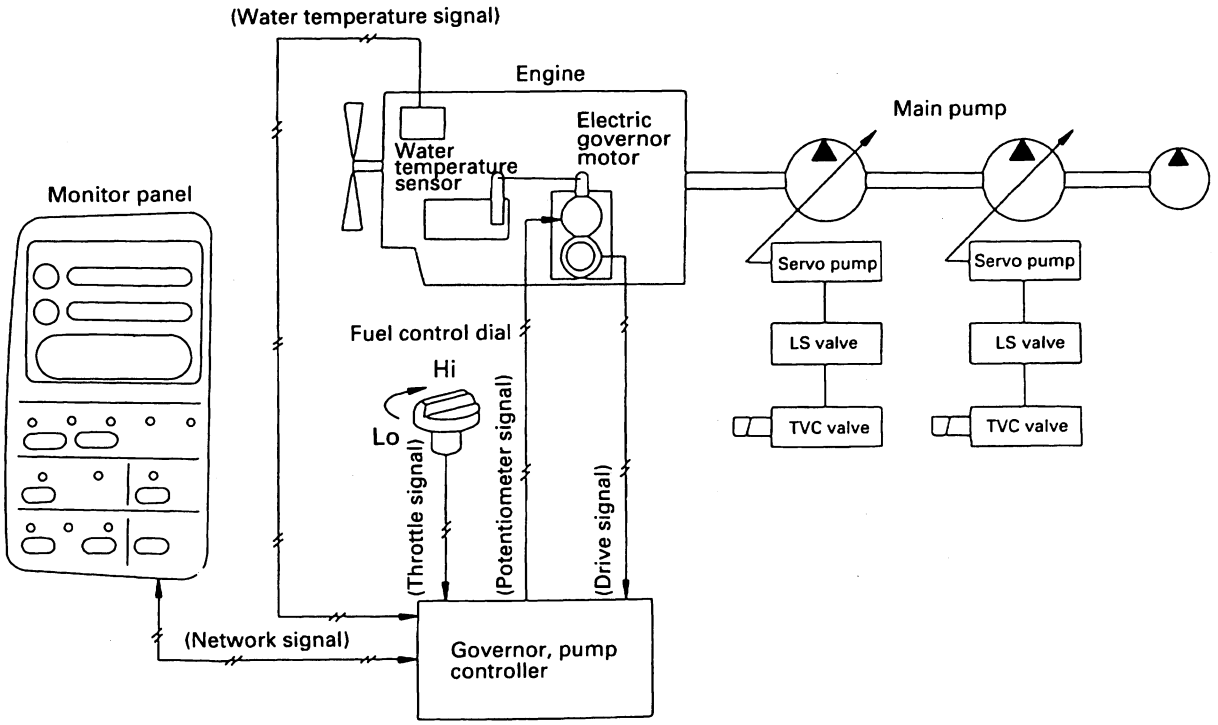
When control lever is operated

- If any control lever is operated when the engine speed is at No. 2 deceleration, the engine speed will immediately rise to the speed set by the fuel control dial.



SAP00356

5. Automatic warming-up and engine overheat prevention function



Function

- If the water temperature is low, this automatically raises the engine speed to warm up the engine after it is started. (Automatic warming-up function).
  In addition, if the water temperature rises to high during operations, it reduces the load of the pump to prevent overheating. (Engine overheat prevention function)

1) Engine automatic warming-up function

- After the engine is started, if the engine coolant temperature is low, the engine speed is automatically raised to warm up the engine.

Conditions for actuation (both are necessary)	
Coolant temperature:	Less than 30°C
Engine speed:	Less than 1,250 rpm

⇒

Actuation	
Engine speed:	1,250 rpm or below

⇓

Conditions for cancellation (any one)	
Automatic	Coolant temperature: 30°C or above
	Automatic warming-up time: 10 minutes or more
Manual	Fuel control dial: Held at more than 70% of full throttle for mor than 3 seconds

⇐

Cancellation
Engine speed: As desired

2) Engine overheat prevention function

- This function protects the engine by lowering the pump load and engine speed to prevent overheating when the engine coolant temperature has risen too far.
- This system is actuated when the water temperature is 105°C and above.

Actuation condition
Water temperature: 105°C and above Water temperature: Red range)

⇒

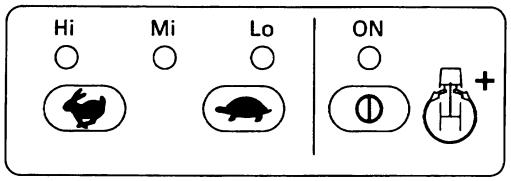
Actuation, remedy
Working mode: In any mode Engine speed: Low idling Monitor warning lamp: Lights up Alarm buzzer: Sounds

⇓

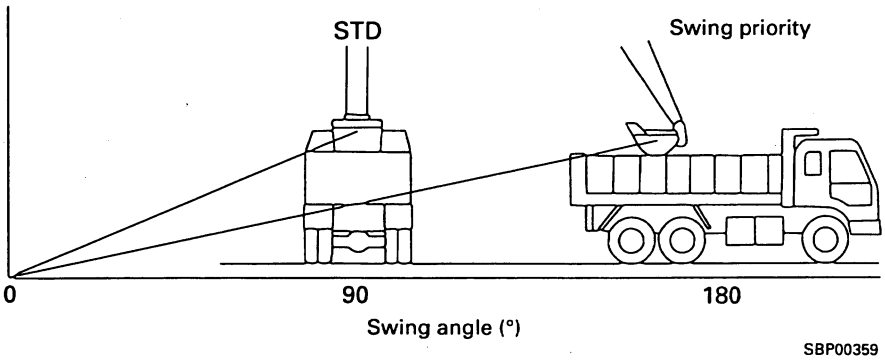
Cancel condition	
Water temperature:	Below 105°C
Fuel control dial:	Return temporarily to low idling position
• When the above conditions are met, the system returns to the condition before the overheat prevention function was actuated (manual reset)	

6. Swing priority function

- There is as SWING PRIORITY mode switch on the monitor panel. This switch can be turned ON or OFF to change the matching. The oil flow is divided and sent to the swing to match the swing angle to allow compound operations to be carried out easily.
  Swing priority mode OFF: 90° swing and loading of dump truck
  Swing priority mode ON: 180° swing and loading of dump truck

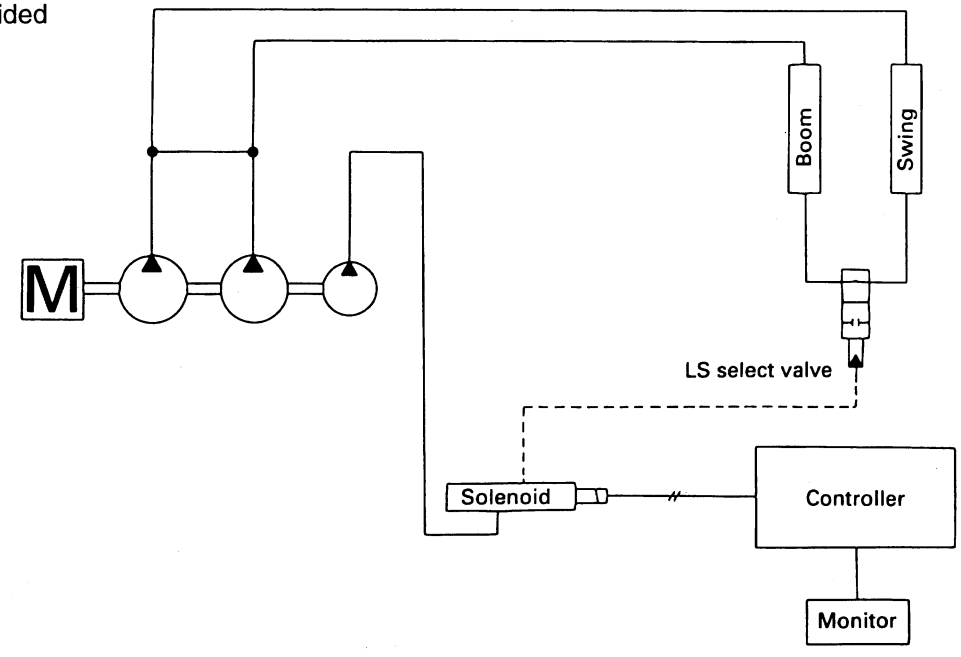


SAP00783



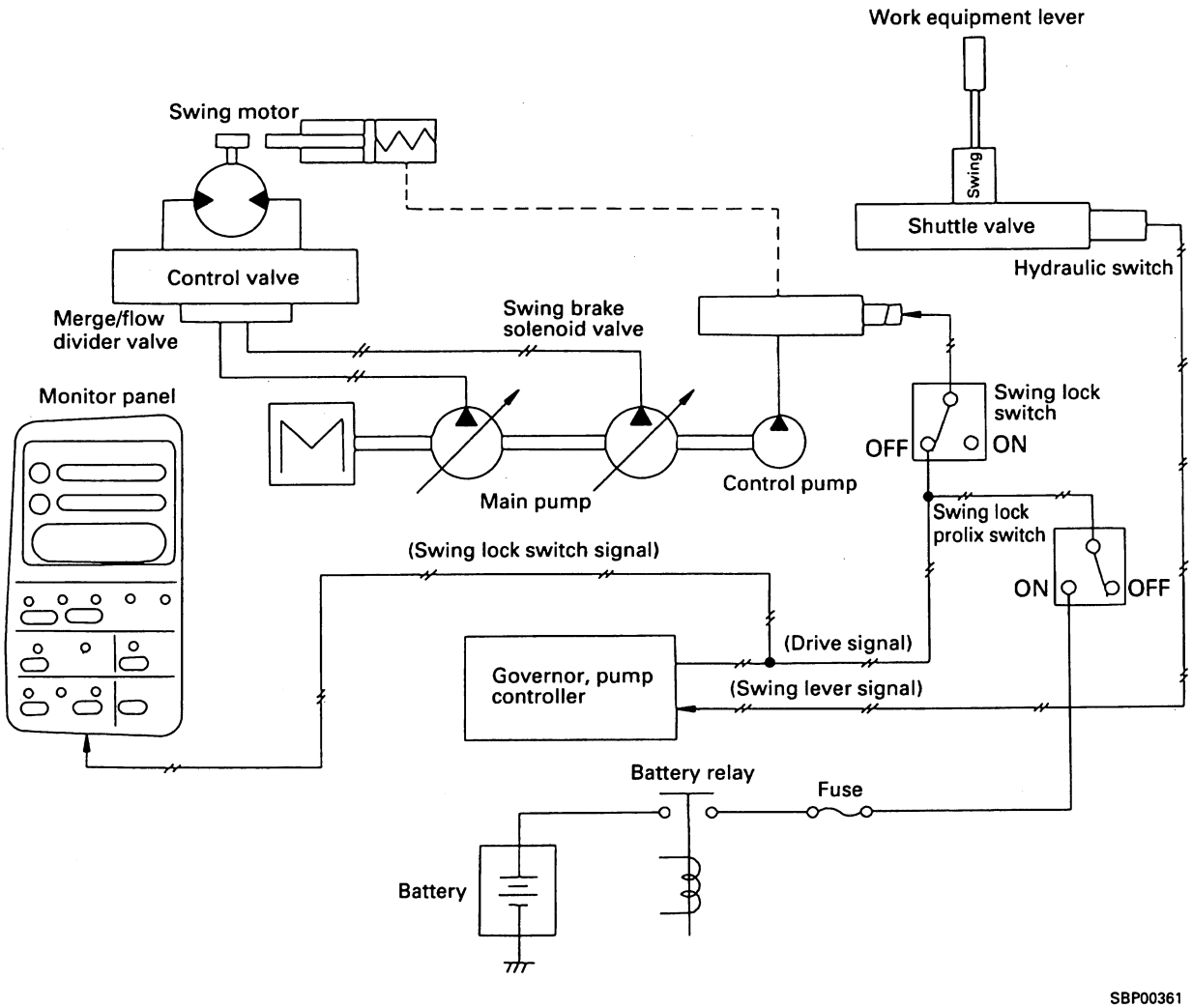
SBP00359

- The change in the matching between the boom RAISE and SWING is carried out by changing the signal to the LS select valve.
  When swing priority mode is OFF
  Solenoid: ON
  LS select valve: merged
  When swing priority mode is ON
  Solenoid: OFF
  LS select valve: divided



SBP00360

7. Swing control system



Function

- The system is provided with a swing lock and swing holding brake function.

1) Swing lock, swing holding brake function

- The swing lock (manual) can be locked at any desired position, and the swing holding brake (automatic) is interconnected with the swing, so it prevents any hydraulic drift after the swing is stopped.

※ Operation of swing lock prolix switch

- If any abnormality should occur in the controller, and the swing holding brake is not actuated normally and the swing cannot be operated, the swing lock prolix switch can be operated to cancel the swing lock and allow the swing to be operated.

★ Even when the swing lock prolix switch is turned ON, the swing lock switch stays ON and the swing brake is not canceled.

★ When the swing brake is canceled, the swing has only a hydraulic brak operated by the safety valve, so if the swing is stopped on a slope, ther may be hydraulic drift.

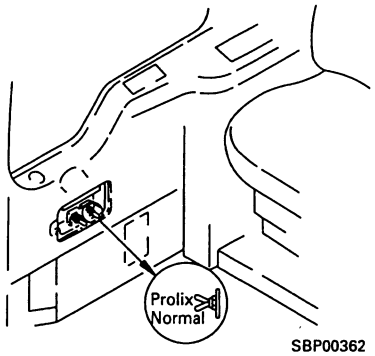
2) Hydraulic oil quick warm-up function when swing lock switch is ON

- When the swing lock switch is turned ON, the pump cut-off is canceled. If the work equipment is relieved in this condition, the hydraulic oil temperature will rise more quickly and the warming-up time can be reduced.

- Swing lock switch and swing lock, swing holding brake

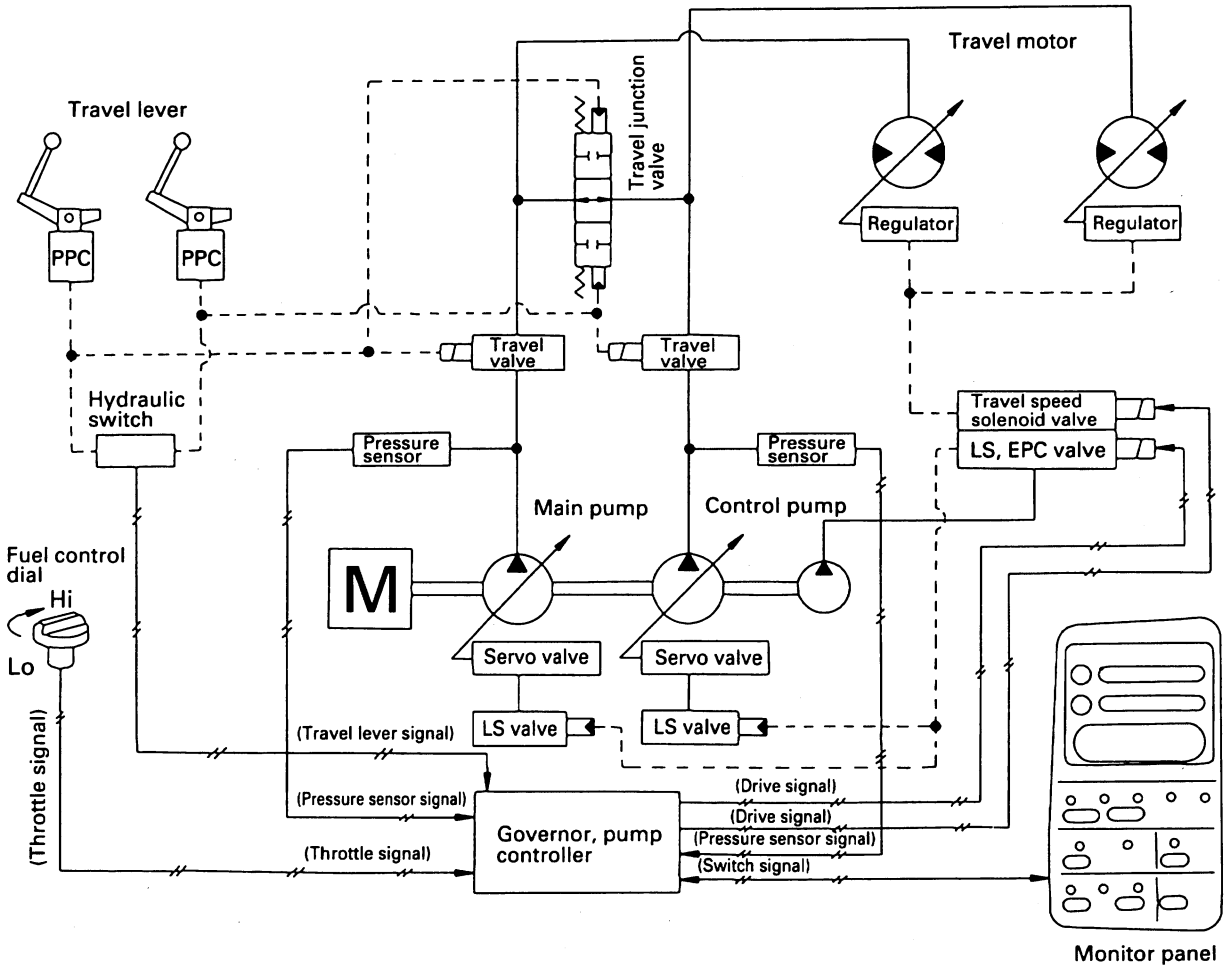
Lock switch	Lock lamp	Function	Operation
OFF	OFF	Swing holding brake	When swing lever is placed at neutral, swing brake is applied after approx. 5 sec; when swing lever is operated, brake is canceled and swing can be operated freely
ON	ON	Swing lock	Swing lock is actuated and swing is held in position. Even when swing lever is operated, swing lock is not canceled and swing does not move.

Swing lock prolix switch	On (When controller is abnormal)		OFF (when controller is normal)	
Swing lock switch	ON	OFF	ON	OFF
Swing brake	Swing lock applied	Swing lock canceled	Swing lock applied	Swing holding brake applied



SBP00362

8. Travel control system



Function

- When traveling, the pump control is carried out, and the travel speed can be selected manually or automatically to give a travel performance that suits the nature of the work or the jobsite.

1) Pump control function when traveling

- If the travel is operated in any working mode, other than the heavy-duty operation mode, this increases the pump absorption torque while keeping the working mode and engine speed as they are.

★ For details, see PUMP & ENGINE MUTUAL CONTROL

2) Travel speed selection function

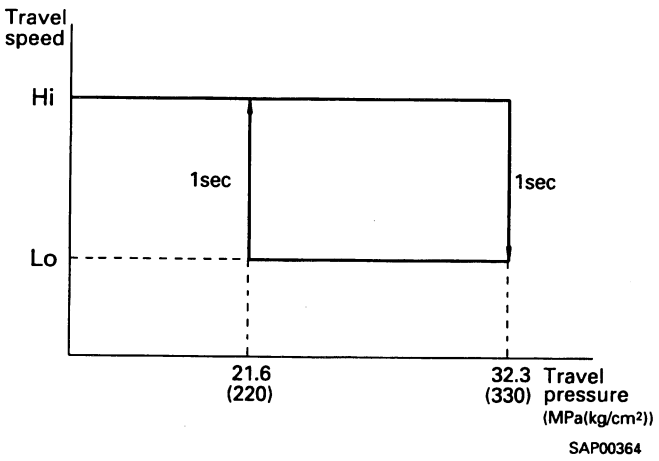
i) Manual selection using travel speed switch
If the travel speed switch is set to Lo, Mi or Hi, the governor and pump controller controls the pump flow and motor volume at each speed range as shown on the right to switch the travel speed.

Travel speed switch	Lo (Low speed)	Mi (Mid-range speed)	Hi (High speed)
Pump flow (%)	80	60	100
Motor volume	Max.	Min.	Min.
Travel speed (km/h)	3.2	4.5	5.5

ii) Automatic selection according to engine speed.
If the engine speed is reduced to below 1350 rpm by the fuel control dial:

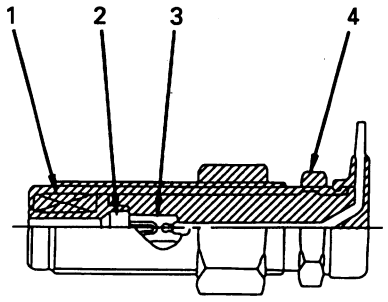
- If the machine is traveling in Lo, it will not shift even if Mi or Hi are selected.
- If the machine is traveling in Mi, it will not shift even if Hi is selected.
- If the machine is traveling in Hi, it will automatically shift to Lo.

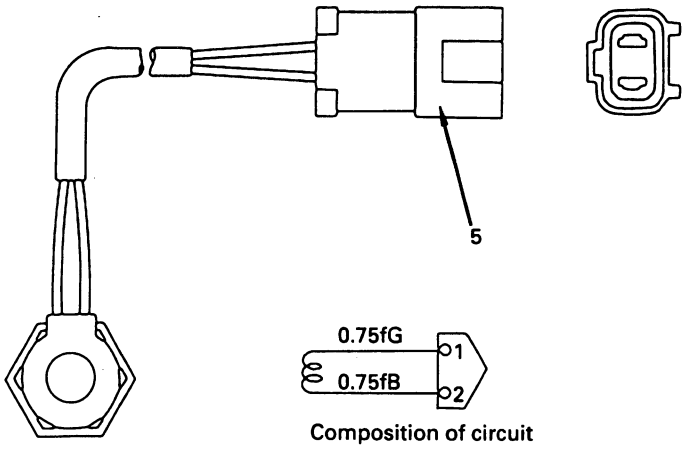
iii) Automatic selection according to pump discharge pressure
If the machine is traveling with the travel speed switch at Hi, and the load increases, such as when traveling up a steep hill, if the travel pressure continues at 32.3 MPa (330 kg/cm²) for more than 1.0 sec, the pump volume is automatically switched and the travel speed changes to Lo.
(The travel speed switch stays at Hi.)
The machine continues to travel in Lo, and when the load is reduced, such as when the machine travels again on flat ground or goes downhill, and the travel pressure stays at 21.6 MPa (220 kg/cm²) or less for more than 1.0 sec, the pump volume is automatically switched and the travel speed returns to Hi.



9. Components of system

1) Engine speed sensor





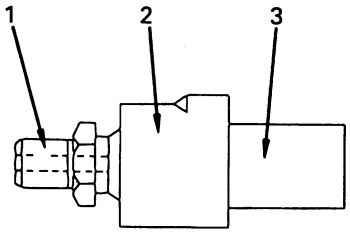
SBP00365

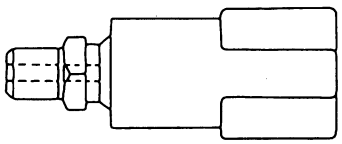
1. Wire
2. Magnet
3. Terminal
4. Housing
5. Connector

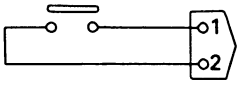
Function

- The engine speed sensor is installed to the ring gear portion of the engine flywheel. It counts electrically the number of gear teeth that pass in front of the sensor, and sends the results to the governor and pump controller.
- This detection is carried out by a magnet, and an electric current is generated every time the gear tooth passes in front of the magnet.

2) PPC hydraulic switch







SBP00366

1. Plug
2. Switch
3. Connector

Specificatins

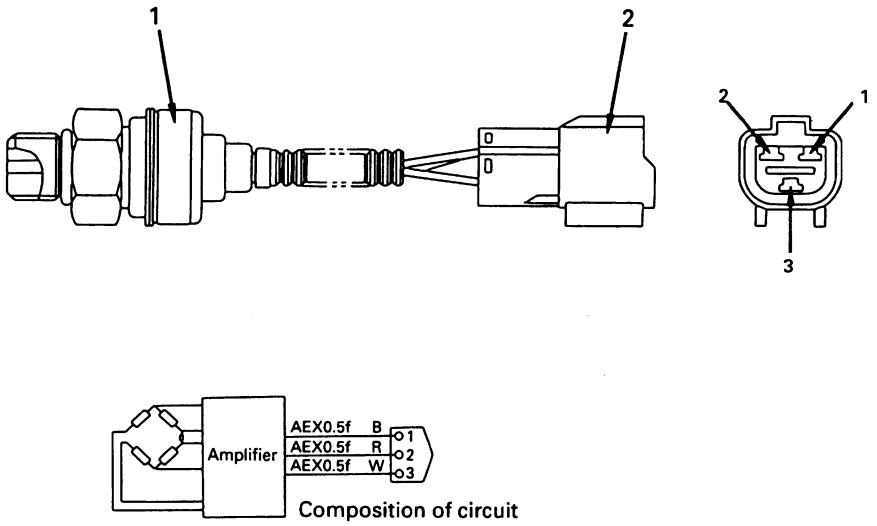
Composition of points:
N.O. points
Actuation (ON) pressure:
0.5 ± 0.1 MPa
(5.0 ± 1.0 kg/cm²)
Reset (OFF) pressure:
0.3 ± 0.005 MPa
(3.0 ± 0.5 kg/cm²)

Function

- There are 8 switches installed to the PPC shuttle valve. The operating condition of each actuator is detected from the PPC pressure, and this is sent to the governor and pump controller.

3) Pump pressure sensor

1. Sensor
2. Connector



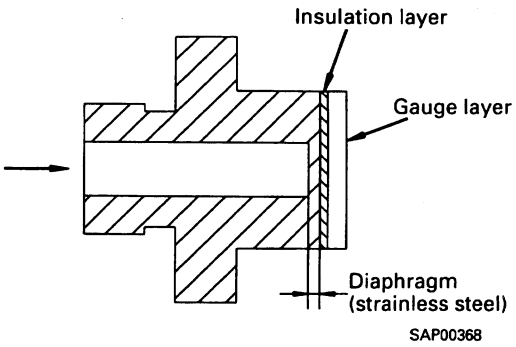
SBP00367

Function

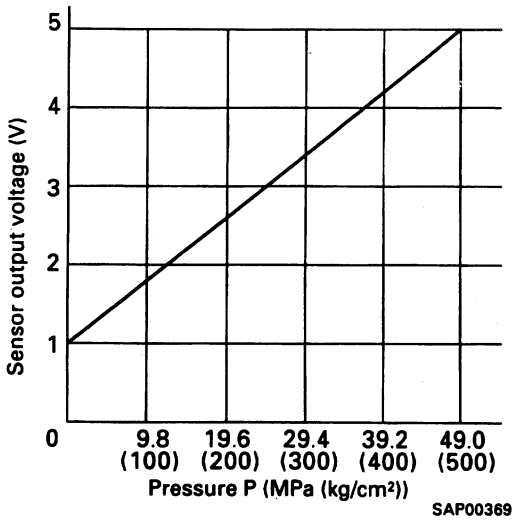
- This sensor is installed to the inlet port circuit of the control valve. It converts the pump discharge pressure to a voltage and sends this to the governor and pump controller.

Operation

- When the pressurized oil entering from the pressure introduction portion pressurizes the diaphragm of the pressure detection portion, the diaphragm deflects and changes shape.
- A gauge layer is installed to the face opposite the diaphragm, and the resistance of the gauge layer converts the deflection of the diaphragm into an output voltage and sends it to the amp (voltage amplifier).
- The voltage is further amplified by the amplifier and is sent to the governor and pump controller.
- Relationship between P pressure (MPa (kg/cm²)) and output voltage (V).
  V = 0.008 x P = 1.0

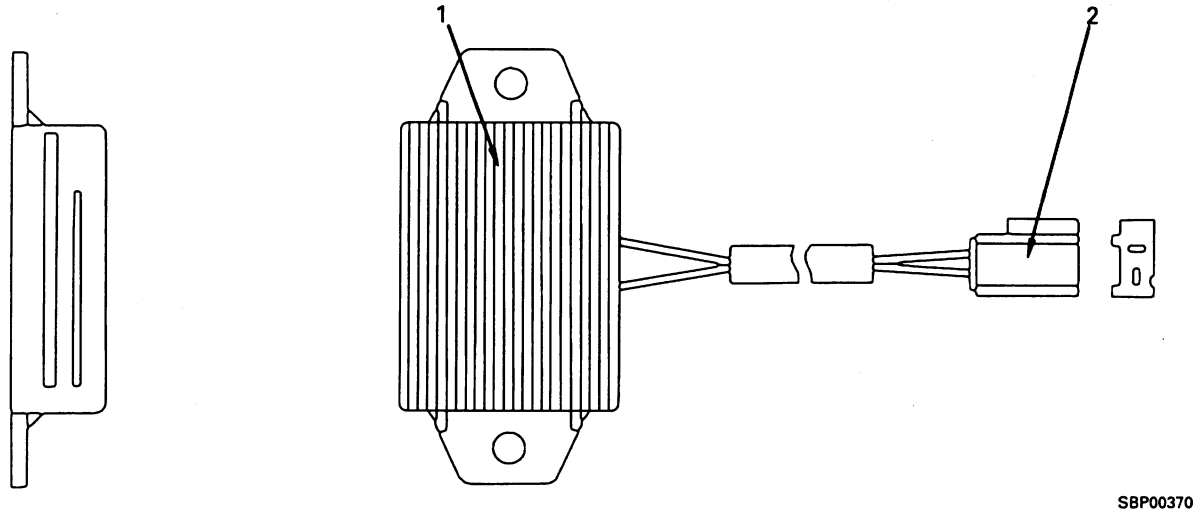


SAP00368



SAP00369

4) TVC prolix resistor



1. Resistor
2. Connector

Specification
Resistance: 8.5 Ω

Function
- This resistor acts to allow a suitable current to flow to the TVC solenoid when the TVC prolix switch is ON.
- No current flows when the TVC prolix switch is OFF.

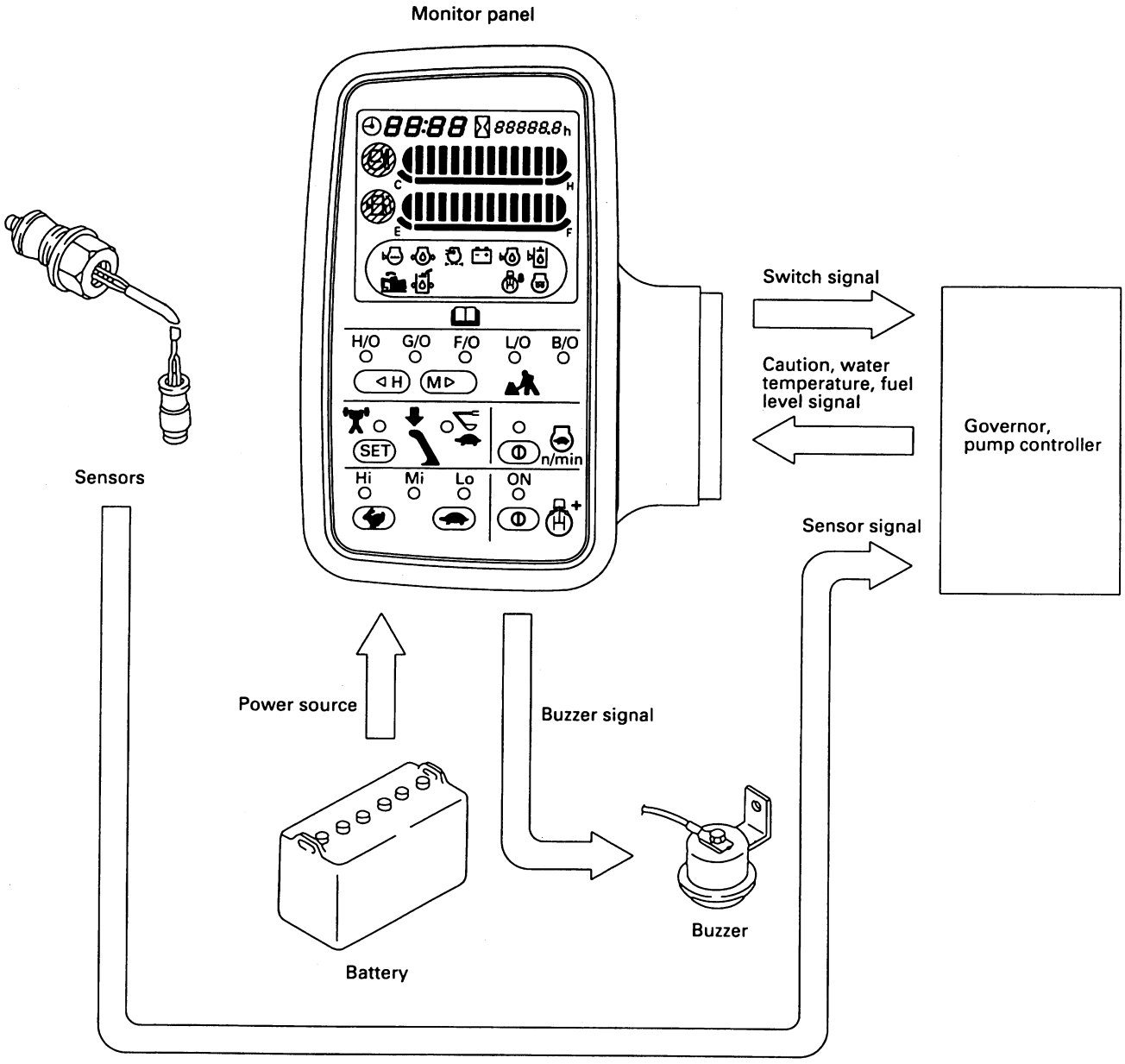
5) Fuel control dial, governor motor, governor and pump controller
★ See ENGINE CONTROL

6) Monitor panel
★ See MONITORING SYSTEM

7) TVC valve
★ See HYDRAULIC PUMP

8) LS control EPC valve
LS select solenoid valve
Boom Hi 2-stage safety valve solenoid valve
Merge/flow divider valve solenoid valve
Travel speed solenoid valve
Swing brake solenoid valve
★ See EPC SOLENOID VALVE

MACHINE MONITOR SYSTEM



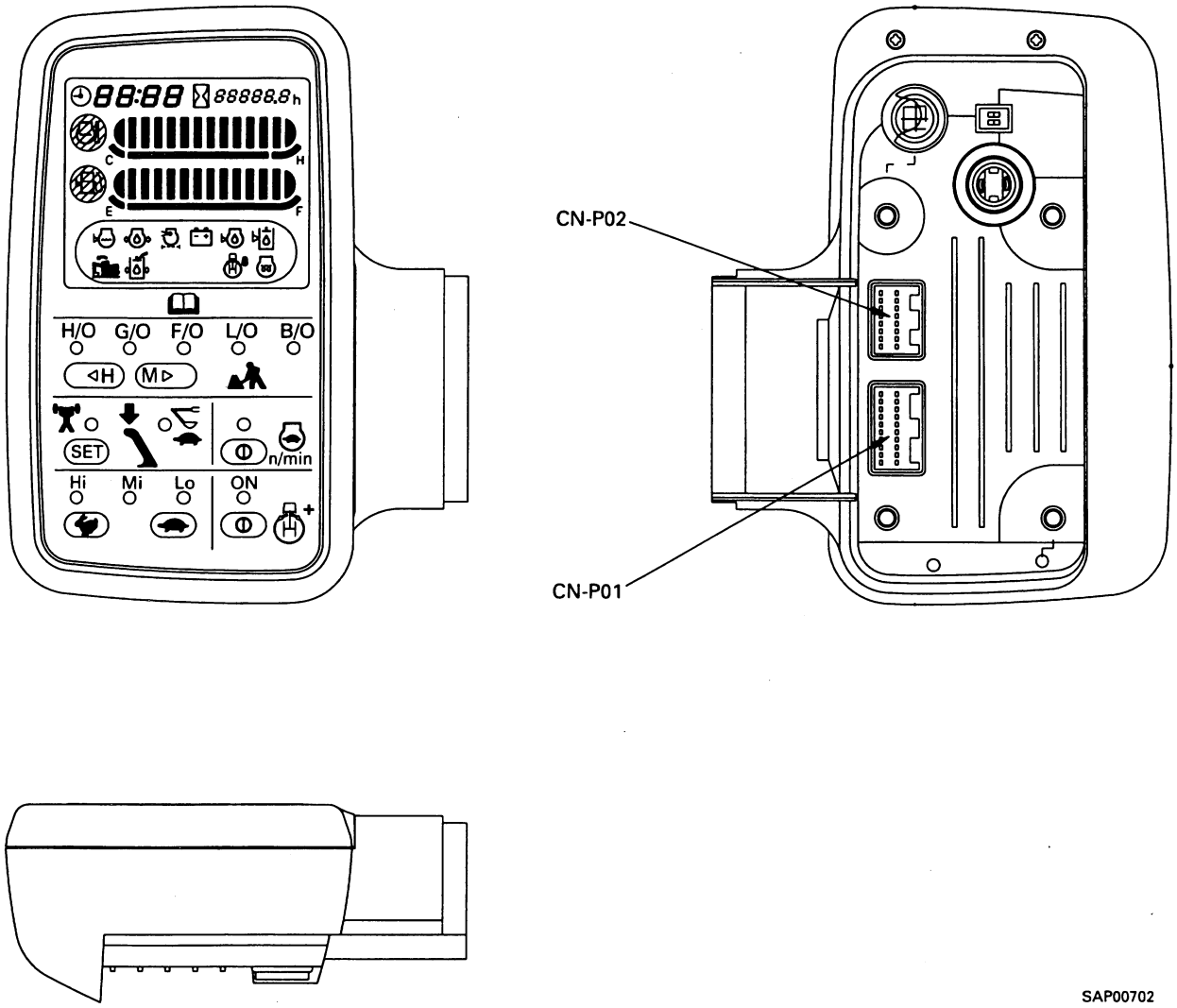
Function

- The machine monitor system uses the sensors installed to all parts of the machine to observe the condition of the machine. It processes this information swiftly, and displays it on a panal to inform the operator of the condition of the machine.
  The content of the information displayed on the machine can broadly be divides as follows.

1. Monitor portion
   This gives an alarm if any abnormality occurs in the machine.
2. Gauge portion
   This always displays the condition of the machine (coolant temperature, fuel level).

- The monitor panel also has various built-in mode selector switches, and functions as the control panal for the machine control system.

1. Monitor panel



SAP00702

Outline

- The monitor panel consistes of the switches for the monitor display functions, mode selector, and electrical components.
  It has a built-in CPU (Central Processing Unit), and processes, displays, and outputs the information.
  The monitor display panel uses a liquid crystal display (LCD). The mode switches are flat sheet switches.

Input and output signals

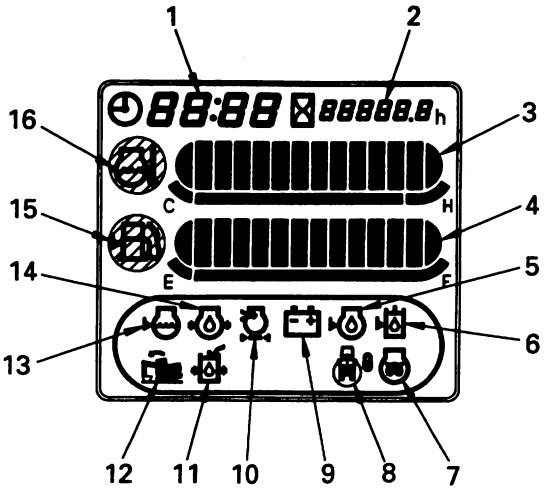
CN-P01

Pin No.	Name of signal
1	N/W signal
2	N/W GND
3	ND
4	NC
5	Swing lock
6	Buzzer stop
7	Buzzer output
8	Lamp
9	Key ON signal
10	Terminal BR
11	N/W signal
12	N/W GND
13	NC
14	NC
15	NC
16	NC
17	NC
18	Preheating
19	Start signal
20	NC

CN-P02

Pin No.	Name of signal
1	GND
2	NC
3	NC
4	NC
5	NC
6	NC
7	NC
8	+VB
9	GND
10	NC
11	NC
12	NC
13	NC
14	NC
15	NC
16	+VB

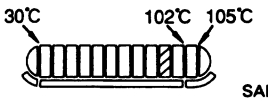
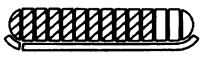
DISPLAY MONITOR



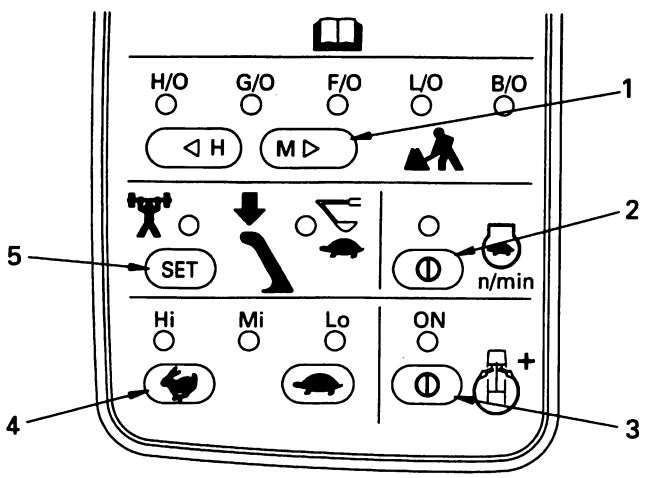
SDP00687

1. Clock (displays error code when error occurs)
2. Service meter (displays telephone number when error occurs)
3. Coolant temperature gauge
4. Fuel gauge
5. Engine oil level caution lamp
6. Hydraulic oil level caution lamp
7. Preheating pilot lamp
8. Swing holding brake pilot lamp
9. Charge level caution lamp
10. Air cleaner clogging caution lamp
11. PPC oil pressure caution lamp
12. Overload caution lamp
13. Coolant level caution lamp
14. Engine oil pressure caution lamp
15. Fuel level caution lamp
16. Coolant temperature caution lamp

Content of display

Symbol	Display item	Display range	When engine is stopped	When engine is running
SAP00519	Coolant level	Below low level	Flashes when abnormal	Flashes and buzzer sounds when abnormal
SAP00520	Engine oil pressure	Below 0.08 MPa (0.8 kg/cm^2)	Lights up when normal (goes out when engine starts)	Flashes and buzzer sounds when abnormal
SAP00521	Air cleaner clogging	When clogged	OFF	Flashes when abnormal
SAP00522	Charge level	When charging is defective	Lights up when normal (goes out when engine starts)	Flashes when abnormal
SAP00523	Engine oil level	Below low level	Flashes when abnormal	OFF
SAP00524	Hydraulic oil level	Below low level	OFF	Flashes when abnormal
SDP00688	Over load	Above high level	OFF	Flashes when abnormal
SDP00689	PPC oil pressure	Below low level	OFF	Flashes when abnormal
SDP00582	Parking	When swing is locked	Lights up when swing lock switch is ON, flashes when swing lock prolix switch is ON	
SAP00526	Preheating	During preheating	Lights up for 30 seconds when starting switch is at HEAT, then flashes for 10 seconds to indicate that preheating is completed	
SAP00703	Coolant temperature	Flashes when above 102°C, flashes and buzzer sounds when above 105°C	 SAP00529	
SAP00704	Fuel level	Flashes when below low level	 SAP00530	

MODE SELECTION SWITCHES



SAP00705

1. Working mode switches
2. Auto deceleration switch
3. Swing priority mode switch
4. Travel speed switch
5. Power max./Swift slow-down switch

- The switch portion consists of fice mode selection switches, and the condition of the machine changes each time that any switch is pressed. The LED above the switch lights up to display the present condition of the machine.

Switch actuation table

Switch	Item	Action
◁H M▷ SDP00692	WORKING MODE	H/0 ⟷ G/O ⟷ F/O ⟷ L/O ⟷ B/O
SET SDP00693	KNOB BUTTON	(POWER UP) ⟷ (SPEED DOWN) SDP00694
n/min SDP00695	AUTO DECEL	ON ⟷ OFF
SDP00696	TRAVEL SPEED	Hi ⟷ Mi ⟷ Lo
+ SAP00706	SWING PRIORITY MODE	OFF ⟷ ON

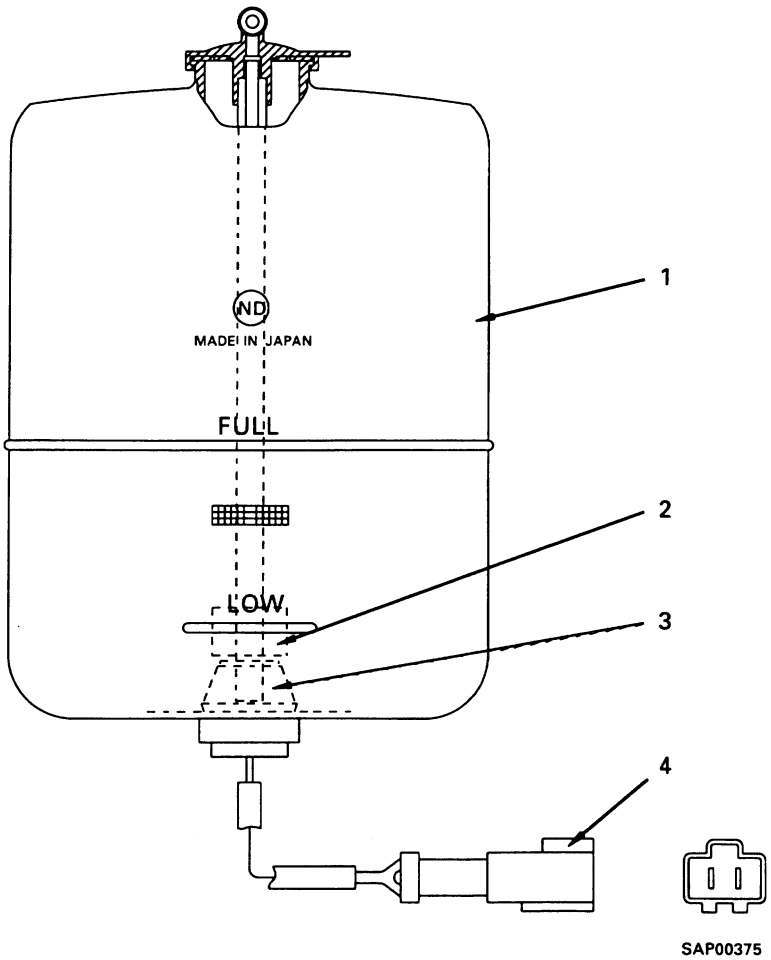
★ The bold letters indicate the default position of the switch when the starting switch is turned ON.

2. Sensors

- The signals from the sensors are input directly to the monitor panel.
  The contact type sensors are always connected at one end of the chassis GND.

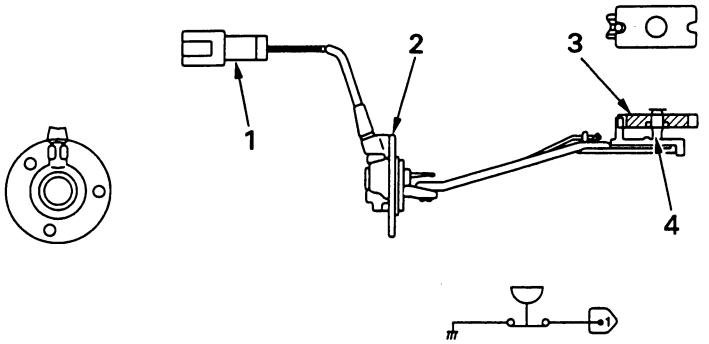
Name of sensor	Type of sensor	When normal	When abnormal
Coolant level	Contact type	ON (closed)	OFF (open)
Engine oil level	Resistance type	-	-
Hydraulic oil level	Contact type	ON (closed)	OFF (open)
Engine oil pressure	Contact type	OFF (open)	ON (closed)
Coolant temperature	Resistance type	-	-
Fuel level	Resistance type	-	-
Air cleaner clogging	Contact type	OFF (closed)	ON (open)

Coolant level sensor



1. Sub-tank
2. Float
3. Sensor
4. Connector

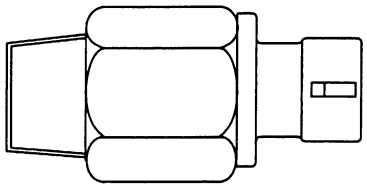
Hydraulic oil level sensor

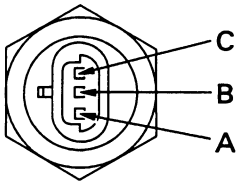


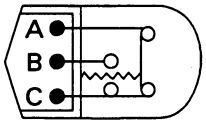
1. Connector
2. Bracket
3. Float
4. Switch

Composition of circuit

Engine oil pressure senor

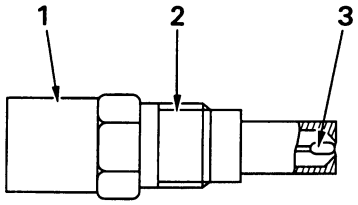




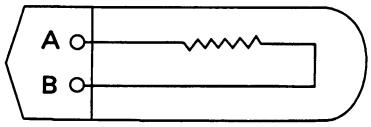


Composition of circuit

Coolant temperature sensor

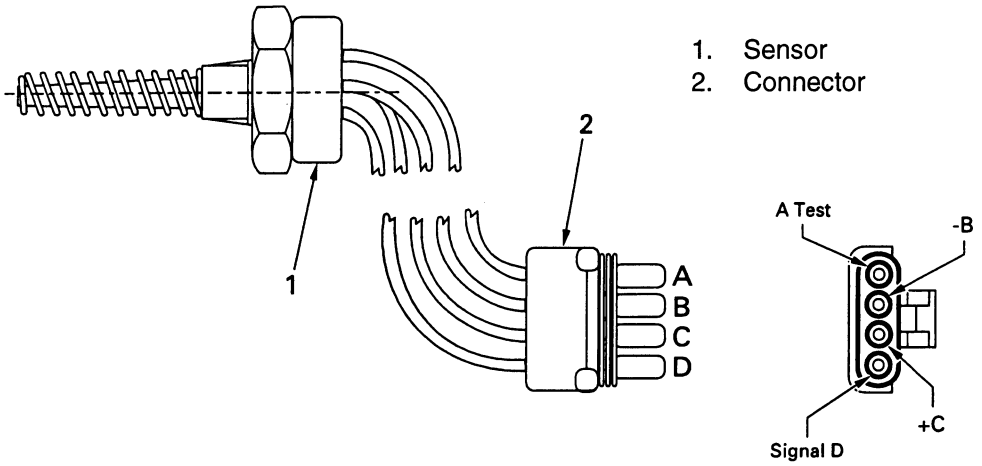


1. Connector
2. Plug
3. Thermistor

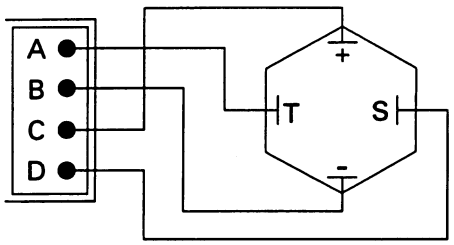


Composition of circuit

Engine oil level sensor

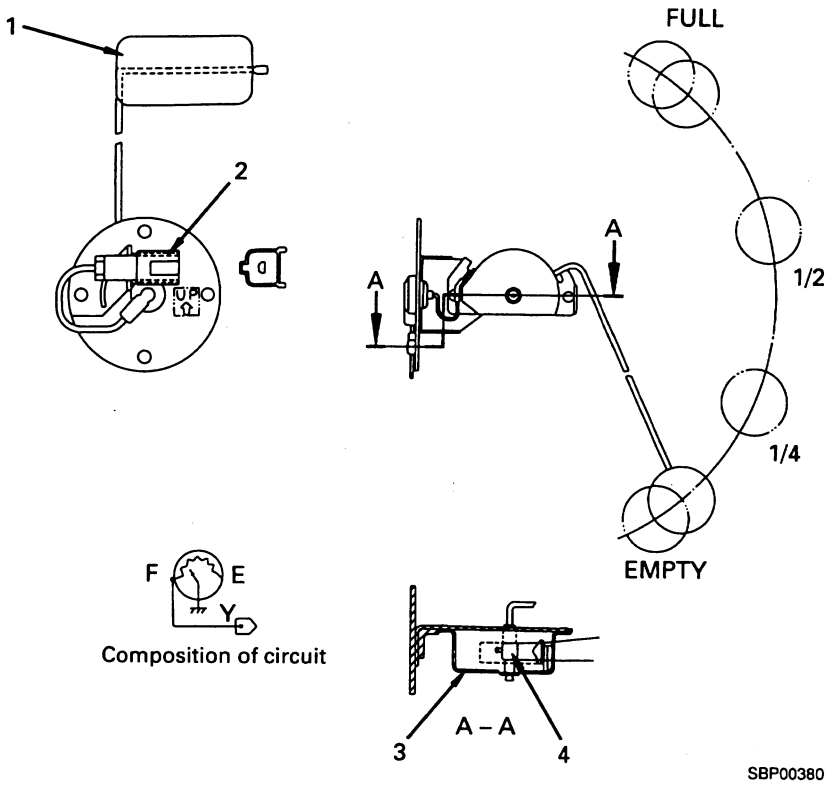


1. Sensor
2. Connector



Composition of circuit

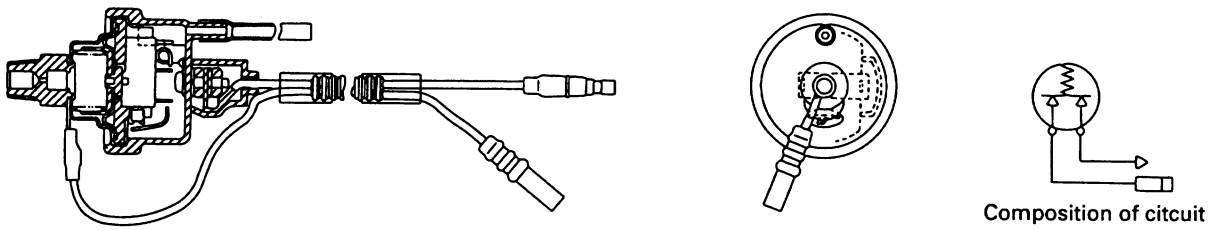
Fuel level sensor



SBP00380

1. Float
2. Connector
3. Cover
4. Variable resistor

Air cleaner clogging sensor



SBP00381

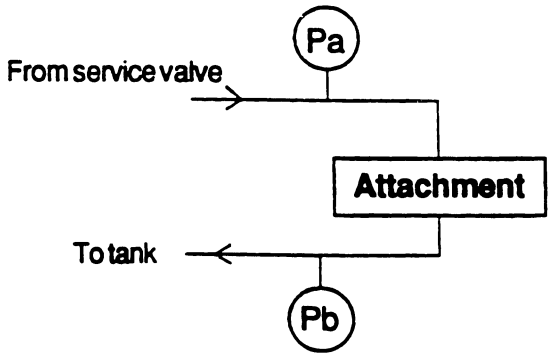
BREAKER MODE HYDRAULIC PERFORMANCE

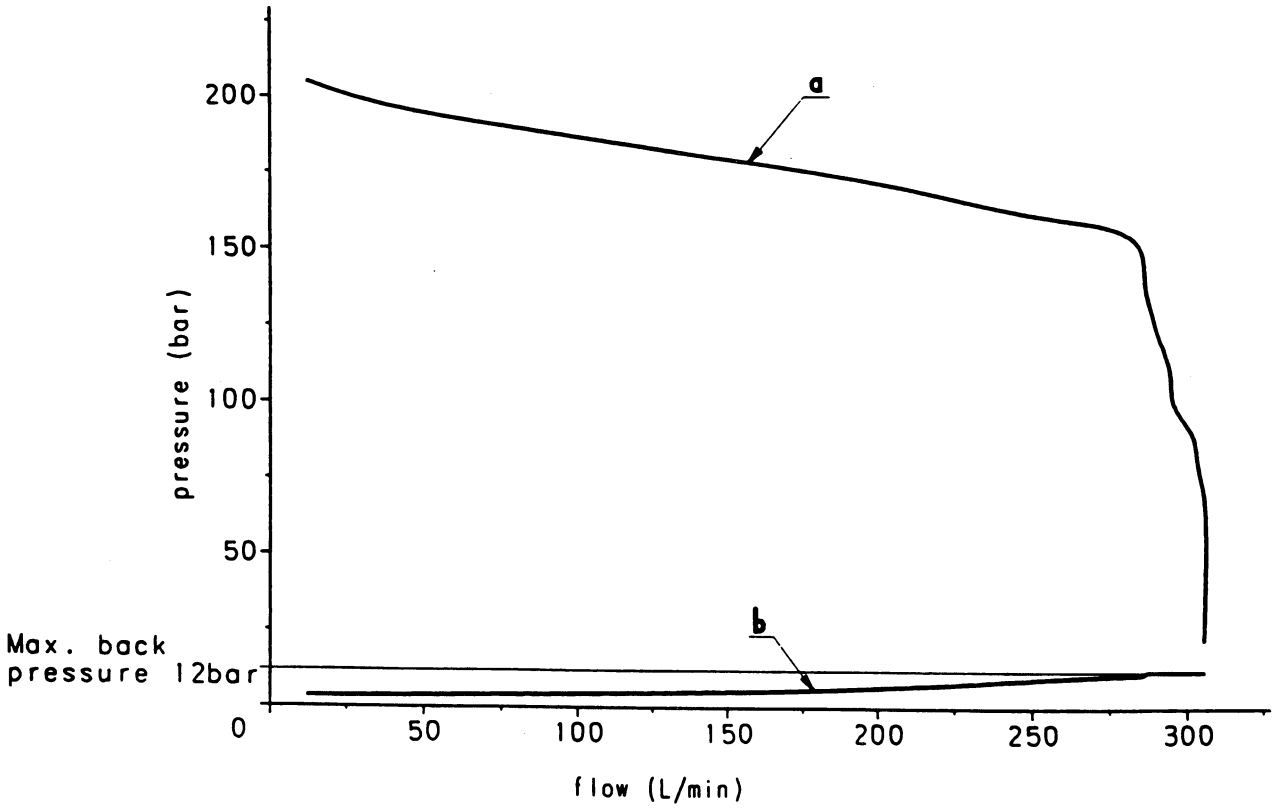
The performance of the hydraulic system when used in the B.O. mode for attachment operation, is shown below.

The pressure **Pa** is that wich is observed at the inlet to the Attachment.

The pressure **Pb** is the pressure observed on the return line or tank line (back pressure).

The figure below shows the pressures at points **A** and B for varying flow through the attachment.





Note: The above graph shows pressure~flow for a relief valve pressure setting of 210 bar.

20

20 TESTING AND ADJUSTING

★ Note the following when making judgements using the standard value tables for testing adjusting, or troubleshooting.

1. The standard value for a new machine given in the table is the value used when shipping the machine from the factory and is given for reference. It is used as a guidline for judging the progress of wear after the machine has been operated, and as a reference value when carrying out repairs.

2. The service limit value given in the tables is the estimated value for the shipped machine based on the results of various tests. It is used for reference together with the state of repair and the history of operation to judge if there is a failure.

3. These standard values are not the standards used in dealing with claims.

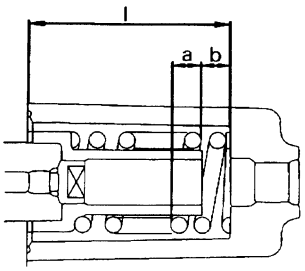
⚠ When carrying out testing, adjusting, or troubleshooting, park the machine on level ground, inset the safety pins, and blocks to prevent the machine from moving.
⚠ When carrying out work together with other workers, always use signals and do not let unauthorized people near the machine.
⚠ When checking the water level, always wait for the water to cool down. If the radiator cap is removed when the water is still hot, the water will spurt out and cause burns.
⚠ Be careful not to get caught in the fan, fan belt or other rotating parts.

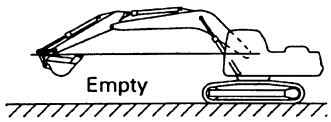
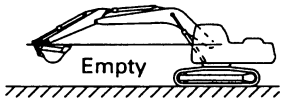
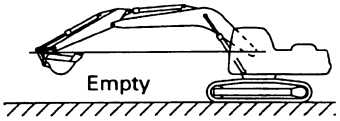
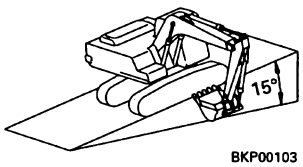
STANDARD VALUE TABLE FOR ENGINE RELATED PARTS

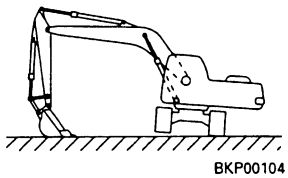
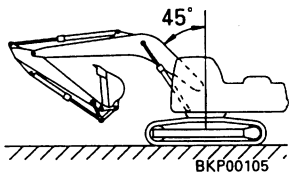
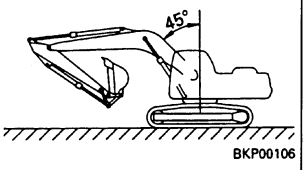
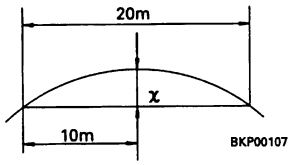
Applicable model				PC450-6k	
Engine				MTA 11	
Item	Measurement conditions		Unit	Standard value for new machine	Service limit value
Engine speed	High idling		rpm	2,100 ± 50	2,100 ± 50
	Low idling			700 ± 50	700 ± 50
	Rated speed			1,900	-
Rated speed	Air supply pressure (boost pressure)		mmHg	Min 1168.4	Min. 1110
Exhaust gas color	At sudden acceleration		Bosch index	Max. 3.2	7.5
	At high idling			Max. 0.2	2.0
Valve clearance (normal temperature)	Intake valve		mm	0.36	Max. 0.41
	Exhaust valve			0.69	Max. 0.76
	Injector valve			-	Max. 2.04
Blowby pressure (SAE oil)	(Water temperature: Operating range) At rated output		mmH_2O	Max. 305	460
Oil pressure	(Water temperature: Operating range) At 1400 rpm		kPa (kg/cm^2)	Min 207 (2.11)	Min. 207 (2.11)
	At low idling			Min. 70 (0.7)	Min. 70 (0.7)
Oil temperature	At rated speed (inside oil pan)		°C	Max. 125	Max. 125
Fuel injection timing	Before top dead center		mm	Refer to page 20-25	-
Belt tension	Deflection when pressed with finger force of approx. 58.8N (6 kg)	Fan pully-alternator	mm	8	6 - 10
		Crankshaft pulleyair conditioner compressor		15 - 18	15 -18

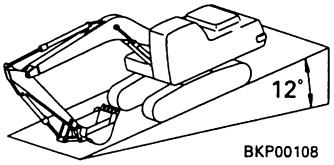
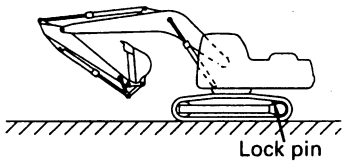
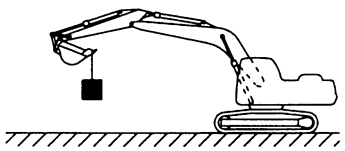
STANDARD VALUE TABLE FOR CHASSIS RELATED PARTS

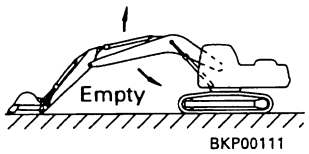
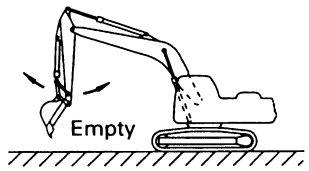
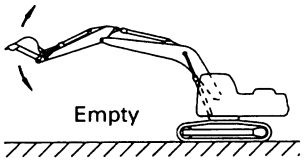
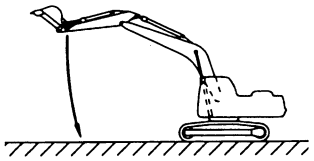
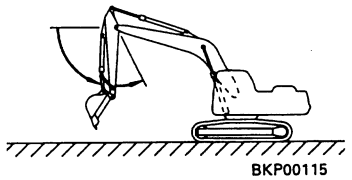
★ The Standard value for new machine and Service limit value in the table below are all values when measured in the heavy-duty mode.

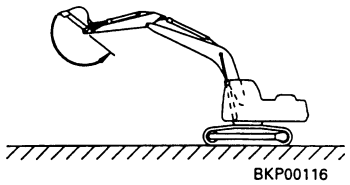
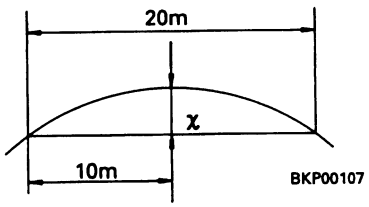
Applicable model				PC450-6k					
Category	Item	Measurement conditions	Unit	Standar value for new machine			Service limit value		
Engine speed	At 2-pump relief	• Engine water temperature: Within operating range • Hydraulic oil temperature: 45 - 55°C • Engine at full throttle • In H/O mode • Arm IN relief	rpm	When swing lock switch is OFF: 2,100 $^{+50}_{-100}$			When swing lock switch is OFF: 2,100 $^{+50}_{-100}$		
				When swing lock switch is ON: 1,900 ± 100			1,900 ± 100		
	At 2-pump relief + power max.	• Engine at full throttle • In H/O mode • Arm IN relief + power max. ON		1,880 ± 50			1,880 ± 100		
	Engine speed when auto-deceleration is actuated	• Auto-deceleration switch ON • Fuel control dial at MAX. • Control levers at neutral.		1,500 ± 50			1,500 ± 50		
Spool stroke	Boom Lo control valve	 BLP00101	mm	ℓ	a	b	ℓ	a	b
	Boom Hi control valve			-	9.5 ± 0.5 Boom Lo LOWER only 8.7 ± 0.5	9.5 ± 0.5 Boom Lo LOWER only 8.7 ± 0.5	-	9.5 ± 0.5 Boom Lo LOWER only 8.7 ± 0.5	9.5 ± 0.5 Boom Lo LOWER only 8.7 ± 0.5
	Arm Lo control valve								
	Arm Hi control valve								
	Bucket control valve								
	Swing control valve								
	Left travel control valve								
	Right travel control valve			-			-		
Travel of control levers	Boom control lever	• Center of lever knop • Read max. value to end travel • Engine stopped • Exclude play at neutral	mm	85 ± 10			Max. 95 Min. 75		
	Arm control lever			85 ± 10			Max. 95 Min. 75		
	Bucket control lever			85 ± 10			Max. 95 Min. 75		
	Swing control lever			85 ± 10			Max. 95 Min. 75		
	Travel control lever			115 ±12			Max. 127 Min. 103		
	Play of control lever	Work equipment, swing		Max. 10			Max. 15		
		Travel		Max. 20			Max. 30		

Applicable model				PC450-6k	
Category	Item	Measurement conditions	Unit	Standard value for new machine	Service limit value
Swing	Overrun when stopping swing	Work equipment posture Max. reach  BKP00102 • Engine at full throttle • Hydraulic oil temperature: 45 - 55°C • In H/O mode • Stop after swinging one turn and measure distance that swing circle moves	Deg.	Max. 120	Max. 150
	Time taken to start swing	Work equipment Max. reach posture  BKP00326 90° • Engine at full throttle • Hydraulic oil temperature: 45 - 55°C • In H/O mode • Time taken to swing 90° and 180° from starting postition 180°	Sec	3.7 ± 0.4	Max. 4.6
				5.4 ± 0.5	Max. 6.4
	Time taken to swing	Work equipment posture Max. reach  BKP00102 • Engine at full throttle • Hydraulic oil temperature: 45 - 55°C • In H/O mode • Swing one turn, then measure time taken to swing next 5 turns		33.7 ± 1.7	Max. 38
	Hydraulic drift of swing	 BKP00103 • Engine stopped • Hydraulic oil temperature: 45 - 55°C • Set machine on 15° slope, and set upper structure at 90° to the side. • Make match marks on swing circle outer race and track frame. • Measure distance that match marks move apart after 5 minutes.	mm	0	0
	Leakage from swing motor	• Engine at full throttle • Hydraulic oil temperature: 45 - 55°C • Swing lock switch ON • Relieve swing circuit.	ℓ/min	Max. 5.5	Max. 11

Applicable model					PC450-6k	
Category	Item	Measurement conditions		Unit	Standard value for new machine	Service limit value
Travel	Travel speed (1)	 BKP00104 • Engine at full throttle • Hydraulic oil temperature: 45 - 55°C • In H/O mode • Raise track on one side at a time, rotate one turn, then measure time taken for next 5 turns with no load	Travel speed		STD LC	STD LC
			Lo	Sec	59.5 ± 6.0 62.5 ± 6.5	53.5 - 71.5 56.0 - 75.5
			Mi		42.0 ± 4.5 44.5 ± 4.8	37.5 - 51.0 39.7 - 54.1
			Hi		34.5 ± 3.5 36.5 ± 3.7	31.0 - 41.5 32.8 - 43.9
	Travel speed (2)	 BKP00105 • Engine at full throttle • Hydraulic oil temperature: 45 - 55°C • In H/O mode • Run up for at least 10 m, and measure time taken to travel next 20 m on flat ground.	Lo		22.5 ± 3.5	19.0 - 29.5
			Mi		16.0 ± 2.0	14.0 - 20.0
			Hi		13.1 ± 1.0	12.0 - 15.1
	Travel deviation	 BKP00106 • Engine at full throttle • Hydraulic oil temperature: 45 - 55°C • In H/O mode • Travel speed: Hi • Run up for at least 10 m, and measure deviation when traveling next 20 m on flat ground. ★ Use a hard horizontal surface  BKP00107 ★ Measure dimension x.		mm	Max. 200	Max. 300

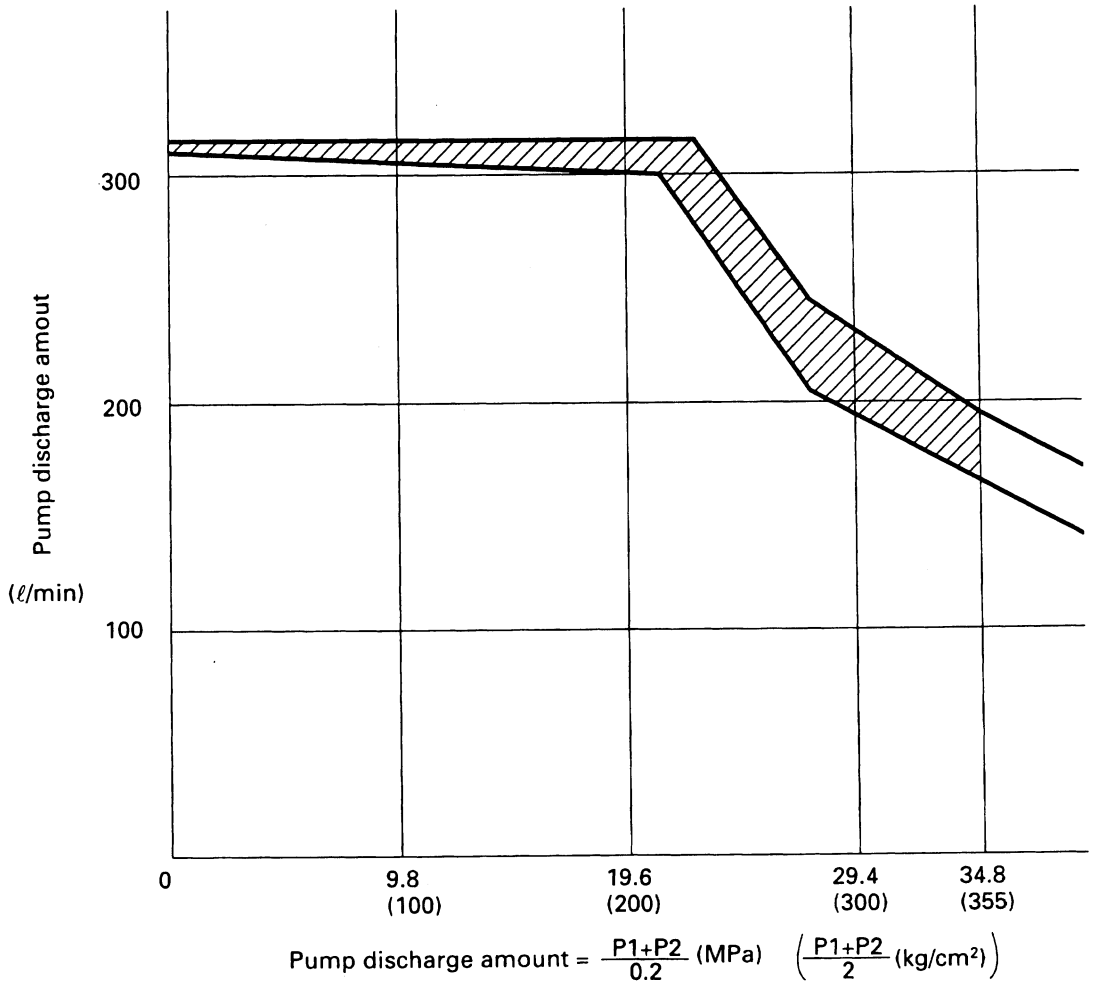
Applicable model					PC450-6k	
Category	Item		Measurement conditions	Unit	Standard value for new machine	Service limit value
Travel	Hydraulic drift of travel		 BKP00108 • Engine stopped • Hydraulic oil temperature: 45 - 55°C • Stop machine on 12° slope with sprocket facing straight up the slope. • Measure the distance the machine moves in 5 minutes.	mm	0	0
	Leakage of travel motor		 BKP00109 • Engine at full throttle • Hydraulic oil temperature: 45 - 55°C • Lock shoes and relieve travel circuit.	⁄/mm	Max. 20	Max. 40
Work equipment	Hydraulic drift work equipment	Total work equipment (hydraulic drift at tip of bucket teeth)	Posture for measurement  BKP00110 • Place in above posture and measure extension or retraction of each cylinder and downward movement at tip of bucket teeth. • Bucket: Rated load 28.2 kN (2880 kg) • Horizontal, flat ground • Levers at neutral • Engine stopped • Hydraulic oil temperature: 45 - 55°C • Start measuring immediately after setting. • Measure hydraulic drift every 5 minutes, and judge from results for 15 minutus.	mm	Max. 600	Max. 900
		Boom cylinder (amount of retraction of cylinder)			Max. 25	Max. 38
		Arm cylinder (amount of extension of cylinder)			Max. 85	Max. 128
		Bucket cylinder (amount of retraction of cylinder)			Max. 30	Max. 45

Applicable model					PC450-6k	
Category	Item	Measurement conditions		Unit	Standard value for new machine	Service limit value
Work equipment	Work equipment speed	Boom Bucket teeth in contact with ground ↕ Cylinder fully extended	 BKP00111 • Engine at full throttle • Hydraulic oil temperature: 45 - 55°C • In H/O mode	RAISE	sec	4.2 ± 0.4	Max. 5.0
				LOWER		3.1 ± 0.3	Max. 3.6
		Arm Cylinder fully retracted ↕ Fully extended	 BKP00112 • Engine at full throttle • Hydraulic oil temperature: 45 - 55°C • In H/O mode	IN		4.8 ± 0.5	Max. 5.8
				OUT		3.9 ± 0.4	Max. 4.7
		Bucket Cylinder fully retracted ↕ Fully extended	 BKP00113 • Engine at full throttle • Hydraulic oil temperature: 45 - 55°C • In H/O mode	CURL		3.8 ± 0.4	Max. 4.6
				DUMP		2.9 ± 0.3	Max. 3.5
	Time lag	Boom	 BKP00114 • Lower boom and measure time taken from point where bucket contacts ground to point where chassis rises from ground • Engine at low idling • Hydraulic oil temperatrure: 45 - 55°C			Max. 3.0	Max. 5.0
		Arm	 BKP00115 • Stop arm suddenly and measure time taken for arm to stop • Engine at low idling • Hydraulic oil temperature: 45 - 55°C			Max. 3.0	Max. 5.0

Applicable model					PC450-6k	
Category	Item		Measurement conditions	Unit	Standard value for new machine	Service limit value
Work equipment	Time lag	Bucket	 BKP00116 • Stop bucket suddenly and measure time taken for bucket to stop at bottom and then start again • Engine at low idling • Hydraulic oil temperature: 45 - 55°C	Sec	Max. 3.0	Max. 5.0.
	Internal leakage	Cylinders	• Hydraulic oil temperature: 45 - 55°C • Engine at full throttle • Relieve circuit to be measured	cc/min	Max. 4.5	Max. 20
		Center swivel joint			Max. 10	Max. 50
Performance in compound operation	Travel deviation when work equipment + travel are operated		• Hydraulic oil temperature: 45 - 55°C ★Use a hard horizontal surface. ★ Measure dimension x.  BKP00107 • Oil temperature: 45 - 55°C	mm	Max. 400	Max. 440
Performance of hydraulic pump	Hydraulic pump delivery	Control pump	• Measure with engine at rated speed • At relief valve set pressure (3.1 MPa (32 kg/cm²)) See next page	ℓ/min	Max. 34.0	Max. 30.5
		Piston pump	See next page		See next page	

Category: Performance of hydraulic pump

PC450-6k: Discharge amount of main piston pump (in H/O mode)



- Pump speed: At 1,950 rpm, TVC current 180 mA

Check point	Test pump discharge pressure (MPa (kg/cm²))	Discharge pressure of other pump (MPa (kg/cm²))	Average pressure (MPa (kg/cm²))	Standard value for discharge amount Q (ℓ/min)	Judgement standard lower limit Q (ℓ/min)
As desired	P1	P2	$\frac{P1+P2}{0.2}$ $\left(\frac{P1+P2}{2}\right)$	See graph	See graph

★ As far as possible, bring pump discharge pressures P1 and P2 as close as possible to the average pressure when measuring.
The error is large near the point where the graph curves, so avoid measuring at this point.

★ When measuring with the pump mounted on the machine, if it is impossible to set the engine speed to the specified speed with the fuel control dial, take the pump discharge amount and the engine speed at the point of measurement, and use them as a base for calculating the pump discharge amount at the specified speed.

STANDARD VALUE TABLE FOR ELECTRICAL PARTS

System	Name of component	Connector No.	Inspection method	Judgement table	Measurement conditions
Control system	Fuel control dial	E06 (male)	Measure resistance	If the condition is within the range shown in the table below, it is normal Between (1) - (2): 0.25 - 7 kΩ Between (2) - (3): 0.25 - 7 kΩ Between (1) - (3): 4 - 6 kΩ	1) Turn starting switch OFF. 2) Disconnect connector.
	Governor motor: Potentiometer	E04 (male)	Measure resistance	If the condition is within the range shown in the table below, it is normal Between (1) - (2): 0.25 - 7 kΩ Between (2) - (3): 0.25 - 7 kΩ Between (1) - (3): 4 - 6 kΩ	1) Turn starting switch OFF. 2) Disconnect connector.
	Governor motor: Motor	E05 (male	Measure resistance	If the condition is as shown in the table below, it is normal Between (1) - (2): 2.5 - 7.5 Ω Between (3) - (4): 2.5 - 7.5 Ω Between (1) - (3): No continuity Between (1) - chassis: No continuity Between (3) - chassis: No continuity	1) Turn starting switch OFF. 2) Disconnect connector.
	Engine speed sensor	E07	Measure resistance	If the condition is within the range shown in the table below, it is normal Between(male) (1) - (2): 500 - 1,000 Ω Between(male) (2) - chassis: Min. 1 MΩ	1) Turn starting switch OFF. 2) Disconnect connector.
			Measure voltage	Measure with AC range Between (1) - (2): 0.5 - 3.0 V	1) Start engine. 2) Insert T-adapter.
			Adjust	1) Screw in rotation sensor until it contacts ring gear, then turn back 1 ± 1/6 turns. 2) It must work normally when adjusted as above.	
	PPC oil pressure switch	Travel S01 boom RAISE S02 arm OUT S03 boom LOWER S04 arm IN S05 bucket CURL S06 bucket DUMP S07 swing S08	Measure resistance	If the condition is as shown in the table below, it is normal When boom, arm, and bucket levers are operated Between (male) (1) - (2): All levers at neutral: Min 1 MΩ Between (male) (1) - (2): Levers operated: Max. 1 Ω Between (male) (1), (2) - chassis: Min. 1MΩ	1) Start engine (or with engine stopped and accumulator charged) 2) Disconnect connectors S01 - S08

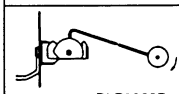
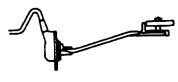
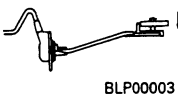
System	Name of component	Connector No.	Inspection method	Judgement table	Measurement conditions
Control system	Pump pressure sensor	C07 (male) (rear) C08 (male) (front)	Measure voltage	If the condition is as shown in the table below, it is normal Between (2) - (1): 18 - 28 V Between (3) - (1): All levers at neutral: 0.5 - 1.5 V; At arm IN relief: 3.1 - 4.5 V	1) Start engine. 2) Turn fuel control dial to MAX position 3) Insert T - adapter
	Swing lock switch	X05 (female)	Measure resistance	It the condition is as shown in the table below, it is normal Between (1) - (2) / Between (3) - (4): When switch is OFF: Min. 1 MΩ; When switch is ON: Max. 1 Ω	1) Turn starting switch OFF. 2) Disconnect connector C02
	TVC solenoid valve	C04 (male) C13 (male)	Measure resistance	If the condition is as shown in the table below, it is normal Between (1) - (2): 10 - 22 Ω Between (1), (2) - chassis: Min. 1 MΩ	1) Turn TVC prolix switch OFF. 2) Turn starting switch OFF. 3) Disconnect connectors C04, C13
	Swing holding brake solenoid valve	V04 (male)	Measure resistance	If the condition is within the range shown in the table below, it is normal Between (1) - (2): 20 -60 Ω Between (1), (2) - chassis: Min. 1 MΩ	1) Turn starting switch OFF. 2) Disconnect connector VO4
	Travel speed solenoid valve	V06 (male)	Measure resistance	If the condition is within the range shown in the table below, it is normal Between (1) - (2): 20 -60 Ω Between (1), (2) - chassis: Min. 1 MΩ	1) Turn starting switch OFF. 2) Disconnect connector V06
	LS select solenoid valve	V02 (male)	Measure resistance	If the condition is within the range shown in the table below, it is normal Between (1) - (2): 20 -60 Ω Between (1), (2) - chassis: Min. 1 MΩ	1) Turn starting switch OFF. 2) Disconnect connector V02.
	Pump merge/ divider solenoid valve	V03 (male)	Measure resistance	If the condition is within the range shown in the table below, it is normal Between (1) - (2): 20 -60 Ω Between (1), (2) - chassis: Min. 1 MΩ	1) Turn starting switch OFF. 2) Disconnect connector V03
	Machine 2-stage relief solenoid valve (governor, pump controller does not carry out control)	V05 (male)	Measure resistance	If the condition is within the range shown in the table below, it is normal Between (1) - (2): 20 -60 Ω Between (1), (2) - chassis: Min. 1 MΩ	1) Turn starting switch OFF. 2) Disconnect connector V05

System	Name of component		Connector No.	Inspection method	Judgement table	Measurement conditions
Control system	LS-EPC solenoid		C10 (male)	Measure resistance	If the condition is within the range shown in the table below, it is normal Between (1) - (2): 7 - 14 Ω Between (1), (2) - chassis: Min. 1 MΩ	1) Turn starting switch OFF. 2) Disconnect connector C10.
	Covernor, pump controller	Power source voltage	C01 C02	Measure voltage	If the condition is within the range shown in the table below, it is normal Between C01 (7), (13) - (6), (12): 20 - 30 V Between C02 (11), (21) - (6), (12): 20 - 30 V	1) Turn starting switch ON. 2) Insert T - adapter
		Fuel control dial	C03	Measure voltage	If the condition is as shown in the table below, it is normal Between (7) - (17) (power source): 4.75 - 5.25 V Between (4) - (17) (low idling): 4.0 - 4.75 V Between (4) - (17) (high idling): 0.25 - 1.0 V	1) Turn starting switch ON. 2) Insert T - adapter
		Governor potentiometer	C03	Measure voltage	If the condition is as shown in the table below, it is normal Between (14) - (17) (low idling): 2.9 - 3.3 V Between (14) - (17) (high idling): 0.5 - 0.9 V Between (7) - (17) (power source): 4.75 - 5.25 V	1) Turn starting switch ON. 2) Insert T - adapter
		Coolant temperature sensor	P07 (male)	Measure resistance	If the condition is as shown in the table below, it is normal Normal temperature (25°C): Aprrox. 37 - 50 kΩ 100°C: Aprrox. 3.5 - 4.0 kΩ	1) Turn starting switch OFF. 2) Disconnect connector P07 3) Insert T - adapter into connector at sensor end.
		Governor motor	C02	Measure voltage	If the condition is as shown in the table below, it is normal Between (2) - (3): 1.8 - 4.6 V Between (4) - (5): 1.8 - 4.6 V	1) Turn starting switch ON. 2) Insert T - adapter.
		Battery relay	C01	Measure voltage	If the condition is within the range shown in the table below, it is normal Between (1) - (6): 20 - 30 V ★This is only for 2.5 sec after the starting switch i operated ON → OFF; at other times it must be 0 V.	1) Turn starting switch ON. 2) Insert T - adapter.

System	Name of component	Connector No.	Inspection method	Judgement table	Measurement conditions
Control system — Governor, pump controller	Swing holding brake solenoid	C01	Measure voltage	If the condition is as shown in the table below, it is normal When either swing or work equipment control lever is operated (solenoid ON, swing holding brake canceled) — Between (3) - (6), (12) — 20 -30 V Approx. 5 sec after swing lever and work equipment control levers are placed at neutral (solenoid OFF, swing holding brake applied) — Between (3) - (6), (12) — 0 - 4 V	1) Start engine. 2) Turn swing lock switch OFF. 3) Turn swing lock prolix switch OFF. 4) Insert T - adapter. ★ The lever can be operated slightly (without moving the equipment).
	Travel speed solenoid	C01	Measure voltage	If the condition is as shown in the table below, it is normal With travel speed switch at Hi or Mi (solenoid ON, travel motor swash plate angle MIN) — Between (9) - (6), (12) — 20 -30 V When travel speed switch is at Lo (solenoid OFF travel motor swash plate angle MAX) — Between (9) - (6), (12) — 0 - 3 V	1) Start engine. 2) Insert T - adapter. 3) Turn fuel control dial to MAX position. 4) Operate the lever slightly not enough to move the machine. To check that the solenoid is OFF, measure with the fuel control dial at LOW (1200 rpm or below)
	LS select solenoid	C01	Measure voltage	If the condition is as shown in the table below, it is normal When swing lock switch is OFF, and swing + travel levers are operated simultaneously (solenoid ON, LS not divided) — Between (8) - (6), (12) — 20 -30 V When sing lock switch is ON (solenoid OFF, LS not divided) — Between (8) - (6), (12) — 0 - 3 V	1) Turn starting switch ON. 2) Isert T - adapter. ★ The lever can be operated slightly (without moving the equipment).
	Pump merge/ divider valve solenoid	C01	Measure voltage	If the condition is as shown in the table below, it is normal. When travel is operated independently (solenoid ON, divided) — Between (2) - (6), (12) — 20 -30 V When levers and pedals are at neutral (solenoid OFF, merged) — Between (2) - (6), (12) — 0 - 3 V	1) Turn starting switch ON. 2) Insert T - adapter. ★ The lever can be operated slightly (without moving the equipment).

<table>
<tr><th>System</th><th colspan="2">Name of component</th><th>Connector No.</th><th>Inspection method</th><th>Judgement table</th><th>Measurement conditions</th></tr>
<tr><td rowspan="7">Control system</td><td rowspan="7">Governor, pump controller</td><td>TVC solenoid valve (default value)</td><td>C02</td><td>Measure current</td><td>If the condition is as shown in the table below, it is normal
• H/O mode
<table><tr><td>Between front (8) - (18)</td><td rowspan="2">520 ± 80 mA</td></tr><tr><td>Between rear (9) - (19)</td></tr></table></td><td>1) Turn starting switch ON.
2) Turn fuel control dial to MAX positon
3) Turn prolix switch OFF.</td></tr>
<tr><td>LS-EPC solenoid valve (default value)</td><td>C02</td><td>Measure current</td><td>If the condition is as shown in the table below, it is normal
• H/O mode
<table><tr><td>Between (7) - (17)</td><td>900 ± 80 mA</td></tr></table></td><td>1) Turn starting switch ON.
2) Turn fuel control dial to MAX position
3) All levers at neutral.</td></tr>
<tr><td>L.H. knob switch</td><td>C03</td><td>Measure voltage</td><td>If the condition is as shown in the table below, it is normal
<table><tr><td>When switch is ON</td><td rowspan="2">Between (9) - GND</td><td>20 - 28 V</td></tr><tr><td>When switch is OFF</td><td>0 - 1 V</td></tr></table></td><td>1) Turn starting switch ON.
2) Insert T - adapter.</td></tr>
<tr><td>S-NET</td><td>C17</td><td>Measure voltage</td><td>If the condition is as shown in the table below, it is normal
<table><tr><td>Between (4), (12) - GND</td><td>4 - 8 V</td></tr></table></td><td>1) Turn starting switch ON.
2) Insert T - adapter</td></tr>
<tr><td>No. 2 throttle signal</td><td>Monitoring code 16</td><td>Engine speed</td><td>If the condition is as shown in the table below, it is normal
High idling (rpm)
<table><tr><td>H/O</td><td>Approx. 2150</td></tr><tr><td>G/O</td><td>Approx. 2000 (during operation)
Approx. 1900 (idling)</td></tr><tr><td>F/O</td><td>Approx. 1900</td></tr><tr><td>L/O</td><td>Approx. 1600</td></tr><tr><td>Power max. (H/O) (G/O)</td><td>Approx. 2150</td></tr><tr><td>Swift slow-down (H/O) (G/O)</td><td>Approx. 1600</td></tr></table></td><td>1) Start engine.
2) Set monitoring code to 10 or 16 (command value).
3) Operate working mode switch and L.H. knob switch.</td></tr>
<tr><td>Model selection</td><td>C17 - C02</td><td>Continuity</td><td>If the condition is as shown in the table below, it is normal
<table><tr><td>Between selection 1</td><td>C17 (5) - C02 (11)</td><td>No continuity</td></tr><tr><td>Between selection 2</td><td>C17 (13) - C02 (11)</td><td>Continuity</td></tr><tr><td>Between selection 3</td><td>C17 (6) - C02 (11)</td><td>Continuity</td></tr><tr><td>Between selection 4</td><td>C17 (14) - C02 (11)</td><td>No continuity</td></tr><tr><td>Between selection 5</td><td>C17 (7) - C02 (11)</td><td>No continuity</td></tr></table></td><td>1) Turn starting switch OFF.
2) Disconnect connector.
3) Connect T - adapter to wiring harness end.</td></tr>
</table>

System	Name of component	Connector No.	Inspection method	Judgement table	Measurement conditions
Monitor	Air cleaner clogging sensor	P11 (male) P12 (female)	Continuity	If the condition is as shown in the table below, it is normal Air cleaner normal — Between P11 - P12 — Continuity Air cleaner clogged — Between P11 - P12 — No continuity	1) Start engine. 2) Disconnect P11, P12. 3) Put tester in contact with connector at sensor end to measure.
	Engine speed sensor	E07	Measure resistance	If the condition is within the range shown in the table below, it is Between (1) - (2): 500 - 1000 Ω Between (2) - chassis: Min. 1 MΩ	1) Turn starting switch OFF. 3) Disconnect connector.
			Measure voltage	Measure with AC range Between (1) - (2): 0.5 - 3.0 V	1) Start engine. 2) Insert T - adapter.
			Adjust	1) Screw in rotation sensor until it contacts ring gear, then turn back 1 ± 1/6 turns 2) It must work normally when adjusted as above.	
	Coolant level sensor	P08 (male)	Measure resistance	If the condition is as shown in the table below, it is normal Above LOW level in sub-tank: Max. 1Ω Below LOW level in sub-tank: Min. 1MΩ	1) Turn starting switch OFF. 2) Disconnect connecter P08. 3) Insert T - adapter into connector at sensor end.
	Engine oil level sensor	P05 (male)	Measure resistance	If the condition is as shown in the table below, it is normal Submerged: Max. 1Ω Not submerged in oil: Min. 1MΩ	1) Turn starting switch OFF. 2) Disconnect connector P05 3) Drain oil, then remove sensor.
	Coolant temperature sensor	P07 (male)	Measure resistance	If the condition is as shown in the table below, it is normal Normal temperature (25°C): Approx. 70 - 78 kΩ 100°C: Approx. 3.4 - 3.8 kΩ	1) Turn starting switch OFF. 2) Disconnect connector P07. 3) Insert T - adapter into connector at sensor end.

<table>
<tr><th>System</th><th>Name of component</th><th>Connector No.</th><th>Inspection method</th><th>Judgement table</th><th>Measurement conditions</th></tr>
<tr><td rowspan="3">Monitor</td><td>Engine oil pressure sensor</td><td>-</td><td>Measure resistance</td><td>If the condition is as shown in the table below, it is normal.
Low pressure sensor
<table><tr><td>Pressure rising</td><td>Opens at 0.110 ± 0.014 MPa (Non continuity) (1.12 ± 0.14 kg/cm²)</td></tr><tr><td>Pressure dropping</td><td>Closes at 0.08 ± 0.014 MPa (Continuity) (0.85 ± 0.14 kg/cm²)</td></tr></table>Sensor connector
 
</td><td>1) Install oil pressure measuring gauge.
2) Remove wiring harness terminal.
3) Start engine.
4) Put tester in contact between sensor terminals A & C.</td></tr>
<tr><td>Fuel level sensor</td><td>P06 (male)</td><td>Measure resistance</td><td>If the condition is as shown in the table below, it is normal
<table><tr><td> 
BLP00004</td><td>Raise float to stopper</td><td>Approx. 12 Ω or below</td></tr><tr><td> 
BLP00005</td><td>Lower float to stopper</td><td>Approx. 85 - 110 Ω</td></tr></table></td><td>1) Turn starting switch OFF.
2) Disconnect connecter P06.
3) Drain fuel, then remove sensor.
4) Insert T - adapter into sensor.
★ Connect the T - adapter to the connector and sensor flange.</td></tr>
<tr><td>Hydraulic oil level sensor</td><td>P09 (male)</td><td>Measure resistance</td><td>If the condition is as shown in the table below, it is normal
<table><tr><td> 
BLP00002</td><td>Raise float</td><td>Approx. 12 Ω or below</td></tr><tr><td> 
BLP00003</td><td>Lower float</td><td>Approx. 85 - 110 Ω</td></tr></table></td><td>1) Turn starting switch OFF.
2) Disconnect connecter P09
3) Drain oil, then remove sensor.
4) Insert T - adapter into sensor.</td></tr>
</table>

<table>
<tr><th>Name of component</th><th>Connector No.</th><th>Inspection method</th><th>Judgement table</th><th>Measurement conditions</th></tr>
<tr><td>Alternator</td><td>Between alternator terminal R and chassis</td><td>Measure voltage</td><td>When engine is runnig (1/2 throttle or above) below, the sensor is defective.
→ 27.5 - 29.5 V
★ If the battery is old, or after starting in cold areas, the voltage may not rise for some time.</td><td>1) Start engine</td></tr>
<tr><td>Gauges</td><td colspan="3">
<table>
<tr><td></td><td>Position of gauge display</td><td>Display level resistance kΩ (Monitor panel input resistance)</td></tr>
<tr><td></td><td>Starting switch ON</td><td>Starting switch OFF</td></tr>
<tr><td>Measure resistance between coolant temperature gauge C03 (female) (1) - C03 (female) (16)</td><td>Right side
↑
Display position
↓
Left side</td><td>ALL OFF (15)
14
13
12
11
10
9
8
7
6
5
4
3
2
1</td><td>Min. - Max.
- 0.646
0.575 - 3.420
3.156 - 3.708
3.422 - 3.804
3.512 - 3.900
3.600 - 4.125
3.807 - 4.349
4.015 - 5.122
4.728 - 5.899
5.445 - 6.818
6.294 - 7.910
7.302 - 9.210
8.502 - 10.774
9.946 - 36.535
33.725 -</td></tr>
</table>
★ Levels 13 and 14 flasch</td><td>1) Insert a dummy resistance with the starting switch OFF, or measure the resistance of the sensor.
2) Check the display with the starting switch ON.</td></tr>
<tr><td></td><td colspan="3">
<table>
<tr><td></td><td>Position of gauge display</td><td>Display level resistance kΩ (Monitor panel input resistance)</td></tr>
<tr><td></td><td>Starting switch ON</td><td>Starting switch OFF</td></tr>
<tr><td>Measure resistance between fuel level gauge C03 (female) (2) - chassis</td><td>Right side
↑
Display position
↓
Left side</td><td>14
13
12
11
10
9
8
7
6
5
4
3
2
1
ALL OFF (0)</td><td>Min. - Max.
- 13.82
11.71 - 17.43
15.18 - 21.25
18.90 - 25.05
22.59 - 28.45
25.82 - 31.85
29.18 - 35.22
32.45 - 39.91
37.00 - 44.60
41.77 - 48.72
45.52 - 55.14
50.42 - 64.35
60.61 - 77.07
72.98 - 69.15
638.00 - 69.15</td></tr>
</table>
★ Level 1 flashes.</td><td>1) Insert a dummy resistance with the starting OFF, or measure the resistance of the sensor.
2) Check the display with the starting switch ON.</td></tr>
</table>

TOOLS FOR TESTING, ADJUSTING, AND TROUBLESHOOTING

Check or measurement item	Symbol		Part No.	Part Name	Remarks
			CU ST-1293	Gauge	Belt tensioner gauge-alternator
			CU ST-1138	Gauge	Belt tensioner gauge-fan belt
Coolant and oil temperatures	B		799-101-1502	Digital temperature gauge	-50 -1,200°C
Oil pressure	C	1	799-1010-5002	Hydraulic tester	Pressure gauge 2.5, 5.9, 39.2, 58.8 MPa (25, 60, 400, 600 kg/cm²)
			790-261-1203	Digital hydraulic tester	Pressure gauge 71.4 MPa (700 kg/cm²)
		2	795-790-1100	Hydraulic gauge	
		3	• 790-261-1311	Adapter	Both male and female 14 x 1.5 (female PT 1/8)
			• 790-261-1321		Both male and female 18 x 1.5 (female PT 1/8)
			• 790-261-1331		Both male and female) 22 x 1.5 (female PT 1/8)
		4	799-401-2700	Differential pressure gauge	
		5	790-261-1370	Nut	For 14 x 1.5 blind
			07003-31419	Gasket	For blind
			07040-11409	Plug	For 14 x 1.5 blind
Compression pressure	D	1	795-502-1590	Compression gauge	0 - 6.9 MPa (0 - 70 kg/cm²)
		2	795-502-1360	Adapter	Kit Part No.: 795-502-1205
Blowby pressure	E	1	CU 3822566	Blow-by adapter	0 - 500 mmH_20
	E	2	795-790-1610	MANOMETER	
Injector timing	-		CU 3823451	Timing tool	
Pushrod alignment	-		CU 3376180	Alignment tool	
Air supply pressure (boost pressure)	F		795-790-1470	Pressure gauge	1,500 mmHg
Valve clearance	G		Commercially available	Feeler gauge	
Exhaust color	H	1	799-201-9000	Handy Smoke Checker	Discoloration 0 - 70% (with standard color)
		2	Commercially available	Smoke meter	Discoloration % x 1/10 = Bosch index)
Operating effort	J		79A-264-0020	Push-pull scale	0 - 294N (30 kg)
			79A-264-0090		0 - 490N (50 kg)
Stroke, hydraulic drift	K		Commercially available	Scale	
Work equipment speed	L		Commercially available	Stop watch	
Measuring voltage and resistance values	M		79A-264-0210	Tester	
Troubleshooting of wiring harnesses and sensors	N	1	7996017100	T-adapter box	
		2	799-601-7070	Adapter	For SWP 14P
			799-601-7360		For relay 5P

MEASURING EXHAUST COLOR

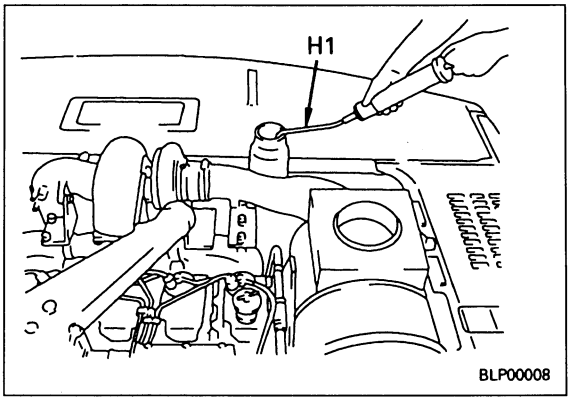
- When measuring in the field when there is no air or power supply, use handy smoker checker **H1**; when recording official data, use smoke meter **H2**.

★ Raise the coolant temperature to the operating range before measuring.

⚠ When removing or installing the measuring equipment, be careful not to touch any high temperature part.

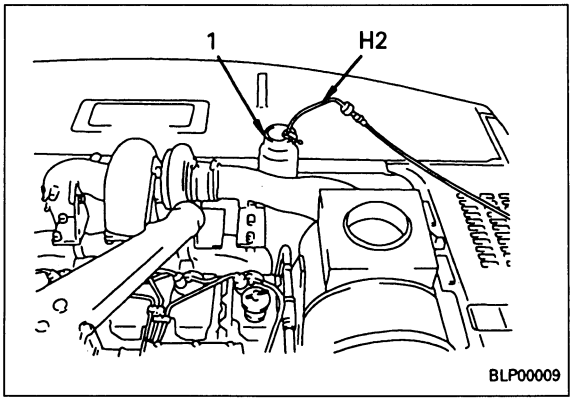
1. Measuring with handy smoke checker H1

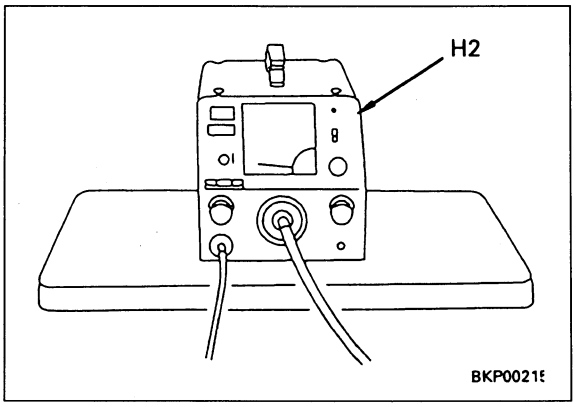
1) Fit filter paper in tool **H1**.
2) Insert the exhaust gas intake port into the exhaust pipe, accelerate the engine suddenly, and at the same time operate the handle of tool **H1** to catch the exhaust gas on the filter paper.
3) Remove the filter paper and compare it with the scale provided to judge the condition.



2. Measuring with smoke meter H2

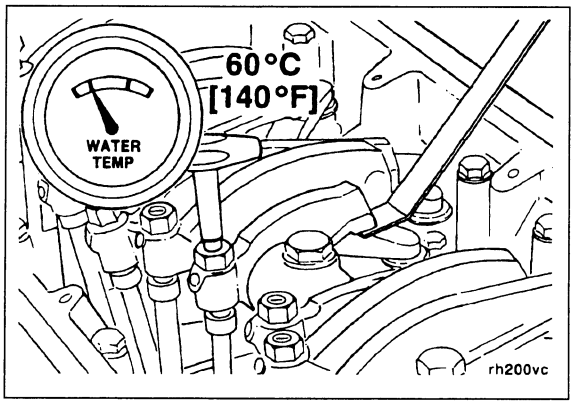
1) Insert the probe of tool **H2** into the outlet port of exhaust pipe (1), then tighten the clip to secure it to the exhaust pipe.
2) Connect the probe hose, accelerator switch plug, and air hose to tool **H2**.
   ★ The pressure of the air supply should be less than 1.5 MPa (15 kg/cm^2).
3) Connect the power cord to the AC100V outlet.
   ★ When connecting the port, check first that the power switch of tool **H2** is OFF.
4) Loosen the cap nut of the suction pump, then fit the filter paper.
   ★ Fit the filter paper securely so that the exhaust gas does not leak.
5) Turn the power switch of tool **H2** ON.
6) Accelerate the engine suddenly, and at the same time, depress the accelerator pedal of tool **H2** and catch the exhaust gas color on the filer paper.
7) Lay the filter paper used to catch the exhaust gas color on top of unused filter papers (10 sheets or more) inside the filter paper holder, and read the indicated value.





VALVES AND INJECTORS

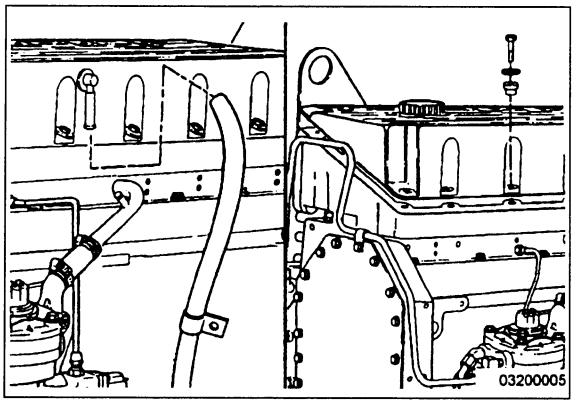
Injector Adjustment



Valves and injectors **must** be correctly adjusted for the engine to operate efficiently. Valve and injector adjustment **must** be performed using the values listed in this section. The accompanying table gives the adjustment mimits for STC engines.

Adjust the valves and the injectors at each 1,500 hour maintenance interval. If the valves and injectors have been adjusted during troubleshooting or before the 1,500 hour scheduled maintenance interval, adjustment is **not** required at this time.

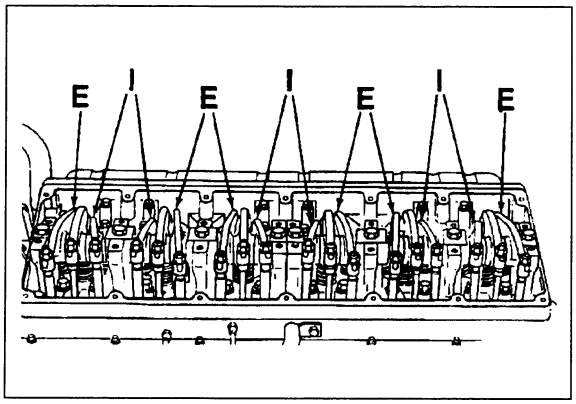
All overhead, valve and injector, adjustments **must** be made when the engine is cold, any stabilized coolant temperature at 60°C [140°F] or below.



Remove the crankcase breather tube from the crankcase breather outlet.

Remove the 16 capscrews, isolators, and spacers from the cover.

Remove the rocker lever cover and gasket.



Each cylinder has three rocker levers:

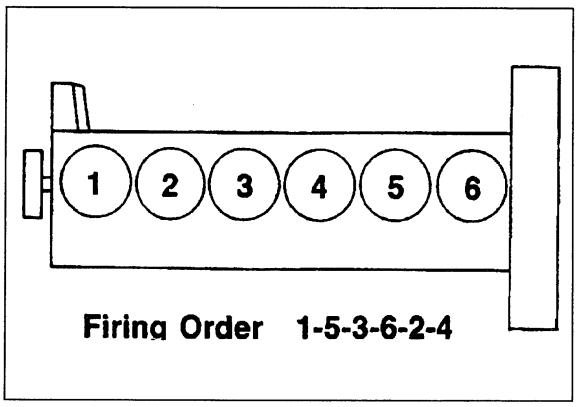
- The long rocker lever (E) is the exhaust lever.
- The center rocker lever is the injector lever.
- The short rocker lever (I) in the intake lever.

Refer to the accompanying chart for valve rocker lever locations.

The crankshaft rotation is **clockwise** when viewed from the front of the engine.

The cylinders are numberd from the front gear housing end of the engine.

The engine firing order is 1-5-3-6-2-4



The valves and injectors on the same cylinders are **not** adjusted at the same index mark on the accessory drive pulley on STC engines.

One pair of valves and one injector are adjusted at each pully index mark **before** rotating the accessory drive to the next index mark.

Two crankshaft revolutions are required to adjust all the valves and injectors.

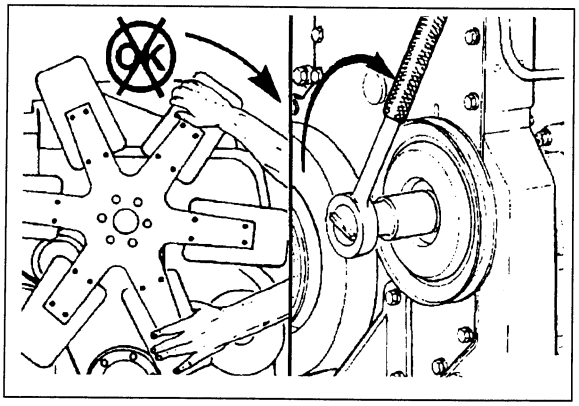
STC
Injector and Valve Measurement Sequence

Bar Engine in Direction of Rotation	Pulley Position	Set Cylinder	
		Injector	Valve
Start	A	3	5
Advance to	B	6	3
Advance to	C	2	6
Advance to	A	4	2
Advance to	B	1	4
Advance to	C	5	1

Firing Order: 1-5-3-6-2-4

⚠ WARNING ⚠

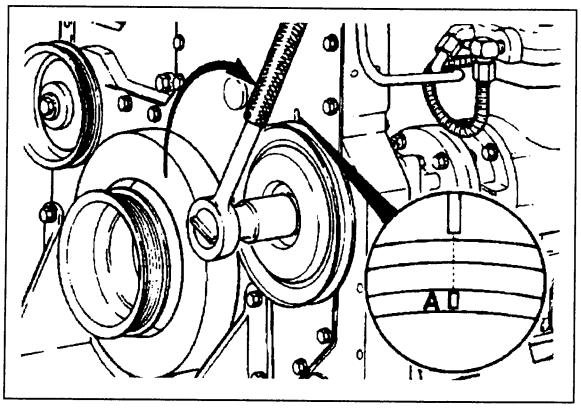
Do not pull or pry on the fan to manually rotate the cranshaft. To do so can damage the fan blades. Damaged fan blades can cause premature fan failures which can result in serious personal injury or property damage.



The valve set marks are located on the accessory drive pulley. The marks align with a pointer on the gear cover.

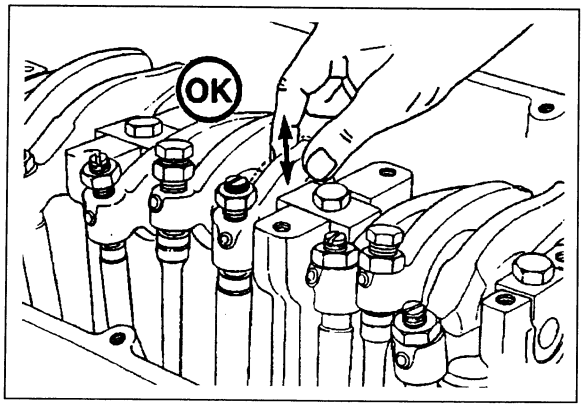
Use the accessory drive shaft to rotate the crankshaft.

The adjustment can begin on any valve set mark. In the following example the adjustment will begin on the "A" valve set mark with cylinder number five valves closed and cylinder number three injector ready for adjustment.



Rotate the accessory drive **clockwise** until the "A" valve set mark on the accessory drive pulley is aligned with the pointer on the cover.

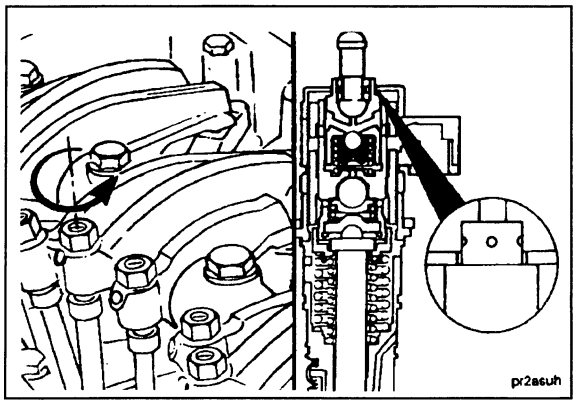
When the "A" mark is aligned with the pointer, the intake and exhaust valves for cylinder number five **must** be closed. If these conditions ar **not** correct, cylinder number four injector and cylinder number two valves **must** be ready to set.



Both valves are closed when both rocker levers are loose and can be moved from side to side.

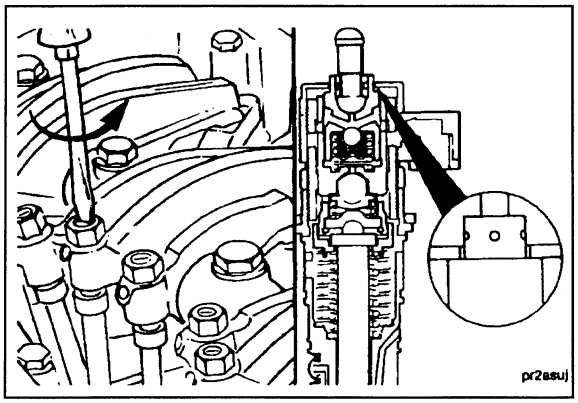
Loosen the injector adjusting screw locknut on cylinder number three. Tighten the adjusting screw until all the clearance is removed from the injector train.

Tighten the adjusting screw one additional turn to correctly seat the link.

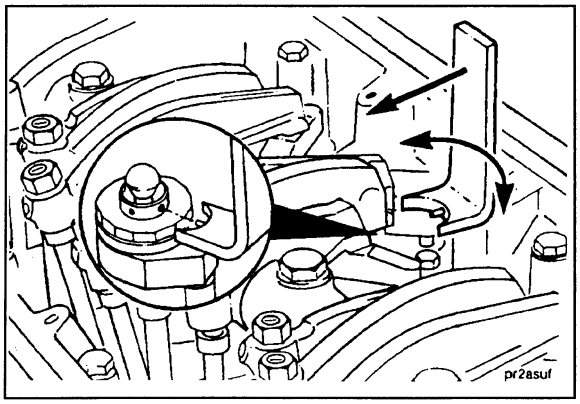


Loosen the injector adjusting screw until the STC tappet touches the top-cap of the injector.

Be sure to loosen the adjusting screw enough, so there is no pre load on the injector. This will be accomplished when the rocker lever is loose enough to move.

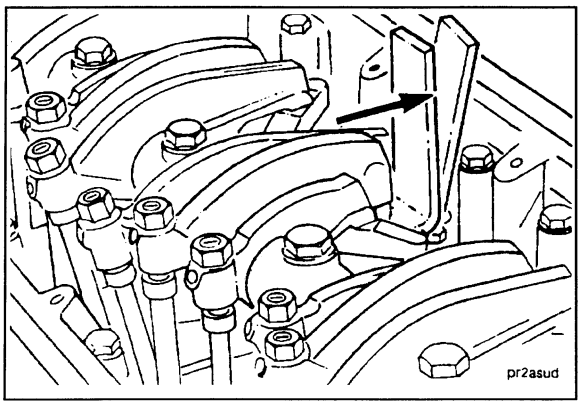


Place the STC tappet adjusting tool, Part No.3823348, on the upper surface of the STC injector top-cap. Rotate the tool around the tappet until the tool's locating pin inserted into one of the four holes in the top of the tappet.



Apply thumb pressure to the tool handle to hold the tappet in the maximum upward position.

NOTE: Apply only enough force to the tool to hold the tappet in the maximum upward position. Excess force will cause the tool to break.

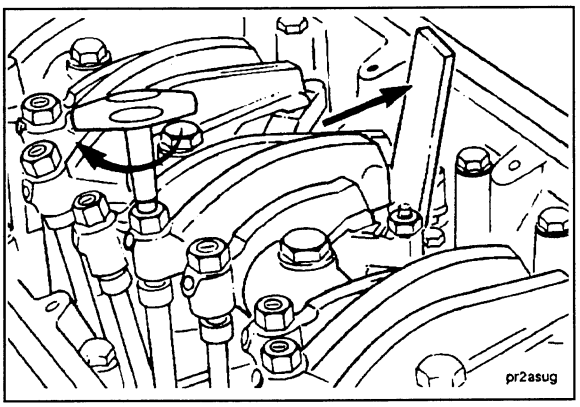


⚠ CAUTION ⚠

An overtightened setting on the injector adjusting screw will produce increased stress on the injector train and the camshaft injector lobe which can result in engine damage.

Use torque wrench, Part No.3376592, to tighten the adjusting screw while holding the tappet in the maximum upward position.

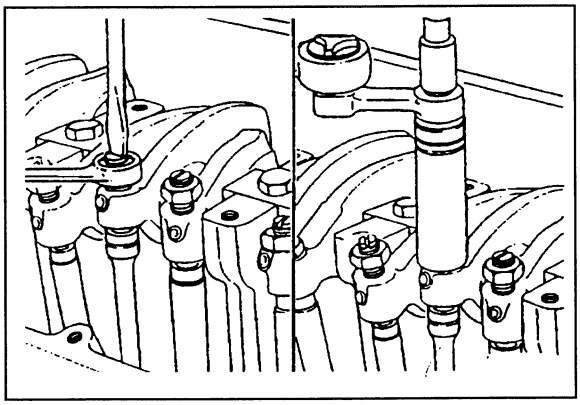
Torque Value: 0.6 to 0.7 N•m [5 to 6 in-lb]



Hold the adjusting screw in this position. The adjusting screw **must not** turn when the locknut is tightened.

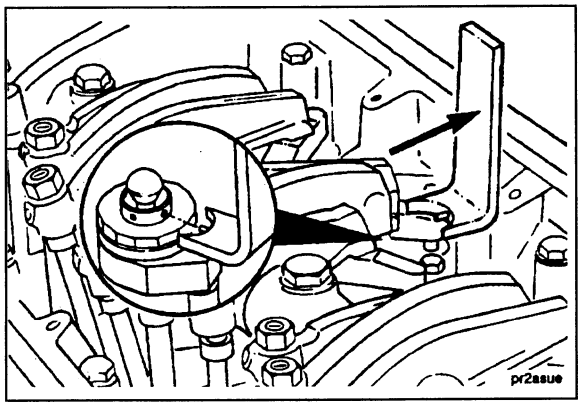
Torque Value:

- **Without** Torque Wrench Adapter: 61 N•m [45ft-lb]
- **With** Torque Wrench Adapter (1): 47 N•m [35 ft-lb]



The tappet tool **must** be removed before rotating the crankshaft to prevent damage to the tappet. Remove the tappet adjusting tool.

Check to make sure the injector push rod can be rotated by hand. If it can't, the setting is too tight.



VALVE ADJUSTMENT

Adjust the valves on the appropriate cylinder according to the sequence chart before rotating the accessory drive to the next valve set mark.

STC
Injector and Valve Adjustment Sequence

Bar Engine in Direction of Rotation	Pulley Position	Set Cylinder	
		Injector	Valve
Start	A	3	5
Advance to	B	6	3
Advance to	C	2	6
Advance to	A	4	2
Advance to	B	1	4
Advance to	C	5	1

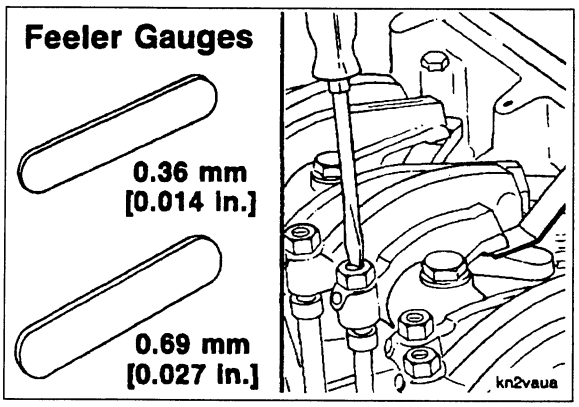
Firing Order: 1-5-3-6-2-4

oi200vl

Select a feeler gauge for the correct valve lash specification.

Valve Lash Specification		
	mm	in
Intake	0.36	0.014
Exhaust	0.69	0.027

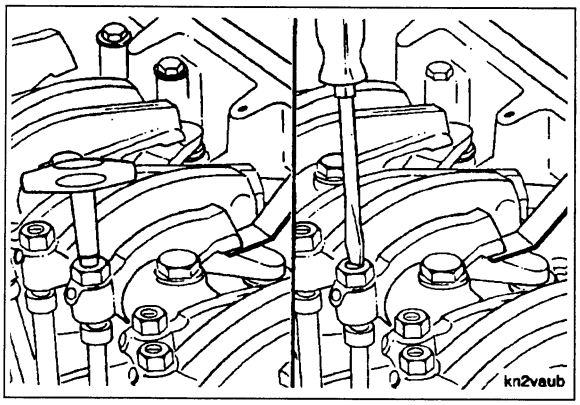
Insert the feeler gauge between the top of the crosshead and the rocker lever pad.



Two different methods for establishing valve lash clearance are described below. Either method can be used; however, the torque wrench method has proven to be the most consistent. It eliminates the need to feel the drag on the feeler gauge.

- **Torque Wrench Method:** Use the inch pound torque wrench. Part No.3376592, (normally used to set preload on top stop injectors), and tighten the adjusting screw.

Torque Value: 0.7 N•m [6 9n-lb]

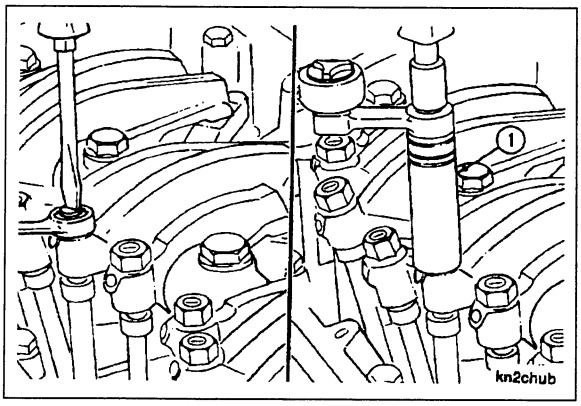


- **Toch Method:** Tighten the adjusting screw until a light drag is felt on the feeler gauge.

Hold the adjusting screw in this position. The adjusting screw **must not** turn when the locknut is tightened. Tighten the locknut.

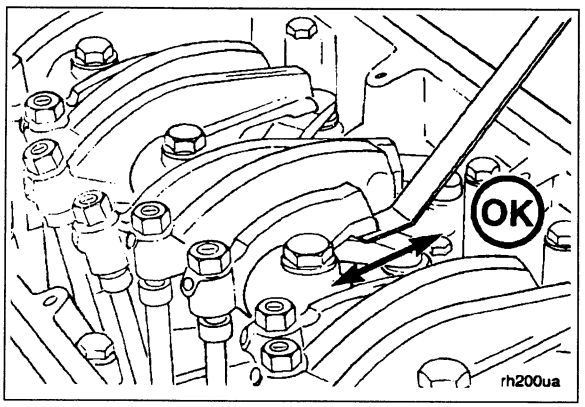
Torque Value:

- **Without** Torque Wrench Adapter: 61 N•m [45 ft-lb]
- **With** Torque Wrench Adaper (1): 47 N•m [35 ft-lb]

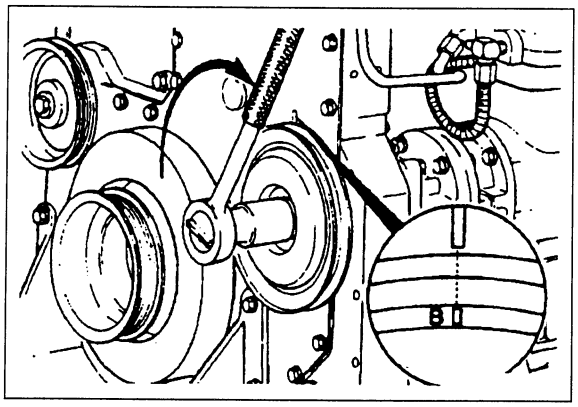


After tightening the locknut to the correct torque value, check to make sure the feeler gauge will slide backward and forward between the crosshead and the rocker lever with only a slight drag.

If using the touch method, attempt to insert a feeler gauge that is 0.03 mm [0.001 inch] thicker between the crosshead and the rocker lever pad. The valve lash is **not** correct when a thicker feeler gauge will fit.



After adjusting the injector and valves on the appropriate cylinder, rotate the accessory drive pulley and align the next valve set mark with the pointer on the gear cover.



Adjust the appropriate injector and valves following the Injector and Valve Adjustment Sequence Chart. Repeat the process to adjust all injectors and valves.

After adjusting all the injectors and valves, check the torque on the adjusting screw locknuts to make sure none were overlooked.

STC
Injector and Valve Adjustment Sequence

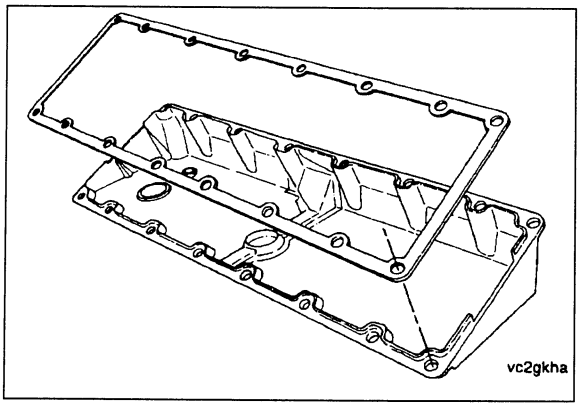
Bar Engine in Direction of Rotation	Pulley Position	Set Cylinder	
		Injector	Valve
Start	A	3	5
Advance to	B	6	3
Advance to	C	2	6
Advance to	A	4	2
Advance to	B	1	4
Advance to	C	5	1

Firing Order: 1-5-3-6-2-4

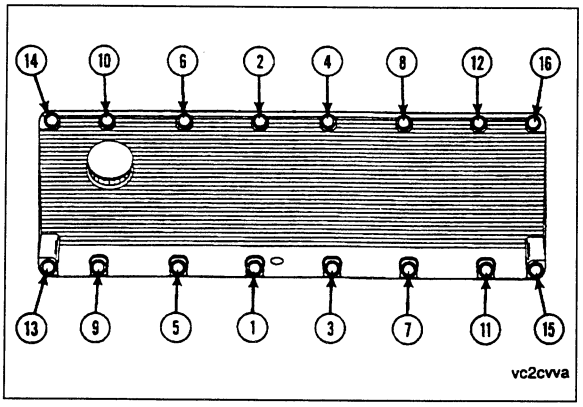
oi200vl

If the valve cover gasket was **not** damaged, it can be used again. If the gasket was damaged, it **must** be discarded and a new one used.

Install the gasket on the cover.



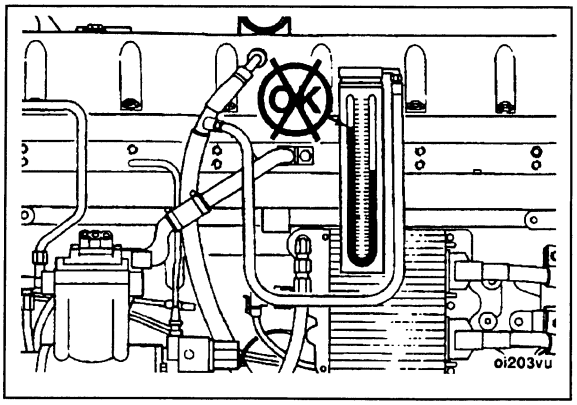
Install the cover on the rocker lever housing.
Install the 16 isolators, spacers and capscrews in the
cover.
Tighten the capscrews in the sequence shown.
Torque Value: 15 N•m [130 in-lb]



MEASURING BLOW-BY PRESSURE

Engine blowby
Install the Engine Blowby Tool, to the breather on the rocker lever cover to measure engine crankcase pressure.

NOTE: A pressure gauge can be used to record the engine blowby.



Blowby specifications

New, rebuilt engines*	30.5 cm HO [12.0 in H20]
Used engines**	46.0 cm H20 [18.0 in H20]

* Less than 160,000 km [100,000 miles] or 3600 hours.

** Over 160,000 km [100,000 miles] or 3600 hours. [1]

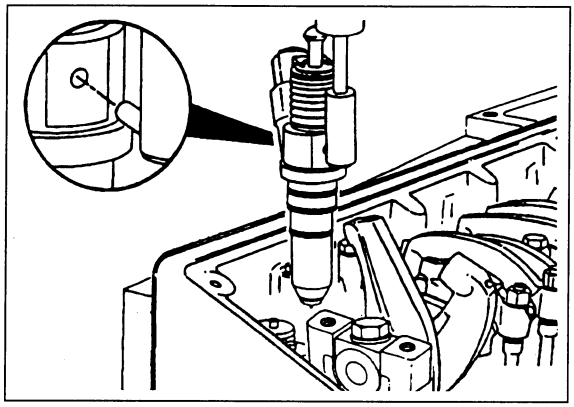
TESTING AND ADJUSTING FUEL INJECTION TIMING

Timing tool installation

Remove the rocker lever cover.

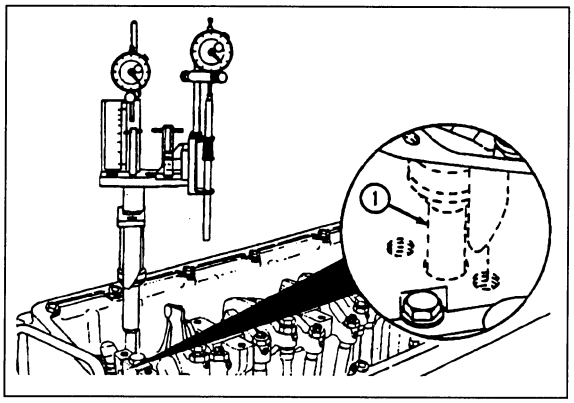
Remove the injector from cylinder No. 1.

NOTE: It is **not** necessary to remove all injectors; however, engine rotation will be easier with all injectors removed.



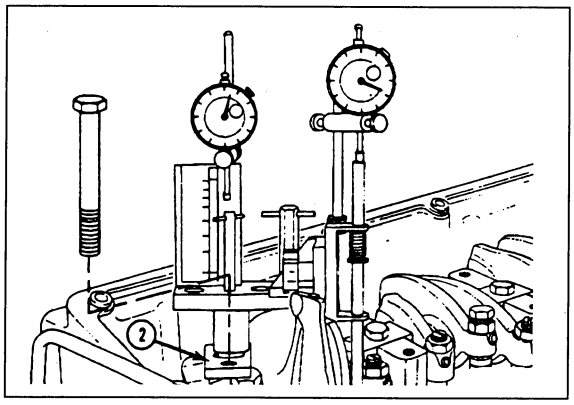
The timing tool, Part No. 3823451, can be installed without removing the rocker housing.

Install the piston plunger rod (1) in the injector bore of the number one cylinder.



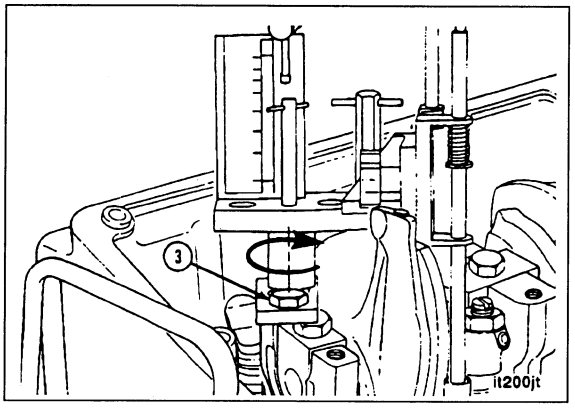
Align the swivel bracket (2) with the injector hold down capscrew hole.

Install capscrew, Part No. 3823600, through the swivel bracket. The capscrew is included with timing tool kit.

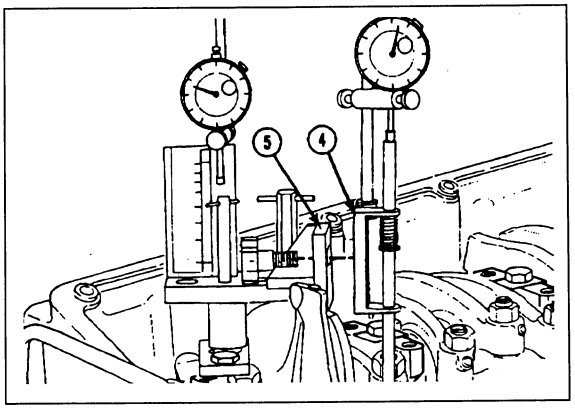


Caution: Do not tighten the capscrew too tight. The capscrew can be damaged.

Tighten the capscrew (3) enough to hold the timing fixture rigid.

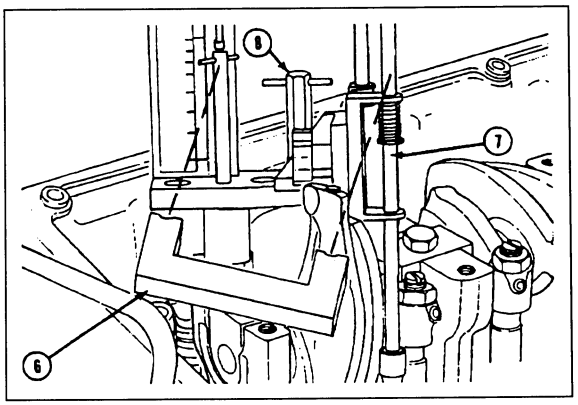


Position the timing tool push tube plunger bracket (4) on the back side of the center bracket (5).



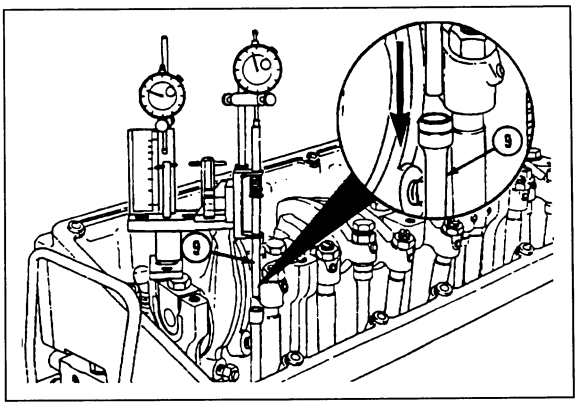
Use the alignment tool (6), Part No. 3376180, to align the push rod plunger rod (7).

Be sure to tighten the clamp handle (8) after the plunger rod is aligned, and remove the alignment tool.



Install the injector push rod (9) between the injector camshaft follower and the plunger rod.

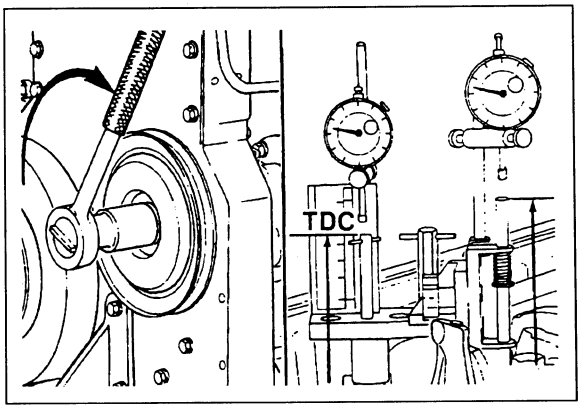
The push rod (9) **must** be vertically aligned with the plunger rod. If it is **not**, incorrect timing values will result.
Be careful **not** to drop the push rod into the engine.



△ **Caution: Use the accessory drive shaft to rotate the crankshaft. If another method is used, the injection timing will not be correct, or the engine can be damaged.**

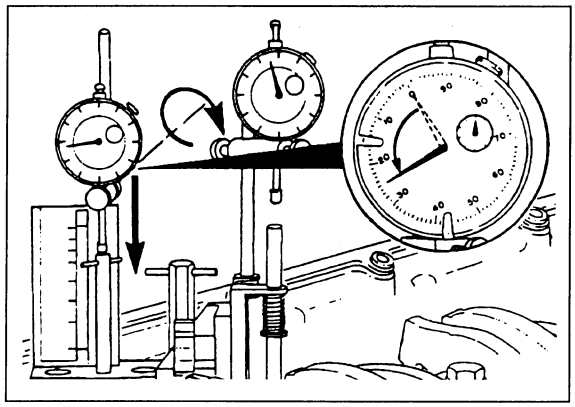
Determine the piston top dead center (TDC) on the compression stroke by rotating the accessory drive shaft **clockwise**.

The piston is on the compression stroke when both plungers move in an upward direction at the same time. TDC is indicated by the maximum **clockwise** indicator position of the piston travel indicator pointer.

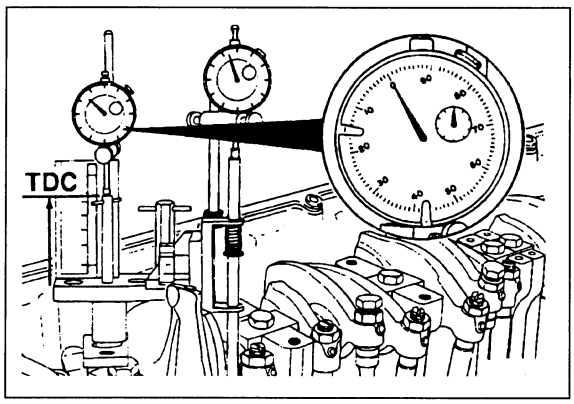


Caution: Both indicators must have a travel range of at least 6.35 mm [0.250 inch], or the indicators will be damaged.

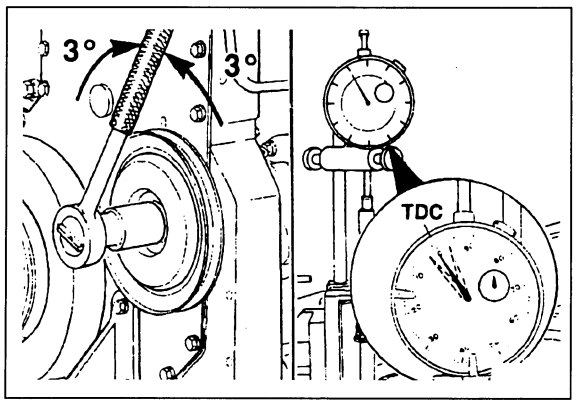
Position the gauge contact tip in the center of the plunger rod and lower the gauge to within 0.63 mm [0.025 inch] of the fully compressed position.



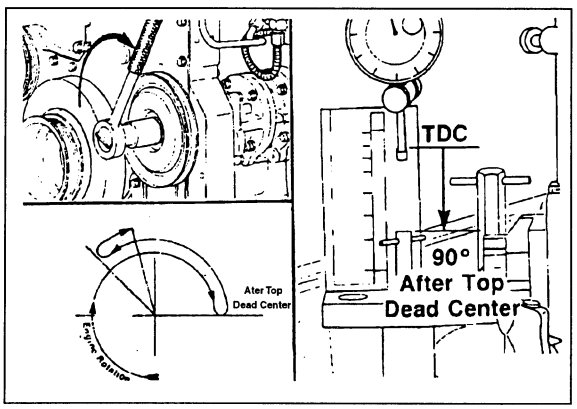
Set the dial indicator over the piston plunger rod to zero "0" when the piston plunger rod has reached maximum upward movement (TDC)



Rotate the accessory drive shaft back and forth, before and after the zero "0" indicator reading, for approximately 3 degrees to be sure the piston is at TDC.



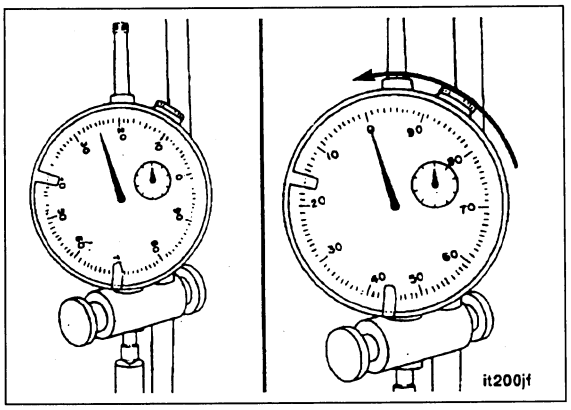
Rotate the accessory drive shaft **clockwise** to 90 degrees after top dead center (ATDC).
The piston plunger will be at the 'L10 90 degree' mark on the timing fixture.



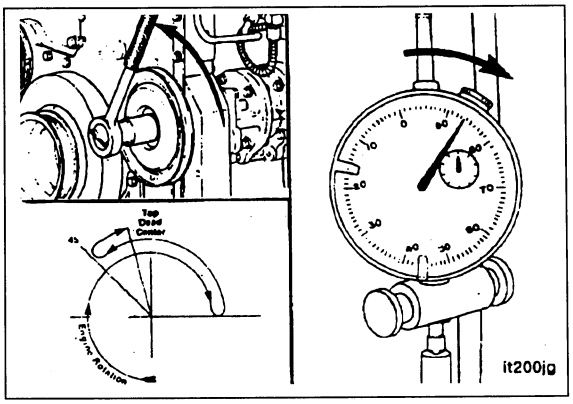
Position the push rod dial indicator contact tip in the center of the plunger rod and lower the gauge to with in 0.63 mm [0.025 inch] of the fully compressed position.

Set the push rod dial indicator to zero "0".

Rotate the accessory drive shaft **counterclockwise** to TDC.

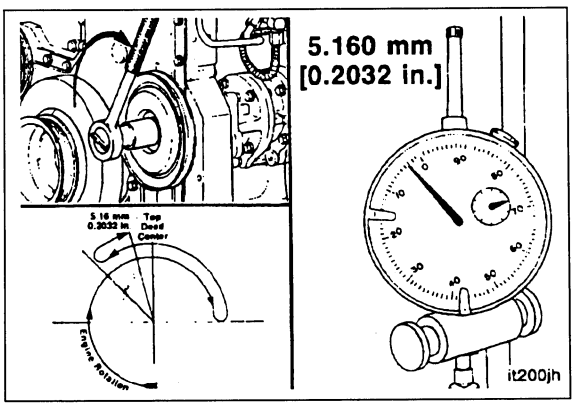


Continue to rotate the accessory drive shaft **counterclockwise** until the crankshaft is at 45 degrees before top dead center (BTDC). This step is necessary to remove gear backlash in the engine.



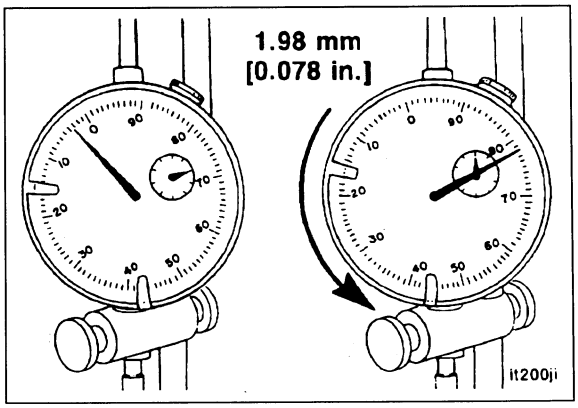
Rotate the accessory drive shaft **clockwise** slowly until the piston travel gauge is at 5.160 mm [0.2032 inch] BTDC.

If the crankshaft is rotated beyond the 5.160 mm [0.2032 inch] BTBC position, the crankshaft **must** be rotated **counterclockwise** back to the 45 degrees BTDC mark.



Read the push rod travel gauge **counterclockwise** from zero "0". This travel represents the injection timing value. In the example shown, the value is 1.98 mm [0.078 inch].

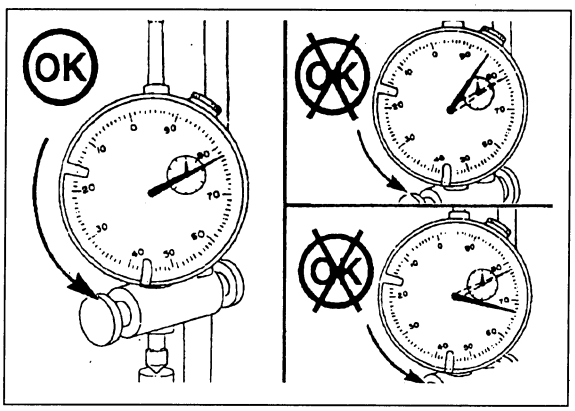
Injection timing for the PC450-6k engine is 335 mm [0.132 inch] to 3.45 mm [0.135 inch] BTDC.



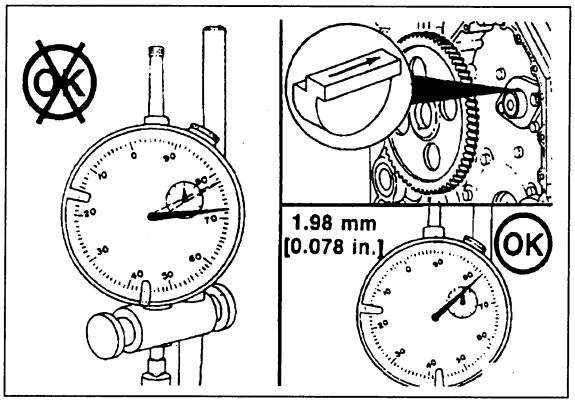
If the indicator reading is lower than the specification, the timing is advanced.

If the indicator reading is higher than the specification, the timing is retarded.

NOTE: The push rod **must** be vertically aligned with the plunger, or incorrect timing values will result. Repeat the procedure if in doubt.



Injection timing can be changed by removing the camshaft gear and installing an offset key.



The accompanying table lists offset keys by part number and degree of offset.

Never advance injection timing beyond the specification limits. The engine durability will be affected.

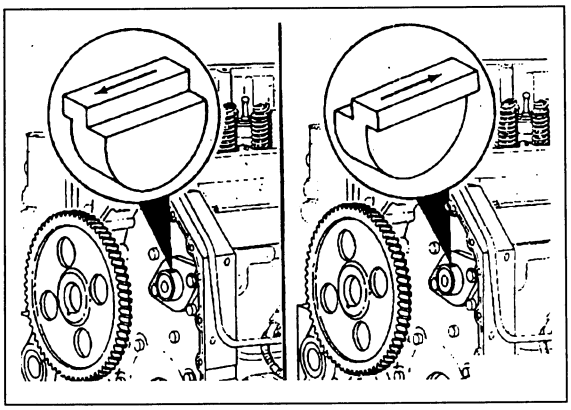
Camshaft Keys

	Degree of offset	Change in push rod travel	
Key part no.	(To the camshaft)	mm	In.
CU3009953	0.00	0.000	0.0000
CU3030893	0.25	0.051	0.0020
CU3009948	0.50	0.102	0.0040
CU3030894	0.75	0.152	0.0060
CU3009949	1.00	0.203	0.0080
CU2020895	1.25	0.254	0.0100
CU3009950	1.50	0.305	0.0120
CU3030896	1.75	0.356	0.0140
CU3009951	2.00	0.406	0.0160
CU3030897	2.25	0.457	0.0180
CU3030898	2.50	0.508	0.0200

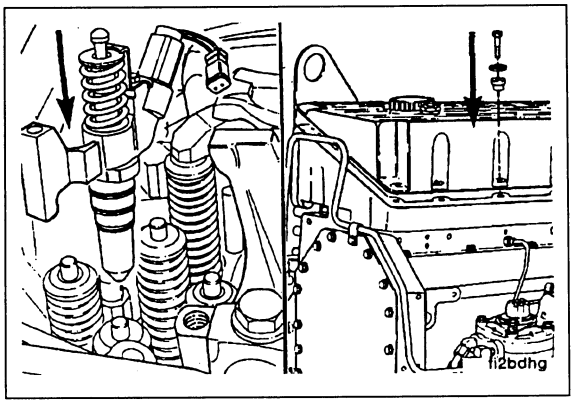
If the arrow on the key is pointing towards the engine, the timing is retarded.

If the arrow is pointing away from the engine, the timing is advanced.

After installing a new timing key, always recheck the timing to be sure the timing is within the specifications.



Install the injector(s)
Install the rocker lever cover.

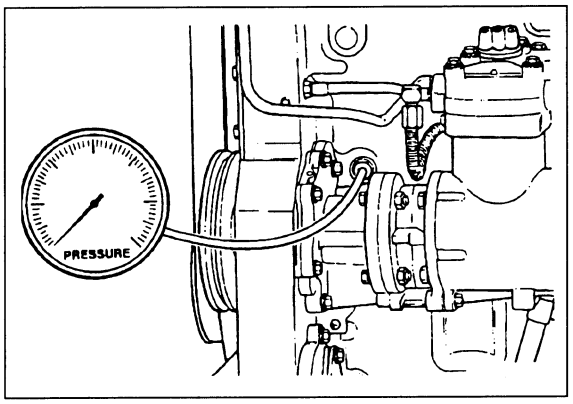


MEASURING ENGINE OIL PRESSURE

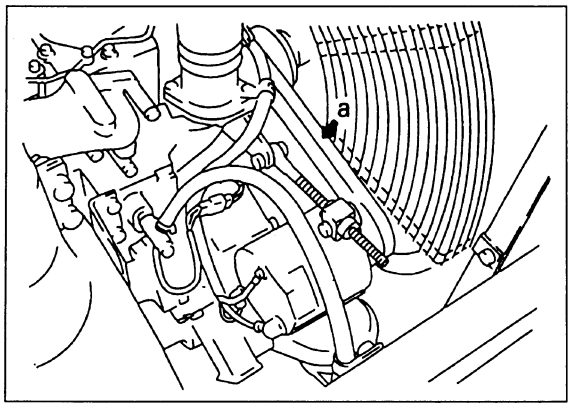
★ Measure the engine oil pressure under the following conditions.
- Coolant temperature: Within operating range

1. Remove engine oil pressure sensor (1) then install the adapter and oil pressure gauge C2 (1.0 MPa (10 kg/cm^2)).

2. Start the engine, and measure the oil pressure with the engine at low idling and at high idling.

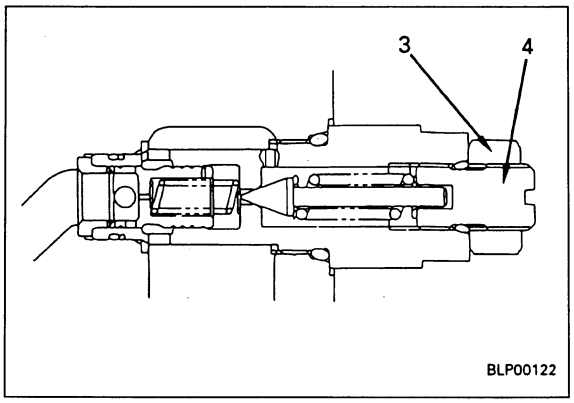


TESTING AND ADJUSTING FAN BELT TENSION



1. **Testing belt tension**
   Measure the deflection of the belt when it is pushed with a finger force (approx. 59.2 N (6 kg)) at point **a** midway between the fan pulley and the alternator pulley.
   ★ Deflection of V-belt: 6 - 10 mm

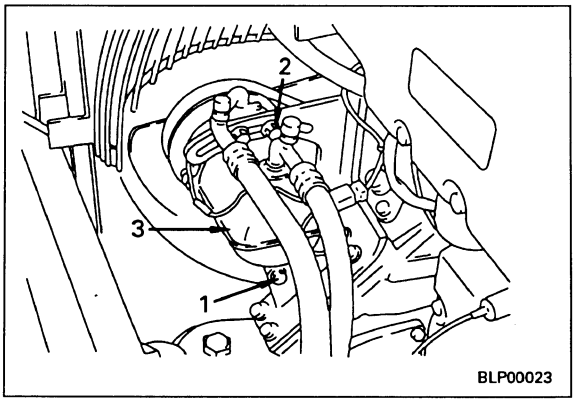
2. **Adjusting belt**
   1) Loosen alternator mount bolt (1), then loosen mounting bolt and nut (3) of adjustment screw (2).
   2) Loosen locknut (4), then turn adjustment nut (5) to adjust the tension of the belt.
   3) After adjusting the belt tension to the standard value with adjustment nut (5), tighten locknut (4), then tighten mounting bolt and nut (3) of adjustment screw (2) and alternator mount bolt (1).

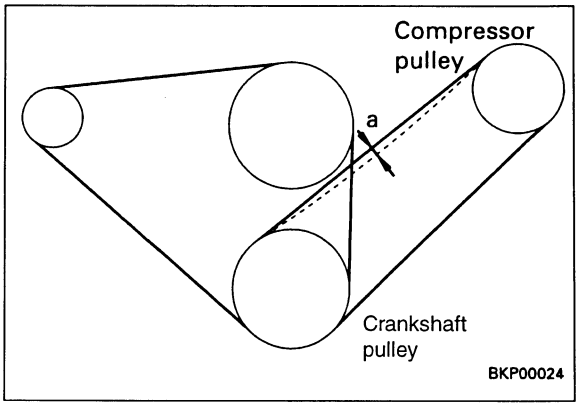


TESTING AND ADJUSTING BELT TENSION FOR AIR CONDITIONER COMPRESSOR

★ If the deflection of the belt when it is pressed at a point **a** midway between the drive pulley and the compressor pulley is not within the standard value, or when carrying out maintenance after replacing the belt, adjust the belt tension as follows.

1. Loosen mount bolt (1) and adjustment plate bolt (2).
2. Move the position of compressor (3) to adjust the tension of the belt.
3. When the position of the compressor is fixed, tighten adjustment plate bolt (2) and mounts bolts (1) to secure in position.
4. After adjusting the belt tension, repeat the above procedure to check that deflection **a** is within the standard value.
   • Deflection **a** of V-belt; 15 - 18 mm

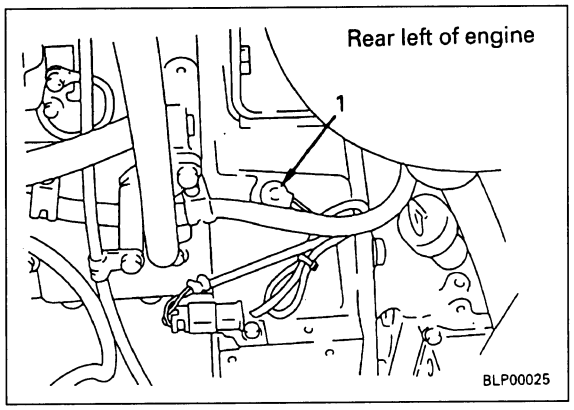


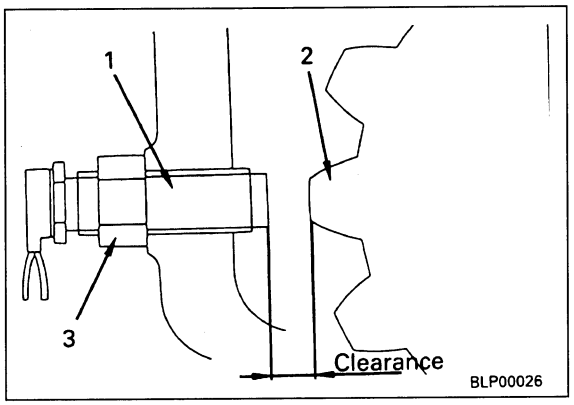


ADJUSTING ENGINE SPEED SENSOR

1. Screw in until the tip of sensor (1) contacts gear (2).
2. When gear (2) contacts sensor (1), turn back 1 ± 1/6 turns.
3. Tighten locknut (3).
   kgm Locknut: **58.8 ± 9.8 Nm (6 ± 1 kgm)**

★ Be particularly careful when handling the sensor wiring to ensure that no excessive force is brought to bear on the wiring.
★ Be careful not to let the tip of the sensor be scratched or to let any iron particles stick to the sensor tip.





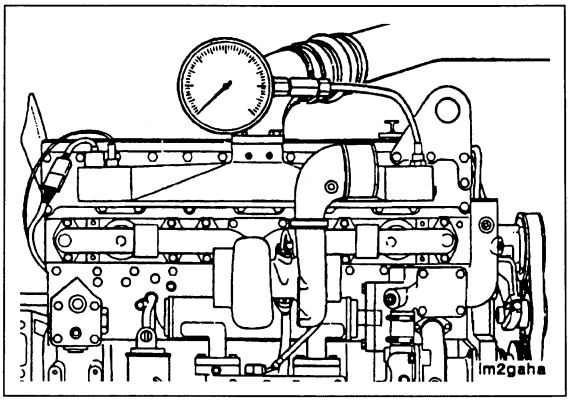
MEASURING AIR SUPPLY PRESSURE (BOOST PRESSURE)

⚠ When removing or installing the measuring equipment or when carrying out the measurements, be careful not to touch any high temperature parts or rotating parts.

1. Remove air supply pressure measurement plug (1) (PT 1/8), then install the pressure gauge **F**.

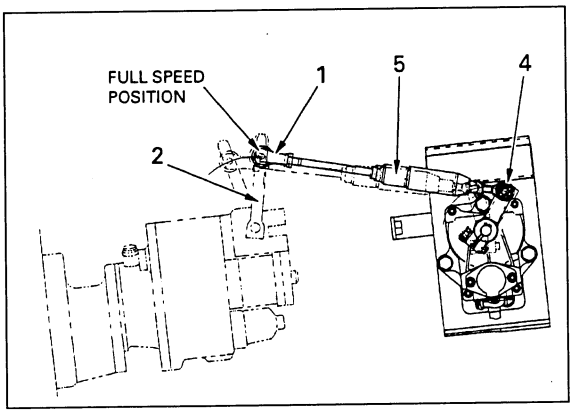
   Note: Run the engine at a mid-range speed or above, and use the self-seal portion of the gauge to bleed the oil from inside the hose.
   - Insert the gauge about half way, and repeatedly open the self-seal portion to bleed the oil.
   - ★ The gauge does not work if there is any oil inside the hose, so always be sure to bleed all the oil.

2. Run the engine at near the rated speed and measure the pressure indicated by the gauge.
   - ★ Near rated output
   - Run the engine at near the rated output. For details, see the measurement of the engine speed when the arm IN circuit is relieved in the H/O mode and power max. mode.



★ The air supply pressure (boost pressure) should be measured with the engine running at rated output. However, when measuring in the field, a similar value can be obtained with the above conditions.

TESTING AND ADJUSTING GOVERNOR MOTOR LEVER STROKE



Testing

★ Use the governor motor adjustment mode.

1. Preparatory work
   1) Keep the monitor panel time switch + travel speed (R.H.) switch + working mode (R.H.) switch pressed for 2.5 seconds.
   2) Set the fuel control dial to MAX, and the auto-deceleration switch to OFF.
      ★ Any working mode can be used.
2. In this condition, check the governor lever and spring rod.
3. After checking, repeat the procedure in Step 1 to complete the governor motor adjustment mode.

Adjusting

1. Turn the starting switch OFF, then remove the nut and disconnect joint (1) from governor lever (2).
2. Repeat the procedure in Step 1 above to set to governor motor adjustment mode.
3. Set governor lever (2) to a position where it contacts full speed stopper of the fuel injection pump, then turns joints (1) and (4) to adjust the length of spring assembly (5) and adjust to the postition of the hole of governor lever (2).
4. From the above position, shorten joints (1) and (4) a total of 2 turns (approx. 2.5 mm), and secure in position with the locknut.

Caution

★ When the spring assembly is removed and the starting switch is at the OFF position, if the governor motor lever is moved suddenly, the governor motor wil generate electricity, and this may cause a failure in the governor controller.

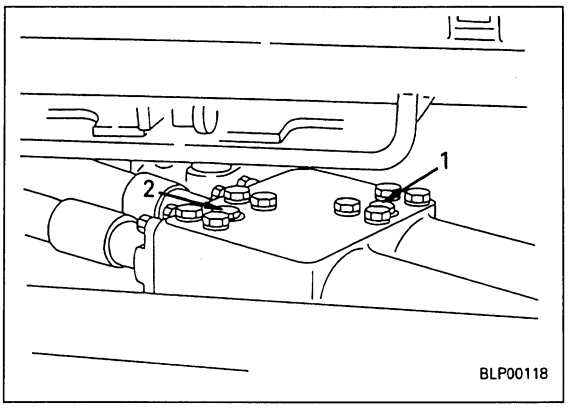
★ When moving the governor motor lever, disconnect connector EO5 first.

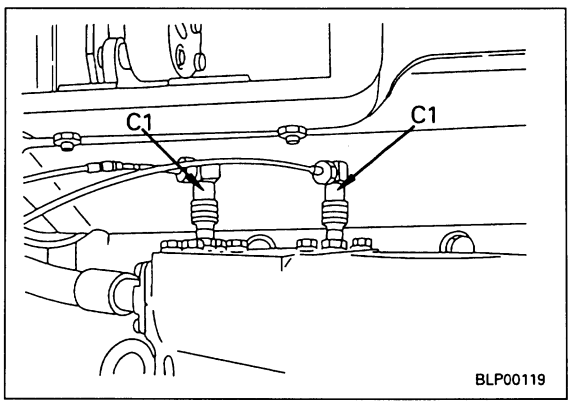
TESTING AND ADJUSTING HYDRAULIC PRESSURE IN WORK EQUIPMENT, SWING, TRAVEL CIRCUIT

Measuring

★ Oil temperature when measuring: 45 - 55°C
Lower the work equipment to the ground and stop the engine. Loosen the oil filler cap slowly to release the pressure inside the hydraulic tank. Then put the safety lock lever in the LOCK position.

1. Remove pressure pick-up plug (1) or (2) (thread dia. = 10 mm, Pitch = 1.25 mm) from the circuit to be measured, then install oil pressure gauge **C1** (58.8 MPa (600 kg/cm²))
2. **Measuring unload pressure**
   1) Run the engine at full throttle and measure in the H/O mode.
   2) Measure the hydraulic pressure when all levers are at neutral.
3. **Measuring main relief pressure**
   1) Run the engine at full throttle and measure in the H/O mode.
   2) Measure the hydraulic pressure when each actuator is relieved.
      ★ If the power max. switch is turned ON, the pressure will rise, so measure with both the switch OFF and ON.
      (When the switch is turned ON, it is automatically turned OFF after approx. 8 seconds, so measure during the first 8 seconds.)
      ★ Note that the set pressure of the safety valve for the swing motor and head end of the boom is lower than the LS relief pressure, so the value measured will be the relief pressure of the safety valve.
      ★ To check the operation of the safety valve at the boom LOWER end, measure the hydraulic pressure when the machine push-up switch is OFF (low pressure) and ON (high pressure).
      ★ When measuring the hydraulic pressure in the boom LOWER circuit, block the hose (fit blind plug) at the boom cylinder head end.
      ★ If the swing lock switch is turned ON, the pressure will rise, so always keep the lock switch OFF when measuring.
      ★ To relieve the travel circuit, put block under the track shoe grouser, or put block between the sprocket and frame to lock the track.





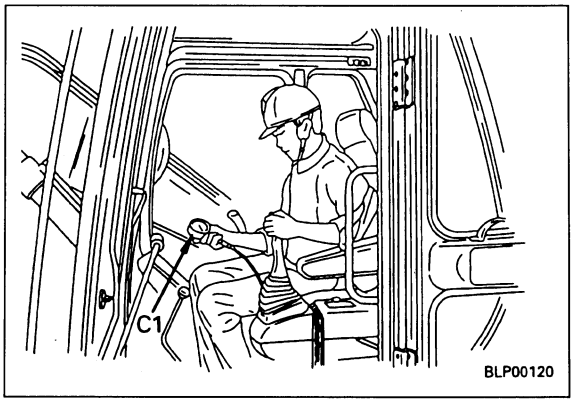


Table 1 Combination of pumps and actuators controlled when flow from front and rear pumps is divided.

Plug	Pump	Controlled actuator
1	Front pump	Boom cylinder (Lo, Hi) Arm cylinder (Hi) Bucket cylinder R.H. travel motor Service
2	Rear pump	Arm cylinder (Lo) Swing motor L.H. travel motor

Adjusting

* The unload valve cannot be adjusted.

1. Main relief valve

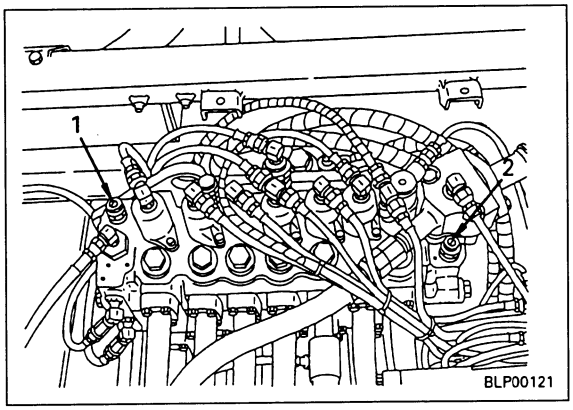
- (1): For front pump
- (2): for rear pump

Loosen locknut (3), then turn adjustment screw (4) to adjust.

★ Turn the adjustment screw to adjust as follows.
- To INCREASE pressure, turn CLOCKWISE
- TO DECREASE pressure, turn COUNTER-CLOCKWISE.

★ Amount of adjustment for one turn of adjustment screw:
Approx. 12.5 MPa (128 kg/cm²)

kgm Locknut: **68.6 ± 9.8 Nm (7 ± 1 kgm)**



2. Boom cylinder head safety valve

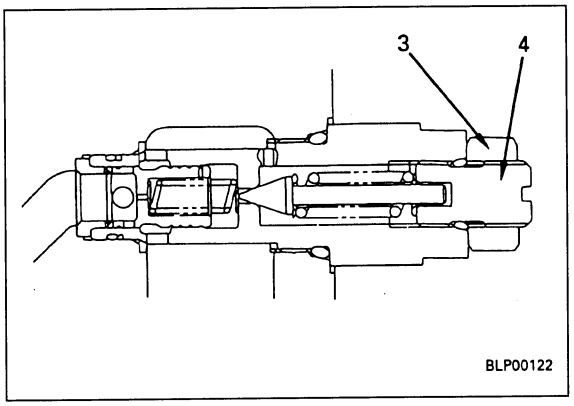
★ Adjust the safety valve at the high-pressure end first, then adjust the low-pressure end.

- (1): Boom cylinder head (LOWER) end

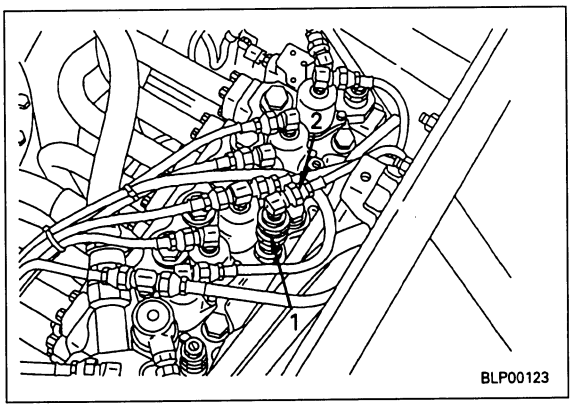
1) Disconnect pilot hose (2).
2) Adjusting high-pressure setting
Loosen locknut (3), then turn holder (4) to adjust.
kgm Locknut:
107.8 ± 14.7 Nm (11 ± 1.5 kgm)
3) Adjusting low-pressure setting
Loosen locknut (5), then turn holder (6) to adjust.
kgm Locknut:
85.8 ± 7.4 Nm (8.75 ± 0.75 kgm)

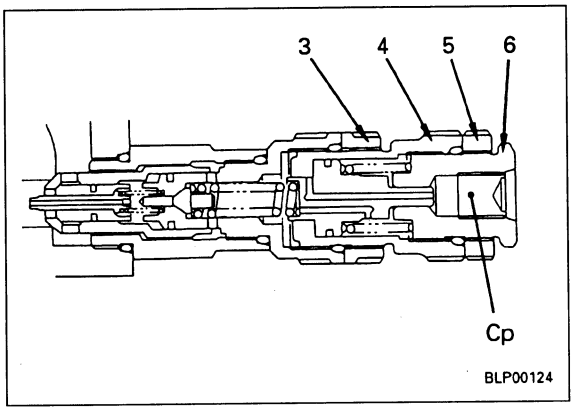
★ Turn the holder to adjust as follows.
- To INCREASE pressure, turn CLOCKWISE.
- To DECREASE pressure, turn COUNTER-CLOCKWISE.

★ Amount of adjustment for one turn of holder:
Approx. 21.8 MPa (222 kg/cm²)



[Reference] The oil pressure acting on port **CP** is as follows.
Machine push-up switch ON (high pressure):
0 MPa (0 kg/cm²)
Machine push-up switch OFF (low pressure):
2.7 MPa (28 kg/cm²)





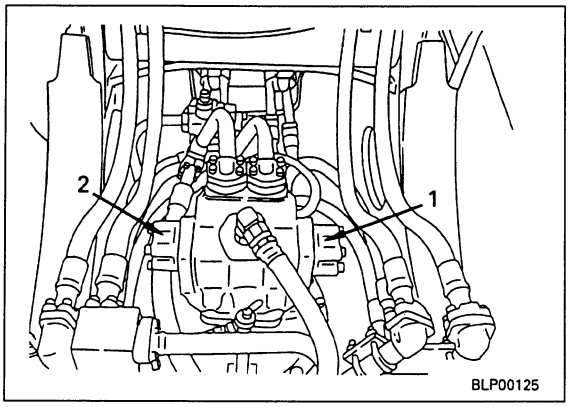
3. Swing motor safety valve

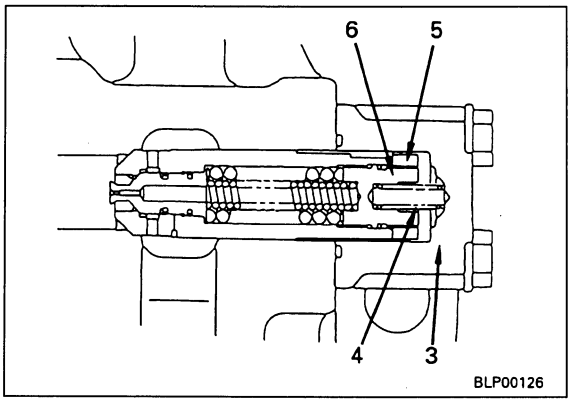
- (1): For starting left swing (stopping right swing)
- (2): For starting right swing (stopping left swing)

1) Remove the mounting bolts, then remove cover (3) and spring (4).
2) Loosen locknut (5), then turn adjustment screw (6) to adjust.
   - ★ Carry out the adjustment with the valve assembly installed to the motor.
   - ★ Turn the adjustment screw to adjust as follows.
     - To INCREASE pressure, turn CLOCKWISE.
     - To DECREASE pressure, turn COUNTERCLOCKWISE.
   - ★ Amount of adjustment for one turn of adjustment screw: Approx. 3.9 MPa (39.5 kg/cm²)

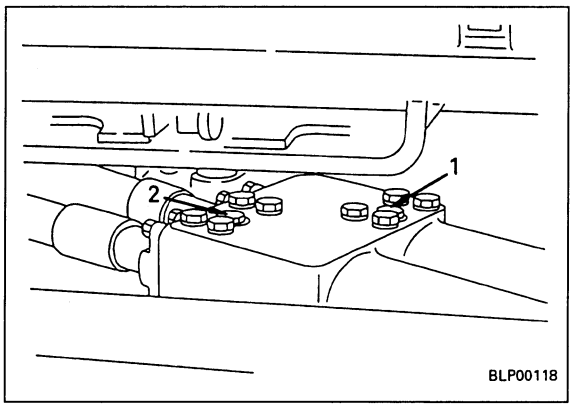
   kgm Locknut: **132.3 ± 1.47 (13.5 ± 1.5 kgm)**
3) After completing the adjustment, install spring (4) and cover (5), then tighten the mounting bolts to the specified torque.

   kgm Cover mounting bolt: **110.3 ± 12.3 Nm (11.25 ± 1.25 kgm)**





TESTING AND ADJUSTING TVC VALVE OUTPUT PRESSURE (SERVO PISTON INPUT PRESSURE)



Measuring

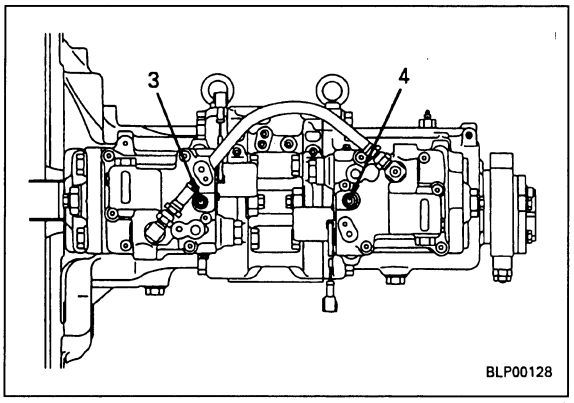
★ Oil temperature when measuring: 45 - 55°C

⚠ Lower the work equipment to the ground and stop the engine. Loosen the oil filler cap slowly to release the pressure inside the hydraulic tank. Then put the safety lock lever in the LOCK position.

1. Remove pressure measurement plugs (1), (2), (3), and (4) (Thread dia. = 10 mm, Pitch = 1.25 mm), and install oil pressure gauge **C1**.
   ★ Plugs and measured pressure

1	Front pump discharge pressure	3	Front servo piston input pressure
2	Rear pump discharge pressure	4	Rear servo piston input pressure

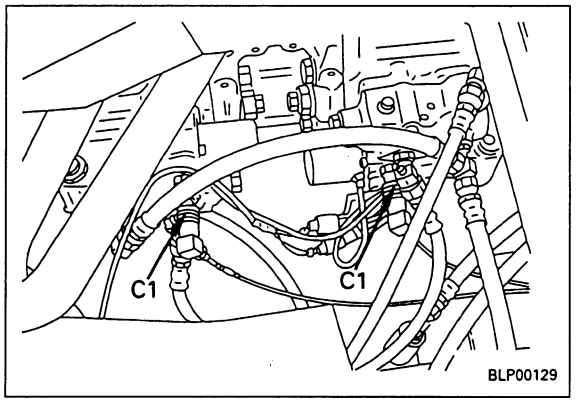
   ★ Install a 39.2 MPa (400 kg/cm²) gauge to the servo valve end, and a 58.8 MPa (600 kg/cm²) gauge to the pump outlet port end.



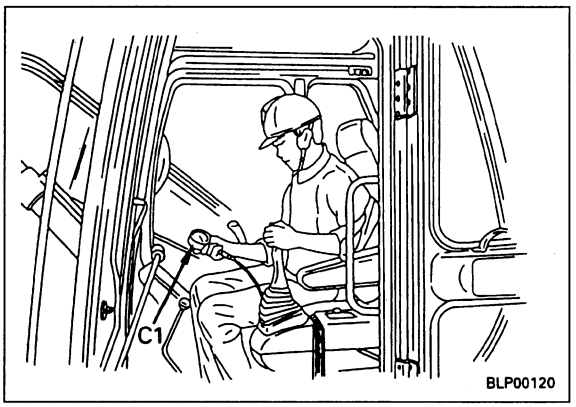
2. Turn the swing lock switch ON.

3. Set the working mode to H/O mode and set the knob switch function to POWER MAX.

4. Run the engine at full throttle, turn the L.H. knob switch ON, and measure the oil pressure when the arm IN circuit is relieved.
   ★ For the front pump, measure the oil pressure at plugs (1) and (3) at the same time; for the rear pump, measure the oil pressure at plugs (2) and (4) at the same time.
   ★ The power max. function is automatically turned OFF 8 seconds after it is switched ON, so measure during the first 8 seconds.
   ★ Check that the servo piston input pressure is 2/5 of the pump discharge pressure.



[Reference]
If there is any abnormality in the LS valve or servo piston, the servo piston input pressure will be almost the same or 0 of the pump discharge pressure.

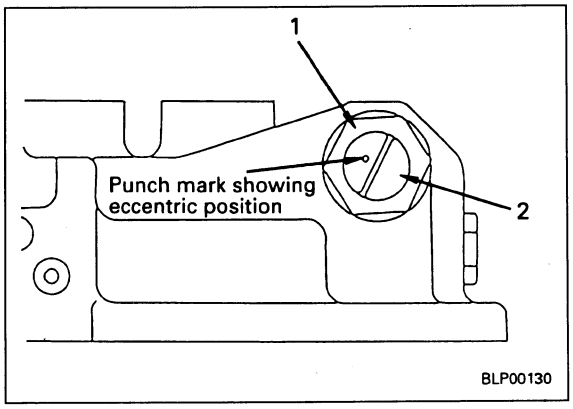


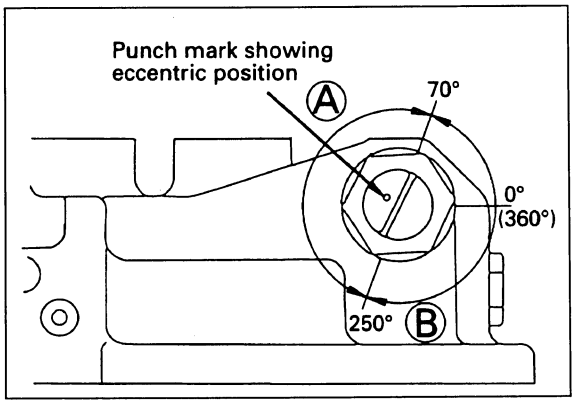
Adjusting

★ If the load becomes larger, the engine speed will drop. Or if the engine speed remains normal, the work equipment speed will drop. In such cases, if the pump discharge pressure and LS differential pressure are normal, adjust the TVC valve as follows.

1. Loosen locknut (1), and turn screw (2) to adjust.
   ★ The direction to turn differs according to the position of the eccentric position punch mark on the screw, so check the mark before turning.
   ★ Turn the screw as follows.
   - If work equipment is slow, turn in INCREASE direction
   - If engine speed drops, turn in DECREASE direction.

Punch mark	Increase	Decrease
Range Ⓐ	Within 90° in counterclockwise direction	Within 90° in clockwise direction
Range Ⓑ	Within 90° in clockwise direction	Within 90° in counterclockwise direction

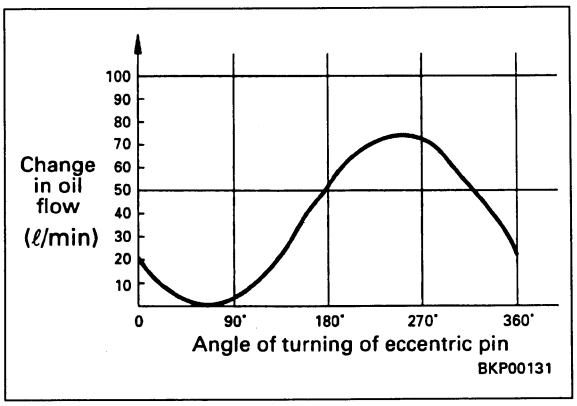




2. After completing the adjustment, tighten locknut (1).

   kgm Locknut: **29.4 ± 4.9 Nm (3.0 ± 0.5 kgm)**

Note: The screw is an eccentric cam, so if it is turned from the 0 position in the graph, the stroke of the servo piston (change in oil flow) will move as shown in the graph.
If it is turned one full turn, it will return to the orginal position, but the screw will become looser, so there will be play in the screw.
Therefore, turn the screw a maximum of 90° to the left or right from the position set when the machine was shipped.



TESTING AND ADJUSTING LS VALVE OUTPUT PRESSURE (SERVO PISTON INPUT PRESSURE) AND LS DIFFERENTIAL PRESSURE

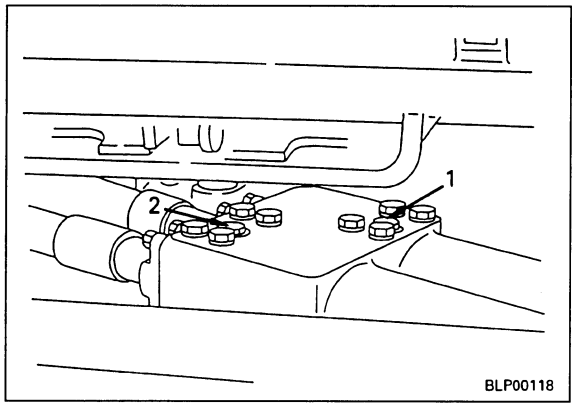
★ Oil temperature when measuring: 45 - 55°C

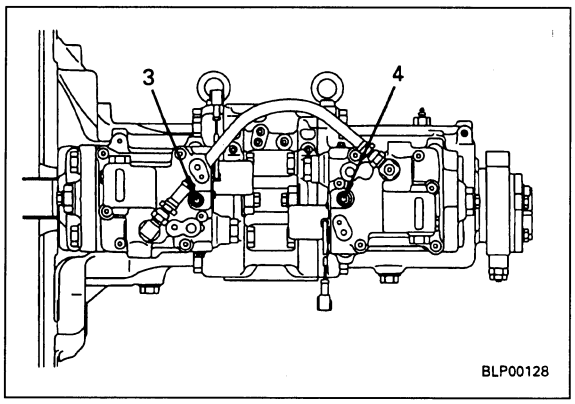
1. Measuring LS valve output pressure (servo piston input pressure)

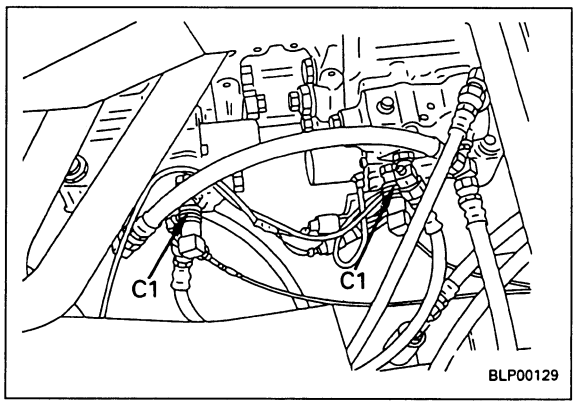
1) Remove pressure measurement plugs (1), (2), (3), and (4) (Thread dia.= 10 mm, Pitch = 1.25 mm), and install oil pressure gauge **C1**.
   ★ Plugs and measured pressure

1	Front pump discharge pressure	3	Front servo piston input pressure
2	Rear pump discharge pressure	4	Rear servo piston input pressure

   ★ Install a 39.2 MPa (400 kg/cm²) gauge to the servo valve end, and a 58.8 MPa (600 kg/cm²) gauge to the pump outlet port end.
2) Set the working mode to H/O mode, and turn the travel speed switch to Hi.
3) Use the work equipment to rais the track assembly on one side.
   ★ When measuring the front pump, push up the right track; when measuring the rear pump, push up the left track.
4) Run the engine at full throttle, set to the conditions shown in Table 1, and measure the pump discharge pressure and servo inlet pressure.
   ★ For the front pump, measure the oil pressure at plugs (1) and (3) at the same time; for the rear pump, measure the oil pressure at plugs (2) and (4) at the same time.







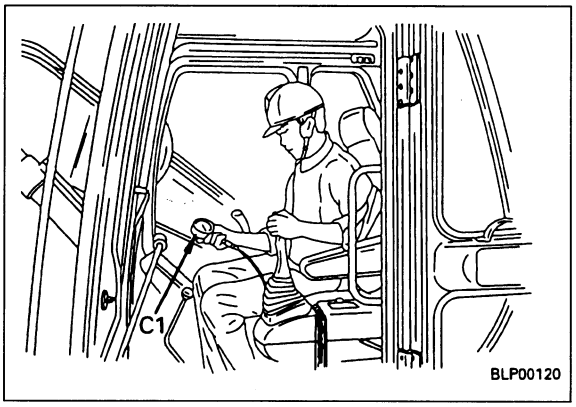


Table 1

Working mode	Travel lever	Pump pressure (MPa (kg/cm²))	Servo inlet port pressure (MPa (kg/cm²))	Remarks
H/O mode	Neutral	3.9 ± 1.0 (40 ± 10)	3.9 ± 1.0 (40 ± 10)	About same pressure
H/O mode	Half (travel circuit under no load)	Approx. 4.9 (50)	Aprox. 4.9 (50)	About 2/5 of pressure

2 Measuring LS differential pressure

1) Measuring with a differential pressure gauge

i) Remove pressure measurement plugs (1), (2), (3), and (4) (Thread dia. = 10 mm, Pitch = 1.25 mm), and install differential pressure gauge **C4**.

★ Plugs and measured pressure

1	Front pump discharge pressure	3	Front LS pressure
2	Rear pump discharge pressure	4	Rear LS pressure

★ Connect the pump discharge pressure to the high-pressure side of the differential gauge and the LS pressure to the low-pressure side.

ii) Set the working mode to H/O mode, and turn the travel speed switch to Hi.

iii) Use the work equipment to raise the track assembly on one side.

★ When measuring the front pump, push up the right track; when measuring the rear pump, push up the left track.

iv) Run the engine at full throttle, set to the conditions shown in Table 2 and measure the LS differential pressure.

Table 2

Working mode	Travel lever	LS differential pressure (MPa (kg/cm²))	Remarks
H/O mode	Neutral	3.9 ± 1.0 (40 ± 10)	(Note)
H/O mode	Half (travel circuit under no load)	2.5 ± 0.1 (25 ± 1)	

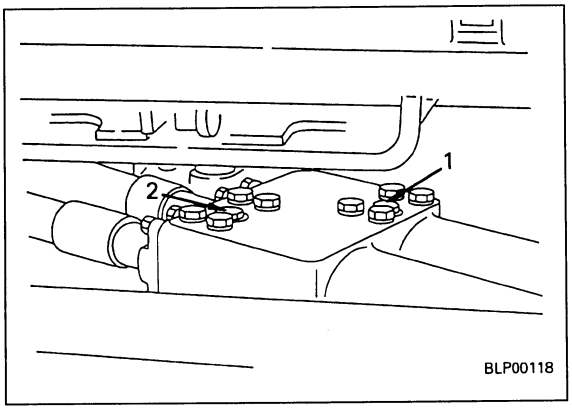
Note: When all control levers are at neutral, the LS differential pressure is the same as the unload pressure.

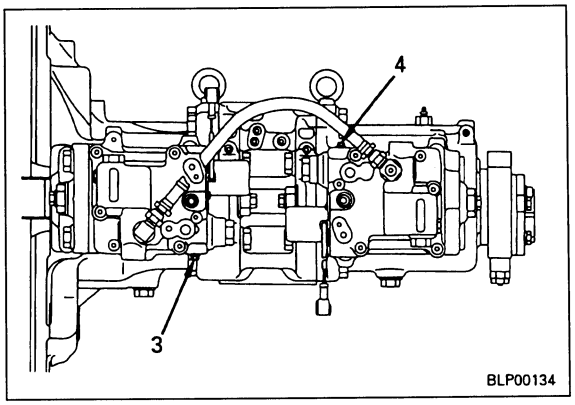
2) Measuring with oil pressure gauge

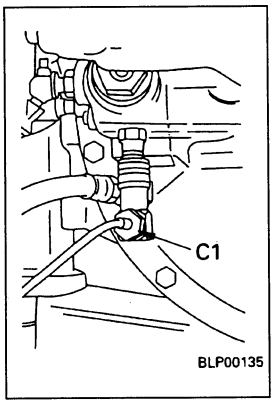
★ The maximum differential pressure is 2.9 ± 1.0 MPa (30 ± 10 kg/cm²), so measure with the same gauge.

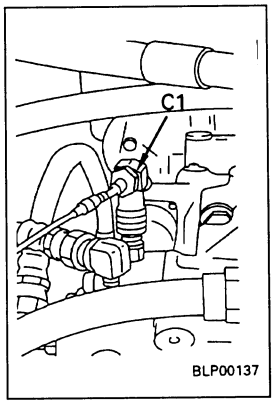
i) Remove pressure measurement plugs (1), (2), (3), and (4) (thread dia. = 10 mm, pitch = 1.25 mm), and install the plug of pressure gauge **C1**.

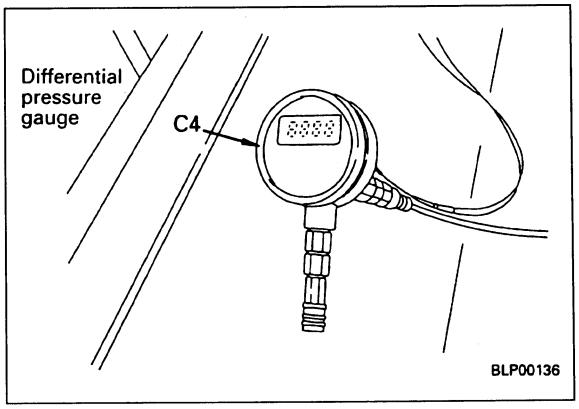
ii) Carry out the same operation as in Step 1)-ii), iii) above.









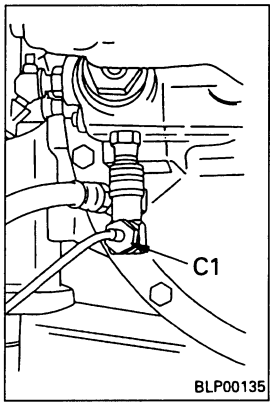


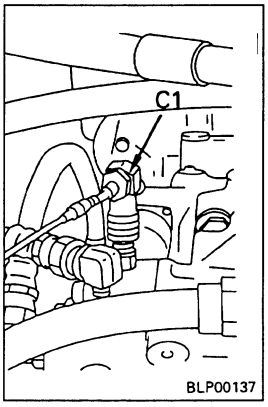
iii) Install oil pressure gauge **C1**(58.8 MPa (600 kg/cm2) to the measurement plug for the pump discharge pressure.
★ Use a gauge with a scale in units of 1.0 MPa (10 kg/cm²).
(If no 58.8 MPa (600 kg/cm²) pressure gauge is available, a 39. 2 MPa (400 kg/cm²) pressure gauge can be used.)

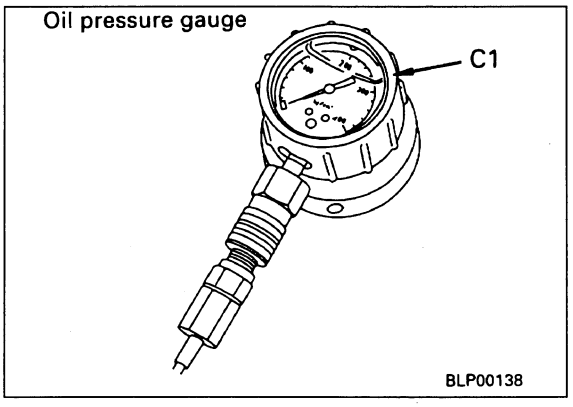
iv) Set to the conditions in Table 2 and measure the pump discharge pressure.
★ Stand directly in front of the indicator and be sure to read it correctly.

v) Remove oil pressure gauge **C1**, then install it to the LS pressure measurement plug.

vi) Set to the conditions in Table 2 and measure the LS pressure.
★ Stand directly in front of the indicator and be sure to read it correctly. (Pump discharge pressure) - (LS pressure) = LS Differential pressure







3. Adjusting LS valve

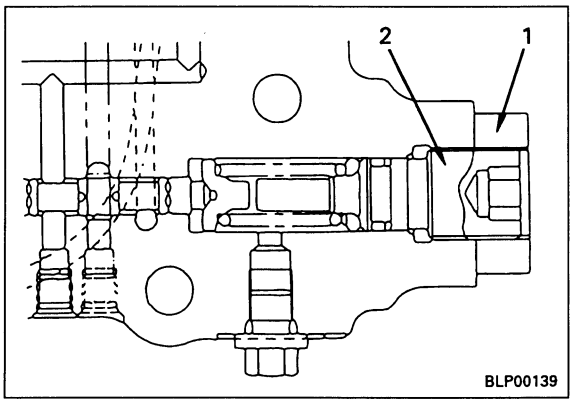
When the differential pressure is measured under the conditions above, and the results show that the differential pressure is not within the standard value, adjust as follows.

1) Loosen locknut (1) and turn screw (2) to adjust the differential pressure.
★ Turn the screw to adjust the differential pressure as follows.
- To INCREASE pressure, turn CLOCKWISE.
- To DECREASE pressure, turn COUNTER-CLOCKWISE

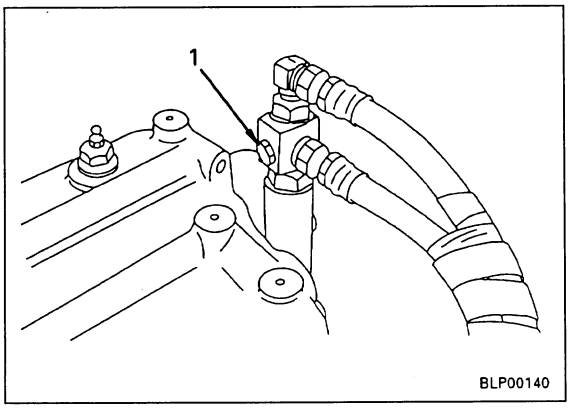
★ Amount of adjustment for one turn of adjustment screw: Approx. 1.3 MPa (13.2 kg/cm²)

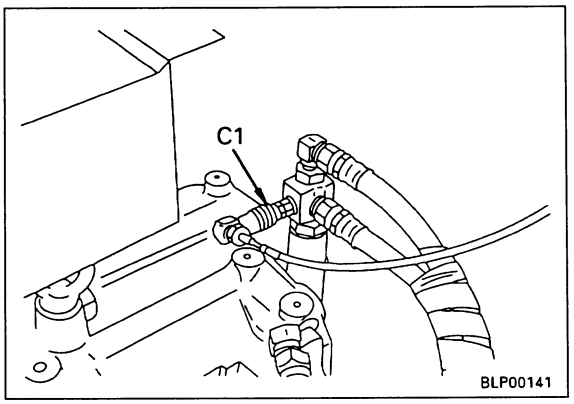
Note: Always measure the differential pressure while adjusting.

2) After adjusting, tighten locknut (1).
kgm Locknut: **68.6 .6 ± 9.8 Nm (7 ± 1 kgm)**



TESTING AND ADJUSTING CONTROL PUMP CIRCUIT OIL PRESSURE





Measuring

★ Oil temperature when measuring: 45 - 55°C

1. Remove pressure pick-up plug (1) (Thread dia. = 10 mm, Pitch = 1.25 mm), and install oil pressure gauge **C1** (5.9 MPa (60 kg/cm²)).
2. Start the engine and measure with the engine at full throttle.

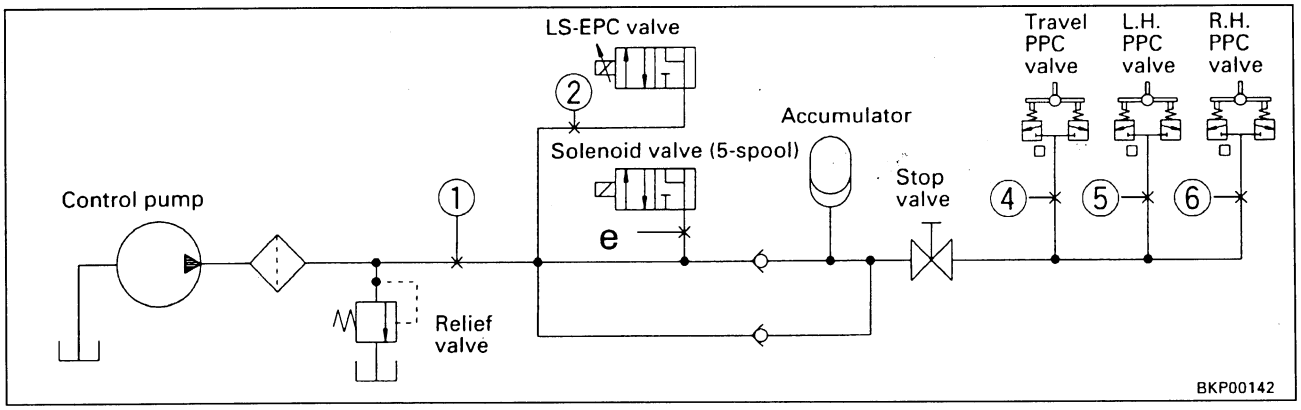
★ When testing for internal leakage of the equipment in the control circuit, use the parts given below to shut off the circuit for the following sections when measuring the relief pressure.

NO.	Section of hydraulic circuit shut off	Component that can be checked
1.	Control pump outlet port	Control pump
2.	LS-EPC vavle inlet port	LS-EPC valve
3.	Solenoid valve inlet port	Solenoid valve
4.	Travel PPC valve inlet port	Travel PPC valve
5.	L.H. PPC valve inlet port	L.H. PPC valve
6.	R.H. PPC valve inlet port	R.H. PPC valve

★ Items No.2 and below can be checked if the equipment in the previous number is normal.

★ Use the following parts to shut off the circuit.

- For elbow
  Sleeve nut: 07221-20210, 07221-20315
  07221-20422
  Plug: 07222-00210, 07222-00315
  07222-00414
- For hose
  Plug: 07376-50210, 07376-50315
  07376-50422

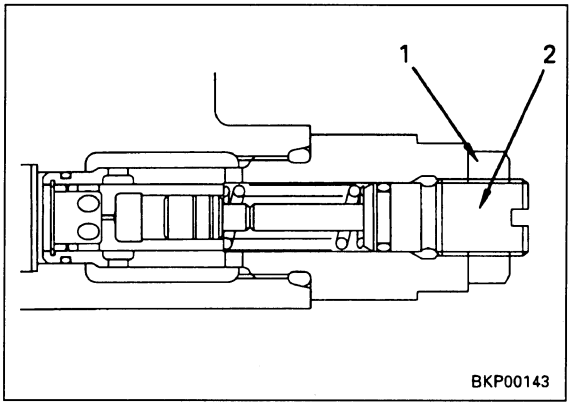


Adjusting

1. Loosen locknut (1) and turn adjustment screw (2) to adjust.
   - ★ Turn the adjustment screw as follows.
     - To INCREASE pressure, turn CLOCKWISE
     - To DECREASE pressure, turn COUNTER-CLOCKWISE
   - ★ Amount of adjustment for one turn of adjustment screw:

     Approx. 0.56 MPa (5.7 kg/cm²)

   - kgm Locknut: **63.7 ± 9.8 Nm (6.5 ± 1 kgm)**
   - ★ After completion of adjustment, repeat the procedure in Item 1 to check the set pressure again.



TESTING SOLENOID VALVE OUTPUT PRESSURE

★ Oil temperature when measuring: 45 - 55°C

1. Measuring output pressure of LS-EPC solenoid valve

1) Disconnect output hose (1) of the LS-EPC solenoid valve, then use adapter **C3** in the oil pressure gauge kit to install oil pressure gauge C1 (5.9 Mpa (60 kg/cm²))
2) Measure the output pressure under the conditions in Table 1.

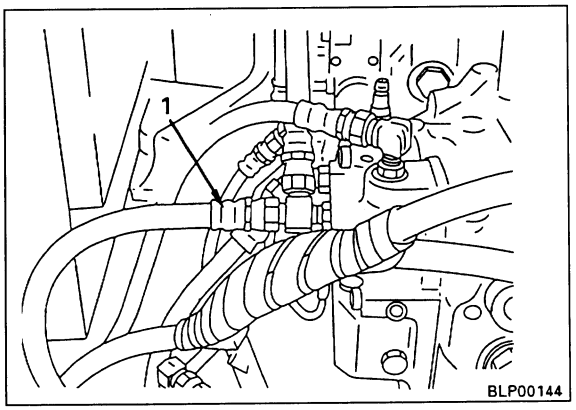
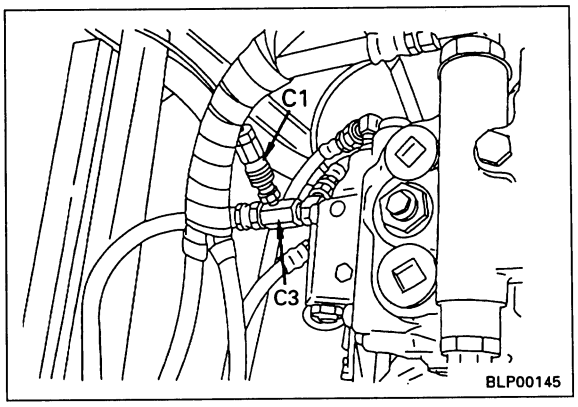
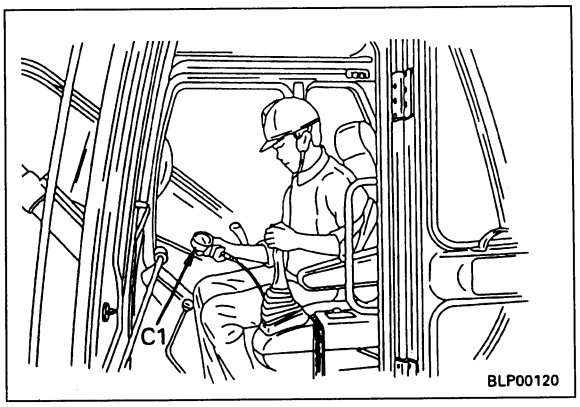


Table 1

Operation and working mode	Engine speed (rpm)	Output pressure (MPa (kg/cm²))	[Reference] Current (A)
• All control levers at neutral	Min. 1500	2.9 ± 0.2 (30 ± 2)	900 ± 30
• H/O mode or G/O mode • Operate any control lever with travel at neutral	Min. 1900	0	0

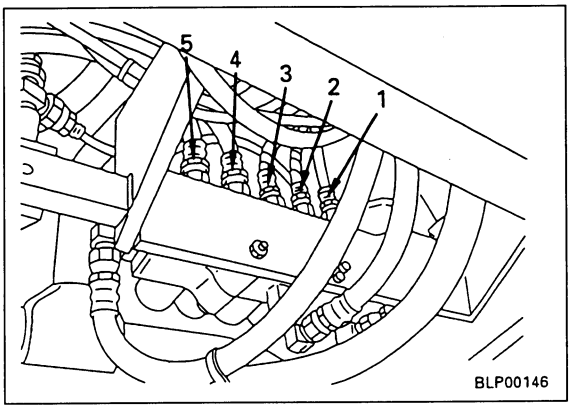


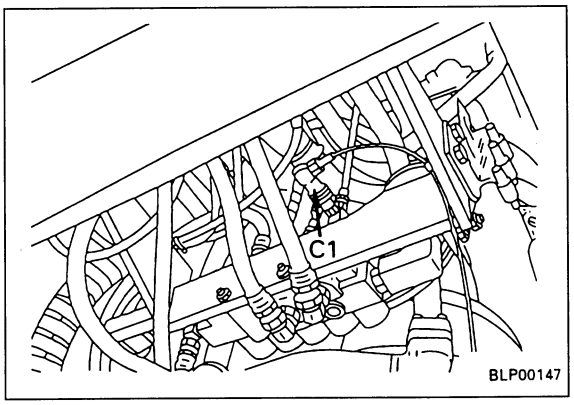
★ The engine speed and LS-EPC current can be measured using the monitoring code on the monitor panel.
- Engine speed : [10] or [40]
- LS-EPC current : [15]



2. Measuring output pressure of ON/OFF solenoid valve

1) Disconnect outlet hose (1) of the solenoid valve to be measured, then use adapter **C3** in the oil pressure gauge kit to install oil pressure gauge **C1** (5.9 MPa (60 kg/cm²)).
2) Measure the output pressure under the conditions in Table 2





Hose	Solenoid	Measurement conditions	Operating conditions	Condition of solenoid	Oil pressure (MPa (kg/cm²))	Remarks
1	LS select	Swing lock switch OFF, compound operation of swing + travel	LS circuit divided	ON	Min. 2.7 (28)	When the solenoid is ON, the oil pressure is the output pressure of the travel PPC valve
		Swing lock switch ON	LS circuit not divided	OFF	0	
2	Machine push-up	When machine push-up switch is at high-pressure setting	Safety valve at high-pressure setting	OFF	0	
		When machine push-up switch is at low-pressure setting	Safety valve at low-pressure setting	ON	Min. 2.7 (28)	
3	Pump merge/ divider valve	Travel operated independently	Flow from front and rear pumps divided	ON	Min. 2.7 (28)	
		All levers at neutral	Flow from front and rear pumps merged	OFF	0	
4	Travel speed	When operate travel lever with travel speed switch at Hi or Mi	Motor swash plate angle at MIN	ON	Min. 2.7 (28)	
		Travel speed switch at Lo	Motor swash plate angle at MAX	OFF	0	
5	Swing holding brake	Swing or work equipment lever operated	Brake canceled	ON	Min. 2.7. (28)	
		All levers except travel at neutral (5 sec after returning to neutral)	Brake actuated	OFF	0	

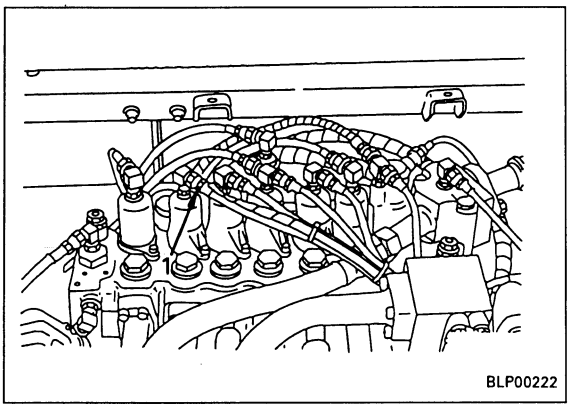
★ With monitoring code (23), check at the same time that the solenoid is switched ON/OFF electrically. (The machine push-up solenoid is not displayed.)
★ The measurement conditions in the table are typical conditions for measuring the output pressure. The solenoid valve may be actuated (ON/OFF) under conditions other than the measurement conditions given above.
★ Operate the lever slightly not enough to move the machine.

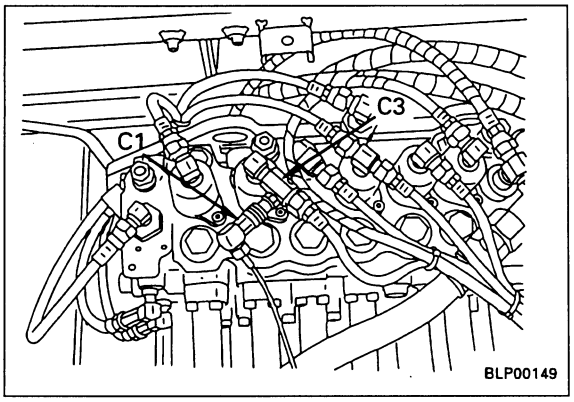
MEASURING PPC VALVE OUTPUT PRESSURE AND TESTING PPC SHUTTLE VALVE

★ Oil temperature when measuring: 45 - 55°C

1. Measuring PPC valve output pressure

1) Disconnect hose (1) of the circuit to be measured.
2) Install adapter **C3** between the hose and elbow.
3) Install oil pressure gauge **C1** (5.9 MPa (60 kg/cm²)) to adapter **C3**
4) Run the engine at full throttle, operate the control lever of the circuit to be measured, and measure the oil pressure.

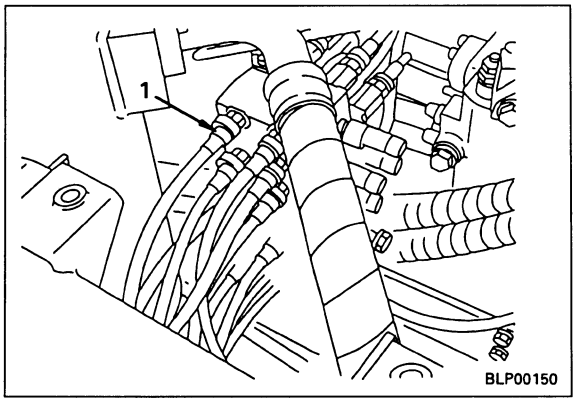


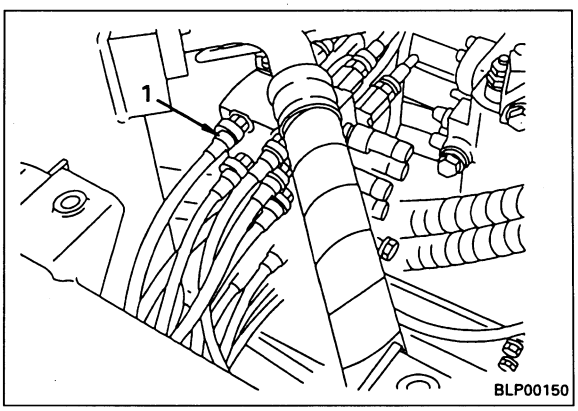


2. Checking PPC shuttle valve

★ If the output pressure at the control valve end is low, check for leakage of oil from the PPC shuttle valve as follows.

1) Disconnect hose (1) between the PPC valve and the shuttle valve of the circuit to be measured. Disconnect the hose from the shuttle valve toghether with the nipple.
2) Install adapter **C5** to the tip of the hose, then install oil pressure gauge **C1** (5.9 MPa (60 kg/cm²)).
   ★ Install a blind plug to the shuttle valve.
3) Run the engine at full throttle, operate the control lever, and measure the output pressure.
   ★ If the output pressure becomes normal, there is leakage from the PPC shuttle valve: if there is no change, the PPC valve is defective.

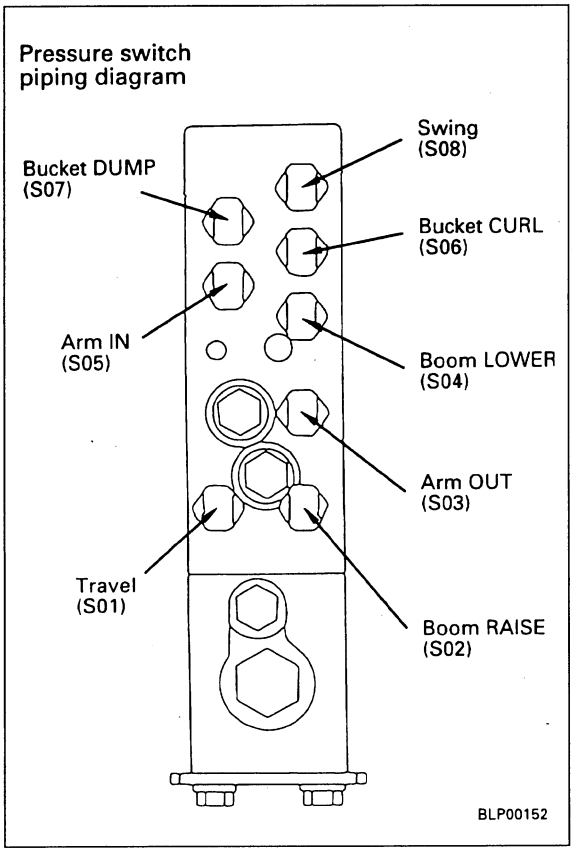


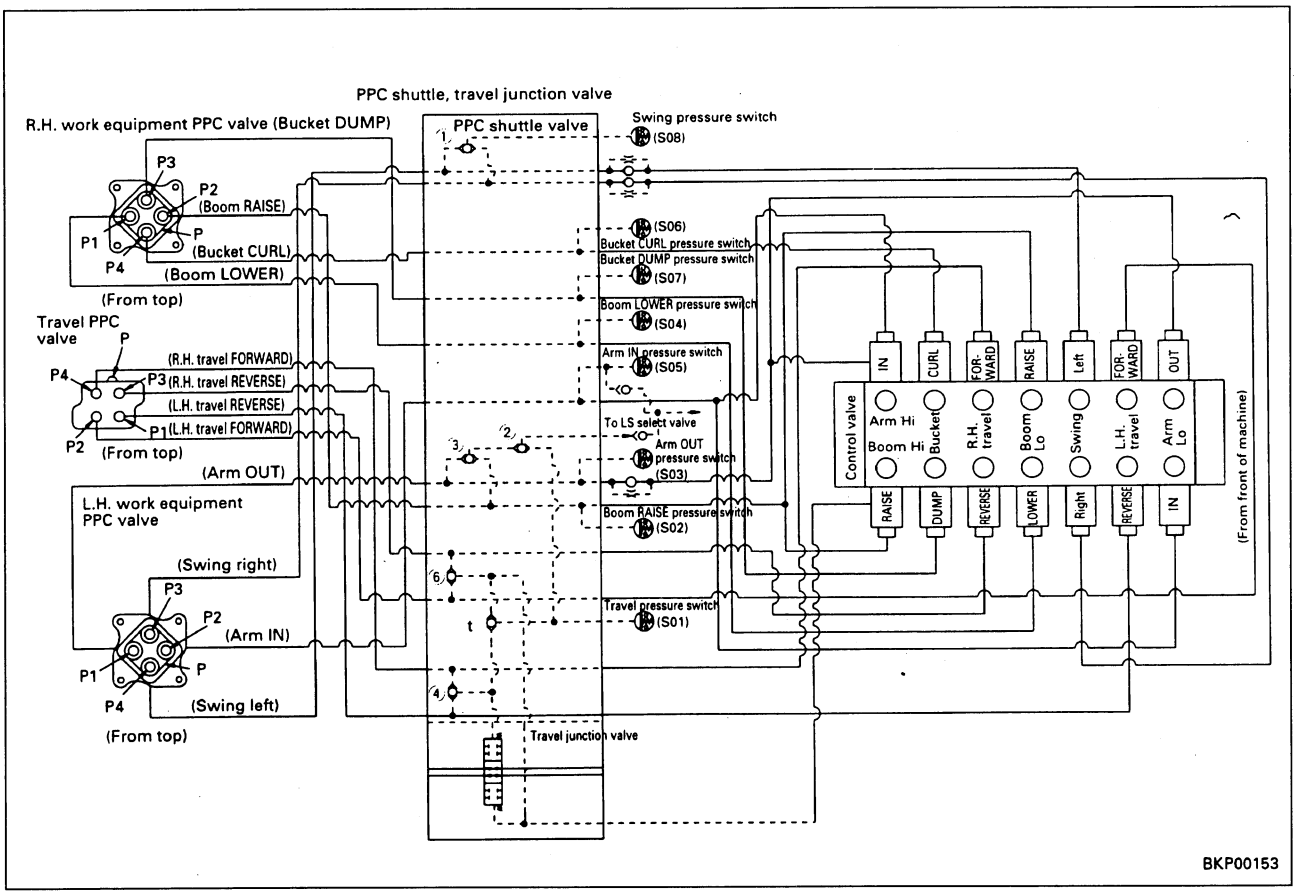


3. Checking defective operations of PPC shuttle valve

1) Remove the applicable oil pressure switch, then install oil pressure gauge **C1** (5.9 MPa (60 kg/cm²))
   - ★ Disconnect the outlet hose of the LS select shuttle valve before installing the oil pressure gauge.
2) Run the engine at full throttle, operate the applicable lever, and measure the output pressure.
   - ★ If output pressure is generated for all the applicable operations, the shuttle valve is normal.
   - ★ If no output pressure is generated all the applicable operations, the shuttle valve is defective.

①: Swing left, right shuttle valve
②: LS select shuttle valve (boom RAISE, arm OUT all travel)
③: Boom RAISE, arm OUT shuttle valve
④: L.H. travel FORWARD, R.H. travel FORWARD, REVERSE)
⑤: All travel shuttle valves (L.H., R.H. FORWARD, REVERSE)
⑥: L.H. travel REVERSE, R.H. travel FORWARD shuttle valve





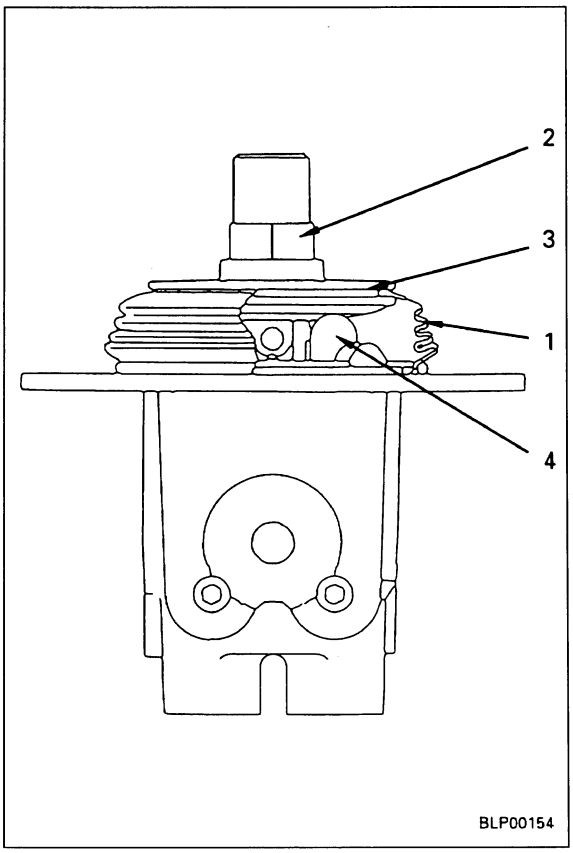
ADJUSTING WORK EQUIPMENT, SWING PPC VALVE

★ If there is excessive play in the work equipment or swing lever, adjust as follows.

⚠ Lower the work equipment to the ground and stop the engine. Loosen the oil filler cap slowly to release the pressure inside the hydraulic tank.
Then set the safety lock lever to the LOCK position.

1. Remove the PPC valve.
2. Remove boot (1).
3. Loosen locknut (2), then screw in disc (3) until it contacts the 4 heads of piston (4).
   ★ When doing this, do not move the piston.
4. Secure disc (3) in position, then tighten locknut (2) to be specified torque.
   kgm Locknut: **112.7 ± 14.7 Nm (11.5 ± 1.5 kgm)**
5. Install boot (1).

★ With the above adjustment, the clearance between disc (3) and piston (4) becomes 0.

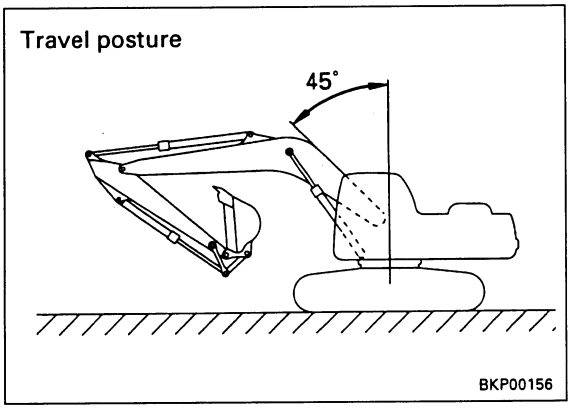


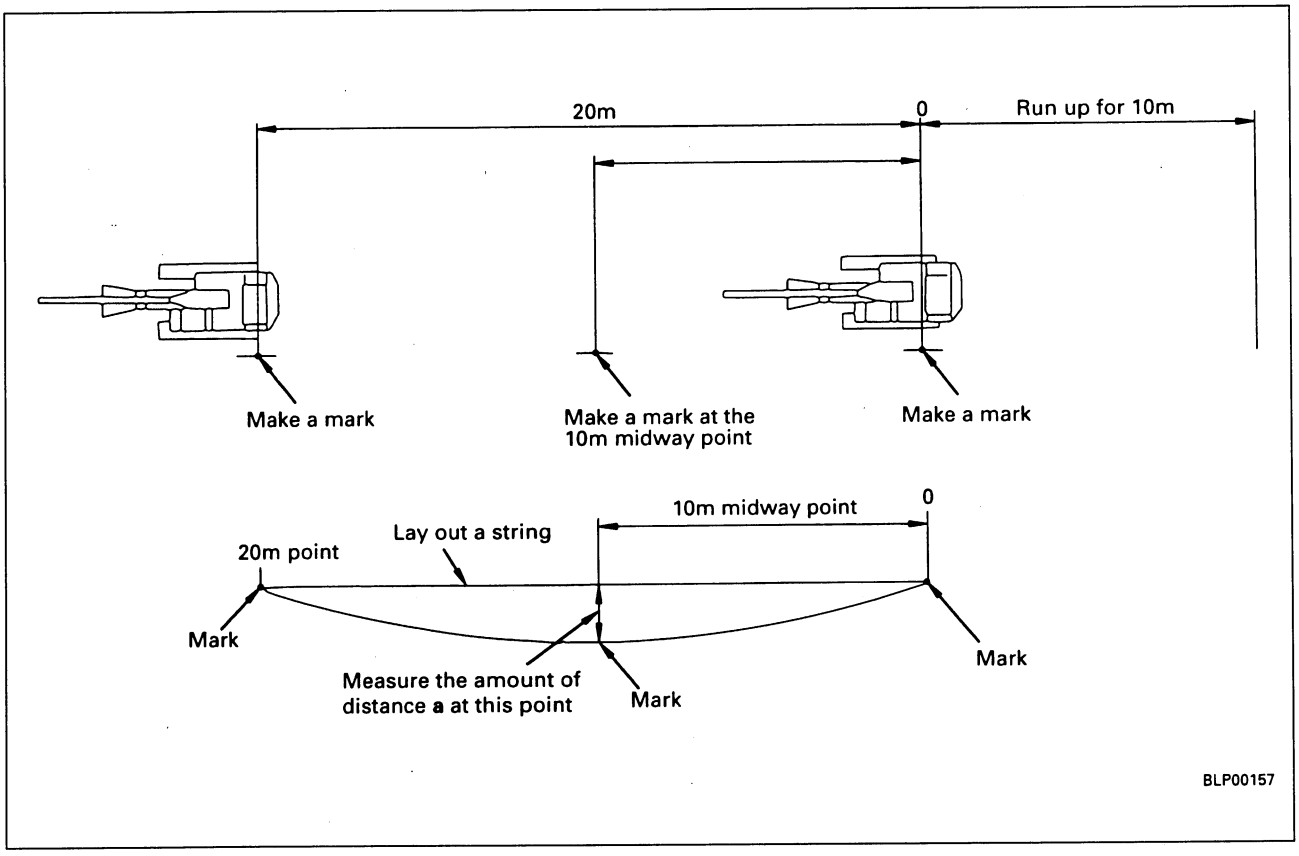
TESTING TRAVEL DEVIATION

* When traveling on level ground.

1. Set the machine in the travel posture.
   ★ For the travel posture, extend the bucket and arm cylinder rods fully, and hold the boom angle at 45°.

2. Travel for 10 m, then measure the deviation when traveling for the next 20 m.
   ★ Set to H/O mode and measure with the engine at full throttle.
   ★ Install the hydraulic pressure gauge and measure the pump discharage pressure at the same time.





