SHOP MANUAL

KOMATSU

PW130ES-6K

MACHINE MODEL	SERIAL NUMBER
PW130ES-6K	**K32001 and up**
PW130ES-6K	**K34001 and up**

- This shop manual may contain attachments 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.

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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

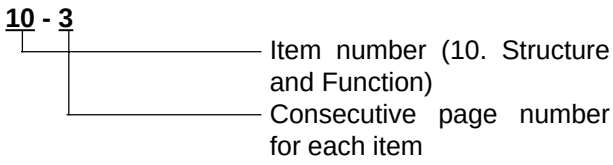
These various volumes are designed to avoid duplicating the same information. Therefore, to deal with all repairs for any model, it is necessary that chassis, engine , electrical and attachement volumes be available.

DISTRIBUTION AND UPDATING

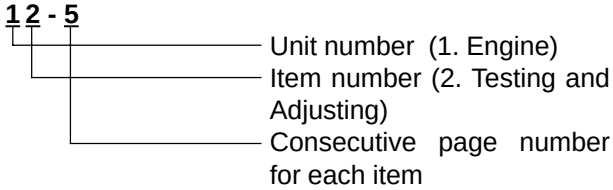
Any additions, amendments or other changes will be sent to KOMATSU distributors. Get the most up-to-date information before you start any work.

FILING METHOD

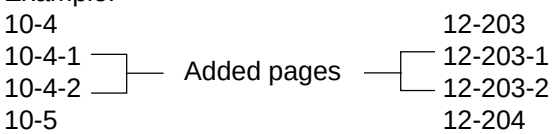
1. See the page number on the bottom of the page. File the pages in correct order.
2. Following examples show how to read the page number
   Example 1 (Chassis volume:)



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

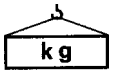
When a manual is revised, an edition mark (1,2,3,...) is recorded on the bottom of the pages.

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:

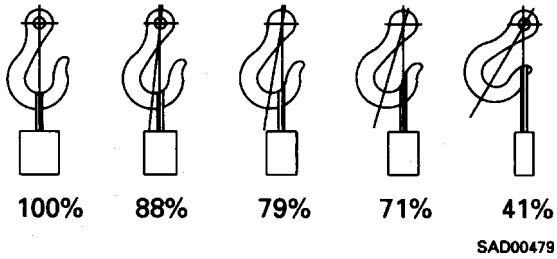
Wire ropes
(Standard "Z" or "S" twist ropes
without galvanizing

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.

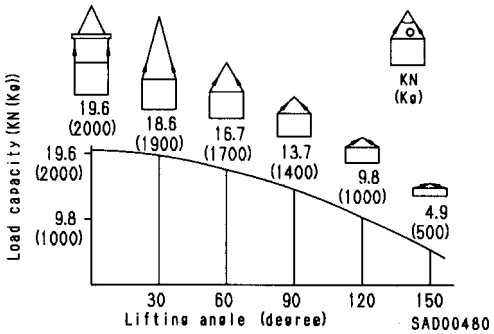
2) Sling wire ropes from the middle portion of the hook.

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

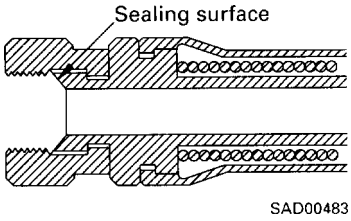
★ This torque table does not apply to the bolts with nylon packaging or other nonferrous metal washers are to be used, or which require tightening to otherwise specified torque.

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

TIGHTENING TORQUE FOR FLRED NUTS



SAD00483

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

1/ = 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

1/ = 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.

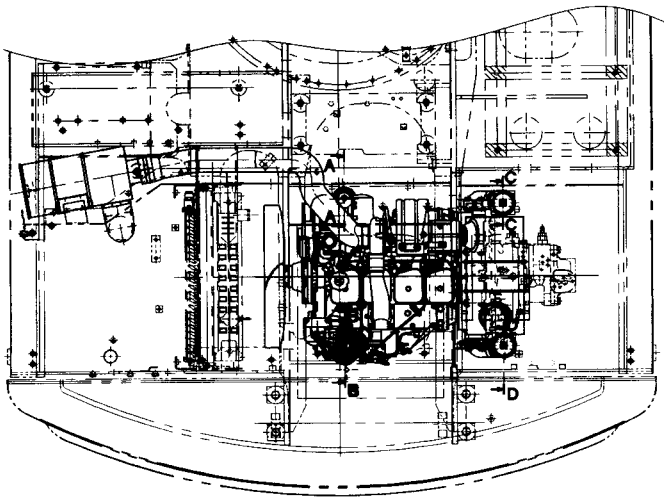
If it is desired to convert from Centigrade to Fahrenheit degrees, consider the center column as a table of Centigrade values, and read the corresponding Fahrenheit temperature on the right.

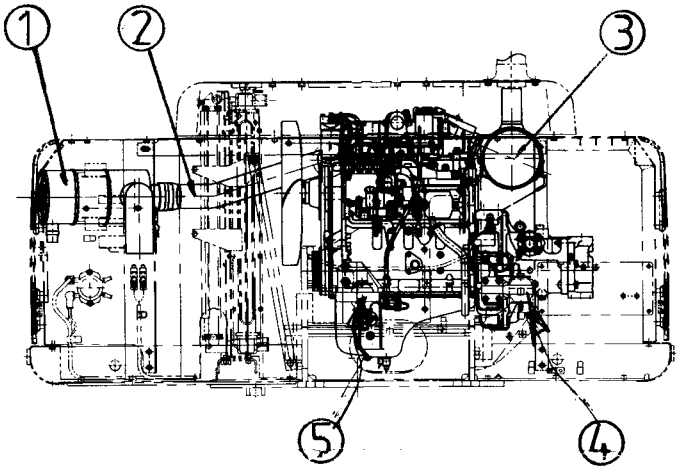
1°C = 33.8°F

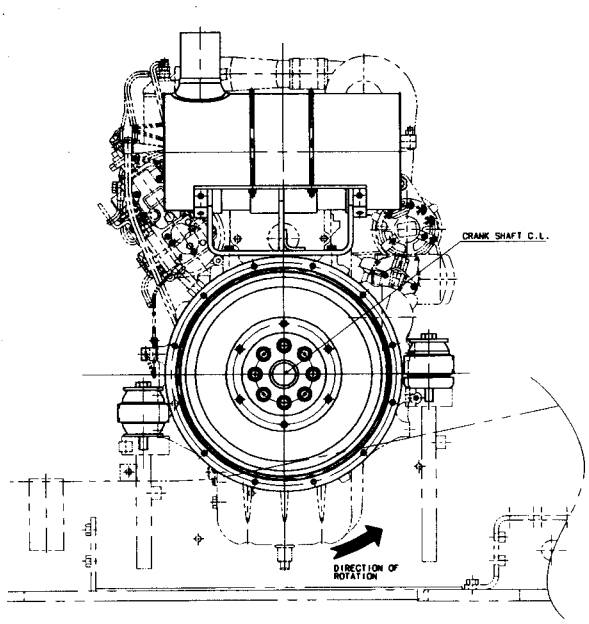
°C		°F	°C		°F	°C		°F	°C		°F
-40.4	-40	-40.0	-11.7	11	51.8	7.8	46	114.8	27.2	81	117.8
-37.2	-35	-31.0	-11.1	12	53.6	8.3	47	116.6	27.8	82	179.6
-34.4	-30	-22.0	-10.6	13	55.4	8.9	48	118.4	28.3	83	181.4
-31.7	-25	-13.0	-10.0	14	57.2	9.4	49	120.2	28.9	84	183.2
-28.9	-20	-4.0	-9.4	15	59.0	10.0	50	122.0	29.4	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

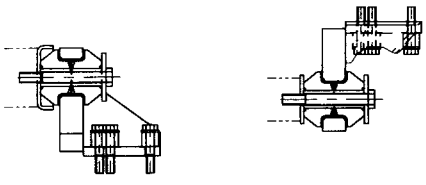
10 STRUCTURE AND FUNCTION

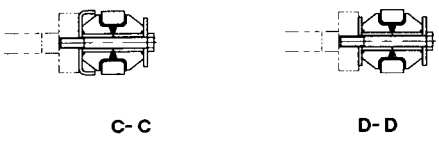
ENIGNE RELATED PARTS





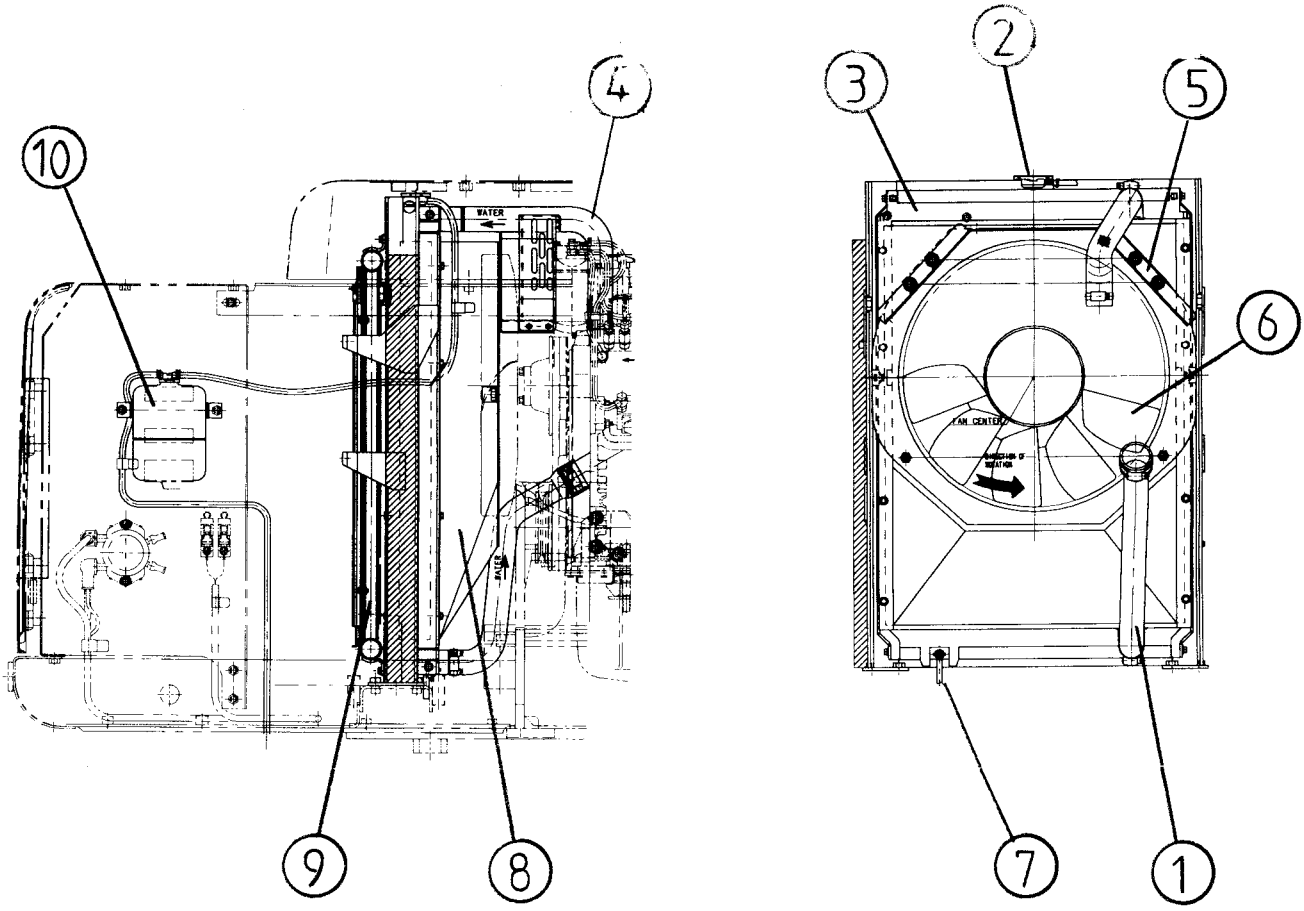






1. Air cleaner
2. Intake hose
3. Muffler
4. Rear engine mount
5. Front engine mount

RADIATOR AND OIL COOLER



SPECIFICATIONS

RADIATOR

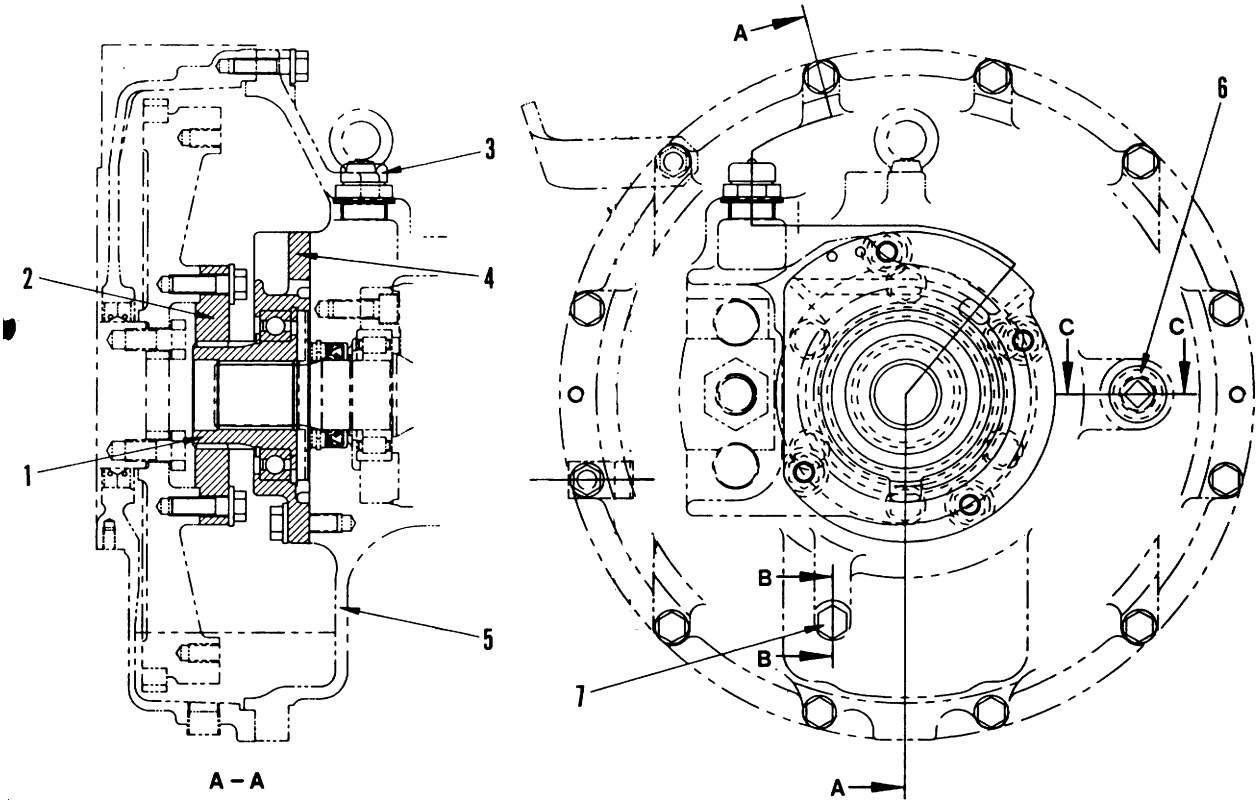
- Core type: CWX-4
- Fin pitch: 3.5/2 mm
- Total radiation area: 40.37 m^2
- Pressure valve cracking pressure: 0.05 MPa (0.5 kg/cm^2)
- Vacuum valve cracking pressure: -0.005 MPa (-0.05 kg/cm^2)

OIL COOLER

- Core Type: CF40-1
- Fin pitch: 4.5/2 mm
- Total radiation area 10.41 m^2

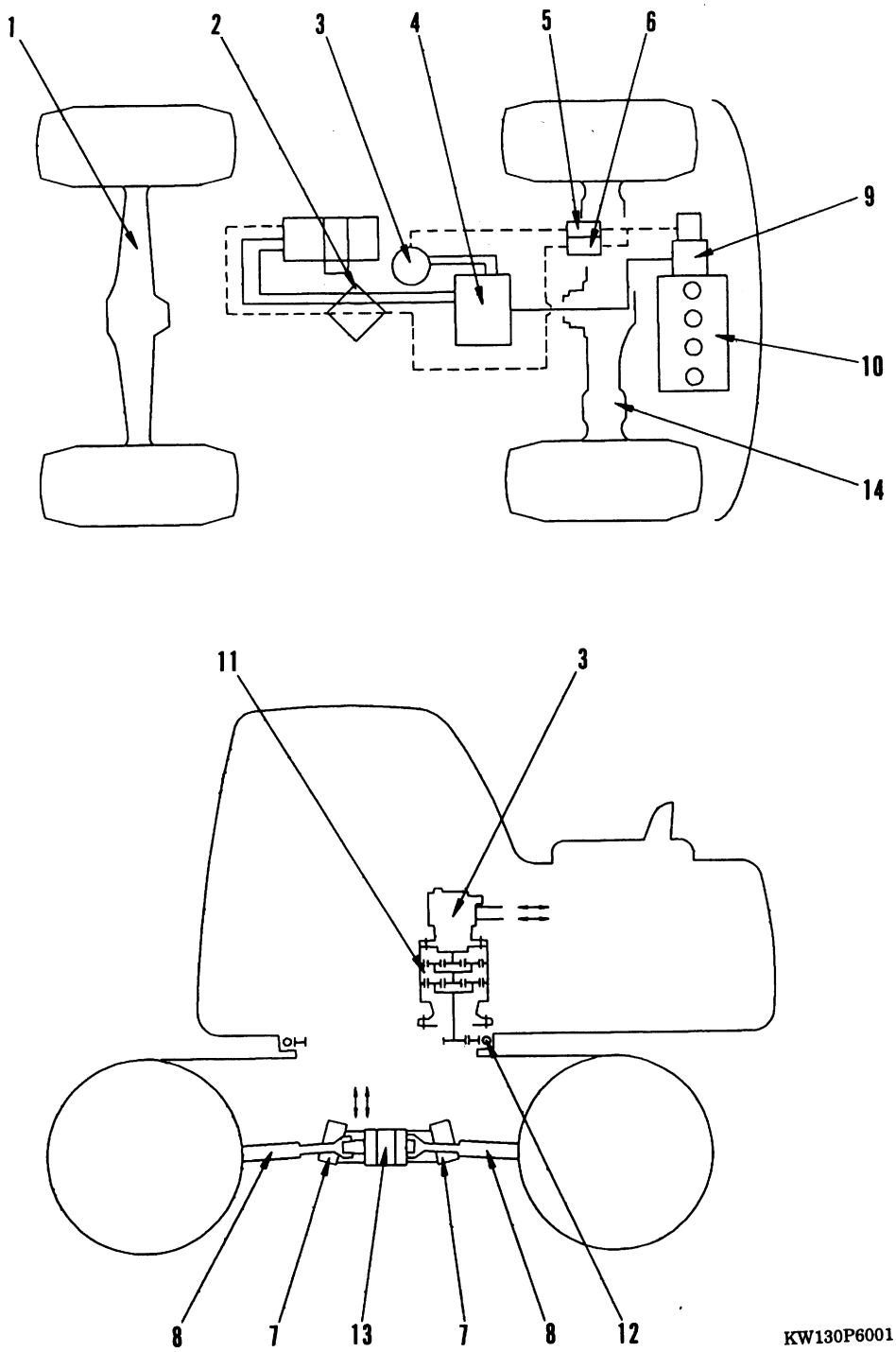
1. Radiator outlet hose
2. Radiator cap
3. Radiator
4. Radiator inlet hose
5. Fan guard
6. Fan
7. Drain valve
8. Shroud
9. Oil cooler
10. Reservoirtank

PTO (COUPLING)



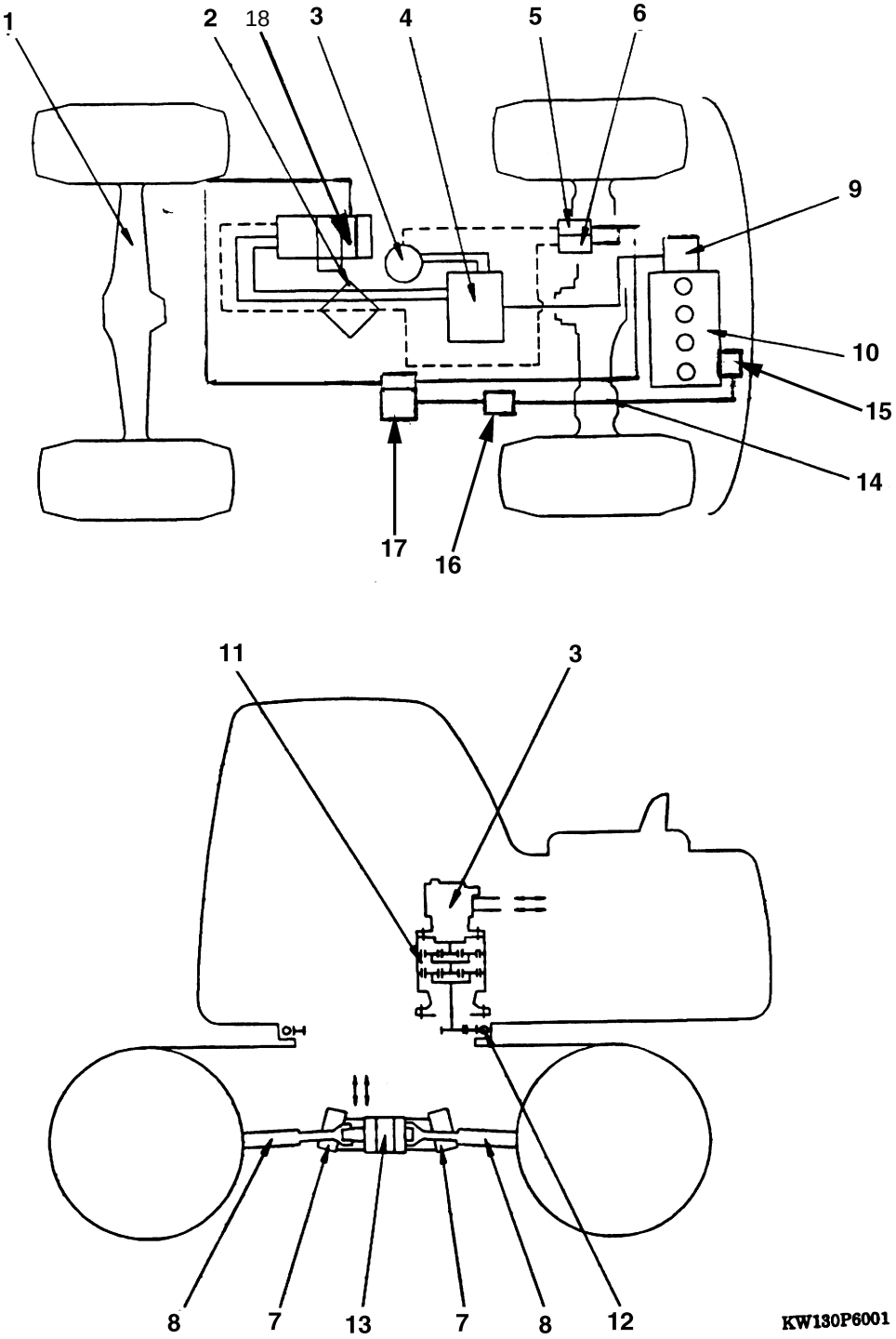
1. Shaft
2. Coupling
3. Breather
4. Cage
5. Hydraulic pump
6. Oil filler plug
7. Level plug

POWER TRAIN - 20 Km/h TRAVEL SPEED SPEC.



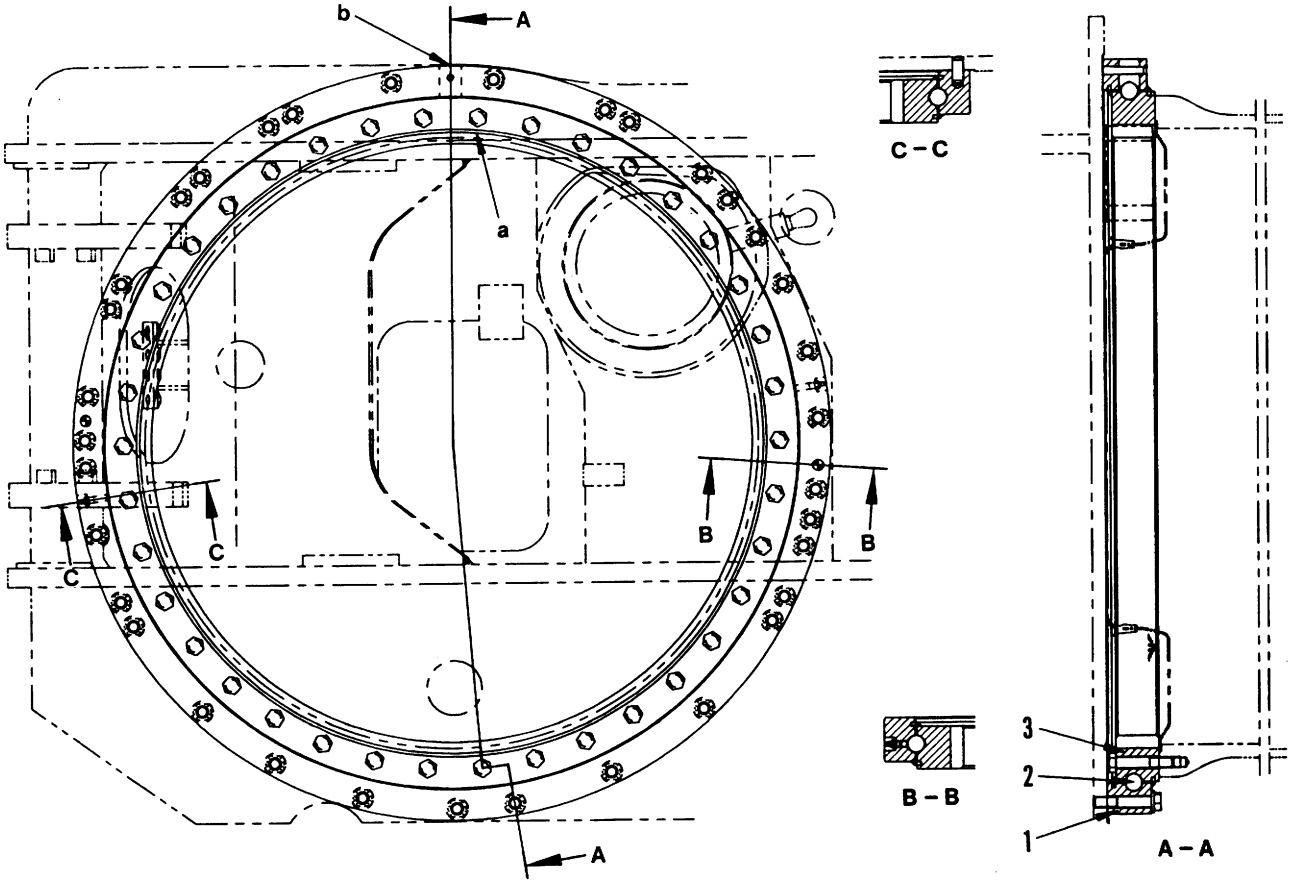
1. Front axle
2. Center swivel joint
3. Swing motor
4. Control valve
5. Swing brake solenoid valve
6. Travel speed solenoid valve
7. Travel motor
8. Propshaft
9. Hydraulic pump
10. Engine
11. Swing machinery
12. Swing circle
13. Transmission
14. Rear axle

POWER TRAIN - 30 Km/h TRAVEL SPEED SPEC.



1. Front axle
2. Center swivel joint
3. Swing motor
4. Control valve
5. Swing brake solenoid valve
6. Travel speed solenoid valve
7. Travel motor
8. Propshaft
9. Hydraulic pump
10. Engine
11. Swing machinery
12. Swing circle
13. Transmission
14. Rear axle
15. Gear pump
16. Priority valve
17. Power brake valve
18. Clutch

SWING CIRCLE



202CD06011

1. Outer race
2. Ball
3. Inner race

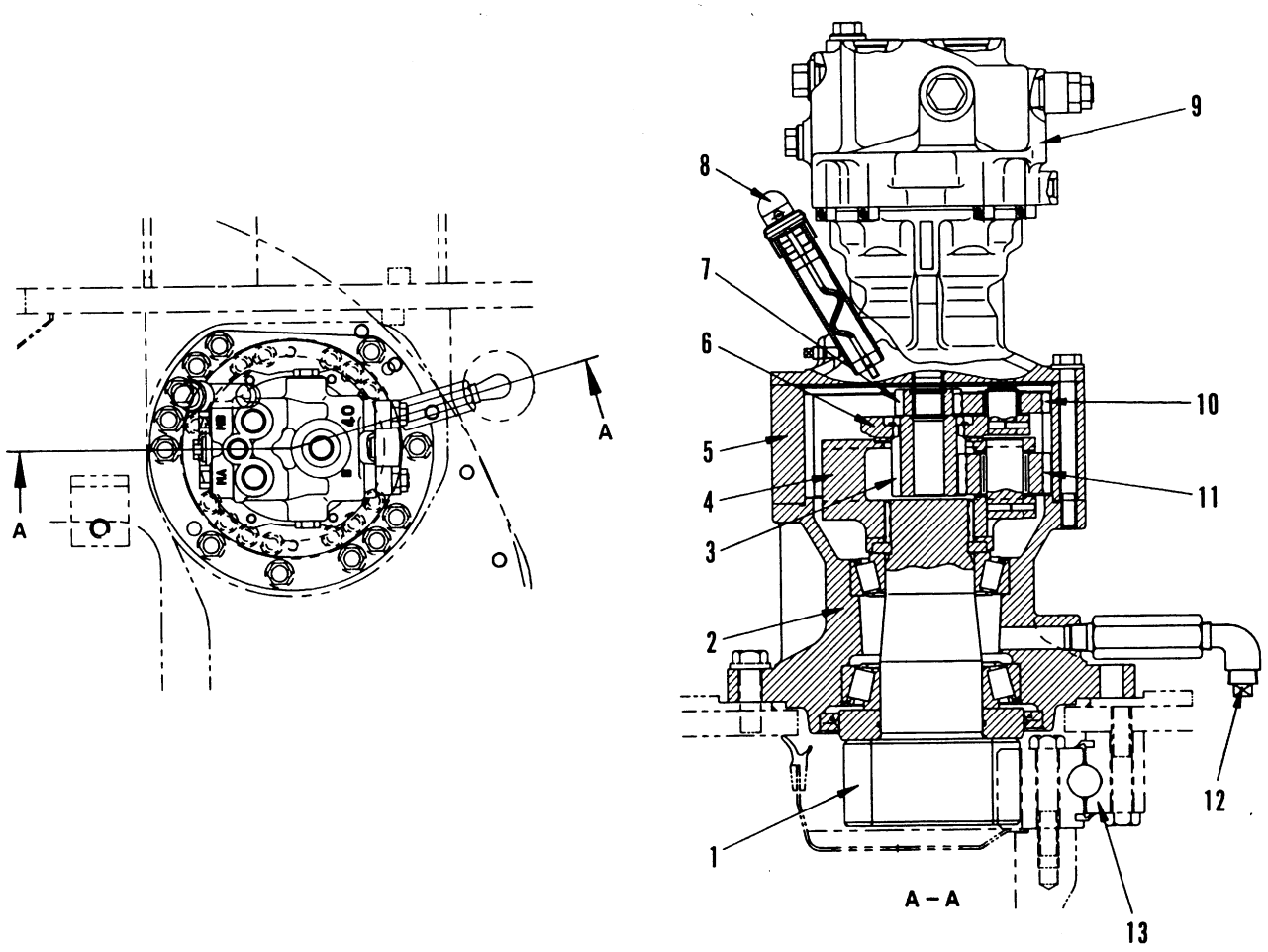
a. Inner race soft zone "S" position
b. Outer race soft zone "S" position

Specifications

Reduction ratio: $\frac{90}{11} = 8.182$

Amount of grease: 10 / (Grease: (G2-LI)

SWING MACHINERY



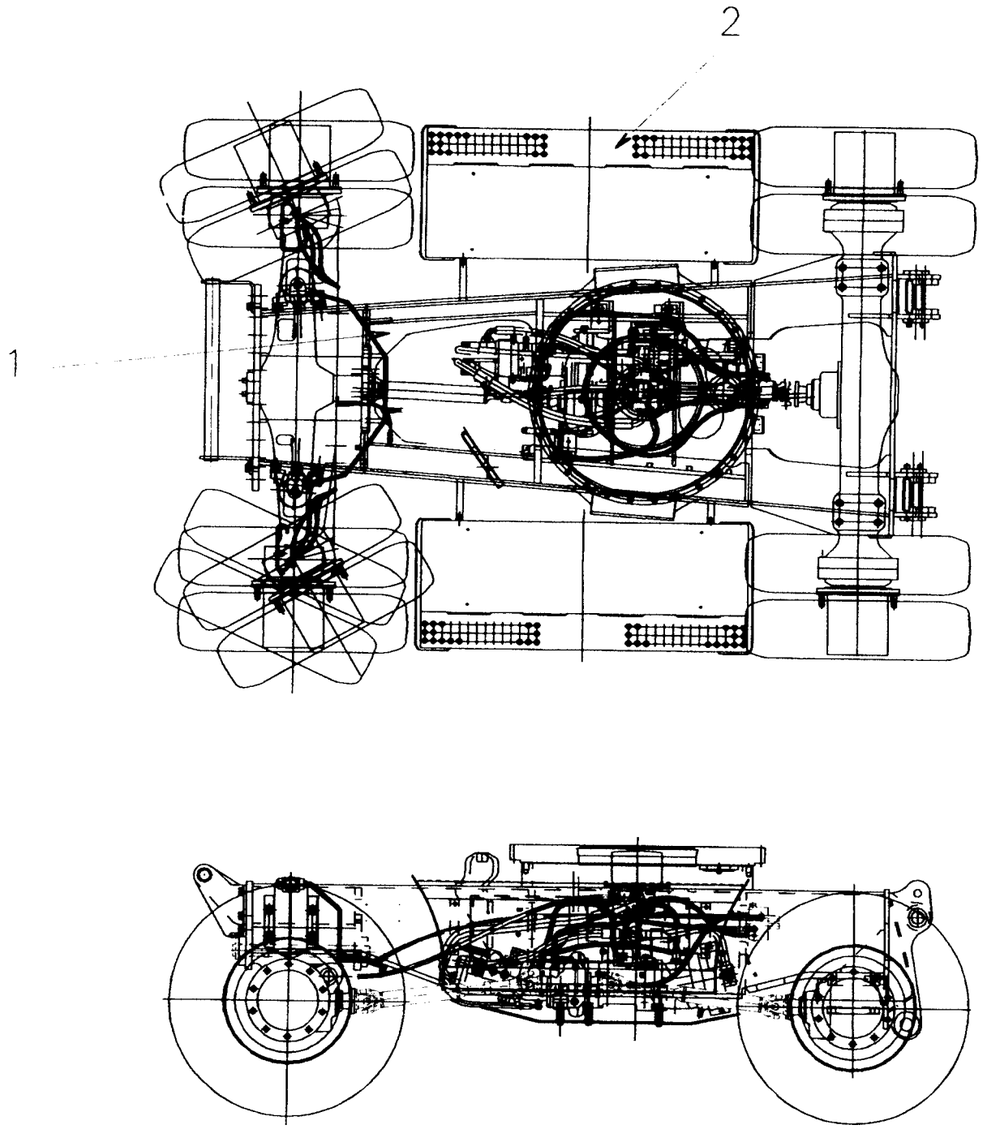
202CD06010

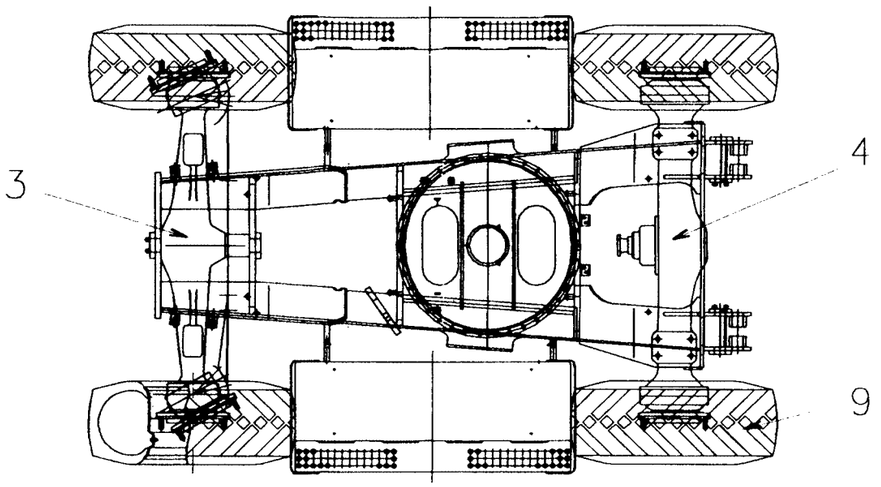
1. Swing pinion (No. of teeth:11)
2. Case
3. No. 2 sun gear (No. of teeth: 17)
4. No. 2 planetary carrier (No. of teeth: 17)
5. Ring gear (No. of teeth:61)
6. No. 1 planetary carrier (No. of teeth: 17)
7. No. 1 sun gear (No. of teeth: 14)
8. Oil level gauge/oil filler port
9. Swing motor
10. No. 1 planetary gear (No. of teeth: 24)
11. No. 2 planetary gear (No. of teeth: 22)
12. Drain plug
13. Swing circle

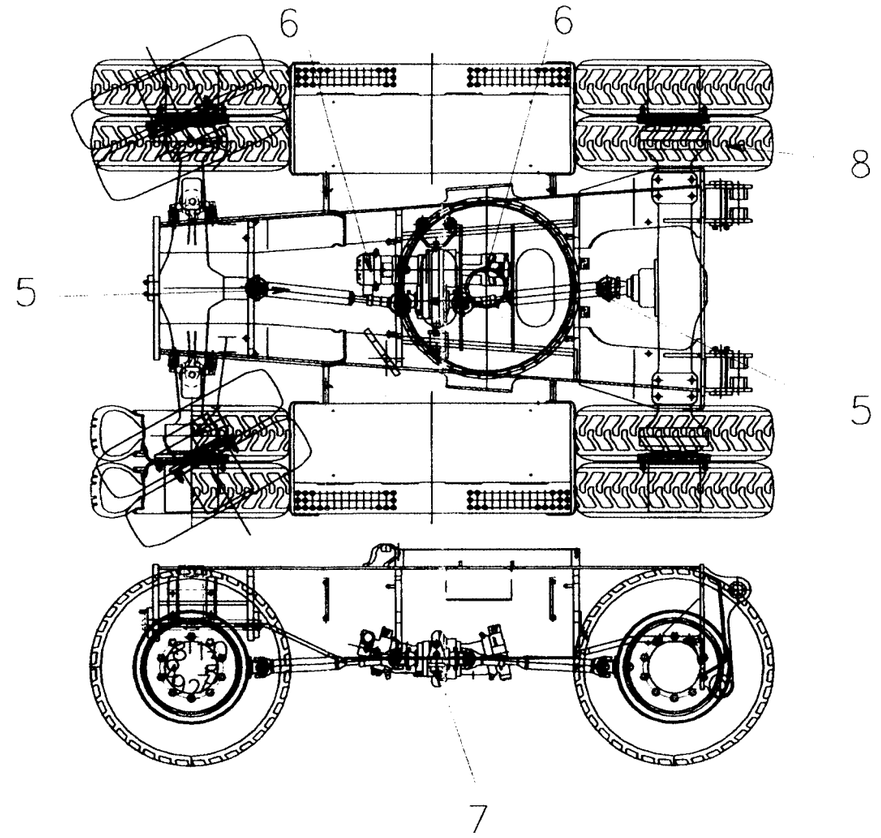
Specification

Reduction ratio $\frac{14 + 61}{14} \times \frac{17 + 61}{17} = 24.586$

UNDERCARRIAGE

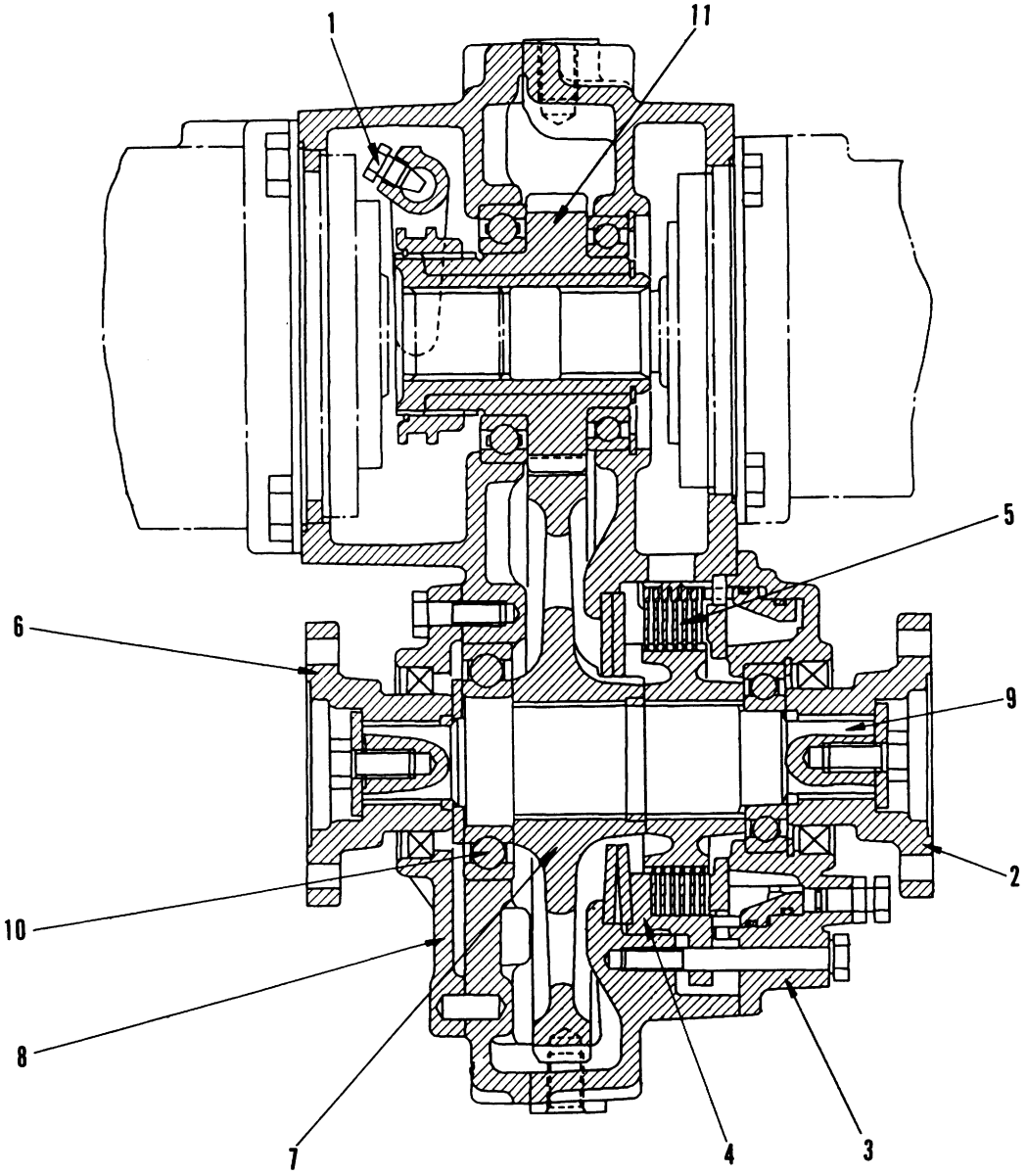






1. Undercarriage
2. Step
3. Wheel chock
4. Front oscillating steering axle
5. Rear axle
6. Propshaft
7. Travel motor
8. Transmission
9. Double wheel ass'y
10. Single wheel ass'y

TRANSMISSION - 20 Km/h TRAVEL SPEED SPEC.

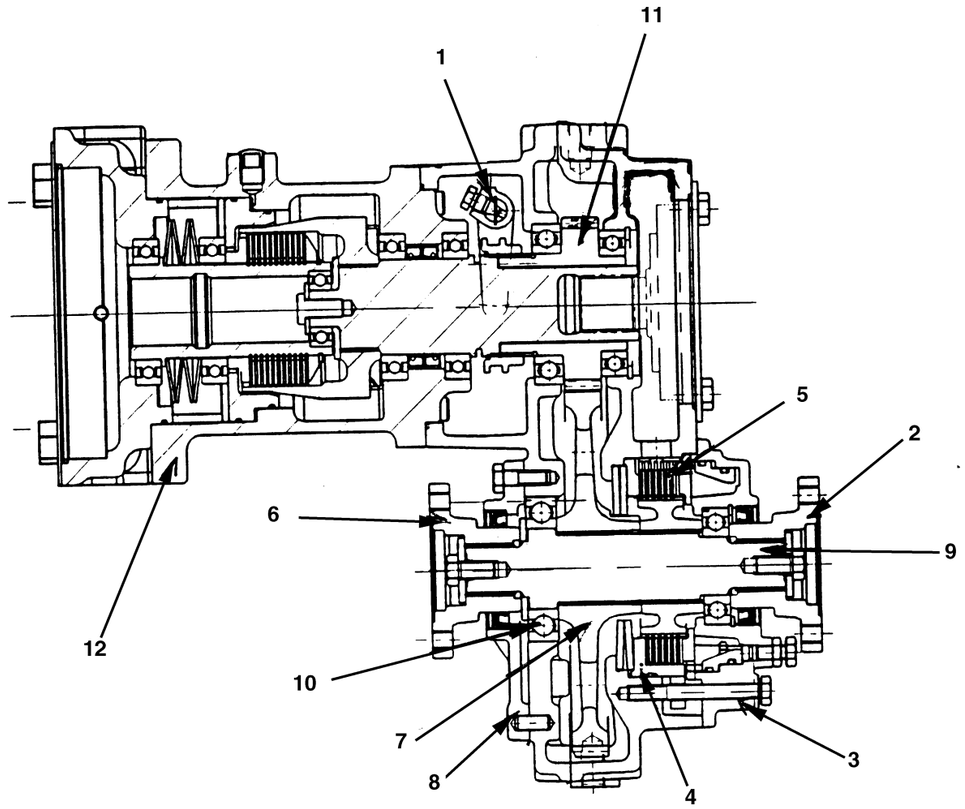


1. Screw-fork to shaft
2. Flange
3. Brake cylinder
4. Brake drum
5. Friction disk
6. Flange
7. Gear
8. Cover
9. Output shaft
10. Bearing
11. Gear

Specification

Reduction ratio: 2.265 : 1

TRANSMISSION - 30 Km/h TRAVEL SPEED SPEC.

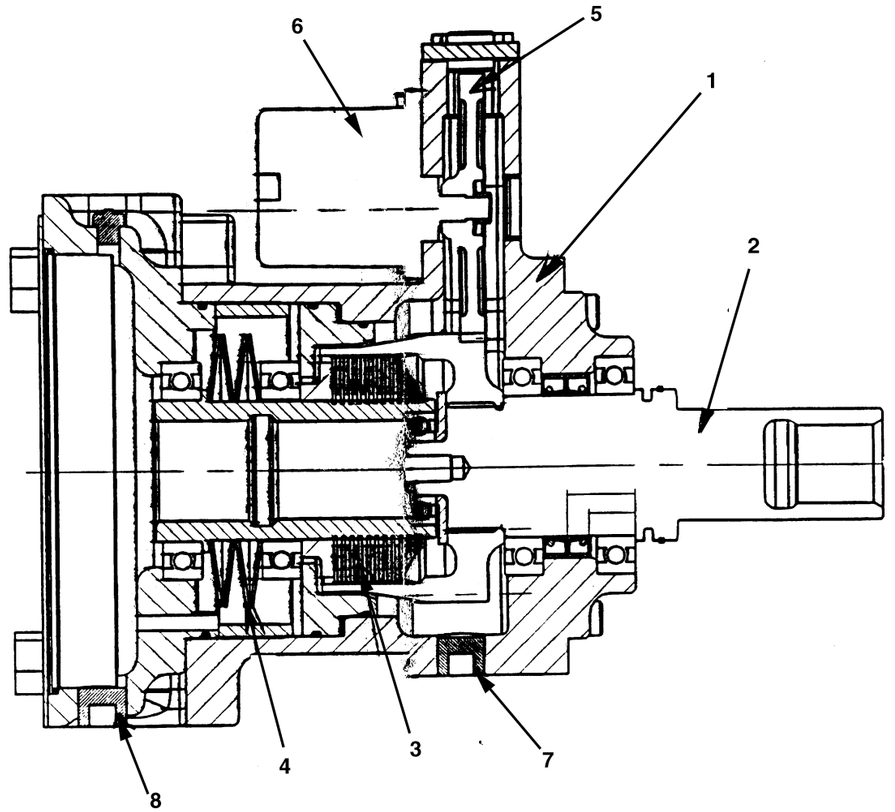


1. Screw-fork to shaft
2. Flange
3. Brake cylinder
4. Brake drum
5. Friction disk
6. Flange
7. Gear
8. Cover
9. Output shaft
10. Bearing
11. Gear
12. Clutch ass'y

Specification

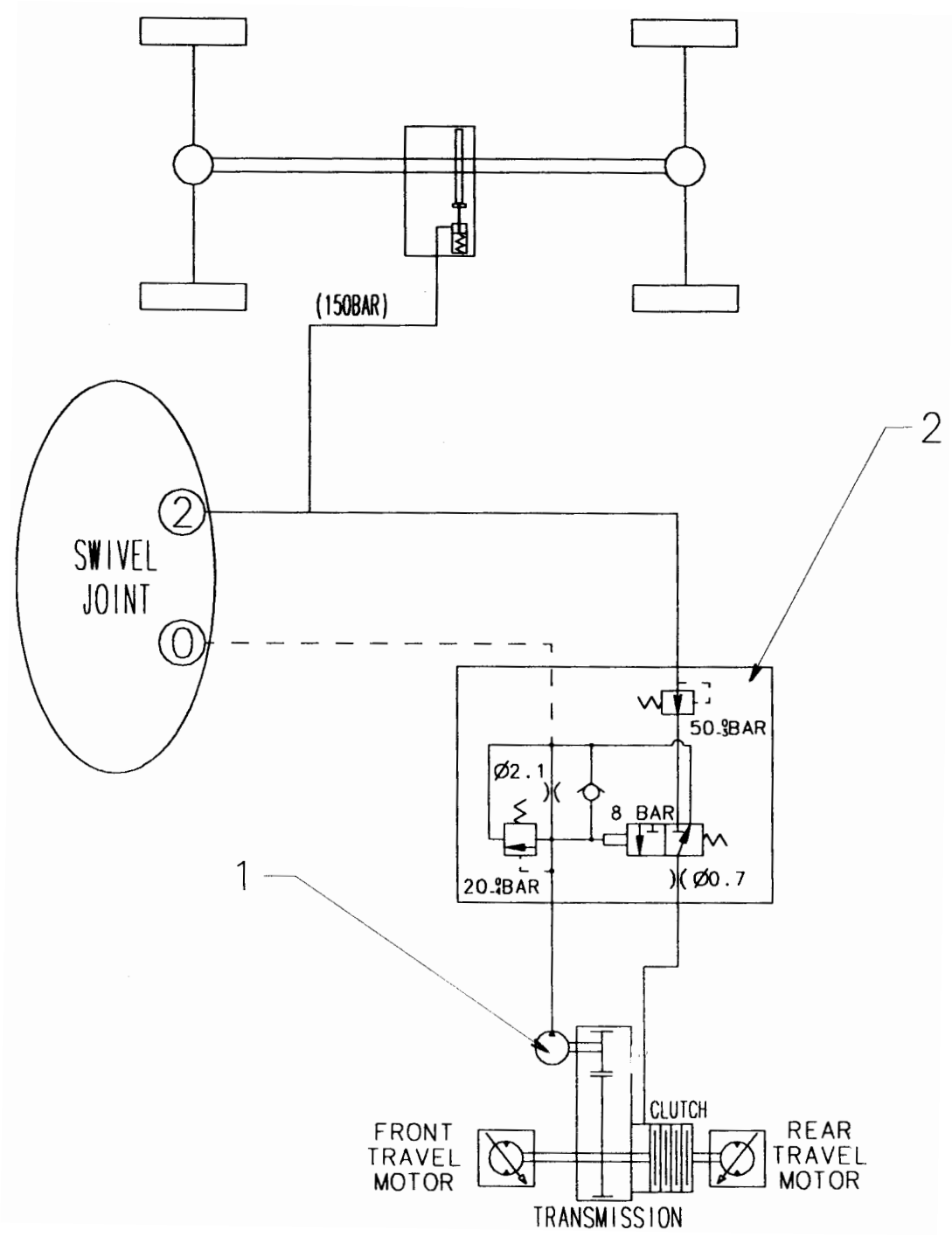
Reduction ratio: 1.846 : 1

CLUTCH ASS'Y - 30 Km/h TRAVEL SPEED SPEC.



1. Casing
2. Drive shaft
3. Friction plates
4. Spring discs
5. Gear
6. Clutch control gear pump
7. Plug
8. Plug

CLUTCH CONTROL CIRCUIT (30 Km/h SPEC. ONLY)



STRUCTURE

1. Clutch control pump
2. Clutch control valve

FUNCTION

The clutch is a device which automatically disengages the drive between the large diplacement (Rear) travel motor and the transmission. This occurs when the machine is accelerating and the disengagement occurs at 11 Kph. The transmission system becomes more efficient (by reducing losses caused by the unnecessary rotation of the rear travel motor) providing better acceleration and enabling a maximum speed of 30 Kph.
When the machine decelerates from a high speed the clutch will re-engage automatically at 9 Kph and will remain engaged until the speed is increased above 11 Kpm again.

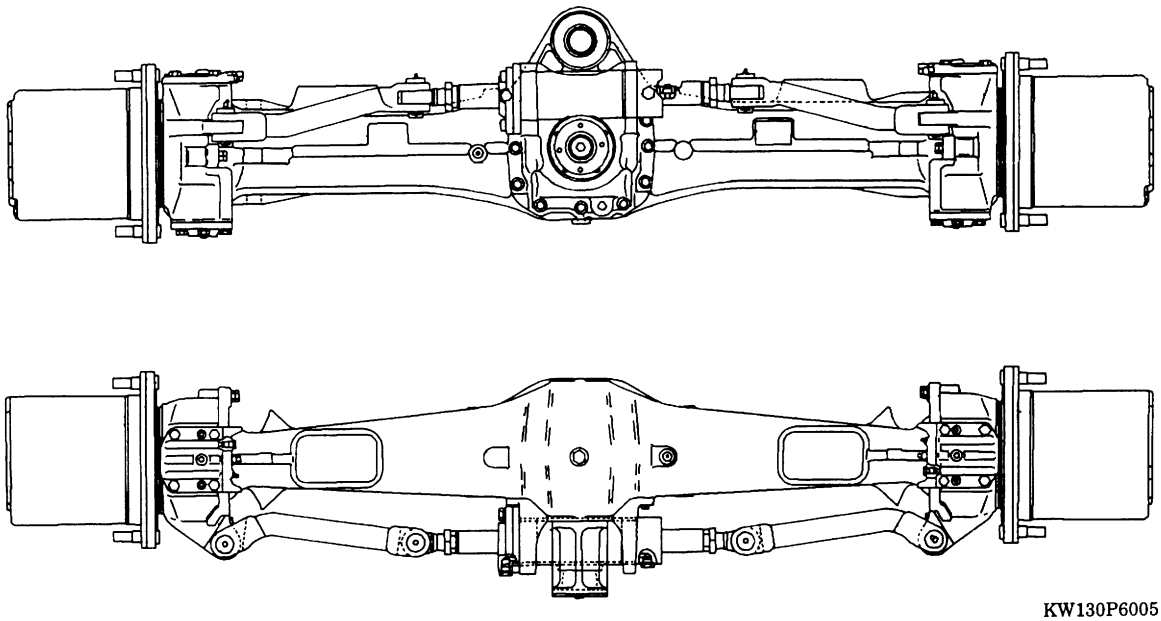
AXLE

OUTLINE

- Each axle consists of an axle housing supporting the chassis weight, a differential set in the axle housing, a final drive, and a brake provided at each end.

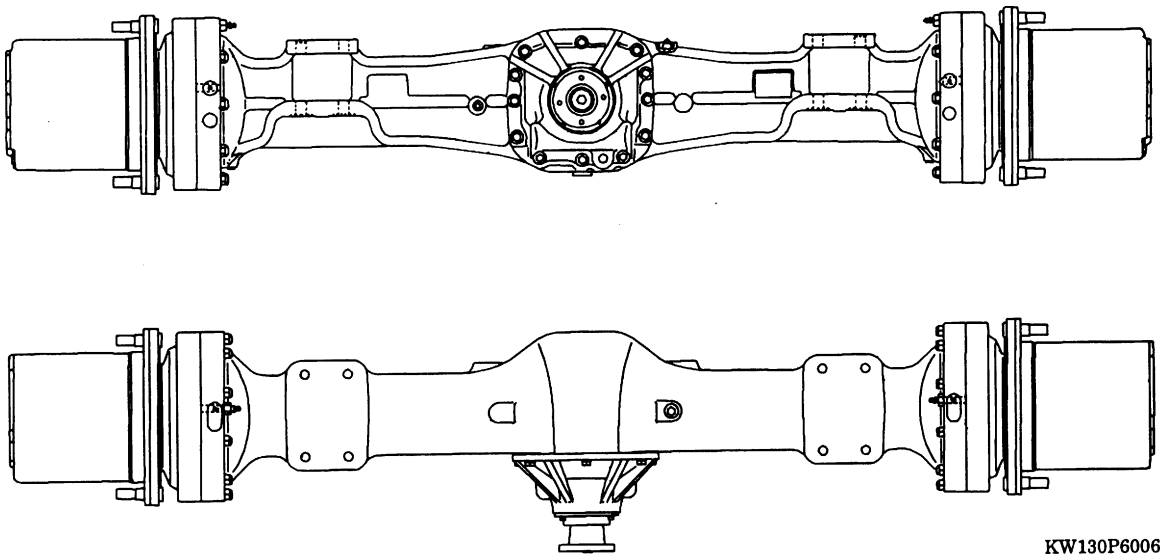
- A trunnion-type axle shaft with a king pin at the final drive end is used to enable the direction of travel of the machine to be changed.

FRONT AXLE

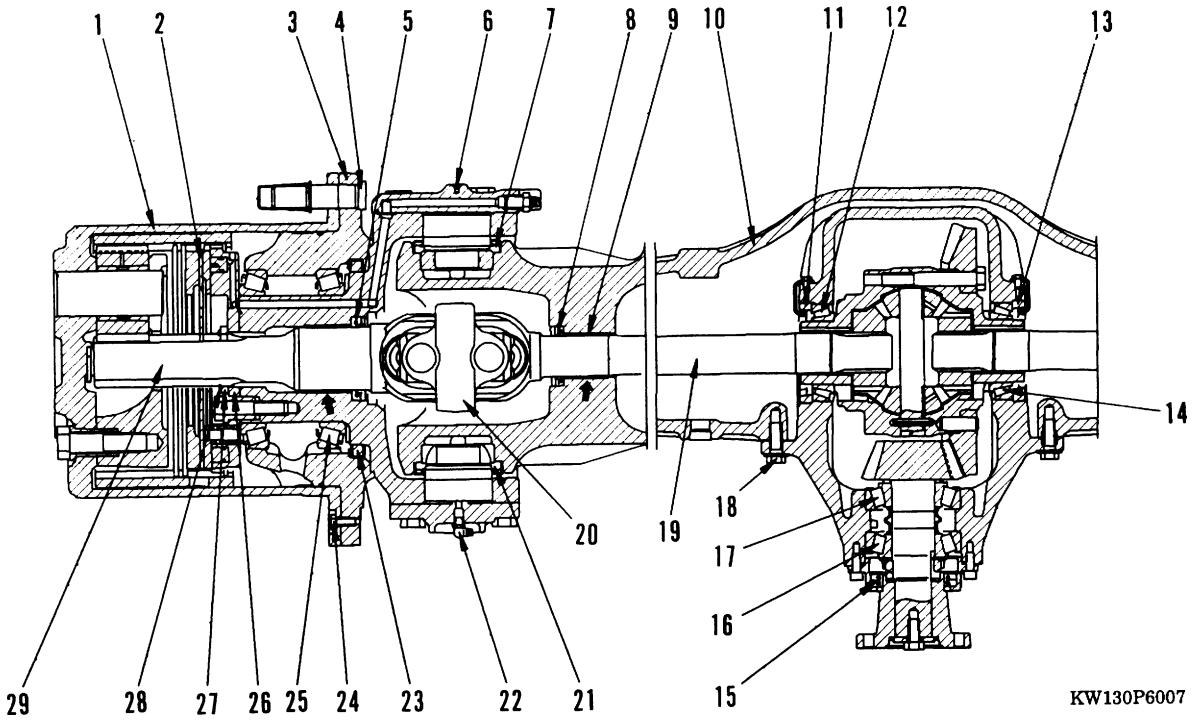


KW130P6005

REAR AXLE



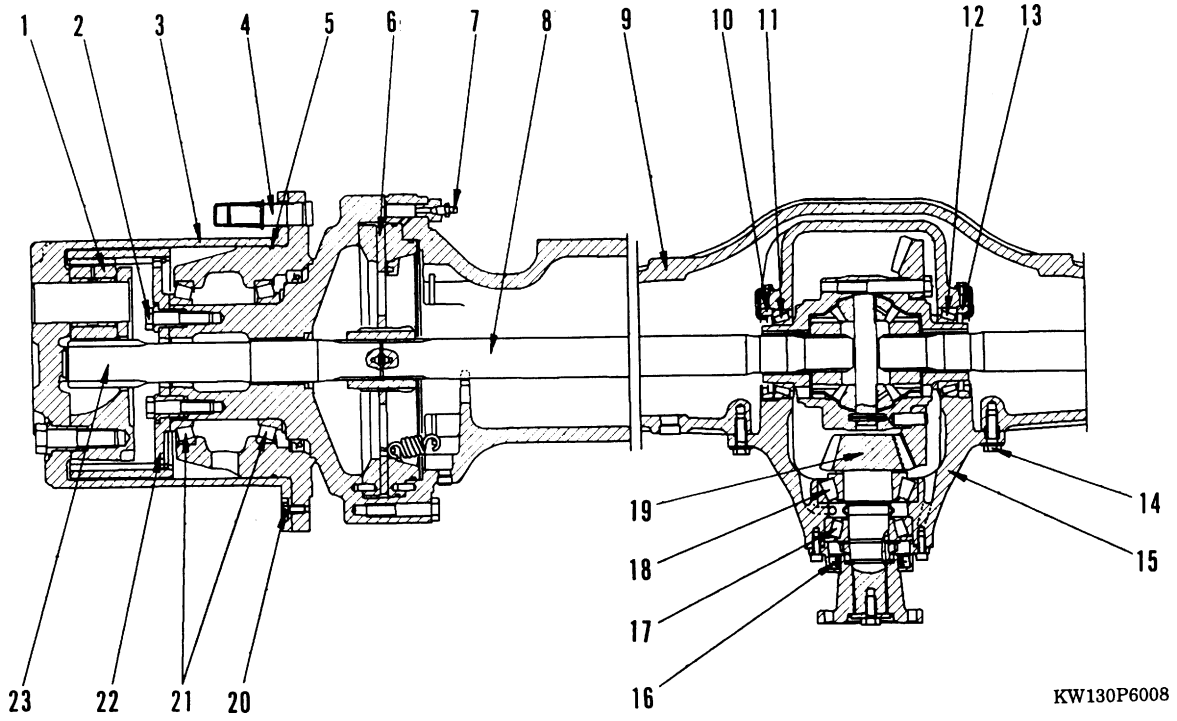
FRONT AXLE



Axle reduction ratio = 17,73 : 1

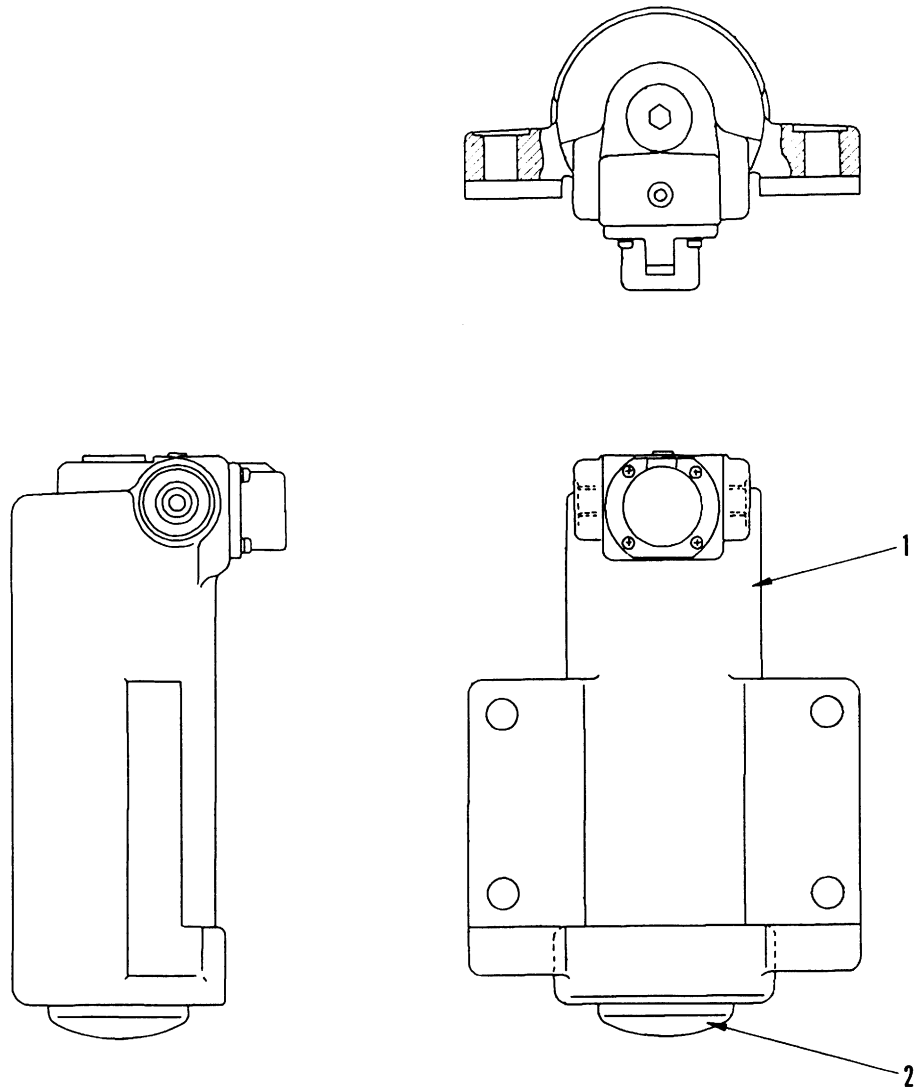
1. Planetary carrier
2. Washer
3. Brake drum
4. Pin
5. Seal ring
6. Grease nipple
7. Seal ring
8. Seal ring
9. Bushing
10. Axle tube
11. Ring nut
12. Ball bearing
13. Ring nut
14. Ball bearing
15. Seal ring
16. Roller bearing
17. Roller bearing
18. Hexagon head screw
19. Shaft
20. Joint
21. Bushing
22. Grease nipple
23. Seal ring
24. Cylinder head screw
25. Roller bearing
26. Washer
27. Ring
28. Hexagon head screw
29. Sun gear

REAR AXLE



1. Planetary gear
2. Bolt
3. Planetary carrier
4. Stud
5. Wheel Hub
6. Bushing
7. Socket
8. Shaft
9. Axle tube
10. Ring nut
11. Roller bearing
12. Roller bearing
13. Shim
14. Bolt
15. Cover
16. Seal ring
17. Roller bearing
18. Roller bearing
19. Bevel gear
20. Cylinder head screw
21. Bearing
22. Ring gear plate
23. Sun gear

SUSPENSION LOCK CYLINDER



1. Barrel
2. Plunger

Specifications

Piston: ø 85 mm
Stoke: 160 mm
Operating pressure: 40.0 MPa (408 kg/cm^2)
Pilot pressure: 3.0 MPa (30.6 kg/cm^2)
Max 5.0 MPa (51.0 kg/cm^2)

CIRCUIT

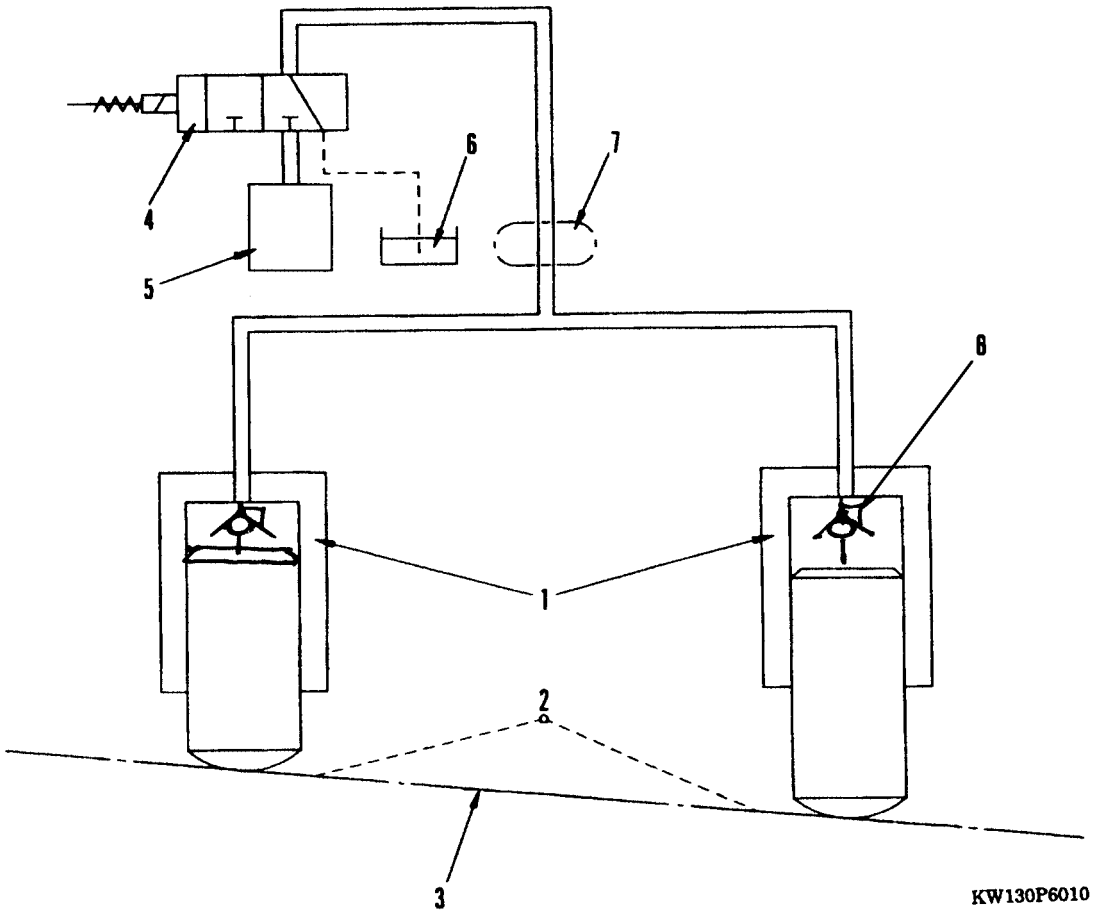
Purpose

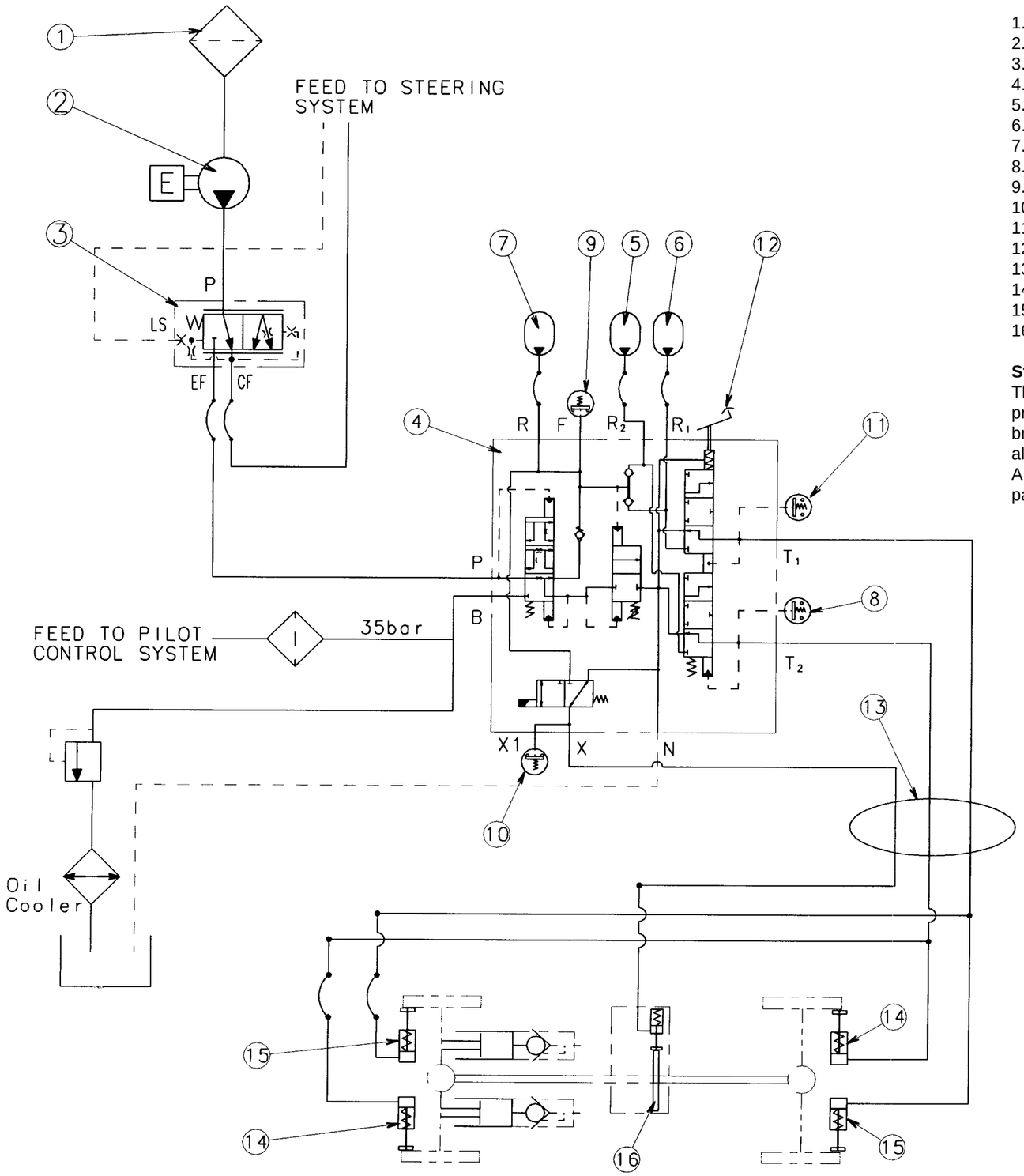
The undercarriages of wheeled hydraulic excavators have one of the two driven axles oscillating mounted. This makes it possible to fully utilize the excavator's rimpull in rough terrain - all of the wheels being constantly in contact with the ground.
An oscillation blocking ram is fitted on each side of the undercarriage to block the axle during digging or lifting work.
Blocking the axle increases the excavator's stability.

1. Ram
2. Axle oscillation point
3. Oscillating axle
4. Oscillation lock solenoid valve
5. Pilot pressure reducing valve
6. Hydraulic tank
7. Swivel joint
8. Check valve

Function

The oscillating axle (3) is mounted in bearing (2) in the middle of the excavator. The two rams (1) which are full of hydraulic oil are connected through pipelines to the oscillation lock solenoid valve (4).
When the excavator is being moved, the oscillation lock solenoid valve should be de-energized so that the hydraulic oil in the ram can be returned to tank as the axle is oscillating up and down. Before commencing excavating operations, the oscillation lock solenoid valve should be energized to pressurize the oil in the rams. This will lock the axle in the position it is in.





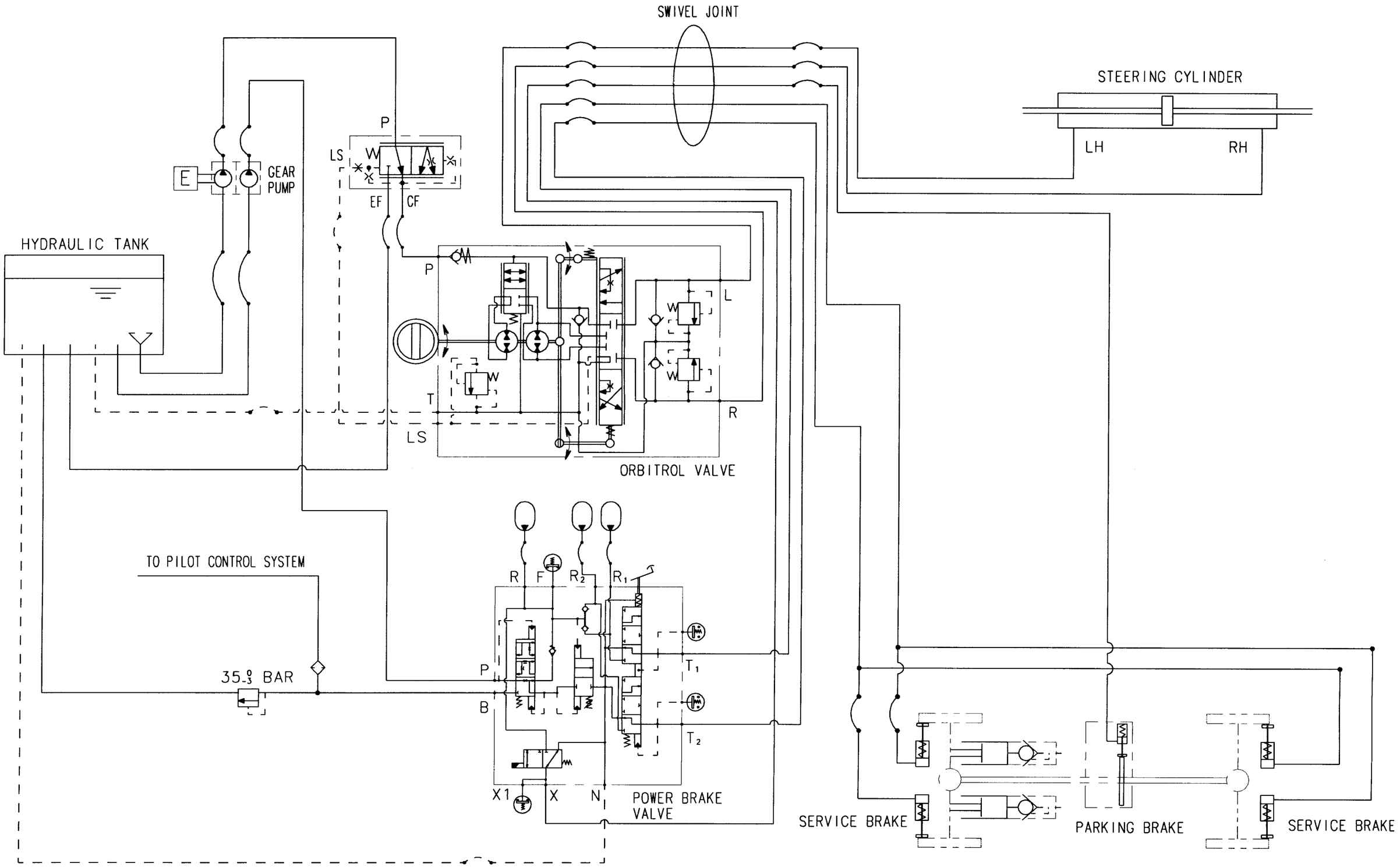
1. Hydraulic oil filter
2. Hydraulic oil pump (shared with steering system)
3. Priority valve
4. Brake control valve
5. Accumulator - service brake
6. Accumulator - service brake
7. Accumulator - parking brake
8. Pressure switch - stop light
9. Pressure switch - accumulator
10. Pressure switch - parking brake
11. Pressure switch - service brake
12. Brake pedal
13. Swivel joint
14. Service brake cylinder
15. Service brake cylinder
16. Parking brake cylinder

Structure and function

The brake system is fully hydraulic. Oil is supplied at high pressure by a pump to a priority valve. The priority valve gives priority to the steering circuit. When braking, oil is sent to the brake valve which provides braking pressure to two separate braking circuits (service brakes). In the event of a failure of the power supply, the accumulators provide brake pressure to allow the machine to be safety stopped.

A parking brake is provided which is operated by energizing a solenoid valve in the brake valve which sends pressure to the park brake in the transmission. Park brake on solenoid off.

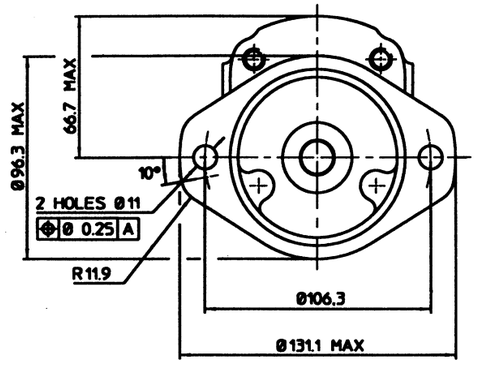
BRAKE & STEERING CIRCUIT (ITALIAN SPECIFICATION)

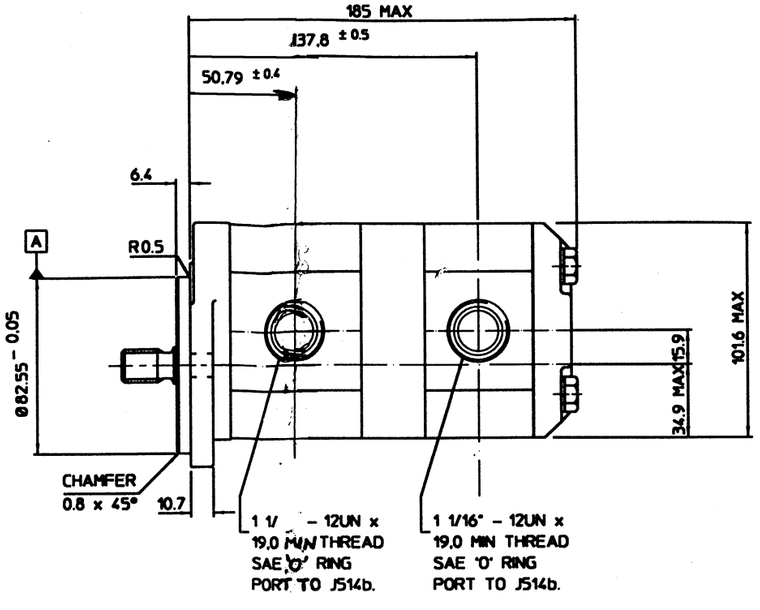


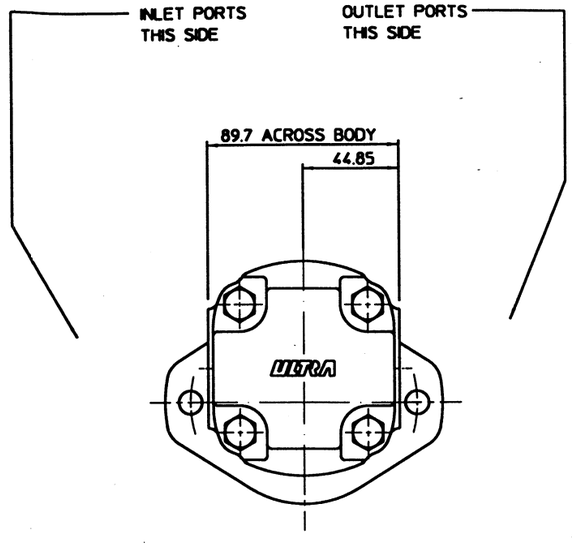
Function

The function of the steer/brake circuit (Italian specification) is identical to the standard circuit except for the tandem gear pump.
The tandem pump consists of two gear pumps, one for each circuit. The priority value is maintened in the steering circuit to provide a load sensing output for emergency steering when required.

GEAR PUMP (ITALIAN SPECIFICATION)

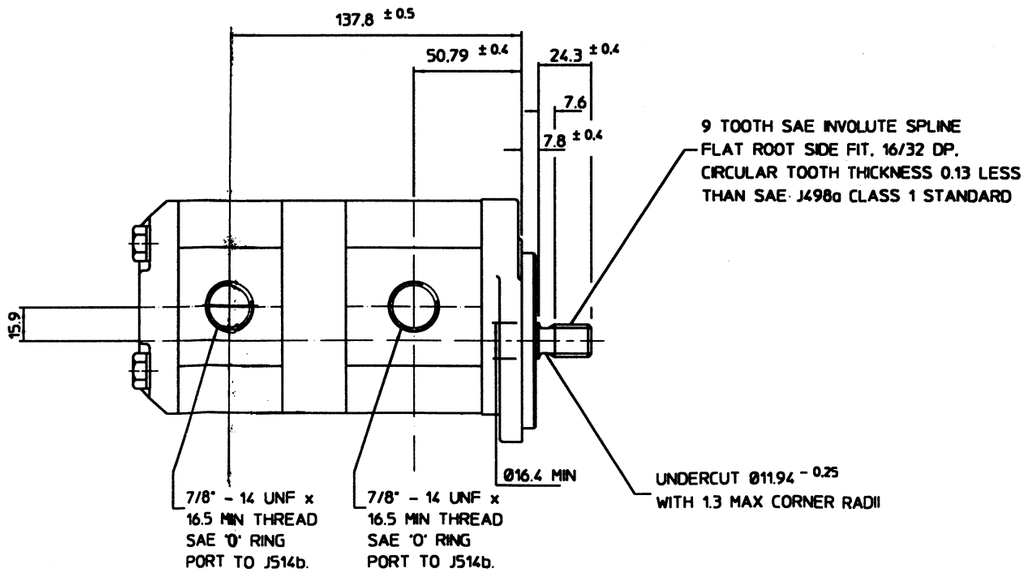




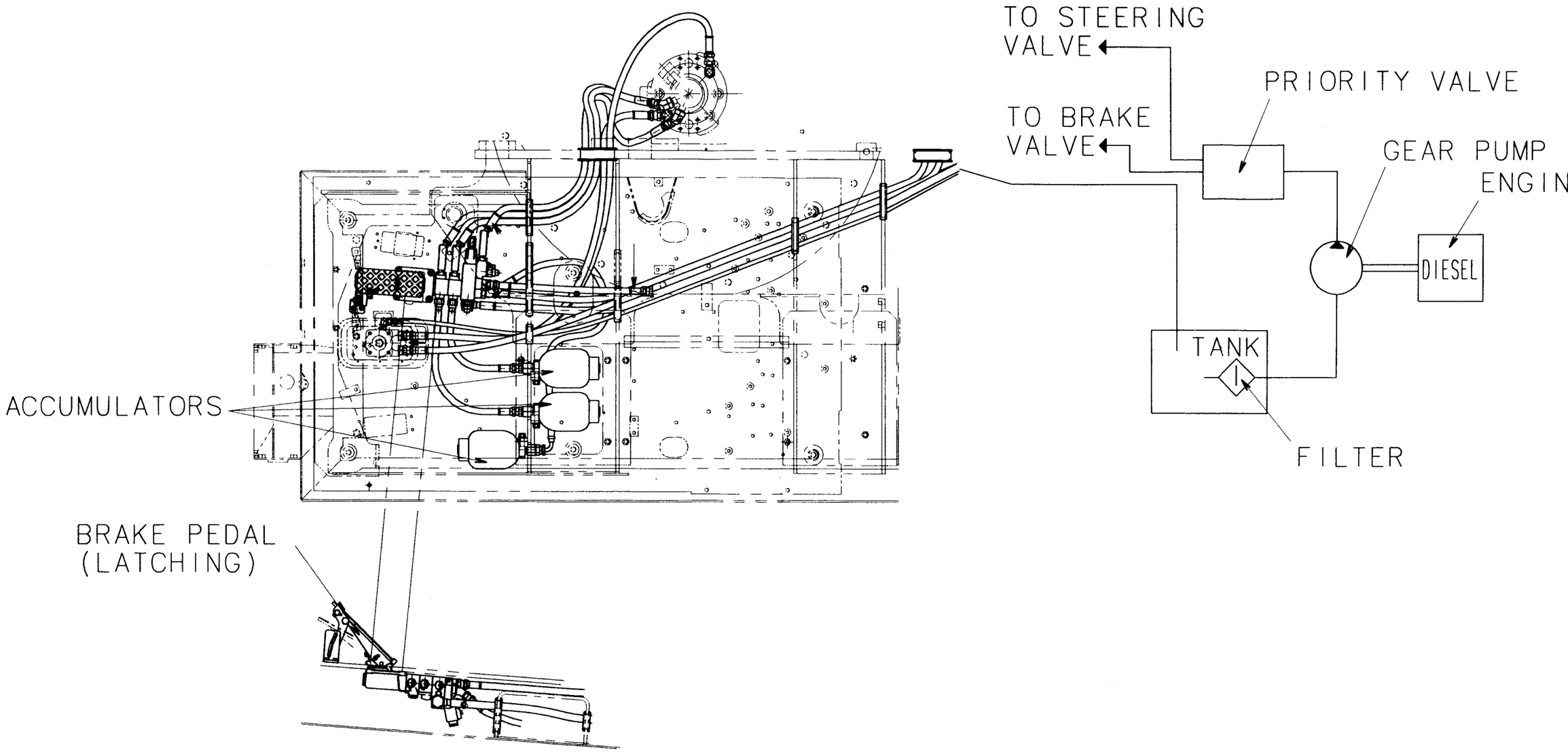


PUMP DATA		
	FRONT PUMP	REAR PUMP
PUMP TYPE	1PX146	1PX064
THEORETICAL DISPLACEMENT	14.6 cc/rev (0.89 cu in/rev)	6.4 cc/rev (0.39 cu in/rev)
MAXIMUM CONTINUOUS PRESSURE P1	145 bar (2103 psi)	150 bar (2175 psi)
MAXIMUM SPEED AT PRESSURE P1	3500 rev/min	
MINIMUM SPEED AT PRESSURE P1	500 rev/min	
ROTATION WHEN VIEWED ON END OF DRIVESHAFT	CLOCKWISE	
APPROX WEIGHT	kg (lb)	
OPERATING TEMPERATURE RANGE	CONTINUOUS 0°C TO 80°C COLD START -20°C MAX INTERMITTENT 100°C	
SHAFT SEAL TYPE	DOUBLE NITRILE	

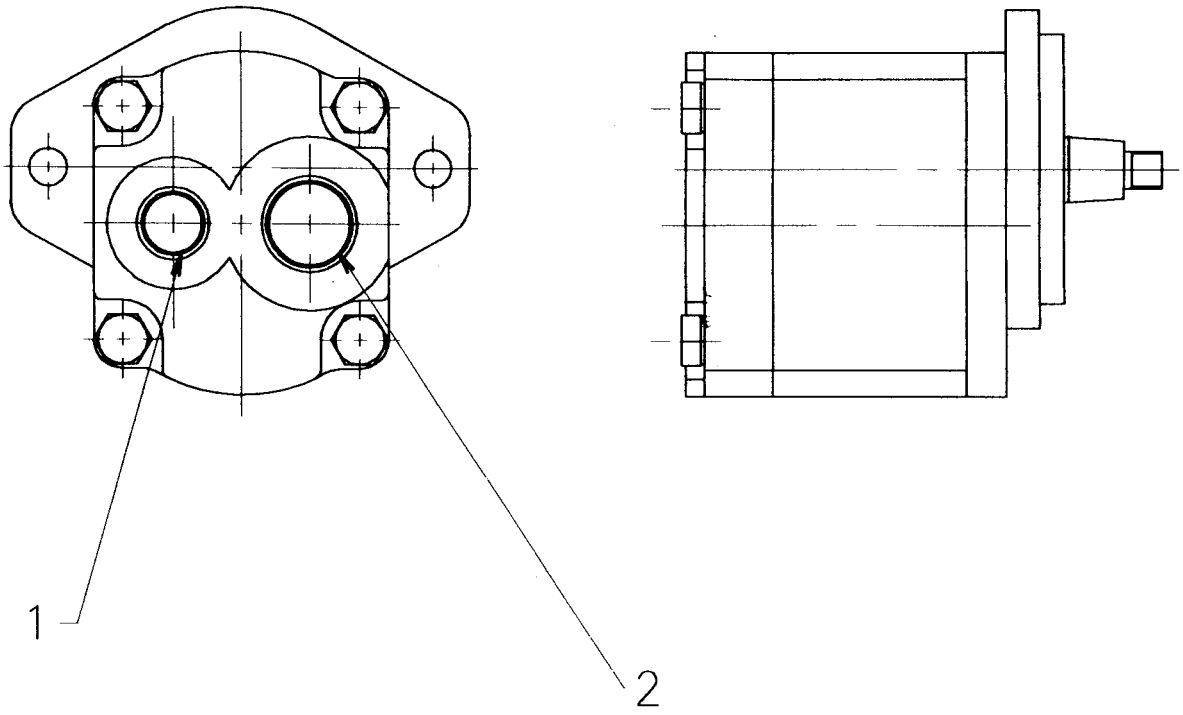
FOR OPERATING CONDITIONS OUTSIDE THOSE STATED PLEASE CONSULT ULTRA HYDRAULICS LIMITED TECHNICAL SALES DEPARTMENT.



BRAKING TRAIN



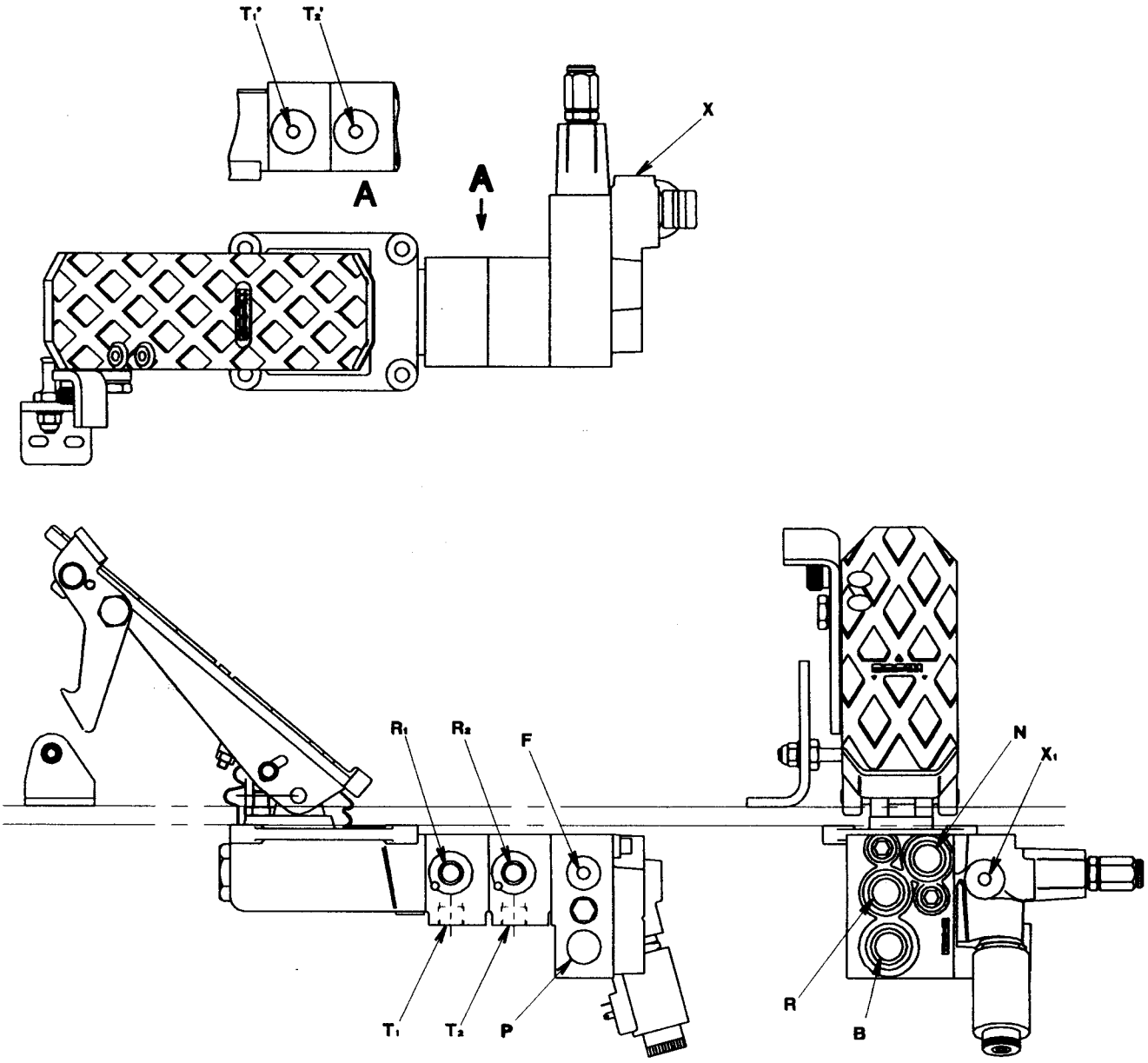
BRAKE/STEER PUMP



1. Delivery port
2. Suction port

Specifications
Rated peed: 2,400 RPM
Displacement: 19 cc/REV
Rated pressure: 250 bar
Type: gear pump

BRAKE PEDAL INCORPORATING BRAKE VALVE

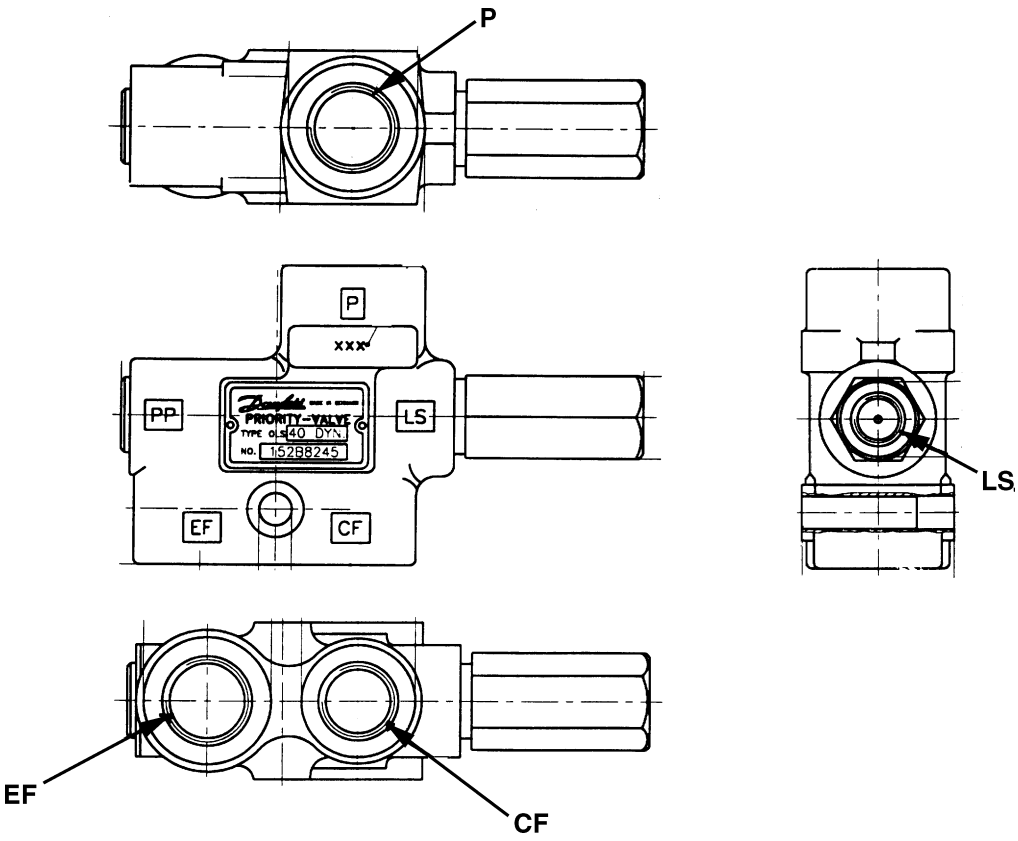


F = Accumulator pressure switch
R = Accumulator (parking brake)
R_1 = Accumulator (service brake)
r_2 = Accumulator (service brake)
T_1 = Service brake
T_1^1 = Service brake pressure switch
T_2 = Service brake
T_2^1 = Stop light pressure switch
X = Parking brake
X_1 = Parking brake pressure switch
P = Delivery
B = Return
N = Tank

Specifications

Accumulator charge pressure	(cut in) = 122^{+6}_{-2} bar
	(cut out) = 150^{+8}_{-4} bar

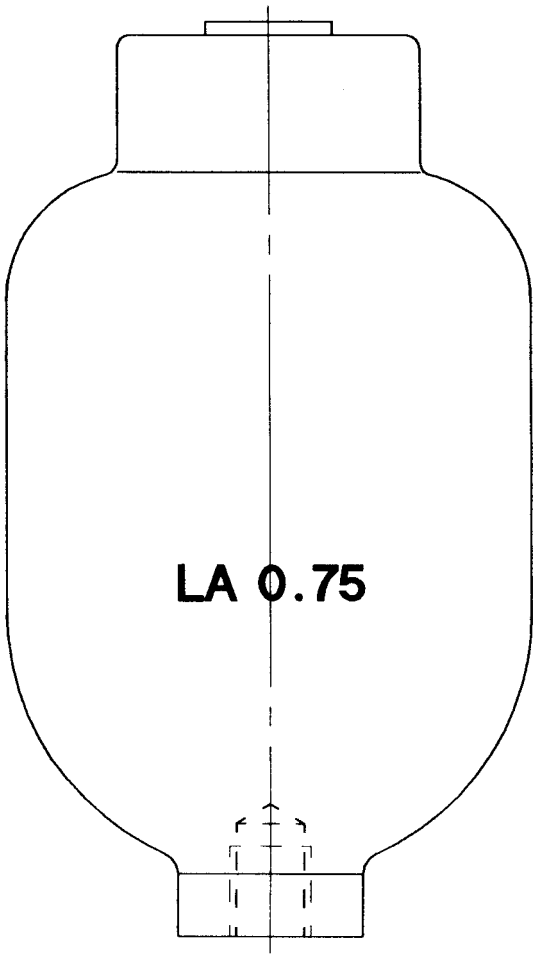
PRIORITY VALVE



P = Pressure port (from pump)
EF = Output port to brake system
CF = Output port to steering system
LS = Load sensing port from steering valve

Specification
Control spring pressure: 7 bar

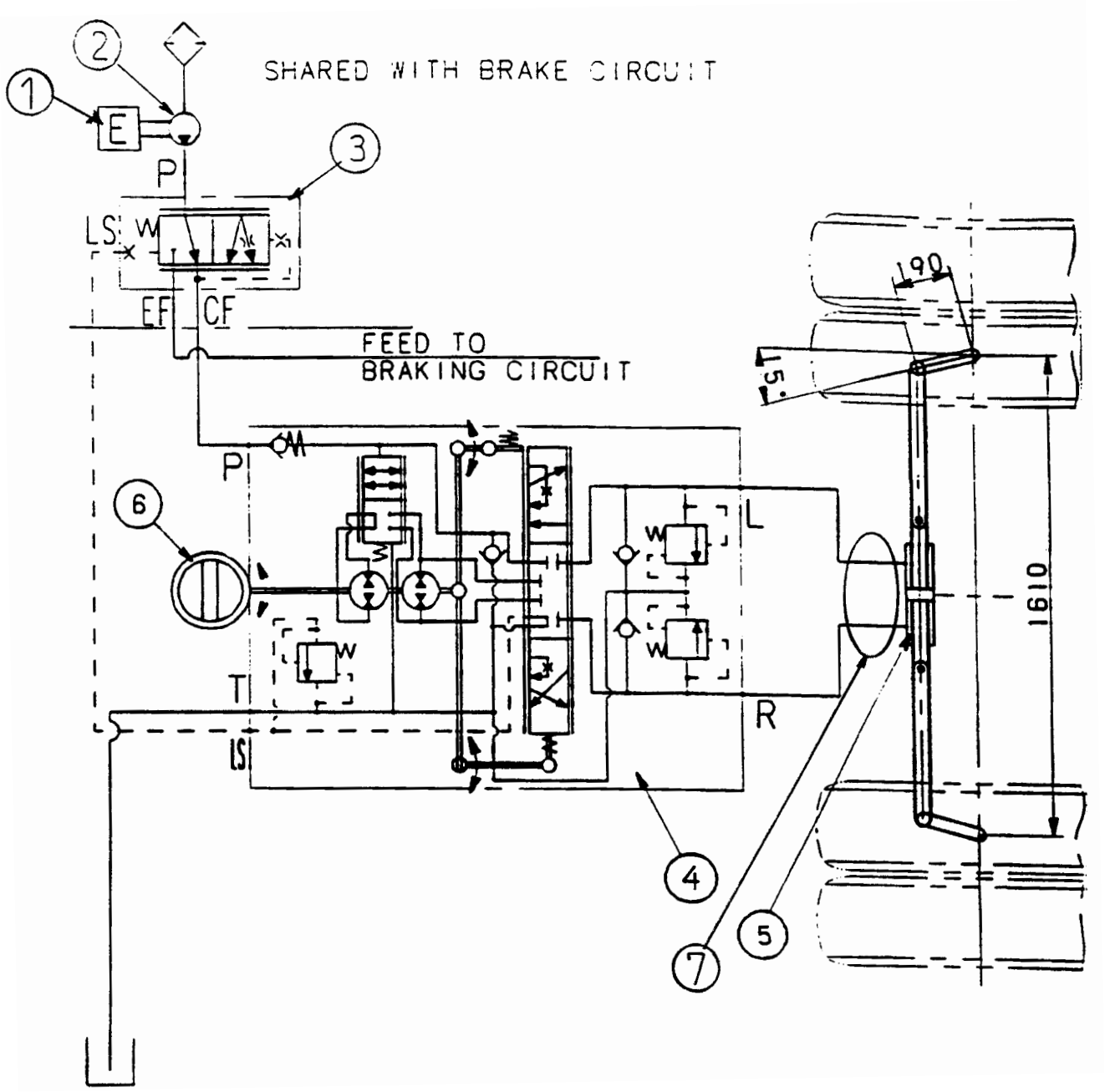
ACCUMULATOR FOR BRAKE SYSTEM



Specifications

Volume: 0.75 *l*
Max working pressure: 210 bar

STEERING TRAIN



Structure and function

- The steering is fully hydraulic. The oil sent by the brake/steer pump (2) mounted on the PTO at the front of the engine (1) flows via the priority valve (3) to the steering valve (4). From here it is passed through swivel joint (7) to steering cylinder (5). The steering cylinder then extends or retracts to move the tie-rod and steer the machine.
- In the event of failure of the power supply the machine can be steered by emergency steering. The steering valve acts as a pump to send oil to the steering cylinder.

ITEM
POSITIONS

1. ENGINE

2. HYDRAULIC OIL PUMP (SHARED WITH BRAKING CIRCUIT) 19cc/rev

3. PRIORITY VALVE
   CONTROL SPRING PRESSURE ..... 7 bar

4. STEERING VALVE ..... OSPD 70/195 LS DYN.

5. STEERING CYLINDER ..... D=ø90, d=ø50, STROKE=170^{0}_{-1}
   STEERING CYLINDER VOLUME = $\frac{(9 - 5) \times \pi}{4} \times 17 = 748\ cmm^2$

6. STEERING WHEEL Ø352

7. SWIVEL JOINT

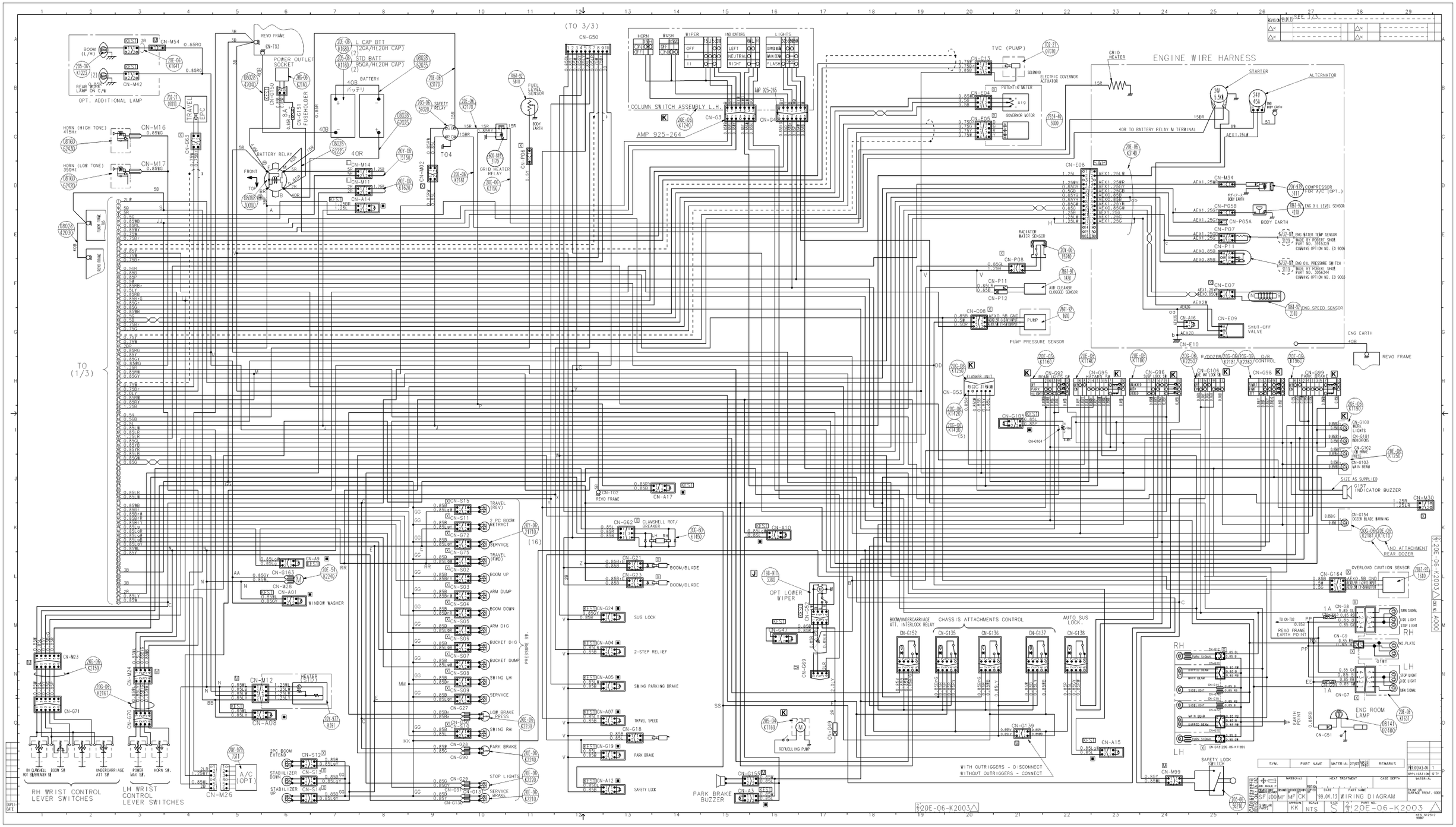
QUANTITIY OF STEERING TURNS

NORMAL

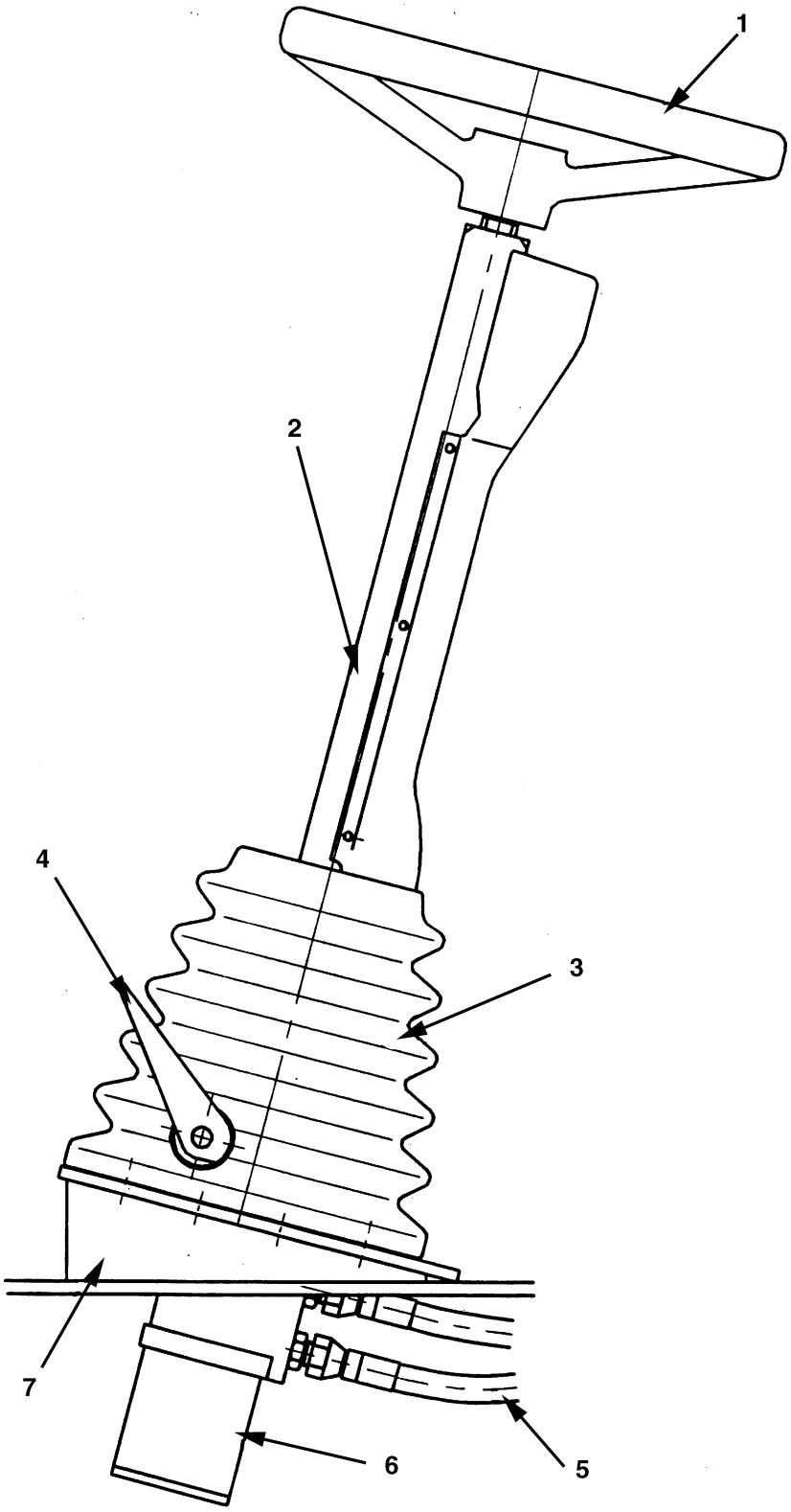
$$1 = \frac{\text{CYL. VOL}}{\text{PUMP.VOL}} = \frac{748\ cm^3}{195\ cm^3} = 3.8\ \text{TURNS}$$

EMERGENCY

$$1 = \frac{\text{CYL. VOL}}{\text{PUMP.VOL}} = \frac{748\ cm^3}{70\ cm^3} = 10.7\ \text{TURNS}$$

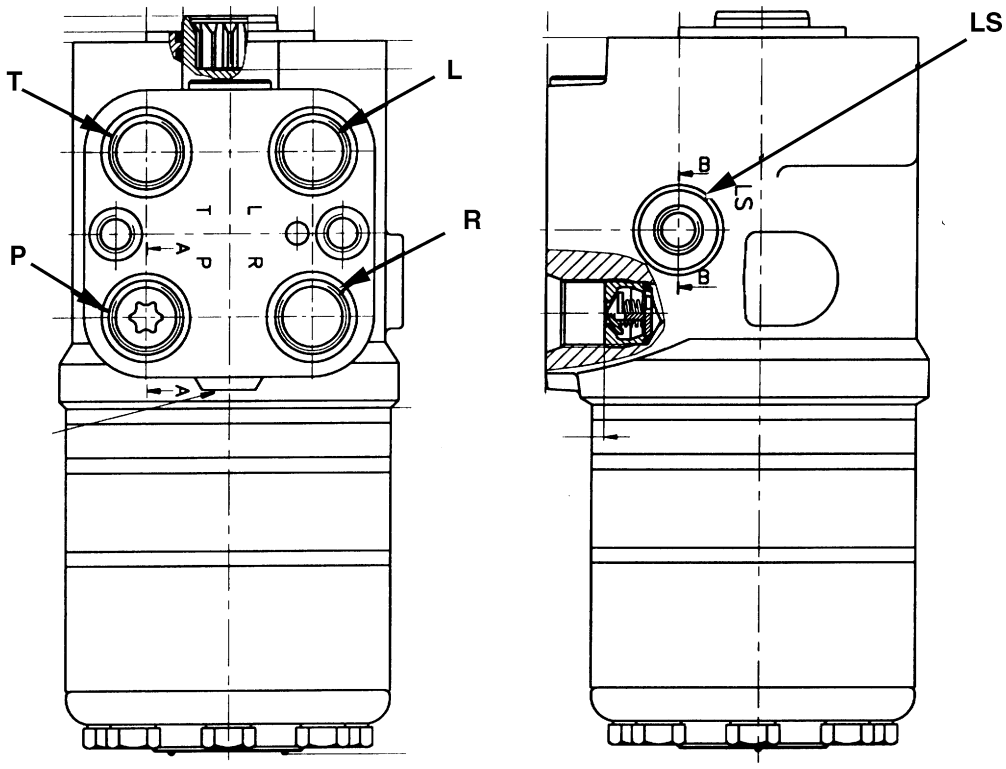

ENGINE WIRE HARNESS
TVC (PUMP)
SOLENOID
ELECTRIC GOVERNOR ACTUATOR
POTENTIO METER
GOVERNOR MOTOR
GRID HEATER
STARTER
ALTERNATOR
COMPRESSOR A/C (OPT.)
ENG OIL LEVEL SENSOR
BODY EARTH
ENG WATER TEMP SENSOR
ENG OIL PRESSURE SWITCH
ENG SPEED SENSOR
RADIATOR WATER SENSOR
AIR CLEANER CLOGGED SENSOR
PUMP
PUMP PRESSURE SENSOR
SHUT-OFF VALVE
ENG EARTH
REVO FRAME
R/DOZER
O/R CONTROL
HORN (HIGH TONE) 415Hz
HORN (LOW TONE) 350Hz
OPT. ADDITIONAL LAMP
REAR WORK LAMP CN-C/W
TRAVEL EPC
POWER OUTLET SOCKET
BATTERY
BATTERY RELAY
GRID HEATER RELAY
FUEL LEVEL SENSOR
BODY EARTH
COLUMN SWITCH ASSEMBLY L.H.
AMP 925-264
AMP 925-265
HORN
WASH
WIPER
INDICATORS
LIGHTS
OPT LOWER WIPER
WINDOW WASHER
REFUELLING PUMP
PARK BRAKE BUZZER
ROOM/UNDERCARRIAGE ATT. INTERLOCK RELAY
CHASSIS ATTACHMENTS CONTROL
AUTO SUS LOCK
WITH OUTRIGGERS - DISCONNECT
WITHOUT OUTRIGGERS - CONNECT
SAFETY LOCK SWITCH
OVERLOAD CAUTION SENSOR
NO ATTACHMENT REAR DOZER
ENG ROOM LAMP
NO. PLATE
SIZE AS SUPPLIED
INDICATOR BUZZER
DOZER BLADE WARNING
TO 3/3
TO 1/3
TO T04
SEE 3/3
RH WRIST CONTROL LEVER SWITCHES
LH WRIST CONTROL LEVER SWITCHES
RH CANCHELL BOOM SW
BOOM SWBREAKER SW
UNDERCARRIAGE ATT SW
POWER MAX SW.
HORN SW.
2PC BOOM EXTEND
STABILIZER DOWN
STABILIZER UP
A/C (OPT)
TRAVEL (REV)
2 PC BOOM RETRACT
SERVICE
TRAVEL (FWD)
BOOM UP
ARM DUMP
BOOM DOWN
ARM DIG
BUCKET DIG
BUCKET DUMP
SWING LH
SERVICE
LOW BRAKE PRESS
SWING RH
PARK BRAKE
STOP LIGHTS
SERVICE BRAKE
PRESSURE SW.
CLAMSHELL ROT/ BRAKE
BOOM/BLADE
SUS LOCK
2-STEP RELIEF
SWING PARKING BRAKE
TRAVEL SPEED
PARK BRAKE
SAFETY LOCK
FLASHER UNIT
20E-06-K2003
SF JD0 MF MF CK 99.04.13 WIRING DIAGRAM
KK NTS

STEERING COLUMN



1. Steering wheel
2. Steering column
3. Gaiter
4. Pedal
5. Hose
6. Orbitroll valve
7. Mounting bracket

ORBITROL VALVE



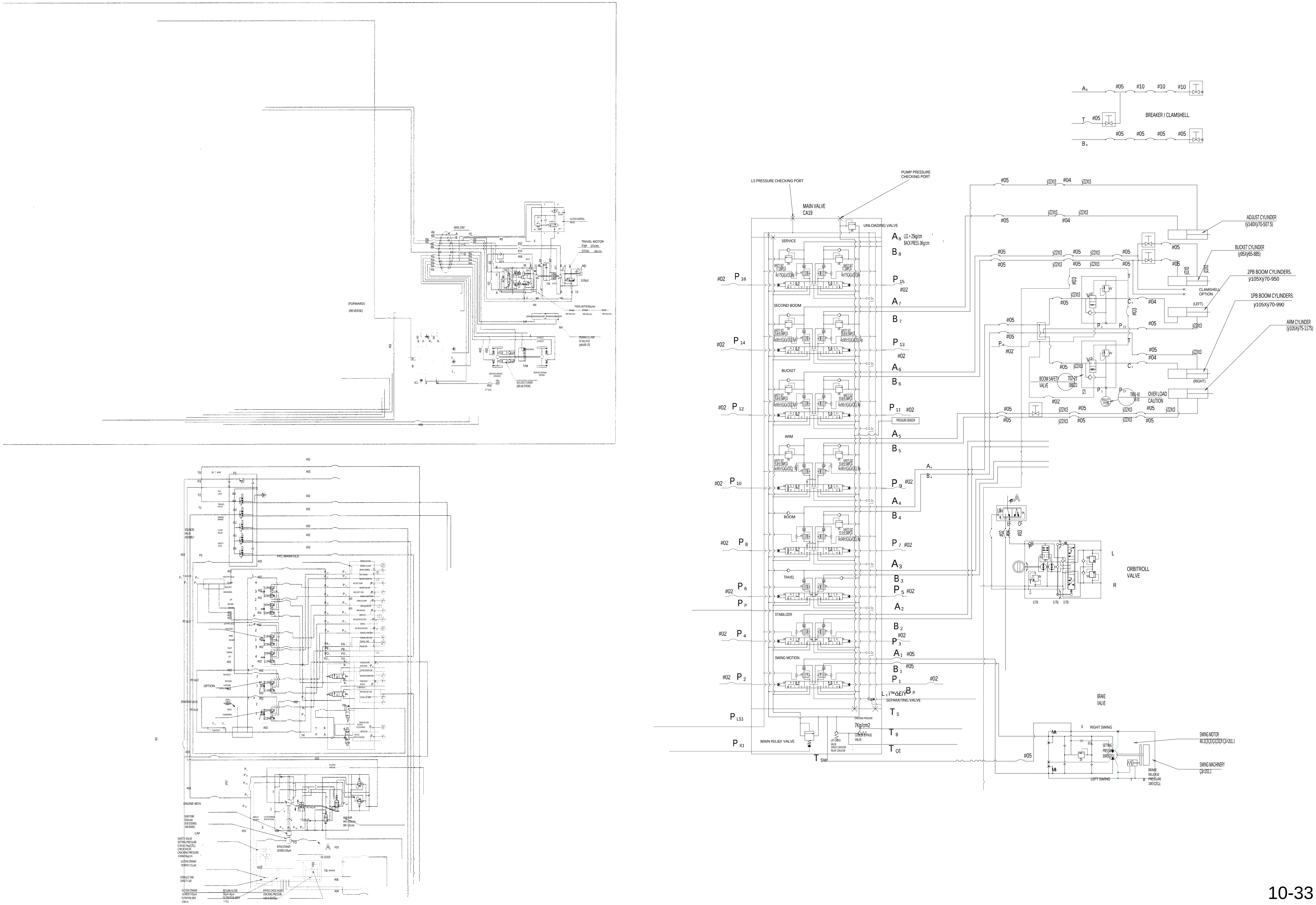
P = Pressure port (from priority valve)
T = Tank port
L = Left turn port
R = Right turn port
LS = Load sensing port (to priority valve)

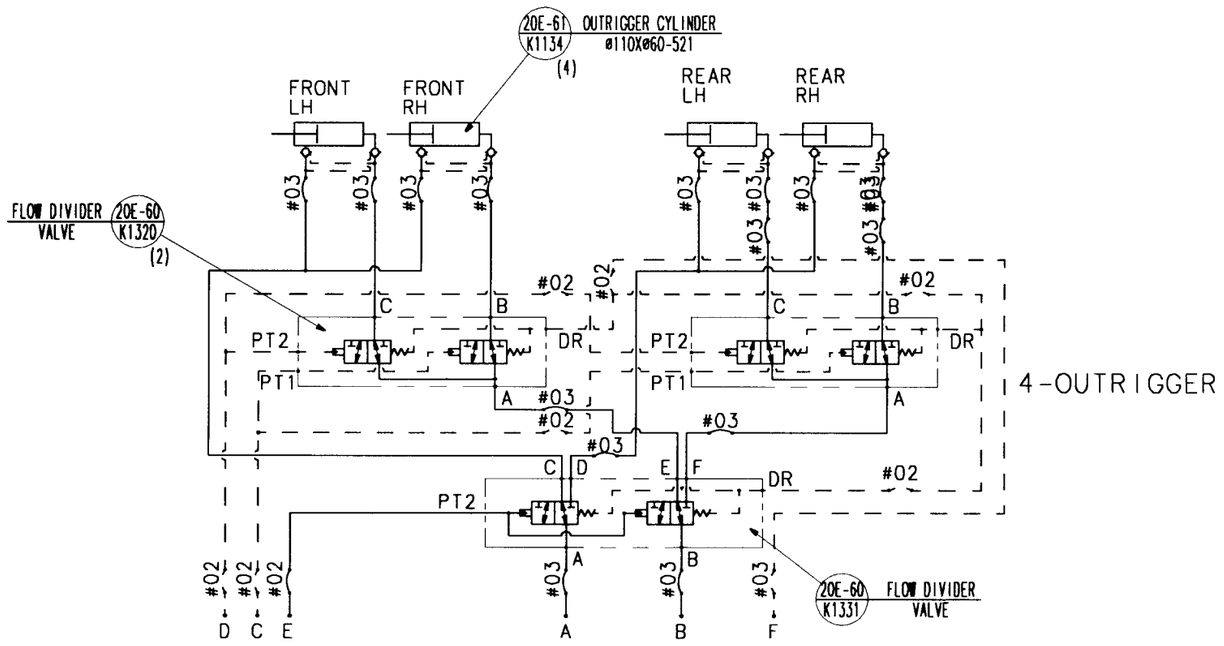
Specifications

Nominal displacement (normal operation):
195 cc/REV

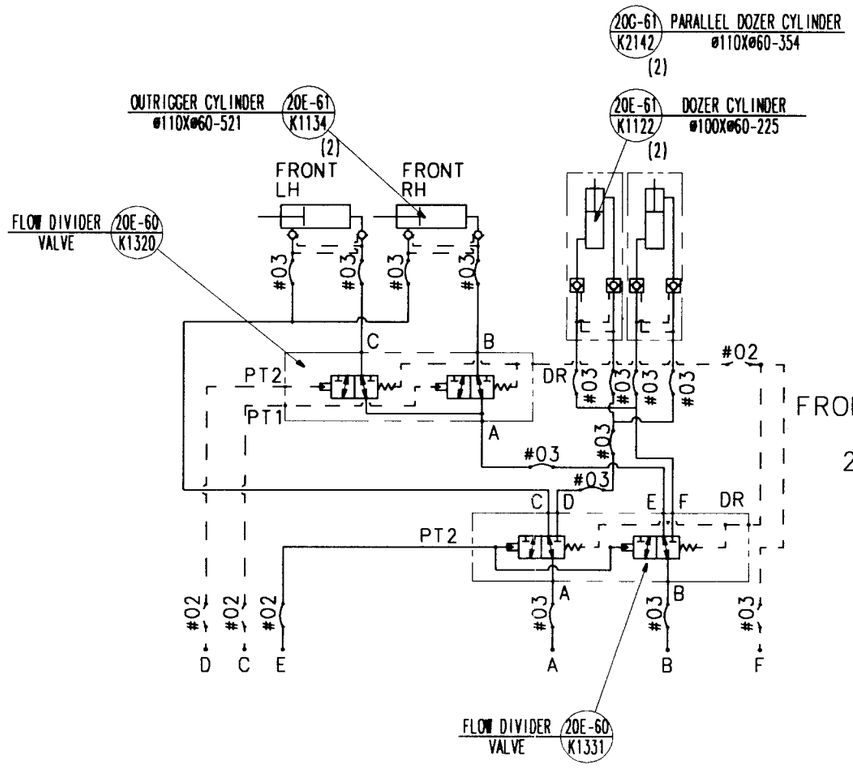
Nominal displacement (emergency operation):
70cc/REV

Relief valve setting:
150 +5 bar

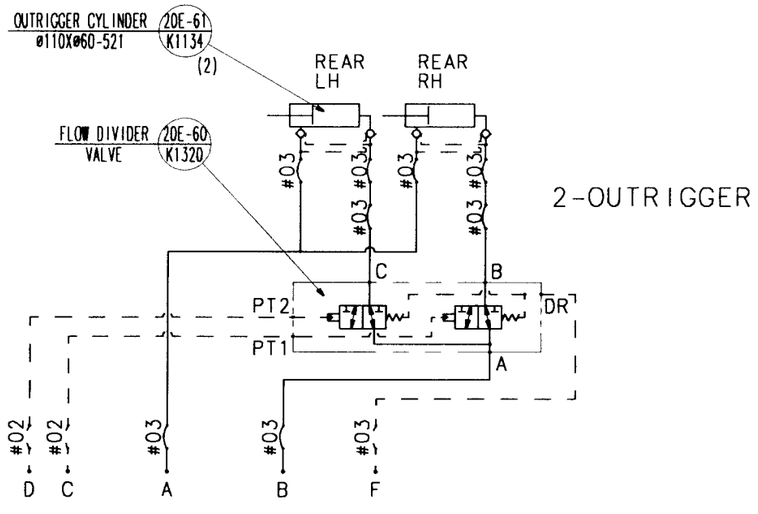

BREAKER / CLAMSHELL
LS PRESSURE CHECKING PORT
PUMP PRESSURE CHECKING PORT
MAIN VALVE
CA19
UNLOADING VALVE
SERVICE
SECOND BOOM
BUCKET
ARM
BOOM
TRAVEL
STABILIZER
SWING MOTION
SEPARATING VALVE
MAIN RELIEF VALVE
ADJUST CYLINDER
BUCKET CYLINDER
2PB BOOM CYLINDERS.
1PB BOOM CYLINDERS.
ARM CYLINDER
CLAMSHELL OPTION
BOOM SAFETY VALVE
OVER LOAD CAUTION
ORBITROLL VALVE
BRAKE VALVE
RIGHT SWING
LEFT SWING
SWING MOTOR
SWING MACHINERY
TRAVEL MOTOR
PPC MANIFOLD
(FORWARD)
(REVERSE)



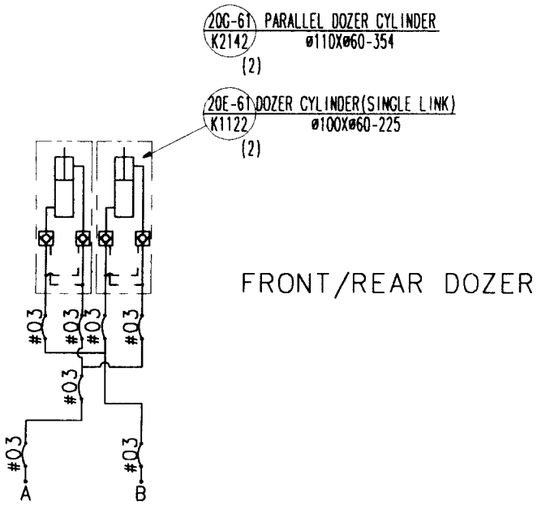
4-OUTRIGGER



FRONT/REAR DOZER
&
2-OUTRIGGER



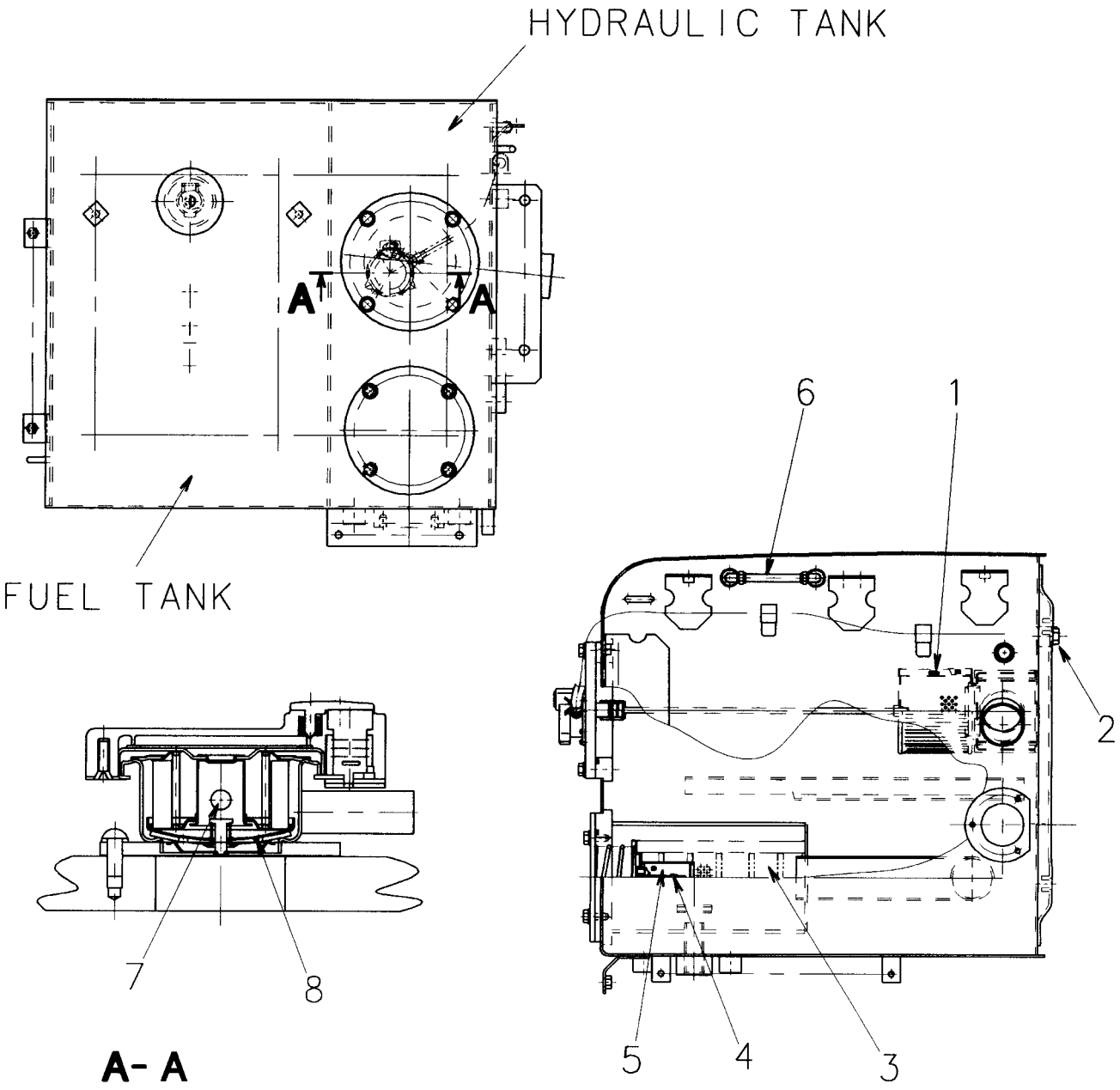
2-OUTRIGGER



FRONT/REAR DOZER

FUEL / HYDRAULIC TANK

K32001 and up



1. Suction strainer
2. Drain plug
3. Filter element
4. Bypass valve
5. Bypass strainer
6. Sight gauge
7. Vacuum valve
8. Pressure valve

Specifications

Fuel capacity: 246 *l*

Oil capacity: 145 *l*

Pressure valve cracking pressure:

38 ± 3.14.7 kPa (0.39 ± 0.15 kg/cm^2)

Vacuum valve cracking pressure:

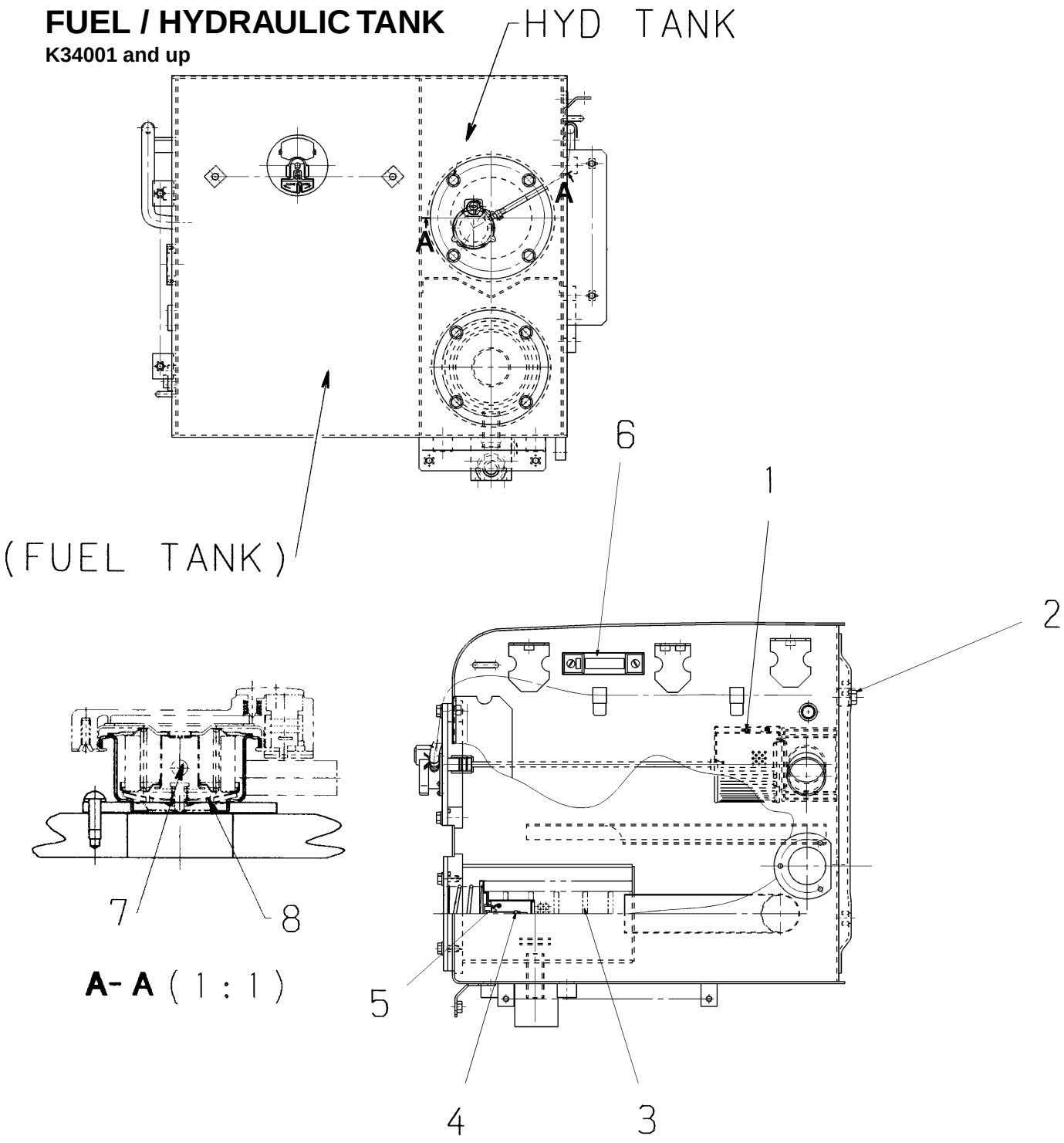
-4.5 - 0 Pa (-0.046 -0 kg/cm^2)

Bypass valve cracking pressure

1.05 ± 0.2 kg/cm^2

FUEL / HYDRAULIC TANK

K34001 and up



1. Suction strainer
2. Drain plug
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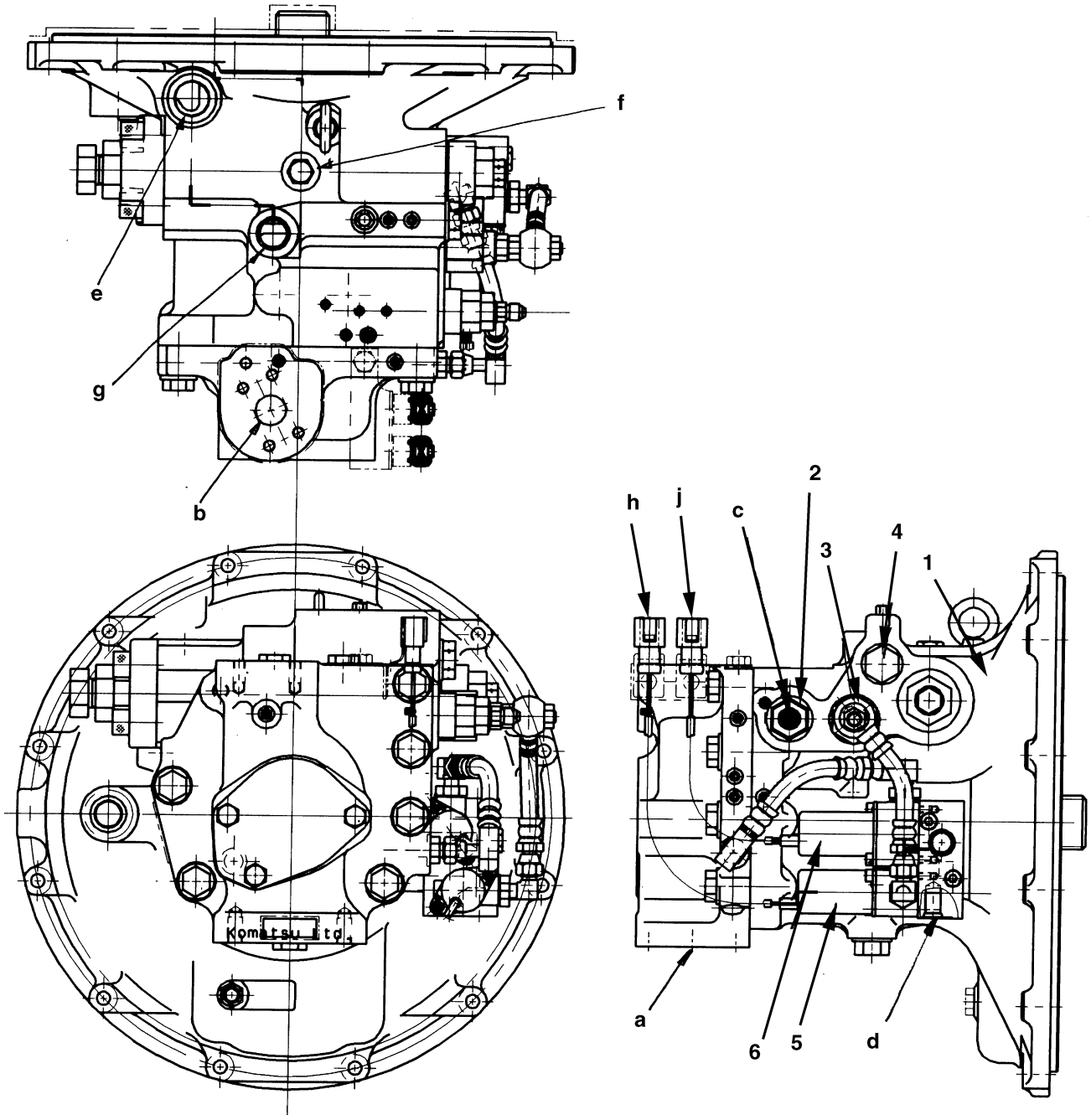
8. Pressure valve

Specifications

Fuel capacity: 246 *l*
Oil capacity: 145 *l*
Pressure valve cracking pressure:
38 ± 3.14.7 kPa (0.39 ± 0.15 kg/cm^2)
Vacuum valve cracking pressure:
-4.5 - 0 Pa (-0.046 -0 kg/cm^2)
Bypass valve cracking pressure
1.05 ± 0.2 kg/cm^2

HYDRAULIC PUMP

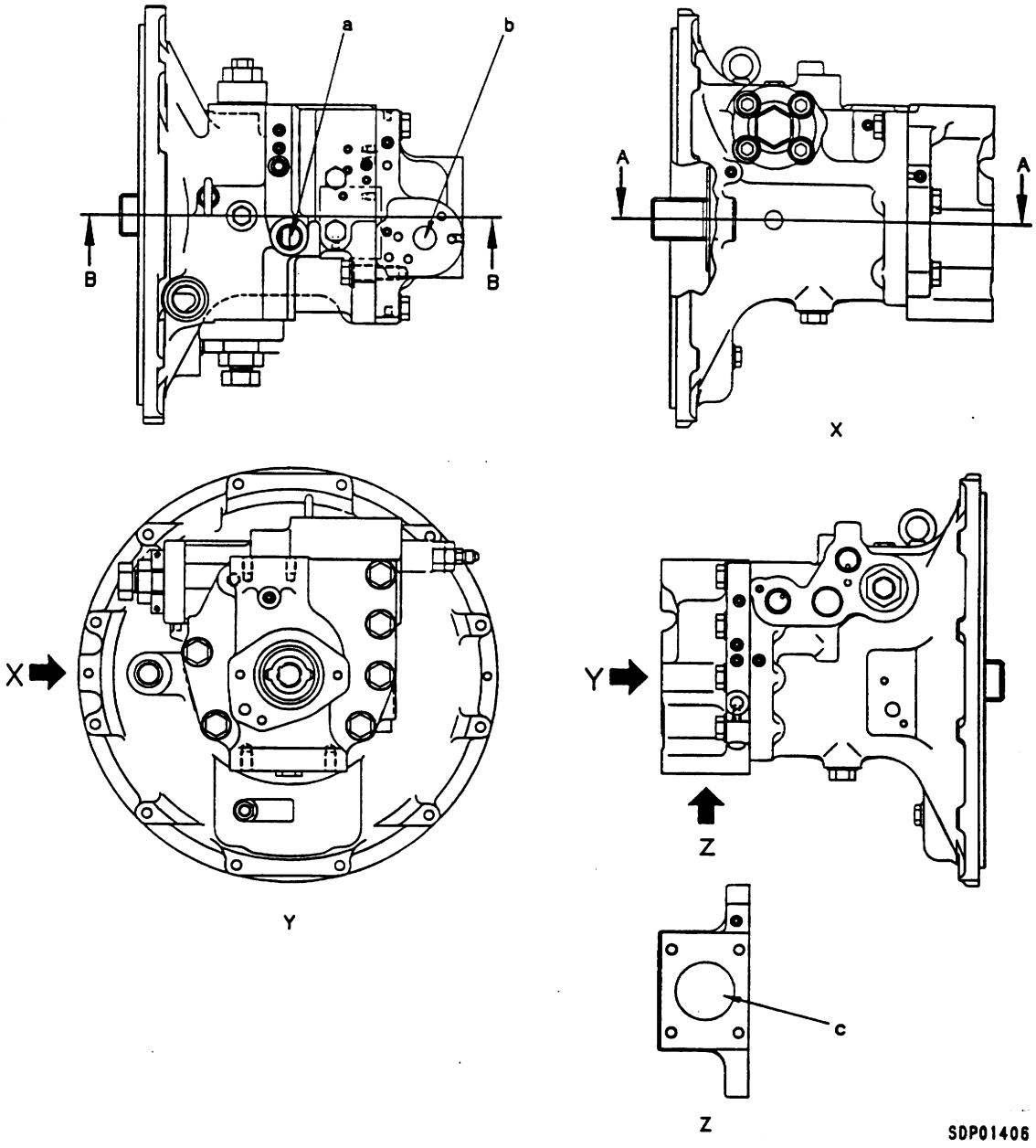


a. Port PS (suction)
b. Port PA (delivery)
c. Port PLS (load pressure input port)
d. Port PEPC (EPC basis pressure port)
e. Breather mounting port
f. Port Pd3 (Air bleeder plug)
g. Port Pd1 (case drain)
h. Port im (PC mode selector current)
j. Port isig (LS set selector current)

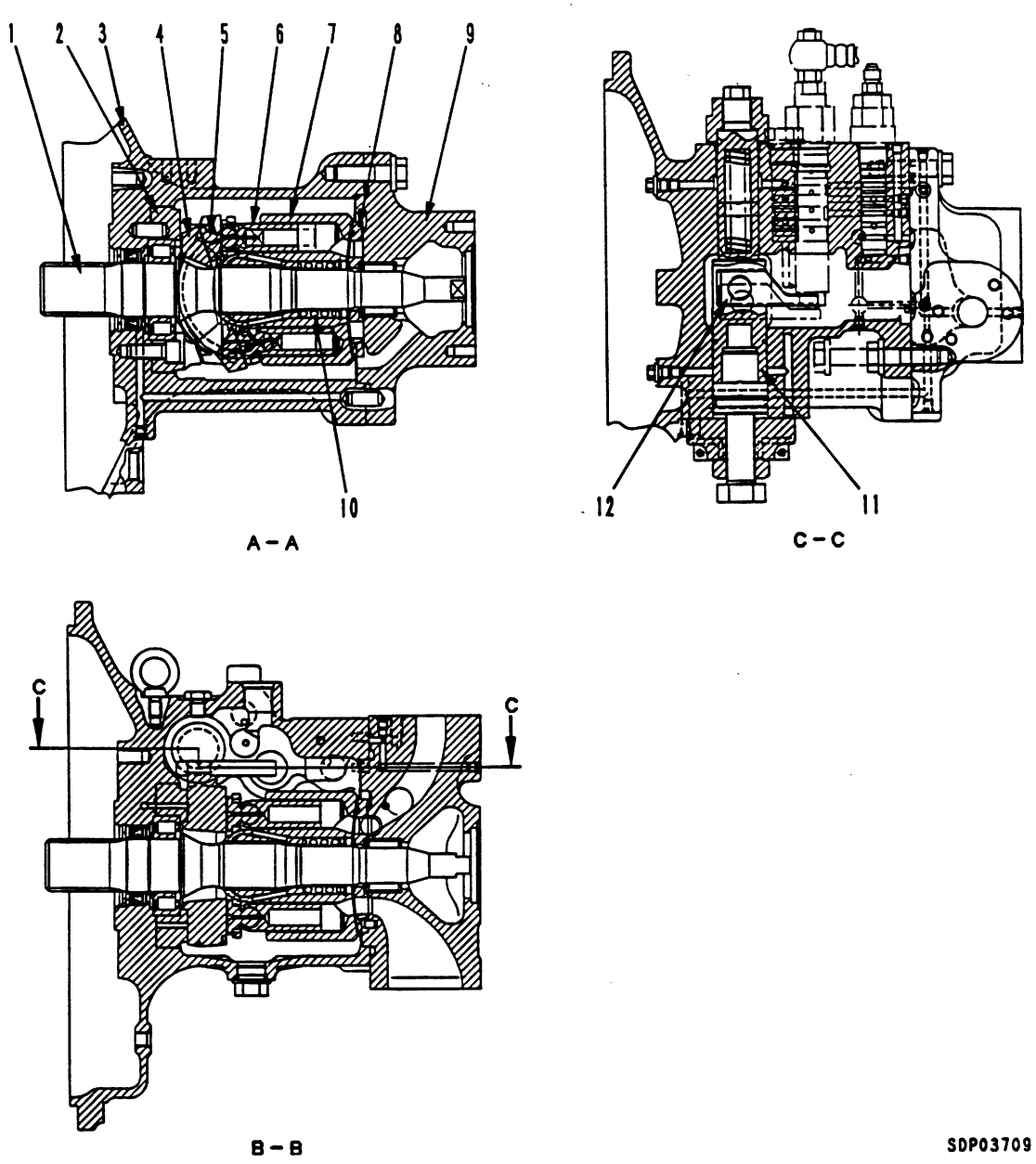
1. Main pump
2. LS valve
3. PC valve
4. Fixed throttle valve
5. PC-EPC valve (for PC mode selector)
6. LS-EPC valve (for LS set selector)

MAIN PUMP

HPV 105



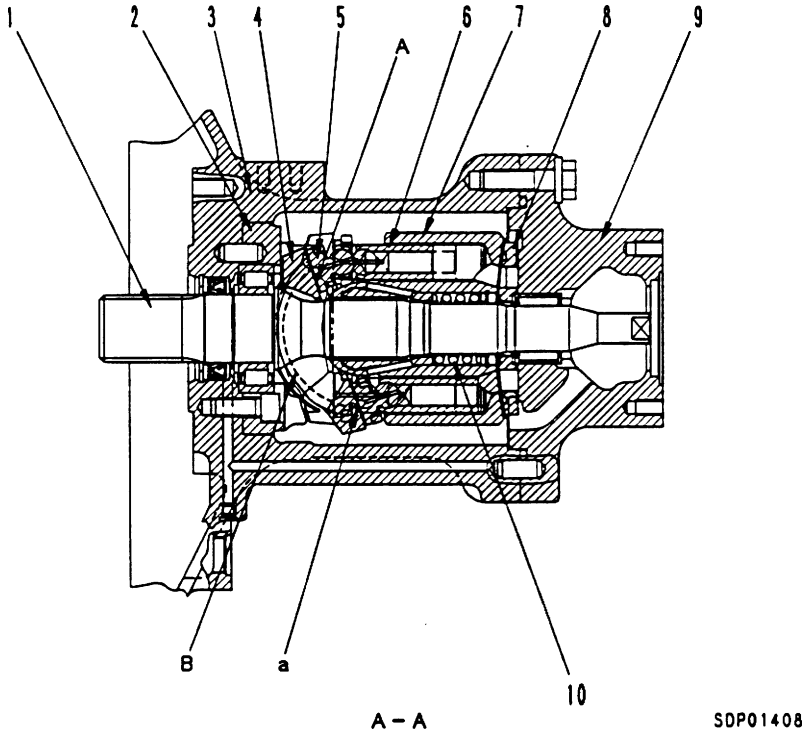
a. Port Pd (drain)
b. Port PA (discharge)
c. Port PS (suction)



1. Shaft
2. Cradle
3. Case
4. Rocker cam
5. Shoe
6. Piston
7. Cylinder block
8. Valve plate
9. End cap
10. Spring
11. Servo piston
12. Slider

Function

- The engine 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.



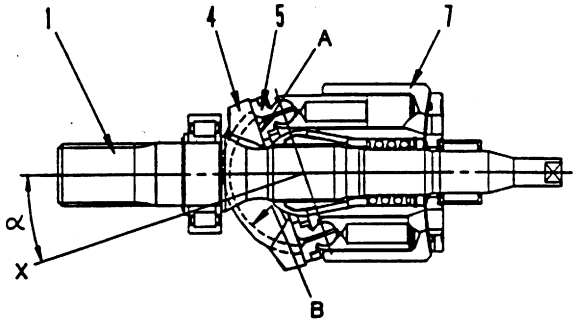
Structure

- Cylinder block (7) is supported to shaft (1) by spline a, 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 from one unit. Piston (6) and shoe (5) form a spherical bearing.
- Locker 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).
- Cylinder block (7) 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).

OPERATION

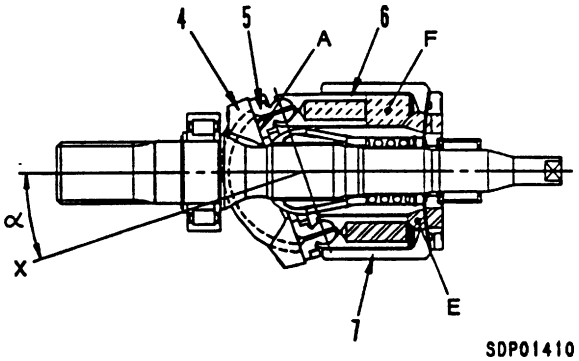
1. Operation of pump

1) 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 (between center liner **X** of rocker cam (4) and the axial direction of cylinder block (7) changes. (Angle (is called the swash plate angle.)



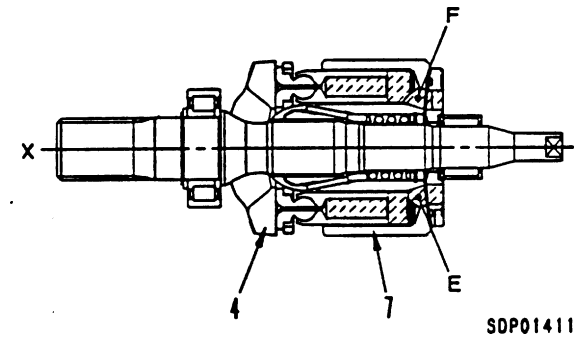
SDP01409

2) 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 carried out by 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, so in that stroke, the oil is sucked in.



SDP01410

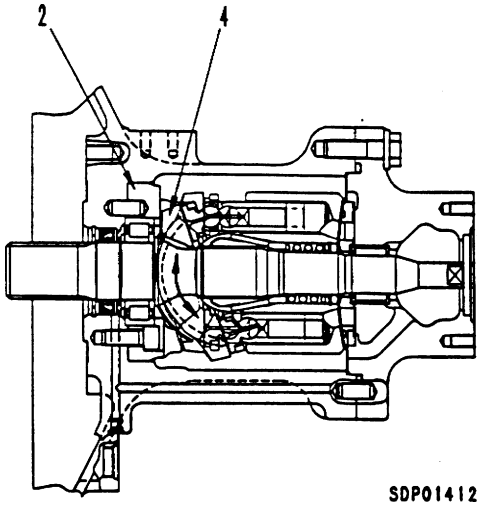
3) If center line **X** of rocker cam (4) is in line with the axial direction of cylinder block (7) (swash plate angle = 0), the difference between volumes **E** and **F** inside cylinder block (7) becomes 0, so the pump does not carry out any suction or discharge of oil. (In actual fact, the swash plate angle never becomes 0.)

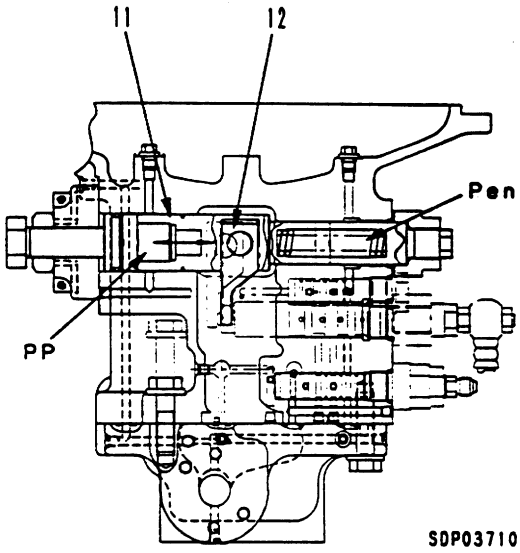


SDP01411

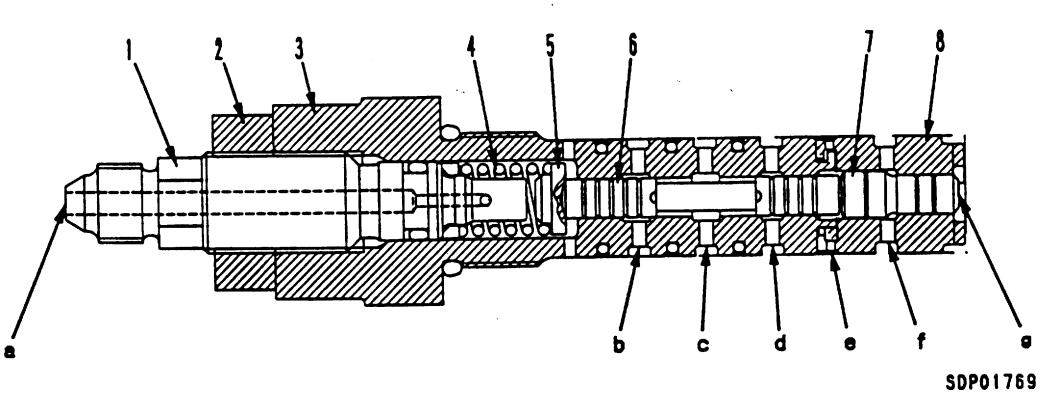
2) Control of discharge amount

- 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 (11).
- Servo piston (11) moves in a reciprocal movement ($\longleftrightarrow$) under the signal pressure of the PC and LS valves. This straight line movement is transmitted through rod (12) to rocker cam (4), and rocker cam (4), which is supported by the cylindrical surface to cradle (2), slides in a rotating movement in direction ($\longleftrightarrow$).
- With servo piston (11), the area receiving the pressure is different on the left and right, so main pump discharge pressure (self pressure) **PP** is always brought to the pressure chamber on the small diameter piston side (front).
  Output pressure **Pen** of the LS valve is brought to the pressure chamber at the large diameter piston end (rear). The relationship in the size of pressure **PP** at the small diameter piston end and pressure **Pen** at the large diameter piston end, and the ratio between the area receiving the pressure of the small diameter piston and the large diameter piston controls the movement of servo piston (11).





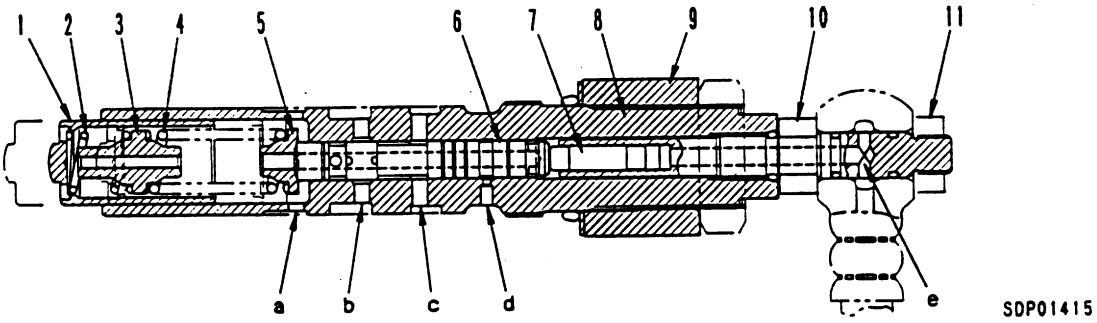
LS VALVE



a. Port **PLS** (Control valve LS pressure inlet port)
b. Port **PA** (Pump delivery pressure inlet port)
c. Port **PLP** (LS valve signal pressure outlet port)
d. Port **PPL** (PC valve signal pressure inlet port)
e. Port **Pa** (Drain pressure outlet port)
f. Port **PSIG** (LS control EPC valve pressure inlet port)
g. Port **PA** (Pump delivery pressure inlet port)

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

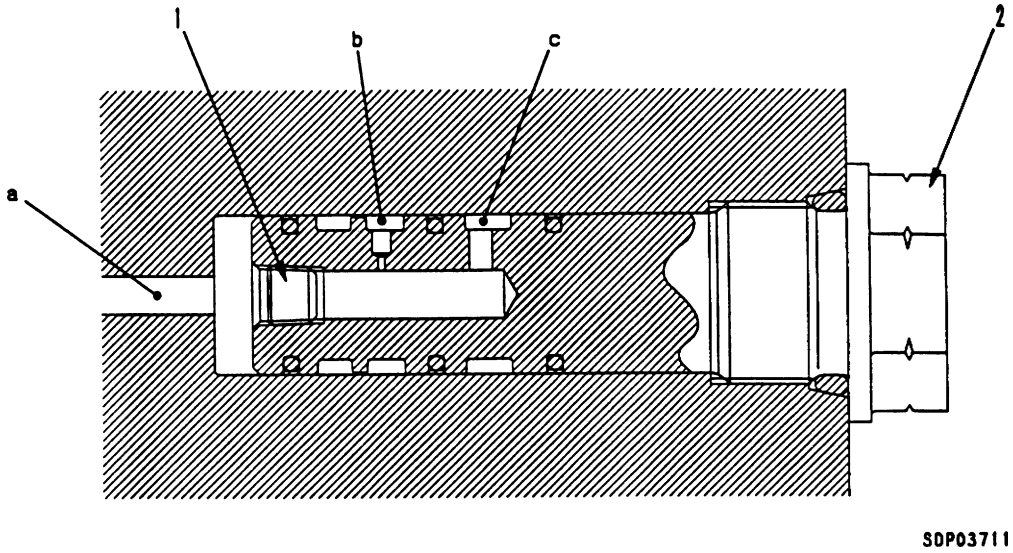
PC VALVE



a. Port **Pa** (Drain pressure outlet port)
b. Port **PPL** (PC valve signal pressure outlet port)
c. Port **PA** (Pump delivery pressure inlet port)
d. Port **PA2** (Pump delivery pressure inlet port)
e. Port **PM** (PC mode select pressure inlet port)

1. Piston
2. Spring
3. Seat
4. Spring
5. Seat
6. Spool
7. Piston
8. Sleeve
9. Locknut
10. Plug
11. Locknut

FIXED THROTTLE VALVE



a. Port **Pa** (drain pressure outlet port)
b. Port **Pout** (control pressure outlet port)
c. Port **Pin** (LS valve signal pressure inlet port)

1. Plug
2. Plug

FUNCTION

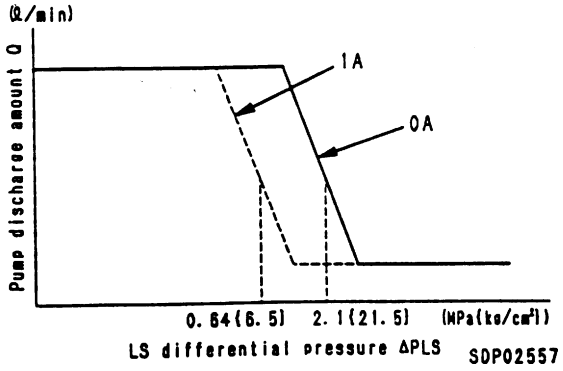
1. LS VALVE

The LS valve detects the load and controls the discharge amount.

This valve controls main pump discharge amount **Q** according to differential pressure △**PLS** (=**PP-PLS**) (the difference between main pump pressure **PP** and control valve outlet port pressure **PLS**) [called the LS differential pressure].

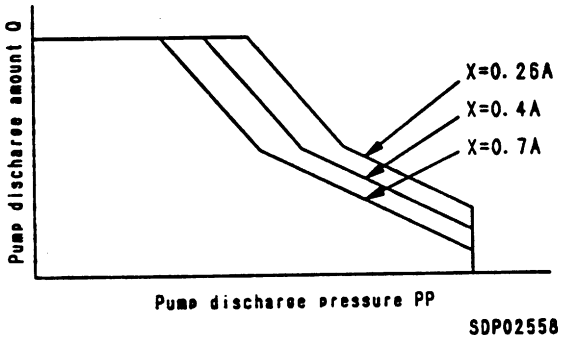
Main pump pressure **PP**, pressure **PLS** [called the LS pressure] coming from the control valve output, and pressure **PSIG** [called the LS selector pressure] from the LS-EPC valve enter this valve. The relationship between discharge amount **Q** and differential pressure △**PLS**, (the difference between main pump pressure **PP** and LS pressure **PLS**) (= PP-**PLS**) changes as shown in the diagram on the right according to LS selector current isig of the LS-EPC valve.

When isig changes between **0** and **1A**, the set pressure of the spring changes according to this, and the switching point for the pump discharge amount changes at the rated central value between 0.64 ⟷ 2.1 MPa {6.5 ⟷ 21.5 kg/cm^2).

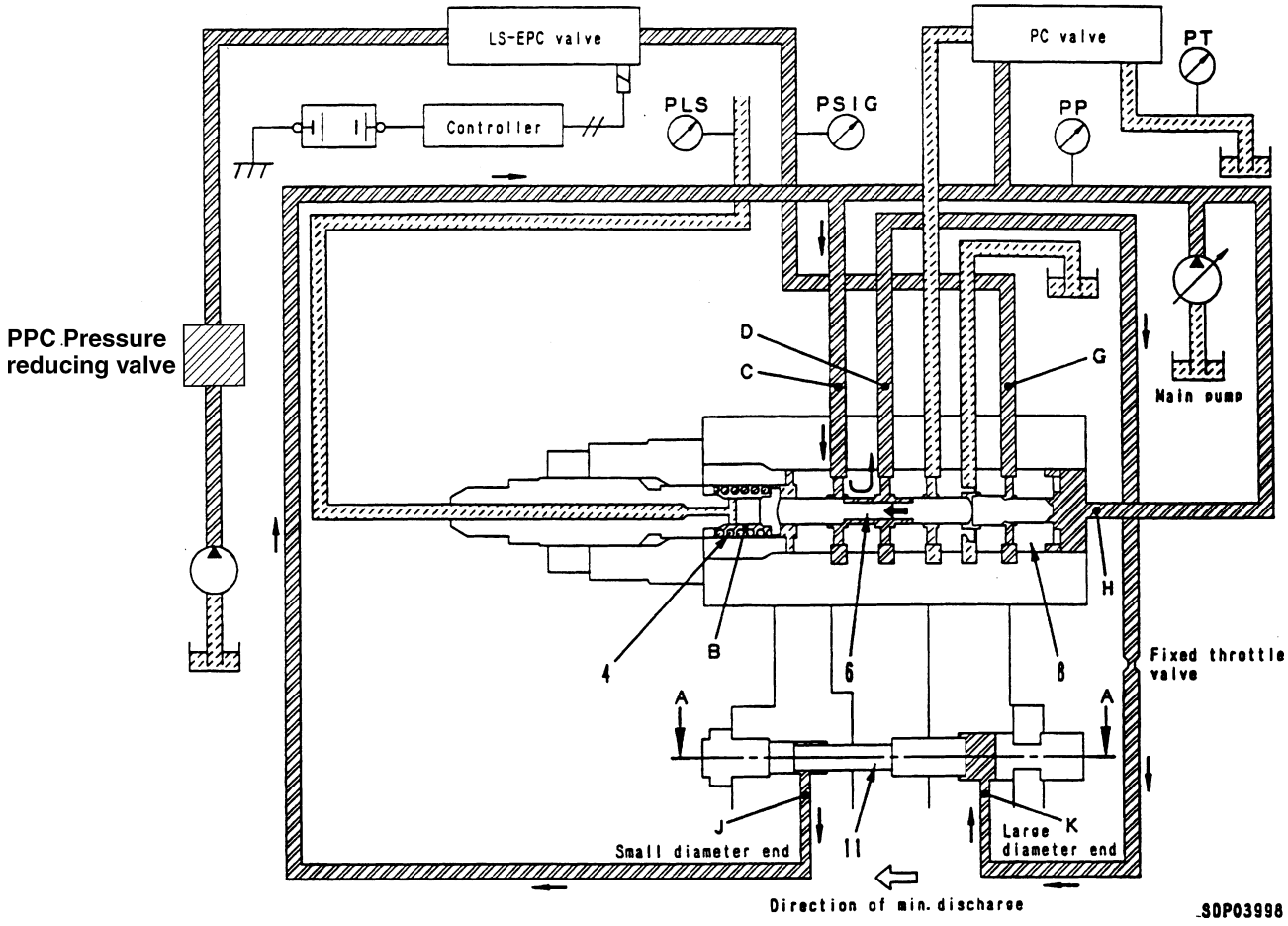


2. PC VALVE

When the pump discharge pressure **PP** is high, the PC 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 pump discharge pressure **PP** and pump discharge amount Q is shown in the diagram on the right, with the current given to the PC-EPC valve solenoid shown as a parameter. 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 because 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 current to the PC-EPC valve solenoid from the controller increases according to the drop in the engine speed to reduce the pump swash plate angle.



OPERATION

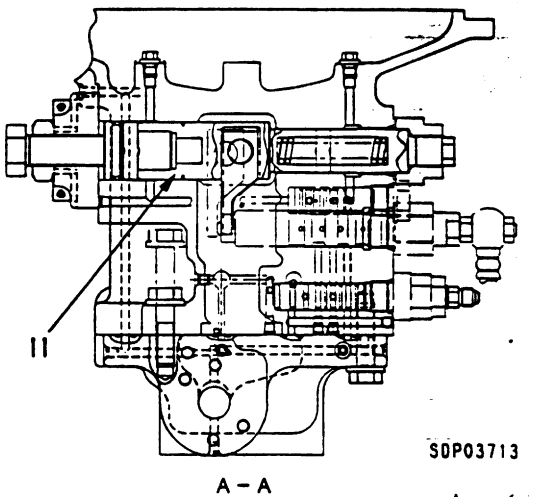


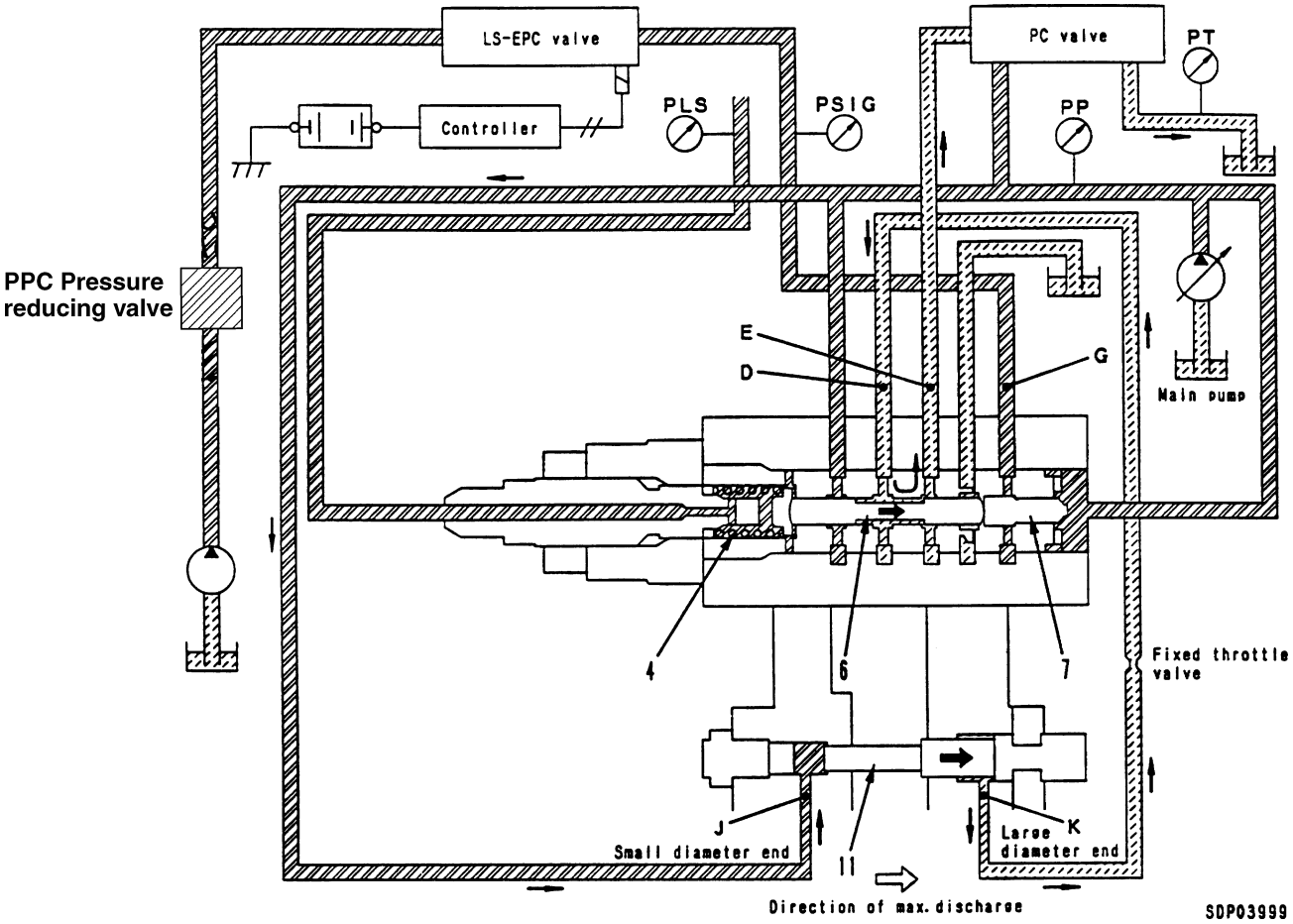
1. LS VALVE

1) When control valve is at neutral position

- The LS valve is a three-way selector valve. with pressure **PLS** (LS pressure) from the inlet port of the control valve brought to spring chamber **B**, and main pump discharge pressure **PP** brought to port **H** of sleeve (8).
  The size of the force produced by this LS pressure **PLS** + force **Z** of spring (4) and the main pump pressure (self-pressure) **PP** determines the position of spool (6). However, the size of the output pressure **PSIG** (the LS selection pressure) of the EPC valve for the LS valve entering port **G** also changes the position of spool (6). (The set pressure of the spring changes.)
- Before the engine is started, servo piston (11) is pushed to the right (large diameter end). (See the diagram on the right.)
- When the engine is started and the control lever is at the neutral position, LS pressure **PLS** is 0 MPa {0 kg/cm^2}. (It is interconnected with the drain circuit through the control valve spool.)

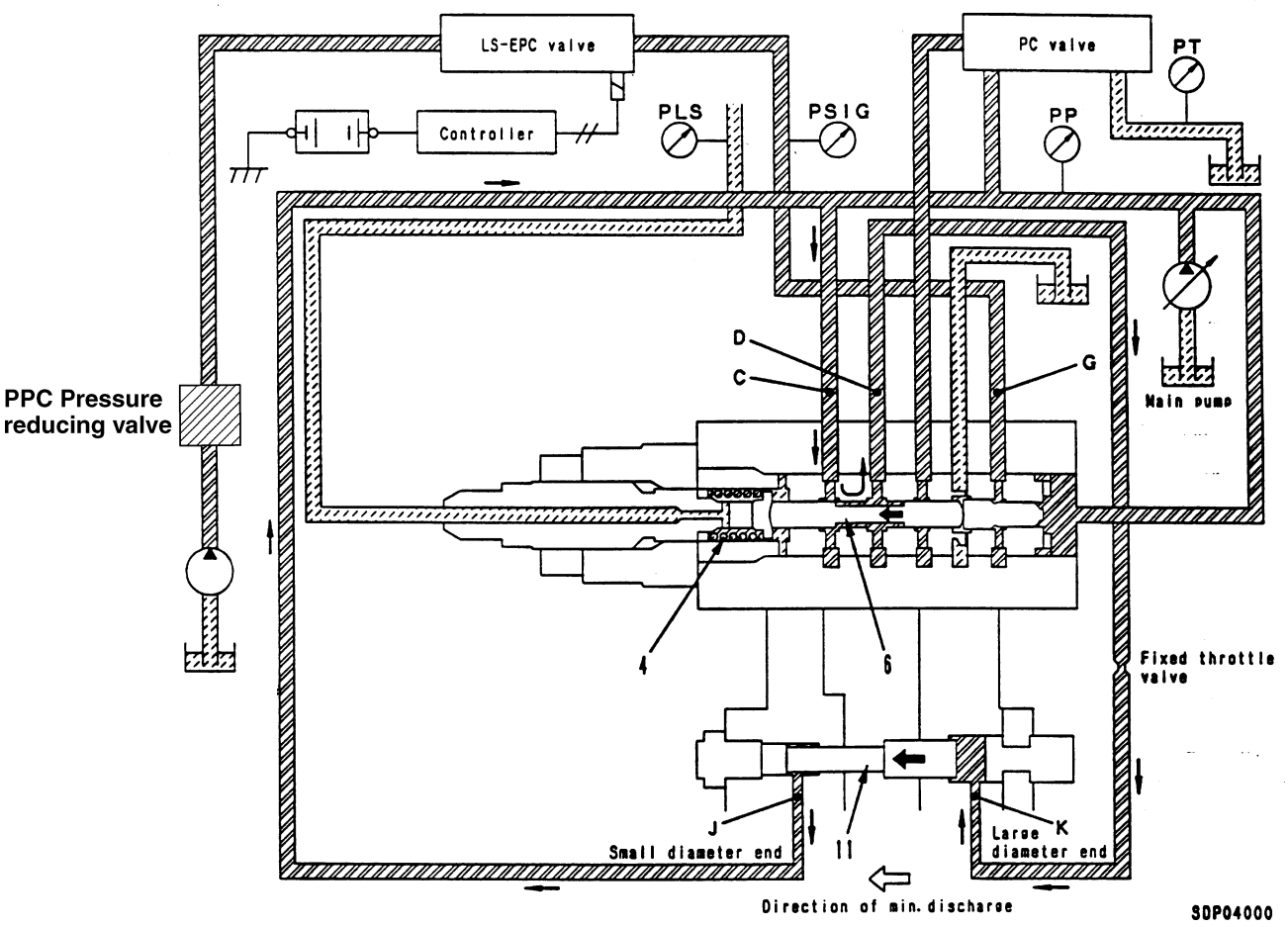
At this point, spool (6) is pushed to the left, and port **C** and port **D** are connected. Pump pressure **PP** enters the large diameter end of the piston from port **K**, and the same pump pressure **PP** also enters port **J** at the small diameter end of the piston, so the swash plate is moved to the minimum angle by the difference in area of piston (11).





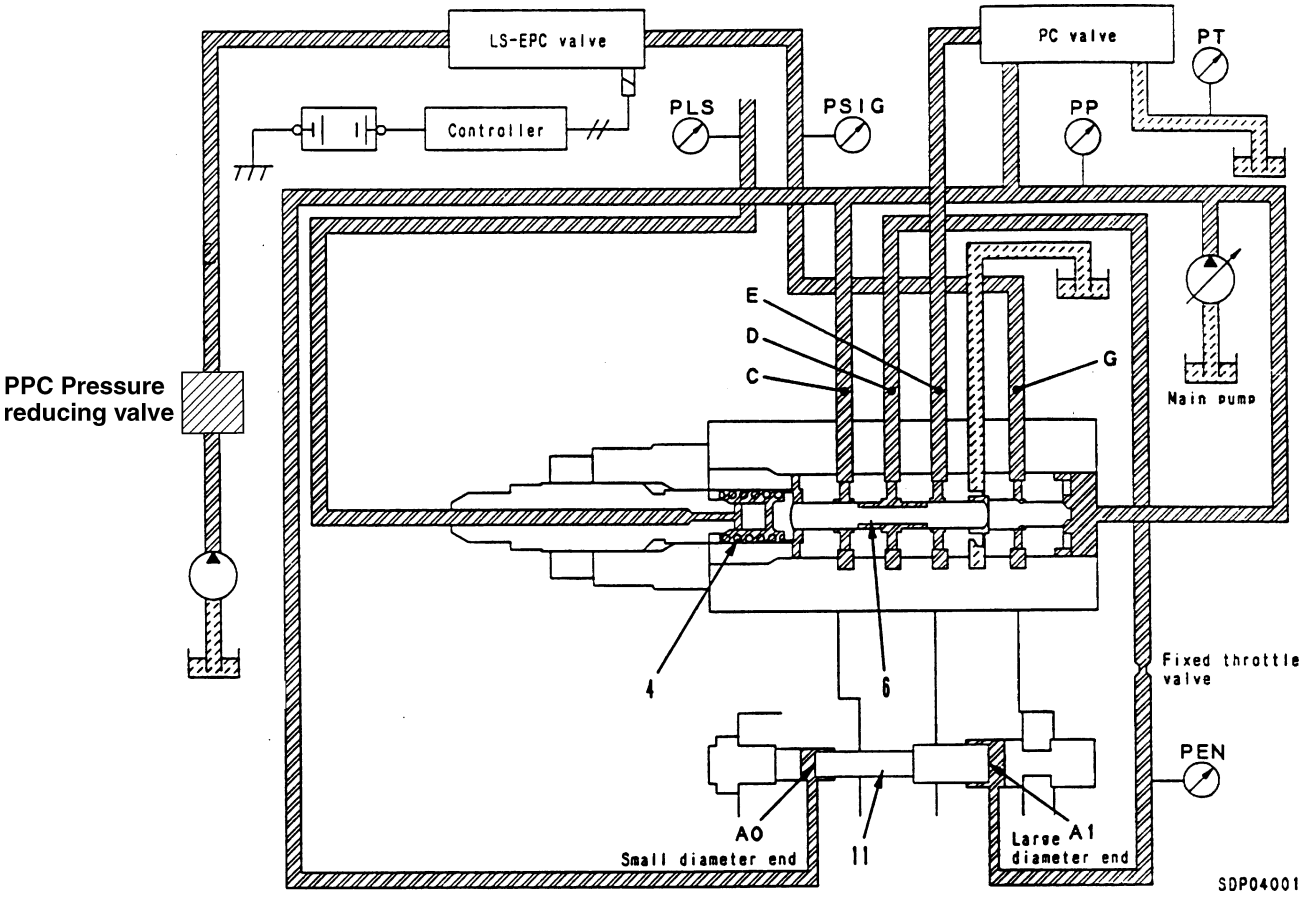
2) Operation in maximum direction for pump discharge amount

- When the difference between main pump pressure **PP** and LS pressure **PLS**, in other words, LS differential pressure △**PLS** becomes smaller (for example, when the area of opening of the control valve becomes larger and pump pressure **PP** drops), spool (6) is pushed to the right by the combined force of LS pressure **PLS** and the force of spring (4).
- When spool (6) moves, port **D** and port **E** are joined and connected to the PC valve. When this happens, the PC valve is connected to the drain port, so circuit **D** - **K** becomes drain pressure **PT**. (The operation of the PC valve is explained later.)
- For this reason, the pressure at the large diameter end of servo piston (11) becomes drain pressure **PT**, and pump pressure **PP** enters port **J** at the small diameter end, so servo piston (11) is pushed to the right. Therefore, the swash plate moves in the direction to make the discharge amount larger.
- If the output pressure of the EPC valve for the LS valve enters port **G**, this pressure creates a force to move piston (7) to the left. If piston (7) is pushed to the left, its acts to make the set pressure of spring (4) weaker, and the difference between hydraulic pressure **PLS** and **PP** changes when ports **D** and **E** of spool (6) are connected.



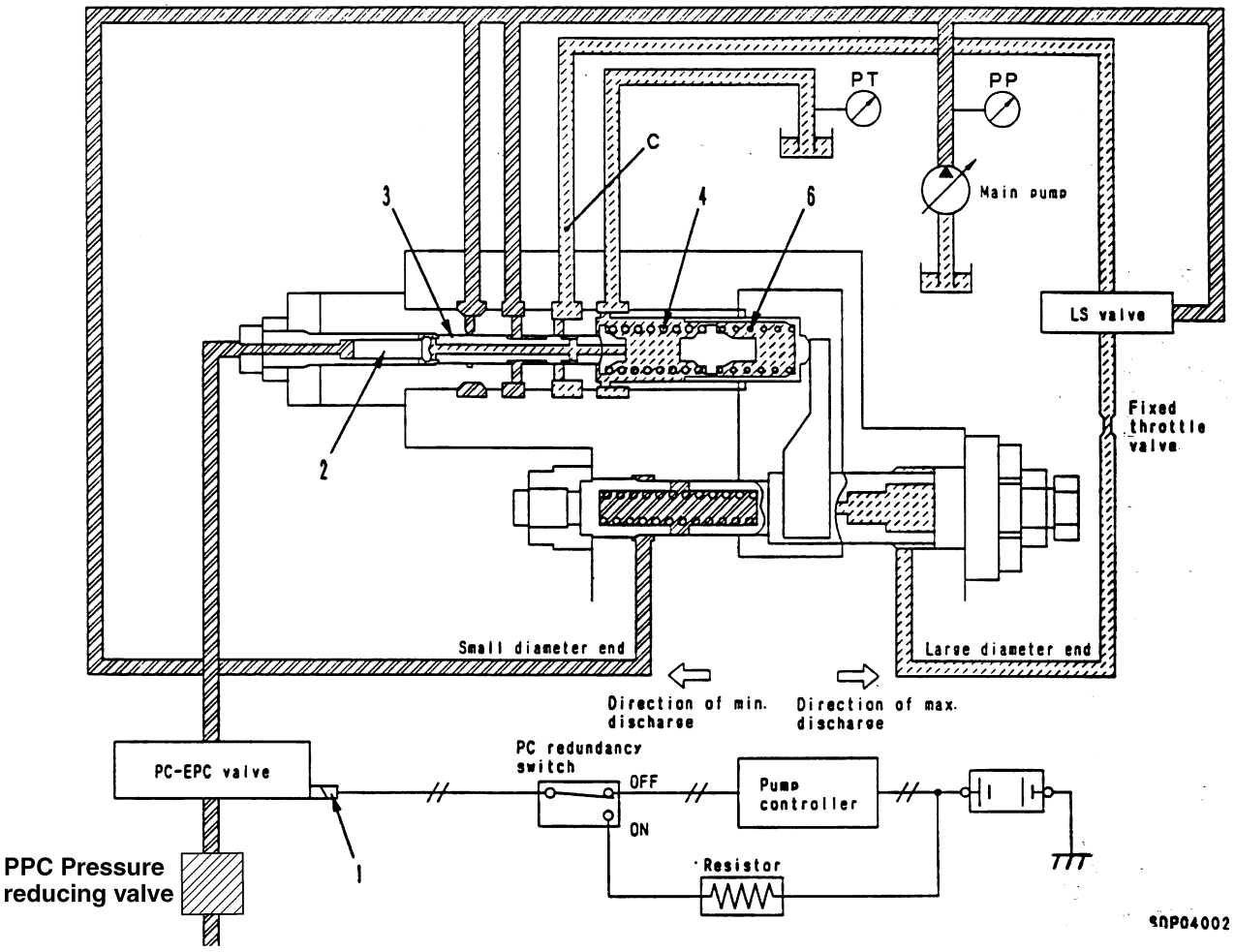
3) Operation in minimum direction for pump discharge amount

- The following explains the situation if servo piston (11) moves to the left (the discharge amount becomes smaller). When LS differential pressure △**PLS** becomes larger (for example, when the area of opening of the control valve becomes smaller and pump pressure **PP** rises), the force produced by pump pressure **PP** pushes spool (6) to the left.
- When spool (6) moves, main pump pressure **PP** flows from port **C** to port **D**, and it enters the large diameter end of the piston from port **K**.
- Main pump pressure **PP** also enters port **J** at the small diameter end of the piston, but because of the difference in area between the large diameter end and the small diameter end of servo piston (11), servo piston (11) is pushed to the left.
  As a result, the swash plate moves in the direction to make angle smaller.
- If LS selection pressure **PSIG** enters port G, it acts to make the set pressure of spring (4) weaker.



4) When servo piston is balanced

- Let us take the area receiving the pressure at the large diameter end of the piston as **A1**, the area receiving the pressure at the small diameter end as **A0**, and the pressure flowing into the large diameter end of the piston as Pen. If main pump pressure **PP** of the LS valve and the combined force of force **Z** of spring (4) and LS pressure **PLS** are balanced, and the relationship is **A0** x **PP** = **A1** x **Pen**, servo piston (11) will stop in that position, and the swash plate will be kept at an intermediate position. (It will stop at a position where the openings of the throttle from port **D** to port **E** and from port **C** to port **D** of spool (6) are approximately the same.)
- At this point, the relationship between the area receiving the pressure at both ends of piston (11) is **A0** : **A1** = 1 : 2, so the pressure applied to both ends of the piston when it is balanced becomes **PP** : **Pen** = 1.75 : 1.
- The position where spool (6) is balanced and stopped is the standard center, and the force of spring (4) is adjusted so that it is determined when **PP**-**PLS** = 2.1 MPa {21.5 kg/cm^2}. However, if PSIG (the output pressure of 0 $\longleftrightarrow$ 2.9 MPa {0 $\longleftrightarrow$ 30 kg/cm^2} of the EPC valve of the LS valve) is applied to port **G**, the balance stop position will change in proportion to pressure PSIG between **PP**-**PLS** = 2.1 $\longleftrightarrow$ 0.64 MPa {21.5 $\longleftrightarrow$ 6.5 kg/cm^2}.



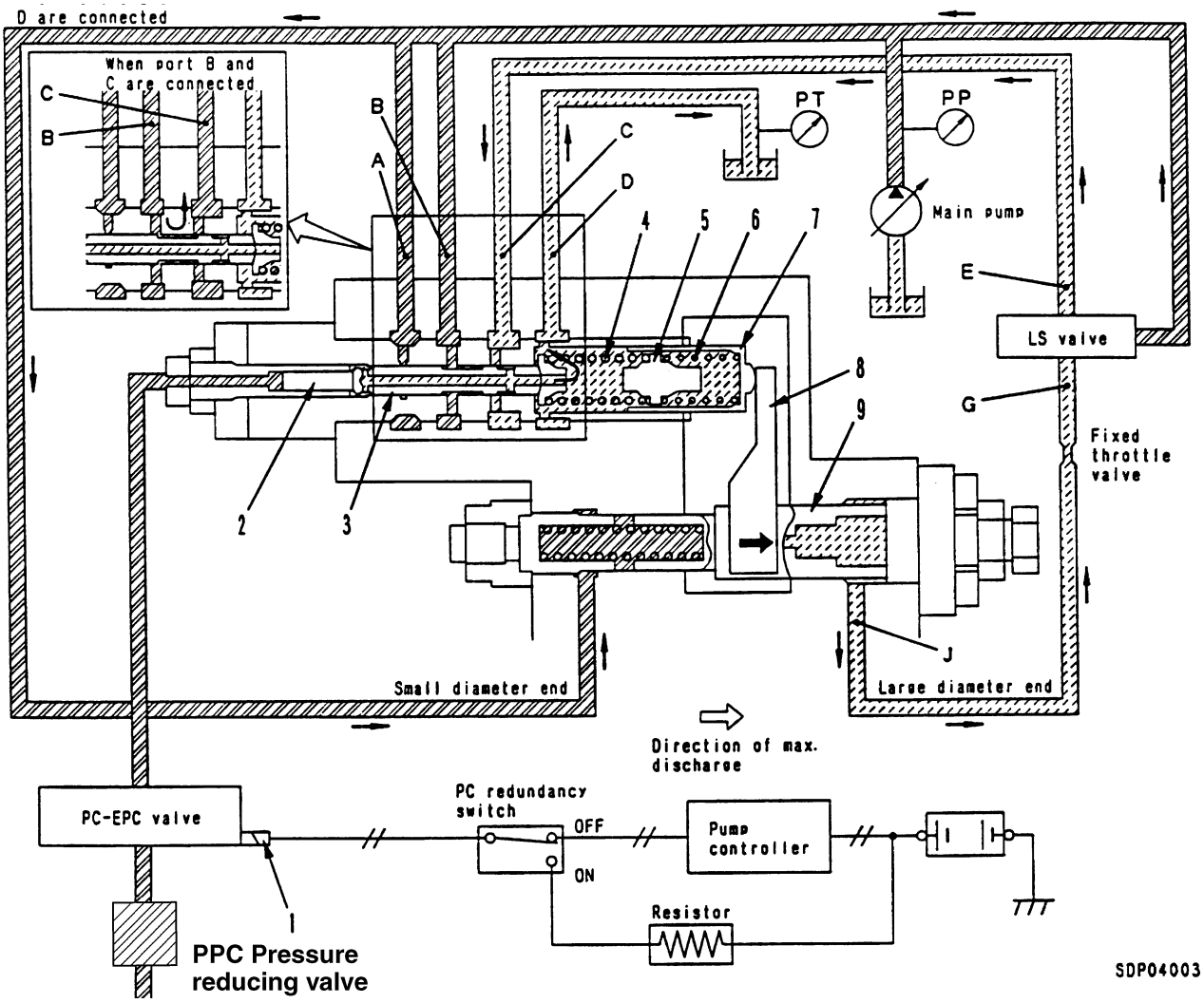
2. PC VALVE

1) When pump controller is normal

a. When the load on the actuator is small and pump pressure PP is low

(1) Action of PC-EPC solenoid (1)

- The command current from the pump controller flows to PC-EPC solenoid (1).
  This command current acts on the PC-EPC valve and outputs the signal pressure. When this signal pressure is received. the force pushing piston (2) is changed.
- On the opposite side to this force pushing piston (2) is the spring set pressures of springs (4) and (6) and pump pressure **PP** pushing spool (3). Spool (3) stops at a position where the combined force pushing spool (3) is balanced, and the pressure (pressure of port **C**) output from the PC 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.

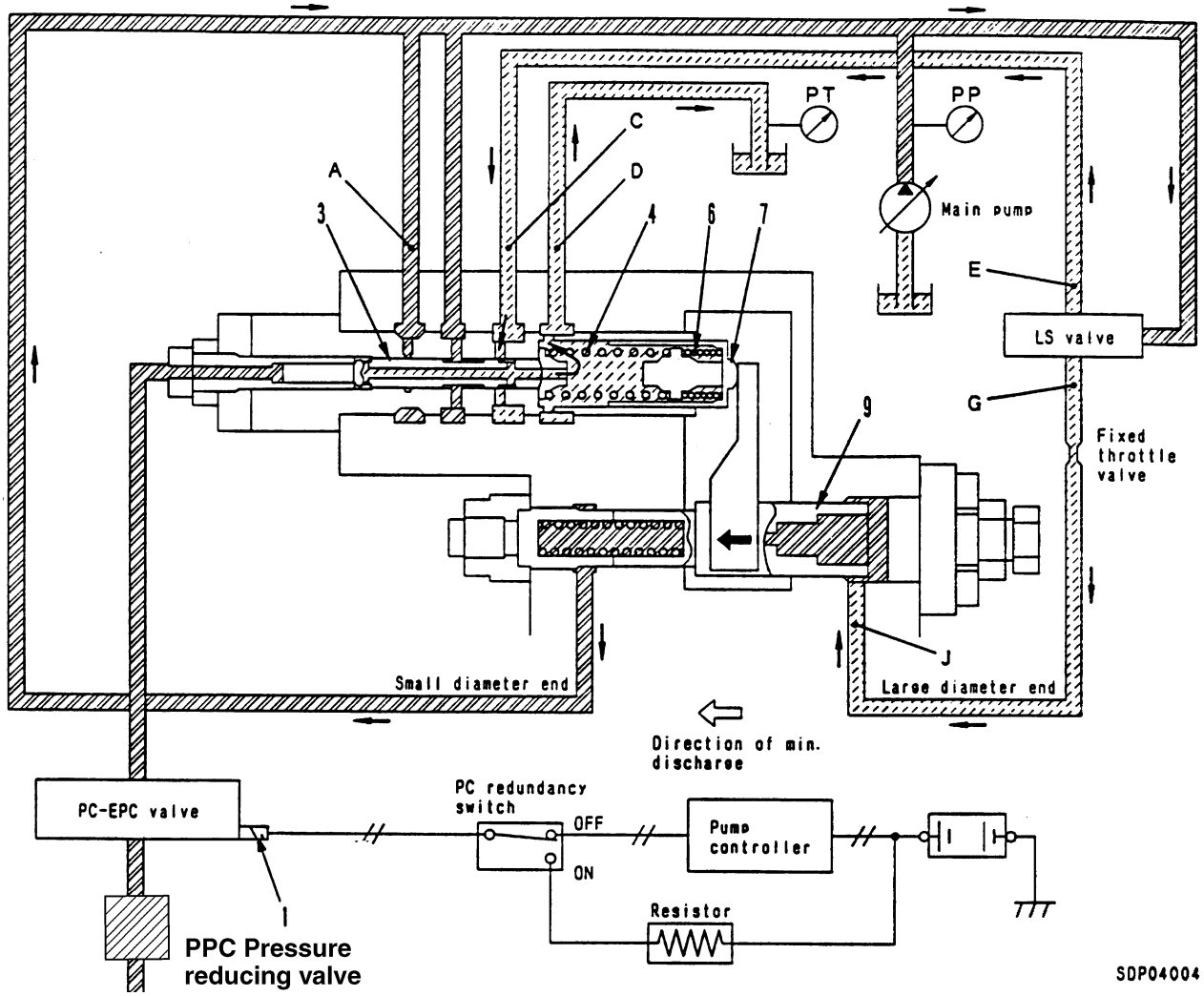


(2) Action of spring

- The spring load of springs (4) and (6) in the PC valve is determined by the swash plate position.
- When servo piston (9) moves, piston (7), which is connected to slider (8), also moves to the right or left.
- If piston (7) moves to the left, spring (6) is compressed, and if it moves further to the left, spring (6) contacts seat (5) and is fixed in position. From this point, only spring (4) is actuated. In other words, the spring load is changed by piston (7) extending or compressing springs (4) and (6).
- If the command current input to PC-EPC valve solenoid (1) changes further, the force pushing piston (2) changes. The spring load of springs (4) and (6) also changes according to the value of the PC-EPC valve solenoid command current.
- Port **C** of the PC valve is connected to port **E** of the LS valve (see (1) LS valve).
  Self-pressure **PP** enters port B, the small diameter end of servo piston (9) and port A.

- When pump pressure **PP** is small, spool (3) is on the left. At this point, port **C** and port **D** are connected, and the pressure entering the LS valve becomes drain pressure **PT**. If port E and port **G** of the LS valve are connected (see (1) LS valve), the pressure entering the large diameter end of the piston from port **J** 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 (7) is moved to the right by slider (8). Springs (4) and (6) expand and the spring force becomes weaker. When spring force becomes weaker, spool (3) moves to the right, so the connection between port **C** and port **D** is cut, and the pump discharge pressure ports **B** and **C** are connected. As a result, the pressure at port **C** rises, and the pressure at the large diameter end of the piston also rises, so the movement of piston (9) to the right is stopped.

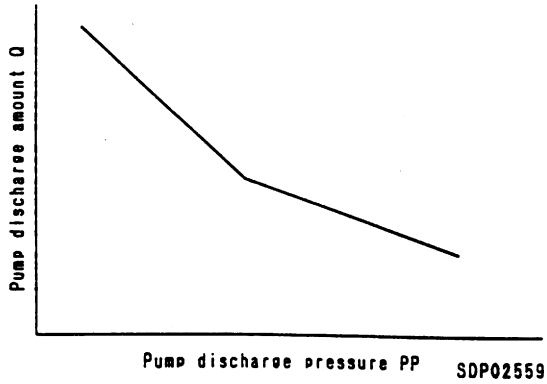
In other words, the stop position for piston (9) (= pump discharge amount) is decided at the point where the force of springs (4) and (6) and the pushing force from the PC-EPC valve solenoid and the pushing force created by pressure PP acting on spool (3) are in balance.



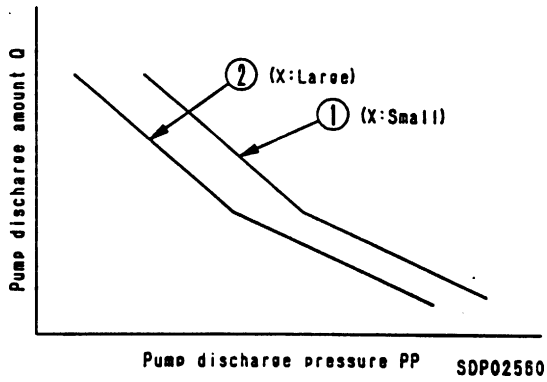
b. When load on actuator is large and pump discharge pressure is high

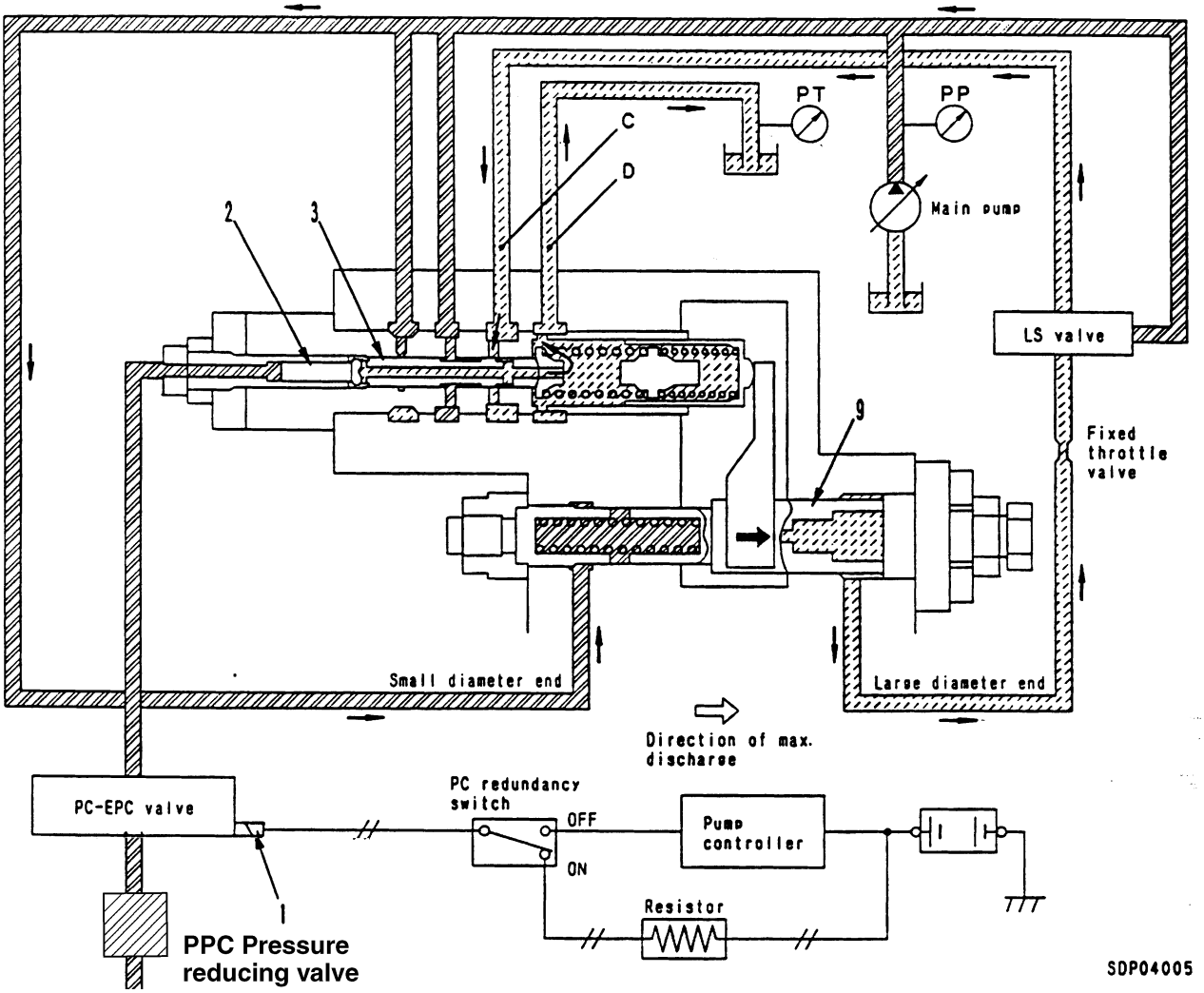
- When the load is large and pump discharge pressure **PP** is high, the force pushing spool (3) to the left becomes larger and spool (3) moves to the position shown in the diagram above.
  When this happens, as shown in the diagram above, part of the pressurized oil from port **A** passes through the LS valve, flows out from port **C** to port **D**, and the pressurized oil flowing from port **C** to the LS valve becomes approximately 3/5 of main pump pressure **PP**.
- When port **E** and port **G** of the LS valve are connected (see (1) LS valve), the pressure from port **J** enters the large diameter end of servo piston (9), and servo piston (9) stops.
- If main pump pressure **PP** increases further and spool (3) moves further to the left, main pump pressure **PP** flows to port **C** and acts to make the discharge amount the minimum. When piston (9) moves to the left, piston (7) is moved to the left. For this reason, springs (4) and (6) are compressed and push back spool (3).
  When spool (3) moves to the left, the opening of port **C** and port **D** becomes larger. As a result, the pressure at port **C** (= **J**) drops, and piston (9) stops moving to the left. The position in which piston (9) stops when this happens is further to the left than the position when pump pressure **PP** is low.

- The relation of pump pressure **PP** and the position of servo piston (9) forms a bent line because of the double-spring effect of springs (6) and (4). The relationship between pump pressure **PP** 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 pressure **PP** and pump discharge amount **Q** is proportional to the pushing force of the PC-EPC valve of output pressure. In other words, if the pushing force of output pressure is added to the force pushing to the left because of the pump pressure applied to the piston (2), the relationship between **PP** and **Q** moves from ① to ② in accordance with the increase.

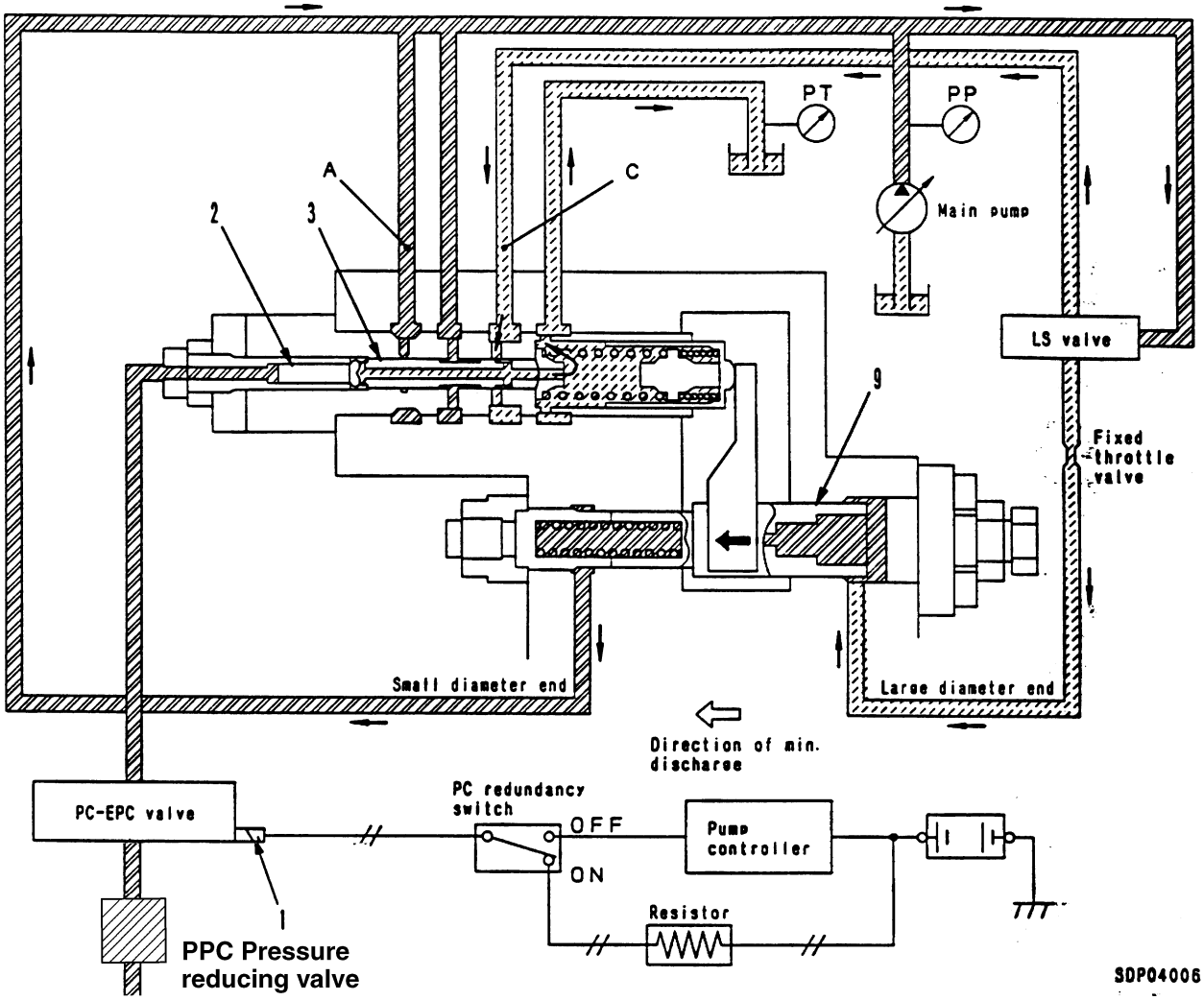




2) When pump controller is abnormal and PC prolix switch in ON

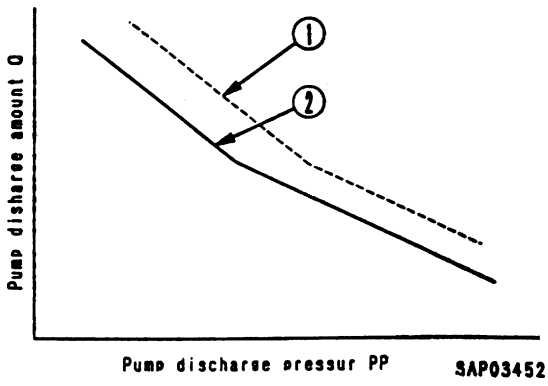
a. When load on main pump is light

- If there is a failure in the pump controller, turn PC 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 too large, so the resistor is used to control the current flowing to PC-EPC valve solenoid (1).
- When this is done, the current becomes constant, so the force pushing piston (2) is also constant.
- If main pump pressure **PP** is low, the combined force of the pump pressure and the force of PC-EPC valve solenoid (1) is weaker than the spring set force, so spool (3) is balanced at a position to the left.
- At this point, port **C** is connected to the drain pressure of port **D**, and the large diameter end of the piston of servo piston (9) also becomes the drain pressure **PT** through the LS valve. When this happens, the pressure at the small diameter end of the piston is large, so servo piston (9) moves in the direction to make the discharge amount larger.