TESTING LOCATIONS CAUSING HYDRAULIC DRIFT OF WORK EQUIPMENT

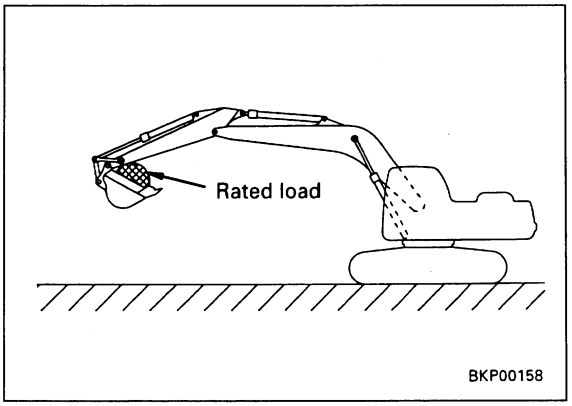
★ If there is any hydraulic drift in the work equipment (cylinders), check as follows to determine if the cause is in the cylinder packing or in the control valve.

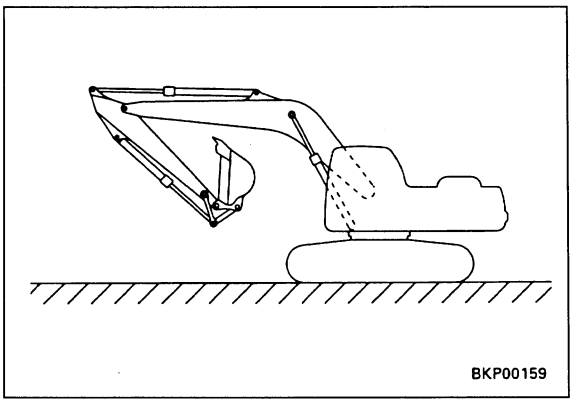
1. Checking for defective cylinder packing

1) Checking boom and bucket cylinders
   i) Set in the same posture as when measuring hydraulic drift, and stop the engine.
   ii) Operate the boom control lever to RAISE or the bucket control lever to CURL.
      • If the lowering speed increases, the packing is defective.
      • If there is no change, the boom lock valve (boom) or the control valve (bucket) is defective.
2) Checking arm cylinder
   i) Operate the arm cylinder to move the arm in fully, then stop the engine.
   ii) Operate the control lever to arm IN.
      • If the lowering speed increases, the packing is defective.
      • If there is no change, the control valve is defective.
      ★ If the pressure in the accumulator has dropped, run the engine for approx. 10 seconds to charge the accumulator again before operating.

[Reference] If the cause of the hydraulic drift is in the packing, and the above operation is carried out, the downward movement becomes faster for the following reasons.

1) If the work equipment is set to the above posture (holding pressure applied to the bottem end), the oil at the bottom end leaks to the head end. However, the volume at the head end is smaller than the volume at the bottom end by the volume of the rod, so the internal pressure at the head end increases because of the oil flowing in from the bottom end.
2) When the internal pressure at the head end increases, the pressure at the bottom end also rises in proportion to this. The ballance is maintained at a certain pressure (this differs according to the amount of leakage) by repeating this procedure.
3) When the pressure is balanced, the downward movement becomes slower. If the lever is then operated according to the procudure given above, the circuit at the head end is opened to the drain circuit (the bottom end is closed by the check valve), so the oil at the head end flows to the drain circuit and the downward movement becomes faster.





2. Checking PPC valve

If the hydraulic drift differs when the safety lock lever is in the LOCK of FREE position, (engine running), the PPC valve is defective.

MEASURING OIL LEAKAGE

★ Oil temperature when measuring: 45 - 55°C

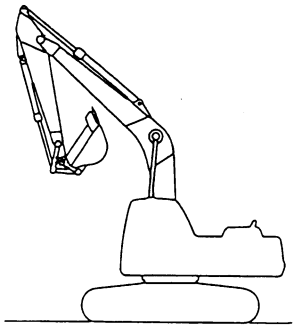
1. Work equipment cylinder

★ If the hydraulic drift of the work equipment is outside the standard value, measure the leakage inside the cylinder as follows, and judge if the cause of the hydraulic drift is in the cylinder or in the control valve.

- If the leakage is within the standard value, the problem is in the control valve.
- If the leakage is greater than the standard value, the problem is in the cylinder.

1) Fully extend the rod of the cylinder to be measured, then stop the engine.
2) Disconnect piping (1) at the head end, then block the piping at the chassis end with a blind plug.
   ⚠ Be careful not to disconnect the piping at the bottom end.
3) Start the engine and apply the relief pressure to the bottom end of the cylinder with the engine at full throttle.
   ★ Boom cylinder: RAISE
   Arm cylinder: IN
   Bucket cylinder: CURL
4) Continue this condition for 30 seconds, then measure the oil leakage for the next one minute.

Posture for measuring boom cylinder



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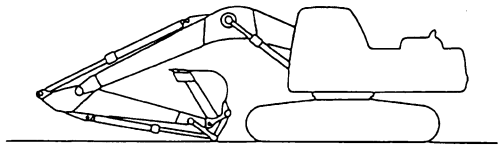
Posture for measuring arm, bucket cylinder



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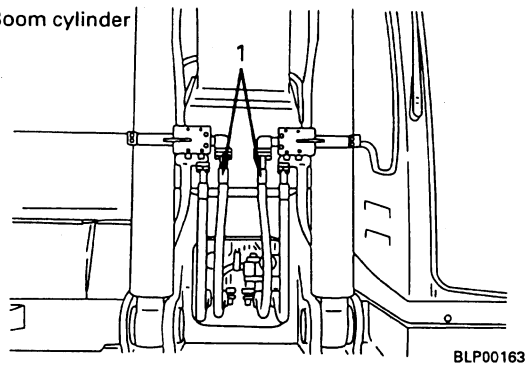
Boom cylinder



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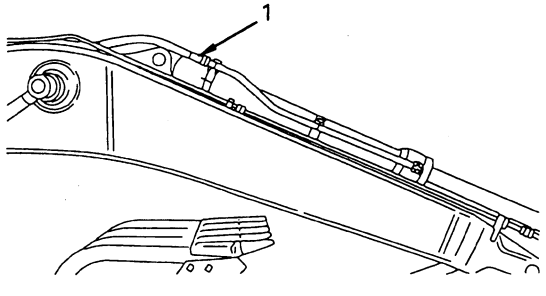
Arm cylinder



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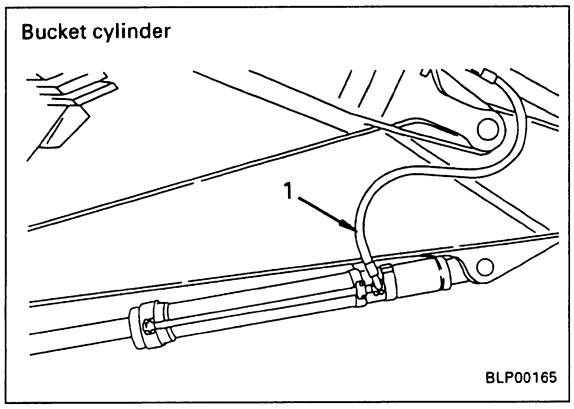
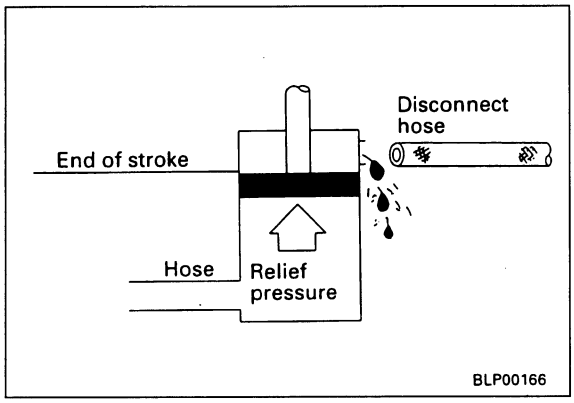
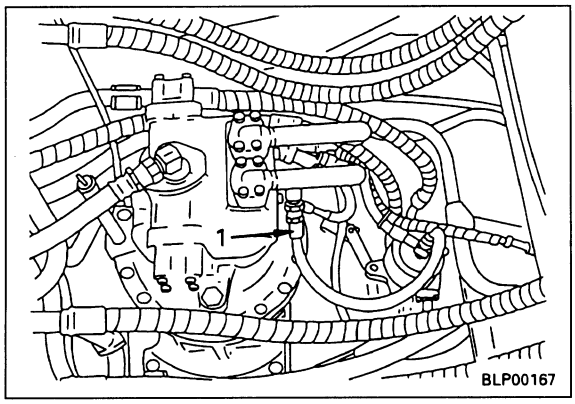


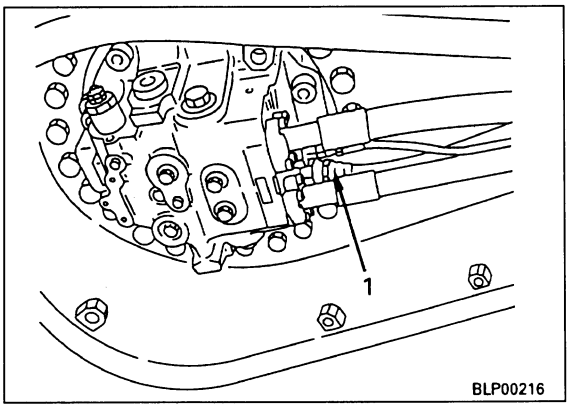


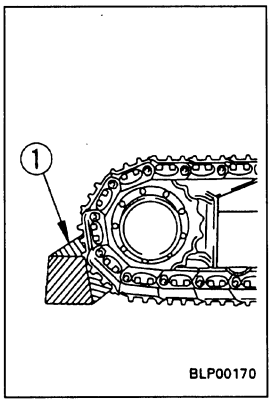
2. Swing motor

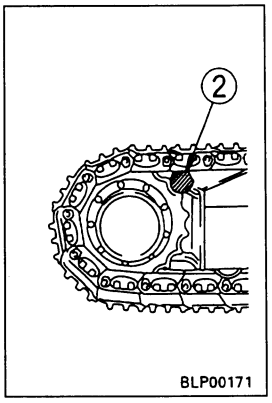
1) Disconnect drain hose (1) from the swing motor, then install a blind plug at the tank end.
2) Turn the swing lock switch ON.
3) Start the engine and operate the swing relief with the engine at full throttle.
4) Continue this condition for 30 seconds, then measure the oil leakage for the next one minute.
   ★ After measuring, swing 180° and measure again.



3. **Travel motor**
   1) Disconnect drain hose (1) from the travel motor, then fit a blind plug at the hose end.
   2) Fit block ① under the track shoe grouser, or fit block ② between the sprocket and frame to lock the track.
   3) Start the engine and operate the travel relief with the engine at full throttle.
      ⚠ When measuring the oil leakage from the travel motor, mistaken operation of the control lever may lead to a serious accident, so always use signals and check when carrying out this operation.
   4) Continue this condition for 30 seconds, then measure the oil leakage for the next one minute.
      ★ When measuring, move the motor slightly (to change the position between the valve plate and cylinder, and piston and cylinder), and measure several times.







RELEASING REMAINING PRESSURE IN HYDRAULIC CIRCUIT

★ If the piping between the hydraulic cylinder and the control valve is to be disconnected, release the remaining pressure from the circuit as follows.
The travel circuit is an open circuit, so there is no remaining pressure. It is enough to remove the oil filler cap.

1. Loosen the oil filler cap slowly to release the pressure inside the tank.

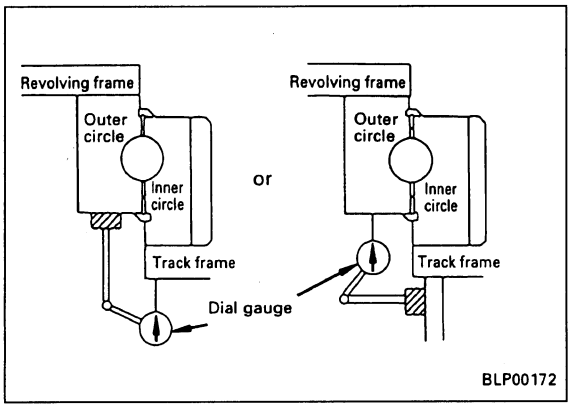
2. Operate the control levers.
   ★ When the levers are operated 2 - 3 times, the pressure stored in the accumulator is removed.

3. Start the engine, run at low idling for approx. 5 minutes, then stop the engine and operate the control levers.
   ★ Repeat the above operation 2 - 3 times to release all the remaining pressure.

TESTING CLEARANCE OF SWING CIRCLE BEARING

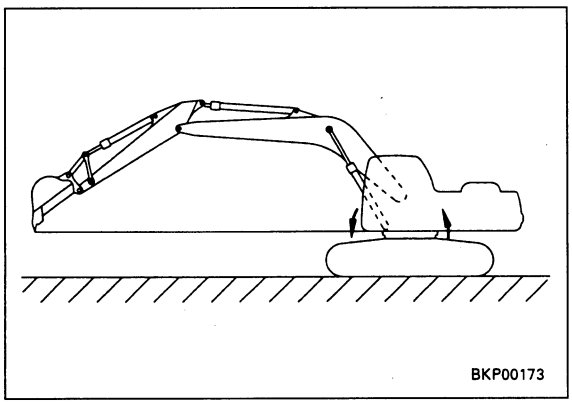
Method of testing clearance of swing circle bearing when mounted on machine

1. Fix a magnet-type dial gauge to the outer circle (or inner circle) of the swing circle, and put the tip of the probe in contact with the inner circle (or outer circle). Set the dial gauge at the front or rear.



2. Extend the work equipment to the maximum reach, and set the tip of the bucket to the same height as the bottom of the revolving frame.
   When this is done, the upper structure will tilt forward, so the front will go down and the rear will rise.

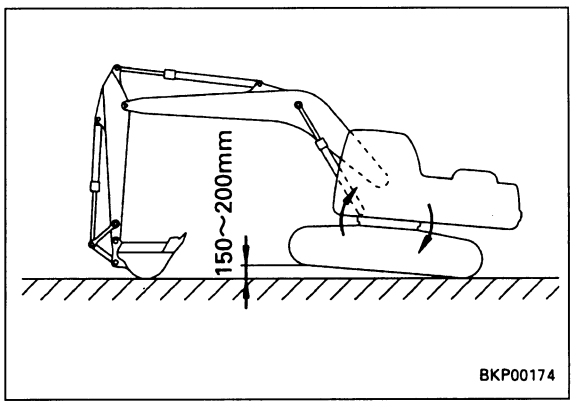
3. Set the dial gauge to the zero point.



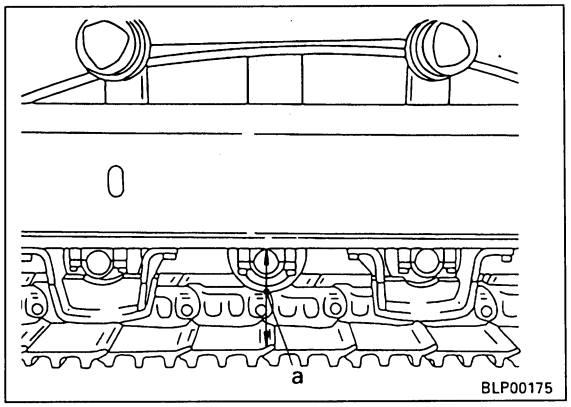
4. Set the arm more or less at right angles to the ground surface, then lower the boom until the front of the machine comes off the ground.
   When this is done, the upper structure will tilt back, so the front will rise and the rear will go down.

5. Read the value on the dial gauge at this point. The value on the dial gauge is the clearance of the swing circle bearing.
   ⚠ When carrying out the measurement, do not put your hand or feet under the undercarriage.

6. Return to the condition in Step 2, and check that the dial gauge has returned to the zero point. If it has not returned to the zero point, repaet Steps 3 to 5.



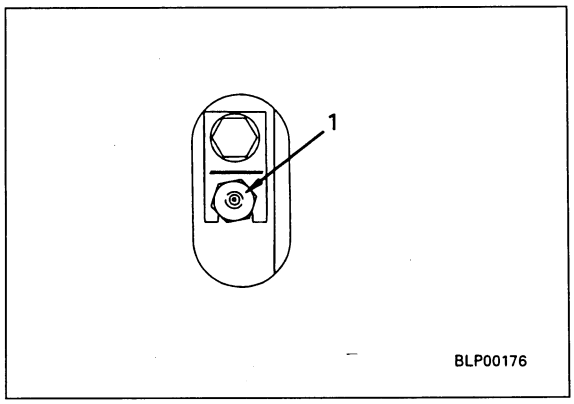
TESTING AND ADJUSTING TRACK SHOE TENSION



Testing

1. Raise the track frame on one side using the arm and boom.

2. Measure the clearance **a** (tension) between the bottom of the track frame and the top of the track shoe.
   - Measurement position
     STD: 4th track roller from the sprocket.
     LC: Midway between the 4 th and 5 the track roller from the sprocket.
   - Standard clearance **a** (tension) : 358 ± 20 mm



Adjusting

★ If the track shoe tension is not within the standard value, adjust as follows.

1. **If the track tension is too high:**
   Loosen plug (1) gradually, and release the grease.
   ⚠ There is danger that the plug may fly out under the high internal pressure of the grease, so never loosen plug (1) more than 1 turn.
   ★ If the grease does not come out easily, move the machine backwards or forwards slowly.

2. **If the track tension is too low:**
   Pump in grease through grease fitting (2).
   ★ If the grease cannot be pumped in easily, move the machine backwards and forwards slowly.

BLEEDING AIR

Order for operations and procedure for bleeding air

Nature of work \ Air bleeding item	Air bleeding procedure					
	1	2	3	4	5	6
	Bleeding air from pump	Start engine	Bleeding air from cylinder	Bleeding air from swing motor	Bleeding air from travel motor	Start operations
• Change hydraulic oil • Clean strainer	○ →	○ →	○ →	○(note) →	○(note) →	○
• Replace return filter element		○	→	→	→	○
• Replace, repair pump • Remove suction piping	○ →	○ →	○	→	→	○
• Replace, repair control valve		○ →	○	→	→	○
• Replace cylinder • Remove cylinder piping		○ →	○	→	→	○
• Replace swing motor • Remove swing motor piping		○	→	○	→	○
• Replace travel motor, swivel • Remove travel motor, swivel piping		○	→	→	○ →	○

Note: Bleed the air from the swing and travel motors only when the oil inside the motor case has been drained.

1. Bleeding air from pump

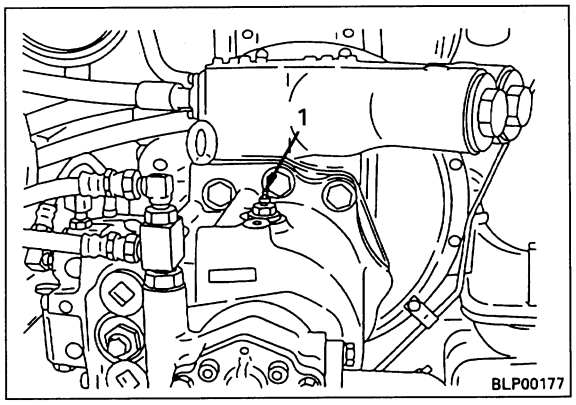
1) Loosen air bleed plug (1), and check that oil oozes out from the plug.
2) When oil oozes out, tighten plug (1).
   kgm Air bleed plug:
   8.8 ± 1.0 Nm (0.9 ± 0.1 kgm)

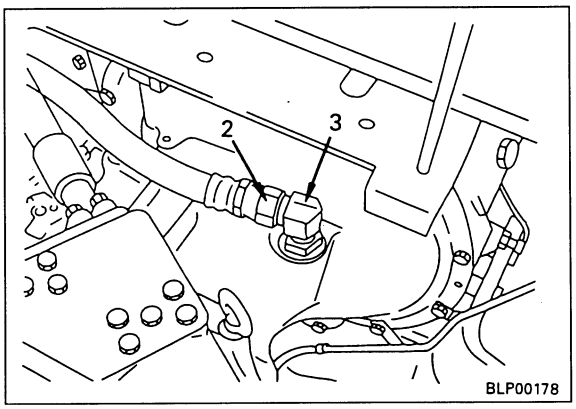
★ If no oil oozes out from the air bleed plug:

3) Leave plug (1) loosened and remove drain hose (2) and elbow (3).
4) Pour in oil through the elbow mount hole until oil oozes out from plug (1).
5) Fit elbow (3) and install drain hose (2).
6) Tighten air bleed plug (1).
   kgm Air bleed plug:
   8.8 ± 1.0 Nm (0.9 ± 0.1 kgm)

★ Precautions when starting the engine
After completing the above procedure and starting the engine, run the engine at low idling for 10 minutes.

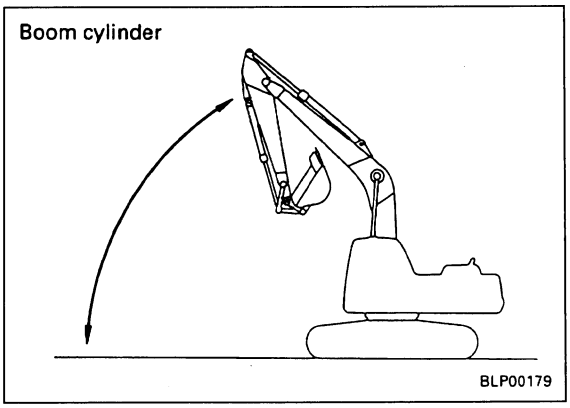
★ If the coolant temperature is low and automatic warming-up is carried out, cancel it by using the fuel control dial after starting the engine.





2. Bleeding air from hydraulic cylinders

1) Start the engine and run at idling for approx. 5 minutes.
2) Run the engine at low idling, then raise and lower the boom 4 - 5 times in succession.
   ★ Operate the piston rod to approx. 100 mm before the end of its stroke. Do not relieve the circuit under any circumstances.
3) Run the engine at full throttle and repeat Step 2). After that, run the engine at low idling, and operate the piston rod to the end of its stroke to relieve the circuit.
4) Repeat Steps 2) and 3) to bleed the air from the arm and bucket cylinders.
   ★ When the cylinder has been replaced, bleed the air before connecting the piston rod.
   Be particularly careful not to operate the cylinder to the end of its stroke when the piston rod been connected to the LOWER end of the boom cylinder.

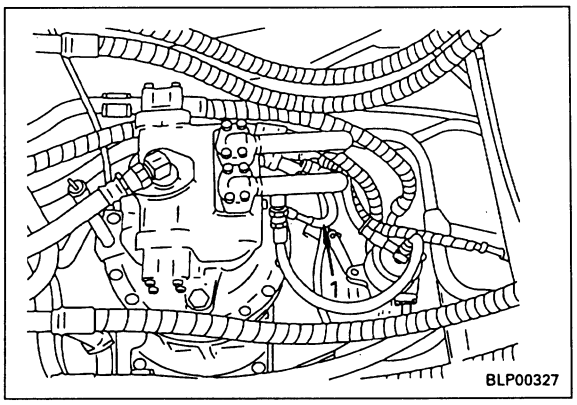


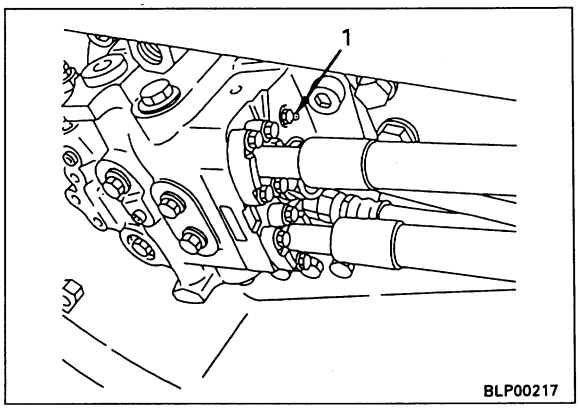
3. Bleeding air from swing motor

1) Inside motor case
   Run the engine at low idling for 5 minutes.
   ★ This operation will bleed the air inside the motor case automatically
2) Inside brake case
   ★ Normally, the air inside the brake case is bled automatically, but if it feels that the swing, bleed the air as follows.
   Loosen the mouthpiece of brake hose (1), start the engine, and operate the swing prolix switch ON-OFF repeatedly. When oil oozes out, tighten the mounthpiece.

4. Bleeding air from travel motor

1) Run the engine at low idling, loosen air bleed plug (1), and check that oil oozes out from the plug.
2) When oil oozes out, tighten air bleed plug (1) again.
   kgm Air bleed plug:
   8.8 ± 1.0 Nm (0.9 ± 0.1 kgm)





TROUBLESHOOTING

POINTS TO REMEMBER WHEN TROUBLESHOOTING

⚠ Stop the machine in a level place, and check that the safety pin, blocks, and parking brake are securely fitted.

⚠ When carrying out the operation with two or more workers, keep strictly to the agreed signals, and do not allow any unauthorized person to come near.

⚠ If the radiator cap is removed when the engine is hot, hot water may spurt out and cause burns, so wait for the engine to cool down before starting troubleshooting.

⚠ Be extremely careful not to touch any hot parts or to get caught in any rotating parts.

⚠ When disconnecting wiring, always disconnect the negative (-) terminal of the battery first.

⚠ When removing the plug or cap from a location which is under pressure from oil, water or air, always release the internal pressure first. When installing measuring equipment, be sure to connect it properly.

The aim of troubleshooting is to pinpoint the basic cause of the failure, to carry out repairs swiftly, and to prevent reoccurrence of the failure.
When carrying out troubleshooting, and import point is of course to understand the structure and function. However, a short cut to effective troubleshooting is to ask the operator various questions to form some idea of possible causes of the failure that would procudure the reported symptoms.

1. When carrying out troubleshooting, do not hurry to disassemble the components.
   If components are diassembled immediately any failure occurs:
   - Parts that have no connection with the failure or other unnecessary parts will be disassembled.
   - It will becom impossible to find the cause of the failure.

   It will also cause a waste of manhours, parts, or oil or grease, and at the same time, will also lose the confidence of the user or operator.
   For this reason, when carrying out troubleshooting, it is necessary to carry out thorough prior investigation and to carry out troubleshooting in accordance with the fixed procedure.
2. Points to ask user or operator
   1) Have any other problems occured apart from the problem that has been reported?
   2) Was there anything strange about the machine before the failure occured?
   3) Did the failure occur suddenly, or were there problems with the machine condition before this?
   4) Under what conditions did the failure occur?
   5) Had any repairs been carried out before the failure?
      When were these repairs carried out?
   6) Has the same kind of failure occurred before?
3. Check before troubleshooting
   1) Check the oil level
   2) Check for any external leakage of oil from the piping or hydraulic equipment.
   3) Check the travel of the control levers.
   4) Check the stroke of the control valve spool.
   5) Other maintenance items can be checked externally, so check any item that is considered to be necessary
4. Confirming failure
   - Confirm the extent of the failure yourself, and judge whether to handle it as a real failure or as a problem with the method of operation, etc.
     ★ When operating the machine to reenact the troubleshooting symptoms, do not carry out any investigation or measurement that may make the problem worse.
5. Troubleshooting
   - Use the results of the investigation and inspection in items 2 - 4 to narrow down the causes of failure, then use the troubleshooting flowchart to locate the position of the failure exaxtly.
     ★ The basic procedure for troubleshooting is as follows.
   1) Start from the simple points.
   2) Start from the most likely points.
   3) Investigate other related parts or information.
6. Measures to remove root cause of failure
   - Even if the failure is repaired, if the root cause of the failure is not repaired, the same failure will occur again.
     To prevent this, always investigate why the problem occurred. Then remove the root cause.

SEQUENCE OF EVENTS IN TROUBLESHOOTING

Office, shop

TEW00180

Step 1

Examination, confirmation of symptoms

1) When a request for repairs is received, first ask the following points.
   - Name of customer
   - Type, serial numer of machine
   - Details of jobsite, etc.
2) Ask questions to gain an outline of the problem.
   - Condition of failure
   - Work being carried out at the time of the failure
   - Operating environment
   - Past history, details of maintenance, etc.

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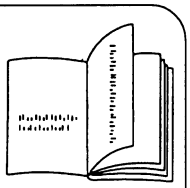
Step 2

Determining probable location of cause

1) Look at the troubleshooting section of the shop manual to find locations of possible causes.



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Step 3

Preparation of troubleshooting tools

1) Look at the table of troubleshooting tools in the shop manual and prepare the necessary tools.
   - T - adapter
   - Hydraulic pressure gauge kit. etc.
2) Look in the parts book and prepare the necessary replacement parts.

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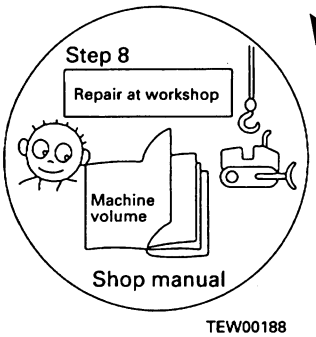

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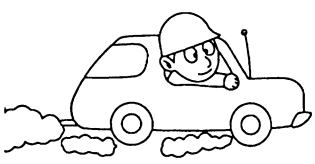
Step 4

Go to jobsite



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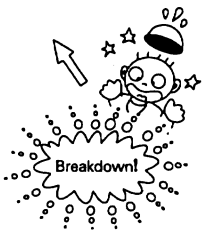
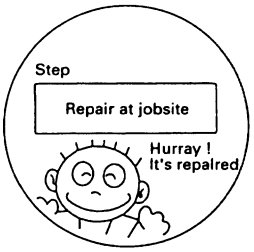
Jobsite

TEW00181



TEW00183



TEW00185

Step 7

- Pinpoint locations of failure (carry out troubleshooting)
- Decide action to take

1) Before starting troubleshooting, locate and repair simple failures.
   - Check before starting items
   - Other check items
2) See the Troubleshooting Section of the shop manual, select a troubleshooting flowchart that matches the symptoms, and carry out troubleshooting.

TEW00187

Step 6

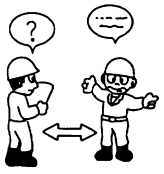
Re-enacting failure

- Drive and operate the machine to confirm the condition and judge if there is really a failure.

Step 5

Ask operator questions to confirm details of failure

- Was there anything strange about the machine before the failure occurred?
- Did the failure occur suddenly?
- Had any repairs been carried out before the failure?



TEW00190

POINTS TO REMEMBER WHEN CARRYING OUT MAINTENANCE

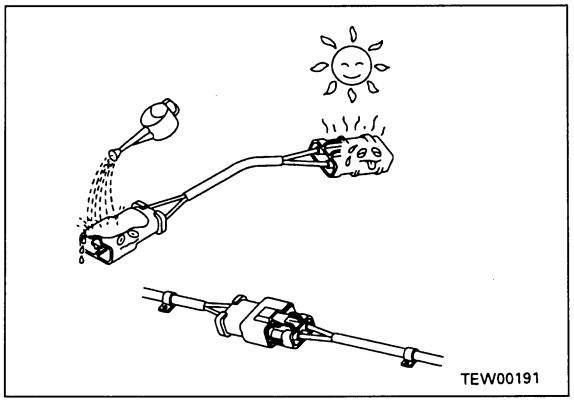
To maintain the performance of the machine over a long period, and to prevent failures or other troubles before they occur, correct operation, maintenance and inspection, troubleshooting, and repairs must be carried out. This section deals particularly with correct repair procedures for mechatronics and is aimed at improving the quality of repairs. For this purpose, it gives sections on "handling electric equipment" and "Handling hydraulic equipment" (particularly gear oil and hydraulic oil).

1. POINTS TO REMEMBER WHEN HANDLING ELECTRIC EQUIPMENT

1) Handling wiring harnesses and connectors

Wiring harness consist of wiring connecting one component to another component, connectors used for connecting and disconnecting one wire from another wire, and protectors or tubes used for protecting the wiring.

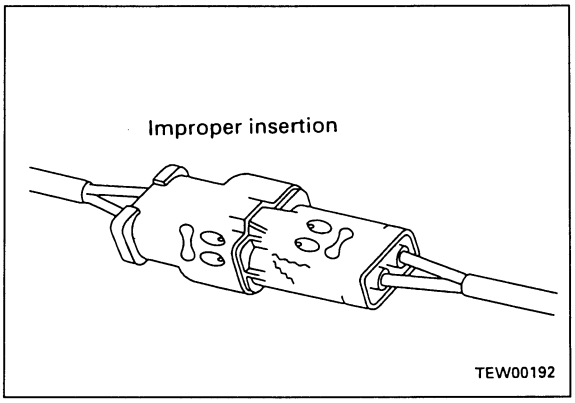
Compared with other electrical components fitted in boxes or cases, wiring harnesses are more likely to be affected by the direct effects of rain, water, heat, or vibration. Furthermore, during inspection and repair operations, they are frequently removed and installed again, so the are likely to suffer deformation or damage. For this reason, it is necessary to be extremely careful when handling wiring harnesses.


TEW00191

Mail failures occurring in wiring harness

① Defective contact of connectors (defective contact between male and female)

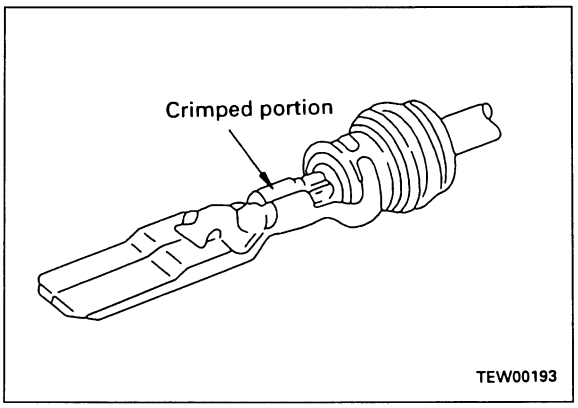
Problems with defective contact are likely to occur because the male connector is not properly inserted into the female connector is deformed or the position is not correctly aligned, or because there is corrosion or oxidization of the contact surfaces.



TEW00192

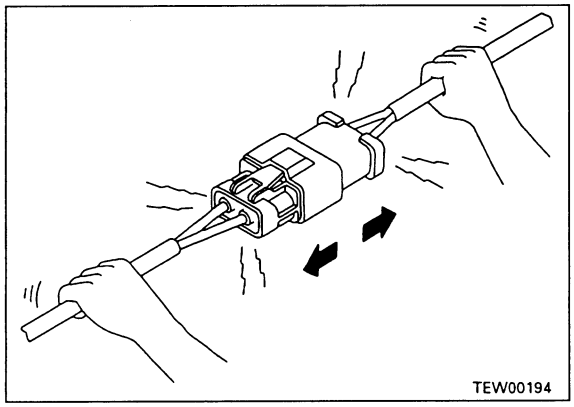
② Defective crimping or soldering of connectors

The pins of the male and female connectors are in contact at the crimped terminal or soldered portion, but if there is excessive force brought to bear on the wiring, the plating at the joint will peel and cause improper connection or breakage.

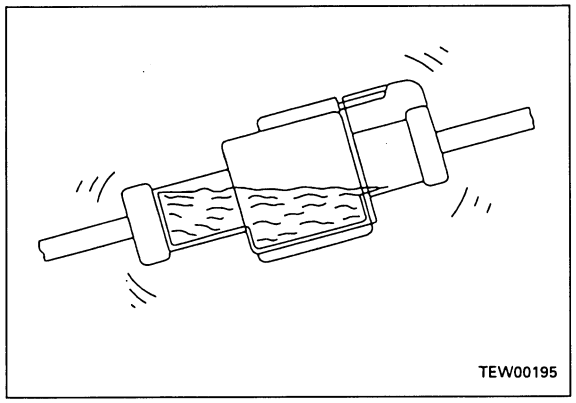


TEW00193

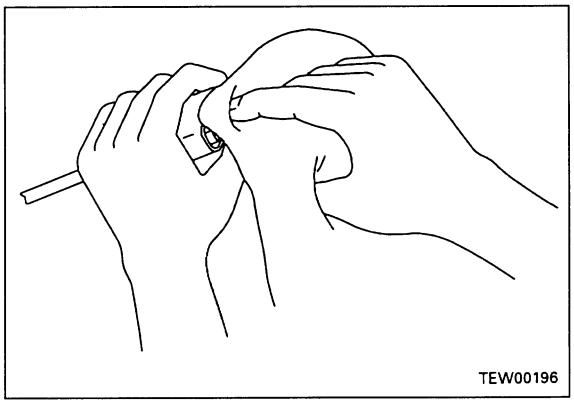
③ Disconnections in wiring
If the wiring is held and the connectors are pulled apart, or components are lifted with a crane with the wiring, the crimping of the connector may separate, or the soldering may be damaged, or the wiring may be broken.


TEW00194

④ High-pressure water entering connector
The connector is designed to make it difficult for water to enter (drip-proof structure), but if high-pressure water is sprayed directly on the connector, water may enter the connector, depending on the direction of the water jet.
As already said, the connector is designed to prevent water from entering, but at the same time, if water does enter, it is difficult for it to be drained. Therefore, if water should get in to the connector, the pins will be shortcircuited by the water, so if any water gets in, immediately dry the connector or take other appropriate action before passing electricity through it.


TEW00195

⑤ Oil or dirt stuck to connector
If oil or grease are stuck to the connector and an oil film is formed on the mating surface between the male and female pins, the oil will not let the electricity pass, so there will be defective contact.
If there is oil or grease stuck to the connector, wipe it off with a dry cloth or blow it dry with compressed air and spray it with a contact restorer.
★ When wiping the mating portion of the connector, be careful not to use excessive force or deform the pins.
★ If there is oil or water in the compressed air, the contacts will become even dirtier, so remove the oil and water from the compressed air completeley before cleaning with compressed air.

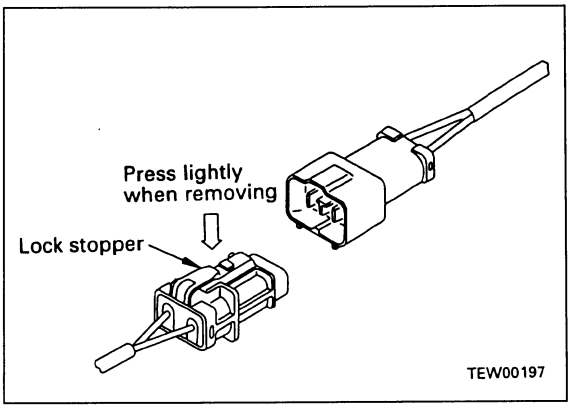

TEW00196

2) Removing, installing, and drying connectors and wiring harnesses

- **Disconnecting connectors**

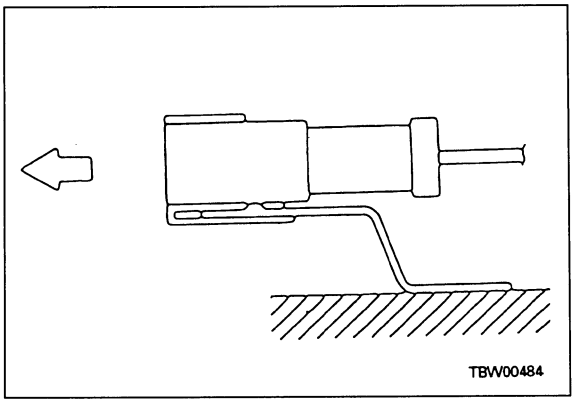
① Hold the connectors when disconnecting. When disconnecting the connectors, hold the connectors and not the wires. For connectors held by a screw, loosen the screw fully, then hold the male and female connecters in each hand and pull apart. For connectors which have a lock stopper, press down the stopper with your thumb and pull the connectors apart.

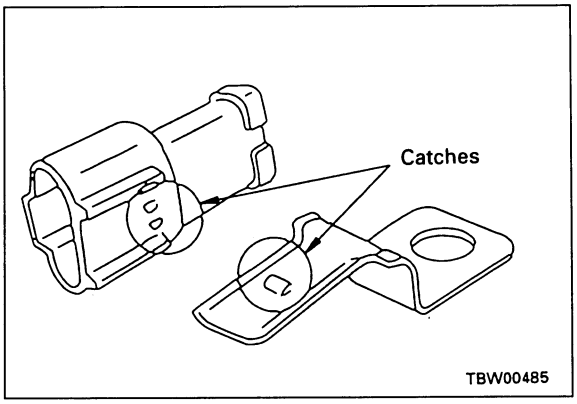
★ Never pull with one hand.



② When removing from clips
When removing a connector from a clip pull the connector in a parallel direction to the clip.

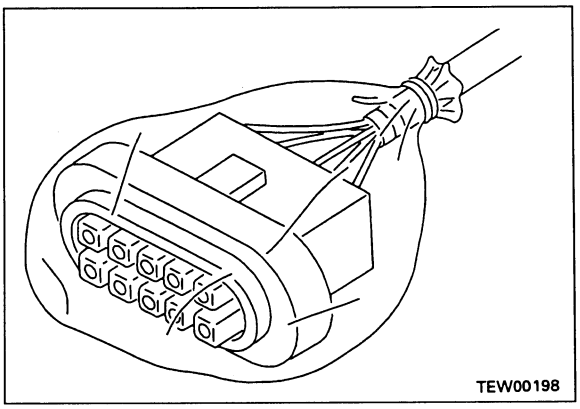
★ If the connector is twisted up and down or to the left or right, the housing may break.





3 Action to take after removing connectors
After removing any connector, cover it with a vinyl bag to prevent any dust, dirt, oil, or water from getting int the connector protion.

★ If the machine is left disassembled for a long time, it is particulary easy for improper contact to occur, so always cover the connector.



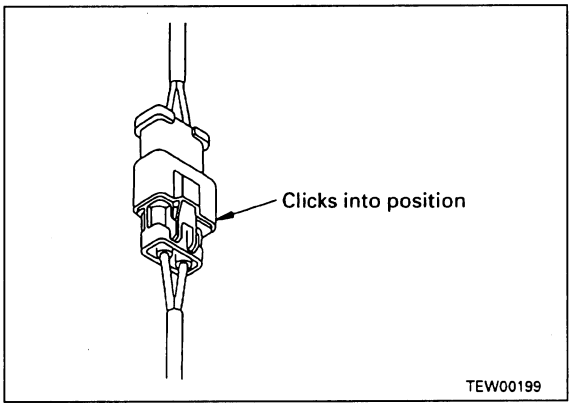
- **Connecting connectors**

① Check the connector visually

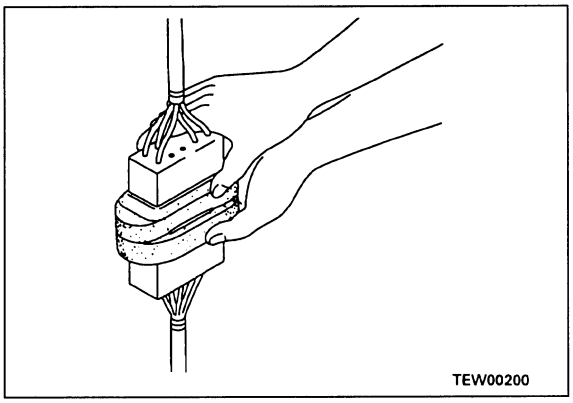
1) Check that there is no oil, dirt, or water stuck to the connector pins (mating portion).
2) Check that there is no damage or breakage to the outside of the connector.
3) Check that there is no damage or breakage to the outside of the connector.

★ If there is any oil, water, or dirt stuck to the connector, wipe it off with a dry cloth. If any water has got inside the connector, warm the inside of the wiring with a dryer, but be careful not to make it too hot as this will cause short circuits.

★ If there is any damage or breakage, replace the connector.

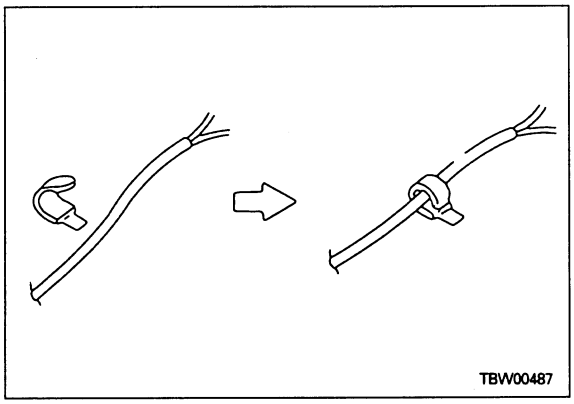


② Fix the connector securely
Align the position of the connector correctly, then insert it securely.
For connectors with lock stopper, push in the connector until the stopper clicks into position.



③ Correct any protrusion of the boot and any misalignment of the wiring harness
For connectors fitted with boots, correct any protrusion of the boot. In addition, if the wiring harness is misaligned, or the clamp is out of position, adjust it to its correct position.

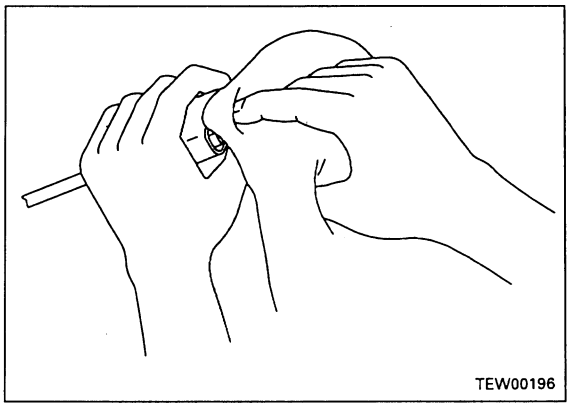
★ If the connector cannot be corrected easily, remove the clamp and adjust the position.



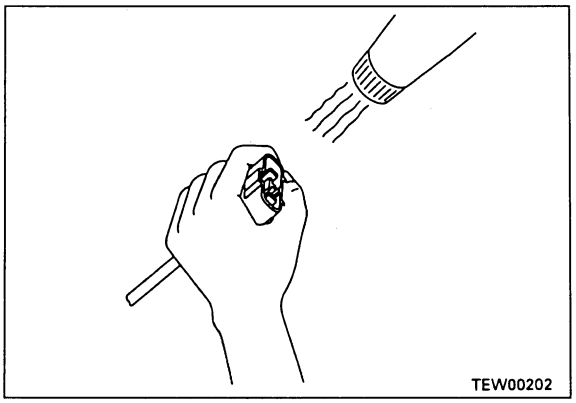
④ If the connector clamp has been removed, be sure to return it to its original position.
Check also that there are no loose clamps.

- **Drying wiring harness**
  If there is any oil or dirt on the wiring harness, wipe it off with a dry cloth. Avoid washing it in water or using steam. If the connector must be washed in water, do not use high-pressure water or steam directly on the wiring harness.

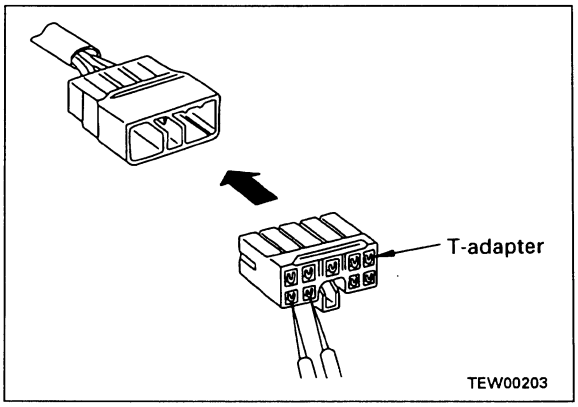
  If water gets directly on the connector, do as follows.
  ① Disconnect the connector and wipe off the water with a dry cloth.
  ★ If the connector is blown dry with compressed air, there is the risk that oil in the air may cause defective contact, so remove all oil and water from the compressed air before blowing with air.



② Dry the inside of the connector with a dryer.
If water gets inside the connector, use a dryer to dry the connector.
★ Hot air from the dryer can be used, but regulate the time that the hot air is used in order not to make the connector or related parts too hot, as this will cause deformation or damage to the connector.



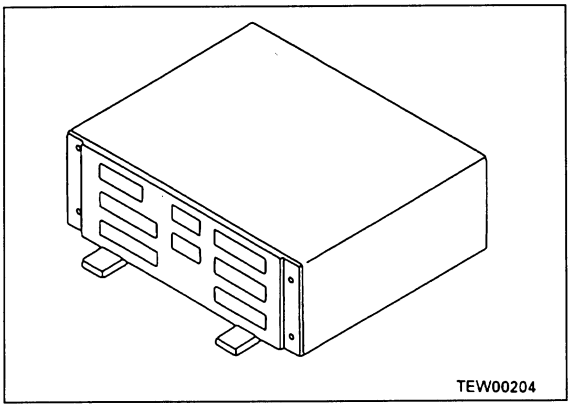
③ Carry out a continuity test on the connector.
After drying, leave the wiring harnes disconnected and carry out a continuity test to check for any short circuits between pins caused by water.
★ After completely drying the connector, blow it with contact restorer and reassemble.



3) Handling control box

① The control box contains a microcomputer and electronic control circuits. These control all of the electronic circuits on the machine, so be extremely careful when handling the control box.

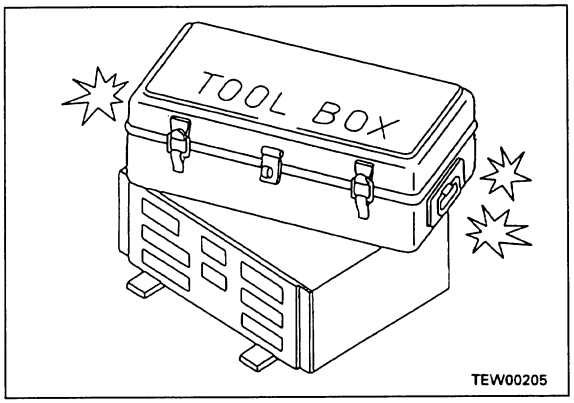
② Do not open the cover of the control box unless necessary.


TEW00204

③ Do not place objects on top of the control box.

④ Cover the control connectors with tape or a vinyl bag.
Neve touch the connector contacts with your hand.

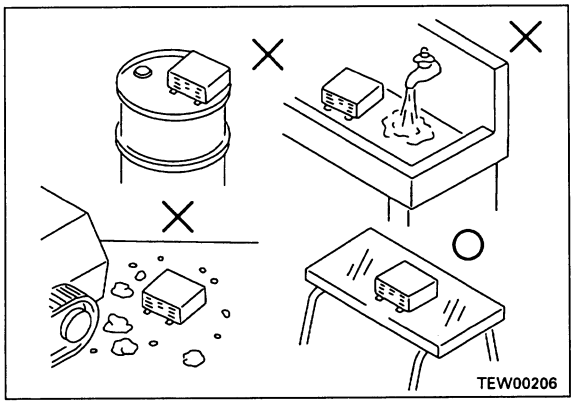
⑤ During rainy weather, do not leave the control box in a place where it is exposed to rain.



TEW00205

⑥ Do not place the control box on oil, water, or soil, or in any hot place, even for a short time.
(place it on a suitable dry stand).

⑦ Precautions when carrying out arc welding disconnect all wiring harness connectors connected to the control box. Fit an arc welding ground close to the welding point.


TEW00206

2. Points to remember when troubleshooting electric circuits

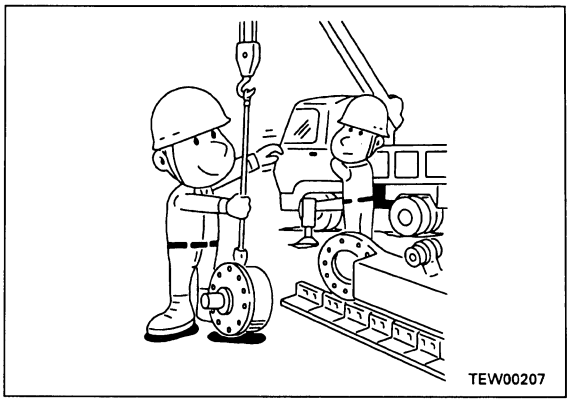
1) Always turn the power OFF before disconnecting or connect connectors.
2) Before carrying out troubleshooting, check that all the related connectors are properly inserted.
   ★ Disconnect and connect the related connectors several times to check.
3) Always connect any disconnected connectors before going on to the next step
   ★ If the power is turned ON with the connectors still disconnected, unnecessary abnormality displays will be generated.
4) When carrying out troubleshooting of circuits (measuring the voltage, resistance, continuity, or current), move the related wiring and connectors several times and check that there is no change in the reading of the tester.
   ★ If there is any change, there is probably defective contact in that circuit.

3. POINTS TO REMEMBER WHEN HANDLING HYDRAULIC EQUIPMENT

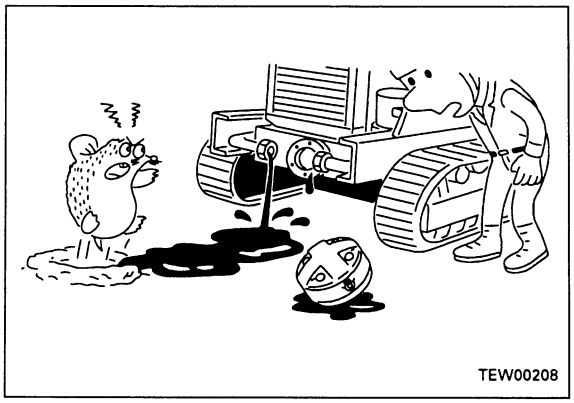
With the increase in pressure and precision of hydraulic equipment, the most common cause of failure is dirt (foreign material) in the hydraulic circuit. When adding hydraulic oil, or when disassembling or assembling hydraulic equipment, it is necessary to be particularly careful.

1) **Be careful of the operating environment.**
Avoid adding hydraulic oil, replacing filters, or repairing the machine in rain or high winds, or places where there is a lot of dust.

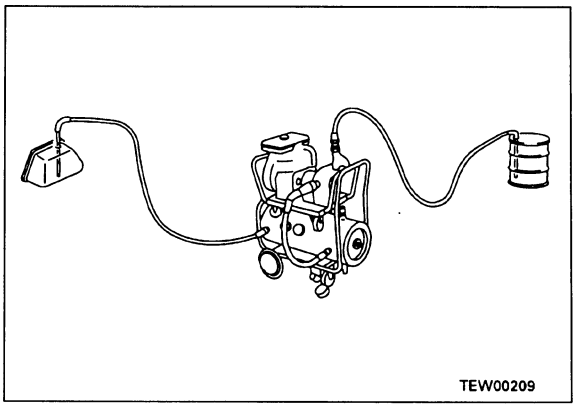
2) **Disassembly and maintenance work in the field**
If disassembly or maintenance work is carried out on hydraulic equipment in the field, there is danger of dust entering the equipment. It is also difficult to confirm the performance after repairs, so it is desirable to use unit exchange. Disassembly and maintenance of hydraulic equipment should be carried out in a specially prepared dustproof workshop, and the performance should be confirmed with special test equipment.


TEW00207

3) **Sealing openings**
After any piping or equipment is removed, the openings should be sealed with caps, tapes or vinyl bags to prevent any dirt or dust from entering. If the opening is left open or is blocked with a rag, there is danger of dirt entering or of the surrounding area being made dirty by leaking oil so never do this.
Do not simply drain oil out on to the ground, collect it and ask the customer to dispose of it, or take it bake with you for disposal.

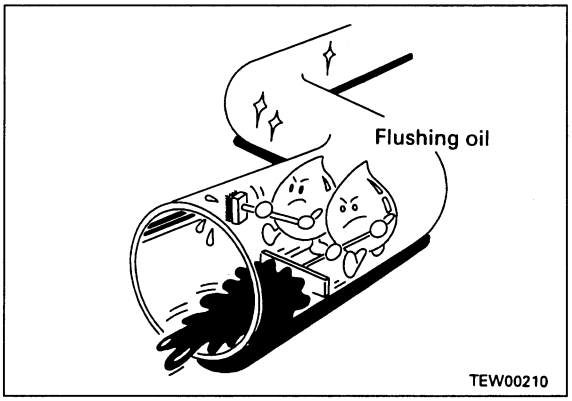

TEW00208

4) **Do not let any dirt or dust get in during refilling operations.**
Be careful not to let any dirt or dust get in when refilling with hydraulic oil. Always keep the oil filler and the area around it clean, and also use clean pumps and oil containers. If an oil cleaning device is used, it is possible to filter out the dirt that has collected during storage, so this is an even more effective method.

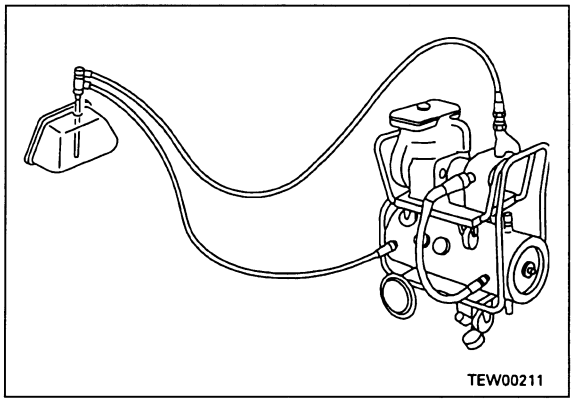

TEW00209

5) **Change hydraulic oil when the temperature is high.**
When hydraulic oil or other oil is warm, it flows easily. In addition, the sludge can also be drained out easily from the circuit together with the oil, so it is best to change the oil when it is still warm. When changing the oil must be drained out. (Do not drain the oil from te hydraulic tank; also drain the oil from the filter and from the drain plug in the circuit.) If any old oil is left, the contaminants and sludge in it will mix with the new oil and will shorten the life of the hydraulic oil.

6) **Flushing operations**
After disassembling and assembling the equipment, or changing the oil, use flushing oil to remove the contaminants, sludge, and old oil from the hydraulic circuit. Normally, flushing is carried out twice: primary flushing is carried out with flushing oil, and secondary flushing is carried out with the specified hydraulic oil.



7) **Cleaning operations**
After repairing the hydraulic equipment (pump, control valve, etc.) or when running the machine, carry out oil cleaning to remove the sludge or contaminants in the hydraulic oil circuit.
The oil cleaning equipment is used to remove the ultrafine (about3μ) particles that the filter built into the hydraulic equipment cannot remove, so it is an extremely effective device.



CHECKS BEFORE TROUBLESHOOTING

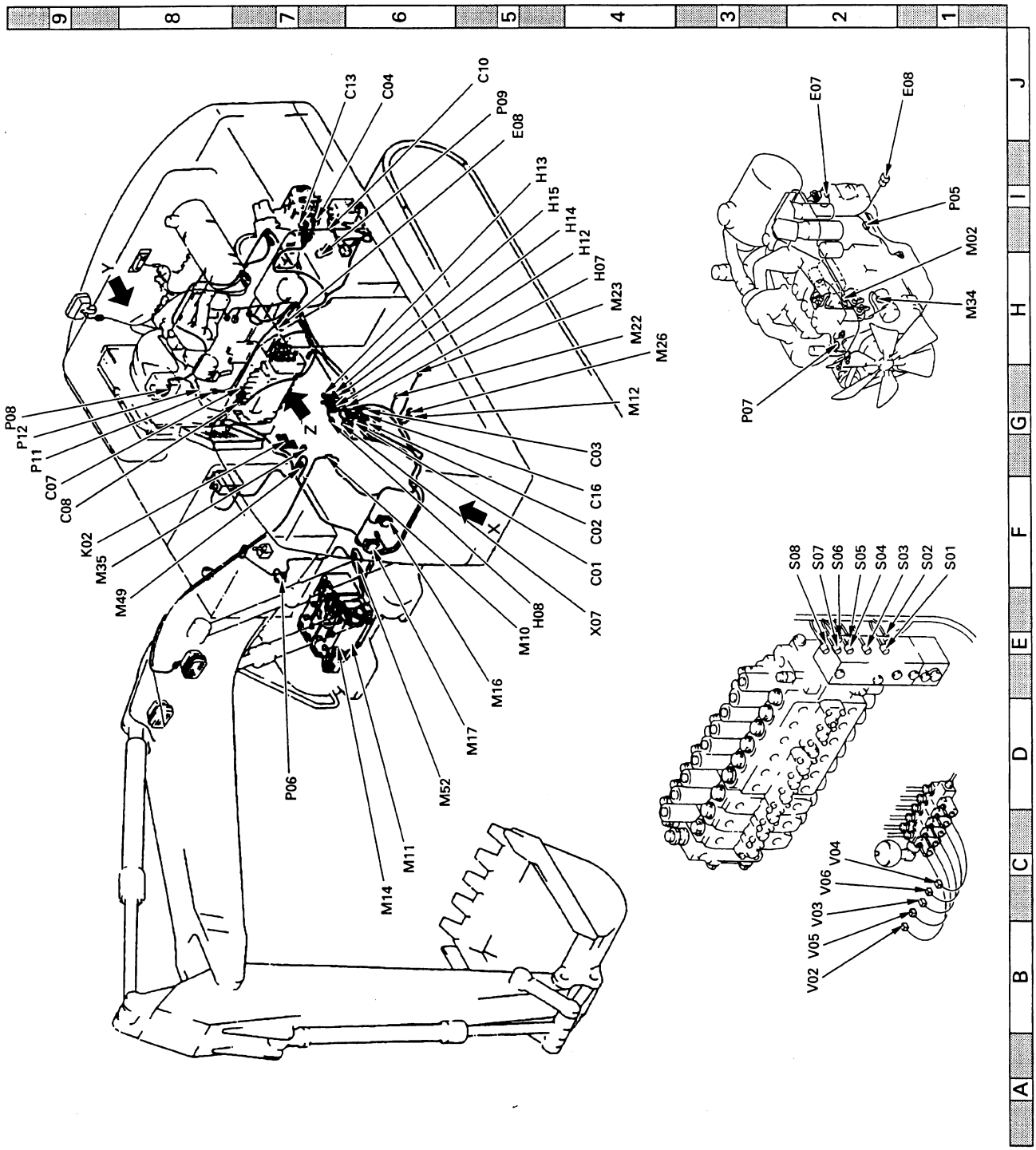
	Item	Judgement value	Action
Lubricating oil, coolant	1. Check fuel level, type of fuel	-	Add fuel
	2. Check for impurities in fuel	-	Clean, drain
	3. Check hydraulic oil level	-	Add oil
	4. Check hydraulic strainer	-	Clean, drain
	5. Check swing machinery oil level	-	Add oil
	6. Check engine oil level (oil pan oil level, type of oil	-	Add oil
	7. Check coolant level	-	Add water
	8. Check dust indicator for clogging	-	Clean or replace
	9. Check hydraulic filter	-	Replace
Electrical equipment	1. Check for looseness, corrosion of battery terminal, wiring	-	Tighten or replace
	2. Check for looseness, corrosion of alternator terminal, wiring	-	Tighten or replace
	3. Check for looseness, corrosion of starting motor terminal,wiring	-	Tighten or replace
Hydraulic, mechanical equipment	1. Check for abnormal noise, smell	-	Repair
	2. Check for oil leakage	-	Repair
	3. Carry out air bleeding	-	Bleed air
Electrics, electrical equipment	1. Check battery voltage (engine stopped)	20-30V	Replace
	2. Check battery electrolyte level	-	Add or Replace
	3. Check for discolored, burnt, exposed wiring	-	Replace
	4. Check for missing wiring clamps, hanging wiring	-	Repair
	5. Check for water leaking on wiring (be particularly careful attention to water leaking on connectors or terminals)	-	Disconnect connector and dry
	6. Check for blown, corroded fuses	-	Replace
	7. Check alternator voltage (engine running at 1/2 throttle or above)	After running for several minutes: 27.5 - 29.5 V	Replace
	8. Check operating sound of battery (when switch is turned ON/OFF)	-	Replace

CONNECTOR TYPES AND MOUNTING LOCATIONS

★ The Adress collum in the table below shows the address in the connector arrangement drawing. (2-dimensional drawing)

Connector No.	Type	No. of pins	Mounting location	Address
C01	MIC	13	Governor pump controller	F4
C02	MIC	21	Governor pump controller	F4
C03	040	20	Governor pump controller	G4
C04	X	2	Rear pump TVC solenoid valve	J6
C05	S	10	Pump redundancy circuit switch	M1
C06	M	2	Resister	O2
C07	X	3	Rear pump pressure sensor	F9
C08	X	3	Front pump pressure sensor	F9
C09	S	8	Model selection connector	P2
C10	X	2	EPC valve for LS	J5
C13	X	2	Front pump	J6
C16	MIC	17	Governor pump controller	F4
E07	X	2	Engine speed sensor	J2
E08	SWP	14	Engine harness	J5, J1
H07	S	12	Panel harness	H4
H08	M	6	Base harness	E5
H12	S	16	Base harness	I4
H13	S	16	Base harness	I5
H14	M	6	Base harness	I4
H15	L	2	Base harness	I5
K02	X	4	Pressure switch for A/C (option)	F9
M02	X	2	Starting motor	F9
M08	M	2	Right deck	I1
M10	M	1	Working lamp boom (left)	L8
M11	L	2	Fusible link	N9, E5
M12	M	4	Heater	C6
M13	-	8	Speaker	G4
M14	L	2	Fusible link	P5
M16	-	1	Horn (high tone)	C6
M17	-	1	Horn (low tone)	E5
M18	M	4	Wiper, washer switch	D5
M20	-	1	Cigar lighter	M5
M22	M	2	Left knob switch	M4
M23	M	2	Horn switch	H4
M26	-	11	To A/C (option)	H4, N6
M34	-	1	A/C compressor	H4
M35	X	4	To A/C condensor (option)	H1
M38	M	3	Lamp switch	F9

Connector No.	Type	No. of pins	Mounting location	Address
M49	-	1	Refuelling pump (option)	F8
M51	KESI	2	Left front lamp	L5
M52	X	2	Overload alarm (option)	D6
M53	-	2	Heated seat (option)	O6
P01	040	20	Monitor	K3
P02	040	18	Monitor	L3
P03	M	2	Buzzer cancel switch	N5
P04	M-	2	Alarm buzzer	L3
P05	X	4	Engine oil level sensor	I1
P06	X	1	Fuel level sensor	D7
P07	X	2	Engine temperature sensor	G3
P08	X	2	Radiator water level sensor	G9
P09	-	1	Hydraulic oil level sensor	J5
P11	-	1	Hydraulic oil level sensor	G9
P12	SINGA-WA	1	Air cleaner clogging sensor	G9
R04	SINGA-WA	6	Air cleaner clogging sensor	N1
R05	SINGA-WA	6	Relay for std. lamp	N1
R10	SINGA-WA	6	Relay for optional lamp	M1
R11	X	6	Relay for opt. lamp	M1
S01	X	2	Relay for opt. lower wiper	F1
S02	X	2	Travel	F1
S03	X	2	Boom up	F1
S04	X	2	Arm dump	F2
S05	X	2	Boom down	F2
S06	X	2	ARm dig	F2
S07	X	2	Bucket dig	F2
S08	X	2	Bucket dump	F2
S09	X	2	Swing	L6
V02	X	2	Service pressure switch	B2
V03	X	2	LS Divide valve	C2
V04	X	2	confluence vlave	C2
V05	X	2	Swing parking brake	B2
V06	X	2	Machine push up	C2
W04	M	2	Travel speed	L6
W08	070	6	Wiper motor	N2
W10	M	18	Wiper motor controller	N2
W15	KES	4	Connector	K2
X01	MIC	4	To wiper	N5
X05	M	21	Intermediate connector	M4
X07	MIC	17	Panel harness	P3, E4


9
8
7
6
5
4
3
2
1
A
B
C
D
E
F
G
H
I
J
C13
C04
C10
P09
E08
H13
H15
H14
H12
H07
M23
M22
M26
M12
C03
C16
C02
C01
X07
H08
M10
M16
M17
M52
M11
M14
P06
P08
P12
P11
C07
C08
K02
M35
M49
Y
Z
X
E07
E08
P05
M02
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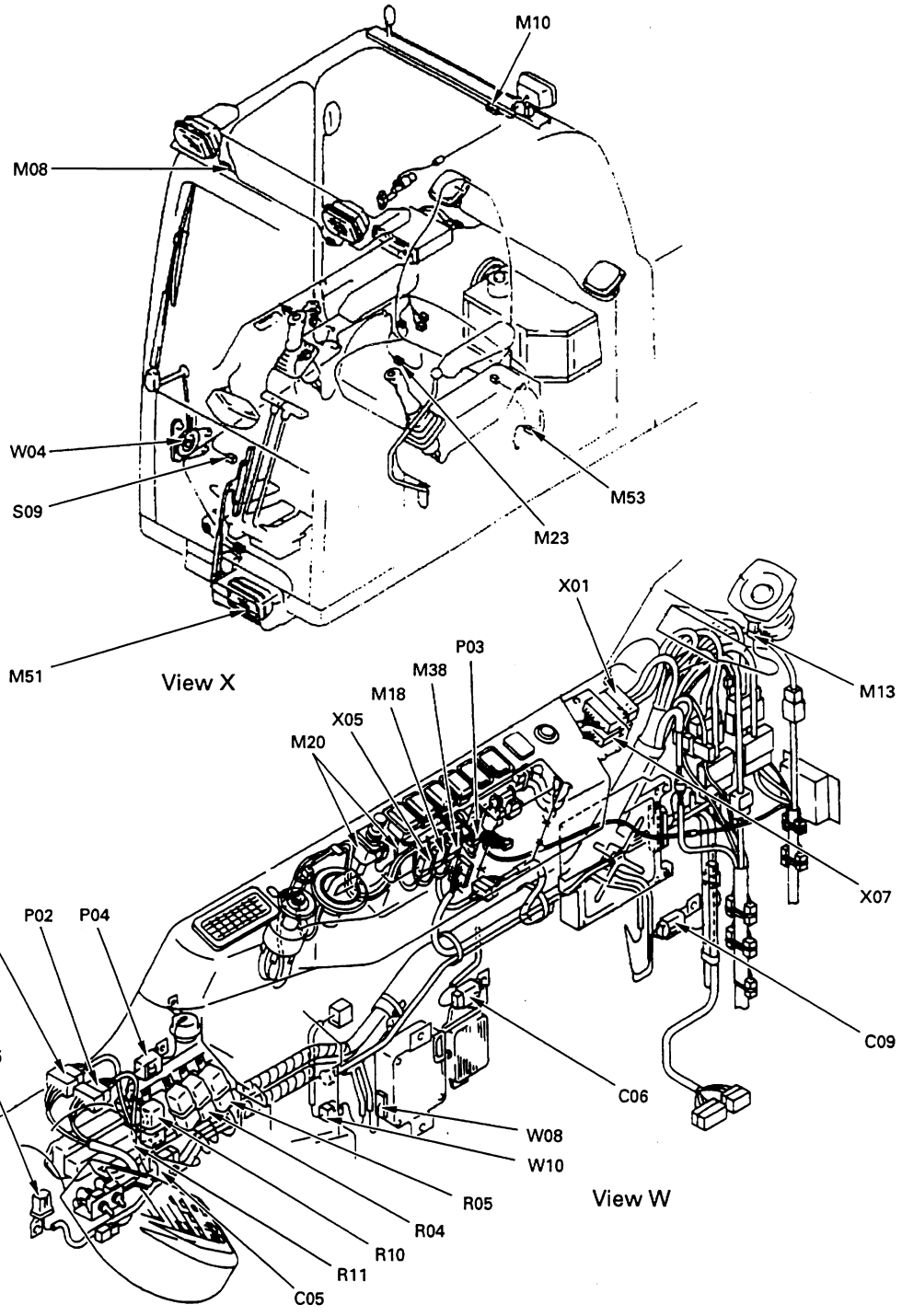
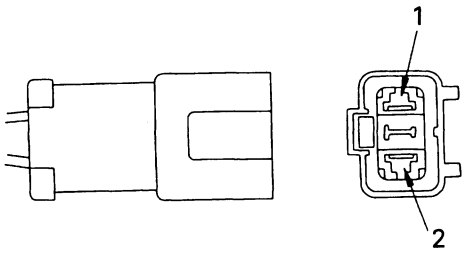
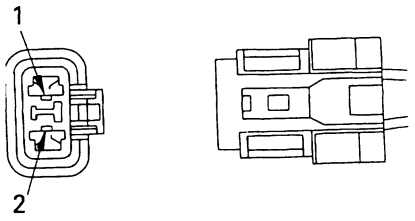
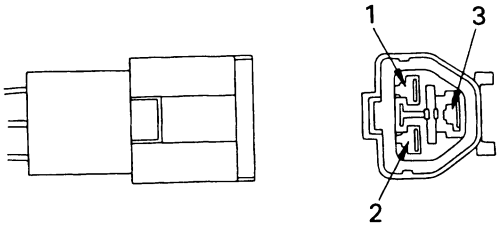
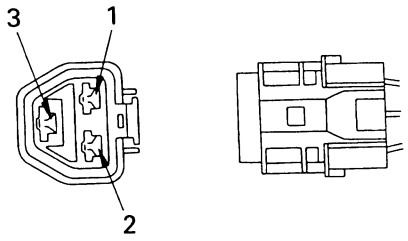
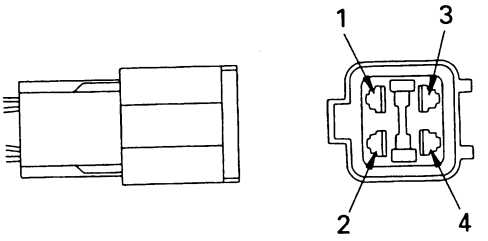
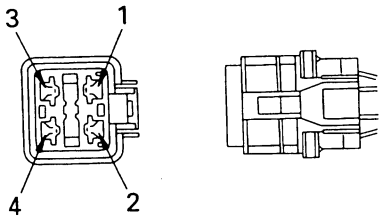
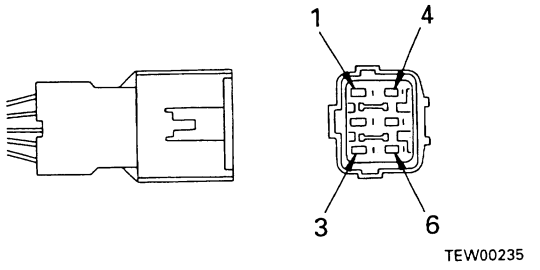
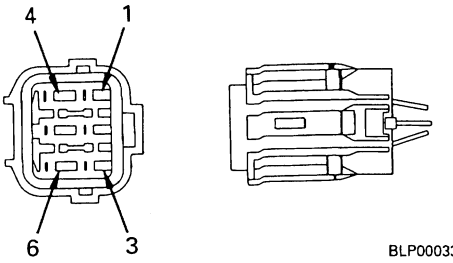
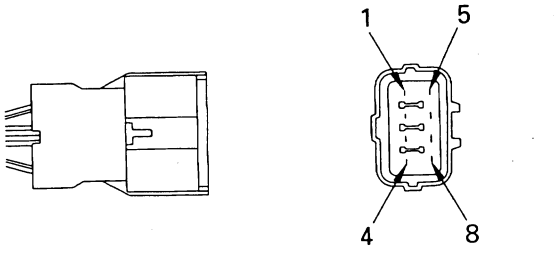
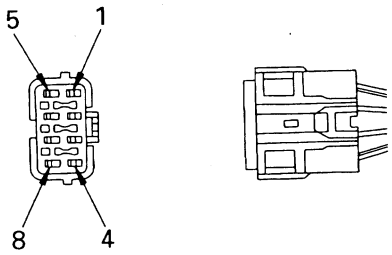
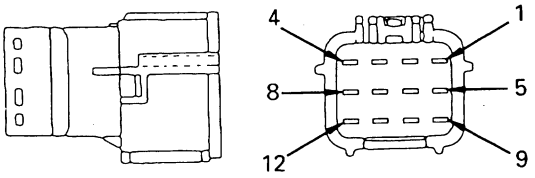
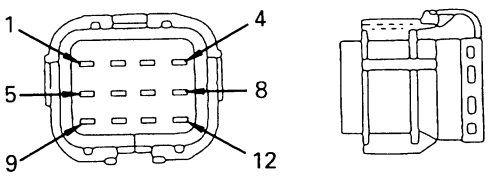
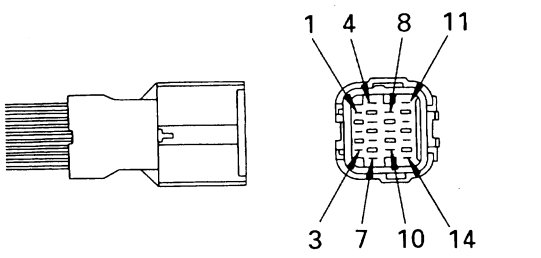
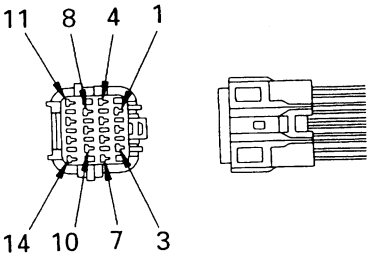
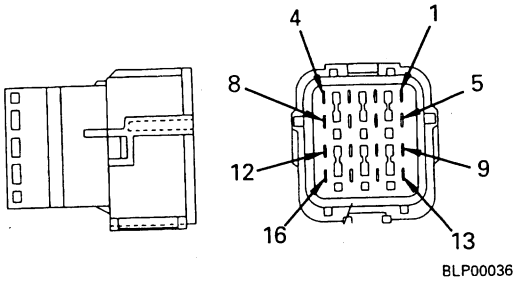
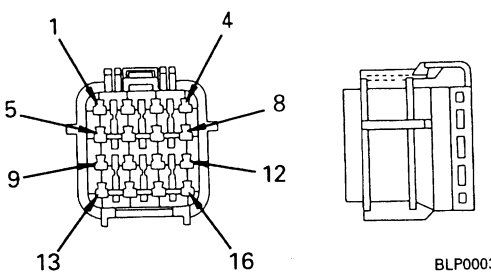
V06
V03
V05
V02

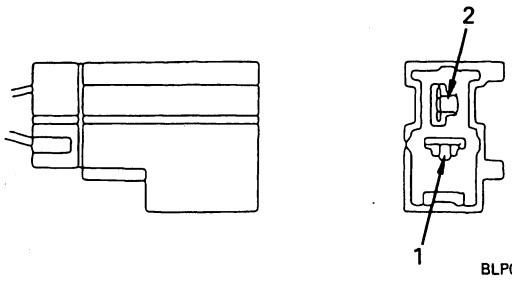
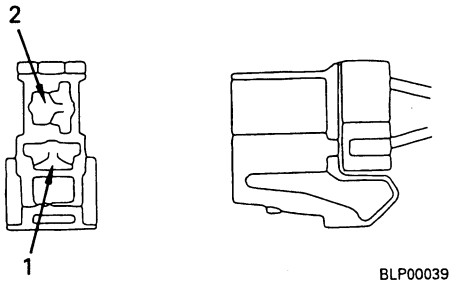
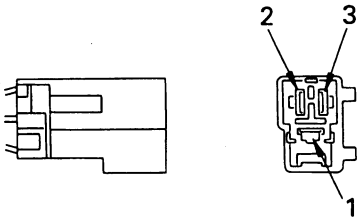
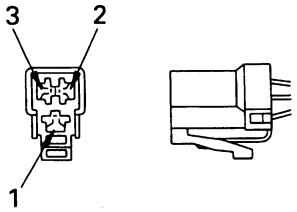
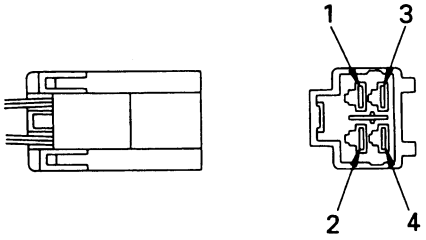
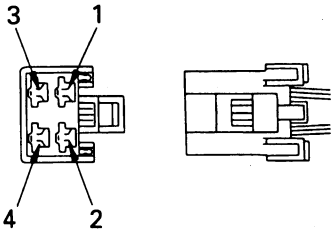
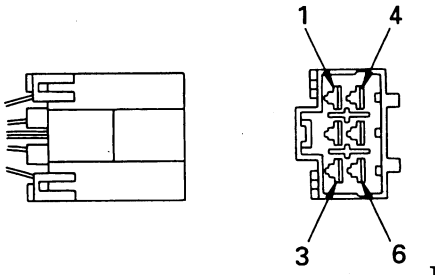
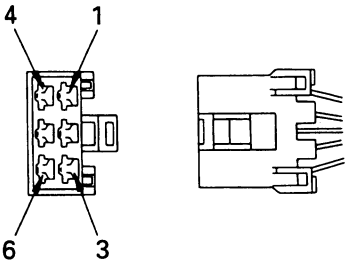
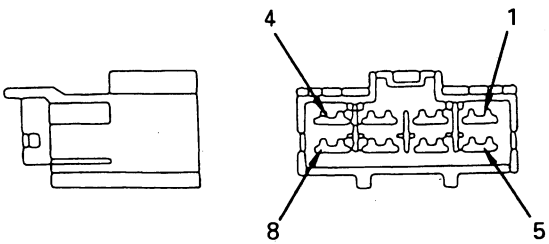
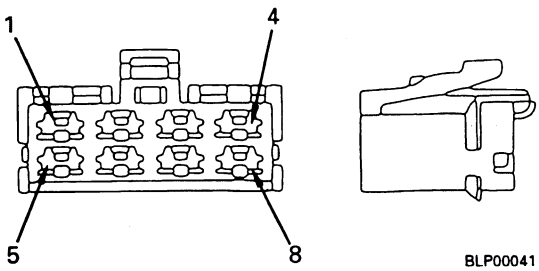

M10
M08
W04
S09
M53
M23
M51
View X
X01
M13
P03
M38
M18
X05
M20
X07
P01
P02
P04
C09
W15
C06
W08
W10
R05
R04
R10
R11
C05
View W

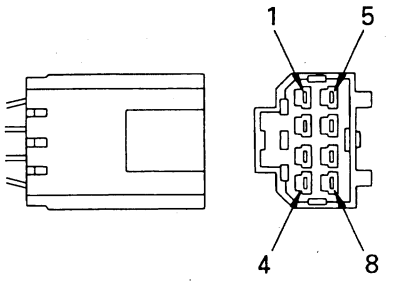
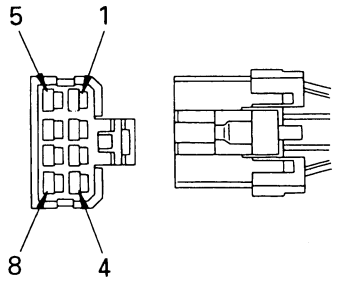
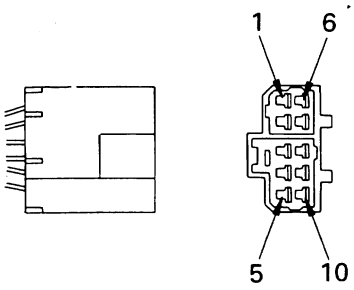
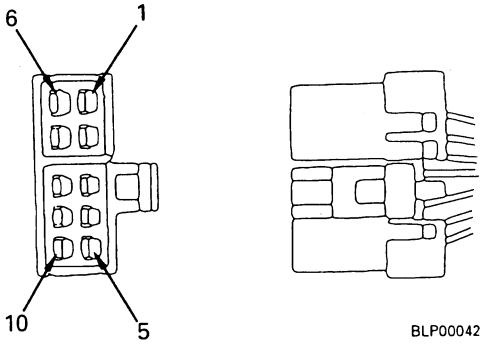
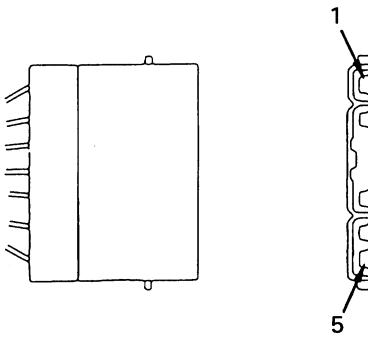
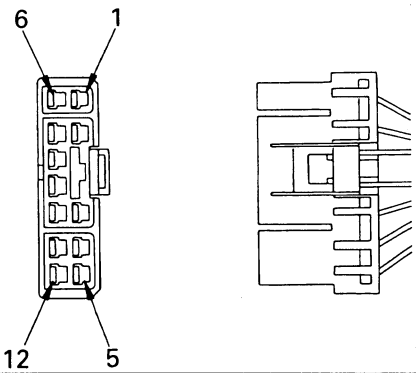
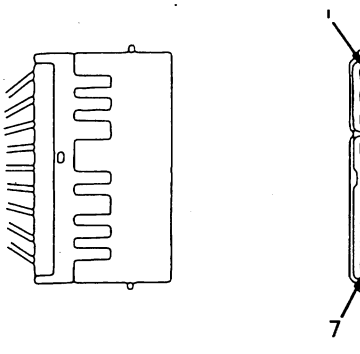
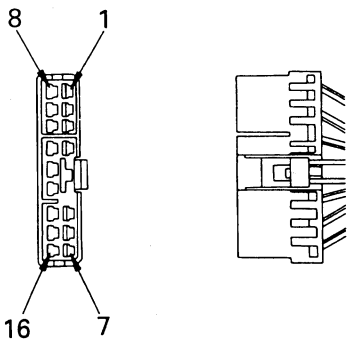
CONNECTION TABLE FOR CONNECTOR PIN NUMBERS

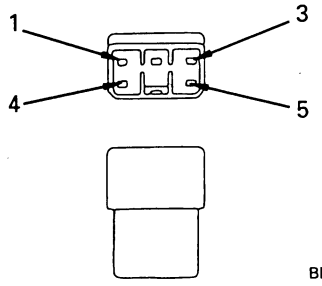
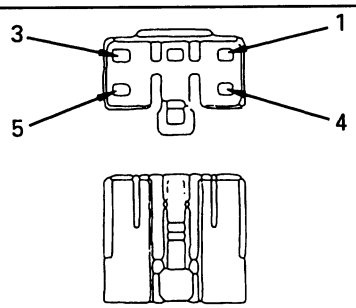
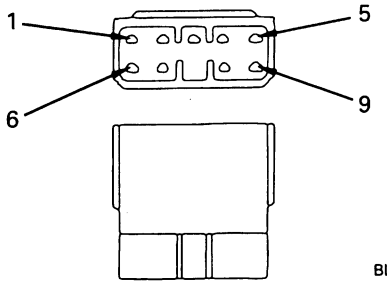
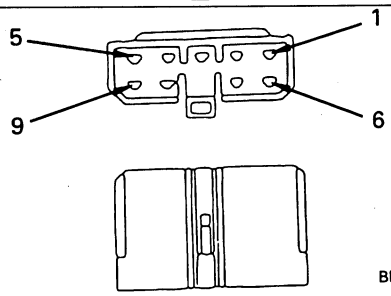
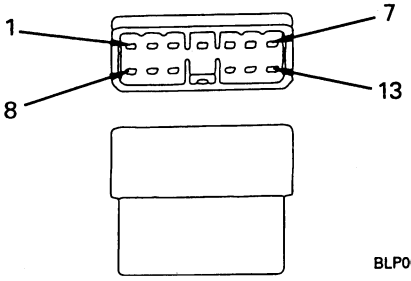
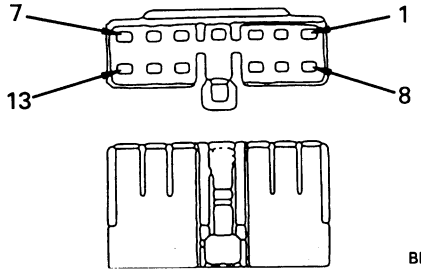
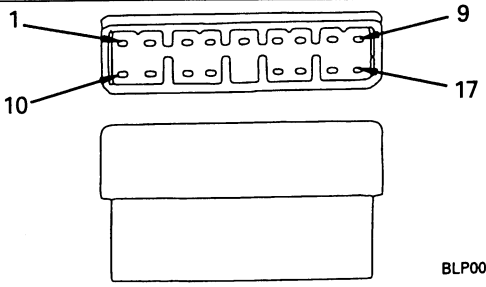
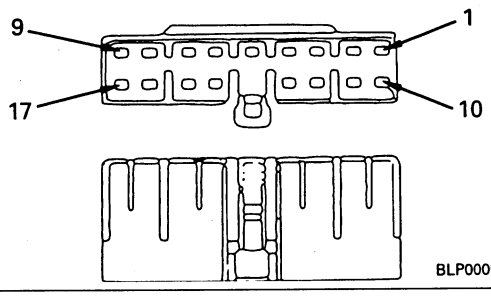
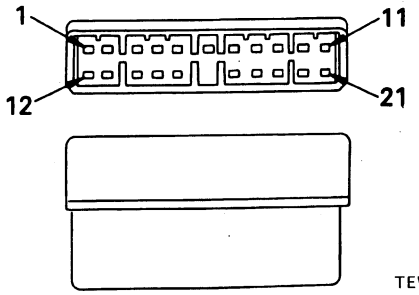
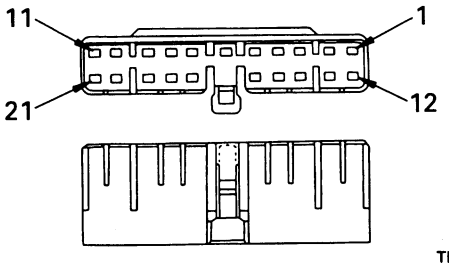
★ The terms male and female refer to the pins, while the terms male housing and female housing refer to the mating portion of the housing.

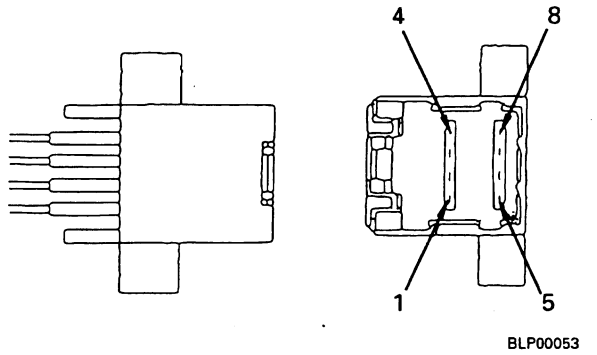
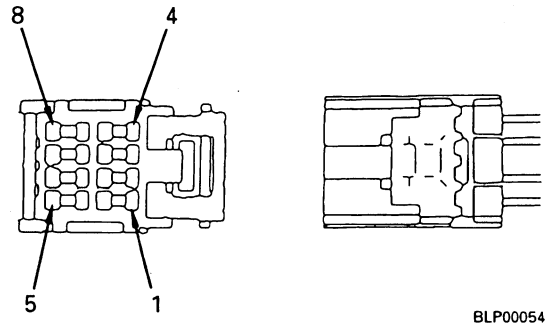
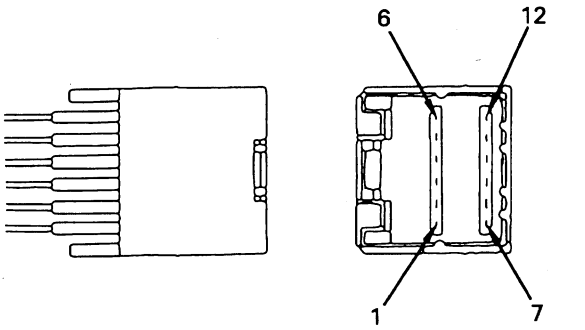
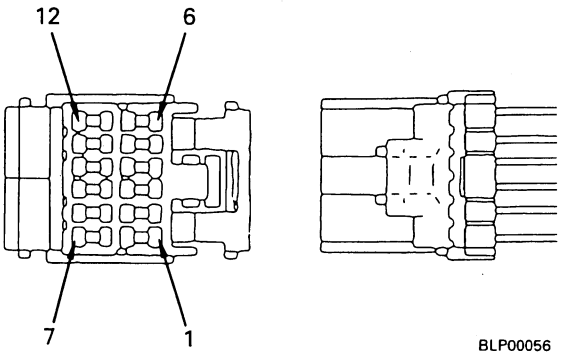
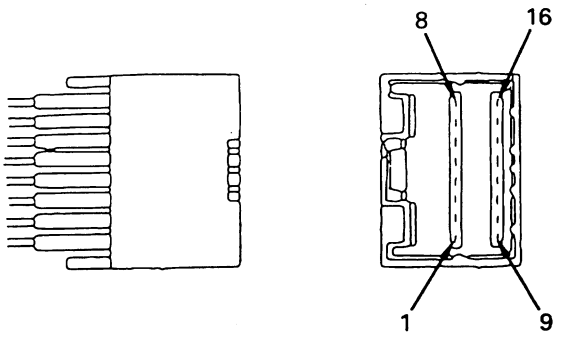
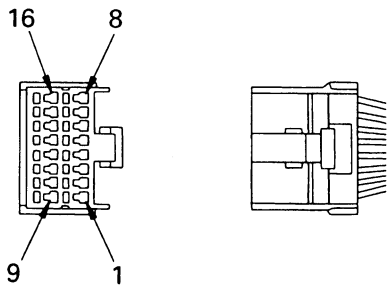
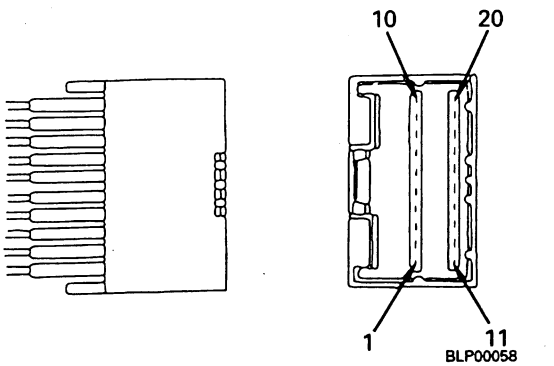
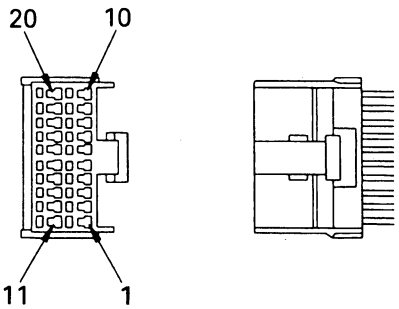
No. of pins	X type connector	
	Male (female housing)	Female (male housing)
2	 TEW00221	 TEW00222
3	 TEW00223	 TEW00224
4	 TEW00225	 TEW00226

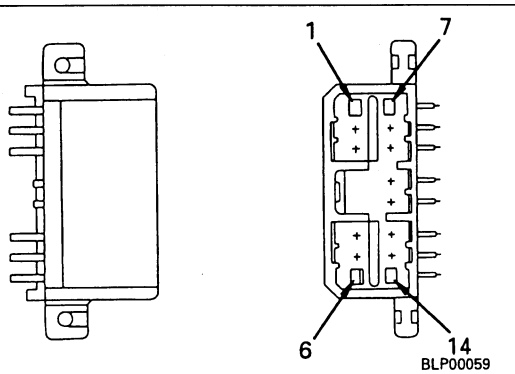
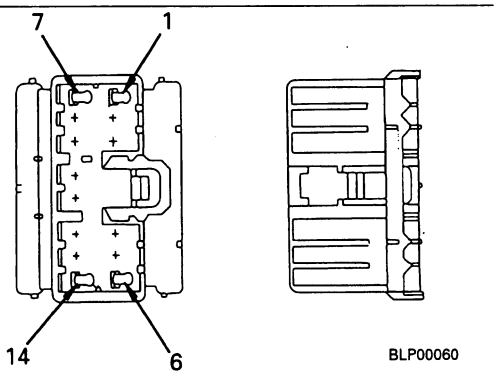
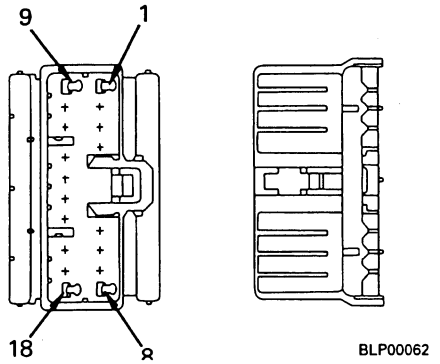
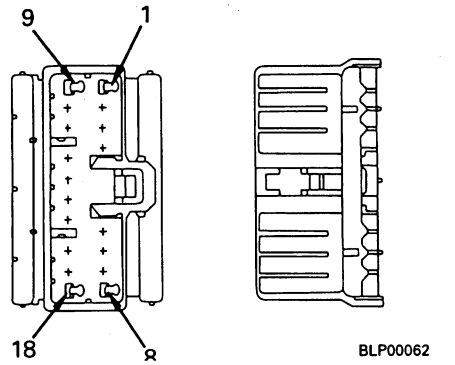
No. of pins	SWP type connector	
	Male (female housing)	Female (male housing)
6	 TEW00235	 BLP00033
8	 TEW00237	 TEW00238
12	 BLP00034	 BLP00035
14	 TEW00239	 TEW00240
16	 BLP00036	 BLP00037

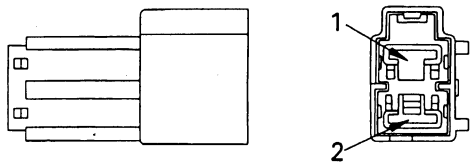
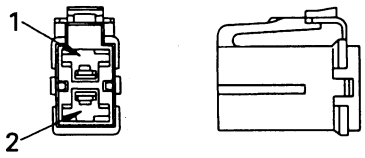
No. of pins	M type connector	
	Male (female housing)	Female (male housing)
2	 BLP00038	 BLP00039
3	 TEW00243	 TEW00244
4	 TEW00245	 TEW00246
6	 TEW00247	 TEW00248
8	 BLP00040	 BLP00041

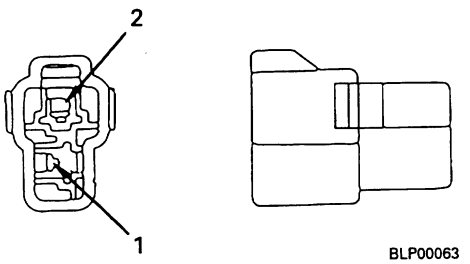
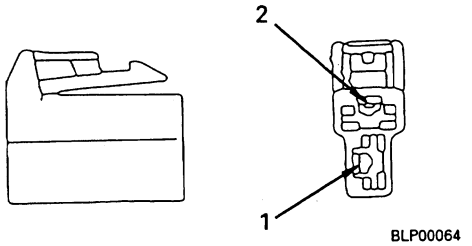
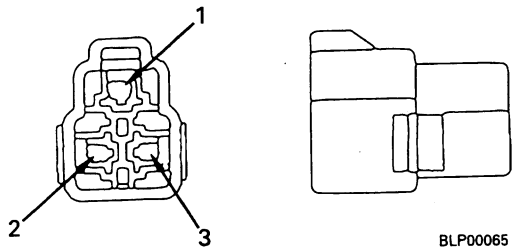
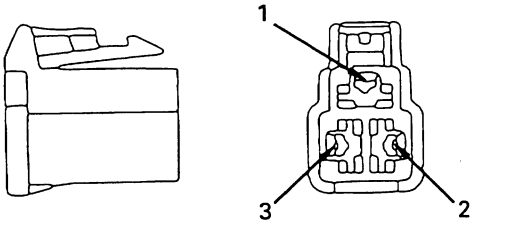
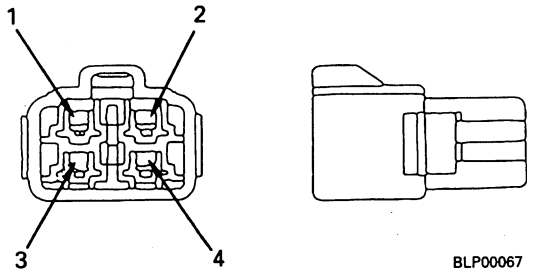
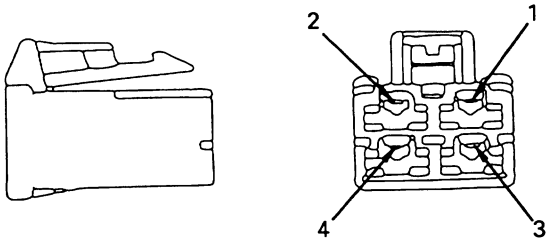
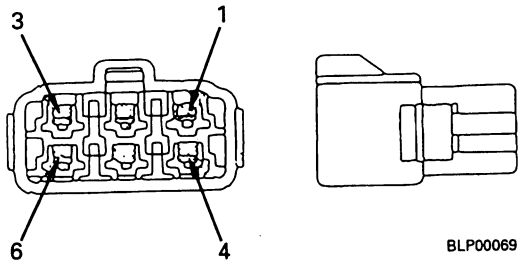
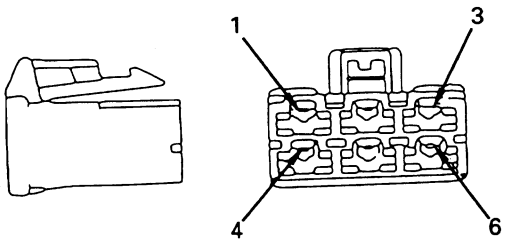
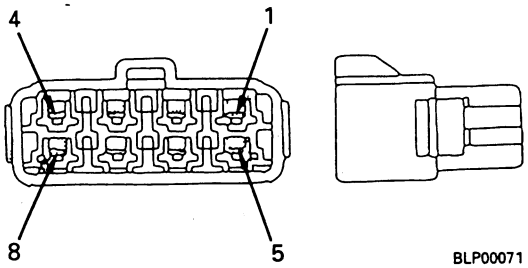
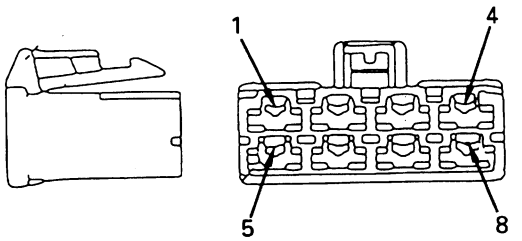
No. of pins	S type connector	
	Male (female housing)	Female (male housing)
8	 TEW00249	 TEW00250
10	 TEW00251	 BLP00042
12	 BLP00043	 TEW00254
16	 BLP00044	 TEW00256

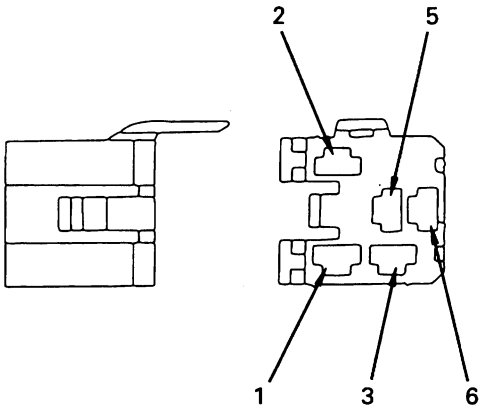
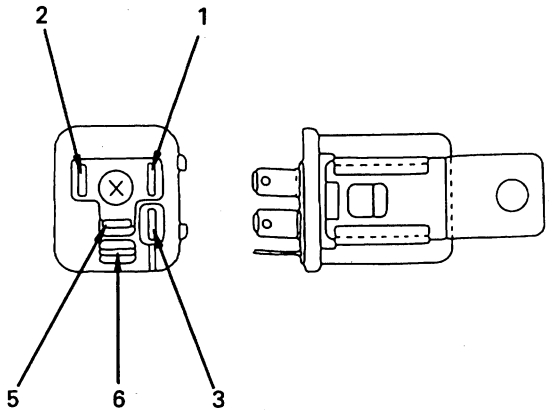
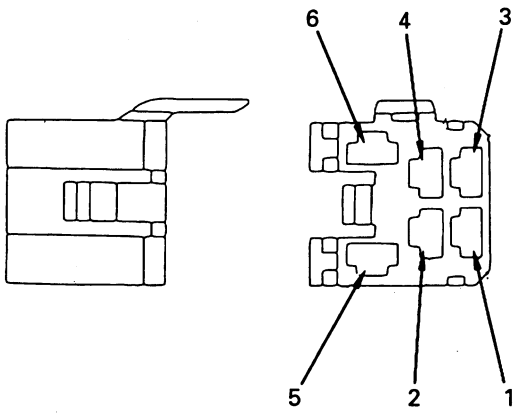
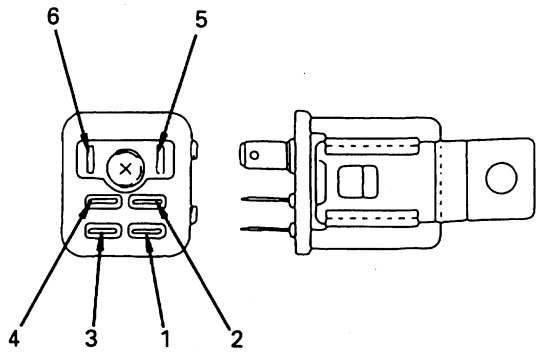
No. of pins	MIC connector	
	Male (female housing)	Female (male housing)
5	 BLP00045	 BLP00046
9	 BLP00047	 BLP00048
13	 BLP00049	 BLP00050
17	 BLP00051	 BLP00052
21	 TEW00259	 TEW00260

No. of pins	AMP040 type connector	
	Male (female housing)	Female (male housing)
8	 BLP00053	 BLP00054
12	 BLP00055	 BLP00056
16	 BLP00057	 TEW00232
20	 BLP00058	 TEW00234

No. of pins	AMP070 type connector	
	Male (female housing)	Female (male housing)
8		
12		

No. of pins	L type type connector	
	Male (female housing)	Female (male housing)
2	 TEW00257	 TEW00258

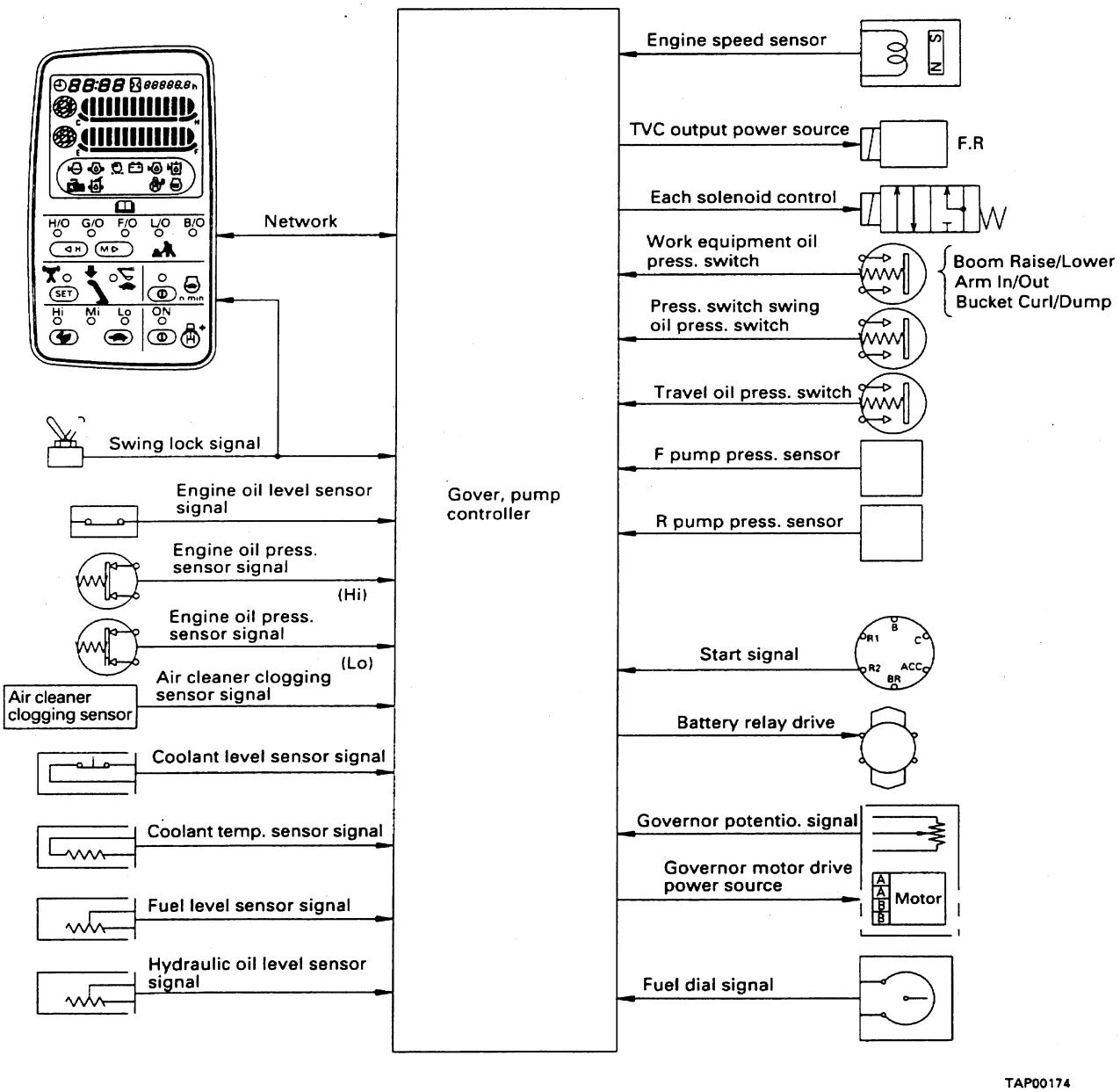
No. of pins	Automobile connector	
	Male (female housing)	Female (male housing)
2		
3		
4		
6		
8		

No. of pins	Relay connector	
	Male (female housing)	Female (male housing)
5	 BLP00073	 BLP00074
6	 BLP00075	 BLP00076

EXPLANATION OF CONTROL MECHANISM FOR ELECTRICAL SYSTEM

1 Explanation of machine control functions

The control mechanism for the electrical system consists of the monitor panel and governor and pump controller. The monitor panel and the governor and pump controller input the signals that are necessary, and together with the signals selected by the monitor panel, the governor and pump controller outputs the necessary signals and control the pump absorption torque and engine output.



DISPLAY METHOD AND SPECIAL FUNCTIONS OF MONITOR PANEL

1. Display on machine monitor

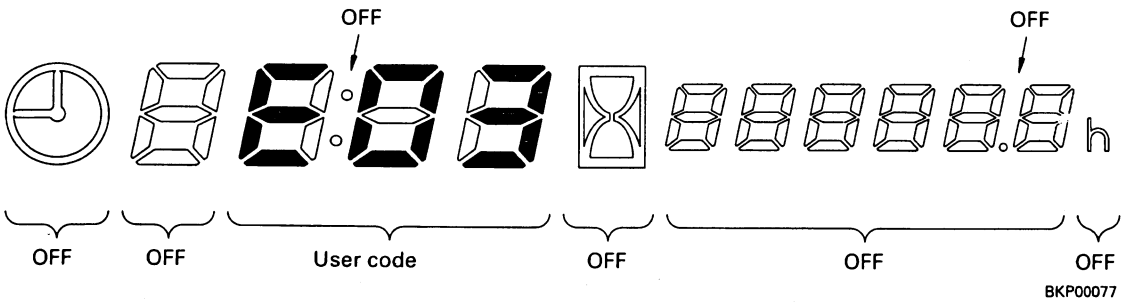
When the starting switch is turned on, all the monitor and gauge lamps lught up for approx. 3 seconds, and the buzzer souds for approx. 1 second. During this time, the monitor itself carries out self diagnosis, and after it has finished, it returns to the normal display.

2. Recording of service codes and user code display function

1) All the abnormality data for the governor and pump controller is sent to the monitor panel. When the monitor panel receives this data, it records the abnormality data, and at the same time, depending on the nature of the abnormality, it displays the user code on time display panel to advise the operator of the action to take.
However, in cases of abnormalities which are not urgent and do not require the user code to be displayed, only the content of the abnormality is recorded, and no display is given.

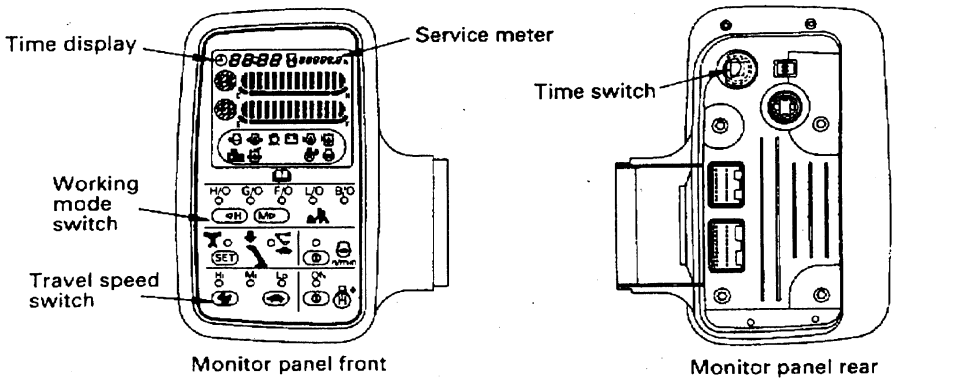
2) Types of user code and system
E02 (TVC system)
E03 (Swing holding brake system)
E05 (Governor motor system)
★ For details of the service codes included in the user code, see the action taken by the controller when an abnormality occurs, the symptoms on the machine or the judgement table.

3) Displaying user code
If it becomes necessary to display the user code, the time displayed panel is automatically switched to advise the operator to take the necessary action.
• Actual display (Example: Disconnection in the cancel solenoid system for the swing holding brake)



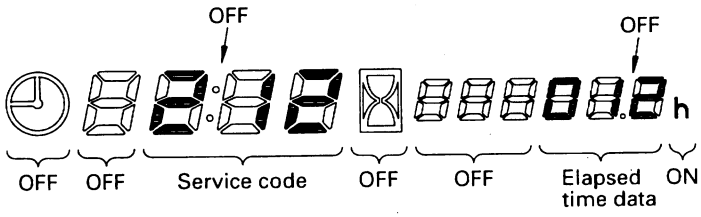
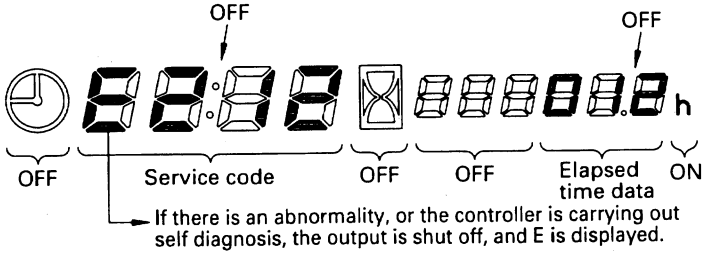
4) Display of trouble data
The monitor panel records both service codes which are included in the user code, and service codes which are not included. This data can be displayed on the time display as follows.

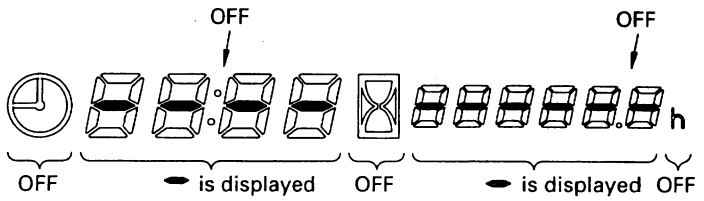
★ For details of the service codes that are not included in the user code, see ACTION TAKEN BY CONTROLLER WHEN ABNORMALITY OCCURS AND PROBLEMS ON MACHINE or the JUDGEMENT TABLE



TAP00175

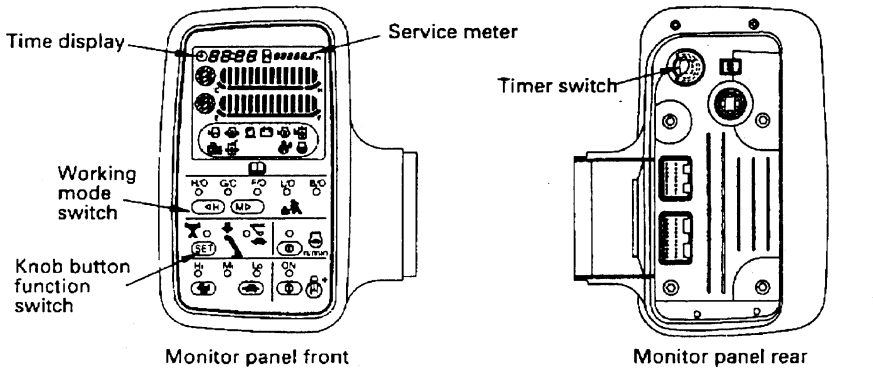
i) Method of displaying trouble data

Operation	Display
1. To set to the trouble data display mode, Keep the TIME switch + L.H. travel speed switch pressed for 2.5 seconds. Note: It is possible to call it up at the following times. 1) In the normal mode 2) In the user code display mode 3) In the machine data monitoring mode 4) In the time adjustment mode 2. To go to the next service code display, press the time switch + R.H. woking mode switch. 3. To go back to the previous service code display, press the time switch + L.H. working mode switch.	1. On the time display and service meter display, the service code and number of hours (service meter hours) that have elapsed since the occurrence of the abnormality are displayed. • Example of display : When E212 has occurred 12 hours before (service meter) 1) Display of service code 2) Display of elapsed time  BKP00079 3) If any abnormality exists at this time, the E mark is displayed.  BKP00080

Operation	Display
4. To finish with the trouble data display mode, keep the TIME switch + L.H. travel speed switch pressed for 2.5 seconds. 5. To erase the memory, keep the time switch pressed, turn the starting switch from OFF to ON, and keep the time switch pressed for 5 seconds.	4) If there is no abnormality code in memory  BKP00081

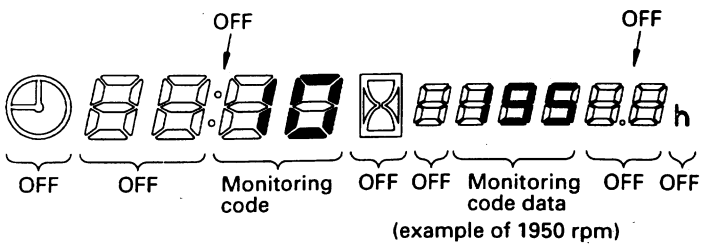
3. Machine data monitoring function

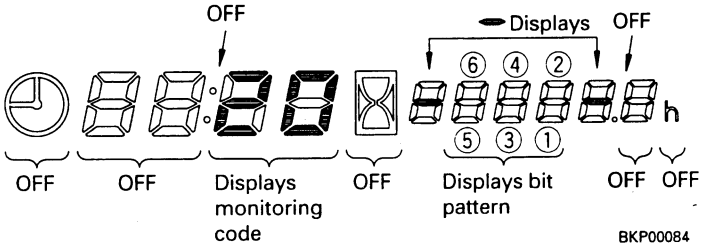
The input signals from the sensors and the output signals to drive the solenoid are displayed on the time display and service meter display.



TAP00176

1) Method of displaying monitoring code

Operation	Display
1. To set to the machine data monitoring mode, do as follows. Keep the time switch + knob button function switch pressed for 2.5 seconds. Note:This is possible at the following times. 1) During the normal mode 2) During the user code display mode 3) During the time adjustment mode 4) During the trouble data display mode	1. On the time display and service meter display, the monitoring code and data are displayed. • Example of display 1) When engine speed is monitored (monitoring code 10)  BKP00083

Operation	Display
2. To go to the next monitoring code display, press the time switch + R.H. working mode switch. 3. To go back to the previous monitoring code display, press the time switch + L.H. working mode switch. 4. To finish with the machine data monitoring code mode, keep the time switch + knob button function switch pressed for 2.5 seconds.	2) When displaying bit pattern • For monitoring codes 08, 20 - 24, 36, 37, 47 - 49, 4A, display the bit pattern. • Example of monitoring code 20  • The code No. is displayed in the monitoring code portion, and the display lights up to display bit patterns (1) - (6).

2) Table of machine data monitoring codes

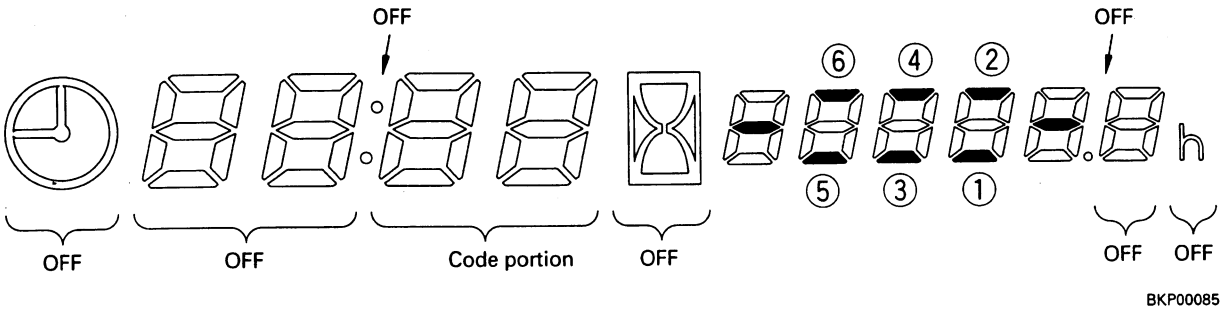
★ For details of the B in the Unit column, see the bit pattern chart in the next section.

No.	Item	Unit	Name of component
01	Monitor model code	-	Monitor panel
02	Governor, pump controller model code	-	Governor, pump controller
03	Governor, pump controller model code	-	Governor, pump controller
08	S-Net component condition display	B	Governor, pump controller
10	Engine speed	10rpm	Governor, pump controller
11	Pump discharge pressure (F) input	MPa(kg/cm^2)	Governor, pump controller
12	Pump discharge pressure (R) input	MPa(kg/cm^2)	Governor, pump controller
13	TVC current (F) output	10mA	Governor, pump controller
14	TVC current (R) output	10mA	Governor, pump controller
15	LS-EPC current output	10mA	Governor, pump controller
16	No. 2 throttle command	10mA	Governor, pump controller
20	Governor, pump controller PPC oil pressure switch input signal (1)	B	Governor, pump controller
21	Governor, pump controller PPC oil pressure switch input signal (2)	B	Governor, pump controller
22	Governor, pump controller PPC oil pressure switch input signal (3)	B	Governor, pump controller
23	Governor, pump controller solenoid actuation	B	Governor, pump controller
24	Input condition of sensor for governor, pump controller monitor warning	B	Governor, pump controller
30	Ruel control dial input value	10mV	Governor, pump controller
31	Potentiometer voltage	10mV	Governor, pump controller
32	VBB voltage (battery voltage)	100mV	

★ For details of the B in the Unit column, see the bit pattern chart in the next section.

No.	Item	Unit	Name of component
33	Governor motor A phase current	10mV	Governor, pump controller
34	Governor motor B phase current	10mV	Governor, pump controller
35	Battery relay output voltage	100mV	Governor, pump controller
36	Governor governor input condition	B	Governor, pump controller
37	Governor governor output condition	B	Governor, pump controller
40	Governor governor output condition	10rpm	Governor, pump controller
41	Engine speed	10mV	Governor, pump controller
42	Coolant temperature sensor voltage	10mV	Governor, pump controller
43	Ruel sensor input vooltage	100mV	Governor, pump controller
47	Monitor panel output condition 1	B	Governor, pump controller
48	Monitor panel input condition 1	B	Governor, pump controller
49	Monitor panel input condition 2	B	Governor, pump controller
4A	Monitor panel input condition 3	B	Governor, pump controller

3) Bit pattern chart
As shown in the diagram below, the time dispay has bit numbers which light up to show that the signal is being transmitted. (For details, see METHOD OF DISPLAYING MONITORING CODE.)



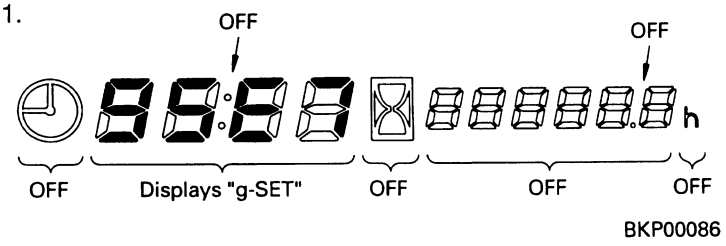
Code	Content	Bit	Details (condition when lighted up)
08	Connection of S-NET components	(1)	Governor, pump controller connected (ID=2)
		(2)	Governor, pump controller connected (IC=3)
		(3)	
		(4)	
		(5)	
		(6)	
20	Input condition of governor, pump controller PPC switches	(1)	Swing switch ON
		(2)	Travel switch ON
		(3)	Boom LOWER switch ON
		(4)	Boom RAISEswitch ON
		(5)	Arm IN switch ON
		(6)	Arm OUT switch ON
21	Input condition of governor, pump controller PPC switches and other switches	(1)	Bucket CURL switch ON
		(2)	Bucket DUMP switch ON
		(3)	Swing lock switch ON
		(4)	Service switch On
		(5)	Model selection 5
		(6)	Swing prolix switch ON
22	Input condition of governor, pump controller model selection and other switches Drive condition of governor,	(1)	Model selection 1 GND connected
		(2)	Model selection 2 GND connected
		(3)	Model selection 3 GND connected
		(4)	Model selection 4 GND connected
		(5)	Kerosene mode input GND connected
		(6)	Knob switch ON

Code	Content	Bit	Details (condition when lighted up)	
23	pump controller ON/OFF solenoid valves	(1)		
		(2)	LS select solenoid ON	
		(3)	Swing holding brake ON	
		(4)	Pump merge/divider solenoid ON	
		(5)		
		(6)	Travel speed selector solenoid ON	
24	Input condition 1 of sensor for governor, pump controller monitor warning	(1)	Above engine oil pressure sensor Lo set pressure	
		(2)	Above engine oil pressure sensor Hi set pressure	
		(3)	Radiator water level sensor abnormal	
		(4)	Engine oil level sensor abnormal	
		(5)	Hydraulic oil level sensor abnormal	
		(6)	Air cleaner clogging sensor abnormal	
36	Input condition of governor, pump controller	(1)		
		(2)		
		(3)		
		(4)		
		(5)	Starting switch ON	
		(6)		
37	Output condition of governor, pump controller	(1)	Battery relay: Actuated	
		(2)		
		(3)		
		(4)		
		(5)		
		(6)		
47	Monitor panel output condition 1	(1)		
		(2)	Alarm buzzer: when operated machine	
		(3)		
		(4)		
		(5)		
		(6)		
49	Monitor panel input condition	(1)	KEY ON SW	FF
		(2)	Terminal BR	Voltage Hi
		(3)	LIGHT SW	OFF
		(4)	Preheating switch	OFF
		(5)	START C	Sometimes turns ON
		(6)		

Code	Content	Bit	Details (condition when lighted up)
4A	Monitor panel output condition	(1)	Time switch OFF
		(2)	PPC oil pressure selector switch OFF
		(3)	Overload selector switch OFF
		(4)	STD/DLX selection STD
		(5)	Swing lock switch OFF
		(6)	Buzzer cancel switch OFF

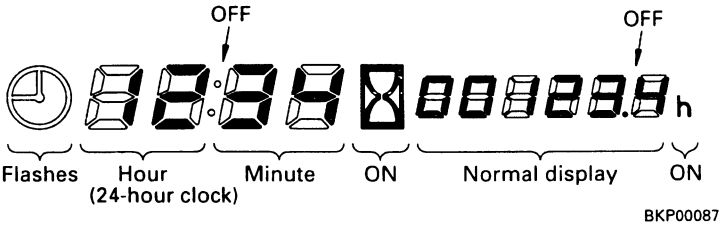
4. Governor motor adjustment mode

This is used when adjusting the linkage between het governor motor and the injection pump. (For details of the procedure, see TESTING AND ADJUSTING.)

Operation	Display
1. To set to the governor motor adjustment mode, press the time switch + R. H. travel speed switch + R.H. working mode switch.	1.  BKP00086
2. To return to the time display mode use the same procedure as Step 1.	2. Buzzer sounds once a second

5. Time adjustment mode

To adjust the time, do as follows.

Operation	Display
1. To set to the time adjustment mode, keep the time switch depressed for 2.5 seconds. 2. Use the L.H. working mode switch to advance the hour. 3. Use the R.H. working mode switch to advance the minute. 4. To return to the time display mode use the same procedure as in Step 1.	1. The time mark portion flashes  BKP00087 ★ The example shows the situation when setting to 12:34.

METHOD OF USING JUDGEMENT TABLE

This judgement table is a tool to determine if the problem with the machine is caused by an abnormality in the electrical system or by an abnormality in the hydraulic or mechanical system. The symptoms are then used to decide which troubleshooting table (E- , S- ,C- ,F- ,H- ,M-) matches the symptoms.
The judgement table is designed so that it is easy to determine from the user code and service code which troubleshooting table to go to.

★ The abnormality display (warning) given by the monitor panel leads directly to troubleshooting of the machine monitor (M-). (See troubleshooting of the machine monitor system)

1. When using judgement table for governor, pump controller (governor control system) and engine related parts

- If a service code is displayed on the monitor panel, go to the troubleshooting code at the bottom of the judgement table (E-).
  (A ● mark is put at the places where the failure mode and service code match.)
- If a problem has appeared but no service code is displayed on the monitor panel, go to the point where the failure mode matches the troubleshooting code on the right of the judgement table(E- or S-).
  <Example> Failure mode "Engine does not start".
  Procedure: Check if the service code is being displayed on the monitor panel.

Failure mode		User code	E05					
		Service code	308	317	318	306	315	316
1	Engine does not start easily							
2	Engine does not start							
3	Engine speed stays at low idling, and does not follow accelerator; or engine pickup is poor		●	●	●	●	●	
4	Engine stops during operation							
5	Engine rotation is irregular	When idling speed is irregular						
		When there is hunting		●	●	●	●	●
6	Lack of output (engine high idling speed is too low)			●			●	
7	Auto-deceleration does not work							
8	Engine does not stop		●		●	●	●	
9	Warming up operation is defective							
10	Exhaust gas is black							
11	Oil consumption is excessive, or exhaust gas is blue							
12	Oil becomes dirty prematurely							
13	Fuel consumption is excessive, or exhaust gas is blue							
14	Oil is mixed in coolant							
15	Engine oil pressure caution lamp lights up							
16	Oil level rises							
17	Coolant temperature rises too high (overheating)							
18	Abnormal noise is generated							
19	There is excessive vibration							
20	Engine speed does not change even when working mode is switched							
	Troubleshooting code when service code is displayed		E-1	E-2	E-3	E-4	E-5	E-6	E-7
	Troubleshooting code when there is abnormality in monitoring or machine monitor check		—	—	—	—	—	—	—

● : This shows applicable item for service code
✣ : This shows item that needs only checking with monitoring

Checking monitoring, check items	Monitoring code	Troubleshooting code if no service code display is given
	35	S-1
	16	S-2
	30	S-3
	31	S-4
	33	E-9A), S-5
	34	E-9A), S-5
	41	E-10, S-6
	102 °C or above	E-3 · E-4
	105 °C or above	E-11
	108	E-3 · E-4
		S-7
		S-8
		S-9
		S-10
		S-11
		S-12
		S-13
		S-14
		S-15
		S-16
		E-3 · E-4
	—	—
	E-12	—

: This shows item to check with monitoring or machine monitor

[Judgement]

1) If a service code is being displayed on the monitor panel..... go to troubleshooting [E3:] for the governor, pump controller (governor control system).
2) If no service code is displayed on the monitor panel, and the engine does not start:

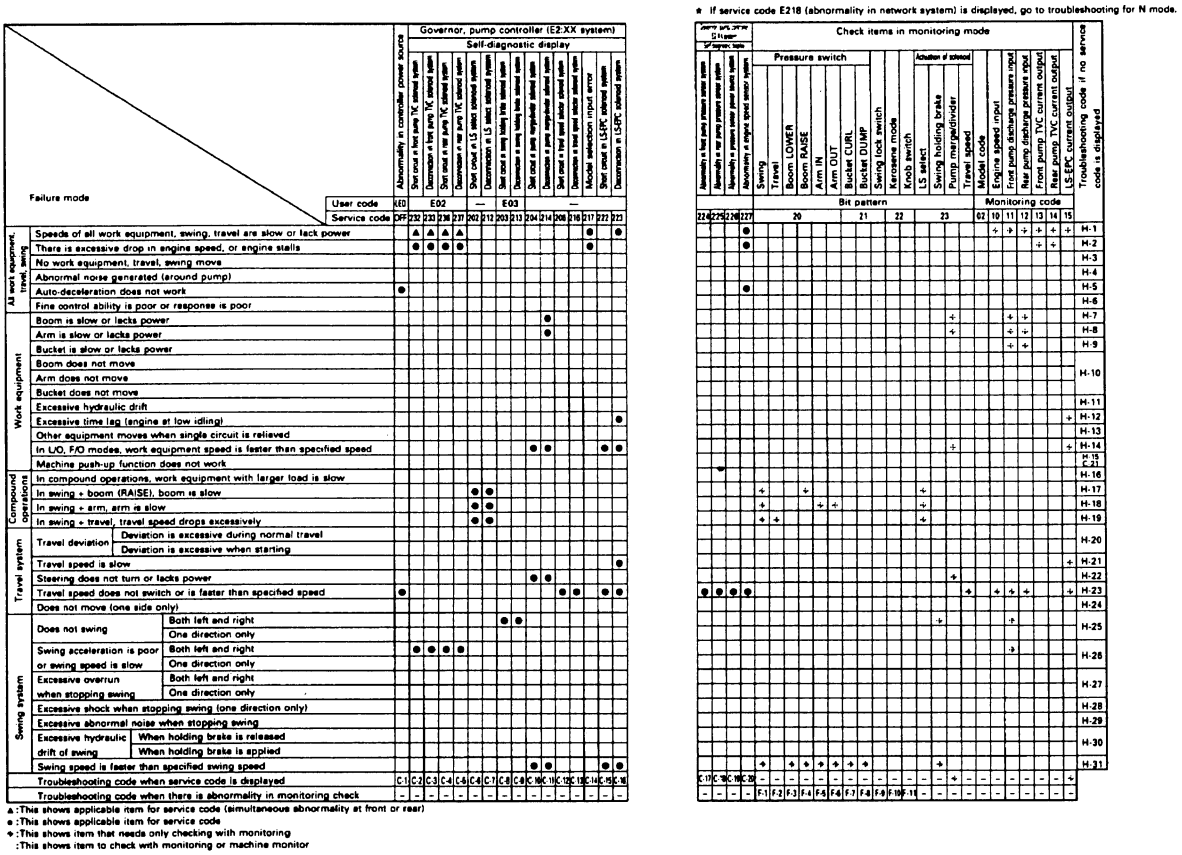
- Check that starting motor rotates
  - Starting motor rotates ..... Go to troubleshooting S-2 of mechanical system
  - Starting motor does not rotate ..... Go to troubleshooting E-8 of electrical system

2. When using judgement table for governor, pump controller (governor control system) and hydraulic related parts

- If a service code is displayed on the monitor panel, go to the troubleshooting code at het bottom of the judgement table (C-).
  (A ● mark is put at the places where the failure mode and service code match.)
- If a problem has appeared but no service code is displayed on the monitor panel, go to the point where the failure mode matches the input signal, and check the display for the input signal (the display at the place with a mark).
  - If it is displayed normally, go to the troubleshooting code on the right of the judgement table (H-).
  - If the input signal is not displayed on the monitor panel, go to the troubleshooting code at the bottom of the judgement table (F-).

<Example> Failure mode "Upper structure does not swing".

Procedure: Check if the service code is being displayed on the monitor panel.



[Judgement]

1) If a service code is being displayed on the monitor panel..... go to troubelshooting [E2:] for the governor, pump controller (pump control system).
2.) If no service code is displayed on the monitor panel, and the upper structure does not swing:

- Check governor, pump controller input signal (Check in monitoring mode)
  - There is a signal ..... Go to troubleshooting H-25 of mechanical system
  - There is no signal ..... Go to troubleshooting F- of governor, pump controller input signal system (F mode for applicable system)

METHOD OF USING TROUBLESHOOTING CHARTS

1. Category of troubleshooting code number

Troubleshooting Code No.	Component	Service code
N-	Troubleshooting of communication abnormality system	E218 group
E-	Troubleshooting of electrical system for governor, pump controller (governor control system)	E3- group
S-	Troubleshooting of engine related parts	-
C-	Troubleshooting of electrical system for governor, pump controller (pump control system)	E2- group
F-	Troubleshooting of governor, pump controller (input signal system)	-
H-	Troubleshooting of hydraulic, mechanical system	-
M-	Troubleshooting of machine monitor	E1- group

2. Method of using troubleshooting table for each troubleshooting mode

1) Troubleshooting code number and problem
The title of the troubleshooting chart gives the troubleshooting code, service code, and failure mode (problem with the machine). (See Example (!))

2) Distinguishing conditions
Even with the same failure mode (problem), the method of troubleshooting may differ according to the model, component, or problem. In such cases, the failure mode (problem) is further divided into sections marked with small letters (for example, a), so go to the appropriate section to carry out troubleshooting. (See Example (2)) If the troubleshooting table is not divided into sections, start troubleshooting from the first check item in the failure mode.

3) Method of following troubleshooting chart
- Check or measure the item inside ▭, and according to the answer follow either the YES line or the NO line to go to the next ▭. (Note: The number written at the top right corner of the ▭ is an index number ; it does not indicate the order to follow.)
- Following the YES or NO lines according to the results of the check or measurement will lead finally to the Cause column. Check the cause and take the action given in the Remedy column on the right. (See Example (3))
- Below the ▭ there are the mehods for inspection or measurement, and the judgement values. If the judgement values below the ▭ are correct or the answer to the question inside the ▭ is YES, follow the YES line; if the judgement value is not correct, or the answer to the question in NO, follow the NO line.
- Below the ▭ is given the preparatory work needed for inspection and measurement, and the judgement values. If this preparatory work is neglected, or the mehod of operation or handling is mistaken, there is danger that it may cause mistaken judgement, or the equipment may be damaged. Therefore, before starting inspection or measurement, always read the instructions carefully, and start the work in order from Item 1).

4) General precautions
When carrying out troubleshooting for the failure mode (problem), precautions that apply to all items are given at the top of the page and marked with ★ (See Example (4)).
The precautions marked ★ are not given in the ▭, but must always be followed when carrying out the check inside the ▭.

5) Troubleshooting tools
When carrying out the troubleshooting, prepare the necessary troubleshooting tools. For details, see TOOLS FOR TESTING, ADJUSTING, AND TROUBLESHOOTING.

6) Installation position, pin number
A diagram or chart is given for the connector type, installation position, and connector pin number connection. When carrying out troubleshooting, see this chart for details of the connector pin number and location for inspection and measurement of the wiring connector number appearing in the troubleshooting flow chart for each failure mode (problem).

<Example>

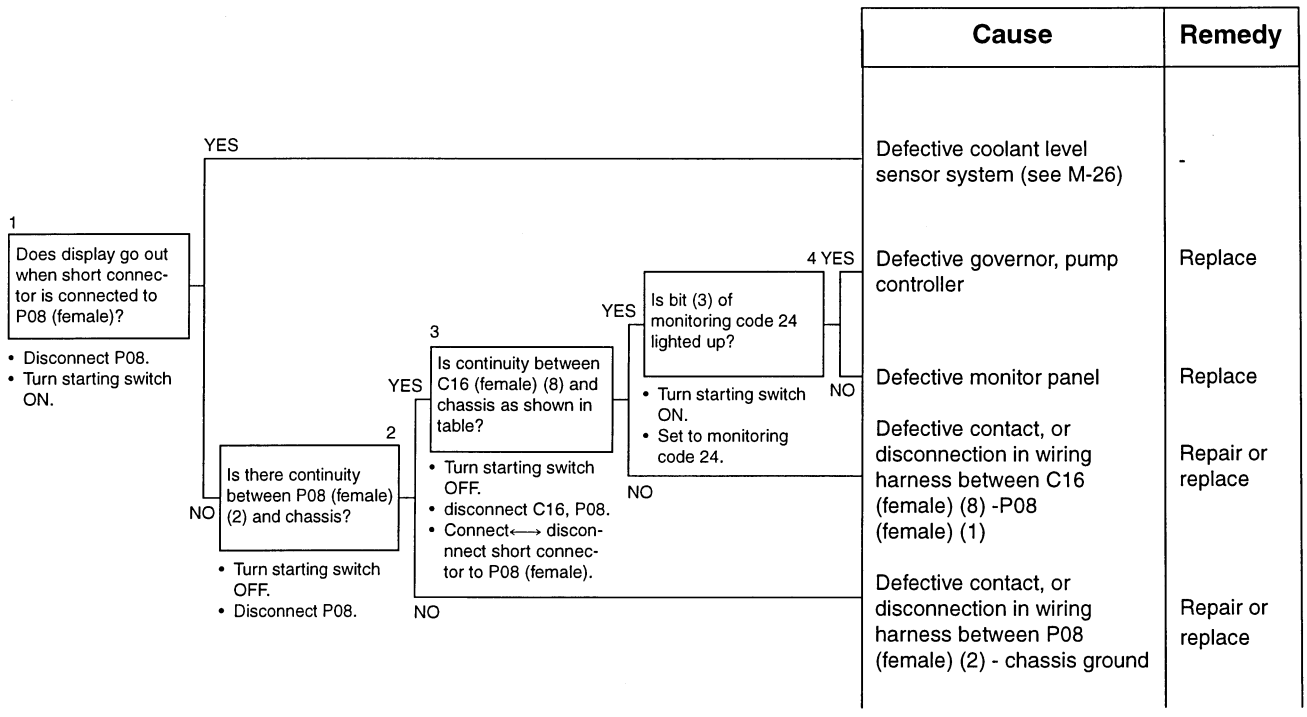
(1) **M-9 When starting switch is turned ON (engine stopped), check item for previous troubleshooting flashes**

(4) ★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.
★ Check that the coolant is at the specifies level before carrying out troubleshooting

(2) a)  (coolant level) flashes
SAP00519
Divided into sections a) and b)

b)  (engine oil level) flashes
SAP00523

(3)



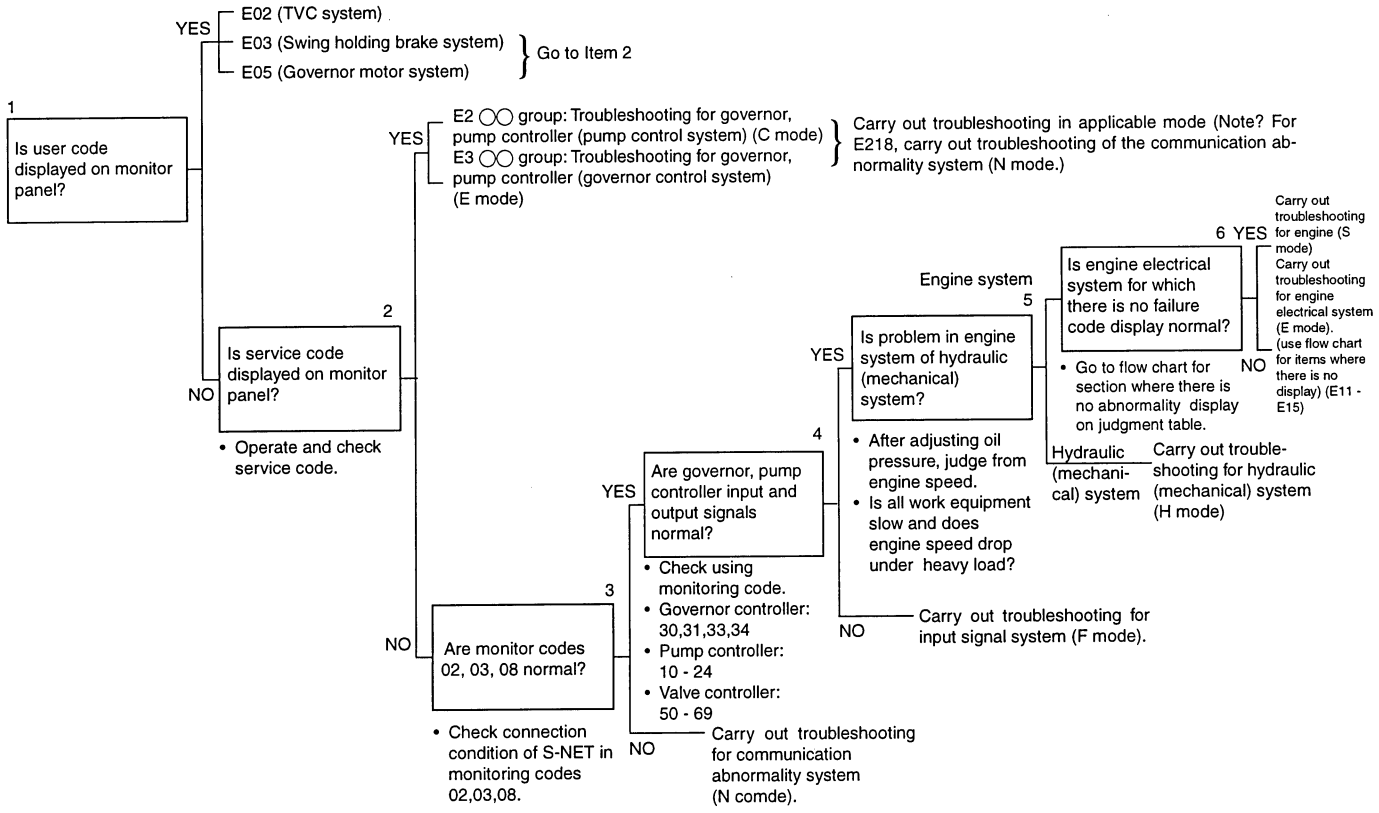
Table

Short connector	Continuity
Connected	Yes
Disconnected	No

DETAILS OF TROUBLESHOOTING AND TROUBLESHOOTING PROCEDURE

If any abnormality should occur, it is necessary to go to the correct troubleshooting chart in accordance with the judgement table for that type of failure (governor, pump controller (governor control system) and governor, pump controller (pump control system). For details of the troubleshooting and troubleshooting procedure, refer to this flow chart.
When carrying out troubleshooting, ask the operator as much as possible about the condition of the machine, and check the following items before starting.
(1) Condition of controller connection (check with monitoring codes 02 - 03)
(2) Blown fuses
(3) Battery voltage (monitoring mode 32)
(4) Electricity generation (charge input) voltage (monitoring code 43)

The procedure for carrying out check items No. 3 and 4 in the flow chart below is given on the following pages.



★ For details, see governor, pump controller (governor control system) (pump control system) in the JUDGEMENT TABLE.

If there is no abnormality display in the communications system transmitted in S-NET, it can be taken that the output signal from the monitor panel has been transmitted. However, even if there is no abnormality display, if the operation is defective, use the following procedure when checking directly. If any abnormality occurs in the S-NET system, the system is automatically switched to the following default mode, so be careful when carrying out troubleshooting.

Default Mode when communications cannot be carried out for the monitor and governor, pump controller

	Set mode	Pump Control	Governor control
1	Working mode	G/O mode	H/O mode
2	Throttle signal	FULL	FULL
3	Auto-deceleration	ON (deceleration mode)	ON (deceleration mode)
4	Coolant temperature signal	OFF	-
5	Priority mode	OFF	-
6	Power max. mode	ON (power max. possible)	-
7	Travel speed	Lo	-
8	Automatic warming up	-	ON (automatic warming-up mode)

1. Procedure for checking monitor panel output signal

★ For details of operating the monitoring mode, see MONITOR PANEL DISPLAY AND SPECIAL FUNCTIONS.

1. Connnection condition of components
   1) Set to the monitoring mode and display monitoring code 08.
   2) The time display (bits) will light up to display the components that are connected.
      ★ Governor, pump controller (pump control system) (1) and governor, pump controller (governor control system) (2) will light up.

2. Checking working mode signal (check No. 2 throttle signal monitoring code 16) at the same time)
   1) Set to the monitoring mode and display monitoring code 10.
   2) Switch the working mode as shown in Table 1 and check that the engine speed changes.

Table 1

Working mode	High idling speed (rpm) [The figures in ( ) are the rated speed]
H/O	Approx. 2100 (1900)
G/O	Approx. 2000 <during operation> Approx. 1900 <idling> (1,800)
F/O	Approx. 1900 (1700)
L/O	Approx. 1600 (1400)

3. Checking travel speed selection signal
   1) Set to the monitoring mode and display monitoring code 23.
   2) Change the speed selector switch to Hi or Mi (front or rear pump oil pressure: 21.6 - 32.3 MPa (220 - 330 kg/cm^2)
4. Checking swing priority mode signal
   ★ If the travel oil pressure switch signal is not input to the controller, the flow from the front and rear pumps will remain divided.
   1) Set to the monitoring mode and display monitoring code 23.
   2) Check that bit (4) lights up when the travel is operated (even when operated slightly).
      ★ Check the operating condition of the pump merge/divider solenoid valve

2. Checking input signal of governor, pump controller
   ★ Check the input signals for each controller as follows.
   • Pump control system
   1. Checking input signal
      1) Check hydraulic switch
         i) Set to the monitoring mode, and display monitoring codes 20 and 21.
         ii) Operate each work equipment lever, and check how the bit pattern lights up.
            ★ For details of the bit pattern chart, see MONITOR PANEL DISPLAY AND SPECIAL FUNCTIONS.
      2) Check speed sensor (check engine speed)
         i) Set to the monitoring mode, and display monitoring code 10.
         ii) Use the fuel control dial to change the speed, and measure the speed when this is done.
      3) Check pump discharge pressure sensor
         i) Set to the monitoring mode, and display monitoring codes 11 and 12.
            ★ Code 11 is for the front pump and code 12 is for the rear pump.
         ii) Refer to Table 2 and measure the hydraulic pressure at the front or rear pump.

Table 2 Pump merge/flow ligic and pumps actuated by control lever

	Independent operation (basic flow merged)		Travel operated independently or compound operation together with travel ※	
	Front pump	Rear pump	Front pump	Rear pump
L.H. travel	○		○	
Swing	○	○	○	
Arm	○	○	○	
Boom	○	○		○
Bucket	○	○		○
R.H. travel		○		○

※ Conditions for compound operation with travel.
(1) When measuring the oil pressure for any circuit other than travel, operate the travel lever slightly or connect a short connector (X-2P) to the travel oil pressure switch connector (CN-S01).
(2) The circuits merge when the pressure of the front pump or rear pump is more than 19.6 MPa (200 kg/cm^2).

4) Check kerosene mode input signal
   i) Set to the monitoring mode, and display monitoring code 22.
   ii) Connect the CN-M36 connector and check that bit (5) lights up.
5) Check knob switch input signal.
   i) Set to the monitoring mode, and display monitoring code 22.
   ii) Turn the knob switch ON and check that bit (6) lights up.

2. Check output signals
   1) Check LS-EPC solenoid output current
      i) Set to the monitoring mode, and display monitoring code 15.
      ii) Run the engine at high idling with all the levers at neutral and in the G/O or H/O mode, and measure the current.
         ★ All levers at neutral: 900 ± 80 mA
            Engine at high idling, any lever operated (other than travel): o A
   2) No. 2 throttle signal
      i) Set to the monitoring mode, and display monitoring code 16.
      ii) Use the procedure in Item 2 for checking the monitor panel output signal, and measure the engine speed.
   3) Checking ON OFF solenoid condition
      i) Set to the monitoring mode, and display monitoring code 23.
      ii) Refer to Table 3 and check that the applicable bit lights up.

Table 3 Types of solenoid and conditions for actuation

Name of solenoid	Actuation condition	Bit that lights up
LS select	Swing lock switch OFF, swing + travel lever operated simultaneously	(2)
Swing holding brake	Swing or work equipment lever operated	(3)
Pump merge/divider	Travel operated independently	(4)
Travel speed selector	Travel speed selector switch Hi or Mi	(6)

★ Operate the lever slightly not enough to move the machine.

4) Check TVC solenoid output current
   i) Set to the monitoring mode, and display monitoring codes 13 and 14.
   • Code 13 is for the front pump and code 14 is for the rear pump.
   ii) With the starting switch kept at the ON position (G/O mode), measure the current when the fuel control dial is turned to the MAX position.
   • Current with starting switch ON (G/O mode) and fuel control dial at MAX : 520 ± 80 (mA)

- **Governor control system**
  1. Check input signal
     1) Check fuel control dial input voltage
        i) Set to the monitoring mode, and display monitoring code 30.
        ii) Measure the voltage when the fuel control dial is turned from low idling to high idling.
            ★ Voltage: 0.25 - 4.75 V
     2) Check governor potentiometer voltage
        i) Set to the monitoring mode, and display monitoring code 31.
        ii) Measure the potentiometer voltage when the fuel control dial is turned from low idling to high idling.
            ★ Voltage: 0.5 - 3.3. V

  2. Check output signal
     1) Check governor motor drive current
        i) Set to the monitoring mode, and display monitoring codes 33 and 34.
            ★ code 33 is the A phase (engine speed acceleration direction) and code 34 is the B phase (engine speed deceleration direction)
        ii) Measure the governor motor drive current when the fuel control dial is turned in the acceleration direction and deceleration direction.
            ★ Current: 700 ± 70 (mA)

     2) Measure battery relay drive output voltage
        i) Set to the monitoring mode, and display monitoring code 35.
        ii) Measure the battery relay drive output voltage when the starting switch is turned from ON to OFF.
        or
        iii) Set to the monitoring mode, and display monitoring code 37.
        iv) Check that bit (1) lights up when the starting switch is turned from ON to OFF.

SERVICE CODE TABLE

Service code	Abnormal system	User code
E101	Abnormality in error history data	
E102	Abnormality in time data	
E103	Short circuit in buzzer output, contact with 24V wiring harness for buzzer drive	
E104	Air cleaner clogging detected	
E106	Abnormality in engine oil pressure sensor (Hi) detected	
E108	Water temperature over 105*C	
E202	Short circuit in LS select solenoid system	
E203	Short circuit in swing holding brake solenoid system	E03
E204	Short circuit in pump merge/divider solenoid system	
E206	Short circuit in travel speed solenoid system	
E212	Disconnection in LS select solenoid system	
E213	Disconnection in swing holding brake solenoid system	
E214	Disconnection in pump merge/divider solenoid system	E03
E216	Dicsonnection in travel speed solenoid system	
E217	Error in model selection input	
E218	Network response overtime error	
E222	Short circuit in LS-EPC solenoid system	
E223	Disconnection in LS-EPC solenoid system	
E224	Abnormality in F pump pressure sensor system	
E225	Abnormality in R pump pressure sensor system	
E226	Abnormality in pressure sensor system power source	
E227	Abnormality in engine speed sensor	
E232	Short circuit in F pump TVC solenoid system	E02
E233	Disconnection in F pump TVC solenoid system	E02
E236	Short circuit in R pump TVC solenoid system	E02
E237	Disconnection in R pump TVC solenoid system	E02
E306	Abnormality in feedback potentiometer system	
E308	Abnormality in fuel control dial input value	E05
E315	Short circuit in battery relay output system	
E316	Step-out in governor motor	E05
E317	Disconnection in governor motor system	E05
E318	Short circuit in governor motor system	

Service code	Abnormal system	User code

TROUBLESHOOTING OF COMMUNICATION ABNORMALITY SYSTEM (N MODE)

N-1 [E218] Communication abnormality

★ This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if the service code E is not displayed, the problem has been removed.
★ If the starting switch was turned off after the abnormality occurred, turn the starting switch on and check that the service code displays E. (If it is not displayed, the problem has been removed.)
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

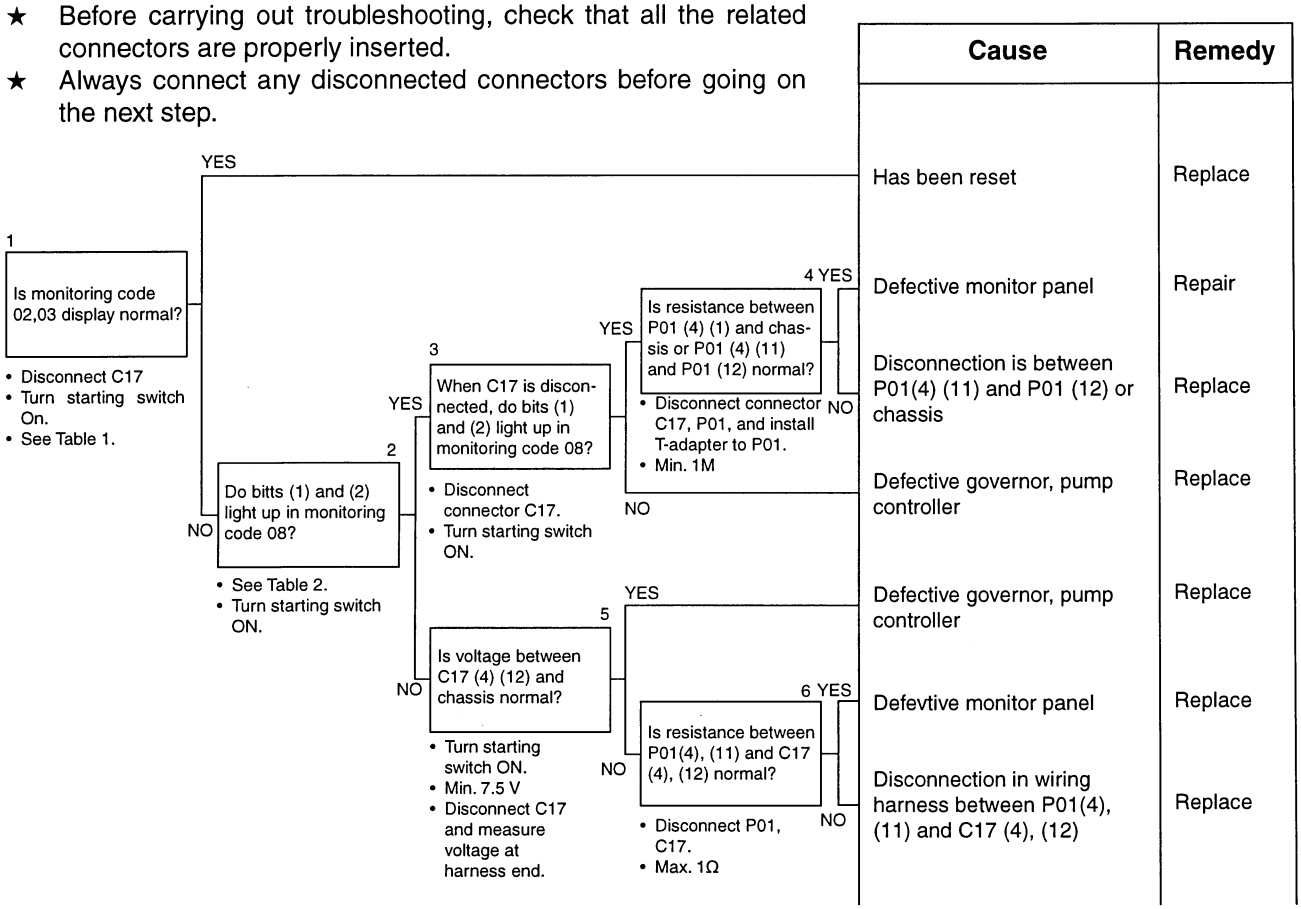


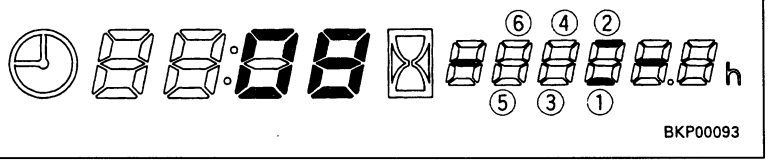
Table 1

Monitoring code		Display
01	Monitor panel model code	300
02	Governor, pump controller model code	300
03	Governor, pump controller model code	300

- When each controller is connected to the network,"_" is displayed. If the correct alphanumerics are not displayed (another model is displayed), each controller shows model selection abnormal.

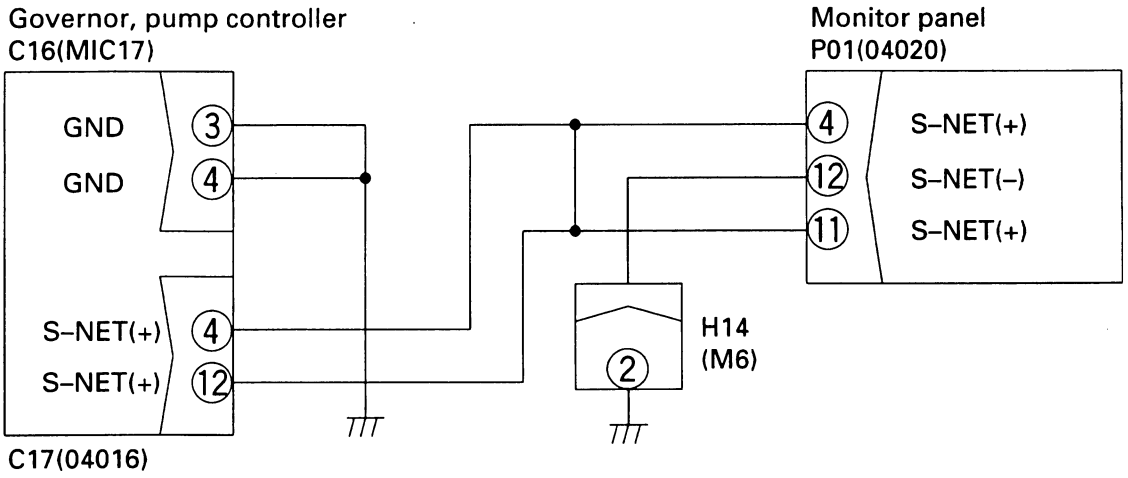
Table 2

Display / Monitoring code	
08	Network connection condition



- Light up when connected
  (1) Governor, pump controller
  (2) Governor, pump controller
- Note: Checks can be carried out with code 08 only when there is a disconnection. The display does not change when there is a short circuit.
  Therefore, checks when there is a short circuit should be carried out basically using Table 1

N-1 Related electric circuit diagram



TROUBLESHOOTING OF GOVERNOR, PUMP CONTROLLER (GOVERNOR CONTROL SYSTEM) (E MODE)

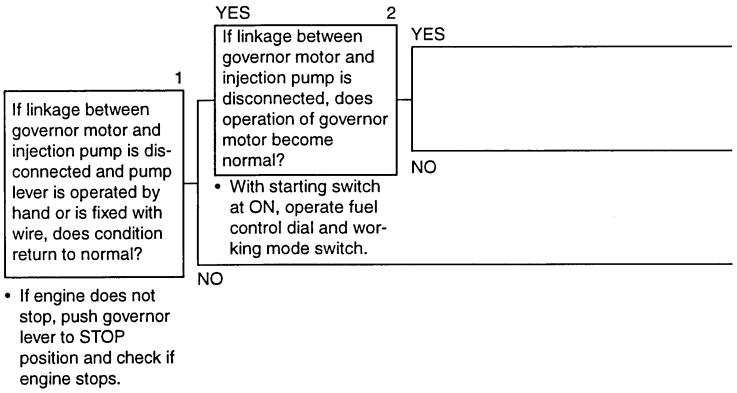
POINTS TO REMEMBER WHEN CARRYING OUT TROUBLE-SHOOTING OF GOVERNOR, PUMP CONTROLLER SYSTEM

1. Points to remember when there is abnormality which is not displayed by user code

The engine is controlled by the governor and pump controller.
The problems that may occur with this system include the following.

1. Idling speed is too high (too low)
2. High idling speed is too low
3. Auto-deceleration speed is too high (too low)
4. Engine speed for automatic warming-up operation is too high (too low)
5. There is hunting
6. Engine does not stop

If any abnormality occurs, and the abnormality is displayd on the time display portion of the monitor panel, use the troubleshooting table to determine the appropriate troubleshooting flow chart from E-1 to E-12. However, if there is any abnormality in the machine and no abnormality display is given, it is necessary to determine whether the problem is in the mechanical system or in the electrical system. If the linkage between the governor motor and the injection pump is not properly adjusted, problems 1 to 6 listed above may occur. Therefore, if there is no abnormality display, but one of problems 1 to 6 above has occurred, carry out troubleshooting as follows.



Defective adjustment of governor motor likage See TESTING AND ADJUSTING.

Go to troubleshooting E-9 - E-12 of electrical system

Go to troubleshooting S-1 - S-16 of engine system

Disconnect the linkage as explained above, or check the adjustment and go to the troubleshooting flow chart for the mechanical system or electrical system.
For details of the procedure for adjusting the linkage, see TESTING AND ADJUSTING.

2. Points to remember if abnormality returns to normal by itself

In the following two cases, there is a high probability that same problem will occur again, so it is desirable to follow up this problem carefully.

1) If any abnormality returns to normal by itself, or
2) If the connector is disconnected and the T-adapter is inserted, or if the T-adapter is removed and the connector is returned to its original position when carrying out troubleshooting of the failure, and the service code is no longer displayed, or if the monitor display returns to normal.
3) After completing troubleshooting, always erase the service code from memory.

3. User code memeory retention function

When displaying the abnormality code in memory and carrying out troubleshooting, note down the content of the display, then erase the display. After trying to re-enact the problem, carry out troubleshooting according to the failure code that is displayed.
(There are cases where mistaken operation or abnormalities that occur when the connector is disconnected are recorded by the memory retention function. Erasing the data in this way saves any wasted work.)

ACTION TAKEN BY CONTROLLER WHEN ABNORMALITY OCCURS AND PROBLEMS ON MACHINE

User code	Service code	Abnormal system	Nature of abnormality
E05	E308	Abnormality in fuel control dial input value	1. Short circuit in wiring harness between C03 (7) - (14), (7) - (17), (14) - (17) 2. Short circuit in wiring harness between E04 (1) - (2), (1) - (3), (2) - (3) 3. Short circuit in wiring harness between E06 (1) - (2), (1) - (3), (2) - (3) 4. Short circuit in wiring harness between C03 (7) - (4), (4) - (17) 5. Disconnection in wiring harness between C03 (7) - X07 (6) - E06 (1) 6. Disconnection in wiring harness between C03 (4) - X07 (5) - E06 (2) 7. Disconnection in wiring harness between C03 (17) - X07 (4) - E06 (3) 8. Defective fuel control dial 9. Defective contact of C03, X07, E06 connectors
	E317	Abnormality (disconnection) in motor drive system	1. Disconnection inside governor motor 2. Disconnection in wiring harness between C02 (2) - E05 (1) 3. Disconnection in wiring harness between C02 (4) - E05 (3) 4. Disconnection in wiring harness between C02 (3) - E05 (2) 5. Disconnection in wiring harness between C02 (5) - E05 (4) 6. Defective contact of E05 connector
	E318	Abnormality (short circuit) in motor drive system	1. Short circuit inside governor motor 2. Wiring harness between C02 (2) - E05 (1) and between C02 (4) - E05 (3) short circuiting with wiring harness between C02 (3) - E05 (2) 3. Wiring harness between C02 (4) - E05 (3) and between C02 (2) - E05 (1) short circuiting with wiring harness between C02 (5) - E05 (4) 4. Wiring harness in Items 2 and 3 short circuiting with ground

<table>
<tr><th>Condition when normal (voltage, current, resistance)</th><th>Action by controller when abnormality is detected</th><th>Problem that appears on machine when there is abnormality</th></tr>
<tr>
<td>
<table>
<tr><th>C03 (female)</th><th>E06 (male)</th><th>Resistance value</th></tr>
<tr><td>(7) - (4)</td><td>(1) - (2)</td><td>0.25 - 7kΩ</td></tr>
<tr><td>(4) - (17)</td><td>(2) - (3)</td><td>0.25 - 7kΩ</td></tr>
<tr><td>(7) - (17)</td><td>-</td><td>2 - 3kΩ</td></tr>
<tr><td>-</td><td>(1) - (3)</td><td>4 - 6kΩ</td></tr>
<tr><td>Between each pin and chassis</td><td>-</td><td>Min. 1 MΩ</td></tr>
</table>
</td>
<td>Maintains engine speed at position of fuel control dial immediately before abnormality occurred</td>
<td>1. Does not become partial speed when set at MAX position
2. Does not reach high idling when set at partial speed
3. There are cases of hunting
4. Lacks output (max. speed of engine is too low)</td>
</tr>
<tr>
<td>
<table>
<tr><th>E05 (male)</th><th>C02 (female)</th><th>Resistance value</th></tr>
<tr><td>(1) - (2)</td><td>(2) - (3)</td><td>0.25 - 7kΩ</td></tr>
<tr><td>(3) - (4)</td><td>(4) - (5)</td><td>0.25 - 7kΩ</td></tr>
<tr><td>(1) - (3)</td><td>(2) - (4)</td><td>Min. 1 MΩ</td></tr>
<tr><td>(1) _ 94)</td><td>(2) - (5)</td><td>Min. 1 MΩ</td></tr>
<tr><td>Between pins (1), (2), (3), (4) and chassis</td><td>Between pins (2), (3), (4), and (5) and chassis</td><td>Min. 1 MΩ</td></tr>
</table>
Motor drive current: Hold: 0.7 A
Start: 0.84 A
</td>
<td>Takes no particular action</td>
<td>1. When there is a disconnection in both the A phase and B phase at the same time, the problem is the same as for a short circuit in the governor motor system
2. When there is a disconnection in only one of A phase or B phase
1) Engine does not stop
2) Stops moving at position immediately before failure, so engine speed cannot be controlled
3) There are cases of hunting</td>
</tr>
<tr>
<td>
<table>
<tr><th>E05 (male)</th><th>C02 (female)</th><th>Resistance value</th></tr>
<tr><td>(1) - (2)</td><td>(2) - (3)</td><td>0.25 - 7kΩ</td></tr>
<tr><td>(3) - (4)</td><td>(4) - (5)</td><td>0.25 - 7kΩ</td></tr>
<tr><td>(1) - (3)</td><td>(2) - (4)</td><td>Min. 1 MΩ</td></tr>
<tr><td>(1) - (4)</td><td>(2) - (5)</td><td>Min. 1 MΩ</td></tr>
<tr><td>Between pins (1), (2), (3), (4) and chassis</td><td>Between pins (2), (3), (4), and (5) and chassis</td><td>Min. 1 MΩ</td></tr>
</table>
Motor drive current: Hold: 0.7 A
Start: 0.84 A
</td>
<td>Sets motor drive current to 0</td>
<td>1. If during operation
1) Set to low idling
2) Engine does not stop
3) There are cases of hunting
2. When stopped
1) Engine starts, but stays at low idling
2) Engine does not stop after starting
3) There are cases of hunting</td>
</tr>
</table>

User code	Service code	Abnormal system	Nature of abnormality
-	E306	Abnormality in feedback potentiometer system	1. Short circuit in wiring harness between C03 (7) - (14), (7) - (17), (14) - (17) 2. Short circuit in wiring harness between E04 (1) - (2), (1) - (3), (2) - (3) 3. Short circuit in wiring harness between E06 (1) - (2), (10 - (3), (2) - (3) 4. Short circuit in wiring harness between C03 (7) - (4), (4) - (17) 5. Disconnection in wiring harness between C03 (7) - E04 (1) 6. Disconnection in wiring harness between C03 (14) - E04 (2) 7. Disconnection in wiring harness between C03 (17) - E04 (3) 8. Defective governor motor potentiometer 9. Defective contact of C03, E04 connectors
-	E315	Abnormality (short circuit) in battery relay output system	If excess current flows between C03 (1) and battery relay ★ This occurs only when turning starting switch to OFF and stopping engine
-	E316	Abnormality (step-out) in motor	1. Defective adjustment of rod or scuffing of loose spring
			2. Abnormality in governor motor
			3. Abnormality in govenor, pump controller

<table>
<tr><th>Condition when normal (voltage, current, resistance)</th><th>Action by controller when abnormality is detected</th><th>Problem that appears on machine when there is abnormality</th></tr>
<tr><td>
<table>
<tr><th>C03 (female)</th><th>E04 (male)</th><th>Resistance value</th></tr>
<tr><td>(7) - (14)</td><td>(1) - (2)</td><td>0.25 - 7kΩ</td></tr>
<tr><td>(7) - (17)</td><td>(2) - (3)</td><td>0.25 - 7kΩ</td></tr>
<tr><td>(14) - (17)</td><td>-</td><td>2 - 3kΩ</td></tr>
<tr><td>-</td><td>(1) - (3)</td><td>4 - 6kΩ</td></tr>
<tr><td>Between each pin and chassis</td><td>-</td><td>Min. 1 MΩ</td></tr>
</table>
</td><td>Calculates position of motor and carries out control from value of voltage immediately before abnormality occurred</td><td>1. Precision of engine speed control may be reduced.
For example:
1) Engine does not rise to high idling speed (a little too low)
2) Engine does not go down to low idling speed (a little too high)
3) Defective engine speed for autodeceleration or automatic warming-up
4) Engine may not stop
★ The governor motor moves in the direction to stop the engine, but the motor may not move completely to the position to stop the engine.
5) There are cases of hunting</td></tr>
<tr><td>Between C03 (1) and chassis: 20 - 30 V
★ Holds with the motor in the stop position for 2 - 2.5 sec, returns to the low idling position, the turns the battery relay OFF.</td><td>Sets battery relay drive current to 0</td><td>Engine does not stop</td></tr>
<tr><td>1. Linkage adjustment correct</td><td rowspan="3">1. Displays when returning from high idling to low idling
★ Starts again (repeats step-out)
2. In some cases it may not display when returning from partial speed to low idling</td><td rowspan="3">Engine speed cannot be controlled (particularly at high idling), so there is hunting</td></tr>
<tr><td>2. Must move lightly when connector is removed</td></tr>
<tr><td>3. Normal</td></tr>
</table>

JUDGEMENT TABLE FOR GOVERNOR, PUMP GOVERNOR (GOVERNOR CONTROL SYSTEM) AND ENGINE RELATED PARTS

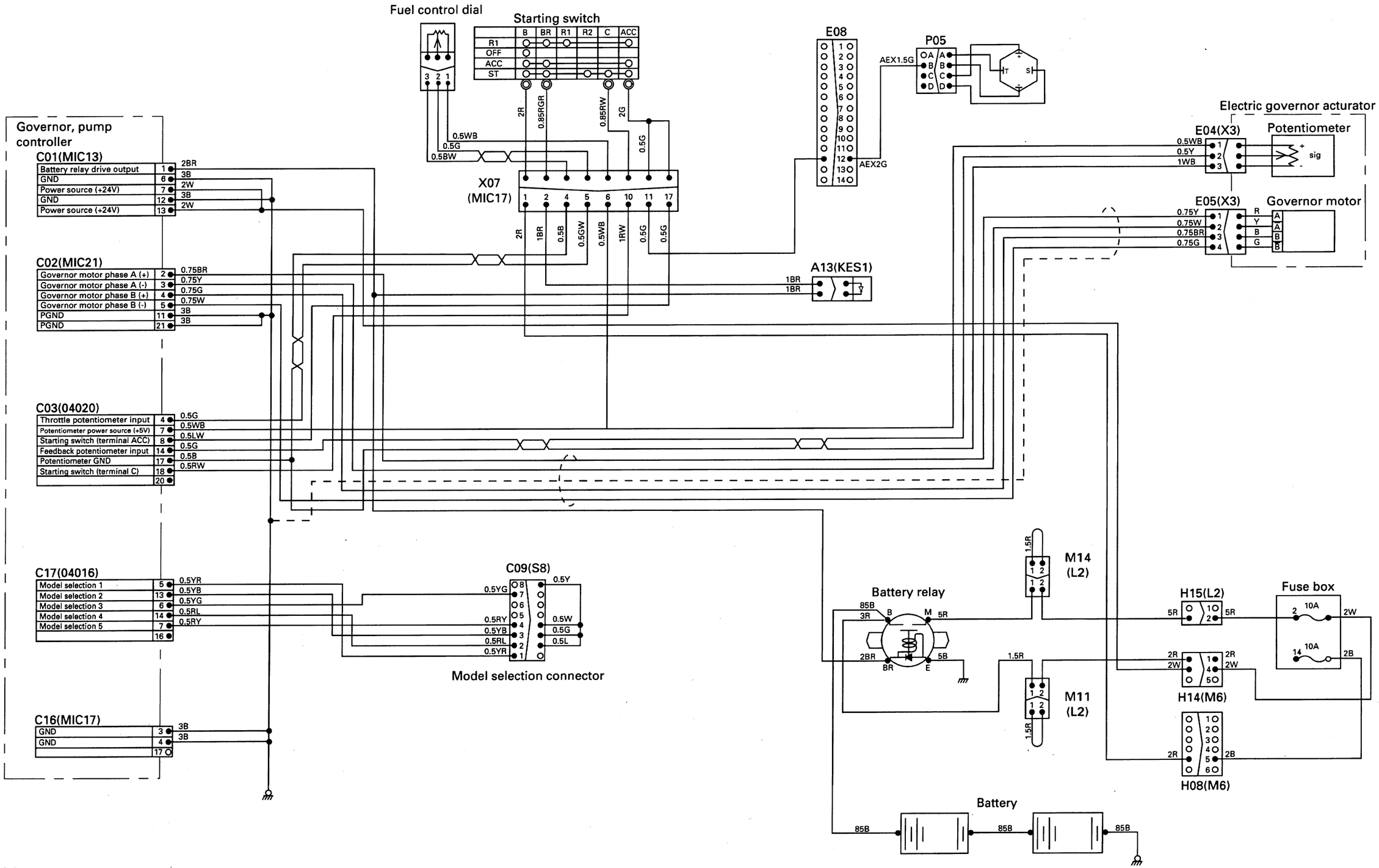
	Failure mode		Abnormality in governor, pump controller power source system	Governor, pump controller, engine related parts (E3: system)					
				Self-diagnostic display					
				Abnormality in fuel control dial input value	Abnormality (disconnection) in motor drive system	Abnormality (short circuit) in motor drive system	Abnormality in feedback potentiometer system	Abnormality (short circuit) in battery relay output	Abnormality (step-out) in motor
		User code		E05					
		Service code	308	317	318	306	315	316	
1	Engine does not start easily								
2	Engine does not start								
3	Engine speed stays at low idling, and does not follow accelerator; or engine pickup is poor		●	●	●	●	●		
4	Engine stops during operation								
5	Engine rotation is irregular	When idling speed is irregular							
		When there is hunting		●	●	●	●		●
6	Lack of output (engine high idling speed is too low)			●			●		
7	Auto-deceleration does not work								
8	Engine does not stop		●		●	●	●	●	●
9	Warming-up operation is defective								
10	Exhaust gas is black								
11	Oil consumption is excessive, or exhaust gas is blue								
12	Oil becomes dirty prematurely								
13	Fuel consumption is excessive, or exhaust gas is blue								
14	Oil is mixed in coolant								
15	Engine oil pressure caution lamp lights up								
16	Oil level rises								
17	Coolant temperature rises too high (overheating)								
18	Abnormal noise is generated								
19	There is excessive vibration								
20	Engine speed does not change even when working mode is switched								
Troubleshooting code when service code is displyed			E-1	E-2	E-3	E-4	E-5	E-6	E-7
Troubleshooting code when there is abnormality in monitoring or machine monitor check			-	-	-	-	-	-	-

• : This shows applicable item for service code
★ : This shows item that needs only checking with monitoring

Checking monitoring, check items							Machine monitor check item			
							Is the range displayed?			
Battery relay drive signal	No. 2 throttle command value	Fuel control dial command value	Governor motor potentiometer	Governor motor A phase current	Governor motor B phase current	Coolant temperature voltage	102°C or above	105°C or above	Does starting motor turn?	Troubleshooting code if no service code display is given
Monitoring code										
35	16	30	31	33	34	41		108		
										S-1
										S-2
		※	※	※	※					S-3
										S-4
			※							E-9A), S-5
	※	※								E-9A), S-5
										E-10, S-6
										E-3. E-4
				※	※					E-11
										E-3 . E-4
										S-7
										S-8
										S-9
										S-10
										S-11
										S-12
										S-13
										S-14
										S-15
										S-16
	※									E-3 . E-4
-	-	-	-	-	-	-	-	-	-	
E-12	-	-	-	-	-	M-14	M-13	M-13	E-8	

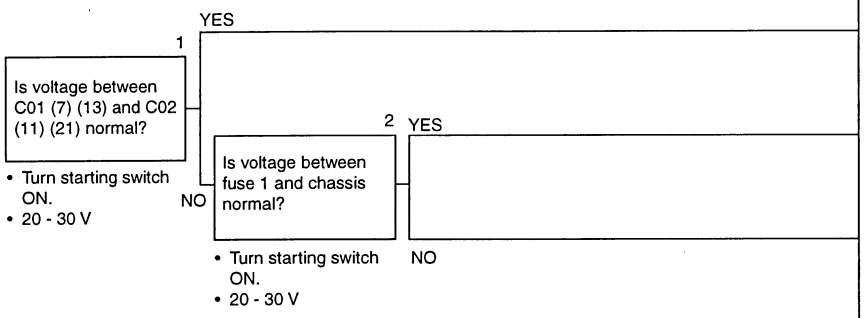
: This shows item to check with monitoring or machine monitor

LECTRICAL CIRCUIT DIAGRAM FOR E MODE SYSTEM



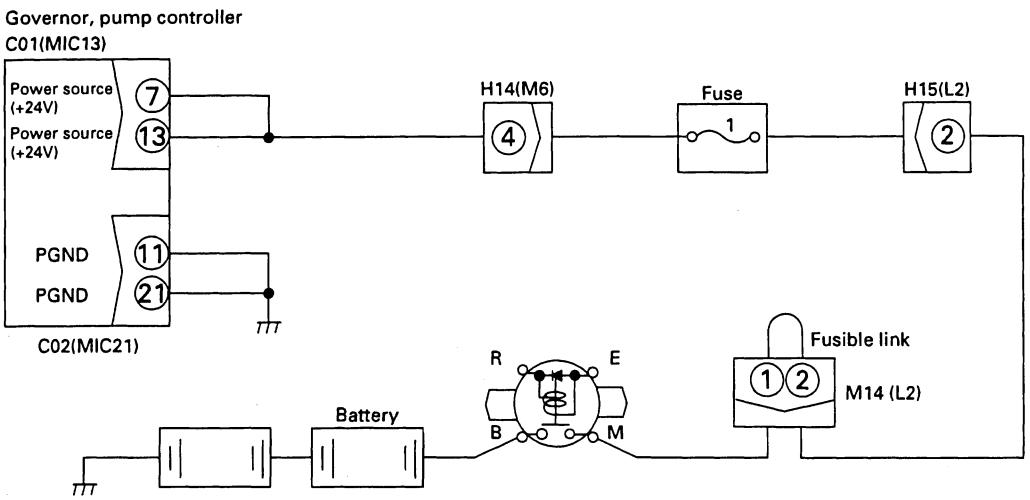
E-1 Abnormality in governor, pump controller power source (controller LED is OFF)

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if the service code E is not displayed, the problem has been removed.**
★ Check that fuse 1 is not blown.
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.
★ When the starting motor rotates correctly. (If the starting motor also does not rotate, goe to E-8.)



Cause	Remedy
Defective governor, pump controller	Replace
Defective contact, or disconnection in wiring harness between fuse 1 and C01 (female) (7) (13)	Repair or replace
Defective contact, or disconnection in wiring harness between fuse 1-H15 (2)-M14 (2) (1)-battery relay M	Repair or replace

E-1 Related electric circuit diagram

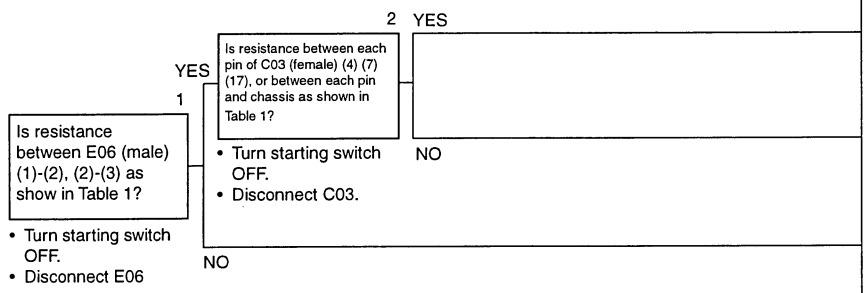


E-2 [E308] Abnormality in fuel control dial input value is displayed

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if the service code E is not displayed, the problem has been removed.**

★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.

★ Always connect any disconnected connectors before going on the next step.



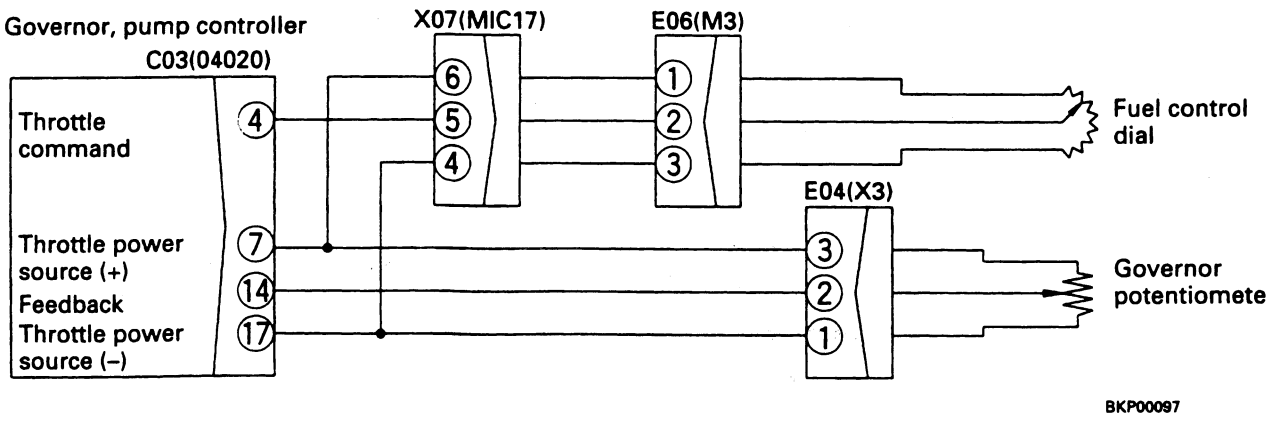
Cause	Remedy
Defective governor, pump controller	Replace
Defective wiring harness in system with defective resistance	Replace
Defective fuel control dial	Replace

★ If E306 also occurs at the same time, check the wiring harness below.
- Wiring harness between c03 (female) (7) - E04 (female) (1) short circuiting with ground, or contact with other wiring harness

Table 1

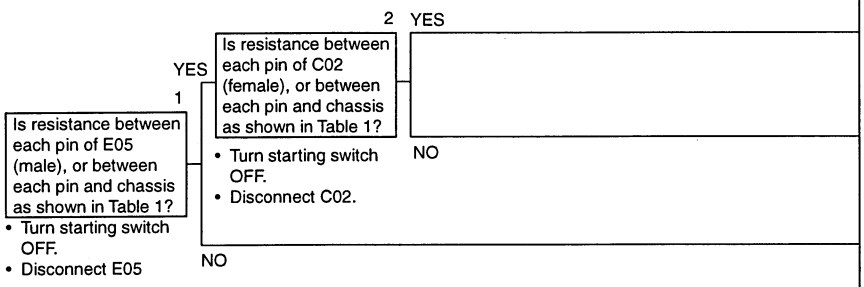
C03 (female)	E04 (male)	Resistance value
(7) - (4)	(1) - (2)	0.25 - 7kΩ
(4) - (17)	(2) - (3)	0.25 - 7kΩ
(7) - (17)	-	2 - 3kΩ
-	(1) - (3)	4 - 6kΩ
Between each pin and chassis	-	Min. 1 MΩ

E-2 Related electric circuit diagram



E-3 [E317] Abnormality (disconnection) in motor drive system is displayed

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if the service code E is not displayed, the problem has been removed.**
★ During operation, if there is
1) a simultaneous disconnection in A phase and B phase:
1) the engine will run at low idling
2) the engine will not stop
2) a disconnection in either A phase or B phase, the engine speed will remain the same as before the abnormality occured
★ If the problem occurs when the engine is stopped,
1) the engine can be started, but is stays in low idling, or 2) it will not stop after it is started.
⚠ Check with the engine stopped (push the fuel control lever of the fuel injection pump to the NO INJECTION position).
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

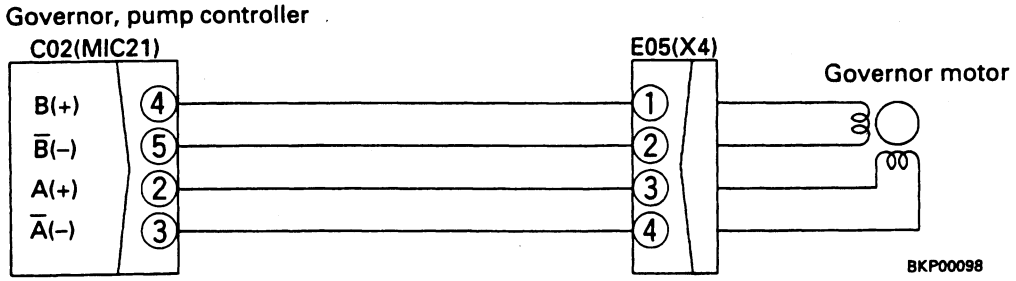


Cause	Remedy
Defective governor, pump controller	Replace
Defective wiring harness in system with defective resistance	Replace
Defective governor motor	Replace

Table 1

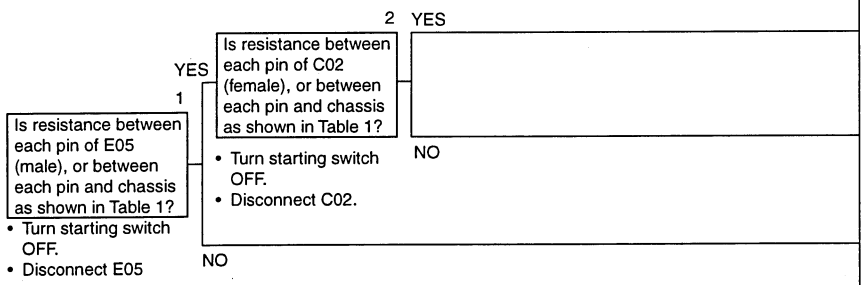
E05 (male)	C02 (female)	Resistance value
(1) - (2)	(2) - (3)	2.5 - 7.5 kΩ
(3) - (4)	(4) - (5)	2.5 - 7.5 kΩ

E-4 Related electric circuit diagram



E-4 [E318] (short circuit) in motor drive system is displayed

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if the service code E is not displayed, the problem has been removed.**
★ If the abnormality occurs during operation, because of the force of the spring,
1) the engine will run at low idling
2) the engine will not stop
★ If the problem occurs when the engine is stopped,
1) the engine can be started, but it stays in low idling, or 2) it will not stop after it is started.
Check with the engine stopped (push the fuel control lever of the fuel injection pump to the NO INJECTION position).
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

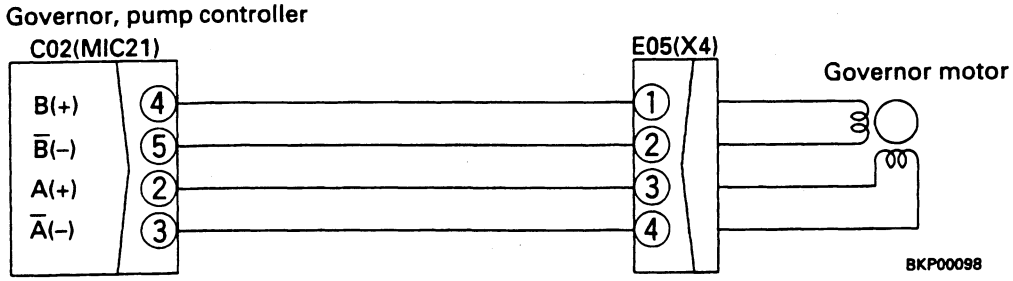


Cause	Remedy
Defective governor, pump controller	Replace
Defective wiring harness in system with defective resistance	Replace
Defective governor motor	Replace

Table 1

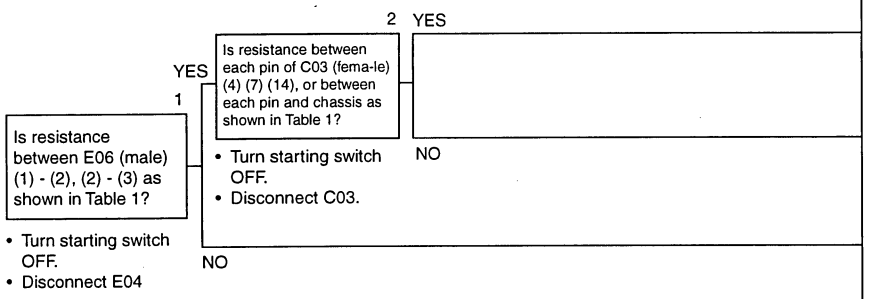
E05 (male)	C02 (female)	Resistance value
(1) - (2)	(2) - (3)	2.5 - 7.5kΩ
(3) - (4)	(4) - (5)	2.5 - 7.5kΩ
(1) - (3)	(2) - (4)	Min. 1 MΩ
(1) - (4)	(2) - (5)	Min. 1 MΩ
Between chassis and pins (1) (2) (3) (4)	Between chassis and pins (2) (3) (4) (5)	Min. 1 MΩ

E-4 Related electric circuit diagram



E-5 [E306] Abnormality in feedback potentiometer system is displayd

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if the service code E is not displayed, the problem has been removed.**
★ Before carrying out troubleshooting, check that all the related connectors are proberly inserted.
★ Always connect any disconnected connectors before going on the next step.



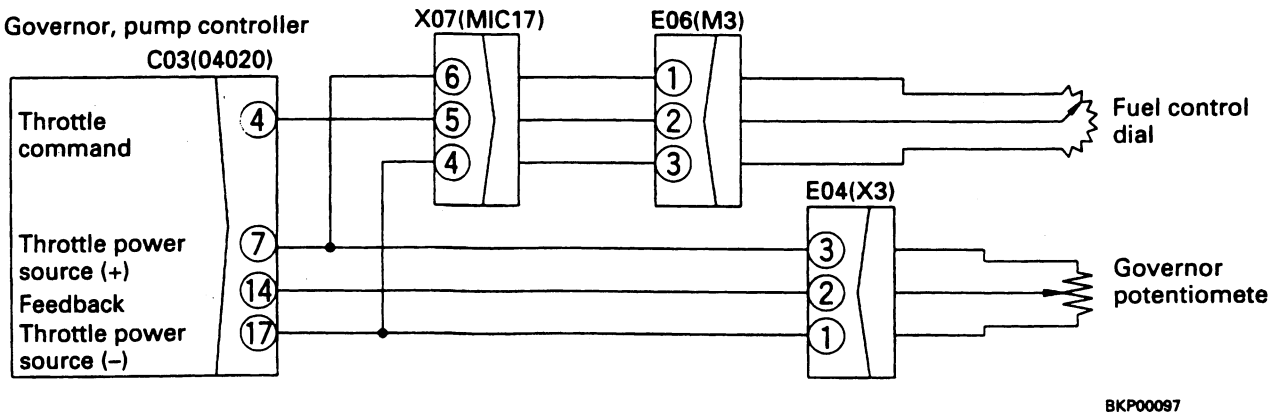
Cause	Remedy
Defective governor, pump controller	Replace
Defective wiring harness in system with defective resistance	Replace
Defective governor motor	Replace

★ If E308 also occurs at the same time, check the wiring harness below.
- Wiring harness between C03 (female) (7) - X07 (6) - E06 (female) (1) short circuiting with ground, or contact with other wiring harness

Table 1

C03 (female)	E04 (male)	Resistance value
(7) - (4)	(1) - (2)	2.5 - 7kΩ
(14) - (17)	(2) - (3)	2.5 - 7kΩ
(7) - (17)	-	2 - 3kΩ
-	(1) - (3)	4 - 6kΩ
Between chassis and pins	Between chassis and pins	Min. 1 MΩ

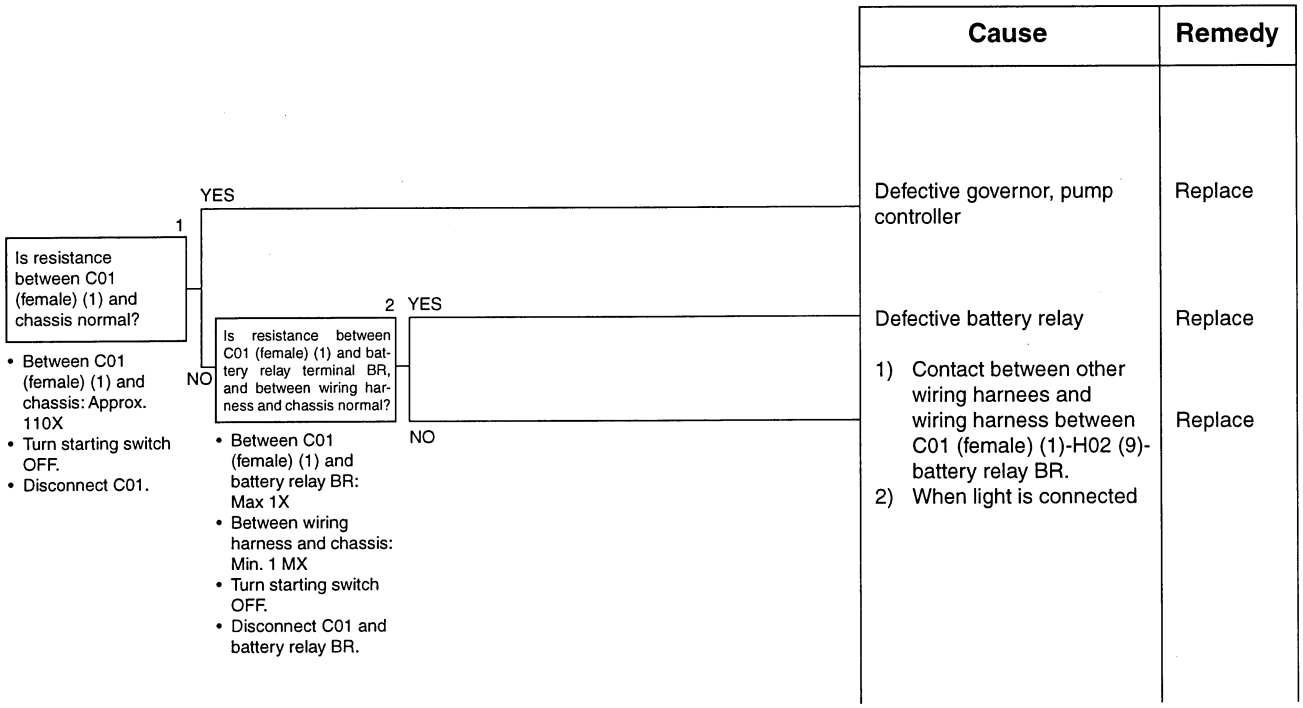
E-5 Related electric circuit diagram



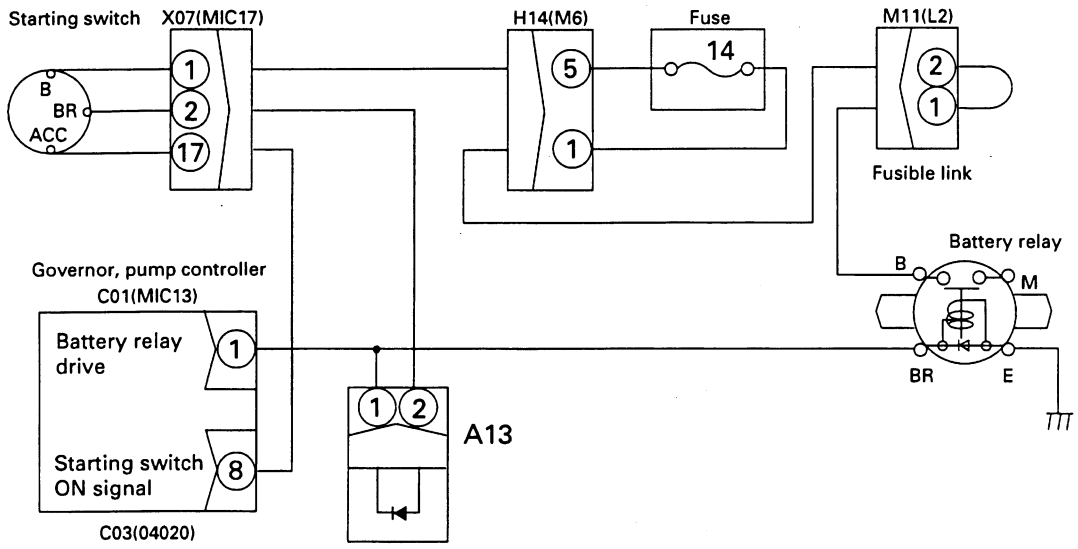
BKP00097

E-6 [E315] Abnormality (short circuit) in battery relay output system is displayed

★ This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if the service code E is not displayed, the problem has been removed.
Check with the engine stopped (push the fuel control lever of the fuel injection pump to the NO INJECTION position).
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.
★ This only occurs when the engine is stopped and the starting switch is turned OFF.

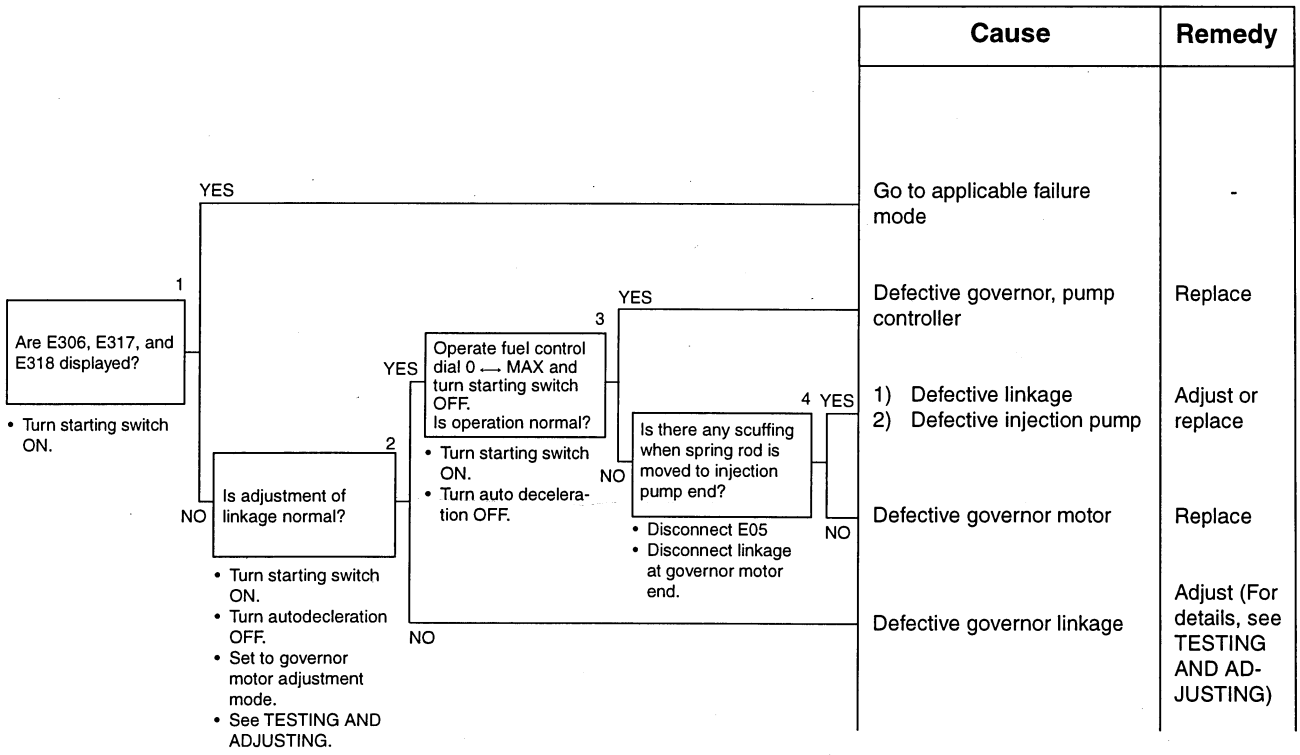


E-6 Related electric circuit diagram



E-7 [E316] Abnormality (step-out) in motor is displayed

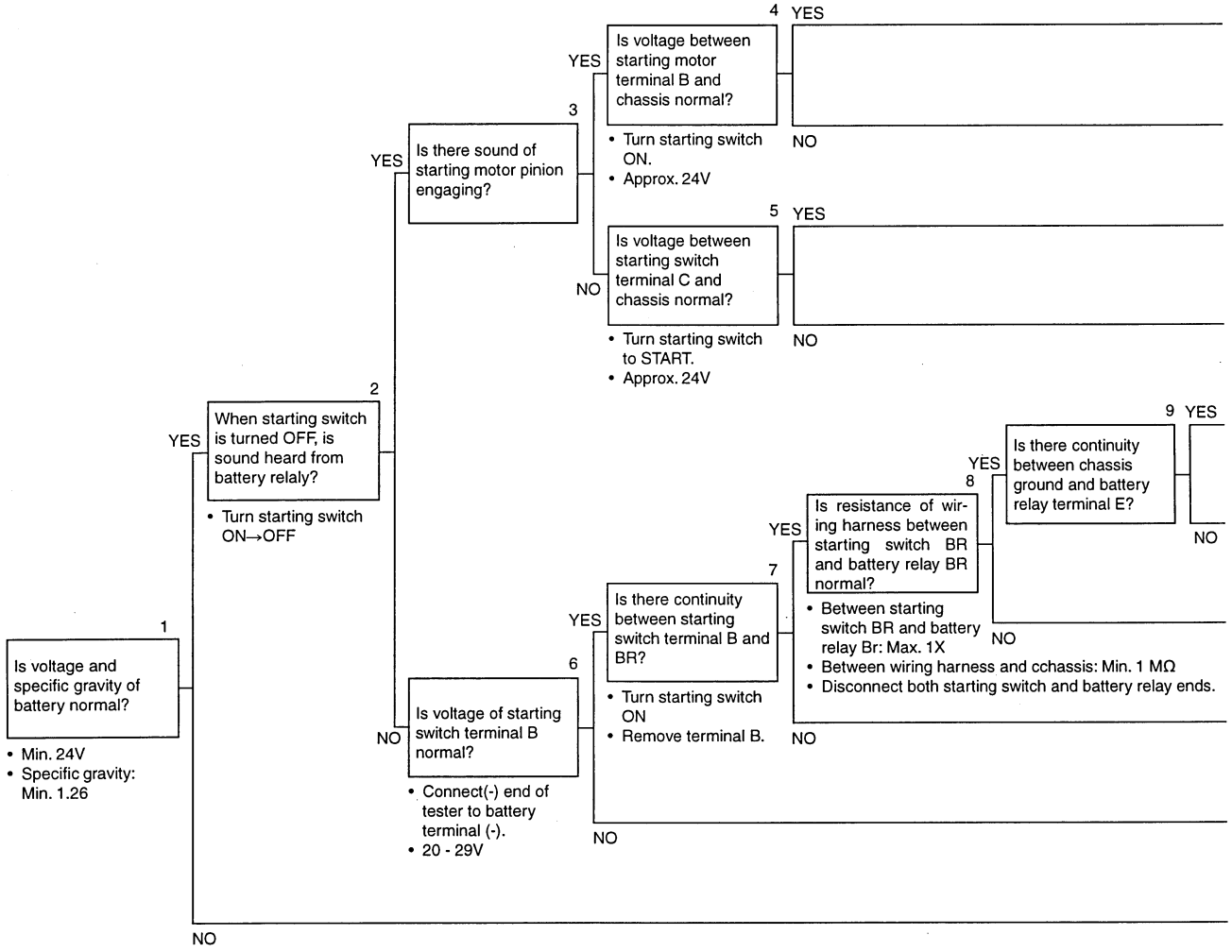
★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if the service code E is not displayed, the problem has been removed.**
★ If any other service code [E06] - [E318] has occurred at the same time, start troubleshooting from the code except code [E316].
★ Check that the fuse is normal
★ Read the precautions given in TESTING AND ADJUSTING, "Adjusting travel of governor motor lever" before carrying out the troubleshooting.
★ Before carrying out the troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



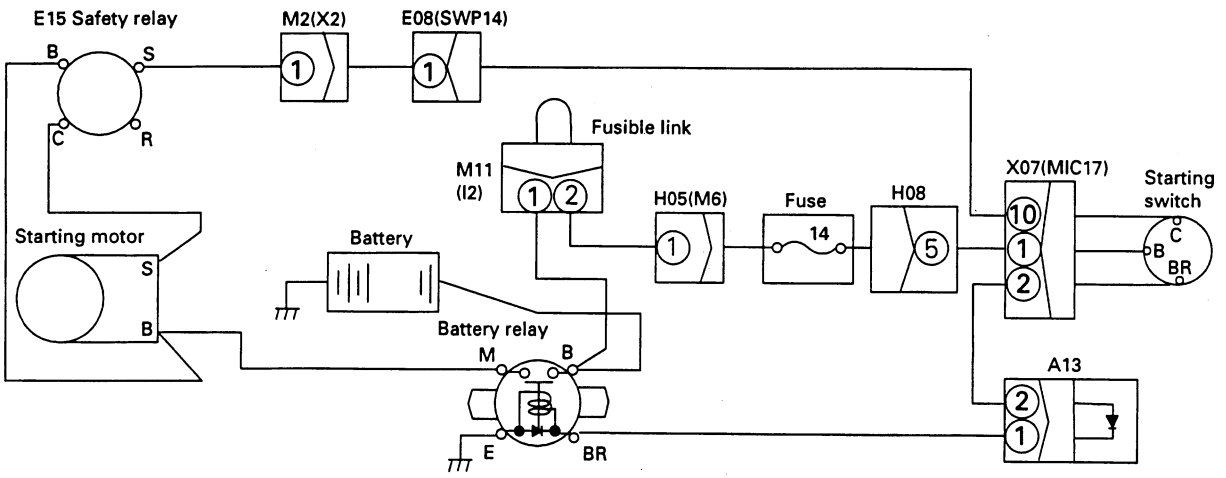
Cause	Remedy
Go to applicable failure mode	-
Defective governor, pump controller	Replace
1) Defective linkage 2) Defective injection pump	Adjust or replace
Defective governor motor	Replace
Defective governor linkage	Adjust (For details, see TESTING AND ADJUSTING)

E-8 Engine does not start

★ When starting motor does not rotate.
★ Check that fuse No. 14 is not blown before starting troubleshooting.
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



E-8 Related electric circuit diagram



Cause	Remedy
Defective starting motor	Replace
Defective contact of wiring harness between battery (+) - battery relay B-battery relay M- starting motor terminal B (including battery relay)	Replace
Defective contact, or disconnection in wiring harness between starting switch terminal C-X07 (10)-E08 (1) -M2 (1) -starting motor terminal S	Replace
Defective starting switch (between terminals B and C)	Replace
Defective battery relay	Replace
Defective contact of wiring harness between battery relay terminal E and revolving frame grond connection terminal	Replace
Defective contact or disconnection in wiring harness between starting switch terminal BR-D13- battery relay terminal BR	Replace
Defective starting switch (between B and BR)	Replace
Defective contact, or disconnection in wiring harness between battery terminal (+)-M11-H05 (6)-X07 (1)-starting switch terminal B (including fusible link)	Replace
Lack of battery capacity	Charge or replace

E-9 Engine speed is irregular

★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

a) Idling speed is irregular

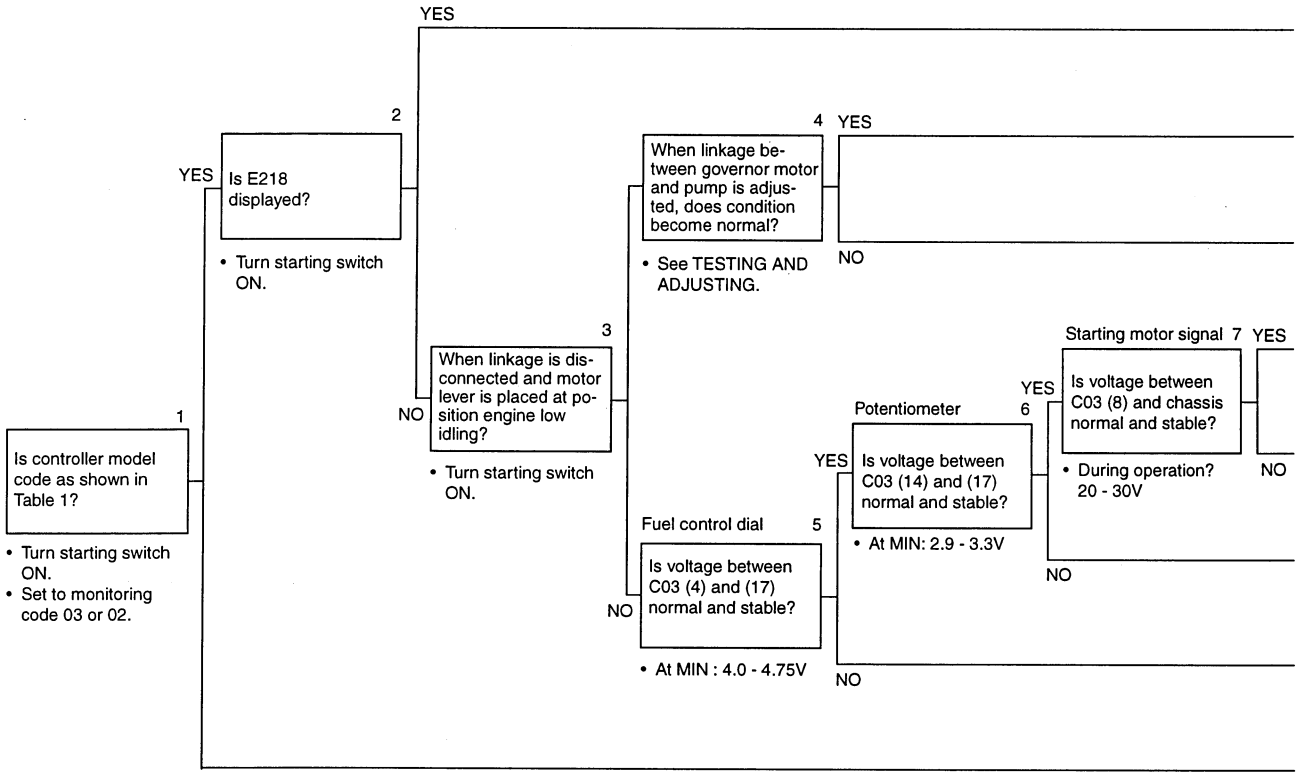


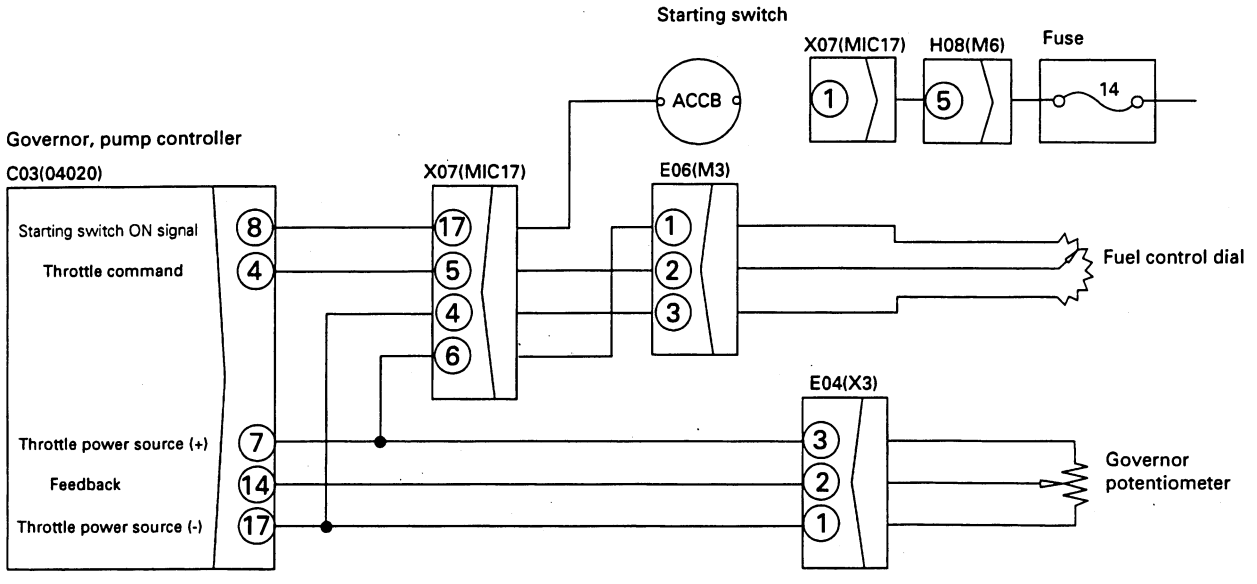
Table 1

Controller model code


★ The diagram shows monitoring code 03.

Cause	Remedy
See N mode	
Defective adjustment of linkage	Adjust
Defective injection pump	See S mode
Defective governor motor	Replace
Defective contract of wiring harness between starting switch ACC-X07 (17)-C03 (femal) (8), or defective starting switch	Repair or replace
See E-5	-
See E-2	-
See C-14	-

E-9 Related electric circuit diagram



b) There is hunting

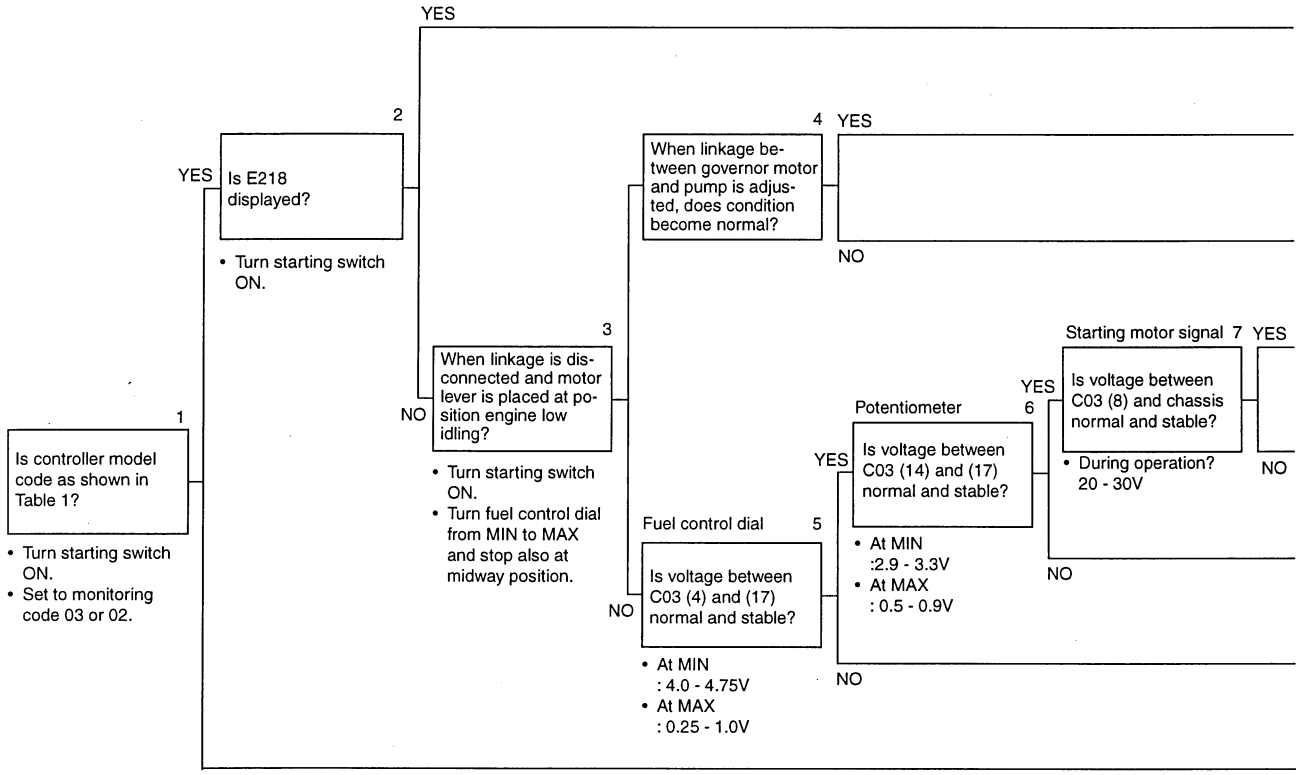


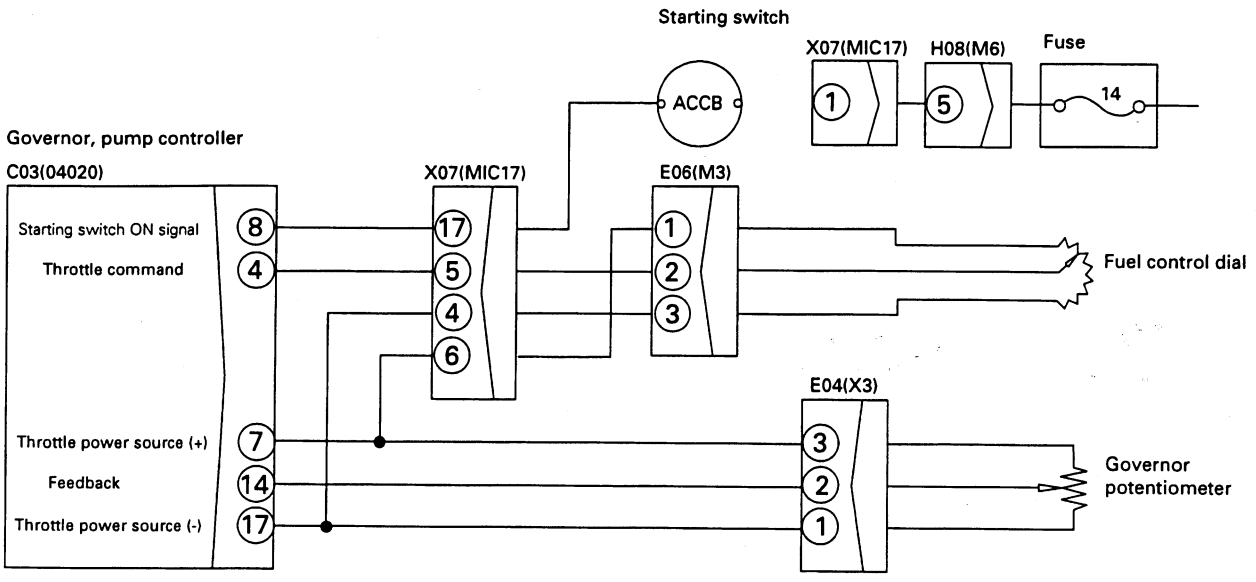
Table 1

Controller model code
03 400
BKP00209

★ The diagram shows monitoring code 03.

Cause	Remedy
See N mode	
Defective adjustment of linkage	Adjust
Defective injection pump	See S mode
Defective governor motor	Replace
Defective contract of wiring harness between starting switch ACC-X07 (17)-C03 (femal) (8), or defective starting switch	Repair or replace
See E-5	-
See E-2	-
See C-14	-

E-9 Related electric circuit diagram



E-10 Lack of output (engine high idling speed is too low)

★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

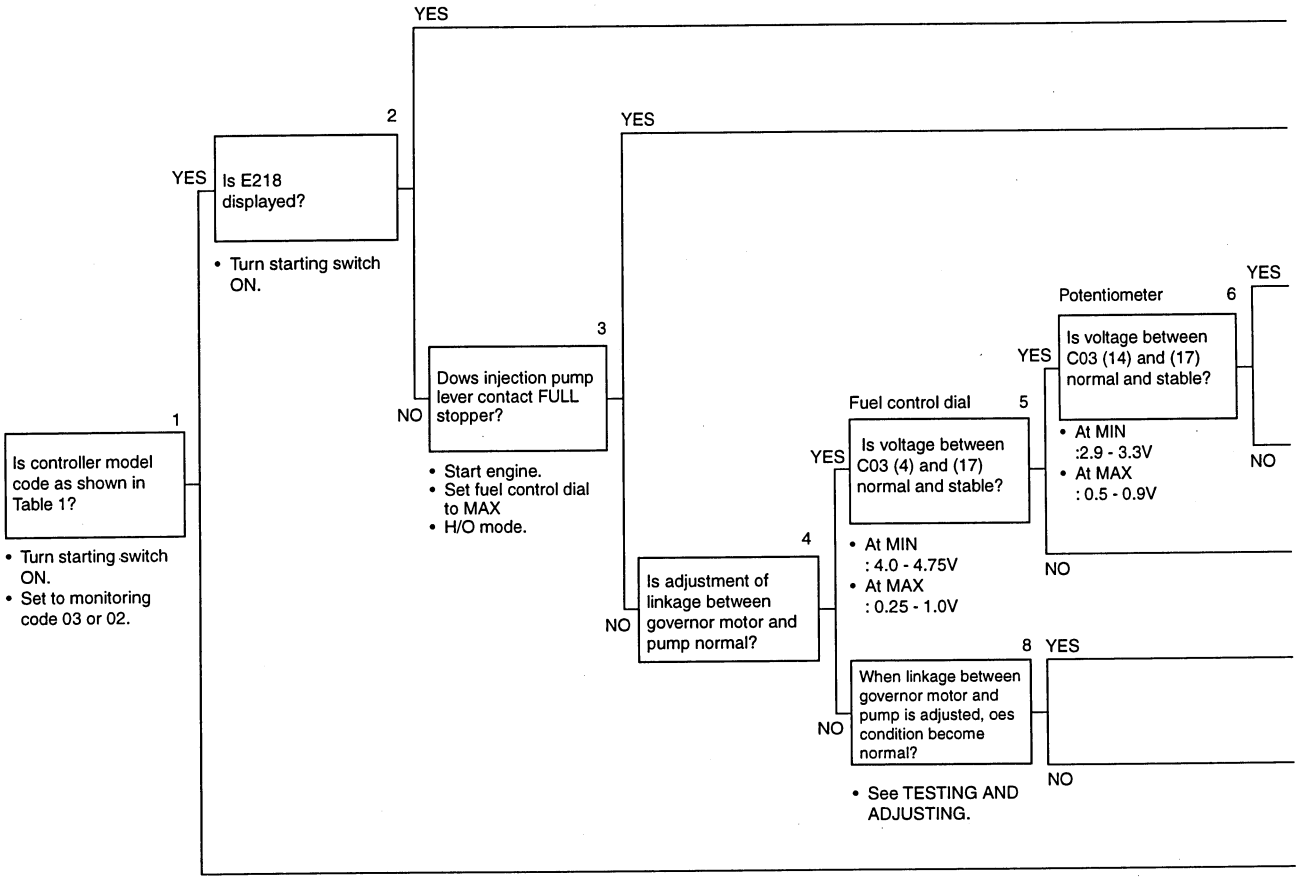


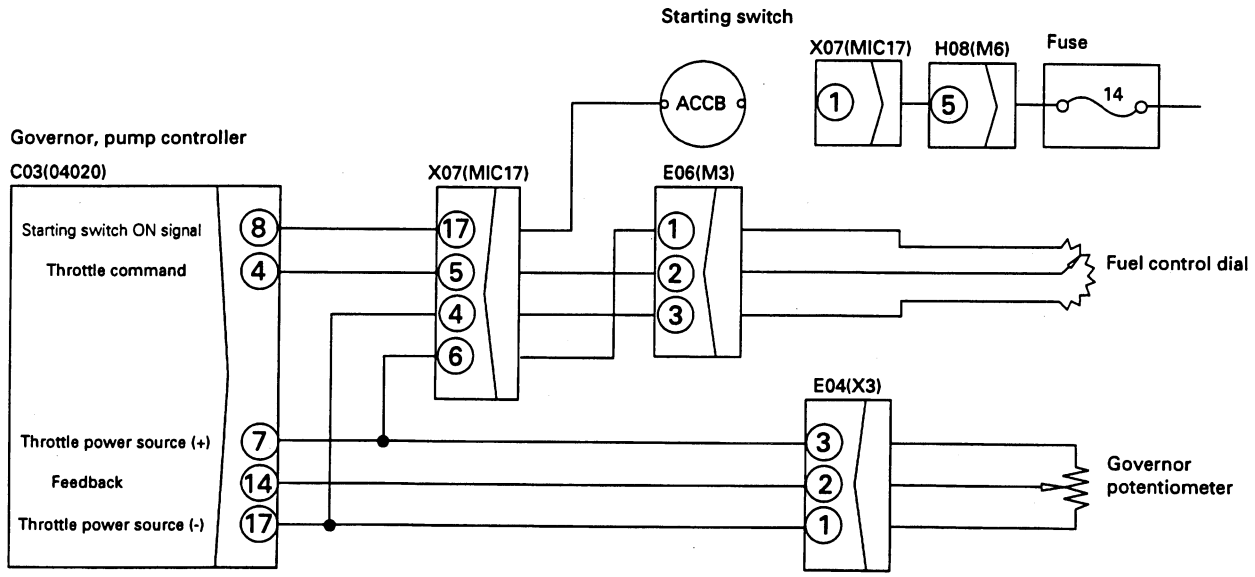
Table 1

Controller model code
03 400
BKP00209

★ The diagram shows monitoring code 03.

	Cause	Remedy
	See N mode	-
	Defective injection pump	See S mode
Starting motor signal 7 — Is voltage between C03 (8) and chassis normal and stable? — YES	Defective governor motor	Replace
• During operation? 20 - 30V — NO	Defective contact of wiring harness between starting switch ACC - X07 (17) - C03 (female) (8), or defective starting switch	Repair or replace
	See E-5	
	See E-2	
	Defective adjustment of governor motor linkage	
	See S mode	Adjust
	See C-14	-

E-10 Related electric circuit diagram



E-11 Engine does not stop

⚠ Check with the engine stopped (push the fuel control lever of the fuel injection pump to the NO INJECTION position).

★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.

★ Always connect any disconnected connectors before goning on the next step.

★ Read the precautions given in TESTING AND ADJUSTING, "Adjusting travel of governor motor lever" before carrying out the troubleshooting.

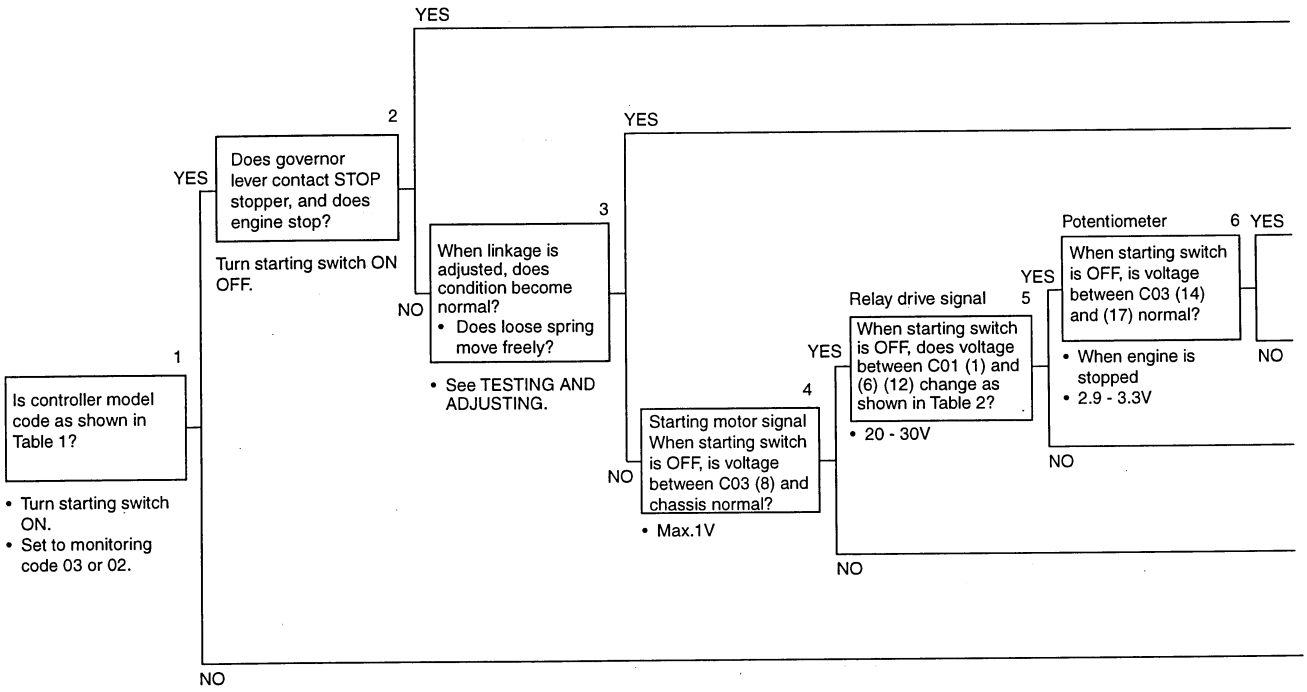
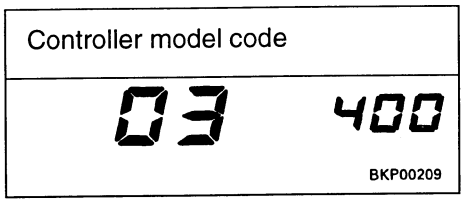
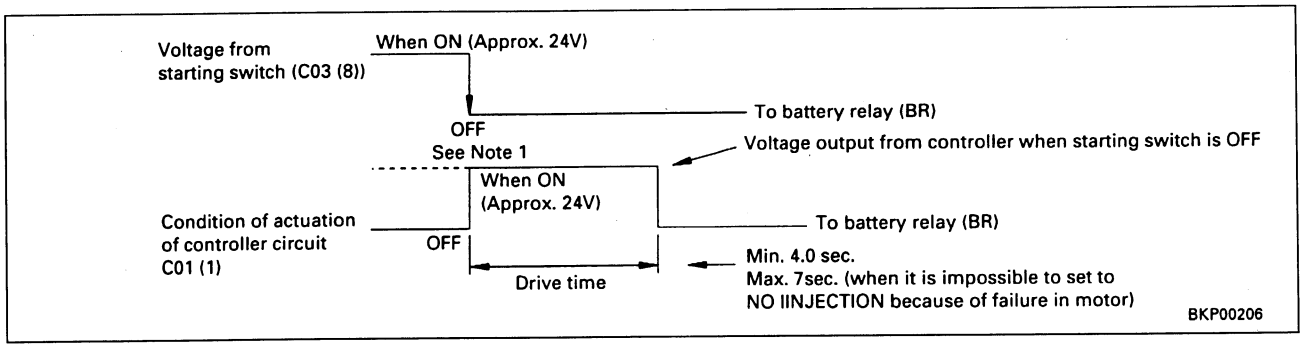


Table 1



★ The diagram shows monitoring code 03.

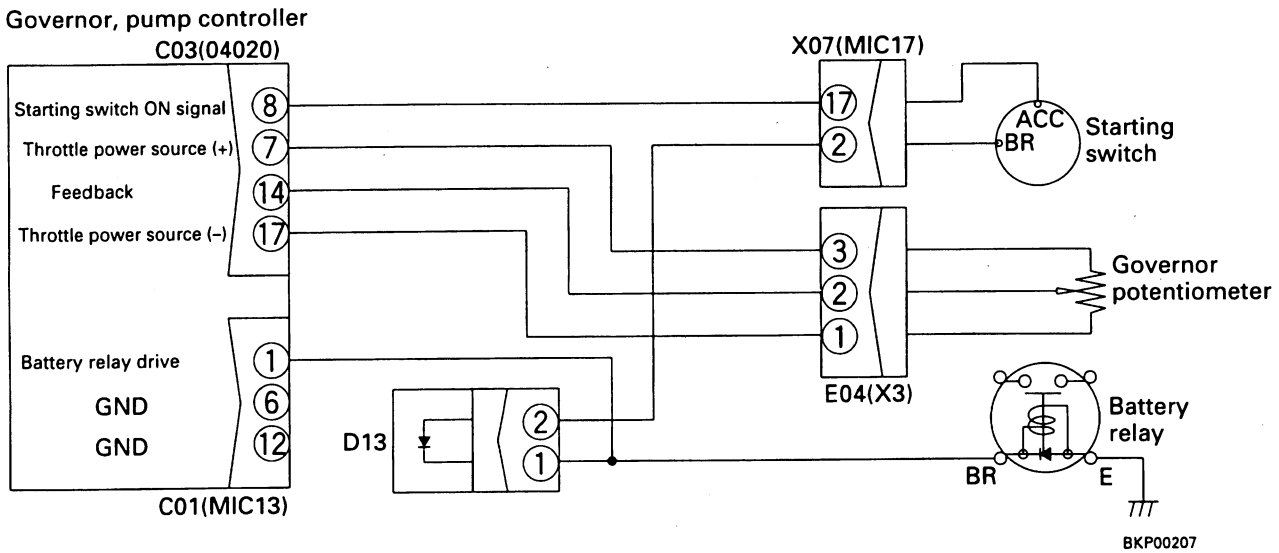
Table 2



Note 1: When the starting switch is ON, the controller end is OFF, but a voltage of approx. 20 - 30V is always from starting switch BR, so if the voltage is measured at C01 (1), there is a voltage of 20 -30V

Cause	Remedy
Defective injection pump	See S mode
Defective adjustment of linkage	Adjust
Defective governor motor	Replace
See E-5	-
Defective governor, pump controller	Replace
Contact with 24V wiring harness of wiring harness between starting switch ACC - X07 (17) - C03 (female) (8), or defective starting switch	Replace
See C-14	-

E-11 Related electric circuit diagram



E-12 Defective operation of battery relay system (engine does not stop)

★ This only occurs when the engine is stopped and the starting switch is turned OFF.
⚠ Check with the engine stopped (push the fuel control lever of the fuel injection pump to the NO INJECTION position).
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

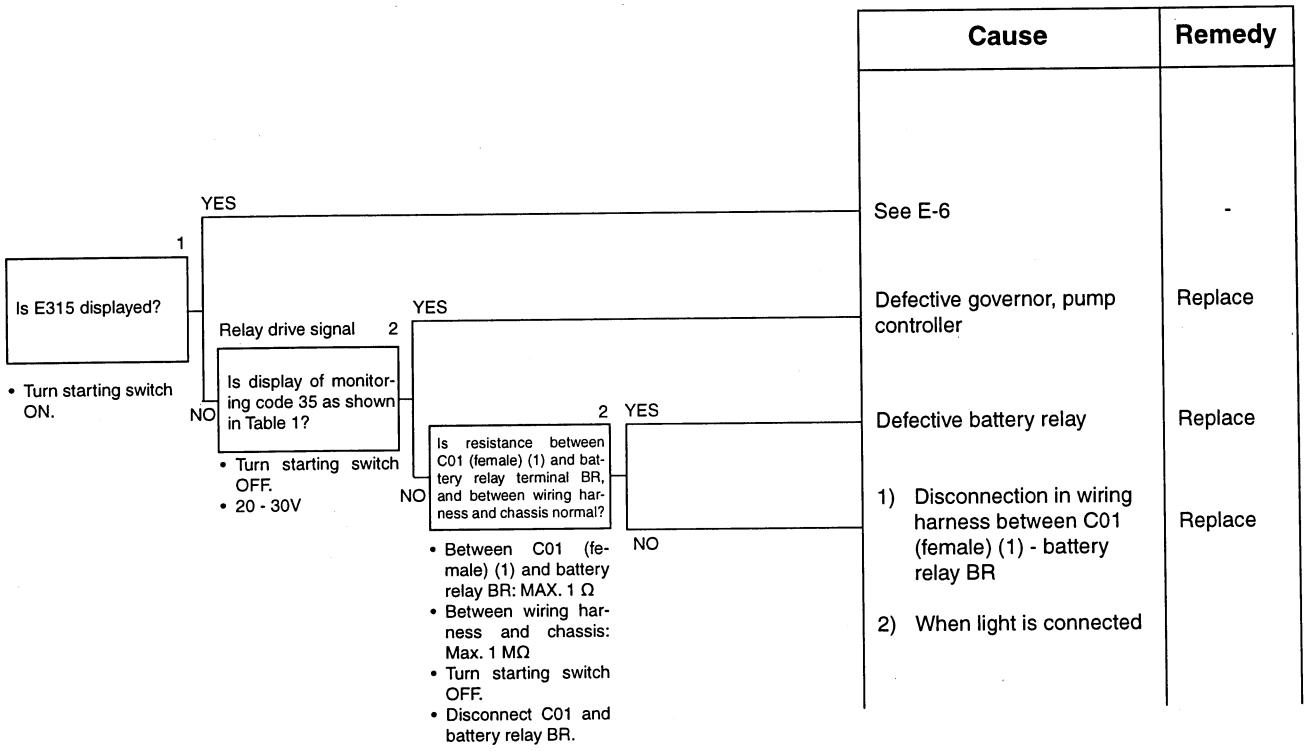
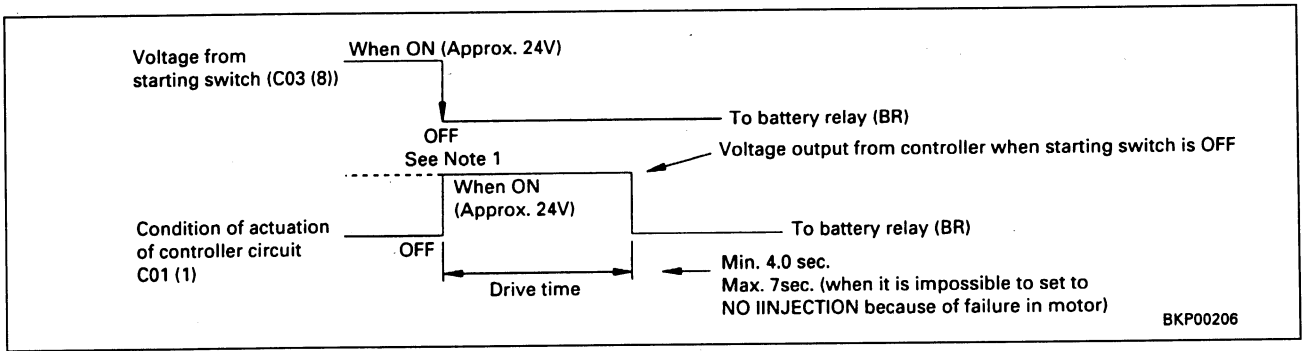
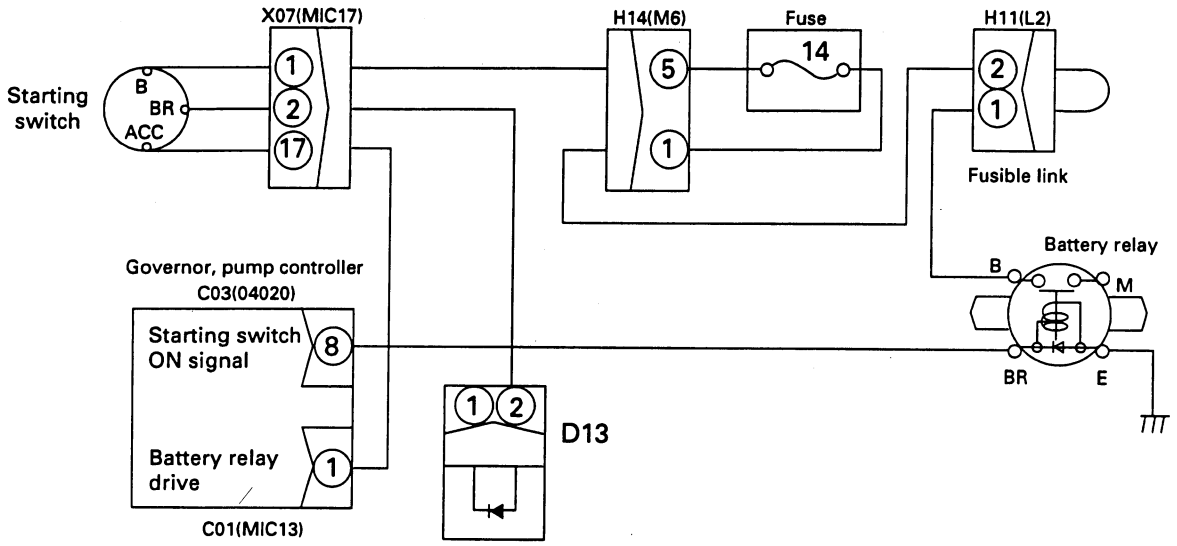


Table 1



Note 1: When the starting switch is ON, the controller end is OFF, but a voltage of approx. 20 - 30V is always from starting switch BR, so if the voltage is measured at C01 (1), there is a voltage of 20 - 30V.

E-12 Related electric circuit diagram



Section Contents

Troubleshooting Procedures and Techniques

A thorough analysis of the customer's complaint is the key to successful troubleshooting. The more information known about a complaint, the faster and easier the problem can be solved.

The Troubleshooting Symptoms Charts beginning on Page T-5 are organized so that a problem can be located and corrected by doing the easiest and most logical things first. Complete all steps in the sequence shown from top to bottom.

It is **not** possible to include all the solutions to problems than can occur; however, these charts should stimulate a thought process that will lead to the cause and correction of the problem.

Follow these basic troubleshooting steps:

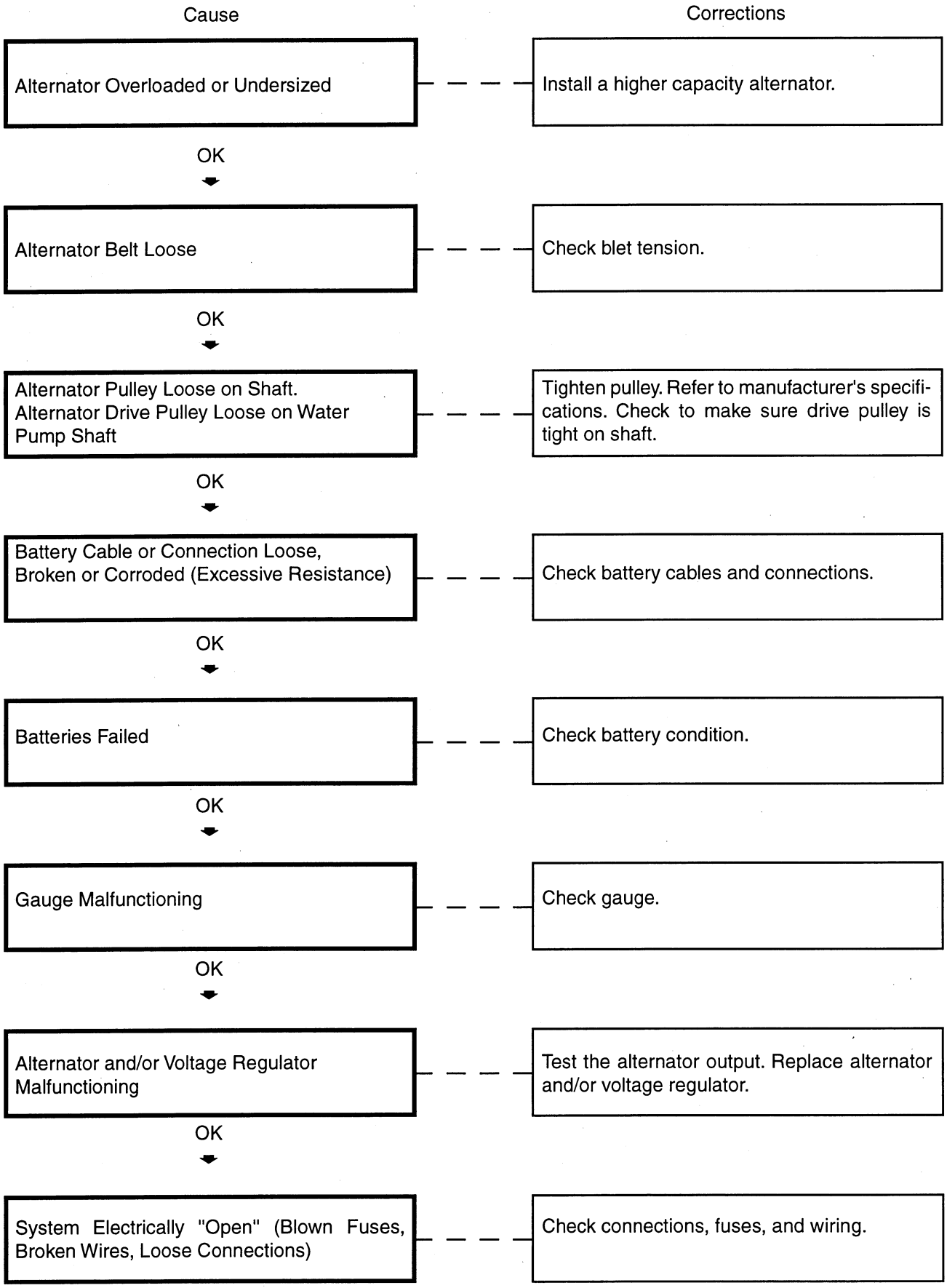
- Get all the facts concerning the complaint.
- Analyze the problem thoroughly.
- Relate the symptoms to the basic engine systems and components.
- Consider any recent maintenance or repair action that can relate to the problem.
- Double-check before beginning any disassembly.
- Solve the problem by using the logic charts and doing the easiest things first.
- Use a chassis dynamometer where applicable to diagnose a problem.
- Determine the cause of the problem and make a thorough repair.
- After repairs have been made, operate the engine to make sure the cause of the problem has been corrected.

Troubleshooting Symptoms Charts

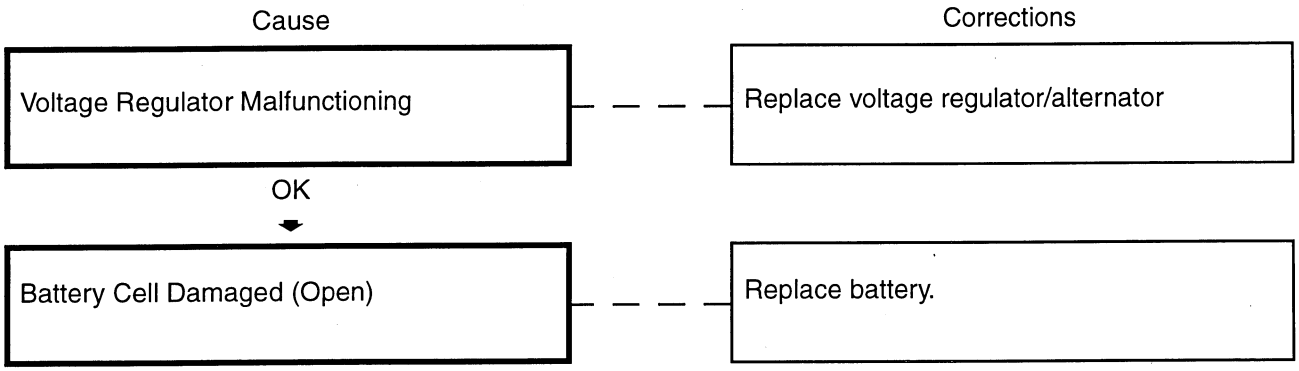
Read and follow the 'Warnings' listed in 'General Safety Instructions' in Section i.

Use the charts on the following pages of this section to aid in diagnosing specific engine problems. Read each row of blocks from top to bottom. Follow the arrows through the chart to identify the corrective action.

Alternator Not Charging or Insufficient Charging



Alternator Overcharging

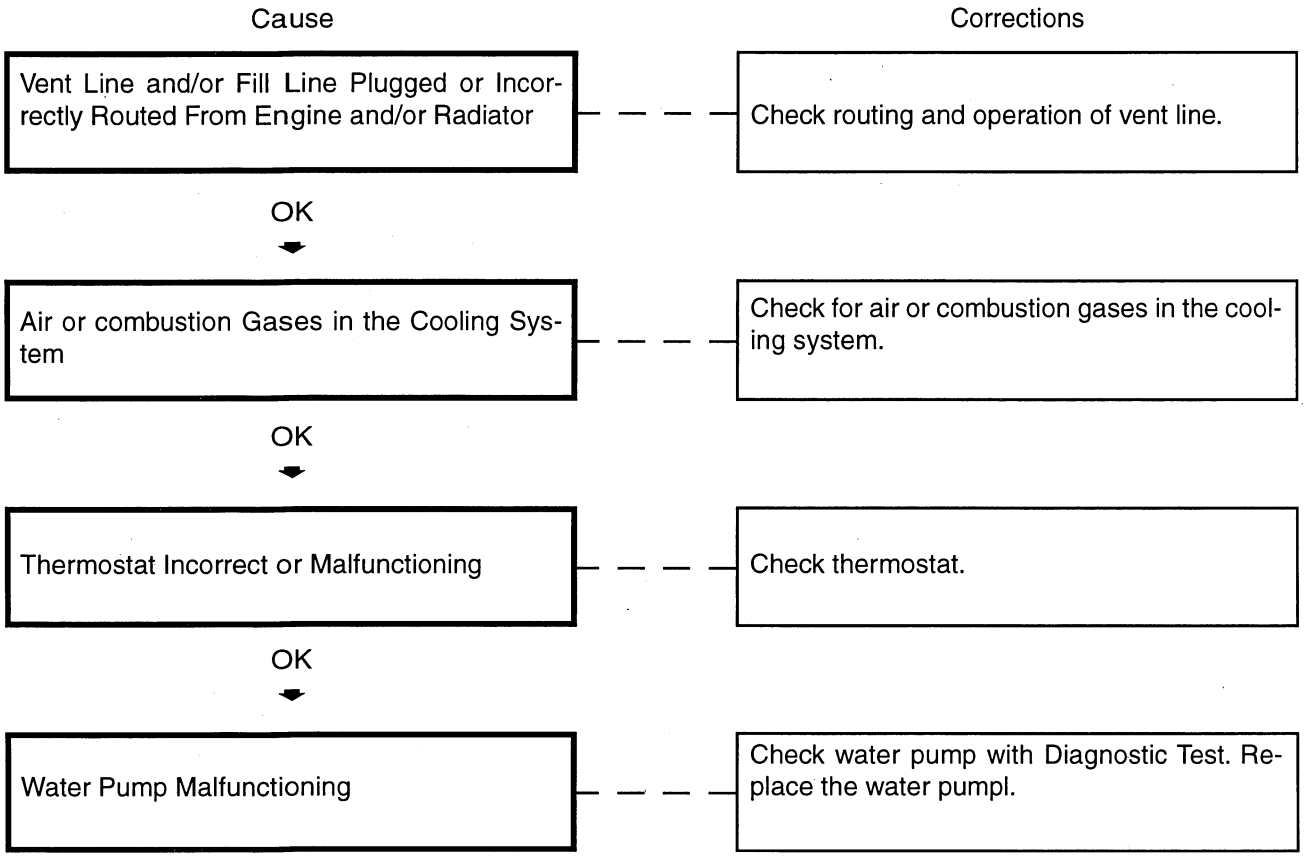


Coolant Loss - External

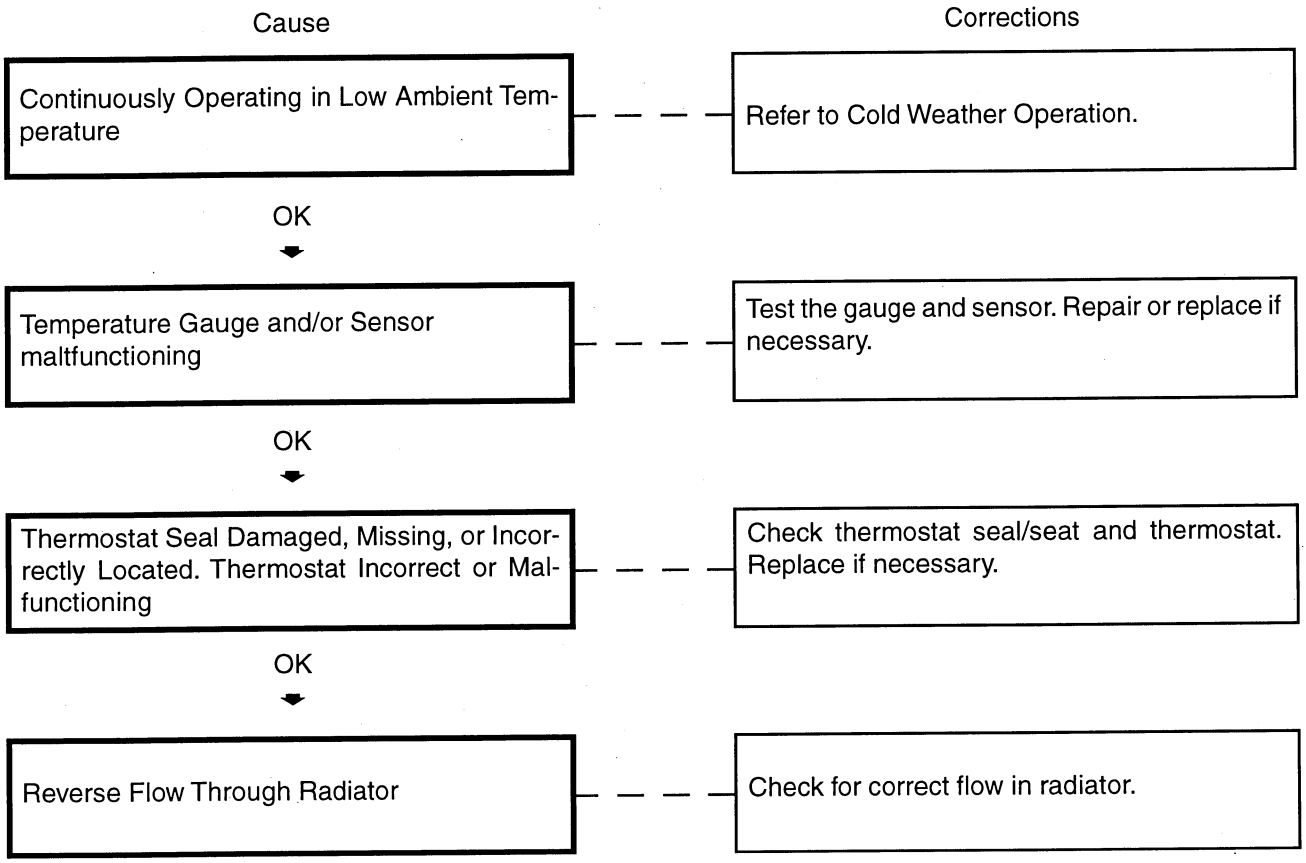
Cause	Corrections
Coolant Level High	Check coolant level.
OK ⬇	
Visually Inspect For Leaks: Hoses, Hose Clamps, Coolant Draincocks, Water Manifold Jumper Tubes, Expansion Plugs, Pipe Plugs, Fittings, Radiator Core, Air Compressor and/or Cylinder Head Gaskets, Lubricating Oil Cooler, Water Pump Seal, Fuel Heater, Torque Converter Cooler, Transmission Cooler,etc.	Tighten or replace if necessary. If necessary, pressure test the cooling system.
OK ⬇	
Radiator Cap Incorrect or Malfunctioning	Check the radiator pressure cap.
OK ⬇	
Dirt, Scale or Sludge In The Cooling System	Clean the cooling system.
OK ⬇	
Restricted, Obstructed or Incorrectly Routed Vent Lines	Check lines for restrictions. Check for correct routing.
OK ⬇	
Restricted or Obstructed Coolant Fill Line	Check line for restrictions and obstructions.
OK ⬇	
Coolant Frozen Due To Incorrect Antifreeze Concentration	Check coolant antifreeze concentration.
OK ⬇	

(Continued)

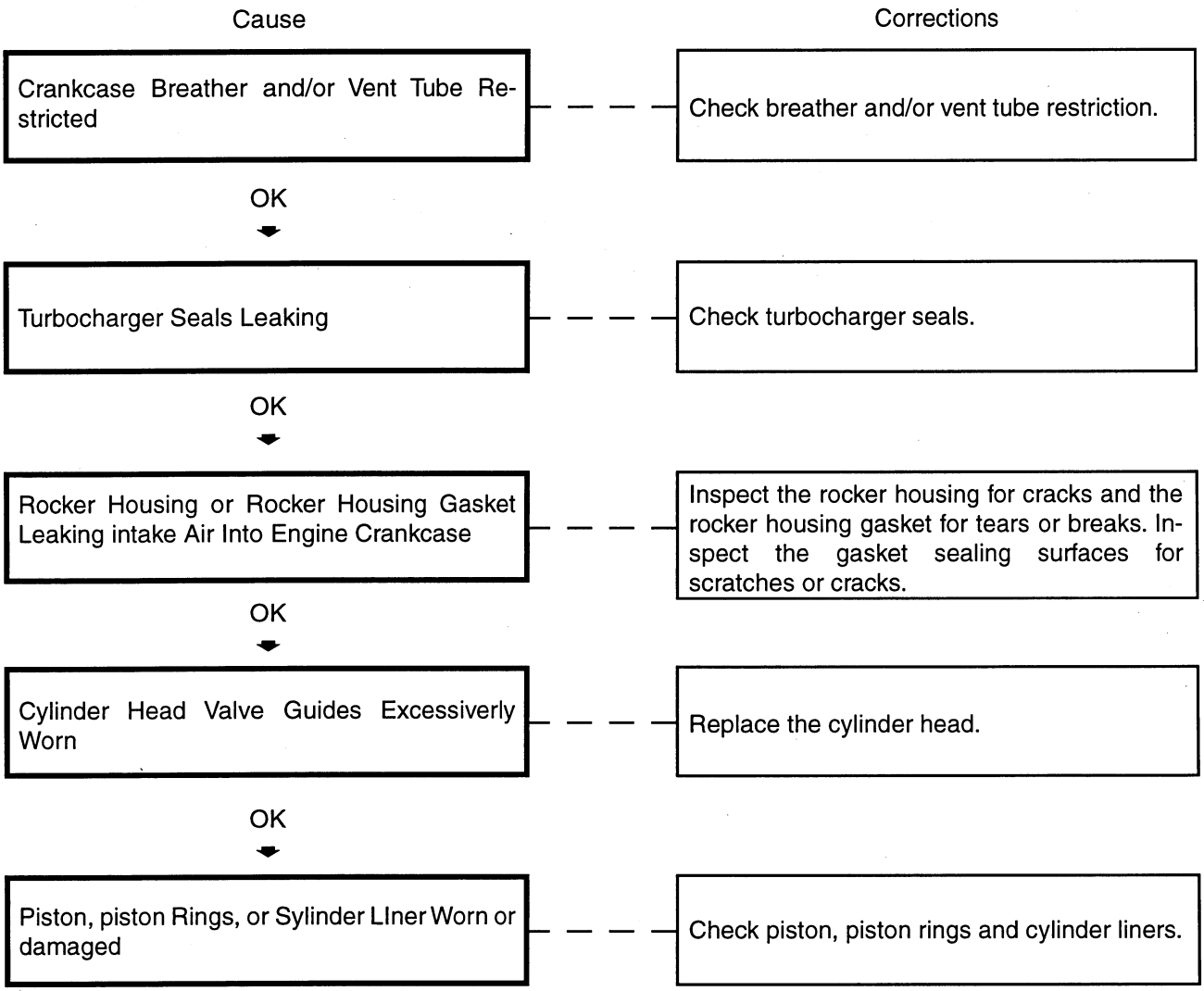
Coolant Temperature Above Normal - Sudden Overheat (Continued)



Coolant Temperature Below Normal



Crankcase Gases (Blowby) - Excessive



Engine Acceleration/Response Poor

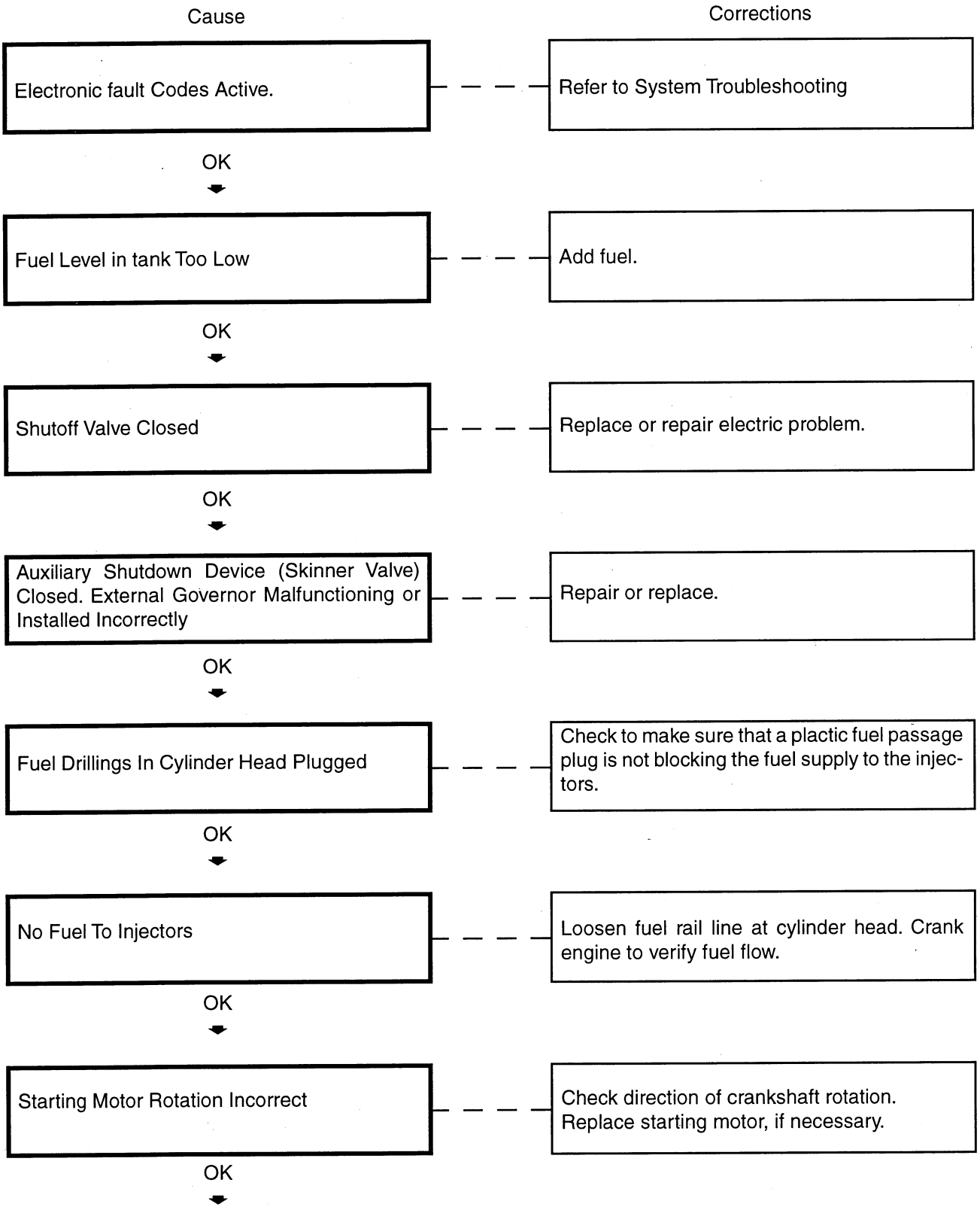
Cause	Corrections
Fuel Inlet Restriction - Above 254 mm Hg [10 in-Hg]	Correct the restriction or replace the fuel filter. Check the fuel pump screen.
OK ⬇	
Frel Drainline Restriction - Above 89 mm Hg [3.5 in-Hg]	Inspect drainline for loops, crimps, swelled lines or plugged tank vents.
OK ⬇	
Intake Air Restriction Above 762 cm H2O [30 in-H_2O]	Replace air cleaner or air filter element. Inspect air piping.
OK ⬇	
Intake Air Leak	Visually check for air leaks in the intake system. Tighten clamps.
OK ⬇	
Air In The Fuel	Check for air in fuel. Tighten fuel connections and fuel filter(s)
OK ⬇	
Fuel Inlet Temperature Above 71 C [160 F]	Fill fuel tanks. Shutoff or bypass the fuel heater.
OK ⬇	
Poor Quality Fuel	Verify by operating from a tempory tank that contains good fuel.
OK ⬇	

(Continued)

Engine Acceleration/Response Poor (Continued)

Cause	Corrections
Fuel Supply Line Excessive Restriction Between Pump and Injectors	Check rail supply line from fuel pump to cylinder head for sharp bends which can cause restriction. Remove injectors and check inlet screen. Check fuel drillings in the cylinder head for restrictions.

Engine Cranks But Will Not Start (No Smoke From Exhaust)



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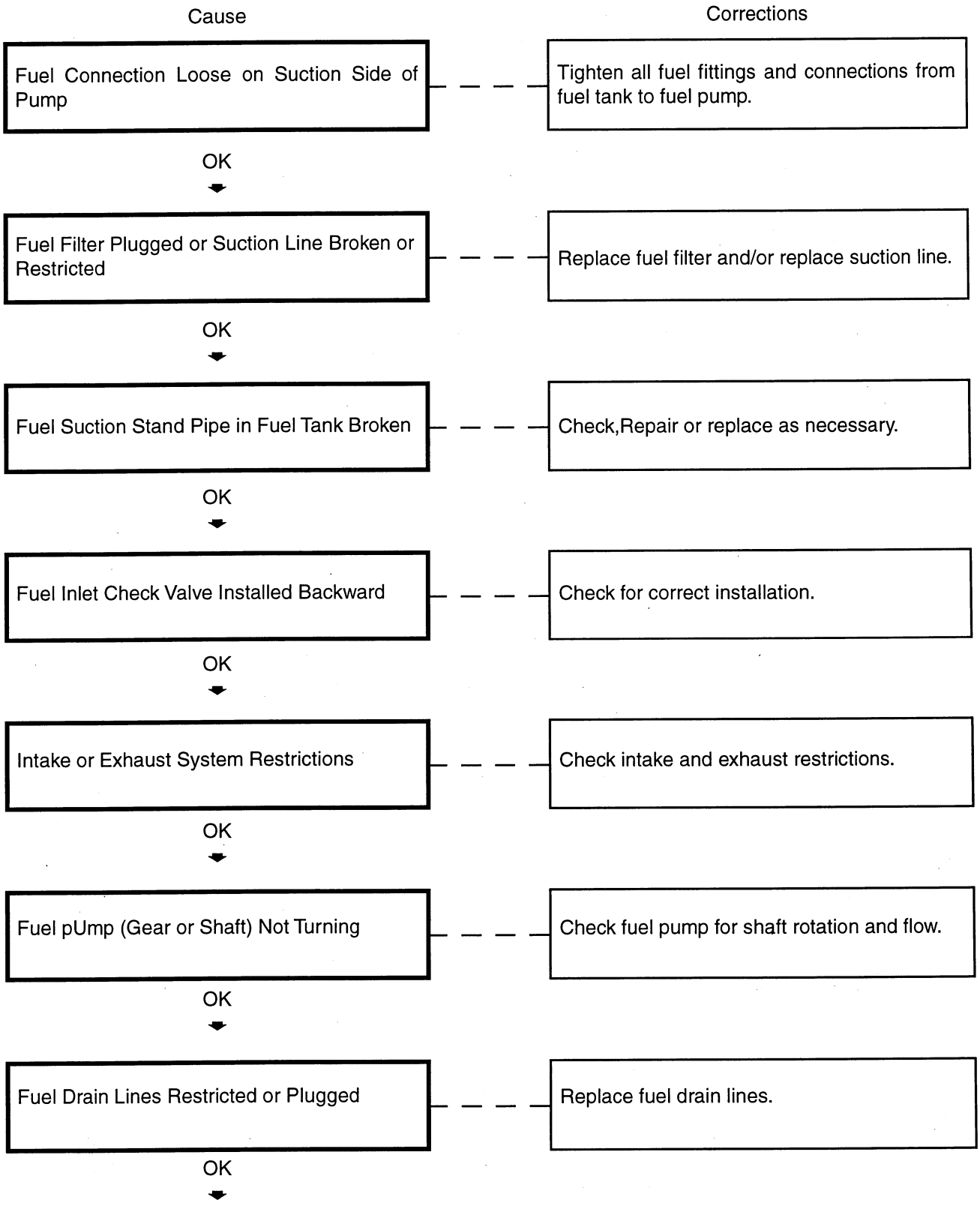
Engine Cranks But Will Not Start (No Smoke From EXhaust) (Continued)



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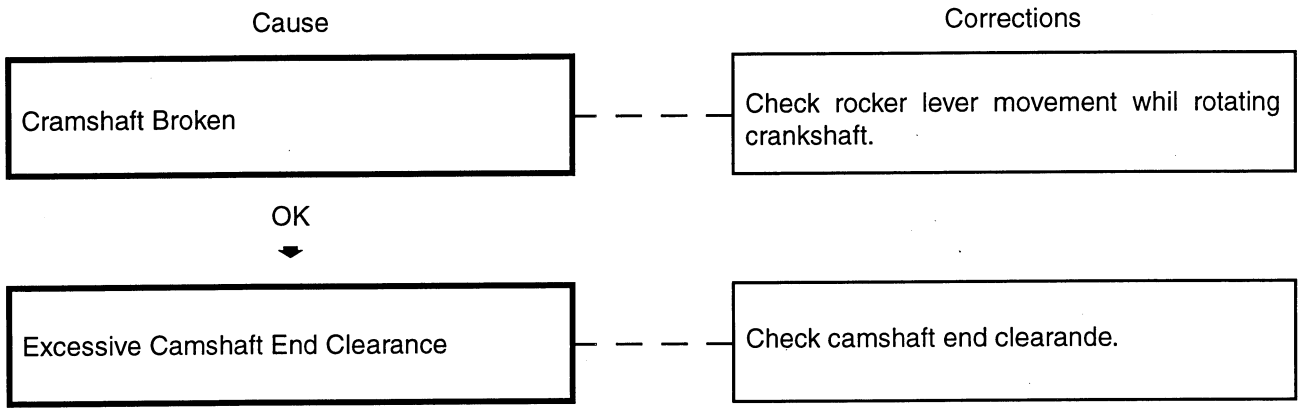
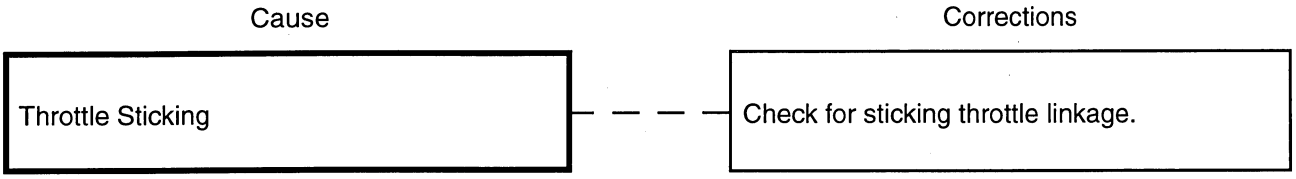
Engine Cranks But Will Not Start (No Smoke From EXhaust) (Continued)



Engine Decelerates Slowly

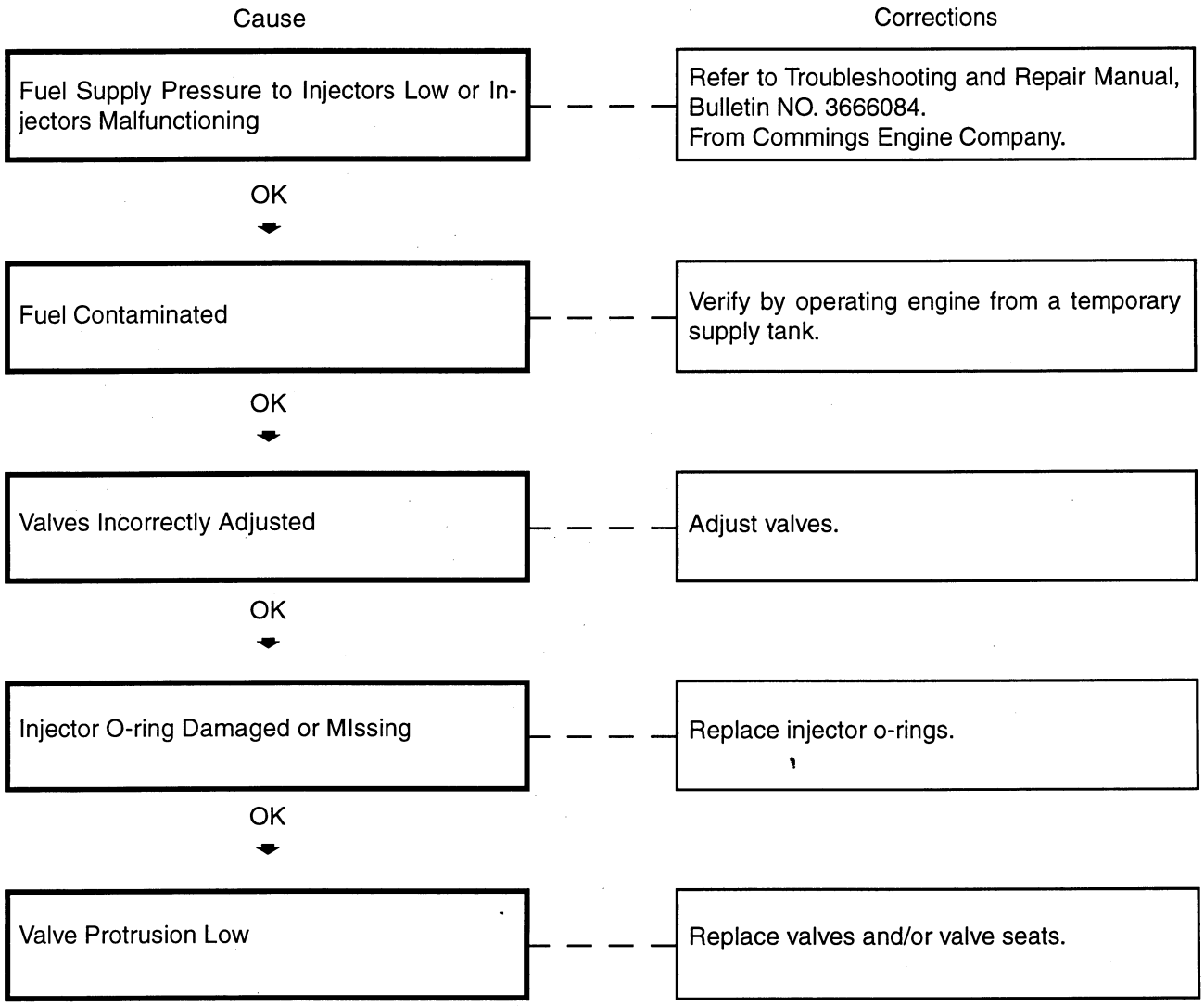


Engine Difficult to Start or will Not Start - Exhaust Smoke Present

Cause	Corrections
Engine Cranking Speed Too Slow	Check engine cranking RPM. Refer to "Engine Will Not Crank or Cranks Slowly" symptom chart.
OK ⬇	
Starting Aid Needed for Cold Weather or Not Working Correctly	Check, repair or replace cold starting aid if necessary.
OK ⬇	
Fuel Filter Plugged	Replace fuel filter.
OK ⬇	
Air in the Fuel system	Check for suction leaks.
OK ⬇	
Fuel Supply Restricted	Clean or replace pre-filters and screens and check fuel lines for restrictions.
OK ⬇	
Intake Air or Exhaust System Restricted	Check intake air and exhaust system for restrictions.
OK ⬇	

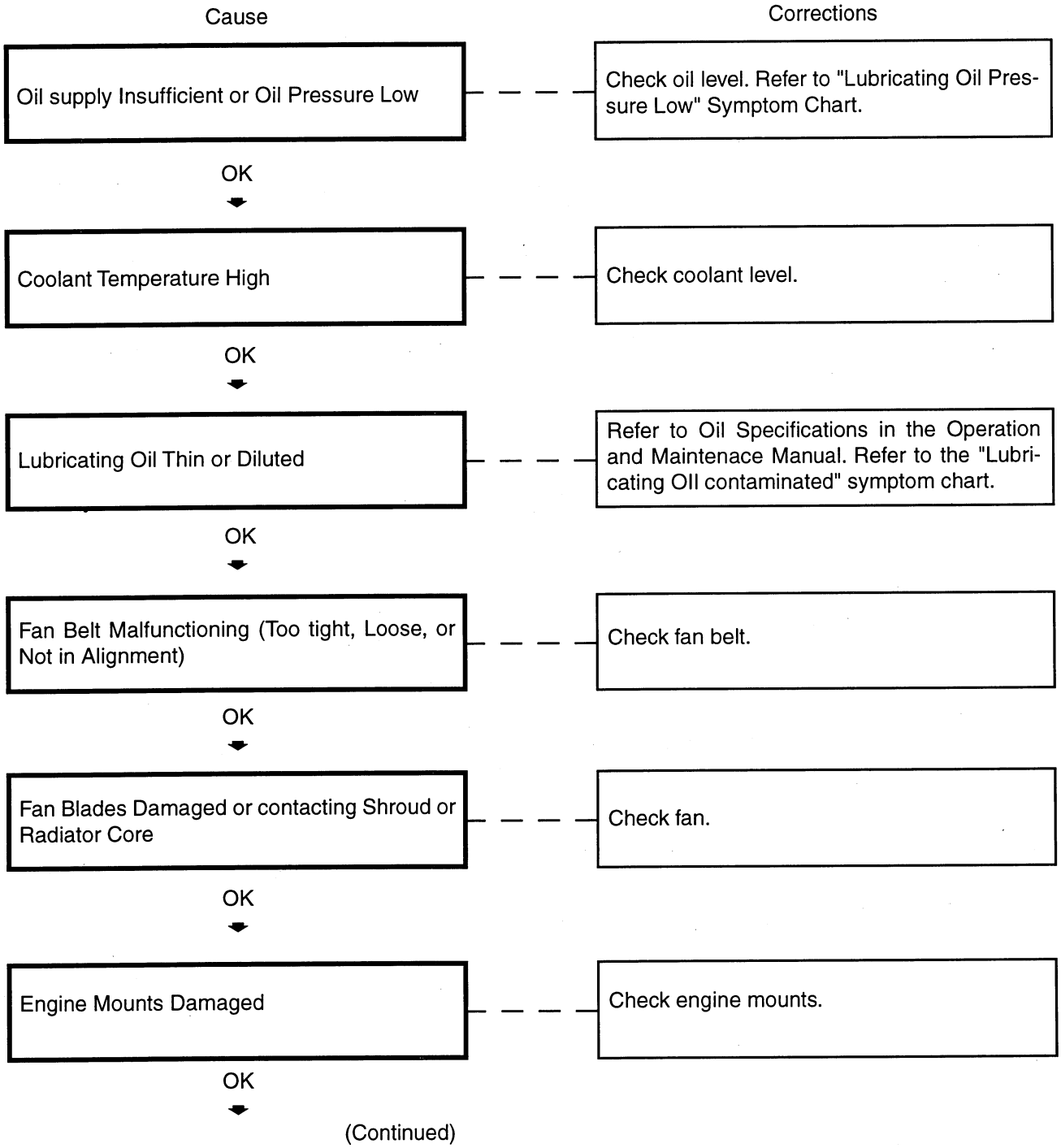
(Continued)

Engine Difficult to Start or will Not Start - Exhaust Smoke Present (Continued)



Engine Noise Excessive*

* **Note**: When troubleshooting engine noise problems, make sure the engine accessories (fan, or hydraulic pump) are **not** the cause of the noise. Refer to Engine Noise Diagnostic Procedures General Information at the end of this section before using this chart.



(Continued)

Engine Noise Excessive* (Continued)

* **Note**: When troubleshooting engine noise problem, make sure the engine accessories (fan, or hydraulic pump) are **not** the cause of the noise. Refer to Engine Noise Diagnostic Procedures - General Information at the end of this section before using this chart.

Cause	Corrections
Intake Air or Exhaust Gas Leak	Check for leak.
OK ⬇	
Turbocharger Noise	Refer to "Engine Noise Excessive - Turbocharger" symptom chart.
OK ⬇	
Valve or Injector Clearance Excessive	Check valve and injector adjustment.
OK ⬇	
Injector Malfunction	Replace or rebuild injectors.
OK ⬇	
Valve Train and/or Overhead Components (Push Rod, Cam Follower, Rocker Shaft) Damaged	Check valve train and overhead components for damage.
OK ⬇	
Injection Timing Too Fast	Check injection timing.
OK ⬇	

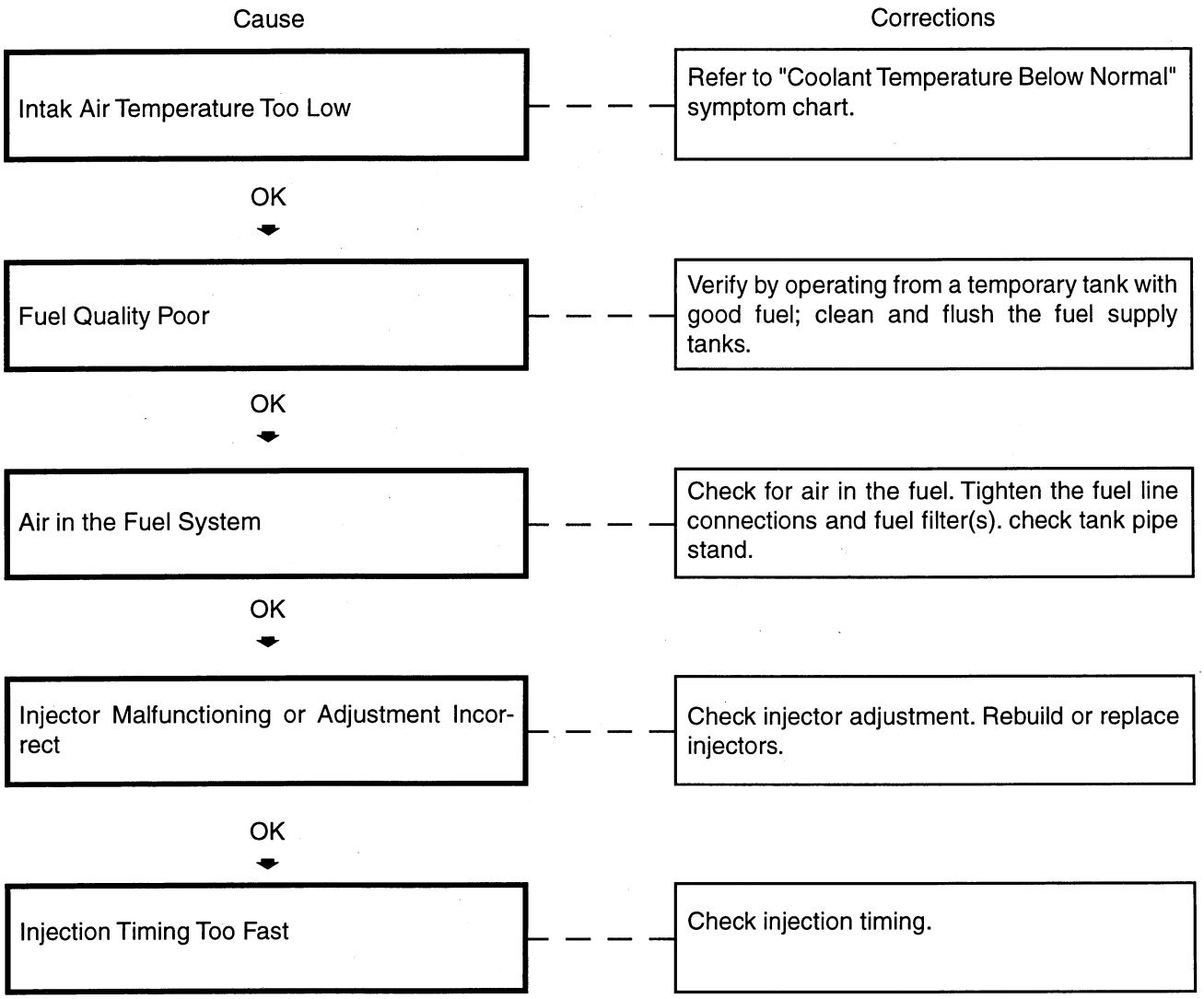
(continued)

Engine Noise EXcessive* (Continued)

* **Note**: when troubleshooting engine noise problems, make sure the engine accessories (fan or hydraulic pump) are not the cause of the noise. Refer to Engine Noise Diagnostic Procedures- General Information at the end of this section before using this chart.

Cause	Corrections
Vibration Damper Damaged	Check vibration damper.
OK ⬇	
Noise Excessive	Disconnect to isolate noise source
OK ⬇	
Gear Train Backlash Excessive or Gear Teeth Damaged	Check gear backlash and gear teeth.
OK ⬇	
Main or Connecting Rod Bearing Problem	Refer to "Engine Noise Excessive - Connecting Rod or Main Bearing" symptom chart.
OK ⬇	
Flywheel/Flexplate Capscrews Loose or Broken	Check flywheel and flywheel mounting capscrews.
OK ⬇	
Poston, Piston Rings, sylinder Liner Damaged or Excessively worn	Refer to "Engine Noise Excessive - Piston" symptom chart.
OK ⬇	
Internal Engine Damaged	Use oil analysis and inspect oil filters for probable cause.

Engine Noise Excessive - Combustion Knocks



Engine Noise Excessive - connecting Rod*

* Refer to Engine Noise Diagnostic Procedures on General Information at the end of this section before using this symptom chart.

Cause	Corrections
Insufficient Oil Supply or Low Oil Pressure	Check oil level. Refer to "Lubricating Oil Pressure - Low" symptom chart.
OK ⬇	
Thin or diluted Lubricating Oil	Refer to "Lubricating Oil - Specifications". Refer to "Fuel in Lubricating Oil" and "Lubricating Oil Contaminated" symptom chart.
OK ⬇	
Connecting Rod Capscrews Loose or Not Tightened Correctly	Inspect the connecting rod capscrews.
OK ⬇	
Connecting Rod Bearings Not Assembed Correctly, Damaged, Worn, or Wrong Bearings Installed	Inspect the connecting rod bearings.
OK ⬇	
Connecting Rods Bent or Out-Of-Alignment	Remove connecting rods. Inspect connecting rods.
OK ⬇	
Crankshaft Journals Damaged or Out-Of-Round	Inspect the crankshaft journals.

Engine Noise Escessive - Main Bearing*

* Refer to Engine Noise Diagnostic on General Information at the end of this section before using this symptom chart.

Cause	Corrections
Main Bearing Capscrews Loose, Worn, or Not Tightened Correctly	Inspect main bearing caps and capscrews.
OK ↓	
Main Bearings Damaged, Worn or Wrong Bearings Installed	Inspect main bearings. Inspect the crankshaft journals.
OK ↓	
Crankshaft Journals damaged or Out-Of Round	Inspect the crankshaft journals.

Engine Noise Excessive - Piston*

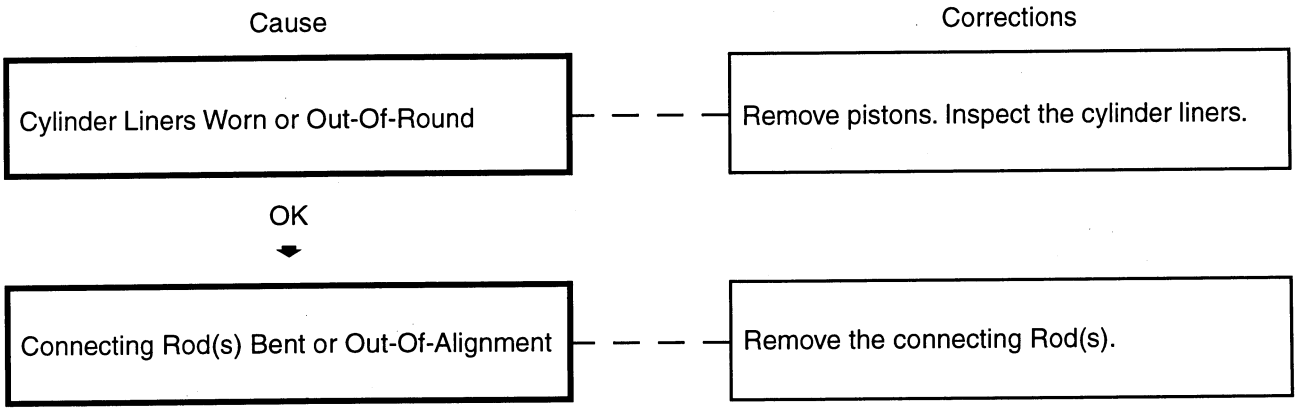
* Refer to Engine Noise Diagnostic Procedures on General Information at the end of this section before using this symptom chart.

Cause	Corrections
Contaminated or Poor Quality Fuel	Verify by operating engine from a temporary tank containing good fuel.
OK ⬇	
Injectors Malfunctioning or Asjustment Incorrect	Check injector adjustment. Rebuild or replace injectors.
OK ⬇	
Carbon Deposits on the Top of the Piston contacting the Cylinder Head	Remove the cylinder head and pistons and carbon from the pistons. Inspect the piston rings for damage or wear.
OK ⬇	
Piston Pin or Bushing Loose, worn, or Not Installed Correctly	Incorrect fit of the piston pin. Listen for a light ticking or tapping noise which is more noticeable with no load on the enigine. The noise can disappear completely when the engine is pulling a load. Piston pin noise can normally be noticed during deceleration of the engine. Remove pistons and inspect the piston pin and bushing for damage, wear, and correct installation.
OK ⬇	
Piston Rings Worn or Broken	Remove and inspect piston rings.
OK ⬇	
Piston Cracked or Broken	Remove and inspect pistons for cracks or damage.
OK ⬇	

(Continued)

Engine Noise Excessive - Piston* (Continued)

* Refer to Engine Noise Diagnostic Procedures on General Information at the end of this section before using this Symptom Chart.

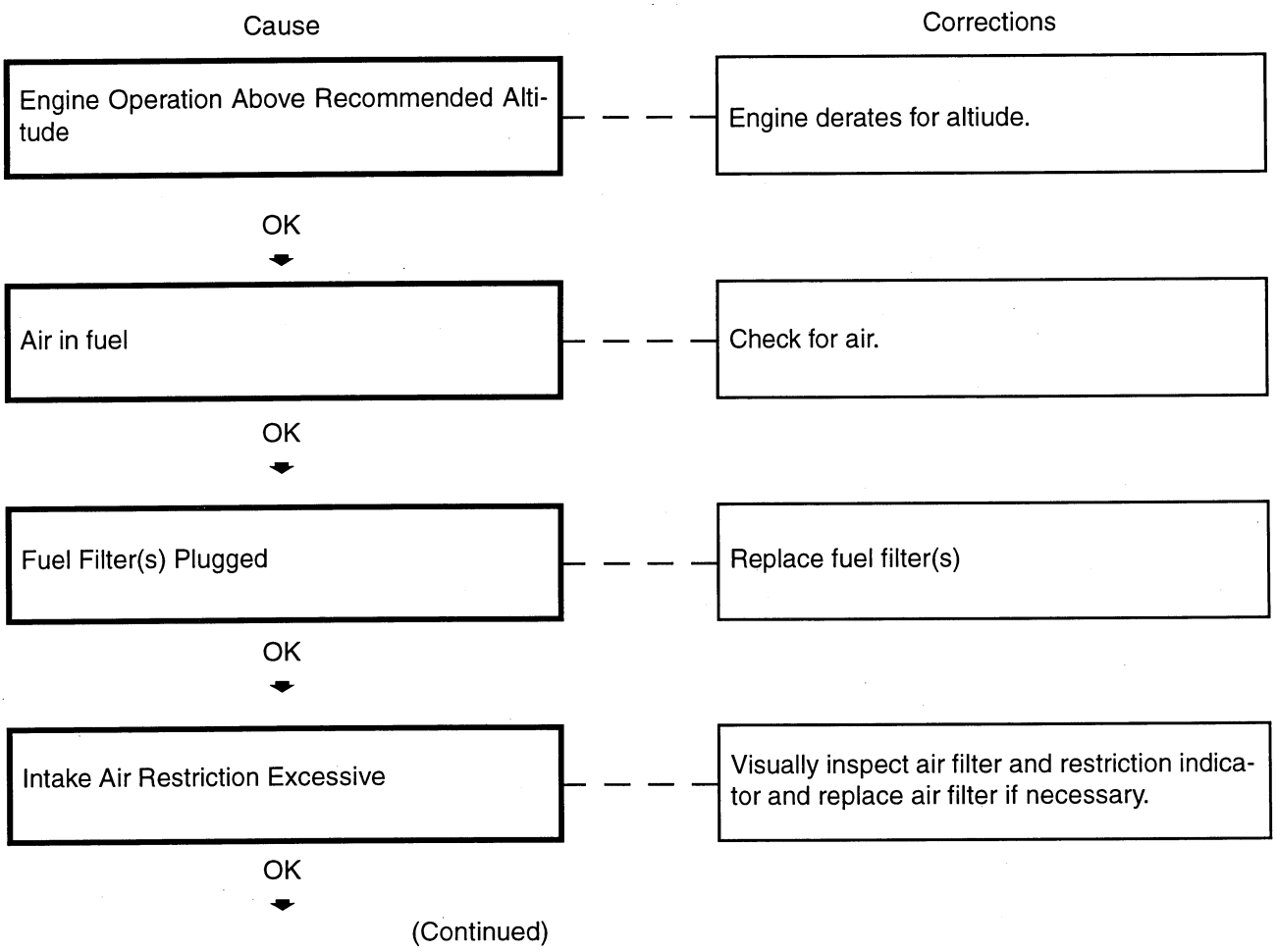


Engine Noise Excessive - Turbocharger*

* Refer to Engine Noise Diagnostic procedures on General Information at the end of this section before using this symptom chart.

Cause	Corrections
Exhaust Air Leaks	Check for loose or damaged piping.
OK ⬇	
Intake Air Leaks	Check for looste or damaged piping.
OK ⬇	
Excessive Intake Air Restriction	Check intake air restriction.
OK ⬇	
Excessive Exhaust Restriction	Check exhaust restriction.
OK ⬇	
Turbocharger Compressor Impeller, Turbine Wheel, or Nose Cone Damaged	Check compressor impeller and turbine wheel for damage.
OK ⬇	
Turbocharger Bearing Damage	Check axial and radial clearance.

Engine Power Output Low - Basics



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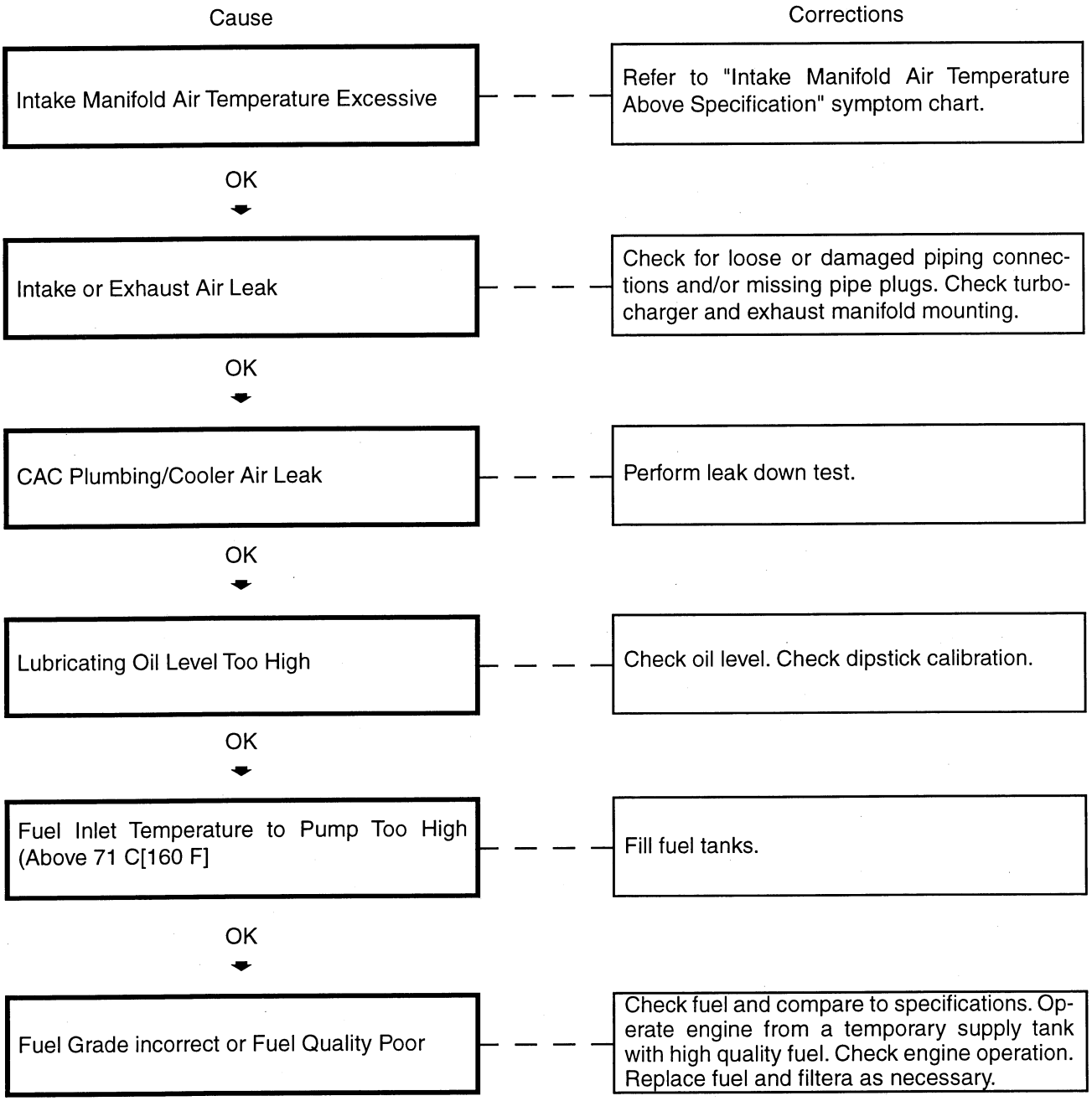
Engine Power Output Low - Basics (Continued)



Engine Power Output - Performance Measurement

NOTE: After conducting the performance test, use this chart to analyze the performace data.

Cause	Corrections
Intake Air Restriction Excessive	Clean/replace air filter element or damaged air intake piping.
OK ▼	
Ruel Inlet (Suction Line) Restriction Excessive or Sucking Air	Check fuel plumbing. Replace As necessary.
OK ▼	
Fuel Supply (Pump Out Line) Restriction Excessive	Inspect fuel plumbing to injectors. If applicable, check fuel pressure before and after auxiliary fuel control devices installed between fuel pump and injectors.
OK ▼	
Fuel Rate OK, Fuel Pressure OK, Intake Manifold Pressure Low	• Excessive intake air restriction. • Excessive exhaust restriction. Check for exhaust pipe damage or restriction. • Check for intake air or exhaust leaks between the turbocharger and engine. • Check turbocharger wheel clearance.
OK ▼	
Fuel Rate Low, Fuel Pressure OK, Intake manifold Pressure Low	Check for correct calibration.
OK ▼	
Fuel Rate Low, Fuel Pressure OK, Intake Manifold Pressure High, Ambient Air Temperature Between 0 and 38 C [32 and 100 F]	Check for correct parts for CPL. Refer to CPL Manual, Bulleting NO. 3379133. From Comming Engien Company.
OK ▼	

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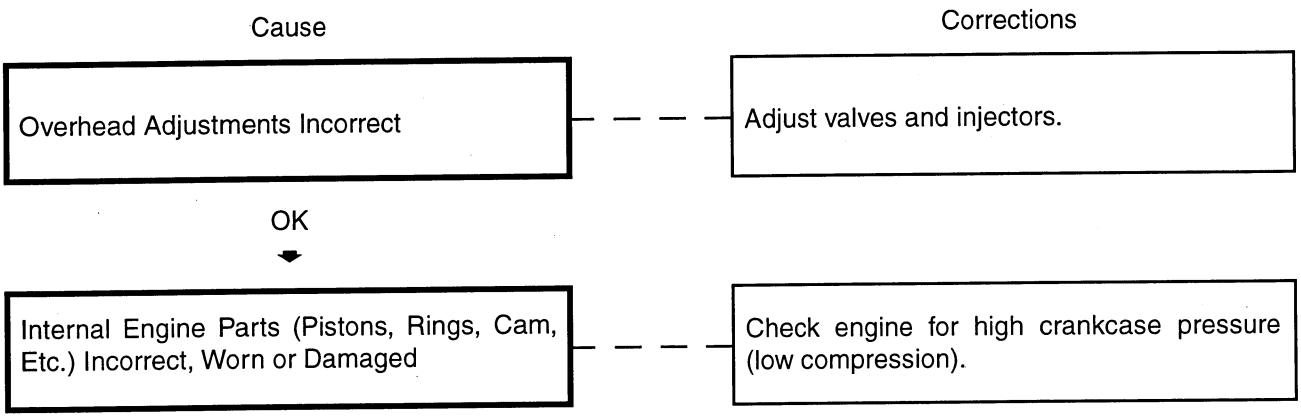
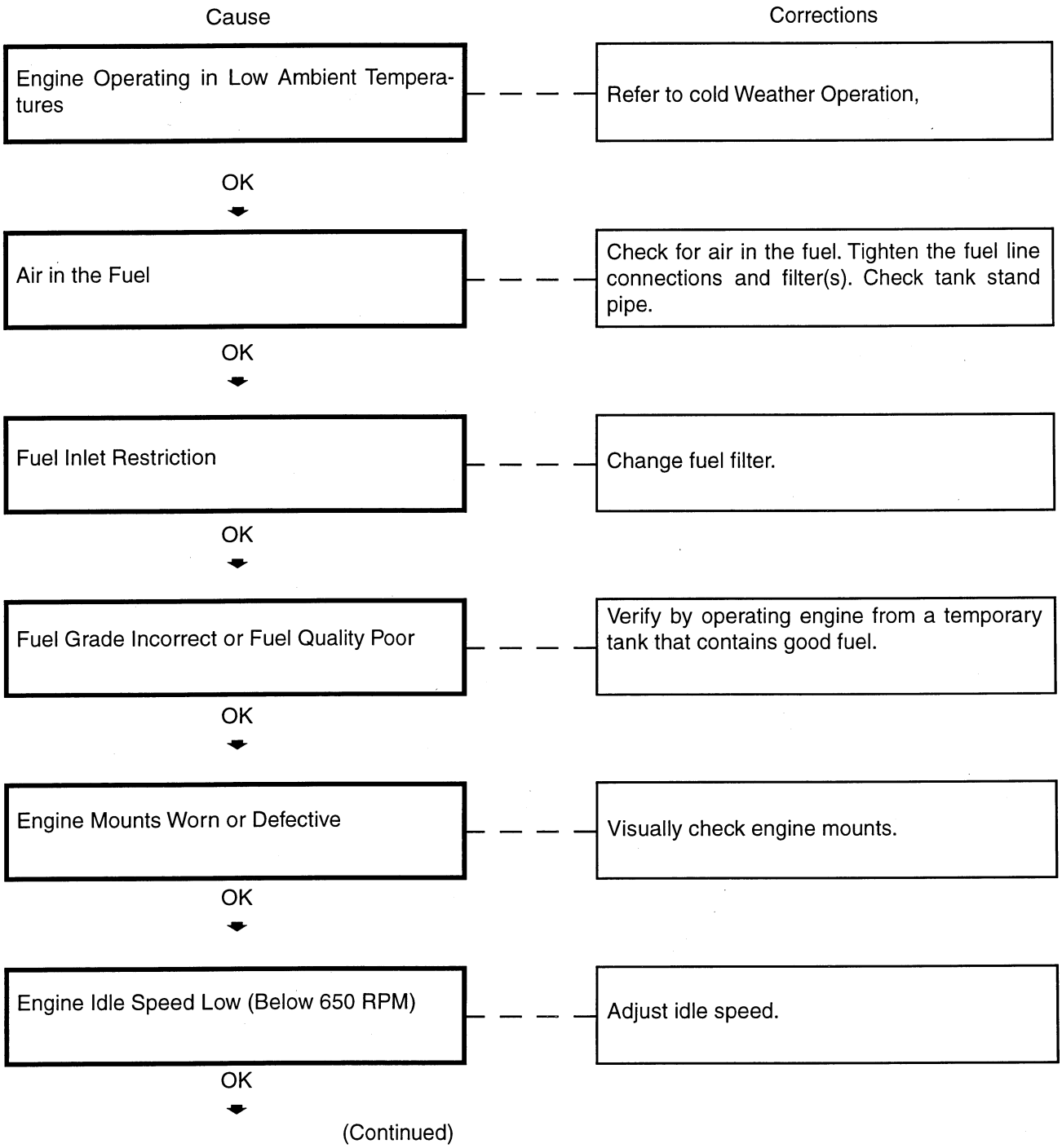
Engine Power Output Low - Performance measurement (Continued)



Engine Runs Rough at Idle



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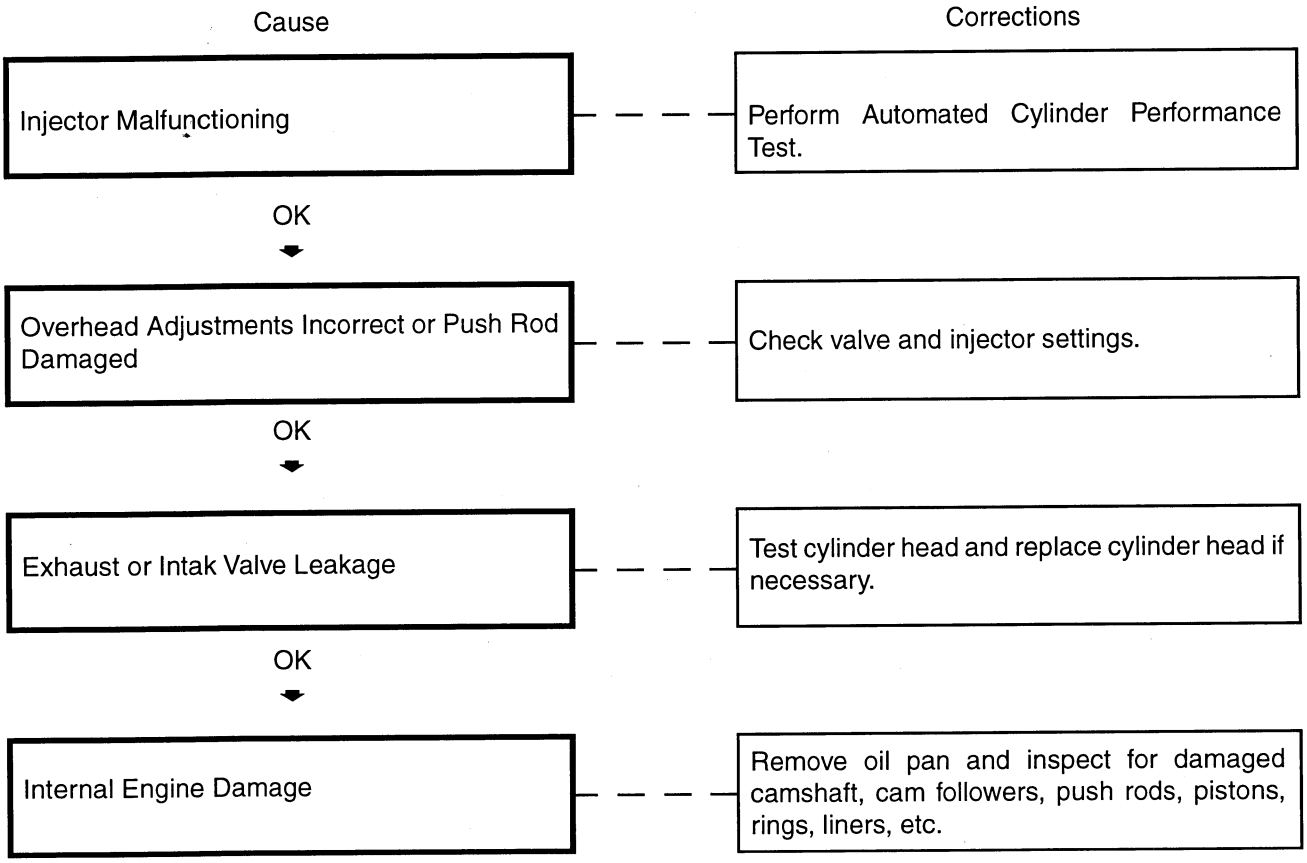
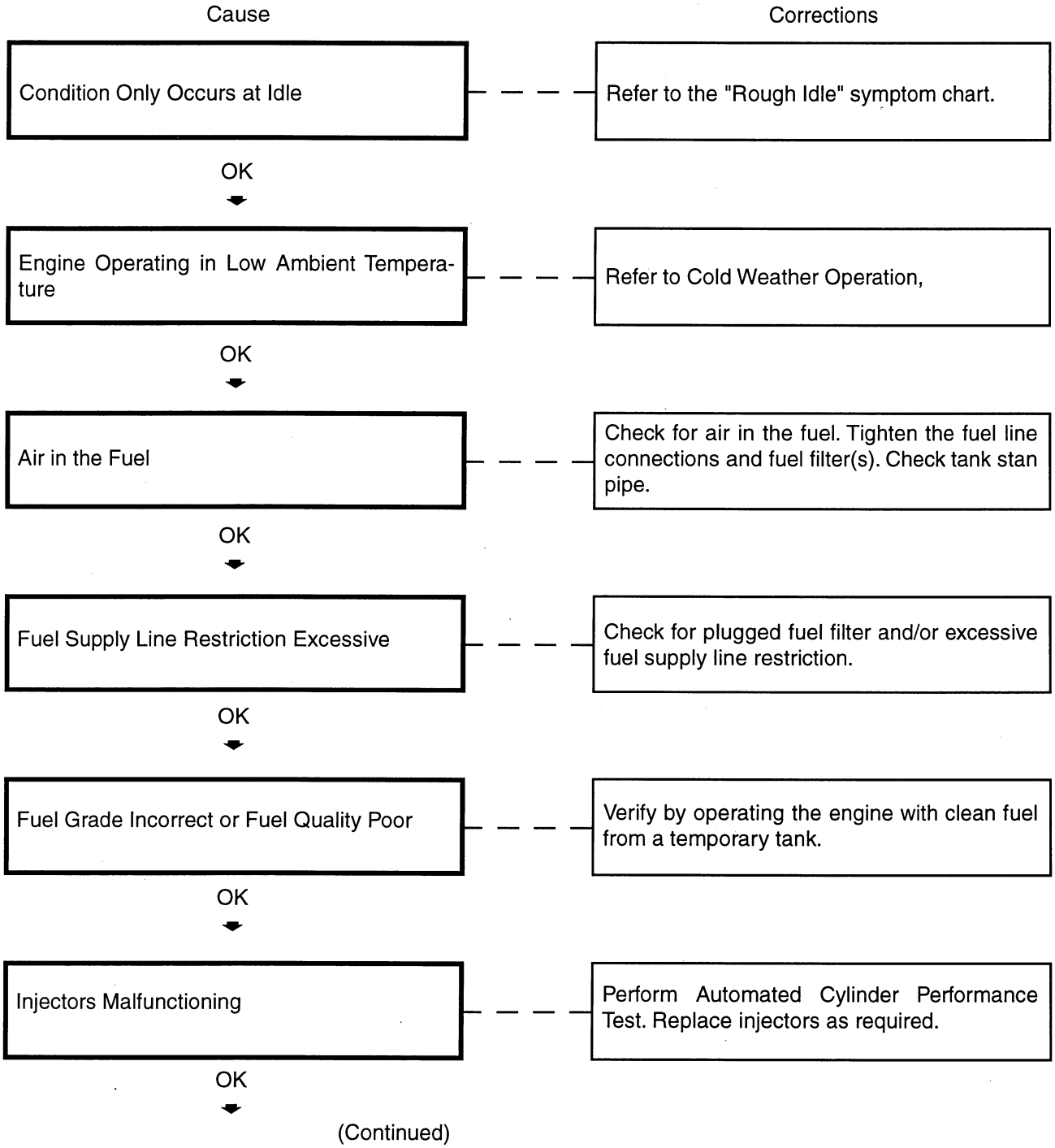
Engine Runs Rough at Idle (continued)



Engine Runs Rough or Misfires



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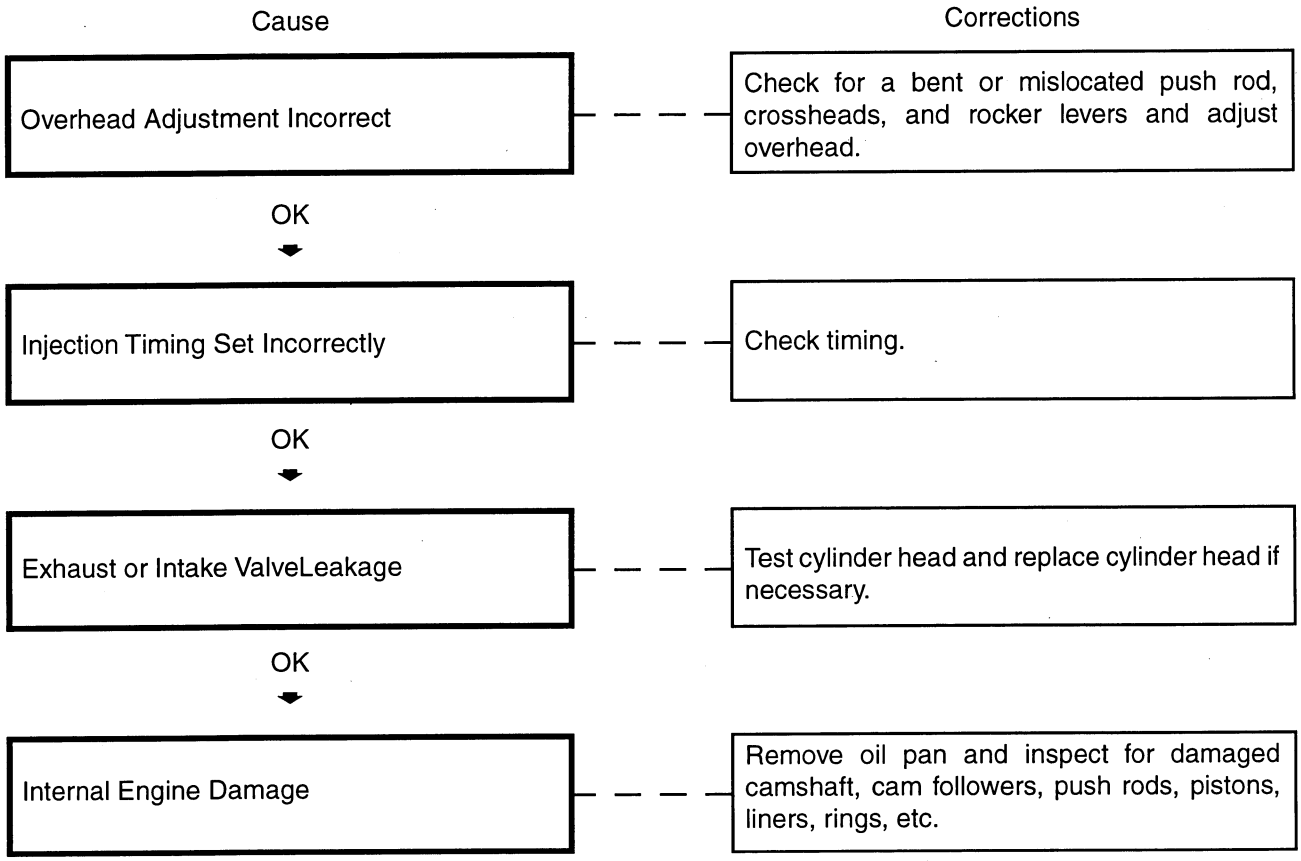
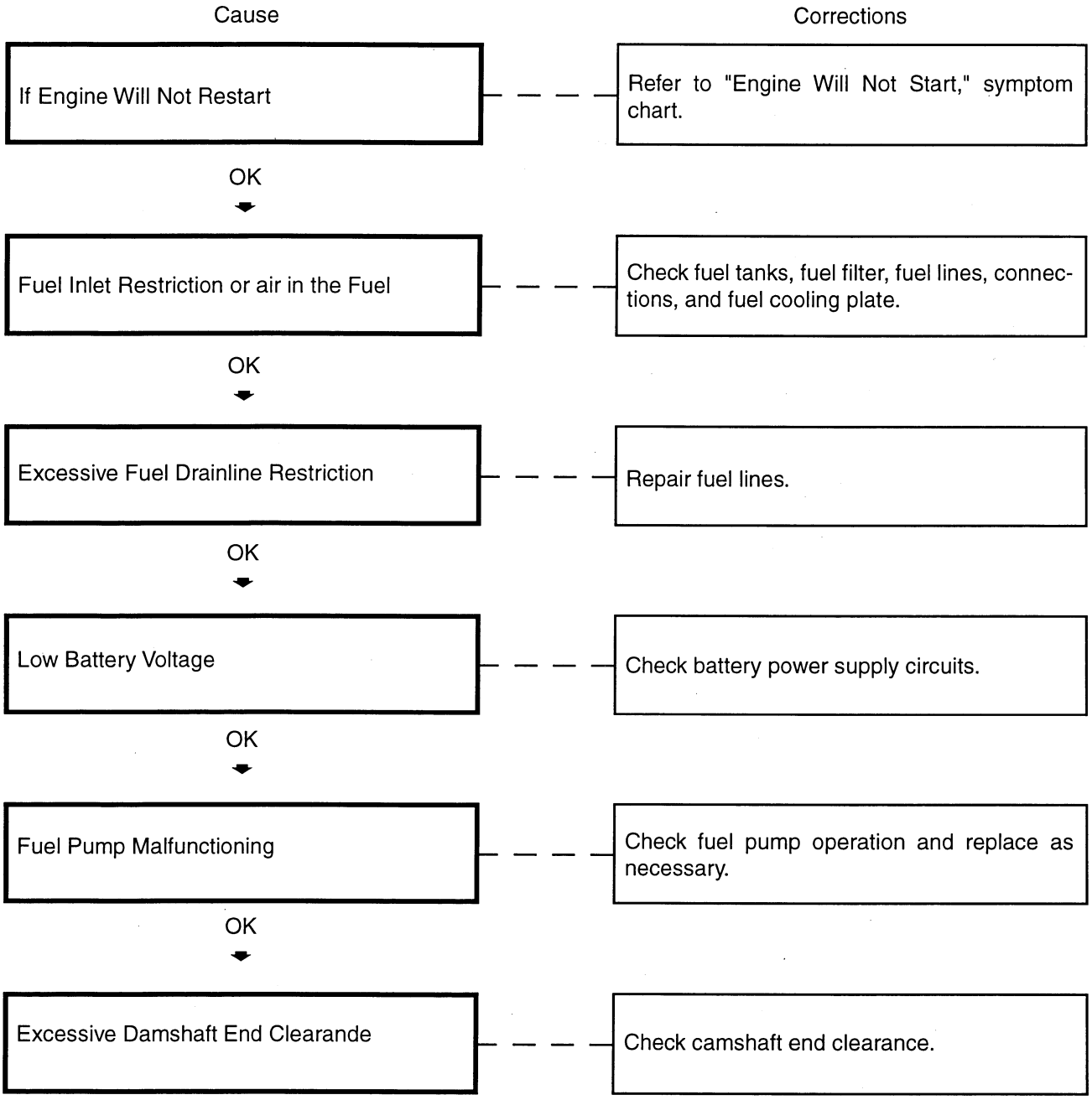
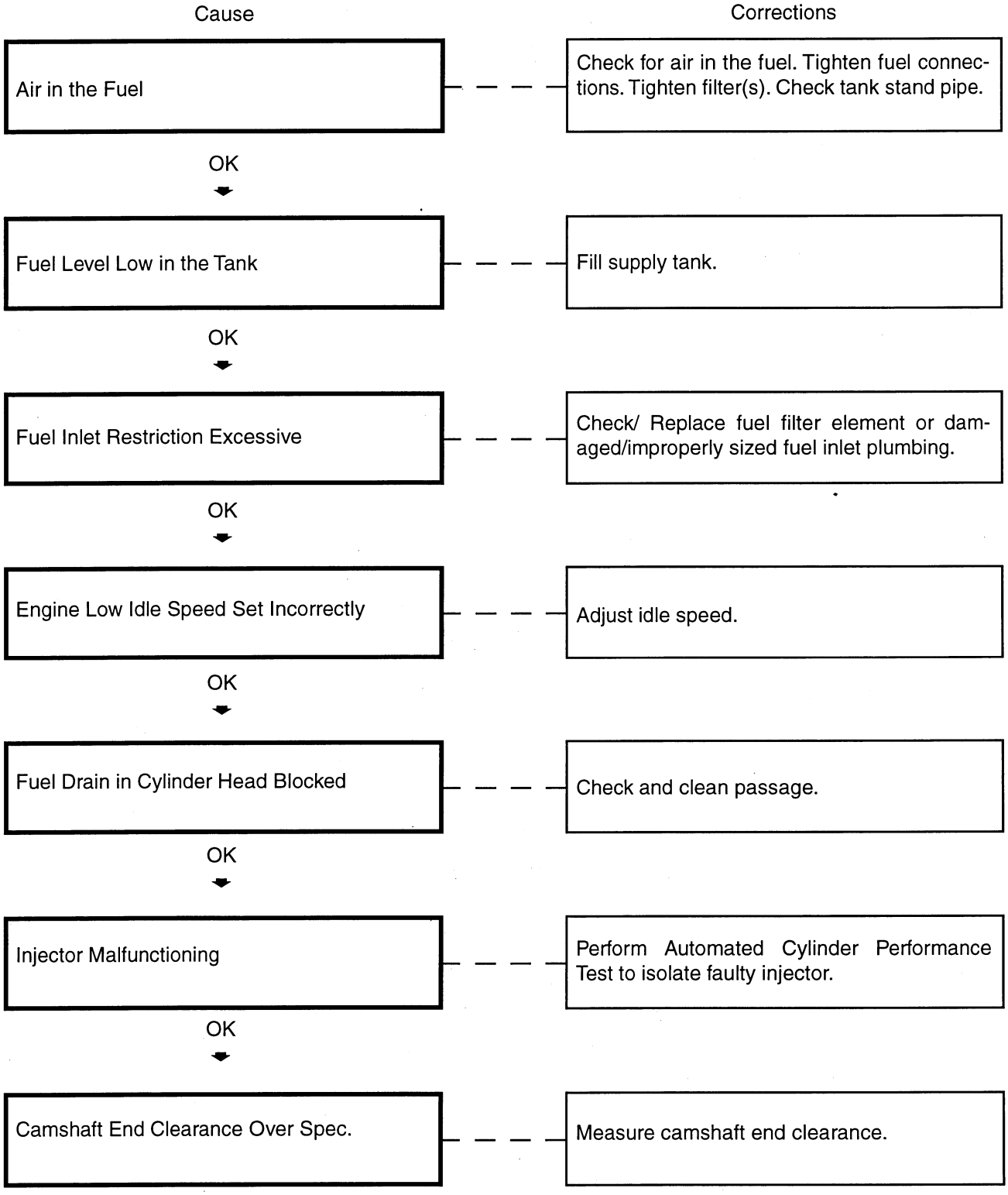
Engine Runs Rough or Misfires (Continued)



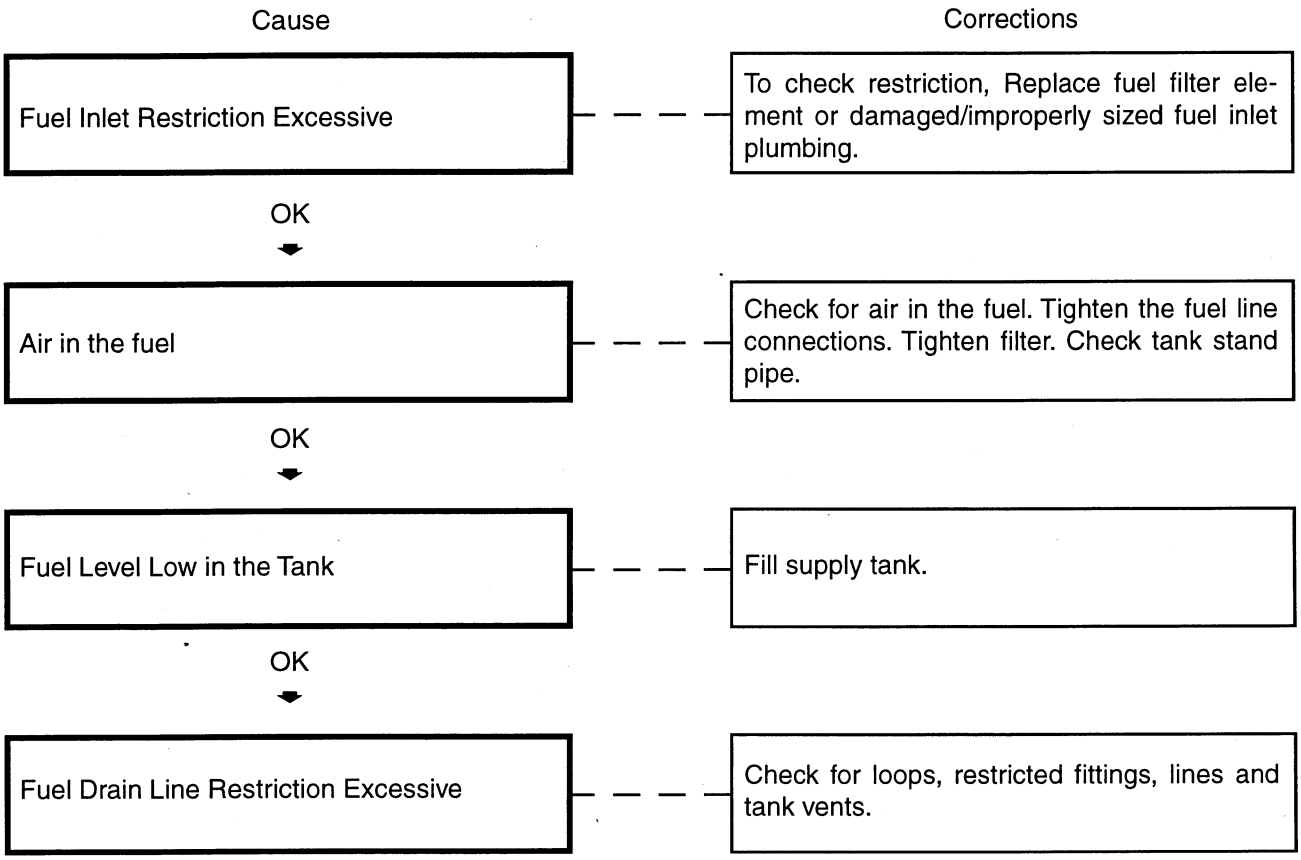
Engine Shuts Off Unexpectedly or Dies During Deceleration



Engine Speed Surges at Low Idle



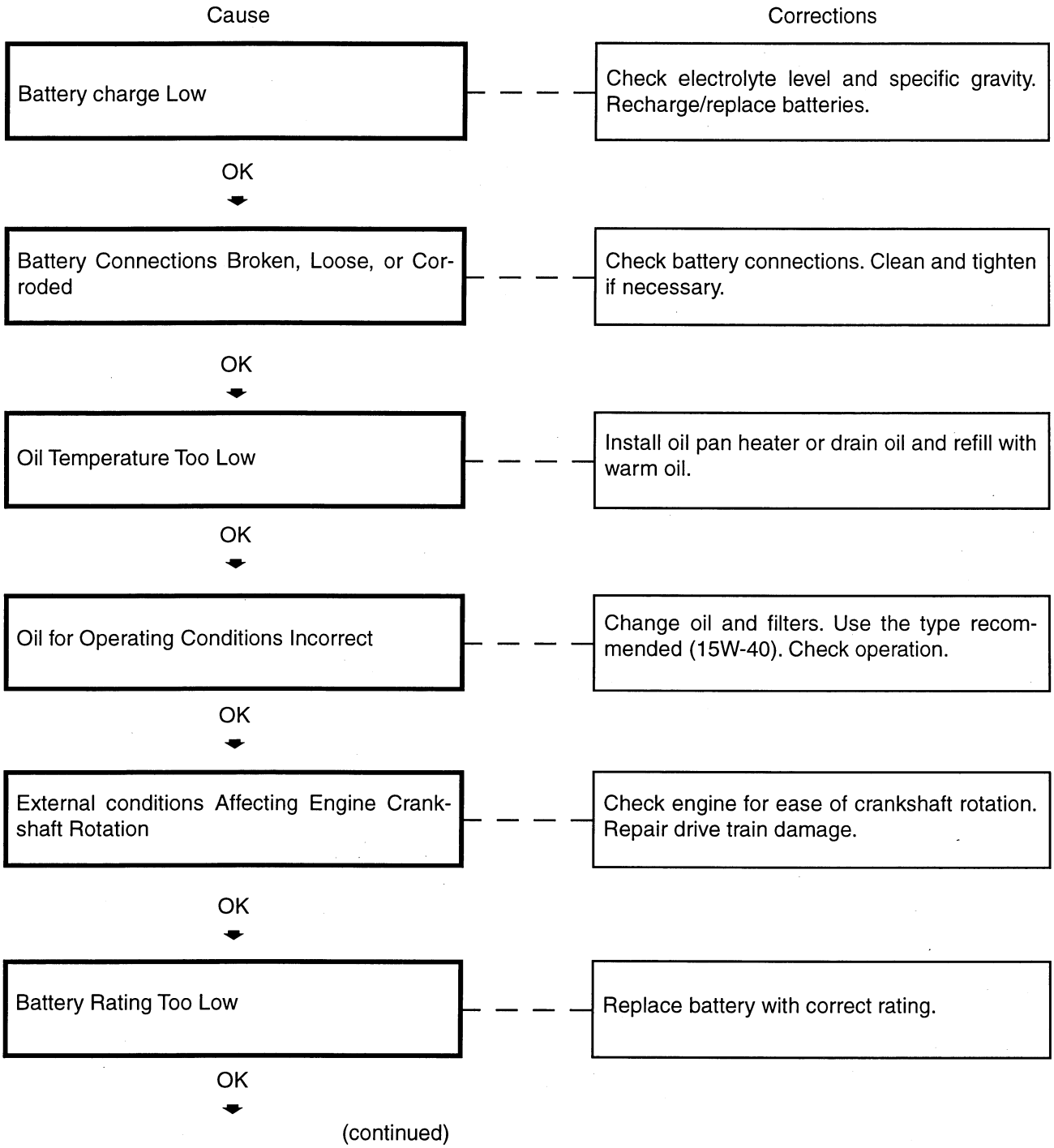
Engine Speed Surges (Other Than Low Idle)



Engine Vibration - Excessive

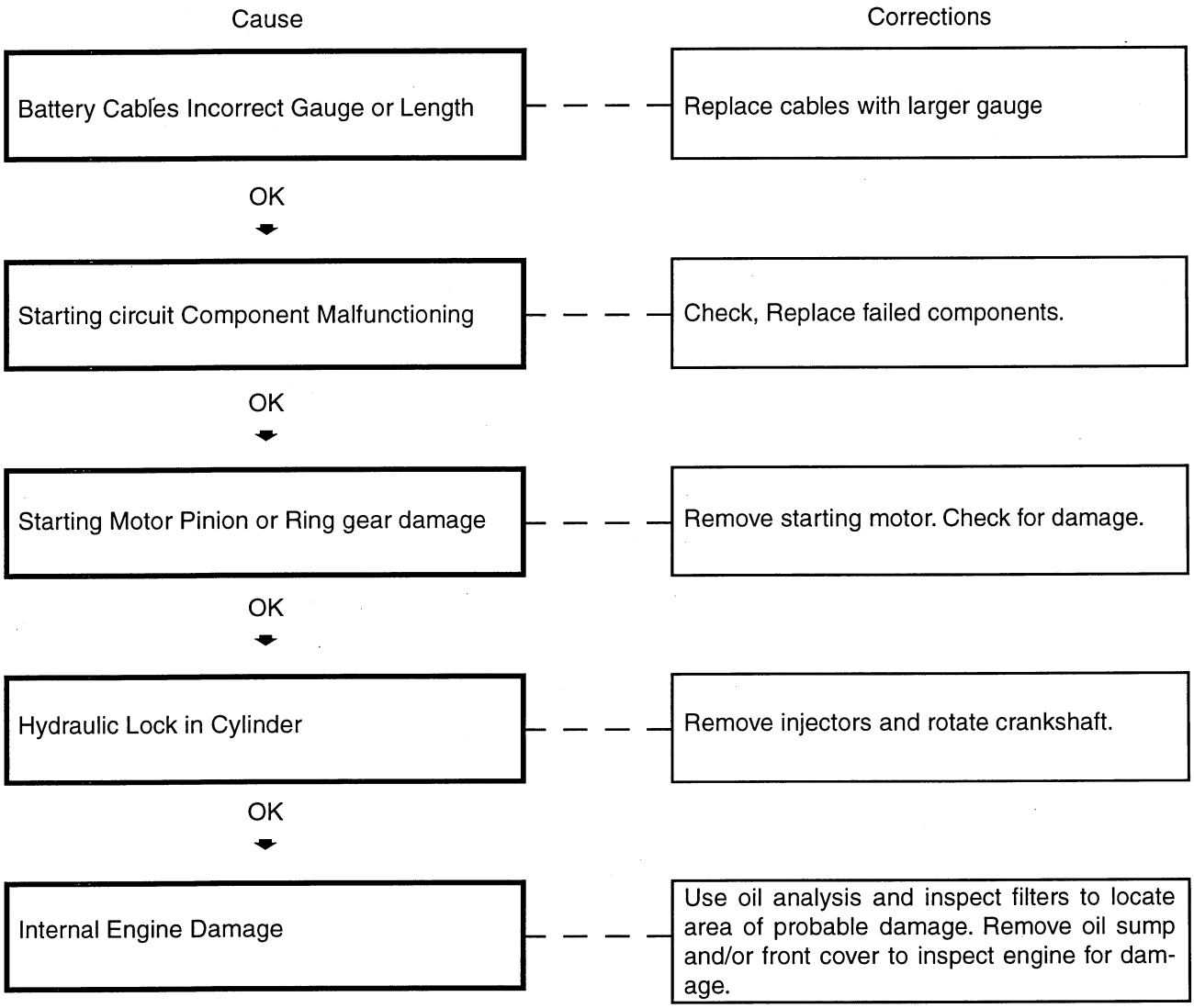
Cause	Corrections
Engine Misfiring	Refer to "Engine Runs Rough or Misfires" symptom chart.
OK ⬇	
Engine Idle Speed Too Low	Check dataplate for correct idle speed and adjest if necessary.
OK ⬇	
Fan is Loose, Damaged, or Unbalanced	Check fan.
OK ⬇	
Engine Belt Driven Accessories Maltfunctioning: Fan Hub, Alternator, Air conditioner Compressor	Check for interference. Loosen belt to isolate component from vibration.
OK ⬇	
Engine Mounts or Mounting Brackets Loose or Damaged	Check engine mounting.
OK ⬇	
Vibration Damper Loose or Damaged	Check vibration damper.
OK ⬇	
Engine Gear Direct Drive Accessories Malfunctioning: Hydraulic Pump , Air Compressor	Isolate accessory component to eliminate vibrations.
OK ⬇	
Flywheel Loose or Damaged/Flywheel Housing Misaligned	Check flywheel. Check flywheel housing alignment.

Engine Will Not Crank or Cranks Slowly (Electric Starting Motor)

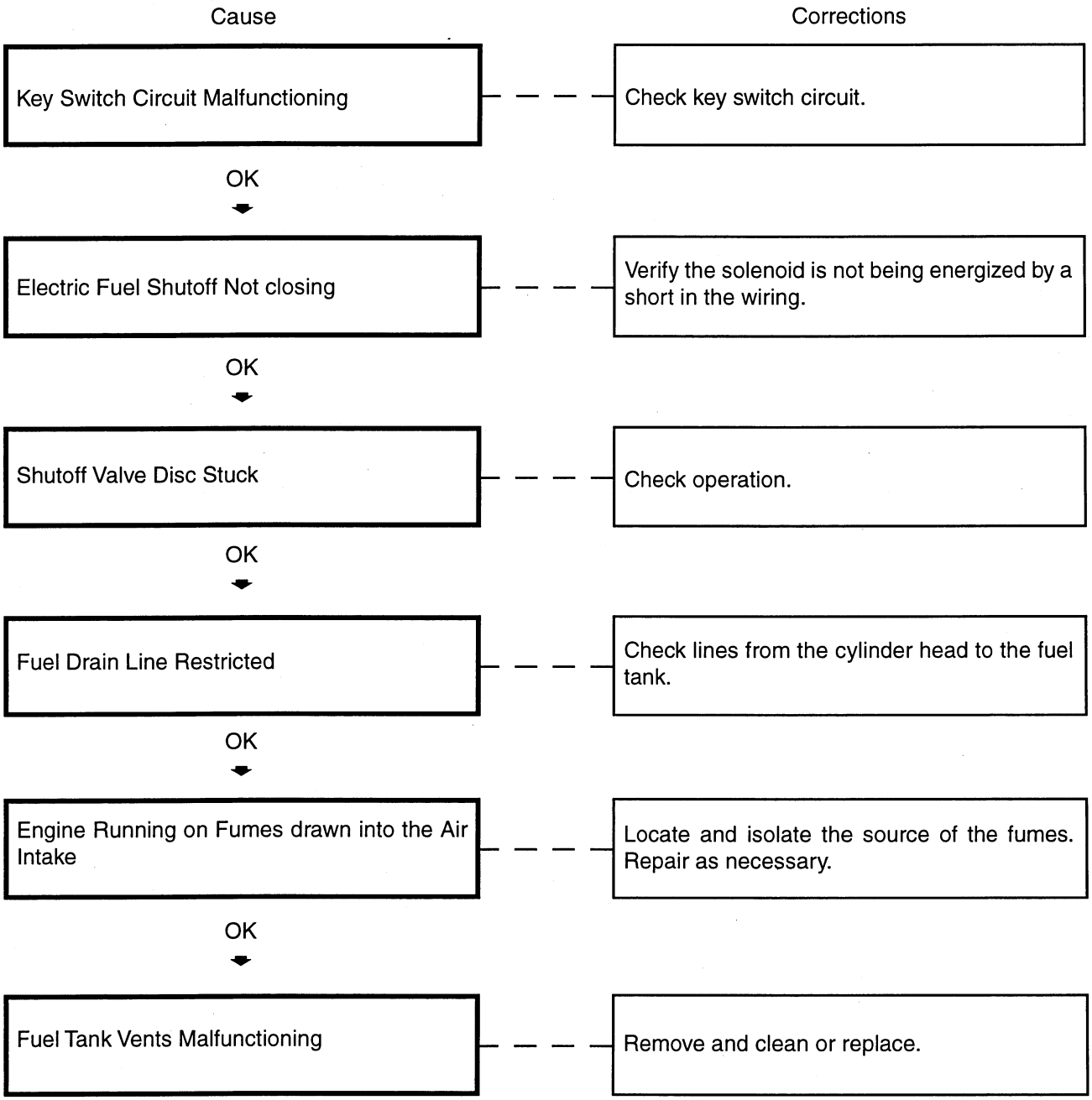


(continued)

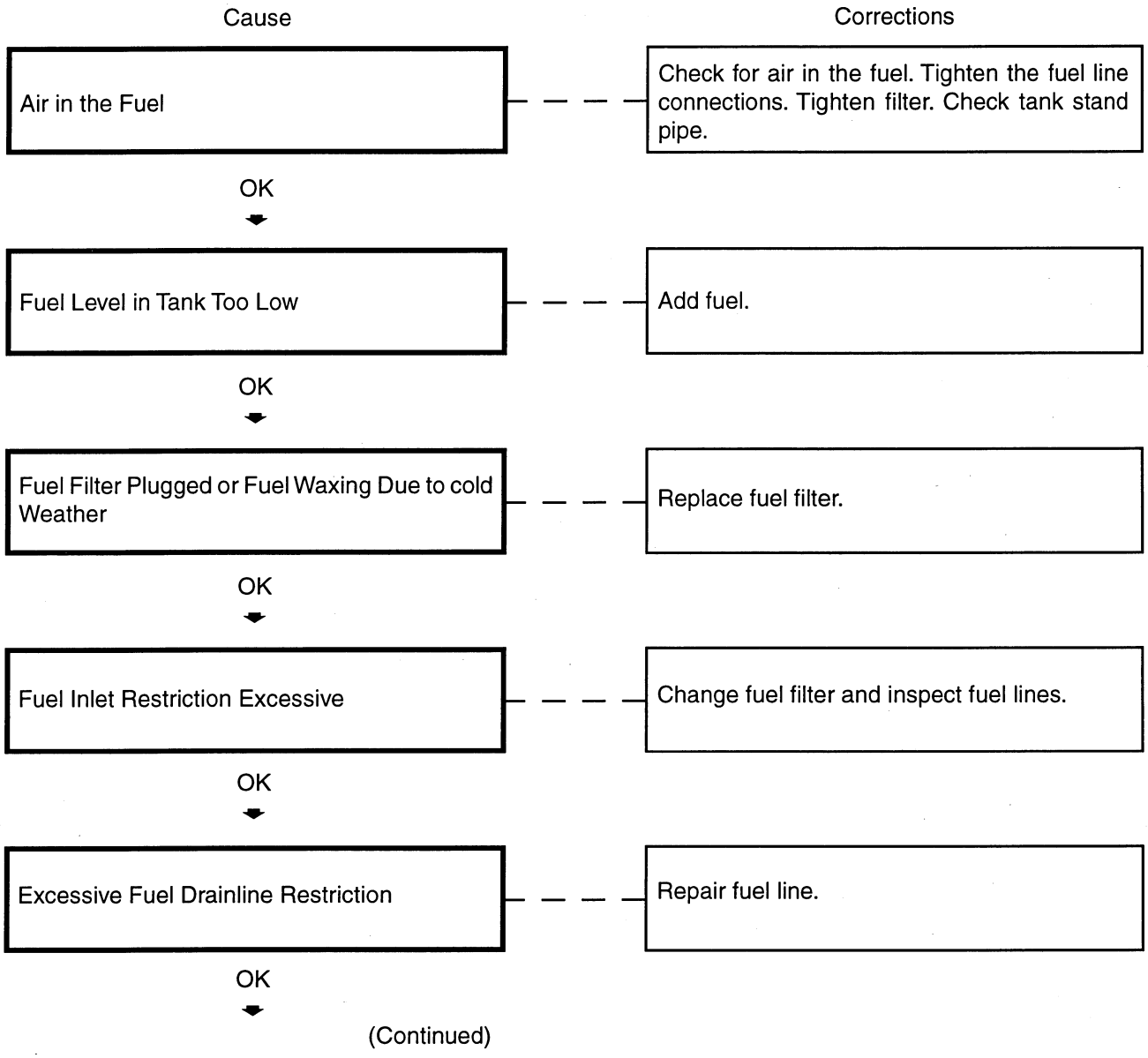
Engine Will Not Crank or Cranks slowly (Electric Starting Motor) (Continued)



Engine Will Not Shut Off

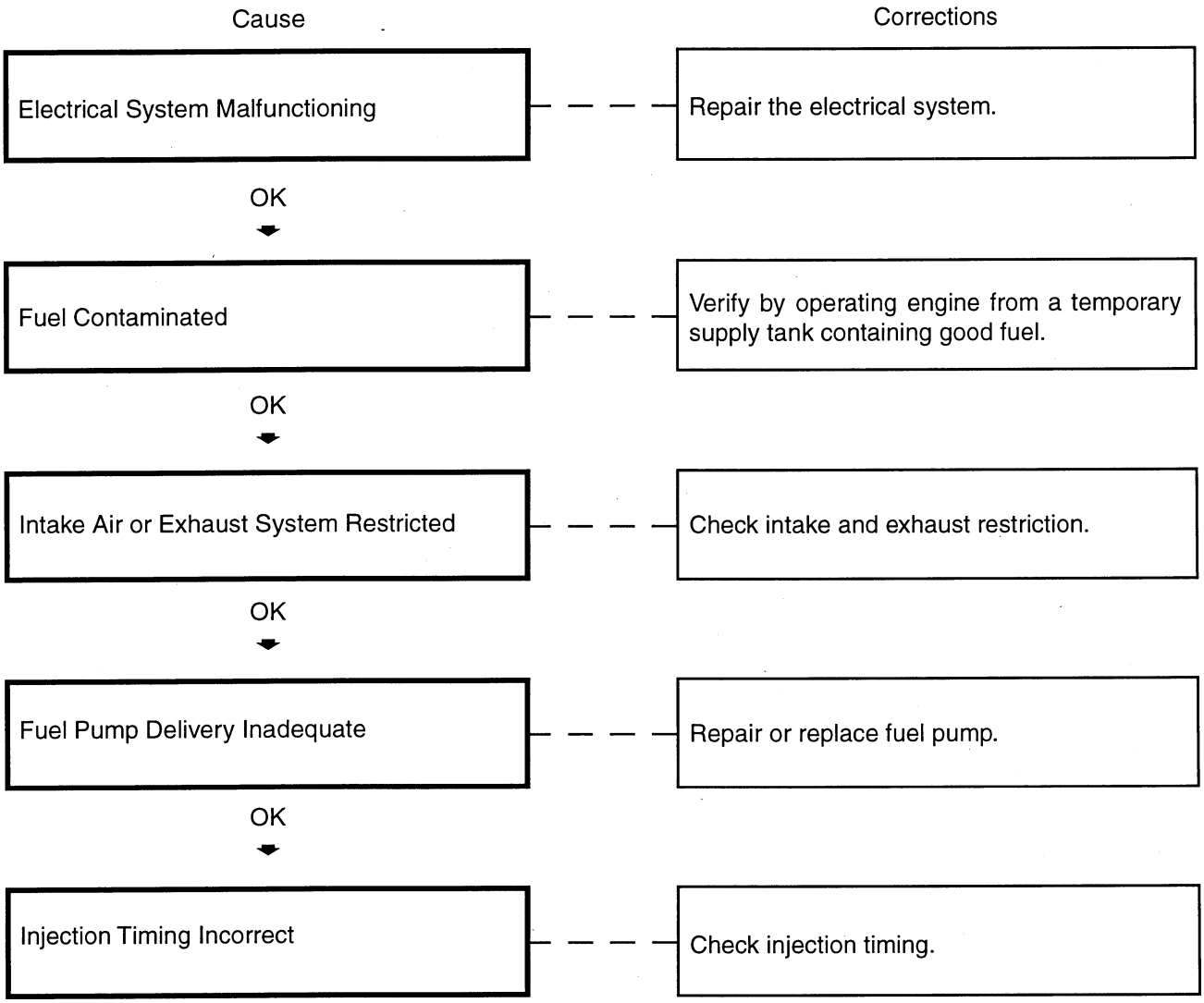


Engine Will Start But Will Not Keep Running

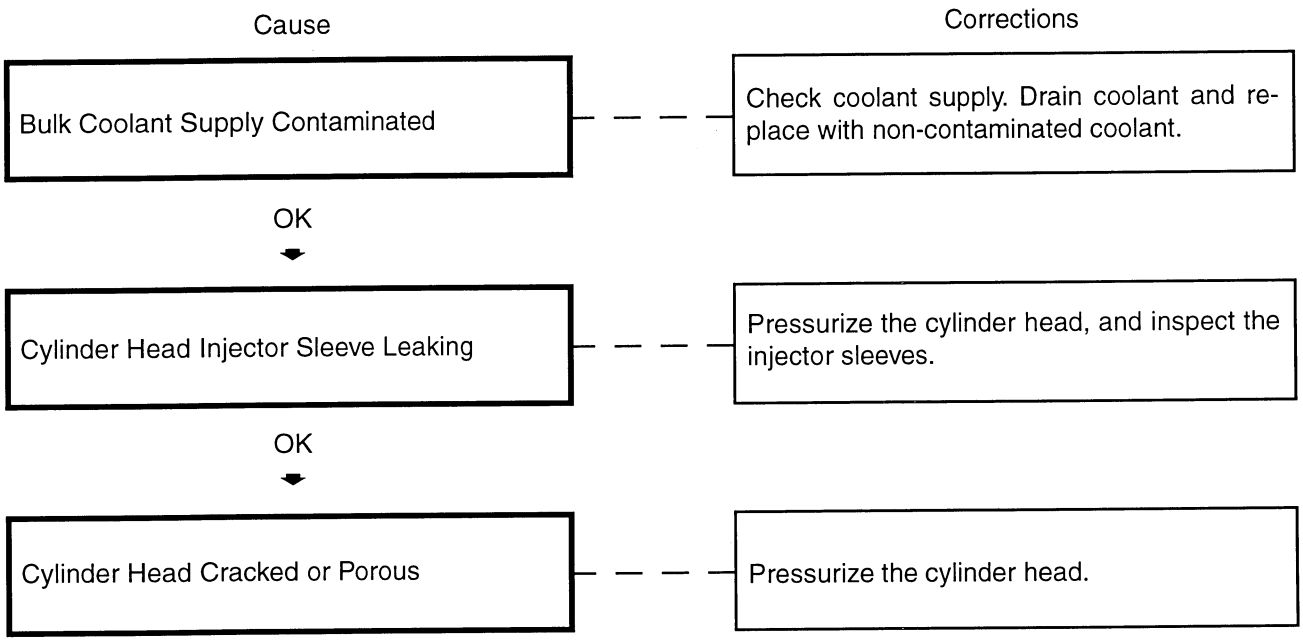


(Continued)

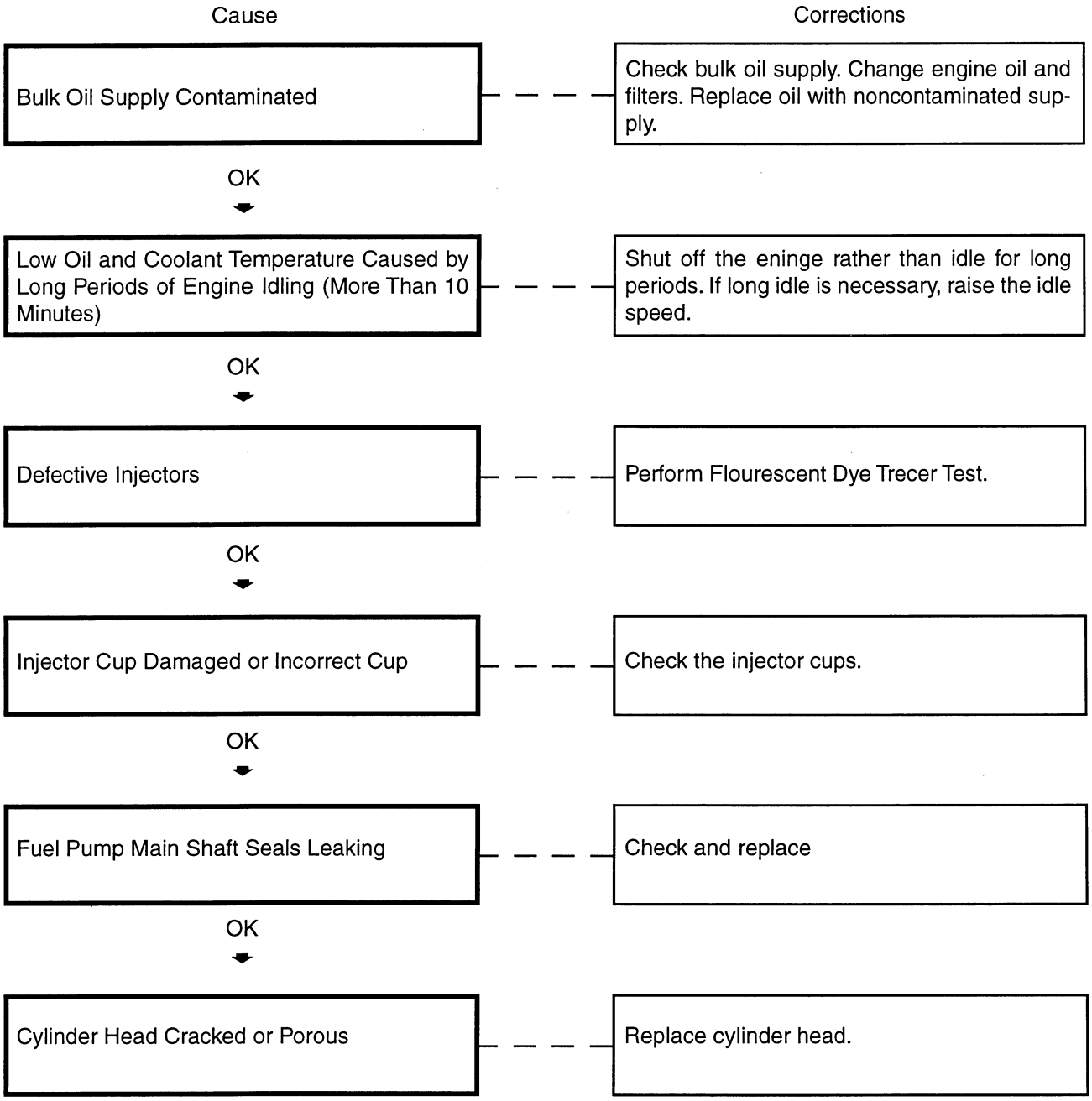
Engine Will Start But Will Not Keep Running (Continued)



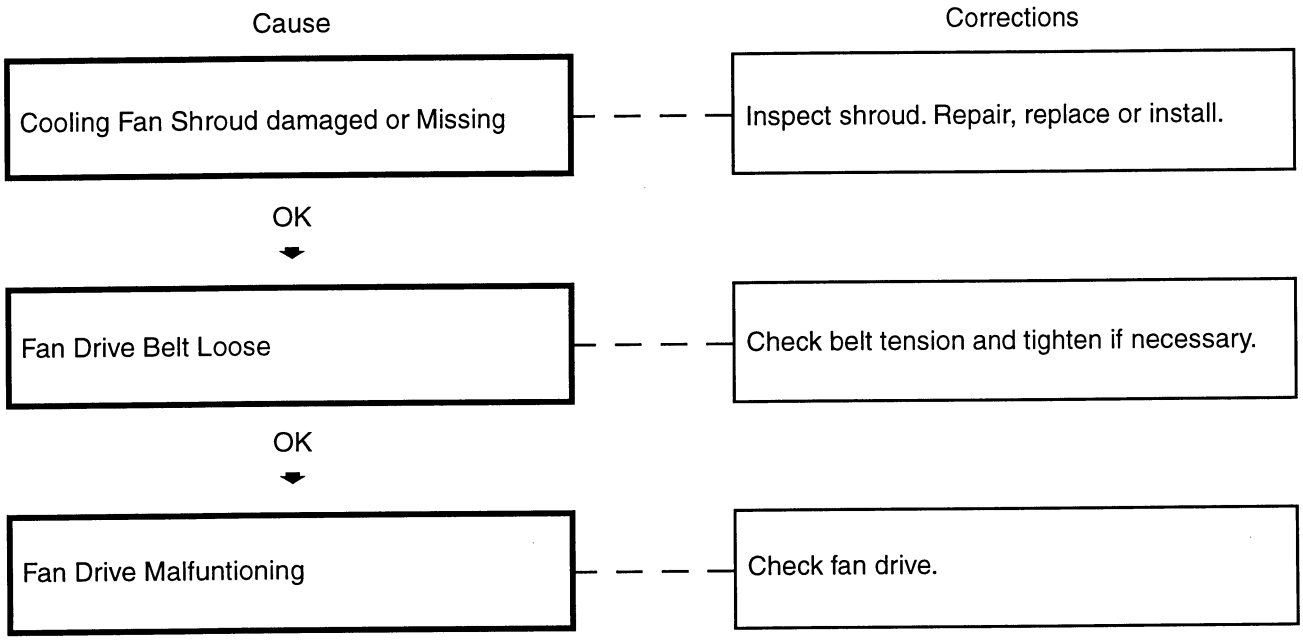
Fuel in Coolant



Fuel in the Lubricating Oil



Intake Manifold Air Temperature Above Specifictation

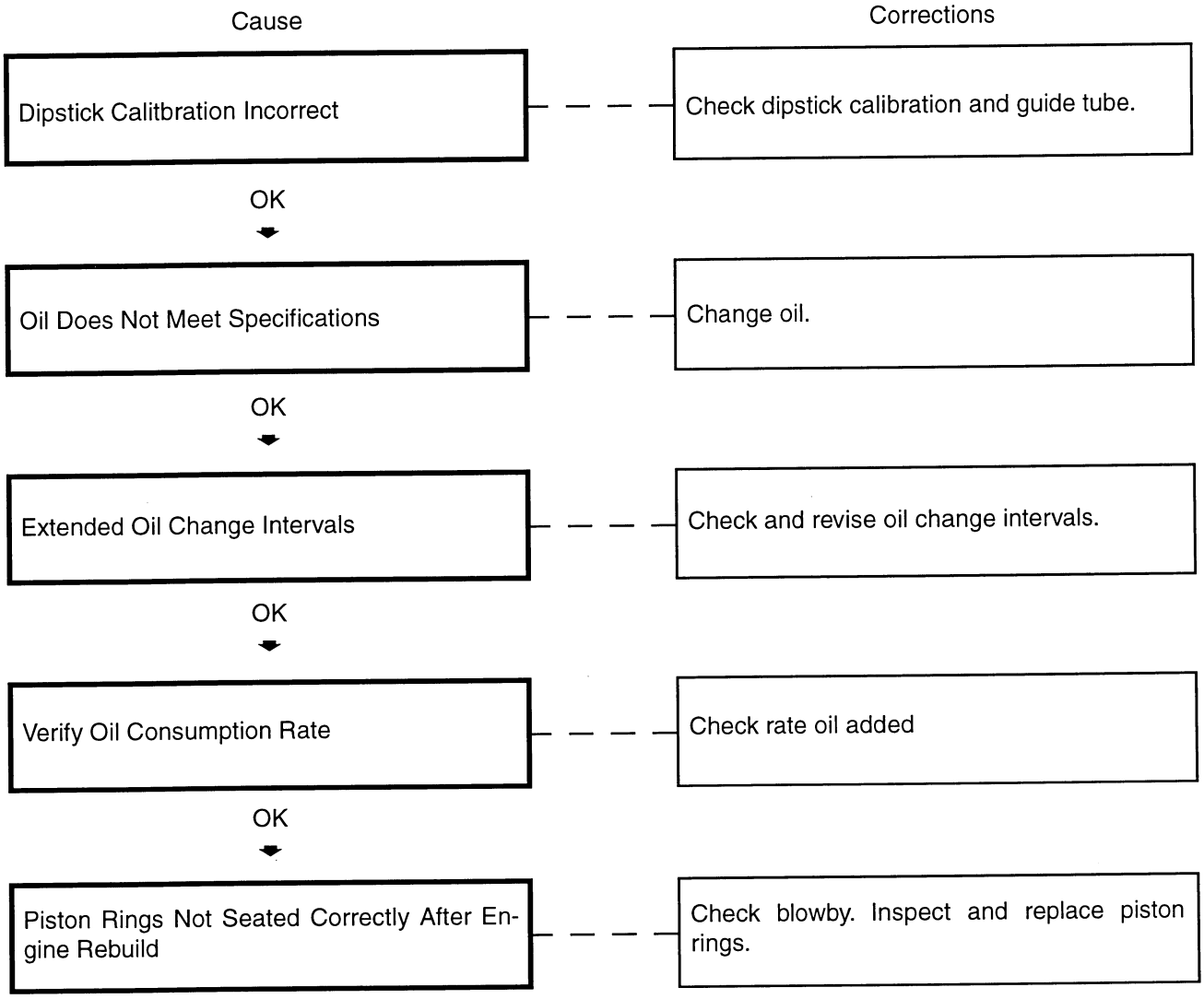


Lubricating Oil consumption Excessive

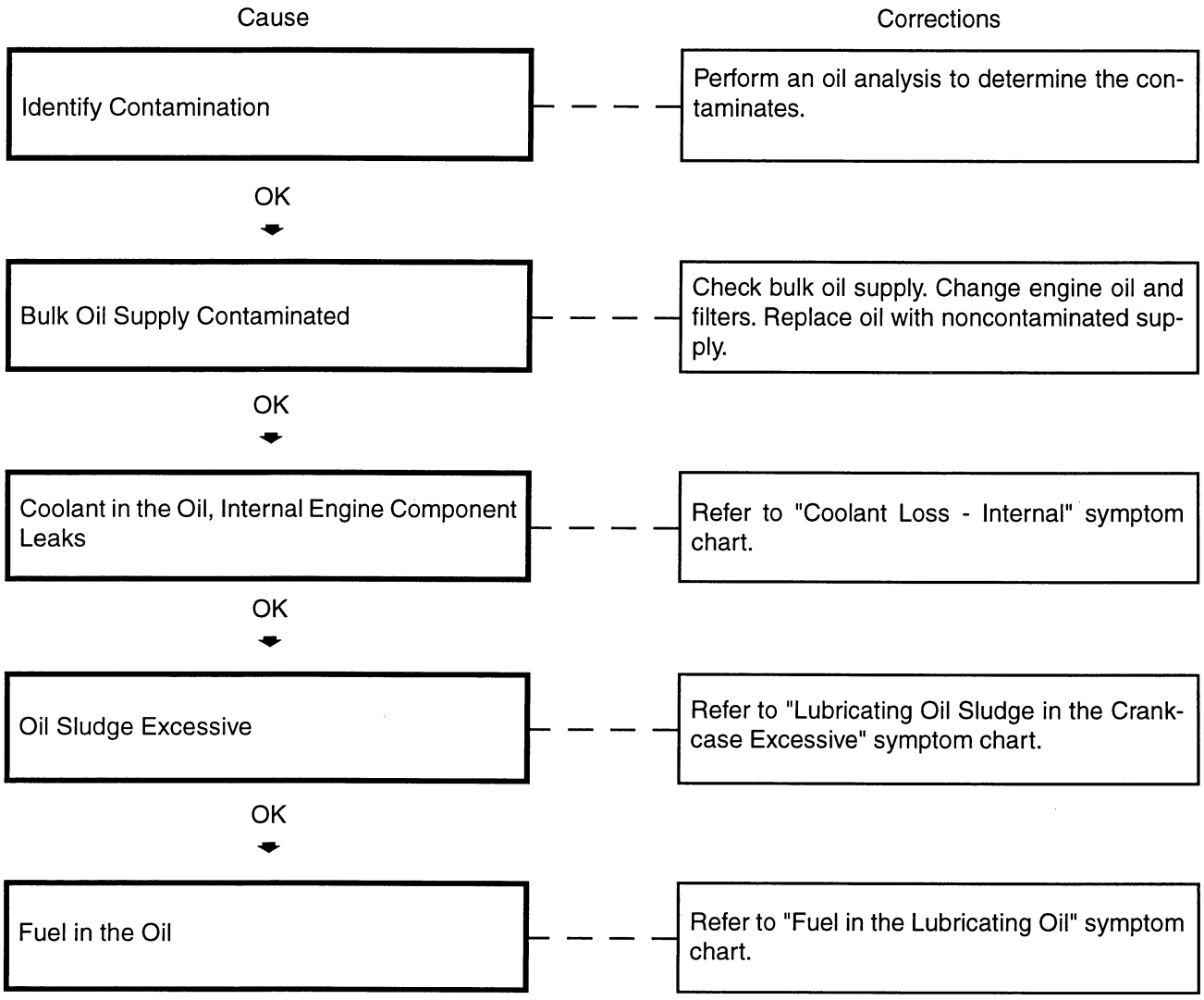
Cause	Corrections
External Oil Leaks	Visually check for oil leaks. Tighten capscrews, pipe plugs, and fittings as needed.
OK ↓	
Crankcase Breather and/or Breather Vent Tube Restricted	Check crankcase breather and/or vent tube.
OK ↓	
Turbocharger Seal Malfunctioning	Check turbocharger for internal oil leaks.
OK ↓	
Oil Temperature High (Above 120°C[250 F])	Check oil temperature thermostat and oil cooler.
OK ↓	
Oil Cooler Leak	Check for oil in the coolant. Refer to "Lubricating or Transmission Oil in the Coolant" symptom chart.
OK ↓	
Intake Air contamination causing Excessive Cylinder Liner and Piston Ring Wear	Check intake system for leaks.
OK ↓	
Oil Contaminated With Fuel	Refer to "Fuel in the Lubrication Oil" symptom chart.
OK ↓	

(Continued)

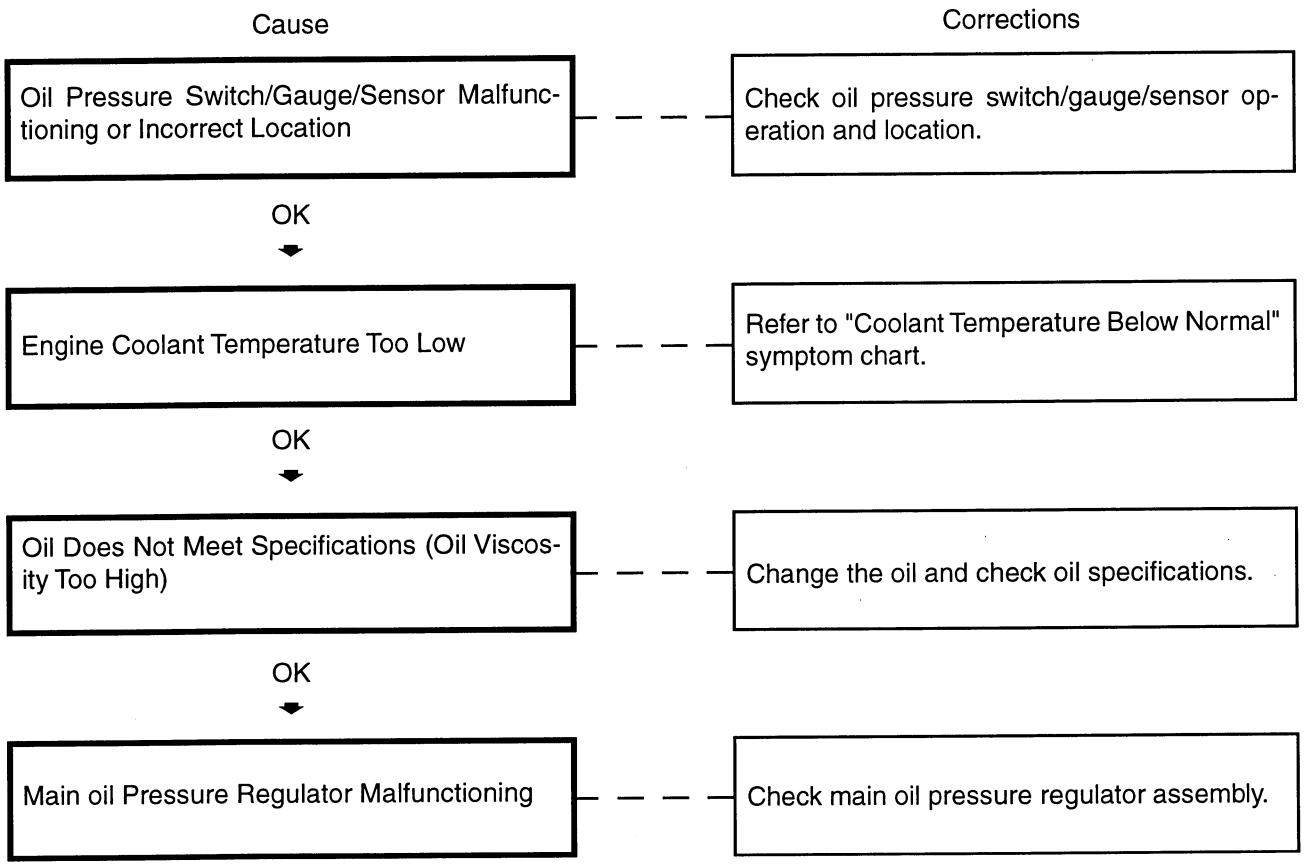
Lubricating Oil Consumption Excessive (Continued)



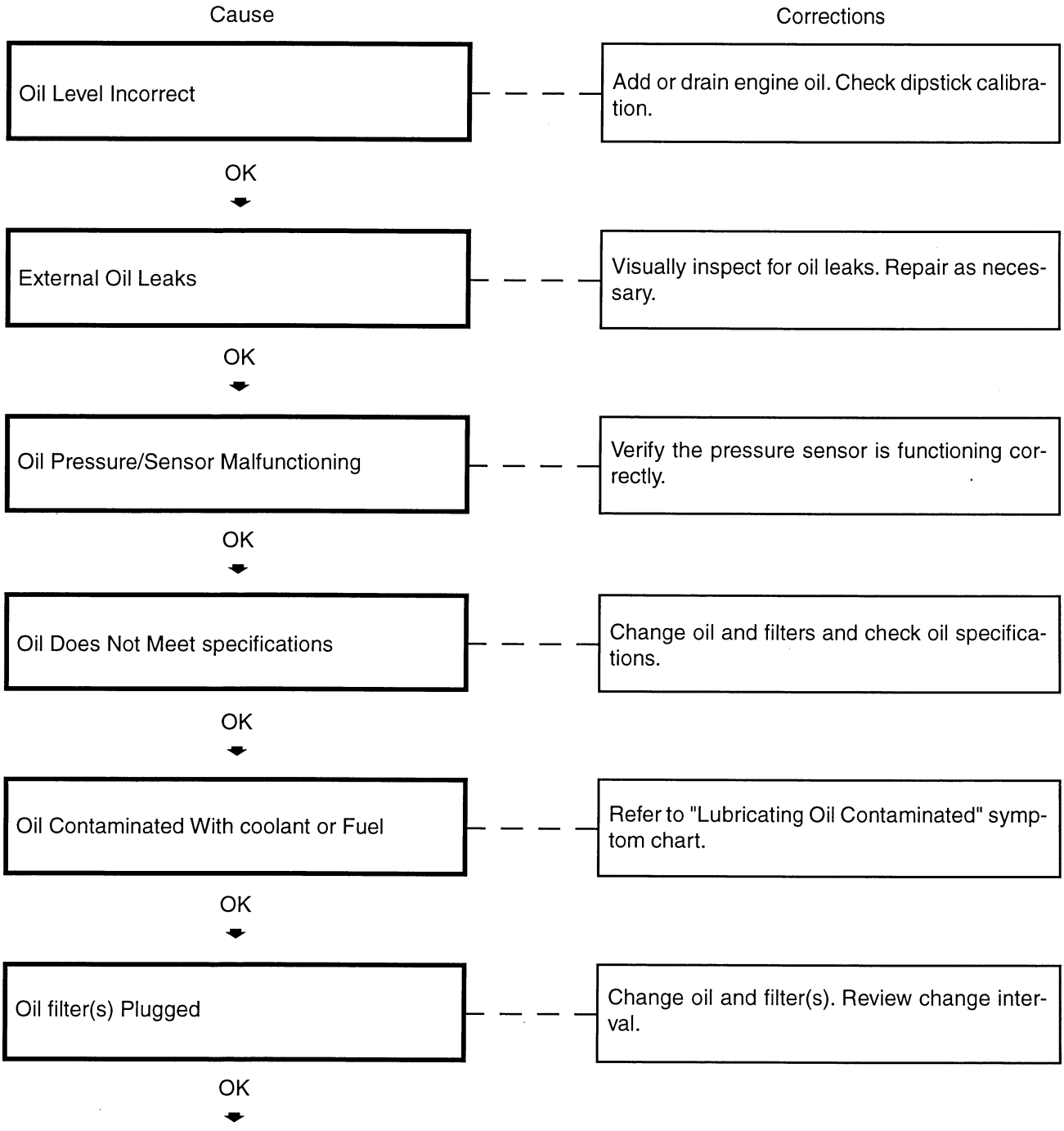
Lubricating Oil Contaminated



Lubricating Oil Pressure - High



Lubricating Oil Pressure - Low



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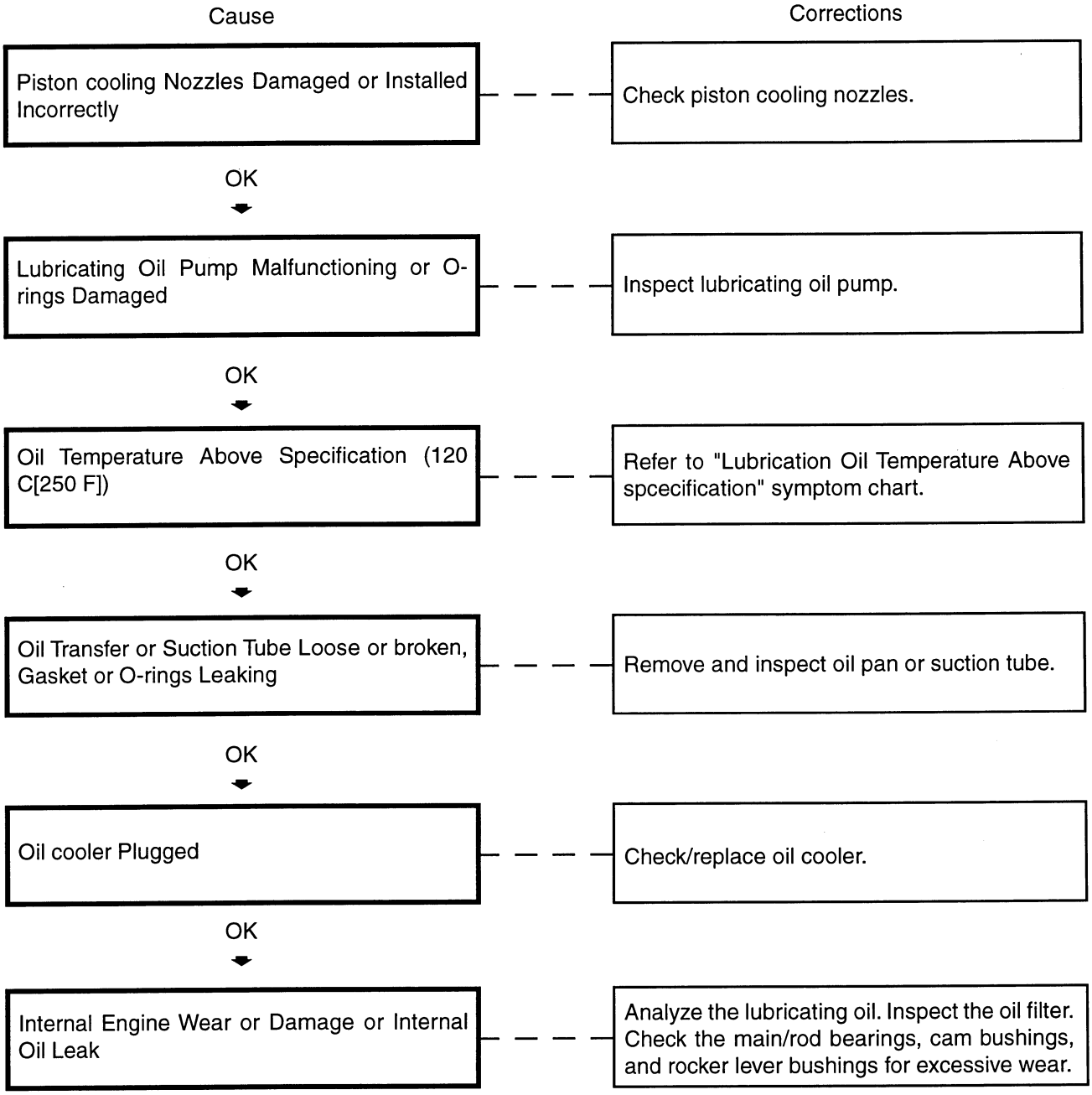
Lubricating Oil Pressure - Low (Continued)

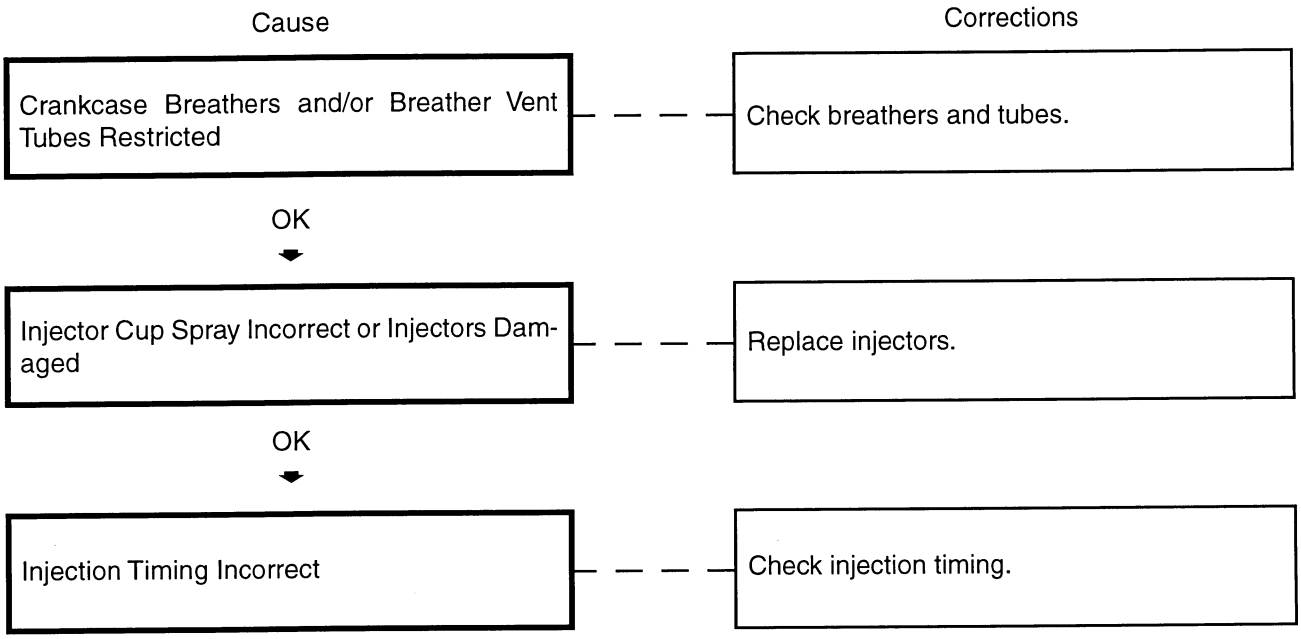


Lubricating Oil Sludge in the Engine Crankcase Excessive

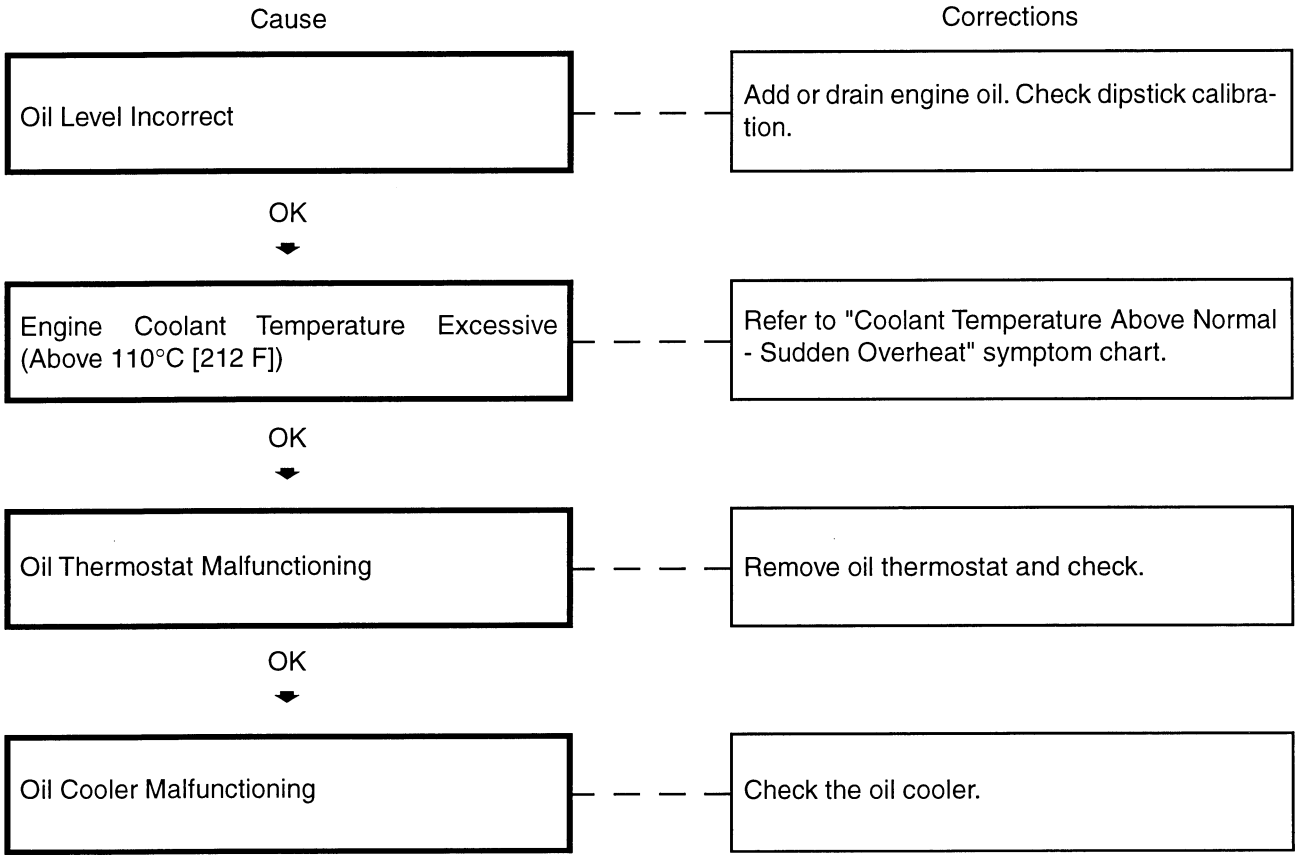
Cause	Corrections
Bulk Oil Supply Contaminated	Check bulk oil supply. Change engine oil and filters. Replace oil with noncontaminated supply.
OK ⬇	
Oil Does Not Meet Specifications	Change oil and filters. Refer to the Operation and Maintenance manual, for the correct oil specification.
OK ⬇	
Oil Drain Interval and/or Oil Filter Replacement Interval Incorrect	Check records. Refer to the Operation and Maintenance Manual for the correct specifications.
OK ⬇	
Fuel Grade or Fuel Quality Poor or Incorrect	Check fuel and compare to specifications. Inspect/replace fuel lifters and fuel.
OK ⬇	
Engine Coolant and Oil Temperature Too Low	Refer to the "Coolant Temperature Below Normal" symptom chart.
OK ⬇	
Coolant in the oil	Refer to the "Coolant in the Lubricating Oil" symptom chart.
OK ⬇	
Blowby Excessive	Refer to "Engine Crankcase Gases (Blowby) - Excessive" sympton chart.
OK ⬇	

(Continued)

Lubricating Oil Sludge in the Engine Crankcase Excessive (Continued)



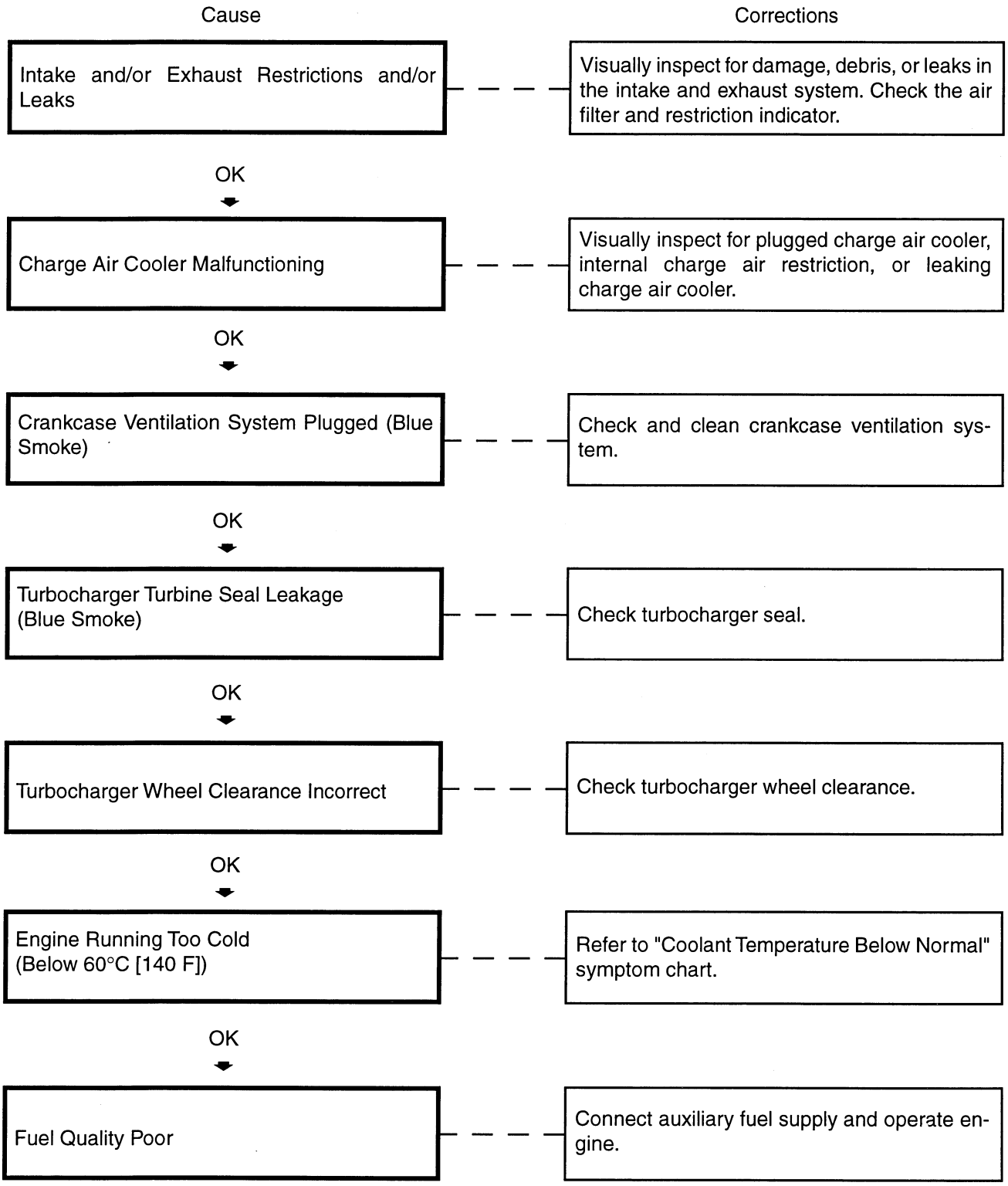
Lubricating Oil Temperature Above Specification



Lubricating Oil in the Coolant

Cause	Corrections
Bulk Coolant Supply contaminated	Check coolant supply, flush system, and replace with non-contaminated coolant. Replace filter. Check oil cooler to thermostat support mounting o-rings.
OK ⬇	
Lubricating Oil Cooler Malfunctioning	Inspect the oil cooler.
OK ⬇	
Torque Converter or Hydraulic Oil Cooler Malfunctioning	Remove and inspect torque converter oil cooler cores and o-rings.
OK ⬇	
Cylinder Head Gasket Leakage	Replace head gasket.
OK ⬇	
Cylinder Head Cracked or Porous	Inspect cylinder head.
OK ⬇	
Cylinder Block Cracked or Porous	Inspect cylinder block.

Smoke, Black - Excessive



Smoke, Black - Excessive - Performance Measurement

NOTE: After conducting the performance test, use this chart to analyze the performance data.

Cause	Corrections
Intake Air Restriction Excessive	Clean/replace air filter element or damaged air intake piping.
OK ↓	
Fuel Drainline Restriction Above 89 mm Hg [3.5 in Hg]	Inspect fuel return system for loops, swelled lines, or clamped points. Replace/reroute fuel linen. Verify fuel tank vents are not blocked, plugged, or corroded.
OK ↓	
Fuel Suction Line Restricted Max: 254 mm Hg [10 in Hg]	Replace fuel filter. Inspect fuel inlet system for swelled lines or clamped spots. Verify that additional filters/water separators, or fuel heater/coolers are not the cause of the restriction.
OK ↓	
Injector Cups or Nozzles Eroded or damaged and/or Injector Defective	Perform Automated Cylinder Performance Test.
OK ↓	
Fuel Rate High, Fuel Pressure OK, Intake Manifold Pressure OK	Rebuild or replace injectors.
OK ↓	
Fuel Rate Low, Fuel Pressure OK, Intake Manifold Pressure Low	Check fuel calibration
OK ↓	
Fuel Rate Ok, Fuel Pressure OK, Intake Manifold Pressure Low	• Excessive Intake air restriction. • Excessive exhaust restriction. Check for exhaust pipe damage or restriction. • Check for intake air or exhaust leaks between the turbocharger wheel clearance.
OK ↓	

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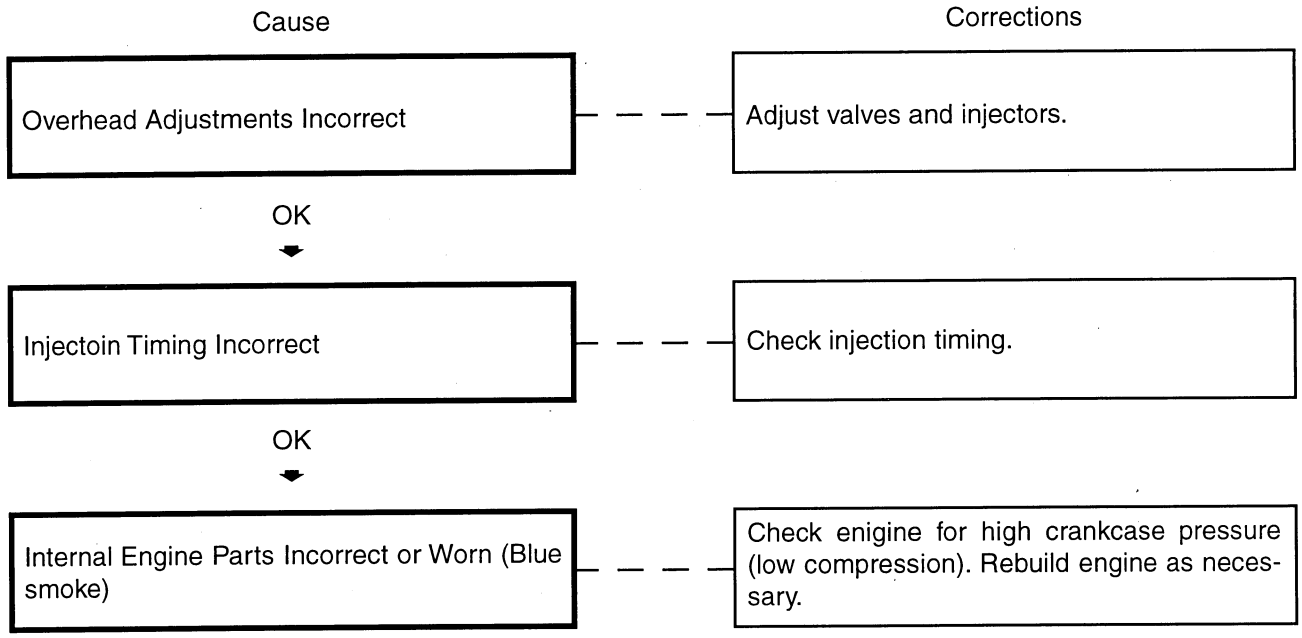
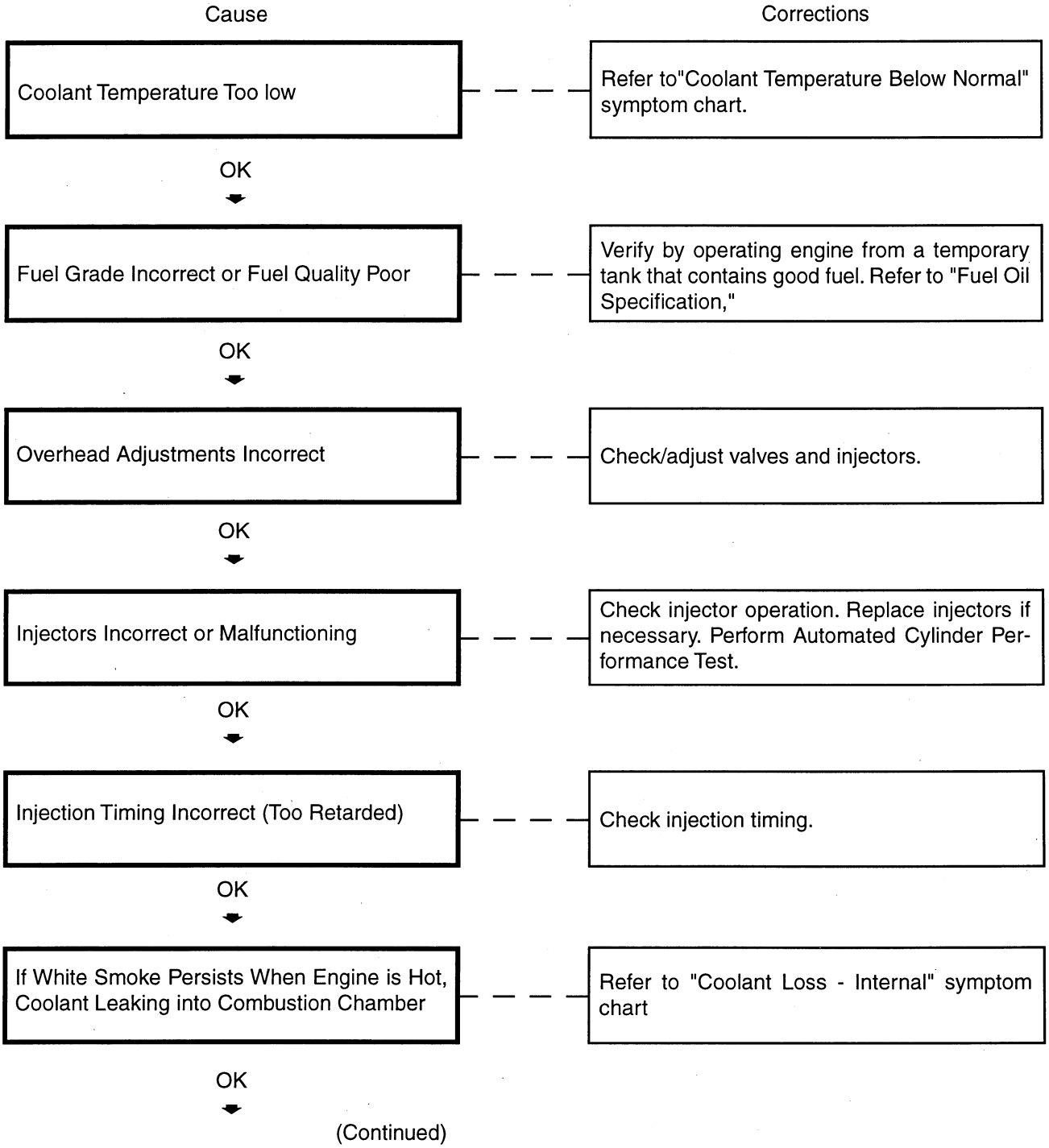
Smoke, Black - Excessive - Performace Measurement (Continued)



Smoke, White - Excessive



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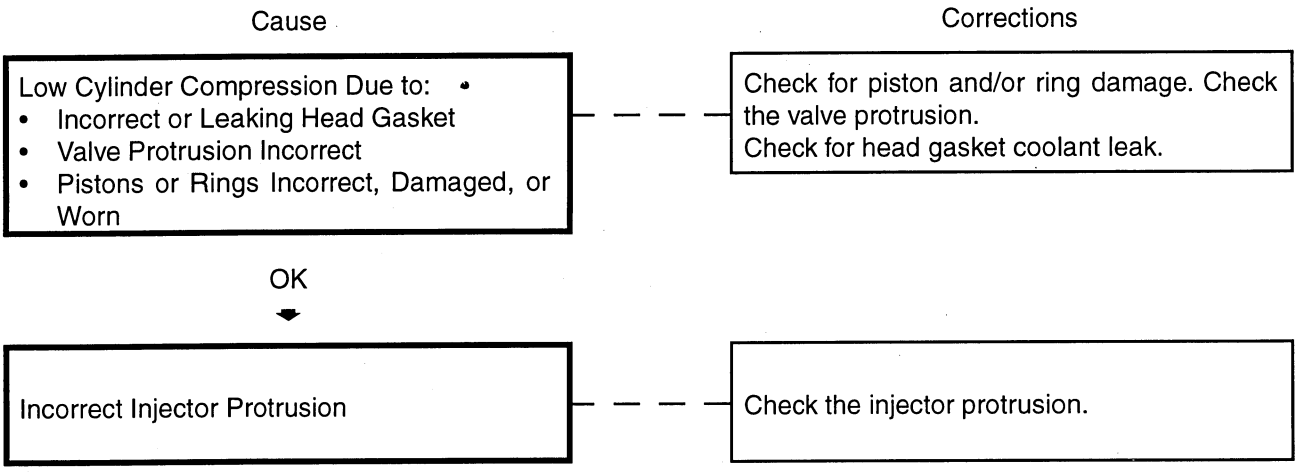
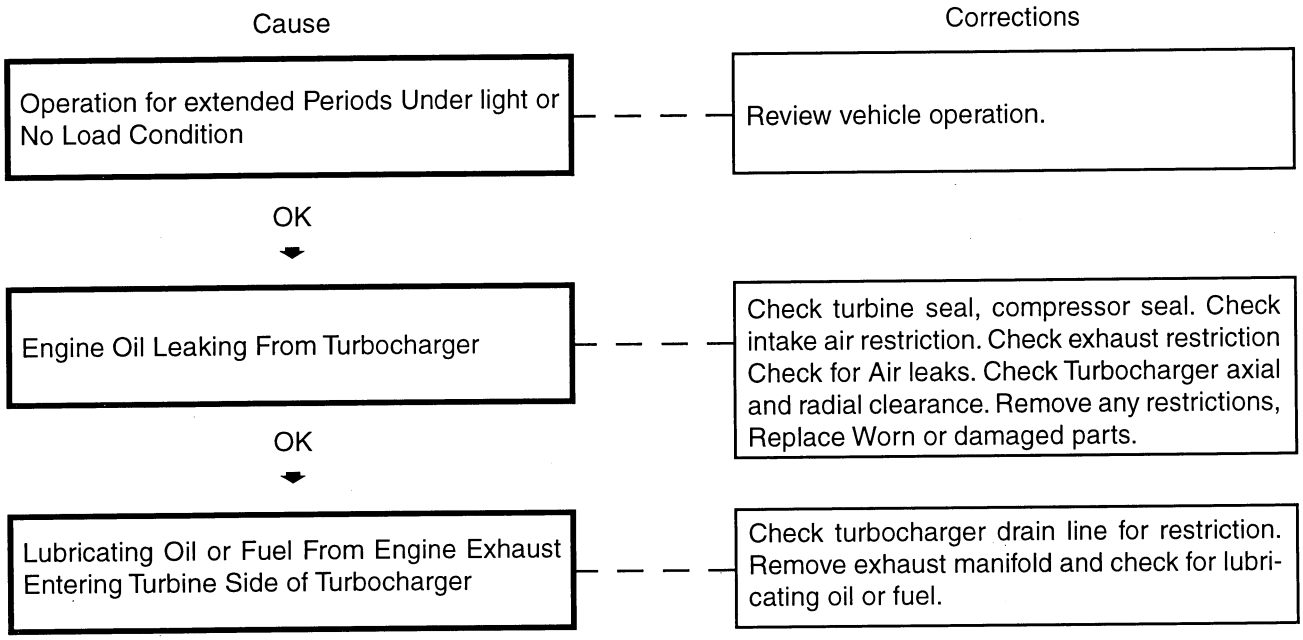
Smoke, White - Excessive (Continued)



Turbocharger Boost Pressure Low

Cause	Corrections
Intake, CAC, or Exhaust Air Leaks Rocker Housing gasket Leak	Check for losse or damaged piping connections and/or missing pipe plugs. Check turbocharger and exhaust manifold mounting. Check rocker housing gasket.
OK ↓	
Intake Air Restriction Excessive	Check restriction, Clean or replace air filter element or damaged air intake piping.
OK ↓	
Exhoust Gas restriction Excessive	Check restriction. Replace damaged piping or parts.
OK ↓	
Turbocharger Worn or damaged	Remove intake and exhaust piping from turbocharger. Check turbocharger. Check compressor and turbine wheel clearance, replace.
OK ↓	
Charge Air Cooler Plugged	Check air to air cooler for internal plugging.
OK ↓	
Fuel System Malfunctioning	Refer to the "Engine Power Output - Low" symptom chart.

Turborcharger Leaks - Engine Oil or Fuel



Engine Noise Diagnostic Procedures - General Information

NOTE: When diagnosing engine noise problems, make sure that noises caused by accessories, such as the air compressor and power takeoff, are **not** mistaken for engine noises. Remove the accessory drive belts to eliminate noise caused by these units. Noise will also travel to other metal parts **not** related to the problem. The use of a stethoscope can help locate an engine noise.

Engine noises heard at the crankshaft speed, engine RPM, are noises related to the crankshaft, rods, pistons, and piston pins. Noises heard at the camshaft speed, one-half of the engine RPM, are realted to the valve train. A hand-held digital tachometer can help to determine if the noise is related to components operating at the crankshaft or camshaft speed.

Engine noise can sometimes be isolated by performing a cylinder cutout test. If the volume of the noise decreases or the noise disappears, it is related to that particular engine cylinder.

There is **not** a definite rule or test that will positively determine the source of a noise complaint.

Engine driven components and accessories, such as gear-driven fan clutches, hydraulic pumps, belt-driven alternator, air-conditioning compressors, and turbocharges can contribute to engine noise. Use the following information as a guide to diagnosing engine noise.

Main Bearing Noise

(Refer to Engine Noice Excessive - Main Bearing Symptom Chart)

The noise caused by a loose main bearing is a loud dull knock heard when the engine is pulling a load. If all main bearings are loose, a loud clatter will be heard. The knock is heard regularly every other revolution. The noise is the loudest when the engine is lugging or under heavy load. The knock is duller than a connecting rod noise. Low oil pressure can also accompany this condition.

If the bearing is **not** loose enough to produce a knock by itself, the bearing can knock if the oil is too thin, or if there is no oil at the bearing.

An irregular noise can indicate worn crankshaft thrust bearings.

An intermittent sharp knock indicates excessive crankshaft end clearance. Repeated clutch disengagements can cause a change in the noise.

Connecting Rod Bearing Noise

(Refer to Engine Noise Excessive - Connecting Rod Symptom Chart)

Connecting rods with excessive clearance knock at all engine speed, and under both idle and load conditions. When the bearings begin to become loose, the noise can be confused with piston slap or loose piston pins. The noise increases in volume with engine speed. Low oil pressure can also accompany this condition.

Piston Noise

(Refer to Engine Noise Excessive - Piston symptom Chart)

It is diffictult to tell the difference between piston pin, connecting rod, and piston noise. A loose piston pin causes a loud double knock which is usually heard when the engine is idling. When the injector to this cylinder is cut out, a noticeable change will be heard in the sound of the knocking noise. However, on some engines the knock becomes more noticeable when the vehicle is operated on the road at a steady speed condition.

TROUBLESHOOTING OF GOVERNOR, PUMP CONTROLLER (PUMP CONTROL SYSTEM) (C MODE)

POINTS TO REMEMBER WHEN TROUBLESHOOTING PUMP CONTROLLER SYSTEM

1. **Points to remember if abnormality returns to normal by itself**
   In the following two cases, there is a high probability that the same problem will occur again, so it is desirable to follow up this problem carefully.
   1) If any abnormality returns to normal by itself, or
   2) If the connector is disconnected and the T-adapter is inserted, or if the T-adapter is removed and the connector is returned to its original position when carrrying out troubleshooting of the failure, and the service code is no longer displayed, or if the monitor display returns to normal.
   3) After completing troubleshooting, always erase the user code from memory.

2. **User code memory retention function**
   When displaying the abnormality code in memory and carrying out troubleshooting, note down the content of the display, then erase the display. After trying to re-enact the problem, carry out troubleshooting according to the failure code that is displayed.
   (There are cases where mistaken operation or abnormalities that occur when the connector is disconnected are recorded by the memory retention function. Erasing the data in this way saves any wasted work.)

User code	Service code	Abnormal system	Nature of abnormality
-	E202	Short circuit in LS select solenoid system	1. Short circuit with ground, short circuit inside LS select solenoid 2. Short circuit with ground in wiring harness between controller C01 (8) and soenoid V02 (2) ((+) side) 3. Defective governor, pump controller
-	E204	Short circuit in pump merge/divider solenoid system	1. Short circuit with ground, short circuit inside pump merge/divider solenoid 2. Short circuit with ground in wiring harness between controller C01 (2) and solenoid V03 (2) ((+) side) 3. Defective governor, pump controller
-	E206	Short circuit in travel speed solenoid system	1. Short circuit with ground, short circuit inside travel speed solenoid 2. Short circuit with ground in wiring harness between controller C01 (9) and solenoid V06 (2) ((+) side) 3. Defective governor, pump controller
-	E212	Disconnection in LS select solenoid system	1. Disconnection, defective contact inside LS select solenoid 2. Disconnection, defective contact, short circuit with power source in wiring harness between controller C01 (9) and solenoid V02 (2) ((+) side) 3. Disconnection, defective contact in wiring harness between solenoid V02 (1) and chassis ground((-) side) 4. Defective governor, pump controller
-	E214	Disconnection in pump merge/divider solenoid system	1. Disconnection, defective contact inside pump merge/divider solenoid 2. Disconnection, defective contact, short circuit with power source in wiring harness between controller C01 (2) and solenoid V03 (2) ((+) side) 3. Disconnection, defective contact in wiring harness between solenoid V02 (1) and chassis ground ((-) side) 4. Defective governor, pump controller
-	E216	Disconnection in travel speed solenoid system	1. Disconnection, defective contact inside travel speed solenoid 2. Disconnection, defective contact, short circuit with power source in wiring harness between controller C01 (9) and solenoid V06 (2) ((+) side) 3. Disconnection, defective contact in wiring harness between solenoid V06 (1) and chassis ground ((-) side) 4. Defective governor, pump controller
-	E217	Model selection input error	1. Disconnection, defective contact, short circuit with ground in model selection wiring harness C17(5) (6) (13) (14) 2. Defective governor, pump controller

Condition when normal (voltage, current, resistance)	Action by controller when abnormality is detected	Problem that appears on machine when there is abnormality
• Resistance of solenoid: 20 - 60 Ω	1. Makes output to solenoid 0. ★ If the abnormality is restored by the vibration of the machine, it resets the power source to restore to the proper condition. (However, the service code display does not go out.)	1. With swing + boom RAISE, the boom is slow. 2. With swing + arm IN, the arm IN movement is slow. 3. With swing + arm OUT, the arm OUT movement is slow. 4. With swing + travel, there is a big drop in the travel speed.
• Resistance of solenoid: 20 - 60 Ω	1. Makes output to solenoid 0. ★ If the abnormality is restored by the vibration of the machine, it resets the power source to restore to the proper condition. (However, the service code display does not go out.)	The pump merge/divider valve continues to merge the oil flow. 1. In the L/O and F/O modes, the work equipment and swing speeds become faster. 2. The steering is difficult to turn.
• Resistance of solenoid: 20 - 60 Ω	1. Makes output to solenoid 0. ★ If the abnormality is restored by the vibration of the machine, it resets the power source to restore to the proper condition. (However, the service code display does not go out.)	Even if the travel speed is switched, the travel speed does not change (remains at Lo)
• Resistance of solenoid: 20 - 60 Ω	1. The current stops flowing to the solenoid, so no particular action is taken. ★ If the abnormality is restored by the vibration of the machine, it resets the power source to restore to the proper condition. (However, the service code display does not go out.)	Same content as display for E202
• Resistance of solenoid: 20 - 60 Ω	1. The current stops flowing to the solenoid, so no particular action is taken. ★ If the abnormality is restored by the vibration of the machine, it resets the power source to restore to the proper condition. (However, the service code display does not go out.)	Same content as display for E204
• Resitance of solenoid: 20 - 60 Ω	1. The current stops flowing to the solenoid, so no particular action is taken. ★ If the abnormality is restored by the vibration of the machine, it resets the power source to restore to the proper condition. (However, the service code display does not go out.)	Same content as display for E206
• Between C17 (5), (6), (13) and chasssis: Max. 1Ω Between C17 (7), (14) and chassis: Min. 1 MΩ	Detects abnormality in input 1) Retains data when starting switch is ON 2) Functions as PC100 when non-set conditions are input	1. Engine stalls, or 2. Work equipment, swing, travel speeds are all slow, and there is no power

User code	Service code	Abnormal system	Nature of abnormality
-	E218	Network response overtime error	1. Disconnection, short circuit, short circuit with ground in network wiring harness 2. Abnormality in governor, pump controller 3. Abnormality in monitor
-	E222	Short circuit in LS-EPC solenoid system	1. Short circuit with ground, short circuit inside LS-EPC solenoid 2. Short circuit with power source, short circuit with ground in wiring harness between controller C02 (7) and solenoied C10 (1) ((+) side) 3. Short circuit with power source in wiring harness between controller C02 (17) and solenoid C10 (2) ((-) side) 4. Defective goverhnor, pump controller
-	E223	Disconnection in LS-EPC solenoid system	1. Disconnection, defective contact inside LS-EPC solenoid 2. Disconnection, defective contact in wiring harness between controller C02 (7) and solenoid C10 (1) ((+) side) 3. Disconnection, defective contact, short circuit with ground in wiring harness between controller C02 (17) and solenoid C10 (2) ((-) side) 4. Defective governor, pump controller
-	E224	Abnormality in front pump pressure sensor system	1. Disconnection, defective contact, short circuit, short circuit with ground inside front pump pressure sensor 2. Disconnection, defective contact, short circuit in wiring harness and between C03 (6) and pressure sensor C08 (2) ((+) siede) and between C03 (16) and C08 (1) ((-) side) 3. Disconnection, defective contact, short circuit with power source, short circuit with ground in wiring harness between controller c03 (3) and pressure sensor C08 (30 (SIG side) 4. Defective governor, pump controller
-	E225	Abnormality in rear pump pressure sensor system	1. Disconnection, defective contact, short circuit , short circuit with ground inside rear pump pressure sensor 2. Disconnection, defective contact, short circuit in wiring harness between controller C03 (6) and pressure sensor C07 (2) ((+) side) and between C03 (16) and C07 (1) (9-) side) 3. Disconnection, defective contact, short circuit with power source, short circuit with ground in wiring harness between controller C03 (13) and pressure sensor C07 (3) (SIG side) 4. Defective governor, pump controller
-	E226	Abnormality in pressure sensor power source system	1. Short circuit, short circuit with ground inside front pump pressure sensor or rear pump pressure sensor 2. Short circuit, short circuit with ground in wiring harness between controller C03 (6) and front pressure sensor C08 (2) or rear pressure sensor C07 (2) ((+) side) 3. Defective governor, pump controller
-	E227	Abnormality in speed sensor system	1. Disconnection, defective contact, short circuit inside engine speed sensor 2. Disconnection, defective contact, short circuit with ground in wiring harness between controller C16 (10 and speed sensor E07 (2) ((-) side) and between C16 (2) and E07 (1) (SIG side) 3. Defective governor, pump controller

Condition when normal (voltage, current, resistance)	Action by controller when abnormality is detected	Problem that appears on machine when there is abnormality
	1. When communications are impossible with the monitor, control is carried out with the following settings. ① Working mode: G/O ② Priority mode: OFF ③ Travel speed: Lo ④ Auto-deceleration: ON ⑤ Power max : ON (others are as usual)	1. ① Even when travel is operated, the power max. function does not work ② The swift speed- down function does not work ③ The auto-deceleration cannot be canceled ④ The travel speed does not increase ⑤ The priority mode has no effect ⑥ The automatic mode has no effect
• Resistance of solenoid: 7 - 14 Ω	1. Makes output to LS-EPC solenoid O. ★ If the abnormality is restored by the vibration of the machine, it resets the power source to restore to the proper condition. (However, the service code display does not go out.)	1. The Lo travel speed is too fast. 2. In L/O and F/O modes, the work equipment speed is too fast. 3. When the engine is running at low idling, the swing speed is too fast.
• Current: Approx. 705 mA (Levers at neutral, low idling)	1. The current stops flowing to the LS-EPC solenoid, so no particular action is taken. 2. If there is a short circuit with the ground at the (-) end, the current (min. 1A) continues to flow to the LS-EPC solenoid. ★ If the abnormality is restored by the vibration of the machine, it resets the power source to restore to the proper condition. (However, the service code display does not go out.)	1. In the case of 1, it is the same as E222 2. In the case of 2, electric current (min. 1A) continues to flow to the LS-EPC solenoid, so the work equipment, travel, and swing speeds are slow
• Between C03 (3) and (16): 0.5 - 4.5 V • Between Co3 (6) and (16): 18 - 28 V • Between C03 (female) (3) and (16), (3) and chassis • Resistance: Min. 1 MΩ (disconnect connectors C03 and C08.)	1. Takes front pump pressure as 0 MPa (0 kg/cm^2) when actuating. ★ If the abnormality is restored by the vibration of the machine, it resets the power source to restore to the proper condition. (However, the service code display does not go out.)	1. The travel speed does not automatically shift (it does not change from Hi to Lo). ★ If the button is operated manually, the panel display is switched.
• Between C03 (13) and (16): 0.5 - 4.5 V • Between c03 (6) and (16): 18 - 28 V • Between c03 (female) (13) and (16), (13) and chassis • Resistance: Min. 1 MΩ (disconnect connectors C03 and C07.)	1. Takes rear pump pressure as 0 MPa (0 kg/cm^2) when actuating. ★ If the abnormality is restored by the vibration of the machine, it resets the power source to restore to the proper condition. (However, the service code display does not go out.)	1. The travel speed does not automatically shift (it does not change from Hi to Lo). ★ If the button is operated manually, the panel display is switched.
• Voltage between C03 (6) and (16)" 18 - 28 V	1. Takes front pump and rear pump pressure as 0 MPa (0 kg/cm^2) when actuating. 2. When abnormality is detected, it switches the output OFF, and when all levers are returned to neural, it outputs again. ★ This automatic resetting is repeated up to 3 times.	1. The travel speed does not automatically shift (it does not change from Hi to Lo). ★ If the button is operated manually, the panel display is switched.
• Resistance: 500 - 1000 Ω • Voltage (AC range): 0.5 - 3.0 V (engine started)	1. It functions in the equivalent of the G/O mode (the speed rises)	It operates about the same as G/O mode (prolix) (the power is slightly lower)

JUDGEMENT TABLE FOR GOVERNOR, PUMP CONTROLLER (PUMP CONTROL SYSTEM) AND HYDRAULIC RELATED PARTS

Failure mode			Governor, pump controller (E2:XX system) Self-diagnostic display: Abnormality in controller power source	Short circuit in front pump TVC soenoid system	Disconnection in front pump TVC solenoid system	Short circuit in rear pump TVC solenoid system	Disconnection in rear pump TVC solenoid system	Short circuit in LS select solenoid system	Disconnection in LS select solenoid system	Short circuit in swing holding brake solenoid system	Disconnection in swing holding brake solenoid system	Short circuit in pump merge/divider solenoid system	Disconnection in pump merge/divider solenoid system	Short circuit in travel speed selector solenoid system	Disconnection in travel speed selector solenoid system	Model selection input error	Short circuit in Ls-EPC solenoid system	Disconnection in LS-EPC solenoid system
		User code	LED	E02				-		E03		-						
		Service code	OFF	232	233	236	237	202	212	203	213	204	214	206	216	217	222	223
All work equipment travel, swing	Speeds of all work equipment, swing, travel are slow or lack power			▲	▲	▲	▲									•		•
	There is excessive drop in engine speed, or engine stalls			•	•	•	•									•		
	No work equipment, travel, swing move																	
	Abnormal noise generated (around pump)																	
	Auto-deceleration does not work		•															
	Fine control ability is poor or response is poor																	
Work equipment	Boom is slow or lacks power												•					
	Arm is slow or lacks power												•					
	Bucket is slow or lacks powwer																	
	Boom does not move																	
	Arm does not move																	
	Bucket does not move																	
	Excessive hydraulic drift																	
	Excessive time lag (engine at low idling)																	•
	Other equipment moves when single circuit is relieved																	
	In L/O, FO modes, work equipment speed is faster than specified speed											•	•				•	•
	Machine 2-stage relief function does not work																	
Compound operations	In compound operations, work equipment with larger load is slow																	
	In swing + boom (RAISE), boom is slow							•	•									
	In swing + armp, arm is slow							•	•									
	In swing + travel, trave sspeed drops excessively							•	•									
Travel system	Travel deviation	Deviation is excessive during normal travel																
		Deviation is excessive when starting																
	Travel speed is slow																	•
	Steering does not turn or lacks power											•	•					
	Travel speed does not switch or is faster than specified speed		•											•	•		•	•
	Does not move (one side only)																	
Swing system	Does not swing	Both left and right								•	•							
		One direction only																
	Swing acceleration is poor or swing speed is slow	Both left and right		•	•	•	•											
		One direction only																
	Excessive overrun when stopping swing	Both left and right																
		One direction only																
	Excessive shock when stopping swing (one direction only)																	
	Excessive abnormal noise when stopping swing																	
	Excessive hydraulic drift of swing	When holding brake is released																
		When holding brake is applied																
	Swing speed is faster than specified swing speed											•	•				•	•
	Troubleshoooting code when service code is displayed		C-1	C-2	C-3	C-4	C-5	C-6	C-7	C-8	C-9	C-10	C-11	C-12	C-13	C-14	C-15	C-16
	Troubleshooting code when there is abnormality in monitoring check		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

▲ :This shows applicable item for service code (simultaneous abnormality at front or rear)
• :This shows applicable item for service code
※ :This shows item that needs only checking with monitoring
: This shows item to check with monitoring or machine monitor

★ If service code E218 (abnormality in network system) is displayed, go to troubleshooting for N mode.

Governor, pump controller (E2:XX system) Self-diagnostic display				Check items in monitoring mode																								
				Pressure switch											Actuation of solenoid													
Abnormality in front pump pressure sensor system	Abnormality in rear pump pressure sensor system	Abnormality in pressure sensor power source system	Abnormality in engine speed sensor system	Swing	Travel	Boom LOWER	Boom RAISE	Arm IN	Arm OUT	Bucket CURL	Bucket DUMP	Swing lock switch	Kerosene mode	Knob switch	LS select	Swing holding brake	Pump merge/divider	Travel speed	Model code	Engine speed input	Front pump discharge pressure input	Rear pump discharge pressure input	Front pump TVC current output	Rear pump TVC current output	LS-EPC current output	Troubleshooting code if no service code is displayed
				Bit pattern															Monitoring code							
224	225	226	227	20								21			22		23					02	10	11	12	13	14	15	
			•																	※	※	※	※	※	※	※	H+1
			•																								H+2
																											H+3
																											H+4
			•																								H+5
																											H+6
																	※				※	※					H+7
																	※				※	※					H+8
																					※	※					H+9
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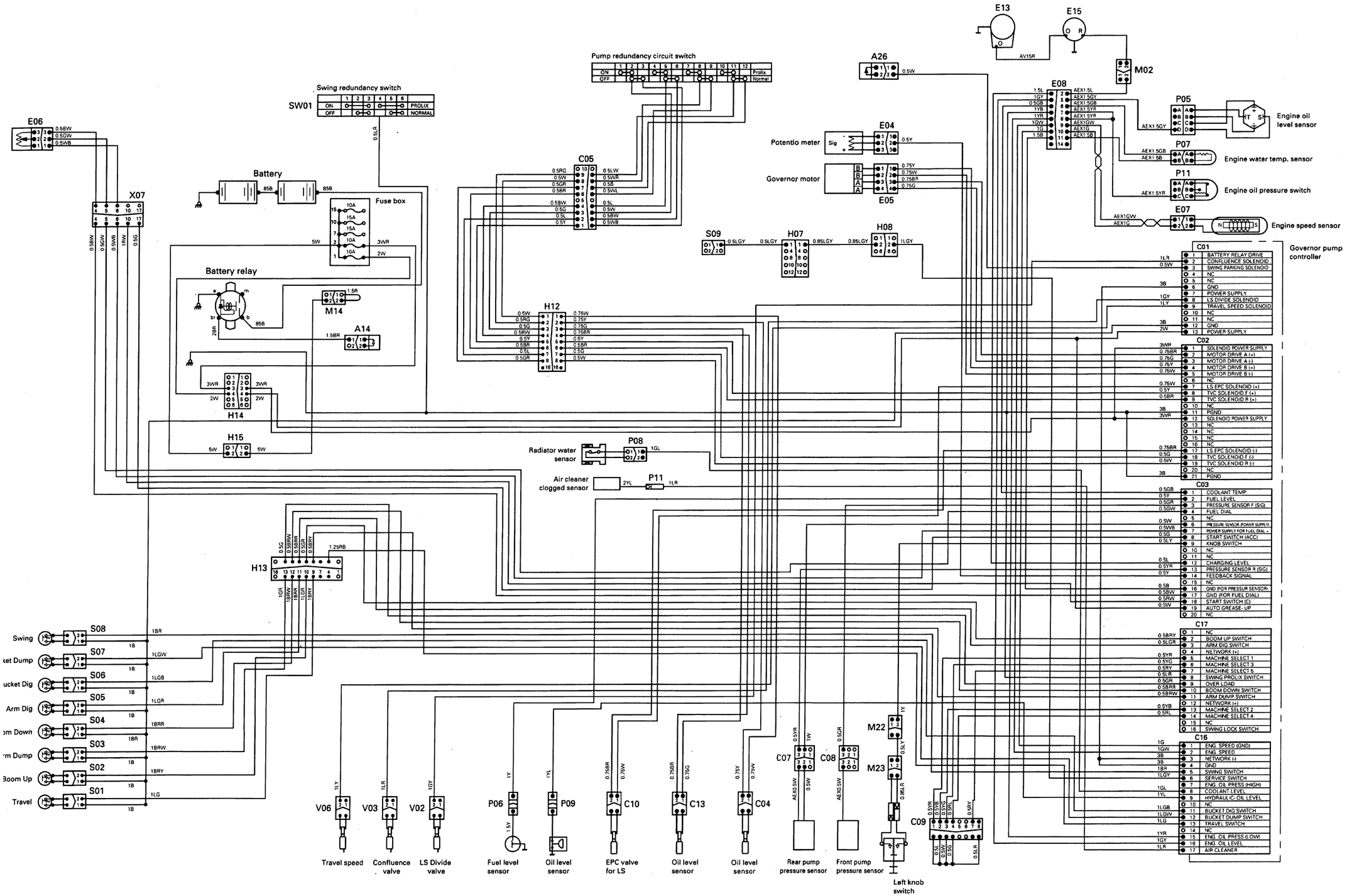
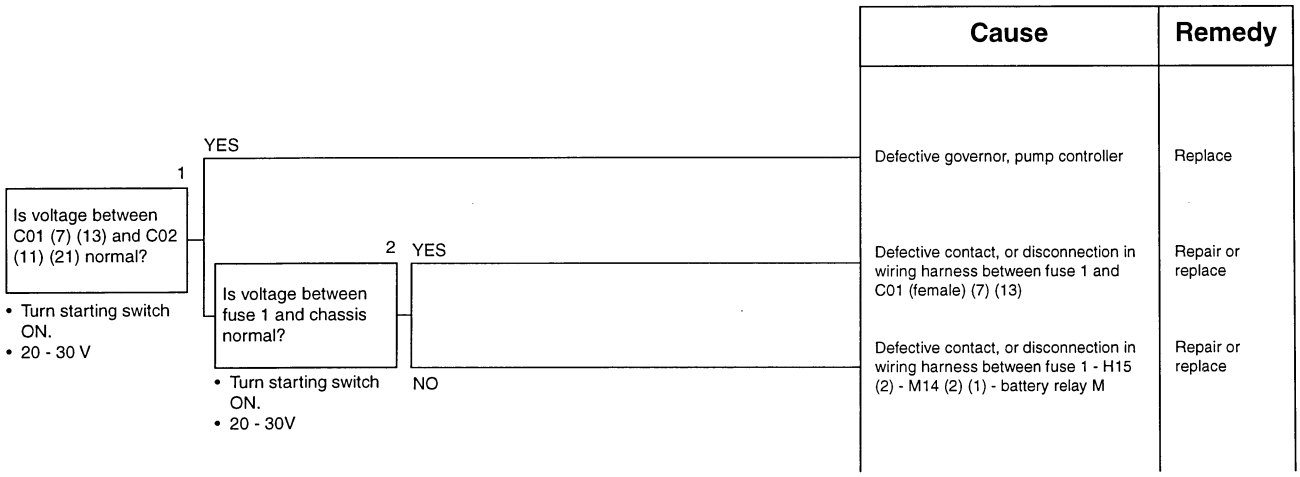
																					※						H+26
																											H+27
																											H+28
																											H+29
																											H+30
				※		※	※	※	※	※	※					※											H+31
C-17	C-18	C-19	C-20	-	-	-	-	-	-	-	-	-	-	-	-	-	※	-	-	-	-	-	-	-	※	
-	-	-	-	F-1	F-2	F-3	F-4	F-5	F-6	F-7	F-8	F-9	F-10	F-11	-	-	-	-	-	-	-	-	-	-	-	

LECTICAL CIRCUIT DIAGRAM FOR C MODE

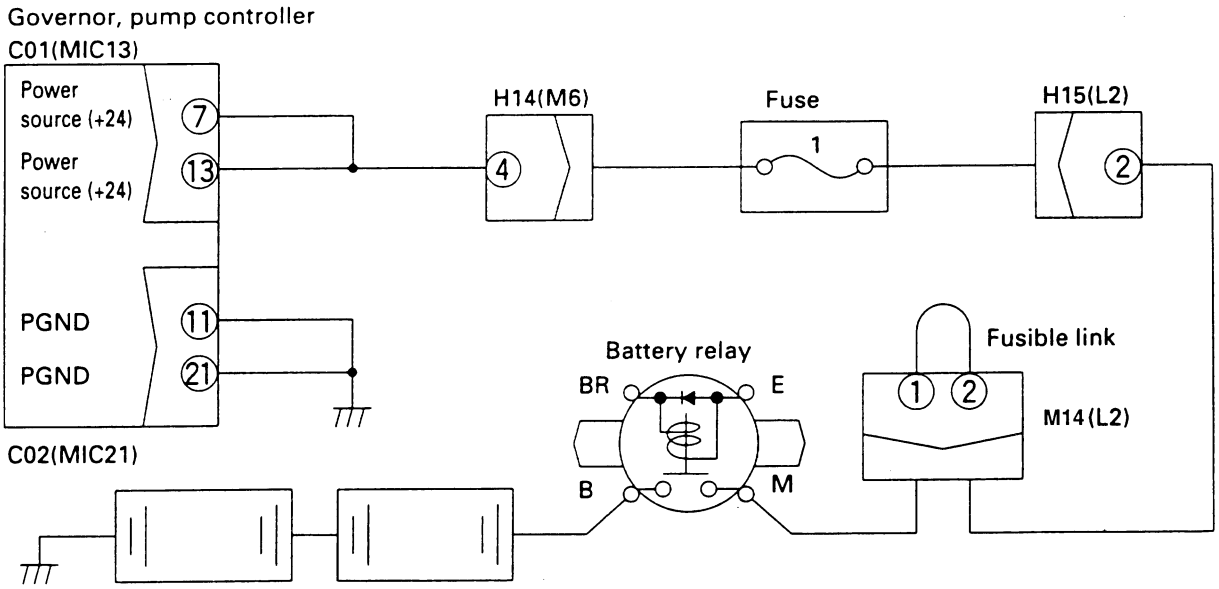


C-1 Abnormality in controller power source system (controller LED is OFF)

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if an E service code in not displayed, the problem has been removed.**
★ Check that fuse 1 is not blown.
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.
★ When the starting motor rotates normally. (If the starting motor also does not rotate, go to E-8.)

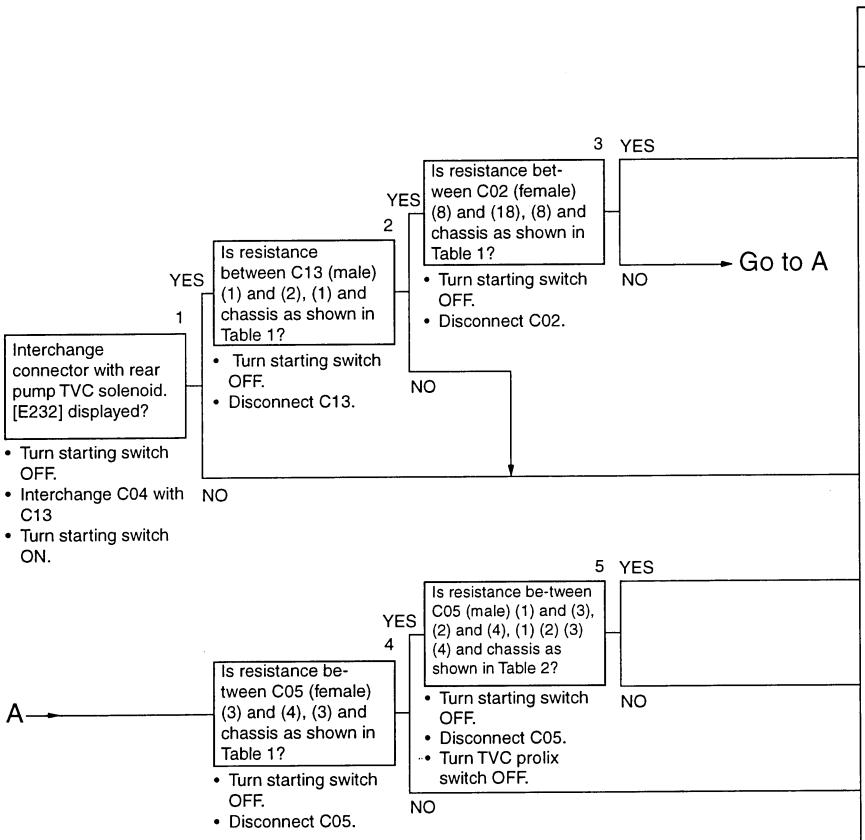


C-1 Related electric circuit diagram



C-2 [E232] Short circuit in front pump TVC solenoid system is displayed

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if an E service code in not displayed, the problem has been removed.**
★ If the starting switch is turned OFF after an abnormality occurs, turn the starting switch ON and check if an E service code is displayed. (If it is not displayed, the problem has been removed.)
★ Always turn the TVC prolix switch OFF.
★ Before carrying out troubleshooting, check thtat all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



Cause	Remedy
Defective governor, pump controller	Replace
Defective front pump TVC solenoid (internal short circuit or short circuit with ground)	Replace
Short circuit with ground or short circuit with power source in wiring harness between C02 (female) (8) - H12 (5) - C05 (female) (1), or short circuit with power source in wiring harness between C02 (female) (18) - H12 (7) -C05 (female) (2)	Repair or replace
Defective TVC prolix switch (internal short circuit with ground or short circuit with power source)	Replace
Short circuit with ground or short circuit with power source in wiring harness between C05 (female) (3) - H12 (3) - C13 (female) (1) , or short circuit with power source in wiring harness between C05 (female) (4) - H12 (4) -C13 (female) (2)	Repair or replace

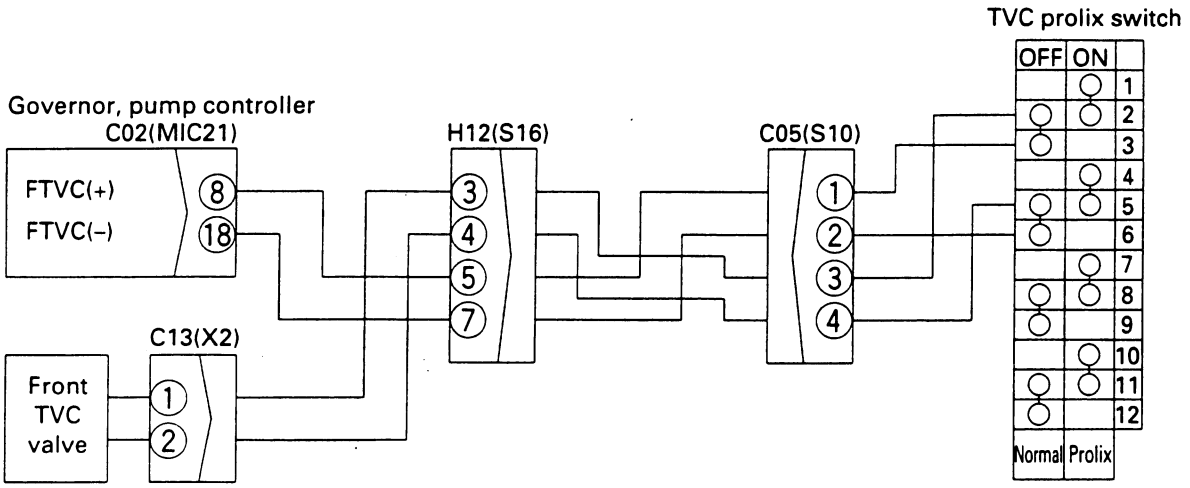
Table 1

Troubleshooting No.2	Troubleshooting No. 3	Troubleshooting No.4	Resistance value
Between C13 (male) (1) - (2)	Between C02 (female) (8) - (18)	Between C05 (female) (3) - (4)	10 - 22 Ω
Between C13 (male) (1) - chassis	Between C02 (female) (8) - chassis	Between C05 (female) (3) - chassis	Min. 1 MΩ

Table 2

Troubleshooting No.5	Resistance value
Between C05 (male) (1) - (3),(2) - (4)	Max. 1 Ω
Between C05 (male) (1) (2) (3) (4) - chassis	Min. 1 MΩ

C-2 Related electric circuit diagram



BKP00187

C-3 [E233] Disconnection in front pump TVC solenoid system is displayed

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if an E service code is not displayed, the problem has been removed.**

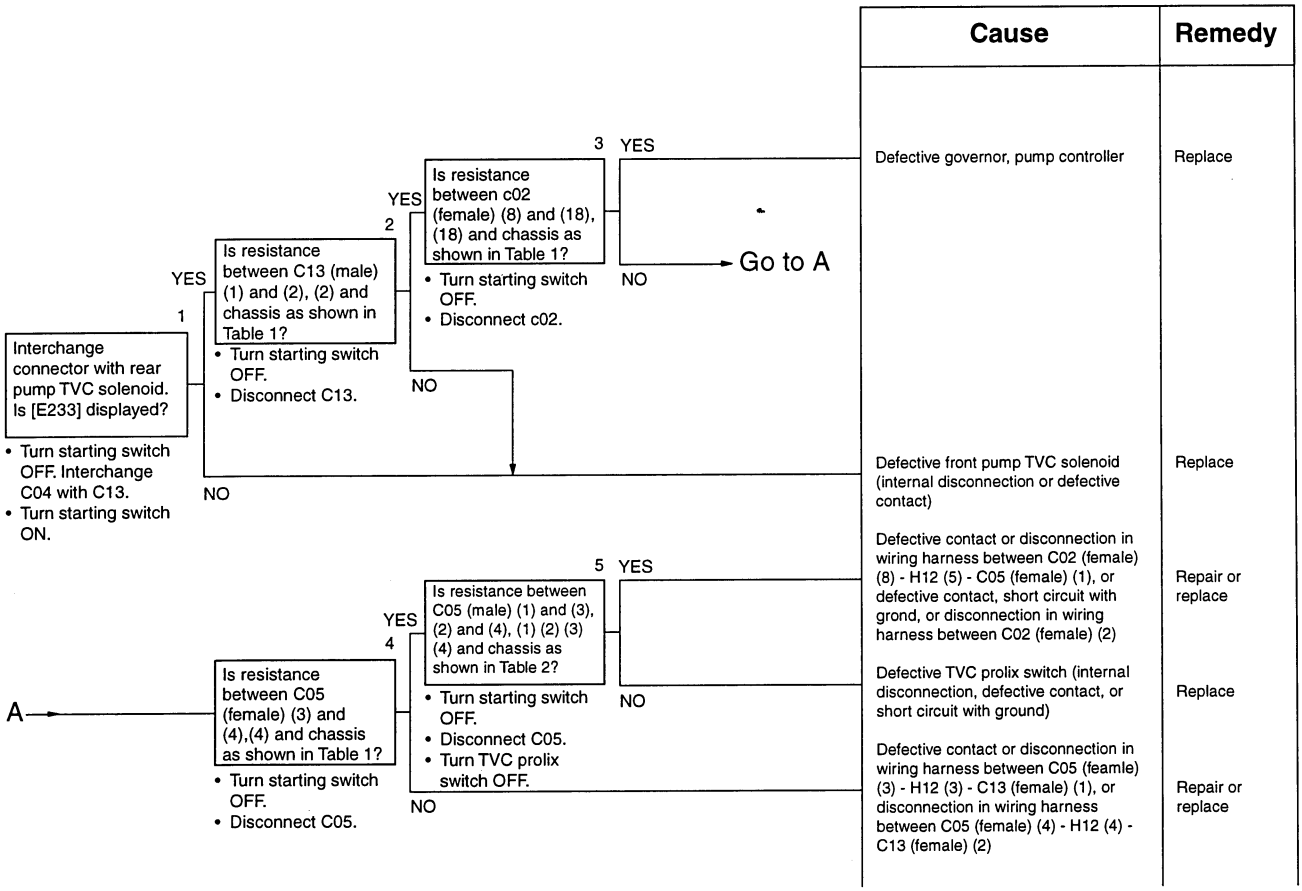
★ If the starting switch is turned OFF after an abnormality occurs, turn the starting switch ON and check if an E service code is displayed. (If it is not displayed, the problems has been removed.)

★ If there is a disconnection in the solenoid or wiring harness, no current flows to the solenoid. If the No. 2 pin of the solenoid is short circuiting with the ground, the current (approx. 1 A) continues to flow to the solenoid.

★ Always turn the TVC prolix switch OFF.

★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.

★ Always connect any disconnected connectors before going on the next step.



Cause	Remedy
Defective governor, pump controller	Replace
Defective front pump TVC solenoid (internal disconnection or defective contact)	Replace
Defective contact or disconnection in wiring harness between C02 (female) (8) - H12 (5) - C05 (female) (1), or defective contact, short circuit with grond, or disconnection in wiring harness between C02 (female) (2)	Repair or replace
Defective TVC prolix switch (internal disconnection, defective contact, or short circuit with ground)	Replace
Defective contact or disconnection in wiring harness between C05 (feamle) (3) - H12 (3) - C13 (female) (1), or disconnection in wiring harness between C05 (female) (4) - H12 (4) - C13 (female) (2)	Repair or replace

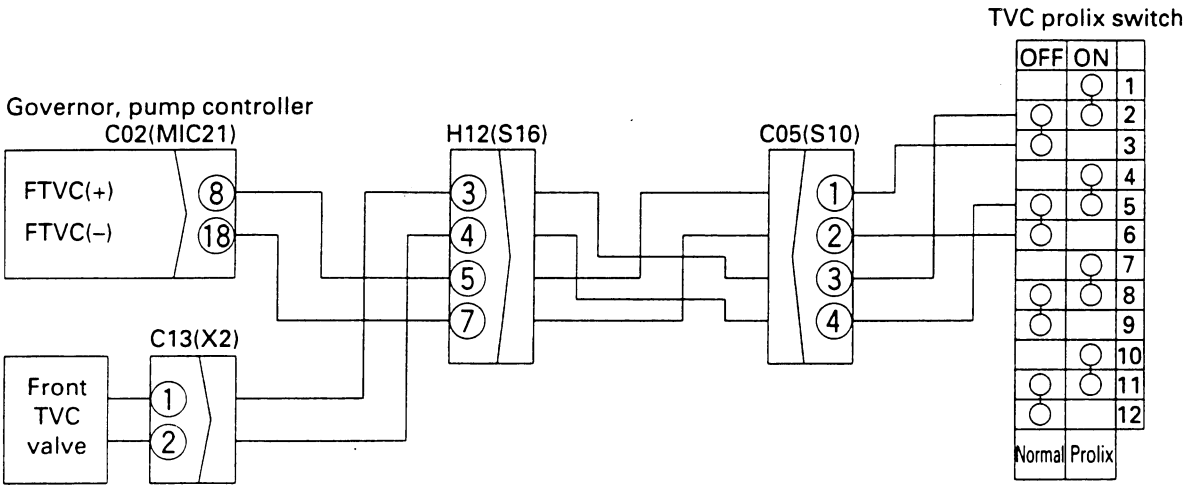
Table 1

Troubleshooting No.2	Troubleshooting No. 3	Troubleshooting No.4	Resistance value
Between C13 (male) (1) - (2)	Between C02 (female) (8) - (18)	Between C05 (female) (3) - (4)	10 - 22 Ω
Between C13 (male) (2) - chassis	Between C02 (female) (18) - chassis	Between C05 (female) (4) - chassis	Min. 1 MΩ

Table 2

Troubleshooting No.5	Resistance value
Between C05 (male) (1) - (3), (2) - (4)	Max. 1 Ω
Between C05 (male) (1) (2) (3) (4) - chassis	Min. 1 MΩ

C-3 Related electric circuit diagram



BKP00187

C-4 [E236] Short circuit in rear pump TVC solenoid system is displayed

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if an E service code is not displayed, the problem has been removed.**
★ If the starting switch is turned OFF after an abnormality occurs, turn the starting switch ON and check if an E service code is displayed. (If it is not displayed, the problem has been removed.)
★ Always turn the TVC prolix switch OFF.
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted
★ Always connect any disconnected connectors before going on the next step.