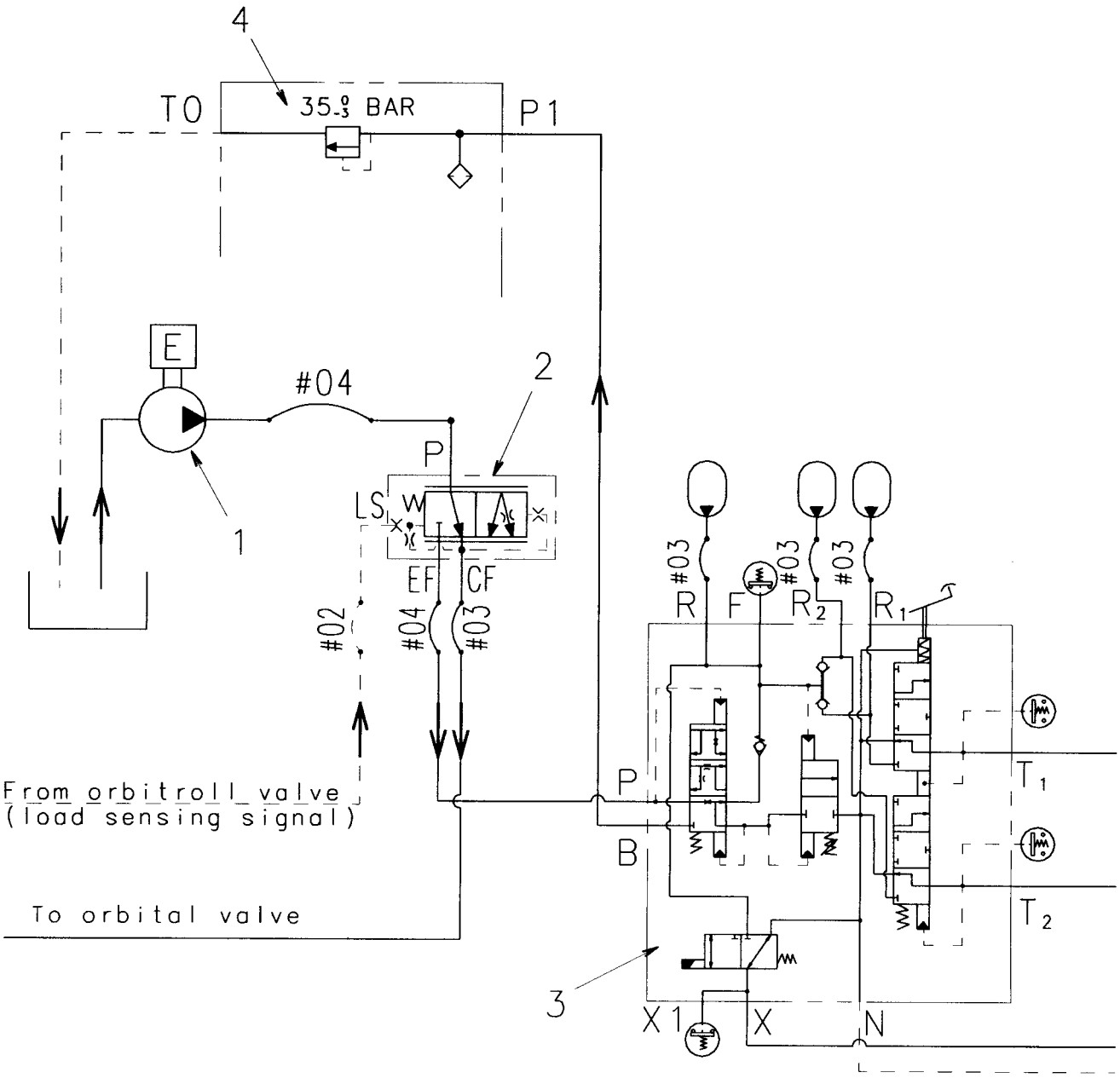


b. When main pump load is heavy

- In the same way as in the previous item, when the PC prolix switch is ON, the command current sent to PC-EPC valve solenoid (1) becomes constant. For this reason, the force of piston (2) pushing spool (3) is constant.
- If main pump pressure **PP** increases, spool (3) moves further to the left than when the main pump load is light, and is balanced at the position in the diagram above.
- In this case, the pressure from port **A** 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, and stops at a position to the left of the position when the load on the pump is light. In other words, even when the PC prolix switch is ON, the curve for the pump pressure **PP** and discharge amount **Q** is determined as shown in the diagram for the value of the current sent to the PC-EPC valve solenoid through the resistor. The curve when the PC prolix switch is ON is curve ②, which is to the left of curve ① for when the pump controller is normal.



PPC PUMPLESS SYSTEM



1. Gear pump
2. Steering/braking priority valve
3. Power brake valve
4. Pressure reducing valve

FUNCTION

The PPC pumpless system discharged pressurized oil to operate the PPC circuit and solenoid valve assemblies.

OPERATION

The PPC pumpless system utilizes the return line oil from the power brake valve. Oil is supplied to the steering/braking circuits from a gear pump driven by the engine. Oil flow is prioritized to the steering circuit via the priority valve with the remaining oil flow feeding the power brake valve.
The return line from the brake valve passes through a pressure reducing valve where the oil pressure is maintained at 35^{0}_{-3} bar. This pressure is utilized to charge the PPC circuit.

CONTROL VALVE

OUTLINE

The following control valve is standard:
- 8-spool valve (includes 2 service valves)

The cross sections shown are for the 6-spool valve (sub assembly)

★ The cross-sectional structure of the service valve is the same as the structure for the bucket valve, so refer to the bucket valve for details.

General locations and names of ports (common for each external view diagram)

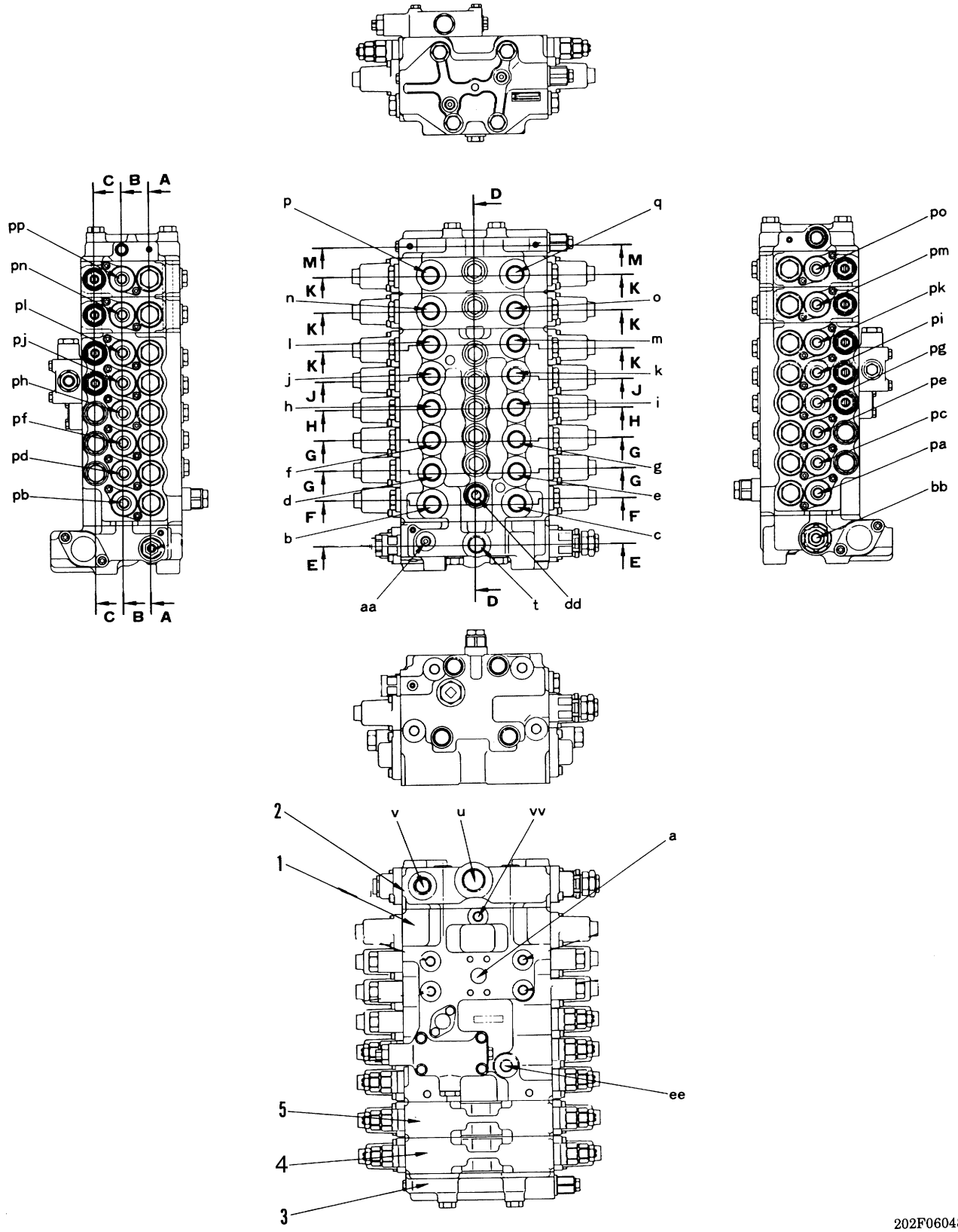
1. 6- spool valve sub assembly
2. Cover A (main relief valve)
3. Cover B (unload valve)
4. No. 1 service valve
5. No. 2 service valve

a. Port **PP** (from main pump)
b. Port **A1** (to swing motor MB)
c. Port **B1** (to swing motor MA)
d. Port **A2** (to stabilizer cylinder head)
e. Port **B2** (to stabilizer cylinder bottom)
f. Port **A3** (to travel motor A)
g. Port **B3** (to travel motor B)
h. Port **A4** (to boom lift cylinder bottom)
i. Port **B4** (to boom adjust cylinder head)
j. Port **A5** (to arm cylinder head)
k. Port **B5** (to arm cylinder bottom)
l. Port **A6** (to bucket cylinder head)
m. Port **B6** (to bucket cylinder bottom)
n. Port **A7** (to boom adjust cylinder bottom)
o. Port **B7** (to boom adjust cylinder head)
p. Port **A8** (to attachment)
q. Port **B8** (to attachment)
t. Port **Tsw** (to swing motor)
u. Port **Tc** (to oil cooler)
v. Port **Tb** (to tank)

aa. Port **P_{LS1}** (to pump LS valve)
bb. Port **P_{X1}** (from 2-stage relief solenoid valve)
dd. Port **Bp** (from PPC shuttle valve)
ee. Pressure sensor port
(pressure sensor installed)
vv. Port **Ts** (from sus lock solenoid valve)
Pa. Port **P1** (from swing LEFT PPC valve)
Pb. Port **P2** (from swing RIGHT PPC valve)
Pc. Port **P3** (from stabilizer EXTEND PPC valve)
Pd. Port **P4** (from stabilizer RETRACT PPC valve)
Pe. Port **P5** (from travel FORWARD PPC valve)
Pf. Port **P6** (from travel REVERSE PPC valve)
Pg. Port **P7**
(from boom lift cylinder RAISE PPC valve)
Ph. Port **P8**
(from boom lift cylinder LOWER PPC valve)
Pi. Port **P9** (from arm OUT PPC valve)
Pj. Port **P10** (from arm IN PPC valve)
Pk. Port **P11** (from bucket DUMP PPC valve)
Pl. Port **P12** (from bucket CURL PPC valve)
Pm. Port **P13**
(from boom adjust EXTEND PPC valve)
Pn. Port **P14**
(from boom adjust RETRACT PPC valve)
Po. Port **P15** (from service PPC valve)
Pp. Port **P16** (from service PPC valve)

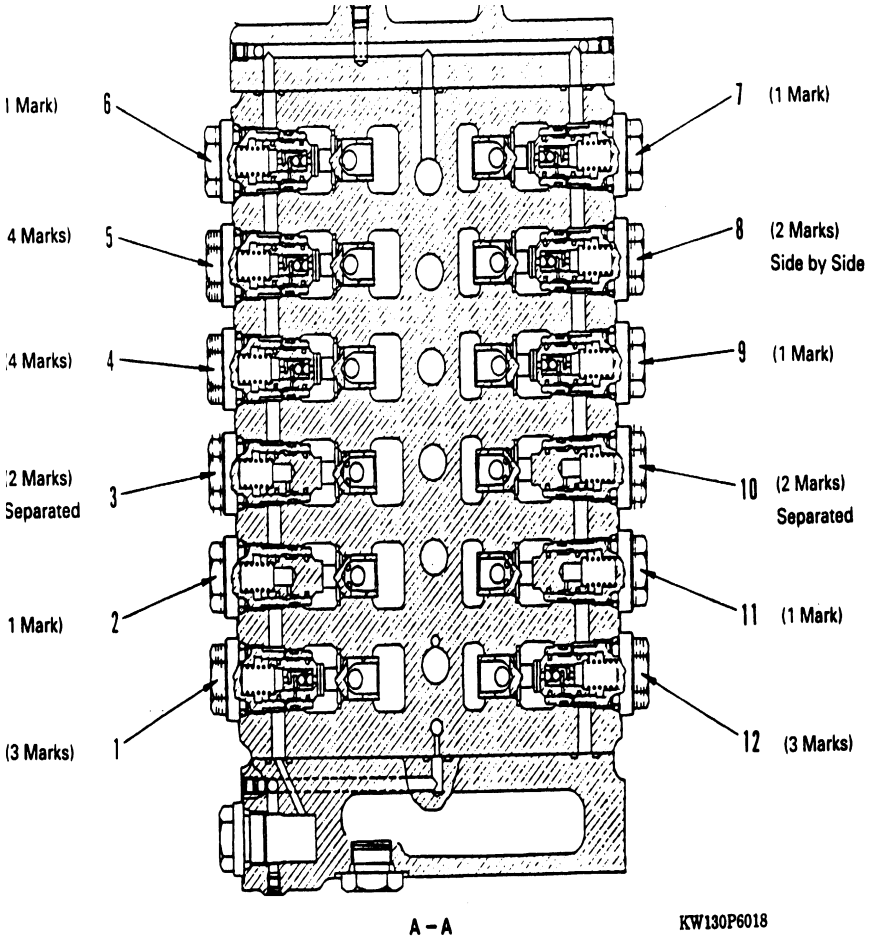
EXTERNAL VIEW

8-Spool valve (includes 2 service valves)



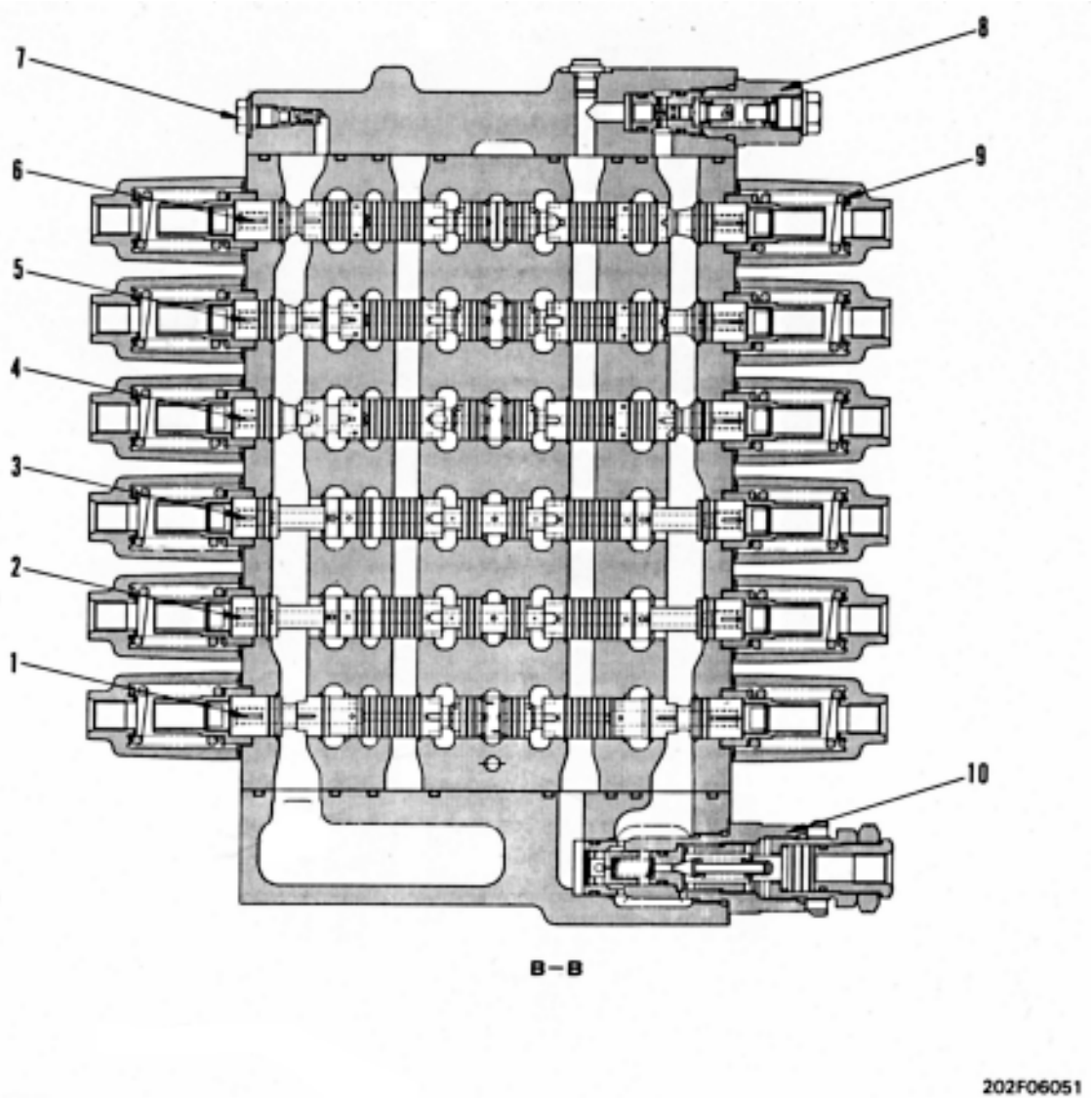
Cross-sectional drawing

★ The cross section is given only for the 6-spool valve (STANDARD). The cross-sectional structure of the service valves in an 8-spool valve are the same as the structure for the bucket valve, so refer to the bucket valve for details.

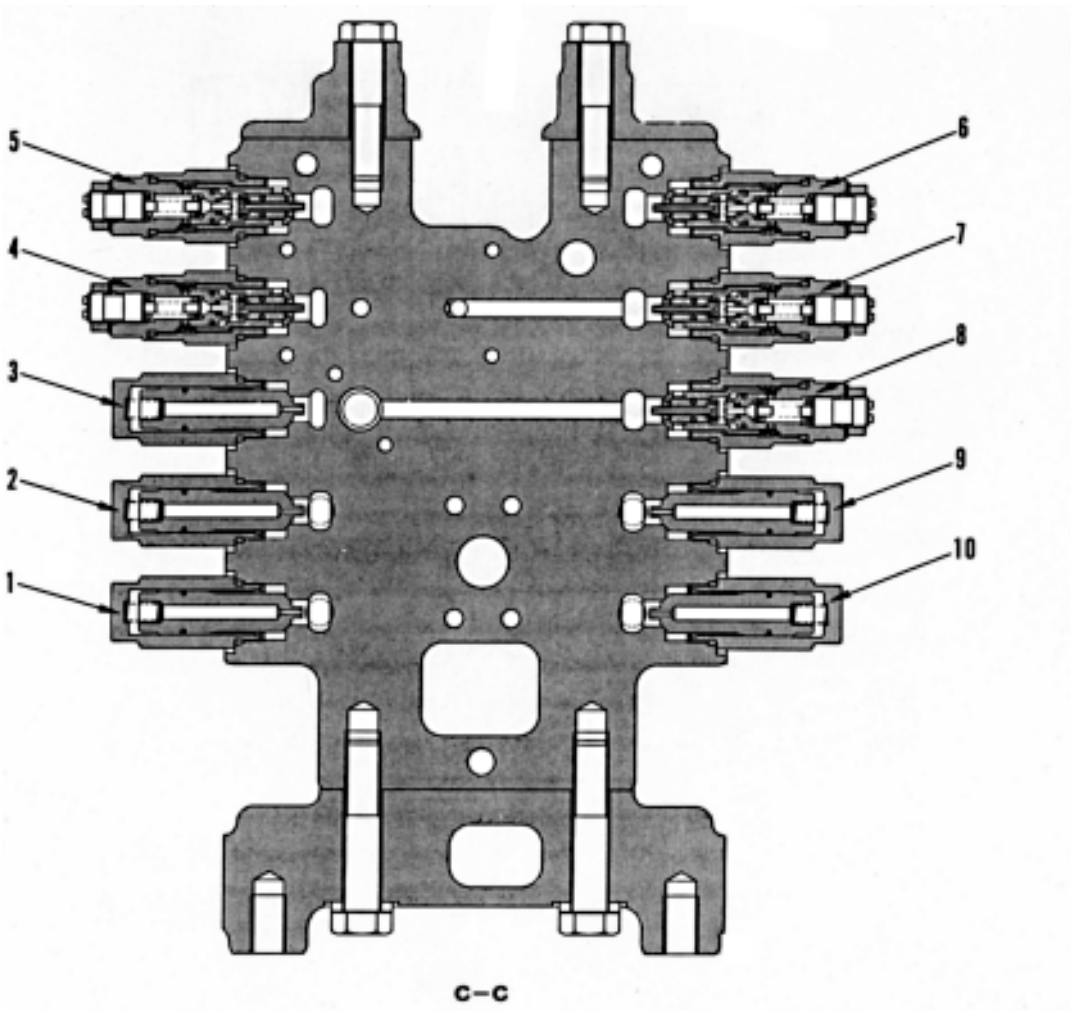


1. Pressure compensation valve (swing LEFT)
2. Pressure compensation valve (stabilizer EXTEND)
3. Pressure compensation valve (travel FORWARD)
4. Pressure compensation valve (boom RAISE)
5. Pressure compensation valve (arm OUT)
6. Pressure compensation valve (bucket DUMP)
7. Pressure compensation valve (bucket CURL)
8. Pressure compensation valve (arm IN)
9. Pressure compensation valve (boom LOWER)
10. Pressure compensation valve (travel REVERSE)
11. Pressure compensation valve (stabilizer RETRACT)
12. Pressure compensation valve (swing RIGHT)

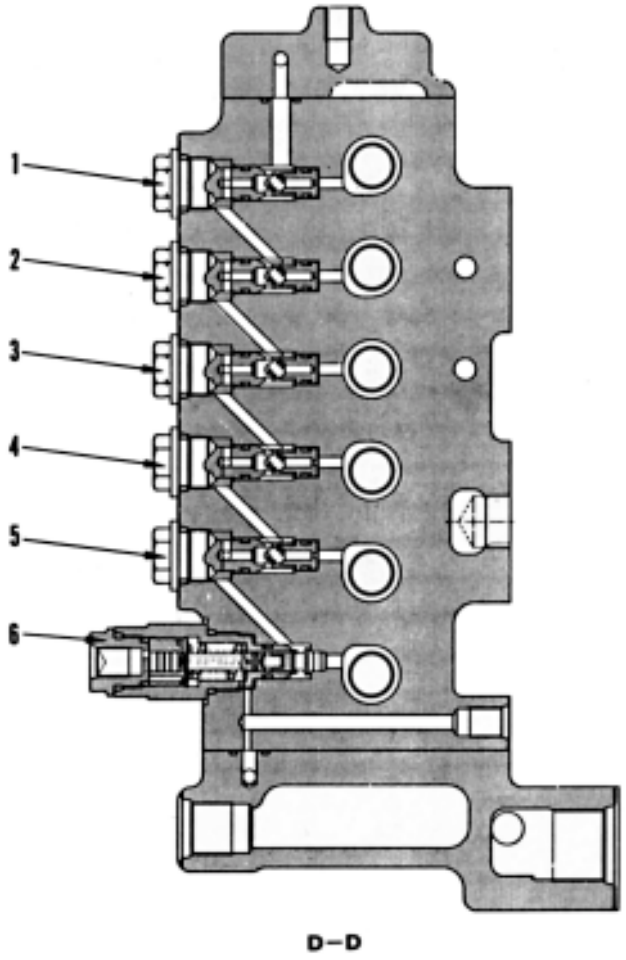
Note: Pressure compensation valves are identified by marking on the valve assembly. (See disassembly and assembly section for details.)



1. Spool (swing)
2. Spool (stabilizer)
3. Spool (travel)
4. Spool (boom)
5. Spool (arm)
6. Spool (bucket)
7. LS bypass plug
8. Unload valve
9. Spool return spring
10. Main relief valve



1. Suction valve (stabilizer head)
2. Suction valve (travel motor A)
3. Suction valve (boom lift cylinder bottom)
4. Safety-suction valve (arm head)
5. Safety-suction valve (bucket head)
6. Safety-suction valve (bucket bottom)
7. Safety-suction valve (arm bottom)
8. Safety-suction valve (boom lift cylinder head)
9. Suction valve (travel motor B)
10. Suction valve (stabilizer bottom)



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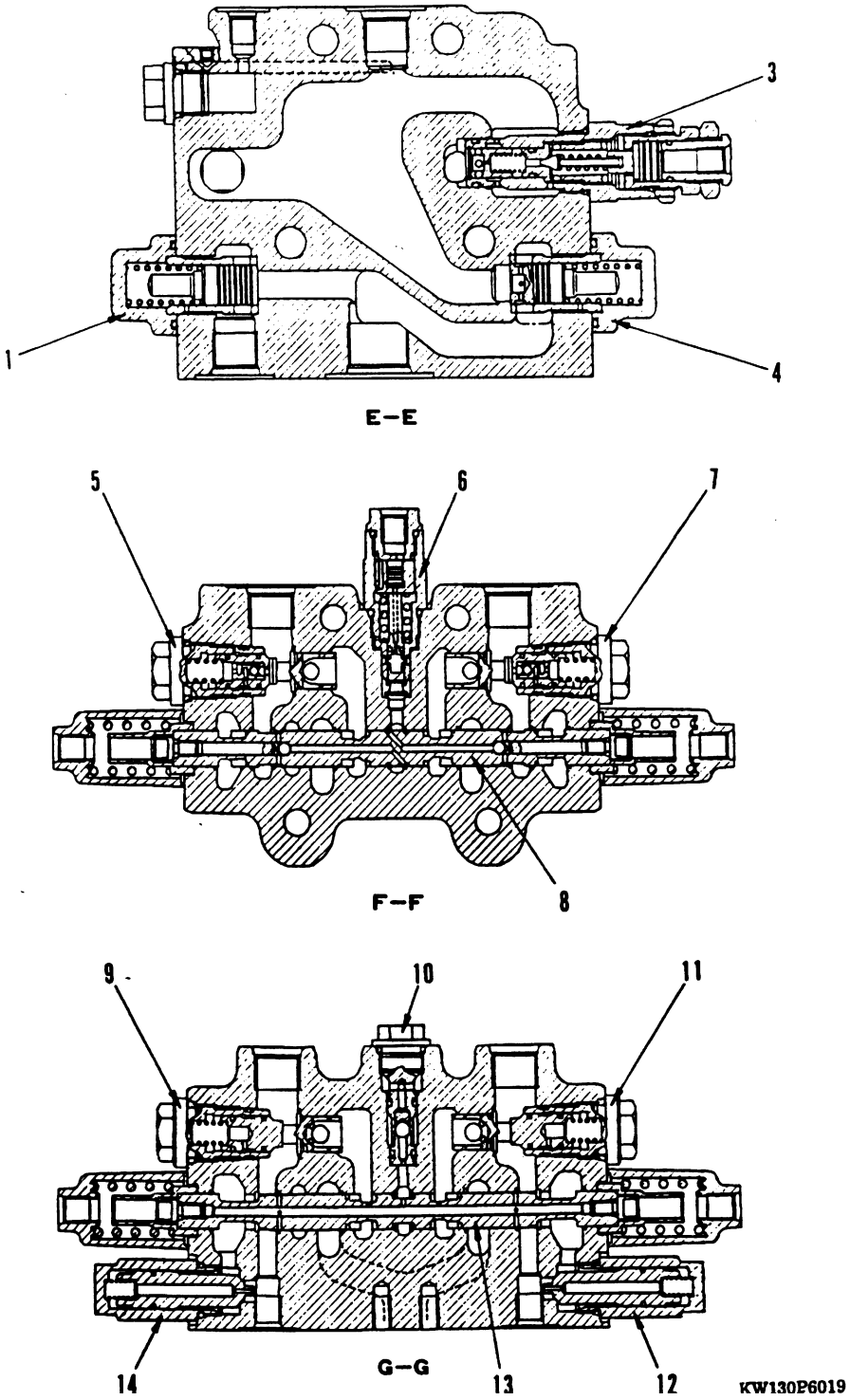
1. LS shuttle valve (bucket)
2. LS shuttle valve (arm)
3. LS shuttle valve (boom)
4. LS shuttle valve (travel)
5. LS shuttle valve (stabilizer)
6. LS select valve

Note: LS shuttle valves are identified by markings on the valve assembly. (See disassembly and assembly section for details.)



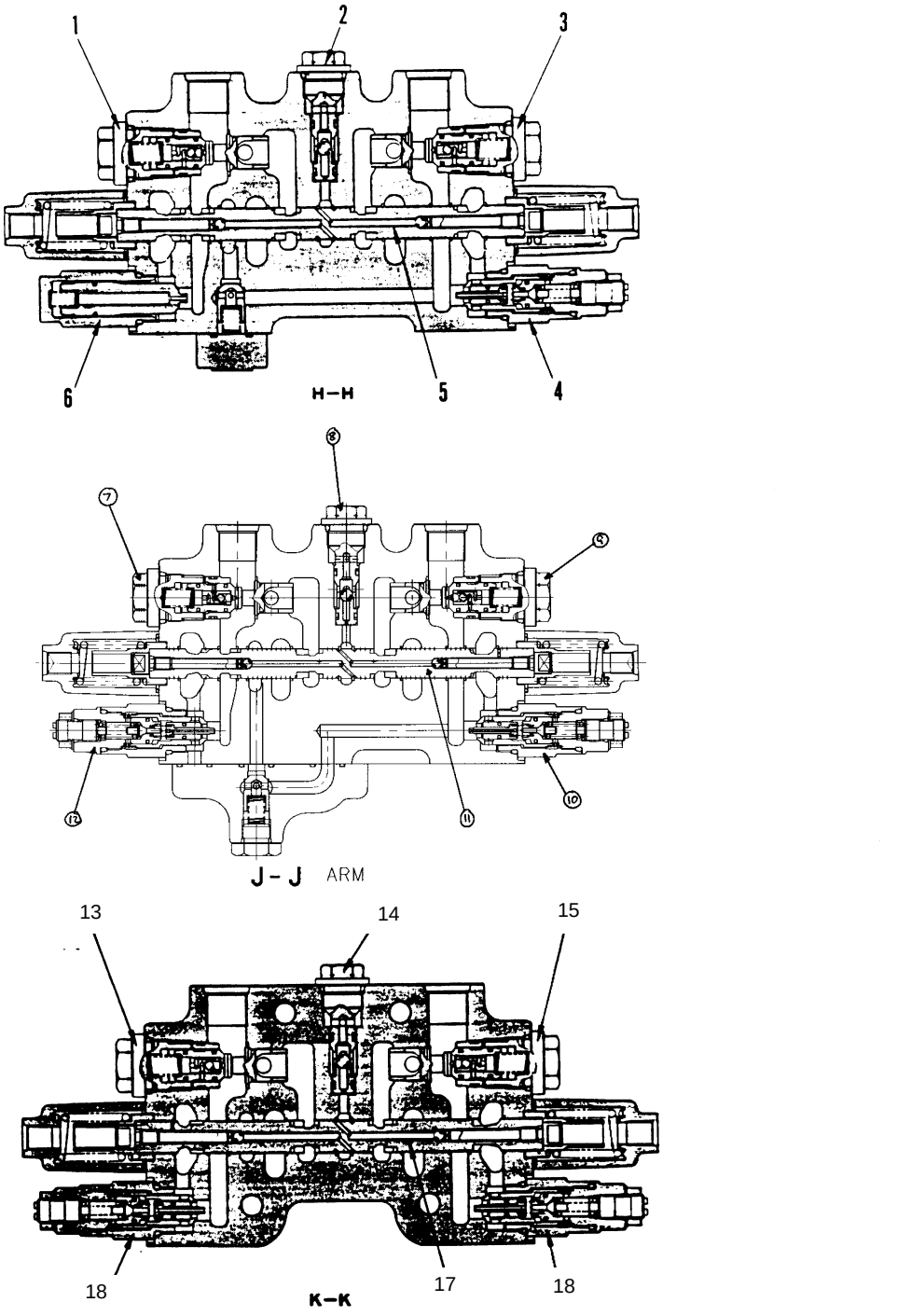
1. Cooler bypass valve
3. Main relief valve
4. Lift check valve

Swing valve

5. Pressure compensation valve (LEFT)
6. LS select valve
7. Pressure compensation valve (RIGHT)
8. Spool

Stabilizer valve

9. Pressure compensation valve (EXTEND)
10. LS shuttle valve
11. Pressure compensation valve (RETRACT)
12. Suction valve
13. Spool
14. Suction valve



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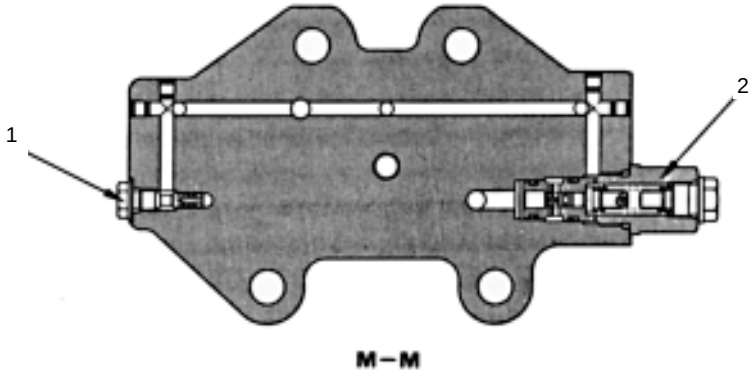
Boom valve
1. Pressure compensation valve (RAISE)
2. LS shuttle valve
3. Pressure compensation valve (LOWER)
4. Safety-suction valve
5. Spool
6. Suction valve

Arm valve
7. Pressure compensation valve (OUT)
8. LS shuttle valve
9. Pressure compensation valve (IN)
10. Safety-suction valve
11. Spool
12. Safety-suction valve

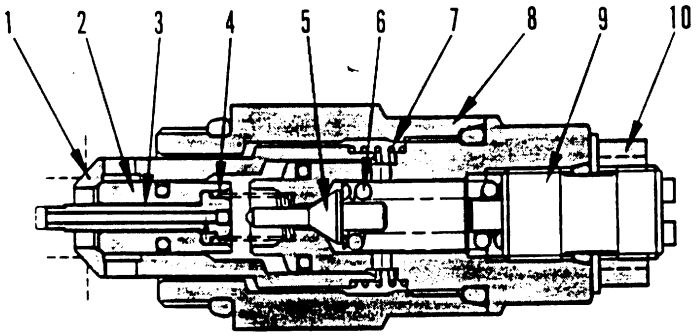
Bucket valve (service valve)
13. Pressure compensation valve (DUMP)
14. LS shuttle valve
15. Pressure compensation valve (CURL)
16. Safety-suction valve
17. Spool
18. Safety-suction valve



202F06056

1. LS bypass plug
2. Unload valve

SAFETY-SUCTION VALVE FOR SERVICE VALVE



202F06057

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

Specifications

Model code	Part. No. (reference)	Set pressure	Use
W24800	709-70-74700	17.15 MPa (175 kg/cm^2) (at 5 l /min)	Clamshell/Breaker
	709-70-74302	35.79 MPa (365 kg/cm^2) (at 5 l /min)	2 piece/Breaker (Boom adjust cylinder)
	709-70-74600	24.5 MPa (250 kg/cm^2) (at 5 l /min)	For crusher (Okada)

CLSS

OUTLINE

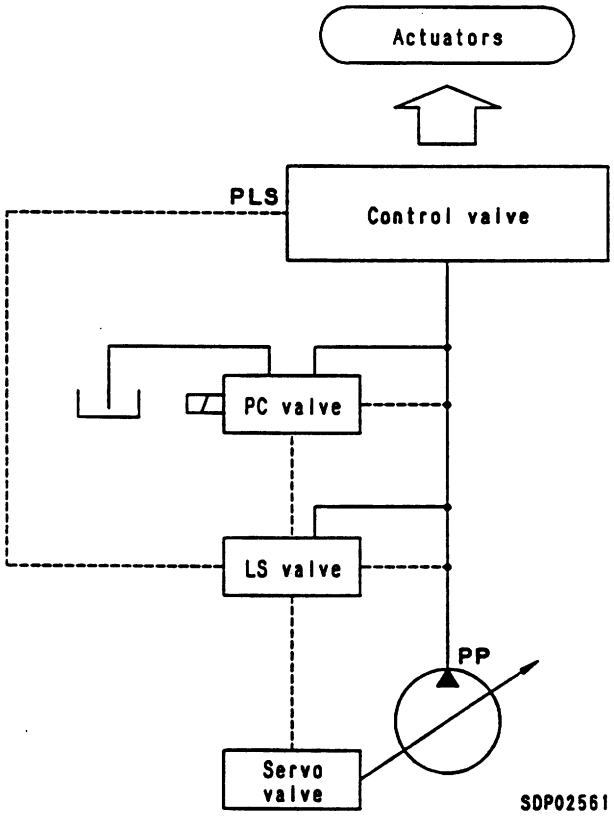
Features

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

1) Fine control not influenced by load
2) Control enabling digging even with fine control
3) Ease of compound operation ensured by flow divider function using area of opening of spool during compound operations
4) Energy saving using variable pump control

Structure

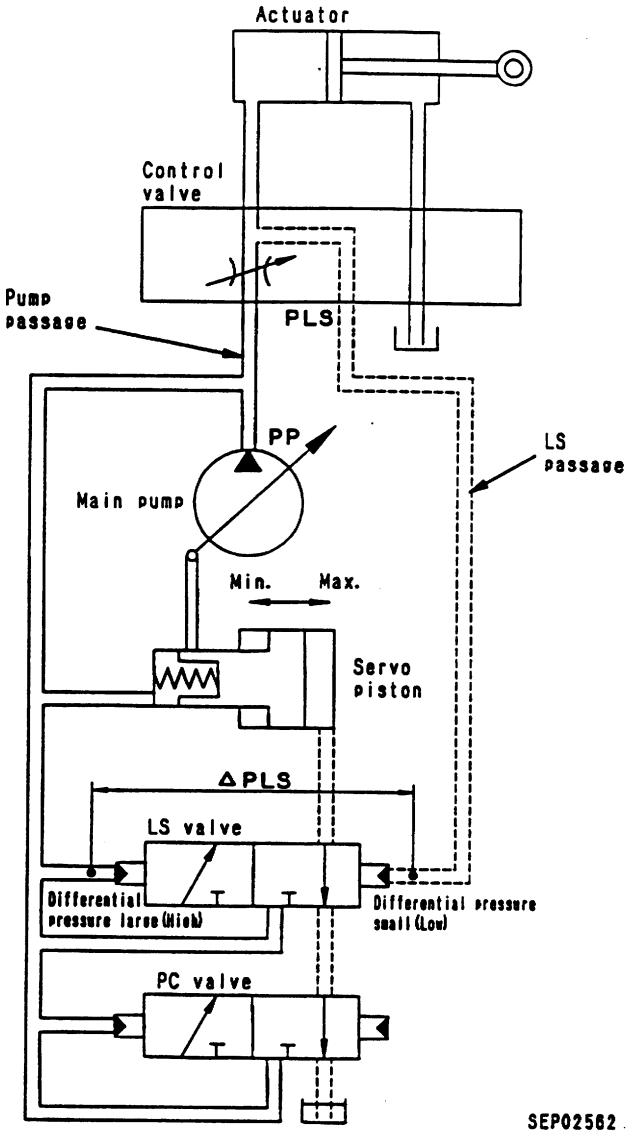
- The CLSS consists of a variable displacement single piston pump, control valve, and actuators.
- The pump body consists of the main pump, PC valve and LS valve.



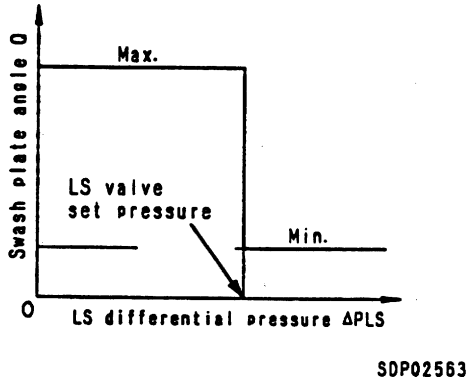
BASIC PRINCIPLE

1. Control of pump swash plate angle

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

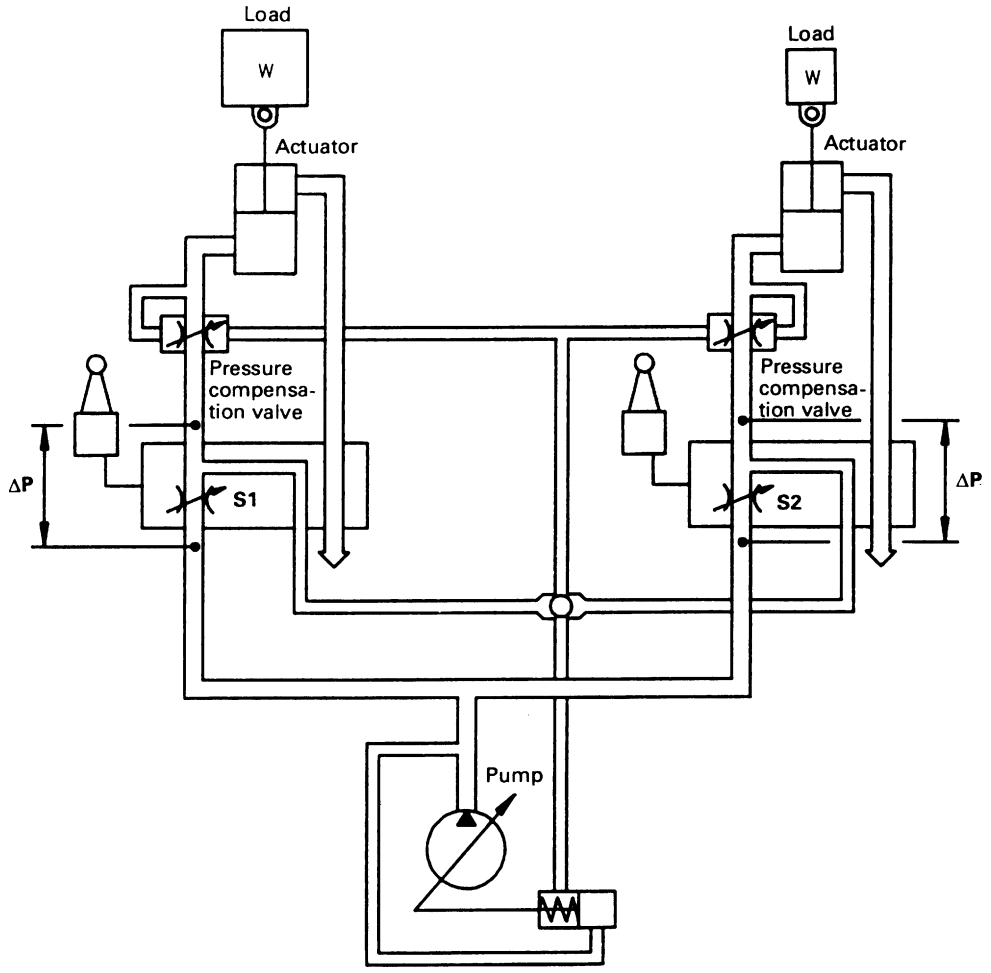


- If LS differential pressure △**PLS** becomes lower than the set pressure of the LS valve (when the actuator load pressure is high), the pump swash plate moves towards the maximum position; if it becomes higher than the set pressure of the LS valve (when the actuator load pressure is low), the pump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



2) Pressure compensation control

- A valve (pressure compensation valve) is installed to the outlet port side of the control valve to balance the load.
  When there is compound operation of the actuators, this valve acts to make pressure difference △**P** constant for the upstream flow (inlet port) and downstream (outlet port) of the spool of each valve. In this way, the flow of oil from the pump is divided in proportion to area of opening **S1** and **S2** of each valve.



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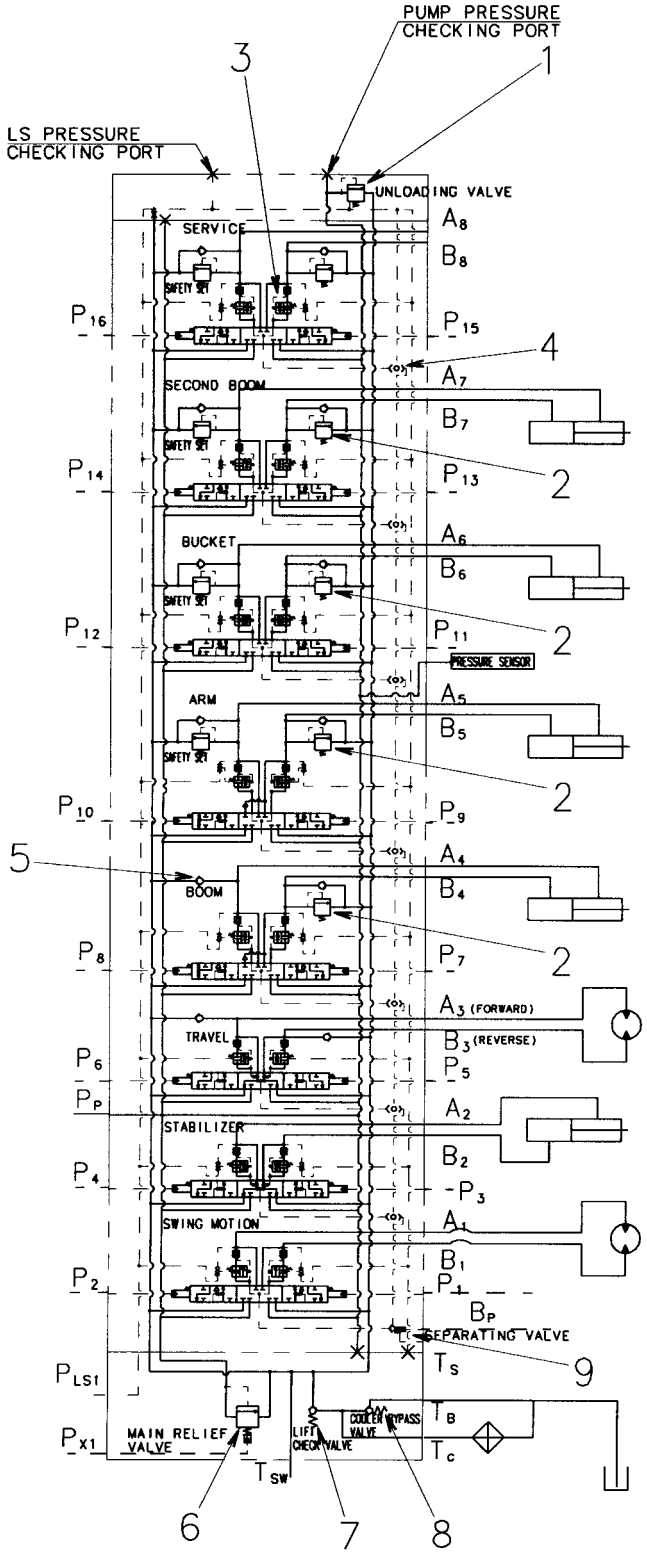
3. Operation for each function and valve

Hydraulic circuit diagram and name of valves

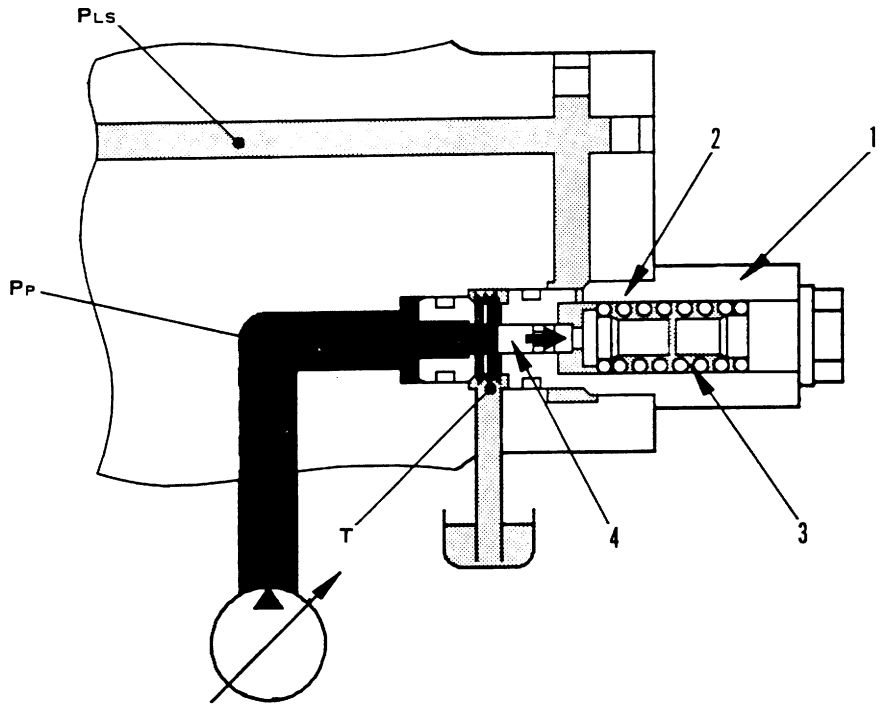


1. Unload valve
   (LS pressure + 2.45 MPa (25 kg/cm^2)
2. Safety-suction valve
   (35.8 MPa (365 kg/cm^2)
   Arm, Bucket & 2nd Boom
   (33.3 MPa (340 kg/cm^2)
3. Pressure compensation valve
4. LS shuttle valve
5. Suction valve
6. Main relief valve
   (normal: 31.85 MPa (325 kg/cm^2)),
   when pressure rises: 34.79 Map (355 kg/cm^2))
7. Lift check valve:
   (cracking pressure: 0.2 MPa (2.0 kg/cm^2))
8. Bypass check valve
9. LS select valve

1) Unload valve

Function

1. When the control valve is at neutral, pump discharge amount **Q** discharged by the minimum swash plate angle is released to the tank circuit.
   When this happens, pump discharge pressure **PP** is set at 2.45 MPa (25 kg/cm^2) by spring (3) inside the valve. (LS pressure **PLS**: 0 MPa (0 kg/cm^2))



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Operation

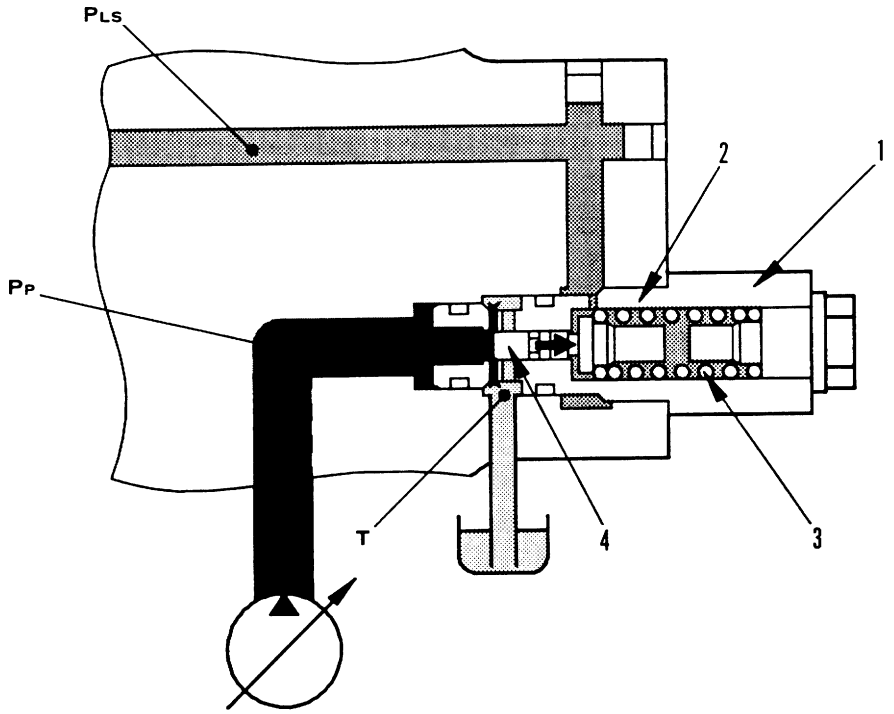
When control valve is at neutral

- Pump discharge pressure **Pp** is acting on the left end of spool (4), and LS pressure **PLS** is acting on the right end.
- When the control valve is at neutral, LS pressure **PLS** is 0, so only pump discharge pressure PP has any effect, and **Pp** is set only by the load of spring (3).
- As pump discharge pressure **Pp** rises and reaches the load of spring (3) (2.45 MPa 25 kg/cm^2)), spool (4) is moved to the right in the direction of the arrow. Pump discharge pressure **Pp** then passes through the drill hole in sleeve (2) and is connected to tank circuit **T**.
- In this way, pump discharge pressure **Pp** is set to 2.45 MPa (25 kg/cm^2)

1. Unload valve
2. Sleeve
3. Spring
4. Spool

Pp: Pump circuit (pressure)
PLS: LS circuit (pressure)
T: Tank circuit (pressure)

2. During fine control of the control valve, when the demand flow for the actuator is within the amount discharged by the minimum swash plate angle of the pump, pump discharge pressure **Pp** is set to LS pressure **PLS** + 2.45 MPa (25 kg/cm^2).
   When the differential pressure between pump discharge pressure **Pp** and LS pressure **PLS** reaches the load of spring (3) (2.45 MPa (25 kg/cm^2)), the unload valve opens, so LS differential pressure △**PLS** becomes 2.45 MPa (25 kg/cm^2).



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Operation

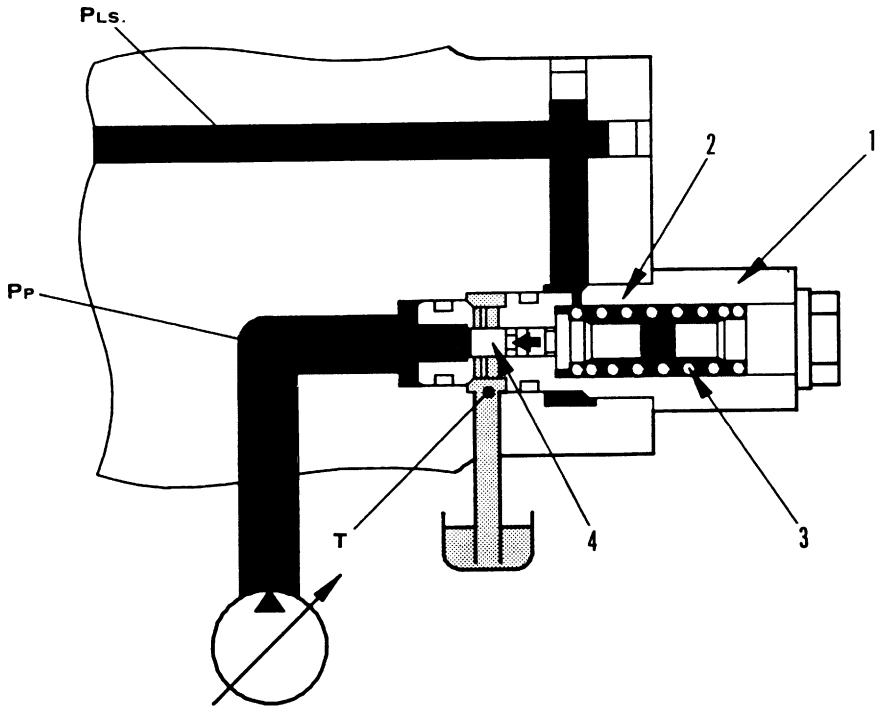
Fine control of control valve

- When fine control is carried out on the control valve, LS pressure **PLS** is generated and acts on the right end of spool (4).
  When this happens, the area of the opening of the control valve spool is small, so there is a big difference between LS pressure **PLS** and pump discharge pressure **Pp**.
- When the differential pressure between pump discharge pressure **Pp** and LS pressure **PLS** reaches the load of spring (3) (2.45 MPa (25 kg/cm^2)), spool (4) moves to the right in the direction of the arrow, and pump circuit **Pp** and tank circuit **T** are connected.
- In other words, pump discharge pressure **Pp** is set to a pressure equal to the spring force (2.45 MPa (25 kg/cm^2)) + LS pressure **PLS**, and LS differential pressure △**PLS** becomes 2.45 MPa (25 kg/cm^2).

1. Unload valve
2. Sleeve
3. Spring
4. Spool

Pp: Pump circuit (pressure)
PLS: LS circuit (pressure)
T: Tank circuit (pressure)

3. When the control valve is being operated and the demand flow for the actuator becomes greater than the pump discharge from the minimum swash plate angle, the flow of the oil out to tank circuit **T** is cut off, and all of pump discharge amount **Q** flows to the actuator circuit.



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Operation

Control valve operated

- When the control valve is operated to a bigger stroke, LS pressure **PLS** is generated and acts on the right end of spool (4). When this happens, the area of the opening of the control valve spool is large, so the difference between LS pressure **PLS** and pump discharge pressure **Pp** is small.
- For this reason, the differential pressure between pump discharge pressure **Pp** and LS pressure **PLS** does not reach the load of spring (3) (2.45 MPa (25 kg/cm^2)), so spool (4) is pushed to the left by spring (3).
- As a result, pump circuit **Pp** and tank circuit **T** are shut off, and all the pump discharge amount **Q** flows to the actuator circuit.

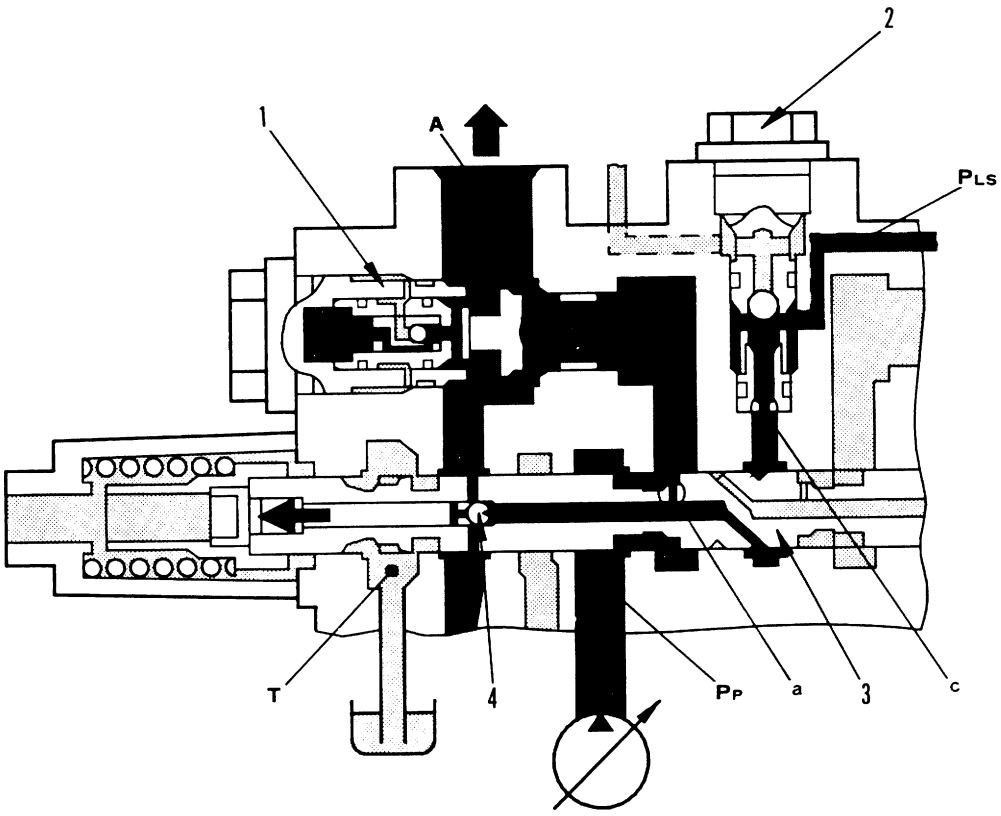
1. Unload valve
2. Sleeve
3. Spring
4. Spool

Pp: Pump circuit (pressure)
PLS: LS circuit (pressure)
T: Tank circuit (pressure)

2) Introduction of LS pressure

Function

- LS pressure **PLS** is the actuator load pressure at the outlet port end of the control valve.
- Actually, it brings the upstream pressure of the pressure compensation valve (the downstream pressure of the spool meter-in) inside spool (3) and sends it to LS shuttle valve (2).
  When this happens, LS circuit **PLS** is interconnected with actuator circuit **A** through check valve (4), and LS pressure **PLS** = actuator load pressure.
- In addition, intake hole **a** of spool (3) and hole **c** at the tip of LS shuttle valve (2) are designed as small diameter holes to give them a throttling function.



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Operation

- When spool (3) is operated, pump discharge pressure **Pp** starts to flow to actuator circuit **A**.
- First, this pump discharge pressure **Pp** passes through intake hole **a** of spool (3) and goes to LS circuit **PLS**.
- When the pump discharge pressure **Pp** rises and actuator circuit pressure **A** also rises to the necessary pressure, check valve (4) inside spool (3) opens and high pressure of LS circuit **PLS** flows to actuator circuit **A**.
- In this way, LS pressure **PLS** becomes almost the same pressure as actuator circuit pressure **A**.

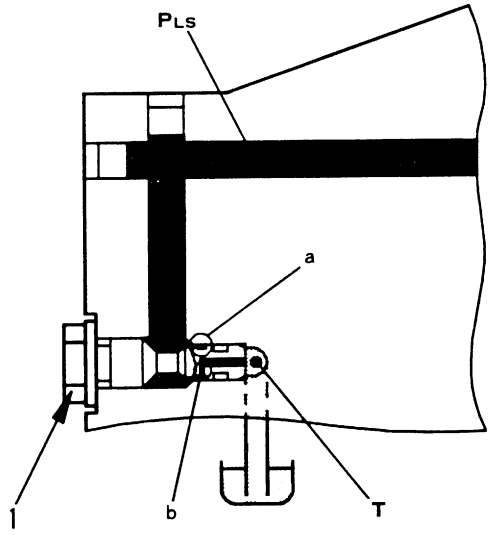
1. Pressure compensation valve
2. LS shuttle valve
3. Spool
4. Check valve

Pp: Pump circuit (pressure)
A: Actuator circuit (pressure)
PLS: LS circuit (pressure)

3) LS bypass plug

Outline

1. This releases the residual pressure of LS pressure **PLS**.
2. This makes the speed of the rise in pressure of LS pressure **PLS** more gentle.
   In addition, with this discarded throttle flow, it creates a pressure loss in the throttled amount of the spool or shuttle valve, and increases the stability by lowering the effective LS differential pressure.



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Operation

- The pressurized oil for LS circuit **PLS** passes from clearance filter **a** (formed by the clearance between LS bypass valve (1) and the valve body) through orifice **b** and flows to the tank circuit.

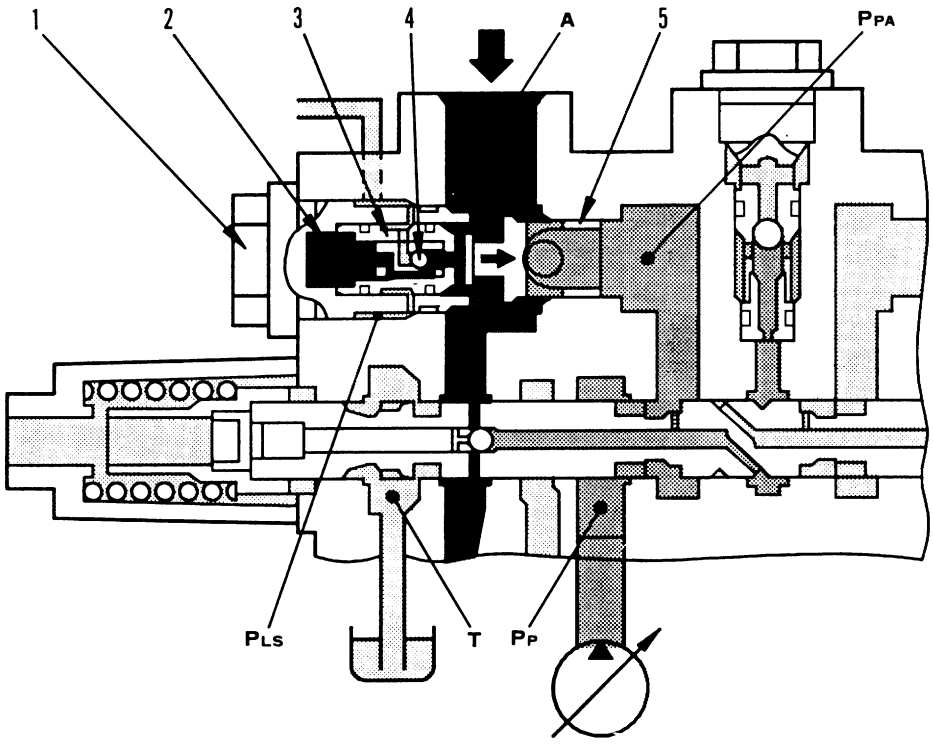
1. LS bypass valve

PLS: LS circuit (pressure)
T: Tank circuit (pressure)

4) Pressure compensation valve

Function

1. If the maximum load pressure is generated during individual operations or compound operations, and the load pressure becomes higher than other actuators, this acts as a load check valve to prevent the oil in the circuit from flowing back.



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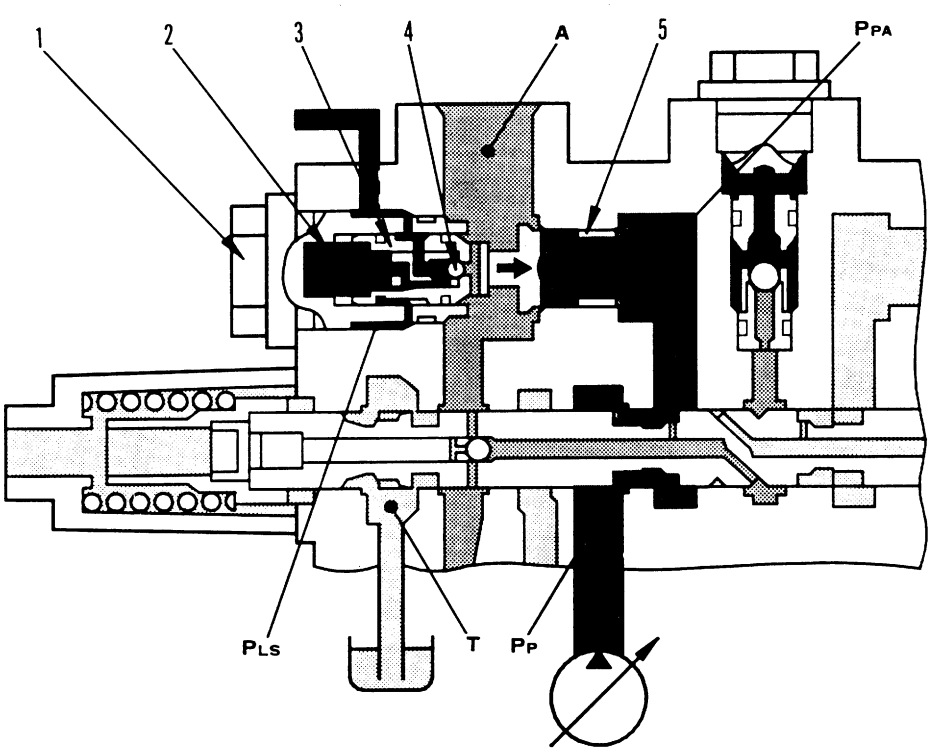
Operation

- If pump discharge pressure **Pp** and LS pressure **PLS** become lower than actuator circuit pressure **A**, shuttle valve (4) inside pressure compensation valve (1) moves to the left in the direction of the arrow, and connects actuator circuit **A** and the spring chamber.
- When this happens, the movement of piston (3) becomes free, so piston (3) is pushed to the right in the direction of the arrow by spring (2).
- As a result, valve (5) is also pushed to the right in the direction of the arrow by piston (3), closes pump outlet port circuit **PPA**, and prevents the oil from flowing back from actuator circuit **A** to pump outlet port circuit **PPA**.

1. Pressure compensation valve
2. Spring
3. Piston
4. Shuttle valve
5. Valve

Pp: Pump circuit (pressure)
PPA: Pump outlet port circuit (pressure)
PLS: LS circuit (pressure)
A: Actuator circuit (pressure)
T: Tank circuit (pressure)

2. During compound operations, if the load pressure becomes lower than the other actuators, and the oil flow tries to increase, compensation is received. In this case, the load pressure at the other actuator end becomes higher and the oil flow tries to decrease.



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Operation

- During compound operations, if the load pressure becomes higher at the other actuator end, the oil flow in actuator circuit **A** tries to increase.
- In this case, LS pressure **PLS** at the other actuator end also becomes higher. LS pressure **PLS** then pushes shuttle valve (4) of pressure compensation valve (1) to the right in the direction of the arrow, so the oil passes through passage inside piston (3) and flows into the spring chamber.
- As a result, piston (3) and valve (5) are pushed to the right in the direction of the arrow, the outlet port end of pump circuit **Pp** is closed, and outlet port pressure **PLS** (spool meter-in downstream pressure) becomes the same as the outlet port pressure of the other actuator.
- Pump discharge pressure **Pp** (spool meter-in upstream pressure) is the same as between all actuators, so pump discharge pressure **Pp** and outlet port **PPA** become the same as all the spools that are operated. Therefore, the flow of oil from the pump is distributed in proportion to the area of the opening of each spool.

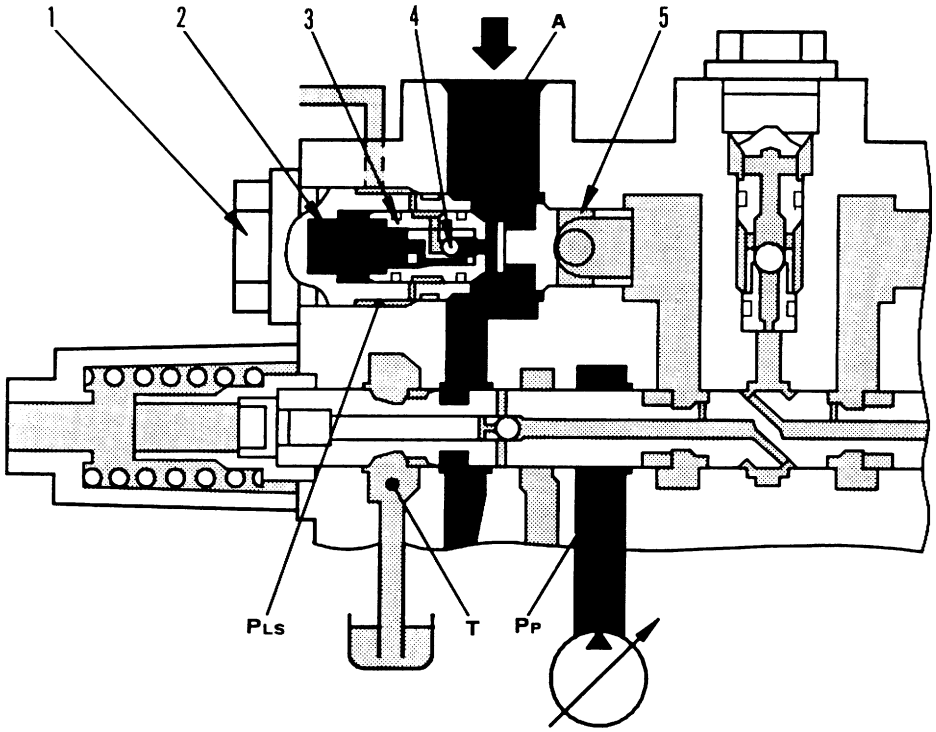
1. Pressure compensation valve
2. Spring
3. Piston
4. Shuttle valve
5. Valve

Pp: Pump circuit (pressure)
PPA: Pump outlet port circuit (pressure)
PLS: LS circuit (pressure)
A: Actuator circuit (pressure)
T: Tank circuit (pressure)

5) Shuttle valve inside pressure compensation valve (work equipment, swing valve)

Function

- When holding pressure **A** in the actuator circuit is higher than LS pressure **PLS**, holding pressure **A** is taken from shuttle valve (4) to the spring chamber to prevent piston (3) and valve (5) from separating.



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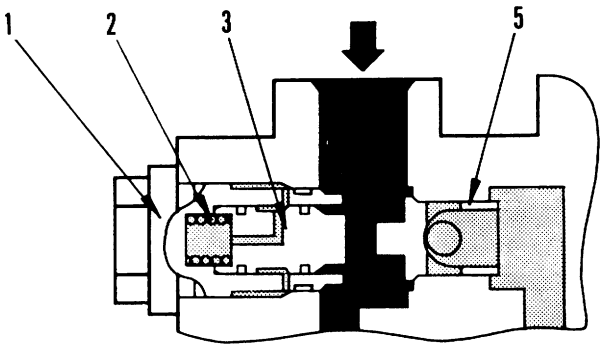
★ When there is no shuttle valve
If there is no shuttle valve installed, piston (3) is pushed back to the left in the direction of the arrow by holding pressure **A**.

In this condition, if another actuator is operated, piston (3) acts as an accumulator, so there is a time lag, and piston (3) cannot follow the rise in LS pressure **PLS**.



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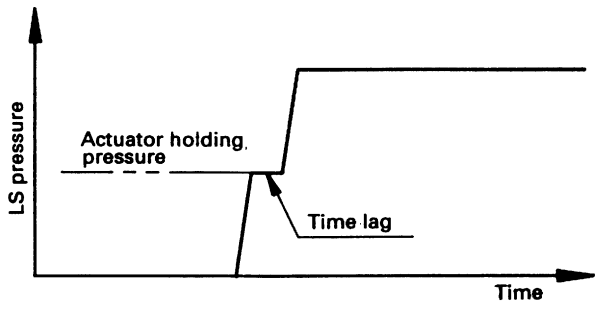

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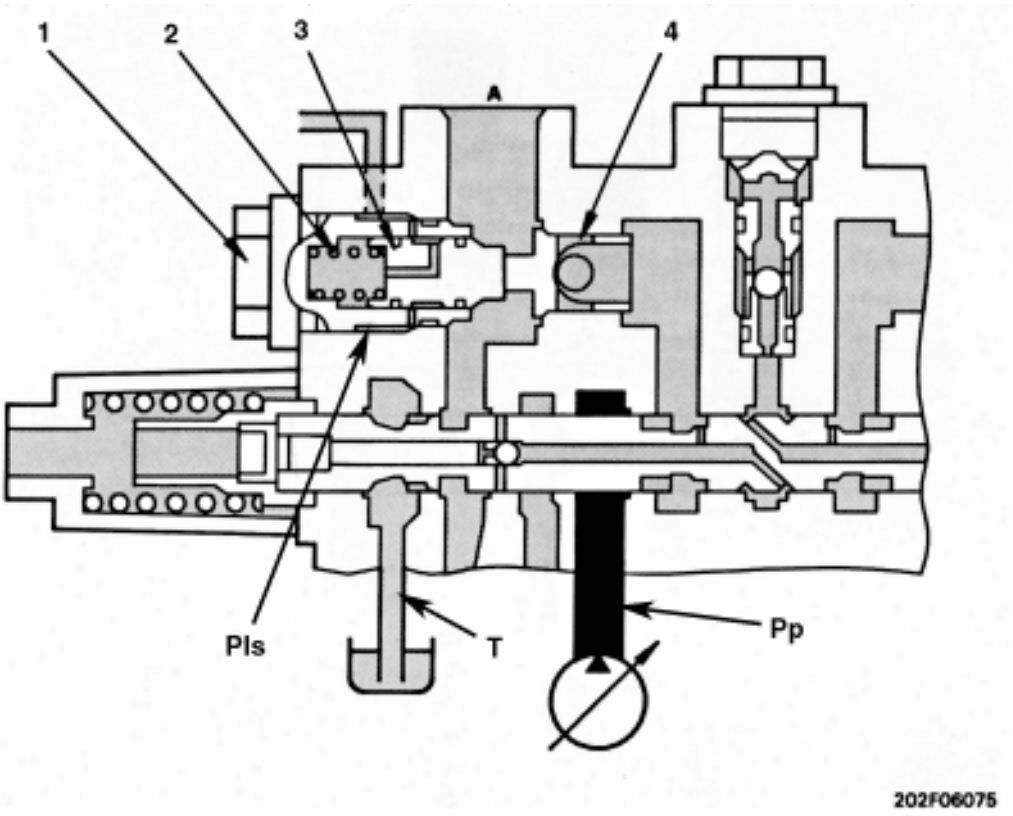
Pressure compensation valve without shuttle valve (travel valve)

- The travel circuit is different from the work equipment and swing circuit because no holding pressure is generated in holding circuit **A**. This means that piston (3) is not pushed back to the left by holding pressure **A**. Therefore, piston (3) and valve (4) always follow, and no shuttle valve is installed.



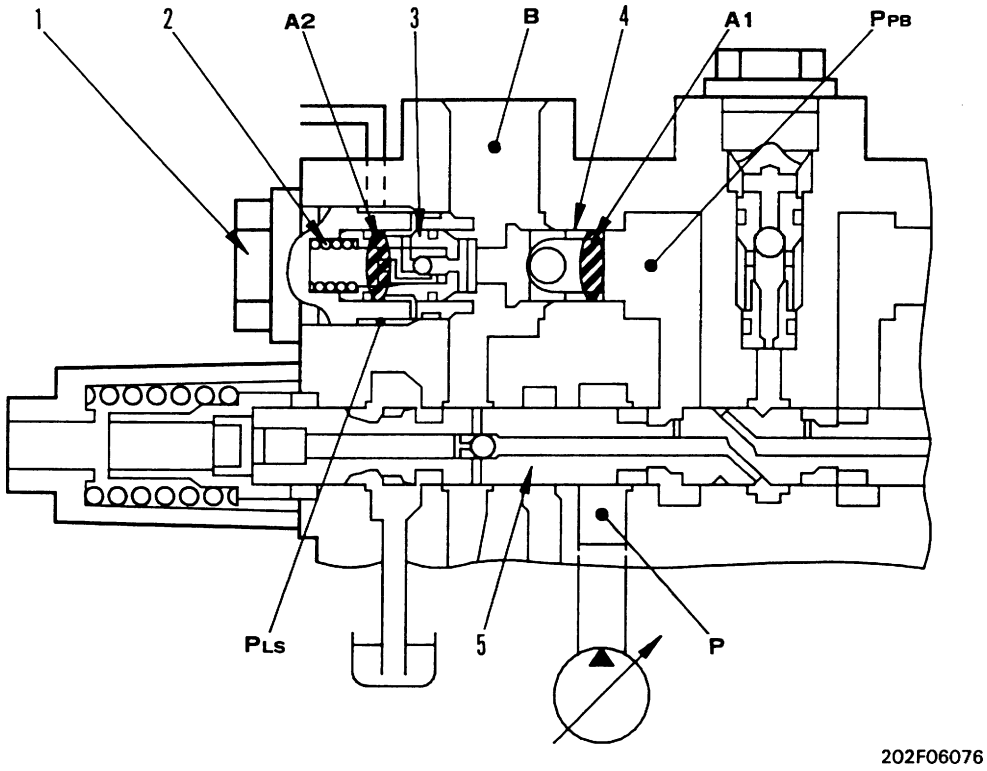
1. Pressure compensation valve
2. Spring
3. Piston
4. Valve

Pp: Pump circuit (pressure)
PLS: LS circuit (pressure)
A: Actuator circuit (pressure)
T: Tank circuit (pressure)

6) Surface area ratio of pressure compensation valve

Function

- The pressure compensation valve determines the compensation characteristics by carrying out fine adjustment of the area ratio (**A2/A1**) between area **A2** of piston (3) and area **A1** of valve (4) to match the characteristics of each actuator.



- **Area ratio (A2/A1) and compensation characteristics**
  When ratio is 1.00: spool meter-in downstream pressure **PPB** = Max. load pressure **B**, and oil flow is divided in proportion to area of opening of spool.
  When ratio is more than 1.00: spool meter-in downstream pressure **PPB** > Max. load pressure **B**, and oil flow is divided in a proportion less than area of opening of spool.
  When ratio is less than 1.00: spool meter-in downstream pressure **PPB** < Max. load pressure **B**, and oil flow is divided in a proportion more than area of opening of spool.

★ Spool meter-in downstream pressure **PPB** acts on area **A1** of valve (4), and max. load pressure **B** (=LS pressure **PLS**) acts on area **A2** of piston (3).

- **Area ratio of each pressure compensation valve**

Valve	Port A		Port B		Remarks
Service		1.00		1.00	
Bucket	DUMP	1.00	CURL	1.00	
Arm	OUT	0.96	IN	0.98	
Boom	RAISE	0.96	LOWER	1.00	
Travel	FOR-WARD	1.00	RE-VERSE	1.00	Throttle ø0.6, without shuttle valve
Stabilizer	RAISE	1.00	LOWER	1.00	
Swing	LEFT	0.98	RIGHT	0.98	Throttle ø0.6

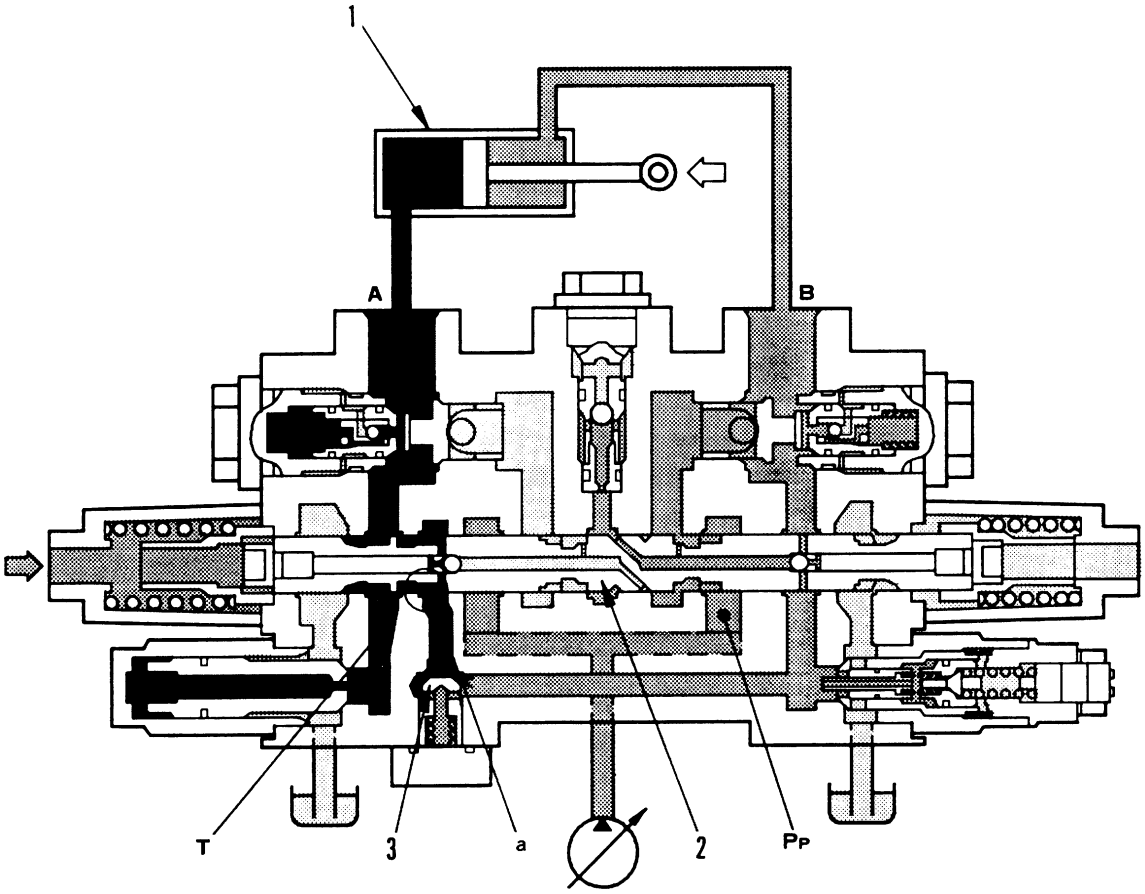
1. Pressure compensation valve
2. Spring
3. Piston
4. Valve
5. Spool

A1: Cross-sectional area of valve
A2: Cross-sectional area of piston
B: Actuator circuit (pressure)
Pp: Pump circuit (pressure)
PPB: Spool meter-in upstream pressure

7) Boom regeneration circuit

Function

1. When the boom is being lowered, if bottom pressure **A** of cylinder (1) is higher then head pressure **B**, and there is hydraulic drift, this sends the return oil flow at the bottom end to the head end to increase the cylinder speed by that amount.



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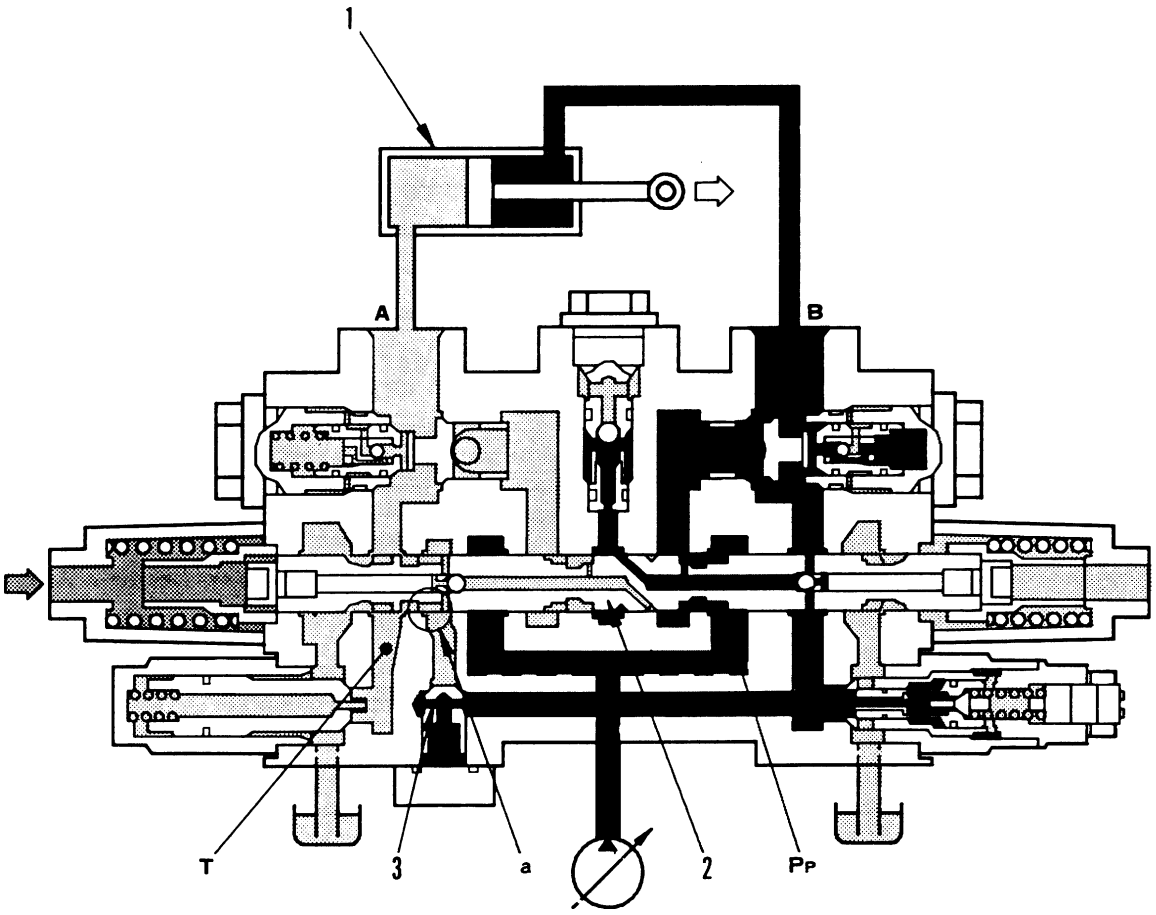
Operation

- When there is hydraulic drift when lowering the boom, pressure **A** at the bottom end of boom cylinder (1) becomes higher than pressure **B** at the head end.
- When this happens, part of the return oil at the bottom end passes through regeneration passage **a** of boom spool (1), pushes check valve (3) open, and flows to the head end.
- As a result, the boom lowering speed is increased.

1. Boom cylinder
2. Boom spool
3. Check valve

Pp: Pump circuit (pressure)
A: Bottom circuit (pressure)
B: Head circuit (pressure)
T: Tank circuit (pressure)

2. When lowering the boom, if head pressure **B** of cylinder (1) is greater than bottom pressure **A**, and the work equipment is in the digging process, check valve (3) closes and shuts off the circuit between the head and bottom ends.



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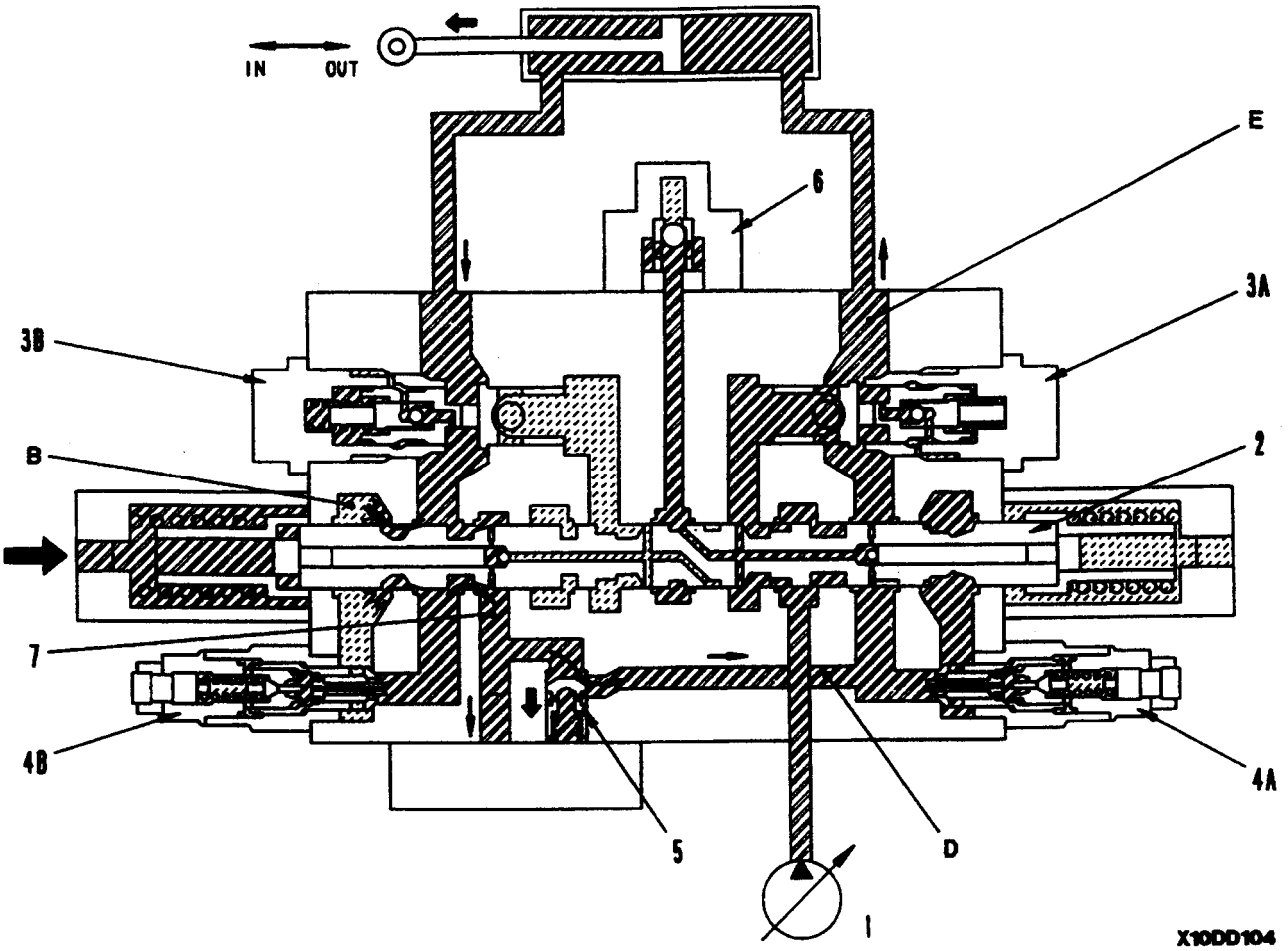
Operation

- When the boom is lowered, if the work equipment is in the digging process, pressure **B** at the head end of cylinder (1) becomes higher than pressure **A** at the bottom end.
- When this happens check valve (3) is closed by the spring and pressure **B** at the head end, so the circuit between the head circuit and bottom circuit is shut of.

1. Boom cylinder
2. Boom spool
3. Check valve

Pp: Pump circuit (pressure)
A: Bottom circuit (pressure)
B: Head circuit (pressure)
T: Tank circuit (pressure)

8) Arm regeneration circuit



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

Function

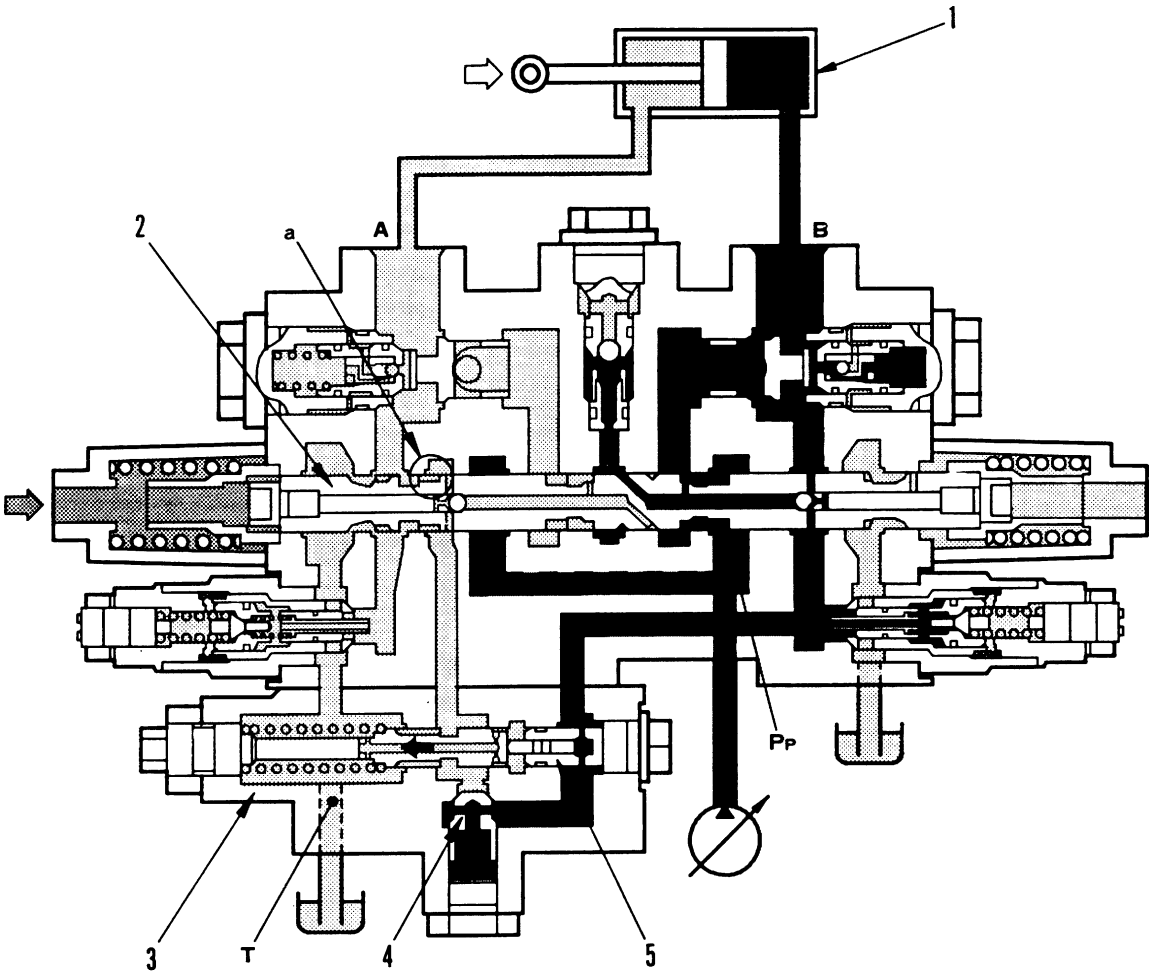
Cylinder head pressure > cylinder bottom pressure

- A return flow circuit is provided 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, and this increases the cylinder speed.

Operation

1. When the cylinder head pressure > cylinder bottom pressure, the pressurized oil from the cylinder head passes through the notch in spool (2), enters regeneration circuit (7) and opens check valve (5), then passes through ports **D** and **E** to flow back to the cylinder bottom.

2. When the arm is being moved in, if bottom pressure **B** of cylinder (1) is greater than head pressure **A**, and the work equipment is in the digging process, check valve (4) closes and shuts off the circuit between the head and bottom ends.
   If pressure **B** at the bottom end rises further and exceeds 17.64 MPa (180 kg/cm^2), spool (5) of counterbalance valve (3) is actuated to maintain the area of the meter-out opening at the head end in order to ensure the digging force.



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Operation

- When the arm is being moved in, if the word equipment is in the digging process, and pressure **B** at the bottom end of cylinder (1) rises, check valve (4) closes and the circuit between the head circuit and bottom circuit is shut off.
- If pressure **B** at the bottom end rises further, spool (5) of counterbalance valve (3) is pushed to the left in the direction of the arrow by pressure **B**. The oil from the regeneration circuit is connected to the tank circuit, and the area of the meter-out opening at the head end is made larger to ensure the digging force.

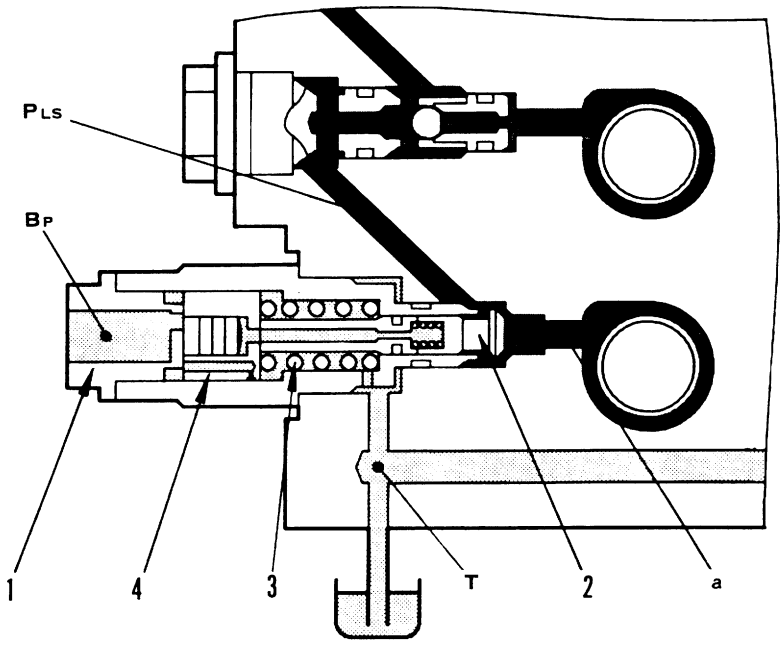
1. Arm cylinder
2. Arm spool
3. Counterbalance valve
4. Check valve
5. Spool

Pp: Pump circuit (pressure)
A: Head circuit (pressure)
B: Bottom circuit (pressure)
T: Tank circuit (pressure)

9) LS select valve

Function

- When the swing + boom RAISE, are operated together, this valve prevents the high pressure which is generated when driving the swing, and prevents swing LS pressure **a** from flowing into LS circuit **PLS**.



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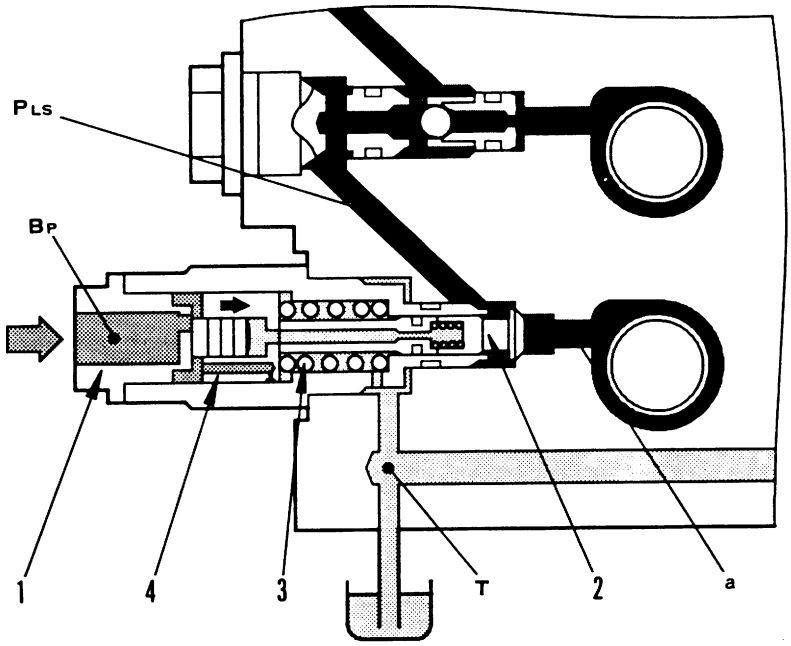
Operation

Normal operation

- Normally, when the swing is operated alone, or when it is operated together with any other movement except boom RAISE, the pilot pressure does not act on pilot port **Bp**.
- In this condition, swing LS pressure **a** pushes valve (2) open, and flows to LS circuit **PLS**.

1. LS select valve
2. Valve
3. Spring
4. Piston

a: Swing LS circuit (pressure)
PLS: LS circuit (pressure)
Bp: PPC pilot circuit (pressure)
T: Tank circuit (pressure)



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Swing + boom RAISE, operated together

- When the swing + boom RAISE, are operated, the pilot pressure from the **PPC** shuttle valve flows into pilot port **Bp**.
- When pilot pressure **Bp** becomes stronger than spring (3), piston (4) is pushed to the right in the direction of the arrow, valve (2) closes, and swing LS pressure **a** does not flow into LS circuit **PLS**.
- The size of pilot pressure **Bp** is determined by the amount the control lever is operated.

1. LS select valve
2. Valve
3. Spring
4. Piston

a: Swing LS circuit (pressure)
PLS: LS circuit (pressure)
Bp: PPC pilot circuit (pressure)
T: Tank circuit (pressure)

4. OPERATION OF SYSTEM AS A WHOLE

1) When all control valves are at neutral

- Pump discharge amount **Q** all flows from unload valve (6) to tank (1).
- Non of the spools (7A to 12A) are being opereted, so the LS pressure **P_{LS}** is not generated. At the same time, the LS pressure **P_{LS}** is connected to the tank circuit by LS bypass plug (5), so it is the tank pressure.
- In this condition, LS differential pressure **△PLS** becomes the unload pressure - tank pressure, and becomes higher than the LS set pressure of LS valve (4), so main pump (2) is set to the minimum swash plate angle.

1. Hydraulic tank

Hydraulic pump

2. Main pump
3. PC valve
4. LS valve

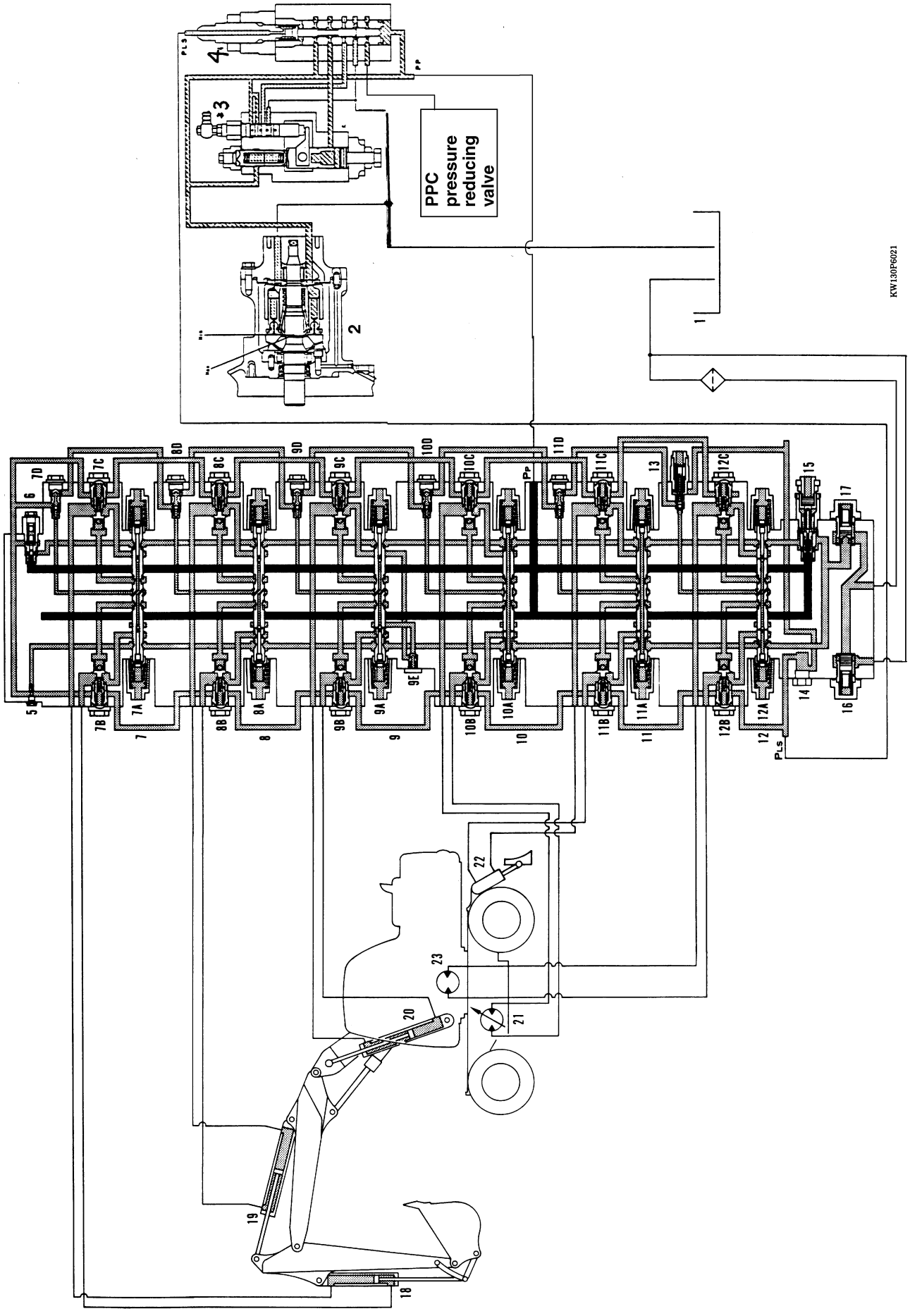
Control valve

5. LS bypass plug
6. Unload valve
7. Bucket valve
   - 7A. Spool
   - 7B. Pressure compensation valve (DUMP)
   - 7C. Pressure compensation valve (CURL)
   - 7D. LS shuttle valve
8. Arm valve
   - 8A. Spool
   - 8B. Pressure compensation valve (OUT)
   - 8C. Pressure compensation valve (IN)
   - 8D. LS shuttle valve
9. Boom valve
   - 9A. Spool
   - 9B. Pressure compensation valve (RAISE)
   - 9C. Pressure compensation valve (LOWER)
   - 9D. LS shuttle valve
   - 9E. Check valve
10. Travel valve
    - 10A. Spool
    - 10B. Pressure compensation valve (FORWARD)
    - 10C. Pressure compensation valve (REVERSE)
    - 10D. LS shuttle valve
11. Stabilizer valve
    - 11A. Spool
    - 11B. Pressure compensation valve (EXTEND)
    - 11C. Pressure compensation valve (RETRACT)
    - 11D. LS shuttle valve
12. Swing valve
    - 12A. Spool
    - 12B. Pressure compensation valve (LEFT)
    - 12C. Pressure compensation valve (RIGHT)
13. LS select valve
14. LS bypass plug
15. Main relief valve
16. Cooler bypass valve
17. Lift check valve

Actuator

18. Bucket cylinder
19. Arm cylinder
20. Boom cylinder
21. Travel motor
22. Dozer cylinder
23. Swing motor

★ The safety-suction valve, and suction valve are not shown.


PPC pressure reducing valve
KW130P6021

2) When boom RAISE is operated independently

- When boom spool (A9) is operated to the RAISE position, pump discharge amount **Q** flows to the bottom end of boom cylinder (20), and at the same time, LS pressure P_{LS} is generated and unload valve (6) closes.
- LS pressure P_{LS} becomes the boom holding pressure, and the area of the opening of boom spool (A9) is larger than the other spools (oversize opening), so the difference between pump discharge pressure **Pp** and LS pressure P_{LS} (LS differential pressure $\triangle P_{LS}$) becomes smaller.
- This LS differential pressure $\triangle P_{LS}$ is lower than the LS set pressure of LS valve (4), so main pump (2) is held at the maximum swash plate angle.

1. Hydraulic tank

Hydraulic pump

2. Main pump
3. PC valve
4. LS valve

Control valve

5. LS bypass plug
6. Unload valve
7. Bucket valve
   - 7A. Spool
   - 7B. Pressure compensation valve (DUMP)
   - 7C. Pressure compensation valve (CURL)
   - 7D. LS shuttle valve
8. Arm valve

8A. Spool
   - 8B. Pressure compensation valve (OUT)
   - 8C. Pressure compensation valve (IN)
   - 8D. LS shuttle valve

9. Boom valve

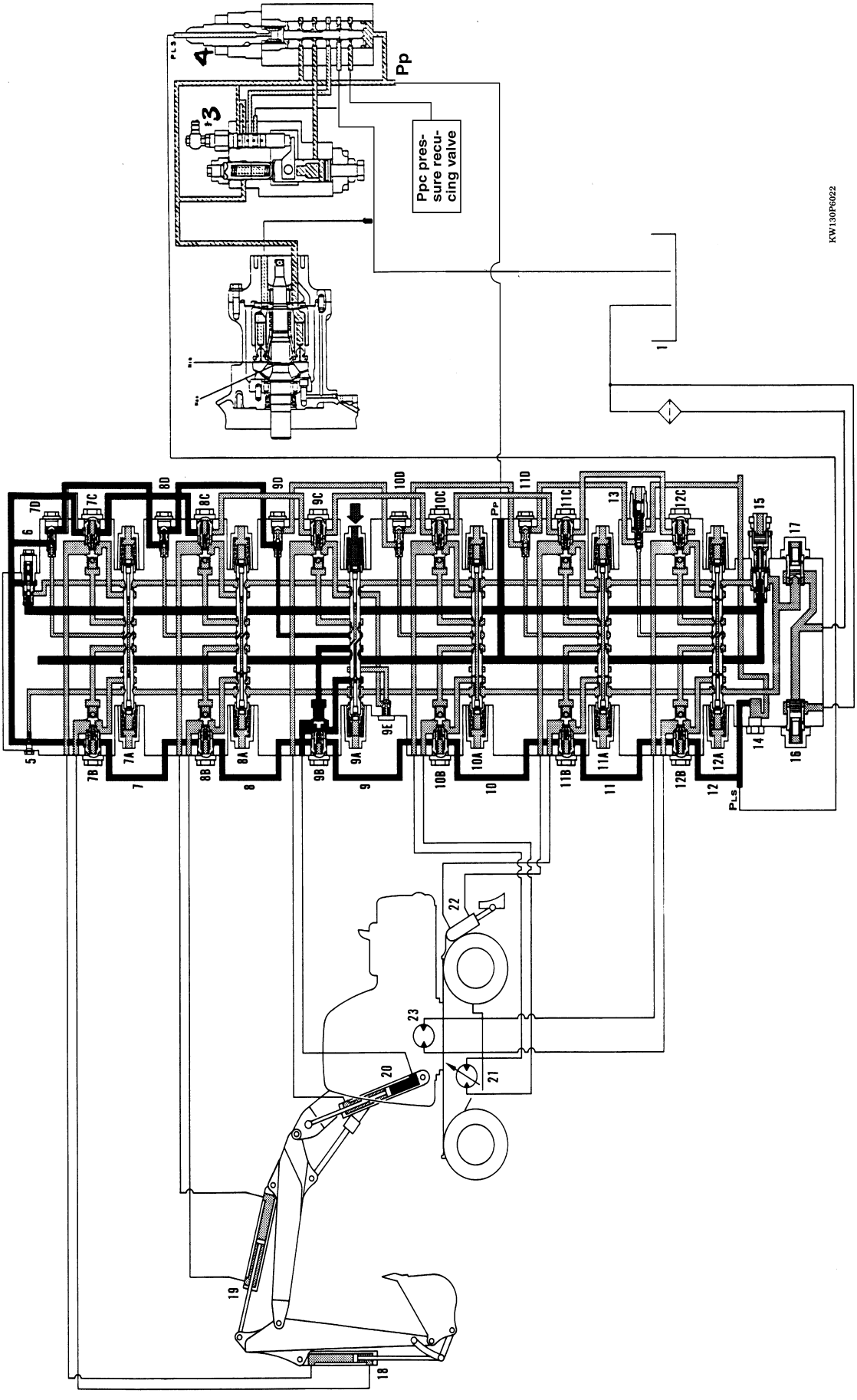
9A. Spool
   - 9B. Pressure compensation valve (RAISE)
   - 9C. Pressure compensation valve (LOWER)
   - 9D. LS shuttle valve
   - 9E. Check valve

10. Travel valve
    - 10A. Spool
    - 10B. Pressure compensation valve (FORWARD)
    - 10C. Pressure compensation valve (REVERSE)
    - 10D. LS shuttle valve
11. Stabilizer valve
    - 11A. Spool
    - 11B. Pressure compensation valve (EXTEND)
    - 11C. Pressure compensation valve (RETRACT)
    - 11D. LS shuttle valve
12. Swing valve
    - 12A. Spool
    - 12B. Pressure compensation valve (LEFT)
    - 12C. Pressure compensation valve (RIGHT)
13. LS select valve
14. LS bypass plug
15. Main relief valve
16. Cooler bypass valve
17. Lift check valve

Actuator

18. Bucket cylinder
19. Arm cylinder
20. Boom cylinder
21. Travel motor
22. Dozer cylinder
23. Swing motor

★ The safety-suction valve, and suction valve are not shown.


Pp
Ppc pressure reducing valve
KW130P6022
PLS
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23

3) When swing is operated independently

- When swing spool (12A) is operated, pump discharge amount **Q** flows to swing motor (23) and, at the same time, LS pressure **P_{LS}** is generated and unload valve (4) closes. LS pressure **PLS** becomes the load pressure of swing motor (23).
- In the swing circuit, the difference between pump discharge pressure **Pp** and LS pressure **P_{LS}** (LS differential pressure **$\triangle P_{LS}$**) becomes the same pressure as the LS set pressure of LS valve (4).
- As a result, the swash plate of main pump (2) is kept at a position midway between the minimum and maximum swash plate angle and the main pump discharges the demand flow (approx. 50%) for the swing circuit.
- When the swing is operated independently pump discharge amount **Q** does not become 100%.

1. Hydraulic tank

Hydraulic pump

2. Main pump
3. PC valve
4. LS valve

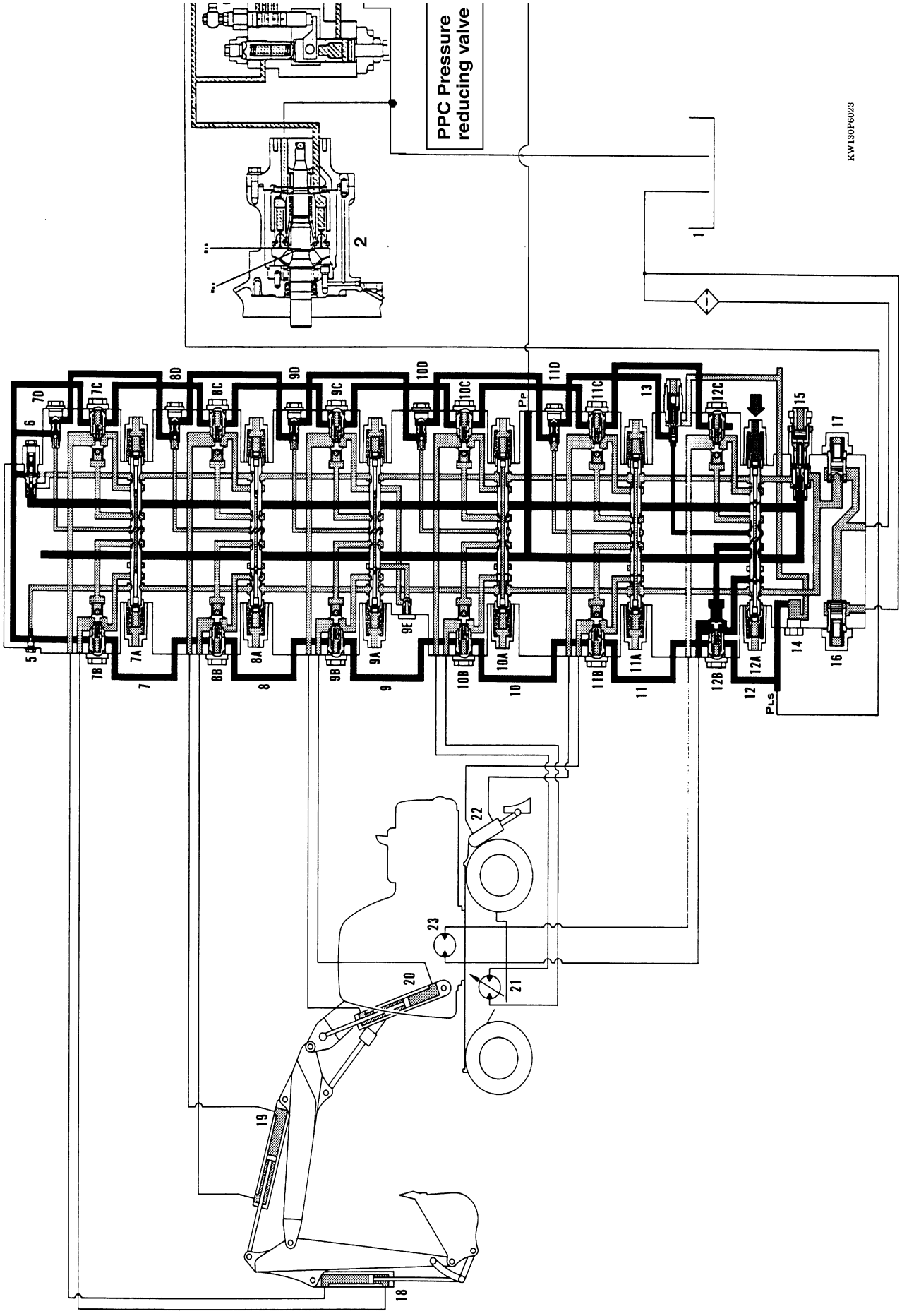
Control valve

5. LS bypass plug
6. Unload valve
7. Bucket valve
   - 7A. Spool
   - 7B. Pressure compensation valve (DUMP)
   - 7C. Pressure compensation valve (CURL)
   - 7D. LS shuttle valve
8. Arm valve
   - 8A. Spool
   - 8B. Pressure compensation valve (OUT)
   - 8C. Pressure compensation valve (IN)
   - 8D. LS shuttle valve
9. Boom valve
   - 9A. Spool
   - 9B. Pressure compensation valve (RAISE)
   - 9C. Pressure compensation valve (LOWER)
   - 9D. LS shuttle valve
   - 9E. Check valve
10. Travel valve
    - 10A. Spool
    - 10B. Pressure compensation valve (FORWARD)
    - 10C. Pressure compensation valve (REVERSE)
    - 10D. LS shuttle valve
11. Stabilizer valve
    - 11A. Spool
    - 11B. Pressure compensation valve (EXTEND)
    - 11C. Pressure compensation valve (RETRACT)
    - 11D. LS shuttle valve
12. Swing valve
    - 12A. Spool
    - 12B. Pressure compensation valve (LEFT)
    - 12C. Pressure compensation valve (RIGHT)
13. LS select valve
14. LS bypass plug
15. Main relief valve
16. Cooler bypass valve
17. Lift check valve

Actuator

18. Bucket cylinder
19. Arm cylinder
20. Boom cylinder
21. Travel motor
22. Dozer cylinder
23. Swing motor

★ The safety-suction valve, and suction valve are not shown.


PPC Pressure reducing valve
KW130P6023
1
2
5
6
7
7A
7B
7C
7D
8
8A
8B
8C
8D
9
9A
9B
9C
9D
9E
10
10A
10B
10C
10D
11
11A
11B
11C
11D
12
12A
12B
12C
13
14
15
16
17
18
19
20
21
22
23
Pp
PLS

4) When boom and arm are operated simultaneously

- If boom spool (A9) is operated to the RAISE position and arm spool (8A) is operated to the OUT position, pump discharge amount Q flows to cylinders (20) and (19).
- When this happens, the load pressure of boom cylinder (20) is greater than the load pressure of arm cylinder (19), where the load pressure is lower. However, the pressure at the downstream side of arm spool (8A) is compensated by pressure compensation valve (7B), which receives the load pressure (= max. LS pressure PLS) of the boom.
- As a result, the upstream pressure and downstream pressure of boom spool (9A) and arm spool (8A) become equal, so the oil flow from main pump (2) is divided in proportion to the area of opening of each spool.
- In the same way as when the boom is operated independently, the area of the opening of boom spool (9A) is a large oversize opening, so the difference between pump discharge pressure P_P and LS pressure P_{LS} (LS differential pressure PLS) becomes smaller.
- This LS differential pressure PLS is lower than the LS set pressure of LS valve (4), so main pump (2) is held at the maximum swash plate angle.

1. Hydraulic tank

Hydraulic pump

2. Main pump
3. PC valve
4. LS valve

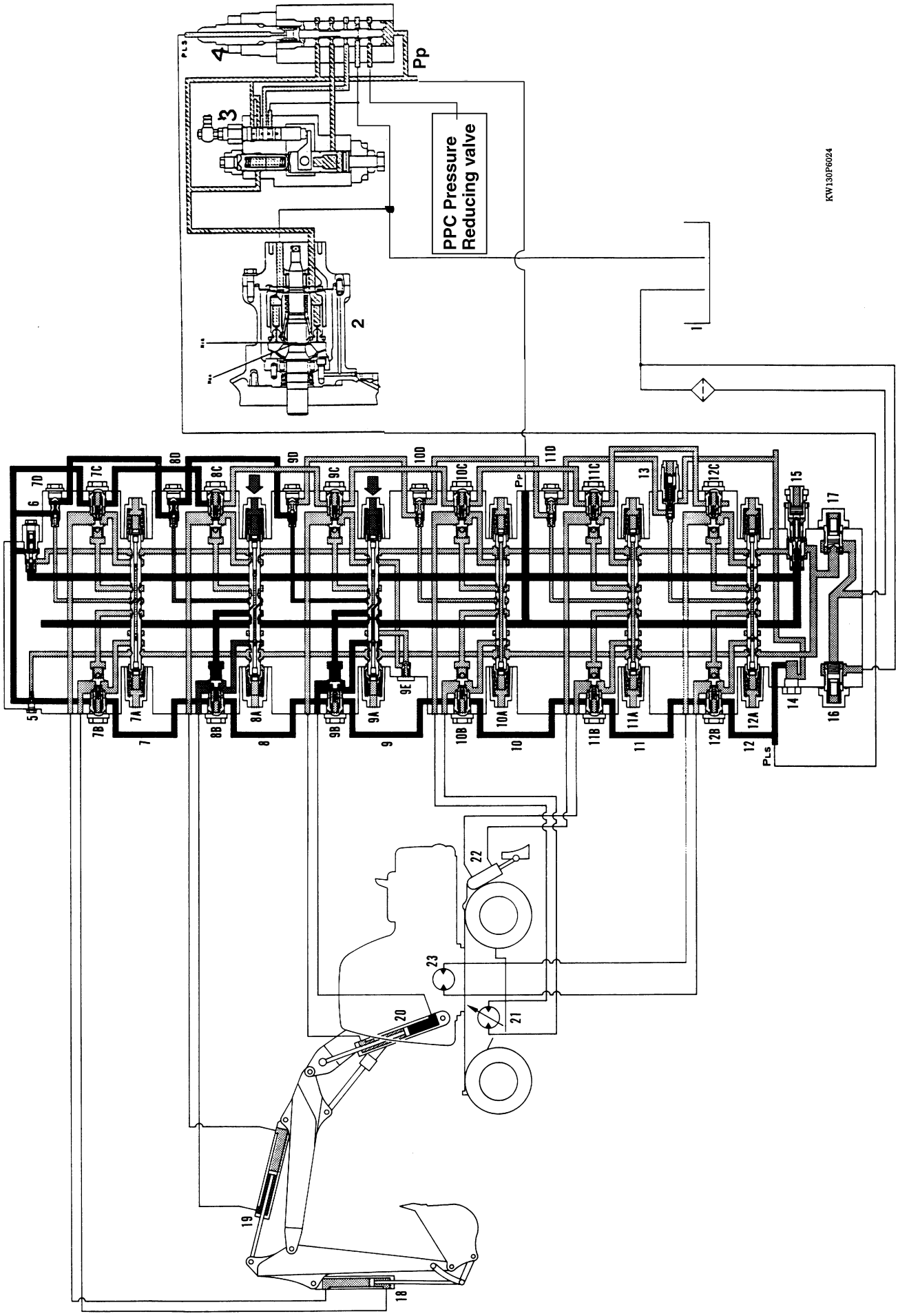
Control valve

5. LS bypass plug
6. Unload valve
7. Bucket valve
   - 7A. Spool
   - 7B. Pressure compensation valve (DUMP)
   - 7C. Pressure compensation valve (CURL)
   - 7D. LS shuttle valve
8. Arm valve
   - 8A. Spool
   - 8B. Pressure compensation valve (OUT)
   - 8C. Pressure compensation valve (IN)
   - 8D. LS shuttle valve
9. Boom valve
   - 9A. Spool
   - 9B. Pressure compensation valve (RAISE)
   - 9C. Pressure compensation valve (LOWER)
   - 9D. LS shuttle valve
   - 9E. Check valve
10. Travel valve
    - 10A. Spool
    - 10B. Pressure compensation valve (FORWARD)
    - 10C. Pressure compensation valve (REVERSE)
    - 10D. LS shuttle valve
11. Stabilizer valve
    - 11A. Spool
    - 11B. Pressure compensation valve (EXTEND)
    - 11C. Pressure compensation valve (RETRACT)
    - 11D. LS shuttle valve
12. Swing valve
    - 12A. Spool
    - 12B. Pressure compensation valve (LEFT)
    - 12C. Pressure compensation valve (RIGHT)
13. LS select valve
14. LS bypass plug
15. Main relief valve
16. Cooler bypass valve
17. Lift check valve

Actuator

18. Bucket cylinder
19. Arm cylinder
20. Boom cylinder
21. Travel motor
22. Dozer cylinder
23. Swing motor

★ The safety-suction valve, and suction valve are not shown.


PPC Pressure Reducing valve
Pp
KW130P6024

5) When circuit is relieved at end of boom stroke

- When boom cylinder (20) reaches the end of its stroke, main relief valve (15) opens and pump discharge amount Q is relieved to tank (1).
- When pump discharge pressure P_P comes close to the relief pressure, the pump controller sends a signal to the solenoid of PC valve (3) to carry out the cut-off function to make pump discharge amount Q the minimum.
- The cylinder is at the end of its stroke, so no oil flows to the upstream or downstream side of boom spool (9A). Pump discharge pressure P_P and LS pressure P_{LS} are the same pressure, and LS differential pressure $\triangle P_{LS}$ becomes 0.
- LS differential pressure $\triangle P_{LS}$ is lower than the LS set pressure of LS valve (4), so LS valve (4) acts to make the pump swash plate angle the maximum. However, because of the mechanism, the operation of PC valve (3) is given priority over the operation of LS valve (4), so the pump is kept at the minimum swash plate angle by the cut-of function of PC valve (3).

1. Hydraulic tank

Hydraulic pump

2. Main pump
3. PC valve
4. LS valve

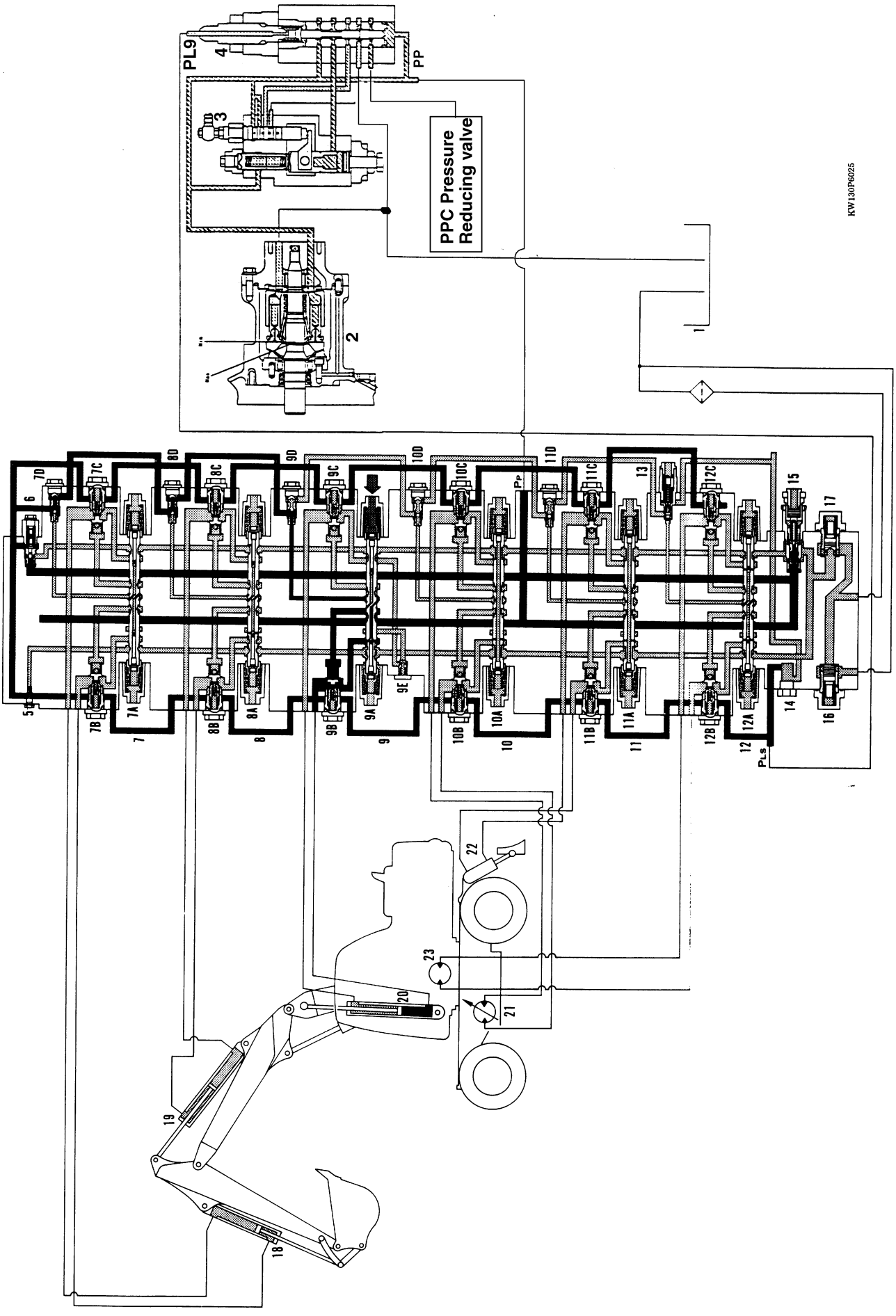
Control valve

5. LS bypass plug
6. Unload valve
7. Bucket valve
   - 7A. Spool
   - 7B. Pressure compensation valve (DUMP)
   - 7C. Pressure compensation valve (CURL)
   - 7D. LS shuttle valve
8. Arm valve
   - 8A. Spool
   - 8B. Pressure compensation valve (OUT)
   - 8C. Pressure compensation valve (IN)
   - 8D. LS shuttle valve
9. Boom valve
   - 9A. Spool
   - 9B. Pressure compensation valve (RAISE)
   - 9C. Pressure compensation valve (LOWER)
   - 9D. LS shuttle valve
   - 9E. Check valve
10. Travel valve
    - 10A. Spool
    - 10B. Pressure compensation valve (FORWARD)
    - 10C. Pressure compensation valve (REVERSE)
    - 10D. LS shuttle valve
11. Stabilizer valve
    - 11A. Spool
    - 11B. Pressure compensation valve (EXTEND)
    - 11C. Pressure compensation valve (RETRACT)
    - 11D. LS shuttle valve
12. Swing valve
    - 12A. Spool
    - 12B. Pressure compensation valve (LEFT)
    - 12C. Pressure compensation valve (RIGHT)
13. LS select valve
14. LS bypass plug
15. Main relief valve
16. Cooler bypass valve
17. Lift check valve

Actuator

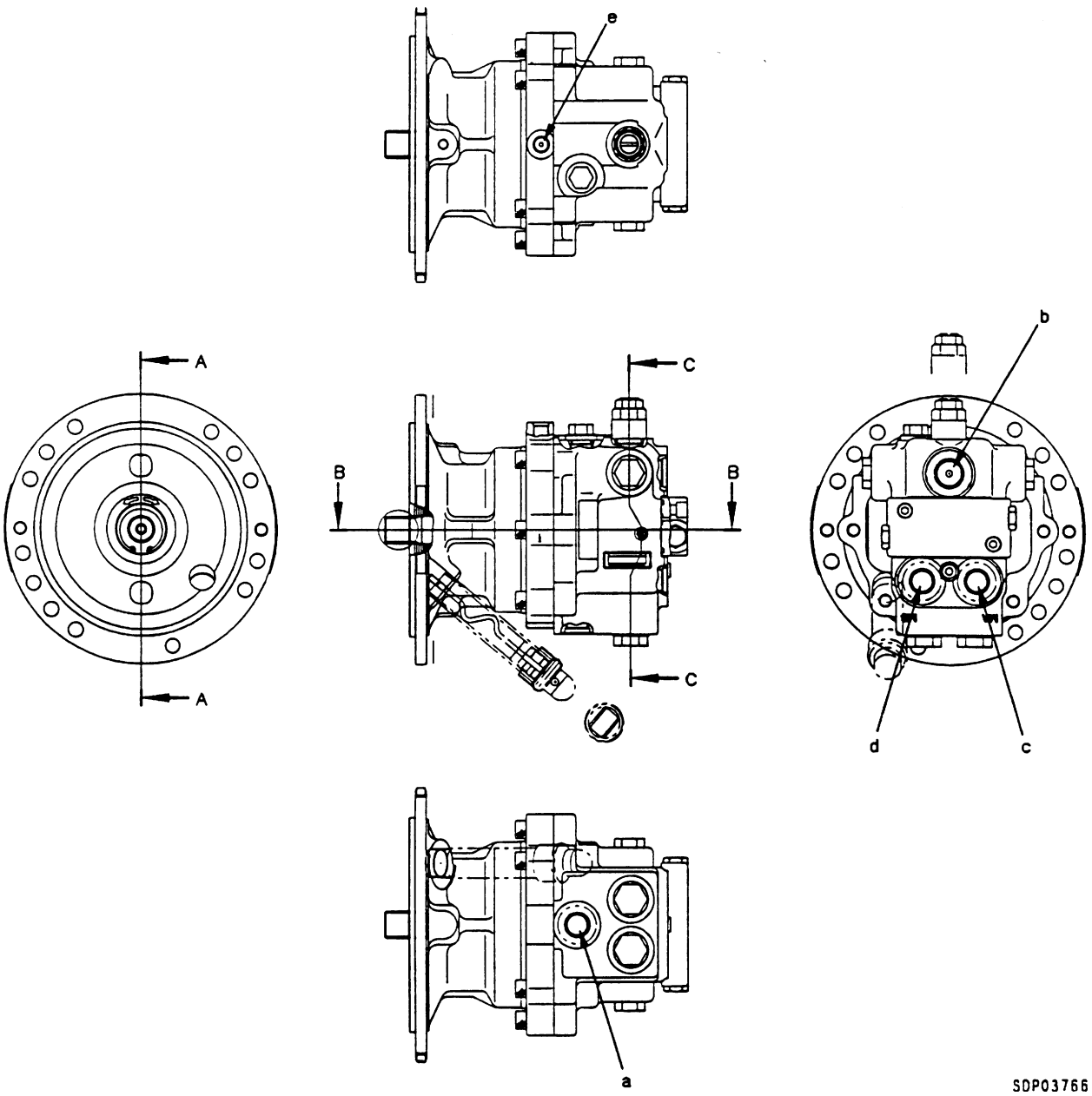
18. Bucket cylinder
19. Arm cylinder
20. Boom cylinder
21. Travel motor
22. Dozer cylinder
23. Swing motor

★ The safety-suction valve, and suction valve are not shown.


PL9
PP
PPC Pressure Reducing valve
KW130P6025

SWING MOTOR

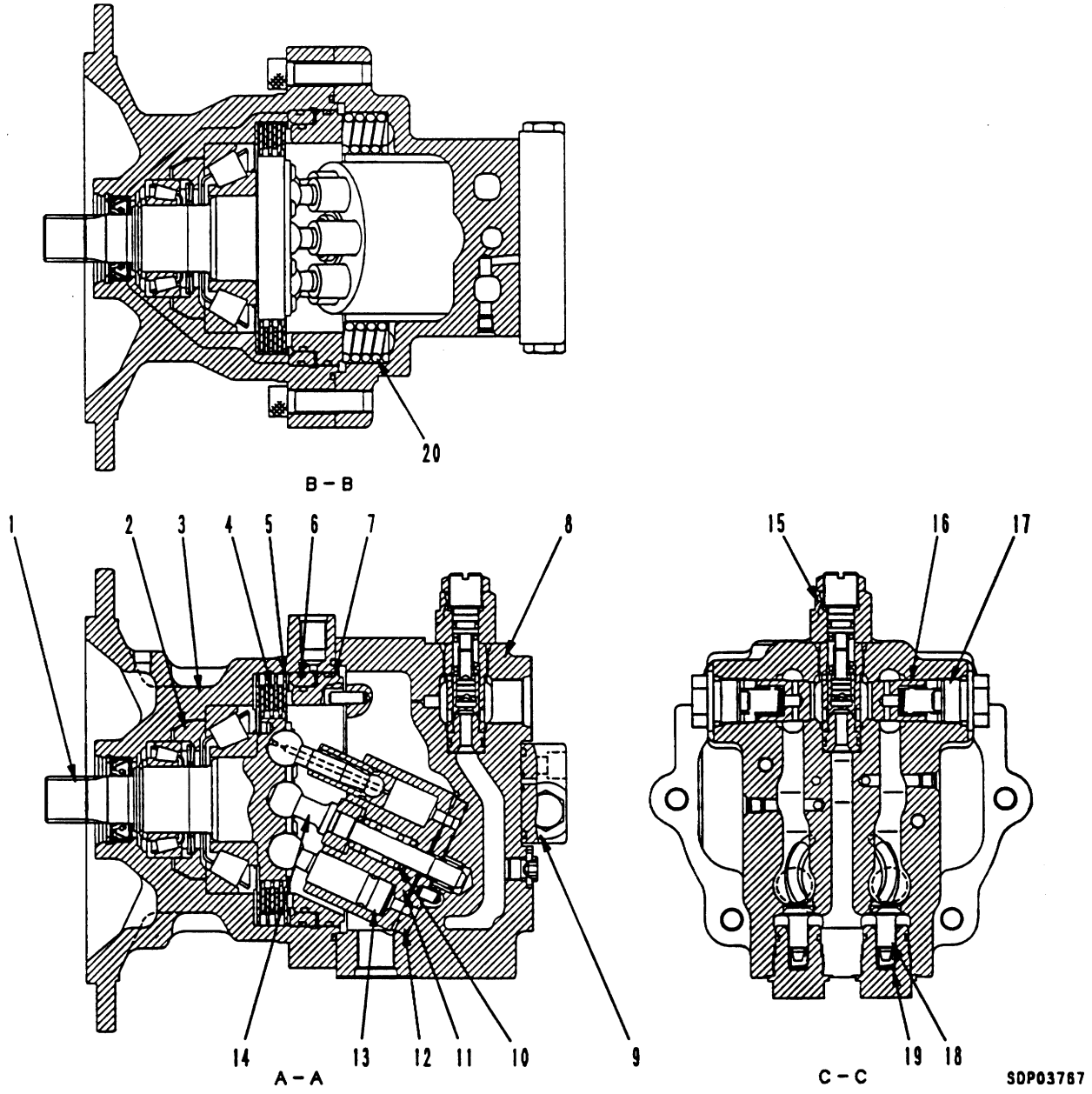
KMF40AB-3



a. Port **T** (to tank)
b. Port **S** (from control valve)
c. Port **MA** (from control valve)
d. Port **MB** (from control valve)
e. Port **B** (from swing brake solenoid valve)

SPECIFICATIONS

Type	: KMF40AB-3
Theoretical delivery	: 40.2 cc/rev
Safety valve set pressure	: 27.5 MPa {280 kg/cm^2}
Rated speed	: 2,413 rpm
Brake releasing pressure	: 1.8 MPa {18 kg/cm^2}



1. Drive shaft
2. Spacer
3. Case
4. Disc
5. Plate
6. Brake ring
7. Brake piston
8. Housing
9. Reverse flow check valve
10. Center spring
11. Cylinder
12. Valve plate
13. Piston
14. Center shaft
15. Safety valve
16. Check valve
17. Check valve spring
18. Shuttle valve
19. Shuttle valve spring
20. Brake spring

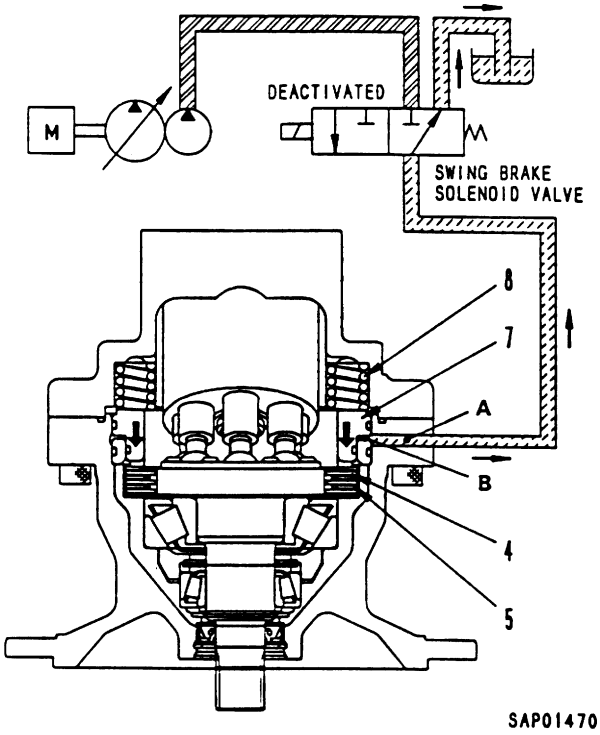
SWING HOLDING BRAKE

OPERATION

1) When swing brake solenoid valve is DEACTIVATED

When the swing brake solenoid valve is DEACTIVATED the pressurized oil from the pressure reducing valve is shut off and port **B** is connected to the tank circuit.

Because of this, brake piston (7) is pushed down in the direction of the arrow by brake spring (8), so disc (4) and plate (5) are pushed together and brake is applied.

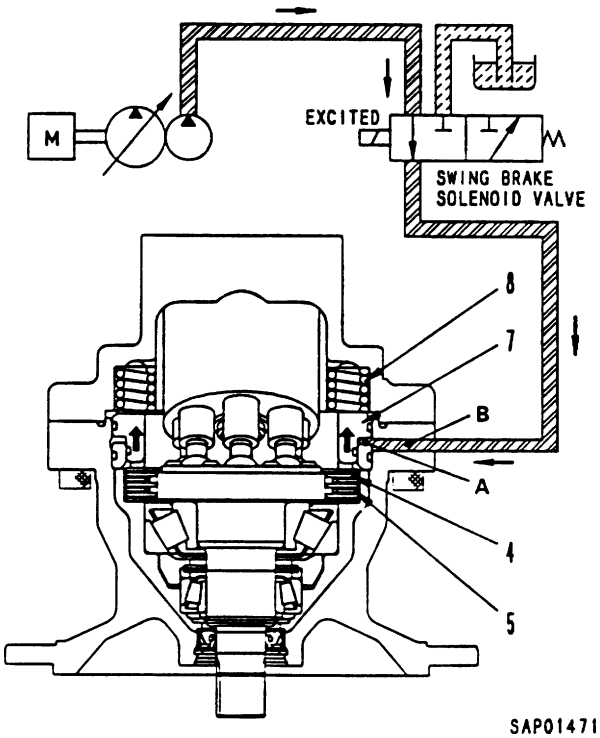


SAP01470

2) When swing brake solenoid valve is EXCITED

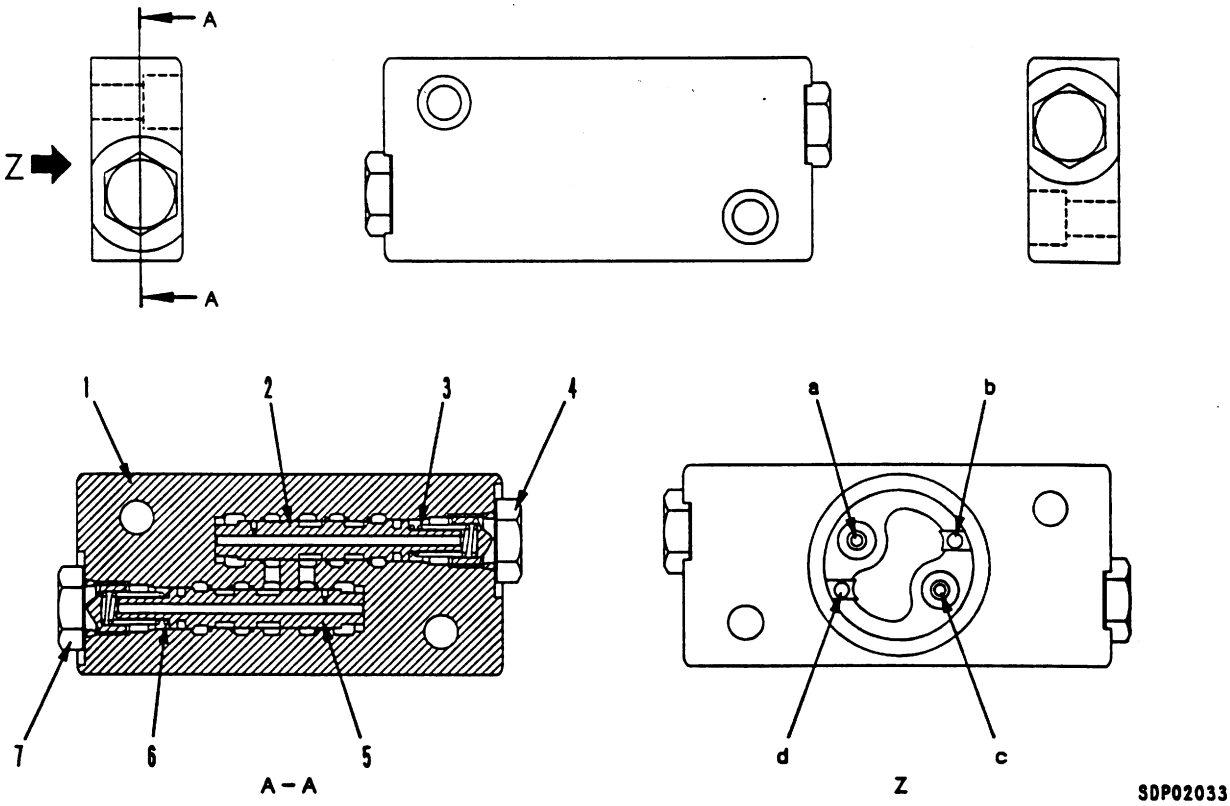
When the swing brake solenoid valve is EXCITED the valve is switched, and the pressurized oil from the pressure reducing valve enters port **B** and flows to brake chamber **A**.

The pressurized oil entering chamber **A**, overcomes the force of brake spring (8), and brake piston (7) is pushed up in the direction of the arrow. Because of this, disc (4) and plate (5) separate, and the brake is released.



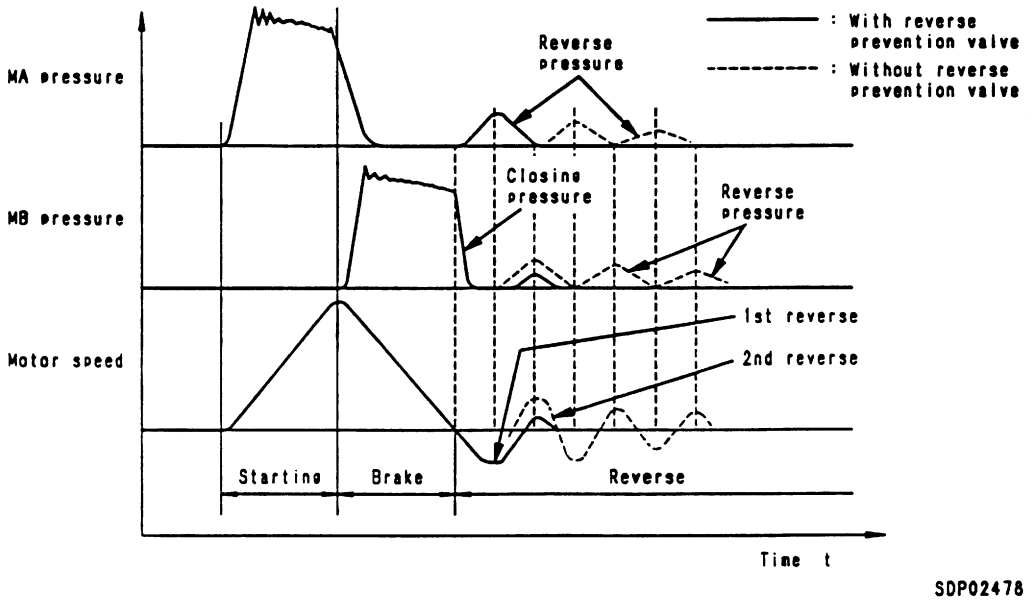
SAP01471

REVERSE FLOW CHECK VALVE



1. Valve body
2. Spool (MA side)
3. Spring (MA side)
4. Plug (MA side)
5. Spool (MB side)
6. Spring (MB side)
7. Plug (MB side)

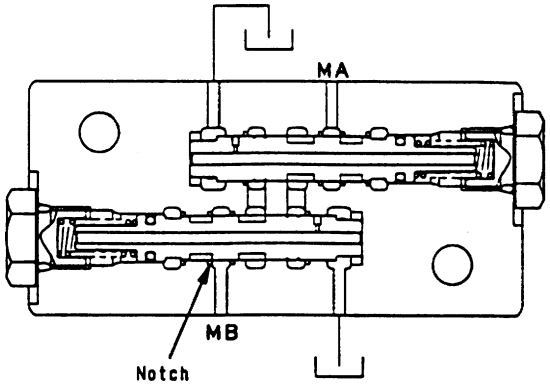
a. Ma port
b. T1 port
c. MB port
d. T2 port



OPERATION OF THE REVERSE FLOW CHECK VALVE

1. Function

When the swing is stopped, this valve reduced the rocking motion of the swing body due to the inertia of the swing body, backlash of the machinery system, the compressibility of the hydraulic oil, etc. This valve is effective to prevent the cargo from being spilled when the swing is stopped as well as to shorten the recycle time (excellent in the positioning accuracy and the next operation can be started quickly).



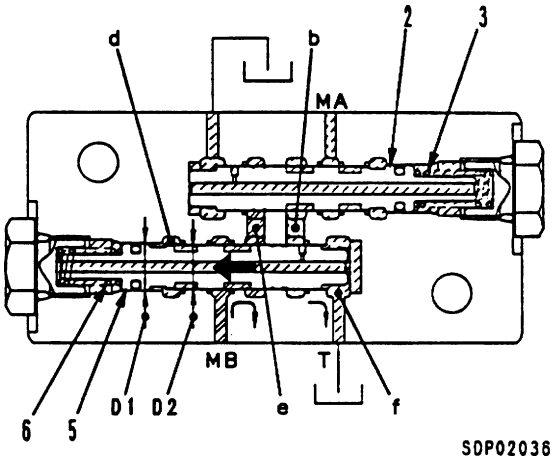
SDP02479

2. Operation

1) While the braking pressure is present at the MB port

The **MB** pressure is introduced to the **d** chamber via the notch and the spool (5) makes a stroke motion to the left, pressing the spring (6) due to the difference in area (D1>D2) and the interconnection of **MB** to **e** is established.

On this occasion, the **MA** pressure is less than the set pressure of the spring (3), so that the spool (2) does not make a stroke motion and the pressure oil is closed by the spool (2), and the braking force is secured.

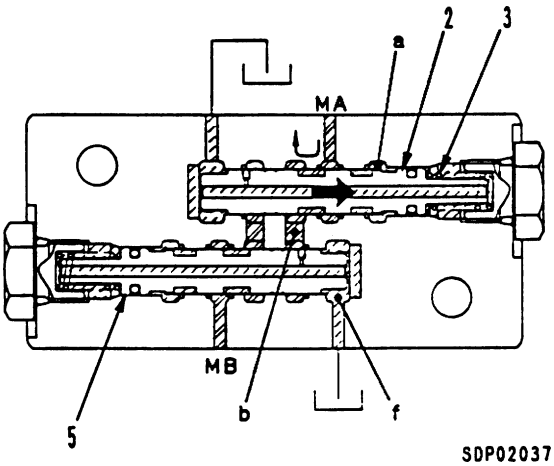


SDP02036

2) When the motor is stopped temporarily

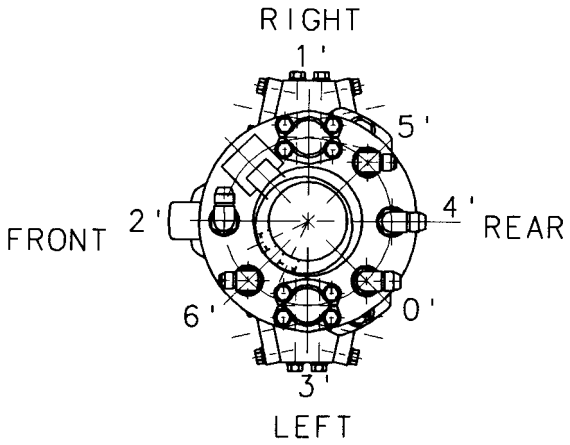
The motor is reversed by the shutoff pressure that occurred at the **MB** port (First reversal).

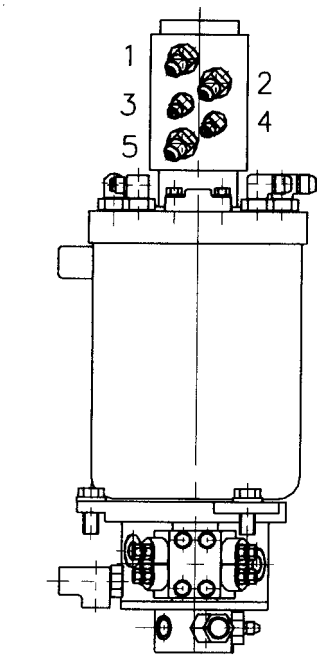
On this occasion, the reverse pressure is generated at the **MA** port side. This pressure at the **MA** port is introduced to the **a** chamber, and the spool (2) makes a stroke motion to the right, pressing the spring (3), and the interconnection of **MA** to **b** is established. Also, the interconnection of **b** to **f** is established through the drill hole and the reverse pressure at the **MA** port is bypassed to the **T** port, thereby preventing the second reversal.

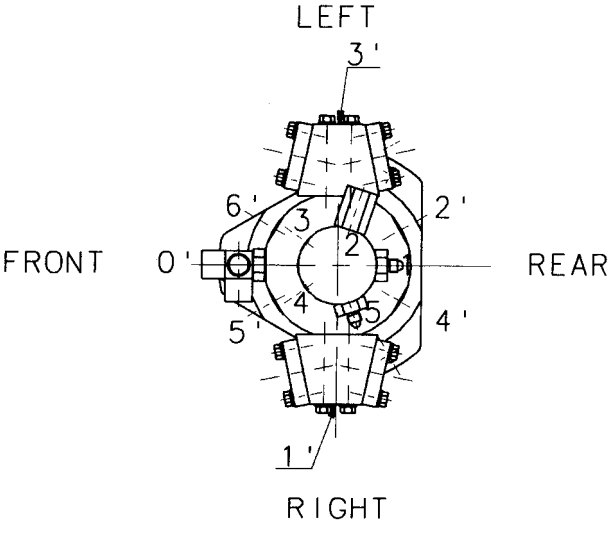


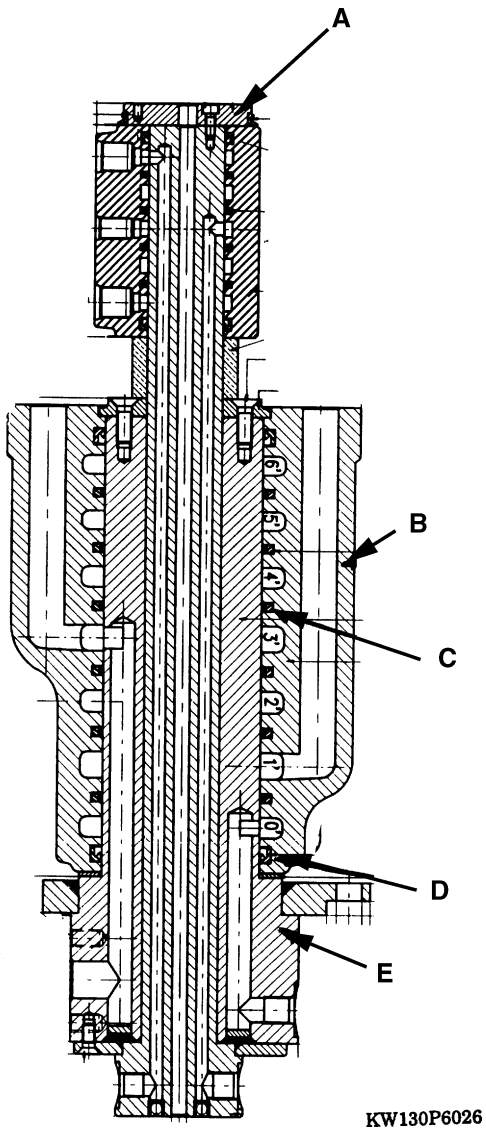
SDP02037

CENTER SWIVEL JOINT





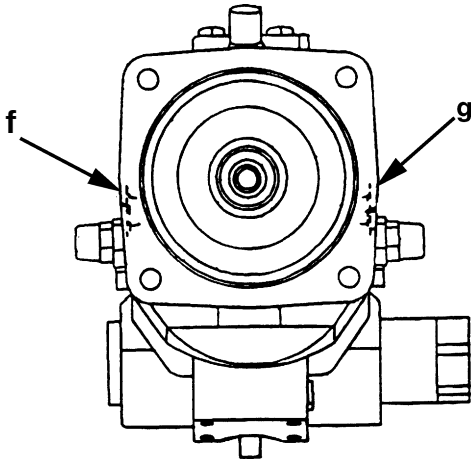


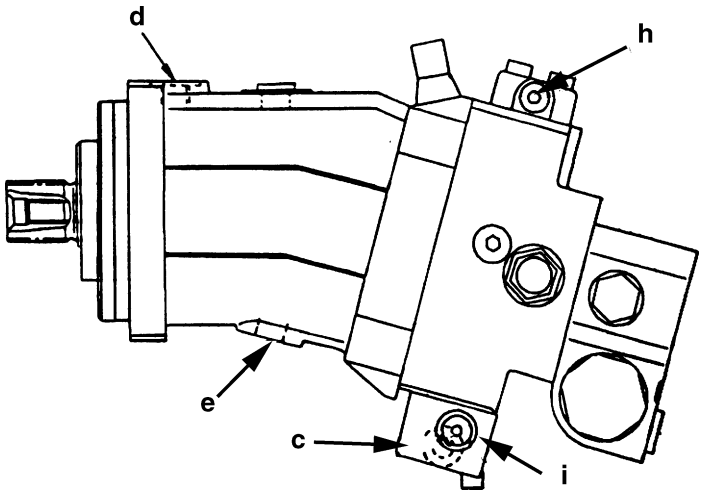


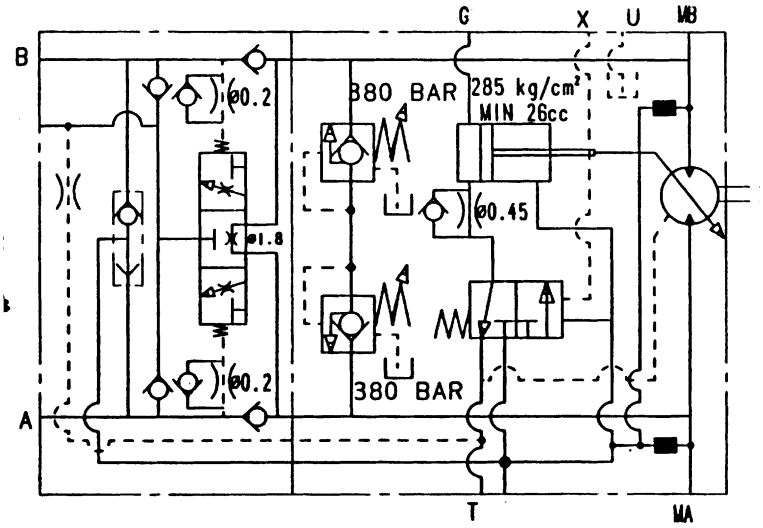
0'	Drain	A.	Cover
1'	Travel FORWARD	B.	Housing
2'	Attachment	C.	Sealing ring
3'	Travel REVERSE	D.	Lip seal
4'	Attachment	E.	Rotor
5'	Steer RH		
6'	Steer LH		

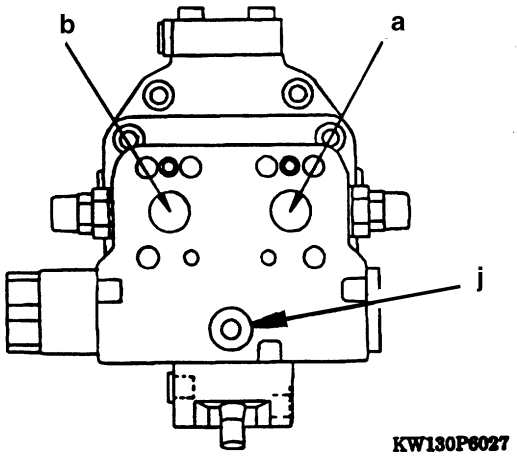
1. Service brake
2. Park brake
3. Oscillation lock
4. Travel HI/LO
5. Service brake

FRONT TRAVEL MOTOR (20 Km/h TRAVEL SPEED SPEC.)









HYDRAULIC SCHEMATIC

SPECIFICATIONS

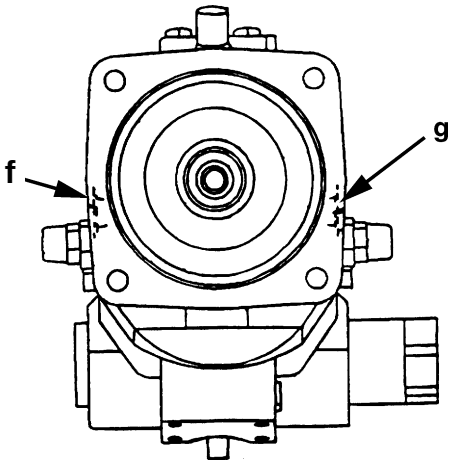
Type: Variable displacement piston motor

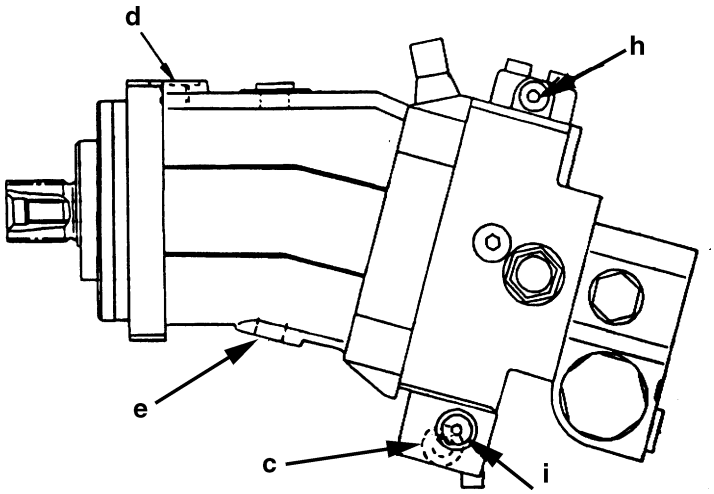
Theoretical delivery: Min. 32 cc/rev
Max. 80 cc/rev

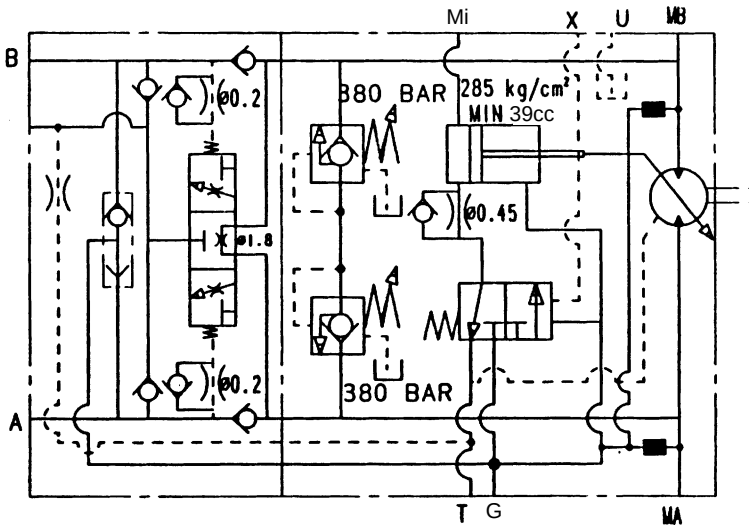
Hi-Lo switching-pressure: 2.94 MPa (30 kg/cm^2)
Rated speed: 4968 rpm. (Max)

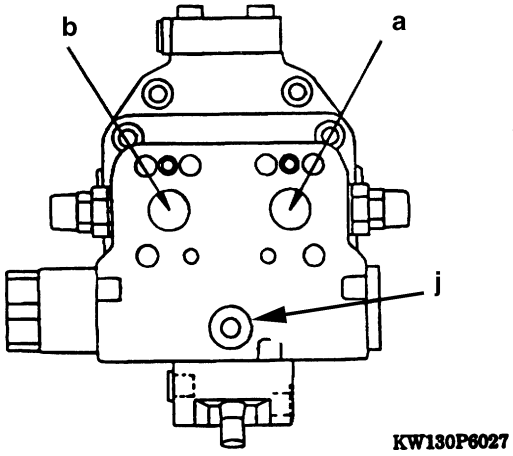
a. Motor inlet (A)
b. Motor outlet (B)
c. Override pressure port (X)
d. Drain port (U)
e. Drain port (T)
f. Pressure test port (MB)
g. Pressure test port (MA)
h. Pressure test port (M1)
i. Pressure test port (G)

FRONT TRAVEL MOTOR (30 Km/h TRAVEL SPEED SPEC.)









HYDRAULIC SCHEMATIC

SPECIFICATIONS

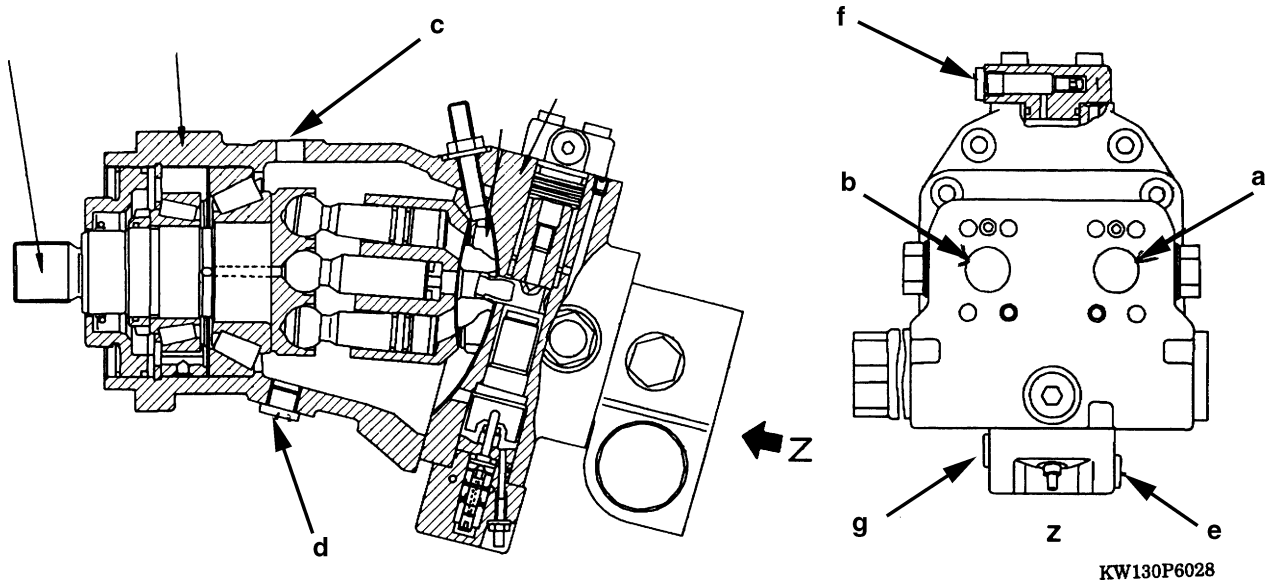
Type: Variable displacement piston motor

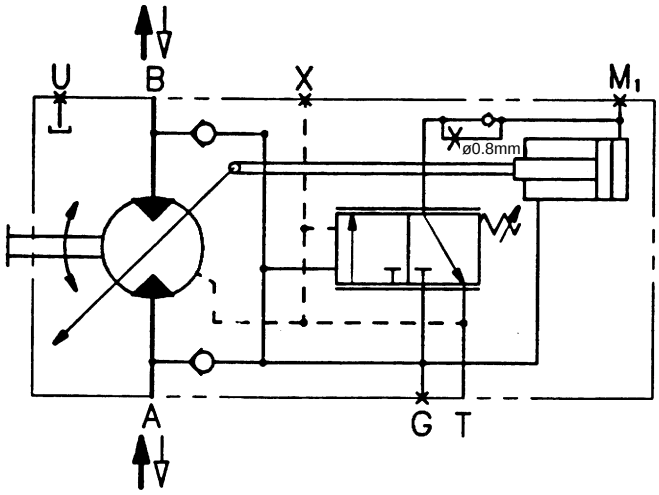
Theoretical delivery: Min. 39 cc/rev
Max. 80 cc/rev

Hi-Lo switching-pressure: 2.94 MPa (30 kg/cm^2)
Rated speed: 5240 rpm. (Max)

a. Motor inlet (A)
b. Motor outlet (B)
c. Override pressure port (X)
d. Drain port (U)
e. Drain port (T)
f. Pressure test port (MB)
g. Pressure test port (MA)
h. Pressure test port (M1)
i. Pressure test port (G)

REAR TRAVEL MOTOR (20 Km/h TRAVEL SPEED SPEC.)





HYDRAULIC SCHEMATIC

SPECIFICATIONS

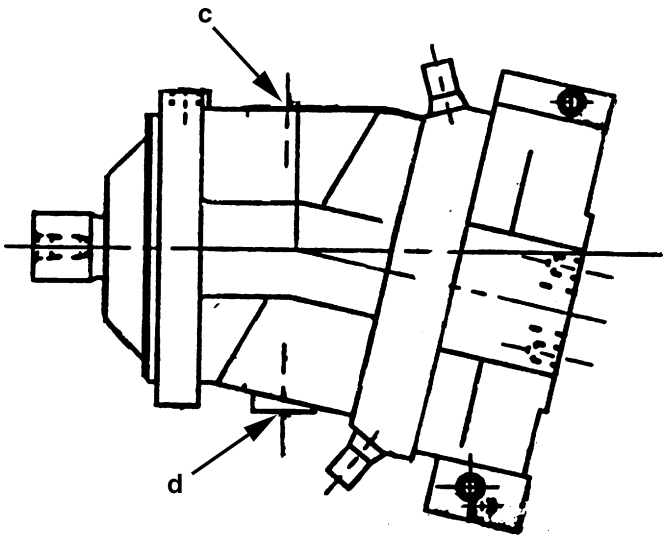
Type: Variable displacement piston motor

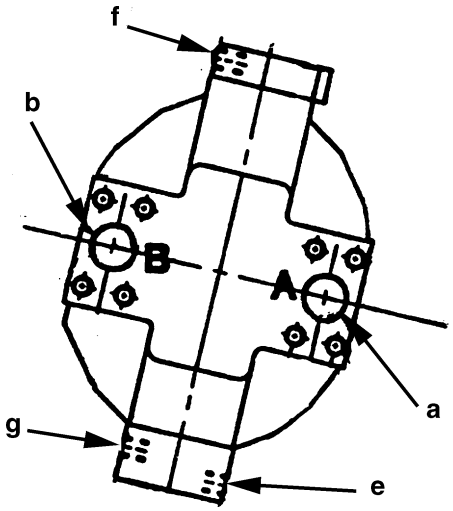
Theoretical delivery: Min. 0 Max. 107 cc/rev

Rated speed: 4968 rpm. (Max)

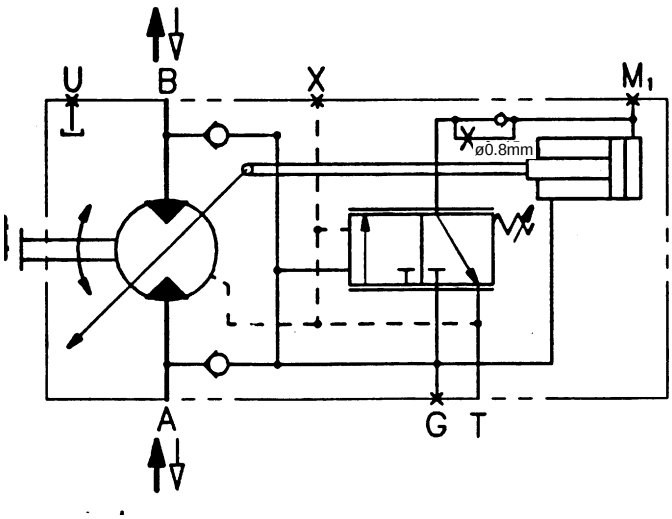
a. Motor inlet (A)
b. Motor outlet (B)
c. Drain port (T)
d. Drain port (T)
e. Override pressure port (X)
f. Pressure test port (M1)
g. Pressure test port (G)

REAR TRAVEL MOTOR (30 Km/h TRAVEL SPEED SPEC.)





a. Motor inlet (A)
b. Motor outlet (B)
c. Drain port (T)
d. Drain port (T)
e. Override pressure port (X)
f. Pressure test port (M1)
g. Pressure test port (G)



Hydraulic Schematic Diagram

SPECIFICATIONS

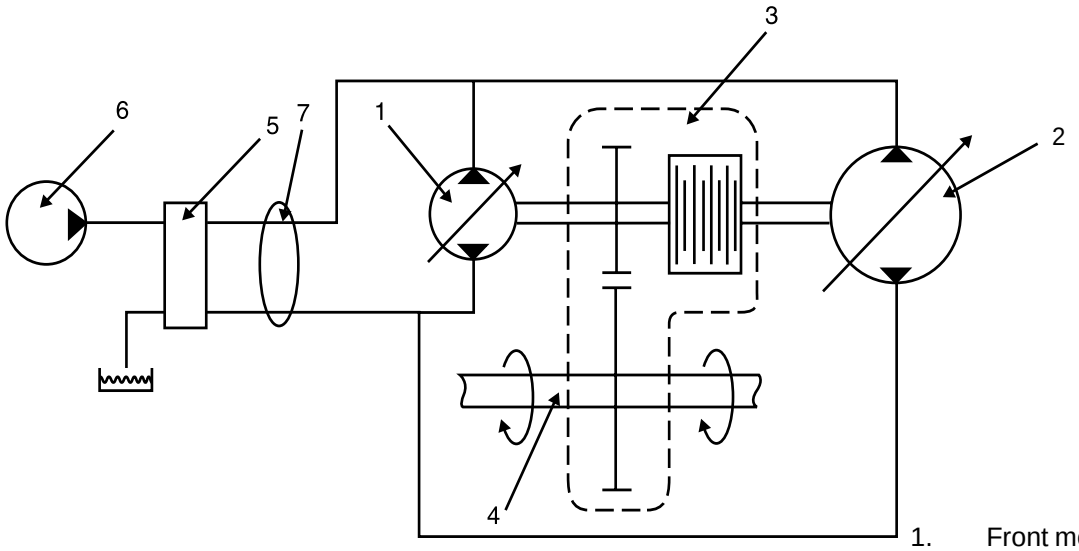
Type: Variable displacement piston motor

Theoretical delivery: Min. 0
Max. 160 cc/rev

Rated speed: 5000 rpm. (Max)

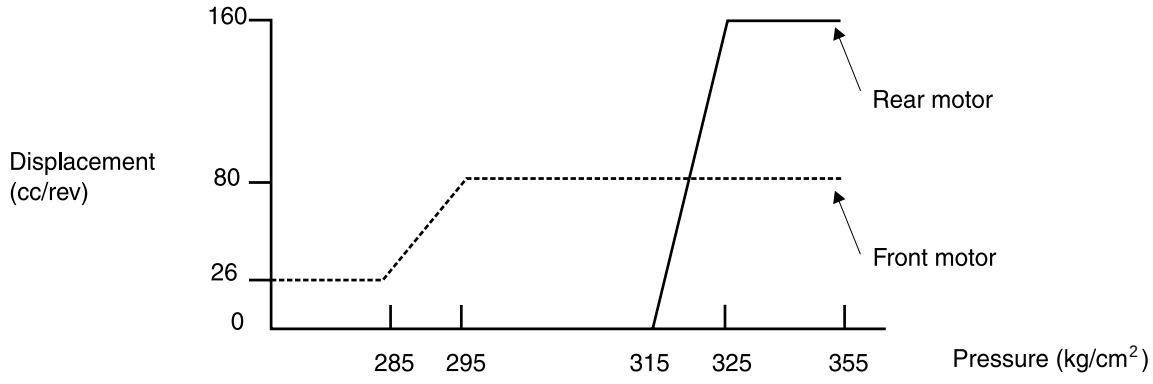
OPERATION OF TRAVEL MOTORS (30 Km/h TRAVEL SPEED SPEC.)

1) During normal travel



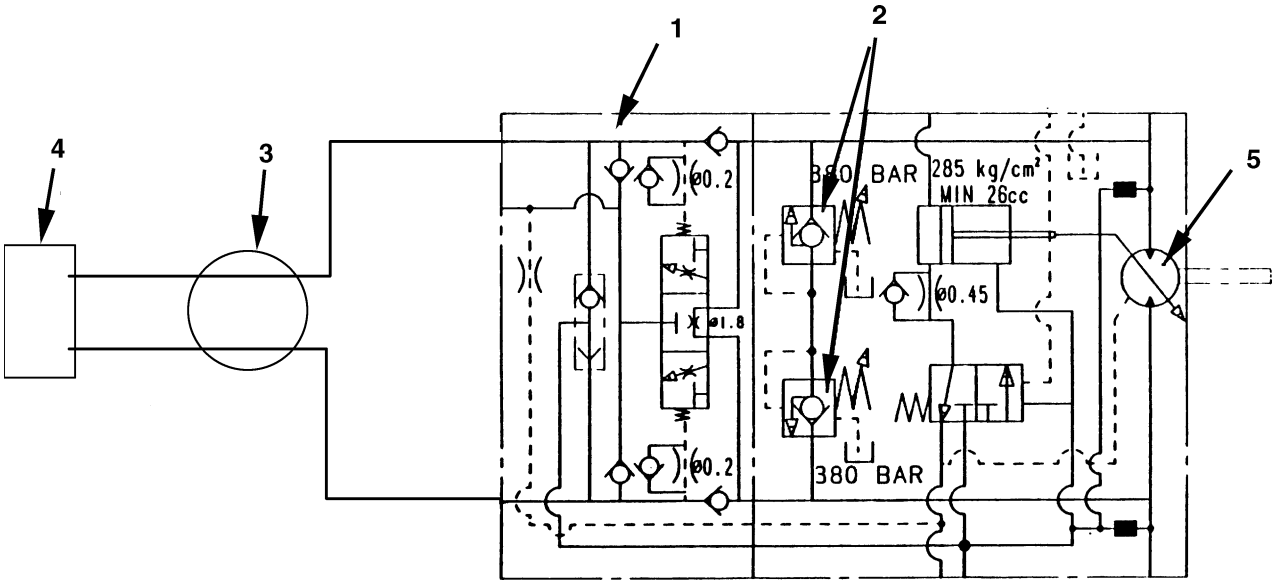
1. Front motor
2. Rear motor
3. Transmission and clutch
4. Drive shafts
5. Main control valve
6. Main pump
7. Swivel joint

- When the machine accelerates from stationary the pressure at the travel motors rises to maximum. This high pressure is used to set the displacement of front and rear travel motor to maximum to give maximum torque.
- As the machine speed increases, the flow to the travel motors increases and so pressure will reduce. This reducing pressure is used to reduce the displacement of the travel motors to allow increasing speed. At first the rear motor changes from maximum displacement to zero and is then disconnected by the clutch and then the front motor changes from maximum to a preset minimum. Displacement changes according to the diagram below.



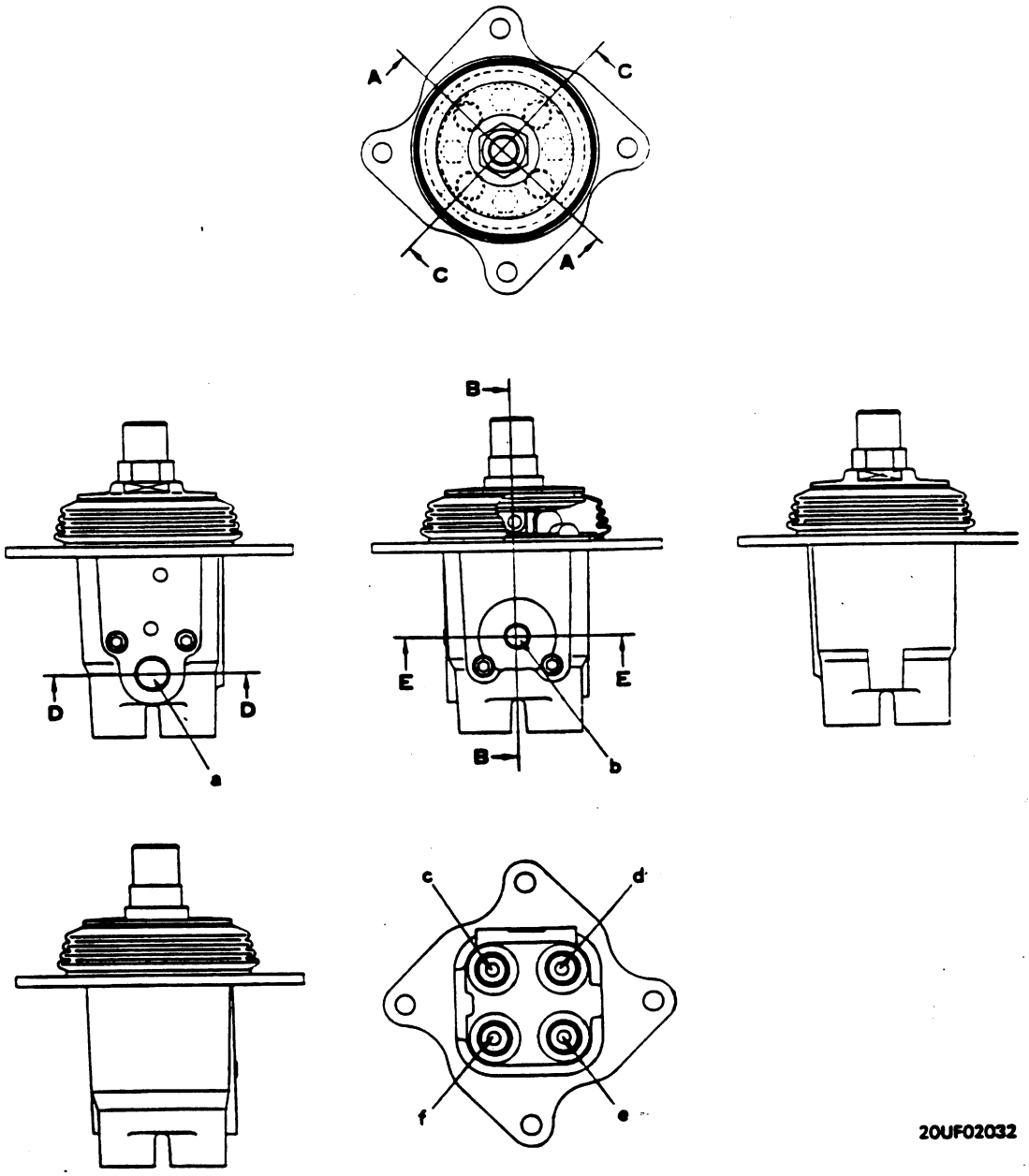
2) Control of speed downhill

At high speed, only the front motor is working. When the machine is travelling downhill, machine speed must be limited to prevent overspeed of travel motor, transmission and axles. In the downhill condition the machine weight is driving the machine and pressure at the travel motor inlet becomes low. This low pressure is used to close the counterbalance valve. The travel motor will rotate because it is driven from the wheels and so oil in the travel motor is circulated at high pressure through the brake valves. This oil circulated at high pressure in the travel motor does work to slow the machine.

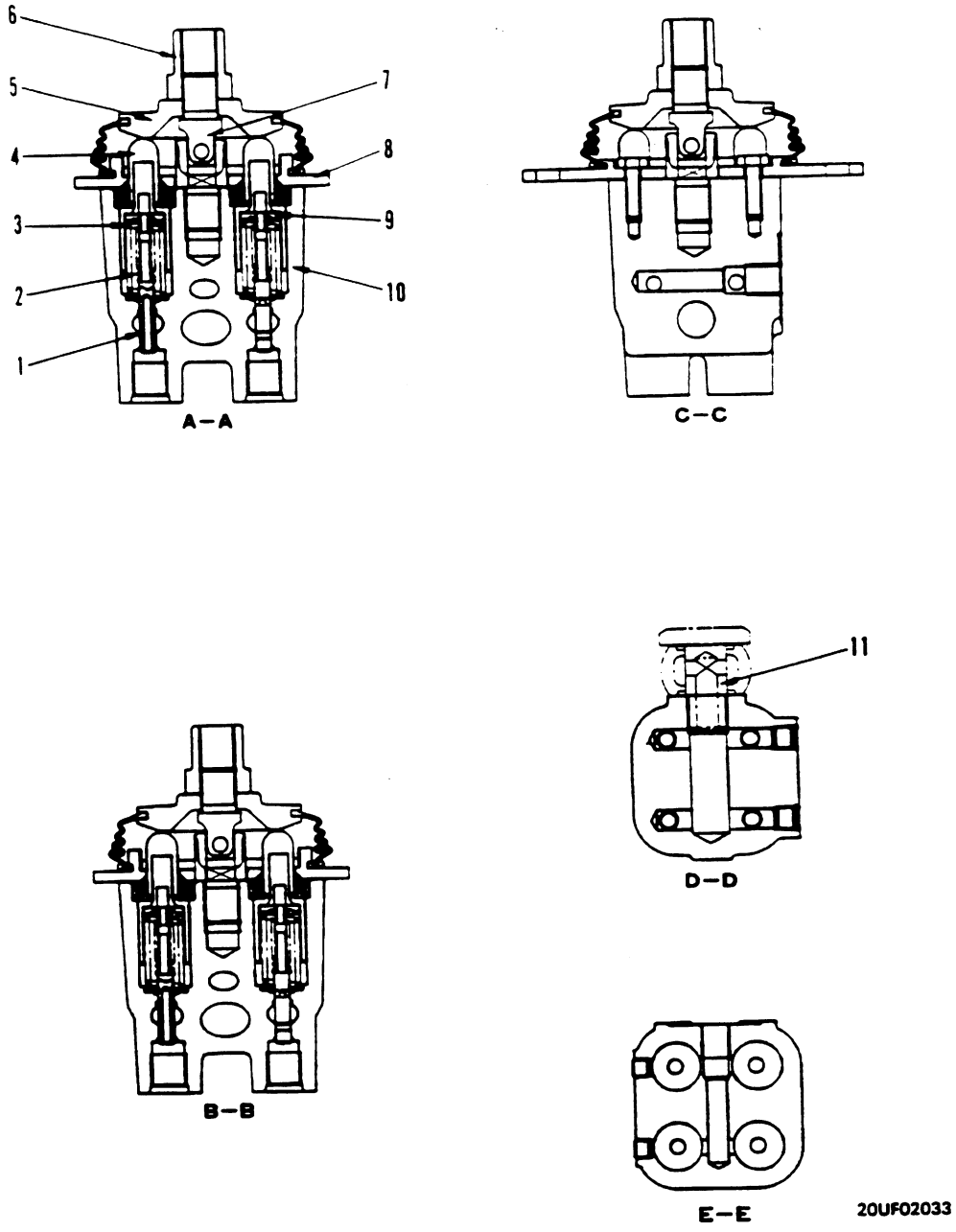


1. Counterbalance valve
2. Brake valve
3. Swivel joint
4. Main control valve
5. Front travel motor

WORK EQUIPMENT - SWING PPC VALVE



a. Port **P** (from PPC Pressure Reducing Valve)
b. Port **T** (to tank)
c. Port **P2** (L.H.: Arm IN/R.H.: Boom RAISE)
d. Port **P4** (L.H.: Swing LEFT/R.H.: Bucket DUMP)
e. Port **P1** (L.H.: Arm OUT/R.H.: Boom LOWER)
f. Port **P3** (L.H.: Swing RIGHT/R.H.: Bucket CURL)

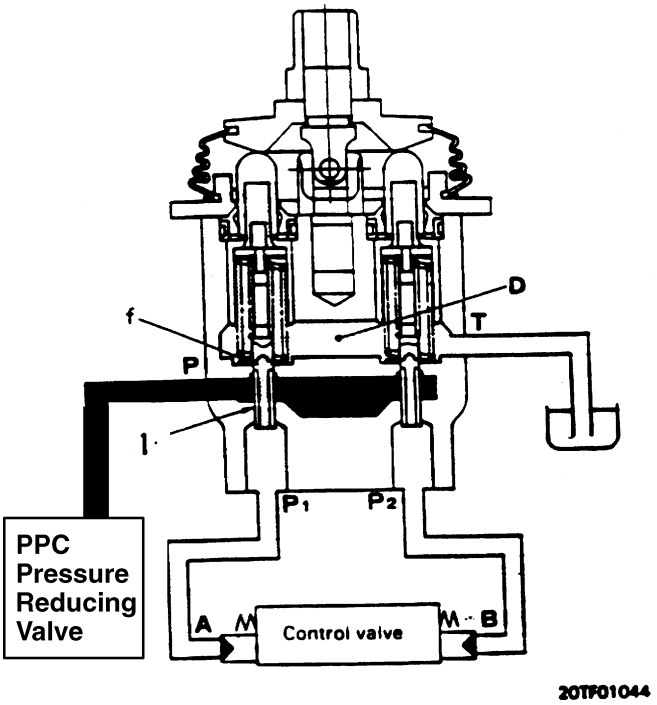


1. Spool
2. Metering spring
3. Centering spring
4. Piston
5. Disc
6. Nut (for connecting lever)
7. Joint
8. Plate
9. Retainer
10. Body
11. Filter

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)



2) During 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.

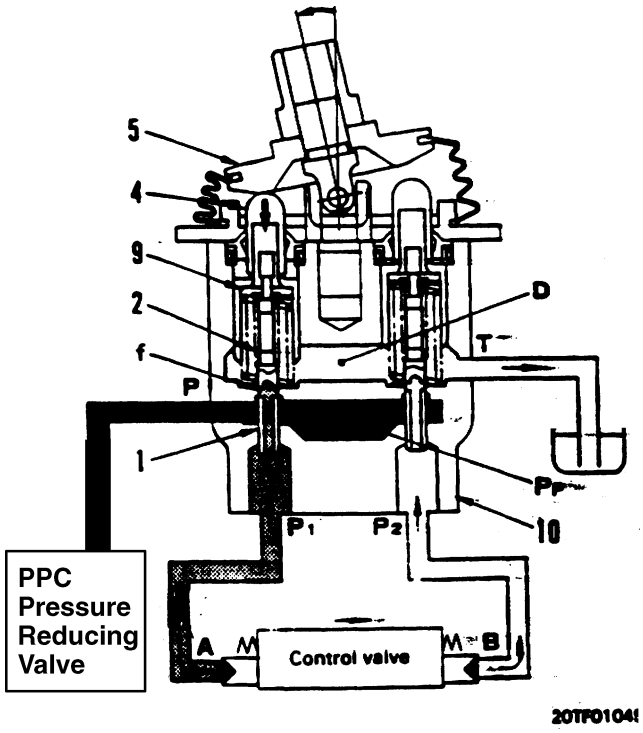
When this happens, fine control hole "**f**" is shut off from drain chamber **D**, and at almost the same time, it is connected to pump pressure chamber **Pp**, so pilot pressure oil from the pressure reducing valve passes through fine control hole "**f**" and goes from port **P1** to port **A**.

When the pressure at port **P1** becomes higher, spool (1) is pushed back and fine control hole "**f**" is shut off from pump pressure chamber **Pp**. At almost the same time, it is connected to drain chamber **D** to release the pressure at port **P1**.

When this happens, spool (1) moves up or down so that the force of metering spring (2) is balanced with the pressure at port **P1**. The relationship in the position of spool (1) and body (10) (fine control hole "**f**" is at a point midway between drain hole **D** and pump pressure chamber **Pp**) does not change until retainer (9) contacts spool (1).

Therefore, metering spring (2) is compressed proportionally to the amount on movement 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 control valve spool moves to a position where the pressure in chamber **A** (the same as the pressure at port **P1**) and the force of the control valve spool return spring are balanced. (Fig.2)



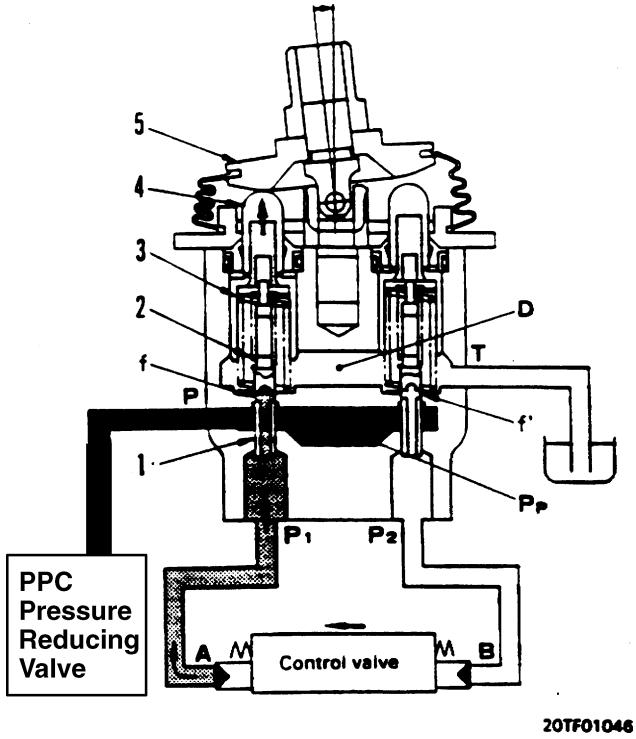
3) During fine control (when control lever is returned)

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**.

When this happens, fine control hole "**f**" is connected to drain chamber **D** and the pressure oil at port **P1** is released.

If the pressure at port **P1** drops too far, spool (1) is pushed down by metering spring (2), and 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 pump pressure is supplied until the pressure at port **P1** recovers to a pressure that corresponds to the lever position. When the spool of the control valve returns, oil in drain chamber D flows in from fine control hole "f" in the valve on the side that is not working.

The oil passes through port **P2** and enters chamber **B** to fill the chamber with oil. (Fig.3)



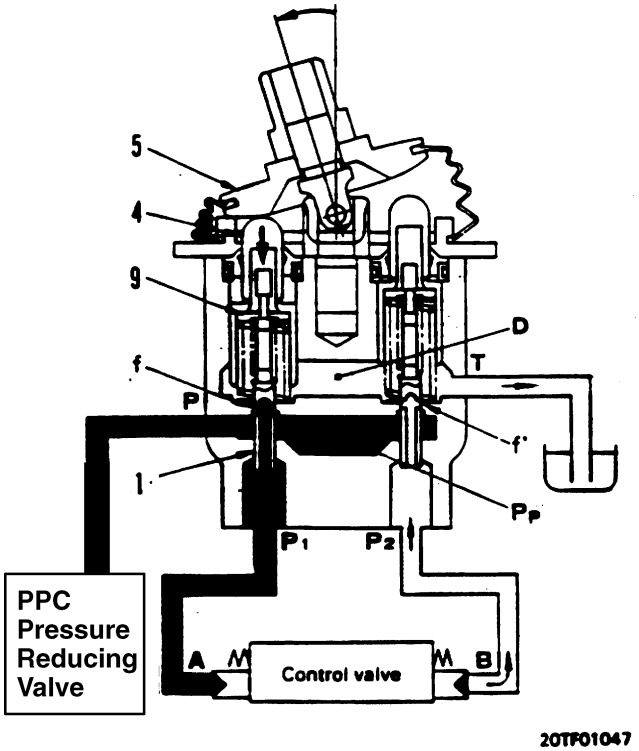
20TF01046

4) At full stroke

When 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 with pump pressure chamber **Pp**.

Therefore, the pilot pressure oil from the pressure reducing valve passes through fine control hole "**f**" and flows to chamber **A** from port **P1**, and pushed the control valve spool.

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



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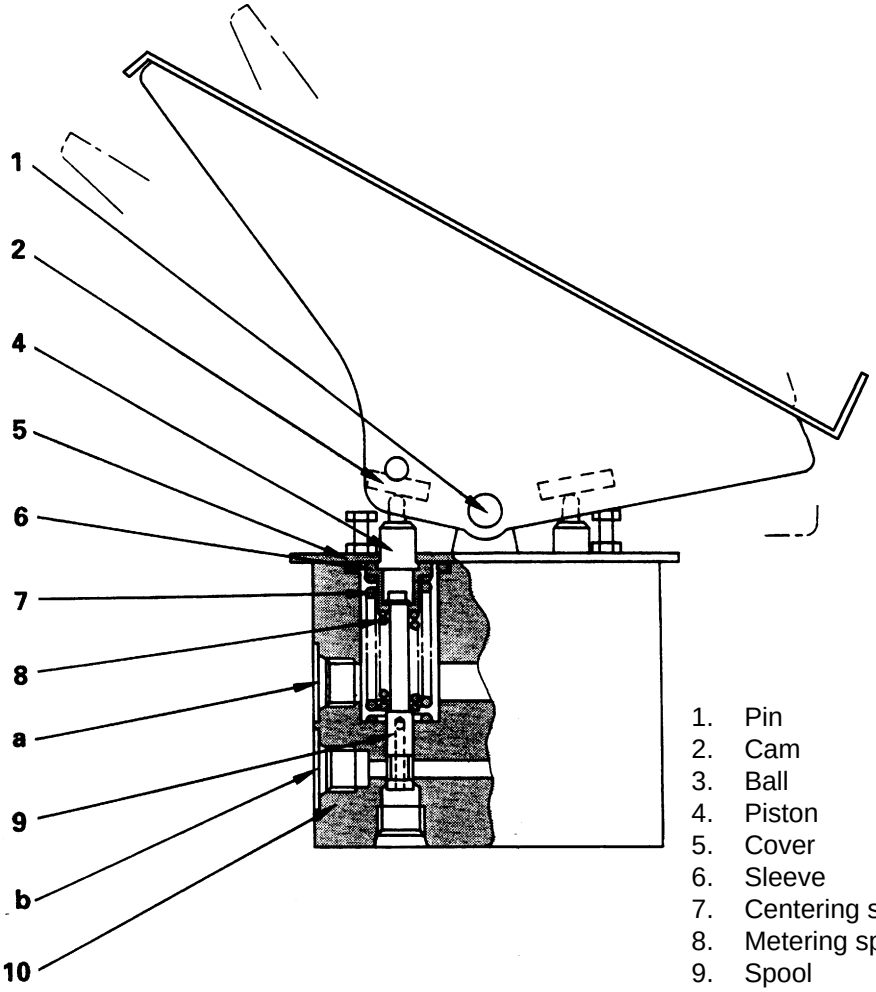
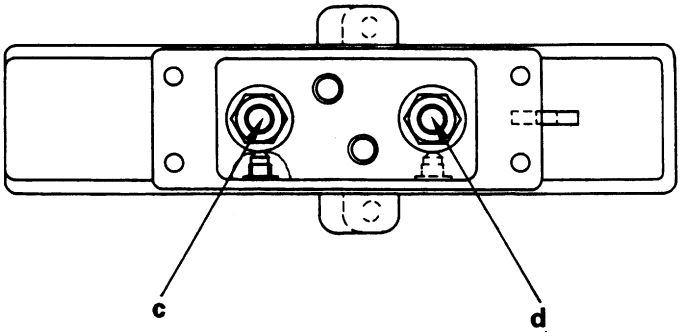
TRAVEL PPC VALVE PEDAL



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

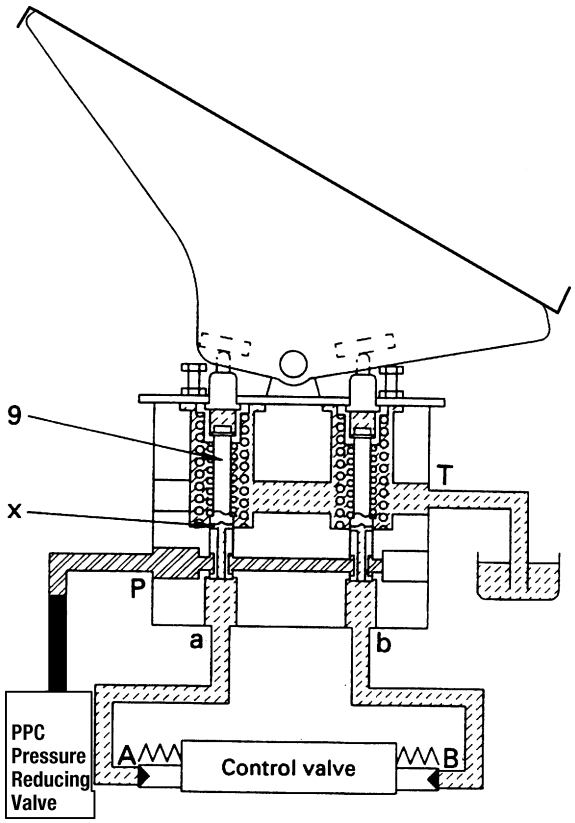
a. Port **T** (to tank)
b. Port **P** (from PPC pressure reducing valve)
c. Port **A** (travel FWD)
d. Port **B** (travel REV)



OPERATION

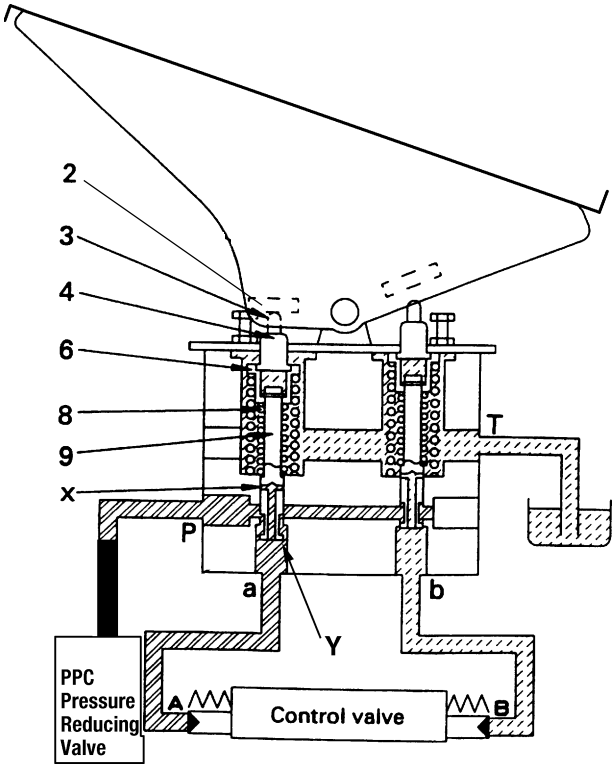
At neutral

- The pressurized oil from the pressure reducing valve 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 the fine control hole **X** of spool (9).

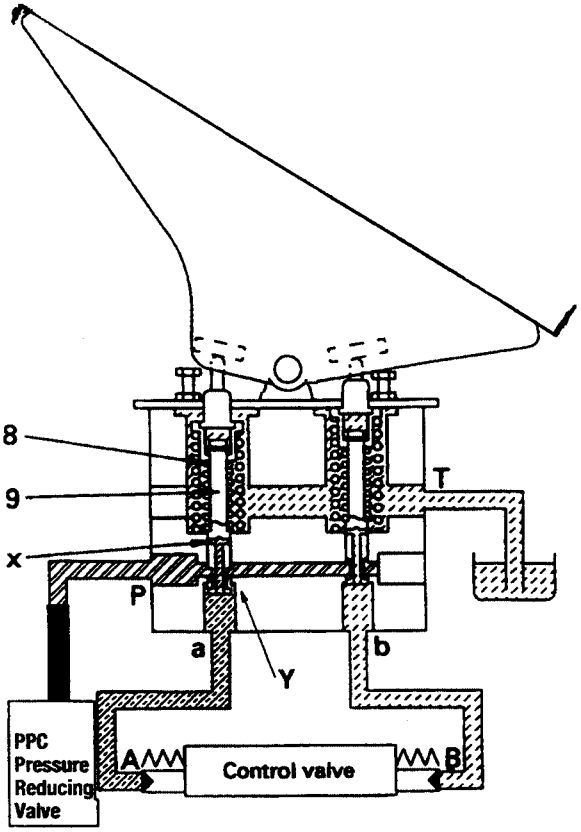


When operated

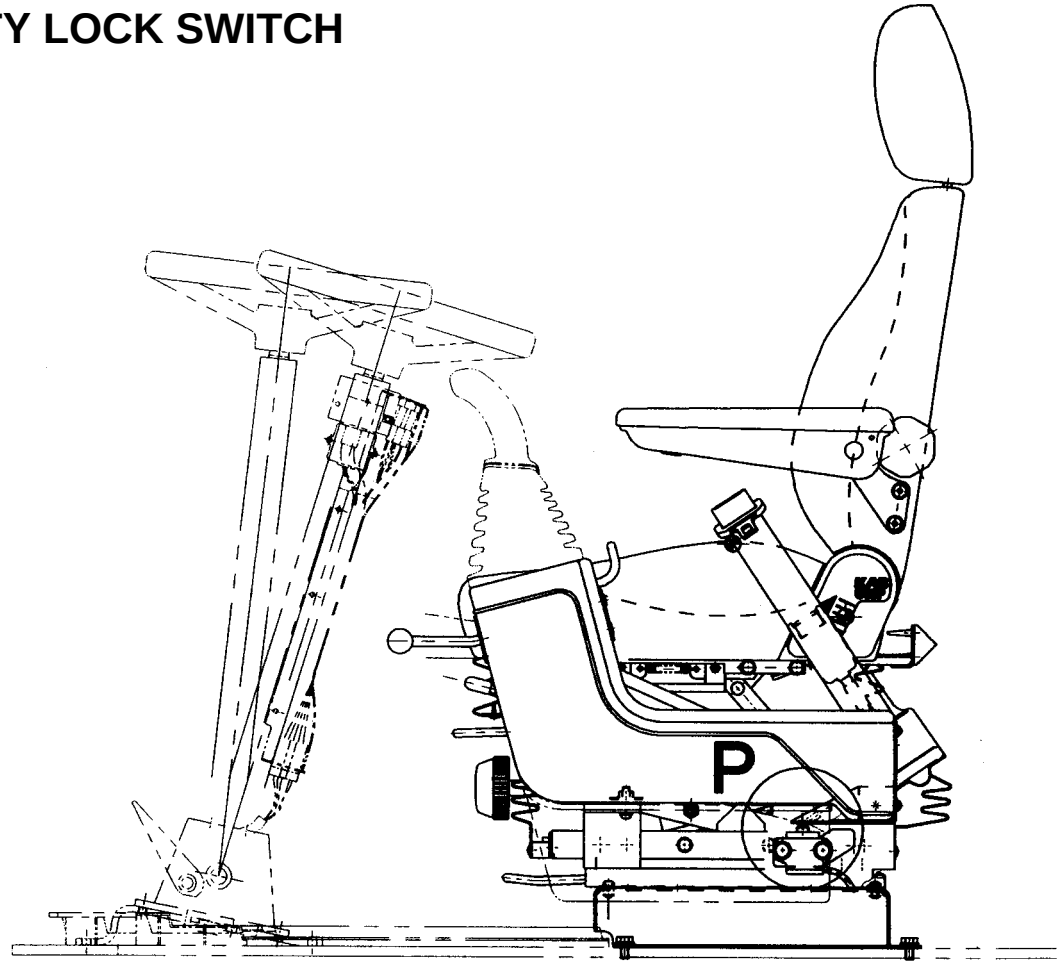
- When cam (2) is moved, metering spring (8) is pushed by ball (3), piston (4), and sleeve (6), and spool (9) is also pushed down by this.
- As a result, fine control hole **X** is shut off from the drain circuit. At almost the same time, fine control portion **Y** is connected with port "**a**", and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

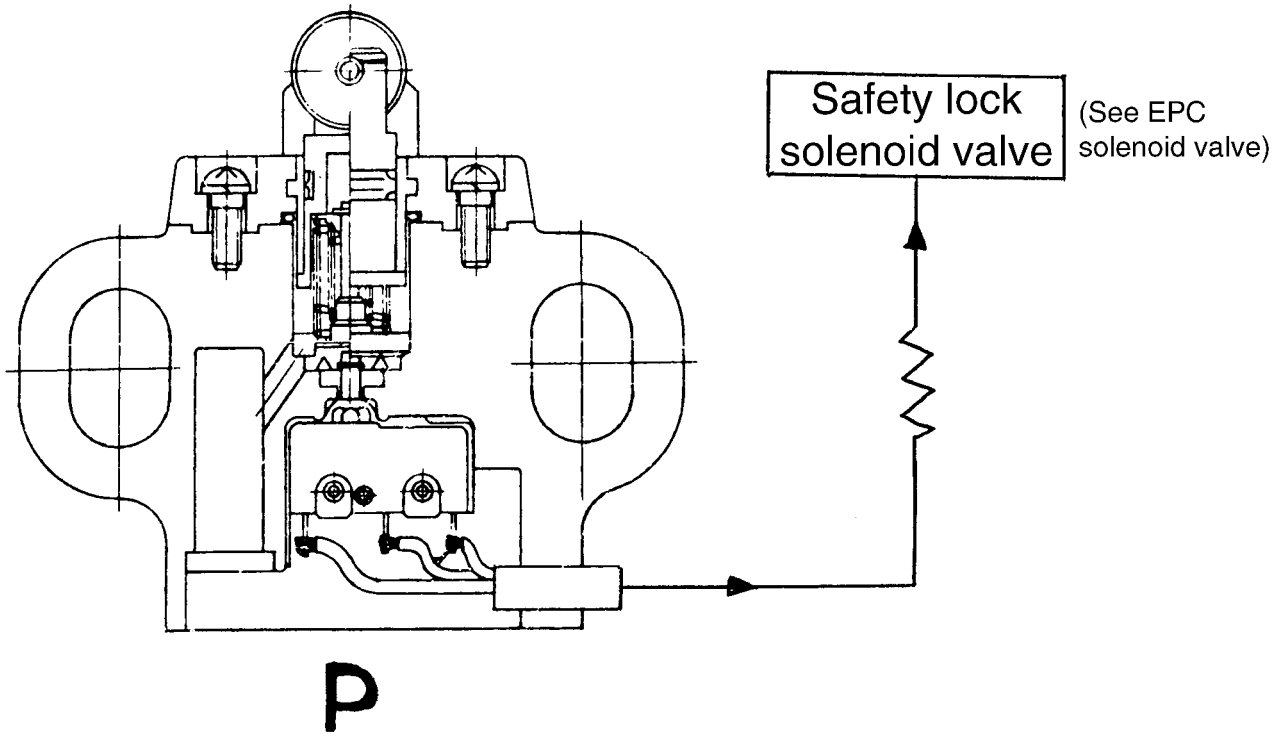


- When the pressure at port "**a**" becomes higher, spool (9) is pushed back by the force acting on the end of the spool. When fine control portion **Y** closes, fine control hole **X** is connected to the drain circuit at almost the same time.
- As a result, spool (9) moves up and down to balance the 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 pedal is operated.
- In this way, the control valve spool moves to a position 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.