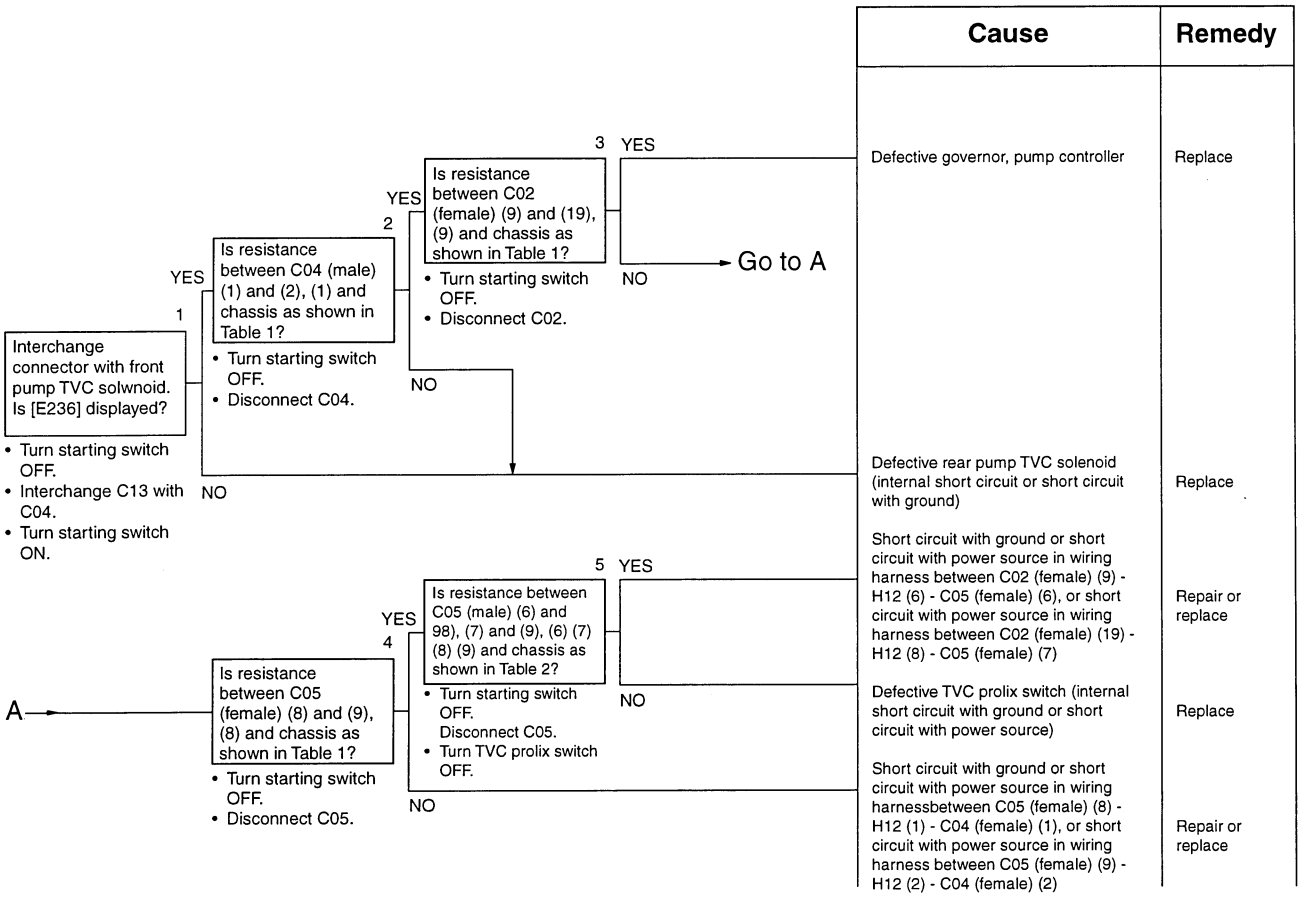


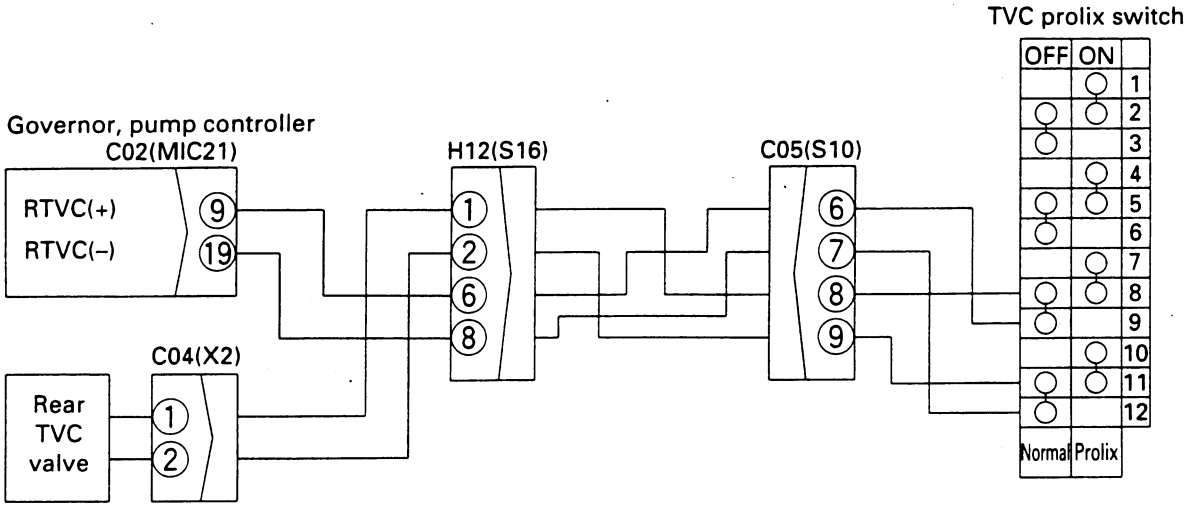
Table 1

Troubleshooting No.2	Troubleshooting No. 3	Troubleshooting No.4	Resistance value
Between C04 (male) (1) - (2)	Between C02 (female) (9) - (19)	Between C05 (female) (8) - (9)	10 - 22 Ω
Between C04 (male) (1) - chassis	Between C02 (female) (9) - chassis	Between C05 (female) (8) - chassis	Min. 1 MΩ

Table 2

Troubleshooting No.5	Resistance value
Between C05 (male) (6) - (8), (7) - (9)	Max. 1 Ω
Between C05 (male) (6) (7) (8) - chassis	Min. 1 MΩ

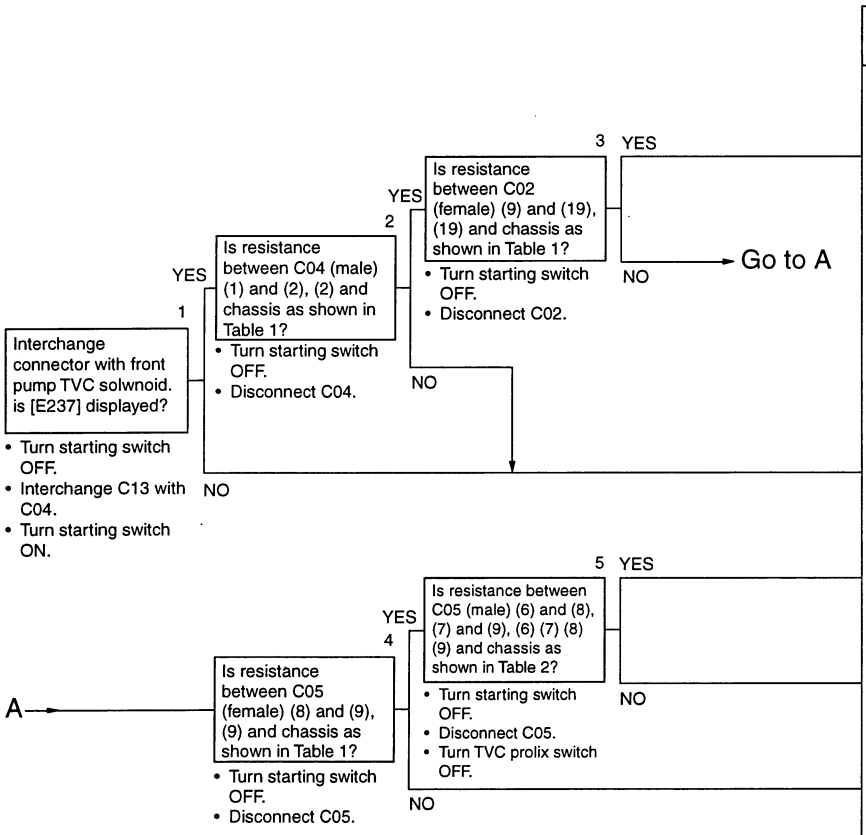
C-4 Related electric circuit diagram



BKP00188

C-5 [E237] Disconnection in rear pump TVC solenoid system is displayed

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if an E service code is not displayed, the problem has been removed.**
★ If the starting switch is turned OFF after an abnormality occurs, turn the starting switch ON and check if an E service code is displayed. (If it is not displayed, the problem has been removed.)
★ If there is a disconnection in the solenoid or wiring harness, no current flows to the solenoid.
If the No. 2 pin if the solenoid is short circuiting with the ground, the current (approx. 1 A) continues to flow to the solenoid.
★ Always turn the TVC prolix switch OFF.
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



Cause	Remedy
Defective governor, pump controller	Replace
Defective rear pump TVC solenoid (internal disconnection or defective	Replace
Defective contact or disconnection in wiring harness between C02 (female) (9) H12 (6) - C05 (female) (6), or defective contact, short circuit with ground, or disconnetion in wiring harness between C02 (female) (19) - H12 (8) - C05 (female (7)	Repaie or replace
Defective TVC prolix switch (internal disconneticon, defective contact, or short circuit with ground)	Repalce
Defective contact or disconnection in wiring harness between C05 (female) (8) - H12 (1) - C04 (female) (1), or defective contact, short circuit with ground, or disconnection in wiring harness between C05 (female) (9) - H12 (2) - C04 (female) (2)	Repair or replace

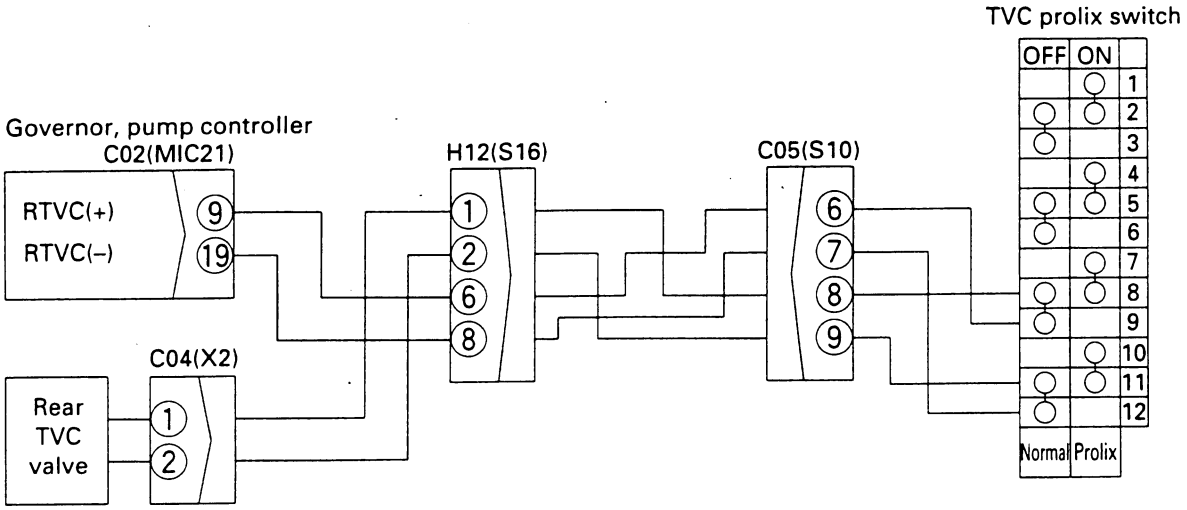
Table 1

Troubleshooting No.2	Troubleshooting No. 3	Troubleshooting No.4	Resistance value
Between C04 (male) (1) - (2)	Between C02 (female) (9) - (19)	Between C05 (female) (8) - (9)	10 - 22 Ω
Between C04 (male) (2) - chassis	Between C02 (female) (19) - chassis	Between C05 (female) (9) - chassis	Min. 1 MΩ

Table 2

Troubleshooting No.5	Resistance value
Between C05 (male) (60 - (8), (7) - 99)	Max. 1 Ω
Between C05 (male) (6) (7) (8) (9) - chassis	Min. 1 MΩ

C-5 Related electric circuit diagram



BKP00188

C-6 [E237] Disconnection in rear pump TVC solenoid system is displayed

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if an E service code is not displayed, the problem has been removed.**
★ If the starting switch is turned OFF after an abnormality occurs, turn the starting switch ON and check if an E service code is displayed. (If it not displayed, the problem has been removed.)
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

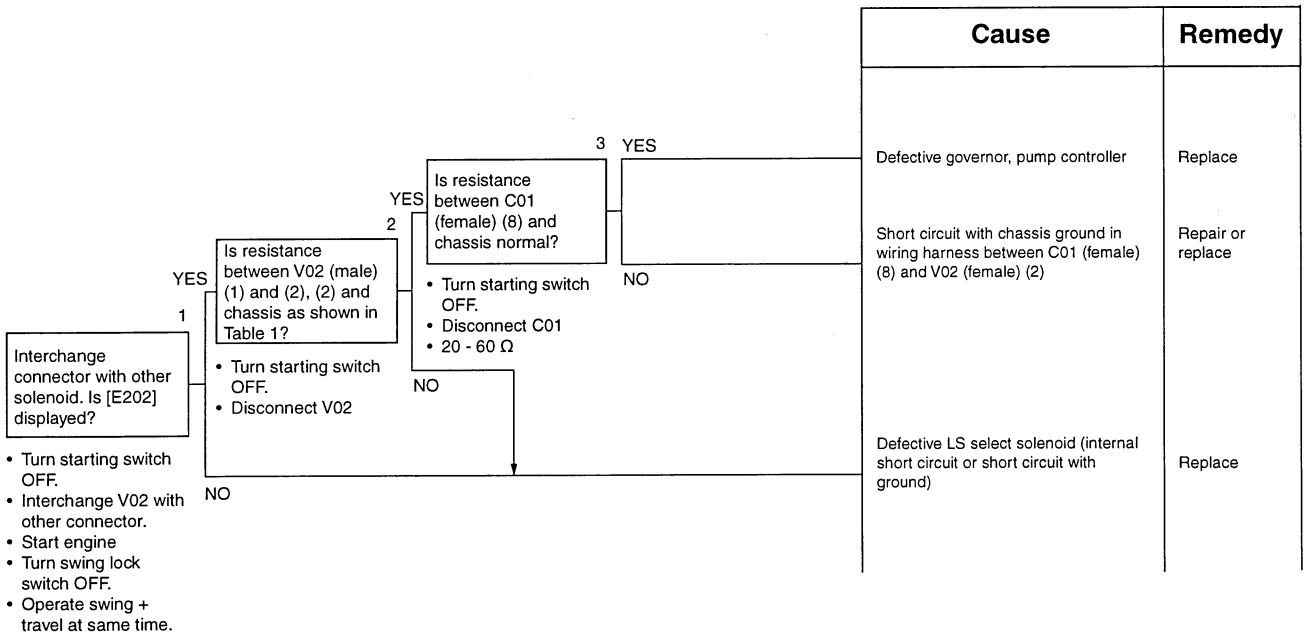
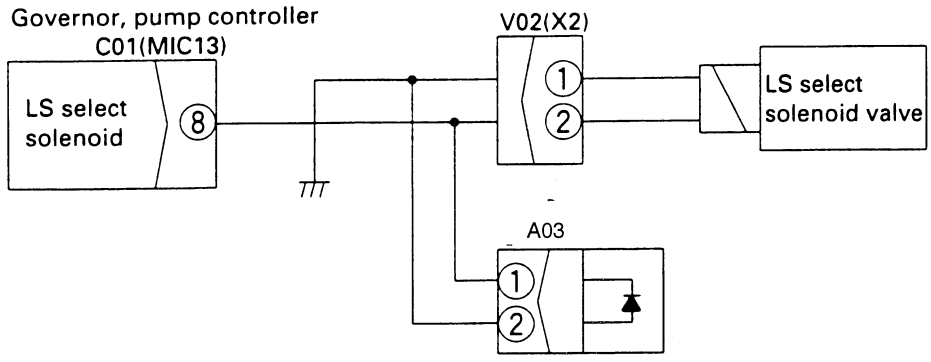


Table 1

Between V02 (male) (1) - (2)	20 - 60 Ω
Between V02 (male) (2) - chassis	Min. 1 MΩ

C-6 Related electric circuit diagram



C-7 [E212] Disconnection is LS select solenoid system is displayed

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if an E service code is not displayed, the problem has been removed.**
★ If the starting switch is turned OFF after an abnormality occurs, turn the starting switch ON and check if an E service code is displayed. (If it not displayed, the problem has been removed.)
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

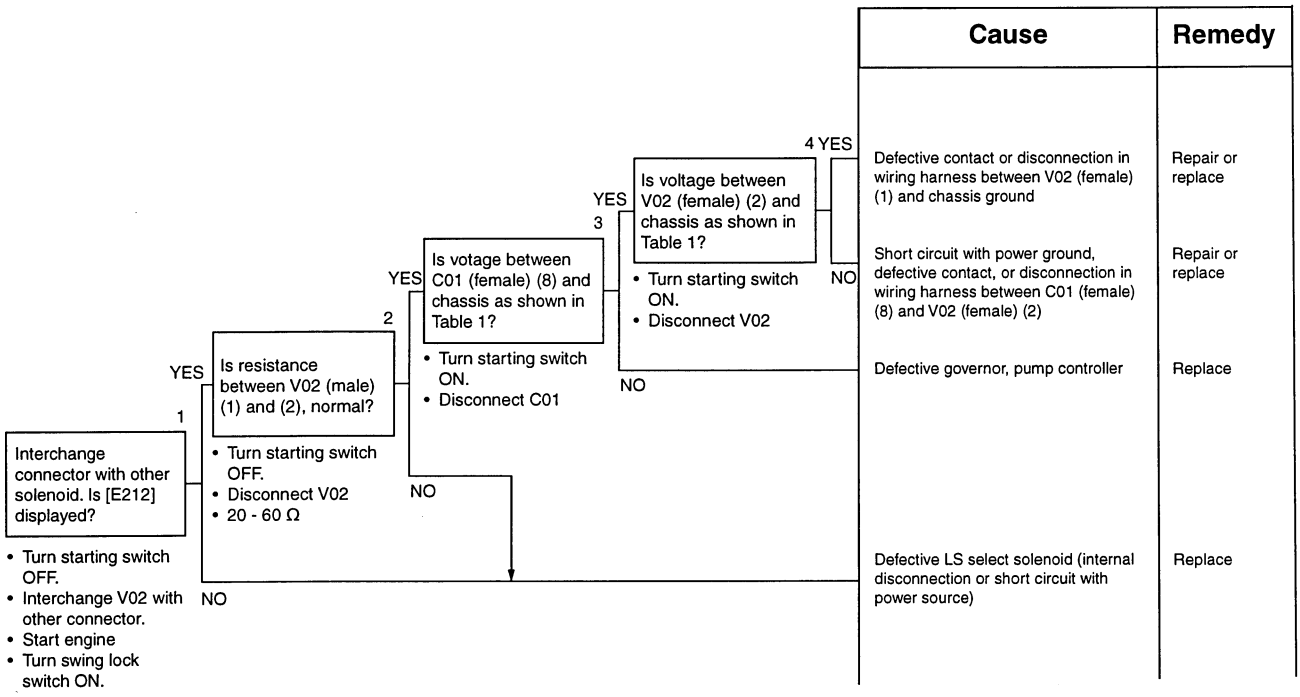
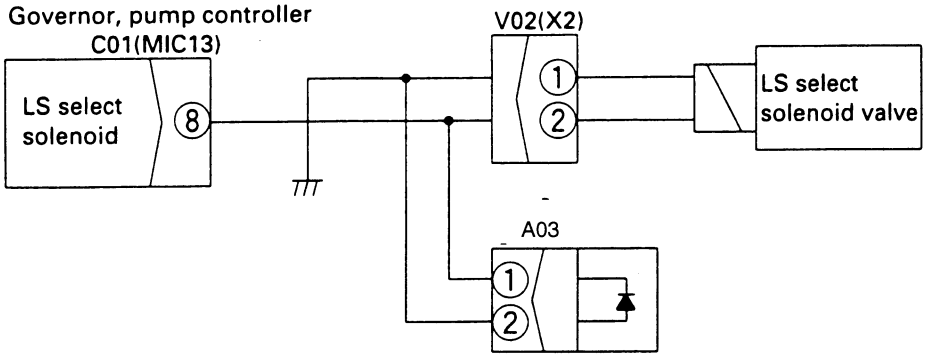


Table 1

Troubleshooting No. 3	Troubleshooting No. 4	Voltage	Measurement condition
Between C01 (male) (8) - chassis	Between V02 (male) (2) - chassis	0 - 3V	When swing lock switch is ON
		20 - 30V	When swing lock switch is OFF When swing and travel are operated at same time

C-7 Related electric circuit diagram



C-8 [E203] Short circuit in swing brake solenoid system is displayed

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if an E service code is not displayed, the problem has been removed.**
★ If the starting switch is turned OFF after an abnormality occurs, turn the starting switch ON and check if an E service code is displayed. (If it is not displayed, the problem has been removed.)
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.
★ Always turn the swing lock prolix switch OFF, then turn the swing lock switch OFF before checking.

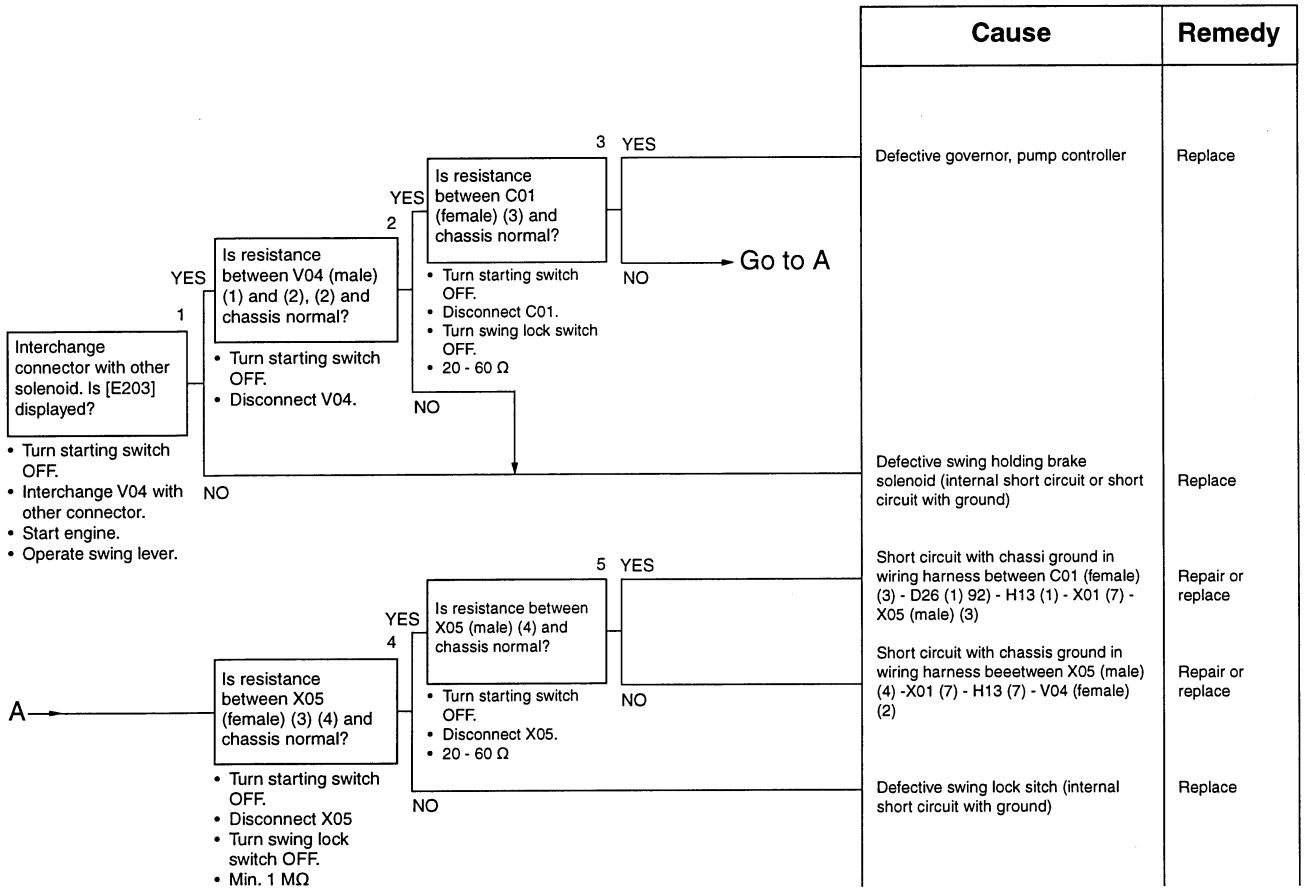
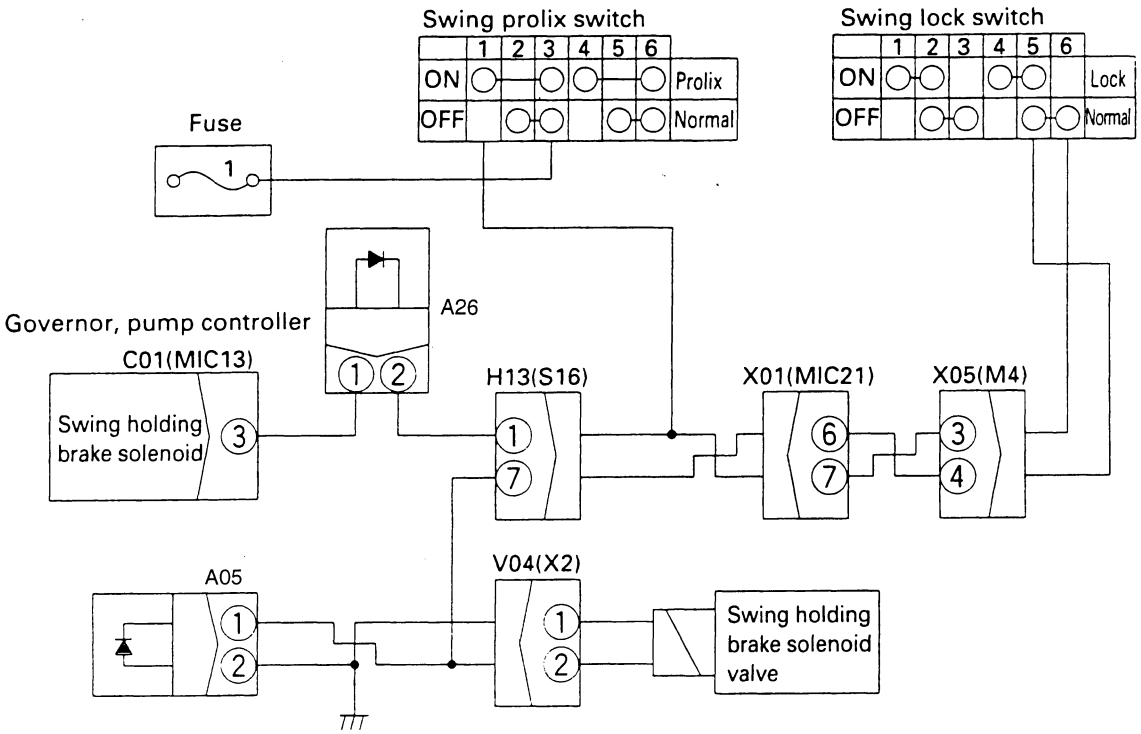


Table 1

Between V04 (male) (1) - (2)	20 - 60 Ω
Between V04 (male) (2) - chassis	Min. 1 MΩ

C-8 Related electric circuit diagram



C-9 [E213] Disconnection in swing brake solenoid system is displayed

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its oringinal position, if an E service code is not displayed, the problem has been removed.**
★ If the starting switch is turned OFF after an abnormality occurs, turn the starting switch ON and check if an E service code is displayed. (If it is not displayed, the problem has been removed.)
★ Always turn the swing lock prolix switch OFF, then turn the swing lock switch OFF before checking.
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

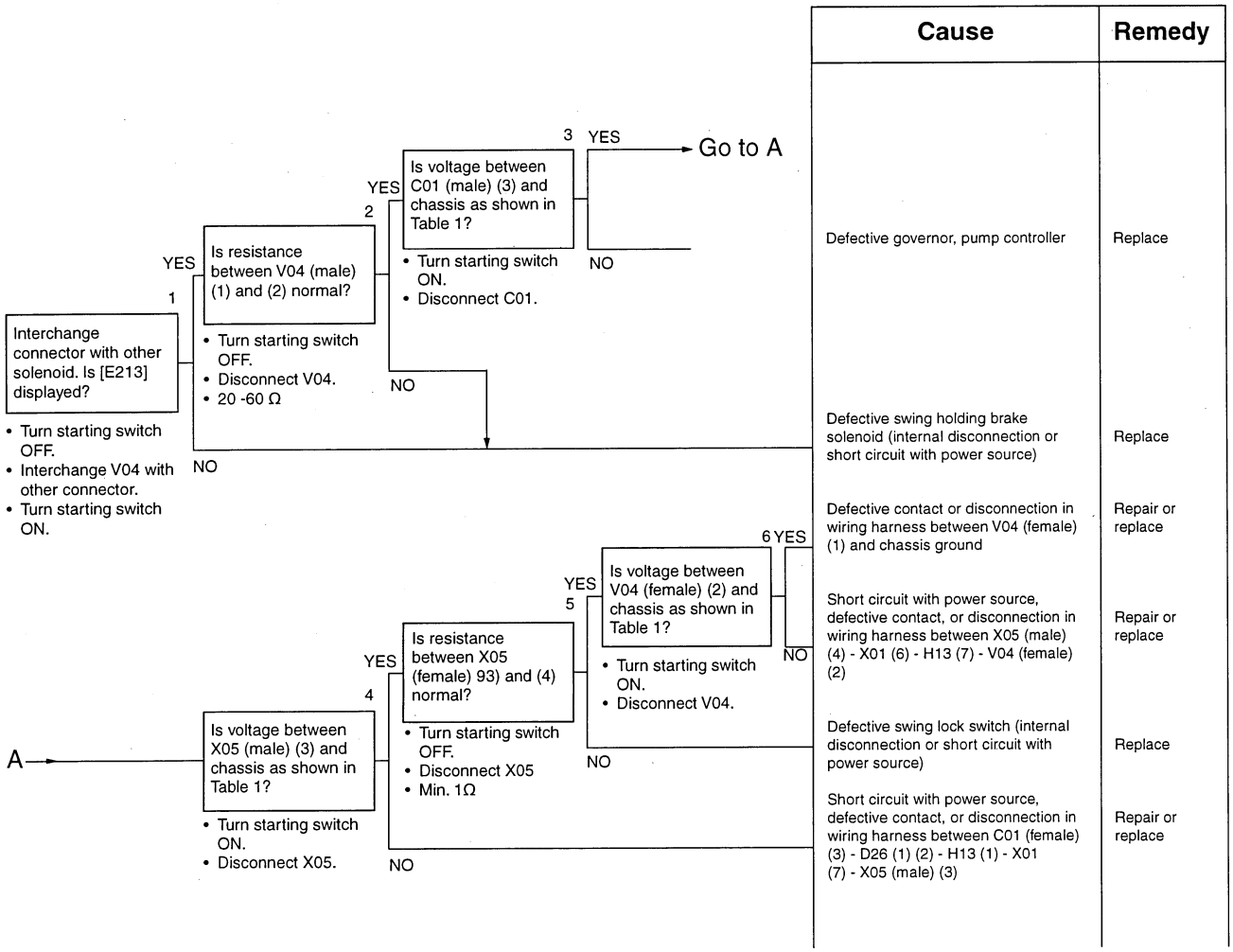
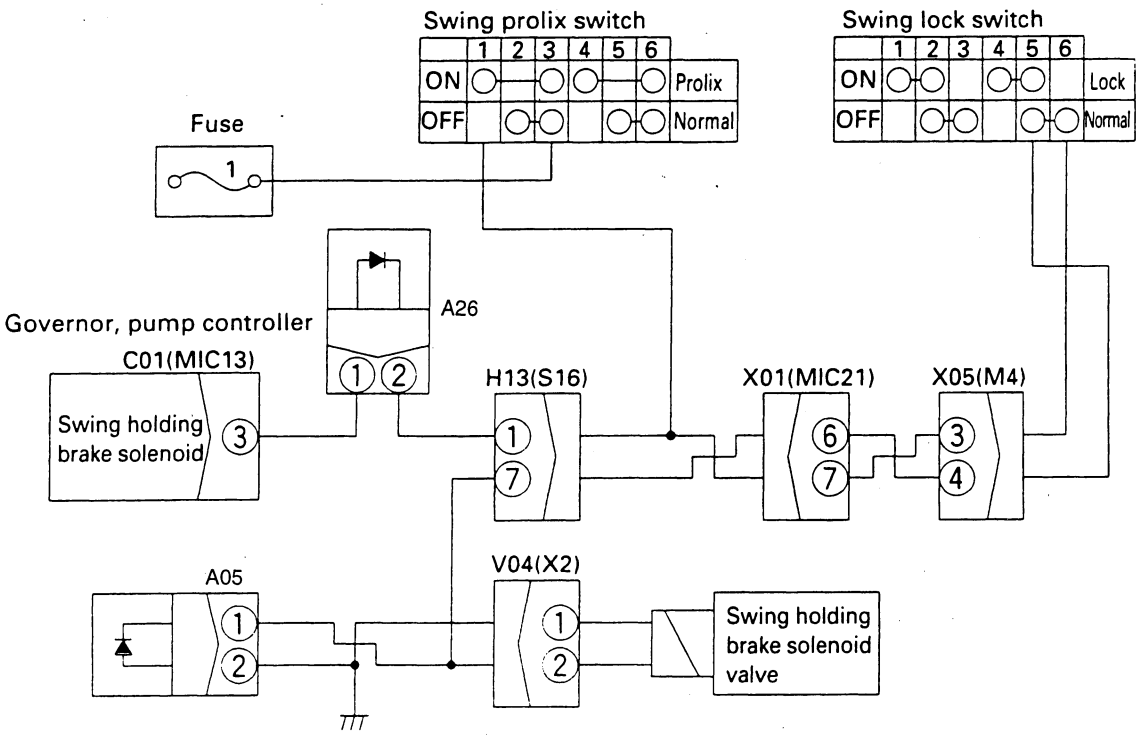


Table 1

Troubleshooting No. 3	Troubleshooting No. 4	Troubleshooting No. 6	Voltage	Measurement condition
Between C01 (male) (3) - chassis	Between X05 (male) (3) - chassis	Between V04 (male) (2) - chassis	0 - 3V	5 seconds after all levers are returned to neutral
			20 - 30V	Swing lever operated

C-9 Related electric circuit diagram



C-10 [E204] Short circuit in pump merge/divider solenoid system is displayed

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if an E service code is not displayed, the problem has been removed.**
★ If the starting switch is turned OFF after an abnormality occurs, turn the starting switch ON and check if an E service code is displayed. (If it not displayed, the problem has been removed.)
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

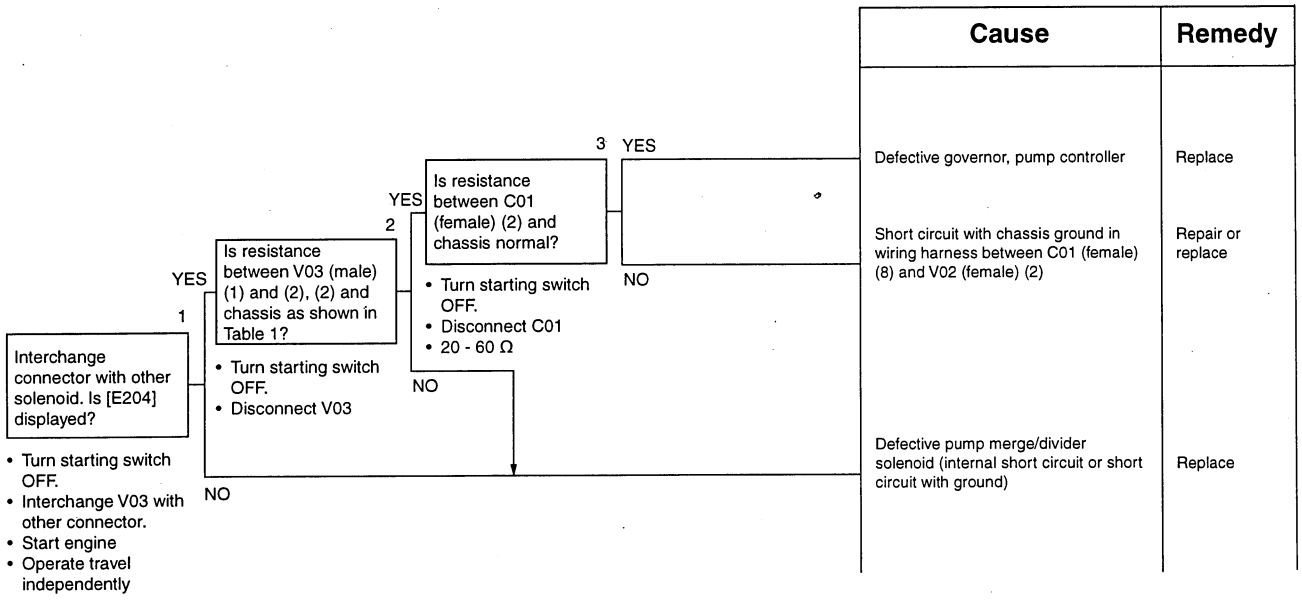
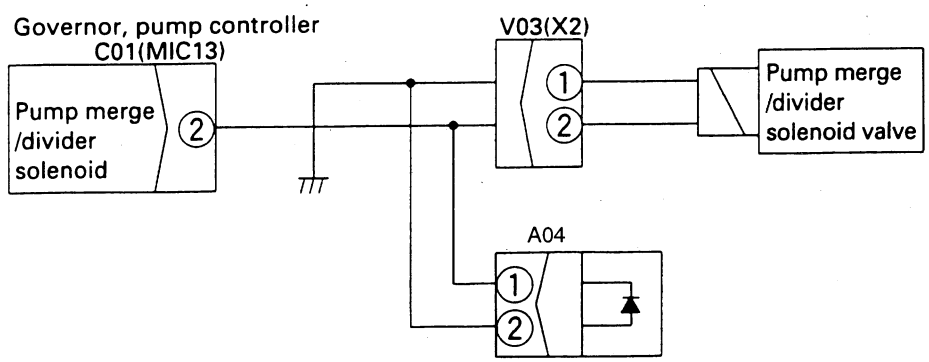


Table 1

Between V03 (male) (1) - (2)	20 - 60 Ω
Between V03 (male) (2) - chassis	Min. 1 MΩ

C-10 Related electric circuit diagram



C-11 [E214] Disconnection in pump merge/divider solenoid system is displayed

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if an E service code is not displayed, the problem has been removed.**
★ If the starting switch is turned OFF after an abnormality occurs, turn the starting switch ON and check if an E service code is displayed. (If it not displayed, the problem has been removed.)
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

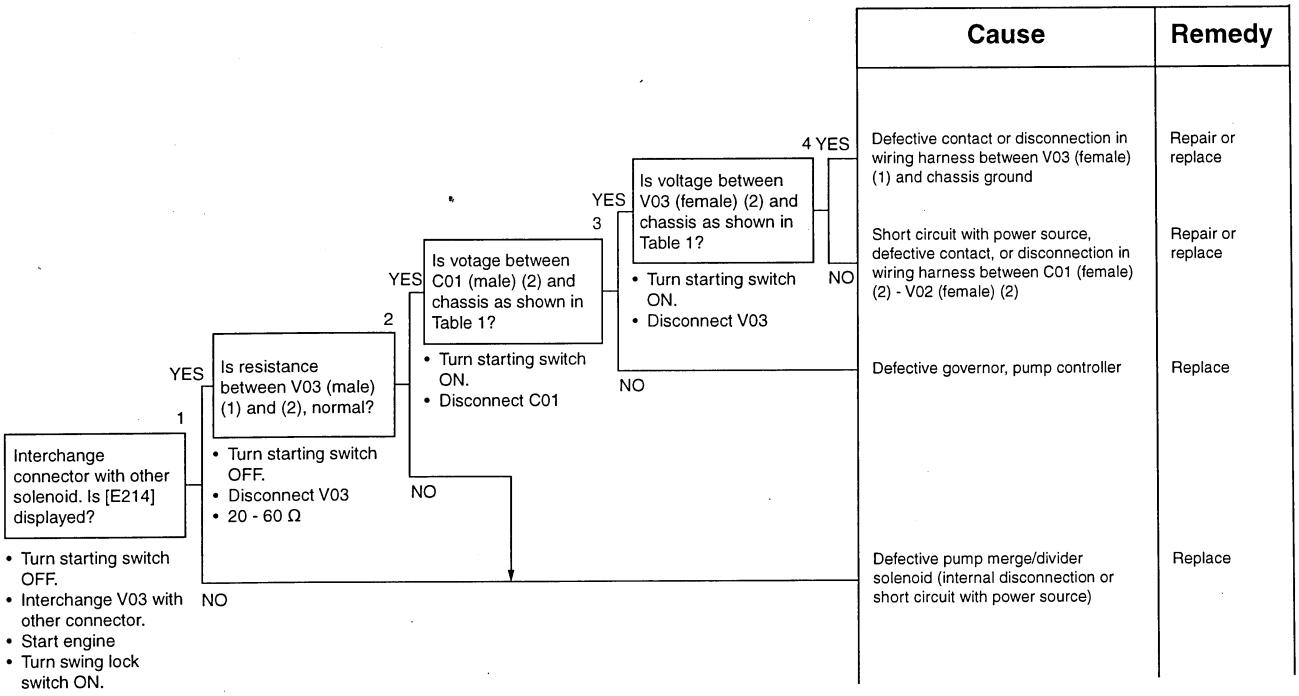
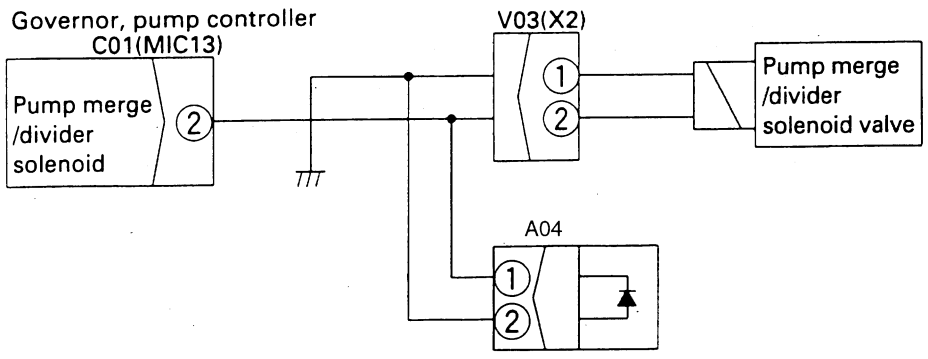


Table 1

Troubleshooting No. 3	Troubleshooting No. 4	Voltage	Measurement condition
Between C01 (male) (2) - chassis	Between V03 (female) (2) - chassis	0 - 3V	All levers at neutral
		20 - 30V	Travel operated independently

C-11 Related electric circuit diagram



C-12 [E206] Short circuit in travel speed solenoid system is displayed

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if an E service code is not displayed, the problem has been removed.**
★ If the starting switch is turned OFF after an abnormality occurs, turn the starting switch ON and check if an E service code is displayed. (If it not displayed, the problem has been removed.)
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

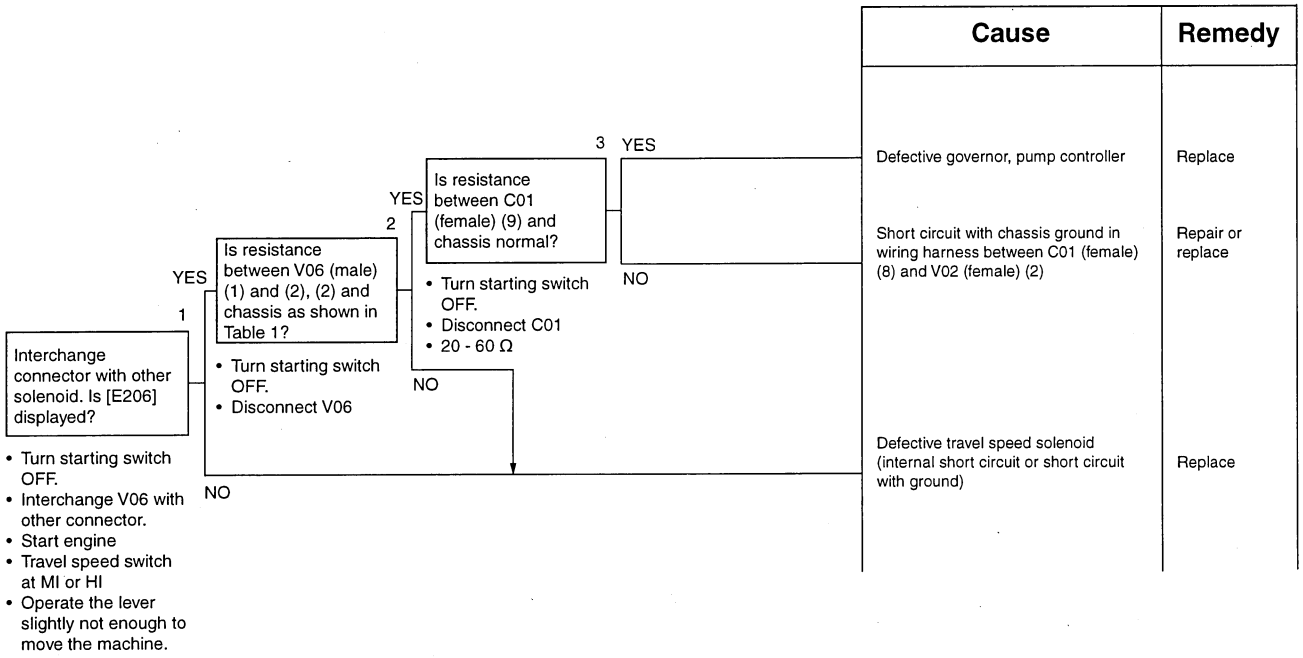
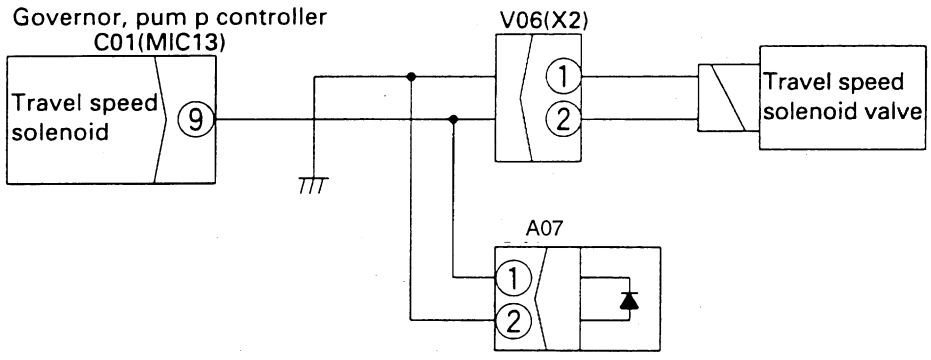


Table 1

Between V06 (male) (1) - (2)	20 - 60 Ω
Between V06 (male) (2) - chassis	Min. 1 MΩ

C-12 Related electric circuit diagram



C-13 [E216] Disconnection in travel speed selector solenoid system is displayed

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if an E service code is not displayed, the problem has been removed.**
★ If the starting switch is turned OFF after an abnormality occurs, turn the starting switch ON and check if an E service code is displayed. (If it not displayed, the problem has been removed.)
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

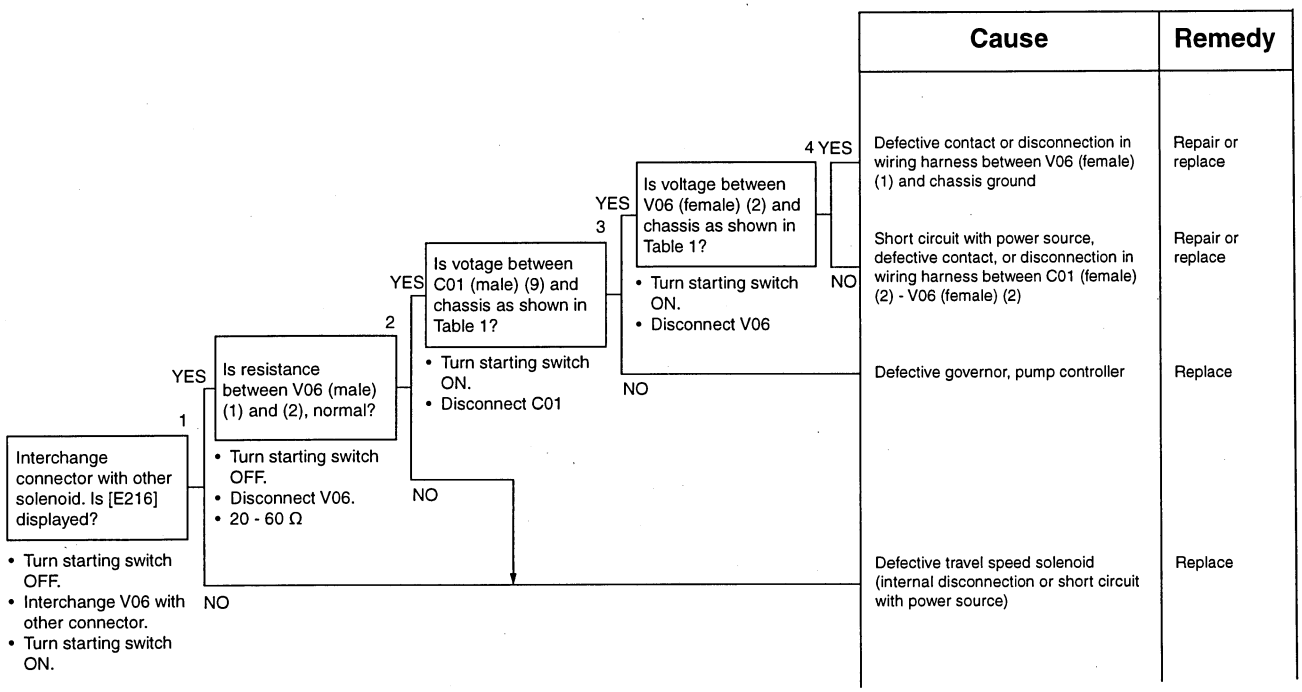
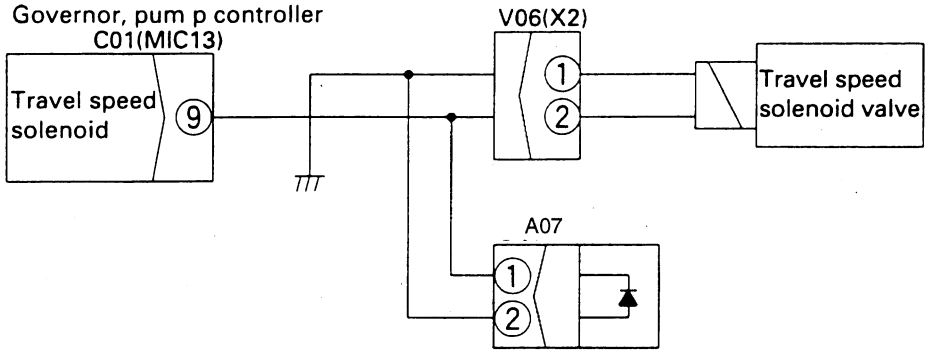


Table 1

Troubleshooting No. 3	Troubleshooting No. 4	Voltage	Measurement condition
Between C01 (male) (9) - chassis	Between V06 (female) (2) - chassis	0 - 3V	Travel speed switch at LO
		20 - 30V	Travel speed switch at Mi or Hi Operate the lever slightly not enough to move the machine

C-13 Related electric circuit diagram



C-14 [E217] Model selection input error is displayed

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if an E service code is not displayed, the problem has been removed.**
★ If the starting switch is turned OFF after an abnormality occurs, turn the starting switch ON and check if an E service code is displayed. (If it is not displayed, the problem has been removed.)
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

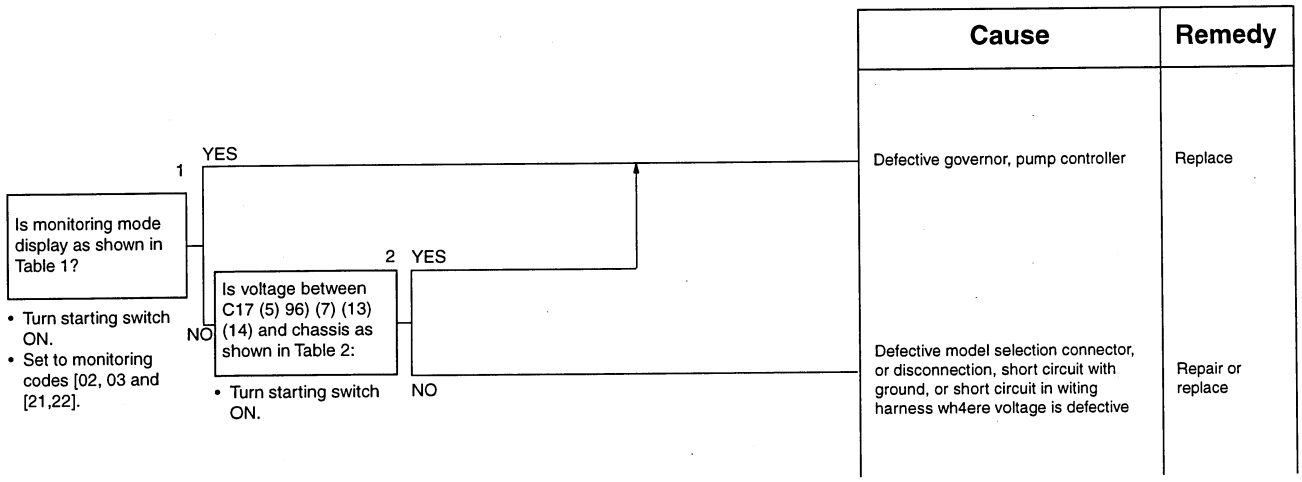
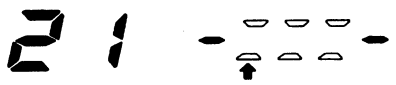
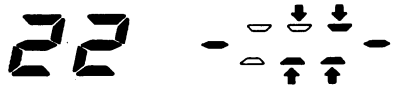


Table 1 Monitoring code display

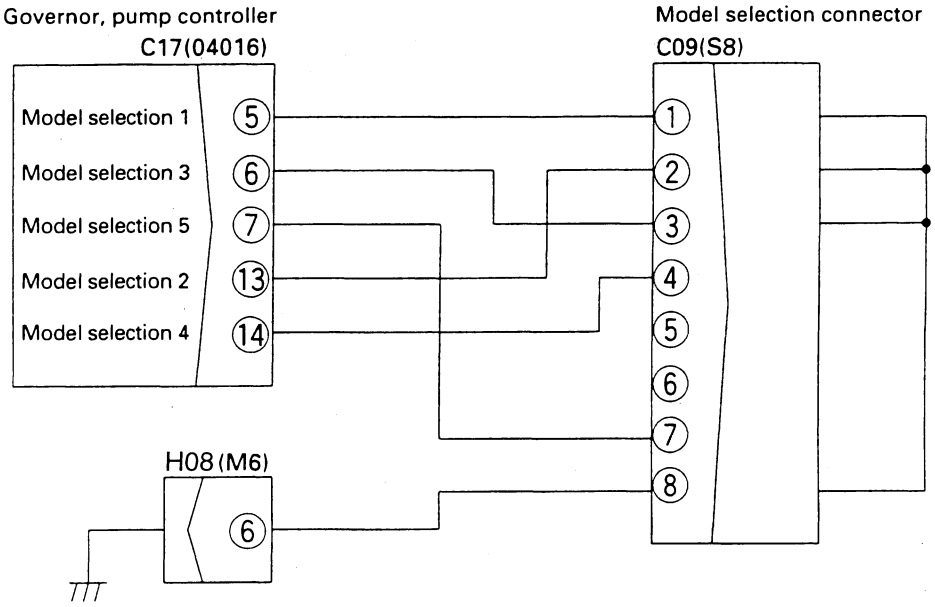
Model code display	Model selection signal input display	
Monitoring codes 02, 03	Monitoring code 21	Monitoring code 22
 BKP00196	 BKP00194	 BKP00198

★ The diagram shows monitoring code 02.
★ Check the bit pattern display marked with ←.

Table 2 Voltage of wiring harness

C17	Between (5) - chassis	Between (6) - chassis	Between (7) - chassis	Between (13) - chassis	Between (14) - chassis
Voltage	Max. 1 V	Max. 1 V	20 - 30 V	Max. 1 V	20 -30 V

C-14 Related electric circuit diagram



C-15 [E222] Short circuit in LS-EPC solenoid system is displayed

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if an E service code in not displayed, the problem has been removed.**
★ If the starting switch is turned OFF after an abnormality occurs, turn the starting switch ON and check if an E service code is displayed. (If it is not displayed, the problem has been removed.)
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

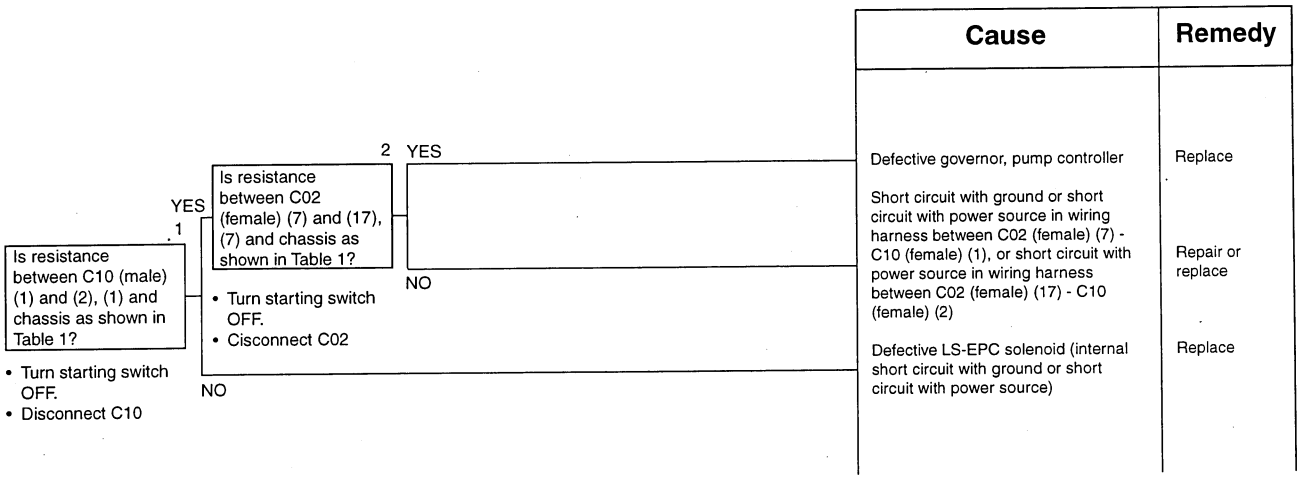
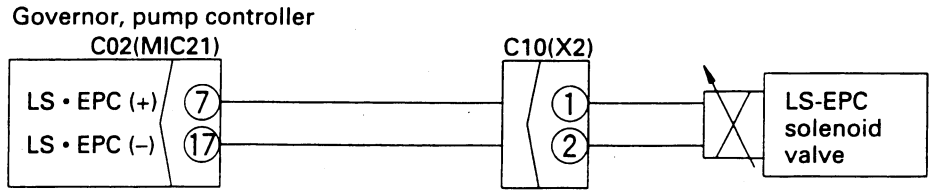


Table 1

Troubleshooting No.1	Troubleshooting No. 2	Resistance value
Between C10 (male) (1) - (2)	Between C02 (female) (7) - (17)	20 - 60 Ω
Between C10 (male) (1) - chassis	Between C02 (female) (7) - chassis	Min. 1 MΩ

C-15 Related electric circuit diagram



BKP00251

C-16 [E223] Disconnection in LS-EPC solenoid system is displayed

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if an E service code in not displayed, the problem has been removed.**
★ If the starting switch is turned OFF after an abnormality occurs, turn the starting switch ON and check if an E service code is displayed. (If it is not displayed, the problem has been removed.)
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

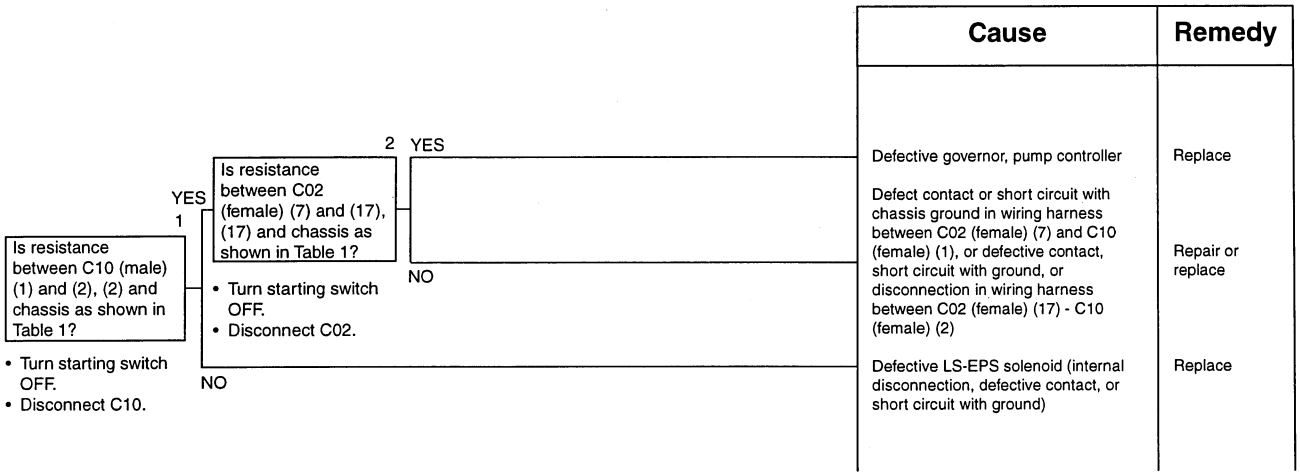
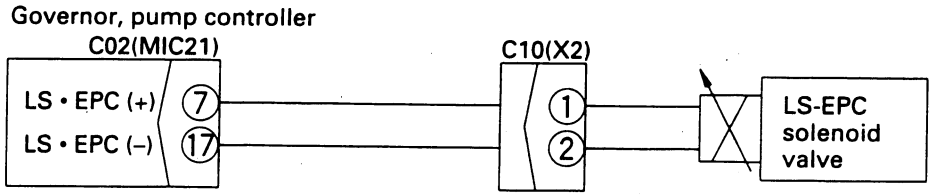


Table 1

Troubleshooting No.1	Troubleshooting No. 2	Resistance value
Between C10 (male) (1) - (2)	Between C02 (female) (7) - (17)	20 - 60 Ω
Between C10 (male) (1) - chassis	Between C02 (female) (7) - chassis	Min. 1 MΩ

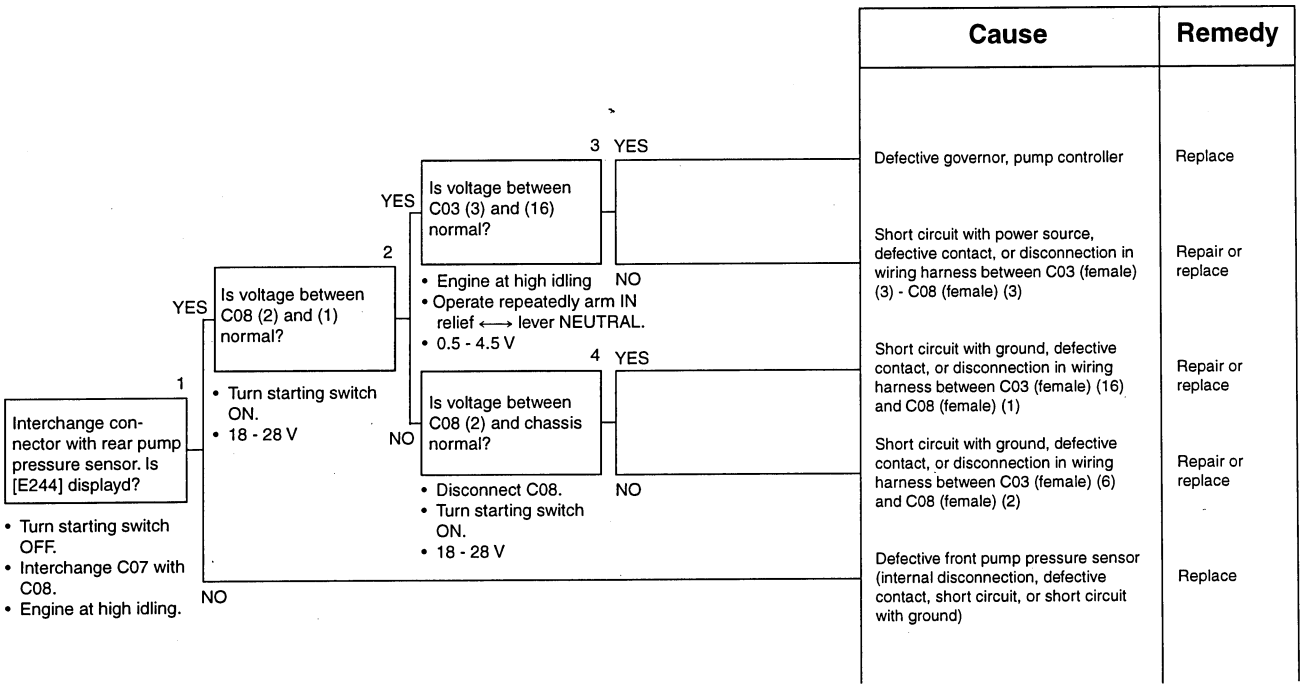
C-16 Related electric circuit diagram



BKP00251

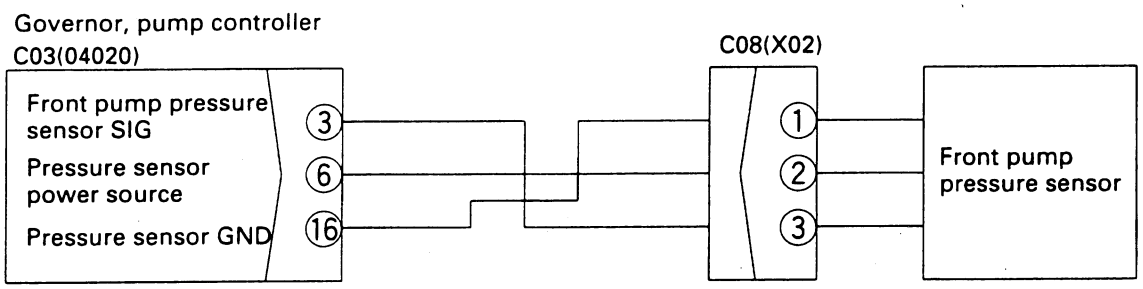
C-17 [E224] Abnormality in front pump pressure sensor system is displayed

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if an E service code in not displayed, the problem has been removed.**
★ If the starting switch is turned OFF after an abnormality occurs, turn the starting switch ON and check if an E service code is displayed. (If it is not displayed, the problem has been removed.)
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



Cause	Remedy
Defective governor, pump controller	Replace
Short circuit with power source, defective contact, or disconnection in wiring harness between C03 (female) (3) - C08 (female) (3)	Repair or replace
Short circuit with ground, defective contact, or disconnection in wiring harness between C03 (female) (16) and C08 (female) (1)	Repair or replace
Short circuit with ground, defective contact, or disconnection in wiring harness between C03 (female) (6) and C08 (female) (2)	Repair or replace
Defective front pump pressure sensor (internal disconnection, defective contact, short circuit, or short circuit with ground)	Replace

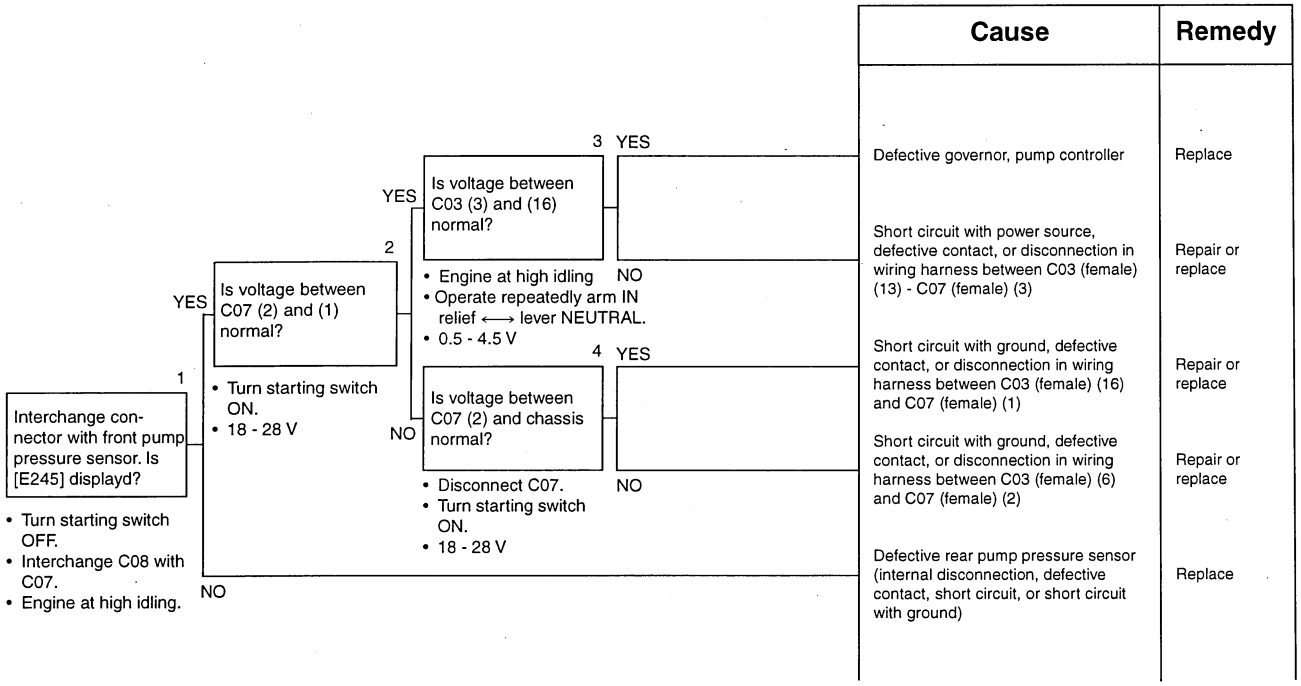
C-17 Related electric circuit diagram



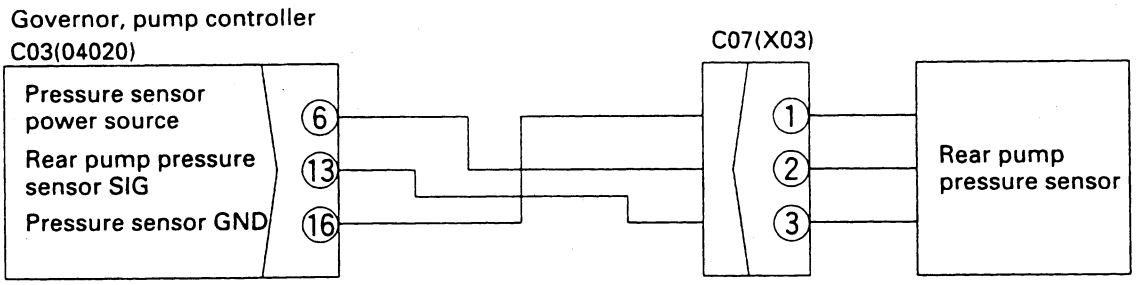
BKP00252

C-18 [E225] Abnormality in rear pump pressure sensor system is displayed

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if an E service code in not displayed, the problem has been removed.**
★ If the starting switch is turned OFF after an abnormality occurs, turn the starting switch ON and check if an E service code is displayed. (If it is not displayed, the problem has been removed.)
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



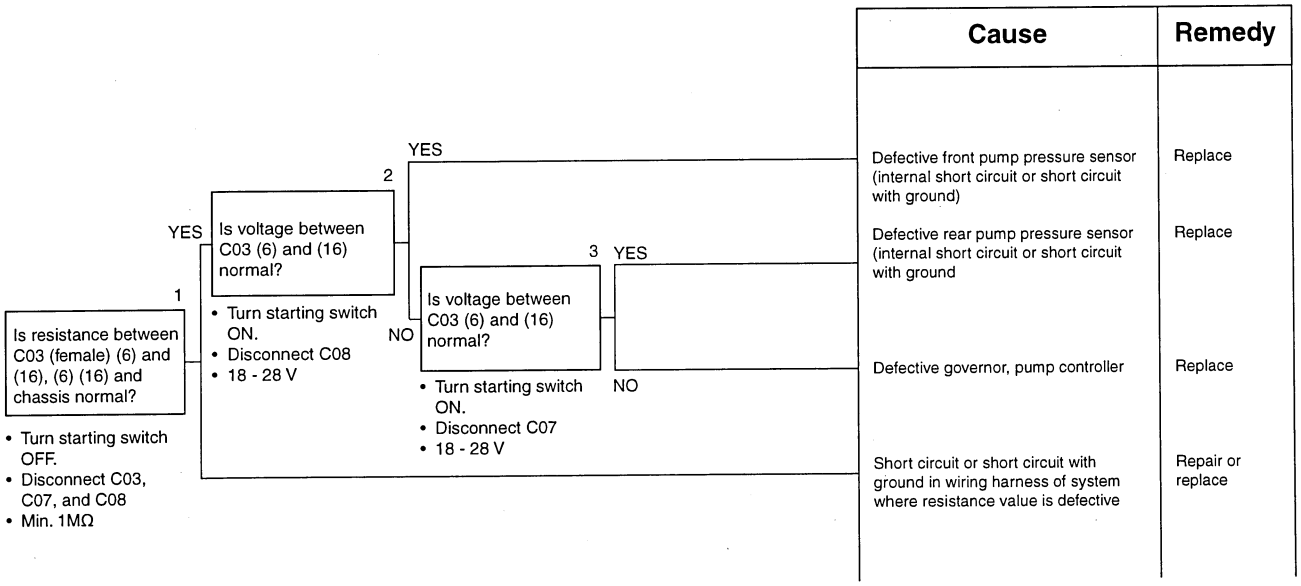
C-18 Related electric circuit diagram



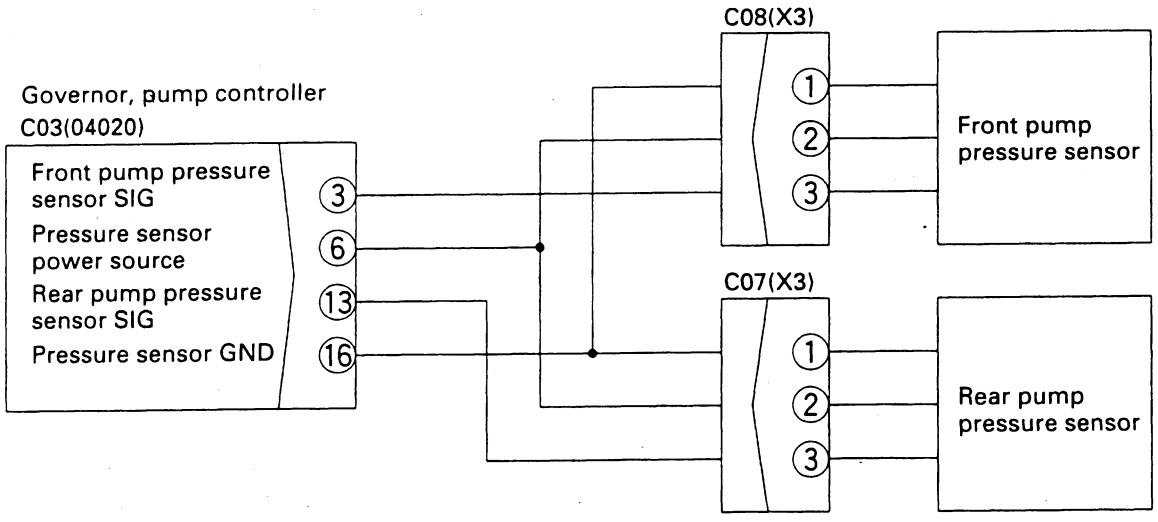
BKP00253

C-19 [E226] Abnormality in pressure sensor power source system is displayed

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if an E service code in not displayed, the problem has been removed.**
★ If the starting switch is turned OFF after an abnormality occurs, turn the starting switch ON and check if an E service code is displayed. (If it is not displayed, the problem has been removed.)
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



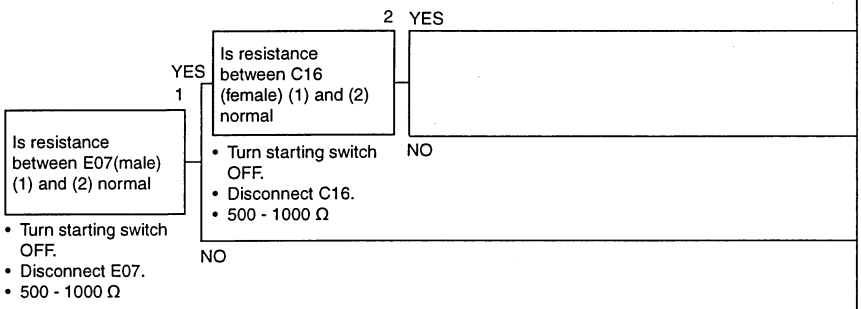
C-19 Related electric circuit diagram



BKP00254

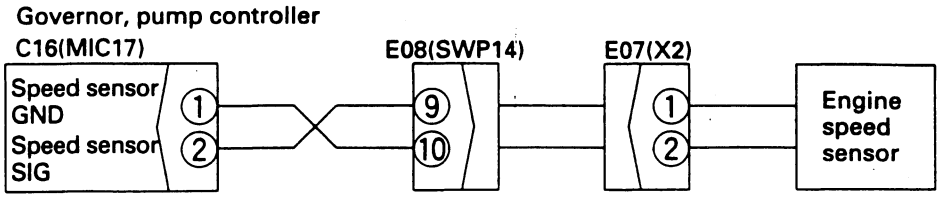
C-20 [E227] Abnormality in engine speed sensor system is displayed

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if an E service code in not displayed, the problem has been removed.**
★ If the starting switch is turned OFF after an abnormality occurs, turn the starting switch ON and check if an E service code is displayed. (If it is not displayed, the problem has been removed.)
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



Cause	Remedy
Defective governor, pump controller	Replace
Short circuit with ground, defective contact, or disconnection in wiring harness between C16 (female) (1) - E08 (10) - E07 (female) (2), or between C16 (female) (2) - E08 (9) - E07 (female) (1)	Repair or replace
Defective engine speed sensor (internal disconnection, defective contact, or short circuit with ground)	Replace

C-20 Related electric circuit diagram



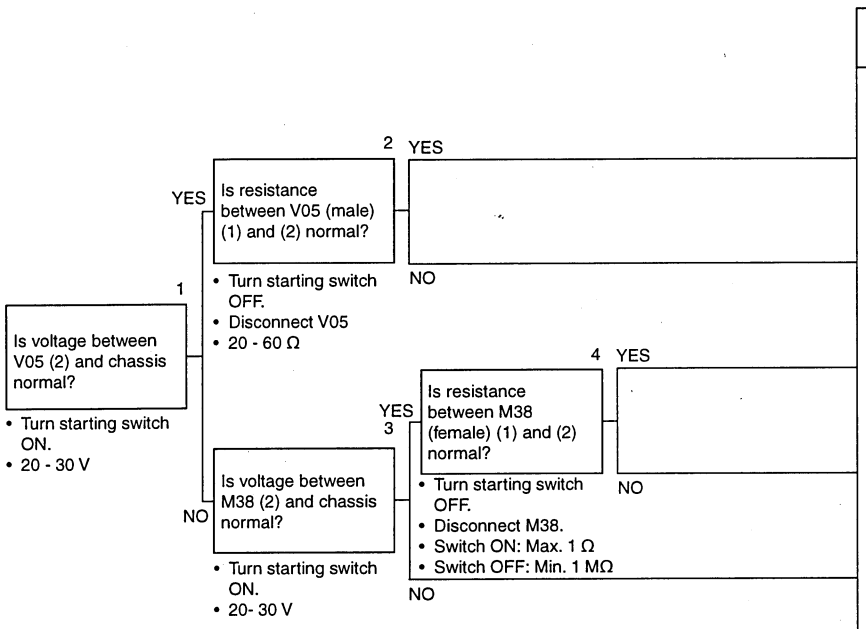
BKP00255

C-21 Abnormality in machine 2-stage pressure relief solenoid system (no service code displayed)

★ Even if any abnormality occurs in the machine 2-stage pressure relief solenoid system, the service code is not displayed on the monitor panel.
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

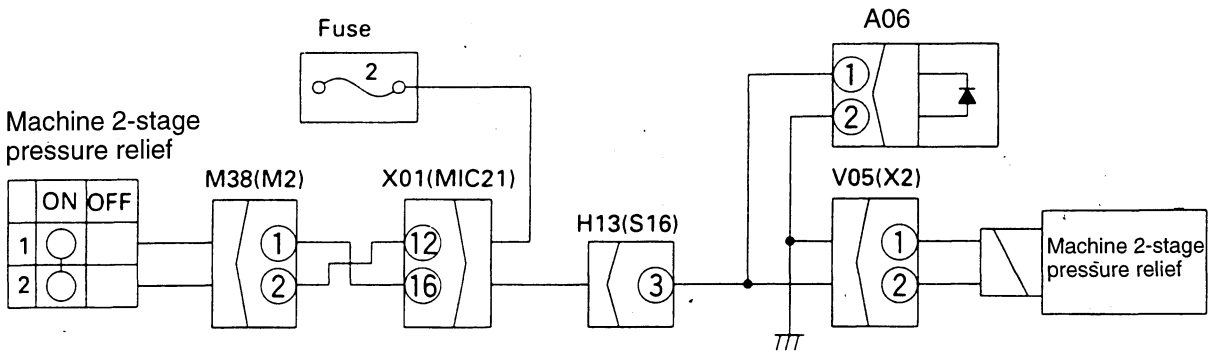
a) If solenoid is not actuated (turned ON) when machine 2-stage pressure relief switch is set to low-pressure setting

★ Check that fuse No. 2 is not blown.
★ Carry out troubleshooting with the machine 2-stage pressure relief switch at the low-pressure setting positon.



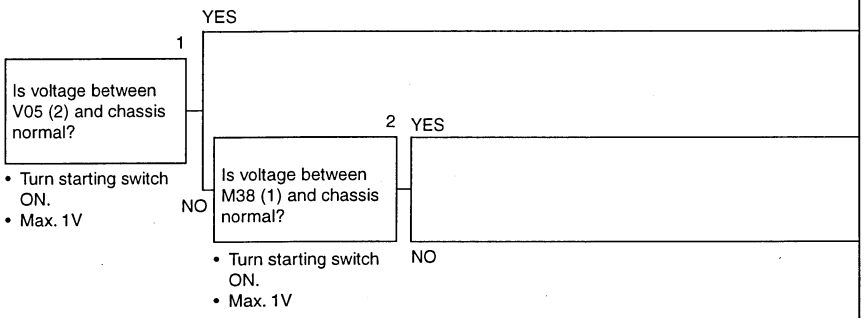
Cause	Remedy
Defective contact or disconnection in wiring harness between V05 (female) (1) and chassis ground	Repair or replace
Defective machine 2-stage pressure relief solenoid (internal disconnection or defective contact)	Replace
Short circuit with ground, defective contact, or disconnection in wiring harness between M38 (male) (1) - X01 (16) - H13 (3) - V05 (female) (2)	Repair or replace
Defective machine 2-stage pressure relief switch (internal disconnection, defective contact, or short circuit with ground)	Replace
Defective fuse 2 or short circuit with ground, defective contact, or disconnection in wiring harness between fuse 2 - X01 (12) - M38 (male) (2)	Repair or replace

C-21 Related electric circuit diagram



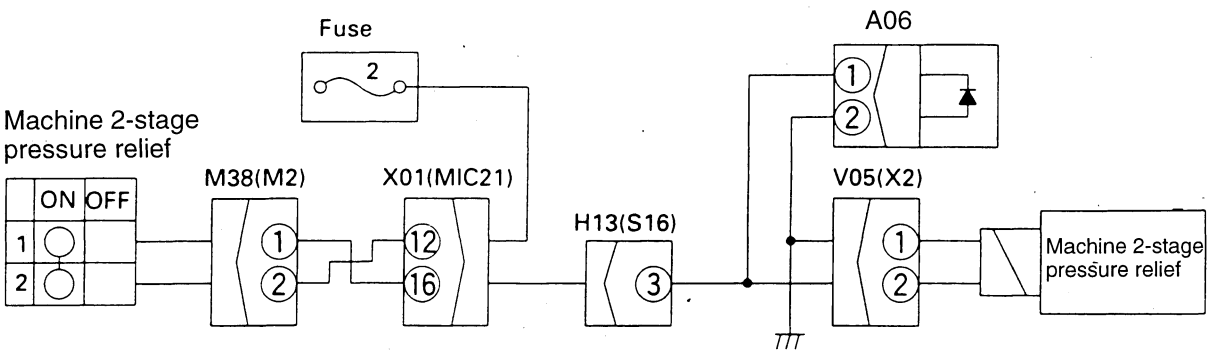
b) If solenoid is not canceled (turned OFF) when machine 2-stage pressure relief switch is set to high-pressure setting

★ Carry out troubleshooting with the machine 2-stage pressure relief switch at the high-pressure setting position.



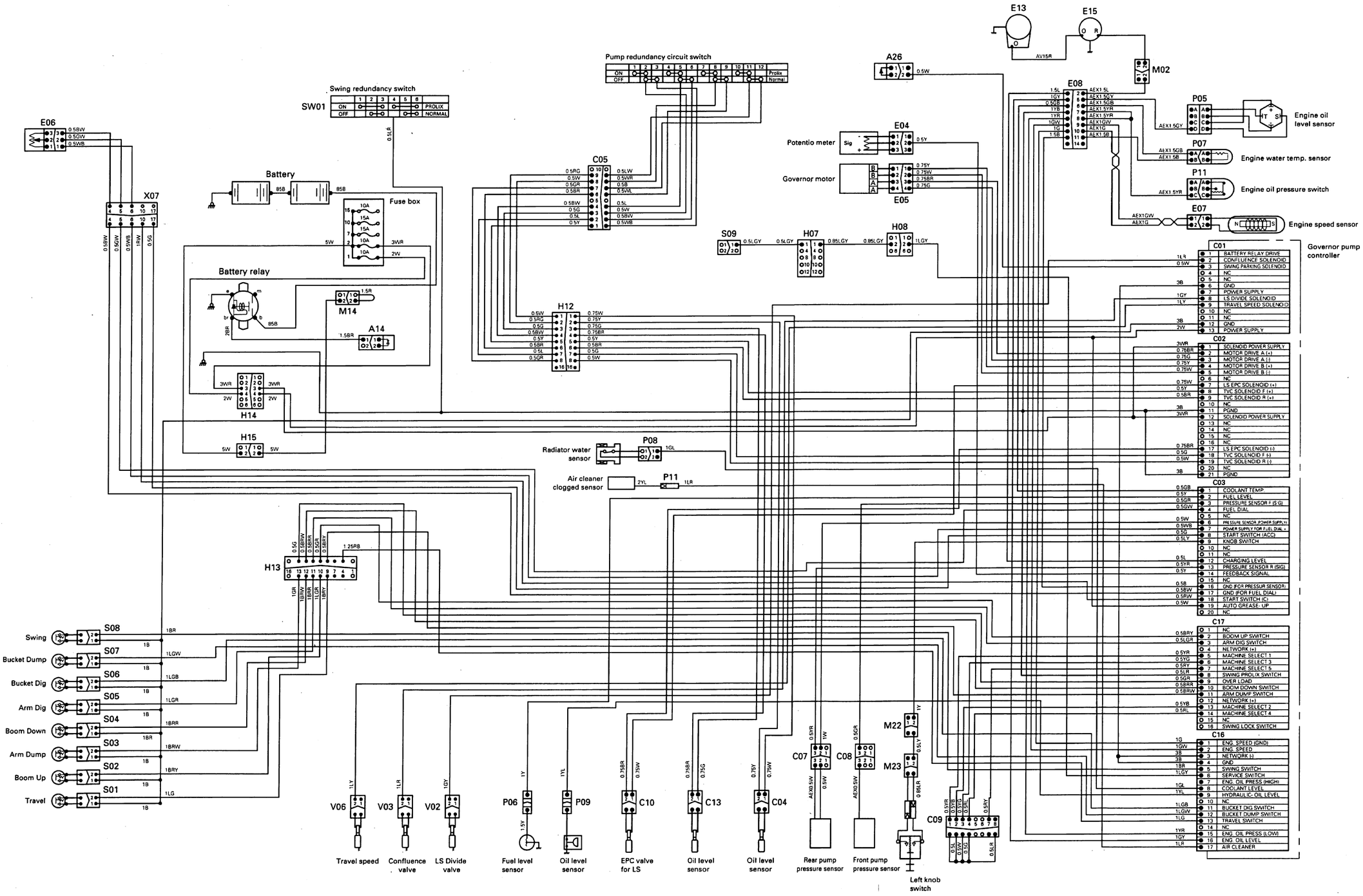
Cause	Remedy
Defective machine 2-stage pressure relief solenoid (internal short circuit with power source)	Replace
Defective machine 2-stage pressure felief switch (internal short circuit with power source)	Replace
Short circuit with power source in wiring harness between M38 (male) (1) - X01 (16) - H13 (3) - V05 (female) (2)	Repair or replace

C-21 Related electric circuit diagram



TROUBLESHOOTING OF GOVERNOR, PUMP CONTROLLER (INPUT SIGNAL SYSTEM) (F MODE)

ELECTRICAL CIRCUIT DIAGRAM FOR F MODE



F-1 Bit pattern 20-(1) Swing oil pressure switch does not light up

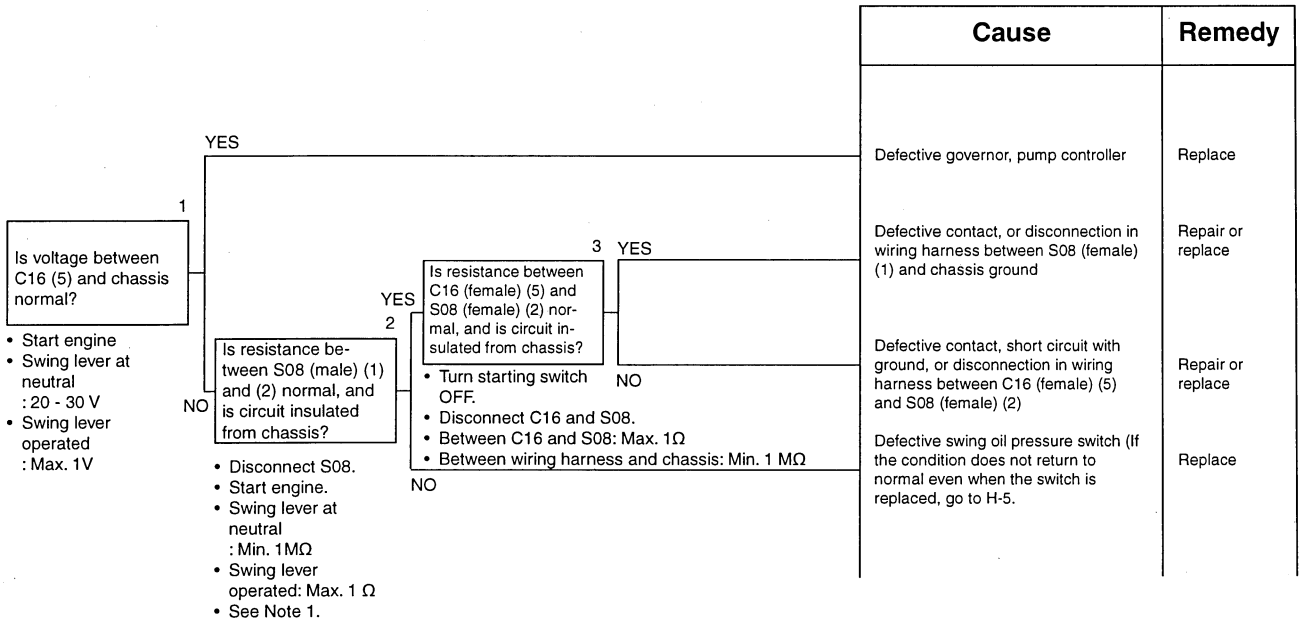
★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if the monitor code display returns to normal, the problem has been removed.**

⚠ Turn the swing lock switch ON before operating the swing lever.

★ If there is no display when the lever is operated on one side, the PPC shuttle valve is defective. (See H-5) (When measuring with the engine stopped, charge the accumulator first)

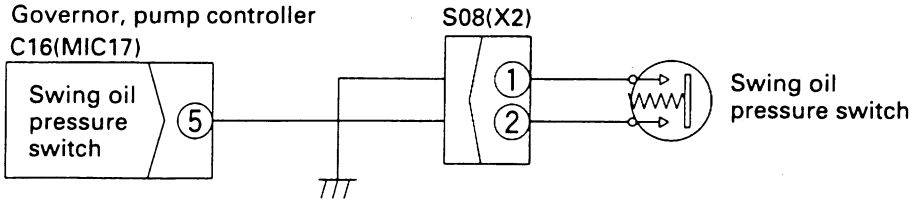
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.

★ Always connect any disconnected connectors before going on the next step.



Note 1: It is also possible to fit a short connector and judge the condition. In this case, check the voltage between C16 (5) and the chassis.
- If it is 20-30 V: go to YES
- If it is less than 1V: Go to NO

F-1 Related electric circuit diagram



BKP00257

F-2 Bit pattern 20-(2) Travel oil pressure switch does not light up

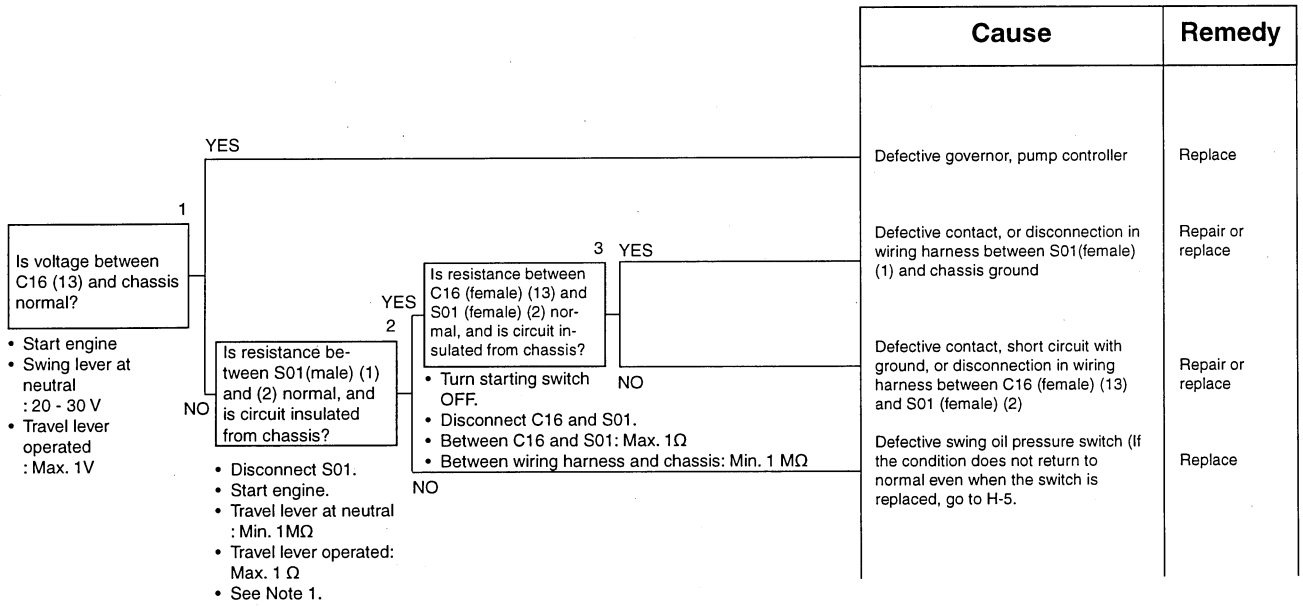
★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if the monitor code display returns to normal, the problem has been removed.**

⚠ Before operating the travel lever, check that the surrounding area is safe.

★ If there is no display when the lever is operated on one side, the PPC shuttle valve is defective. (See H-5) (When measuring with the engine stopped, charge the accumulator first)

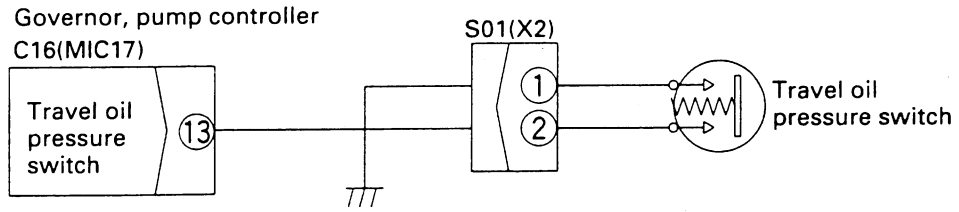
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.

★ Always connect any disconnected connectors before going on the next step.



Note 1: It is also possible to fit a short connector and judge the condition. In this case, check the voltage between C16 (13) and the chassis.
- If it is 20-30 V: go to YES
- If it is less than 1V: Go to NO

F-2 Related electric circuit diagram



BKP00258

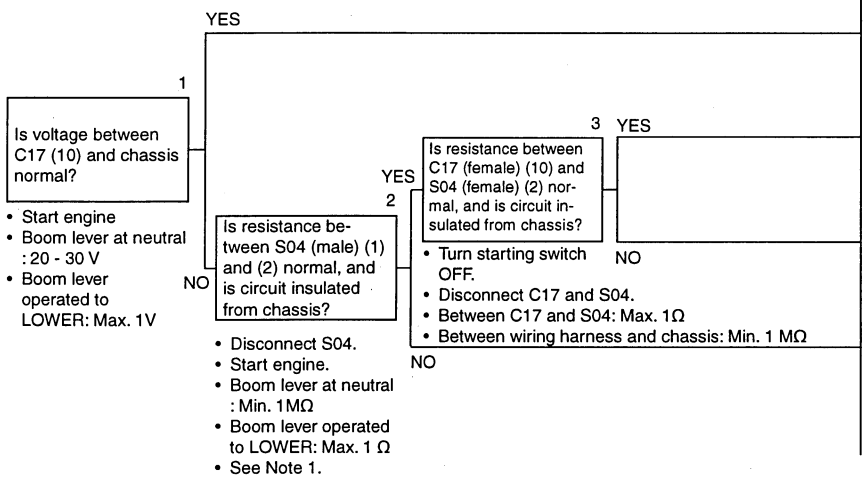
F-3 Bit pattern 20-(3) Boom LOWER oil pressure switch does not light up

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if the monitor code display returns to normal, the problem has been removed.**

⚠ When measuring with the engine running, operate the lever slightly and make sure that the work equipment does not move.
(When measuring with the engine stopped, charge the accumulator first)

★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.

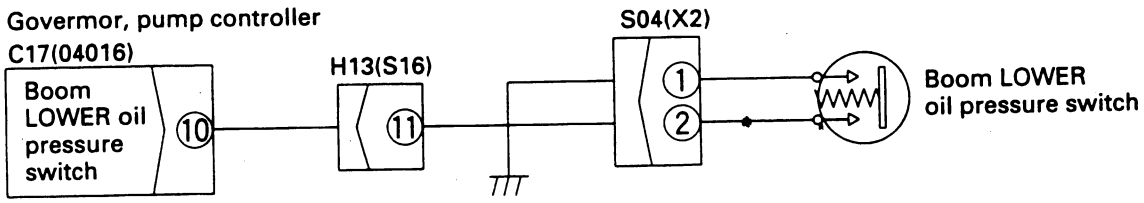
★ Always connect any disconnected connectors before going on the next step.



Cause	Remedy
Defective governor, pump controller	Replace
Defective contact, or disconnection in wiring harness between S04 (female) (1) and chassis ground	Repair or replace
Defective contact, short circuit with ground, or disconnection in wiring harness between C17 (female) (10) - H13 (11) - S04 (female) (2)	Repair or replace
Defective boom LOWER oil pressure switch (If the condition does not return to normal even when the switch is replaced, go to H-5.	Replace

Note 1: It is also possible to fit a short connector and judge the condition. In this case, check the voltage between C17 (10) and the chassis.
- If it is 20-30 V: go to YES
- If it is less than 1V: Go to NO

F-3 Related electric circuit diagram



BKP00259

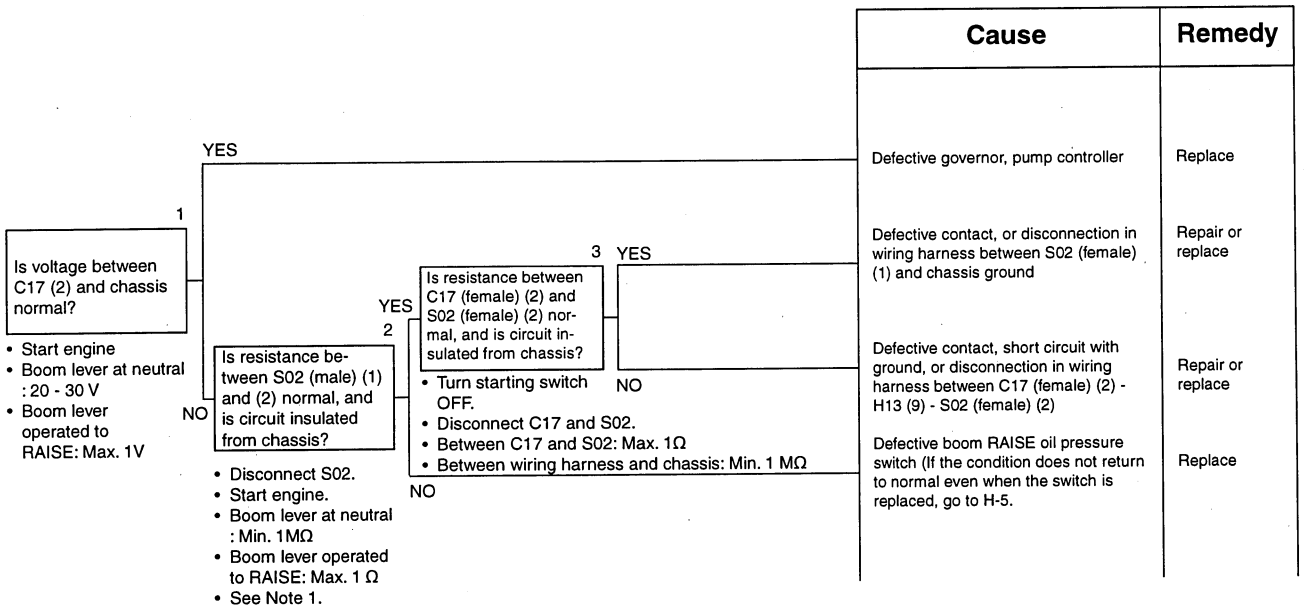
F-4 Bit pattern 20-(4) Boom RAISE oil pressure switch does not light up

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if the monitor code display returns to normal, the problem has been removed.**

⚠ When measuring with the engine running, operate the lever slightly and make sure that the work equipment does not move.
(When measuring with the engine stopped, charge the accumulator first)

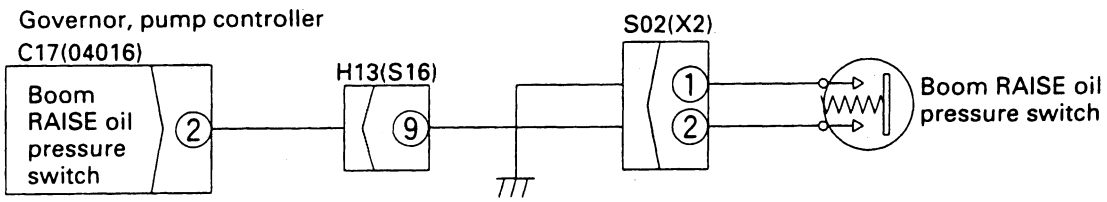
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.

★ Always connect any disconnected connectors before going on the next step.



Note 1: It is also possible to fit a short connector and judge the condition. In this case, check the voltage between C17 (2) and the chassis.
- If it is 20-30 V: go to YES
- If it is less than 1V: Go to NO

F-4 Related electric circuit diagram



BKP00260

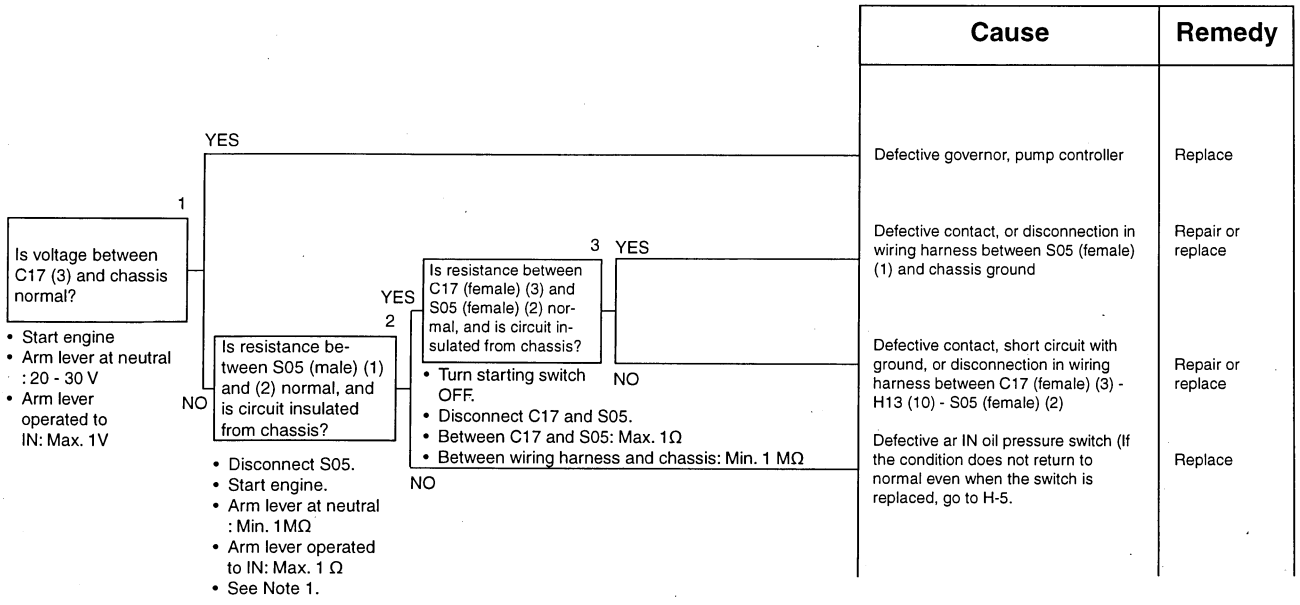
F-5 Bit pattern 20-(5) Arm IN oil pressure switch does not light up

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if the monitor code display returns to normal, the problem has been removed.**

⚠ When measuring with the engine running, operate the lever slightly and make sure that the work equipment does not move.
(When measuring with the engine stopped, charge the accumulator first)

★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.

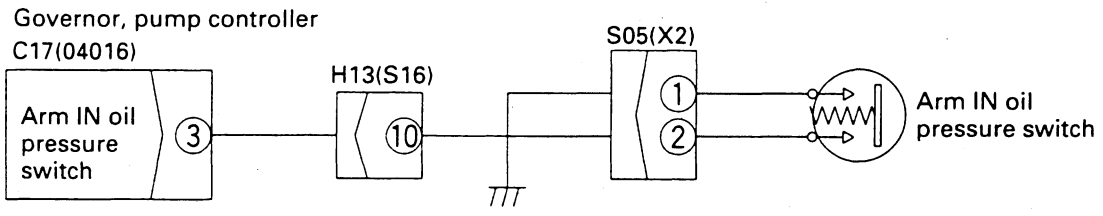
★ Always connect any disconnected connectors before going on the next step.



Cause	Remedy
Defective governor, pump controller	Replace
Defective contact, or disconnection in wiring harness between S05 (female) (1) and chassis ground	Repair or replace
Defective contact, short circuit with ground, or disconnection in wiring harness between C17 (female) (3) - H13 (10) - S05 (female) (2)	Repair or replace
Defective ar IN oil pressure switch (If the condition does not return to normal even when the switch is replaced, go to H-5.	Replace

Note 1: It is also possible to fit a short connector and judge the condition. In this case, check the voltage between C17 (3) and the chassis.
- If it is 20-30 V: go to YES
- If it is less than 1V: Go to NO

F-5 Related electric circuit diagram



BKP00261

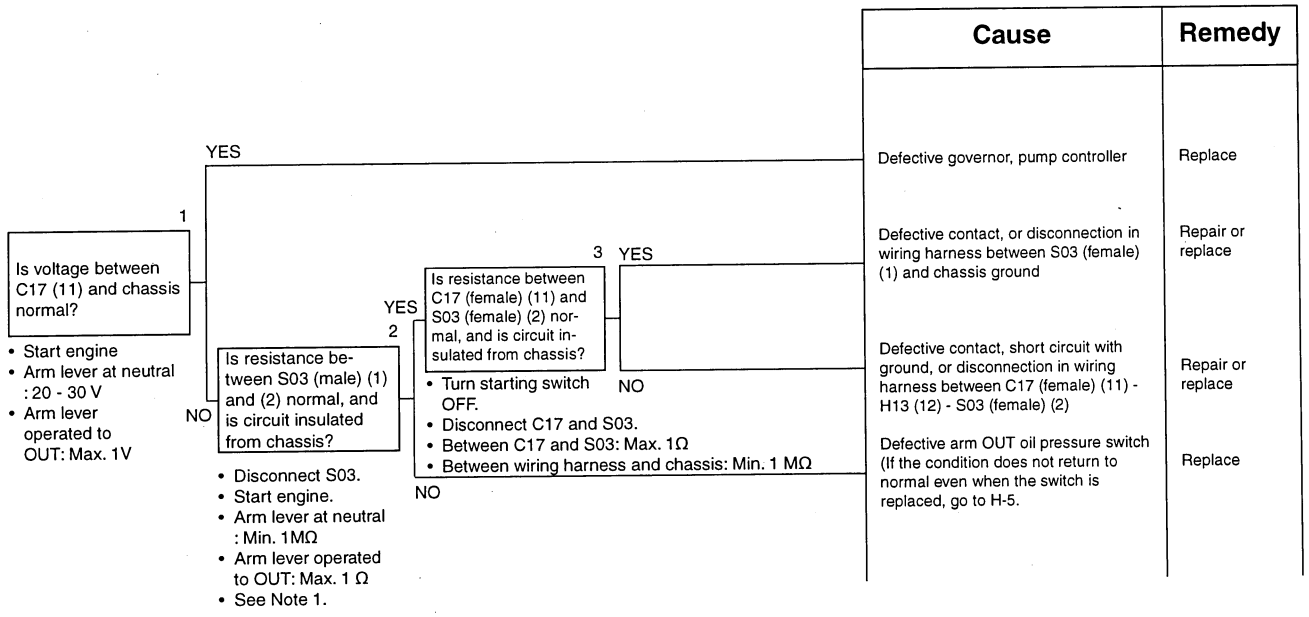
F-6 Bit pattern 20-(6) Arm OUT oil pressure switch does not light up

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if the monitor code display returns to normal, the problem has been removed.**

⚠ When measuring with the engine running, operate the lever slightly and make sure that the work equipment does not move.
(When measuring with the engine stopped, charge the accumulator first)

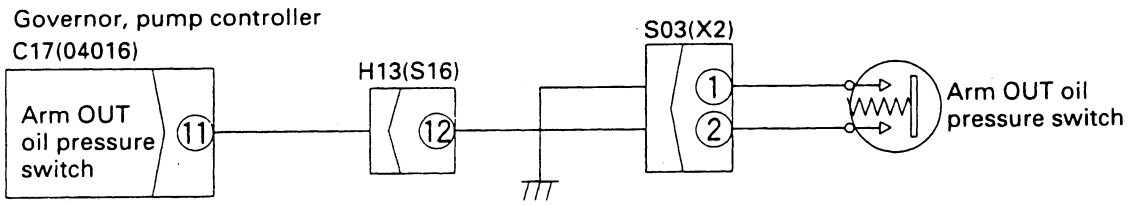
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.

★ Always connect any disconnected connectors before going on the next step.



Note 1: It is also possible to fit a short connector and judge the condition. In this case, check the voltage between C17 (11) and the chassis.
- If it is 20-30 V: go to YES
- If it is less than 1V: Go to NO

F-6 Related electric circuit diagram



BKP00262

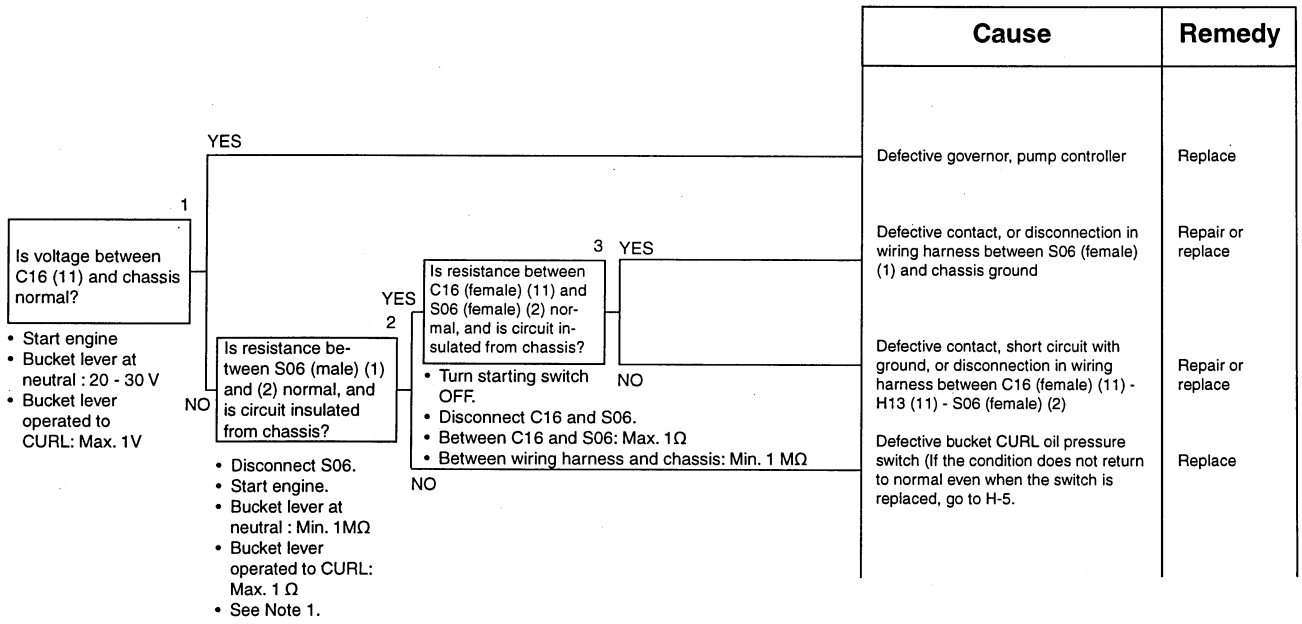
F-7 Bit pattern 21-(7) Bucket CURL oil pressure switch does not light up

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if the monitor code display returns to normal, the problem has been removed.**

⚠ When measuring with the engine running, operate the lever slightly and make sure that the work equipment does not move.
(When measuring with the engine stopped, charge the accumulator first)

★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.

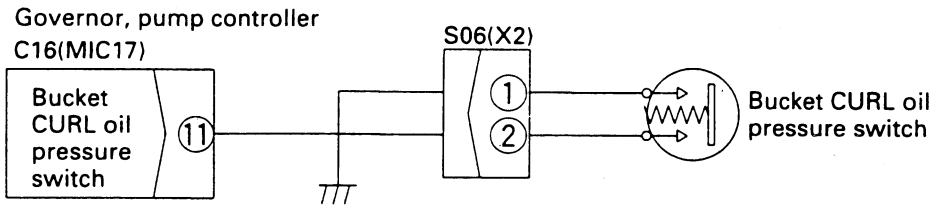
★ Always connect any disconnected connectors before going on the next step.



Cause	Remedy
Defective governor, pump controller	Replace
Defective contact, or disconnection in wiring harness between S06 (female) (1) and chassis ground	Repair or replace
Defective contact, short circuit with ground, or disconnection in wiring harness between C16 (female) (11) - H13 (11) - S06 (female) (2)	Repair or replace
Defective bucket CURL oil pressure switch (If the condition does not return to normal even when the switch is replaced, go to H-5.	Replace

Note 1: It is also possible to fit a short connector and judge the condition. In this case, check the voltage between C16 (11) and the chassis.
- If it is 20-30 V: go to YES
- If it is less than 1V: Go to NO

F-7 Related electric circuit diagram



BKP00263

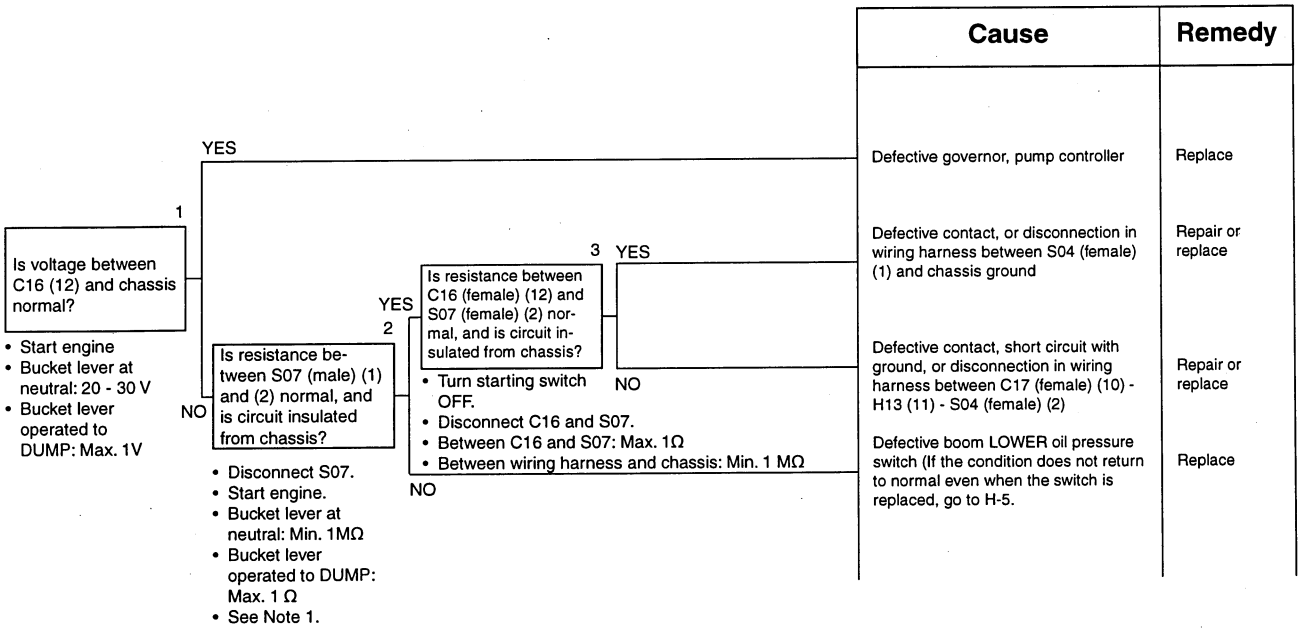
F-8 Bit pattern 21-(8) Bucket DUMP oil pressure switch does not light up

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if the monitor code display returns to normal, the problem has been removed.**

⚠ When measuring with the engine running, operate the lever slightly and make sure that the work equipment does not move.
(When measuring with the engine stopped, charge the accumulator first)

★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.

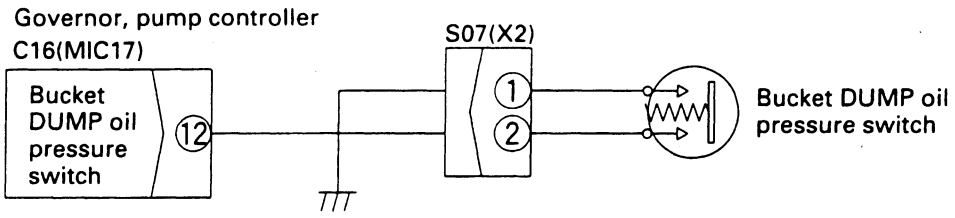
★ Always connect any disconnected connectors before going on the next step.



Cause	Remedy
Defective governor, pump controller	Replace
Defective contact, or disconnection in wiring harness between S04 (female) (1) and chassis ground	Repair or replace
Defective contact, short circuit with ground, or disconnection in wiring harness between C17 (female) (10) - H13 (11) - S04 (female) (2)	Repair or replace
Defective boom LOWER oil pressure switch (If the condition does not return to normal even when the switch is replaced, go to H-5.	Replace

Note 1: It is also possible to fit a short connector and judge the condition. In this case, check the voltage between C16 (12) and the chassis.
- If it is 20-30 V: go to YES
- If it is less than 1V: Go to NO

F-8 Related electric circuit diagram



BKP00264

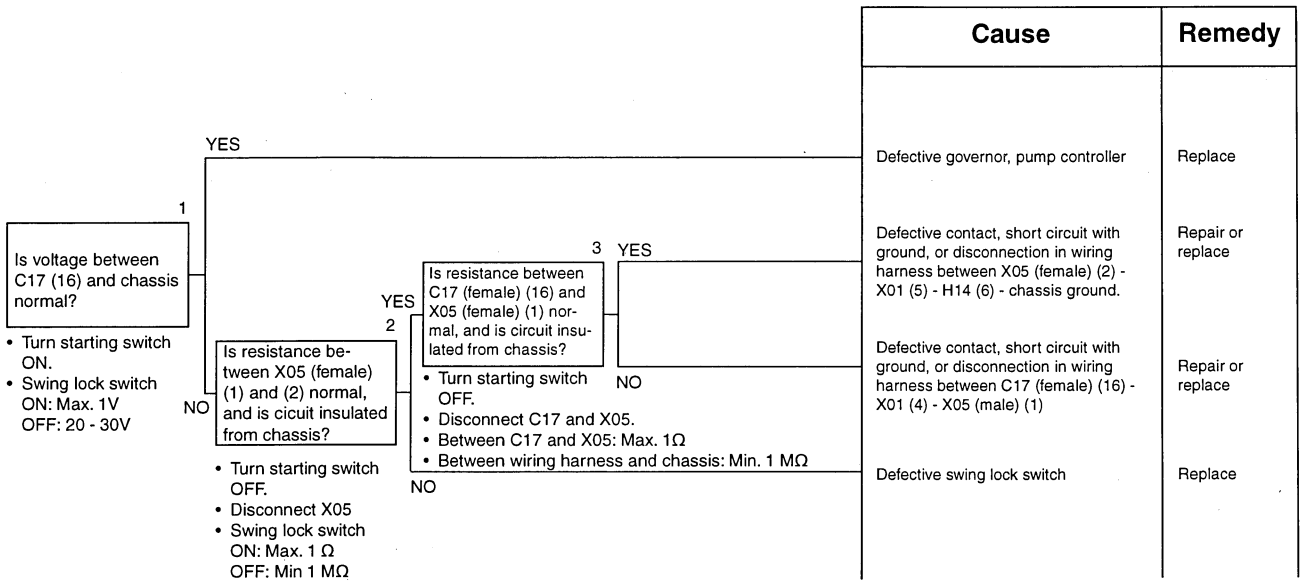
F-9 Bit pattern 21-(3) Swing lock switch does not light up

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if the monitor code display returns to normal, the problem has been removed.**

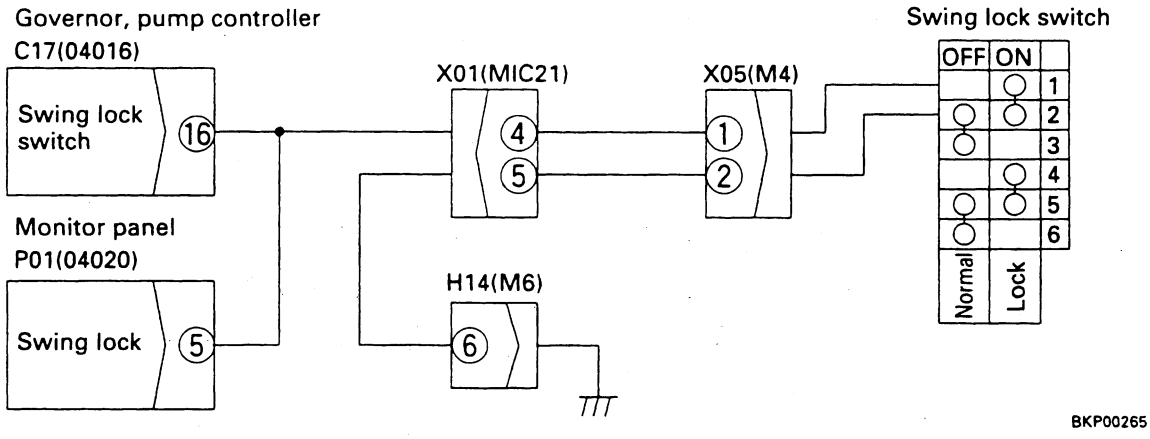
⚠ When measuring with the engine running, operate the lever slightly and make sure that the work equipment does not move.
(When measuring with the engine stopped, charge the accumulator first)

★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.

★ Always connect any disconnected connectors before going on the next step.

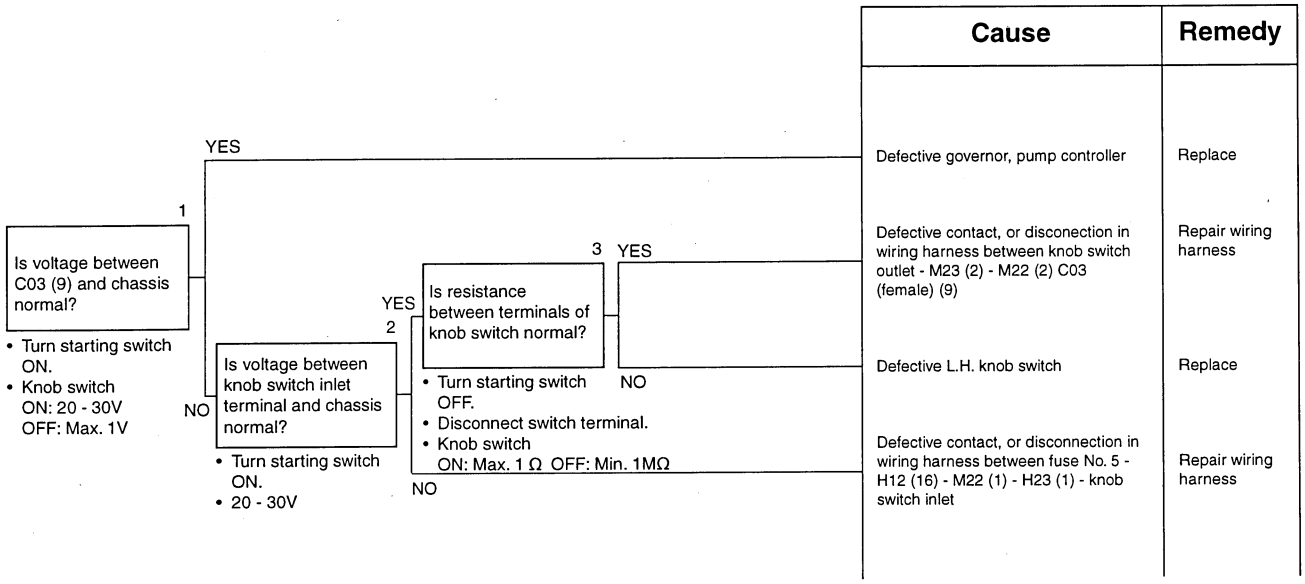


F-9 Related electric circuit diagram

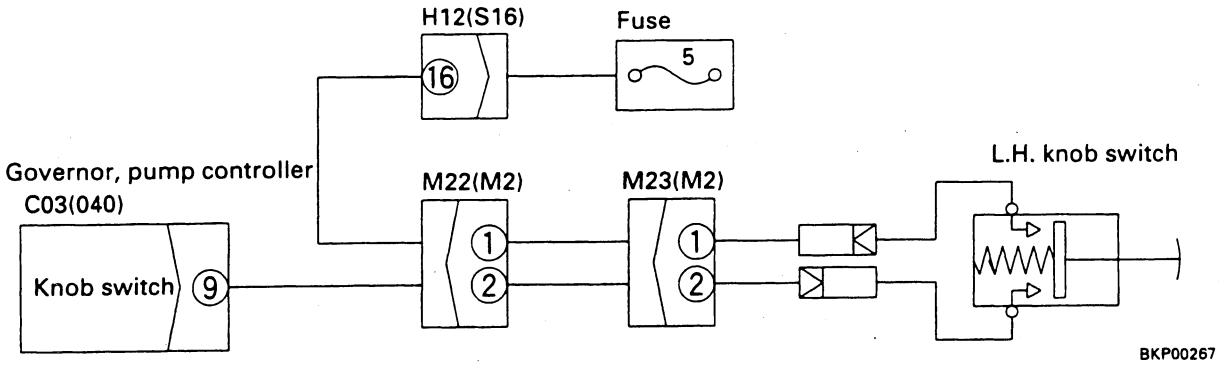


F-11 Bit pattern 22-(6) L.H. knob switch does not light up

★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if the monitor code display returns to normal, the problem has been removed.**
★ When fuse No. 5 is not blown.
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

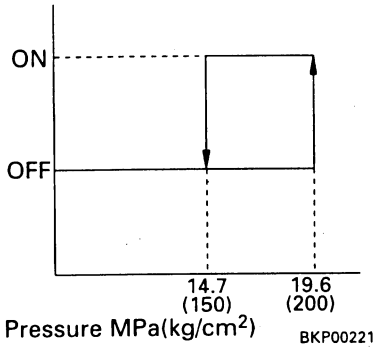


F-11 Related electric circuit diagram



TROUBLESHOOTING OF HYDRAULIC, MECHANICAL SYSTEM (H MODE)

PUMP MERGE/DIVIDER LOGIC

Divider (pump merge/divider solenoid ON)	Merge (pump merge/divider solenoid OFF)
1. Travel operated independently. 2. Travel + work equipment (any one of boom, arm, bucket, swing, or service) + front or rear pump oil pressure 19.6 MPa (200 kg/ cm^2) or above when raised or 14.7 MPa (150 kg/cm^2) or above when lowered. (See diagram)  3. Breaker mode + service (breaker) valve pressure switch ON.	All operations except those on left.

LS SELECT LOGIC

LS separated (LS select solenoid ON)	LS not separated (LS select solenoid OFF)
1. With swing priority mode ON and swing lock switch OFF: Travel + swing 2. With swing priority mode OFF and swing lock switch OFF: 1) Travel + swing 2) Boom RAISE ON 3) Arm OUT ON 4) Arm IN + front or rear pump oil pressure 14.7 MPa (150 kg/cm^2) or above.	1. Swing lock switch ON 2. With swing priority mode ON and swing lock switch OFF: Any operation except travel + swing 3. With swing priority mode OFF and swing lock switch OFF: Any operation except 2-1) - 2-4) on left

SOLENOID ACTUATION TABLE

Name of solenoid	ON (energized)	OFF
Swing holding brake	Brake released	Brake applied
Travel speed	Travel motor swash plate angle at MIN	Travel motor swash plate angle at MAX
LS selecet	LS separated	LS not separated
Pump merge/divider vlave	Divided flow	Merged flow
Machine 2-stage pressure relief	Low pressure	High pressure

TABLE OF FAILURE MODES AND CAUSES (1/2)

Failure mode \ Parts cusing failure			Piston pump								Control valve			
			F				R							
			TVC valve	LS valve	Servo piston	Pump prooper	TVC valve	LS valve	Servo piston	Pump proper	Control pump	Strainer	Damper	Spool
All work equipment, travel, swing	Speeds of all work equipment, swing, travel are slow or lack power		▲	▲	▲	▲	▲	▲	▲	▲	○			
	There is excessive drop in engine speed, or engine stalls		○	○	○		○	○	○					
	No work equipment, travel, swing move					△				△	○		○	
	Abnormal noise generated (around pump)					○				○		○		
	Auto-deceleration does not work													
	Fine control ability is poor or response is poor			○				○						
Work equipment	Boom is slow or lacks power													○
	Arm is slow or lacks power													○
	Bucket is slow or lacks power													○
	Boom does not move													○
	Arm does not move													○
	Bucket does not move													○
	Excessive hydraulic drift													○
	Escessive time lag (engine at low idling)													
	Other equipment moves when single circuit is relieved													
	In L/O, F/O modes, work equipment speed is faster than specified speed			○				○						
	Machine 2-stage pressure relief function does not work													
Compound operations	In compound operations, work equipment with larger load is slow													
	In swing + boom (RAISE), boom is slow													
	In swing + arm, arm is slow													
	In swing + travel, travel speed drops excessively													
Travel system	Travel deviation	Deviation excessive during normal travel												○
		Deviation is excessive when starting												
	Travel speed is slow													○
	Steering does not turn or lacks power													○
	Travel speed does not switch or is faster than specified speed													
	Does not move (one side only)			○				○						
Swing system	Does not swing	Both left and right												
		One direction only												○
	Swing acceleration is poor or swing speed is slow	Both left and right	○	○										
		One direction only												○
	Excessive overrun when stopping swing	Both left and right												
		One direction only												○
	Excessive shock when stopping swing (one direction only)													
	Excessive abnormal noise when stopping swing													
	Exessive hydraulic drift of swing	When brake ON												
		When brake OFF												○
	Swing speed is faster than specified swing speed			○				○						

★ In the failure modes, modes for compound operations are used when independent operations are normal
▲ When there is an abnoramlity for both front and rear

Control valve																											
Front pump		Rear pump			Pump merge/ divider valve								Rege-neration valve														
Main relief valve	Unload valve	Main relief valve	Unload valve	Pressure compensation valve	Main pump merge/divider valve	LS pump merge/divider valve	LS circuit check valve	LS shuttle valve	LS select valve	LS circuit throttle	Arm counterbalance valve	Boom	Arm	Safety-suction valve	Suction valve	Slow return valve for pump Merge/divider	PPC valve	PPC shuttle	Safety ock vlave	Swing PPC slow return valve	Swivel joint	Engine system	Troubleshooting code
▲	▲	▲	▲																				H-1
																						○	H-2
																			○				H-3
																							H-4
																		○					H-5
										○													H-6
				○	○	○		○				○		○	○		○						H-7
				○	○	○		○			○		○	○			○						H-8
				○										○			○						H-9
																	○						H-10
																	○						
																	○						
				○										○									H-11
				○								○	○	○									H-12
				○																			H-13
					○	○																	H-14
														○									H-15
				○																			H-16
					○	○			○									○					H-17
					○	○			○									○					H-18
					○	○			○									○					H-19
																	○	○					H-20
				○				○							○		○	○					H-21
○		○		○	○	○	○	○							○		○	○					H-22
						○									○								H-23
					○	○									○								H-24
																							H-25
																	○						
								○														○	H-26
				○													○	○					
																							H-27
																	○			○			
																	○			○			H-28
																							H-29
																							H-30
				○																			
					○	○																	H-31

TABLE OF FAILURE MODES AND CAUSES (2/2)

Failure mode \ Parts cusing failure			Solenoid valve						Swing motor		
			LS-EPC	LS slect	Pump merge/divider vlave	Swing holding brake	Travel speed selector	Machine push-up	Holding brake	Safety-suction valve	Leakage, breakage inside body
All work equipment, travel, swing	Speeds of all work equipment, swing, travel are slow or lack power		○								
	There is excessive drop in engine speed, or engine stalls										
	No work equipment, travel, swing move										
	Abnormal noise generated (around pump)										
	Auto-deceleration does not work										
	Fine control ability is poor or response is poor										
Work equipment	Boom is slow or lacks power				○						
	Arm is slow or lacks power				○						
	Bucket is slow or lacks power										
	Boom does not move										
	Arm does not move										
	Bucket does not move										
	Excessive hydraulic drift										
	Escessive time lag (engine at low idling)		○								
	Other equipment moves when single circuit is relieved										
	In L/O, F/O modes, work equipment speed is faster than specified speed		○		○						
	Machine 2-stage pressure relief function does not work							○			
Compound operations	In compound operations, work equipment with larger load is slow										
	In swing + boom (RAISE), boom is slow			○							
	In swing + arm, arm is slow			○							
	In swing + travel, travel speed drops excessively			○							
Travel system	Travel deviation	Deviation excessive during normal travel									
		Deviation is excessive when starting									
	Travel speed is slow		○								
	Seering does not turn or lacks power				○						
	Travel speed does not switch or is faster than specified speed		○		○		○				
	Does not move (one side only)										
Swing system	Does not swing	Both left and right				○			○		○
		One direction only								○	
	Swing acceleration is pour or swing speed is slow	Both left and right									○
		One direction only								○	
	Excessive overrun when stopping swing	Both left and right									○
		One direction only								○	
	Excessive shock when stopping swing (one direction only)										
	Excessive abnormal noise when stopping swing									○	
	Exessive hydraulic drift of swing	When brake ON				○			○		
		When brake OFF								○	○
	Swing speed is faster than specified swing speed		○								

★ In the failure modes, modes for compound operations are used when independent operations are normal
▲ When there is an abnormality for both front and rear

Travel motor													Pressure switch								Pressure sensor		Troubleshooting code
													Boom		Arm		Bucket						
Safety valve	Counterbalance valve	Check valve	Travel speed selector servo piston	Leakage, breakage inside body	Swing machinery	Final drive	Hydraulic cylinder	Boom lock valve	Back pressure valve	Travel junction valve			RAISE	LOWER	IN	OUT	CURL	DUMP	Swing	Travel	Front pump	Rear pump	
													○	○	○	○	○	○	○	○			H-1
																							H-2
																							H-3
																							H-4
																							H-5
													○	○									H-6
							○	○					○	○									H-7
							○								○	○							H-8
							○										○	○					H-9
																							H-10
							○	○															H-11
																							H-12
																							H-13
																							H-14
																							H-15
																							H-16
																							H-17
																							H-18
																							H-19
				○						○													H-20
	○																						
				○						○										○			H-21
		○								○										○			H-22
○		○	○							○										○	○	○	H-23
○	○	○		○		○																	H-24
					○														○				H-25
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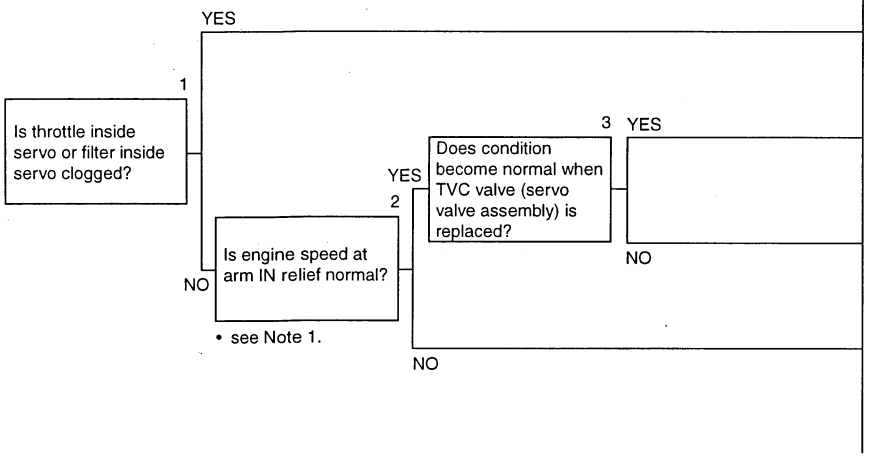
																							H-27
																							H-28
					○				○														H-29
																							H-30
																							H-31

H-2 There is excessive drop in engine speed, or engine stalls

★ Carry out troubleshooting in the H/O mode.
★ Check that the main relief pressure is normal.

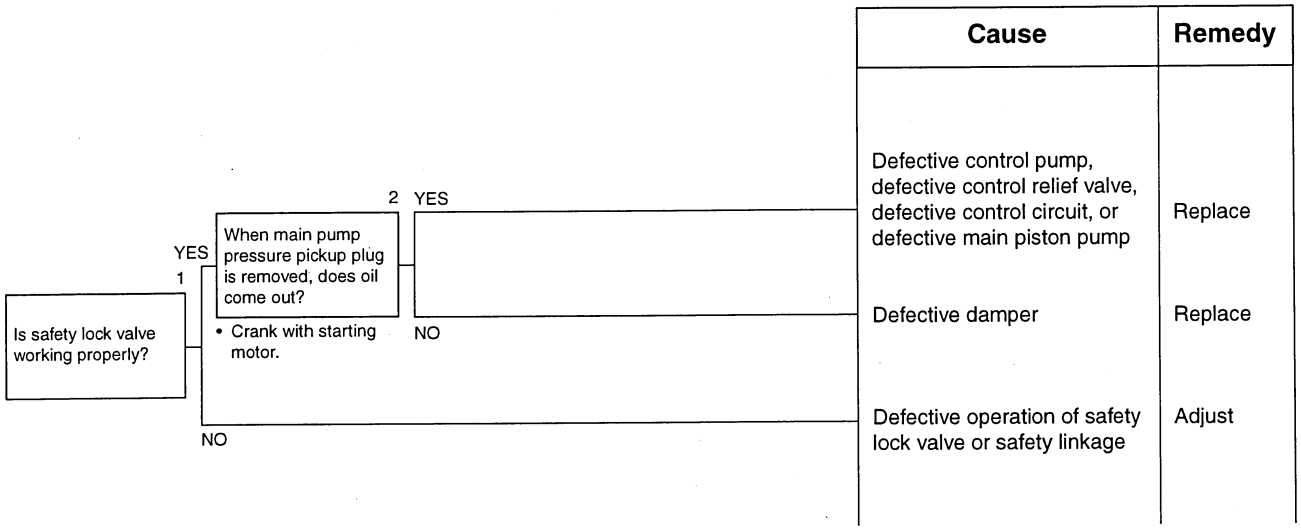


Cause	Remedy
Clogged throttle inside servo or clogged filter inside servo	Clean
Defective TVC valve or defective operation of LS valve	Adjust or replace servo valve assemebly
Defective servo piston	Replace (piston pump assembly)
See troubleshooting for engine (S mode)	-

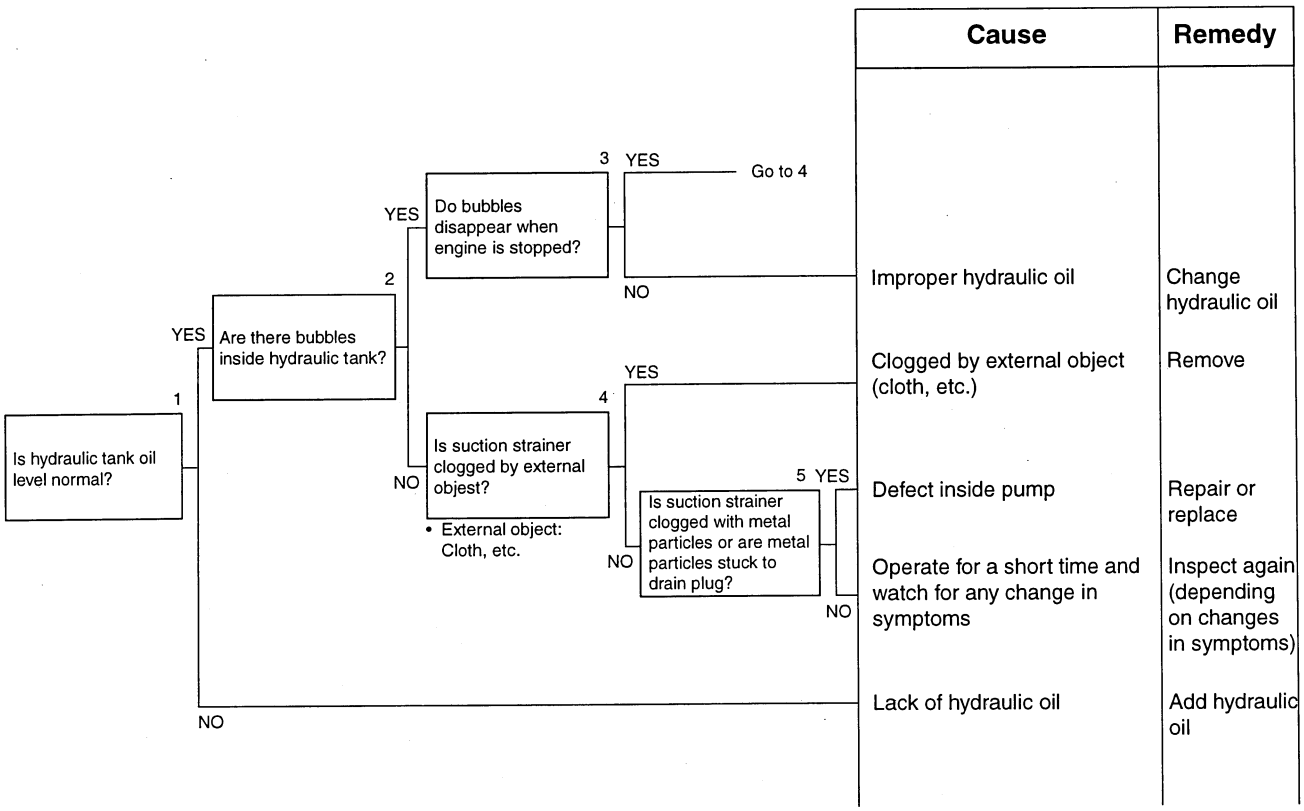
Note 1: Replace the servo valve assembly on the defective side with a new part, and if the engine speed is lower than the value below, carry out troubleshooting for S mode (engine).
If it is higher, it can be judged that the TVC valve (servo valve assembly) is defective, so replace it.
★ Engine speed (reference) at arm IN relief when engine and pump are normal

Engine speed at arm IN relief	Conditions
1,890 ±100rpm	• Engine at high idling
	• Power max. mode
	• L.H. knob switch ON

H-3 No work equipment, travel, swing move

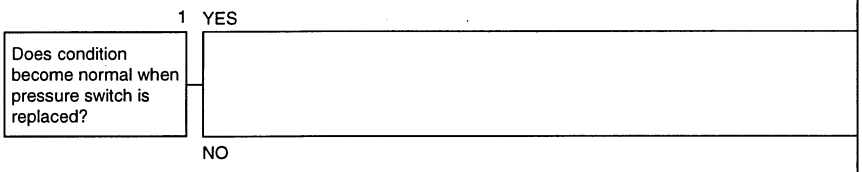


H-4 Abnormal noise generated (around pump)



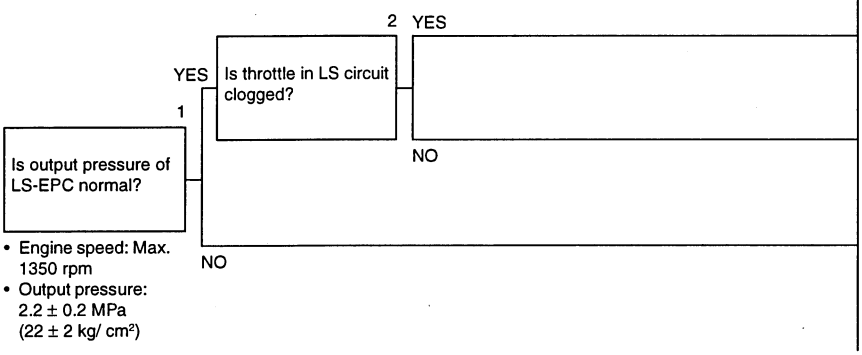
H-5 Auto-deceleration does not work (when PPC shuttle valve is cause)

★ The control pressure for the travel and swing passes through the PPC shuttle valve and is supplied to the pressure switch.



Cause	Remedy
Defective pressure switch	Replace
Defective operation of PPC shuttle valve in applicable system (swing or travel)	Repair or replace

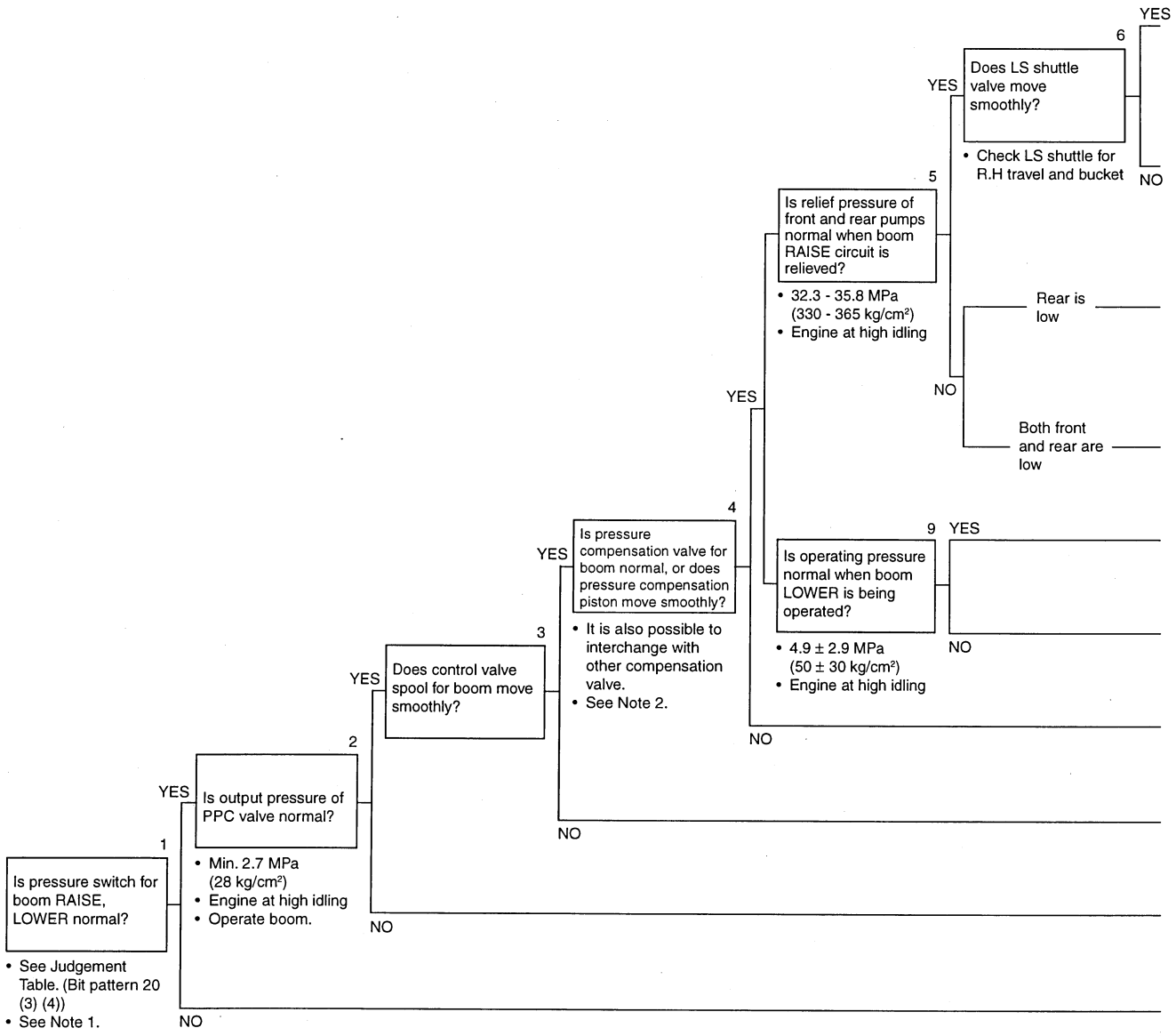
H-6 Fine control ability is poor or response is poor



Cause	Remedy
Clogged throttle in LS circuit	Clean
Defective servo valve assembly (LS valve), or defective servo piston	Replace
Defective LS-EPC valve	Repair or replace

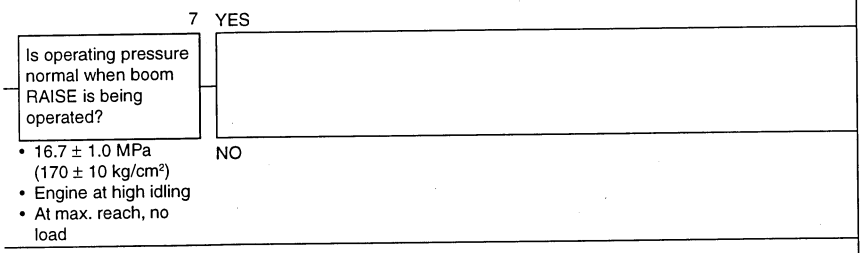
H-7 Boom is slow or lacks power

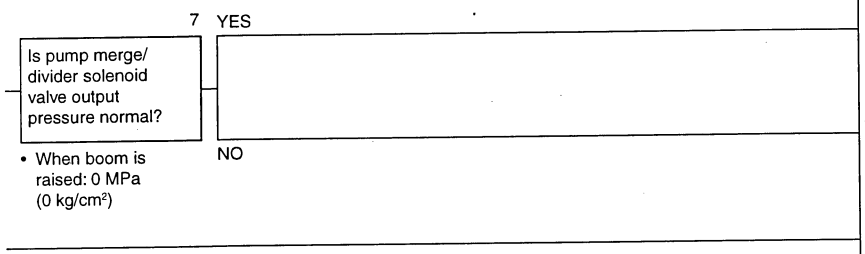
★ When travel and swing speeds are normal.
★ Carry out troubleshooting in the H/O mode.



Note 1: If auto-decleration is canceled when boom RAISE or boom LOWER is operated, system is normal.

Note 2: After inspection, do not forget to return the interchanged valves to the original position.

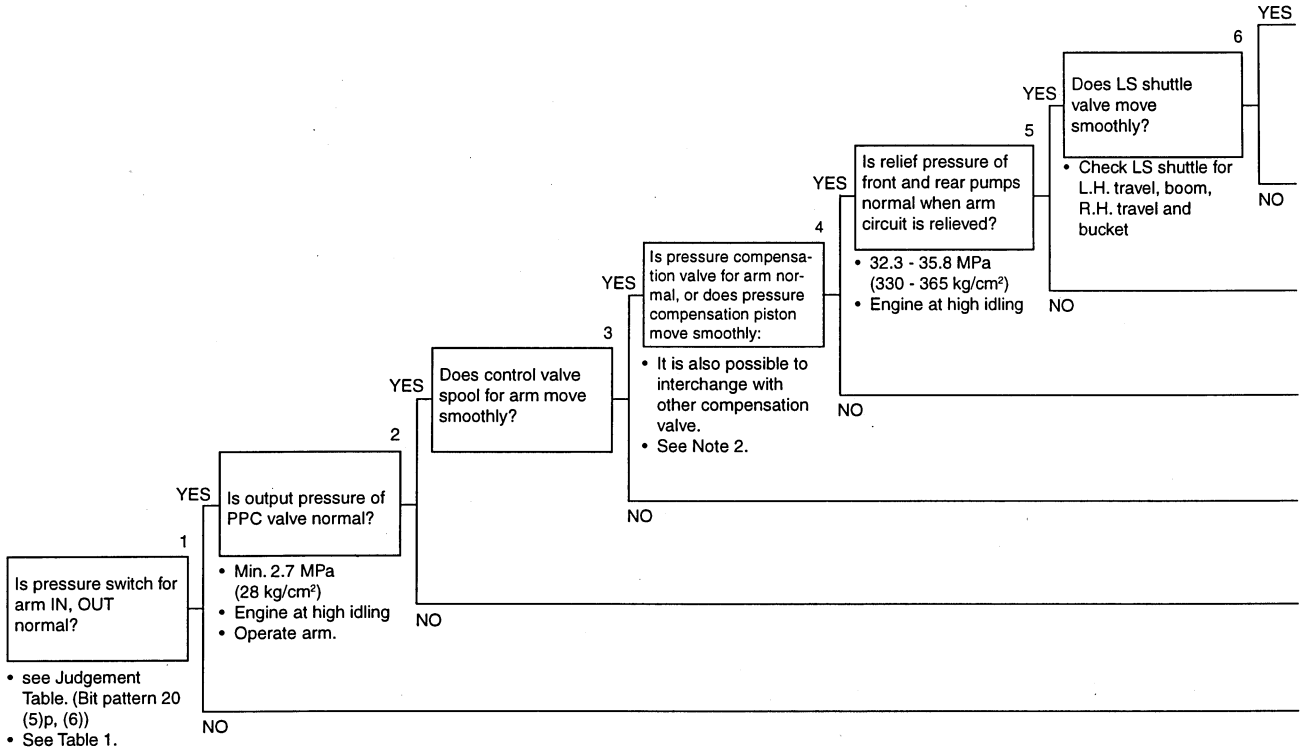




Cause	Remedy
Defective operation of boom lock valve	Correct or replace
Defective boom cylinder piston packing	Correct or replace
Defective operation of LS shuttle valve (LS shuttle for R.H. travel (or bucket)	Correct or replace
Defective operation of pump merge/divider valve or LS pump merge/divider valve	Correct or replace
Defective operation of pump merge/divider solenoid valve	Correct or replace
Defective boom lock valve or suction valve for boom in control valve	Replace
Defective operation of boom lock valve	Correct or replace
Defective operation of boom regeneration valve	Correct or replace
Defective operation of boom pressure compensation valve or pressure compensation valve or pressure compensation piston (for boom RAISE end, check boom Hi also)	Correct or replace
Defective operation of control valve spool (for boom RAISE end, check boom Hi spool also)	Correct or replace
Defective PPC valve	Replace
Defective boom RAISE or boom LOWER pressure switch	Replace

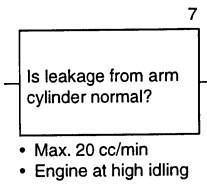
H-8 Arm is slow or lacks power

★ When travel and swing speeds are normal.
★ Carry out troubleshooting in the H/O mode.



Note 1: If the auto-deceleration is canceled when arm IN or arm OUT is operated, the system is normal.

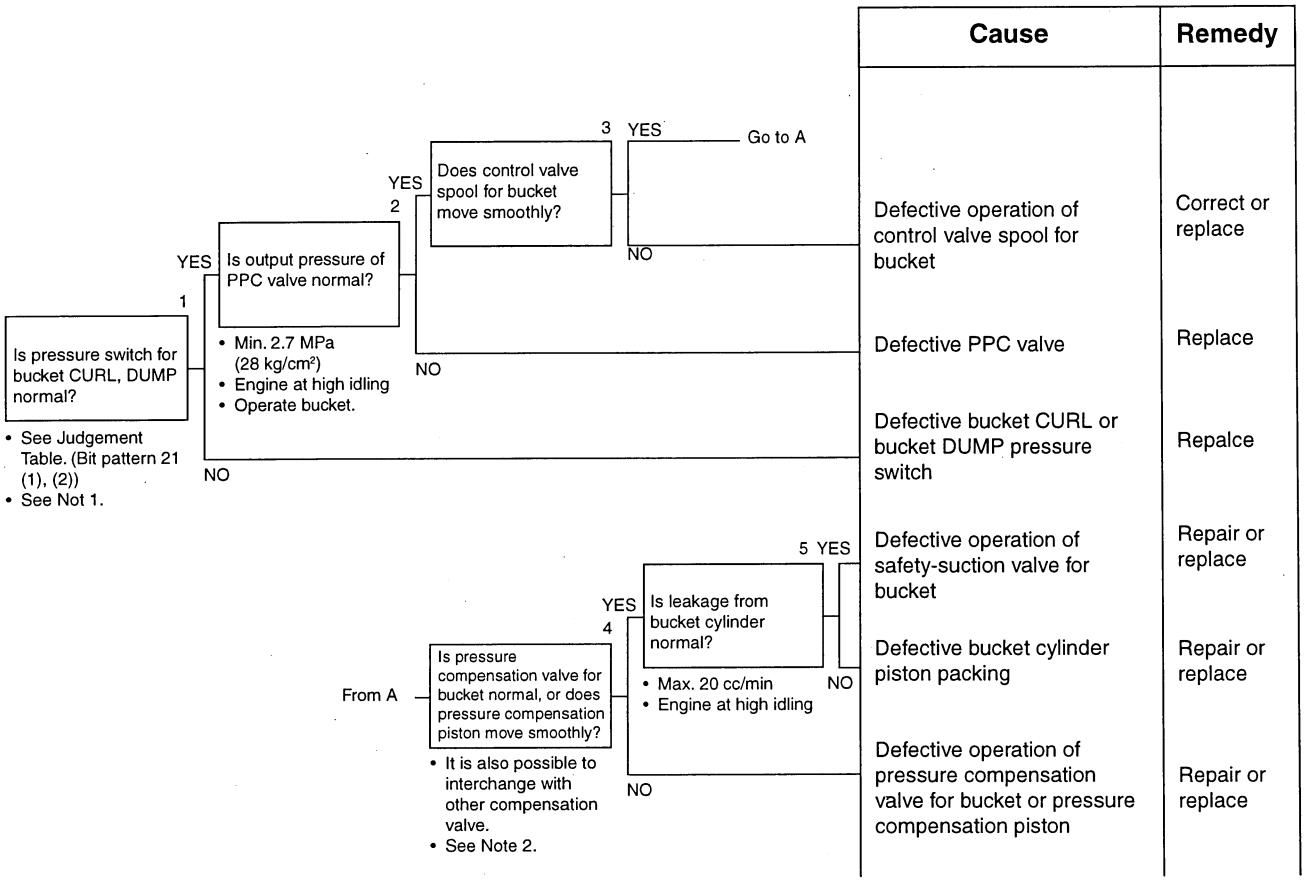
Note 2: After inspection, do not forget to return the interchanged valves to the original position.



Cause	Remedy
Defective operation of arm regeneration valve	Correct or replace
Defective arm cylinder piston packing	Correct or replace
Defective operation of LS shuttle valve (LS shuttle for L.H. travel, boom, R. H. travel or bucket)	Correct or replace
Defective safety-suction valve for arm	Replace
Defective operation of arm pressure compensation valve or pressure compensation piston (for arm Lo and arm Hi)	Correct or replace
Defective operation of control valve spool (for arm Lo and arm Hi)	Correct or replace
Defective PPC valve	Replace
Defective arm IN or arm OUT pressure switch	Replace

H-9 bucket is slow or lacks power

★ When travel and swing speeds are normal.

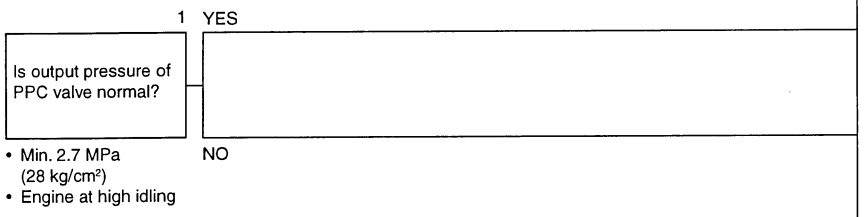


Note 1: If the auto-deceleration is canceled when bucket CURL or bucket DUMP is operated, the system is normal.

Note 2: After inspection, do not forget to return the interchanged valves to the original position.

H-10 Work equipment (boom, arm, bucket) does not move (but travel and swing are normal)

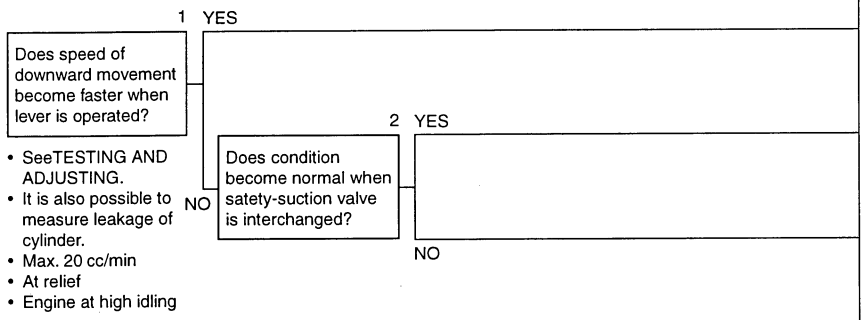
★ When boom, arm, and bucket are each operated independently.



Cause	Remedy
Defective control valve spool	Correct or replace
Defective PPC valve	Replace

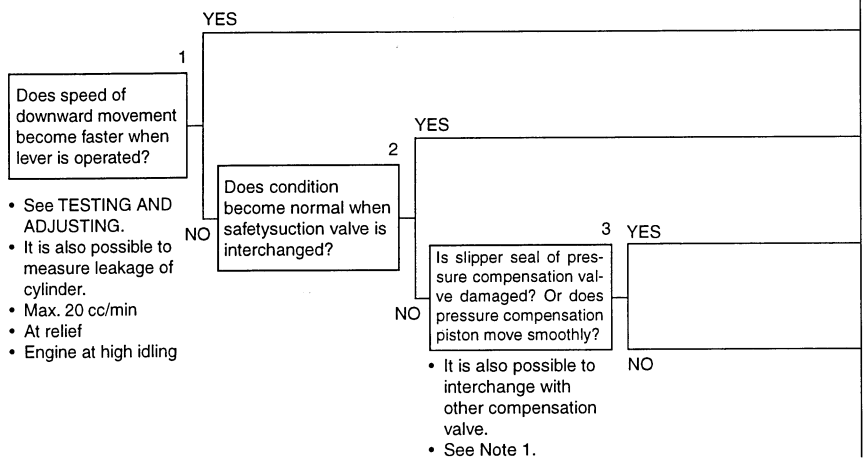
H-11 Excessive hydraulic drift (boom, arm, bucket)

1) Excessive hydraulic drift of boom



Cause	Remedy
Defective hydraulic cylinder piston packing	Replace
Defective operation of satety-suction valve	Replace
Defective operation of boom safety valve	Correct or replace

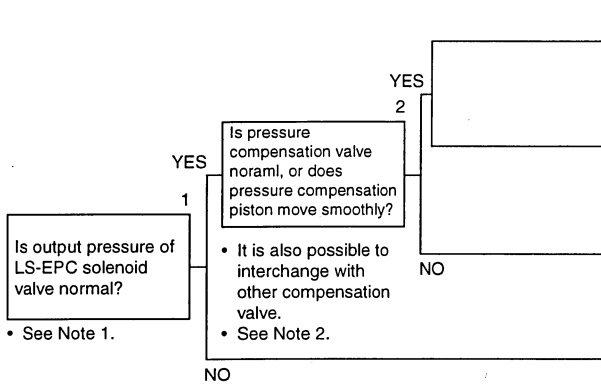
2) Excessive hydraulic drift of arm or bucket



Cause	Remedy
Defective hydraulic cylinder piston packing	Replace
Defective operation of safety-suction valve	Replace
Defective control valve spool	Replace
Damaged slipper seal of pressure compensation valve, or defective operation of pressure compensation piston	Correct or replace

Note 1: After inspection, do not forget to return the interchanged valves to the original position.

H-12 Excessive time lag (engine at low idling)



Cause	Remedy
Defective safety-suction valve, or defective regeneration valve	Replace
Defective safety-suction valve	Repalce
Defective operation of pressure compensation valve or pressure compensation piston	Correct or replace
Defective operation of LS-EPC solenoid valve	Correct or replace

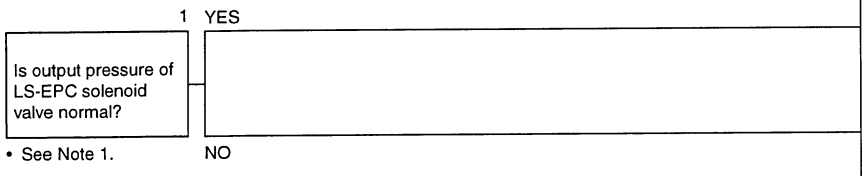
Note 1: Output pressure of LS-EPC solenoid
- 2.2 ± 0.2 MPa (22 ± 2 kg/cm^2) is output from the LS-EPC solenoid when the engine is at low idling (approx. 1350 rpm or bleow) regardless of the working mode.

Note 2: After inspection, do not forget to return the interchanged valves to the original postition.

H-13 Other equipment moves when single circuit is relieved

Cause	Remedy
Defective operation of pressure compensation valve slipper seal (The slipper seal in the pressure compensation valve of the circuit that moved is defective.)	Replace

H-14 IN L/O, F/O modes, work equipment speed is faster than specified speed

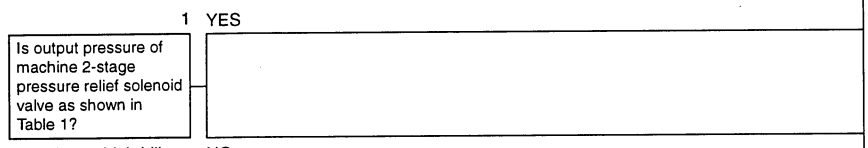


Cause	Remedy
Defective LS valve	Correct or replace
Defective operation of LS-EPC solenoid valve	Correct or replace

Note 1: Output pressure of LS control EPC solenoid (travel OFF)
- 2.2 ± 0.2 MPa (22 ± 2 kg/cm²) is output from the LS-EPC solenoid when the engine is at low idling (approx. 1350 rpm or below) regardless of the working mode.

H-15 Defective actuation of machine 2- stage pressure relief function

★ When electrical system is normal.



Cause	Remedy
Defective safety valve	Replace
Defective operation of solenoid valve	Correct or replace

Table 1

Machine 2-stage pressure relief switch	Oil pressure MPa (kg/cm²)
① Low pressure setting	$2.9^{+0.5}_{-0.3}$ (30^{+5}_{-3})
② High pressure setting	0

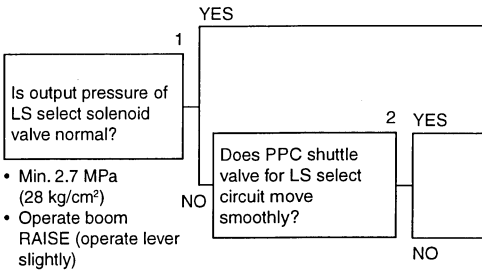
H-16 In compound operations, work equipment with larger load is slow

Cause	Remedy
Defective operation of pressure compensation valve	Replace (replace pressure compensation valve on side where load is lower)

	Combination of compound operation	Side where load is larger
1	Boom RAISE + arm IN	Boom RAISE
2	Boom RAISE + arm OUT	Arm OUT
3	Boom RAISE + bucket CURL	Boom RAISE
4	Arm OUT + bucket CURL	Arm OUT
5	Boom LOWER + arm OUT	Arm OUT

H-17 In swing + boom RAISE, boom RAISE is slow

★ If swing and boom RAISE work normally when operated independently.
★ Carry out troubleshooting with the swing priority mode OFF.



Cause	Remedy
Defective operation of LS select valve	Correct or replace
Defective operation of LS select solenoid valve	Correct or replace
Defective operation of PPC shuttle valve for LS select circuit (PPC shuttle for boom RAISE, LS select)	Correct or replace

H-18 In swing + arm, arm is slow

★ See H-17.
(If the operation is normal when the swing and arm are operated independently, carry out troubleshooting with the swing priority mode OFF.
If the Cause column shows that there is defective operation of the LS shuttle valve, the cause is in the shuttle valve for the arm OUT, In and LS select.

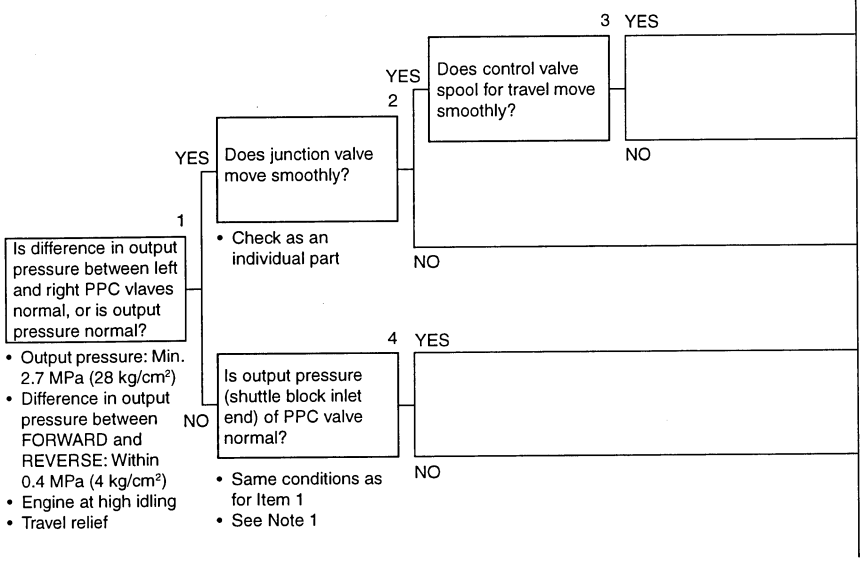
H-19 In swing + travel, travel speed drops excessively

★ See H-17
(If the operation is normal when the swing and travel are operated independently, carry out troubleshooting with the swing priority mode OFF.
If the Cause column shows that there is defective operation of the PPC shuttle valve, the cause is in the shuttle valve for the LS select.

H-20 Travel deviation

★ Carry out troubleshooting in the H/O mode.
★ When swing and work equipment speeds are normal.

a) When there is deviation in normal travel



Cause	Remedy
Defective travel motor assembly	Correct or replace
Defective operation of control valve spool	Correct or replace
Defective operation of travel junction valve	Correct or replace
Defective PPC shuttle	Correct or replace
Defective PPC valve	Replace

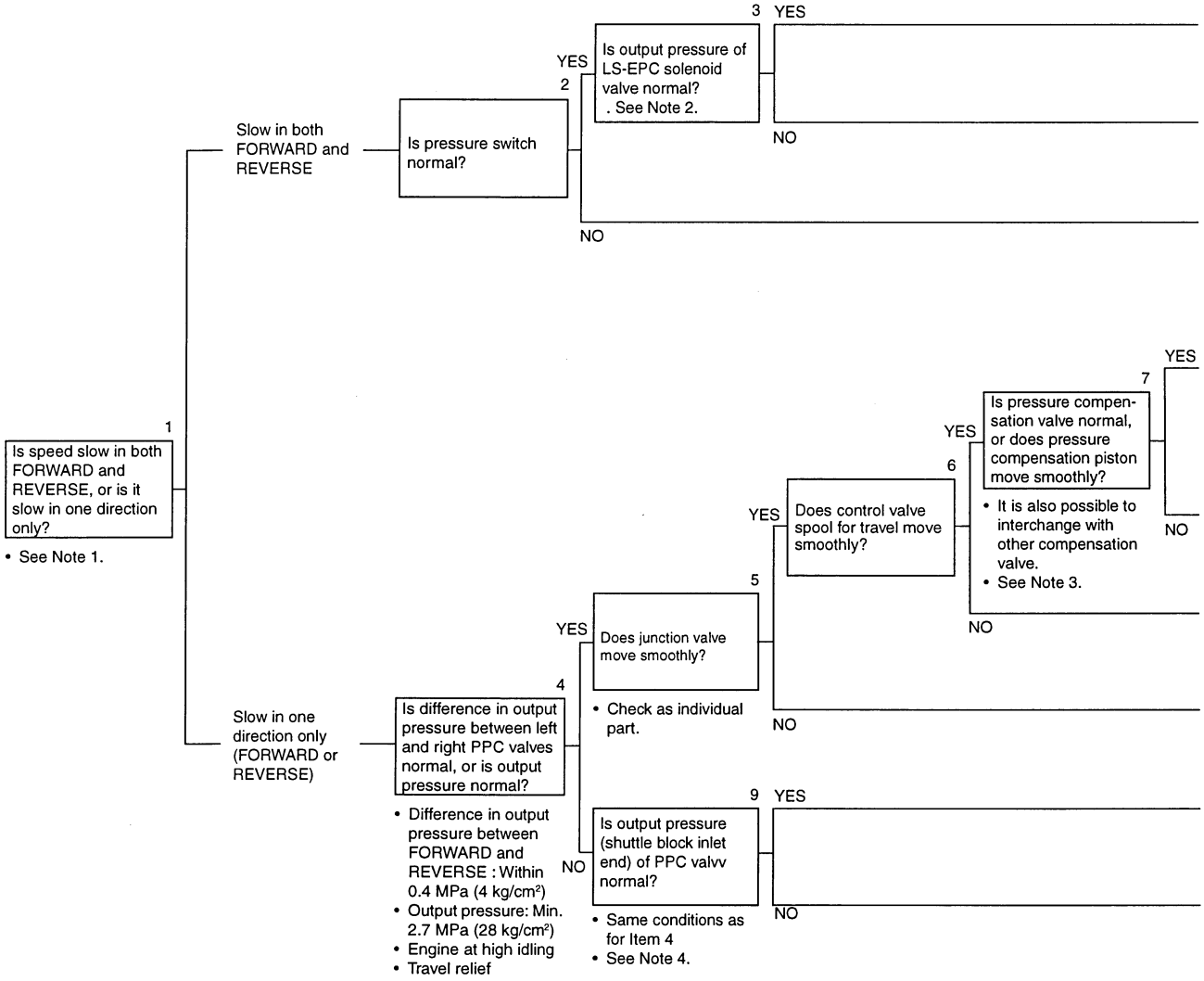
Note 1: Remove the PPC shuttle block inlet hose, fit an adapter, and block the tip.
If the adapter for blocking the circuit is not available, interchange the travel PPC hoses with the PPC hoses for the bucket (CURL, DUMP), boom (LOWER), or arm (IN) at both the inlet and outlet ports of the shuttle block, and check operation.

b) Excessive travel deviation when starting

Cause	Remedy
Defective operation of travel counterbalance valve	Correct or replace
Clogging of throttle inside servo of front or rear pump	Correct or replace

H-21 Travel speed is slow

★ Check that the spool of the travel PPC valve is moving the full stroke before carrying out troubleshooting.
★ Carry out troubleshooting in the H/O mode.
★ When swing and work equipment speeds are normal.

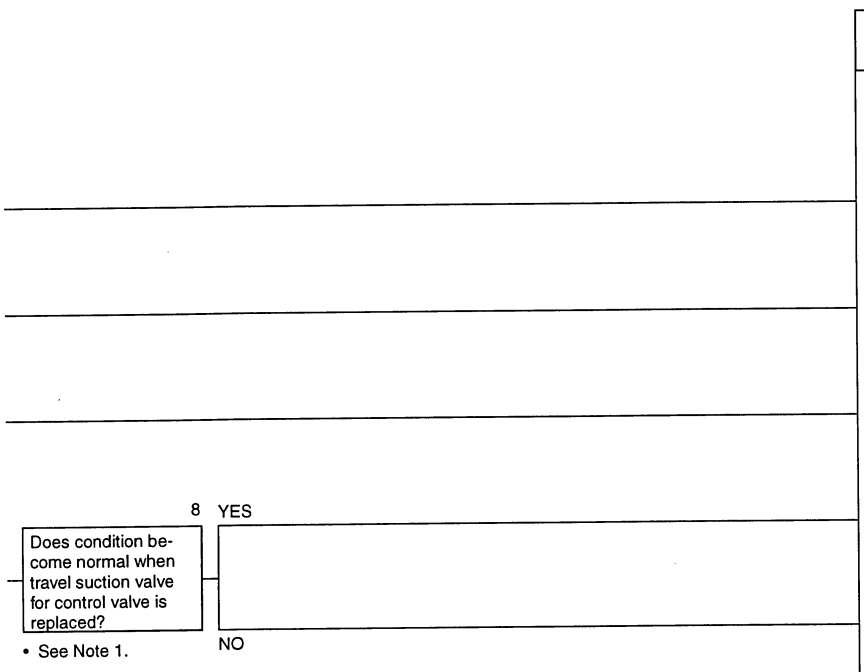


Note 1: Measure the travel speed under no load or measure the time taken to travel 20 m. (See MAINTENANCE STANDARD FOR CHASSIS RELATED PARTS.)
When measuring the speed of the travel motor under no load Remove connector of LS control EPC solenoid, and measure travel speed in Lo and Hi.

Note 2: Output pressure of LS-EPC solenoid

unit: MPa (kg/cm²)

Travel speed / Engine speed (rpm)	Lo	Mi	Hi
Max. 1,350	2.2 ± 0.2 (22.0 ± 2.0)	2.2 ± 0.2 (22.0 ± 2.0)	2.2 ± 0.2 (22.0 ± 2.0)
Max. 1,800	0.6 ± 0.2 (6.7 ± 2.0)	1.8 ± 0.2 (18.4 ± 2.0)	0.6 ± 0.2 (6.7 ± 2.0)
Max. 1,900	0.3 ± 0.2 (3.3 ± 2.0)	1.8 ± 0.2 (18.4 ± 2.0)	0.3 ± 0.2 (3.3 ± 2.0)

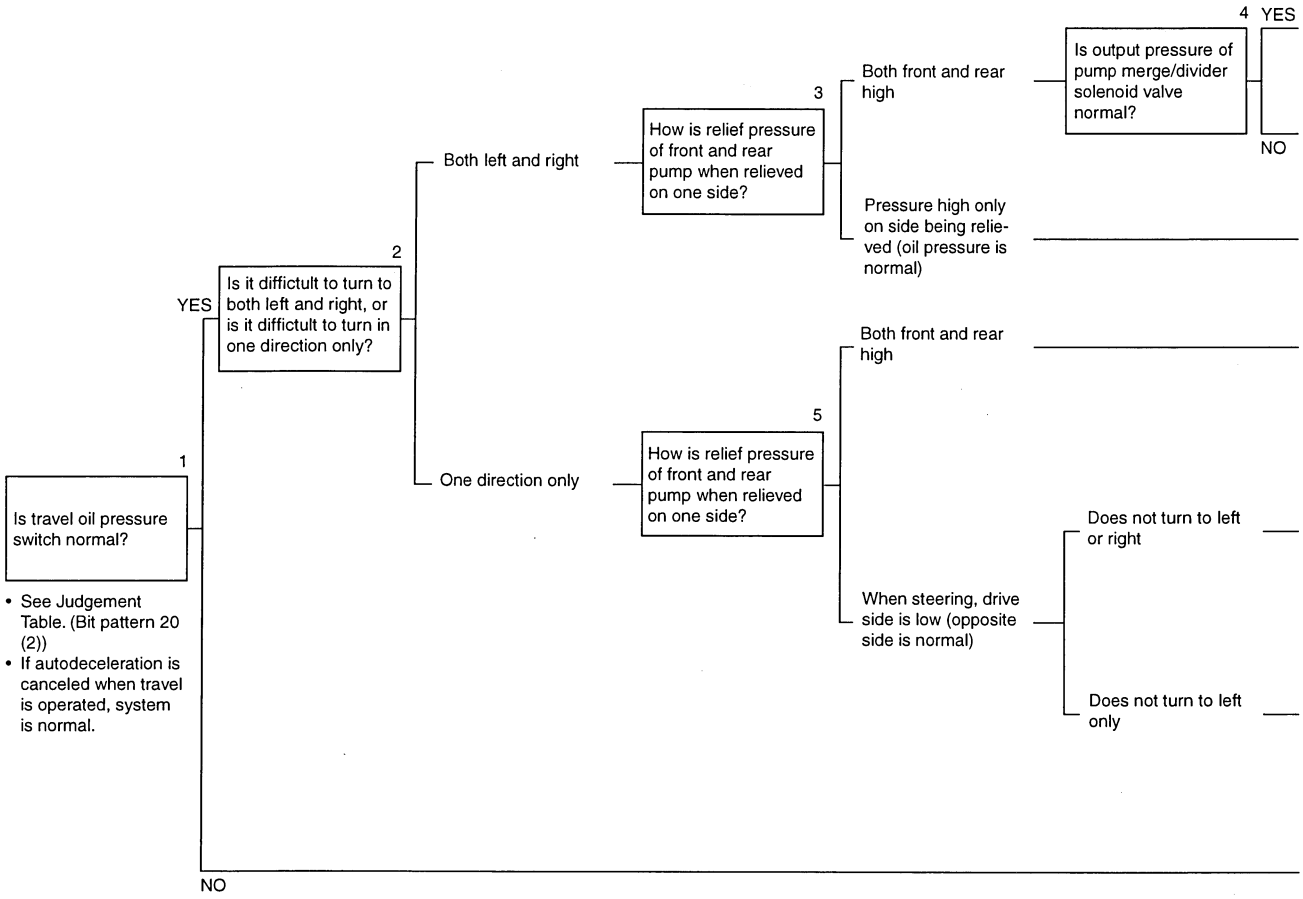


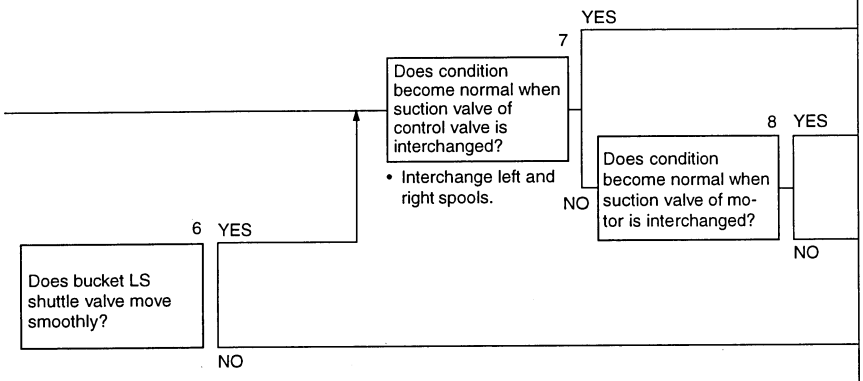
Cause	Remedy
Defective operation of LS shuttle valve (for bucket)	Correct or replace
Defective operation of LS-EPC solenoid valve	Correct or replace
Defective travel pressure switch	Replace
Defective operation of travel suction valve for control valve	Correct or replace
Defective travel motor assembly	Correct or replace
Defective pressure compensation valve, or defecitive operation of pressure compensation piston	Correct or replace
Defective operation of travel spool for control valve	Correct or replace
Defective operation of junction valve	Correct or replace
Defective PPC shuttle	Correct or replace
Defective PPC valve	Replace

Note 3: After inspection, do not forget to return the interchanged valves to the original position.
Note 4: Remove the PPC shuttle block inlet hose, fit an adapter, and block the tip.
If the adapter for blocking the circuit is not available, interchange the travel PPC hoses with the PPC hoses for the bucket (CURL, DUMP), boom (LOWER), or arm (IN) at both the inlet and outlet ports of the shuttle block, and check operation.

H-22 Steering does not turn easily or lacks power

★ Carry out troubleshooting in the H/O mode.

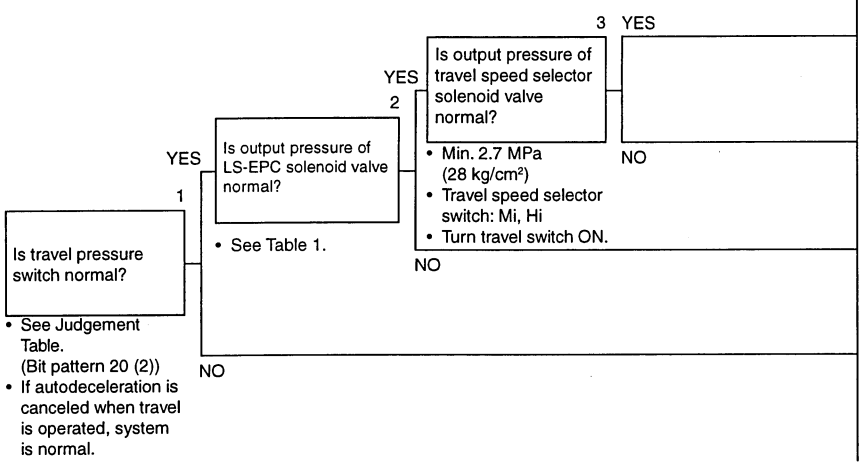




Cause	Remedy
Defecitve operation of pump merge/divider valve or LS pump merge/divider valve	Correct or replace
Defective operation of main pump merge/divider solenoid valve	Correct or replace
Defective operation of travel junction valve spool	Correct or replace
Defective operation of LS circuit check valve	Correct or replace
Defective control valve suction valve	Replace
Defective travel motor check valve	Correct or replace
Defective travel motor safety valve	Replace
Defective operation of Ls shuttle valve for bucket	Correct or replace
Defective travel pressure switch	Replace

H-23 Travel speed does not switch or is faster than specified speed

★ Carry out troubleshooting in the H/O mode.



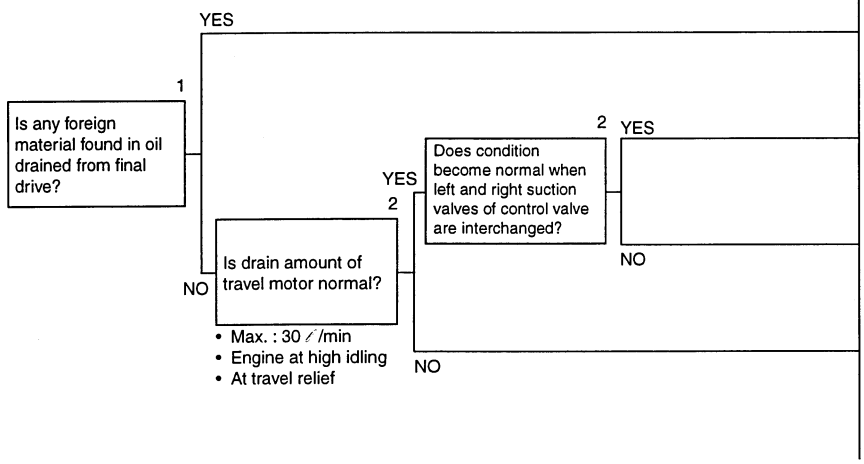
Cause	Remedy
Defective operation of travel speed selector servo piston in travel motor	Replace
Defective operation of travel speed selector solenoid valve	Correct or replace
Defective operation of LS-EPC solenoid valve	Correct or replace
Defective travel pressure switch	Replace

Table 1. Output pressure of LS-EPC solenoid

Unit: MPa (kg/cm²)

Travel speed	Lo	Mi	Hi
LS-EPC output pressure	0.2 ± 0.2 (2.0 ± 2.0)	1.8 ± 0.2 (18.4 ± 2.0)	0.2 ± 0.2 (2.0 ± 2.0)
Remarks	• Engine at high idling • Operate travel lever slightly (auto-deceleration cancel position)		

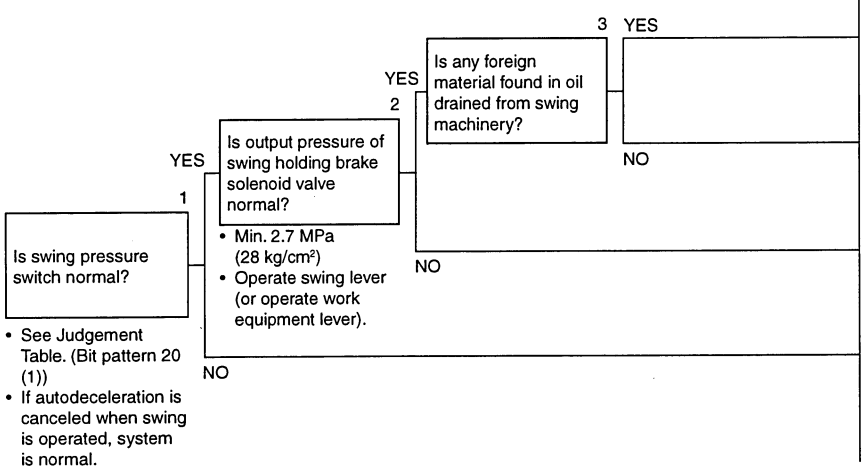
H-24 Travel does not move (one side only)



Cause	Remedy
Defective final drive	Repair or replace
Defective operation of suction valve of control valve	Replace
Defective operation of counterbalance valve or travel motor safety valve	Replace
Defective travel motor	Replace

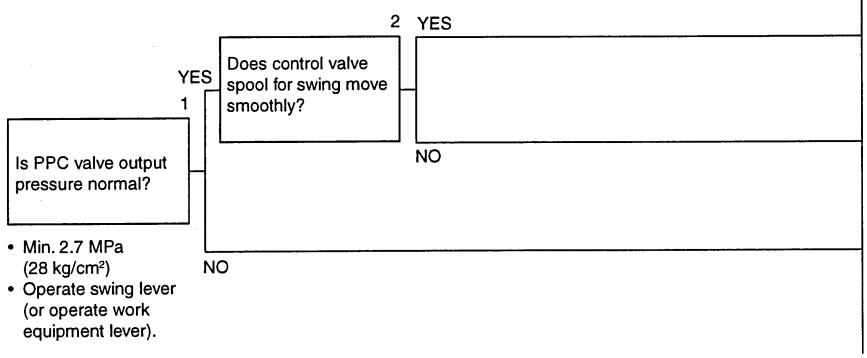
H-25 Does not swing

a) Does not swing to either left or right



Cause	Remedy
Defective swing machinery	Repair or replace
Defective swing holding brake or swing motor	Repair or replace
Defective operation of holding brake solenoid valve	Correct or replace
Defective swing pressure switch	Replace

b) Does not swing in one direction

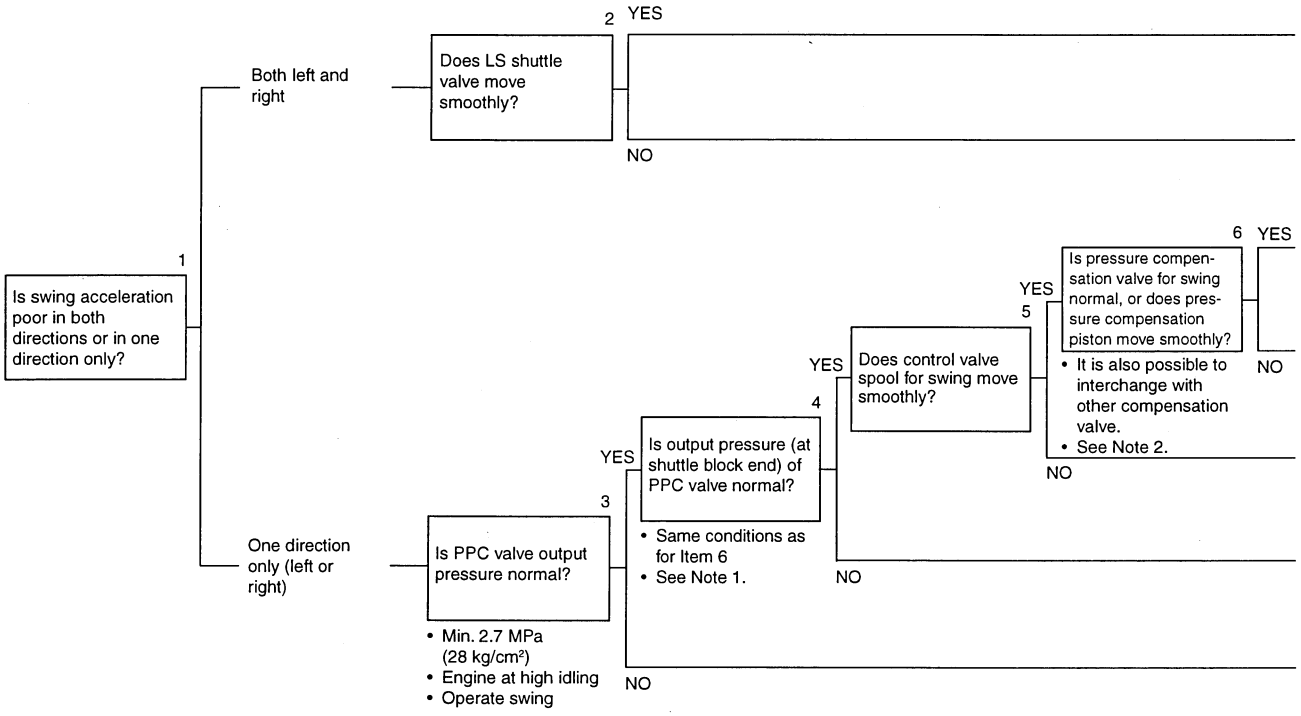


Cause	Remedy
Defective swing motor safety valve or suction valve	Replace
Defective operation of control valve spool for swing	Correct or replace
Defective PPC valve	Replace

H-26 Swing acceleration is poor or swing speed is slow

★ Carry out troubleshooting in the H/O mode.
★ If condition is normal when work equipment is operated independently.

a) Swing acceleration is poor



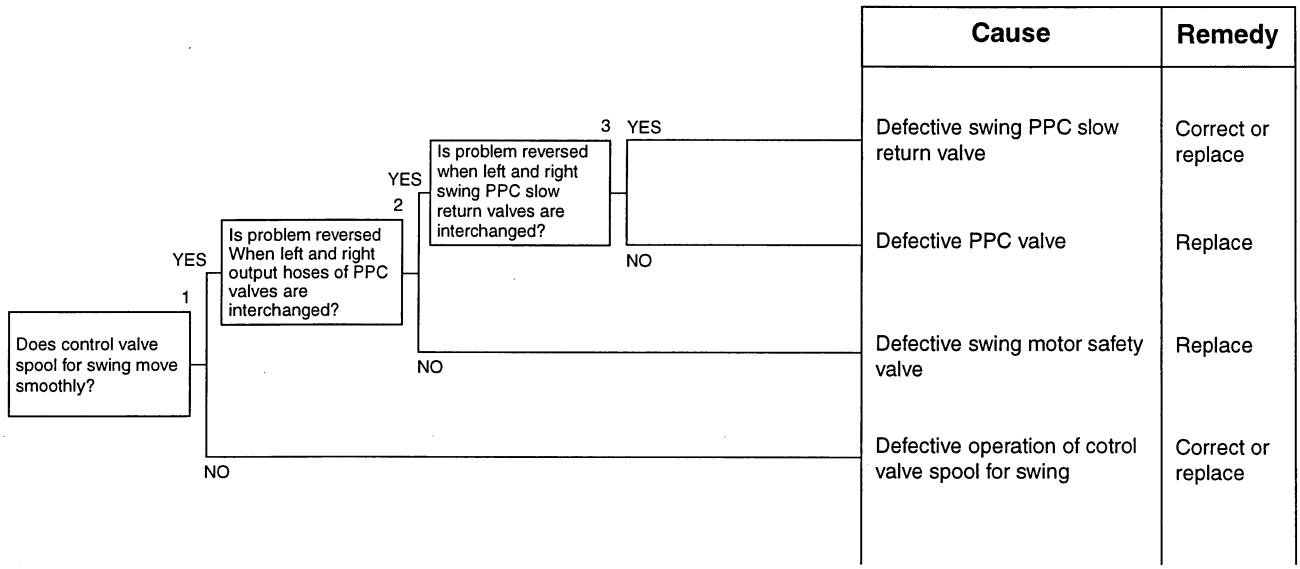
Note 1: • Remove the PPC shuttle block inlet hose, fit an adapter, and block the tip.
• If the adapter for blocking the circuit is not available, interchange the swing PPC hoses with the PPC hoses for the bucket (CURL, DUMP), at both the inlet and outlet ports of the shuttle block, and check operation.

Note 2: After inspection, do not forget to return the interchanged valves to the original position.

Cause	Remedy
Defective swing motor assembly	Replace
Defective operation of LS shuttle valve (all LS shuttles)	Correct or replace
Defective operation of swing motor safetysuction valve	Correct or replace
Defective operation of pressure compensation valve or compensation piston	Correct or replace
Defective operation of control valve spool for swing	Correct or replace
Defective operation of PPC shuttle valve	Correct or replace
Defective PPC valve	Replace

H-27 Excessive overrun when stopping swing

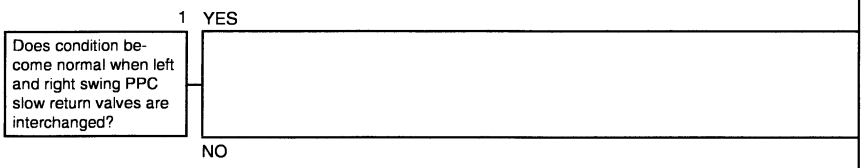
a) One direction only



b) Both directions

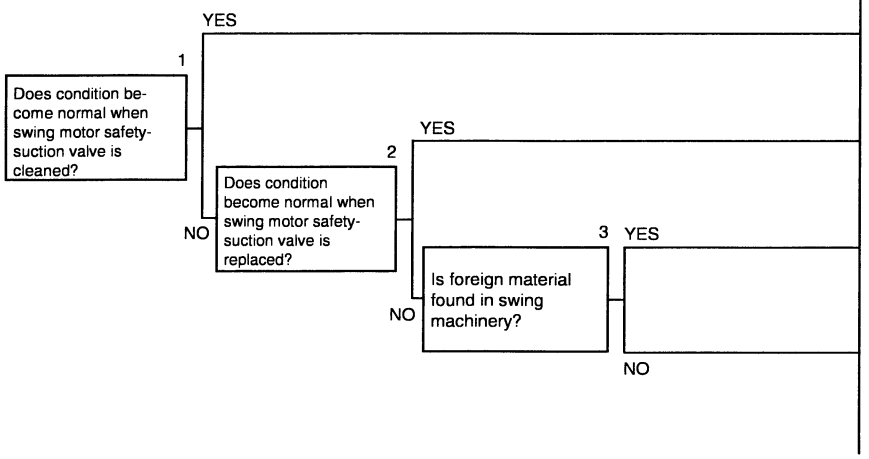
Cause	Remedy
Defective swing motor	Repair or replace

H-28 Excessive shock when stopping swing (one direction only)



Cause	Remedy
Defective swing PPC slow return valve (check valve)	Correct or replace
Defective PPC valve	Replace

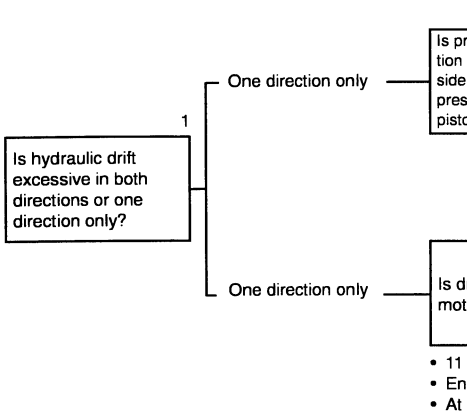
H-29 Excessive abnormal noise when stopping swing



Cause	Remedy
Defective operation of swing motor safetysuction valve	Clean
Defective swing motor safety-suction valve	Replace
Defective swing machinery	Repair or replace
Defective back pressure valve	Correct or replace

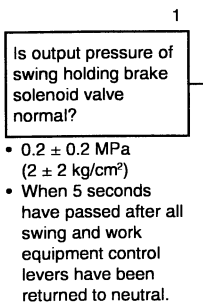
H-30 Excessive hydraulic drift of swing

a) When swing holding brake is released



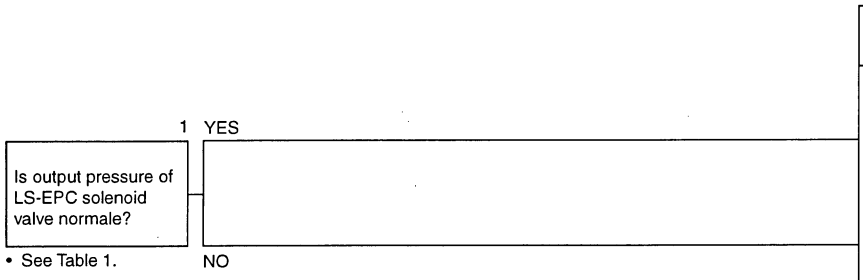
Cause	Remedy
Defective swing motor safety-suction valve	Correct or replace
Defective pressure compensation valve for swing, or defective operation of pressure compensation piston	Correct or replace
Defective control valve spool for swing	Replace
Defective swing motor	Repair or replace

b) When swing holding brake is applied



Cause	Remedy
Defective operation of swing holding brake	Repair or replace
Defective operation of swing holding brake solenoid valve	Correct or replace

H-31 Swing speed is faster than specified swing speed



Cause	Remedy
Defective operation of LS valve	Replace servo assembly
Defective LS-EPC solenoid	Correct or replace

Table 1. Output pressure of LS-EPC solenoid valve

unit: MPa (kg/cm^2)

H/O mode	G/O mode	F/O mode	L/O mode
0.2 ± 0.2 (2.0 ± 2.0)	0.2 ± 0.2 (2.0 ± 2.0)	1.5 ± 0.2 (15.4 ± 2.0)	2.2 ± 0.2 (22.0 ± 2.0)
Enginge at high idling Travel OFF			

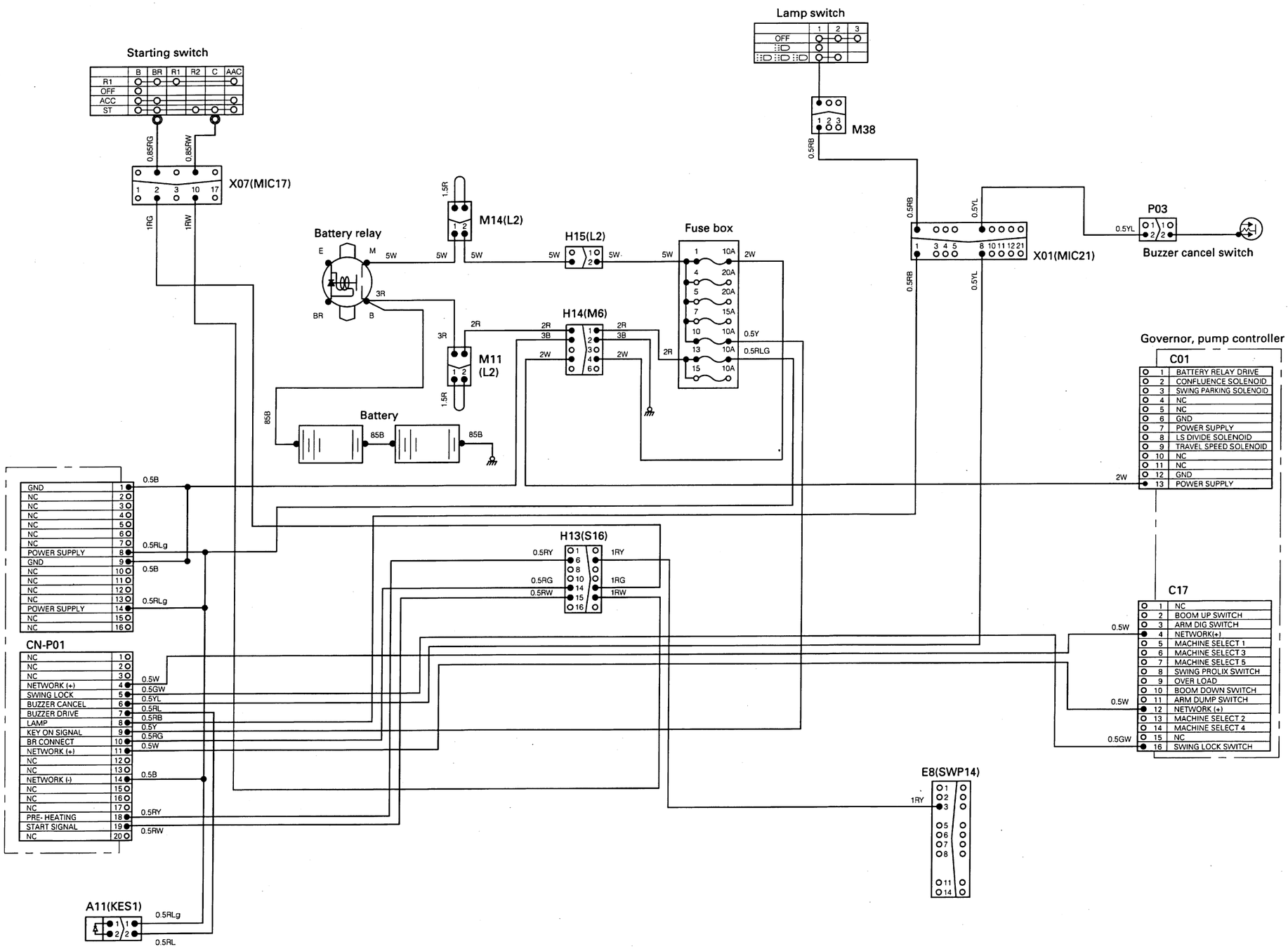
TROUBLESHOOTING OF MACHINE MONITOR SYSTEM (M MODE)

ACTION TAKEN BY MONITOR PANEL WHEN ABNORMALITY OCCURS AND PROBLEMS ON MACHINE

User code	Service code	Abnormal system	Nature of abnormality
-	E101	Abnormality in error data	1. Abnormality in internal memory 2. Excess voltage (more than 36V) has occurred 3. Low voltage (less than 12V) has occurred 4. Connector has separated
-	E102	Abnormality in clock data	1. Abnormality in internal clock function 2. Excess voltage (more than 36V) has occurred 3. Low voltage (less than 12V) has occurred 4. Connector has separated
-	E103	Short circuit in buzzer output system	1. Short circuit inside buzzer 2. Power line in contact with wiring harness between monitor (P01 (7) pin) and buzzer 3. Abnormality in monitor panel
-	E104	Air cleaner clogging detected is displayed	1. Air cleaner clogging sensor has detected clogging
-	E106	Drop in engine oil pressure detected is displayed	1. Engine oil pressure sensor has detected drop in oil pressure
-	E108	Engine water temperature 105°C detected is displayed	1. Coolant temperature gauge has detected water temperature of 105°C

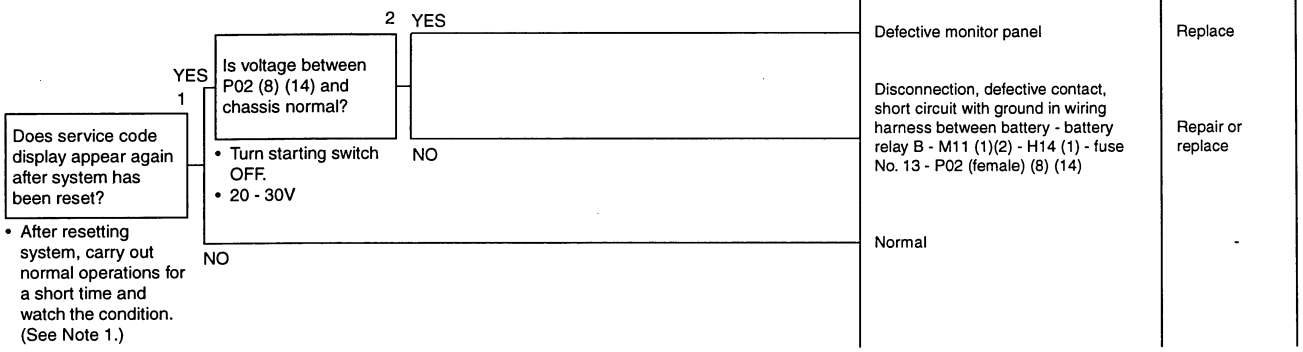
Condition when normal (voltage, current, resistance)	Action by controller when abnormality is detected	Problem that appears on machine when there is abnormality
• When starting switch is turned ON, keep time switch pressed for 5 seconds to actuated clear function	-	1. Service code cannot be cleared 2. Time becomes 00:00
	-	1. Service code cannot be cleared 2. Time becomes 00:00 3. Clock does not advance.
• Voltage between P01 (7) - chassis Buzzer On: Max. 1V Buzzer OFF: 20 - 30V ★ When there is a disconnection, E103 is not displayed and the buzzer does not sound	-	1. Buzzer does not sound
• Resistance between P11 (male) - P12 (male): Min 1Ω (engine started)	-	1. If abnormality detection continues, air cleaner clogging caution lamp flashes and buzzer sounds
• Resistance between sensor terminal and chassis: Min. 1 MΩ (engine at mid-range speed or above)	-	1. If abnoramlity detection continues, engine oil pressure caution lamp flashes and buzzer sounds
• Resistance between P07 (1) - (2): Min. 3.156 Ω (engine started)	-	1. If anbormality detection continues, coolant temperature caution lamp flashes and buzzer sounds 2. If abnormality detection continues, engine speed is reduced to low idling

ELECTRICAL CIRCUITDIAGRAM FOR M MODE SYSTEM



M-1 [E101] Abnormality in error data is displayed [E102] Error in clock data is displayed

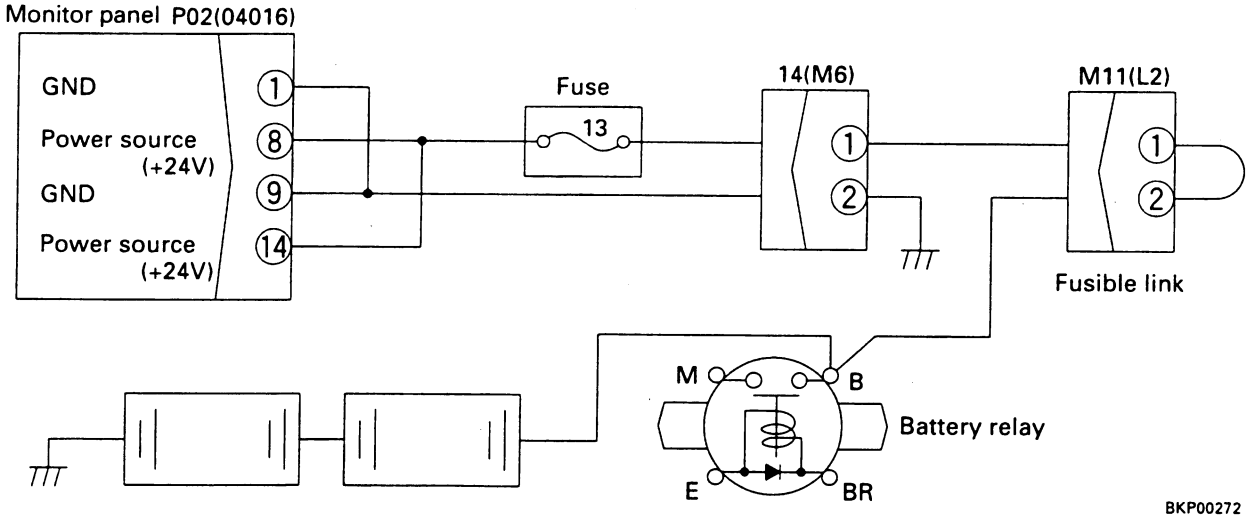
★ This is not an abnormality. It occurs during troubleshooting when disconnecting and connecting connector P02 (for the monitor panel electrical system), fuse No. 13, connector M14, connector M11, battery relay terminal B, or the battery terminal.
(When the monitor panel power source circuit is shut off with the starting switch turned OFF.)
★ If the service code display appears again after the system has been reset, carry out troubleshooting as follows.
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



Cause	Remedy
Defective monitor panel	Replace
Disconnection, defective contact, short circuit with ground in wiring harness between battery - battery relay B - M11 (1)(2) - H14 (1) - fuse No. 13 - P02 (female) (8) (14)	Repair or replace
Normal	-

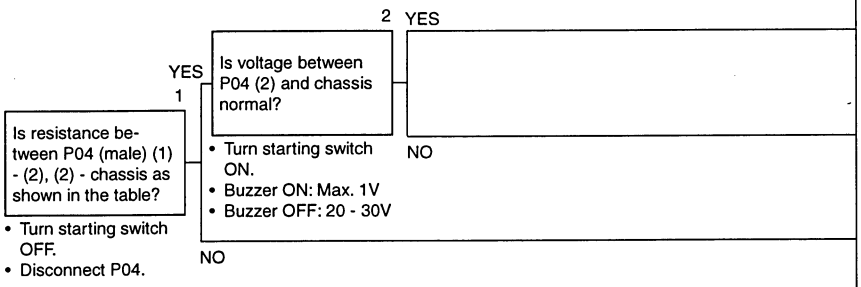
Note 1: Resetting operation:
Turn the starting switch OFF. Then keep the time switch at the back of the monitor panel depressed, switch the starting switch ON again, and keep the time switch depressed for 5 seconds to return the system to normal.
(With this operation, all the service codes in the internal memory are erased.)

M-1 Related electric circuit diagram



M-2 [E103] Short circuit in buzzer output or contact of 24V wiring harness with buzzer drive harness is displayed

★ If the starting switch is turned OFF after an abnormality occurs, turn the starting switch ON and check if an E service code is displayed. (If it is not displayed, the system has been reset.)
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

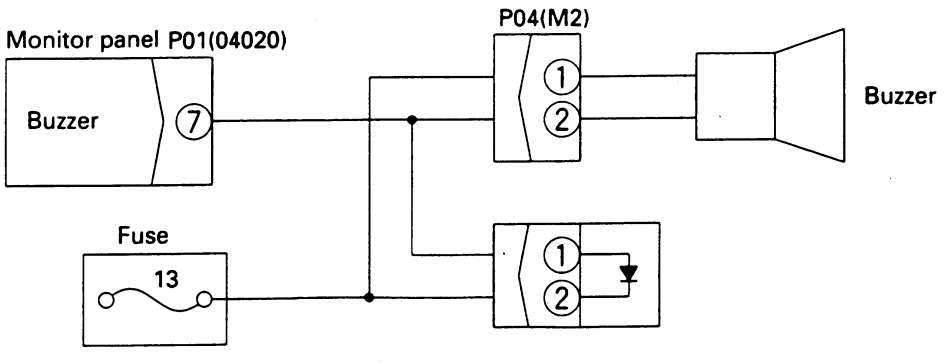


Cause	Remedy
Defective monitor panel	Replace
Short circuit with power source in wiring harness between P01 (female) (7) and P04 (female) (2) or short circuit in wiring harness between P04 (1) and (2)	Repair or replace
Defective buzzer	Replace

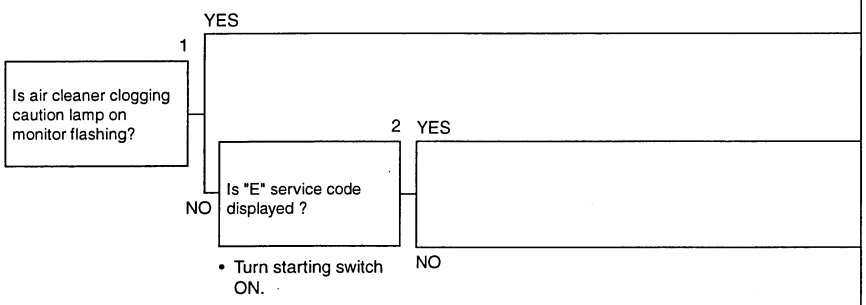
Table

P04 (male)	Resistance value
Between (1) and (2)	200 - 300 Ω
Between (2) and chassis	Min. 1 MΩ

M-2 Related electric circuit diagram



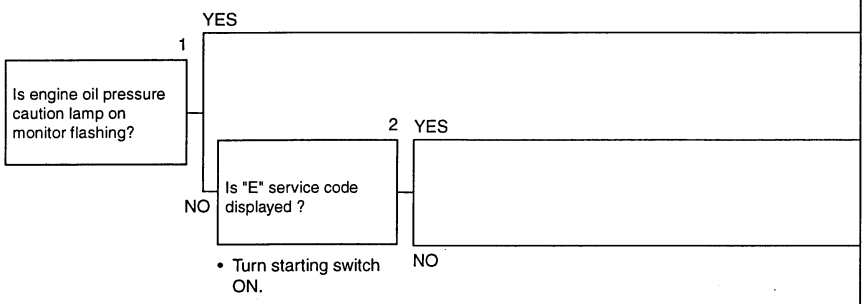
M-3 [E104] Air clogging detected is displayed



Cause	Remedy
See M-13 f)	-
Defective monitor panel	Replace
Failure in engine system (See Note 1)	-

Note 1: The monitor panel display has returned to normal, but the air cleaner clogging sensor has detected symptoms of clogging in the past, so carry out troubleshooting of the engine to remove the problem

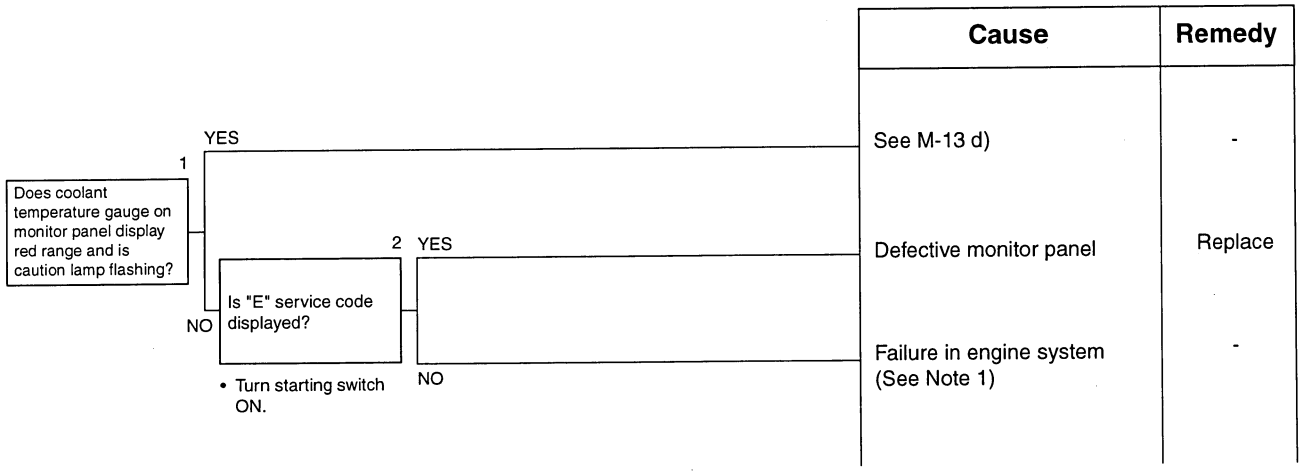
M-4 [E106] Drop in engine oil pressure detected is displayd



Cause	Remedy
See M-13 a)	-
Defective monitor panel	Replace
Failure in engine system (See Note 1)	-

Note 1: The monitor panel display has returned to normal, but the engine oil pressure sensor has detected symptoms of a drop in the oil pressure in the past, so carry out troubleshooting of the engine to remove the problem.