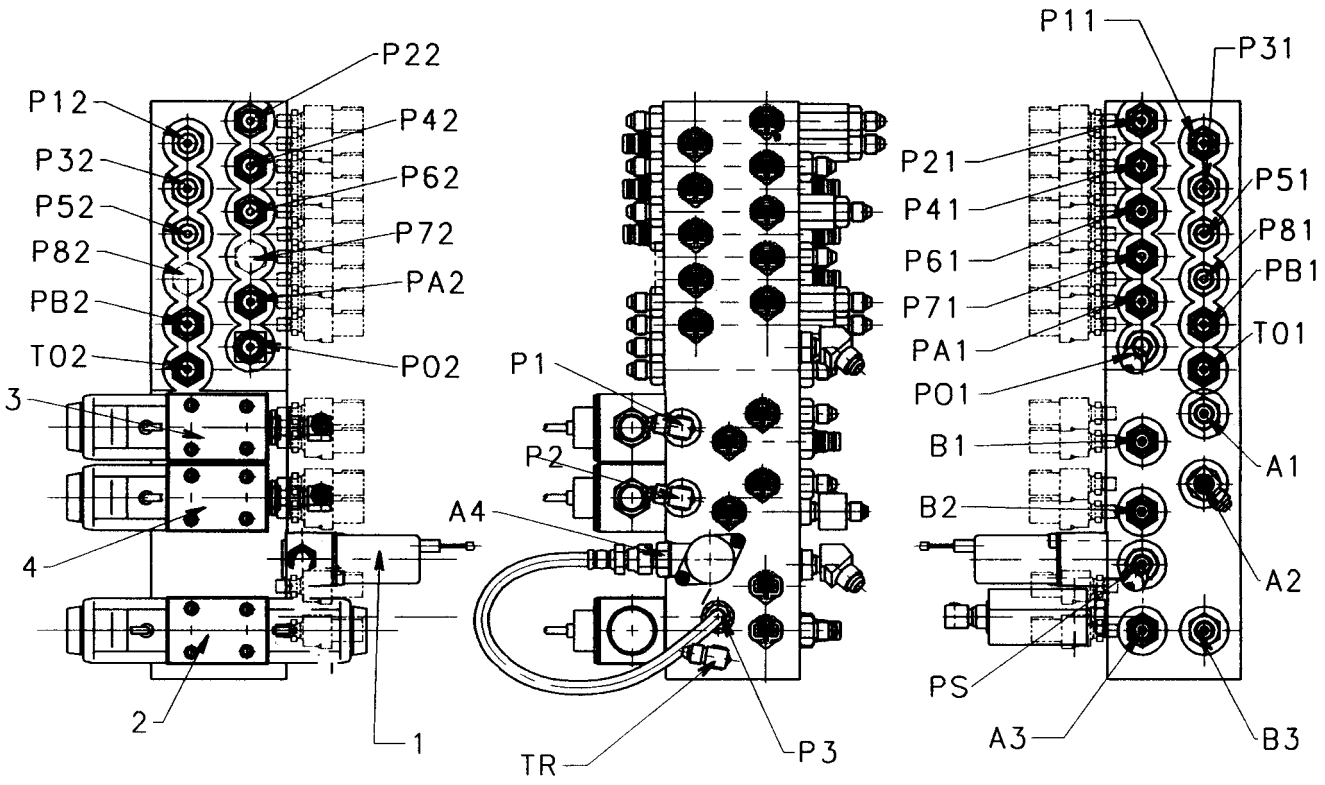


SAFETY LOCK SWITCH





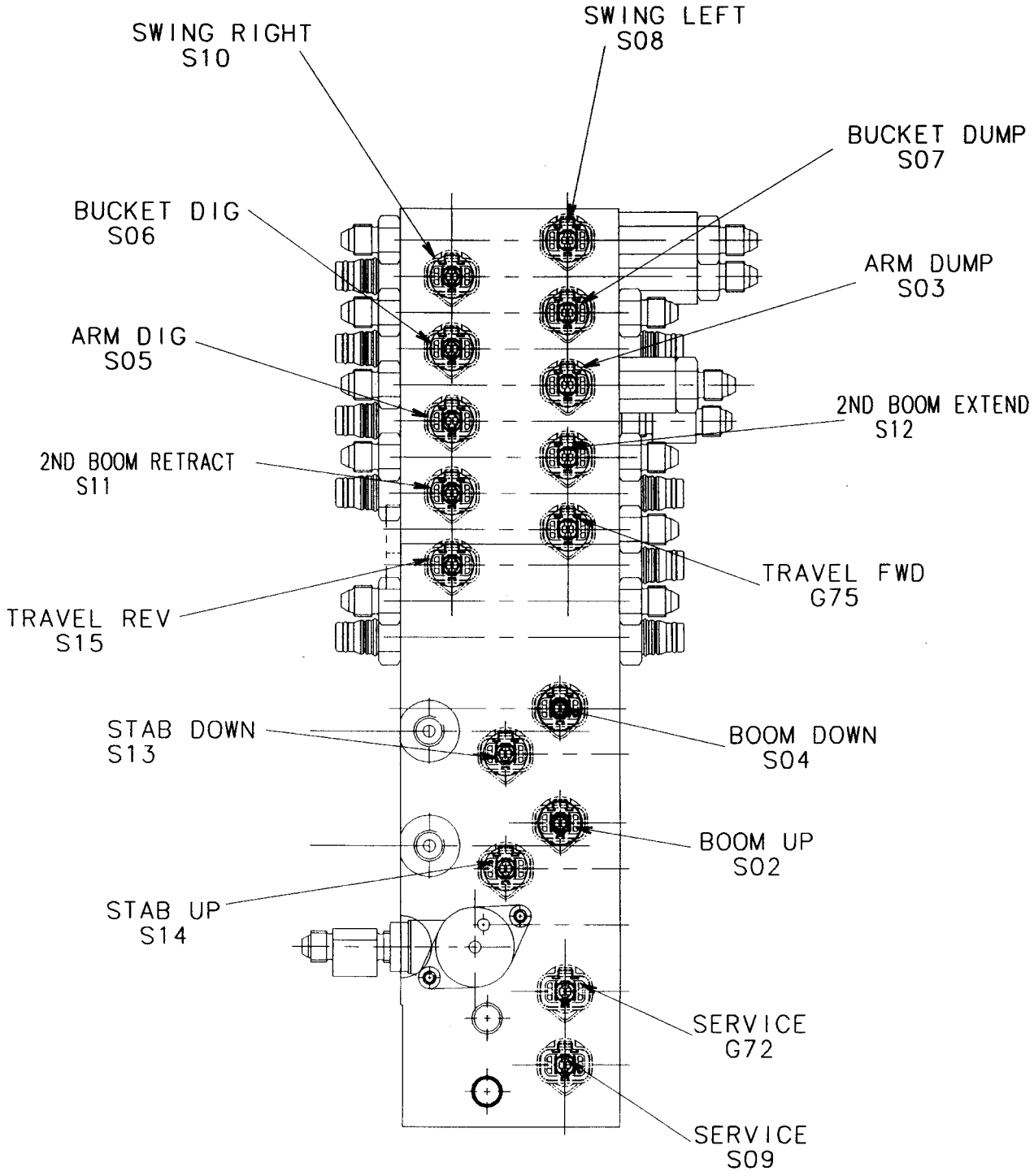
PPC MANIFOLD BLOCK



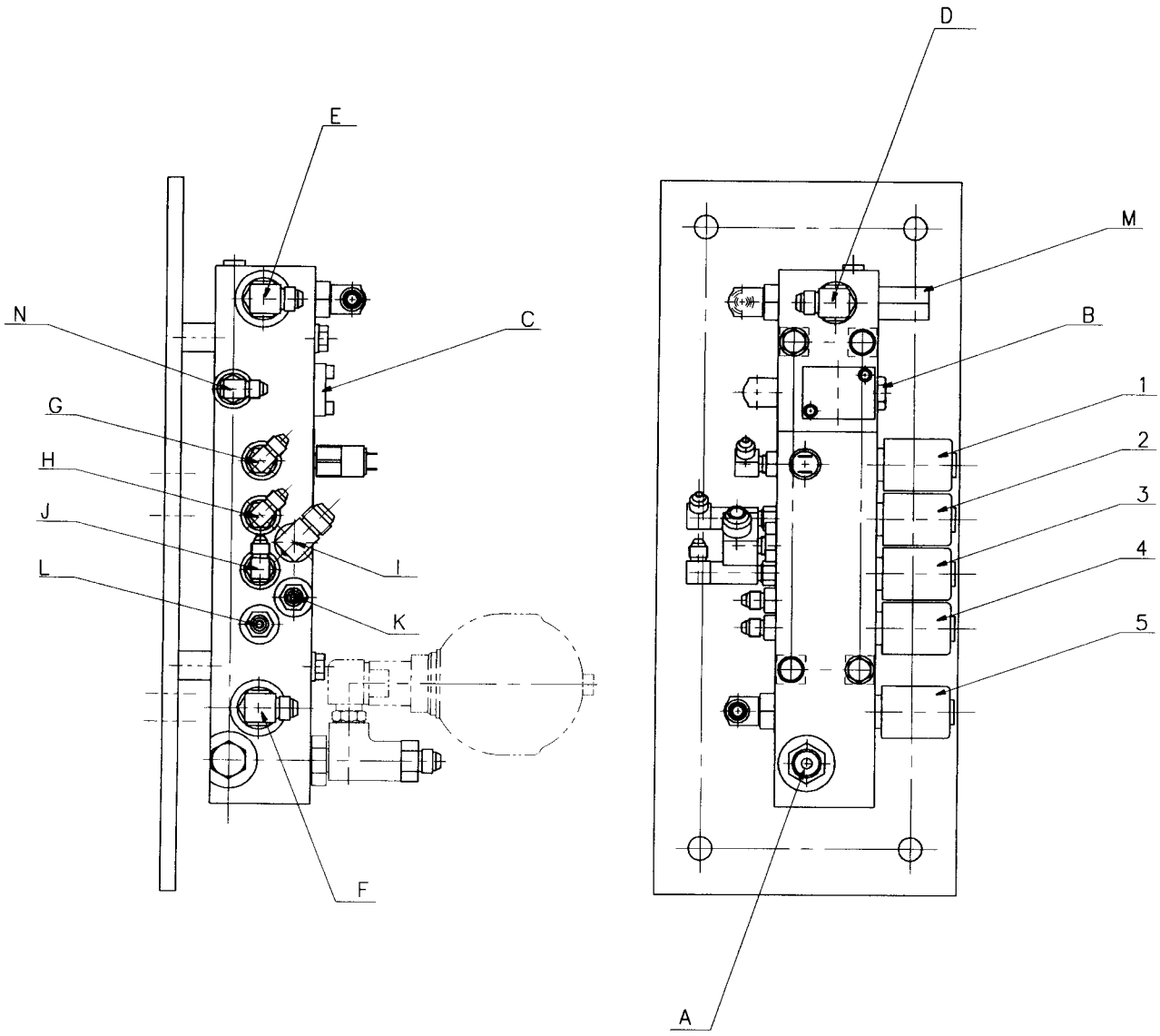
P11	To control valve (left swing)
P12	From swing PPC valve
P21	To control valve (right swing)
P22	From swing PPC valve
P31	To control valve (bucket dig)
P32	From bucket PPC valve
P41	To control valve (bucket dump
P42	From bucket PPC valve
P51	To control valve (arm dig)
P52	From arm PPC valve
P61	To control valve (arm dump)
P62	From arm PPC valve
P71	To control valve (2nd boom exit)
P72	From pedal 2P boom
P81	To control valve (2nd boom retract)
P82	From pedal 2P boom
PA1	To control valve (travel FWD)
PA2	From pedal travel
PA1	To control valve (travel rev)
PA2	From stabilizer solenoid valve
PB1	To control valve (stabilizer extend)
PB2	From pedal travel
P01	From solenoid PPC feed
P02	To P block

T01	To tank
T02	From T block
A1	To control valve (boom down)
P1	From right PPC valve
B1	To control valve (stab down)
A2	To control valve (boom raise)
P2	from right PPC valve
B2	To control valve (stab up)
A4	To port P3
P3	To port A4
TR	To pedal travel
A3	To control valve (service)
B3	To control valve (service)
1.	Travel EPC valve
2.	Clamshell solenoid valve
3.	Boom/stab lower solenoid valve
4.	Boom/stab raise solenoid valve

PPC MANIFOLD BLOCK PRESSURE SWITCHES



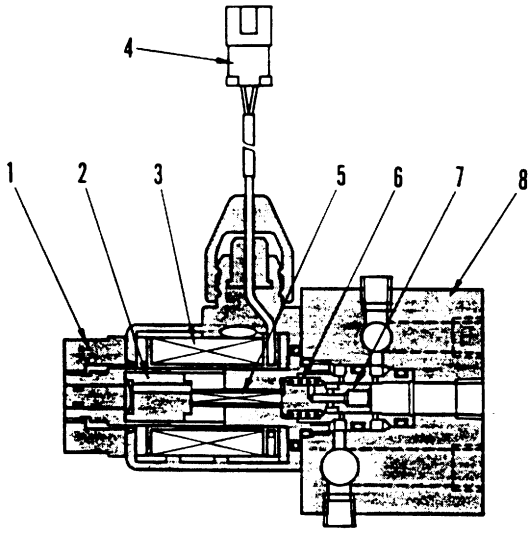
SOLENOID VALVE



A. Port PS (PPC manifold)
B. Port A5 (blank)
C. Port P5 (blank)
D. Port T0 (main valve)
E. Port P1 (feed from brake valve)
F. Port P0 (pressure PPC)
G. Port A4 (sus lock)
H. Port A3 (travel speed)
I. Port T1 (pump suction)
J. Port A2 (swing brake)
K. Port T2 (main valve TS)
L. Port A1 (main valve PX1)
M. PPC control valve (fixed)
N. Port P3 (PEPC valve)

1. Suspension lock solenoid valve
2. Travel speed solenoid valve
3. Swing brake solenoid valve
4. 2 Stage relief solenoid valve
5. Safety lock solenoid valve

TRAVEL SPEED, SWING BRAKE, 2-STAGE RELIEF SUSPENSION LOCK SOLENOID VALVE



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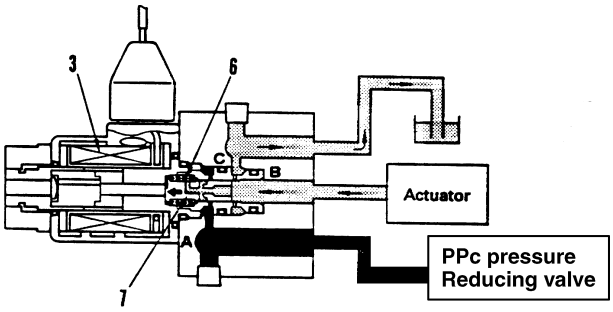
1. Nut
2. Plunger
3. Coil
4. Connector
5. Push pin
6. Spring
7. Spool
8. Block

Operation

When solenoid is deactivated

- The signal current does not flow from the controller, so coil (3) is deactivated.
- For this reason, spool (7) is pushed to the left in the direction of the arrow by spring (6).
- As a result, port A closes, the pressurized oil from the pressure reducing valve does not flow to the actuator.
  At the same time, the pressurized oil from the actuator flows from port B to port C, and is then drained to the tank.



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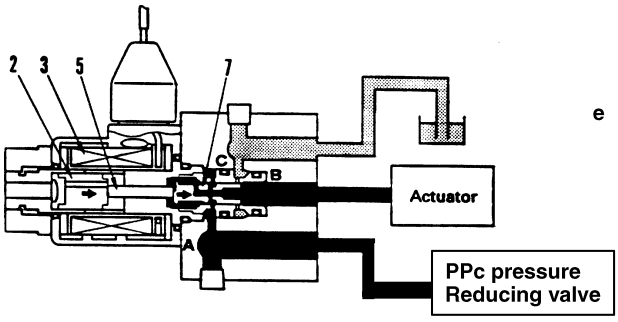
When solenoid is excited

- When the signal current flows from the controller to coil (3), coil (3) is excited, and a propulsion force is generated in plunger (2) to the right in the direction of the arrow.
- For this reason, spool (7) is pushed to the right in the direction of the arrow by push pin (5).
- As a result, the pressurized oil from the pressure reducing valve flows from port A to port B, and then flows to the actuator.
  At the same time, port C is closed, and this stops the oil from flowing to the tank.



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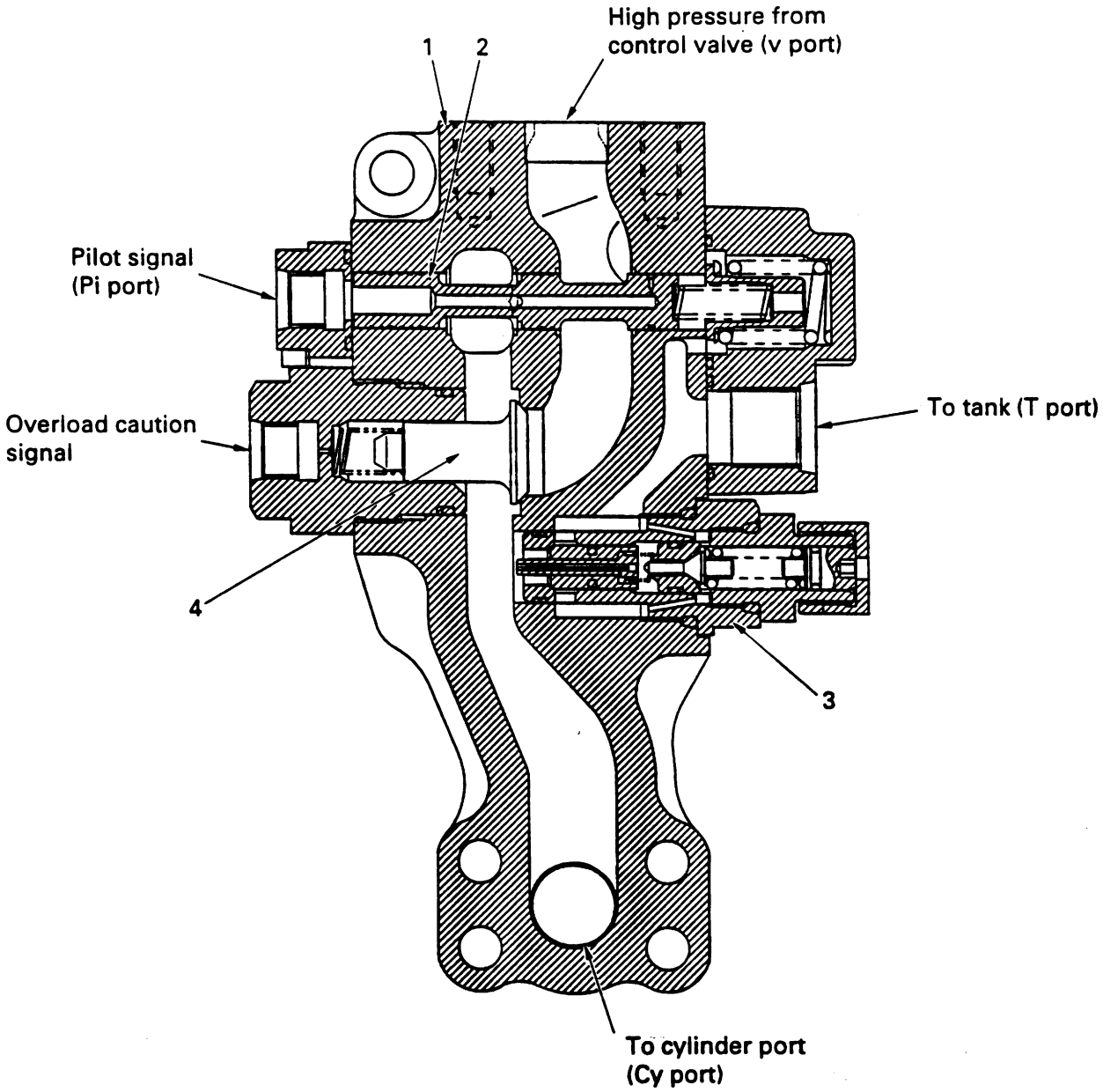
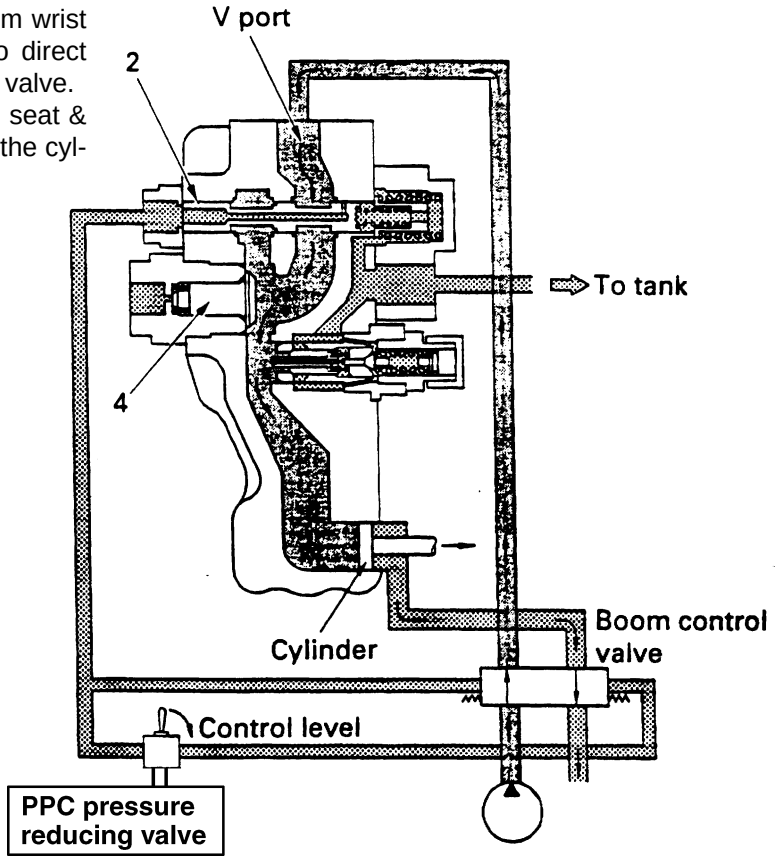
BOOM SAFETY VALVE



OPERATION

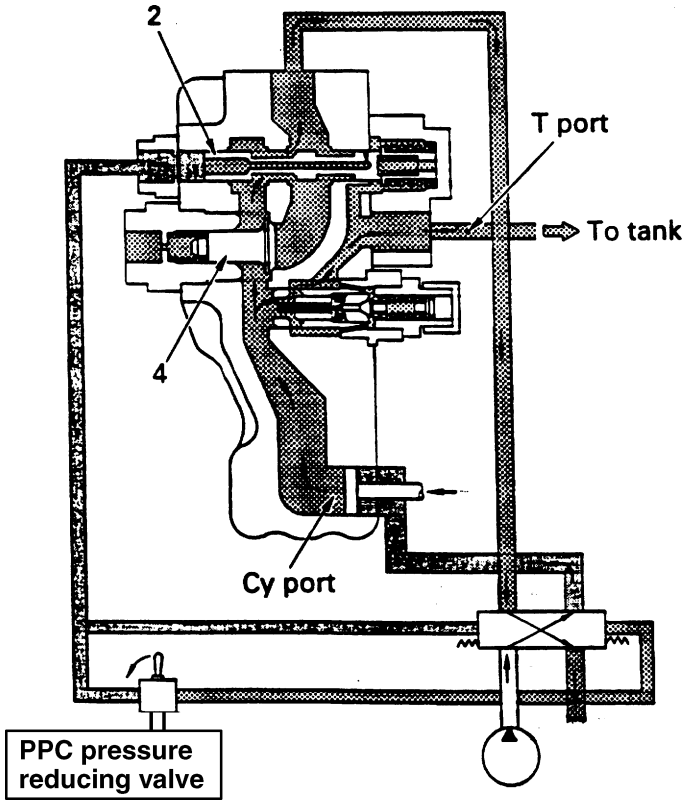
BOOM RAISE

- 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 room.



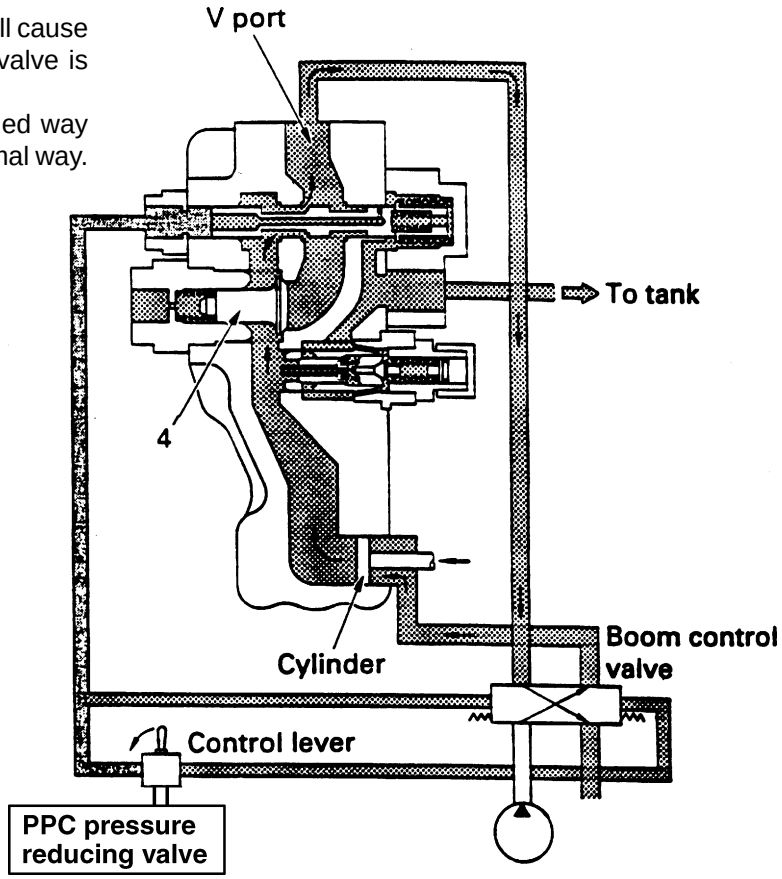
BOOM LOWER

- 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 Cy of the valve but cannot flow past the check valve. The pilot signal also opens the spool (2) of the hose burst valve and allows oil to flow back to tank.



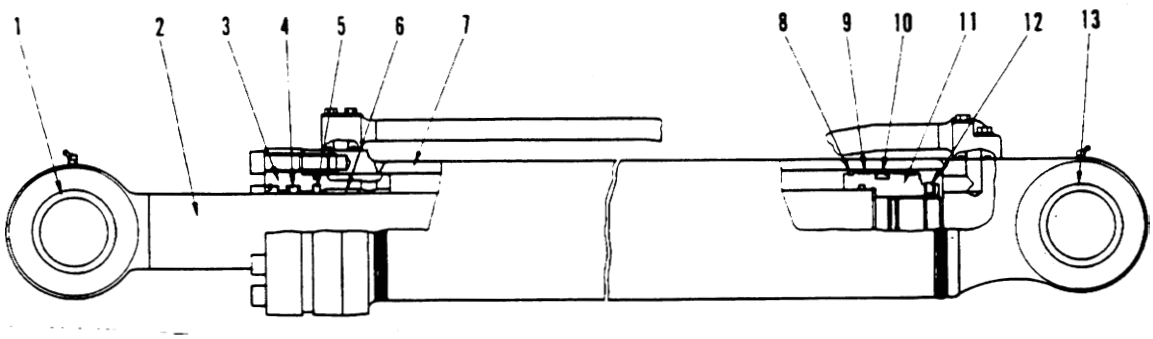
When hose burst occurs
(Operation to lower safety)

- 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.



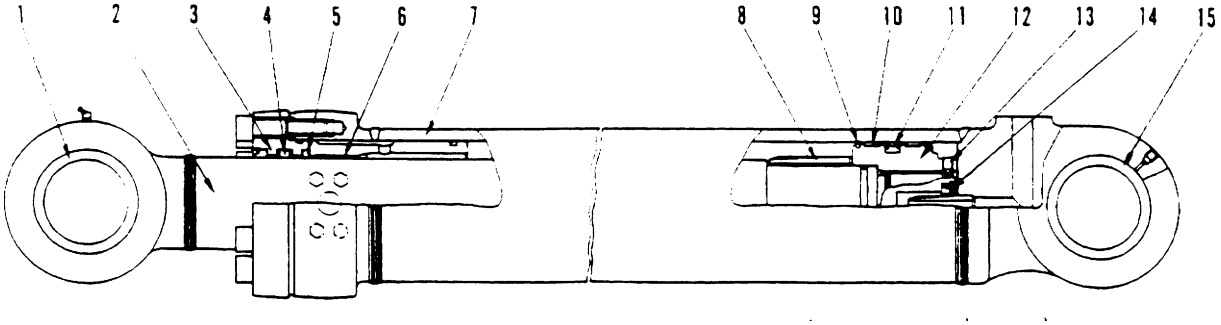
HYDRAULIC CYLINDERS (Boom & Arm)

BOOM LIFT CYLINDER



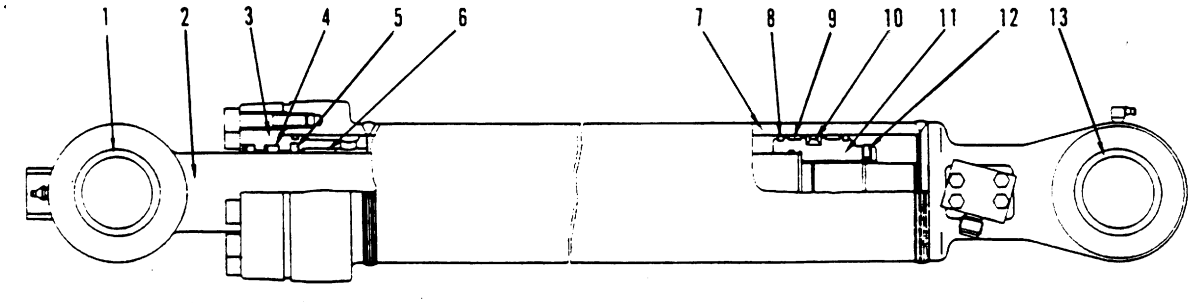
1. Rod side bushing
2. Piston rod
3. Cylinder head
4. Rod packing
5. Buffer ring
6. Wear ring
7. Cylinder
8. Casting ring
9. Wear ring
10. Piston ring
11. Piston
12. Set screws
13. Bottom side bushing

ARM CYLINDER



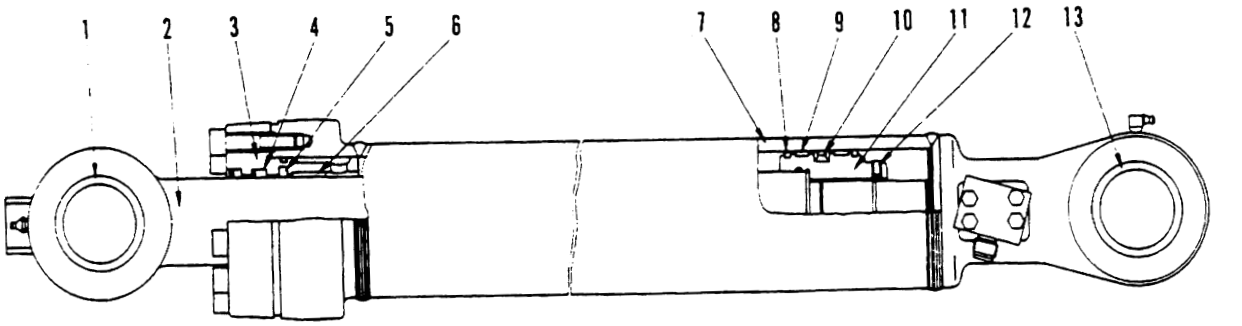
1. Rod side bushing
2. Piston rod
3. Cylinder head
4. Rod packing
5. Buffer ring
6. Wear ring
7. Cylinder
8. Head side cushion plunger
9. Casting ring
10. Wear ring
11. Piston ring
12. Piston
13. Set screw
14. Bottom side cushion plunger
15. Bottom side bushing

BUCKET CYLINDER



1. Rod side bushing
2. Piston rod
3. Cylinder head
4. Rod packing
5. Buffer ring
6. Wear ring
7. Cylinder
8. Casting ring
9. Wear ring
10. Piston ring
11. Piston
12. Set screw
13. Bottom side bushing

BOOM ADJUST CYLINDER



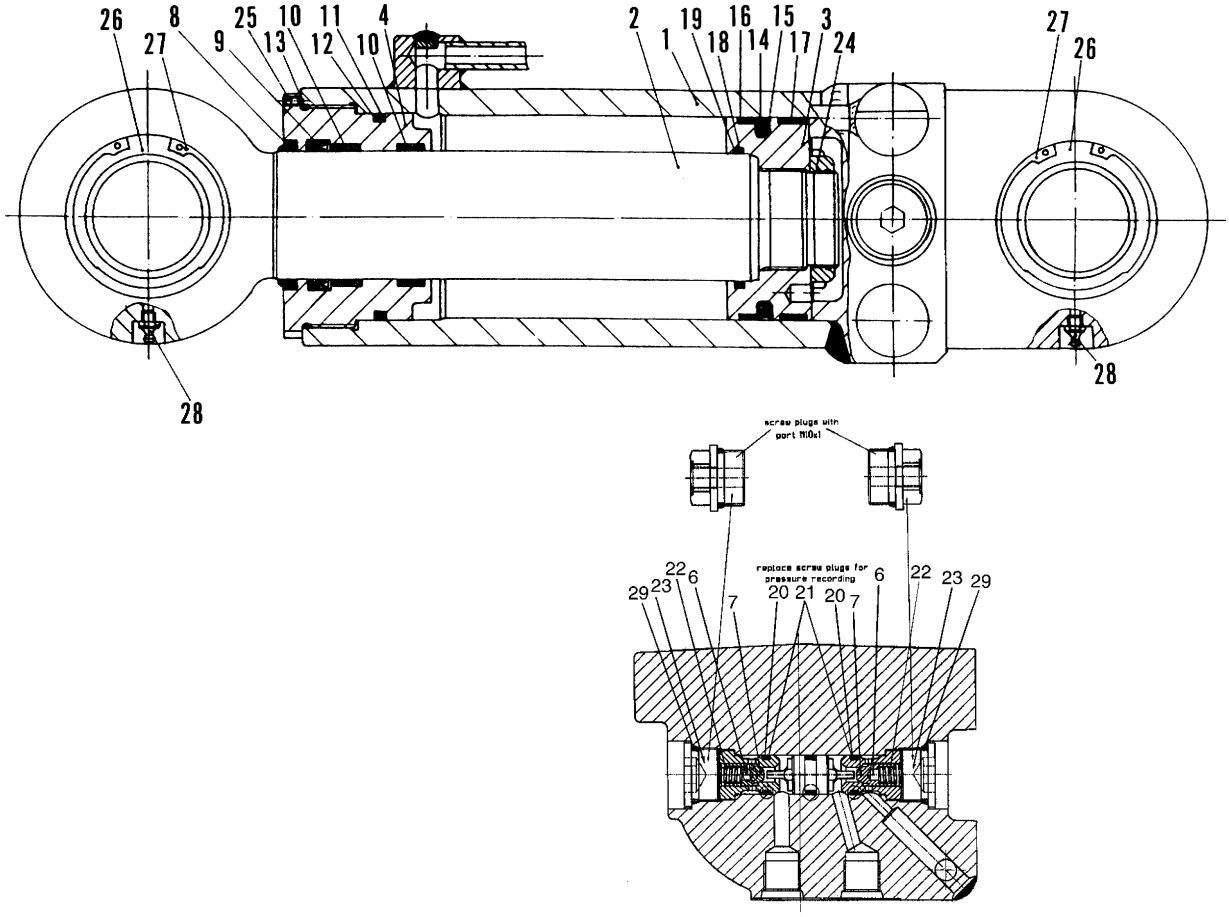
1. Rod side bushing
2. Piston rod
3. Cylinder head
4. Rod packing
5. Buffer ring
6. Wear ring
7. Cylinder
8. Casting ring
9. Wear ring
10. Piston ring
11. Piston
12. Set screw
13. Bottom side bushing

Specifications

Unit: mm

Cylinder	Boom lift		Arm	Bucket	Boom adjust
	1PB	2PB			
Inside diameter of cylinder	105	105	115	95	140
Outside diameter of piston rod	70	70	75	65	70
Stroke	990	950	1175	885	507.5
Max.	2490	2450	2877	2263	1632.5
Min.	1500	1500	1702	1378	1125
Width across flats op piston nut	80	80	85	70	80

OUTRIGGER CYLINDER



1. Cylinder
2. Piston rod with bearing eye
3. Piston
4. Cylinder head
6. Valve seat
7. Valve cone
8. Wiper (Dust seal)
9. Seal
10. Rod guide ring
11. O-ring
12. Backup ring
13. O-ring
14. Piston ring
15. O-ring
16. Backup ring
17. Piston guide ring
18. O-ring
19. Backup ring
20. O-ring
21. Backup ring
22. Relief valve spring
23. Plut
24. Nut
25. Grub screw
26. Bush
27. Circlip
28. Grease nipple
29. O-ring

Cylinder head (4) guides the piston rod (2) which is sealed by seal (9). Seal (9) is protected against dirt by wiper (8).

When oil flows through port **I** tot he piston side of the cylinder the piston rod (2) extends out of the cylinder (1).

The piston is guided in the cylinder (1) by the piston guide ring (7). It is sealed by the piston ring (14). The cylinder head is sealed against the cylinder by O-ring (13).

When oil fows through port **II** to the rod side of the cylinder the piston rod retracts.

Important

Depressurizing the cylinder

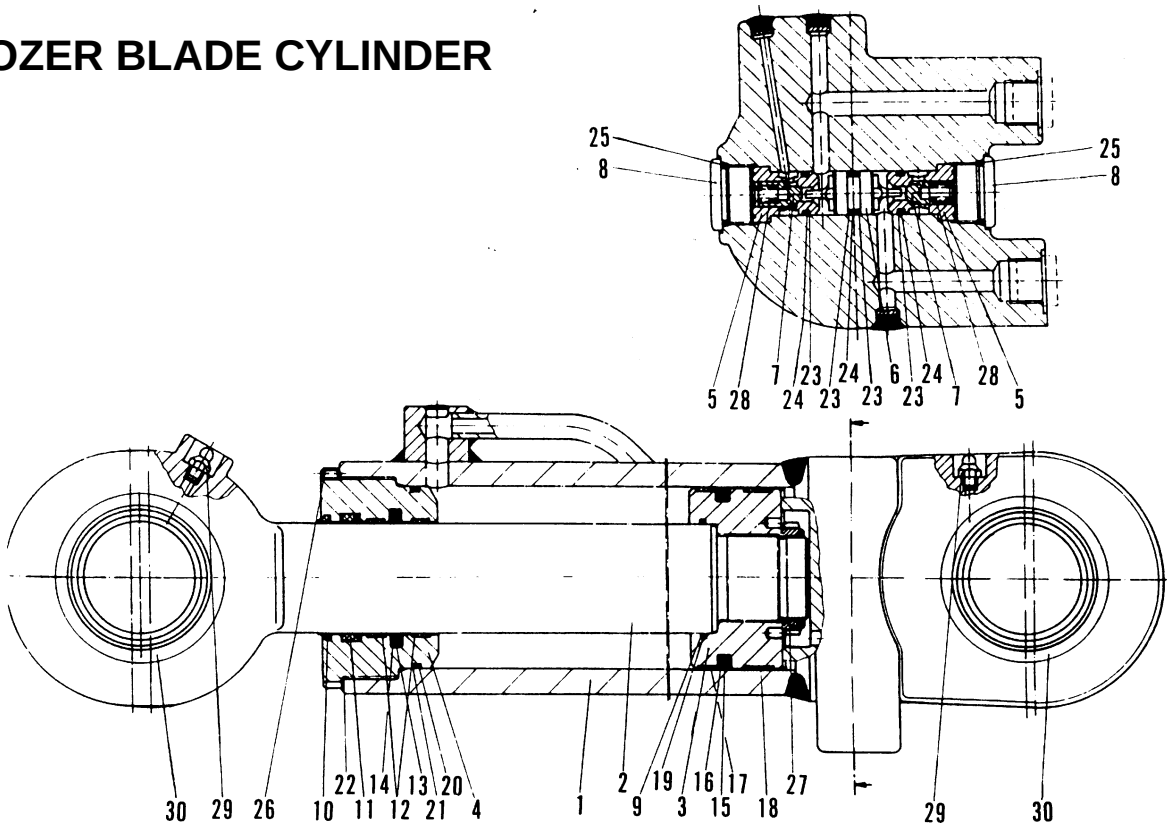
The check valve built into the cylinder prevents any cylinder movement due to oil leakage within the control block or sudden loss of hydraulic pressure due to a hose burst.

The built in check valve also holds hydraulic pressure within the cylinder when the hydraulic hoses are removed from the cylinder.

⚠ Depressurize the cylinder before opening

To depressurize the cylinder, loosen the plug (23) carefully using an Allen key and wait until the pressure has been released. To be absolutely sure the plug can be completely removed.

DOZER BLADE CYLINDER



1. Cylinder
2. Piston rod with bearing eye
3. Piston
4. Cylinder head
5. Valve seal
6. Check valve
7. Valve cone
8. Plug
9. Backup ring
10. Wiper (Dust seal)
11. Seal
12. Rod guide ring
13. Seal
14. 0-ring
15. Piston ring
16. O-ring
17. Backup ring
18. Piston guide ring
19. O-ring
20. O-ring
21. Backup ring
22. O-ring
23. Backup ring
24. O-ring
25. O-ring
26. Grub Screw
27. Nut
28. Relief valve spring
29. Nipple
30. Bush

Cylinder head (4) guides the piston rod (2) which is sealed by seal (11). Seal (11) is protected against dirt by wiper (10).

When oil flows through port **I** to the piston side of the cylinder the piston rod (2) extends out of the cylinder (1). The piston is guided in the cylinder (1) by the piston guide ring (18). It is sealed by the piston ring (16). The cylinder head is sealed against the cylinder by O-ring (20).

When oil flows through port II to the rod side of the cylinder the piston rod retracts.

Important
Depressurizing the cylinder
The check valve built into the cylinder prevents any cylinder movement due to oil leakage within the control block or sudden loss of hydraulic pressure due to a hose burst.

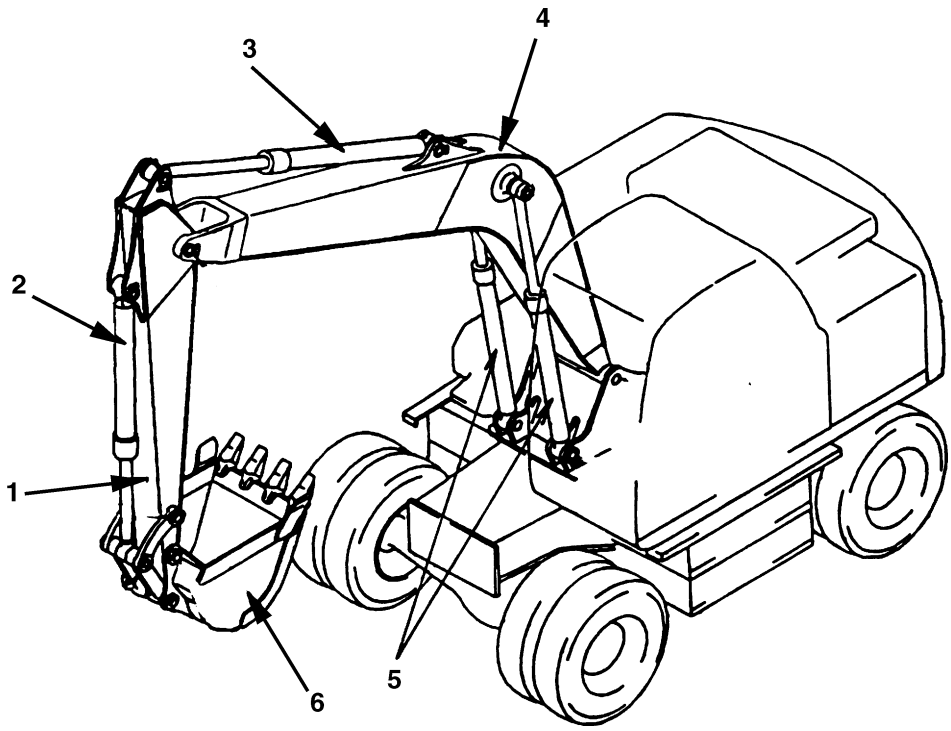
The built in check valve also holds hydraulic pressure within the cylinder when the hydraulic hoses are removed from the cylinder.

⚠ Depressurize the cylinder before opening

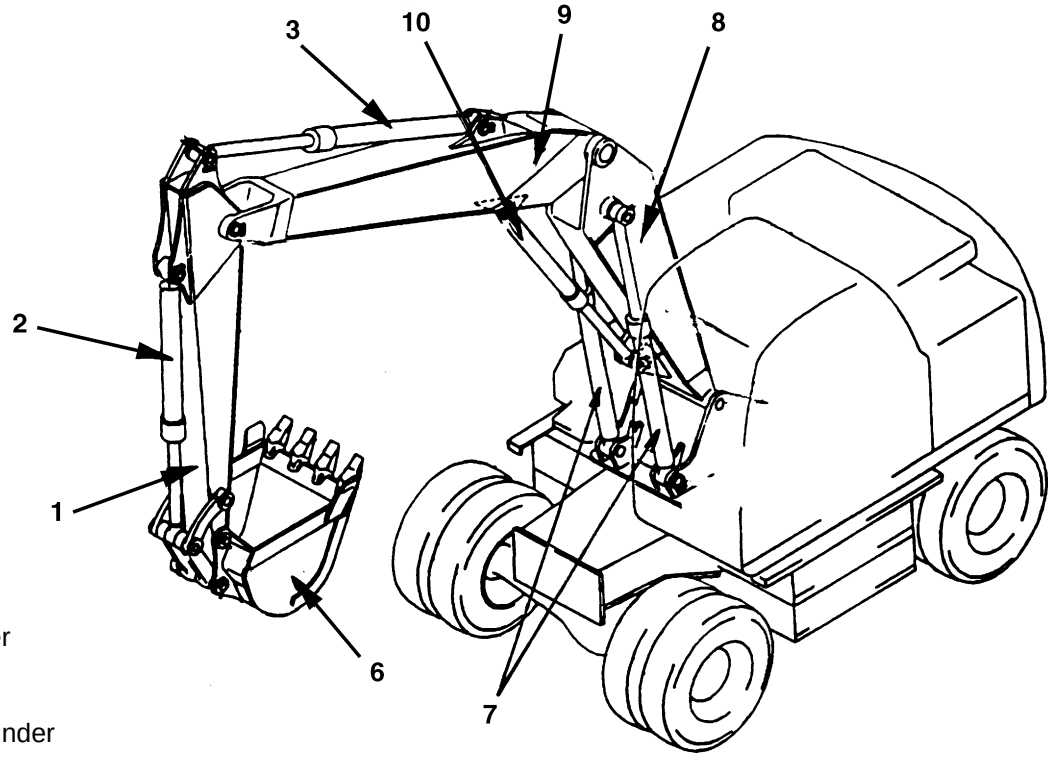
To depressurize the cylinder, loosen the plug (8) carefully using an Allen key and wait until the pressure has been released.

To be absolutely sure the plug can be completely removed.

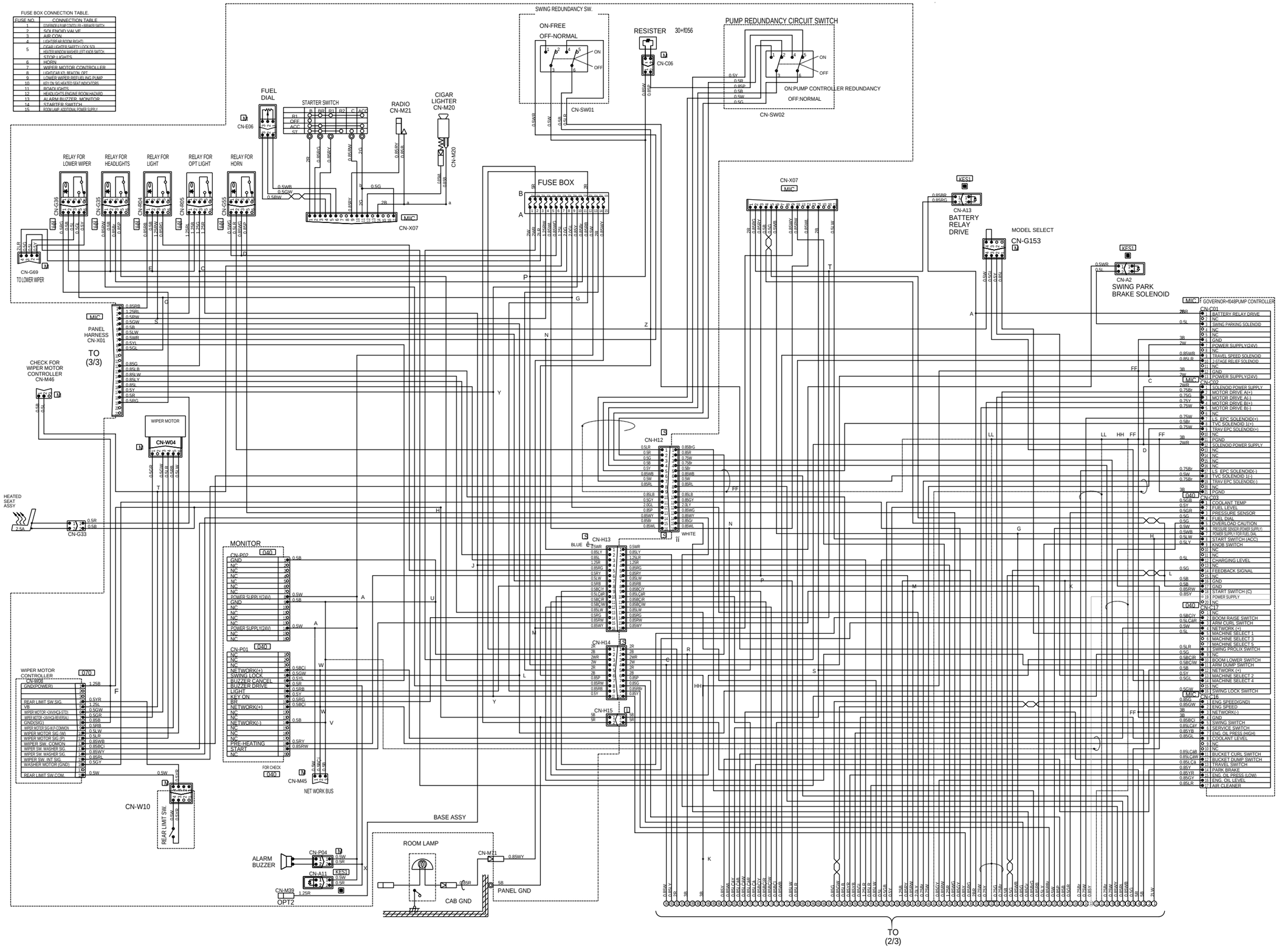
WORK EQUIPMENT - ONE PIECE BOOM

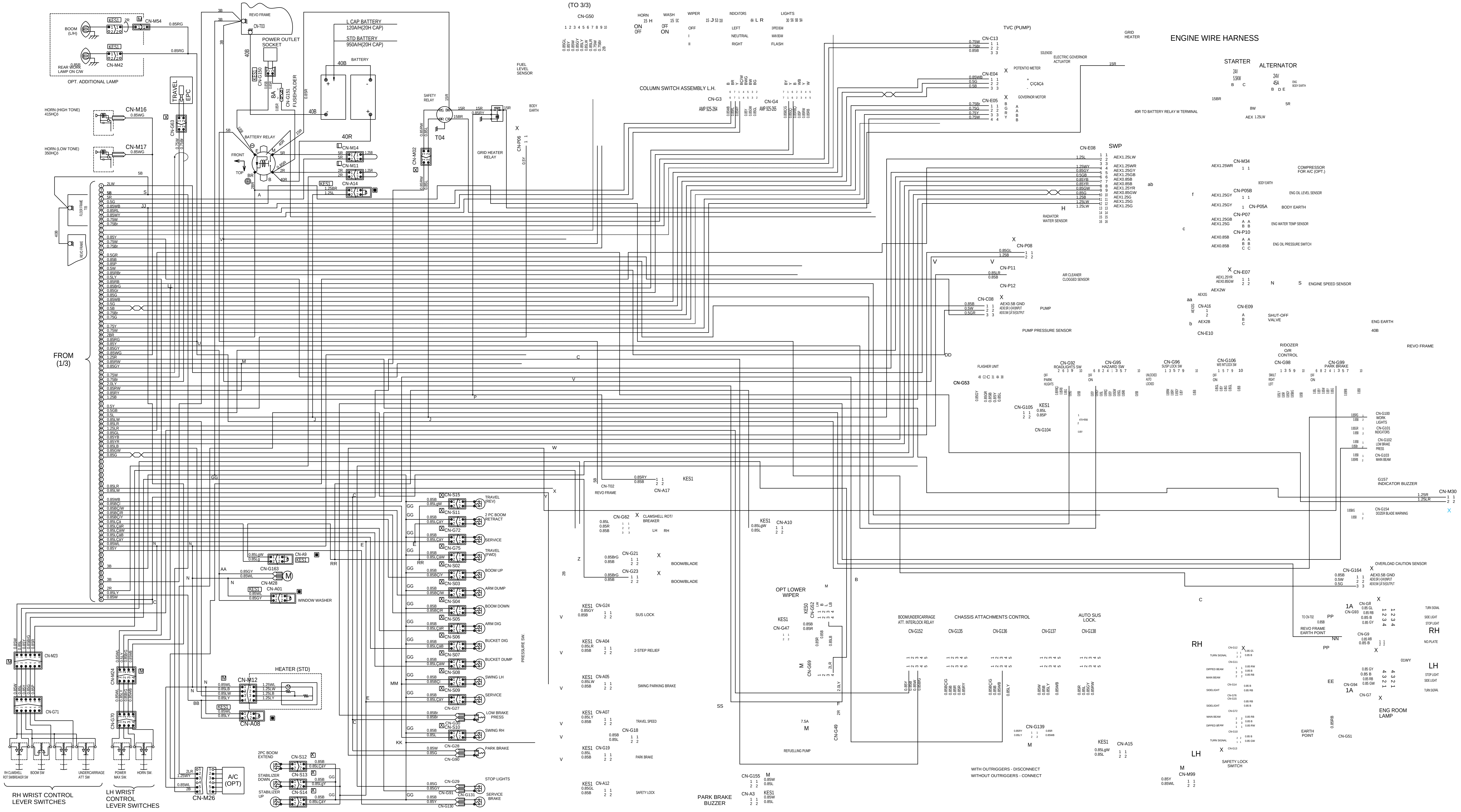


WORK EQUIPMENT - TWO PIECE BOOM

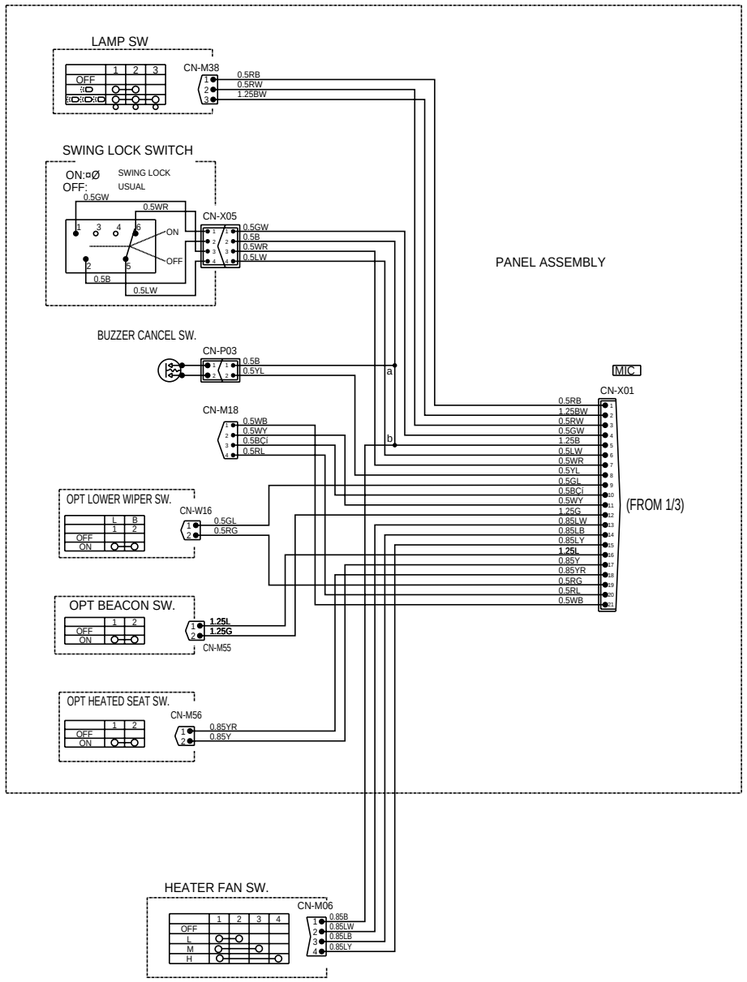


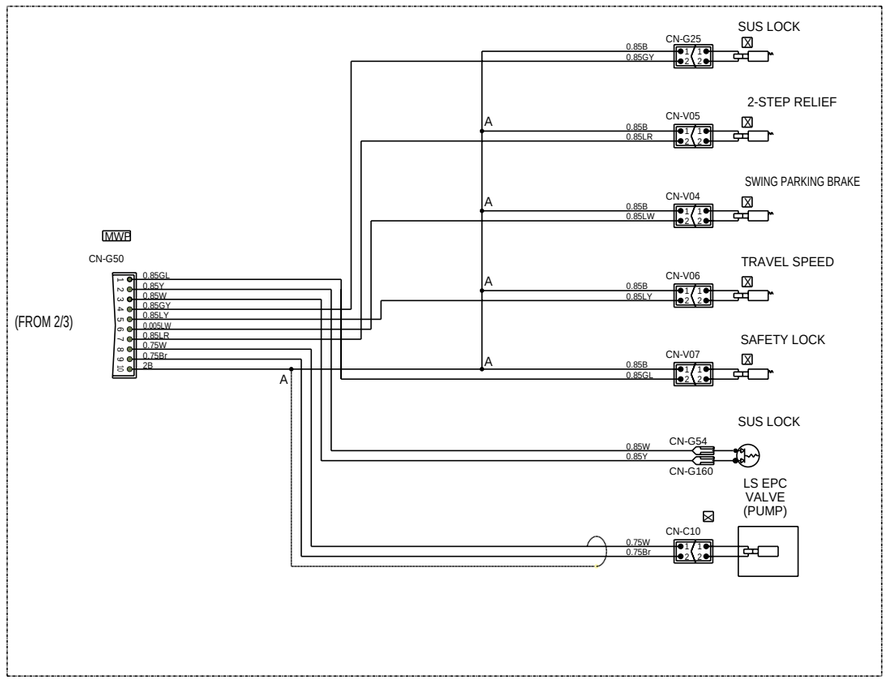
1. Arm
2. Bucket cylinder
3. Arm cylinder
4. Boom
5. Boom cylinder
6. Bucket
7. Boom lift cylinder
8. First boom
9. Second Boom
10. Boom adjust cylinder

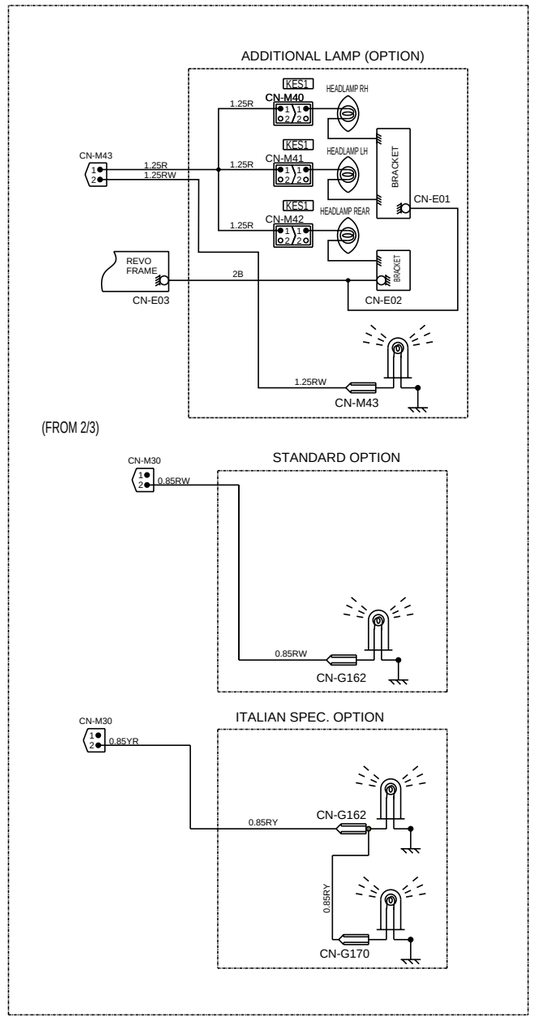

FUSE BOX CONNECTION TABLE.
FUSE NO. CONNECTION TABLE
1 OVERRIDE PUMP CONTROLLER - BREAKER SWITCH
2 SOLENOID VALVE
3 AIR CON.
4 LIGHTS(R.H. BOOM RIGHT)
5 CIGAR LIGHTER SAFETY LOCK SOL
HEATER WINDOW WASHER LEFT KNOB SWITCH
STOP LIGHTS
6 HORN
7 WIPER MOTOR CONTROLLER
8 LIGHTS(R.H. BEACON, OPT.
9 LOWER WIPER REFUELING PUMP
10 KEY ON SIG HEATED SEAT INDICATOR
11 ROAD LIGHTS
12 HEADLIGHTS ENGINE BOOM HAZARD
13 ALARM BUZZER, MONITOR
14 STARTER SWITCH
15 BOOM LAMP, ADDITIONAL POWER SUPPLY
SWING REDUNDANCY SW.
ON-FREE
OFF-NORMAL
CN-SW01
RESISTER 30+/056
CN-C06
PUMP REDUNDANCY CIRCUIT SWITCH
ON:PUMP CONTROLLER REDUNDANCY
OFF:NORMAL
CN-SW02
FUEL DIAL
CN-E06
STARTER SWITCH
R1
OFF
A/C
ST
RADIO
CN-M21
CIGAR LIGHTER
CN-M20
RELAY FOR LOWER WIPER
RELAY FOR HEADLIGHTS
RELAY FOR LIGHT
RELAY FOR OPT LIGHT
RELAY FOR HORN
CN-R06
CN-R05
CN-R04
CN-R03
CN-G55
FUSE BOX
CN-X07
MIC
CN-G69
TO LOWER WIPER
CN-X07
MIC
KES1
CN-A13
BATTERY RELAY DRIVE
MODEL SELECT
CN-G153
KES1
CN-A2
SWING PARK BRAKE SOLENOID
MIC
F GOVERNOR+D48PUMP CONTROLLER
CN-C01
1 BATTERY RELAY DRIVE
2 NC
3 SWING PARKING SOLENOID
4 NC
5 NC
6 GND
7 POWER SUPPLY(24V)
8 NC
9 TRAVEL SPEED SOLENOID
10 2-STAGE RELIEF SOLENOID
11 NC
12 GND
13 POWER SUPPLY(24V)
MIC
CN-C02
1 SOLENOID POWER SUPPLY
2 MOTOR DRIVE A(+)
3 MOTOR DRIVE A(-)
4 MOTOR DRIVE B(+)
5 MOTOR DRIVE B(-)
6 NC
7 LS, EPC SOLENOID(+)
8 TVC SOLENOID 1(+)
9 TRAV EPC SOLENOID(+)
10 NC
11 PGND
12 SOLENOID POWER SUPPLY
13 NC
14 NC
15 NC
16 NC
17 LS, EPC SOLENOID(-)
18 TVC SOLENOID 1(-)
19 TRAV EPC SOLENOID(-)
20 NC
21 PGND
040
CN-C03
1 COOLANT TEMP
2 FUEL LEVEL
3 PRESSURE SENSOR
4 FUEL DIAL
5 OVERLOAD CAUTION
6 PRESSURE SENSOR POWER SUPPLY
7 POWER SUPPLY FOR FUEL DIAL
8 START SWITCH (ACC)
9 KNOB SWITCH
10 NC
11 NC
12 CHARGING LEVEL
13 NC
14 FEEDBACK SIGNAL
15 NC
16 GND
17 GND
18 START SWITCH (C)
19 POWER SUPPLY
20 NC
040
CN-C17
1 NC
2 BOOM RAISE SWITCH
3 ARM CURL SWITCH
4 NETWORK (+)
5 MACHINE SELECT 1
6 MACHINE SELECT 3
7 MACHINE SELECT 5
8 SWING PROLIX SWITCH
9 NC
10 BOOM LOWER SWITCH
11 ARM DUMP SWITCH
12 NETWORK (+)
13 MACHINE SELECT 2
14 MACHINE SELECT 4
15 NC
16 SWING LOCK SWITCH
MIC
CN-C16
1 ENG SPEED(GND)
2 ENG SPEED
3 NETWORK(-)
4 GND
5 SWING SWITCH
6 SERVICE SWITCH
7 ENG. OIL PRESS (HIGH)
8 COOLANT LEVEL
9 NC
10 NC
11 BUCKET CURL SWITCH
12 BUCKET DUMP SWITCH
13 TRAVEL SWITCH
14 PARK BRAKE
15 ENG. OIL PRESS (LOW)
16 ENG. OIL LEVEL
17 AIR CLEANER
PANEL HARNESS CN-X01
TO (3/3)
CHECK FOR WIPER MOTOR CONTROLLER CN-M46
WIPER MOTOR
CN-W04
HEATED SEAT ASSY
2 5A
CN-G33
MONITOR
040
CN-P02
CN-P01
WIPER MOTOR CONTROLLER
070
CN-W08
GND(POWER)
REAR LIMIT SW.SIG.
VB
WIPER MOTOR +12V(HIGH-STD)
WIPER MOTOR +24V(HIGH-RS/RSS)
GND(SIG)
WIPER MOTER SIG.W.P.-COMMON
WIPER MOTOR SIG.(W)
WIPER MOTOR SIG.(P)
WIPER SW. COMMON
WIPER SW. WASHER SIG.
WIPER SW. WASHER SIG.
WIPER SW. INT. SIG.
WASHER MOTOR (GND)
REAR LIMIT SW.COM.
CN-W10
REAR LIMIT SW.
FOR CHECK
040
CN-M45
NET WORK BUS
BASE ASSY
ROOM LAMP
CN-M21
CAB GND
PANEL GND
ALARM BUZZER
CN-P04
CN-A11
KES1
CN-M39
OPT2
CN-H12
CN-H13
CN-H14
CN-H15
BLUE
WHITE
TO (2/3)



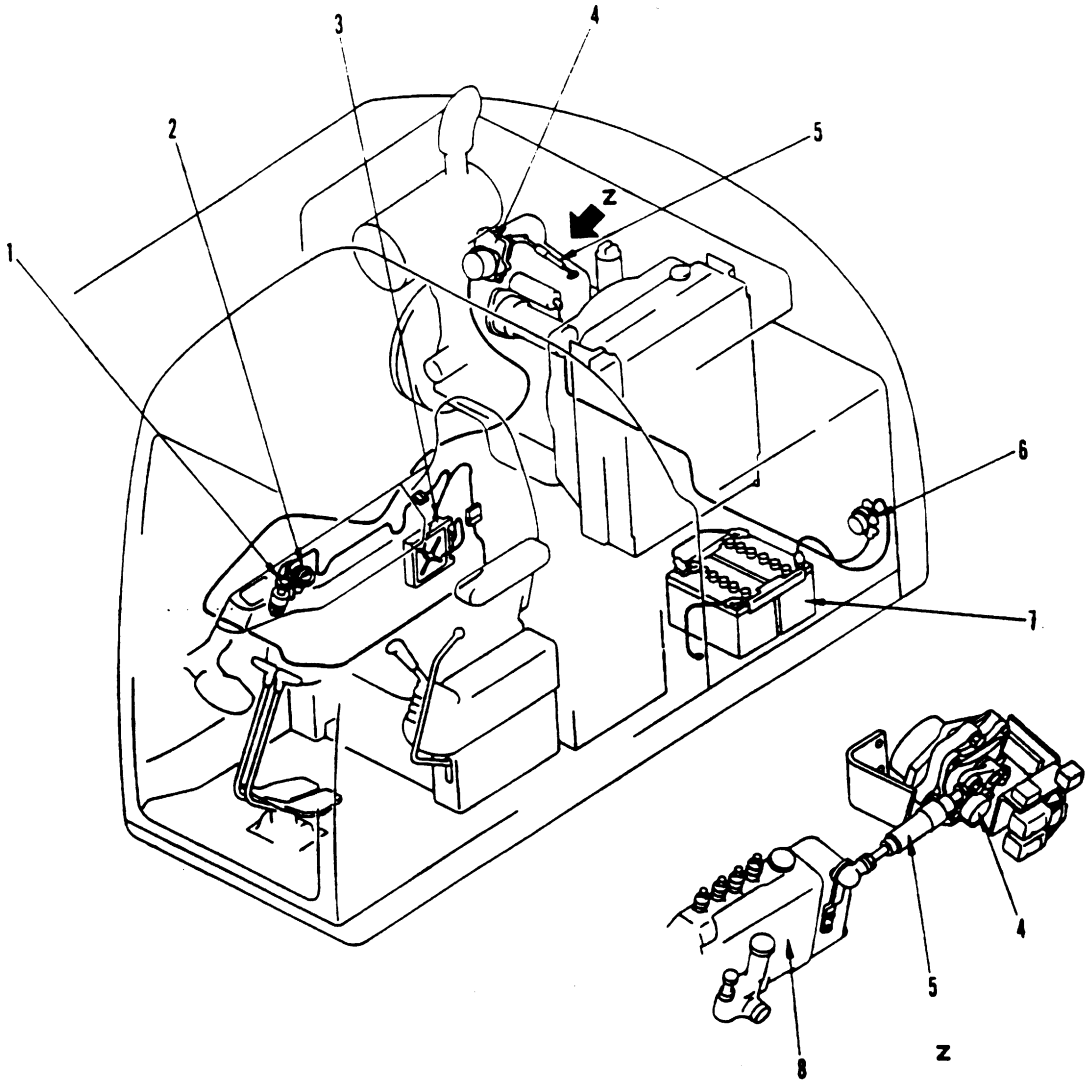
ENGINE WIRE HARNESS
(TO 3/3)
FROM (1/3)
OPT. ADDITIONAL LAMP
BOOM (L/H)
REAR WORK LAMP ON C/W
CN-M54
CN-M42
HORN (HIGH TONE)
HORN (LOW TONE)
CN-M16
CN-M17
TRAVEL EPC
CN-G63
REVO FRAME
CN-T03
POWER OUTLET SOCKET
CN-G150
CN-G151
FUSEHOLDER
L CAP BATTERY 120A/H(20H CAP)
STD BATTERY 950A/H(20H CAP)
BATTERY
BATTERY RELAY
CN-M14
CN-M11
CN-A14
SAFETY RELAY
T04
CN-M02
GRID HEATER RELAY
FUEL LEVEL SENSOR
BODY EARTH
CN-P06
CN-G50
HORN
WASH
WIPER
INDICATORS
LIGHTS
LEFT
NEUTRAL
RIGHT
DIPPED BEAM
MAIN BEAM
FLASH
COLUMN SWITCH ASSEMBLY L.H.
CN-G3
AMP 925-264
CN-G4
AMP 925-265
TVC (PUMP)
CN-C13
CN-E04
CN-E05
SOLENOID
ELECTRIC GOVERNOR ACTUATOR
POTENTIO METER
GOVERNOR MOTOR
GRID HEATER
STARTER
ALTERNATOR
40R TO BATTERY RELAY M TERMINAL
CN-E08
SWP
RADIATOR WATER SENSOR
CN-M34
COMPRESSOR FOR A/C (OPT.)
CN-P05B
ENG OIL LEVEL SENSOR
CN-P05A
BODY EARTH
CN-P07
ENG WATER TEMP SENSOR
CN-P10
ENG OIL PRESSURE SWITCH
CN-P08
CN-P11
AIR CLEANER CLOGGED SENSOR
CN-P12
CN-C08
PUMP
PUMP PRESSURE SENSOR
CN-E07
ENGINE SPEED SENSOR
CN-A16
CN-E09
SHUT-OFF VALVE
CN-E10
ENG EARTH
R/DOZER O/R CONTROL
FLASHER UNIT
CN-G53
CN-G92 ROADLIGHTS SW
CN-G95 HAZARD SW
CN-G96 SUSP LOCK SW
CN-G106 W/E INT'LOCK SW
CN-G98
CN-G99 PARK BRAKE
CN-G105
CN-G104
CN-G100 WORK LIGHTS
CN-G101 INDICATORS
CN-G102 LOW BRAKE PRESS
CN-G103 MAIN BEAM
G157 INDICATOR BUZZER
CN-M30
CN-G154 DOZER BLADE WARNING
CN-S15 TRAVEL (REV)
CN-S11 2 PC BOOM RETRACT
CN-G72 SERVICE
CN-G75 TRAVEL (FWD)
CN-S02 BOOM UP
CN-S03 ARM DUMP
CN-S04 BOOM DOWN
CN-S05 ARM DIG
CN-S06 BUCKET DIG
CN-S07 BUCKET DUMP
CN-S08 SWING LH
CN-S09 SERVICE
CN-G27 LOW BRAKE PRESS
CN-S10 SWING RH
CN-G28 PARK BRAKE
CN-G29 STOP LIGHTS
CN-G131 SERVICE BRAKE
PRESSURE SW.
CN-T02
CN-A17
CN-G62 CLAMSHELL ROT/ BREAKER
CN-G21 BOOM/BLADE
CN-G23 BOOM/BLADE
CN-G24 SUS LOCK
CN-A04 2-STEP RELIEF
CN-A05 SWING PARKING BRAKE
CN-A07 TRAVEL SPEED
CN-G18
CN-G19 PARK BRAKE
CN-A12 SAFETY LOCK
PARK BRAKE BUZZER
CN-G155
CN-A3
CN-A10
OPT LOWER WIPER
CN-G52
CN-G47
CN-G69
CN-G49
REFUELLING PUMP
BOOM/UNDERCARRIAGE ATT. INTERLOCK RELAY
CHASSIS ATTACHMENTS CONTROL
AUTO SUS LOCK.
CN-G152
CN-G135
CN-G136
CN-G137
CN-G138
CN-G139
CN-A15
WITH OUTRIGGERS - DISCONNECT
WITHOUT OUTRIGGERS - CONNECT
CN-M99
SAFETY LOCK SWITCH
OVERLOAD CAUTION SENSOR
CN-G164
REVO FRAME EARTH POINT
EARTH POINT
CN-G51
ENG ROOM LAMP
RH
LH
TURN SIGNAL
SIDE LIGHT
STOP LIGHT
NO.PLATE
CN-A9
CN-G163
CN-M28
CN-A01
WINDOW WASHER
HEATER (STD)
CN-M12
CN-A08
CN-M23
CN-G71
CN-M24
CN-G70
RH CLAMSHELL ROT SW/BREAKER SW
BOOM SW
UNDERCARRIAGE ATT SW
POWER MAX SW.
HORN SW.
RH WRIST CONTROL LEVER SWITCHES
LH WRIST CONTROL LEVER SWITCHES
A/C (OPT)
CN-M26
2PC BOOM EXTEND
CN-S12
STABILIZER DOWN
CN-S13
STABILIZER UP
CN-S14


LAMP SW
CN-M38
0.5RB
0.5RW
1.25BW
SWING LOCK SWITCH
SWING LOCK
USUAL
ON
OFF
CN-X05
0.5GW
0.5B
0.5WR
0.5LW
PANEL ASSEMBLY
BUZZER CANCEL SW.
CN-P03
0.5B
0.5YL
MIC
CN-X01
CN-M18
0.5WB
0.5WY
0.5BCl
0.5RL
OPT LOWER WIPER SW.
CN-W16
0.5GL
0.5RG
OPT BEACON SW.
1.25L
1.25G
CN-M55
OPT HEATED SEAT SW.
CN-M56
0.85YR
0.85Y
HEATER FAN SW.
CN-M06
0.85B
0.85LW
0.85LB
0.85LY
(FROM 1/3)


MWB
CN-G50
(FROM 2/3)
SUS LOCK
CN-G25
0.85B
0.85GY
2-STEP RELIEF
CN-V05
0.85LR
SWING PARKING BRAKE
CN-V04
0.85LW
TRAVEL SPEED
CN-V06
0.85LY
SAFETY LOCK
CN-V07
0.85GL
SUS LOCK
CN-G54
0.85W
0.85Y
CN-G160
LS EPC
VALVE
(PUMP)
CN-C10
0.75W
0.75Br


ADDITIONAL LAMP (OPTION)
CN-M43
1.25R
1.25RW
CN-M40
HEADLAMP RH
CN-M41
HEADLAMP LH
CN-M42
HEADLAMP REAR
BRACKET
CN-E01
REVO
FRAME
CN-E03
2B
CN-E02
1.25RW
(FROM 2/3)
STANDARD OPTION
CN-M30
0.85RW
CN-G162
ITALIAN SPEC. OPTION
0.85RY
0.85RY
CN-G170

ENGINE CONTROL SYSTEM



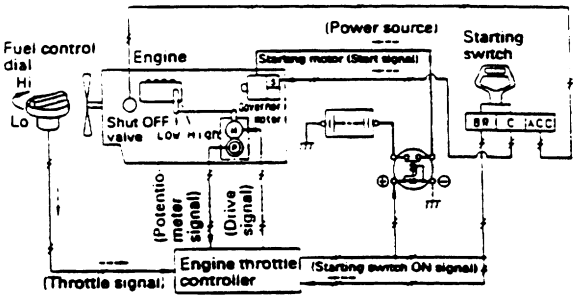
202F06148

1. Starting switch
2. Fuel control dial
3. Pump and engine throttle controller
4. Governor motor
5. Loose spring
6. Battery relay
7. Battery
8. Fuel injection pump

FUNCTION

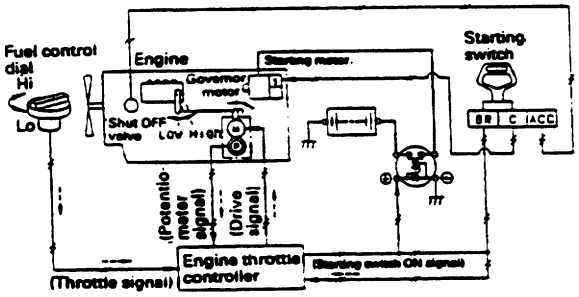
- The engine can be started and stopped simply by using the starting switch.
- A dial type engine control is used to control the engine speed. The engine throttle controller receives the control signal from the fuel control dial, sends a drive signal to the governor motor, and controls the angle of the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

1. OPERATION OF SYSTEM



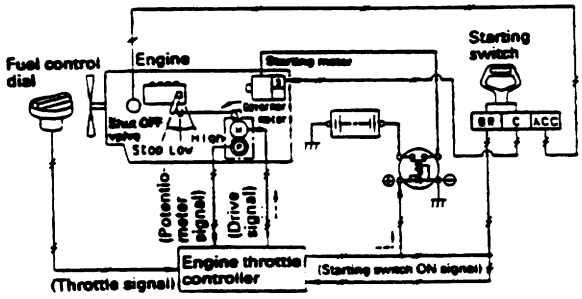
Starting engine

- 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 engine throttle 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 engine throttle controller according to the position of the dial. The engine throttle controller calculates the angle of the governor motor according to the 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 engine throttle controller, so that it can observe the operation of the governor motor.

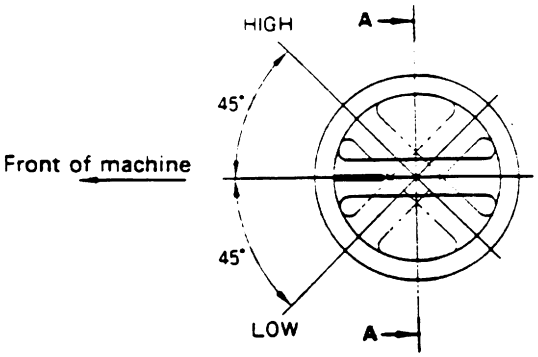


Stopping engine

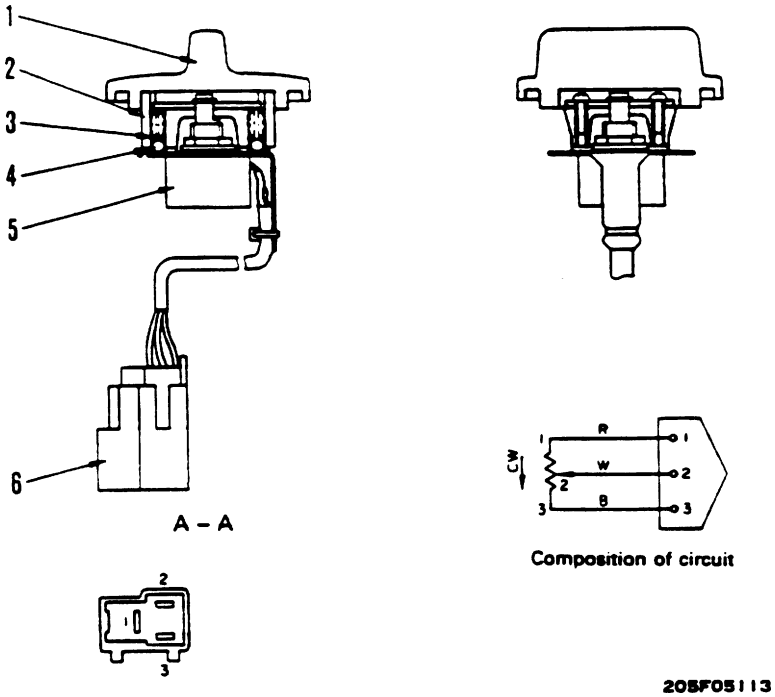
- When the starting switch is placed at the OFF position, the shut off valve is closed so the supply of fuel to the engine is shut off and the engine stops.

2. COMPONENTS OF SYSTEM

1) FUEL CONTROL DIAL

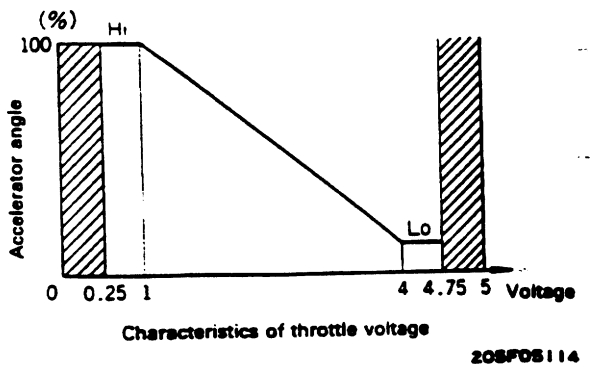


1. Knob
2. Dial
3. Spring
4. Ball
5. Potentiometer
6. Connector



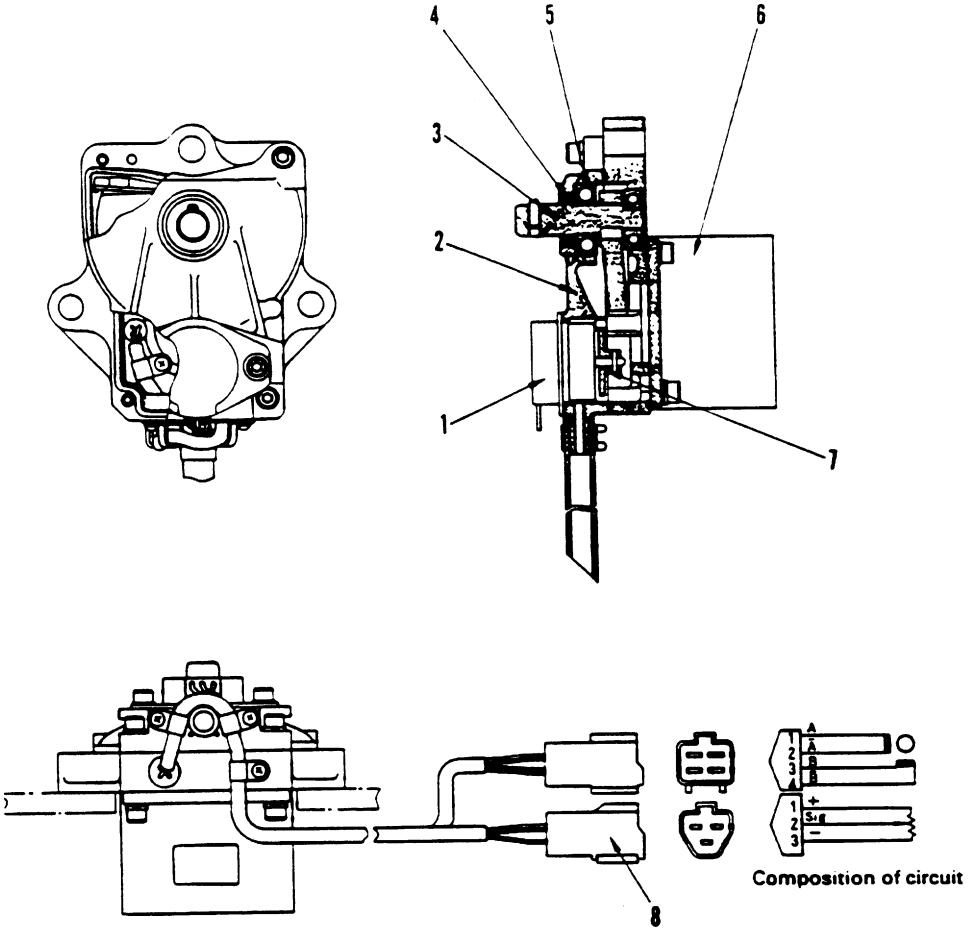
FUNCTION

- The fuel control dial is installed at the front of the switch 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 engine throttle controller.
  The shaded area in the graph on the right is the abnormality detection area and the engine speed is set at low idling.



2) GOVERNOR MOTOR

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



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FUNCTION

- The motor is rotated and the governor lever of the fuel injection pump is controlled by the drive signal from the engine throttle controller.
- A stepping motor is used for the motor which provides the motive 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

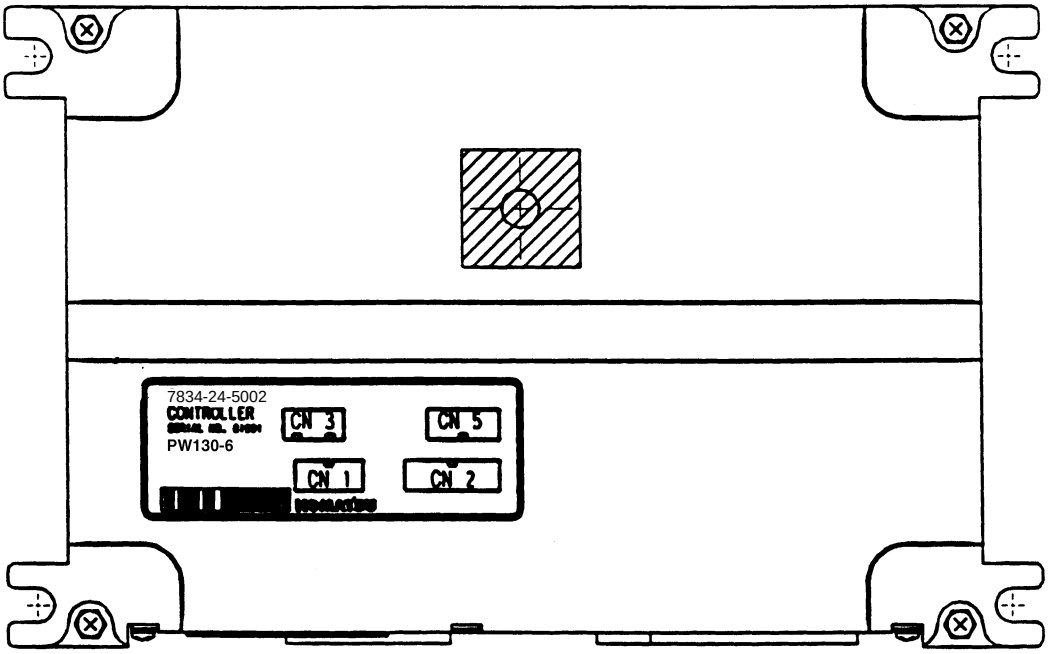
Motor stationary

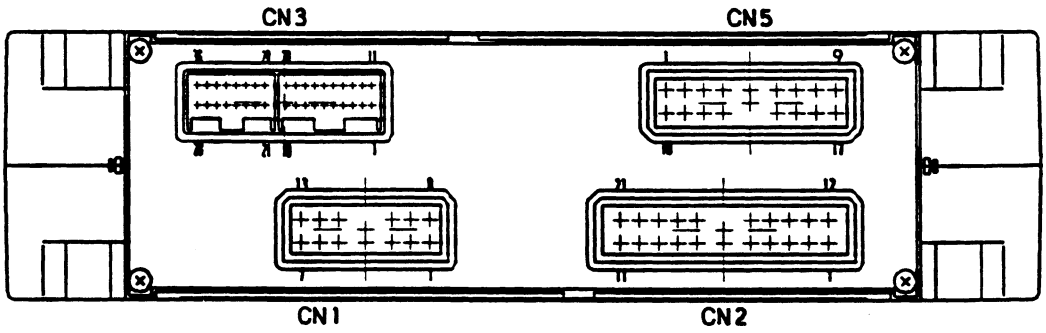
- Both A phase and B phase of the motor are continuous, and a holding torque is generated in the motor.

Motor rotating

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

Governor, pump controller





Input and output signals

CN-1

Pin. No.	Name of signal	Input/ output
1	Battery relay drive output	Output
2	NC	
3	Swing holding brake solenoid	Output
4	NC	
5	NC	
6	GND	Input
7	Power source (+24V)	Input
8	NC	
9	Travel selector solenoid	Output
10	2-stage relief solenoid	Output
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	Travel EPC solenoid (+)	Output
10	NC	
11	PGND	Input
12	Solenoid power source (+24 V)	Input
13	NC	
14	NC	
15	NC	
16	NC	
17	LS-EPC solenoid (-)	Output
18	TVC solenoid 1 (-)	Output
19	Travel EPC solenoid (-)	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 pressure input	Input
4	Throttle potentiometer input	Input
5	Overload caution	
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	NC	
14	Feedback potentiometer input	Input
15	NC	
16	Pressure sensor GND	Input
17	Potentiometer GND	Input
18	Starting switch (terminal C)	Input
19	Power source	
20	NC	

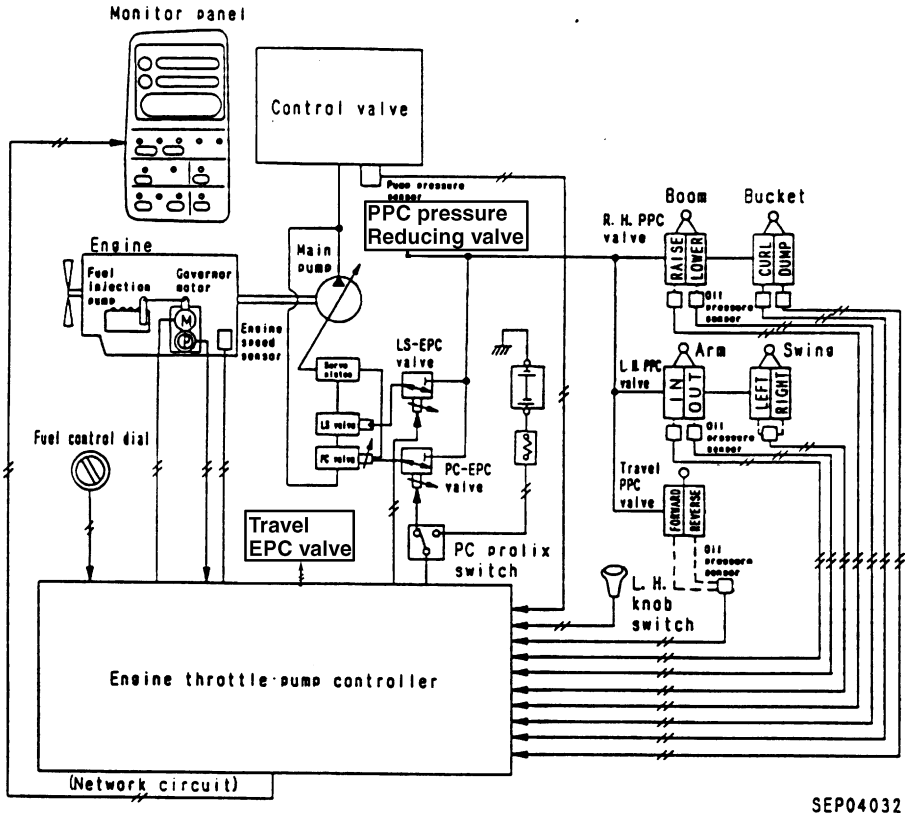
CN-17

1	NC	
2	Boom RAISE pressure switch	Input
3	Arm IN pressure switch	Input
4	S-NET (+)	Input, output
5	Model selection 1	Input
6	Model selection 3	Input
7	Model selection 5	Input
8	Swing prolix switch	Input
9	Lower wiper	Input
10	Boom LOWER pressure switch	Input
11	Arm OUT pressure switch	Input
12	S-NET (+)	Input, output
13	Model selection 2	Input
14	Model selection 4	Input
15	NC	Input
16	Swing lock switch	Input

CN-16

Pin. No.	Name of signal	Input/ output
1	Engine speed sensor GND	Input
2	Engine speed sensor	Input
3	S-NET (-)	Input/- output
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	NC	
10	NC	
11	Bucket CURL pressure switch	Input
12	Bucket DUMP pressure switch	Input
13	Travel pressure switch	Input
14	Park brake	Input
15	Engine oil pressure sensor L	Input
16	Engine oil level sensor	Input
17	Air cleaner clogging sensor	Input

1. PUMP & ENGINE MUTUAL CONTROL FUNCTION

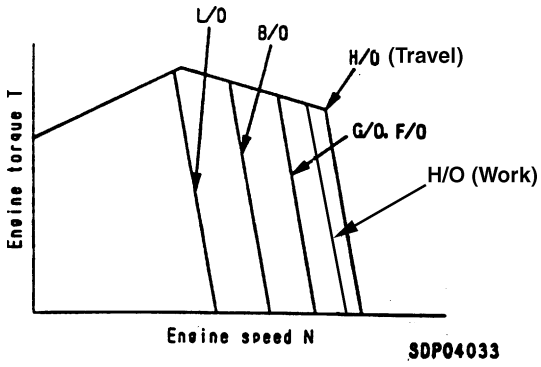


FUNCTION

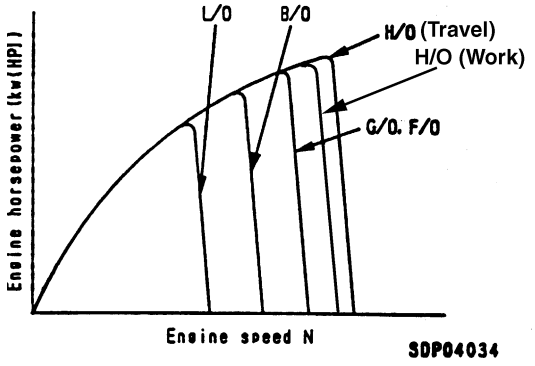
- There are five modes available for selection with the working mode switch on the monitor panel. These modes are the heavy-duty operation (H/O) mode, general operation (G/O) mode, finishing operation (F/O) mode, lifting operation (L/O) mode, and breaker operation (B/O) mode. It is possible to select the most suitable engine torque and pump absorption torque to match the nature of the work.

- The pump controller detects the actual engine speed and the speed set by the engine governor through the fuel control dial matches 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.

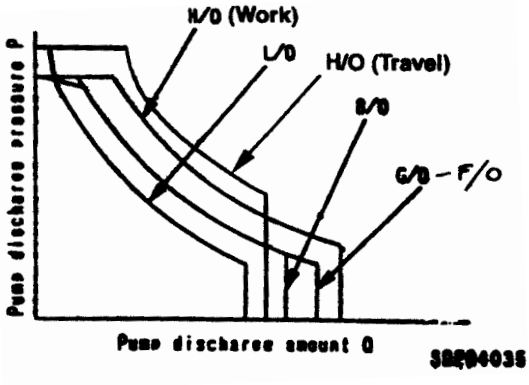
- Engine torque curve



- Engine horsepower curve



- Pump output curve

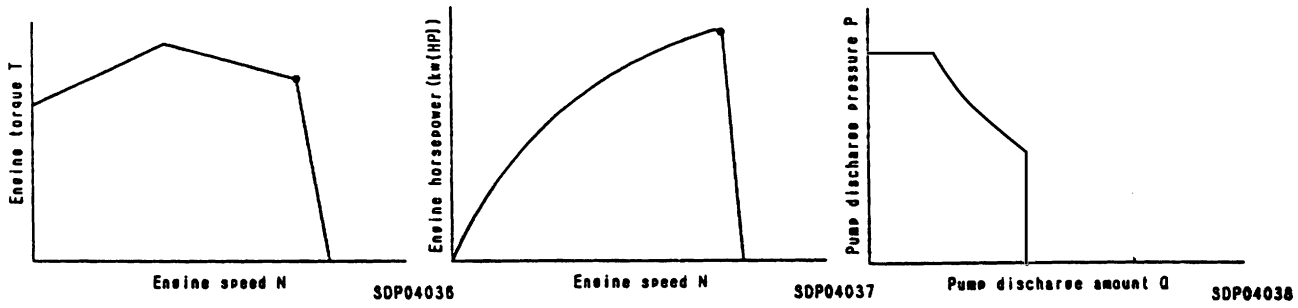


1) Control method in each mode

Heavy-duty travel operation (H/O travel) mode

- Matching point in heavy-duty operation mode: Rated output point.
- When the load on the pump rises 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 rated speed. Just the cut-off at relief is cancelled and the oil flow at relief is increased.
- 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 reaches the rated speed.
  By repeating this control, the engine can always be used at near the rated output point.

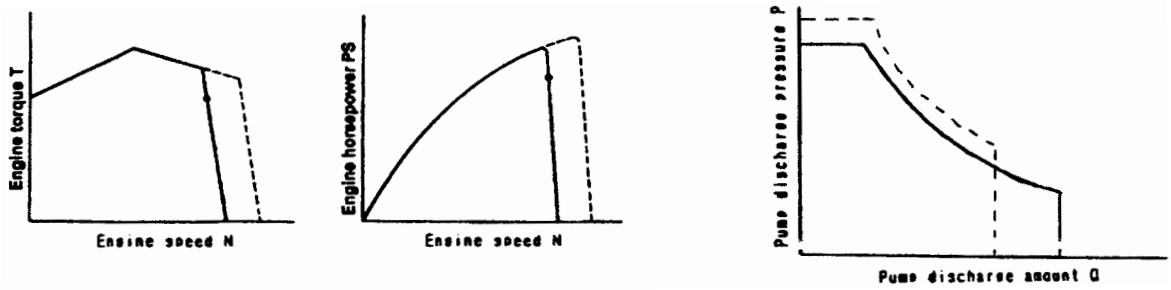
Heavy-duty travel	75 kW (102 PS)
operation (H/O travel)	2250 rpm



Heavy-duty working (H/O work) mode

- Matching point in heavy-duty working operation mode: 90% partial output point.
- 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.

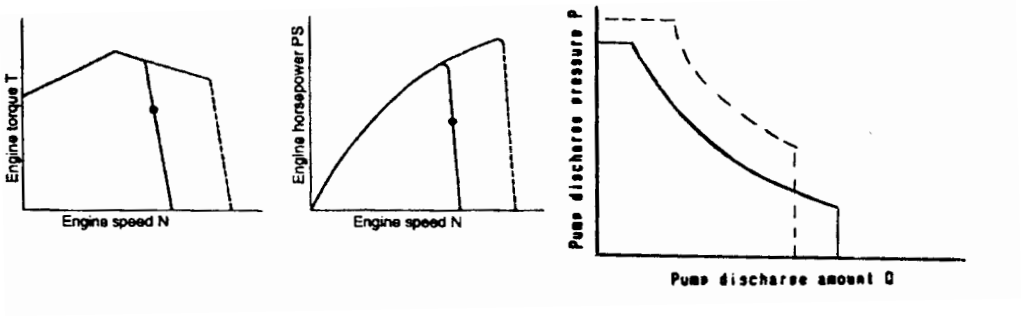
Heavy-duty travel	66 kW (90 PS)
operation (H/O travel)	1900 rpm



General operation (G/O), finishing operation (F/O) mode

- Matching point in general operation and finishing operation modes:
  65% partial output point.
  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.

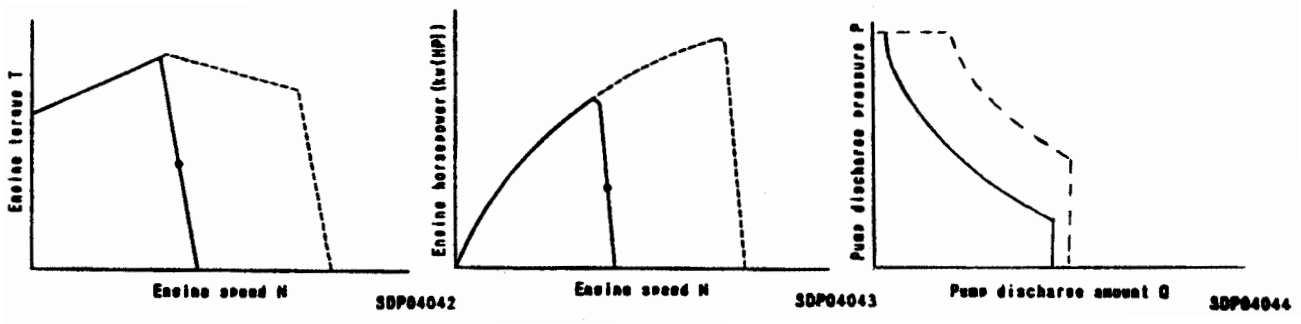
General operation (G/O)	48 kW (65 PS)
Finishing operation (F/O)	1760 rpm



Lifting operation (L/O) mode

- Matching point in lifting operation mode: 45% partial output point.
- When the lifting operation mode is selected, the engine speed is automatically lowered to the partial position.
  The cut-off function is cancelled and also the relief pressure is increased.
- In this condition, control is carried out in the same way as for the general operation and finishing operation modes to match the load on the pump.
- In this way, the fuel consumption is reduced and the fine control ability is improved.

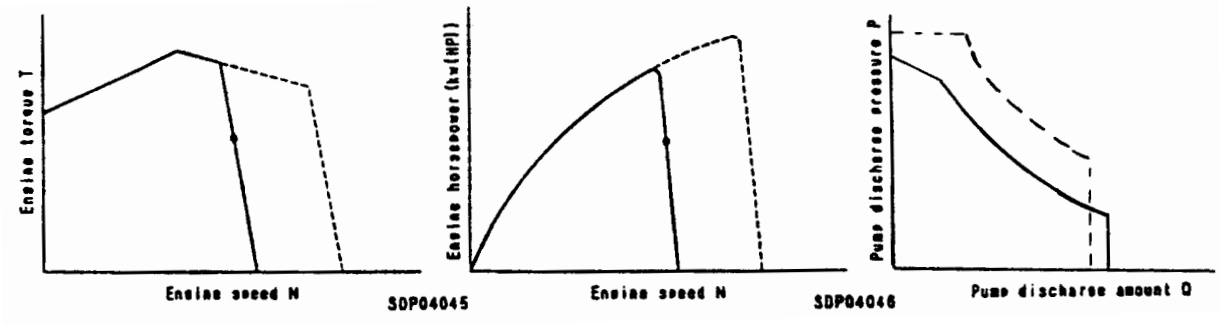
Lifting operation (L/O)	33 kW (45 PS) 1450 rpm



Breaker operation (B/O) mode

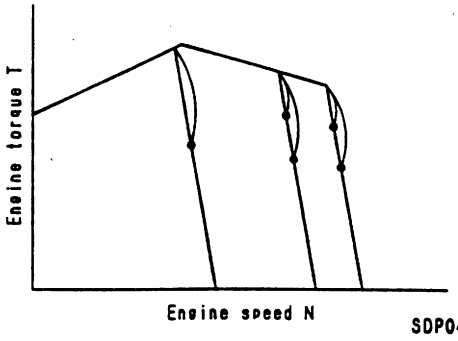
- Matching point in breaker operation mode: 65% partial output point.
- The pump absorption torque in the breaker operation mode is the same as for the general operation and finishing operation modes, and is controlled to become an even lower speed.
- As a result, the pump absorption torque needed to ensure the breaker drive is ensured, and the engine is used in a range that provides a much better fuel consumption ratio than for the general operation mode or finishing operation mode.
- Camshell control is at full flow in B/O mode only.

Breaker operation (B/O)	48 kW (65 PS) 1570 rpm

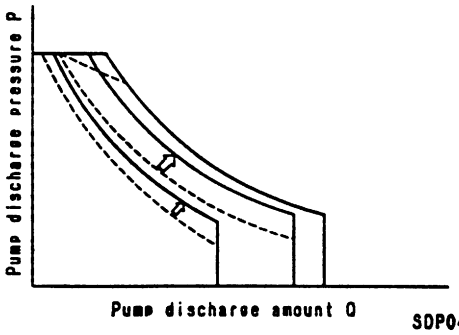


2) Pump control function when traveling

- If the travel is operated in any working mode other than the heavy-duty operation (H/O) mode, the working mode and engine speed are kept as they are, and the pump absorption torque is increased to the maximum horse-power at that speed.



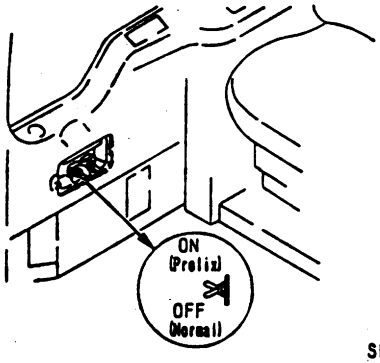
SDP04048



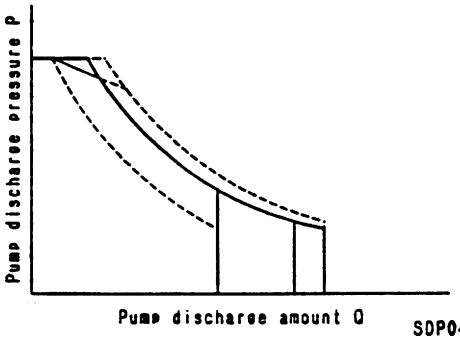
SDP04049

3) Control function when PC prolix switch is ON

- Even if any abnormality should occur in the controller or sensor, the PC prolix switch can be turned ON to provide an absorption torque more or less equivalent to the general operation (G/O) mode, thereby 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 PC valve, so oil pressure sensing is carried out only by the PC valve.

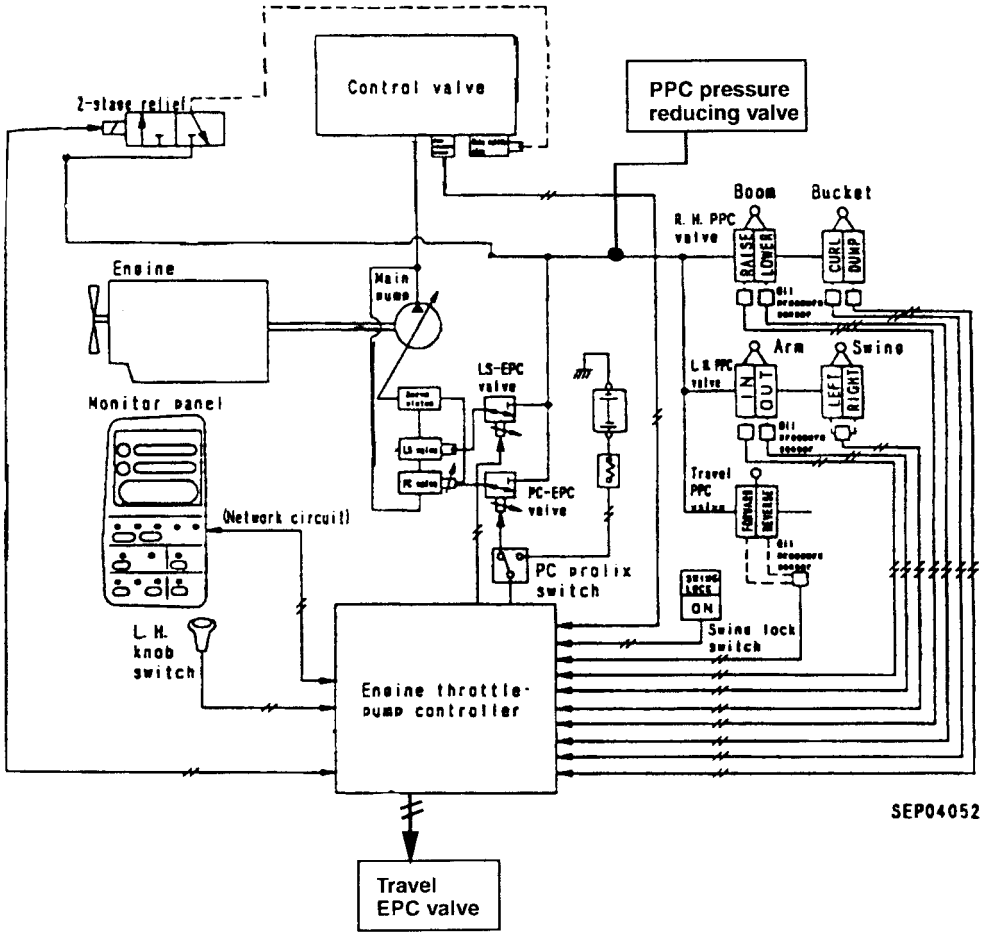


SEP04050



SDP04051

2. PUMP AND VALVE CONTROL FUNCTION



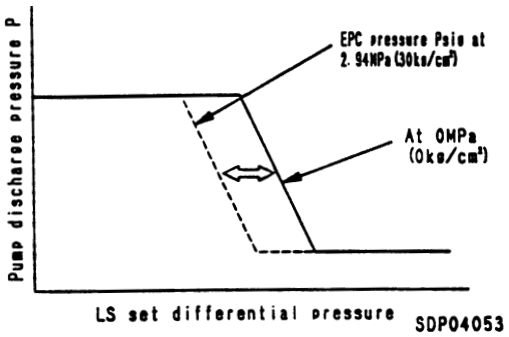
FUNCTION

- The following functions are available to provide the optimum matching under various working conditions: a cut-off function which reduces the relief loss; a function which cancels the cut-off function and prevents the speed from dropping; a 2-stage relief function which increases the digging power; and a fine control mode function which 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 control 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.

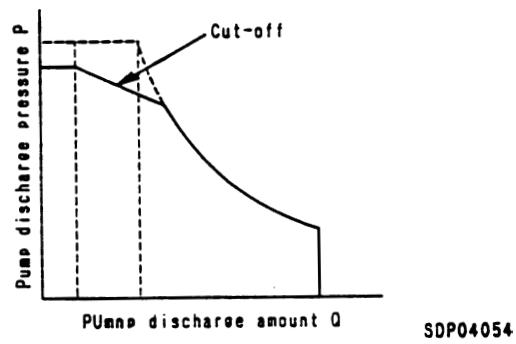
★ For details of the operation, see HYDRAULIC PUMP.



2) Cut-off function

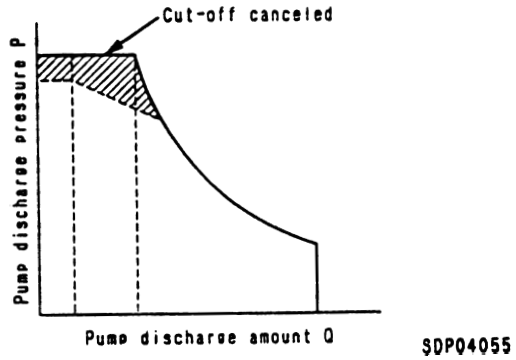
- If the load becomes larger during operation, and the pump discharge pressure rises too close to the relief pressure, the pump pressure sensor detects this, and the controller sends a signal to the PC valve to reduce the discharge amount, thereby reducing the relief loss.

★ For details of the operation, see CLSS.



3) Cut-off cancel function

- The cut-off cancel function acts to stop the operation of the cut-off function in order to ensure the pump flow when close to the relief pressure, thereby preventing any drop in speed.
- The relief pressure when the cut-off is operated is 31.85 MPa (325 kg/cm^2), and when the cut-off cancel function is operated, the relief pressure becomes approx. 34.79 MPa (355 kg/cm^2).
- Actuation conditions for cut-off cancel function



	Working mode switch				Swing lock	Switch	Knob switch	
	H/O	G/O, F/O, B/O	L/O	Travel ON	ON	OFF	ON	OFF
Cut-off function	Cancelled	Actuated	Cancelled	Cancelled	Cancelled	Actuated	Cancelled	Actuated
2-stage relief function	-	-	Actuated	Actuated	Actuated	-	Actuated at H/O, G/O	-

★ Quick warming up for hydraulic oil when swing lock switch is ON:
When the swing lock switch is turned ON, the cut-off function is cancelled.
If the work equipment is relieved in this condition, the temperature of the hydraulic oil can be raised more quickly to reduce the warming up time.

4) 2-stage relief function

- The relief pressure for normal operations is 31.85 MPa (325 kg/cm2), but when the 2-stage relief function is actuated, the relief pressure rises to approx. 34.79 MPa (355 kg/cm2).
  Because of this, the hydraulic pressure is increased by one stage.
- When the 2-stage relief function is actuated, the cut-off cancel function is also actuated automatically.

- Actuating conditions for 2-stage relief function

Conditions	Relief pressure
• When travelling • When swing lock switch is ON • In lifting operation (L/O) mode • When power max. function or swift slow-down function are actuated	31.9 MPa (325 kg/cm^2) ⇩ 34.8 MPa (355 kg/cm^2)

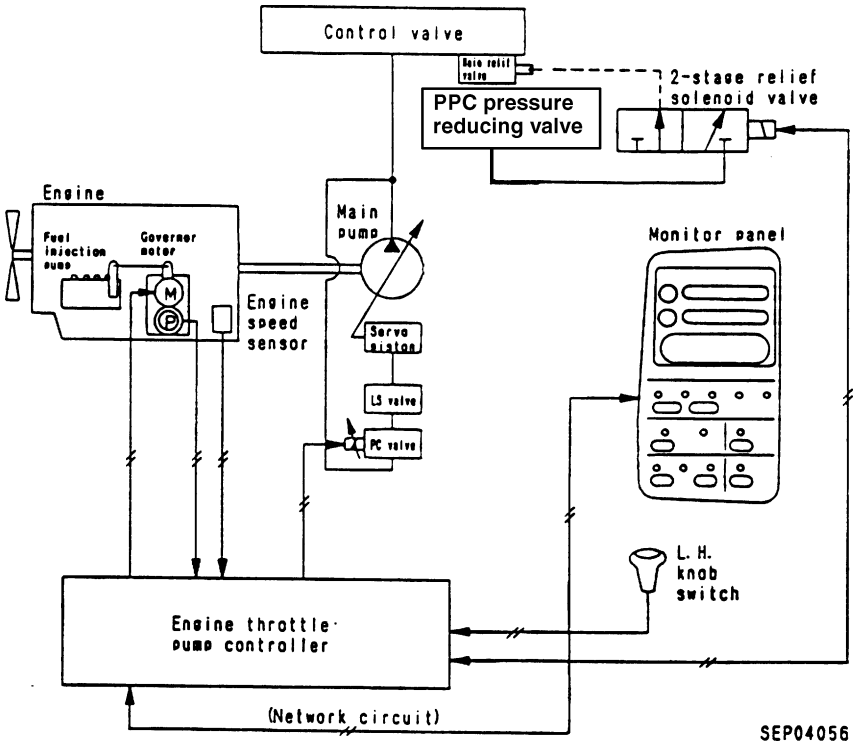
5) Fine control mode function

- When the finishing operation (F/O) mode is selected from 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	Boom		Arm		Bucket Swing	
Mode	RAISE	LOWER	IN	OUT		
Heavy-duty operation (H/O)	100	50	100	100	50	50
General operation (G/O)						
Finishing operation (F/O)	80	50	60	80	40	40
Lifting operation mode (L/O)	100	50	100	100	50	50
Breaker operation (B/O)						

3. POWER MAXIMIZING AND SWIFT SLOW-DOWN FUNCTION



FUNCTION

- This function provides an increase in the digging power for a certain time or switches the working mode to the lifting operation (L/O) and reduced 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	Cut-off function	2-stage relief function	Actuating time
Heavy-duty working operation (H/O work)	Cancelled	Actuated 31.85→34.79 MPa (325→355 kg/cm^2)	Automatically cancelled after 8.5 sec.

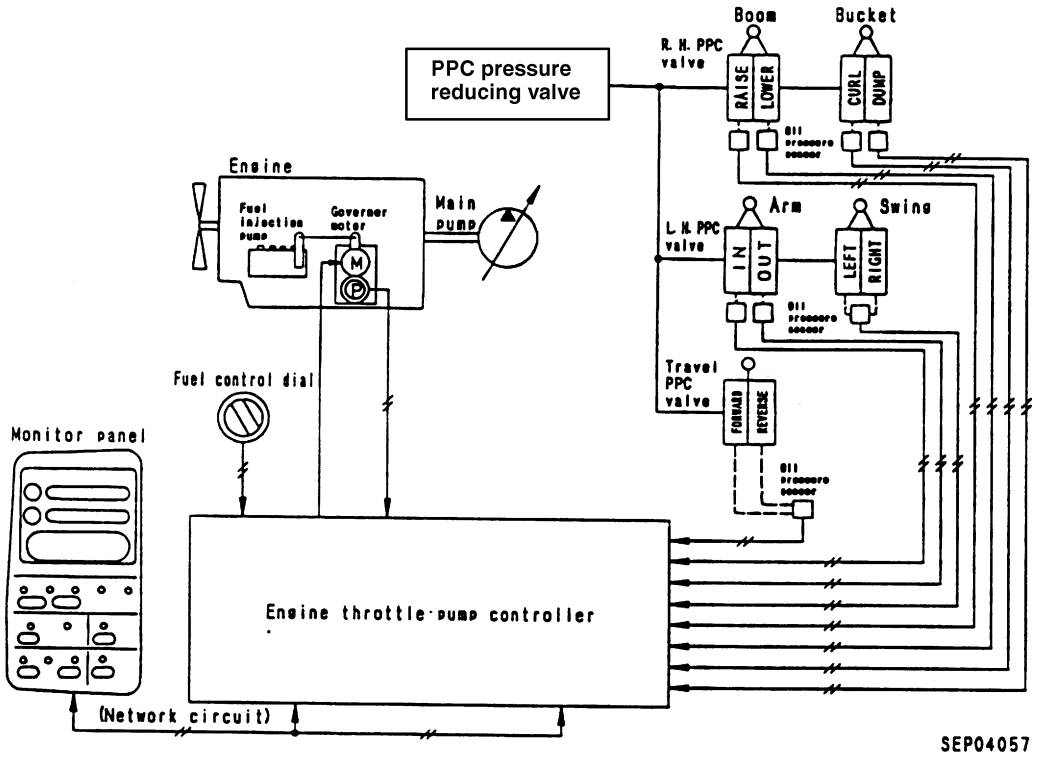
2) Swift slow-down function

- 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 lifting operation (L/O) mode 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 L/O	While switch is kept pressed

4. AUTO-DECELERATION FUNCTION



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.

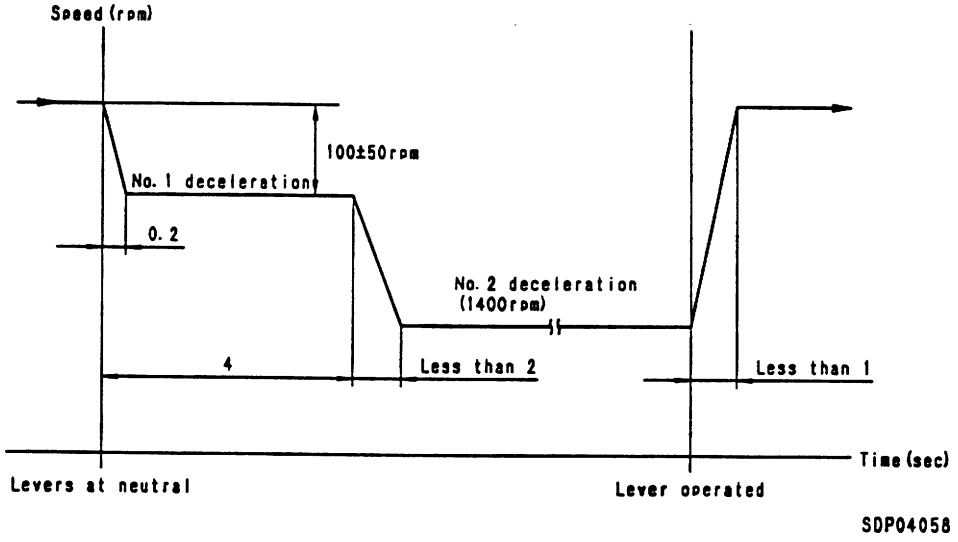
OPERATION

Control levers at neutral

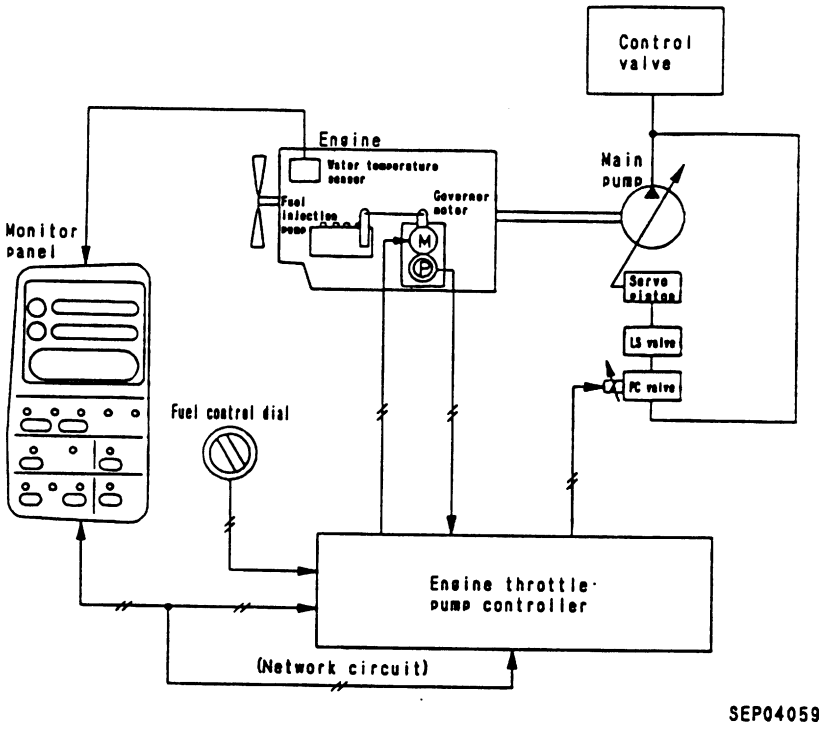
- If the engine is running at above the deceleration actuation speed (approx. 1400 rpm), and all the control levers are returned to neutral, the engine speed drops immediately to approx. 100 rpm below the set speed to the No. 1 deceleration position.
- If another 4 seconds passes, the engine speed is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



5. AUTOMATIC WARMING-UP AND ENGINE OVERHEAT PREVENTION FUNCTION



FUNCTION

- If the coolant 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 coolant temperature rises too 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 1400 rpm

⇒

Actuation
Engine speed: 1250 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 speed for more 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 in two stages. The first stage is when the coolant temperature is between 102°C and 105°C, and the second stage is when the coolant temperature is 105°C and above.

Normal operation
(coolant temperature below 102°C)

Actuation condition	
Normal operation	Coolant temperature: below 102°C (Coolant temperature gauge: Green range)

1st stage (Coolant temperature between 102°C and 105°C)

Actuation condition	
1st stage	Coolant temperature between 102°C and 105°C (Coolant temperature gauge: Red range)

Actuation, remedy	
Working mode	
Heavy-duty General Finishing Breaker	Mode kept as it is, output reduced
Lifting	Lifting operation kept as it is

Cancel condition	
2nd stage	Coolant temperature: Below 102°C When the above condition is met, the system returns to the condition before the overheat prevention function was actuated (automatic reset).

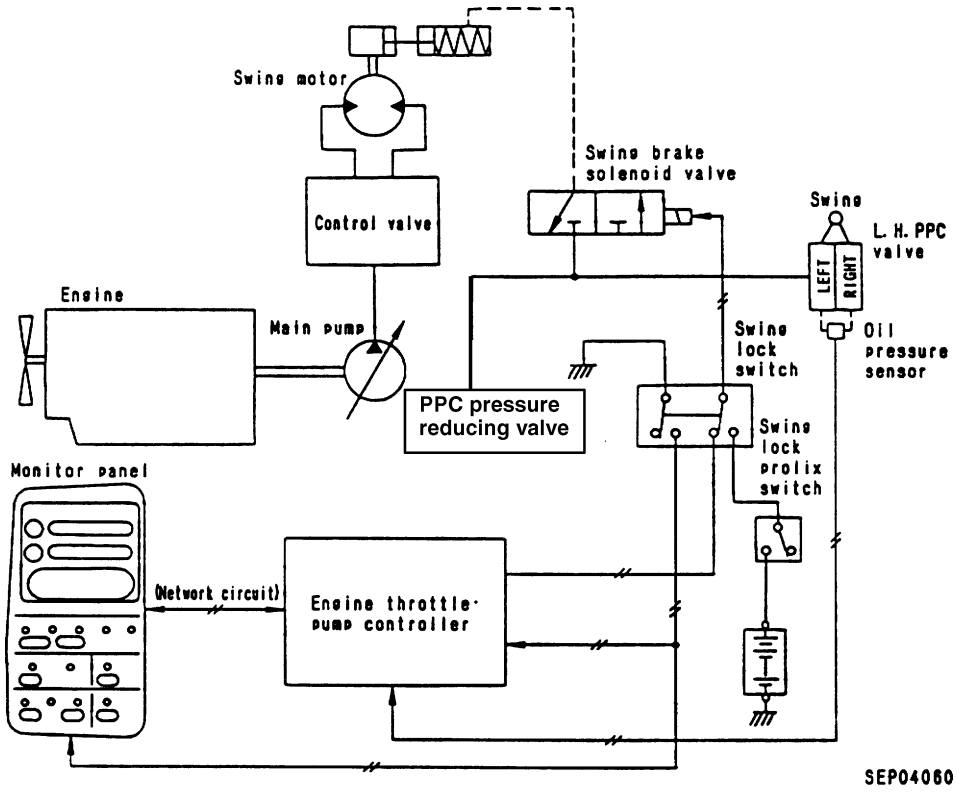
2nd stage (Coolant temperature 105°C and above)

Actuation condition	
2nd stage	Coolant temperature 105°C and above (Coolant temperature gauge: Red range)

Actuation, remedy	
Working mode	In any mode
Engine speed	Low idling
Monitor caution lamp	Lights up
Caution buzzer	Sounds

Cancel condition	
2nd stage	Coolant temperature: Below 102°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 CONTROL FUNCTION



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 brake operated by the safety valve, so if the swing is stopped on a slope, there may be hydraulic drift.

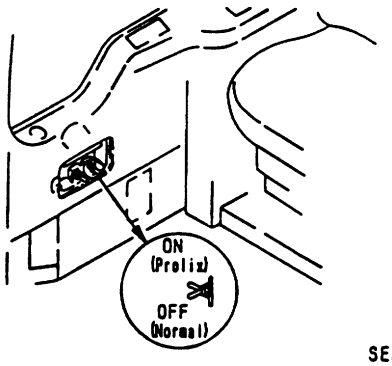
2) Hydraulic oil quick warm-up function when swing lock switch is ON

★ For details, see PUMP AND VALVE CONTROL FUNCTION.

- Swing lock switch and swing lock, 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. 4 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



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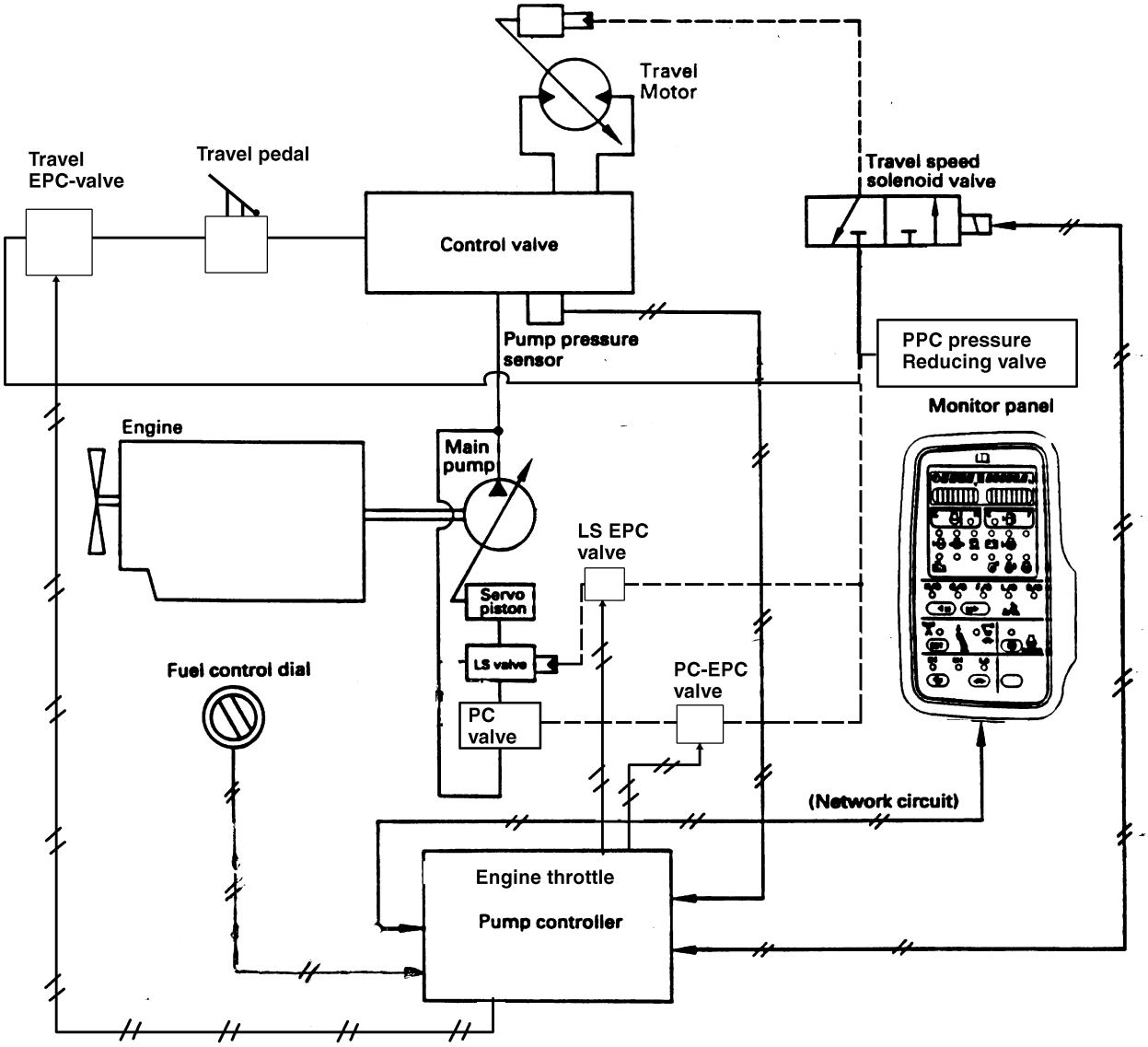
7. Travel control function



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 (H/O) mode, this increases the pump absorption torque while keeping the working mode and engine speed as they are.

★ For details, see PUMP & ENGINE MUTUTAL CONTROL FUNCTION.

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 pump controller controls the pump flow and motor volume at each speed range as follows to switch the travel speed.

30 Km/h TRAVEL SPEED SPEC.

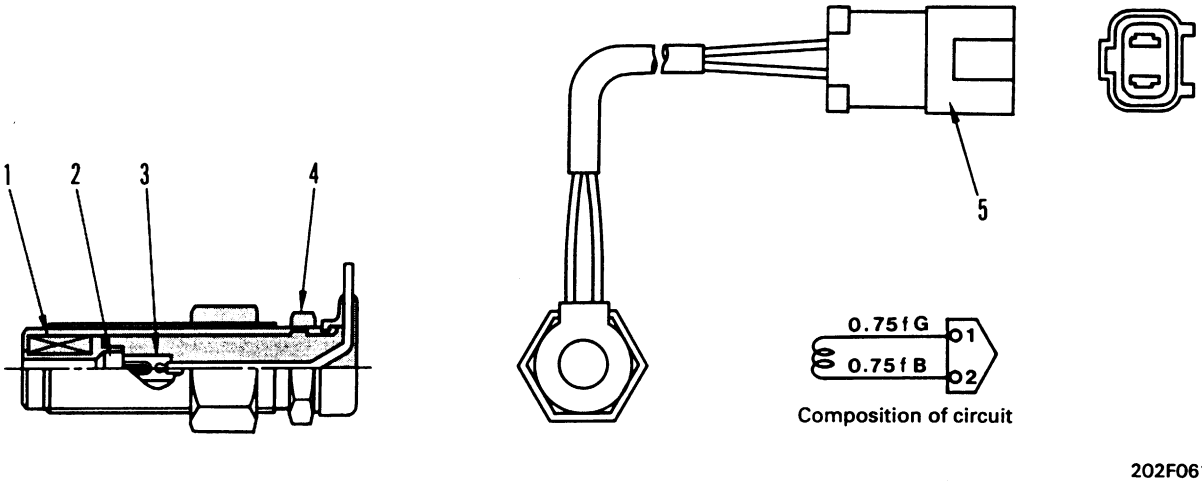
Travel speed switch	Lo (Low speed)	Mi (Midrange speed)	Hi (High speed)
Pump flow (%)	30	100	100
Motor volume	Max.	Max.	Min.
Travel speed (km/h)	3.5	10	30

20 Km/h TRAVEL SPEED SPEC.

Travel speed switch	Lo (Low speed)	Mi (Midrange speed)	Hi (High speed)
Pump flow (%)	30	100	100
Motor volume	Max.	Max.	Min.
Travel speed (km/h)	2.7	8	20

8. Components of system

1) Engine speed sensor



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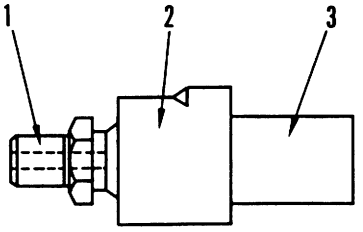
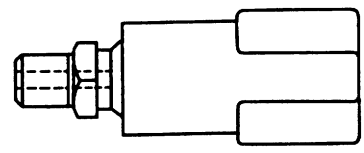
1. Wire
2. Magnet
3. Terminal
4. Housing
5. Connector

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 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 oil pressure switch





1. Plug
2. Switch
3. Connector

SPECIFICATIONS

Composition of points: N.O. points

Actuation (ON) pressure:

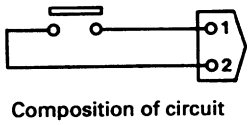
0.49 ± 0.1 MPa (5.0 ± 1.0 kg/cm^2)

Reset (OFF) pressure: 0.29 ± 0.05 MPa

(3.0 ± 0.5 kg/cm^2)

Function

- There are 16 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 pump controller.



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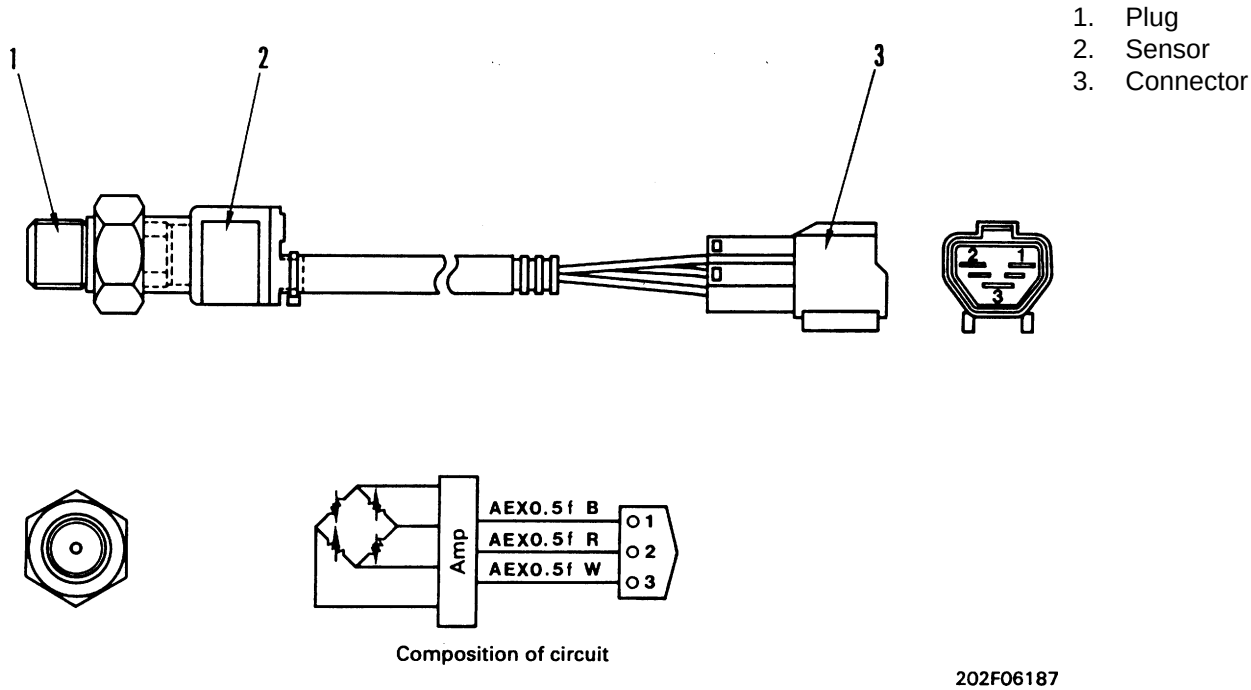
3) Pump pressure sensor



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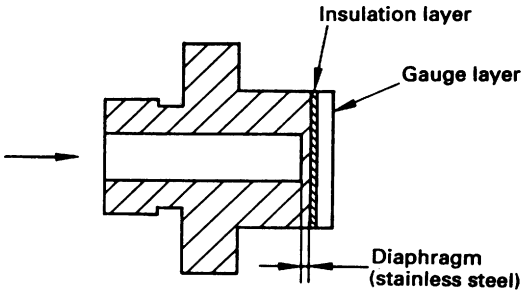
Function

- 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 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 pump controller.
- Relationship between P (kg/cm2) and output voltage (V)
  V = 0.008 x P + 1.0
  ★ 1 kg/cm^2 = 0.098 MPa



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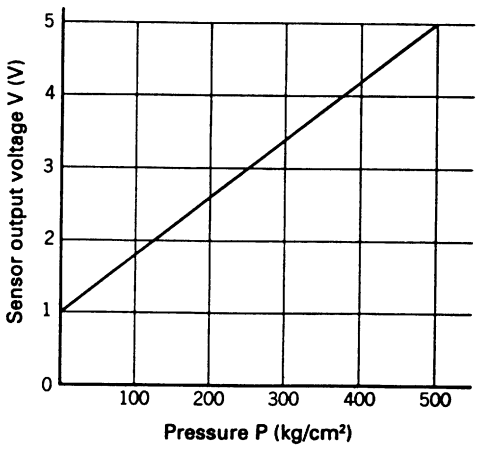

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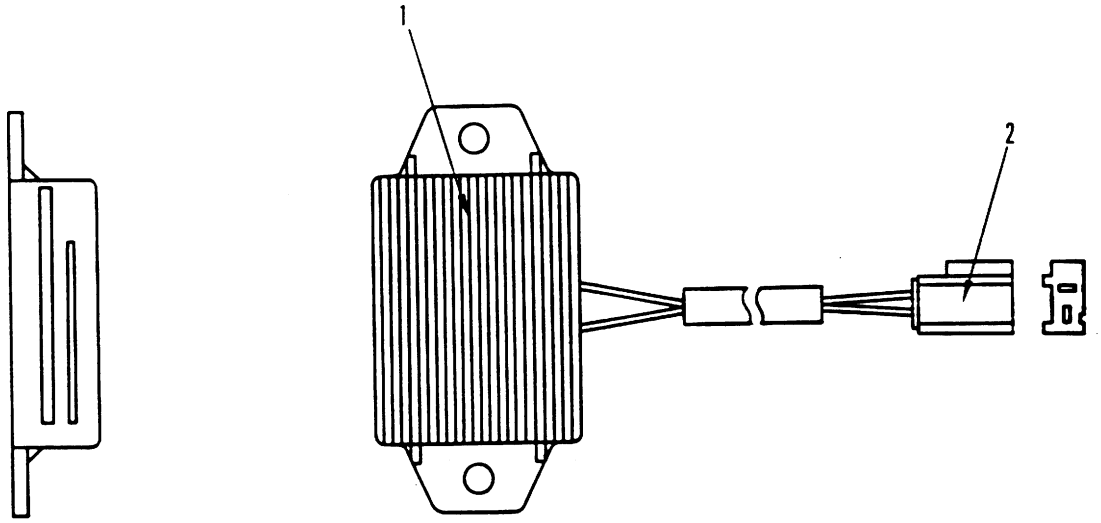
5) TVC prolix resistor



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1. Resistor
2. Connector

SPECIFICATION
Resistance: 30 Ω

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

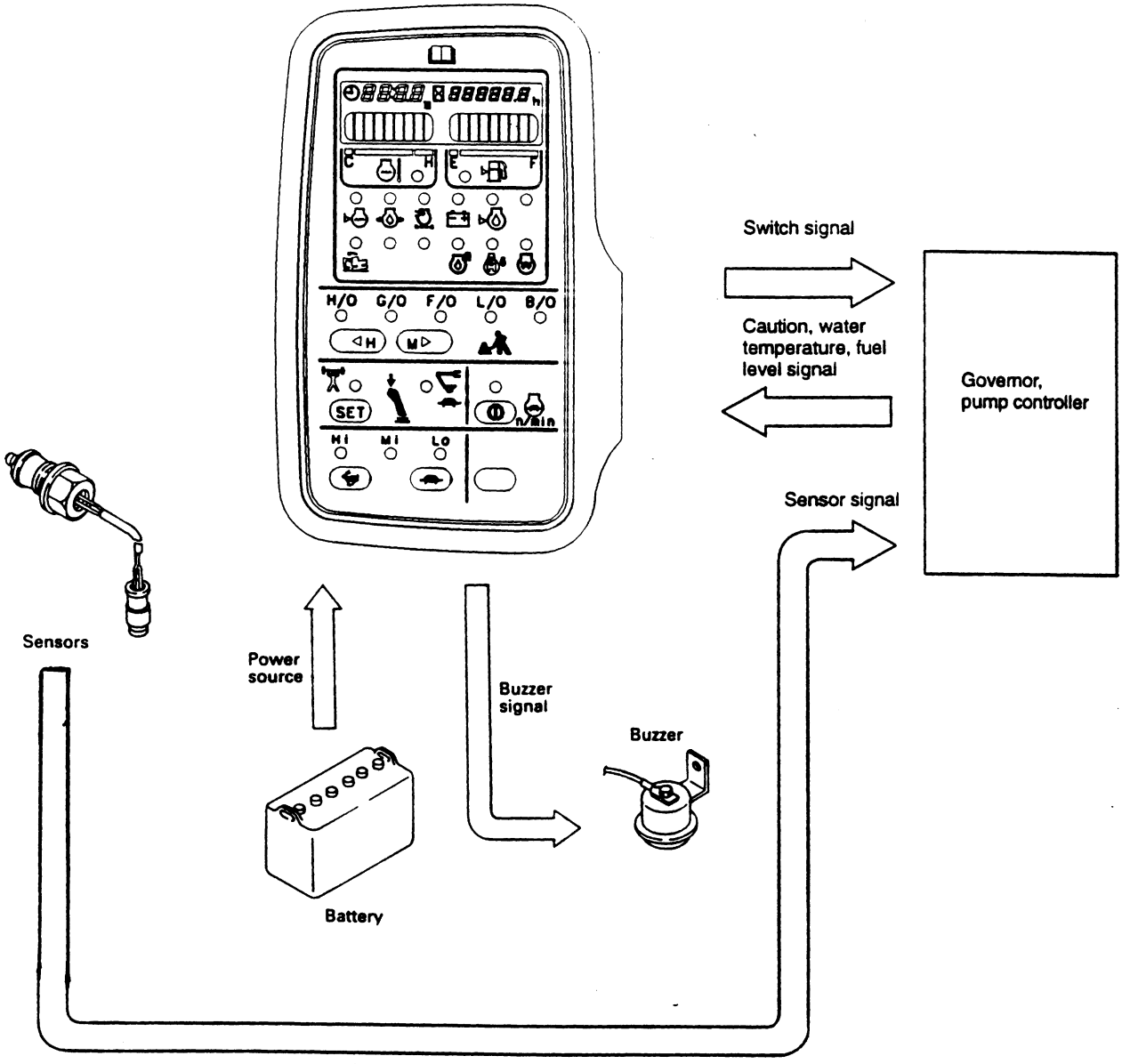
6) Fuel control dial, governor motor, engine throttle controller
★ See ENGINE CONTROL SYSTEM.

7) Monitor panel
★ See MONITORING SYSTEM.

8) PC valve
★ See HYDRUALIC PUMP.

9) LS control epc valve, travel EPC valve
Suspension lock solenoid valve
Travel speed solenoid valve
Swing brake solenoid valve
2-stage relief solenoid valve
Safety lock solenoid valve
★ See EPC solenoid valve

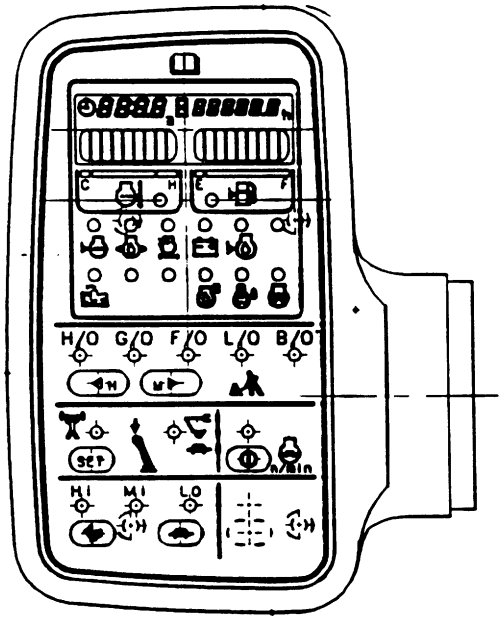
MACHINE MONITOR SYSTEM

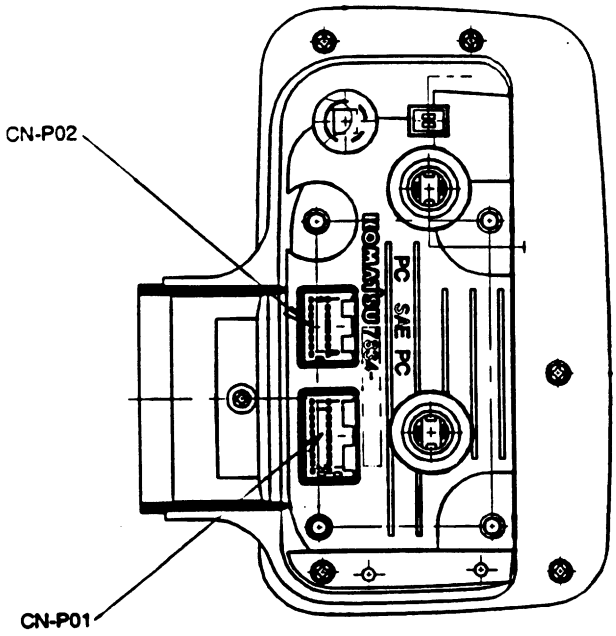


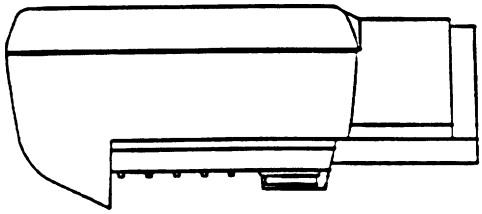
Function

- 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 panel to inform the operator of the condition of the machine.
  The content of the information displayed on the machine can broadly be divided 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 panel for the machine control system.

1. Monitor panel







Outline

- The monitor panel consists 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.

Input and output signals

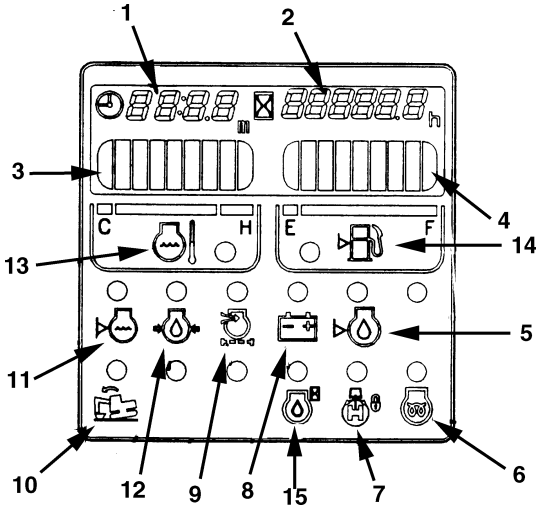
CN-P01

Pin NO.	Name of signal
1	NC
2	NC
3	NC
4	Network (+)
5	Swing lock
6	Buzzer cancel
7	Buzzer output
8	Lamp
9	Key ON signal
10	Terminal BR
11	Network (+)
12	NC
13	NC
14	Network (-)
15	NC
16	NC
17	NC
18	Preheating
19	Start signal
20	NC

CN-P02

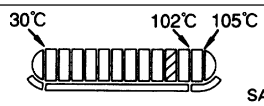
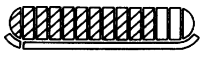
Pin No.	Name of signal
1	GND
2	NC
3	NC
4	NC
5	NC
6	NC
7	NC
8	Power supply (24V)
9	GND
10	NC
11	NC
12	NC
13	NC
14	Power supply (24V)
15	NC
16	NC

DISPLAY MONITOR

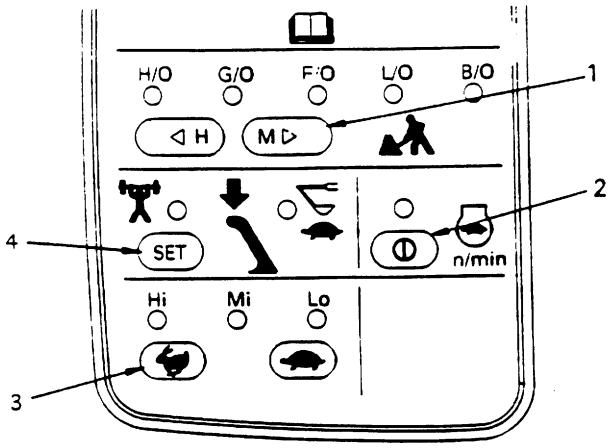


1. Clock (displays error code when error occurs)
2. Service meter
3. Coolant temperature gauge
4. Fuel gauge
5. Engine oil level caution lamp
6. Preheating pilot lamp
7. Swing holding brake pilot lamp
8. Charge level caution lamp
9. Air cleaner clogging caution lamp
10. Overload caution lamp
11. Coolant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

Contents 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 1,500 rpm: below 0.05 MPa (0.5 kg/cm^2) Above 1,500 rpm: below 0.15 MPa (1.5 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
SDP00688	Over load	Above high 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	
	Oil maintenance			

MODE SELECTION SWITCHES



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

- The switch portion consists of five 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	tem	Action
◁ H M ▷ SDP00692	WORKING MODE	H/O - 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

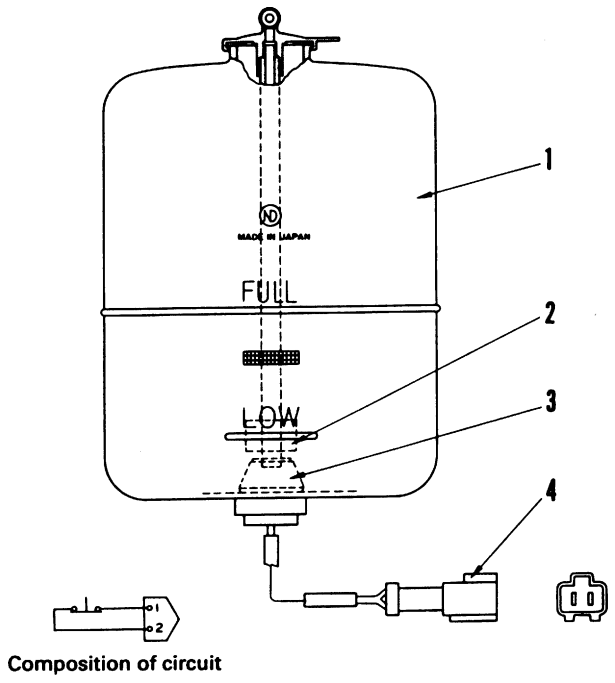
2. Sensors

- The signals from the sensors are input directly to the monitor panel.
- There are two types of sensors: contact type and resistance type. The contact type sensors are always connected at one end to the chassis GND.

Display	Name of sensor	Type of sensor	When normal	When abnormal
CHECK	Coolant level	Contact type	ON (close)	OFF (open)
	Engine oil level	Contact type	ON (close)	OFF (open)
CUATION	Engine oil pressure Lo	Contact type	OFF (open)	ON (close)
	Engine oil pressure Hi	Contact type	OFF (open)	ON (close)
	Air cleaner clogging	Contact type	ON (close)	OFF (open)
GAUGE	Coolant temperature	Resistance type	-	-
	Fuel level	Resistance type	-	-

1) Coolant level sensor

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



Composition of circuit

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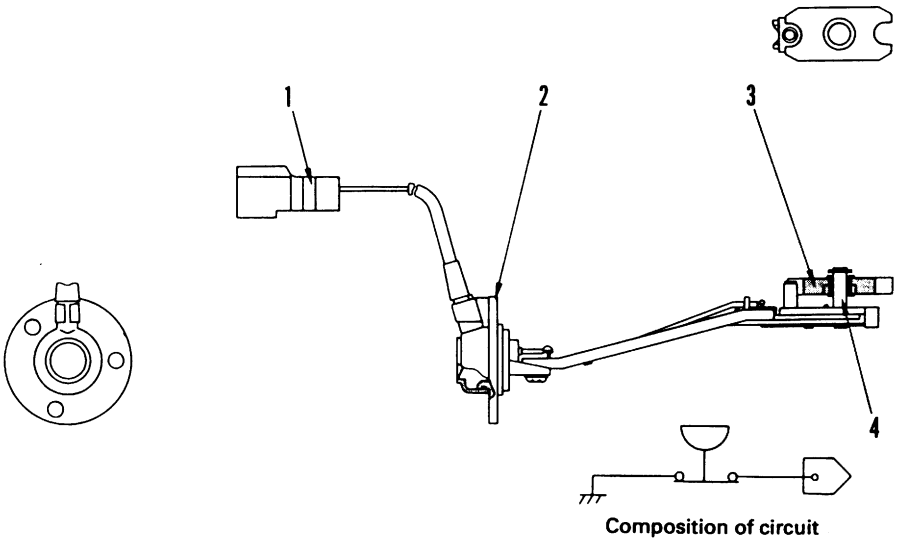
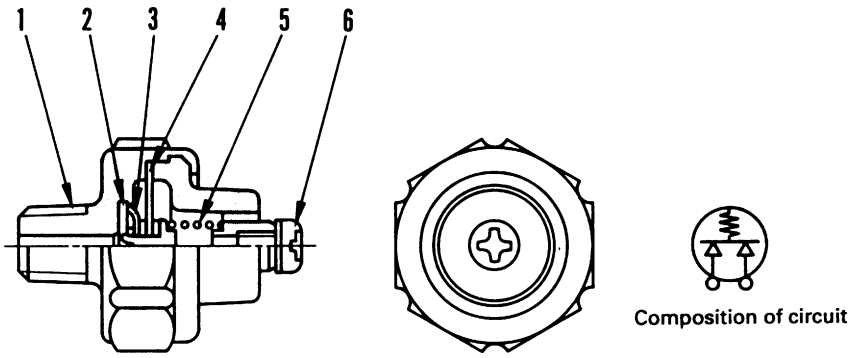
2) Engine oil level sensor



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

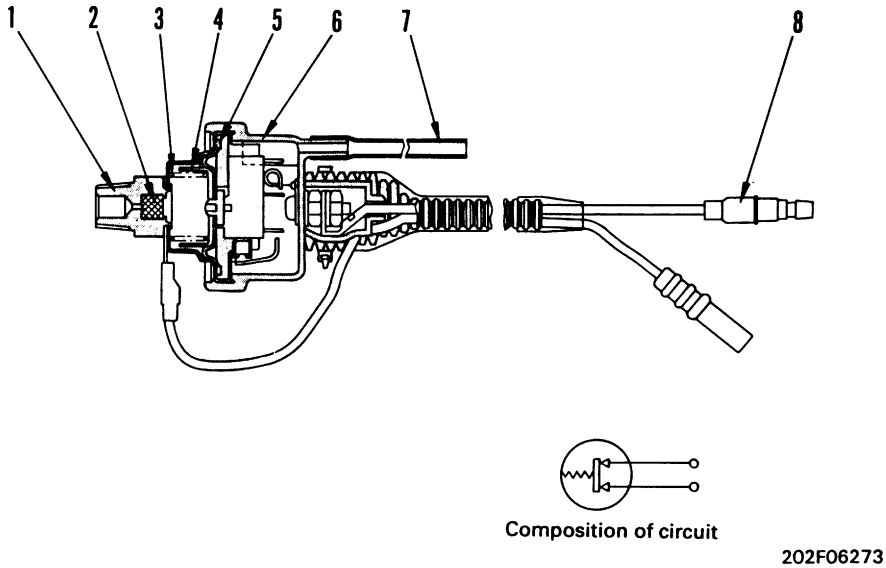
3) Engine oil pressure sensor (Lo, Hi)



1. Plug
2. Contact ring
3. Contact
4. Diaphragm
5. Spring
6. Terminal

Actuation (ON) pressure Lo: 0.05 ± 0.02 MPa (0.5 ± 0.2 kg/cm^2) or less

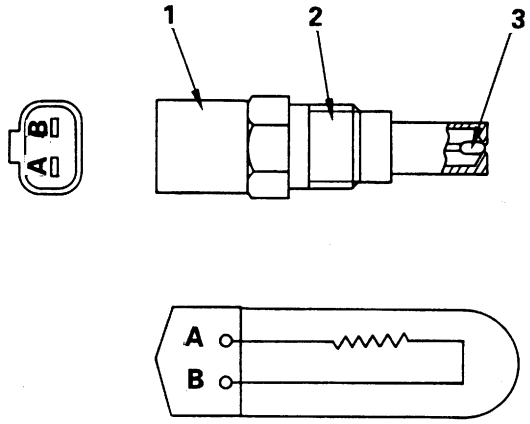
4) AIR CLEANER CLOGGING SENSOR



1. Boss
2. Filter
3. Spring
4. Guide
5. Diaphragm
6. Case
7. Hose
8. Connector

Actuation (OFF) pressure: -7.47 ± 0.49 Kpa (-762 ± 50 mmH2O)

5) COOLANT TEMPERATURE SENSOR



Composition of circuit

1. Connector
2. Plug
3. Thermistor

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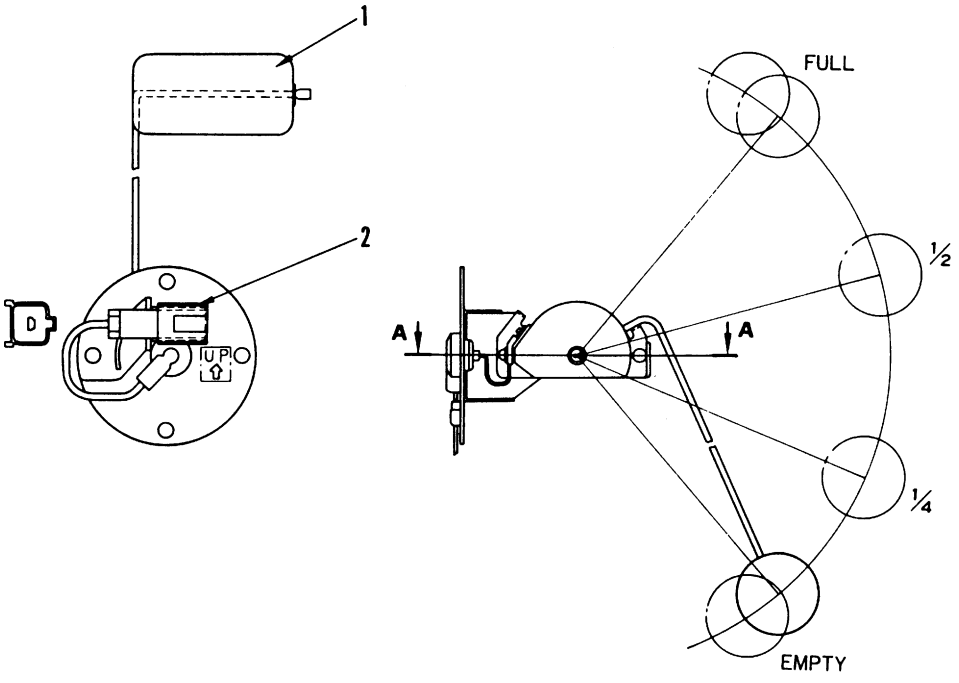
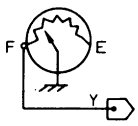
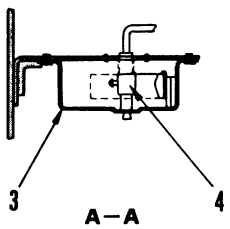
6) Fuel level sensor





Composition of circuit



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

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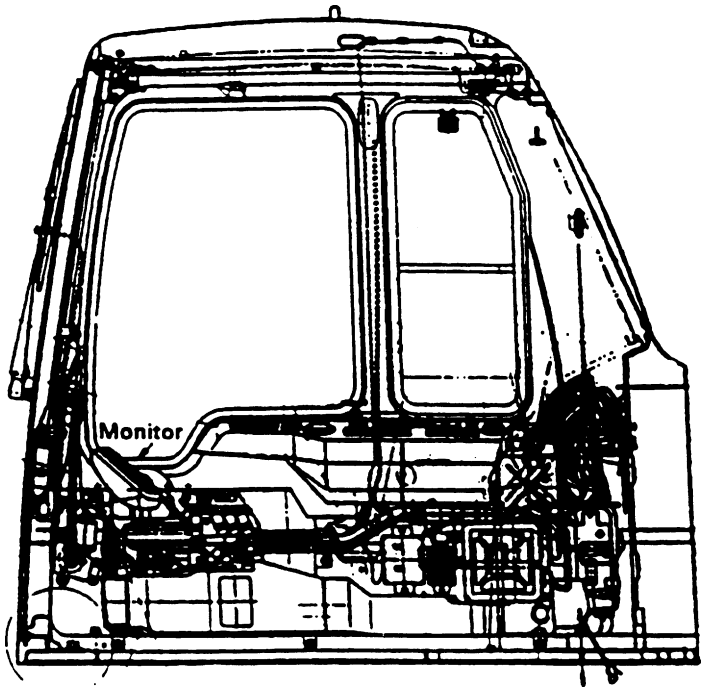
OVERLOAD WARNING DEVICE

1) OUTLINE



Function

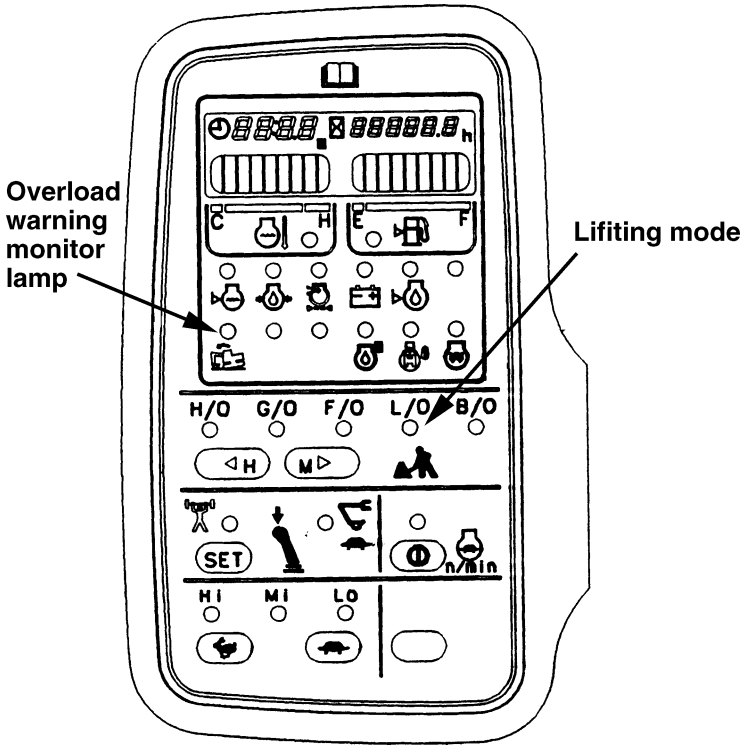
- This device is installed to prevent the machine from tipping over when it lifts an excessive weight while being used as a crane.

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 bring the arm closer in the operator to prevent the machine from tipping over.

Note

The overload caution system can only be activated when the L/O mode (lifting) is activated on the monitor panel.



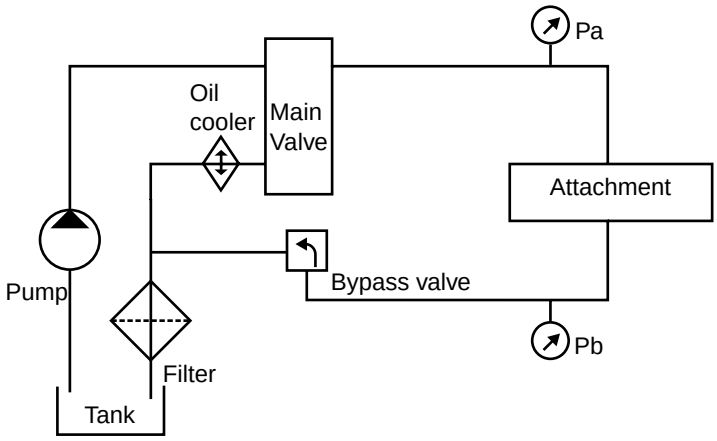
BREAKER MODE HYDRAULIC PERFORMANCE (MAIN VALVE BYPASSED)

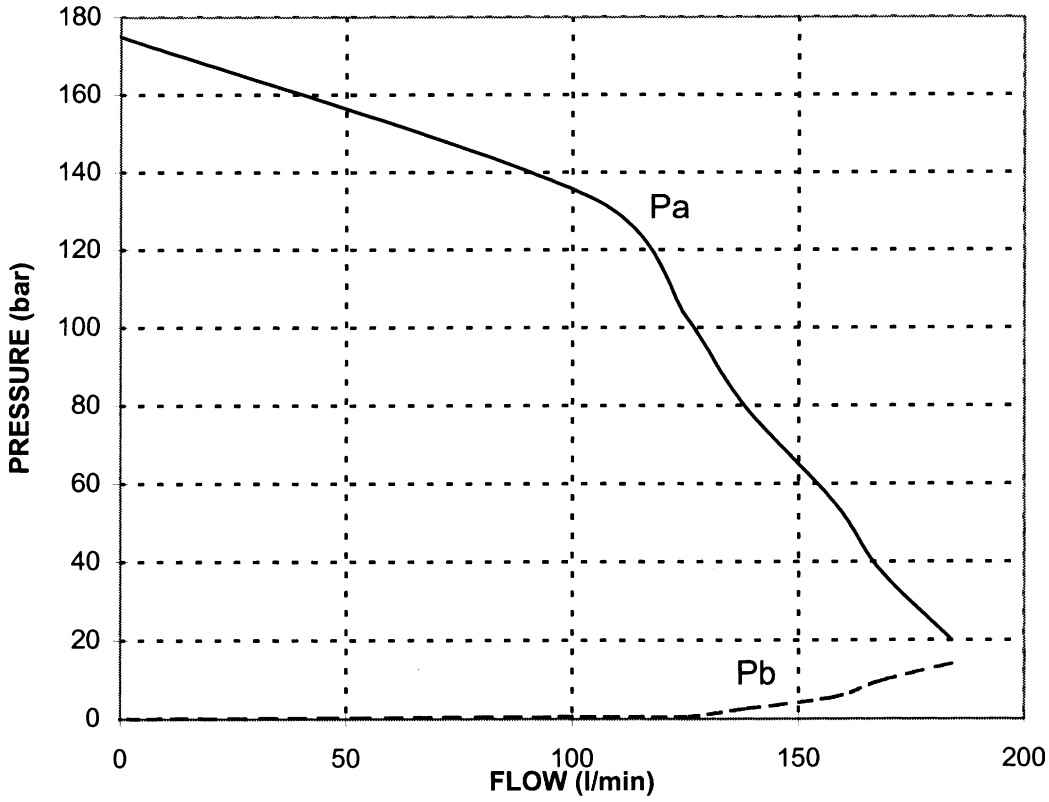
The performance of the hydraulic system when used in the B.O. mode for attachment operation, is shown below.

The pressure **Pa** is that which 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.





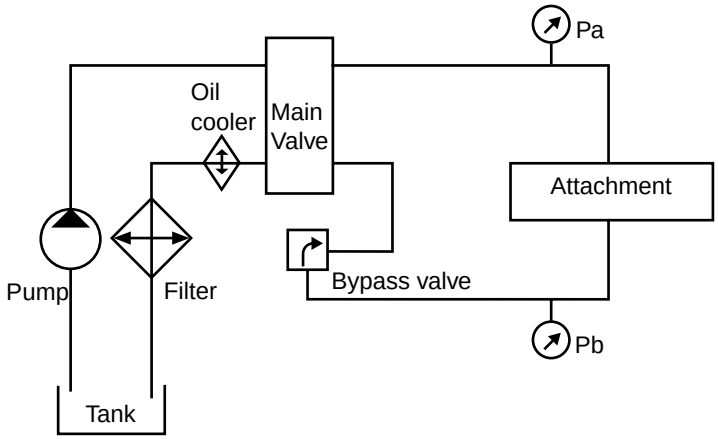
BREAKER MODE HYDRAULIC PERFORMANCE (VIA MAIN VALVE)

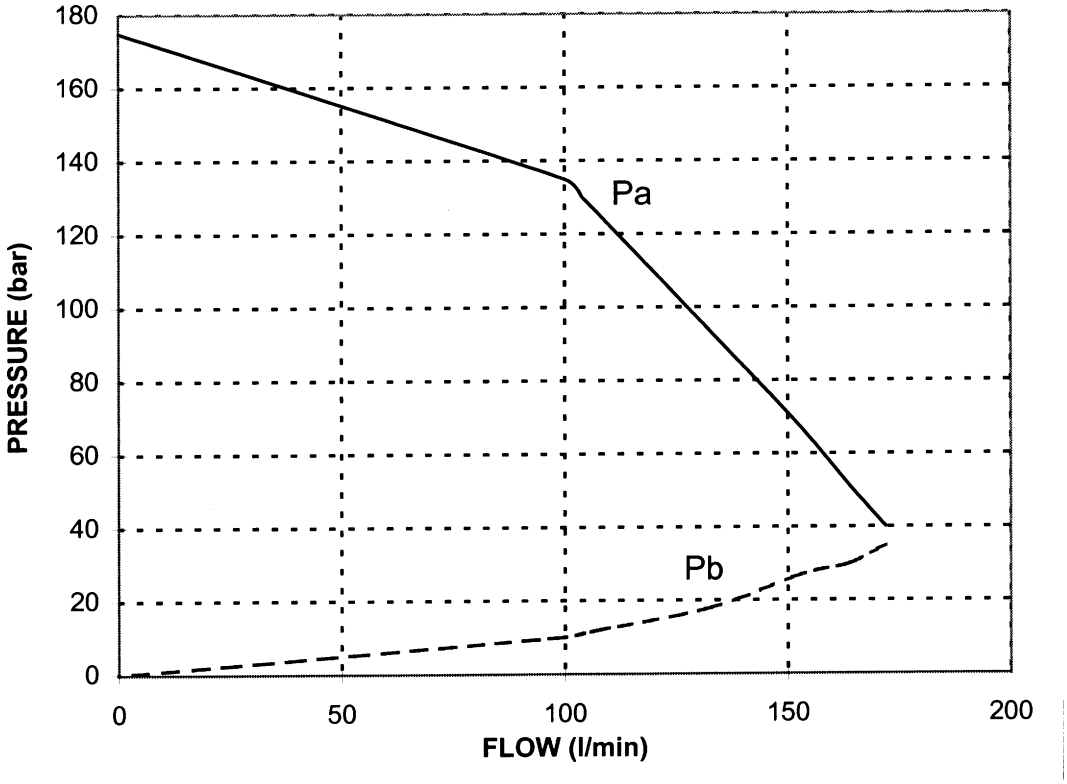
The performance of the hydraulic system when used in the B.O. mode for attachment operation, is shown below.

The pressure **Pa** is that which 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.





20 TESTING AND ADJUSTING

When carrying out testing, adjusting, or troubleshooting, park the machine on level ground and use 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.

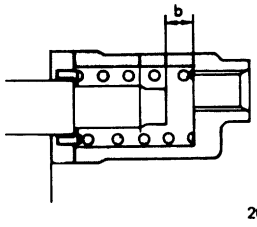
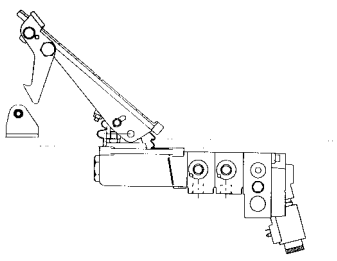
TABLE OF JUDGEMENT STANDARD VALUE

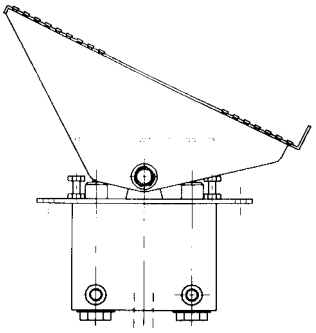
- **FOR ENGINE**

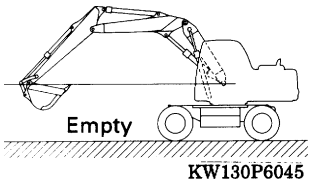
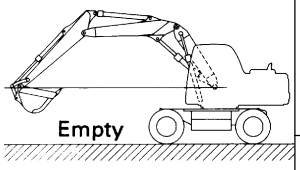
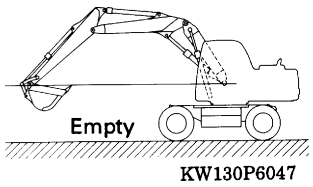
Machine model			PW130-6	
Engine			4BTA	
Item	Measurement conditions	Unit	Standard value	Permissible value
Engine speed	High idling - Travel	rpm	2450	2413 - 2487
	- Working (HO Mode)		2100	2068 - 2132
	Low idling		920	897 - 943
	Rated speed - Travel		2260	-
	- Working			
	- Working (HO Mode)		1900	-

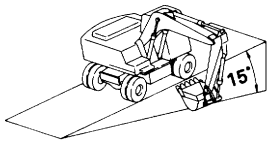
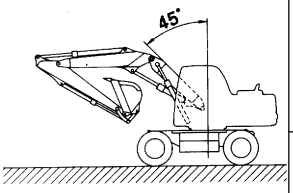
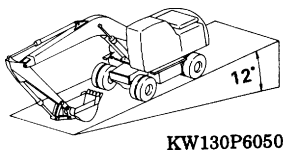
- **FOR CHASSIS**

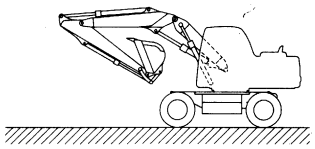
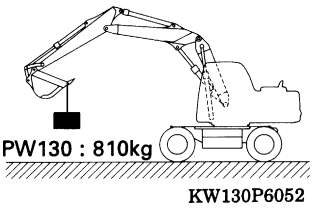
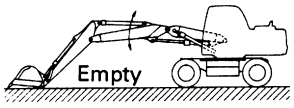
★ The standard values and permissible values shown in this table are all values for H/O (heavy-duty operation) mode.

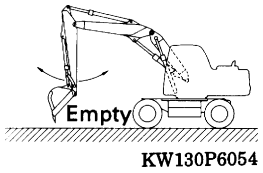
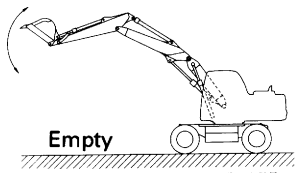
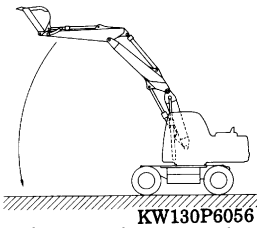
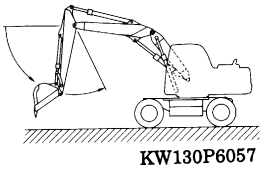
Machine model				PW130-6	
Category	Item	Measurement conditions	Unit	Standard value	Permissible value
Engine speed	At pump relief (LS relief)	• Hydraulic oil temperature: 45-55°C • Coolant temperature: Within operating range • Pump relief: Arm relief	rpm	1,900	-
	At pump relief (power max.)			2,270	-
	Speed when auto deceleration is operated	• Fuel control dial at MAX. • Control lever at neutral		1,400±200	1,400±200
Spool stroke	1st Boom control valve		mm	b	b
	Arm control valve			8±0.5	8±0.5
	Service valve				
	Bucket control valve				
	2nd Boom control valve				
	Swing control valve				
	Stabilizer control valve				
	Travel control valve				
Travel of control levers	Boom control lever	• Center of lever knob • Read max. value to end of travel • Engine stopped • Excluding neutral play • Engine at high idling	mm	80±10	80±10
	Arm control lever			80±10	80±10
	Bucket control lever			80±10	80±10
	Swing control lever			80±10	80±10
	Play of control lever			10±5	10±5
Operating force of control levers	Boom control lever	• Hydraulic oil temperature 45-55°C • Fit push-pull scale to center of control lever knob to measure • Measure max. value to end of travel • Tip of pedal	N (kg)	18.6 (1-9)	Max. 23.3 (Max. 2.4)
	Arm control lever			18.6 (1-9)	Max. 23.3 (Max. 2.4)
	Bucket control lever			18.6 (1-9)	Max. 23.2 (Max. 2.4)
	Swing control lever			14.7 (1-5)	Max. 18.4 (Max. 1.9)
	Brake pedal	• Engine at high idling • Hydraulic oil temperature: 45-55°C • Measure max. value to end of travel 		325±25 (33±2.5)	Max. 488 (Max. 50)

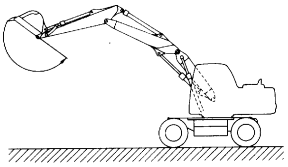
Machine model						PW130-6	
Cate-gory	Item	Measurement conditions			Unit	Standard value	Permissible value
Operating force of control levers	Travel control pedal	• Engine at high idling • Hydraulic oil temperature: 45-550C • Measure max. value to end of travel 			N (kg)	337.5±107.5 (34.5±11)	Max. 506 (Max 52)
Hydraulic pressure	Boom	• Hydraulic oil temperature: 45-55°C • Relief pressure with engine at high idling (Relieve only circuit to be measured)	RAISE	Normal	MPa (kg/cm²)	31.85±1.47 (325±15)	31.85±2.45 (325±25)
				Power max.		34.79±1.47 (355±15)	34.79±2.45 (355±25)
			LOWER	Normal		31.85±1.47 (325±15)	31.85±2.45 (325±25)
				Power max.		33.8 ±1.47 (345±15)	33.81±2.45 (345±25)
	Arm			Normal		31.85±1.47 (325±15)	31.85±2.45 (325±25)
				Power max		34.79±1.47 (355±15)	34.79±2.45 (355±25)
	Bucket			Normal		31.85±1.47 (325±15)	31.85±2.45 (325±25)
				Power max		34.79±1.47 (355±15)	34.79±2.45 (355±25)
	Swing	• In H/O mode				28.9±1.5 (295±15)	28.9±3 (295±30)
	Travel Stabilizer					34.79±0.98 (355±10)	34.79±1.96 (355±20)
	Pilot circuit pressure					3.2-3.5 (35-3)	3.2-3.5 (35-3)
	LS differential pressure	• Hydraulic oil temperature: 45-550C		Levers at neutral		2.74±0.98 (28±10)	2.74±0.98 (28±10)
	PC valve output pressure (servo piston input pressure)	• Engine at high idling		Control levers at neutral		3.4±0.5 (35±5)	3.4±0.6 (35±6)
		• In H/O mode	Pump relief	Normal		15.97±1.47 (163±15)	15.97±2.45 (163±25)
				Power max.		17.44±1.47 (178±15)	17.44±2.45 (178±25)

Machine model				PW130-6	
Cate-gory	Item	Measurement conditions	Unit	Standard value	Permissible value
Swing	Overrun when stopping swing	Work equipment posture Max. reach  KW130P6045 • Engine at high idling • Hydraulic oil temperature: 45-55°C • Stop after swinging one turn and measure distance that swing circle moves • (): Distance of movement on outside circumference of swing circle	deg. (mm)	75±10 (730±100)	Max. 90 (Mac. 870)
	Time taken to start swing	Work equipment posture Max. reach 90°  KW130P6046 • Engine at high idling • Hydraulic oil temperature: 45-55°C • In H/O mode • Time taken to swing 90° and 180° from starting position	sec.	2.9±0.3	Max. 3.5
		180°		4.0	8.5
Swing	Time taken to swing	Work equipment posture Max. reach  KW130P6047 • Engine at high idling • Hydraulic oil temperature: 45-55°C • In H/O mode • Swing one turn, and measure time taken to swing next 5 turns.		25±2.4	20.5-30.0

Machine model					PW130-6			
Cate-gory	Item	Measurement conditions		Unit	Standard value		Permissible value	
Swing	Hydraulic drift of swing	 KW130P6048 • Engine stopped • Hydraulic oil temperature: 45-55°C • Set machine on 150 slope, and set upper structure at 900 to the side. • Make match marks on swing circle outer race and track frame. • Measure distance that match marks move apart after 15 minutes.		mm	0		0	
	Leakage from swing motor	• Engine at high idling • Hydraulic oil temperature: 45-55°C • Swing lock switch ON • Relieve swing circuit.		l /mm	3		6	
Travel	Travel speed	 KW130P6049 • Engine at high idling • Hydraulic oil temperature: 45-55°C • In H/O mode • Run up for at least 200 m, and measure time taken to travel next 50m on flat ground.	Lo	sec.	30 KPH SPEC.	20 KPH SPEC.	30 KPH SPEC.	20 KPH SPEC.
					51.5	66.7	45.5-57.5	60.7-72.7
			Mi		18	22.5	15-21	19.5-25.5
			Hi		6	9	5.8-6.2	8.6-9.4
	Hydraulic drift of travel	 KW130P6050 • Engine stopped • Hydraulic oil temperature: 45-55°C • Stop machine on 120 slope • Apply park brake • Measure the distance the machine moves in 5 minutes.		mm	0		0	

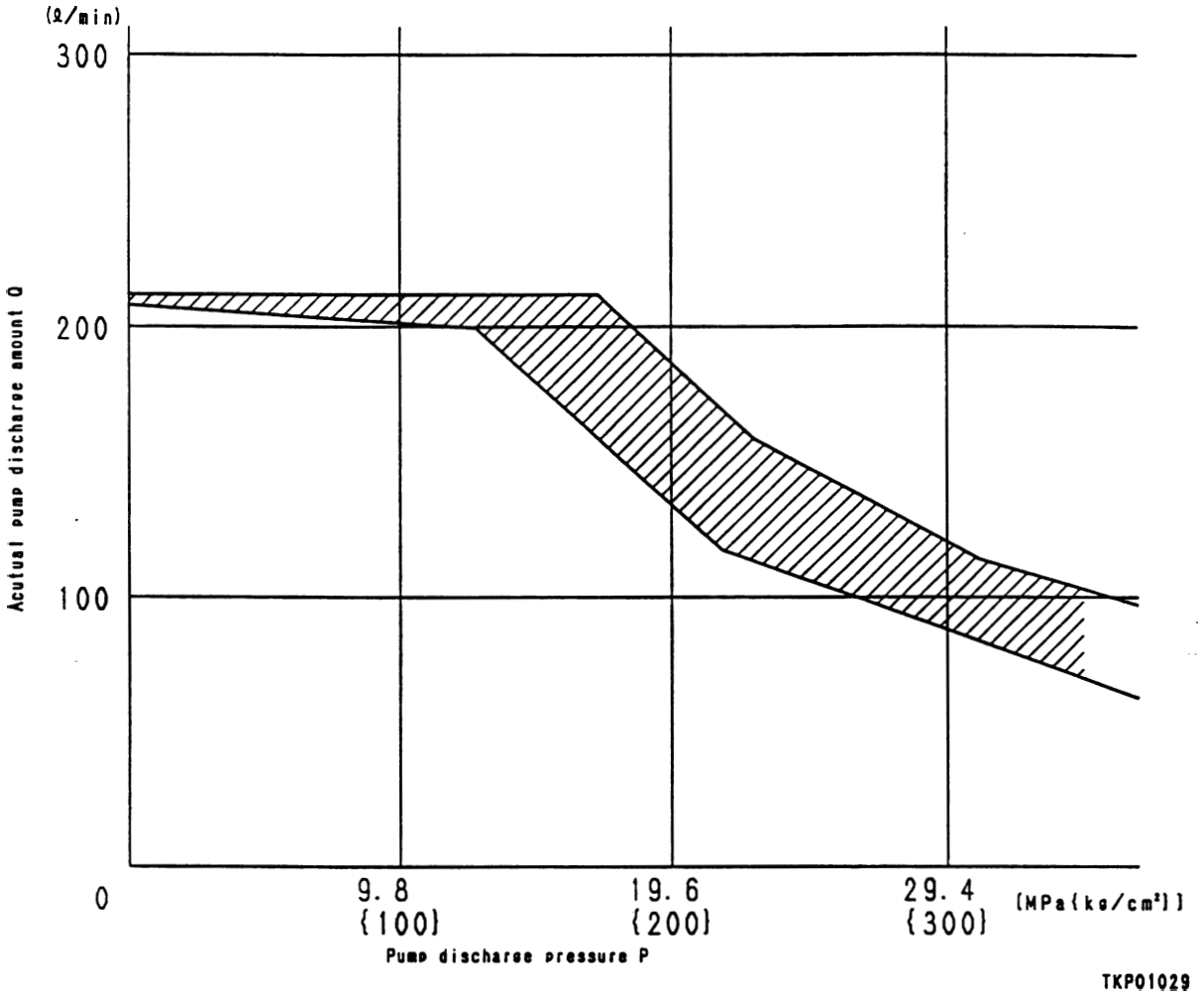
Machine model					PW130-6	
Cate-gory	Item		Measurement conditions	Unit	Standard value	Permissible value
Travel	Leakage of travel motor(s)		 KW130P6051 • Engine at high idling • Hydraulic oil temperature: 45-55°C • Apply park brake and relieve travel circuit	l /mm	30	-
Work equipment	Hydraulic drift of work equipment	Total work equipment (hydraulic drift at tip of bucket teeth)	Posture for measurement  PW130 : 810kg KW130P6052 • Place in above posture and measure extension or retraction of each cylinder and downward movement at tip of bucket teeth • Bucket: Rated load • 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 minutes.	mm	Max. 460	Max. 700
		Boom cylinder (amount of retraction of cylinder)			Max.8	Max. 12
		Arm cylinder (amount of extension of cylinder)			Max.90	Max. 90
		Bucket cylinder (amount of retraction of cylinder)			Max. 40	Max. 40
	Work equipment speed	Boom Bucket teeth in contact with ground ↕ Cylinder fully extended	 Empty KW130P6053 Engine at high idling • Hydraulic oil temperature: 45-55°C	RAISE	sec. 3.8±0.3	Max. 4.4
				LOWER	2.9±0.3	Max. 3.5

Machine model						PW130-6	
Cate-gory		Item	Measurement conditions		Unit	Standard value	Permissible value
Work equipment	Work equipment speed	Arm Cylinder fully retracted ↕ Fully extended	 KW130P6054 • Engine at high idling • Hydraulic oil temperature: 45-55°C	IN	sec.	3.7±0.3	Max. 4.5
				LOWER		3.1±0.3	Max. 3.7
		Bucket Cylinder fully retracted ↕ Fully extended	 KW130P6055 • Engine at high idling • Hydraulic oil temperature: 45-55°C	RAISE		2.9±0.4	Max. 3.7
				LOWER		2.4±0.3	Max. 3.0
	Time lag	Boom	 KW130P6056 • Lower boom and measure time taken from point where bucket contacts ground to point where chassis rises from ground • Engine at high idling • Hydraulic oil temperature: 45-55°C			Max.3	Max. 4
		Arm	 KW130P6057 • Stop arm suddenly and measure time taken for arm to stop • Engine at low idling • Hydraulic oil temperature: 45-55°C			Max.2	Max. 3

Machine model					PW130-6	
Cate-gory	Item		Measurement conditions	Unit	Standard value	Permissible value
Work equipment	Time lag	Bucket	 KW130P6058 • Stop bucket 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.2	Max. 3
	Internal leakage	Cylinders	• Hydraulic oil temperature: 45-55°C • Engine at high idling • Relieve circuit to be measured	cc/min	Max. 3.5	15
		Center swivel joint			10	50

Category

Discharge amount of main piston pump (in heavy-duty operation mode)



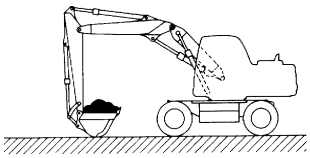
- Pump speed: At 2,000 rpm, PC-EPC current 400 mA

Check point	Test pump discharge pressure (kg/cm^2)	Average pressure (kg/cm^2)	Standard value for discharge amount Q (l/min.)	Judgement standard Q (l/min.)
As desired	P1	P1	See graph	See graph

★ 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 its 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 (same as pump speed) at the point of measurement, and use them as a base for calculating the pump discharge amount at the specified speed.

Flow control characteristics of PC-EPC valve (STD)

★ The values in this table are used as reference values when carrying out troubleshooting.

Cate-gory	Item	Measurement conditions	Unit	PW130-6
Performance in compound operations	Time taken for swing for boom RAISE + starting swing	 KW130P6059 • Engine at high idling • Hydraulic oil temperature: 45-55°C • In H/O mode • Load the bucket with the rated load and measure the time taken from the position of starting the swing to the point of passing the 90° position.	sec.	4.0

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 as 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 as 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 kΩ Between (3) - (4): 2.5 - 7.5 kΩ 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 as 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 the speed sensor until it contacts the ring gear, then turn back 1 ± 1/6 turns. 2) It must work normally when adjusted as above.	
	PPC pressure switch	Left swing S08 Right swing S10 Bucket DUMP S07 Bucket CURL S06 Arm OUT S03 Arm IN S05 Boom LOWER S04 Boom RAISE S02 2p Boom RETRACT S11 2p Boom EXTEND S12 Stabilizer UP S14 Stabilizer DOWN S13 Service S09 Service G72 Travel (auto susp. lock) G132 Travel (auto DECEL) G75	Measure resistance	If the condition is as shown in the table below, it is normal Between (male) (1) - (2): Levers at neutral: Min. 1 MΩ Between (male) (1) - (2): Lever operated: Max. 1Ω Between (male) (1), (2) - chassis: Min. 1 MΩ	1) Start engine (or with accumulator charged if engine is stopped) 2) Disconnect connectors.

System	Name of component	Connector No.	Inspection method	Judgement table	Measurement conditions
Control system	Pump pressure sensor	C08	Measure voltage	If the condition is as shown in the table below, it is normal Between (2) - (1): 18-27 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	If the condition is as shown in the table below, it is normal Between (1) - (2): When switch is OFF: Min. 1MΩ Between (1) - (2): When switch is ON: Max. 1 Ω	1) Turn starting switch OFF. 2) Disconnect connector C02.
	PC-EPC solenoid valve	C13 (male)	Measure resistance	If the condition is as shown in the table below, it is normal Between (1) - (2): 7 - 14 Ω Between (1), (2) - chassis: Min. 1 MΩ	1) Turn pump prolix switch OFF. 2) Turn starting switch OFF. 3) Disconnect connector C13.
	Swing holding brake solenoid valve	V04 (male)	Measure resistance	If the condition is as 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 V04.
	Travel speed solenoid valve	V06 (male)	Measure resistance	If the condition is as 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.
	2-stage relief solenoid valve	V05 (male)	Measure resistance	If the condition is as 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.
	Suspension lock solenoid valve	G25 (male)	Measure resistance	If the condition is as 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 G25.
	LS-EPC solenoid valve	C10 (male)	Measure resistance	If the condition is as 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.

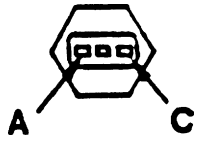
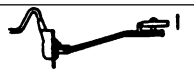
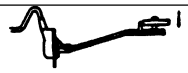
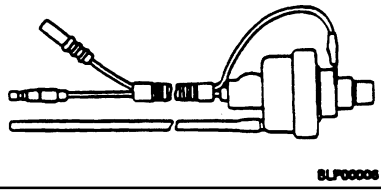
System	Name of component		Connector No.	Inspection method	Judgement table	Measurement conditions
Control system	Engine throttle, pump controller	Travel EPC solenoid valve	G63	Measure resistance	If the condition is as shown in the table below, it is normal Between (1) - (2): 7-14 Ω Between (1), (2) - chassis: Min. 1 MΩ	1) Turn starting switch OFF. 2) Disconnect connector G63.
		Power source voltage	C01 C02	Measure voltage	If the condition is as shown in the table below, it is normal Between C01, (7), (13) - C01 (6), (12): 20 - 30 V Between C02 (11), (21) - C01 (1), (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) (power source): Low idling: 2.9 - 3.3 V 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.
		Radiator water temperature signal	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. 3.5-4.0 kΩ	1) Turns starting switch OFF. 2) Disconnect connector P7. 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 as 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 is 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	Engine shrottle, pump controller	Swing holding brake solenoid	C01	Measure voltage	If the condition is as shown in the table below, it is normal When swing lever is operated (solenoid ON, swing holding brake canceled) — Between (3) - (6), (12) — 20 - 30 V After approx. 5 seconds have passed since returning swing lever to neutral (solenoid OFF, swing holding brake operated) — Between (3) - (6), (12) — 0 - 3 V	1) Start engine. 2) Turn swing lock switch OFF. 3) Turn swing lock prolix switch OFF. 4) Insert T-adapter.
		Travel speed solenoid	C01	Measure voltage	If the condition is as shown in the table below, it is normal When traveling with travel speed switch at Hi (solenoid OFF, travel motor swash plate angle at MIN) — Between (9) - (6), (12) — 0 - 3 V When traveling with travel speed switch at Lo, Mi (solenoid ON, travel motor swash plate angle at MAX) — Between (9) - (6), (12) — 20 - 30 V	1) Start engine. 2) Insert T-adapter. 3) Turn fuel control dial to MAX position. 4) Travel on level ground.
		2-stage relief solenoid	C01	Measure voltage	If the condition is as shown in the table below, it is normal Work equipment control lever operated + power max. switch ON (solenoid ON, 2-stage relief actuated) — Between (10) - (6), (12) — 20 - 30 V All levers at neutral (solenoid OFF, 2-stage relief canceled) — Between (10) - (6), (12) — 0 - 3 V	1) Start engine. 2) Insert T-adapter.

System	Name of component		Connector No.	Inspection method	Judgement table	Measurement conditions
Control system	Engine throttle, pump controller	TVC solenoid valve (default value)	C02	Measure current	If the condition is as shown in the table below, it is normal • General operation mode Between (8) - (18): 650 ± 40mA	1) Turn starting switch ON. 2) Turn fuel control dial to MAX position. 3) Turn pump prolix switch OFF.
		LS-EPC solenoid valve (default value)	C02	Measure current	If the condition is as shown in the table below, it is normal • General operation mode Between (7) - (17): 800 ± 80mA	1) Turn starting switch ON. 2) Turn fuel control dial to MAX position. 3) All levers at neutral.
		L.H. knob switch	C03	Measure voltage	If the condition is as shown in the table below, it is normal When switch is ON: Between (9) - GND: 20 - 28 V When switch is OFF: Between (9) - GND: 0 - 1 V	1) Turn starting switch ON. 2) Insert T-adapter.
		S-NET	C17	Measure voltage	If the condition is as shown in the table below, it is normal (4), (12) - GND: 4 - 8 V	1) Turn starting switch ON. 2) Insert T-adapter.

<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="2">Control system</td><td rowspan="2">Engine throttle, pump controller</td><td>No.2 throttle signal</td><td>Monitoring code 16</td><td></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. 2100</td></tr><tr><td>G/O</td><td>Approx. 1950</td></tr><tr><td>F/O</td><td>Approx. 1950</td></tr><tr><td>L/O</td><td>Approx. 1600</td></tr><tr><td>H/O + Power max.</td><td>Approx. 2100</td></tr><tr><td>Swift slow-down</td><td>Approx. 1600</td></tr></table></td><td>1) Start engine.
2) Set monitoring code to 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>Model selection 1</td><td>C17 (5) - C02 (11)</td><td>No continuity</td></tr><tr><td>Model selection 2</td><td>C17 (13) - C02 (11)</td><td>No continuity</td></tr><tr><td>Model selection 3</td><td>C17 (6) - C02 (11)</td><td>No continuity</td></tr><tr><td>Model selection 4</td><td>C17 (14) - C02 (11)</td><td>No continuity</td></tr><tr><td>Model 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>

<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="5">Monitor system</td><td rowspan="3">Engine speed sensor</td><td rowspan="3">E07 (male)</td><td>Measure current</td><td>If the condition is as shown in the table below, it is normal
<table><tr><td>Between (1) - (2)</td><td>500 - 1,000 Ω</td></tr><tr><td>Between (2) - chassis</td><td>Min. 1 MΩ</td></tr></table></td><td>1) Turn starting switch OFF.
2) Disconnect connector E7.</td></tr>
<tr><td>Measure voltage</td><td>If the condition is as shown in the table below, it is normal
<table><tr><td>Between (1) - (2)</td><td>0.5 - 3.0 V</td></tr></table></td><td>1) Start engine.
2) Insert T-adapter.</td></tr>
<tr><td>Adjust</td><td>1) Screw in the speed sensor until it contacts the ring gear, then turn back 1 ± 1/6 turns.
2) It must work normally when adjusted as above.</td><td></td></tr>
<tr><td>Coolant level sensor</td><td>P08 (male)</td><td>Measure current</td><td>If the condition is as shown in the table below, it is normal
<table><tr><td>Above LOW level in reservoir tank</td><td>Max. 1 Ω</td></tr><tr><td>Below LOW level in reservoir tank</td><td>Min. 1 MΩ</td></tr></table></td><td>1) Turn starting switch OFF.
2) Disconnect connector P08.
3) Insert T-adapter into connector at sensor end.</td></tr>
<tr><td>Engine oil level sensor</td><td>P05 (male)</td><td>Measure current</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>Max. 1 Ω</td></tr><tr><td>  </td><td>Lower float</td><td>Min. 1 MΩ</td></tr></table></td><td>1) Turn starting switch OFF.
2) Disconnect connector P05.
3) Drain oil, then remove sensor.</td></tr>
</table>

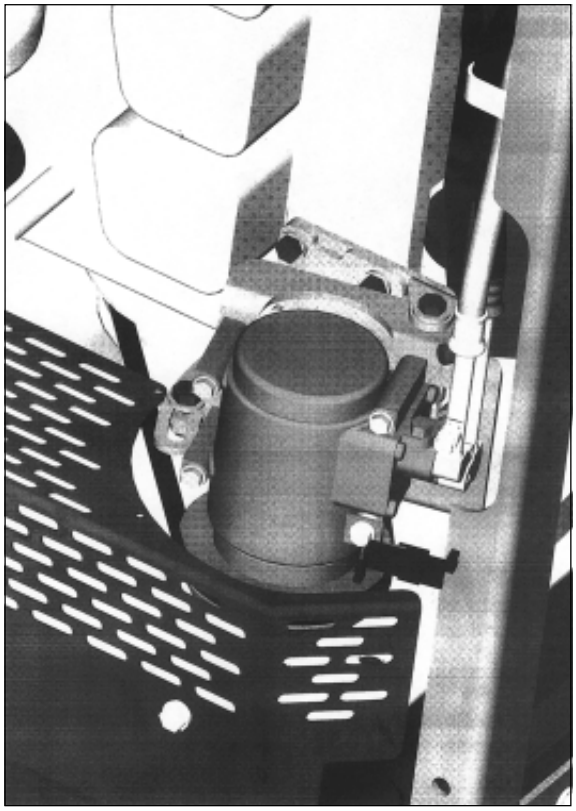
<table>
<tr><th>System</th><th>Name of component</th><th>Connector No.</th><th>Inspection method</th><th>Judgement table</th><th>Measurement conditions</th></tr>
<tr><td rowspan="3">Monitor</td><td>Engine oil pressure sensor</td><td>P10 (male)</td><td>Measure resistance</td><td>If the condition is as 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>  </td><td>Raise float to stopper</td><td>Approx. 12 Ω or below</td></tr><tr><td>  </td><td>Lower float to stopper</td><td>Approx. 85 - 110 Ω</td></tr></table></td><td>1) Turn starting switch OFF.
2) Disconnect connector 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>Air cleaner clogging sensor</td><td>P11
P12</td><td>Measure resistance</td><td>If the condition is as shown in the table below, it is normal
<table><tr><td>Air cleaner normal</td><td>Continuity</td></tr><tr><td>Air cleaner clogged</td><td>No continuity</td></tr></table>  </td><td>1) Start engine.
2) Disconnect P11, P12.
3) Put tester in contact with connector at sensor end to measure.</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>If the condition is as shown in the table below,
When engine is running
(1/2 throttle or above) → 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><th></th><th colspan="2">Position of gauge display</th><th>Display level resistance (KO) (Monitor panel input resistance)</th></tr>
<tr><th></th><th colspan="2">Starting switch ON</th><th>Starting switch OFF</th></tr>
<tr><td rowspan="16">Measure resistance between coolant temperature gauge C03 (female) (1) - C03 (female) (16)</td><td rowspan="16">Display position</td><td>Right side
All OFF (15)</td><td>Min. - Max.
- 0.646</td></tr>
<tr><td>14</td><td>0.575 - 3.420</td></tr>
<tr><td>13</td><td>3.156 - 3.708</td></tr>
<tr><td>12</td><td>3.422 - 3.804</td></tr>
<tr><td>11</td><td>3.512 - 3.900</td></tr>
<tr><td>10</td><td>3.600 - 4.125</td></tr>
<tr><td>9</td><td>3.807 - 4.349</td></tr>
<tr><td>8</td><td>4.015 - 5.122</td></tr>
<tr><td>7</td><td>4.728 - 5.899</td></tr>
<tr><td>6</td><td>5.445 - 6.818</td></tr>
<tr><td>5</td><td>6.294 - 7.910</td></tr>
<tr><td>4</td><td>7.302 - 9.210</td></tr>
<tr><td>3</td><td>8.502 - 10.774</td></tr>
<tr><td>2</td><td>9.946 - 36.535</td></tr>
<tr><td>Left side
1</td><td>33.725 -</td></tr>
</table>
★ Levels 13, 14 flash
</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><th></th><th colspan="2">Position of gauge display</th><th>Display level resistance (KO) (Monitor panel input resistance)</th></tr>
<tr><th></th><th colspan="2">Starting switch ON</th><th>Starting switch OFF</th></tr>
<tr><td rowspan="16">Measure resistance between fuel level gauge C03 (female) (2) - chassis</td><td rowspan="16">Display position</td><td>Right side
14</td><td>Min. - Max.
- 13.82</td></tr>
<tr><td>13</td><td>11.71 - 17.43</td></tr>
<tr><td>12</td><td>15.18 - 21.25</td></tr>
<tr><td>11</td><td>18.90 - 25.05</td></tr>
<tr><td>10</td><td>22.59 - 28.45</td></tr>
<tr><td>9</td><td>25.82 - 31.85</td></tr>
<tr><td>8</td><td>29.18 - 35.22</td></tr>
<tr><td>7</td><td>32.45 - 39.91</td></tr>
<tr><td>6</td><td>37.00 - 44.60</td></tr>
<tr><td>5</td><td>41.77 - 48.72</td></tr>
<tr><td>4</td><td>45.52 - 55.14</td></tr>
<tr><td>3</td><td>50.42 - 64.35</td></tr>
<tr><td>2</td><td>60.61 - 77.07</td></tr>
<tr><td>1</td><td>72.98 - 691.5</td></tr>
<tr><td>Left side
All OFF (0)</td><td>638.00 -</td></tr>
</table>
★ Levels 13, 14 flash
</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>
</table>

TOOLS FOR TESTING, ADJUSTING, AND TROUBLESHOUTING

Check or measurement item	Symbol		Part No.	Part Name	Remarks
Engine speed	A	1	799-203-8001	Multi-tachometer	Kit part No.: 799-203-9000 Digital display L: 60 - 2,000 rpm H - 19,999 rpm
		2	795-790-2500	Take-off drive	
Coolant and oil temperatures	B		790-101-6000	Digital temperature gauge	-50 - 1,200°C
Oil pressure	C	1	799-101-5002	Hydraulic tester	Pressure gauge 2.5,5.9,39.2,58,8 MPa (25,60,400,600 kg/cm^2)
			790-261-1203	Digital hydraulic tester	Pressure gauge 68.6MPa (700 kg/cm^2)
		2	799-401-2320	Hydraulic gauge	1.0 MPa {10 kg/cm^2)
		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	790-261-1360	Adapter	Both male and female 14 x 1.5 (PT 1/8)
			790-261-1370	Nut	For 14 x 1.5 blind
			07003-31419	Gasket	For blind
		6	-	Hose	
Barring of engine	D		795-799-1130	Gear	
Blow-by pressure	E	1	799-201-1504	Blow-by checker	0 - 4.9 kPa (0 - 500 mm H_2O)
		2	795-790-1950	Tool	
Valve clearance	F		Commercially available	Feeler gauge	
Exhaust color	G	1	799-201-9000	Handy Smoke Checker	Discoloration 0 - 70% (With standard color) (Discoloration % x 1/10 = Bosch index)
		2	Commercially available	Smoke meter	
Operating effort	H		79A-264-0020	Push-pull scale	0 - 294N (0 - 30 kg)
			79A-261-0090		0 - 490N (0 - 30 kg)
Stroke, hydraulic drift	I		Commercially available	Scale	
Work equipment speed	J		Commercially available	Stop watch	
Measuring voltage and resistance values	K		79A-261-0210	Tester	
Troubleshooting of wiring harnesses and sensors	L	1	799-601-2600	T-adapter box	• Kit Part No. T-adapter kit 799-601-8000
		2	799-601-7000	Adapter assembly	
		3	799-601-7910	Adapter	
			799-601-7010		
			799-601-7070		
			799-601-7080		
			799-601-7330		
Main pump delivery	M		790-303-1003	Flow meter kit	

CHECKING AND ADJUSTING BELT TENSION FOR AIR CONDITIONER COMPRESSOR



CHECKING

1. Press compressor drive belt midway between fan pulley and compressor pulley. The belt should normally deflect by about 15-18 mm (0.60-0.70 inch) when pressed with the finger (with a force of approx. 6 kg (13 1b.)

ADJUSTING

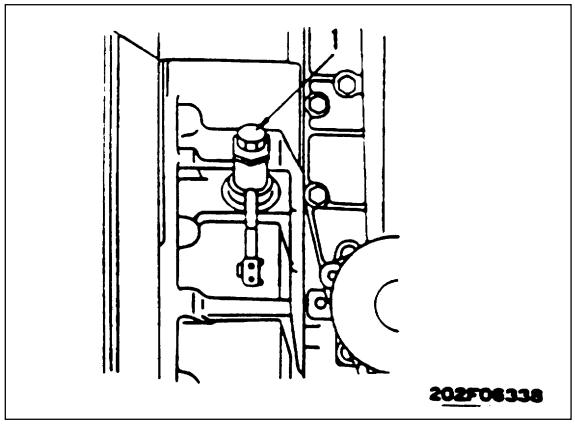
1. Loosen two nuts and bolts ②
2. Carefully lever compressor housing to tighten belt to tightness criteria. Tighten lower bolt to hold in position.
3. Tighten upper bolt.
4. Check each pulley for damage, wear of the V-groove and wear of the V-belt. In particular, be sure to check the V-belt is not touching the bottom of the V-groove.
5. Replace belt if it has stretched, leaving no allowance for adjustment, or if there is a cut or crack on belt.
6. Refit belt guard.
7. When the new belt is set, readjust it after operating for one hour.

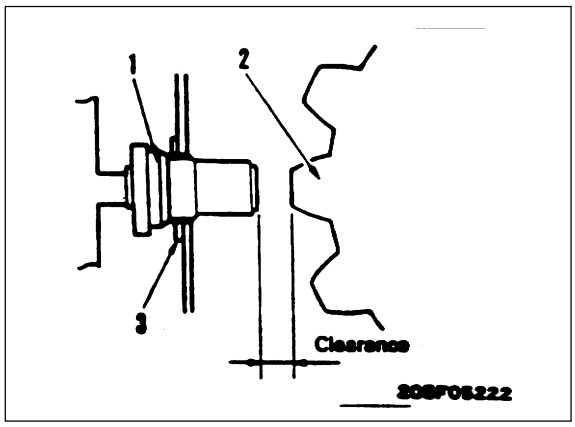
ADJUSTING ENGINE SPEED SENSOR

1. Screw in until the tip of sensor (1) contact gear (2).
2. When gear (2) contact sensor (1), turn back one turn.
3. Tighten locknut (3).

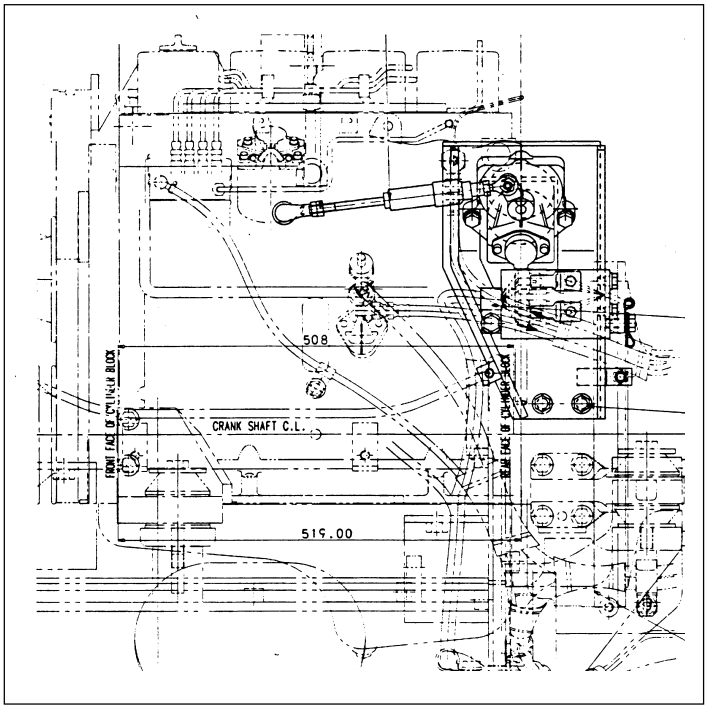
★ Be particularly careful when securing the sensor wiring to ensure that no excessive force is brought to bear on the wiring.

★ Be careful not to let the tip of the sensor be scratched or to let any iron particles stick to the sensor tip.





TESTING AND ADJUSTING GOVERNOR MOTOR LEVER STROKE



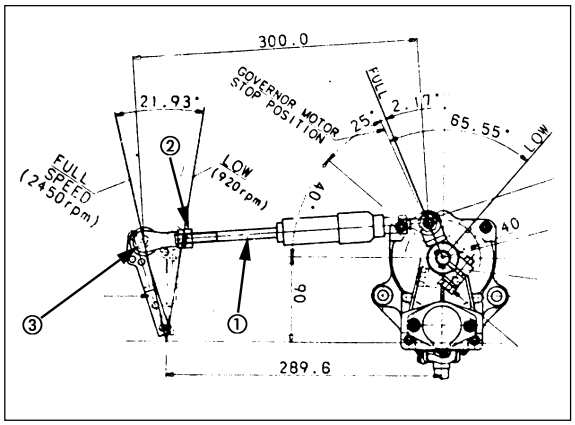
TESTING

1. Check engine speed at high idle in HO work mode

2. Check engine speed in HO travel mode (lightly depress travel pedal until engine speed vises without machine moving) and at LOW idle.

ADJUSTING

Set engine speed at high idle in HO work mode to the standard value.



1. Loosen lock nut ② from linkage ①. Engine speed will be changed by turning linkage ① into or out of joint ③ so that linkage length is changed.

2. Adjust length of linkage and confirm engine speed.

3. Tighten lock nut ② when correct adjustment is achieved.

4. Confirm engine speeds are within tolerance according to:

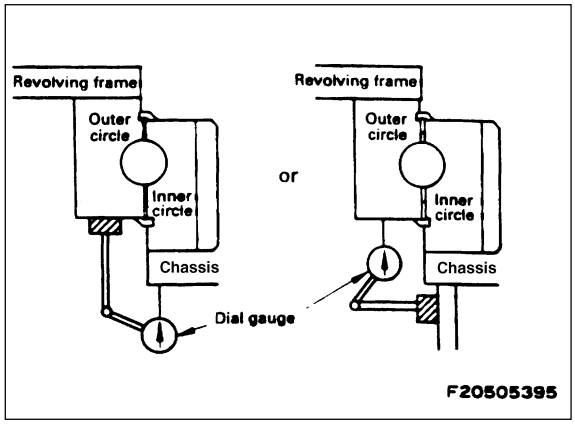
No load engine speed

Condition	Fuel dial	Engine speed
Low idle	MIN.	900 ± 75
Auto decel	MAX	1400± 100
L.O.	MAX	1600 ± 100
G.O., F.O.	MAX	1950 ± 100
H.O. work	MAX	2100 ± 100
H.O. travel	MAX	2450 ± 100

TESTING CLEARANCE OF SWING CIRCLE BEARING

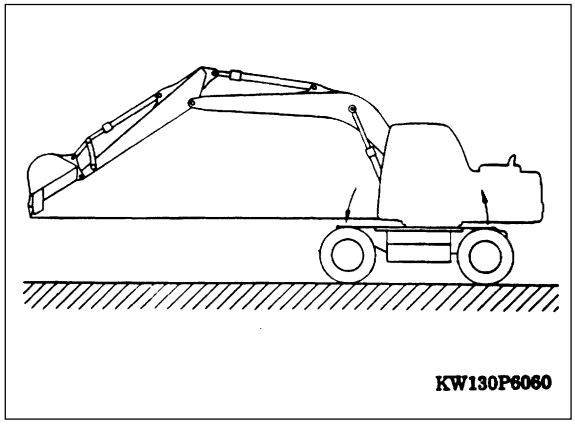
Method of testing clearance of swing circle bearing when mounted on machine

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.

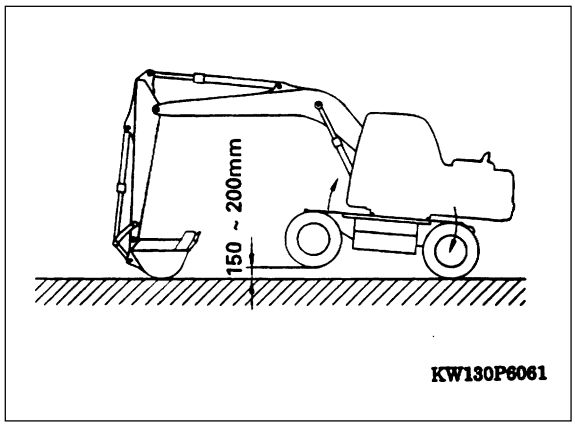


4. Set the arm more or less at right angles to the ground surface, then lower the boom until the front of the machine comes off the ground.
   When this is done, the upper structure will tilt back, so the front will rise and the rear will go down.

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, repeat Steps 2 to 5.



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

MEASURING

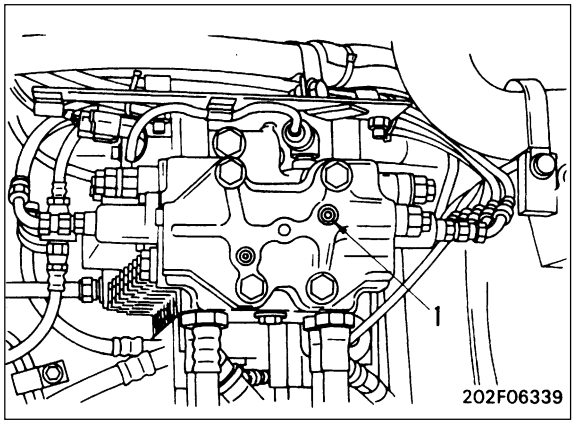
★ Hydraulic oil temperature when measuring
45 - 55°C

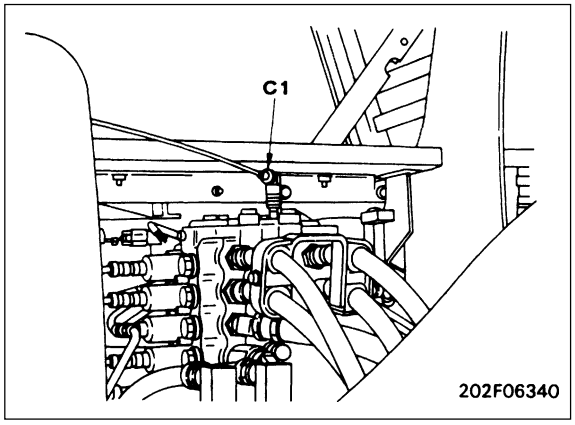
⚠ Lower the work equipment to the ground and stop the engine. Loosen the oil filler cap slowly to release the pressure inside the hydraulic tank. Then put the safety lock lever in the LOCK position.