M-5 [E108] Engine water temperature 105°C detected is displayed

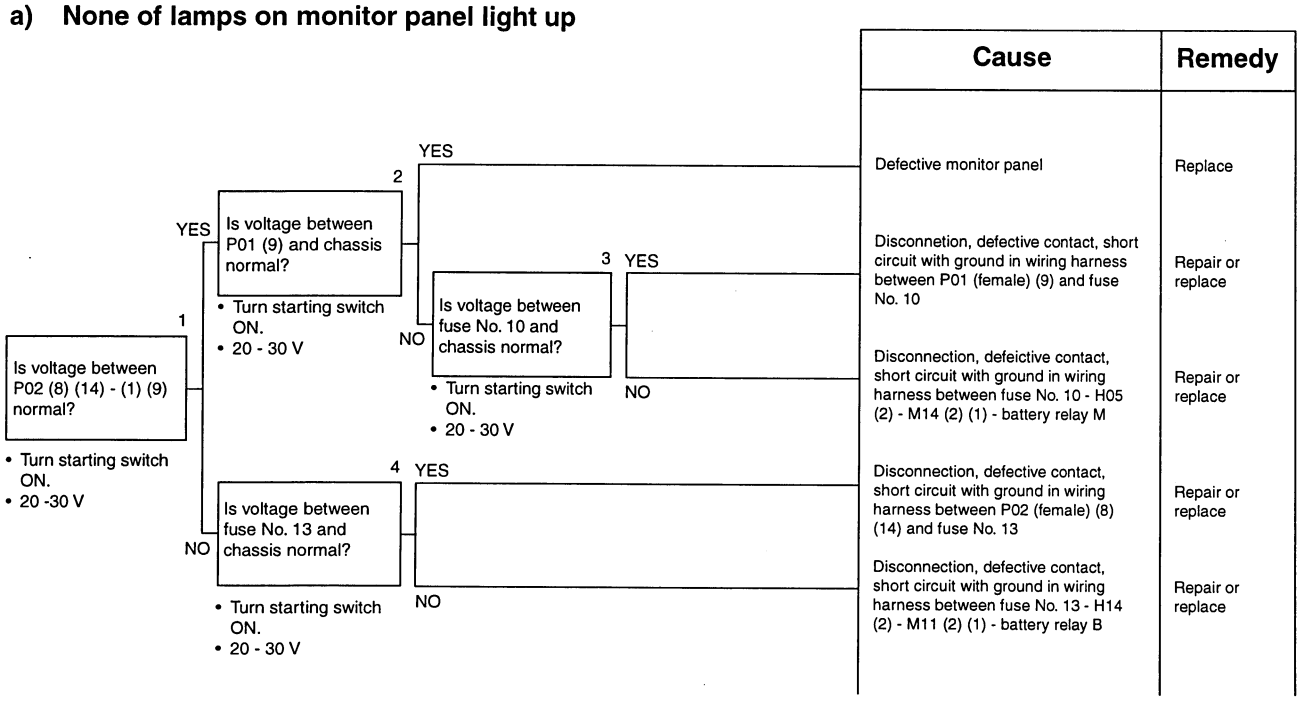


Note 1: The monitor panel display has returned to normal, but the coolant temperature sensor has detected symptoms of the coolant temperature reaching 105°C in the past, so carry out troubleshooting of the engine to remove the problem.

M-6 When starting switch is turned ON, none of the lamps on the monitor panel light up for 3 seconds

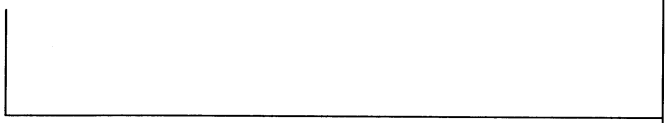
★ Check that fuses No. 10 and 13 are not blown.
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

a) None of lamps on monitor panel light up



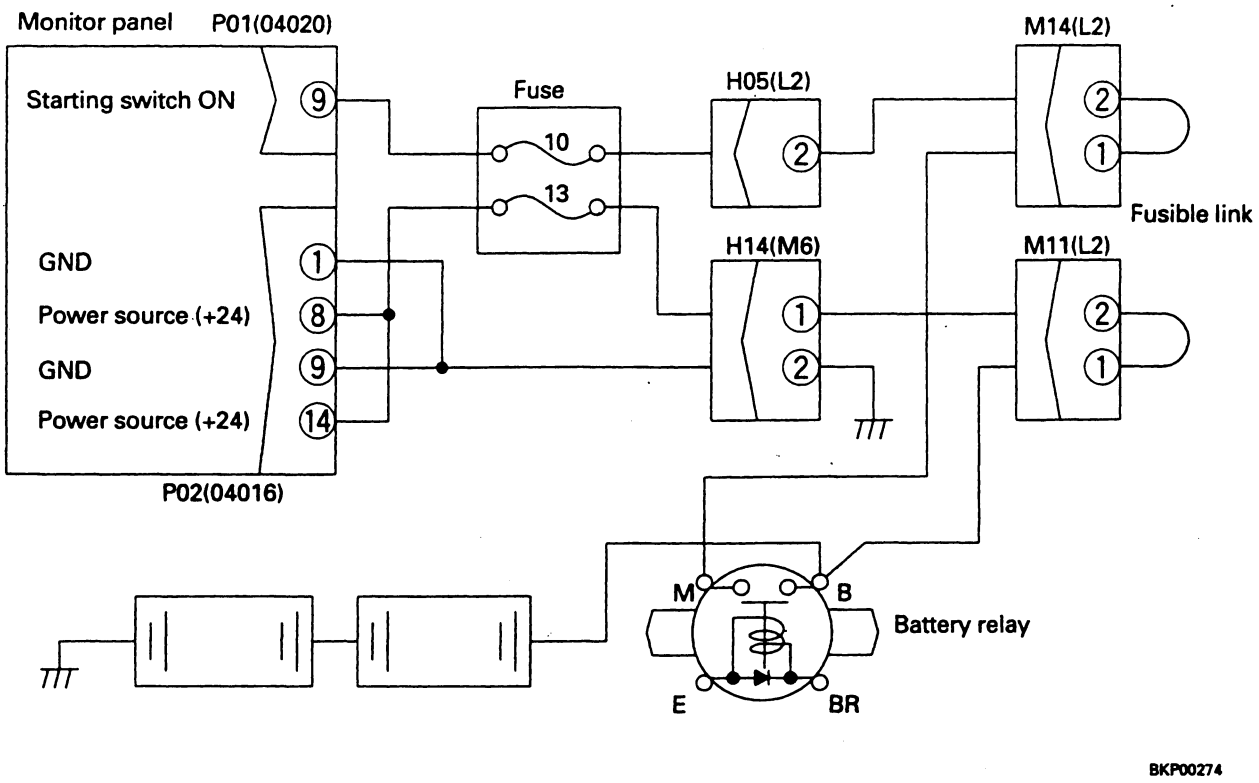
Cause	Remedy
Defective monitor panel	Replace
Disconnetion, defective contact, short circuit with ground in wiring harness between P01 (female) (9) and fuse No. 10	Repair or replace
Disconnection, defeictive contact, short circuit with ground in wiring harness between fuse No. 10 - H05 (2) - M14 (2) (1) - battery relay M	Repair or replace
Disconnection, defective contact, short circuit with ground in wiring harness between P02 (female) (8) (14) and fuse No. 13	Repair or replace
Disconnection, defective contact, short circuit with ground in wiring harness between fuse No. 13 - H14 (2) - M11 (2) (1) - battery relay B	Repair or replace

b) Some of lamps on monitor panel do not light up



Cause	Remedy
Defective monitor panel	Replace

M-6 a) Related electric circuit diagram



M-7 When starting switch is turned ON, monitor panel lamps all stay lit up and do not go out

Cause	Remedy
Defective monitor panel	Replace

M-8 When starting switch is turned ON, items lit up on monitor panel are different from actual machine (model)

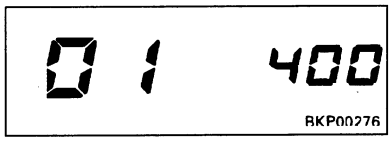
★ Immediately after replacing the monitor panel, turn the starting switch OFF, then turn it On again

1 Is display of monitoring code 01 as shown in table?

- Turn starting switch ON.
- Set to monitoring code 01.

Cause	Remedy
YES: Defective monitor panel	Replace
NO: Go to troubleshooting for C mode (See C-14)	-

Table



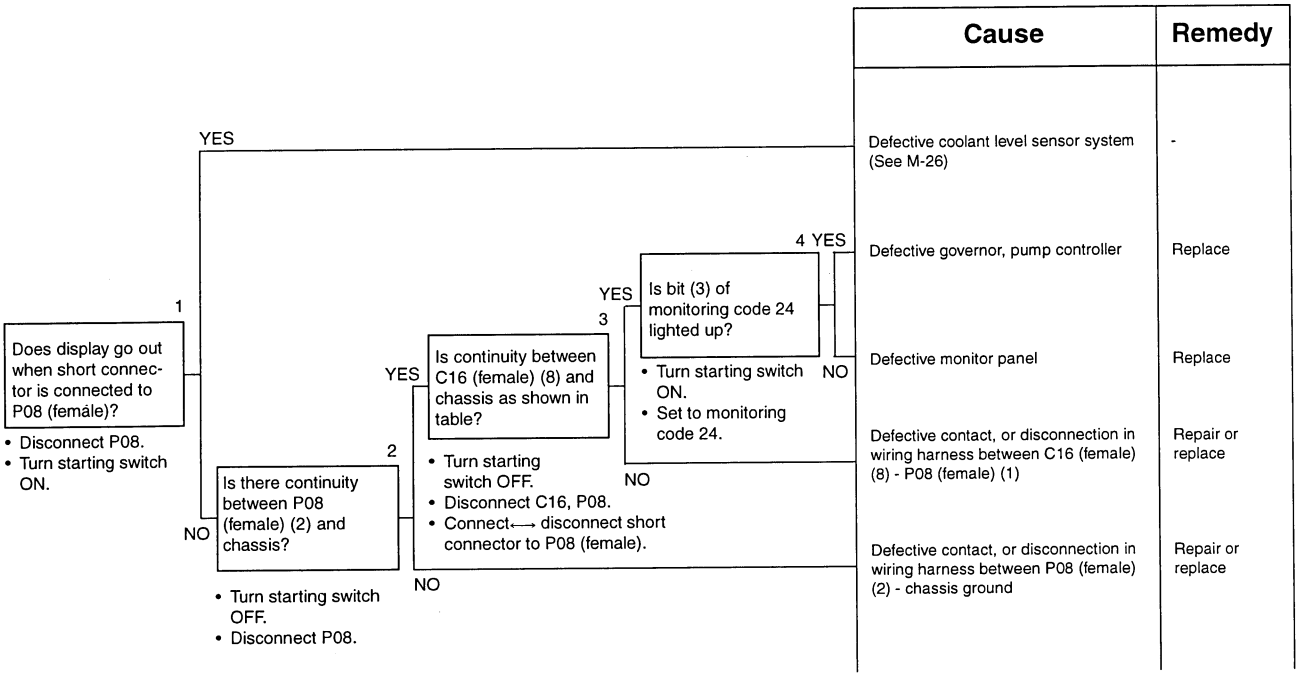
M-9 When starting switch is turned ON (engine stopped), basic check items flashes

★ Before carrying out troubleshoting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

a) (coolant level) flashes

SAP00519

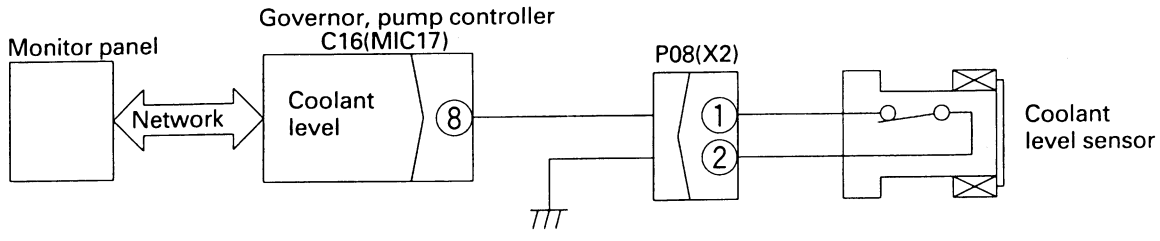
★ Check that the coolant is at the specified level before carrying out troubleshooting.



Table

Short connector	Continuity
Connected	Yes
Disconnected	No

M-9 a) Related electric circuit diagram

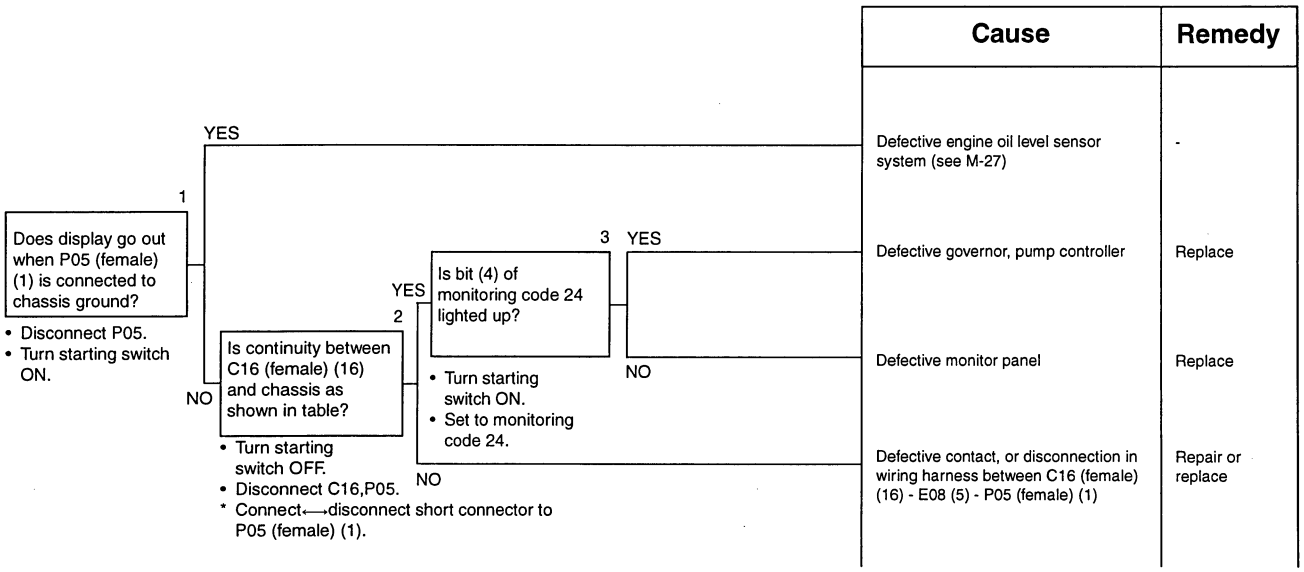


BKP00277

b) (coolant level) flashes

SAP00523

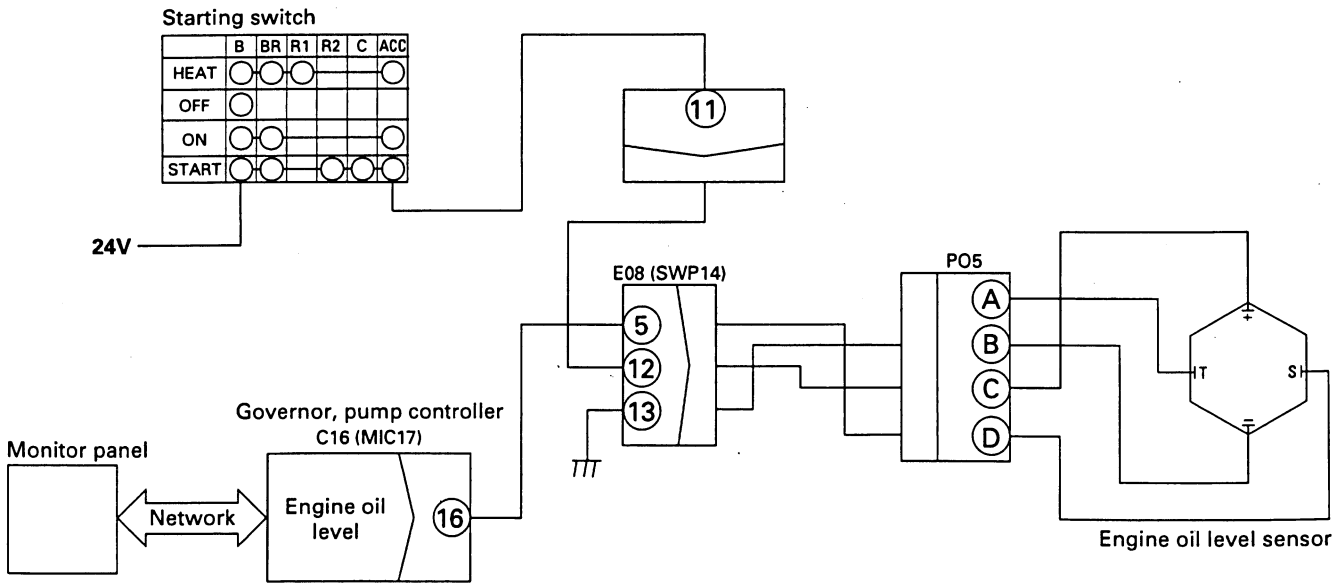
★ Chek that the engine oil is at the specified level before carrying out troubleshooting.



Table

Chssis ground	Continuity
Connected	Yes
Disconnected	No

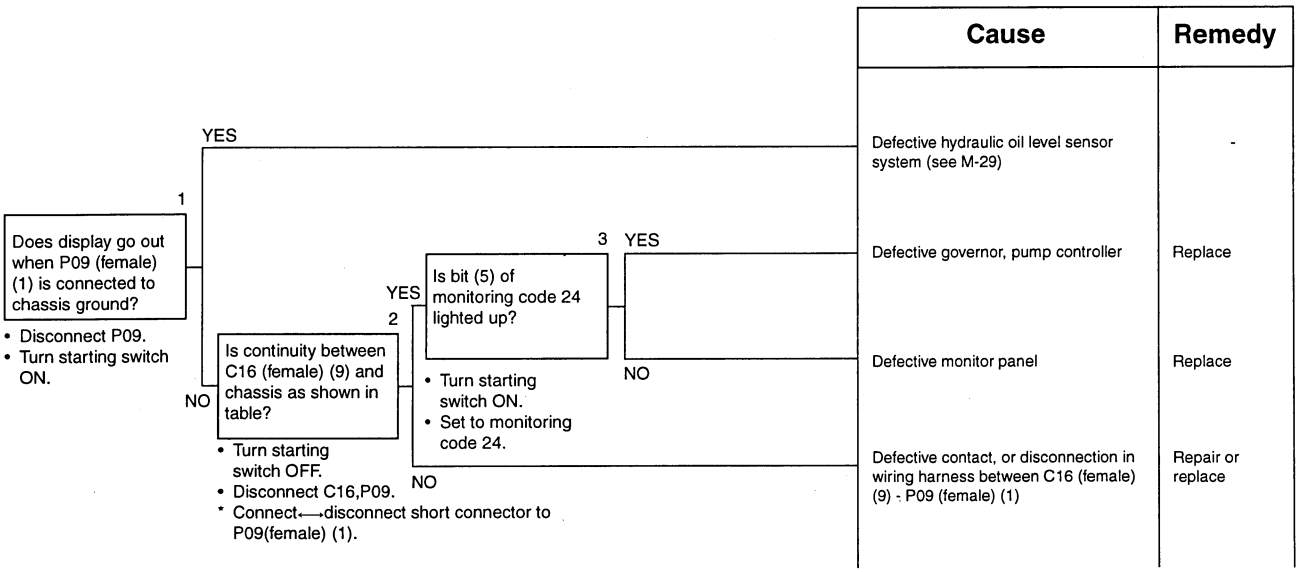
M-9 b) Related electric circuit diagram



c) (hydraulic oil level) flashes

SAP00524

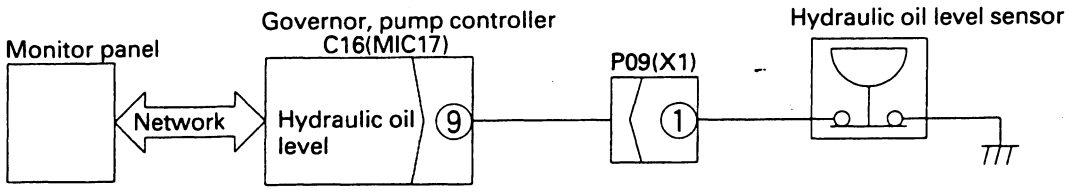
★ Check that the hydraulic oil is at the specified level before carrying out troubleshooting



Table

Chassis ground	Continuity
Connected	Yes
Disconnected	No

M-9 c) Related electric circuit diagram

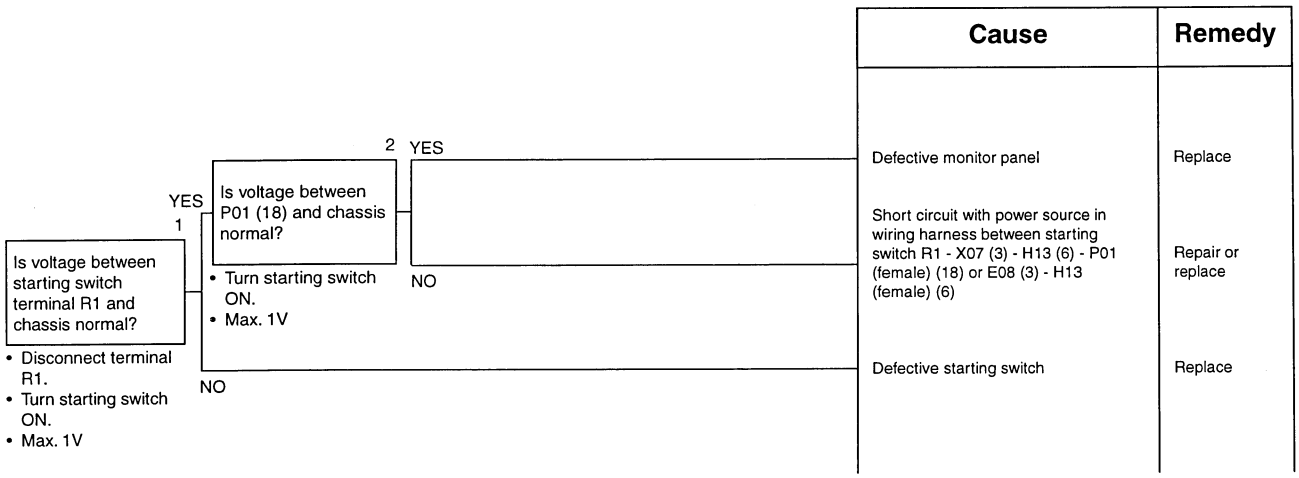


BKP00279

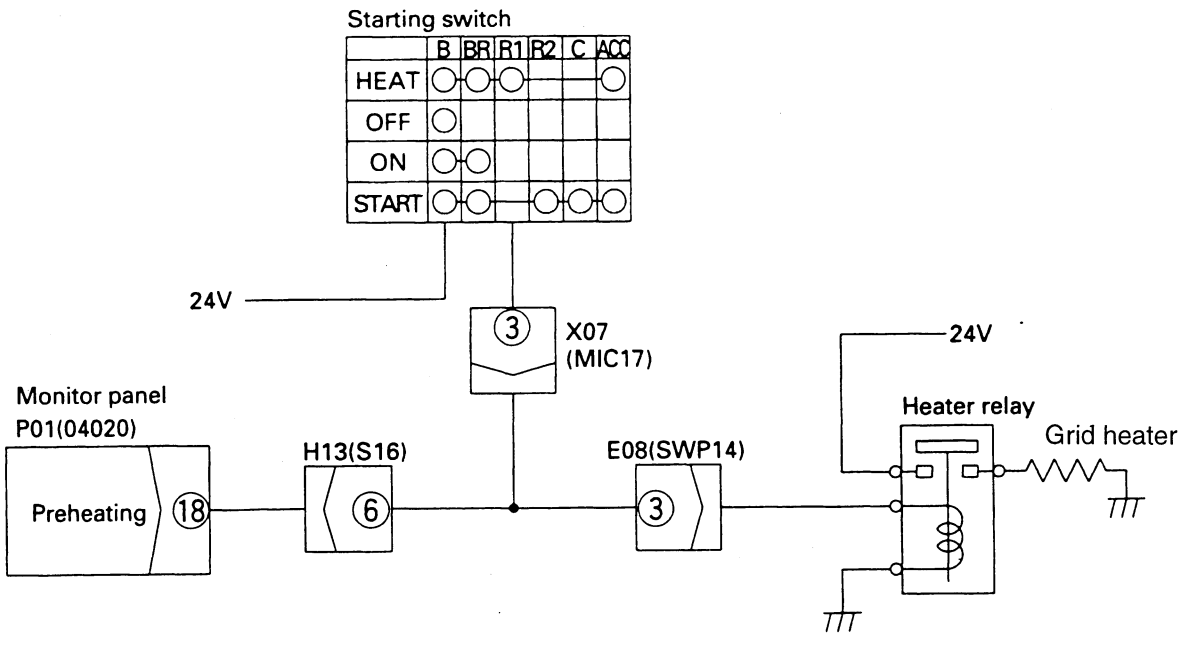
M-10 Preheating is not being used but (preheating monitor) lights up

SAP00526

★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



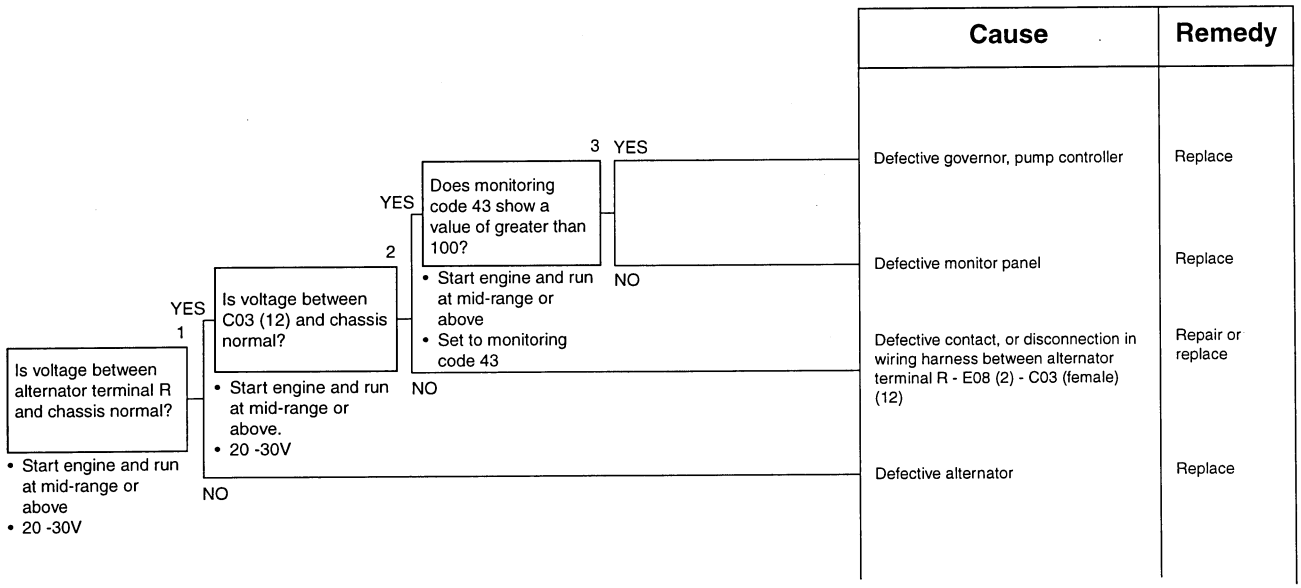
M-10 Related electric circuit diagram



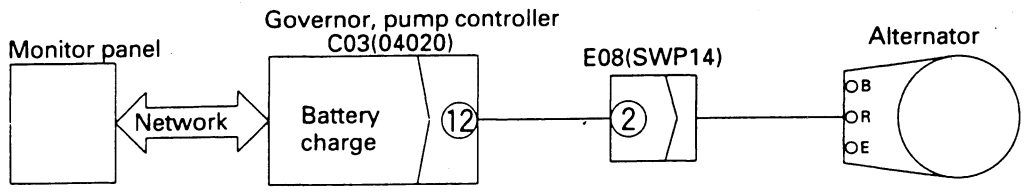
M-11 When starting switch is turned ON and engine is started, basic check items flash

★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.
★ Check both the alternator system and the engine oil pressure system.

a) Alternator system



M-11 a) Related electric circuit diagram

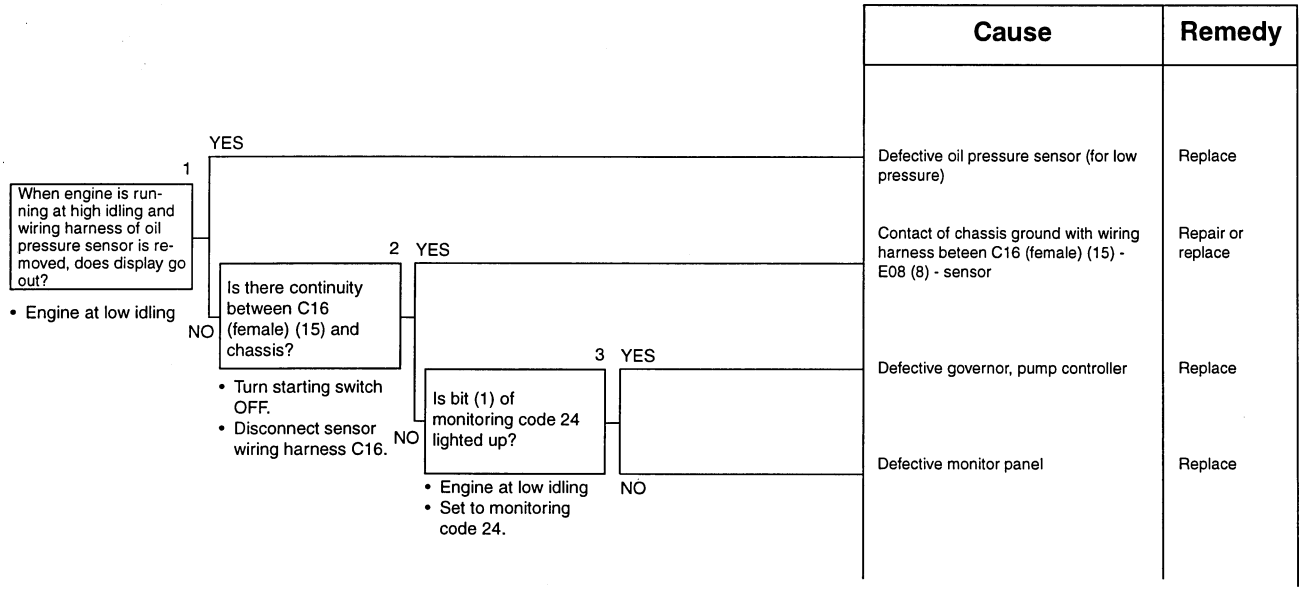


BKP00282

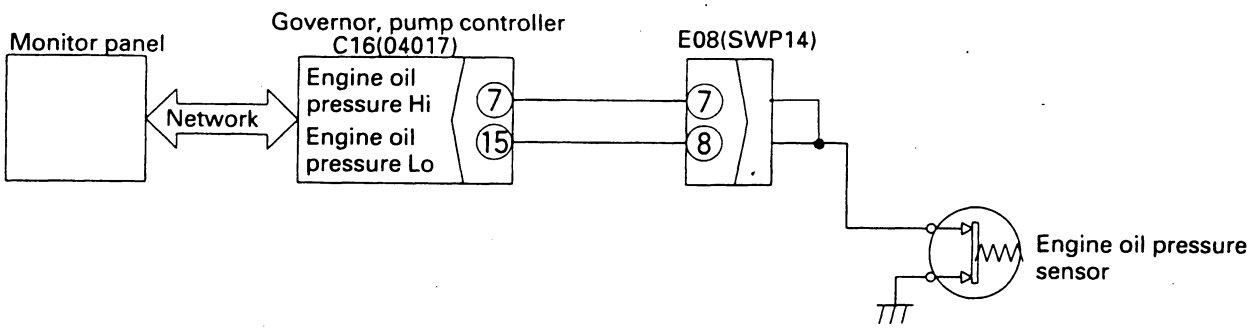
b) Engine oil pressure system

★ When engine oil pressure is normal

1) Low-pressure sensor



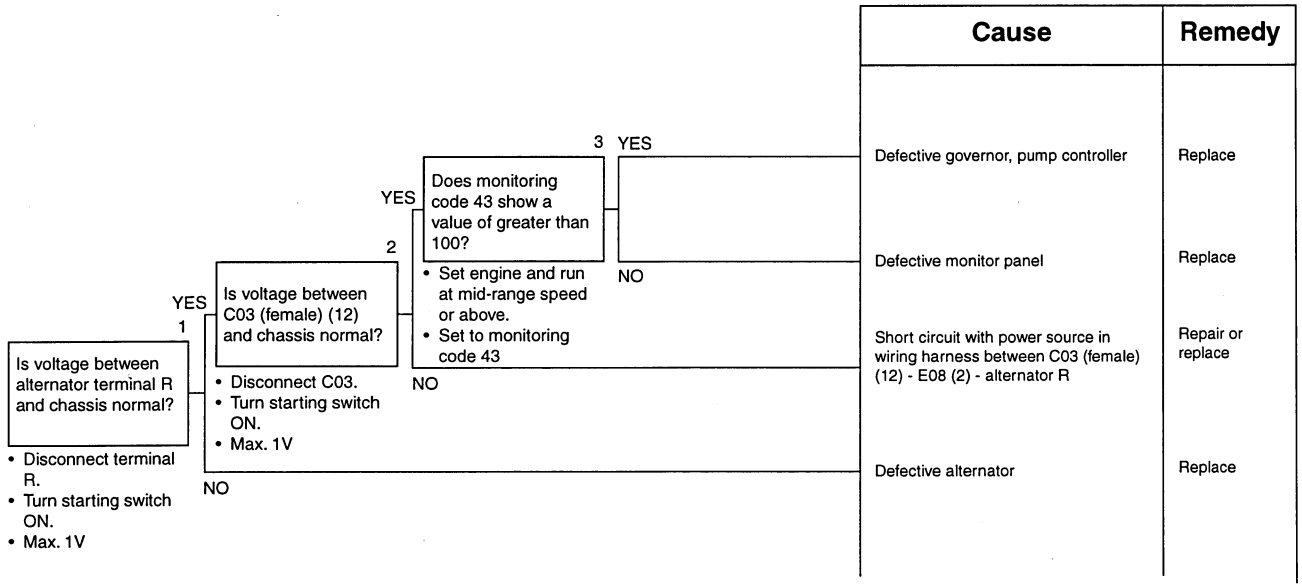
M-11 b) Related electric circuit diagram



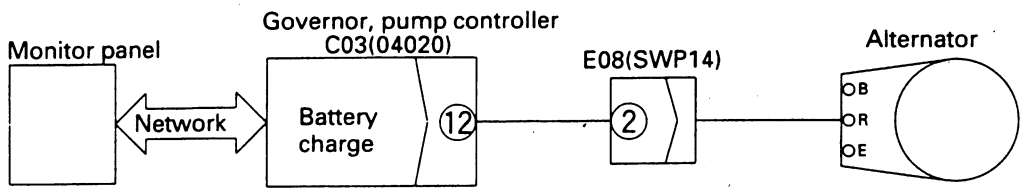
M-12 When starting switch is turned ON (engine stopped), caution items, emergency items flash (battery, engine oil pressure lamps do not light up)

★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.
★ Check both the alternator system and the engine oil pressure system.

a) Alternator system



M-12 a) Related electric circuit diagram

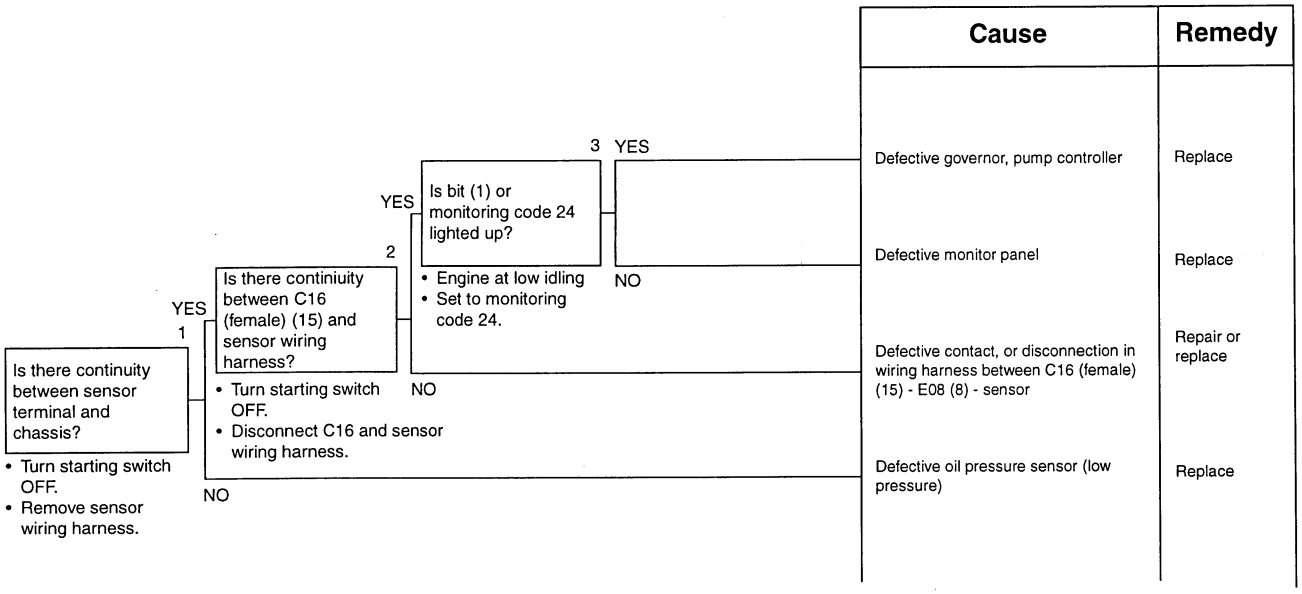


BKP00282

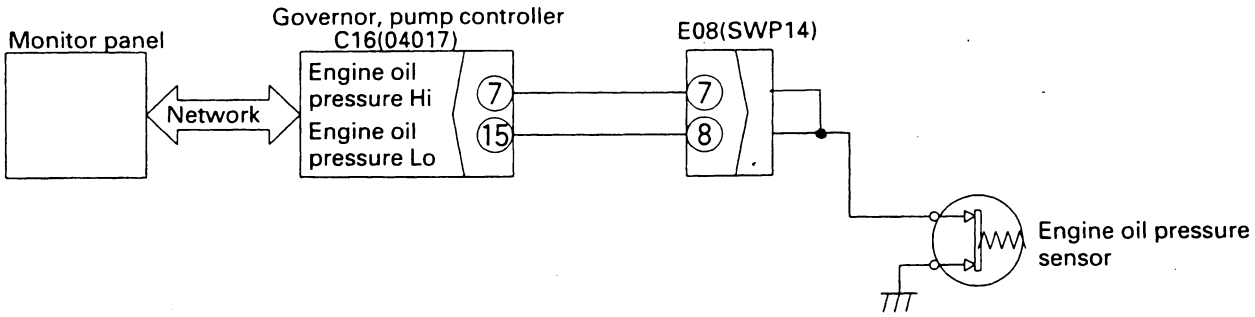
b) Engine oil pressure sensor system

★ When engine oil pressure is normal.

1) Low-pressure sensor



M-12 b) Related electric circuit diagram



M-13 When starting switch is turned ON and engine is started, caution items, emergency items flash (then there is no abnormality in engine or items to check before troubleshooting)

★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

a) (engine oil pressure) flashes


SAP00520

★ Check that the engine oil pressure is normal before carrying out troubleshooting.

Cause	Remedy
See M-11 b)	-

b) (coolant level) flashes


SAP00519

★ Check that the coolant level is normal before carrying out troubleshooting.

Cause	Remedy
See M-9 a)	-

c) (battery charge) flashes

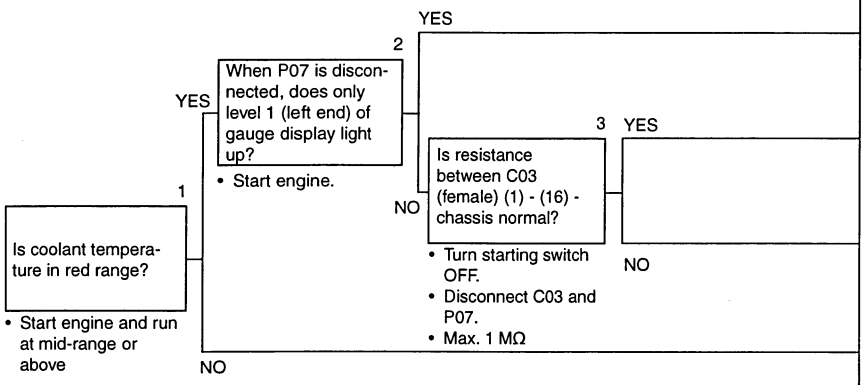

SAP00522

Cause	Remedy
See M-11 a)	-

d) (coolant temperature) flashes

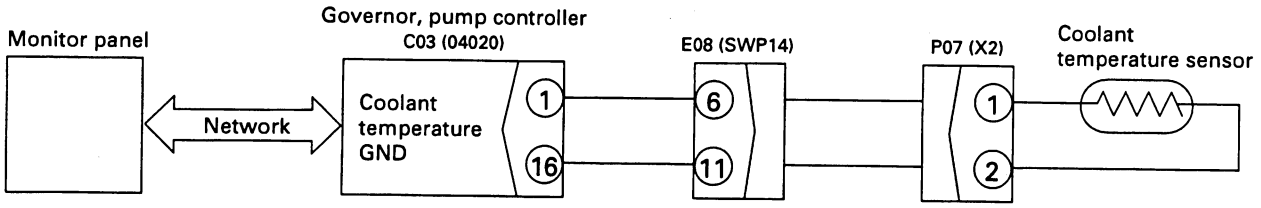
SAP00527

★ Check that the coolant temperature is normal before carrying out troubleshooting



Cause	Remedy
Defective coolant temperature sensor system (see M-26)	-
Defective governor, pump controller	Replace
Short circuit of wiring harness between, C03 (female) (1) - E08 (6) - P07 (female) (1) and wiring harness between C03 (female) (16) - E08 (11) - P07 (female) (2)	Repair or replace
Defective monitor panel	Replace

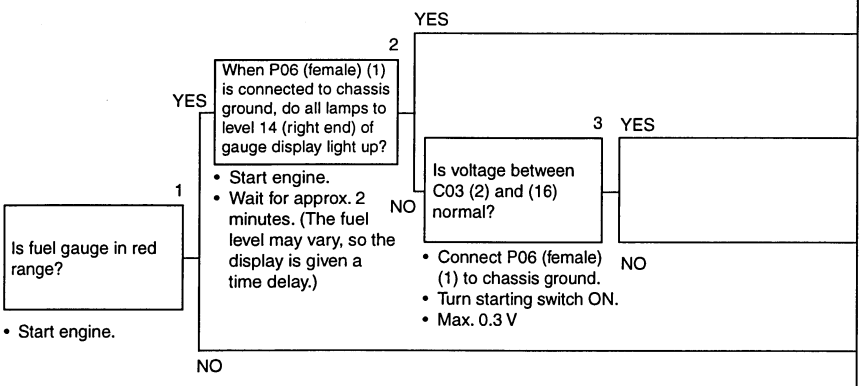
M-13 d) Related electric circuit diagram



e) (feul level) flashes

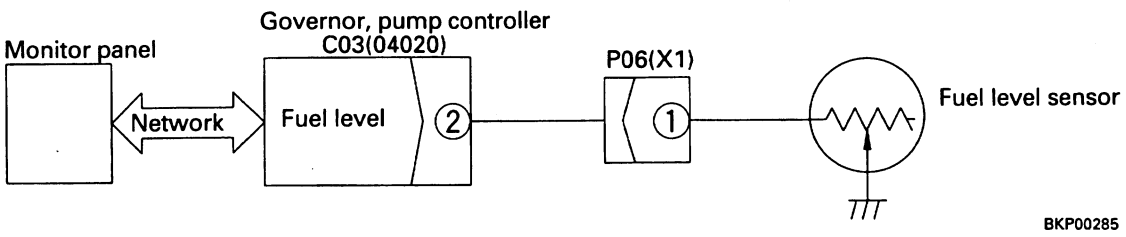
SAP00528

★ Check that there is fuel before carrying out troubleshooting.



Cause	Remedy
Defective fuel level sensor system (see M-25)	-
Defective governor, pump controller	Replace
Defective contact or disconnection in wiring harness between C03 (female) (2) and P06 (feamle) (1)	Repair or replace
Defective monitor panel	Replace

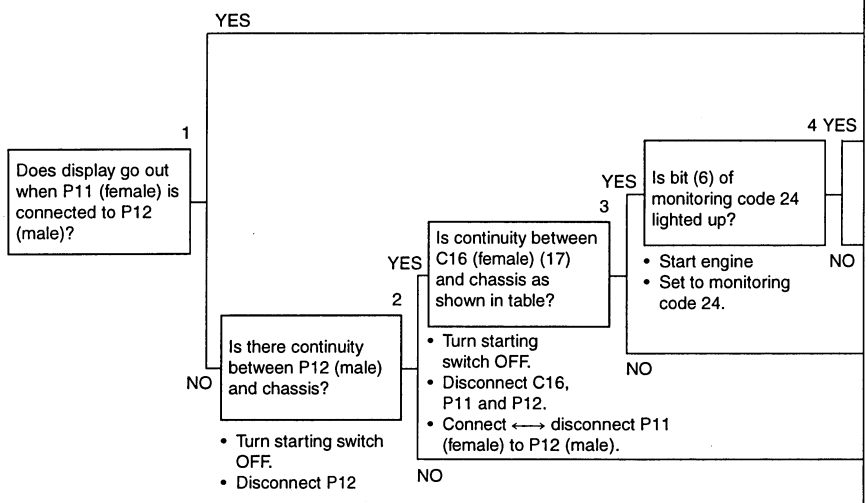
M-13 e) Related electric circuit diagram



f)  (air cleaner clogging) flashes

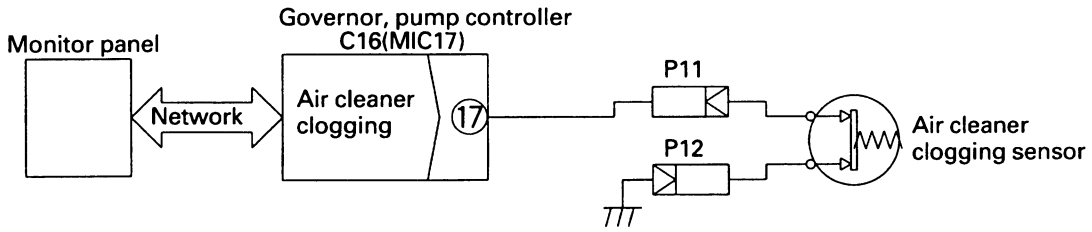
SAP00521

★ Check that the air cleaner is not clogged before carrying out troubleshooting



Cause	Remedy
Defective air cleaner clogging sensor	Replace
Defective governor, pump controller	Replace
Defective monitor panel	Replace
Defective contact or disconnection in wiring harness between C16 (female) (17) and P11 (female)	Repair or replace
Defective contact or disconnectrion in wiring harness between P12 (male) and chassis ground	Repair or replace

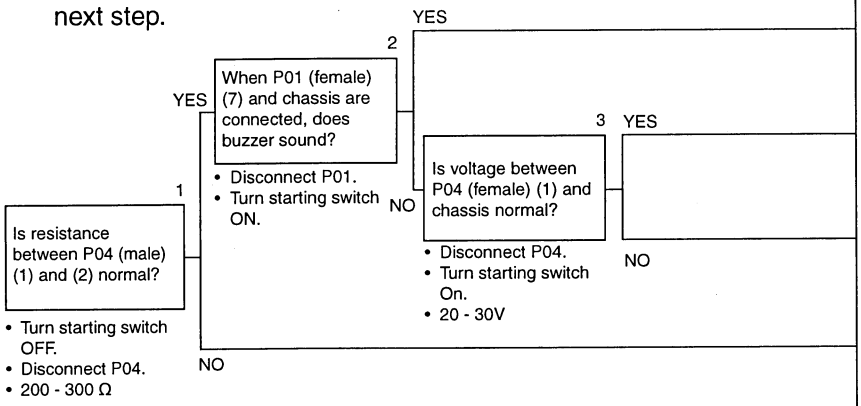
M-13 f) Related electric circuit diagram



BKP00286

M-14 When starting switch is turned ON (engine stopped), buzzer does not sound for 1 second Caution item flashes but buzzer does not sound

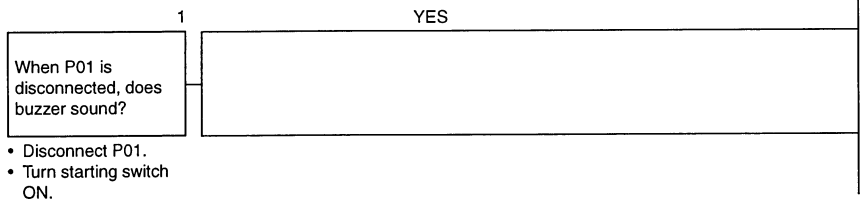
★ Of the caution items, the buzzer will not sound even if there is an abnormality in the battery charge or fuel level.
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



Cause	Remedy
Defective monitor panal	Replace
Defective contact or disconnection in wiring harness between P01 (female) (7) and P04 (female) (2).	Repair or replace
Disconnection, defective contact, short circuit with ground in wiring harness between P04 (female) (1) and fuse No. 13	Repair or replace
Defective buzzer	Replace

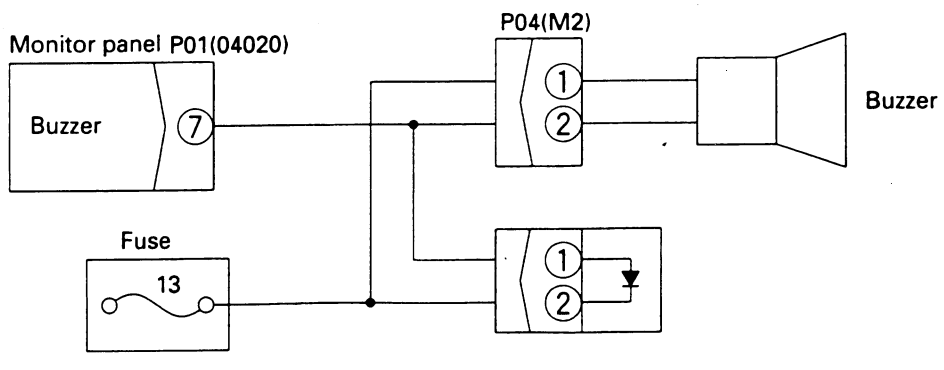
M-15 No abnormality is displayed on monitor but buzzer sounds

★ When the buzzer sounds continuously.
If the buzzer sounds intermittently, carry out troubleshooting M-14.)
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



Cause	Remedy
Contact of chassis ground with wiring harness between P01 (female) (7) and P04 (female) (2), or defective buzzer	Repair or replace
Defective monitor panel	Replace

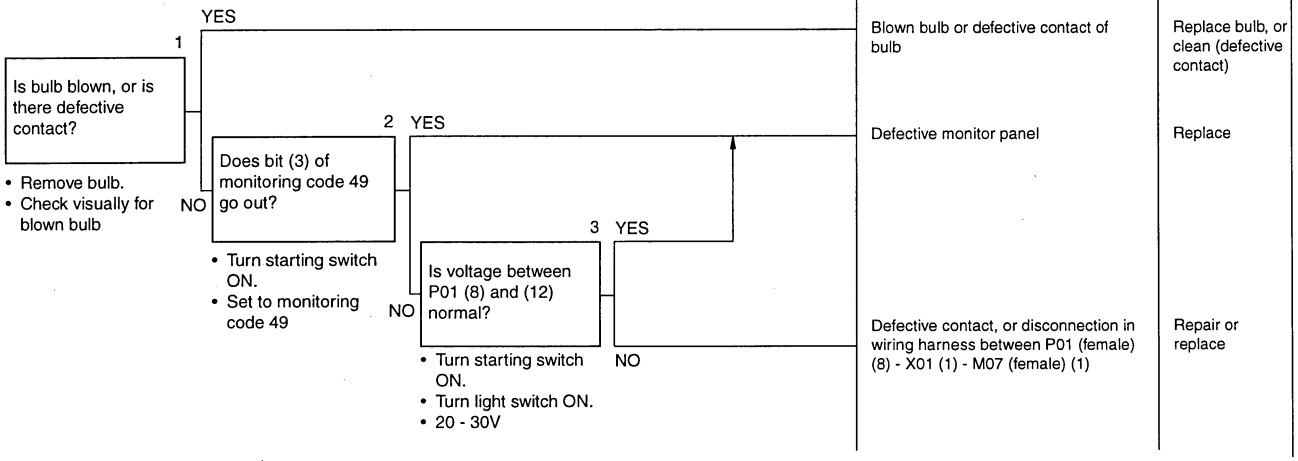
M-14, 15 Related electric circuit diagram



BKP00273

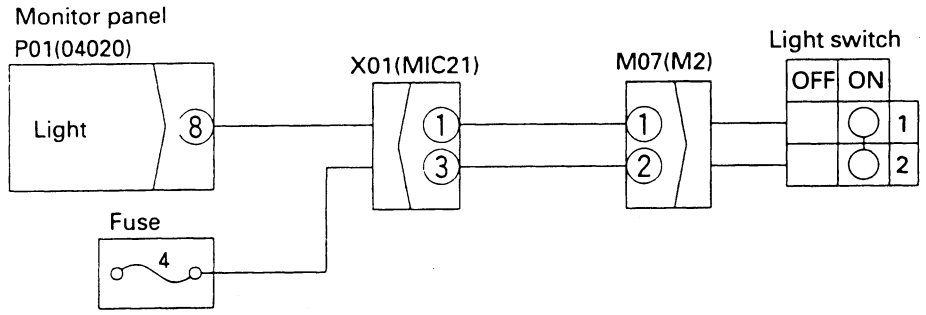
M-16 Night lighting on monitor panel does not light up (liquid crystal display is normal)

★ When the front lamp and working lamp light up normaly



Cause	Remedy
Blown bulb or defective contact of bulb	Replace bulb, or clean (defective contact)
Defective monitor panel	Replace
Defective contact, or disconnection in wiring harness between P01 (female) (8) - X01 (1) - M07 (female) (1)	Repair or replace

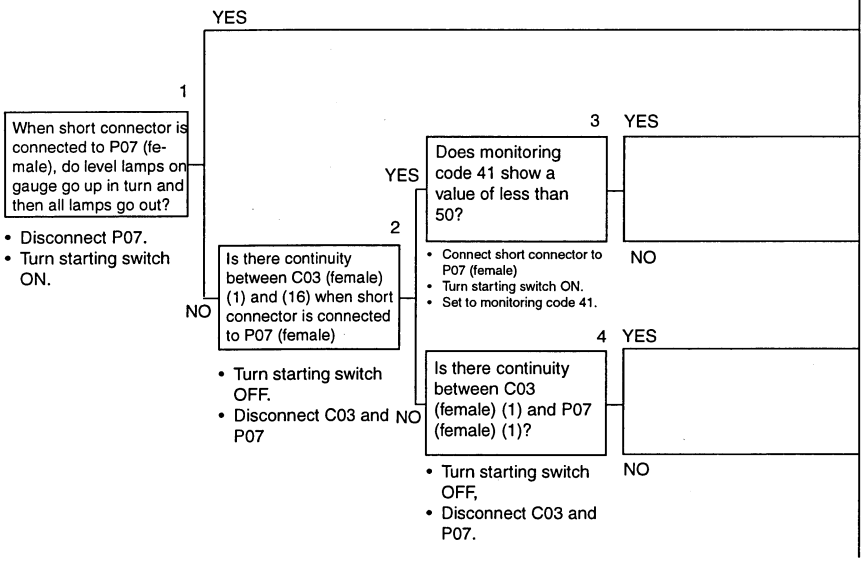
M-16 Related electric circuit diagram



BKP00287

M-17 Coolant temperature gauge does not rise

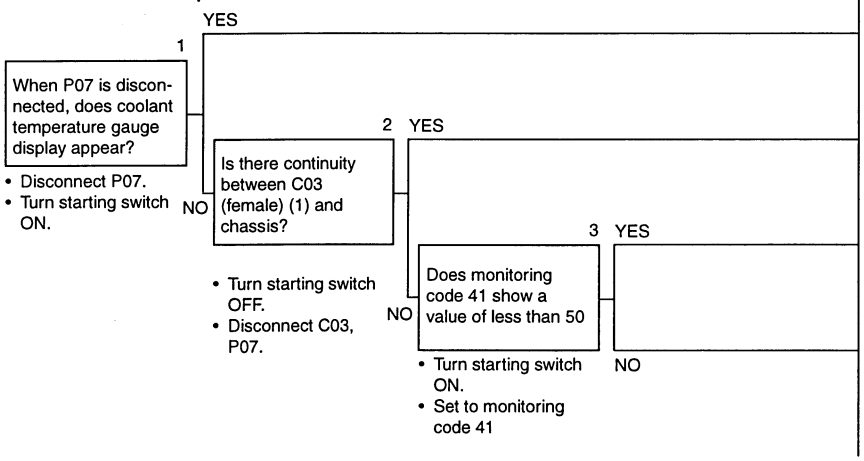
★ If the coolant temperature actually does not rise, check the engine system.
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



Cause	Remedy
Defective coolant temperature sensor system (see M-26)	-
Defective monitor panal	Replace
Defective governor, pump controller	Replace
Defective contact, or disconnection in wiring harness between C03 (female) (16) - E08 (11) - P07 (female) (2)	Repair or replace
Defective contact or disconnection in wiring harness between C03 (female) (1) - E08 (6) - P07 (female) (1)	Repair or replace

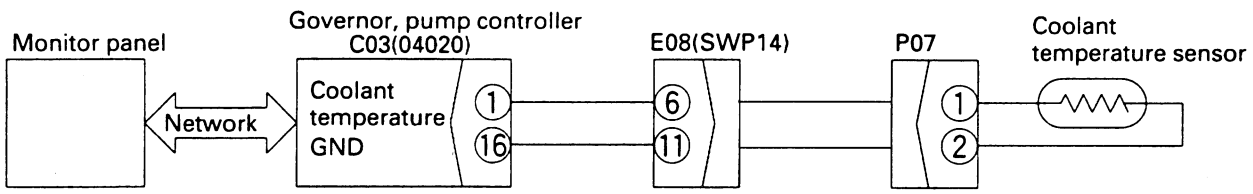
M-18 Coolant temperature gauge does not give any display (none of gauge lamps light up during operation)

★ Before carrying out troubleshooting, check that all the related connectores are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



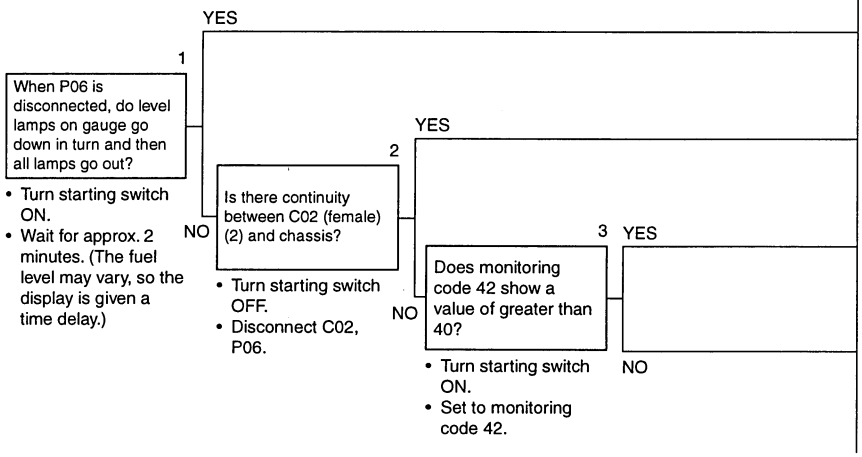
Cause	Remedy
Defective coolant temperature sensor system (see M-26)	-
Contact of chassis ground with wiring harness between C03 (female) (1) - E08 (6) - P07 (female) (1)	Repair or replace
Defective governor, pump controller	Replace
Defective montior panel	Replace

M-17, 18 Related electric circuit diagram



M-19 Fuel level gauge always displays FULL

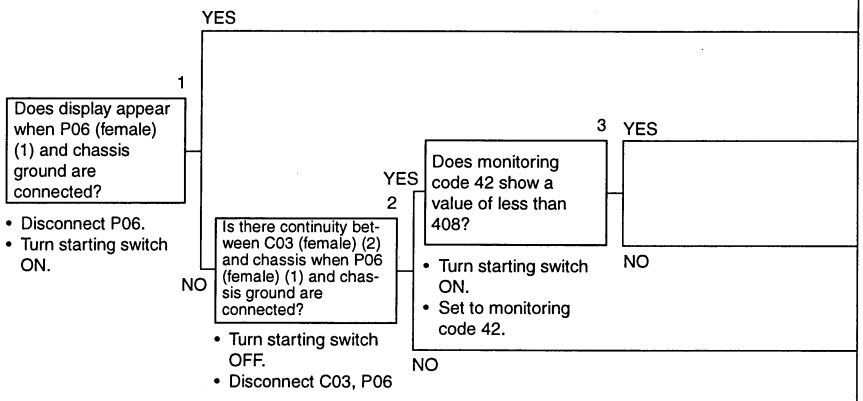
★ Check if the tank is actually full before carrying out troubleshooting.
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



Cause	Remedy
Defective fuel level senor system (see M-25)	-
Contact of chassis ground with wiring harness between C03 (female) (2) and P06 (female) (1)	Repair or replace
Defective monitor panel	Replace
Defective governor, pump controller	Replace

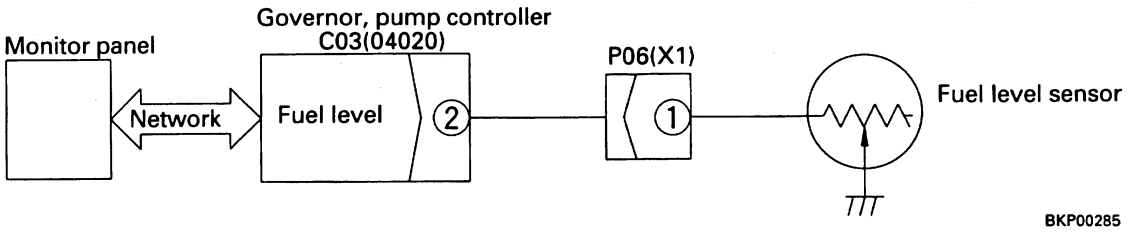
M-20 Fuel level gauge does not give display

★ Check that there is actually no fuel before carrying out troubleshooting.
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.

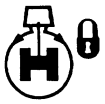


Cause	Remedy
Defective fuel level sensor system (see M-25)	-
Defective governor, pump controller	Replace
Defective monitor panel	Replace
Defective contact, or disconnection in wiring harness between C03 (female) (2) and P06 (female) (1)	Repair or replace

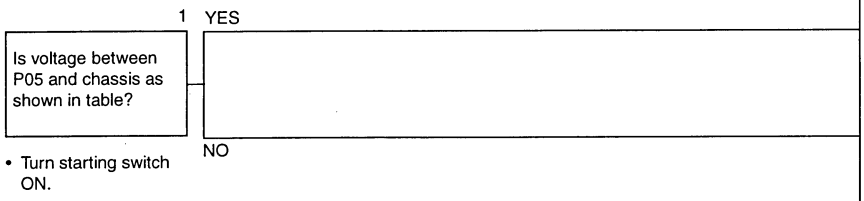
M-19, 20 Related electric circuit diagram



M-21 Swing lock switch is turned ON (LOCK) but (swing lock monitor) does not light up

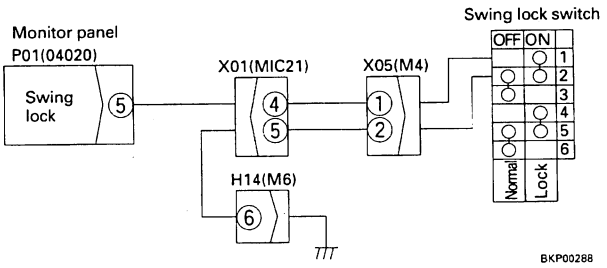


★ Carry out this troubleshooting only if the swing lock is actually being actuated.
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



Cause	Remedy
Defective monitor panel	Replace
Defective contact or disconnection in wiring harness between P01 (female) (5) - X01 (4) - X05 (male)	Repair or replace

M-21 Related electric circuit diagram

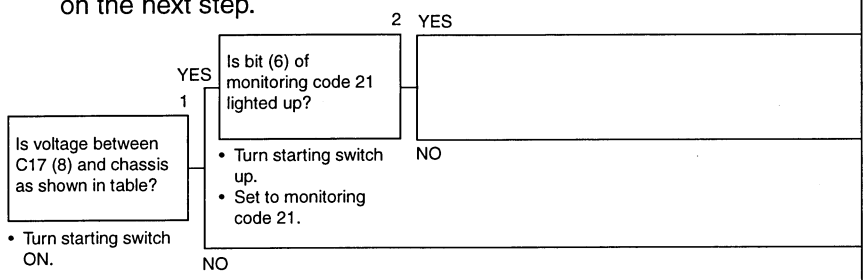


Table

Swing lock switch ON	Max. 1 V
Swing lock switch OFF	20 - 30 V

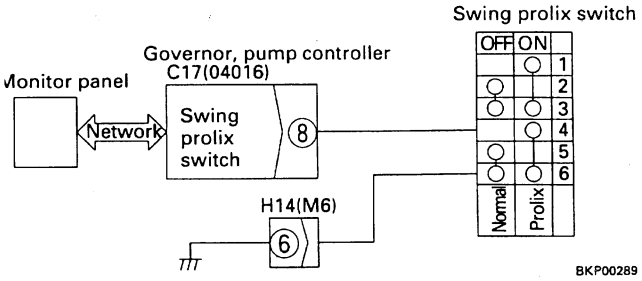
M-22 Swing prolix switch is turned ON (prolix), but (swing lock monitor) does not flash

★ Carry out this troubleshooting only if the swing prolix is actually being actuated.
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



Cause	Remedy
Defective monitor panel	Replace
Defective governor, pump controller	Replace
Defective contact or disconnection in wiring harness between C17 (female) (8) and prolix switch (4)	Repair or replace

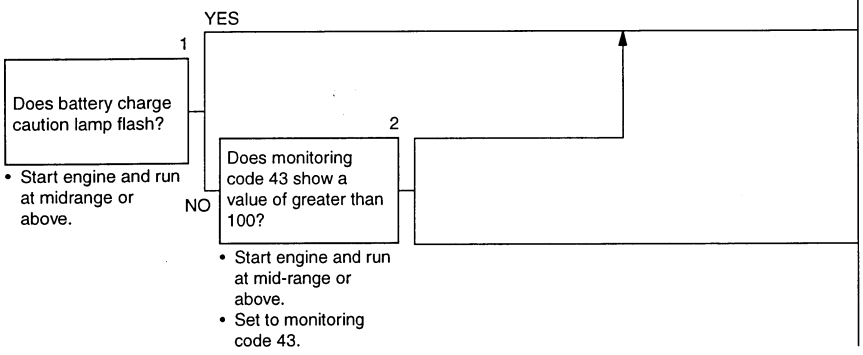
M-22 Related electric circuit diagram



Table

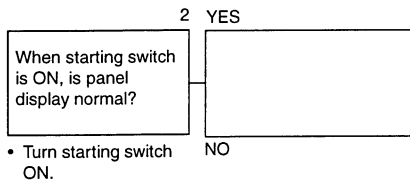
Swing prolix switch ON	Max. 1 V
Swing prolix switch OFF	20 - 30 V

M-23 Service meter does not advance while engine is running



Cause	Remedy
See M-13 d)	-
Defective monitor panel	Replace
Defective governor, pump controller	Replace

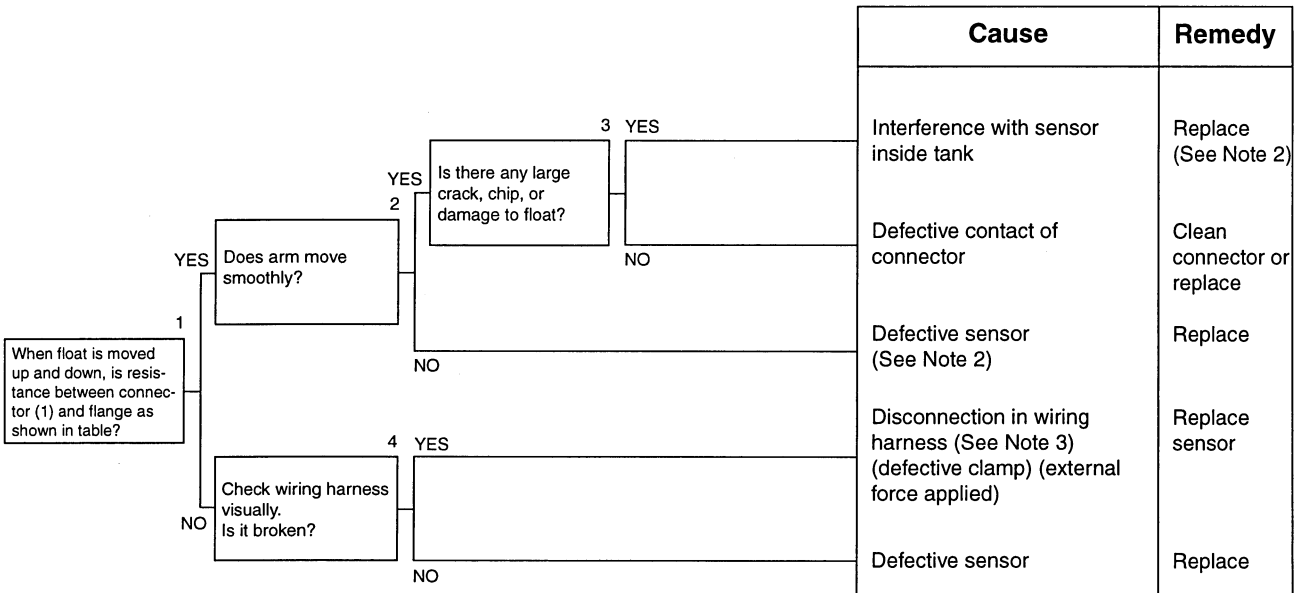
M-24 When starting switch is at OFF and time switch is pressed, time and service meter are not displayed



Cause	Remedy
Defective monitor panel	Replace
See M-6	-

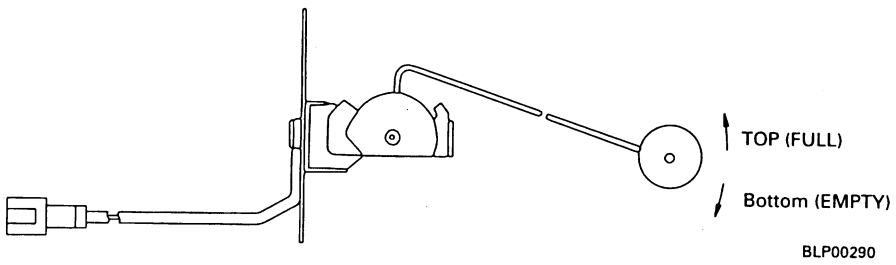
M-25 Defective fuel level sensor system

★ Remove the fuel level sensor when carrying out thetroubleshooting



Table

Top (FULL)Stopper postion	Approx. 12Ω or below
Bottom (EMPTY) stopper position	Approx. 85 - 110 Ω

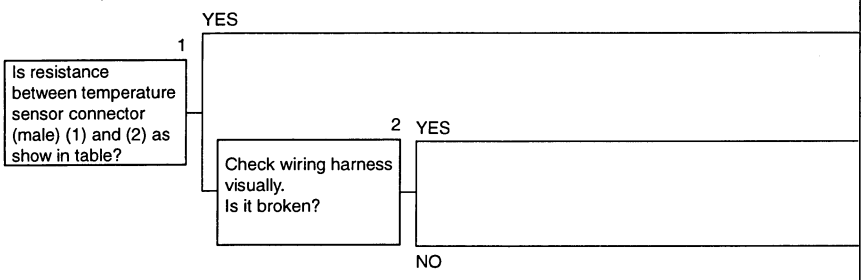


Note 1: Difference between fuel level and gauge display
For guage display position 14 (FULL), the amount of fuel is 78-100%; and for display position 1 (EMPTY) it is below 14,5%. If the chassis is at an angle, the displayed amount of fuel will be different from the actual amount. Therefore, when checking, stop the machine at a horizontal place and wait for at least 2 minutes before checking the gauge. (The display is given a time delay so that the gauge can deal with sidden changes in the fuel level.)

Note 2: There is the possibility of defective installation or interference with the sensor inside the tank, so be careful when installing.

Note 3: Check for vibration at the connector mount. If there is excessive vibration, take the appropriate action.

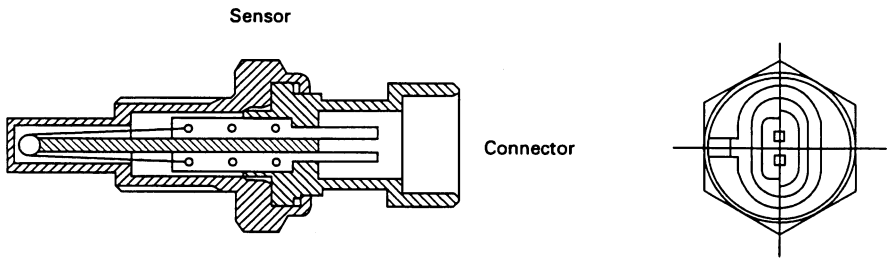
M-26 Defective coolant temperature sensor system



Cause	Remedy
Defective contact of connector (See Note 1)	Clean connector or replace sensor
Disconnection in wiring harness (See Note 2) (defective clamp) (external force applied)	Replace sensor
Defective sensor	Replace

Table

Normal temperature (20°C)	Approx. 70 ~ 78 kΩ
100°C	Approx. 3Ω



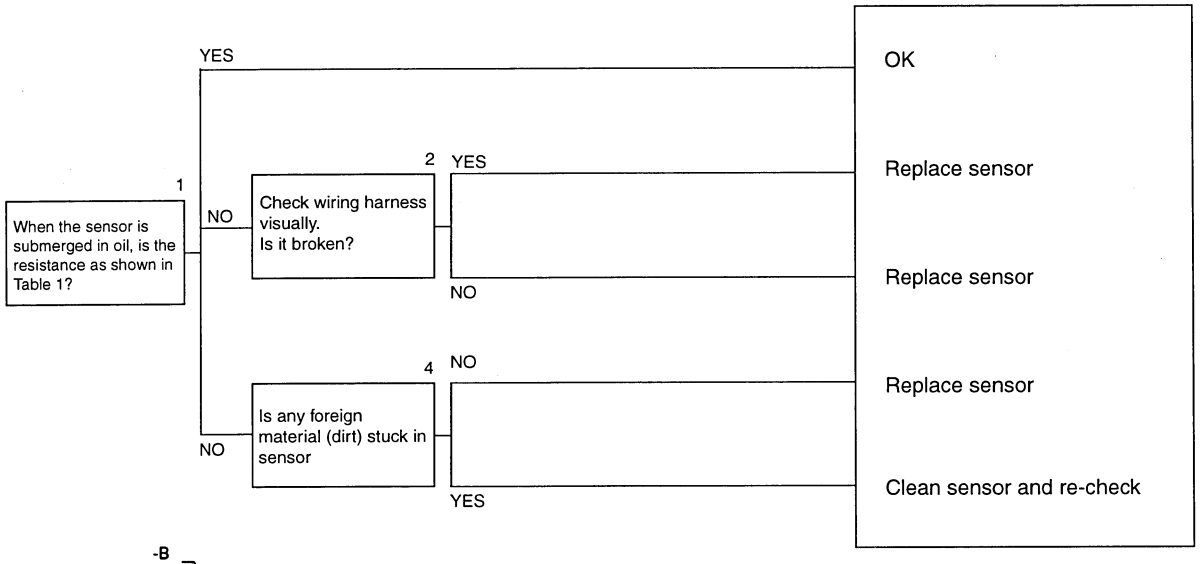
Note 1: If the problem occurs again, the connector (female) at the chassis end is probably defective, so check the connector and wiring harness at the chassis end.
Note 2: Check for vibration at the connector mount. If there is excessive vibration, take the appropriate action.

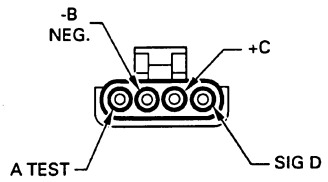
M-27 Defective engine oil level sensor system

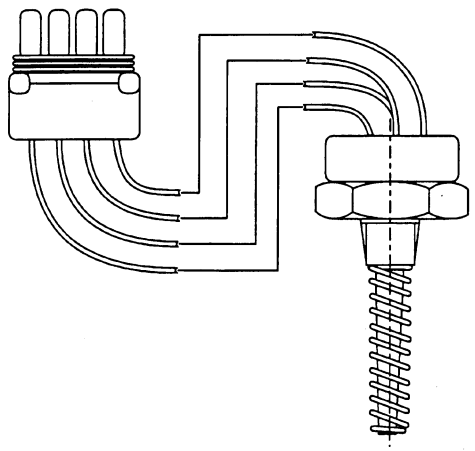
★ Remove the engine oil level sensor when carrying out troubleshooting.
★ Connect a 24V power supply to the oil level sensor '+' (pin C) and '-' (pin B).
★ Connect a multi-meter between the 'SIG' (pin D) and '-' (pin B).
★ Clean any dirt or foreign matter from sensor elements.

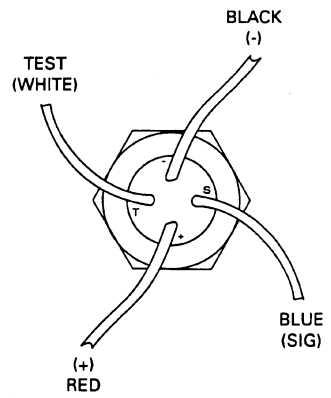
Table 1

Submerged	Max. 1Ω
Not submerged	Min. 1 MΩ





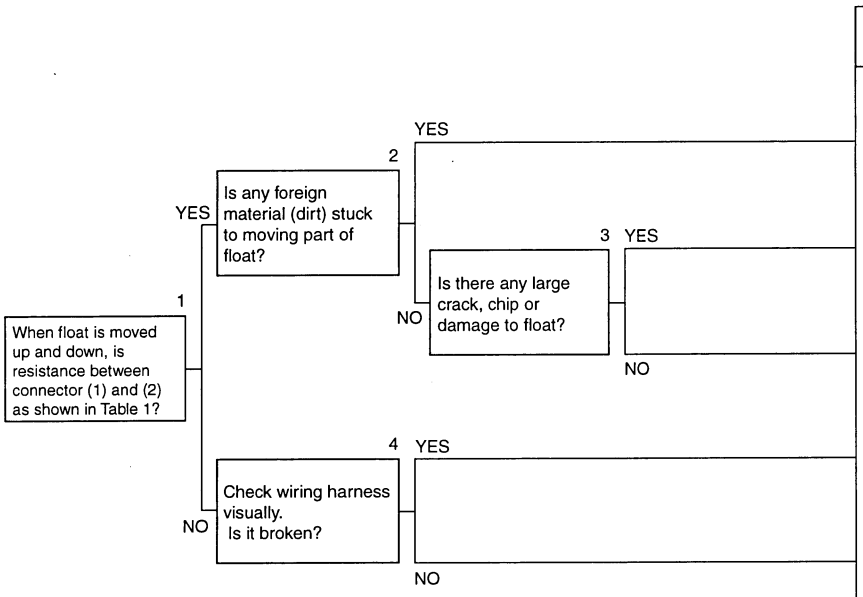




Note 1: Variations in oil level
The oil may change according to the angle of the machine, the engine speed, or the temperature of the oil, so if there is any display check the oil level again with the machine on horizontal ground.
Note 2: If the problem persists, check the connector and wiring harness at the chassis end.
Note 3: Check for vibration at the connector mount. Take the appropriate action for any excessive vibration.

M-28 Defective coolant level sensor system

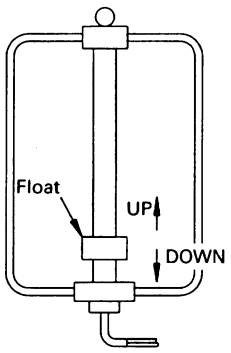
★ Remove the coolant level sensor when carrying out troubleshooting.



Cause	Remedy
Defective movement of float due to dirt	Clean
Resonance of mount (See Note 2)	Replace sensor (See Note 4)
Defective contact of connector (See Note 2)	Clean connector or replace
Disconnection in wiring harness (Se Note 3) (defective clamp) (external force applied)	Replace sensor
Defective sensor	Replace

Table

Float UP	Max. 1 Ω
Float DOWN	Min. 1 MΩ

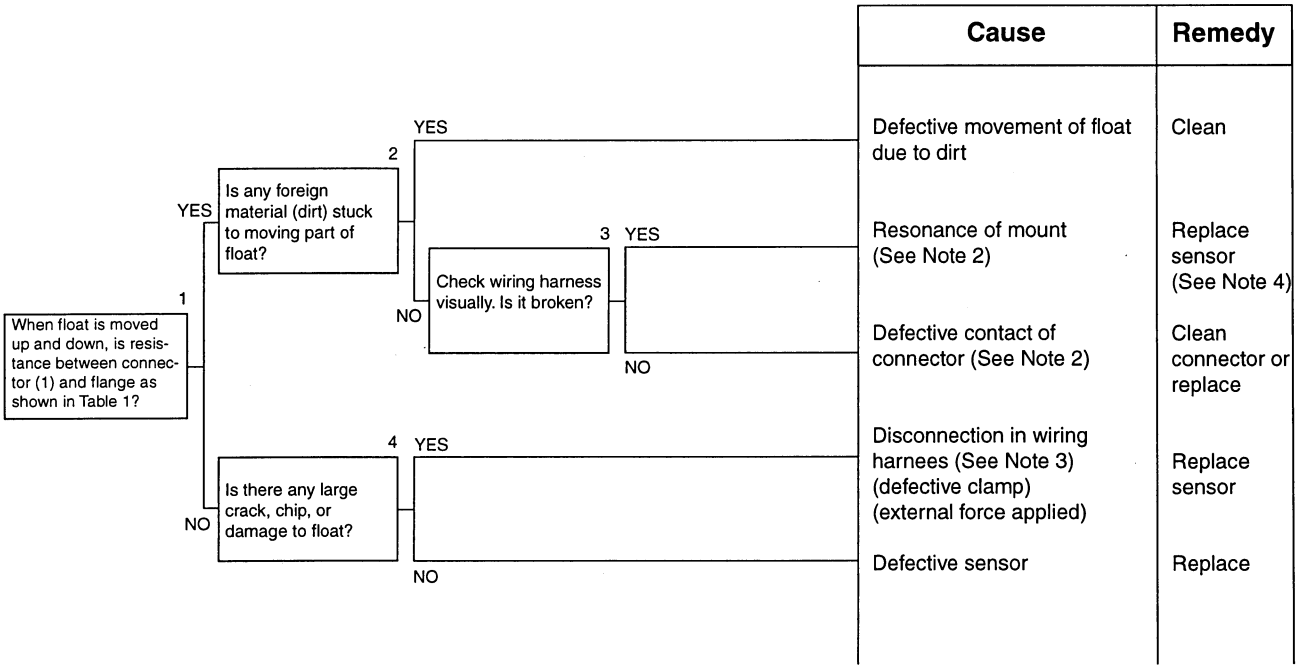


BLP00293

Note 1: Variations in coolant level
The coolant level may change according to the angle of the machine, or the swaying of the machine, so if there is any display, check the coolant level again with the machine at a horizontal place.
Note 2: If the problem occurs again, the connector (female) at the chassis end is probably defective, so check the connector and wiring harness at the chassis end.
Note 3: Check for vibration at the connector mount. If there is excessive vibration, take the appropriate action.
Note 4: Defective installation is a possible cause, so be careful installing. If the problem occurs again, check for any vibration of the mount, and if there is excessive vibration, take the appropriate action.

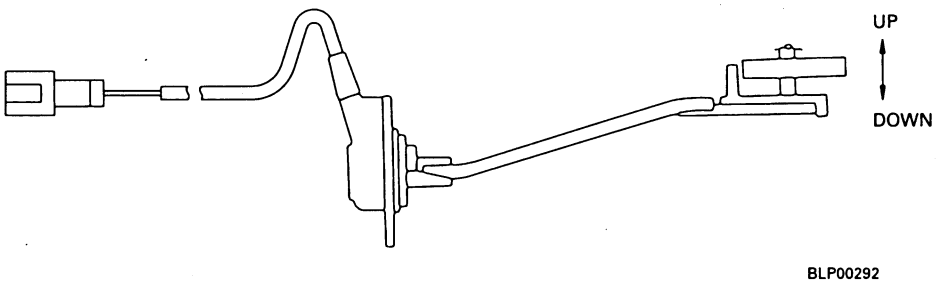
M-29 Defective hydraulic oil level sensor system

★ Remove the hydraulic oil level sensor when carrying out troubleshooting.



Table

Float UP	Max. 1 Ω
Float DOWN	Min. 1 MΩ



Note 1: Variations in hydraulic oil level
The hydraulic oil level may change according to the angle of the machine, or the swaying of the machine, so if there is any display, check the hydraulic oil level again with the machine at a horizontal place.

Note 2: If the problem occurs again, the connector (female) at the chassis end is probably defective, so check the connector and wiring harness at the chassis end.

Note 3: Check for vibration at the connector mount. If there is excessive vibration, take the appropriate action.

Note 4: Defective installation is a possible cause, so be careful when installing. If the problem occurs again, check for any vibration of the mount, and if there is excessive vibration, take the appropriate action.

M-30 Wiper does not work or switch is not being used but wiper is actuated

a) Wiper does not work

★ Check that fuse No. 7 is normal.

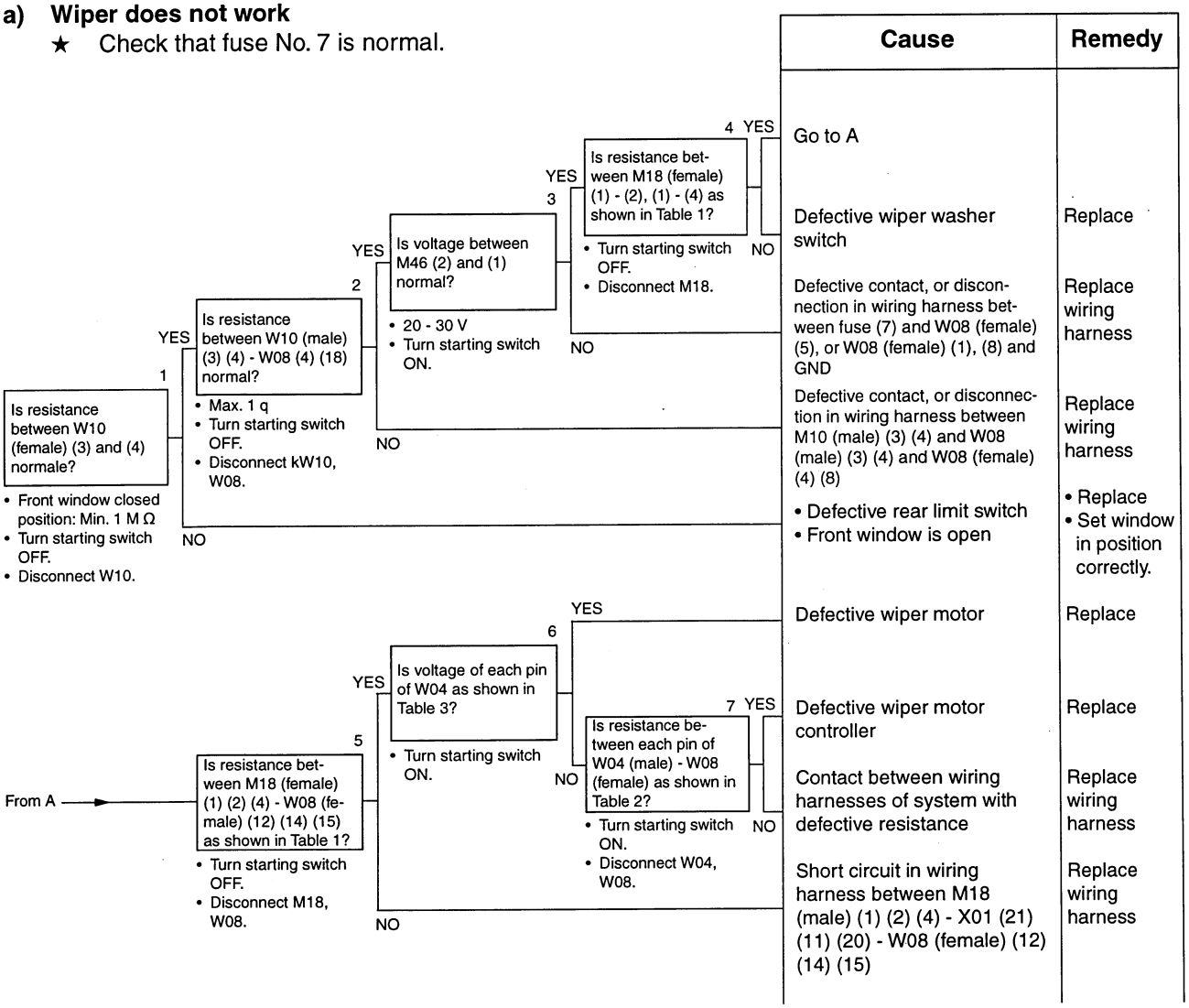


Table 1

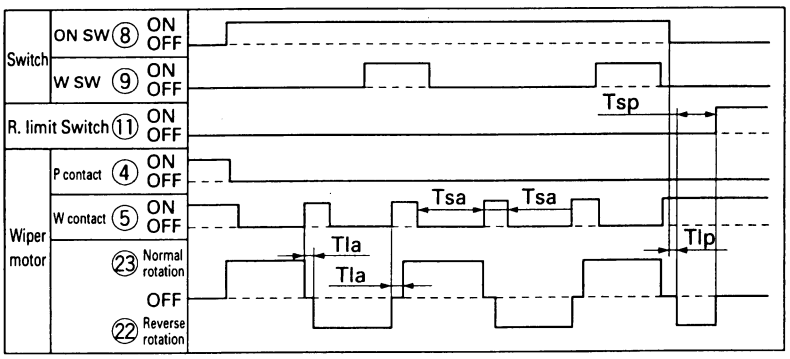
Actuation mode	M18 (female)	W08 (female)	Resistance (Ω)
INT mode	Between (1) - (4)	Between (12) - (15)	Max. 1 Ω
	Between (1) - (2)	Between (12) - (14)	Max. 1 MΩ
	Between (2) - (4)	Between (14) - (15)	
OFF mode	Between (1) - (2)	Between (12) - (14)	Max. 1 MΩ
	Between (1) - (4)	Between (12) - (15)	
	Between (2) - (4)	Between (14) - (15)	
ON mode	Between (1) - (2)	Between (12) - (14)	Max. 1 Ω
	Between (1) - (4)	Between (12) - (15)	Max. 1 MΩ
	Between (2) - (4)	Between (14) - (15)	

Table 2

Between W04 (female) (1) - W08 (female) (7)	Max. 1 Ω
Between W04 female) (3) - W08 (female) (6)	
Between W04 (female) (4) - w08 (female) (11)	
Between W04 (female) (5) - W08 (female) (9)	
Between W04 (female) (6) - W08 (female) (10)	
Between W04 (female) (1) (3) (4) (5) (6) - GND	Min. 1 MΩ

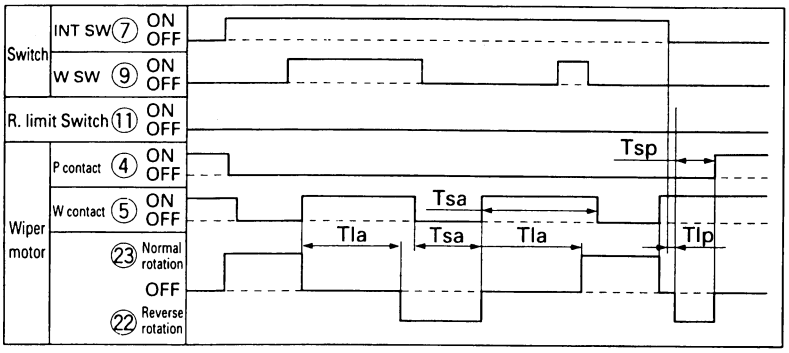
Table 3

Timing chart (when wiper is ON)



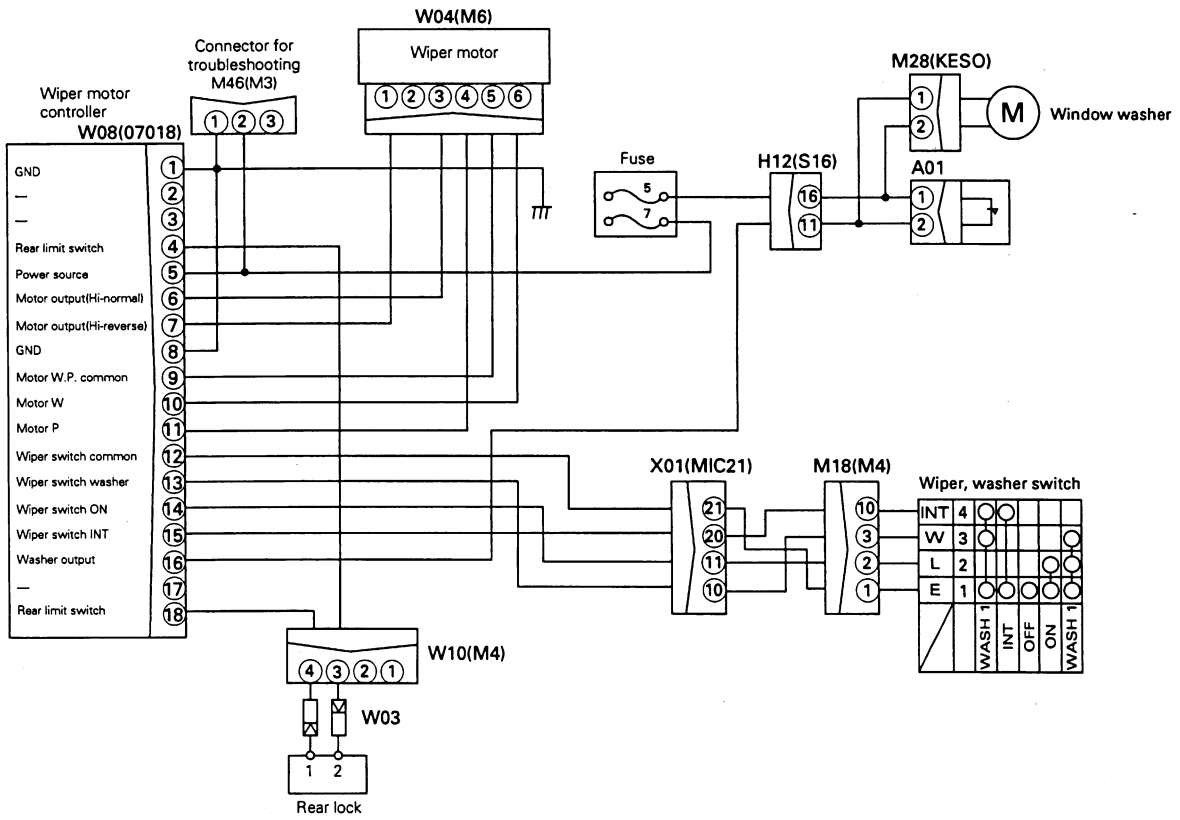
Item	Symbol	Set time
Length of pause until next actuation	Tla	0.13 sec
Safety circuit during operation of wiper [safety function (1)]	Tsa	10 sec
Lenght of pause when stowing wiper blade	Tlp	1.5 sec
Safety circuit during stowing of wiper [safety function (2)]	Tsp	10 sec

Timing chart (for wiper INT)

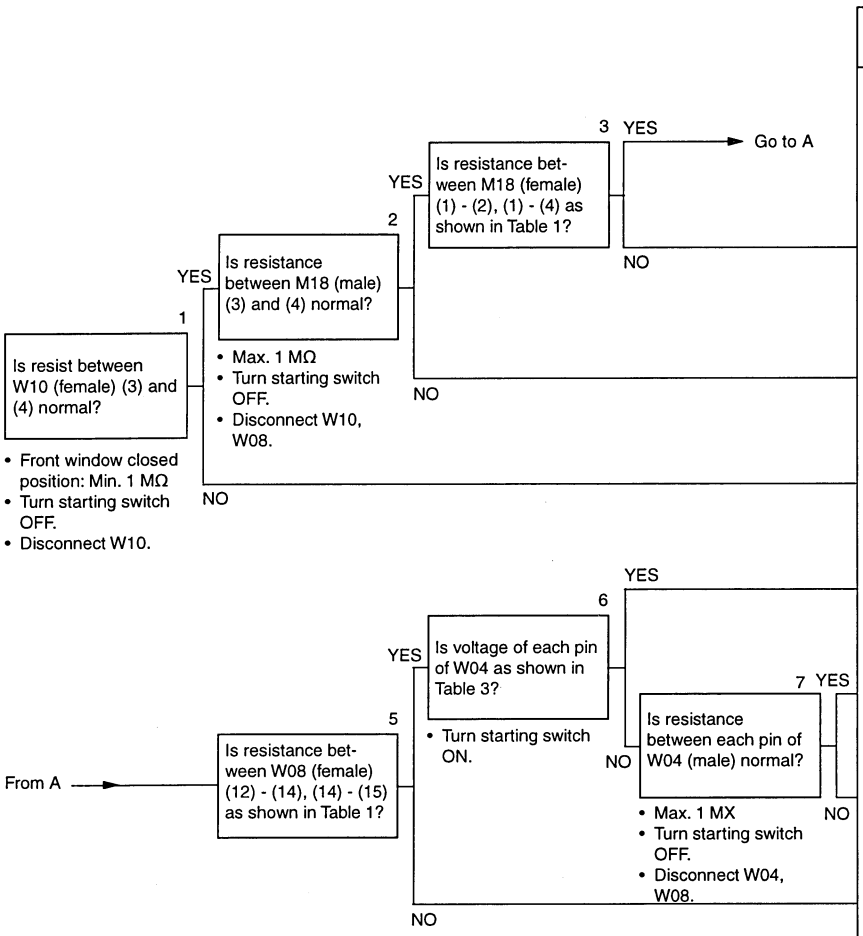


Item	Symbol	Set time
Length of pause until next actuation	Tla	4 sec
Safety circuit during operation of wiper [safety function (1)]	Tsa	10 sec
Lenght of pause when stowing wiper blade	Tlp	1.5 sec
Safety circuit during stowing of wiper [safety function (2)]	Tsp	10 sec

M-30 Related electric circuit diagram



b) Wiper switch is not being used but wiper is actuated



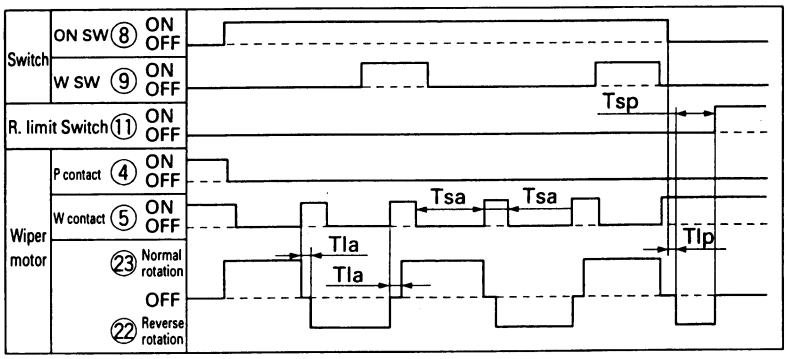
Cause	Remedy
Defective wiper washer switch	Replace
Defective contact. or disconnection in wiring harness between M10 (male) (3) (4) - W08 (female) (4) (18)	Replace wiring harness
• Defective rear limit switch • Front window is open	• Replace • Set window in position correctly.
Defective wiper motor	Replace
Defective wiper motor controller	Replace
Contact between wiring harnesses of system with defective resistance	Replace wiring harness
Short circuit of wiring harness between M18 (male) (1) (2) (4) - X01 (21) (11) (20) - W08 (female) (12) (14) (15)	Replace wiring harness

Table 1

Actuation mode	M18 (female)	W08 (female)	Resistance (Ω)
INT mode	Between (1) - (4)	Between (12) - (15)	Max. 1 Ω
	Between (1) - (2)	Between (12) - (14)	Max. 1 MΩ
	Between (2) - (4)	Between (14) - (15)	
OFF mode	Between (1) - (2)	Between (12) - (14)	Max. 1 MΩ
	Between (1) - (4)	Between (12) - (15)	
	Between (2) - (4)	Between (14) - (15)	
ON mode	Between (1) - (2)	Between (12) - (14)	Max. 1 Ω
	Between (1) - (4)	Between (12) - (15)	Max. 1 MΩ
	Between (2) - (4)	Between (14) - (15)	

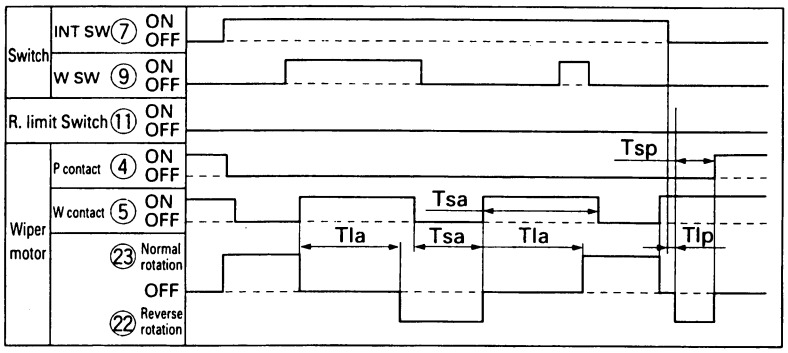
Table 3

Timing chart (when wiper is ON)



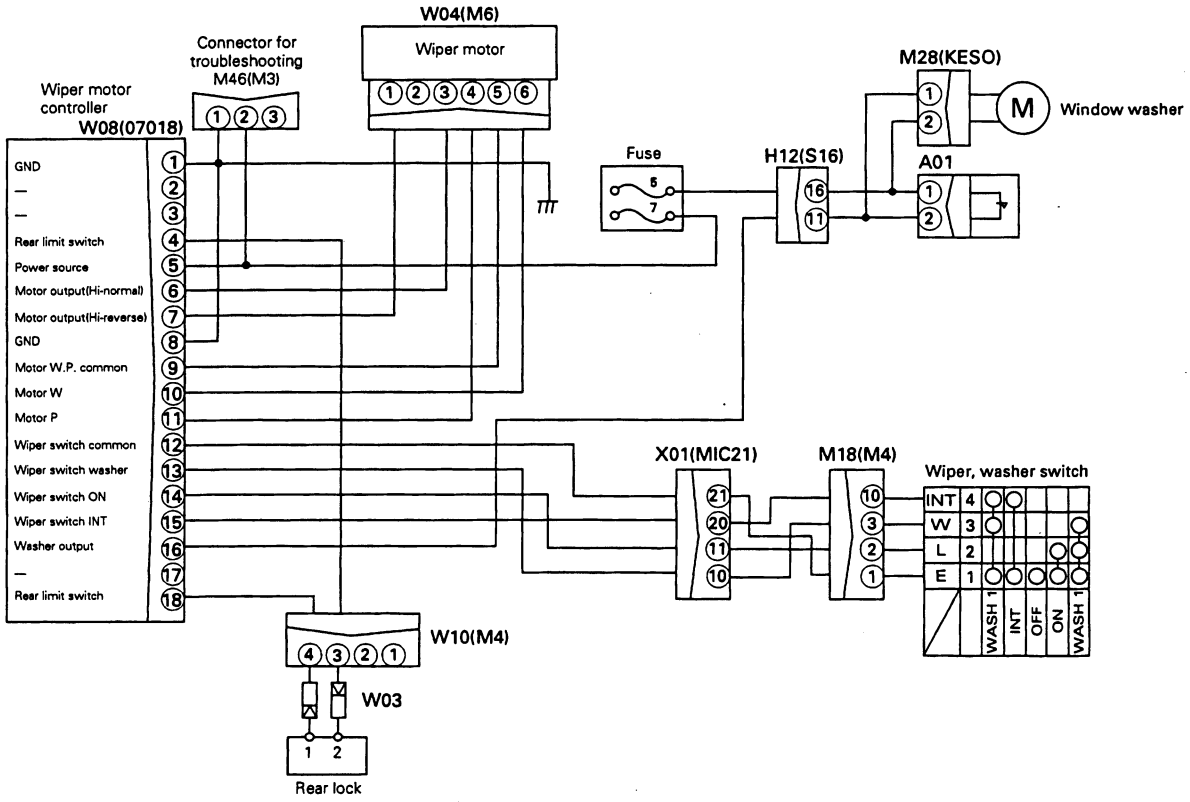
Item	Symbol	Set time
Length of pause until next actuation	Tla	0.13 sec
Safety circuit during operation of wiper [safety function (1)]	Tsa	10 sec
Lenght of pause when stowing wiper blade	Tlp	1.5 sec
Safety circuit during stowing of wiper [safety function (2)]	Tsp	10 sec

Timing chart (for wiper INT)



Item	Symbol	Set time
Length of pause until next actuation	Tla	4 sec
Safety circuit during operation of wiper [safety function (1)]	Tsa	10 sec
Lenght of pause when stowing wiper blade	Tlp	1.5 sec
Safety circuit during stowing of wiper [safety function (2)]	Tsp	10 sec

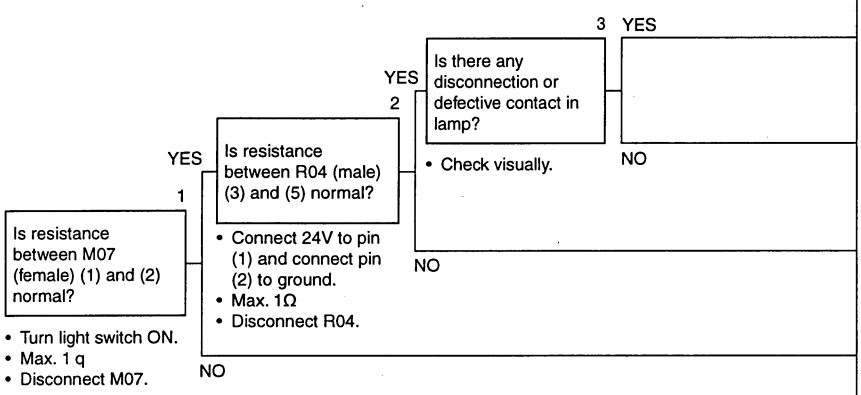
M-30 Related electric circuit diagram



M-31 Working light, panel lighting do not light up, or switch is not being used but lights light up

a) Working light does not light up

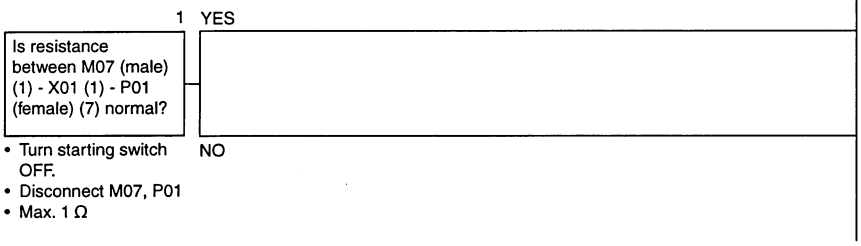
★ Check that fuse 4 is normal.



Cause	Remedy
Defective contact, disconnection in lamp Defective contact or disconnection in wiring harness between M07 (male) (2) - X01 (3) - fuse (4), between M07 (male) (1) - X01 (1) - R04 (1) R04 (2) - H06 (1) - chassis ground, between R04 (3) and fuse (4) between H04 (5) - H02 (10) - M08 (female) (1) or between R04 (15) - H02 (10 - M10 (1) - M09 (remale) (1)	Repair or replace
	Repair or replace
Defective light relay	Replace
Defective light switch	Replace

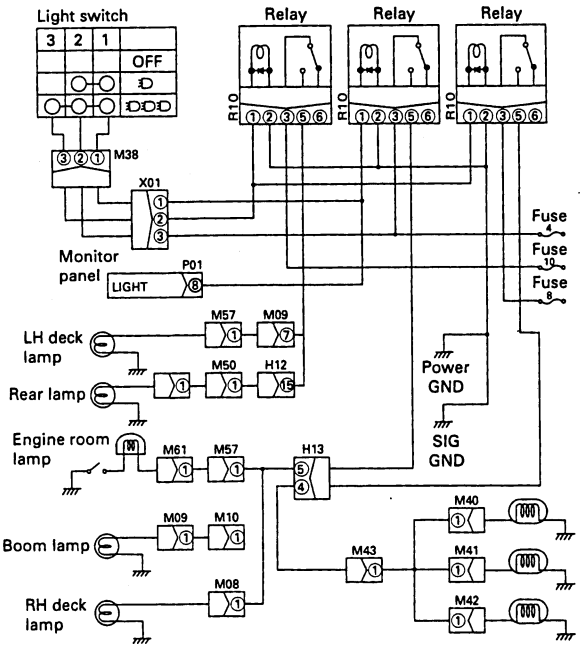
b) Panel lighting does not light up

★ When the lamp light up normally.



Cause	Remedy
Defective contact, disconnection in lamp for lighting inside moitor panel	Repair or replace
Defective contact, or disconnection in wiring harness between M07 (male) (1) - X01 (1) - P01 (female) (7)	Repair or replace

M-31 Related electric circuit diagram



30 DISASSEMBLY AND ASSEMBLY

METHOD OF USING MANUAL

1. When removing or installing unit assemblies
   ① When removing or installing a unit assebmly, the order of work and techniques used are given for the removal operation; the order of work for the installation operation is not given.
   ② Any special techniques applying only to the installation procedure are marked , and the same mark is placed after the relevant step in the removal procedure to indicate which step in the installation procedure it applies to.

(Example)

REMOVAL OF ○○○○ ASSEMBLY ..... Title of operation

 ..... Precautions related to safety when carrying out the operation

1. XXXX (1) ..... Step in operation
   ★ ..... Technique or important point to remember when removing XXXX (1).
2. △ △ △ △ (2): ..... ※1 Indicated that a technique is listed for use during installation
3. □□□□ assembly (3)

 ..... Quantity of oil or water drained

INSTALLATION OF ○○○○ ASSEMBLY ..... Title of operation

- Carry out installation in the reverse order to removal.

※1 ..... Technique used during installation

★ ..... Technique or important point to remember when installing △ △ △ △ (2).

- Adding water, oil ..... Step in operation

★ ..... Point to remember when adding water or oil

 ..... Quantity when filling with oil and water

2. General precautions when carrying out installation or removal (disassembly or assembly) of units are given thogether as PRECAUTIONS WHEN CARRYING OUT OPERATION, so be sure to follow these precautions when carrying out the operation.

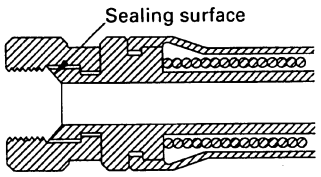
3. Listing of special tools

① For details of the description, part number, and quantity of any tools (**A1**, etc.) that appear in the operation procedure, see the SPECIAL TOOLS LIST given in this manual.

4. General tightening torque table (when using torque wrench)

★ In the case of metric nuts and bolts for which there is no special instruction, tighten to the torque given in the table below.

Thread diameter	Width across flats	 SAD00481	 SAD00482
mm	mm	kgm	Nm
6	10	1.35 ± 0.15	13.2 ± 1.4
8	13	3.2 ± 0.3	31.4 ± 2.9
10	17	6.7 ± 0.7	65.7 ± 6.8
12	19	11.5 ± 1.0	112 ± 9.8
14	22	18.0 ± 2.0	177 ± 19
16	24	28.5 ± 3	279 ± 29
18	27	39 ± 4	383 ± 39
20	30	56 ± 6	549 ± 58
22	32	76 ± 8	745 ± 78
24	36	94.5 ± 10	927 ± 98
27	41	135 ± 15	1320 ± 140
30	46	175 ± 20	1720 ± 190
33	50	225 ± 25	2210 ± 240
36	55	280 ± 30	2750 ± 290
39	60	335 ± 35	3280 ± 340



SAD00483

5. Table of tightening torques for flared nuts

★ In the case of flared nuts for which there is no special instruction, tighten to the torque given in the table below.

Thread diameter	Width across flats	Tightening torque	
mm	mm	kgm	Nm
14	19	2.5 ± 0.5	24.5 ± 4.9
18	24	5 ± 2	49 ± 19.6
22	27	8 § 2	78.5 ± 19.6
24	32	14 ± 3	137.3 ± 29.4
30	36	18 ± 3	176.5 ± 29.4
33	41	20 ± 5	196.1 ± 49
36	46	25 ± 5	245.2 ± 49
42	55	30 ± 5	294.2 ± 49

6. Table of tightening torques for split flange bolts

★ In the case of split flange bolts for which there is no special instruction, tighten to the torque given in the table below.

Thread diameter	Width across flats	Tightening torque	
mm	mm	Kgm	Nm
10	14	6.7 ± 0.7	65.7 ± 6.8
12	17	d11.5 ± 1	112 ± 9.8
16	22	28.5 ± 3	279 ± 29

PRECAUTIONS WHEN CARRYING OUT OPERATION

[When carrying out removal or installation (disassembly or assembly) of units, be sure to follow the gneral precautions given below when carrying out th4e operation.]

1. Prcautions when carrying out removal work

- If the coolant contains antifreeze, dispose of it correctly.
- After disconnecting hoses or bubes, cover them or fit blind plugs to prevent dirt or dust from entering.
- When draining oil, prepare a container of adequate size to chatch the oil.
- Confirm the match marks showing the installation position, and make match marks in the necessary places before removal to prevent any mistake when assembling.
- To prevent any excessive force from being applied to the wiring, always hold the connectors when disconnecting the connectors. Do not pull the wires.
- Fit wires and hoses with tags to show their installation posistion to prevent any mistake when installing.
- Check the number and thichkness of the shims, and keep in a safe place.
- When raising components, be sure to use lifing equipment of ample strength.
- When using forcing screws to remove any components, tighten the focing screws uniformly in turn.
- Before removing any unit, clean the surrrounding area and fit a cover to prevent any dust or dirt from entering after removal.

★ Precautions when handling piping during disassembly

Fit the following blind plugs into the piping after disconnecting it during disassembly operations.

1) Hoses and tubes using sleeve nuts

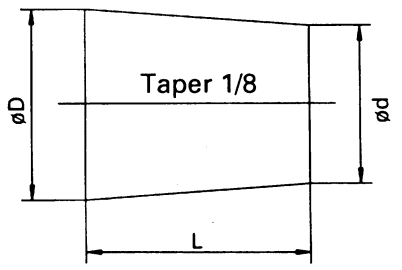
Nominal number	Plug (nut end)	Sleeve nut (elbow end) Use the two items below as a set
02	07376-50210	07221-20210 (Nut), 07222-00210 (Plug)
03	07376-50315	07221-20315 (Nut), 07222-00312 (Plug)
04	07376-50422	07221-20422 (Nut), 07222-00414 (Plug)
05	07376-50522	07221-20522 (Nut), 07222-00515 (Plug)
06	07376-50628	07221-20628 (Nut), 07222-00616 (Plug)
10	07376-51034	07221-21034 (Nut), 07222-01018 (Plug)
12	07376-51234	07221-21234 (Nut), 07222-01219 (Plug)

2) Split flange type hoses and tubes

Nominal number	Flange (hose end)	Sleeve head (tube end)	Split flange
04	07379-00400	07378-10400	07371-30400
05	07379-00500	07378-10500	07371-30500

3) If the part is not under hydraulic pressure, the following corks can be used.

Nominal number	Part Number	Dimensions		
		D	d	L
06	07049-00608	6	5	8
08	07049-00811	8	6.5	11
10	07049-01012	10	8.5	12
12	07049-01215	12	10	15
14	07049-01418	14	11.5	18
16	07049-01620	16	13.5	20
18	07049-01822	18	15	22
20	07049-02025	20	17	25
22	07049-02228	22	18.5	28
24	07049-02430	24	20	30
27	07049-02734	27	22.5	34



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2. Precautions when carrying out installation work

- Tighten all bolts and nuts (sleeve nuts) to the specified (KES) torque.
- Install the hoses without twisting or interference.
- Rplace all gaskets, O-rings, cotter pins, and lock plates with new parts.
- Bend the cotter pins and lock plates securely.
- hen coating with adhesive, clean the part and remove all oil and grease, then coat the threaded portion with 2 - 3 drops of adhesive.
- When coating with adhesive, clean the part and remove all oil and grease, then coat the treaded portion with 2 - 3 drops of adhesive.
- When coating with gasket sealant, clean the surface and remove all oil and grease, check that there is no dirt or damage, then coat uniformly with gasket sealant.
- Clean all parts, and correct any damgae, dents, burrs, or rust.
- Coat rotating parts and sliding parts with engine oil.
- When press fitting parts, coat the surface with anti-friction compound (LM-P).
- After fitting snap rings, check that the snap ring is fitted securely in the ring groove.
- When connecting wiring connectors, clean the connector to remove all oil, dirt, or water, then connect securely.
- When using eyebolts, check that there is no defeormation or deterioration, screw them in fully, and align the direction of the hook.
- When tightening split flanges, tighten uniformly in turn to prevent excessive tightening on one side.

★ When operating the hydraulic cylinders for the first time after reassembling cylinders, pumps and other hydraulic equipment removed for repair, always bleed the air as follows:

1. Start the engine and run at low idling.
2. Operate the work equipment control lever to operate the hydraulic cylinder 4 - 5 times, stopping the cylinder 100 mm from the end of its stroke.
3. Next, operate the hydraulic cylinder 3 - 4 times to the end of its stroke.
4. After doing this, run the engine at normal speed.

★ When using the machine for the first time after repair or long storage, follow the same procedure.

3. precautions when completing the operation

- If the coolant has been drained, tighten the drain valve, and add water to the specified level. Run the engine to circulate the water through the system. Then check the water level again.
- If the hydraulic equipment has been removed and installed again, add engine oil to the specified levle. Run the engine to circulate the oil through the system. Then check the oil level again.
- If the piping or hydraulic equipment have been removed, always bleed the air form the system after reassembling the parts.
  ★ For details, see TESTING AND ADJUSTING, Bleeding air.
- Add the specified amount of grease (molybdenum disulphide grease) to the work equipment parts.

SPECIAL TOOL LIST

★ Tools with part number 79◯T-◯◯◯-◯◯◯◯ cannot be supplied (they are items to be locally manufactured).
★ New/remodel: N: Tools with new part numbers, newly developed * for this model.
R: Tools with upgraded part numbers, remodeled from items already available for other models.
★ Blank: Tools already available for other models, used without any modification.
★ Tools marked ◯ in the Sketch column are tools introduced in special sketches (See SKETCHES OF SPECIAL TOOLS).

Component	Symbol		Part No.	Part Name	Q'ty	New/remodel	Sketch	Nature of work, remarks	
Engine assembly	A	1	Cust-1293	Gauge	1				Alternator belt tension gauge
			Cust-1325	Gauge	1				Fan belt tension gauge
		2	CU3823579	Puller	1				Injector removal
			CU3376592	Wrench	1				Valve lash adjustment
			CU3822479	Bracket	1				Liffing of cylinder head
			CU3823546	Gauge	1				To measure cylinder head both length
		3	790-331-1110	Wrench	1				Tightening of cylinder head bolt
Swing machinery assembly	F		796T-626-1110	Push tool	1	N	◯	Dias-sembly, assem-bly	Press fitting of bearing
Final drive assembly	J	1	796-627-1310	Wrench	1	N		Disassembly, assembly	Removal, installation of round nut
		2	1	796T-627-1330	Push tool	1	N	◯	Pushing of bearing inner race
			2	790-101-2510	Bock	1			
			3	790-101-2250	Leg	2			
			4	790-101-2740	dapter	2			
			5	790-101-2560	Nut	2			
			6	790-101-2570	Washer	4			
			7	790-101-2102	Jack	1			
			8	790-101-1102	Pump	1			
		3	790-331-1110	Wrench	1				Tightening of cover bolt
		4	796-627-1020	Installer	1				Installation of floating seal
Idler assembly	L	1	791-575-1520	Installer	1			Dias-sembly, assem-bly	Installation of floating seal
		2	791-601-1000	Oil pump	1				Charging with oil
Track roller assembly		3	796-570-1020	Installer	1			Dias-sembly, assem-bly	Installation of floating seal
		4	791-601-1000	Oil pump	1				Charging with oil
Carrier roller assembly		5	790-302-1500	Wrench kit	1			Dias-sembly, assem-bly	Removal, installation of nut
			•09003-05560	•Wrench	1				
		6	796-670-1020	Installer	1				Instalation of floating seal
		7	796T-630-1130	Push tool	1	N	◯		Press fitting of ring
		8	791-601-1000	Oil pump	1				Charging with oil

Component	Symbol		Part No.	Part Name	Q'ty	New/ remodel	Sketch	Nature of work, remarks	
Recoil spring assembly	M	1	791-658-8005	compressor (B)	1			Disassembly, assembly	Removal, installation of recoil spring
			791-635-3160	Extension					
			790-101-1600	Cylinder (70 ton)					
			790-101-1102	Pump	1				
		2	790-201-1500	Push tool kit	1				Installation of piston dust seal
			•790-201-1660	•Plate					
			•790-101-5021	•Grip					
			•01010-50816	•Bolt					
Track shoe assembly	R		791-646-3000	Remover & Installer	1			Removal, instalation	Removal, press fitting of master pin
			790-101-1300	Cylinder	1				
			790-101-1102	Pump	1				
Hydraulic pump assembly	S	1	7966601200	Oil stopper assembly	1	N		Removel, installation	Shutting off hydraulic oil
			•796-460-1210	•Oil stopper	1				
			•796-660-1210	•Rod	1	N			
			•20Y-60-21330	•Rod assembly	1				
		2	790-201-2700	Push tool kit	1				Press fitting of shaft oil seal
			•790-201-2740	•Spacer	1				
Main pump	Disassembly, assembly of pump	S	3	1	790-501-5000	Unit repair stand	1				For Japan
				1	790-501-5200	Unit repair stand	1				For overseas
				2	790-901-2110	Bracket	1				
				3	793-617-1110	Plate	1				For front
				4	796-660-1430	Plate	1	N			For rear
	Removal, installation of cylinder block spring	S	4	1	799-201-3610	Bolt	1				
				2	796-465-1110	Washer	1				
				3	01643-33080	Wahser	1				
				4	01643-32060	Washer	2				
				5	01582-02016	Nut	1				
	Removal, installation of cover	S	5	1	796-720-2250	Screwdriver	1				
				2	796-720-2220	Socket	1				
	Removal, installation of servo piston rod	S	6	1	791-463-1100	Holder	1				
				2	791-463-1150	•Plate	1				
				3	791-463-1160	•Bolt	1				
	Press fitting of bearing	S	7		790-201-2700	Push tool kit	1				
					•790-201-2740	•Spacer	1				

Component		Symbol			Part No.	Part Name	Q'ty	New/re-model	Sketch	Nature of work, remarks
Main pump	Positioning of servo piston swash plate angle	S	8		796-660-1400	Gauge assembly	1	N		
					•796-660-1440	•Plate	1	N		
					•796-660-1460	•Plate	1	N		
					•01010-51030	•Bolt	1			
					•01010-51835	•Bolt	1			
	Press fitting of needle bearing	S	9		791-101-5201	Push tool kit	1			
					•790-101-5251	•Plate	1			
					•790-101-5221	•Grip	1			
					•01010-51225	•Bolt	1			
	Measuring drive shaft rotating torque	S	10		01435-01016	Bolt	1			
	Leak test of servo valve	S	11		799-301-1600	Oil leak tester	1			
	Press fitting of oil seal	S	12		790-201-2700	Push tool kit	1			
					•790-201-2740	•Spacer	1			
Swing motor	Disassembly, assembly of motor	S	13	1	790-501-5000	Unit repair stand	1			For Japan
				1	790-501-5200	Unit repair stand	1			For overseas
				2	790-901-2110	Bracket	1			
				3	790-401-1470	Plate	1			
	Removal, installation of retainer mouning screw	S	14	1	796-730-2120	Screwdriver	1			
				2	796-720-2220	Socket	1			
	Releasing brake	S	15	1	796T-660-1510	Pump adapter	1	N	○	
				1	•790-101-1430	•Coupler assembly	1			
				1	•796-660-1490	•Nipple	1	N		
				1	•799-101-5130	•Gauge	1			
				1	•799-101-5160	•Nipple	1			
				1	•790-301-1190	•Nipple	1			
				1	•790-301-1660	•Tee	1			
				1	•205-70-51390	•Nipple	1			
				1	•790-301-1210	•Joint	1			
				1	•07002-01423	•O-ring	1			
				2	790-101-1102	Pump	1			
	Press fitting of main bearing inner race beraring inner race	S	16		790-201-2850	Spacer	1			
	Installation of sub bearing outer race	S	17		790-201-2860	Spacer	1			
	Press fitting of sub bearing inner race	S	18		790-201-2840	Spacer	1			

	Component	Symbol			Part No.	Part Name	Q'ty	New/re-model	Sketch	Nature of work, remarks
Swing motor	Pushing out drive shaft	S	19	1	790-101-2510	Block	1			
				2	791-600-1120	Bolt	2			
				3	01643-31845	Washer	6			
				4	01580-11613	Nut	6			
				5	790-105-2100	Jack	1			
				6	790-101-1102	Pump	1			
	Measuring drive shaft rotating torque	S	20		01435-01220	Bolt	1			
	Press fitting of oil seal	S	21		790-201-1500	Push tool kit	1			
					•790-201-1590	•Plate	1			
					•790-101-5021	•Grip	1			
					•01010-50816	•Bolt	1			
	Securing housing	S	22	1	796T-660-1520	Plate	1	N	○	
				2	01010-51020	Bolt	2			
				3	01010-51835	Bolt	4			
				4	01580-11815	Nut	4			
	Press fitting of dowel pin	S	23		796T-660-1540	Push tool	1	N	○	
	Removal of brake piston	S	24		799-301-1600	Oil leak tester	1			
Travel motor	Disassembly, assembly of motor	S	25	1	790-501-5000	Unit repair stand	1			For Japan
				2	790-501-5200	Unit repair stand	1			For overseas
				3	790-901-2110	Bracket	1			
				4	790-901-2121	Plate	1	N		
	Raising end cover	S	26	1	796T-660-1550	Plate	1	N	○	
				2	01050-52035	Bolt	2			
				3	04530-11222	Eyebolt	1			
				4	01580-11210	Nut	1			
	Tightening retainer	S	27	1	796-720-2250	Screwdriver	1			
				2	796-720-2220	Socket	1			
	Removal of brake	S	28		799-301-1600	Oil leak tester	1			
	Disassembly, pulling out drive shaft	S	29		796T-660-1310	Push tool	1	N	○	
	Press fitting of main bearing	S	30		791-685-8310	Push tool	1			
	Press fitting of sub bearing inner race	S	31		790-201-2700	Push tool kit	1			
		S			•790-201-2750	•Spacer	1			

	Component	Symbol				Part No.	Part Name	Q'ty	New/ remodel	Sketch	Nature of work, remarks
Travel motor	Assembly of drive shaft assembly	S	32	1		796T-660-1320	Guide	1	N	○	
				2		796-660-1530	Eyebolt	1	N		
				3	1	796T-660-1330	Plate	1	N	○	
					2	01580-11008	Nut	1			
					3	790-201-3200	Bolt kit	1			
						•790-201-3240	•Bolt	1			
	Posistioning of brake piston	S	33	1		796-660-1350	Positioner	1	N		
				2		796-660-1360	Plate	1	N		
				3		796-660-1370	Pin	2	N		
				4		796-660-1380	Pin	1	N		
	Knocking in dowel pin	S	34			796T-660-1340	Push tool	1	N	○	
	Scuring valve plate	S	35			796-660-1390	Pin	2	N		
	Assembly of case and end cover	S	36			796-660-1410	Pin	1	N		
	Releasing brake	S	37	1		796T-660-1480	Pump adapter	1	N		
						•790-101-1430	•Coupler assembly	1			
						•796-660-1490	•Nipple	1	N		
						•799-101-5130	•Gauge	1			
						•799-101-5160	•Nipple	1			
						•790-301-1190	•Nipple	1			
						•790-301-1660	•Tee	1			
						•205-70-51390	•Nipple	1			
						•790-301-1271	•Joint	1			
						•07002-01023	•O-ring	1			
				2		790-101-1102	Pump	1			
	Measuring drive shaft rotating torque	S	38			01435-01016	Bolt	1			
	Press fitting of oil seal	S	39			790-201-2700	Push tool kit	1			
						•790-201-2750	•Spacer	1			

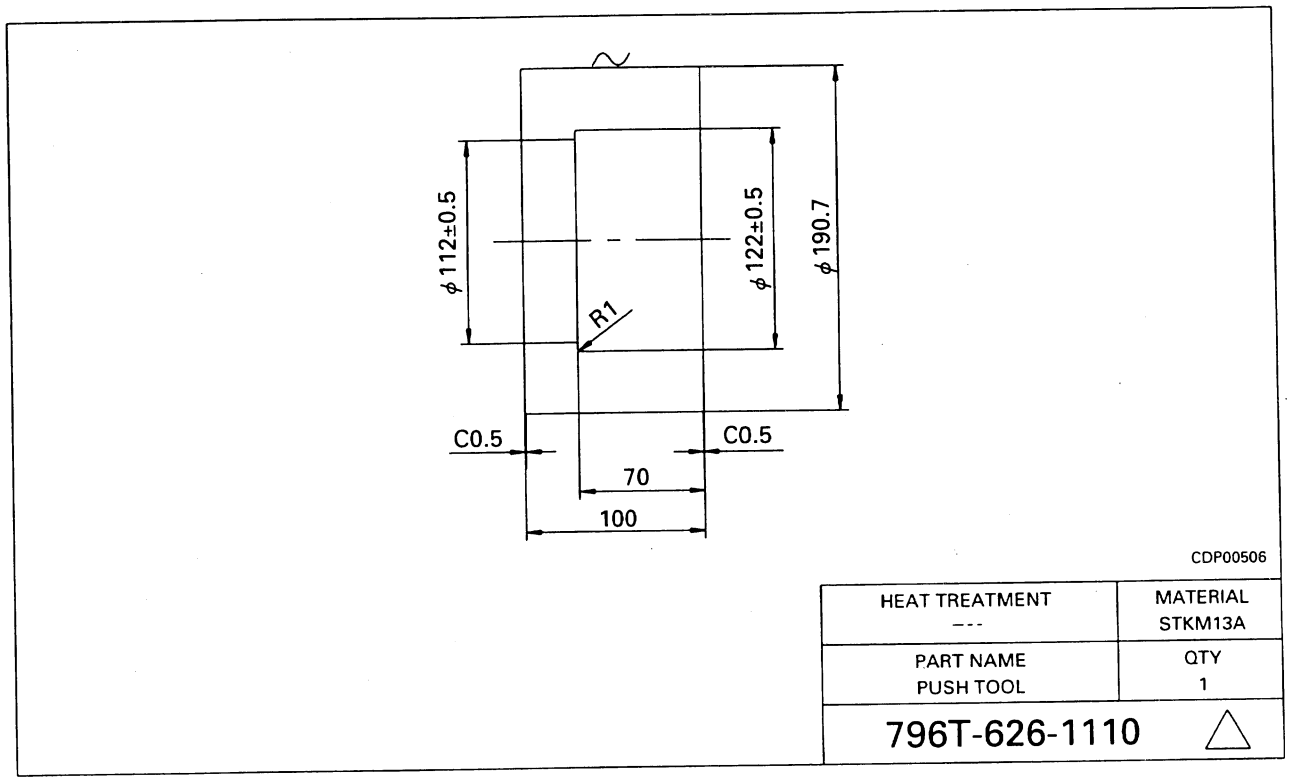
Component	Symbol		Part No.	Part Name	Q'ty	New/ remodel	Sketch	Nature of work, remarks	
Center swivel joint assembly	T		790-101-2501	Push tool kit	1			Disassembly, assembly	Disconnection of shaft and rotor
			•790-101-2510	•Block	1				
			•790-101-2520	•Screw	1				
			•791-112-1180	•Nut	1				
			•790-101-2540	•Washer	1				
			•790-101-2630	•Leg	2				
			•790-101-2570	•Plate	4				
			•790-101-2560	•Nut	2				
			•790-101-2650	•Adapter	2				
Hydraulic cylinder assembly	U	1	790-502-1003	Cylinder repair stand	1			Disassembly, assembly	Securing of cylinder
		2	790-720-1000	Expander	1				Installation of piston ring
		3	796-720-1680	Ring	1				Boom, bucket
			07281-01589	Clamp	1				
			796-720-1690	Ring	1				Arm
			07281-02169	Clamp	1				
		4	790-201-1702	Push tool kit	1				Press fitting of coil bushing
			•790-201-1861	•Push tool	1				Boom, bucket
			•790-101-5021	•Grip	1				
			•01010-50816	•Bolt	1				
			•790-445-4210	•Push tool	1				Arm (PC400-6)
			•790-101-5421	•Grip	1				
			•01010-51240	•Bolt	1				
			791-863-1130	•Push tool	1				Arm (PC450-6)
			790-101-5221	•Grip	1				
			01010-51225	•Bolt	1				
		5	790-201-1500	Push tool kit	1				Installation of dust seal
			•790-201-1670	•Plate	1				Boom, bucket
			•790-101-5021	•Grip	1				
			•01010-50816	•Bolt	1				
			•790-201-1970	•Plate	1	N			Arm (PC400-6)
			•790-201-1680	•Plate	1				Arm (PC450)-6)

Component	Symbol	Part No.	Part Name	Q'ty	New/ remodel	Sketch	Nature of work, remarks	
Work equipment assembly, boom assembly	V	•796-670-1100	•Remover assembly	1	N			Removal of boom foot pin
		•796-670-1110	•Sleeve	1	N			
		•796-670-1120	•Plate	1	N			
		•796-670-1130	•Screw	1	N			
		•791-775-1150	•Adapter	1				
		•01643-33080	•Washer	1				
		•01803-13034	•Nut	1				
		790-101-4000	Puller	1				
		790-101-1102	Pump					
Components related to air conditioner	X	799-703-1200	Service tool kit	1				Chargin with freon gas (R134a)
		799-703-1100	Vacuum pump (100V)	1				
		799-703-1100	Vacuum pump (220V)	1				
		799-703-1120	Vacuum pump (240V)	1				
		799-703-1400	Gas leak detector	1				

SKETCHES OF SPECIAL TOOLS

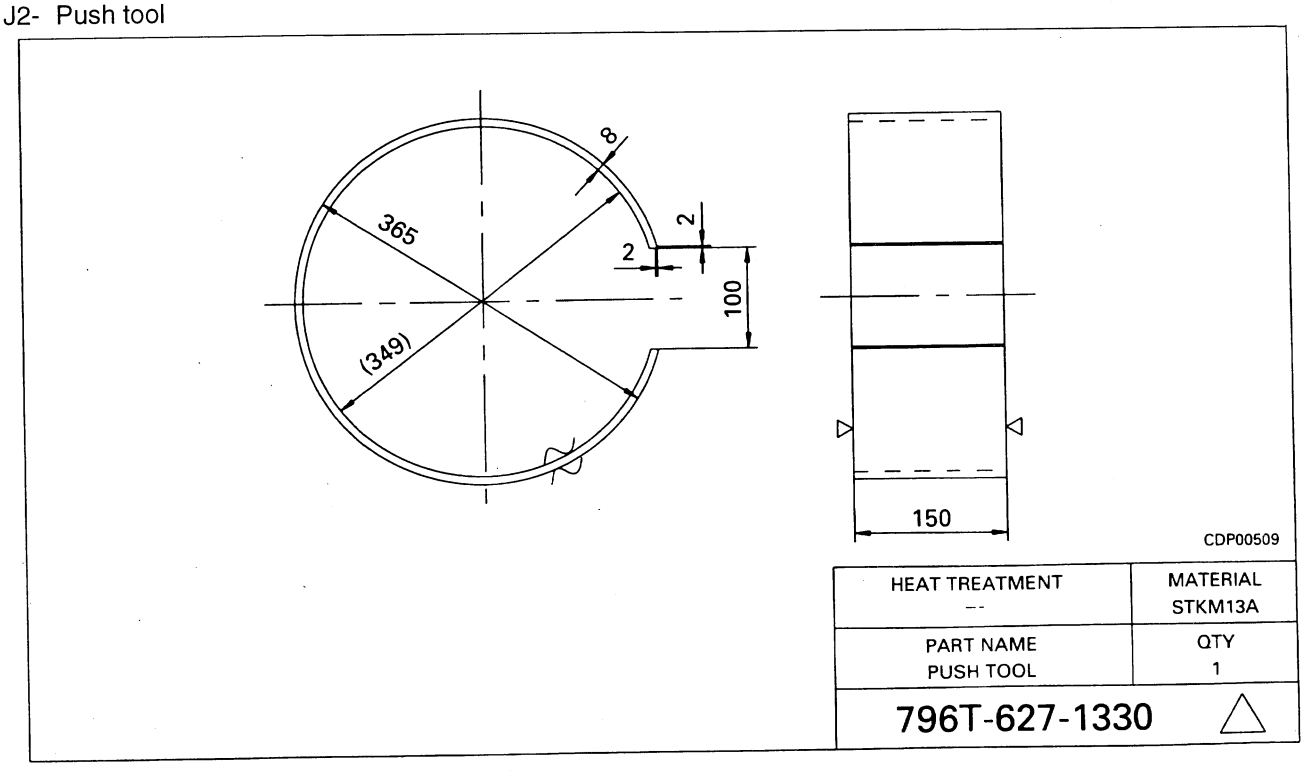
Note: Komatsu cannot accept any responsibility for special tools manufactured according to these sketches

F Push tool



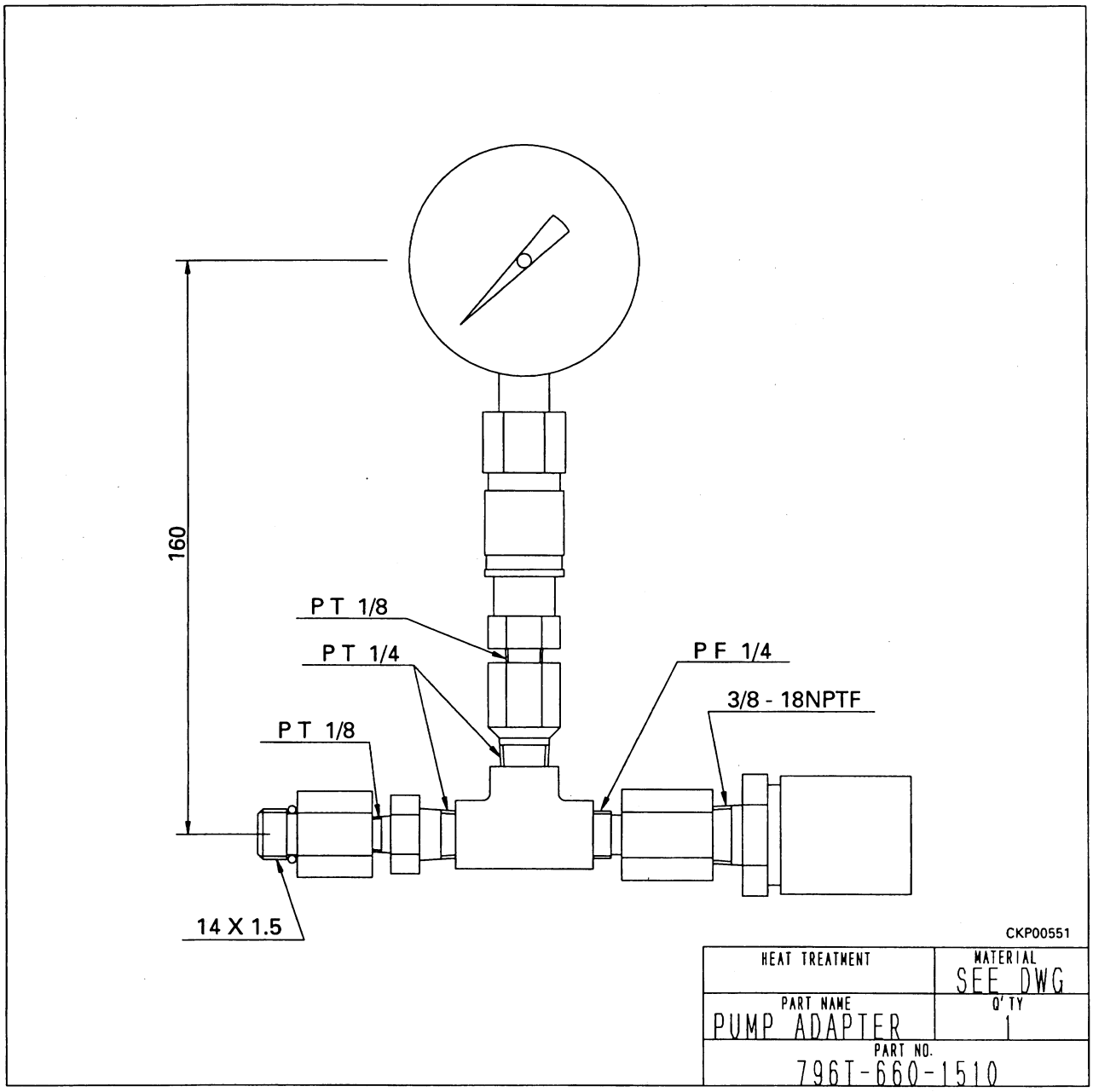
HEAT TREATMENT ---	MATERIAL STKM13A
PART NAME PUSH TOOL	QTY 1
796T-626-1110 △	

J2- Push tool

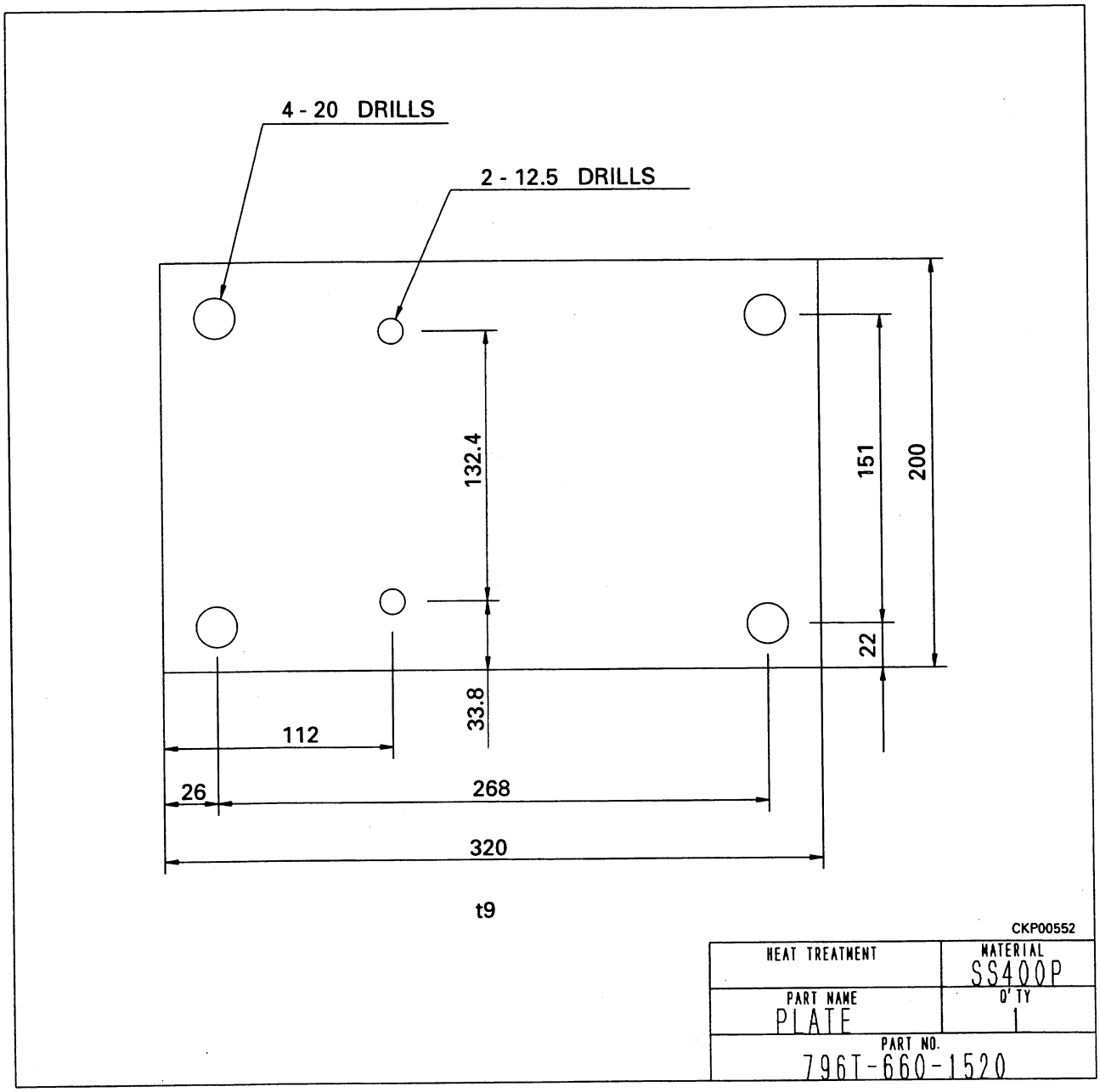


HEAT TREATMENT --	MATERIAL STKM13A
PART NAME PUSH TOOL	QTY 1
796T-627-1330 △	

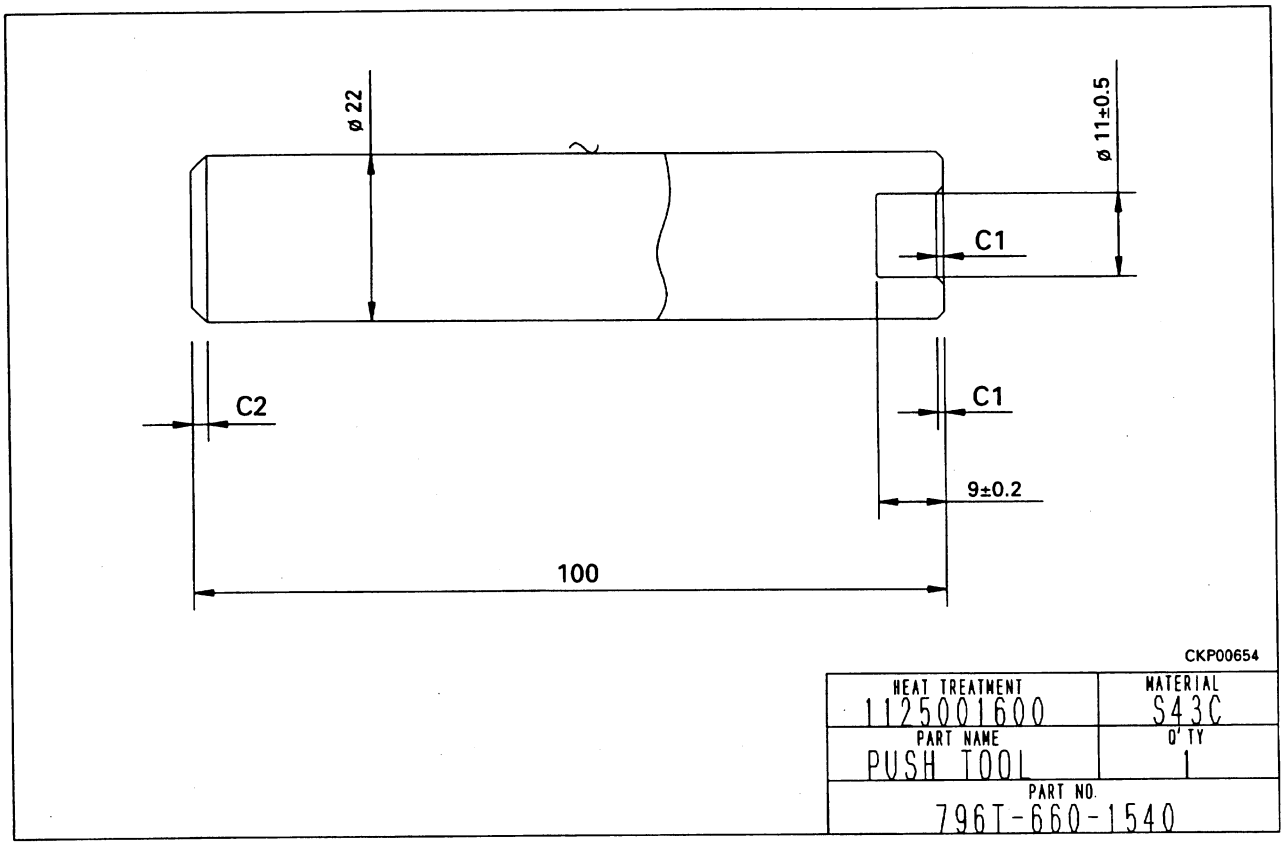
S15-1
Pump adapter



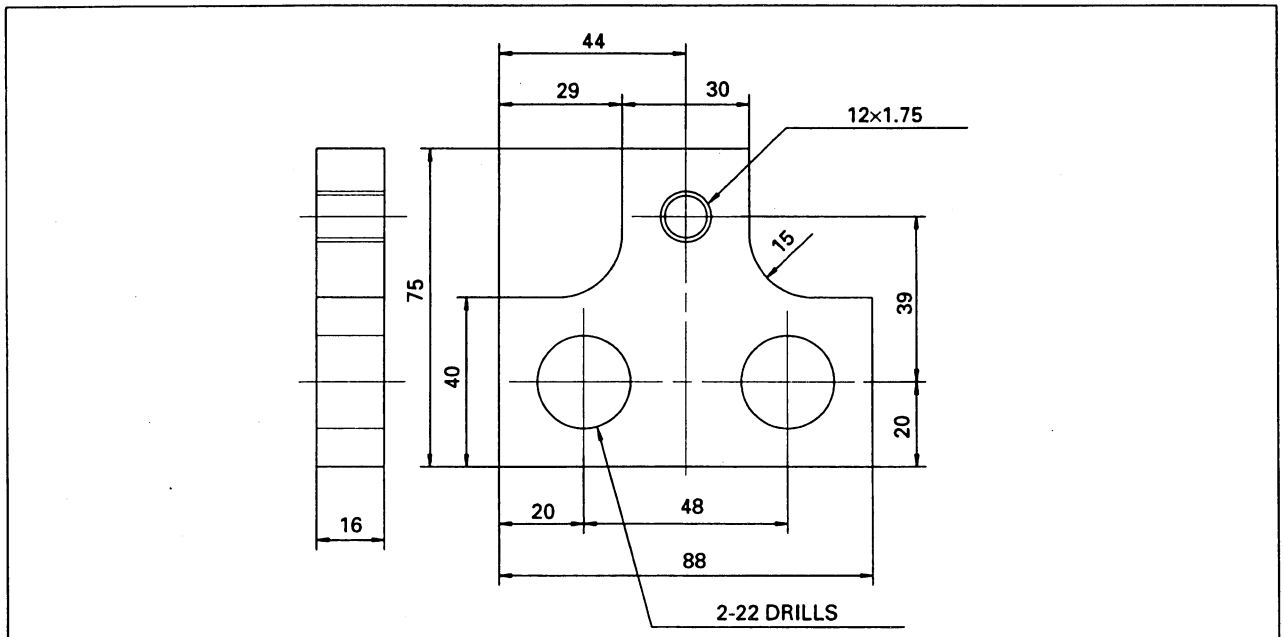
S22-1
Plate


4 - 20 DRILLS
2 - 12.5 DRILLS
132.4
151
200
22
33.8
112
26
268
320
t9
CKP00552
HEAT TREATMENT
MATERIAL
SS400P
PART NAME
PLATE
Q'TY
1
PART NO.
796T-660-1520

S23
Push tool

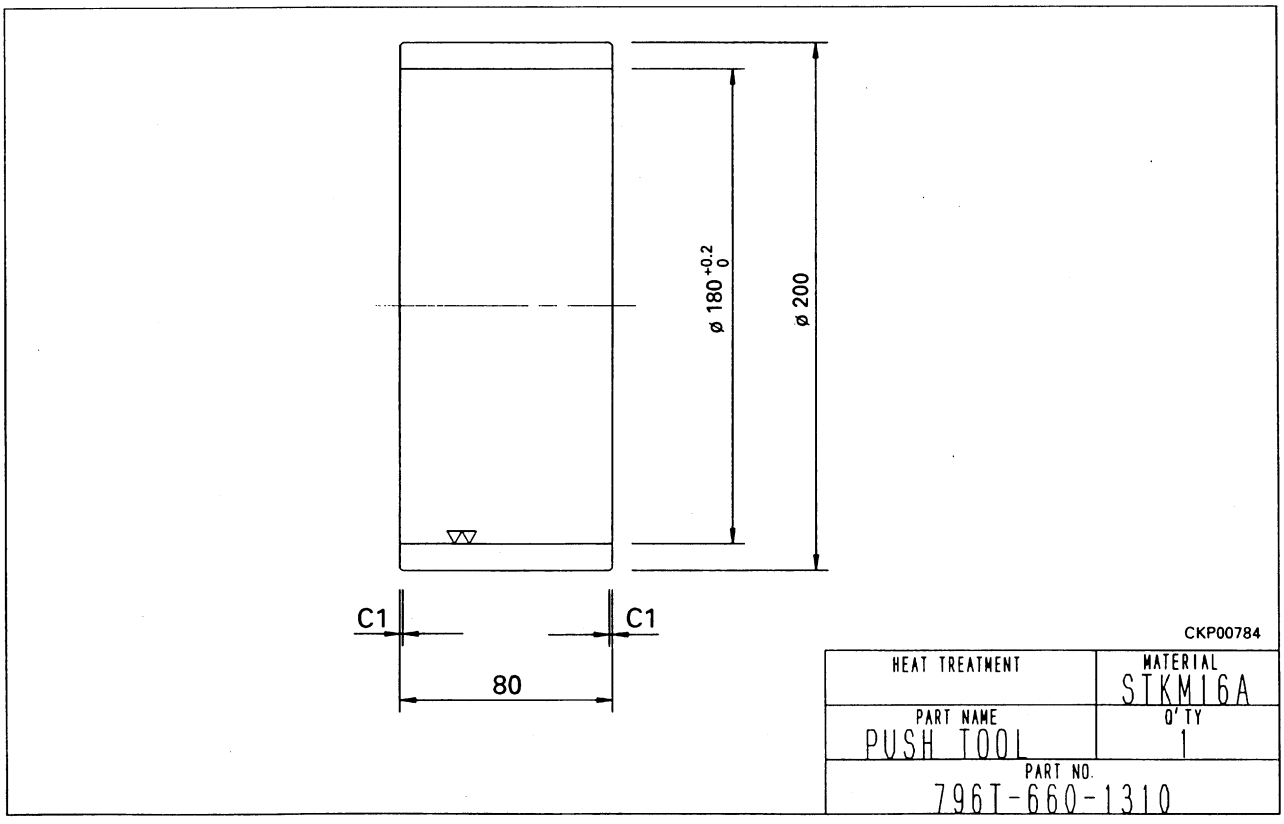


S26 Plate



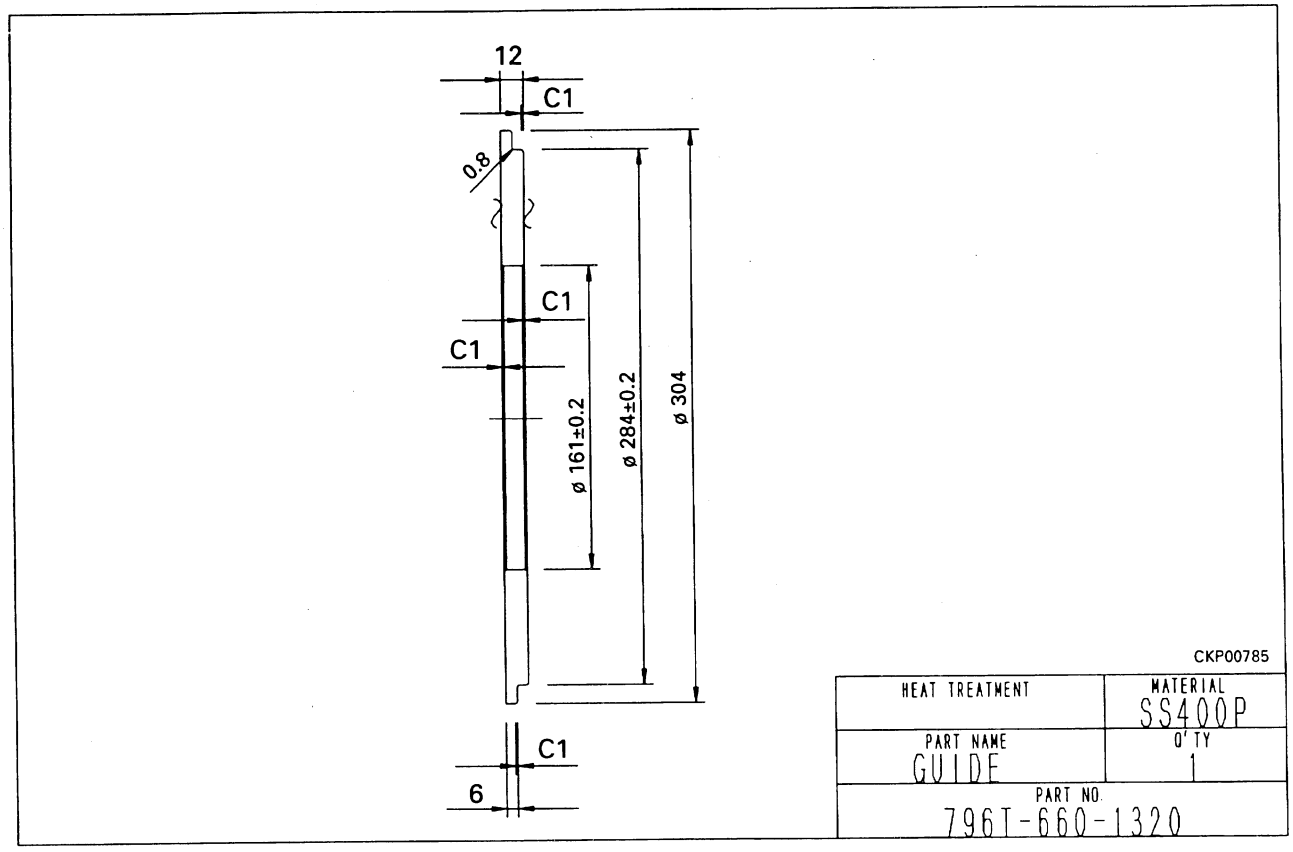
HEAT TREATMENT	MATERIAL SS400P
PART NAME PLATE	Q'TY 1
PART NO. 796T-660-1550	

S29 Push tool

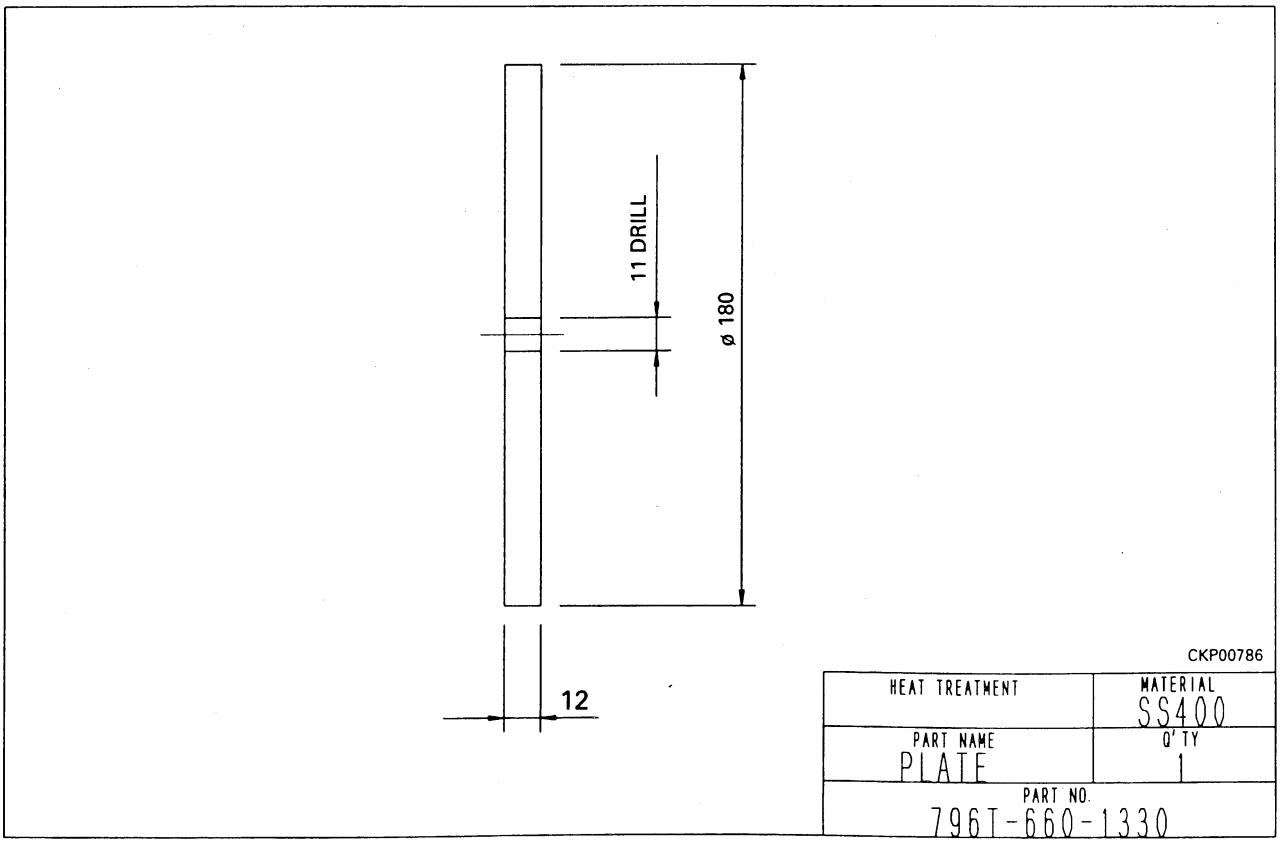


HEAT TREATMENT	MATERIAL STKM16A
PART NAME PUSH TOOL	Q'TY 1
PART NO. 796T-660-1310	

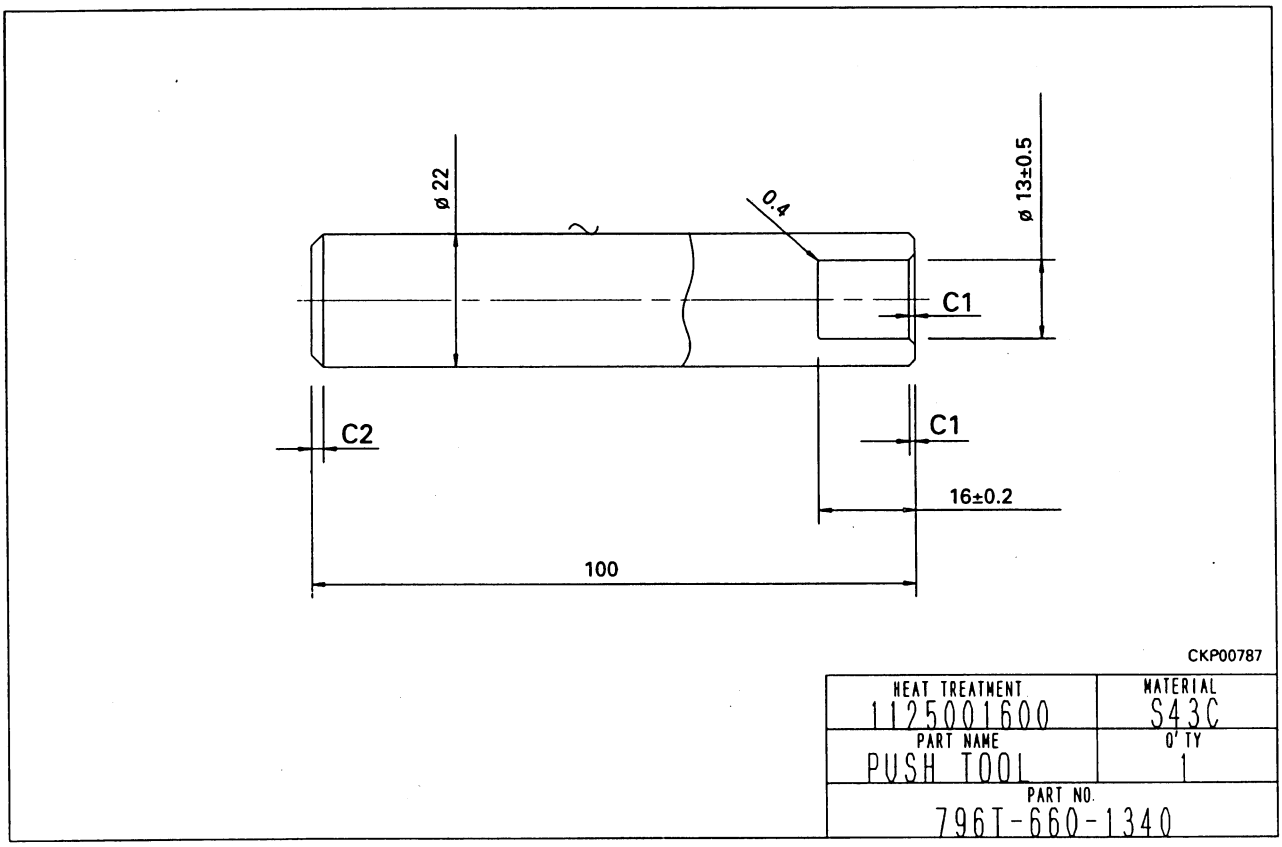
S32-1 Guide



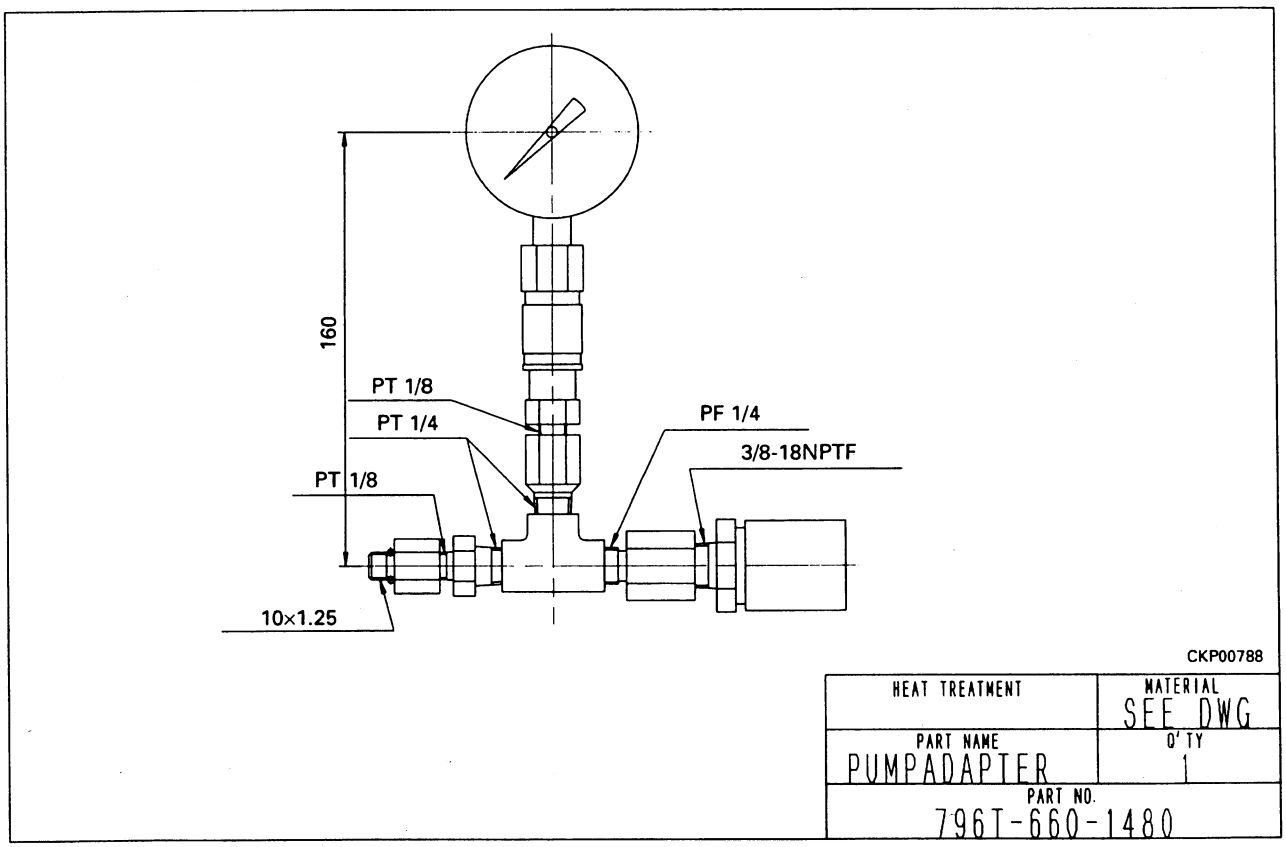
S32-3 Plate



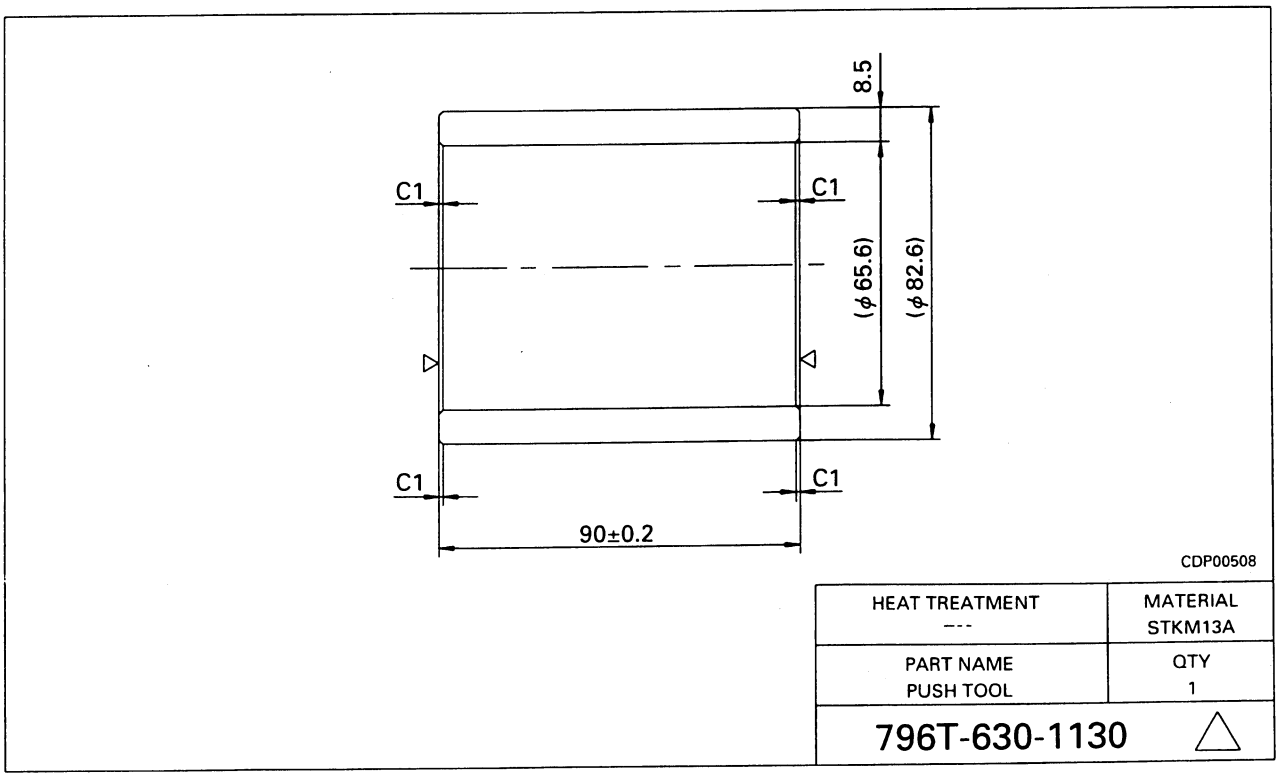
S34 Push tool



S37-1 Pump adapter



L7 Push tool

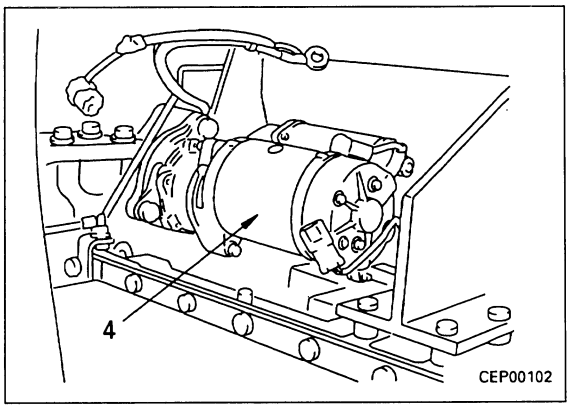

8.5
C1
C1
(φ65.6)
(φ82.6)
C1
C1
90±0.2
CDP00508
HEAT TREATMENT

MATERIAL
STKM13A
PART NAME
PUSH TOOL
QTY
1
796T-630-1130

REMOVAL OF STARTING MOTOR ASSEMBLY

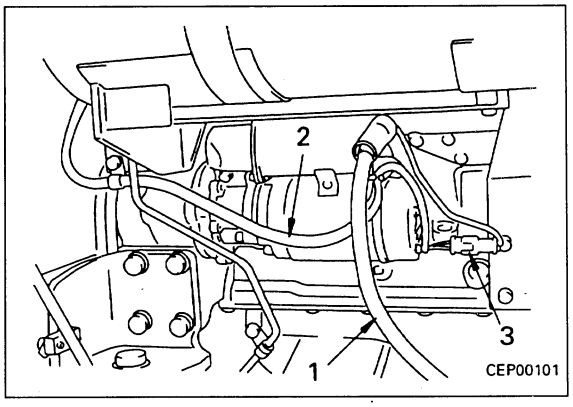
⚠ Disconnect the cable from the negative (-) terminal of the battery.

1. Remove undercover under engine.
2. disconnect starting motor wiring (1) and (2), and connector (3) (CN-M2).
3. Remove mounting bolts of starting motor assembly (4), then remove starting motor assembly frokm undercover.



INSTALLATION OF STARTING MOTOR ASSEMBLY

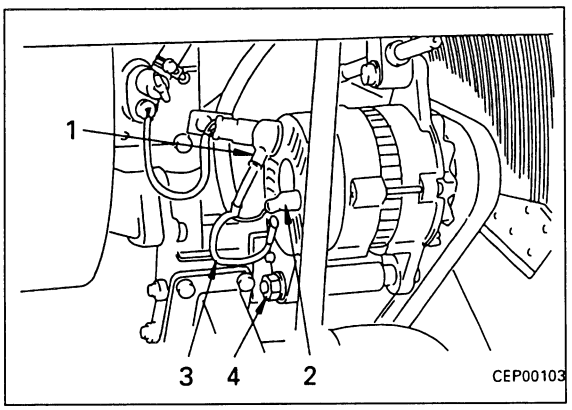
Carry out installation in the reverse order to removal.
Torque : 90 Nm.

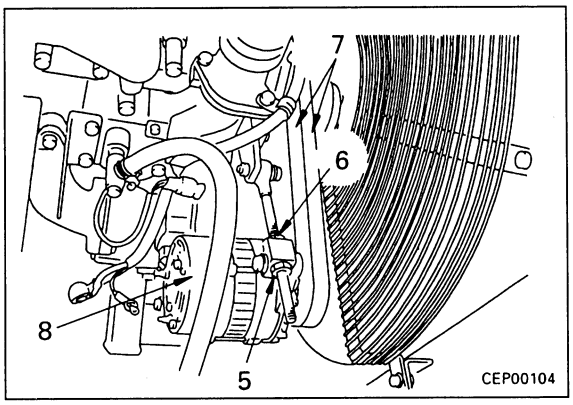


REMOVAL OF ALTERNALTOR ASSEMBLY

Disconnect the cable from the negative (-) terminal of the battery.

1. Open engine hood.
2. Disconnect alternator wiring (1), (2), and (3).
3. Loosen mount bolt and nut (4).
4. Loosen locknut (5), then turn adjustment nut (6), and remove 2 bolts (7) from alternator (8). [※ 1]
5. Remove mount bolt and nut (4), then remove alternator assembly (8).





INSTALLATION OF ALTERNATOR ASSEMBLY

Carry out installation in the reverse order to removal.

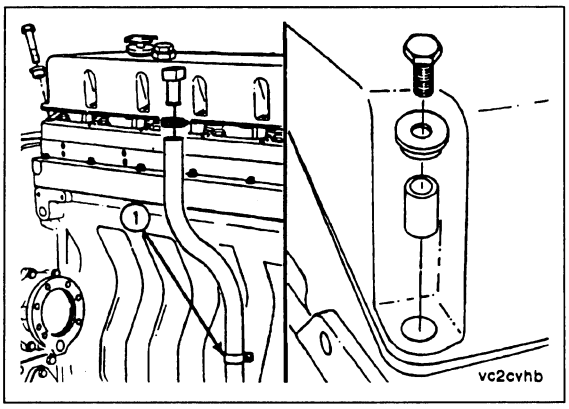
[※ 1]

★ Adjust the fan belt tension.
Fordetails, see TESTING AND ADJUSTING, Testing and adjusting fan belt tension.

REMOVAL OF NOZZLE HOLDER ASSEMBLY

Injectors - Removal

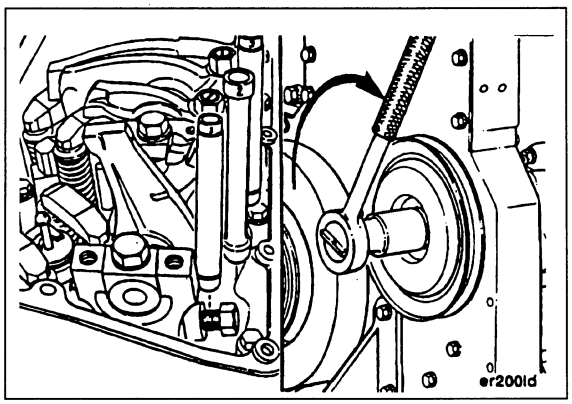
Remove the breather tube and the tube retaining clib (1) from the side of the cylinder block.



Remove the 16 capscrews, isolators and spacers from the cover.

Remove the cover and gasket.

Mark the olcation of the valve push tubes and injector push rods as they are removed. The push tubes and push rods must be installed in the same location when the engine is assambled.



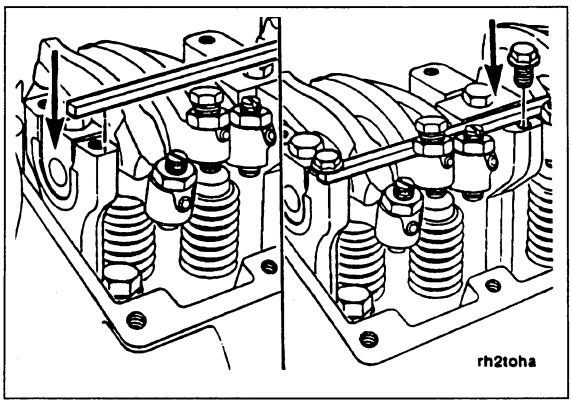
Loosen the adjusting screws and remove the valve push tubes and injector push rods.

hold the push tubes and push rods while loosening the adjusting screws. Do not let them fall into the engine while rotating the accessory drive pulley.

NOTE: Some push tubes and rods are under compression due to the valves being open. Rotate the crankshaft clockwise with the accessory drive pulley to relieve the spring tension.

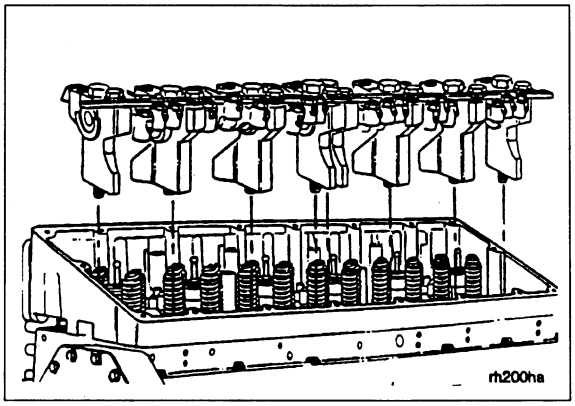
Rocker Lever Assemblies - Removal

Install a piece of one-quarter inch key stock 18 inches long on top of the four front rocker lever assembly supports. Use four (M10-1.5 X 25) flange head capscrews to secrue the bar stoch to the supports.



The two capscrews on the end supports will fasten on one side of the bar stock to the engine brake mounting holes. The two capscrews on the center supports will fasten on the opposite side of the bar stock to the engine brake mounting holes.

Loosen, but do not remove, the eight rocker shaft capscrews. The capscrews hold the rocker lever assemblies together.



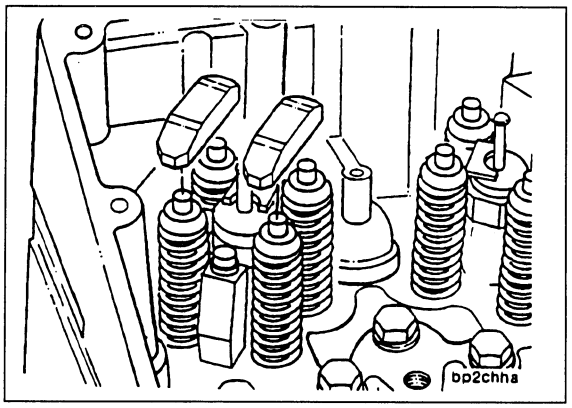
Grasp hold of the bar stock and lift the front rocker lever assembly from the engine.

Repeat the process to remove the rear rocker lever assembly.

Remove the crossheads.

Number each crosshead with the cylinder numbewr and position as it is removed.

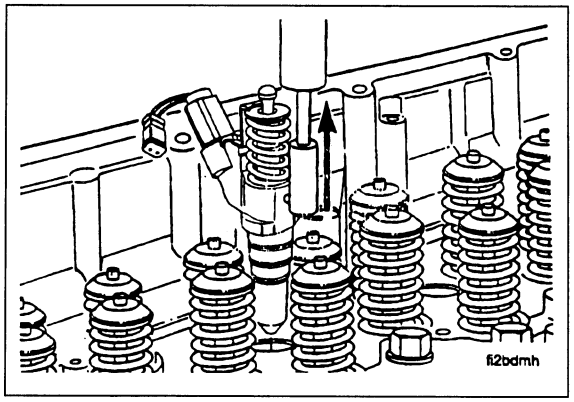
NOTE: Each crosshead must be installed in the same position as it was removed from when the engine is assembled.



Remove the injector hold down capscrews and hold down clamps.

Use injector puller, Part No. 3823579, to remvoe the injectors from the engine. Insert the pin of the tool into the hole provided in the body of the injector.

Number each injector with the cylinder number as it is removed.

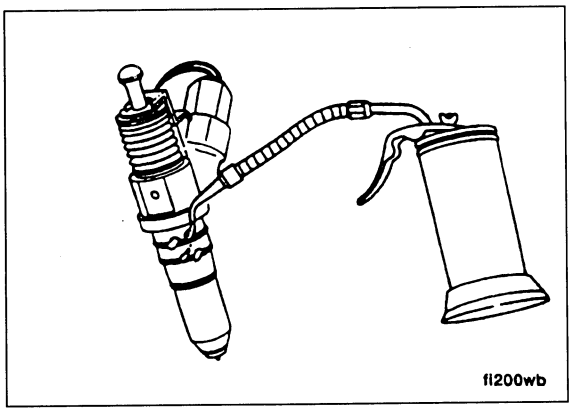


Injectors - Installation

Do not stretch the o-rings as they are installed. The o-rings must be correctly installed in the grooves to prevent leaks.

NOTE: It is important that the three injector o-rings be installed in the correct orientation. Install the three new o-rings as follows:

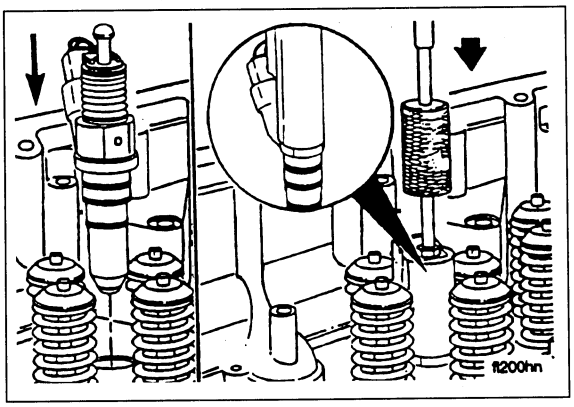
Part No.	Location	Color Code
3070136	Top	Black or Red
3070137	Middle	Brown or White
3070138	Bottom	Black with Dot or Litht Blue



Lubricate the o-rings with clean 15W-40 oil just before installation.

Place the injector in the cylinder head injector bore with the injector solenoid valve toward the intake port. Align the injector equally between the valve springs.

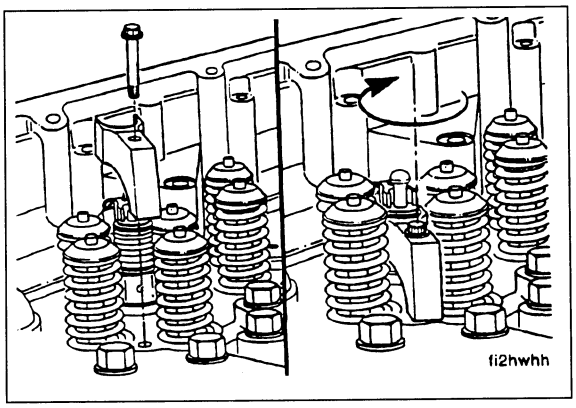
Caution: Do not drive the injector in by striking the top stop or solenoeid valve area. This can damage the solenoid, or cause the injector to be out of alignment in the bore which will result in o-ring damage.



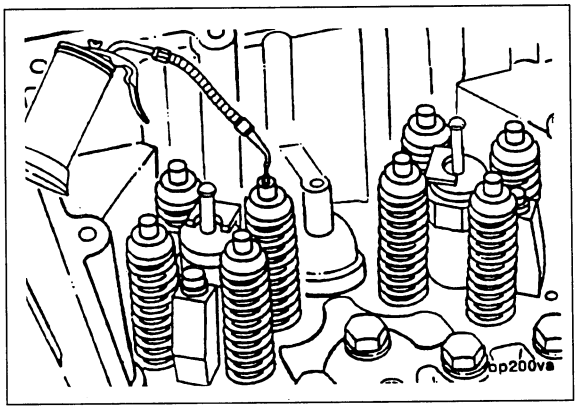
Use injector tool, Part No. 3823579, to seat the injector in the bore.

Install the hold down clamp and capscrew (M10-1.25 X 75). Tighten the capscrew.

Torque Value: 75 •N M [55 ft-lb]

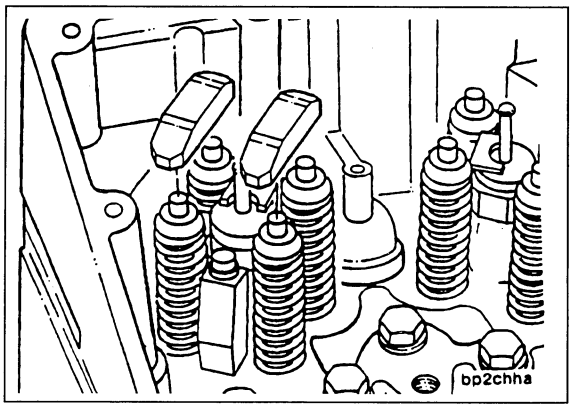


Use clean 15W-40 oil to lubricate the end of the valve stems.



If the same crossheads are used, they must be installed in the same location as from which they were removed.

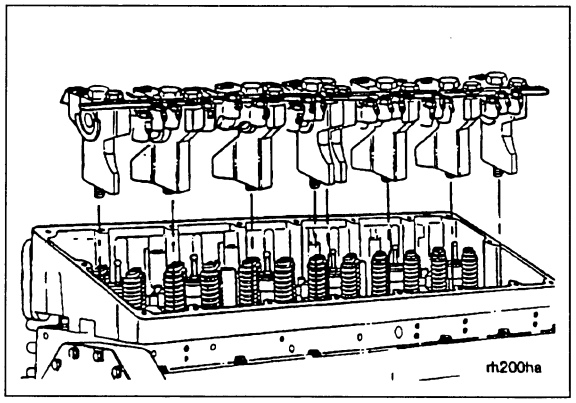
Install the crossheads on the valve stems.



The rocker lever assemblies must be installed in the engine so they are in the same position as they were removed from.

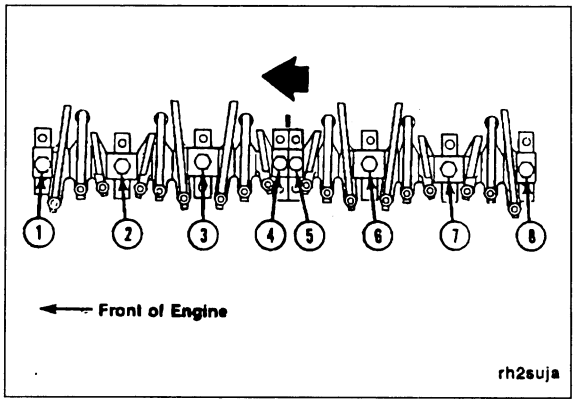
Install the assemblies on the engine.

Only snug the mounting capscrews. do not tighten the capscrews to more than 5 N m [45 in -lb] torque at this time. The rocker lever side slearance must be adjusted before the capscrews are tightened to their final torque value.



Push the number five rocker lever support toward the front of the engine and tighten the support capscrew.

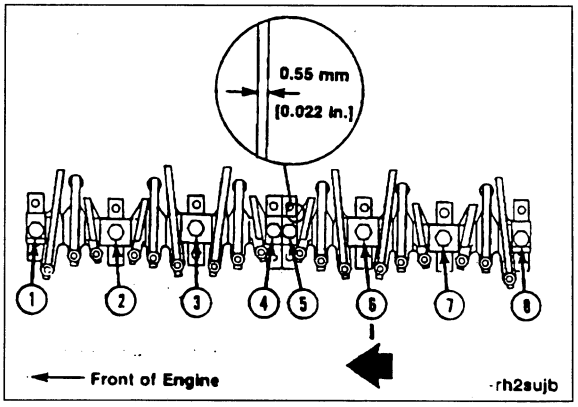
Torque Value: 122 N• m [90 ft-lb]



Install a 0.55 mm [0.022 inch] feeler gauge between the number five support and the intake lever for the number four cylinder.

Push the number six support toward the front of the engine and tighten the support capscrew.

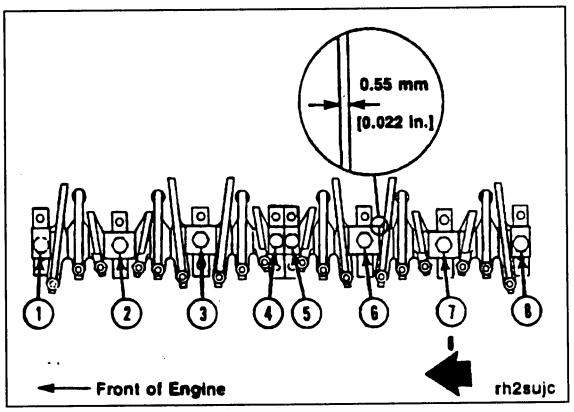
Torque Value: 122 N• m [90 ft-lb]



Install a 0.55 mm [0.022 inch] feeler gauge between the number six support and the exhaust lever for thenumber five cylinder.

Push the number seven support toward the front of the enginge and tightent he support capscrew.

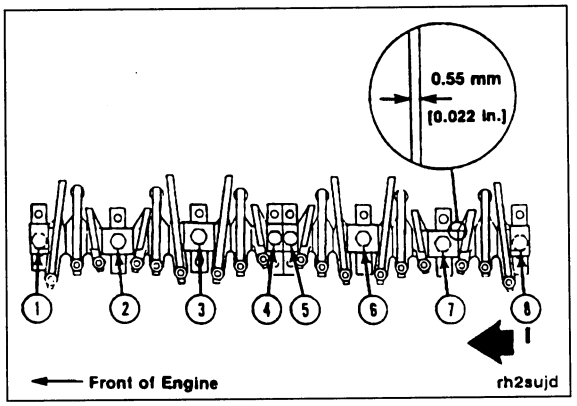
Torque Value: 122 N•m [90 ft-lb]



Install a 0.55 mm [0.022 inch] feeler gauge between the number seven support and the intake lever for the number six cylinder.

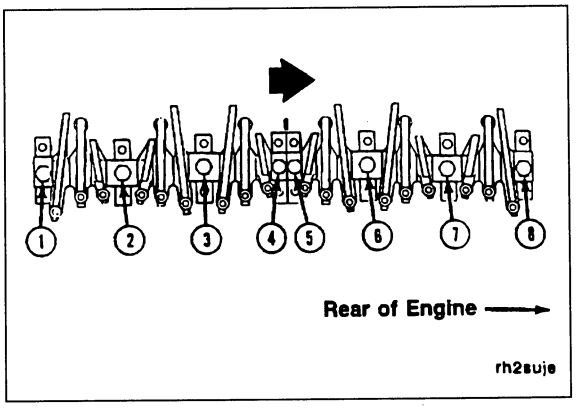
Push the number eight support toward the front of the engine and tighten the support capscrew.

Torque Value: 122 N•m [90 ft-lb]



Push the number four support toward the rear of the engine and tighten the support capscrew.

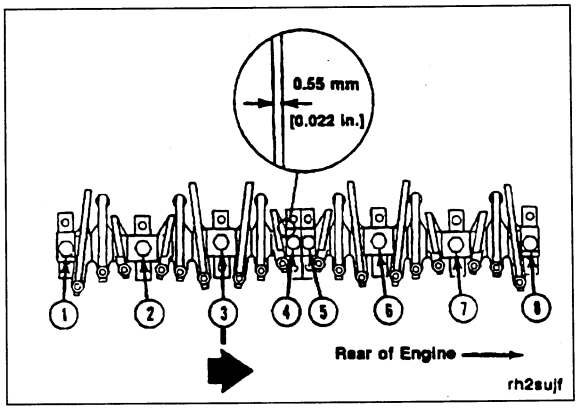
Torque Value: 122 N•m [90 ft-lb]



Install a 0.55 mm [0.022 inch] feeler gauge between the number four support and the intake lever for the number three cylinder.

Push the number threee support toward the rear of the engine and tighten the support capscrew.

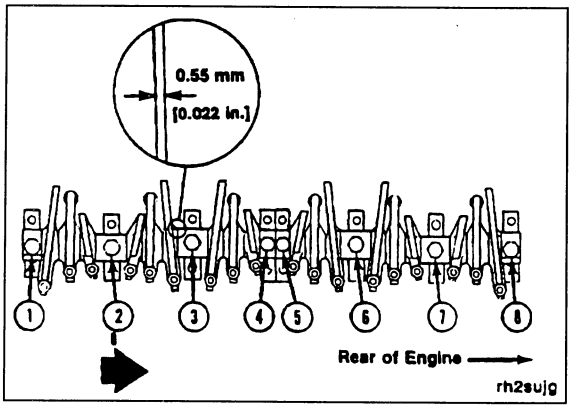
Torque Value: 122 N•m [90 ft-lb]



Install a 0.55 mm [0.022 inch] feeler gauge between the number three support and the exhaust lever for the number two cylinder.

push the number two support toward the rear of the engine and tighten the support capscrew.

Torque Value: 122 N•m [90 ft-lb]

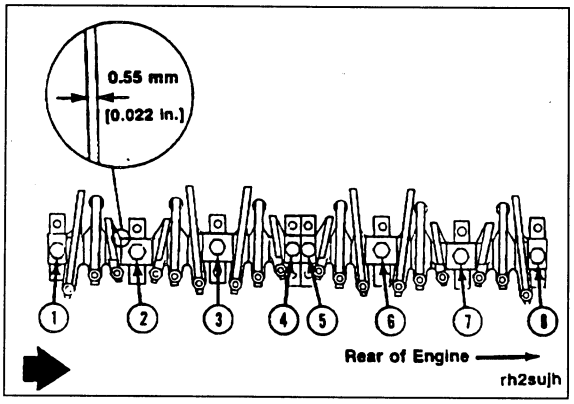


Install a 0.55 mm [0.022 inch] feeler gauge between the number two support and the intake lever for the number one cylinder.

Push the number one support toward the rear of the engine and tighten the support capscrew.

Torque Value: 122 N•m [90 ft-lb]

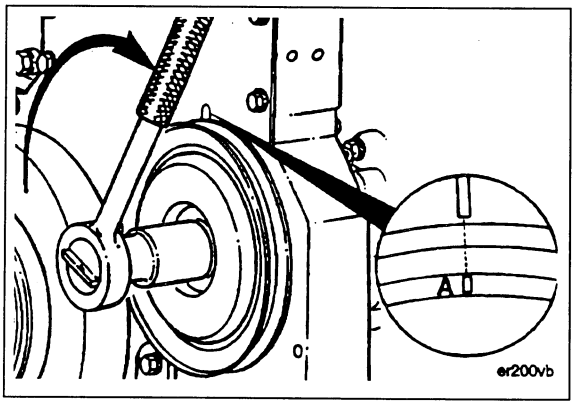
Check the front and rear assemblies for correct clearance. Check the support capscrews for the correct torque value.



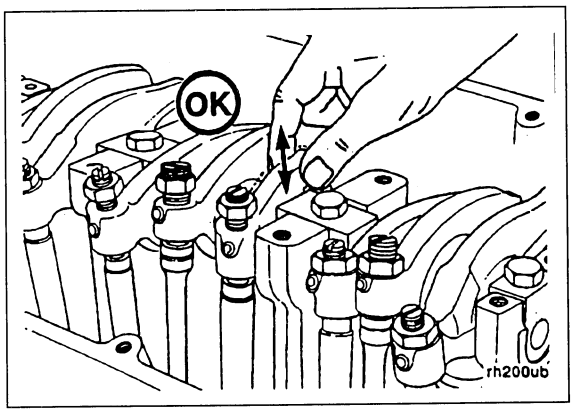
The valve set marks are located on the accessory drive pulley. The marks align with a pointer on the gear cover.

The adjustment can begin on any valve set mark. In the following examlple, the adjustment will begin on the "A" valve set mark with cylinder number one ready for adjustment.

Rotate the accessory drive clockwise until the "A" valve set mark on the pulley is aligned with the pointer on the gear cover.



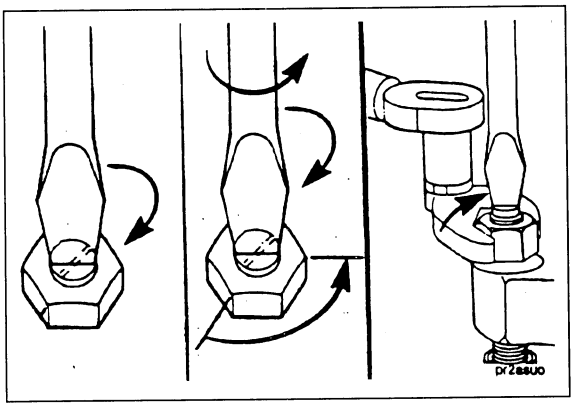
When the "A" mark is aligned with the pointer, the intake and exhaust valves for cylinder number one **must** be closed. If these conditions are **not** correct, cylinder number six **must** be ready to set. Set the injector and valves on the cylinder that both the intake and exhaust valve rocker lever arms loose and can be moved from side to side by hand.



Both valves are closed when both rocker levers are loose and can abe moved from side to side.

Loosen the injector adjusting screw locknut. Using a screwdriver or box end wrench, and the adjusting screw, bottom the injector plunger three of four times to remove the fuel.

Turn the adjusting screw in until you can feel it just bottom the plunger.



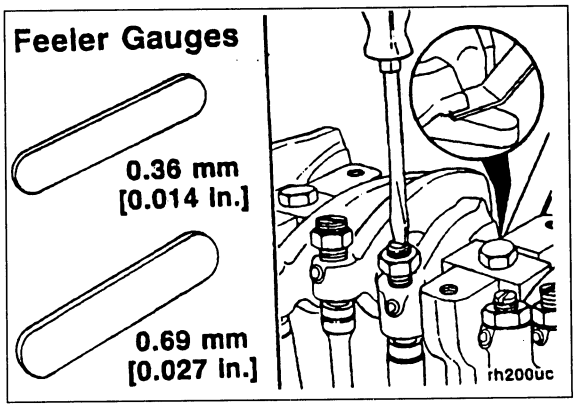
NOTE: Do **not** use excess force when bottoming the plunger.

Back out the adjusting screw two flats (120 degrees). Hold the adjusting screw and torque the locknut.

Torque Value: 61 N•m [45 ft-lb]

After adjusting the injector, set the valves on the same cylinder.

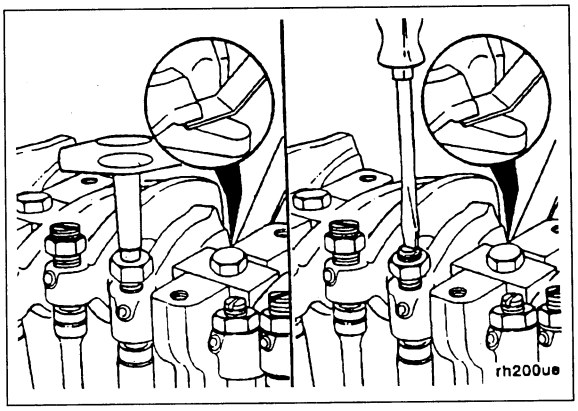
Select a feeler gauge for the correct valve lash specification.



Valve Lash Specifications		
	mm	in
Intake	0.36	0.014
Exhaust	0.69	0.027

Insert the feeler gauge between the top of the crosshead and the rocker lever pad.

Two different methods for establishing valve lash clearance are described below. Either method can be used; however, the torque wrench method has proven to be the most consistent. It eliminates the need to feel the drag on the feeler gauge.

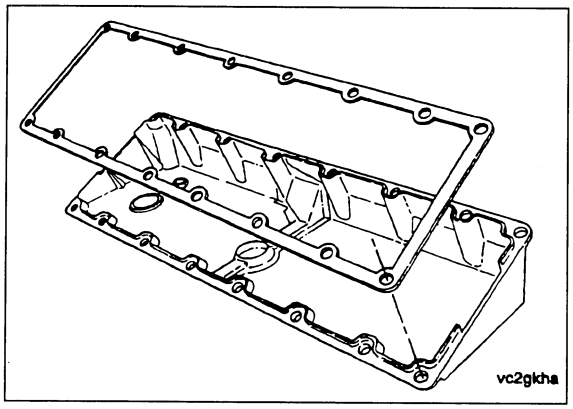


- **Torque Wrench Method**: Use the inch pund torque wrench, Part No. 3376592, normally used to set preload on top stop injectors, and tighten the adjusting screw.

Torque value: 1 N•m [6 in-lb]

- **Touch Method**: Tighten the adjusting screw until a slight drag is felt on the feeler gauge.

Install a new gasket on the cover.



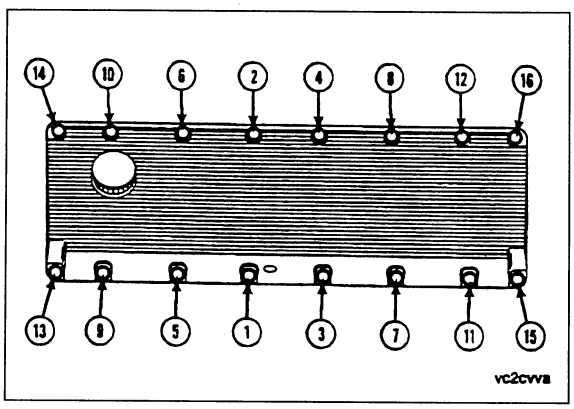
Install teh cover on teh rocker lever housing.

Install the 16 isolators and capscrews (M8-1.25 X 40) in the cover.

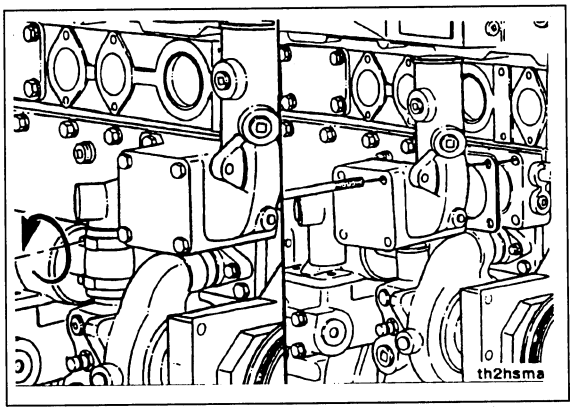
Tighten the capscrews in the sequentce shown.

Torque Value: 15 N•m [130 in-lb]

Install the breather hose and retaining clip.



REMOVAL OF THERMOSTAT ASSEMBLY



⚠ Disconnect the cable from the negatigve (-) terminal of the battery.

1. Drain engine coolant.
2. Open engine hood.

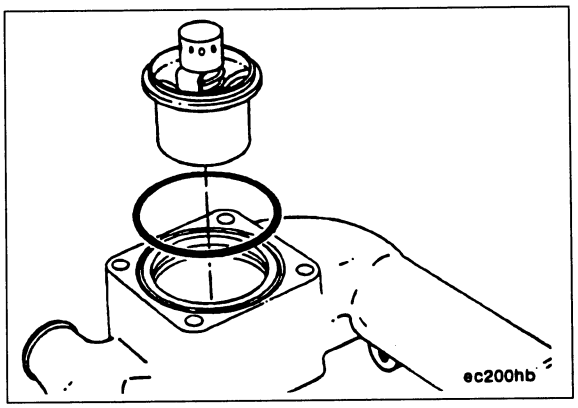
Loosen the radiator top hose clamp.

Loosen the bottom coolant bypass hose clamp.

NOTE: If the housing is stuck, hit the housing with a mallet to lossen it.

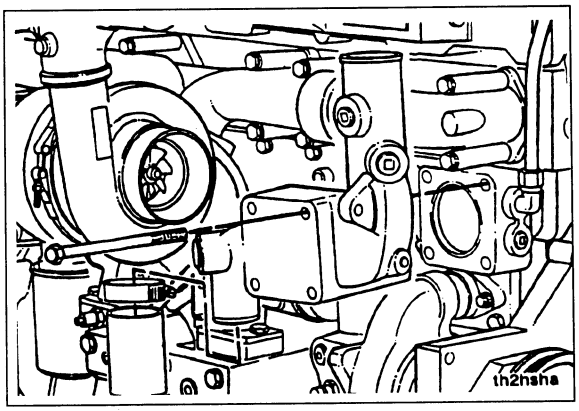
Remove the four capscrews, the housing, and the thermostat.

INSTALLATION OF THERMOSTAT ASSEMBLY



Install the thermostat into the housing.

Install a new seal in the groove on the thermostat housing mounting surface.



Install the thermostat housting with four capscrews (M10-1.50 X 145).

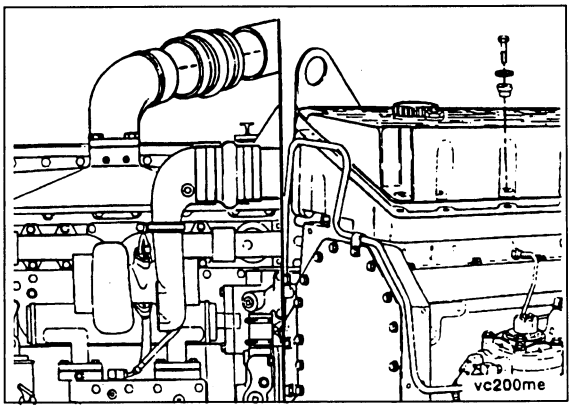
Torque Value : 54 N•m [40 ft-lb]

Evenly space the bypass hose on the water pump and thermostat housing connections.

Tighten the hose clamps.

Torque Value: 3 N•m [30 in-lb]

REMOVAL OF CYLINDER HEAD ASSEMBLY



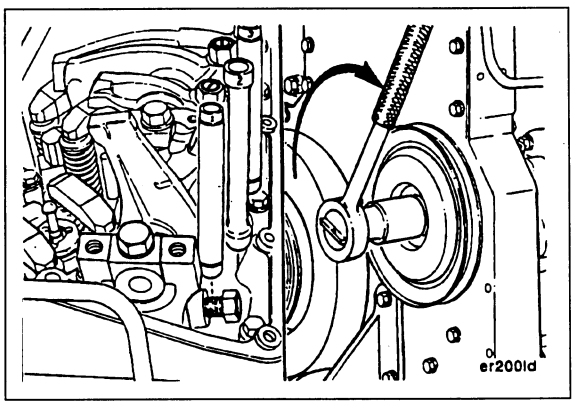
⚠ Disconnect the cable from the negative (-) terminal of the battery.

Drain coolant.

Remove the air piping from the intake manifold and the tubocharger.

Remove the rocker lever cover.

Remove the push tubes and push rods.

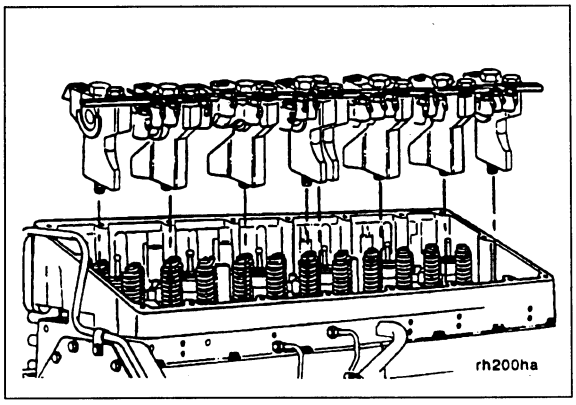


Remove the crossheads.

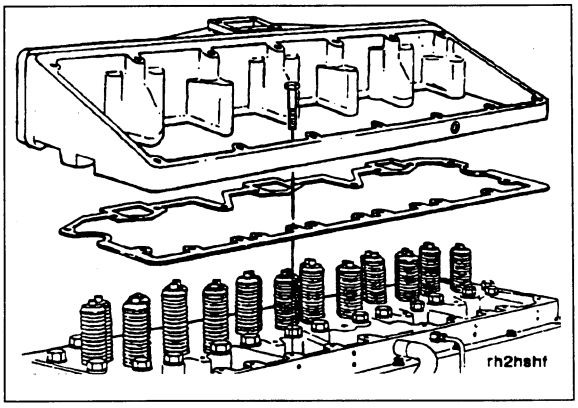
NOTE: Mark the position of the crossheads as they are removed. The crossheads must be installed in the same position when the engine is assembled.

Remove the rocker levers.

Remove the injectors.



Remove the rocker lever housing.



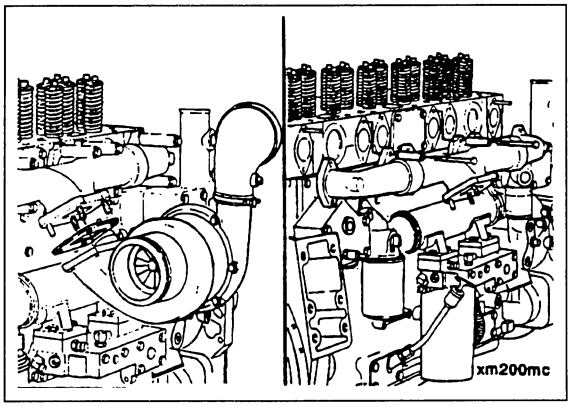
Remove the tubocharger.

Remove the exhaust manifold.

Disconnect the fuel lines from the cylinder head.

Remove the fan and fan hub.

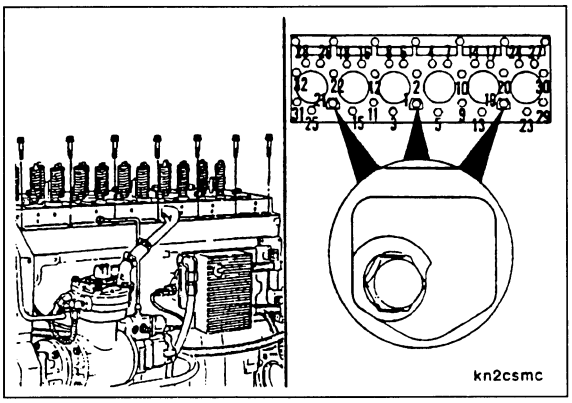
Remove all the necessary brackets and clamps.



Remove the seven 12 point cylinder head capscrews on the fuel pump side of the engine.

Remove the remaining 32 sylinder head capscrews in the sequence shown.

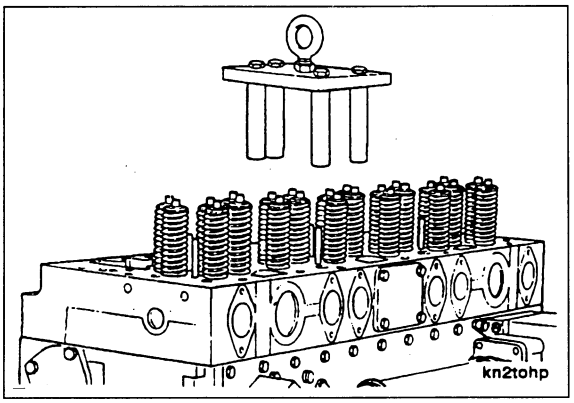
NOTE: Three capscrews are located inside the intake ports.



Install cylinder head lifting bracket, Part No. 3822479, with two rocker lever support mounting capscrews and two of the long rocker housing mounting capscrews.

Tighten the cpascrews.

Torque Value: 47 N•m [35 ft-lb]

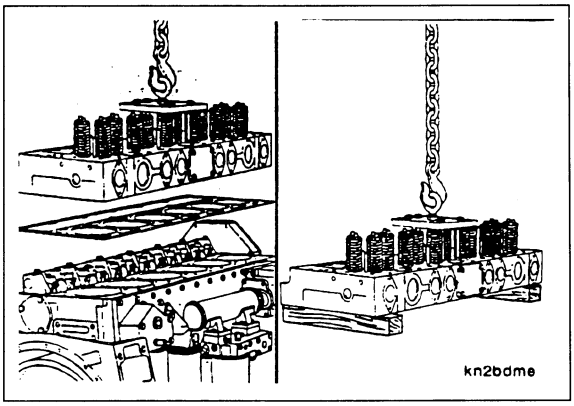


This component weights 23 kg [50 lb] or more. To avoid perasonal injury, use a hoist or get assistance to lift the component.

Caution: Place the cylinder head on wood blocks to prevent damage to the combustion face.

Use a hoist or hydraulic arm and remove the cylinder head.

Remove the cylinder head gasket.



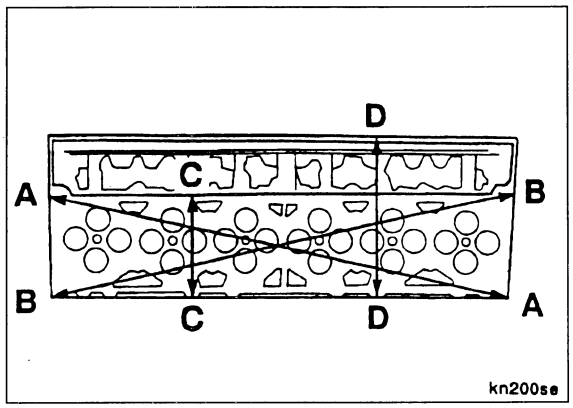
INSTALLATION OF CYLINDER HEAD ASSEMBLY

- Carry out installation in the reverse order to removal.

Measure the flatness of the cylinder head combustion feace surface as follows:

- AA and BB (corner to corner)
- CC (across combustion face)
- DD (across entire head surface)

NOTE: Dimensions CC and DD must be checked from front to rear of cylinder head.

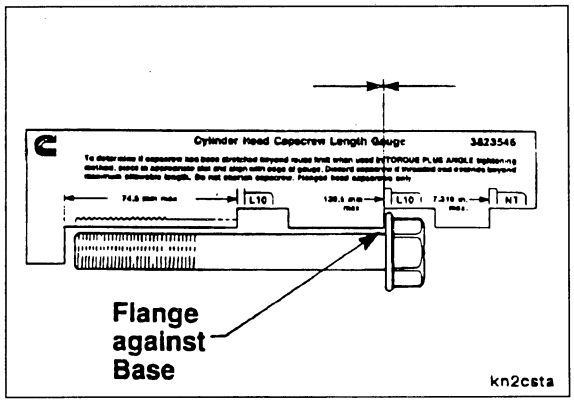


Cylinder Head Flatness			
	mm		in
AA and BB	0.200	MAX	0.008
CC	0.076	MAX	0.003
DD	0.127	MAX	0.005

If the cylindre head is pitted, has grooves or wear greater than the maximum specified, the cylinder head surface must be machined or cut.

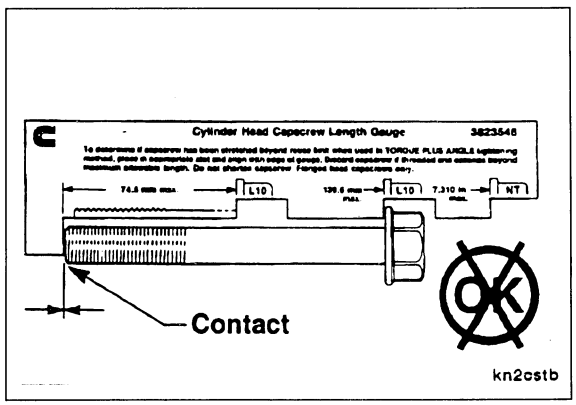
Flange Head Capscres Reuse Guidelines

Using flange head capscrews with the torque plus angle mehtod of installation places the capscrew beuond the yield point and permanently stretches the capscrew. These capscrews can be reused throughout the life of the engine unless the capscrew exceeds the specified free length. The free length must be checked to avoid bottoming in the block during installation.



Cylinder head capscrew length gauge, Part No. 3823546, has been developed to check capscrew free length.

To check the capscrew free length, place the head of the capscrew in the appropriate slot, long or short, with the flange against the base of the slot.

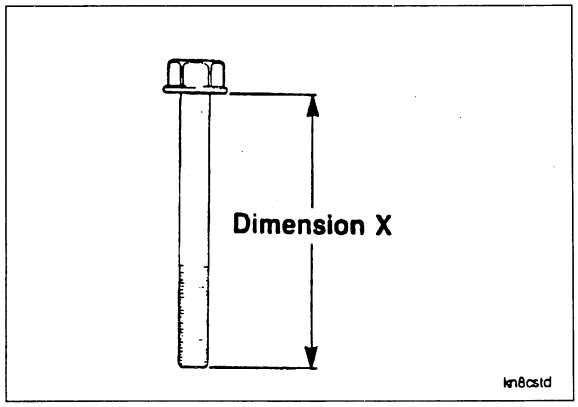


NOTE: Use the slot marked for L10 cylinder head capscrews when checking M11 cylinder head capscrews.

If the end of the capscrew touches the foot of the gauge, the capscrew is too long and must be discarded.

If there is clearanc between the end of the capscrew and the bottom base of the tool, the capscrew is OK for reuse.

The capscrew can also be checked using a set of calipers. The maximum allowable free length is measured from the bottom of the flange to the end of the capscrew (Dimension X).



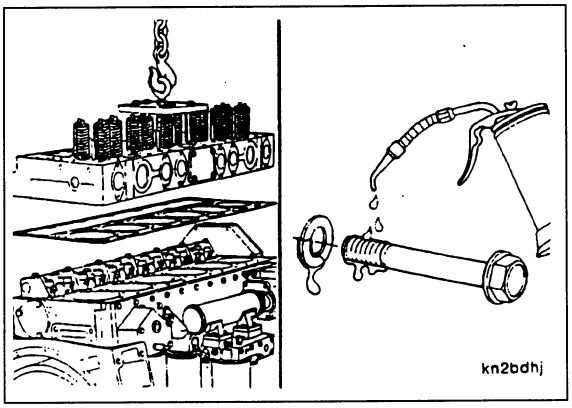
Part No.	Maximum Free Length
3045849	74.5 mm [2.933 in]
3045850	139.5 mm [5.492 in]

Caution: Do not drop the cylinder head on the cylinder head gasket. The gasket material can be damaged.

Use a new gasket and install the cylinder head.

Use clean 15W-40 oil to lightly coat the cylinder head capscrew threads and bottom of the flange.

Allow the excess oil to drain from the capscrew threads.



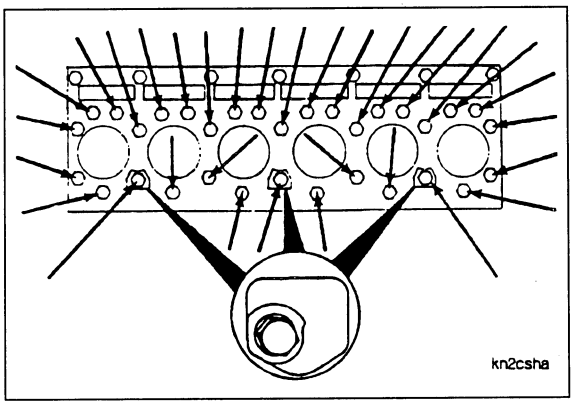
Install the cylinder head capscrews.

NOTE: Be sure to install the three capscrews inside the intake ports.

The markings on the head of the flange head capscrews serve as an aid during installation.

Tighten the capscrews in the sequence shown to the specified values.:

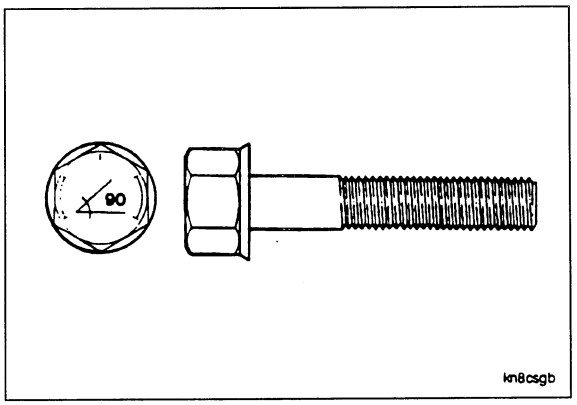
Torque Value: Step 1 - 136 N•m [100 ft-lb]
2 - 217 N•m [160 ft-lb]
3 - Rotate 90 Degrees



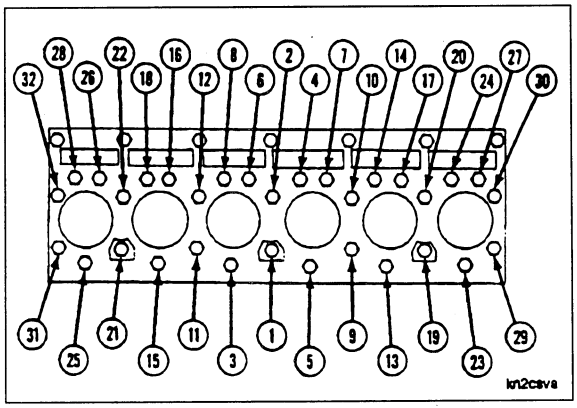
NOTE: Rotate at least one flat, but not more than two.

After torquing to Step 2, mark the cylinder head adjacent to one of the two single marks on the capscrew head.

All 32 capsrews **must** be rotated 90 degrees after they have been torqued to Step 2. Rotate the capscrew until the mark on the cylinder head is between the next two marks joined by an arc (more than one flat and less than two flats).



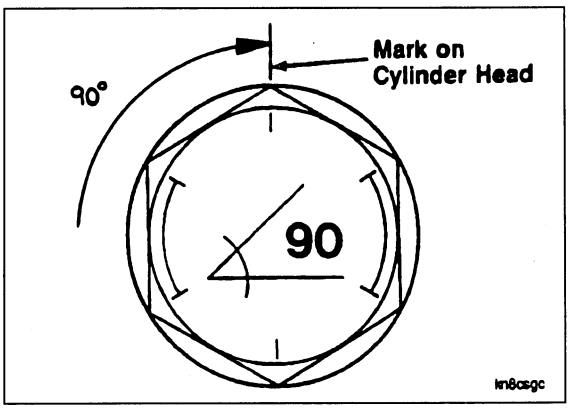
NOTE: When using torque plus angle, the tolerance on the 90 degree angle of rotation is between one and two flats. If the capscrew is unintenionally rotated beyond two flats, do **not** loosen the capscrew. The clamp load is still acceptable. However, rotating the capscrew beyond two flats reduces the number of reuses.

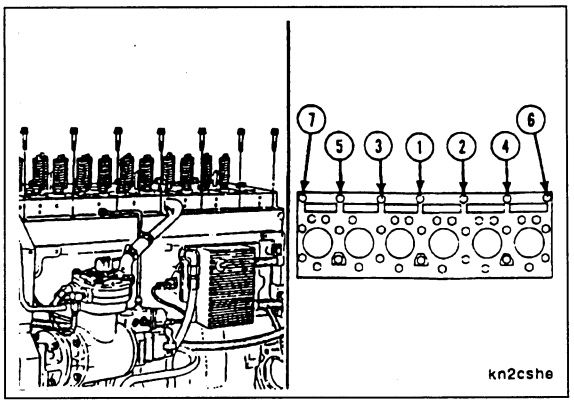


Use new copper sealing washers and install the seven capscrews on the fuel pump side of the cylinder head.

Tighten the capscrews in the sequence shown.

Torque Value: 47 N•m [35 ft-lb]





Install the fan hub an fan.
Install all brackets and clamps that were removed.

Install the fuel lines to the cylinder head.

Install the exhaust manifold.

Torgue Valve: Step 1 - 27 N•m
2 - 47 N•m

The rocker lever housing **must** be installed before the injectors on M11 engines.

Use a new gasket and install the rocker lever housing using four mounting capscrews (M10-1.50 X 100) and 20 mounting capscrews (M10-1.50 X 35).

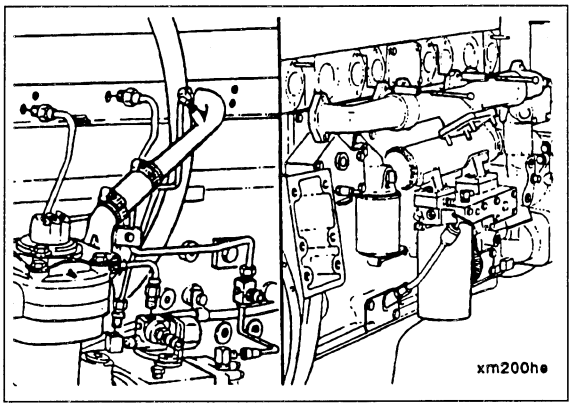
Tighten the capscrews, in the sequence shown.

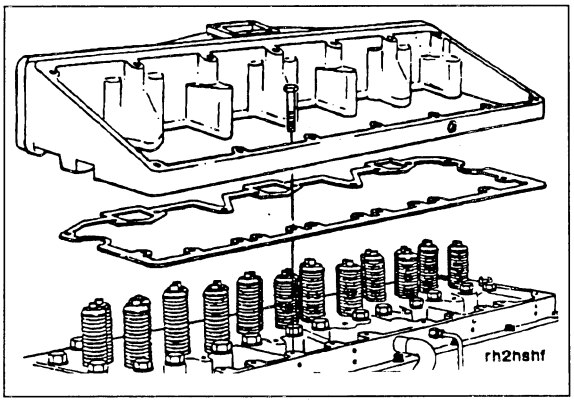
Torque Value: 47 N•m [35 ft-lb]

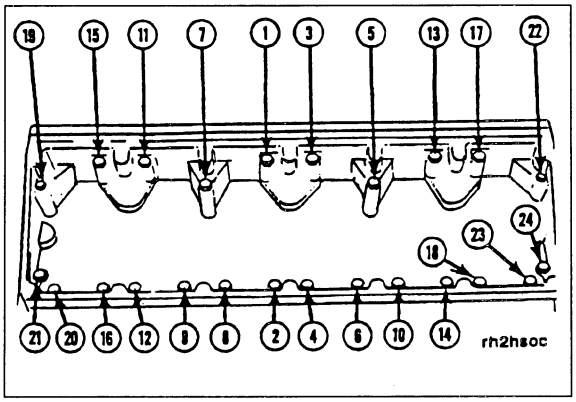
Install the injectors.

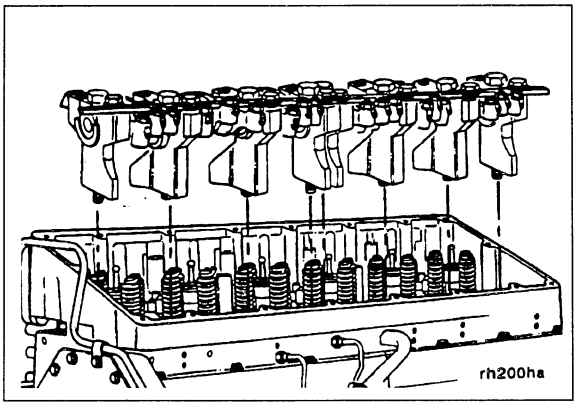
Torque Value: 75 N•m [55 ft-lb]

Install the rocker levers.







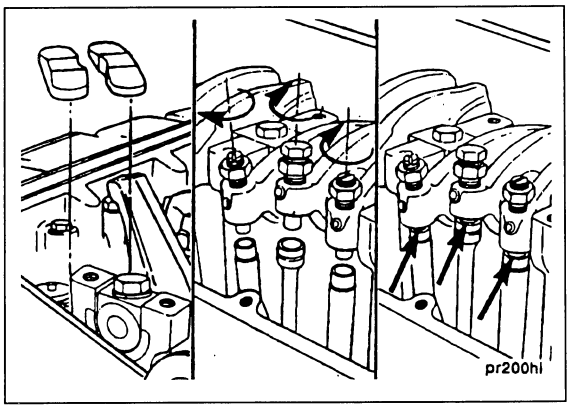


NOTE: The crossheads must be installed in the same position as they were removed.

Install the crossheads.

Rotate the rocker levers up and install the push tubes and push rods.

Adjust the valves and injectors.



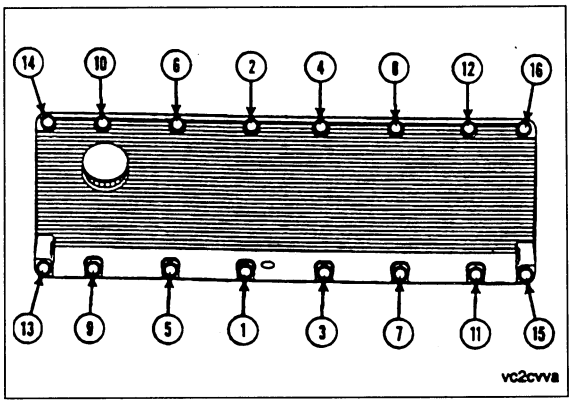
Install a new gasket on the cover.

Install the cover on the rocker lever housing.

Install the 16 isolators and capscrews (M8-1.25 X 40) in the cover.

Tighten the capscrews in the sequence shown.

Torque Value: 15 N•m [130 in-lb]



Install a new gasket.

Install the intake manifold.

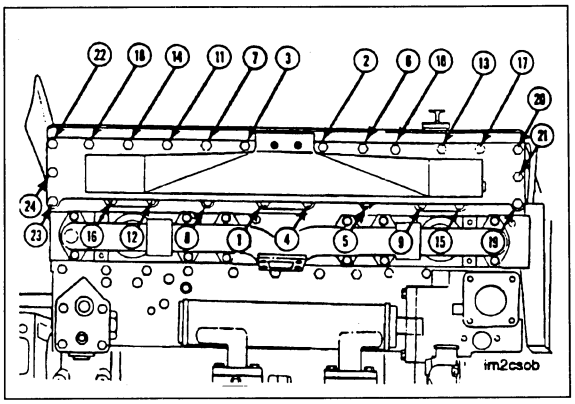
Install the front lifting bracket using three capscrews (m10-1.50 X 50) in locations 17, 20 and 21. Install one capscrews (M10-1.50 X 48) capscrew in location 13.

Install the two sensor harness wire clamps at locations 18 and 24.

Install the remaining capscrews (M10-1.50 X 40).

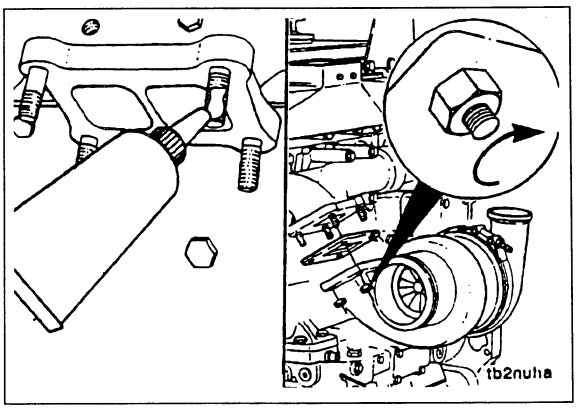
Tighten the capscrews in the sequence shown.

Torque Value: 47 N•m [35 ft-lb]



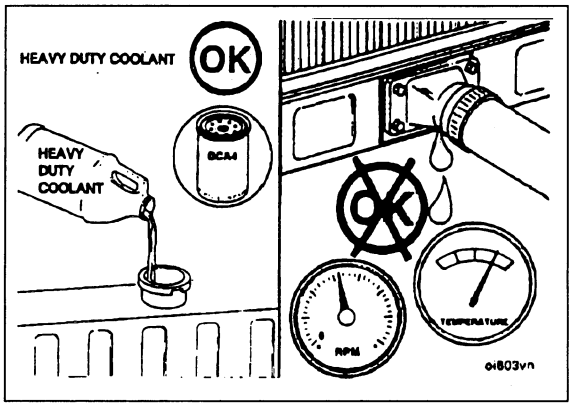
Install the turbocharger
Torque Value: 61 N•m [45 ft-lb]

Install the air piping to the turbocharger and the intake manifold.



Fill the cooling system.

Operate the engine to normal operating temperature and check for leaks, and coolant level.



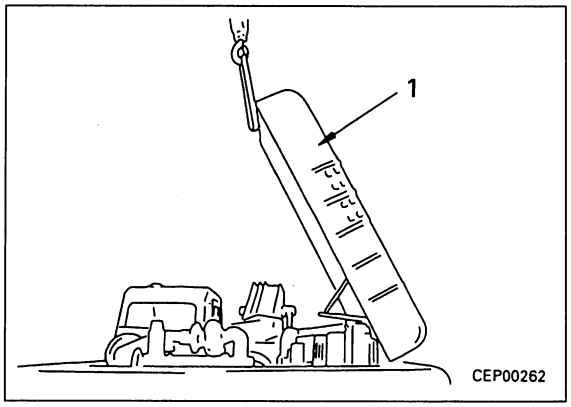
REMOVAL OF HYDRAULIC COOLER ASSEMBLY

⚠ Loosen the oil filler cap slowly to release the pressure inside the hydraulic tank.

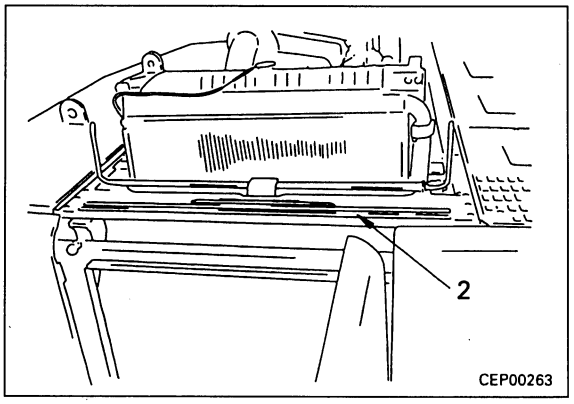
1. Drain oil from hydraulic tank.

Hydraulic tank: **Approx. 270** ℓ

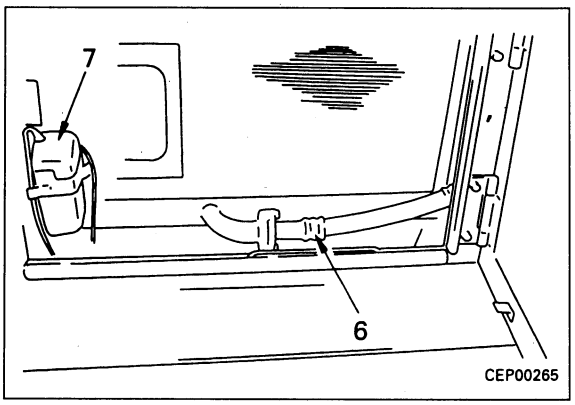
2. Lift off engine hood (1).



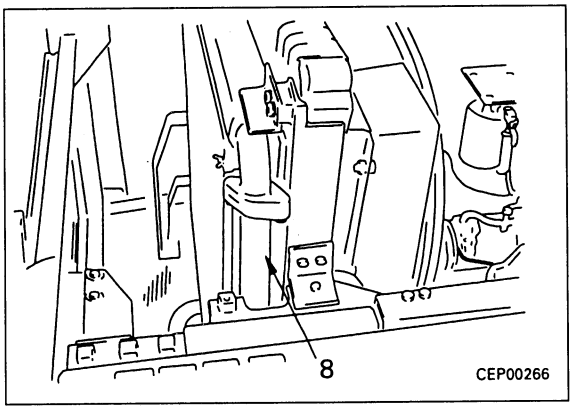
3. Remove frame and spring assembly (2).



4. Disconnect cooler outlet hose (6), and remove radiator sub-tank (7).

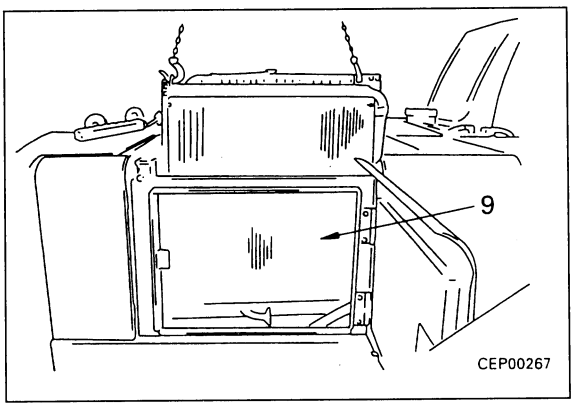


5. Disconnect cooler inlet tube (8).



6. Sling hydraulic cooler assembly (9), remove mounting bolts (bottom: left and right; top: left and right), then lift off hydraulic cooler assembly (9).

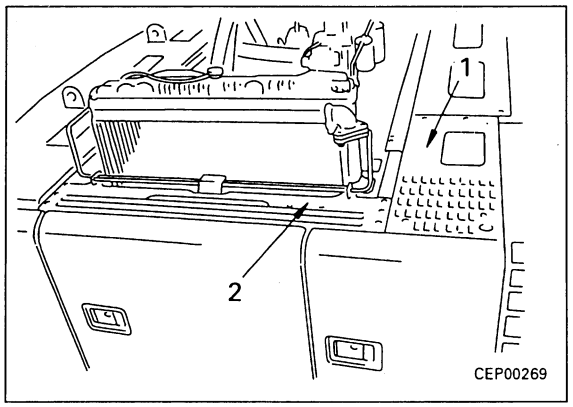
kg Hydraulic cooler assembly: 110 kg



INSTALLATION OF HYDRAULIC COOLER ASSEMBLY

- Carry out installation in the reverse order to removal.
- **Refilling with oil (hydraulic tank)**
  ★ Add oil through the oil filler to the specified level. Run the engine to circulate the oil through the system. Then check the oil level again.

REMOVAL OF RADIATOR, HYDRAULIC COOLER ASSEMBLY



⚠ Lower the work equipment completely to the ground and stop the engine. Then loosen the oil filler cap slowly to release the pressure inside the hydraulic tank.

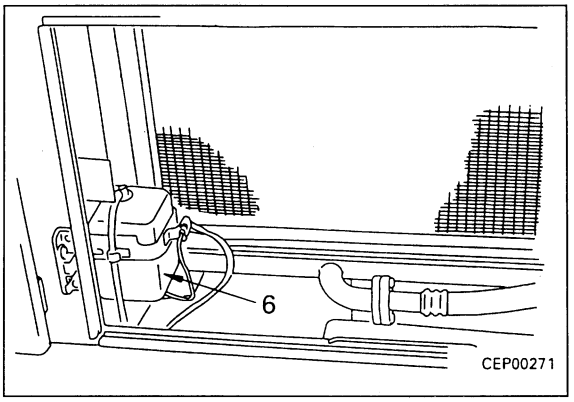
1. Drain oil from hydraulic tank.

Hydraulic tank: **Approx. 270** ℓ

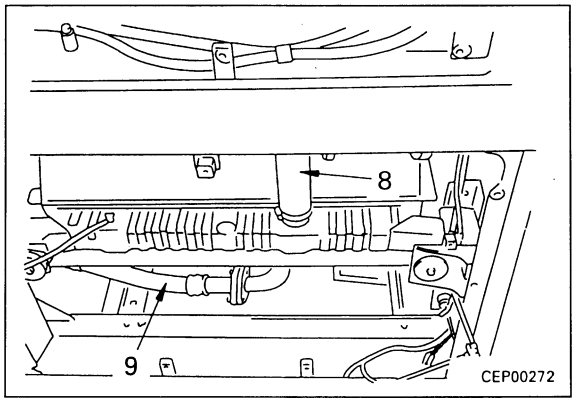
2. Drain coolant.

3. Lift off engine hood, then remove cover (1) and frame and spring assembly (2).

4. Remove radiator sub-tank (6).

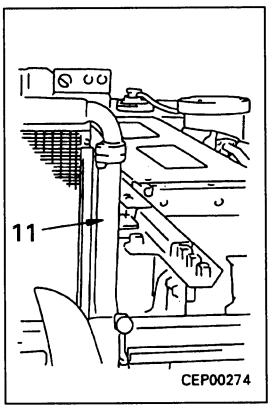


5. Remove undercover under radiator, and disconnect radiator lower hose (8) and cooler outlet hose (9).
   - ★ The radiator lower hose is clamped to the radiator, so be sure to disconnect the clamps.
   - ★ When the cooler outlet hose is disconnected, oil will flow out, so set a container under the machine to catch the oil, and disconnect the hose from the cover on the right side of the machine.



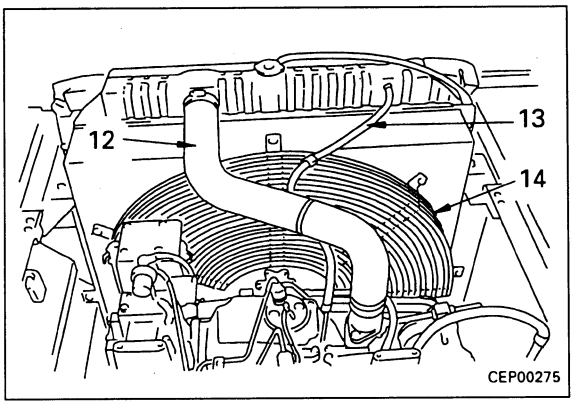
6. Disconnect hydraulic cooler inlet hose (11).

7. Disconnect radiator Trop reserve tank noses, tank and breaketry.



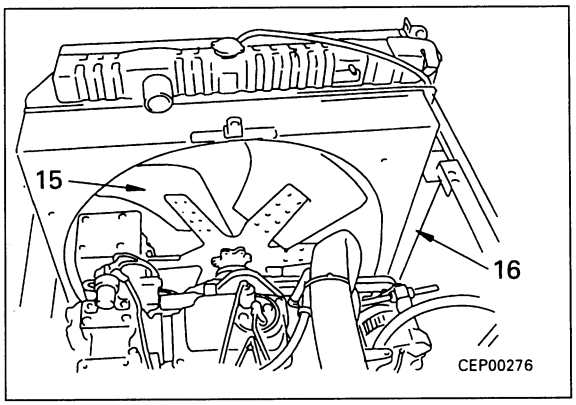
8. Disconnect radiator upper hose (12) and aeration hose (13) at radiator end, and move towards engine.

9. Remove fan guard (14).

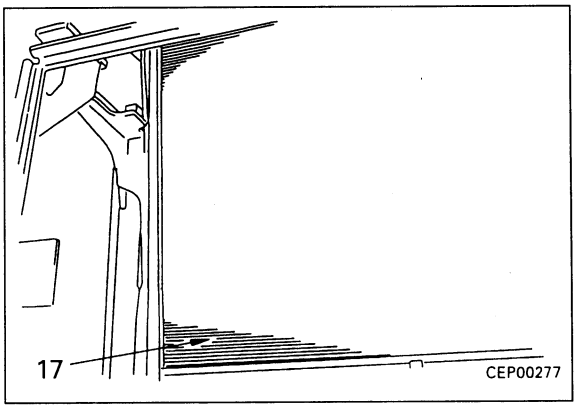


10. Remove fan (15), and move towards radiator.
    ★ Fit cardboard between the radiator core and fan (15) to prevent damage to the radiator core>

11. Remove right side cover (16) of radiator.

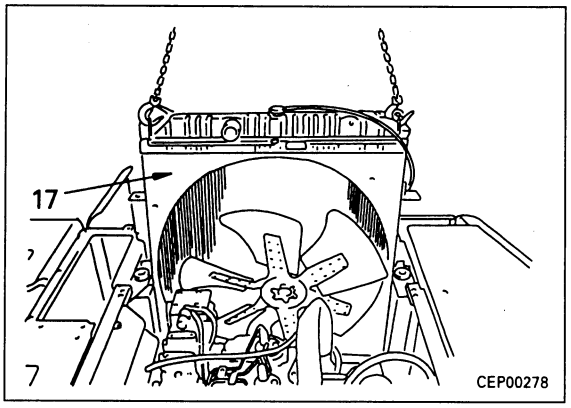


12. Sling radiator and hydraulic cooler assembly (17), remove mount bolts (top: 2; bottom: 2). When raising, be careful of the position in relation to the surrounding area.



14. Lift off radiator and hydraulic cooler assembly (17).
    ★ When removing, be careful of the position in relation to the surrounding area.

kg Radiator, hydraulic cooler assembly: **190 kg**



INSTALLATION OF RADIATOR, HYDRAULIC COOLER ASSEMBLY

- Carry out installation in the reverse order to removal.

※ 1 Radaitor mount bolt:
kgm **110.32 ± 12.26 Nm (11.25 ± 1.25 kgm)**

- **Refilling with water**
  ★ Add water through the water filler to the specified level.
  Run the engine to circulate the water through the system. Then check the water level again.

- **Refilling with oil (hydraulic tank)**
  ★ Add oil through the oil filler to the specified level.
  Run the engine to circulate the oil through the system. Then check the oil level again.

REMOVAL OF ENGINE, MAIN PUMP ASSEMBLY

⚠ Disconnect the cable from the negative (-) terminal of the battery.

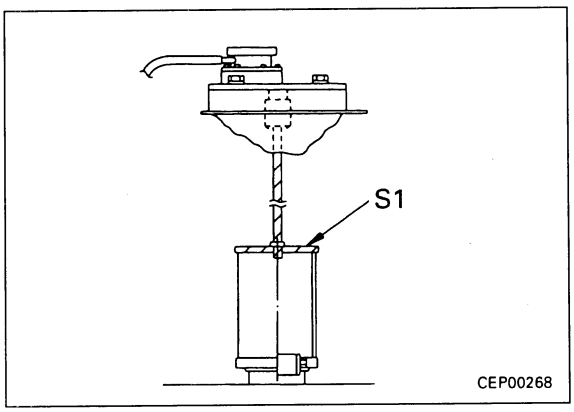
⚠ Lower the work equipment completely to the ground and stop the engine. Then loosen the oil fillre cap slowly to release the pressure inside the hydraulic tank.

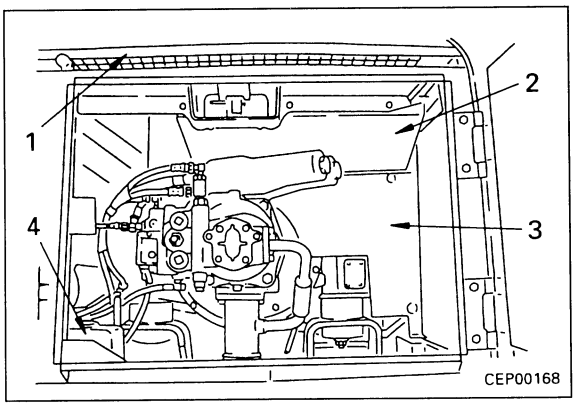
1. Remove hydraulic tank strainer, and using tool **S1**, stop oil.
   - When not using tool **S1**, remove the drain plug, and drain the oil from the hydraulic tank and inside the system.

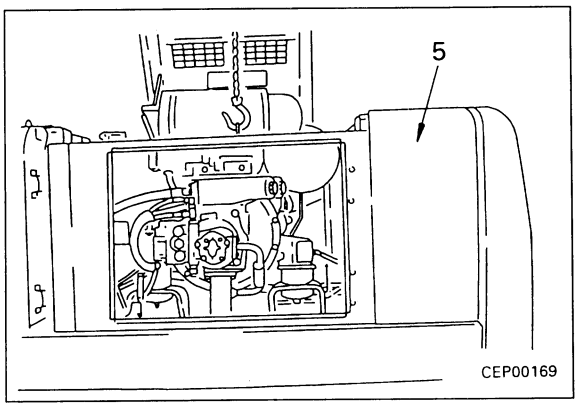
   Hydraulic tank: **Approx. 270** ℓ

★ Mark all the piping with tags to prevent mistakes in the mounting position when installing.

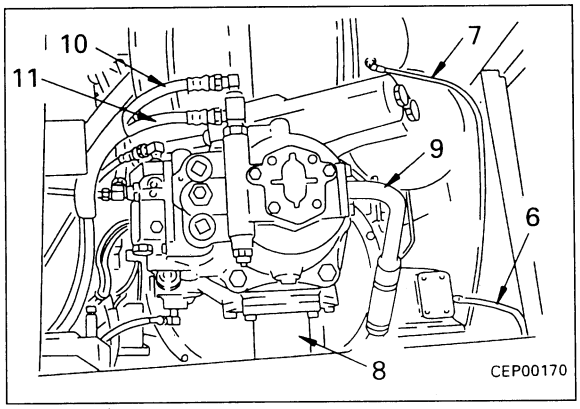
2. Drain coolant.
3. Remove main pump side cover, undercover, and engine undercover.
4. Open engine hood.
5. Remove main pump top cover (1), and partitions (2) and (3).
6. Remove washer tank (4), then remove main pump side cover (5).
   ★ Remove to prevent interference when raising the engine and main pump assembly.







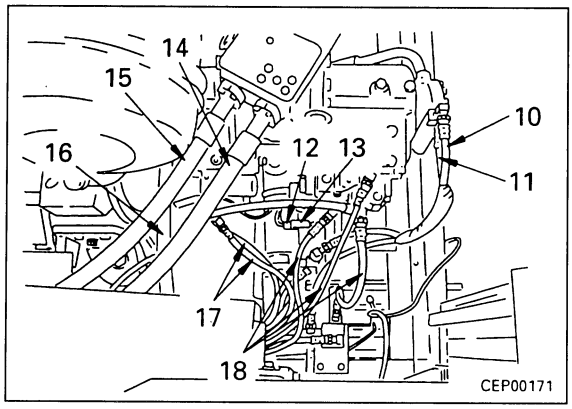
7. Disconnect chassis ground (6), then disconnect air cleaner clogging sensor hose (7) from air cleaner.
8. Disconnect main pump inlet tube (8) and control pump inlet tube (9).
9. Disconnect control pump outlet hoses (10) and (11).



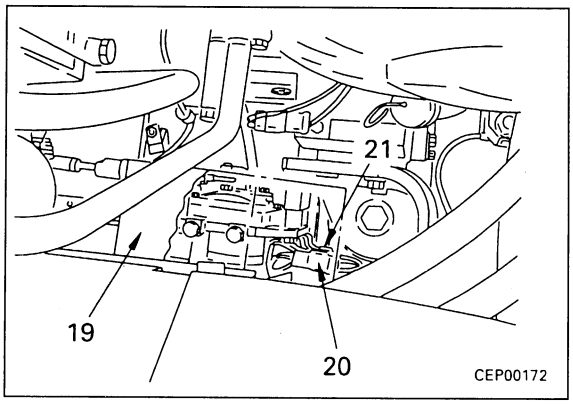
10. Disconnect TVC solenoid connectors (12) and (13) (CN-C04 and CN-C13).
    ★ Disconnect clamps at two places (pump and frame).

11. Disconnect main pump outlet hoses (14) and (15) and pump case drain hose (16).

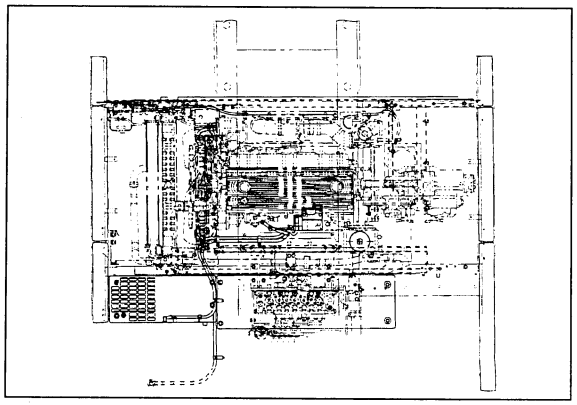
12. Disconnect 2 front pump servo valve hoses (17) and 3 rear pump servo valve hoses (18).



13. Disconnect governor motor connectors (20) (CN-E05) and (21) (CN-E04).

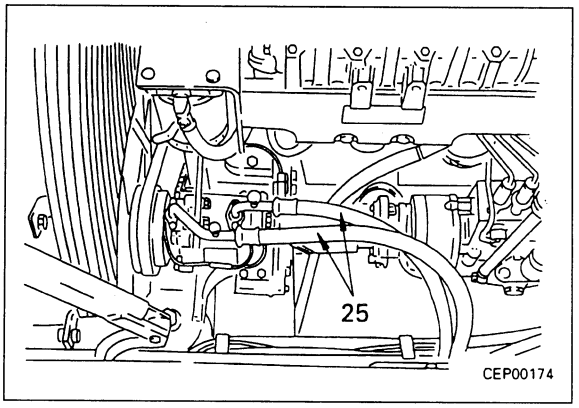


14. Disconnect fuel supply hose (22) and return hoses (23).
    ★ There is stop valve installed to the supply hose, so shut the valve.

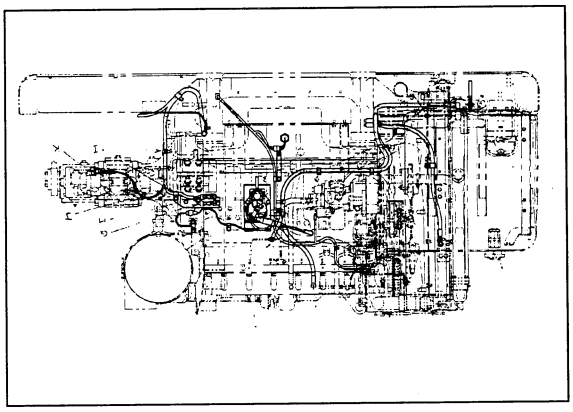


⚠ Push the valve of the air conditioner compressor hose slowly and release the refrigerant (R134a) gradually.

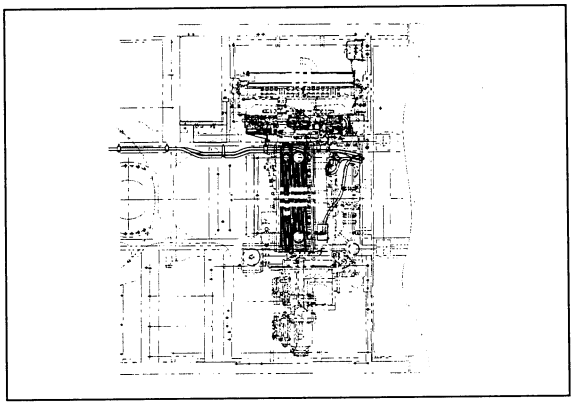
15. Disconnect air conditioner compressor hoses (25).



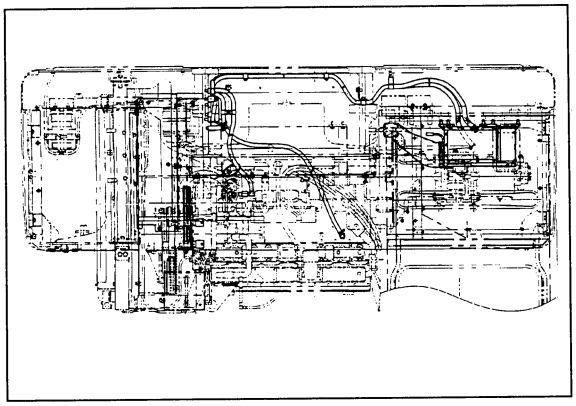
16. Disconnect radiator upper hose (engine water outlet hose) (26)
17. Disconnect fan guard (28).
18. Disconnect aeration nose (A)
19. Disconnect header tank nose (B)
20. Remove tank (C) and mounting brackets (D), (E)
21. Disconnect nose (F)



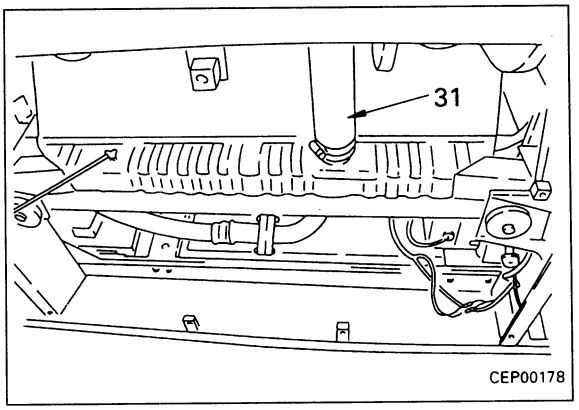
22. Remove fan (29), and move towards radiator.
    ★ The fan cannot be removed upward.
    ★ Be careful not to bend the radiator fan.



23. Disconnect 2 car heater hoses (30).



24. Disconnect radiator lower hose (31) at water pump end (engine end).



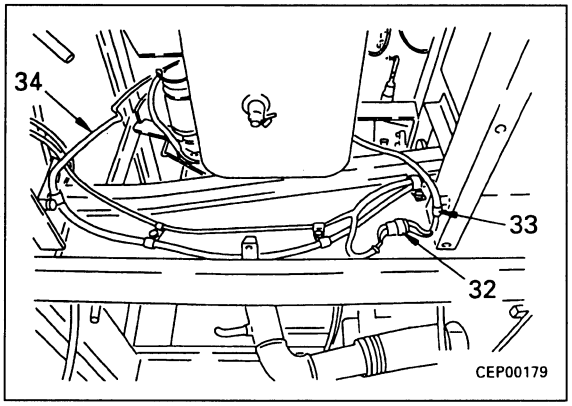
21. Disconnect intermediate connector (32) (CN-E08) to engine.

22. Disconnect wiring harness (34) from starting motor.

23. Remove engine mount bolts at front (35) and rear (36).

24. Lift off engine and main pump assembly (37).
    ★ Before lifting off, check carefully that all the piping and wiring has been disconnected.

kg Engine, main pump assembly:
Approx. 1420 kg



INSTALLATION OF ENGINE, MAIN PUMP ASSEMBLY

- Carry out installation in the reverse order to removal.

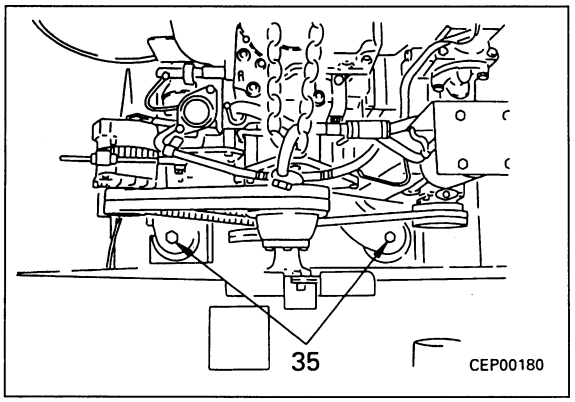
kgm Joint bolt: Fuel hoses & Air conditioner hoses, Radiator mounting
17.16 ± 2.45 Nm (1.75 ± 0.25 kgm)

★ Check that there is no damage or deterioration of the O-ring, then connect the hose.

kgm Hose clamp bolt:
8.8 ± 0.98 Nm (0.9 ± 0.1 kgm)

Engine mount bolt (front) (rear):
Thread tightener (LT-2)

kgm Engine mount bolt (front) (rear):
926.7 ± 103.0 Nm (94.5 ± 10.5 kgm)

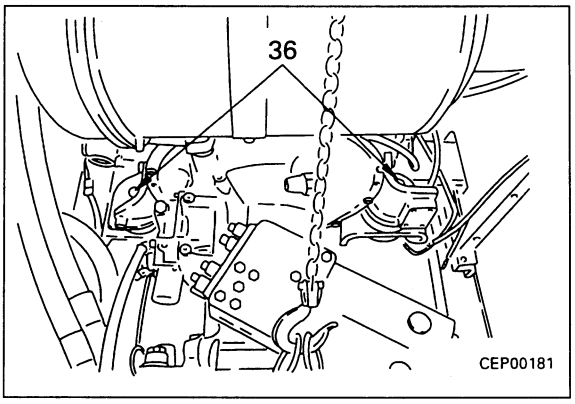


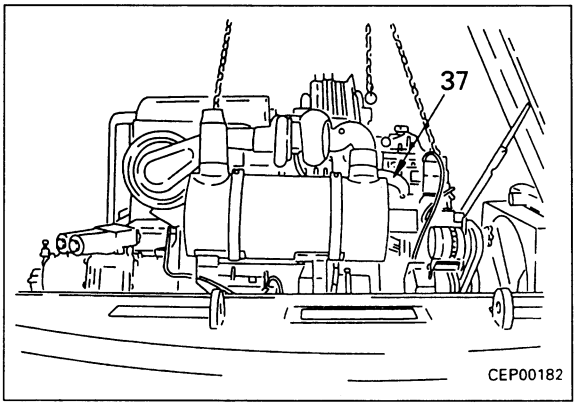
- **Refilling with water**
  ★ Add water through the water filler to the specified level.
  Run the engine to circulate the water through the system. Then check the water level again.

- **Refilling with oil (hydraulic tank)**
  ★ Add oil through the oil filler to the specified level.
  Run the engine to circulate the oil through the system. Then check the oil level again.

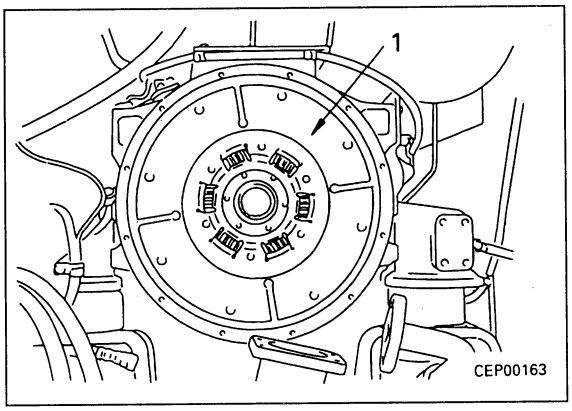
- **Charging air conditioner with gas**
  ★ Using tool X, charge the air conditioner circuit with refrigerant (R134a).

- **Bleeding air**
  ★ Bleed the air from the main pump.
  For details, see TESTING AND ADJUSTING.





REMOVAL OF DAMPER ASSEMBLY



1. Remove main pump assembly.
   For details, see REMOVAL OF MAIN PUMP ASSEMBLY.
2. Remove damper assembly (1).

INSTALLATION OF DAMPER ASSEMBLY

- Carry out installation in the reverse order to removal.

Damper mounting bolt: **Thread tightener (LT-2)**

REMOVAL OF FUEL TANK ASSEMBLY

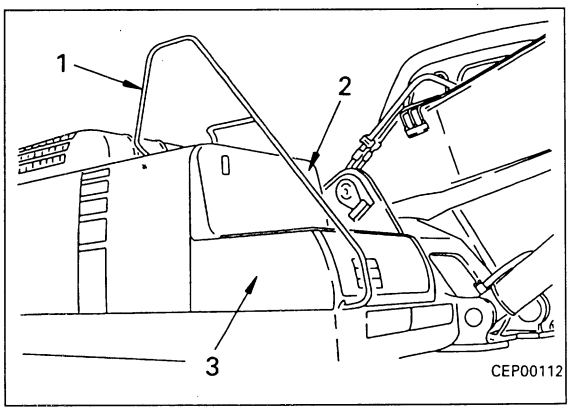
⚠ Disconnect the cable from the negative (-) terminal of the battery.

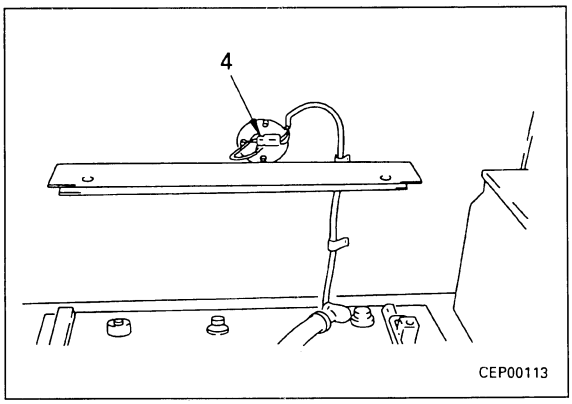
1. Open drain valve of fuel tank and drain fuel.

   Fuel tank: Approx. **470** ℓ (when tank is full)

2. Remove air conditioner condenser top cover.
3. Remove hadrail (1), front cover (2), and battery case cover (3).
4. Disconnect fuel level sensor connector (4) (CN-P06).
5. Disconnect fuel supply hose (5), return hose (6), spill hose (7), and clamp (8).
6. Remove mounting bolts, and lift off fuel tank assembly (9).

   kg Fuel tank assembly: **235 kg**

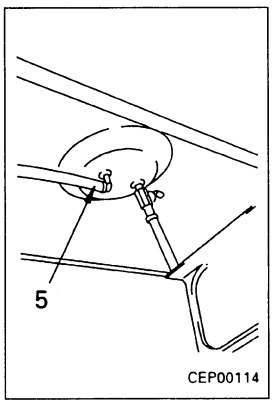


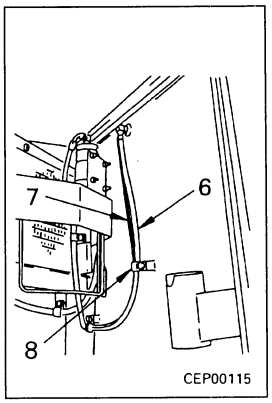


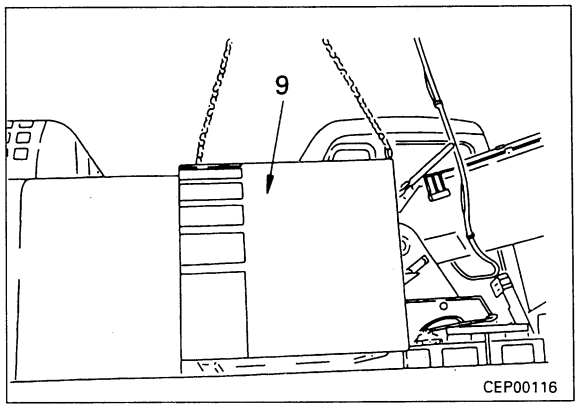
INSTALLATION OF FUEL TANK ASSEMBLY

- Carry out installation in the reverse order to removal.

  kgm Fuel tank mounting bolt:
  227.04 ± 31.87 Nm (28.25 ± 3.25 kgm)







REMOVAL OF CENTER SWIVEL JOINT ASSEMBLY

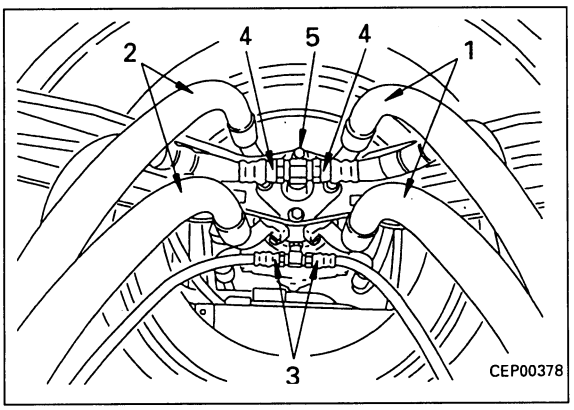
⚠ Relase the remaining pressure in the hydraulic circuit. For details, see TESTING AND ADJUSTING, Releasing remaining pressure from hydraulic circuit.

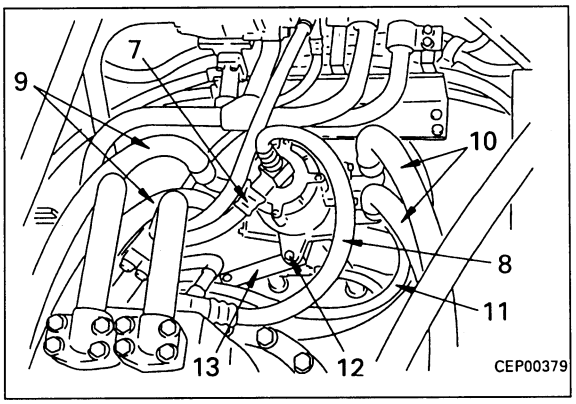
⚠ Loosen the hydraulic tank oil filler cap slowly to release the pressure inside the hydraulic tank.

★ Mark all the piping with tags to prevent mistakes in the mounting position when installing.

1. Disconnect travel motor hoses (1) and (2).
2. Disconnect speed selector hose (3).
3. Disconnect drain hose (4), and remove elbow (5).
   ★ Install a blind plug in the drrain hose.
4. Disconnect drain hoses (7) and (8).
   ★ Install a blind plug in the drain hose.
5. Disconnect travel hoses (9) and (10), and speed selector hose (11).
6. Pull out pin (12), and disconnect plate (13).
7. Sling center swivel joint assembly (14), remove mounting bolts from below, then lift off.

kg Center swivel joint assembly: **40 kg**





INSTALLATION OF CENTER SWIVEL JOINT ASSEMBLY

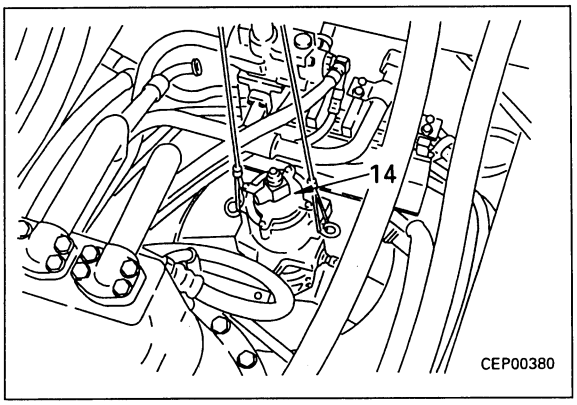
- Carry out installation in the reverse order to removal.

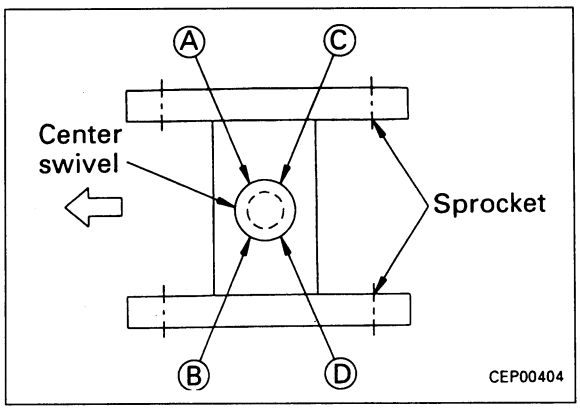
  * Assemble the center swivel as shown in the diagram below.

❄ 1

- **Refilling with oil (hydraulic tank)**
  ★ Add oil through the oil filler to the specified level. Run the engine to circulate the oil through the system. Then check the oil level again.

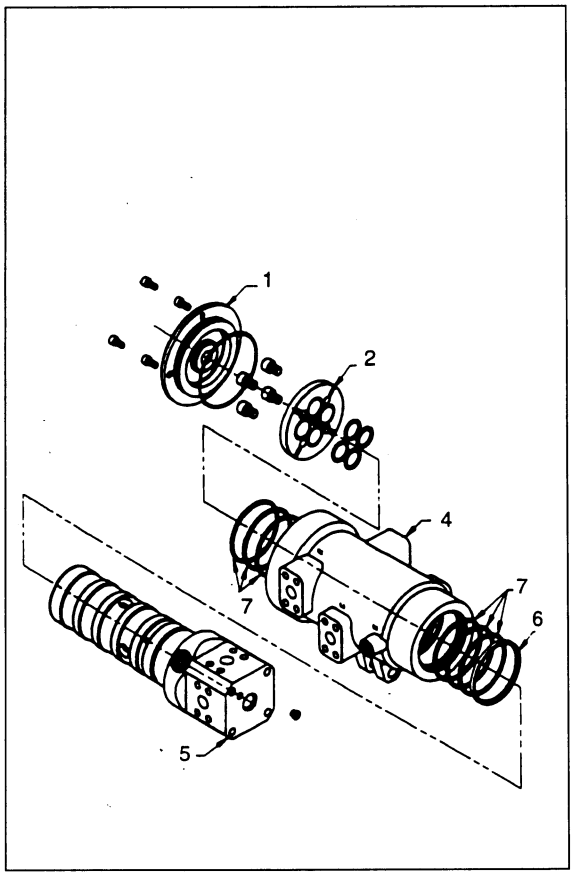
- **Bleeding air**
  ★ Bleed the air from the travel motor.
  For details, see TESTING AND ADJUSTING, Bleeding air.





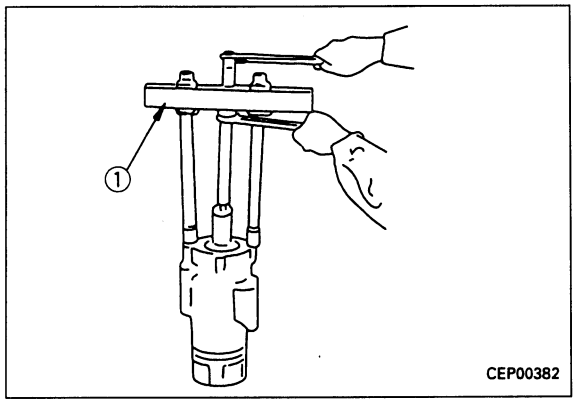
DISASSEMBLY OF CENTER SWIVEL JOINT ASSEMBLY

1. Remove cover (1).
2. Remove snap ring (2).
3. Using puller ①, pull out swivel rotor (4) and ring (3) from swivel shaft (5).
4. Remove O-ring (6) and slipper seal (7) from swivel rotor.



ASSEMBLY OF CENTER SWIVEL JOINT ASSEMBLY

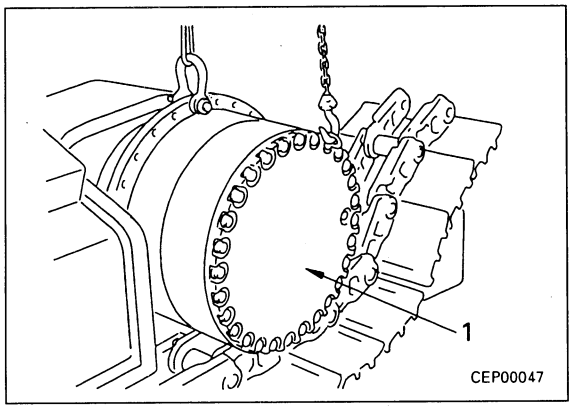
1. Assemble slipper seal (7) and O-ring (6) to swivel rotor.
2. Set swivel shaft (5) to block, then using push tool, tap swivel rotor (4) with a plastic hammer to install.
   Contact surface of rotor, shaft:
   Grease (G2-LI)
   ★ When installing the rotor, be extremely careful not to damage the slipper seal and the O-ring.
3. Install ring (3) and secure with snap ring (2).
4. Fit O-ring and install cover (1).
   kgm Mounting bolt: 31.4 ± 2.9 Nm
   (3.2 ± 0.3 kgm)



REMOVAL OF FINAL DRIVE ASSEMBLY

1. Remove sprocket.
   For details, see REMOVAL OF SPROCKET.

2. Sling final drive assemlby (1).

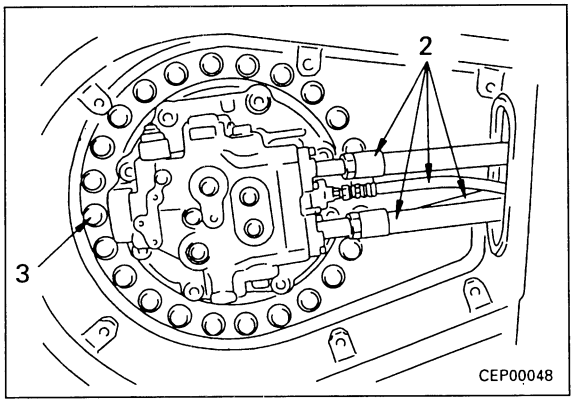


3. Remove cover, and disconnect 4 travel motor hoses (2).

4. Remove mounting bolts (3) of final drive and travel motor assembly.
   ★ To maintain the lifting balance, leave two mounting bolts installed.

5. Adjust lifting balance of final drive assembly (1), remove 2 mounting bolts (3), then lift off final drive assembly (1).

   kg Final drive assembly: **800 kg**



INSTALLATION OF FINAL DRIVE ASSEMBLY

- Carry out installation in the reverse order to removal.

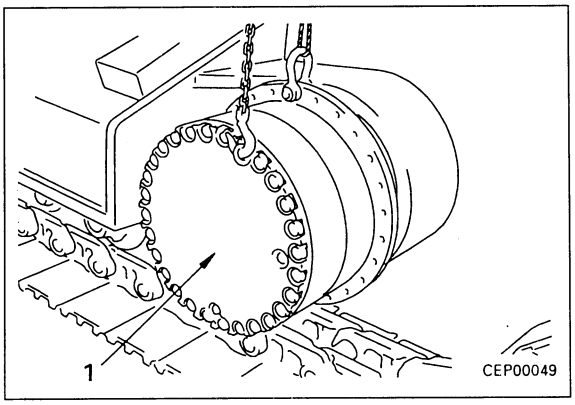
※ 1

Mounting bolt: **Thread tightener (LT-2)**

kgm Mounting bolt: **549 ± 59 Nm (56 ± 6 kgm)**

- **Refilling with oil (hydraulic tank)**
  ★ Add oil through the oil filler to the specified level. Run the engine to circulate the oil through the system. Then check the oil level again.

- **Bleeding air**
  ★ Bleed the air from the travel motor.
  For details, see TESTING AND ADJUSTING, Bleeding air.

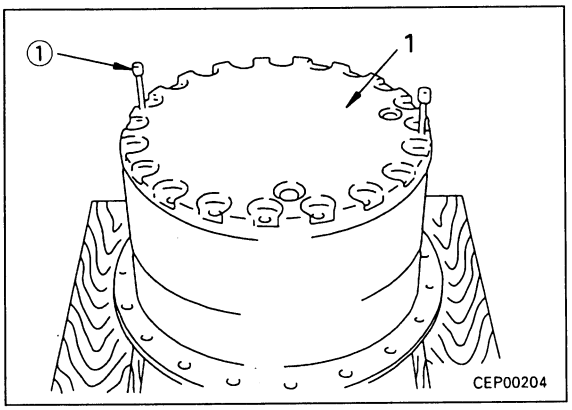


DISASSEMBLY OF FINAL DRIVE ASSEMBLY

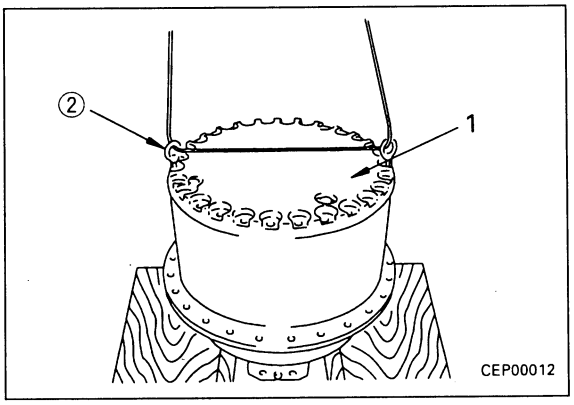
1. Draining oil
   Remove drain plug and drain oil from final drive case.

   Final drive case: Approx. **12** ℓ

2. **Cover**
   1) Remove mounting bolts, then use forcing screws ① to disconnect cover (1) from ring gear.

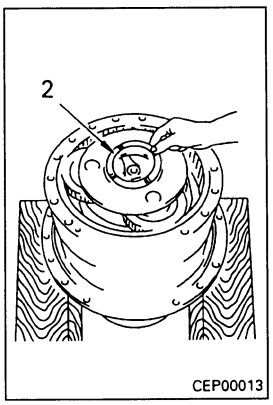


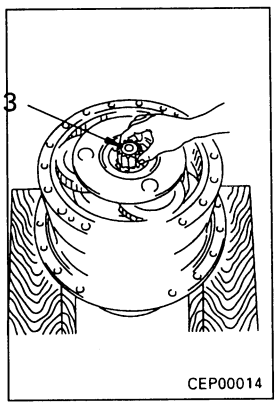
   2) Use eyebolts ② to remove cover (1).



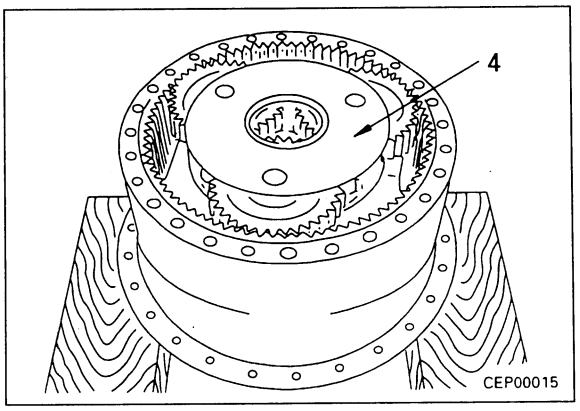
3. **Spacer**
   Remove spacer (2).

4. **No. 1 sun gear shaft**
   Remove N0.1 sun gear shaft (3).

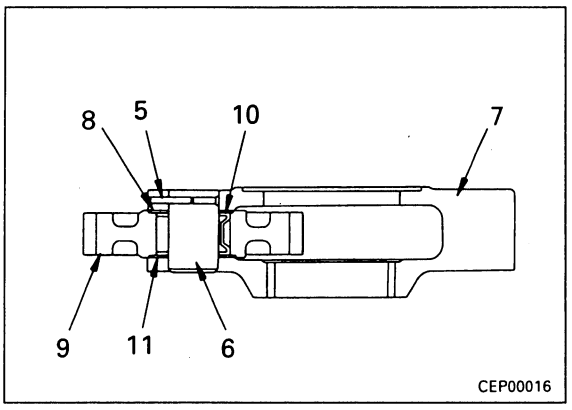




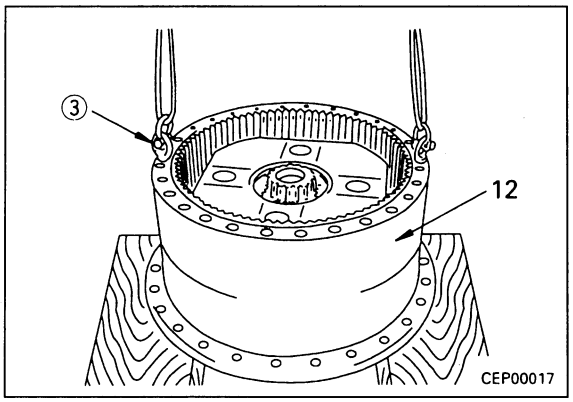
5. **No. 1 carrier assembly**
   1) Remove No. 1 carrier assembly (4).



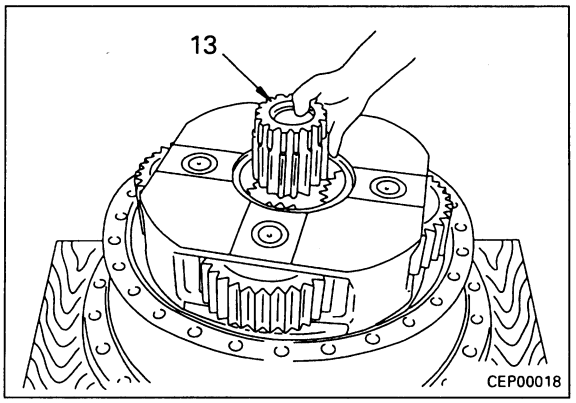
2) Disassembly No. 1 carrier assembly as follows.
   i) Push in pin (5), and knock out shaft (6) from carrier (7).
      ★ After removing the shaft, remove pin (5).
   ii) Removing thrust washer (8), gear (9), bearing (10), and thrust washer (11).



6. Ring gear
Using eyebolts ③, remove ring gear (12).
★ After removing ring gear (12), remove the O-ring fitted to the face mating with the hub assembly.

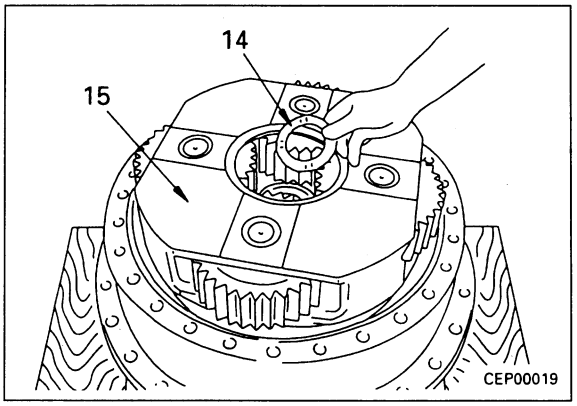


7. No. 2 sun gear
Remove No. 2 sun gear (13).

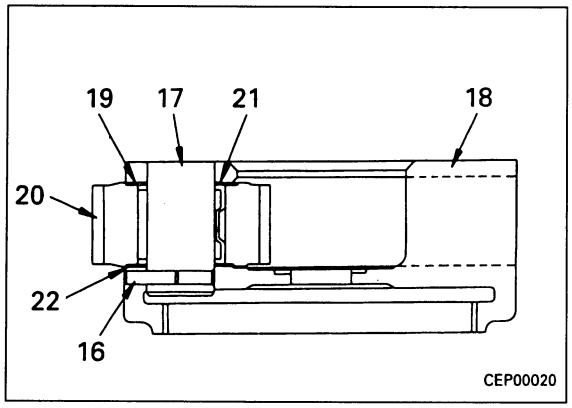


8. Thrust washer
Remove thrust washer (14).

9. No. 2 carrier assembly
1) Remove N0. 2 carrier assembly (15).

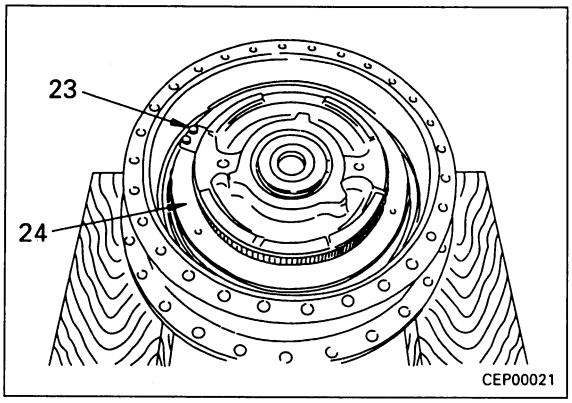


2) Disassemble No. 2 carrier assembly as follows.
   i) Push in pin (16) and pull out shaft (17) from carrier (18).
      ★ After removing the shaft, remove pin (16).
   ii) Remove thrust washer (19), gear (20), bearing (21), and thrust washer (22).

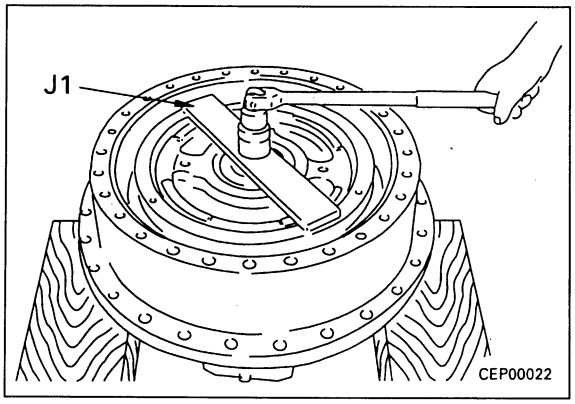


10. Nut

1) Remove lock plate (23).

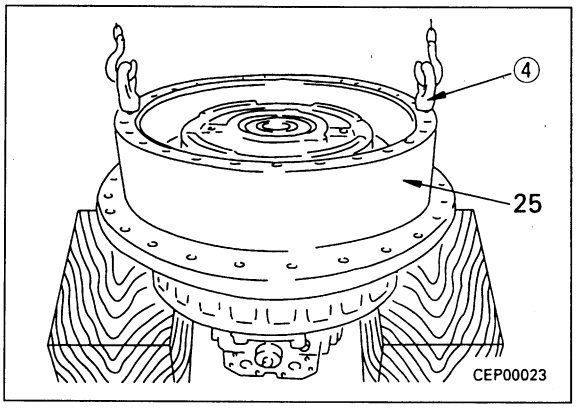


2) Using tool **J1**, remove nut (24).

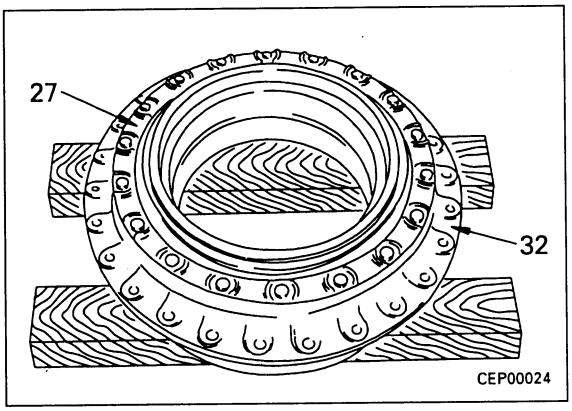


11. Hub assembly

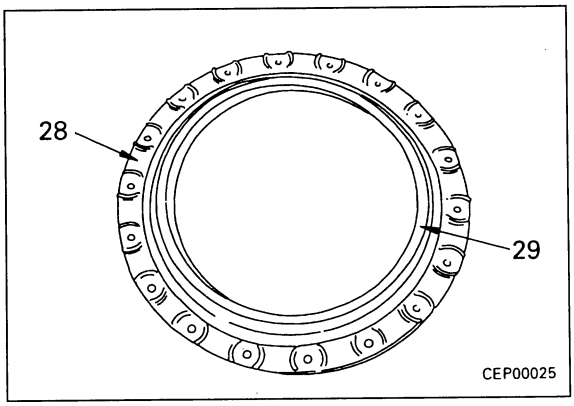
1) Using eyebolts ④, remove hub assembly (25) from travel motor.



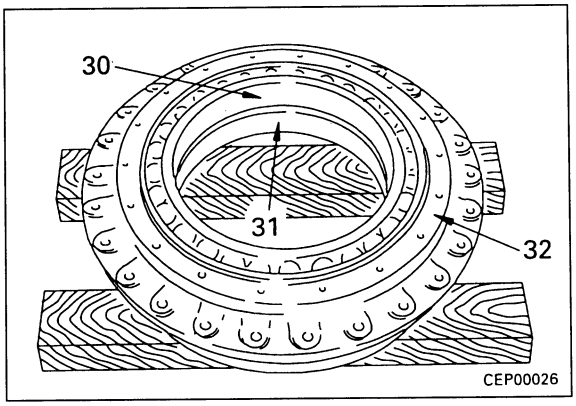
2) Disassemble hub assembly as follows.
   i) Remove floating seal and cage assembly (27) from hub (32).



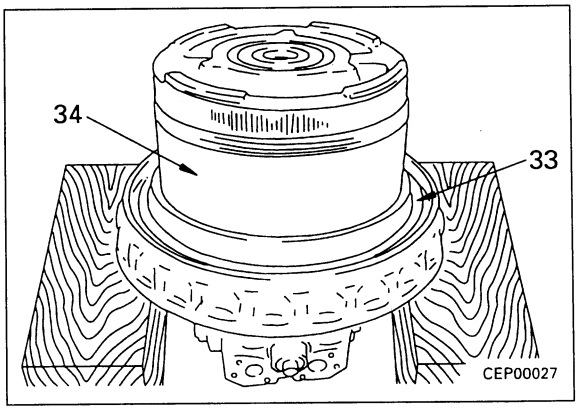
   ii) Remove floating seal (29) from cage (28).



   iii) Remove bearings (30) and (31) from hub (32).



3) Remove floating seal (33) from travel motor (34).

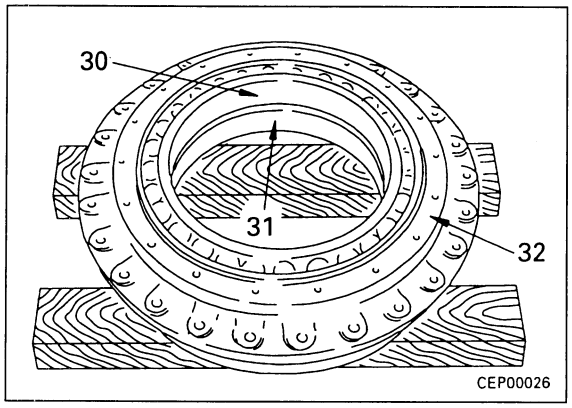


ASSEMBLY OF FINAL DRIVE ASSEMBLY

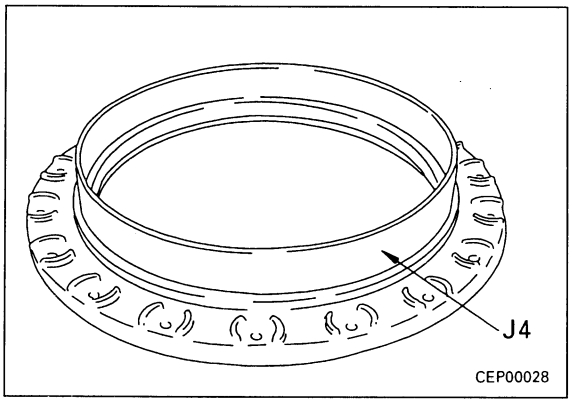
★ Clean all parts, and check for dirt or damage.
Coat the sliding surfaces of all parts with engine oil before installing.

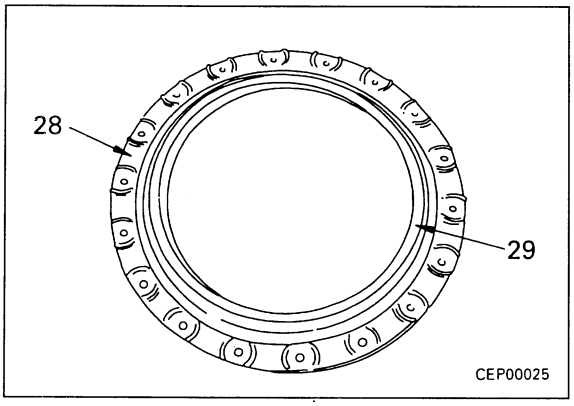
1. Hub assembly

1) Using push tool, press fit bearings (31) and (30) to hub (32).

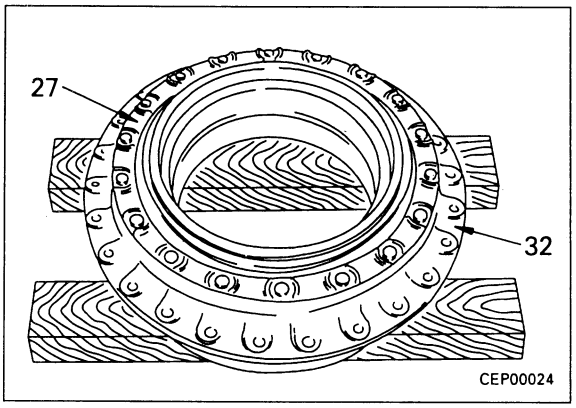


2) Using tool **J4**, install floating seal (29) to cage (28).
   - ★ Remove all oil and grease from the O-ring and O-ring contact surface, and dry the parts befrore installing the floating seal.
   - ★ After installing the floating seal, check that the angle of the floating seal is within 1 mm.
   - ★ After installing the floating seal, coat the sliding surfac thinly with engine oil.

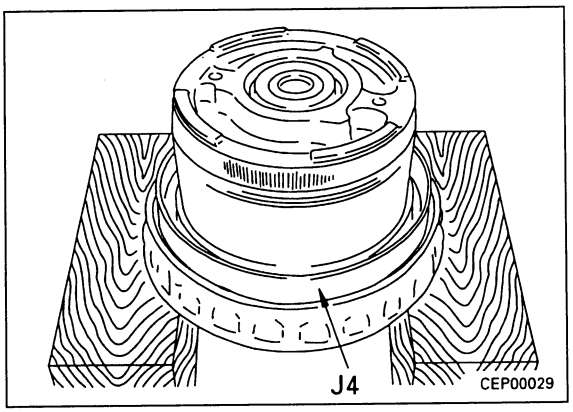


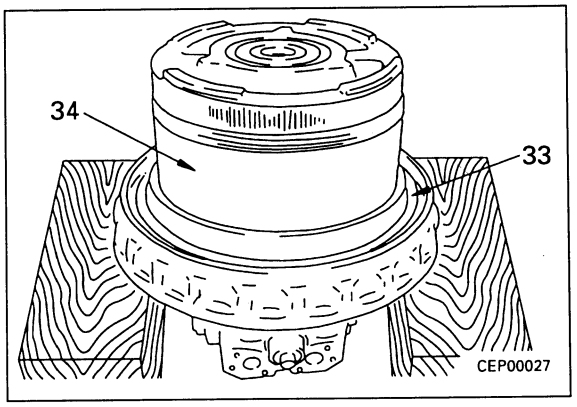


3) Install floating seal and cage assembly (27) to hub (32).
   kgm Mounting bolt:
   66.19 ± 7.35 Nm (6.75 ± 0.75 kgm)

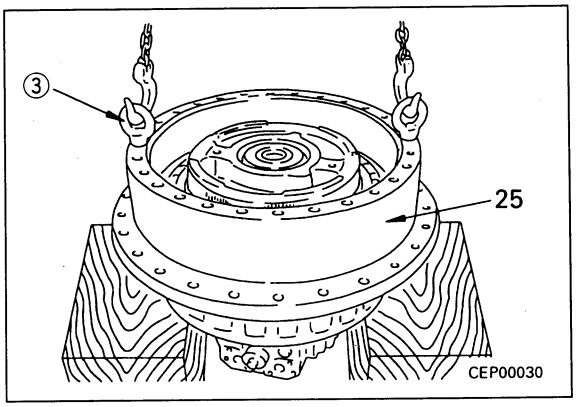


4) Using tool **J4**, install floating (33) to cage (34).
   - ★ Remove all oil and grease from the O-ring and O=ring contact surface, and dry the pparts before installing the floating seal.
   - ★ After installing the floating seal, check that the angle of the floating seal is within 1 mm.
   - ★ After installing the floating seal, coat the sliding surface thinly with engine oil.



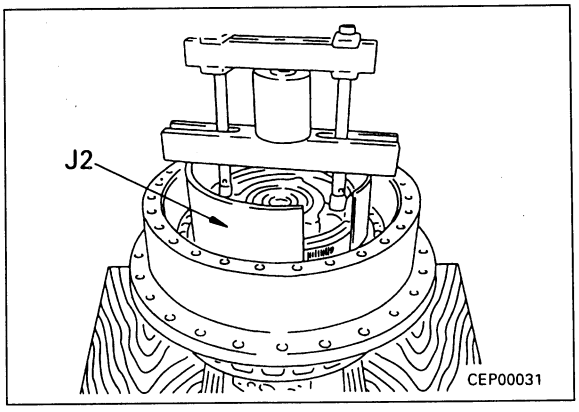


5) Using eyebolts ③, set hyb assembly (25) to travel motor, then using push tool, tap to press fit bearing portion.

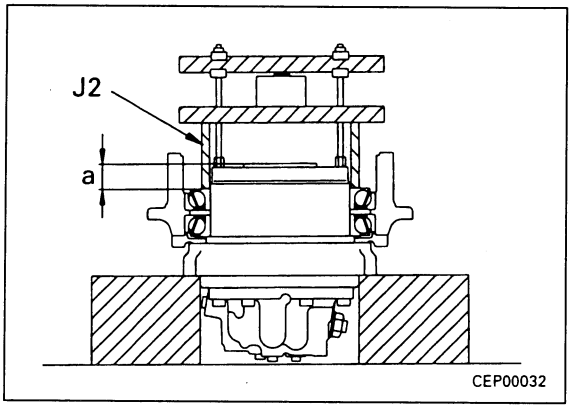


2. Nut

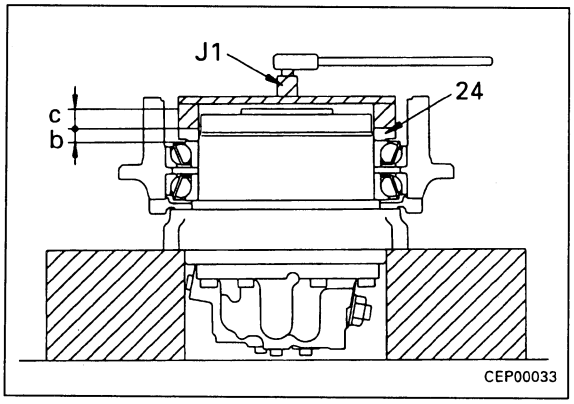
1) Install nut as follows.
   i) Using tool **J2**, push inner race portion of bearing.
   - ★ Pushing force:
     21.6 - 25.5 kN (2.2 - 2.6 ton)
   - ★ Rotate the hub 2 -3 times before applying the pushing force to the bearing inner race.



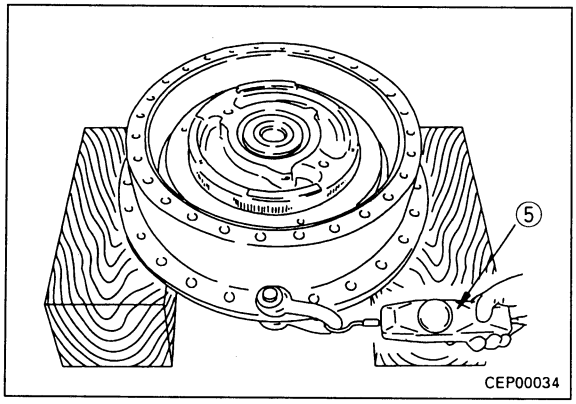
II) Measure dimension **a** in the condition in Step i) above.



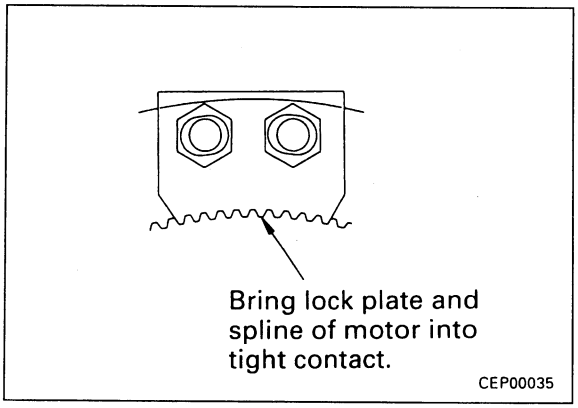
iii) Measure thickness **b** of nut (24) as an individual part.
iv) Calculate **a - b = c.**
v) Using tool **J1**, tighten nut (24) until **c** portion dimension is as follows.
c portion dimension = $c^{0}_{-0.1}$mm.



vi) Using push-pull scale ⑤, measure tangential force in direction of rotation of hub in relation to motor case.
★ Tangential force: Max. 667 N (68 kg)
★ The tangential force is the maximum force when starting rotation.

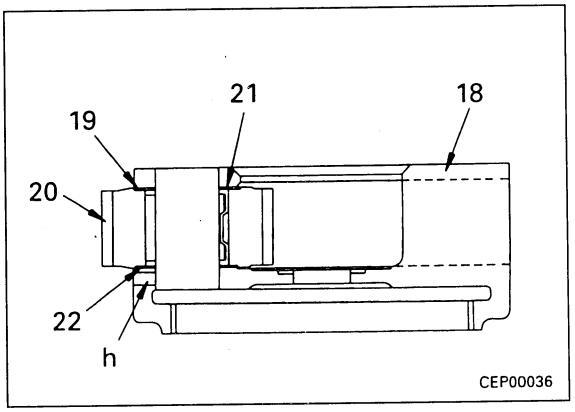


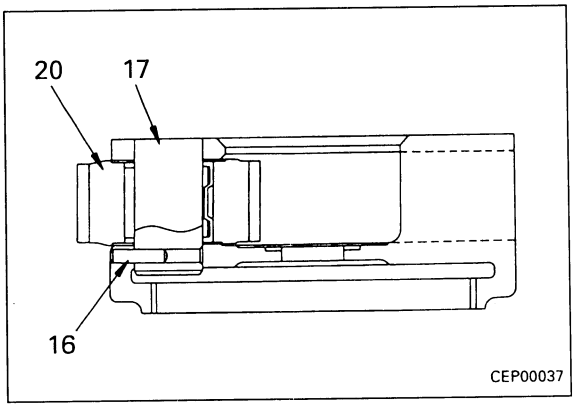
vii) Install lock plate (23).
★ Install the lock plate as shown in the diagram on the right.
Thread of mounting bolt:
Thread tightener (LT-2)
kgm Mounting bolt:
66.19 ± 7.35 Nm (6.75 ± 0.75 kgm)



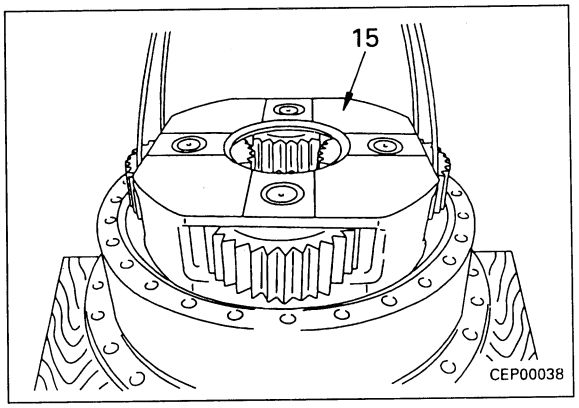
3. No. 2 carrier assembly

1) Assemble no. 2 carrier assembly as follows.
   - ★ There are the remains of the caulking when the pin is inserted at the end face of hole h at the side of the carrier, so remvoe the caulked metal from the inside diameter of the hole before starting to assemble.
   - i) Assemble bearing (21) to gear (20), fit top and bottom thrust washers (19) and (22), and set gear assembly in carrier (18).
   - ii) Align with position of pin holes of shaft and carrier, then tap with a plastic hammer to install shaft (17).
     - ★ When installing the shaft, rotate the planetary gear, and be careful not to damage the thrust washer.
   - iii) Insert pin (16).
     - ★ After inserting the pin, caulk the pin portion of the carrier.
   - ★ After assembling the carrier assembly, chekc that gear (20) rotates smoothly.



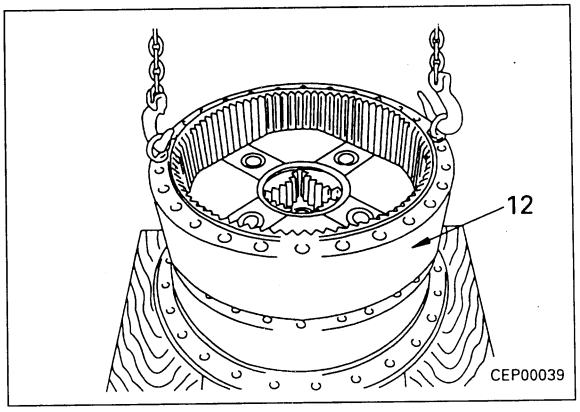


2) Install No. 2 carrier assembly (15).
   - ★ Align the position so that the four tips of the gear shafts of carrier assembly (15) enter the four hollows in the end face of the motor case, then install.



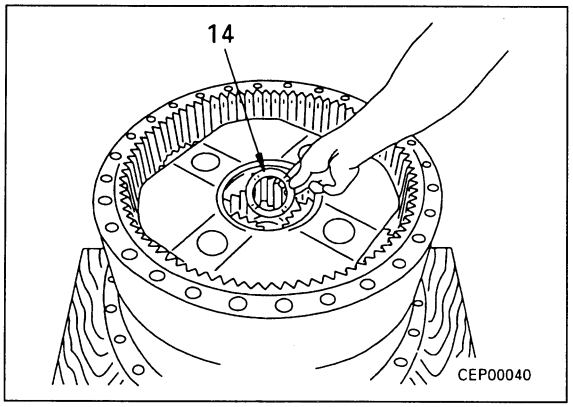
4. Ring gear

Lift ring gear (12) and install.
- ★ Assemble and O-ring to the face mating with the hub assembly.
- ★ Remove all grease and oil from the mating surface of the ring gear and hub.
- ★ Do not put any gasket sealant on the mating surface of the ring gear and hub under any circumstances.



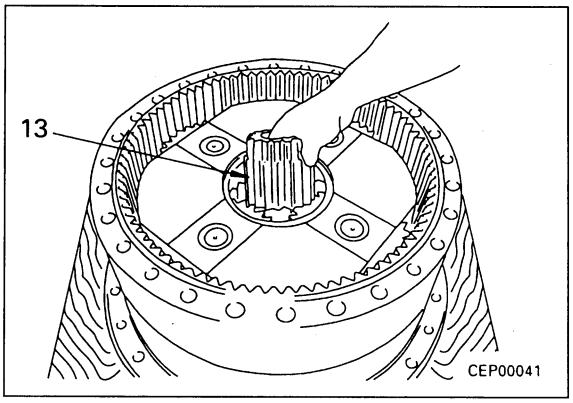
5. Thrust washer

Install thrust washer (14).



6. No. 2 sun gear

Install No. 2 sun gear (13).

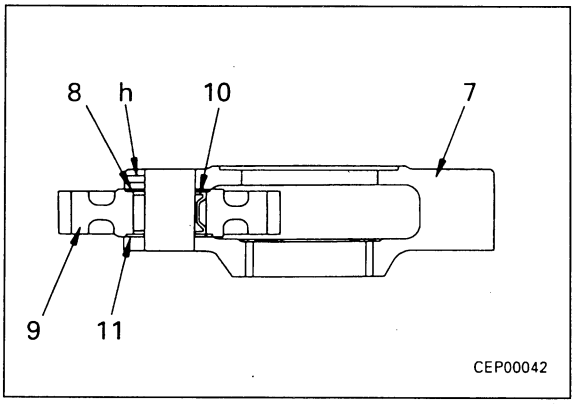


7. No. 1 carrier assembly

1) Assemble No. 1 carrier assembly as follows.

★ There are the remain of the cauling when the pin is inserted at the end face of hole **h** at the side of the carrier, so remove the caulked metal from the inside diameter of the hole before starting to assemble.

i) Assemble bearing (10) to gear (9), fit top and bottom thrust washers (8) and (11) and set gear assembly to carrier (7).



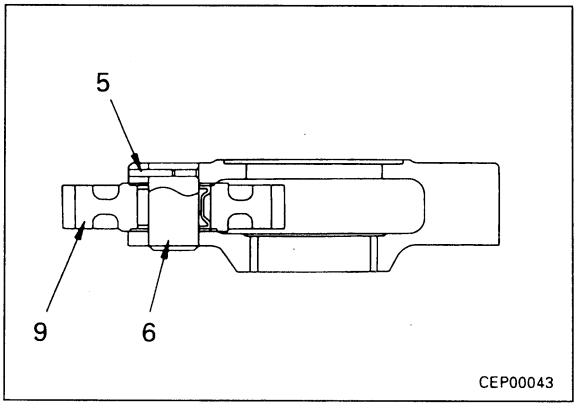
ii) Align position of pin holes of shaft and carrier, then tap with a plastic hammer to install shaft (6).

★ When installing the shaft, rotate the planetary gear, and be careful not to damage the thrust washer.

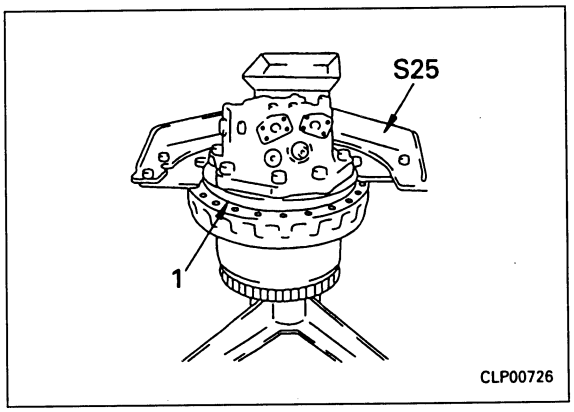
iii) Insert pin (5).

★ After inserting the pin, caulk the pin portion of the carrier.

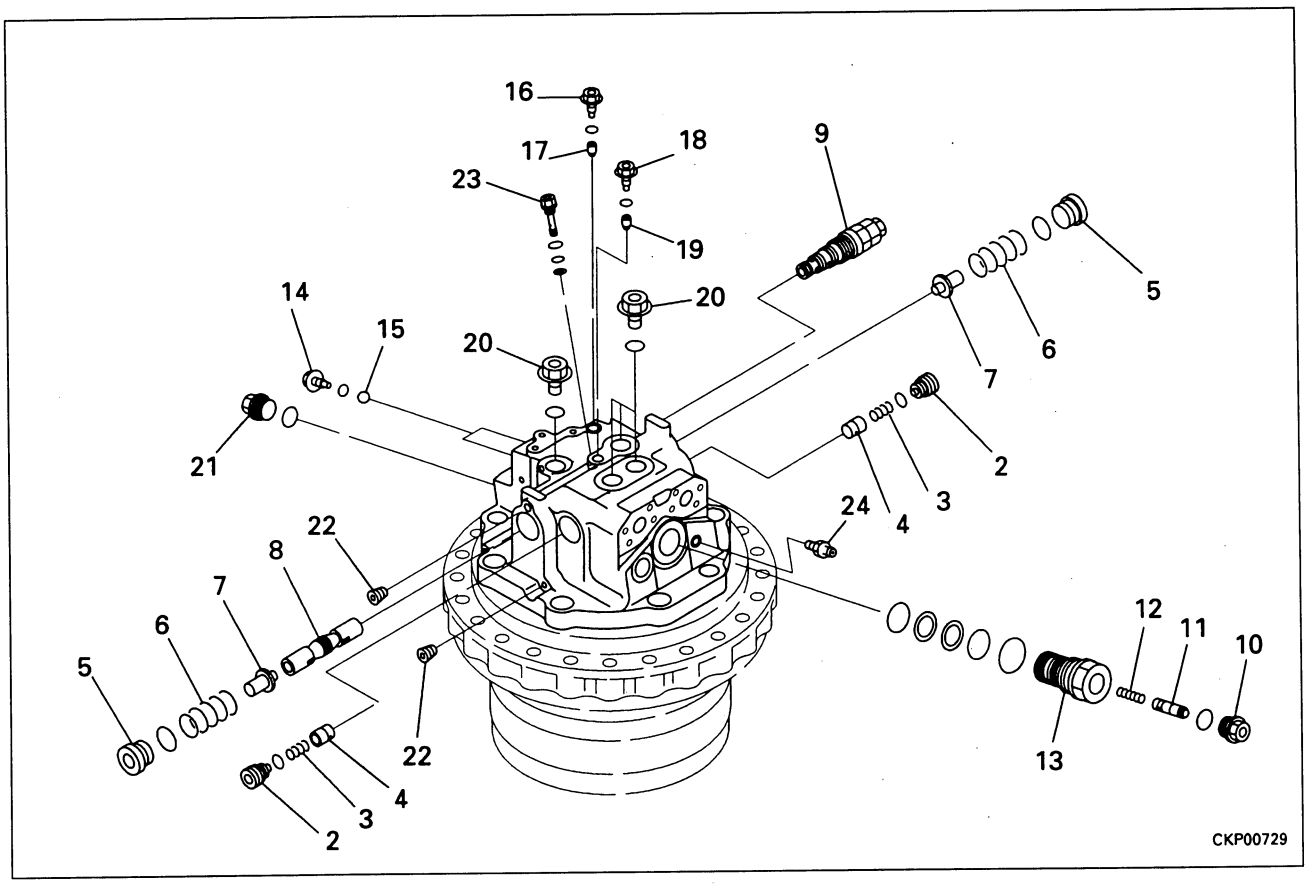
★ After assembling the carrier assembly, check that gear (9) rotates smoothly.



DISASSEBMLY OF TRAVEL MOTOR ASSEMBLY



1. **Travel motor assembly**
   Set travel motor assembly (1) to tool **S25**.



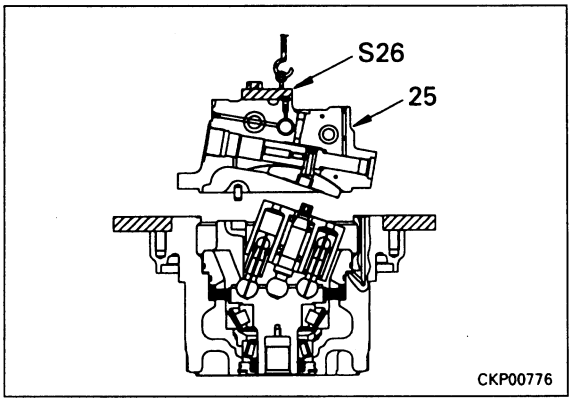
2. **Plugs, valve**
   1) Remove plug (2), then remove spring (3) and check valve (4).
   2) Remove plug (5), then remove spring (6), pistong (7), and spool (8).
   3) Remove safety valve (9).
   4) Remove plug (10), then remove regulator valve (11) and spring (12).
   5) Remove plug (13).

6) Remove plug (14), then remove ball (15).
7) Remove plug (16), then remove valve (17).
8) Remove plug (18), then remove valvve (19).
9) Remove plug (20), (21), and (22), then remove sleeve (23) and bleeder (24).

3. End cover assembly

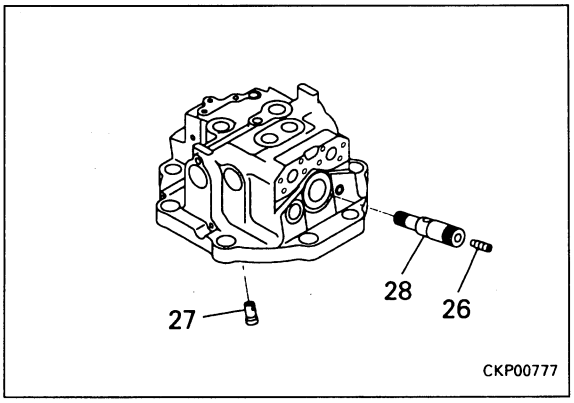
Using tool S26, lift off end cover assembly (25).

★ The valve plate may be stuck to the rear face, so be careful not to drop it.



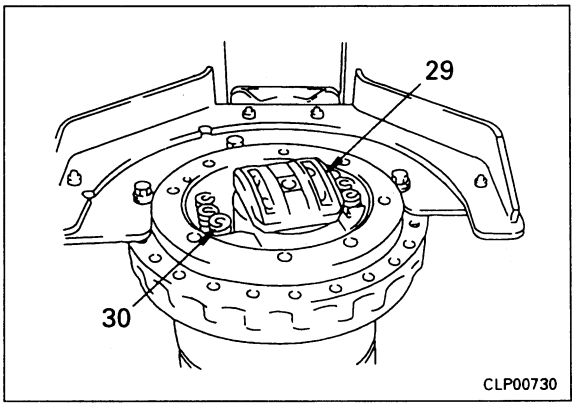
4. Regulator piston

Remove screw (26), pull out pin (27), THEN REMOVE REGULATOR PISTONS (28).



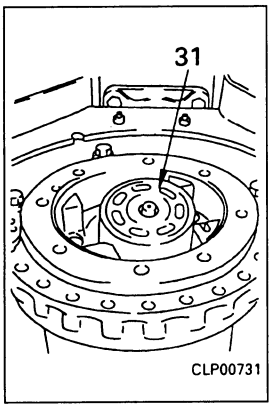
5. Valve plate, spring

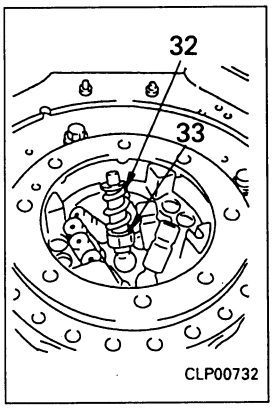
1) Remove valve plate (29).
   ★ When using again, keep in a safe place and be careful not to scratch or damage the cylinder block contact surface.
2) Remove brake pistons (30).



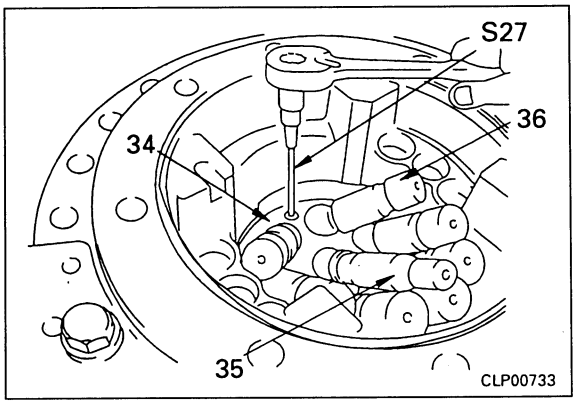
6. Center shaft, piston

1) Remove cylinder block (31).
2) Remove spring (32) and center ring (33).



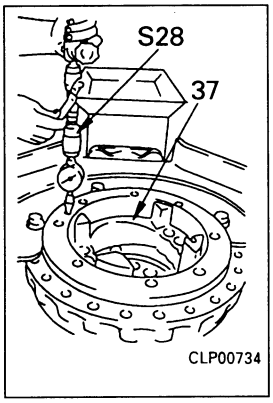


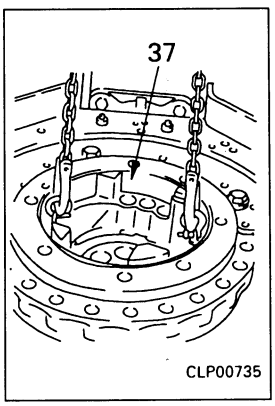
3) Using tool **S27**, remove 7 mounting screws, then remove retainer (34), center shaft (35), and pistons (36) as one assembly.
4) Remove center shaft (35) and pistons (36) from retainer (34).



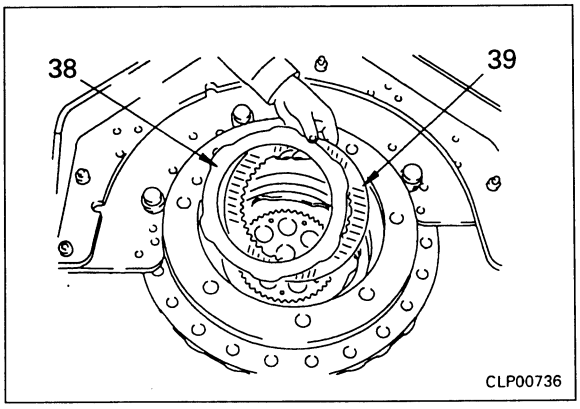
7. Brake piston, discs, plates

1) Set tool **S28** to port hole for brake piston.
2) Apply pressure gradually until brake piston (37) comes up.
   ★ Be careful that the air pressure is not too high. The brake piston will fly out.
3) Lift off brake piston (37).



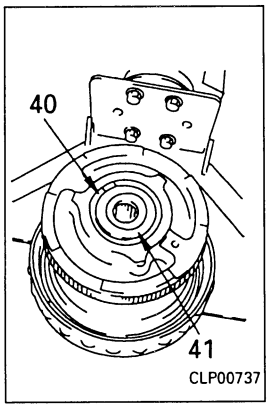


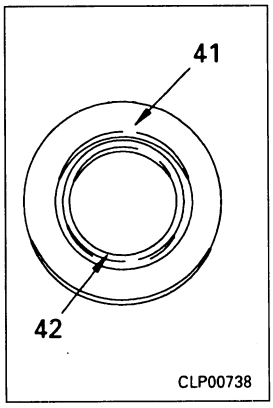
4) Remove plates (38) and discs (39) in order.
   ★ Plates : 4
   ★ Discs: 3



8. Oil seal

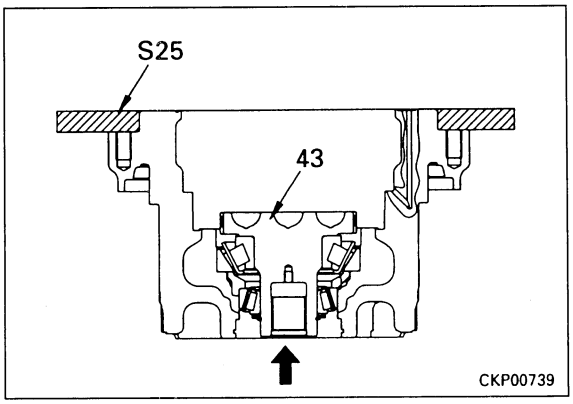
1) Turn over tool **S25**.
2) Remove snap ring (40), then remove cover (41).
3) Remove oil seal (42) from cover (41).





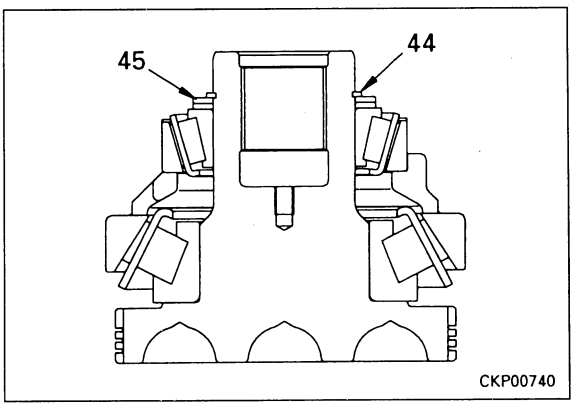
9. Drive shaft, bearing assembly

1) Rotate tool **S25** 90 and set openring of motor case facing side.
2) Tap end face of drive shaft with plastic hammer to remove drive shaft and bearing assembly (43).

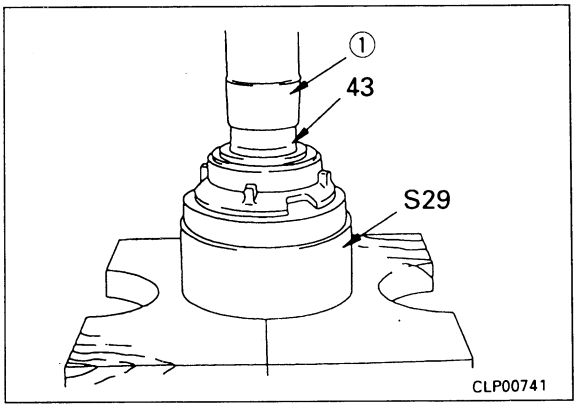


10. Disassembly of drive shaft, bearing assembly

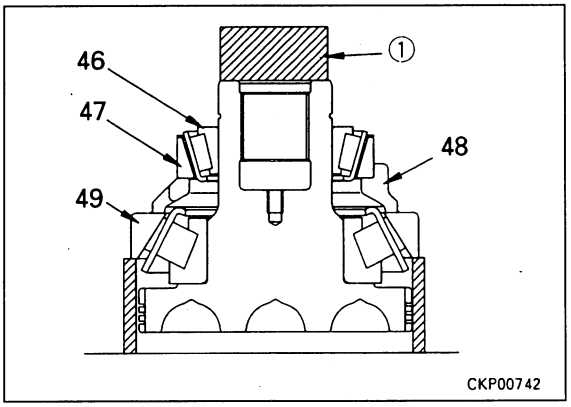
1) Remove snap ring (44), then remove 2 spacers (45).



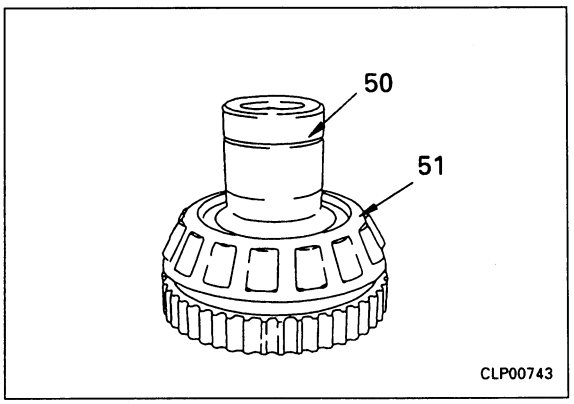
2) Set drive shaft and bearing assembly (43) to tool **S29**.
3) Set push tool 1 to drive shaft, then push with press to remove drive shaft and main bearing inner race assembly.



4) Remove sub bearing inner race (46), outher race (47), retainer (48), and main bearing outer race (49).



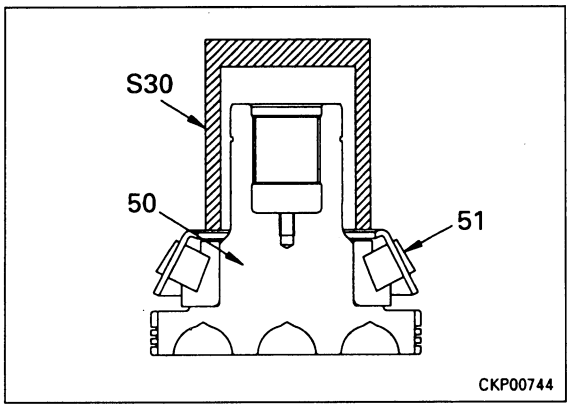
5) Remove main bearing inner race (51) from drive shaft (50).



ASSEMBLY OF TRAVEL MOTOR ASSEMBLY

Precautions when assembling

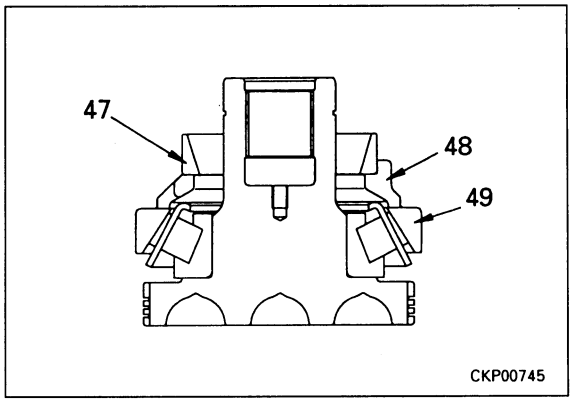
1) Clean all parts, remove all burrs, and check for dirt or damage.
2) Coat the rotating and sliding surfaces of all parts with engine oil (E010-CD) before installing.
3) Before coating any part with thread tightener, remove all oil and grease from the thread and tap hole, and dry completely.



1. Drive shaft assembly

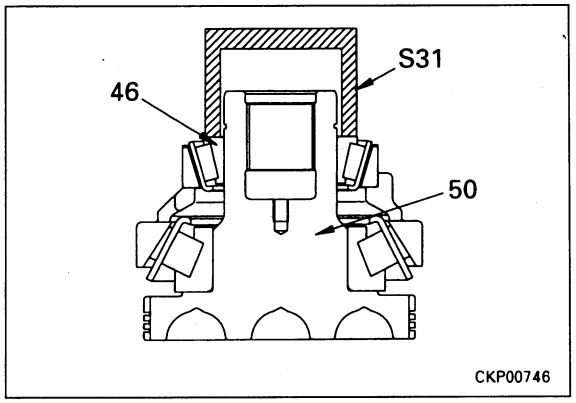
1) Using tool **S30**, press fit main bearing (51) to drive shaft (50).
   - ★ Press fit until the end face of the inner race is in tight contact with the end face of the drive shaft.
   - ★ Press-fitting load : **47.6 kN (4,850 kg)**

   Press-fitting surface of bearing : **Lubricating oil (E010-CD)**
2) Install main bearing outer race (49), retainer (48), and sub bearing outer race (47).



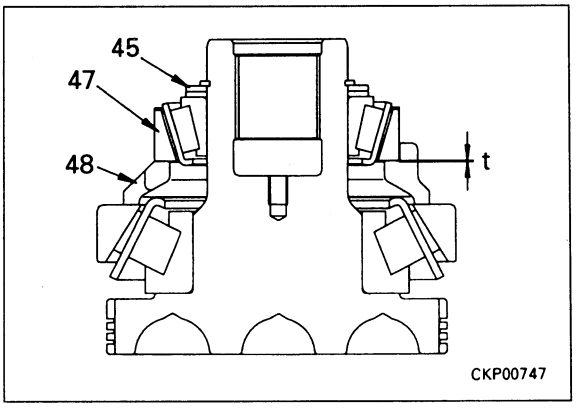
3) Using tool **S31**, press fit sub bearing inner race (46) to drive shaft (50).
   - ★ Press fit until the roller of the inner race is in tight contact with the outer race.
   - ★ Press-fitting load : **11.8 kN (1,208 kg)**

   Press-fitting surface of bearing: **Lubricating oil (E010-CD)**



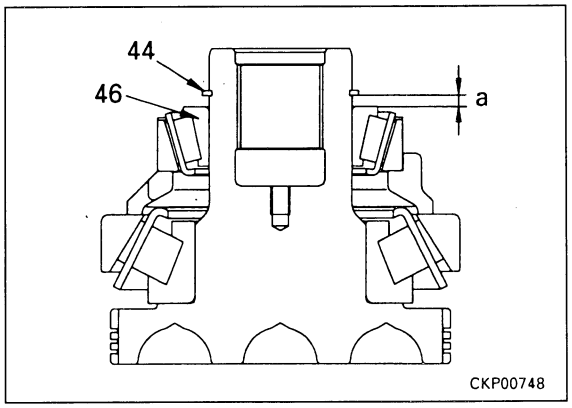
2. Adjusting end play of shaft

1) Select 2 spacers (45) as follows, and adjust clearance "**t**" between retairner (48) and sub bearing outer reace (47) to make clearinace of 0.05 - 0.25 mm.

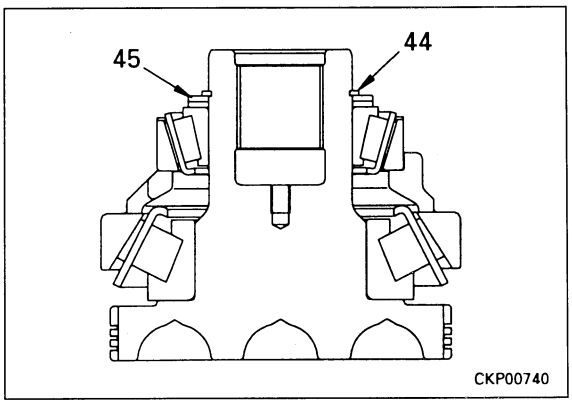


2) Measure dimention "**a**" between sub bearing inner race (46) and snap ring (44), and select 2 spacers (45) from table below.
   ★ Check that snap ring (44) is fitted securely in the mounting groove.

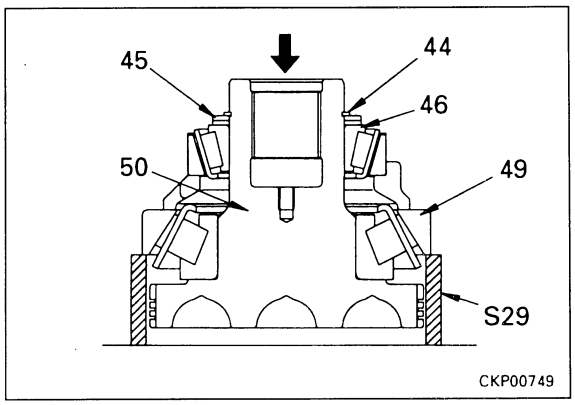
No.	Measurement of dimension "a"	Necessary spacer (including thichness of 2 spacers)	Necessary spacers: 2 spacers marked with ○ in table below		
			Spacer thickness: 2.9	3.1	3.3
1	5.850 - 6.049	5.8	○ ○		
2	6.050 - 6.244	6.0	○	○	
3	6.250 - 6.449	6.2		○ ○	
4	6.450 - 6.649	6.4		○	○
5	6.650 - 6.849	6.6			○ ○
Part No. of spacer			706-88-40440	706-88-40450	706-88-40460



3) Install selected spacers (45), then install snap ring (44).
   ★ Check that snap ring (44) is fitted securely in the mounting groove.

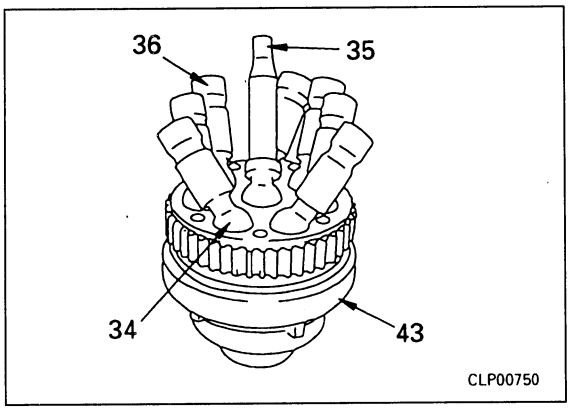


4) Push out drive shaft as follows.
   i) Support main bearing outer race (49) with tool **S29**.
   ii) Apply load to drive shaft (50) until top surface of sub bearing inner race (46), spacer (45), and snap ring (44) are all in tight contacct with each other.
      ★ Load when pushing out:
      21.7 kN (2,208 kg)
   iii) Check that 2 spacers (45) are in tight contact and cannot be rotated by hand.
      ★ If the spacers can be rotated or are not fully in tight contact, adjust again from Step 2).



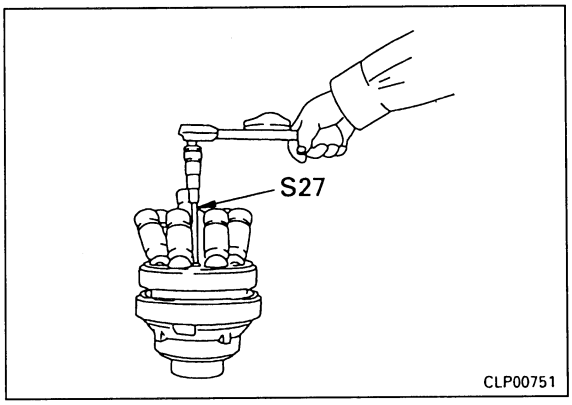
3. Shaft, center shaft, cylinder block

1) Set center shaft (35) and pistons (36) in position on retainer (34), then install drive shaft (43).

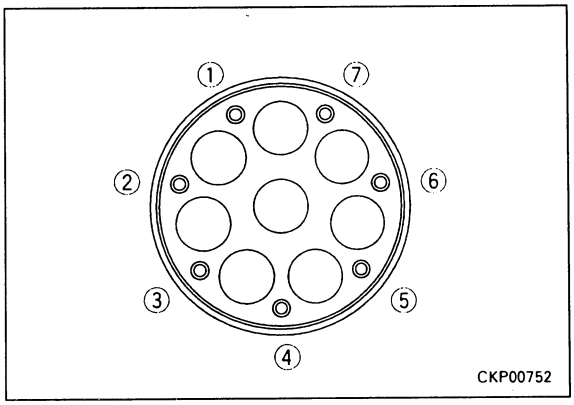


2) Using tool **S27**, tighten mounting screws.
★ Replace the mounting screws with new parts.
Mounting screw:
Thread tightener (LT-2)

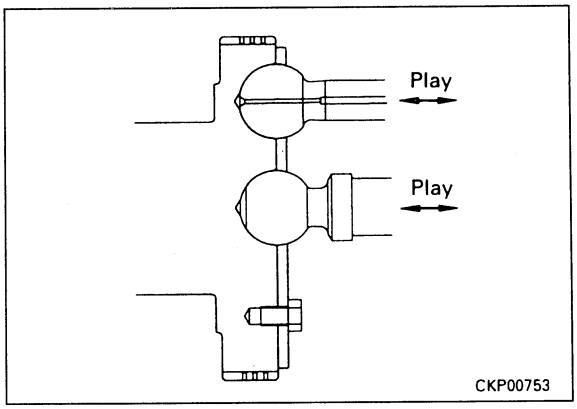
Mounting screw:
1st step:
Max. 0.98 Nm (0.1 kgm)
2nd step:
7.8 - 9.8 Nm (0.8 - 1.0 kgm)
3rd step:
24.5 ± 1.9 Nm (2.5 ± 0.2 kgm)



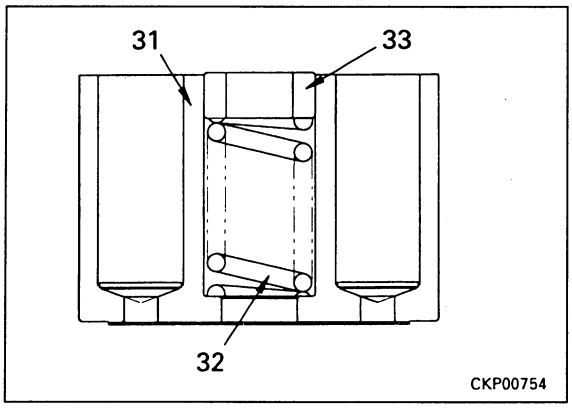
★ Order for tightening: ①-④-⑦-③-⑥-②-⑤
Tighten in three steps as shown above.
★ After tightening, wipe off any adhesive that has been squeezed out.
★ Check that the large ball of the piston and the center shaft move smoothly.



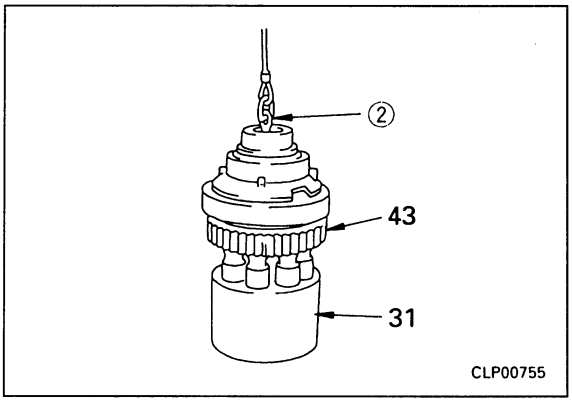
3) Measure play of piston (36) in axial direction.
★ Standard play of piston in axial direction: Max. 0.35 mm



4) Assembly spring (32) and center ring (33) in turn in center shaft hole of cylinder block (31).

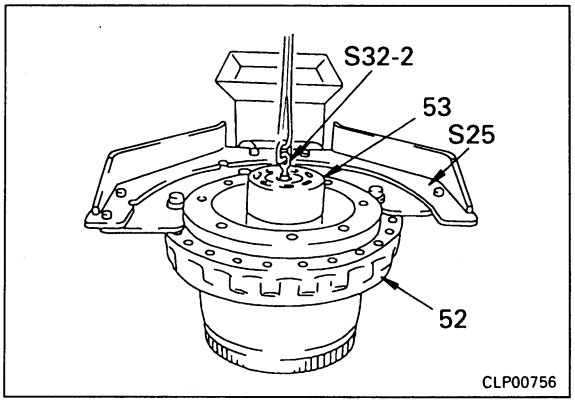


5) Turn over drive shaft assembly (43), and use eyebolt ② (10 X 1.5 mm, length below head: approx. 85 mm) to raise drive shaft assembly.
6) Align center shaft and piston with each hole in cylinder block (31), then install drive shaft (43).

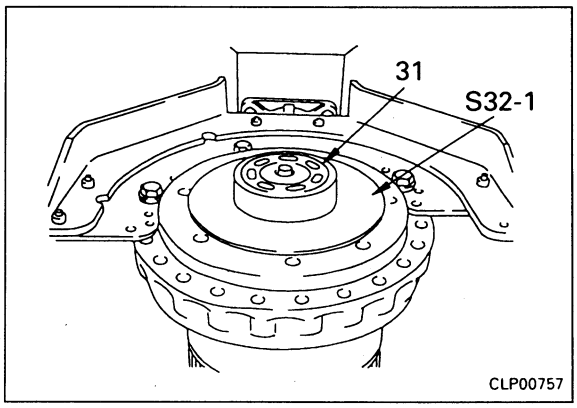


4. Drive shaft, cylinder block assembly

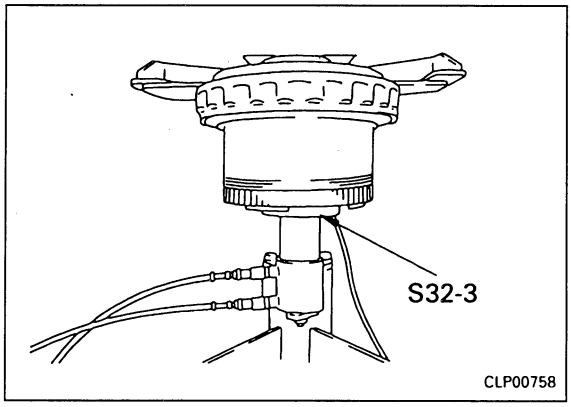
1) Set motor case (52) to tool **S25**.
2) Raise drive shaft and cylinder block assembly (53) with tool **S32-2** and install motor case (52).
   ★ Align the protrusions on the retainer (4 places around circumference) with the oil grooves in the case (4 places around circumference) and install.



3) Set tool **S32-1** in position and hold cylinder block (31) at center position.

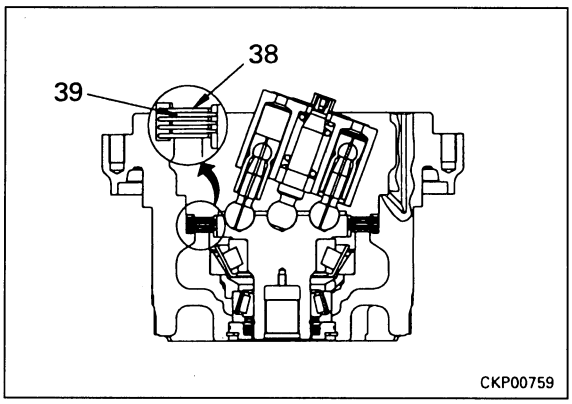


4) Install tool **S32-3** to drive shaft, then press fit until end face of main bearing outer race is in tight contact with case.
★ Press-fitting load: **13.3 kN (1,360 kg)**



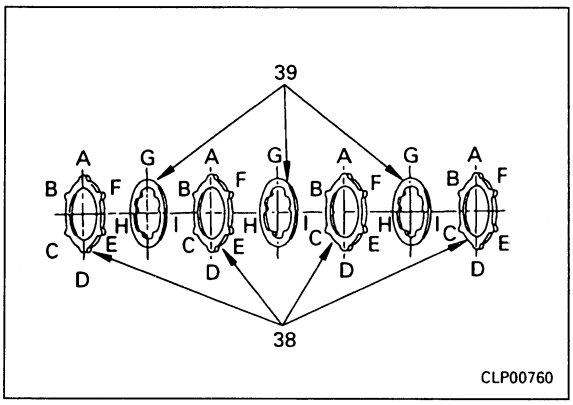
5. Plate, disc, piston

1) Assemble plates (38) and discs (39) in order.
★ Plates : 4
★ Discs : 3
★ Do not wash the discs in trichlene or drizol, or blow strongly with air.
Front face of disc:
Lubricating oil (EO10-CD)

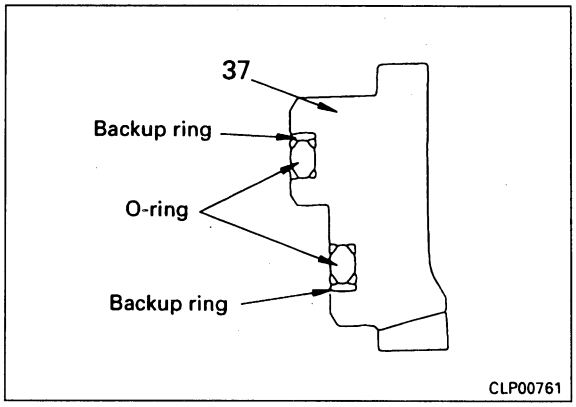


• **Method of placing plates and discs on top of each other.**

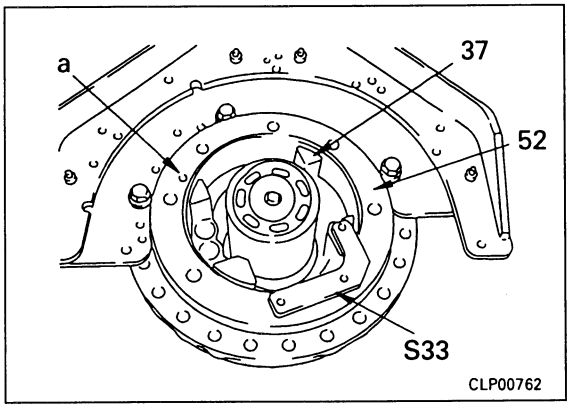
i) Align cutcout arc teeth areas **G**, **H**, and **I** of discs (39).
ii) Protrusions **A**, **B**, **C**, **D**, **E**, and **F** on plates (38) can be set any position in relation to positions **G**, **H**, and **I** of discs.



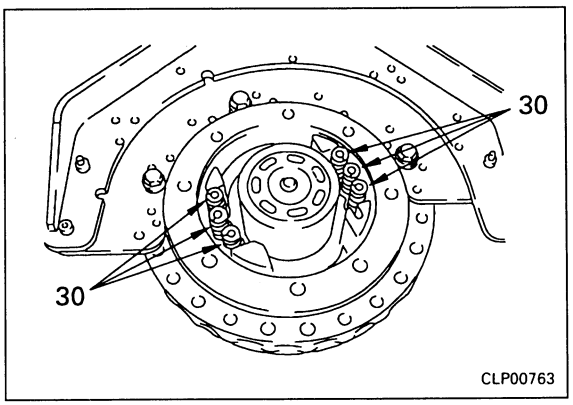
2) Fit O-ring and backup ring to brake piston (37).
★ Assemble the backup ring in the direction shown in the diagram.



3) Install brake piston (37) to motor case (52), and determine position with tool **S33**.
   ★ Install tool **S33** in the postion shown in the diagram on the right in relation to port hole "**a**" for the brake piston.

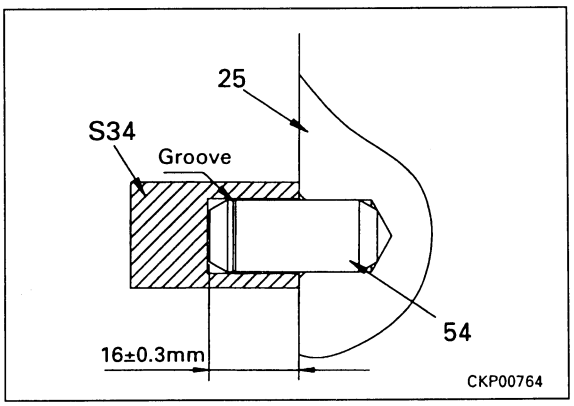


4) Install 6 brake springs (30).



6. Dowel pin

Using tool **S34**, press fit dowel pin (54) to end cover (25) to dimension shown in diagram.
★ Install with the groove end at the brake piston end.



7. Regulator piston

Insert regulator piston (28) in piston hole, then assemble pin (27) and secure with screw (26).

★ Assemble pin (27) from the opposite side to regulator piston counterbore "a".

★ Apply one drop of adhesive to screw (26) at the point shown in the diagram on the right.

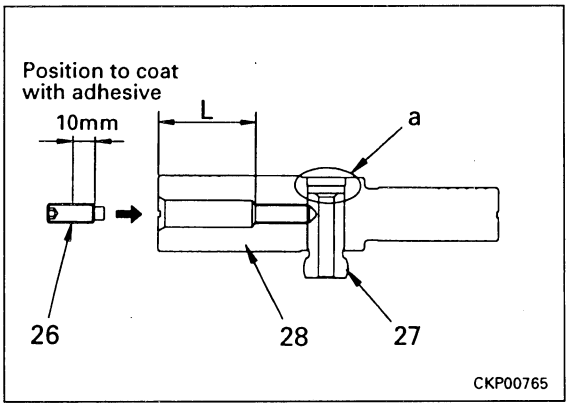
★ Be careful not to apply too much adhesive.

Screw: Thread tightener (LT-2)

kgm Screw: 28.4 ± 2.9 Nm (2.9 ± 0.3 kgm)

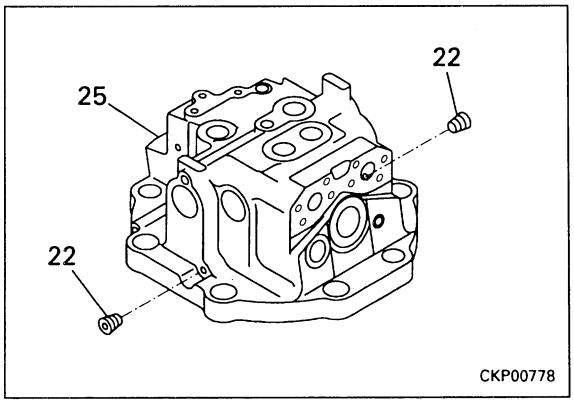
★ After assembling the screw, check dimension L between the end face of the piston and the rear end of the screw.

★ Dimension L : 50 - 52 mm

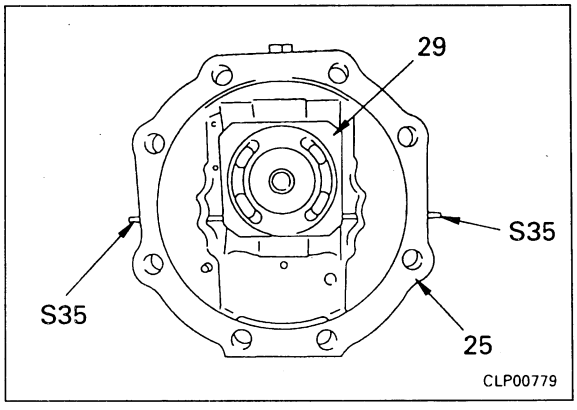


8. Valve plate

1) Remove plugs (22) from end cover assembly (25).

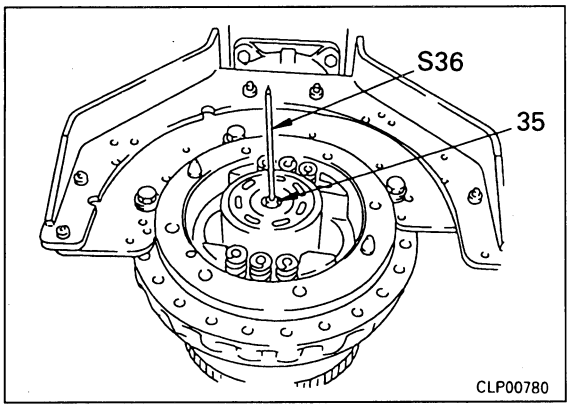


2) Install valve plate (29) to end cover assembly (25).
   ★ Align the hole in the valve plate exactly with pin (27) of teh regulator piston.
   ★ Check that the valve plate moves smoothly in the end cover mounting groove.
3) pass tool S35 through plug hole and secure valve plate (29) in position.



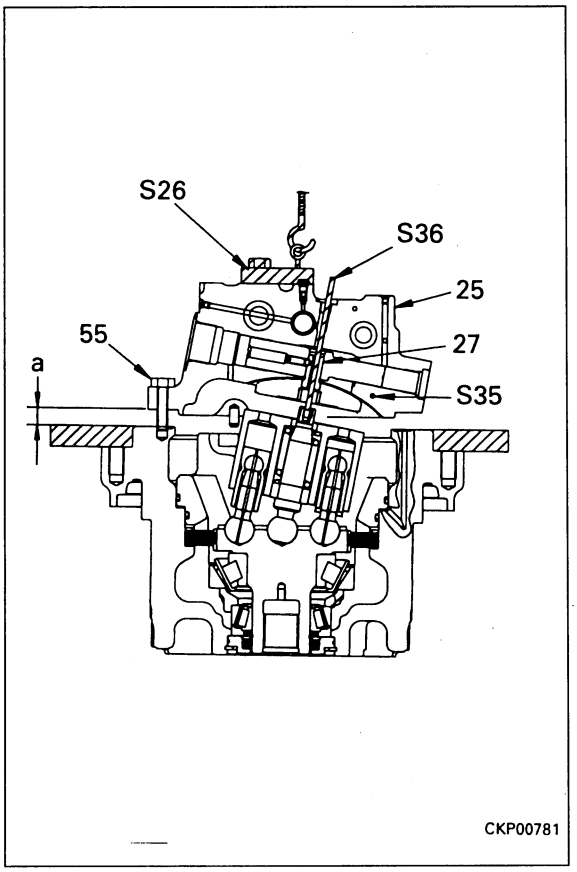
9. End cover

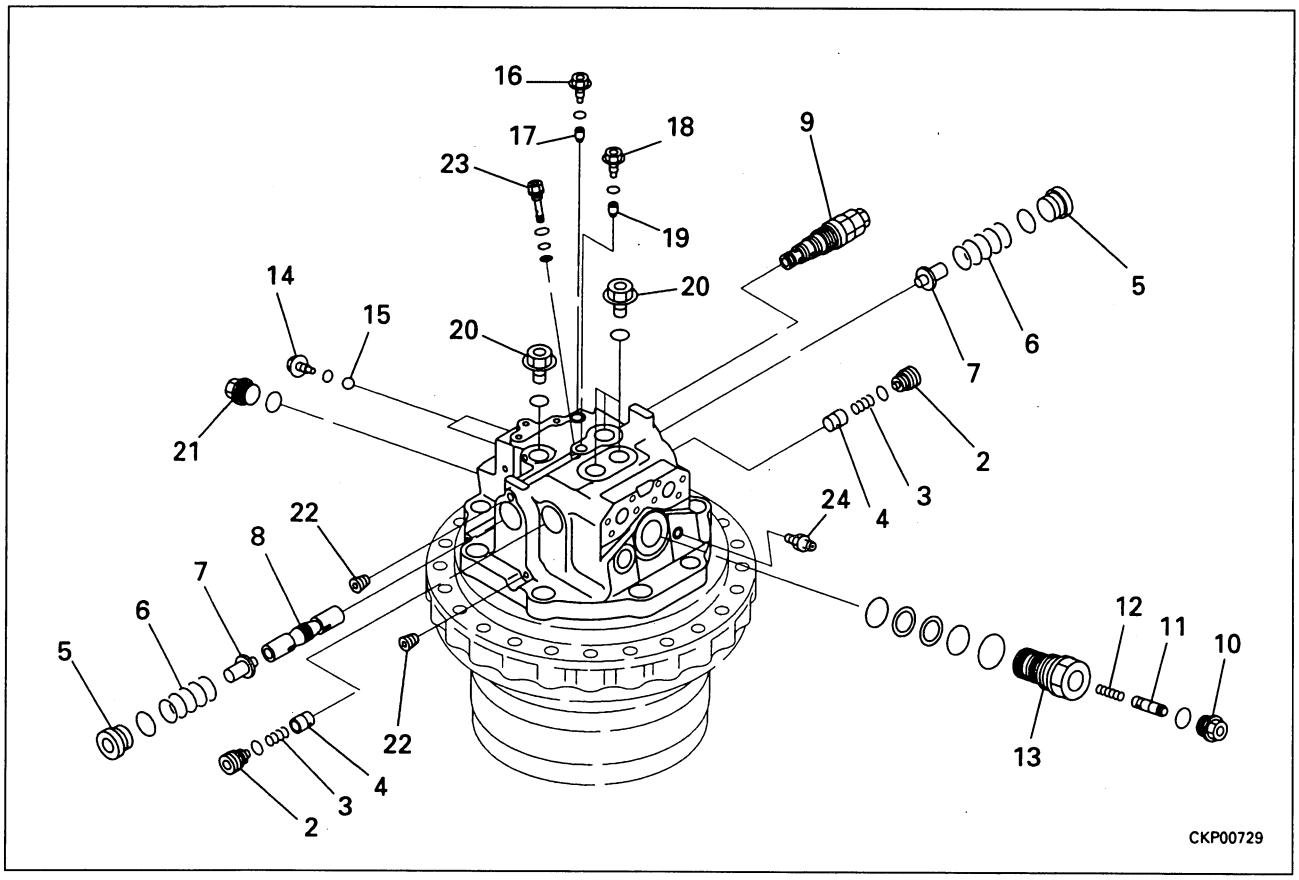
1) Set tool **S36** to center shaft (35).



2) Using tool **S26**, raise end cover assembly (25).
3) Lower end cover assembly (25) and pass tool **S36** through hole in pin (27) of regulator piston.
   ★ Check that the valve plate is in tight contact with the end cover.
4) Check that valve plate does not slip out of position and lower end cover assembly until it is in tight contact with cylinder block, then temporarily tighten 4 mounting bolts (55) on opposite sides to secure in position.
5) Tighten mounting bolts (55) uniformly until clearance "**a**" at mating surface is approx. 12 mm.
   ★ Measure the clearance at serveral places around the circumference to check that the motor case and end cover are parallel.
6) Remove tools **S35** and **S36**.
   ★ When doing this, check that the valve plate moves to the maximum end and makes a sound of contact.
   ★ Chck that the regulator piston moves to the maximum end.
7) Tighten mounting bolts (55) uniformly until the plate is fixed firmly.
   ★ If the mounting bolts become heavy before they contact the seat, repeat the procedure again from Step 2).
8) Remove tool **S26**.
9) Tighten all mounting bolts (55).
   ★ Tighten the mounting bolts uniformly on opposite sides.

   kgm Mounting bolt:
   568.7 ± 49.0 nm (58 ± 5 kgm)





10. Valve, plugs

1) Install bleeder (24).

kgm Bleeder:

8.8 ± 0.98 Nm (0.9 ± 0.1 kgm)

2) Install sleeve (23).

Sleeve:

Thread tightener (Loctit4e 638 or 648)

kgm Sleeve:

39.2 ± 4.9 Nm (4.0 ± 0.5 kgm)

3) Install plug (21).

Plug:

Thread tightener (Loctite 638 or 648)

kgm Plug:

215.72 ± 29.4 Nm (22 ± 3 kgm)

4) Install plugs (20).

Plug:

Thread tightener (Loctite 638 or 648)

kgm Plug:

39.2 ± 4.9 nm (4.0 ± 0.5 kgm)

5) Assemble plugs (19) and (1&), then tighten plugs (18) and (16).

Plug:

Thread tightener (Loctite 638 or 648)

kgm Plug:

39.2 ± 4.9 Nm (4.0 ± 0.5 kgm)

6) Assemble ball (15), then tighten plug (14).

Plug:

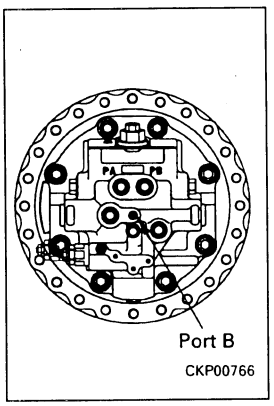
Thread tightener (Loctite 638 or 648)

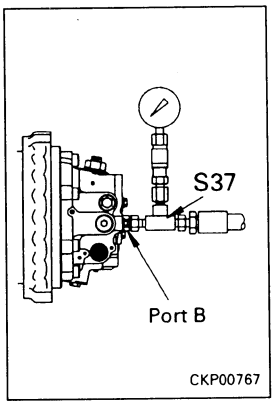
kgm Plug:

23.5 ± 3.9 Nm (2.4 ± 0.4 kgm)

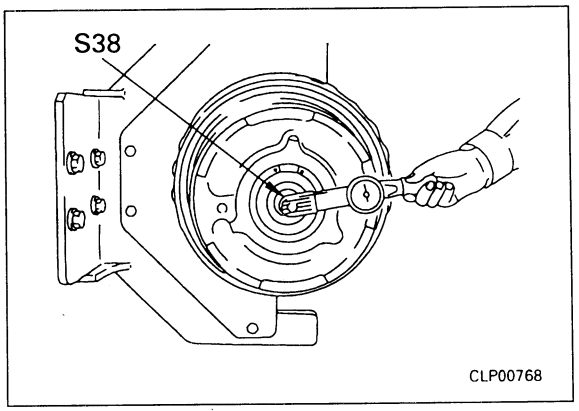
7) Install plug (13).
Plug:
Thread tightener (Loctite 638 or 648)
kgm Plug:
985.5 ± 112.8 Nm (100.5 ± 11.5 kgm)
8) Assemble spring (12) and regulator valve (11), then tighten plug (10).
kgm Plug:
169.2 ± 75.9 Nm (17.25 ± 7.75 kgm)
9) Install safety valve (9).
kgm Safety valve assembly:
318.7 ± 24.5 Nm (32.5 ± 2.5 kgm)
10) Assemble spool (8), piston (7), and spring (6), then tighten plug (5).
11) Assemble check valve (4) and spring (3), then tighten (2).
Plug:
Thread tightener (Loctite 638 or 648)
kgm Plug:
382.4 ± 58.8 Nm (39 ± 6 kgm)
12) Tighten plugs (22).
kgm Plug:
9.8 ± 1.9 Nm (1.0 ± 0.2 kgm)

11. Measure drive shaft rotating torque
1) Using tool **S37**, apply pressure through port B to release brake.
★ Brake release pressure: **2.5 ± 0.5 MPa (25 ± 5 Kg/cm²)**





2) Using tool **S38**, rotate drive shaft at low speed (5 sec/1 turn) and measure rotating torque and variation.
★ Standard value for rotating torque:
7.8 - 19.6 (0.8 - 2.0 kgm)
★ Vaiation range:
Max. 1.5 Nm (0.15 kgm)



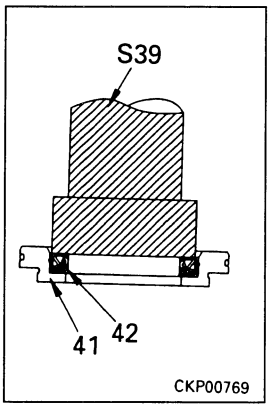
12. Oil seal

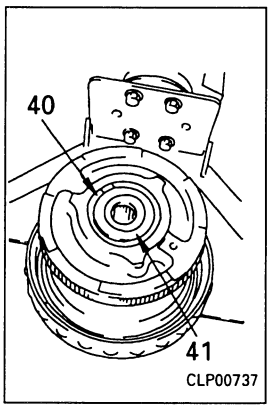
1) Using tool S39, press fit oil sela(42) to cover (41).

Lip of oil seal : **Grease (G2-LI-S)**

2) Install cover (41), and secure with snap ring (40).

★ Check that the snap ring is fitted securely in the mouting groove.

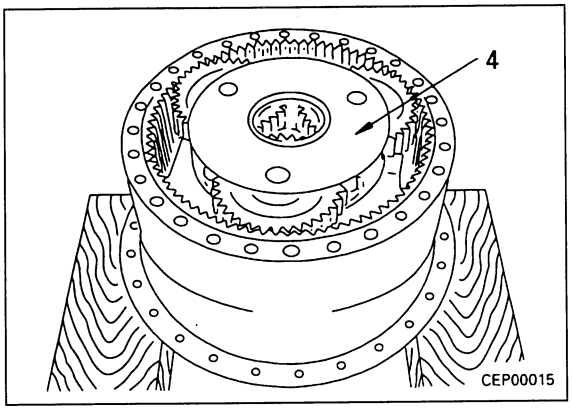




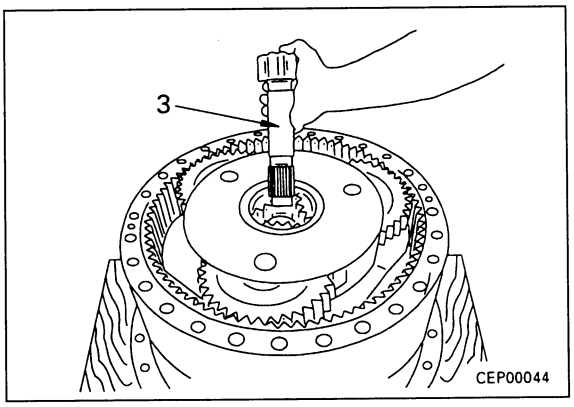
13. Checking performance

Carry out a bench test to check the performance.

2) Install No. 1 carrier assembly (4).



8. No. 1 sun gear shaft
Install No. 1 sun gear shaft (3).

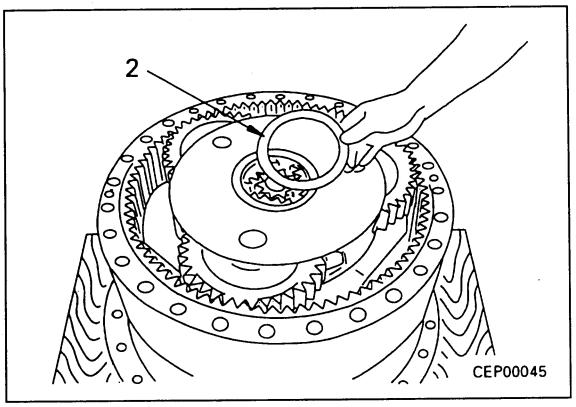


9. Spacer
Install spacer (2).

10. Cover
Using eyebolts ①, install cover (1), then using angle tightening wrench **J3**, tighten mounting bolts.

Mounting surface of cover:
Gasket sealang (LG-6)

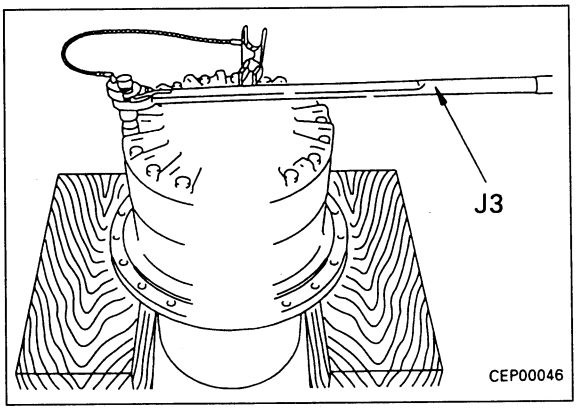
kgm Mounting bolt:
Initial torque: 98 Nm (10 kgm)
Additional tightening angle: **115 - 125°**



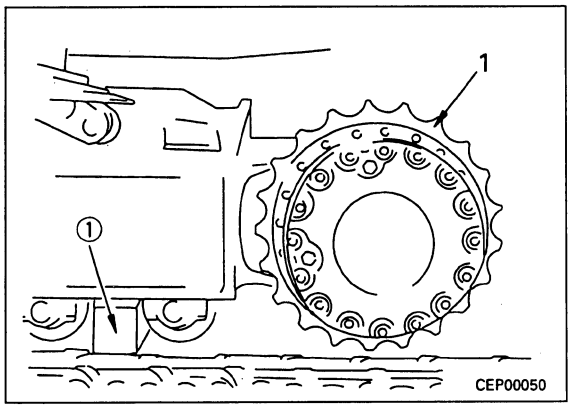
11. Refilling with oil
Tighten drain plug and add engine oil through oil filler.

Final drive case: **Approx. 12 ℓ**

★ Carry out a final check of the oil level at the determined position after installing the final drive assembly to the chassis.



REMOVAL OF SPROCKET



1. Remove track shoe assembly.
   For details, see REMOVAL OF TRACK SHOE ASSEMBLY.

2. Swing work equipment 90°, then push up chasis with work equipment and set block ① between track frame and track shoe.

3. Remove mounting bolts, then lift off sprocket (1). ※ 1

   kg Sprocket: **70 kg**

INSTALLATION OF SPROCKET

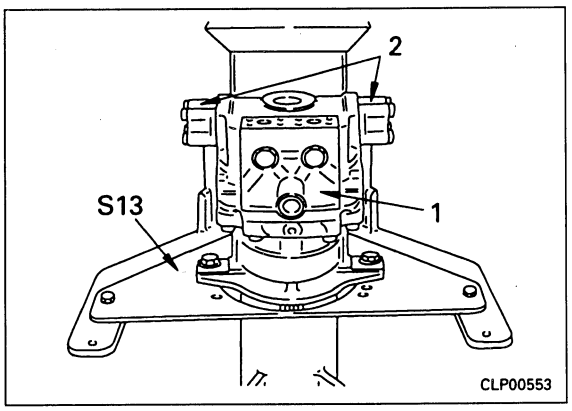
- Carry out installation in the reverse order to removal.

  Thread of sprocket mounting bolt:
  Thread tightener (LT-2)

  kgm Sprocket mounting bolt:
  637 ± 49 Nm (65 ± 5 kgm)

DISASSEMBLY OF SWING MOTOR ASSEMBLY

1. Motor assembly
Set swing motor assembly (1) to tool S13.

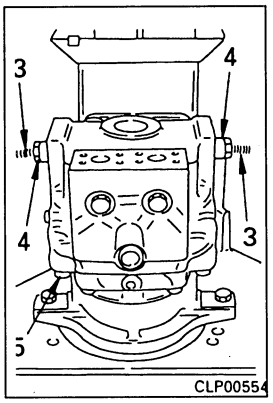


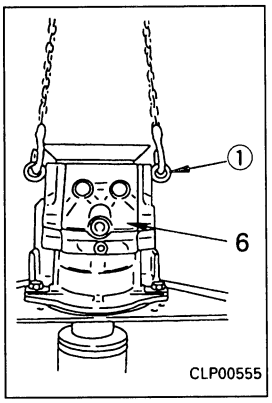
2. Housing

1) Remove covers (2), then remove springs (3) and sleeves (4).

2) Remove housing mounting bolts (5).

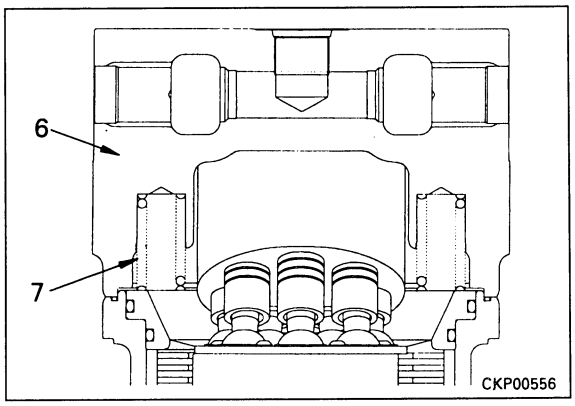
3) Using eyebolts ① (Thread: 12 mm, Pitch = 1.75 mm), lift off housing (6).





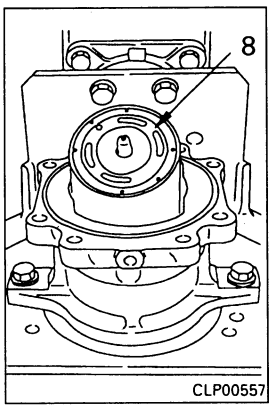
★ Springs (7) may fall out during the removal operation, so be careful not to lose them.

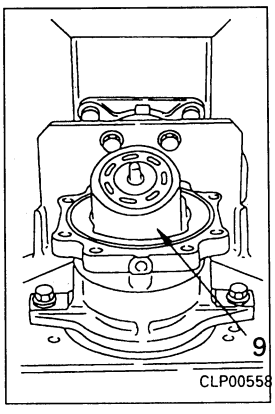
4) Remove 6 springs (7) from valve case.



3. Valve plate
Remove valve plate (8).

4. Cylinder block
Remove cylinder block (9).

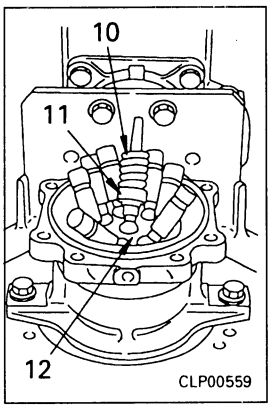


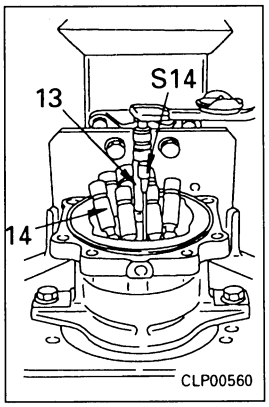


5. Spring
Remove spring (10) and center ring (11).

6. Retainer
Using tool **S14**, remove 7 mounting screws, then remove retainer (12).

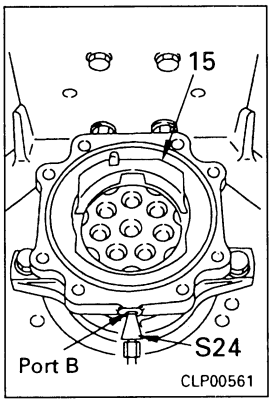
7. Shaft, piston
Remove center shaft (13) and 7 pistons (14).

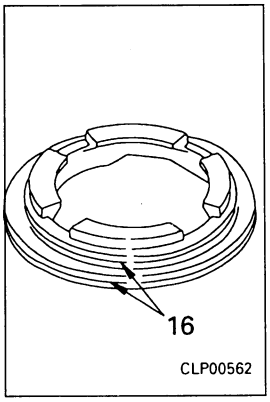




8. Brake piston
1) Using tool **S24**, pump in air through port **B** and remove brake piston (15).
★ Air pressure: 0.2 MPa (2 kg/cm2)
★ Be careful that the air pressure is not too high. The brake piston will fly out.

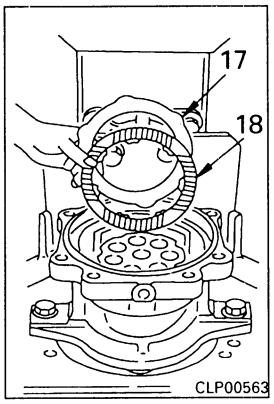
2) Remove O-ring (16) from piston.

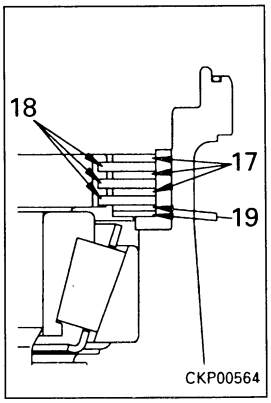




9. Plates, discs
1) Remove plates (17) and discs (18).

2) Remove plates (19).
★ Plates (17) (19) :5
★ Discs (18) :3



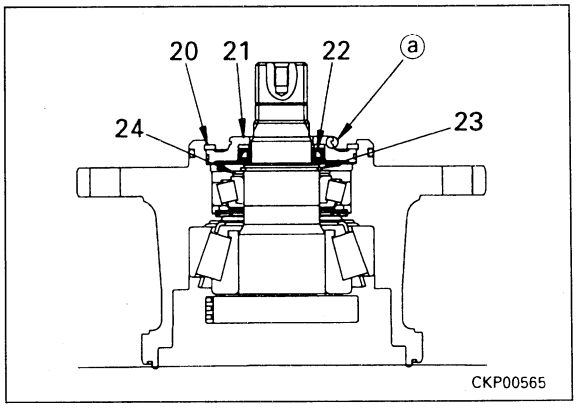


10. Cover
1) Remove case assembly from tool **S13**, and turn over.

2) Remove snap ring (20), then remove cover (21).
★ Put a screwdriver in contact with portion ⓐ and remove cover (21).

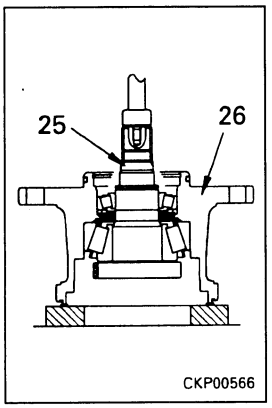
3) Remove oil seal (22) from cover (21).

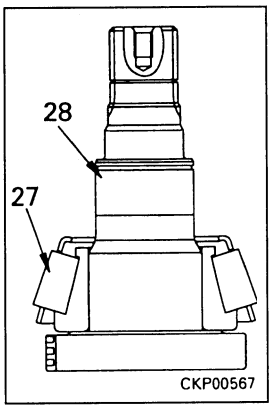
11. Shaft assembly
1) Remove snap ring (23), then remove 2 spacers (24).



2) Set case assembly to press, and remove shaft assembly (25) from case (26).

3) Remove bearing (27) from shaft (28).





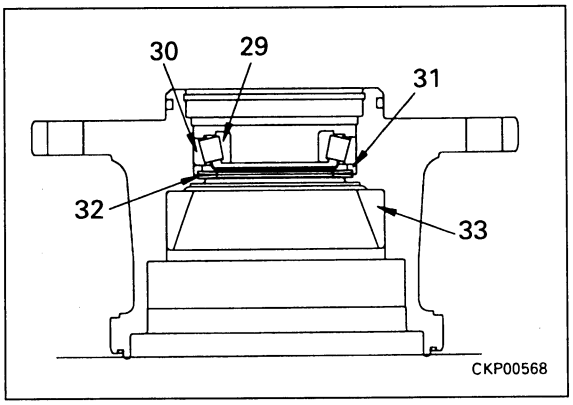
12. Bearing, seat, belleville spring

1) Remove bearing inner race (29) from case.

2) Remove bearing outer race (30).

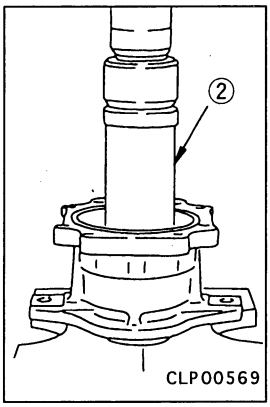
3) Remove seat (31) and belleville spring (32).

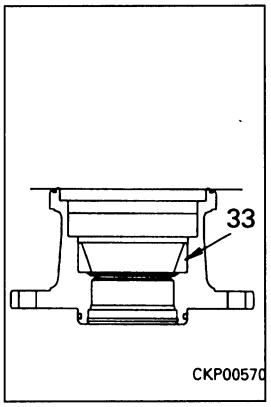
4) Remove main bearing outer race (33).



ASSEMBLY OF SWING MOTOR ASSEMBLY

Clean all parts, remove all burrs, and check for dirt or damage. Coat the rotating and sliding surfaces of all parts with engine oil (EO10-CD) before installing. Using chromium oxide, remove all the lapping powder from the places that have been lapped.



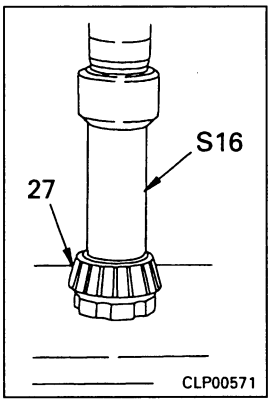


1. Outer race

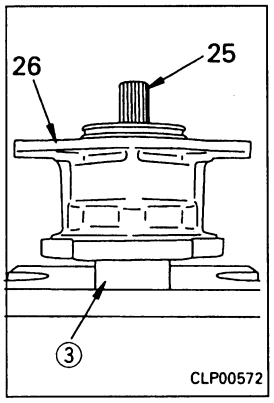
Using push tool ② (outside diameter: 159 mm), press fit outer rac (33) to case.

2. Shaft assembly

1) Using tool **S16**, press fit bearing (27) to shaft.
   ★ Press fit until the end face of the inner race is in tight contact with the shaft. Press fitting load:
   7.71 - 39.22 kN (787 - 4,000 kg)

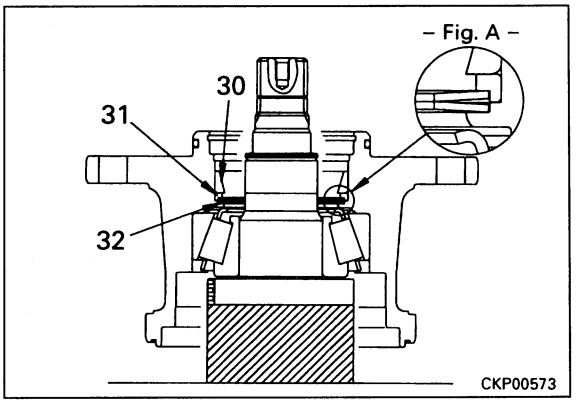


2) Set shaft assembly (25) to block ③(outside diameter: 130mm, height: 50mm), then set case (26) in position.

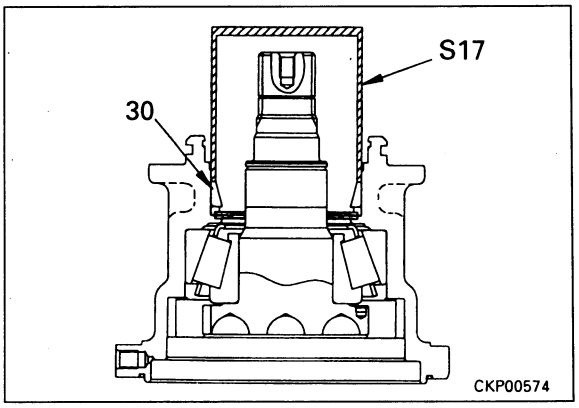


3. Belleville spring, seat, bearing

1) Install bellville spring (32) and seat (31).
   ★ Install the bellevill spring in the direction shown in Fig. A.



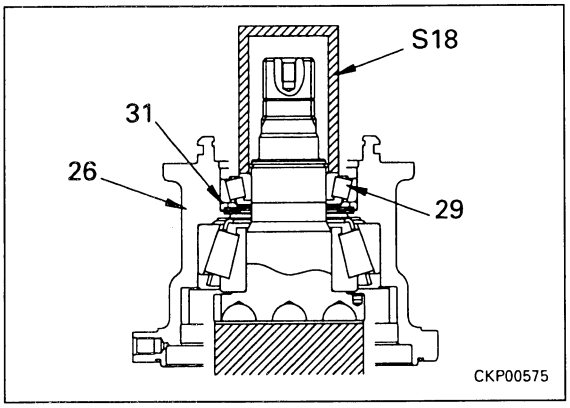
2) Using tool **S17**, install outer race (30).



3) Using tool **S18**, press fit bearing (29).
★ During the press-fitting operation, rotate case (26) and check that the bearing rotates smoothly.

★ Press fit until seat (31) is in tight contact with case (26).

※ Bearing press-fitting load: 3.92 - 20.15 kN (400 - 2,055kg)

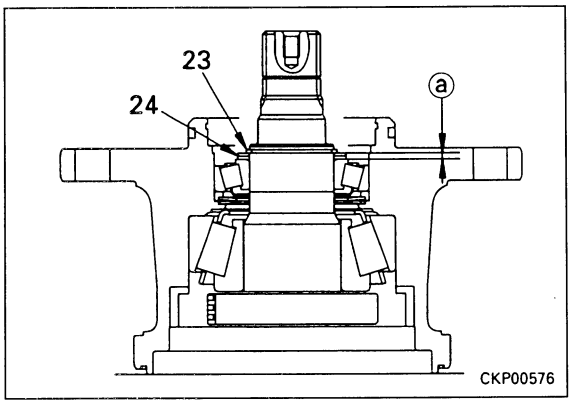


4. Spacer

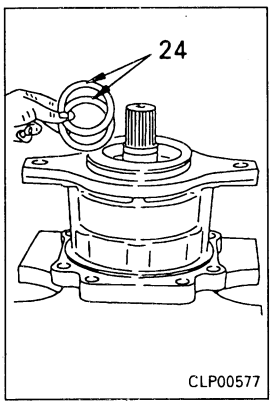
1) Measure clearance ⓐbetween bottom face of snap ring (23) and top face of bearing inner race, then select 2 spacers (24) equivalent to clearance ① from table below.

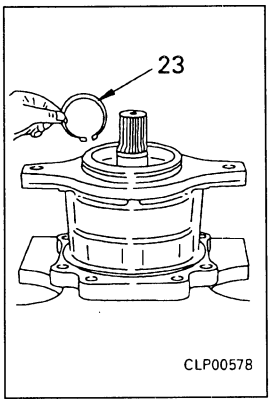
	Part No. of spacer (24)	Thickness
①	706-77-42440	2.3
②	706-77-42450	2.5
③	706-77-42460	2.7

★ Standard assembled thickness of spacer: 5.1 mm



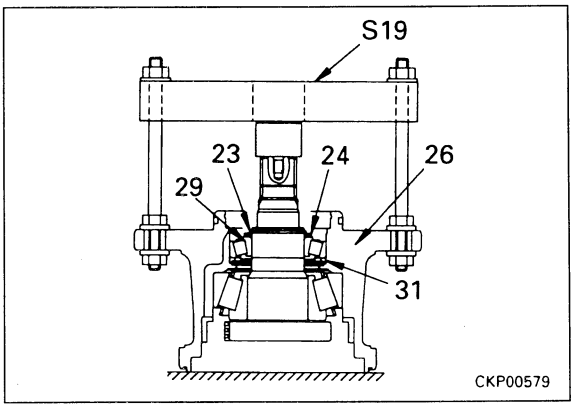
2) After assembling spacer (24), install snap ring (23).
★ Check that the snap ring is fitted securely in the snap ring groove.



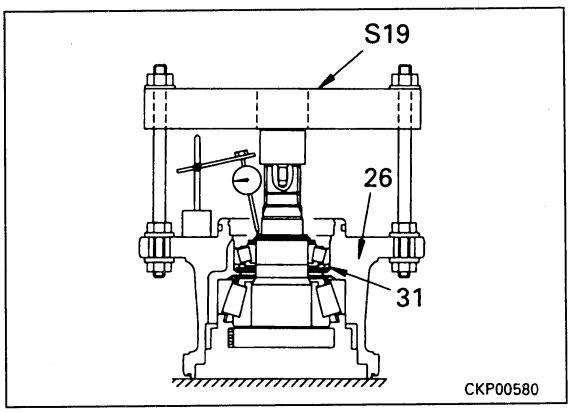


3) Pushing out drive shaft
i) Set tool **S19** to case (26), then push out drive shaft under load given below until end face of bearing inner race (29) is in tight contact with spacer (24) and snap ring (23).
★ Load when pushing out shaft:
3.92 - 16.18 kN (400 - 1,650 kg)

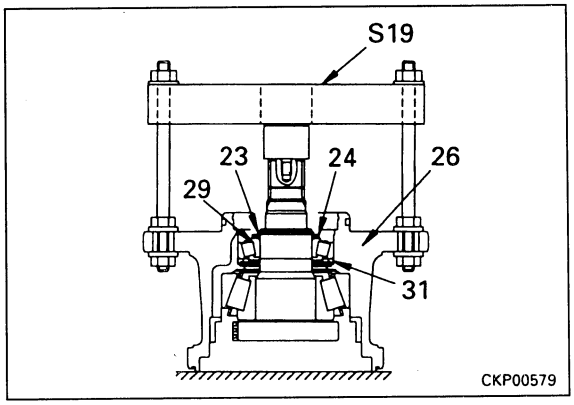
ii) After bringing into tight contact, apply a load of 21.57 kN (2,200 kg), and check that spacer (24) cannot be totated by hand and that spacer is in tight contact.

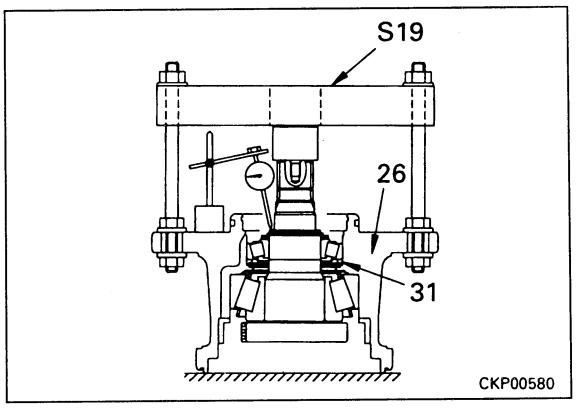


4) Check clearance between case (26) and seat (31) as follows.
   i) Using tool **S19**, apply a load of 4.90 - 21.57 kN (500 - 2,200 kg) to tip of drive shaft, measure movement of drive shaft, and check that it is within specified value.
      ★ Movement of drive shaft:
      0.1 - 0.4 mm

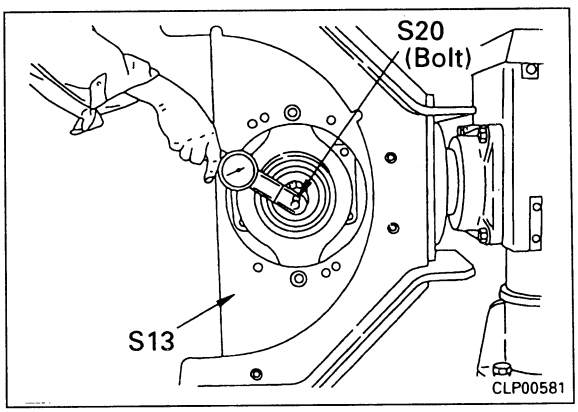


   ii) If movement of drive shaft is not within specified value, adjust spacer as follows.
      • If clearance is less than 0.1 mm: Replace spacer with (706-77-42440) and install snap ring.
      • If clearance is more than 0.4 mm: Replace spacer with (706-77-42460) and install snap ring.
      • Repeat Steps 4-3) - 4) to measure movement of drive shaft, and check that clearance is withing range of 0.1 - 0.4 mm.

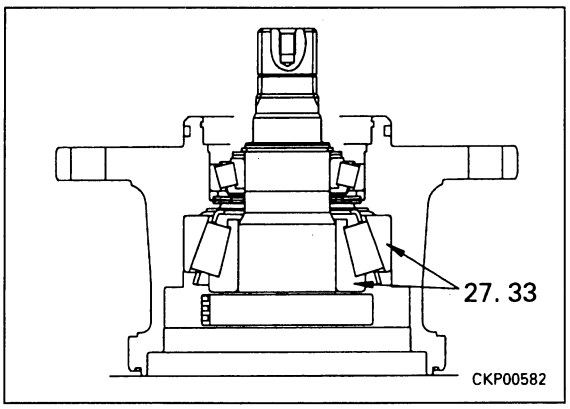




   iii) Set motor case to tool S13, then use tool S20 to measure rotating torque of drive shaft.
      ★ Rotating torque of drive shaft: 1.5 - 4.9 Nm (0.15 - 0.50 kgm)
      ★ Before carrying out the measurement, supply the bearing well with oil, and rotate the drive shaft at a speed of 1 turn every 5 seconds when measuring the rotating torque.



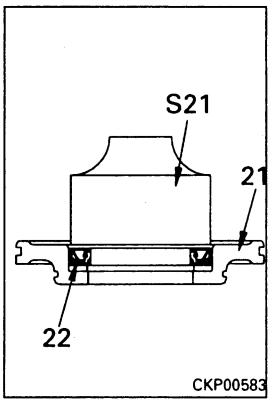
★ If the rotating torqeu is not within the range of 1.5 - 4.9 Nm (0.15 - 0.50 kgm), replace bearings (27) and (33) with new parts and adjust again.

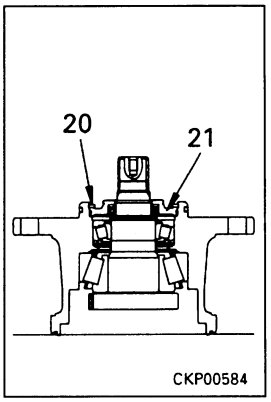


5. Cover

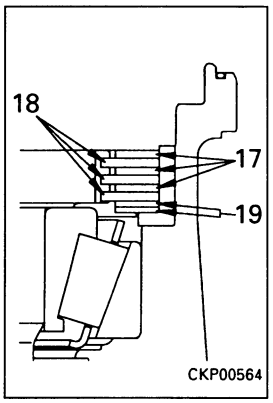
1) Using tool **S21**, press fit oil seal (22) until it is in tight contact with cover (21).

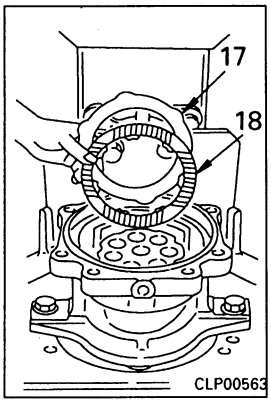
2) Assemble cover (21), and install snap ring (20).
★ Be careful not to damage the lip of the oil seal when installing the cover.
Lip: **Grease (G2-LI-S)**





6. Plates, discs
Assemble plates (19), discs (18), and plates (17) to case.
★ Plates (17) (19) :5
★ Discs (18): 3
★ Before assembling the discs, coat the surface with lubricating oil.
★ Do not wash the discs in trichlene or drizol, or blow strongly with air.

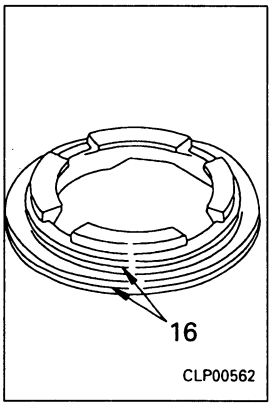


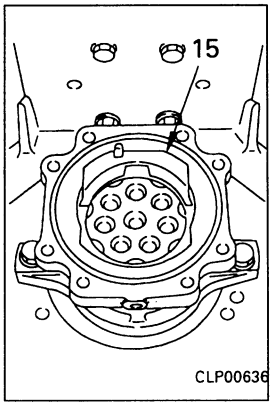


7. Brake piston

1) Install O-ring (16) to piston.

2) Install brake piston (15).





8. Piston, shaft

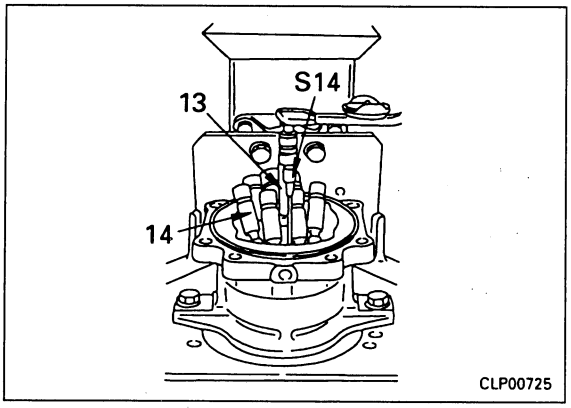
1) Set 7 pistons (14) and center shaft (13) in position.

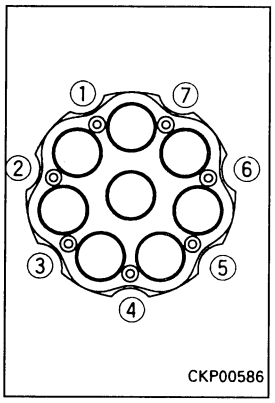
2) Using tool **S14**, tighten 7 retainer mounting screws.
   - ★ Replace the retainer mounting screws with new parts.

   Screw: Thread tightener (LT-2)

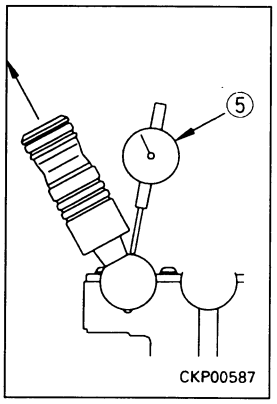
   Screw: 1st step (tighten temporarily): Max. 0.98 Nm (0.1 kgm)
   2nd step: 3.9 - 5.9 Nm (0.4 - 0.6 kgm)
   3rd step: 13.2 ± 1.5 Nm (1.35 kgm)

   - ★ Remove all oil and grease fromthe thread (male and female), and dry completely.
   - ★ Order for tightening: ①-④-⑦-③-⑥-②-⑤ Tighten either clockwise or coutner-clockwise.
   - ★ After tightening, wipe off any adhesive that has been squeezed out.
   - ★ Check that the large ball of piston (14) and center shaft (13) move smoothly.





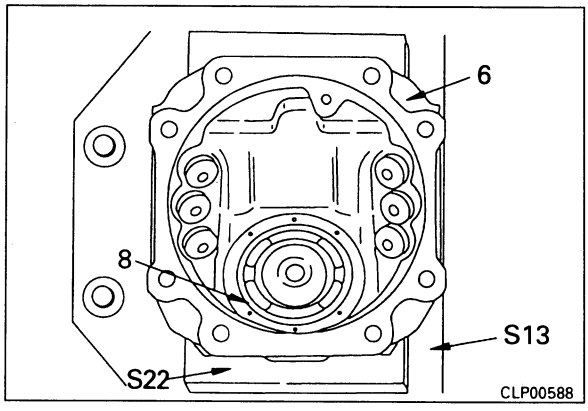
3) Using dial gauge ⑤, measure play of piston (14) in axial direction.
   - ★ Play of piston in axial direction: Max. 0.25 mm



9. Spring

1) Set housing (6) to tool **S13** together with tool **S22**, then adjust angle so that valve plate mounting surface is horizontal.

2) Install valve plate (8).

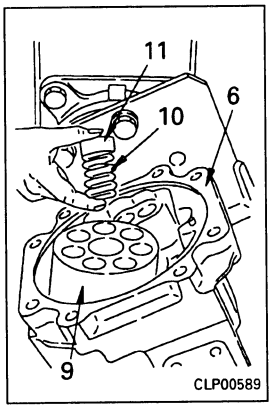


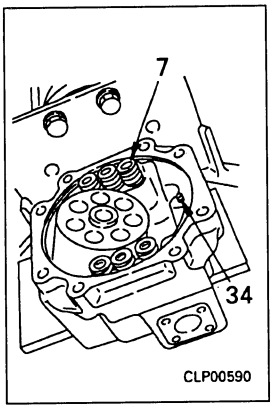
3) Assembly cylinder block (9) to housing (6).

4) Assemble spring (10) and center ring (11) to cylinder block.

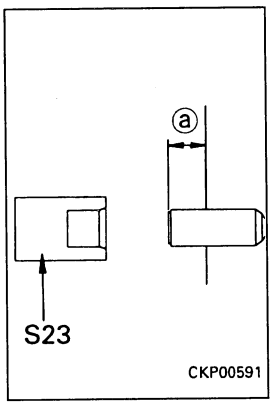
5) Install 6 springs (7) to housing.

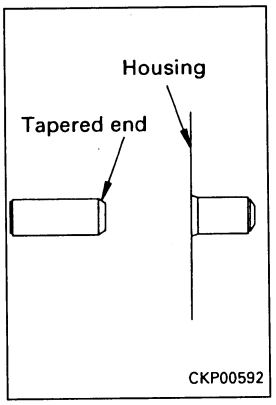
6) Press fit dowel pin (34).





★ Using tool **S23**, knock in the dowel pin so that dimension ⓐ is the standard value.
★ Standard dimension ⓐ : 8.0 - 10.0 mm
★ Assemble the tapered end to the hole in the housing.
★ Be careful not to damage the dowel pin and the brake piston.



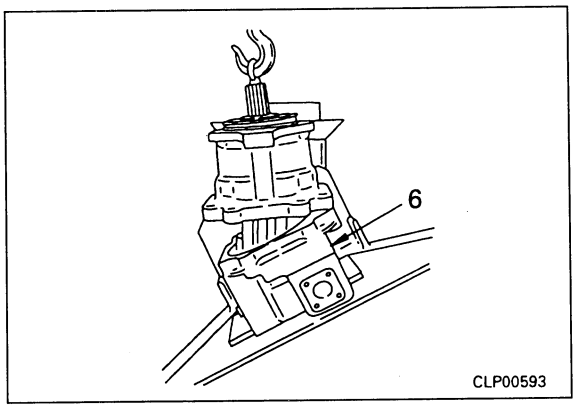


10. Raise motor case assembly, align with housing and lower slowly, align 7 center shaft pistons with holes in cylinder block, then install housing (6).

Mating surface of case:
Gasket sealant (LG5 of LG7)

★ Align the positions of the dowel pin and motor case exactly when installing.

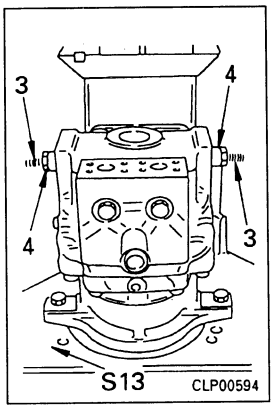
kgm Mounting bolt:
277.0 ± 31.9 Nm (28.25 ± 3.25 kgm)

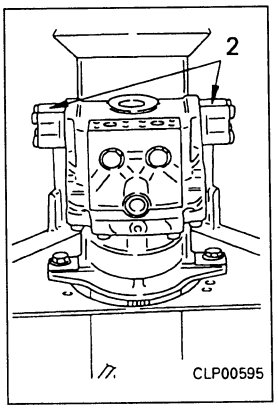


11. Set swing motor assembly to tool **S13**.

12. Install sleeves (4), springs (3), and covers (2).

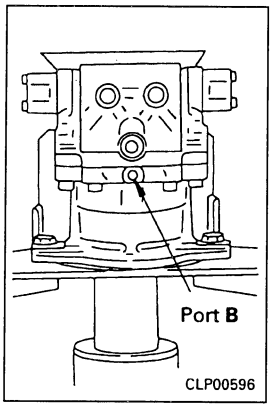
kgm Cover mounting bolt:
110.3 ± 12.3 Nm (11.25 ± 1.25 kgm)

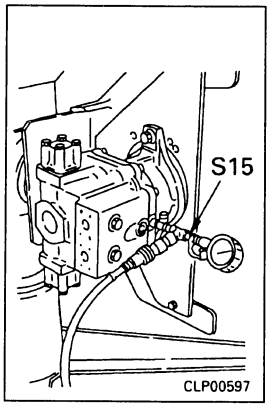




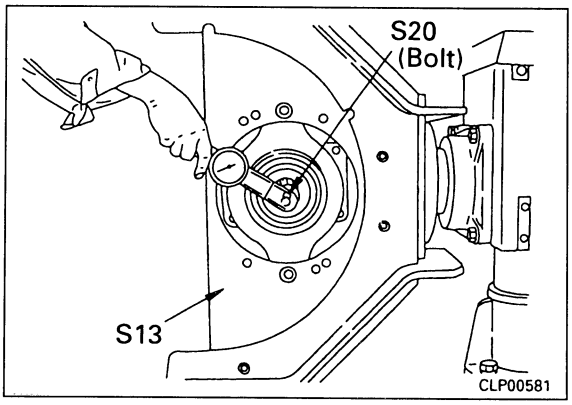
13. Checking drive shaft rotating torque

1) Using tool **S15**, apply pressure of at least 2.0 MPa (20 kg/cm²) through port B to release brake.





2) Set tool **S20** in position and check rotating torque.
   - ★ When checking the rotating torque, check that the shaft rotates smoothly without any variation.
     Variation range: Max. 1.5 Nm (0.15 kgm)
     Rotating torque:
     5.9 - 15.2 Nm (0.60 - 1.55 kgm)
   - ★ If it is not within the specified range, adjust again from Step 4.

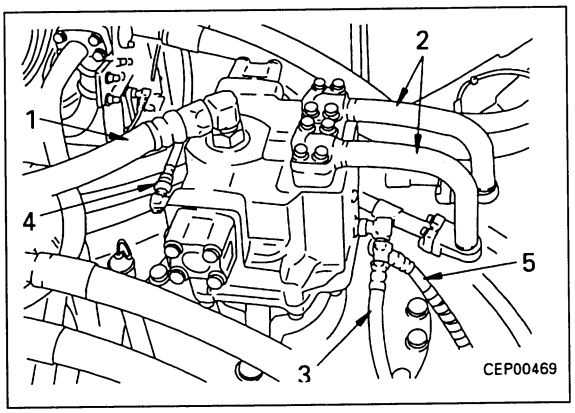


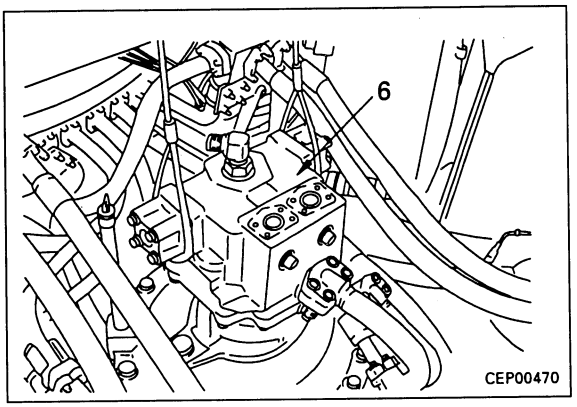
REMOVAL OF SWING MOTOR ASSEMBLY

⚠ Release the remaining pressure in the hydraulic circuit.
For details, see TESTING AND ADJUSTING, Releasing remaining pressure form hydraulic circuit.
⚠ Loosen the oil filler cap slowly to release the pressure inside the hydraulic tank.
★ Fit blind plugs in the disconnected hoses and tubes.
1. Disconnect suction hose (1).
2. Disconnect swing hoses (2).
3. disconnect drain hoses (3) and (4).
4. Disconnect swing holding brake hose (4).
5. Remove mounting bolts, and lift off swing motor assembly (6).

kg Swing motor assembly: **110 kg**

Disassembly and assembly of swing motor see page 30-94 and 30-98





INSTALLATION OF SWING MOTOR ASSEMBLY

- Carry out installation in the reverse order to removal.

- **Refilling with oil (hydraulic tank).**
  ★ Add oil through the oil filler to the specified level. Run the engine to circulate the oil through the system. Hen check the oil level again.

- **Bleeding air**
  ★ Bleed the air from the swing motor.
  For details, see TESTING AND ADJUSTING, Bleeding air.

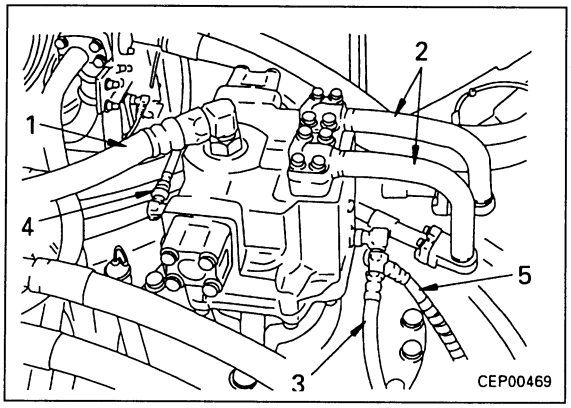
REMOVAL OF SWING MACHINERY ASSEMBLY

⚠ Release the remaining pressure in the hydraulic circuit.
For details, see TESTING AND ADJUSTING, Releasing remaining pressure form hydraulic circuit.

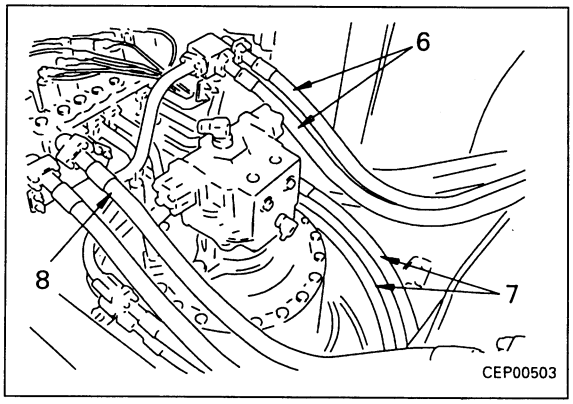
⚠ Loosen the oil filler cap slowly to release the pressure inside the hydraulic tank.

★ Fit blind plugs in the disconnected hoses and tubes to prevent oil from flowing out.

1. Remove step on top of control valve.
2. Disconnect suction hose (1), swing hose (2), drain hoses (3) and (4), and swing holding brake hose (5) connected to swing motor assembly.



3. Disconnect arm hose (6), and let it hang down.
4. Disconnect L.H. travel hose (7) at control valve end and move towards boom.
   ★ Secure it to the boom with rope.
5. Disconnect bucket cylinder hose (8) at control valve end.



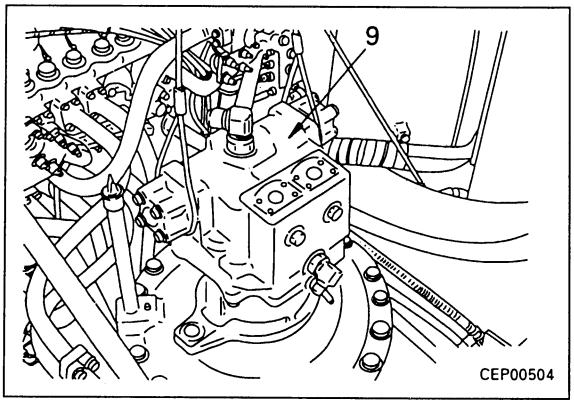
6. Lift off swing motor assembly (9).

   kg Swing motor assembly: **110 kg**

7. Lift off swing machinery assembly (10).

   kg Swing machinery assembly: **550 kg**

   • After removing the R.H. travel hose clamp mounting bracket, remove the swing machinery assembly.

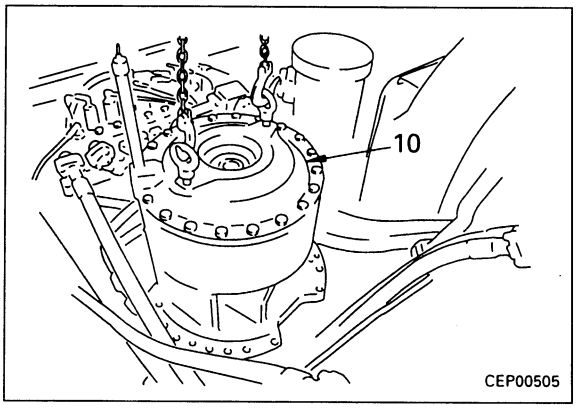


INSTALLATION OF SWING MACHINERY ASSEMBLY

• Carry out installation in the reverse order to removal.

※ 1

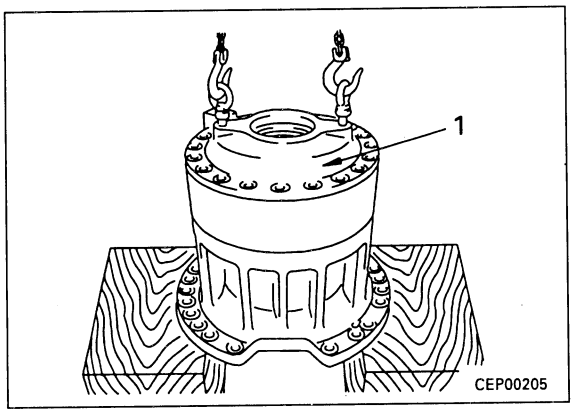
kgm Swing machinery case mounting bolt:
926.7 ± 103.0 Nm (94,5 ± 10.5 kgm)



DISASSEMBLY OF SWING MACHINERY ASSEMLBLY

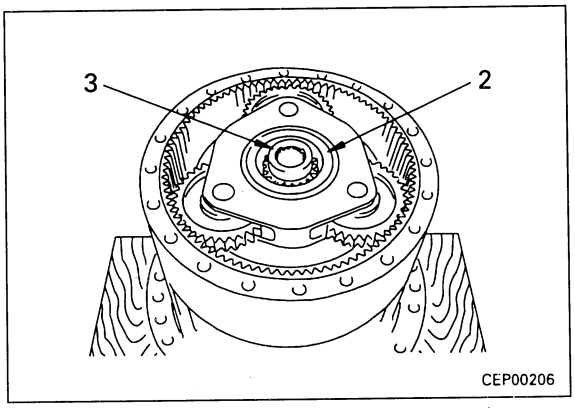
1. **Draining oil**
   Loosen drain plug and drain oil from swing machinery.

   Swing machinery case: Approx. **21.5** ℓ

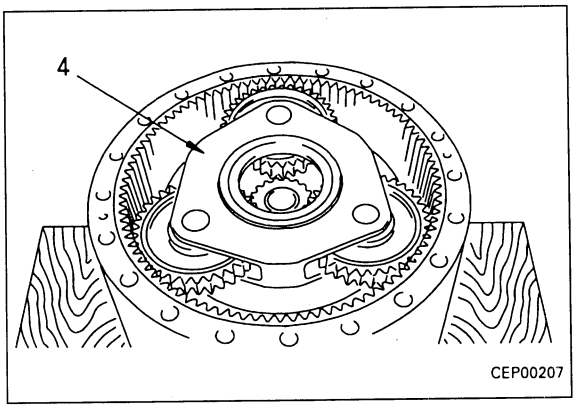


2. **Cover**
   Remove mounting bolts, then lift off cover (1).

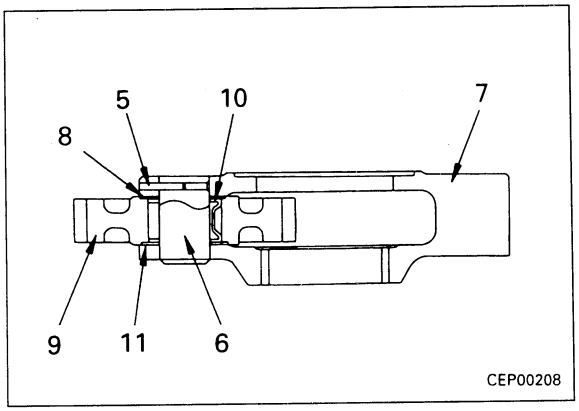
3. **No. 1 carrier assembly.**
   1) Remove thrust washer (2).
   2) Remove No. 1 sun gear (3).



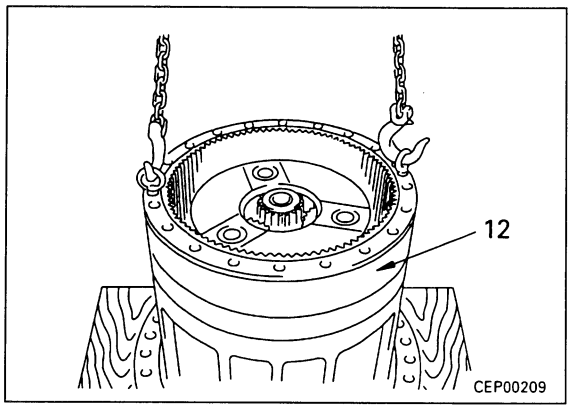
   3) Remove No. 1 carrier assembly (4).



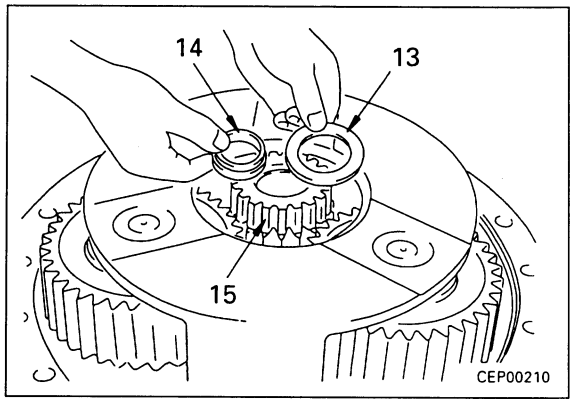
4. Disassemble No. 1 carrier assembly as follows.
   1) Push in pin (5), and knock out shaft (6) from carrier (7).
      ★ After removing the shaft, remove pin (5).
   2) Remove thrust washer (8), gear (9), bearing (10), and thrust washer (11).



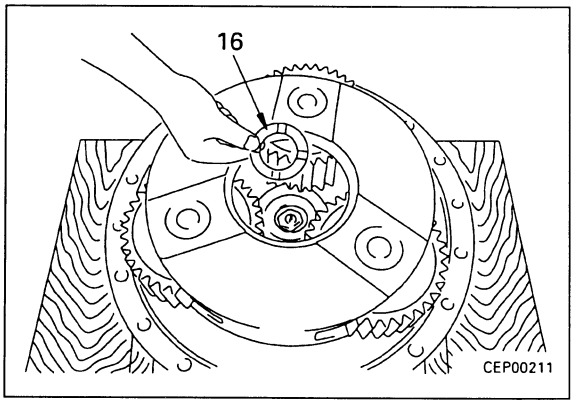
5. **Ring gear**
   Lift off ring gear (12).



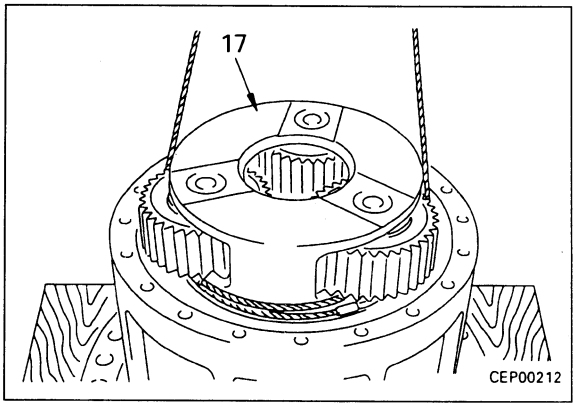
6. **No. 1 sun gear**
   1) Remove thrust washer (13) and collar (14).
   2) Remove No. 1 sun (15).



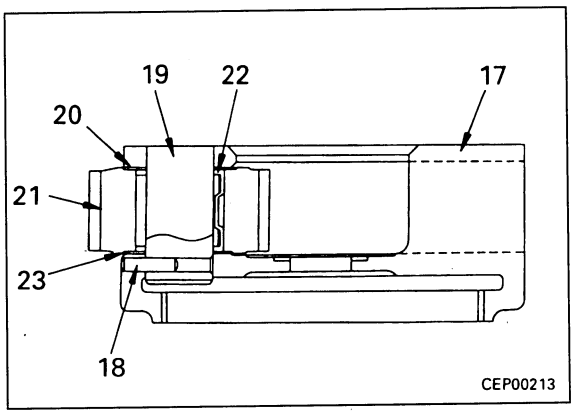
   3) Remove thrust washer (16).



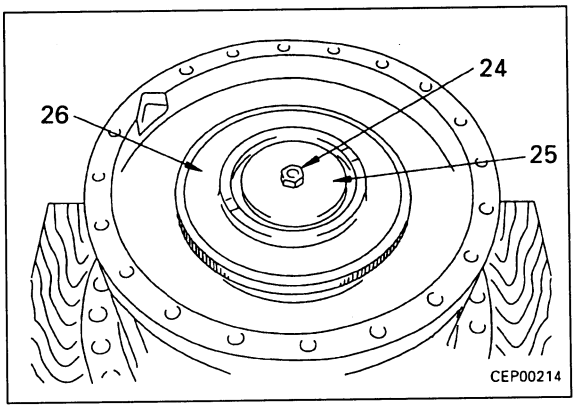
7. **No. 2 carrier assembly**
   Lift off No. 2 carrier assembly (17).



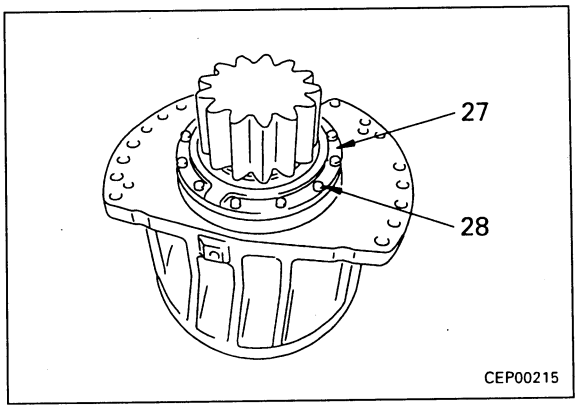
8. Disassemble No. 2 carrier assembly as follows.
   1) Push in pin (18), and knock out shaft (19) from carrier (17).
      ★ After removing the shaft, remove pin (18).
   2) Remove thrust washer (20), gear (21), bearing (22), and thrust washer (23).



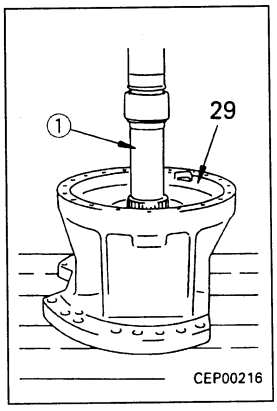
9. **Pinion shaft assembly.**
   1) Remove bolt (24), then remove holder 25).
   2) Remove gear (26).

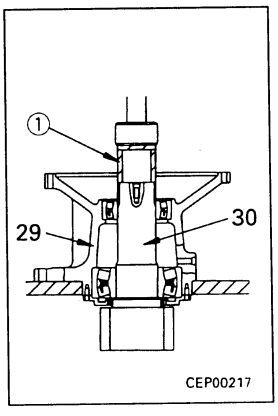


   3) Turn over case and pinion assembly, then remove mounting bolts (28) of cover assembly (27).

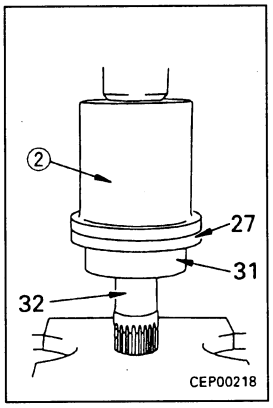


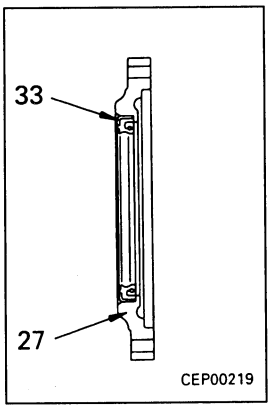
   4) Turn over case and pinion assembly (29), and set on press stand, then using push tool ①, remove pinion shaft assembly (30) with press.
      ★ Set a wooden block under the press, and be careful not to damage the pinion shaft assembly when removing it.



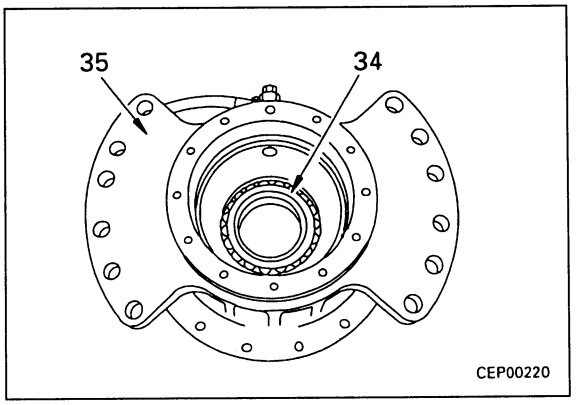


10. Disassemble pinion shaft assembly as follows.
    1) Using push tool ②, remove cover assembly (270 and bearing (31) from shaft (32).
    2) Remove oil seal (33) from cover (27).





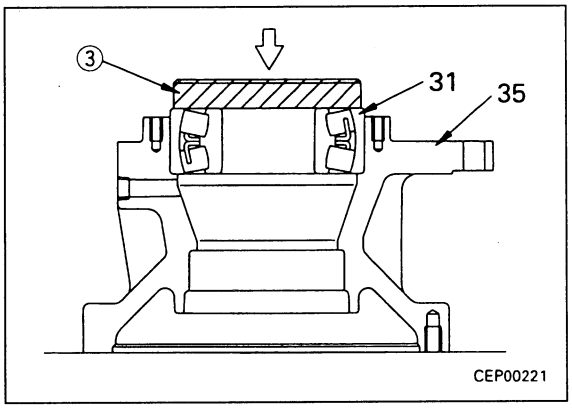
11. Bearing
Using push tool, remove bearing (34) from case (35).



ASSEMBLY OF SWING MACHINERY ASSEMBLY

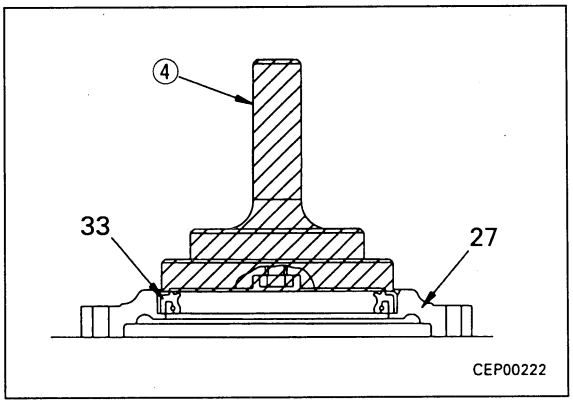
★ Clean all parts, and check for dirt or damage.
Coat the sliding surfaces of all parts with engine oil before installing.

1. Bearing
Using push tool ③, press fit bearing (31) to case (35).

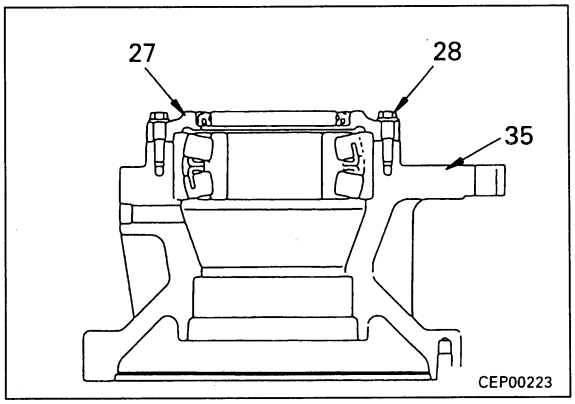


2. Cover assembly

1) Using push tool ④, press fit oil seal (33) to cover (27).
Outside cirucimference of oil seal: **Gasket sealant (LG-6)**
★ Be careful not to let the gasket sealant (LG-6) get on the oil seal lip when press fitting.

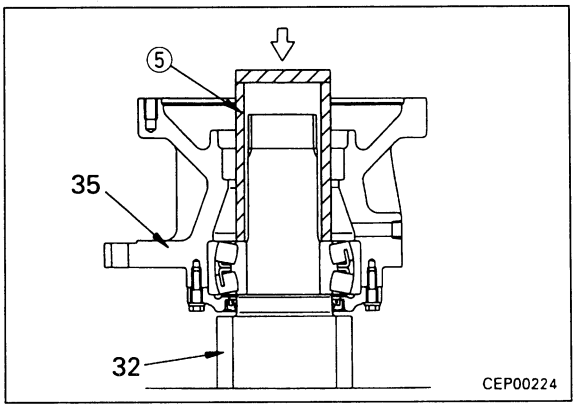


2) Fit cover assembly (27) to case (35), and tighten mounting bolts (28).
Cover mounting surface: **Gasket sealant (LG-6)**
kgm Mounting bolt: **66.19 ± 7.35 Nm (6.75 ± 0.75 kgm)**
Lip of oil seal: **Grease (G2-LI)**

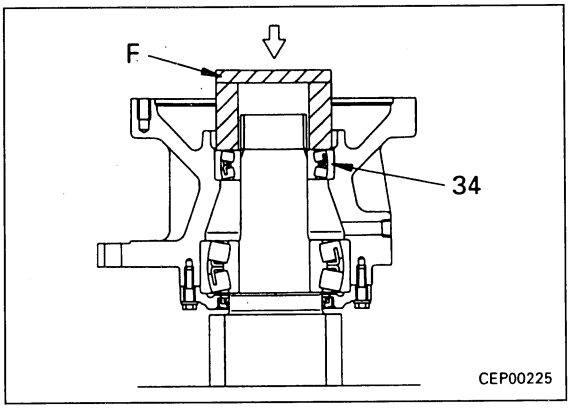


3. Case assembly

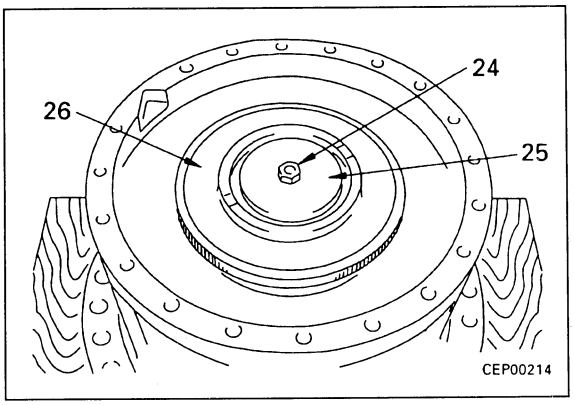
1) Set case assembly (35) to shaft 932), then using push tool ⑤, press fit bearing inner race portion.
★ When setting the case assembly to the shaft, be extremely careful not to damage the oil seal.



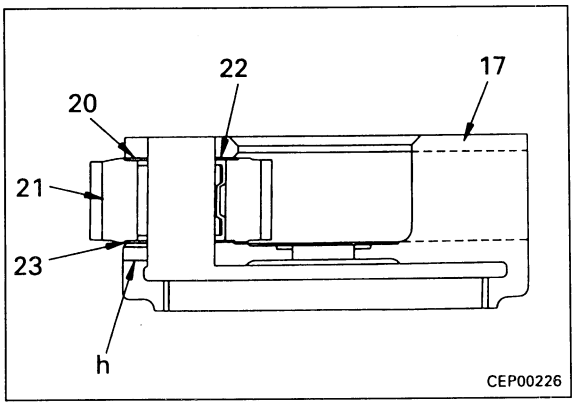
2) Bearing
Using tool **F**, press fit bearing (34).
★ Press the bearing inner race and outer race at the same time when press fitting. Do not press only the inner race when press fitting.
★ After press fitting the bearing, check that the case rotates smoothly.



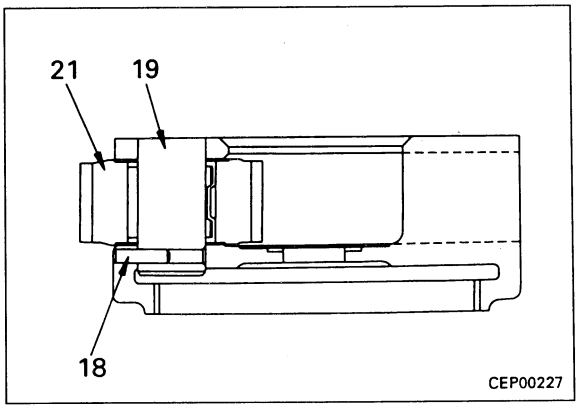
3) Gear, holder
Assemble gear (26), then fit holder (25) and tighten bolt (24).
Mounting bolt:
Thread tightenere (LT-2)
kgm Mounting bolt:
380.00 ± 46.58 Nm (38.75 ± 4.75 kgm)



4. Assemble No. 2 carrier assembly as follows
★ There are the remain of the caulking when the pin is inserted at the end face of hole h at the side of the carrier, so remove the caulked metal from the inside diameter of the hole before starting to assemble.
1) Assemble bearing (22) to gear (21), fit top and bottom thrust washers (23) and (20) and set gear assembly to carrier (17).

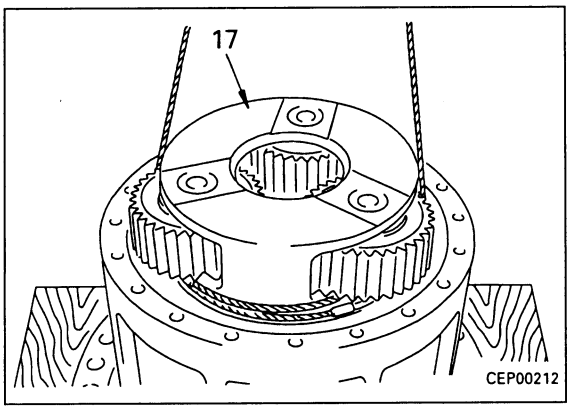


2) Align with position of pin holes of shaft and carrier, then tap with a plastic hammer to install shaft (19).
★ When installing the shaft, rotate the planetary gear, and be careful not to damage the thrust washer.
3) Insert pin (18).
★ After insering the pin, caulk the pin portion of the carrier.
★ After assembling the carrier assebmly, check that gear (21) rotates smoothly.



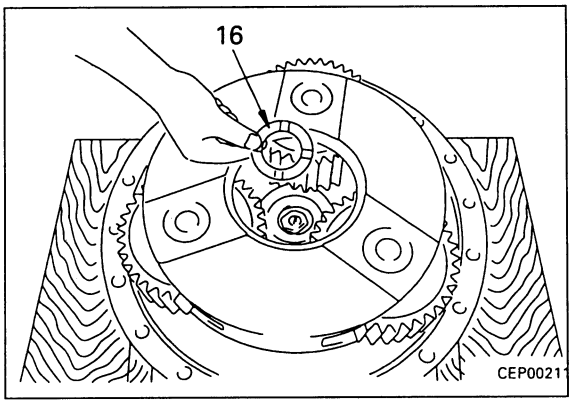
5. No. 2 carrier assembly

Raise No. 2 carrier assembly (17) and install.

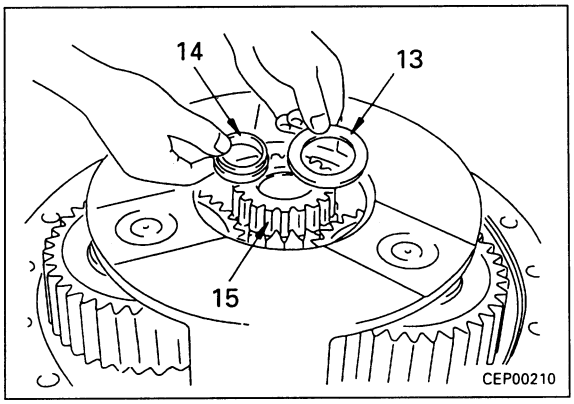


6. No. 2 sun gear

1) Assemble thrust washer (16).



2) Install No. 2 sun gear (15) to No. 2 carrier, then install collar (14) and thrust washer (13).

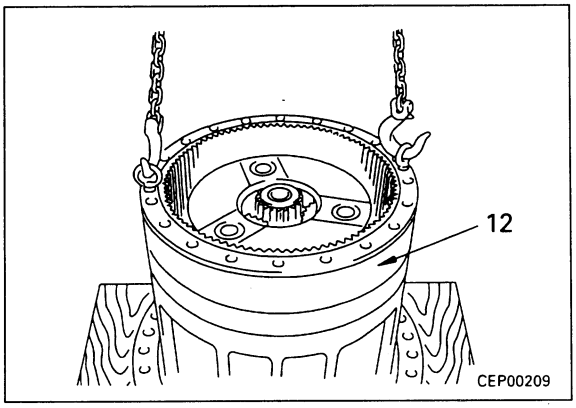


7. Ring gear

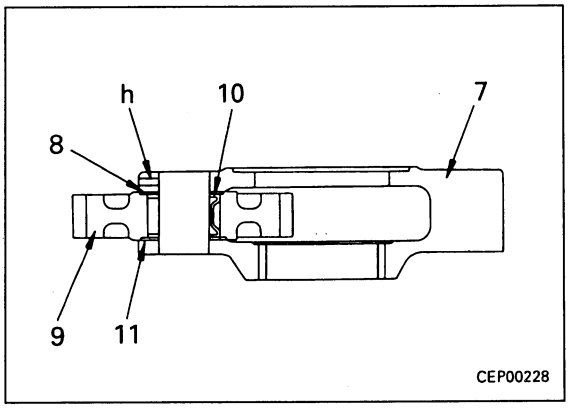
Raise ring gear (12) and install

★ Align with the drain hole and assemble.

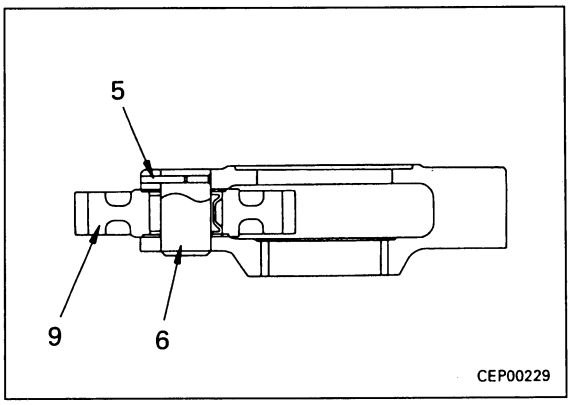
Mating surface of ring gear and case:
Gasket sealant (LG-6)



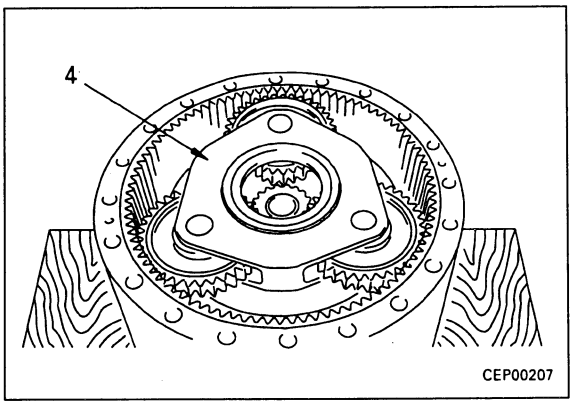
8. Assemble No. 1 carrier assembly as follows.
   ★ There are the remains of the caulking when the pin is inserted at the end face of hole h at the side of the carrier, so remvoe the caulked metal from the inside diameter of the hole before starting to assemble.
   1) Assemble bearing (10) to gear (9), fit top and bottom thrust washers 98) and (11) and set gear assembly to carrier (7).