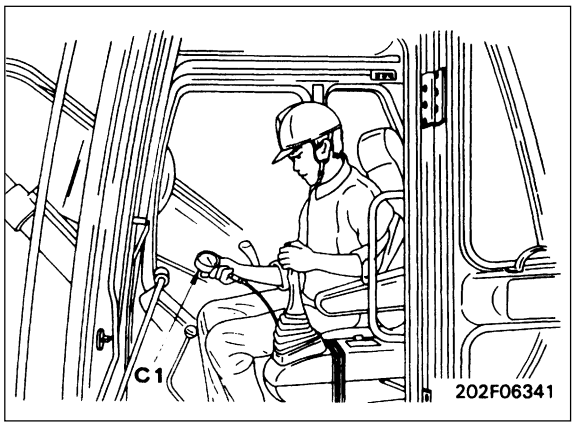
- Remove pressure pick-up plug (1) (Thread dia.=10mm, Pitch=1.25mm) from the circuit to be measured, then install oil pressure gauge **C1** (58.8 MPa (600 kg/cm^2).

- **Measuring unload pressure**
  1. Measure the oil pressure in H/O mode with the engine at high idling and the control levers at neutral.

- **Measuring pump relief pressure**
  1. Oil pressure when main relief pressure is at low pressure (31.9 MPa (325 kg/cm^2))
     1) Measure the pressure when each actuator except the travel is relieved in H/O mode with the engine at high idling.
     ★ Note that the set pressure of the safety valve for the swing motor is lower than the main relief pressure, so the value measured will be the relief pressure of the safety valve.
     If the swing lock switch is turned ON, the pressure will rise, so always keep the lock switch OFF when measuring [engage the swing lock pin].







2. When main relief pressure is raised
   (34.8 MPa (355 kg/cm^2))
   1) When travel is operated
      Measure the oil pressure when the travel is relieved on each side separately in H/O mode with the engine at high idling.
      ★ To relieve the travel circuit, apply the service brake.
   2) When power max. function is actuated
      When measuring the oil pressure in G/O or H/O mode with the engine at high idling and the power max. function actuated, relieve one of the boom, arm, or bucket circuits, and measure the oil pressure.

2. ADJUSTING

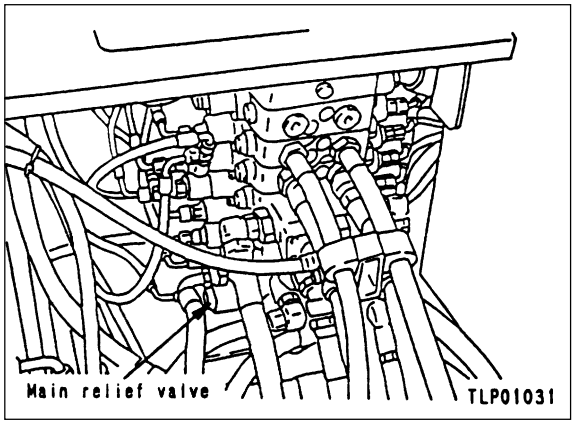
Main relief valve

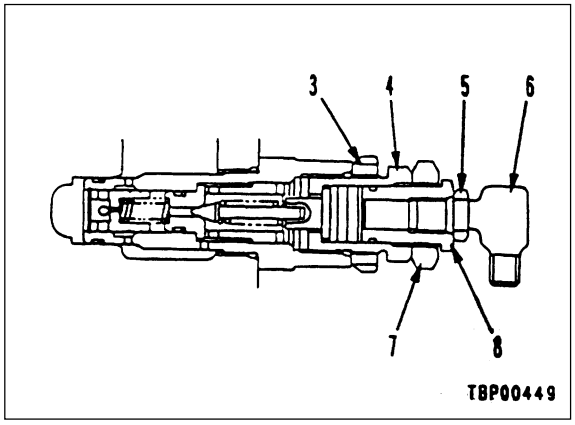
1) Adjusting high set pressure end
   i) Loosen locknut (5).
      ★ Check that elbow (6) can move.
   ii) Loosen locknut (3), then turn holder (4) to adjust.
      ★ Turn the holder to adjust as follows.
         • To INCREASE pressure, turn CLOCKWISE.
         • To DECREASE pressure, turn COUNTERCLOCKWISE.
      ★ Amount of adjustment for one turn of holder: 12.6 MPa {128 kg/cm^2}

      kgm Locknut:
      58.8 ± 4.9 Nm {6 ± 0.5 kgm}
      ★ When the high-pressure end is adjusted, the low-pressure end also changes, so adjust the low-pressure end also.

2) Adjusting low set pressure end
   i) Loosen locknut (5).
      ★ Check that elbow (6) can move.
   ii) Loosen locknut (7), then turn holder (8) to adjust.
      ★ Turn the holder to adjust as follows.
         • To INCREASE pressure, turn CLOCKWISE.
         • To DECREASE pressure, turn COUNTERCLOCKWISE.
      ★ Amount of adjustment for one turn of holder: 12.6 MPa {128 kg/cm^2}

      kgm Locknut:
      44.1 ± 4.9 Nm {4.5 ± 0.5 kgm}
      ★ Normally, there is a pressure of approx. 1.3 MPa {13 kg/cm^2} or less applied to port **PR**, but at high-pressure setting the pressure is approx. 2.9 MPa {30 kg/cm^2}.

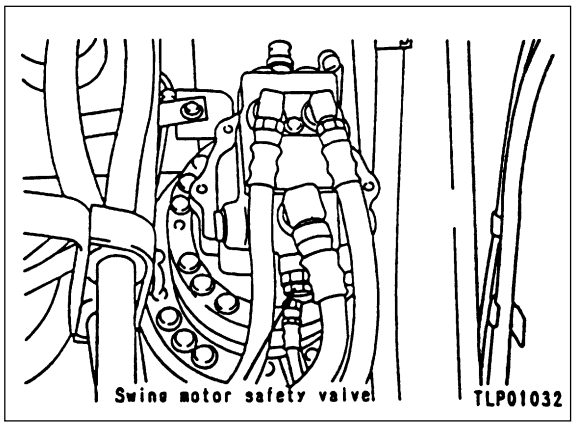


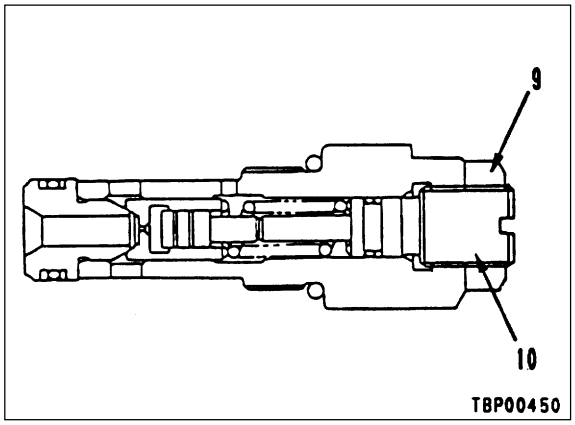


Swing motor safety valve

- Loosen locknut (9), then turn adjustment screw (10) to adjust.
  ★ Turn the adjustment screw to adjust as follows.
     • To INCREASE pressure, turn CLOCKWISE.
     • To DECREASE pressure, turn COUNTERCLOCKWISE.
  ★ After completion of adjustment, repeat the procedure in Item 1 to check again.

★ The safety valve set pressure can be adjusted only for the swing motor. Do not try to adjust the setting for anything except the swing motor.





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

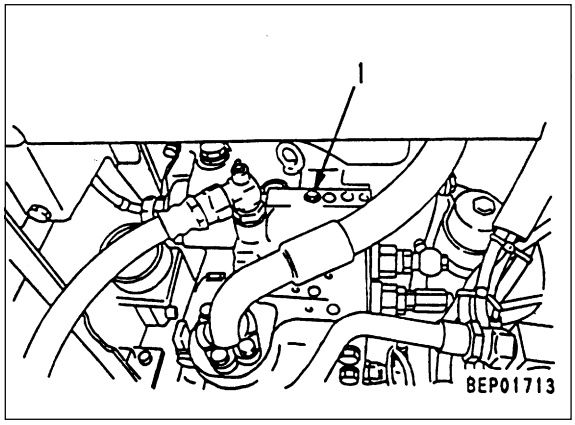
Measuring

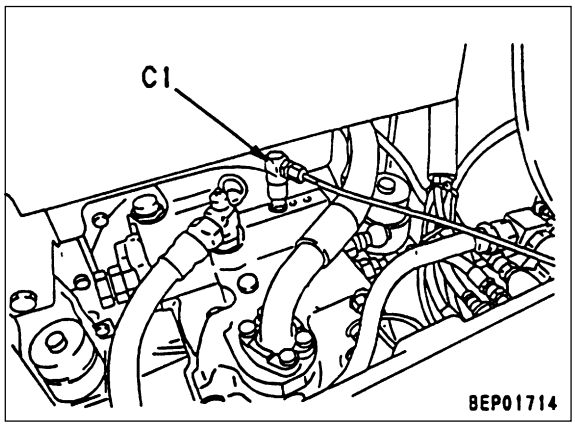
★ Oil temperature when measuring 45 - 550C

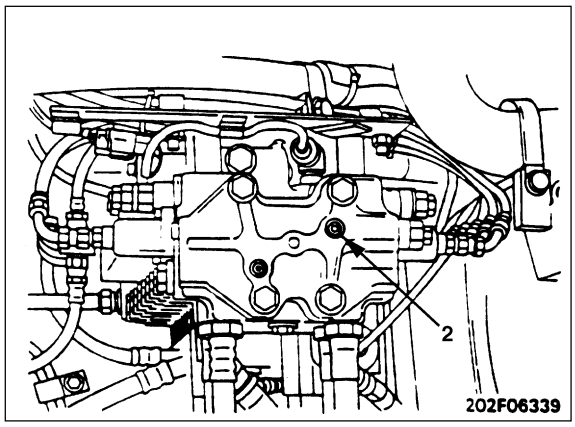
• Measure the oil pressure when the circuit is relieved in the pressure rise mode.
  1) Remove pressure measurement plugs (1) and (2) (Thread dia.=10 mm, Pitch=1.5 mm), and install oil pressure gauge **C1**.
     ★ Install a 39.2 MPa {400 kg/cm^2} gauge to the servo valve end, and a 58.8 MPa {600 kg/cm^2} gauge to the pump outlet port end.
  2) Turn the swing lock switch ON.
  3) Set the working mode to heavy-duty operation mode.
  4) Run the engine at full throttle, turn the knob switch ON, and measure the oil pressure when the arm (IN) circuit is relieved.
     ★ Check that the servo piston input pressure is 1/2 of the pump discharge pressure.

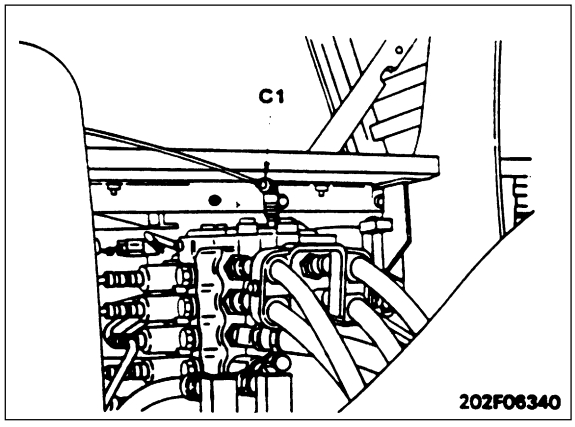
[Reference]

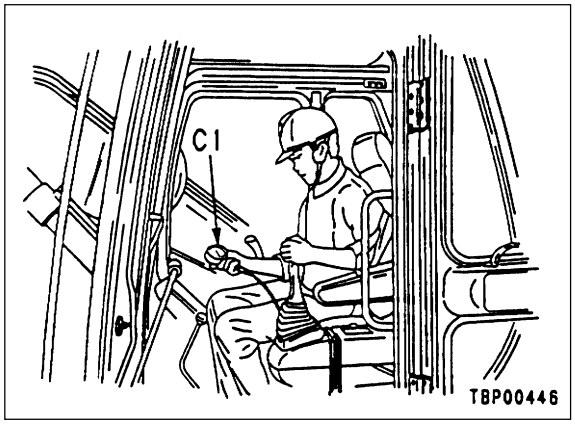
If there is any abnormality in the LS valve or servo piston, the servo piston input pressure will be 0 or almost the same as the pump discharge pressure.









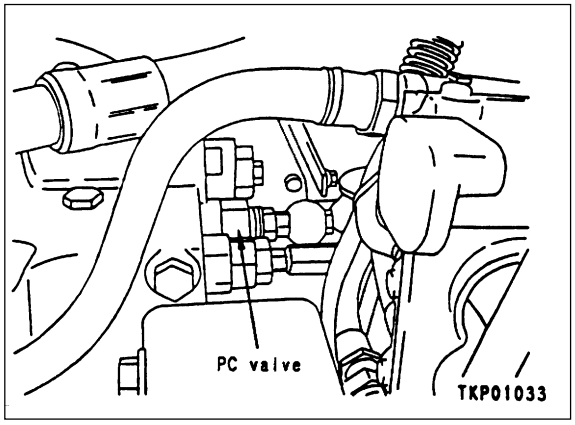


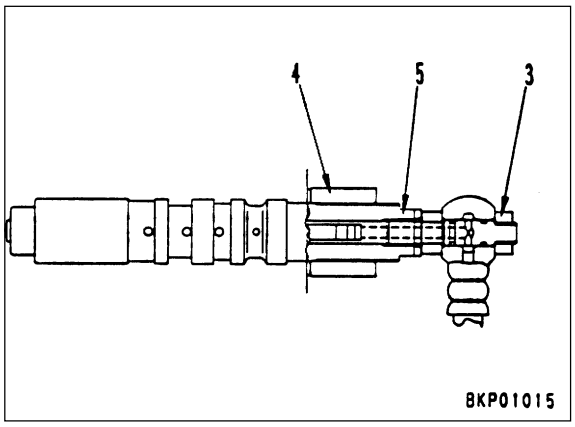
Adjusting

★ If the load becomes larger and the engine speed drops, or if the engine speed remains normal and the work equipment speed drops, and the pump discharge pressure and LS differential pressure are normal, adjust the PC valve as follows.

1) Loosen locknut (4), and if the speed is slow, turn screw (5) to the right; if the engine speed drops, turn the screw to the left.
   - ★ If the screw is turned to the right, the pump absorption torque will be increased, and if it is turned to the left, the pump absorption torque will be reduced.
   - ★ The adjustment range for the screw is a maximum of 1 turn to the left and 1800 to the right.
   - ★ Amount of adjustment for one turn of screw: 1.5 mm movement of servo piston stroke.

2) After completing the adjustment, tighten the locknuts.
   kgm Locknut (3):
   34.3 ± 4.9 Nm {3.5 ± 0.5 kgm}
   kgm Locknut (4):
   100.5 ± 12.3 Nm {10.25 ± 1.25 kgm}





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

★ Oil temperature when measuring 45 - 550C

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

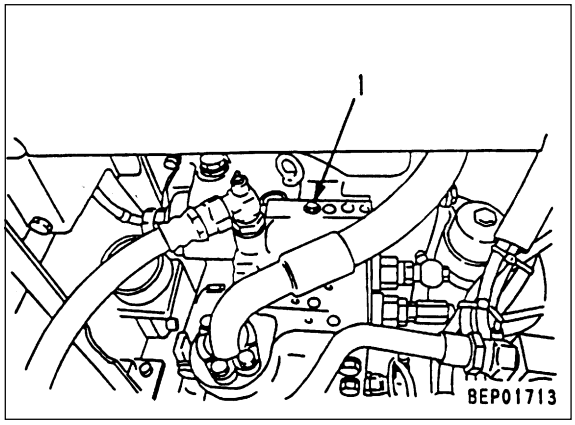
1) Remove pressure measurement plugs (1) and (2) (Thread dia.=10mm, Pitch=1.25 mm), and install oil pressure gauge **C1**.
   ★ Install a 39.2 MPa {400 kg/cm^2} gauge to the servo valve end, and a 58.8 MPa {600 kg/cm^2} gauge to the pump outlet port end.

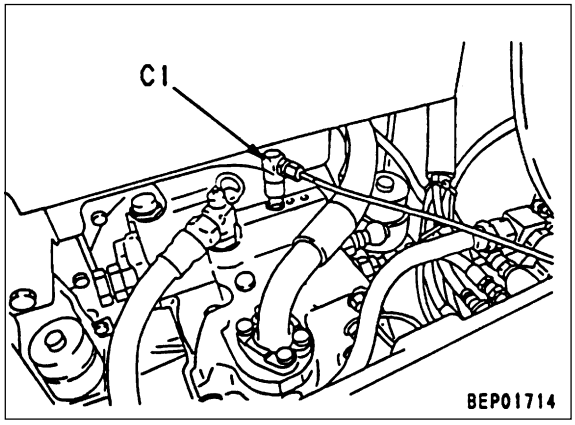
Oil pressure when wheels are rotating under no load on one side

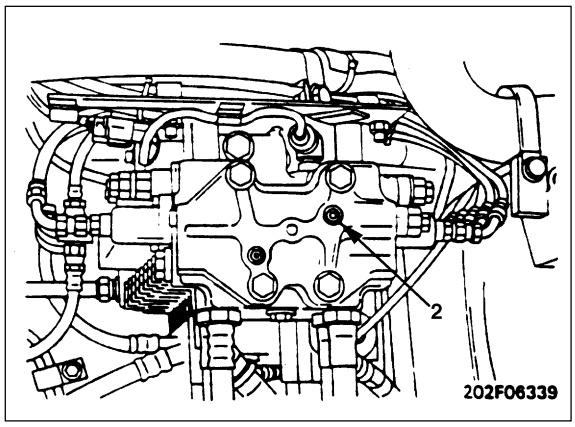
i) Set the working mode to heavy-duty operation mode, and turn the travel speed switch to Mi.
ii) Use the work equipment to raise the wheels off the ground.
iii) Measure the oil pressure with the engine at full throttle and the travel pedal operated to the end of its stroke to rotate the wheels under no load.
Run the engine at full throttle, operate travel pedal to the end of its stroke, and measure the oil pressure when the working mode and travel speed are switched as shown in Table 1.

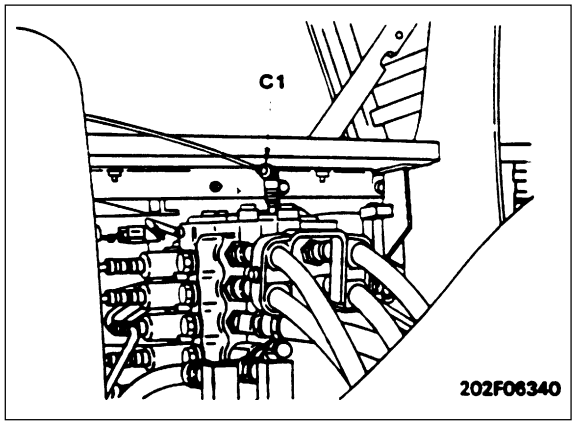
Table 1

Working mode	Travel pedal	Pump pressure MPa {kg/cm^2}	Servo inlet port pressure MPa {kg/cm^2}	Remarks
H/O mode	neutral	2.9 ± 0.5 {30 ±5}	2.9 ± 0.5 {30 ± 5}	About same pressure
H/O mode	Full	7.8 ± 2.0 {80 ± 20}	3.9 ± 1.0 {40 ± 10}	About 1/2 of 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 (4) and turn screw (5) to adjust the differential pressure.

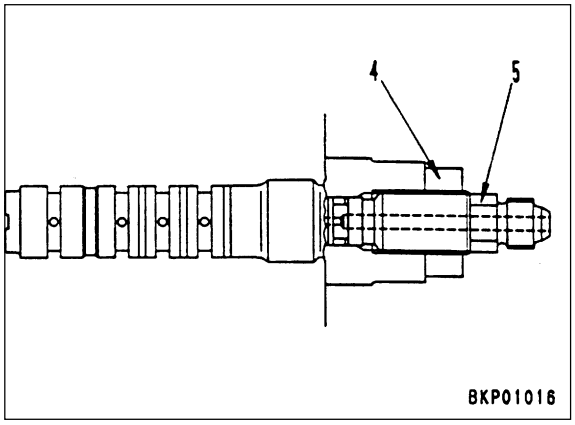
- Turn the screw to adjust as follows.
  To INCREASE pressure, turn CLOCKWISE.
  To DECREASE pressure,
  turn COUNTERCLOCKWISE.
  - ★ Amount of adjustment for one turn of screw: 1.3 MPa {13.3 kg/cm^2}

2) After adjusting, tighten locknut (4).

kgm Locknut:

56.4 ± 7.4 Nm {5.75 ± 0.75 kgm}

Note: Always measure the differential pressure while adjusting.



TESTING AND ADJUSTING PILOT CIRCUIT OIL PRESSURE

MEASURING

★ Hydraulic oil temperature when measuring 45 - 550C

1. Remove pressure pick-up plug ① (Thread dia.=10mm, Pitch=1.25mm) and install oil pressure gauge **C1** (5.88 MPa (60 kg/cm^2))

2. Start the engine and measure with the engine at high idle (HO mode).

ADJUSTING

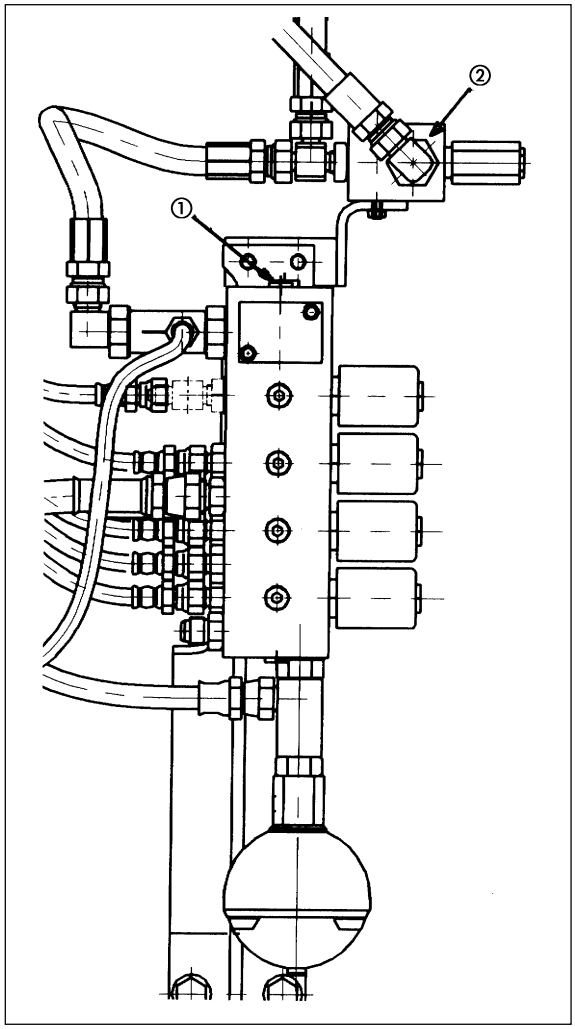
ALWAYS MEASURE WHILST ADJUSTING

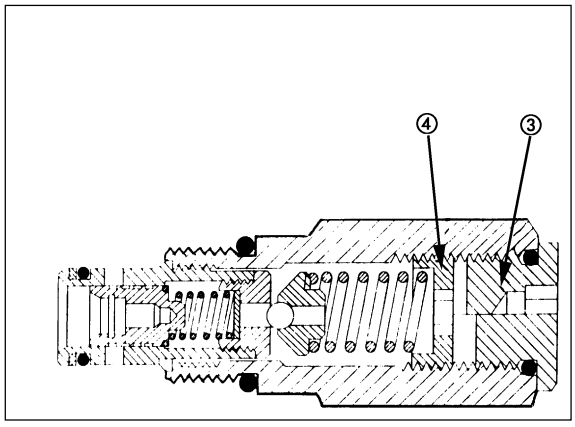
1. Remove cap ③ from PPC pressure reducing valve ②. Turn the adjustment sleeve ④ as follows:
   - To INCREASE pressure, turn CLOCKWISE.
   - To DECREASE pressure, turn COUNTERCLOCKWISE.

2. After adjustment tighten cap ③

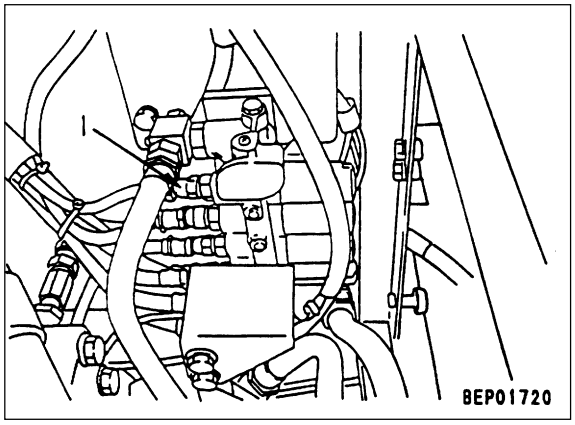
JUDGEMENT TABLE

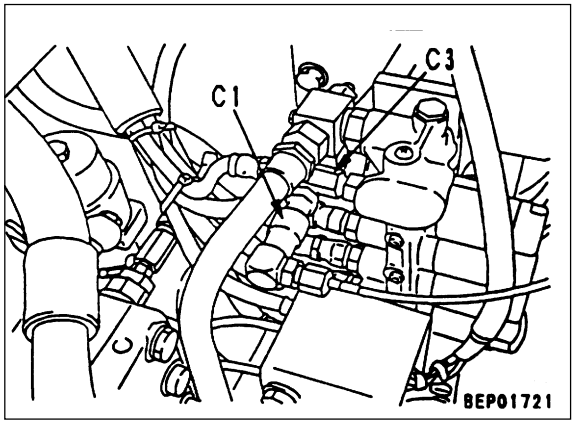
Work mode/ engine condition	Operation	PPC pressure kg/cm^2
HO mode High idle	Work	34 ± 1
	Travel	35 ± 1
Low idle		28 ± 1





TESTING SOLENOID VALVE OUPUT PRESSURE





Measuring

★ Oil temperature when measuring 45 - 550C

1. Measuring output pressure of ON/OFF solenoid valve

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

Note: The condition of the solenoid valves is as follows.

When ON: Current flows (hydraulic pressure is generated)

When OFF: Current does not flow (hydraulic pressure: 0 MPa {0 kg/cm^2})

However, the condition of the LS bypass and active mode solenoids is as follows.

When ON: Current flows (hydraulic pressure 0 MPa {0 kg/cm^2})

When OFF: Current does not flow (hydraulic pressure: 2.9 MPa {30 kg/cm^2})

Table 1

Name of solenoid		Measurement conditions	Operating condition	Condition of solenoid	Oil pressure (MPa {kg/cm^2}	Remarks
1	Swing holding brake	Swing or work equipment lever operated	Brake canceled	ON	2.9 ± 0.5 {30 ± 5}	
		All levers except travel at neutral (5 sec after returning to neutral)	Brake actuated	OFF	0	
2	Travel speed selection	Travel speed selection switch at Hi • Engine speed 1,500 rpm or above • Travel lever operated	Travel speed Hi	ON	2.9 ± 0.5 {30 ± 5	Motor swash plate angle at minimum
		Travel speed selector switch at Lo or engine speed 1,500 rpm or below	Travel speed Lo	OFF	0	Motor swash plate angle at maximum
3	2-stage relief	Swing lock switch ON + work equipment lever operated	Pressure rise	ON	2.9 ± 0.5 {30 ± 5}	
		All levers at neutral		OFF	0	
4	Suspension lock	Suspension lock switch ON	Sus lock actuated	ON	2.9 ± 0.5 {30 ± 5}	
		Suspension lock switch OFF	Sus lock canceled	OFF	0	

MEASURING PPC VALVE OUTPUT PRESURE

★ Oil temperature when measuring 45 - 550C

1. Measuring PPC valve output pressure

1) Disconnect the hose of the circuit to be measured.

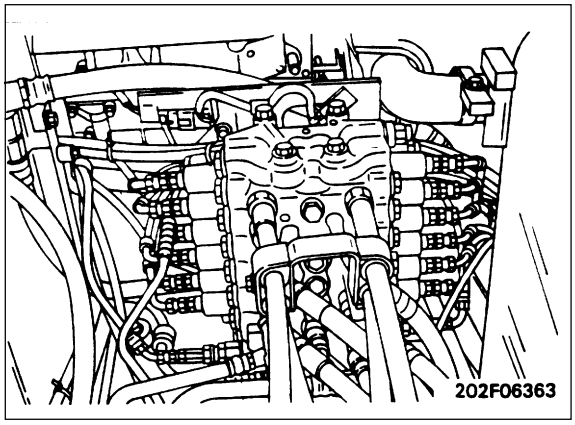
2) Install adapter C3 between the hose and elbow.

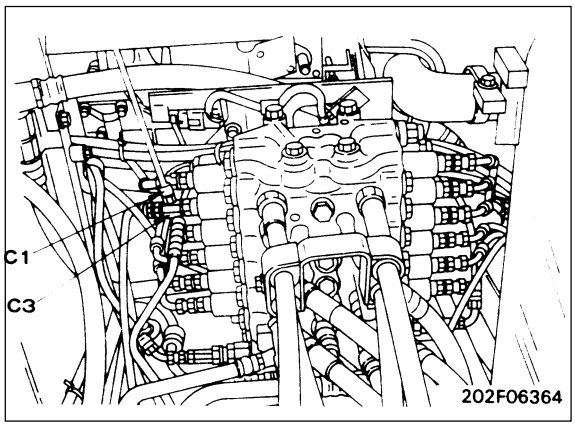
3) Install oil pressure gauge C1 (5.9 MPa {60 kg/cm2}) to adapter C3.

4) Run the engine at full throttle, operate the control lever of the circuit to be measured, and measure the oil pressure.

JUDGEMENT STANDARD

Minimum pressure = 2.7 MPa 26.5 kg/cm^2.





TESTING TRAVEL MOTOR RELIEF PRESSURE

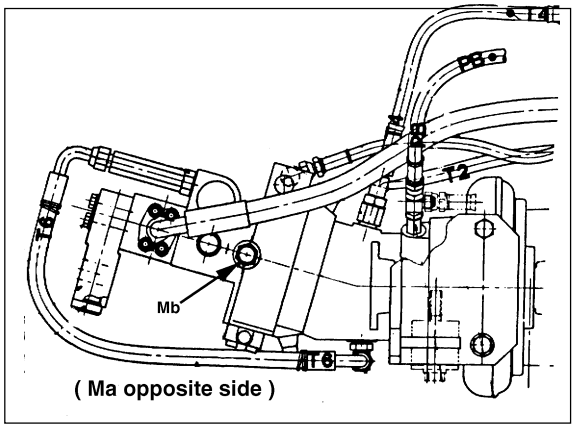
The front (26-80 cc/rev) travel motor has two pressure relief valves which control the deceleration of the machine (when travelling and the travel pedal is in neutral). One operates in forward travel and one in reverse.

★ Set pressure = 37.3 MPa (380 kg/cm^2).

Measuring travel motor
Relief pressure

Oil temperature should be 45 - 55°C

- Fit a 600 kg/cm^2 pressure gauge to port Mb on the front travel motor.
- Test the machine on a downhill slope with a smooth surface and long enough to allow the pressure to stabilize. If the slope is steep (more than 5 degrees) test in Mi mode, otherwise test in Hi mode.
- Travel forward at approximately half maximum speed (for the selected mode), then release the travel pedal. Read the pressure gauge after the pressure stabilizes.
- If necessary repeat the test in reverse gear but with the pressure gauge fitted to port Ma (opposite site to Mb on front motor).



WARNING

Take extreme care traveling at high speeds in reverse.

ADJUSTING TRAVEL MOTOR RELIEF PRESSURE

The value controlling deceleration of forwards travel is located on the left side of the motor (facing forwards) which is the same side as ports Pa and Ma. It is on the opposite side to the measurement port for forwards travel, Mb.
The value controlling deceleration of rewards travel, similarly located on the right side (Ppt Mb side) of the motor.

- Remove the seal and cap from the valve.
- Loosen the locking nut with an M19 spanner.
- Turn the adjustment screw with a 6 mm Allen key, clockwise to increase, and counterclockwise to decrease the pressure.
- Tighten the locknut.

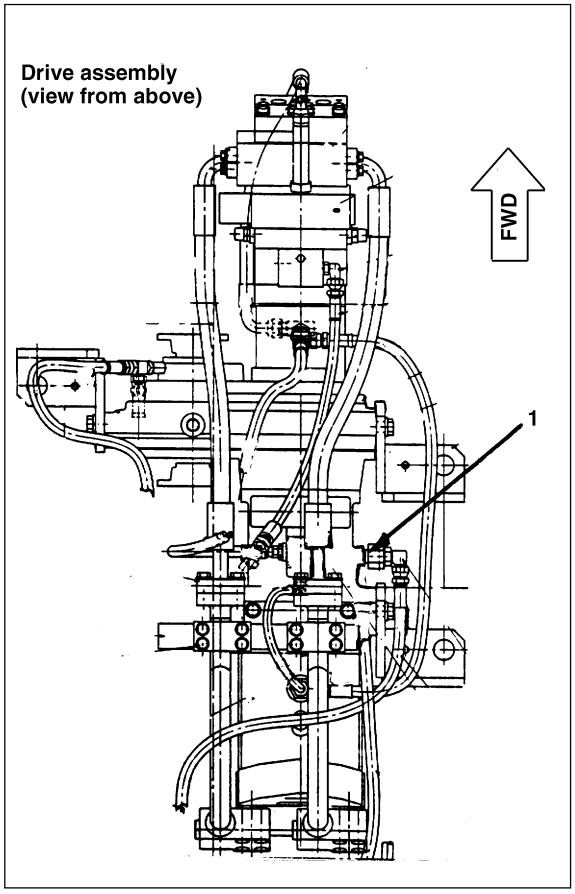
Note: The set pressure cannot be measured whilst making an adjustment.
Always repeat the measurement to check the set pressure after adjusting.

TESTING TRANSMISSION CLUTCH CONTROL CIRCUIT

DESCRIPTION (30 kph versions only)

The transmission clutch acts to dis-engage the rear travel motor from the transmission at travel speeds above 12 ± 1 kph. It has a fully automatic control system which provides an actuation pressure applied from the park brake circuit via a pressure reducing valve and a control valve.
The control valve is piloted by a control pressure which delivers from a gear pump on the transmission (which delivers a flow directly proportional to road speed) and is regulated by an orifice of diameter 2.1 mm (clutch control orifice). There is a pressure relief valve across this orifice which cracks open at 20 kg/cm^2 to prevent overpressurisation of the circuit, and a check valve to prevent operation of the clutch in rewards travel.

1. Measuring clutch actuation pressure
Oil temperature 45 - 55°C
Fit a tee connector to the clutch actuation port (1) and fit a 150 kg/cm^2 pressure gauge to the third leg of the tee. Measure pressure with the wheels lifted from the ground and rotating at maximum speed (pedal fully depressed) in Ho mode high idle (forwards travel).

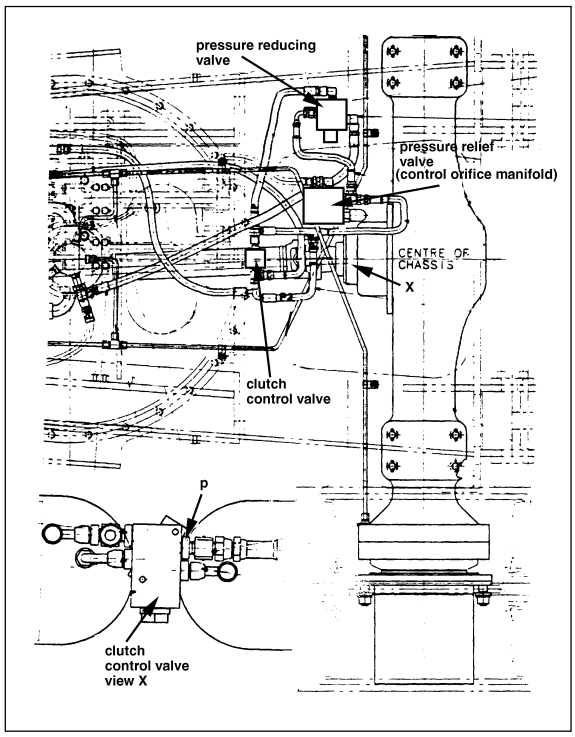


JUDGEMENT TABLE

Travel mode	Pressure MPa (kg/cm2)	Remarks
Hi	4.7 ± 0.2 (48 ± 2)	If pressure is zero check clutch control pressure. If pressure is low or high check and adjust clutch supply pressure.
Mi	0 + 0 0.2 (0 ± 2 -0)	If pressure is not zero check clutch control pressure.

2. Measuring the clutch supply pressure

Oil temperature 45 - 55°C
Disconnect pressure reducing valve delivery hose at clutch control valve input (port P) and attach a 150 kg/cm^2 pressure gauge to the hose end.
Check pressure in Ho mode High idle. With park brake OFF.
TARGET 48 ± 2 kg/cm^2

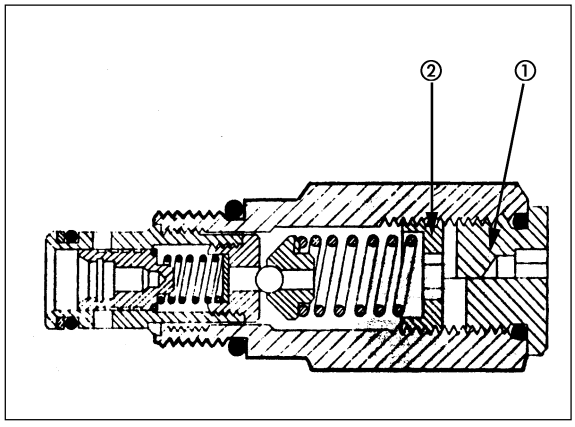


ADJUSTING THE CLUTCH SUPPLY PRESSURE

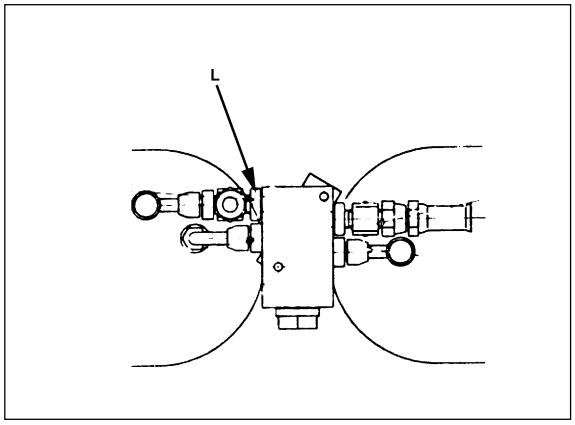
Always measure the pressure (as above) whilst adjusting

2.1 Remove cap ① from pressure reducing valve. Turn the adjustment sleeve ② as follows
- To INCREASE pressure, turn CLOCKWISE.
- To DECREASE pressure, turn COUNTERCLOCKWISE.

2.2 After adjustment tighten cap ①.



CLUTCH CONTROL CIRCUITS COMPONENTS



3. MEASURE CLUTCH CONTROL PRESSURE

★ Oil temperature to be 45 - 55°C for all measurements

Measure pressure at clutch control valve input port L (pilot port).
Fit a tee connection at clutch control valve input (pilot line) and attach pressure gauge (60 kg/cm2) to the third leg of the tee.
Measure pressure with the wheels lifted off the ground and rotating at maximum speed (pedal fully depressed) in Ho mode high idle (forwards travel).

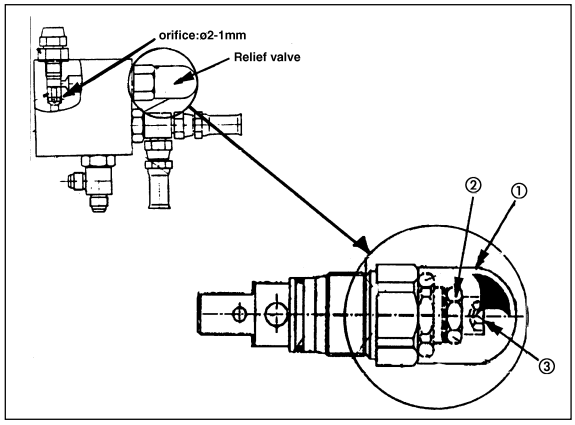
JUDGMENT TABLE

	Travel mode	Pressure valve MPa (kg/cm^2)	Remarks
1	Hi	2.4 ± 0.5 (25 ± 5)	If pressure is outside tolerance adjust pressure relief valve in control orifice manifold.
2	Mi	0.64 ± 0.15 (6.5 ± 1.5)	If pressure is low adjust pressure relief valve in control orifice manifold.* If pressure is high check control orifice for blockage and correct size (2.1 mm diameter)

★ Always adjust pressure relief valve when in Hi travel mode (as in check item 1).

SAFETY NOTE: Do not attempt to measure pressure at the clutch pump output port directly as there is no internal relief valve.

TESTING CLUTCH CONTROL CIRCUIT



4. ADJUSTING CLUTCH CONTROL PRESSURE RELIEF VALVE

Adjust whilst measuring the clutch control pressure in Hi travel mode (Ho mode Hi idle) with the wheels off the ground and rotating at maximum speed (forwards direction).

4.1 Break seal and remove cap ①.

4.2 Loosen locknut ② with a 19 mm wrench.

4.3 Turn the pin ③ with a 6 mm Allen key
To INCREASE pressure, turn CLOCKWISE.
To DECREASE pressure,
turn COUNTERCLOCKWISE.

4.4 After adjustment, tighten locknut ② and refit cap ②.
TARGET: 2.4 ± 0.5 MPa (25 ± 5 kg/cm^2)

CHECKING FOR CORRECT OPERATION OF THE CLUTCH

- After any adjustment check for correct operation of the clutch as follows.

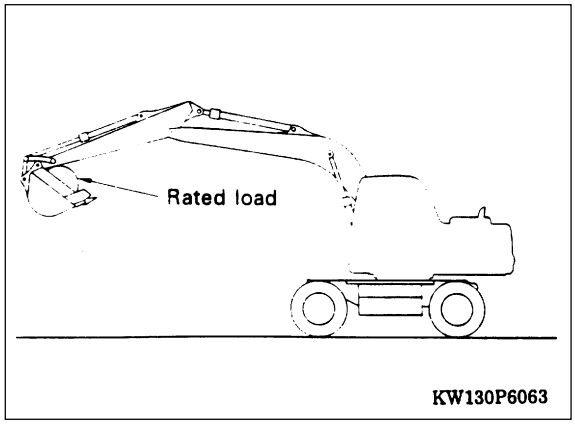
1. Prepare to measure the clutch actuation pressure (as section 1).

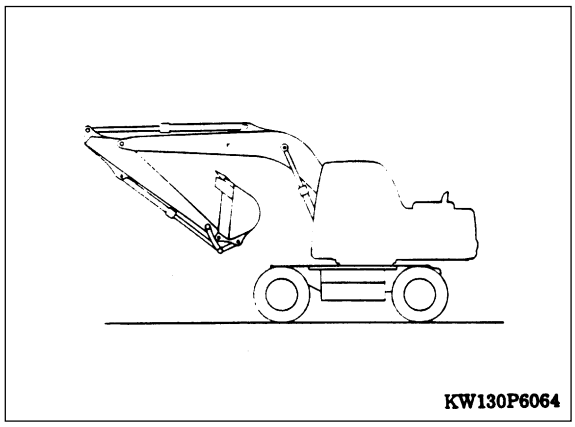
2. With the wheels on or off the ground run the machine in forwards travel in Mi travel mode at maximum speed. Clutch actuation pressure should remain (clutch engaged) at zero^. Without stopping, switch to Hi mode. The wheels will start to increase in rotating speed and the clutch should immediately dis-engage. (at 11 ± 2 kph travel speed).
Clutch actuation pressure will rise to 48 ± 2 kg/cm^2 and a change in noise from the travel motors will be heard.

3. Reduce speed slowly. At (or just above) 10 kph - maximum speed in Mi mode*, the clutch should re-engage. Clutch actuation pressure will fall to zero, a slight shock will be felt, and a noise heard from the travel motors.

* This speed must be estimated during the test.

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

★ For machine equipped with accumulator

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 holding 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 bottom 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 balance 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 procedure given above, the circuit at the head end is opened to the drain circuit (the bottom end is closed by the check vale), 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 or FREE position (engine running), the PPC valve is defective.

MEASURING OIL LEAKAGE

★ Hydraulic oil temperature when measuring
45 - 55°C

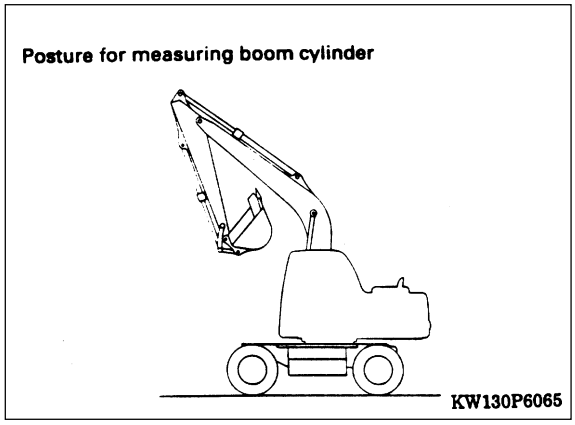
1. Work equipment cylinder

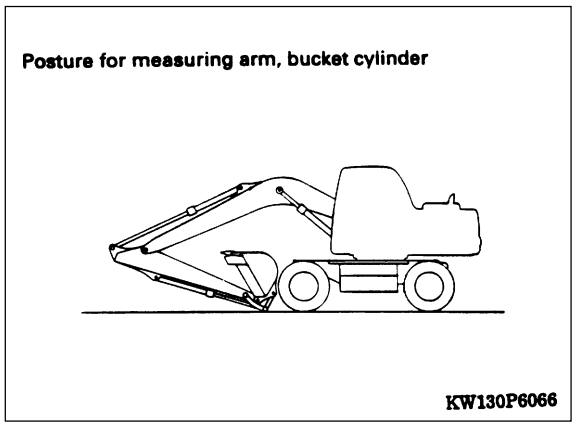
★ If the hydraulic drift of the work equipment is outside the standard value, measure the leakage inside the cylinder as follows, and judge if the cause of the hydraulic drift is in the cylinder or in the control valve.
- If leakage is within the standard value, the problem is in the control valve.
-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

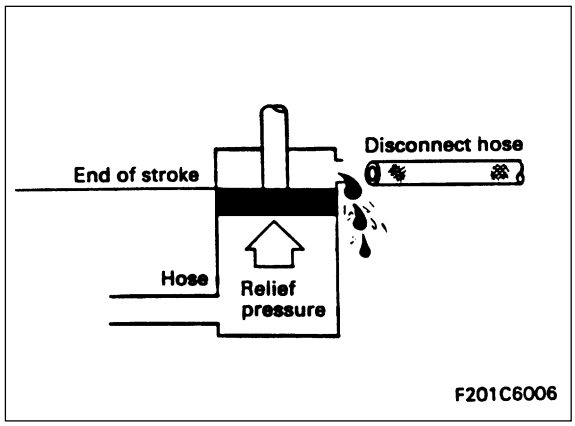
1) Fully extend the rod of the cylinder to be measured, then stop the engine.
2) Disconnect piping (1) at the head end, then block the piping at the chassis end with a blind plug.

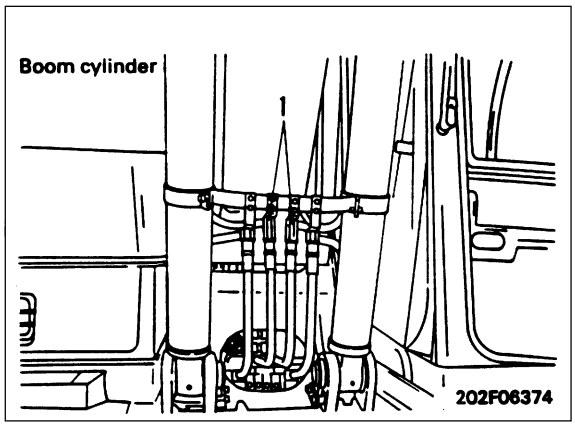
⚠ Be careful not to disconnect the piping at the bottom end.

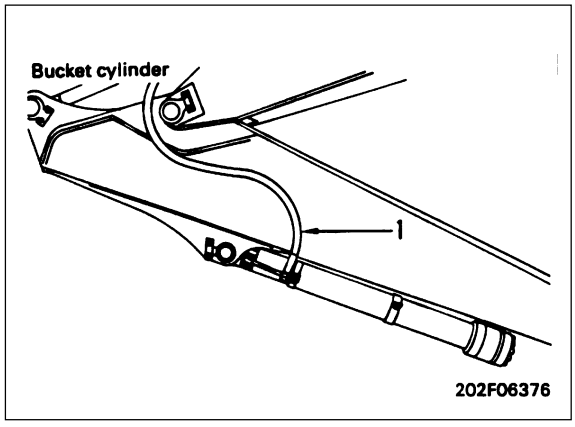
3) Start the engine and apply the relief pressure to the bottom end of the cylinder with the engine at high idling.
4) Continue this condition for 30 seconds, then measure oil leakage for the next one minute.

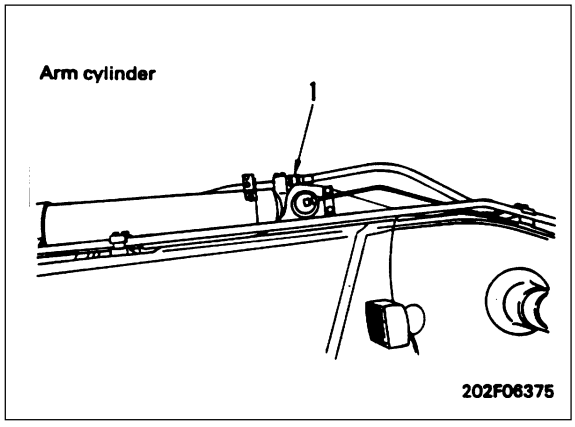






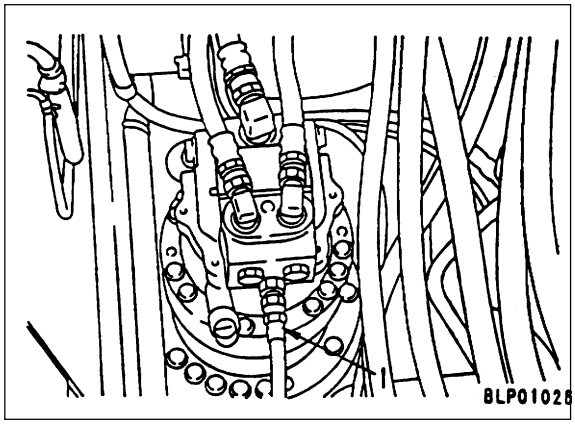






2. Swing motor

1) Disconnect drain hose (1) from the swing motor, thenfit 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 high idling.
4) Continue this condition for 30 seconds, then measure the oil leakage for the next one minute.
   ★ After measuring, swing 1800 and measure again.

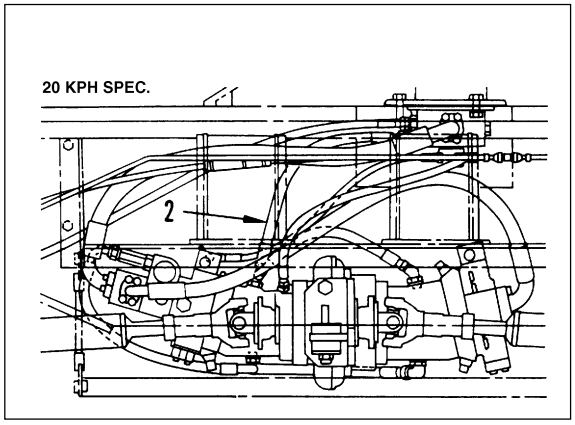


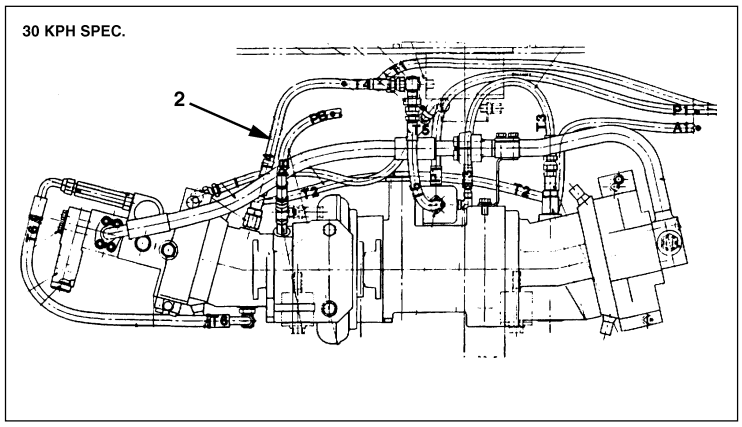
3. Travel motor

1) Disconnect drain hose (2) from the travel motor, then fit a blind plug at the hose end.
2) Apply park brake.
3) Start the engine and operate the travel relief with the engine at high idling.

⚠ When measuring the oil leakage from the travel motor, mistaken operation of the control valve 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

★ No accumulator is installed, so the pressure remaining in the piping between the control valve and the hydraulic cylinder or swing motor cannot be released by operating the control levers. Therefore, when removing the above piping, be careful of the following points.

1. Run the engine at low idling, operate the hydraulic cylinders so that they are not relieved at the end of the stroke, lower the work equipment to the ground, then stop the engine.
   ★ If the engine is stopped with the cylinder relieved at the end of the stroke, wait for 5 - 10 minutes before starting the operation.
2. When removing the piping, gradually loosen the sleeve nut of the piping to slowly release the pressure remaining in the piping. Remove the piping when the oil stops spurting out.

BLEEDING AIR

ORDER FOR OPERATIONS AND PROCEDURE FOR BLEEDING AIR

Air bleeding item / Nature of work	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
• Replace 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		○ →			○ →	○

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 Plug:
17.25 ± 2.5 Nm {1.75 ± 0.25 kgm}

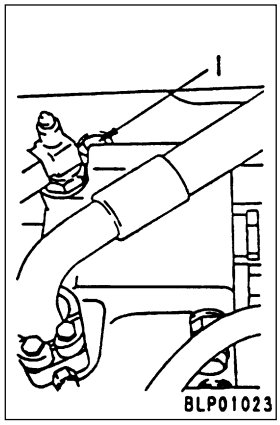
★ If no oil oozes out from the air bleed plug:

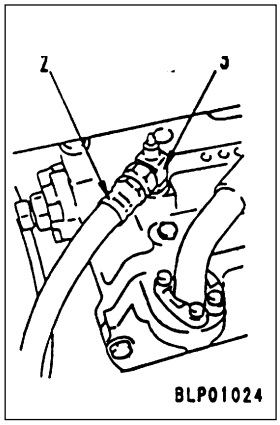
3) Leave plug (1) loosened and remove hose (2) and elbow (3).
4) Pour in oil through the elbow mount hole until oil oozes out from plug (1).
5) Fit elbow (3) and install hose (2).
6) Tighten air bleed plug (1).

kgm Plug:
17.25 ± 2.5 Nm {1.75 ± 0.25 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 coolant temperature is low and automatic warming-up is carried out, cancel it by using the fuel control dial after starting the engine.

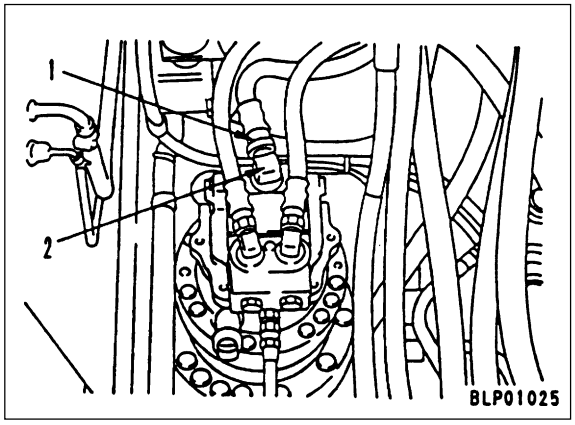




2. Bleeding air from hydraulic cylinders

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.

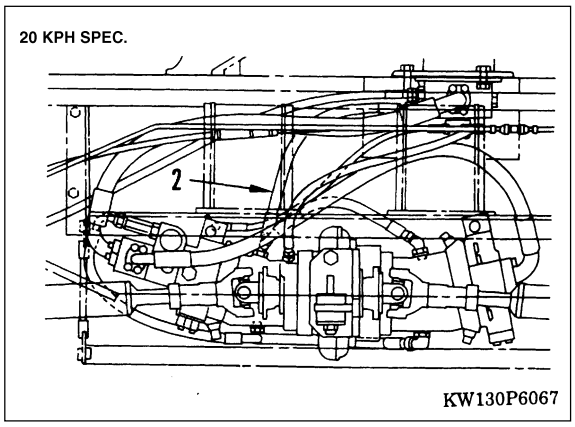
★ When the cylinder has been replaced, bleed the air before connecting the piston rod.
Be particularly careful not to operate the cylinder to the end of its stroke when the piston rod has been connected to the LOWER end of the boom cylinder.



3. Bleeding air from swing motor

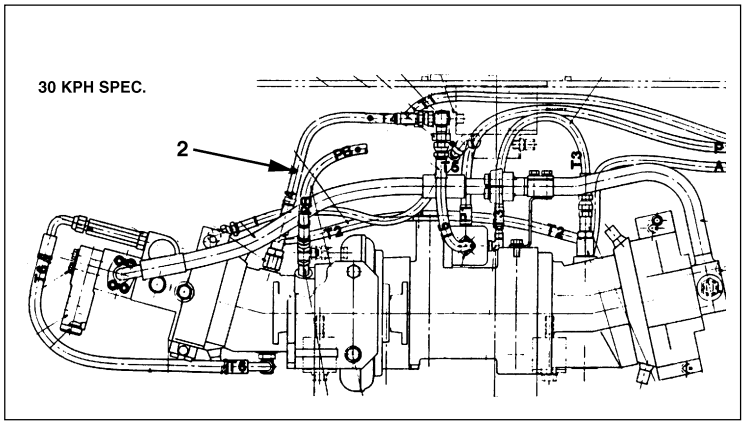
1) Lock the swing lever and run at idling for 5 minutes.
   ★ The system is designed so that the pressure at port S carries out the air bleeding.
2) Disconnect hose (1) of the swing motor and fit a blind plug in the hose.
3) Run the engine at low idling, and check that oil oozes out from elbow (2).
   ★ If no oil oozes out from the elbow, carry out Step 1) again.
4) Connect hose 91).

kgm hose:
137.3 ± 29.4 Nm {14 ± 3.0 kgm}



4. Bleeding air from travel motor

1) Disconnect motor drain hose (2).
2) Run t he engine at low idling and check that oil oozes out from the nipple.
3) If oil oozes out, connect hose (2).



ACCUMULATORS

CHARACTERISTIC DETAILS

1. Model Code FP **K** **100** **E** **2.5** **G2** **K**

Charging and Testing Unit
for piston and diaphragm accumulators K

Gauge Indication Range
0 - 100 bar 0 - 1450 psi 100

Charging Hose
with cap screw G1
(fem. thread W 24.32 cylinder 1/14" - DIN 477)
suitable for direct connection with nitrogen bottles
in Germany, Netherlands, Switzerland, Sweden,
Finland, Russia, Belgium (see point 4.3).

Length of Charging Hose
2.5 m 2.5
4.0 m 4.0
other lengths on request

Adapter to Cap Screw G1
(see point 4.4) for nitrogen bottles

in Great Britain, Australia	G2
France	G3
USA	G4
Italy	G5
Japan	G6
Japan	G7
Brazil	G8
China	G9
Russia	G10
other adapters on request	G2

Case

Accessories
full details required when ordering
Gas safety valve with intermediate piece (see point 4.5)
Pressure release valve with connector (see point 4.5)
Adapter for cap screw D (see point 4.1)

2. Weight
2.2 kg with case
1.0 kg without case

3. Mounting Position
optional

OPERATING INSTRUCTIONS

1. Gas charging pressures

The critical value of gas pre-charge for accumulator 20E-60K1150 is as follows.
(Ratio between maximum working pressure and gas pre-charge pressure.)

20E-60K1150
Max working pressure (P2) = 210 bar
Gas pre-charge (P0) = 50 bar

Permissible pressure ratio P2 : P0 = 8 : 1
If gas pre-charge falls below this ratio then it becomes "Critical".

2. Temperature effect to be taken into account

In order not to exceed the stated temperatures, the pre-charge pressure P0 has to be determined at charging temperature:

$$p0,t0 = p0.t2 \ \frac{t0 + 273}{t2 + 273}$$

t0 = pre-charge temperature (0C)
t2 = max. operating temperature (0C)

3. PREPARATION

Prior to each testing, charging or topping-up of nitrogen, the accumulator has to be separated from the pressurized system by means of the shut-off valve and the fluid has to be released. The protective cap **S** has to be unscrewed. Slightly loosen the int. hex. screw by means of an Allen key GW 0, DIN 911 (approx. 1/2 turn). Screw cap nut **D** by hand onto accumulator gas valve. Turn charging unit to a position where the gauge can be easily read.

4. TESTING

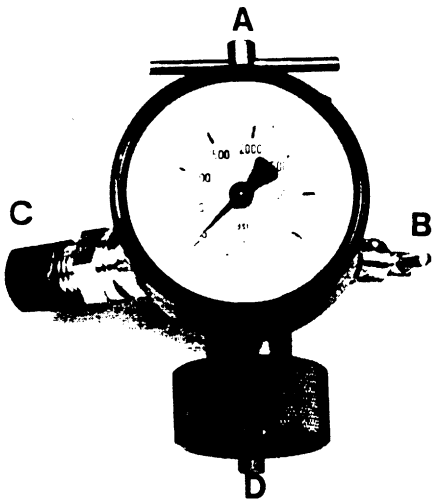
Valve **V** is opened by loosening the int. hex. screw with spindle **A**. **After the pointer of the gauge begins to deflect unscrew the spindle by a further full turn.** The gauge now shows the charging pressure in the accumulator. The check valve prevents any escape of nitrogen.

5. PRESSURE RELEASE

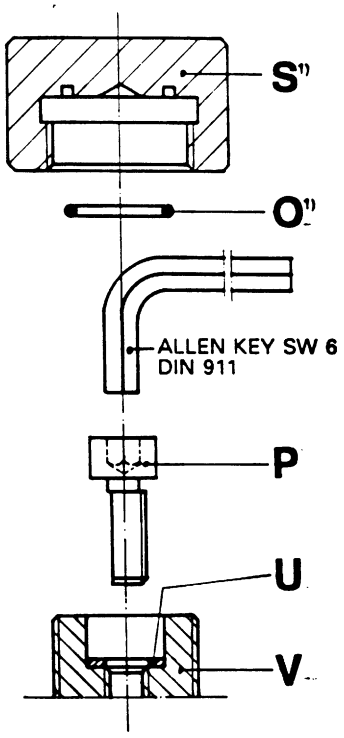
By carefully opening relief valve **B**, the nitrogen escapes into the atmosphere.

6. PRESSURE INCREASE (CHARGING)

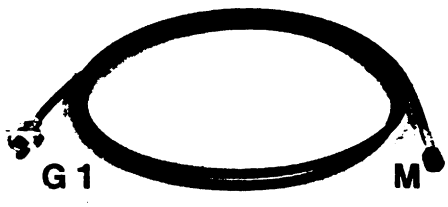
Use only nitrogen for charging accumulators.
Never use oxygen! Danger of explosion! If the gas pressure in the nitrogen bottle is higher than the max. operating pressure of the accumulator, a pressure release valve and a gas safety valve must be fitted.



Charging and testing unit
piston and diaphragm accumulators



Piston and diaphragm accumulators
(gas valve)



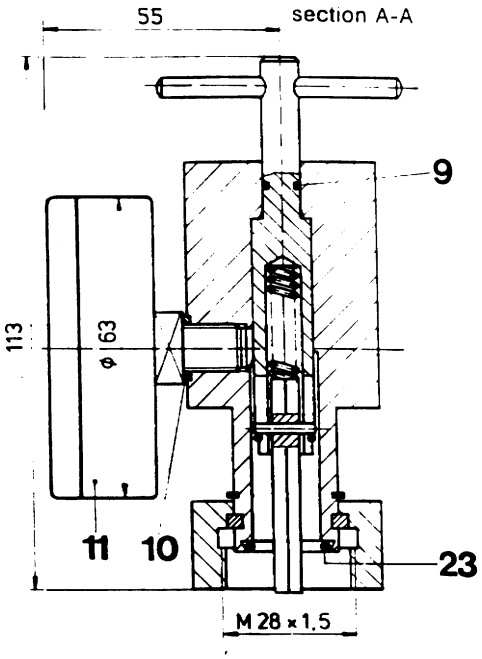
Charging hose for FPS and FPK
1) not for diaphragm accumulators

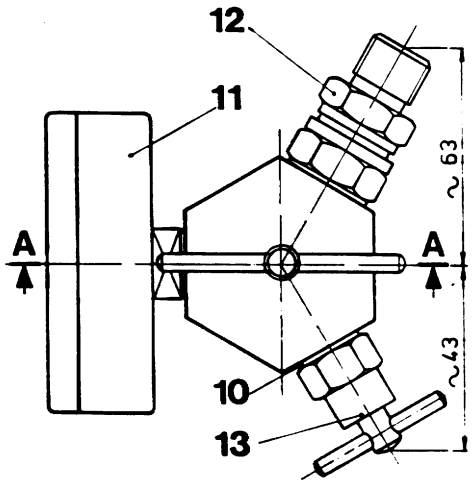
- The flexible charging hose is connected to the pressure release valve on the commercially available nitrogen bottle by means of the cap nut **G1**. (For nitrogen bottle connections from other countries the appropriate adapter is required.)
  Cap nut **M** of the charging hose is for the connection with nipple **C** of the charging and testing unit. By opening the shut-off valve on the nitrogen bottle, with spindle **A** screwed in, slowly release nitrogen into accumulator, to ensure better pressure compensation and to prevent damage to the gas valve insert. Close shut-off valve of the nitrogen bottle and check charging pressure on the gauge.

- Repeat this project until the required pre-charge pressure is reached. After a period of approx. 5 minutes, during which time temperature compensation takes place (for higher charging quantities a longer period has to be allowed), recheck pressure (see point 3.3); adjust if necessary.

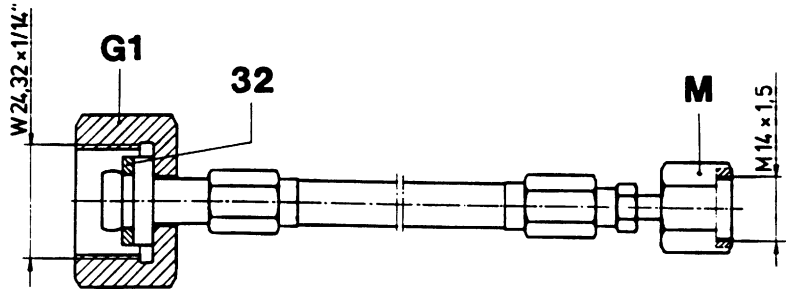
- When the required pre-charge pressure is reached, the int. hex. screw **P** is tightened which closes gas valve **V**. Now the charging and testing unit is inscrewed and the int. hex. screw **P** is retightened (torque 25 Nm). Check the gas valve on the accumulator for leakage by means of sealing spray or soapy water.

- Screw protective cap **S** onto the gas valve of the accumulator and tighten. Then seal ring **U** and the int. hex. screw **P** are always in the gas valve **V** and are only loosened when the charging and testing unit is used.

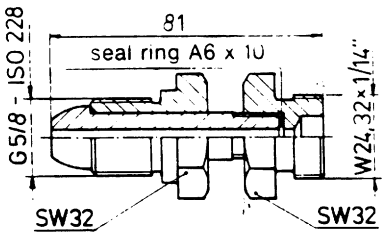




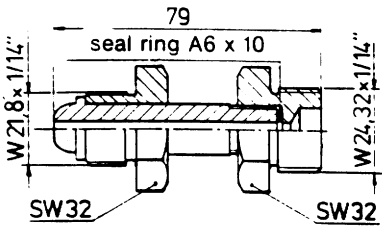
Length 2.5 m (part no. 236514)
Length 4.0 m (part no. 236515)



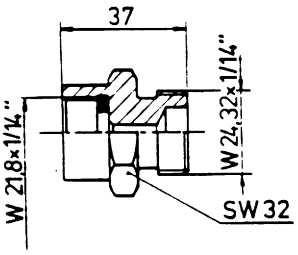
G 2 (part no. 236376)



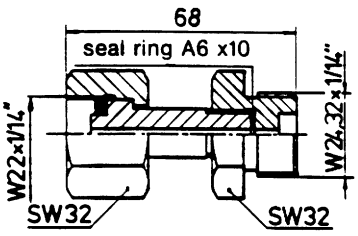
G 5 (part no. 236373)



G 3 (part no. 2103421)



G 6 (part no. 2103423)



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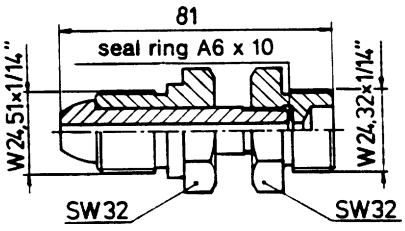


TROUBLESHOOTING

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 basis cause of the failure, to carry out repairs swiftly, and to prevent reoccurrence of the failure.
When carrying out troubleshooting, an important 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 produce the reported symptoms.

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

   It will also cause a waste of man-hours, 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 through 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 occurred apart from the problem that had been reported?
   2) Was there anything strange about the machine before the failure occurred?
   3) Did the failure occur suddenly, ore 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) Where there abnormal symptoms about the machine?
   2) Check checking items before starting.
   3) Check other checking items.
   4) 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 exactly.
   ★ The basis 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. Than, remove the root cause.

SEQUENSE OF EVENTS IN TROUBLESHOOTING

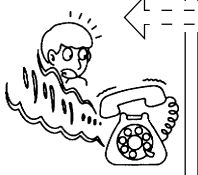

TEW00180

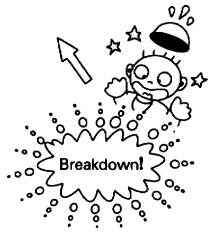

TEW00181

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.


TEW00182

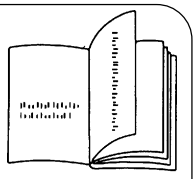


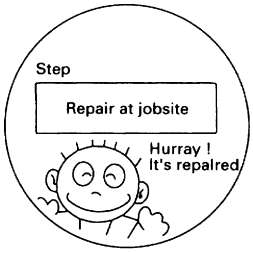
TEW00183

Step 2

Determining probable location of cause

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


TEW00184

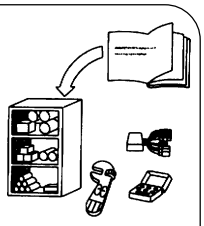


TEW00185

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.

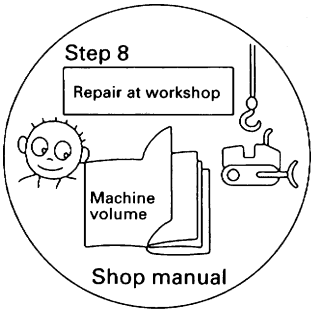

TEW00186

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



TEW00188

Step 6

Re-enacting failure

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

Step 4

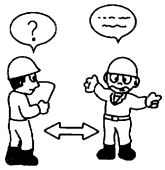
Go to jobsite


TEW00189

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

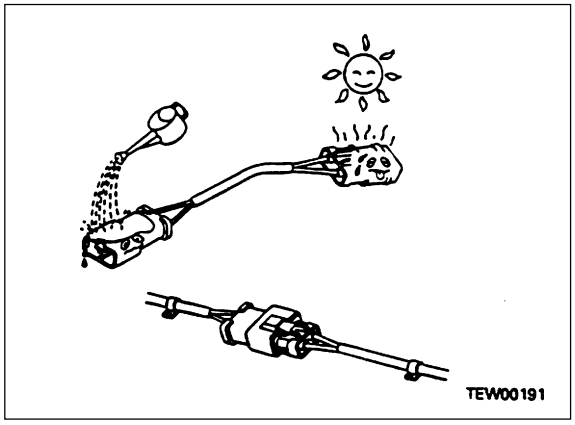
To maintain the performance of the machine over a long period, and to prevent failures or other troubles before they occur, correct operation, maintenance and inspection, troubleshooting, and repairs must be carried out. This section deals particularly with correct repair procedures for mechatronics 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 harnesses 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.

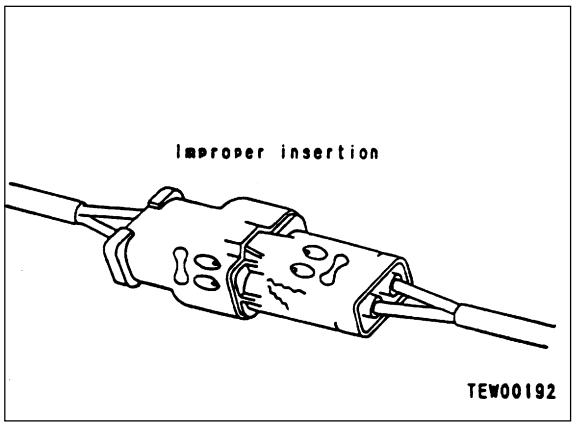
Compared with other electrical components fitted in boxes or cases, wiring harnesses are more likely to be affected by the direct effects of rain, water, heat, or vibration. Furthermore, during inspection and repair operations, they are frequently removed and installed again, so they are likely to suffer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



Main failures occurring in wiring harness

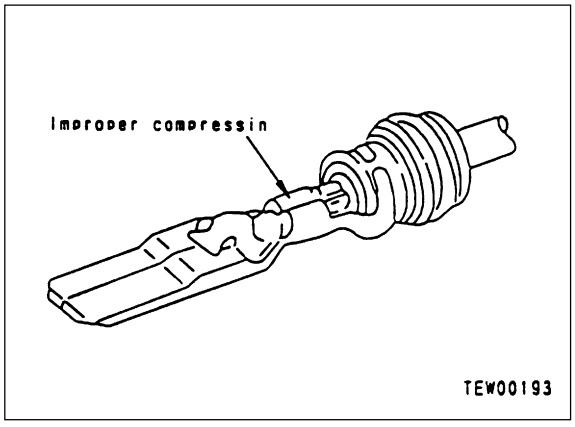
① Defective contact of connectors (defective contact between male and female)

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

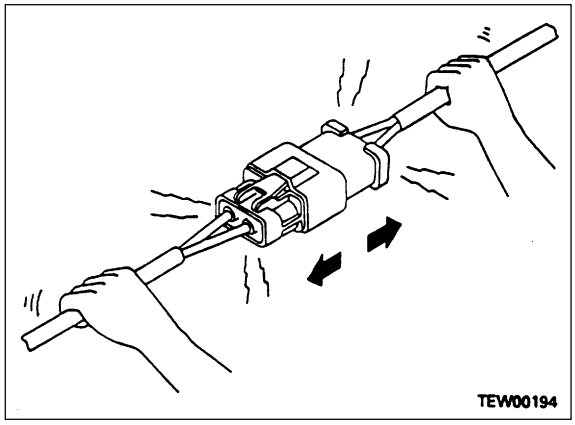


② Defective crimping or soldering of connectors

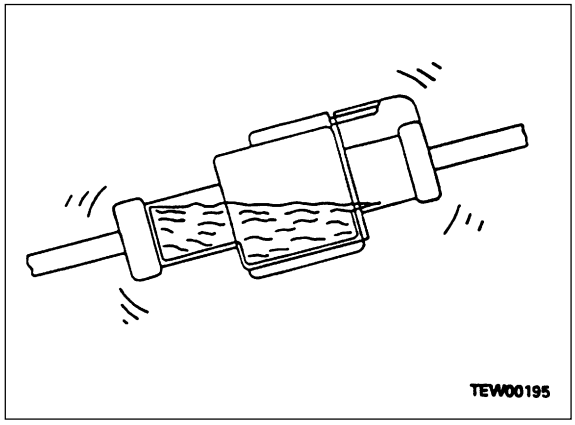
The pins of the male and female connectors are in contact at the crimped terminal or soldered portion, but if there is excessive force brought to bear on the wiring, the plating at the joint will peel and cause improper connection or breakage.



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

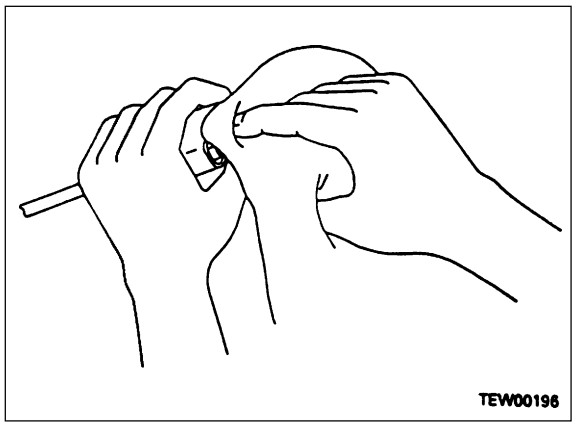


④ High-pressure water entering connector
The connector is designed to make it difficult for water to enter (drip-proof structure), but if high-pressure water is sprayed directly on the connector, water may enter the connector, depending on the direction of the water jet.
As already said, the connector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



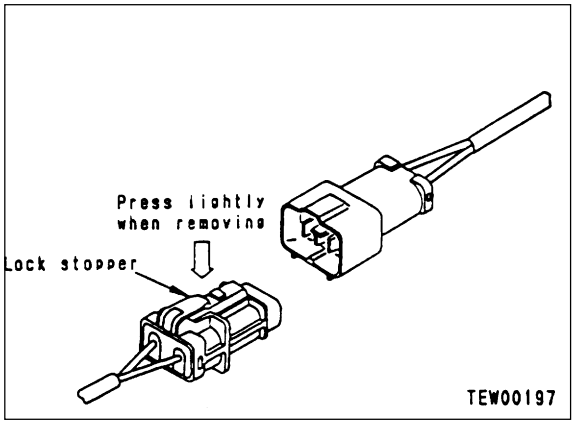
⑤ Oil or dirt stuck to connector
If oil or grease are stuck to the connector and an oil film is formed on the mating surface between the male and female pins, the oil will not let the electricity pass, so there will be defective contact.
If there is oil or grease stuck to the connector, wipe it off with 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 completely before cleaning with compressed air.

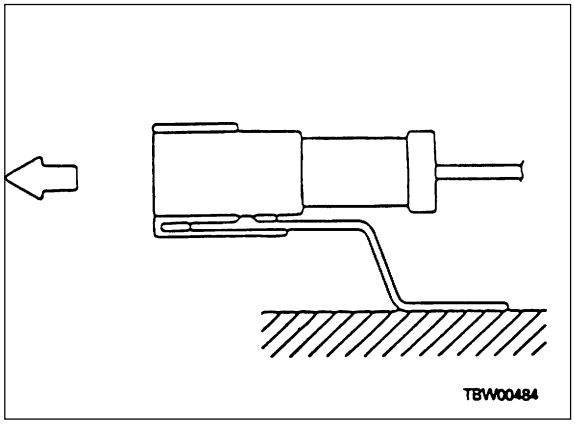


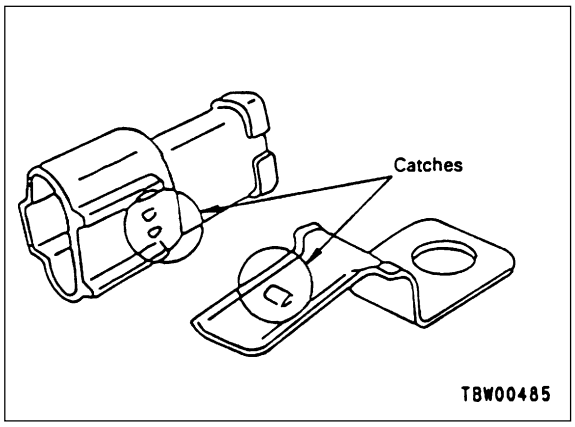
2) Removing, installing, and drying connectors and wiring harnesses

- 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 connectors 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.

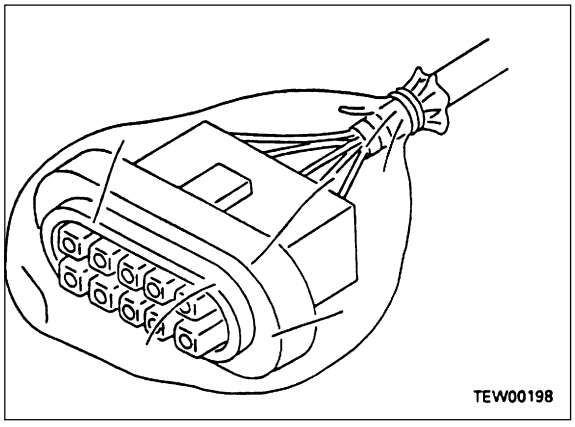


  ② When removing from clips
  When removing a connector from a clip, pull the connector in a parallel direction to the clip.
  ★ If the connector is twisted up and down or to the left or right, the housing may break.





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

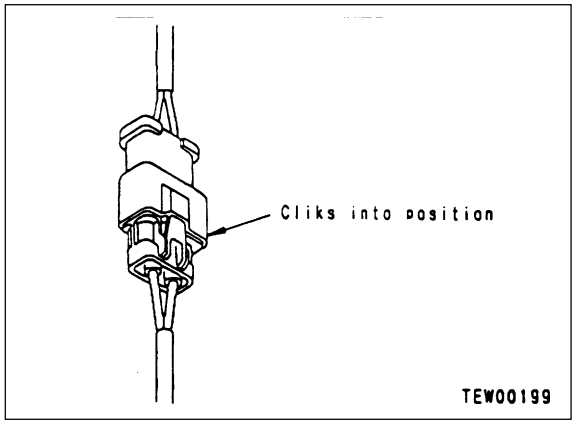


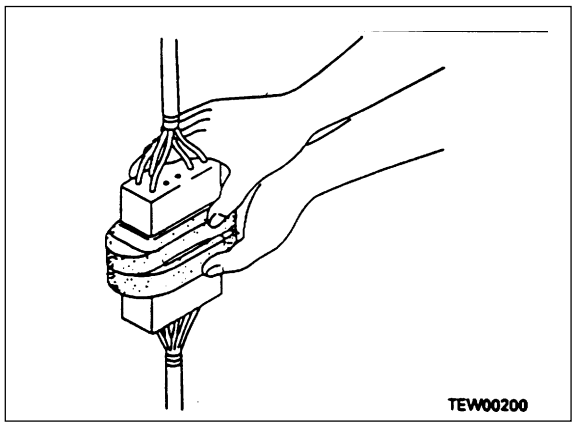
- **Connecting connectors**
  ① Check the connector visually.
  1) Check that there is no oil, dirt, or water stuck to the connector pins (mating portion).
  2) Check that there is no deformation, defective contact, corrosion, or damage to the connector pins.
  3) Check that there is no damage or breakage 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.

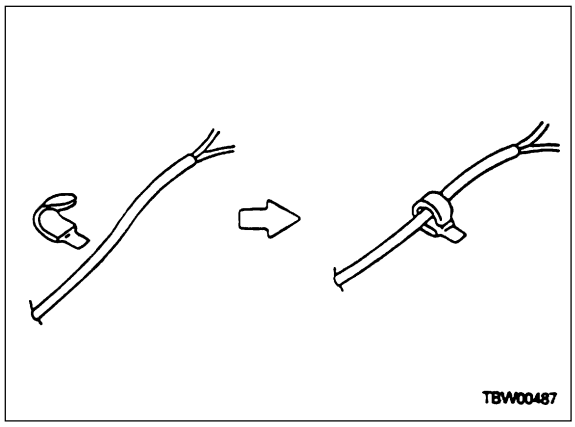
  ② Fix the connector securely.
  Align the position of the connector correctly, then insert it securely.
  For connectors with lock stopper, push in the connector until the stopper clicks into position.

  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.

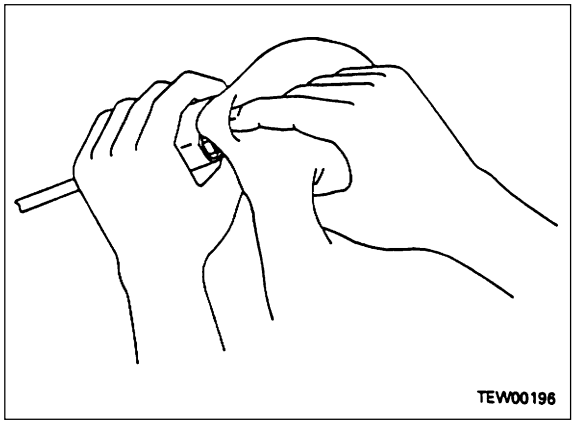




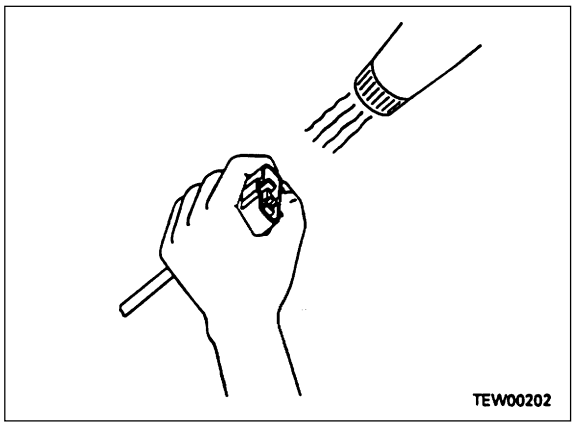


- **Drying wiring harness**
  If there is any oil or dirt on the wiring harness, wipe it of with a dry cloth. Avoid washing it in water or using steam. If the connector must be washed in water, do not use high-pressure water or steam directly on the wiring harness.

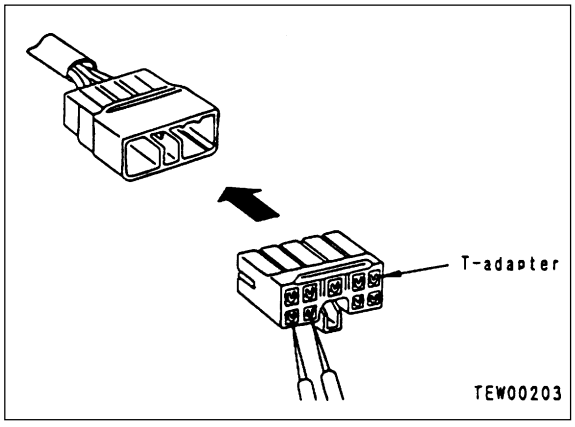
  If water gets directly on the connector, do as follows.
  1) Disconnect the connector and wipe off the water with a dry cloth.
     ★ If the connector is blown dry with compressed air, there is the risk that oil in the air may cause defective contact, so remove all oil and water from the compressed air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



  2) Dry 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.



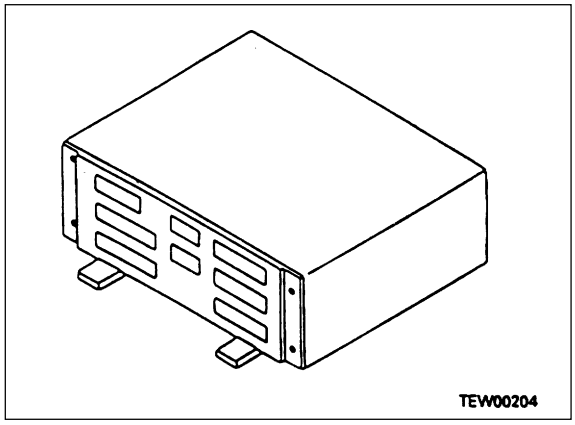
  3) Carry out a continuity test on the connector. After drying, leave the wiring harness disconnected and carry out a continuity test to check for any short circuits between pins caused by water.
     ★ After completely drying the connector, blow it with contact restorer and reassemble.



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.

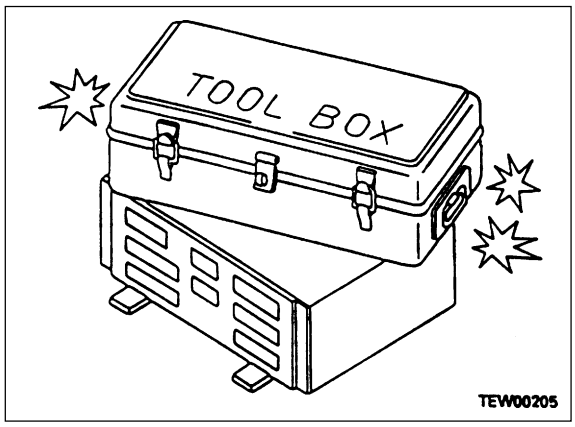
② Do not open the cover of the control box unless necessary.



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

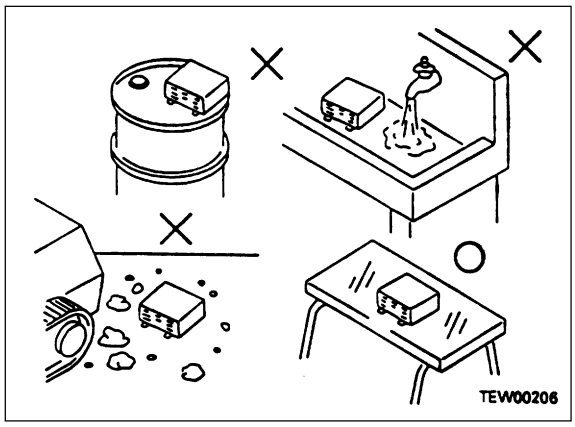
④ Cover the control connectors with tape or a vinyl bag.
Never touch the connector contacts with your hand.

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



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
When carrying out arc welding on the body, disconnect all wiring harness connectors connected to the control box. Fit an arc welding ground close to the welding point.



2. Points to remember when troubleshooting electric circuits

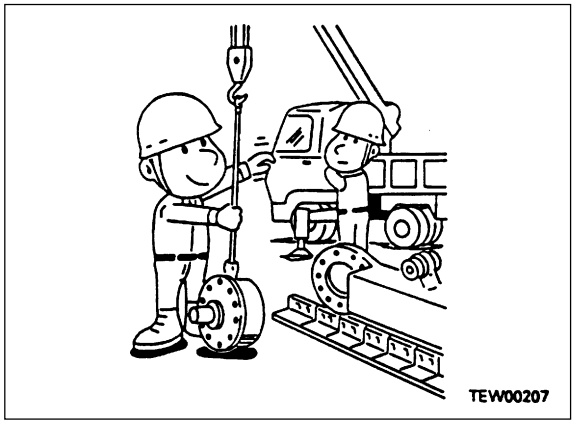
1) Always turn the power OFF before disconnecting or connect connectors.
2) Before carrying out troubleshooting, check that all related connectors are properly inserted.
   ★ Disconnect and connect the related connectors several times to check.
3) Always connect any disconnected connectors before going 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

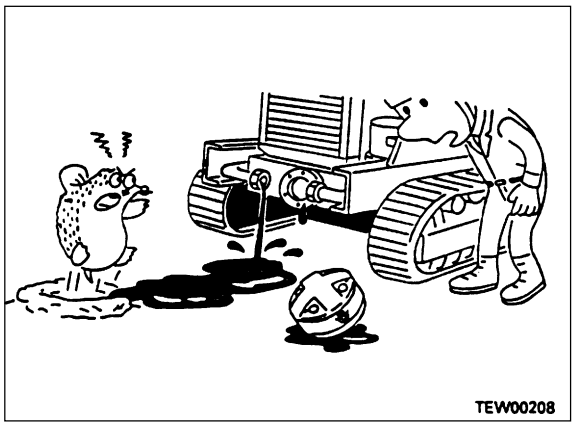
With the increase in pressure and precision of hydraulic equipment, the most common cause of failure is dirt (foreign material) in the hydraulic circuit. When adding hydraulic oil, or when disassembling or assembling hydraulic equipment, it is necessary to be particularly careful.

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.

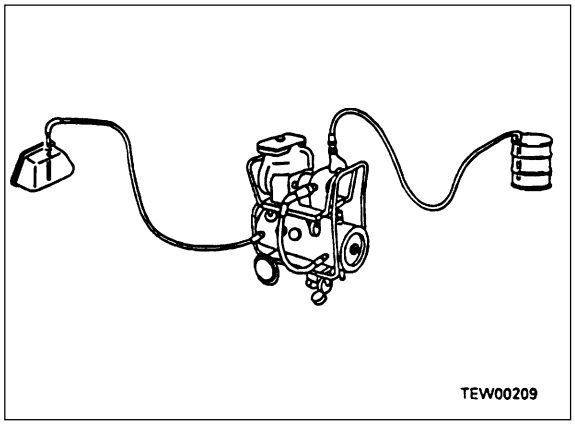
2) Disassembly and maintenance work in the field
If disassembly or maintenance work is carried out on hydraulic equipment in the field, there is danger of dust entering the equipment. It is also difficult to confirm the performance after repairs, so it is desirable to use unit exchange. Disassembly and 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 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 is and ask the customer to dispose of it, or take it back 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.

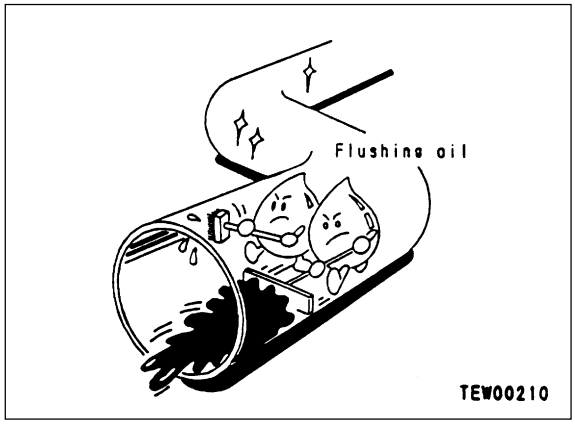

TEW00209

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, as much as possible of the old hydraulic oil must be drained out. Drain the oil from the hydraulic tank; also drain the oil from the filter and from the drain plug in the circuit. If any oil is left, the contaminants and sludge in it will mix with the new oil and will shorten the life of the hydraulic oil.

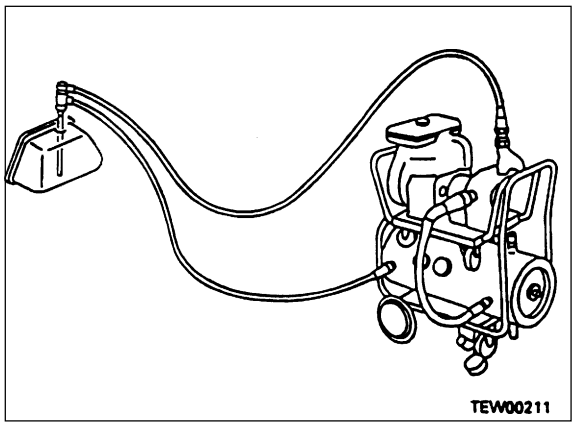
6) Flushing operations

After disassembling and assembling the equipment, or changing the oil, use flushing oil to remove the contaminants, sludge, and 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 (about 3u) particles that the filter built into the hydraulic equipment cannot remove, so it is an extremely effective device.



CHECKS BEFORE TROUBLESHOOTING

	Item	Judgement standard	Remedy
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	-	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 - 30 V	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/OF)	-	Replace

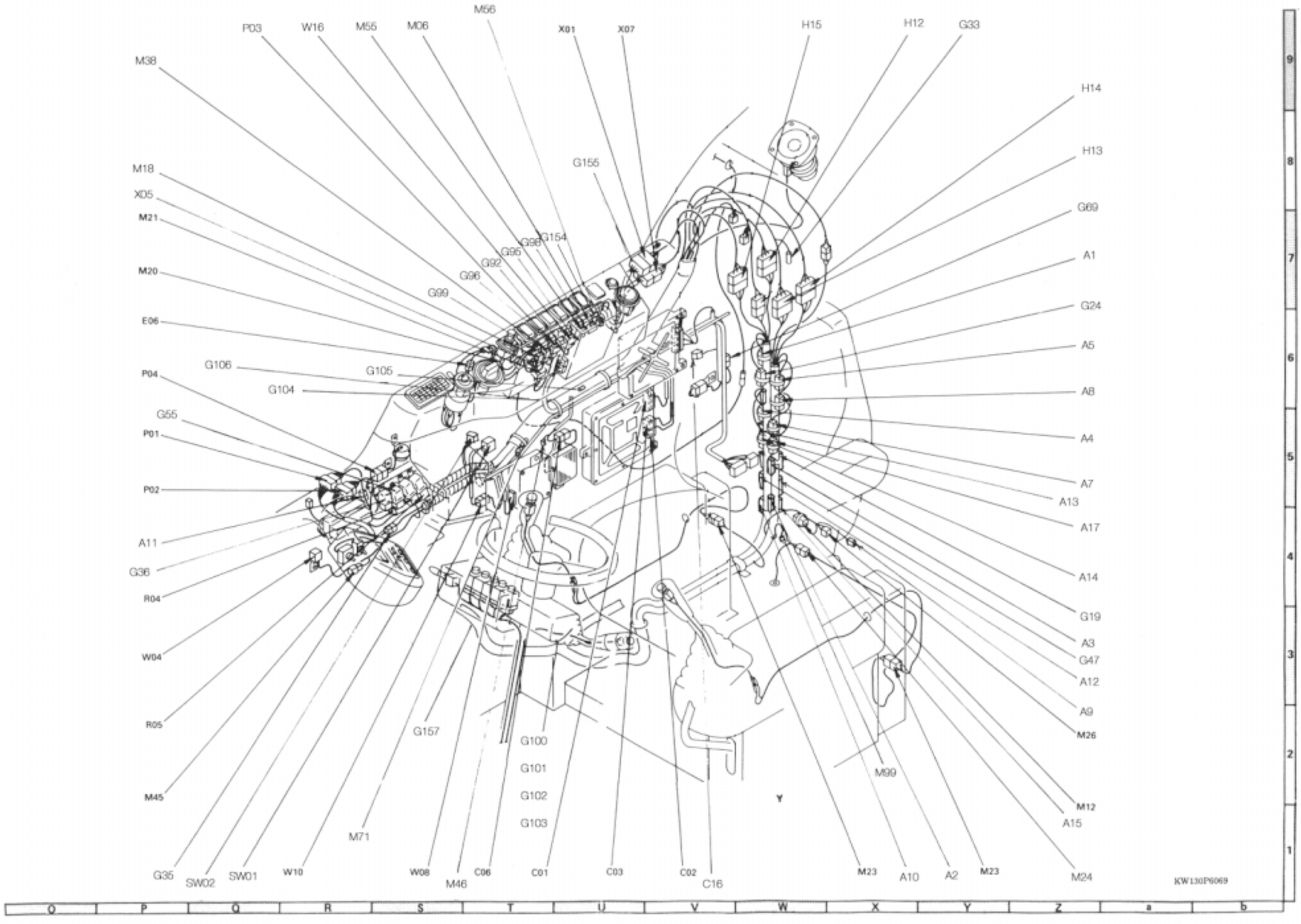
CONNECTOR TYPES AND MOUNTING LOCATIONS

Connector No.	Type	No. of pins	Mounting location	Address
A01	KES1	2	Window washer circuit	Z7
A02	KES1	2	Swing park brake sol	Y1
A03	KES1	2	Diode	Z3
A04	KES1	2	2stage relief sol	Z5
A05	KES1	2	Swing park sol circuit	Z6
A07	KES1	2	Travel speed sol circuit	Z5
A08	KES1	2	Heater circuit	Z6
A9	KES1	2	Travel diode	Z2
A10	KES1	2	Travel diode	X1
A11	KES1	2	Alarm buzzer circuit	P4
A12	KES1	2	Safety lock solenoid diode	Z3
A13	KES1X	2	Battery relay drive circuit	Z5
A14	KES1	2	Battery relay drive circuit	Z4
A15	KES1	2	Auto suspension lock diode	Z1
A16	KES1	2	Fuel shut off circuit	M2
A17	KES1	2	Horn	Z4
C01	MIC	17	Pump controller	T1
C02	40	20	Pump controller	V1
C03	40	16	Pump controller	U1
C06	M	2	TVC Prolix resistor	T1
C08	X	3	Pump pressure sensor	J9
C10	X	2	LS control EPC sol valve	H9
C13	X	2	Pump TVC solenoid valve	G9
C16	MIC	17	Governor,pump controller	V1
E04	X	3	Governor potentiometer	N3
E05	MIC	4	Governor motor	N3
E06	X	3	Fuel control dial	P5
E07		2	Engine speed sensor	M1
E08	SWP	14	Intermediate connector	L1
E09		3	Fuel shut off valve	N3
G03	AMP 925	7	Wiper, indicators	H2
G04	AMP 925	7	Horn, wash, lights	H2
G05		2	Air suspension seat switch	I3
G7	X	4	Taillight LH	L9
G8	X	4	Taillight LH/RH	L6
G9	X	2	Number plate light	I9
G10	SIMPLE CONNECTOR	3	Headlight	G2
G11	SIMPLE CONNECTOR	3	Headlight	C6
G12	X	2	Indicator RH	C6
G13	X	2	Indicator LH	H2
G14	AMP	1	Sidelight RH	C6
G15	AMP	1	SIdelight LH	G2
G18	REXROTH	2	Diode	J3
G19	KES1	2	Boom/outrigger solenoid	Z3

Connector No.	Type	No. of pins	Mounting location	Address
G21	X	2	Boom/outrigger solenoid	K4
G23	X	2	Diode	K4
G24	KESI	2	Suspension lock valve	Z7
G25	X	2	Suspension lock valve	F9
G27	X	2	Low brake pressure switch	J2
G28	SIMPLE CONNECTOR	1	Park brake switch	J1
G29	SIMPLE CONNECTOR	1	Brake light switch	J2
G30		1	Low brake pressure switch	J1
G33	KES1	2	Heated seat	Y9
G35	LUCAS		STD W/lights relay	P1
G36	LUCAS		Lower wiper relay	P4
G41	M	1	Beacon	D7
G47	KES1	2	Diode	Z3
G49	SIMPLE CONNECTOR	1	Refuelling pump	D7
G50		13	Solenoid harness	J9
G51	SIMPLE CONNECTOR	1	Engine room lamp	I9
G52	KES0	4	Lower wiper	F2
G53	HELLA	6	Flasher unit	G2
G54	SIMPLE CONNECTOR	1	Suspension lock switch	F9
G55	SHINIGAWA	5	Horn relay	P6
G62	X	3	Forward/reverse solenoid	K4
G63	X	2	EPC flow	K4
G69	M	2	Lower wiper	Z8
G72	X	2	Service solenoid	M6
G75	X	2	Travel switch	M7
G76	SIMPLE CONNECTOR	1	Sidelight	C6
G77	SIMPLE CONNECTOR	1	Sidelight	H1
G90	SIMPLE CONNECTOR	1	Park brake switch	J3
G91	SIMPLE CONNECTOR	1	Brake light switch	J1
G92	Britax	5	Roadlights switch	T7
G94	AMP	1	Fuseholder	K5
G95	Britax	9	Hazard switch	T7
G96	Britax	6	Suspension lock switch	T7
G98	Britax	6	Outriggers L/R switch	T7
G99	Britax	9	Park brake switch	S7
G100	Britax	2	Worklights pilot	T2
G101	Britax	2	Indicators pilot	T2
G103	Britax	2	Main beam pilot	T1
G104		2	Resistor	R6
G105		2	Diode	S6
G106	M	10	Work equipment interlock	Q6
G130	SIMPLE CONNECTOR	1	Service brake	J1
G131	SIMPLE CONNECTOR	1	Service brake	J1
G135	LUCAS	5	Undercarriage control relay	J2
G136	LUCAS	5	Undercarriage control relay	J2

Con-nector No.	Type	No. of pins	Mounting location	Add-ress
G137	LUCAS	5	Undercarriage control relay	J2
G138	LUCAS	5	Neutral start relay	J2
G139	M	2	Undercarriage control	J2
G150		2	Power outlet socket	K4
G152	LUCAS	5	Undercarriage control diode	J1
G154		2	Outrigger warning	T1
G155	M	1	Park brake buzzer	U8
G157		2	Indicator buzzer	S2
G160	SIMPLE CONNECTOR	1	Suspension lock switch	F9
G163	SIMPLE CONNECTOR	1	Washer tank	E7
G164	X	3	Overload caution sensor	F2
H12	S	16	Intermediate connector	X9
H13	S	16	Intermediate connector	Z8
H14	M	6	Intermediate connector	Z9
H15	L	2	Intermediate connector	W9
M02	X	2	Safety relay	H9
M06	M	4	Heater switch	S9
M11	KES1	2	Fusible link	L6
M12	L	3	Heater	Z1
M14		2	Fusible link	L6
M16	M	1	Horn (high sound)	G2
M17	SIMPLE CONNECTOR	1	Horn	F2
M18		4	Wiper, washer switch	P8
M20	PA		Cigarette lighter	P7
M21	M	9	Radio	P8
M23	M	4	R.H.stand switches	Y1
M24	M	4	LH wrist	Z1
M26	X	6	Heater	Z2
M28		2	Window washer motor	F2
M30		1	Work lights (option)	H3
M34	M	1	Electromagnetic clutch for aircon compressor	K1
M38	M	3	Light switch	P9
M40	M	1	Right working light	E9
M41	M	1	Left working light	D9
M42	KES1	2	Rear working light	I9
M45	40	3	Network bus	P1
M46	M	3	Check	S1
M54	SIMPLE CONNECTOR	1	Boom lamp (LH)	D7
M55	M	2	Beacon switch	R9
M56	M	2	Heated seat switch	T9
M71	SIMPLE CONNECTOR	1	Cab light	R1
M99	M	2	Safety lock switch	X2

Con-nector No.	Type	No. of pins	Mounting location	Add-ress
P01	40	20	Monitor panel	P5
P02	M	16	Monitor panel	P5
P03	M	2	Buzzer cancel switch	Q9
P04	X	2	Alarm buzzer	P6
P05	X	1	Engine oil level sensor	L1
P06	X	1	Fuel level sensor	D9
P07	X	2	Coolant temperature sensor	K4
P08	X	2	Coolant level sensor	L7
P11		1	Air cleaner clogging sensor	K8
P12		1	Air cleaner clogging sensor	K8
R04	SHINIGAWA	5	Light relay	P4
RO5	SHINIGAWA	5	Light relay	P2
S02	X	2	Boom raise oil pressure switch	M6
S03	X	2	Arm out oil pressure switch	M7
S04	X	2	Boom lower oil pressure switch	M7
S05	X	2	Arm in oil pressure switch	L7
S06	X	2	Bucket curl oil pressure switch	L8
S07	X	2	Bucket dump oil pressure switch	M8
S08	X	5	Swing oil pressure switch	M8
S09	X	S	Swing oil pressure switch	M6
S10	X	2	Swing RH switch	L8
S11	X	2	2PB retract switch	L7
S12	X	2	2PB extend switch	M7
S13	X	2	STabiliser down switch	L6
S14	X	2	Stabiliser up switch	L6
S15	X	2	Travel reverse switch	L7
SW01			Swing redundancy switch	Q1
SW02			Pump redundancy switch	Q1
T02			Grd	
T03			GRD (revo frame)	
T05			Grd	
V04	X	2	Swing brake solenoid valve	F9
V05	X	2	2-stage relief solenoid valve	G9
V06	X	2	Travel speed solenoid valve	F9
V07	X	2	Solenoid valve safety	F9
W04	X	6	Wiper motor	P3
W08	M	18	Wiper motor controller	S1
W10	70	4	Rear limit switch	R1
W16	KES0	4	Wiper, indicator switch	R9
X01	MIC	21	Intermediate connector	U9
X05	M	4	Swing lock switch	P8
X07	MIC	17	Intermediate connector	U9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G33
M38
H14
H13
M18
G155
X05
M21
G69
G154
G98
G95
G92
A1
M20
G96
G99
G24
E06
A5
G106
G105
P04
G104
A8
G55
P01
A4
P02
A7
A13
A17
A11
A14
G36
G19
R04
A3
G47
W04
A12
A9
M26
R05
G157
G100
G101
M99
G102
M12
M45
G103
A15
Y
M71
G35
SW02
SW01
W10
W08
M46
C06
C01
C03
C02
C16
M23
A10
A2
M23
M24
KW130P6069
9
8
7
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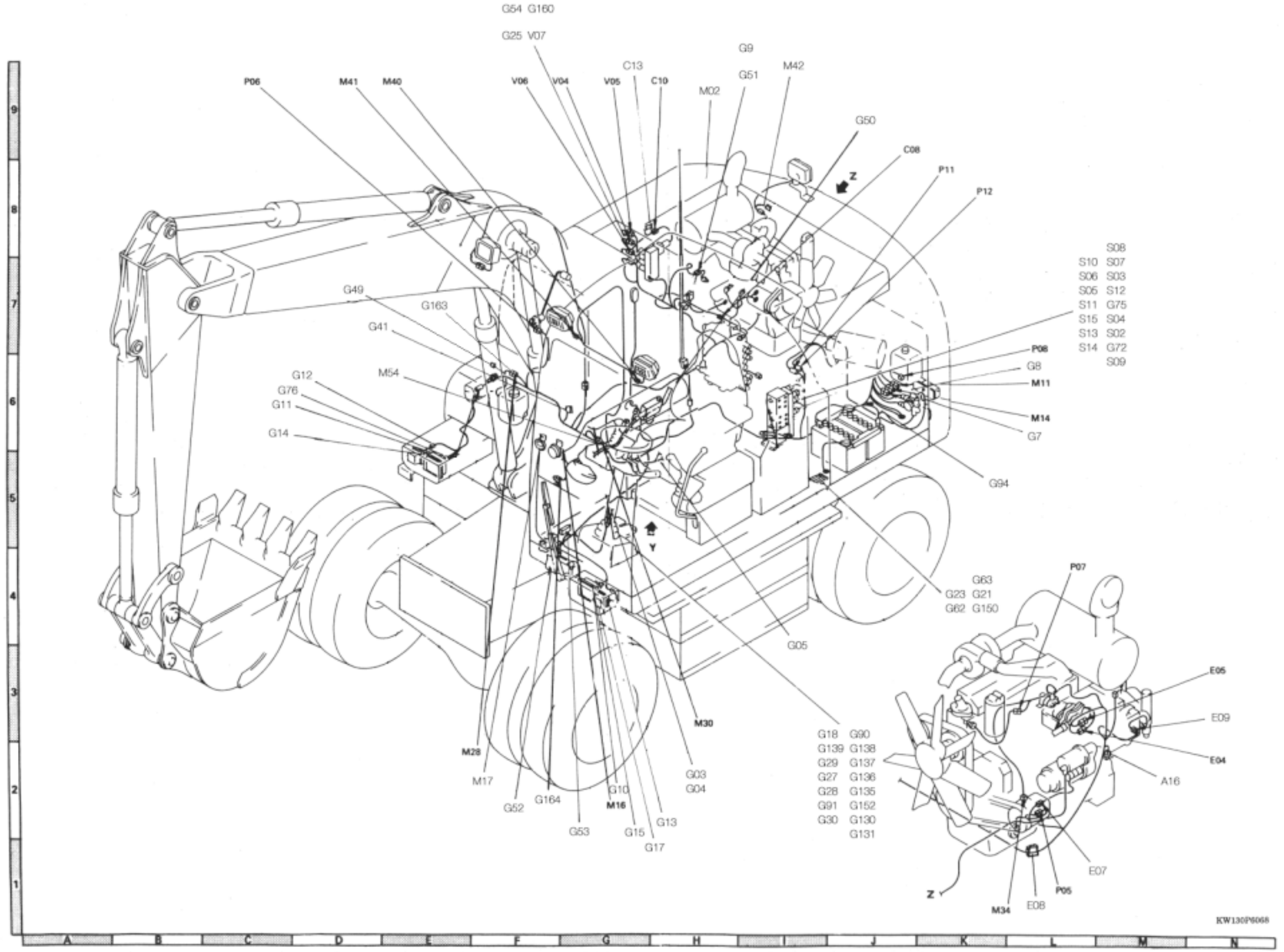
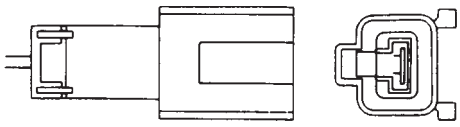
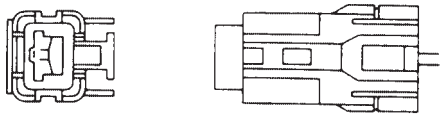
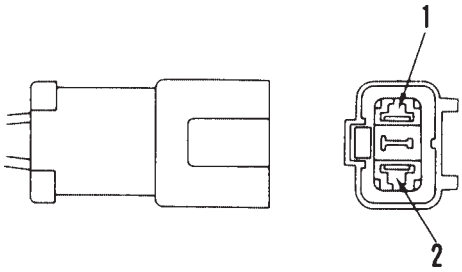
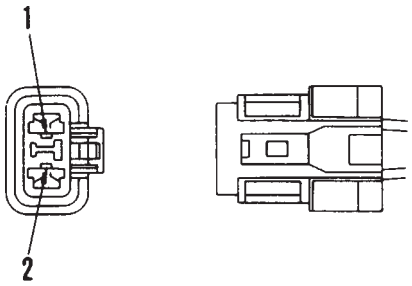
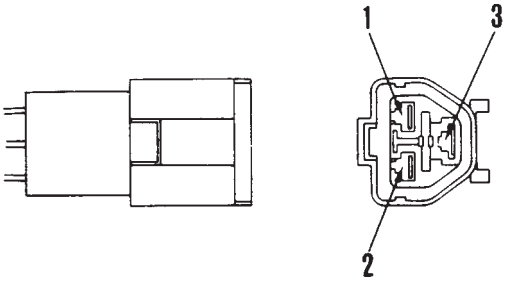
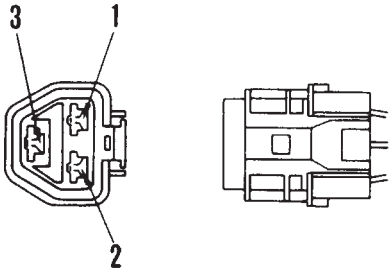
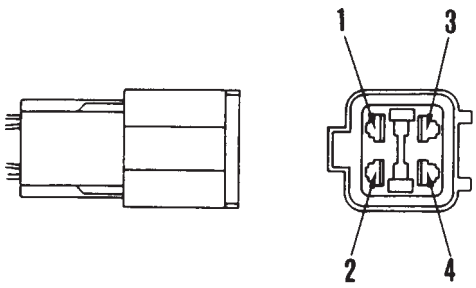
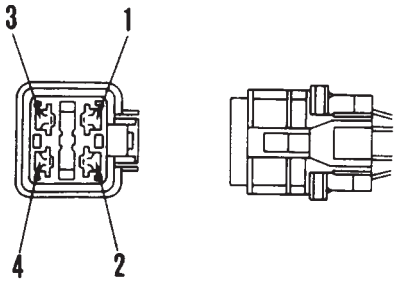
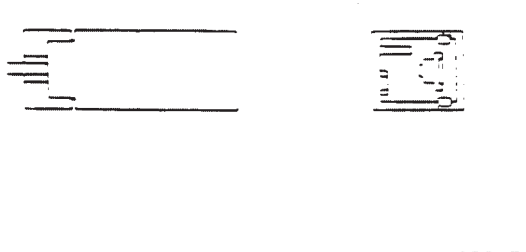
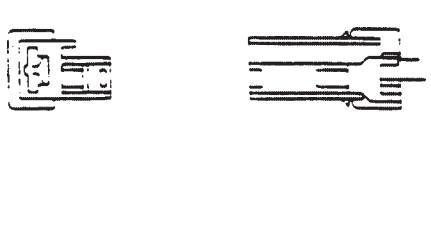
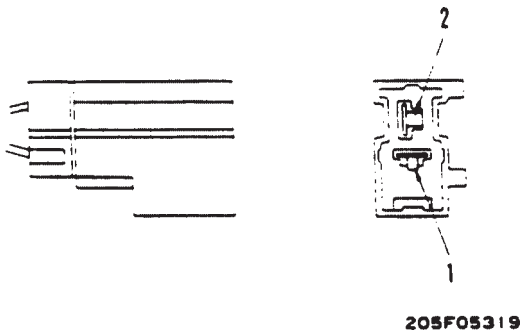
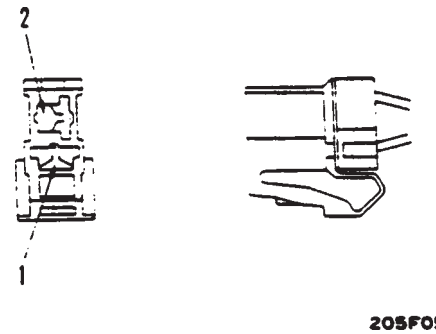
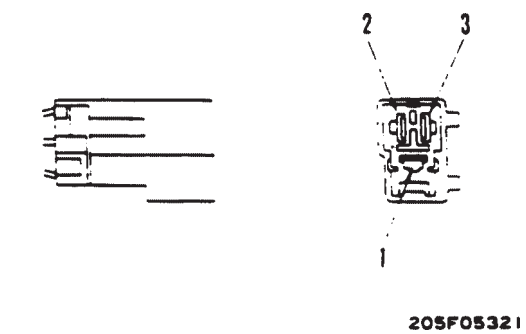
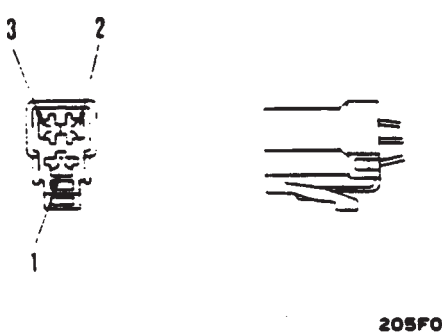
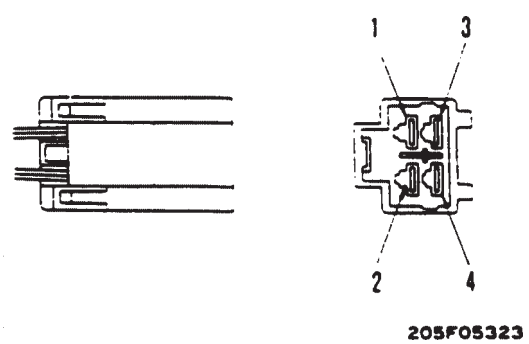
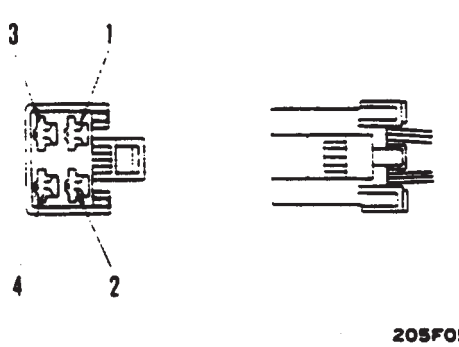
a
b

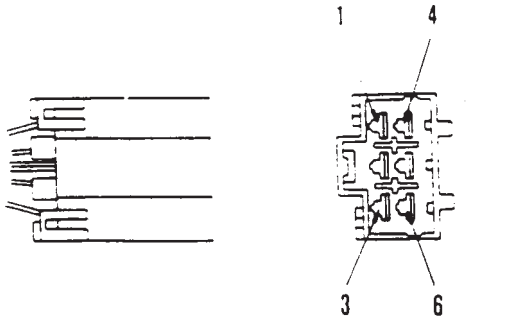
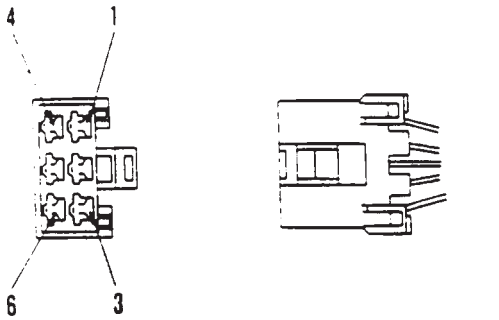

G54 G160
G25 V07
G9
C13
M42
P06
M41
M40
V06
V04
V05
C10
G51
M02
G50
C08
P11
P12
Z
S08
S10 S07
S06 S03
S05 S12
S11 G75
S15 S04
S13 S02
S14 G72
S09
G49
G163
G41
P08
G8
M11
G12
M54
G76
G11
G14
M14
G7
G94
Y
G63
G23 G21
G62 G150
P07
G05
E05
E09
E04
A16
M30
G18 G90
G139 G138
G29 G137
G27 G136
G28 G135
G91 G152
G30 G130
G131
M28
M17
G52
G164
G10
M16
G53
G15
G13
G17
G03
G04
E07
Z
M34
E08
P05
KW130P5068

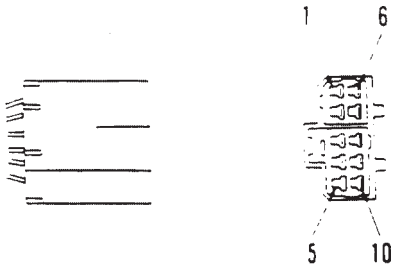
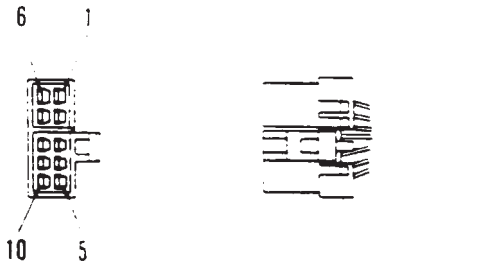
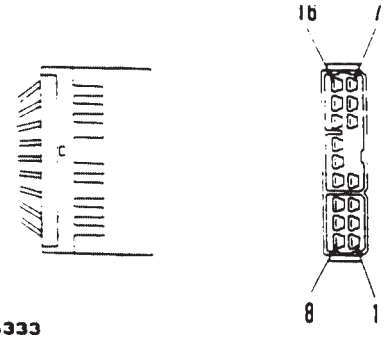
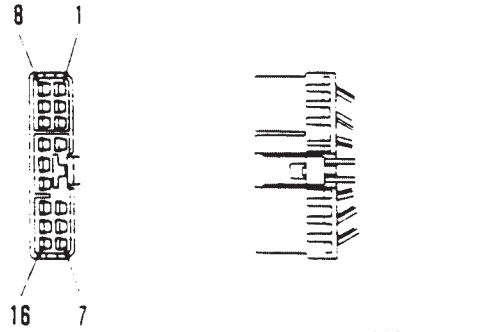
CONNECTION TABLE FOR CONNECTOR PIN NUMBERS

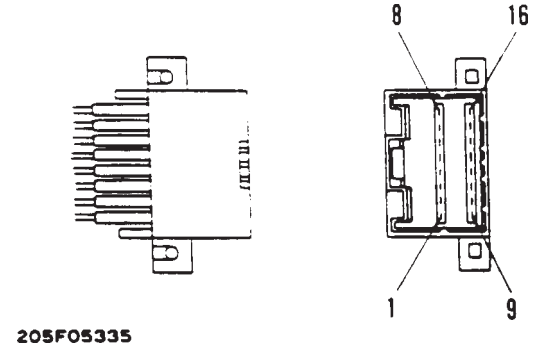
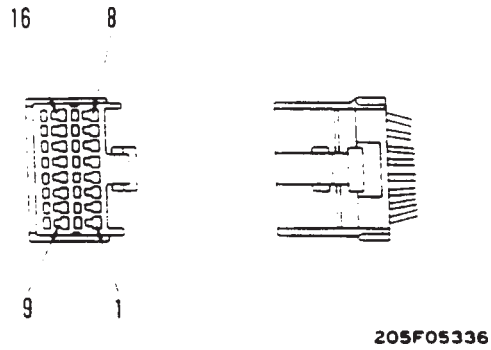
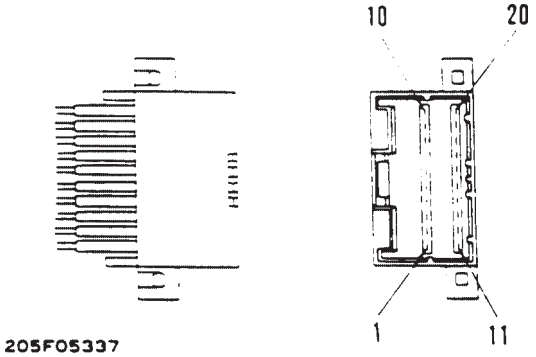
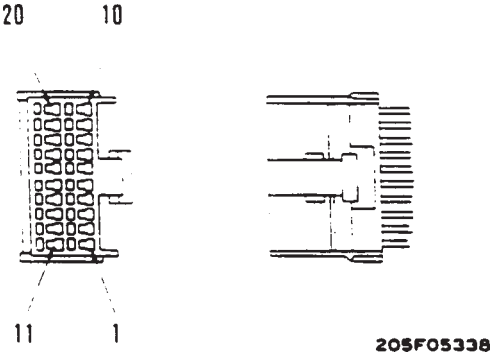
★ The terms male and female refer to the pins, while the terms male housing and female housing refer to the mating portion of the housing.

No. of pins	X type connector	
	Male (female housing)	Female (male housing)
1	 205F05309	 205F05310
2	 205F05311	 205F05312
3	 205F05313	 205F05314
4	 205F05315	 205F05316

No. of pins	M type connector	
	Male (female housing)	Female (male housing)
1	 205F05317	 205F05318
2	 205F05319	 205F05320
3	 205F05321	 205F05322
4	 205F05323	 205F05324

No. of pins	M type connector	
	Male (female housing)	Female (male housing)
6	 205F05325	 205F05326

No. of pins	S type connector	
	Male (female housing)	Female (male housing)
10	 205F05329	 205F05330
16	 205F05333	 205F05334

No. of pins	AMP040 type connector	
	Male (female housing)	Female (male housing)
16	 205F05335	 205F05336
20	 205F05337	 205F05338

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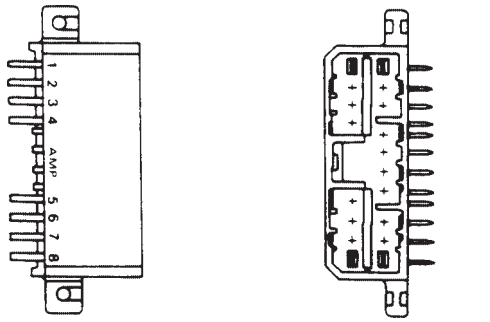
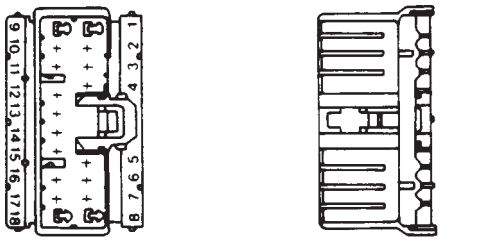
	Male (female housing)	Female (male housing)
18	 205F06366	 205F06367

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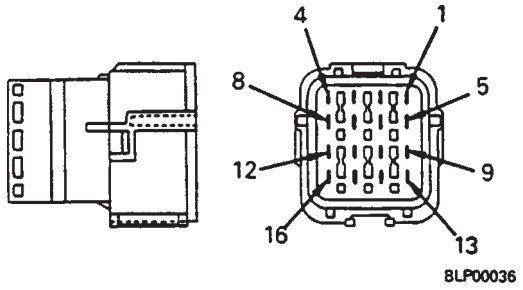
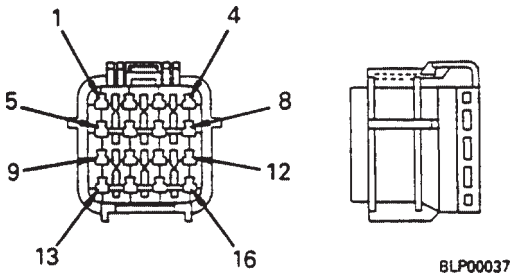
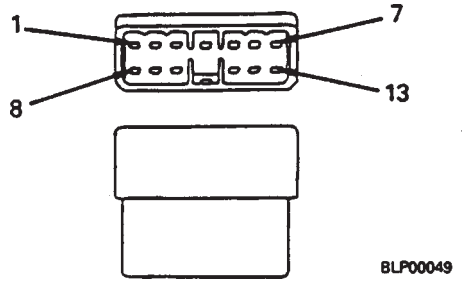
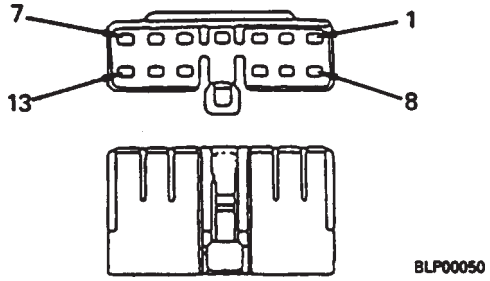
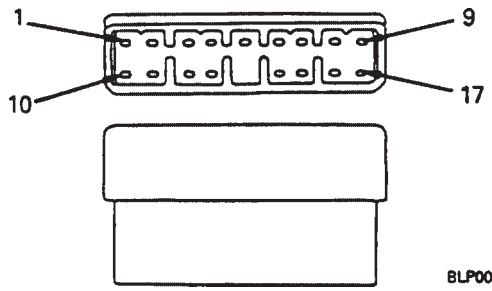
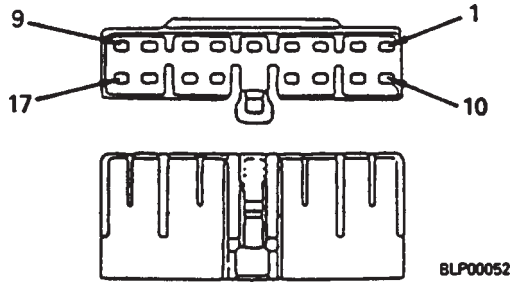
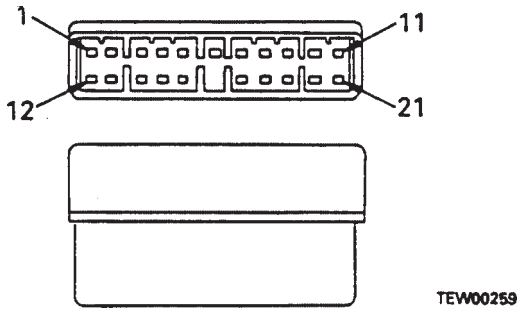
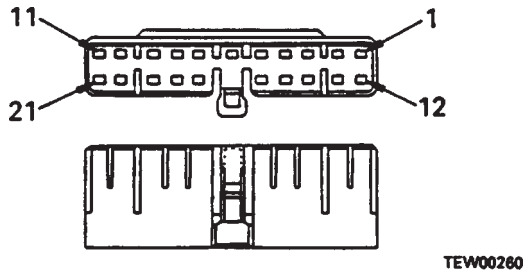
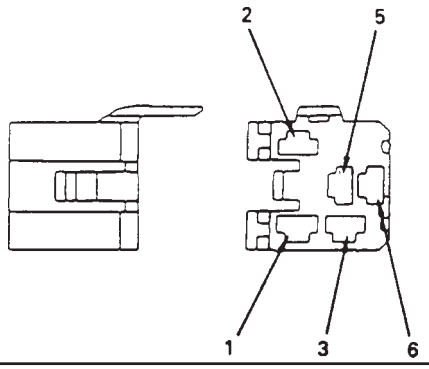
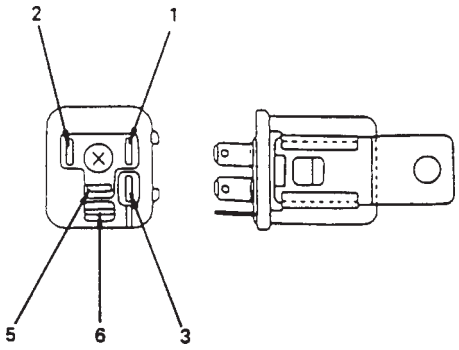
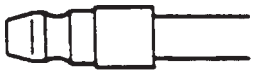
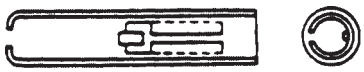
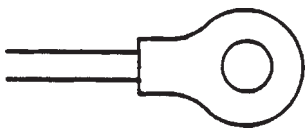
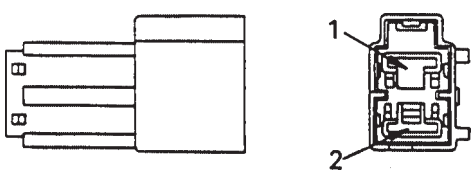
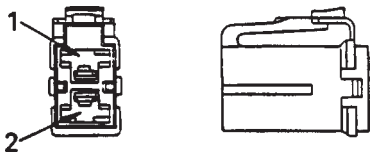
16	 BLP00036	 BLP00037

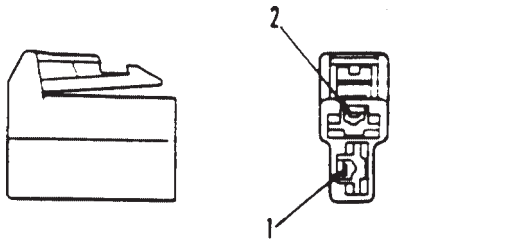
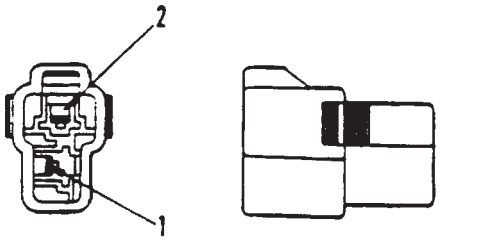
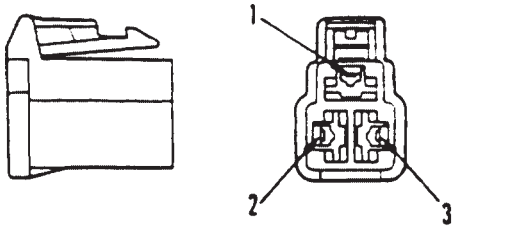
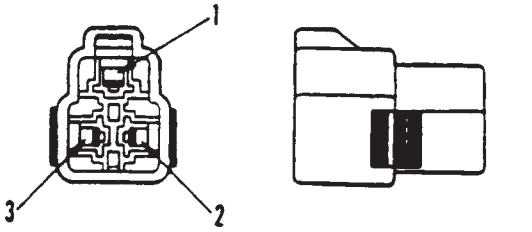
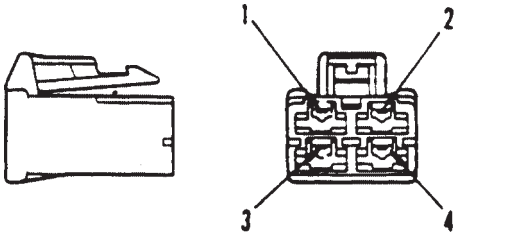
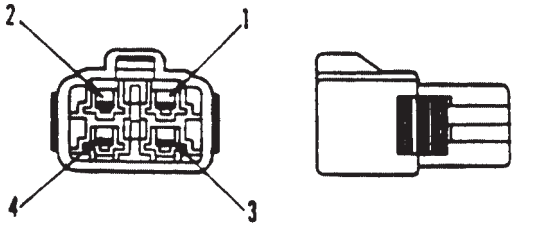
No. of pins	MIC type connector	
	Male (female housing)	Female (male housing)
13		
17		
21		

No. of pins	Relay connector - SHINAGAWA	
	Male (female housing)	Female (male housing)
5		

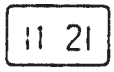
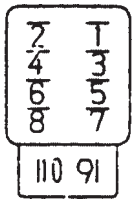
No. of pins	Simple connector	
	Male (male housing)	Female (female housing)
1		

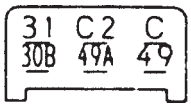
No. of pins	Ring connector
1	

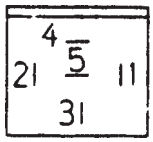
No. of pins	L type connector	
	Male (female housing)	Female (male housing)
2	 TEW00257	 TEW00258

No. of pins	Automobile connector (KES1)	
	Male (female housing)	Female (male housing)
2	 423F349	 423F350
3	 423F351	 423F352
4	 423F353	 423F354

No. of pins	AMP type connectors	
	Male (female housing)	Female (male housing)
3		
7		

No. of pins	BRITAX type connectors	
	Male (female housing)	Female (male housing)
2		
10		

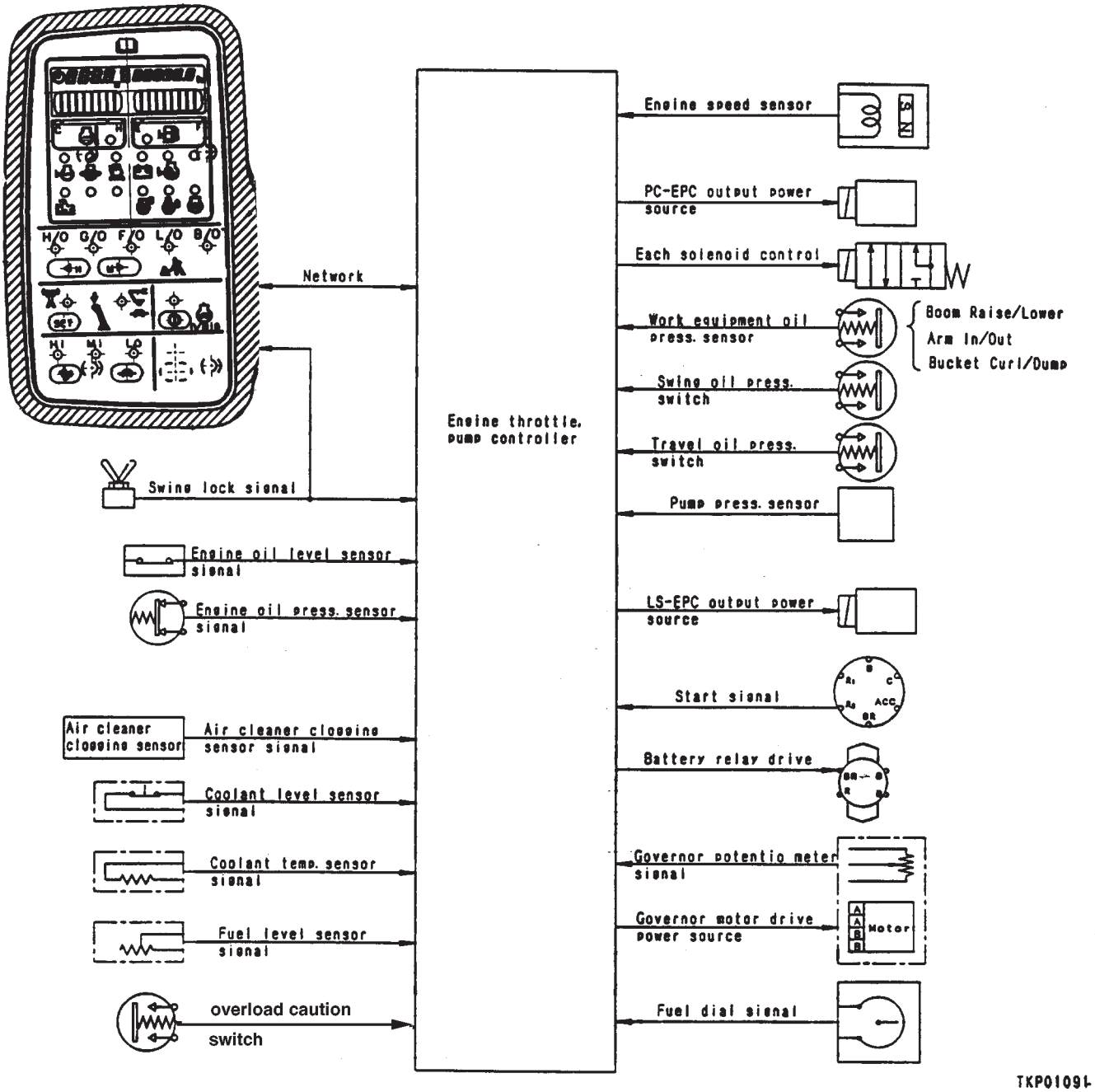
No. of pins	HELLA type connector	
	Male (female housing)	Female (male housing)
6		

No. of pins	Relay connector - LUCAS	
	Male (female housing)	Female (male housing)
5		

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, engine throttle, and pump controller. The monitor panel, engine throttle and pump controller input the signals that are necessary, and together with the signals selected by the monitor panel, engine throttle, and pump controller output or input 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

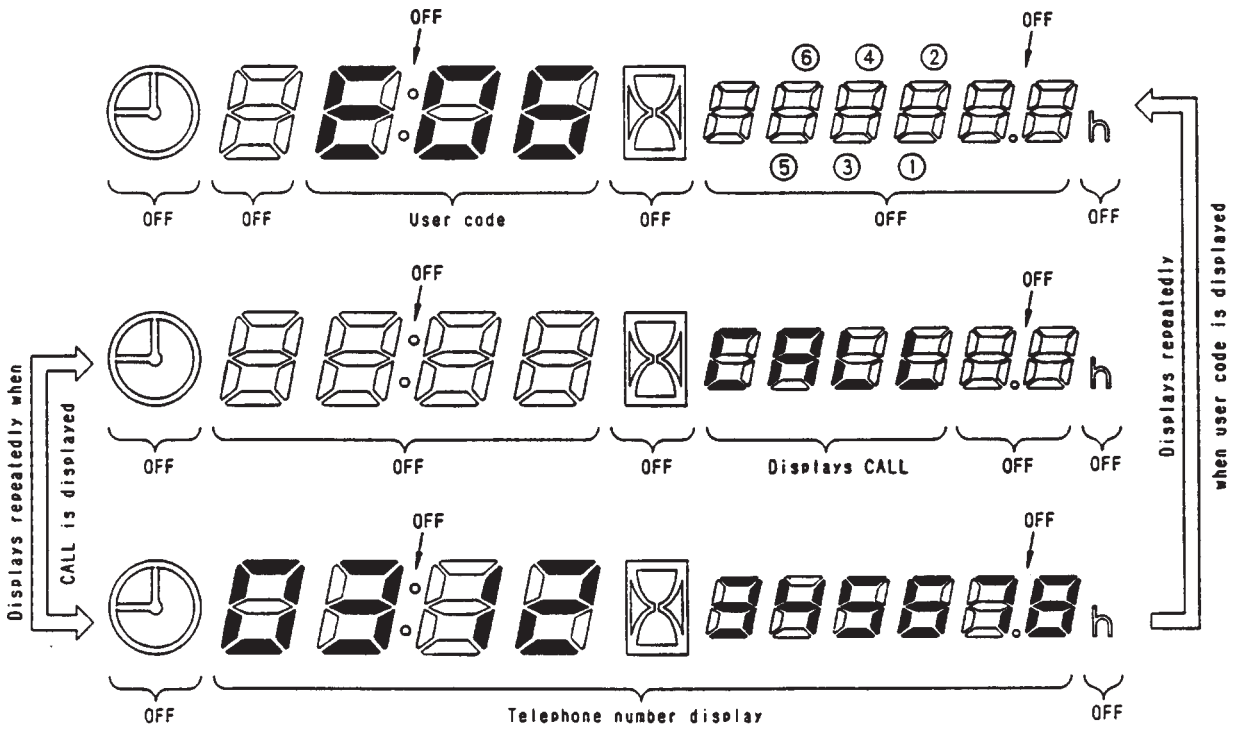
When the starting switch is turned on, all the monitor and gauge lamps light up for approx. 3 seconds, and the buzzer sounds for approx. 1 second. During this time, the monitor itself carries out self diagnosis, and after it has finished, it returns to the normal display.

2. Recording of service codes and user code display function

1) All the abnormality data for the engine throttle 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 the 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, the content of the abnormality is simply recorded, and no display is given.

2) Types of user code and system
E-02 (PC-EPC system)
E-03 (Swing holding brake system)
E-05 (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.

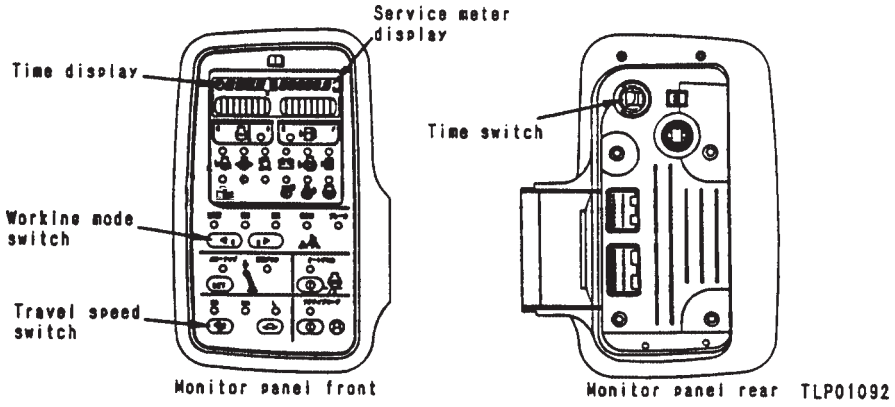
3) Displaying user code
If it becomes necessary to display the user code, the time display panel is automatically switched to advise the operator to take the necessary action.
• Actual display
(Example: Disconnection in the cancel solenoid system for the swing holding brake)



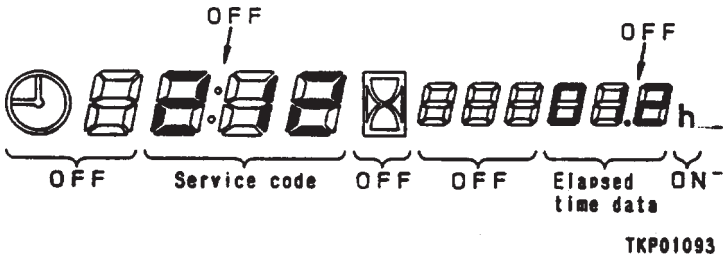
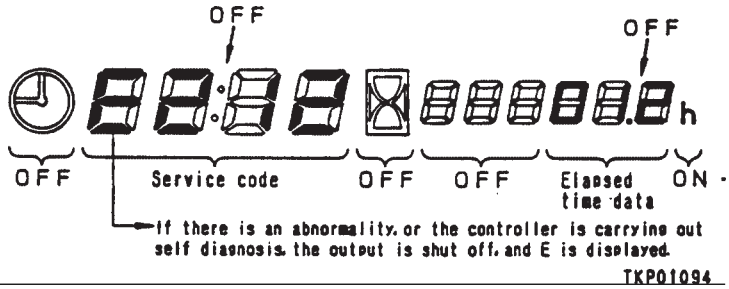
TKP00784

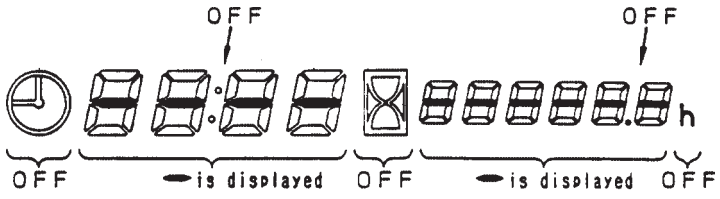
4) Display of trouble data
The monitor panel records both the service codes which are included in the user code and the service codes which are not included. This data can be displayed on the time display as follows.

★ 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.



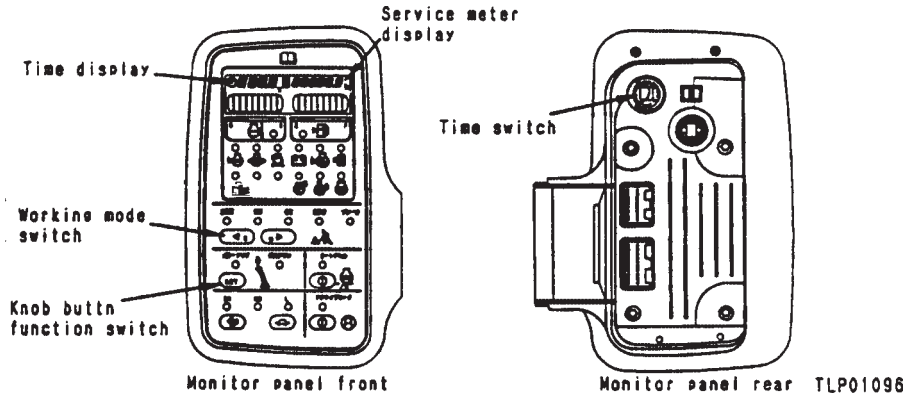
i) Method of displaying trouble data

Operation	Display
1. To set the trouble data display mode, keep the TIMW 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 the next service code display, press the time switch + R.H. working mode switch. 3. To go back the previous service code display, press the time switch + L.H. working	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 (on the service meter) 1) Display of service code 2) Display of elapsed time  TKP01093 3) If any abnomality exists at this time, the E mark is displayed.  TKP01094

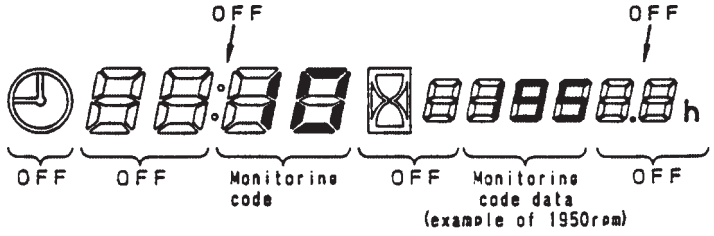
Operation	Display
4. To finish with the trouble data display mode, keep the time switch + L.H. travel speed switch pressed for 2.5 seconds. 5. To erase the memory, press the time switch, turn the starting switch from OFF to ON, and keep the time switch pressed for 5 seconds.	4) If there is no abnormality code in memory  TKP01095

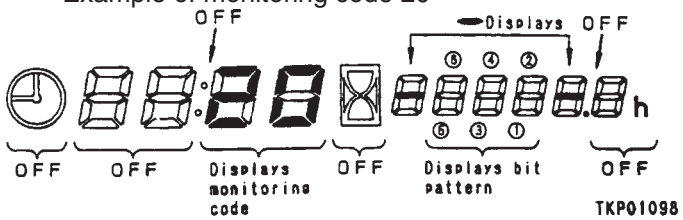
3. Machine data monitoring function

The input signals from the sensors and the output signals to drive the solenoid are displayed on the time display and service meter display.



1) Method of displaying monitoring code

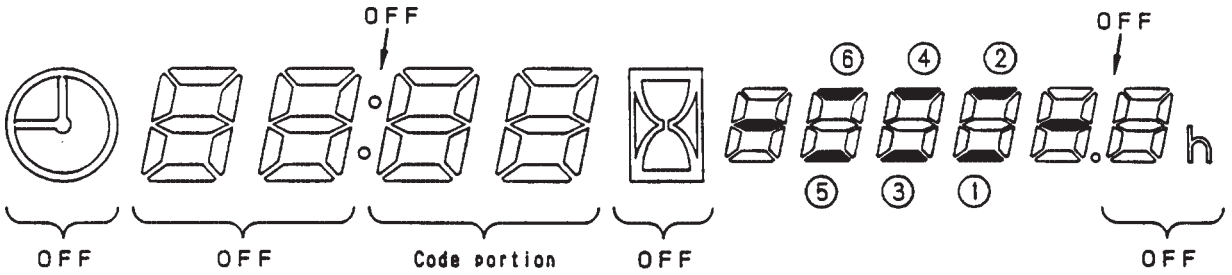
Operation	Display
1. To set to the machine data monitoring mode, keep the time switch + knob button function switch pressed for 2.5 seconds. Note: This is possible at the following times. 1) During the normal mode 2) During the user code display mode 3) During the time adjustment mode 4) During the trouble 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)  TKP01097

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	Engine throttle, pump controller model code	-	Engine throttle, pump controller
03	Engine throttle, pump controller model code	-	Engine throttle, pump controller
08	S-NET component condition display	B	Engine throttle, pump controller, etc.
10	Engine speed	10 rpm	
11	Pump discharge pressure input	MPa {kg/cm^2}	Engine throttle, pump controller
13	PC-EPC electric current output	10 mA	Engine throttle, pump controller
15	LS-EPC electric current output	10 mA	Engine throttle, pump controller
16	No. 2 throttle command Engine throttle, pump controller	rpm	
20	Input signal (1) for engine throttle, pump controller PPC oil pressure switch	B	Engine throttle, pump controller
21	Input signal (2) for engine throttle, pump controller PPC oil pressure switch	B	Engine throttle, pump controller
22	Input signal (3) for engine throttle, pump controller PPC oil pressure switch	B	Engine throttle, pump controller
23	Engine throttle, pump controller solenoid actuation	B	Engine throttle, pump controller
24	Input condition 1 of sensor for engine throttle, pump controller monitor warning	B	Engine throttle, pump controller
25	Input condition 2 of sensor for engine throttle, pump controller monitor warning	B	Engine throttle, pump controller
30	Fuel control dial input value	10 mV	Engine throttle, pump controller
31	Input value for governor motor feedback potentiometer	10 mV	Engine throttle, pump controller
32	VBB voltage (battery voltage)	100 mV	Engine throttle, pump controller
33	Governor motor A phase current	10 mV	Engine throttle, pump controller
34	Governor motor B phase current	100 mV	Engine throttle, pump controller
35	Battery relay output voltage	100 mV	Engine throttle, pump controller
36	Input condition of engine throttle, pump controller	B	Engine throttle, pump controller
37	Output condition of engine throttle, pump controller	B	Engine throttle, pump controller
40	Engine speed	10 rpm	Engine throttle, pump controller
41	Coolant temperature sensor voltage	10 mV	Engine throttle, pump controller
42	Fuel sensor input voltage	10 mV	Engine throttle, pump controller
43	Battery charge input voltage	100 mV	Engine throttle, pump controller
47	Monitor panel output condition 1	B	Monitor panel
48	Monitor panel input condition 1	B	Monitor panel
49	Monitor panel input condition 2	B	Monitor panel
4A	Monitor panel input condition 3	B	Monitor panel
4C	Monitor panel input condition 4	B	Monitor panel

3) Bit pattern chart
As shown in the diagram below, the time display has bit numbers which light up to show that the signal is being transmitted. (For details, see Method of displaying monitoring code.)



TKP01099

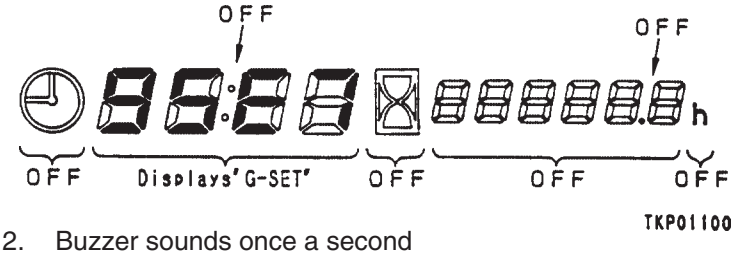
Code	Content	Bit	Details (condition when lighted up)	
08	Connection of S-NET components	①	Engine throttle, pump controller connected (ID=2)	
		②	Engine throttle, pump controller connected (ID=3)	
		③		
		④		
		⑤		
		⑥		
20	Input condition of engine throttle, pump controller PPC switches	①	Swing switch ON	
		②	Travel switch ON	
		③	Boom LOWER switch ON	
		④	Boom RAISE switch ON	
		⑤	Arm IN switch ON	
		⑥	Arm OUT switch ON	
21	Input condition of engine throttle, 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 engine throttle, pump controller model selection and other switches	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	Drive condition of engine throttle, pump controller ON/OFF solenoid valves	① ② ③ ④ ⑤ ⑥	 Swing holding brake solenoid ON 2-stage relief solenoid ON Travel speed selector solenoid ON
24	Input condition 1 of sensor for engine throttle, pump controller monitor warning	① ② ③ ④ ⑤ ⑥	Engine oil pressure sensor normal (above set pressure) Radiator water level sensor abnormal Engine oil level sensor abnormal Air cleaner clogging sensor abnormal
25	Input condition 2 of sensor for engine throttle, pump controller monitor warning	① ② ③ ④ ⑤ ⑥	
36	Output condition of engine throttle, pump controller	① ② ③ ④ ⑤ ⑥	 Starting switch ON
37	Output condition of engine throttle, pump controller	① ② ③ ④ ⑤ ⑥	Battery relay Actuated
47	Monitor panel output condition 1	① ② ③ ④ ⑤ ⑥	 Alarm buzzer Actuated Wiper motor drive (R) Actuated Wiper motor drive (L) Actuated Window washer drive Actuated

Code	Content	Bit	Details (condition when lighted up)	
48	Monitor panel input condition 1	①	Wiper (on)	OFF
		②	Wiper (INT)	OFF
		③	Wiper (WASHER)	OFF
		④	Window limit switch	Open
		⑤	Limit switch (P)	Open
		⑥	Limit switch (W)	Open
49	Monitor panel input condition 2	①	KEY ON SWITCH	OFF
		②	Terminal BR	Voltage Hi
		③	LIGHT SWITCH	OFF
		④	Preheating switch	OFF
		⑤	START C	Sometimes turns ON
		⑥	Monitor panel LED lighting output	OFF
4A	Monitor panel input condition 3	①	Time switch	OFF
		②	PPC oil pressure selector switch	OFF
		③	Overload selector switch	OFF
		④	STD/DLX selection	When STD
		⑤	Swing lock switch	OFF
		⑥	Buzzer cancel switch	OFF
4C	Monitor panel input condition 4	①		
		②	Wiper motor normal rotation relay output	When there is abnormality in specified voltage
		③	Wiper motor reverse rotation relay output	When there is abnormality in specified voltage
		④	Window washer motor drive output	When there is abnormality in specified voltage
		⑤		
		⑥		

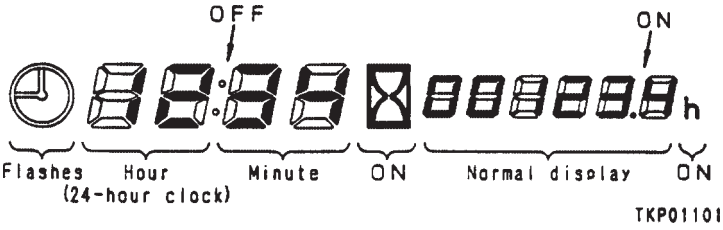
4. Governor motor adjustment mode

This is used when adjusting the linkage between the governor motor and the injection pump. (For details of the procedures, see TESTING AND ADJUSTING.)

Operation	Display
1. To set to the governor motor adjustment mode, keep the time switch + R.H. travel speed switch + R.H. working mode switch pressed for 2.5 seconds.	1.  TKP01100
2. To return to the time display mode use the same procedure as in Step 1.	2. Buzzer sounds once a second

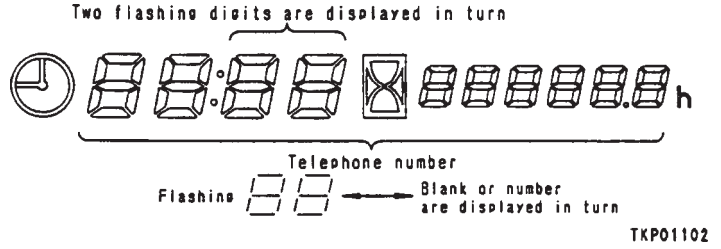
5. Time adjustment mode

To adjust the time, do as follows.

Operation	Display
1. To set to the time adjustment mode, keep the time switch pressed 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  TKP01101 ※ The example shows the situation when setting to 12:34.

6. Telephone number input

To input telephone numbers, do as follows.

Operation	Display
1. To set to the telephone number input mode, keep the time switch + auto-deceleration switch pressed for 2.5 seconds. 2. When the time switch + L.H. working mode switch are pressed, the display moves 2 digits at a time to the left, and when the R.H. working mode switch is pressed, the display moves 2 digits at a time to the right. The 2 digits at the new location flash.	1. The time mark portion flashes  TKP01102

Operation	Display
3. When the time switch + R.H. travel speed switch are pressed, the flashing number on the right changes [0] - [9] - [blank] - [0], and when the time switch + L.H. travel speed switch are pressed, the flashing number on the left changes in the same way. 4. After inputting the telephone number, keep the time switch + autodeceleration switch pressed for 2.5 seconds. This returns to the time mode (normal mode) and saves the telephone number.	

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 engine throttle - 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.

JUDGEMENT TABLE FOR ENGINE THROTTLE, PUMP CONTROLLER (GOVERNOR CONTROL SYSTEM), AND ENGINE RELATED PARTS

	Failure mode	User code	E06																		
		Service code	308	317	318	306	315	316	38	16	30	31	33	34	41	102°C or above	105°C or above	Does starting motor turn?	Troubleshooting code if no service code display is given
1	Engine does not start easily																		S-1
2	Engine does not start																	○	S-2
3	Engine speed stays at low idling, and does not follow accelerator or engine picks up poor		●	●	●	●	●				*	*	*	*			○		S-3
4	Engine stops during operation																		S-4
5	Engine rotation is irregular	When idling speed is irregular																	E-Ser. S-5
		When there is hunting		●	●	●	●		●			*							E-Ser. S-5
6	Lack of output (engine high idling speed is too low)			●			●				*	*			○				E-10, S-6
7	Auto-decelerator does not work																		E-3, E-3
8	Engine does not stop		●		●	●	●	●	○				*	*					E-11
9	Warming-up operation is defective														○		○		E-3, E-4
10	Exhaust gas is black																		S-7
11	Oil consumption is excessive, or exhaust gas is blue																		S-8
12	Oil becomes dirty prematurely																		S-9
13	Fuel consumption is excessive, or exhaust gas is blue																		S-10
14	Oil is mixed in coolant																		S-11
15	Oil pressure lamp lights up																		S-12
16	Oil level rises																		S-13
17	Coolant temperature rises too high														○	○			S-14
18	Abnormal noise is generated																		S-15
19	There is excessive vibration																		S-16
20	Engine speed does not change even when watching mode is switched										*								E-3, E-4
21	Troubleshooting code when service code is displayed		E-1	E-2	E-3	E-4	E-5	E-6	E-7	—	—	—	—	—	—	—	—	—	
22	Troubleshooting code when there is abnormality in monitoring or machine monitor check		—	—	—	—	—	—	E-12	—	—	—	—	—	—	M-4/M-13/M-18	E-8		

○: 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

[Judgement]

1) If a service code is being displayed on the monitor panel ..... go to troubleshooting [E3:○○] for the engine throttle - 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

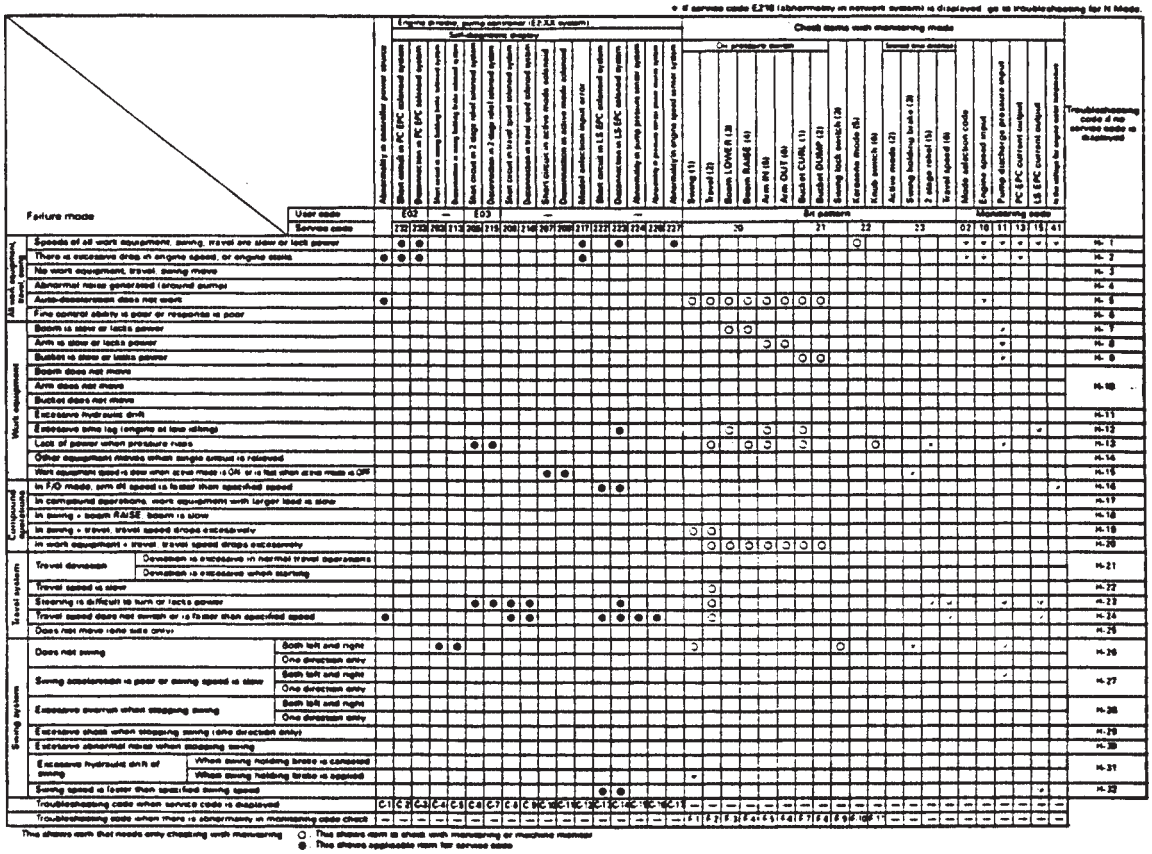
2. When using judgement table for engine throttle - pump controller (governor control system) and hydraulic related parts

- If a service code is displayed on the monitor panel, go to the troubleshooting code at the 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 O 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 TABLE FOR PUMP CONTROLLER AND HYDRAULIC RELATED PARTS



[Judgment]

1) If a service code is being displayed on the monitor panel .... go to troubleshooting [E2:○○) for the engine throttle - pump controller (pump control system).
2) If no service code is displayed on the monitor panel, and the upper structure does not swing:

- Check engine throttle - 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 engine throttle - 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
C-○○	Troubleshooting of engine throttle, pump controller (Pump control system)	E2-○○ system
E-○○	Troubleshooting of engine throttle, pump controller (Governor control system)	E3-○○ system
F-○○	Troubleshooting of engine throttle, [Input single system]	-
H-○○	Troubleshooting of hydraulic, mechanical system	-
M-○○	Troubleshooting of machine monitor panel system	E1-○○ system
N-○○	Troubleshooting of communications system	E218 system
S-○○	Troubleshooting of engine system	-

2. Method of using troubleshooting table for each troubleshooting mode

(1) Troubleshooting code number and problem (for (1) - (4), see the examples on the next page.)
The title at the top of the troubleshooting chart gives the troubleshooting code and failure mode (problem with the machine).

(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.
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.
- Below the □ there are the methods 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 is 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 method of operation or handling is mistaken, there is danger that is 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 ★.
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. When carrying out troubleshooting, see this chart for details of the location for inspection and measurement of the wiring connector CNOO appearing in the troubleshooting flow chart for each failure mode (problem).

<Example>

(1) M-9 When starting switch is turned ON (engine stops), basis check items flash

(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.

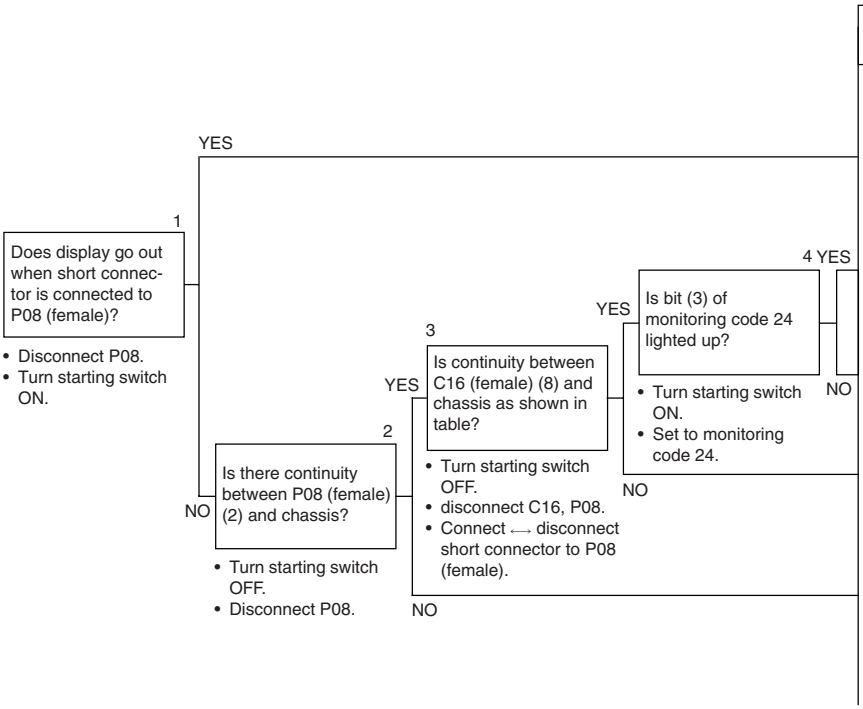
(2) a) 

(coolant level) flashes
★ Check that the coolant level is correct before carrying out troubleshooting.

b) 

(engine oil level) flashes
★ Check that the engine oil level is correct before carrying out troubleshooting.

(3)



Cause	Remedy
Defective coolant level sensor system (see M-26)	-
Defective governor, pump controller	Replace
Defective monitor panel	Replace
Defective contact, or disconnection in wiring harness between C16 (female) (8) -P08 (female) (1)	Repair or replace
Defective contact, or disconnection in wiring harness between P08 (female) (2) - chassis ground	Repair or replace

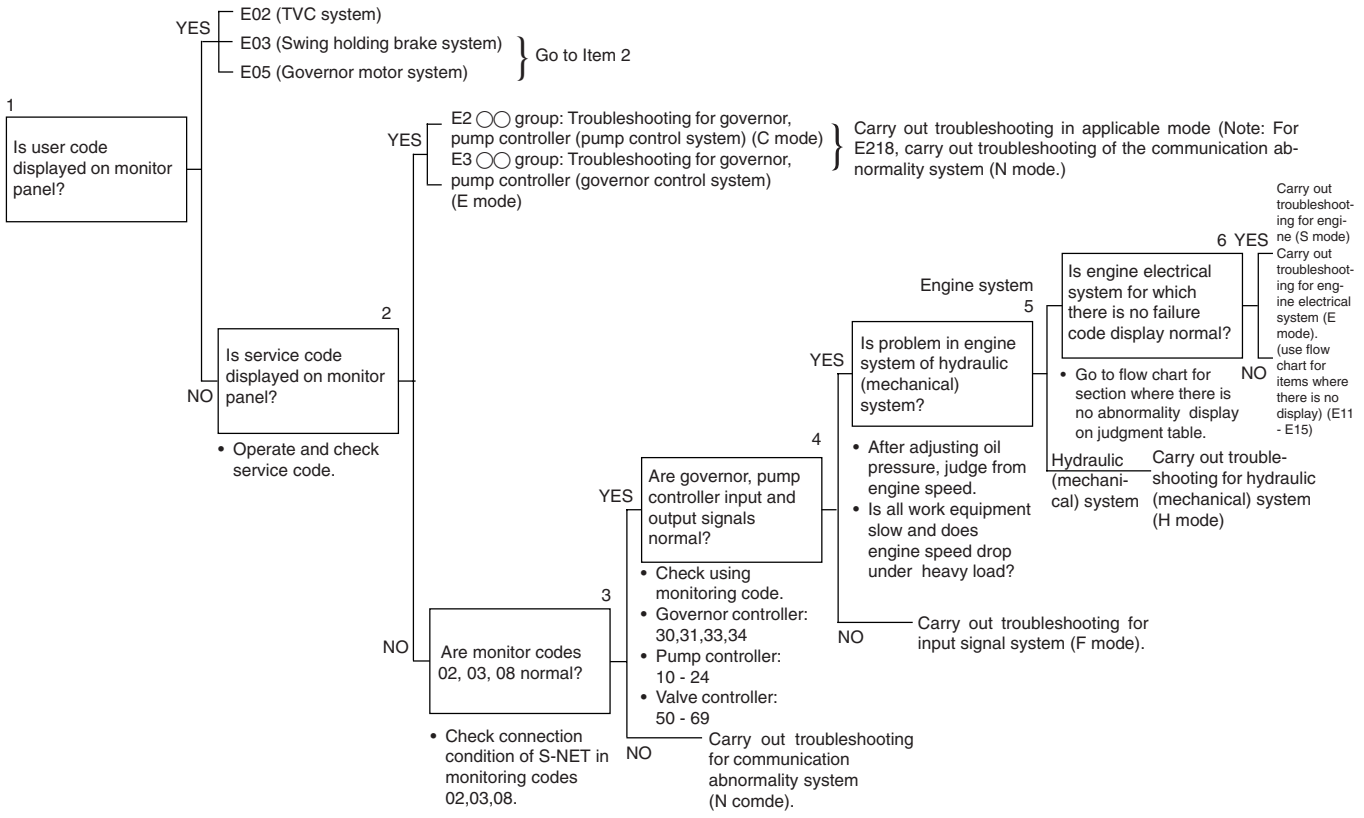
Table

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 (engine throttle - pump controller (governor control system) and engine throttle - pump controller (pump control system). For details of the troubleshooting and troubleshooting procedure, refer to this flow chart.
When carrying out troubleshooting procedure, 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) Blow 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 engine throttle - 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	-	-	-
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. Connection 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.
      ★ Engine throttle - pump controller (pump control system) (1) and engine throttle - 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.

Working mode	Operation	Enginge speed (high idling) [The figures in ( ) are the rated speed] (rpm)
H/O	Work equipment	Approx. 2100 (1900)
	Travel	Approx. 2450 (2250)
G/O, F/O	Work equipment	Approx. 1950 (1760)
	Travel	Approx. 1950 (1760)
L/O	Work equipment	Approx. 1600 (1450)
	Travel	Approx. 1600 (1450)
B/O	Work equipment	Approx. 1800 (1580)
	Travel	Approx. 1800 (1580)

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 and run the engine at 1500 rpm or above.
      Check that bit (6) lights up when traveling at Hi or Mi (pump oil pressure: 17.7 - 23.5 MPa {180 - 240 kg/cm^2}

2. Checking input signal of engine throttle - 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 code 11.

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: 800 ± 80 mA
      Engine at high idling, any lever operated (other than travel): 0 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
Swing holding brake	Swing or work equipment lever operated	(3)
2 stage relief	Travel lever operated	(5)
Travel speed selector	Travel speed selector switch Mi or Lo	(6)

★ Operate the lever slightly not enough to move the machine.

   4) Check PC-EPC solenoid output current
      i) Set to the monitoring mode, and display monitoring codes 13 and 14.
      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 and auto-decel is OFF.
      • Current with starting switch ON (G/O mode) and fuel control dial at MAX: 650 ± 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 - 4.2 V (auto-decel at OFF)

  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 and code 34 is the B phase
        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 24 V wiring harness for buzzer drive	-
E104	Air cleaner clogging detected	-
E106	Abnormality in engine oil pressure sensor (Hi) detected	-
E108	Water temperature over 1050C detected	-
E112	Short circuit in wiper motor drive normal rotation system	-
E113	Short circuit in wiper motor drive reverse rotation system	-
E114	Short circuit in window washer drive system	-
E201	Short circuit in LS bypass solenoid system	-
E203	Short circuit in swing holding brake solenoid system	E03
E205	Short circuit in 2-stage relief solenoid system	-
E206	Short circuit in travel speed solenoid system	-
E213	Disconnection in swing holding brake solenoid system	-
E215	Disconnection in 2 stage relief solenoid system	-
E216	Disconnection in travel speed solenoid system	E03
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 pump pressure sensor system	-
E226	Abnormality in pressure sensor system power source	-
E227	Abnormality in engine speed sensor	-
E232	Short circuit in pump PC-EPC solenoid system	-
E233	Disconnection in pump PC-EPC solenoid system	-
E306	Abnormality in feedback potentiometer system	E02
E308	Abnormality in fuel control dial input value	-
E313	Automatic greasing controller error (option)	E05
E315	Short circuit in battery relay output system	-
E316	Step-out governor motor	-
E317	Disconnection in governor motor system	E05
E318	Short circuit in governor motor system	E05

TROUBLESHOOTING OF COMMUNICATIONS SYSTEM (N MODE)

N-1 Communications 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 to the next step.

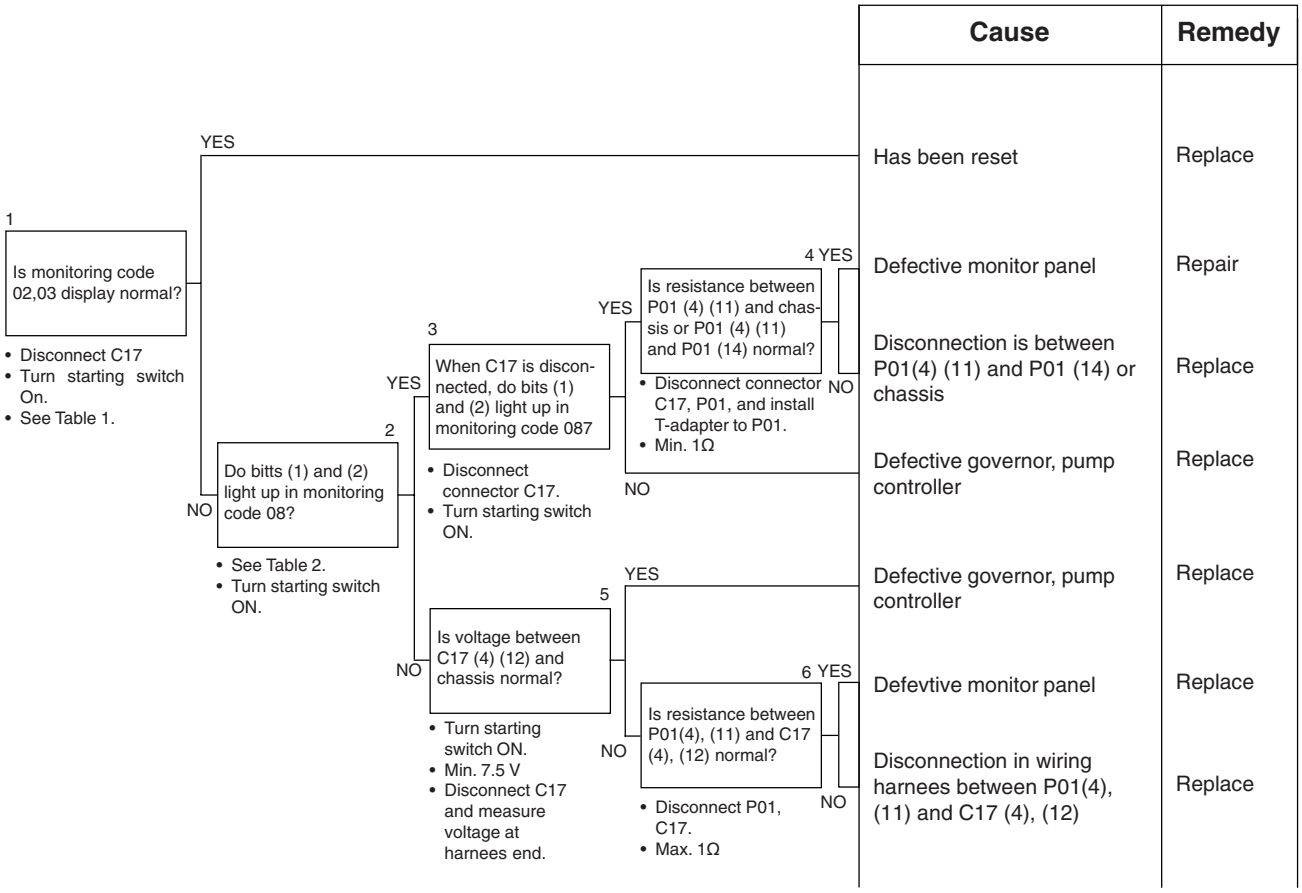


Table 1

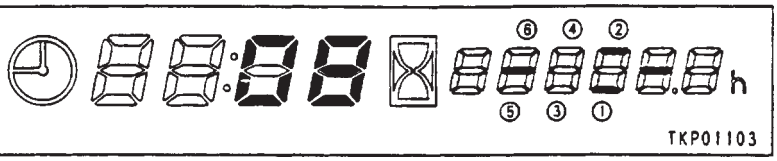
Monitoring code		Display
01	Monitor panel mode code	150
02	Engine throttle, pump controller model code	130
03	Engine throttle, pump controller model code	130

- When the controllers are not connected to the network, "..." is displayed. If the correct alphanumerics are not displayed (or another model is displayed), the controllers show abnormal model selection.

Table 2

Table 2

Monitor code \ Display	
08	Network when connected

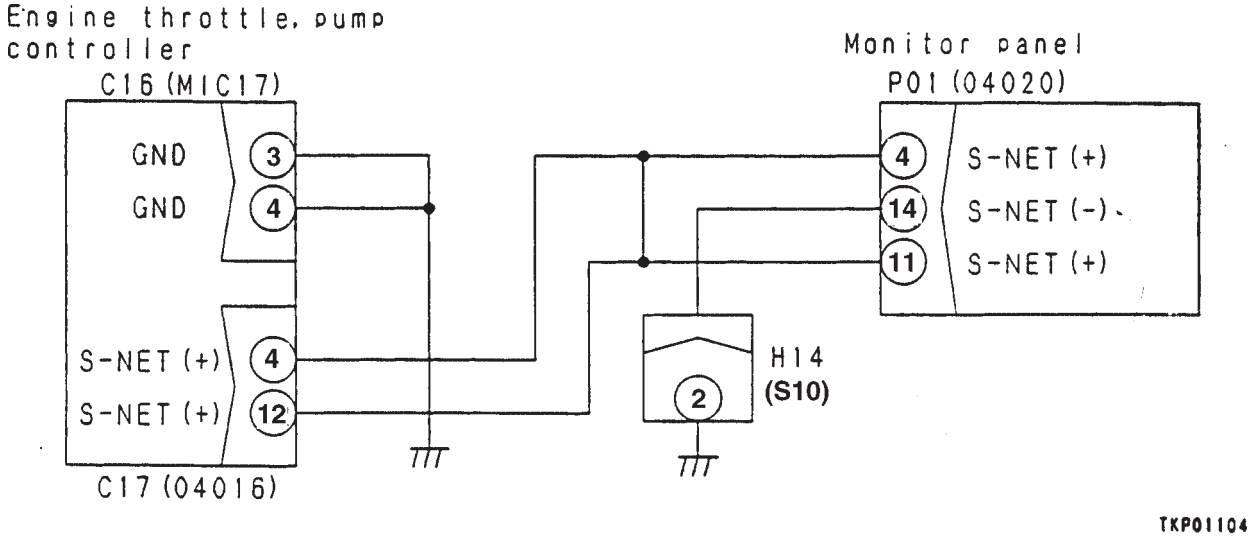


- Light up when connected

(1) Engine throttle, pump controller
(2) Engine throttle, pump controller

- Note: Checks can be carried out with code 08 only when there is a disconnection in the network. 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 electrical circuit diagram



TROUBLESHOOTING OF ENGINE TRHOTTLE, PUMP CONTROLLER [GOVERNOR CONTROL SYSTEM] (E MODE)

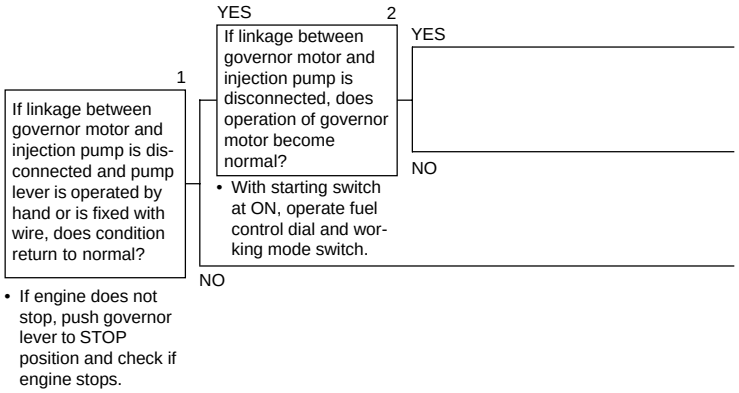
POINTS TO REMEMBER WHEN CARRYING OUT TROUBLESHOOTING OF ENGINE THROTTLE, PUMP CONTROLLER (GOVERNOR CONTROL SYSTEM)

1. Points to remember when there is abnormality which is not displayed by user code

The engine is controlled by an engine throttle, 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 to 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 displayed on the time display portion of the monitor panel, use the troubleshooting table to determine the appropriate troubleshooting flow chart from E1 to E10. 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 listed above has occurred, carry out troubleshooting as follows.



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 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 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 memory retention function

When displaying the abnormality code in memory and carrying out troubleshooting, not 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	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 harnesses between C02 (2) - E05 (1), and between C02 (4) - E05 (3) short circuiting with wiring harness between C02 (5) - E05 (2) 3. Wiring harnesses 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>E03 (male)</th><th>E06 (female)</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 - 3 kΩ</td></tr>
<tr><td>-</td><td>(1) - (3)</td><td>2 - 3 kΩ</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>E01 (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>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>E01 (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) Sets 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), (1) - (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 order to stop engine
-	E316	Abnormality (step-out) in motor	1. Defective adjustment of rod or twisting of loose spring 2. Abnormality in governor motor 3. Abnormality in engine throttle, 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>E05 (male)</th><th>E01 (female)</th><th>Resistance value</th></tr>
<tr><td>(7) - (4)</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 - 3 kΩ</td></tr>
<tr><td>-</td><td>(1) - (3)</td><td>4 - 6 kΩ</td></tr>
<tr><td>Between each pin and chassis</td><td>-</td><td>Min. 1 MΩ</td></tr>
</table>
</td><td>Calculated 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 change to high idling speed (a little too low)
2) Engine does not change to low idling speed (a little too high)
3) Defective engine speed for auto-deceleration or automatic warming-up
4) Engine may not stop
★ The governor motor moves in the direction to stop the engine, but motor may not move completely to the position to stop the engine.
5) There are cases of hunting</td></tr>
<tr><td>Between C0(3) (1) and chassis:
20 - 30 V

★ Hold with the motor in the stop position for 2 - 2.5 sec, return to the low idling position, then turn 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
★ Start again (repeat 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 ENGINE THROTTLE, PUMP CONTROLLER (GOVERNOR CONTROL SYSTEM), AND ENGINE RELATED PARTS

	Failure mode		Abnormality in engine throttle, pump controller power source system	Engine throttle, 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	Oil pressure lamp lights up								
16	Oil level rises								
17	Coolant temperature rises too high								
18	Abnormal noise is generated								
19	There is excessive vibration								
20	Engine speed does not change even when working mode is switched								
21	Troubleshooting code when service code is displayed		E-1	E-2	E-3	E-4	E-5	E-6	E-7
22	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

hecking monitoring, check items							Machine monitor check item			
							Is red 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-3
○				※	※					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	—

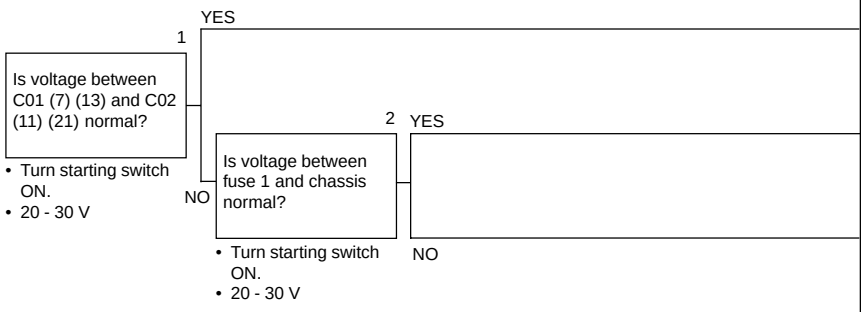
○ : This shows item to check with monitoring or machine monitor

A3
OPNEMEN

A3 OPNEMEN

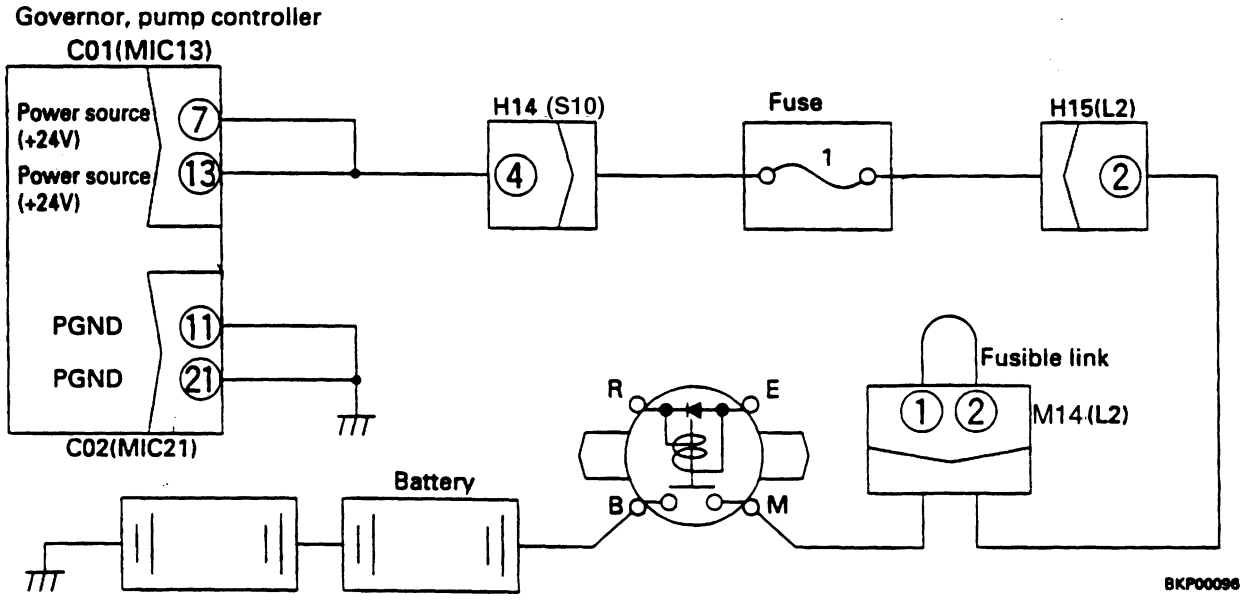
E-1 Abnormality in governor, pump controller power source (controller LED is OFF)

★ **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 to the next step.
★ When the starting motor rotates correctly. (If the starting motor also does not rotate, go to E-8)



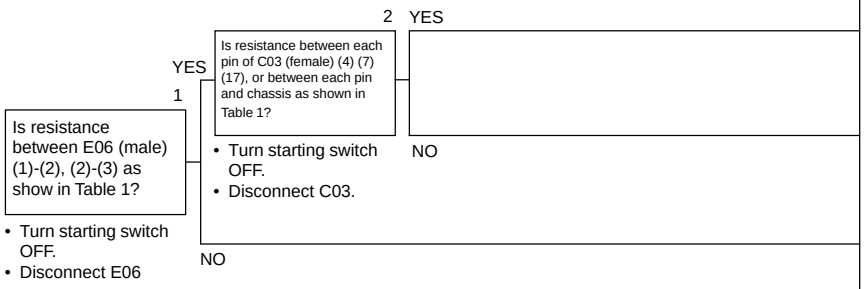
Cause	Remedy
Defective governor, pump controller	Replace
Defective contact, or disconnection in wiring harness between fuse 1 and C01 (female) (7) (13)	Repair or replace
Defective contact, or disconnection in wiring harness between fuse 1-H15 (2)-M14 (2) (1)-battery relay M	Repair or replace

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 to the next step.



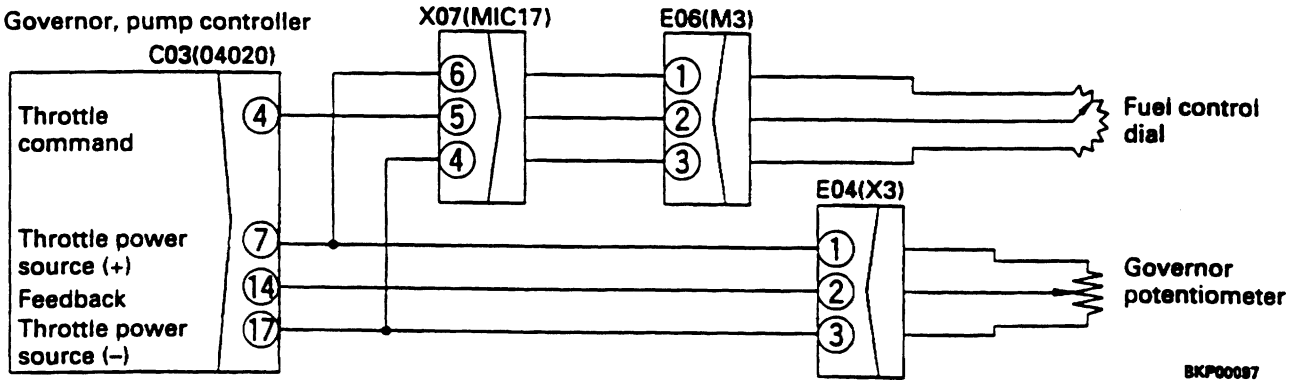
Cause	Remedy
Defective governor, pump controller	Replace
Defective wiring harness in system with defective resistance	Replace
Defective fuel control dial	Replace

★ 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 - 3 kΩ
-	(1) - (3)	4 - 6 kΩ
Between each pin and chassis	-	Min. 1 MΩ

E-2 Related electric circuit diagram



E3 [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 occurred
★ 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 to the next step.

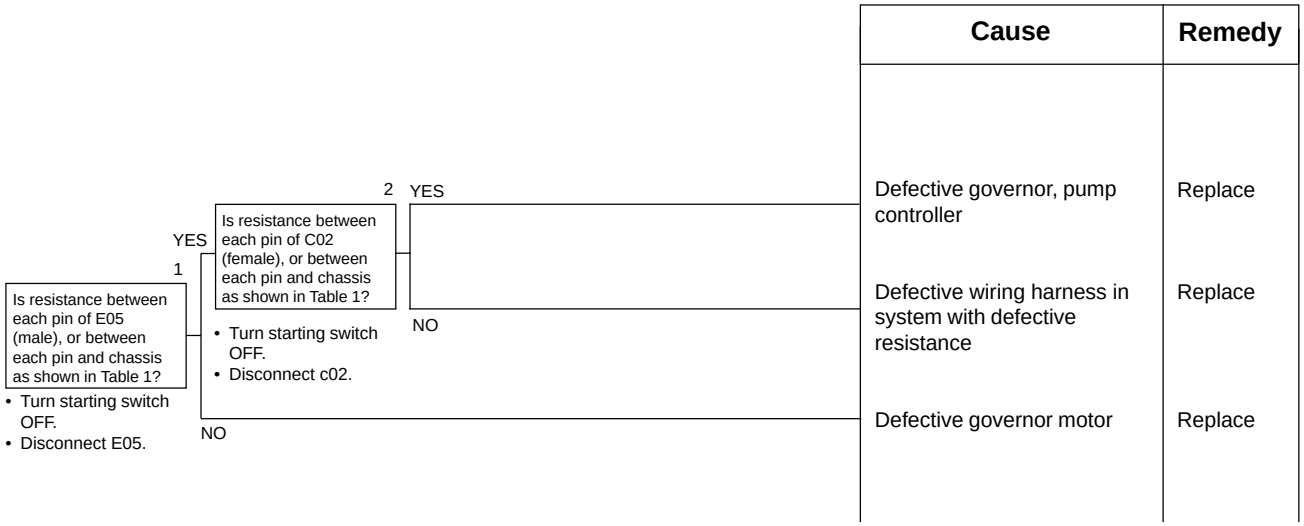
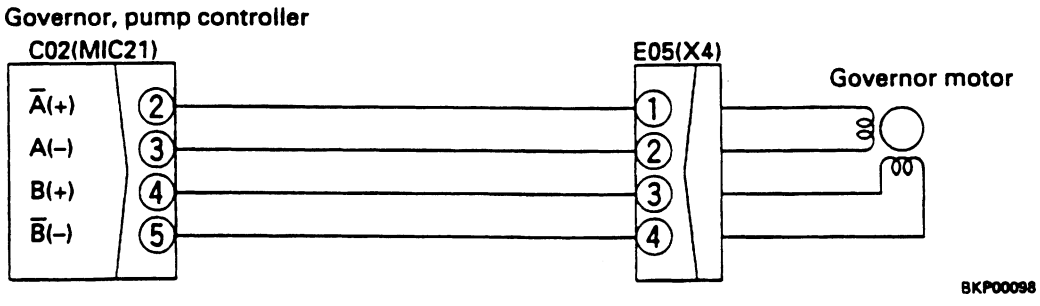


Table 1

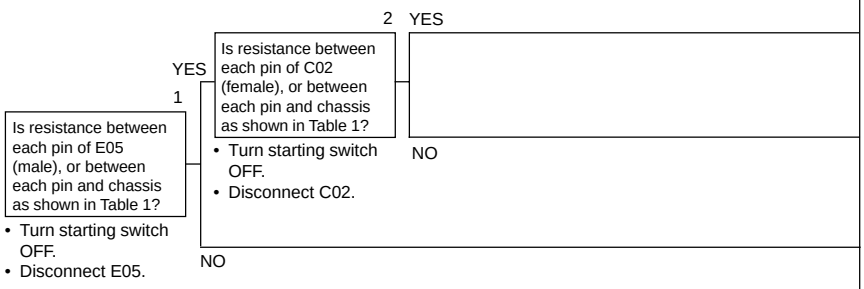
E05 (male)	C02 (female	Resistance value
(1) - (2)	(2) - (3)	2.5 - 7.5 kΩ
(3) - (4)	(4) - (5)	2.5 - 7.5 kΩ

E-3 Related electric circuit diagram



E-4 [318] Abnormality (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 to the next step.

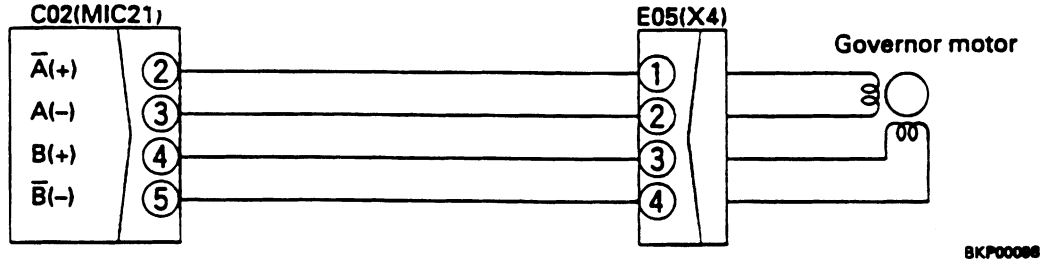


Cause	Remedy
Defective governor, pump controller	Replace
Defective wiring harness in system with defective resistance	Replace
Defective governor motor	Replace

Table 1

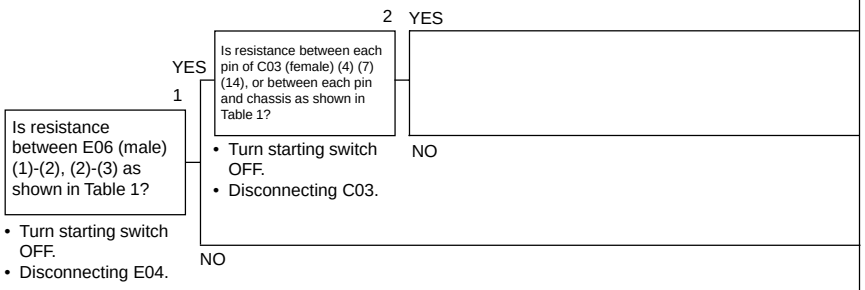
E05 (male)	C02 (female	Resistance value
(1) - (2)	(2) - (3)	2.5 - 7.5 kΩ
(3) - (4)	(4) - (5)	2.5 - 7.5 kΩ
(1) - (3)	(2) - (4)	Min. 1 MΩ
(1) - (4)	(2) - (5)	Min. 1 MΩ
Between chassis and pins (1) (2) (3) (4)	Between chassis and pins (2) (3) (4) (5)	Min. 1 MΩ

E-4 Related electric circuit diagram



E-5 [E306] Abnormality in feedback potentiometer system is 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.



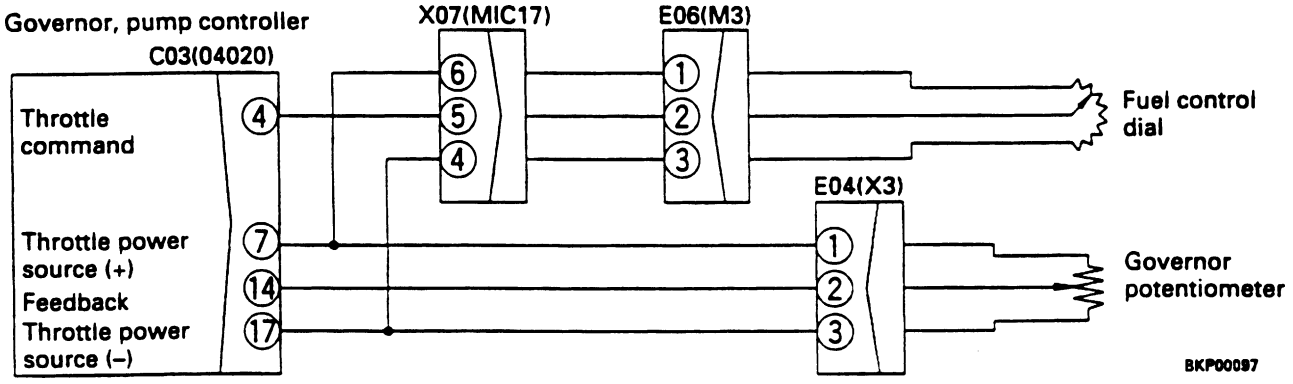
Cause	Remedy
Defective governor, pump controller	Replace
Defective wiring harness in system with defective resistance	Replace
Defective governor motor	Replace

★ 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)	0.25 - 7kΩ
(14) - (17)	(2) - (3)	0.25 - 7kΩ
(7) - (17)	-	2 - 3kΩ
-	(1) - (3)	4 - 6kΩ
Between each pin and chassis	-	Min. 1 MΩ

E-5 Related electric circuit diagram



E-6 [E315] Abnormality (short circuit) in battery relay output system is displayed

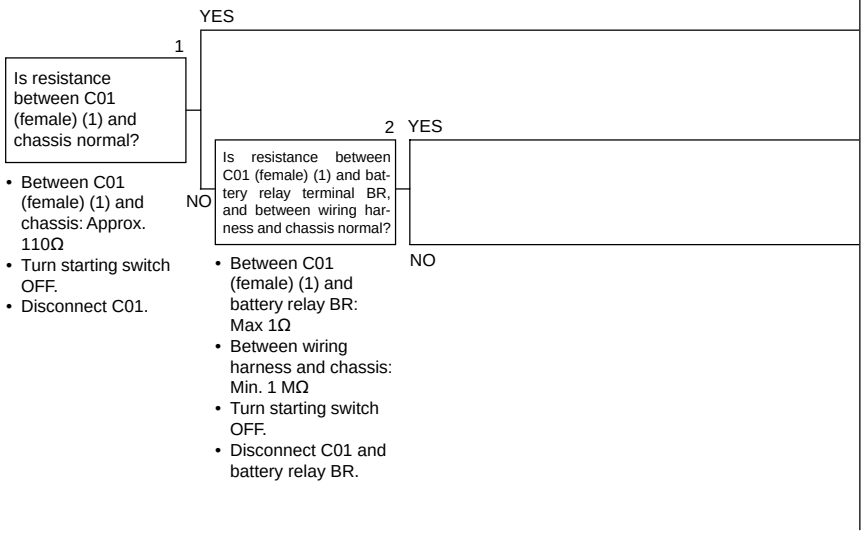
★ This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its oringinal position, if the service code E is not displayed, the problem has been removed.

⚠ 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.

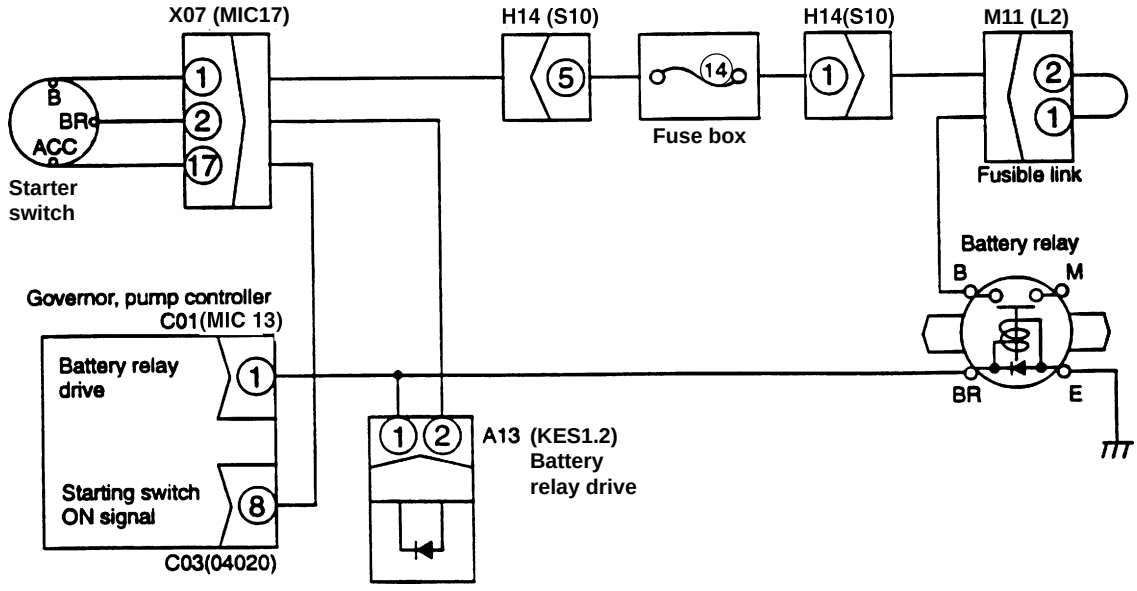
★ Always connect any disconnected connectors before going on the next step.

★ This only occurs when the engine is stopped and the starting switch is turned OFF.