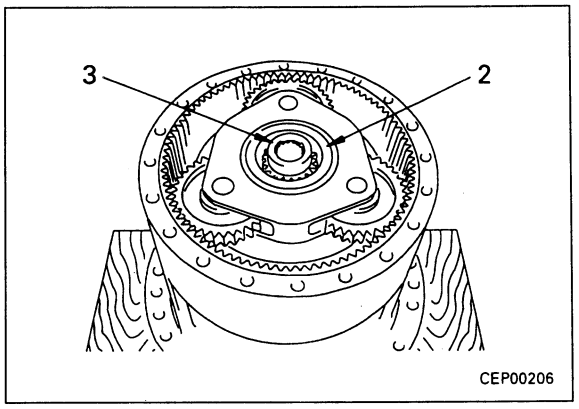
   2) Align position of pin holes of shaft and carreir, then tap with a plastic hammer to install shaft (6).
      ★ When installing the shaft, rotate the planetary fear, and be careful not to damage the thrust washer.
   3) Insert pin (5).
      ★ After insering the pin, caulk the pin portion of the carrier.
      ★ After assembling the carrier assembly, check that gear (9) rotates smoothly.



9. **No. 1 carrier assembly**
   Install No. 1 carrier assembly (4).



10. **No. 1 sun gear**
   1) Assemble No. 1 sun gear (3) to carrier assembly.
   2) Install thrust washer (2).

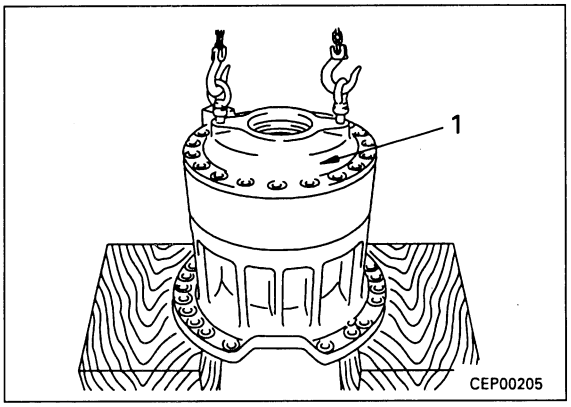


11. Cover

Install cover (1).

Cover mounting surface: **Gasket sealant (LG-6)**

Mounting bolt 1st pass: **98 Nm (10 kgm)**
2nd pass: **120 ± 5°**



12. Refilling with oil

Tighten drain plug and add engine oil through oil filler.

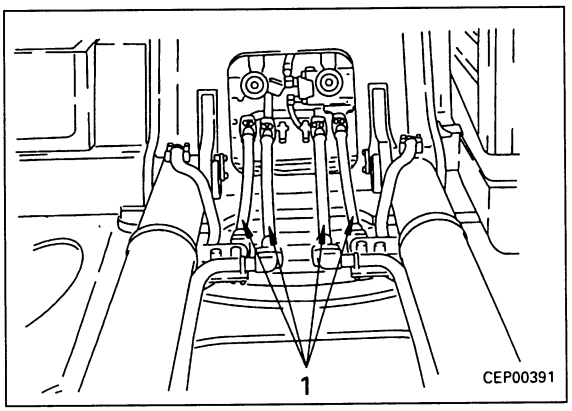
Swing machinery case: Approx. **21.5** ℓ

REMOVAL OF REVOLVING FRAME ASSEMBERLY

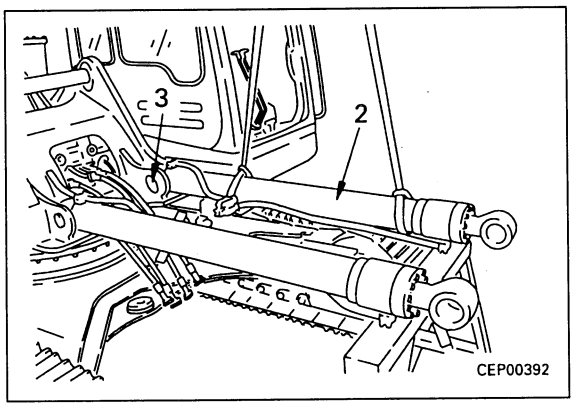
1. Remove work equipment assembly.
   For details, see REMOVAL OF WORK EQUIPMENT ASSEMBLY.

⚠ When disconnecting then hydraulic hoses, release the remaining pressure in the hydraulic circuit.
For details, see TESTING AND ADJUSTING, Releasing remaining pressure form hydraulic circuit.

2. Disconnect boom cylinder hoses (1).
   ★ Fit blind plugs in the hoses and make it possible to swing the upper structure.

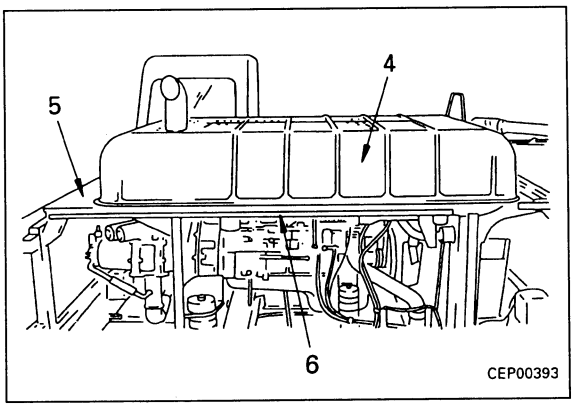


3. Raise boom cylinder assembly (2), then pull out foot pin (3) and lift off.
   ★ Remove the right cylinder assembly in the same way.
   kg Boom cylinder assembly: **410 kg**



4. Remove coutnerweight assembly.
   For details, see REMOVAL OF COUTERWEIGHT ASSEMBLY.

5. Remvoe engine hood (4), cover (5), and frame (6).
   ★ For details of the method of removing the engine hood, see REMOVAL OF HYDRAULIC COOLER ASSEMBLY.

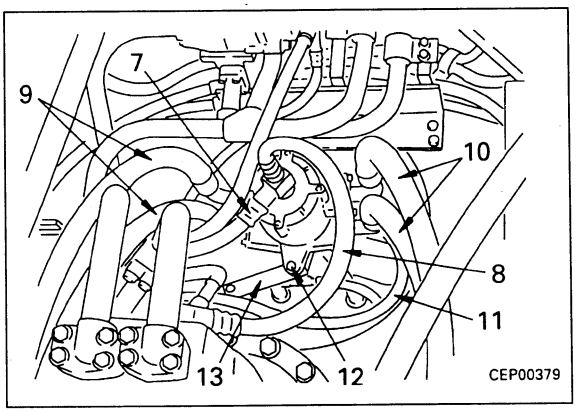


6. Leave 3 mounting bolts each at front and rear of revolving frame, and remvoe other mounting bolts.
   ★ Swing the upper structure and set to a position where it ist easy to remove the mounting bolts.

7. Disconnect drain hoses (7) and (8).
   ★ Install blind plugs in the drain hoses.

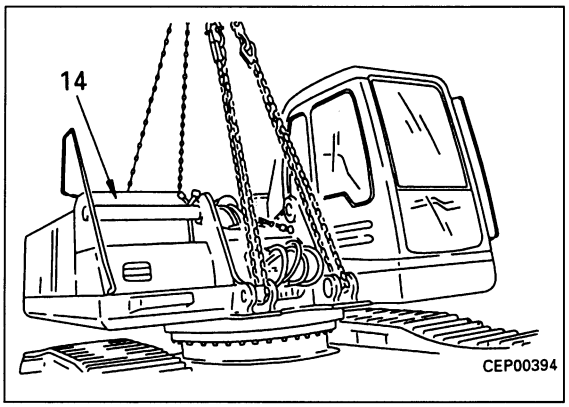
8. Disconnect travel hoses (9) and (10), and speed selector hose (11).

9. Pull out pin (12), and disconnect plate (13) from swivel joint.



10. Sling revolving frame assembly (14), then remove mounting bolts, and lift off revolving frame assembly.
    - ★ Use 2 lever blocks.
    - ★ Loosen the mounting bolts remaining at the front and rear and adjust the center of gravity with the lever ablock while lifting off.

    kg Revolving frame assembly: **10,000 kg**

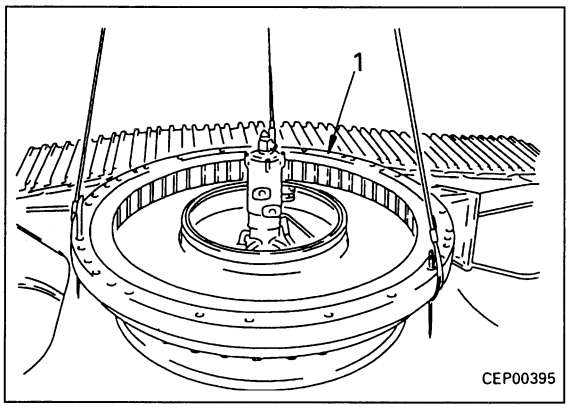


INSTALLATION OF REVOLVING FRAME ASSEMBLY

- Carry out installation in the reverse order to removal.

※ 1
Mating surface of swing circle:
Gasket sealant (LG-4)
Tread of revolving frame mounting bolt:
Thread tightener (LT-2)
kgm Revolving frame mounting bolt:
926.7 ± 103.0 Nm (94.5 ± 10.5 kgm)

REMOVAL OF SWING CIRCLE ASSEMBLY

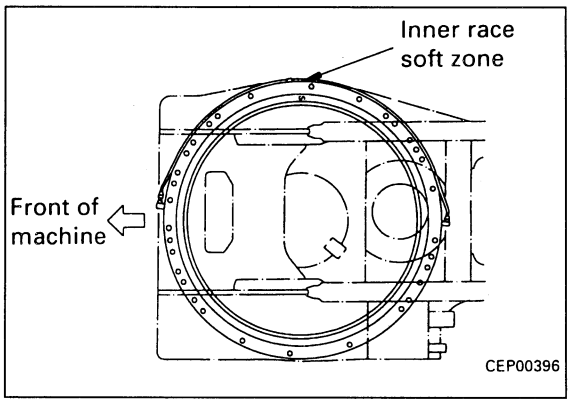


1. Remove revolving frame assembly.
   For details, see REMOVAL OF REVOLVING FRAME ASSEMBLY.

2. Sling swing circle assembly (1) at three points, then remove mounting bolts, and lift off swing circle asssembly.

   kg Swing cicle assembly: **600 kg**

INSTALLATION OF SWING CIRCLE ASSEMBLEY



- Carry out installation in the reverse order to removal.

※ 1

Thread of swing circle mounting bolt:
Thread tightener (LT-2)

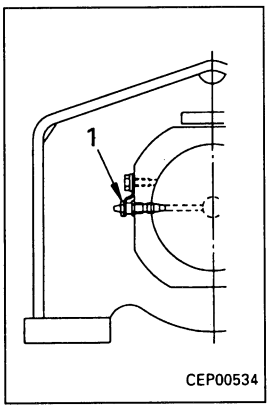
kgm Swing circle mounting bolt:
926.7 ± 103. 0 Nm 994.5 ± 10.5 kgm)

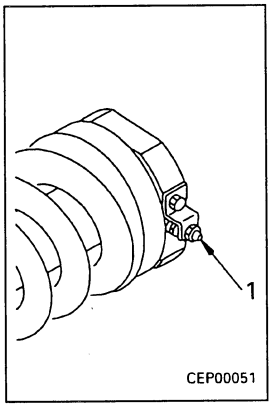
★ Set the soft zone S mark on the inside ring of the inner race facing the right side of the machine as shown in the diagram, then install to the track frame.

Swing circle: **Grease (G2-LI) 35**

REMOVAL OF IDLER, RECOIL SPRING ASSEMBLY

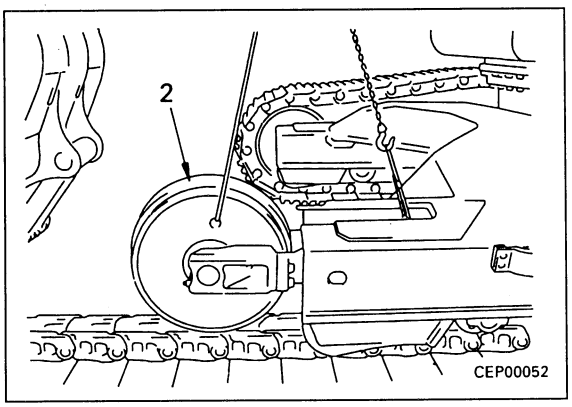
1. Remove track shoe assembly.
   For details, see REMOVAL OF TRACK SHOE ASSEMBLY.
   ★ Remove lubricator (1).





2. Sling idler and recoil spring assembly (2), and pull out to the front to remove.
   ★ Fit wire to the idler and spring of the idler and recoil spring assembly, and adjust the balance when removing.

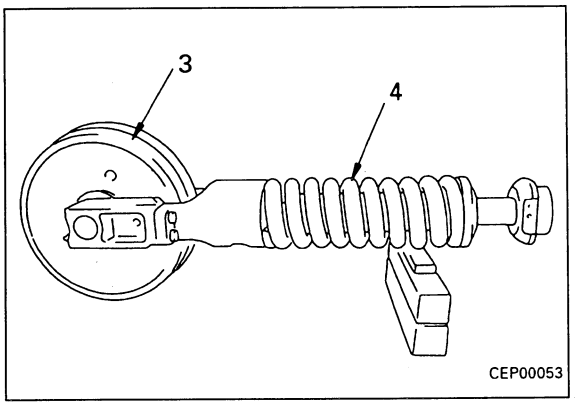
   kg Idler, recoil spring assembly: **650 kg**



3. Disconnect recoil spring assembly (4) from idler assembly (3).

   kg Idler assembly: **272 kg**

   kg Recoil spring assembly: **370 kg**



INSTALLATION OF IDLER, RECOIL SPRING ASSEMBLY

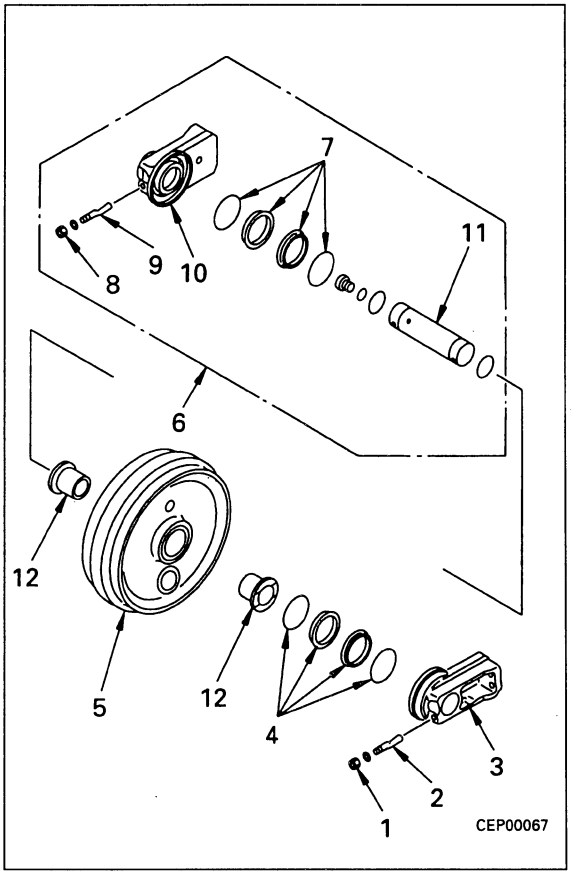
- Carry out installation in the reverse order to removal.

※ 1

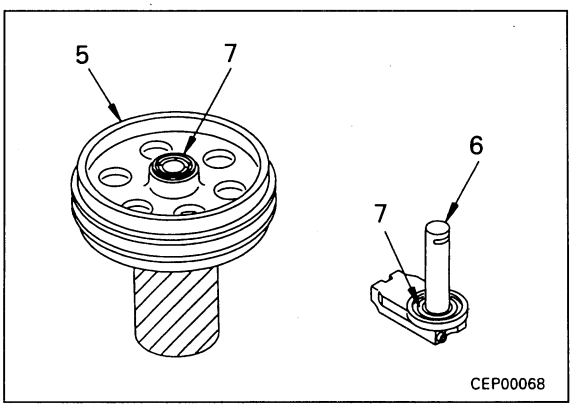
★ When installing the idler assembly and recoil spring assembly, assembly so that the position of the greasing plug on the idler is on the outside for the right side of the machine and on the inside for the left side of the machine.

DISASSEMBLY OF IDLER

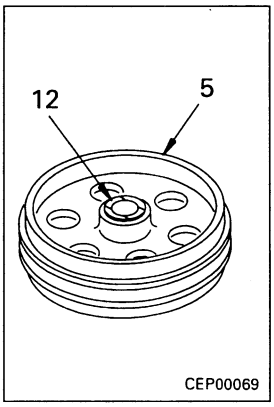
1. Remove nut (1), pull out bolt (2), then remove support (3).
2. Remove floating seal (4) from support (3) and idler (5).
3. Pull out shaft and support assembly 96) from idler (5).
   ★ It is filled with approx. 345 cc. of oil, so drain the oil at this point or lay a cloth to prevent the area from becoming dirty.

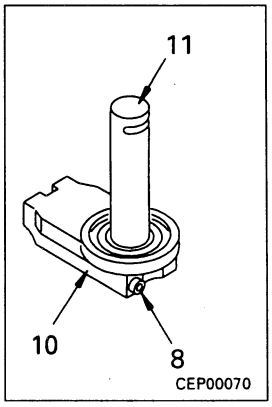


4. Remove floating seal (7) on opposite side from idler (5) and shaft and support assembly (6).



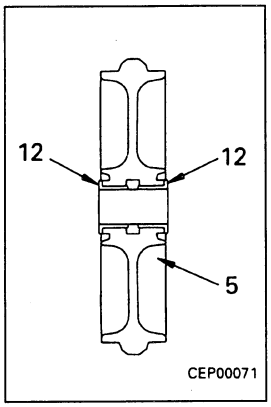
5. Remove nut (8), pull out bolt (9), then remove support (10) from shaft (11).
6. Remove bushing (12) from idler (5).
   ★ Turn over the idler and remove the bushing on the opposite side.



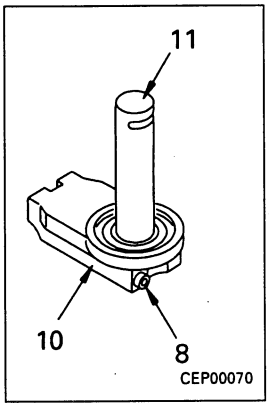


ASSEMBLY OF IDLER

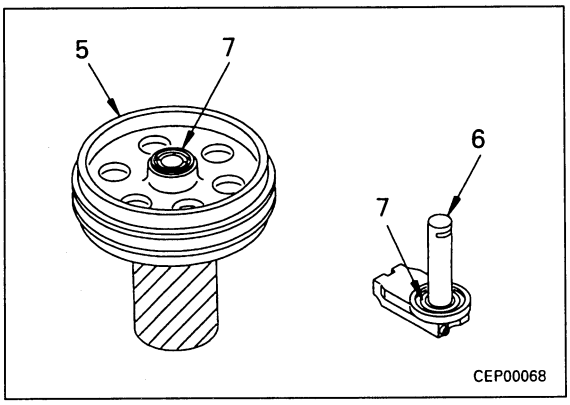
1. Press fit bushing (12) to idler (5) with press.

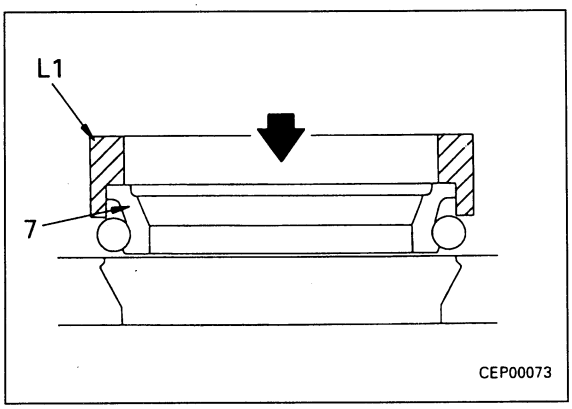


2. Fit O-ring and install support (10) to shaft (11), then install bolt (9) and tighten with nut (8).

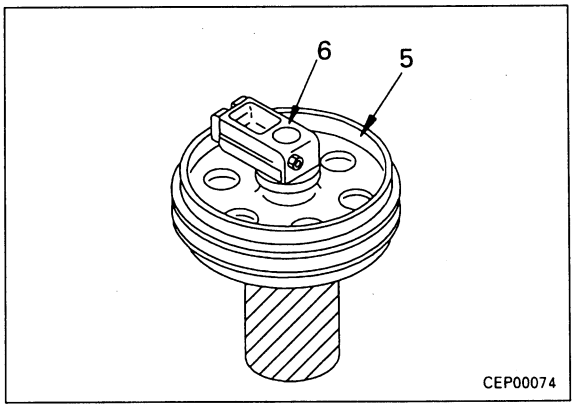


3. Using tool **L1**, install floating seal (7) to idler (5) and shaft and support assembly (6).
   - ★ Coat the sliding surface of the floating seal with oil, and be careful not to let any dirt or dust get stuck to it.
   - ★ Remove all grease and oil from the contact surface of the O-ring and the floating seal.

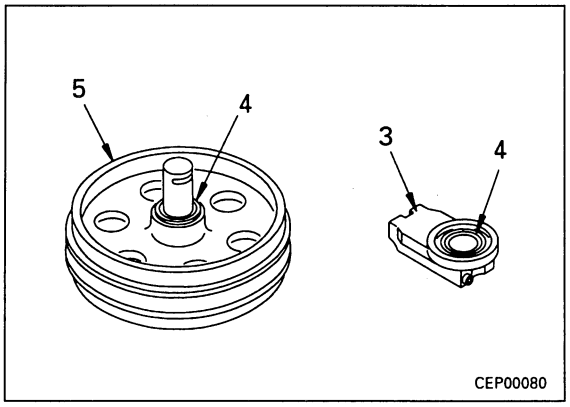


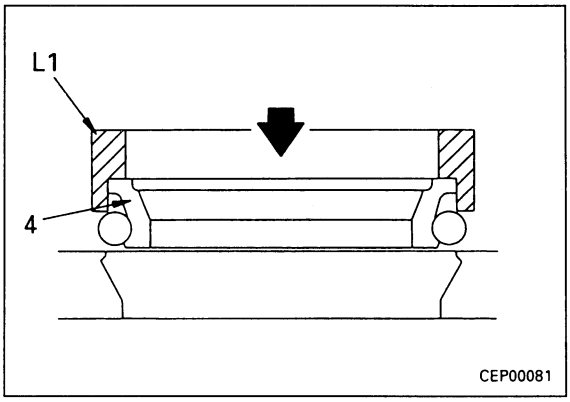


4. Assemble shaft and support assembly (6) to idler (5).



5. Using tool L1, install floating seal (4) to idler (5) and support (3).
   ★ Coat the sliding surface of the floating seal with oil, and be careful not to let any dirt or dust get stuck to it.
   ★ Remove all grease and oil from the contact surface of the O-ring and the floating seal.



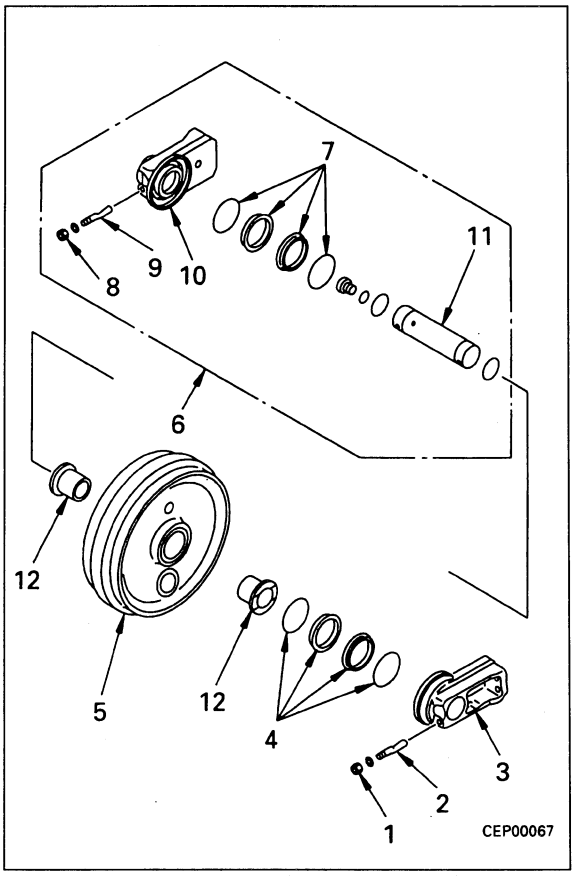


6. Fit O-ring and assemble support (3), then install bolt (2) and tighten nut (1).

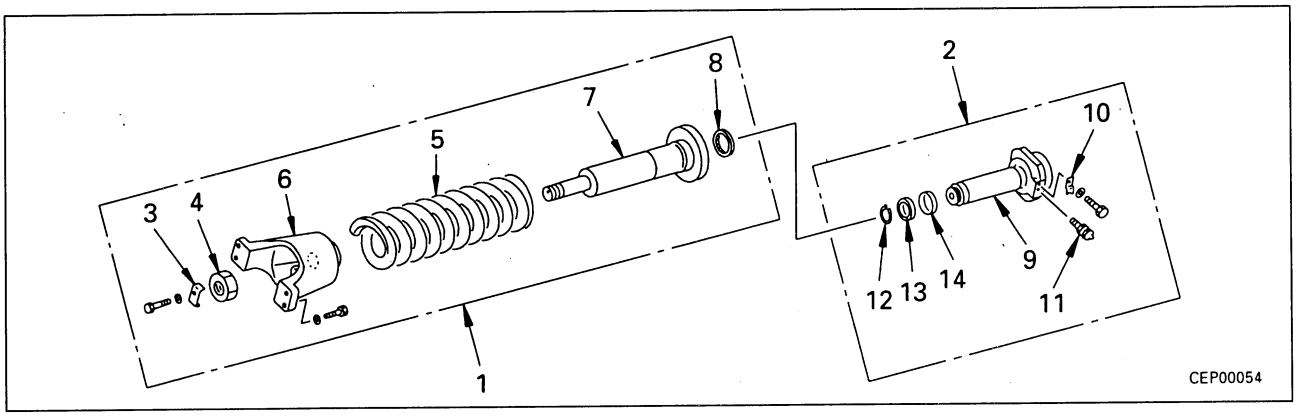
7. Add oil and tighten plug.

   Oil: Approx. **345 cc (EO30-CD)**

   kgm Plug: **152.0 ± Nm (15.5 ± 2.5 kgm)**



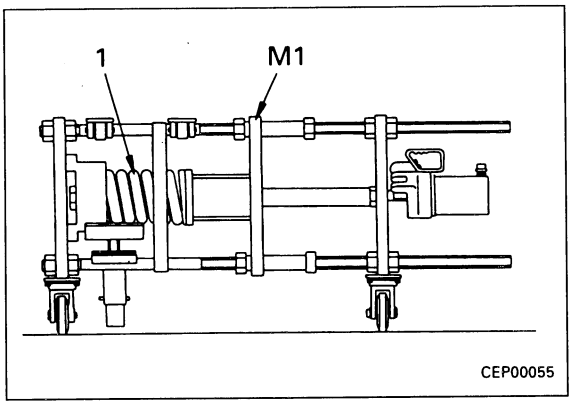
DISASSEMBLY OF RECOIL SPRING ASSEMBLY



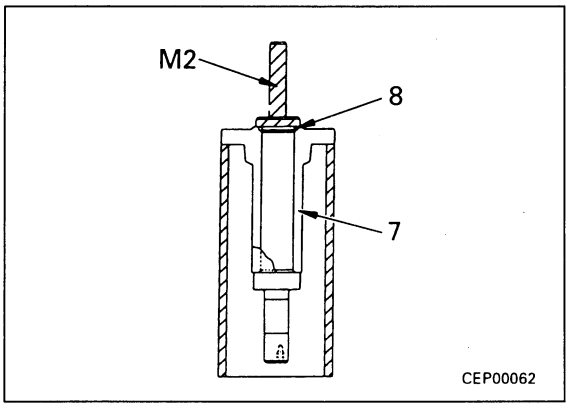
1. Remove piston assembly (2) from recoil spring assembly (1).

2. **Disassembly of recoil spring assembly**
   1) Set tool **M1** to recoil spring assembly (1).
      ⚠ The recoil spring is under large installed load, so be sure to set the tool properly. Failure to do this is dangerous.
      ★ Installed load of spring: 238.9 kN (24,375 kg)
   2) Apply hydraulic pressure slowly to compress spring, then remove lock plate (3), and remove nut (4).
      ★ Compress the spring to a point where the nut becomes loose.
      ★ Free length of spring: 857 mm
   3) Remove yoke (6), cylinder (7), and dust seal (8) from spring (5).

4. **Disassembly of piston assembly**
   1) Remove lock plate (10) from piston (9), then remove valve (11).
   2) Remove snap ring (12), then remove U-packing (13) and ring (14).



ASSEMBLY OF RECOIL SPRING ASSEMBLY



1. Assembly of piston assembly

1) Assemble ring (14) and U-packing (13) to piston (9), and secure with snap ring (12).

2) Tighten valve (11) temporarily, and secure with lock plate (10).

2. Assembly of recoil spring assembly

1) Using tool **M2**, assemble dust seal (8) to cylinder (7).

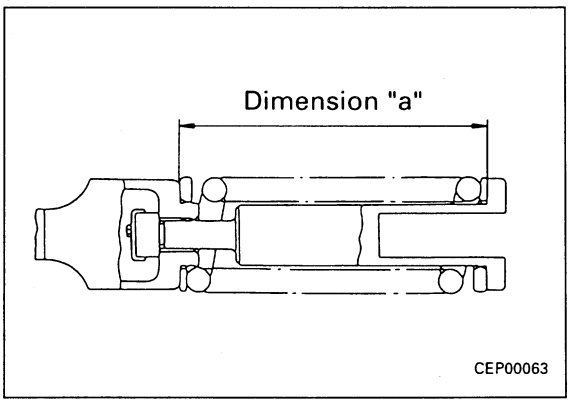
2) Assemble cylinder (7) and yoke (6) to spring (5), and set in tool **M1**.

Sliding portion of cylinder:
Grease (G2-LI)

3) Apply hydraulic pressure slowly to compress spring, and tighten nut (4) so that installed length of spring is dimension "**a**", then secure with lock plate (3)

★ Installed length "**a**" of spring: 707 mm

4) Remove recoil spring assembly (1) from tool **M1**.



3. Assemble piston assembly (2) to recoil spring assembly (1).

Piston sliding portion and wear ring:
Grease (G2-LI)

★ Assemble the cylinder assembly so that the mounting position of the valve is 90° to the side.

★ Fil the inside of the cylinder with approx. 200 cc of greace (G2-LI), then bleed the air and check that grease comes out of the grease hole.

REMOVAL OF TRACK ROLLER ASSEMBLY

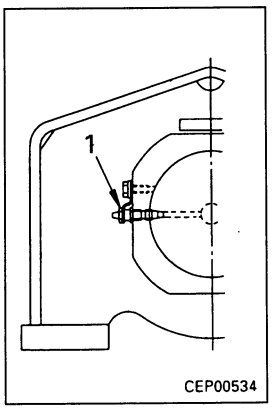
1. Lower work equipment to ground, then loosen lubricator (1), and relieve track tension. ※ 1
   ⚠ The adjustment cylinder is under extremely high pressure, so never loosen the lubricator more than one turn. If the grease does not come out easily, move the machine backwards and forwards.

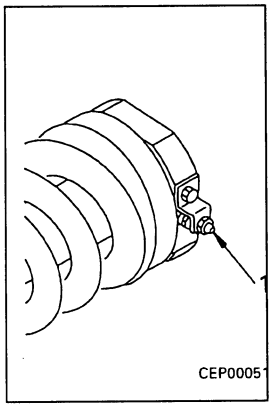
2. Remove mounting bolts of track roller quard (2), then swing work equipment 90°, jack up machine with work equipment, and remove track roller guard (2) towards outside of machine. ※ 2

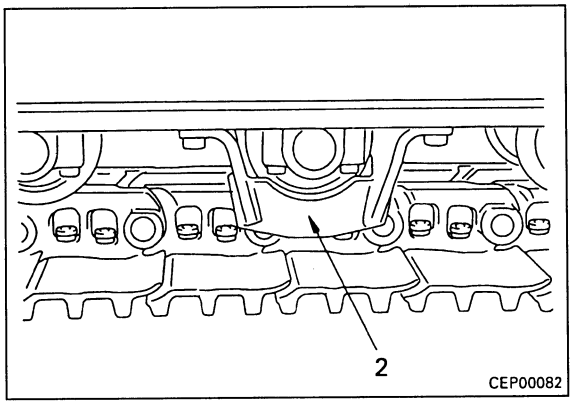
   kg Track roller guard: **45 kg**

3. Lower chassis completely, remove mounting bolts of track roller assembly (3), then jack up machine with work equipment, and remove track roller assembly (3) to outside of machine. ※ 3

   kg Track roller assembly: **75 kg**







INSTALLATION OF TRACK ROLLER ASSEMBLY

- Carry out installation in the reverse order to removal.

※ 1

★ Adjust the track tension.
For details, see TESTING AND ADJUSTING, Testing and adjusting track tension.

※ 2

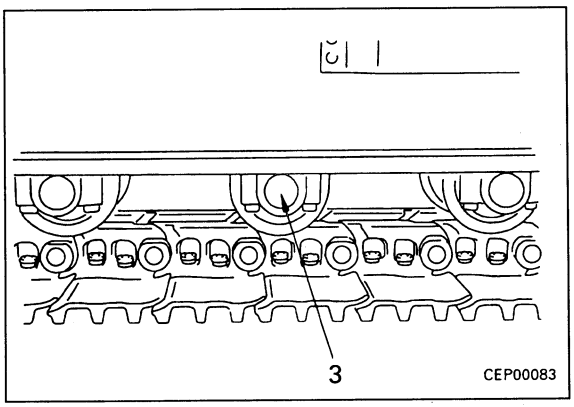
Roller guard mounting bolt:
Thread tightener (LT-2)

kgm Roller guard mounting bolt:
926.7 ± 103.0 Nm (94.5 ± 10.5 kgm)

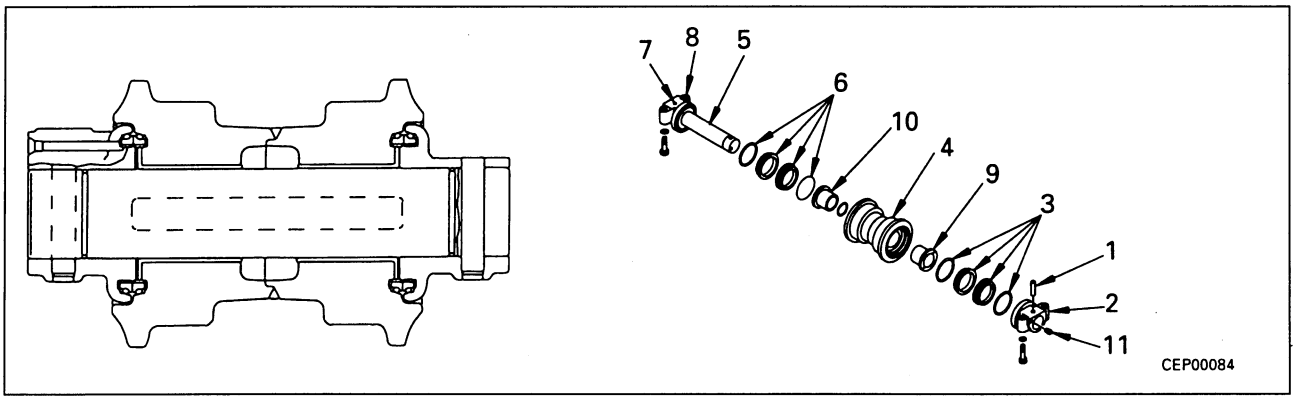
※ 3

Track roller mounting bolt:
Thread tightener (LT-2)

kgm Track roller mounting bolt:
1st pass: 196.1 ± 19.6 Nm (20 ± 2 kgm)
2nd pass: Tighten an additional 105 ± 5°



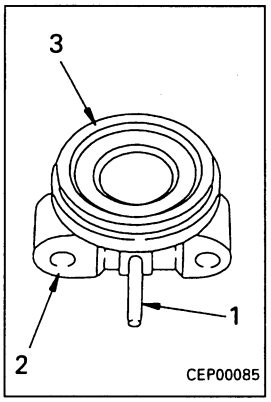
DISASSEMBLY OF TRACK ROLLER ASSEMBLY

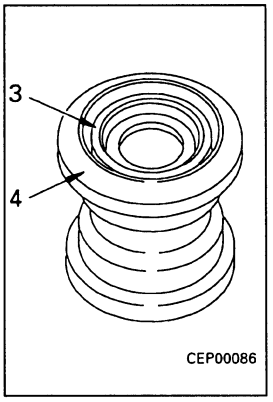


1. Remove pin (1), then remove collar (2).

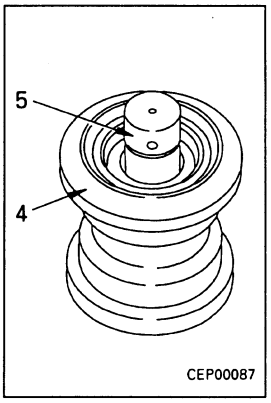
2. Remove floating seal (3) from collar (2) and rollar (4).

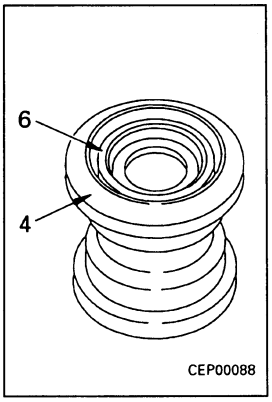
3. Pull out roller (4) from shaft (5).
   ★ It is filled with 280 - 310 cc. of oil, so drain the oil at this point or lay a cloth to prevent the area from becoming dirty.





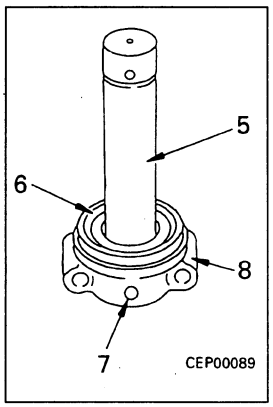
4. Remove flaoting seal (6) on opposite side from roller (4) and collar (8).

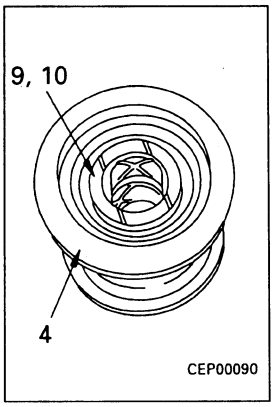




5. Remove pin (7), then remove collar (8) from shaft (5).

6 Remove bushings (9) and (10) from roller (4).



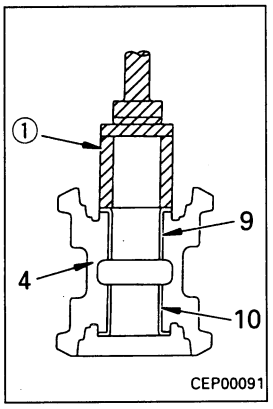


ASSEMBLY OF TRACK ROLLER ASSEMBLY

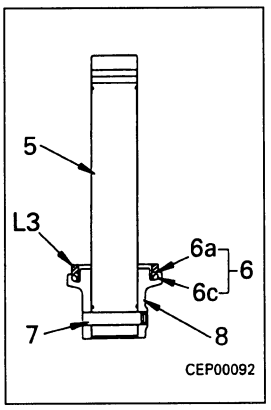
1. Using push tool ①, press fit bushings (9) and (10) to roller (4).

2. Assemble collar (8) to shaft (5), and install pin (7).

3. Using tool **L3**, install floating seal (6) to shaft (5).
   - ★ When assembling the floating seal, clean the contact surface of O-ring (6c) and floating seal (6a), remove all grease and oil, and dry it. Make sure that no dirt or dust sticks to the contact surface of the floating seal.
   - ★ After inserting the floating seal, check that the angle of the seal is less than 1 mm and that the protrussion of the seal is within a range of 5 - 7 mm.



CEP00091



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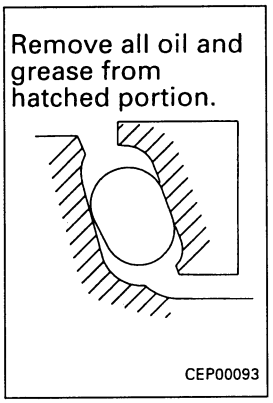

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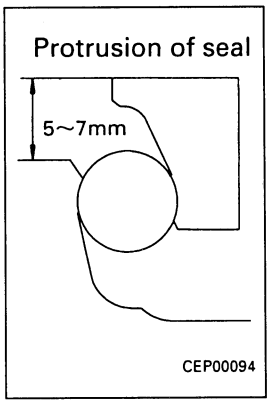
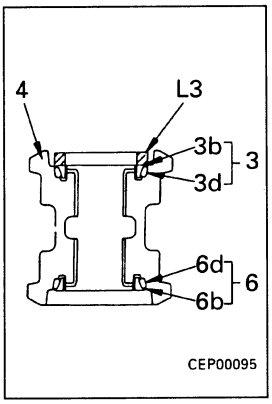


CEP00094

4. Using tool **L3**, install floating seals (6) and (3) to roller (4).
   - ★ For details of the precautions when installing floating seals (6b) and (6d), and (3b) and (3d), see the precautions marked ★ for Step 3.

5. Assemble shaft (5) to roller (4).



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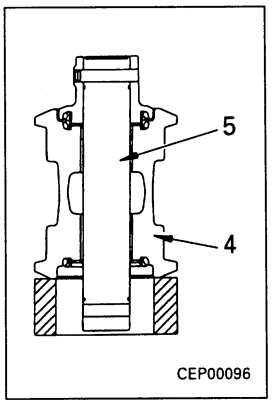
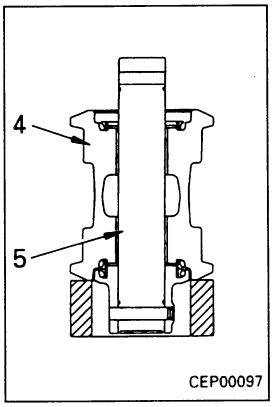


CEP00096

6. Turn over roller (4) and shaft (5) assembly.

7. Using tool **L3**, install floating seal (3) to collar (2).
   - ★ For details of the prcautions when installing floating seals (3a) and (3c), see the precautions marked ★ for Step 3.



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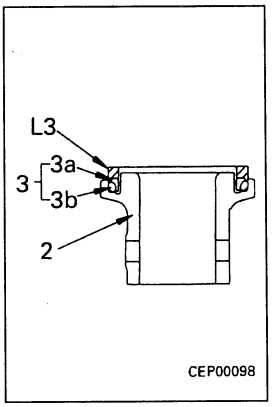
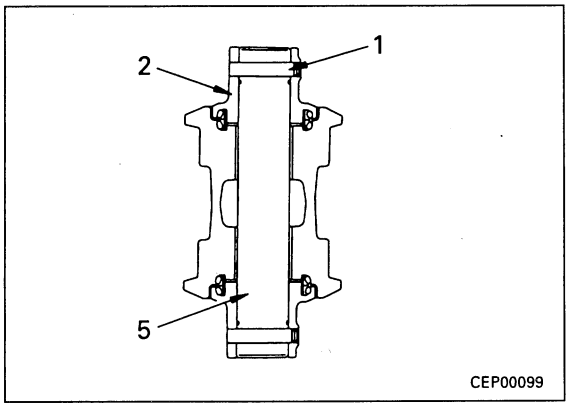
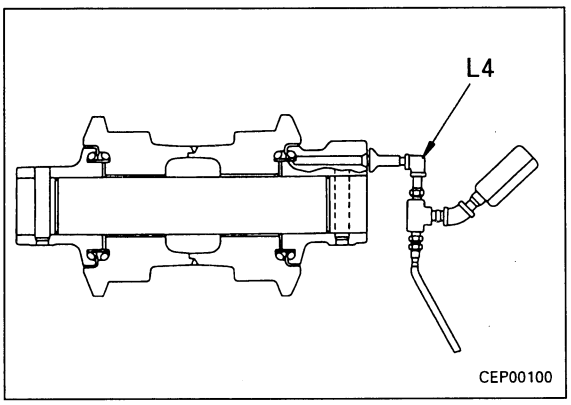


CEP00098

8. Assemble collar (2) to shaft (5), and install pin (1).



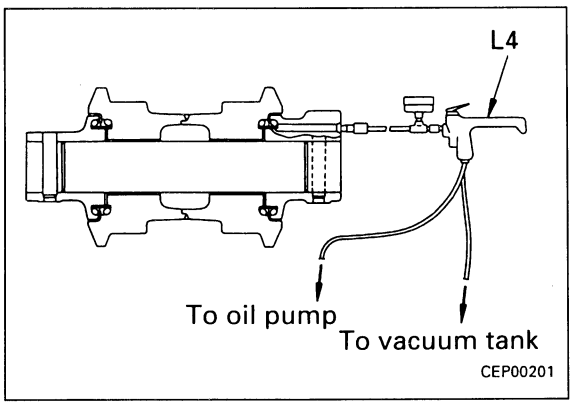
9. Using tool **L4**, apply standard pressure to roller oil filler port, and check for leakage of air from seal.
   - ★ Standard pressure: 0.1 MPa (1 kg/cm²)
   - ★ Method of checking
     The standard pressure shall be maintained for 10 seconds and the indicator of the gauge shall not go down.

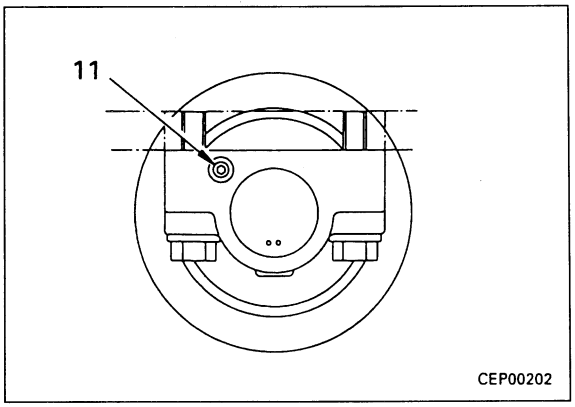


10. Using tool **L4**, fill track roller assembly with oil, then tighten plug (11)

    Track roller oil: **280 - 310 cc (EO30-CD)**

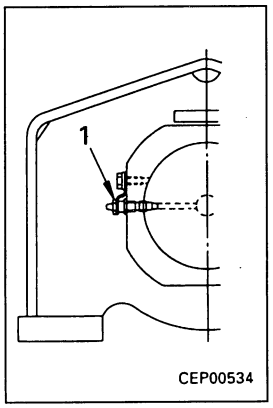
    kgm Plug: **14.7 ± 4.9 Nm (1.5 ± 0.5 kgm)**

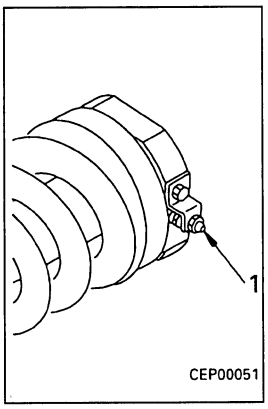




REMOVAL OF CARRIER ROLLER ASSEMBLY

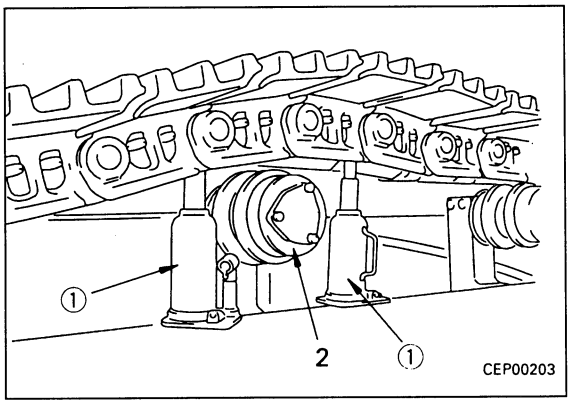
1. Lower work equipment to ground, then loosen lubricator (1), and relieve track tension. ※ 1
   ⚠ The adjustment cylinder is under extremely high pressure, so never loosen the lubricator more than one turn. If the grease does not come out, move the machine backwards and forwards.





2. Using hydraulic jacks ①, push up track to a position where carrier roller assembly can be removed, then remove carrier roller assembly (2). ※ 2

   kg Carrier roller assembly: **35 kg**



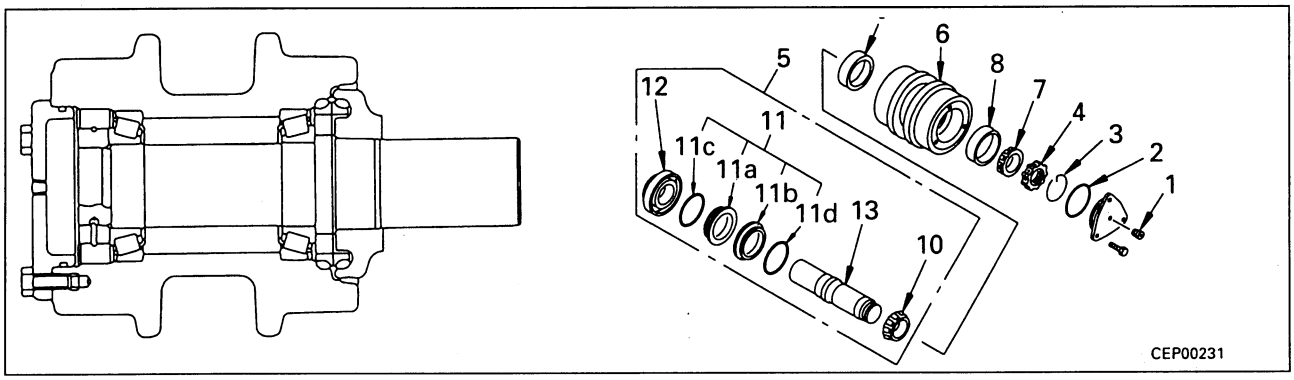
INSTALLATION OF CARRIER ROLLER ASSEMBLY

- Carry out installation in the reverse order to removal.

※ 1

★ Adjust the track tension.
For details, see TESTING AND ADJUSTING, Testing and adjusting track tension.

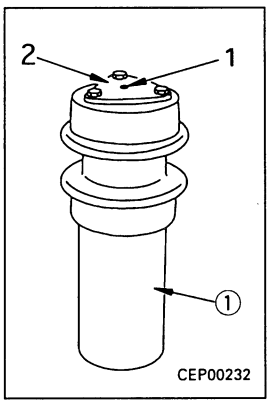
DISASSEMBLY OF CARRIER ROLLER ASSEMBLY

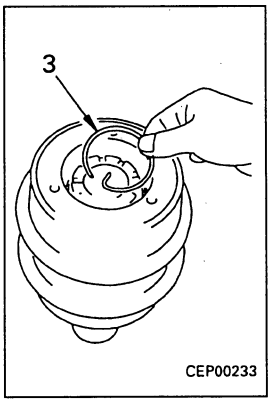


1. Remove plug (1) and drain oil.

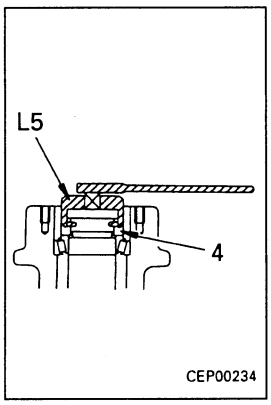
   Carrier roller assembly: **450 - 500 cc**

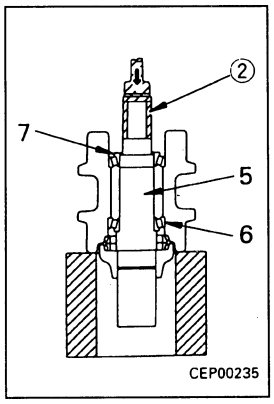
2. Set carrier roller assembly on stand 1.
3. Remove cover (2).
4. Remove ring (3).



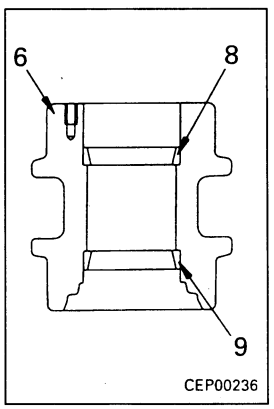


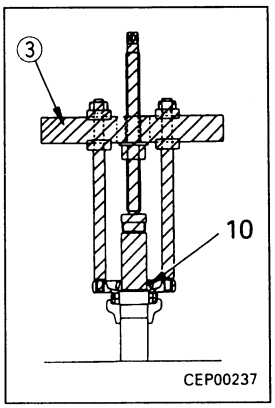
5. Using tool **L5**, remove nut (4).
6. Using push tool ②, pull out shaft assembly (5) from roller (6) with press, then remove inner race (7).



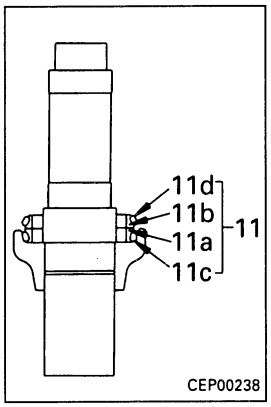


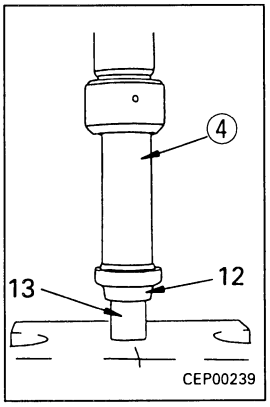
7. Remove outer races (8) and (9) from roller (6).
8. **Disassembly of shaft assembly.**
   1) Using puller ③, remove inner race (10).





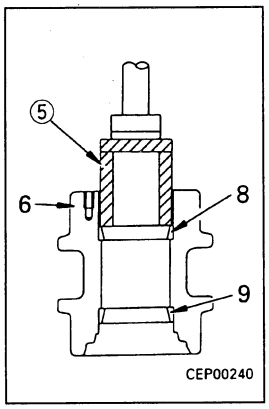
2) Remove floating seals (11).
3) Using push tool ④, remove collar (12) from shaft (13).



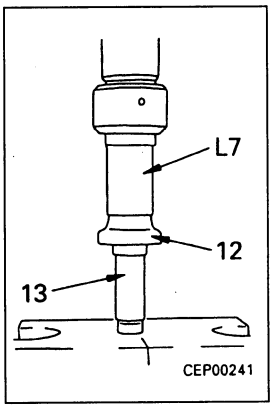


ASSEMBLY OF CARRIER ROLLER ASSEMBLY

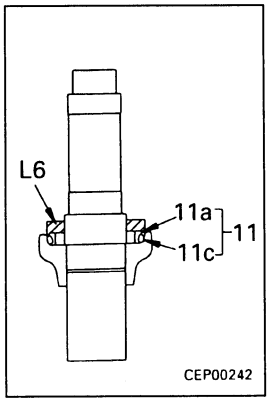
1. Using push tool ⑤, press fit outer races (8) and (9) to roller (6).



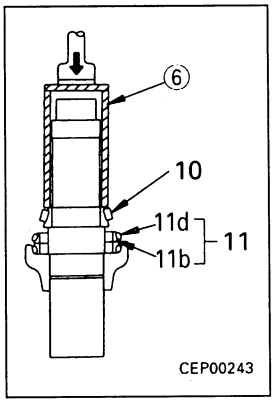
2. **Assembly of shaft assembly.**
   1) Using tool **L7**, press fit collar (12) to shaft (13).
      ★ When press fitting, be careful that there is no scuffing.
      Fitting protion of shaft:
      Engine oil (EO30-CD)

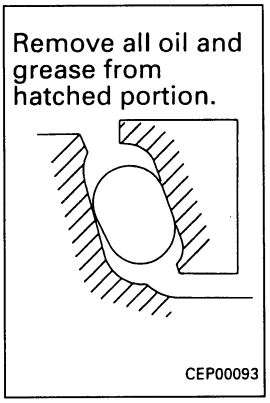


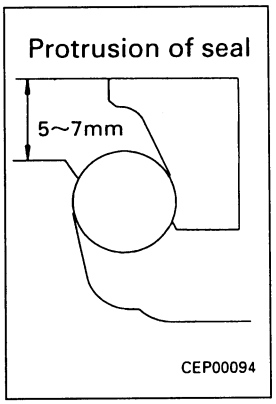
   2) Using tool **L6**, assemble floating seals (11).
      ★ When assembling the floathing seal, clean the contact surface of O-ring (11c) and floating seal (11a), remove all grease and oil, and dry it. Make sure that no dirt or dust stickts to the contact surface of the floating seal.
      ★ After insering the floating seal, check that the angle of the seal is less than 1 mm and that the protrusion of the seal is within a range of 5 - 7 mm.



   3) Assemble floating seals (11), then using push tool ⑥, press fit inner race (10).
      ★ For details of the precautions when installing floating seals (11b) and (11d), see the precautions marked ★ for Step 2).



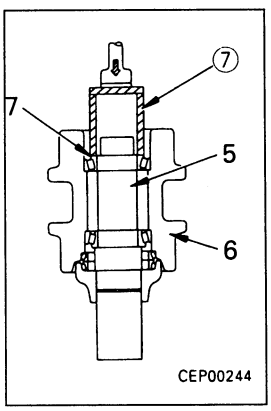


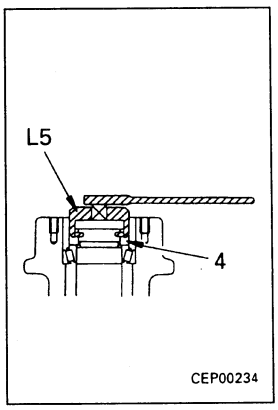


3. Assemble roller (6) to shaft assembly (5).

4. Using push tool ⑦, press fit inner race (7).
   ★ When press fitting the bearing, rotate the roller, and press fit to a point where the rotation becomes slightly heavier.

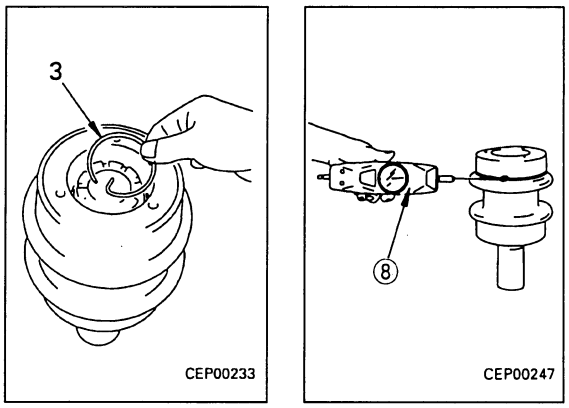
5. Using tool **L5**, tighten nut (4) to a point where drill hole in shaft is aligned with drill hole in nut.



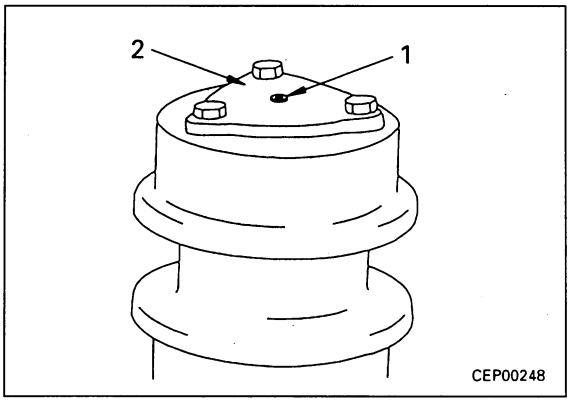


6. Install ring (3).

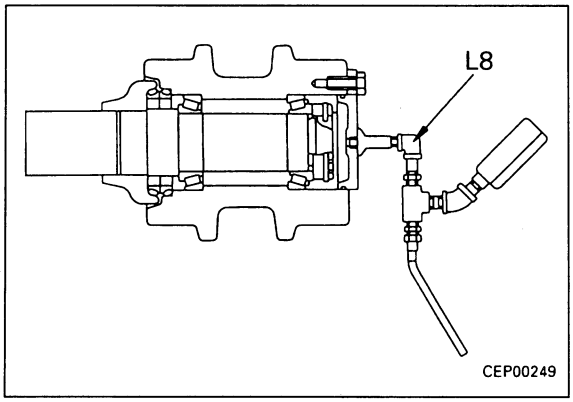
7. Using push-pull scale ⑧, check that roller rotates smoothly.



8. Fit O-ring and install cover (2).



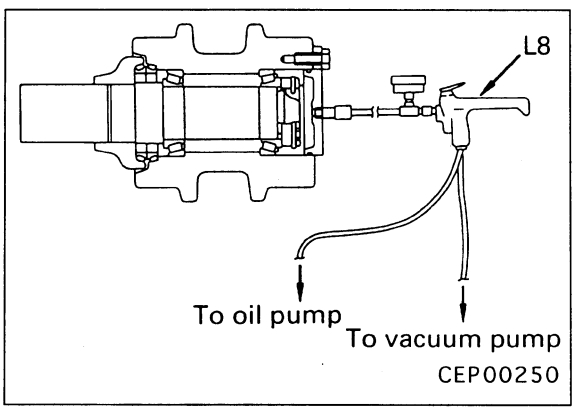
9. Using tool **L8**, apply standard pressure to roller oil filler port, and check for leakage of air form seal.
   - ★ Standard pressure: 0.1 MPa (1 kg/cm²)
   - ★ Method of checking
     The standard pressure shall be maintained for 10 seconds and the indicator of the gauge shall not go down.



10. Using tool **L8**, fill carrier roller assembly with oil, then tighten plug (1).

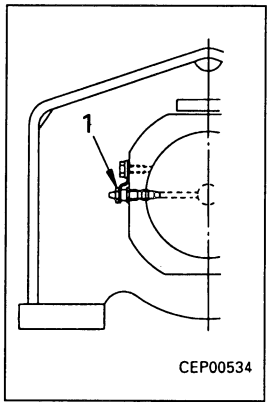
    Carrier roller oil: **450 - 500 cc (EO30-CD)**

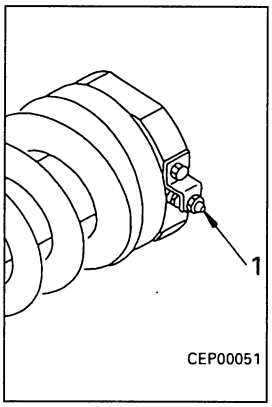
    kgm Plug: **14.7 ± 4.9 Nm (1.5 ± 0.5 kgm)**



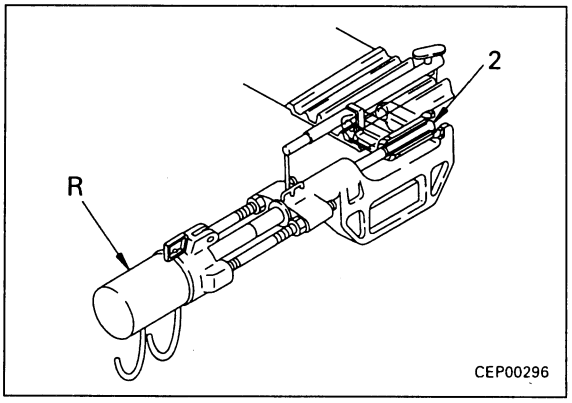
REMOVAL OF TRACK SHOE ASSEMBLY

1. **Positioning track shoe**
   - ★ Stop the machine at a point where it is easy to set master pin removal tool R, and where master pin is in the middle of the track frame, then loosen lubricator (1), and relieve the track tension. ※ 1
   - ⚠ The adjustment cylinder is under extremely high pressure, so never loosen the lubricator more than one turn. If the grease does not come out, movve the machine backwards and forwards.





2. Using tool **R**, pull out master pin (2). ※ 2



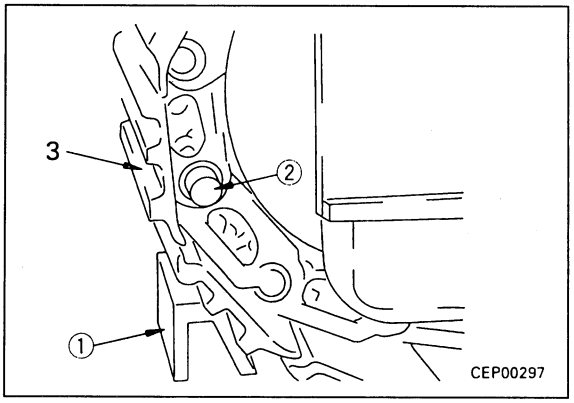
3. Lay out track as follows.
   1) Move machine forwards so that position of temporary pin is at front of idler, set block ① in position, then remove temporary pin ②, and remove dust seal. ※ 3
   2) Drive machine in reverse to lay out track.

INSTALLATION OF TRACK SHOE ASSEMBLY

- Carry out installation in the reverse order to removal.

※ 1

Adjust the track tension.
For details, see TESTING AND ADJUSTING, Testing and adjusting track tension.

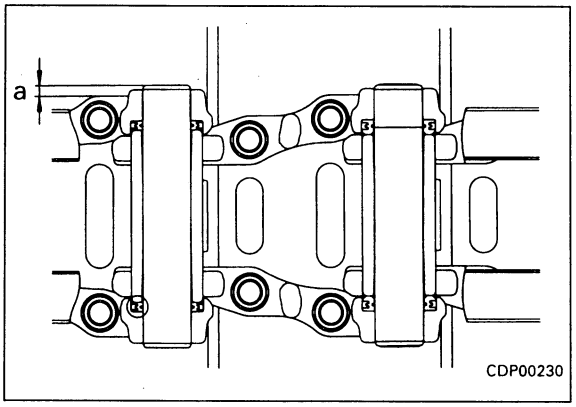


※ 2

★ Use tool **R** and press fit so that the protrusion of the master pin is dimention "**a**". Protrusion "**a**" of master pin: 4.2 ± 2 mm

※ 3

When assembling the dust seal, coat the bushing contact surface with grease (G2-LI).



REMOVAL OF HYDRAULIC TANK ASSEMBLY

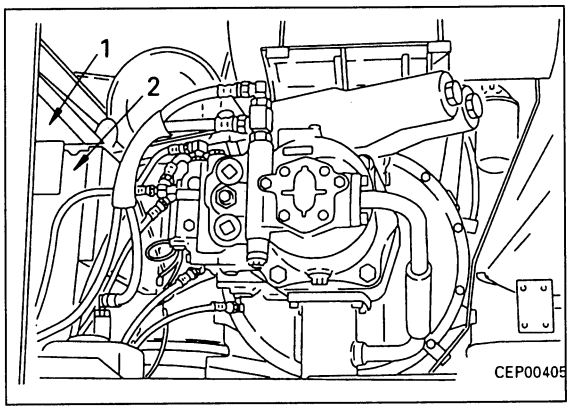
- Swing the upper structure to set the position of the hydraulic tank drain and mounting bolt outside the track.

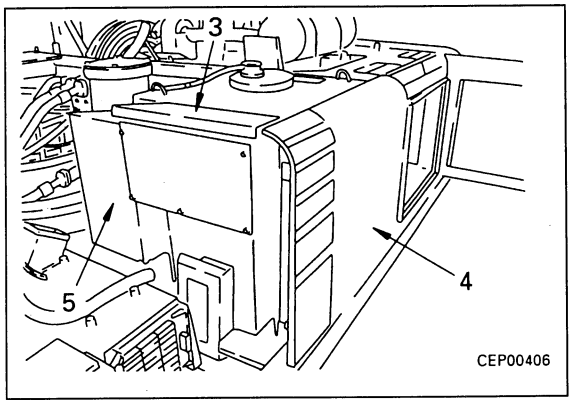
⚠ Loosen the hydraulic tank oil filler cap slowly to release the pressure inside the hydraulic tank.

1. Drain oil from hydraulic tank.

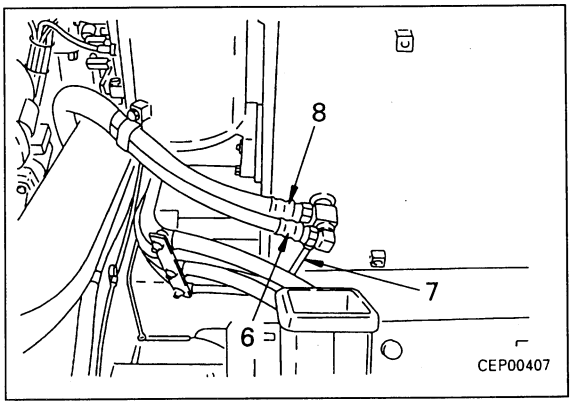
   Hydraulic tank: Approx: **270** ℓ

2. Remove operator's cab assembly.
   For details, see REMOVAL OF OPERATOR'S CAB ASSEMBLY.
3. Remove control valve top cover, hydraulic tank undercover, and main pump undercover.
4. Open main pump side cover, then remove partions (1) and (2).
5. Remove covr (3) and (4).
6. Remove air conditioner air suction port (5).

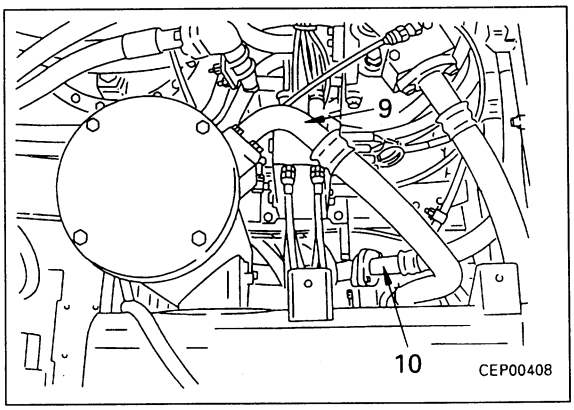




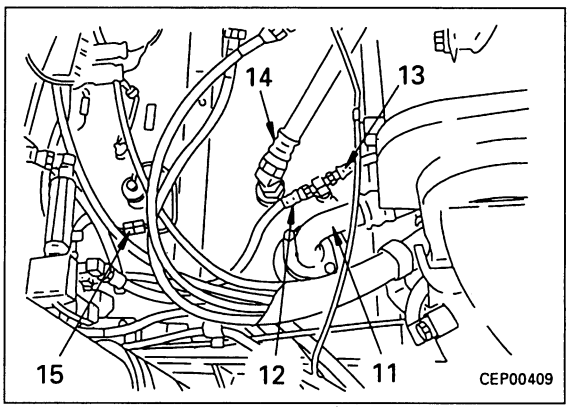
7. Disconnecct drain hoses (6), (7), and (8).



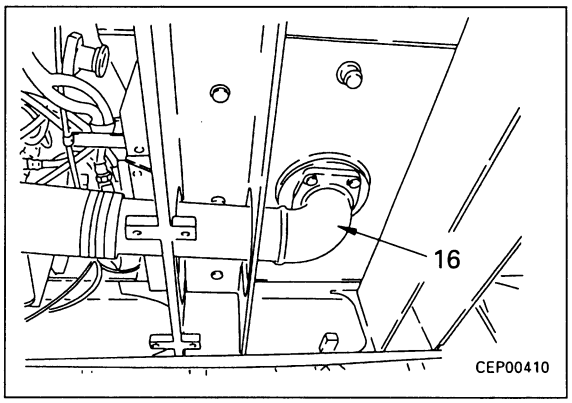
8. Disconnect hydraulic oil filter inlet hose (9) and outlet hose (10).



9. Disconnect hydraulic oil cooler return hose (11).
10. Disconnect drain hoses (12), (13), and (14).
11. Disconnect hydraulic oil level sensor connector (15) (CN-P09).

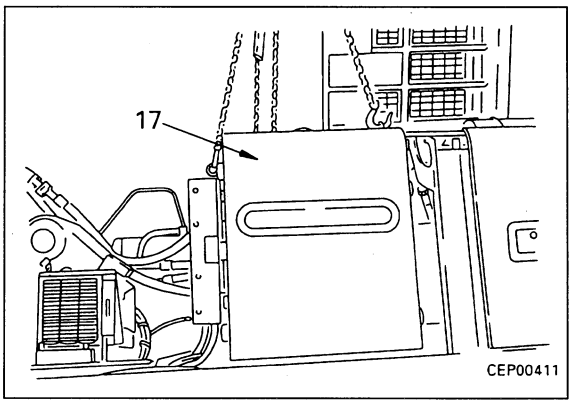


12. Remove main pump suction tube (16).
    ★ A box wrench cannot be fitted on the center rear mount bolt, so disconnect both sides of tube (16) and offset them.



13. Remove mounting bolts, and lift off hydraulic tank assembly (17). ※ 1

kg Hydraulic tank assembly: **260 kg**



INSTALLATION OF HYDRAULIC TANK ASSEMBLY

- Carry out installation in the reverse order ot removal.

kgm Hydraulic tank mounting bolt:
277.04 ± 31.87 Nm (28.25 ± 3.25 kgm)

- **Refilling with oil (hydraulic tank)**
  ★ Add oil through the oil filler to the specified level. Run the engine to circulate the oil through the system. Then check the oil level again.
- **Bleeding air**
  Bleed the air.
  For details, see TESTING AND ADJUSTING, Bleeding air.

REMOVAL OF CONTROL PUMP ASSEMBLY

⚠ Lower the work equipment completely to the ground and stop the engine. Then loosen the oil filler cap slowly to release the pressure inside the hydraulic tank.

⚠ Disconnect the cable from the negative (-) terminal of the battery.

★ Mark all the piping with tags to prevent mistakes when installing.

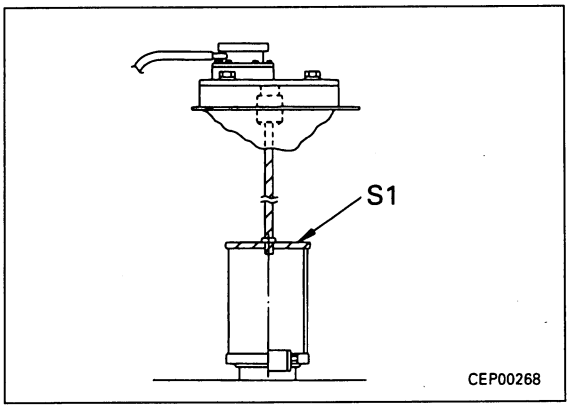
1. Remove hydraulic tank strainer, and using tool S1, stop oil.
   ★ When not using tool **S1**, remove the drain plug, and drain the oil from the hydraulic tank and inside the system.

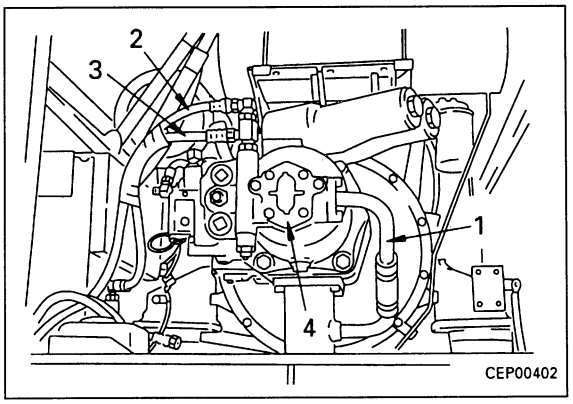
   Hydraulic tank: Approx. **270** ℓ

2. Remove control pump inlet tube (1).

3. Disconnect control pump outlet hoses (2) and (3).

4. Remove control pump assembly (4). [※ 1]
   ★ Remove only the bolts with a width across flats of 17 mm.





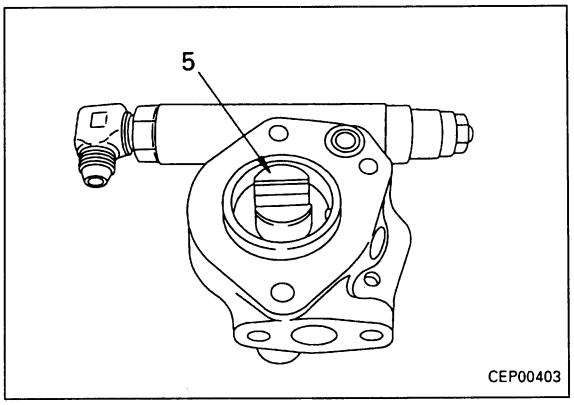
INSTALLATION OF CONTROL PUMP ASSEMBLY

- Carry out installation in the reverse order to removal.

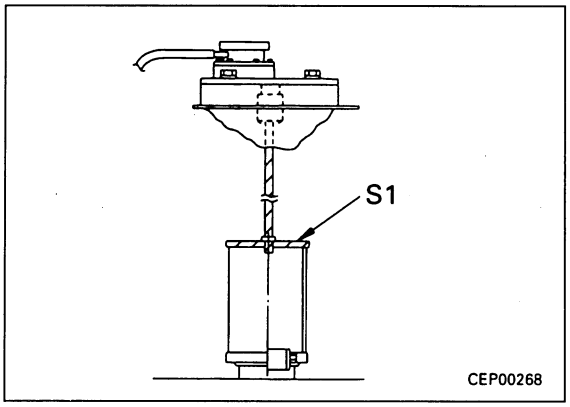
[※ 1]

★ Align with the groove of coupling (5), then install.
   kgm Control pump mounting bolt:
   66.19 ± 7.35 Nm (6.75 ± 0.75 kgm)

- **Refilling with oil (hydraulic tank)**
  ★ Add oil through the oil filler to the specified level. Run the engine to circulate the oil through the system. Then check the oil level again.



REMOVAL OF MAIN PUMP ASSEMBLY



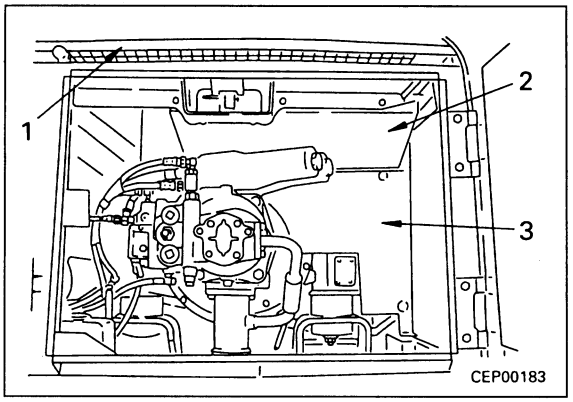
⚠ Lower the work equipment completely to the ground and stop the engine. Then loosen the oil filler cap slowly to release the pressure inside the hydraulic tank.

⚠ Disconnect the cable from the negative (-) terminal of the battery.

★ Mark all the piping with tags to prevent mistakes when installing.

1. Remove hydraulic tank strainer, and using tool **S1**, stop oil.
   ★ When not using tool **S1**, remove the drain plug, and drain the oil from the hydraulic tank and inside the system.

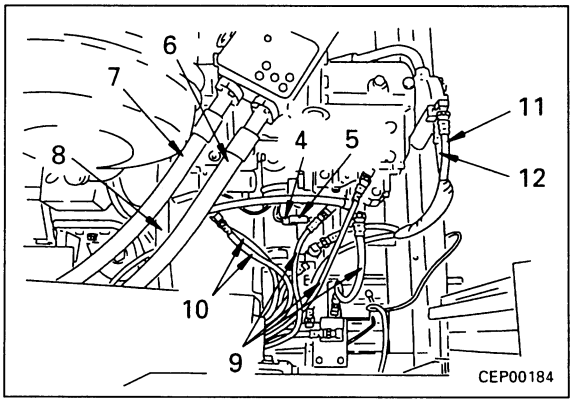
   Hydraulic tank: **Approx. 280** ℓ



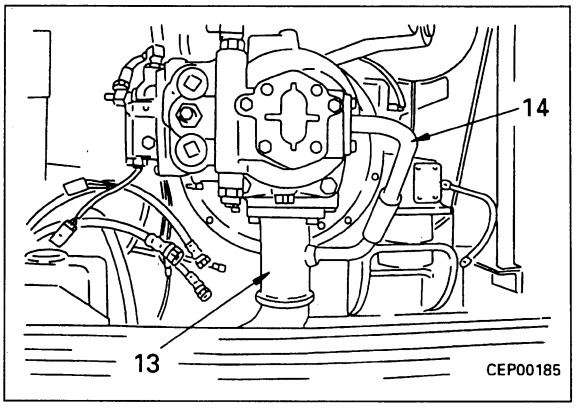
2. Remove main pump side cover and undercover, and open engine hood.
3. Drain oil from damper case.

   Damper case: **Approx. 1.1**ℓ

4. Remove main pump top cover (1), and partitions (2) and (3).
5. Disconnect TVC solenoid connectors (4) and (5) (CN-C04 and CN-C13).
   ★ There is a clamp for the front servo valve.
6. Disconnect main pump outlet hoses (6) and (7).
7. Disconnect pump case drain hose (8).
8. Disconnect rear pump servo valve hose (9).
9. Disconnect front pump servo valve hose (10).
10. Disconnect control pump outlet hoses (11) and (12).

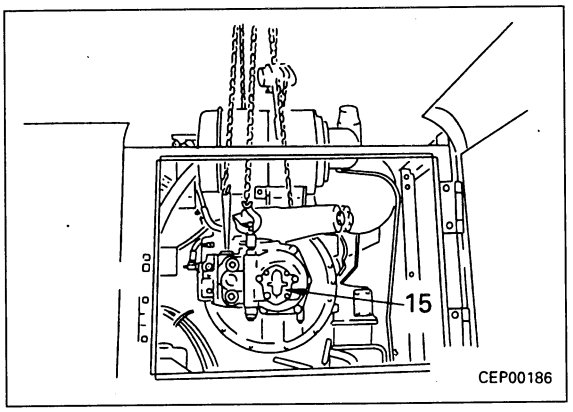


11. Disconnect main pump inlet tube (13) and control pump inlet tube (14).



12. Sling main pump assembly (15), remove mounting bolts, then lift off.

kg Main pumpp assebmly: **250 kg**



INSTALLATION OF MAIN PUMP ASSEMBLY

- Carry out installation in the reverse order to removal.

※ 1
Involute spline of main pump:
Anti-friction compound (LM-G)
Mating surface of main pump case:
Gasket sealant (LG-6)

- **Refilling with oil (damper case)**
  ★ Add engine oil through the oil filler to the specified level. Run the engine, then stop the engine, wait for 15 minutes, and check the oil level again.

- **Refilling with oil (hydraulic tank)**
  ★ Add oil through teh oil filler to the specified level. Run the engine to circulate the oil through the system. Then check the oil level again.

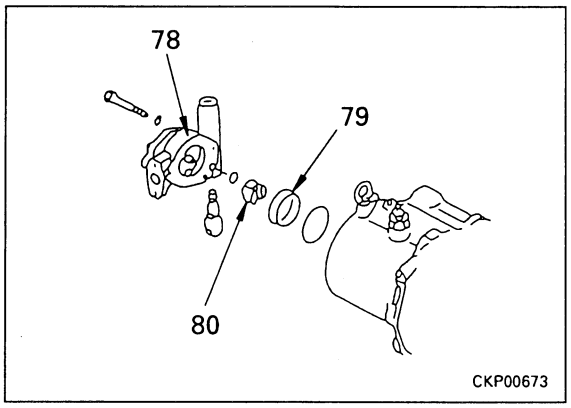
- **Bleeding air**
  ★ Bleed the air.
  For details, see TESTING AND ADJUSTING, Bleeding air.

20. Control pump assembly

1) Install collar (79).
2) Fit coupling (80) to drive shaft, then fit O-ring and install control pump assembly (78).

kgm Mounting bolt:
66.2 ± 7.4 Nm (6.75 ± 0.75 kgm)

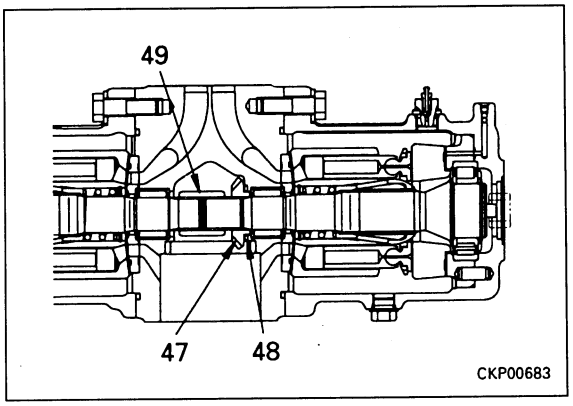
Mating sruface of control pump:
Gasket sealant (LG-7 or LG-5)



21. Rear pump assembly

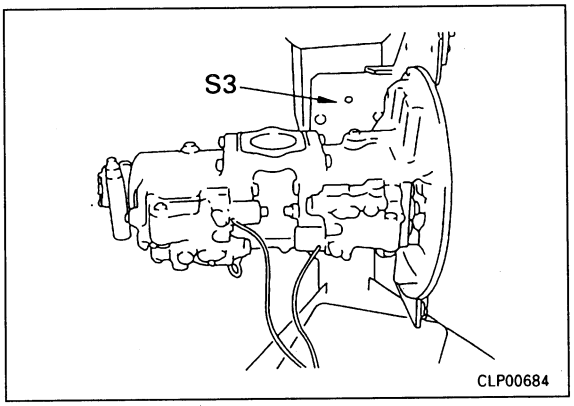
1) Assembly dowel pin, valve plate, and O-ring to end cap.
2) Sling rear pumpp assembly.
   ★ When slinging, be careful not to drop the cylinder block, piston assembly, or other parts.

3) Hold thrust bearing (48) and belvel gear (47) inside end cap, align with spline of rear pump drive shaft, and assemble.
4) align rear pump drive shaft with spline of coupling (49) and assemble.
5) Tighten mounting bolts of rear pump assembly.
   kgm Mounting bolt:
   384.9 ± 41.7 Nm (39.25 ± 4.215 kgm)
   Mating surface of pump case:
   Gasket sealant (LG-7 or LG-5)

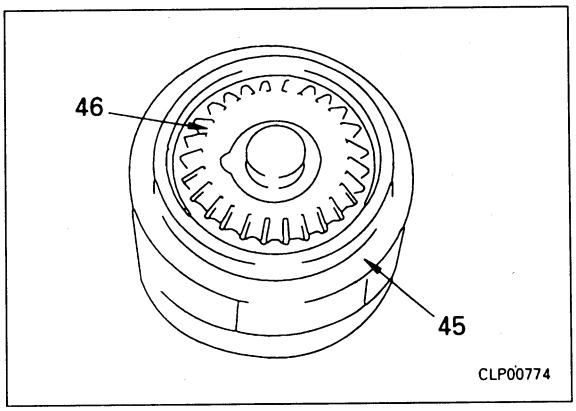


22. Impeller assembly

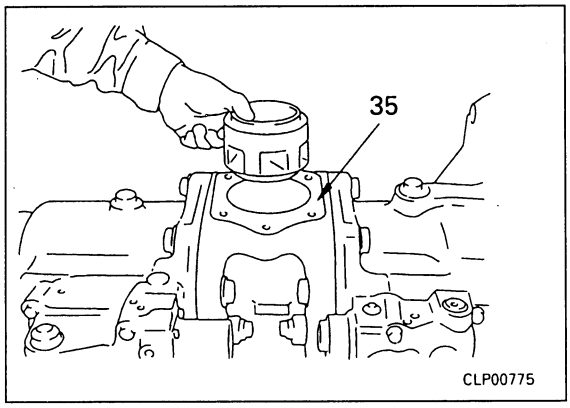
1) Turn over tool s3 180 and set with impeller mounting port facing up.



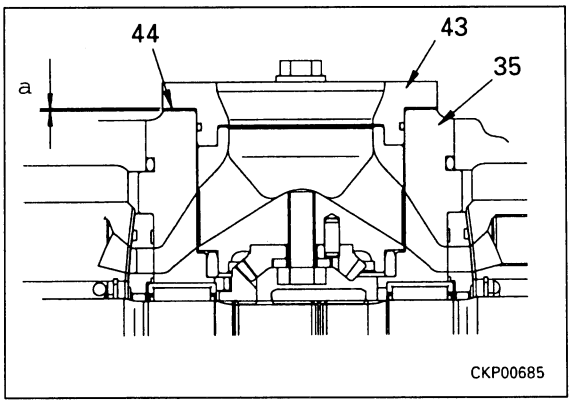
2) Fit bevel gear (46) to impeller (45) to make impeller assembly.
   Mounting bolt:
   Thread tightener (Locite 648)
   kgm Mounting bolt:
   110.3 ± 12.3 Nm (11.25 ± 1.25 kgm)



3) Assembly impeller assembly inside end cap (35).



4) Positioning impeller assembly
   i) Install cover (43) to end cap.
      ★ Do not install the O-ring.
   ii) Measure clearance a between end cap (35) and cover (43).
      ★ Measure at 3 places around the circumference of the cover and take the average.
   iii) Select shim (44) from table below to make thickness of (**a**+0.1) to (**a**+0.2), then install



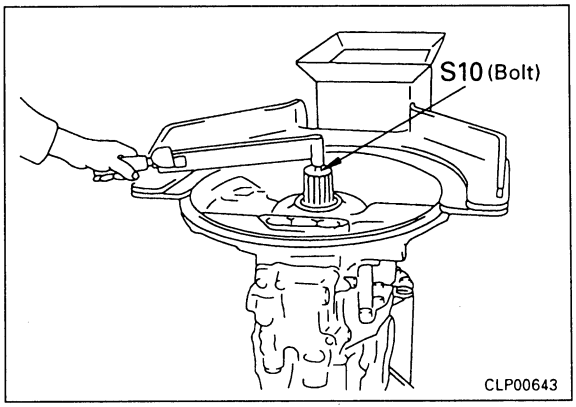
Part. No.	708-2H-21710	708-2H-21720	708-2H-21730
Shim tickness (mm)	0.1	0.2	0.5

   iv) Fit O-ring to cover (43) , then assemble selected shim (44) and install.

kgm Mounting bolt:
110.3 ± 12.3 Nm (11.25 ± 1.25 kgm)

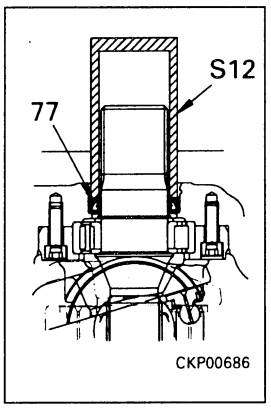
23. Measuring rotating torque of pump assembly

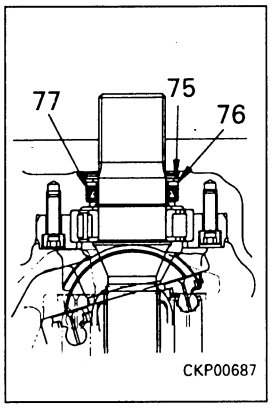
1) Set tool **S10** to pump shaft.
2) Set torque wrench to tool **S10**, rotate shaft at low speed (3 - 5 sec/ 1 turn) and measure rotating torque.
   ★ When checking the rotating torque, check that the shaft rotates smoothly without any variation.
      • Variation range:
        Max. 2.9 Nm (0.3 kgm)
      • Rotating torque:
        Max. 4.9 Nm (5.0 kgm)
   ★ If there is any abnormality in the rotating torque, disassemble and adjust again.



24. Oil seal

1) Check that there are no buurs or flashes at conrers of shaft.
2) Using tool **S12**, press fit oil seal (77).
3) Assemble spacer (76) and install snap ring (75).





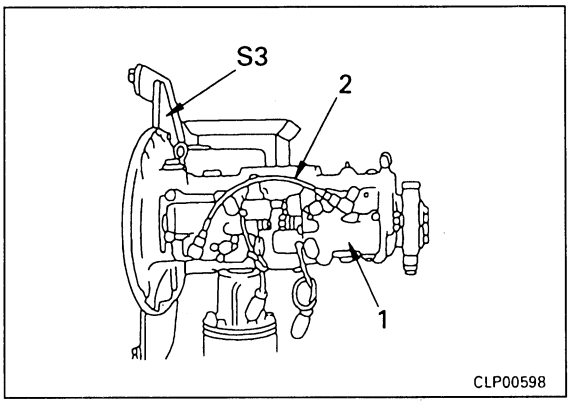
25. Hose

Install elbow, tee, and hose (2).

kgm Hose: **24.5 ± 4.9 Nm (2.5 ± 0.5 kgm)**

26. Pump assembly

Remove pump assembly (1) from tool **S3**.



CHECKING CONTACT BETWEEN CYLINDER BLOCK AND VALVE PLATE, ROCKER CAM AND CRADLE, VALVE PLATE AND END CAP

1. Checking contact between cylinder block and valve plate

★ This check is unnecessary if both the cylinder block and valve plate are replacement parts (new parts).

★ This check applies if one of the parts is a replacement part or a restored part.

1) Make a centering tool for the cylinder block and valve plate.

★ The tool can be made from plastic, bakelite or any other soft material.

2) Remove all oil and grease from the parts to be checked.

★ Do not wipe with a cloth.

3) Set the tool in position, then paint the cylinder block with inspection paint.

★ Coat thinly with paint.

4) Push the valve plate with a force of 39 - 49 N (4 - 5 kg) against the cylinder block, turn the valve plate 90°, then turn it back to the original position. Repeat this process 2 or 3 times.

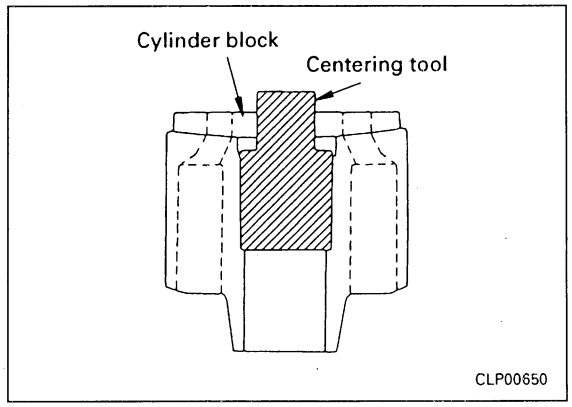
5) Remvoe the valve plate, transfer the contact surface to a tape, and check the contact surface.

★ The contact of the spherical surface of the valve plate and cylinder block must fulfill the conditions below and cover the whole circumference without any break.

i) The contact at the seal portion (range from bottom to ø 101.5 mm) must be at least 80%.

ii) The contact at the land portion (range from ø 101.5 mm to ø 128 mm) must be 20 - 80%.

	Seal portion	Land portion
Valve plate	Min. 80%	20 - 80%
Cylinder block	Min. 80%	20 - 80%



2. Checking contact between rocker cam and cradle

* This check is unnecessary if both the rocker cam and cradle are replacement parts (new parts).

* This check applies if one of the parts is a replacement part or a restrored part.

1) Remove all oil and grease from the parts to be checked.
   ★ Do not wipe with a cloth.

20 Paint the cradle with inspection paint.
   ★ Coat thinly with paint.

3) Put the rocker cam on top, push with a force of 39 - 49 N (4 - 5 kg), and move it between th4e maximum swash plate angle and the position where it contracts the stopper. Repeat theis process 2 or 3 times.

4) Remove the rocker cam, transfer the contact surface to a tape, and check the contact surface.
   ★ The standard for the contact surface is as given below.

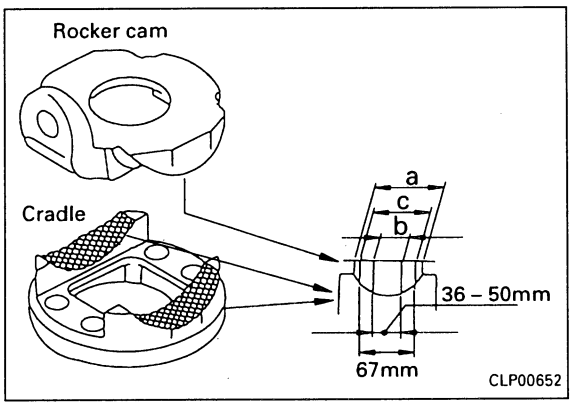
i) Contact within central portion (36 - 50 mm) must be at least 90%.

ii) Contact in range betwen central portion (36 - 50 mm) and 67 mm must be 50 - 990%.

iii) Contact of area outside 67 mm width must be less than 50%.
(It is not premitted to have contact only at the outside and no contact at the center.)

[Reference]
If the contact is not within the standard value, and lapping is carried out, it must always be carried out for both parts together.

★ parts with any scratches or damage must not be used.



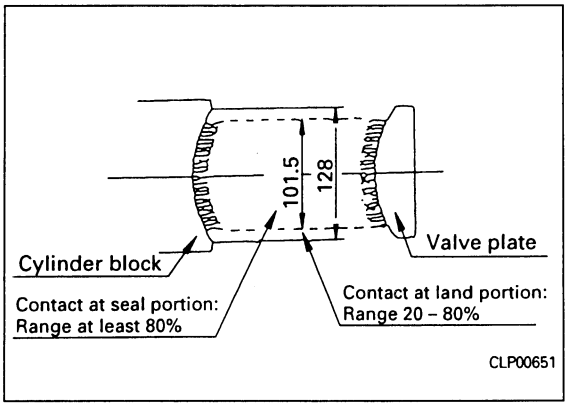
3. Checking contact between valve plate and end cap

★ This check is unnecessary if both the valve plate and end cap are replacement parts (new parts).

★ This check applies if one of the parts is a replacement part or a restored part.

★ If the contact is defective, use a surface plate and correct by lapping.

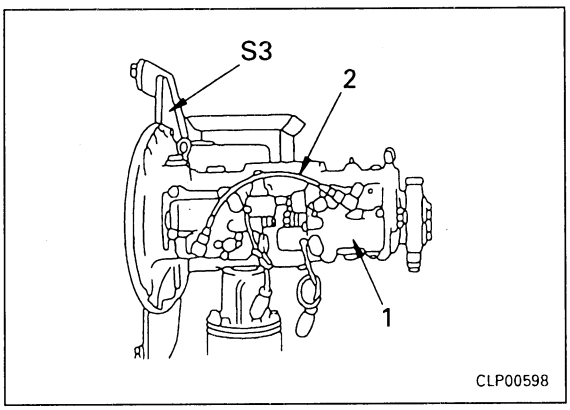
1) Remove all oil and grease form the parts to be checked.
   ★ Do not wipe with a cloth.
2) Paint the end cap with inspection paint.
   ★ Coat thinly with paint.
3) Push the valve plate with a force of 39 0 49 N (4 - 5 kg) against the end cap, turn the valve plate 90°, then turn it back to the original position. Repeat this process 2 or 3 times.
4) Remove the valve plate, transfer the contact surface to a tape, and check the contact surface.
   ★ The contact of the plane surface between the valve plate and end cap must cover at least 80% without any variation.
   ★ Fro details of the operation, see the Parts judgement Guide.



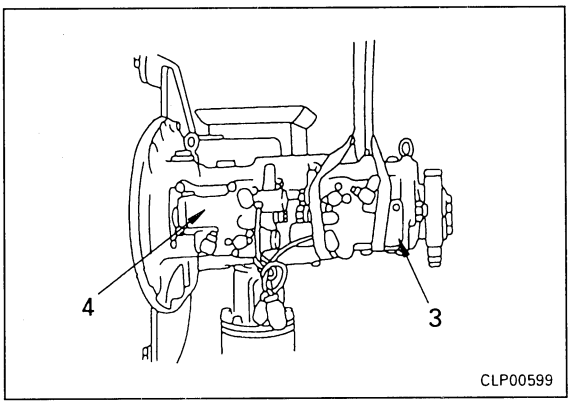
DISASSEMBLY OF MAIN PUMP ASSEMBLY

1. **Pump assembly**
   Set pump assembly (1) to tool **S3**.

2. **Hose**
   Remove hose (2), elbow, and tee.

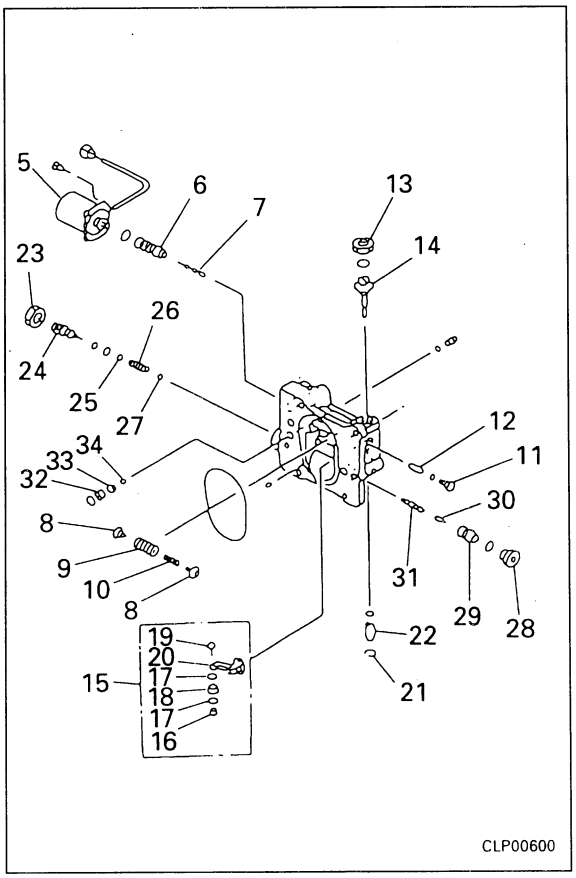


3. **Rear pump assembly**
   1) Sling rear pump assembly (3).
   2) Remove 8 bolts at rear pump end, then remove rear pump assembly (3).
      ★ Leave the end cap at the front end.
      ★ Be careful not to drop the rear pump valve plat, cylinder block, piston assembly, or other parts.



- **Disassembly of front pump assembly**

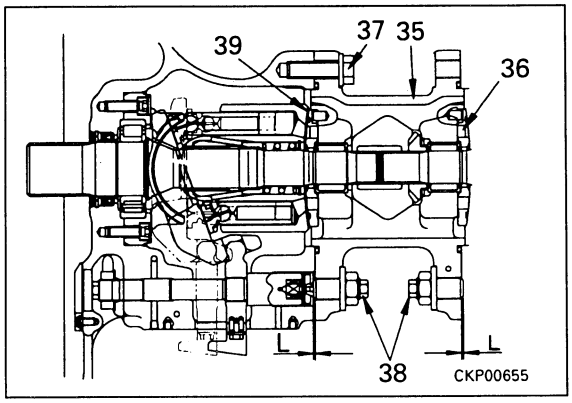
4. **Servo valve assembly**
   1) Remove servo valve assembly (4).
   2) Disassembly of servo valve assembly
      - **TVC valve**
        i) Remove solenoid asseeembly (5), then remove sleeve (6) and spool (7).
        ii) Remove seat (8), then remove springs (9) and (10).
        iii) Remove plug (11), then remove piston (12).
        iv) Remove locknut (13), then remvoe plug (14) and lever assembly (15).
        v) Remove nut (16) from lever assembly (15), then remove washer (17), bearing (18), pin (19), and lever (20).
        vi) Remove snap ring (21), then remove plug (22).



- **LS valve**
  - i) Remove locknut (23), then remove plug (24), seat (25), spring (26), and seat (27).
    - ★ Measure the dimentsion between the end face of locknut (23) and the end face of plug (24).
  - ii) Remove plug (28), then remove sleeve (29), piston (30), and spool (31).
- Remove filter (32), then remove spacer (33) and ori fice (34).

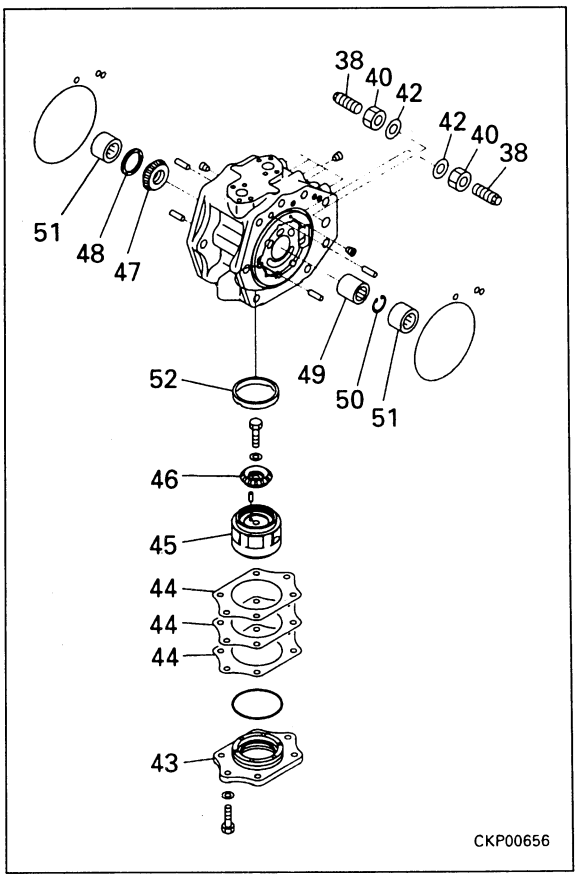
5. Valve plate, end cap

1) Remove valve plate (36) from end cap (35).
2) Remove 8 mounting bolts (37), then remove end cap (35).
   - ★ If the valve plate is stuck to the end cap, be careful not to drop it.
   - ★ Measure protrusion **L** of maximum swash plate angle adjustment screw (38).
3) Remove valve plate (39) from end cap (35).

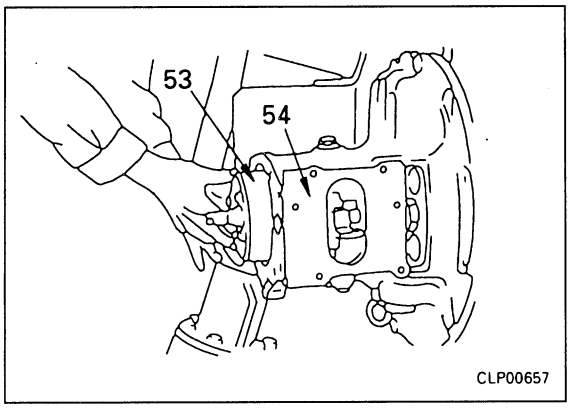


- **Disassembly of end cap**

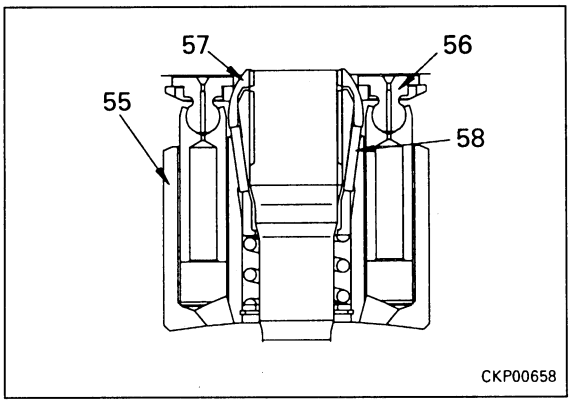
i) Loosen locknut (40), and remove screw (38) and washer (42).
ii) Remove cover (43), then remove shim (44).
   - ★ Check the number and thickness of the shims, and keep in a safe place.
iii) Remove impeller (45).
iv) Remove bevel gear (46) from impeller (45)
v) Remove bevel gear (47), thrust bearing (48), and coupling (49) from inside of end cap.
vi) Remove snap ring (50) from coupling.
vii) Remove bearing (51) from end cap (35)
Viii) Remove O-ring and bushing (52) from end cap (35).



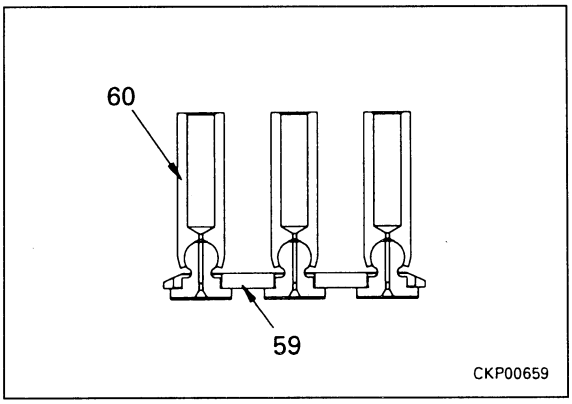
6. **Cylinder block, piston assembly**
Remove cylinder block and piston assemlby (53) from pump case (54).
★ The cylinder block and piston assembly may come off serparately, so be careful not to drop them.



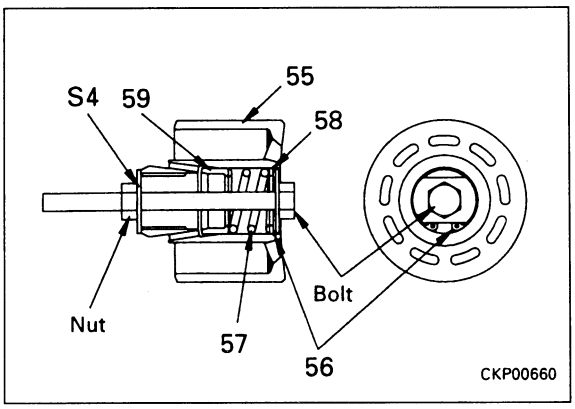
- **Disassembly of cylinder block, piston assembly**
Pull out piston assembly (56) from cylinder block (55), and remvoe retainer guide (57) and 3 preload pins (58).
★ When removing the piston assembly from the cylinder block, the preload pins may come out, so be careful not to lose them.



- **Disassembly of piston assembly**
Pull out piston (60) from retainer shoe (59).

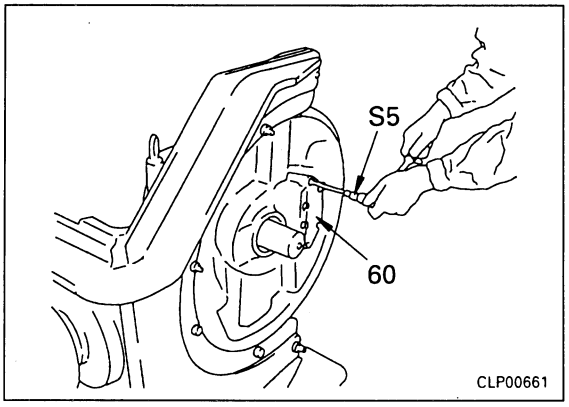


- **Disassembly of cylinder block**
1) Set tool **S4** to cylinder block (55).
2) Hold bolt of tool **S4** with wrench, tighten nut to compress spring, and remove snap ring (56).
3) Loosen nut of tool **S4** slowly to release tension of spring (57), then remove tool **S4**.
4) Remove seat (58), spring (57), and seat (59) from cylinder block (55).
★ Check the assembly direction of seat (59).

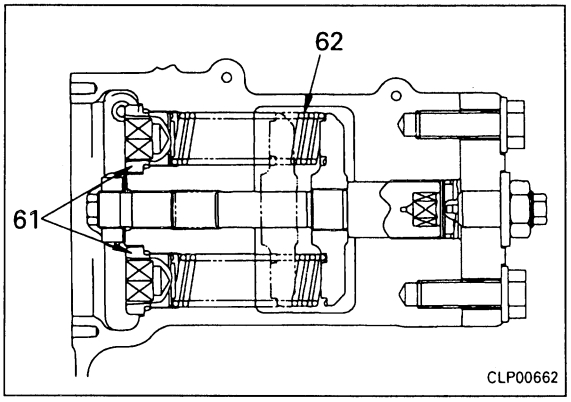


7. Servo piston assembly

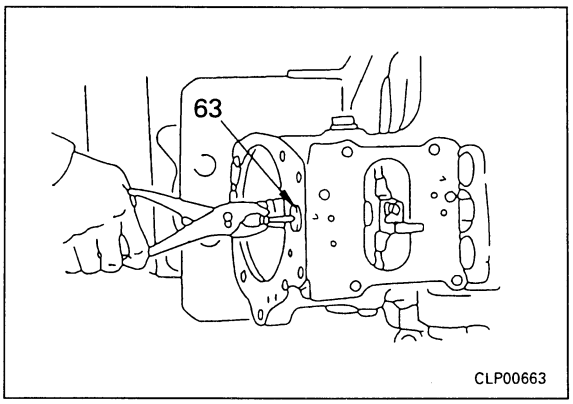
1) Remove mounting screws with tool **S5**, then remove cover (60). Front pump only)



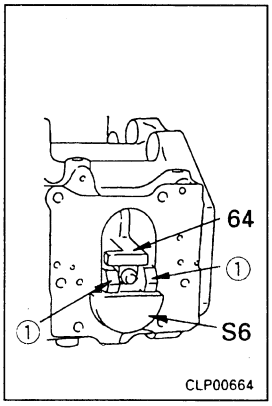
2) Remove plug (61), then remove spring (62).

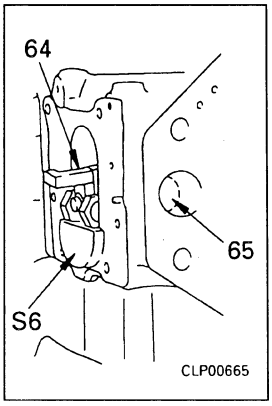


3) Using bolt (6mm), remove stopper (63).



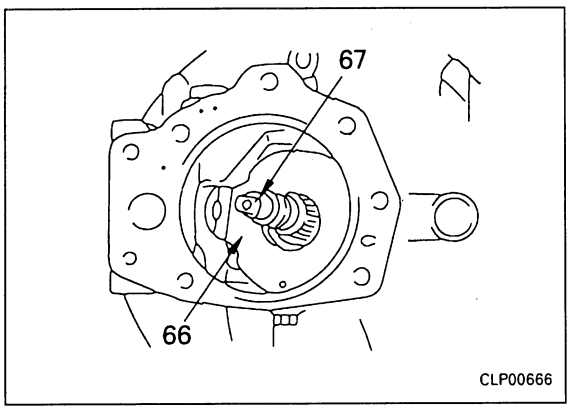
4) Set tool **S6** in position, and assemble spacers ① to both ends of rod (64).
5) Move to side and loosen piston (65) so that width across flats of rocker cam comes off from width across flats of cradle.
   ★ Be careful not to let the bolt portion of tool **S6** come off the rod.
6) Remove piston (65), then remove rod (64).
   ★ Check the assembly direction of rod (64).





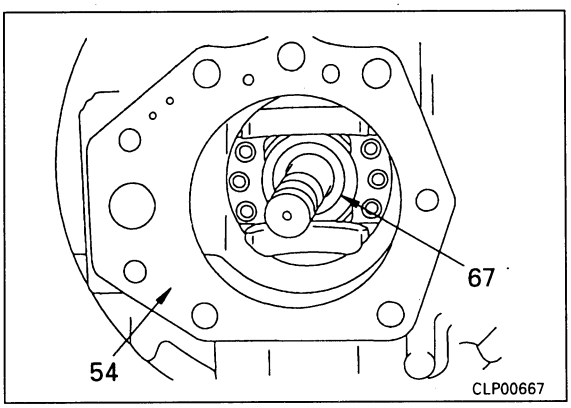
8. Shaft, cradle assembly

1) Remove rocker cam (66) from shaft and cradle assembly (67).
2) Remopve 6 bolts, then remove shaft and cradle assembly (67) from front pump case (54).



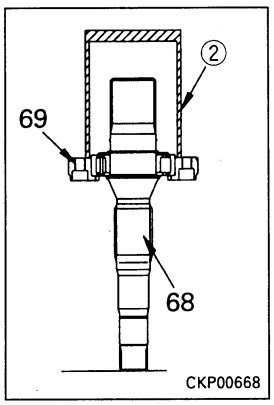
- **Disassembly of shaft, cradle assembly**

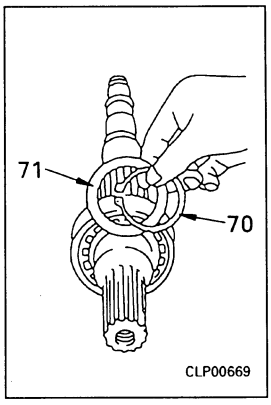
1) Push cradle (69) with push tool ② to remove it from shaft (68). When removeing, be careful to keep cradle (69) straight.
2) Remove snap ring (70), then remove washer (71).
3) Using push tool ③, remove bearing (72) from shaft (68).
   - ★ Bearing (72) into the flange ring and the bearing, so be careful not to lose either part.
   - ★ Check the installation direction of the bearing.

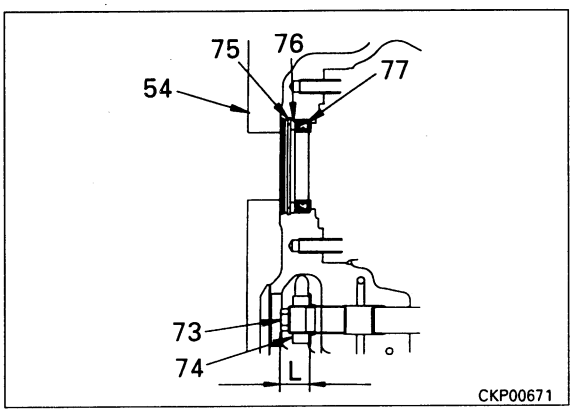


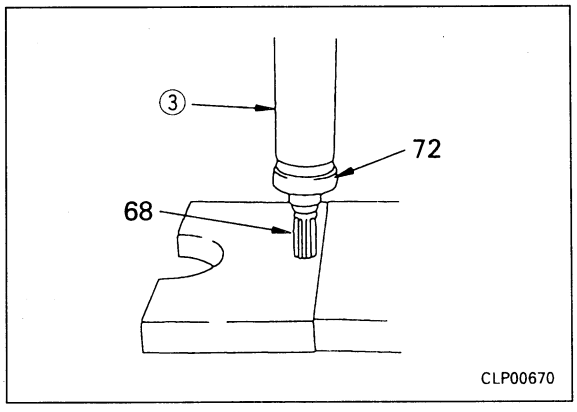
9. Disassembly of pump case

1) Loosen locknut (74) of minimum swash plate angle adjustment screw (73), and remove screw (73).
   - ★ Before loosening the locknut, measure dimention **L** between the end face of the case and the end face of thescrew.
2) Rotate tool **S3** 90°, remvoe snap ring (75) from front pump case (54), then remove spacer (76).
3) Remove oil seal (77).



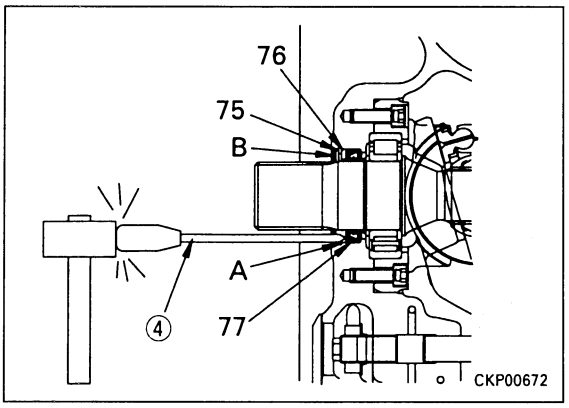






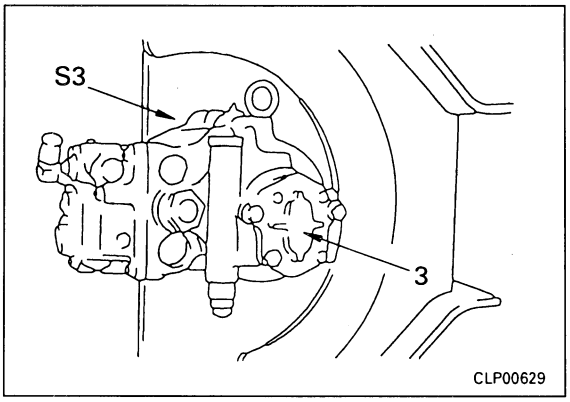
10. If above disassembly operation is not needed, and only oil seal is to be replaced, replace oil seal as follows.

1) Remove snap ring (75) and spacer (76).
2) Using bar ④ (hit end facer with hammer), hit through to core of oil seal (77), then twist to remove.
   - ★ Hit at a point midway between the inside and outside circumference of the oil seal, and twist at two places on opposite sideees (**A** and **B** in diagraam) to remove.
   - ★ Be careful not to damage the shaft.



- **Disassembly of rear pump assembly**

11. Rear pump assembly
Set rear pump assembly (3) to tool **S3**.



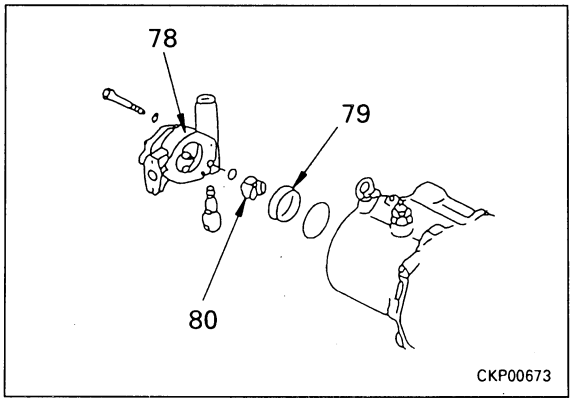
12. Control valve assembly
Same operation as in item 4.

13. Control pump assembly
Remove control pump assembly (78), then remove collar (79) and coupling (80).

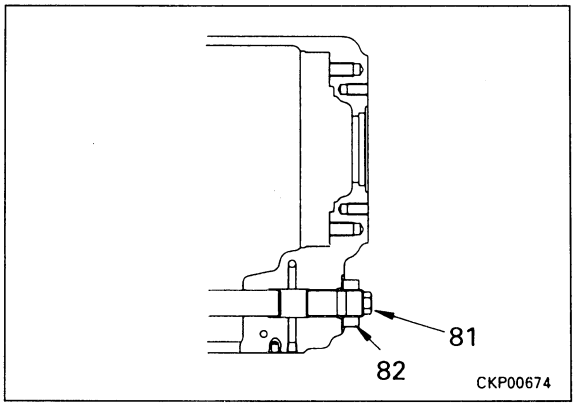
14. Cylinder block, piston assembly
Same operation as in Item 6.

15. Servo piston assembly
Same operation as in Item 7.

16. Shaft, cradle assembly
Same operation as in Item 8.



17. Disassembly of pump case
Loosen locknut (82) of minimum swash plate angle adjustment screw (81), then remove screw (81).
- ★ Before loosening the locknut, measure the dimension between the end face of the locknut and the end face of the screw.



ASSEMBLY OF MAIN PUMP

★ Clean all part, remove all burrs, and check for dirt or damage. Coat the rotating and sliding surfaces of all parts with engine oil (EO10-CD) before installing.

Always check the following parts before assembling.
i) Check contact of cradle and rocker cam (for details, see procedure for checking contact).
ii) Check contact between cylinder block and valve plate (for details, see procedure for checking contact).
iii) Check contact between valve plate and end cap (for details, see procedure for checking contact).

- **Assembly of front pump assembly**

1. Shaft, cradle assembly

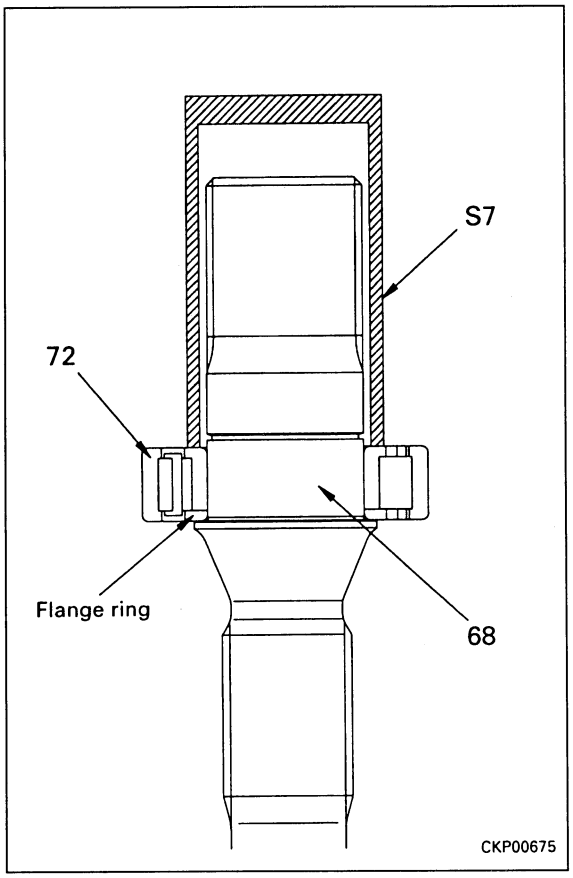
- **Assembly of shaft and cradle assembly**

1) Assemble flange ring to shaft (68), then use tool **S7** to press fit bearing (72).

Press-fitting surface of bearing: **Grease (G2-LI)**

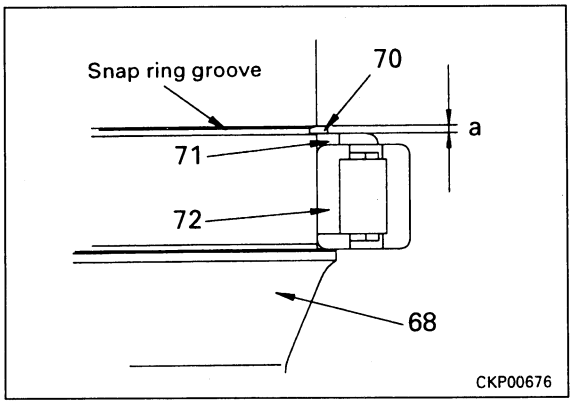
★ When press fitting the bearing, push the end face of the bearing, push the end face of the bearing inner race with tool **S7**.

2) Assemble washer (71), and install snap ring (7)).



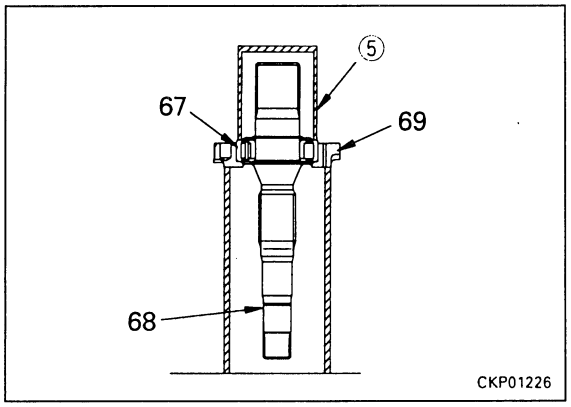
- **Method of selecting lock washer (71)**

i) After press fitting bearing (72) to shaft (68), assemble washer (71) (removed dureing disassembly).
ii) Measure clearance dimension "**a**" between end face of assembled washer (71) and snap ring groove.
★ Clearance dimension "**a**" : **1.45 - 1.60 mm**
iii) If clearance "**a**" is not within above standard value, select waher from table below assemble.

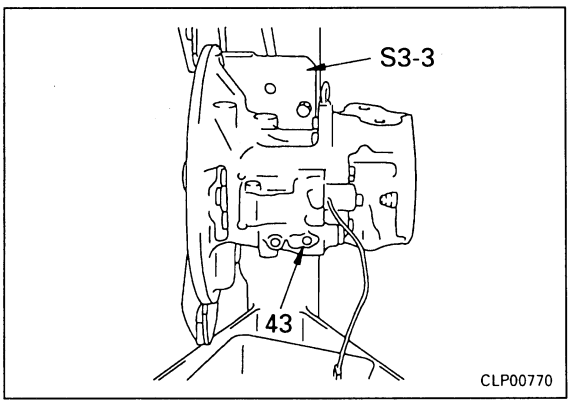


Washer Part No.	708-17-12750	708-17-12760	708-17-12770
Washer thichness (mm)	3.0	3.1	3.2

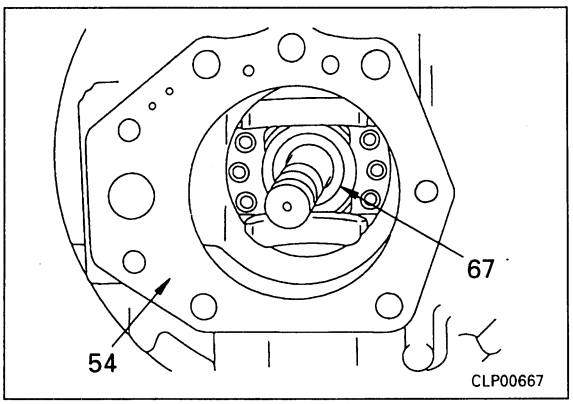
3) Using push tool ⑤, press fit cradle (69) to shaft (68) to make shaft and cradle assembly (67).
Press-fitting surface of bearing:
Grease (G2-LI)
★ When press fitting the bearing, push the end face of the bearing outer race with push tool ⑤.



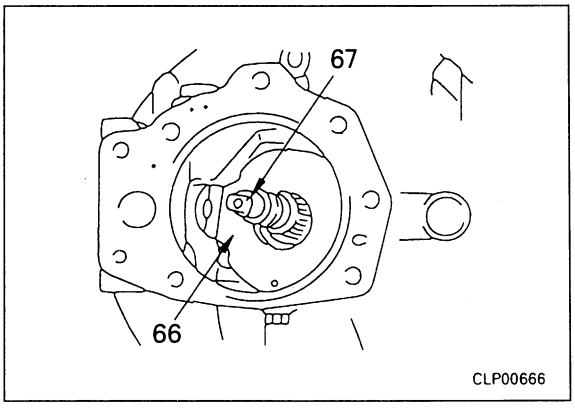
4) Set pump case (54) to tool **S3-3.**



5) Fit dowel pin and O-ring to bottom sruface of inside of pump case (54), then install shaft and cradle assembly (67).
Cradle mounting bolt:
110.3 ± 12.3 Nm (11.25 ± 1.25 kgm)
★ Check that there is no rising and that the pin does not fall out.
★ be extremely careful that the O-ring does not come out or get caught.



2. Rocker cam
Assemble rocker cam (66) to shaft and cradle assembly (67).

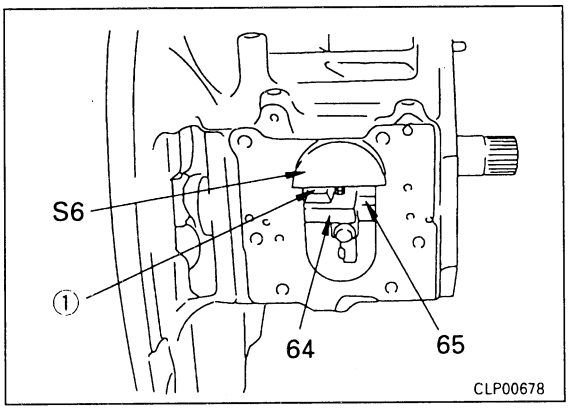


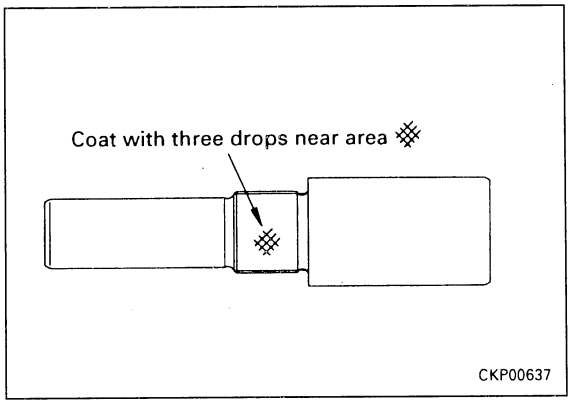
3. Servo piston assembly

1) Assemble spherical portion of rod (64) to rocker cam.
   ★ When assembling the rod, assemble with the spring seat surface facing in the direction of assembly.
2) Fit piston (65), set too **S6** on opposite side from when loosening, set spacer 1 on fron end of rod (64), and tighten pistoen (65).
   ★ Before tightening piston (65), move to the side so that the width across flats of the rocker cam comes out from the width across flats of the cradle.
   (This is to prevent damage to the rocker cam and cradle when tightening the piston.)


Near # area of piston thread in diagram on right:
Coat with three drops of adhesive (Loctite 648)


Piston:
475.6± 34.3 Nm (48.5 ± 3.5 kgm)





4. Positioning minimum swash plate angle

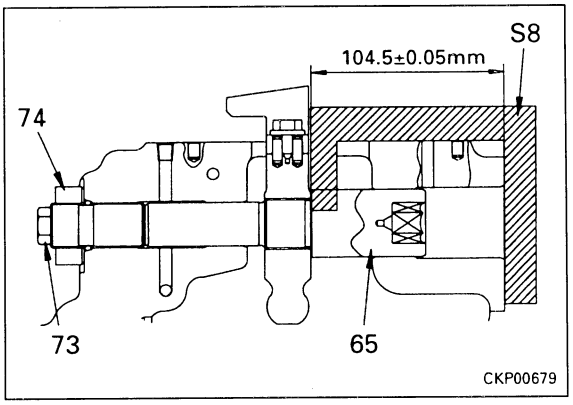
1) Remove 2 dowel pins from servo valve assembly mounting surface.
2) Set tool **S8** in position.
3) Assemble O-ring and tighten screw (73) until it contacts piston (65).

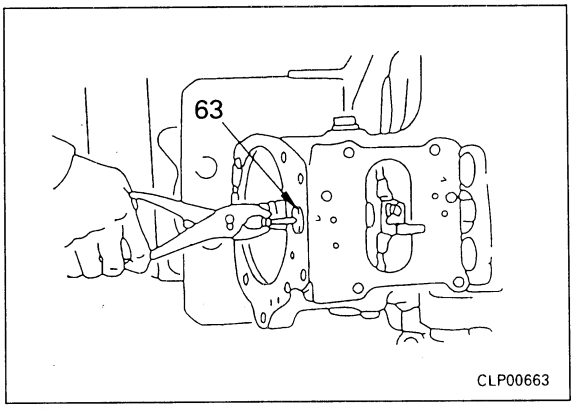

Screw:
12.3 ± 2.5 Nm (1.25 ± 0.25 kgm)

4) Tigthe locknut (74) to hold screw (73) in position.


Locknut:
254.9 ± 29.4 Nm (26 ± 3 kgm)

★ After completion of assembly, carry out a bench test to check the minimum flow.
★ Assemble the spring after measuring the rotating torque of the pump assembly.
(5) Assemble backup ring and o-ring to stopper (63), and install to case.

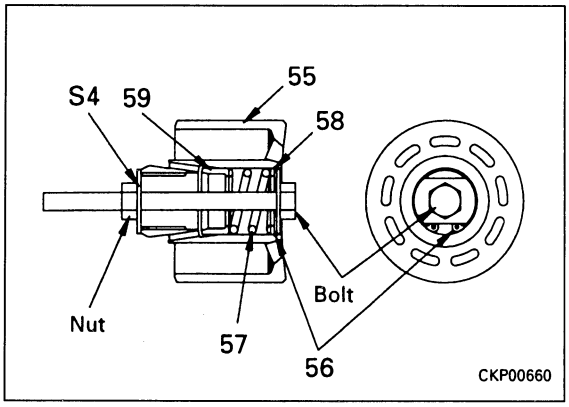




5. Cylinder block, piston assembly

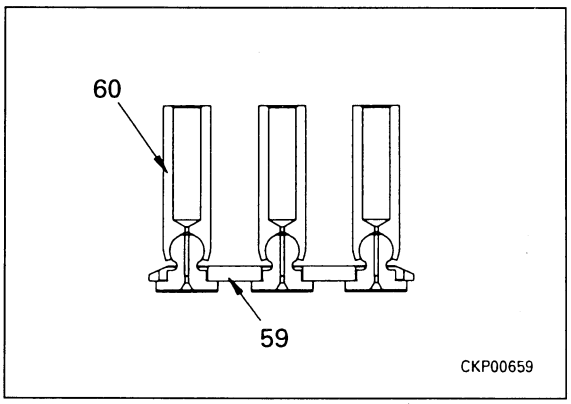
- **Assembly of cylinder block**

1) Assemble seat (59), spring (57), and seat (58) to cylinder block (55).
   ★ Assemble with the taperaed portion on the inside of seat (59) facing down.
2) Set tool **S4** to cylinder block (55).
3) Hold bolt of tool **S4** with wrench, tighten nut to compress spring (57), then install snap ring (56).
   * Check that the snap ring is fitted secrurely in the groove.
4) Remove tool **S4**.



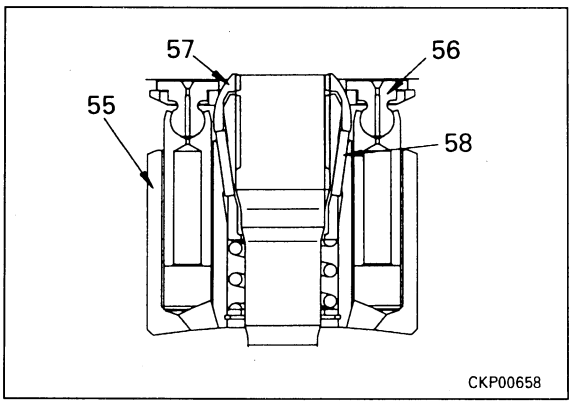
- **Assembly of piston assembly**

5) Assemble piston (60) to retainer shoe (59).



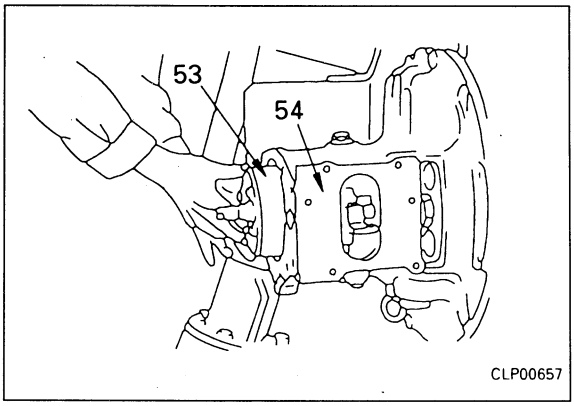
- **Assembly of cylinder block and piston assembly**

6) Assemble 3 preload pins (58) to cylinder block (55).
   • To prevent the preload pins from coming out, coat the pins with grease (G2-LI).
7) Assemble retainer guide (57) to cylinder block (55) then install piston assembly (56) to make cylinder block and piston assembly (53).
   • Align the spline for the cylinder block and retainer guide.



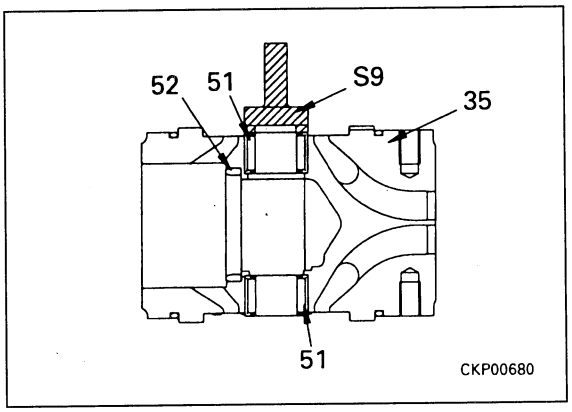
- **Installation of cylinder block and piston assembly**

8) Install cylinder block and piston assembly (53) to pump case (54).
   ★ Before assembling the cylinder block and piston asssembly, assemble the width across flats of the rocker cam to the cradle securely.



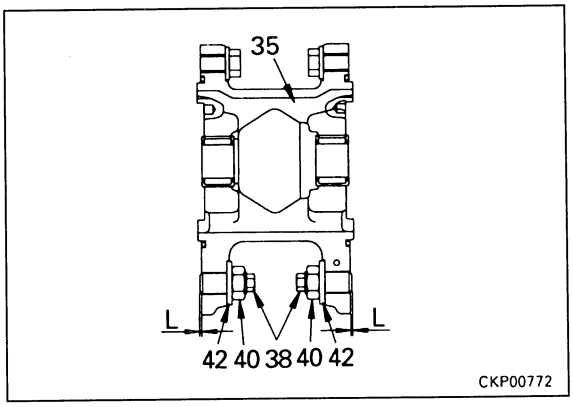
6. Assembly of end cap

1) Install bushing (52) to end cap.
2) Using tool **S9**, press fit bearing (51) until it comes into contact with end cap (35).
   Press-fitting surface of bearing:
   Grease (G2-LI)
3) Install 2 dowel pins for pump case and 2 dowel pins for valve plate to end cap.



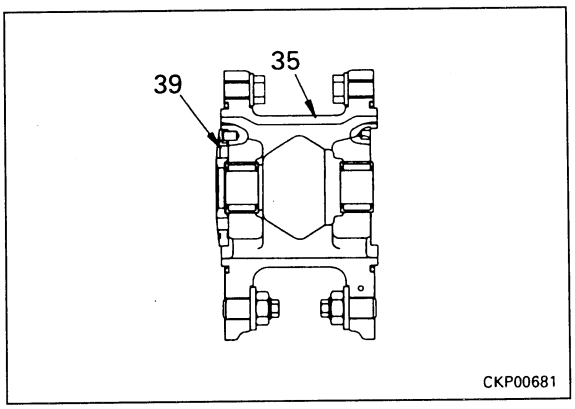
7. Positioning maximum swahs plate angle

1) Install screw (38), locknut (40), and washer (42) to end cap.
   ★ Adjust so that the protrusion of screw (3*) fromt the matin surface of the case with en cap (35) is dimension **L**.
   ★ Dimension **L**: 1.9 mm
2) Tighten locknut (40) to hold in position.
   kgm Locknut: **254.9 ± 29.4 Nm (26 ± 3 kgm)**

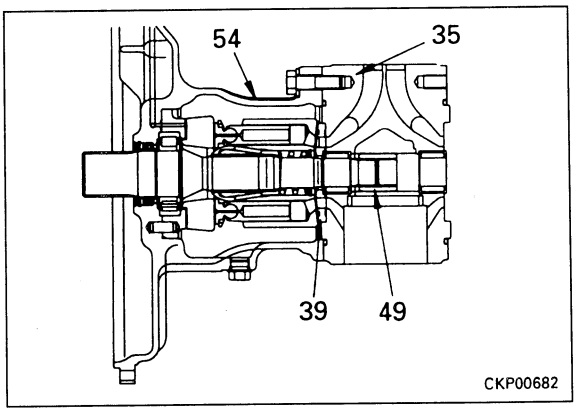


8. End cap assembly

1) Assemble valve plate (39) to end cap (35).
   ★ Align the dowel pin and pin hole to install.
   ★ Check that there is no interference with the bearing and dowel pin.
   ★ Check that the end cap and valve plate port hoes are aligned.
   ★ Do not hit the valve plate or apply any impact when assembling.
   (There is danger that this will damage the sliding surface or cause distortion.)

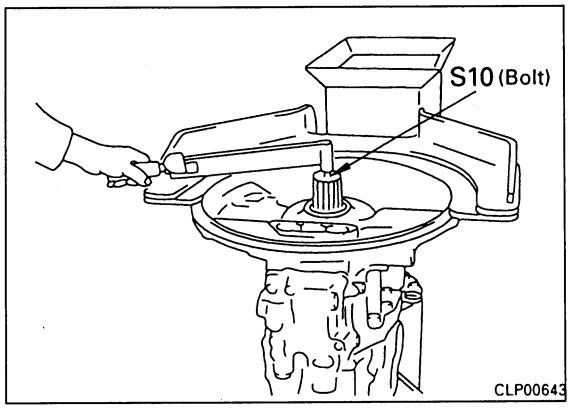


2) Assemble end cap assembly (35) to front pump case (54).
   ★ Check that there is no rising and that the pin does not fall out.
   ★ Be extremely careful that the O-ring does not come out or get caught.
   Mating surface of pump case:
   Gasket sealant (LG-7 or LGG-5)
   kgm Mounting bolt:
   384.9 ± Nm (39.25 ± 4.25 kgm)



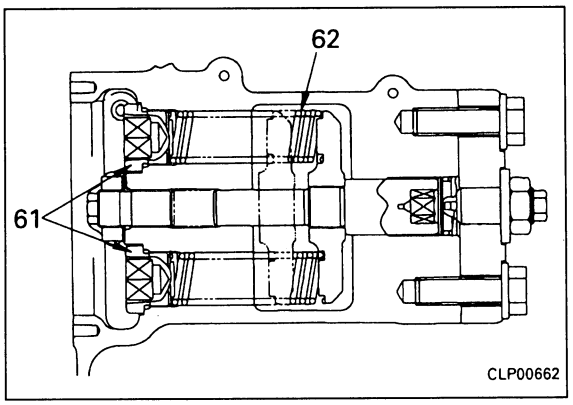
9. Measuring rotating torque of pump assembly

1) Set tool **S10** to pump shaft.
2) Set torque wrench to tool S10, rotate shaft at low speed (3 - 5 sec/1turn) and measure rotating torque.
   - ★ When checking the rotating smoothly without any variation.
   - • Variation range:
     Max. 2.9 Nm (0.3 kgm)
   - • Rotating torque:
     Max. 24.5 Nm (2.5 kgm)
   - ★ If there is any abnormality in the rotating torque, disassemble againr and check.
3) Install coupling (49) to front pump drive shaft through impeller mounting hole.

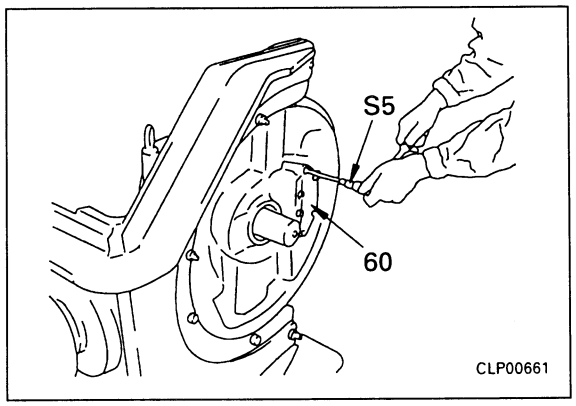


10. Servo piston spring

1) Assemble spring (62)
2) Fit O-ring and install plug (61).
   kgm Plug:
   151.9 ± 24.5 Nm (15.5 ± 2.5 kgm)



3) Using tool **S5**, tighten mounting screws and install cover (60).
   kgm Mounting screw:
   30.9 ± 3.4 Nm (3.15 ± 0.35 kgm)



11. Servo valve assembly

1) Assembly of servo valve assembly LS valve

- **LS valve**

i) Assemble spool (31), piston (30), and sleeve (29) to body, then fit O-ring and install plug (28).

kgm Plug (28):
110.3 ± 12.3 Nm (11.25 ± 1.25 kgm)

★ Check that the relative movements of the body and spool (31), and sleeve (29) and piston (30) are smooth.

ii) Assemble seat (27), spring (26), and seat (25), then fit backup ring and O-ring and install plug (24).

iii) Tighten locknut (23).

kgm Locknut (23):
68.6 ± 9.8 Nm (7 ± 1 kgm)

★ Install so that the dimension between the end face of locknut (23) and the end face of plug (24) is the dimension measured during disassembly.

iv) After completion of assembly, carry out a bench test of the performance and make final adjustment of plug (24).

- **TVC valve**

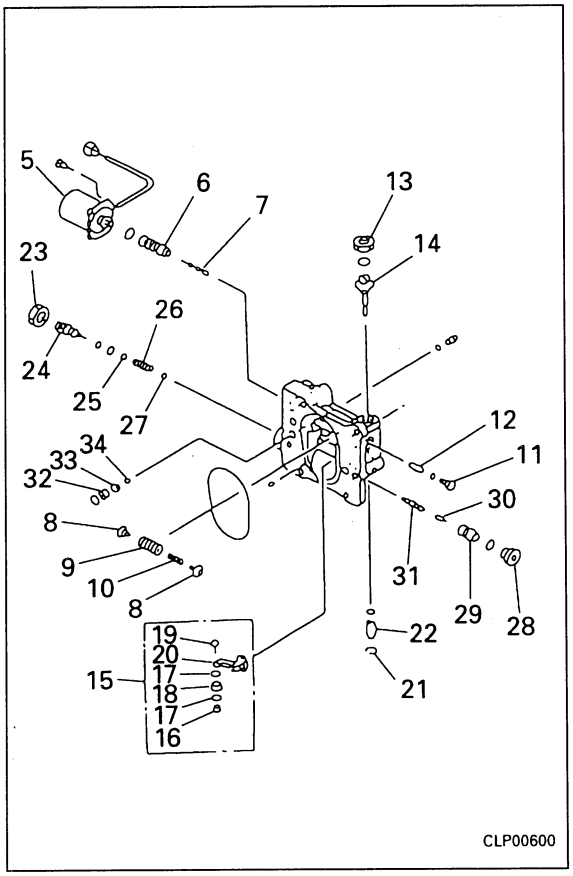
i) Fit O-ring and assemble plug (22), then install snap ring (21).

ii) Install pin (19), washer (17), bearing (18), and nut (16) to lever (20) to make lever assembly (15).

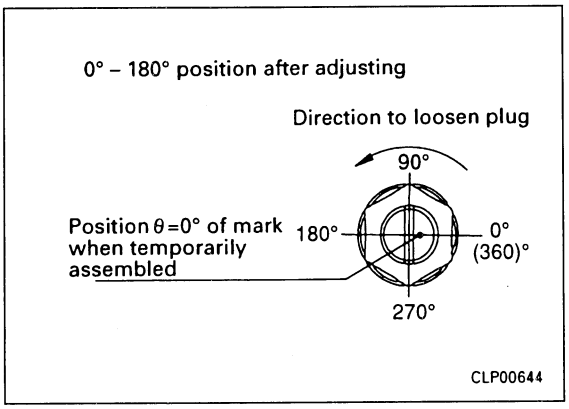
kgm Nut (16):
10.8 ± 0.98 Nm (1.1 ± 0.1 kgm)

Nut (16):
Thread tightener (Loctite 648)

★ Check that the movement of lever (20) and bearing (18) is smooth.



iii) Fit O-ring to plug (14), then install to lever assembly (15) and body.
★ Tighten to a point where the tip of plug (14) is in contact with plug (22), then turn back at least 180° in the direction of loosening and move the mark to the position $\theta = 0°$ in the diagram on the right.
★ If the position of the mark is between the 180 and 360 positions in the diagram on the right at the point where the tip of plug (14) contacts plug (22), turn back at least 1 turn to the temporary assembly position ($\theta = 0°$).



iv) Tighten locknut (13)
kgm Locknut (13):
29.4 ± 4.9 Nm (3 ± 0.5 kgm)
★ Check that the movement of lever (20) and plug (22) and plug (14) is smooth.

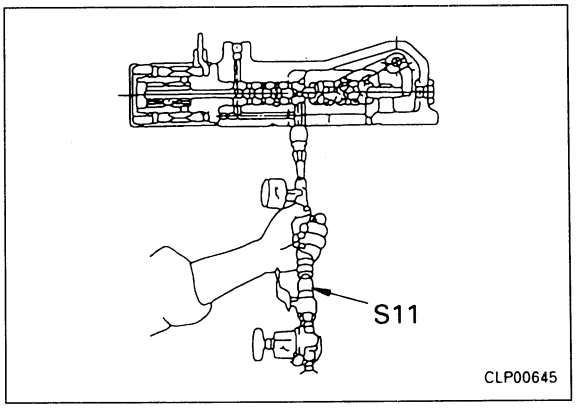
v) Assemble piston (12), then fit O-ring and install plug (11).
kgm Plug (11) :
11.3 ± 1.5 Nm (1.15 ± 0.15 kgm)

vi) Assemble spool (7) to sleeve (6), then install to body together with seat 98), and springs (9) and (10).
★ Chekc that the relative movement of sleeve (7) and spool (6) is smooth.

vii) Install O-ring, then install solenoid assembly (5).
kgm Solenoid assembly mounting bolt:
13.2 ± 1.5 Nm (1.35 ± 0.15 kgm)
Mating surface of solenoid assembly:
Gasket sealant (LG-7 or LG-5 (Loctite 572/575))

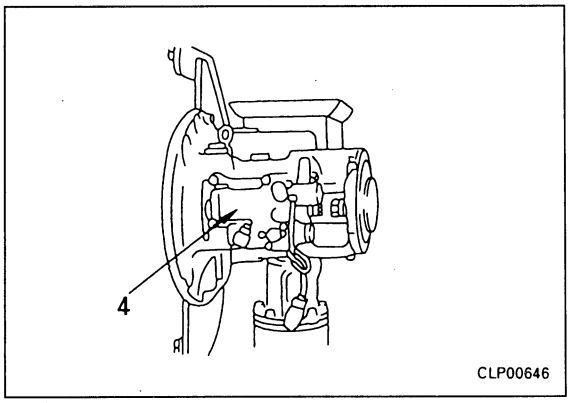
viii) Using tool **S11**, check that there is no leakage of oil or air form mating surface of solenoid assembly.
★ Air pressure: 0.5 MPa (5 kg/cm²)

ix) After completion of assembly, carry out a bench test to check performace, and make final adjustment of plug (14).



- Assemble ofifice (34), and install spacer (33), filter (32), and O-ring.
  kgm Orifice (34):
  9.8 ± 1.9 Nm (1.0 ± 0.2 kgm)

  2) After completion of assembly, carry out bench test of servo valve assembly (4) as an individual part to check performace, and carry out adjustment.
  3) Install 2 knock pins to pump end.
  4) Fit O-ring and filter to servo valve assembly (4) and install to pump case.
     ★ Install the filter so that the mesh end is at the front face end of the valve body.
     ★ Be extremely careful that the O-ring and filter do not fall out.
     ★ Tighten the mounting bolts fradually in turn on opposition sides.
     kgm Mounting bolt:
     66.2 ± 7.4 NM (6.75 ± 0.755 kgm)
     Mating sruface of servo valve:
     Gasket sealant (LG-7 or LG-5)



- **Assembly of rear pump assembly**

12. Shaft, cradle assembly
Same operation as in Item 1. (Set pump case to tool **S3-4**.)
★ Be careful not to mistake the dowel pin hole and control pump oil hole in the operation in Step 1-5).

13. Rocker cam
Same operation as in Item 2.

14. Servo piston assembly
Same operation as in Item 3.

15. positioning minimum swash plate angle
Same oeration as in Item 4.

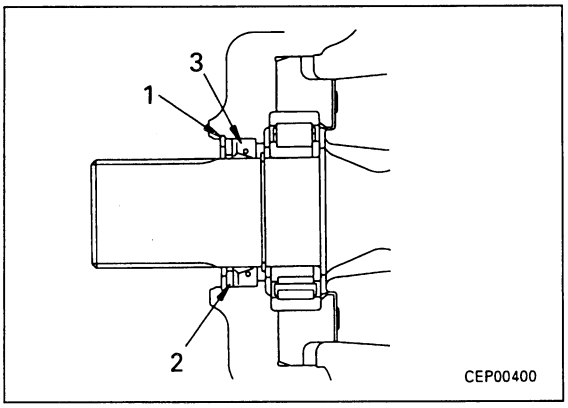
16. Cylinder block, piston assembly
Same operation as in Item 5.

17. positioning maximum swash plate angle
Same operation as in Item 8.

18. Servo piston spring
Same operation as in Item 11.

19. Servo valve assembly
Same operation as in Item 12.

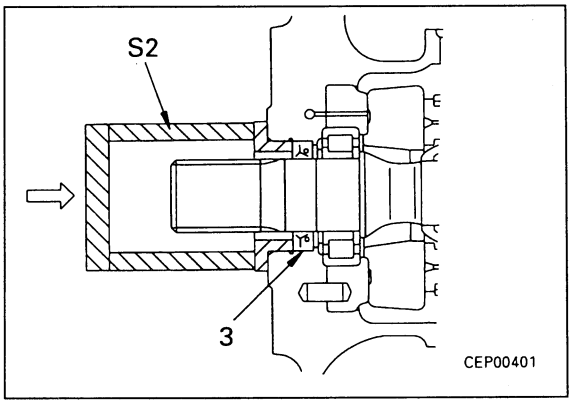
REMOVAL OF MAIN PUMP INPUT SHAFT OIL SEAL



1. Remove main pump assembly.
   For details, see REMOVAL OF MAIN PUMP ASSEMBLY.
2. Remove snap ring (1), then remove spacer (2).
3. Lever up oil seal (3) with a screwdriver to remove. ※ 1

   ★ When removing the oil seal, be extremely carful not to damge the shaft.

INSTALLATION OF MAIN PUMP INPUT SHAFT OIL SEAL



- Carry out installation in the reverse order to removal.

※ 1

Lip of oil seal: **Grease (G2-LI)**

Coat the outside circumference of the oil seal with grease (G2-LI) thinly, then press fit.

★ Using tool **S2**, press fit oil seal (3).

REMOVAL OF CONTROL VALVE ASSEMBLY

⚠ Lower the work equipment completely to the ground and stop the engine. Then loosen the oil filler cap slowly to release the pressure inside the hydraulic thank.

⚠ Release the remaining pressure in the hydraulic circuit.
For details, see TESTING AND ADJUSTING, Releasing pressure in hydraulic circuit.

★ Make match marks before disconnecting the PPC circuit hoses.

★ Fit blind plugs in the disconnected hoses and tubes.

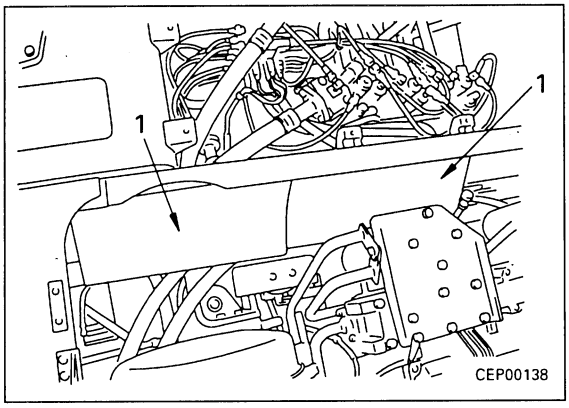
1. Open engine hood.

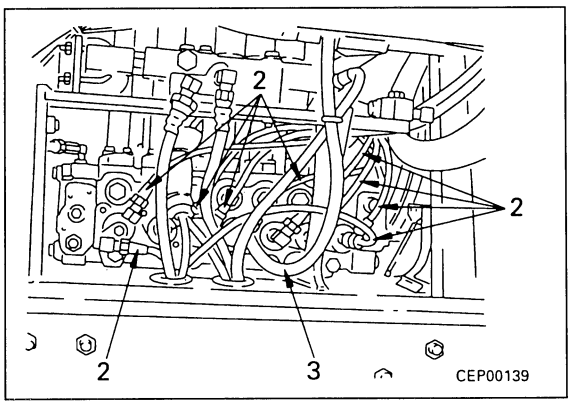
2. Remove control valve top cover.

3. Remove partitions (1) (2 pieces).

4. Disconnect 9 bottom PPC hoses (2).

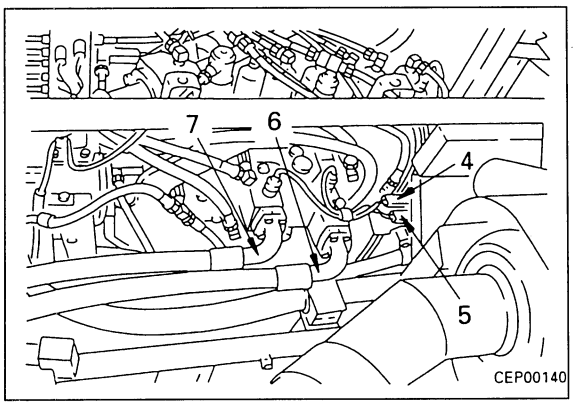
5. Disconnect pump merge/divider solenoid hose (3).



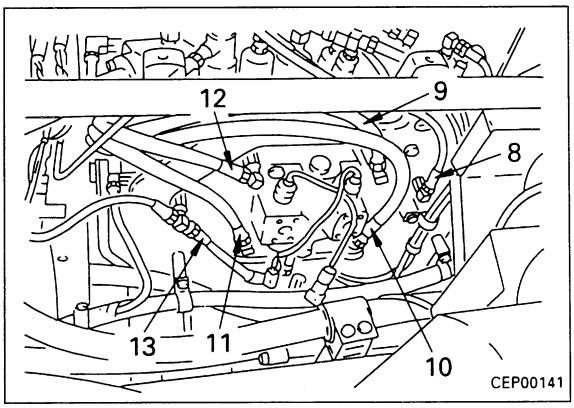


6. Disconnecct pressure sensor connectors (4) and (5) (CN-C08 and CN-C07).

7. Disconnect main pump outlet hoses (6) and (7).

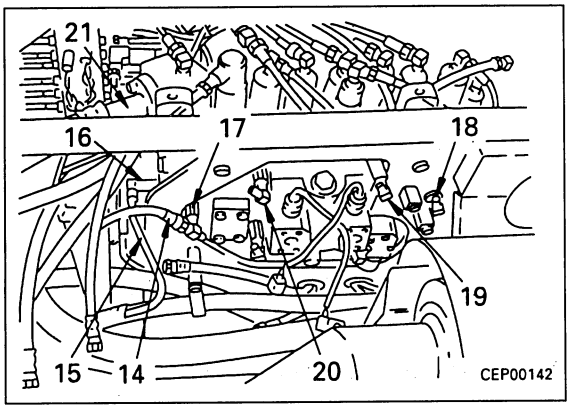


8. Disconnect hoses (8), (9), (10), (11), (12), and (13).
★ Hose (8): For arm boost PPC
Hoses (9) and (10): For R.H. straight travel
Hoses (11) and (12): For L.H. straight travel
Hose (13): For drain circuit

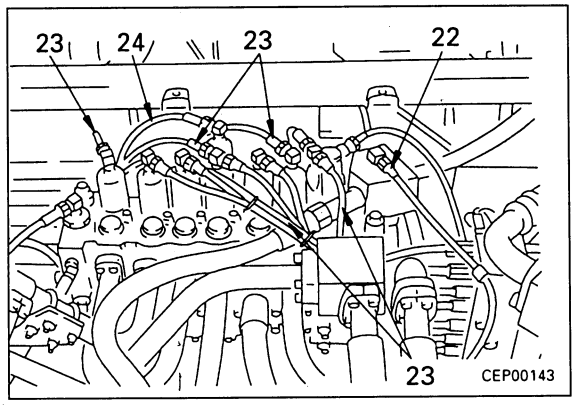


9. Disconnect hoses (14) and (15).
   ★ Hose (14): For drain circuit
   Hose (15): For high-pressure circuit

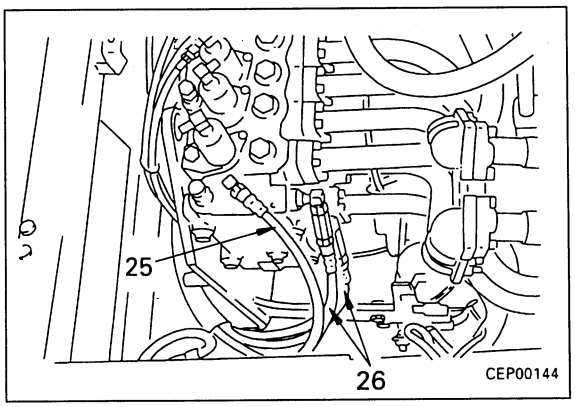
10. Remove elbows (16), (17), and (18).
11. Set hose mounts of elbows (19) and (20) facing down.
12. Disconnect control valve return hose (21).



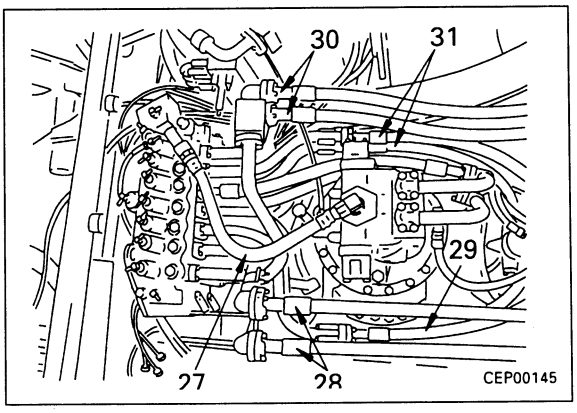
13. Disconnect drain hose (22).
14. Disconnect 10 top PPC hoses (23).
15. Disconnect safety valve hose (24).



16. Disconnect high-pressure circuit hose (25) and LS pressure (26).



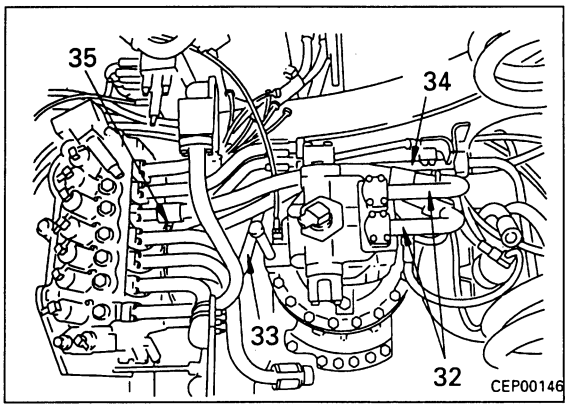
17. Disconnect swing motor suction hose (27).
18. Disconnect bucket hoses (28).
19. Disconnect 2 R.H. travel hoses (29).
20. Disconnect arm hoses (30).
21. Disconnect L.H. travel hoses (31).



22. Remove swing motor hoses (32).

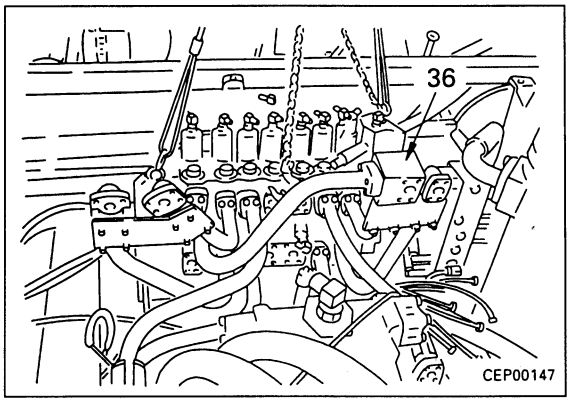
23. Remove boom tubes (33) and (34).

24. Disconnect LS select valve hose (35).



25. Sling control valve assembly (36), then remove mounting bolts, and lift off control valve assembly.
    ★ Move slightly to the front and pass through the bracket to lift off.

    kg Control valve assembly: **260 kg**



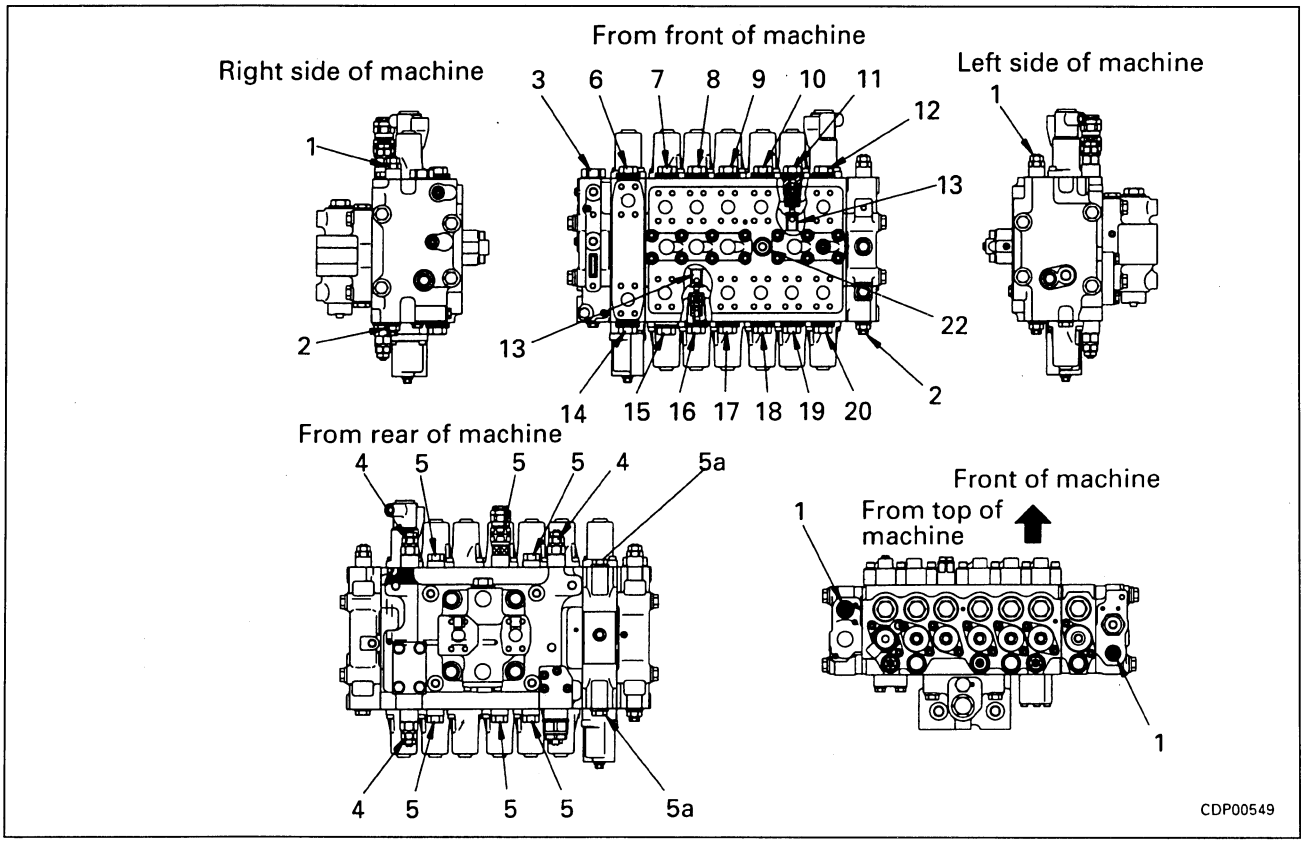
INSTALLATION OF CONTROL VALVE ASSEMBLY

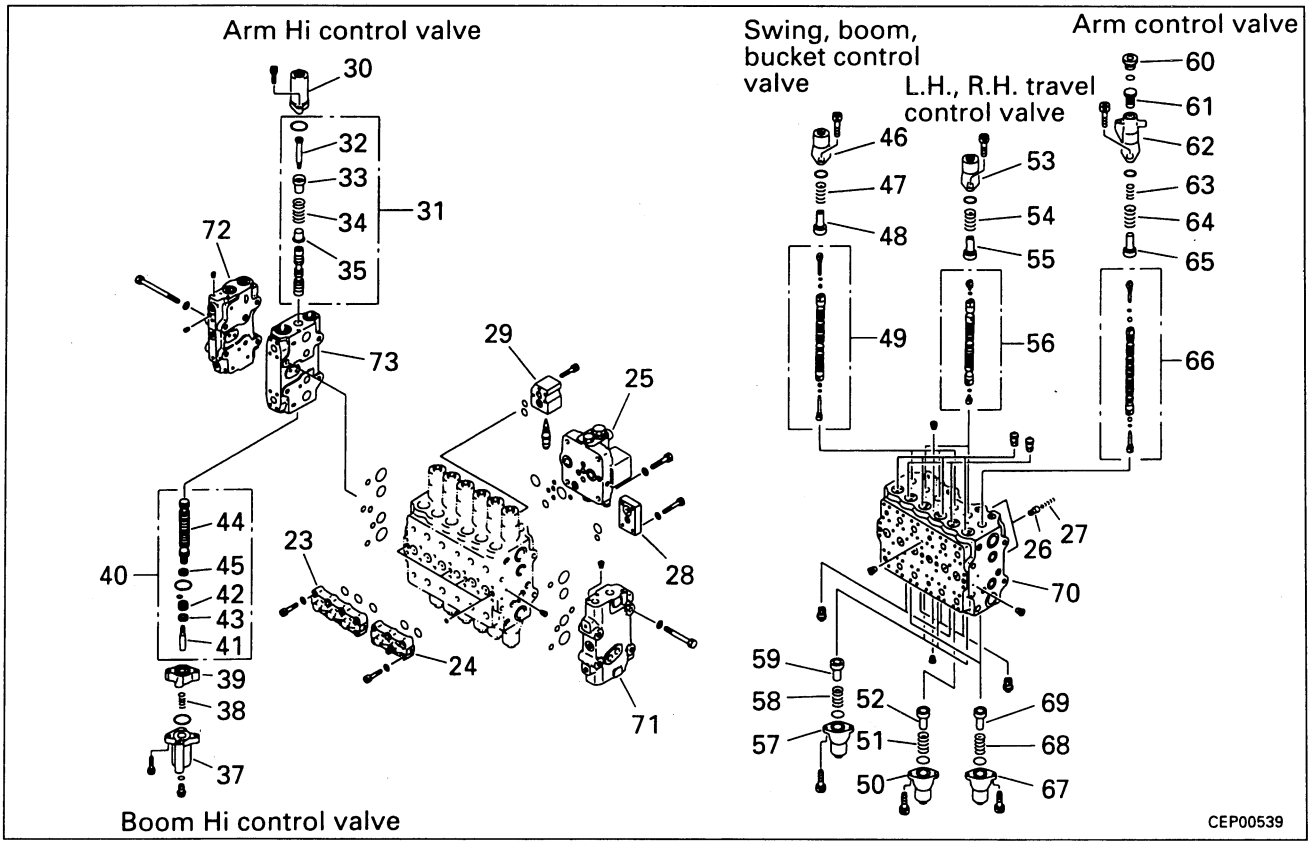
- Carry out installation in the reverse order to removal.

- **Refilling with oil (hydraulic tank)**
  ★ Add oil through the oil filler to the specified level. Run the engine to circulate the oil through the system. Then check the oil level again.

DISASSEMBLY OF CONTROL VALVE ASSEMBLY

Note: Control valve assembly has additional spool fitted as standard (For HCU circuit)





★ The set pressure of the safety valve and arm counterbalance valve cannot be adjusted when they are installed on the machine, so do not disassemble.

1. Main relief valve, unload LS relief valve.
1) Remove main relief valve (1).
2) Remove unload LS relief valve (2) and sleeve (3).

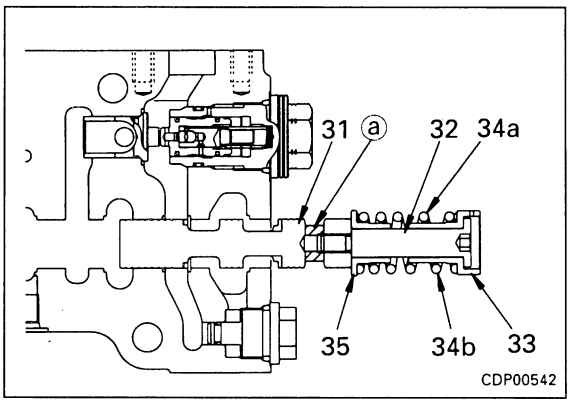
2. Safety-suction valve, suction valve.
1) Remove safety-suction valve (4).
2) Remove suction valve (5).
3) Remove plug (5a).

3. Pressuree compensation valves
* Before removing any pressure compensation valve, check and mark its mounting position.
1) Remove arm Hi IN pressure compensation valve (6), bucket DUMP pressure compensation valve (7), R.H. travel REVERSE pressure compensation valve (8), boom LOWER pressure compensation valve (9), right swing pressure compensation valve (10), L.H. travel REVERSE pressure compensation valve (11), and arm IN pressure compensation valve (12).
★ After removing the pressure compensation valves, remove check valve (13) from each pressure compensation valve mount.
2) Remove boom Hi RAISE pressure compensation valve (14), bucket CURL pressure compensation valve (15), R.H. travel FORWARD pressure compensation valve (16), boom RAISE pressure compensation valve (17), left swing pressure compensation valve (18), L.H. travel FORWARD pressure compensation valve (19), and arm OUT pressure compensation valve (20).
★ After removing the pressure compensation valves, remove check valve (21) from each pressure compensation valve mount.

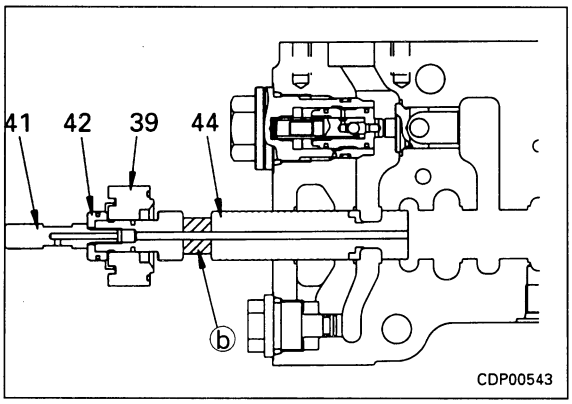
4. LS select valve.
Remove LS select valve (22).

5. **LS shuttle valves, pump merge/divider valve, regeneration valve, block.**
   1) Remove LS shuttle valves (23) and (24).
   2) Remove pump merge/ divider valve (25), then remove spring (26) and valve (27).
   3) Remove regeneration valve (28), then remove spring (26) and valve (27).
   4) Remove block (29).

6. **Boom Hi, arm Hi control valves.**
   - **Arm Hi control valve**
     ★ Mark with tags to prevent mistakes in the mounting position when assembling the springs and spools.
   1) Remove case (30), then pull out spool assembly 931) to position shown in diagram on right.
   2) To prevent damage to spool assembly (31), hold position a shown in diagram on right with a wrench (width across flats: 24mm), remove plug (32), then disassemble into retainer (33), springs (34a) and (34b), retainer (35), and spool (36).



   - **Boom Hi control valve**
     ★ Mark with tags to prevent mistakes in the mounting position when assembling the springs and spools.
   3) Remove case (37), then remove spring (38) and plate (39).
   4) To prevent damage to spool assembly (40), hold position b shown in diagram on right with a wrench (width across flats: 24 mm), remove plug (41), then remove valve.
   5) Remove seal (43) from valve (42), then remove seal (45) from spool (44).



7. Swing, boom, bucket control valves.

★ Mark with tags to prevent mistakes in the mounting position when assembling the springs and spool assembly.

★ Do not disassemble the spool assembly.

1) Remove case (46), then remove spring (47) and retainer (48).
2) Remove spool assembly (49).
3) Remove case (50), then remove spring (51) and retainer (52).

8. L.H. travel, R.H. travel control valves

★ Mark with tags to prevent mistakes in the mounting position when assembling the springs and spool assembly.

★ Do not disassemble the spool assembly.

1) Remove case (53), then remove spring (54) and retainer (55).
2) Remove spool assembly (56).
3) Remove case (57), spring (58), and retainer (59).

9. Arm control valve

★ Mark with tags to prevent mistakes in the mounting position when assembling the springs and spool assembly.

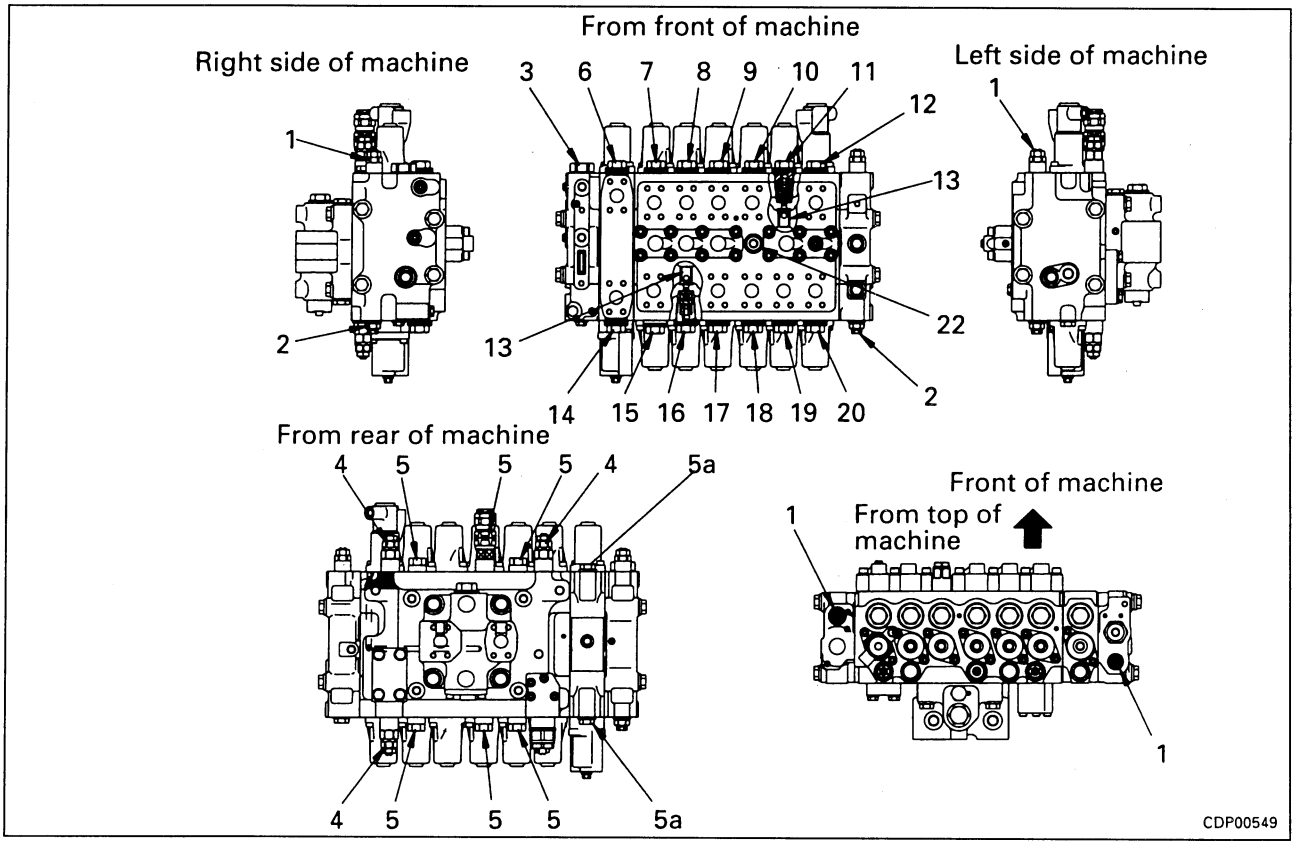
★ Do not disassemble the spool assembly.

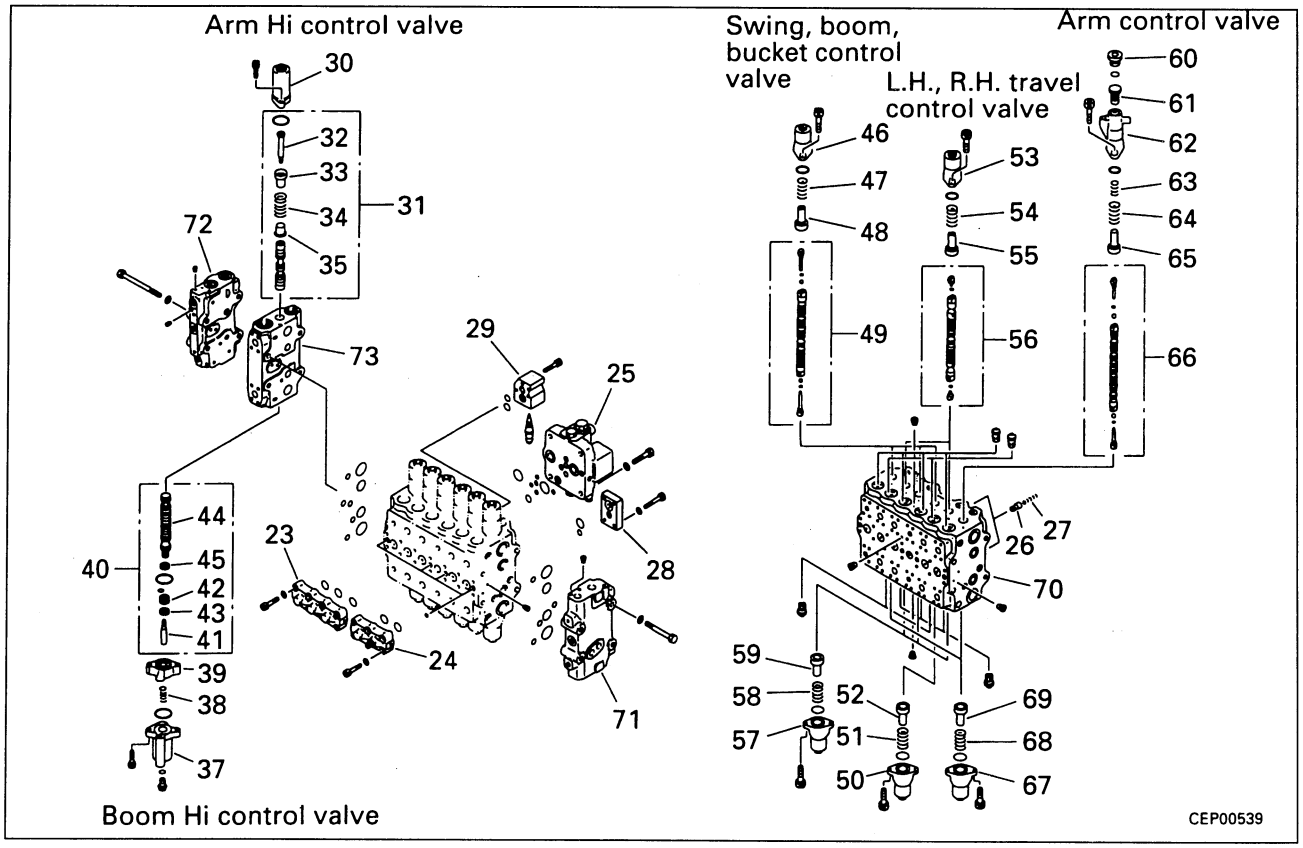
1) Remove plug (60), then remove valve (61).
2) Remove case (62), then remove springs (63) and (64), and retainer (65).
3) Remove spool assembly (66).
4) Remove case (67), then remove spring (68) and retainer (69).

10. Covers

Remove covers (71) and (72), and valve (73) from valve body (70).

ASSEMBLY OF CONTROL VALVE ASSEMLBY





★ Check the spools and valves for dirt, damage, or burrs. Coat the sliding surfaces of all parts with engine oil before installing.

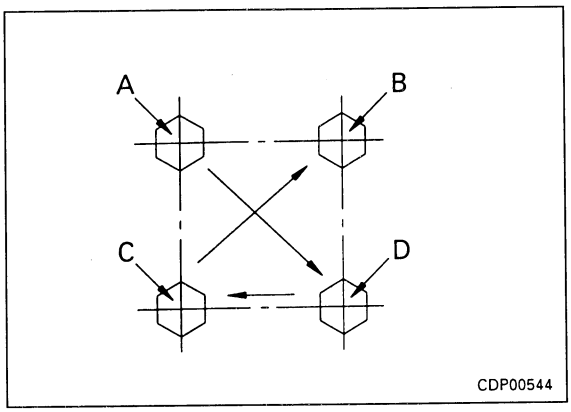
1. Covers

Install valve (73), and covers (72) and (71) to valve body (70).

★ Check that there is no damage to the O-ring, then install securely to the mating surface of the cover and valve.

★ Tighten the mounting bolts of covers (72) and (71) in the order shown in the diagram on the right.

kgm Cover mounting bolt:
166.7 ± 9.8 Nm (17 ± 1 kgm)



2. Arm control valve spool

★ Check the mounting position of the springs and spool assembly before installing.

1) Assembel spool assembly (66) to valve body (70), and fit retainer (69) and spring (68), then fit O-ring to case (61) and install.
2) Fit retainer (65), and springs (64) and (63) to spool assembly (66), then fit O-ring to case (62) and install.
3) Assemble valve (61), and install plug (60).
4) Tighten mounting bolts of cases (67) and (62) to specified torque.
   kgm Case mounting bolt:
   30.89 ± 3.34 Nm (3.15 ± 0.35 kgm)
5) Tighten plug (60) to specified torque.
   kgm Plug:
   107.9 ± 14.7 Nm (11 ± 1.5 kgm)

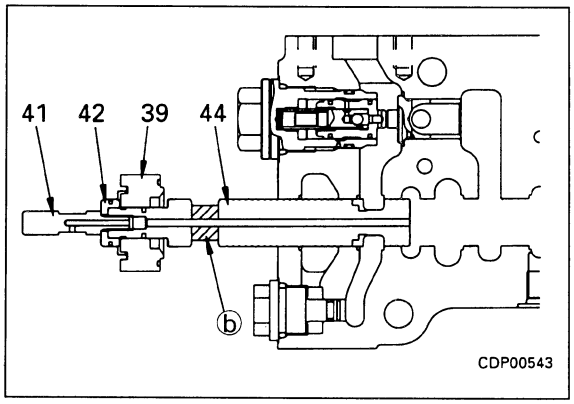
3. L.H. travel, R.H. travel control valves

★ Check the mounting position of the spring and spool assembly before installing.

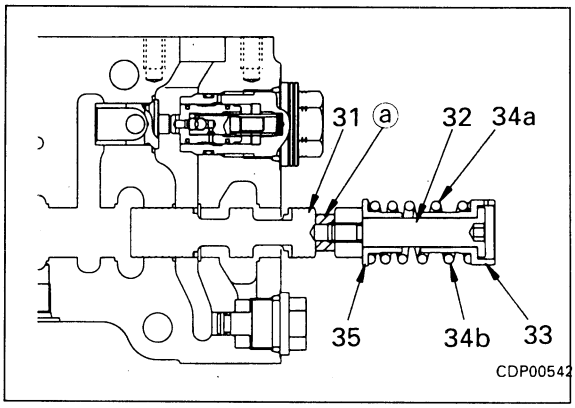
1) Assemble spool assembly (56) to valve body (70), assemble retainer (59) and spring (58), then fit O-ring to case (57) and install.
2) Assemble retainer (55) and spring (54) to spool, then fit O-ring to case (53) and install.
3) Tighten cases (57) and (53) to specified torqeu.
   kgm Case mounting bolt:
   30.89 ± 3.43 Nm (3.15 ± 0.35 kgm)

4. Swing, boom, bucket control valve spools
   ★ Check the mounting position of the springs and spool assembly before installing.
   1) Assemble spool assembly (49) to valve body (70).
   2) Assemble retainer (52) and spring (51), then fit O-ring to case (5) and install.
   3) Assemble retainer (48) and spring (47) to spool, then fit O-ring to case (46) and install.
   4) Tighten mounting bolts of cases (50) and (46) to specified torque.
      kgm Case mounting bolt:
      30.89 ± 3.43 Nm (3.15 ± 0.35 kgm)

5. **Boom Hi, arm Hi control valve spools**
   • **Boom Hi control valve spool**
   ★ Check the mounting position of the spring and spool assembly before installing.
   1) Fit seal (45) to spool (44), and install seal (43) to valve (42).
   2) Assemble spool (44) to position shown in diagram on right, install plate (39) and valve (42) to spool (44), then hold position b shown in diagram on right with a wrench (width across flats: 24 mm), and tighten plug (41).
      kgm Plug:
      13.24 ± 1.47 Nm (1.35 ± 0.15 kgm)
   3) Push spool assembly (40) into body, fit spring (38), then fit O-ring to case (37) and install.
      kgm Case mounting bolt:
      30.89 ± 3.43 Nm (3.15 ± 0.35 kgm)



   • **Arm Hi control valve spool**
   ★ Check the mounting position of the spring and spool assembly before installing.
   1) Assemble spool (31) to position shown in diagram on right, install retainer (35), springs (34a) and 34b), and retainer (33), then install plug (32).
   2) Hold spool (31) at position ⓐ shown in diagram on right with a wrench (width across flats: 24 mm), and tighten plug (32).
      kgm Plug:
      17.16 ± 2.45 Nm (1.75 ± 0.25 kgm)



3) Push spool assembly (31) into body, then fit O-ring to case (30) and install.

kgm Case mounting bolt:
30.89 ± 3.43 Nm (3.15 ± 0.35 kgm)

6. **LS shuttle valve, pump merge/divider valve, regerneration valve, block.**
   1) Install block (29).

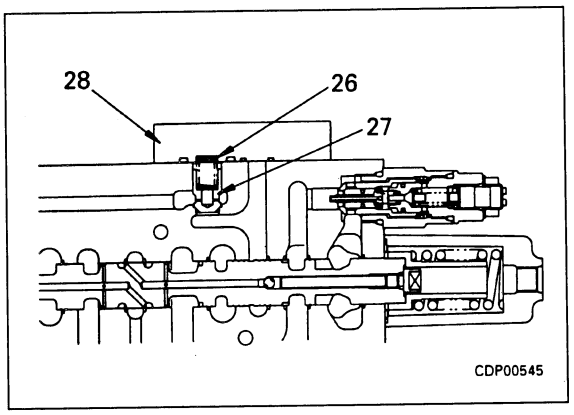
   kgm Block mounting bolt:
   30.89 ± 3.43 Nm (3.15 ± 0.35 kgm)
   2) Assemble valve (27) and spring (26) to valve body (70), fit O-ring to regeneration valve (28), and install.

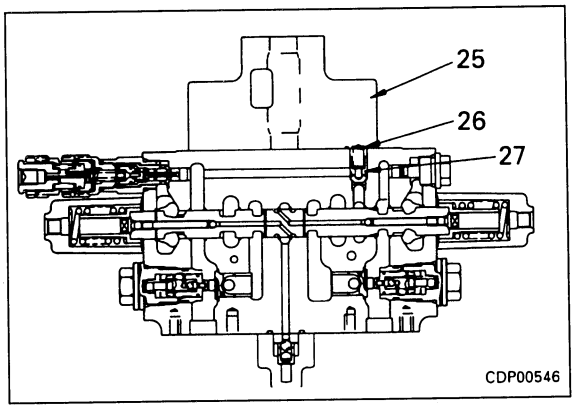
   kgm Valve mounting bolt:
   66.19 ± 7.35 Nm (6.75 ± 0.75 kgm)
   3) Assemble valve (27) and spring (26) to valve body (70), and install pump merge/divider valve (25).

   kgm Mounting bolt:
   166.7 ± 9.8 Nm (17 ± 1 kgm)

   ★ Tighten the mounting bolts of the pump merge/divider valve in the order shown in the diagram on the right.
   4) Install LS shuttle valves (24) and (23).

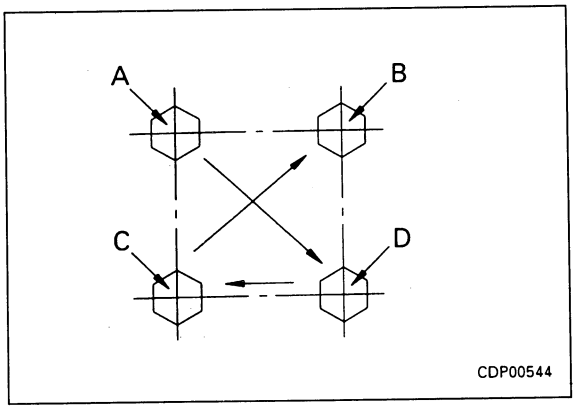
   kgm Mounting bolt:
   66.19 ± 7.35 Nm (6.75 ± 0.75 kgm)





7. **LS select valve**
   Install LS select valve (22).
   LS select valve: 127.5 ± 19.6 Nm (13 ± 2 kgm)

8. **Pressure compensation valves**
   ★ Check the marks made on each pressure compensation valve during disassembly, and install in the correct position.
   1) Before installing pressure compensation valves below, install check valves (21) and (13).
   2) Install arm OUT pressure compensation valve (20), L.H. travel FORWARD pressure compensation valve (19), left swing pressure compensation valve (18), boom LOWER pressure compensation valve (17), R.H. travel FORWARD pressure compensation valve (16), bucket CURL pressure compensation valve (15), and boom Hi RAISE pressure compensation valve (14).



3) Install arm IN pressure compensation valve (12), L.H. travel REVERSE pressure compensation valve (11), right swing pressure compensation valve (10), boom LOWER pressure compensation valve (9), R.H. travel REVERSE pressure compensation valve (8), bucket DUMP pressure compensation valve (7), and arm Hi IN pressure compensation valve (6).

kgm Pressure compensation valve:
392.3 ± 19.6 Nm (40 ± 2 kgm)

9. Safety-suction valve, suction valve

1) Fit O-ring and install suction valve (5).

kgm Suction valve:
147.1 ± 9.8 Nm (15 ± 1 kgm)

2) Fit O-ring and install safety-suction valve (4).

kgm Safety-suction valve:
147.1 ± 9.8 Nm (15 ± 1 kgm)

3) Install plug (5a).
Plug: 147.1 ± 9.8 Nm (15 ± 1 kgm)

10. Main relief valve, unload LS relief valve

1) Fit O-ring and install sleeve (3).

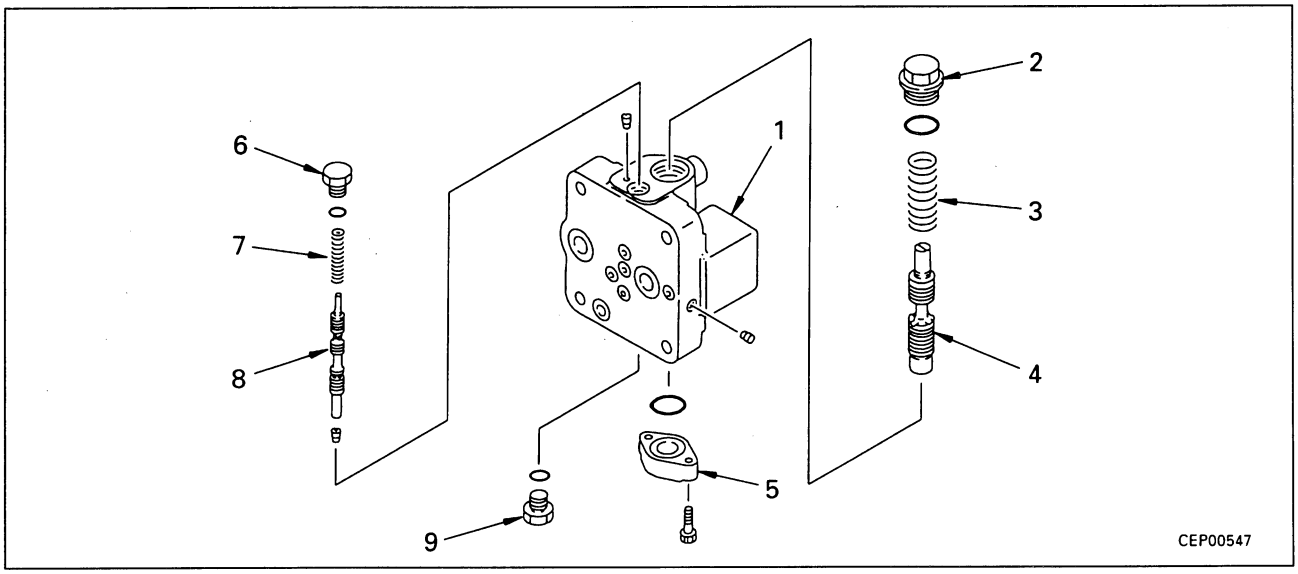
kgm Sleeve:
85.80 ± 7.35 Nm (8.75 ± 0.75 kgm)

2) Fit O-ring and install unload LS relief valve (2).
Unload LS relief valve:
166.7 ± 19.6 Nm (17 ± 2 kgm)

3) Fit O-ring and install main relief valve (1).

kgm Main relief valve:
53.9 ± 4.9 Nm (5.5 ± 0.5 kgm)

DISASSEMBLY OF PUMP MERGE/DEVIDER VALVE ASSEMBLY



1. Remove plug (2) from valve body (1), then remove spring (3) and spool (4).
2. Remove plate (5).
3. Remove plug (6), then remove spring (7) and spool (8).
4. Remove plug (9).

★ After disassembling, if there is any abnormality in body (1) or spools (4) or (8), replace the whole pump merge/divider valve assembly.

ASSEMBLY OF PUMP MERGE/ DEVIDER VALVE ASSEMBLY

- Before assembling, coat the sliding surface with engine oil.

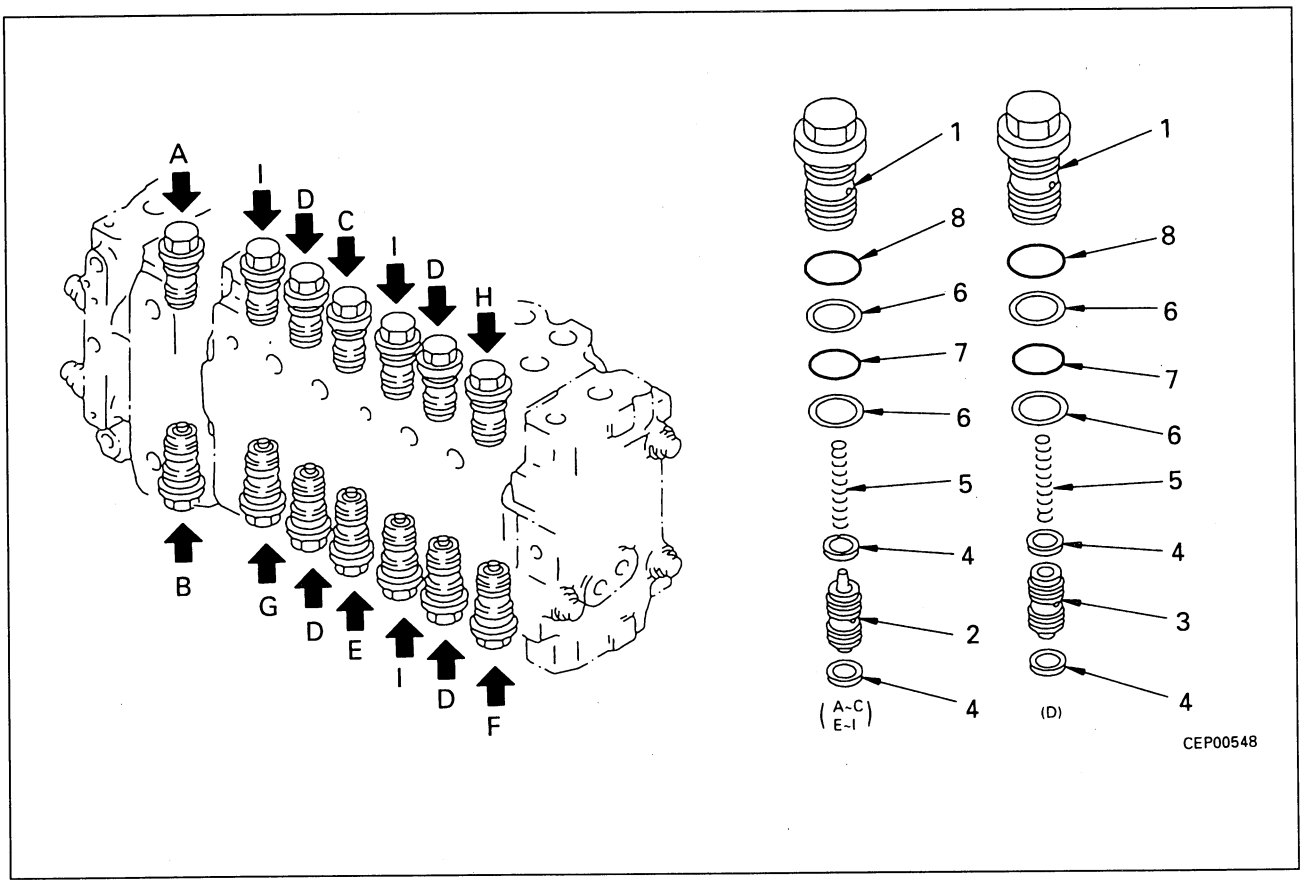
1. Fit O-ring to plug (9) and install to valve bocy (1).
   kgm Plug (9):
   39.2 ± 5.9 Nm (4.0 ± 0.6 kgm)

2. Assemble spool (8) and spring (7), then fit O-ring to plug (6) and install.
   kgm Plug (6):
   39.2 ± 5.9 Nm (4.0 ± 0.6 kgm)

3. Fit O-ring to plate (5) and install valve body.

4. Assemble spool (4) and spring (3), then fit O-ring to plug (2) and install.
   kgm Plug (2):
   152.0 ± 24.5 Nm (15.5 ± 2.5 kgm)

DISASSEMBLY OF PRESSURE COMPENSATION VALVE ASSEMBLY



- The structure of the parts for pressure compensation valves A - I is the same, but the part numbers for the component parts is different, so be careful when assembling.

1. Remove piston sub-assembly (2) and piston (3) from sleeve (1), then remove seal (4).
   ★ Sub-piston assembly (2) is assembled to pressure compensation valves A-C, E-I, and piston (3) is assembled to pressure compensation valves D.
2. Remove spring (5), then remove ring (6) and O-rings (7) and (8) from slleve (1).
   ★ After disassembling, if there is any abnormality in sleeve (1), seal (4), piston sub-assembly (2), or piston (3), replace the whole pressure compensation valve assembly.

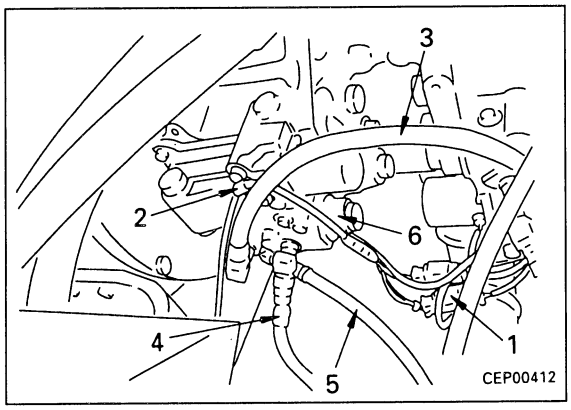
Pressure compensation valves
A: Arm IN Hi
B: Boom RAISE Hi
C: Boom LOWER
D: R.H. travel REVERSE, L.H. travel REVERSE
R.H. TRAVEL FORWARD, L.H. travel FORWARD
E: Boom RAISE
F: Arm OUT
G: Bucket CURL
H: Arm IN
I: Right swing, left swing, bucket dump.

ASSEMBLY OF PRESSURE COMPENSATION VALVE ASSEMBLY

- Before assembling, coat the sliding surface with engine oil.

1. Install O-rings (8) and (7) and ring (6) to sleeve (1).
2. Assemble spring (5), then assemble seal (4) to piston sub-assembly (2) and piston (3), and install to sleeve.

REMOVAL OF SERVO VALVE ASSEMBLY FOR FRONT PUMP



⚠ Disconnect the cable from the negative (-) terminal of the battery.

⚠ Loosen the oil filler cap slowly to release the pressure inside the hydraulic tank.

1. Disconnect TVC solenoid connector (1) (CN-C13).
2. Disconnect clamp (2).
3. Disconnecct LS-EPC hose (3), LS pressure hose (4), and pump circuit pressure hose (5).
   ★ Fit blind plugs in teh disconnected hoses.
4. Remove servo valve assembly (6) for front pump.

※ 1

INSTALLATION OF SERVO VALVE ASSEMBLY FOR FRONT PUMP

- Carry out installation in the reverse order to removal.

※ 1

★ Be careful not to let the O-ring or filter fall out when installing.

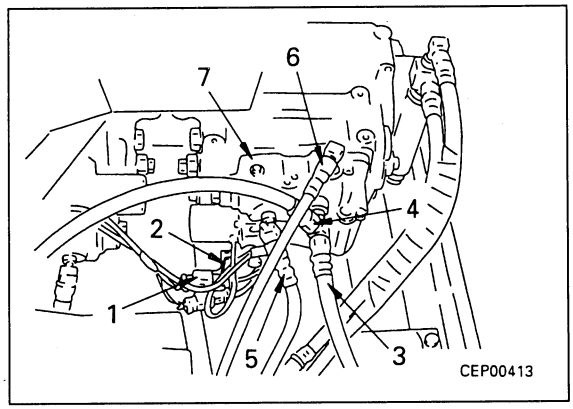
★ Tighten the mounting bolts gradually on opposite sides in turn.

kgm Servo valve mounting bolt:
66.19 ± 7.35 Nm (6.75 ± 0.75 kgm)

★ Check the performance of the work equipment, travel, and swing.
For details, see TESTING AND ADJUSTING.

- **Refilling with oil (hydraulic tank)**
  ★ Add oil through the oil filler to the specified level. Run the engine to circulate the oil through the system. Then check the oil level again.

REMOVAL OF SERVO VALVE ASSEMBLY FOR REAR PUMP



⚠ Disconnect the cable from the negative (-) terminal of the battery.

⚠ Loosen the oil filler cap slowly to release the pressure inside the hydraulic tank.

1. Disconnect TVC solenoid connector (1) (CN-C04).
2. Disconnect connector bracket (2) from servo valve.
3. Disconnect LS-EPC hoses (3) and (4), LS pressure hose (5), and pump circuit pressure hose (6).
   Fit blind plugs in the disconnected hoses.
4. Remove servo valve assembly (7) for rear pump. ※ 1

INSTALLATION OF SERVO VALVE ASSEMBLY FOR REAR PUMP

- Carry out installation in the reverse order to removal.

※ 1

★ Be careful not to let the O-ring or filter fall out when insttalling.

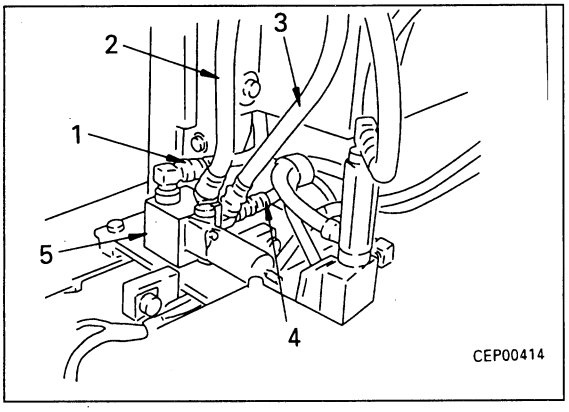
★ Tighten the mounting bolts gradually on opposite sides in turn.

kgm Servo valve mounting bolt:
66.19 ± 7.35 Nm (6.75 ± 0.75 kgm)

★ Check the performance of the work equipment, travel, and swing.
For details, see TESTING AND ADJUSTING.

- **Refilling with oil (hydraulic tank)**
  * Add oil throuth the oil filler to the specified level. Run the engine to circulate the oil through the system. Then check the oil level again.

REMOVAL OF LS-EPC SOLENOID VALVE ASSEMBLY



⚠ Disconnect the cable from the negative (-) terminal of the battery.

⚠ Loosen the hydraulic tank oil filler cap slowly to release the pressure inside the hydraulic tank.

1. Open main pump side cover.
2. Disconnect wiring connector (CN-C10).
3. Disconnect hoses (1), (2), (3), and (4).
   ★ Fit blind plugs in the disconnected hoses.
4. Remove LS-EPC solenoid valve assembly (5).

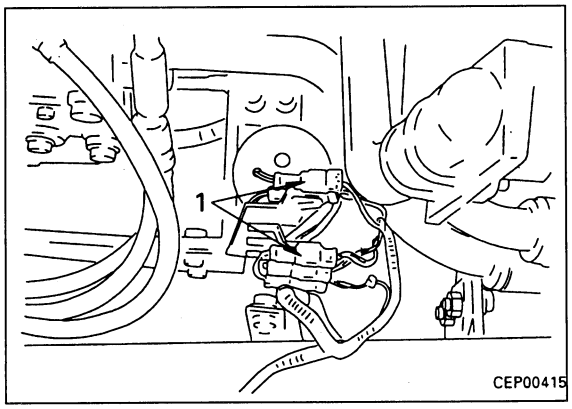
INSTALLATION OF LS-EPC SOLENOID VALVE ASSEMBLY

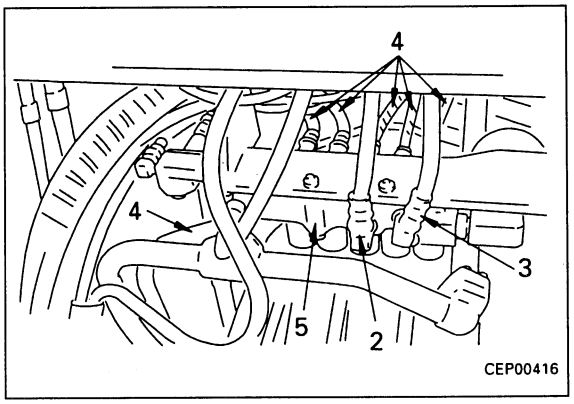
- Carry out installation in the reverse order to removal.

REMOVAL OF SOLENOID VALVE ASSEMBLY

⚠ Disconnect the cable from the negative (-) terminal of the battery.
⚠ Loosen the hydraulic tank oil filler cap slowly to release the pressure inside the hydraulic tank.
★ Make match marks on teh hoses and at the male and female ends of the connectors.
1. Remove 5 soelnoid wiring connectors (1) from clip and disconnect.
2. Disconnect hoses (2) and (3) installed to bottom of valve.
3. Disconnect valve hoses (4).
4. Remove mounting bolts, then remove solenoid valve assembly (5).

- When removing solenoid valve as an individual part.
  1) If mounting nut (6) is removed, only coil assembly needs to be removed. ※ 1
  2) When washing valve, loosen mounting nut (7) and remove. ※ 2



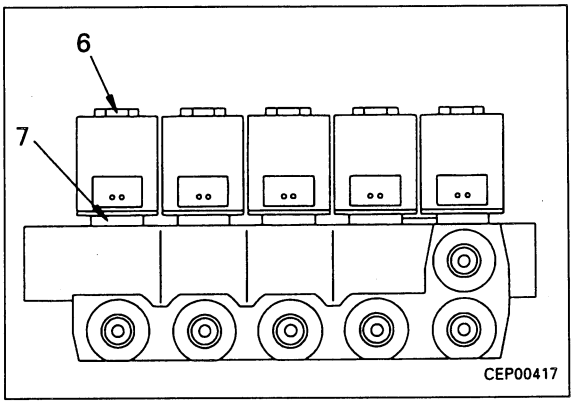


INSTALLATION OF SOLENOID VALVE ASSEMBLY

- Carry out installation in the reverse order to removal.

※ 1 kgm Coil mounting nut (6):
7.85 ± 0.98 Nm (0.8 ± 0.1 kgm)

※ 2 kgm Valve mounting nut (7):
50.99 ± 3.43 Nm (5.2 ± 0.35 kgm)



REMOVAL OF WORK EQUIPMENT PPC VALVE ASSEMBLY

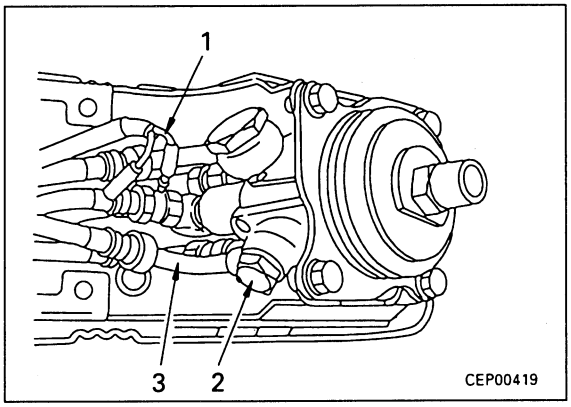
⚠ Lower the work equipment completely to the ground and stop the engine. Then loosen the oil filler cap slowly to release the pressure inside the hydaulic tank.

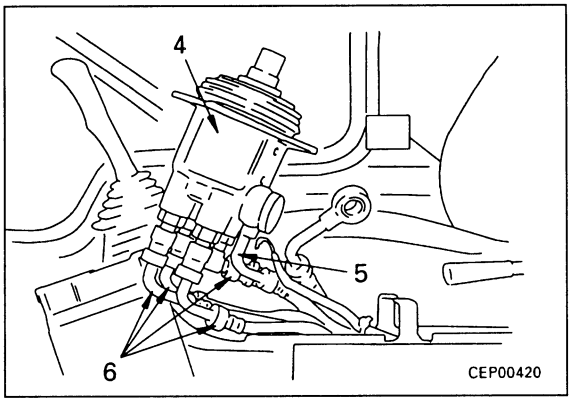
1. Remove case.
   For details, see REMOVAL OF CONTROL STAND CASE.

2. Disconnect wiring connector (1).

3. Remove joint bolt (2), and disconnect hose (3).
   ★ Make match marks on the hoses. ※ 1

4. Remove mounting bolts, raise PPC valve assembly (4), then disconnect hoses (5) and (6), and remove. ※ 2





INSTALLATION OF WORK EQUIPMENT PPC VALVE ASSEMBLY

- Carry out installation in the reverse order to removal.

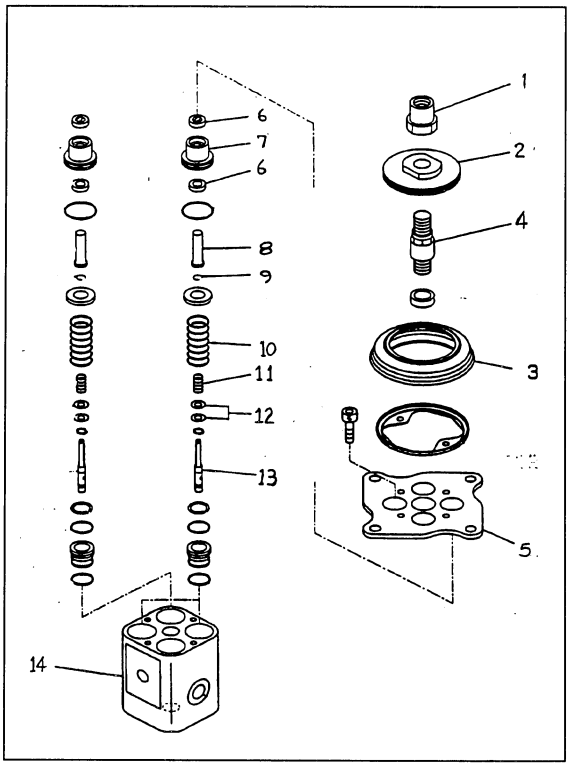
※ 1 kgm Hose mount joint bolt:
29.4 ± 4.9 Nm (3.0 ± 0.5 kgm)

※ 2 kgm Hose mount joint bolt:
39.2 ± 4.9 Nm (4.0 ± 0.5 kgm)

★ If there is excessive play in the control levers, adjust the PPC valve.
For details, see TESTING AND ADJUSTING , Adjusting PPC valve.

DISASSEMBLY OF WORK EQUIPMENT PPC VALVE ASSEMBLY

1. Remove nut (1), then remove disc (2) and boot (3).
2. Remove bolts, then remove plate (5).
   ★ Do not remove joint (4) unless it is to be replaced.
3. Remove seal (6) and collar (7).
4. Pull out piston (8), and remove retainer (9), springs (10) and (11), and shim (12).
   ★ Spring (10) consist of two springs each of two types with different installed loads, so check the mounting position (hydraulic port) and mark with tags to prevent mistakes when installing.
5. Pull out valve (13) form body (14).

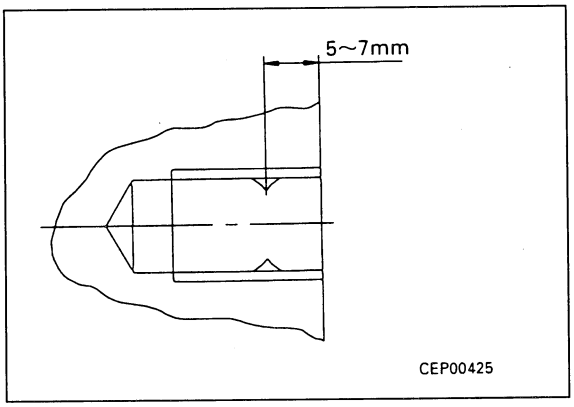


ASSEMBLY OF WORK EQUIPMENT PPC VALVE ASSEMBLY

1. Assemble valve (13) to body (14).
2. Assemble shim (12) and spring (11) to valve (13).
   ★ When assembling spring (11), set the end with the small coil diameter (inside diameter) at shim (12) end.
3. Assemble spring (10), retainer (9), and piston (8).
   ★ The number of loops in the coil for spring (10) is different for each of the hydraulic ports below, so be careful when installing.

Position of port	Free length of spring (mm)
P1, P2	44.4
P3, P4	42.4

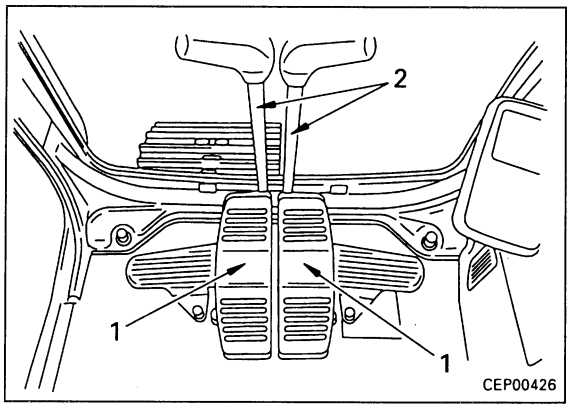
   ★ The position of each port is marked at the bottom of the valve body.
   Piston: **Grease (G2-LI)**
   ★ When assembling piston (8), coat6 the outside of the piston and the inside of the hole in the body with grease.
4. Fit O-ring to collar (7) and assemble in body (14), then install seal (6).
5. Install plate (5).
   kgm Mounting bolt:
   13.24 ± 1.47 Nm (1.35 ± 0.15 kgm)
6. Install joint (4).
   Sliding portion of joint: **Grease (G2-LI)**
   Female thread of body:
   Thread tighterner (LT-2)
   ★ Coat two places on the female thread with one drop of Locite each as shown in the diagram on the right.
   kgm Joint: **44.1 ± 4.9 Nm (4.5 ± 0.5 kgm)**
   ★ Keep strictly to the tightening torque.
7. Assemble boot (3) and disc (2), and tighten with nut (1).
   kgm Nut: **112.8 ± 14.7 Nm (11.5 ± 1.5 kgm)**
   ★ After assembling the disc, adjust the height of the disc.
   For details, see TESTING AND ADJUSTING, Adjusting PPC valve.