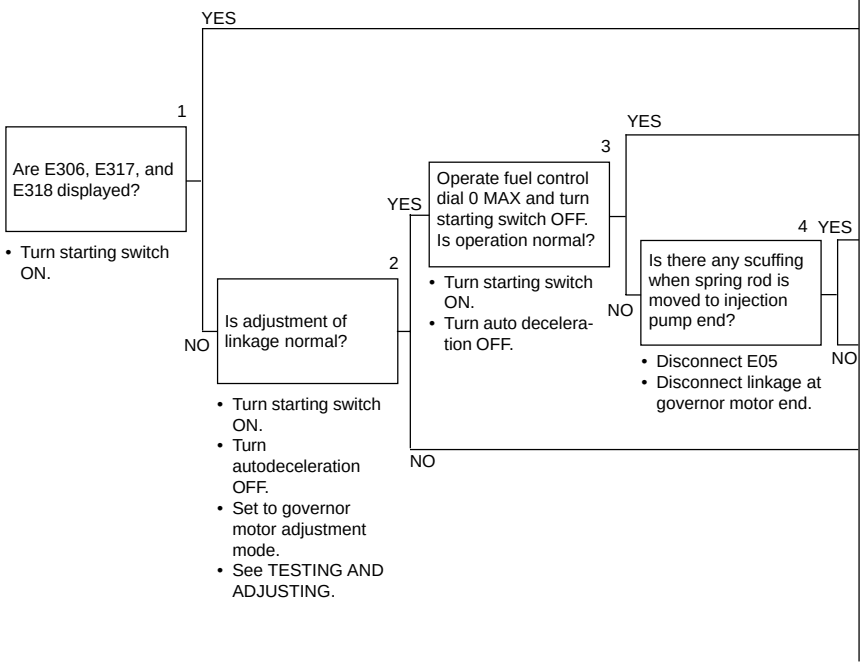
Cause	Remedy
Defective governor, pump controller	Replace
Defective battery relay	Replace
1) Contact between other wiring harness and wiring harness between C01 (female) (1)-battery relay BR. 2) When light is connected	Replace

E-6 Related electric circuit diagram



E-7 [E316] Abnormality (step-out) in motor is displayed

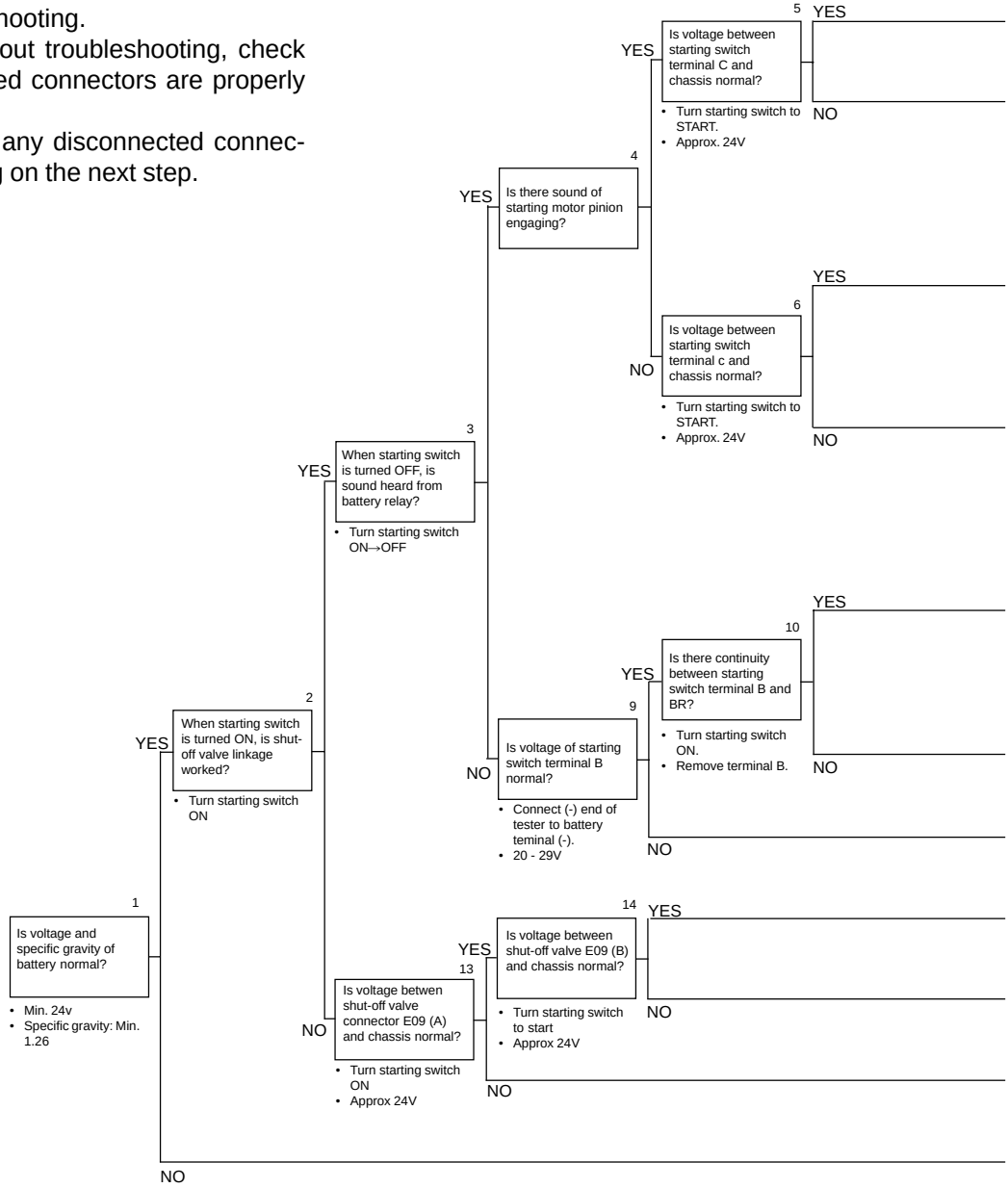
★ **This troubleshooting is carried out when there is still an abnormality, so when disconnecting the connector and inserting the T-adapter, or when removing the T-adapter and returning the connector to its original position, if the service code E is not displayed, the problem has been removed.**
★ If any other service code [E306] - [E318] has occured at the same time, start troubleshooting from the code exept 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 troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



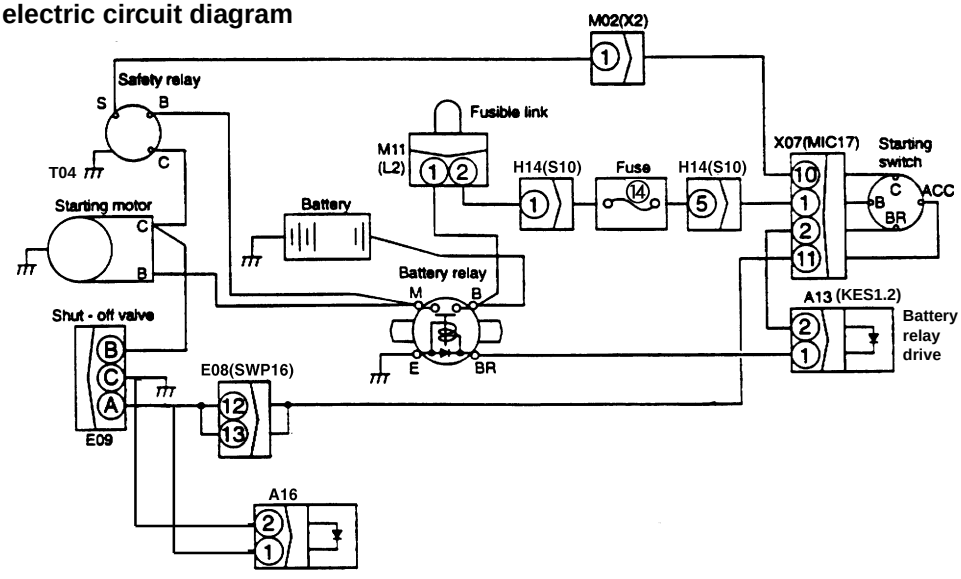
Cause	Remedy
Go to applicable failure mode	-
Defective governor, pump controller	Replace
1) Defective linkage 2) Defective injection pump	Adjust or replace
Defective governor motor	Replace
Defective governor linkage	Adjust (For details, see TESTING AND ADJUSTING)

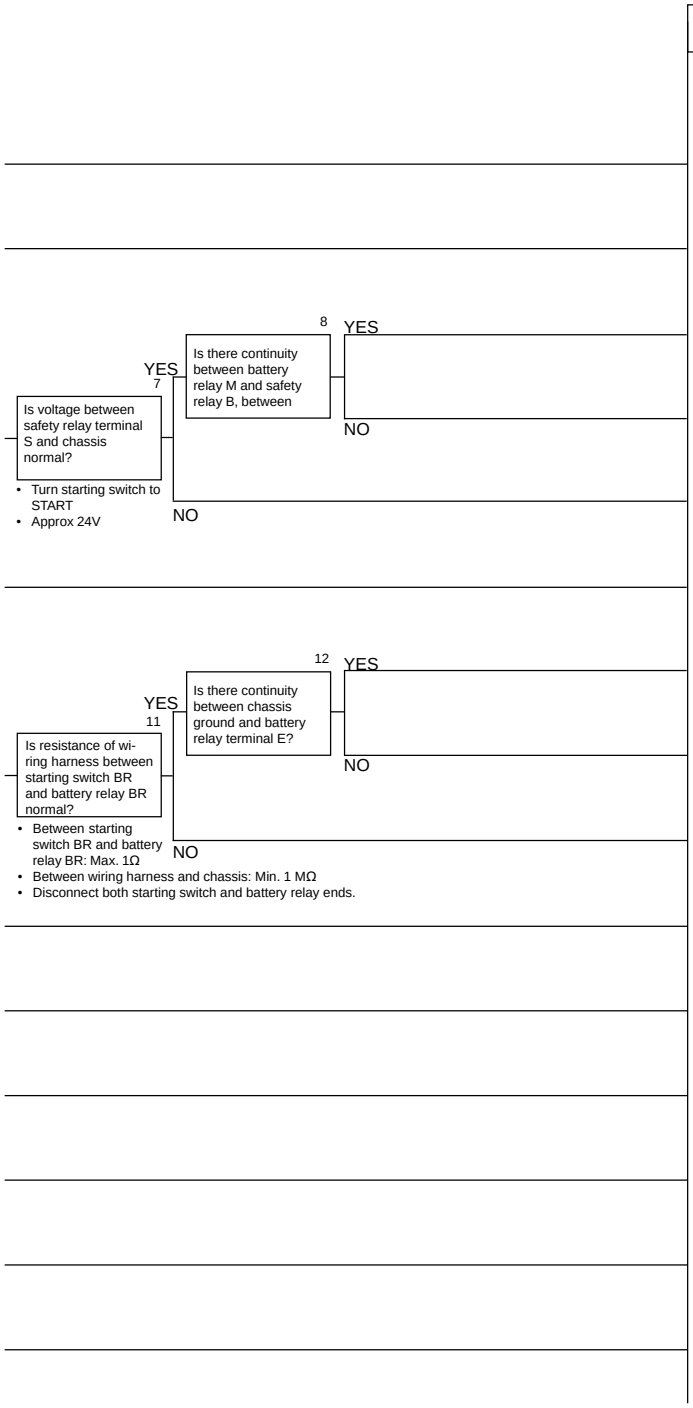
E-8 Engine does not start

★ 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 releay M-starting motor terminal B (including battery relay)	Replace
Defective safeyt relay	Replace
Defective contact, or discon-nectionin wiring harness be-tween battery relay terminal M and safety relay terminal B, between safety relay terminal C and starting motor terminal C	Replace
Defective contact, or discon-nection in wiring harness be-tween starting switch terminal C-X07(10)-M02(1)-safety relay terminal S	Replace
Defective starting switch (between terminals B and C)	Replace
Defective battery relay	Replace
Defective contact or 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-H14 (1)-Fuse14-H14(4) starting switch terminal B (including fusible link)	Replace
Defective shut-off valve	Replace
Defecitve contact, or disconnection in wiring harness between starting motor terminal C and shut-off valve E09 (B)	Replace
Defective contact, or disconnection in wiring harness between starting switch terminal ACC-X07(11)-E08 (12, 13) -shut-off vlave E09 (A).	Replace
Lack of battery capacity	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

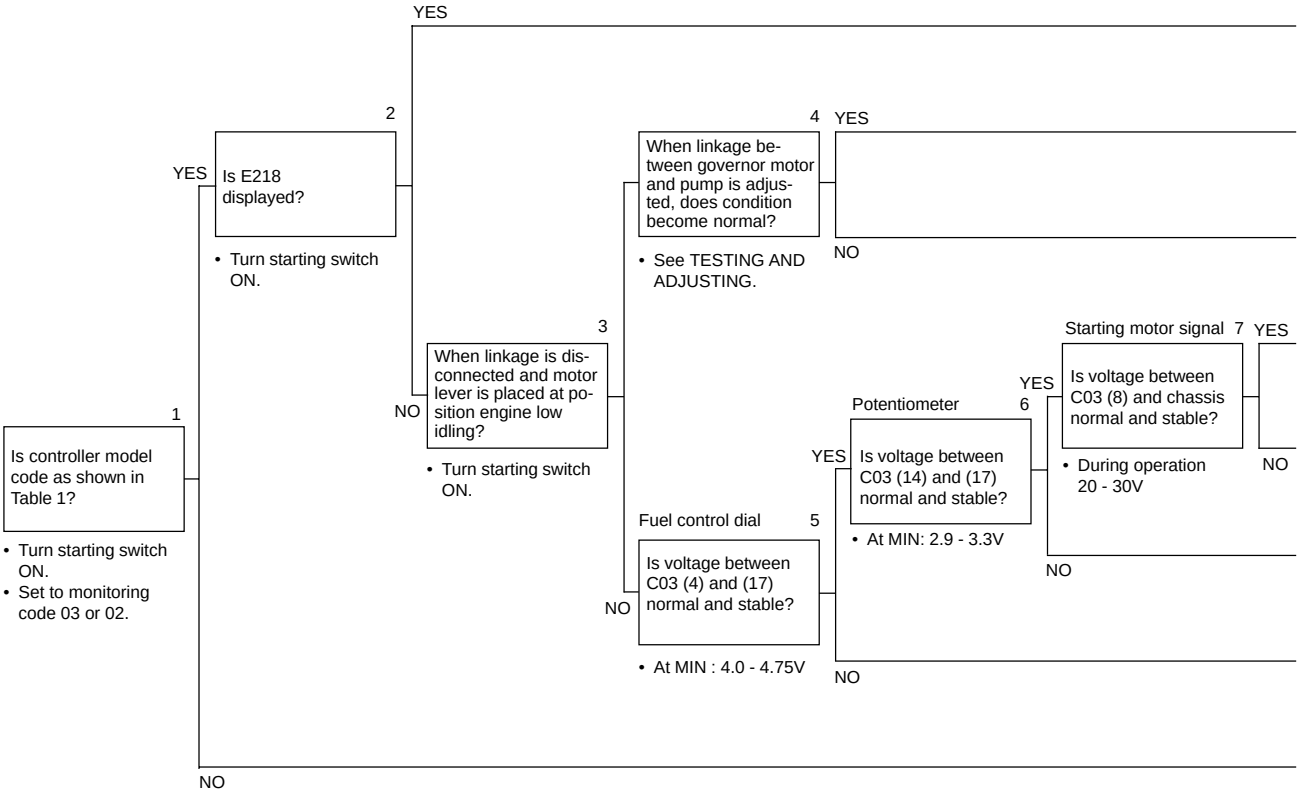


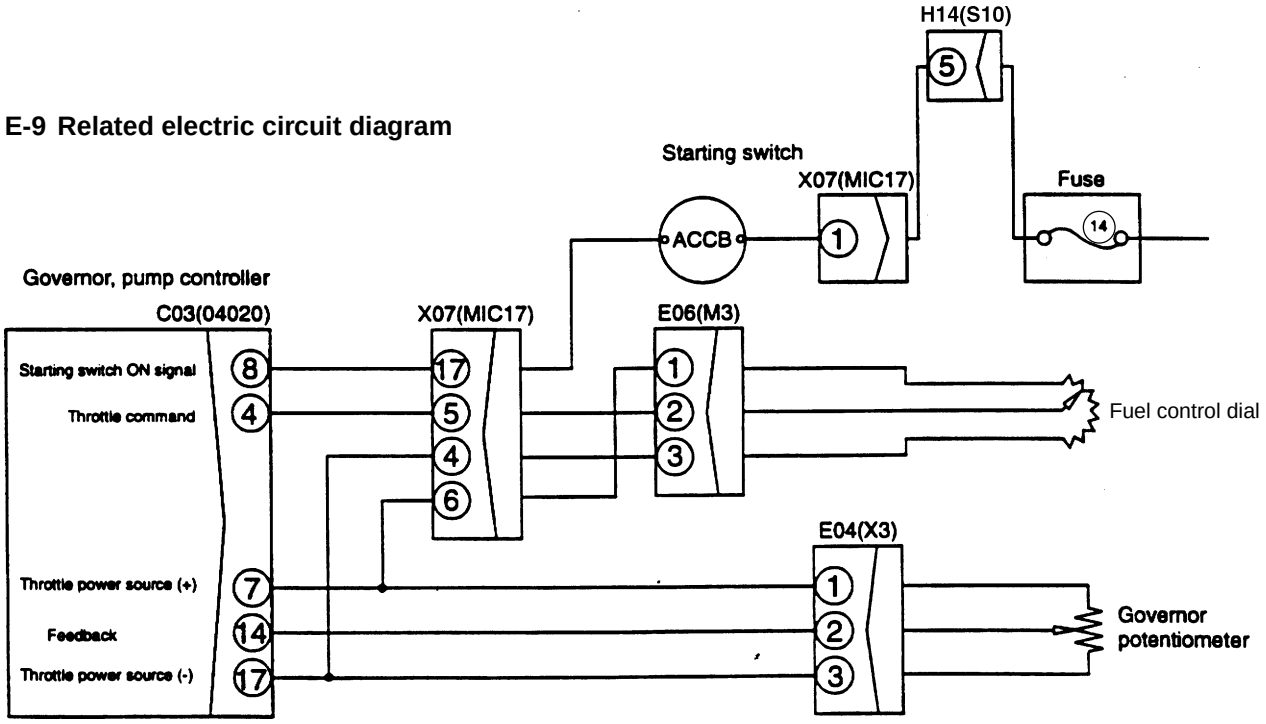
Table 1

Controller model code
03 130

★ 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 contact 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

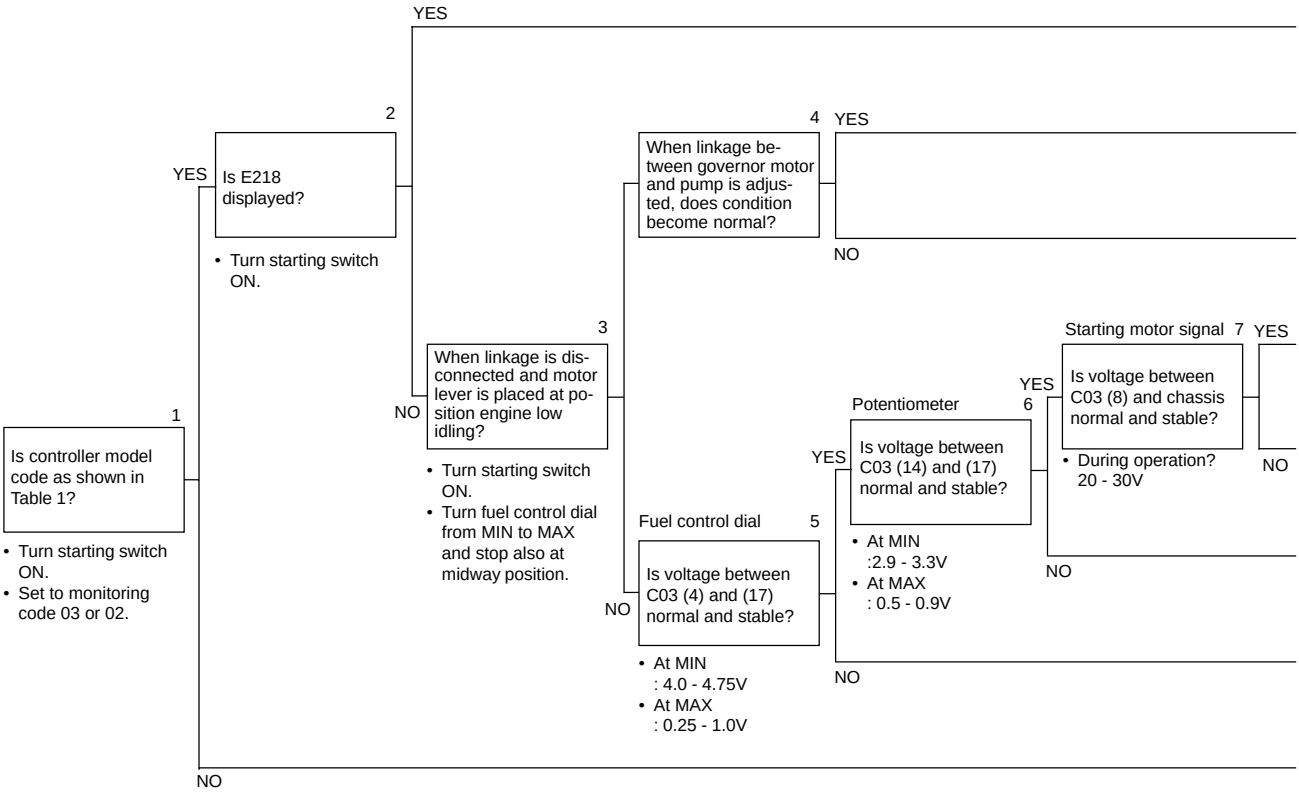


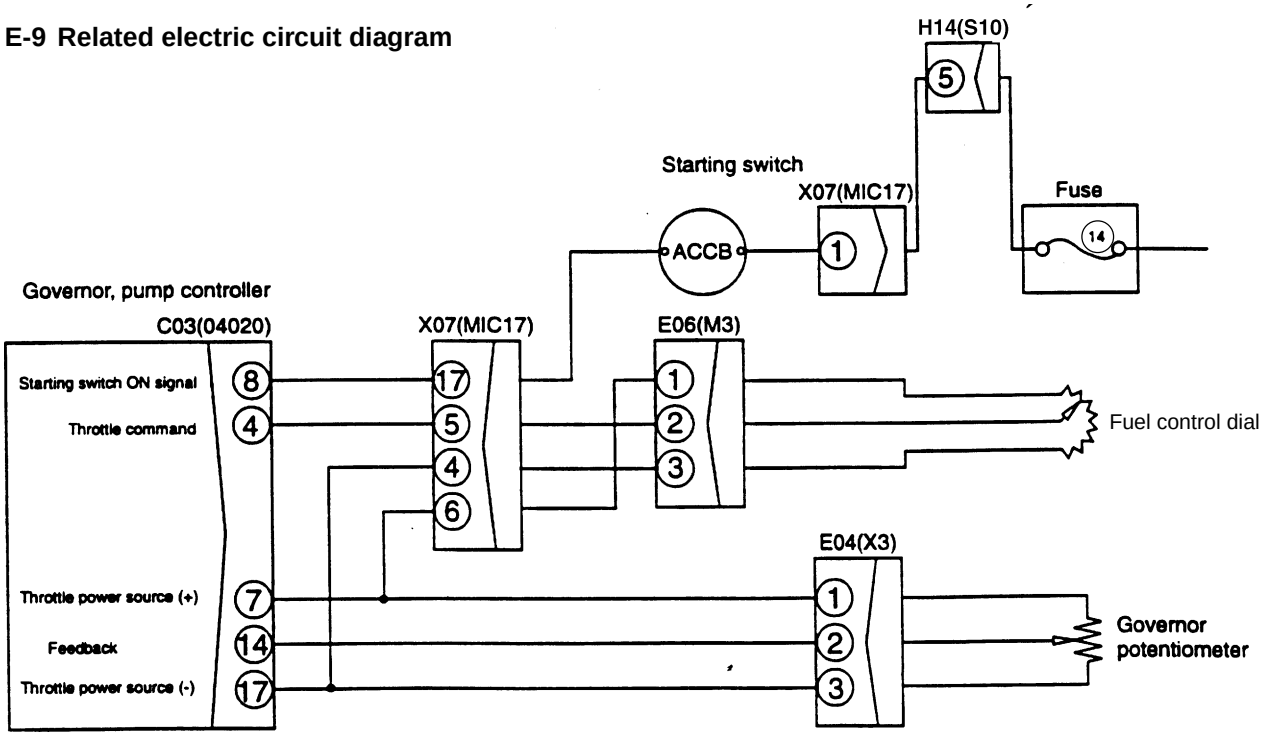
Table 1

Controller model code
03 130

★ 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 contact 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.

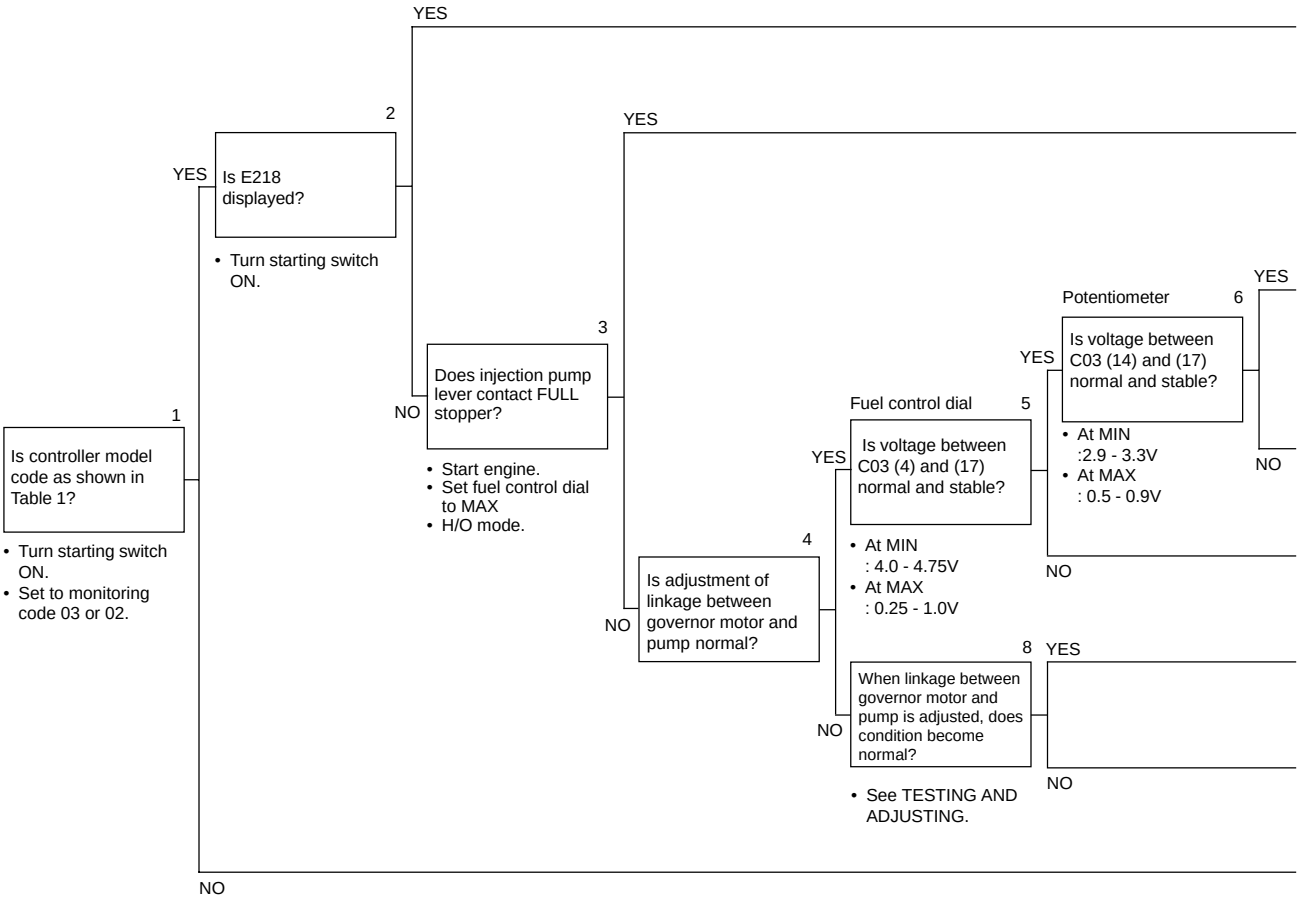


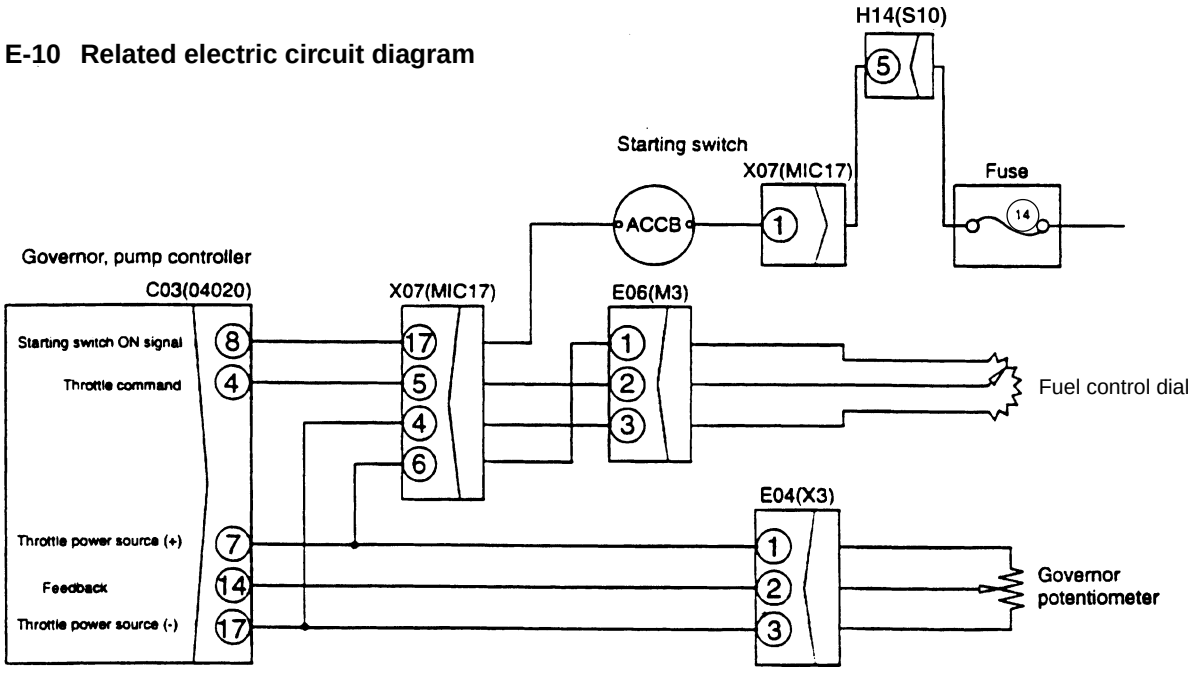
Table 1

Controller model code
03 130

★ The diagram shows monitoring code 03.

	Cause	Remedy
	See N mode	-
	Defective injection pump	See S mode
Starting motor signal 7 YES	Defective governor motor	Replace
Is voltage between C03 (8) and chassis normal and stable?	Defective contact of wiring harness between starting switch ACC - X07 (17) - C03 (female) (8), or defective starting switch	Repair or replace
• During operation? 20 - 30V NO		
	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.

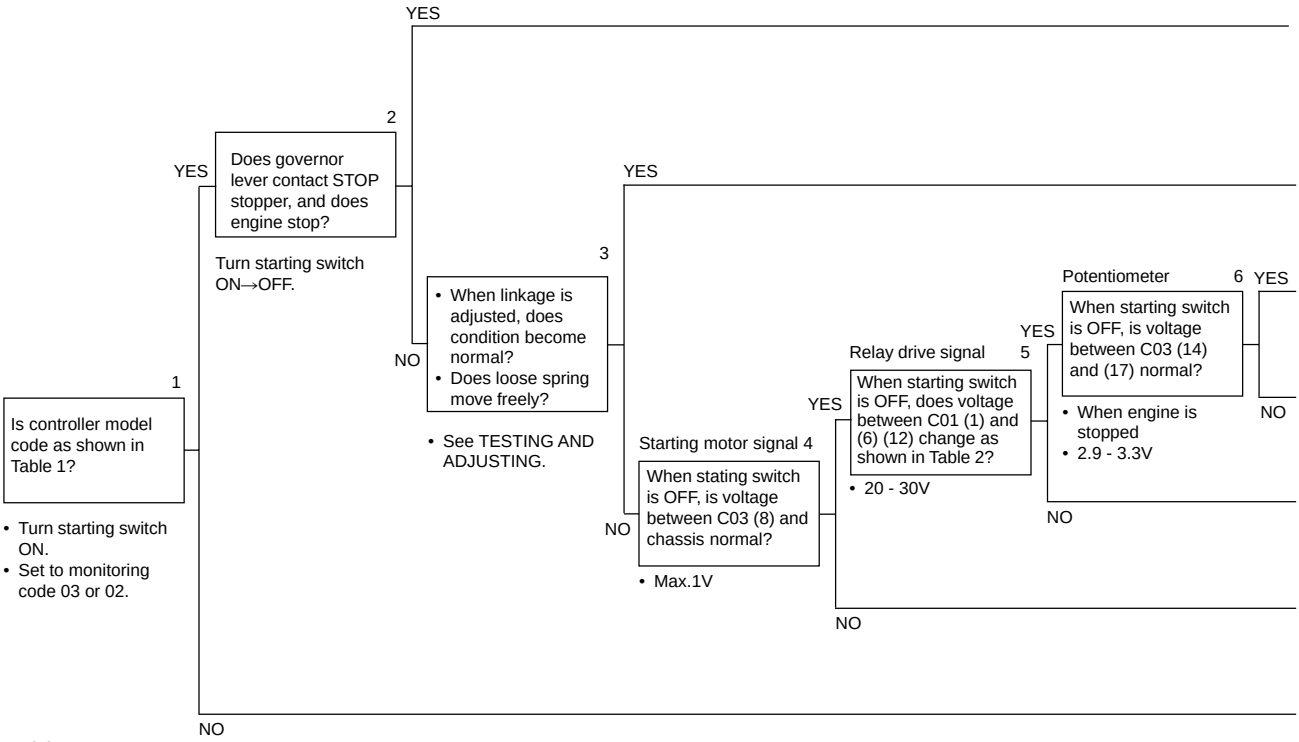
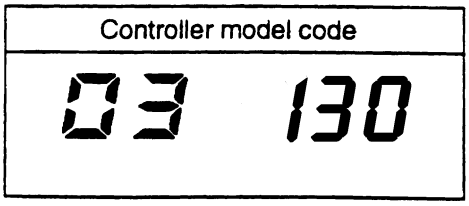
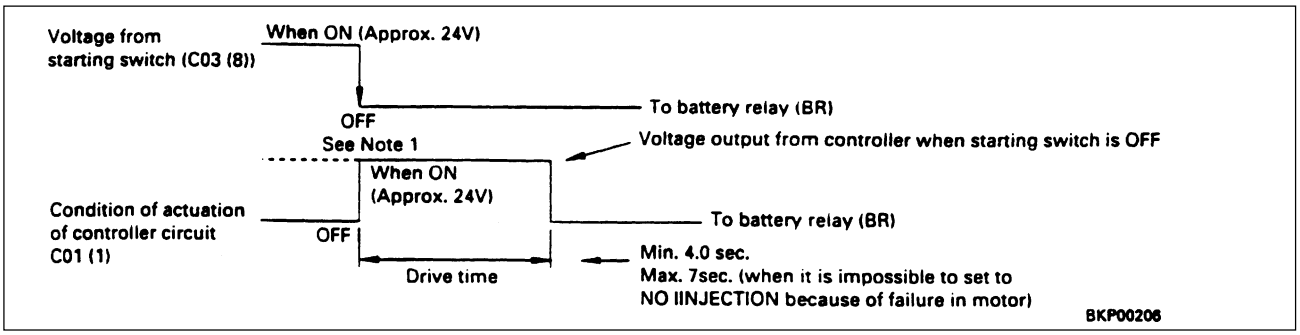


Table 1



★ The diagram shows monitoring code 03.

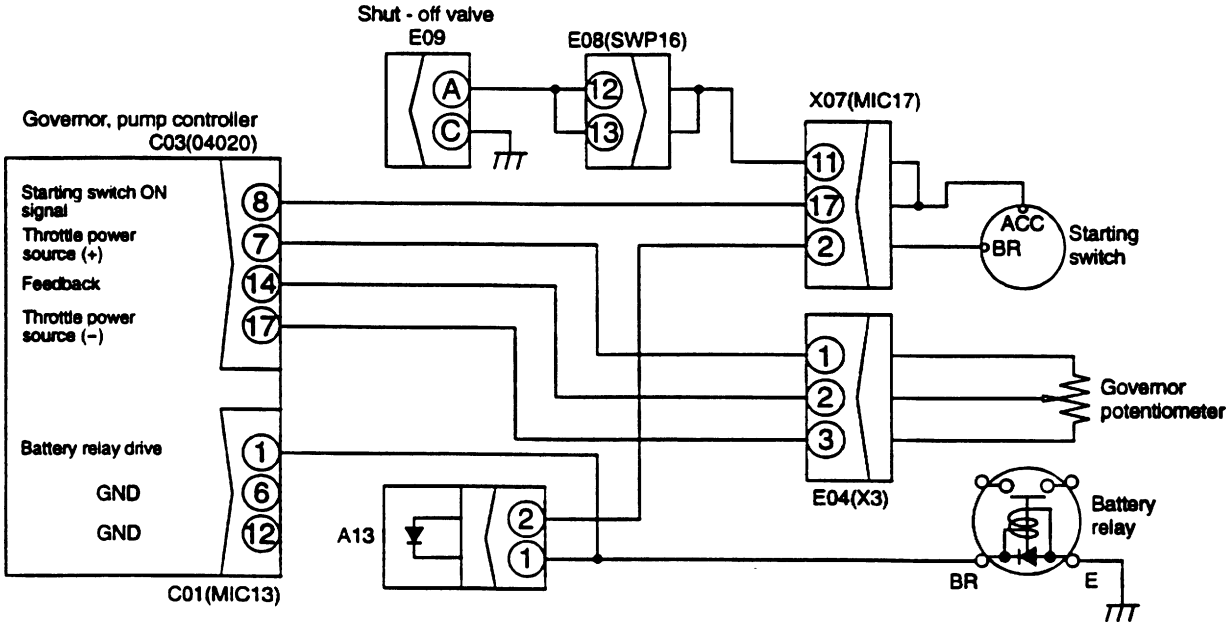
Table 2



Note 1: When the starting switch is ON, the controller end is OFF, but a voltage of approx. 20 - 30V is always flowing from starting switch BR, so if the voltage is measured at C01 (1), there is a voltage of 20 -30V

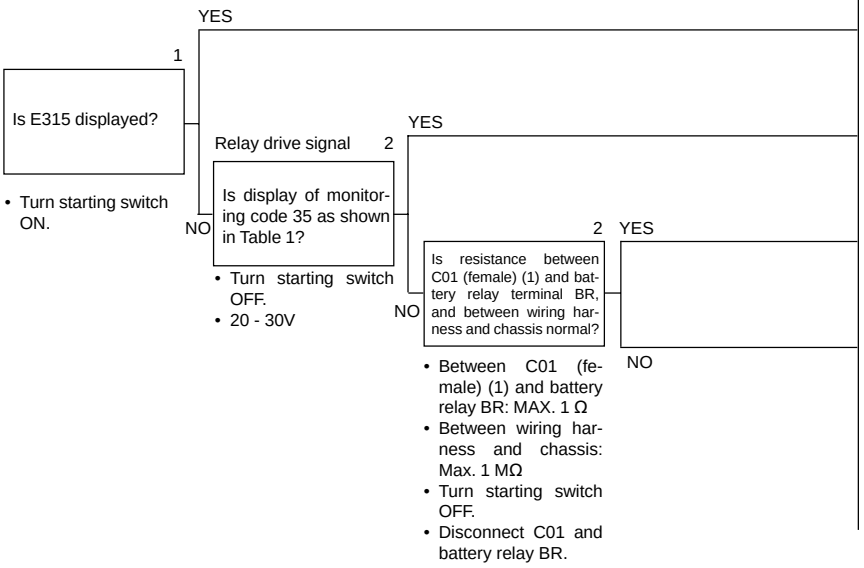
	Cause	Remedy
7 When shut-off vlave connector E09 is disconnected, does Engine stop? YES	Defective wiring harness between starting switch Terminal ACC-X07 (11) -E08 (12, 13) -shut-off valve connecter E09 (A)	Replace
NO	Defective shut-off valve	See S mode
	Defective adjustment of linkage	Adjust
	Defective 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



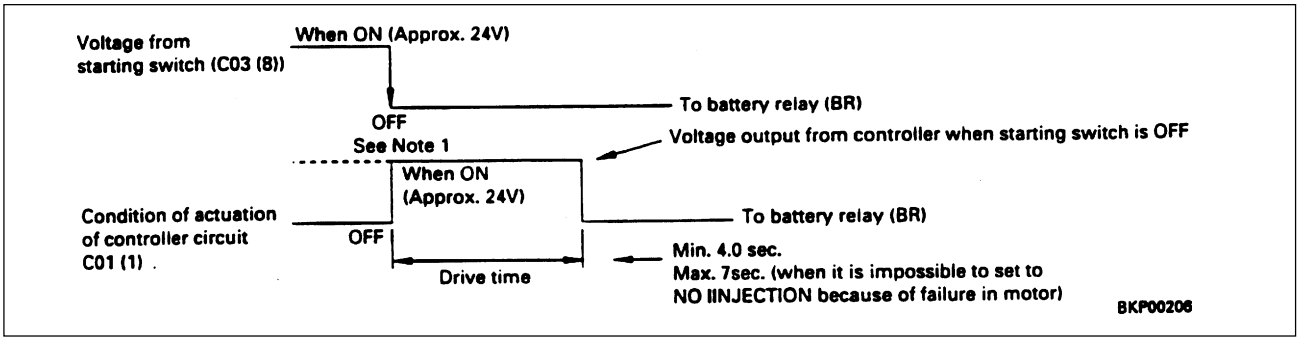
E-12 Defective operation of battery relay system (engine does not stop)

★ 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.



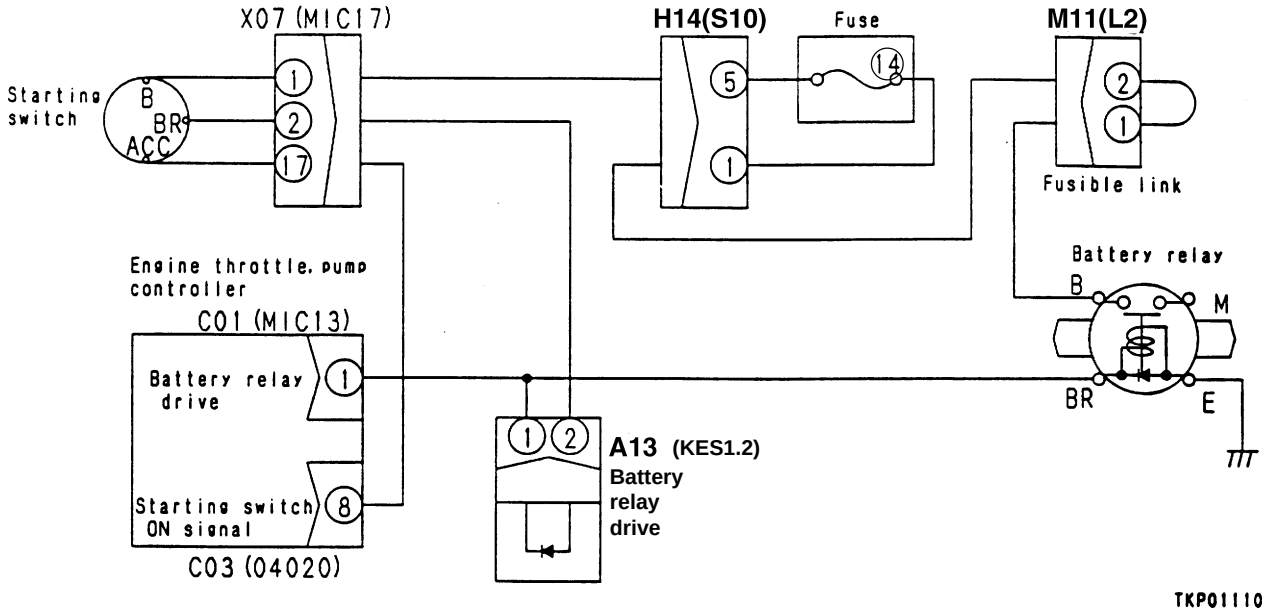
Cause	Remedy
See E-6	-
Defective governor, pump controller	Replace
Defective battery relay	Replace
1) Disconnection in wiring harness between C01 (female) (1) - battery relay BR	Replace
2) When light is connected	

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 electrical circuit diagram



TROUBLESHOOTING OF ENGINE SYSTEM (S MODE)

METHOD OF USING TROUBLESHOOTING CHARTS

This troubleshooting chart is divided into three sections: questions, check items, and troubleshooting. The questions and check items are used to pinpoint high probability causes that can be located from the failure symptoms or simple inspection without using troubleshooting tools.
Next, troubleshooting tools or direct inspection are used to check the high probability causes to make final confirmation.

[Questions]

Sections A + B in the chart on the right corresponds to the items where answers can be obtained from the user. The items in B are items that can be obtained from the user, depending on the user's level.

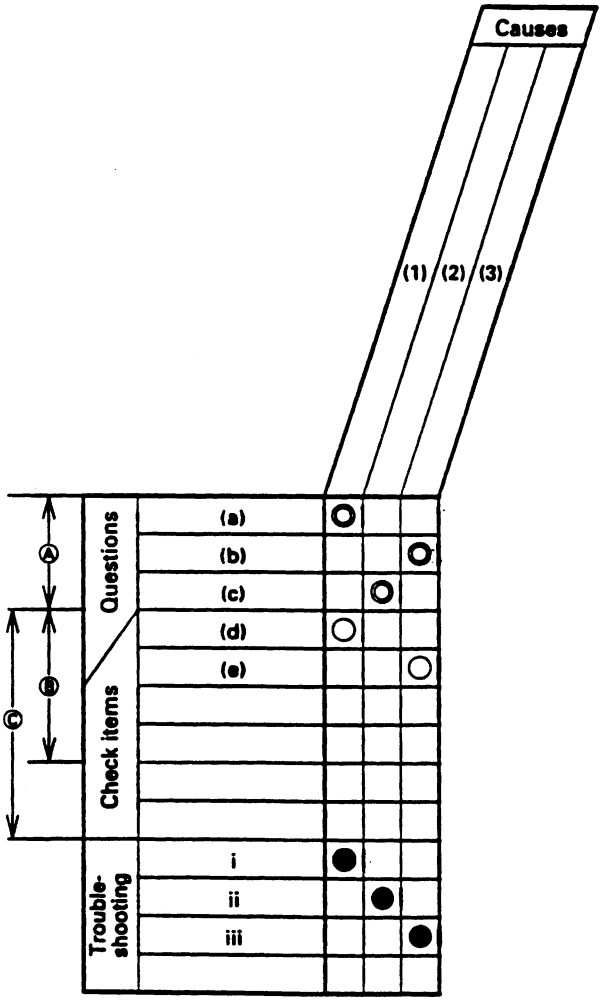
[Check items]

The serviceman carries out simple inspection to narrow down the causes. The items under C in the chart on the right correspond to this.

The serviceman narrows down the causes from information A that he has obtained from the user and the results of C that he has obtained from his own inspection.

[Troubleshooting]

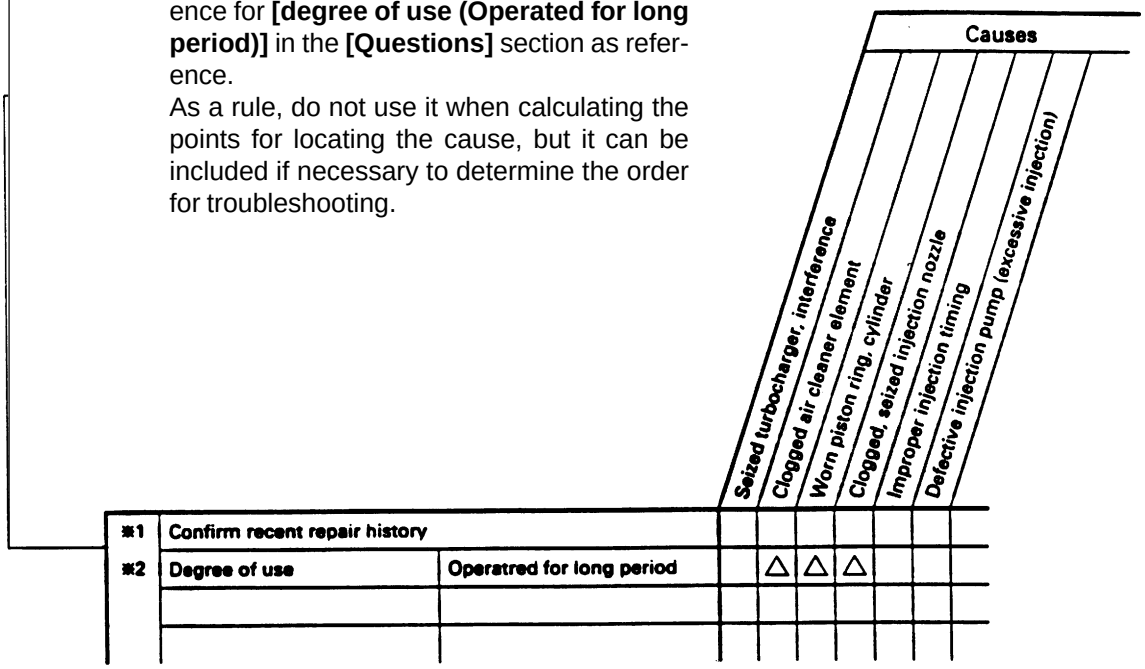
Troubleshooting is carried out in the order of probability, starting with the causes that have been marked as having the highest probability from information gained from **[Questions]** and **[Check items]**.



The basic method of using the troubleshooting chart is as follows.
Items listed for **[Questions]** and **[Check items]** that have a relationship with the Cause items are marked with o, and of these, causes that have high probability are marked with ◎.
Check each of the [Questions] and [Check items] in turn, and mark the o or O in the chart for items where the problem appeared. The vertical column (Causes) that has the highest number of points is the most probable cause, so start troubleshooting for that item to make final confirmation of the cause.

※ 1. For **[Confirm recent repair history]** in the **[Questions]** section, ask the user, and mark the Cause column with ^ to use as reference for locating the cause of the failure. However, do not use this when making calculations to narrow down the causes.

※ 2. Use the △ in the Cause columns as reference for **[degree of use (Operated for long period)]** in the **[Questions]** section as reference.
As a rule, do not use it when calculating the points for locating the cause, but it can be included if necessary to determine the order for troubleshooting.

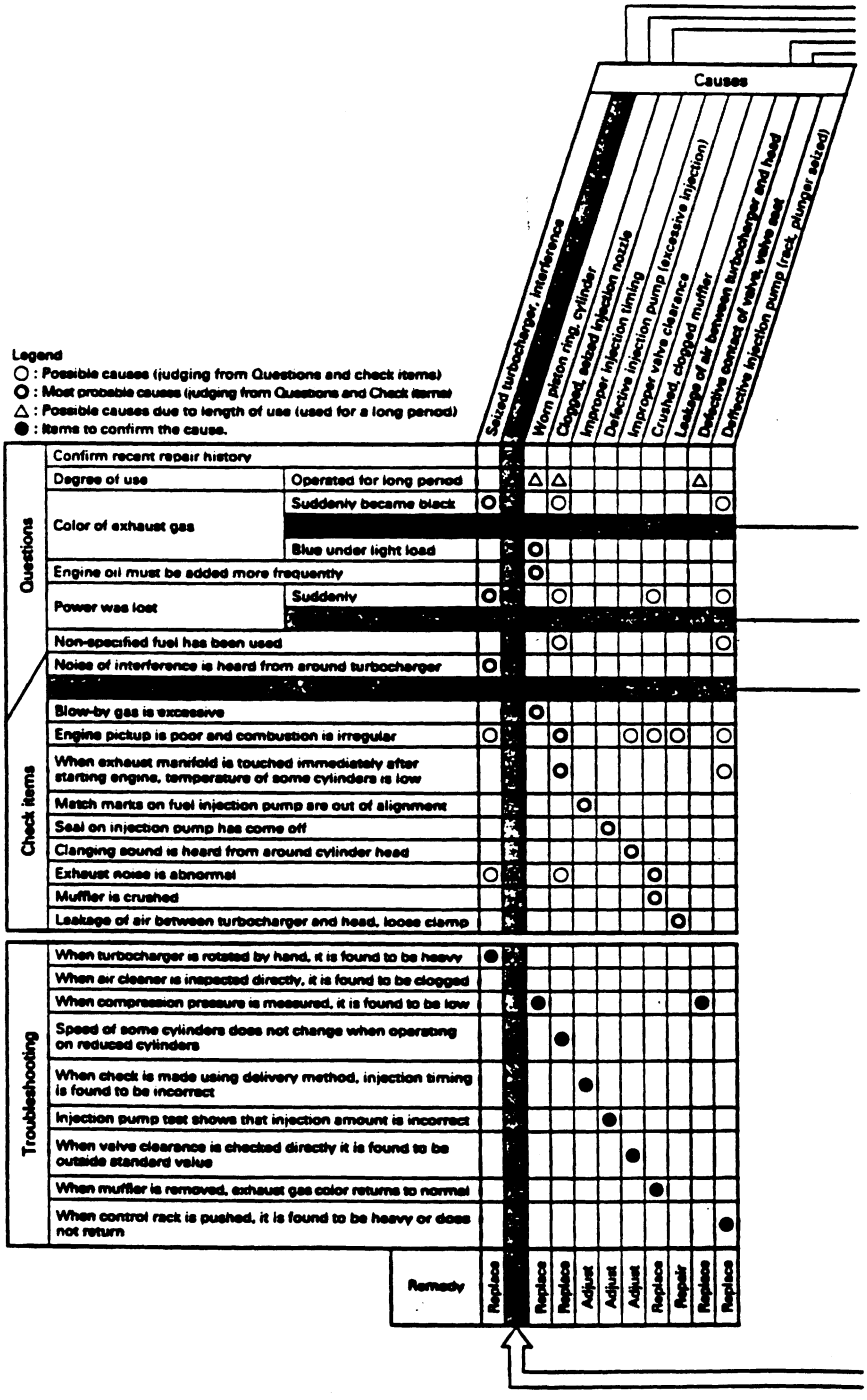


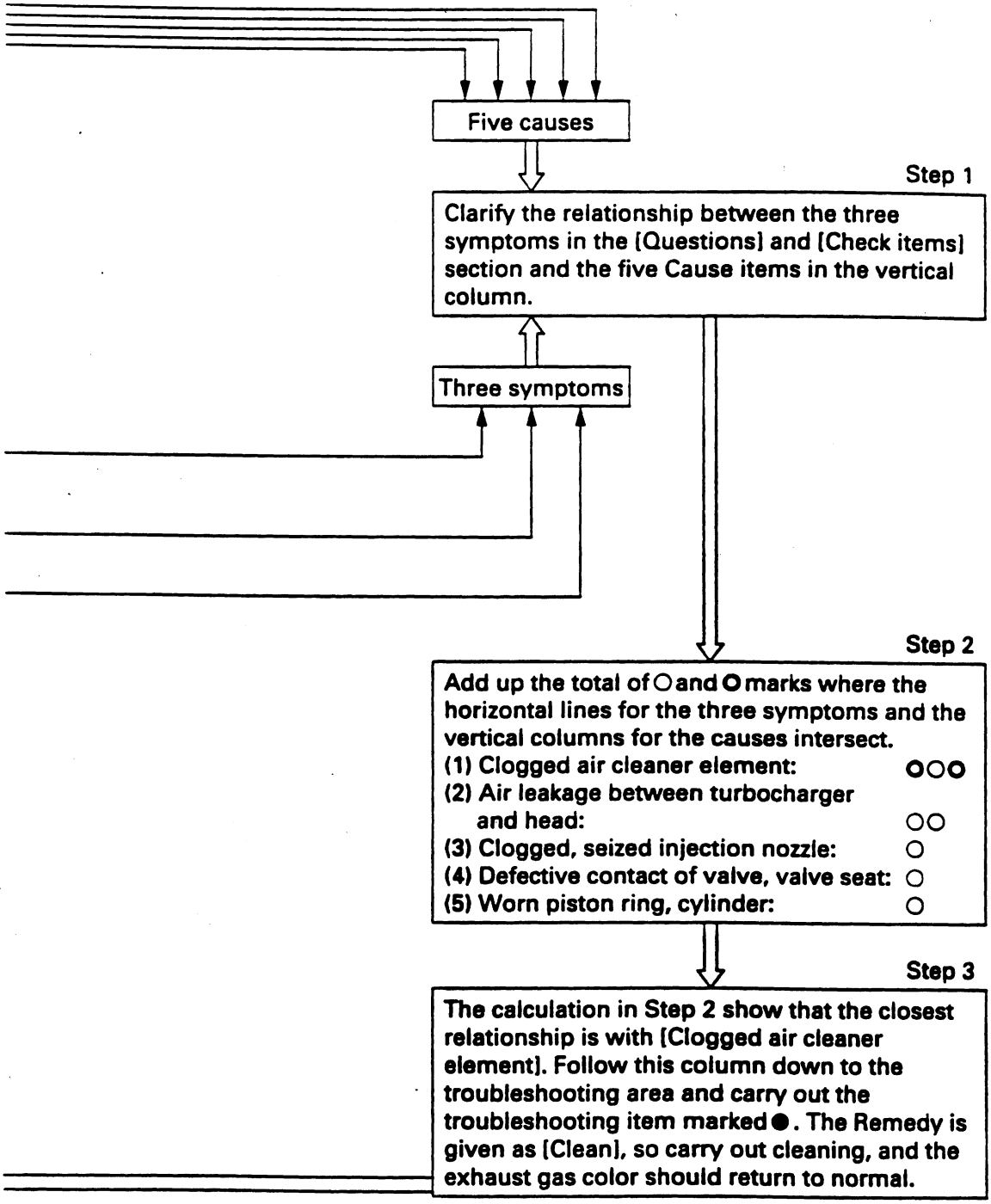
- **Example of troubleshooting when exhaust gas is black**
  Let us assume that [clogged air cleaner] is taken to be the cause of black exhaust gas. Three symptoms have causal relationship with this problem: [Exhaust gas slowly became black], [Power slowly became weaker], and [dust indicator is red].
  If we look from these three symptoms to find the causes, we find that there is a relationship with five causes. Let us explain here the method of using this causal relationship to pinpoint the most probable cause.

S-7 Exhaust gas is black (incomplete combustion)

General causes why exhaust gas is black

- Insufficient intake of air
- Improper condition of fuel injection
- Excessive injection of fuel




Five causes
Step 1
Clarify the relationship between the three symptoms in the [Questions] and [Check items] section and the five Cause items in the vertical column.
Three symptoms
Step 2
Add up the total of ○ and ◎ marks where the horizontal lines for the three symptoms and the vertical columns for the causes intersect.
(1) Clogged air cleaner element: ◎○○
(2) Air leakage between turbocharger and head: ○○
(3) Clogged, seized injection nozzle: ○
(4) Defective contact of valve, valve seat: ○
(5) Worn piston ring, cylinder: ○
Step 3
The calculation in Step 2 show that the closest relationship is with [Clogged air cleaner element]. Follow this column down to the troubleshooting area and carry out the troubleshooting item marked ●. The Remedy is given as [Clean], so carry out cleaning, and the exhaust gas color should return to normal.

S-1 Starting performance is poor (starting always takes time)

★ Check that the monitor panel does not display any abnormality in the governor control system. General causes why exhaust smoke comes out but engine takes time to start
- Defective electrical system
- insufficient supply of fuel
- Insufficient intake of air
- Improper selection of fuel
  (At ambient temperature of 100C or below, use ASTM D975 No. 1)

★ Battery charging rate

Charging rate / Ambient temperature	100%	90%	80%	75%	70%
20°C	1.28	1.26	1.24	1.23	1.22
0°C	1.29	1.27	1.25	1.24	1.23
-10°C	1.30	1.28	1.26	1.25	1.24

- The specific gravity should exceed the value for the charging rate of 70% in the above table.
- In cold areas the specific gravity must exceed the value for the charging rate of 75% in the above table.

Legend
○ : Possible causes (judging from Questions and check items)
◎ : Most probable causes (judging from Questions and Check items)
△ : Possible causes due to length of use (used for a long period)
● : Items to confirm the cause

			Causes: Worn piston ring, cylinder	Defective contact of valve, valve seat	Clogged air cleaner element	Clogged fuel filter, strainer	Clogged feed pump strainer	Starting aid	Defective regulator	Electrical intake air heater	Defective alternator	Defective or deteriorated battery	Defective injection nozzle	Defective injection timing	Leakage, clogging, air in fuel piping (rack, plunger stuck)	Clogged air breather hole in fuel tank cap
Questions	Confirm recent repair history															
	Degree of use of machine	Operated for long period			△	△	△				△					
	Ease of starting	Gradually became worse	○	○	○	○	○									
		Starts when warm						○			○					
	Indicator lamp does not light up							○								
	Engine oil must be added more frequently		○													
	Replacement of filters has not been carried out according to Operation Manual				○	○	○					○		○		
	Air cleaner clogging caution lamp flashes				○											
	Non-specified fuel is being used					○	○					○		○		
Check items	Battery charge lamp is ON								○	○						
	Starting motor cranks engine slowly										○					
	When exhaust manifold is touched immediately after starting engine, temperature of some cylinders is low											○				
	Engine does not pick up smoothly, and combustion is irregular		○	○								○				
	Blow-by gas is excessive		○													
	Match marks on fuel injection pump are out of alignment												○			
	Mud is stuck to fuel tank cap															○
	When engine is cranked with starting motor, 1) Little fuel comes out even when injection pump sleeve nut is loosened													○		
	2) Little fuel comes out even when fuel filter air bleed plug is loosened					○	○							○		
	Leakage from fuel piping													○	○	
	There is hunting from engine (rotation is irregular)					○	○								○	○
Troubleshooting	When compression pressure is measured, it is found to be low		●	●												
	When air cleaner element is inspected directly, it is found to be clogged				●											
	When fuel filter, strainer are inspected directly, they are found to be clogged					●									●	
	When feed pump strainer is inspected directly, it is found to be clogged						●									
	Heater mount does not become warm							●								
	Is voltage 26 – 30V between alternator terminal R and terminal E with engine at low idling?	Yes *							●							
		No								●						
	Either specific gravity of electrolyte or voltage of battery is low										●					
	Speed does not change when operation of certain cylinders is stopped											●				
	When check is made using delivery method, injection timing is found to be incorrect												●			
	When control rack is pushed, it is found to be heavy or does not return (when blind cover at rear of pump is removed, it can be seen that plunger control sleeve does not move)													●		
	When fuel cap is inspected directly, it is found to be clogged															●
		Remedy	Replace	Correct	Clean	Clean	Clean	Replace	Replace	Replace	Replace	Replace	Adjust	Replace	Correct	Clean

* It is not permitted to replace only the regulator.

S-2 Engine does not start

(1) Engine does not turn

General causes why engine does not turn
- Internal parts of engine seized
  - ★ If internal parts of the engine are seized, carry out troubleshooting for "Engine stops during operations".
- ★ Defective electrical system

Legend
◯: Possible causes (judging from Questions and check items)
◎: Most probable causes (judging from Questions and Check items)
△: Possible causes due to length of use (used for a long period)
●: Items to confirm the cause.

			Causes: Defective wiring of starting circuit	Defective or deteriorated battery	Defective starting motor	Broken ring gear	Defective safety relay or safety switch	Defective battery relay	Defective battery terminal connection	Defective starting switch
Questions	Confirm recent repair history									
	Degree of use of machine	Operated for long period		△		△				
	Condition of horn when starting switch is turned ON	Horn sounds	◎						◯	◯
		Horn does not sound or volume is low		◎						
Check items	When starting switch is turned to START, pinion moves out, but	Makes grating noise			◎	◎				
		Soon disengages again					◎			
		Makes rattling noise and does not turn	◎							
	When starting switch is turned to START, pinion does not move out									
	When starting switch is turned to ON, there is no clicking sound							◎		
	Battery terminal is loose								◎	
	When battery is checked, battery electrolyte is found to be low			◎						
Troubleshooting	Specific gravity of electrolyte, voltage of battery is low		●							
	For the following conditions 1) - 5), turn the starting switch OFF, connect the cord, and carry out troubleshooting at ON									
	1) When terminal B and terminal C of starting switch are connected, engine starts									●
	2) When terminal B and terminal C of starting motor are connected, engine starts				●					
	3) When terminal B and terminal C of safety relay are connected, engine starts					●				
	4) When terminal of safety switch and terminal B of starting motor are connected, engine starts					●				
	5) There is no 24V between battery relay terminal M and terminal E						●			
	When ring gear is inspected directly, tooth surface is found to be chipped					●				
		Remedy	—	Replace	Replace	Replace	Replace	Replace	Replace	Replace

Troubleshooting of electrical system

(2) Engine turns but no exhaust smoke comes out (fuel is not being injected)

★ Check that the monitor panel does not display any abnormality in the governor control system.
General causes why engine turns but not exhaust smoke comes out
- Supply of fuel impossible
- Supply of fuel is extremely small
- Improper selection of fuel (particularly in winter)

★ Standard for use of fuel

Type of fuel	Ambient temperature
	-22 -4 14 32 50 68 86 104°F
	-30 -20 -10 0 10 20 30 40°C
Diesel fuel	ASTM D975 No.2
	ASTM D975 No.1

Legend
○: Possible causes (judging from Questions and check items)
◎: Most probable causes (judging from Questions and Check items)
△: Possible causes due to length of use (used for a long period)
●: Items to confirm the cause.

		Causes: Broken injection pump drive shaft, key	Defective injection pump (rack, plunger seized)	Seized, broken feed pump piston	Clogged fuel filter, strainer	Clogged feed pump strainer	Clogged, leaking fuel piping	Clogged air breather hole in fuel tank cap	Improper fuel used
Questions	Confirm recent repair history								
	Degree of use of machine / Operated for long period				△	△		△	
	Exhaust smoke suddenly stops coming out (when starting again)	◎	◎	◎					
	Replacement of filters has not been carried out according to Operation Manual				◎	◎			
	There is leakage from fuel piping						◎		
Check items	Mud is stuck to fuel tank cap							◎	
	When fuel filter is drained, fuel does not come out								◎
	When engine is cranked with starting motor, 1) Injection pump coupling does not turn	◎							
	2) No fuel comes out even when fuel filter air bleed plug is loosened	◎			○	○			○
	3) No fuel spurts out even when injection pipe sleeve nut is loosened	◎	◎	◎					
	Rust and water are found when fuel tank is drained				○	○			
Troubleshooting	Inspect injection pump directly	●							
	When control rack is pushed, it is found to be heavy, or does not return		●						
	Inspect feed pump directly			●					
	When fuel filter, strainer are inspected directly, they are found to be clogged				●				●
	When feed pump strainer is inspected directly, it is found to be clogged					●			
	When fuel cap is inspected directly, it is found to be clogged							●	
	Remedy	Replace	Replace	Replace	Clean	Clean	Correct	Correct	Replace

(3) Exhaust smoke comes out but engine does not start (Fuel is being injected)

★ General causes why exhaust smoke comes out but engine does not start

- Lack of rotating force due to defective electrical system
- Insufficient supply of fuel
- Insufficient intake of air

8 Improper selection of fuel and oil

Legend
○ : Possible causes (judging from Questions and check items)
● : Most probable causes (judging from Questions and Check items)
△ : Possible causes due to length of use (used for a long period)
● : Items to confirm the cause.

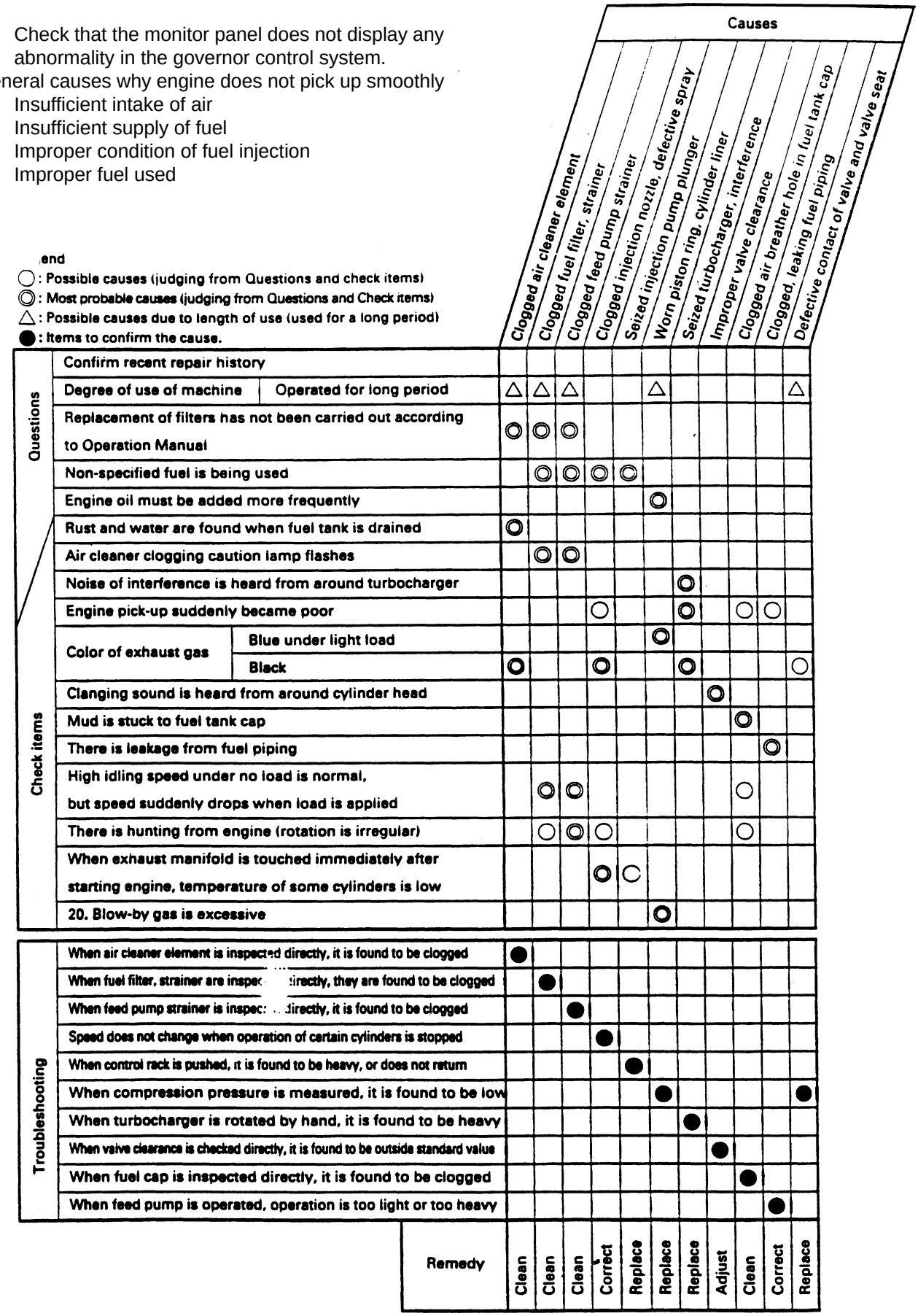
		Causes: Defective, broken valve system (valve, rocker lever, etc.)	Defective injection pump (rack, plunger stuck)	Worn piston ring, cylinder liner	Clogged fuel filter, strainer	Clogged feed pump strainer	Clogged air cleaner element	Electrical intake air heater	Defective or deteriorated battery	Leakage, clogging, air in fuel system (Starting aid)	Clogged injection nozzle, defective spray	Clogged air breather hole in fuel tank cap	Improper fuel used
Questions	Confirm recent repair history												
	Degree of use of machine — Operated for long period			△	△	△				△			
	Suddenly failed to start	●	●										
	When engine is cranked, abnormal noise is heard from around head	●											
	Engine oil must be added more frequently			●									
	Non-specified fuel is being used		○							○			
	Replacement of filters has not been carried out according to Operation Manual				●	●	●						
	Rust and water are found when fuel tank is drained					●							
Check items	Air cleaner clogging caution lamp flashes				●	●							
	Preheating indicator lamp does not light up						●						
	Starting motor cranks engine slowly							●					
	Mud is stuck to fuel tank cap										○		
	When fuel lever is placed at FULL position, it does not contact stopper		○										
	When engine is cranked with starting motor, 1) Little fuel comes out even when injection pump sleeve nut is loosened		●										
	2) No fuel comes out even when fuel filter air bleed plug is loosened				●	●							○
	There is leakage from fuel piping								●				
	When exhaust manifold is touched immediately after starting engine, temperature of some cylinders is low									●			
	When fuel filter is drained, no fuel comes out												●
Troubleshooting	Remove head cover and check directly	●											
	When control rack is pushed, it is found to be heavy, or does not return		●										
	When compression pressure is measured, it is found to be low			●									
	When fuel filter, strainer are inspected directly, they are found to be clogged				●								●
	When feed pump strainer is inspected directly, it is found to be clogged					●							
	When air cleaner element is inspected directly, it is found to be clogged						●						
	Heater mount does not become warm							●					
	Either specific gravity of electrolyte or voltage of battery is low								●				
	When feed pump is operated, operation is too light or too heavy									●			
	When injection nozzle is tested as individual part, spray condition is found to be poor										●		
	When fuel cap is inspected directly, it is found to be clogged											●	
	Remedy	Replace	Replace	Replace	Clean	Clean	Clean	Replace	Replace	Correct	Clean	Clean	Replace

S-3 Engine does not pick up smoothly (follow-up is poor)

★ Check that the monitor panel does not display any abnormality in the governor control system.

General causes why engine does not pick up smoothly

- Insufficient intake of air
- Insufficient supply of fuel
- Improper condition of fuel injection
- Improper fuel used



S-4 Engine stops during operations

★ Check that the monitor panel fuel level display shows that there is still fuel remaining.

General causes why engine stops during operations

- Seized parts inside engine
- Insufficient supply of fuel
- Overheating

★ If there is overheating and the engine stops, carry out troubleshooting for overheating

- Failure in main piston pump

★ If the engine stops because of a failure in the main piston pump, carry out troubleshooting for the hydraulic system (H MODE).

Legend
○ : Possible causes (judging from Questions and check items)
◎ : Most probable causes (judging from Questions and Check items)
△ : Possible causes due to length of use (used for a long period)
● : Items to confirm the cause.

			Causes: Broken, seized piston, connecting rod	Broken, seized crankshaft bearing	Broken valve system (valve, rocker lever, etc.)	Broken, seized gear train	Broken fuel pump drive shaft, key	Clogged fuel filter, strainer	Clogged feed pump strainer	Broken, seized feed pump piston	Clogged, leaking fuel piping	Clogged air breather hole in fuel tank cap	Defective injection pump (rack, plunger stuck)	Failure in main pump
Questions	Confirm recent repair history													
	Degree of use of machine	Operated for long period					△	△						
	Condition when engine stopped	Abnormal noise was heard and engine stopped suddenly	◎	◎	◎	◎	◎			○			○	◎
		Engine stopped slowly	◎	○										
		There was hunting and engine stopped					○	○						
		Engine overheated and stopped					○	○				○		
	Replacement of filters has not been carried out according to Operation Manual						◎	◎						
	Non-specified fuel is being used						○	○	○				○	
	When feed pump is operated, operation is too light or too heavy						○	○	◎	○				
	Mud is stuck to fuel tank cap										◎			
	Try to turn by hand using barring tool	Does not turn at all	◎	◎										
		Turns in opposite direction			◎									
		Moves amount of backlash				◎								
	Rust and water are found when fuel tank is drained						◎	◎						
	Metal particles are found when oil is drained		◎	◎				○	○					
Troubleshooting	When oil pan is removed and inspection is made directly, it is found to be abnormal		●	●										
	When head cover is removed and inspection is made directly, it is found to be abnormal				●									
	When gear train is inspected, it does not turn					●								
	When fuel filter, strainer are inspected directly, they are found to be clogged						●							
	When feed pump strainer is inspected directly, it is found to be clogged							●						
	Inspect feed pump directly								●					
	When control rack is pushed, it is found to be heavy, or does not return												●	
		Remedy	Replace	Replace	Replace	Replace	Clean	Clean	Replace	Correct	Clean	Replace	—	See troubleshooting of hydraulic, mechanical system (H mode)

S-5 Engine does not rotate smoothly (hunting)

★ Check that the monitor panel does not display any abnormality in the governor control system.

General causes why engine does not rotate smoothly

- Air in fuel system
- Defective governor mechanism
- Defective electric governor mechanism

★ If hunting does not occur when the rod between the governor motor and the injection pump is disconnected, troubleshoot by using the electrical system troubleshooting (E mode).

Legend
○: Possible causes (judging from Questions and check items)
◎: Most probable causes (judging from Questions and Check items)
△: Possible causes due to length of use (used for a long period)
●: Items to confirm the cause.

			Causes: Defective operation of governor	Defective adjustment of governor	Defective operation of control rack	Low idling speed is too low	Clogged feed pump strainer	Clogged fuel filter, strainer	Clogged, air in circuit between fuel tank and feed pump	Clogged, air in circuit between feed pump and nozzle	Clogged air breather hole in fuel tank cap
Questions	Confirm recent repair history										
	Degree of use of machine	Operated for long period					△	△			
	Condition of hunting	Occurs at a certain speed range	◎	◎	◎	○					
		Occurs at low idling	○			◎	○	○	○	○	
		Occurs even when speed is raised	○	○	○						○
Check items	Replacement of filters has not been carried out according to Operation Manual						◎	◎			
	Rust, water are found when fuel tank is drained						○	○			
	Leakage from fuel piping								◎	◎	
	When feed pump is operated,	1) No response, light, return is quick						◎	◎		
		2) No response, light, return is normal						◎			
	Engine speed sometimes rises too far		◎	◎							
	Engine is sometimes difficult to stop		◎		◎						
	Seal on injection pump has come off			◎		◎					
Troubleshooting	When governor lever is moved it is found to be stiff		●		●						
	When injection pump is tested, governor is found to be improperly adjusted			◕							
	When control rack is pushed, it is found to be heavy, or does not return				●						
	When fuel cap is inspected directly, it is found to be clogged					●					●
	When feed pump strainer is inspected directly, it is found to be clogged						●				
	When fuel filter, strainer are inspected directly, they are found to be clogged							●			
	Remedy		Adjust	Adjust	Adjust	Adjust	Clean	Clean	Correct	Correct	Clean

S-6 Engine lacks output (no power)

★ Check that the monitor panel does not display any abnormality in the governor control system.

Measure the engine speed and judge if the cause is in the engine or in the chassis.

General causes why engine lacks output

- Insufficient intake of air
- Insufficient supply of fuel
- Improper condition of fuel injection
- Improper fuel used (if non-specified fuel is used, output drops)
- Lack of output due to overheating

★ If there is overheating and insufficient output, carry out troubleshooting for overheating.

Legend
○ : Possible causes (judging from Questions and check items)
● : Most probable causes (judging from Questions and Check items)
△ : Possible causes due to length of use (used for a long period)
● : Items to confirm the cause.

			Causes: Clogged air cleaner element	Seized turbocharger, interference	Worn piston ring, cylinder liner	Clogged fuel filter, strainer	Clogged feed pump strainer	Seized injection nozzle, defective spray	Improper valve pump plunger	Defective valve clearance	Bent fuel control linkage, defective adjustment	Clogged, leaking fuel piping	Clogged air breather hole in fuel tank cap	Overheating
Questions	Confirm recent repair history													
	Degree of use of machine	Operated for long period	△		△	△	△			△				
	Power was lost	Suddenly		●										●
		Gradually	○		○	○	○	○			○			
	Engine oil must be added more frequently				●									
	Replacement of filters has not been carried out according to Operation Manual		●			●	●							
	Non-specified fuel is being used					●	●	●	●					
	Air cleaner clogging caution lamp flashes		●											
	Color of exhaust gas	Black	●	●										
		Blue under light load			●									
	Noise of interference is heard from around turbocharger			●										
	Blow-by gas is excessive				●									
Check items	Engine pickup is poor and combustion is irregular			●				●				○	○	
	High idling speed under no load is normal, but speed suddenly drops when load is applied					●	●						○	
	When exhaust manifold is touched immediately after starting engine, temperature of some cylinders is low							●	○					
	There is hunting from engine (rotation is irregular)					○	○					○	○	
	Clanging sound is heard from around cylinder head								●					
	High idling speed of engine is low							○			●			
	Leakage from fuel piping											●		
	Water temperature gauge is in red range													●
Troubleshooting	When air cleaner element is inspected directly, it is found to be clogged		●											
	When turbocharger is rotated by hand, it is found to be heavy			●										
	When compression pressure is measured, it is found to be low				●					●				
	When fuel filter, strainer are inspected directly, they are found to be clogged					●								
	When feed pump strainer is inspected directly, it is found to be clogged						●							
	Speed does not change when operation of certain cylinders is stopped							●						
	When control rack is pushed, it is found to be heavy, or does not return								●					
	When valve clearance is checked directly, it is found to be outside standard value									●				
	When lever is placed at FULL position, it does not contact stopper										●			
	When feed pump is operated, operation is too light or too heavy											●		
	When fuel cap is inspected directly, it is found to be clogged												●	Carry out troubleshooting for overheating
		Remedy	Clean	Replace	Replace	Clean	Clean	Correct	Replace	Adjust	Replace	Adjust	Correct	Clean	—	

S-7 Exhaust smoke is black (incomplete combustion)

General causes why exhaust smoke is black
- Insufficient intake of air
- Improper condition of fuel injection
- Excessive injection of fuel

Legend
◯ : Possible causes (judging from Questions and check items)
◎ : Most probable causes (judging from Questions and Check items)
△ : Possible causes due to length of use (used for a long period)
● : Items to confirm the cause.

			Causes: Seized turbocharger, interference	Clogged air cleaner element	Worn piston ring, cylinder liner	Clogged injection nozzle, defective spray	Improper injection timing	Defective injection pump (excessive injection)	Improper valve clearance	Crushed, clogged muffler	Leakage of air between turbocharger and head	Defective contact of valve and valve seat	Defective injection pump (rack, plunger seized)
Questions	Confirm recent repair history												
	Degree of use of machine	Operated for long period		△	△	△						△	
	Color of exhaust gas	Suddenly became black	◎										◯
		Gradually became black	◎	◎							◯		
		Blue under light load			◎								
	Engine oil must be added more frequently				◎								
	Power was lost	Suddenly	◎			◯				◯			◯
		Gradually		◯	◯						◯	◯	
	Non-specified fuel is being used					◯							◯
	Noise of interference is heard from around turbocharger		◎										
Check items	Air cleaner clogging caution lamp flashes			◎									
	Blow-by gas is excessive				◎								
	Engine pickup is poor and combustion is irregular		◯			◎			◯	◯	◯		◯
	When exhaust manifold is touched immediately after starting engine, temperature of some cylinders is low					◎							◯
	Match marks on fuel injection pump are out of alignment						◎						
	Seal on injection pump has come off							◎					
	Clanging sound is heard from around cylinder head								◎				
	Exhaust noise is abnormal		◯			◯				◎			
	Muffler is crushed									◎			
	Leakage of air between turbocharger and head, loose clamp										◎		
Troubleshooting	When turbocharger is rotated by hand, it is found to be heavy		●										
	When air cleaner is inspected directly, it is found to be clogged			●									
	When compression pressure is measured, it is found to be low				●							●	
	Speed does not change when operation of certain cylinders is stopped					●							
	When check is made using delivery method, injection timing is found to be incorrect						●						
	Injection pump test shows that injection amount is incorrect							●					
	When valve clearance is checked directly it is found to be outside standard value								●				
	When muffler is removed, exhaust color returns to normal									●			
	When control rack is pushed, it is found to be heavy, or does not return												●
		Remedy	Replace	Clean	Replace	Replace	Adjust	Adjust	Adjust	Replace	Correct	Replace	Replace

S-8 Oil consumption is excessive (or exhaust smoke is blue)

★ Do not run the engine at idling for more than 20 minutes continuously. (Both low and high idling.)

General causes why oil consumption is excessive

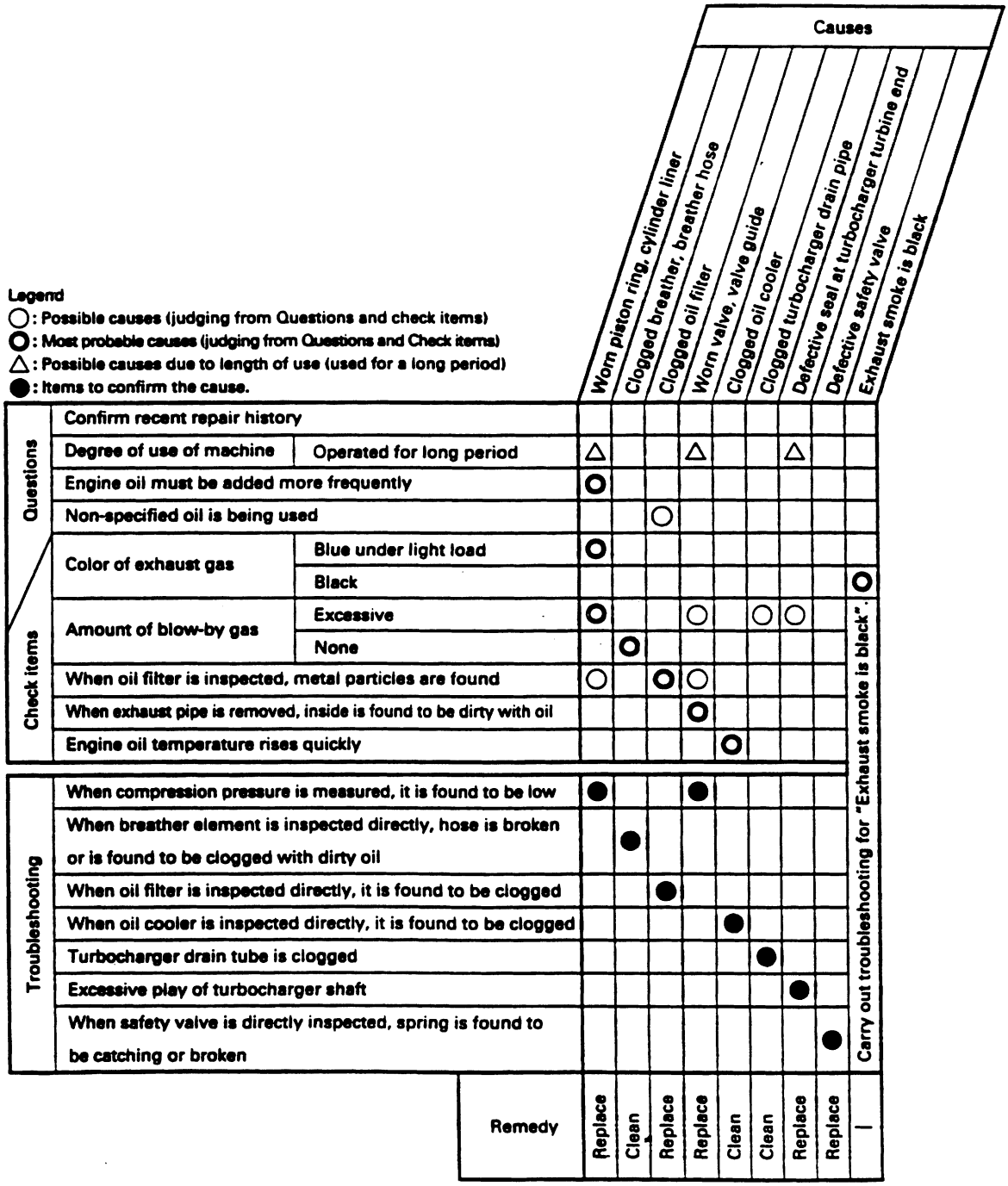
- Abnormal combustion of oil
- Eternal leakage of oil
- Wear of lubrication system

Legend
◯: Possible causes (judging from Questions and check items)
◎: Most probable causes (judging from Questions and Check items)
△: Possible causes due to length of use (used for a long period)
●: Items to confirm the cause.

			Causes													
			Broken piston ring	Worn piston ring, cylinder liner	Clogged breather or breather hose	Leakage from oil filter or oil cooler	Leakage from oil piping	Leakage from oil drain plug	Leakage from oil pan or cylinder head	Broken oil cooler	Turbocharger: Worn seal at turbine end	Turbocharger: Worn seal at blower end	Turbocharger: Worn, broken rear seal, seal surface	Dust sucked in from intake system	Worn valve (stem, guide), broken seal
Questions	Confirm recent repair history															
	Degree of use of machine	Operated for long period		△						△	△				△
	Oil consumption suddenly increased		◎						◯						
	Engine oil must be added more frequently			◎					◯						
	Engine oil becomes contaminated quickly		◯	◎	◯										
	Exhaust smoke is blue under light load		◎	◎											
	Amount of blow-by gas	Excessive	◎	◎							◯				◯
		None			◎										
Check items	Area around engine is dirty with oil				◎	◎	◎	◎							
	There is oil in engine cooling water								◎						
	When exhaust pipe is removed, inside is found to be dirty with oil									◎					◯
	When turbocharger air supply pipe is removed, inside is found to be dirty with oil										◎				
	Oil level in PTO chamber rises											◎			
	Clamps for intake system are loose												◎		
Check items	When compression pressure is measured, it is found to be low		●	●											
	When breather element is inspected, it is found to be clogged with dirty oil				●										
	There is external leakage of oil from engine					●	●	●	●						
	Pressure-tightness test of oil cooler shows there is leakage									●					
	Excessive play of turbocharger shaft										●	●			
	Inspect rear seal directly												●		
	When intake manifold is removed, dust is found inside													●	
	When intake manifold is removed, inside is found to be dirty with oil														●
	Remedy		Replace	Replace	Clean	Correct	Correct	Correct	Correct	Replace	Replace	Replace	Correct	Correct	Correct

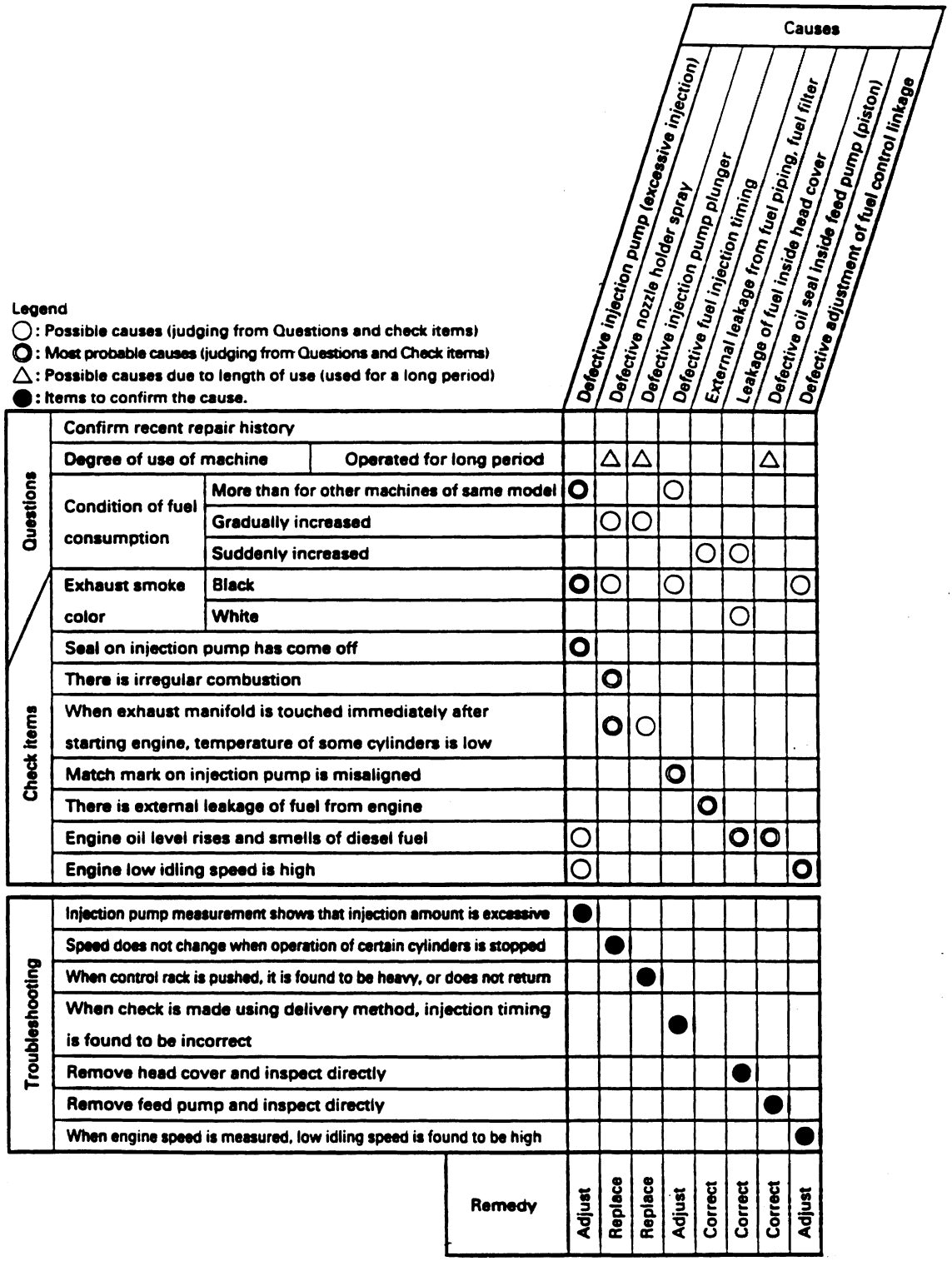
S-9 Oil becomes contaminated quickly

General causes why oil becomes contaminated quickly
- Intake of exhaust gas due to internal wear
- Clogging of lubrication passage
- Improper fuel
- Improper oil used
- Operation under excessive load



S-10 Fuel consumption is excessive

General causes why fuel consumption is excessive
- Leakage of fuel
- Improper condition of fuel injection
- Excessive injection of fuel



S-11 Oil is in cooling water, or water spurts back, or water level goes down

General causes why oil is in cooling water
- Internal leakage in lubrication system
- Internal leakage in cooling system

Legend
○ : Possible causes (judging from Questions and check items)
◎ : Most probable causes (judging from Questions and Check items)
△ : Possible causes due to length of use (used for a long period)
● : Items to confirm the cause.

			Causes: Broken oil cooler core, O-ring	Broken cylinder head, head gasket	Insufficient protrusion of liner	Broken liner O-ring, holes caused by pitting	Internal cracks in cylinder block
Questions	Confirm recent repair history						
	Degree of use of machine	Operated for long period	△			△	
	Oil level	Suddenly increased	○	○			
		Gradually increased				○	○
Check items	Hard water is being used as cooling water		○			○	
	Engine oil level has risen, oil is cloudy white		◎			○	○
	Excessive air bubbles inside radiator, spurts back			◎	◎		
Troubleshooting	Pressure-tightness test of oil cooler shows there is leakage		●				
	Pressure-tightness test of cylinder head shows there is leakage			●			
	Remove cylinder head and inspect directly				●		
	Remove oil pan and inspect directly					●	●
		Remedy	Replace	Replace	Replace	Replace	Replace

S-12 Oil pressure caution lamp lights up (drop in oil pressure)

★ Check that the monitor panel engine oil level lamp is not lighted up.
★ When the oil pressure sensor is normal (see M mode).

General causes why oil pressure lamp lights up
- Leakage, clogging, wear of lubricating system
- Defective oil pressure control
- Improper oil used (improper viscosity)
- Deterioration of oil due to overheating

★ Standards for engine oil selection

Type of fuel	Ambient temperature
	-22 -4 14 32 50 68 86 104°F -30 -20 -10 0 10 20 30 40°C
Diesel fuel	SAE 30 SAE 10W SAE 10W-30 SAE 15W-40

Legend
◯ : Possible causes (judging from Questions and check items)
◎ : Most probable causes (judging from Questions and Check items)
△ : Possible causes due to length of use (used for a long period)
● : Items to confirm the cause.

			Causes: Clogged oil filter	Worn bearing, journal	Clogged strainer inside oil pan	Clogged, broken oil pipe inside oil pan	Broken suction pipe brazing	Defective oil pump	Defective regulator valve	Defective main relief valve	Leaking, crushed hydraulic piping	Defective oil pressure sensor	Water, fuel in oil
Questions	Confirm recent repair history												
	Degree of use of machine	Operated for long period	△	△				△					
	Replacement of filters has not been carried out according to Operation Manual		◎										
	Non-specified oil is being used		◯	◯									
Check items	Condition when oil pressure lamp lights up	Lights up at low idling		◎					◯				
		Lights up at low, high idling			◎	◎	◎	◎	◯	◯			
		Sometimes lights up							◎	◎		◯	
	There is clogging, leakage from hydraulic piping (external)										◎		
	Metal particles are found when oil is drained			◎									
	Metal particles are stuck to oil filter element			◎				◯					
	Oil is cloudy white or smells of diesel oil												◎
Troubleshooting	When oil filter is inspected directly, it is found to be clogged		●	●									
	Remove oil pan and inspect directly				●	●	●						
	Oil pump rotation is heavy, there is play							●					
	There is catching of relief valve or regulator valve, spring or valve guide is broken								●	●			
	When oil pressure is measured, it is found to be within standard value											●	
			Carry out troubleshooting for "Oil level rises".										
	Remedy		Clean	Clean	Clean	Clean	Correct	Replace	Adjust	Adjust	Correct	Replace	—

S-13 Oil level rises (water, fuel in oil)

★ If there is oil in the cooling water, carry out trouble-shooting for "Oil is in cooling water".

General causes why oil level rises

- Water in oil
- Fuel in oil (diluted, and smells of diesel fuel)
- Entry of oil from other component

Legend
○: Possible causes (judging from Questions and check items)
◎: Most probable causes (judging from Questions and Check items)
△: Possible causes due to length of use (used for a long period)
●: Items to confirm the cause.

		Causes											
		Broken oil cooler core, O-ring	Defective nozzle holder sleeve	Broken cylinder head, head gasket (precombustion chamber)	Clogged water pump breather hole, defective seal	Worn, damaged rear seal surface	Defective main pump seal	Leakage of fuel inside head cover	Defective part inside injection pump (flange type)	Defective thermostat seat portion	Damaged liner O-ring, holes made by pitting · Defective thermostat seat	Cracks inside cylinder block
Questions	Confirm recent repair history											
	Degree of use of machine / Operated for long period		△		△	△	△				△	
	When engine is first started, drops of water come from muffler		◎									
	Exhaust smoke is white		◎					○		○	○	
Check items	There is oil in radiator cooling water	◎	○	○							○	○
	Leave radiator cap open. When engine is run at idling, an abnormal number of bubbles appear, or water spurts back			◎							○	
	Water pump breather hole is clogged with mud				◎							
	When water pump breather hole is cleaned, water comes out				◎							
	Oil level goes down in damper chamber					◎						
	Oil level goes down in hydraulic tank						◎					
	Engine oil smells of diesel fuel							◎	◎	◎		
	Fuel must be added more frequently							◎	◎	◎		
Troubleshooting	Pressure-tightness test of oil cooler shows there is leakage	●										
	Pressure-tightness test of cylinder head shows there is leakage		●									
	When compression pressure is measured, it is found to be low			●								
	Remove water pump and inspect directly				●							
	Remove rear seal and inspect directly					●						
	When main pump is removed, seal is found to be damaged						●					
	Remove head cover and inspect directly							●				
	Remove injection pump and inspect directly								●			
	Defective contact of thermostat seal valve									●		
	Remove oil pan and check directly										●	●
	Remedy	Replace	Replace	Replace	Replace	Correct	Replace	Correct	Replace	Replace	Replace	Replace

S-14 Water temperature becomes too high (overheating)

★ Check that the monitor panel coolant level caution lamp is not lightened up.
★ When the monitor panel water temperature gauge is normal, go to troubleshooting of machine monitor system (M mode).

General causes why water temperature becomes too high
- Lack of cooling air (deformation, damage of fan)
- Drop in heat dissipation efficiency
- Defective cooling circulation system

★ Carry out troubleshooting for chassis.

Legend
◯ : Possible causes (judging from Questions and check items)
◎ : Most probable causes (judging from Questions and Check items)
△ : Possible causes due to length of use (used for a long period)
● : Items to confirm the cause.

			Causes											
			Broken water pump	Clogged, crushed radiator fins	Clogged radiator core	Defective thermostat (does not open)	Defective water temperature gauge	Fan belt slipping, worn fan pulley	Clogged, broken oil cooler	Defective radiator pressure valve	Broken head, head gasket	Damaged liner O-ring, holes made by pitting	External leakage from cooling water piping
Questions	Confirm recent repair history												
	Degree of use of machine	Operated for long period		△	△						△	△	
	Condition of overheating	Suddenly overheated	◎				◯						
		Always tends to overheat		◎	◎	◯		◯					
	Water temperature gauge	Rises quickly				◎							
		Does not go down					◎						
Check items	Fan belt whines under sudden load							◎					
	Cloudy white oil is floating on cooling water								◎				
	Cooling water flows out from overflow hose									◎			
	Excessive air bubbles inside radiator, water spurts back										◎		
	Engine oil level has risen, oil is cloudy white							◯				◎	
	There is play when fan pulley is rotated		◎										
	Radiator shroud, inside of underguard are clogged with dirt or mud			◎									
	When light bulb is held behind radiator, no light passes through			◎									
	Water is leaking because of cracks in hose or loose clamps												◎
	When belt tension is inspected, it is found to be loose						◎						
Troubleshooting	Temperature difference between top and bottom radiator tanks is excessive		●										
	Temperature difference between top and bottom radiator tanks is slight			●									
	When water filler port is inspected, core is found to be clogged				●								
	When function test is carried out on thermostat, it does not open even at cracking temperature					●							
	When water temperature is measured, it is found to be normal						●						
	When oil cooler is inspected directly, it is found to be clogged							●					
	When measurement is made with radiator cap tester, set pressure is found to be low								●				
	When compression pressure is measured, it is found to be low									●			
	Remove oil pan and inspect directly										●		
		Remedy	Replace	Correct	Correct	Replace	Replace	Correct	Replace	Replace	Replace	Replace	Correct, replace

S-15 Abnormal noise is made

★ Judge if the noise is an internal noise or an external noise.

General causes why abnormal noise is made

- Abnormality due to defective parts
- Abnormal combustion
- Air sucked in from intake system

Legend
○ : Possible causes (judging from Questions and check items)
◎ : Most probable causes (judging from Questions and Check items)
△ : Possible causes due to length of use (used for a long period)
● : Items to confirm the cause.

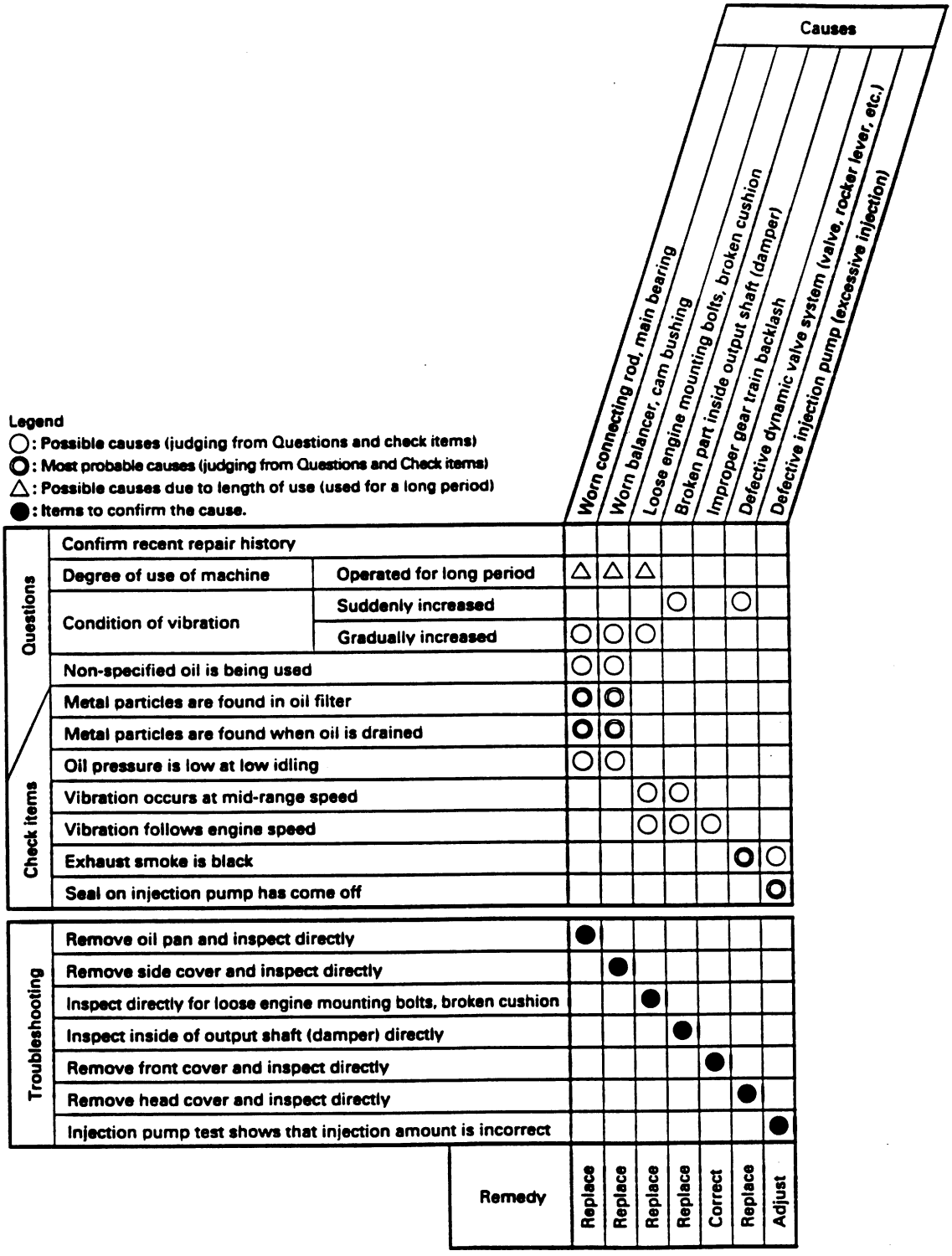
			Causes												
			Excessive wear of piston ring, cylinder liner	Seized turbocharger, interference	Missing, seized busning	Clogged, seized injection nozzle	Defective injection pump (rack, plunger seized)	Defective injection pump (excessive injection)	Deformed fan, fan belt interference	Defective adjustment of valve clearance	Broken dynamic valve system (valve, rocker lever, etc.)	Improper gear train backlash	Leakage of air between turbocharger and head	Defect inside muffler (dividing board out of position)
Questions	Confirm recent repair history													
	Degree of use of machine	Operated for long period	△											
	Condition of abnormal noise	Gradually occurred	○						○					
		Suddenly occurred		○	○						○			
	Non-specified fuel is being used					○	○							
	Engine oil must be added more frequently		◎											
Check items	Color of exhaust gas	Blue under light load	◎											
		Black		◎						○			○	
	Metal particles are found in oil filter		◎		◎									
	Blow-by gas is excessive		◎											
	Noise of interference is heard from around turbocharger			◎										
	Engine pickup is poor and combustion is abnormal					◎								
	When exhaust manifold is touched immediately after starting engine, temperature of some cylinders is low					◎	○							
	Seal on injection pump has come off						◎							
	Abnormal noise is loud when accelerating engine					○	○	○	○	○		○		
	Clanging sound is heard from around cylinder head								◎	◎				
	Leakage of air between turbocharger and head, loose clamp												◎	
	Vibrating noise is heard from around muffler													◎
Troubleshooting	When compression pressure is measured, it is found to be low		●											
	When turbocharger is rotated by hand, it is found to be heavy			●										
	Remove gear cover and inspect directly				●							●		
	Speed does not change when operation of certain cylinders is stopped					●								
	When control rack is pushed, it is found to be heavy, or does not return						●							
	Injection pump test shows that injection amount is incorrect							●						
	Fan is deformed, belt is loose								●					
	When valve clearance is checked, it is found to be outside standard value									●				
	Remove cylinder head cover and inspect directly										●			
	When muffler is removed, abnormal noise disappears													●
	Remedy		Replace	Replace	Replace	Replace	Correct	Replace	Correct	Replace	Correct	Replace	Replace	Replace

S-16 Vibration is excessive

★ If there is abnormal noise together with the vibration, carry out troubleshooting for "Abnormal noise is made".

General causes why vibration is excessive

- Defective parts (abnormal wear, breakage)
- Improper alignment
- Abnormal combustion



TROUBLESHOOTING OF ENGINE THROTTLE, 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 cases, there is a high probability that the same problem will occur again, so it is desirable to follow up the 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.

2. Service code memory retention function

When displaying the abnormality code in memory and carrying out troubleshooting, note down all the contents of the display, then erase the display. After trying to re-enact the problem, carry out troubleshooting according to the service 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
E02	E232	Short circuit in pump PC-EPC solenoid system	1. Internal short circuit, short circuit with chassis ground in pump PC-EPC solenoid 2. Short circuit with power source, short circuit with chassis ground in wiring harness between controller C02 (8) and PC-EPC solenoid C13 (1) ((+) end) 3. Wiring harness between controller C02 (18) and PC-EPC solenoid C13 (2) ((-) end) short circuiting with power source 4 Defective engine throttle, pump controller
	E233	Disconnection in pump PC-EPC solenoid system	1. Internal disconnection, defective contact in pump PC-EPC solenoid 2. Defective contact or disconnection in wiring harness between controller C02 (8) and PC-EPC solenoid C13 (1) ((+ end) 3. Short circuit with chassis ground, defective contact or disconnection in wiring harness between controller C02 (18) and PC-EPC solenoid C13 (2) ((-) end) 4. Defective engine throttle, pump controller
E02	E203	Short circuit in swing holding brake solenoid system	1. Internal short circuit, short circuit with chassis ground in swing holding brake solenoid 2. Wiring harness between controller C01 (3) and solenoid V04 (1) ((+) end) short circuiting with chassis ground 3. Defective engine throttle, pump controller
	E213	Disconnection in swing holding brake solenoid system	1. Internal disconnection, defective contact in swing holding brake solenoid 2. Short circuit with power source, defective contact or disconnection in wiring harness between controller C01 (3) and solenoid V04 (1) ((+) end) 3. Defective contact or disconnection in wiring harness between solenoid V04 (2) and chassis ground ((-) end) 4. Defective engine throttle, 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: 7 - 14 Ω	1. Makes output to PC-EPC solenoid 0 2. Displays user code E02 on monitor panel ★ If the abnormality is restored by the vibration of the machine, the condition will return to normal when the power source is reset. (However, the service code does not go out.)	1. No current flows to the pump PC-EPC solenoid Therefore, when the load is large, there is a big drop in the engine speed, which may result in the engine stalling. 2. Swing acceleration is poor
• Resistance of solenoid: 7 - 14 Ω • Current: 1,000 mA [H/O mode, auto-decele-ration ON, levers at neutral, fuel control dial at MAX.]	1. The current stops flowing to the PC-EPC solenoid, so no particular action is taken. 2. If there is short circuit with chassis ground at (-) terminal, current (1A or more) continues to flow to PC-EPC solenoid 3. Displays user code E02 on monitor panel ★ If the abnormality is restored by the vibration of the machine, the condition will automatically return to normal. (However, the service code does not go out.)	1. In the case of 1, it is the same as E232. 2. In the case of 2, current (1A or more) continues to flow to the pump PC-EPC solenoid, so the output pressure of the pump PC-EPC valve increases and the overall speed becomes slower.
• Resistance of solenoid: 20 - 60Ω	1. Makes output to solenoid 0 2. Displays user code E03 on monitor panel ★ If the abnormality is restored by the vibration of the machine, the condition will return to normal when the power source is reset. (However, the service code does not go out.)	When the swing is operated, the motor brake is not released, so the upper structure does not swing.
• Resistance of solenoid: 20 - 60 Ω	1. The current stops flowing to the solenoid, so no particular action is taken. 2. Displays user code E03 on monitor panel ★ If the abnormality is restored by the vibration of the machine, the condition will automatically return to normal. (However, the service code does not go out.)	Same as E203 display

User code	Service code	Abnormal system	Nature of abnormality
-	E205	Short circuit in 2-stage relief solenoid system	1. Internal short circuit, short circuit with chassis ground in 2-stage relief solenoid 2. Wiring harness between controller C01 (10) and solenoid V05 (1) (= end short circuiting with chassis ground 3. Defective engine throttle, pump controller
-	E206	Short circuit in travel speed solenoid system	1. Internal short circuit, short circuit with chassis ground in travel speed solenoid 2. Wiring harness between controller C01 (9) and solenoid V06 (1) (= end) short circuiting with chassis ground 3. Defective engine throttle, pump controller
-	E215	Disconnection in 2-stage relief solenoid system	1. Internal disconnection, defective contact in 2-stage relief solenoid 2. Short circuit with power source, defective contact or disconnection in wiring harness between controller C01 (10) and solenoid V05 (1) (= end) 3. Defective contact or disconnection in wiring harness between solenoid V05 (1) and chassis ground (- end) 4. Defective engine throttle, pump controller
-	E216	Disconnection in travel speed solenoid system	1. Internal disconnection, defective contact in travel speed solenoid 2. Short circuit with power source, defective contact or disconnection in wiring harness between controller C01 (9) and solenoid V06 (1) (= end) 3. Defective contact or disconnection in wiring harness between solenoid V06 (2) and chassis ground (- end) 4. Defective engine throttle, 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, the condition will return to normal when the power source is reset. (However, the service code does not go out.)	1. When traveling or using the power max. function, the relief pressure is not raised, so there is lack of power. ★ When traveling, 2-stage relief solenoid works only on PC120 and 130
• Resistance of solenoid: 20 - 60 Ω	1. Makes output to solenoid 0 ★ If the abnormality is restored by the vibration of the machine, the condition will return to normal when the power source is reset. (However, the service code does not go out.)	Even when travel speed selection is operated, travel speed does not change (remains at Lo)
• Resistance of solenoid: 20 - 60 Ω	1. Makes output to solenoid 0 ★ If the abnormality is restored by the vibration of the machine, the condition will return to normal when the power source is reset. (However, the service code does not go out.)	
• 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, the condition will return to normal when the power source is reset. (However, the service code does not go out.)	Same as E207 display
• 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, the condition will return to normal when the power source is reset. (However, the service code does not go out.)	Same as E205 display
• 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, the condition will return to normal when the power source is reset. (However, the service code does not go out.)	Same as E206 display

User code	Service code	Abnormal system	Nature of abnormality
-	E217	Model selection input error	1. Short circuit with chassis ground, defective contact or disconnection in model selection wiring harness C17 (5) (6) (7) (13) (14) 2. Defective engine throttle, pump controller
-	E218	Network response overtime error	1. Disconnection, short circuit, short circuit with chassis ground in network wiring harness 2. Abnormality in engine throttle, pump controller 3. Abnormality in monitor panel
-	E222	Short circuit in LS-EPC solenoid system	1. Internal short circuit, short circuit with chassis ground in LS-EPC solenoid 2. Short circuit with power source, short circuit with chassis ground in wiring harness between controller C02 (7) and solenoid C10 (1) (= end) 3. Wiring harness between controller C02 (17) and solenoid C10 (2) (- end) short circuiting with power source 4. Defective engine throttle, pump controller
-	E224	Disconnection in LS-EPC solenoid system	1. Internal disconnection, defective contact in LS-EPC solenoid 2. Defective contact or disconnection in wiring harness between controller C02 (7) and solenoid C10 (1) (= end) 3. Short circuit with chassis ground, defective contact or disconnection in wiring harness between controller C02 (17) and solenoid C10 (2) (- end) short circuiting with power source 4. Defective engine throttle, pump controller
-	E223	Abnormality in pump pressure sensor system	1. Internal disconnection, defective contact, short circuit, short circuit with chassis ground in pump pressure sensor 2. Short circuit, defective contact or disconnection in wiring harness between controller C03 (6) and pressure sensor C08 (2) (= end), and between C03 (16) and C08 (1) (- end) 3. Short circuit with chassis ground, short circuit with power source, defective contact or disconnection in wiring harness between controller C03 (3) and pressure sensor C08 (3) (SIG end) 4. Defective engine throttle, pump controller

Condition when normal (voltage, current, resistance)	Action by controller when abnormality is detected	Problem that appears on machine when there is abnormality
• Between C17 (6) (13) and chassis: Max. 1Ω • Between C17 (5) (7) (14) and chassis: Min. 1Ω	Detects abnormality in input 1. Retains data when starting switch is ON	1. Engine stalls, or 2. All work equipment, swing, travel speeds are slow or lack power
	1. When communications are impossible with the monitor, controls as follows. (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 does not increase (2) The swift slow-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 0 ★ If the abnormality is restored by the vibration of the machine, the condition will return to normal when the power source is reset. (However, the service code does not go out.)	1. The Lo travel speed is too fast 2. In L/O mode and F/O mode, the work equipment speed is too fast 3. When the engine is running at low idling, the swing speed is too fast
• Current: 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 short circuit with chassis ground at (-) terminal, current (1A or more) continues to flow to LS-EPC solenoid ★ If the abnormality is restored by the vibration of the machine, the condition will return to normal when the power source is reset. (However, the service code does not go out.)	1. In the case of 1, it is the same as E222 2. In the case of 2, the current (1A or more) 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 C03 (6) and (16): 18 - 28 V • Between C03 (female) (3) and (16), (3) and chassis: Min. 1 MΩ (Disconnect connectors C03 and C08.)	1. Takes pump pressure as 0 MPa {0 kg/cm^2)} when actuating. ★ If the abnormality is restored by the vibration of the machine, the condition will return to normal when the power source is reset. (However, the service code 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

User code	Service code	Abnormal system	Nature of abnormality
-	E226	Abnormality in pressure sensor power source system	1. Internal short circuit, short circuit with chassis ground in pump pressure sensor 2. Short circuit with chassis ground, short circuit in wiring harness between controller C03 (6) and pressure sensor C08 (2) (= end) 3. Defective engine throttle, pump controller
-	E227	Abnormality in engine speed sensor system	1. Short circuit with chassis ground, internal disconnection, defective contact in engine speed sensor 2. Short circuit with chassis ground, defective contact or disconnection in wiring harness between controller C16 (1) and speed sensor E07 (2) (- end), and between C16 (2) and E07 (1) (SIG end) 3. Defective engine throttle, pump controller

Condition when normal (voltage, current, resistance)	Action by controller when abnormality is detected	Problem that appears on machine when there is abnormality
• Between C03 (6) and (16): 18 - 28 V	1. Takes pump pressure as 0 MPa {0 kg/cm^2)} when actuating. 2 If the abnormality is detected, it switches the output OFF, and when all levers are returned to neutral, 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 as the equivalent of the G/O mode (the speed rises)	1. It operates about the same as G/O mode (prolix) (the power is slightly lower)

JUDGEMENT TABLE FOR PUMP CONTROLLER AND HYDRAULIC RELATED PARTS

Failure Mode			Abnormality in controller power source	Engine throttle, pump controller (E2: XX system) Self-diagnostic display: Short circuit in PC-EPC solenoid system	Disconnection in PC-EPC solenoid system	Short circuit in swing holding brake solenoid system	Disconnection in swing holding brake solenoid system	Short circuit in 2-stage relief solenoid system	Disconnection in 2-stage relief solenoid system	Short circuit in travel speed solenoid system	Disconnection in travel speed solenoid system	Model selection input error
	User code			E02		-		E03		-		
	Service code			232	233	203	213	205	215	206	216	217
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											
	Excessive time lag (engine at low idling)											
	Lack of power when pressure rises							●	●			
	Other equipment moves when single circuit is relieved											
Compound operations	In F/O mode, arm IN speed is faster than specified speed											
	In compound operations, work equipment with larger load is slow											
Travel system	Travel speed is slow											
	Travel speed does not switch or is faster than specified speed		●							●	●	
Swing system	Does not swing	Both left and right				●	●					
		One direction only										
	Swing acceleration is poor or swing speed is low	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 swing holding brake is canceled										
		When swing holding brake is applied										
	Swing speed is faster than specified swing speed											
	Troubleshooting 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-12
	Troubleshooting code when there is abnormality in monitoring code check		-	-	-	-	-	-	-	-	-	-

❋ :This shows item that needs only checking with monitoring
● :This shows applicable item for service code
○ : 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.

					Check items with monitoring mode																					Troubleshooting code if no service code is displayed
Short circuit in LS-EPC solenoid system	Disconnection in LS-EPC solenoid system	Abnormality in pump pressure sensor system	Abnormality in pressure sensor power source system	Abnormality in engine speed sensor system	Oil pressure switch								Swing lock switch (3)	Knob switch (6)	Solenoid drive condition			Mode selection code	Engine speed input	Pump discharge pressure input	PC-EPC current output	LS-EPC current output	Is the voltage for engine water temperature		
		-			Bit pattern													Monitoring code							
222	223	224	226	227	20						21			22	23			02	10	11	13	15	41		
	●			●																					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
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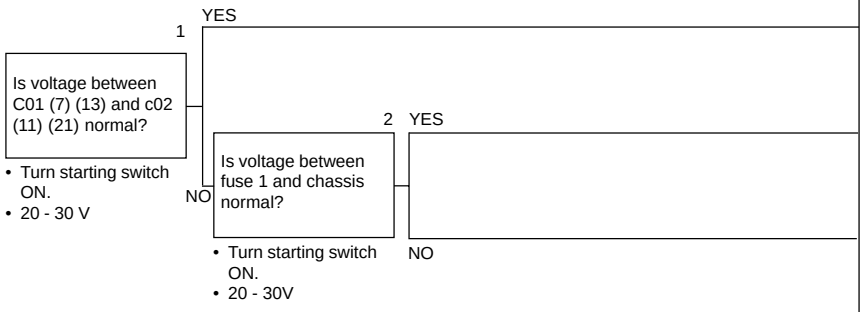
																									H-22
																									H-23
																									H-24
●	●																								H-25
C-13	C-14	C-15	C-16	C-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
-	-	-	-	-	F-1	F-2	F-3	F-4	F-5	F-6	F-7	F-8	F-9	F-11	-	-	-	-	-	-	-	-	-		

A3

A3

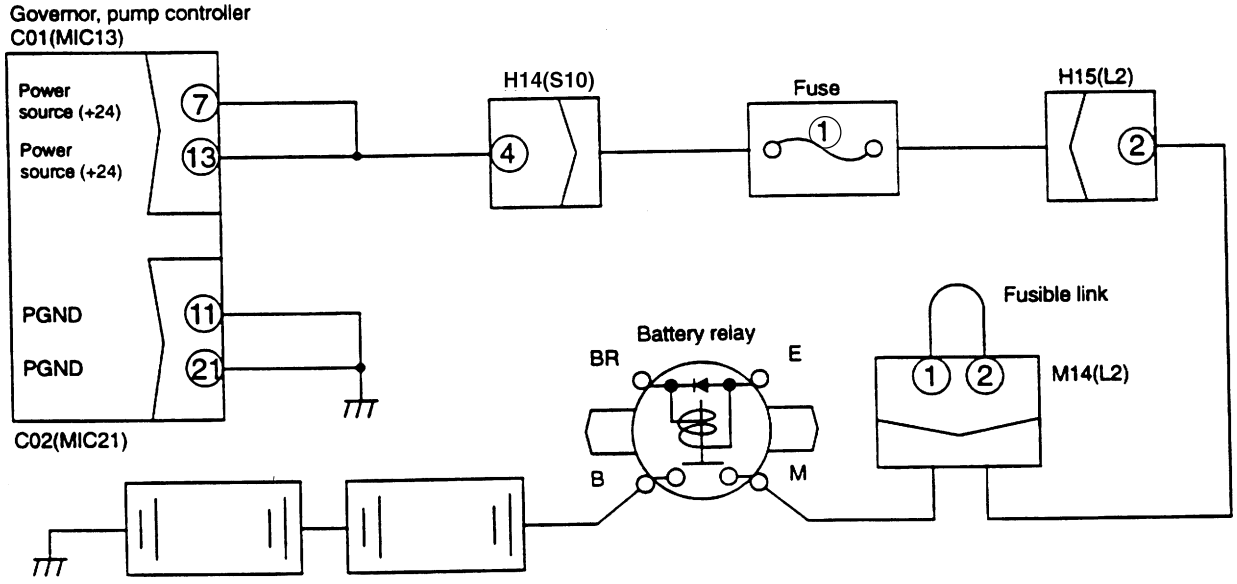
C-1 Abnormality in controller power source system (controller LED is OFF)

★ **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 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 to the next step.
★ When the starting motor rotates normally. (If the starting motor also does not rotate, go 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

C-1 Related electric circuit diagram



C-2 [E232] Short circuit in pump PC-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 the service code "E" 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 that the service code "E" is displayed. (If it is not displayed, the problem has been removed.)
★ Always turn the pump prolix switch OFF.
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on to the next step.

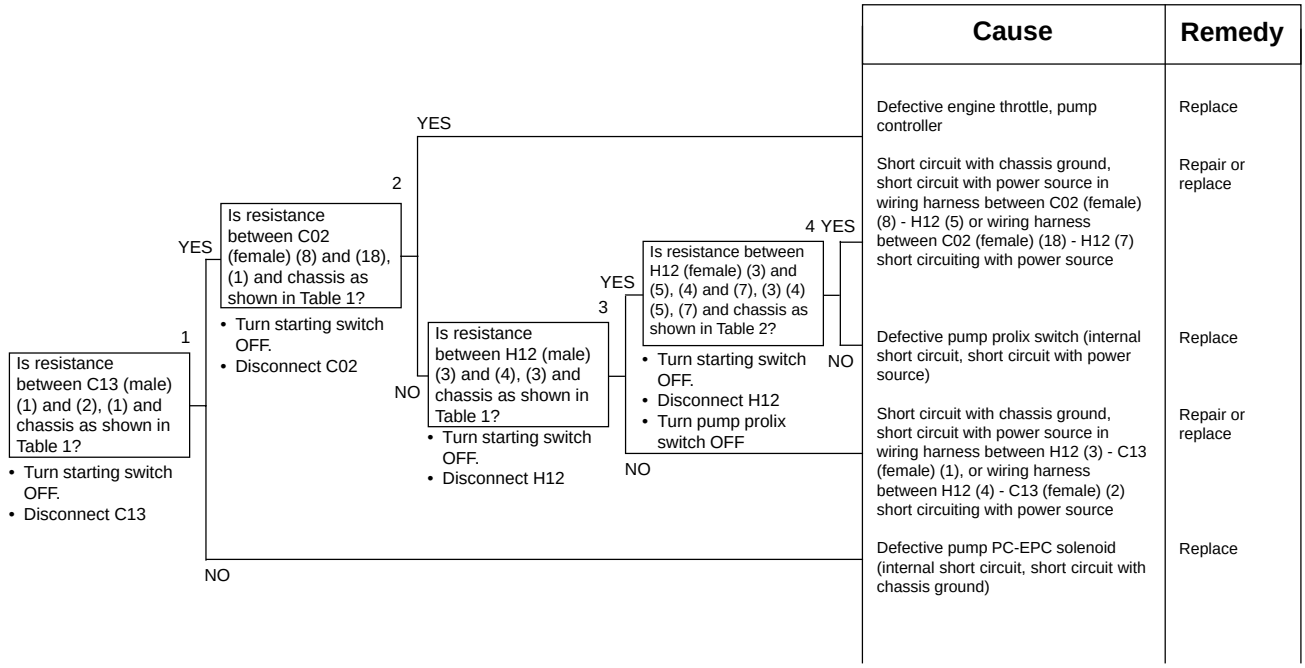


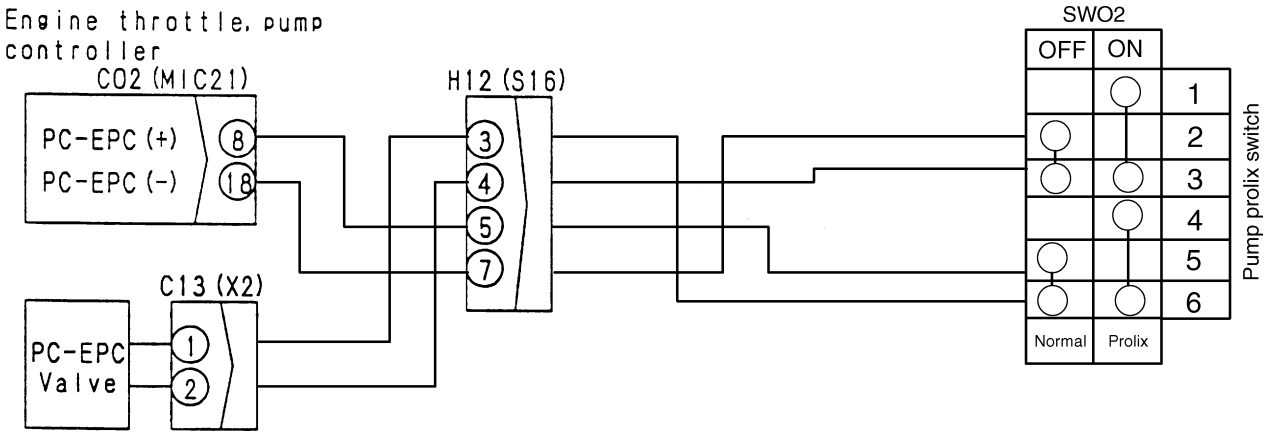
Table 1

Troubleshooting 1	Troubleshooting 2	Troubleshooting 3	Resistance value
Between C13 (male) (1) and (2)	Between C02 (female) (8) and (18)	Between H12 (male) (3) and (4)	10 - 22 Ω
Between C13 (male) (1) and chassis	Between C02 (female) (8) and chassis	Between H12 (male) (3) and chassis	Min. 1 MΩ

Table 2

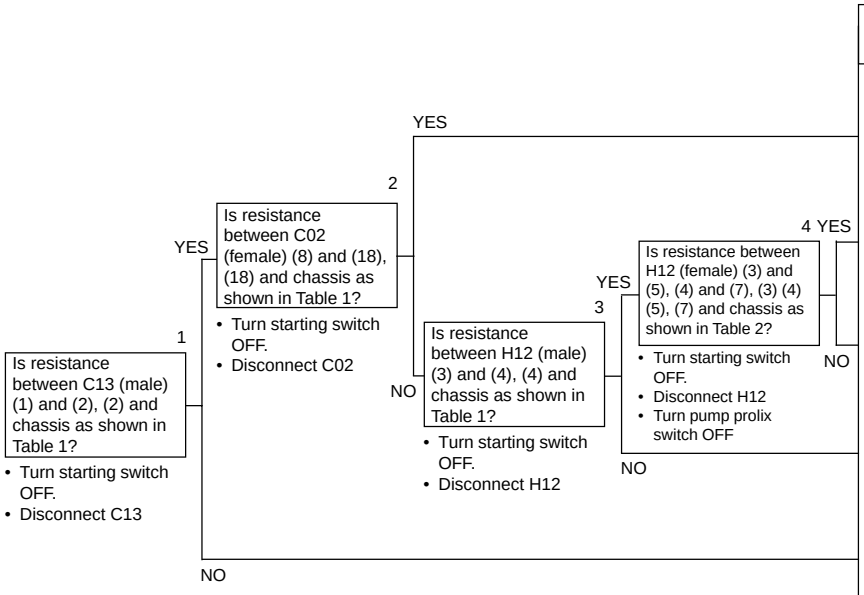
Troubleshooting 4	Resistance value
Between H12 (female) (3) - (5), (4) - (7)	Max. 1 Ω
Between H12 (female) (3) (4) (5) (7) and chassis	Min. 1 MΩ

C-2 Related electrical circuit diagram



C-3 [E233] Disconnection in PC-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 the service code "E" 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 that the service code "E" 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 of the solenoid is short circuiting with the chassis ground, the current (approx. 1A) continues to flow to the solenoid.
★ Always turn the pump prolix switch OFF.
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on to the next step.



Cause	Remedy
Defective engine throttle, pump controller	Replace
Defective contact or disconnection between wiring harness between C02 (female) (8) - H12 (5) or short circuit with chassis ground, defective contact or disconnection in wiring harness between C02 (female) (18) - H12 (7) - C05 (female) (2)	Repair or replace
Defective pump prolix switch (internal disconnection, defective contact, short circuit with chassis ground)	Replace
Defective contact or disconnection in wiring harness between H12 (3) - C13 (female) (1), or short circuit with chassis ground, defective contact or disconnection in wiring harness between H12 (4) - C13 (female) (2)	Repair or replace
Defective PC-EPC solenoid (internal disconnection, defective contact)	Replace

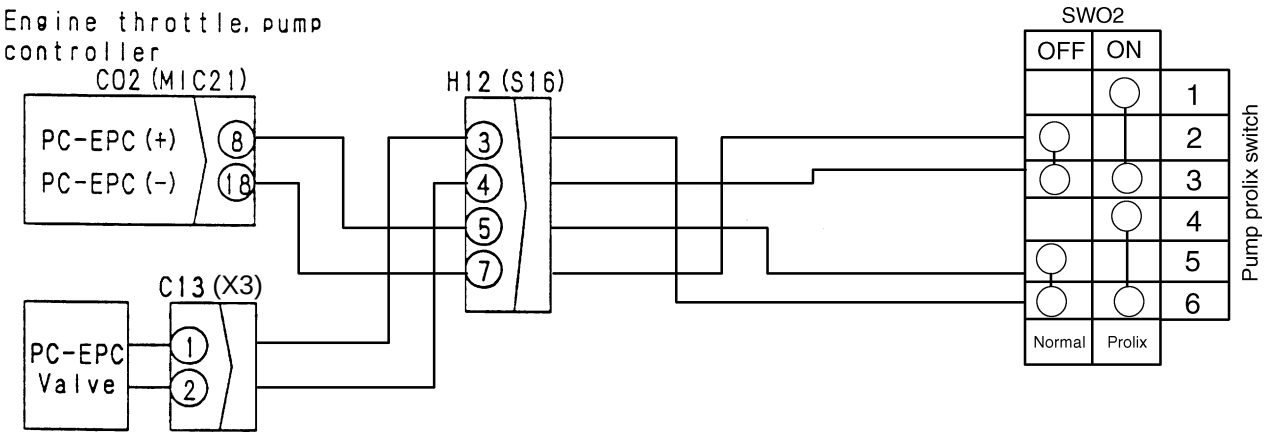
Table 1

Troubleshooting 1	Troubleshooting 2	Troubleshooting 3	Resistance value
Between C13 (male) (1) and (2)	Between C02 (female) (8) and (18)	Between H12 (male) (3) and (4)	10 - 22 Ω
Between C13 (male) (2) and chassis	Between C02 (female) (18) and chassis	Between H12 (male) (4) and chassis	Min. 1 MΩ

Table 2

Troubleshooting 4	Resistance value
Between H12 (female) (3) - (5), (4) - (7)	Max. 1 Ω
Between H12 (female) (3) (4) (5) (7) and chassis	Min. 1 MΩ

C-3 Related electrical circuit diagram



C-4 [E203] Short circuit in swing holding 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 the service code "E" 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 that the service code "E" 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 to the next step.

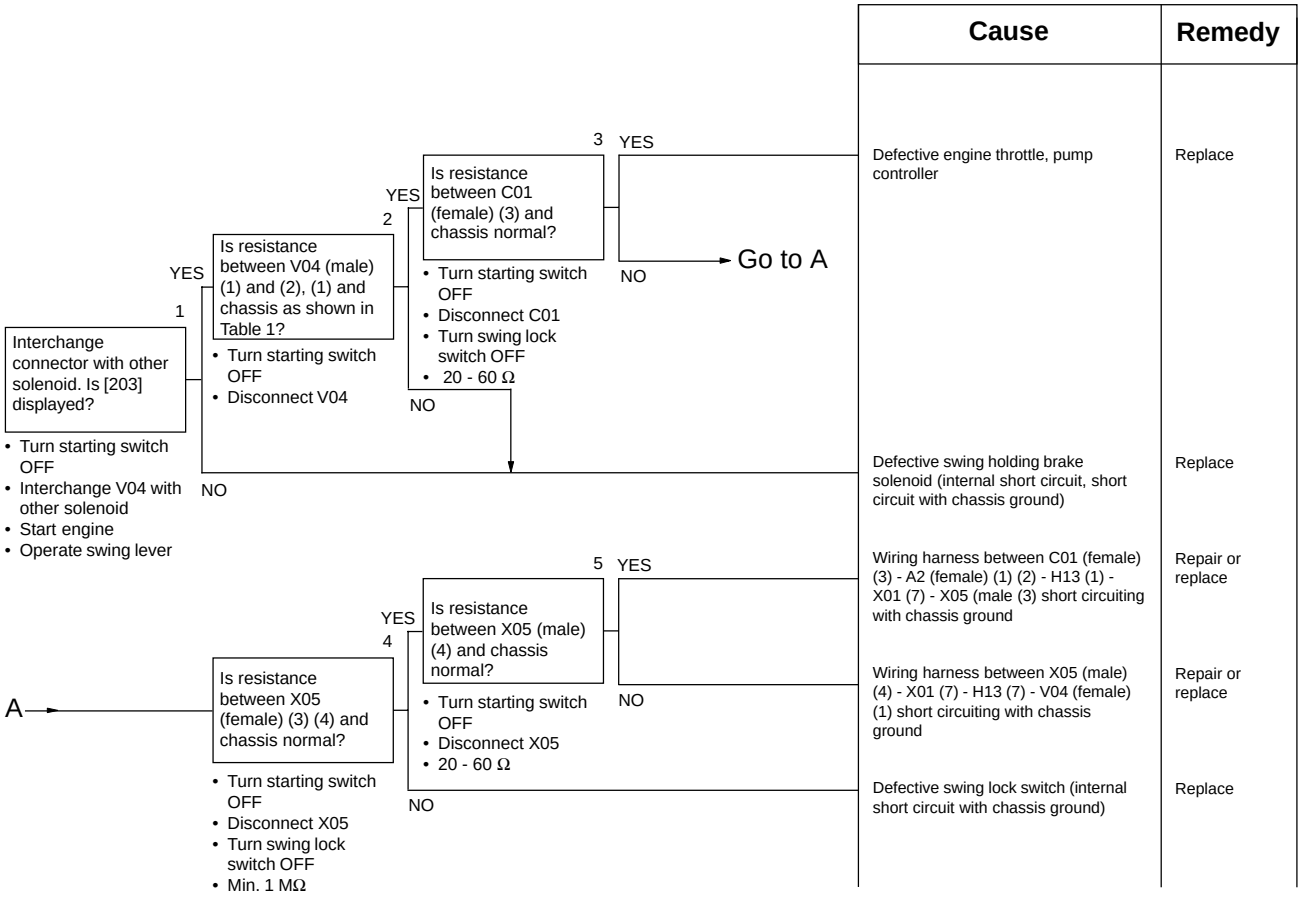
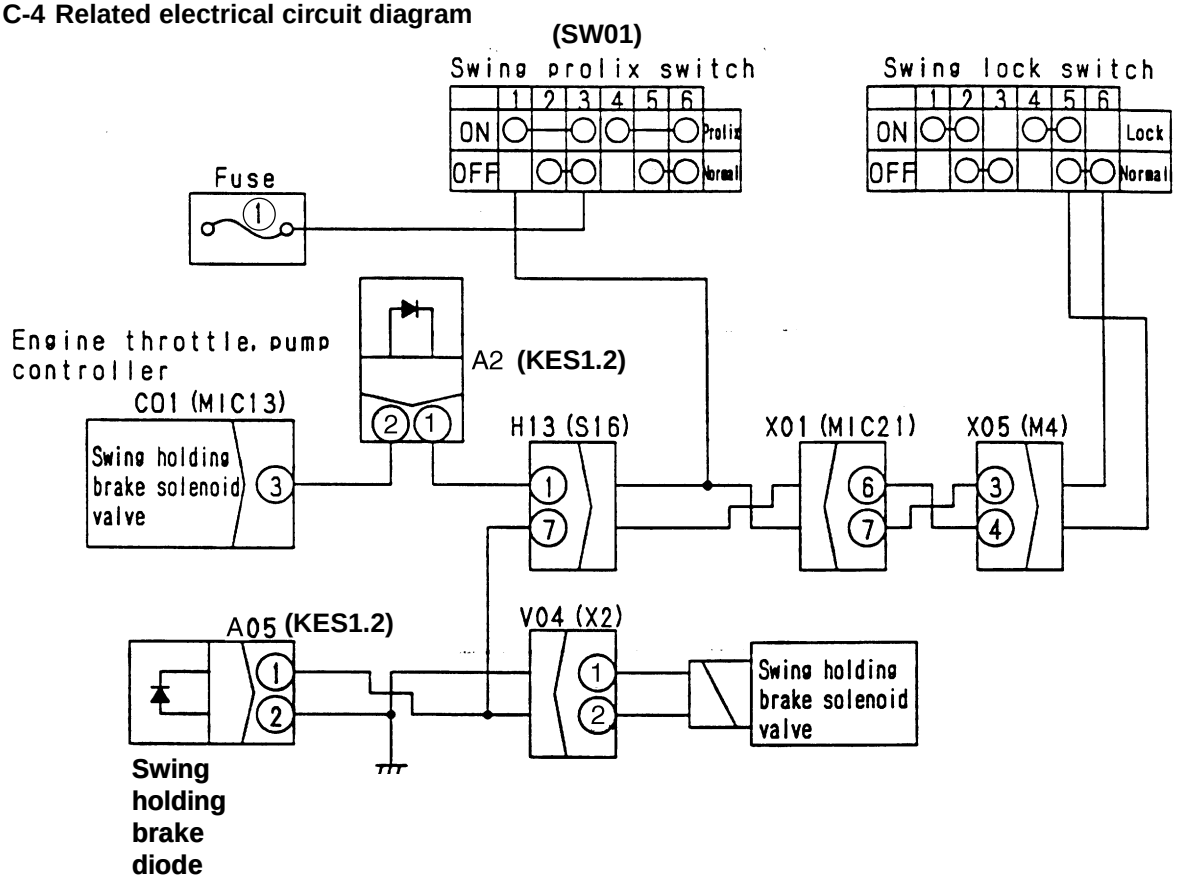


Table 1

Between V04 (male) (1) and (2)	20 - 60 Ω
Between V04 (male) (2) and chassis	Min. 1 MΩ

C-4 Related electrical circuit diagram



C-5 [E213] Disconnection in swing holding 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 the service code "E" 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 that the service code "E" 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 to the next step.

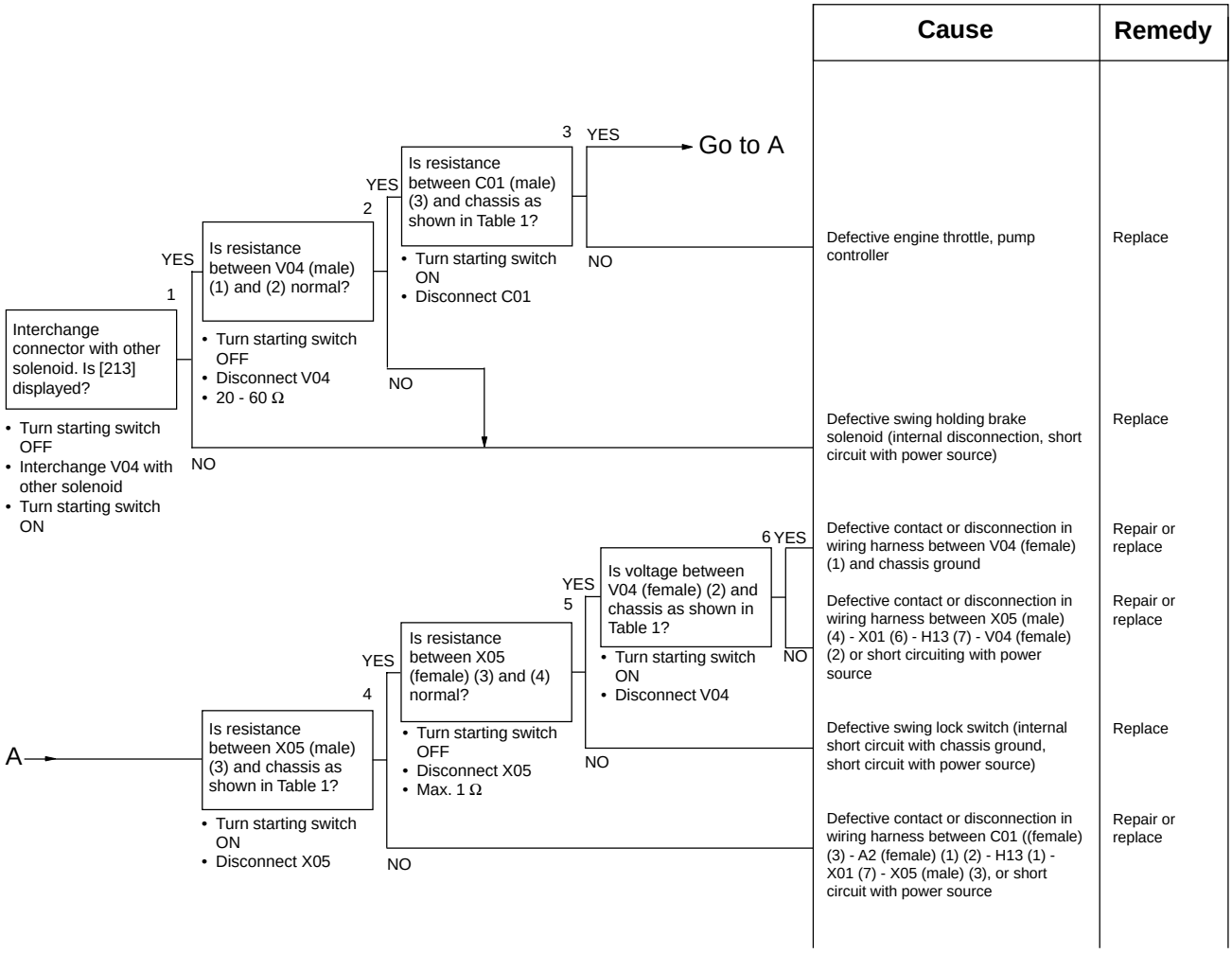
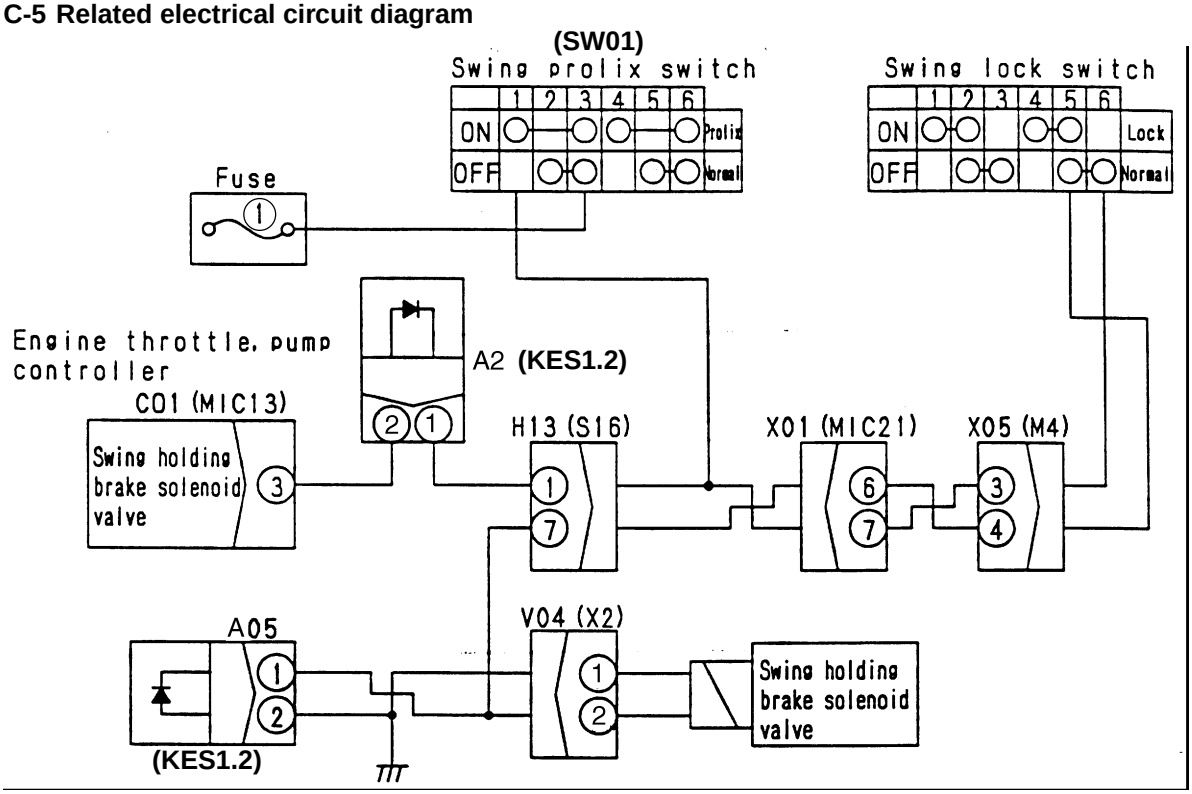


Table 1

Troubleshooting 3	Troubleshooting 4	Troubleshooting 6	Voltage	Measurement condition
Between C01 (male) (3) and chassis	Between X05 (male) (3) and chassis	Between V04 (female (2) and chassis	0 - 3 V	5 sec. after all levers are returned to neutral
			20 - 30 V	When swing lever is operated

C-5 Related electrical circuit diagram



C-6 [E205] Short circuit in 2-stage relief 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 the service code "E" 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 that the service code "E" 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 to the next step.

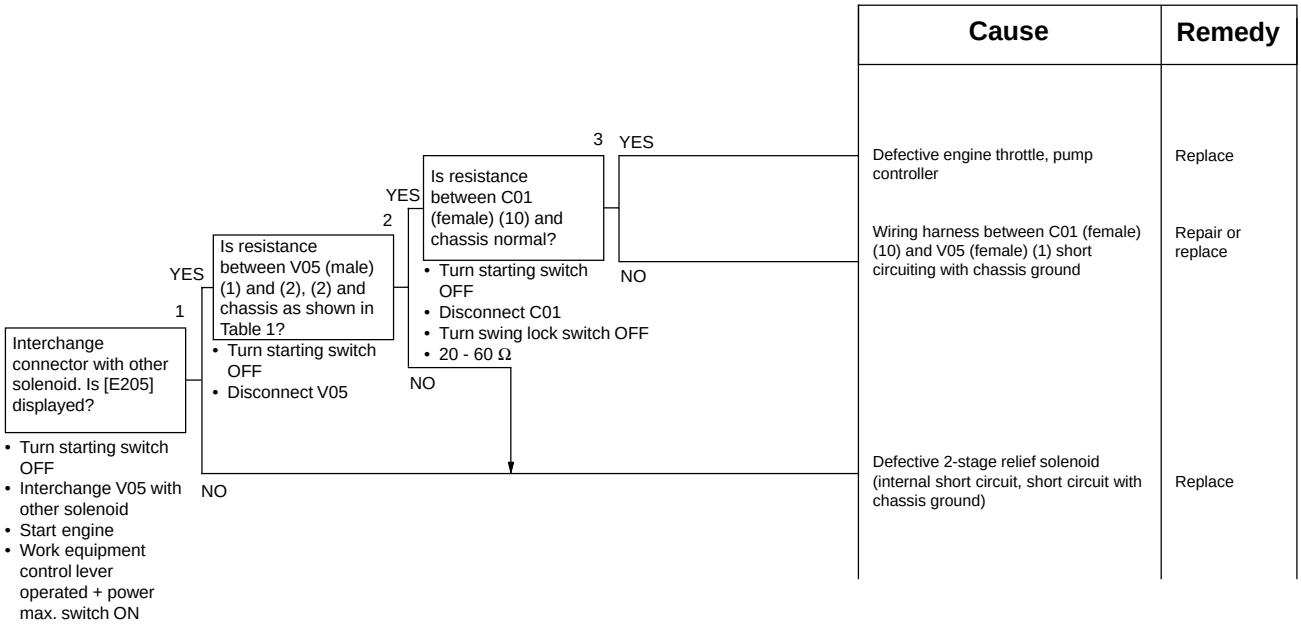
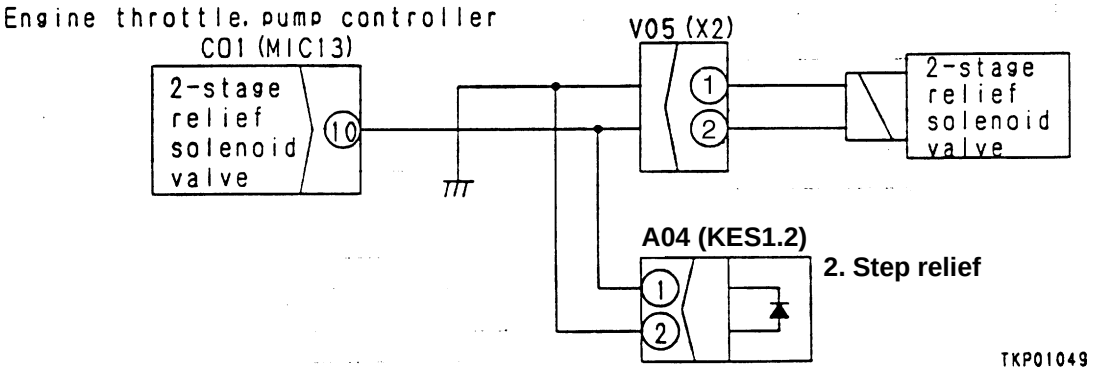


Table 1

Between V05 (male) (1) and (2)	20 - 60 Ω
Between V05 (male) (2) and chassis	Min. 1 MΩ

C-6 Related electrical circuit diagram



C-7 [E215] Disconnection in 2-stage relief 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 the service code "E" 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 that the service code "E" 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 to the next step.

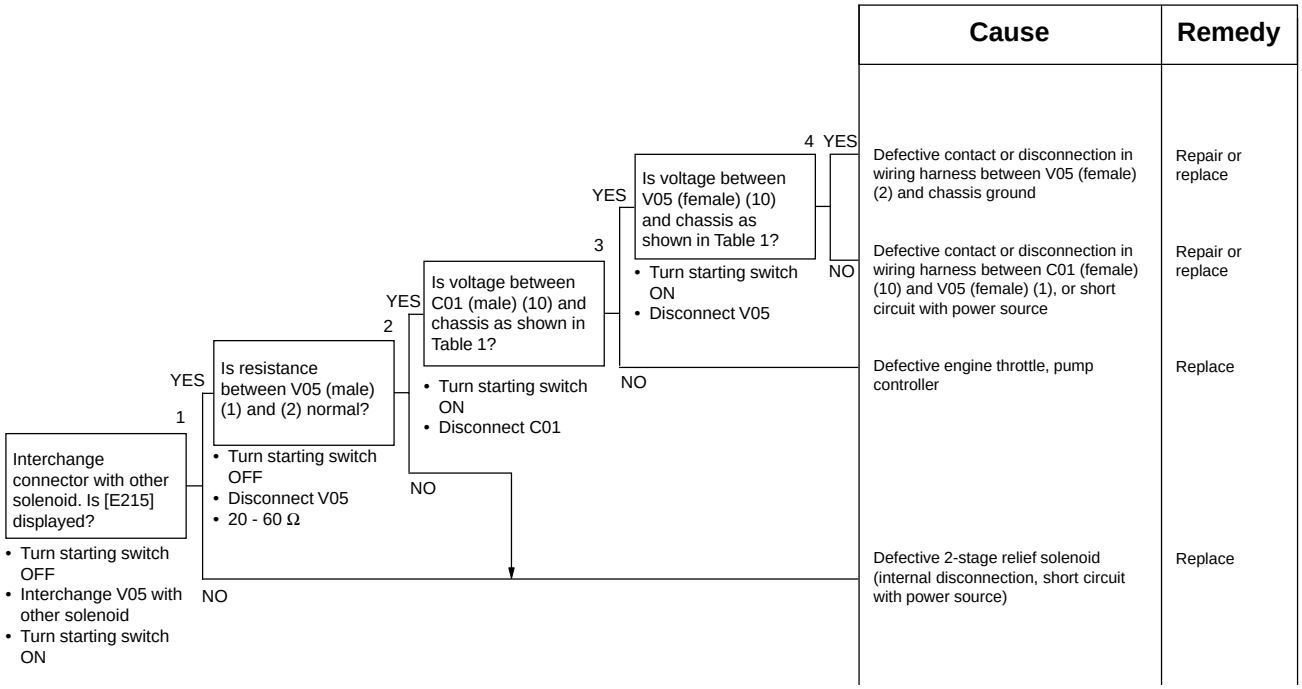
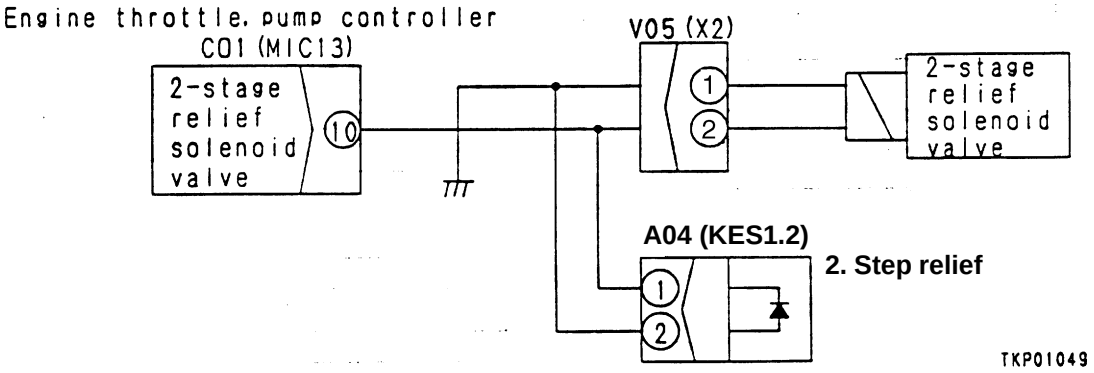


Table 1

Troubleshooting 3	Troubleshooting 4	Voltage	Measurement condition
Between C01 (male) (10) and chassis	Between V05 (female) (2) and chassis	0 - 3 V	All control levers at neutral
		20 - 30 V	When control lever is operated + power max. switch ON

C-7 Related electrical circuit diagram



C-8 [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 the service code "E" 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 that the service code "E" 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 to the next step.

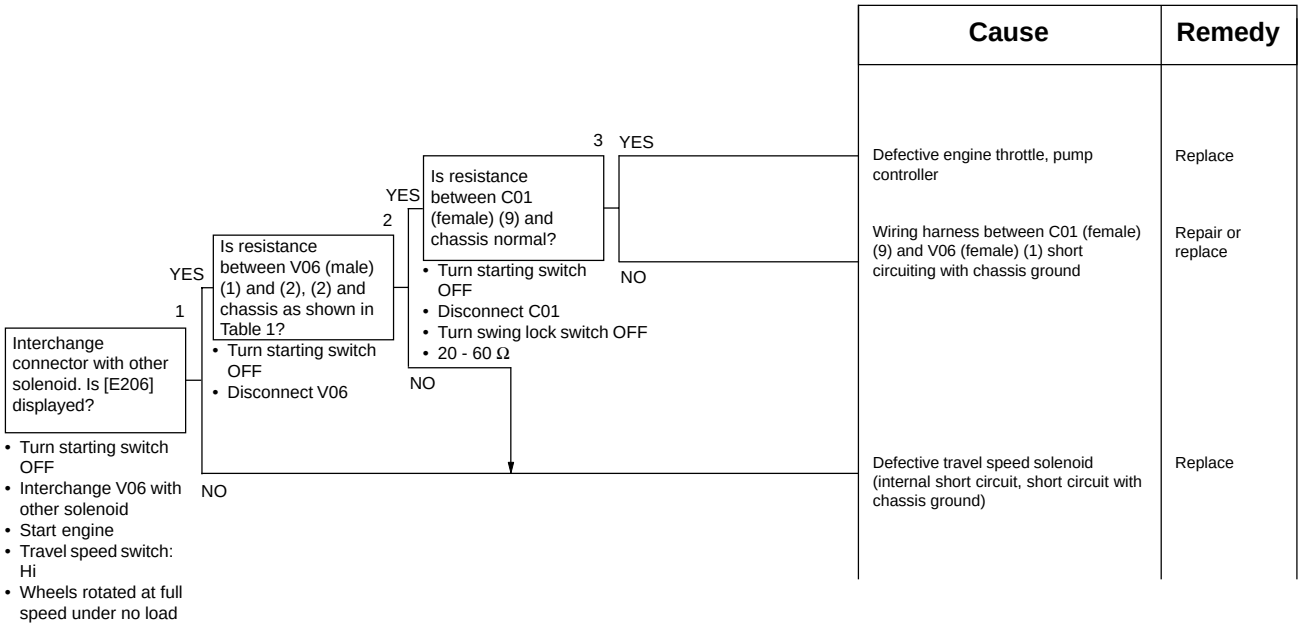
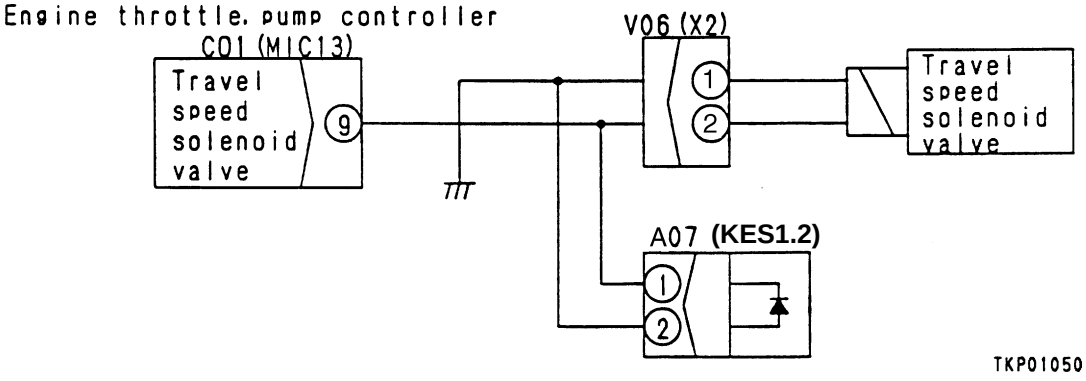


Table 1

Between V06 (male) (1) and (2)	20 - 60 Ω
Between V06 (male) (2) and chassis	Min. 1 MΩ

C-8 Related electrical circuit diagram



C-9 [E216] Disconnection 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 the service code "E" 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 that the service code "E" 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 to the next step.

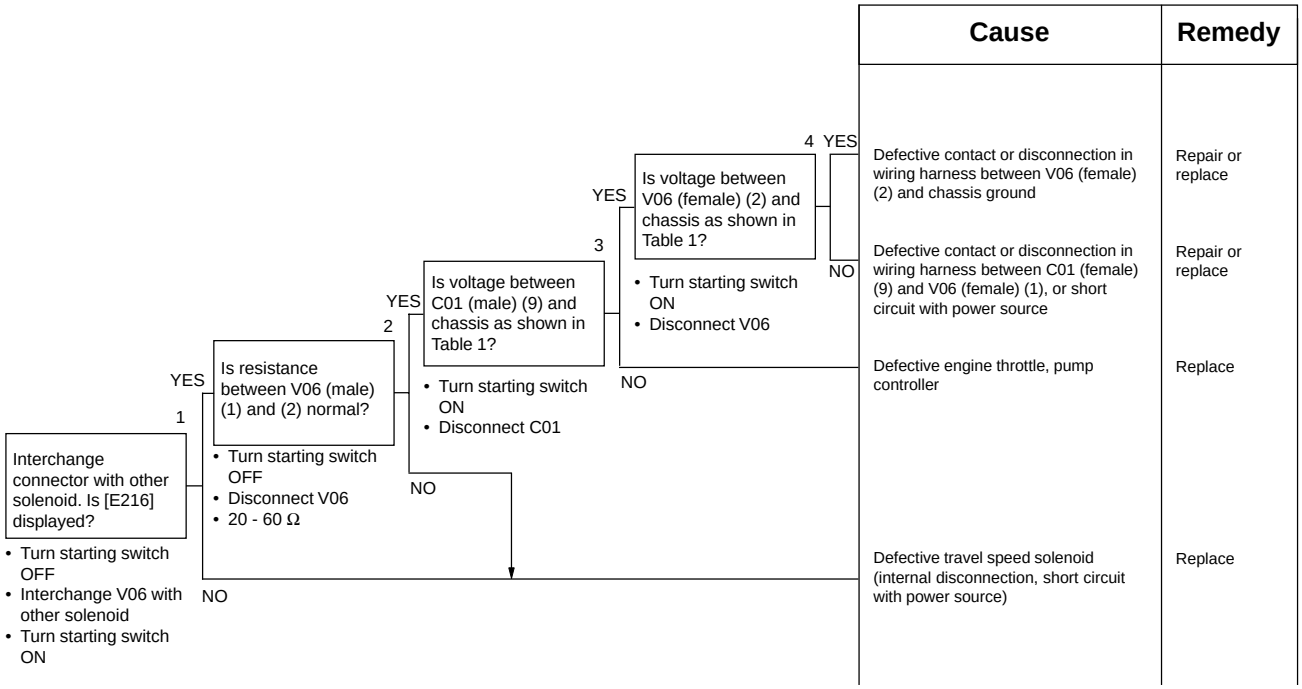
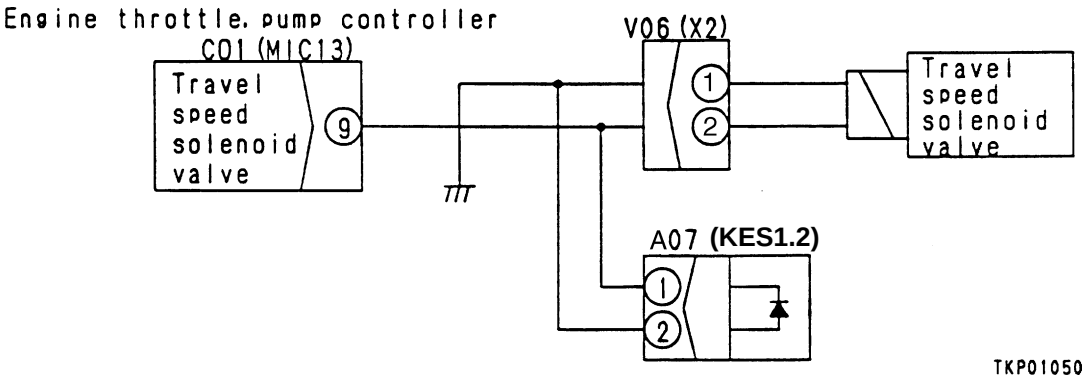


Table 1

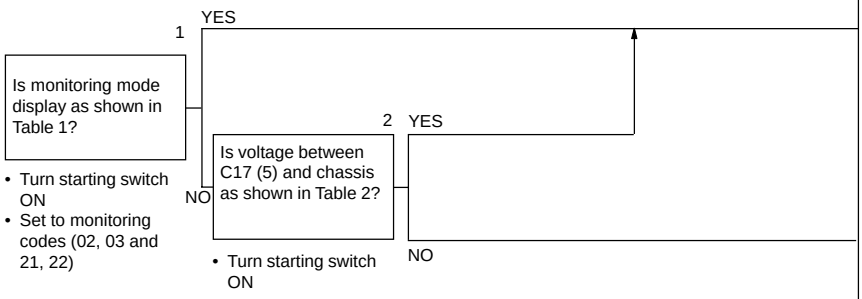
Troubleshooting 3	Troubleshooting 4	Voltage	Measurement condition
Between C01 (male) (9) and chassis	Between V06 (female) (2) and chassis	0 - 3 V	When travel speed switch is at Lo
		20 - 30 V	Travel speed switch Hi + wheels rotated at full speed under no load

C-9 Related electrical circuit diagram



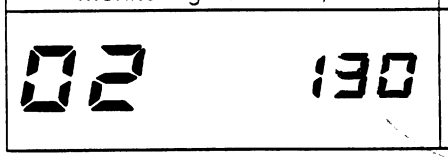
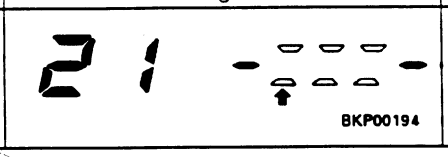
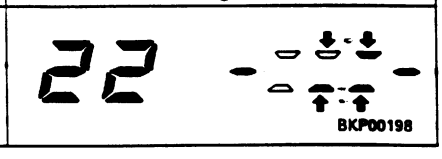
C-12 [E217] Model selection input error is displayed

★ **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 the service code "E" 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 that the service code "E" 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 to the next step.



Cause	Remedy
Defective governor, pump controller	Replace
Defective model selection connector, or disconnection, short circuit with ground, or short circuit in wiring harness where voltage is defective	Repair or replace

Table 1 Monitoring code display

Model code display	Model selection signal input display	
Monitoring codes 02, 03	Monitoring code 21	Monitoring code 22
		

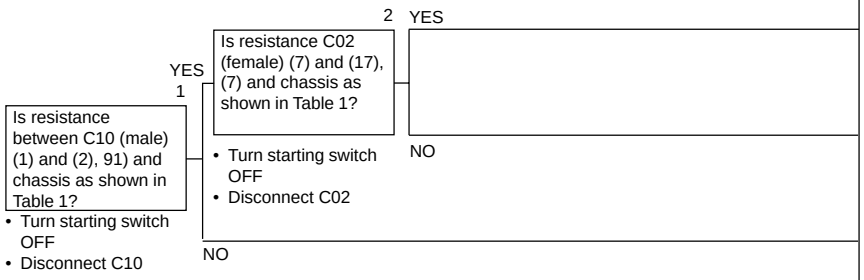
★ The diagram shows monitoring code 02.
★ Check the bit pattern display marked with <-.

Table 2 Voltage of wiring harness

C17	Between (5) - chassis
Voltage	Max. 1 V

C-13 [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 the service code "E" 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 that the service code "E" 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 to the next step.

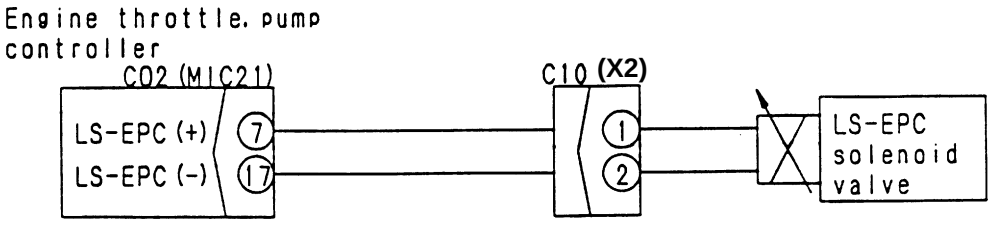


Cause	Remedy
Defective engine throttle, pump controller	Replace
Short circuit with ground, short circuit with power source in wiring harness between C02 (female) (7) and C10 (female)(91), or short circuit with power source in wiring harness between C02 (female) (17) and C10 (female) (2)	Repair or replace
Defective LS-EPC solenoid (internal disconnection, short circuit with power source)	Replace

Table 1

Troubleshooting 1	Troubleshooting 2	Resistance value
Between C10 (male) (1) and (2)	Between C02 (female) (7) and (17)	7 - 14 Ω
Between C10 (male) (1) and chassis	Between C02 (female) (7) and chassis	Min. 1 MΩ

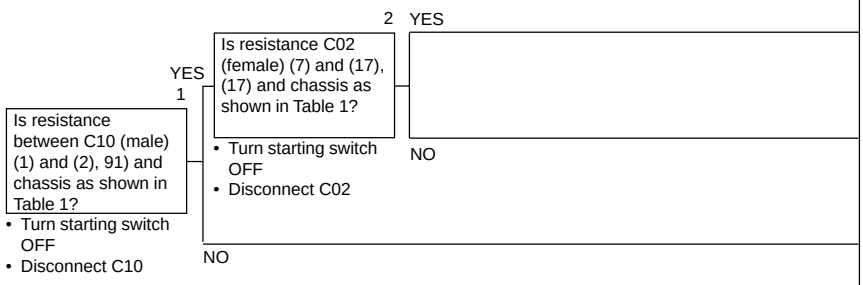
C-13 Related electrical circuit diagram



TKP01054

C-14 [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 the service code "E" 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 that the service code "E" 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 to the next step.

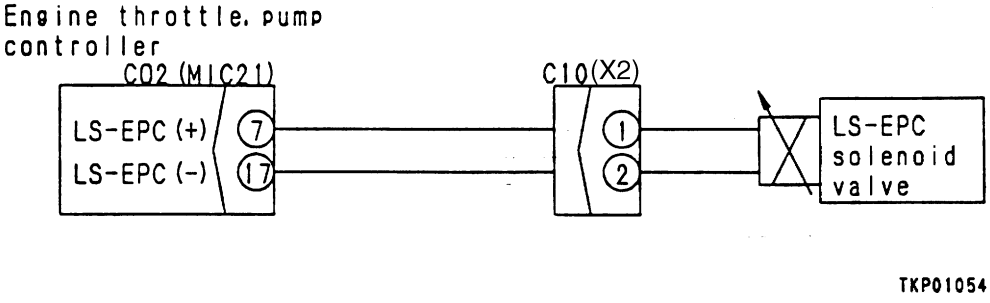


Cause	Remedy
Defective engine throttle, pump controller	Replace
Defective contact short circuit with chassis ground in wiring harness between C02 (female) (7) and C10 (female) (1), or defective contact or disconnection in wiring harness between C02 (female) (17) and C10 (female) (2) or short circuit with chassis ground	Repair or replace
Defective LS-EPC solenoid (internal disconnection, defective contact, short circuit with chassis ground)	Replace

Table 1

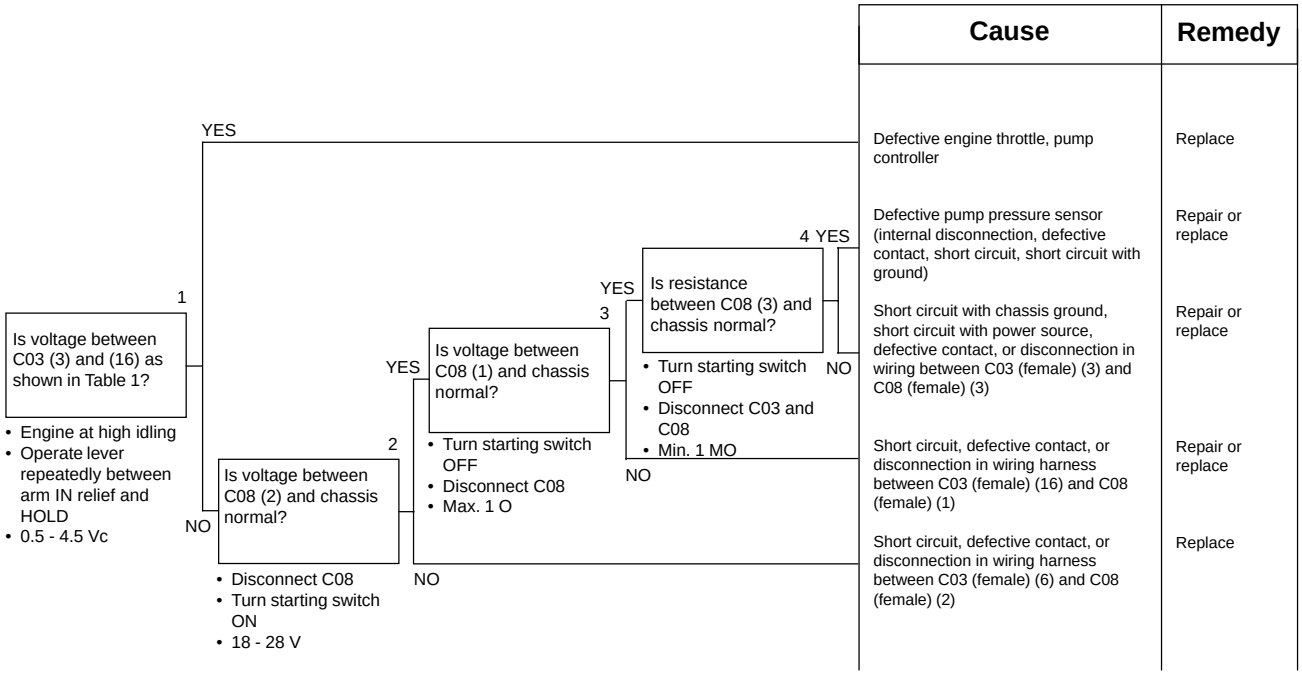
Troubleshooting 1	Troubleshooting 2	Resistance value
Between C10 (male) (1) and (2)	Between C02 (female) (7) and (17)	7 - 14 Ω
Between C10 (male) (2) and chassis	Between C02 (female) (17) and chassis	Min. 1 MΩ

C-14 Related electrical circuit diagram

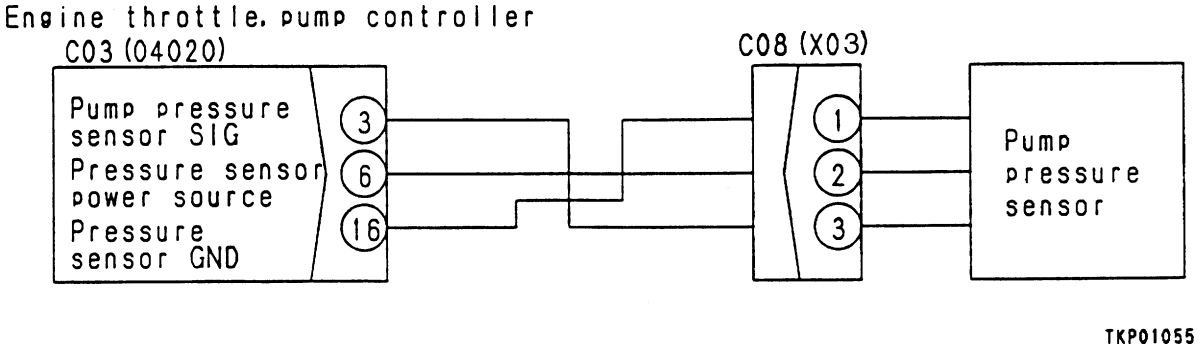


C15 [E224] Abnormality in pump pressure sensor system is displayed

★ **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 the service code "E" 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 that the service code "E" 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 to the next step.

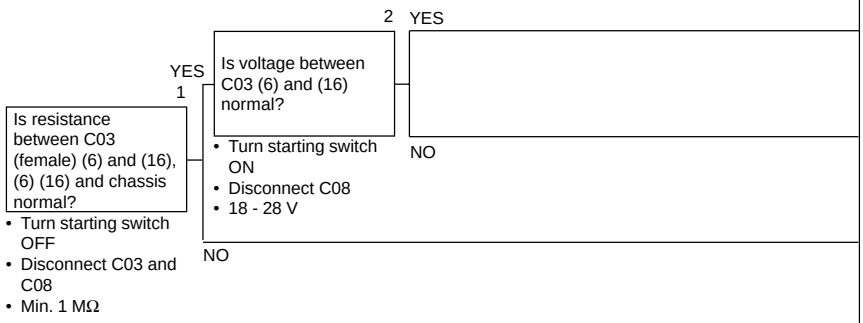


C-15 Related electrical circuit diagram



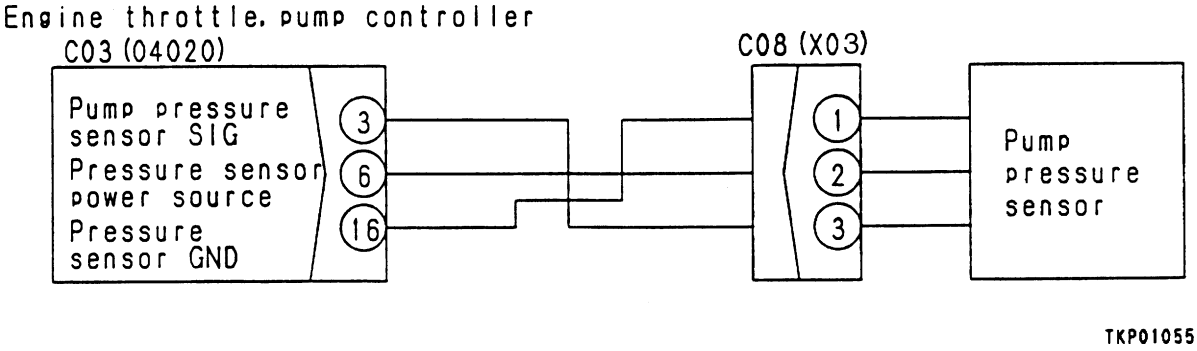
C-16 [E226] Abnormality in pressure sensor power source system is displayed

★ **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 the service code "E" 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 that the service code "E" 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 to the next step.



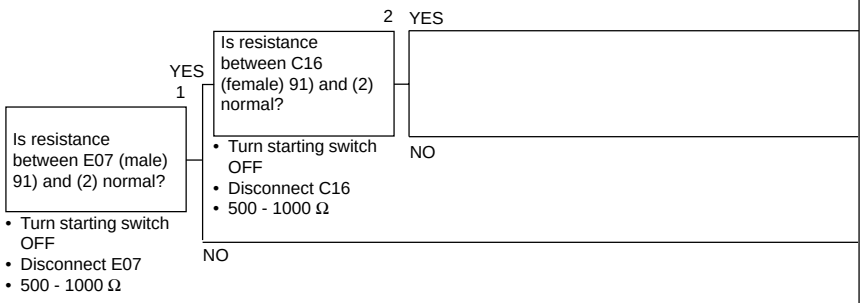
Cause	Remedy
Defective pump pressure sensor (internal short circuit, short circuit with chassis ground)	Replace
Defective engine throttle, pump controller	Replace
Short circuit, short circuit with chassis ground between C03 (female) (6) and C08 (female) (2)	Repair or replace

C-16 Related electrical circuit diagram



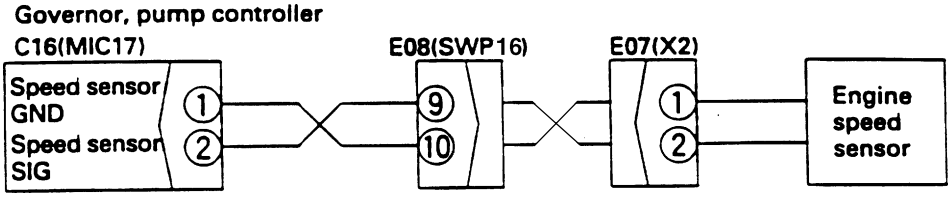
C-17 [E227] Abnormality in engine speed sensor system is displayed

★ **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 the service code "E" 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 that the service code "E" 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 to 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-17 Related electrical circuit diagram



TROUBLESHOOTING OF GOVERNOR, PUMP CONTROLLER (INPUT SIGNAL SYSTEM) (F MODE)

A3

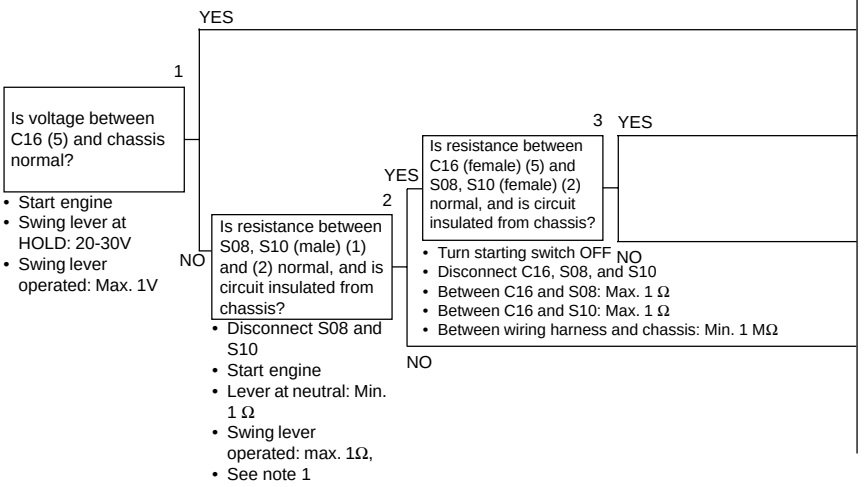
A3

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 monitoring mode display returns to normal, the problem has been removed.**

⚠ Turn the swing lock switch ON before operating the swing lever.

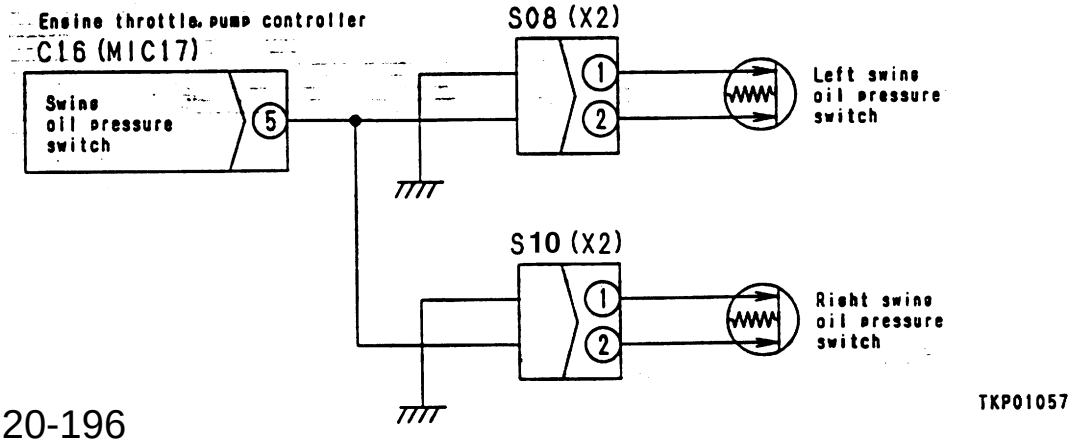
★ If there is no display when the lever is operated in one direction, the PPC shuttle valve is defective. (see H- 5)
(When measuring with the engine stopped, charge the accumulator before starting.)
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



Cause	Remedy
Defective engine throttle, pump controller	Replace
Defective contact, or disconnection in wiring harness between S08, S10 (female) (1) and chassis ground.	Repair or replace
Short circuit with chassis ground, defective contact, or disconnection in wiring harness between C16 (female) (5) and S08, S10 (female) (2)	Repair or replace
Defective swing oil pressure switch. (If condition does not return to normal even when switch is replaced, go to H-5)	Replace

Note: 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 20-30V: Go to Yes
- If it is less than 1V: Go to NO

F-1 Related electrical circuit diagram

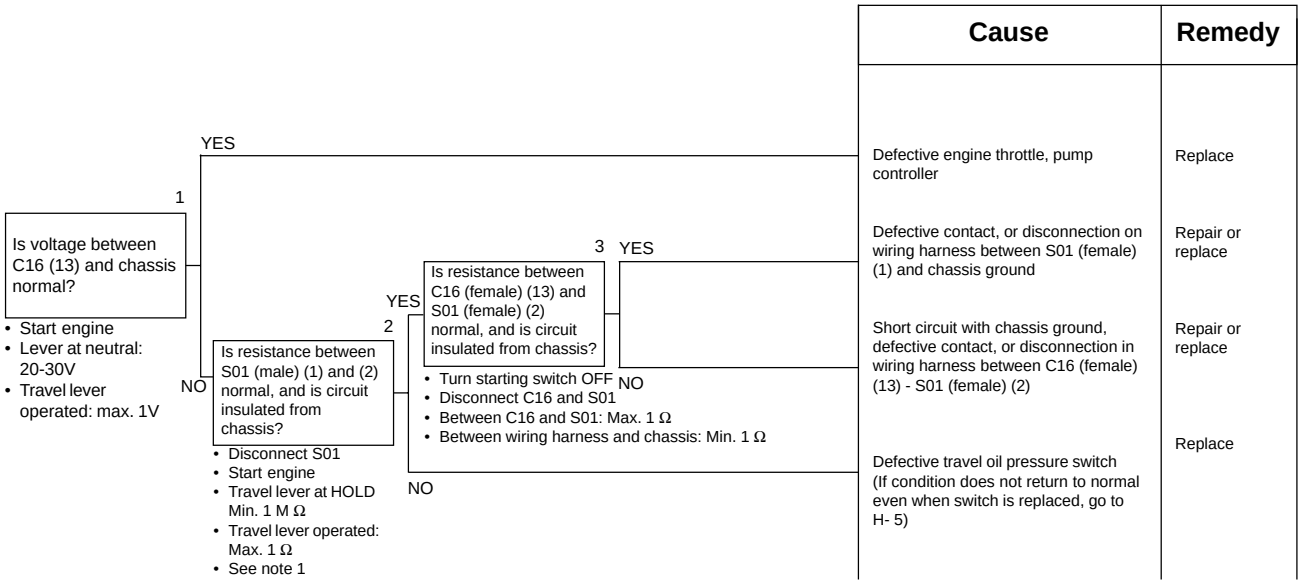


F-2 Bit pattern 20- (2) Travel oil pressure switch does not light up.

★ **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 monitoring mode display returns to normal, the problem has been removed.**

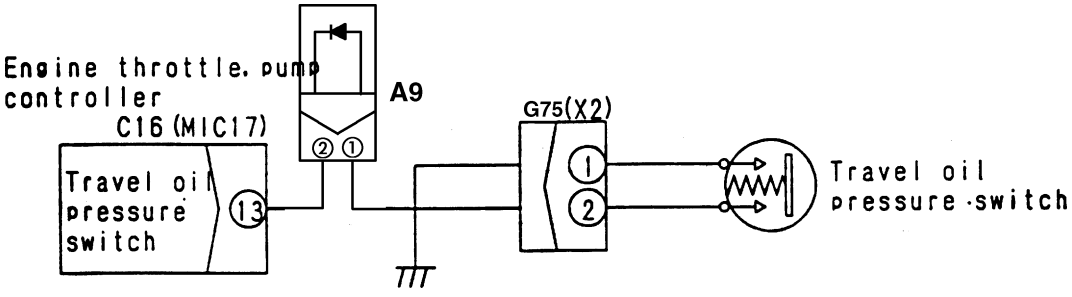
⚠ Before operating the travel lever, check that the surrounding area is safe.

★ If there are displays which light up and not light up when the travel lever is operated on every operations, the PPC shuttle valve is defective. (see H- 5)
(When measuring with the engine stopped, charge the accumulator before starting.)
★ 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 20-30V: Go to YES
- If it is less than 1V: Go to NO

F-2 Related electrical circuit diagram



TKP01058

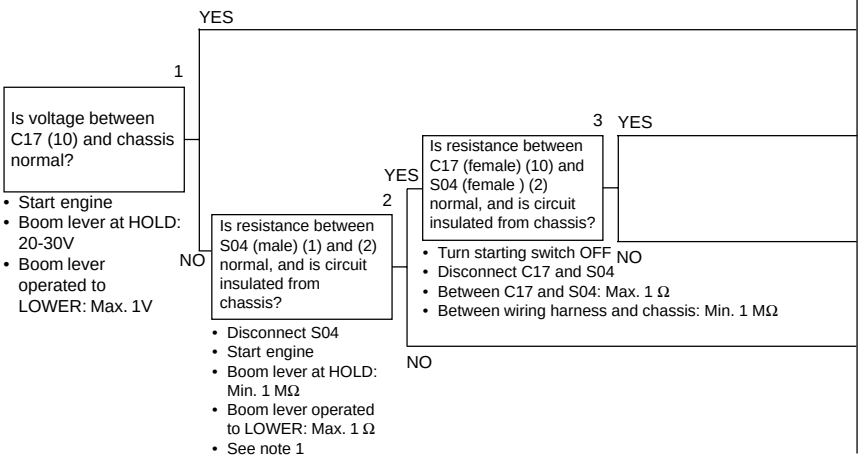
F-3 Bit pattern 20-(3) Boom LOWER oil pressure switch does not light up

★ **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 monitoring mode display returns to normal, the problem has been removed.**

⚠ When measuring with the engine running, make sure that the work equipment does not move when the lever is operated.
(When measuring with the engine stopped, charge the accumulator before starting.)

★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.

★ Always connect any disconnected connector before going on the next step.

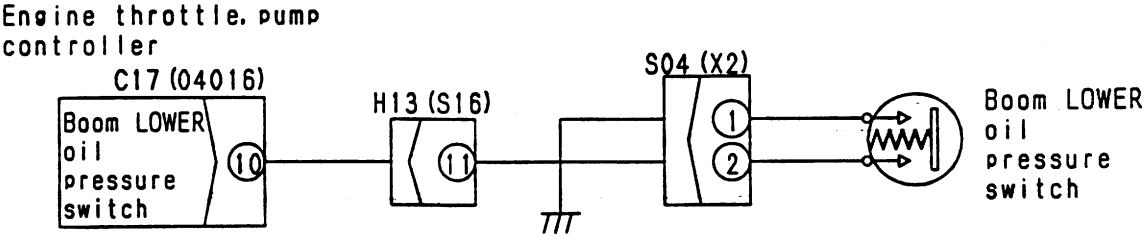


Cause	Remedy
Defective engine throttle, pump controller	Replace
Defective contact, or disconnection in wiring harness between S04 (female) (1) and chassis ground.	Repair or replace
Short circuit with chassis ground, defective contact, or disconnection between C17 (female) (10) - H13 (11) - S04 (female) (2)	Repair or replace
Defective boom LOWER oil pressure switch (If condition does not return to normal even when 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 20-30V: Go to YES
- If it is less than 1V: Go to NO

F-3 Related electrical circuit diagram



TKP01059

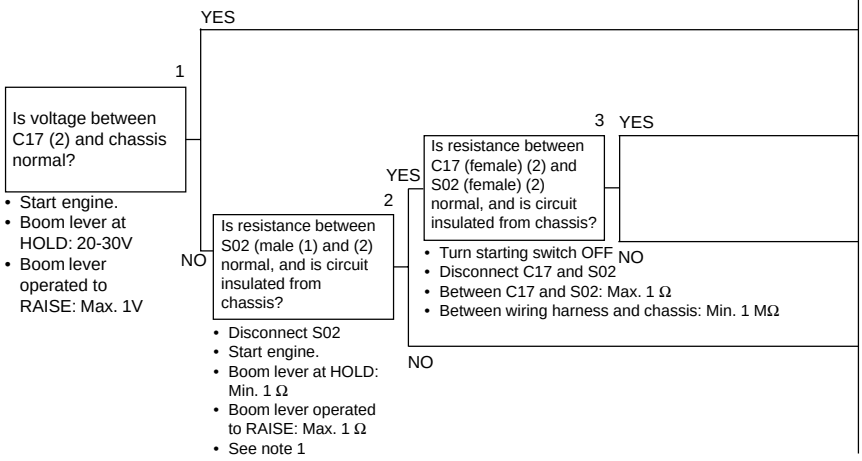
F-4 Bit pattern 20-(4) Boom RAISE oil pressure switch does not light up

★ **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 monitoring mode display returns to normal, the problem has been removed.**

⚠ When measuring with the engine running, make sure that the work equipment does not move when the lever is operated.
(When measuring with the engine stopped, charge the accumulator before starting.)

★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.

★ Always connect any disconnected connectors before going on the next step.

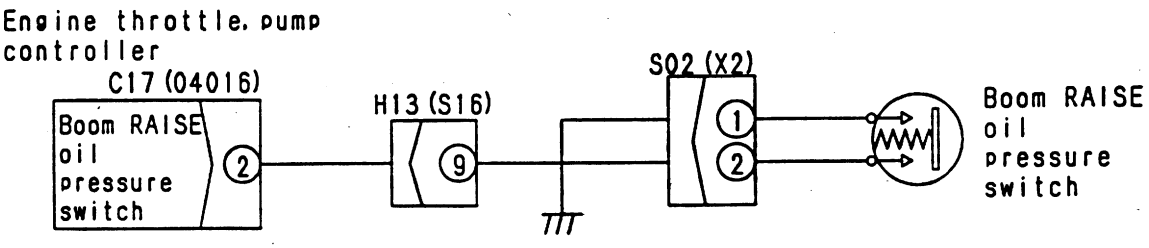


Cause	Remedy
Defective engine throttle, pump controller	Replace
Defective contact, or disconnection in wiring harness between S02 (female) (1) and chassis ground	Repair or replace
Short circuit with chassis ground, defective contact, or disconnection in wiring harness between C17 (female) (2) - H13 (9) - S02 (female) (2)	Repair or replace
Defective boom RAISE oil pressure switch. (If condition does not return to normal even when 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 (2) and the chassis.

- If it is 20-30V: Go to YES
- If it is less than 1V: Go to NO

F-4 Related electrical circuit diagram



TKP01060

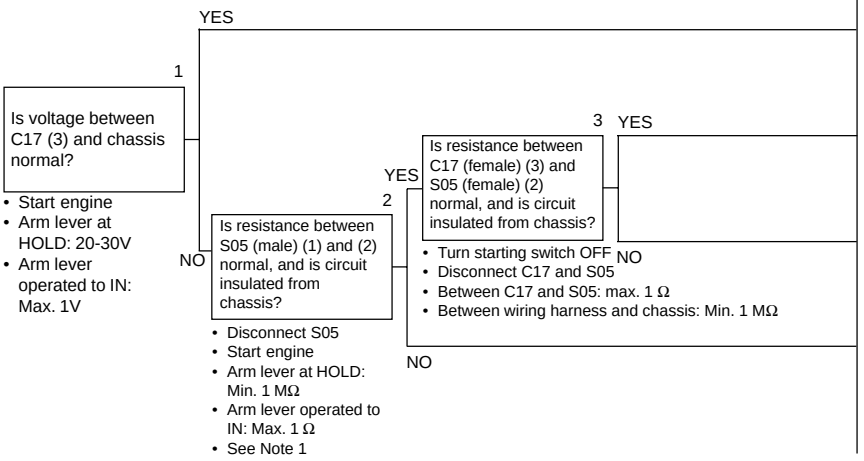
F-5 Bit pattern 20-(5) Arm IN oil pressure switch does not light up

★ **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 monitoring mode display returns to normal, the problem has been removed.**

⚠ When measuring with the engine running, make sure that the work equipment does not move when the lever is operated.
(When measuring with the engine stopped, charge the accumulator before starting.)

★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.

★ Always connect any disconnected connectors before going on the next step.

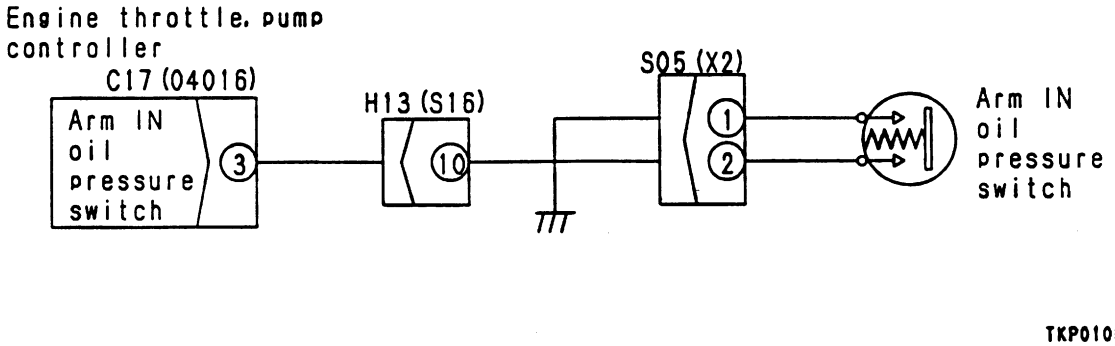


Cause	Remedy
Defective engine throttle, pump controller	Replace
Defective contact, or disconnection in wiring harness between S05 (female) (1) and chassis ground	Repair or replace
Short circuit with chassis ground, defective contact, or disconnection in wiring harness between C17 (female) (3) - H13 (10) - S05 (female) (2).	Repair or replace
Defective arm IN oil pressure switch (If condition does not return to normal even when 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 20-30V: Go to YES
- If it is less than 1V: Go to NO

F-5 Related electrical circuit diagram



TKP01061

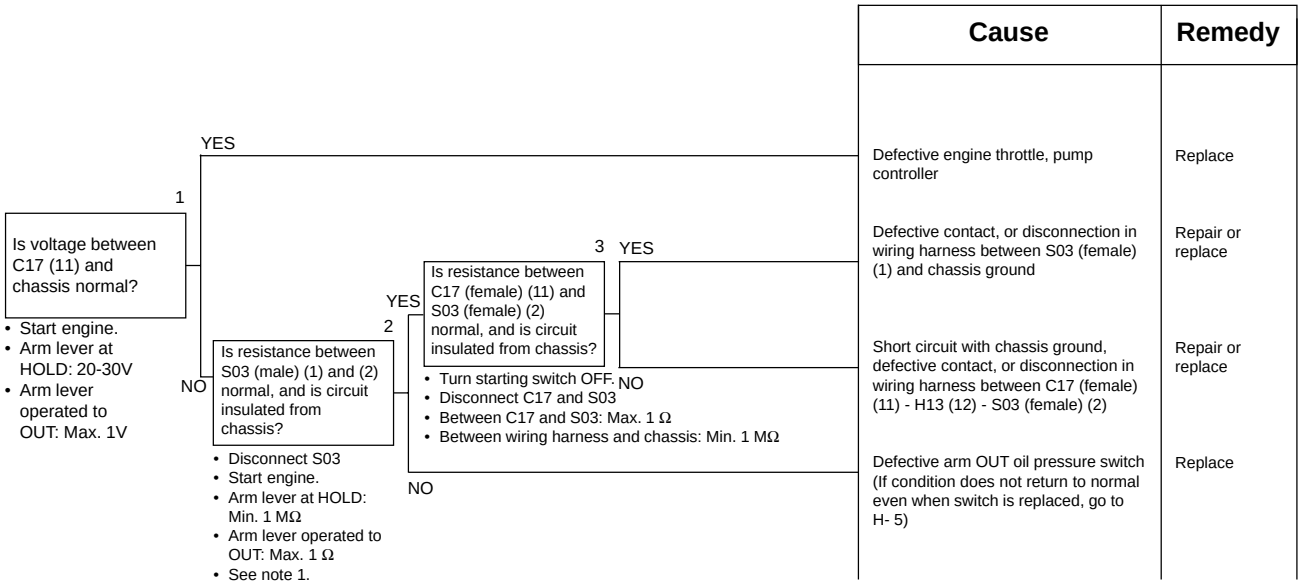
F-6 Bit pattern 20-(6) Arm OUT oil pressure switch does not light up

★ **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 monitoring mode display returns to normal, the problem has been removed.**

⚠ When measuring with the engine running, make sure that the work equipment does not move when the lever is operated.
(When measuring with the engine stopped, charge the accumulator before starting.)

★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.

★ Always connect any disconnected connectors before going on the next step.

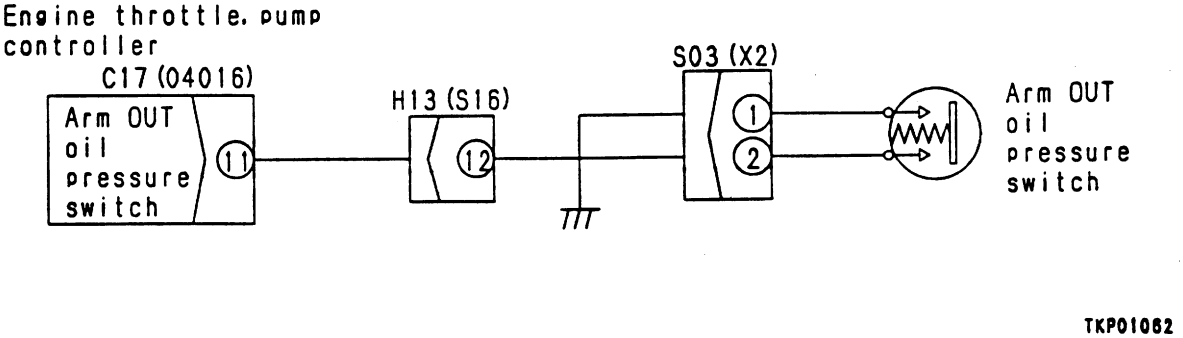


Cause	Remedy
Defective engine throttle, pump controller	Replace
Defective contact, or disconnection in wiring harness between S03 (female) (1) and chassis ground	Repair or replace
Short circuit with chassis ground, defective contact, or disconnection in wiring harness between C17 (female) (11) - H13 (12) - S03 (female) (2)	Repair or replace
Defective arm OUT oil pressure switch (If condition does not return to normal even when 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 (11) and the chassis.

- If it is 20-30V: Go to YES
- If it is less than 1V: Go to NO

F-6 Related electrical circuit diagram.



TKP01082

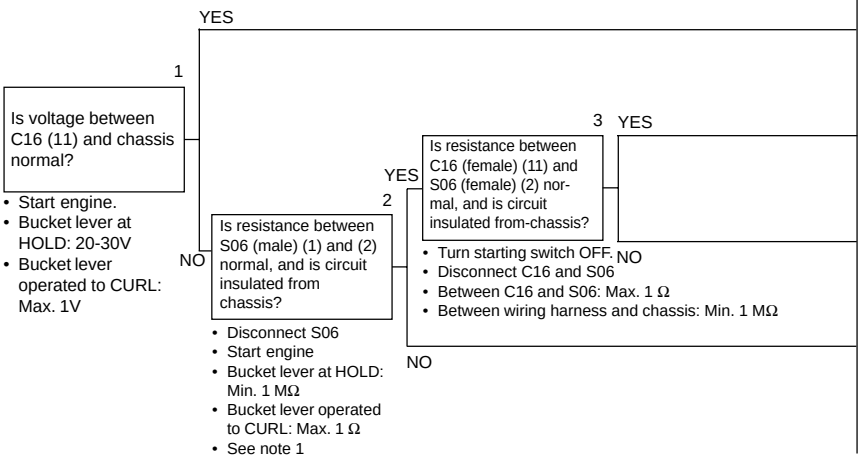
F-7 Bit pattern 21-(1) Bucket CURL oil pressure switch does not light up

★ **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 monitoring mode display returns to normal, the problem has been removed.**

⚠ When measuring with the engine running, make sure that the work equipment does not move when the lever is operated.
(When measuring with the engine stopped, charge the accumulator before starting.)

★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.

★ Always connect any disconnected connectors before going on the next step.

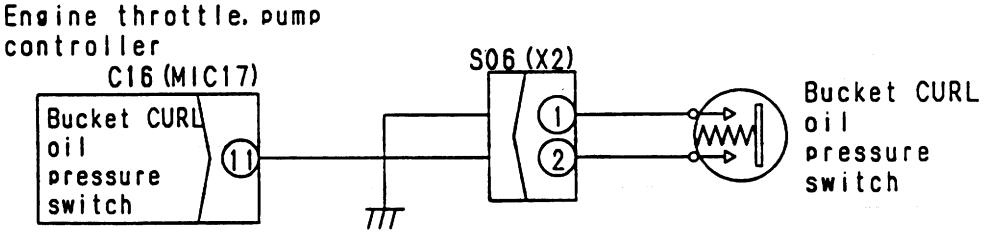


Cause	Remedy
Defective engine throttle, pump controller	Replace
Defective contact, or disconnection in wiring harness between S06 (female) (1) and chassis ground	Repair or replace
Short circuit with chassis ground, defective contact, or disconnection in wiring harness between C16 (female) (11) S06 (female) (2).	Repair or replace
Defective bucket CURL oil pressure switch (If condition does not return to normal even when 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 20-30V: Go to YES
- If it is less than 1V: Go to NO

F-7 Related electrical circuit diagram.



TKP01063

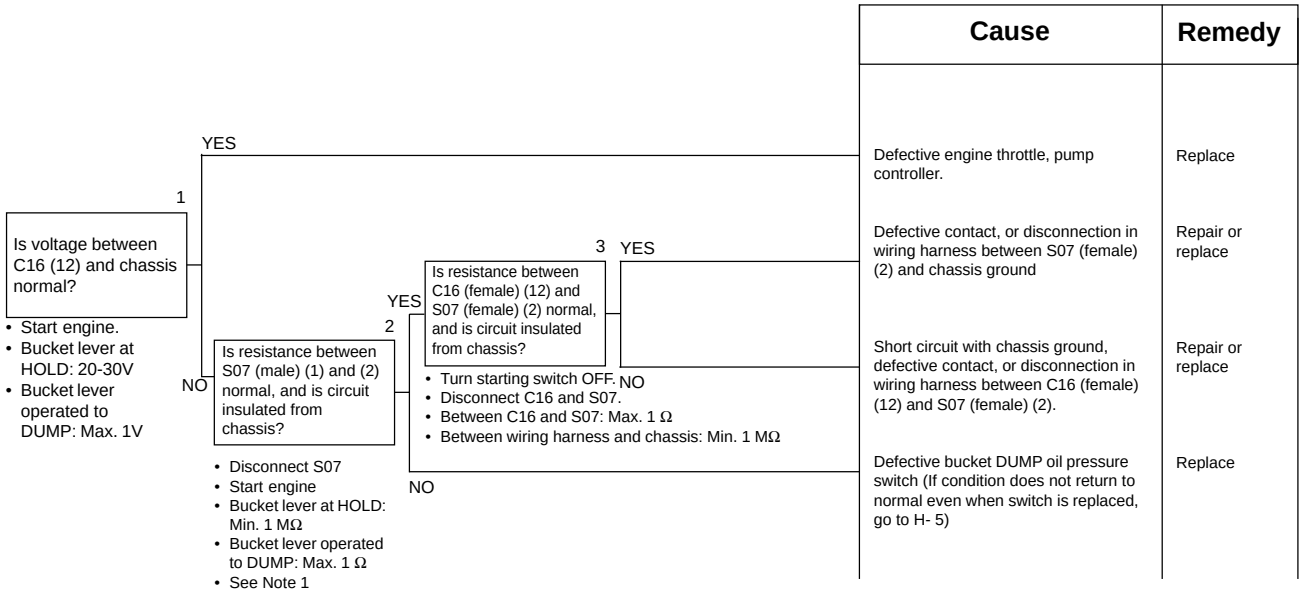
F-8 Bit pattern 21-(2) Bucket DUMP oil pressure switch does not light up

★ **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 monitoring mode display returns to normal, the problem has been removed.**

⚠ When measuring with the engine running, make sure that the work equipment does not move when the lever is operated.
(When measuring with the engine stopped, charge the accumulator before starting.)

★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.

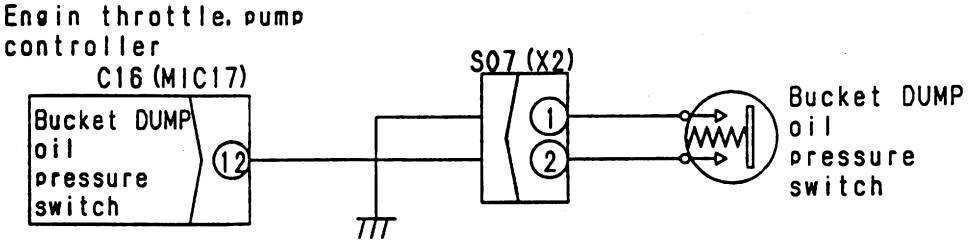
★ Always connect any disconnected connectors before going on the next step.



Note 1: It is also possible to fit a short connector and judge the condition. In this case, check the voltage between C16 (12) and the chassis.

- If it is 20-30V: Go to YES
- If it is less than 1V: Go to NO

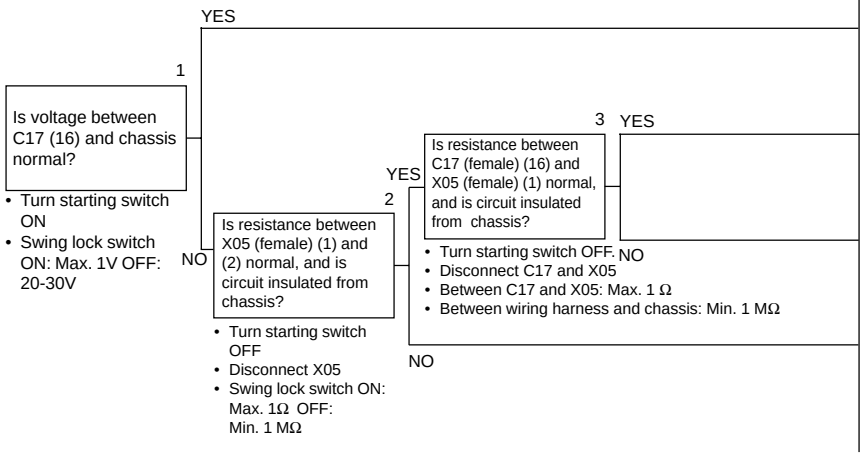
F-8 Related electrical circuit diagram



TKP01064

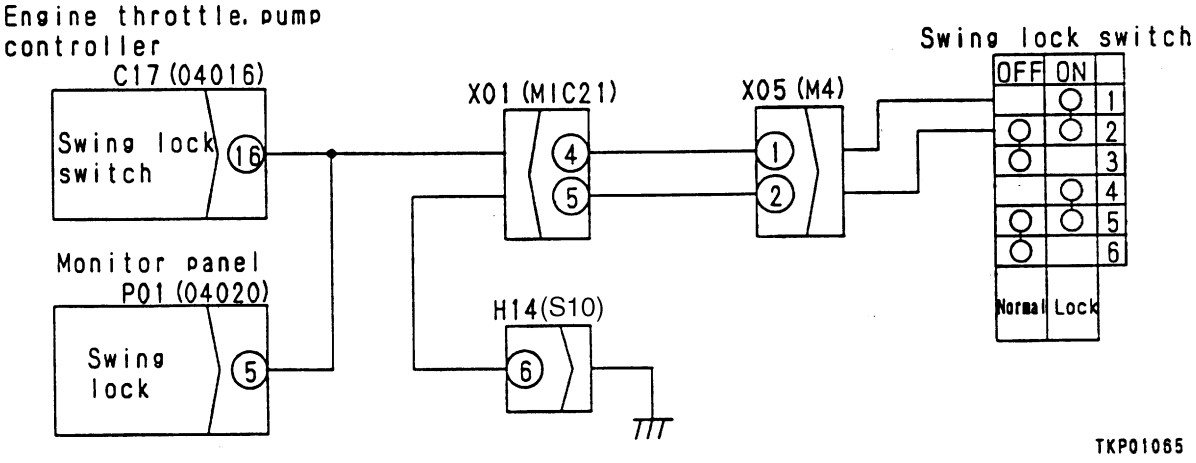
F-9 Bit pattern 21-(3) Swing lock switch does not light up

★ **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 monitoring mode display returns to normal, the problem has been removers.**
★ If the panel display is normal (if the panel swing lock lamp does not light up, go to M- 21)
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



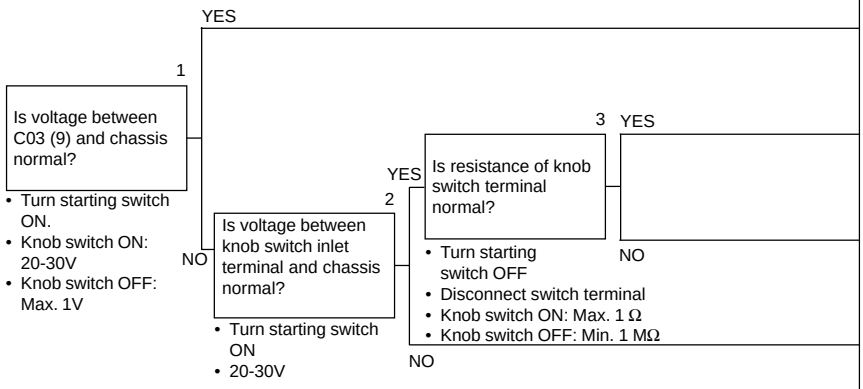
Cause	Remedy
Defective engine throttle, pump controller.	Replace
Short circuit with chassis ground, defective contact, or disconnection in wiring harness between X05 (female) (2) - X01 (5) - H14 (6) - chassis ground	Repair or replace
Short circuit with chassis ground, defective contact, or disonnection in wiring harness between C17 (female) (16) - X01 (4) - X05 (male) (1)	Repair or replace
Defective swing lock switch	Replace

F-9 Related electrical circuit diagram



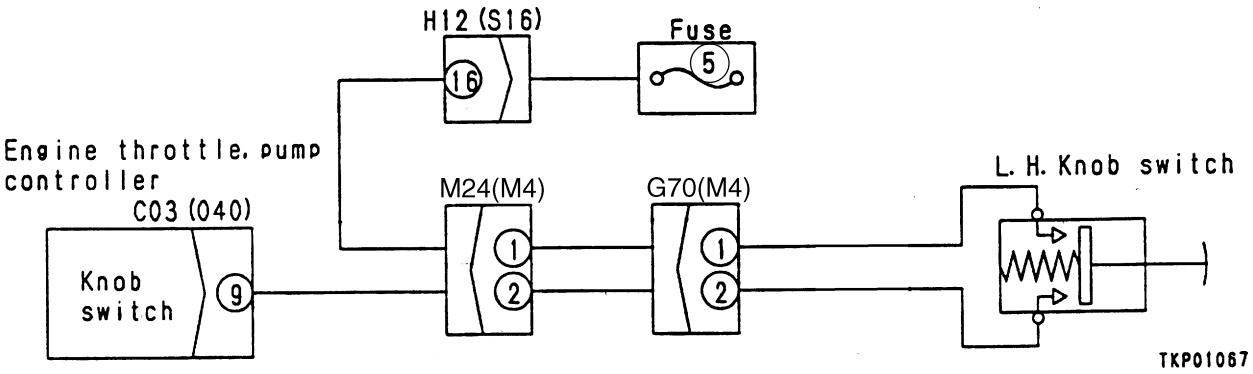
F-11 Bit pattern 22-(6) L.H. knob switch does not light up

★ **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 monitoring mode display returns to normal, the problem has been removed.**
★ Check that fuse 5 is normal.
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next.



Cause	Remedy
Defective engine throttle, pump controller	Replace
Defective contact, or disconnection in wiring harness between knob switch outlet - M23 (2) - M22 (2) - C03 (female) (9)	Repair wiring harness
Defective L.H. knob switch	Replace
Defective contact, or disconnection in wiring harness between fuse 5 - H12 (16) - M22 (1) - H23 (1) - knob switch inlet.	Repair wiring harness

F-11 Related electrical circuit diagram



TROUBLESHOOTING OF HYDRAULIC, MECHANICAL SYSTEM (H MODE)

TABLE OF FAILURE MODES AND CAUSES FOR HYDRAULIC AND MECHANICAL SYSTEM

Failure Mode			Pump							Control valve									
			PC-EPC valve	LS valve	Servo piston	Pump proper	PPC pressure reducing valve	Strainer	PTO spline	Spool	Unload valve	Main relief valve	Pressure compensation valve	LS select valve	LS circuit throttle	Boom lock valve	Regeneration valve: Boom	Regeneration valve: Arm
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									○			○			○		
	Excessive time lag (engine at low idling)												○					
	Lack of power when pressure rises											○						
	Other equipment moves when single circuit is relieved												○					
Compound operations	In F/O mode, arm IN speed is faster than specified speed			○														
	In compound operations, work equipment with larger load is slow												○					
Travel system	Travel speed is slow									○			○					
	Travel speed does not switch or is faster than specified speed																	
Swing system	Does not swing	Both left and right																
		One direction only								○								
	Swing acceleration is poor or swing speed is low	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 brake is ON								○			○					
		When brake is OFF		○														
	Swing speed is faster than specified swing speed																	

★ : In the failure modes, modes for compound operations are used when independet operation
○ : Main cause
△ : Secondary cause

★ If service code E218 (abnormality in network system) is displayed, go to troubleshooting for N Mode.

						Solenoid valve				Swing motor								Pressure switch											
																		Boom		Arm		Bucket		Swing					
Safety-suction valve	Suction valve	PPC valve	PPC shuttle	Safety lock valve	Swivel joint	LS-EPC valve	2-stage relief	Travel speed selector	Swing holding brake	Holding brake	Safety valve	Suction valve	Leakage, breakage inside body	Swing machinery	Hydraulic cylinder	Back pressure valve	RAISE	LOWER	IN	OUT	CURL	DUMP	Left swing	Right swing	Travel	Pressure sensor	Engine system	Troubleshooting code
						○																					○	H-1
				○																								H-2
			○																									H-3
		○															○	○	○	○	○	○	○	○	○			H-4
																												H-5
○	○	○													○		○	○										H-6
○		○													○				○	○								H-7
○		○													○						○	○						H-8
		○																										H-9
		○																										H-10
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							○										○		○		○							H-13
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		○	○			○																			○			H-17
						○		○																	○			H-18
									○	○			○	○										○	○			H-19
		○									○																	
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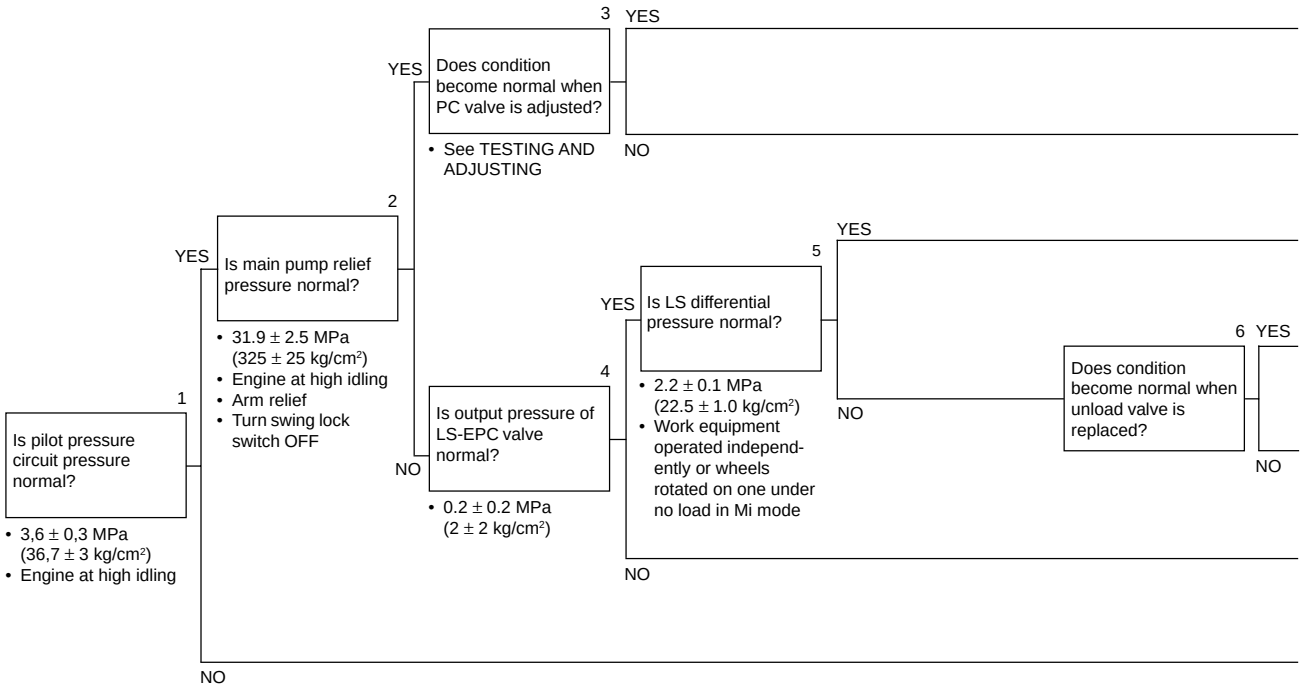
		○	○								○	○																
													○															H-21
		○									○																	
		○																										H-22
											○	○		○		○												H-23
									○	○																		H-24
																												H-25

H-1 Speeds of all work equipment, swing, travel are slow or lack power

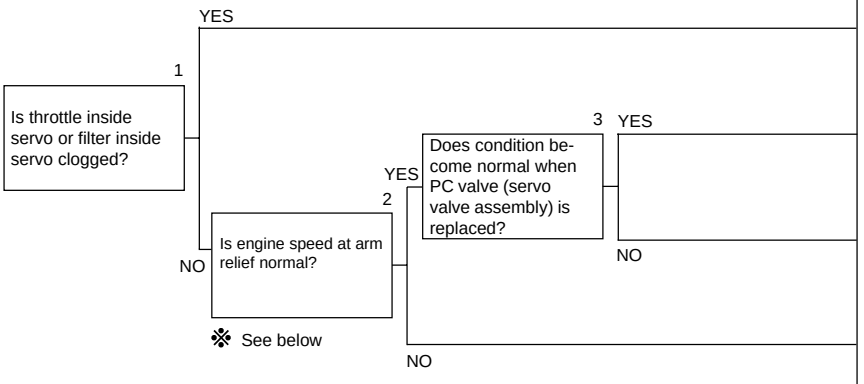
★ Carry out troubleshooting in the heavy-duty operation mode.
★ Check that no abnormal noise is being generated from the main pump before carrying out troubleshooting. (If there is any abnormal noise, carry out troubleshooting for H- 4)



	Cause	Remedy
	Defective adjustment of PC valve	Adjust
	Defective piston pump	Repair or replace
	Defective operation of main valve (Defective reducing valve. Defective main valve LS circuit)	Repair or replace
	Defective operation of unload valve.	Correct or replace
	Defective operation of main relief valve	Replace
	Defective operation of LS-EPC valve	Replace
	Defective hydraulic equipment in control pump circuit (See TESTING AND ADJUSTING)	Adjust or replace

H-2 There is excessive drop in engine speed, or engine stalls

★ Carry out troubleshooting in the heavy-duty operation mode.
★ Check that the main relief pressure is normal.