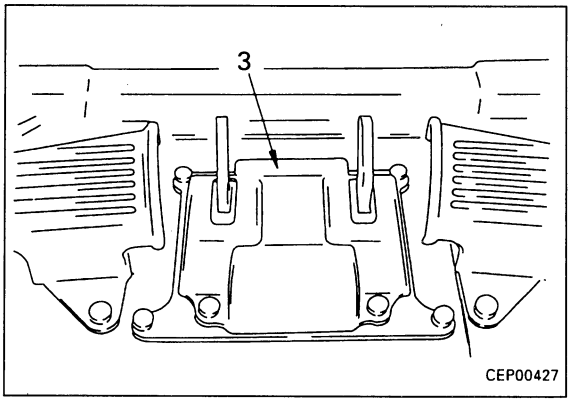


REMOVAL OF TRAVEL PPC VALVE ASSEMBLY

⚠ Lower the work equipment completely to the ground and stop the engine. then loosen the oil filler cap slowly to release the pressure inside the hydraulic tank.

1. Remove travel PPC valve undercover.
2. Remove floor mat.
3. Remove pedals (1) and levers (2).
4. Remove cover (3). ※ 1
5. Remove covers (4), then remove springs (5).
6. Disconnect 6 PPC hoses (7), and remove travel PPC valve assembly (8). ※ 2





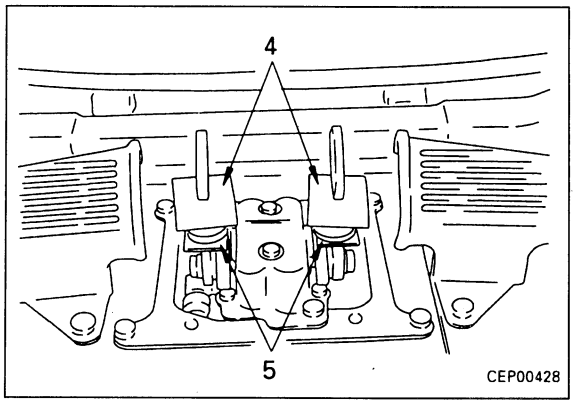
INSTALLATION OF TRAVEL PPC VALVE ASSEMBLY

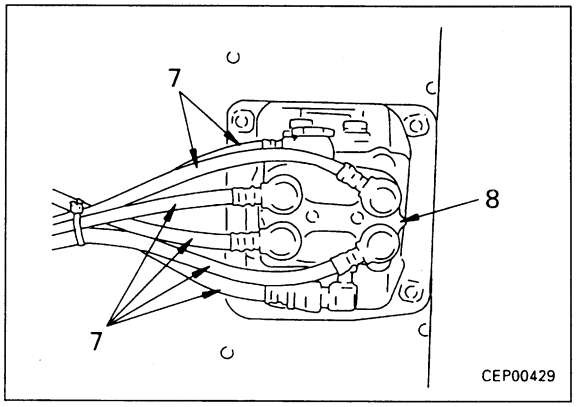
- Carry out installation in the reverse order to removal.

※ 1 kgm — Cover mounting bolt:
19.6 ± 1.9 Nm (2.0 ± 0.2 kgm)

※ 2 kgm — Hose mounting joint bolt
(width across flats: 30mm):
39.2 ± 4.9 Nm (4.0 ± 0.5 kgm)

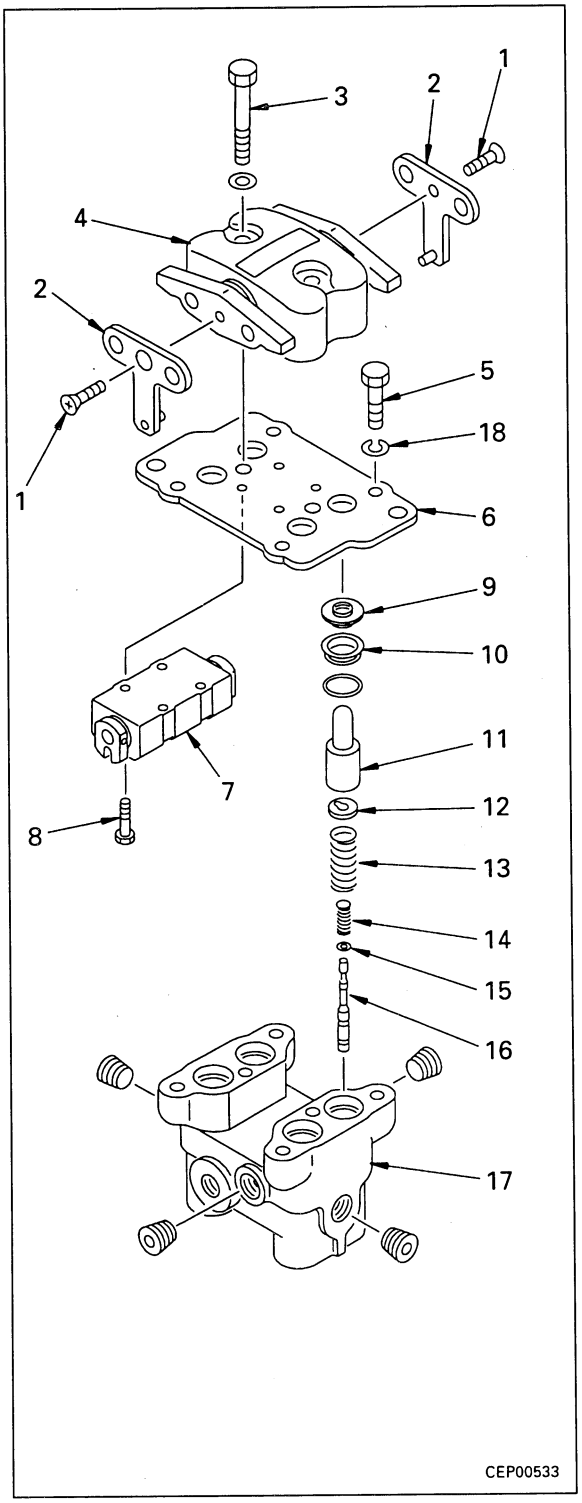
kgm — Hose mounting joint bolt
(width across flats: 22mm):
29.4 ± 4.9 Nm (3.0 ±0.5 kgm)





DISASSEMBLY OF TRAVEL PPC VALVE ASSEMBLY

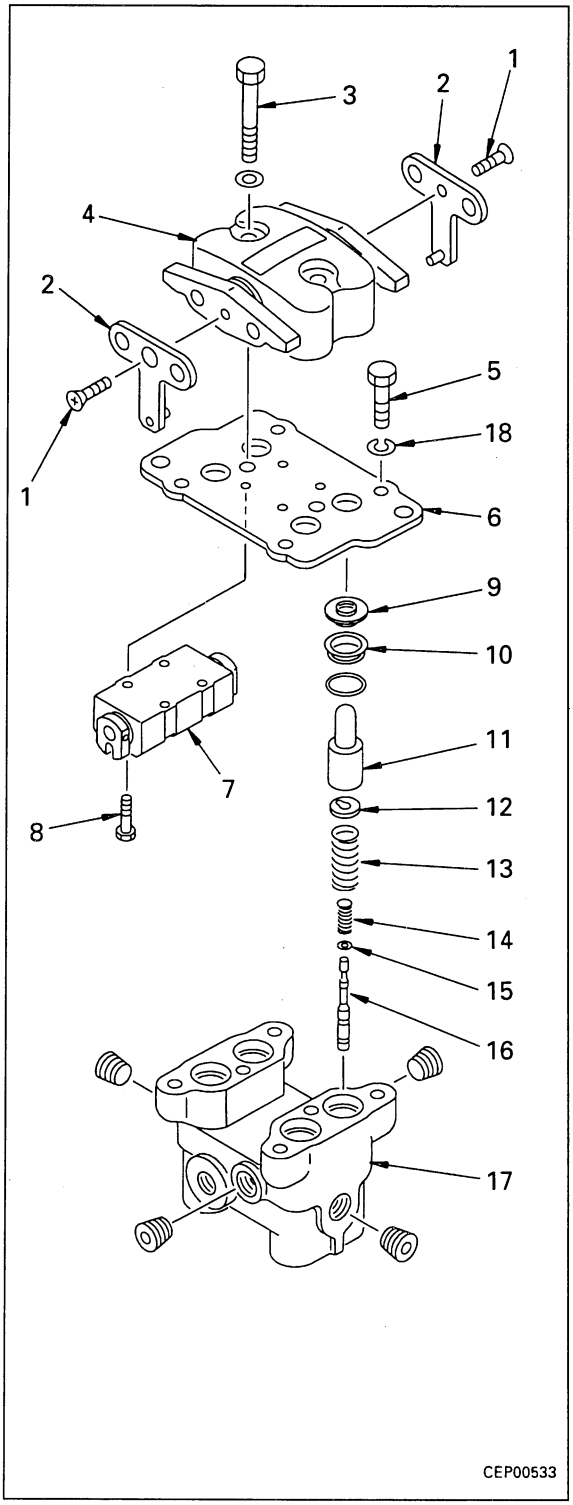
1. Remove screw (1), then remove lever (2).
2. Remove mounting bolts (3), then remove case and shaft assembly 94).
3. Remove mounting bolts (5), then remove plate (6) together with damper assembly (7).
   ★ Check the thickness and mounting position of washer (18).
4. Remvoe mounting bolts (8), then remove damper assembly (7) from plate (6).
5. Remove seal (9) and collar (10).
6. Pull out piston (11), and remove retainer (12), springs (13) and (14), and shims (15).
   ★ Chekc the number and thichness of shims (15) for each mounting position, and keep in a safe place.
7. Pull out valve (16) from body (17).



ASSEMBLY OF TRAVEL PPC VALVE ASSEMBLY

1. Assemble valve (16) in body (17).
2. Assemble shim (15) and spring (14) to valve (16).
   - ★ Assmble the same number and thickness of shim 915) as was removed during disasembly. Standard shim thickness: 0.3 mm
   - ★ Spring (14) is not symmetrical at the top and bottom, so assemble with the small coil diameter (inside diameter) at the shim end.
3. Assemble spring (13), retainer (12), and piston (11).
   Outside circumference of piston, body hole: **Grease (G2-LI)**
4. Fit O-ring to collar (10) and assemble in body (17), then install seal (9).
5. Install damper assembly (7) to plate (6), then tighten mounting bolts (8).
   Mounting bolt: **Trhread tightener (LT-2)**
   kgm Mounting bolt: **4.41 ± 0.49 Nm (0.45 ± 0.05 kgm)**
6. Install plat (6) and damper assembly (7) as one unit, then tighten mounting bolts (5).
   - ★ Temporarily assemble standard washer (1.6 mm) for washer (18). After completing the assembly, measure the difference in the angle when the left and right levers are opoerated fully. If the angle is greater than 0.7 , change the thickness of washer (18) to make the difference less than 0.7°.
     - ★ Washer thickness: 1.0, 1.3, 1.6 mm
     - ★ If the washer is thinner by 0.3 mm, the angle of the full stroke is 0.39 greater.

   kgm Mounting bolt: **30.89 ± 3.34 Nm (3.15 ± 0.35 kgm)**
7. Install case and shaft assembly (4), then tighten mounting bolts (3).
   Rocking portion of shaft, contact portion of lever and piston: **Grease (G2-LI)**
   Mounting bolt: **27.95 ± 3.34 Nm (2.85 ± 0.35 kgm)**
8. Install lever (2), then tighten screw (1).
   Rocking portion of lever pin and plate: **Grease (G2-LI)**
   kgm Screw: **8.8 ± 0.98 Nm (0.9 ± 0.1 kgm)**



REMOVAL OF PPC SHUTTLE VALVE ASSEMBLY

⚠ Lower the work equipment completely to the ground and stop the engine. Then loosen the oil filler cap slowly to release the pressure inside the hydraulic tank.

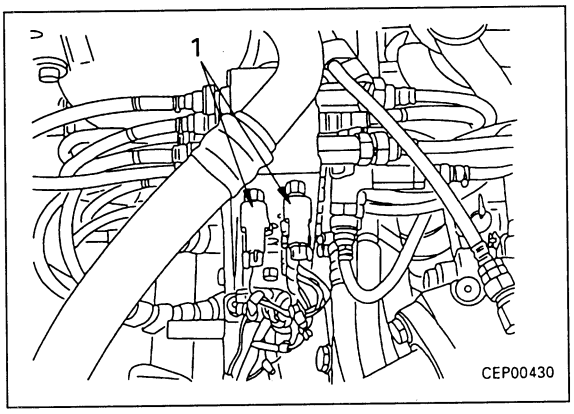
⚠ Disconnect the cable from the negative (-) terminal of the battery.

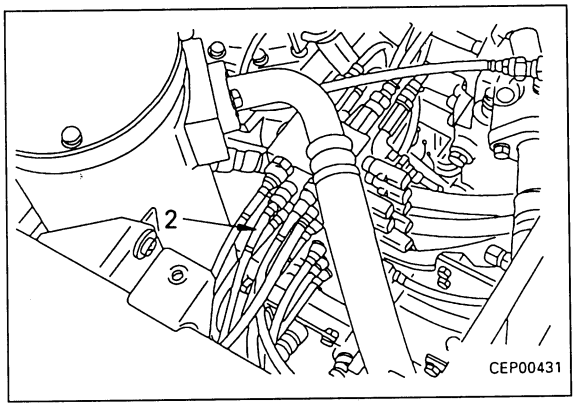
★ Make match marks at the male and female ends of the oil pressure switch connectors.

★ Before disconnecting any hoses, check the distinguithing tape stuck to the hose, or make match marks.

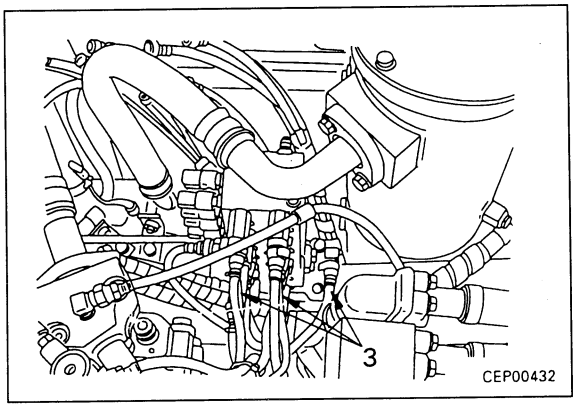
1. Disconnect 8 oil pressure switch connectors (1).

2. Disconnect 12 PPC hoses (2). ※ 1



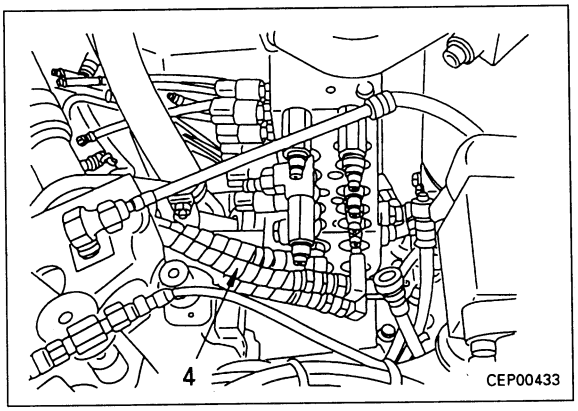


3. Disconnect 15 control valve hoses (3) (quick joint connection). ※ 1



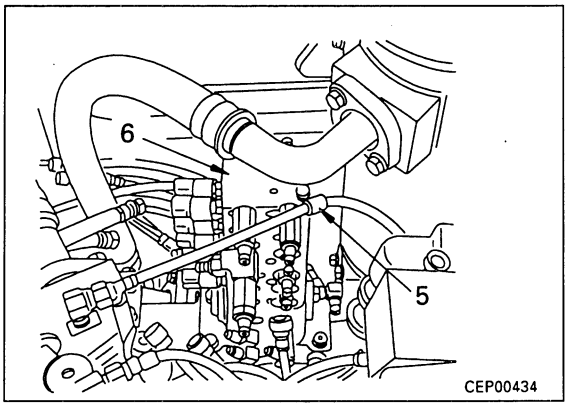
4. Disconnect 4 straight-travel hoses (4).

★ The elbows on the front two hoses are long, so hold the elbow with a wrench when disconnecting the hoses.



5. Disconnect clamp (5).

6. Remove mounting bolts, then remove PPC shuttle valve assembly (6).



INSTALLATION OF PPC SHUTTLE VALVE ASSEMBLY

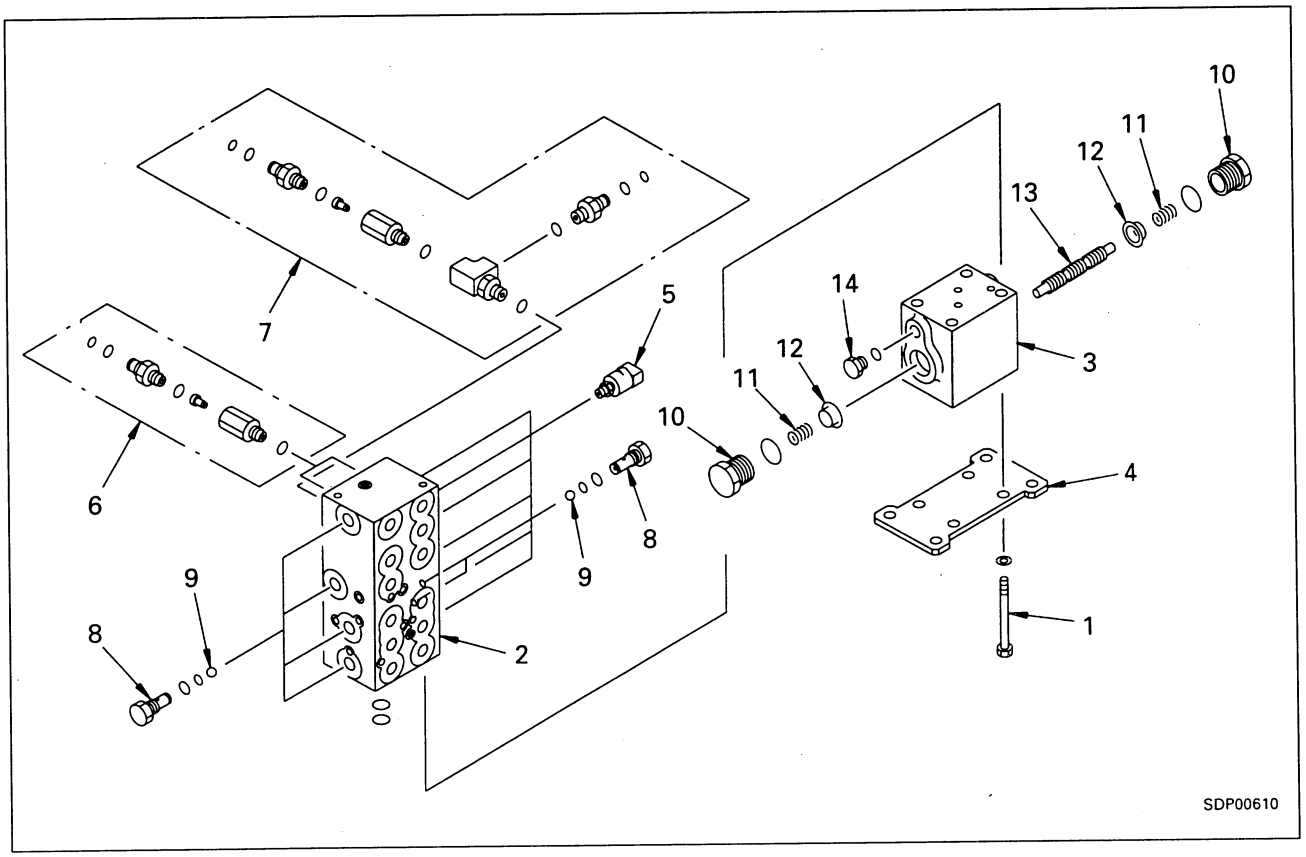
- Carry out installation in the reverse order to removal.

※ 1

- Check that the quick joint does not come out when the hose is pulled.

- **Refilling with oil (hydraulic tank)**
  ★ Add oil through the oil filler to the specified level. Run the engine to circulate the oil through the system. Then check the oil level again.

DISASSEMBLY OF PPC SHUTTLE VALVE ASSEMBLY

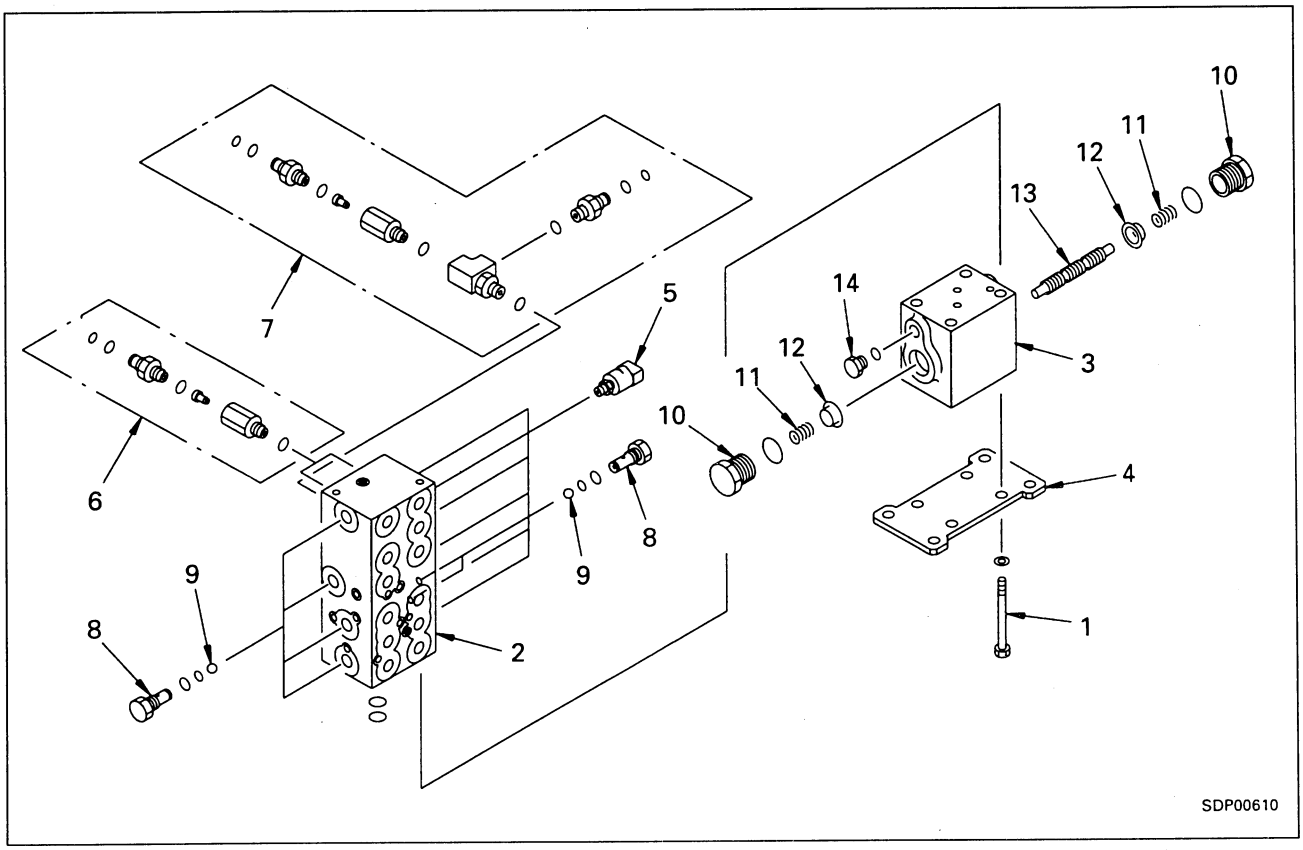


1. **Disconnection of valve**
   Remove mounting bolts (1), and disconnect shuttle valve assembly (2), travel junction valve assembly (3) and plat (4).

2. **Disassembly of shuttle valvve assembly**
   1) Remove 8 oil pressure switches (5).
   2) Remove 2 slow return valves (6).
   3) Remove shuttle valve (7).
   4) Remove plugs (8), then remove balls (9).
      ★ There are 6 plugs and 6 balls.

3. **Disassembly of travel junction valve assembly**
   1) Remvoe 2 each of plug (10), spring (11), and retainer (12).
   2) Remove spool (13).
   3) Remove 2 plugs (14).

ASSEMBLY OF PPC SHUTTLE VALVE ASSEMBLY



1. **Assembly of travvel junction valve assembly.**
   1) Fit O-ring and install 2 plugs (14).
      kgm Plug:
      17.16 ± 2.45 Nm (1.75 ± 0.25 kgm)
   2) Assemble spool (13), and install 2 retainers (12) and springs (11).
   3) Fit O-ring and install 2 plugs (10).
      kgm Plug:
      107.9 ± 14.7 Nm (11.0 ± 1.5 kgm)

2. **Assembly of shuttle valve assembly**
   1) Fit O-ring and assemble balls (9), then install plugs (8).
      ★ There are 6 plugs and 6 balls.
      kgm Plug:
      34.3 ± 4.9 Nm (3.5 ± 0.5 kgm)
   2) Fit O-ring and install shuttle valve (7).
      ★ If the shuttle valve has been disassembled, be careful of the direction of installation of the poppet when assembling.
   3) Fit O-ring and install 2 slow return valves (6).
      ★ If the slow return valve has been disassembled, be careful of the direction of installation of the poppet when assembling.
   4) Install 8 oil pressure switches (5).

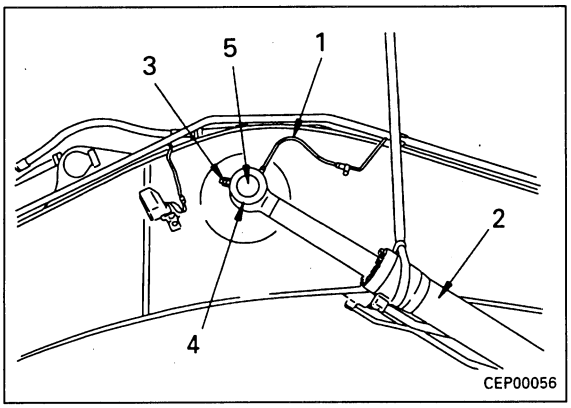
3. **Connection of valve**
   Fit O-ring and assemble shuttle valve assembly (2), travel junction vlave assembly (3) and plate (4), then tighten mounting bolts (1).
   kgm Mounting bolt:
   66.19 ± 7.35 Nm (6.75 ± 0.75 kgm)

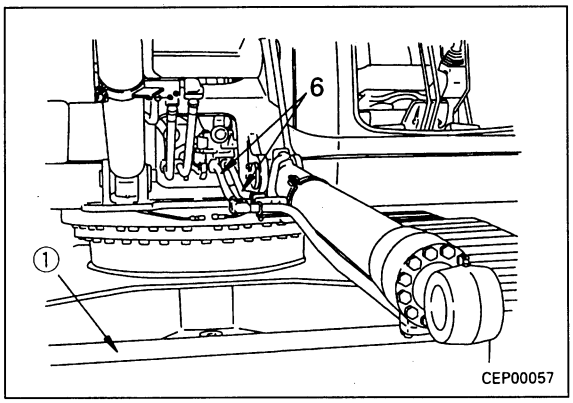
REMOVAL OF BOOM CYLINDER ASSEMBLY

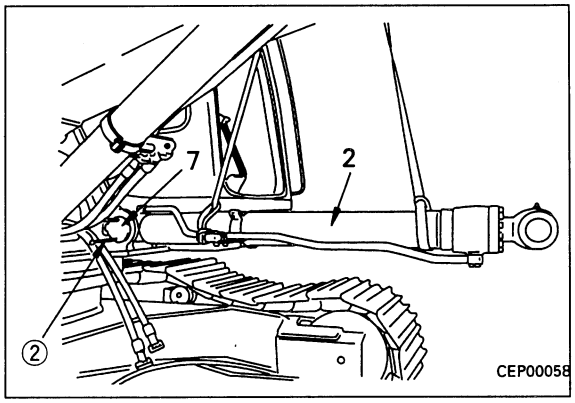
⚠ Extend the arm and bucket fully, lower the work equipment completely to the ground, and put the safety lock lever in the LOCK postion.

1. Disconnect grease hose (1).
2. Sling boom cylinder assembly (2), and remove lock bolt (3). ※ 1
3. Remove plate (4), then remove head pin (5). ※ 2
   ★ There are shims installed, so check the number and thickness, and keep in a safe place.
4. Start engine, and retract piston rod, then tiepiston rod with wire to prevent it from coming out.
   ★ Set stand ① under the cylinder assembly, and adjust the position for slinging the cylinder assembly.
   ⚠ Release the remaining pressure in the hydraulic circuit.
   For details, see TESTING AND ADJUSTING, Releasing remaining pressure in hydraulic circuit.
5. Disconnect hoses (6).
6. Remove plate, then using forcing screws ②, remove bottom pin (7), and remove boom cylinder assembly (2). ※ 3
   ★ There are shims installed, so check the number and thickness, and keep in a safe place.

   kg Boom cylinder assembly; **410 kg**





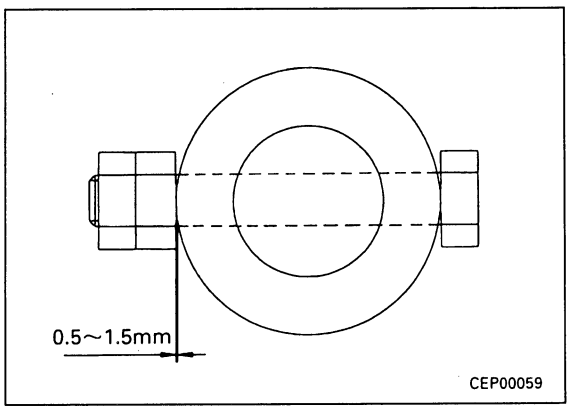


INSTALLATION OF BOOM CYLINDER ASSEMBLY

- Carry out installation in the reverse order to removal.

※ 1

★ When tightening the locknut, tighten so that the clearance between the plate and nut is 0.5 - 1.5 mm.



※ 2

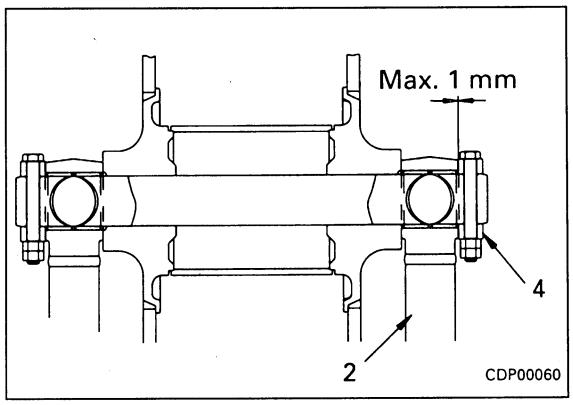
Inside surface of bushing when assembling pin: **Anti-friction compound (LM-P)**

Greasing after assembling pin: **Grease (LM-G)**

⚠ When aligning the position of the pin hole, never insert your fingers in the pin hole.

★ Adjust the shim thickness so that the clearance between the end face of the rod of cylinder (2) and plate (4) is less than 1.0 mm.

- Standard shim thickness: 1.0 mm, 1.5 mm



※ 3

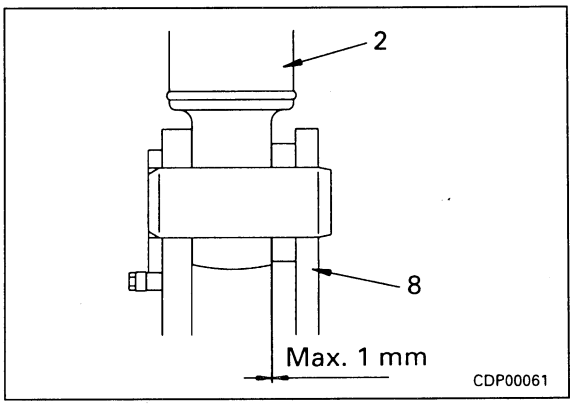
Inside surface of bushing when assembling pin: **Anti-fricton compound (LM-P)**

Greasing after assembling pin: **Grease (LM-G)**

⚠ When aligning the position of the pin hole, never insert your fingers in the pin hole.

★ Adjust the shim thickness so that the clearance between the end face of the bottom of cylinder (2) and bracket (8) is less than 1.0 mm.

- Standard shim thickness: 1.0 mm, 1.5 mm



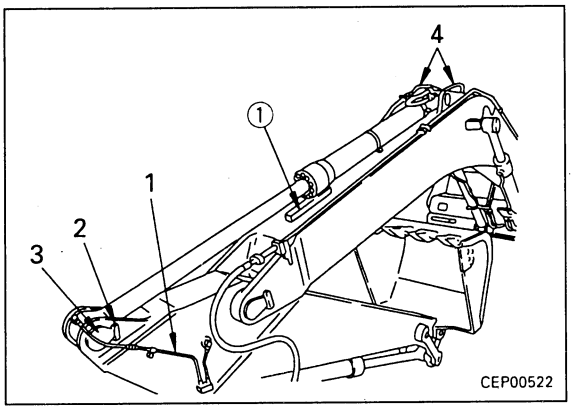
- **Bleeding air**

★ Bleed the air.
For details, see TESTING AND ADJUSTING, Bleeding air.

- **Refilling with oil (hydraulic tank)**

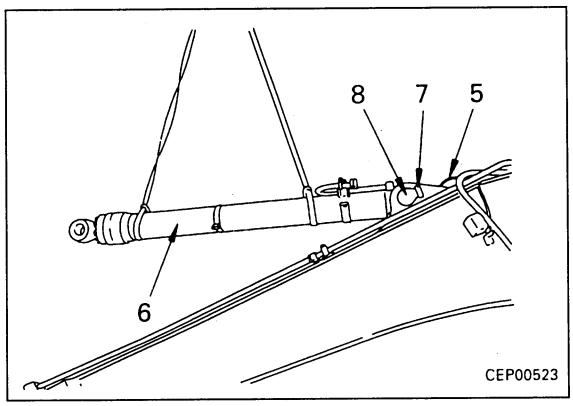
★ Add oil through the oil filler to the specified level. Run teh engine to circulate the oil through the system. Then check the oil level again.

REMOVAL OF ARM CYLINDER ASSEMBLY



⚠ Extend the arm cylinder piston rod to a point approx. 200 mm before the end of the IN stroke, lower the work equipment completely to the ground, then set the safety lock lever to the LOCK position.

1. Set block ① between arm cylinder and boom.
2. Disconnect grease hose (1).
3. Remove plate (2), then remove head pin (3). ※ 1
4. Start engine, and retract piston rod, then tiepiston rod with wire to prevent it from coming out.
   ⚠ Release the remaining pressure in the hydraulic circuit.
   For details, see TESTING AND ADJUSTING, Releasing remaining pressure in hydraulic circuit.
5. Disconnect hoses (4).
6. Disconnect grease hose (5).
7. Raise arm cylinder assembly (6), remove plate (7), then remove bottom pin (8), and remove arm cylinder assembly (6). ※ 1
   ★ There are shims installed, so check the number, thickness, and position, and keep in a safe place.



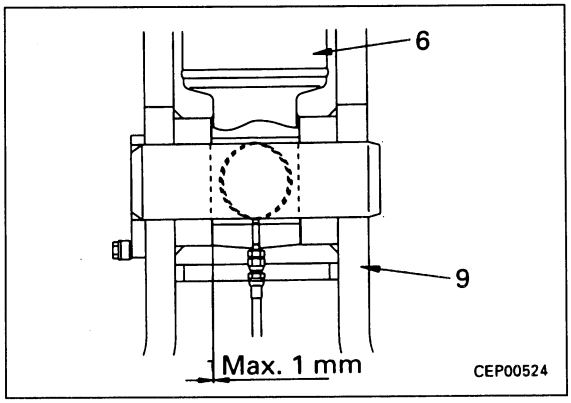
kg Arm cylinder assembly: **600 kg (PC400)**
600 kg (PC450)

INSTALLATION OF ARM CYLINDER ASSEMBLY

- Carry out installation in the reverse order to removal.

※ 1
Inside surface of bushing when assembling pin:
Anti-friction compound (LM-P)
Greasing after assembling pin:
Grease (LM-G)
⚠ When aligning the position of the pin hole, never insert your fingers in the pin hole.

※ 1
Inside surface of bushing when assembling pin:
Anti-friction compound (LM-P)
Greasing after assembling pin:
Grease (LM-G)
⚠ When aligning the positon of the pin hole, never insert your fingers in the pin hole.
★ Adjust the shim thickness so that the clearance between the end face of the bottom of cylinder (6) and bracket (9) is less than 1.0 mm.
- Standard shim thickness: 1.0 mm



- **Bleeding air**
  ★ Bleed the air.
  For details, see TESTING AND ADJUSTING, Bleeding air.

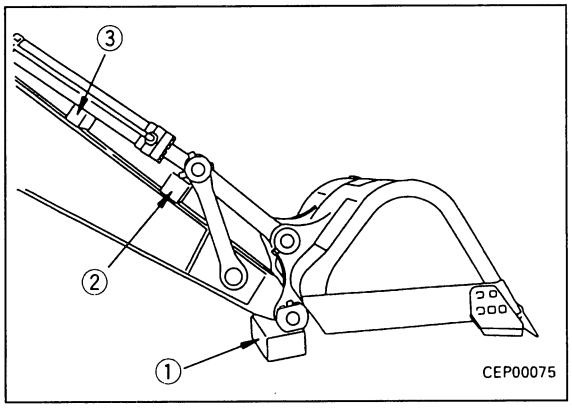
- **Refilling with oil (hydraulic tank)**
  ★ Add oil through the oil filler to the specified level. Run the engine to circulate the oil through the system. Then check teh oil level again.

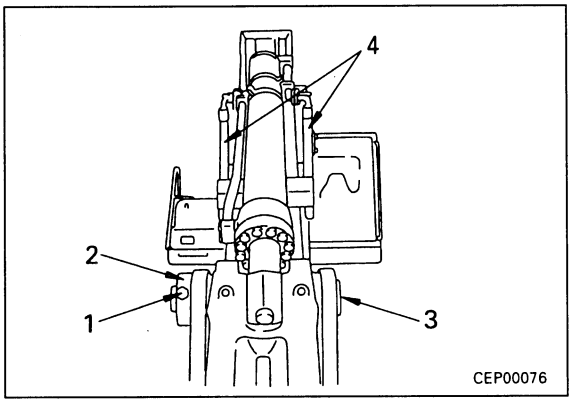
REMOVAL OF BUCKET CYLINDER ASSEMBLY

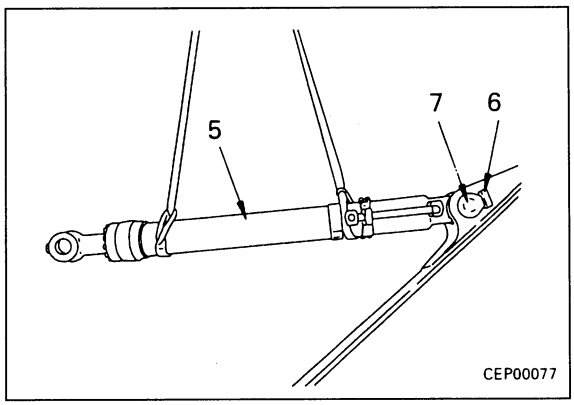
⚠ Extend the bucket cylinder piston rod to a point approx. 200 mm before the end of the DUMP stroke, lower the work equipment completely to the ground, then set the safety lock lever to the LOCK position.

1. Set block ① under arm top, block ② between link and arm, and block ③ between bucket cylinder and arm.
2. Remove lock bolt (1). ※ 1
3. Remove plate (2), then remove head pin (3). ※ 2
4. Start engine, and retract piston rod, then tiepiston rod with wire to prevent it from coming out.
   ⚠ Release the remainign pressure in the hydraulic circuit.
   For details, see TESTING AND ADJUSTING, Releasing remaining pressure in hydraulic circuit.
5. Disconnect hoses (4).
6. Raise bucket cylinder assembly (5), remove plate (6), then remove bottom pin (7), and remove bucket cylinder assembly (5). ※ 3
   ★ There are shims installed, so check the number and thickness, and keep in a safe place.

   kg Bucket cylinder assembly: **350 kg**





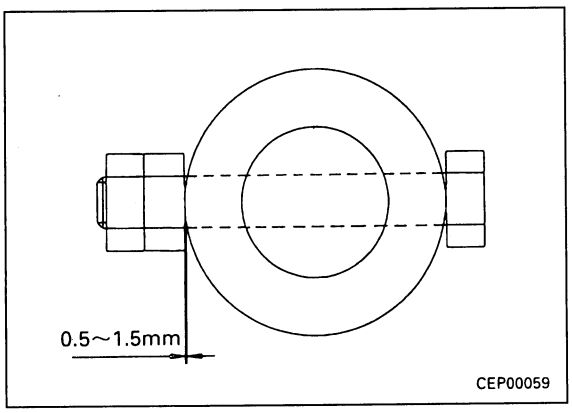


INSTALLATION OF BUCKET CYLINDER ASSEMBLY

- Carry out installation in the reverse order to removal.

※ 1

★ When tightening the locknut, tighten so that the clearance between the plate and nut is 0.5 - 1.5 mm.



※ 1

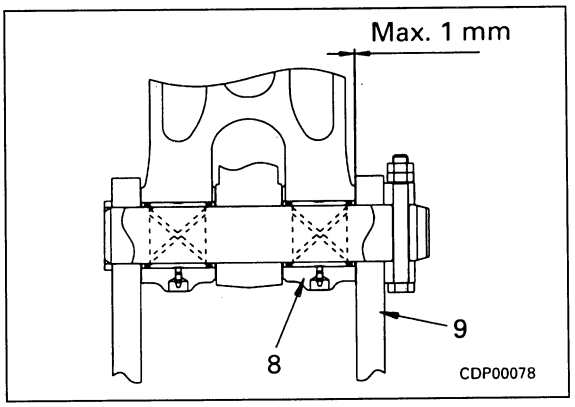
Inside surface of bushing when assembling pin: **Anti-friction compound (LM-P)**

Grease after assembling pin: **Grease (LM-G)**

⚠ When alignign the position of the pin hole, never insert your fingers in the pin hole.

★ Adjust the shim thickness so that the clearance between link (8) and lingk (9) is less than 1.0 mm.

- Standard shim thickness: 0.8 mm



※ 1

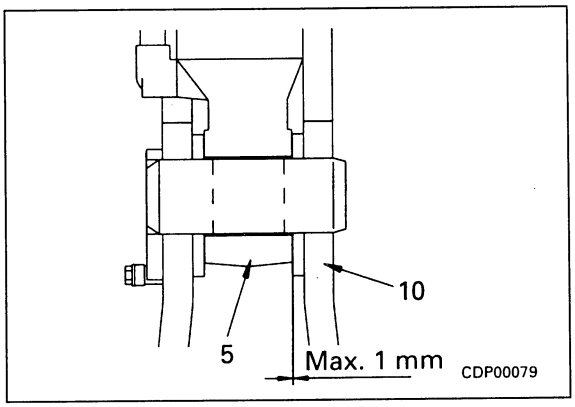
Inside surface of bushing when assembling pin: **Anti-friction compound (LM-P)**

Grease after assembling pin: **Grease (LM-G)**

⚠ When aligning the position of the pin hole, never insert your fingers in the pin hole.

★ Adjust the shim thickness so that the clearance between the end face of the bottom of cylinder (5) and bracket (10) is less than 1.0 mm.

- Standard shim thickness: 1.0 mm



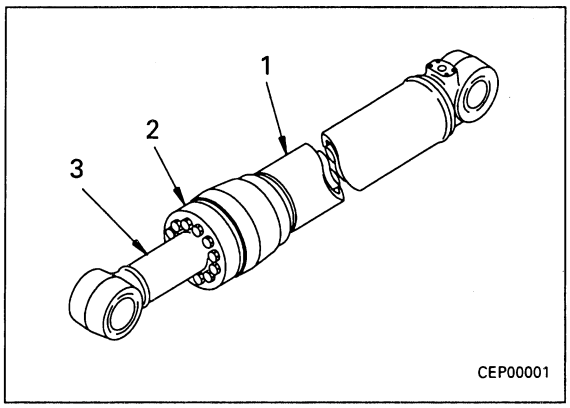
- **Bleeding air**

★ Bleed the air.
For details, see TESTING AND ADJUSTING, Bleeding air.

- **Refilling with oil (hydraulic tank)**

* Add oil through the oil filler to the specified level. Run the engine to circulate the oil through the system. Tehn check the oil level again.

DISASSEMBLY OF HYDRAULIC CYLINDER ASSEMBLY



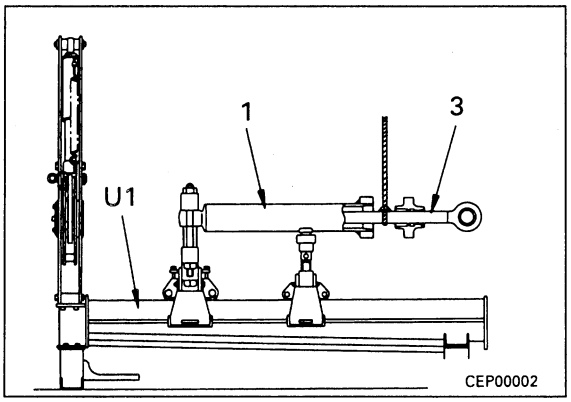
1. Piston rod assembly.

1) Fix bottom end of cylinder assembly (1) in tool **U1** or press, then remove mounting bolts, and disconnect head assembly (2).

Unit: mm

Cylinder	Boom	Arm	Bucket
Bolt (width across flats)	30	36	30

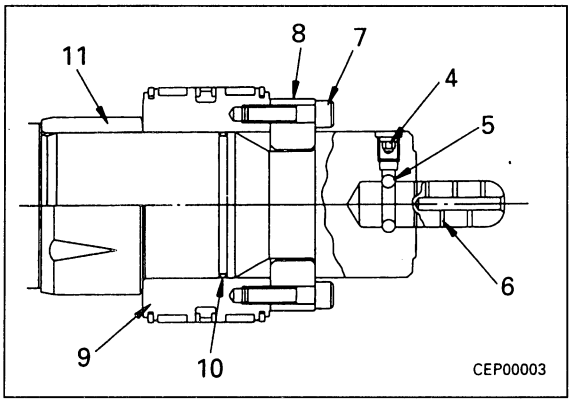
2) Pull out piston rod assembly (3).
   ★ Place a container under the cylinder to catch the oil.



2. Piston assembly, head assembly.

1) Fix head end of piston rod assembly (3) in tool U1 or press.

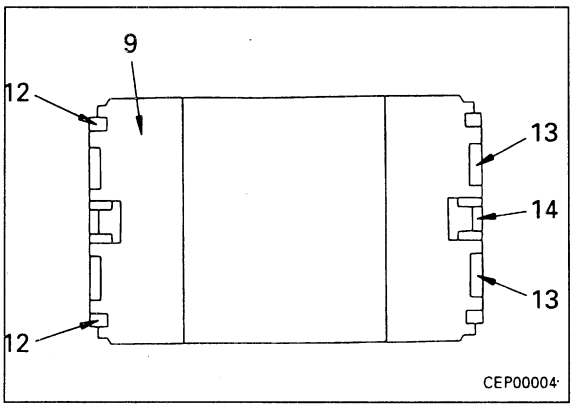
2) Remove screw (4), then remove 11 balls (5), and remove plunger (6).
   ★ Arm cylinder only
3) Remove 6 screws (7), then remove spacer (8).



4) Remove piston assembly (9), O-ring and backup ring (10).

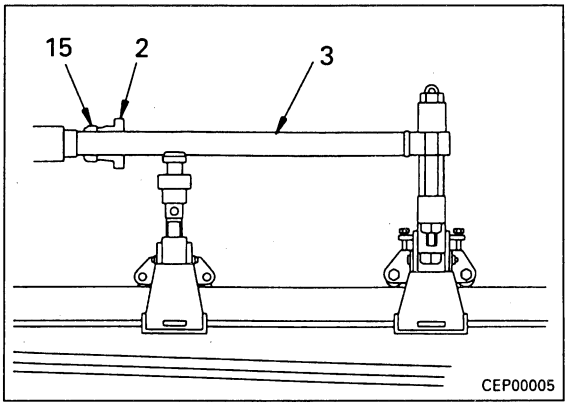
5) Remove plunger (11).
   ★ Boom and arm cylinder only.

6) Disassembly of piston assembly.
   i) Remove rings (12).
   ii) Remove wear rings (13).
   iii) Remove piston ring (14).

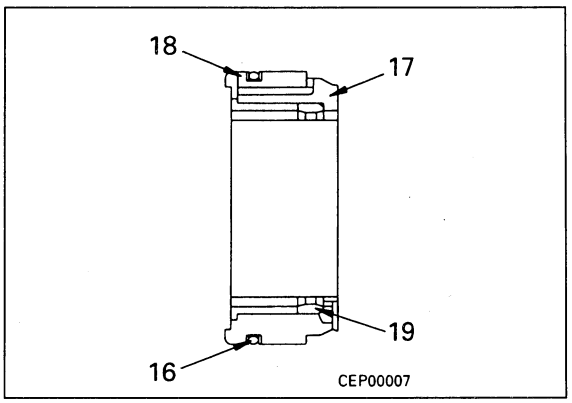


7) Remove collar assembly (15) and head assembly (2) from piston rod (3).

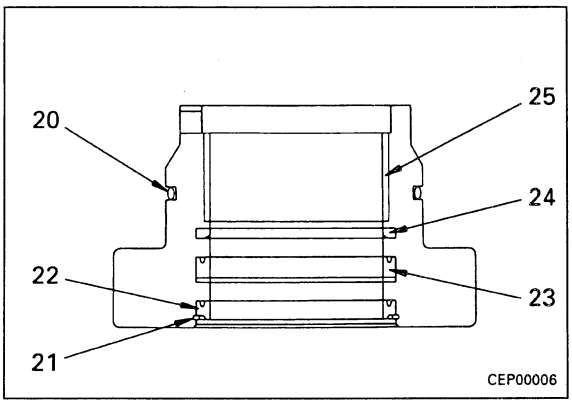
★ The collar is on the boom and arm cylinder only.



8) Disassembly of collar
★ Disassemble collar (15) for the boom and arm cylinders only.
i) Remove O-ring and backup ring (16).
ii) Remove collar (18) and ring (19) from collar (17).



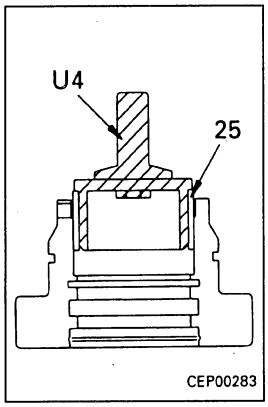
9) Disassembly of head assembly
i) Remove O-ring and backup ring (20).
ii) Remove snap ring (21), then remove dust seal (22).
iii) Remove rod packing (23).
iv) Remove buffer ring (24).
v) Remove bushing (25).

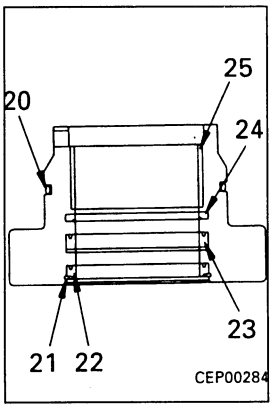


ASSEMBLY OF HYDRAULIC CYLINDER ASSEMBLY

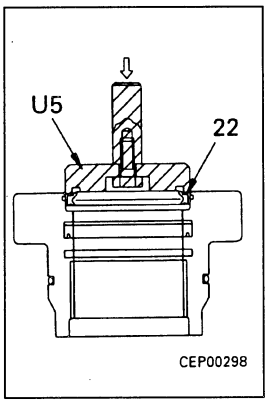
★ Be careful not to damage the packings, dust seals, and O-rings.
★ Do not try to force the backup ring into position. Warm it in warm water (50 - 60°C) before fitting it.

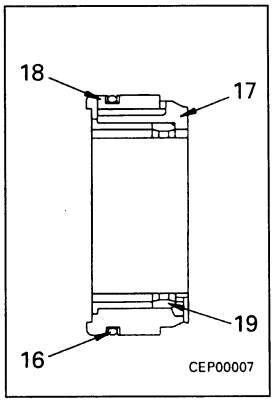
1. Assembly of cylinder head assembly
   1) Using tool **U4**, press fit bushing (25).
   2) Assemble buffer ring (24).
   3) Assemble rod packing (23).
   4) Using tool U5, install dust seal (22), and secure with snap ring (21).
   5) Install O-ring and backup ring (20).





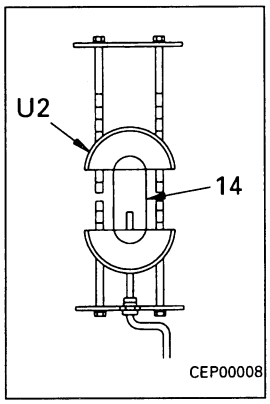
2. **Assembly of collar assembly**
   ★ Assemble collar (15) for the boom and arm cylinders only.
   1) Assemble ring (19) and collar (18) to collar (17).
   2) Assemble O-ring and backup ring (16).

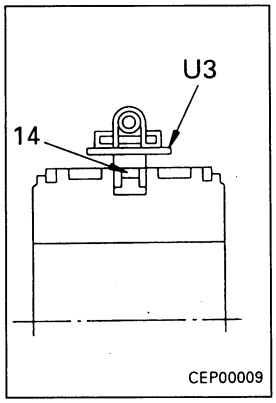


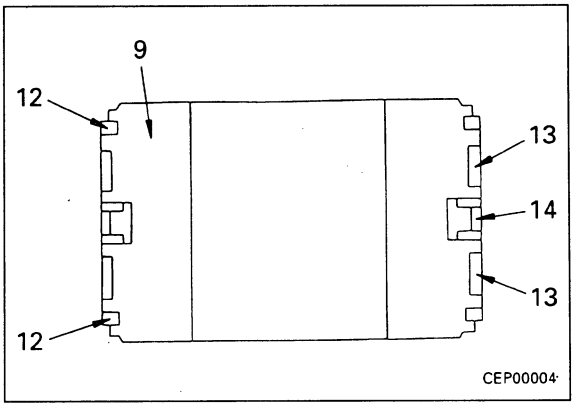


3. **Assembly of piston assembly**
   1) Using tool U2, expand piston ring (14).
      ★ Set the piston ring on the tool U2, and turn the handle 8 - 10 times to expand the ring.
   2) Assemble piston ring (14) to piston.
   3) Set tool U3 in position, and compress piston ring (14).
   4) Assemble wear ring (13).
   5) Assemble ring (12).
      ★ Be careful not to open the end gap of the ring too wide.

   Ring groove: **Grease (G2-LI)**







4. Piston rod assembly

1) Fix head end of piston rod in tool U1 or press.
2) Assemble head assembly (2) and collar assembly (15) to rod.
   ★ Collar assembly (15) is for the boom and arm cylinder only.
3) Install plunger (11), O-ring and backup ring (10).
   ★ Plunger (11) is for the boom and arm cylinder only.
4) Install piston assembly (9) and spacer (8), tighten with screws (7).

Screw (7): **Thread tightener (Loctite No. 262)**

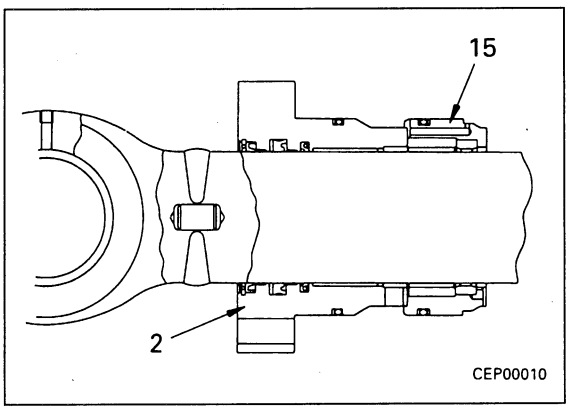
kgm Screw (7): **176.5 ± 19.6 Nm (18 ± 2 kgm)**

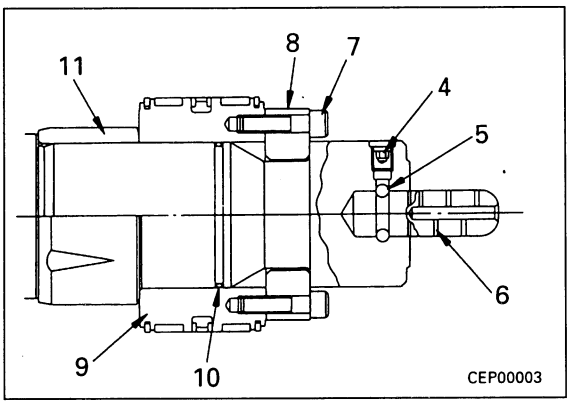
5) Set plunger (6) on piston rod, assemble 11 balls (5), then secure with screw (4).

Screw (4): **Thread tightener (LT-2)**

kgm Screw (4): **156.9 ± 19.6 Nm (16 ± 2 kgm)**

★ Caulk the screw (4) after tightening the screw. (Arm cylinder only.)





5. Cylinder assembly

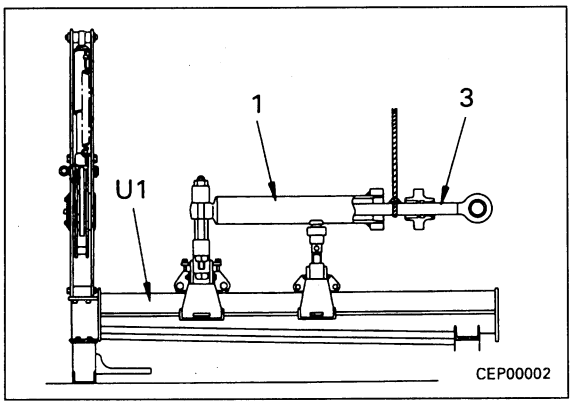
1) Fix bottom end of cylinder tube in tool U1 or press.
2) Assemble piston rod assembly (2).

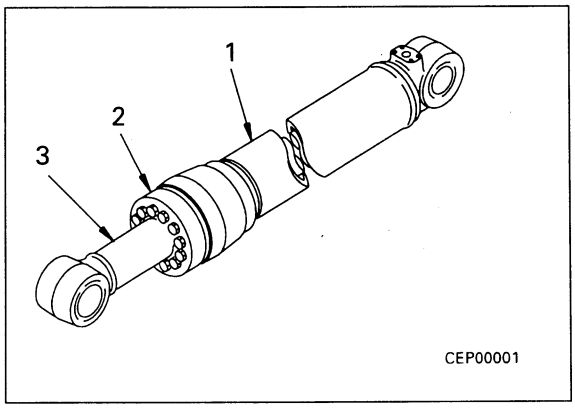
Seal: **Grease (G2-LI)**

   ★ Set the end gap of the ring at the horizontal (side) position, align the center of shaft and cylinder tube, then insert.
   ★ After inserting, check that the ring is not broken and has not come out, then push in fully.
3) Tighten head assembly (1) with mounting bolts.

kgm Mounting bolt:

Cylinder	Width acroos flats (mm)	Tightening
Boom, bucket	30	530 ± 78 (54 ± 8)
Arm	36	892 ± 137 (91 ± 14)





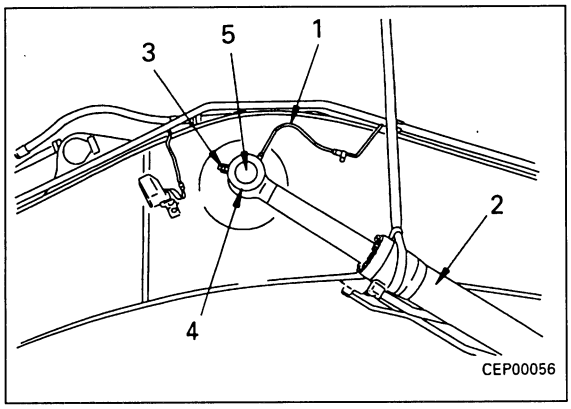
REMOVAL OF WORK EQUIPMENT ASSEMBLY

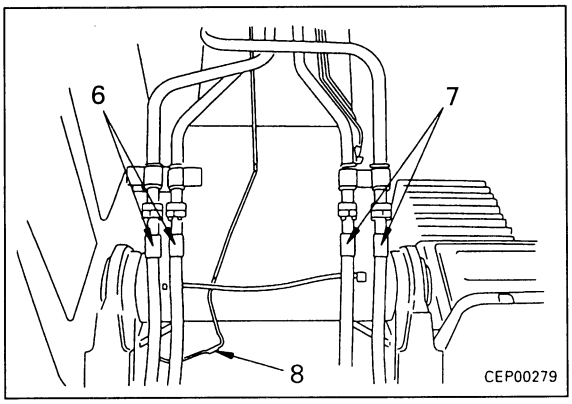
⚠ Extend the arm and bucket fully, lower the work equipment to the ground, and set the safety lock lever to the LOCK position.

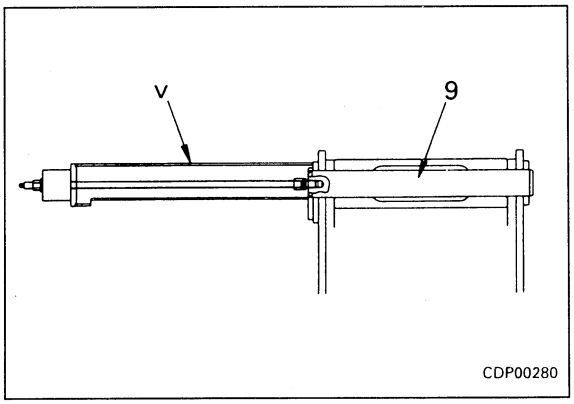
1. Disconnect grease hose (1).
2. Sling boom cylinder assembly (2), and remove lock bolt (3). ※ 1
3. Remove plate (4), then remove head pin (5). ※ 2
   ★ There are shims installed, so check teh number and thickness, and keep in a safe place.
4. Start engine, and retract piston rod, then tie piston rod with wire to prevent it from coming out, and lower cylinder onto stand.
   ★ Disconnect the boom cylinder on the opposite side in the same way.
   ⚠ Release the remaining pressure in the hydraulic circuit.
   For details, see TESTING AND ADJUSTING, Releasing remaining pressure in hydraulic circuit.
5. Disconnect arm cylinder hoses (6) and bucket cylinder hoses (7), and secure to valve with rope.
6. Disconnect wiring connector (8) for working lamp.

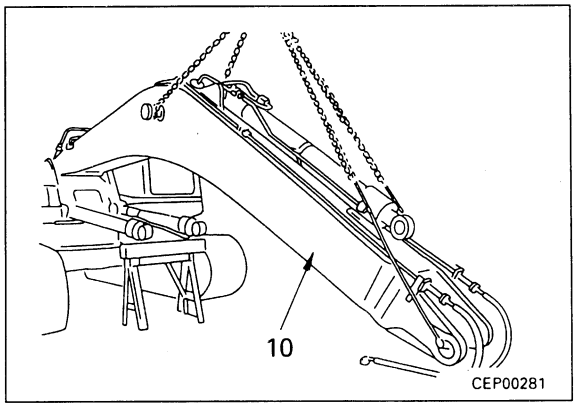
7. Remove plate, and set tool **V** to boom foot pin (9).
8. Raise work equipment assembly (10), then remove boom foot pin (9) using tool **V**, and remove work equipment assembly (10). ※ 3
   ★ There are shims installed, so check the number and thickness, and keep in a safe place.

kg Work equipment assembly: **7600 kg**







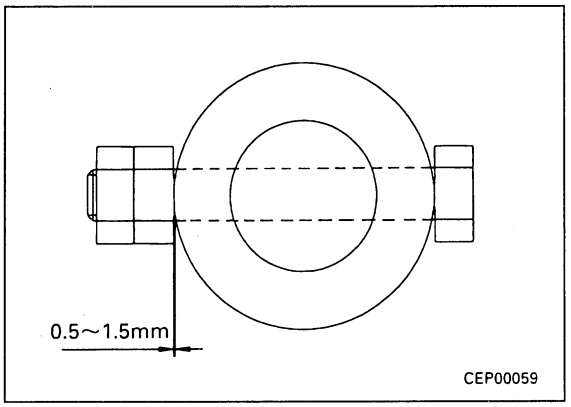


INSTALLATION OF WORK EQUIPMENT ASSEMBLY

- Carry out installation in teh reverse order to removal.

※ 1

★ When tightening the locknut, tighten so that the clearance between the plate and nut is 0.5 - 1.5 mm.



※ 2

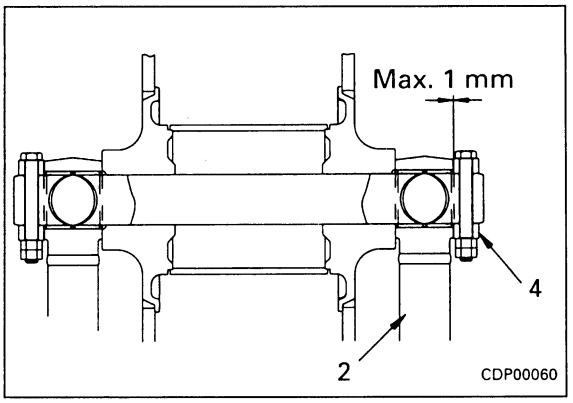
Inside surface of bushing when assembling pin: **Anti-friction compound (LM-P)**

Grease after assembling pin: **Grease (LM-G)**

⚠ When aligning the position of the pin hole, never insert your fingers in the pin hole.

★ Adjust the shim thickness so that the clearance between the end face of the rod of cylinder (2) and plate (4) is less than 1.0 mm.

- Standard shim thickness: 1.0 mm, 1.5 mm



※ 3

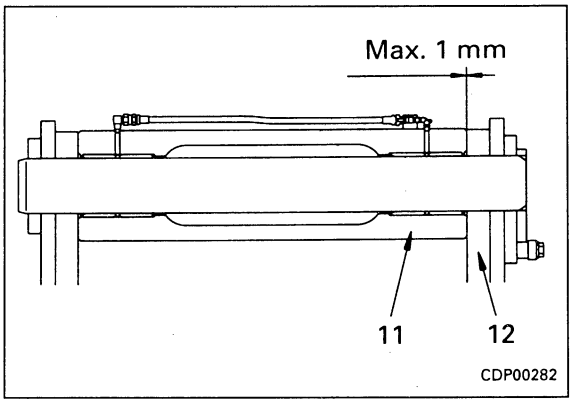
Inside surface of bushing when assembling pin: **Anti-friction compound (LM-P)**

Grease after assembling pin: **Grease (LM-G)**

⚠ When aligning the position of the pin hole, never insert your fingers in the pin hole.

* Adjust the shim thickness so that the clearance between the end face of the foot of boom (11) and bracket (12) is less than 1.0 mm.

- Standard shim thickness: 0.8 mm, 1.5 mm



- **Bleeding air**

★ Bleed th air.
For details, see TESTING AND ADJUSTING, Bleeding air.

- **Refilling with oil (hydraulic tank)**

★ Add oil throught the oil filler to the specified level. Run the engine to circulate the oil through the system. Then check the oil level again.

REMOVAL OF BUCKET ASSEMBLY

⚠ Set the back of the bucket facing down, lower the work equipment completely to the ground, and set the safety lock lever to the LOCK position.

※ 1

1. Remove lock bolt (1).
2. Remvoe connecting pin (2) between link and bucket.

※ 2

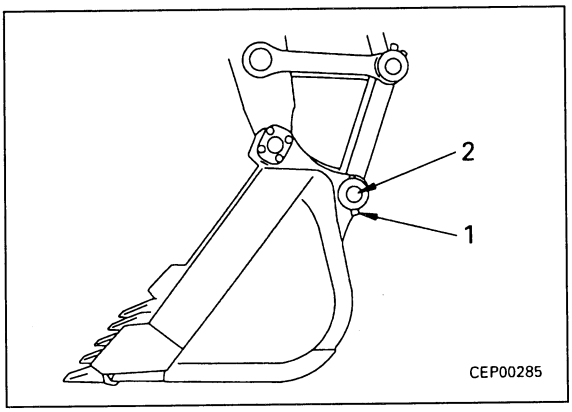
★ There are shims installed, so check the number and thickness, and keep in a safe place.

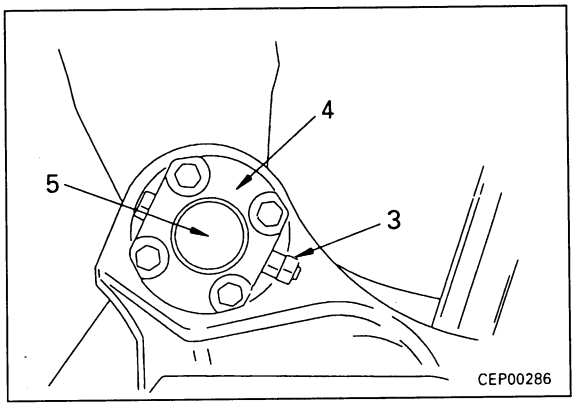
3. Start engine, and retract piston rod, then tie link to arm with wire to prevent piston rod from coming out.
4. Remove lock bolt (3). ※ 3
5. Remove plate (4), then remove connecting pin (5) between arm and bucket. ※ 4

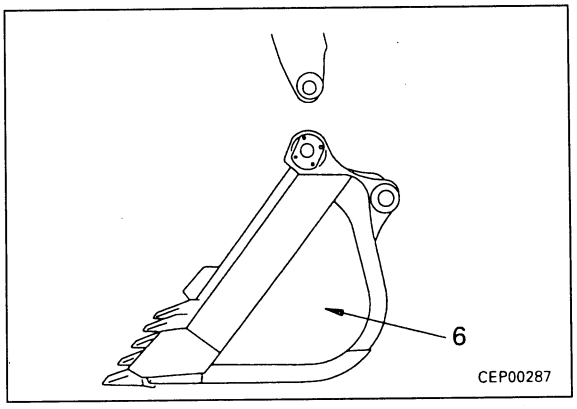
★ There are shims installed, so check the number and thickness, and keep in a safe place.

6. Start engine, then raise work equipment and swing to remove bucket assembly (6).

kg Bucket assembly: **1300 kg**





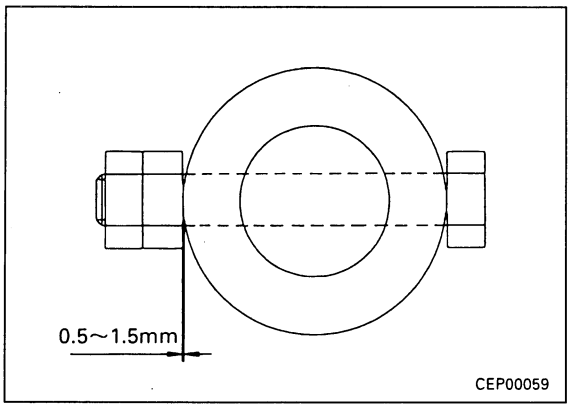


INSTALLATION OF BUCKET ASSEMBLY

Carry out installation in the reverse order to removal.

※ 1, ※ 3

★ When tightening the locknut, tighten so that the clearance between the plate and nut is 0.5 - 1.5 mm.



※ 2

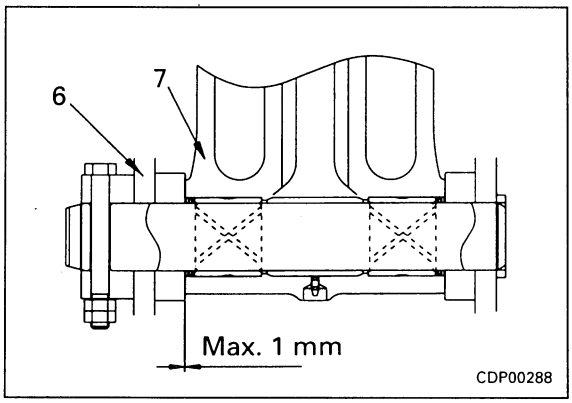
Inside surface of bushing when assembling pin: **Anti-friction compound (LM-P)**

Grease after assembling pin: **Grease (LM-G)**

⚠ When aligning the position of the pin hole, never insert your fingers in the pin hole.

★ Adjust the shim thickness so that the clearance between the end face of the boss of bucket (6) and ling (7) is less than 1.0 mm.

- Standard shim thickness: 0.8 mm



※ 3

Inside surface of bushing when assembling pin: **Anti-friction compound (LM-P)**

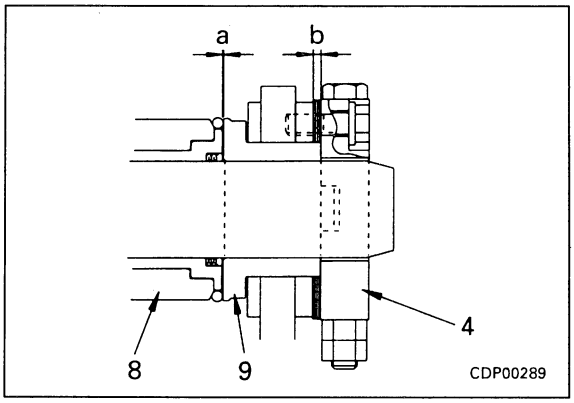
Grease after assembling pin: **Grease (LM-G)**

⚠ When aligning the position of the pin hole, never insert your fingers in the pin hole.

★ Insert the O-ring at the end face of the bucket boss securely.

★ Adjustin bucket clearance.

1) Measure clearance **a** between arm (8) and bushing (9).
   ★ It is easier to measure if the bucket is moved to one side so that all the play is in one place.
2) Select shim thickness **b** so that clearance **a** is 0.5 - 1.0 mm.
   ★ Standard shim thickness: 0.5 mm, 1.0 mm
3) Install selected shim, then install plate (4).



REMOVAL OF ARM ASSEMBLY

1. Remove bucket assembly.
   For details, see REMOVAL OF BUCKET ASSEMBLY.

2. Secure ling to arm with wire.
   ⚠ Extend the arm cylinder piston rod to a point approx. 200 mm before the end of the IN stroke, then lower the arm on to block ① and stand ②, and set the safety lock lever to the LOCK position.

3. Set block ③ between arm cylinder and boom.

4. Disconnect grease hose (1).

5. Remvoe plate (2), then remove arm cylinder head pin (3). ※ 1

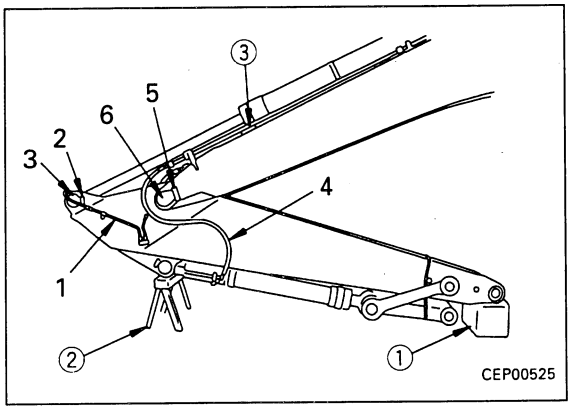
6. Start engine, and retract piston rod, then tie piston rod with wire to prevent it from coming out.
   ⚠ Release the remaining pressure in the hydraulic circuit.
   For details, see TESTING AND ADJUSTING, Releasing remaining pressure in hydraulic circuit.

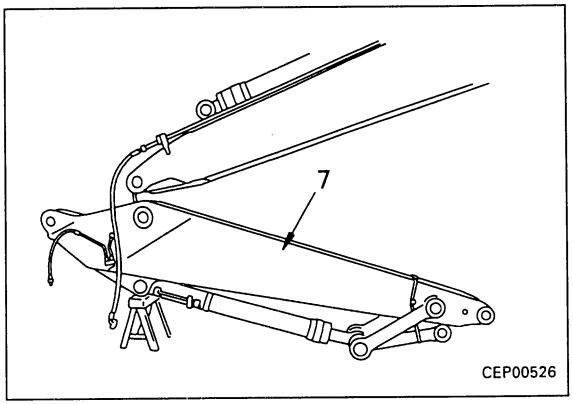
7. Disconnect 2 bucket cylinder hoses (4).

8. Remove plate (5), then remove connecting pin (6) between arm and boom. ※ 2
   ★ There are shims installed, so check the number, thickness, and position, and keep in a safe place.

9. Start engine, then raise boom, and swing to remove arm assembly (7).

kg Arm assembly: **2100 kg**





INSTALLATION OF ARM ASSEMBLY

- Carry out installation in the reverse order to removal.

※ 1

Inside surface of bushing when assembling pin:
Anti-friction compound (LM-P)

Grease after assembling pin:
Grease (LM-G)

⚠ When aligning the position of the pin hole, never insert your fingers in the pin hole.

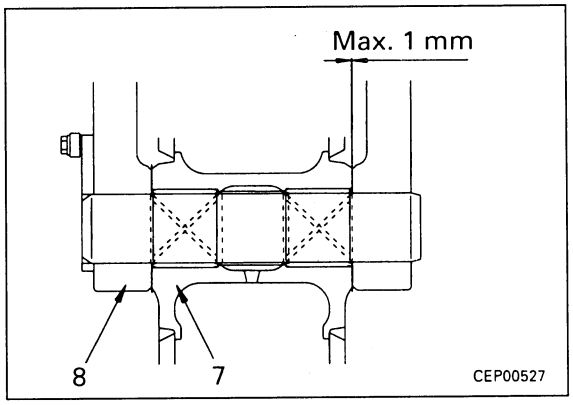
※ 2

Inside surface of bushing when assembling pin:
Anti-friction compound (LM-P)

Grease after assembling pin:
Grease (LM-G)

⚠ When alignging the position of the pin hole, never insert your fingers in the pin hole.

★ Adjust the shim thickness so that the clearance between the end face of the bottom of arm (7) and boom (8) is below 1.0 mm.
  - Standard shim thickness: 1.0 mm



- **Bleeding air**
  ★ Bleed the air.
  For details, see TESTING AND ADJUSTING, Bleding air.

- **Refilling with oil (hydraulic tank)**
  ★ Add oil through the oil filler to the specified level. Run the engine to circulate the oil through the system. Then check the oil level again.

REMOVAL OF BUCKET, ARM ASSEMBLY

⚠ Extend the bucket cylinder piston rod to the end of the CURL stroke, and the arm cylinder piston rod to a point approx. 200 mm before the end of the IN stroke. Then lower the work equipment completely to the ground, and set the safety lock lever to the LOCK position.

1. Set block ① to bucket cylinder bottom mounting boss portion of arm.

2. Disconnect grease hose (1).

3. Remove plate (2), then remove arm cylinder head pin (3). ※ 1

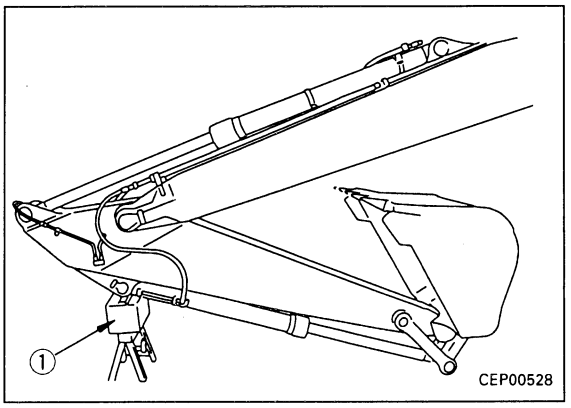
4. Start engine, and retract piston rod, the tie piston rod with wire to prevent it from coming out.
   ⚠ Release the remaining pressure in the hydraulic circuit.
   For details, see TESTING AND ADJUSTING, Releasing remaining pressure in hydraulic circuit.

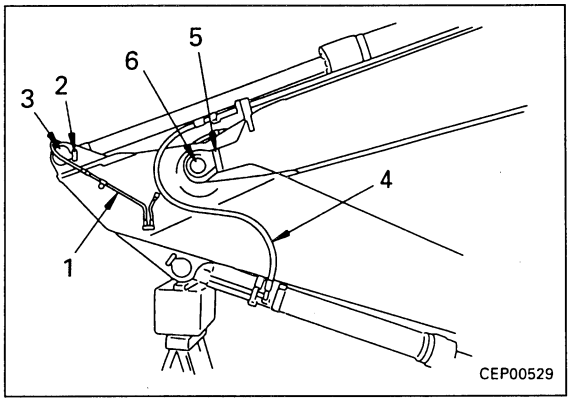
5. Disconnect 2 bucket cylinder hoses (4).

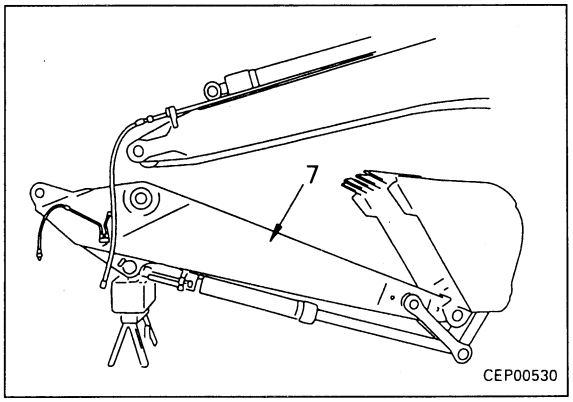
6. Remove plate (5), then remove connecting pin (6) between arm and boom. ※ 2
   ★ There are shims installed, so check the number, thickness, and position, and keep in a safe place.

7. Start engine, then raise boom, and swing to remove bucket and arm assembly (7).

kg Bucket, arm assembly: **3450 kg**





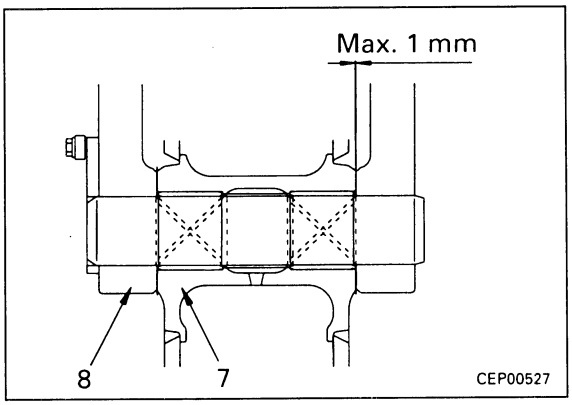


INSTALLATION OF BUCKET, ARM ASSEMBLY

- Carry out installation in the reverse order to removal.

※ 1
Inside surface of bushing when assembling pin:
Anti-fricton compound (LM-P)
Grease after assembling pin:
Grease (LM-G)
⚠ When aligning the position of the pin hole, never insert your fingers in the pin hole.

※ 2
Inside surface of bushing when assembling pin:
Anti-friction compound (LM-P)
Grease after assembling pin:
Grease (LM-G)
⚠ When aligning the position of the pin hole, never insert your fingers in the pin hole.
★ Adjust the shim thickness so that the clearance between the end face of the bottom of arm (7) and boom (8) is less than 1.0 mm.
  - Standard shim thickness: 1.0 mm



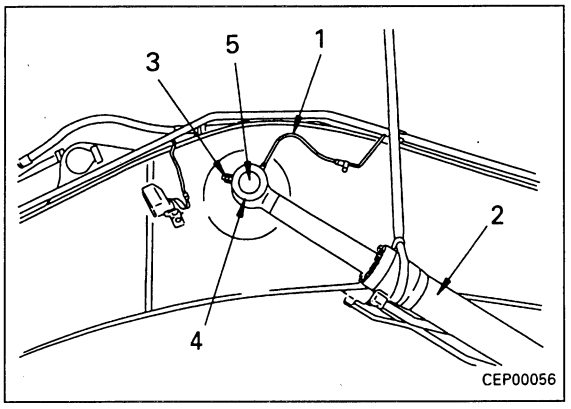
- **Bledding air**
  ★ Bleed the air.
  For details, see TESTING AND ADJUSTING, Bleeding air.

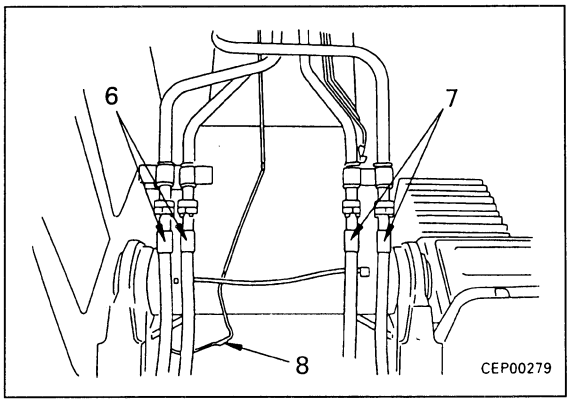
- **Refilling with oil (hydraulic tank)**
  ★ Add oil through the oil filler to the specified level. Run the engine to circulate the oil through the system. Then check the oil level again.

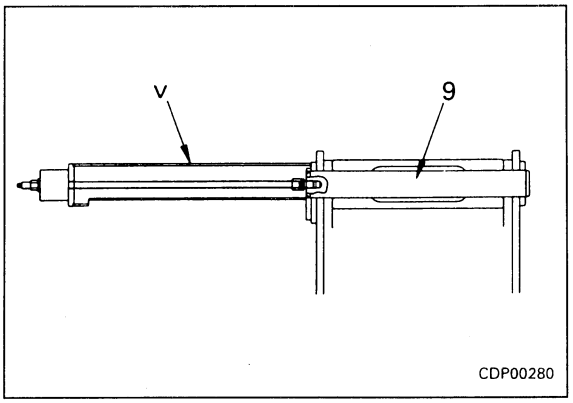
REMOVAL OF BOOM ASSEMBLY

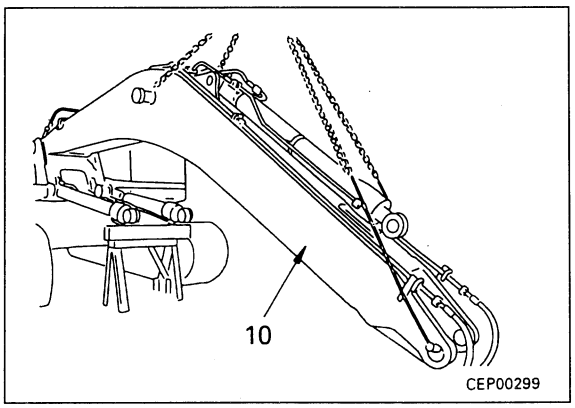
1. Remove bucket and arm assembly
   For details, see REMOVAL OF BUCKET, ARM ASSEMBLY.
   ⚠ Lower the boom assembly completely to the ground, and set the safety lock lever to the LOCK position.
2. Disconnect grease hose (1).
3. Sling boom cylinder assembly (22), and remove lock bolt(3). ※ 1
4. Remove plate (4), then remove head pin (5). ※ 2
   ★ There are shims installed, so check the number and thickness, and keep in a safe place.
5. Start engine, and retract piston rod, thentie piston rod with wire to prevent it from coming out, and lower it onto stand.
   ★ Disconnect the boom cylinder on the opposite side in the same way.
   ⚠ Release the remaining pressure in the hydraulic circuit.
   For details, see TESTING AND ADJSTING, Releasing remaining pressure in hydraulic circuit.
6. Disconnect arm cylinder hoses (6) and bucket cylinder hoses (7), and secure to valve with rope.
7. Disconnect wiring connector (8) for working lamp
8. Remove plate, and set tool **V** to boom foot pin (9).
9. Raise boom assembly (10), remove boom foot pin (9) using tool **V**, then remove boom assembly (10). ※ 3
   ★ There are shims installed, so check the number and thickness, and keep in a safe place.

kg Boom assembly: **3950 kg**







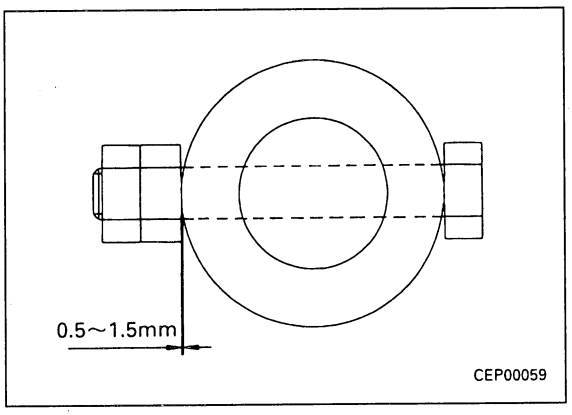


INSTALLATION OF BOOM ASSEMBLY

- Carry out installation in the reverse order to removal.

※ 1

★ When tightening the locknut, tighten so that the clearance between the plate and nut is 0.5 - 1.5 mm.



※ 2

Inside surface of bushing when assembling pin:

Anti-friction compound (LM-P)

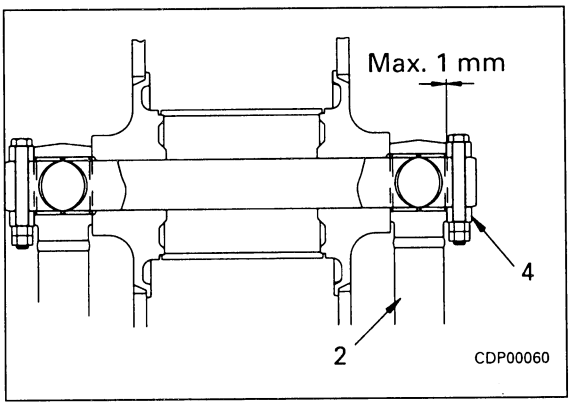
Grease after assembling pin:

Grease (LM-G)

⚠ When aligning the position of the pin hole, never insert your fingers in teh pin hole.

★ Adjust the shim thickness so that the clearance between the end face of the rod of cylinder (2) and plate (4) is less than 1.0 mm.

- Standard shim thickness: 1.0 mm, 1.5 mm



※ 3

Inside surface of bushing when assembling pin:

Anti-friction compound (LM-P)

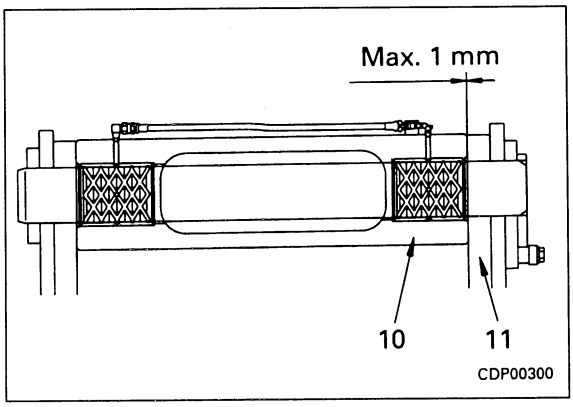
Grease after assembling pin:

Grease (LM-G)

⚠ When aligning the position of the pin hole, never insert your fingers in the pin hole.

★ Adjust the shim thickness so that the clearance between the end face of the foot of boom (10) and bracket (11) is less tan 1.0 mm.

- Standard shim thickness: 0.8 mm, 1.5 mm



- **Bleeding air**

★ Bleed the air.
For details, see TESTING AND ADJUSTING, Bleeding air.

- **Refilling with oil (hydraulic tank)**

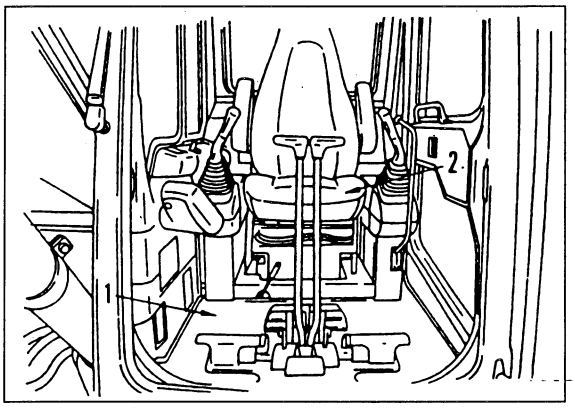
★ Add oil through the oil filler to the specified level. Run the engine to circulate the oil throught the system. Then check the oil level again.

REMOVAL OF OPERATOR'S CAB ASSEMBLY

⚠ Disconnect the cable from the negative (-) terminal of the battery.

1. Remove floor mat (1).

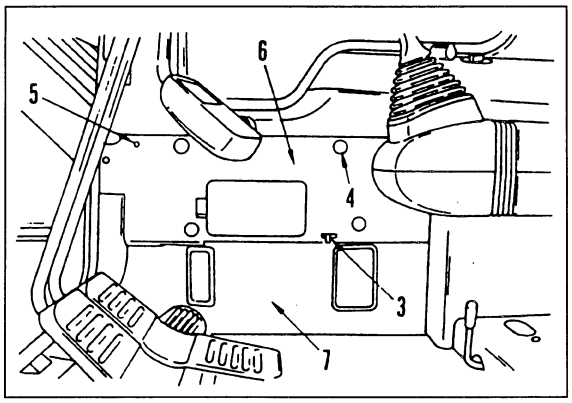
2. Remove operator's seat assemlby (2).
   kg Operator's seat assembly: **40 kg**



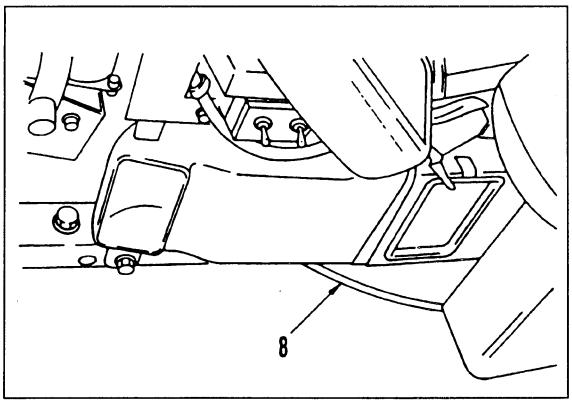
3. Remove knob (3).

4. Remove 4 caps (4) and clip (5), then remove middle panel (6).

5. Remove bottom panel (7).
   ★ The panel is held by a clip, so remove the clip when removing the panel and be careful not to damage it.

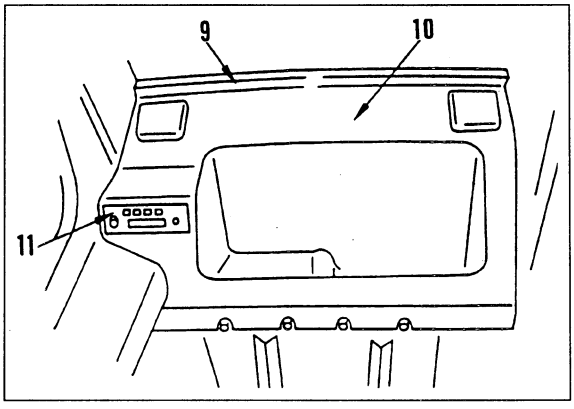


6. Disconnect washer hose (8).



7. Remove radio (11) if fitted (refer to radio operation manual).
   ★ Remove plate (9), tehn remove cover (10).

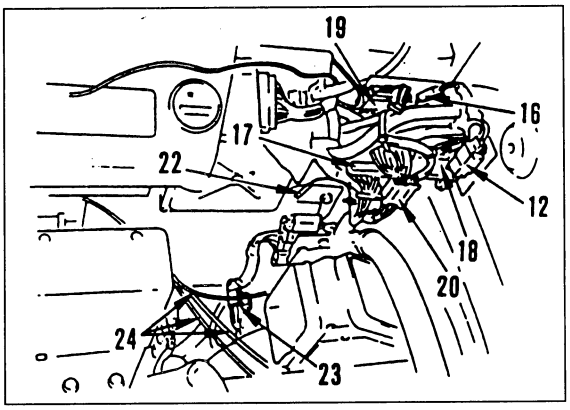
8. Lift cover (10) away carefully to locate speaker harness connector. Disconnect and remove panel completely.



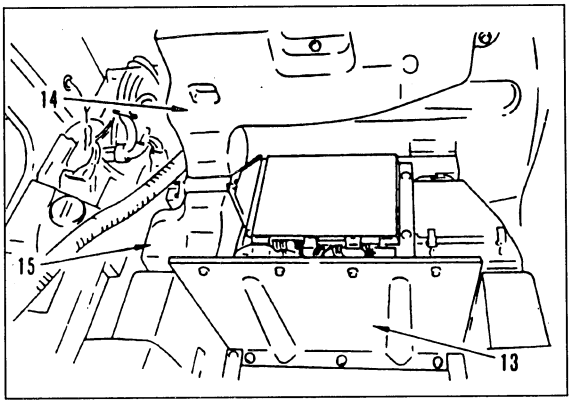
9. Remove divider board (13).

10. Remove heater duct of air conditioner ducts (14) and (15) (if fitted).

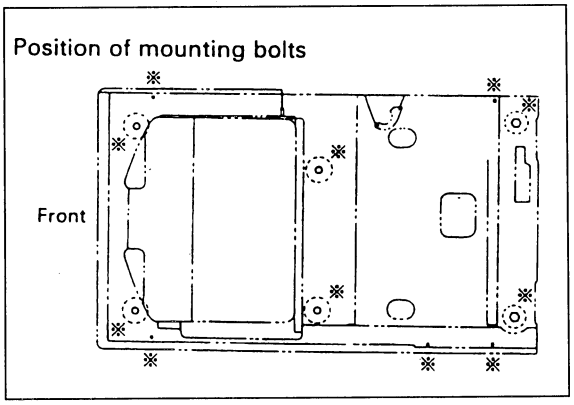
11. Disconnect wiring connectors CN-H01 (16), CN-H02 (17), CN-H03 (18), CN-H04 (19), CN-H05 (20), CN-H06 (21), CN-K01 (22), CN-H07 CN-H08 CN-H09



12. Disconnect heater cables or air conditioner cables (24) (if fitted).



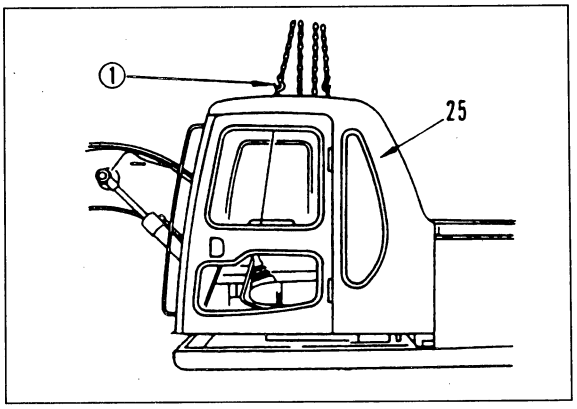
13. Remove 11 cab mounting bolts (marked ※).



14. Using eyebolts ①, remove operator's cab assembly (25)

kg Operator's cab assembly: **300 kg**

★ When raising the cab assembly, check that all the wiring has been disconnected, then lift off slowly and be careful not to hit any part.



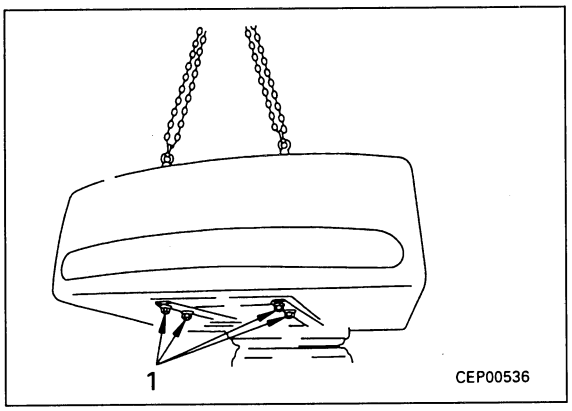
INSTALLATION OF OPERATOR'S CAB ASSEMBLY

- Carry out installation in the reverse order to removal.

REMOVAL OF COUNTERWEIGHT ASSEMBLY

1. Set lifting hook chains of counterweight assembly in position, and sling.
2. Remove mounting bolts (1).
   ★ Check the location of the shims.
3. Lift off counterweight assembly (2). ※ 1

kg Counterweight assembly: **9000 kg**



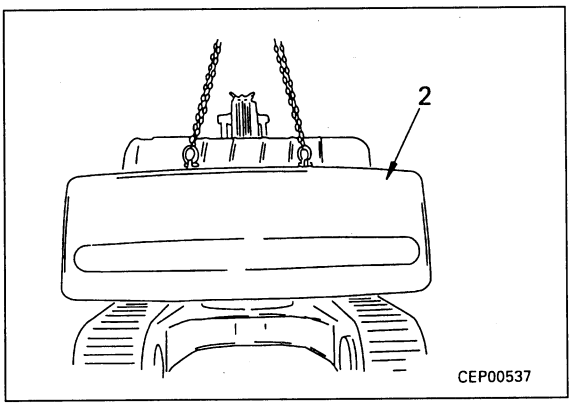
INSTALLATION OF COUNTERWEIGHT ASSEMBLY

- Carry out installation in the reverse order to removal.

※ 1

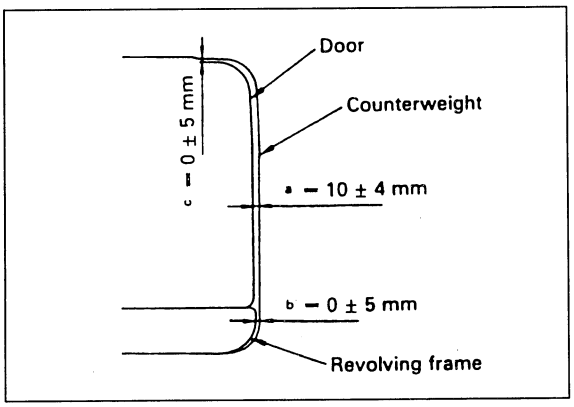
Thread of counterweight mounting bolt:
Thread tightener (LT-2)

kgm Counterweight mounting bolt:
3825 ± 392 Nm (390 ± 40 kgm)

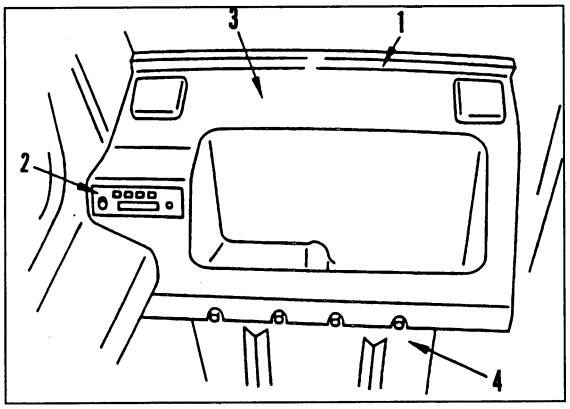


※ 2

★ Installing and adjusting counterweight
   1) Sling counterweight with crane and set in position on frame.
   2) Use counterweight pusher bolt ②, and align mounting bolts ho Thens install shim and mounting bolts (2) and (3), and adjust to following dimensions.
      - Clearance from revolving frame: 10 ± 5 mm (left and right)
      - Clearance from bodywork door: 10 ± 5 mm (left and right)
      - Stepped difference ⓑ from revolving frame in left-to right directio: Max. 5 mm
      - Stepped difference ⓐ from bodywork door in left-to-right direction: 10 ± 4 mm
      - Stepped difference ⓒ from bodywork top cover in up-down direction: Max. 5 mm
   3) After adjuting, remove counterweight pusher bolt ②.



REMOVAL OF GOVERNOR, PUMP CONTROLLER ASSEMBLY



⚠ Disconnect the cable from the negative 9-) terminal of the battery.

1. Remove Radio (2) if fitted.
2. Remove plate (1), then remove cover (2), (3).
3. Lift cover (3) away carefully to locate speaker harness connector. Disconnect and remove panel completely.
4. Remove divider board (5).
5. Disconnect wiring connector (6), and remove engine throttle controller assembly (7).

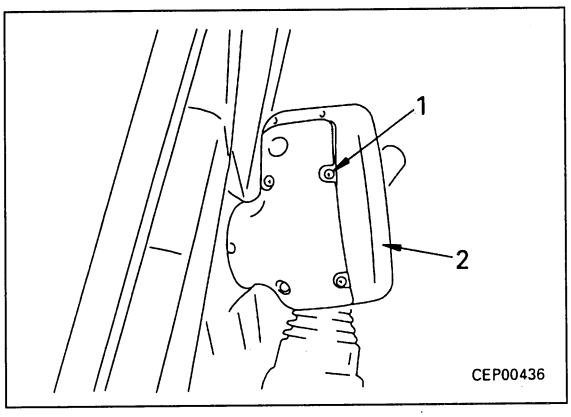
INSTALLATION OF GOVERNOR, PUMP CONTROLLER ASSEMBLY

- Carry out installation in the reverse order to removal.

[*1]

- Check the performance of the work equipment, travel, and swing. For details, see TESTING AND ADJUSTING.

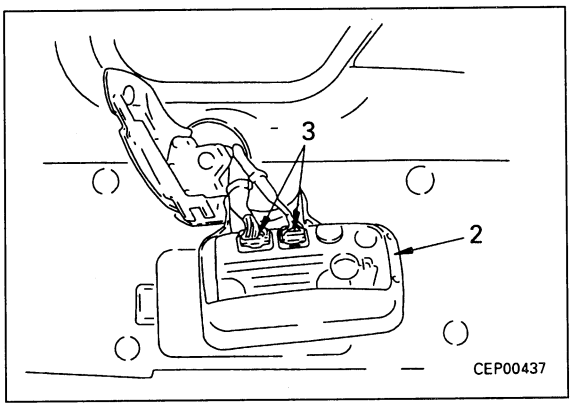
REMOVAL OF MONITOR PANEL ASSEMBLY



⚠ Disconnect the cable from the negative (-) terminal of the battery.

1. Remove 4 screws (1), and disconnect monitor panel assembly (2) from bracket.
2. Disconnect connectors (3), then remove monitor panel assembly (2). ※ 1

INSTALLATION OF MONITOR PANEL ASSEMBLY



- Carry out installation in the reverse order to removal.

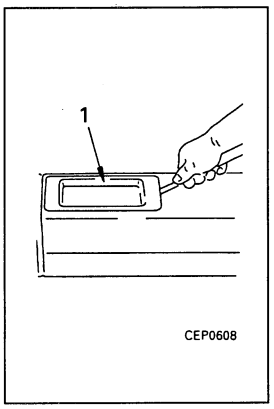
※ 1

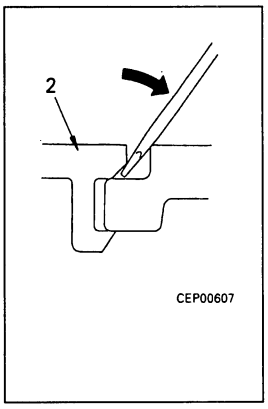
- Check the mode setting and display function.
  For details, see TESTING, ADJUSTING, AND TROUBLESHOOTING.

REMOVAL OF CONTROL STAND CASE

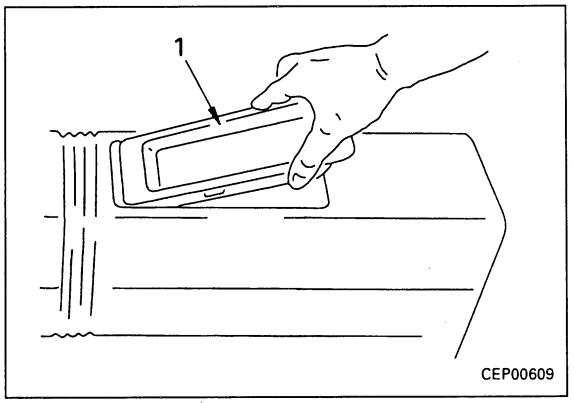
1. Tray

1) Insert a thin flat-headed screwdriver into notch at rear of tray (1) and lever up lightly to release rear claw (2).
★ The claw can only be released from the rear.





2) Pull tray (1) to rear to remove. ※ 1



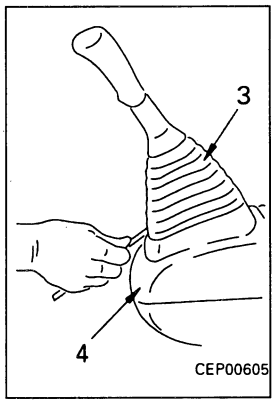
2. Boot

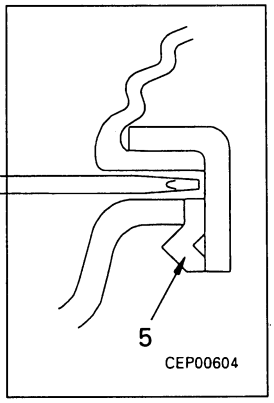
1) Insert a thin flat-headed screwdriver between boot (3) and upper case (4), remove claw (5) at front of boot from upper case, then raise front.

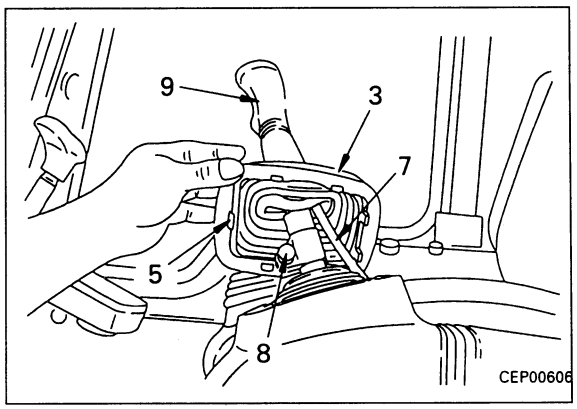
2) Pull boot (3) to front to remove claw at rear of boot. ※ 1

3) Disconnect wiring connector (7) from hole for removed tray.

4) Push boot up, remove bolt (8), then remove lever (9) and boot (3).
★ Check the direction of the lever.

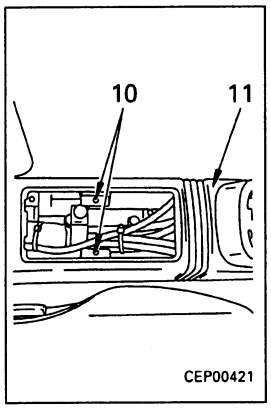


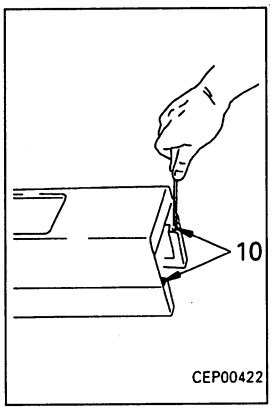




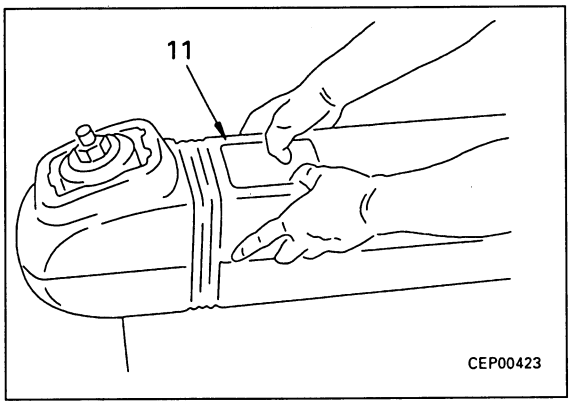
3. Upper case.

1) Remove 4 upper case mounting screws (10).



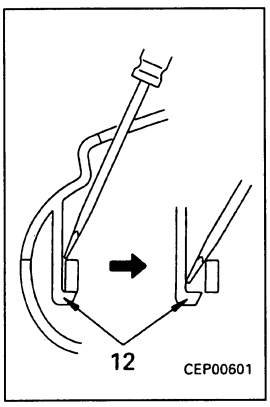


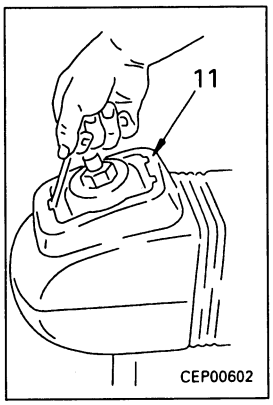
2) Push bottom center of upper case (11) from both sides, and lift up to release claws at both sides.



3) Use a screwdriver from front of upper case to release claws (12) at front of case.

4) Remove upper case (11).





INSTALLATION OF CONTROL STAND CASE

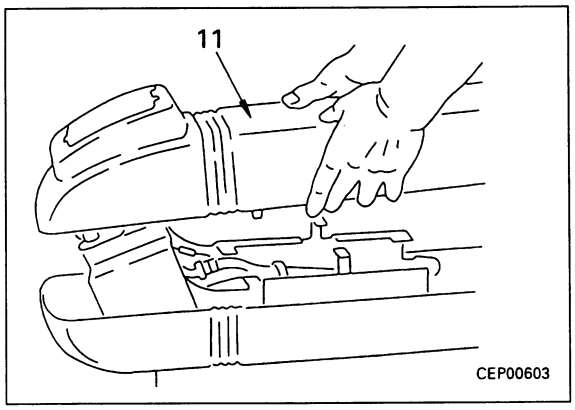
- Carry out installation in the reverse order to removal.

※ 1

★ When installing the boot, insert the claw at the rear first.

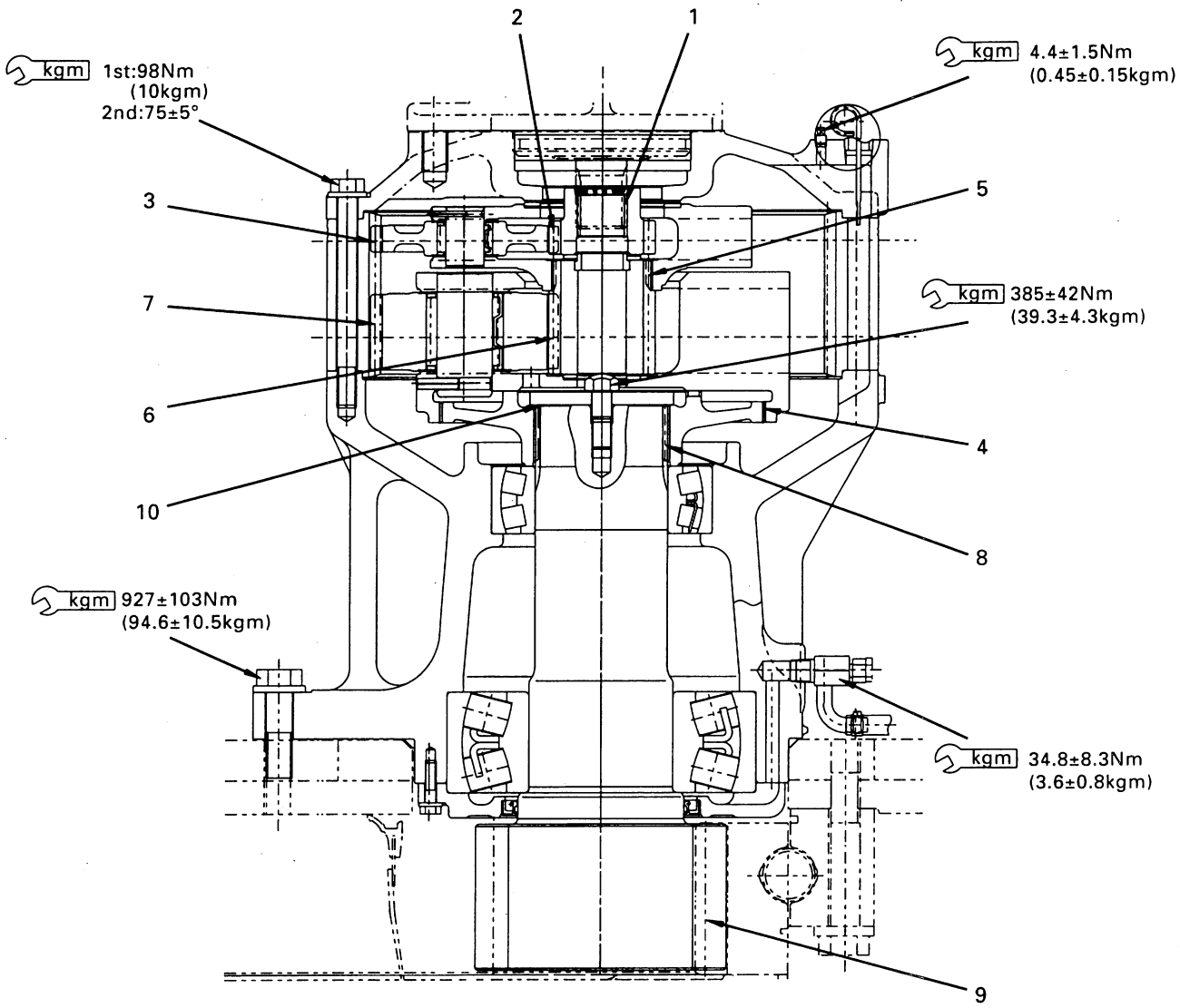
※ 2

★ When installing the tray and upper case, insert the claws at the front firts.



40 MAINTENANCE STANDARD

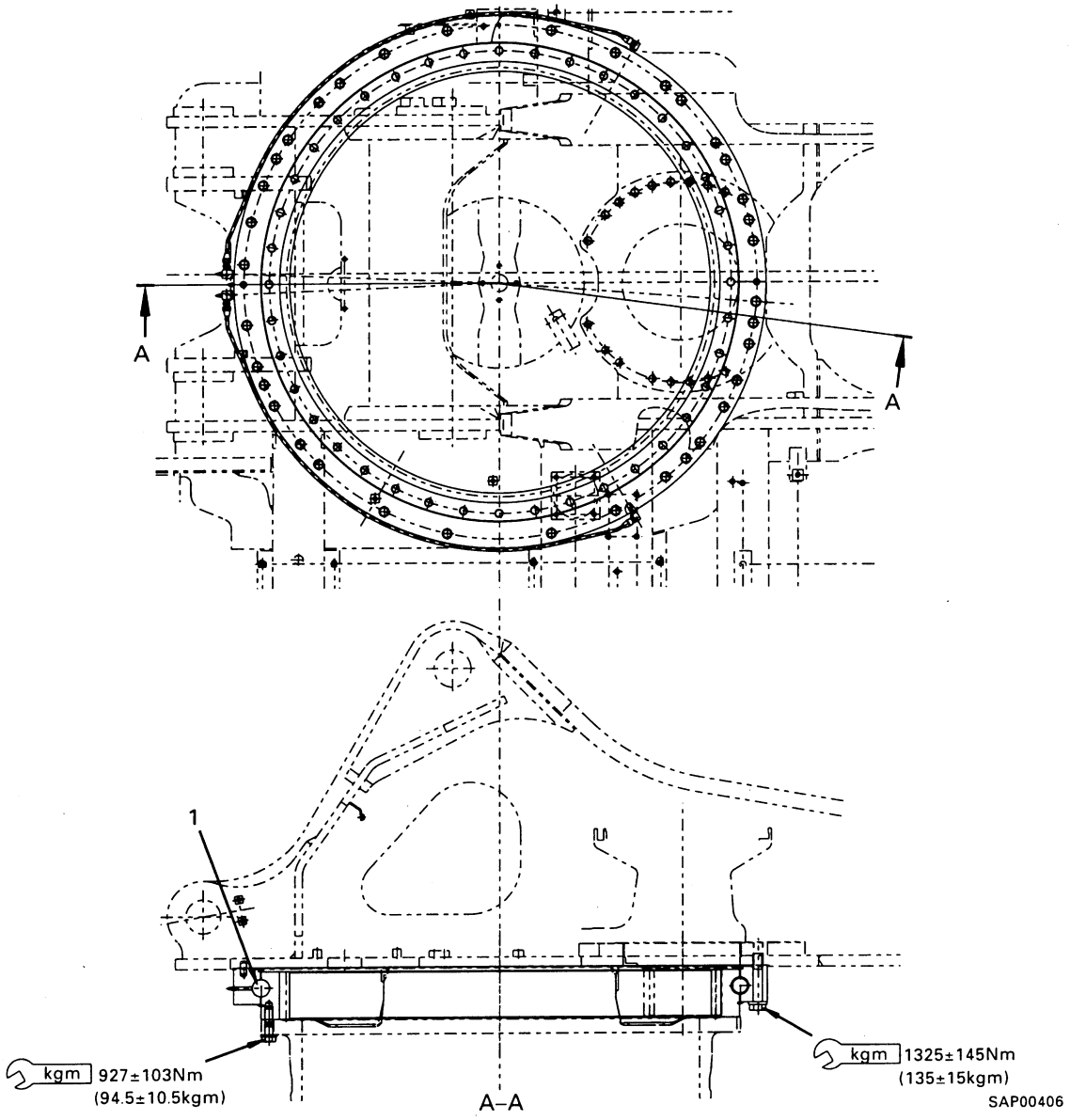
SWING MACHINERY



Unit: mm

No.	Check item	Criteria		Remedy
		Standard clearance	Clearance limit	
1	Backlash between swing motor shaft and No. 1 sun gear	0.19 0.29	-	Replace
2	Backlash betwenn No. 1 sun gear and No. 1 planet gear	0.19 - 0.56	0.90	
3	Backlash between No. 1 planet gear and ring gear	0.24 - 0.70	0.90	
4	Backlash between No.2 planet carrier and coupling	0.06 - 0.24	-	
5	Backlash between No. 1 planet carrier and No. 2 sun gear	0.40 - 0.71	1.10	
6	Backlash between No. 2 sun gear and No. 2 planet gear	0.19 - 0.56	1.00	
7	Backlash between No. 2 planet gear and ring gear	0.24 - 0.70	1.10	
8	Backlash between coupling and swing pinion	0.08 - 0.25	-	
9	Backlash between swing pinion and swing circle	0 - 1.21	2.00	
10	Clearance between plate and coupling	0.006 - 0.86	-	
11	Wear of swing pinion oil seal contact surface	Standard size	Repair limit	Repair hard chrome plating or replace
		$150_{0}^{0.100}$	-	

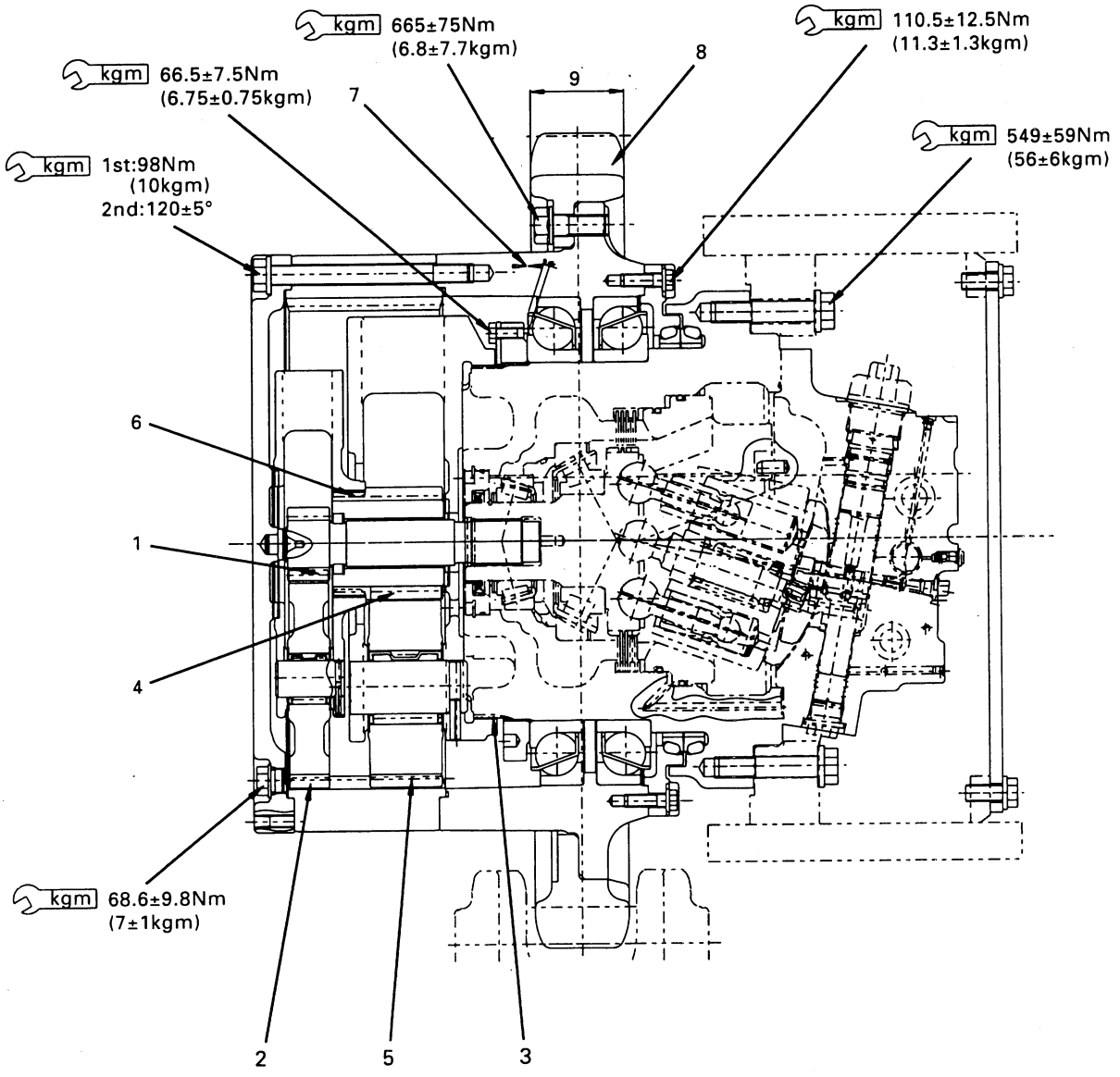
SWING CIRCLE



Unit: mm

No.	Check item	Criteria		Remedy
		Standard clearance	Clearance limit	
1	Clearance of bearing in axial direction (when mounted on machine)	0.5 - 1.6	3.2	Replace

FINAL DRIVE

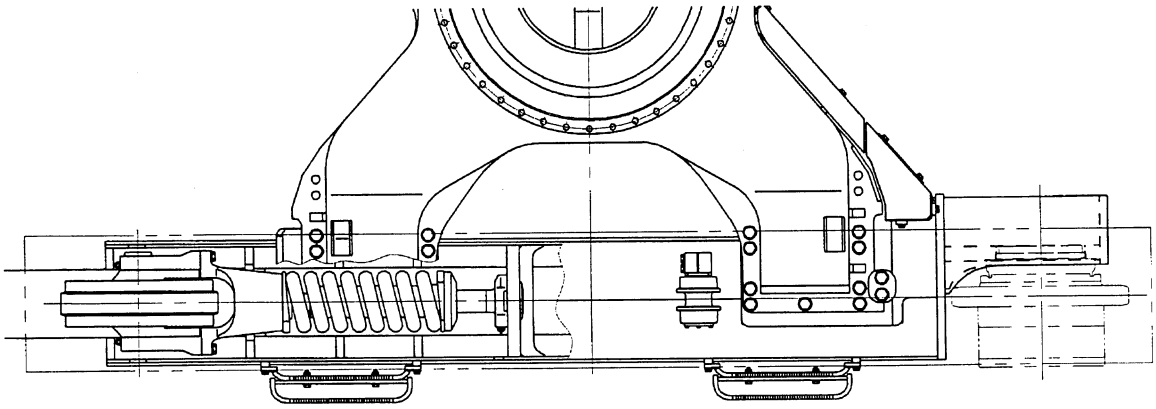

kgm 665±75Nm
(6.8±7.7kgm)
kgm 110.5±12.5Nm
(11.3±1.3kgm)
kgm 66.5±7.5Nm
(6.75±0.75kgm)
kgm 549±59Nm
(56±6kgm)
kgm 1st:98Nm
(10kgm)
2nd:120±5°
kgm 68.6±9.8Nm
(7±1kgm)
1
2
3
4
5
6
7
8
9
SAP00408

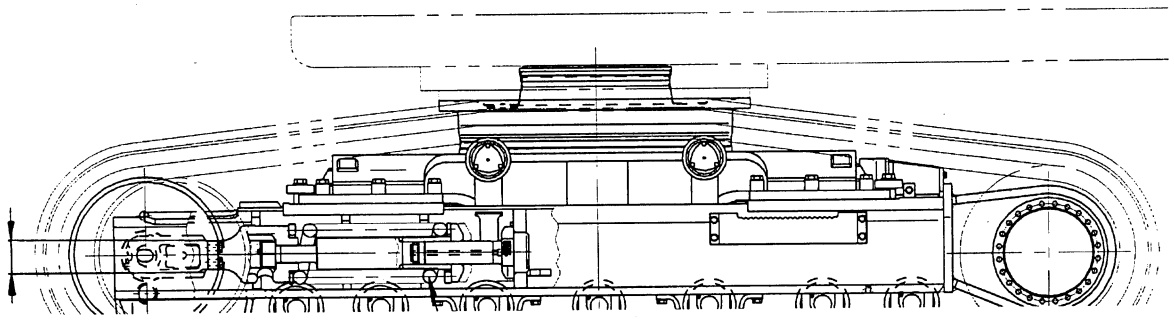
Unit: mm

No.	Check item	Criteria		Remedy
		Standard clearance	Clearance limit	
1	Backlash between No. 1 sun gear and No. 1 planet gear	0.20 - 0.61	1.00	Replace
2	Backlash between No. 1 planet gear and ring gear	0.24 - 0.70	1.10	
3	Backlash between No. 2 planet carrier and motor	0.06 - 0.24	-	
4	Backlash between No. 2 sun gear and No. 2 planet gear	0.20 - 0.63	1.00	
5	Backlash between No. 2 planet gear and ring gear	0.24 - 0.70	1.10	
6	Backlash between No. 1 planet gear and No. 2 sun gear	0.41 - 0.72	1.00	
7	End play of sprocket shaft	0.10 - 0.15	-	
8	Wear of sprocket teeth	Repair limit: 6		
9	Sprocket tooth width	Standard size	Repair limit	Rebuild or replace
		90	87	

TRACK FRAME AND RECOIL SPRING

★ The diagram shows the PC450-6K

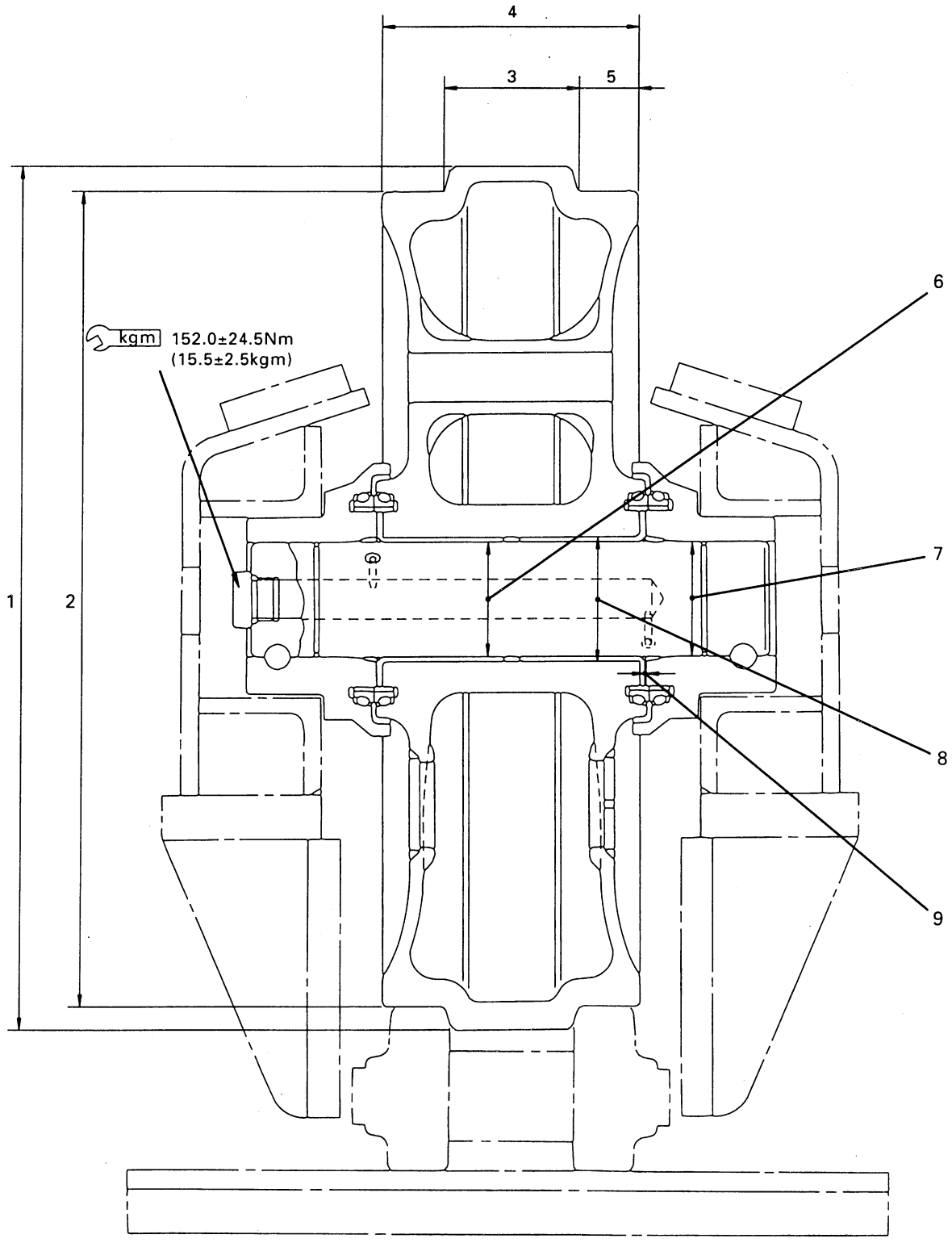




Unit: mm

No.	Check item	Criteria					Remedy
1	Top-to-bottom width of idler guide		Standard size	Tolerance	Repair limit		Rebuild or replace
		Track frame	148	+ 3 - 1	152		
		Idler support	146	± 0.5	143		
2	Left-to right width of idler guide	Track frame	302	+3 - 1	307		
		Idler support	297	-	295		
3	Recoil spring	Standard size			Repair limit		Replace
		Free length X OD	Installed length	Installed load	Free length	Installed load	
		857 X 270	707	239 kN (24,375 kg)	-	191 kN (19,500 kg)	

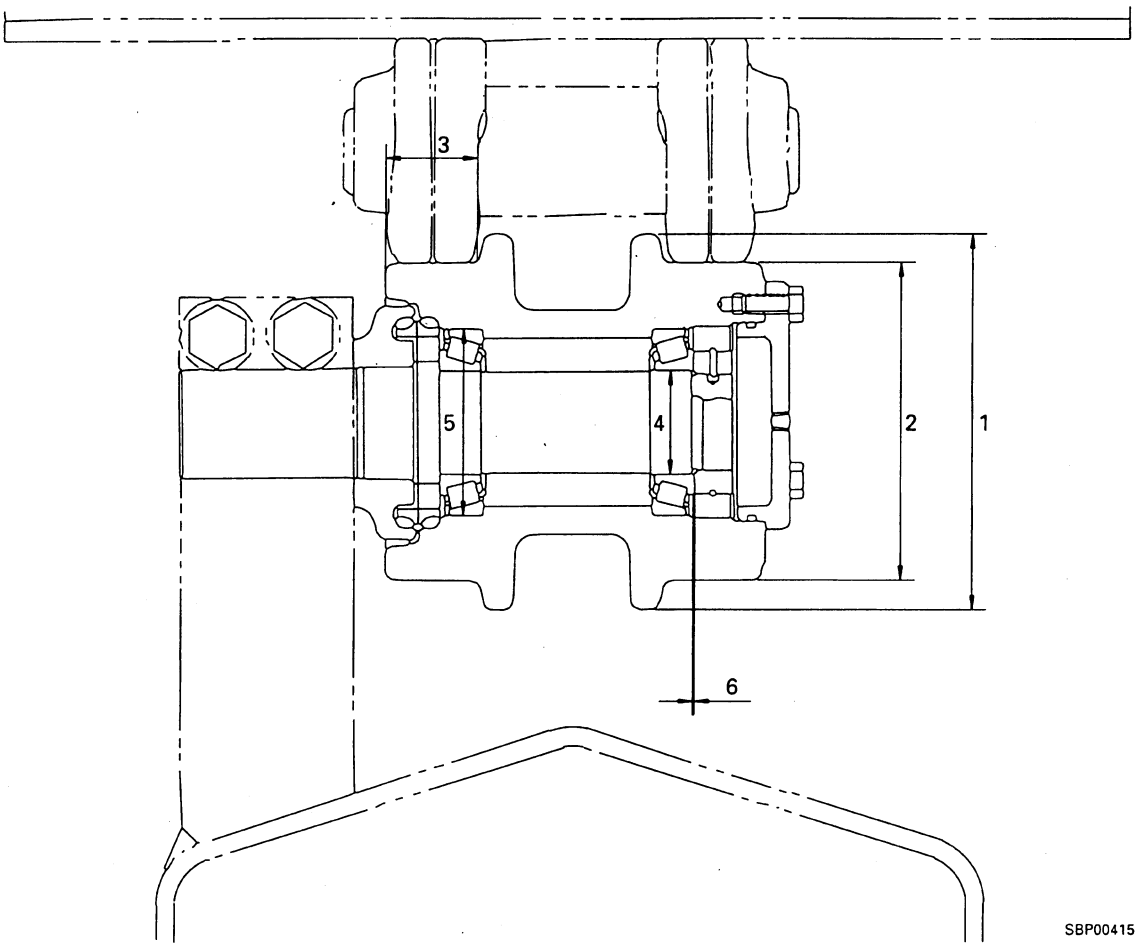
IDLER



Unit: mm

No.	Check item	Criteria					Remedy
1	Outside diameter of proruding portion	Standard size		Repair limit			Rebuild or replace
		704		-			
2	Outside diameter of tread	660		648			
3	Width of protrusion	105		-			
4	Overall width	204		-			
5	Width of tread	49.5		55.5			
6	Clearance between shaft and bushing	Standard size	Tolerance		Standard clearance	Clearance limit	Replace bushing
			Shaft	Hole			
		95	-0.120 -0.207	+0.360 +0.220	0.340 - 0.567	1.5	
7	Clearance between shaft and support	95	-0.120 -0.207	+0.035 0	0.120 - 0.242	-	Replace
8	Interference between idler and bushing	Standard size	Tolerance		Standard interference	Interference limit	Replace bushing
			Shaft	Hole			
		102.9	+0.087 +0.037	-0.027 -0.062	0.064 - 0.149	-	
9	Side clearance of idler (both sides)	Standard clearance		Clearance limit			
		0.46 - 0.86		1.5			

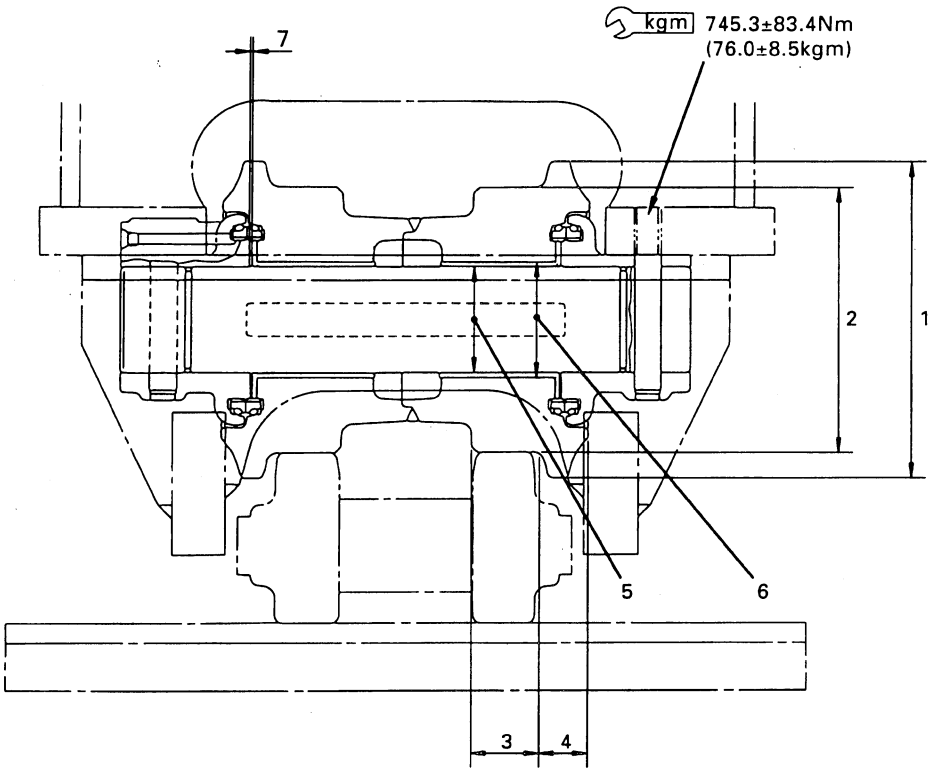
CARRIER ROLLER



Unit: mm

No.	Check item	Criteria					Remedy
1	Outside diameter of flange (outside)	Standard size		Repair limit			Rebuild or replace
		200		-			
2	Outside diameter of tread	168		158			
3	Width of tread	57		65			
4	Interference between shaft and bearing	Standard size	Tolerance		Standard interference	Interference limit	Replace
			Shaft	Hole			
		55	-0.021 -0.002	0 -0.015	0.002 - 0.036	-	
5	Interference between roller and bearing	100	0 -0.015	0.024 -0.059	0.009 - 0.059	-	
6	Side clearance of roller	Standard size		Repair limit			
		0.01 - 0.22		-			

TRACK ROLLER

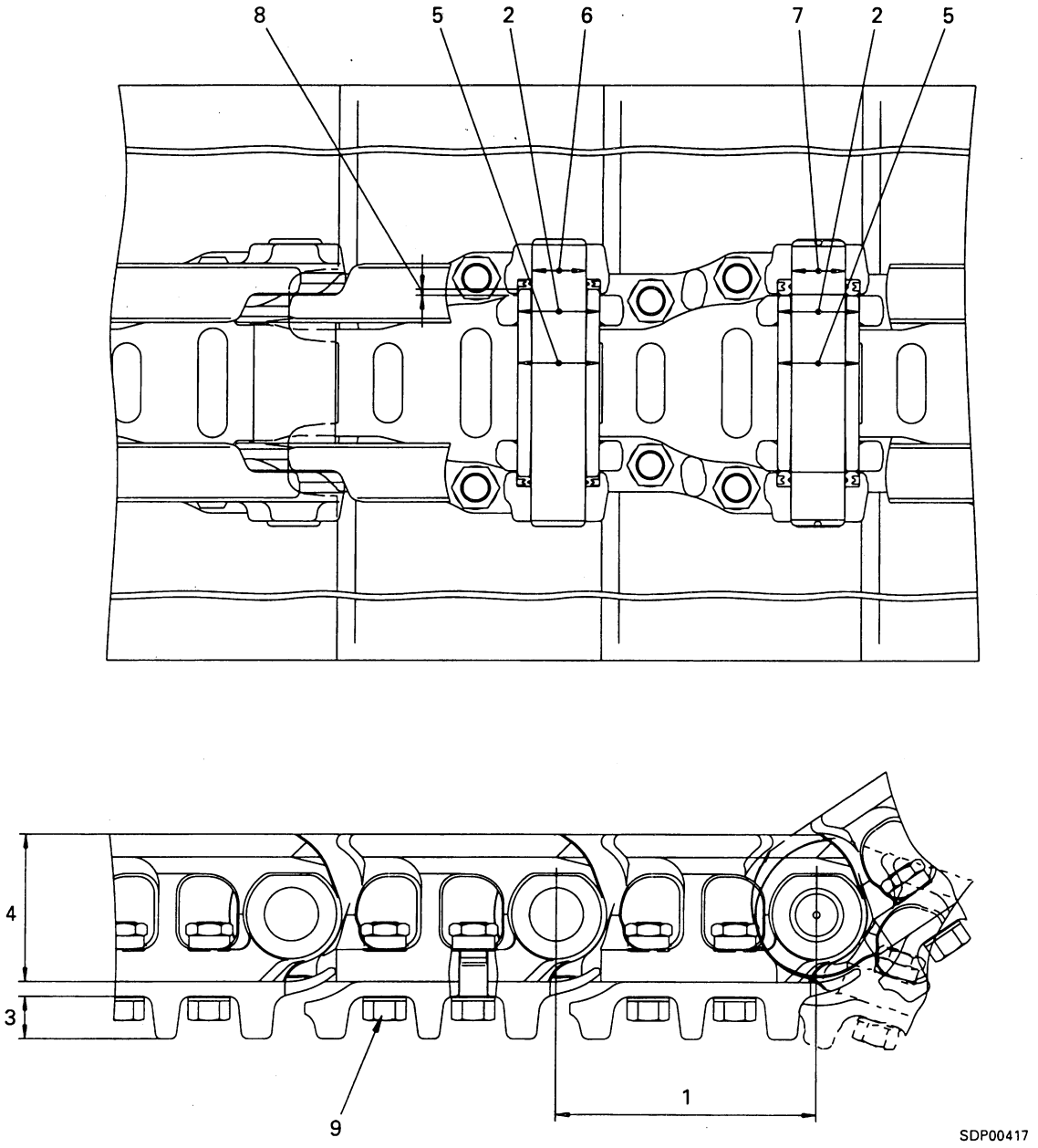


SBP00414

Unit: mm

No.	Check item	Criteria					Remedy
1	Outside diameter of flange (outside)	Standard size		Repair limit			Rebuild or replace
		240		-			
2	Outside diameter of tread	200		188			
3	Width of tread	54.6		61			
4	Width of flange	34.4		-			
5	Clearance between shaft and bushing	Standard size	Tolerance		Standard clearance	Clearance limit	Replace bushing
			Shaft	Hole			
		80	-0.25 -0.35	+0.174 +0.029	0.279 - 0.524	1.5	
6		Standard size	Tolerance		Standard interference	Interference limit	
			Shaft	Hole			
		87.6	+0.022 -0.013	+0.087 +0.037	0.015 - 0.10	-	
7	Side clearance of idler (both sides)	Standard clearance		Clearance limit			Replace
		0.45 - 0.98		1.5			

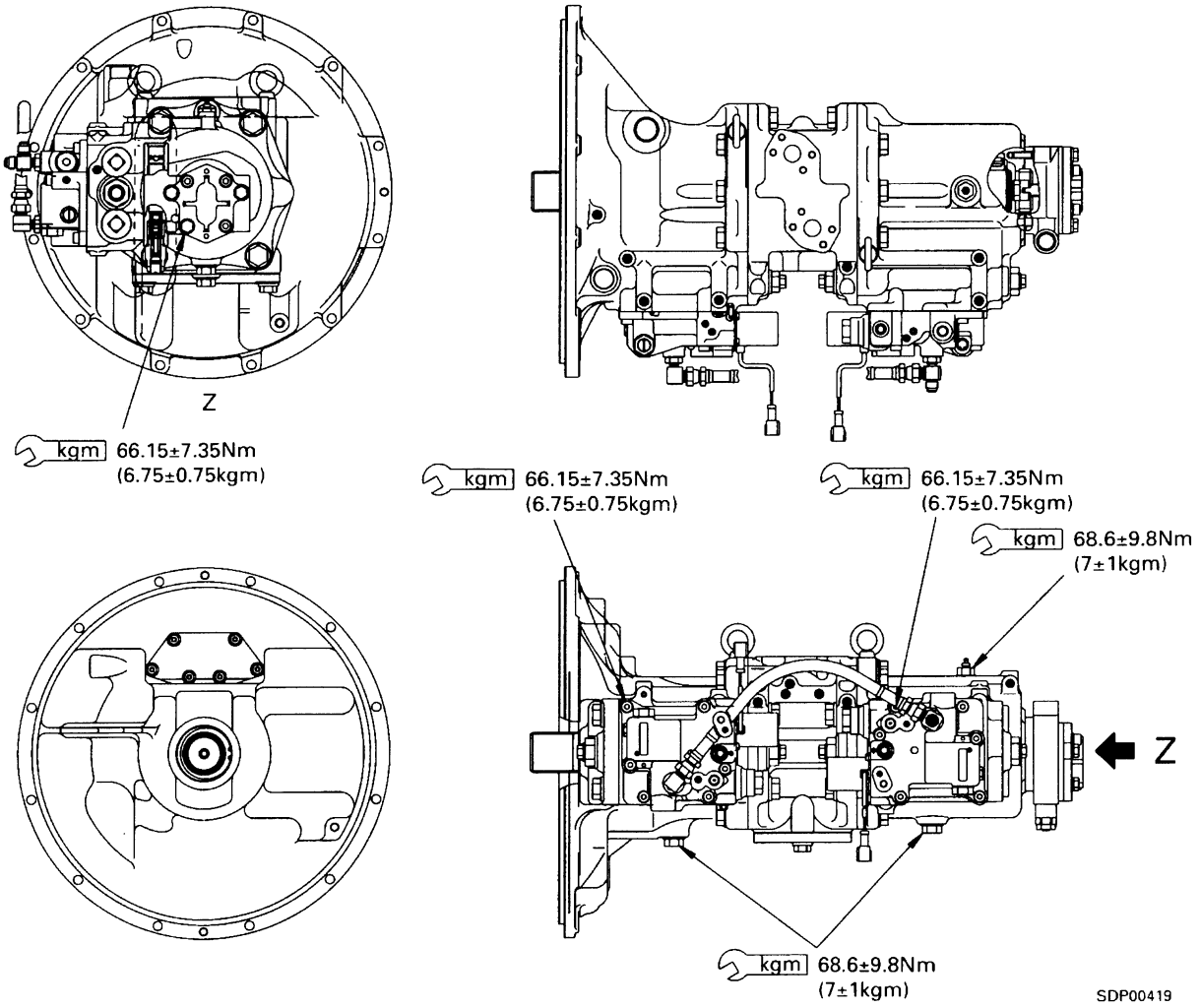
TRACK



Unit: mm

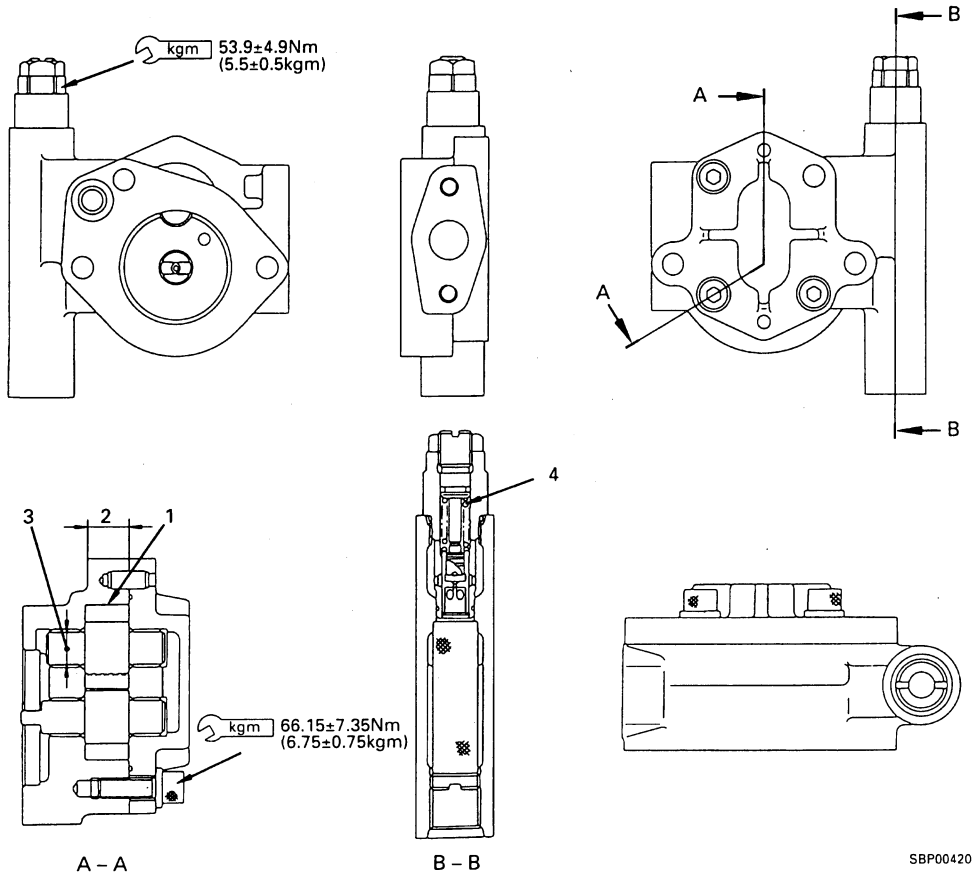
No.	Check item	Criteria					Remedy
1	Link pitch	Standard size		Repair limit			Replace
		228.6		231.9			
2	Outside diameter of bushing	71		66.5			
3	Height of grouser	37		22			Carry out lug welding or rebuild if it is possible withing repairable limit
4	Height of link	129		119			
5	Interference between bushing and link	Standard size	Tolerance		Standard interference	Interference limit	If it is lower than interference limit, replace with oversize
			Shaft	Hole			
		71	+0.494 +0.454	+0.074 0	0.380 - 0.494	0.10	
6	Interference between regular pin and link	47.0 (Shaft) 46.72 (Hole)	+0.235 +0.085	+0.062 0	0.303 - 0.515	0.19	
7	Interference between master pin and link	47.0 (Shaft) 46.72 (Hole)	+0.03 0	+0.062 0	0.218 - 0.31	0.13	
8	Protrusion of bushing	5.25 ± 0.3					
9	Tightening torque for shoe bolt	After tightening to initial torque 392.3 ± 39.2 Nm (40 ± 4 kgm), tighten a further 120 ± 10°					Replace

HYDRAULIC PUMP



CONTROL PUMP AND RELIEF VALVE

BAR-020



Unit: mm

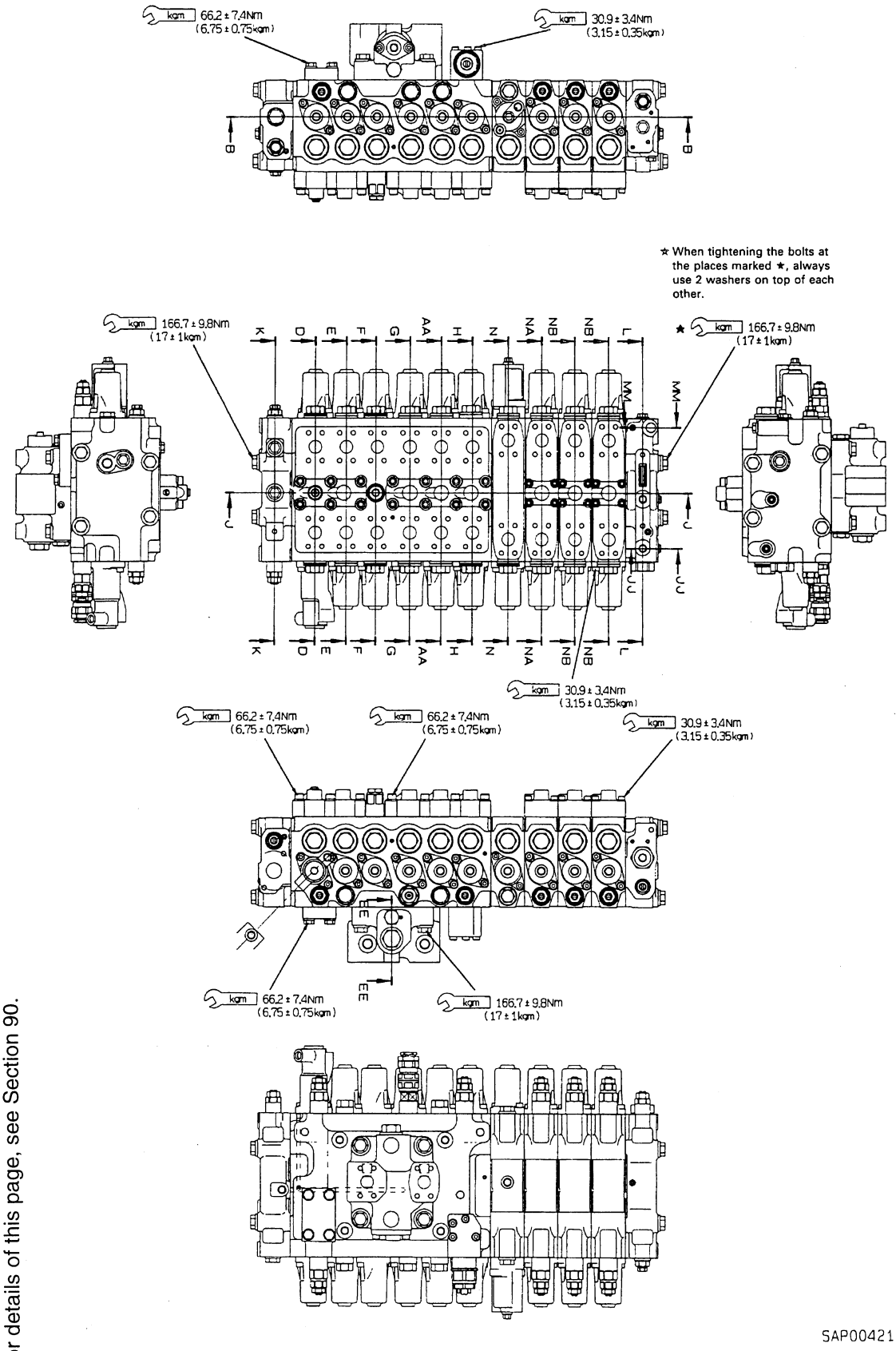
No.	Check item	Criteria					Remedy
1	Top clearance of gear	Standard clearance			Clearance limit		Replace
		0.085 - 0.125			0.145		
2	Side clearance of gear	0.050 - 0.060			0.105		
3	Clearance between gear shaft and bushing	0.045 - 0.098			0.13		
4	Control relief valve spring	Standard size			Repair limit		Replace spring if there is damage or deformation
		Free length x OD	Installed length	Installed load	Free length	Installed load	
		32.3 X 13	25.0	177.5 N (18.1 kg)	-	159.9 N (16.3 kg)	
-	Performance Oil: EO10-CD Oil temperature: 50 ± 5°C Oil pressure: 2.9 MPa (30 kg/cm²)	Standard discharge amount		Discharge limit			Replace
		Speed (rpm)	Delivery (/min)	Speed (rpm)	Delivery (ℓ/min)		
		3,200	60.2	3,200	43		

CONTROL VALVE

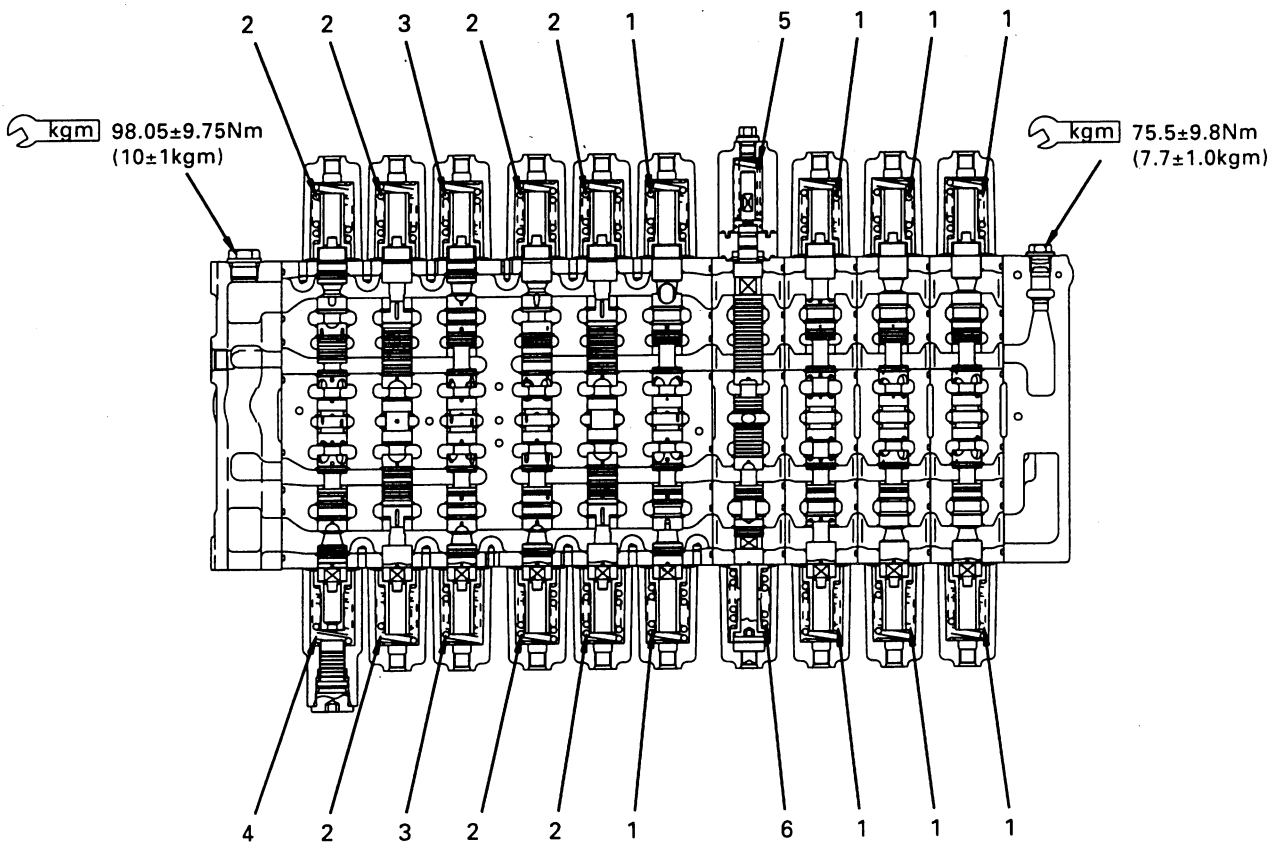
10-spool valve (1/6)

★ ★ For details of the 0-, 8-, and 7- spool valves, see 10-SPOOL VALVE.

For details of this page, see Section 90.



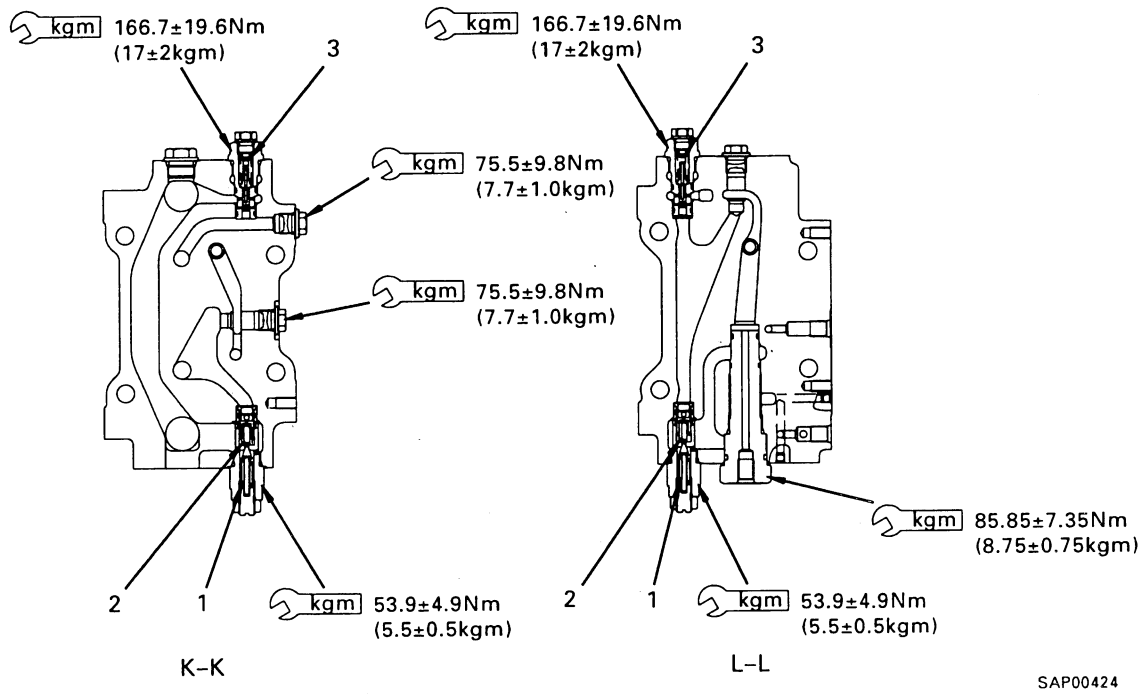
(2/6)



Unit: mm

No.	Check item	Criteria					Remedy
		Standard size			Repair limit		
1	Spool return spring	Free length X OD	Installed length	Installed load	Free length	Installed load	Replace spring if there is damage or deformation
		54.5 X 34.8	51.2	393.3 N (401 kg)	-	314.8 N (32.1 kg)	
2	Spool return spring	54.2 X 34.8	51.2	416.8 N (42.5 kg)	-	338.3 N (34.5 kg)	
3	Spool return spring	54.6 X 34.8	51.2	420.7 N (42.9 kg)	-	342.3 N (34.9 kg)	
4	Spool return spring	54.4 X 34.8	51.2	411.9 N (42.0 kg)	-	333.4 N (34.0 kg)	
5	Spool return spring	54.9 X 24.2	52.0	251.0 N (25.6 kg)	-	201.0 N (20.5 kg)	
6	Spool return spring	54.9 X 34.8	51.2	416.8 N (42.5 kg)	-	338.3 N (34.5 kg)	

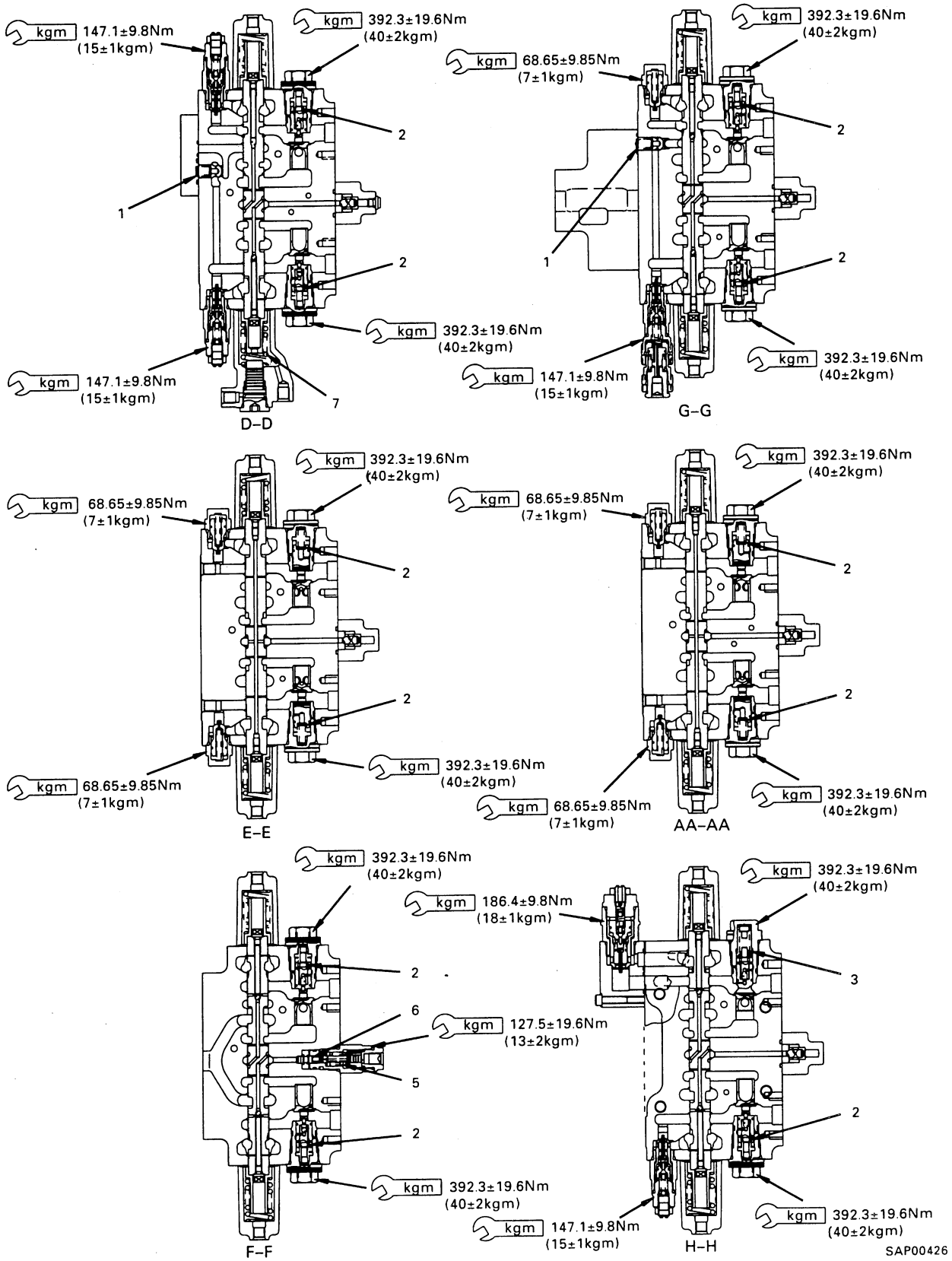
(3/6)



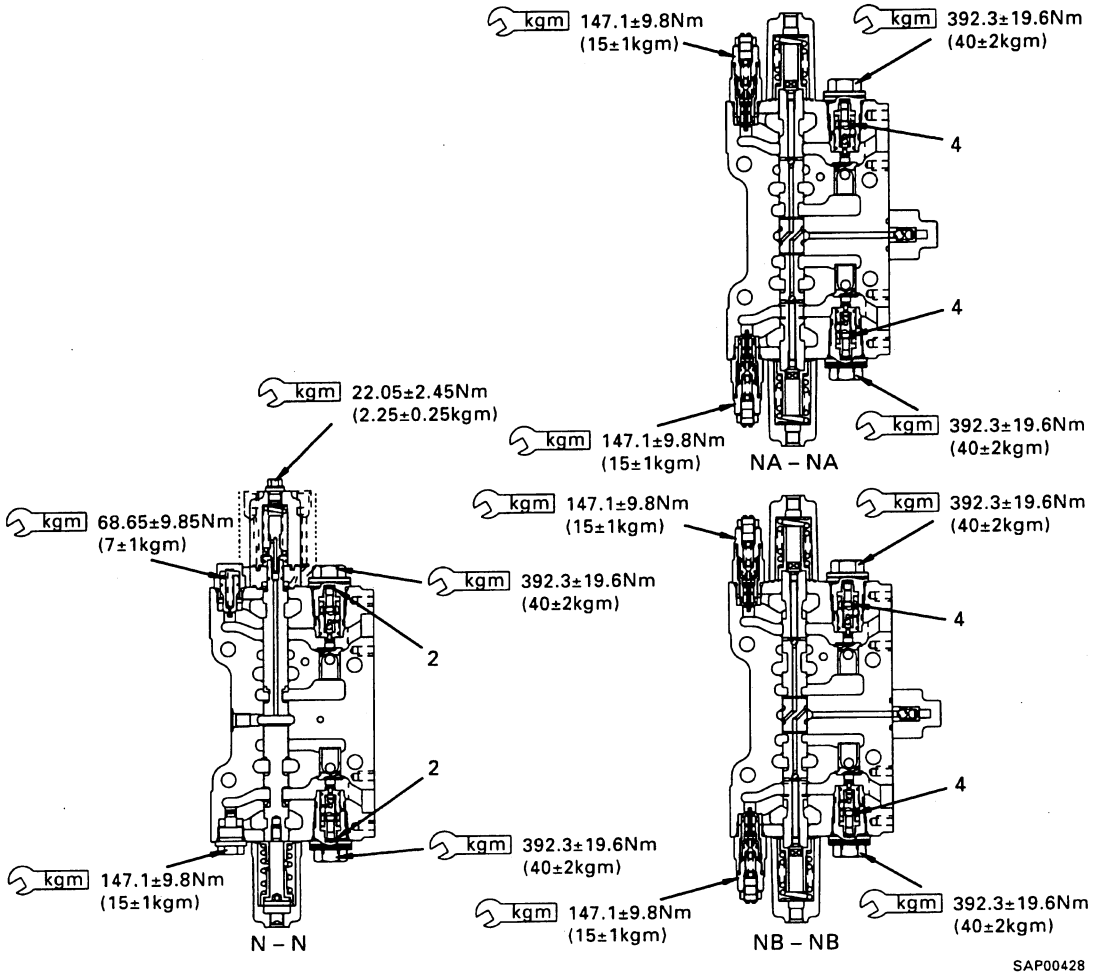
Unit: mm

No.	Check item	Criteria					Remedy
		Standard size			Repair limit		
1	Valve spring	Free length X OD	Installed length	Installed load	Free length	Installed load	Replace spring if there is damage or deformation
		23.2 X 7.2	19	41.2 N (4.2 kg)	-	33.3 N (3.4 kg)	
2	Relief spring	30.7 X 9.6	26.3	369.7 N (37.7 kg)	-	296.2 N (30.2 kg)	
3	Unload spring	38.5 X 9.8	26	83.4 N (8.5 kg)	-	66.7 N (6.8 kg)	

(4/6)


kgm 147.1±9.8Nm (15±1kgm)
kgm 392.3±19.6Nm (40±2kgm)
1
2
7
D-D
kgm 68.65±9.85Nm (7±1kgm)
G-G
E-E
AA-AA
kgm 186.4±9.8Nm (18±1kgm)
3
6
kgm 127.5±19.6Nm (13±2kgm)
5
F-F
H-H
SAP00426

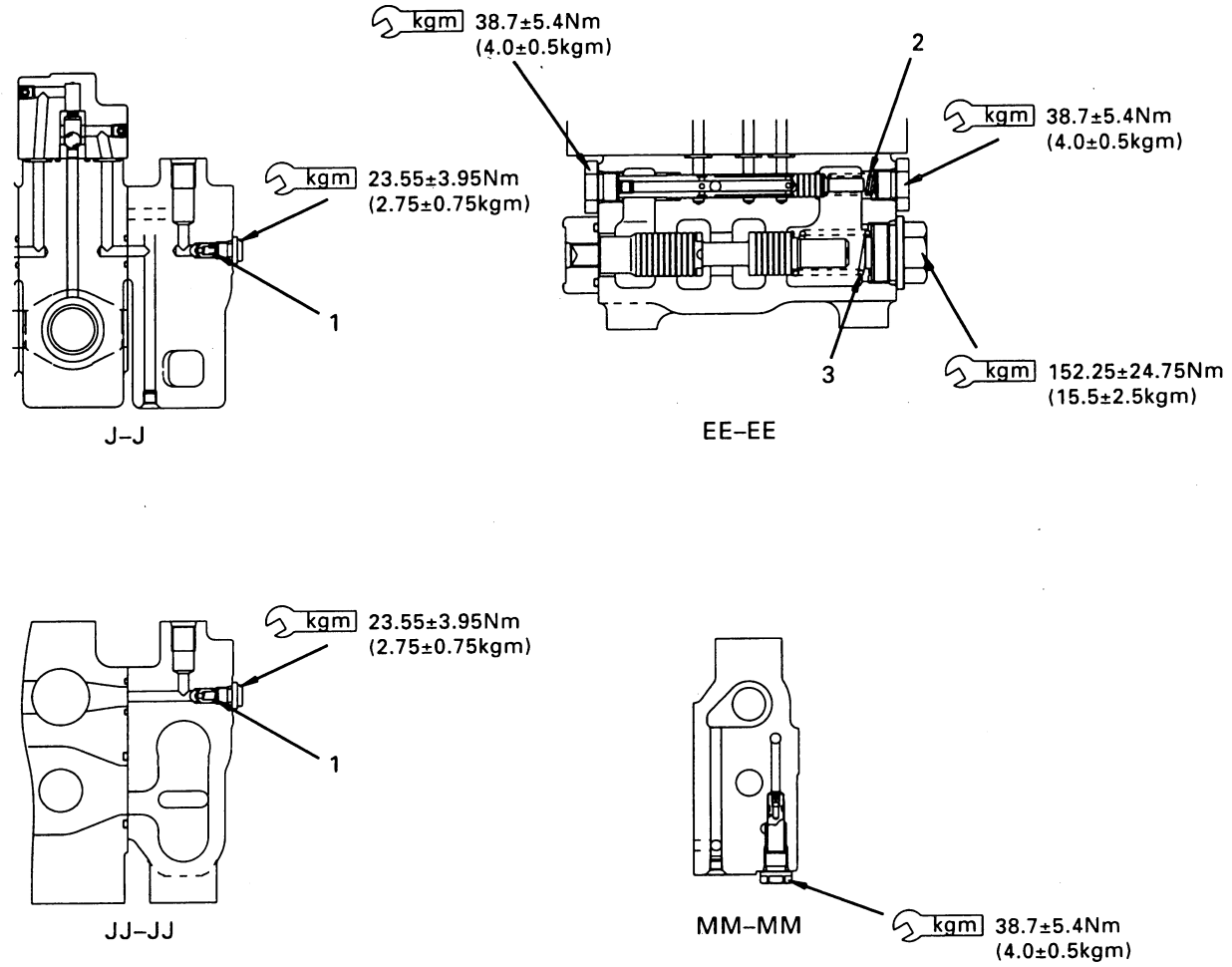
(5/6)



Unit: mm

No.	Check item	Criteria					Remedy
		Standard size			Repair limit		
1	Regeneration valve spring	Free length X OD	Installed length	Installed load	Free length	Installed load	Replace spring if there is damage or deformation
		31.5 X 10.3	19.5	5.9 N (0.6 kg)	-	4.4 N (0.45 kg)	
2	Piston return spring	48.1 X 10.8	28	17.5 N (1.78 kg)	-	13.9 N (1.42 kg)	
3	Piston return spring	50.4 X 17	39	158.9 N (16.2 kg)	-	142.2 N (14.5 kg)	
4	Piston return spring	48 X 10.4	36	59 N (6 kg)	-	47.1 N (4.8 kg)	
5	Load spring	30.4 X 16.7	27	428.6 N (43.7 kg)	-	343.2 N (35.0 kg)	
6	Check valve spring	13.6 X 5.5	10	1.96 N (0.2 kg)	-	1.47 N (0.15 kg)	
7	Piston return spring	24.5 X 25.2	12	1.96 N (0.2 kg)	-	1.47 N (0.15 kg)	

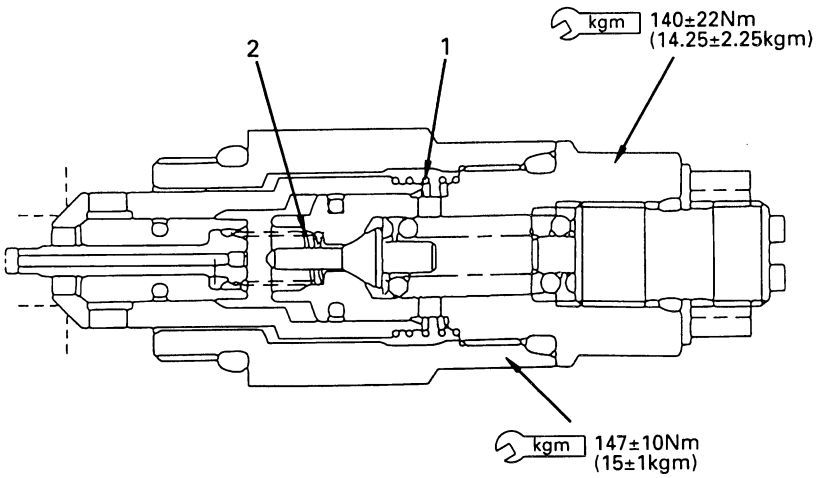
(6/6)



Unit: mm

No.	Check item	Criteria					Remedy
		Standard size			Repair limit		
1	Check valve spring	Free length X OD	Installed length	Installed load	Free length	Installed load	Replace spring if there is damage or deformation
		11.5 X 4.6	8.5	1.47 N (0.15 kg)	-	1.18 N (0.12 kg)	
2	Spool return spring	65.5 X 27.2	50	167.7 N (17.1 kg)	-	134.3 N (13.7 kg)	
3	Spool return spring	13.6 X 5.5	10	1.96 N (0.2 kg)	-	1.47 N (0.15 kg)	

SUCTION-SAFETY VALVE
FOR SERVICE VALVE



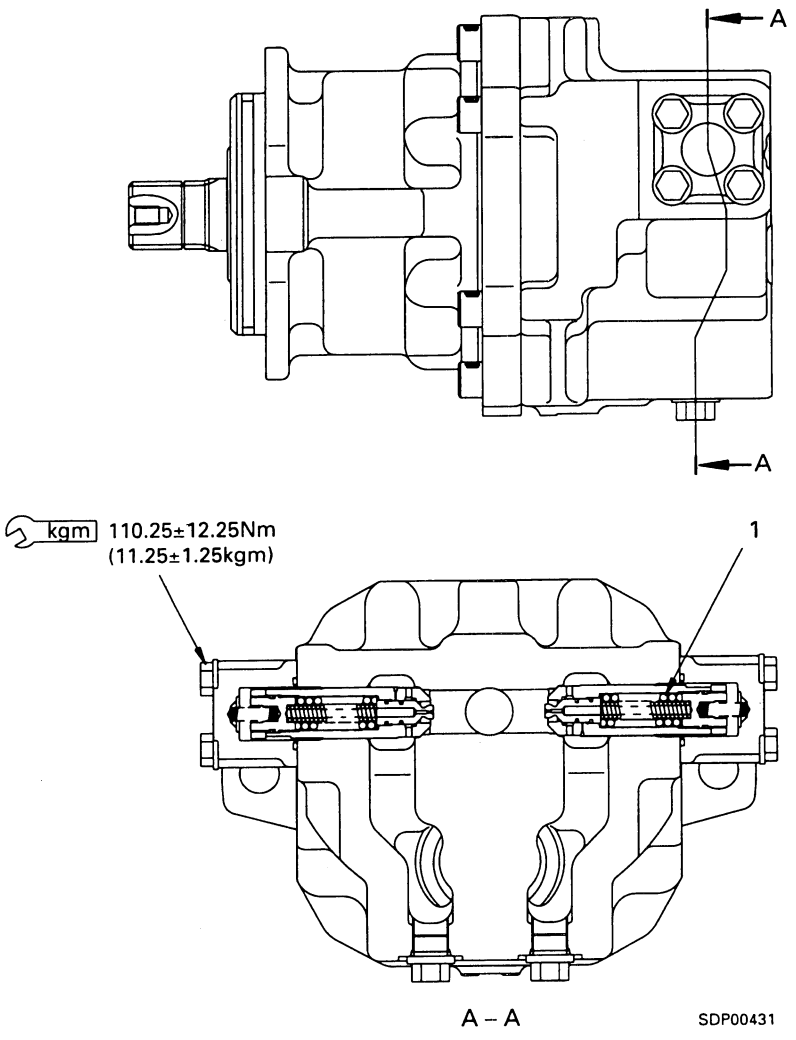
SBP00430

Unit: mm

No.	Check item	Criteria						Remedy
		Standard size				Repair limit		
1	Suction valve spring	Wire diameter	Free length X OD	Installed length	Installed load	Free length	Installed load	Replace
		ø 0.9	16.3 x ø 21.3	1.5	2.06 N (0.21 kg)	-	1.57 N (0.16 kg)	
2	Piston spring	ø 0.5	20 x ø 7	14	2.06 N (0.21 kg)	-	1.57 N (0.16 kg)	

SWING MOTOR

KMF160AB-3

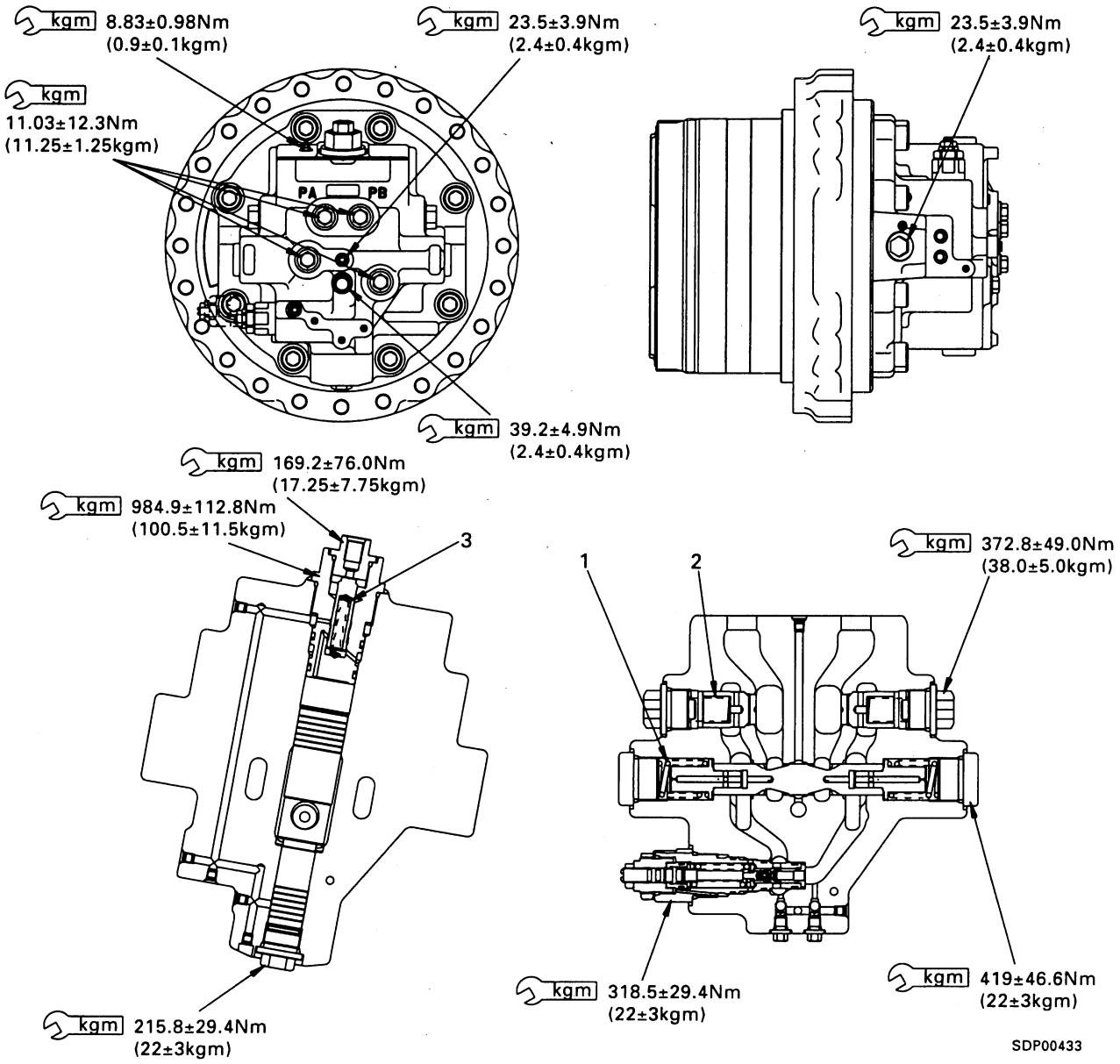


Unit: mm

No.	Check item	Criteria					Remedy
		Standard size			Repair limit		
1	Spool return spring	Free length X OD	Installed length	Installed load	Free length	Installed load	Replace spring if there is damage or deformation
		46.9 x 9.2	53	11.8 N (1.2 kg)	-	9.4 N (0.96 kg)	

TRAVEL MOTOR

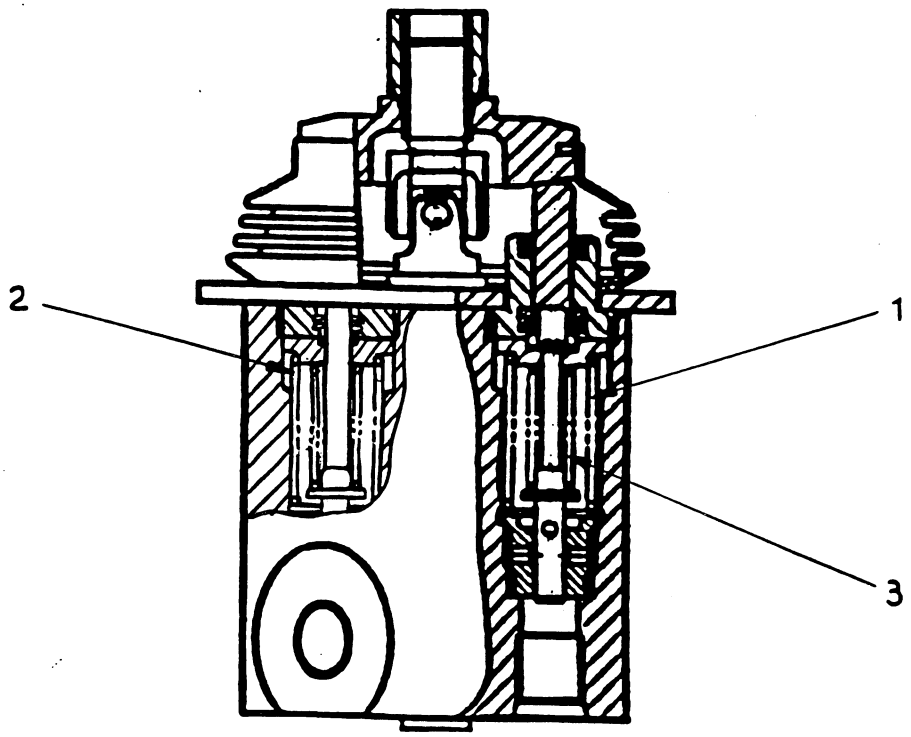
KMV280ADT



Unit: mm

No.	Check item	Criteria					Remedy
		Standard size			Repair limit		
1	Spool return spring	Free length X OD	Installed length	Installed load	Free length	Installed load	Replace spring if there is damage or deformation
		58.43 X 30.0	42.0	426.6 N (43.5 kg)	-	341.3 N (34.8 kg)	
2	Check valve spring	62.5 x 20.0	35.0	3.53 N (0.36 kg)	-	2.84 N (0.29 kg)	
3	Regulator piston spring	53.1 X 14.3	50.0	75.5 N (7.7 kg)	-	60.8 N (6.2 kg)	

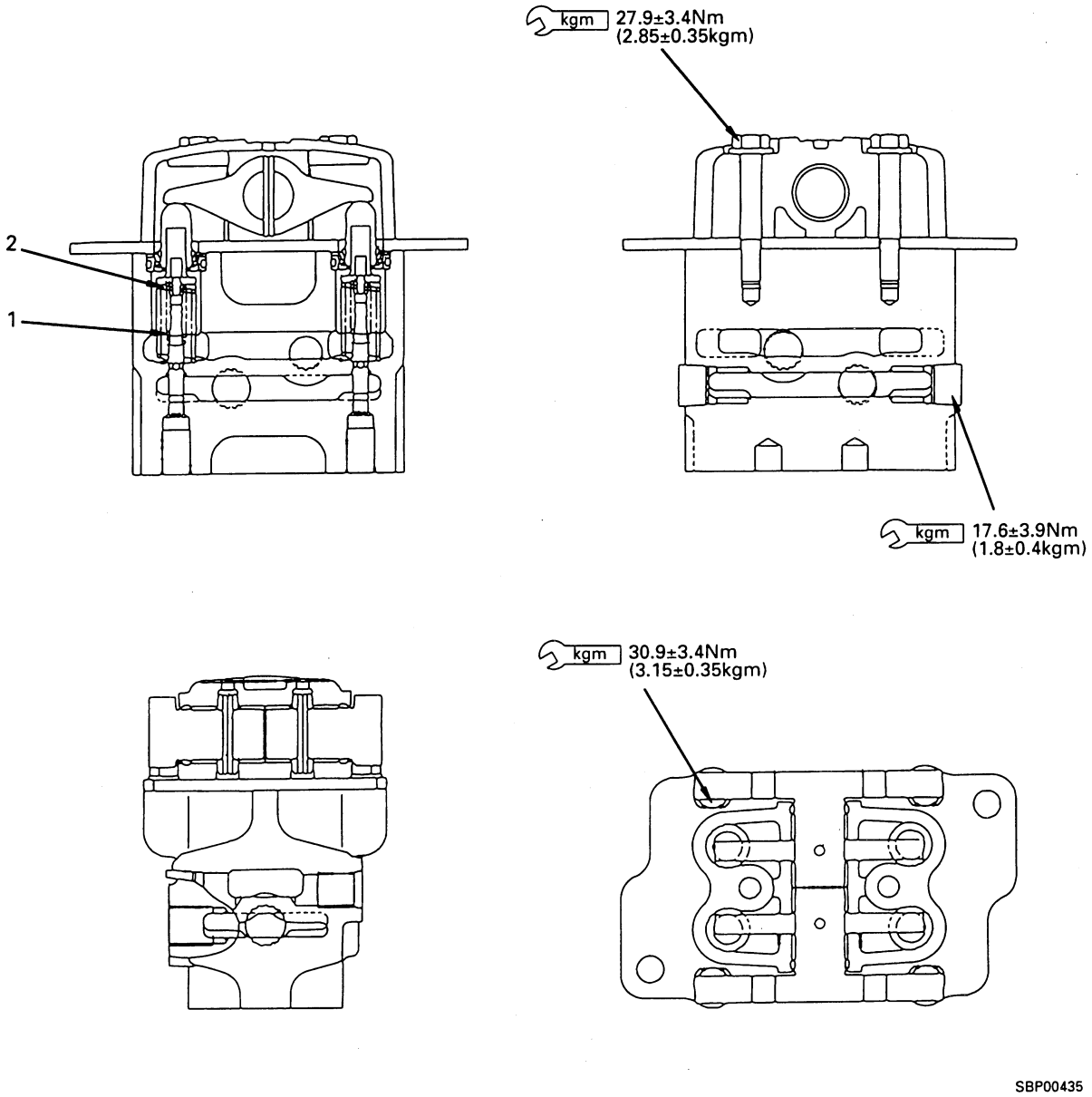
WORK EQUIPMENT, SWING PPC VALVE



Unit: mm

No.	Check item	Criteria					Remedy
		Standard size			Repair limit		
1	Centering spring (for P3, P4)	Free length X OD	Installed length	Installed load	Free length	Installed load	Replace spring if there is damage or deformation
		43.3 X 19.5	33.5	17.7 N (1.8 kg)	-	13.7 N (1.4 kg)	
2	Centering spring (for P1, P2)	45.5 X 19.6	33.5	29.0 N (3.0 kg)	-	23.2 N (2.4 kg)	
3	Metering spring	27.6 X 9.5	26	16.7 N (1.7 kg)	-	13.7 N (1.4 kg)	

TRAVEL PPC VALVE

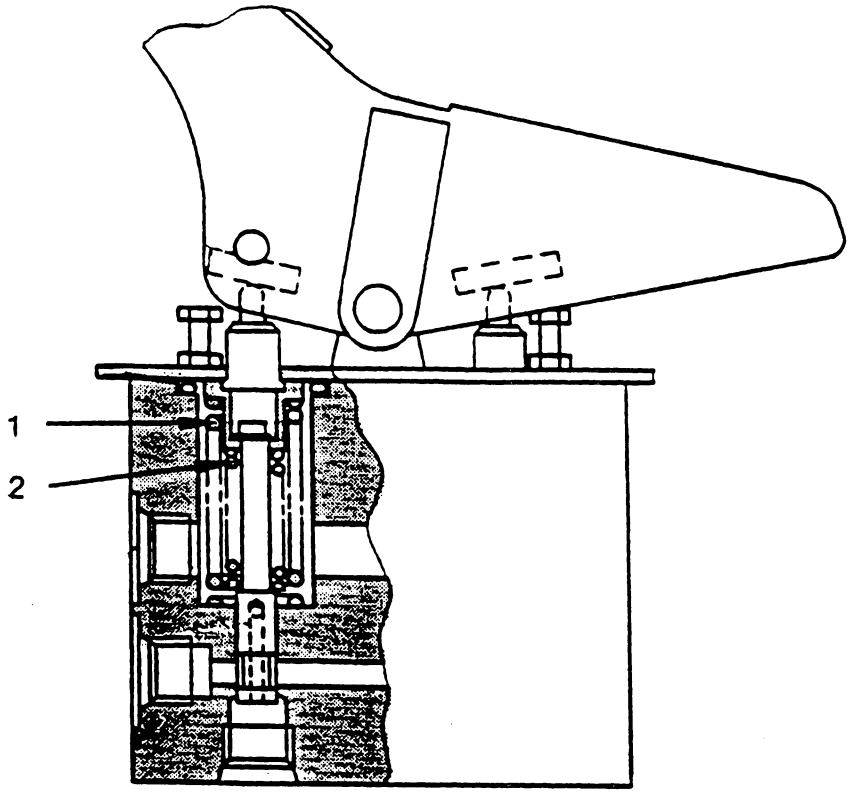


SBP00435

Unit: mm

No.	Check item	Criteria					Remedy
		Standard size			Repair limit		
1	Metering spring	Free length X OD	Installed length	Installed load	Free length	Installed load	Replace spring if there is damage or deformation
		26.5 X 8.15	24.7	16.7 N (1.7 kg)	-	13.7 N (1.4 kg)	
2	Centering spring	48.1 X 15.5	32.5	107.9 N (11 kg)	-	86.3 N (8.8 kg)	

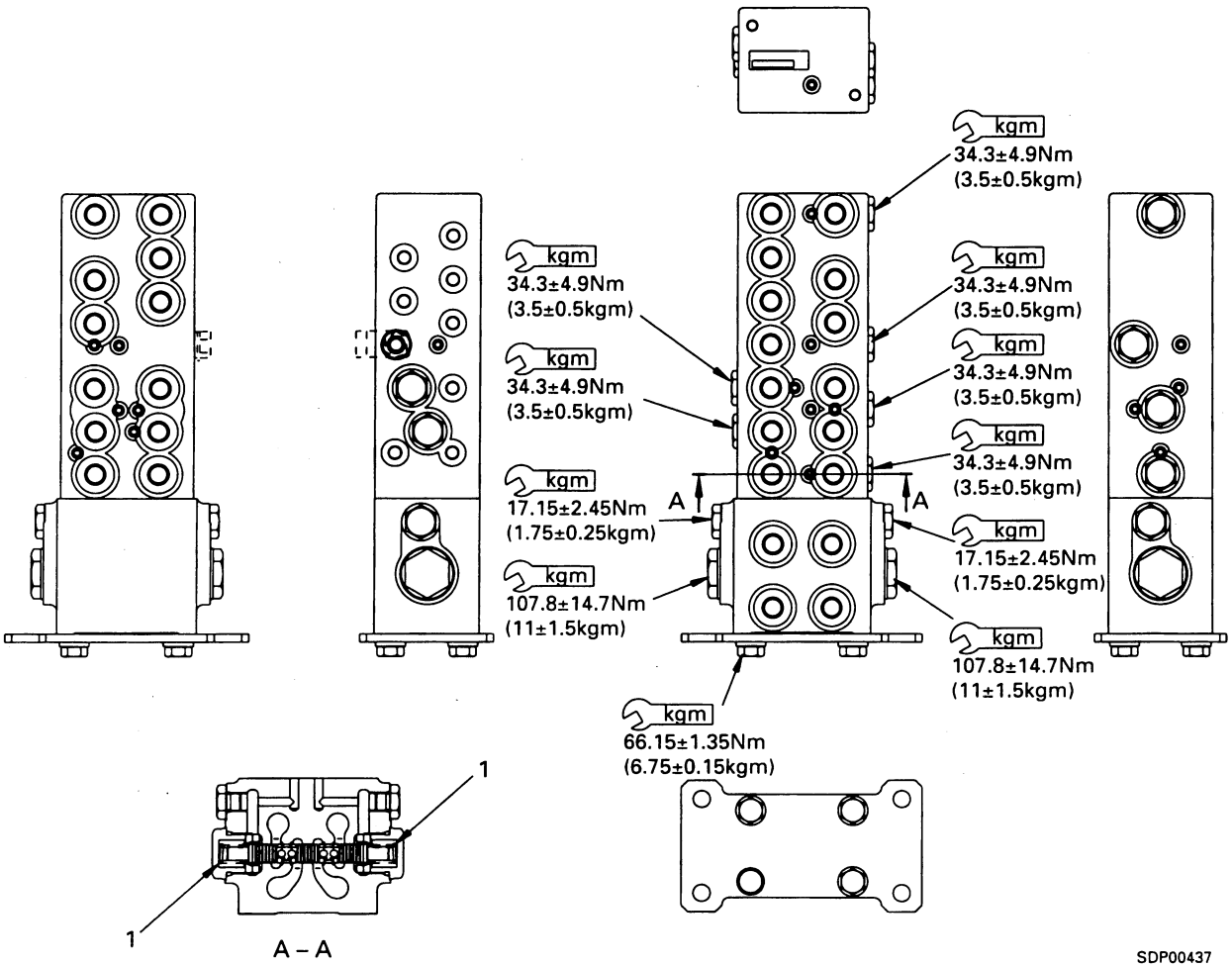
SERVICE PPC VALVE



Unit: mm

No.	Check item	Criteria					Remedy
		Standard size			Repair limit		
1	Centering spring	Free length X OD	Installed length	Installed load	Free length	Installed load	Replace spring iff there is damage or deformation
		41.5 X 18.2	31.5	60 N (6.1 kg)	(40.3)	57.5 N (5.8 kg)	
2	Metering spring	28.5 X 7.6	26.5	17 N (1.7 kg)	(27.6)	16.3 N (1.7 kg)	

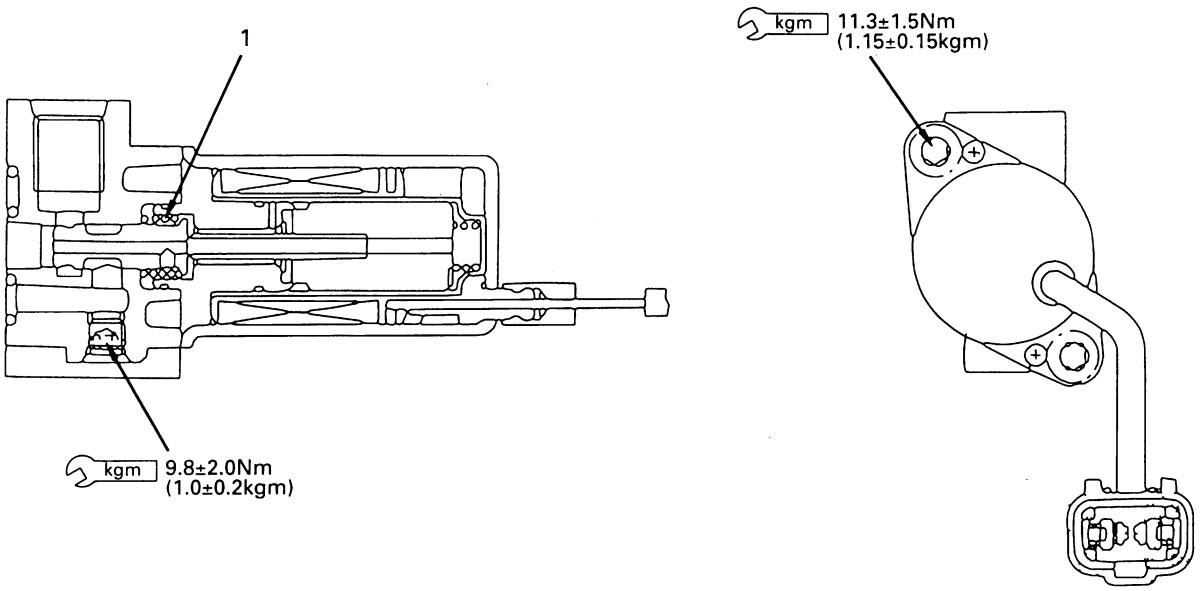
PPC SHUTTLE VALVE, TRAVEL JUNCTION



Unit: mm

No.	Check item	Criteria					Remedy
		Standard size			Repair limit		
1	Spool return spring	Free length X OD	Installed length	Installed load	Free length	Installed load	Replace spring if there is damage or deformation
		23.6 x 13.3	20	14.7 N (1.5 kg)	-	11.8 N (1.2 kg)	

EPC SOLENOID VALVE
FOR LS VALVE

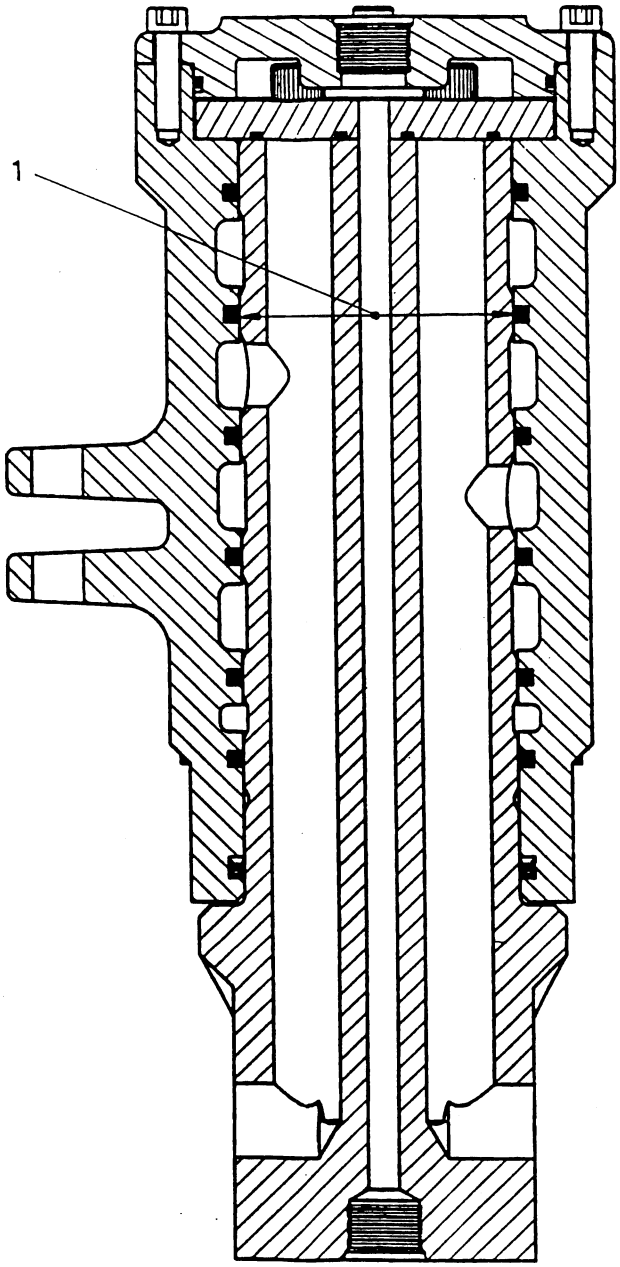


SBP00438

Unit: mm

No.	Check item	Criteria					Remedy
		Standard size			Repair limit		
1	Return spring	Free length X OD	Installed length	Installed load	Free length	Installed load	Replace EPC valve assembly if there is damage or deformation
		9.0 x 11.4	7.9	3.14 N (0.32 kg)	-	-	

CENTER SWIVEL JOINT

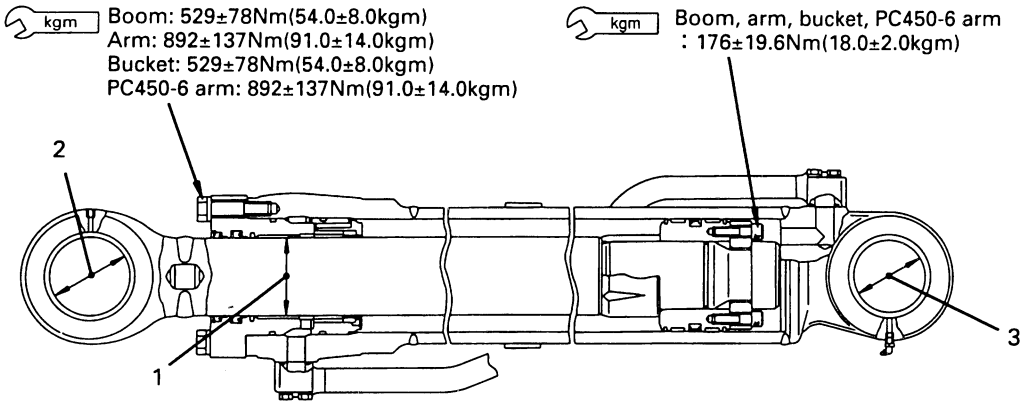


Unit: mm

No.	Check item	Criteria			Remedy
1	Clearance between rotor and shaft	Standard size			Replace
		Standard size	Standard clearance	Clearance limit	
		90	0.06 - 0.125	0.131	

HYDRAULIC CYLINDER

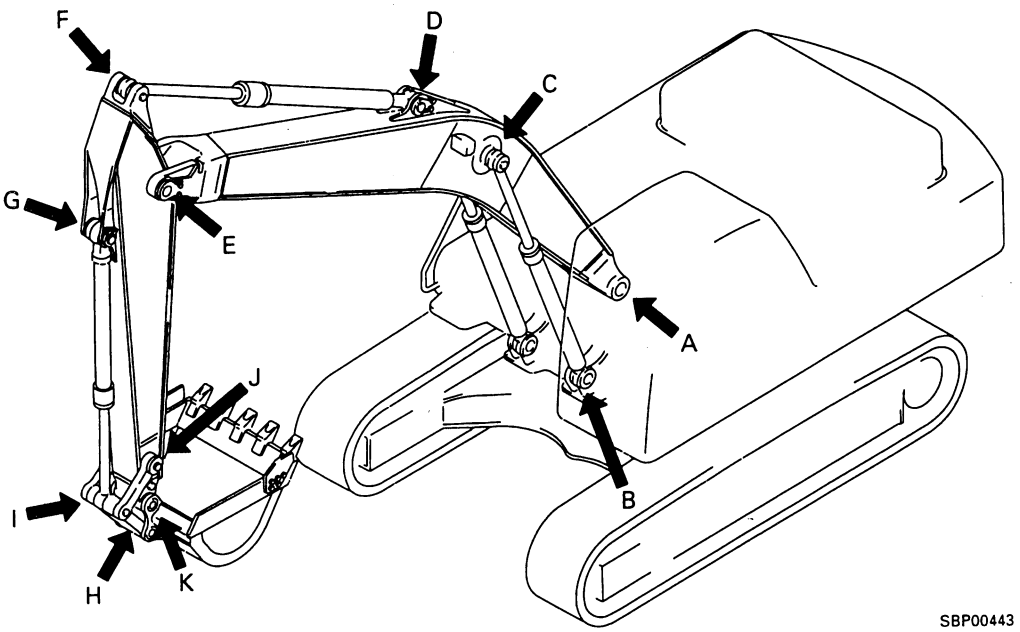
★ The diagram shows the boom cylinder.



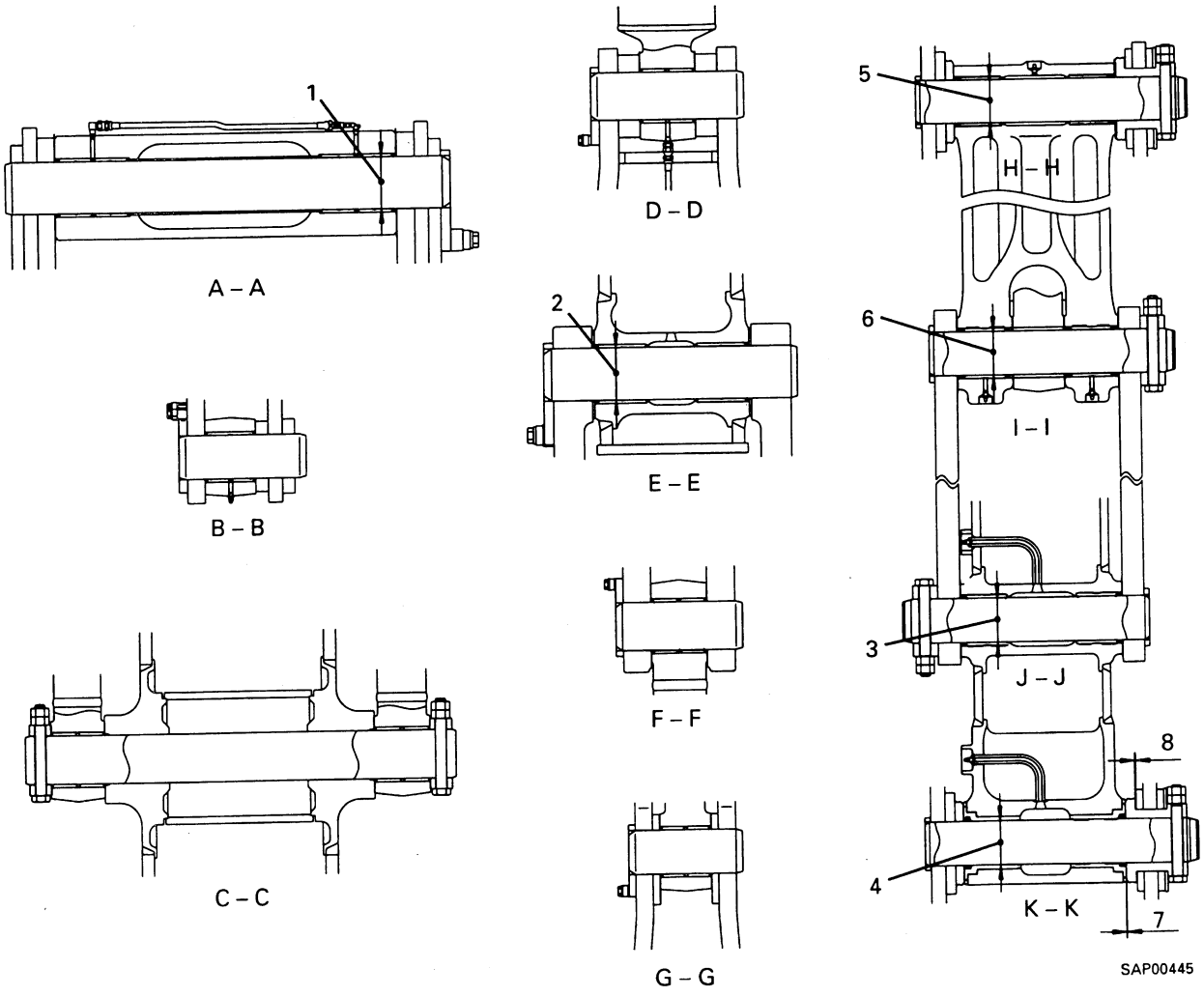
Unit: mm

No.	Check item		Criteria					Remedy
		Name of cylinder	Standard size	Tolerance		Standard clearance	Clearance limit	
				Shaft	Hole			
1	Clearance between piston rod and bushing	Boom	110	-0.036 -0.090	+0.261 +0.047	0.083 - 0.351	0.451	Replace bushing
		Arm	120	-0.036 -0.090	+0.263 +0.048	0.083 - 0.353	0.453	
		Bucket	110	-0.036 -0.090	+0.261 +0.047	0.083 - 0.351	0.451	
2	Clearance between piston rod support shaft and bushing	Boom	110		+0.178 +1.114		1.0	Replace pin, bushing
		Arm	110		+0.457 +0.370		1.0	
		Bucket	100		+0.457 +0.370		1.0	
3	Clearance between cylinder bottom support shaft and bushing	Boom	100		+0.135 +0.076		1.0	
		Arm	110		+0.457 +0.370		1.0	
		Bucket	100		+0.457 +0.370		1.0	

WORK EQUIPMENT



SBP00443



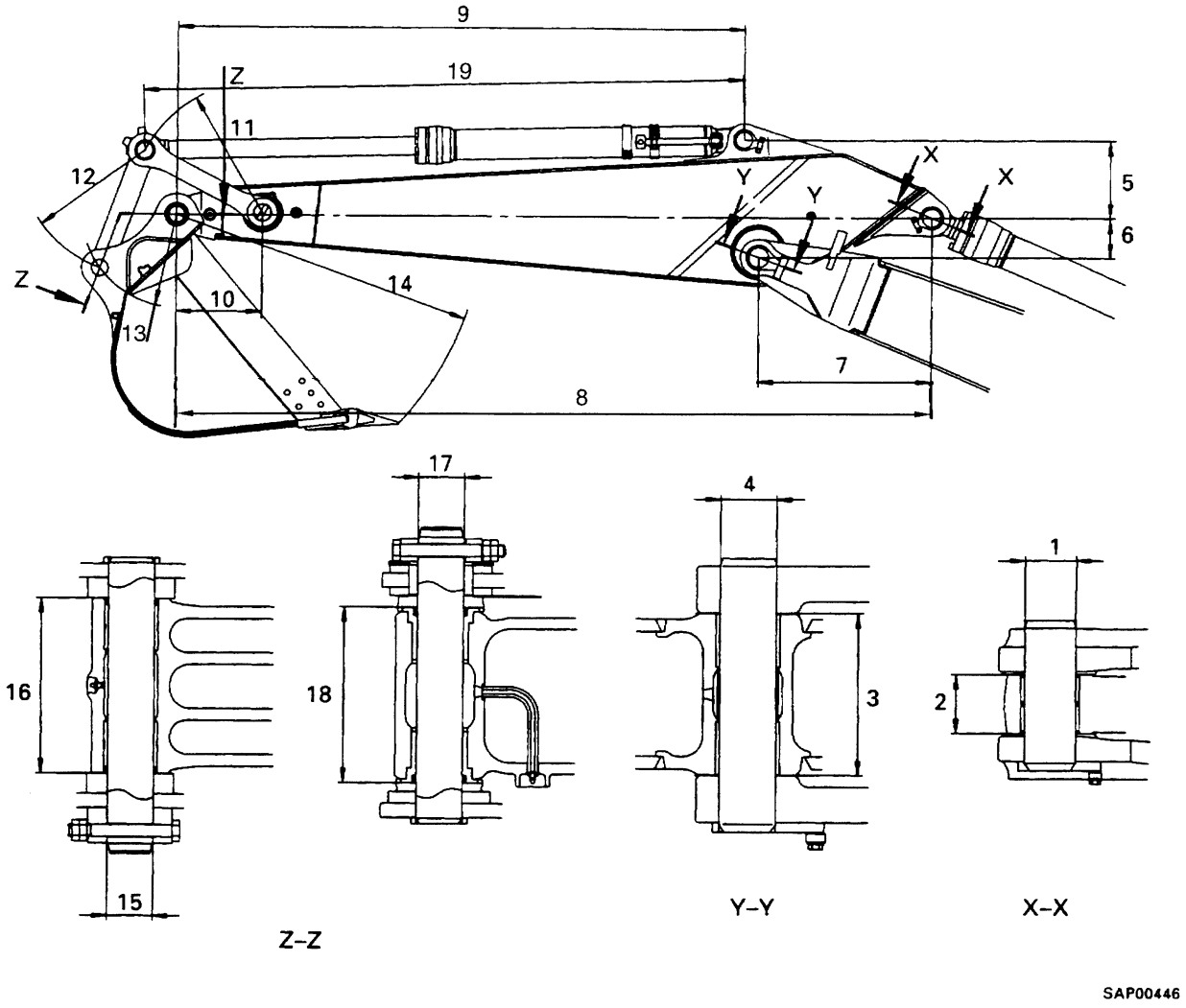
SAP00445

Unit: mm

No.	Check item	Criteria					Remedy
		Standard size	Tolerance		Standard clearance	Clearance limit	
			Shaft	Hole			
1	Clearance between bushing and mounting pin of boom and revolving frame	120	-0.036 -0.090	+0.351 +0.270	0.306 - 0.441	1.0	Replace
2	Clearance between bushing and mounting pin of boom and arm	120	-0.036 -0.090	+0.316 +0.219	0.255 - 0.406	1.0	
3	Clearance between bushing and mounting pin of boom and link	100	-0.036 -0.090	+0.329 +0.259	0.295 - 0.419	1.0	
4	Clearance between bushing and mounting pin of boom and bucket	100	-0.036 -0.090	+0.340 +0.267	0.303 - 0.43	1.0	
5	Clearance between bushing and mounting pin of link and bucket	100	-0.036 -0.090	+0.329 +0.259	0.295 - 0.419	1.0	
6	Clearance between bushing and mounting pin of link and link	100	-0.036 -0.090	+0.329 +0.259	0.295 - 0.419	1.0	
7	Bucket clearance (a)	0.5 - 1.0					Adjust shims
8	Bucket clearance (b)	2.0					

DIMENSIONS OF WORK EQUIPMENT

1. ARM



No. \ Model		PC450-6K
1		ø 110 $^{+0.1}_{0}$ / $^{-0.036}_{-0.090}$
2		ø 127.3 $^{+1.5}_{0}$ / 126 ± 1.2
3		355 $^{+0.5}_{0}$ / $^{-0.3}_{-0.8}$
4		ø 120 $^{+0.054}_{0}$ / $^{-0.036}_{-0.090}$
5		525.2 ± 1.0
6		195.0 ± 0.5
7		1038 ± 1
8		3375 ± 3
9		3102.2 ± 10
10		502 ± 1
11		720.0 ± 0.2
12		719.0 ± 0.5
13		537.1
14		1850
15		ø 100 $^{+0.2}_{0}$ / $^{-0.036}_{-0.090}$
16		370.0 ± 0.5
17		ø 100 $^{+0.2}_{0}$ / $^{-0.036}_{-0.090}$
18	Arm as individual par	355 $^{0}_{-0.5}$
	When press fitting bushing	370
19	Min.	1995
	Max.	3265