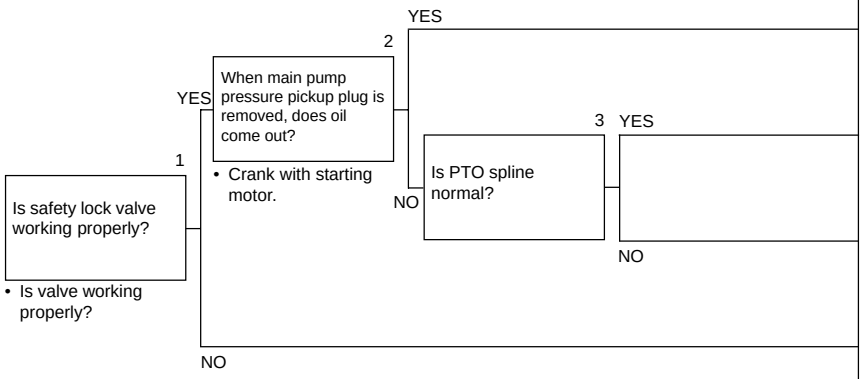
Cause	Remedy
Clogged throttle inside servo or clogged filter inside servo	Clean
Defective PC valve or defective adjustment of PC valve	Adjust or replace servo valve assembly
Defective servo piston	Replace
See troubleshooting for engine (S mode)	Replace (piston assembly)

※ Replace the servo valve assembly with a new part, and if the engine speed is lower than the value in Table 1, carry out troubleshooting for S mode. If it is higher, it can be judged that the PC valve (servo valve) is defective, so replace it.

Table 1

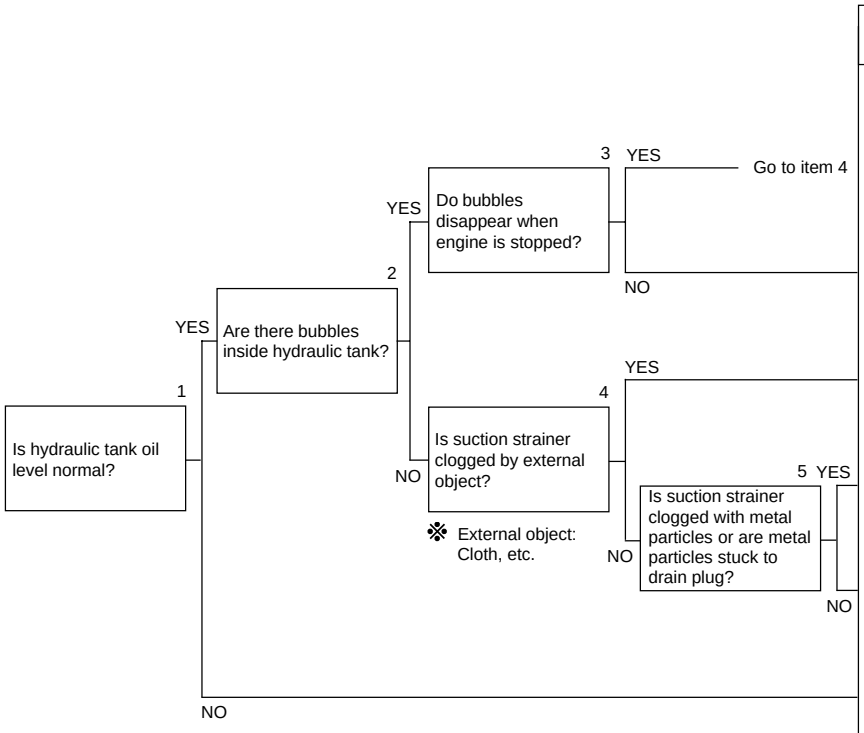
Engine speed at arm relief	Conditions
1900 rpm	• Engine at high idling • Swing lock switch ON • Measure the speed at the point where the drop in engine speed is greatest when the arm cylinder is at end of stroke and the lever is operated slowly to the full position.

H-3 No work equipment, travel, swing move



Cause	Remedy
Defective control pump, control relief valve, or defective control circuit	Replace
Defective main piston pump	Repair or replace
Defective PTO spline	Repair or replace
Defective operation of safety lock valve or safety linkage.	Adjust

H-4 Abnormal noise generated (around pump)

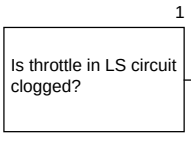


Cause	Remedy
Defective hydraulic oil	Replace Change hydraulic oil
Clogged by external object (cloth, etc.)	Remove
Defect inside pump	Repair or replace
Operate for a short time and watch for any change in symptoms	Inspect again (depending on changes in symptoms)
Lack of hydraulic oil	Add hydraulic oil

H-5 Auto deceleration does not work

Cause	Remedy
Defective pressure switch	Replace

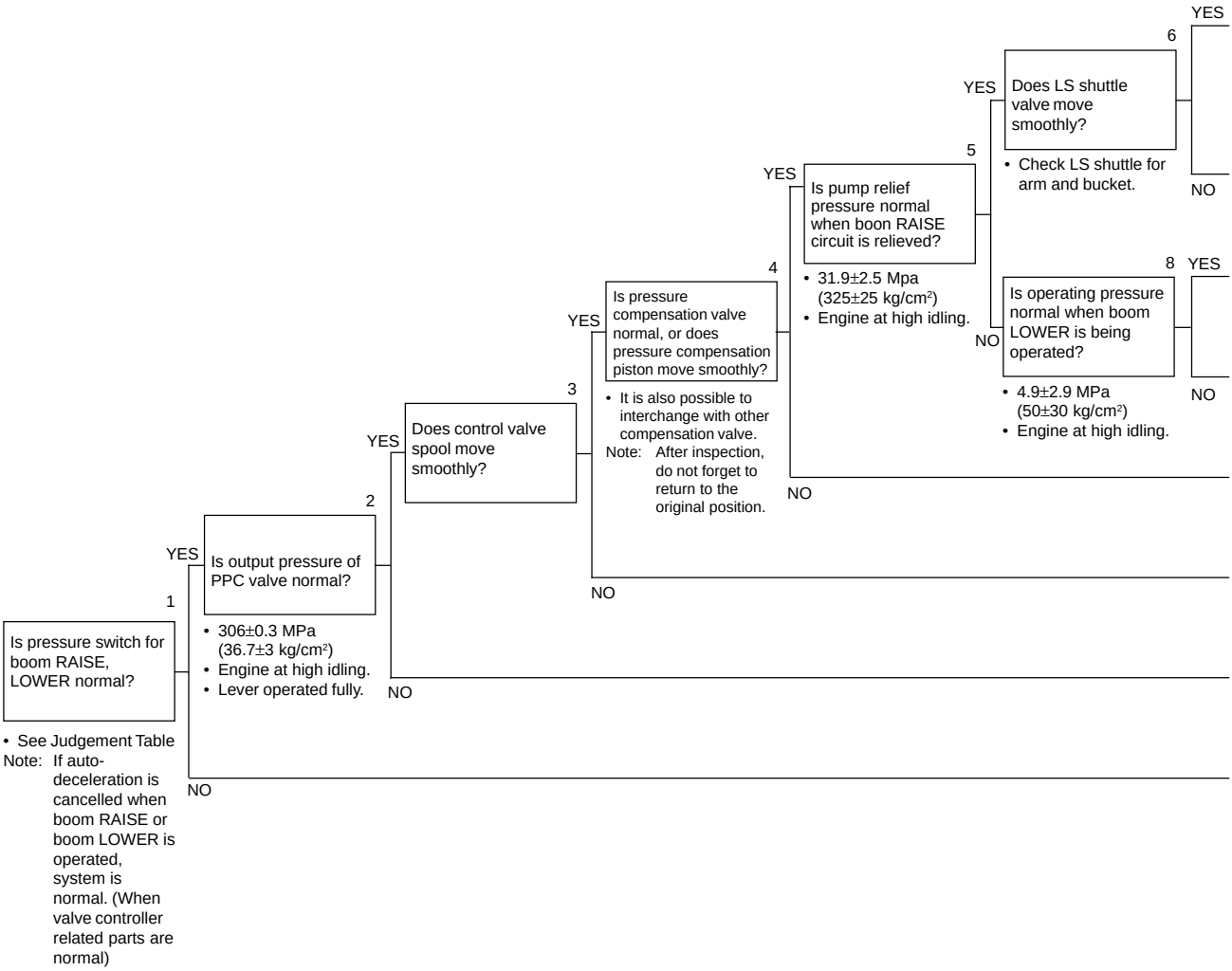
H-6 Fine control ability is poor or response is poor

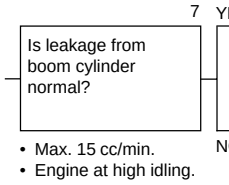


Cause	Remedy
Clogged throttle in LS circuit	Clean
Defective servo valve assembly (LS valve), or defective servo piston.	Replace

H-7 Boom is slow or lacks power

★ When travel and swing speeds are normal.
★ Carry out troubleshooting in the heavy- duty operation mode.





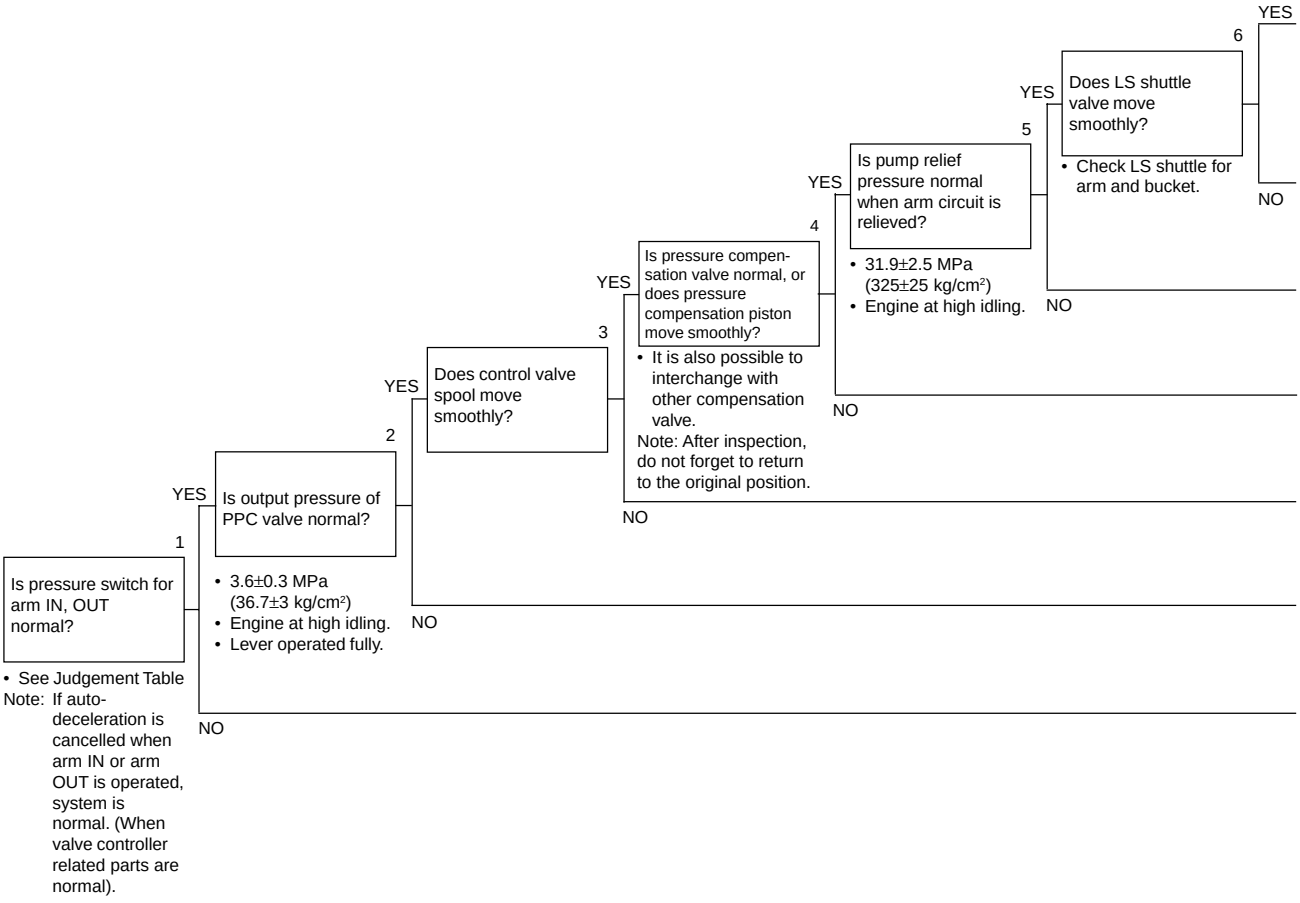
Cause	Remedy
Defective boom cylinder piston packing	Repair or replace
Defective operation of boom lock valve	Correct or replace
Defective operation of LS shuttle valve (LS shuttle for arm or bucket)	Correct or replace
Defective operation of boom lock valve or suction valve of control valve	Correct or replace
Defective operation of boom regeneration valve	Correct or replace
Defective operation of pressure compensation valve or pressure compensation piston	Correct or replace
Defective operation of control valve spool	Correct or replace
Defective PPC valve	Replace
Defective boom RAISE or boom LOWER pressure switch	Replace

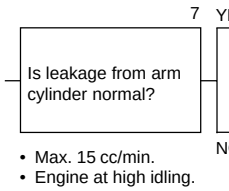
High

Low

H-8 Arm is slow or lacks power.

★ When travel and swing speeds are normal.
★ Carry out troubleshooting in the heavy- duty operation mode.



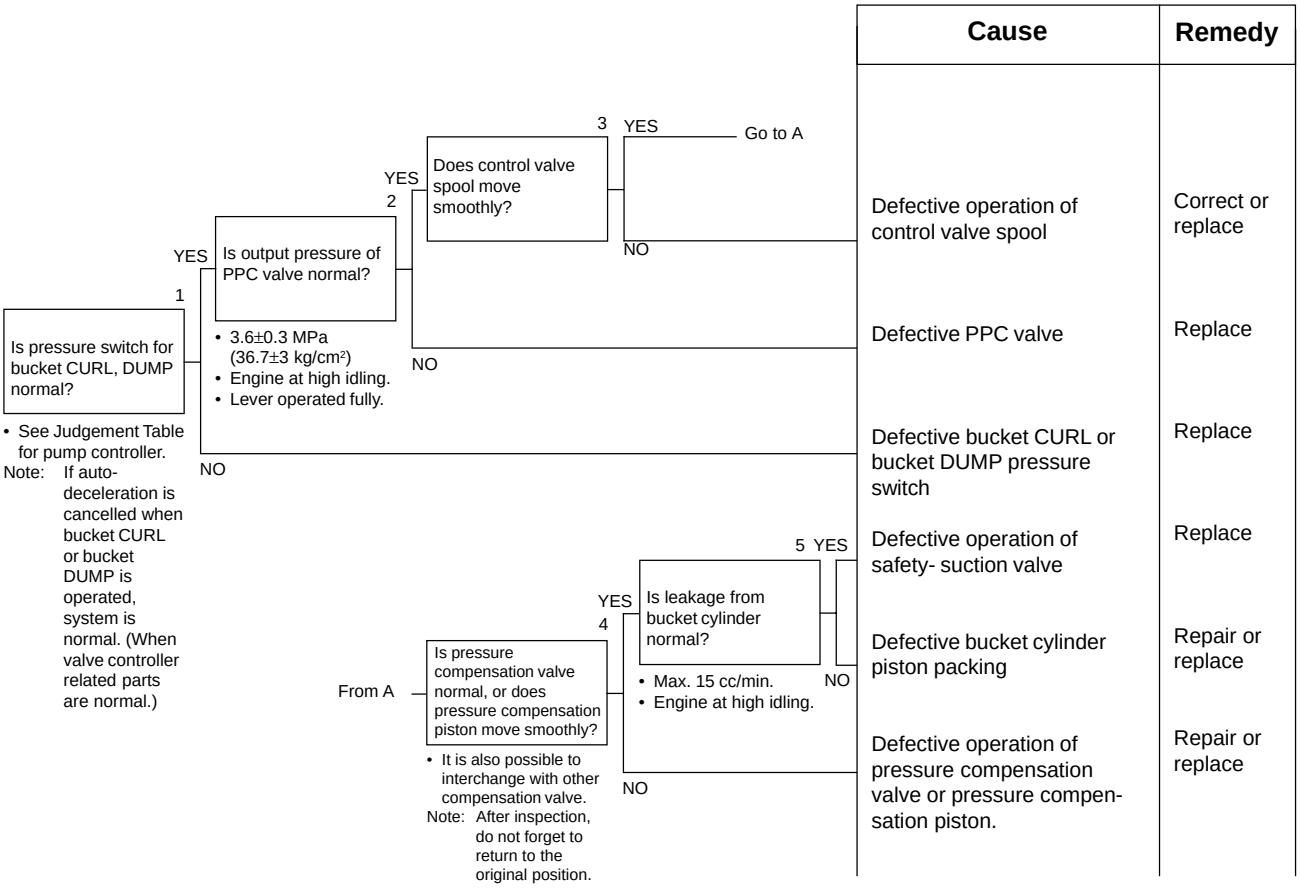


- Max. 15 cc/min.
- Engine at high idling.

Cause	Remedy
Defective operation of arm regeneration valve or arm counterbalance valve	Correct or replace
Defective arm cylinder piston packing	Repair or replace
Defective operation of LS shuttle valve (LS shuttle for bucket)	Correct or replace
Defective operation of safety-suction valve	Replace
Defective operation of pressure compensation valve or pressure compensation piston	Correct or replace
Defective operation of control valve spool	Correct or replace
Defective PPC valve	Replace
Defective arm IN or arm OUT pressure switch.	Replace

H-9 Bucket is slow or lacks power

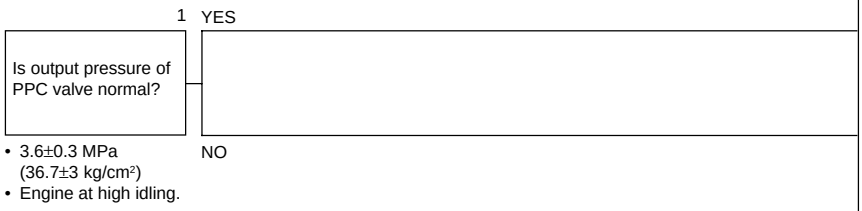
★ When travel and swing speeds are normal.



Cause	Remedy
Defective operation of control valve spool	Correct or replace
Defective PPC valve	Replace
Defective bucket CURL or bucket DUMP pressure switch	Replace
Defective operation of safety- suction valve	Replace
Defective bucket cylinder piston packing	Repair or replace
Defective operation of pressure compensation valve or pressure compensation piston.	Repair or replace

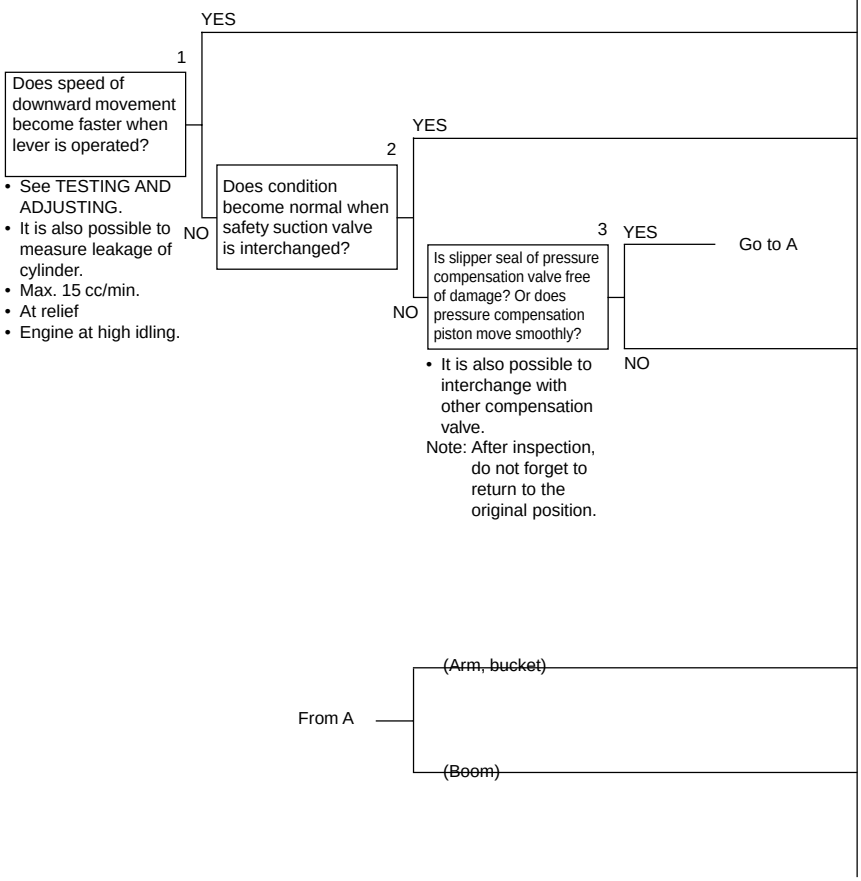
H-10 Work equipment (boom, arm, bucket) does not move (but travel and swing are normal)

★ When boom, arm, and bucket are each operated independently.



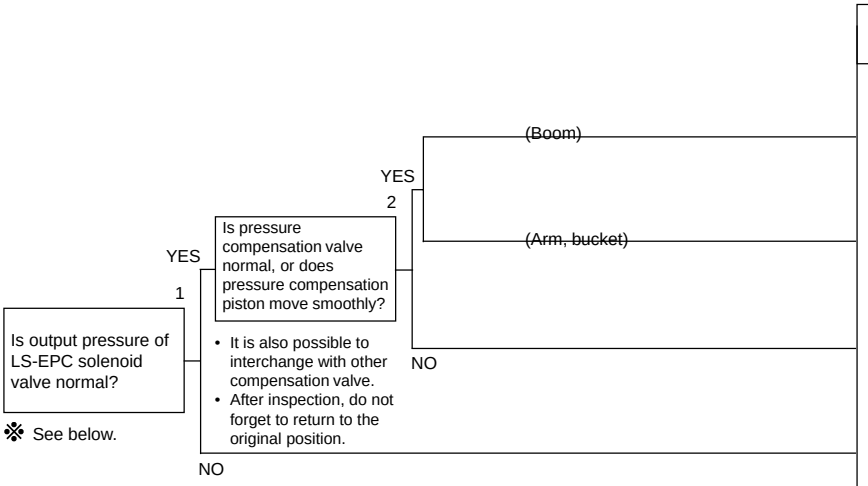
Cause	Remedy
Defective control valve spool	Correct or replace
Defective PPC valve	Replace

H-11 Excessive hydraulic drift (boom, arm, bucket)



Cause	Remedy
Defective hydraulic cylinder piston packing	Replace
Defective operation of safety-suction valve	Replace
Damaged slipper seal of pressure compensation valve, or defective operation of pressure compensation piston	Correct or replace
Defective oil tightness of control valve spool	Replace
Defective operation of boom lock valve	Correct or replace

H-12 Excessive time lag (engine at low idling)



Cause	Remedy
Defective safety-suction valve, or defective boom regeneration valve	Replace
Defective safety-suction valve	Replace
Defective operation of pressure compensation valve or pressure compensation piston	Correct or replace
Defective operation of LS-EPC solenoid valve.	Correct or replace

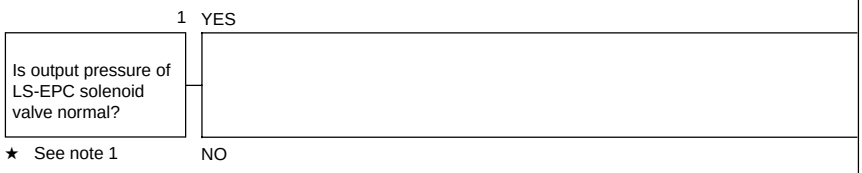
※ Output pressure of LS-EPC solenoid.
- Approx. 2.5 MPa (26 kg/cm^2) is output from the LS-EPC solenoid when the engine is at low idling (approx. 1000 rpm or below), regardless of the working mode.

H-13 Other equipment moves when single circuit is relieved.

Cause	Remedy
Defective operation of pressure compensation valve slipper seal.	Replace

※ The slipper seal in the pressure compensation valve of the circuit that moved is defective.

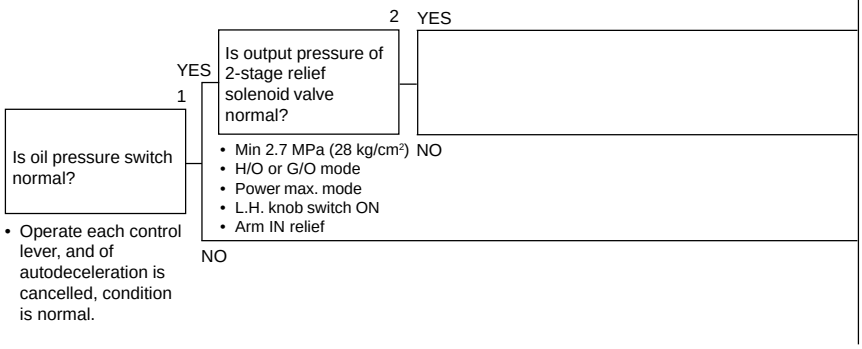
H-14 In F/O modes, work equipment speed is faster than specified speed



Cause	Remedy
Defective LS valve	Correct or replace
Defective operation of LS-EPC solenoid valve	Correct or replace

★ Output pressure of LS control EPC solenoid (travel OFF).
Approx. 2.5 MPa (Approx. 26 kg/cm^2) is output from the LS control EPC solenoid when the engine speed is approx. 1100 rmp or less in the F/O mode. (In the F/O mode, the engine speed is set at 1900 rpm when the fuel control dial is at the MAX position.)

H-15 Lack of power when pressure rises



Cause	Remedy
Defective main relief valve	Replace
Defective operation of 2-stage relief solenoid valve	Repair or replace
Defective oil pressure switch	Replace

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 Travel speed is slow

★ When travel speed is normal.
★ Check operating condition of pressure switch with monitoring code before carrying out troubleshooting.
★ Carry out troubleshooting in the heavy-duty operation mode.

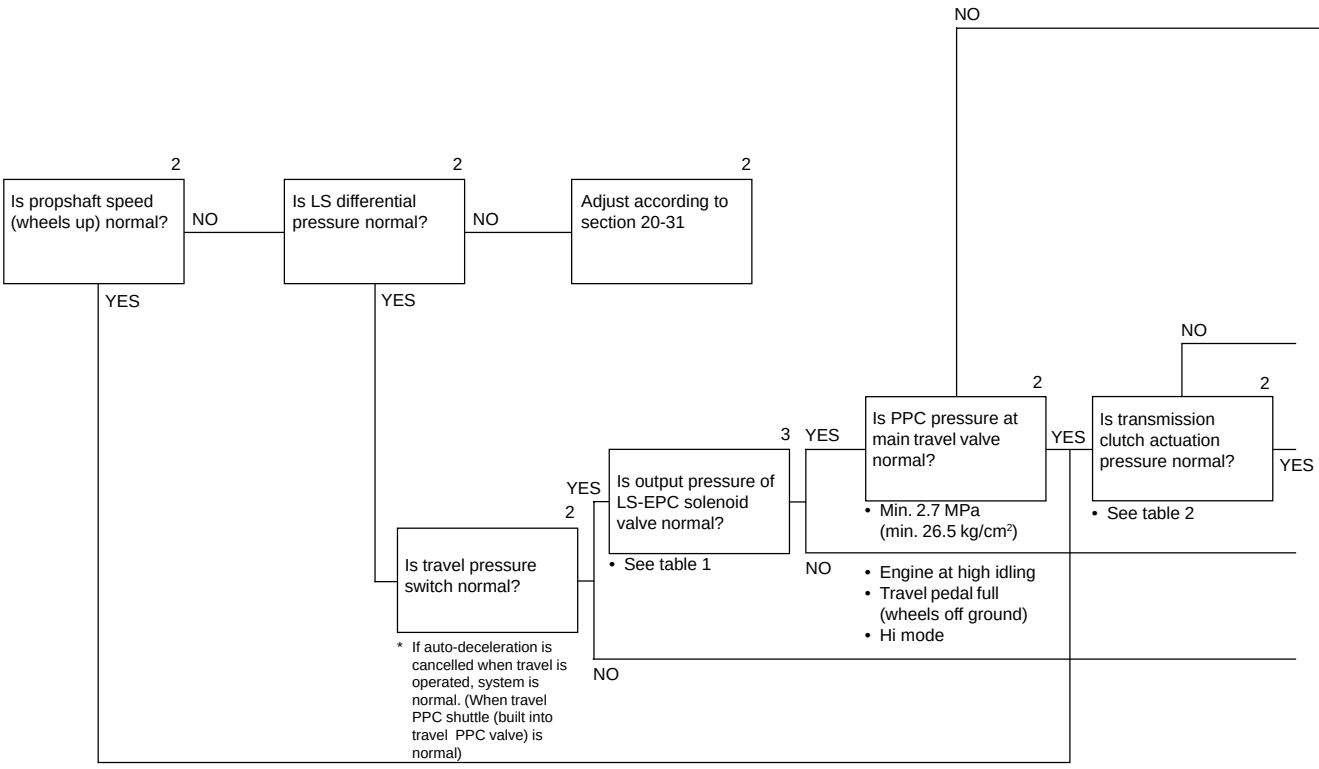


Table 1. Output pressure of LS-EPC solenoid

Lo	Mid	Hi
2.0±0.2 MPa {20±2 kg/cm²}	0.59±0.2 MPa {6±2 kg/cm²}	0.2±0.2 MPa {2±2 kg/cm²}
• Engine at high idling • Travel pedal at fine control position (autodeceleration cancelled)		

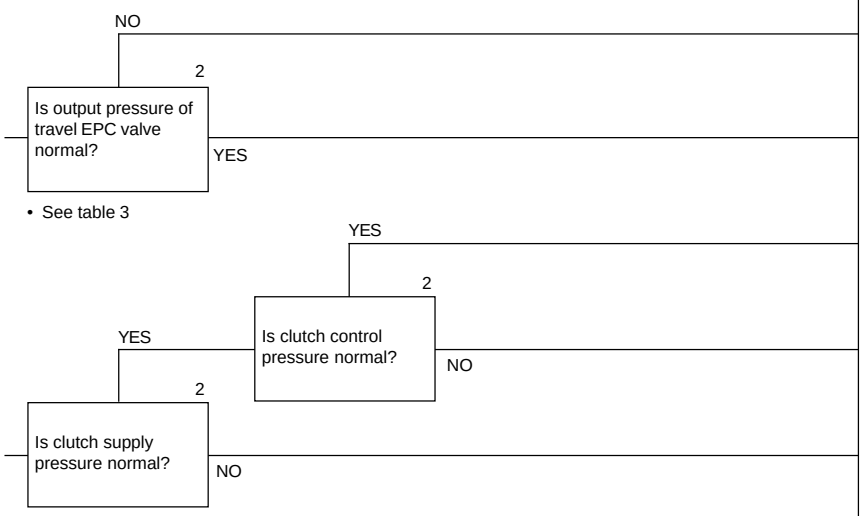
Table 2. Transmission clutch pressure

Lo	Mid	Hi
○	○	4.7 ± 0.2 MPa {48 ± 2 kg/cm²}
• Measure at clutch inlet port • Wheels off ground • Full travel speed, no load		

Table 3 Output pressure of travel EPC

Lo	Mi	Hi
1.4±0.2 MPa (14±2 kg/cm²)	$29.4^{+0.4}_{-0.2}$ MPa (30^{+4}_{-2} kg/cm²)	$29.4^{+0.4}_{-0.2}$ MPa (30^{+4}_{-2} kg/cm²)
• Engine at high idling • Travel lever at fine control position (autodeceleration cancelled)		
• Measure PPC pressure at main valve (travel spool)		

* See testing and adjusting - Testing propshaft speed.

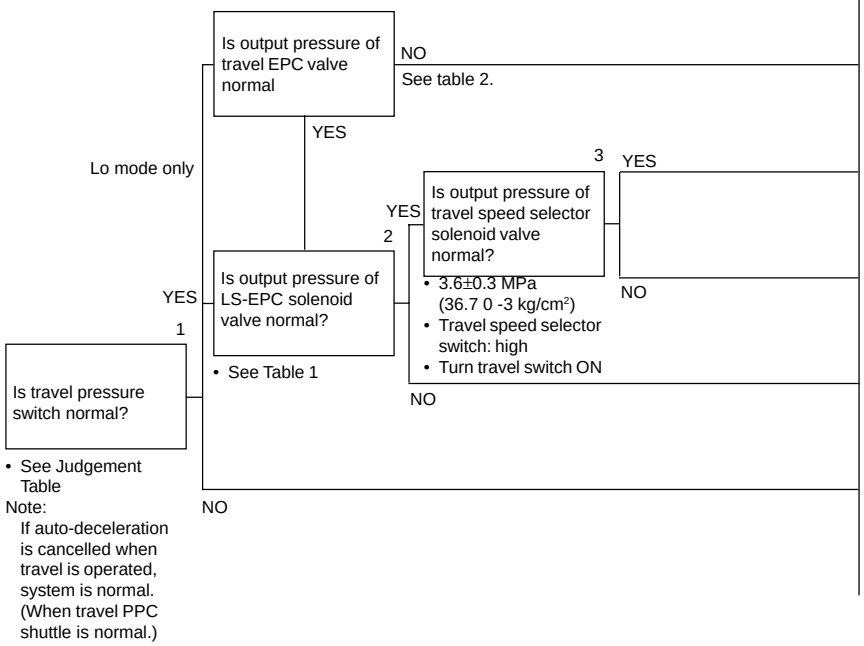


Cause	Remedy
Defective travel EPC valve.	Replace
Travel pedal defective or has restricted movement	Replace, clean and re-set
Defective clutch control valve	Replace
Defective clutch control pump or relief valve	Replace
Defective pressure reducing valve	Replace
Defective operation of main valve travel valve or defective transmission clutch	Correct or replace Replace
Defective operation of LS-EPC solenoid valve	Replace
Defective pressure switch.	Replace

Note: If transmission clutch does not disengage, maximum travel speed in Hi mode will be reduced from 30 kpH to 25 kpH. Maximum speeds in Lo an Mi modes will be unaffected.

H-18 Travel speed does not switch or is faster than specified speed.

★ Carry out troubleshooting in the heavy- duty mode.



Cause	Remedy
Defective travel EPC valve	Replace
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.

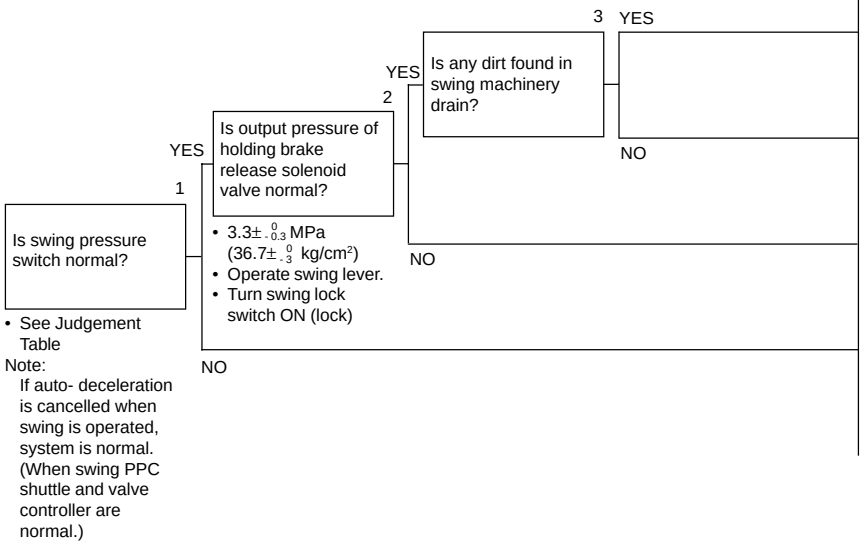
Lo	Mid	Hi
2.0±0.2 MPa {20±2 kg/cm²}	0.59±0.2 MPa {6±2 kg/cm²}	0.2±0.2 MPa {2±2 kg/cm²}
• Engine at high idling • Travel pedal at fine control position (autodeceleration cancelled)		

Table 2. Output pressure of travel EPC

Lo	Mi	Hi
1.4±0.2 MPa (14±2 kg/cm²)	$29.4^{+0.4}_{-0.2}$ MPa (30^{+4}_{-2} kg/cm²)	$29.4^{+0.4}_{-0.2}$ MPa (30^{+4}_{-2} kg/cm²)
• Engine at high idling • Travel lever at fine control position (autodeceleration cancelled)		
• Measure PPC pressure at main valve (travel spool)		

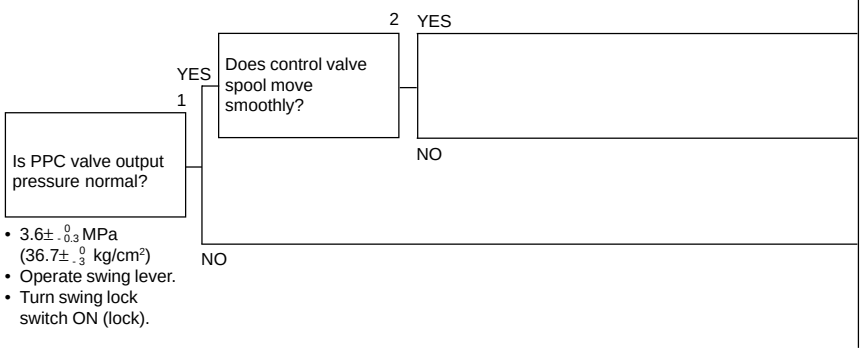
H-19 Does not swing

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 release solenoid valve	Correct or replace
Defective swing pressure switch.	Replace

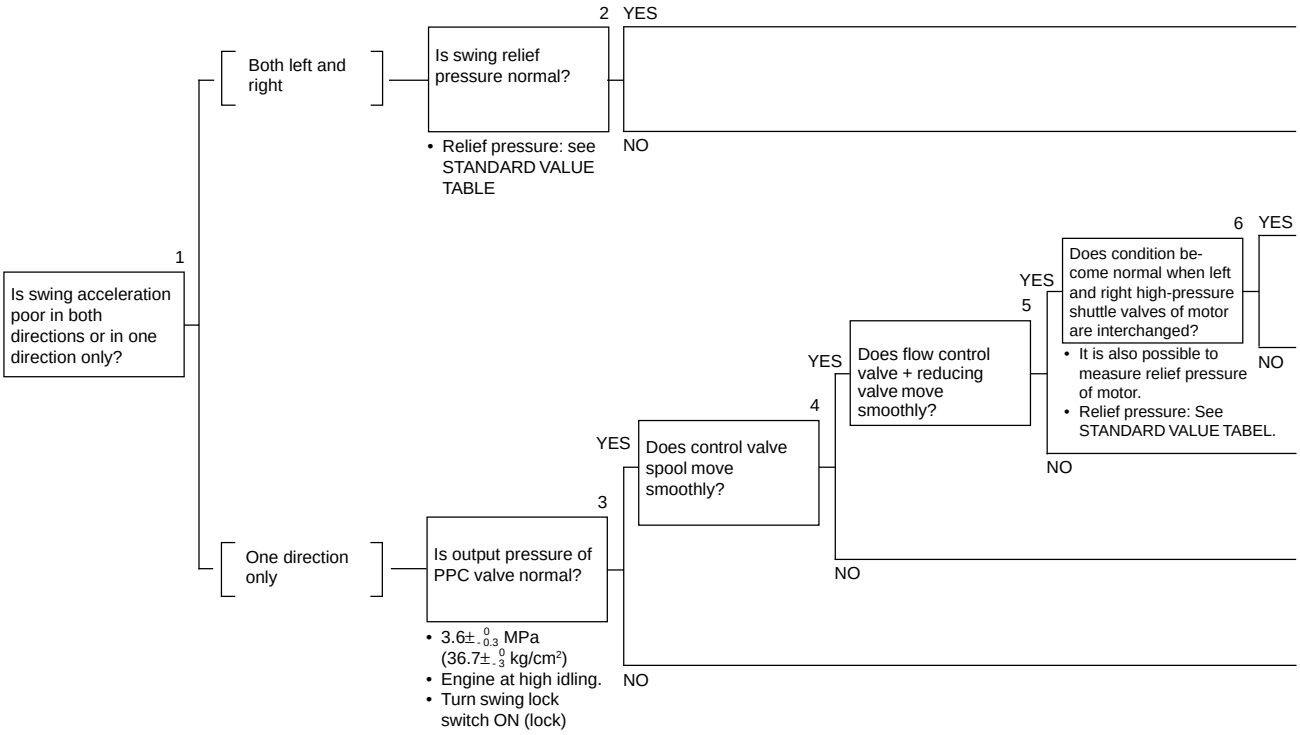
b) Does not swing in one direction



Cause	Remedy
Defective swing motor safety valve	Replace
Defective operation of control valve spool	Correct or Replace
Defective PPC valve	Replace

H-20 Swing acceleration is poor

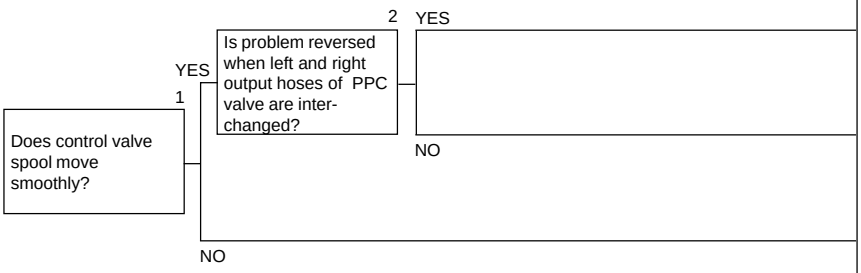
★ Carry out troubleshooting in the heavy- duty operation mode.



	Cause	Remedy
	Go to ONE DIRECTION ONLY	
	Defective swing motor safety valve	Replace
	Defective swing motor high pressure shuttle valve (one side)	Replace
	Defective swing motor suction valve	Replace
	Defective operation of flow control valve + reducing valve	Correct or replace
	Defective operation of control valve spool	Correct or replace
	Defective PPC valve	Replace

H-21 Excessive overrun when stopping swing

a) One direction only

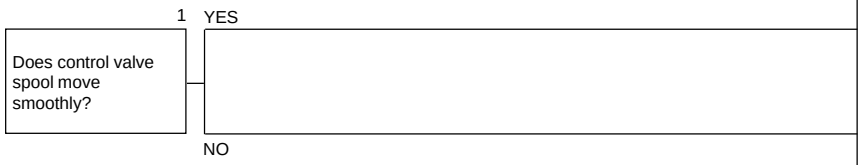


Cause	Remedy
Defective PPC valve	Replace
Defective swing motor safety valve	Replace
Defective operation of control valve spool.	Correct or replace

b) Both directions

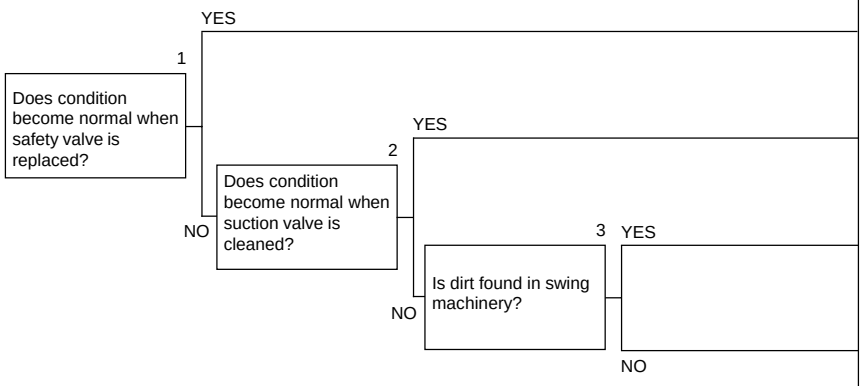
Cause	Remedy
Defective swing motor	Correct or replace

H-22 Excessive shock when stopping swing (one direction only)



Cause	Remedy
Defective PPC valve	Replace
Defective operation of control valve spool.	Correct or replace

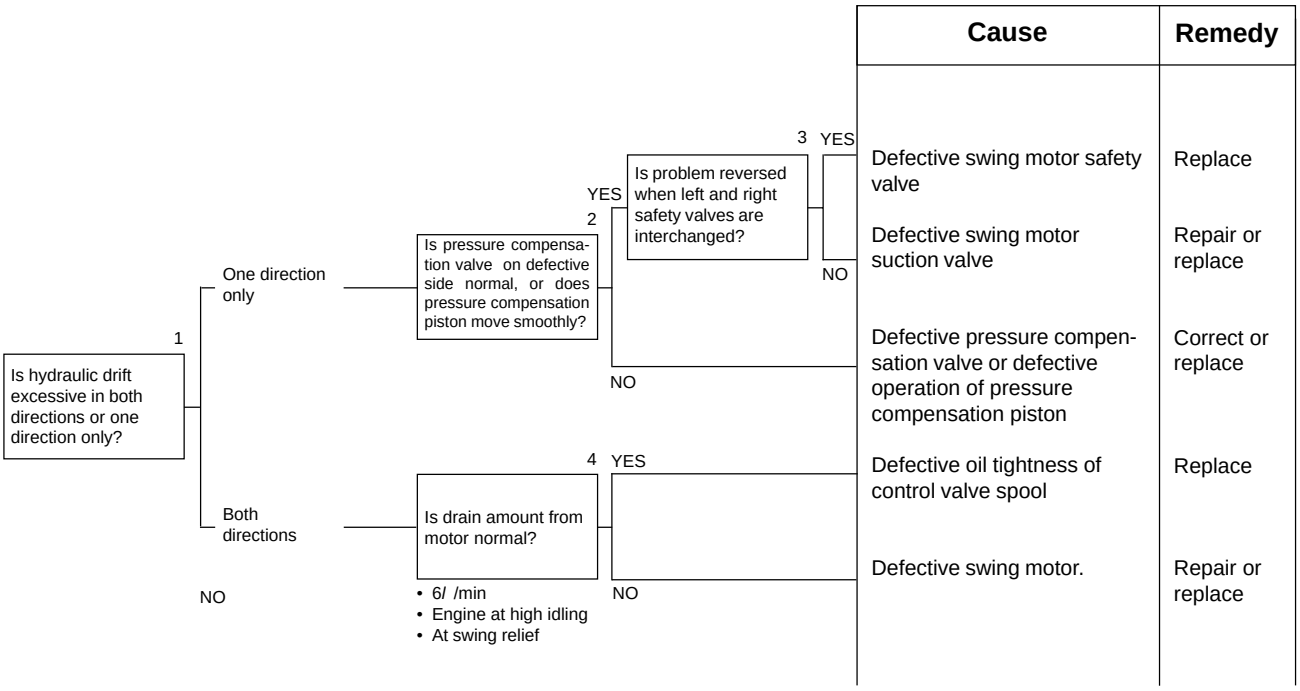
H-23 Excessive abnormal noise when stopping swing



Cause	Remedy
Defective swing motor safety valve	Replace
Defective swing motor suction valve	Replace
Defective swing machinery	Repair or replace
Defective back pressure valve.	Repair or replace

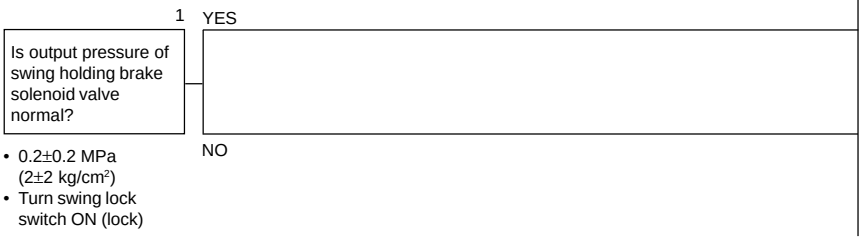
H-24 Excessive hydraulic drift of swing.

a) When holding brake is released



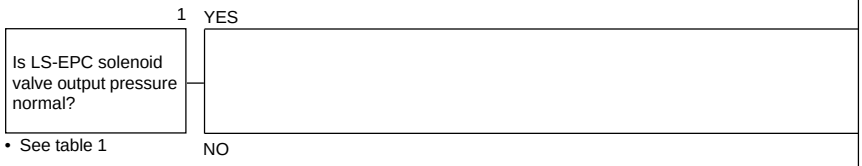
Cause	Remedy
Defective swing motor safety valve	Replace
Defective swing motor suction valve	Repair or replace
Defective pressure compensation valve or defective operation of pressure compensation piston	Correct or replace
Defective oil tightness of control valve spool	Replace
Defective swing motor.	Repair or replace

b) When 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-25 Swing speed is faster than specified swing speed



Cause	Remedy
Defective operation of LS valve	Replace servo assembly
Defective LS-EPC solenoid valve	Repair or replace.

H/O mode	G/O mode	F/O mode	L/O mode
0.2±0.2 MPa {2.0±2.0 kg/cm^2}	0.2±0.2 MPa {2.0±2.0 kg/cm^2}	1.18±0.2 MPa {12±2.0 kg/cm^2}	0.88±0.2 MPa {9.0±2.0 kg/cm^2}
• Engine at high idling			

TROUBLESHOUTING OF MACHINE NOMITOR PANEL SYSTEM (M MODE)

ACTION TAKEN BY MONITOR PANEL WHEN ABNORMALITY OCCURS AND PROBLEMS ON MACHINE

User code	Service code	Abnormal system	Nature of abnormality
-	E 101	Abnormality in trouble data memory	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.
-	E 102	Abnormality in time 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.
-	E 103	Short circuit in buzzer output system	1. Short circuit inside buzzer. 2. Power line in contact with wiring harness between monitor (P01(7)) and buzzer. 3. Abnormality in monitor panel.
-	E 104	Air cleaner clogging detection	Air cleaner clogging sensor detects clogging.
-	E 106	Drop in engine oil pressure detection	Engine oil pressure sensor detects drop in oil pressure.
-	E 108	Engine water temperature 105°C detection	Coolant temperature sensor detects water temperature 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 actuate 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 disconnection, E103 is not displayed and buzzer does not sound.	-	Buzzer does not sound.
• Resistance between P11 (male) and P12 (female): Max. 1 Ω (start engine)	-	If detection of abnormality continues, air cleaner clogging caution lamp flashes and buzzer sounds.
• Resistance between sensor terminal and chassis: Max. 1 Ω (engine running at mid-range speed).	-	If detection of abnormality continues, engine oil pressure caution lamp flashes and buzzer sounds.
• Resistance between P07 (1) and (2): Min. 3.156 kΩ (start engine).	-	1. If detection of abnormality continues, coolant temperature caution lamp flashes and buzzer sounds. 2. If detection of abnormality continues, engine speed is set to low idling.

User code	Service code	Abnormal system	Nature of abnormality
-	E112	AE112 Short circuit in wiper motor drive normal rotation system.	1. Internal short circuit, short circuit with chassis ground in wiper motor. 2. Internal short circuit, short circuit with chassis ground in relay box. 3. Short circuit with chassis ground, short circuit in wiring harness between monitor P02 (11) and relay box W08 (2), or between W08 (6) and wiper motor W04 (3).
-	E113	AE113 Short circuit in wiper motor drive reverse rotation system.	1. Internal short circuit, short circuit with chassis ground in wiper motor. 2. Internal short circuit, short circuit with chassis ground in relay box. 3. Short circuit with chassis ground, short circuit in wiring harness between monitor P02 (3) and relay box W08 (3), or between W08 (7) and wiper motor W04 (1).
-	E114	SE114 Short circuit in window washer drive system.	1. Internal short circuit, short circuit with chassis ground in washer motor. 2. Internal short circuit, short circuit with chassis ground in relay box. 3. Short circuit with power source in wiring harness between monitor P02 (2) (10) and relay box W08 (17), or between W08 (16) and M28 (1).

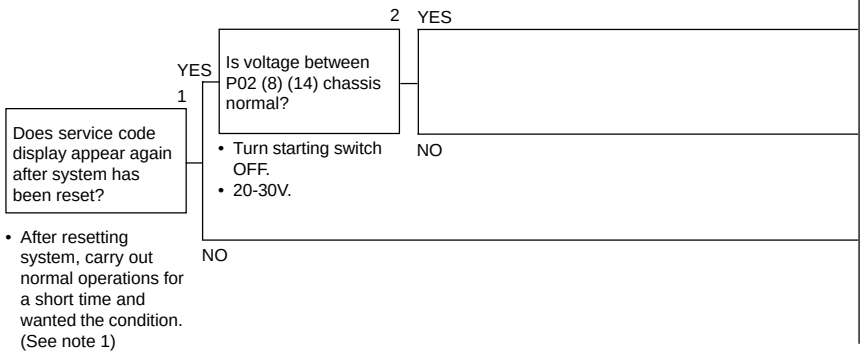
Condition when normal (voltage, current, resistance)	Action by controller when abnormality is detected	Problem that appears on machine when there is abnormality
• Voltage between W04 (3) and (5): max. 3V ↕ 20-30V ★ Repeats in fixed cycle.	Makes output to relay box 0	Operation of wiper stops.
• Voltage between W04 (1) and (5): Max. 3V ↕ 20-30V ★ Repeats in fixed cycle.	Same as E112.	Same as E112.
• Motor resistance: 5-20 Ω.	Makes output to washer motor 0.	Operation of window washer stops.

A3

A3

M-1 [E101] Abnormality in error data is displayed [E102] Error in clock data is displayed

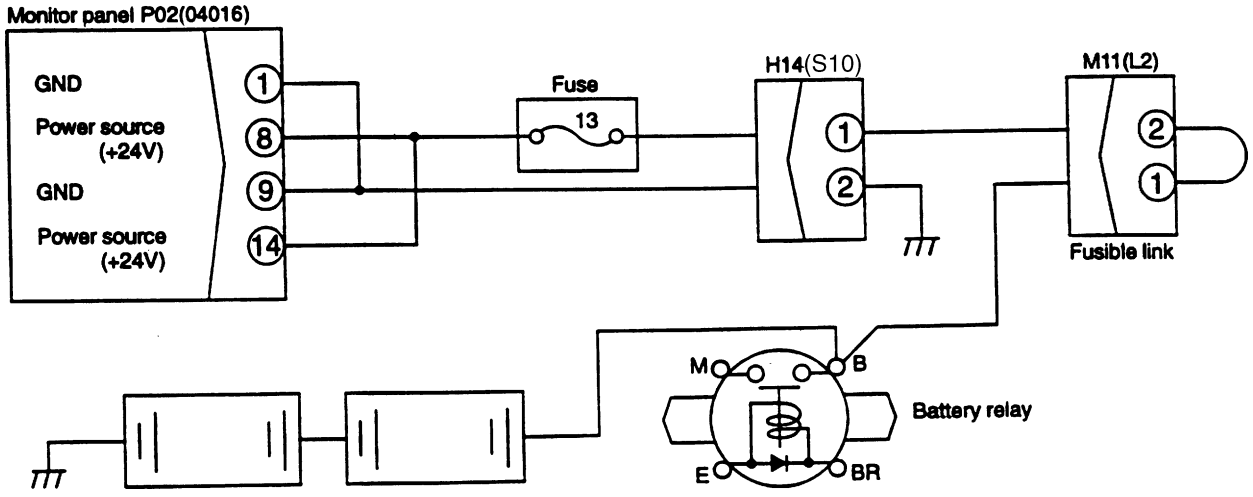
★ This is not an abnormality. It occurs during troubleshooting when disconnecting and connecting connector P02 (for the monitor panel electrical system), fuse No. 13, connector H14, connector M11, battery relay terminal B, or the battery terminal.
(When the monitor panel power source circuit is shut 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	-

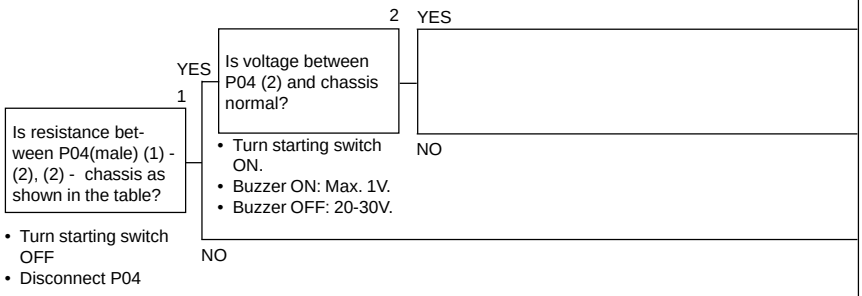
Note 1: Resetting operation:
Turn the starting switch OFF. Then keep the time switch at the back of the monitor panel depressed, switch the starting switch ON again, and keep the time switch depressed for 5 seconds to return the system to normal.
(With this operation, all the service codes in the internal memory are erased.)

M-1 Related electrical 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 to the next step.

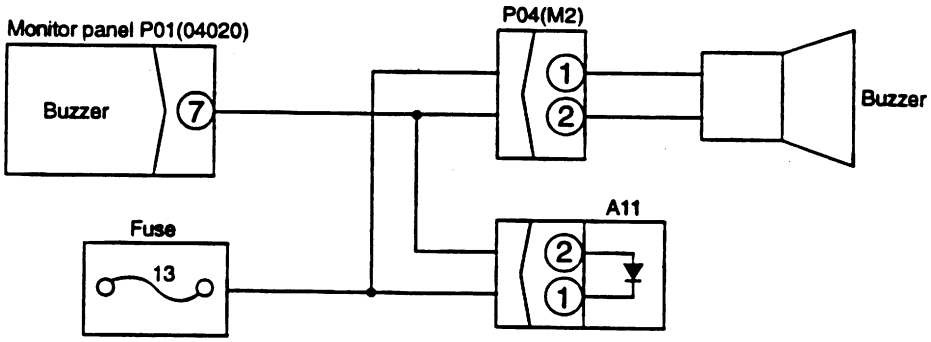


Cause	Remedy
Defective monitor panel	Replace
Short circuit with power source in wiring harness between P01 (female) (7) and P04 (female) (2) or short circuit in wiring harness between P04 (1) and (2)	Repair or replace
Defective buzzer.	Replace

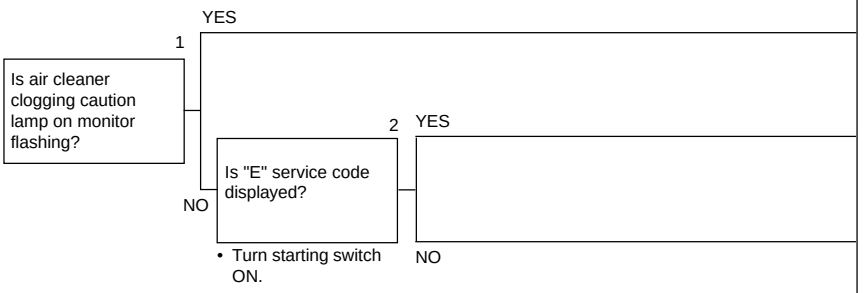
Table

P04 (male)	Resistance value
Between (1) and (2)	200-300 Ω
Between (2) and chassis	Min. 1 MΩ

M- 2 Related electrical circuit diagram.



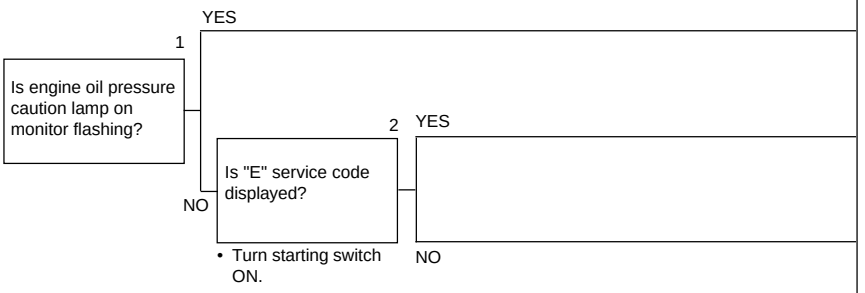
M-3 [E104] Air clogging detected is displayed



Cause	Remedy
(See M-13F)	-
Detective monitor panel	Replace
Failure in engine system (See note 1)	-

Note 1: The monitor panel display has returned to normal, but the air clogging sensor has detected symptoms of clogging in the past, so carry out troubleshooting of the engine to remove the problem.

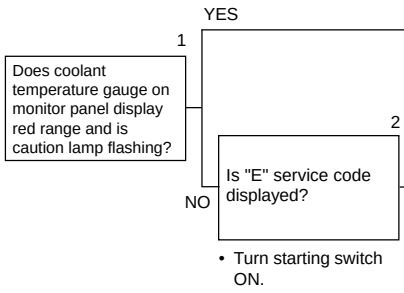
M-4 [E106] Drop in engine oil pressure detected is displayed



Cause	Remedy
(See M-13 a)	-
Detective 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 1050C detected is displayed



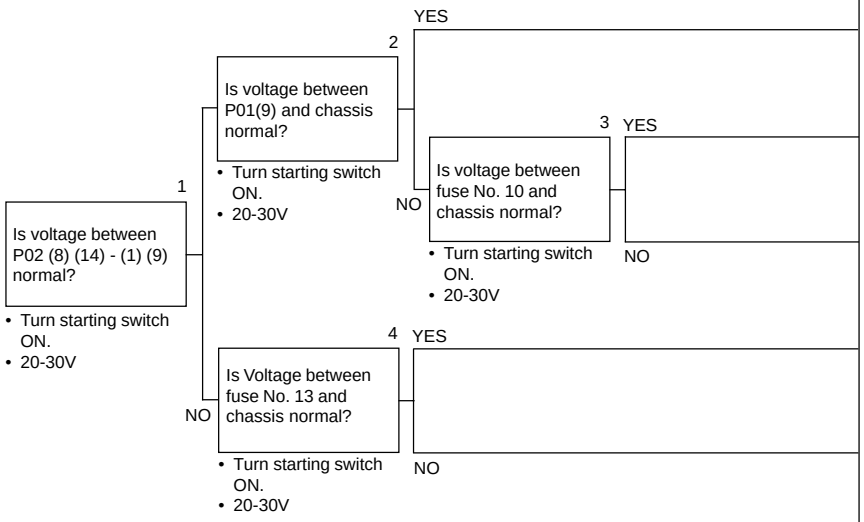
Cause	Remedy
(See M-13 d)	-
Defective monitor panel	Replace
Failure in engine system (See Note 1)	-

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 in monitor panel light up.

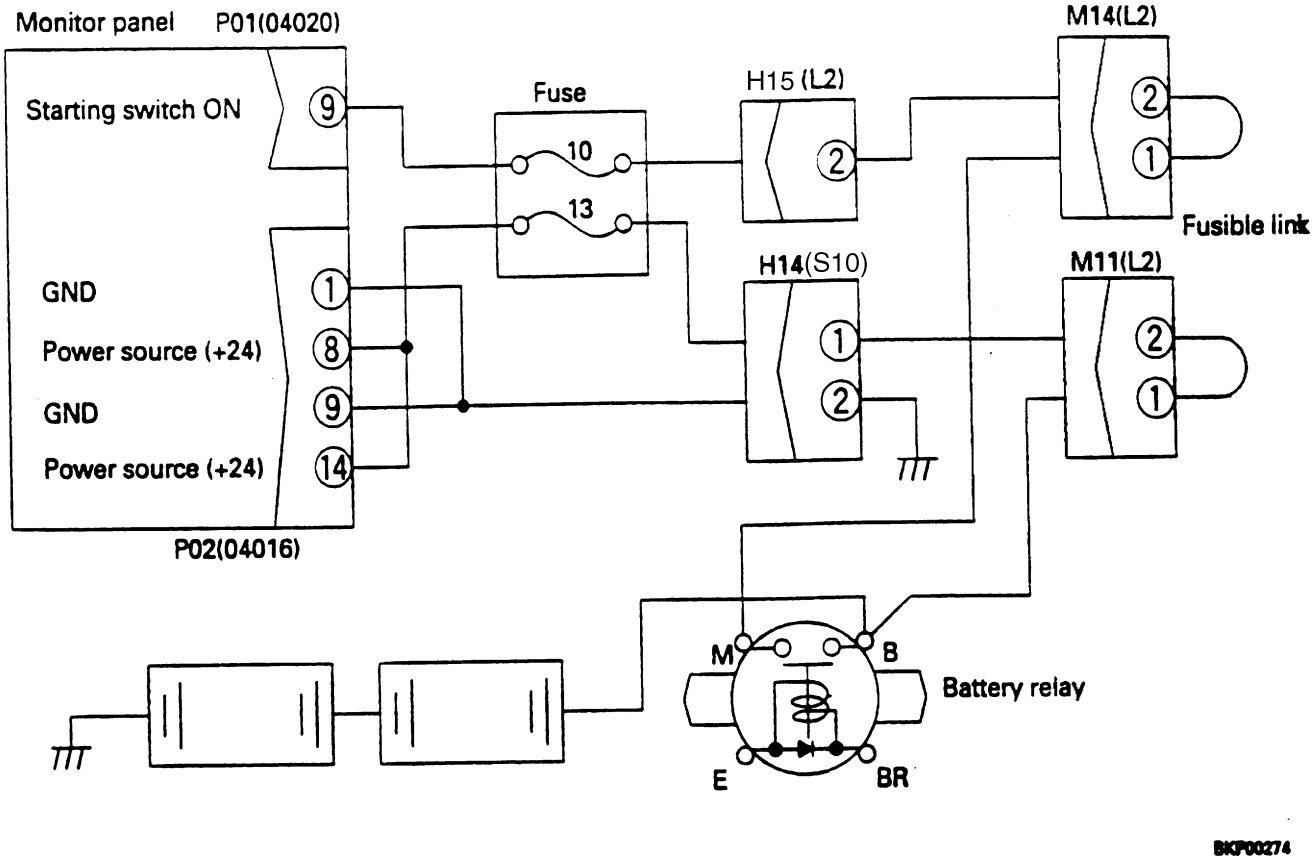


Cause	Remedy
Detective monitor panel	Replace
Disconnection, detective contact, short circuit with ground in wiring harness between P01 (female) (9) and fuse No. 10	Repair or replace
Disconnection, defective contact, short circuit with ground in wiring harness between fuse No. 10 - H05 (2) - M14 (2) (1) - battery relay M	Repair or replace
Disconnection, defective contact, short circuit with ground in wiring harness between P02 (female) (8) (14) and fuse No. 1	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
Detective monitor panel	Replace

M-6 a) Related electrical circuit diagram



M-7 When starting switch is turned ON, monitor panel lamps all stay lighted up and do not go out.

Cause	Remedy
Defective monitor panel	Replace

M-8 When starting switch is turned ON, items lighted up on monitor panel are different from actual machine (model)

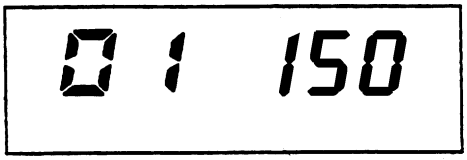
★ Immediately after replacing the monitor panel, turn the starting switch OFF, then turn it ON again.

Cause	Remedy
Defective monitor panel.	Replace
Go to troubleshooting for C mode (See C-14)	-

1 Is display of monitoring code 01 as shown in table?
- YES
- NO

- Turn starting switch ON.
- Set to monitoring code 01.

Table



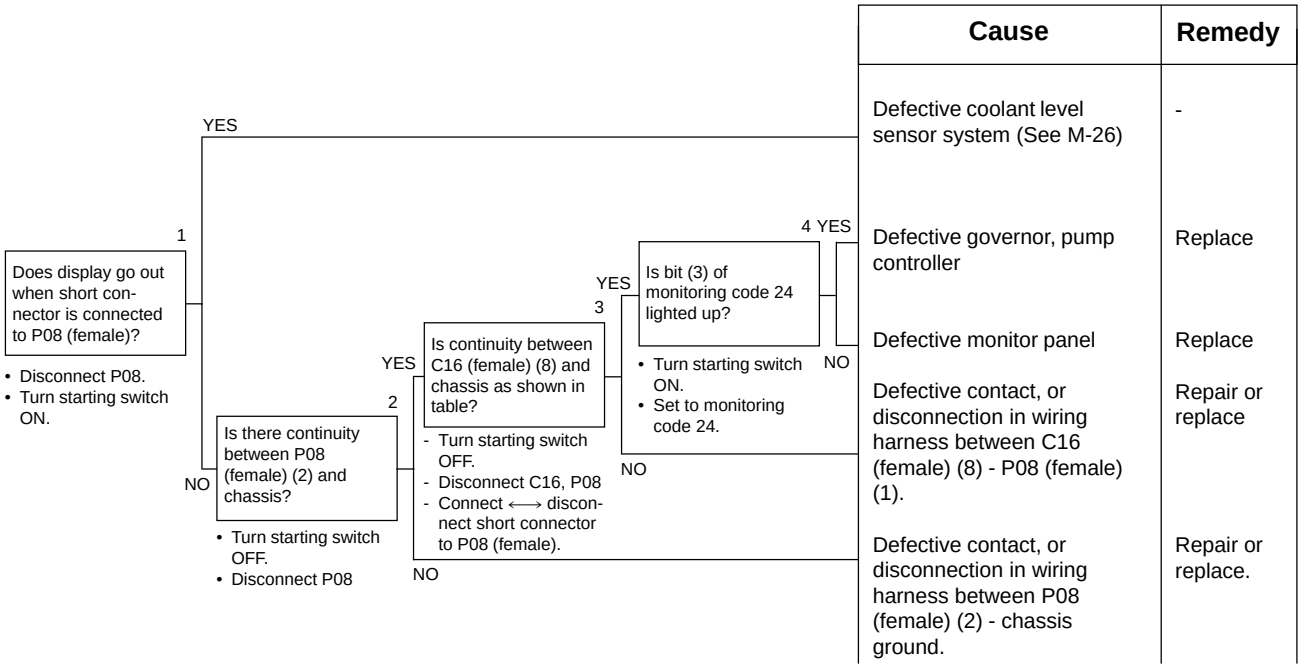
M-9 When starting switch is turned ON (engine stopped), basic check items flashes.

★ 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) (coolant level) flashes

SAP00519

★ Check that the coolant is at the specified level before carrying out troubleshooting.

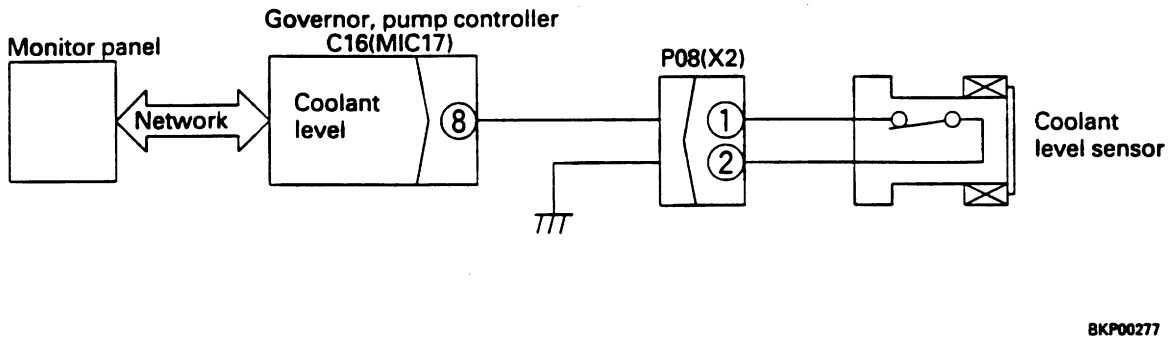


Cause	Remedy
Defective coolant level sensor system (See M-26)	-
Defective governor, pump controller	Replace
Defective monitor panel	Replace
Defective contact, or disconnection in wiring harness between C16 (female) (8) - P08 (female) (1).	Repair or replace
Defective contact, or disconnection in wiring harness between P08 (female) (2) - chassis ground.	Repair or replace.

Table

Short connector	Continuity
Connected	Yes
Disconnected	No

M-9 a) Related electrical circuit diagram

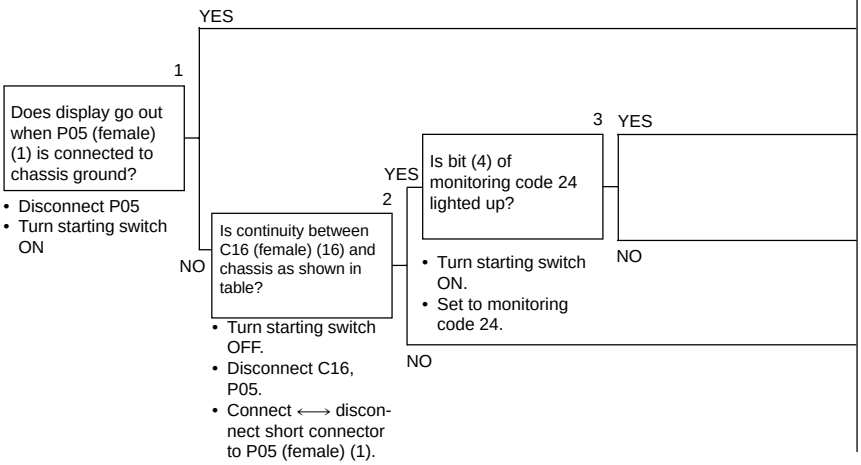


BKP00277

b) (coolant level) flashes

SAP00523

★ Check that the engine oil is at the specified level before carrying out troubleshooting.



Cause	Remedy
Defective engine oil level sensor system (See M-27)	-
Defective governor, pump controller	Replace
Defective monitor panel	Replace
Defective contact, or disconnection in wiring harness between C16 (female) (16) - E08 (5) - P05 (female) (1).	Repair or replace

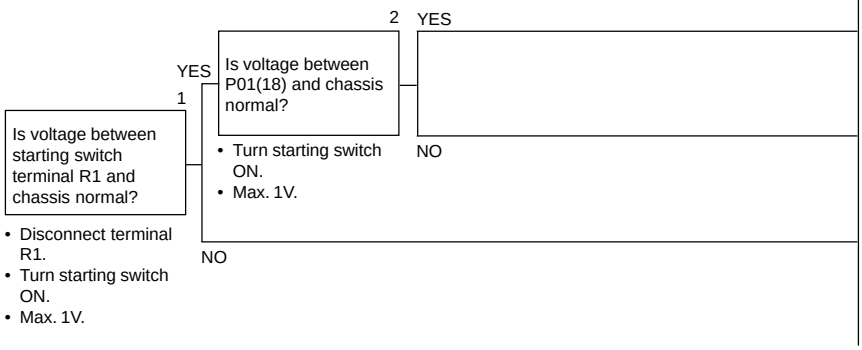
Table

Chassis ground	Continuity
Connected	Yes
Disconnected	No

M-9 b) Related electrical circuit diagram

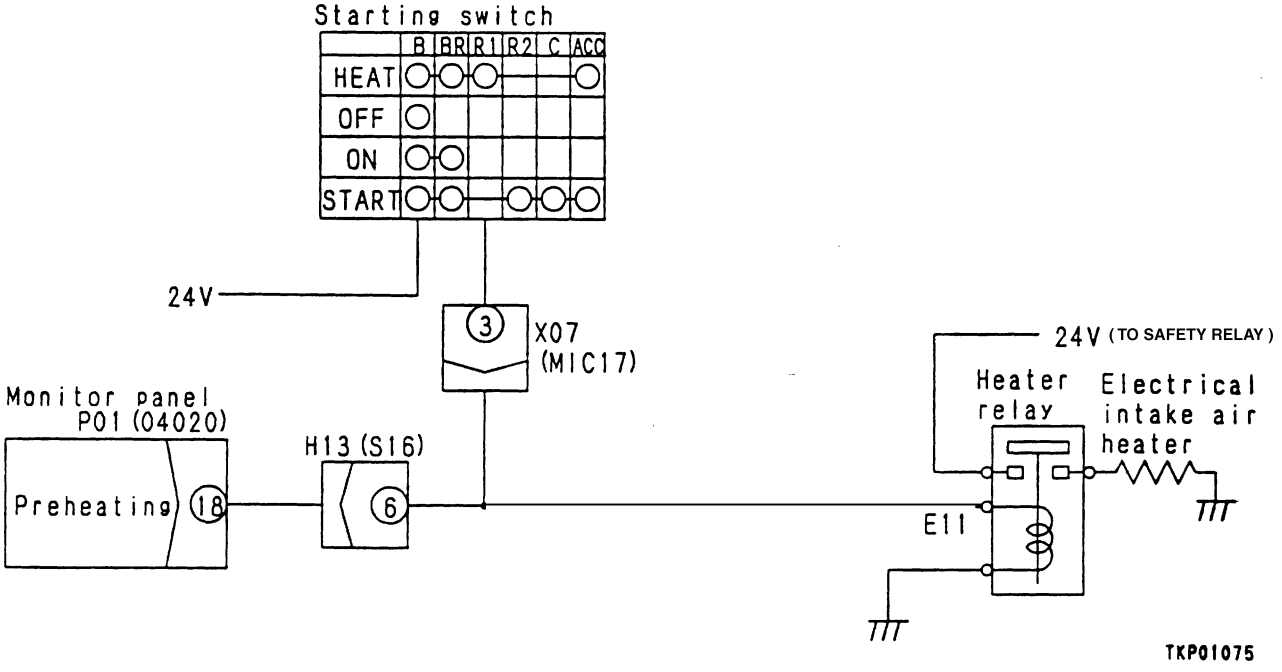
M-10 Preheating is not being used but SAP00526 (preheating monitor) lights up

★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



Cause	Remedy
Defective motor panel	Replace
Wiring harness between starting switch R1 - X07 (3) - H13 (6) - P01 (female) (18), or between E11 and H13 (female) (6) short circuiting with power source	Repair or replace
Defective starting switch	Replace

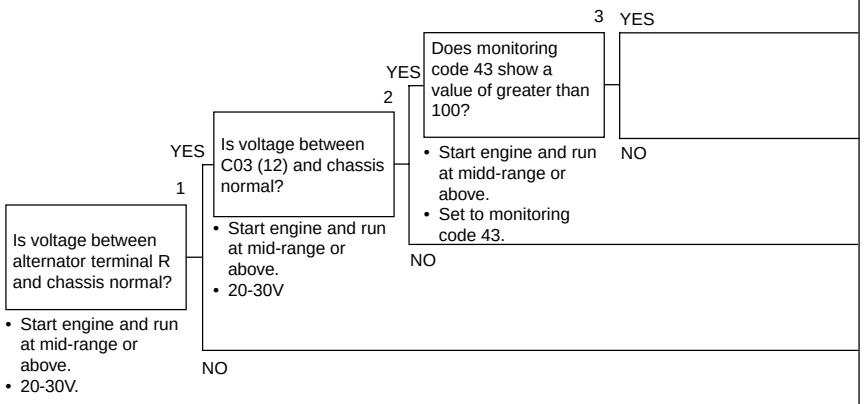
M-10 Related electrical circuit diagram



M-11 When starting switch is turned ON and engine is started, basic check items flash.

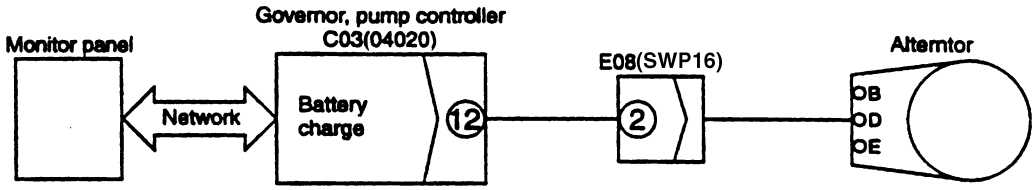
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.
★ Check both the alternator system and the engine oil pressure system.

a) Alternator system.



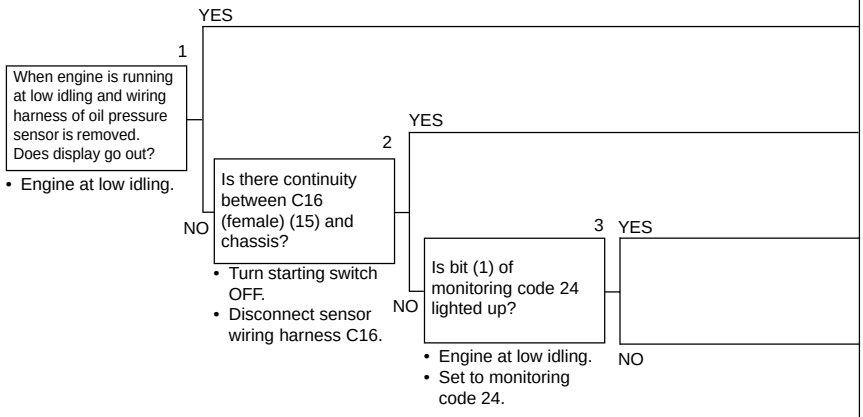
Cause	Remedy
Defective governor, pump controller	Replace
Defective monitor panel	Replace
Defective contact, or disconnection in wiring harness between alternator terminal D-E08 (2) - C03 (female) (12)	Repair or replace
Defective alternator	Replace.

M-11a) Related electric circuit diagram



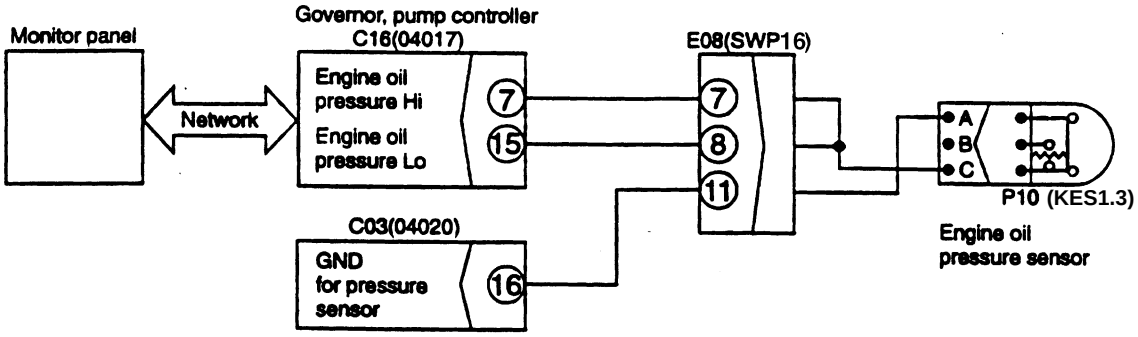
a) Engine oil pressure system

★ When engine oil pressure is normal.



Cause	Remedy
Defective oil pressure sensor	Replace
Contact of chassis ground with wiring harness between C16 (female) (15) - E08 (8) - P10 (C) or P10 (A) - E08 (11) - C03 (16)	Repair or replace
Defective governor, pump controller	Replace
Defective monitor panel.	Replace

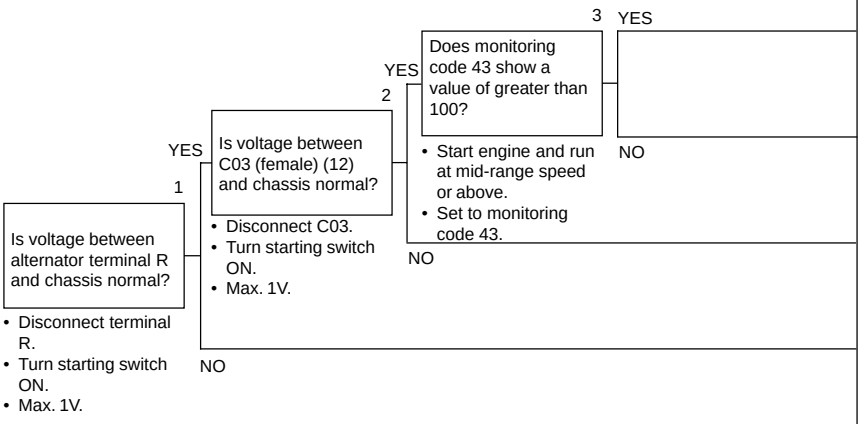
M-11b) Related electric circuit diagram.



M-12 When starting switch is turned ON (engine stopped), caution items, emergency items flash (battery, engine oil pressure lamps do not light up).

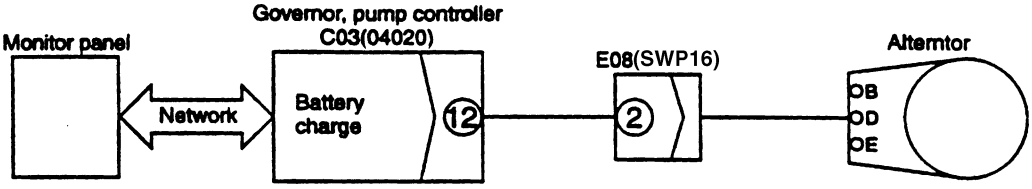
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.
★ Check both the alternator system and the engine oil pressure system.

a) Alternator system.



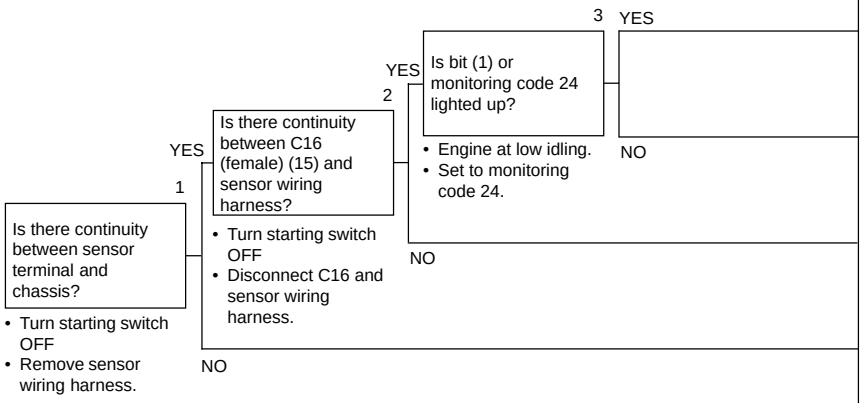
Cause	Remedy
Defective governor, pump controller	Replace
Defective monitor panel	Replace
Short circuit with power source in wiring harness between C03 (female) (12) - E08 (2) - alternator D	Repair or replace
Defective alternator.	Replace

M-12 a) Related electric circuit diagram



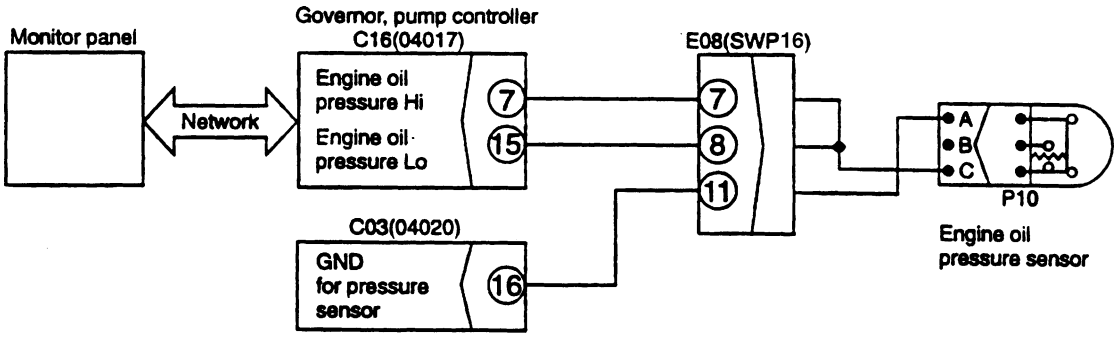
b) Engine oil pressure sensor system

★ When engine oil pressure is normal.



Cause	Remedy
Defective governor, pump controller	Replace
Defective monitor panel	Replace
Defective contact, or disconnection in wiring harness between C16 (female) (15) - E08 (8) - sensor or P10 (A) - E 08 (11) - C03 (16)	Repair or replace
Defective oil pressure sensor.	Replace

M-12 b) Related electric circuit diagram



M-13 When starting switch is turned ON and engine is started, caution items, emergency items flash (when 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-11b)	-

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

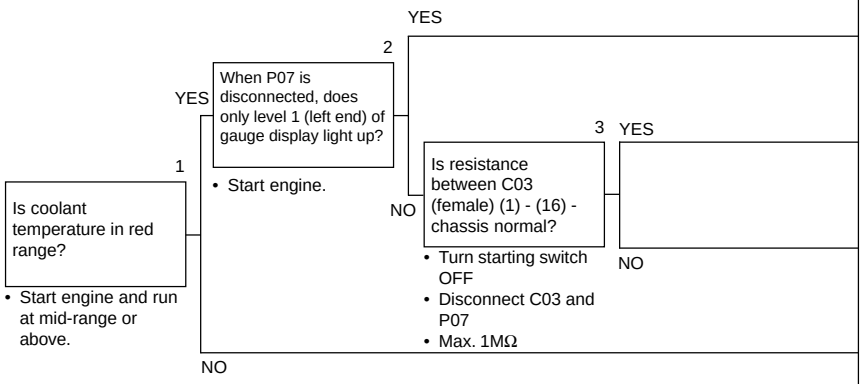
SAP00522

Cause	Remedy
See M-11 a)	-

d) (coolant temperature) flashes

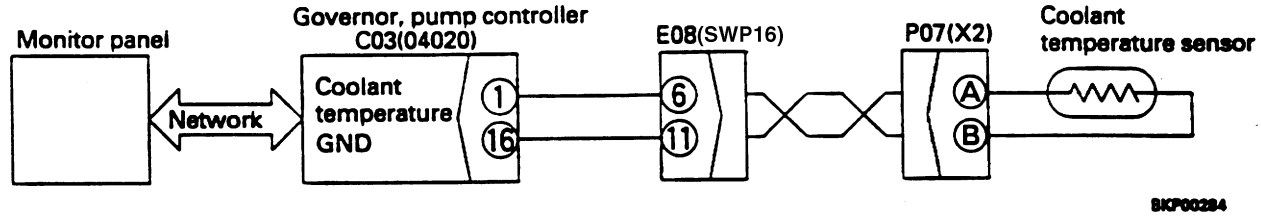
SAP00527

★ 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) (A) - E08 (6) - Position07 (female) (1) and wiring harness between C03 (female) (16) - E08 (11) - P07 (female) (B)	Repair or replace
Defective monitor panel.	Replace

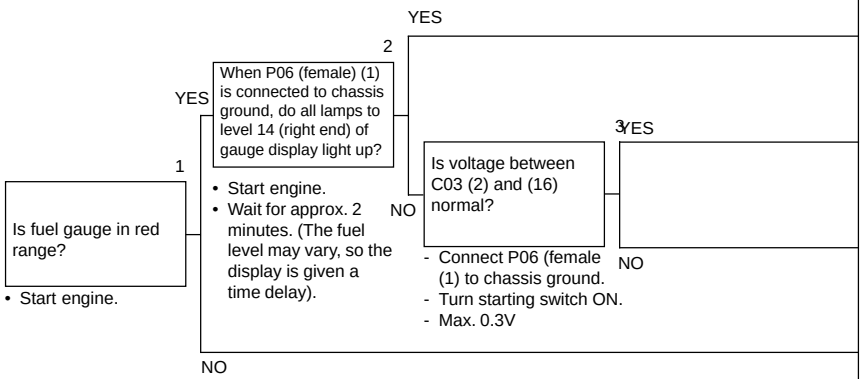
M-13 d) Related electric circuit diagram.



e) (fuel level) flashes

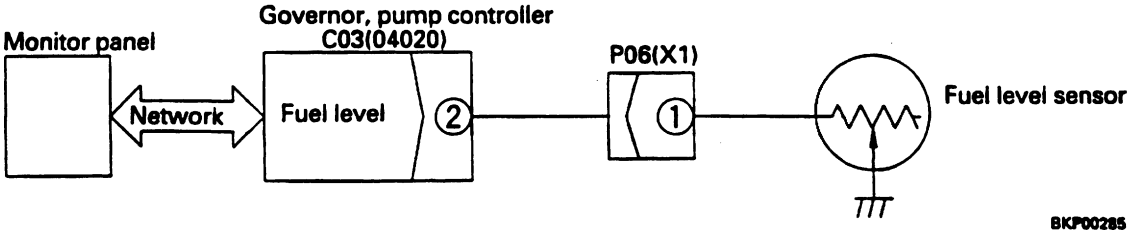
SAP00528

★ Check that there is fuel before carrying out troubleshooting.



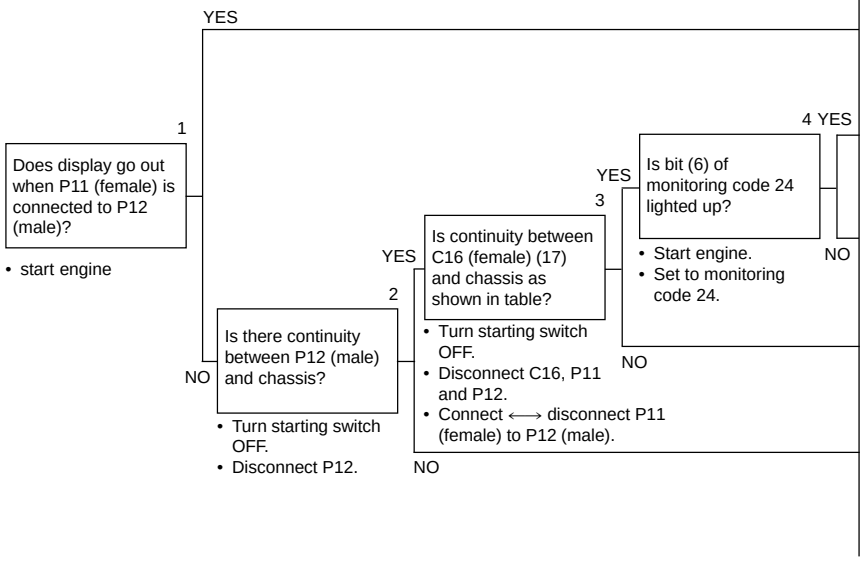
Cause	Remedy
Defective fuel level sensor system (see M-25)	-
Defective governor, pump controller	Replace
Defective contact or disconnection in wiring harness between C03 (female) (2) and P06 (female) (1)	Repair or replace
Defective monitor panel.	Replace

M-13 e) Related electric circuit diagram.



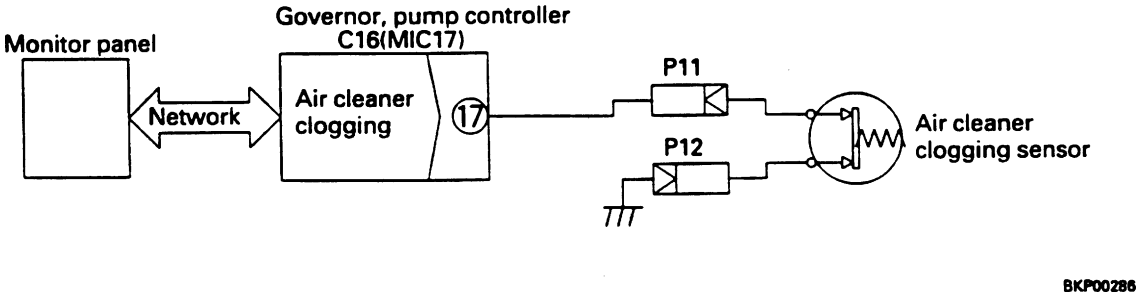
f) (air cleaner clogging) flashes.

★ Check that the air cleaner is not clogged before carrying out troubleshooting.



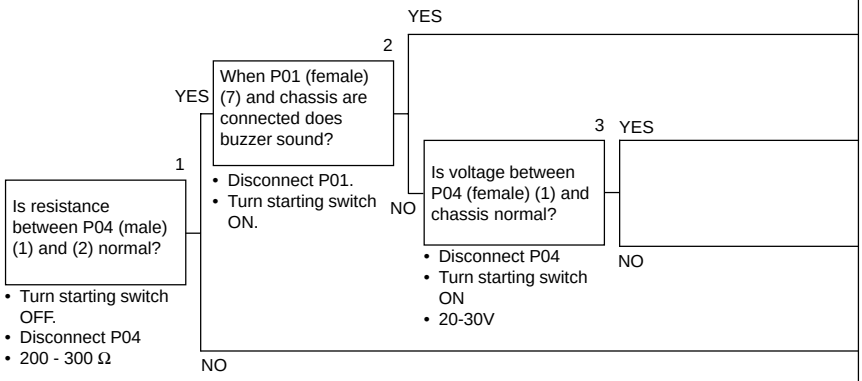
Cause	Remedy
Defective air cleaner clogging sensor	Replace
Defective governor, pump controller	Replace
Defective monitor panel	Replace
Defective contact or disconnection in wiring harness between C16 (female) (17) and P11(female)	Repair or replace
Defective contact or disconnection in wiring harness between P12 (male) and chassis ground	Repair or replace

M-13 f) Related electric circuit diagram.



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 of 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.



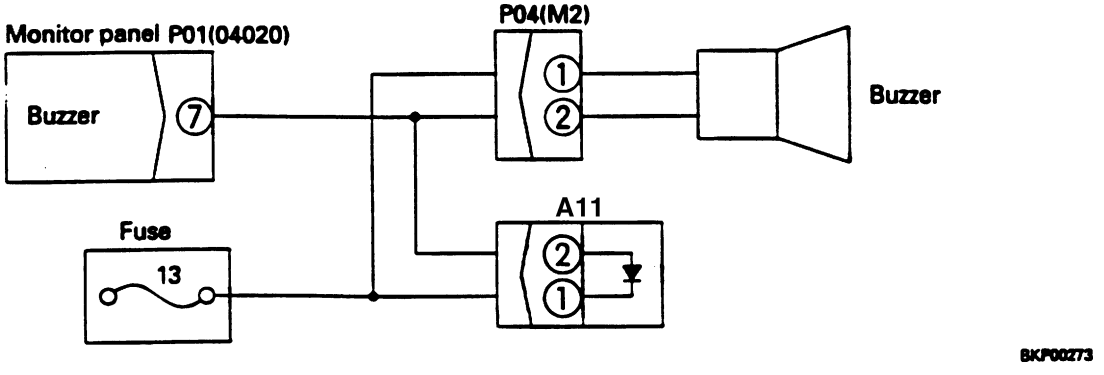
Cause	Remedy
Defective monitor panel	Replace
Defective contact or disconnection in wiring harness between P01 (female) (7) and P04 (female) (2)	Repair or replace
Disconnection, defective contact, short circuit with ground in wiring harness between P04 (female) (1) and fuse No. 13	Repair or replace
Defective 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.

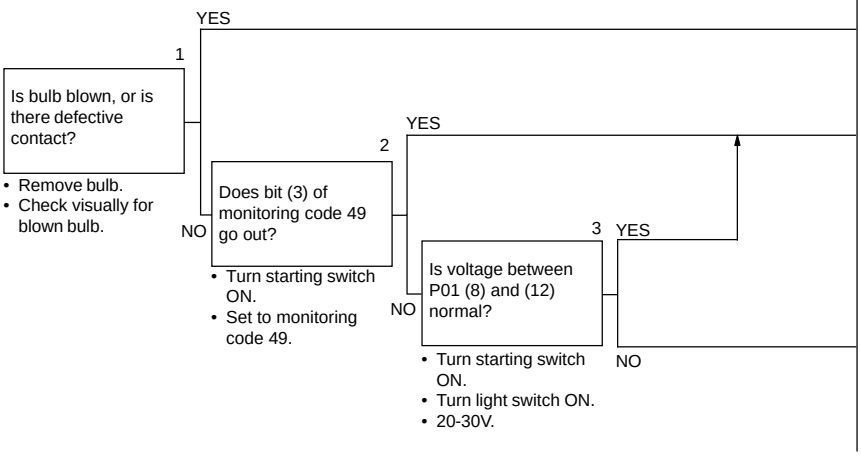
Cause	Remedy
Contact of chassis ground with wiring harness between P01 (female) (7) and P04 (female) (2), or defective buzzer.	Repair or replace
Defective monitor panel	Replace

M-14, 15 Related electric circuit diagram.



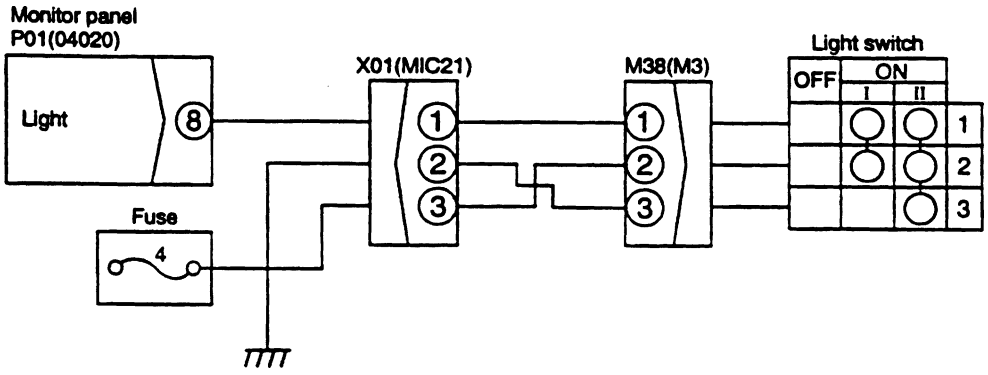
M-16 Night lighting on monitor panel does not light up (liquid crystal display is normal)

★ When the front lamp and working lamp light up normally.



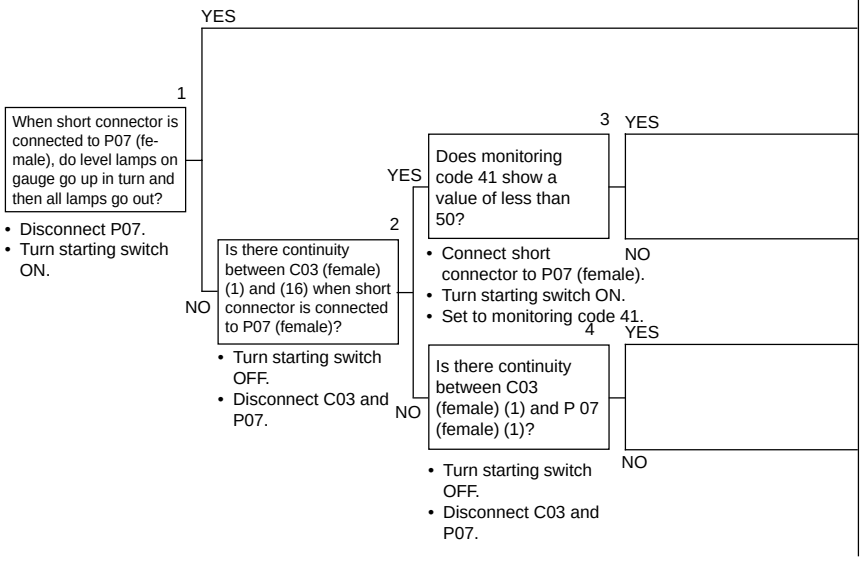
Cause	Remedy
Blown bulb or defective contact of bulb	Replace bulb, or clean (defective contact)
Defective monitor panel	Replace
Defective contact, or disconnection in wiring harness between P01 (female) (8) - X01 (1) - M38 (female) (1)	Repair or replace

M-16 Related electrical circuit diagram.



M-17 Coolant temperature gauge does not rise

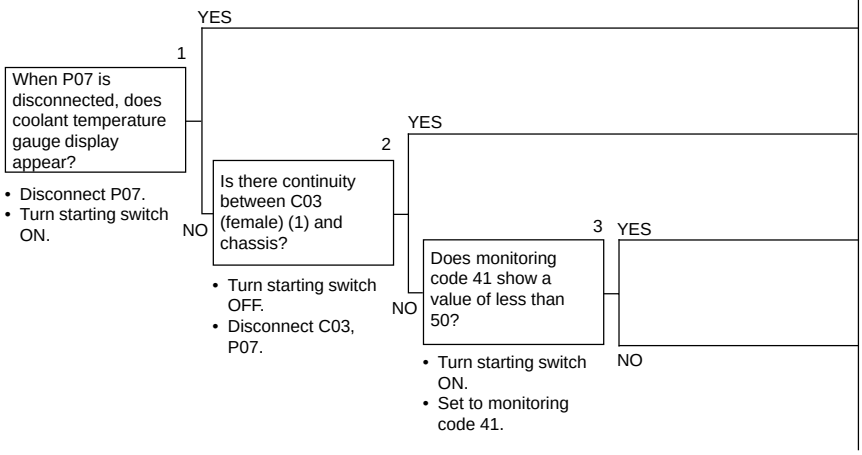
★ If the coolant temperature actually does not rise, check the engine system.
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



Cause	Remedy
Defective coolant temperature sensor system (See M-26)	-
Defective monitor panel	Replace
Defective governor, pump controller	Replace
Defective contact, or disconnection in wiring harness between C03 (female) (16) - E08 (11) - P07 (female) (B)	Repair or replace
Defective contact or disconnection in wiring harness between C03 (female) (1) - E08 (6) - P07 (female) (A).	Repair or replace

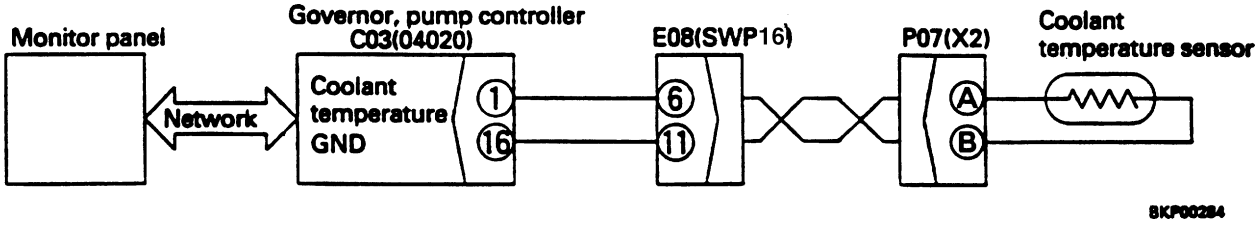
M-18 Coolant temperature gauge does not give any display (none of gauge lamps light up during operation)

★ Before carrying out troubleshooting, check tat all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going to the next step.



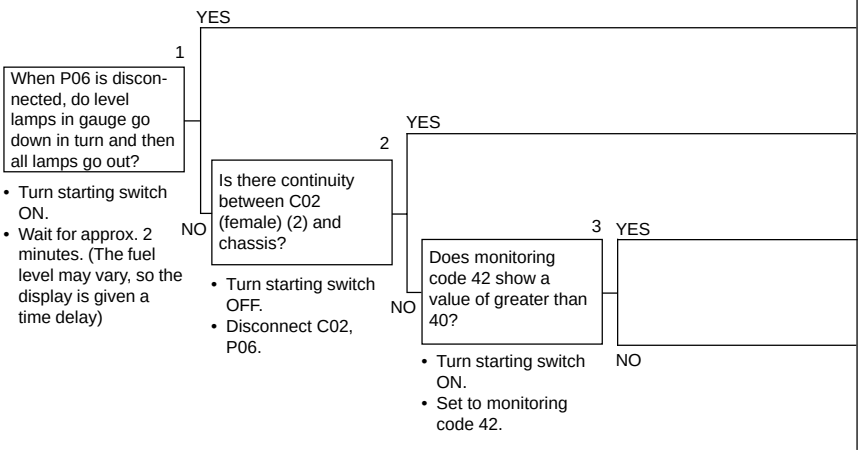
Cause	Remedy
Defective coolant temperature sensor system (see M- 26).	-
Contact of chassis ground with wiring harness between C03 (female) (1) - E 08 (6) - P07 (female) (A).	Repair or replace
Detective governor, pump controller.	Replace
Defective monitor panel.	Replace

M-17, 18 Related electric circuit diagram.



M-19 Fuel level gauge always displays FULL

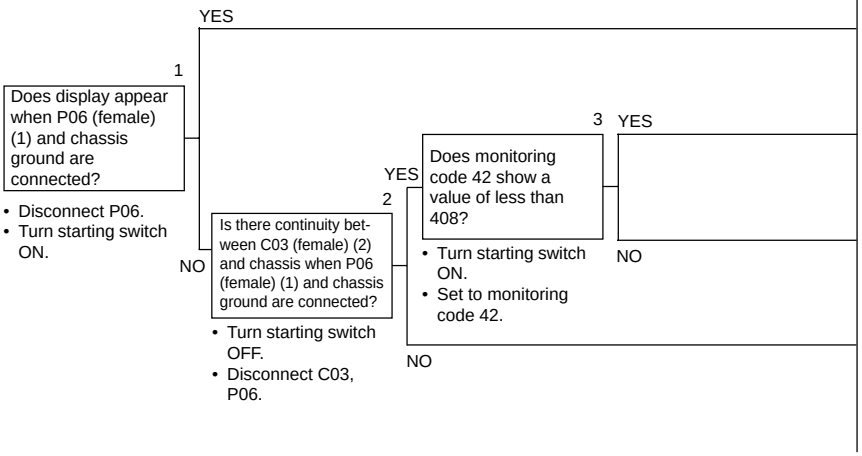
★ Check if the tank is actually full before carrying out troubleshooting.
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on the next step.



Cause	Remedy
Defective fuel level sensor system (see M-25)	-
Contact if 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

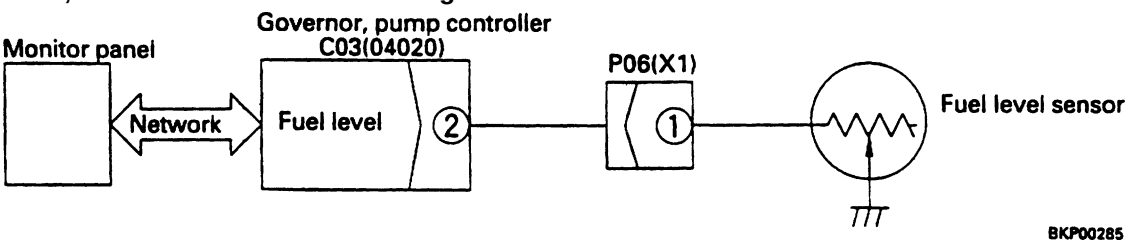
M-20 Fuel level gauge does not give display

★ 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 in the next step.



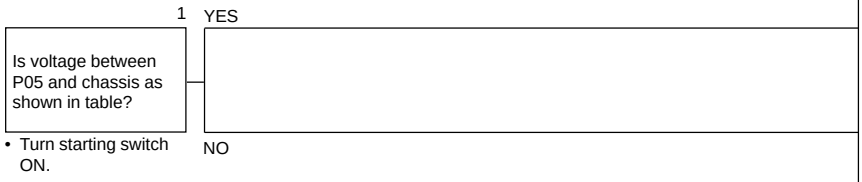
Cause	Remedy
Defective fuel level sensor system (see M-25)	-
Defective governor, pump controller	Replace
Defective monitor panel	Replace
Defective contact, or disconnection in wiring harness between C03 (female) (2) and P06 (female) (1)	Repair or replace

M-19,20 Related electric circuit diagram.



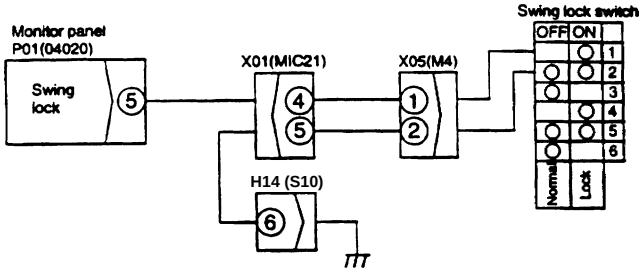
M-21 Swing lock switch is turned ON (LOCK) but (swing lock monitor) does not light up.

★ Carry out this troubleshooting only of 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.

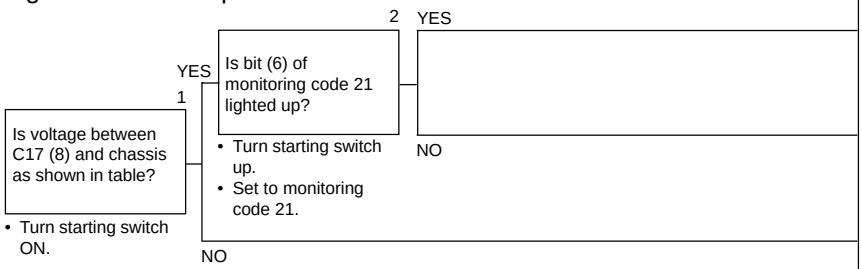


Table

Swing lock switch ON	Max. 1 V
Swing lock switch OFF	20 - 30V

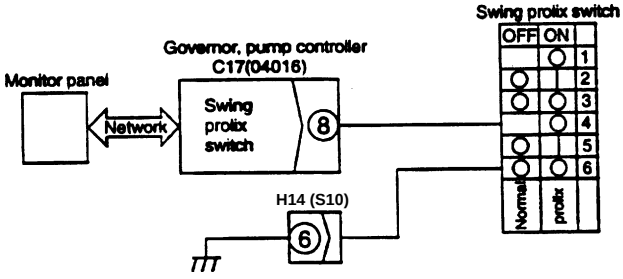
M-22 Swing prolix switch is turned ON (prolix), but (swing lock monitor) does not flash.

★ Carry out this troubleshooting only of 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

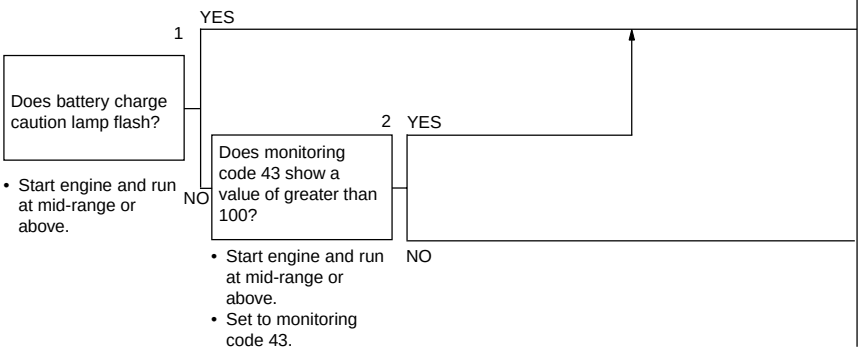
M-22 Related electric circuit diagram



Table

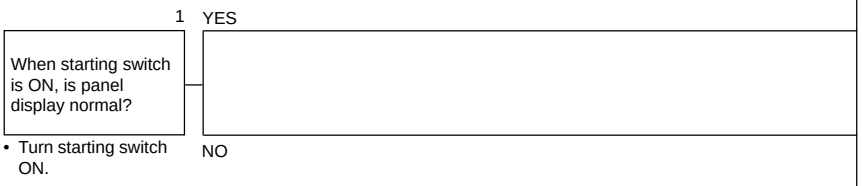
Swing prolix switch ON	Max. 1 V
Swing prolix switch OFF	20 - 30V

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

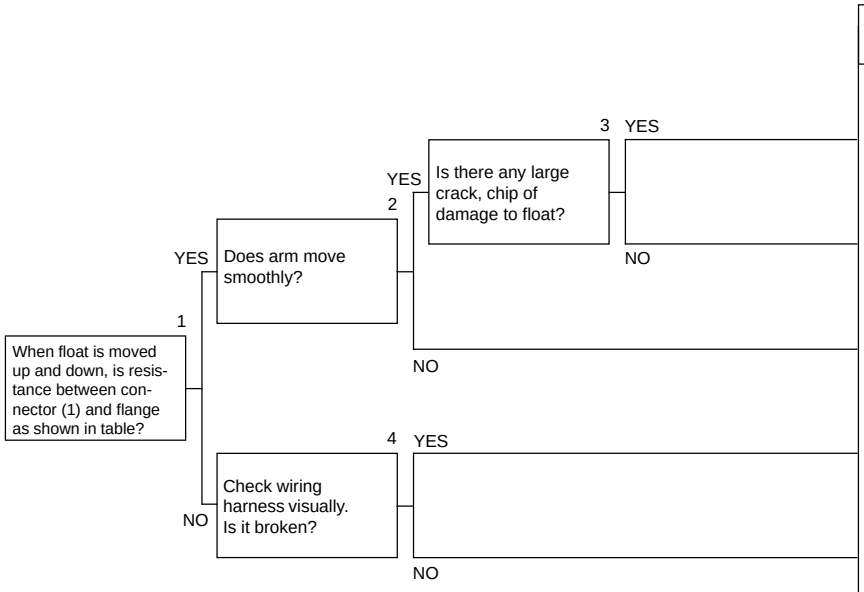
M-24 When starting switch is at OFF and time switch is pressed, time and service meter are not displayed



Cause	Remedy
Defective monitor panel	Replace
See M- 6	-

M-25 Defective fuel level sensor system.

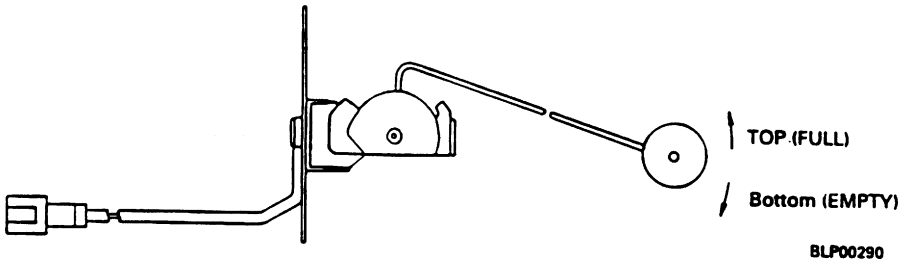
★ Remove the fuel level sensor when carrying out troubleshooting.



Cause	Remedy
Interference with sensor inside tank.	Replace (See note 2)
Defective contact of connector.	Clean connector or replace
Defective sensor (See note 2).	Replace
Disconnection in wiring harness (See note 3) (defective clamp) (external force applied).	Replace sensor
Defective sensor.	Replace

Table

Top (FULL) stopper position	Approx. 12Ω or below
Bottom (EMPTY) stopper position	Approx. 85-110Ω

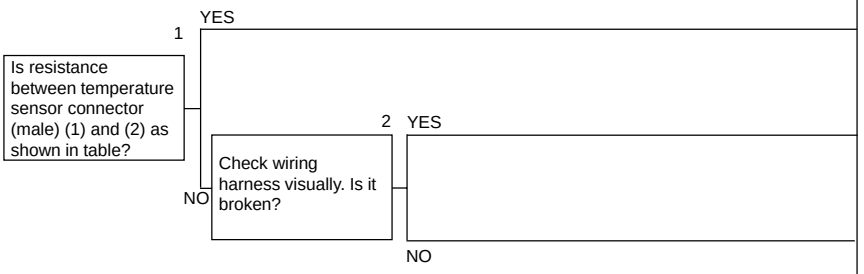


Note 1: Difference between fuel level and gauge display. For gauge display position 14 (FULL), the amount of fuel is 78-100 o/o; and for display position 1 (EMPTY) it is below 14,5 o/o. If the chassis is at an angle, the displayed amount of fuel will be different from the actual amount. Therefore, when 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 sudden 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 appropriate action.

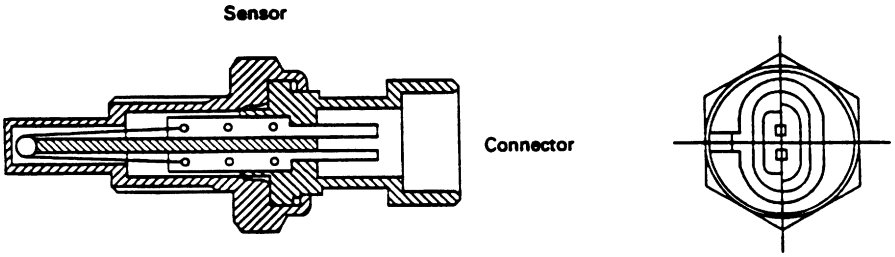
M-26 Defective coolant temperature sensor system.



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

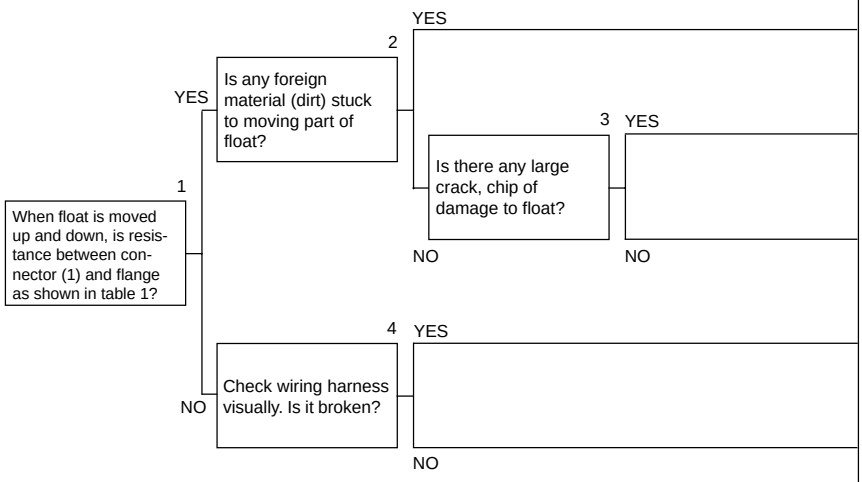
Normal temperature (20°C)	Approx. 70-78 kΩ
100°C	Approx. 3,5Ω



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.

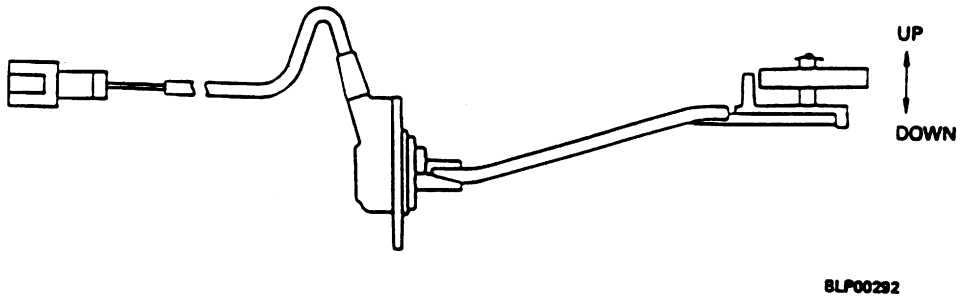
★ Remove the engine oil level sensor when carrying out troubleshooting.



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 (See note 3) (defective clamp) (external force applied).	Replace sensor
Defective sensor.	Replace

Table

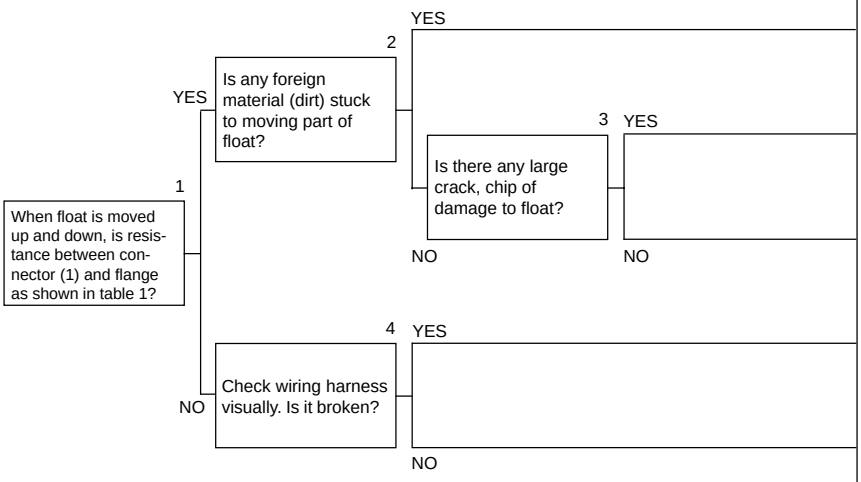
Float UP	Max. 1Ω
Float DOWN	Min. 1 MΩ



Note 1: Variations in oil level. The oil level 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 in 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. It 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-28 Defective coolant level sensor system.

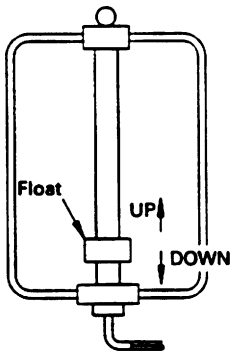
★ Remove the coolant level sensor when carrying out troubleshooting.



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 (See Note 3) (defective clamp) external force applied)	Replace sensor
Defective sensor	Replace

Table

Float UP	Max. 1Ω
Float DOWN	Min. 1 MΩ



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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-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.

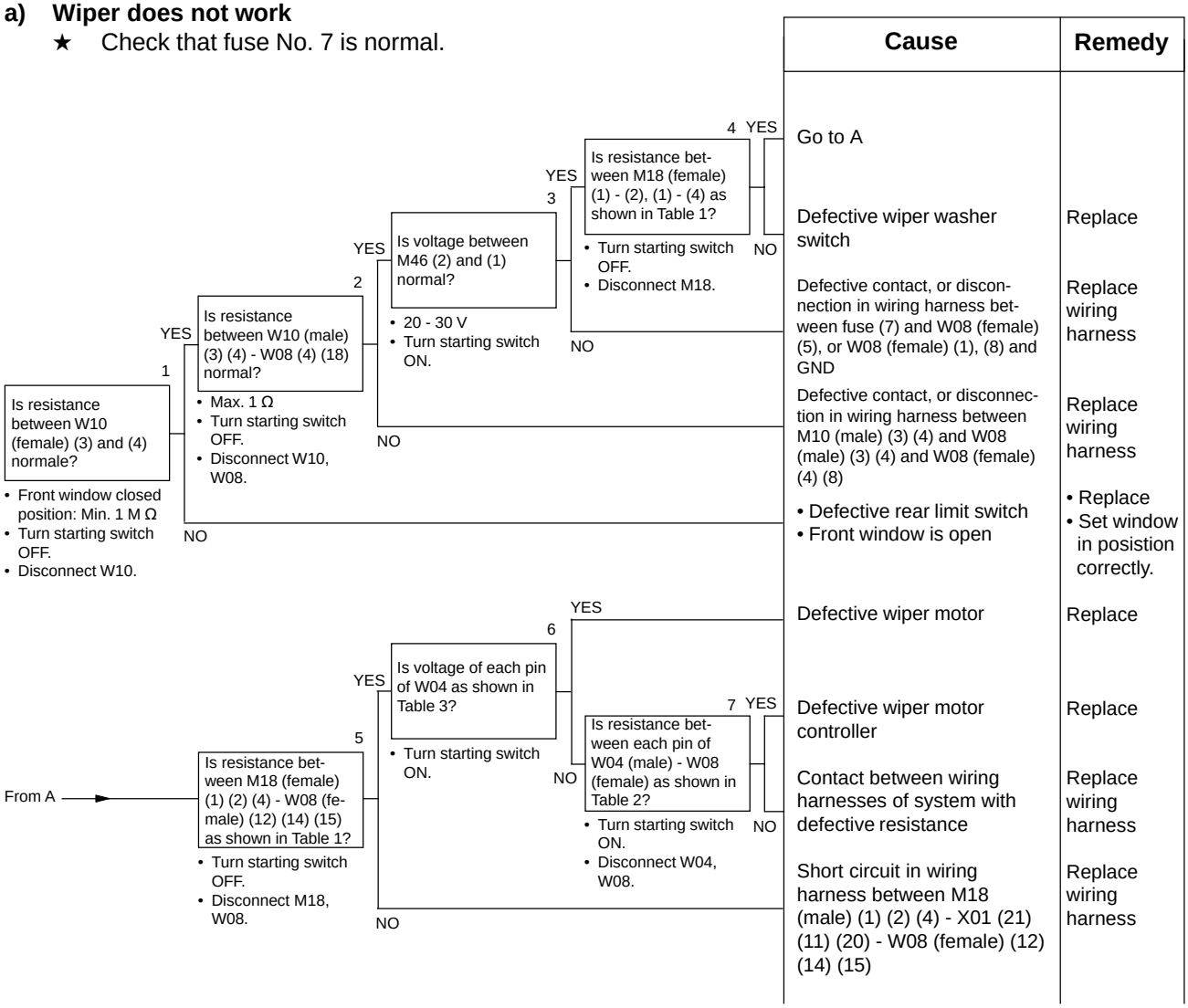


Table 1

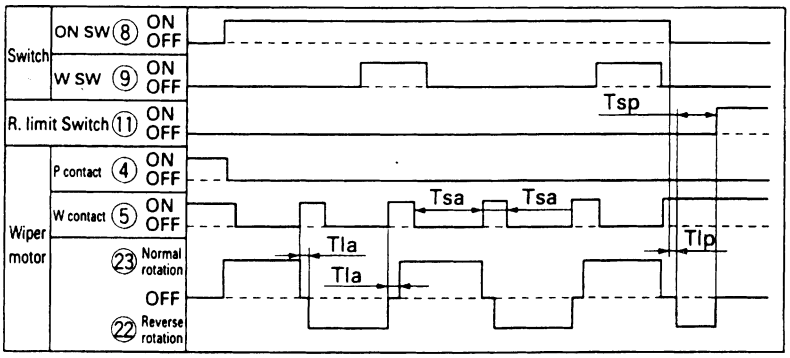
Actuation mode	M18 (female)	W08 (female)	Resistance (Ω)
INT mode	Between (1) - (4)	Between (12) - (15)	Max. 1 Ω
	Between (1) - (2)	Between (12) - (14)	Max. 1 MΩ
	Between (2) - (4)	Between (14) - (15)	
OFF mode	Between (1) - (2)	Between (12) - (14)	Max. 1 MΩ
	Between (1) - (4)	Between (12) - (15)	
	Between (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

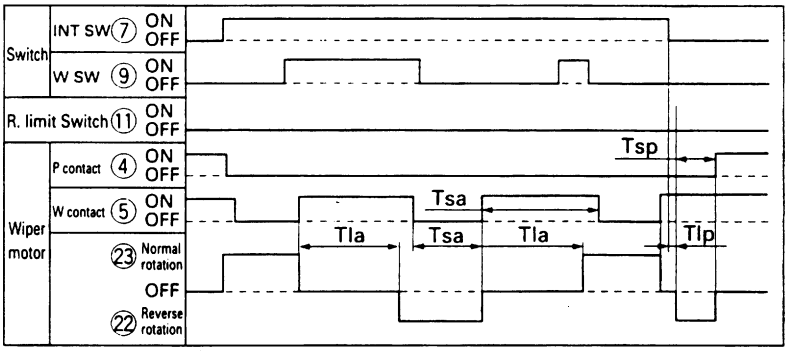
Table 3

Timing chart (when wiper is ON)



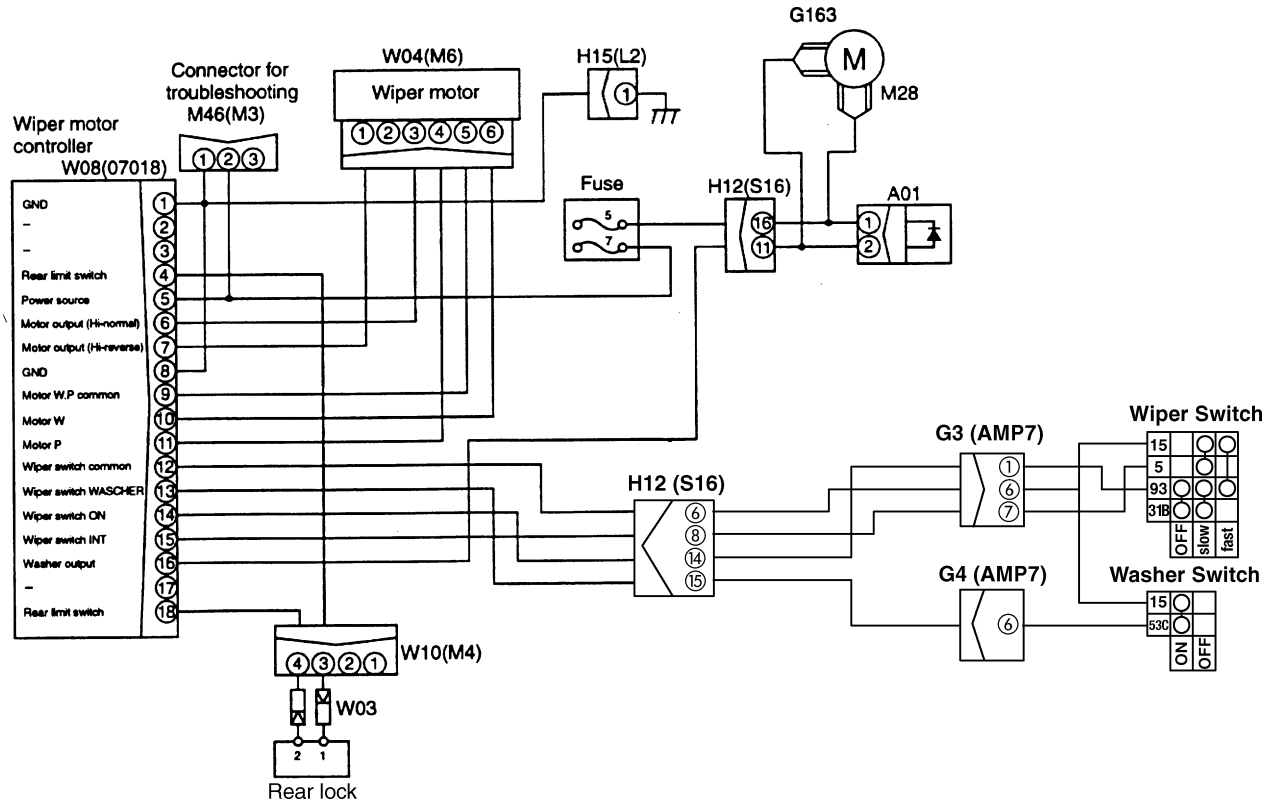
Item	Symbol	Set time
Length of pause until next actuation	Tla	0.13 sec
Safety circuit during operation of wiper [safety function (1)]	Tsa	10 sec
Length of pause when stowing wiper blade	Tlp	1.5 sec
Safety circuit during stowing of wiper [safety function (2)]	Tsp	10 sec

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
Length 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

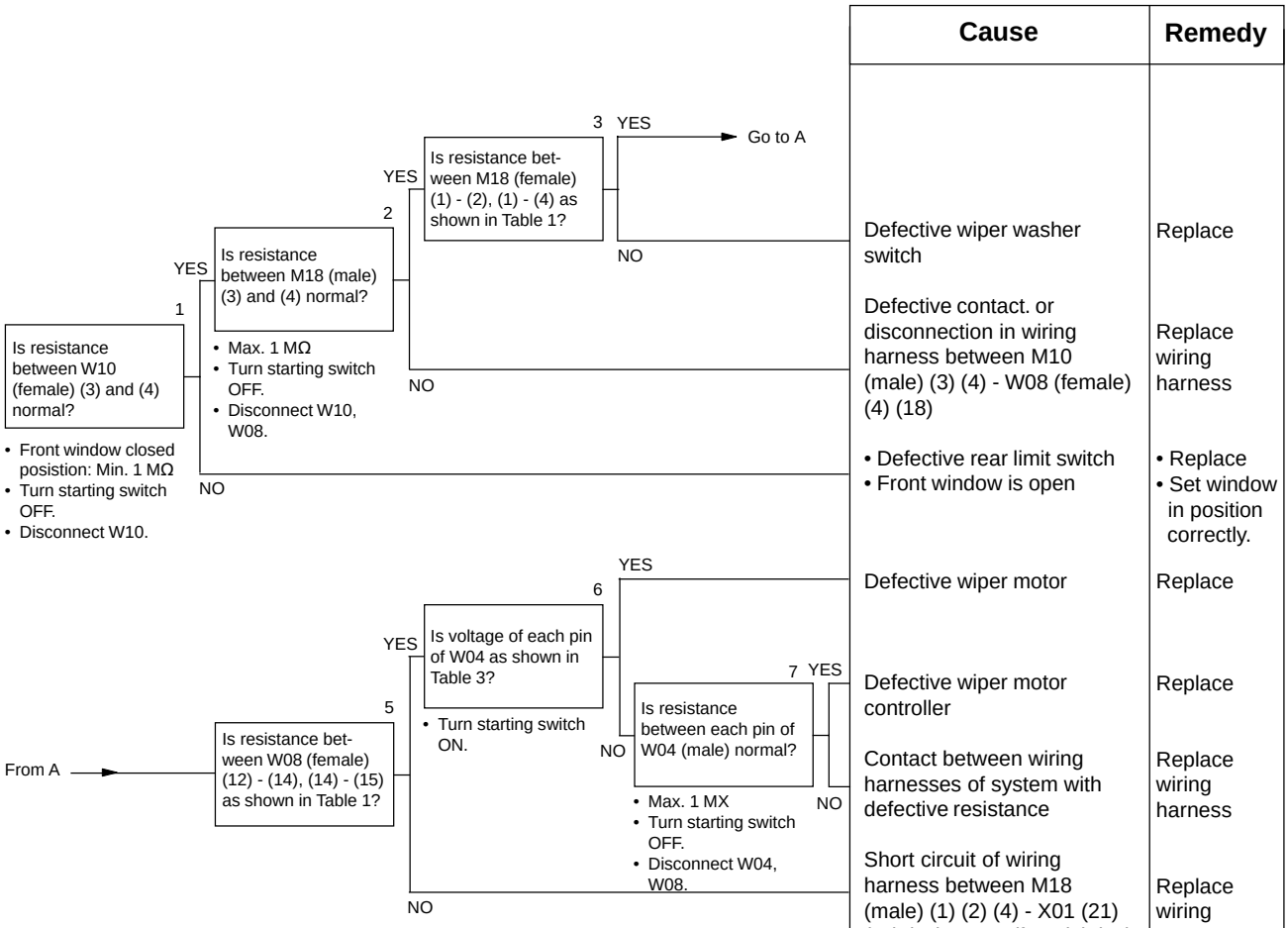
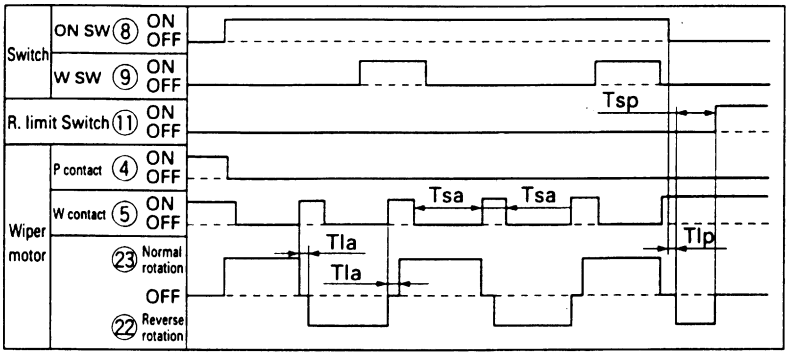


Table 1

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)	

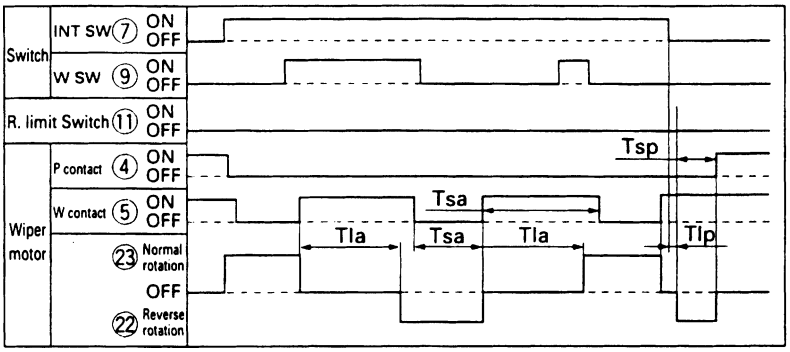
Table 3

Timing chart (when wiper is ON)



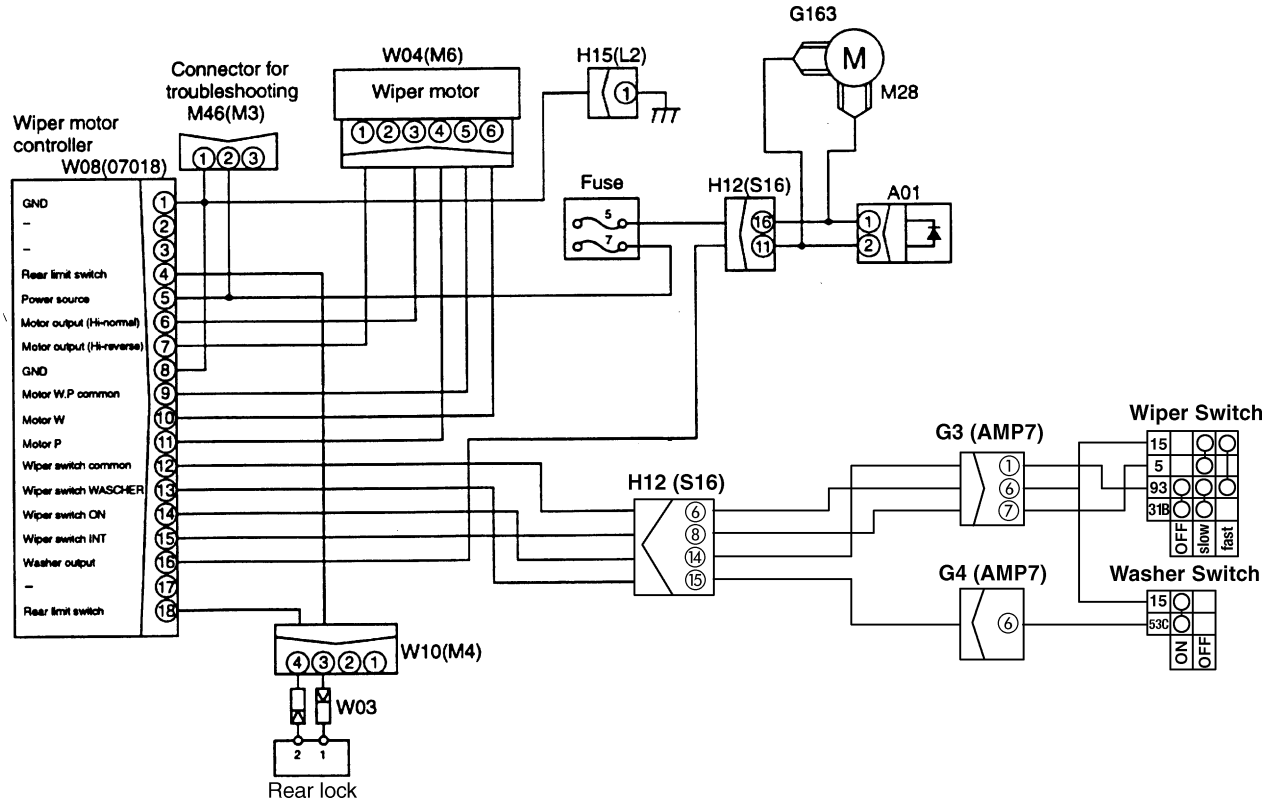
Item	Symbol	Set time
Length of pause until next actuation	Tla	0.13 sec
Safety circuit during operation of wiper [safety function (1)]	Tsa	10 sec
Length of pause when stowing wiper blade	Tlp	1.5 sec
Safety circuit during stowing of wiper [safety function (2)]	Tsp	10 sec

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
Length 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



30 DISASSEMBLY AND ASSEMBLY

METHOD OF USING MANUAL

1. When removing or installing unit assemblies

   (1) When removing or installing a unit assembly, 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 [*1] , 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. XXX (1) ..... Step in operation
      ★ ..... Technique or important point to remember when removing XXX (1)
   2. △ △ △ (2) ..... ※ 1 Indicates that a technique is listed for use during installation
   3. □ □ □ □ assembly (3)

    ..... See Lubricant and Coolant Table

   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

2. General precautions when carrying out installation or removal (disassembly or assembly) of units are given together 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 TOOL LIST given in this manual.

PRECAUTIONS WHEN CARRYING OUT OPERATION

[When carrying out removal or installation (disassembly or assembly) of units, be sure to follow the general precautions given below when carrying out the operation.)

1. Precautions when carrying out removal work

- If the coolant contains antifreeze, dispose of it correctly.
- After disconnecting hoses or tubes, cover them or fit blind plugs to prevent dirt or dust from entering.
- When draining oil, prepare a container of adequate size to catch the oil.
- Confirm the match marks showing the installation position, and make 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.
- Fit wires and hoses with tags to show their installation position to prevent any mistake when installing.
- Check the number and thickness of the shims, and keep in a safe place.
- When raising components, be sure to use lifting equipment of ample strength.
- When using forcing screws to remove any components, tighten the forcing screws alternately.
- Before removing any unit , clean the surrounding area and fit a cover to prevent any dust or dirt from entering after removal.

★ **Precautions when handling piping during disassembling**

Fit the following blind plugs into the piping after disconnecting it during disassembly operations.

1) Hoses and tubes using sleeve nuts

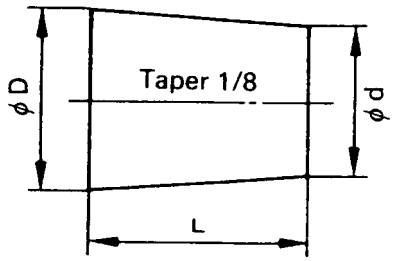
Nominal number	Plug (nut end)	Sleeve nut (elbow end) Use the two items below as a set
02	07376-50210	07221-20210 (Nut), 07222-00210 (Plug)
03	07376-50315	07221-20315 (Nut), 07222-00312 (Plug)
04	07376-50422	07221-20422 (Nut), 07222-00414 (Plug)
05	07376-50522	07221-20522 (Nut), 07222-00515 (Plug)
06	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

Normal 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 for installation operations

- Tighten all bolts and nuts (sleeve nuts) to the specified (KES) torque.
- Install the hoses without twisting or interference.
- Replace all gaskets, O-rings, cotter pins, and lock plates with new parts.
- Bend the cotter pin or lock plate securely.
- When 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 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 damage, dents, burrs, or rust.
- Coat rotating parts and sliding parts with engine oil.
- When press fitting parts, coat the surface with antifriction comopound (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 deformation or deterioration, screw them 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 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 operations

- 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 level. Run the engine to circulate the oil through the system. Then check the oil level again.
- If the piping or hydraulic equipment, such as hydraulic cylinders, pumps, or motors, have been removed for repair, 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 related parts.

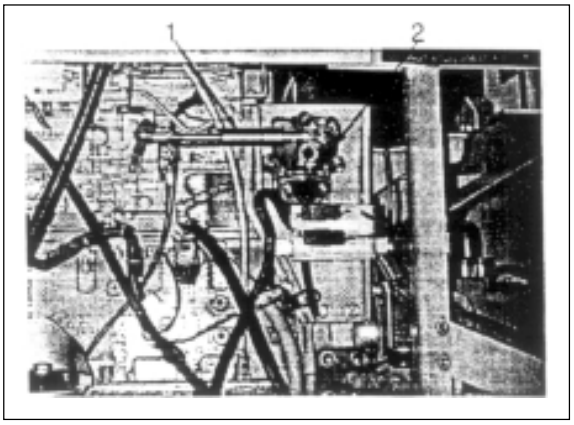
SPECIAL TOOL LIST

Nature of work	Symbol		Part No.	Part Name	Q'ty	Remarks	
• Engine • hydraulic pump assembly • Radiator • hydraulic oil cooler assembly • Hydraulic pump assembly • Removal, installation of PC - LS valve assembly	B		796-740-1300	Oil stopper	1		
Replacement of pump shaft oil seal	D		791-463-1141	Push-tool	1		
			790-201-2740	Spacer	1		
Disassembly, assembly of hydraulic cylinder		1	790-502-1003	Cylinder repair stand	1		
			790-101-1102	Pump	1		
	H	2	790-102-1320	Socket (width across flats: 70mm)	1	Bucket	Removal, installation of piston nut
			790-302-1340	Socket (width across flats: 80mm)	1	Boom	
			790-302-1430	Socket (width across flats: 85mm) long	1	Arm	
		3	790-720-1000	Expander	1	Expansion of piston ring	
		4	796-720-1650 07281-01029	Ring Clamp	1 1	Bucket	Installation of piston ring
			796-720-1660 07281-01159	Ring Clamp	1 1	1st and 2nd Boom Mono Boom	
	H	5	790-201-1702 • 790-201-1791 • 790-101-5021 • 01010-50816	Push tool kit • Push tool • Grip • Bolt	1 1 1	Bucket	Press fitting of bushing
			790-201-1702 • 790-201-1811 • 790-101-5021 • 01010-50816	Push tool kit • Push tool • Grip • Bolt	1 1 1	1st and 2nd Boom Mono Boom	
			790-201-1702 • 790-201-1821 • 790-101-5021 • 01010-50816	Push tool kit • Push tool • Grip • Bolt	1 1 1	Arm	
		6	790-201-1500 • 790-201-1610 • 790-101-5021 • 01010-50816	Push tool kit • Plate • Grip • Bolt	1 1 1	Bucket	Insertion of dust seal
			790-201-1500 • 790-201-1620 • 790-101-5021 • 01010-50816	Push tool kit • Plate • Grip • Bolt	1 1 1	1st and 2nd Boom Mono Boom	
	H	6	790-201-1500 • 790-201-1630 • 790-101-5021 • 01010-50816	Push tool kit • Plate • Grip • Bolt	1 1 1	Arm Arm	

Component	Symbol		Part No.	Part Name	Necessity	Q'ty	New remodel	Sketch	Nature of work, remarks
Disassembly, assembly of hydraulic cylinder	H	1	790-502-1003	Cylinder repair stand	■	1			
			790-101-1102	Pump	■	1			
		2	790-102-1320	Socket (width across flats: 70 mm)	■	1			Removal, installation of piston nut
		3	790-720-1000	Expander	■	1			Expansion of piston ring
		4	796-720-1650 07281-01029	Ring Clamp	■ ■	1 1			Installation of piston ring
			796-720-1660 07281-01159	Ring Clamp	■ ■	1 1			
		5	790-201-1702 • 790-201-1781 • 790-101-5021 • 01010-50816	Push tool kit • Push tool • Grip • Bolt	■	1 1 1 1			Press fitting of coil bushing
			790-201-1702 • 790-201-1791 • 790-101-5021 • 01010-50816	Push tool kit • Push tool • Grip • Bolt	■	1 1 1 1			
			790-201-1702 • 790-201-1811 • 790-101-5021 • 01010-50816	Push tool kit • Push tool • Grip • Bolt	■	1 1 1 1			
			790-201-1702 • 790-201-1821 • 790-101-5021 • 01010-50816	Push tool kit • Push tool • Grip • Bolt	■	1 1 1 1			
		6	790-201-1500 • 790-201-1590 • 790-101-5021 • 01010-50816	Push tool kit • Plate • Grip • Bolt	●	1 1 1 1			Press fitting of coil bushing
			790-201-1500 • 790-201-1610 • 790-101-5021 • 01010-50816	Push tool kit • Plate • Grip • Bolt	●	1 1 1 1			
			790-201-1500 • 790-201-1620 • 790-101-5021 • 01010-50816	Push tool kit • Plate • Grip • Bolt	●	1 1 1 1			
			790-201-1500 • 790-201-1630 • 790-101-5021 • 01010-50816	Push tool kit • Plate • Grip • Bolt	●	1 1 1 1			
		7	790-102-4310	Wrench assembly	■	1			Insertion of dust seal
			790-102-4310	Pin	■	1			

Component	Symbol		Part No.	Part Name	Necessity	Q'ty	New remodel	Sketch	Nature of work, remarks
Disassembly, assembly of hydraulic cylinder	H	1	790-502-1003	Cylinder repair stand	■	1			
			790-101-1102	Pump	■	1			
		2	790-102-1320	Socket (width across flats: 70 mm)	■	1			Removal, installation of piston nut
		3	790-720-1000	Expander	■	1			Expansion of piston ring
		4	796-720-1650 07281-01029	Ring Clamp	■ ■	1 1			Installation of piston ring
			796-720-1660 07281-01159	Ring Clamp	■ ■	1 1			
		5	790-201-1702 • 790-201-1781 • 790-101-5021 • 01010-50816	Push tool kit • Push tool • Grip • Bolt	■	1 1 1 1			Press fitting of coil bushing
			790-201-1702 • 790-201-1791 • 790-101-5021 • 01010-50816	Push tool kit • Push tool • Grip • Bolt	■	1 1 1 1			
			790-201-1702 • 790-201-1811 • 790-101-5021 • 01010-50816	Push tool kit • Push tool • Grip • Bolt	■	1 1 1 1			
			790-201-1702 • 790-201-1821 • 790-101-5021 • 01010-50816	Push tool kit • Push tool • Grip • Bolt	■	1 1 1 1			
		6	790-201-1500 • 790-201-1590 • 790-101-5021 • 01010-50816	Push tool kit • Plate • Grip • Bolt	●	1 1 1 1			Press fitting of coil bushing
			790-201-1500 • 790-201-1610 • 790-101-5021 • 01010-50816	Push tool kit • Plate • Grip • Bolt	●	1 1 1 1			
			790-201-1500 • 790-201-1620 • 790-101-5021 • 01010-50816	Push tool kit • Plate • Grip • Bolt	●	1 1 1 1			
			790-201-1500 • 790-201-1630 • 790-101-5021 • 01010-50816	Push tool kit • Plate • Grip • Bolt	●	1 1 1 1			
		7	790-102-4310	Wrench assembly	■	1			Insertion of dust seal
			790-102-4310	Pin	■	1			

REMOVAL OF GOVERNOR MOTOR ASSEMBLY



Disconnect the cable form the negative (-) terminal of the battery.

1. Open engine hood and disconnect governor motor connector.
2. Remove motor rod (1).
3. Remove governor motor assembly (2). ※ 1
   ★ Rotate the shaft of the governor motor and do not stop it suddenly.

INSTALLATION OF GOVERNOR MOTOR ASSEMBLY

- Carry out installation in the reverse order to removal.

※ 1

★ Adjust the rod. For details, see TESTING AND ADJUSTING, Testing and adjusting of governor motor lever stroke.

REMOVAL OF ENGINE, MAIN PUMP ASSEMBLY

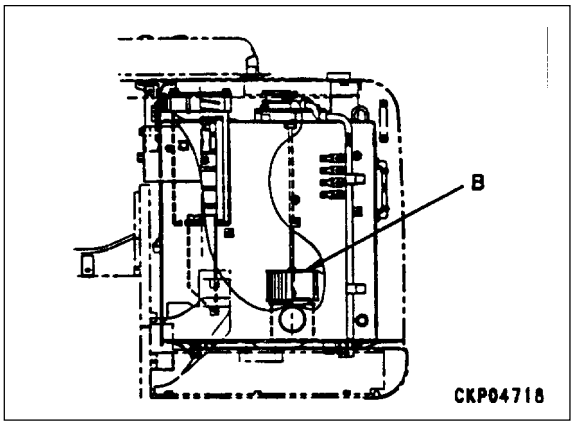
Disconnect the cable from the negative (-) terminal of the battery.

Lower the work equipment completely to the ground and stop the engine. Then loosen the oil filler cap slowly to release the pressure inside the hydraulic tank.

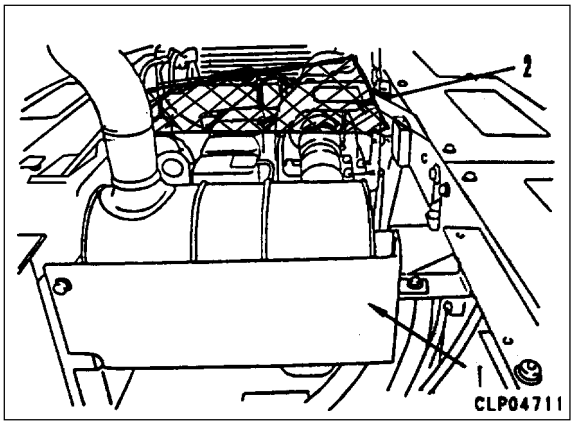
- Remove the hydraulic tank strainer, and using tool **B**, stop the oil.
- When not using tool **B**, remove the drain plug, and drain the oil from the hydraulic tank and inside the system.

  Hydraulic tank: **Approx. 100 /.**
- Drain coolant.

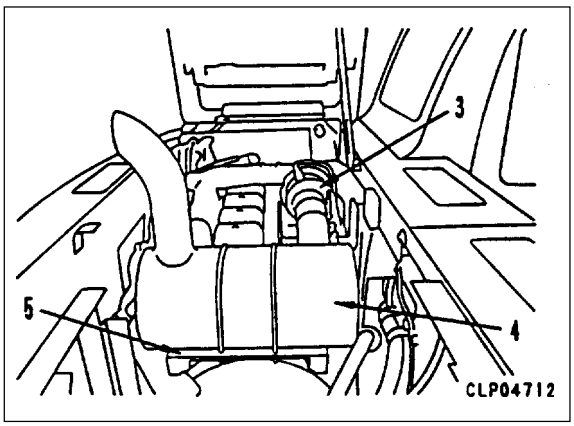
1. Remove pump bottom cover and engine bottom cover.
2. Open engine hood and remove pump top cover.



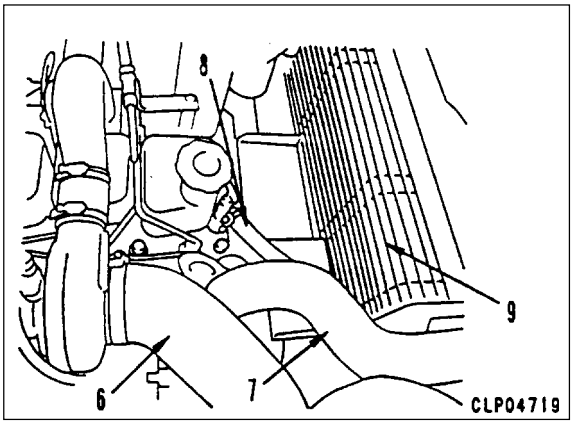
3. Remove counterweight top cover. Exhaust muffler cover (1), and engine maintenance step (2).



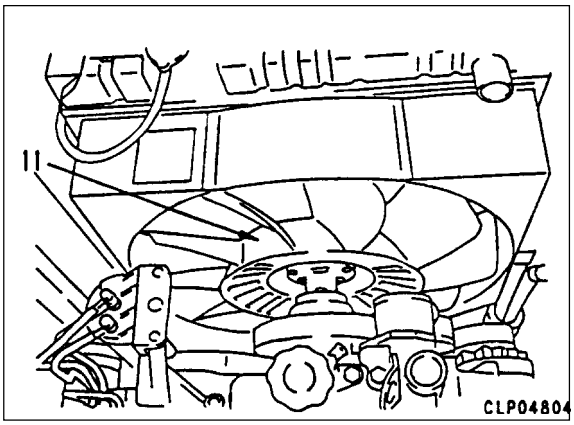
4. Remove clamp (3), then remove exhaust muffler (4) together with bracket (5).



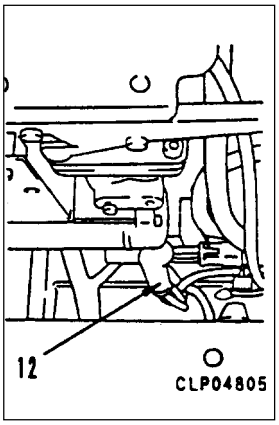
5. Disconnect intake hose (6).
6. Remove radiator inlet hose (7).
7. Disconnect heater hose (8).
8. Remove fan guard (9).

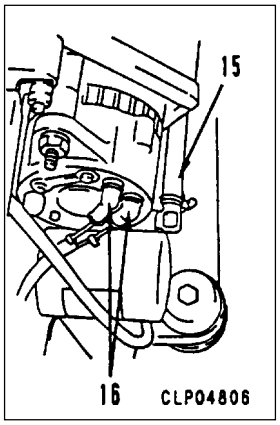


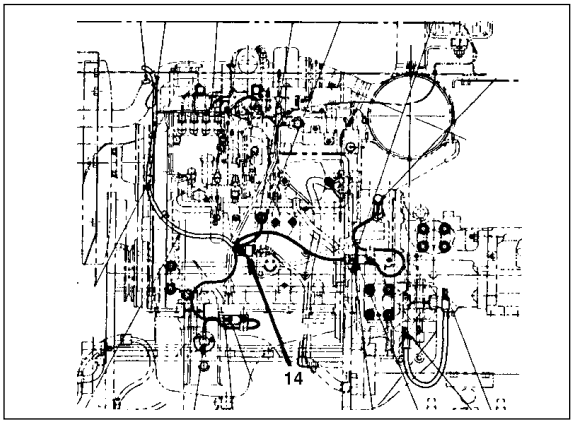
9. Remove fan (11).

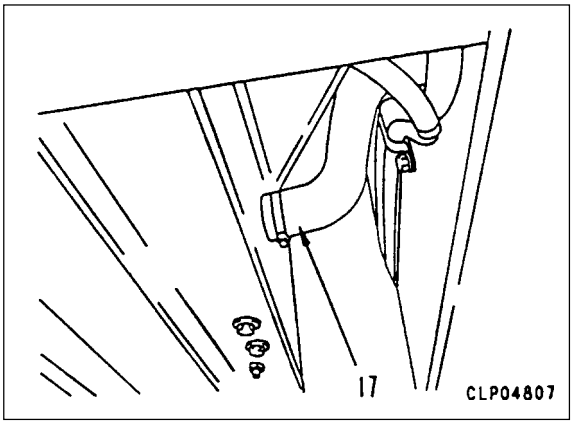


10. Disconnect starting motor wiring (12).
11. Disconnect engine wiring harness connector (14).
12. Disconnect heater hose (15).
13. Disconnect alternator wiring (16).
    ★ Mark the wiring with tags to show the connection position.
14. Disconnect radiator outlet hose (17).

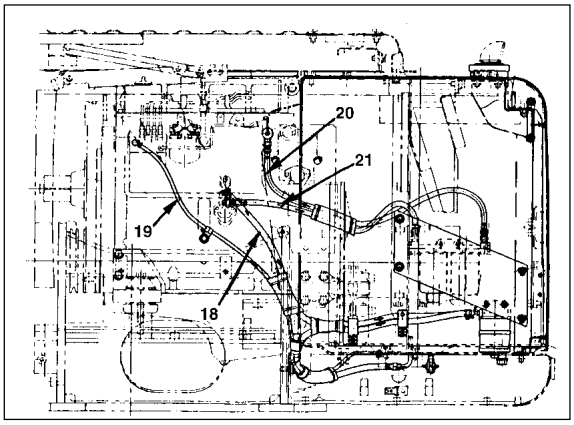




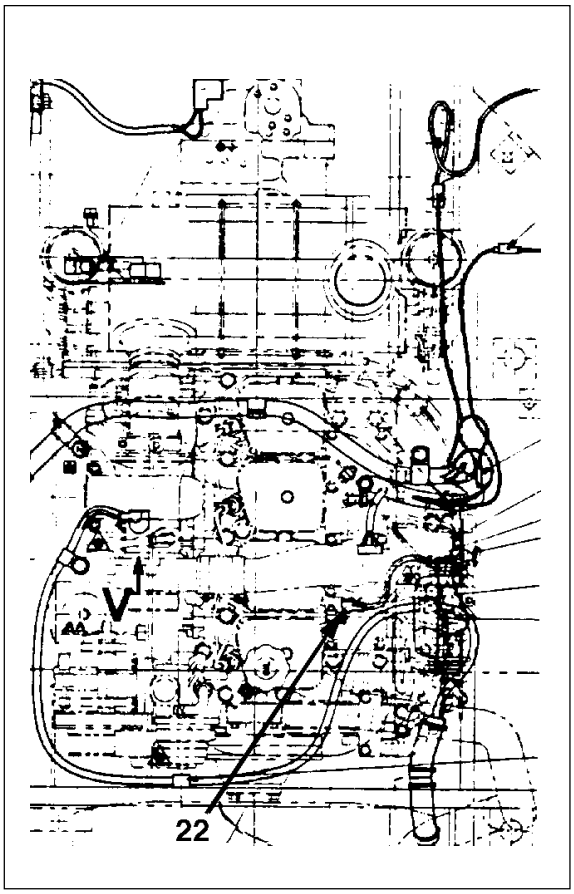




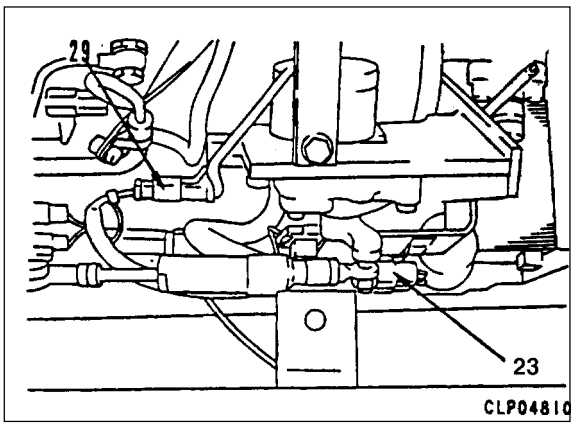
15. Disconnect fuel hoses (18), (19), (20) and (21).
    ★ When the hose is disconnected, fuel will flow out, so insert a wooden plug into the hose to prevent the fuel from leaking out.



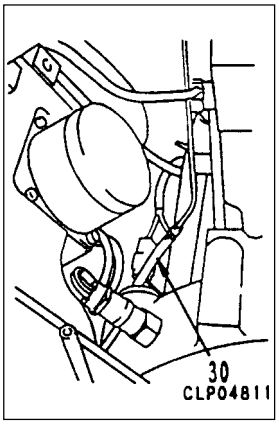
16. Disconnect electrical intake air heater wiring connector (22).

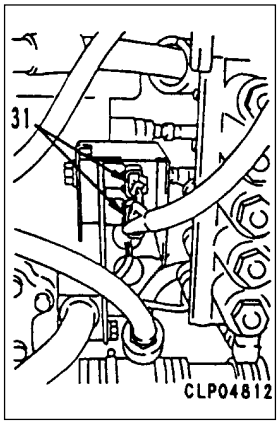


17. Disconnect 2 governor motor wiring connectors (23).

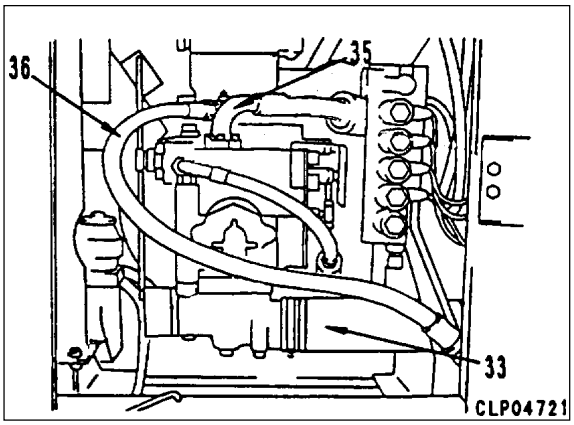


18. Disconnect EPC valve wiring connectors (31).

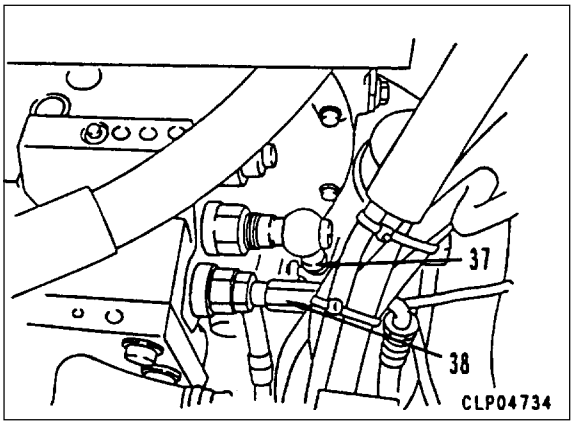




19. Disconnect main pump suction tube (33).
20. Disconnect main pump outlet hose (35).
21. Disconnect main pump drain hose (36).

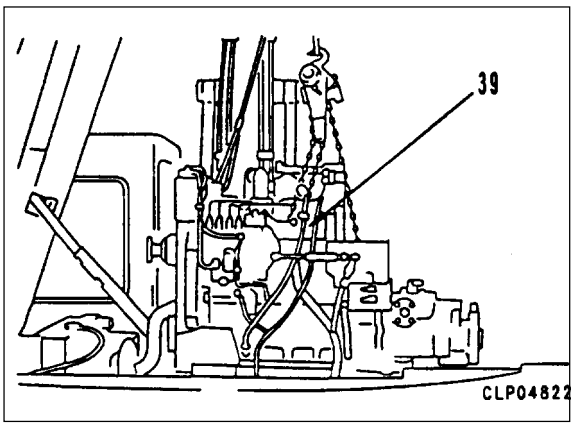


22. Disconnect hoses (37) and (38).
23. Disconnect EPC valve basic pressure hose.



24. Remove mount bolt, then lift off engine and hydraulic pump assembly (39) slowly. ※ 2
    - ❋ When removing the engine and hydraulic pump assembly, check that all wiring and piping has been disconnected, and be careful not to hit any part when removing.

kg Engine, hydraulic pump assembly: **420 kg**



INSTALLATION OF ENGINE, MAIN PUMP ASSEMBLY

- Carry out installation in the reverse order to removal.

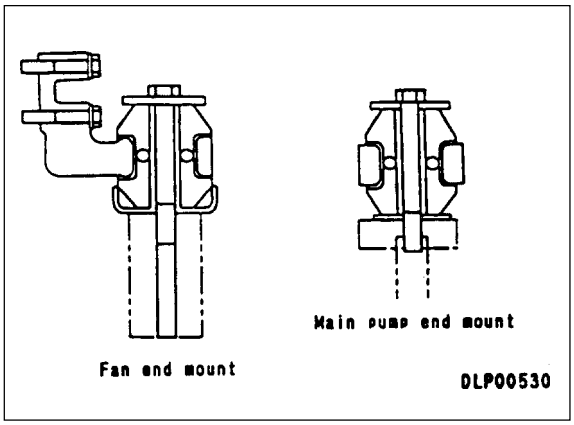
※ 2
★ Set the engine mount rubber as shown in the diagram, then install the engine and main pump assembly.

kgm Engine mounting bolt:
277.0 ± 31.9 Nm {28.25 ± 3.25 kgm}

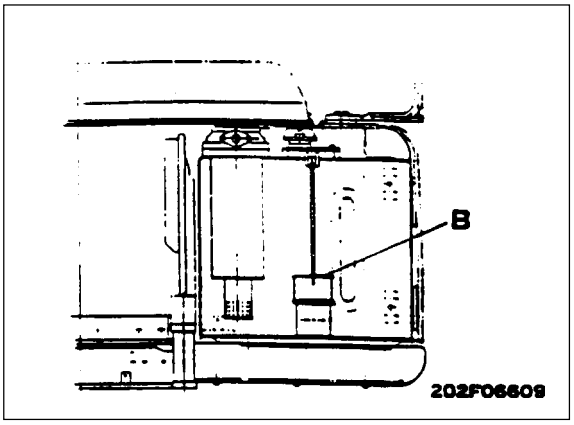
- **Refilling with water**
  ★ Add water through the water filler to the specified level. Run the engine to circulate the water through the system. Then check the water level again.

- **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.

- **Bleeding air**
  ★ Bleed the air from the main pump. For details, see TESTING AND ADJUSTING, Bleeding air.



REMOVAL OF HYADRAULIC OIL COOLER ASSEMBLY



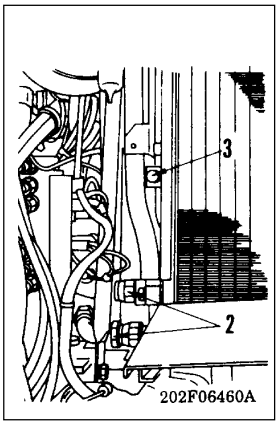
⚠ Lower the work equipment completely to the ground and stop the engine. Then loosen the oil filler cap slowly to release the pressure inside the hydraulic tank.

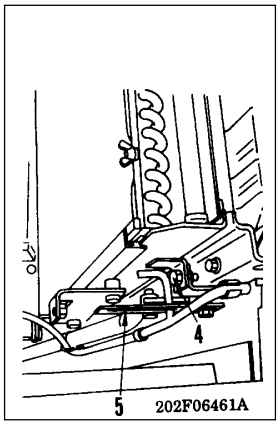
- Remove the hydraulic tank strainer, and using tool **B**, stop the oil.
  - When not using tool **B**, remove the drain plug, and drain the oil from the hydraulic tank and inside the system.

Hydraulic tank: Approx. 100 *l*.

1. Remove battery and set oil container under chassis.
2. Remove engine hood, then remove counterweight top cover and control valve top cover.
3. Disconnect cooler hoses (2).
4. Remove left and right bolts (3) and (4) and left and right plates (5).
5. Sling hydraulic oil cooler assembly (6), remove 4 bottom mounting bolts, then lift off slowly.
   - ★ When removing the hydraulic oil cooler, be extremely careful not to damage the core.

kg Hydraulic oil cooler assembly: 30 kg.





INSTALLATION OF HYDRAULIC OIL COOLER ASSEMBLY

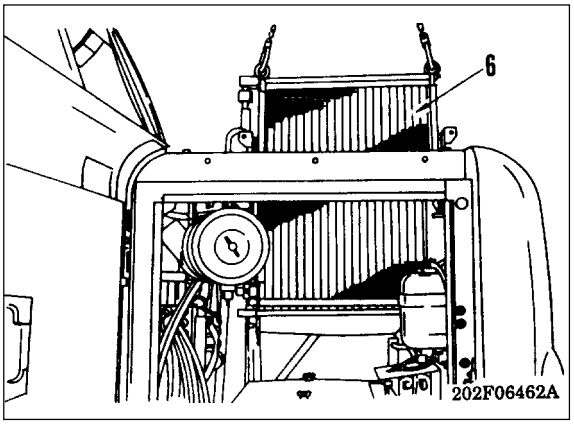
- Carry out installation in the reverse order to removal.

※ 1

- ★ Check that the O-ring is not damaged or deteriorated, then connect the hoses.

- Fill with refrigerant (R-134a).

- 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 OIL COOLER ASSEMBLY

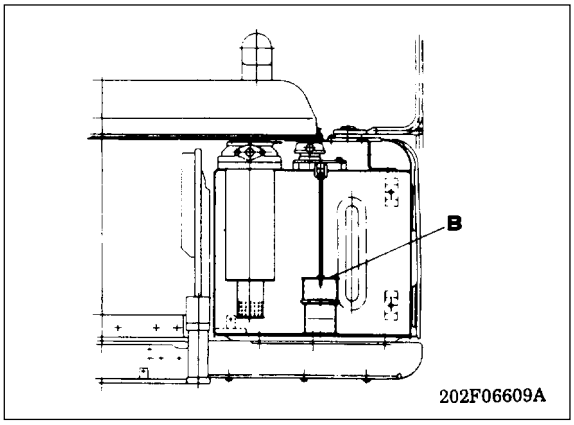
Lower the work equipment completely to the ground and stop the engine. Then loosen the oil filler cap slowly to release the pressure inside the hydraulic tank.

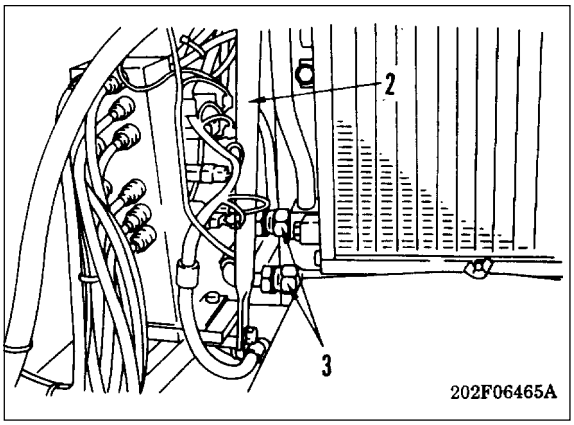
- Remove the hydraulic tank strainer, and using tool **B**, stop the oil.
  - When not using tool **B**, remove the drain plug, and drain the oil from the hydraulic tank and inside the system.

  Hydraulic tank: Approx. 100 *l*.

- Drain engine coolant.

1. Remove engine hood, then remove counterweight top cover and control valve top cover.
2. Remove left and right stays (2).
3. Disconnect hydraulic cooler hoses (3).



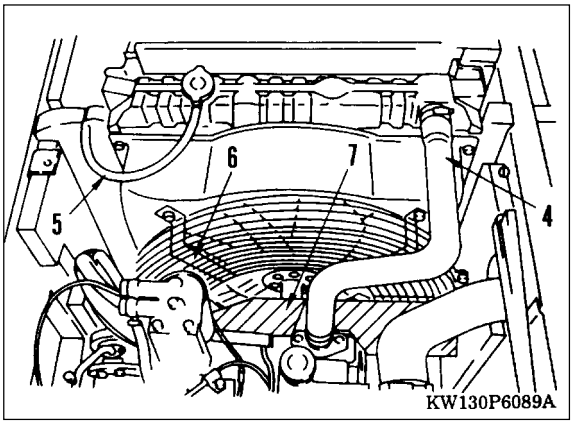


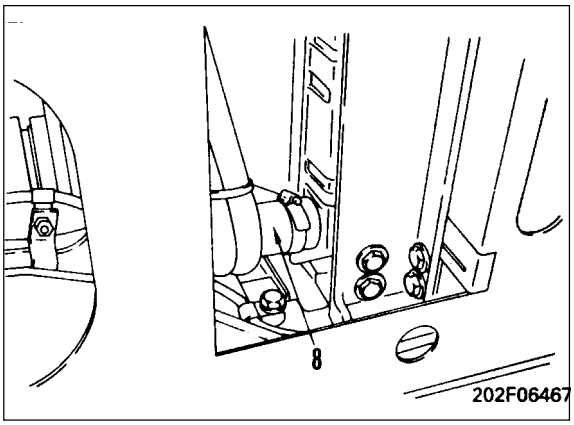
4. Disconnect aeration hose (4).
5. Disconnect radiator inlet hose (5).
6. Remove fan and belt guards (6) (7).
7. Disconnect radiator outlet hose (8).
8. Sling radiator and hydraulic oil cooler assembly (9), remove 4 bottom mounting bolts, then lift off slowly.

   ★ When removing the radiator and hydraulic oil cooler assembly, be extremely careful not to damage the core.

※ 2

kg Radiator - Hydraulic oil cooler assembly: 75 kg





INSTALLATION OF RADIATOR - HYDRAULIC OIL COOLER ASSEMBLY

- Carry out installation in the reverse order to removal.

※ 1

★ Check that the O-ring is not damaged or deteriorated, then connect the hoses.

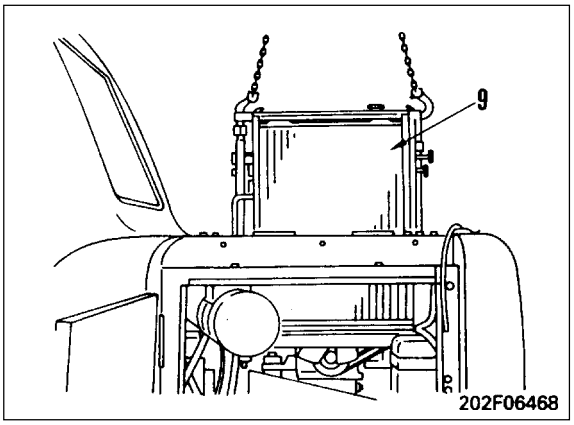
- Fill with refrigerant (R-134a).

※ 2

★ Install the radiator and hydraulic oil cooler assembly so that there is a clearance of 13 mm or more to the left and right, and top and bottom between the fan and shroud.

- Refilling with water
  ★ Add water through the water filler tot 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 FUEL TANK ASSEMBLY

Disconnect the cable from the negative (-) terminal of the battery.

1. Loosen drain valve (1) of fuel tank and drain fuel.

   Fuel tank: Approx.250 / (when tank is full)

2. Disconnect fuel supply hose (2) and return hose (3).

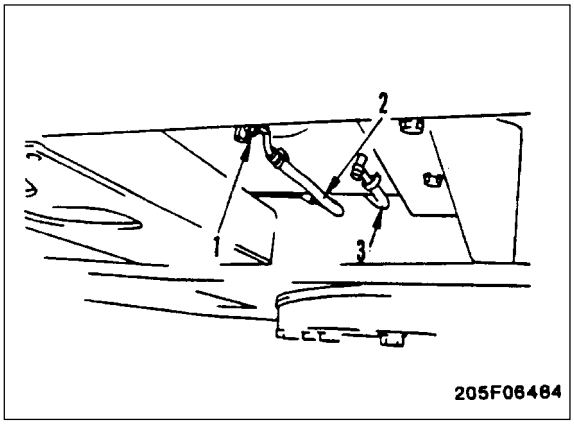
3. Remove handrail (4), battery case (5), and cover (6).

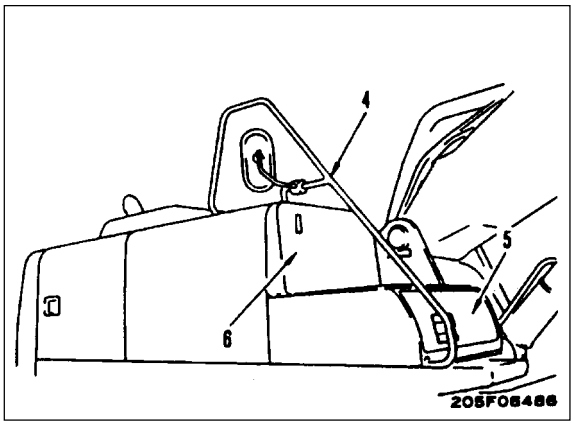
4. Remove connector (7) from holder, and disconnect it.
   ★ Remove the wiring from the clamp, then disconnect from the fuel tank.

5. If refuelling pump is fitted disconnect hose from tank tube.

6. Remove mounting bolts, and lift off fuel tank assembly (8). ※ 1

   kg Fuel tank assembly: 100 kg.





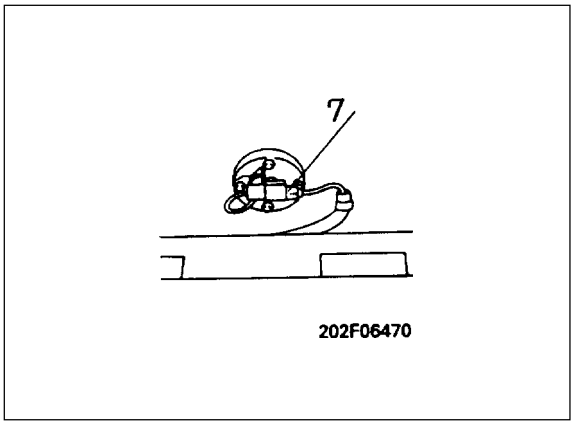
INSTALLATION OF FUEL TANK ASSEMBLY

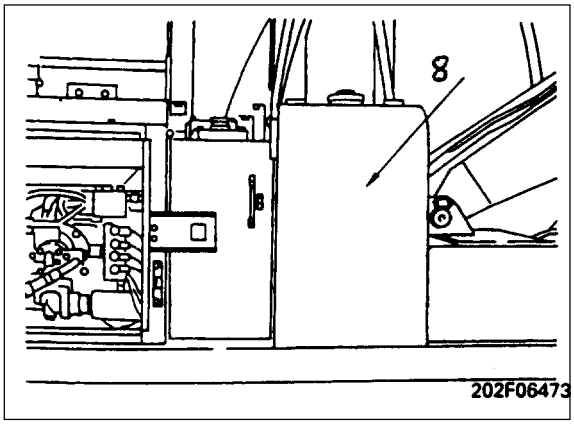
- Carry out installation in the reverse order to removal.

※ 1

kgm Fuel tank mounting bolt:
276.9 ± 31.9 Nm (28.25 ± 3.25 kgm)

- Refilling with oil (fuel tank)
  Add fuel.





REMOVAL OF CENTER SWIVEL JOINT ASSEMBLY

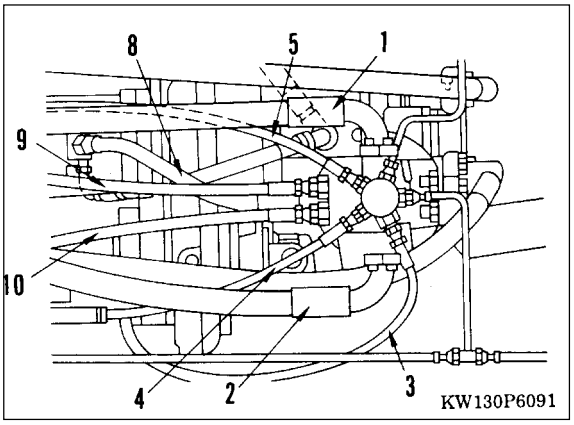
⚠ Lower the work equipment completely to the ground and stop the engine. Then loosen the oil filler cap slowly to release the pressure inside the hydraulic tank.

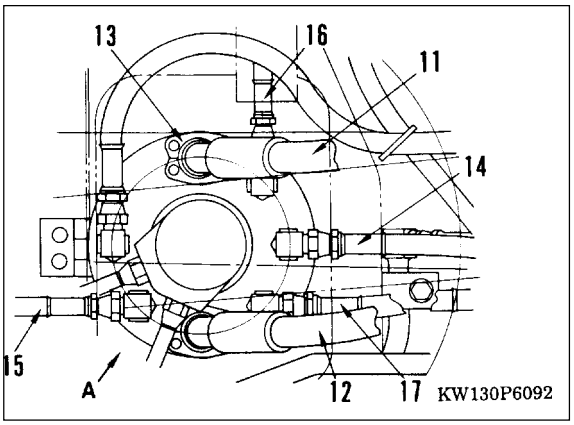
★ Mark all the piping with tags to prevent mistakes in the mounting position when installing.

1. Disconnect hoses (1) and (2) between travel motor and swivel joint.
2. Disconnect pilot hoses (3), (4) and (5) and brake pipes (6) and (7).
3. Disconnect drain hoses (8) and steering hoses (9) and (10).

4. Disconnect hoses (11) (12) (13) & (14) between control valve and swivel joint.
5. Disconnect steering hoses (15) and (16) and drain hose (17)
6. Disconnect brake hoses (18) (19) and (20).
7. Disconnect travel speed selector hose (21) and suspension lock hose (22).
8. Remove center swivel joint assembly (23). ※ 1

kg Center swivel joint assembly: 83 kg.





INSTALLATION OF CENTER SWIVEL JOINT ASSEMBLY

Carry out installation in the reverse order to removal.

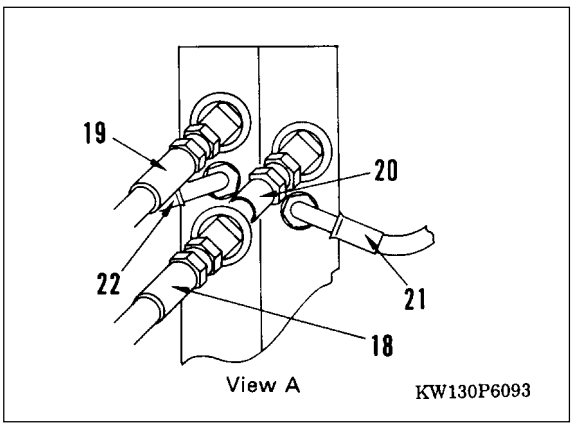
※ 1

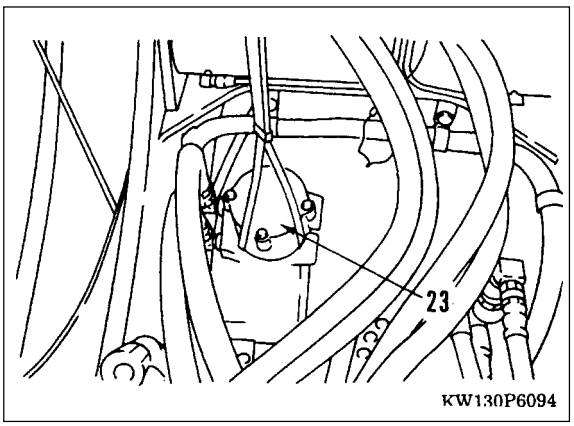
Thread of swivel joint mounting bolt:
Thread tightener (LT-2)

kgm Swivel joint mounting bolt:
277 ± 32 Nm (28.5 ± 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 form the travel motor. For details, see TESTING AND ADJUSTING, Bleeding air.



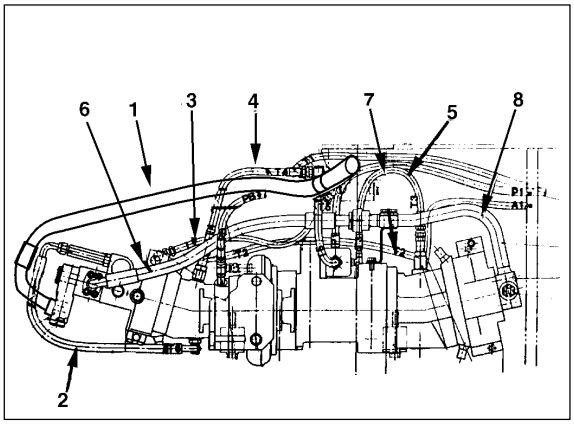


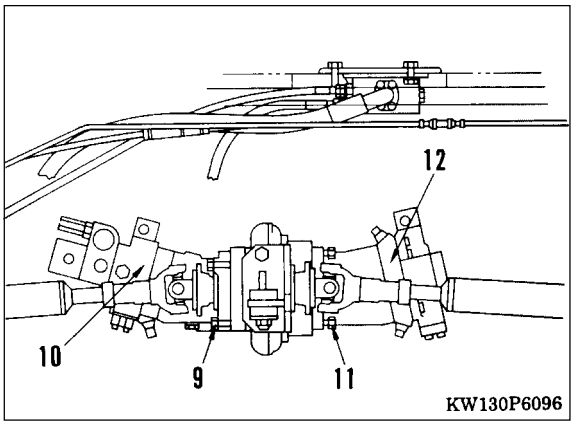
REMOVAL OF TRAVEL MOTOR ASSEMBLY

⚠ Lower the work equipment completely to the ground and stop the engine. Then loosen the oil filter cap slowly to release the pressure inside the hydraulic tank.

1. Disconnect hoses 1, 2, 3, 4, 5, 6, 7 & 8. ※ 1
2. Remove bolts (9) and (11). ※ 2
3. Slide away each travel motor from transmission (Use slings). ※ 3
   ★ Be extremely careful not to damage the hose adaptors.

   kg Travel motor assembly:
   Front: 45 kg
   Rear: 80 kg





INSTALLATION OF TRAVEL MOTOR ASSEMBLY

- Carry out installation in the reverse order to removal.

※ 1

Thread of travel motor mounting bolt:
Thread tightener (LT - 2).

kgm Travel motor mounting bolt:
Rear : 276.9 ± 31.9 Nm (28.25 ± 3.25 kgm)
Front : 110.5 ± 12.5 Nm (11.25 ± 1.25 kgm)

★ Bleed the air from the travel motor.
For details, see TESTING AND ADJUSTING, Bleeding air from travel motor.

- 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 SWING MACHINERY • SWING MOTOR ASSEMBLY

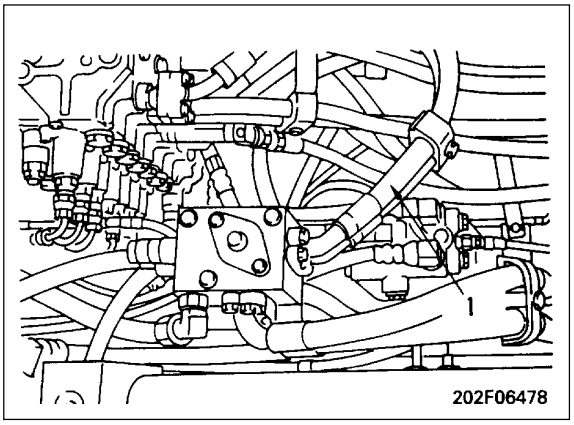
⚠ Release the remaining pressure in the hydraulic circuit.
For details, see TESTING AND ADJUSTING, Releasing pressure in hydraulic circuit.

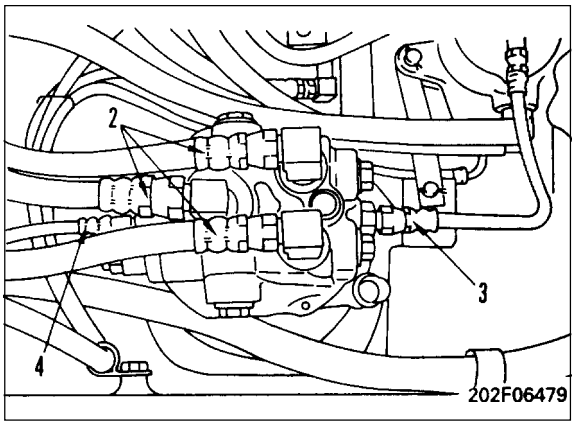
1. Disconnect hose (1).

2. Disconnect swing motor inlet and outlet hoses (2), (3), and (4).

3. Remove mounting bolts, sling swing machinery and swing motor assembly (5), then use forcing screw ① to remove. ※ 1
   ★ When removing the swing machinery and swing motor assembly, lift off slowly and be careful not to damage the wiring or piping.

   kg Swing machinery - swing motor assembly: 110 kg.





INSTALLATION OF SWING MACHINERY - SWING MOTOR ASSEMBLY

- Carry out installation in the reverse order to removal.

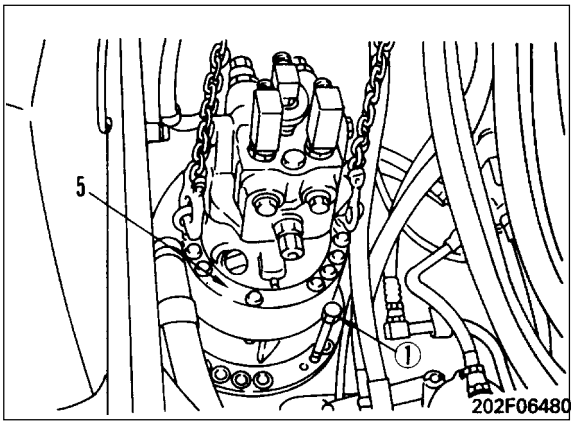
※ 1

Mating surface of swing machinery case: Gasket sealant (LG-4 or LG-6).

kgm Swing machinery, swing motor assembly mounting bolt: 276.9 ± 31.9 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 from the swing motor.
  For details, see TESTING AND ADJUSTING, Bleeding air.



DISASSEMBLY OF SWING MACHINERY ASSEMBLY

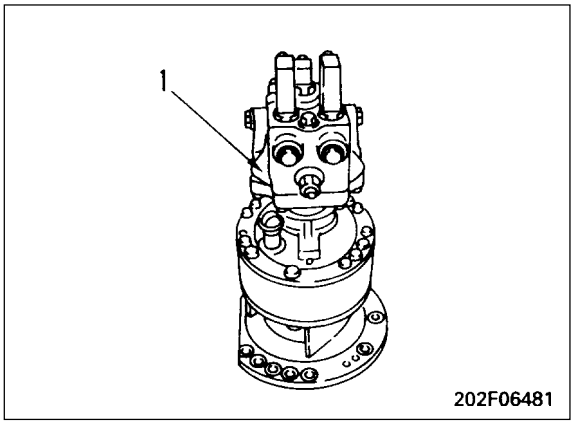
1. Draining oil

Remove drain plug and drain oil from swing machinery.

Swing machinery case: 2.5 *l*.

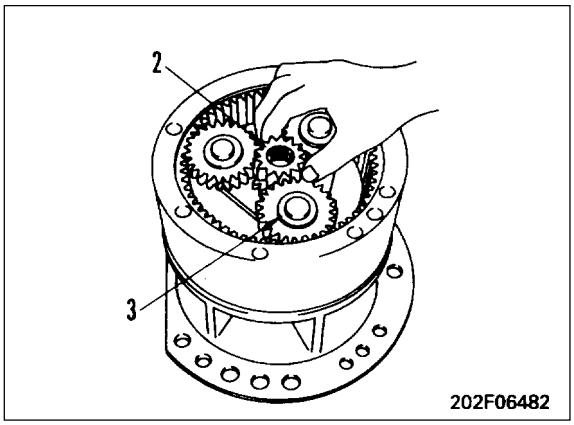
2. Swing motor assembly

Remove swing motor assembly (1).

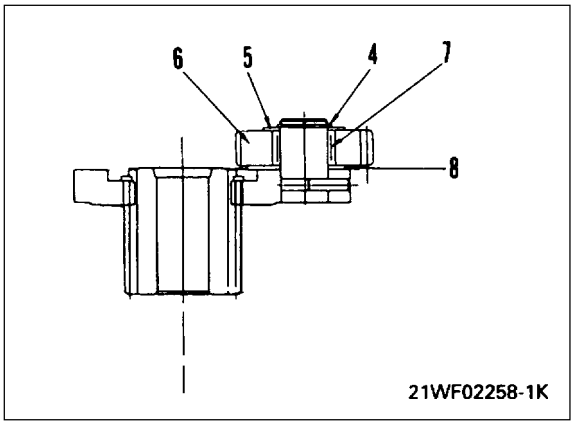


3. No. 1 carrier, No. 2 sun gear assembly

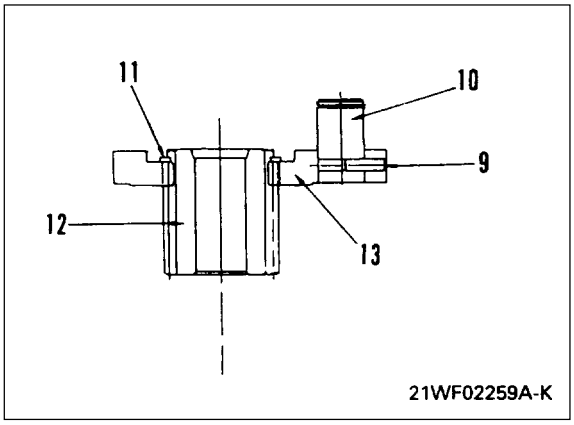
1) Remove No. 1 sun gear (2).
2) Remove No. 1 carrier and No. 2 sun gear assembly (3).



3) Disassemble No. 1 carrier and No. 2 sun gear assembly as follows.
   i) Remove snap ring (4), then remove thrust washer (5), gear (6), bearing (7), and thrust washer (8).

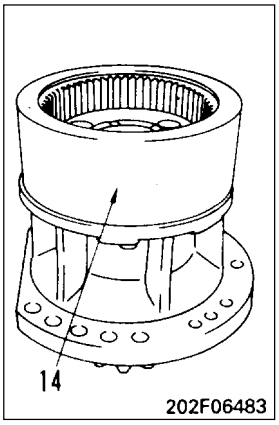


   ii) Knock in pin (9), and knock out shaft (10).
   ★ After removing the shaft, remove pin (9).
   iii) Remove snap ring (11), then remove No. 2 sun gear (12) from carrier (13).



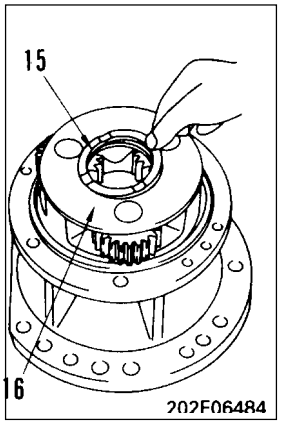
4. Ring gear

Remove ring gear (14).

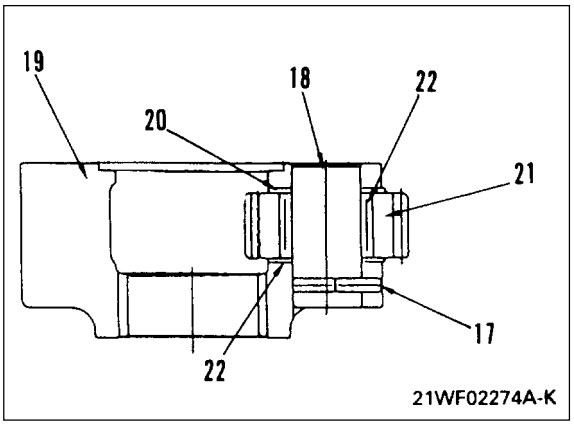


5. No. 2 carrier assembly

1) Remove spacer (15).
2) Remove No. 2 carrier assembly (16).

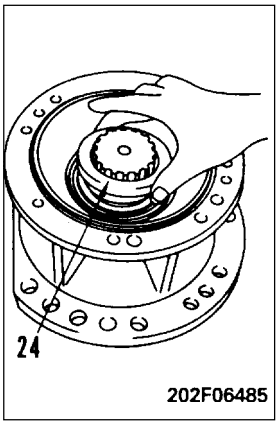


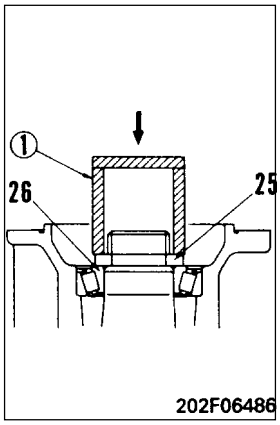
3) Disassemble No. 2 carrier assembly as follows.
   i) Push in pin (17), and knock out shaft (18) from carrier (19).
      ★ After removing the shaft, remove pin (17).
   ii) Remove thrust washer (20), gear (21), bearing (22), and thrust washer (23).



6. Retainer, collar

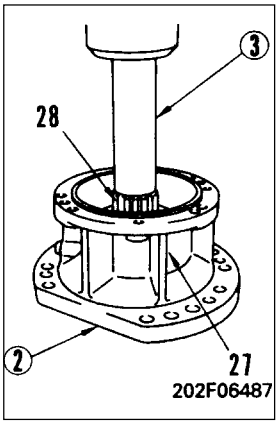
1) Remove retainer (24).
2) Set shaft and case assembly in press, push split collar (25) with push tool ①, and press fit bearing (26).
   ★ Operate the press slowly, and press fit the bearing to a position where it is possible to remove the split collar.
3) Remove split collar (25).

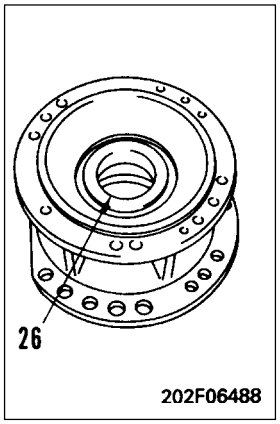




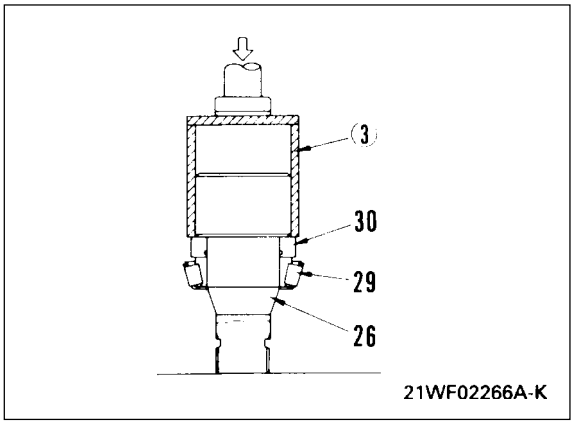
7. Shaft assembly

1) Set block ② to shaft and case assembly (27), then using push tool ③, remove shaft assembly (28) with press.
2) Remove bearing (26).



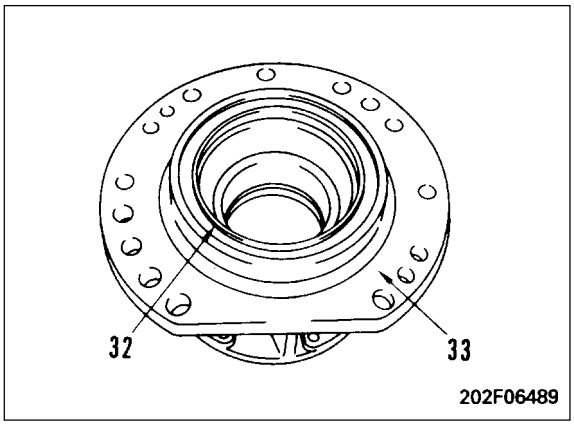


3) Set shaft assembly to press, then using push tool ④, remove bearing (29) and collar (30) from shaft (31).

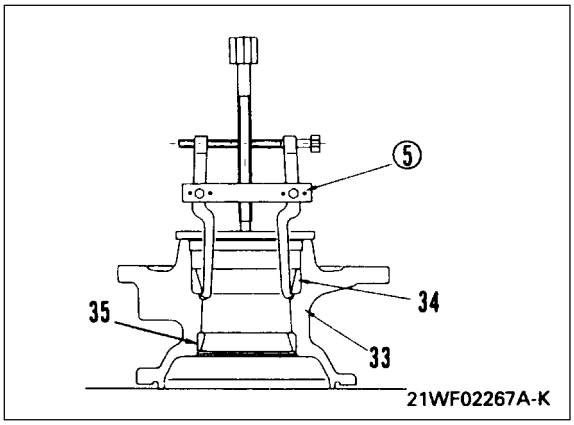


8. Oil seal, bearing outer races

1) Remove oil seal (32) from case (33).



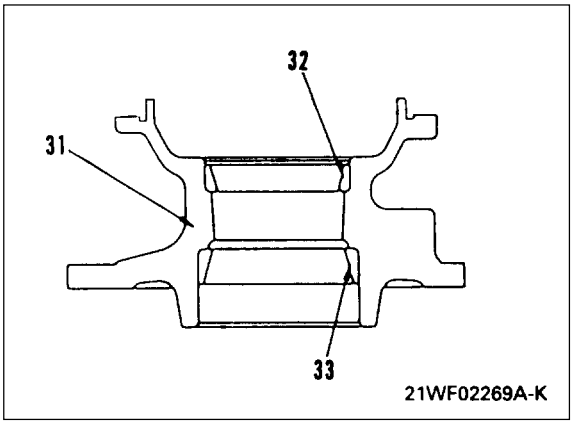
2) Using puller ⑤, remove bearing outer races (34) and (35) from case (33).



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 outer races
Using push tool, press fit outer races (34) and (35) to case (33).

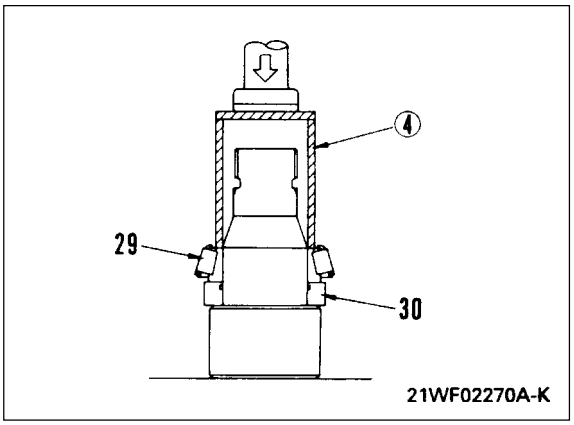


2. Shaft assembly

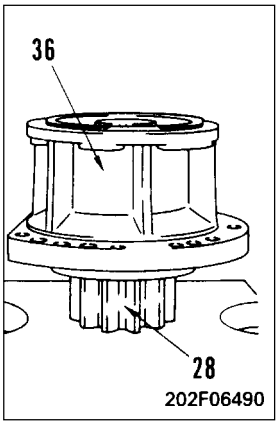
1) Fit O-ring to inside of collar (30), and install to shaft (31).

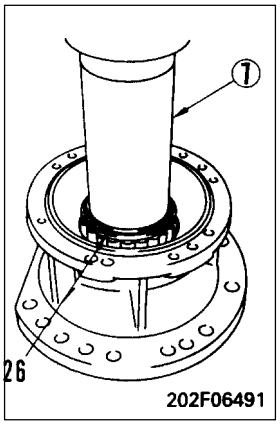
2) Using push tool ⑥, press fit bearing (29) with press.

3) Set case assembly (36) to shaft assembly (28).



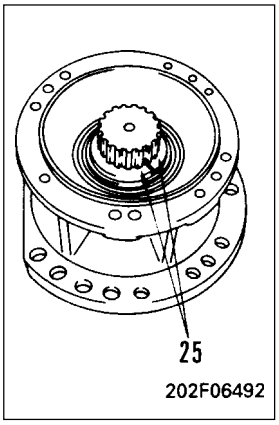
4) Using push tool ⑦, press fit bearing (26) to a position where it is possible to insert split collar.
   ★ Press fitting force: 11.76 kN (1,200 kg).
   ★ Rotate the case and gradually press fit the bearing.

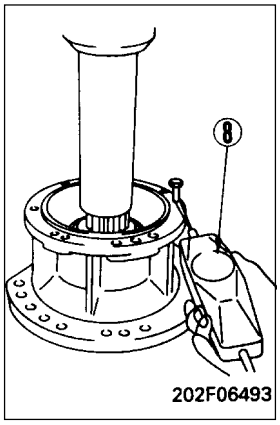




5) Install split collar (25).

6) Screw bolt (Thread dia. = 12 mm, Pitch = 1.75 mm) into case, then using push-pull scale ⑧, measure tangential force in direction of rotation.
   ★ Tangential force: Max. 176.4 N (18 kg).
   ★ The tangential force is the maximum force when starting rotation.



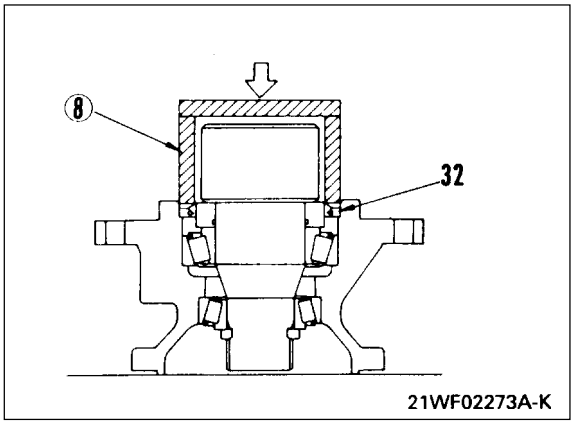


3. Oil seal

Using push tool ⑧, press fit oil seal (32).

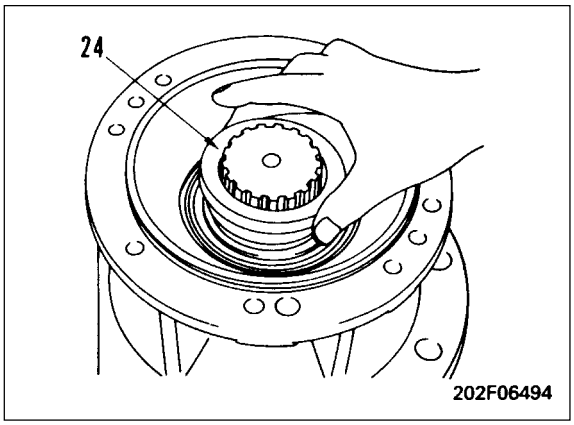
★ Replace the oil seal with a new part.

Lip of oil seal: Grease (G2-LI).



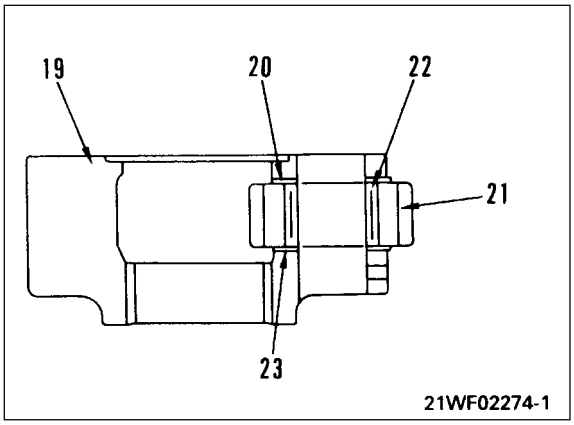
4. Retainer

Install retainer (24).

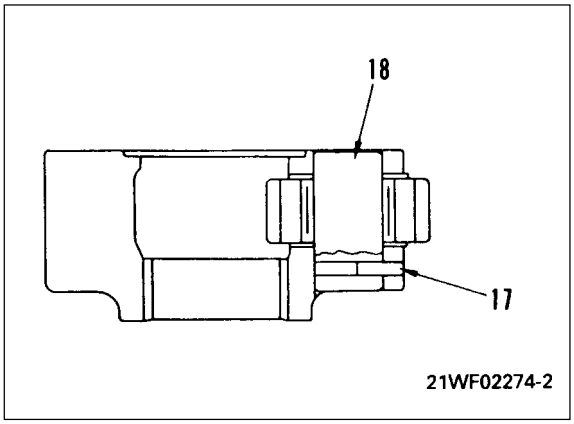


5. No. 2 carrier assembly

1) Assemble No. 2 carrier assembly as follows.
   i) Assemble bearing (22) to gear (21).
   ii) Fit top and bottom thrust washers (20) and (23), then set gear assembly to carrier (19).

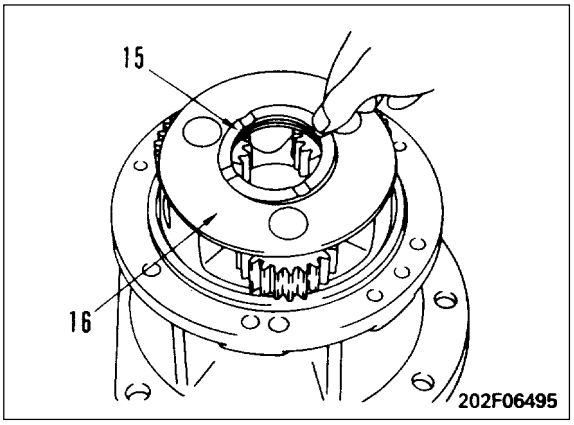


   iii) Align position of pin holes of shaft and carrier, then tap with a plastic hammer to install shaft (18).
      ★ When installing the shaft, rotate the planetary gear and be careful not to damage the thrust washer.
   iv) Insert pin (17).
      ★ After inserting the pin, caulk the pin portion of the carrier.



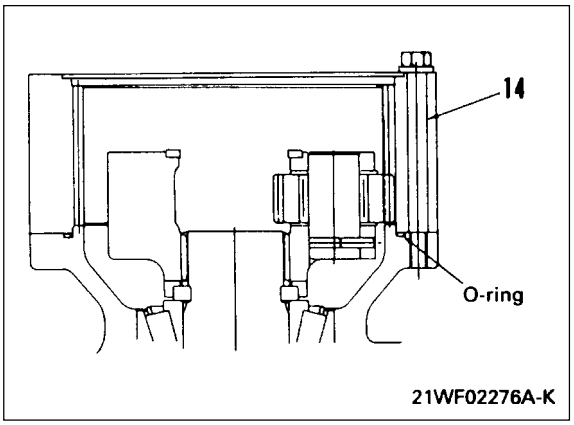
2) Install No. 2 carrier assembly (16) to shaft and case assembly.

3) Install spacer (15).



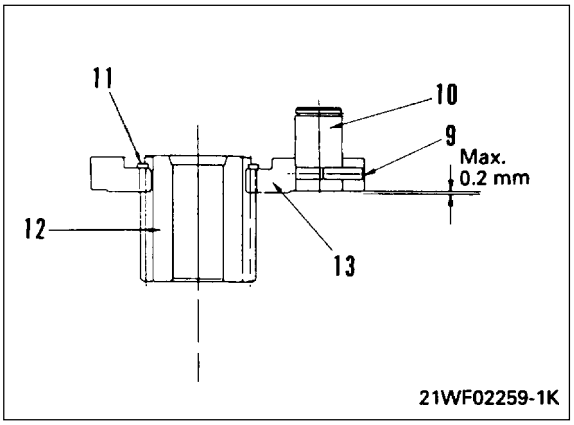
6. Ring gear

Assemble O-ring to shaft and case assembly, and install ring gear (14).

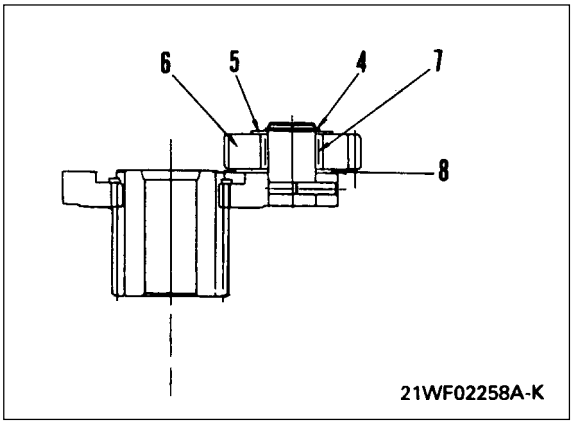


7 No. 1 carrier, No. 2 sun gear assembly

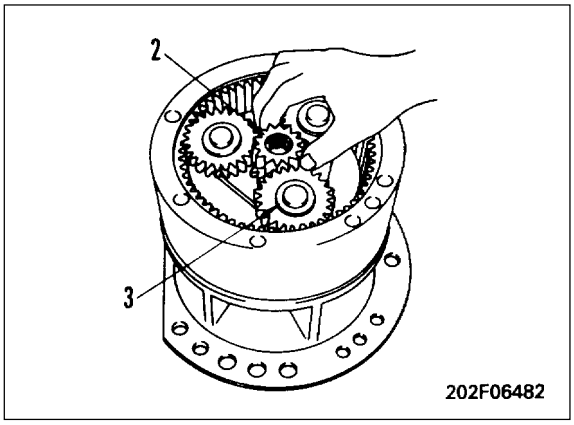
1) Assemble No. 1 carrier and No. 2 sun gear assembly as follows.
   i) Assemble No. 1 carrier (13) to No. 2 sun gear (12), and install snap ring (11).
   ii) Align position of pin holes of shaft and carrier, then tap with a plastic hammer to install shaft (10).
   iii) Insert pin (9).
      ★ After inserting the pin, caulk the pin portion of the carrier.
      ★ Check that the stepped difference between the shaft and carrier is less than 0.2 mm.



   iv) Assemble thrust washer (8), bearing (7), gear (6), thrust washer (5), and install snap ring (4).



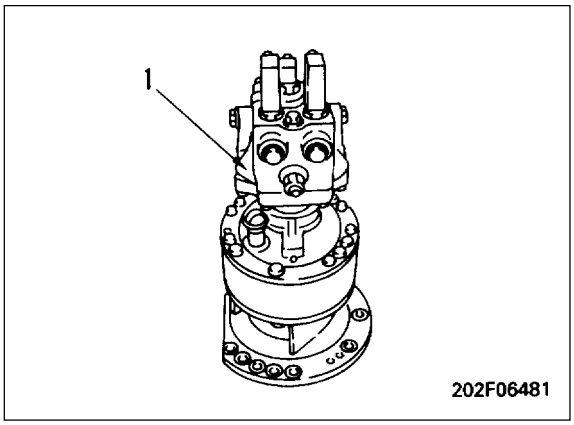
2) Install No. 1 carrier and No. 2 sun gear assembly (3).
3) Install No. 1 sun gear (2).



8. Swing motor assembly

Install swing motor assembly (1).

kgm Mounting bolt:
110.3 ± 12.3 Nm (11.25 ± 1.25 kgm).

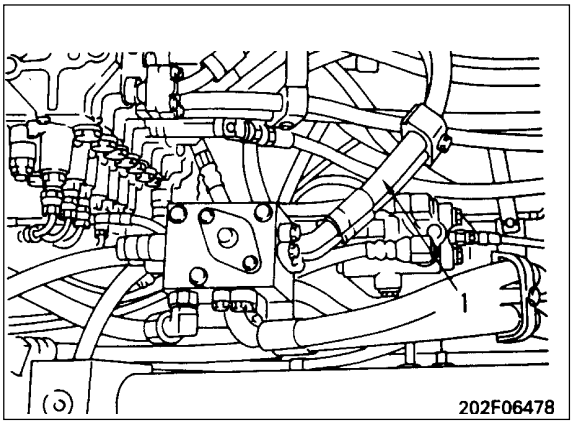


9. Refilling with oil

Tighten drain plug and add engine oil through oil filler.

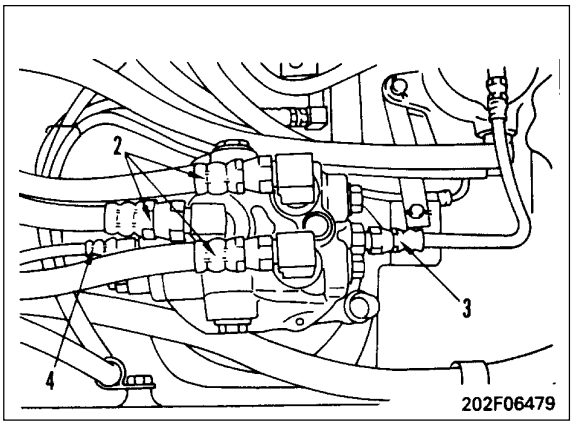
Swing machinery case: Approx. 2.5 *l*.

REMOVAL OF SWING MOTOR ASSEMBLY



Lower the work equipment completely 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. Drain oil from swing machinery case.
   Swing machinery case: Approx. 2.5 *l*.
2. Disconnect hose (1).
3. Disconnect swing motor inlet and outlet hoses (2), (3), and (4).
4. Sling swing motor assembly (5), then use forcing screws ① to remove. ※ 1
   kg Swing motor assembly: 30 kg.

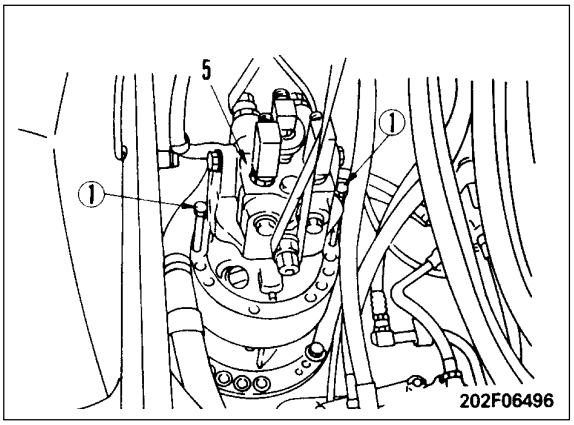


INSTALLATION OF SWING MOTOR ASSEMBLY

- Carry out installation in the reverse order to removal.

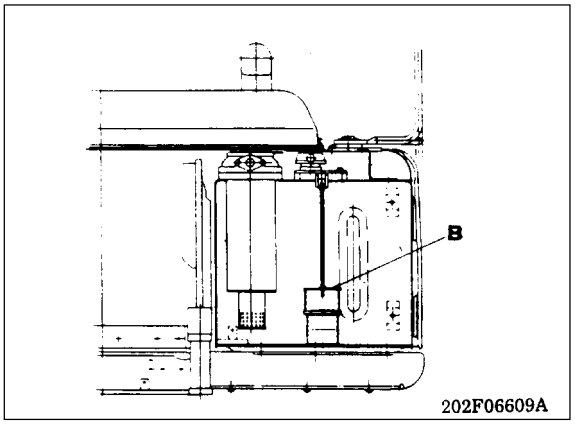
※ 1

kgm Swing motor assembly mounting bolt:
110.3 ± 12.3 Nm (11.25 ± 1.25 kgm).



- Refilling with oil (swing machinery case)
  ★ Add oil through the oil filler to the specified level.
- 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 swing motor.
  For details, see TESTING AND ADJUSTING, Bleeding air.

REMOVAL OF REVOLVING FRAME ASSEMBLY

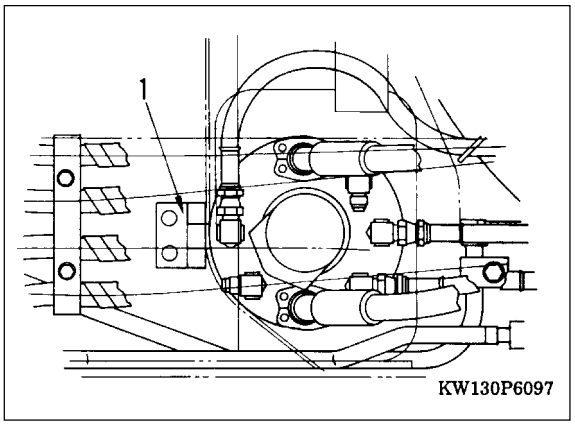


Lower the work equipment completely to the ground and stop the engine. Then loosen the oil filler cap slowly to release the pressure inside the hydraulic tank.

- Remove the hydraulic tank strainer, and using tool **B**, stop the oil.
  - When not using tool **B**, remove the drain plug, and drain the oil from the hydraulic tank and inside the system.

Hydraulic tank: Approx. 100 *l*.

Disconnect the cable from the negative (-) terminal of the battery.



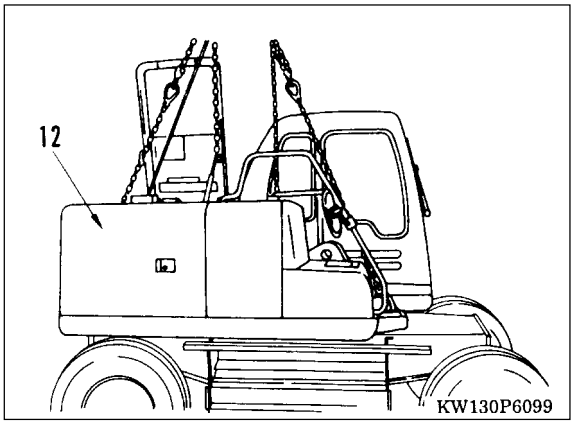
1. Remove 2 boom cylinder assemblies.
   For details, see REMOVAL OF BOOM CYLINDER ASSEMBLY.

2. Remove work equipment assembly.
   For details, see REMOVAL OF WORK EQUIPMENT ASSEMBLY.

3. Remove counterweight assembly.
   For details, see REMOVAL OF COUNTERWEIGHT ASSEMBLY.

4. Disconnect top mounting hoses of swivel joint assembly. For details, see REMOVAL OF SWIVEL JOINT ASSEMBLY. Remove torque arm (1).

5. Remove mounting bolts, then lift off revolving frame assembly (12). ※ 3
   ★ Leave 2 bolts each at the front and rear, use a lever block to adjust the balance of the revolving frame assembly to the front and rear, and left and right, then remove the remaining bolts, and lift off.



When removing the revolving frame assembly, be careful not to hit the center swivel joint assembly.

kg Revolving frame assembly: 3,300 kg.

INSTALLATION OF REVOLVING FRAME ASSEMBLY

- Carry out installation in the reverse order to removal.

※ 1

★ Adjust the governor motor rod.
For details, see TESTING AND ADJUSTING, Adjusting governor motor rod.

※ 2

 Mating surface of swing circle:
Gasket sealant (LG-1)

 Thread of revolving frame mounting bolt:
Thread tightener (LT-2)

 Revolving frame mounting bolt:
227.1 ± 31.9 Nm (28.3 ± 3.3 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.

- 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.

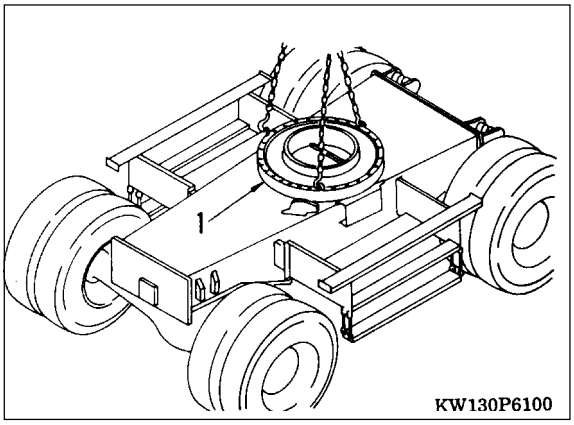
REMOVAL OF SWING CIRCLE ASSEMBLY

1. Remove revolving frame assembly.
   For details, see REMOVAL OF REVOLVING FRAME ASSEMBLY.

2. Sling swing circle assembly (1) and remove 38 mounting bolts. ※ 1

3. Remove swing circle assembly (1). ※ 2

   kg Swing circle assembly: 168 kg.



INSTALLATION OF SWING CIRCLE ASSEMBLY

- Carry out installation in the reverse order to removal.

※ 1

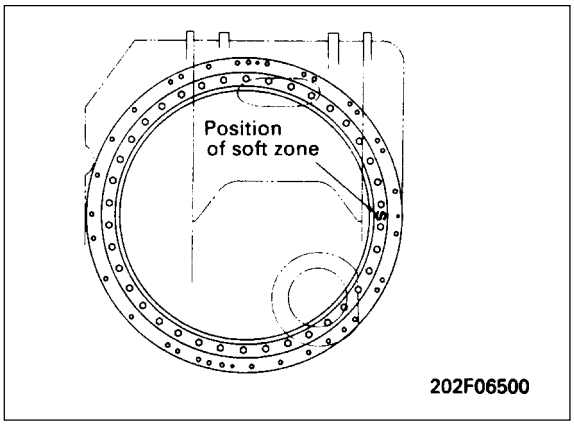
Thread of swing circle mounting bolt:
Thread tightener (LT-2).

kgm Swing circle mounting bolt:
277.1 ± 31.9 Nm (28.3 ± 3.3 kgm).

※ 2

★ Sling swing circle assembly (1), set the soft zone **S** mark on the inside ring of the inner race facing 90° to the left side, then install to the track frame.

Swing circle: Grease (G2-LI) 10 *l*.



TRANSMISSION

DISASSEMBLING, SETTING OPERATIONS AND REASSEMBLING

FOREWARD

Oil seals for rotating shafts

For correct installation of oil seals adhere to the following recommendations:

- Before installation soak the seal for half an hour in the same oil that will be used in the transfer box to be sealed.
- Clean the shaft and ensure the seal area of the same is not damaged, fitted or grooved.
- Place the sealing lips towards the oil side.
- Lubricate the seal lip (oil is better than grease) and fill with grease the space between oil lip and dust lip of dual lip seals.
- Install the oil seal using a suitable seal driver. Avoid hammering directly on the seal.
- To avoid damages to the seal lip caused by the shaft: adequately protect the same during shaft assembly procedure.

O-ring

Ensure adequate lubrication of these seals before inserting them in their seats to avoid twisting during shaft assembly.

Shims

For each adjustment select the correct shims by individual measurements.
Do not trust pack measurement or the thickness indicated on the shim.

Bearings

For a correct assembly it is suggested to warm them in a furnace from 80oC to 90oC before installation in their respective shafts or to cool them before the inserting in their respective seats with outer housing.

Sealing compound

Use LOCTITE 510 or types following the specifications. Ensure that both sides to be sealed are clean, dry and totally free from grease and oil.

Oil drain

Before intervening on transfer box you have to drain oil (refer to page A).

Warning: The exhaust oil disposal must be carried out according to the laws in force.

Removal and installation of the box.

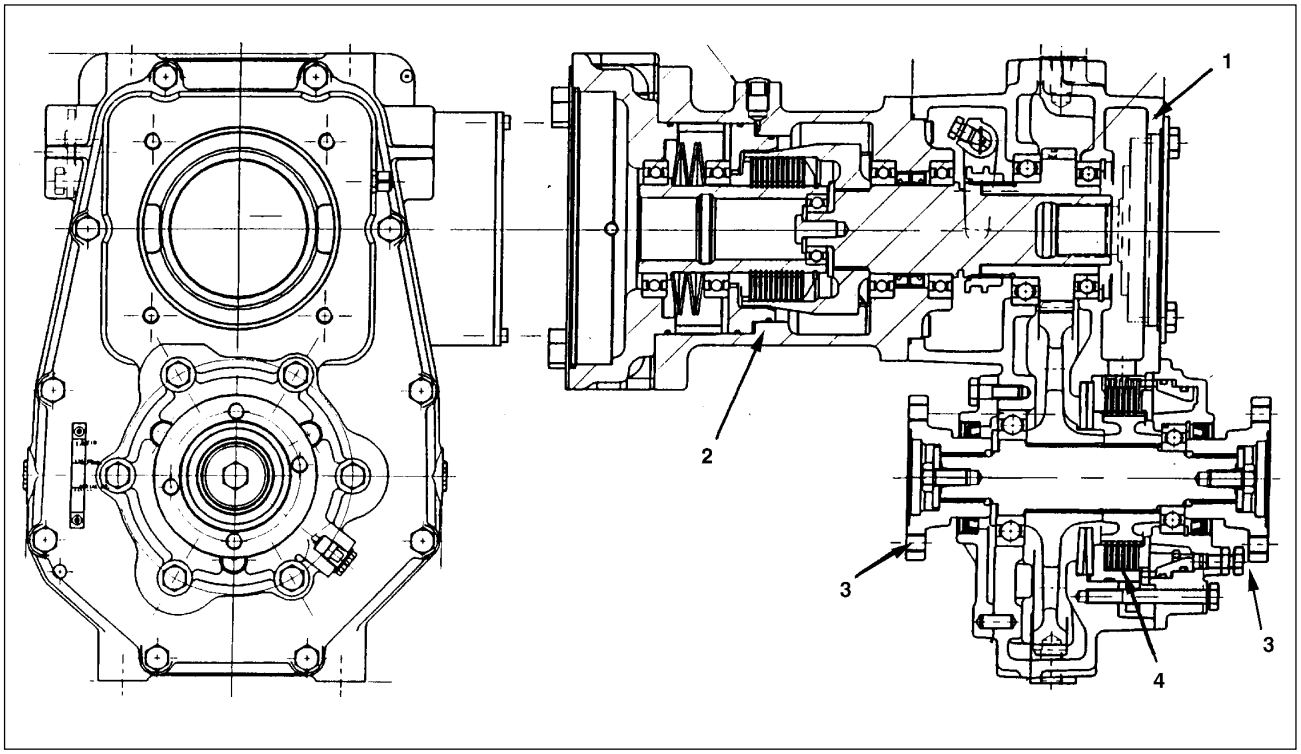
Disconnect the controlling brakes piping, then install a protection plug.

Loose all the remaining connections, then separate the transfer box from the vehicle structure.

Installing the transfer box reverse the order; check for eventual leakage of oil.

Check the oil level and, if necessary, re-fill.

Carry out the braking system bleeding.



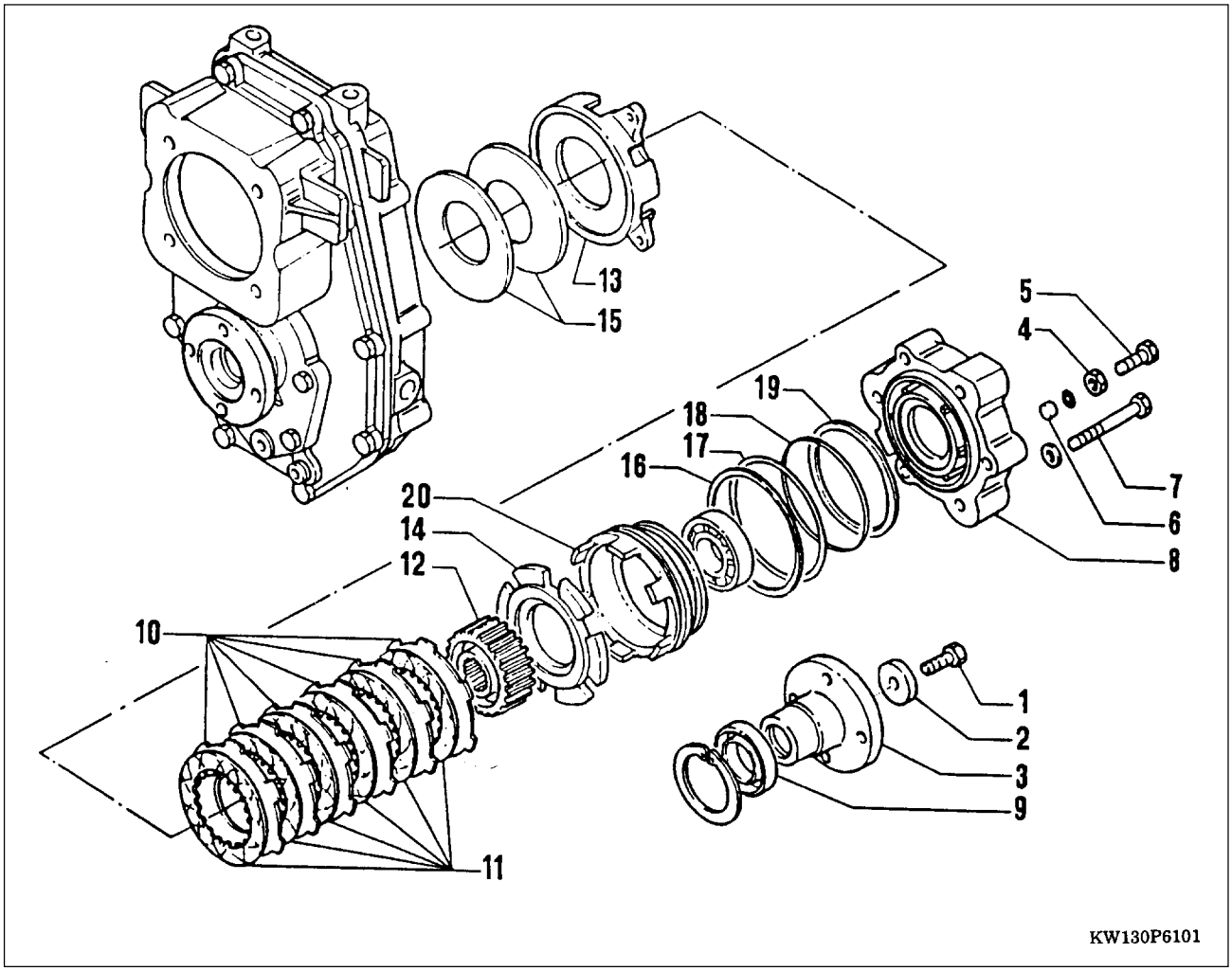
1. Transmission assembly.
2. Clutch assembly.
3. Output flange.
4. Park brake.

EMERGENCY BRAKE
(Refer to page 30-49)

- Unscrew the screw (1), remove the washer (2) and the flange (3).
- Unscrew the screws (7) and remove the brake cylinder (8).
- Keep the brake piston (20) and the seal rings (16-17-18-19); replace if necessary.
- Keep the 3 thrust pins (6) and the O-rings; replace if necessary.
- Do not operate on the screws (5) and the nuts (4), but only in the event of brake release manual intervention. In this case carry out the adjustment setting the screws in touch with the pins (6), then unscrew 1 turn and lock with the counternut (4).
- Check the disks (10) are not distorted or scorched; if necessary, replace them.
- Check the friction disks thickness (11) is not lower than the one specified; if necessary, replace them.
- Check the groove condition on output shaft and on brake sleeve (12).
- Check the brake drum (13) and the reaction plate (14) are not worn out.
- Check the O-ring condition (9); replace, if necessary. Lubricate and use a suitable driver to avoid any damage during assembly.
- Check the Bellaville spring conditions (15).

SPECIAL TOOLS

Driver for oil seal (9): ref. 119038
Interchangeable handle: ref. 119033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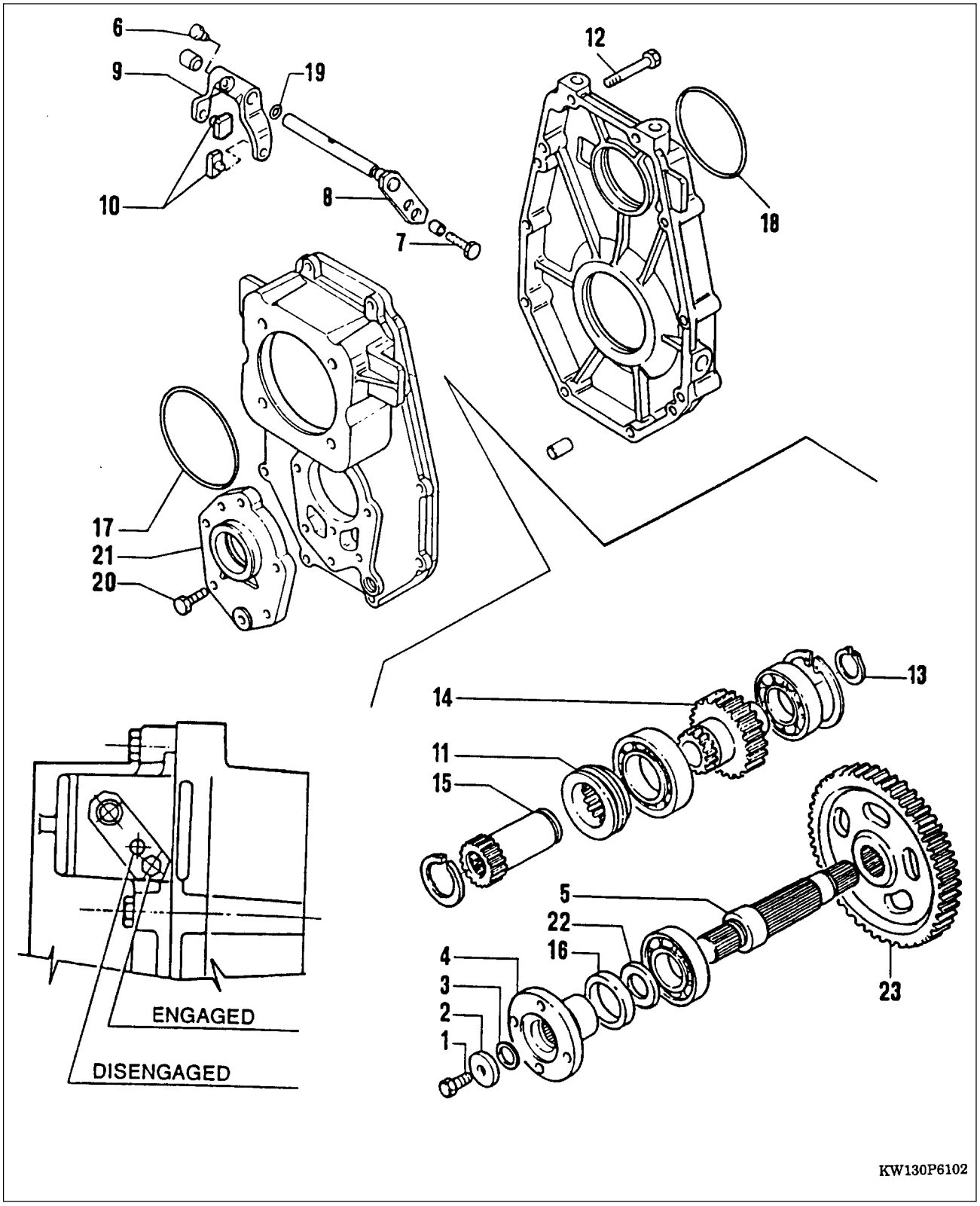
GEAR AND CONTROL BOX
(Refer to page 30-51)

- Remove the emergency brake group as shown previously.
- Unscrew the screw (1), remove the washer (2), the thickness (3) and the flange (4).
- Unscrew the screws (20) and remove the cover (21).
- Check the seal ring condition (16); replace, if necessary. Lubricate and use a suitable coupling tool to avoid any damage during the assembly.
- Extract output shaft (5) and recover the washers (22).
- Unscrew the lever locking screw (7).
- Set the lever to "DISENGAGED" in order to reach the fork locking screw (6).
- Unscrew the screw (6) and extract the fork control lever (8).
- Remove the stop ring (13), then extract fork (9), shaft (15) and sleeve (11) group.
- Separate this group and check pad and sleeve groove wear; replace, if necessary.
- Replace O-rings (17), (18) and (19).
- In the event of gears (14) and (23) replacement, unscrew the screws (12) and separate the half-housing. At re-assembly, clean and degrease the union surfaces of the half-housings and use Loctite 510.
- Check for bearing condition and replace, if necessary.
- Check for oil drain condition, clean and replace, if necessary.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ENGAGED
DISENGAGED
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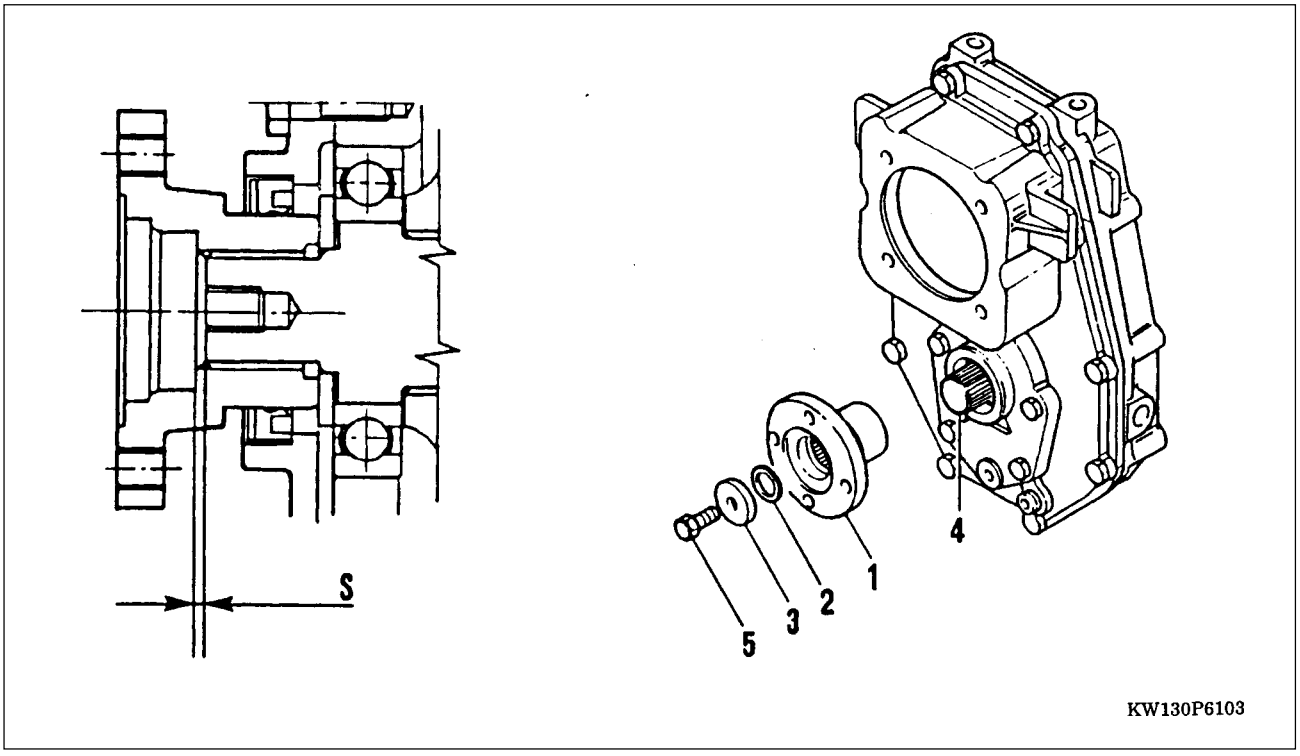
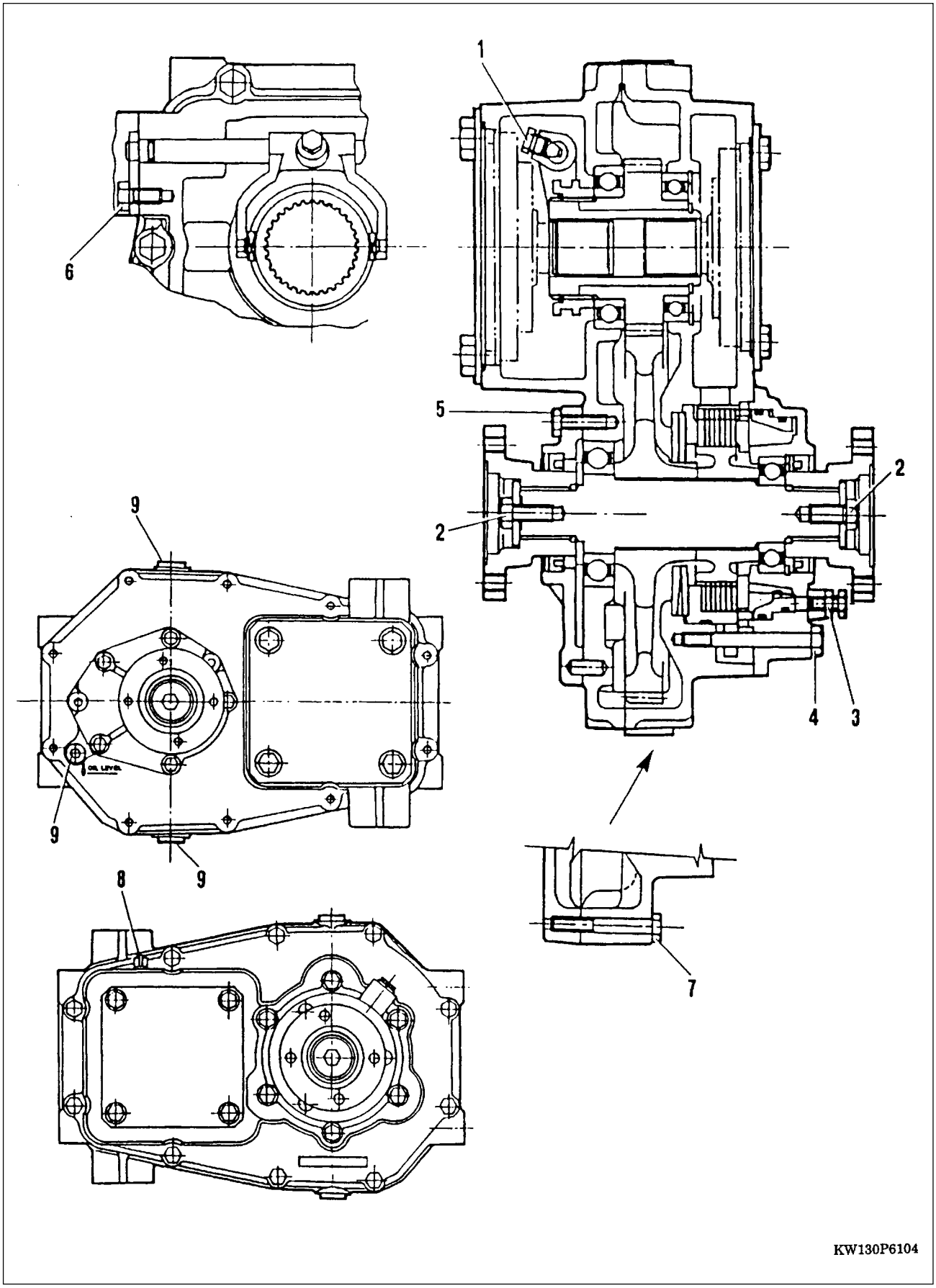
FLANGE POSITIONING

- The motion output flange for forward axle (1) must be mounted by using some adjustment thickness (2) between washer (3) and shaft (4) in order to assure a right assembly.
- Detect with a gauge the dimension (S) of the thickness to use.
- Insert the previously defined thickness and clamp the screw (5) with 139 Nm torque.

TIGHTENING TORQUES
(Refer to page 53)

		Thread	Nm
1	Screw-fork to shaft	-	32
2	Screw-output flanges	M12x25	139
3	Brake release nut-screw	M10x20	50
4	Front cover-screw	M10x90	50
5	Rear cover-screw	M10x30	50
6	Fork control screw-lever	M10x20	50
7	Half-housing fastening screw	M10x65	50
8	Breather	M10	10
9	Oil drain, filling and level plug	M22	60

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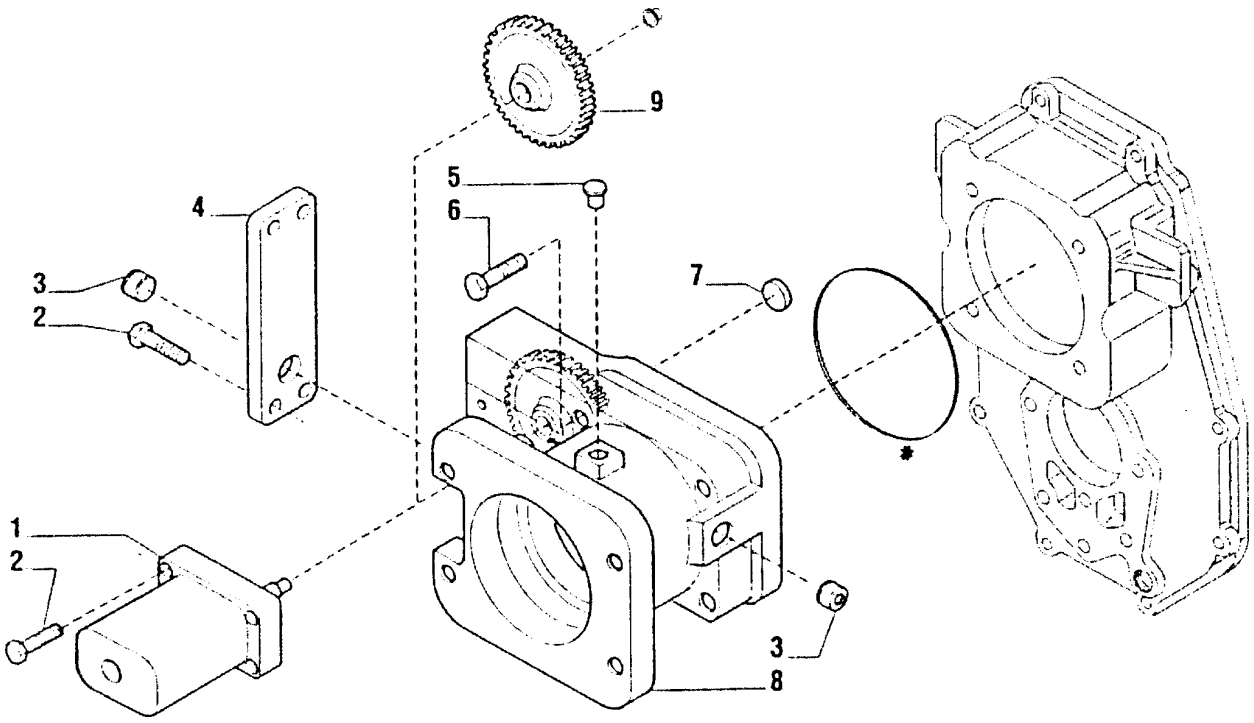
PUMP & CLUTCH ASSEMBLY



- Once the clutch housing has been removed from the transmission:
- replace O-ring (*)
- loosen bolts (2) to remove cover (4)
- loosen and remove bolts (2) to disconnect pump (1)
- remove gear (9) from pump's shaft and inspect for wear and damage. Replace as necessary.
- when reassembling, tighten bolts (6) to a torque of 21,5 daN x m and bolts (2) to a torque of 1 daN x m.

WARNING: do not try to tear down and repair the unit (8).
Such component must be serviced by specialized staff only!

FRONT AXLE

DISASSEMBLING, SETTING OPERATIONS AND REASSEMBLING

FOREWARD

Oil seals for rotating shafts

For correct installation of oil seals adhere to the following recommendations:

- Before installation soak the seal for half an hour in the same oil that will be used in the axle to be sealed.
- Clean the shaft and ensure the seal area of the same is not damaged, fitted or grooved.
- Place the sealing lips towards the oil side.
- Lubricate the seal lip (oil is better than grease) and fill with grease the space between oil lip and dust lip of dual lip seals.
- Install the oil seal using a suitable seal driver. Avoid hammering directly on the seal.
- To avoid damages to the seal lip caused by the shaft: adequately protect the same during shaft assembly procedure.

O-ring

Ensure adequate lubrication of these seals before inserting them in their seats to avoid twisting during shaft assembly.

Shims

For each adjustment select the correct shims by individual measurements.
Do not trust pack measurement or the thickness indicated on the shim.

Bearings

For a correct assembly it is suggested to warm them in a furnace from 80oC to 90oC before installation in their respective shafts or to cool them before inserting in their respective seats with outer housing.

Elastic plugs

During the plug assembly and with turbo off, ensure that their notch has oriented towards the stress which is subjecting the thrust.

On the contrary, the spiral elastic plugs need no assembly orientation.

Sealing compound

Use LOCTITE 510 or types following the specifications. Ensure that both sides to be sealed are clean, dry and totally free from grease and oil.

Disassembling - Reassembling

The overhauling of epicycloidal group and wheel hubs can be completed without removing the axle from the vehicle.

Oil drain

Before intervening on axle you have to drain oil from the final drives and from the axle box (refer to page C).

Warning: The exhaust oil disposal must be carried out according to the laws in force.

Removal and Installation of the axle

In order to remove the axle, support adequately the vehicle to get a certain safety.

Unscrew the fastening nuts and remove the wheels from the hubs.

Disconnect the controlling brakes piping, then install some protection plugs.

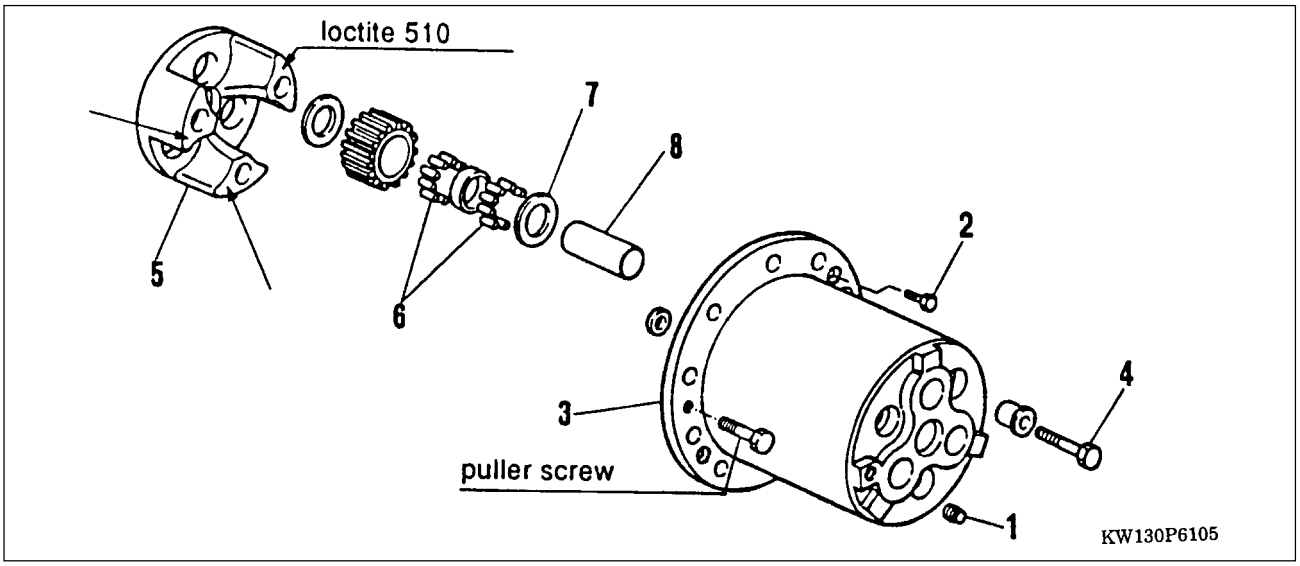
Loose all the remaining connections between frame and axle, then separate the axle from the frame structure.

Installing the axle reverse the order; check for eventual leakage of oil.

Check the oil level and, if necessary, re-fill.

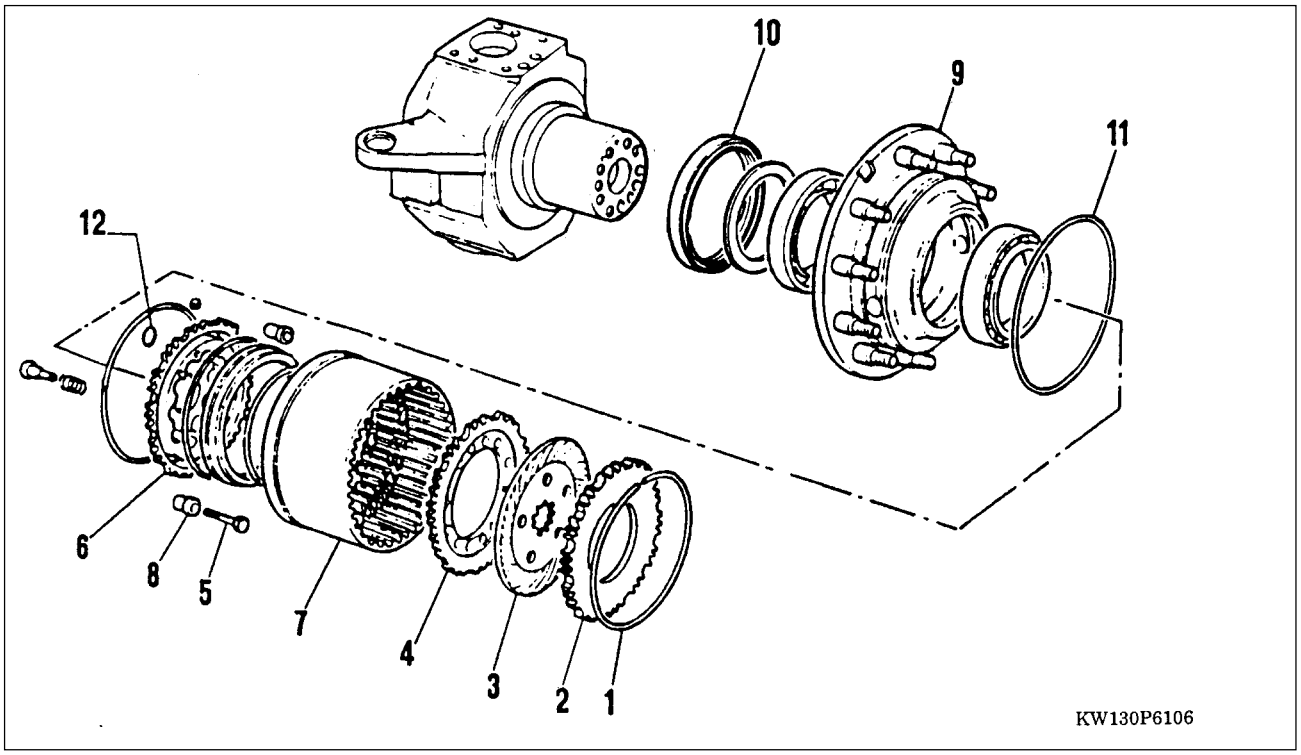
Carry out the braking system bleeding.

FINAL DRIVES



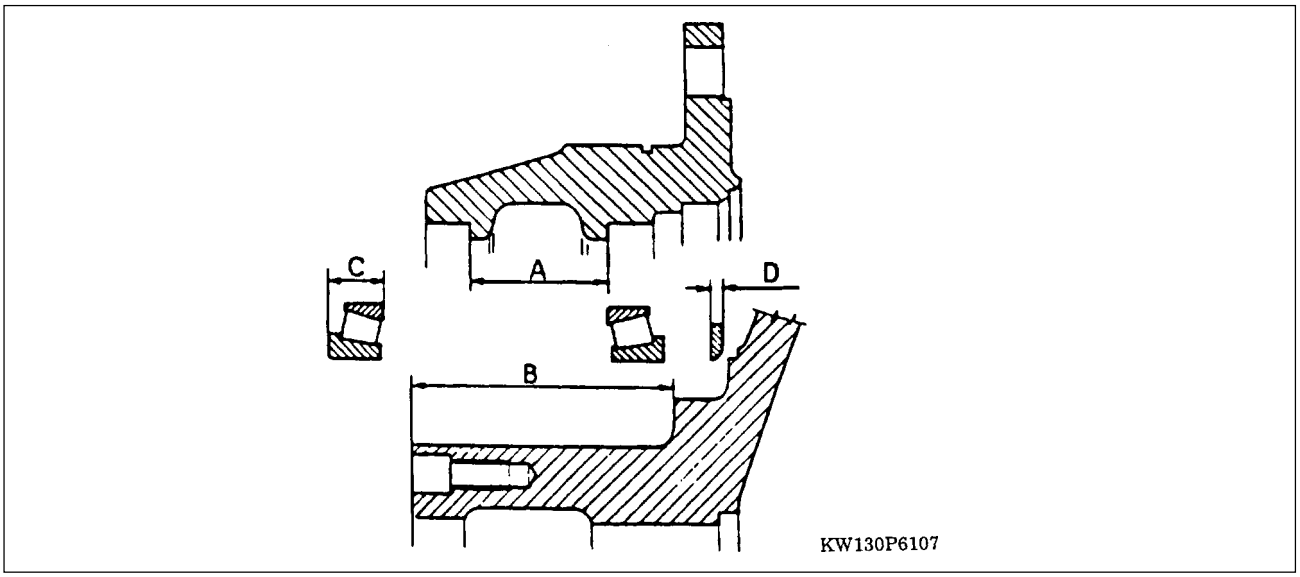
- Unscrew the screws (2) of the carrier assy (3).
- Remove the planetary carrier from the wheel hub, using a puller two screws and operating on the extraction holes.
- Partially unscrew the screws (4) and knock with a plastic hammer to separate the planetary carrier (5). Then remove the screws. When reassembling, clean and degrease the planetary carrier (5) union surface to the carrier assy (3) and use Loctite 510.
- Check the condition of the needle bearing (6) and washers (7). Replace, if necessary.
- Check the planetary pin (8) conditions. As they are forced on the planetary carrier (3), replace the whole planetary carrier if damaged. When reassembling, if necessary, use some grease to hold in position the needle bearing.
- Turn the wheel hub and position the plug (1) to the upper point. Fill it with specified oil.
- Turn the wheel hub setting the plug (1) in horizontal position, then check the oil level.

WHEEL HUBS AND BRAKES



- Remove the ring (1), the reaction plate (2), the brake disc (3) and the reaction plate (4).
- Unscrew the screws (5) and remove the wheel carrier (6) and crown gear (7) by using the two extraction holes M12.
- Recover the two O-ring (12) on brake fluid inlet ports.
- Separate the wheel carrier from the crown gear and remove the centering bushes (8).
- Extract the wheel hub (9).
- Replace the O-ring (11).
- Check the brake disc (3) for deformation or burning traces; replace, if necessary.
- Check that the disc friction material thickness is not lower than 3.9 to 4.2 mm; replace, if necessary.
- Check the reaction plates (2) and (4) do not show any signs of excessive wear or grooves exceeding 0.20 mm.

WHEEL HUBS AND BRAKES

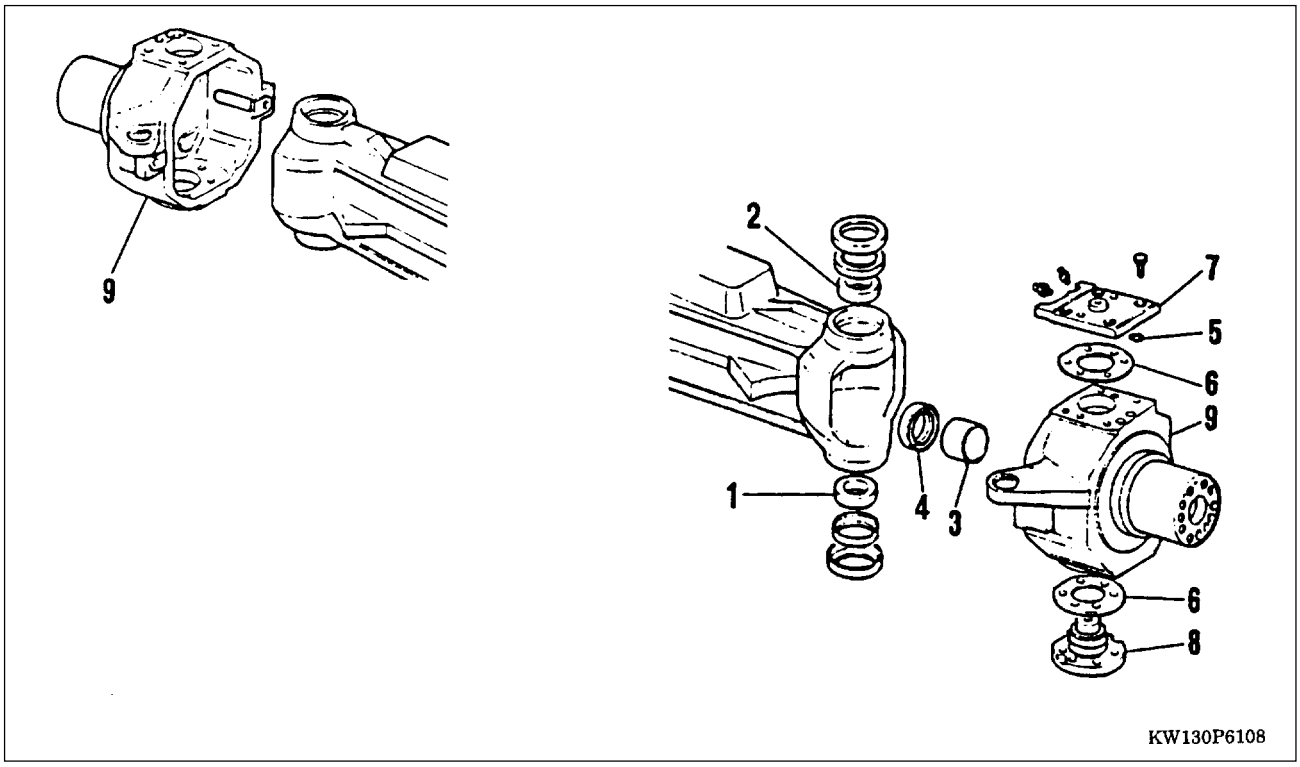


- The special arrangement "Set right" of bearings needs no pre-load or backlash specific rules. However, before reassembling the new spare parts, the following dimensions must be checked:

  A = 51.95 to 52.00
  B = 114.175 to 114.225
  C = 29.00 to 29.15
  D = 3.95 to 4.00

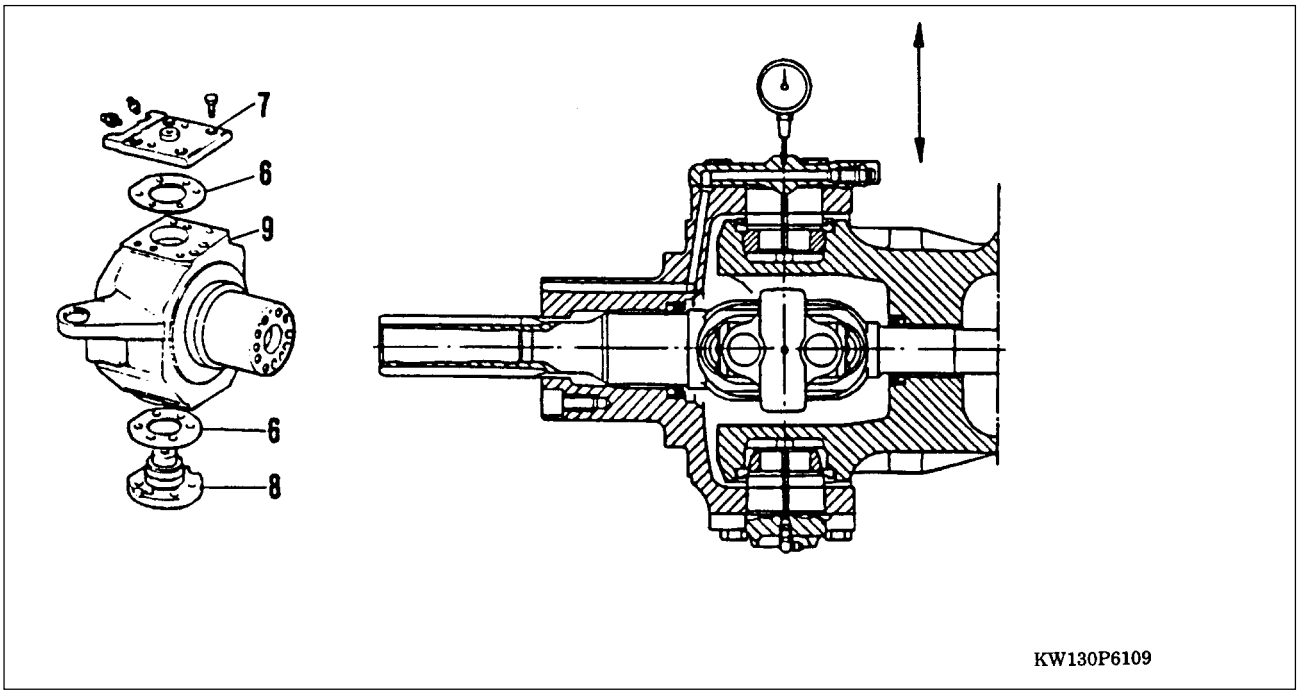
  Change the components out of tolerance.

SWIVEL HOUSING



- The pivot bearing (1) has to be assembled under the press for the race placed on the king pin and in cold conditions (as in azote bath) for the race placed on the axle.
- The top bush (2) must be cooled (as in azote bath) before mounting in the axle seat.
- Check the oil seal (4) conditions; if necessary, replace it. Lubricate it by using a right seal driver to avoid damaging it during the assembly.
- Check the O-ring (5) conditions; if necessary, replace it.
- Carry out the swivel pin bearing clearance record.

SWIVEL PIN BEARING CLEARANCE



The swivel pin bearings are set with 0.00 to 0.10 mm of clearance. Make this operation adding or subtracting shims (6) between king pins (7) and (8) and the swivel housing (9).

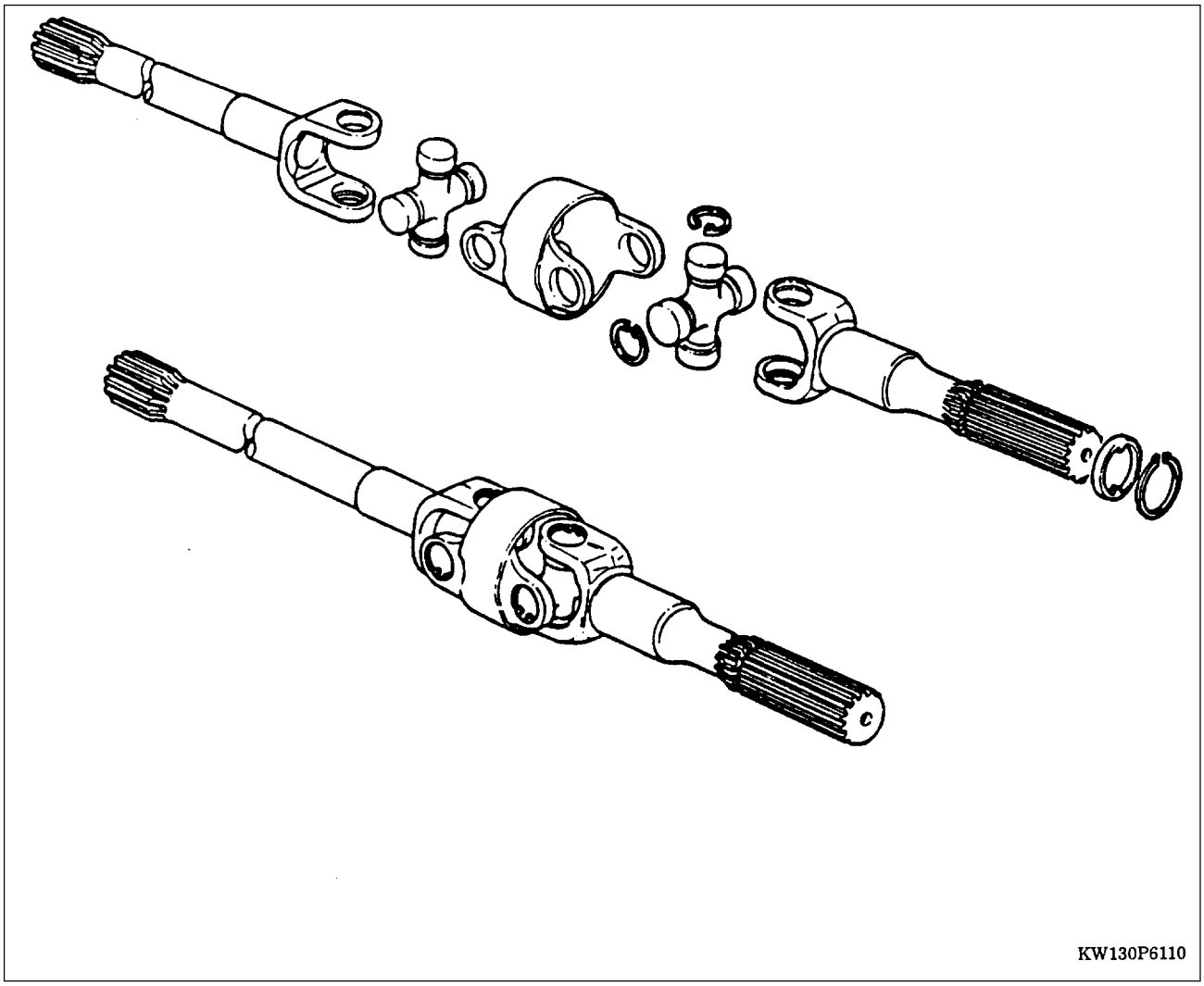
Do the following procedure:

- Install the bottom pin (8) with shims (for example 1.00 mm) and fix by relative screws.
- Without any shims, install the top pin/bearing assembly (7) and fix by relative screws.
- Install a dial gauge on the top cover and take note of the clearance between knuckle and cover.
- Operate with a lever between knuckle and axle beam (example of measure: 0.50 mm).
- Subtract from this value the clearance required for the bearings: 0.50 - (0.00 to 0.10) = 0.50 to 0.40 mm.
- Subtract this value from the employed shims (1.00 mm). Divide by 2 to obtain the shims to employ under each cover:

$$\frac{1.00-(0.50 \text{ to } 0.40)}{2} = 0.25 \text{ to } 0.30 \text{ mm.}$$

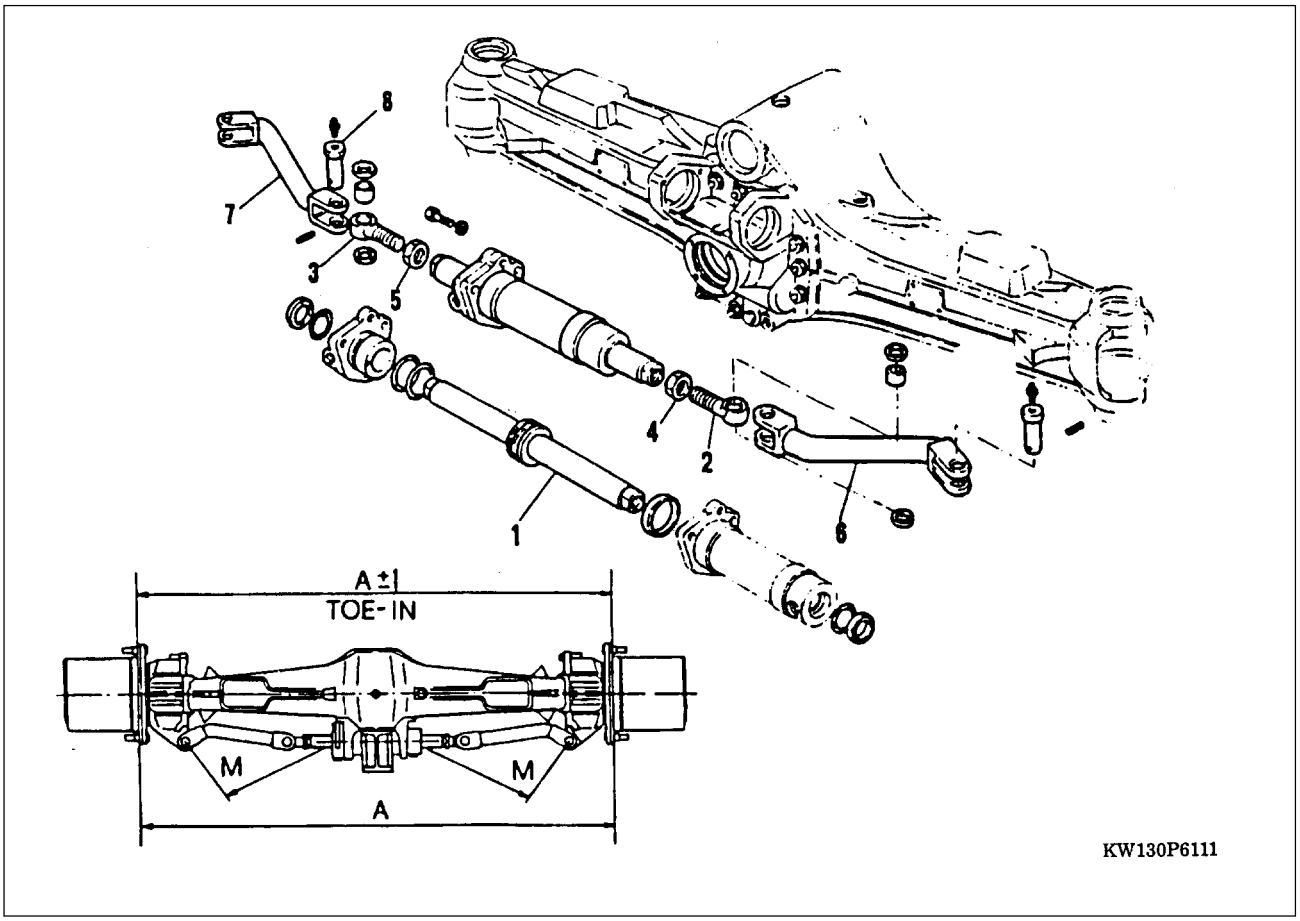
- Remove the covers and install under each of them the shims established before: 0.25 to 0.30 mm.
- Tighten the set screw.

DRIVE SHAFTS



- Inspect the splines on the drive shafts for wear or damage.
- Replace the spider if worn or damaged.

STEERING CYLINDER - TOE-IN



Steering cylinder

- Inspect the steering cylinder rod (1) and its piston for wear or damages.
- Inspect the ball joints assy (2) and (3) for wear or damages.
- If any leakage is evident, replace the steering cylinder seal kit.

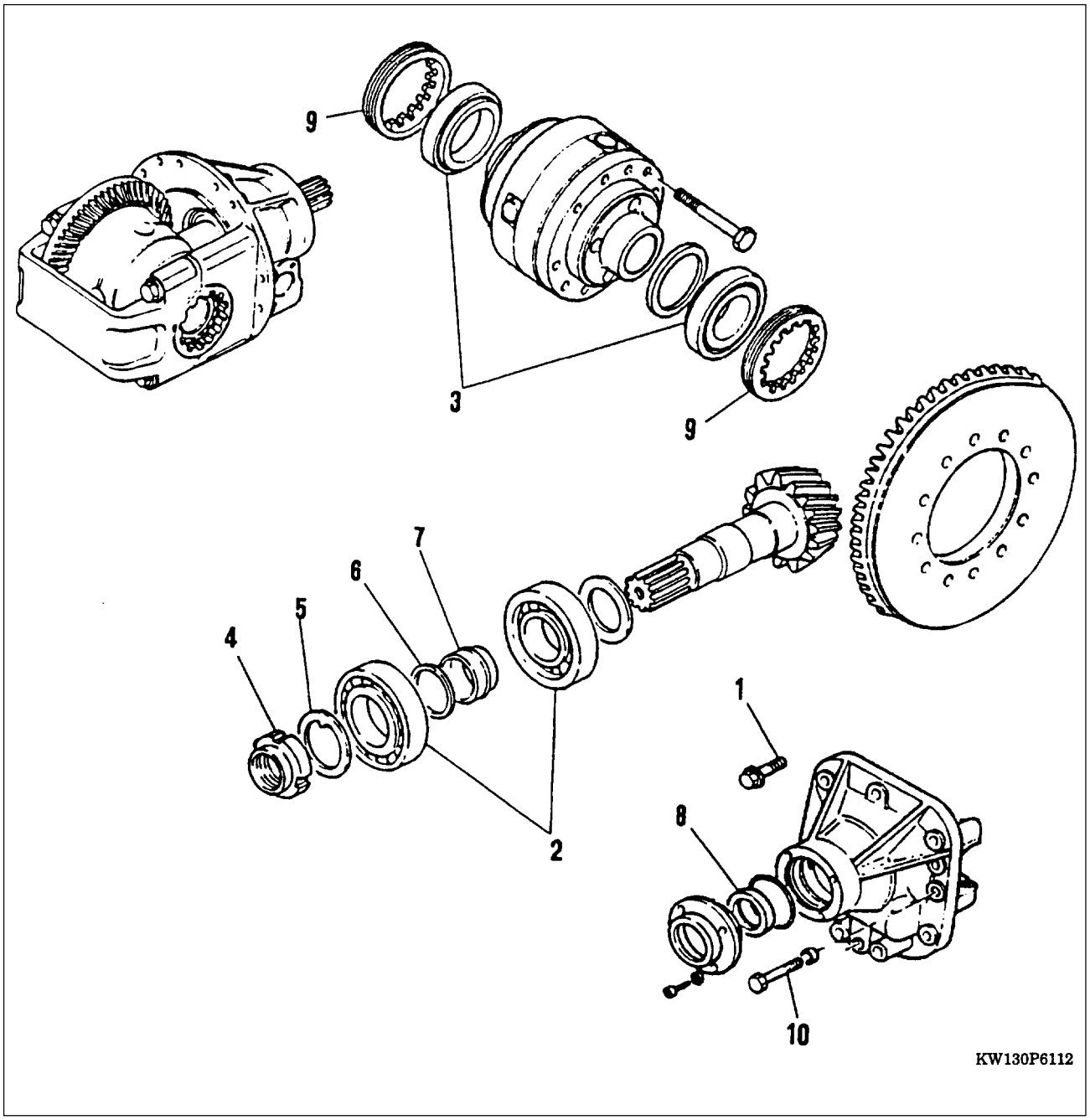
Toe-in

- The toe-in value has to be of +1 to -1 mm (measured on the hubs flange).

To adjust follow this procedure:

- Tighten the shafts threaded (2) and (3) onto the cylinder until approaching the final adjustment value.
- Then connect the shafts threaded (2) and (3) to the tie rods (6) and (7) by the corresponding pins (8).
- Carry out the final adjustment. Turn the cylinder by the relative end seats, until the adjustment is correct; you can dot it as the shafts (2) and (3) are threaded left and right hand.
- Check for the distance (M) is the same both sides.
- When the final adjustment is reached, lock the nuts (4) and (5) to 300 Nm.

BEVEL GEAR AND PINION SET

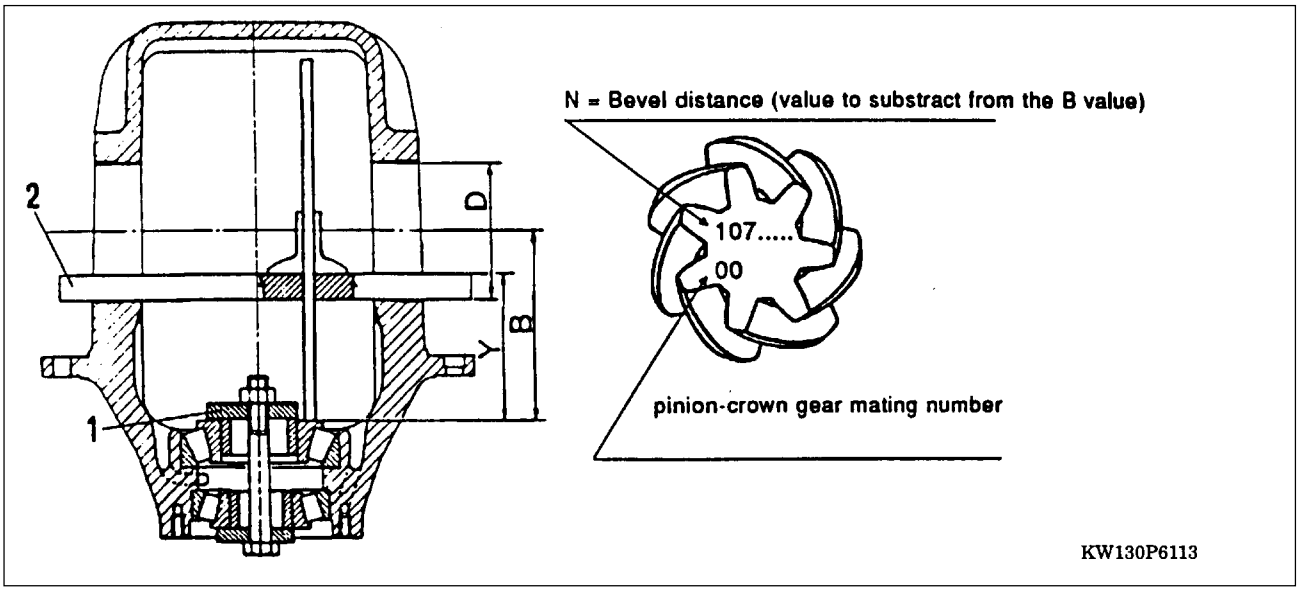


- Unscrew the screw (1) and the bolts (10) to disassemble the complete differential and to be able to work on bench.
- Check the conditions of the bevel pinion bearings (2) and of the differential bearings (3); replace them, if necessary.
- If you change the bevel gear and the pinion set, you have to replace the ring nut (4), the washers (5) and (6) and the collapsible spacer (7).
- Check the oil seal (8) conditions, best replace it. When reassembling, fill with grease the oil seal.

The operations to carry out on this group are the following ones:

PINION POSITIONING
PINION BEARINGS PRE-LOAD
PINION-CROWN TEETH BACKLASH
DIFFERENTIAL BEARINGS PRE-LOAD
ADJUSTMENT PLANGE ON PINION

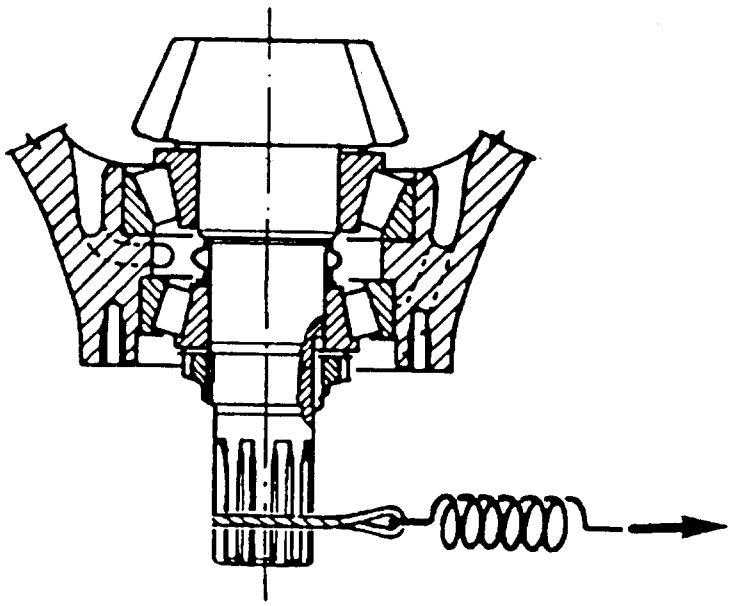
PINION POSITIONING



Bevel distance

- Install the pinion bearings in their seat in the differential end plate and put them in contact using the tool (1); it must be possible to turn the conical bearings by hand, never close tight.
- Assemble the central gear half-cover and fasten it with relative screws.
- With the aid of an internal micrometer measure the diameter (D), bearing seat.
- Put a calibrated rod (2) into the central gear bearing seat and, by using a depth gauge, measure level (Y).
- Carry out the following operation: B = Y - 25 (calibrated rod diameter) + D/2.
- In order to determinate the thickness to be inserted between the pinion and the bearing, simply subtract from the (B) value the one stamped on the pinion head.
- Create this thickness by using the range of the rings on hand, and inserting them in the pinion shaft.
- Insert the bearing in the pinion shaft, and ensure that it is completely seated.

PINION BEARINGS PRE-LOAD



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- The bearing pre-load must be 84 to 126 N, measured on the queue of the pinion outer diameter.
- Tighten progressively the ring nut until the established pre-load value results.
- To control the pre-load, use a dynamometer with the rope twist on the pinion queue.
- When the roating torque is a specified, peen the edge of the ring nut to lock the nut to the shaft (avoid use of sharp punches or chisels).

BEVEL PINION-GEAR TEETH BACKLASH

The backlash has to be 0.21 to 0.28 mm. The adjustment is carried out operating on the side adjustment ring nuts. The ring nuts, pressing on the bearings, bring the crown towards or away from the pinion.

Operate in the following manner:

- Turn the ring nut, crown side, clockwise till getting contact between the crown and the pinion; at the same time use a plastic hammer in order to settle the bearing.
- Turn the other ring nut clockwise, and at the same time use a plastic hammer in order to eliminate any bearing backlash. You can get such a condition when the ring nut rotation becomes difficult.
- Position the dial gauge so that the probe is in contact with it, and at 90° to a tooth of the pinion.
- Measure the backlash between pinion and bevel gear.
- Repeat the operation on two or more points (teeth) turning the pinion and remarking the backlash value.
- If the amount of backlash is different, put the probe on the tooth that has the smallest backlash.
- Bring the crown towards or away the pinion turning each ring nut in the same way, until the specified backlash is achieved.

DIFFERENTIAL BEARINGS PRE-LOAD

To carry out the adjustment operate as follows:

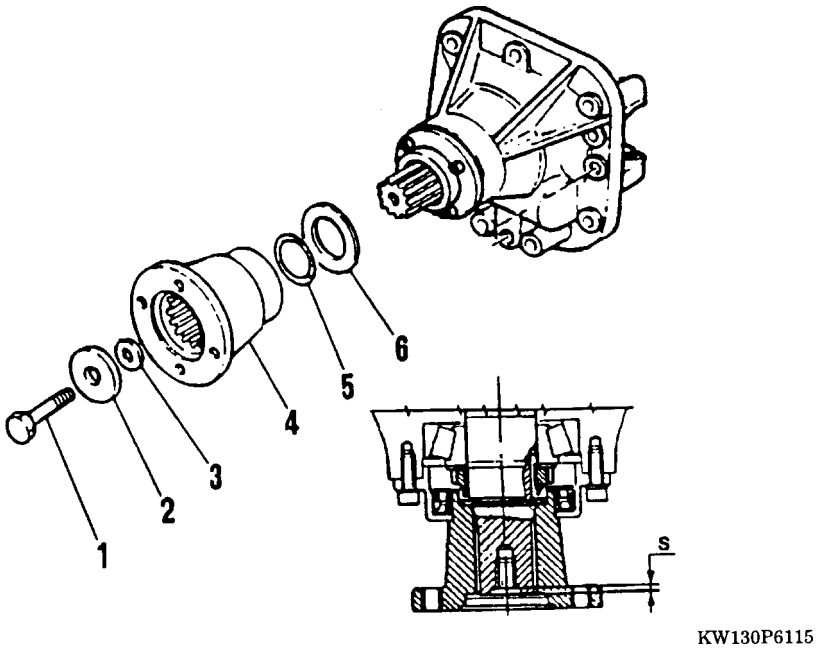
- With the crown engaged to the pinion, and having obtained the correct backlash between pinion and bevel gear, turn the pinion by using a dynamometer with the string wrapped around the queue of the pinion itself. Measure the value of the stress necessary to rotate both the pinion and the differential simultaneously.
- Turn each ring nut to the same extent (tighten or loosen) in order to maintain the same backlash value.

The total pre-load (T) of the bearings (pinion + differential) measured on the queue of the pinion must be the following:

T = (P+29) to (P+44) N

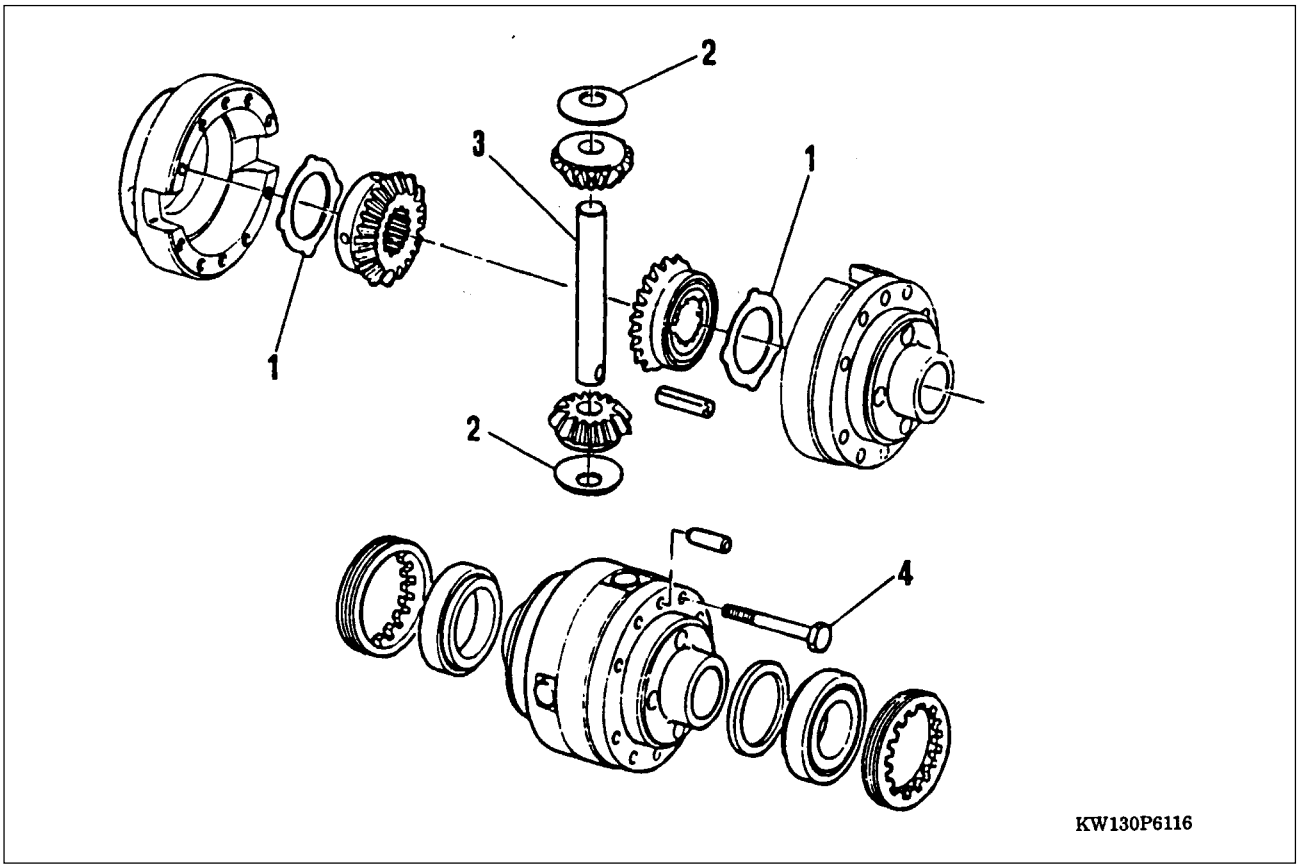
where P is the actual pre-load measured on the pinion.

ADJUSTMENT OF THE FLANGE ON THE PINION



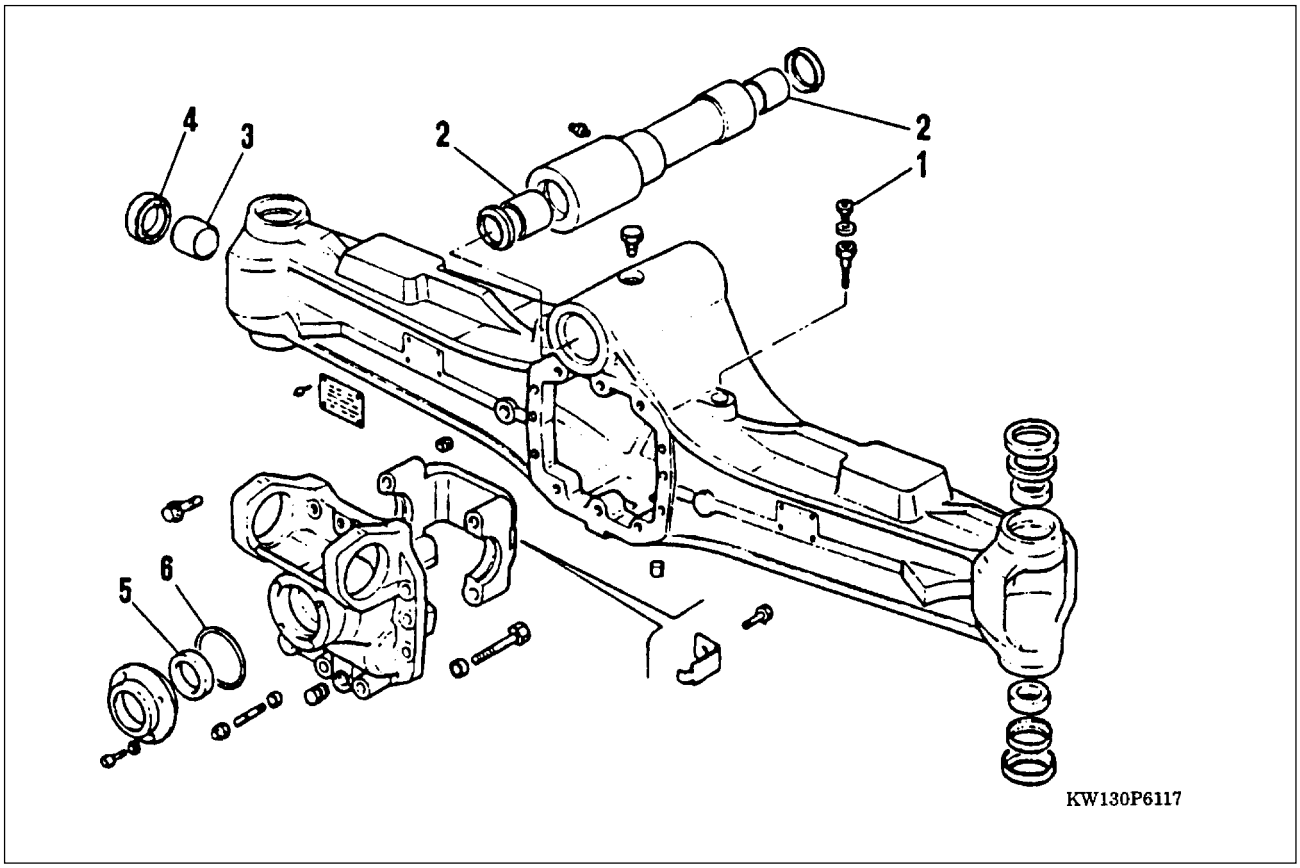
- The motion input flange (4) should be mounted with some adjusting shims (3) between washer (2) and bevel pinion in order to ensure a correct assembling.
- In order to measure the dimension (S) of the shims to be used, it is necessary to mount the washer (6) without O-ring (5), and then the flange (4).
- Measure dimension (S) by using a gauge.
- Remove flange (4), remount O-ring (5) and flange (4).
- Interpose the shims (3) whose size has been previously determined.
- Apply loctite 510 between washer (2) and pinion.
- Tighten screw (1) at 139 Nm.

DIFFERENTIAL

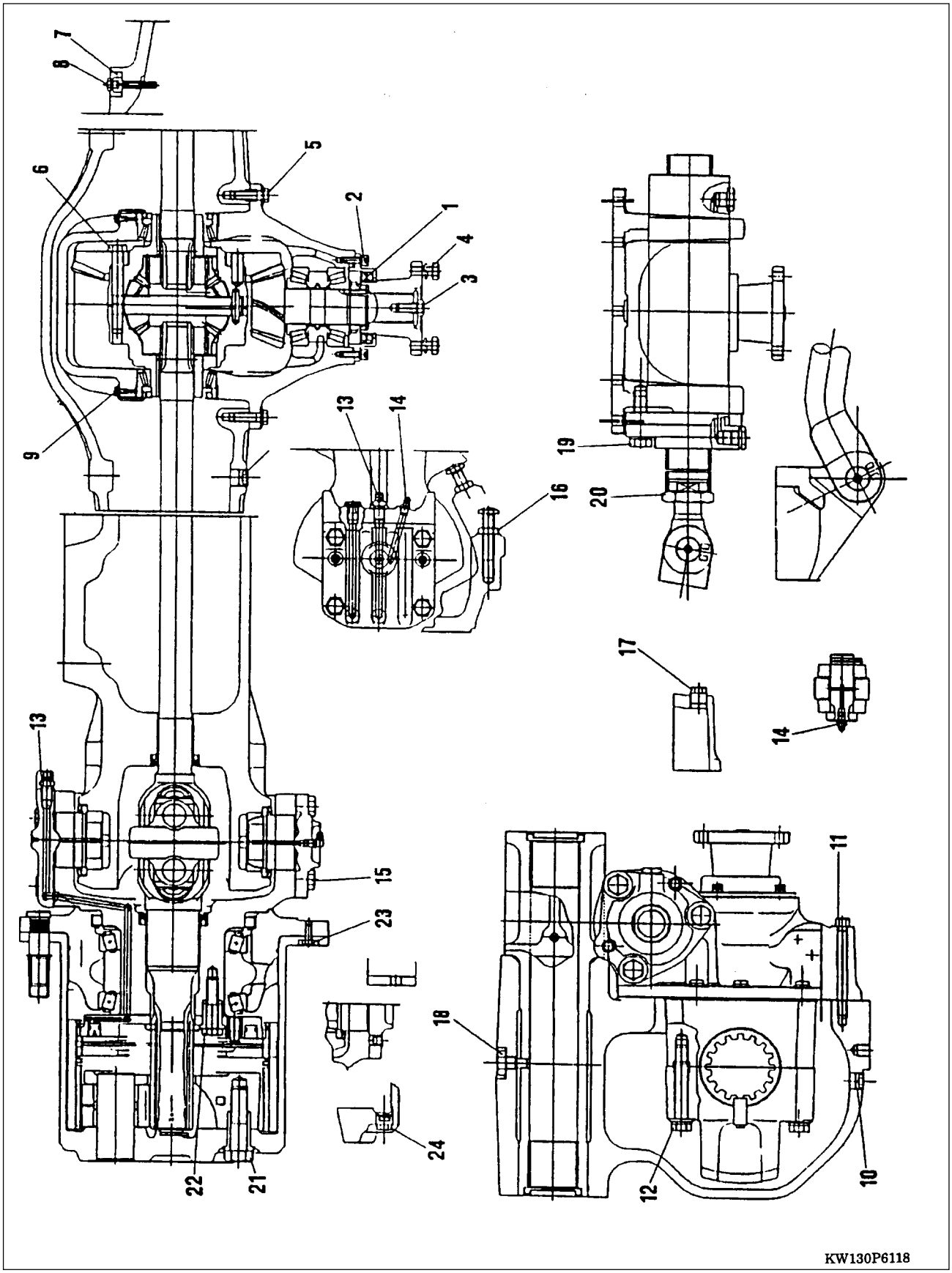


- Check the condition of thrust washer (1) and (2).
- Also check the condition of all other components, particularly of pin (3).
- During reassembly, it is suggested to replace the screws (4) which fasten the bevel gear to the differential case.

AXLE BEAM



- Check the condition of the oil breather (1), clean and replace as necessary.
- Check the condition of the bushes (2) on the center pivot for wear or damage; replace, if necessary.
- Inspect the drive shaft bushing (3) for wear and damages; replace, if necessary.
- Replace the oil seal (4).
- It is suggested to replace oil seal (5) on pinion cover and O-ring (6) between axle housing and differential support.
- Apply Loctite 510 between axle housing and differential end plate.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		Thread	Nm
1	Ring nut - bevel pinion	M45x1.5	pre-load
2	Bolt - bevel pinion cover	M8x25	27
3	Bolt - input flange to bevel pinion	M12x1.25	139
4	Bolt - input flange	M12x1.25	-
5	Bolt - differential support to axle housing	M12x33	150
6	Bolt - crown wheel to differential carrier (use loctite 270)	M14x2	190
7	Breather support	-	15
8	Breather plug	M10x1	5
9	Bolt - ring nut locking plate	M6x1x10	13
10	Oil drain and filling plug	M22x1.5	60
11	Bolts - differential support to axle housing	M12	80
12	Bolt - differential support half-tie	M16x95	413
13	Brake fluid breather plug	-	12 to 16
14	Greaser	M10x1	10
15	Bolt - pivot support	M14x35	190
16	Lock nut for steering-stop screw	M14	100
17	Oil plug	-	60
18	Screw - pivot shaft lock	M16x2	156
19	Screw - steering cylinder	M16x55	240
20	Steering rod lock nuts: - R.H. thread	M36x1.5	300
	- L.H. thread	M36x1.5	300
21	Bolts - planetary gear carrier	M20x80	530
22	Bolts - crown gear carrier to wheel hub	M14x1.5	220
23	Bolts - planetary carrier to wheel shaft	M8x20	23
24	Oil filling level plug	-	60

REAR AXLE

DISASSEMBLING, SETTING OPERATIONS AND REASSEMBLING

FOREWARD

Oil seals for rotating shafts

For correct installation of oil seals adhere to the following recommendations:

- Before installation soak the seal for half an hour in the same oil that will be used in the axle to be sealed.
- Clean the shaft and ensure the seal area of the same is not damaged, fitted or grooved.
- Place the sealing lips towards the oil side.
- Lubricate the seal lip (oil is better than grease) and fill with grease the space between oil lip and dust lip of dual lip seals.
- Install the oil seal using a suitable seal driver. Avoid hammering directly on the seal.
- To avoid damages to the seal lip caused by the shaft: adequately protect the same during shaft assembly procedure.

O-ring

Ensure adequate lubrication of these seals before inserting them in their seats to avoid twisting during shaft assembly.

Shims

For each adjustment select the correct shims by individual measurements.
Do not trust pack measurement or the thickness indicated on the shim.

Bearings

For a correct assembly it is suggested to warm them in a furnace from 80oC to 90oC before installation in their respective shafts or to cool them before inserting in their respective seats with outer housing.

Elastic plugs

During the plug assembly and with turbo off, ensure that their notch has oriented towards the stress which is subjecting the thrust.

On the contrary, the spiral elastic plugs need no assembly orientation.

Sealing compound

Use LOCTITE 510 or types following the specifications. Ensure that both sides to be sealed are clean, dry and totally free from grease and oil.

Disassembling - Reassembling

The overhauling of epicycloidal group and wheel hubs can be completed without removing the axle from the vehicle.

Oil drain

Before intervening on axle you have to drain oil from the final drives, from the central gear and from the reduction gear (refer to page 71).

Warning: The exhaust oil disposal must be carried out according to the laws in force.

Removal and Installation of the axle

In order to remove the axle, support adequately the vehicle to get a certain safety.

Unscrew the fastening nuts and remove the wheels from the hubs.

Disconnect the controlling brakes piping, then install some protection plugs.

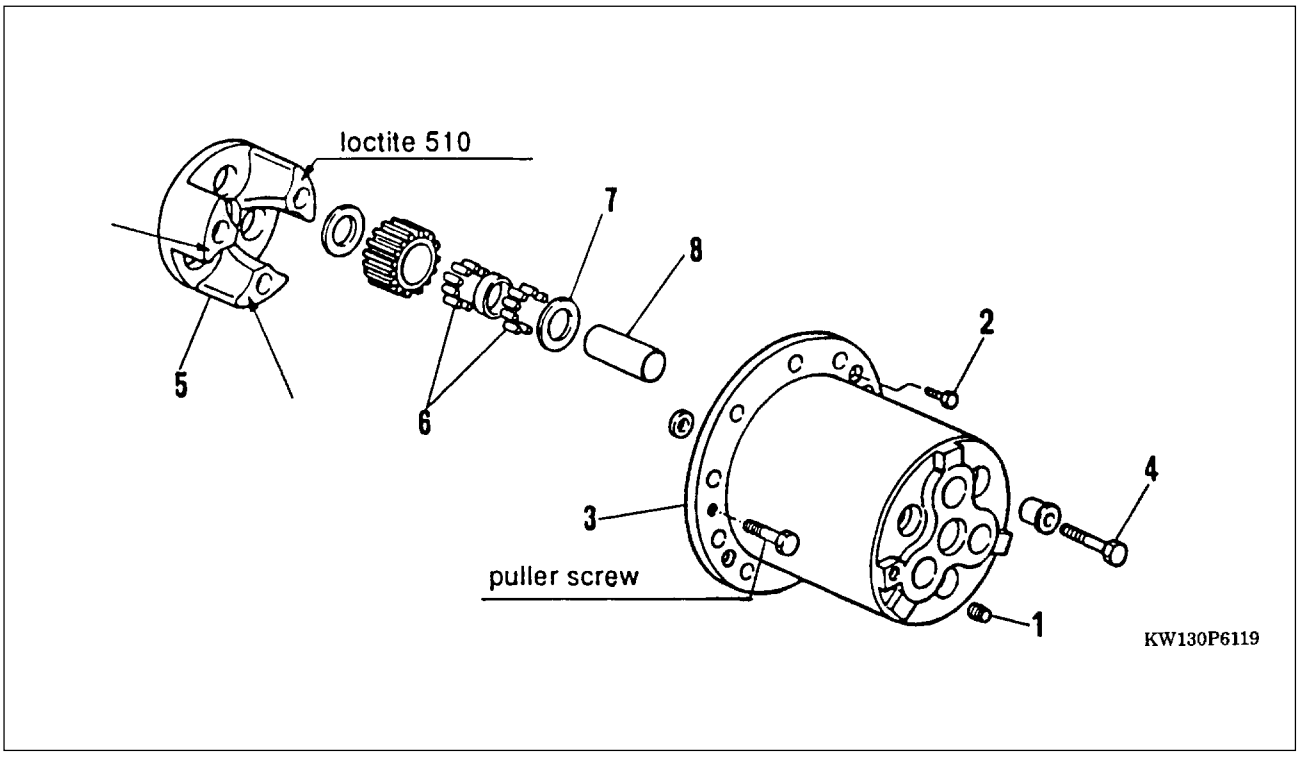
Loose all the remaining connections between frame and axle, then separate the axle from the frame structure.

Installing the axle reverse the order; check for eventual leakage of oil.

Check the oil level and, if necessary, re-fill.

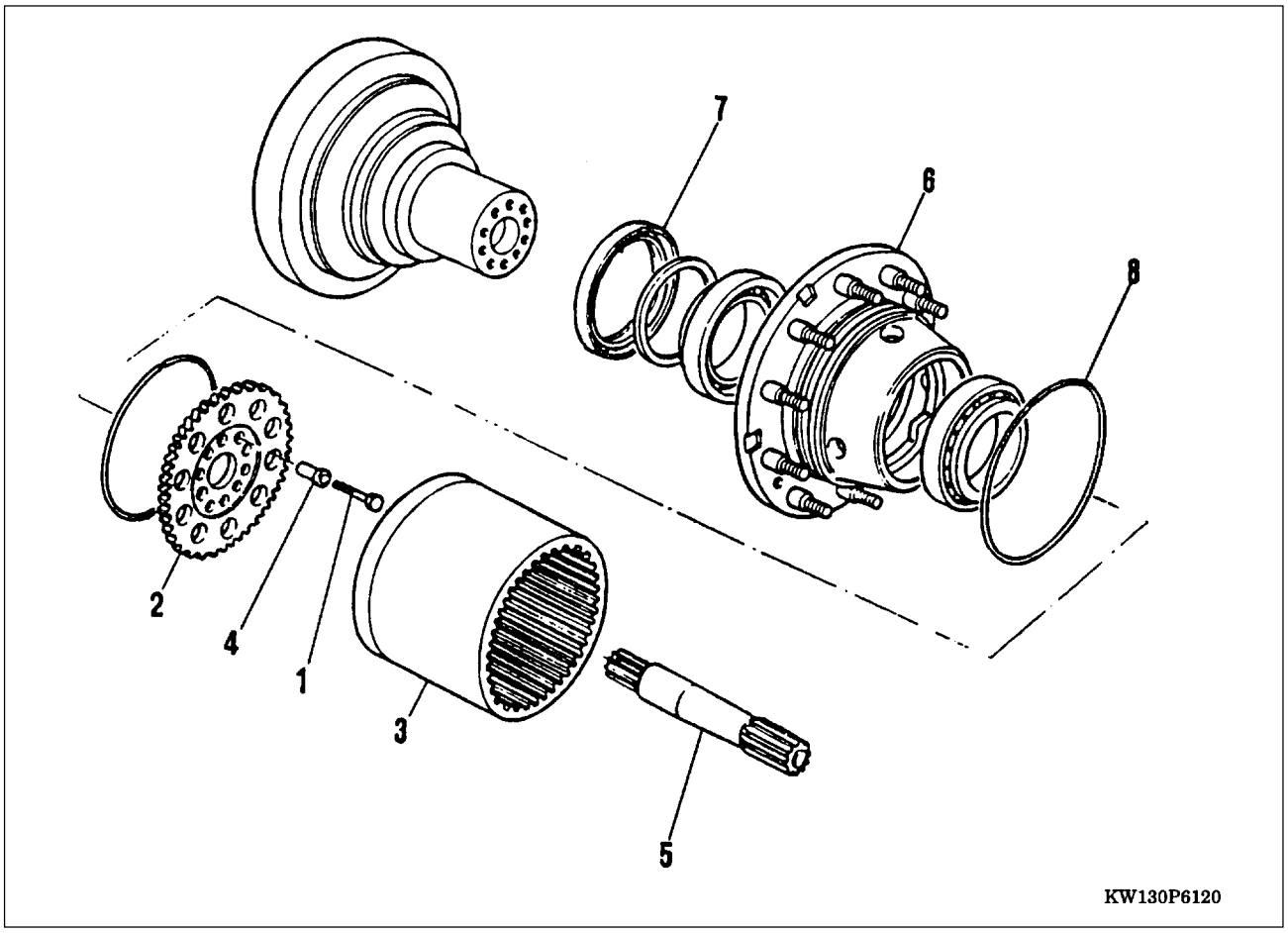
Carry out the braking system bleeding.

FINAL DRIVES

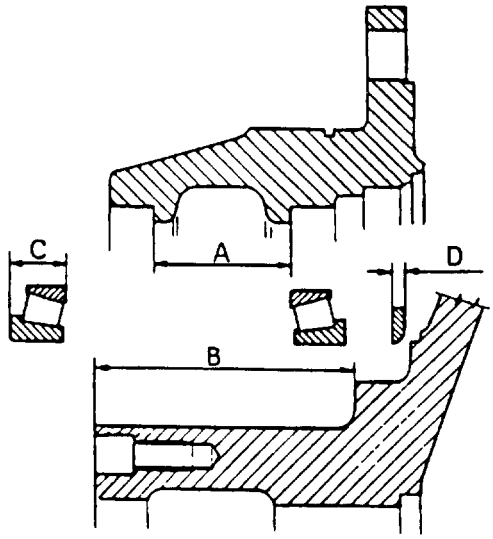


- Unscrew the screws (2) of the carrier assy (3).
- Remove the planetary carrier from the wheel hub, using a puller two screws and operating on the extraction holes.
- Partially unscrew the screws (4) and knock with a plastic hammer to separate the planetary carrier (5). Then remove the screws. When reassembling, clean and degrease the planetary carrier (5) union surface to the carrier assy (3) and use Loctite 510.
- Check the condition of the needle bearing (6) and washers (7). Replace, if necessary.
- Check the planetary pin (8) conditions. As they are forced on the planetary carrier (3), replace the whole planetary carrier if damaged. When reassembling, if necessary, use some grease to hold in position the needle bearing.
- Turn the wheel hub and position the plug (1) to the upper point. Fill it with specified oil.
- Turn the wheel hub setting the plug (1) in horizontal position, then check the oil level.

WHEEL HUBS



- Remove the half shaft (5).
- Unscrew the screw (1) and remove the wheel carrier (2) and crown gear (3) by using the two extraction holes M12.
- Separate the wheel carrier from the crown gear and remove the centering bushes (4).
- Extract the wheel hubs (6).
- Check the condition of the cassette seal (7) on the wheel hub; replace it, if necessary. Lubricate it an use a correct seal driver to avoid damaging it during the assembling.
- Check the conditions of the splines on the half shaft (5).
- Replace the O-ring (8).



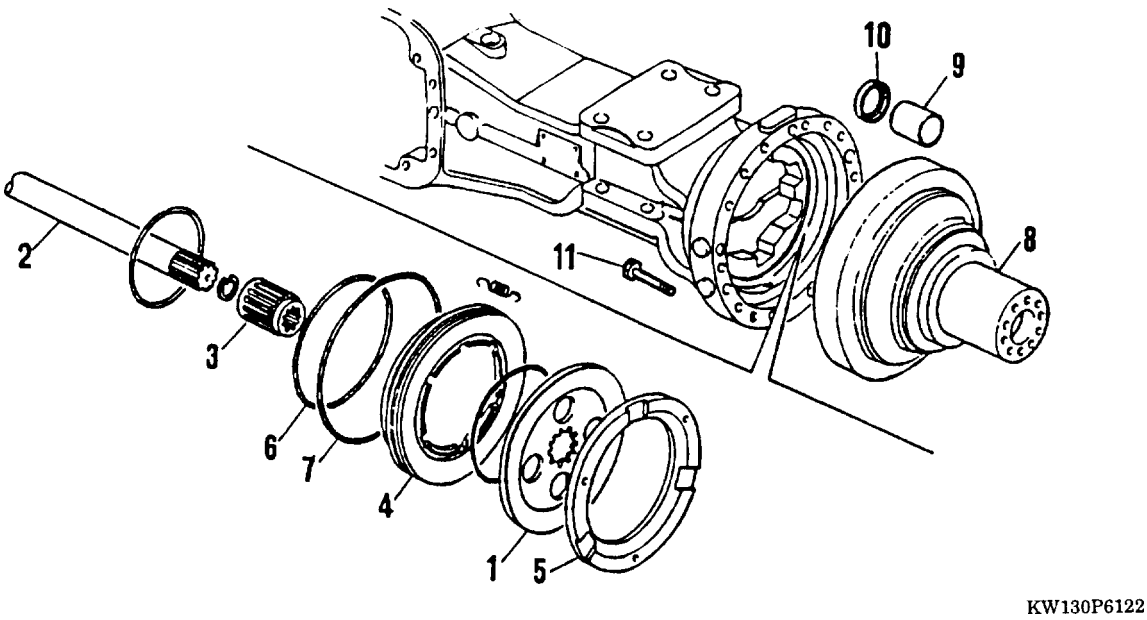
KW130P6121

- The special arrangement "Set right" of bearing needs no pre-load or backlash specific rules. However, before reassembling the new spare parts, the following dimensions must be checked:

  A = 68.95 to 69.00
  B = 132.175 to 132.225
  C = 29.00 to 29.15
  D = 4.95 to 5.00

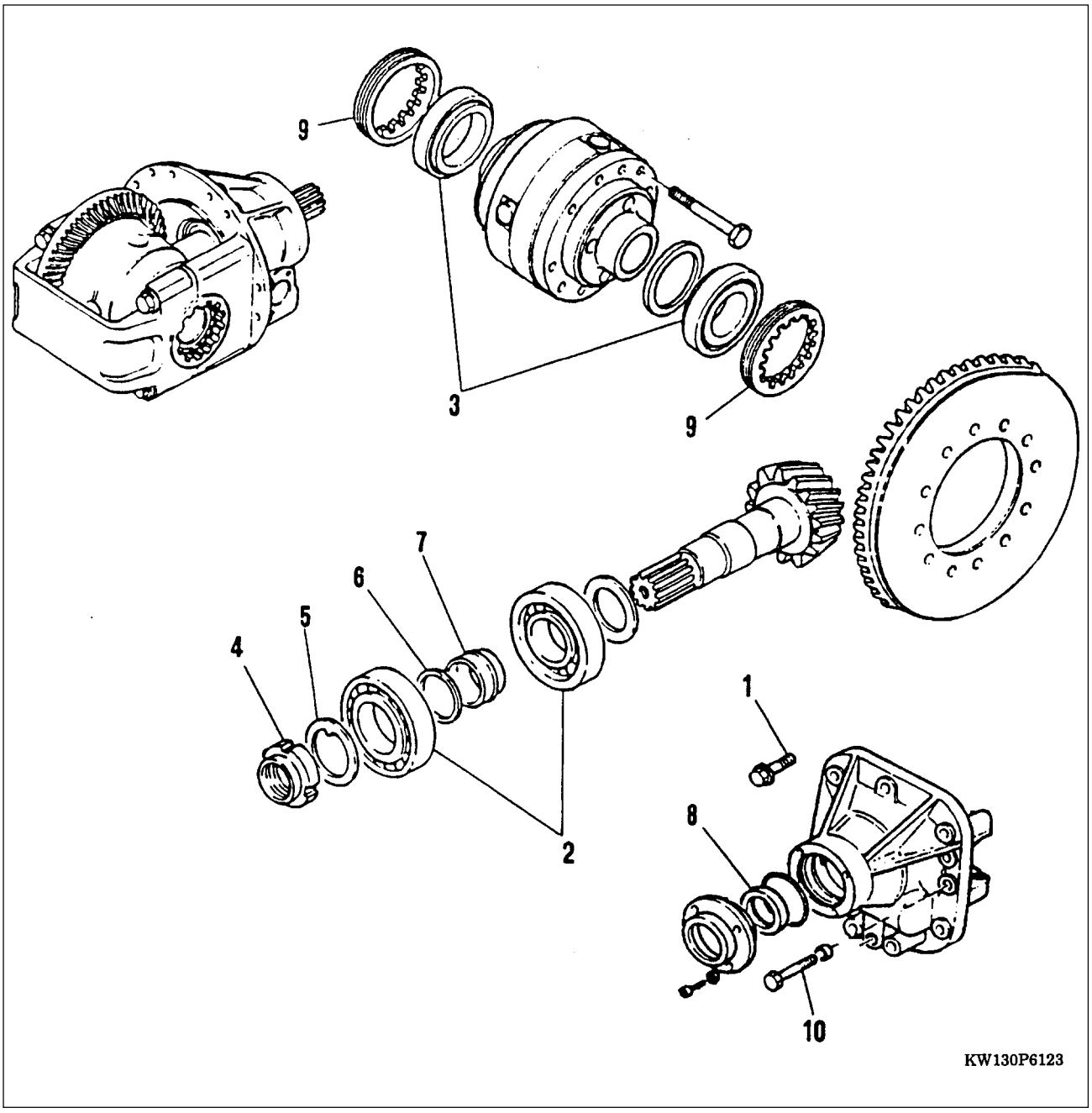
  Change the components out of tolerance.

BRAKES



- Unscrew the bolts (11) and remove the wheel shaft (8).
- Check the oil seal (10) conditions; replace, if necessary. Lubricate and use a correct seal driver to avoid damaging during the assembling.
- Check the bush (9) conditions; replace, if necessary.
- Check the brake disc (1) for deformation or burning traces; replace if necessary.
- Check that the disc friction material thickness is not lower than 7.9 to 8.3 mm; replace, if necessary.
- Check the splines conditions on the side shaft (2) and on the sleeve (3).
- Check the brake piston (4) and the reaction plate (5) do not show any signs of excessive wear or grooves exceeding 0.20 mm.
- Replace the quadrings (6) and (7).

BEVEL GEAR AND PINION SET

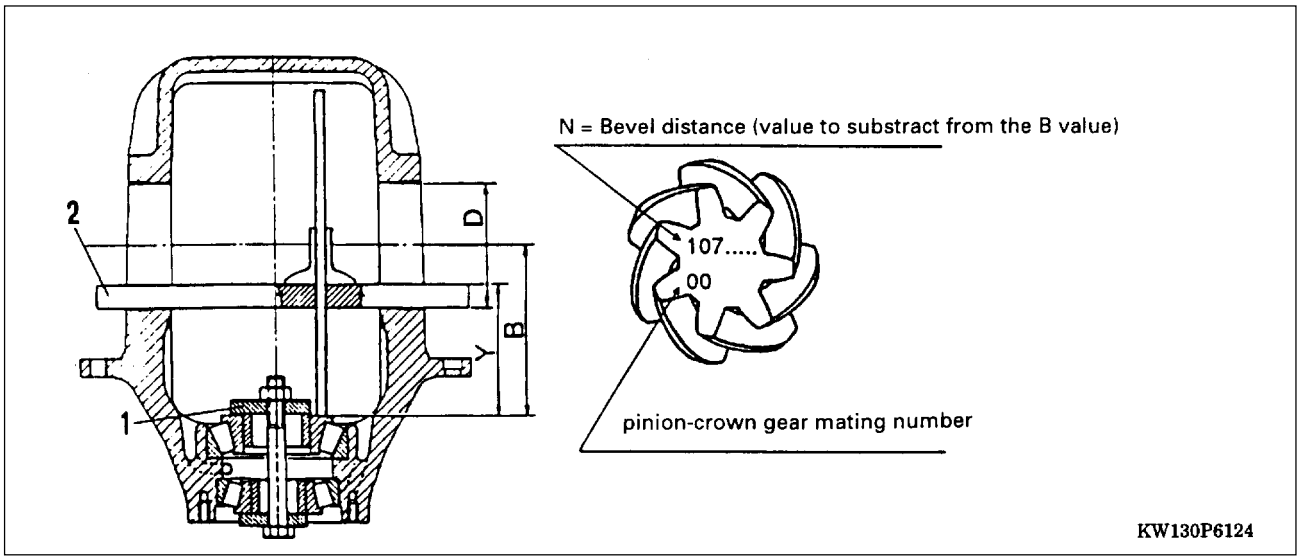


- Unscrew the screw (1) and the bolts (10) to disassemble the complete differential and be able to work on bench.
- Check the conditions of the bevel pinion bearings (2) and of the differential bearings (3); replace them, if necessary.
- If you change the bevel gear and the pinion set, you have to replace the ring nut (4), the washers (5) and (6) and the collapsible spacer (7).
- Check the oil seal (8) conditions, best replace it. When reassembling, fill with grease the oil seal.

The operations to carry out on this group are the following ones:

PINION POSITIONING
PINION BEARINGS PRE-LOAD
PINION-CROWN TEETH BACKLASH
DIFFERENTIAL BEARINGS PRE-LOAD
ADJUSMENT FLANGE ON PINION

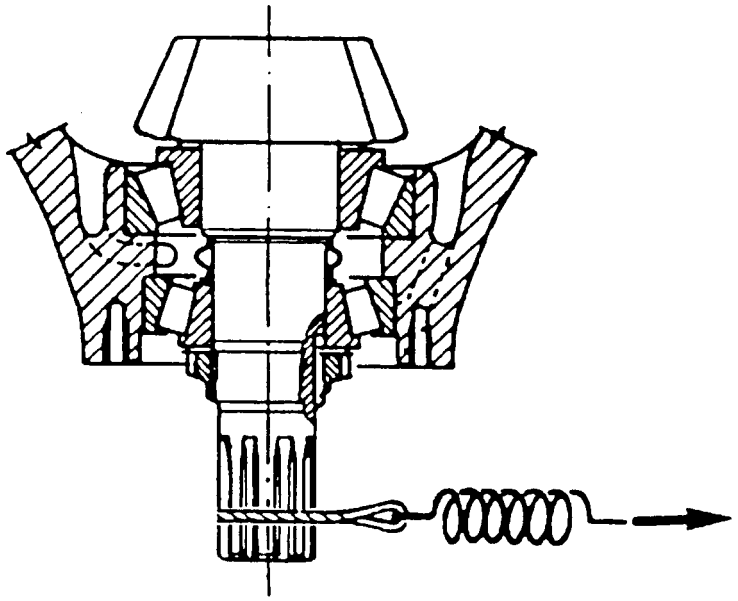
PINION POSITIONING



Bevel distance

- Install the pinion bearings in their seat in the differential end plate and put them in contact using the tool (1); it must be possible to turn the conical bearings by hand, never close tight.
- Assemble the central gear half-cover and fasten it with relative screws.
- With the aid of an internal micrometer measure the diameter (D), bearing seat.
- Put a calibrated rod (2) into the central gear bearing seat and, by using a depth gauge, measure level (Y).
- Carry out the following operation: B = Y - 25 (calibrated rod diameter) + D/2.
- In order to determinate the thickness to be inserted between the pinion and the bearing, simply subtract from the (B) value the one stamped on the pinion head.
- Create this thickness by using the range of the rings on hand, and inserting them in the pinion shaft.
- Insert the bearing in the pinion shaft, and ensure that it is completely seated.

PINION BEARING PRE-LOAD



KW130P6125

- The bearing pre-load must be 84 to 126 N, measured on the queue of the pinion outer diameter.
- Tighten progressively the ring nut until the established pre-load value results.
- To control the pre-load, use a dynamometer with the rope twist on the pinion queue.
- When the roating torque is a specified, peen the edge of the ring nut to lock the nut to the shaft (avoid use of sharp punches or chisels).

BEVEL PINION-GEAR TEETH BACKLASH

The backlash has to be 0.21 to 0.28 mm. The adjustment is carried out operating on the side adjustment ring nuts. The ring nuts, pressing on the bearings, bring the crown towards or away from the pinion.

Operate in the following manner:

- Turn the ring nut, crown side, clockwise till getting contact between the crown and the pinion; at the same time use a plastic hammer in order to settle the bearing.
- Turn the other ring nut clockwise, and at the same time use a plastic hammer in order to eliminate any bearing backlash. You can get such a condition when the ring nut rotation becomes difficult.
- Position the dial gauge so that the probe is in contact with it, and at 90o to a tooth of the pinion.
- Measure the backlash between pinion and bevel gear.
- Repeat the operation on two or more points (teeth) turning the pinion and remarking the backlash value.
- If the amount of backlash is different, put the probe on the tooth that has the smallest backlash.
- Bring the crown towards or away the pinion turning each ring nut in the same way, until the specified backlash is achieved.

DIFFERENTIAL BEARINGS PRE-LOAD

To carry out the adjustment operate as follows:

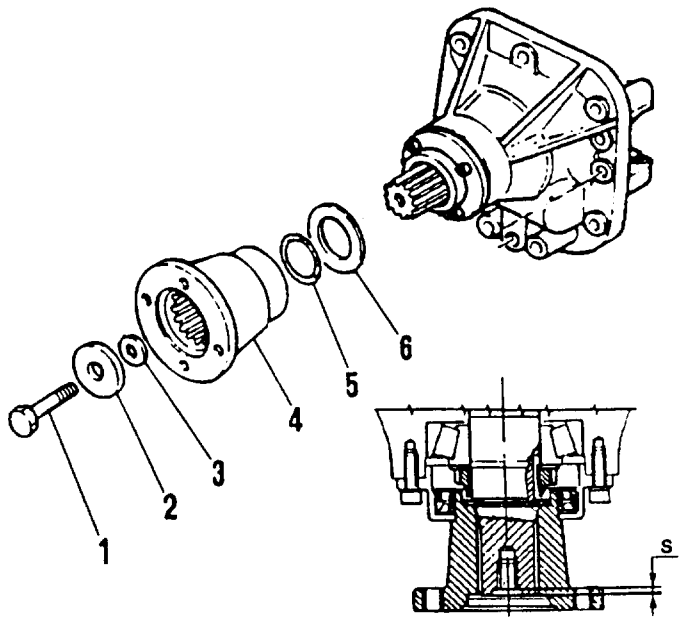
- With the crown engaged to the pinion, and having obtained the correct backlash between pinion and bevel gear, turn the pinion by using a dynamometer with the string wrapped around the queue of the pinion itself. Measure the value of the stress necessary to rotate both the pinion and the differential simultaneously.
- Turn each ring nut to the same extent (tighten or loosen) in order to maintain the same backlash value.

The total pre-load (T) of the bearings (pinion + differential) measured on the queue of the pinion must be the following:

T = (P+29) to (P+44) N

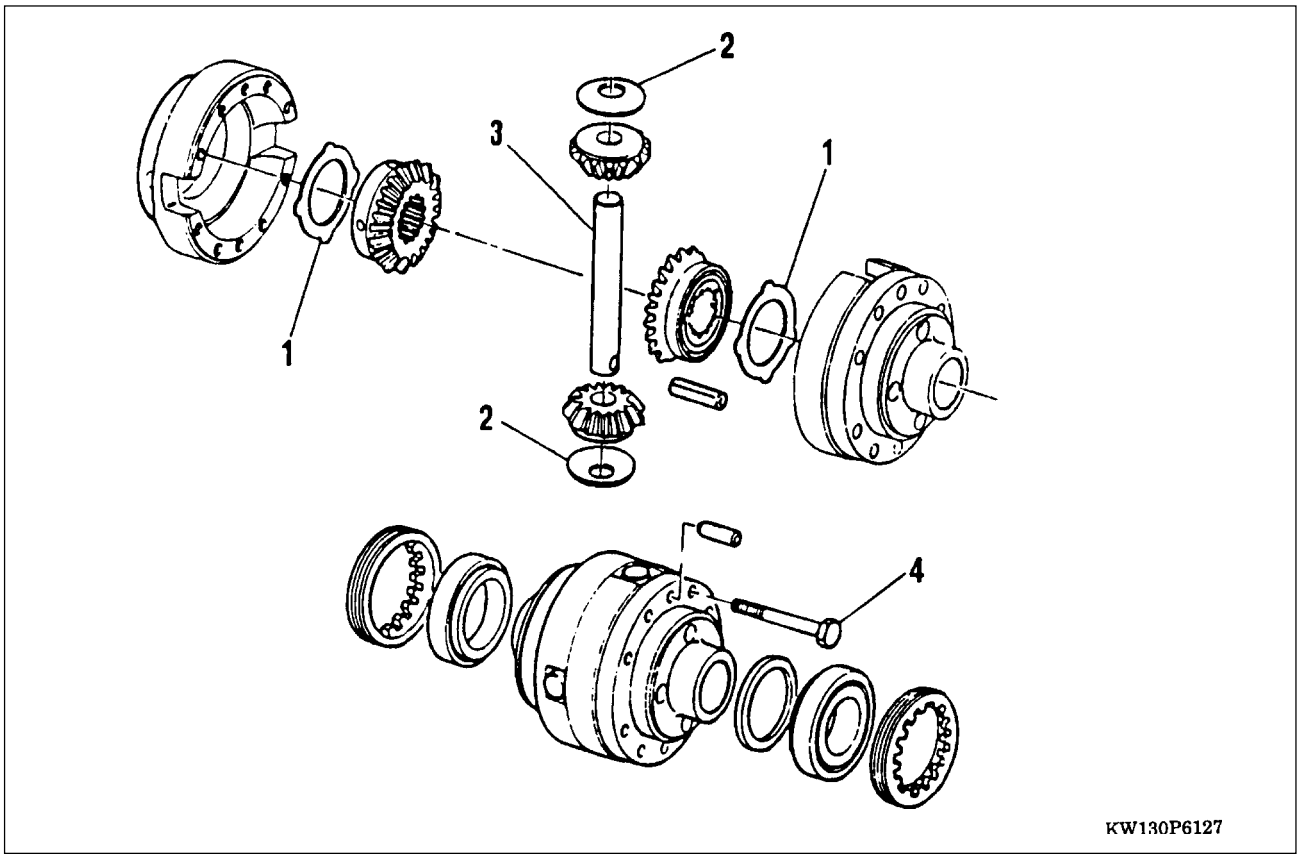
where P is the actual pre-load measured on the pinion.

ADJUSTMENT OF THE FLANGE ON THE PINION



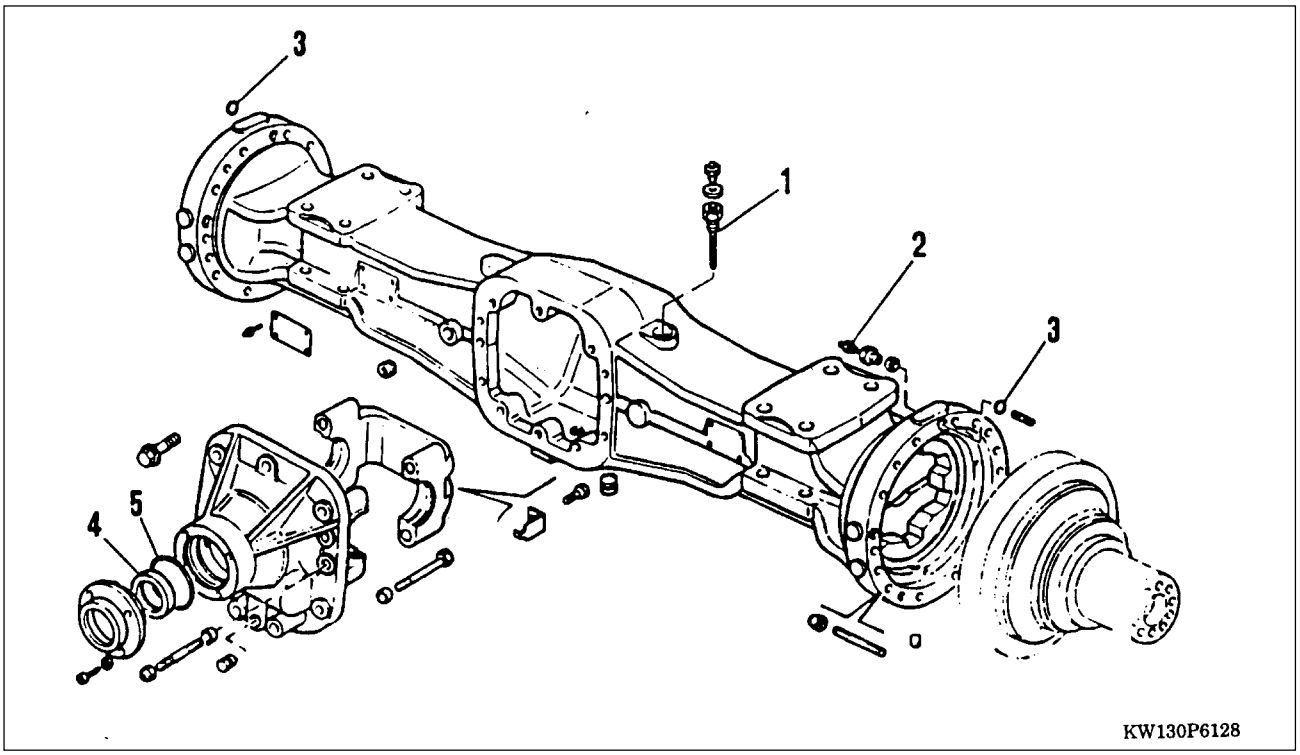
- The motion input flange (4) should be mounted with some adjusting shims (3) between washer (2) and bevel pinion in order to ensure a correct assembling.
- In order to measure the dimension (S) of the shims to be used, it is necessary to mount the washer (6) without O-ring (5), and then the flange (4).
- Measure dimension (S) by using a gauge.
- Remove flange (4), remount O-ring (5) and flange (4).
- Interpose the shims (3) whose size has been previously determined.
- Apply loctite 510 between washer (2) and pinion.
- Tighten screw (1) at 139 Nm.

DIFFERENTIAL

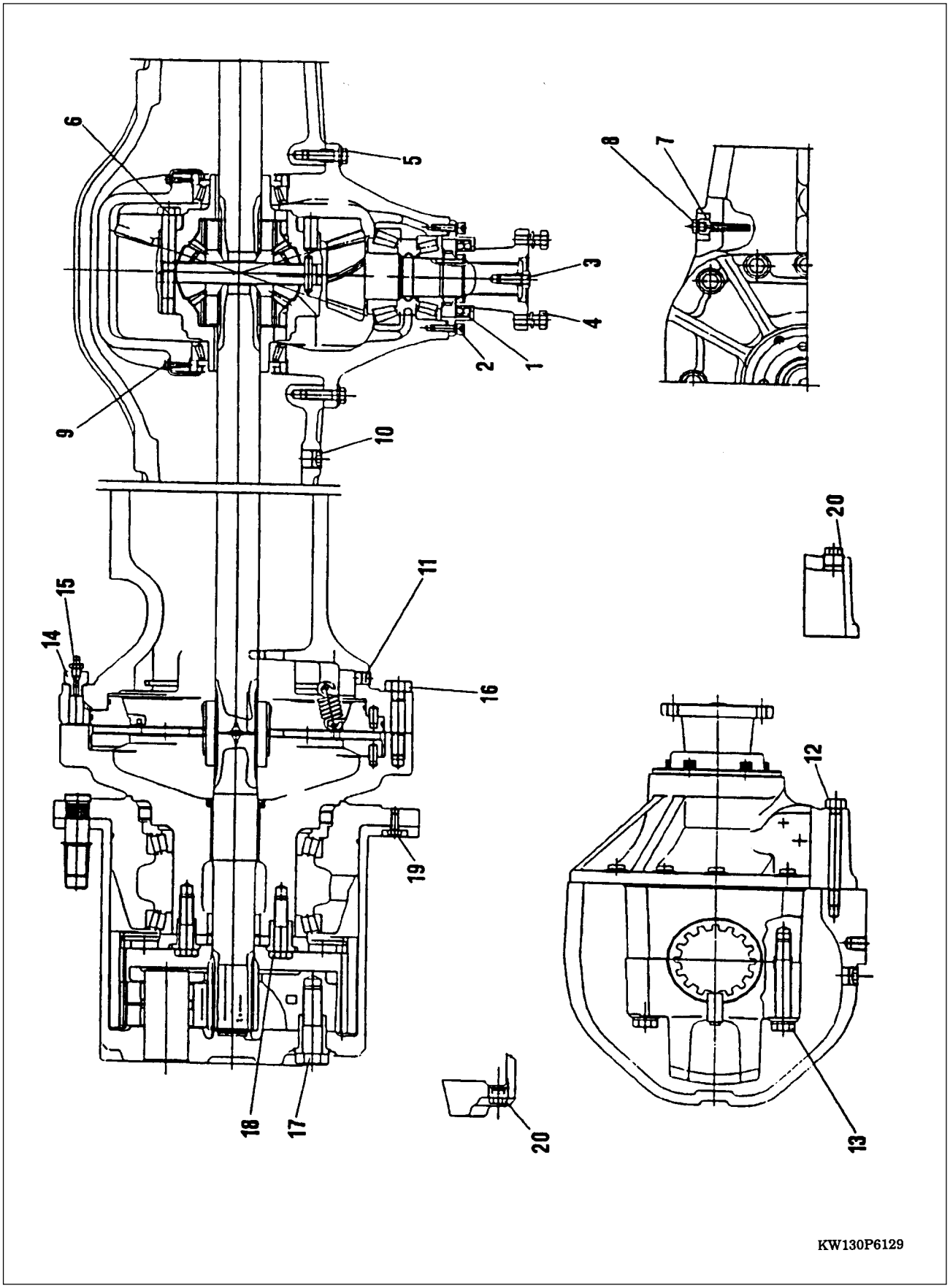


- Check the condition of thrust washers (1) and (2).
- Also check the condition of all other components, particularly of pin (3).
- During reassembly, it is suggested to replace the screws (4) which fasten the bevel gear to the differential case.

AXLE BEAM



- Check the condition of the oil breather (1), clean and replace as necessary.
- Check the condition of the brake fluid bleeding valves (2); replace as necessary.
- Replace O-ring (3) between beam and wheel hub.
- It is suggested to replace oil seal (4) on pinion cover and O-ring (5).
- Between axle beam and differential support apply Loctite 510.


6
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KW130P6129

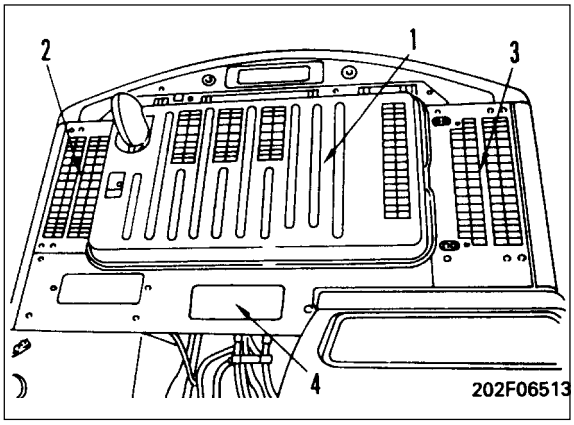
		Thread	Nm
DIFFERENTIAL CASE			
1	Ring nut - bevel pinion	M45x1.5	pre-load
2	Bolt - bevel pinion cover	M8x25	27
3	Bolt - input flange to bevel pinion	M12x1.25	139
4	Bolt - input flange	M12x1.25	-
5	Bolt - differential support to axle housing	M12x33	150
6	Bolt - crown wheel to differential carrier (use loctite 270)	M14x2	190
7	Oil breather extension	-	15
8	Breather plug	M10x1	5
9	Bolt - ring nut locking plate	M6x1x10	13
10	Oil drain and filling plug	M22x1.5	60
11	Oil drain plug	M16x1.5	30
12	Bolts - differential support to axle housing	M12	80
13	Bolt - differential support half-tie	M16x95	413
14	Oil breather extension	-	90
15	Breather plug	-	8 to 12
WHEEL SHAFT AND FINAL DRIVE			
16	Bolts - wheel shaft to axle beam	M14	190
17	Bolts - planetary gear carrier	M20x80	530
18	Bolts - crown gear carrier to wheel hub	M14x1.5	220
19	Bolts - planetary carrier to wheel shaft	M8x20	23
20	Oil filling level plug	-	60

REMOVAL OF HYDRAULIC TANK ASSEMBLY

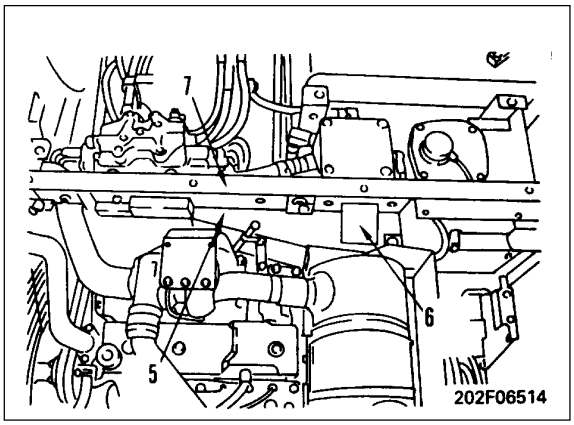
1. Drain oil from hydraulic tank.

   Hydraulic tank: Approx. 100 *l*.

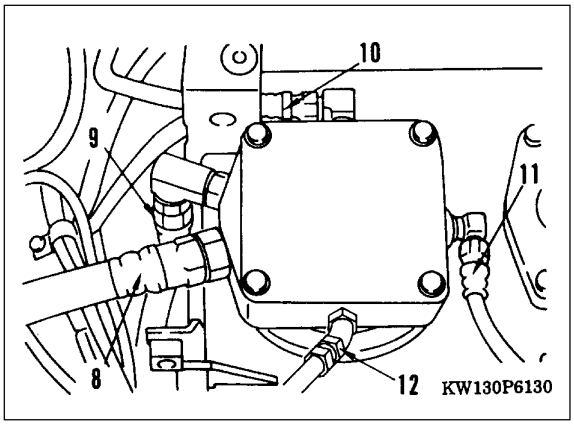
2. Open engine hood, and remove covers (1), (2), (3), and (4).



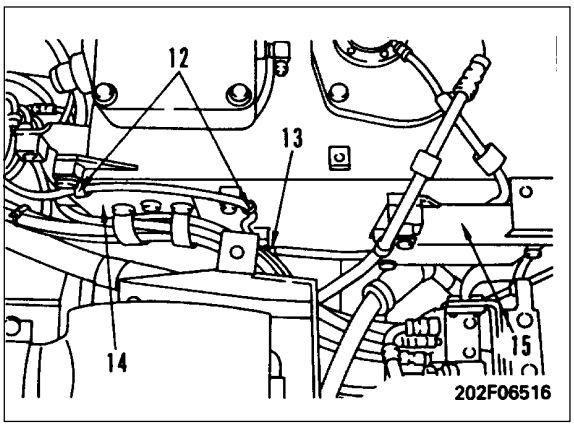
3. Remove engine room partition plate (5), then remove partition plate (6).
4. Remove frame (7).



5. Disconnect hydraulic filter inlet hoses (8), (9), (10), (11) and (12).



6. Remove pressure sensor wiring clamps (12).
7. Remove solenoid valve wiring clamp (13).
8. Remove PPC hose bracket (14).
9. Remove wiring connector bracket (15).

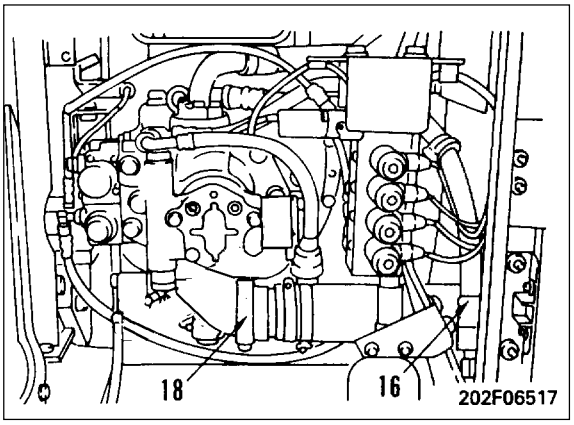


10. Disconnect hydraulic tank inlet hose (16).

11. Remove pump suction tube (18).

12. Remove mounting bolts, and lift off hydraulic tank assembly (19). ※ 1

kg Hydraulic tank assembly: 115 kg.



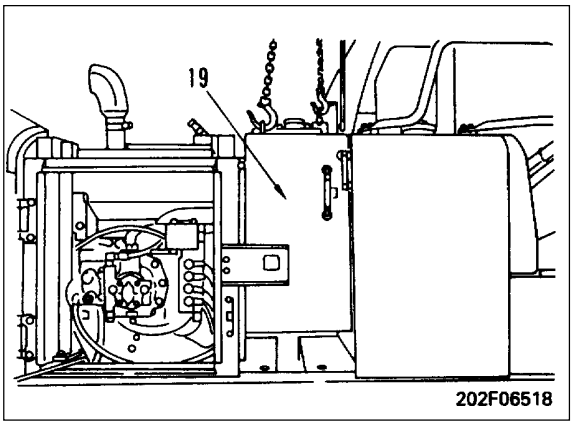
INSTALLATION OF HYDRAULIC TANK ASSEMBLY

- Carry out installation in the reverse order to removal.

※ 1

Thread of hydraulic tank mounting bolt: Thread tightener (LT-2)

kgm Hydraulic tank mounting bolt: 276.9 ± 31.9 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 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 filler cap slowly to release the pressure inside the hydraulic tank.

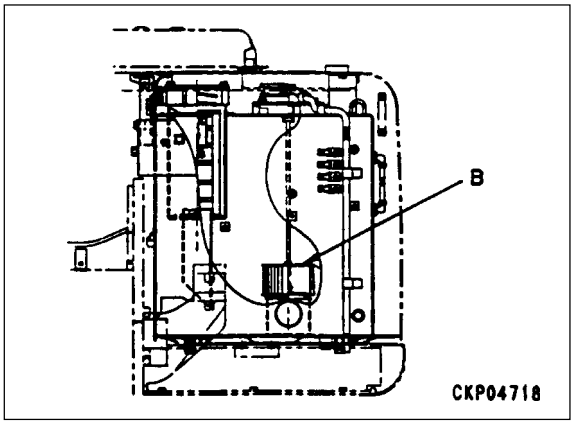
- Remove the hydraulic tank strainer and, using tool **B**, stop the oil.
- When not using tool **B**, remove the drain plug, and drain the oil from the hydraulic tank and inside the system.

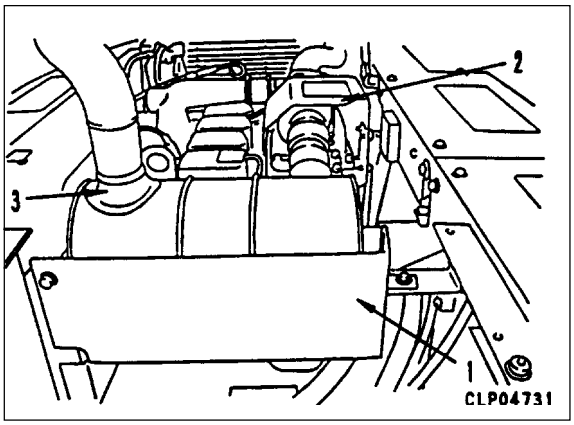
Hydraulic tank: **Approx. 100** /.

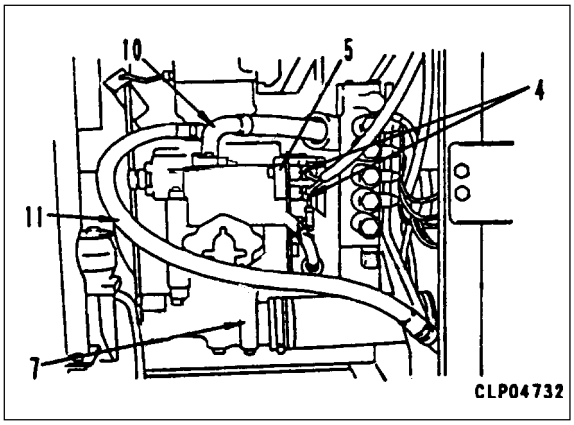
1. Drain oil from PTO gear case.

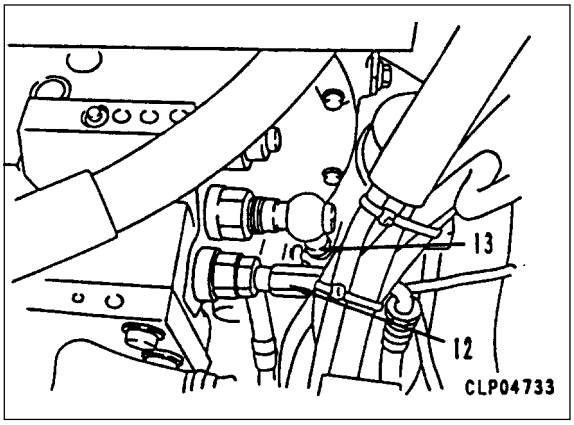
PTO gear case: **Approx. 0.75** /.

2. Open engine hood, and remove main pump top cover, then remove exhaust muffler cover (1) and insulator (2).
3. Disconnect connecting pipe portion at turbocharger end, and remove exhaust muffler (3) together with bracket.
4. Disconnect wiring connectors (4), remove bracket (5) tightened together with tube.
5. Disconnect main pump suction tube (7).
8. Disconnect main pump outlet hose (10).
9. Disconnect main pump drain hose (11).
10. Disconnect LS pressure input hose (12).
11. Disconnect hose (13).
12. Disconnect EPC valve basic pressure hose.





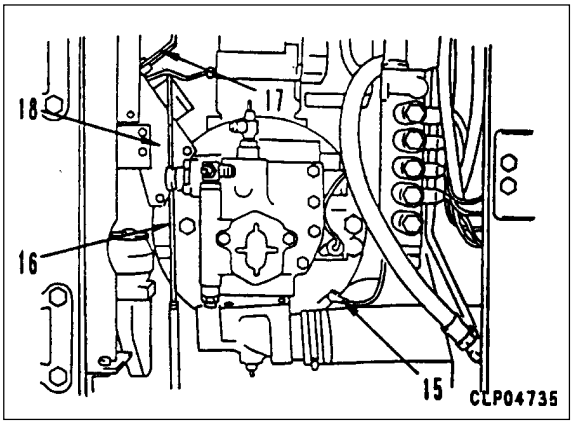




13. Disconnect ground connection (15).

14. Remove exhaust drain pipe (16).

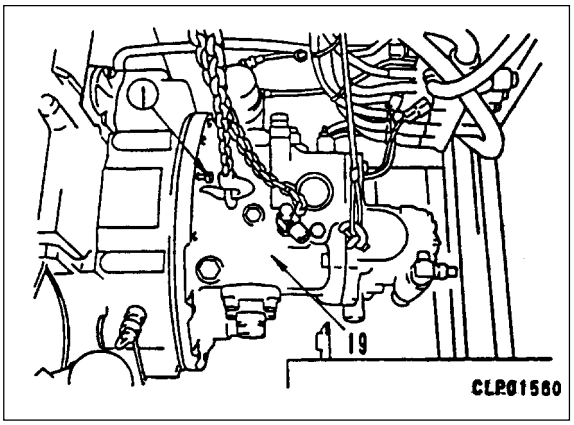
15. Remove bracket (17), then remove ② mounting bolts, and move governor motor bracket assembly (18) towards counterweight end.



16. Sling main pump assembly (19), remove mounting bolts, then use forcing screws ① to remove.

※ 1

Main pump assembly: **85 kg**.



INSTALLATION OF MAIN PUMP ASSEMBLY

- Carry out installation in the reverse order to removal.

※ 1

Mating surface of pump case:
Gasket sealant (LG-6).

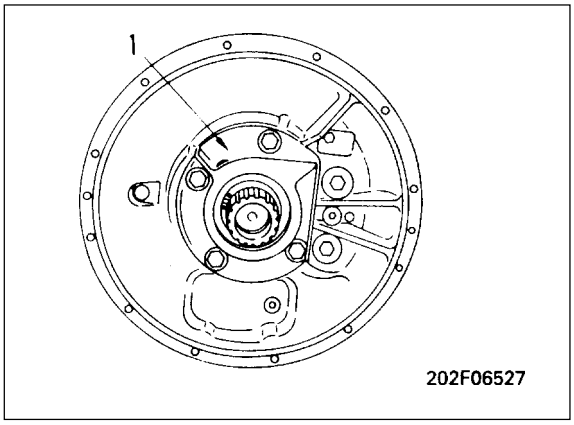
- Refilling with oil (PTO gear case)
  - ★ Add engine oil through the oil filler to the specified level.

- 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 main pump. For details, see TESTING AND ADJUSTING, Bleeding air.

REMOVAL OF MAIN PUMP INPUT SHAFT OIL SEAL

1. Remove main pump assembly.
   For details, see REMOVAL OF MAIN PUMP ASSEMBLY.
2. Remove bearing case assembly (1). ※ 1
3. Remove snap ring (2), then remove spacer (3).
4. Lever up oil seal (4) with a screwdriver to remove. ※ 2
   ★ When removing the oil seal, be extremely careful not to damage the shaft.



INSTALLATION OF MAIN PUMP INPUT SHAFT OIL SEAL

- Carry out installation in the reverse order to removal.

※ 1

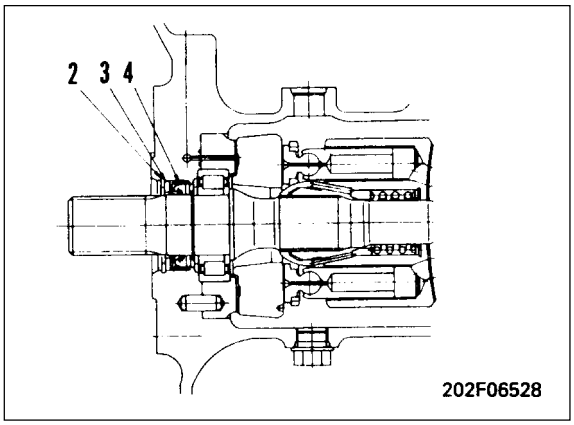
kgm Bearing cage mounting bolt:
110.3 ± 12.3 Nm (11.25 ± 1.25 kgm)

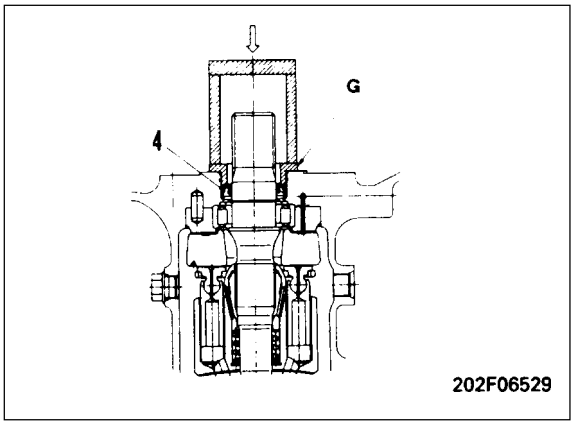
※ 2

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 G, press fit oil seal (4).

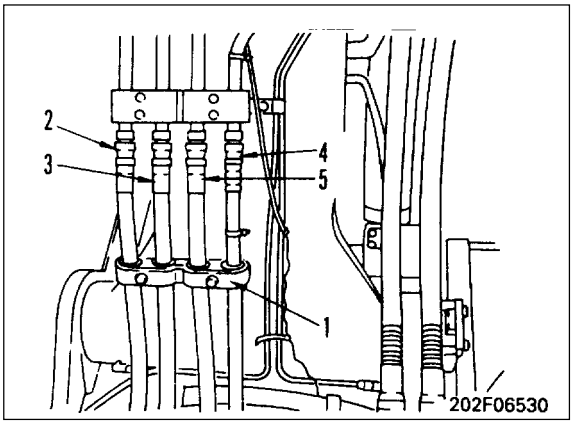


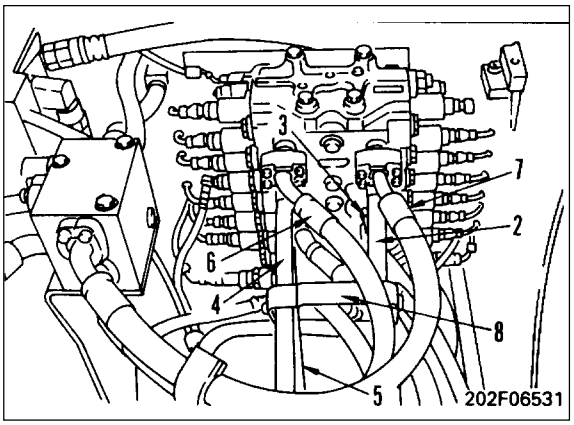


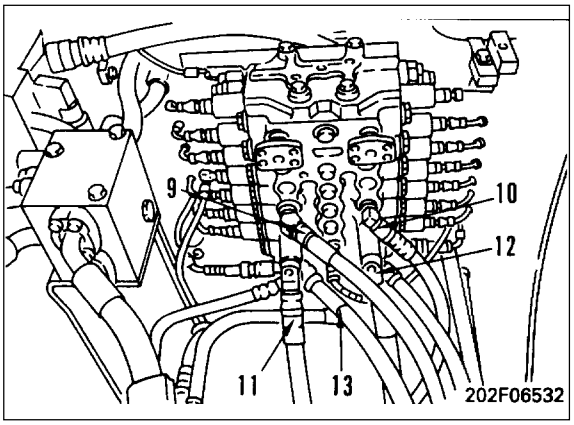
REMOVAL OF CONTROL VALVE ASSEMBLY

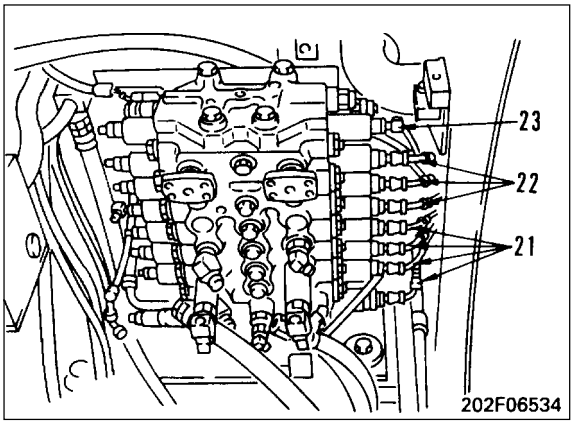
Release the remaining pressure in the hydraulic circuit.
For details, see TESTING AND ADJUSTING, Releasing pressure in hydraulic circuit.

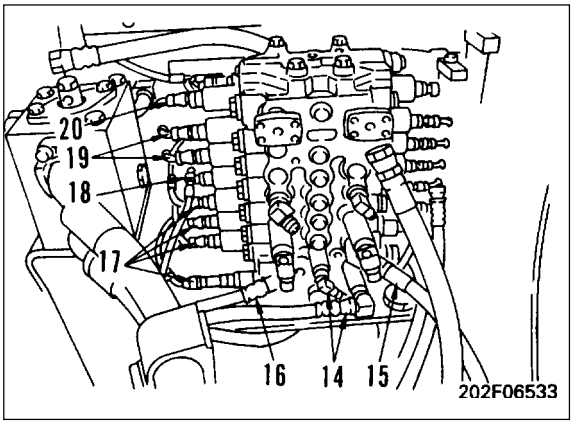
1. Remove engine room partition plate and chassis bodywork cover above control valve assembly.
2. Remove clamp (1), then disconnect hoses (2), (3), (4), and (5).
3. Disconnect hoses (6) and (7).
4. Remove clamp (8), then remove hoses (2), (3), (4), and (5).
5. Disconnect hoses (9), (10), (11), (12), and (13).
6. Disconnect hoses (14), (15), and (16).
7. Disconnect hoses (17), (18), (19), and (20).
   ★ Disconnect 2 hoses (18).
8. Disconnect hoses (21), (22), and (23).











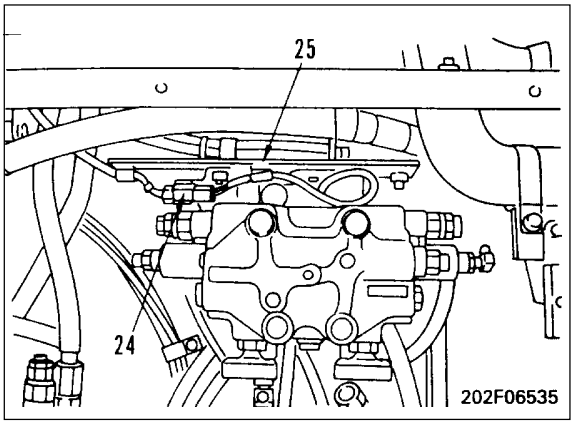
9. Remove connector (24) from clip, then disconnect it.
   ★ Disconnect the wiring harness from the harness clamps (3 places).

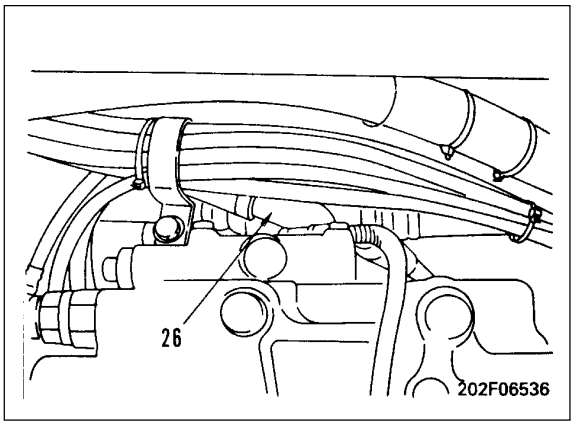
10. Remove harness bracket (25).

11. Disconnect hose (26).

12. Remove mounting bolts, and lift off control valve assembly (27).

   kg Control valve assembly: 100 kg.



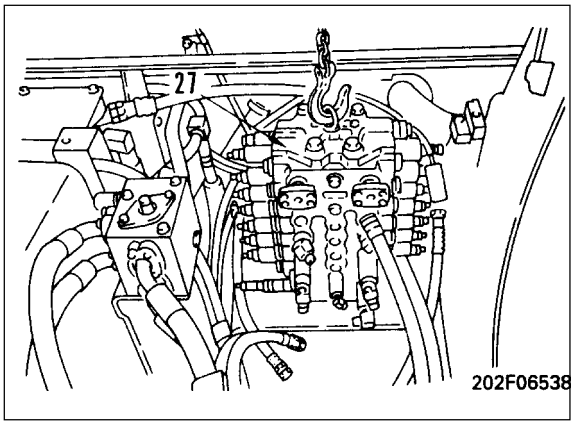


INSTALLATION OF CONTROL VALVE ASSEMBLY

- 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.

- Bleeding air
   ★ Bleed the air from the circuit between the valve and the hydraulic cylinder.
   For details, see TESTING AND ADJUSTING, Bleeding air.



DISASSEMBLY OF CONTROL VALVE ASSEMBLY

★ 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.
• The following explanation describes the standard 6-spools control valve.

1. Main relief valve
Remove main relief valve (1).

2. Unload valve, safety-suction valves, suction valves
1) Remove unload valve (3).
2) Remove safety-suction valves (4), (5), (6), (7), and (8).
3) Remove suction valves (9) and (10).

3. Pressure compensation valves
★ Before removing any pressure compensation valve, check and mark its mounting position.
1) Remove bucket CURL pressure compensation valve (11), arm IN pressure compensation valve (12), boom LOWER pressure compensation valve (13), travel REVERSE pressure compensation valve (14), stabilizer RETRACT pressure compensation valve (15), and swing RIGHT pressure compensation valve (16).
★ After removing the pressure compensation valves, remove check valve (17) from each pressure compensation valve mount.
2) Remove bucket DUMP pressure compensation valve (18), arm OUT pressure compensation valve (19), boom RAISE pressure compensation valve (20), travel FORWARD pressure compensation valve (21), stabilizer EXTEND pressure compensation valve (22), and swing LEFT pressure compensation valve (23).
★ After removing the pressure compensation valves, remove check valve (24) from each pressure compensation valve mount.

4. LS shuttle, LS select valve
Remove LS shuttle valves (25a) and (25b), and LS select valve (26).
★ Mark the mounting positions of LS shuttle valves (25a), and (25b), and be careful not to make any mistake when installing.

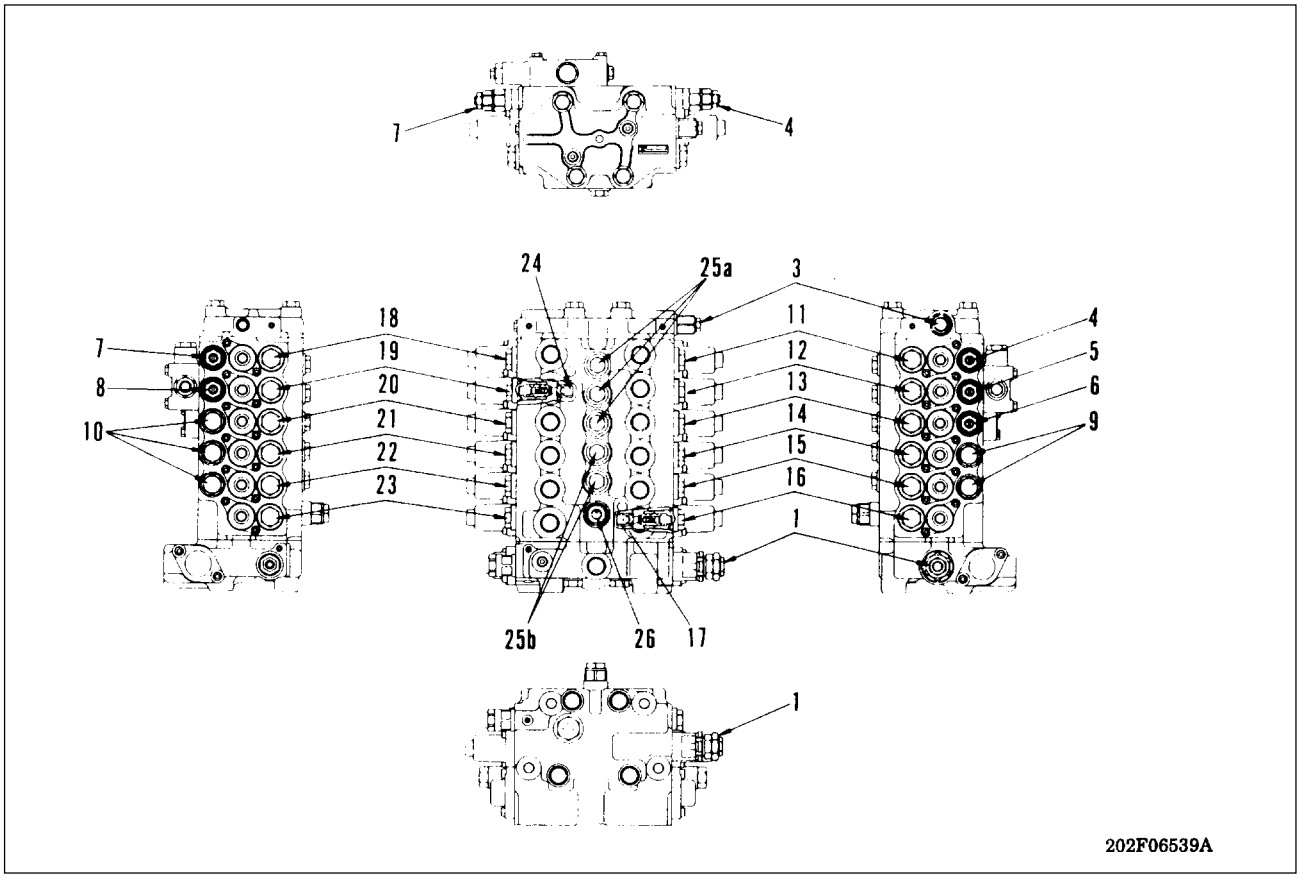
5. Bucket control valve, arm control valve, boom control valve, swing control valve
1) Remove case (27), then remove spring (28) and retainer (29).
2) Remove spool assembly (30).
★ Do not disassemble spool (30).
3) Remove case (31), then remove spring (32) and retainer (33).
★ To avoid assembling spring (32) in mistake for spring (39), mark with tags.

6. Travel control valve, stabilizer control valve
1) Remove case (34), then remove spring (35) and retainer (36).
2) Remove spool assembly (37).
★ Do not disassemble spool (37).
3) Remove case (38), then remove spring (39) and retainer (40).
★ To avoid assembling the spring of the control valve in Step 5 in mistake for spring (39), mark with tags.

7. Arm counterbalance valve, check valve, cover
1) Remove arm counterbalance valve (41).
2) Remove flange (42), then remove spring (43) and check valve (44).
3) Remove covers (45) and (46).

8. Lift check valve
Remove case (47), then remove spring (48), piston (49), and sleeve (50).

9. Cooler bypass valve
Remove case (51), then remove spring (52), piston (53), and sleeve (54).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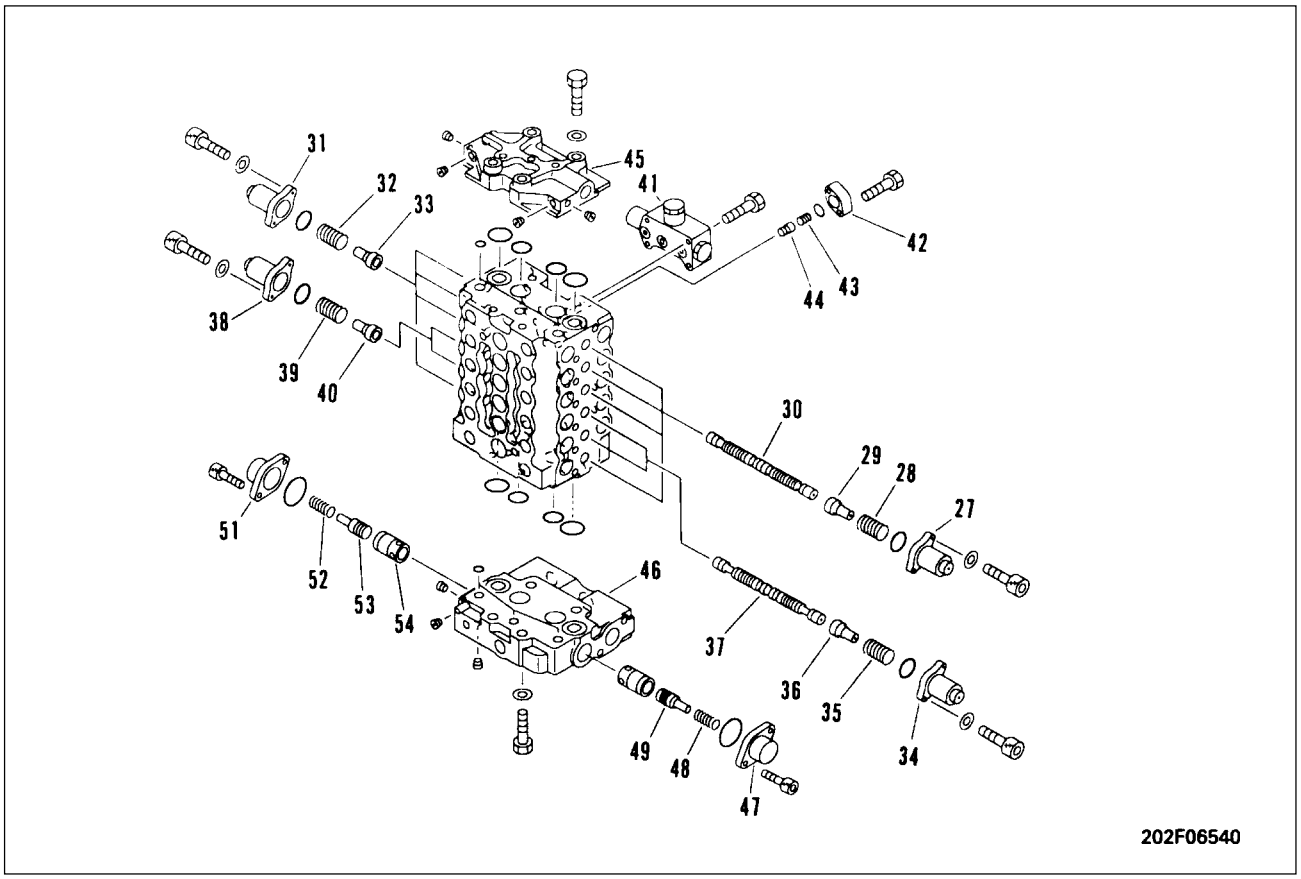
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ASSEMBLY OF CONTROL VALVE ASSEMBLY

- Before assembling coat the sliding surface with engine oil.

1. Cooler bypass valve

Assemble sleeve (54), piston (53), and spring (52) to cover (46), then fit O-ring to case (51) and install.

2. Lift check valve

Assemble sleeve (50), piston (49), and spring (48) to cover (46), then fit O-ring to case (47) and install.

3. Cover, check valve, arm counterbalance valve

1) Fit O-rings and install covers (46) and (45).

kgm Mounting bolt of cover (46):
227.1 ± 32.3 Nm (28.3 ± 3.3 kgm).

kgm Mounting bolt of cover (45):
166.3 ± 10.3 Nm (17 ± 1 kgm)

★ Tighten the mounting bolts in the order shown in the diagram.

2) Assemble check valve (44) and spring (43), then fit O-ring to flange (42) and install.

3) Fit O-ring to arm counterbalance valve (41) and install.

kgm Mounting bolt:
31 ± 3.5 Nm (3.2 ± 0.4 kgm).

★ Tighten the mounting bolts in the order shown in the diagram.

4. Travel control valve, stabilizer control valve

1) Assemble spool assembly (37) to valve body.

2) Assemble retainer (40) and spring (39) to spool, then fit O-ring to case (38) and install.

★ Check springs (32) and (39), and be careful not to mistake them when installing.

kgm Mounting bolt:
11.3 ± 15 Nm (1.2 ± 0.2 kgm)

3) Assemble retainer (36) and spring (35) to spool, then fit O-ring to case (34) and install.

kgm Mounting bolt:
11.3 ± 1.5 Nm (1.2 ± 0.2 kgm).

5. Bucket control valve, arm control valve, boom control valve, swing control valve

1) Assemble spool assembly (30) to valve body.

2) Assemble retainer (33) and spring (32) to spool, then fit O-ring to case (31) and install.

★ Check spring (32) when installing.

kgm Mounting bolt:
11.3 ± 1.5 Nm (1.2 ± 0.2 kgm).

3) Assemble retainer (29) and spring (28) to spool, then fit O-ring to case (27) and install.

kgm Mounting bolt:
11.3 ± 1.5 Nm (1.2 ± 0.2 kgm)

6. LS shuttle valve, LS select valve

1) Fit O-ring and install LS select valve (26).

kgm LS select valve:
127.5 ± 19.6 Nm (13 ± 2 kgm).

2) Fit O-rings and install LS shuttle valves (25a) and 25b).

kgm LS shuttle valve:
166.7 ± 19.6 Nm (17 ± 2.0 kgm).

★ Check valve (25a) and (25b) and be careful not to mistake them when installing.

7. Pressure compensation valve

Check marks made on each pressure compensation valve when disassembling, and install pressure compensation valves in correct position.

1) Before installing pressure compensation valves below, install check valves (17) and (24).

2) Fit O-ring, then install swing LEFT pressure compensation valve (23), travel FORWARD pressure compensation valve (22), pressure compensation valve (21), boom RAISE pressure compensation valve (20), arm OUT pressure compensation valve (19), and bucket DUMP pressure compensation valve (18).

3) Fit O-ring, then install swing RIGHT pressure compensation valve (16), travel REVERSE pressure compensation valve (15), pressure compensation valve (14), boom LOWER pressure compensation valve (13), arm IN pressure compensation valve (12), and bucket CURL pressure compensation valve (11).

kgm Pressure compensation valve:
225.5 ± 19.5 Nm (23 ± 2 kgm)

8. Suction valves, safety-suction valves, unload valve

1) Fit O-rings and install suction valves (10) and (9).

kgm Suction valve:
147 ± 9.8 Nm (15 ± 1kgm).

2) Fit O-rings and install safety-suction valves (8), (7), (6), (5), and (4).

kgm Safety-suction valve:
147.1 ± 9.8 Nm (15 ± 1 kgm).

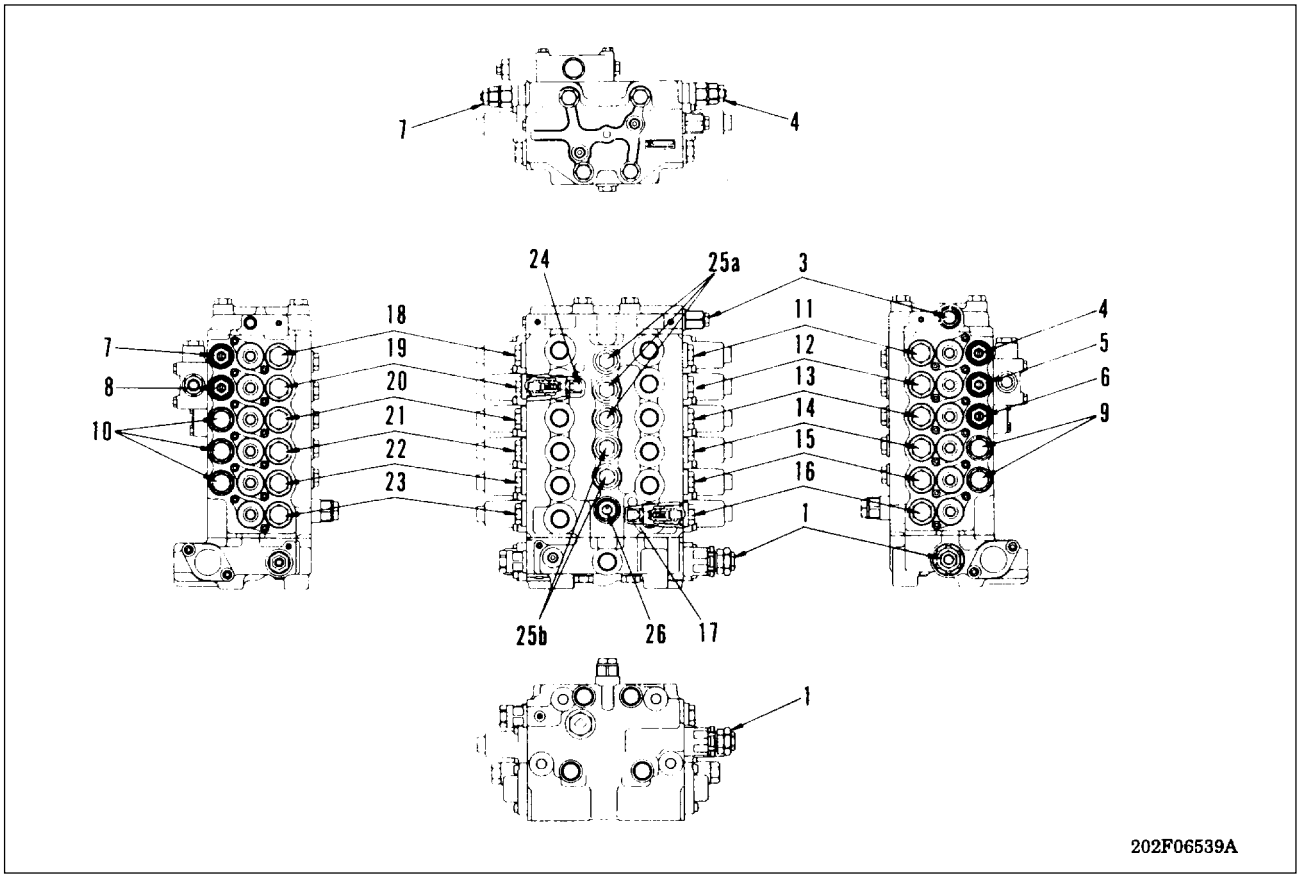
3) Fit O-ring and install unload valve (3).

kgm Unload valve:
166.7 ± 19.7 Nm (17 ± 2 kgm).

9. Main relief valve

1) Fit O-ring and install main relief valve (1).

kgm Main relief valve:
98.1 ± 9.8 Nm (10 ± 1 kgm).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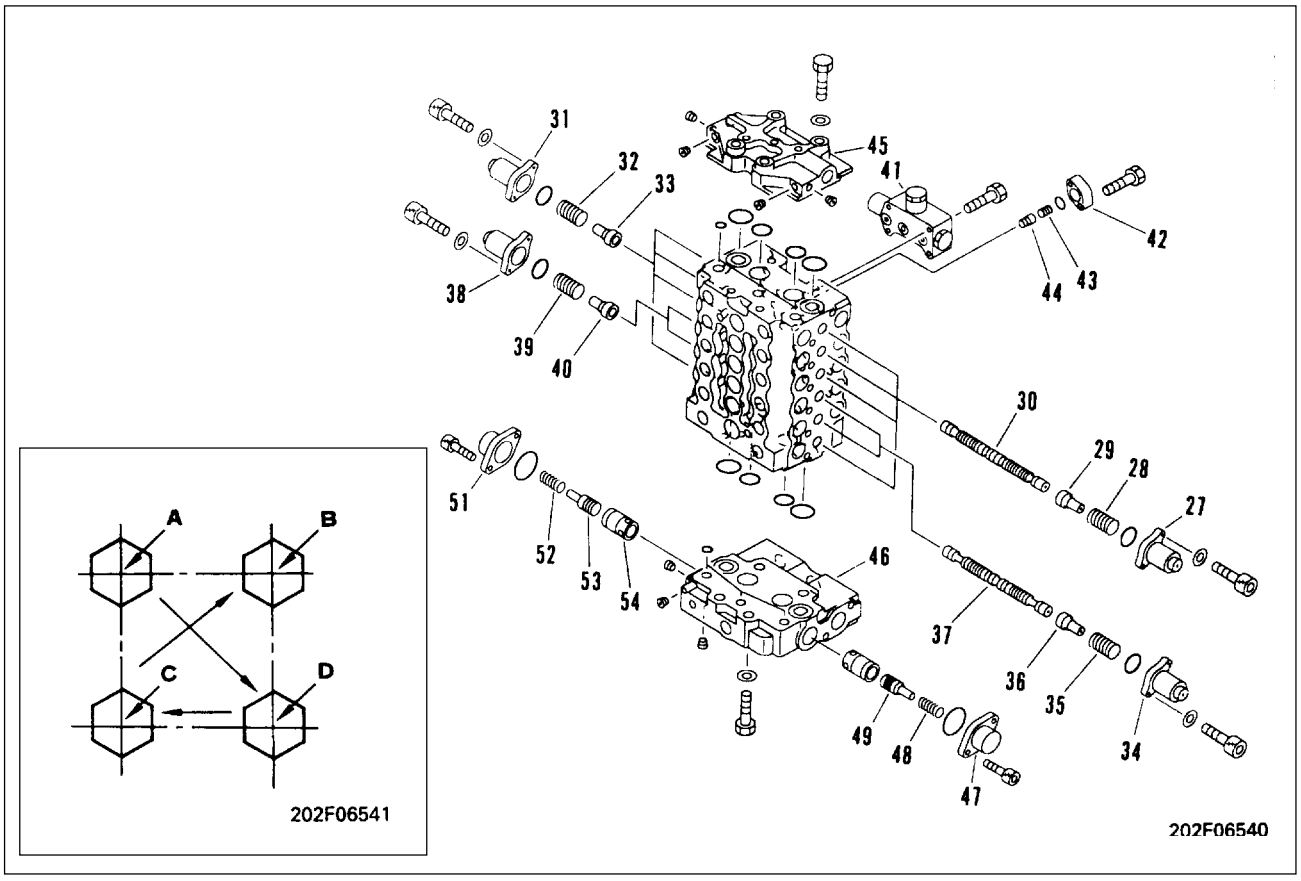
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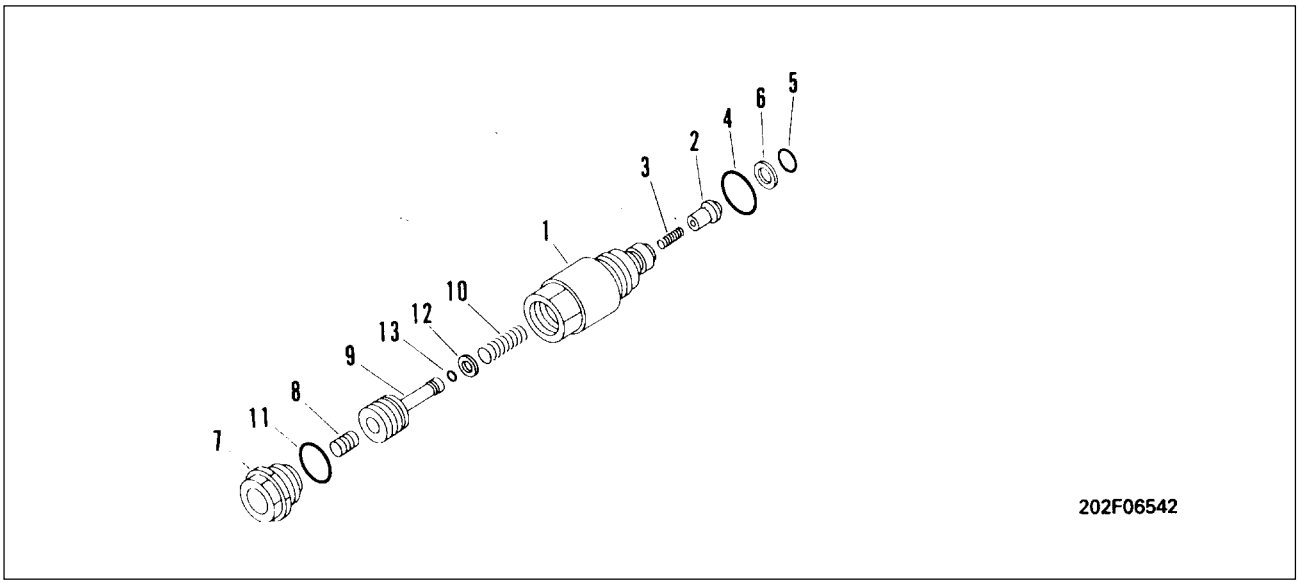
DISASSEMBLY OF LS SELECT VALVE



1. Remove sleeve (2) and spring (3) from sleeve (1).

2. Remove O-rings (4) and (5), and seal (6) from sleeve (1).

3. Remove plug (7), then remove pistons (8) and (9), and spring (10).

4. Remove O-ring (11) from plug (7), then remove seal (12) and O-ring (13) from piston (9).
   ★ After disassembling, if there is any abnormality in any part except O-rings (4), (5), (11), or seal (6), replace the whole LS select valve assembly.

ASSEMBLY OF LS SELECT VALVE

- Before assembling coat the sliding surface with engine oil.

1. Install O-ring (13) and seal (12) to piston (9), then assemble piston (8) and spring (10), and install in sleeve (1).

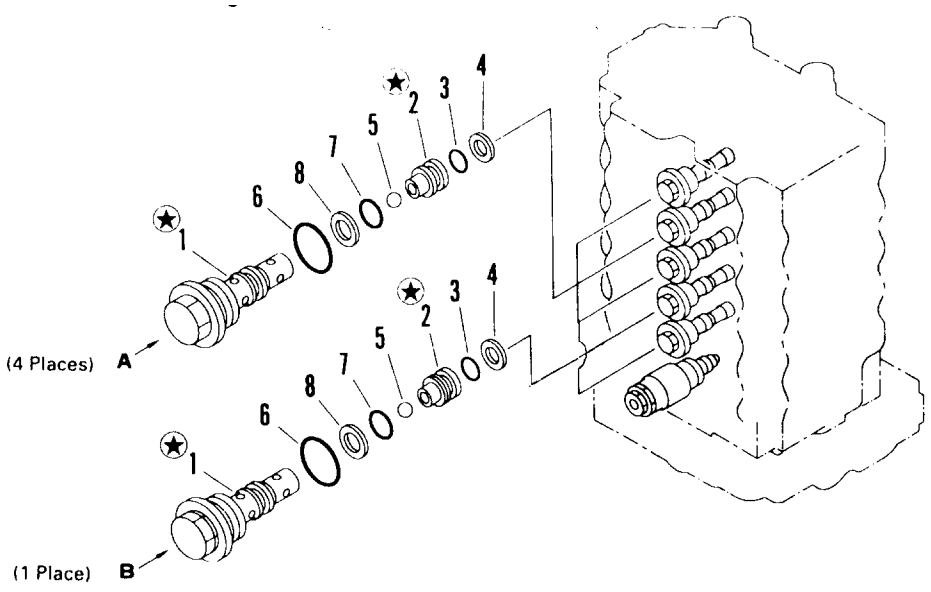
2. Assemble O-ring (11) to plug (7) and install to sleeve (1).

   kgm Plug: 68.6 ± 9.9 Nm (7± 1 kgm).

3. Assemble spring (3) to sleeve (2), and install to sleeve (1).

4. Install O-rings (4) and (5), and seal (6) to sleeve (1).

DISASSEMBLY OF LS SHUTTLE VALVE



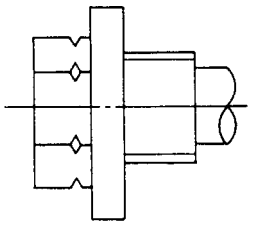
1. Remove seat (2) from plug (1), then remove O-ring (3) and ring (4).
2. Remove ball (5) from plug (1), then remove O-rings (6) and (7), and ring (8).
   ★ After disassembling, if there is any abnormality in plug (1), seat (2), or ball (5), replace the whole LS shuttle valve assembly.

ASSEMBLY OF LS SHUTTLE VALVE

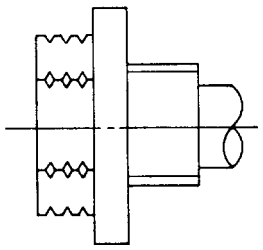
- Before assembling coat the sliding surface with engine oil.

1. Install ring (8) and O-rings (7) and (6) to plug (1).
2. Fit ring (4) and O-ring (3) to seat (2), then assemble ball (5) to plug (1), and install seat (2).

Type A



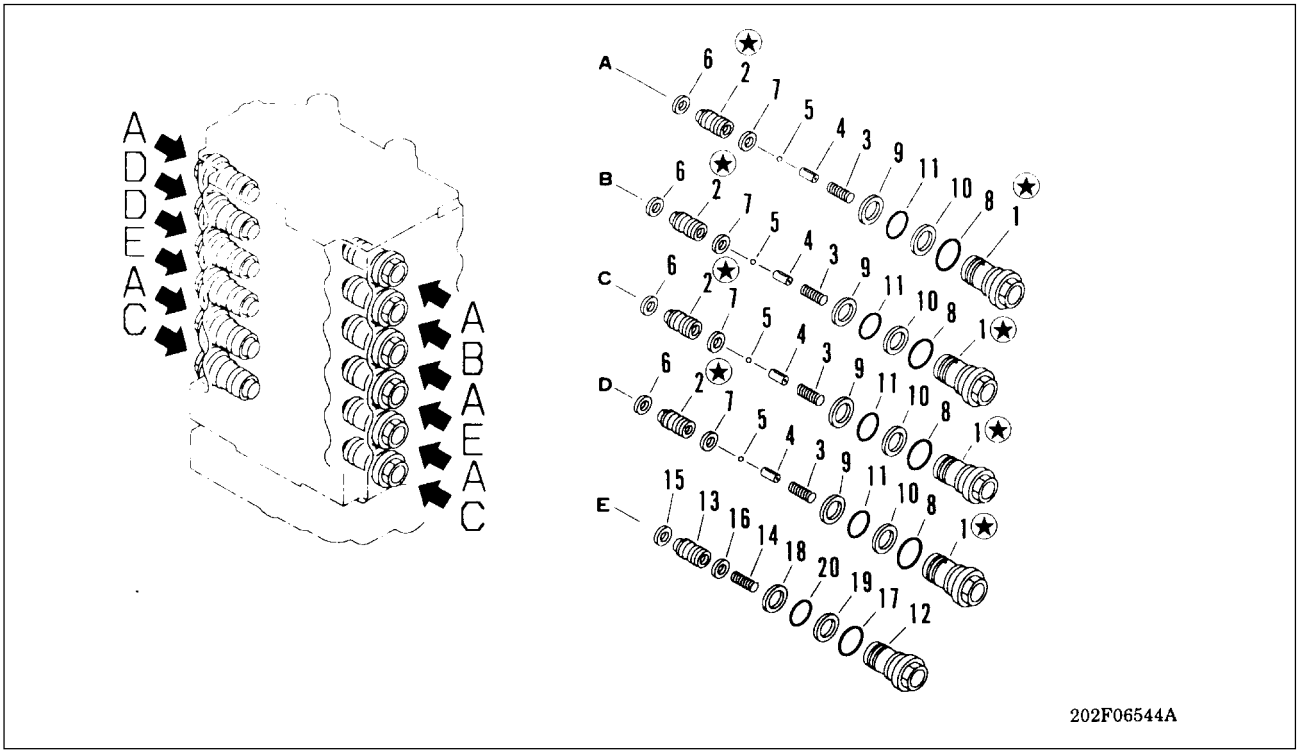
Type B



IDENTIFICATION OF LS SHUTTLE VALVE

Shuttle valves are identified by markings on the valve assembly.
Type A - 1 mark
Type B - 3 marks

DISASSEMBLY OF PRESSURE COMPENSATION VALVE ASSEMBLY



- **Disassembly of pressure compensation valves A, B, C, D**
  - The structure of the parts for pressure compensation valves A, B, C, and D is the same, but the part number for the assembly marked ⋆ is different, so be careful when assembling.

1. Remove piston (2) and spring (3) from sleeve (1).
2. Remove plug (4) and ball (5) from piston (2).
3. Remove seals (6) and (7) from piston (2).
4. Remove O-ring (8) from sleeve (1), then remove seals (9) and (10), and O-ring (11).

★ After disassembling, if there is any abnormality in sleeve (1), piston (2), plug (4), ball (5), or seals (6) and (7), replace the whole pressure compensation valve assembly.

- Disassembly of pressure compensation valve E

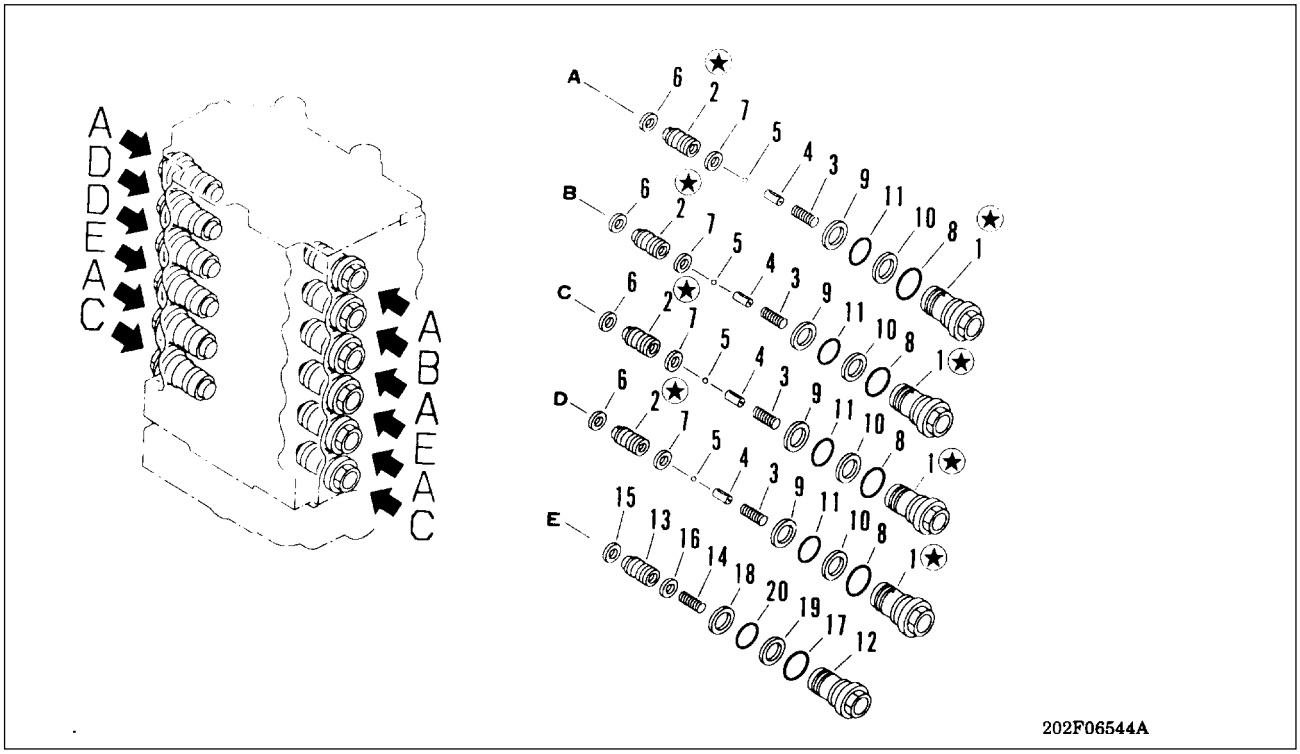
1. Remove piston (13) and spring (14) from sleeve (12).
2. Remove seals (15) and (16) from piston (13), then remove O-ring (17), seals (18) and (19), and O-ring (20) from sleeve (12).

★ After disassembling, if there is any abnormality in sleeve (12), piston (13), or seals (15) and (16), replace the whole pressure compensation valve assembly.

IDENTIFICATION OF PRESSURE COMPENSATION VALVE ASSEMBLY

Valves are identified by markings on the valve assembly.
Type A - 1 mark.
Type B - 2 marks (side by side).
Type C - 3 marks.
Type D - 4 marks.
Type E - 2 marks (separated).

ASSEMBLY OF PRESSURE COMPENSATION VALVE ASSEMBLY



- Before assembling coat the sliding surface with engine oil.

- **Assembly of pressure compensation valve E**

1. Install O-rings (17) and (2), and seals (19) and (18) to sleeve (12).

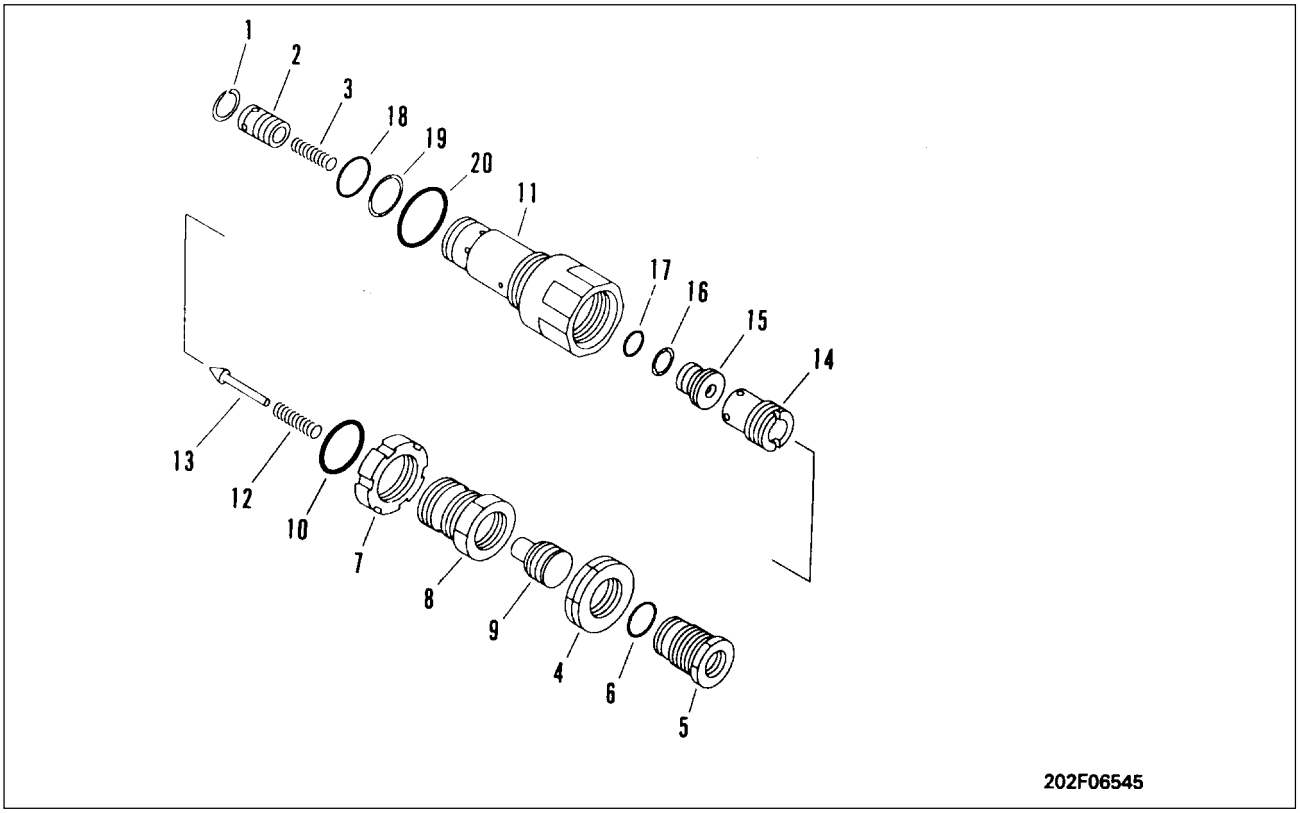
2. Fit seals (16) and (15) to piston (13), then assemble spring (14) and install to sleeve (12).

- **Assembly of pressure compensation valves A, B, C, D**

1. Install O-rings (8) and (11), and seals (10) and (9) to sleeve (1).

2. Fit seals (7) and (6) to piston (2), then assemble ball (5), plug (4), and spring (3), and install to sleeve (1).

DISASSEMBLY OF MAIN RELIEF VALVE ASSEMBLY



1. Remove ring (1), then remove valve (2) and spring (3).

2. Loosen nut (8) and remove plug (5), then remove O-ring (6) and nut (4) from plug (5).

3. Loosen nut (&) and remove holder (8), then remove retainer (9), O-ring (10), and nut (7) from holder (8).

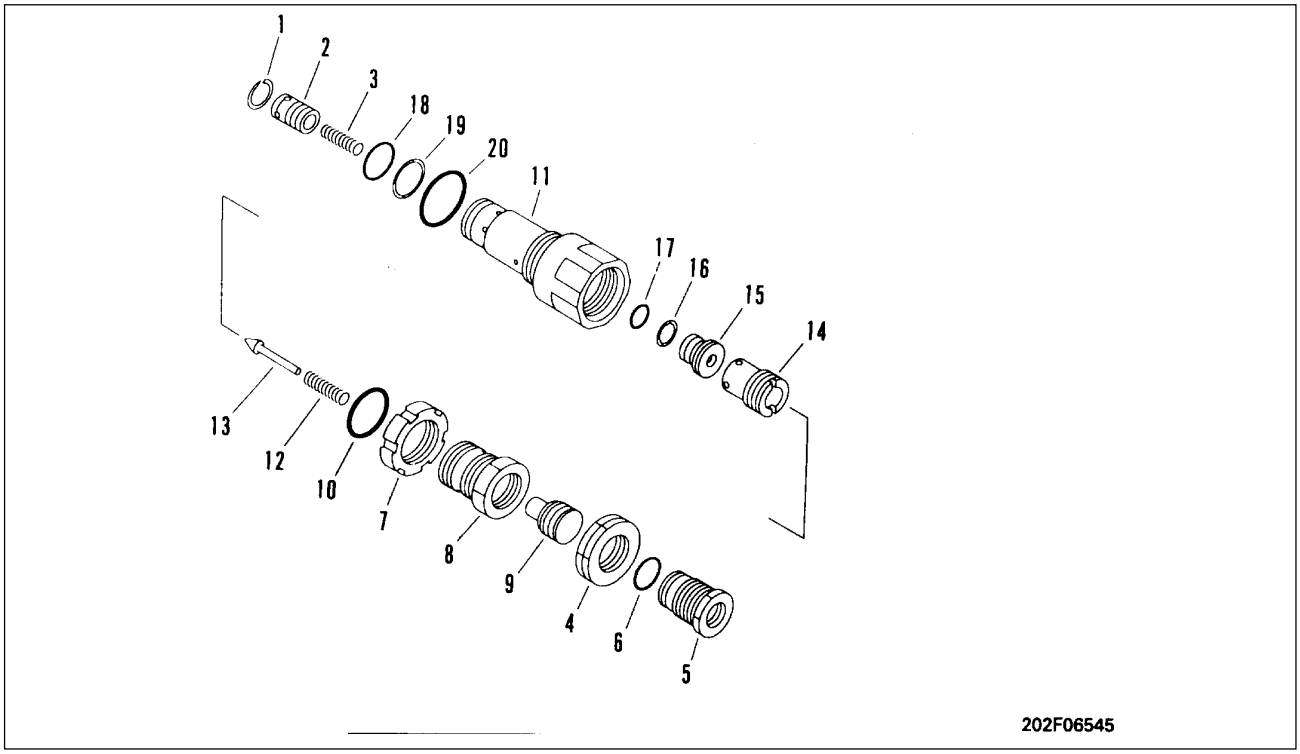
4. Remove spring (12) and poppet (13) from sleeve (11), then remove sleeve (14) and seat (15).

5. Remove ring (16) and O-ring (17) from seat (15).

6. Remove O-ring (18), seal (19), and O-ring (20) from sleeve (11).

★ After disassembling, if there is any abnormality in valve (2), holder (8), retainer (9), sleeve (14), seat (15), ring (16), O-ring (17), or sleeve (11), replace the whole main relief valve assembly.

ASSEMBLY OF MAIN RELIEF VALVE ASSEMBLY



- Before assembling coat the sliding surface with engine oil.

1. Install O-ring (17) and ring (16) to seat (15), and assemble sleeve (11).

2. Assemble sleeve (14) to sleeve (11).

3. Install nut (7) and O-ring (10) to holder (8), then assemble retainer (9), poppet (13), and spring (12), and install to sleeve (11).
   ★ Set contact surface of seat (15) and poppet (13) in position securely.

4. Assemble nut (4) and O-ring (6) to plug (5), and install to holder (8).

5. Assemble spring (3) and valve (2) to sleeve (11), and install ring (1).

6. Install O-rings (20) and (18), and seal (19) to sleeve (11).

7. Tighten nut (7) to specified torque.

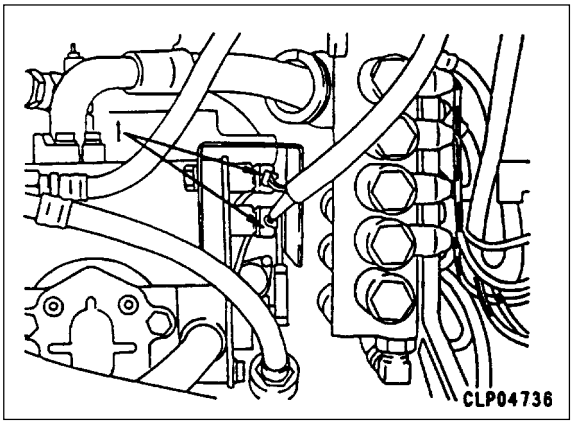
   kgm Nut: 58.8 ± 4.9 Nm (6 ± 0.5 kgm)

8. Tighten nut (4) to specified torque.

   kgm Nut: 44.1 ± 4.9 Nm (4.5 ± 0.5 kgm)

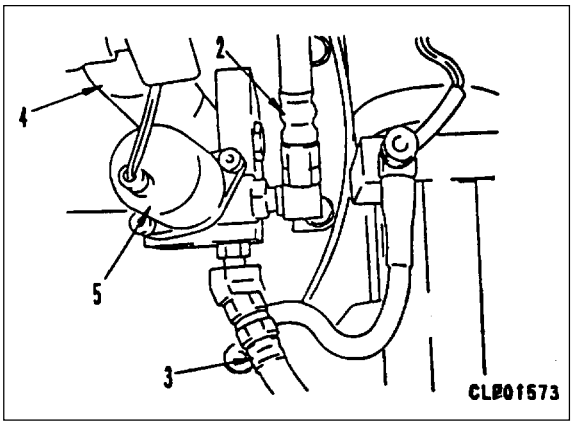
★ After installing to the control valve assembly, adjust the pressure.
For details, see TESTING AND ADJUSTING, Testing and adjusting oil pressure of work equipment, swing, travel circuits.

REMOVAL OF PC, LS-EPC VALVE ASSEMBLY



1. Remove bottom cover of main pump assembly.
2. Disconnect wiring connector (1).
3. Disconnect hoses (2) and (3).
4. Remove PC-EPC valve assembly (4) and LS-EPC valve assembly (5) ※ 1

INSTALLATION PF PC, LS-EPC VALVE ASSEMBLY



- Carry out installation in the reverse order to removal.

※ 1

kgm PC, LS-EPC valve mounting bolt:
11.3 ± 1.5 Nm (1.15 ± 0.15 kgm)

kgm Hose nut:
66.2 ± 7.4 Nm (6.75 ± 0,75 kgm)

REMOVAL OF PC VALVE ASSEMBLY

Disconnect the cable from the negative (-) terminal of the battery.

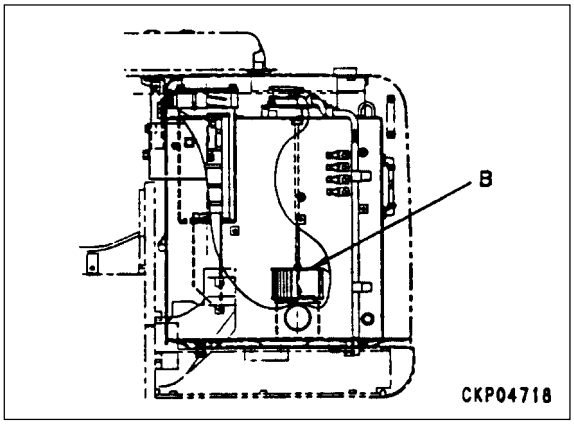
Lower the work equipment completely to the ground and stop the engine. Then loosen the oil filler cap slowly to release the pressure inside the hydraulic tank.

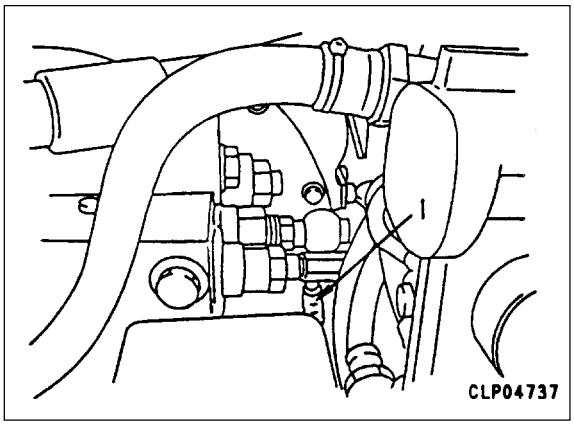
- Remove the hydraulic tank strainer and, using tool **B**, stop the oil.
  - When not using tool **B**, remove the drain plug, and drain the oil from the hydraulic tank and inside the system.

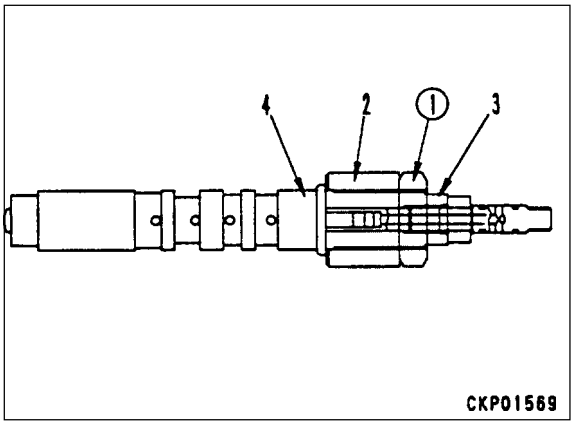
  Hydraulic tank: **Approx. 100 /.**

1. Disconnect hose (1). ※ 1
2. Install locknut ① (796-467-1140. ※ 2

   kgm Locknut:
   100.5 ± 12.3 Nm {10.25 ± 1.25 kgm)
3. Turn locknut (2) in direction of loosening, and tighten to locknut ① end. ※ 3
   ★ Turning angle for locknut (2): Approx. 30'.
4. Fit wrench to hexagonal width across flats of sleeve (3), then loosen and remove PC valve assembly (4).







INSTALLATION OF PC VALVE ASSEMBLY

- Carry out installation in the reverse order to removal.

※ 1

kgm Hose locknut:
34.3 ± 4.9 Nm (3.5 ± 0.5 kgm)

※ 2

★ After installing the PC valve assembly, remove locknut ①.

※ 3

kgm Locknut (2):
100.5 ± 12.3 Nm {10.25 ± 1.25 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.

REMOVAL OF LS VALVE ASSEMBLY

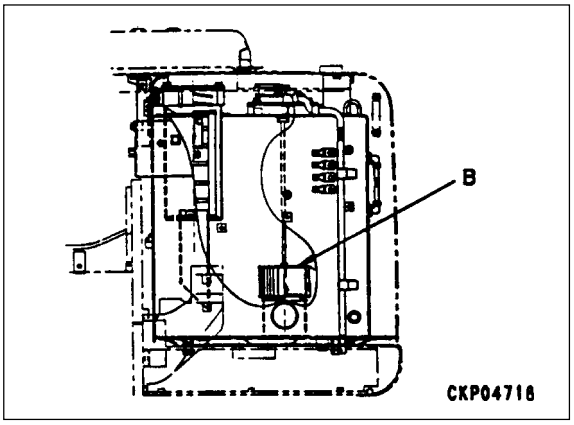
Disconnect the cable from the negative (-) terminal of the battery.

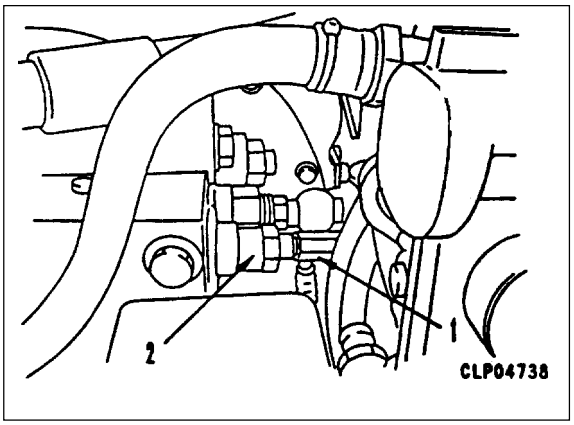
Lower the work equipment completely to the ground and stop the engine. Then loosen the oil filler cap slowly to release the pressure inside the hydraulic tank.

- Remove the hydraulic tank strainer and, and using tool **B**, stop the oil.
  - When not using tool **B**, remove the drain plug, and drain the oil from the hydraulic tank and inside the system.

  Hydraulic tank: **Approx. 100** /.

1. Disconnect hose (1).
2. Fit wrench to hexagonal width across flats of sleeve, then loosen and remove LS valve assembly (2) ※ 1





INSTALLATION OF LS VALVE ASSEMBLY

- Carry out installation in the reverse order to removal.

※ 1

kgm LS valve assembly:
139.7 ± 12.3 Nm {14.75 ± 1.25 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.

REMOVAL OF SOLENOID VALVE ASSEMBLY

Disconnect the cable from the negative (-) terminal of the battery.

1. Open R.H. side cover.
   Remove PPC pumpless valve (1).

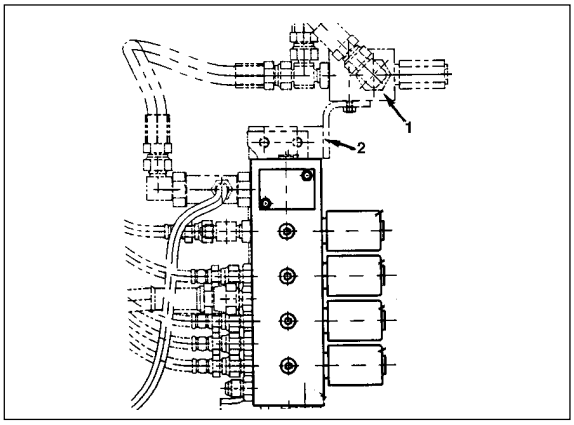
2. Remove valve bracket (2).

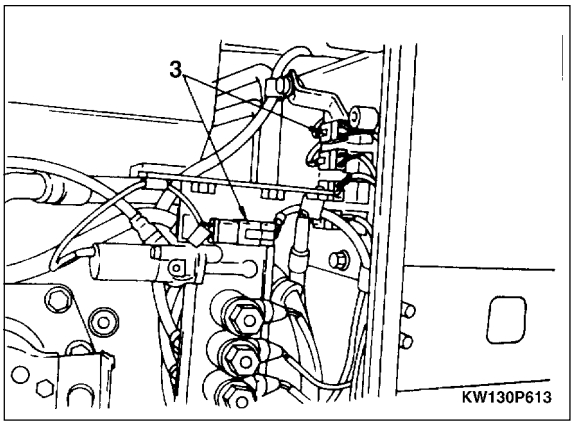
3. Remove 5 solenoid wiring connectors (3) from clip, then disconnect.
   ★ Mark the male and female ends of each connector with tags to prevent mistakes when connecting.

4. Disconnect 10 hoses (4).
   ★ Fit tags on the hoses.

5. Remove mounting bolts, then remove solenoid valve assembly (5).

- When removing solenoid valve as an individual part:
  Remove mounting nut (6), then remove solenoid valve (7). ※ 1





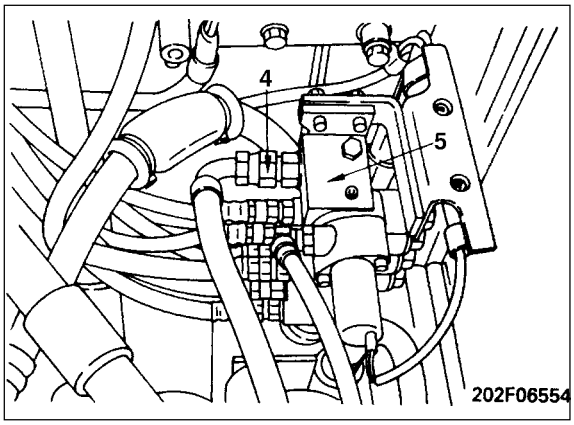
INSTALLATION OF SOLENOID VALVE ASSEMBLY

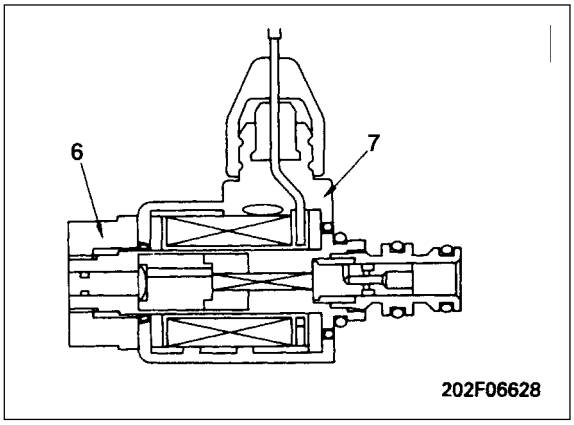
- Carry out installation in the reverse order to removal.

※ 1

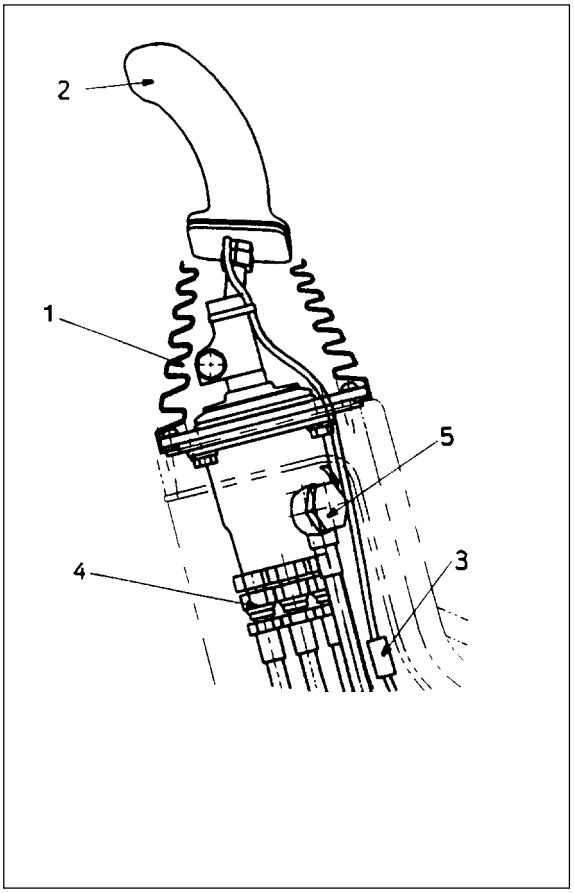
kgm Mounting nut (6):
5-8 Nm (0.5-0.8 kgm).

kgm Solenoid valve (7) (individual part):
39.2 ± 9.8 Nm (4 ± 1 kgm).





REMOVAL OF WORK EQUIPMENT - SWING 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 boot (1) from cover, raise boot, then remove lever (2).
2. Remove mounting bolts.
3. Disconnect wiring connector (3).
4. Disconnect hoses (4), (5) x 6 and remove valve assy.

   ★ Mark the connecting position of the hoses before disconnecting.

INSTALLATION OF WORK EQUIPMENT - SWING PPC VALVE ASSEMBLY

- Carry out installation in the reverse order to removal.

※ 1

kgm Hose mounting joint bolt:
29.4 ± 4.9 Nm (3.0 ± 0.5 kgm)

※ 2

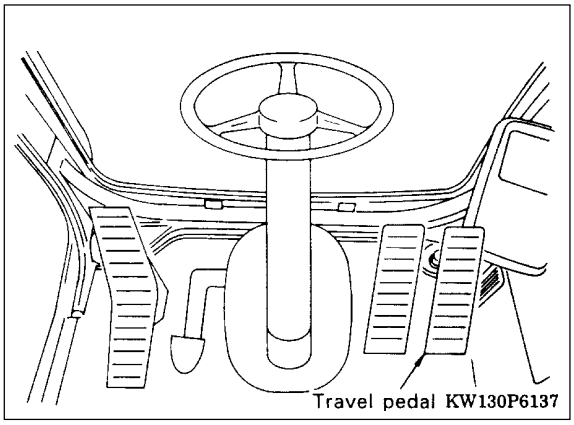
kgm Hose mounting joint bolt:
39.2 ± 4.9 Nm (4.0 ± 0.5 kgm)

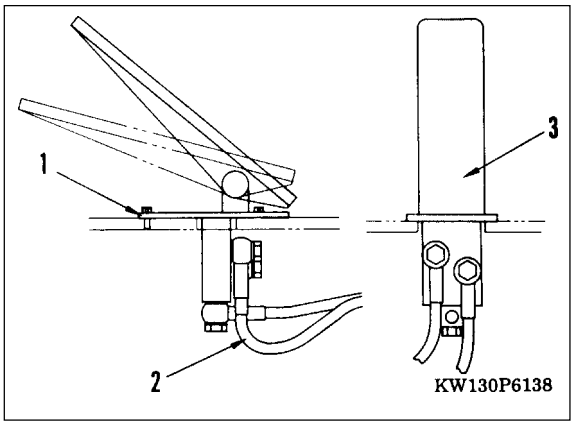
★ If there is excessive play in the control levers, adjust the PPC valve. For details, see TESTING AND ADJUSTING, Adjusting PPC valve.

REMOVAL OF TRAVEL PPC PEDAL ASSEMBLY

Lower the work equipment completely 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 floor mat.
2. Remove under cover (Front).
3. Remove screws (1). ※ 1
4. Disconnect 3 PPC hoses (2), and remove travel PPC valve assembly (3). ※ 2





INSTALLATION OF TRAVEL PPC PEDAL ASSEMBLY

- Carry out installation in the reverse order to removal.

※ 1

kgm Valve mounting bolt:
9.8 ± 1.96 Nm (1.0 ± 0.2 kgm)

※ 2

kgm Hose mounting joint bolt (width across flats: 22 mm): 29.4 ± 4.0 Nm (3.0 ± 0.5 kgm)

REMOVAL OF 1ST BOOM CYLINDER ASSEMBLY

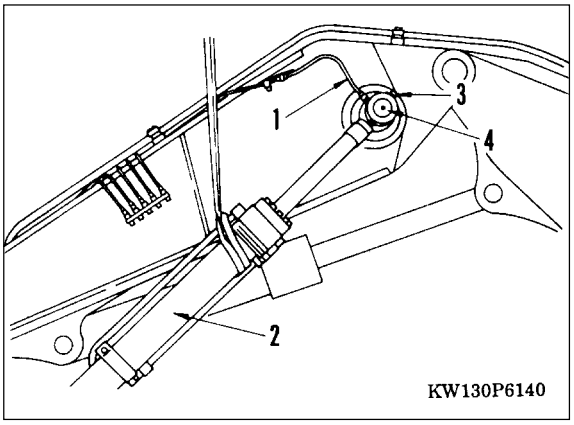
Extend the arm, bucket and second boom fully, lower the work equipment completely to the ground, and put the safety lock lever in the LOCK position.

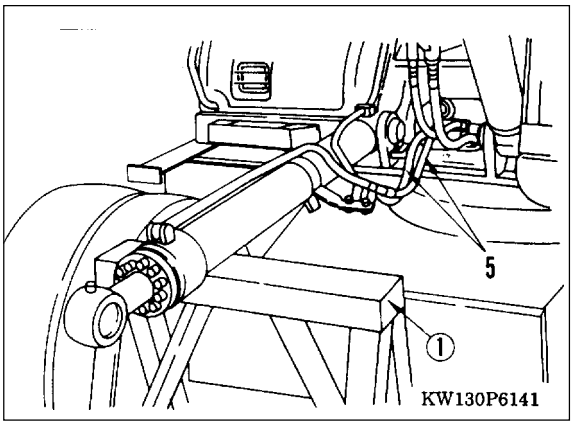
1. Disconnect grease hose (1).
2. Sling boom cylinder assembly (2), and remove lock bolt (3). ※ 1
3. Remove plate, then retrack head pin (4) one side at a time, to allow each cylinder to be lowered. ※ 2
   ★ There are shims installed, so check the number and thickness, and keep in a safe place.
4. Start engine, and retract piston rod, then tie piston rod with wire to prevent it from coming out.
   ★ Set stand ① under the cylinder assembly, and adjust the position for slinging.

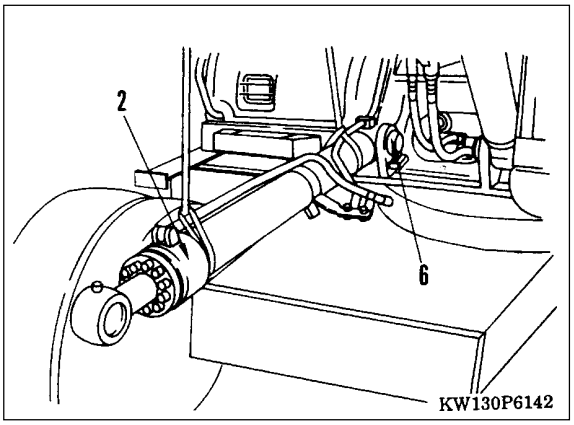
Release the remaining pressure in the hydraulic circuit.
For details, see TESTING AND ADJUSTING, Releasing remaining pressure in hydraulic circuit.

5. Disconnect hoses (5).
6. Remove plate, then remove bottom pin (6), 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: 130 kg.







INSTALLATION OF 1ST 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 cylinder rod (7) and plate (8) is below 1 mm.
★ Standard shim thickness: 1.0 mm.

※ 3

Inside surface of bushing when assembling pin: Anti-friction compound (LM-P).

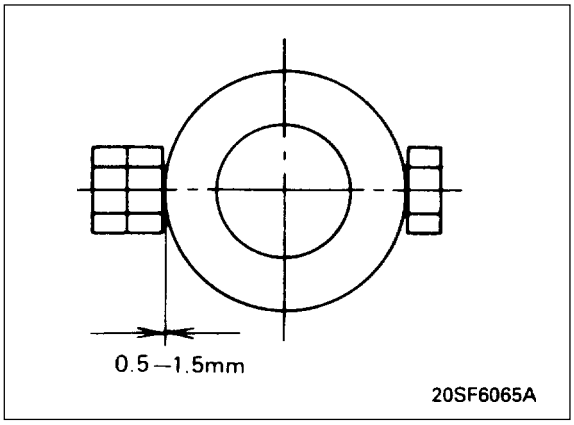
Greasing after assembling pin: Grease (LM-G).

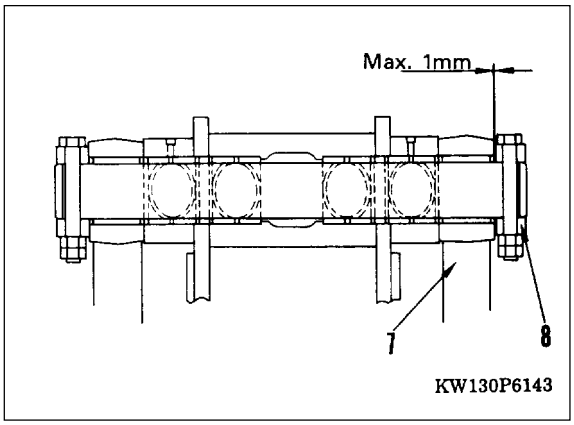
When aligning the position of the pin hole, never insert your fingers in the pin hole.

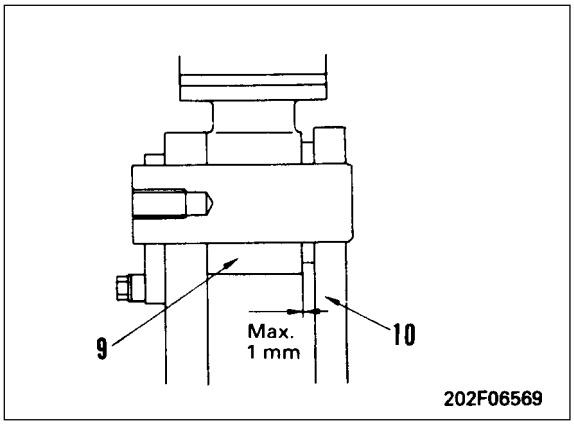
★ Adjust the shim thickness so that the clearance between cylinder bottom (9) and bracket (1) is below 1mm.
★ Standard shim thickness: 1.0 mm, 2.0 mm.

- 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.

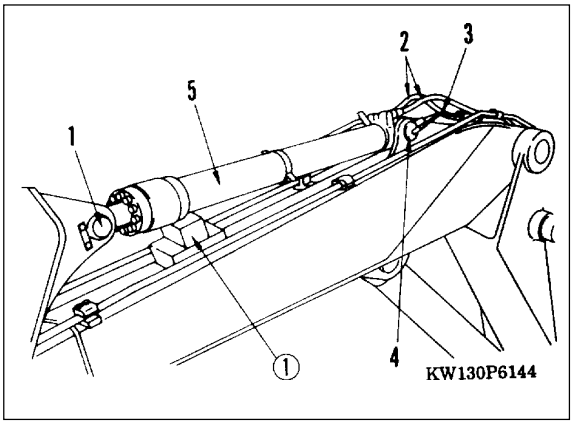
- Bleeding air
★ Bleed the air from the cylinder.
For details, see TESTING AND ADJUSTING, Bleeding air from hydraulic cylinder.







REMOVAL OF ARM CYLINDER ASSEMBLY



Extend the arm cylinder piston rod approx. 200 mm, lower the work equipment completely to the ground, then set the remaining safety lock lever to the LOCK position.

1. Set block ① between arm cylinder and boom.
2. Remove plate, then remove head pin (1). ※ 1
   ★ 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 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.
4. Disconnect hoses (2).
5. Disconnect grease tube (3).
6. Sling arm cylinder assembly, remove plate, remove bottom pin (4), then remove arm cylinder assembly (5). ※ 2
   ★ There are shims installed, so check the number and thickness, and keep in a safe place.

   kg Arm cylinder assembly: 170 kg.

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.

★ Adjust the shim thickness so that the clearance between cylinder rod (6) and bracket (7) is below 1 mm.
★ Standard shim thickness: 1.0 mm.

※ 2

Inside surface of bushing when assembling pin: Anti-friction compound (LM-P).

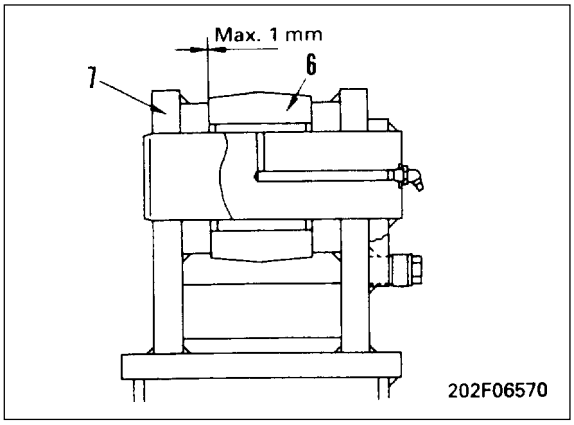
Greasing after assembling pin: Grease (LM-G).

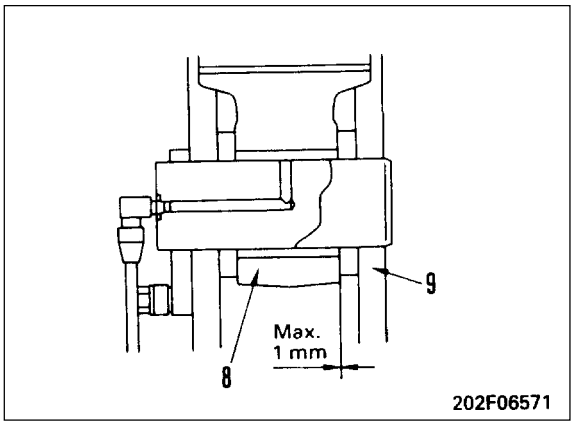
When aligning the position of the pin hole, never insert your fingers in the pin hole.

★ Adjust the shim thickness so that the clearance between cylinder bottom (8) and bracket (9) is below 1 mm.
★ Standard shim thickness: 1.0 mm.

- 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 cylinder.
  For details, see TESTING AND ADJUSTING, Bleeding air from hydraulic cylinder.





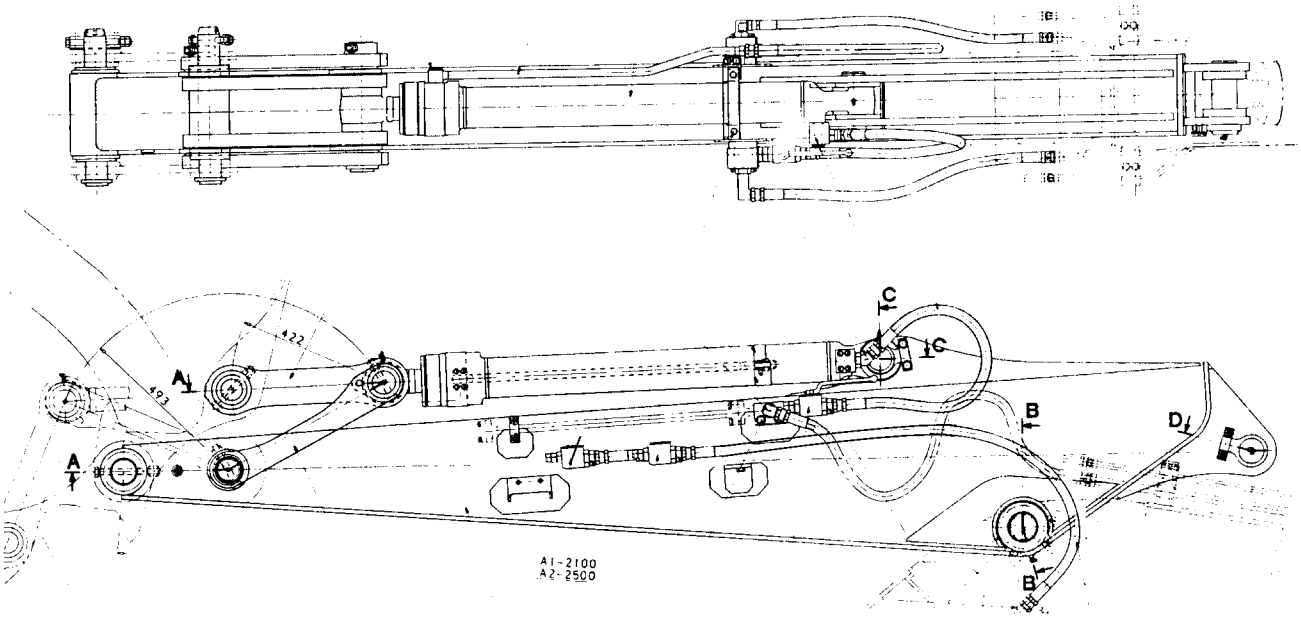
REMOVAL OF BUCKET CYLINDER ASSEMBLY

Extend the bucket cylinder piston rod approx. 200 mm, 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.
2. Set block ② between link and arm, and block ③ between bucket cylinder and arm.
3. Remove lock bolt (1). ※ 1
4. Remove plate, then remove head pin (2). ※ 2
   ★ There are shims installed, so check the number and thickness, and keep in a safe place.
5. 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.
6. Disconnect 2 hoses (3).
7. Sling bucket cylinder assembly, remove plate, remove bottom pin (4), then 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: 100 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.

※ 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 cylinder rod (6) and bracket (7) is below 1 mm.
★ Standard shim thickness: 1.0 mm.

※ 3

Inside surface of bushing when assembling pin: Anti-friction compound (LM-P).

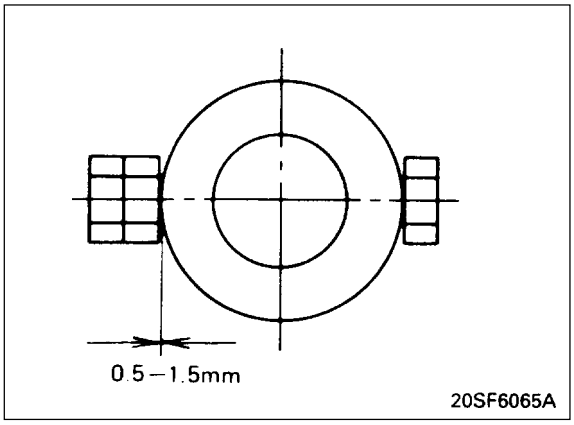
Grease after assembling pin: Grease (LM-G).

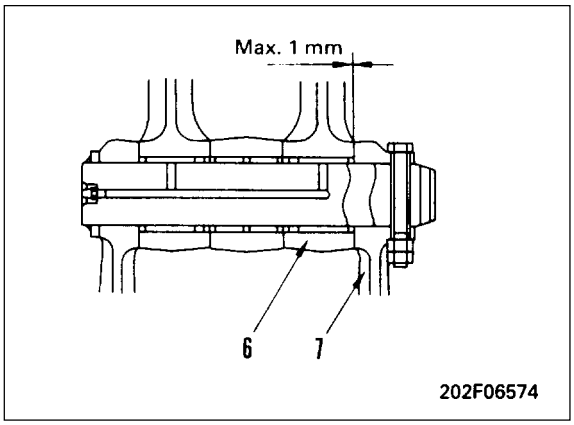
When aligning the position of the pin hole, never insert your fingers in the pin hole.

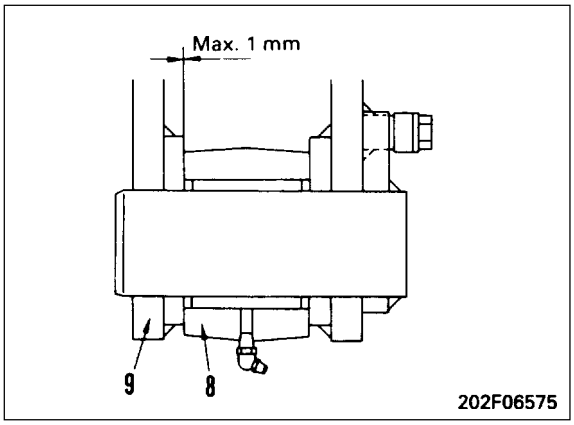
★ Adjust the shim thickness so that the clearance between cylinder bottom (8) and bracket (9) is below 1 mm.
★ Standard shim thickness: 1.0 mm.

- 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.

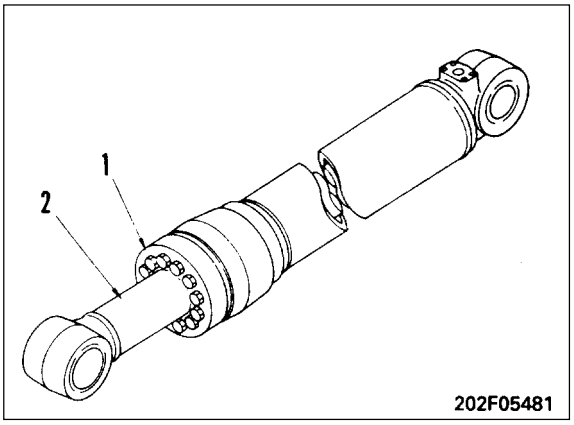
- Bleeding air
  ★ Bleed the air from the cylinder.
  For details, see TESTING AND ADJUSTING, Bleeding air from hydraulic cylinder.







DISASSEMBLY OF HYDRAULIC CYLINDER ASSEMBLY (PISTON FIXED WITH NUT TYPE)



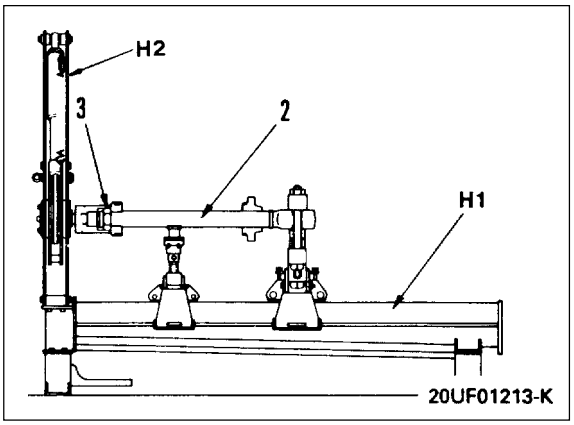
1. Piston rod assembly

1) Remove piping from cylinder assembly.

2) Remove mounting bolts, and disconnect head assembly (1).

3) Pull out piston rod assembly (2).
   ★ Place a container to catch the oil under the cylinder.

4) Disassemble piston rod assembly as follows:
   i) Set piston rod assembly (2) in tool **H1**.

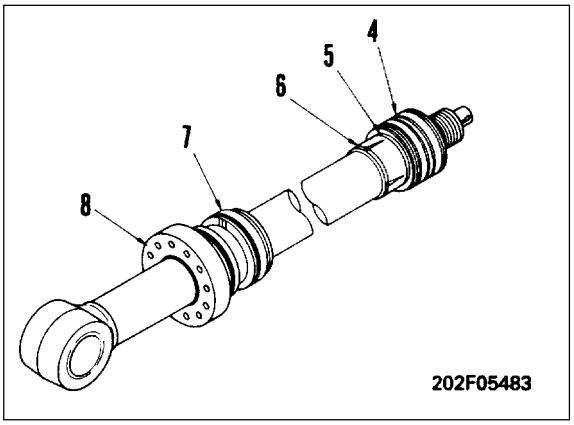


   ii) Using tool **H2**, remove nut (3).
   ★ Width across flats of nut.

Unit: mm

Cylinder / Model	1st Boom	2nd Boom	Arm	Bucket
PW130	80	80	85	70

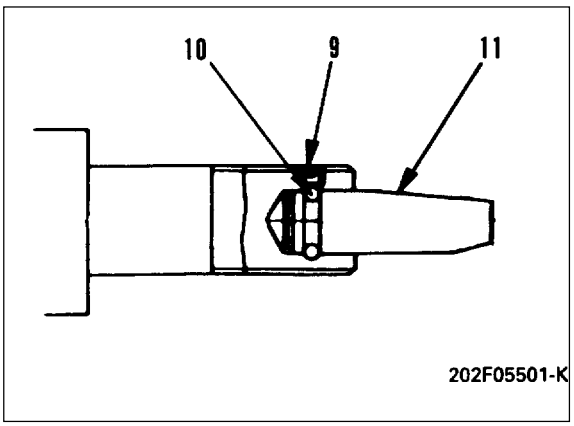
   iii) Remove piston assembly (4).



   iv) Remove retainer (5) and plunger (6).
   • Arm cylinder only.

   v) Remove collar (7).
   • Arm cylinder only.

   vi) Remove head assembly (8).



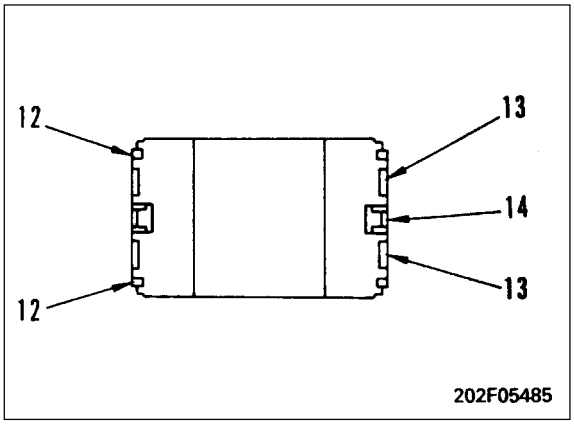
   vii) Remove cap (9), and remove 11 ball bearings (10), then remove plunger (11).
   • Arm cylinder only.

2. Disassembly of piston assembly

1) Remove rings (12).

2) Remove wear rings (13).

3) Remove piston ring (14).



3. Disassembly of cylinder head assembly

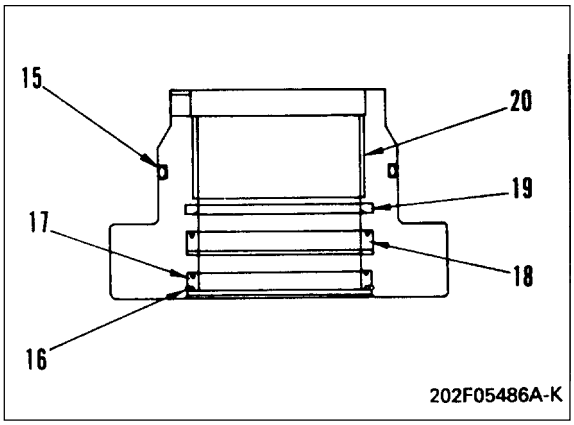
1) Remove O-ring and backup ring (15).

2) Remove snap ring (16), then remove dust seal (17).

3) Remove rod packing (18).

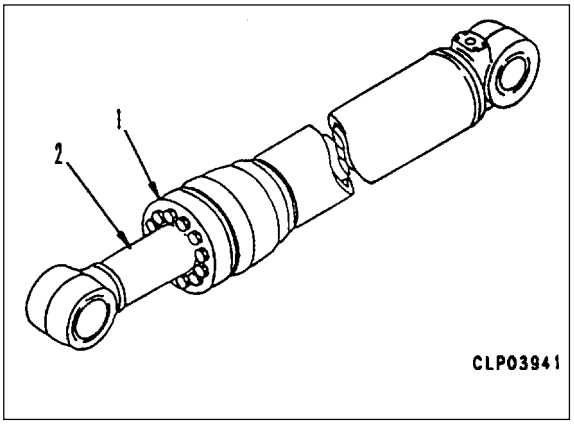
4) Remove buffer ring (19).

5) Remove bushing (20).

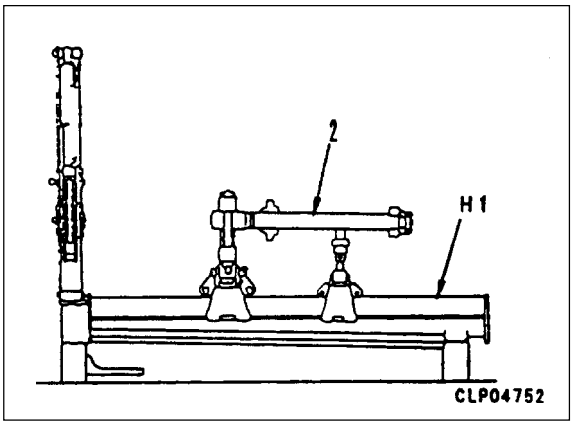


DISASSEMBLY OF HYDRAULIC CYLINDER ASSEMBLY (THREADED PISTON TYPE)

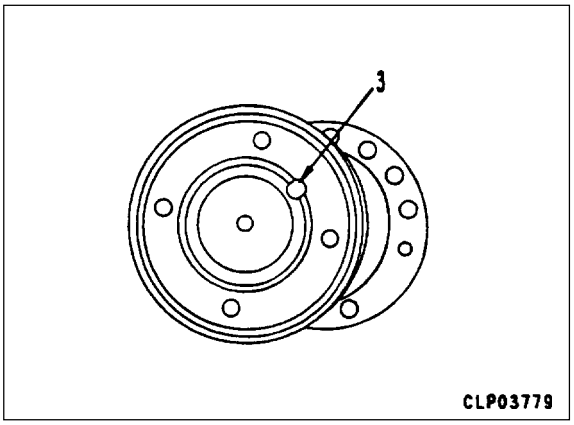
1. Piston rod assembly
   1) Remove piping from cylinder assembly.
   2) Remove mounting bolts and disconnect head assembly (1).
   3) Pull out piston rod assembly (2).
      ★ Place a container under the cylinder to catch the oil.



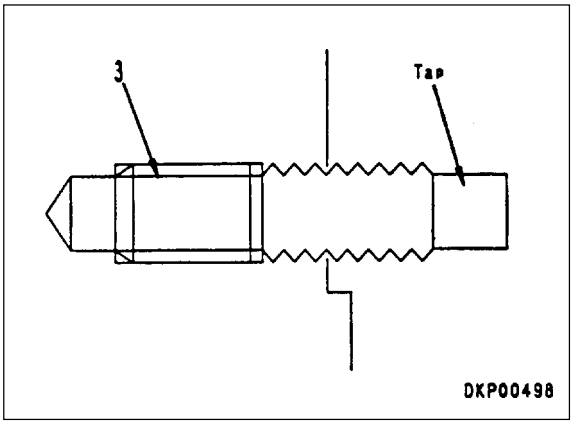
4) Disassemble piston rod assembly as follows:
   i) Set piston rod assembly (2) in tool **H1**.



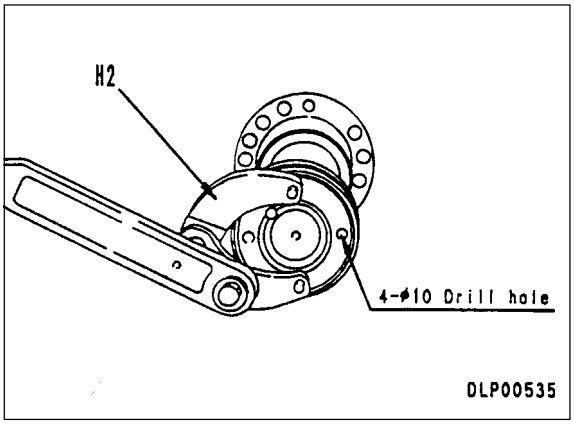
   ii) Remove piston assembly stopper screw (3).
      ★ Screw size (common for all of boom, arm, and bucket cylinders)
         : M12 x Pitch 1.75 (boom, arm)
         : M10 x Pitch 1.5 (bucket).



      ★ If screw (3) is caulked strongly and cannot be removed, screw it in fully and make a tap in the screw to remove it.



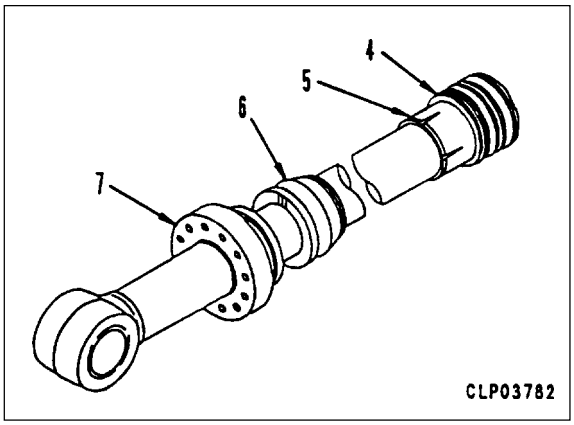
iii) Using tool H2, remove piston assembly (4).
- When not using tool H2, use drill holes (O/10: 4 places) and loosen the piston assembly.



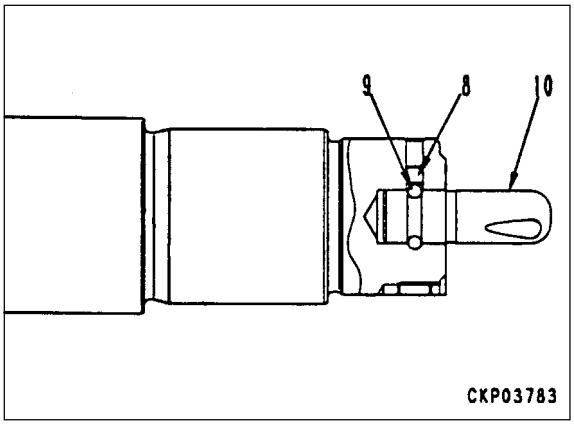
iv) Remove plunger (5).
- Arm cylinder only.

v) Remove collar (6).
- Arm cylinder only.

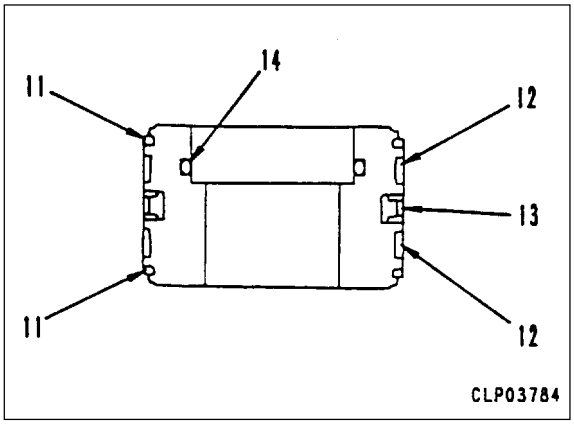
vi) Remove head assembly (7).



vii) Remove cap (8), and pull out 11 balls (9), then remove cushion plunger (10).
- Arm cylinder only.

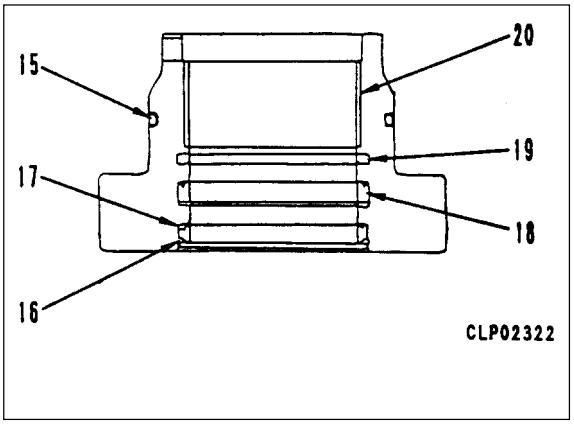


2. Disassembly of piston assembly
1) Remove rings (11).
2) Remove wear rings (12).
3) Remove piston ring (13).
4) Remove O-ring and backup ring (14).



3. Disassembly of cylinder head assembly

1) Remove O-ring and backup ring (15).
2) Remove snap ring (16), then remove dust seal (17).
3) Remove rod packing (18).
4) Remove buffer ring (19).
5) Remove bushing (20).

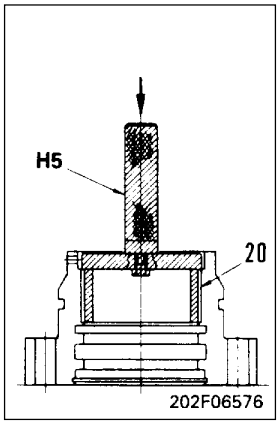


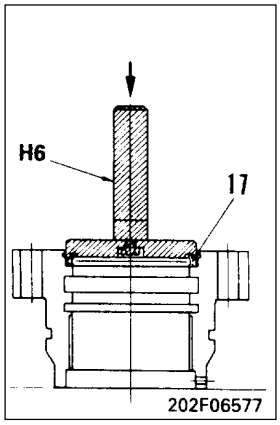
ASSEMBLY OF HYDRAULIC CYLINDER ASSEMBLY (PISTON FIXED WITH NUT TYPE)

★ Be careful not to damage the packings, dust seal, and O-rings.
★ Do not try to force the backup ring into position. Warm it in warm water (50 - 60oC) before fitting it.

1. Assembly of cylinder head assembly

1) Using tool **H5**, press fit bushing (20).



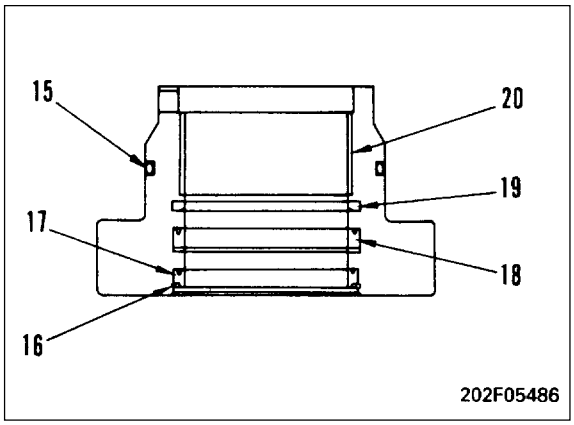


2) Assemble buffer ring (19).

3) Assemble rod packing (18).

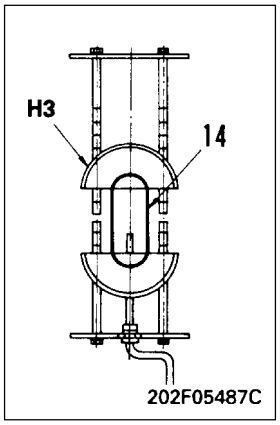
4) Using tool **H6**, install dust seal (17), and secure with snap ring (16).

5) Install backup ring and O-ring (15).

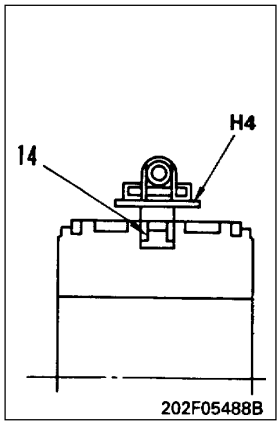


2. Assembly of piston assembly

1) Using tool **H3**, expand piston ring (14).
★ Set the piston ring on the tool **H3**, and turn the handle 8 - 10 times to expand the ring.



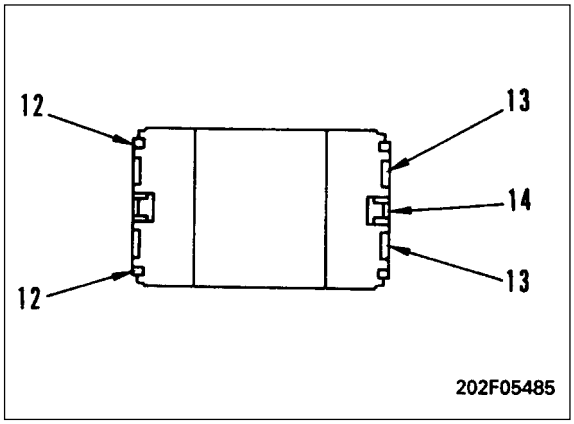
2) Set tool **H4** in position, and compress piston ring (14).



3) Assemble wear ring (13).

4) Assemble ring (12).
★ Be careful not to open the end gap of the ring too wide.

Ring groove: Grease (G2-LI).



3. Piston rod assembly

1) Set plunger (11) to piston rod, and assemble 12 balls (10), then secure with cap (9).
   ★ Check that there is a slight play at the tip of the plunger.
   • Arm cylinder only.

2) Assemble head assembly (8).

3) Fit O-ring and backup ring, and assemble collar (7).
   • Arm cylinder only.

4) Assemble plunger (6).
   • Arm cylinder only.

5) Assemble retainer (5).
   • Arm cylinder only.

6) Assemble piston assembly (4).

7) Set piston assembly (2) to tool **H1**.

8) Using tool **H2**, tighten nut (3).

Nut: Thread tightener (LT-2).

kgm Nut:

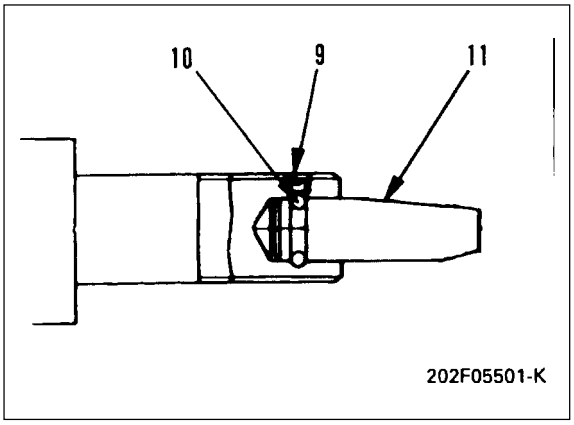
Unit: kNm (kgm)

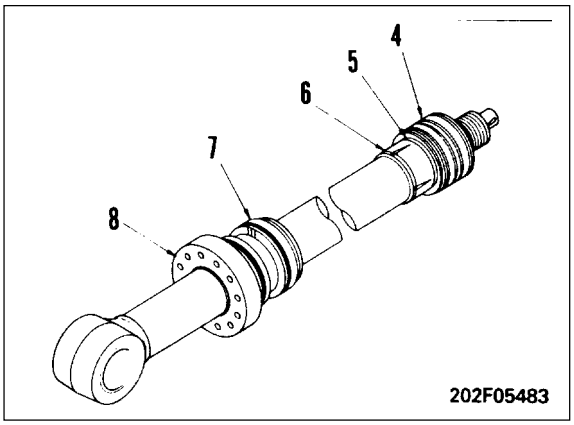
Cylinder / Model	1st & 2nd Boom	Arm	Bucket
PW130	5.1 ± 0.5 (520 ± 52)	7.1 ± 0.7 (720 ± 72)	3.3 ± 0.3 (340 ± 34)

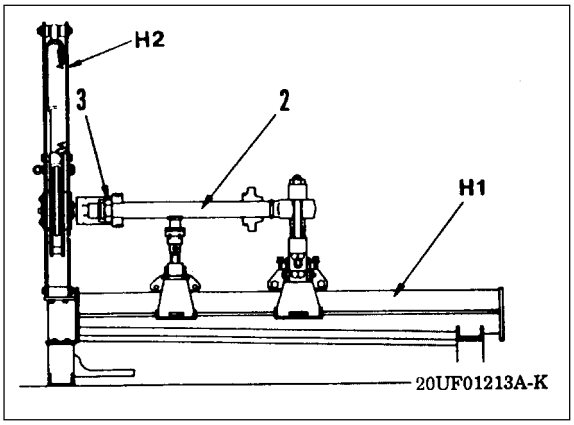
9) Assemble piston rod assembly (2).

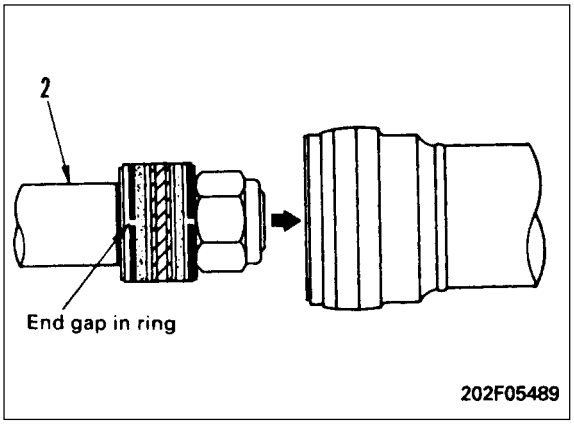
Seal: Grease (G2-LI).

★ 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.







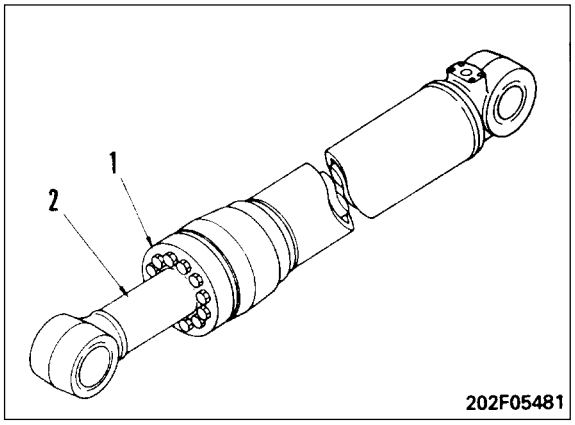


10) Tighten head assembly (1) with mounting bolts.

kgm Mounting bolt:

Unit: Nm (kgm)

Cylinder	Tightening torque
1st Boom	172 ± 24.5 (17.5 ± 2.5)
Arm	270 ± 39 (27.5 ± 4.0)
Bucket	172 ± 24.5 (17.5 ± 2.5)
2nd Boom	372 ± 54 (38 ± 5.5)



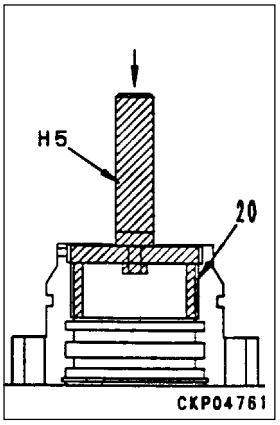
11) Install piping.

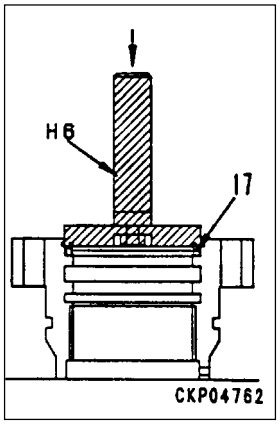
ASSEMBLY OF HYDRAULIC CYLINDER ASSEMBLY (THREADED PISTON TYPE)

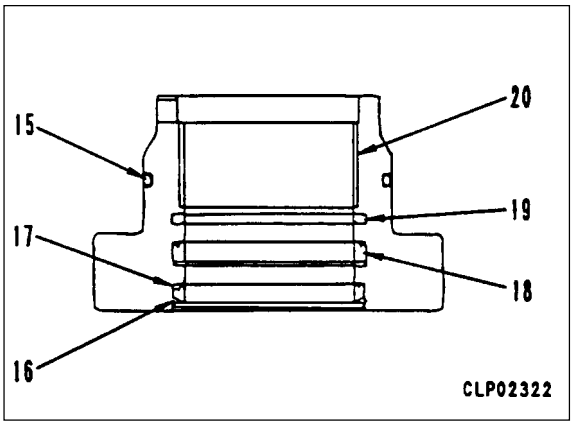
★ Be careful not to damage the packings, dust seals, and O-rings.
★ Do not try to force the backup ring into position. Warm it in warm water (50 - 60°C) before fitting it.

1. Assembly of cylinder head assembly

1) Using tool **H5**, press fit bushing (20).
2) Assemble buffer ring (19).
3) Assemble rod packing (18).
4) Using tool **H6**, install dust seal (17), and secure with snap ring (16).
5) Install backup ring and O-ring (15).

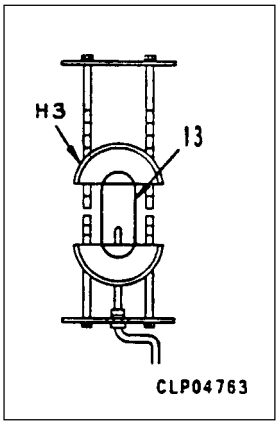


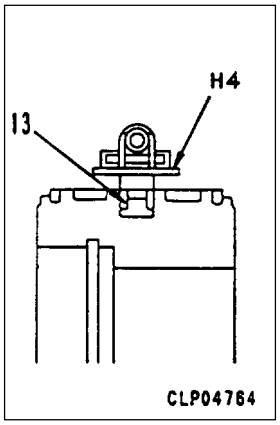




2. Assembly of piston assembly

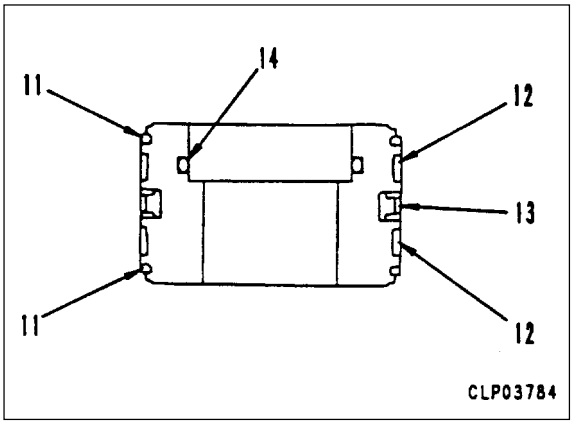
1) Using tool **H3**, expand piston ring (13).
   ★ Set the piston ring on the tool **H3**, and turn the handle 8 - 10 times to expand the ring.
2) Set tool **H4** in position, and compress piston ring (13).





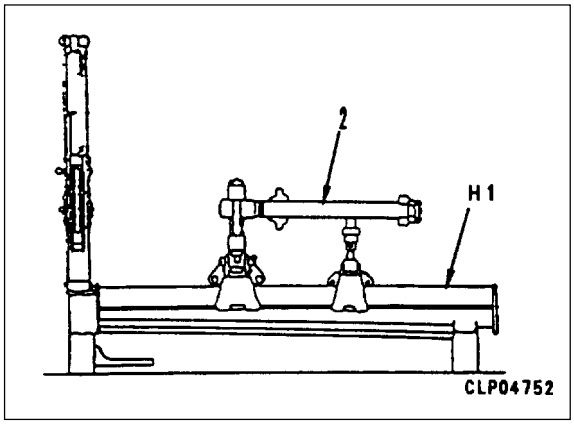
3) Install backup ring and O-ring (14).
4) Assemble wear rings (12).
5) Assemble rings (11).
   ★ Be careful not to open the end gap of the ring too wide.

Ring groove: Grease (G2-LI).

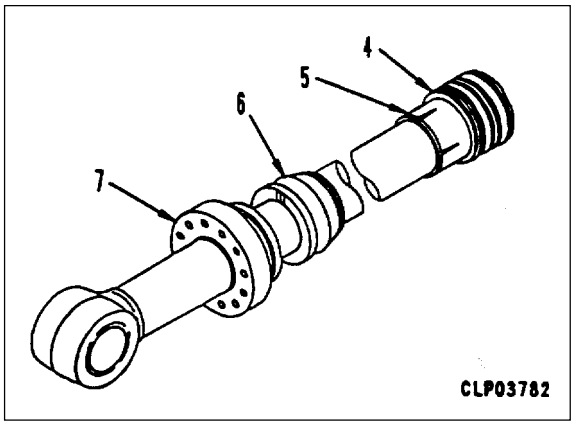


3. Piston rod assembly

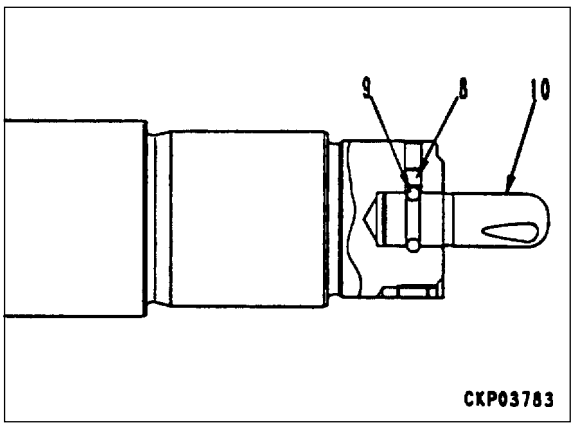
1) Set piston rod assembly (2) in tool H1.



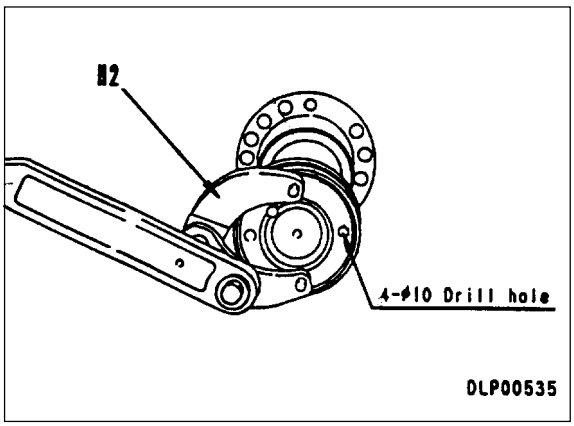
2) Assemble head assembly (7).
3) Fit O-ring and backup ring, to collar (6), and assemble.
   - Arm cylinder only.
4) Assemble plunger (5).
   - Arm cylinder only.
   - ★ Check that there is a small amount of play at the tip of the plunger.



5) Set cushion plunger (10) to piston rod, assemble 11 balls (9), then secure with cap (8).
   - Arm cylinder only.

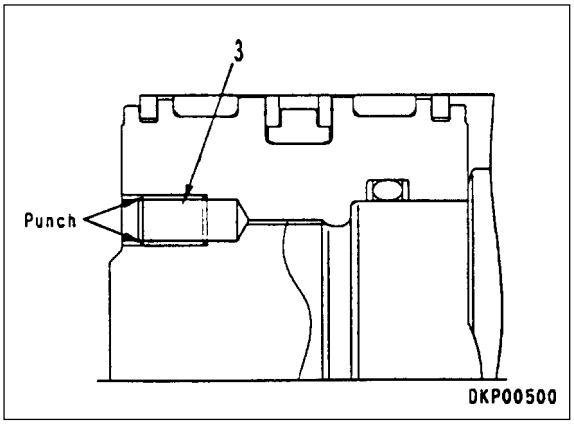


6) Assemble piston assembly (4) as follows:
   - When using rod and piston assembly (2) again:
     - ★ Wash thoroughly and remove all metal particles and dirt.
     - i) Screw in piston assembly (4), then use tool H2 to tighten piston assembly (2) until positions of screw holes are aligned.
       - ★ Use a file to remove all burrs and flashes from the thread.
     - iii) Tighten screw (3).



kgm Screw:
66.2 ± 7.35 Nm {6.75 ± 0.75 kgm}

III) Caulk thread at 2 places with punch.

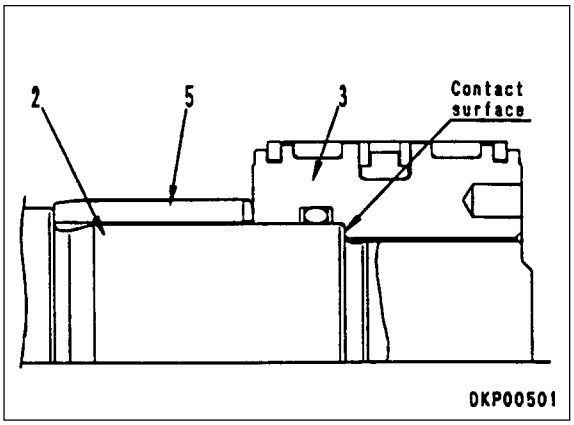


- When using a new part for one or both of rod and piston assembly (2):
  - ★ For rods with a bottom cushion, make a mark on the end face of the rod to show the position of the cushion plug.
    - Arm cylinder only.

i) Screw in piston assembly (4) until it contacts the end face of the rod, then tighten with tool H2.

kgm Piston assembly (4):
294 ± 29.4 Nm {30 ± 3.0 kgm)

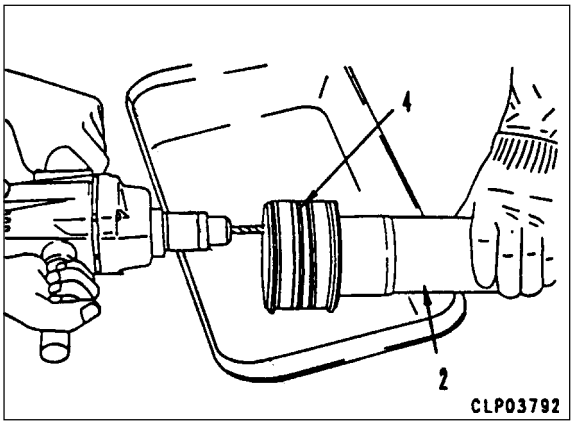
- ★ After tightening the piston, check that there is play in plunger (5).
- Boom, arm cylinder only.



ii) Machine one screw hole to install screw (3).

- ★ Align a drill with the V-groove in the thread of rod (2) and piston (4) and machine the hole horizontally.
- ★ For cylinders with a bottom cushion (arm cylinder), avoid the position of the cushion plug when machining.
- Screw machining dimension (mm)

Bottom drill diameter	Bottom drill depth	Tap size	Tap depth
10.3	27	12 x 1.75	20

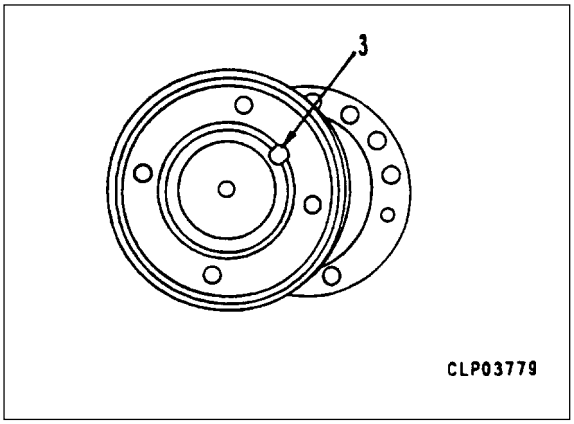


iii) After machining, remove all metal particles and dirt, and wash thoroughly.

iv) Tighten screw (3).

kgm Screw (3):
66.2 ± 7.35 Nm {6.75 ± 0.75 kgm}

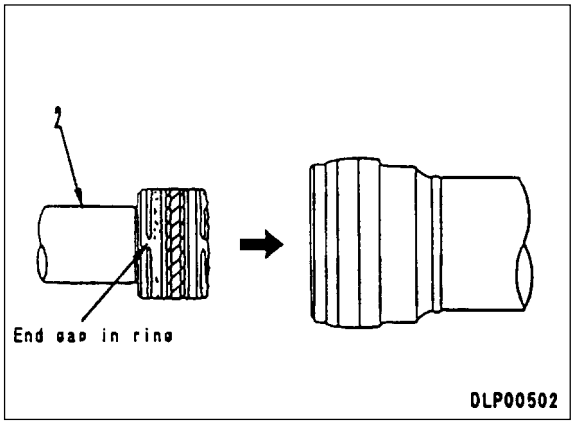
v) Caulk thread at 2 places with punch.



7) Assemble piston rod assembly (2).

Seal: Grease (G2-LI)

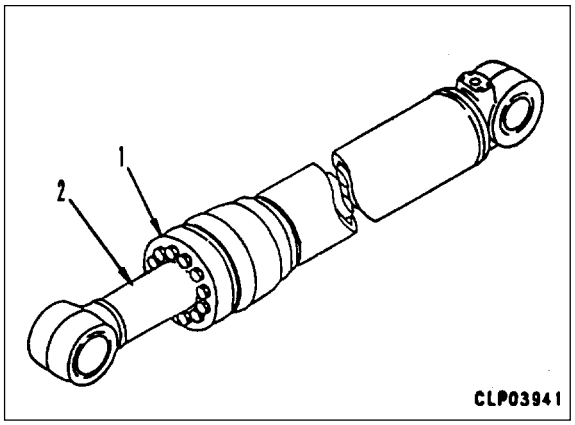
★ Set the end gap of the ring at the horizontal (side) position, align the center of shaft and cylinder tube, then insert.
★ After inserting, check that the ring is not broken and has not come out, then push in fully.



8) Tighten head assembly (1) with mounting bolts.

Mounting bolt:

Cylinder	Tightening torque
Bucket	172 ± 25 Nm {17.5 ± 2.5 kgm}
Arm	270 ± 39 Nm {27.5 ± 4.0 kgm}
Boom	172 ± 25 Nm {17.5 ± 2.5 kgm}



9) Install piping.

REMOVAL OF WORK EQUIPMENT ASSEMBLY

Extend the arm and bucket fully, retract 2nd boom 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, then remove head pin (4). ※ 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 tie piston rod with wire to prevent it from coming out, and lower it onto block.
   ★ Disconnect the boom cylinder on the opposite side in the same way.

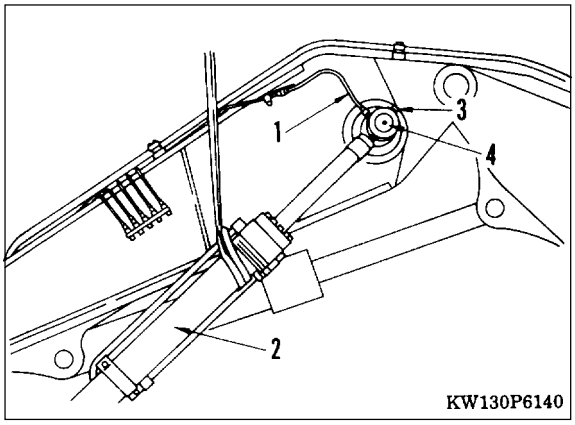
   Release the remaining pressure in the hydraulic circuit.
   For details, See TESTING AND ADJUSTING, Releasing remaining pressure in hydraulic circuit.

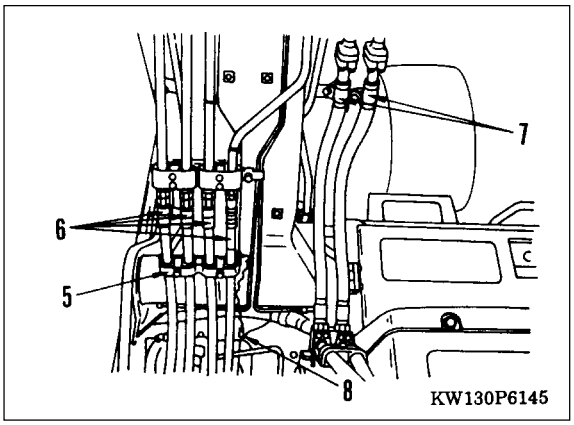
5. Remove clamp (5), and disconnect hoses (6) and (7), then secure it to valve with rope.

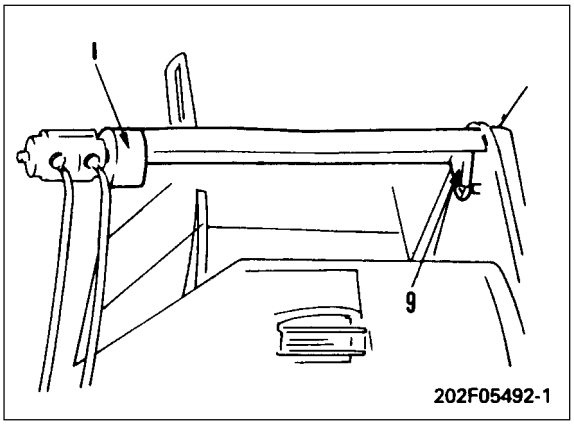
6. Disconnect wiring connector (8) for working lamp.

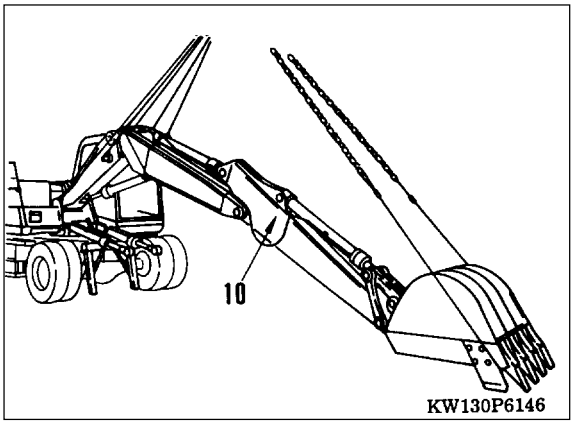
7. Sling work equipment assembly, remove plate, then remove foot pin (9) using tool **I**, and remove work equipment assembly (10). ※ 3
   ★ There are shims installed, so check the number and thickness, and keep in a safe place.

   kg Work equipment assembly:
   1 Piece Boom - 1,900 kg
   2 Piece Boom - 2,200 kg







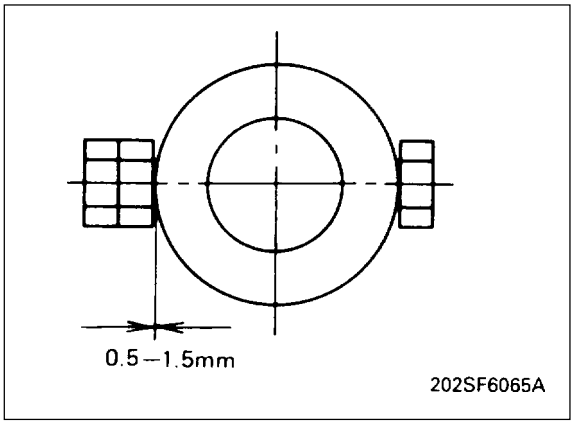


INSTALLATION OF WORK EQUIPMENT ASSEMBLY

- 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.



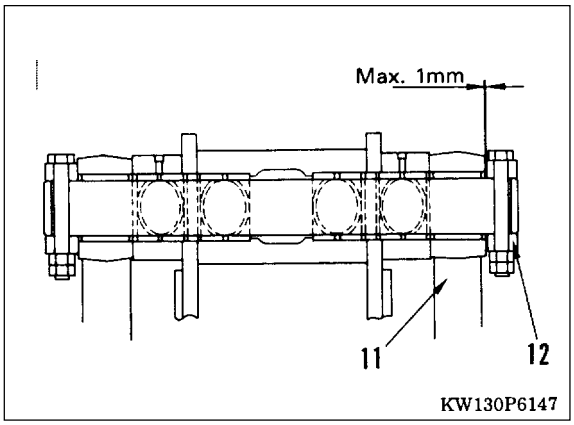
※ 2

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 the pin hole.

★ Adjust the shim thickness so that the clearance between cylinder rod (11) and plate (12) is below 1 mm.
★ Standard shim thickness: 1.0 mm.



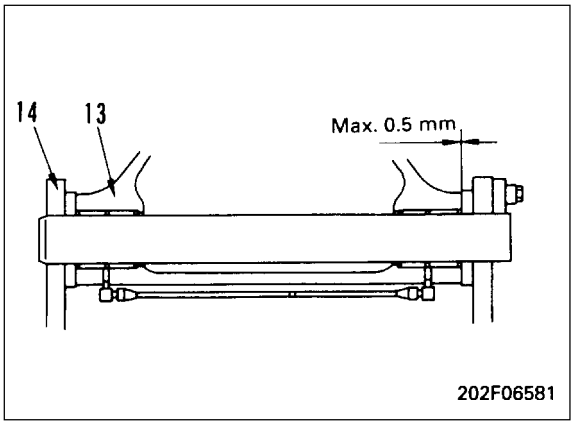
※ 3

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 boom (13) and bracket (14) is below 0.5 mm.
★ Standard shim thickness: 0.5 mm, 1.0 mm, 2.0 mm.



- 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.

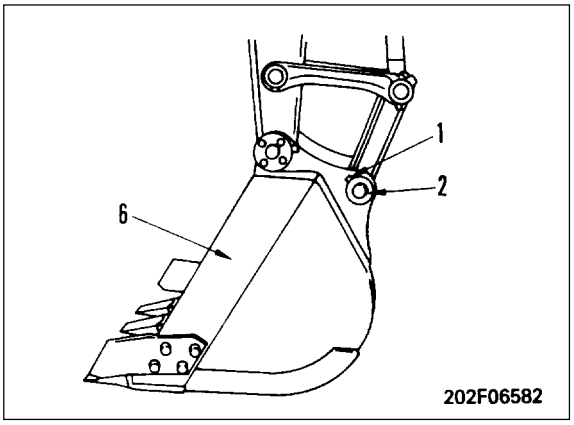
- Bleeding air
★ Bleed the air from the cylinder.
For details, see TESTING AND ADJUSTING, Bleeding air from hydraulic cylinder.

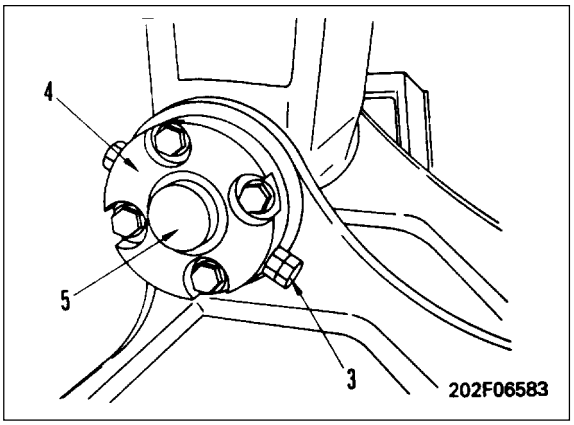
REMOVAL OF BUCKET ASSEMBLY

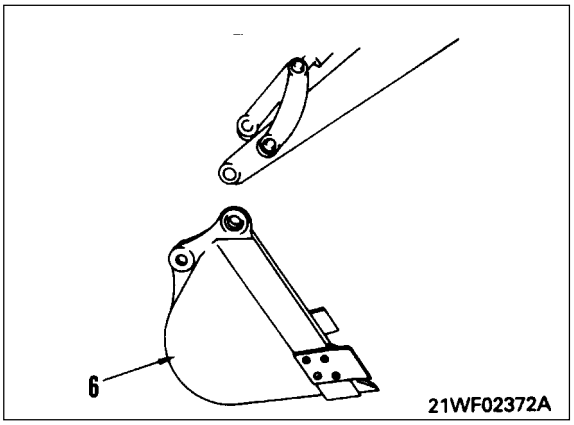
Set the back of the bucket facing down, lower the work equipment completely to the ground, and set the safety lock lever to the LOCK position.

1. Remove lock bolt (1). ※ 1
2. Remove 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 piston rod with wire to prevent it 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. After raising work equipment, swing to disconnect bucket assembly (6).

   kg Bucket assembly: 400 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 bucket boss (7) and link (8) is below 1 mm.
  ★ Standard shim thickness: 1.0 mm, 2.0 mm.

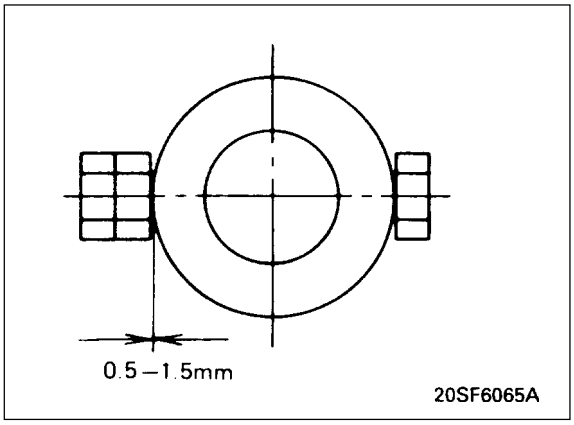
※ 4

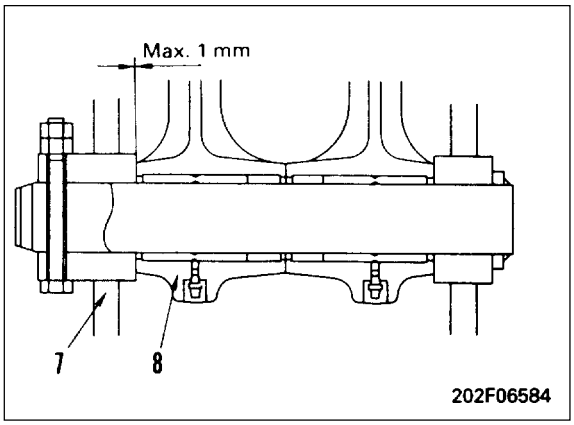
Inside surface of bushing when assembling pin, inside surface, end face of collar (10): Anti-friction compound (LM-P).

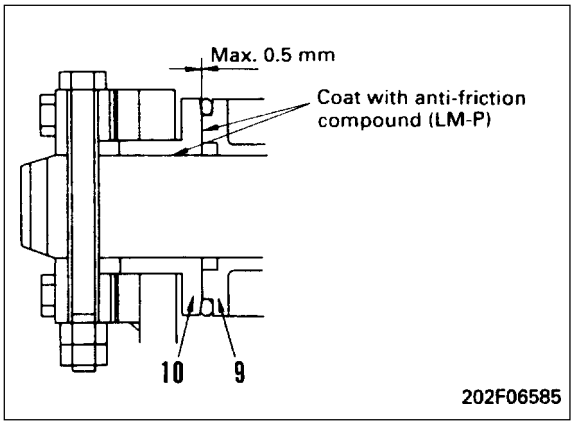
Grease after assembling pin: Grease (LM-G)

When aligning the position of the pin hole, never insert your fingers in the pin hole.

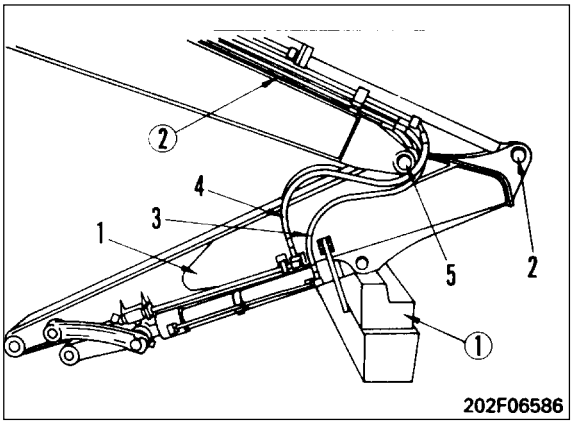
★ Set the O-ring at the end face of the bucket boss securely.
★ Adjust the shim thickness so that the clearance between arm top (9) and spacer (10) is below 0.5 mm.
  ★ Standard shim thickness: 0.5 mm, 1.0 mm.







REMOVAL OF ARM ASSEMBLY



1. Remove bucket assembly.
   For details, see REMOVAL OF BUCKET ASSEMBLY.

2. Secure front link to arm with wire.

3. Pull in arm so that is easy to remove pin at arm cylinder head, then lower arm and bucket cylinder assembly (1) on to block ①.

   Set the safety lock lever to the LOCK position.

4. Set block ② between arm cylinder and boom.

5. Remove plate, then remove arm cylinder head pin (2). ※ 1

   ★ There are shims installed, so check the number and thickness, and keep in a safe place.

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 hoses (3) and 2 hoses (4).

   ★ Install blind plugs at the male end and in the disconnected hoses.

8. Remove plate, then remove connecting ping (5) between arm and boom. ※ 2

   ★ There are shims installed, so check the number and thickness, and keep in a safe place.

9. After raising boom, swing to remove arm and bucket cylinder assembly (1).

   kg Arm - Bucket cylinder assembly: 550 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.

★ Adjust the shim thickness so that the clearance between cylinder rod (6) and bracket (7) is below 1 mm.
★ Standard shim thickness: 1.0 mm.

※ 1

Inside surface of bushing when assembling pin: Anti-friction compound (LM-P).

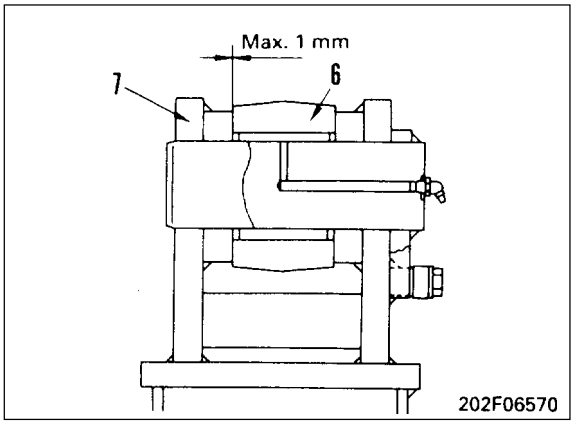
Grease after assembling pin: Grease (LM-G)

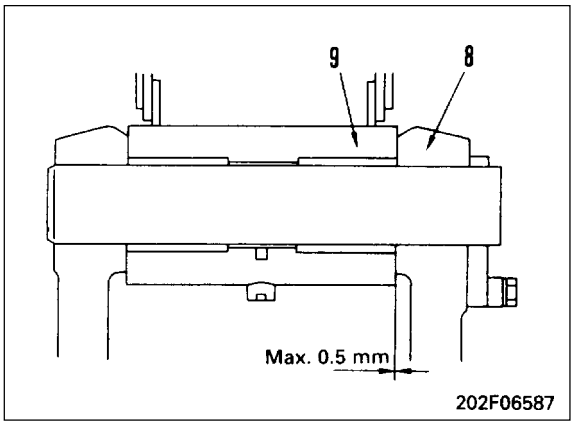
When aligning the position of the pin hole, never insert your fingers in the pin hole.

★ Adjust the shim thickness so that the clearance between boom top (8) and arm bottom (9) is below 0.5 mm.
★ Standard shim thickness: 0.5 mm, 1.0 mm.

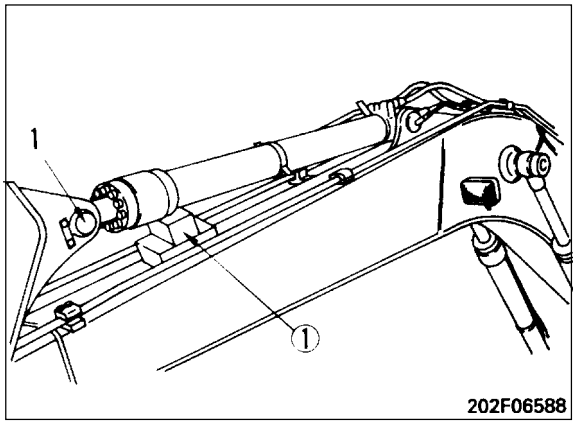
- Refilling with oil (hydraulic tank)
  ★ Add oil through the oil filler to the specified level. Run the engine to circulate the oil through the system. Then check the oil level again.

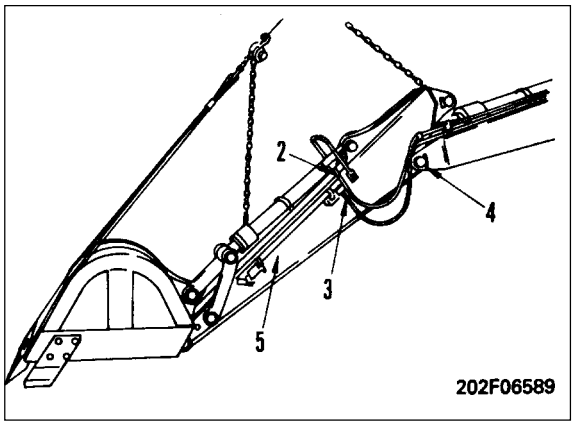
- Bleeding air
  ★ Bleed the air from the cylinder.
  For details, see TESTING AND ADJUSTING, Bleeding air from hydraulic cylinder.





REMOVAL OF BUCKET - ARM ASSEMBLY





Extend the arm cylinder piston rod approx. 200 mm, 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. Remove plate, then remove arm cylinder head pin (1). ※ 1
   - ★ 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 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.
4. Disconnect 2 hoses (2) and 2 hoses (3).
   - ★ Install blind plugs at the male end and in the disconnected hoses. ※ 2
5. Raise bucket and arm assembly, remove plate, then remove connecting pin (4) between arm and boom, and remove bucket and arm assembly (5).
   - ★ There are shims installed, so check the number and thickness, and keep in a safe place.

   kg Bucket - Arm assembly: 950 kg.

INSTALLATION OF BUCKET - 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.

★ Adjust the shim thickness so that the clearance between cylinder rod (6) and bracket (7) is below 1 mm.
★ Standard shim thickness: 1.0 mm.

※ 2

Inside surface of bushing when assembling pin: Anti-friction compound (LM-P).

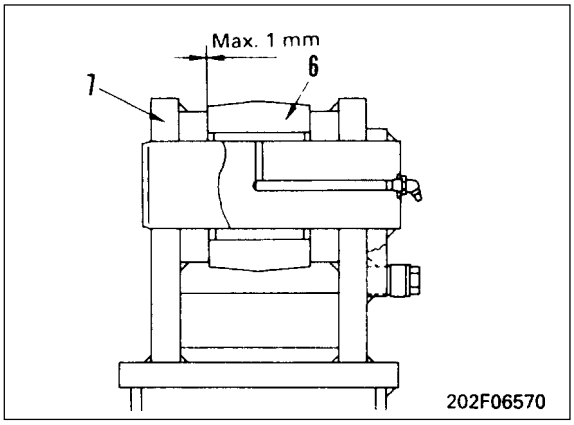
Grease after assembling pin: Grease (LM-G)

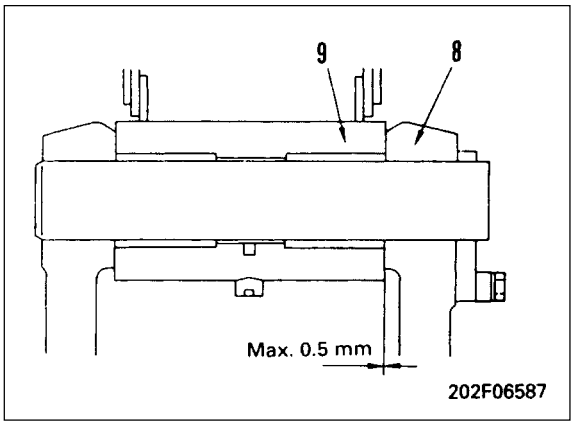
When aligning the position of the pin hole, never insert your fingers in the pin hole.

★ Adjust the shim thickness so that the clearance between boom top (8) and arm bottom (9) is below 0.5 mm.
★ Standard shim thickness: 0.5 mm, 1.0 mm.

- 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 cylinder.
  For details, see TESTING AND ADJUSTING, Bleeding air from hydraulic cylinder.





REMOVAL OF BOOM ASSEMBLY

1. Remove bucket and arm assembly.
   For details, se REMOVAL OF BUCKET, ARM ASSEMBLY.

2. Lower boom assembly completely to the ground, then set the safety lock lever to the LOCK position.

3. Disconnect grease hose (1).

4. Sling boom cylinder assembly (2), and remove lock bolt (3). ※ 1

5. Remove plate, then remove head pin (4). ※ 2
   ★ There are shims installed, so check the number and thickness, and keep in a safe place.

6. Start engine, and retract piston rod, then tie piston rod with wire to prevent it from coming out, and lower it onto block.
   ★ 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.

7. Remove clamp (5), and disconnect hoses (6) and (7), then secure to valve end with rope.
   ★ Hoses (7) are only for the service 1 additional circuit.

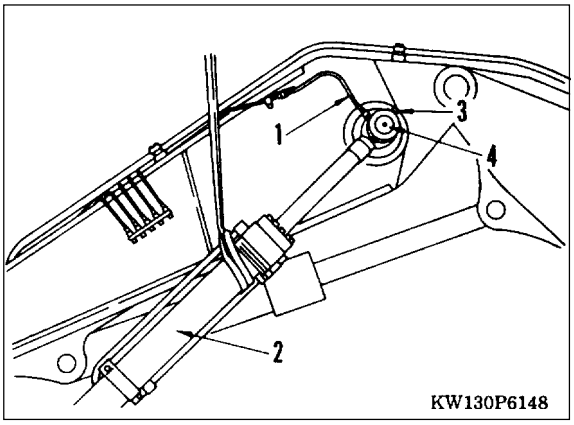
8. Disconnect wiring connector (8) for working lamp. ※ 3

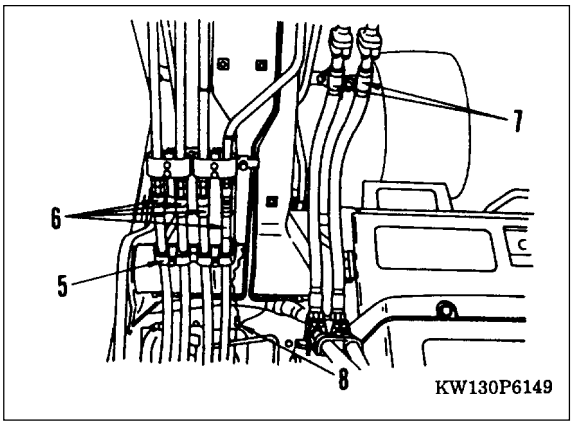
9. Sling boom assembly and remove plate, remove foot pin (9) using tool **I**, then remove boom assembly (10).

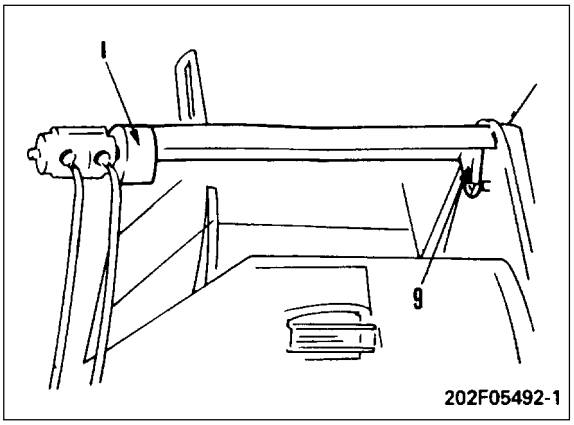
   ★ There are shims installed, so check the number and thickness, and keep in a safe place.

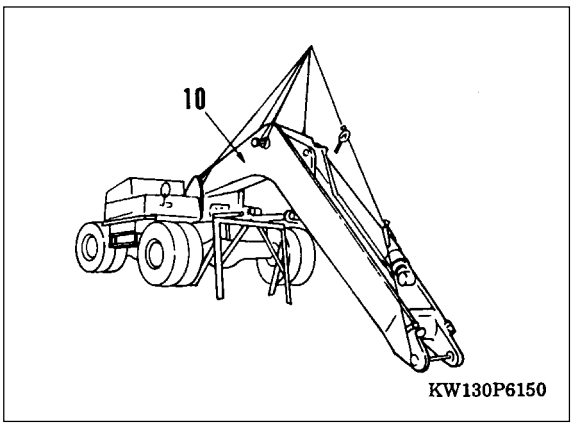
   kg Boom assembly:

   1 Piece Boom - 950 kg
   2 Piece Boom - 1,250 kg







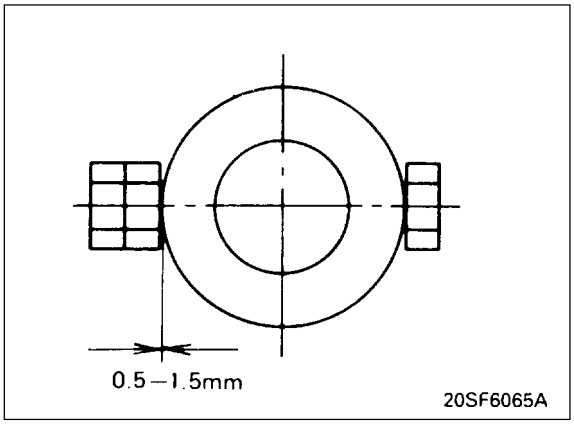


INSTALLATION OF BOOM ASSEMBLY

- 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.



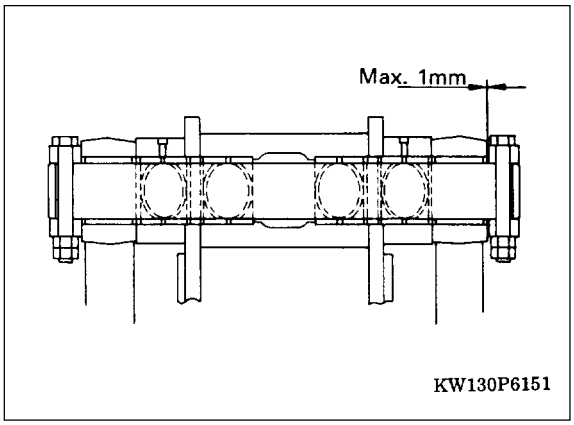
※ 2

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 the pin hole.

★ Adjust the shim thickness so that the clearance between cylinder rod (11) and plate (12) is below 1 mm.
★ Standard shim thickness: 1.0 mm.



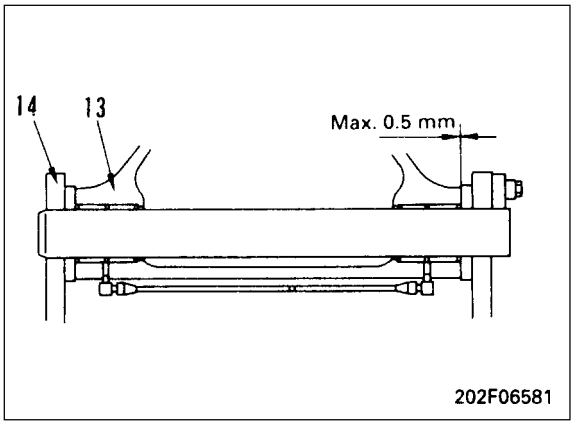
※ 3

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 boom (13) and bracket (14) is below 0.5 mm.
★ Standard shim thickness: 0.5 mm, 1.0 mm, 2.0 mm.



- 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 cylinder.
For details, see TESTING AND ADJUSTING, Bleeding air from hydraulic cylinder.

OUTRIGGER CYLINDER

REMOVAL OF OUTRIGGER CYLINDER

1) Lower the outriggers until they just touch the ground but not take any weight of the machine.

2) Turn off the engine.

3) Depressurize the outrigger hydraulic circuit.

4) Disconnect the hydraulic lines from the cylinder.

5) Attach lifting tackle.

6) Remove bolt (2) and pin (1).

7) Remove bolts (4) and pin (3).

8) Remove cylinder.

9) **Important**: Depressurize cylinder before opening it. To depressurize, loosen the two plugs (5) by approx. 2 turns using an Allen key and wait until pressure has escaped. To be absolutely sure, remove the plugs completely after pressure has dropped.

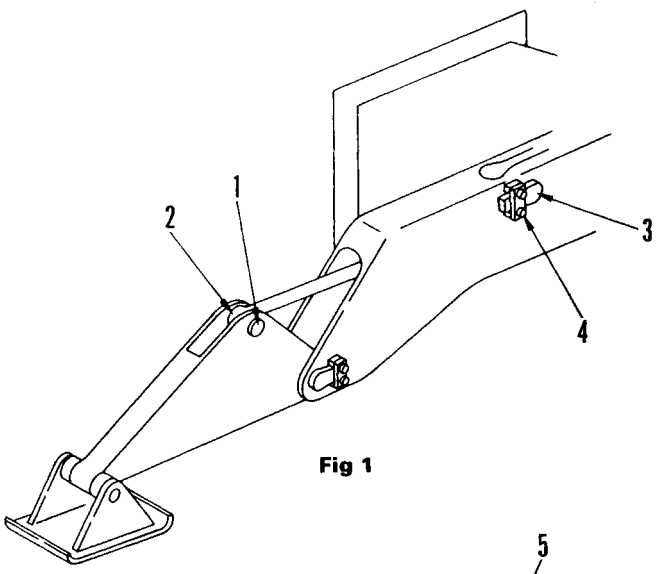


Fig 1

INSTALLATION OF OUTRIGGER CYLINDER

1) Fit the cylinder by following the above procedure in reverse sequence.

2) Grease pins (1) and (3) before fitting. Grease bearing points after assembly.

3) Bleed air from outriggers by raising and lowering the outriggers several times.

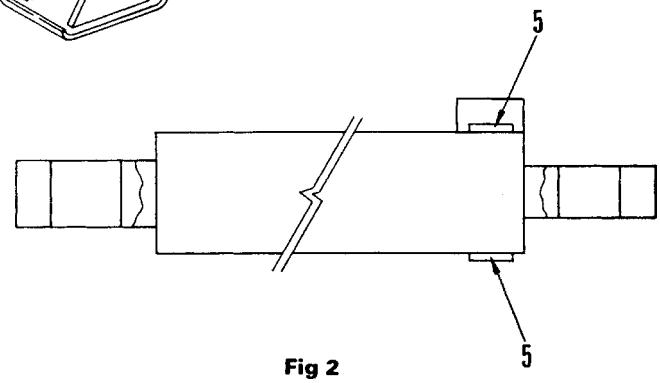
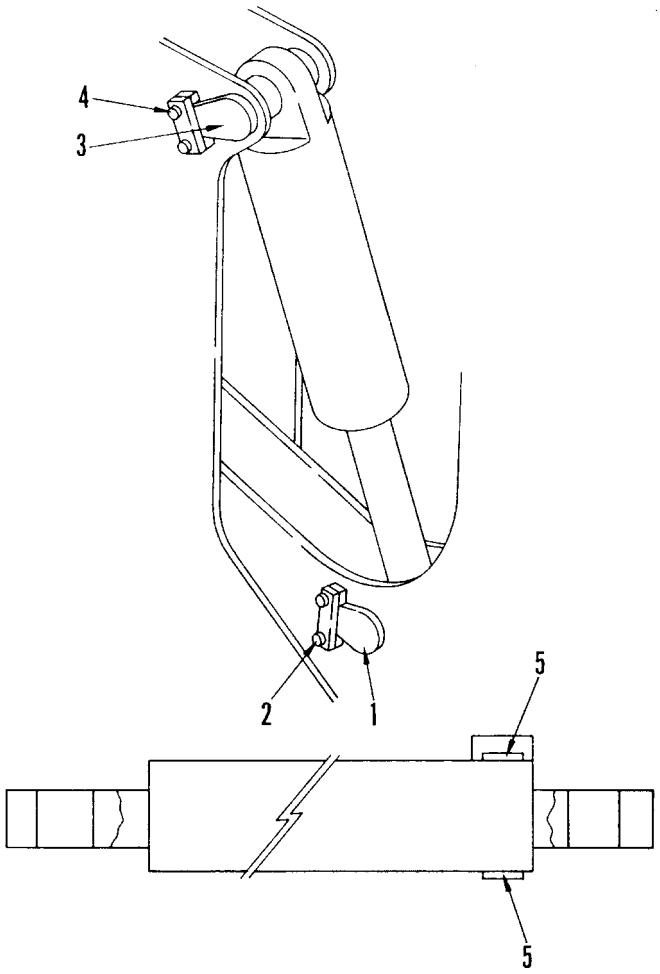


Fig 2

BLADE CYLINDER

REMOVAL OF BLADE CYLINDER

1) Lower the blade until it just touches the ground. Do not take any weight of the machine on the blade.
2) Turn off the engine.
3) Depressurize the blade hydraulic circuit.
4) Disconnect the hydraulic lines from the cylinder.
5) Attach lifting tackle.
6) Remove bolt (2) and pin (1).
7) Remove bolts (4) and pin (3).
8) Remove cylinder.
9) **Important**: Depressurize cylinder before opening it. To depressurize, loosen the plugs (6) by approx. 2 turns using an Allen key and wait until pressure has escaped. To be absolutely sure, remove the plugs completely after pressure has dropped.



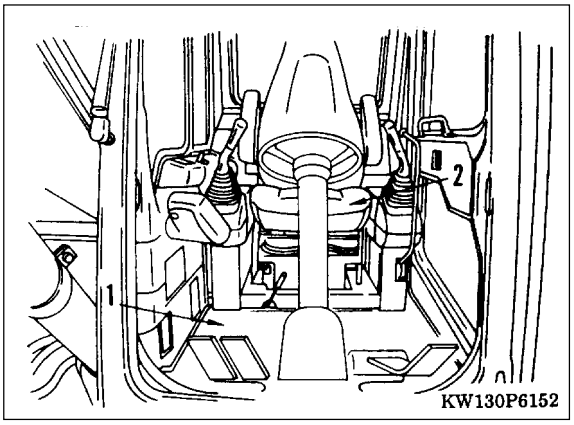
INSTALLATION OF BLADE CYLINDER

1) Fit the cylinder by following the reverse of the above procedure.
2) Grease pins (1) and (3) before fitting. Grease bearing points after assembly.
3) Bleed air from cylinders by raising and lowering the blade several times.

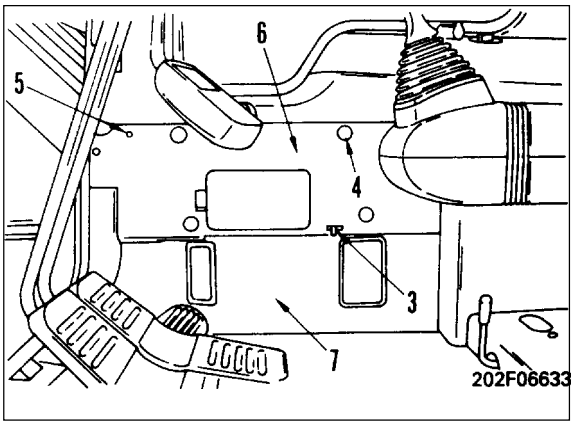
REMOVAL OF OPERATOR'S CAB ASSEMBLY

Disconnect cable from the negative (-) terminal of the battery.

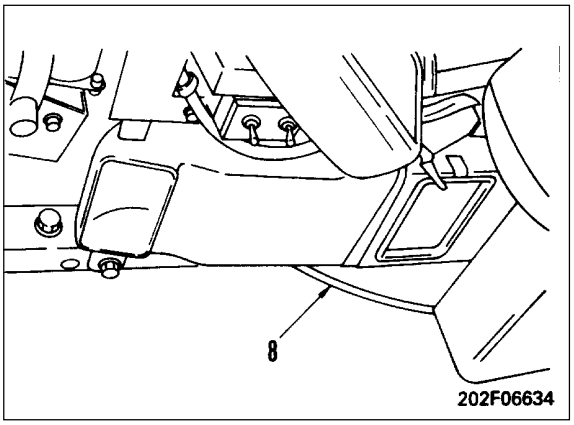
1. Remove floor mat (1).



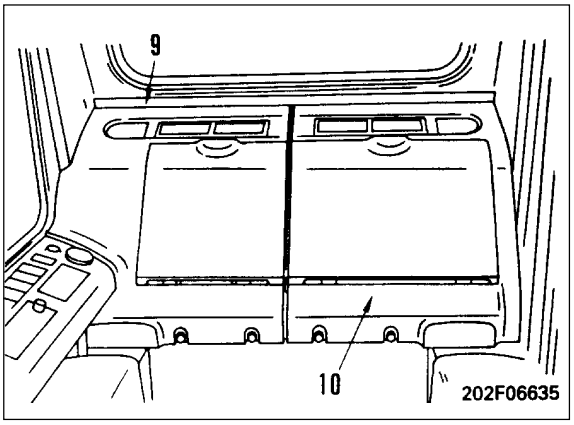
3. Remove knob (3).
4. Remove 4 caps (4) and clip (5), then remove middle panel (6).
5. Remove bottom panel (7).
   ★ The panel is held by a clip, so remove the clip when removing the panel and be careful not to damage it.



6. Disconnect washer hose (8).
7. Remove radio (11) if fitted (refer to radio operation manual).



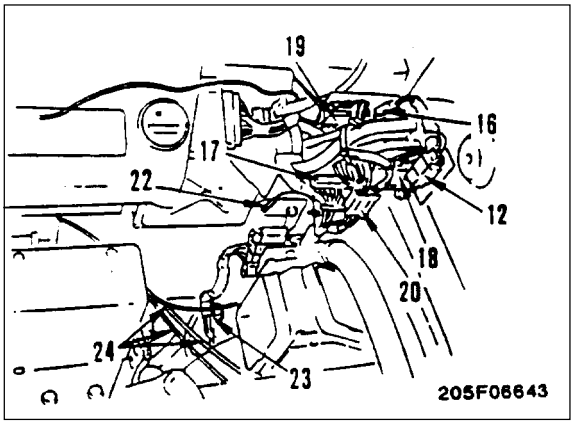
8. Remove plate (9), then lift cover (10) away carefully to locate speaker harness connector. Disconnect and remove panel completely.

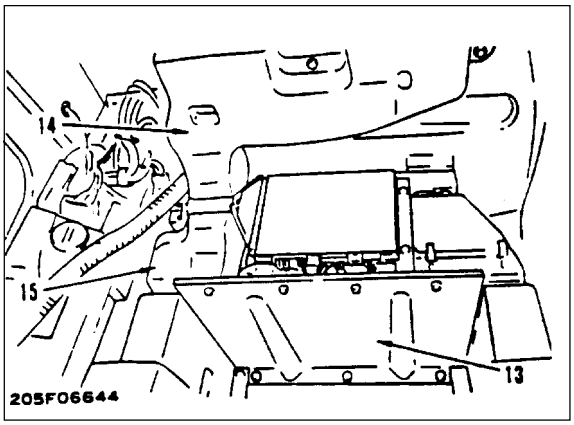


9. Remove divider board (13).

10. Remove heater duct of air conditioner ducts (14) and (15) (if fitted).

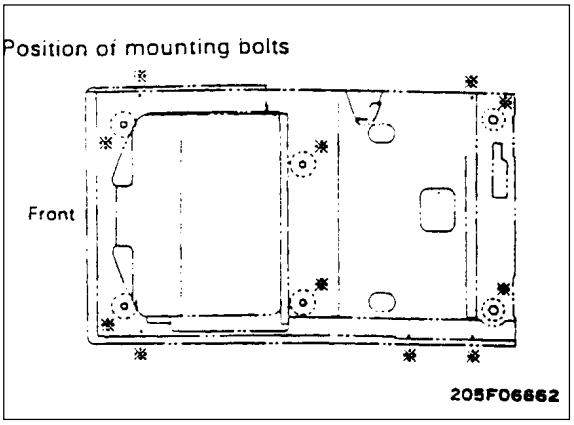
11. Disconnect wiring connectors CN-H01 (16), CN-H02 (17), CN-H03 (18), CN-H04 (19), CN-H05 (20), CN-H06 (21), CN-K01 (22), CN-H07 CN-H08 CN-H09.





12. Disconnect heater cables or air conditioner cables (24) (if fitted).

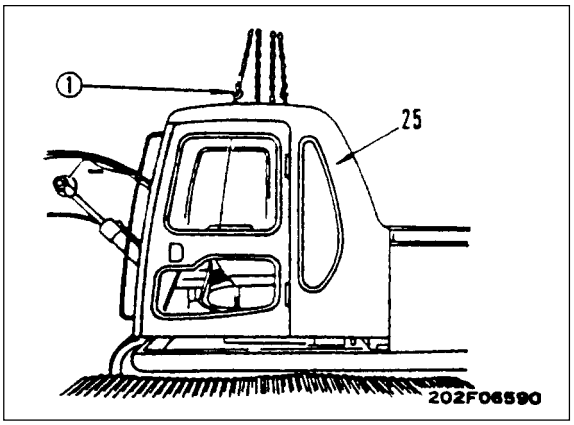
13. Remove 11 cab mounting bolts (marked *).



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

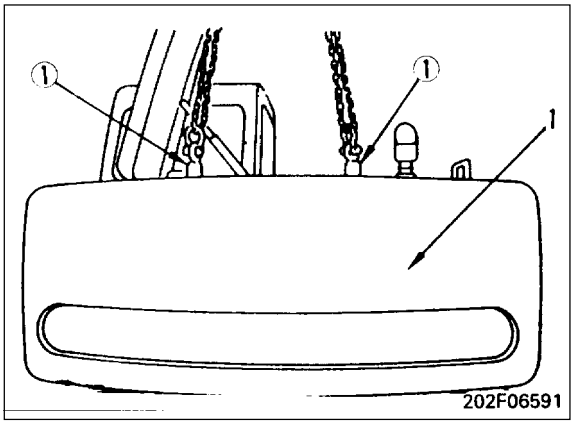
- Carry out installation in the reverse order to removal.

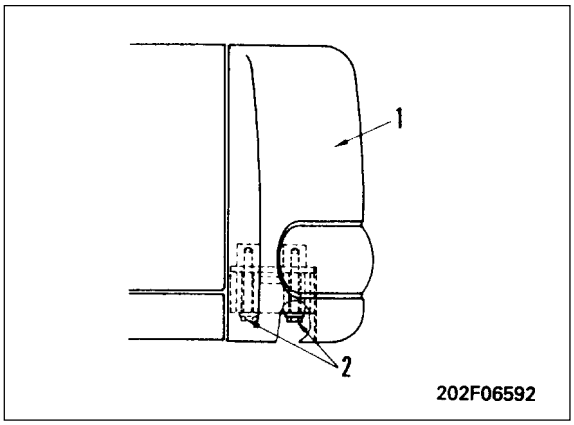
REMOVAL OF COUNTERWEIGHT ASSEMBLY

1. Remove counterweight top cover.
2. Set eyebolts ① to counterweight assembly (1), and sling.
3. Remove 4 mounting bolts (2), and lift off counterweight assembly (1).

※ 1

kg Counterweight assembly: 2,150 kg.





INSTALLATION OF COUNTERWEIGHT ASSEMBLY

- Carry out installation in the reverse order to removal.

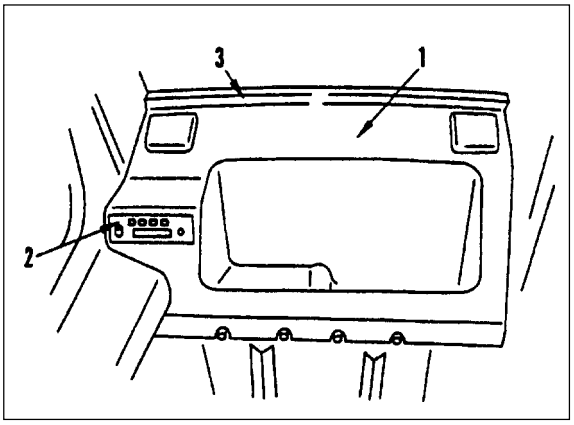
※ 1

Thread of counterweight mounting bolt: Thread tightener (LT-2)

kgm Counterweight mounting bolt: 1,324 ± 147 Nm (135 ± 15 kgm)

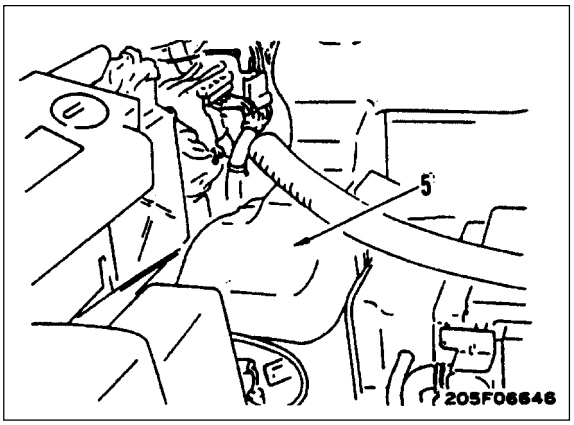
★ When installing the counterweight, adjust so that the stepped difference and the clearance from the bodywork is uniform on the left and right.

REMOVAL OF GOVERNOR, PUMP CONTROLLER ASSEMBLY

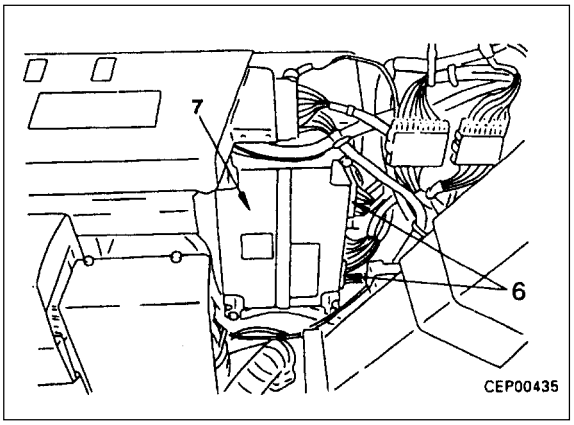


Disconnect the cable from the negative (-) terminal of the battery.

1. Remove radio (2) if fitted.
2. Remove plate (1), then remove cover (3).
3. Lift cover (3) away carefully to locate speaker harness connector. Disconnect and remove panel completely.
4. Remove divider board (5).
5. Remove heater / air conditioner duct (5).
6. Disconnect 3 wiring connectors (6), then remove governor and pump controller assembly (7).



INSTALLATION OF GOVERNOR, PUMP CONTROLLER ASSEMBLY

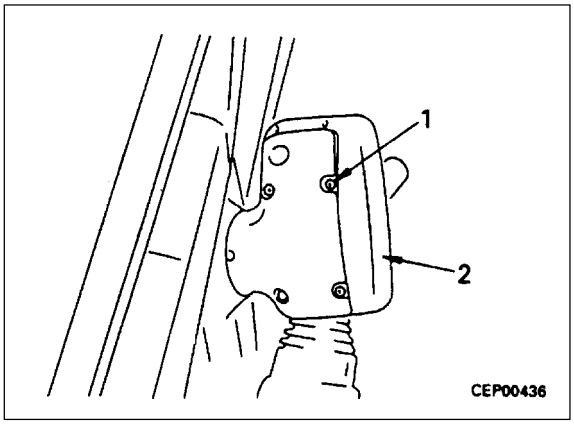


- Carry out installation in the reverse order to removal.

※ 1

- Check the performance of the work equipment, travel, and swing. For details, see TESTING AND ADJUSTING.

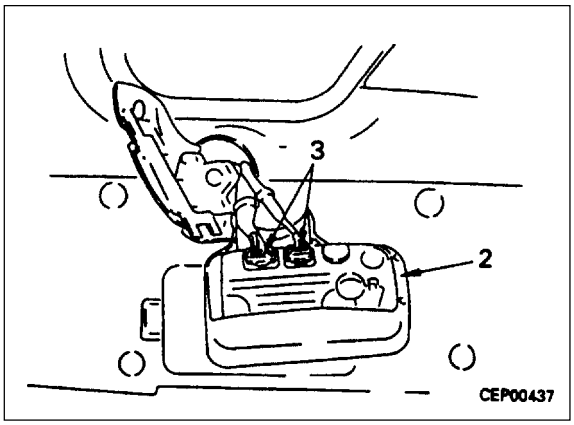
REMOVAL OF MONITOR PANEL ASSEMBLY



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 for the mode setting and display function. For details, see TESTING AND ADJUSTING, AND TROUBLESHOOTING.

ADAPTER WELDING INSTRUCTION - ELECTRODE WELDING

BE SAFE!

When performing the procedures described in this catalog, you should wear OSHA-approved hard hat, safety glasses, work gloves and safety shoes.

IMPORTANT!

ESCO weld-on Helilok adapters are hardened typically to 415BHN. In order to eliminate cracking commonly associated with welding steel at these hardness levels, follow these procedures carefully and employ good welding techniques and practices.

Summary of Welding procedures

Mating surfaces to be welded should be shiny base metal, free of carbon arc surface, hardfacing, grease or dirt.

Use E-7016 or E-7018 low-hydrogen electrodes (keep dry!), or E-70T-5 low-hydrogen wire.

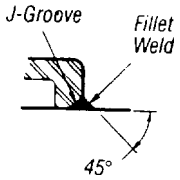
Preheat the lip and adapter to 200°F (95°C); 350° to 400°F (117° to 204oC) if surrounding air temperature is 40°F (5°C) or less. Measure temperature with a Tempilstik (r).

Maintain preheat temperature while welding.

Maximum interpass temperature should not exceed 500oF (260°C).

After welding, postheat to 350o to 400°F (117° to 204°C) if surrounding air temperature is 40oF (5°C) or less, then let air-cool. If air temperature is above 40oF, postheating is not necessary.

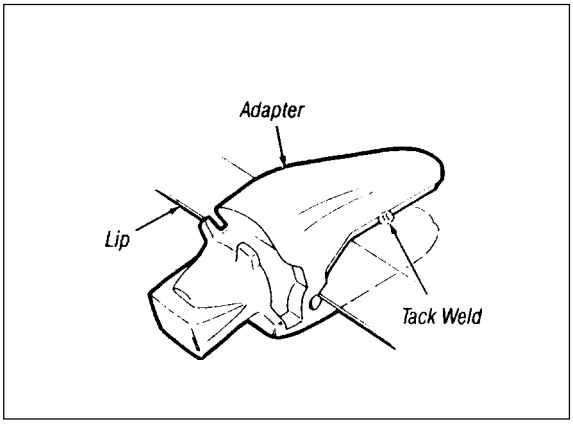
Welds should fill J-grooves to a 45o angle. If an adapter does not have a J-groove, apply fillet welds according to the following:



Bucket Size (volume)

Yards^3	Meter^3	Fillet Size
2	1.8	1/2" (13 mm)
2 1/4 - 5	2 - 4.6	5/8"(16 mm)
5 1/2 - 12	5 - 11	3/4"(19 mm)
above 12	above 11	1"(25 mm)

For complete welding information and procedures, refer to ESCO Products Maintenance Manual, Catalog 100-A, "How to weld ESCO alloy 12 series".



Lip Adapter Installation

1. Locate the adapters on a clean bucket, then tackweld them in place, followed by a root layer all the way around.

2. To prevent the introduction of weld-weakening impurities, every weld pass should begin and end across a starter/runoff plate. Install these plates, made from scrap steel, as shown in the diagram. **Do not stop or start a weld at the rear of the adapter leg!**
   If rod length, adapter size, and welder position allow a continuous weld without stopping, use two starter/runoff plates near the lip leading edge.
   On large adapters and where stops for welder repositioning are required, use two additional starter/runoff plates at the midpoint on both sides of the adapter.
   These procedures also apply to the bottom leg of 11/2 - and 2-legs adapters.

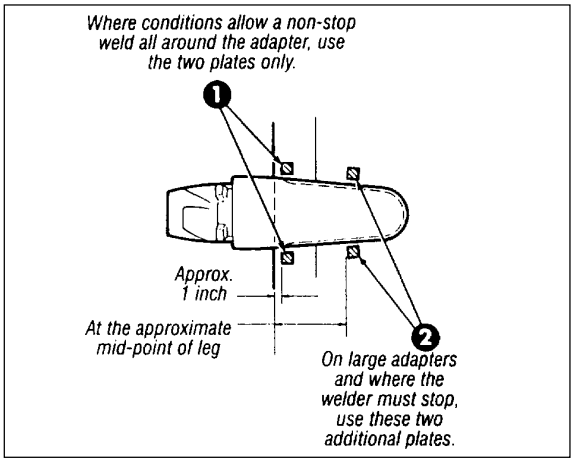
3. If using four starter/runoff plates, weld the rear half of the adapter with alternating clockwise and counter clockwise passes. Build up the weld to a full fillet.
   If using only two starter/runoff plates, use the same technique, welding to the ends of the J-groove, then proceed to step 5. **Do not weld to the lip leading edge!**

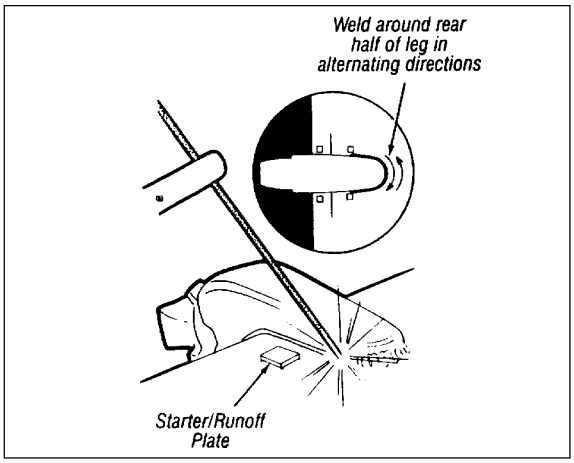
4. If using four plates, continue welding to the ends of the J-groove. **Do not weld to the lip leading edge!** Alternate from side to side until the weld is complete. Maintain a full fillet weld and tie weld ends together.

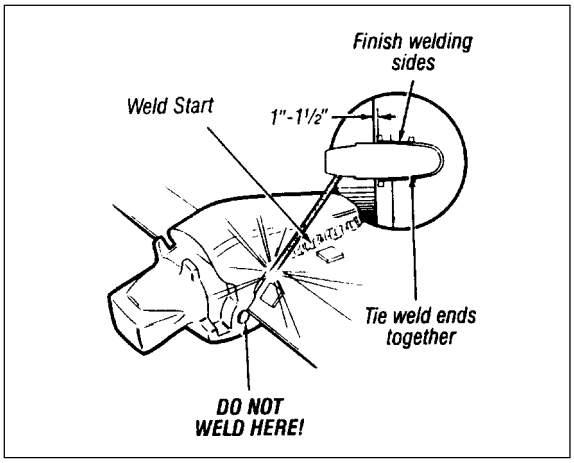
5. Remove the starter/runoff plates, then smooth the forward edge of the welds with a conical grinder. Blend the welds concave to remove stress concentrations.

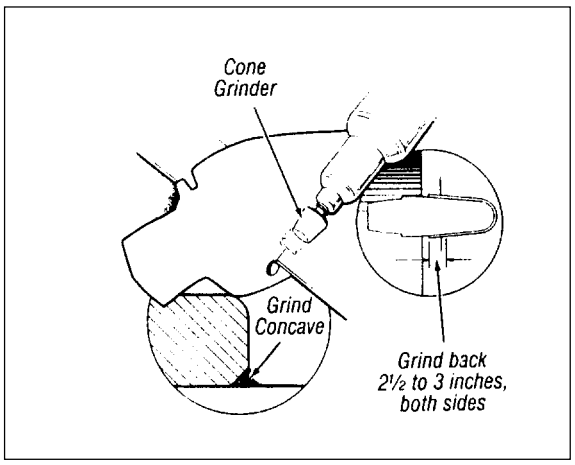
6. Turn the bucket over.

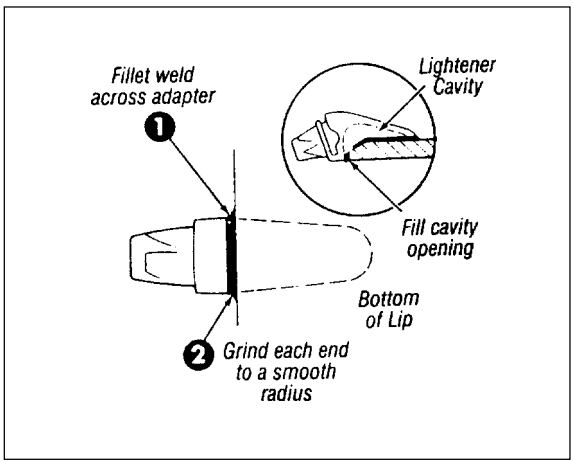
7. **One-leg Flushmount Adapters** fillet weld across the adapter equal to the lip leading edge thickness. Grind the ends smooth at weld junctions. If a lighter cavity extends forward of the lip leading edge, cover the opening with weld. Maintain a full fillet width over the entire weld.











Corner Adapter Modification and Installation

Helilok adapters can be modified by cutting to fit bucket side plates. **A bucket should never be cut to fit an adapter!**

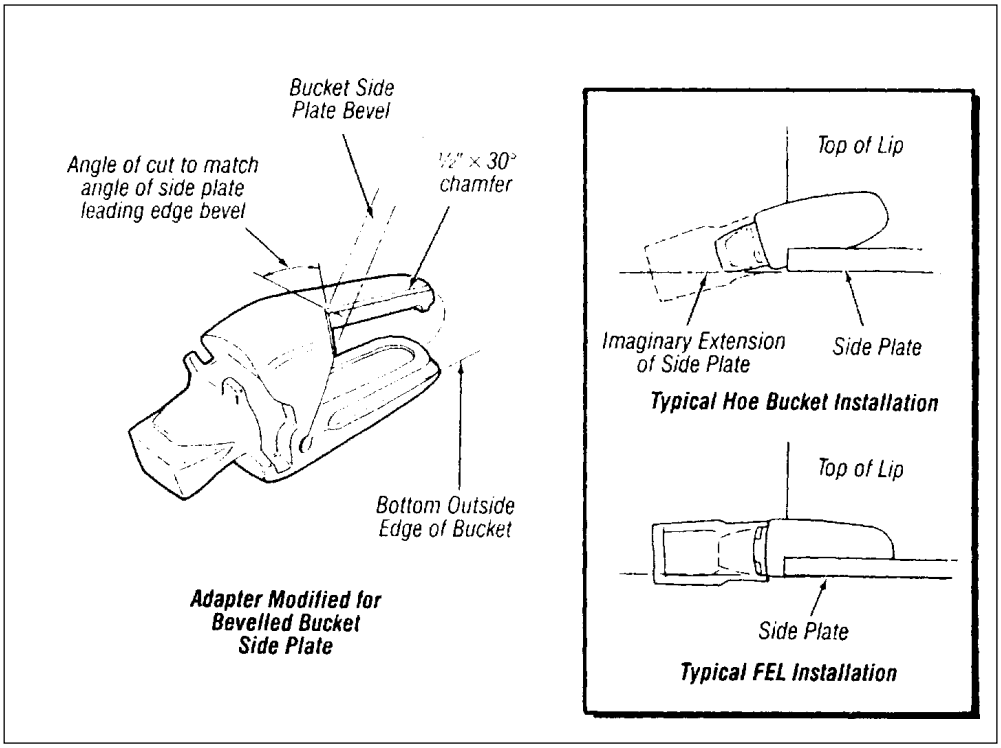
The corner adapter should be positioned so that the point cuts clearance for the bucket. The best bucket wear protection is achieved when the adapter is positioned so the nose is flush with an imaginary line extending forward from the outside edge of the bucket side plate.

If a clean trench is desired, corner adapters can be mounted so points are positioned flush with the outside of the bucket.

When modifying an adapter, **never remove more than 50% of the adapter top leg.** The edges of the cuts should be chamfered 1/2"x 30o for weld preparation.

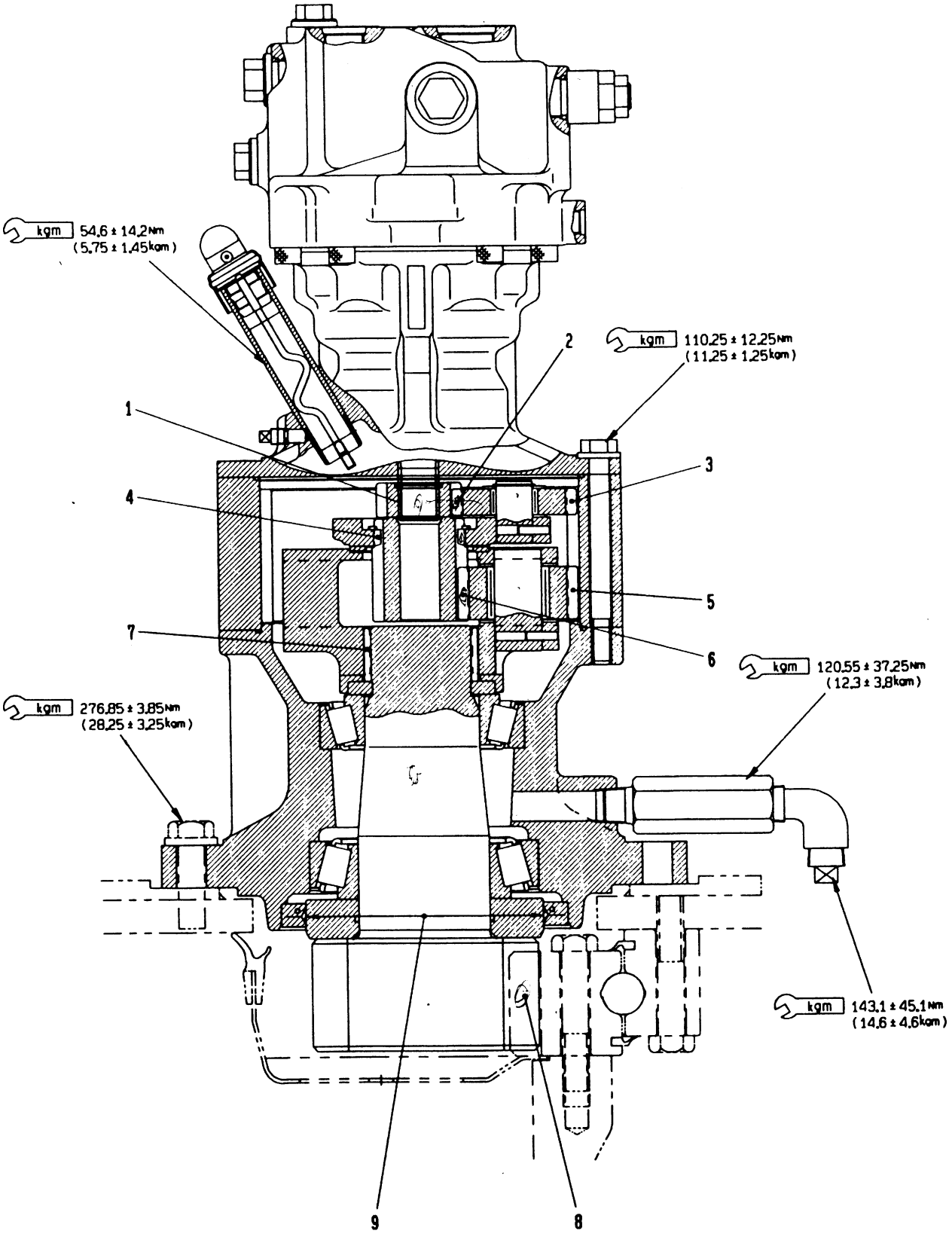
Follow welding procedures described in "Lip Adapter Installation".

Install Helilok points according to the procedures described in ESCO Maintenance Catalog 100-1B (Rev.1), Helilok Tooth System Installation and Removal Instructions.



40 MAINTENANCE STANDARD

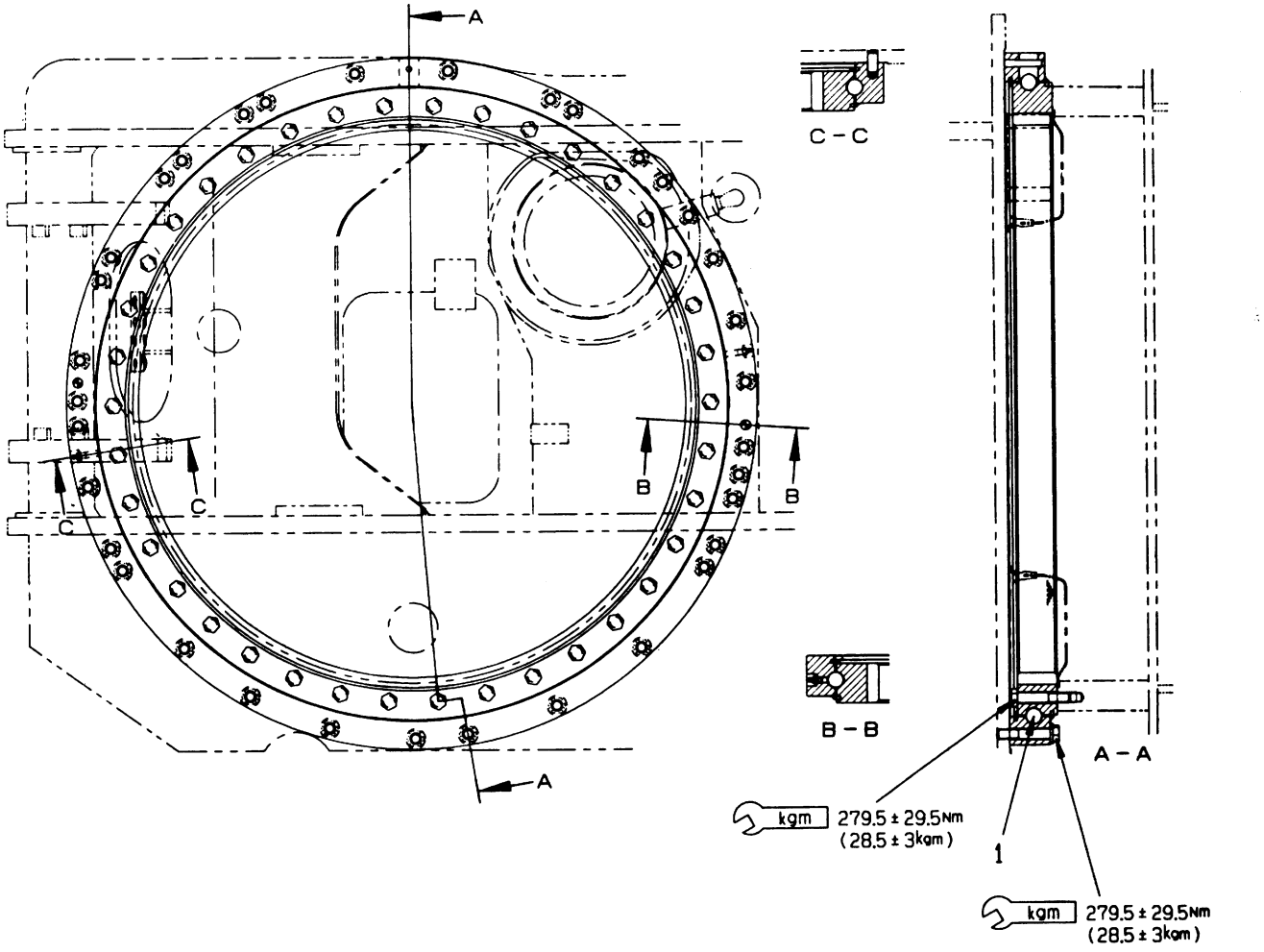
SWING MACHINERY



Unit: mm

No.	Check item	Criteria		Remedy
1	Backlash between swing motor shaft and No.1 sun gear	Standard clearance	Clearance limit	Replace
		0.07-0.18	0.4	
2	Backlash between No.1 sun gear and No.1 planetary gear	0.13-0.31	0.6	
3	Backlash between No.1 planetary gear and ring gear	0.15-0.34	0.7	
4	Backlash between No.1 planetary carrier and No.2 sun gear	0.14-0.34	0.7	
5	Backlash between No.2 sun gear and No.2 planetary gear	0.13-0.31	0.6	
6	Backlash between No.2 planetary gear and ring gear	0.15-0.34	0.7	
7	Backlash between No.2 planetary carrier and swing pinion	0.08-0.19	0.4	
8	Backlash between swing pinion and swing circle	0.13-1.16	2.3	
9	Wear of swing pinion surface contacting with oil seal	standard size	Repair limit	Apply hardchrome plating recondition, or replace
		145 0 -0.100	144.8	

SWING CIRCLE



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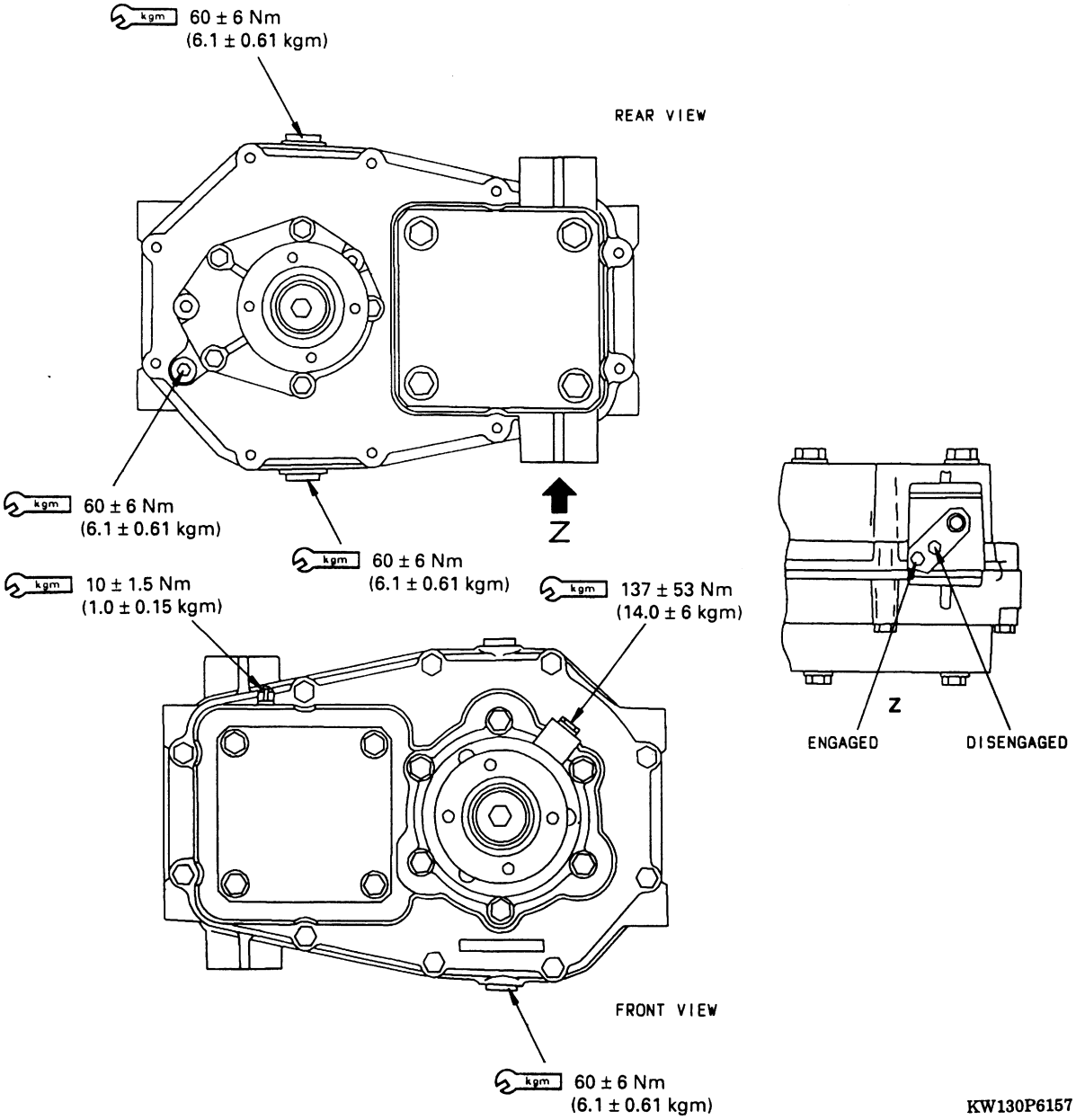
Unit: mm

No.	Check item	Criteria		Remedy
1	Axial clearance of bearing	Standard clearance	Clearance limit	Replace
		0.10-0.25	3.2	

TRANSMISSION

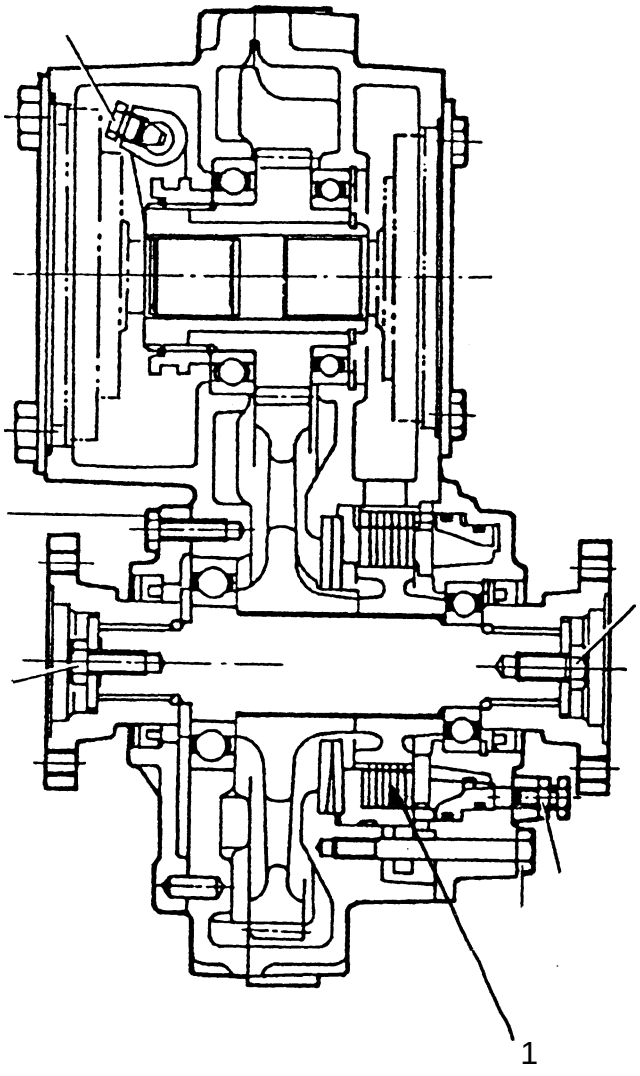
1. Oil filing 60 ± 6 Nm (6.1 ± 0.61 kgm)
2. Oil level 60 ± 6 Nm (6.1 ± 0.61 kgm)
3. Oil drain 60 ± 6 Nm (6.1 ± 0.61 kgm)
4. Oil brake connection port 137 ± 53 Nm (14.0 ± 6 kgm)
5. Oil breather 10 ± 1.5 Nm (1.0 ± 0.15 kgm)



Filling: use oil SAE 85W-140 that meets the specification SAE-J360C, API GL5

Oil quantity: 1.1 litre
Oil checking and changes:
- Initial change at 250 hours
- Subsequent changes every 2000 hours
- Inspection of level every 250 hours

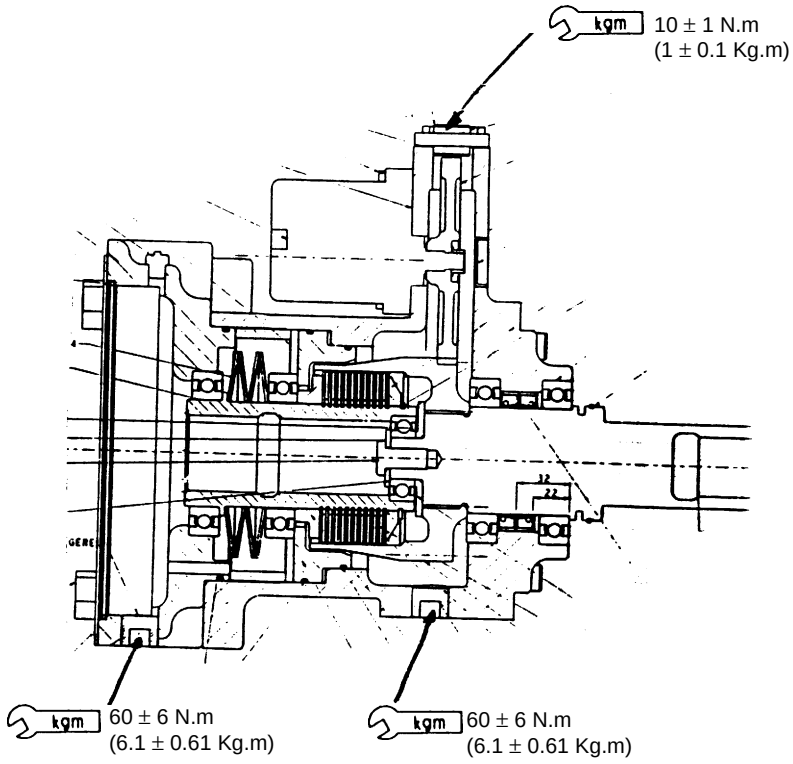
TRANSMISSION - PARK BRAKE



Unit: mm

No.	Check item	Criteria		Remedy
1	Brake disk thickness	Standard	Repair limit	Replace
		2.38-2.40	1.9 min.	
2	Brake release pressure	115 bar	-	-

CLUTCH



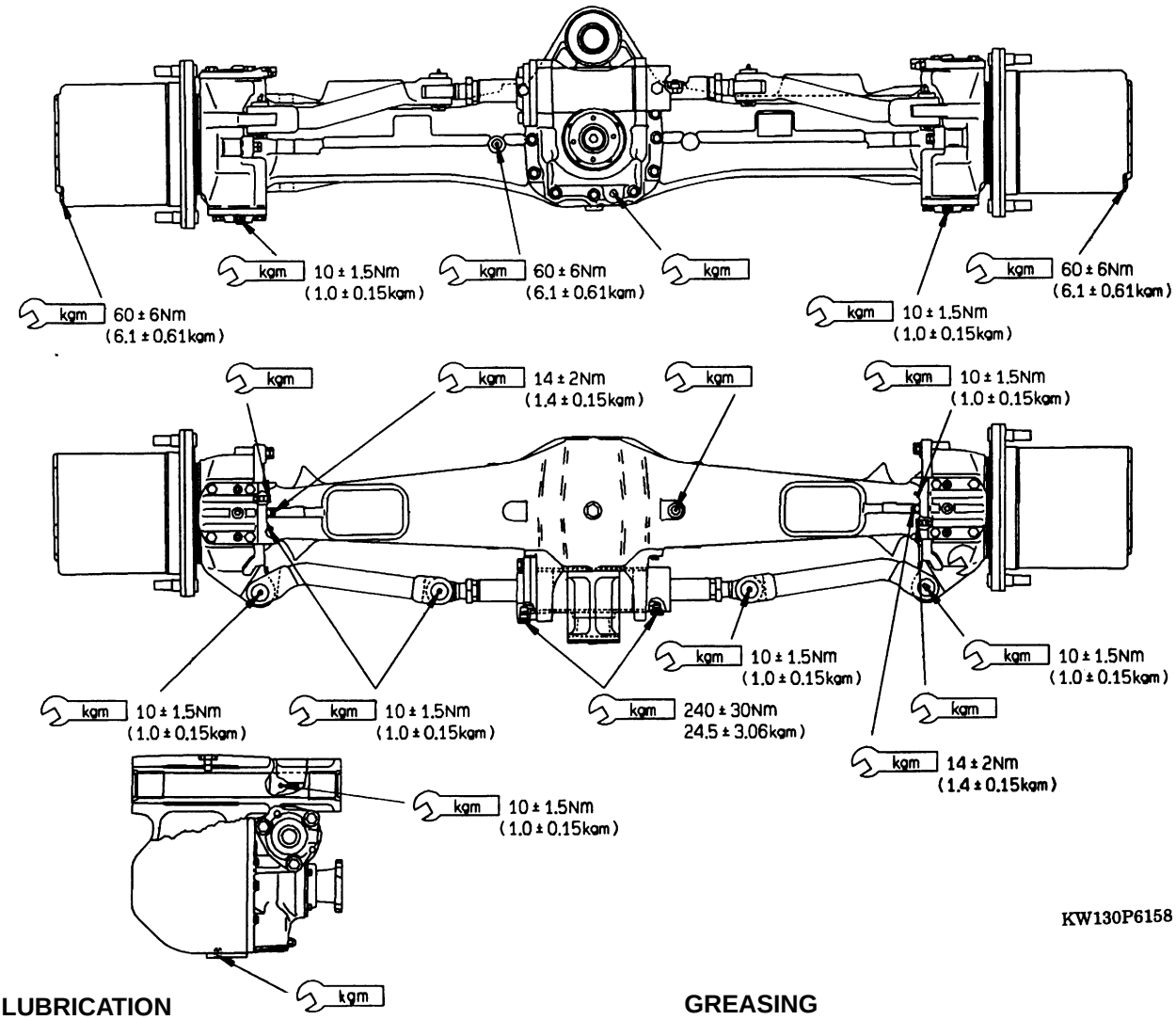
LUBRICATION

Filling: use oil SAE 85W-140 that meets the specification SAE-J306C, API GL5

Oil quantity: 0.5 litre
Oil checking and changes:
- Initial change at 250 hours
- Subsequent changes every 2000 hours
- Inspection of level every 250 hours

FRONT AXLE

1. Wheel hubs drain, filling and level plug — kgm 60 ± 6 NM (6.1 ± 0.61 kgm)
2. Differential oil filling and level plug — kgm 60 ± 6 Nm (6.1 ± 0.61 kgm)
3. Differential drain plug — kgm 60 ± 6 Nm (6.1 ± 0.61 kgm)
4. Brake control fluid inlet port — kgm 14 ± 2 Nm (1.4 ± 0.15 kgm)
5. Brake circuit bleeding — kgm 14 ± 2 Nm (1.4 ± 0.15 kgm)
6. Axle beam oil breather — kgm 5 ± 1 Nm (0.51 ± 0.5 kgm)
7. Lubrication point — kgm 10 ± 1.5 Nm (1.0 ± 0.15 kgm)
8. Steering cylinder feeding — kgm 240 ± 30 Nm (24.5 ± 3.06 kgm)



LUBRICATION

Filling: use oil SAE 80W-90 that meets the specification SAE-J306C, API GL5

Oil quantity:
- differential: 15 litre
- epicyclic reduction (each): 2.5 litre

Oil checking and changes:
- Initial change at 250 hours
- Subsequent changes every 2000 hours
- Inspection of level every 250 hours

GREASING

Use lithium gun grease with molybdenum bisulphide.
Applications: every 250 hours.

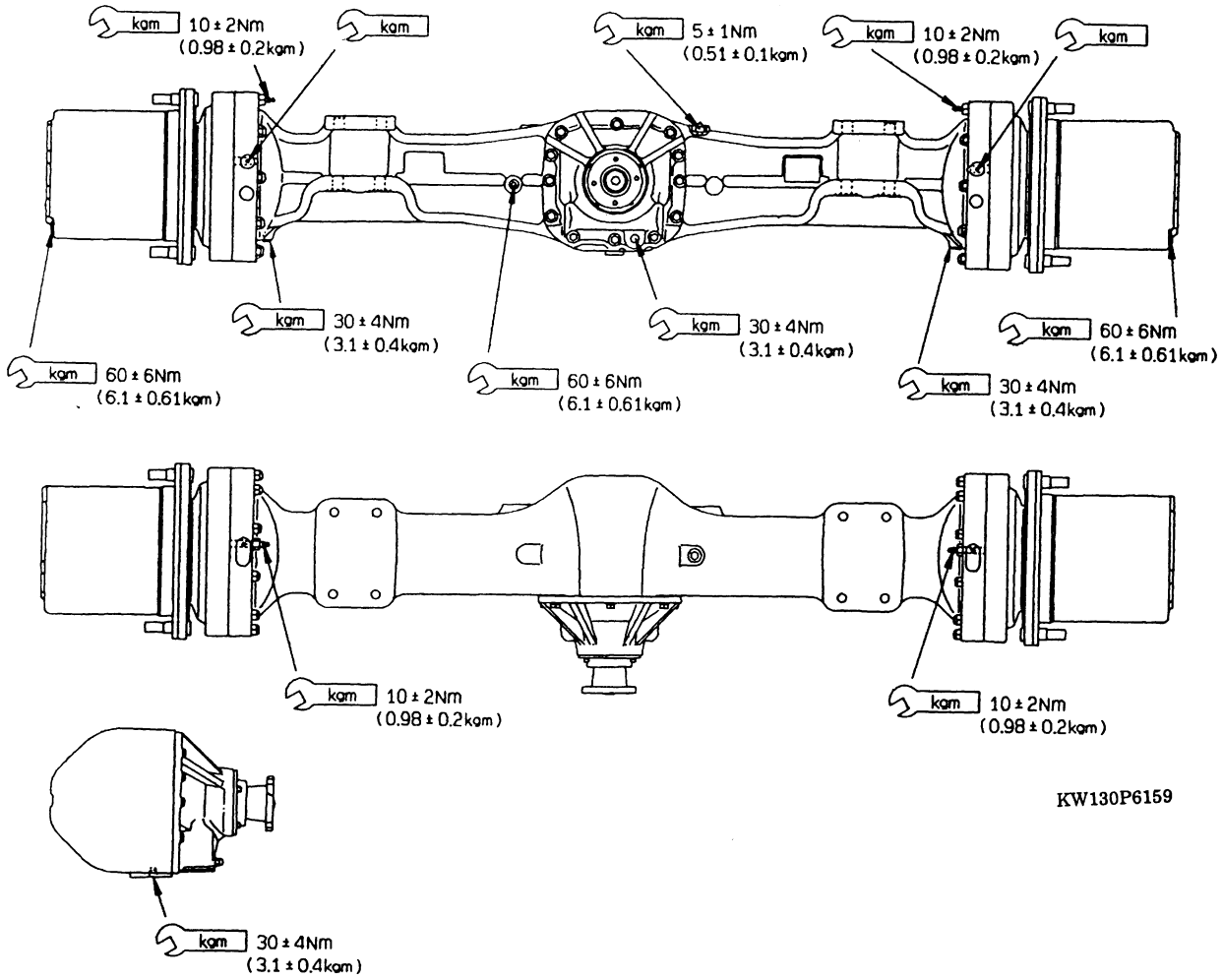
BRAKES CONTROL

Filling: use mineral oil

Oil quantity necessary for activating:
- min. 4.093 cm^3 x 2
- max. 10.66 cm^3 x 2

REAR AXLE

1. Wheel hubs drain, filling and level plug — kgm 60 ± 6 Nm (6.1 ± 0.61 kgm)
2. Differential oil filling and level plug — kgm 60 ± 6 Nm (6.1 ± 0.61 kgm)
3. Differential drain plug — kgm 60 ± 6 Nm (3.1 ± 0.4 kgm)
4. Brake control liquid inlet port — kgm 14 ± 2 Nm (1.4 ± 0.15 kgm)
5. Brake circuit bleeding — kgm 10 ± 2 Nm (0.98 ± 0.2 kgm)
6. Axle beam oil breather — kgm 5 ± 1 Nm (0.51 ± 0.1 kgm)



LUBRICATION

Filling: use oil SAE 80W-90 that meets the specification SAE-J306C, API GL5

Oil quantity:
- differential: 20 litre
- epicyclic reduction (each): 2.7 litre

Oil checking and changes:
- Initial change at 250 hours
- Subsequent changes every 2000 hours
- Inspection of level every 250 hours

BRAKES CONTROL

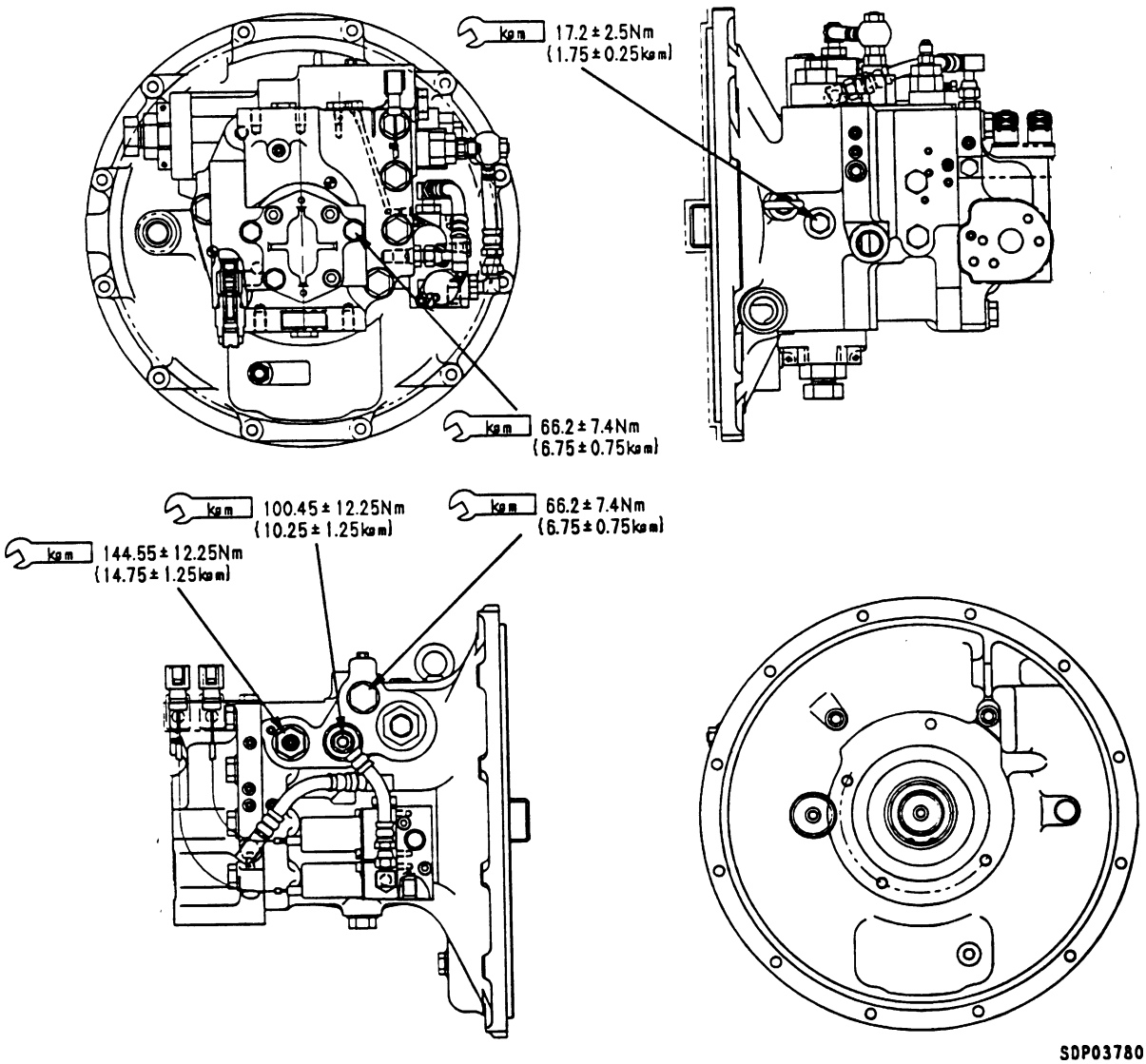
Filling: use mineral oil

Oil quantity necessary for activating:
- min. 5.23 cm^3 x 2
- max. 15.68 cm^3 x 2

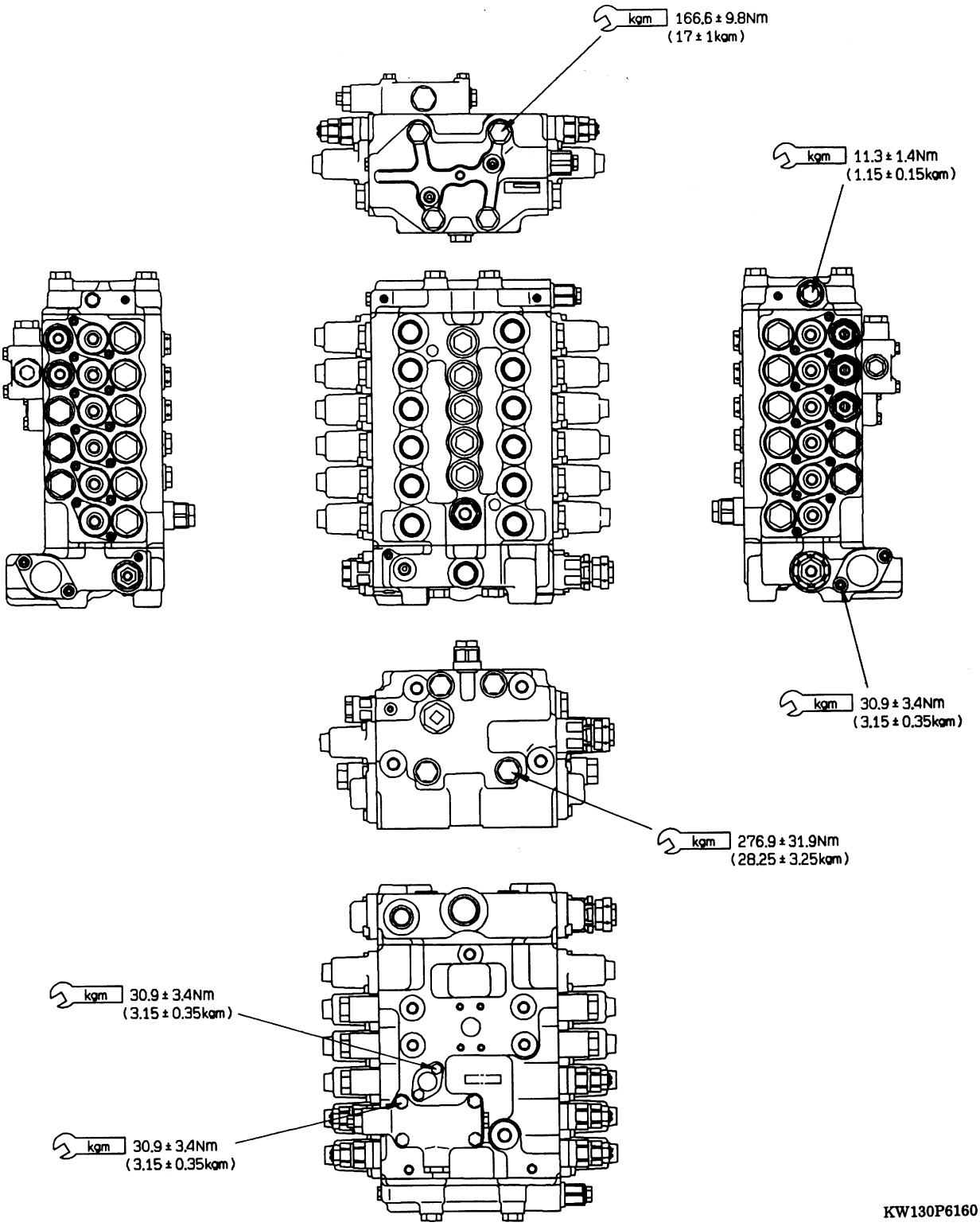
HYDRAULIC PUMP

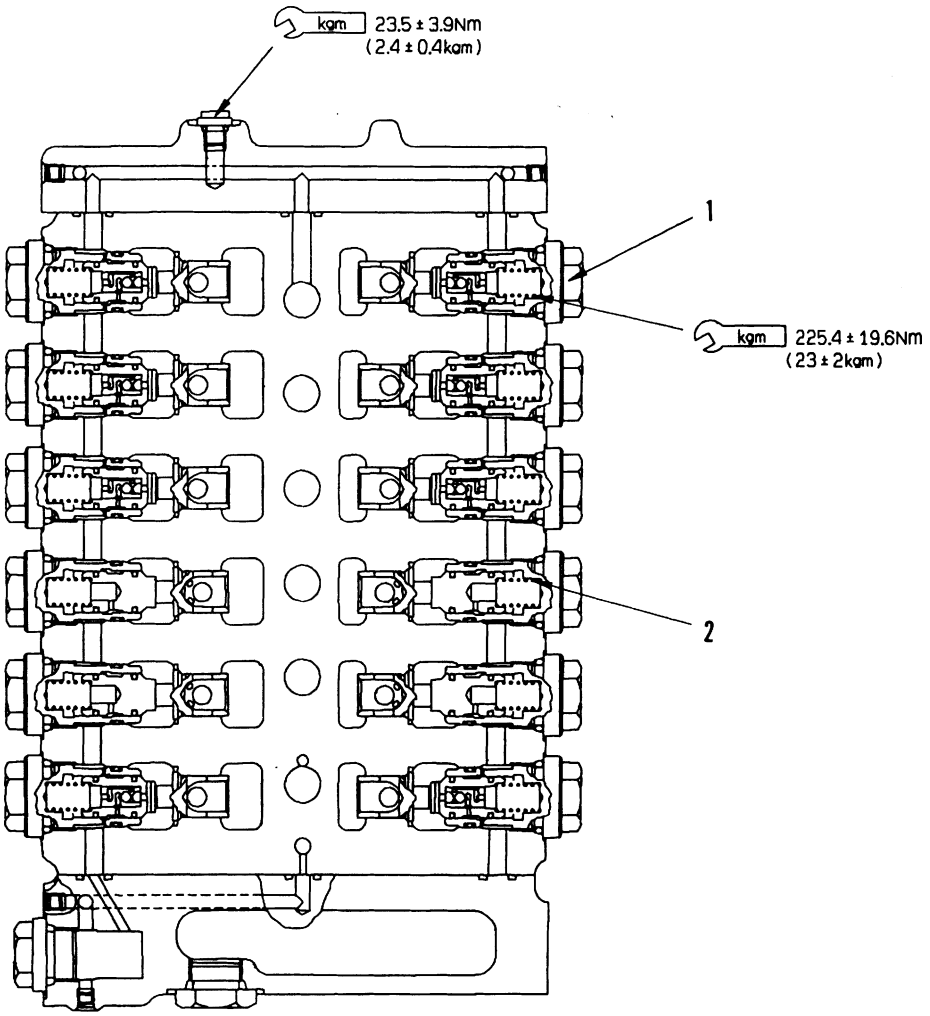
MAIN PUMP

HPV 105



CONTROL VALVE

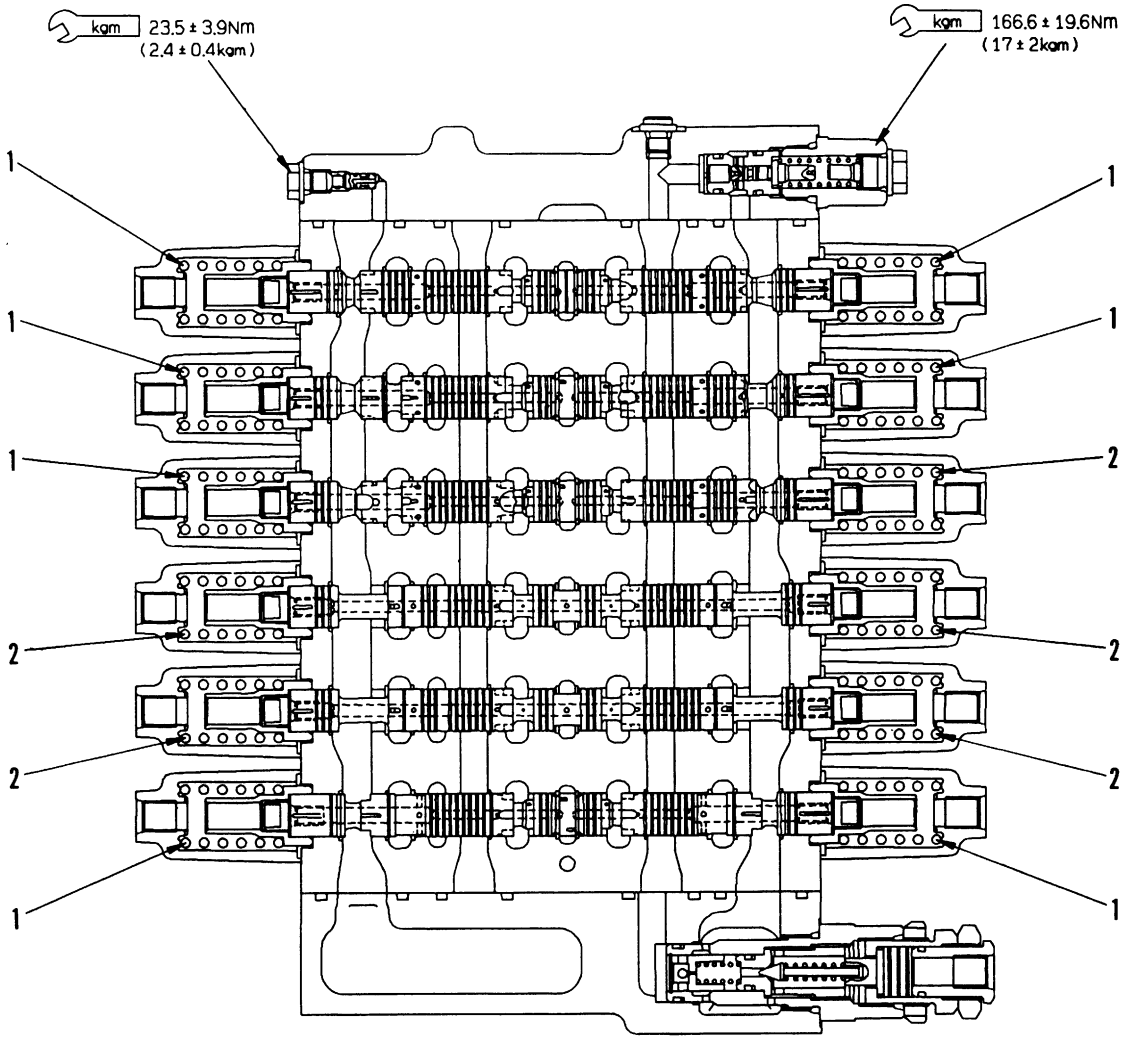




A – A KW130P6161

Unit: mm

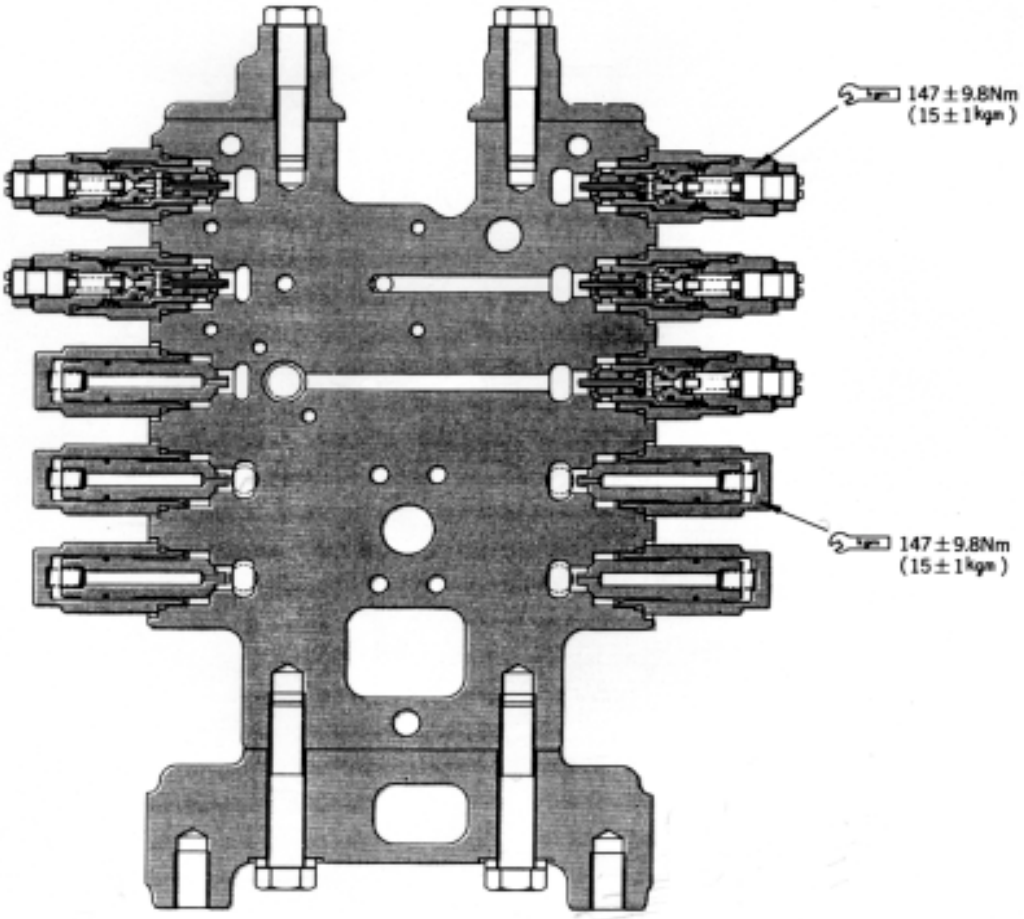
No.	Check item	Criteria					Remedy
		Standard size			Repair limit		
1	Pressure compensation valve spring (work equipment, swing)	Free length x O.D.	Installed length	Installed load	Free length	Installed load	Replace spring if any damage or deformation is found
		26.4 x 12	20	7.8 ± 1.0 N (23.5 ± 1.5 kg)	-	5.9 N (0.6 kg)	
2	Pressure compensation valve spring (travel)	27.3 x 12	20	25.5 N (2.6 kg)	-	19.6 N (2.0 kg)	



B – B KW130P6162

Unit: mm

No.	Check item	Criteria					Remedy
		Standard size			Repair limit		
1	Spool return spring (work equipment, (except boom lower) swing and service)	Free length x O.D.	Installed length	Installed load	Free length	Installed load	Replace spring if any damage or deformation is found
		45.6 x 28	43	230.3 ± 14.7 N (23.5 ± 1.5 kg)	-	208.7 N (21.3 kg)	
2	Spool return spring (travel stabilizer and boom lower)	45.7 x 28	43	221.5 ± 13.7 N (22.6 ± 1.4 kg)	-	179.3 N (18.3 kg)	



C – C

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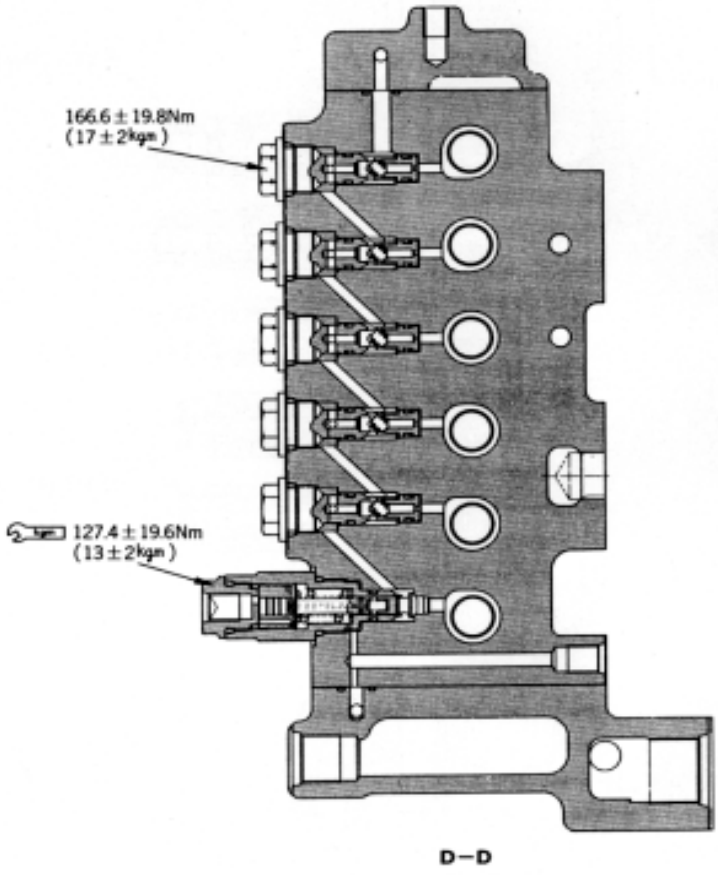

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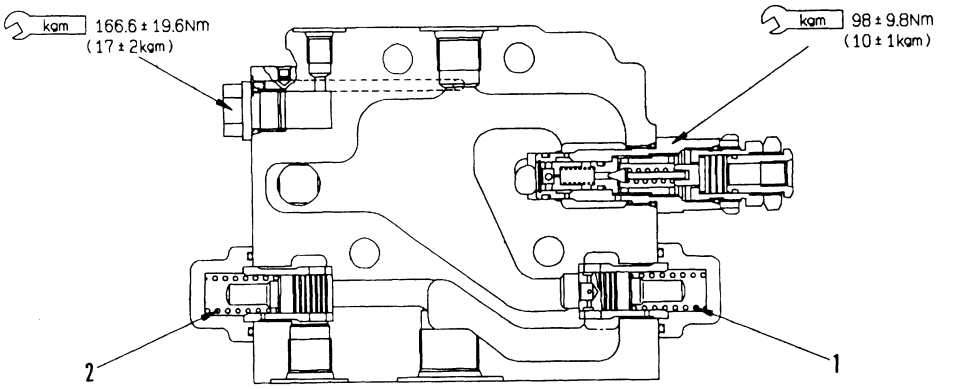
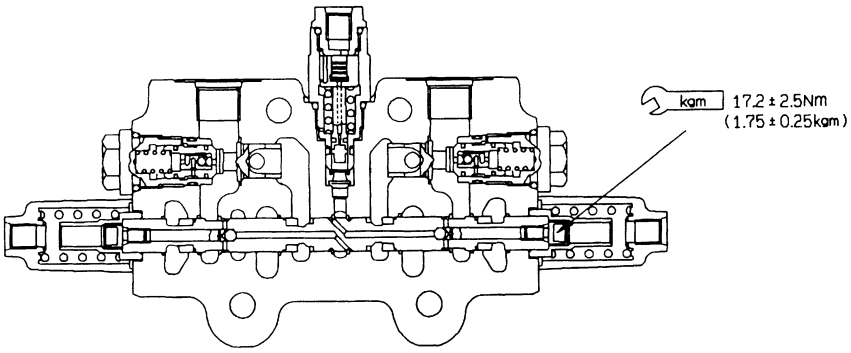
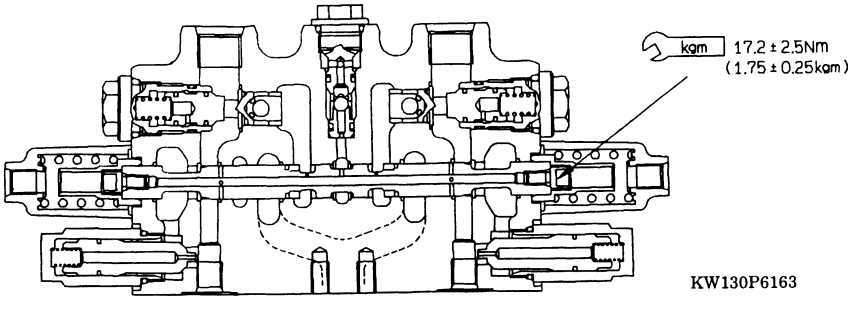


E – E

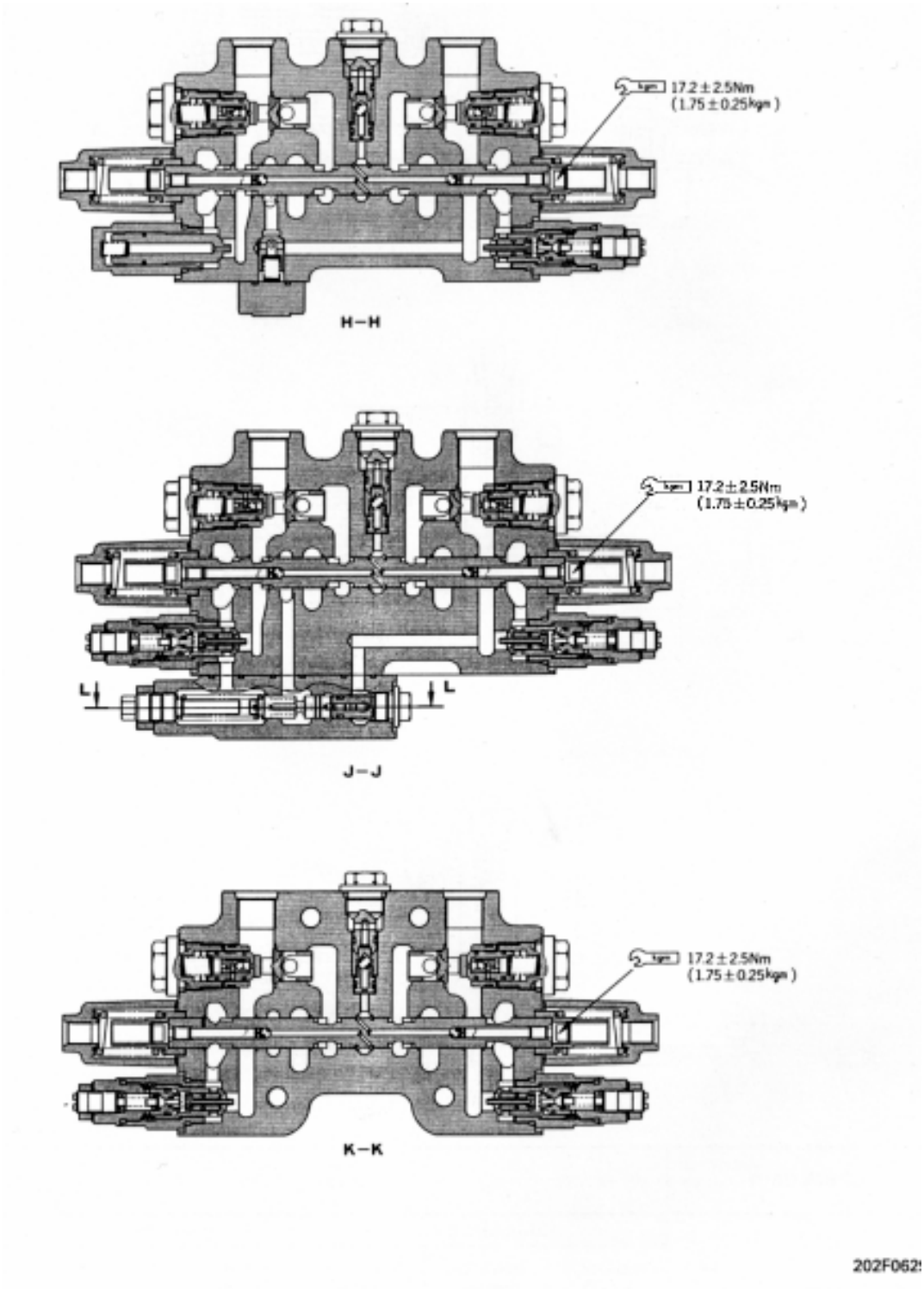


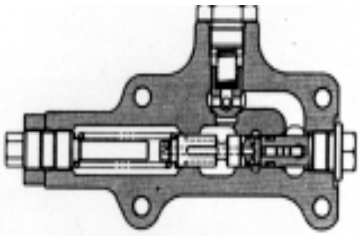
F – F



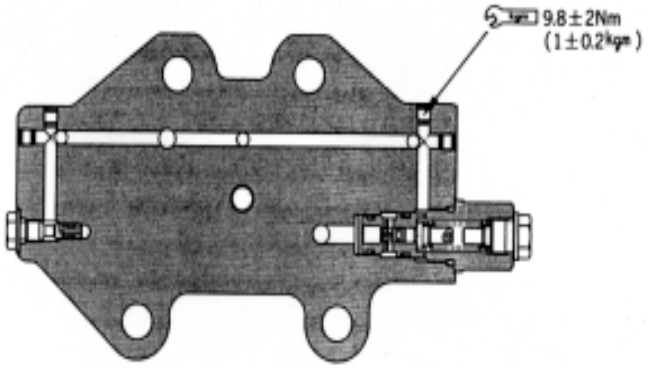
G – G

No.	Check item	Criteria					Remedy
		Standard size			Repair limit		
1	Lift check valve spring	Free length x O.D.	Installed length	Installed load	Free length	Installed load	Replace spring if any damage or deformation is found
		67.7 x 20	42.5	67.7 ± 4.9 N (6.9 ± 0.5 kg)	-	53.9 N (5.5 kg)	
2	Cooler bypass valve spring	72.7 x 20.6	42.5	135.2 ± 4.9 N (13.8 ± 0.5 kg)	-	112.7 N (11.5 kg)	


17.2±2.5Nm
(1.75±0.25kgm)
H–H
17.2±2.5Nm
(1.75±0.25kgm)
L
L
J–J
17.2±2.5Nm
(1.75±0.25kgm)
K–K
202F062

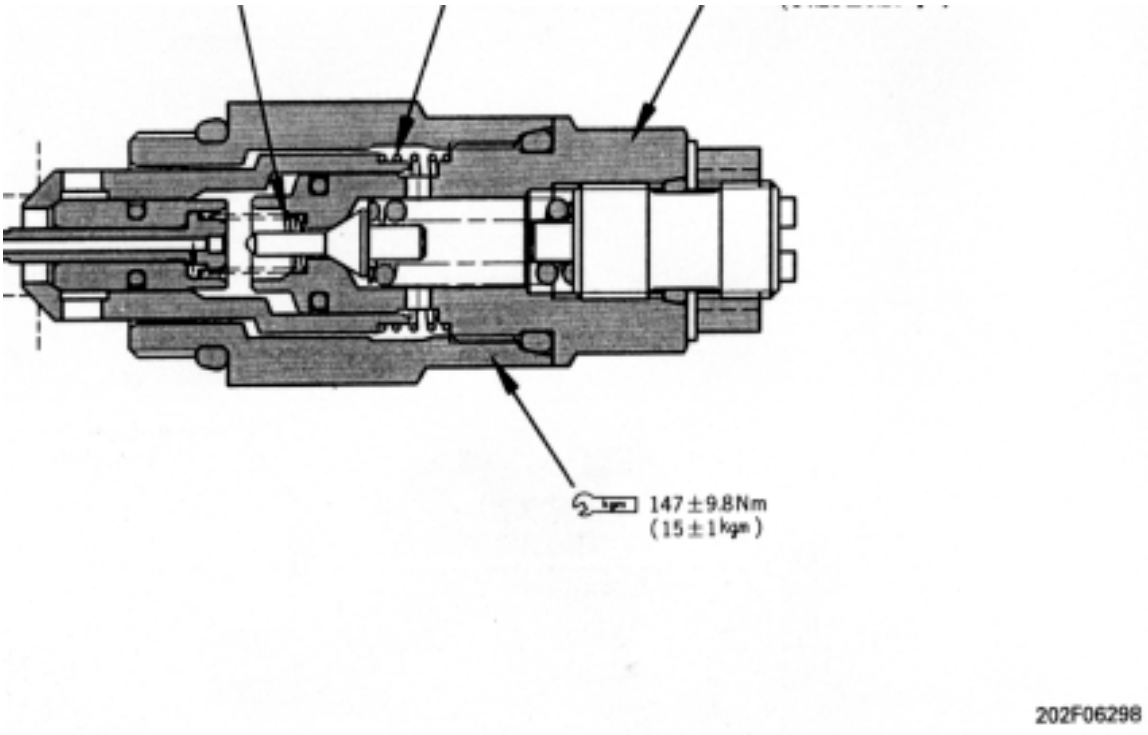


L–L



M–M

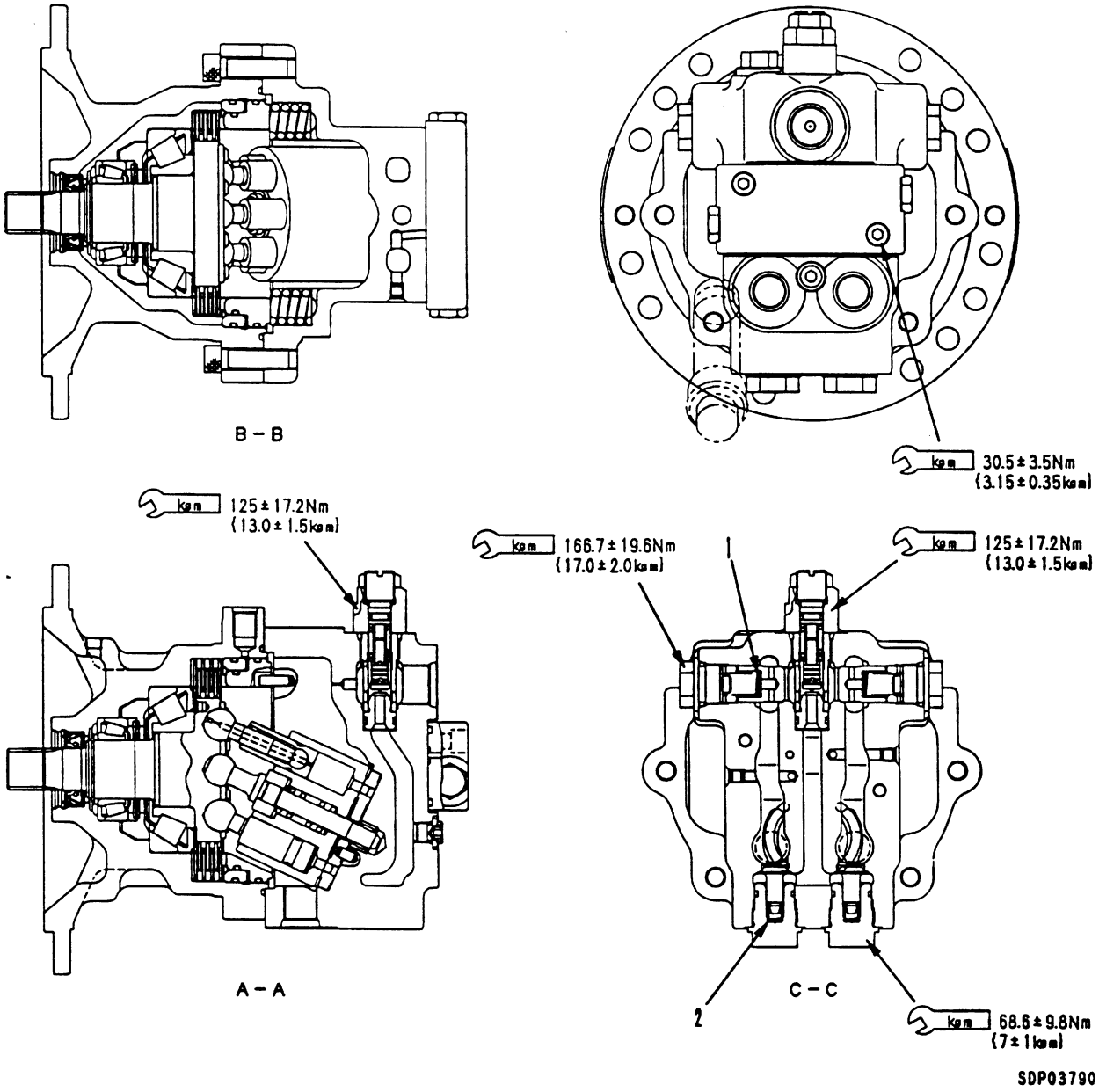
SAFETY-SUCTION VALVE FOR SERVICE VALVE



No.	Check item	Criteria					Remedy
		Standard size			Repair limit		
1	Suction valve spring	Free length x O.D.	Installed length	Installed load	Free length	Installed load	Replace spring if any damage or deformation is found
		16.3 x 21.3	9.5	2.1 N (0.21 kg)	-	1.6 N (0.16 kg)	
2	Main valve spring	20 x 7	14	2.1 N (0.21 kg)	-	1.6 N (0.16 kg)	

SWING MOTOR

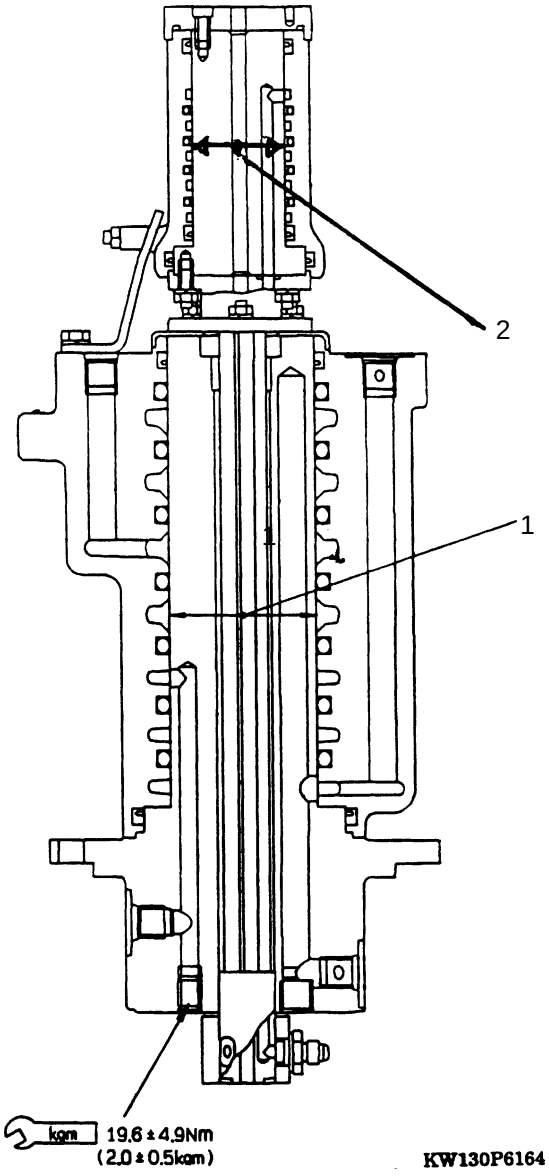
KMF40ABE-3



Unit: mm

No.	Check item	Criteria					Remedy
		Standard size			Repair limit		
1	Check valve spring	Free length x O.D.	Installed length	Installed load	Free length	Installed load	Replace spring if any damage or deformation is found
		33.0 x 13.8	23.0	1.28 N (0.13 kg)	-	0.98 N (0.10 kg)	
2	Shuttle valve spring	16.4 x 8.9	11.5	13.7 N (1.4 kg)	-	10.8 N (1.1 kg)	

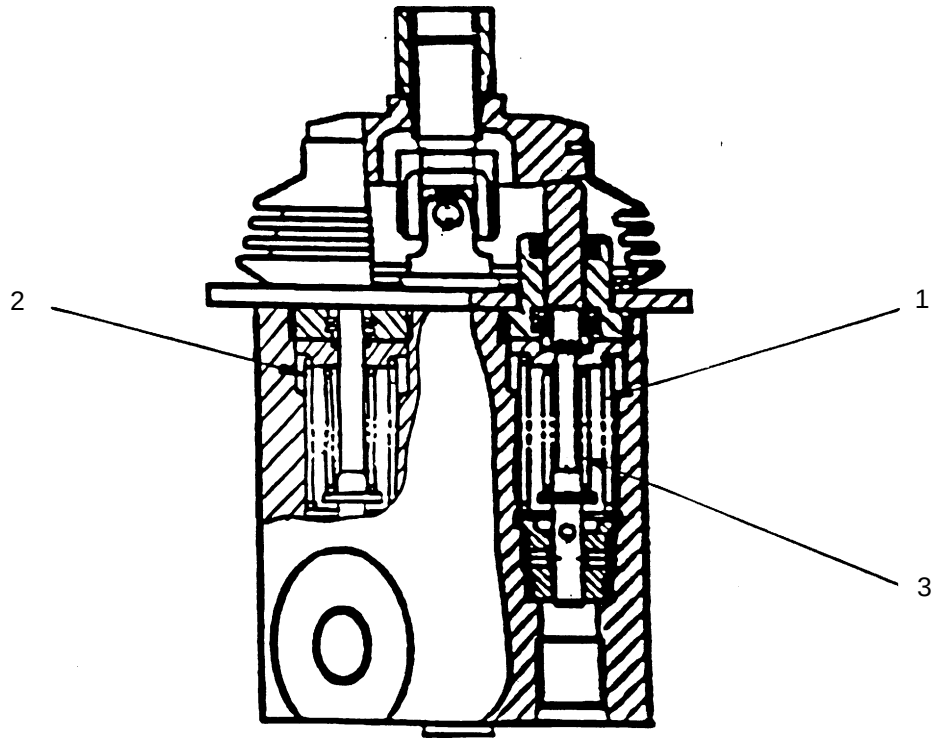
CENTER SWIVEL JOINT



Unit: mm

No.	Check item	Criteria			Remedy
1	Clearance between rotor and shaft	Standard size	Standard clearance	Clearance limit	Replace
		Shaft 0/ 105 +0.02 -0.06 Rotor 0/ 105 +0.15 -0.5	min. - 0.07 mm max. - 0.21 mm	0.28 mm	Replace
2	Clearance between rotor and shaft	Shaft - 0/ 50 +0.02 -0.05 Rotor - 0/ 50 +0.05 -0.02	min. - 0.06 mm max. - 0.17 mm	0.22 mm	

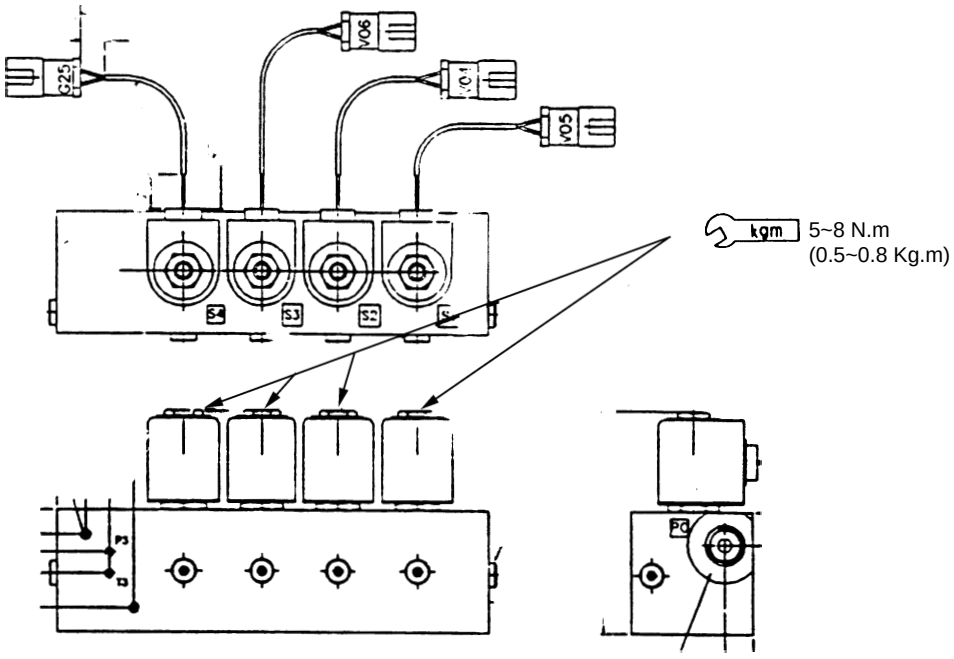
WORK EQUIPMENT, SWING PPC VALVE



Unit: mm

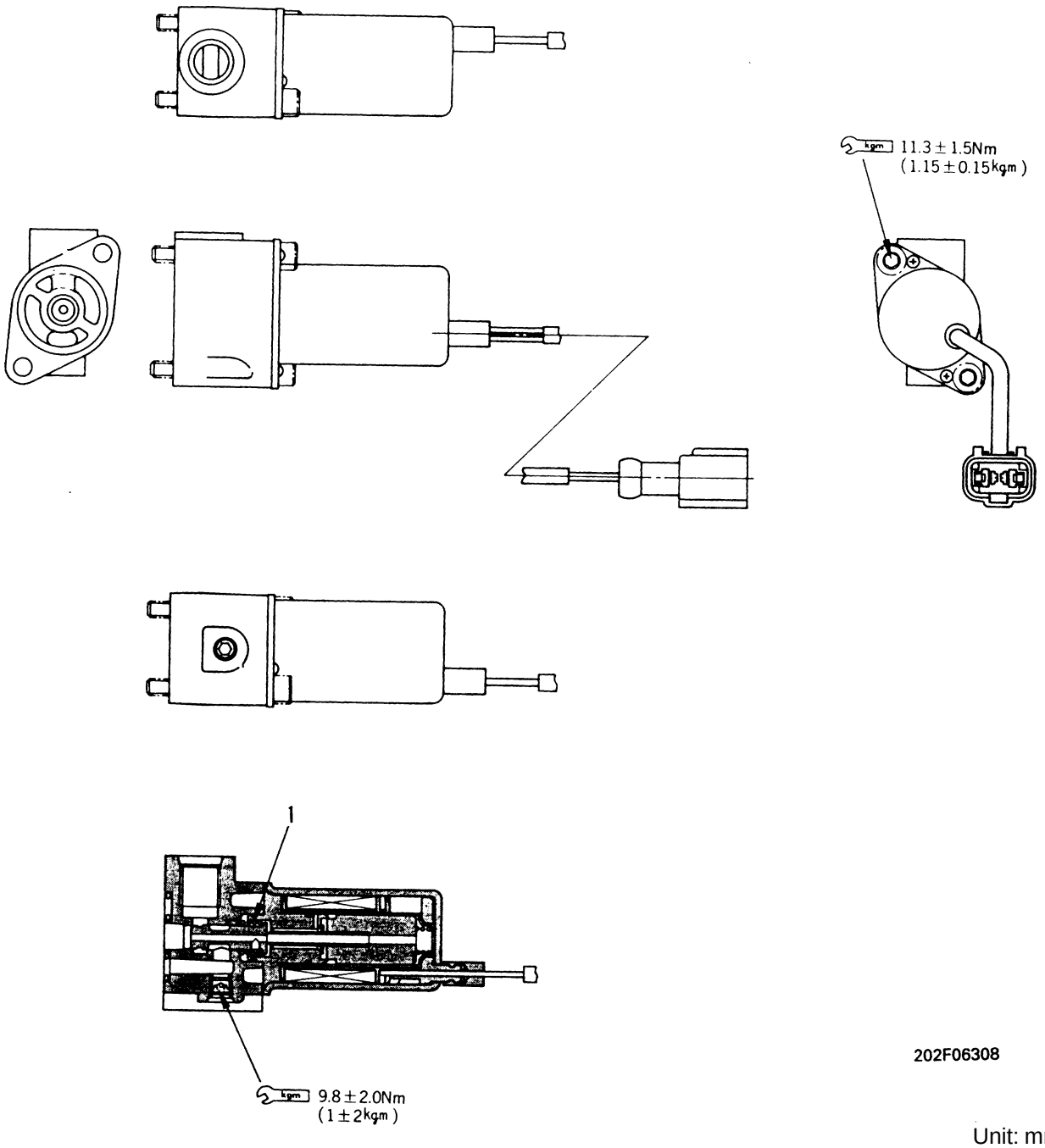
No.	Check item	Criteria					Remedy
		Standard size			Repair limit		
1	Centering spring (for P3, P4)	Free length x O.D.	Installed length	Installed load	Free length	Installed load	Replace spring if any damage or deformation is found
		43.3 x 19.5	33.5	17.7 N (1.8 kg)	-	13.7 N (1.4 kg)	
2	Centering spring (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)	

SOLENOID VALVE



EPC VALVE

LS CONTROL EPC VALVE
TRAVEL SPEED CONTROL EPC VALVE

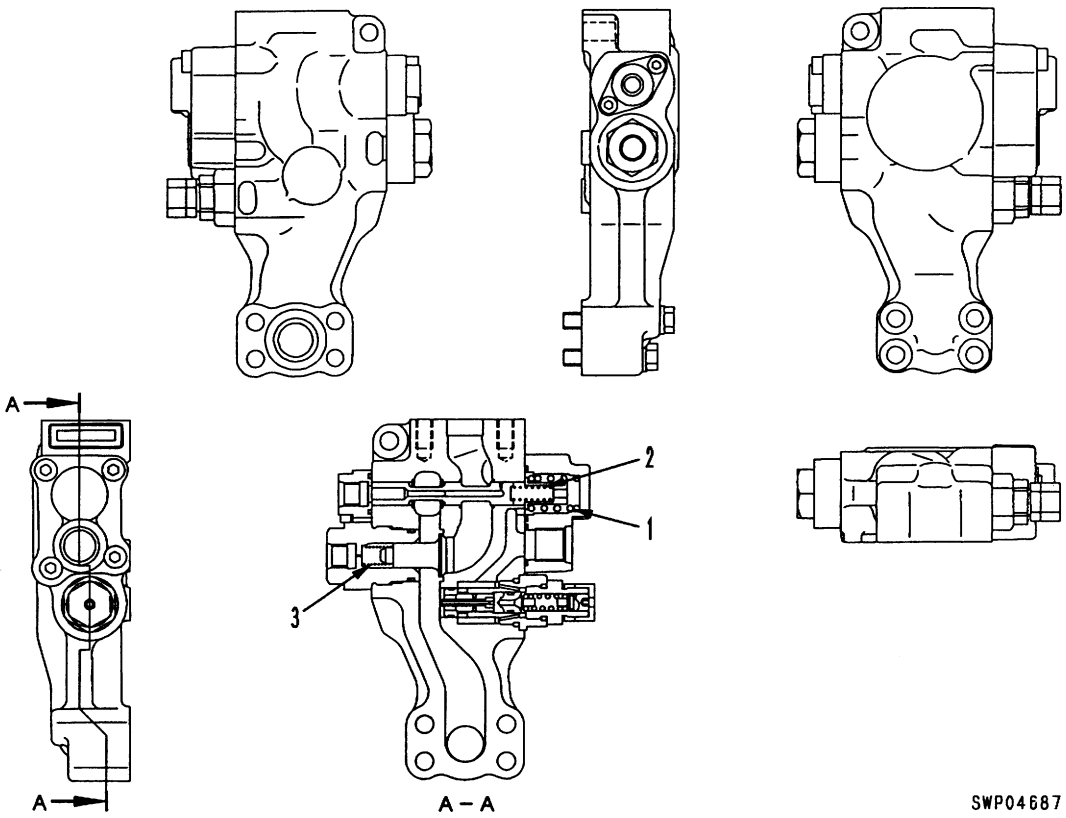


Unit: mm

No.	Check item	Criteria					Remedy
		Standard size			Repair limit		
1	Return spring	Free length x O.D.	Installed length	Installed load	Free length	Installed load	Replace EPC valve if any damage or deformation is found
		9.0 x 11.4	7.9	3.1 N (0.32 kg)	-	-	

ARM, BOOM SAFETY VALVE

* For machine equipped with arm safety valve, the Maintenance Standard of arm safety valve is the same as this valve.

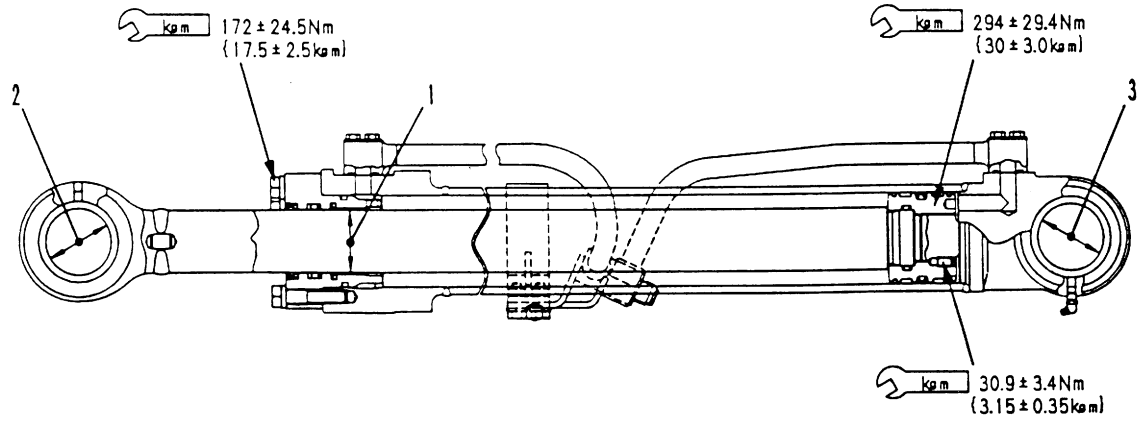


Unit: mm

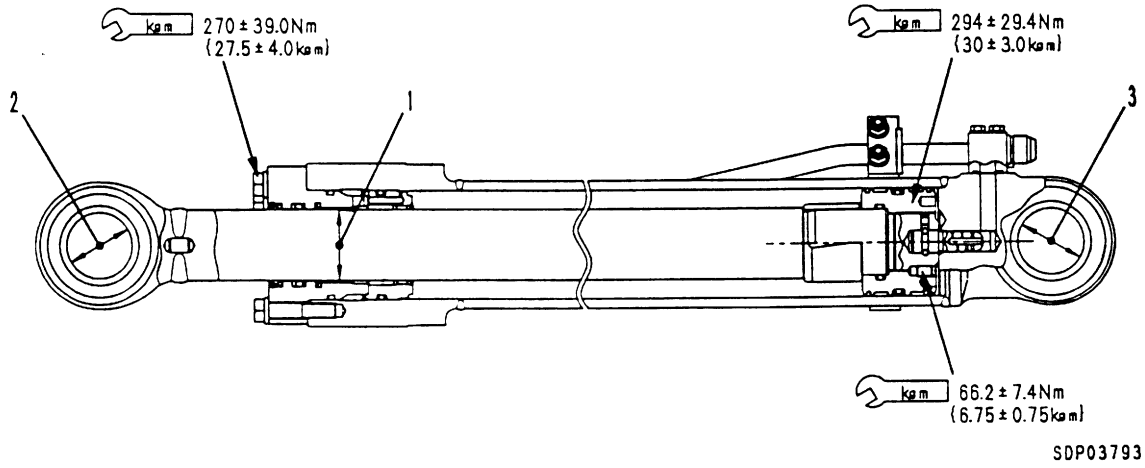
No.	Check item	Criteria					Remedy
		Standard size			Repair limit		
		Free length	Installed length	Installed load	Free length	Installed load	
1	Pilot valve spring N01 (Boom safety valve)	30.9 mm	29.0	69.6 N (7.1 kg)	-	55.9 N (5.7 kg)	Replace spring if any damage or deformation is found
	Pilot valve spring N01 (Arm safety valve)	32.5 mm	29	85.3 N (8.7 kg)	-	68.6 N (7.0 kg)	
2	Pilot valve spring N02 (Boom and arm safety valve)	31.8 mm	25	29.4 N (3.0 kg)	-	23.5 N (2.4 kg)	
3	Check valve spring (Boom and arm safety valve)	24.5 mm	18	4.9 N (0.5 kg)	-	3.9 N (0.4 kg)	

HYDRAULIC CYLINDER (THREADED PISTON TYPE)

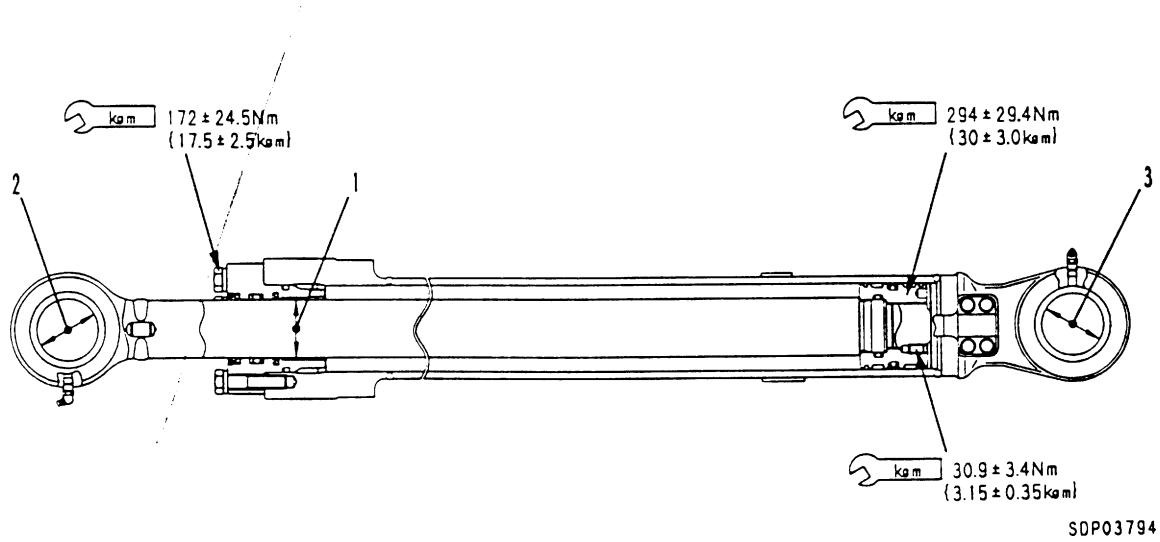
BOOM CYLINDER



ARM CYLINDER



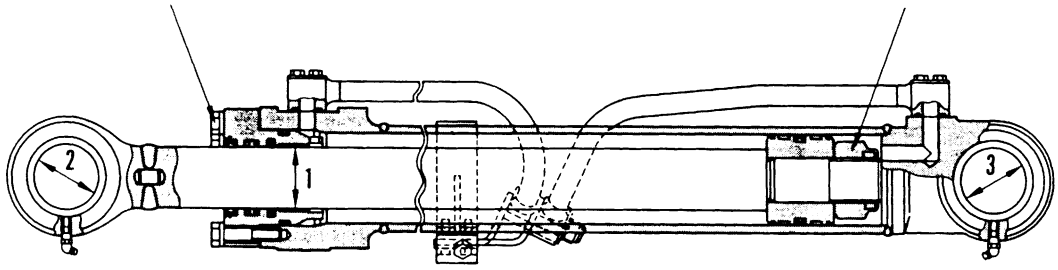
BUCKET CYLINDER



HYDRAULIC CYLINDER (PISTON FIXED WITH NUT TYPE)

★ Figure shows boom lift cylinder.

kgm	Boom1st	: 171.5 ± 24.5	Nm (17.5 ±2.5 kgm)		
	Arm	: 269.5 ± 39.2	Nm (27.5 ± 4.0 kgm)		
	Bucket	: 171.5 ± 24.5	Nm (17.5 ± 2.5 kgm)		
	Boom 2nd	: 372.8 ± 54	Nm (38.0 ± 5.5 kgm)		
kgm	Boom1st	: 5096 ± 509.6	Nm (520 ± 52 kgm)	(Width across flats : 80)	
	Arm	: 7056 ± 705.6	Nm (27.5 ± 4.0 kgm)	(Width across flats : 85)	
	Bucket	: 3332 ± 333.2	Nm (17.5 ± 2.5 kgm)	(Width across flats : 70)	
	Boom 2nd	: 5096 ± 509.6	Nm (38.0 ± 5.5 kgm)	(Width across flats : 80)	



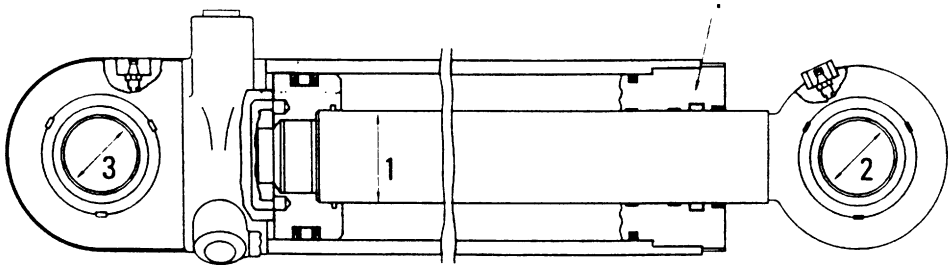
202F06303

Unit: mm

No.	Check item		Criteria					Remedy
		Cylinder	Standard size	Tolerance		Standard clearance	Clearance limit	
				Shaft	Hole			
1	Clearance between piston rod and bushing	Boom (1st & 2nd)	70	-0.030 -0.076	+0.259 +0.063	0.093-0.336	0.436	Replace bushing
		Arm	75	-0.030 -0.076	+0.279 +0.065	0.095-0.355	0.455	
2	Clearance between piston rod support pin and bushing	Bucket	65	-0.030 -0.076	+0.250 +0.055	0.085-0.326	0.426	Replace pin or bushing
		1st Boom	80	+0.100 +0.170	+0.337 +0.273	0.103-0.237	1.0	
		2nd Boom	80	-0.030 -0.076	+0.457 +0.370	0.400-0.533	1.0	
		Arm	70	-0.030 -0.100	+0.198 +0.124	0.154-0.298	1.0	
3	Clearance between cylinder bottom support pin and bushing	Bucket	65	-0.030 -0.080	+0.174 +0.100	0.130-0.254	1.0	
		1st Boom	70	-0.030 -0.100	+0.198 +0.124	0.154-0.298	1.0	
		2nd Boom	80	-0.030 - 0.076	+0.457 +0.370	0.400-0.533	1.0	
		Arm	70	-0.030 -0.100	+0.198 +0.124	0.154-0.298	1.0	
		Bucket	65	-0.030 -0.080	+0.174 +0.100	0.130-0.254	1.0	

DOZER BLADE AND OUTRIGGERS HYDRAULIC CYLINDERS

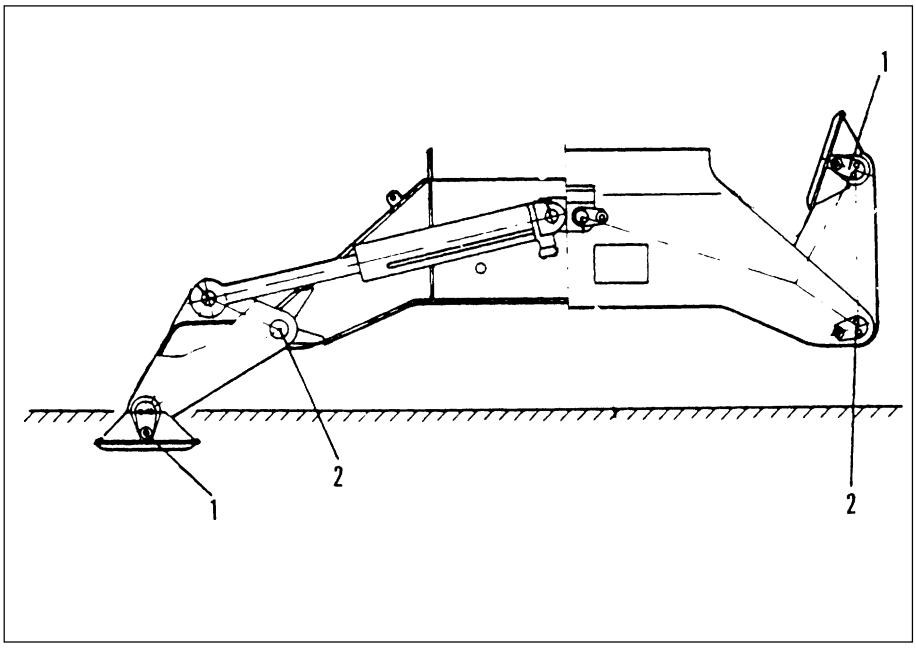
Blade/outrigger



Unit: mm

No.	Check item		Criteria					Remarks
		Cylinder	Tolerance		Standard clearance	Clearance limit	Standard size	
			Shaft	Hole				
1	Clearance between piston and bushing	Blade					60	
		O-ring					70	
2	Clearance between piston rod and shaft support bushing	Blade	-0.030 -0.100	0 -0.015	0.030 0.115	0.30	60	
		O-ring	-0.030 -0.100	0 -0.015	0.030 0.115	0.30	60	
3	Clearance between bottom support shaft and bushing	Blade	-0.030 -0.100	0 -0.015	0.030 0.115	0.30	60	
		O-ring	-0.030 -0.100	0 -0.015	0.030 0.115	0.30	60	
4	Cylinder head torque	Blade					800 Nm	
		O-ring					800 Nm	

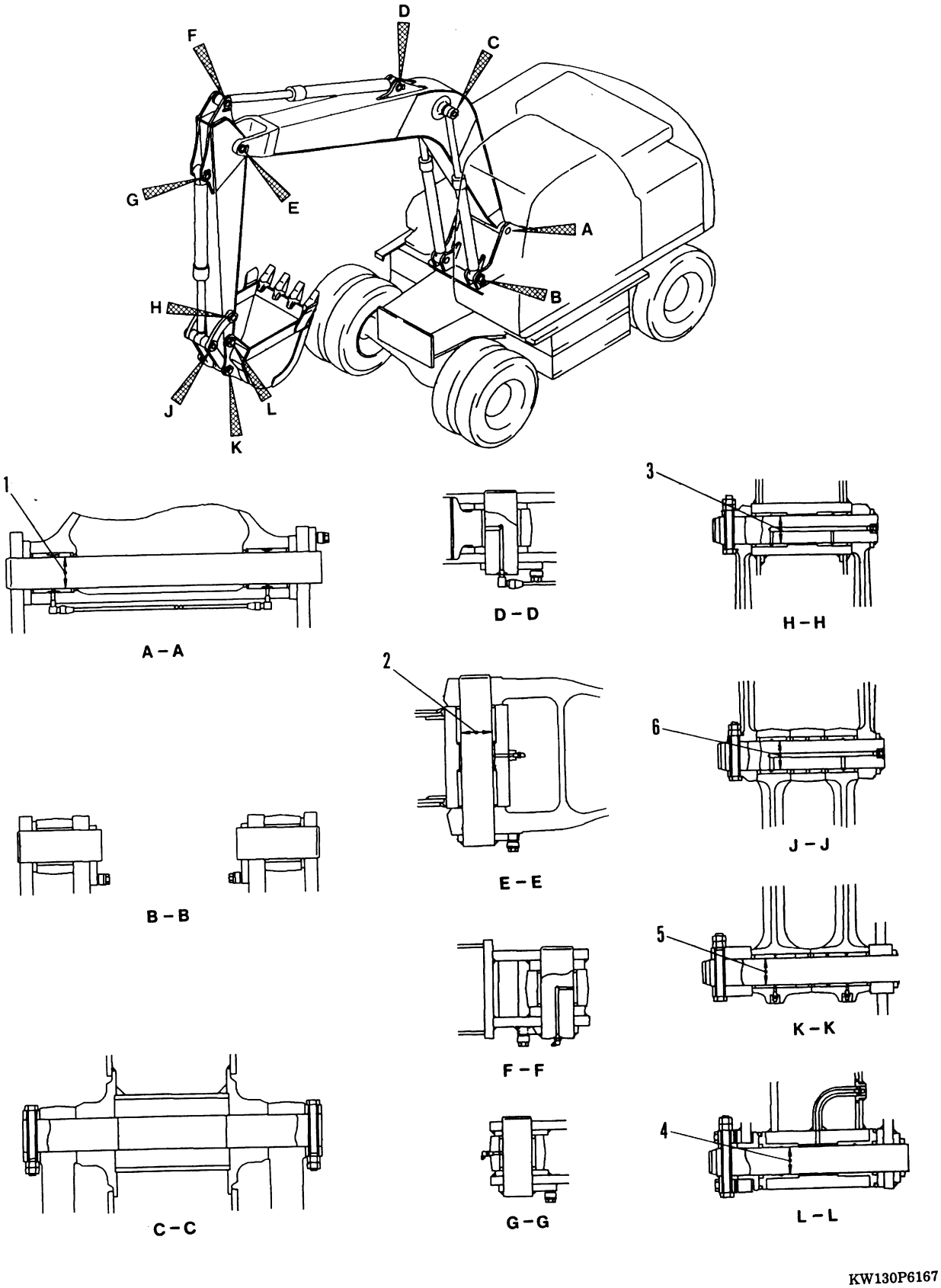
OUTRIGGER BUSH PINS



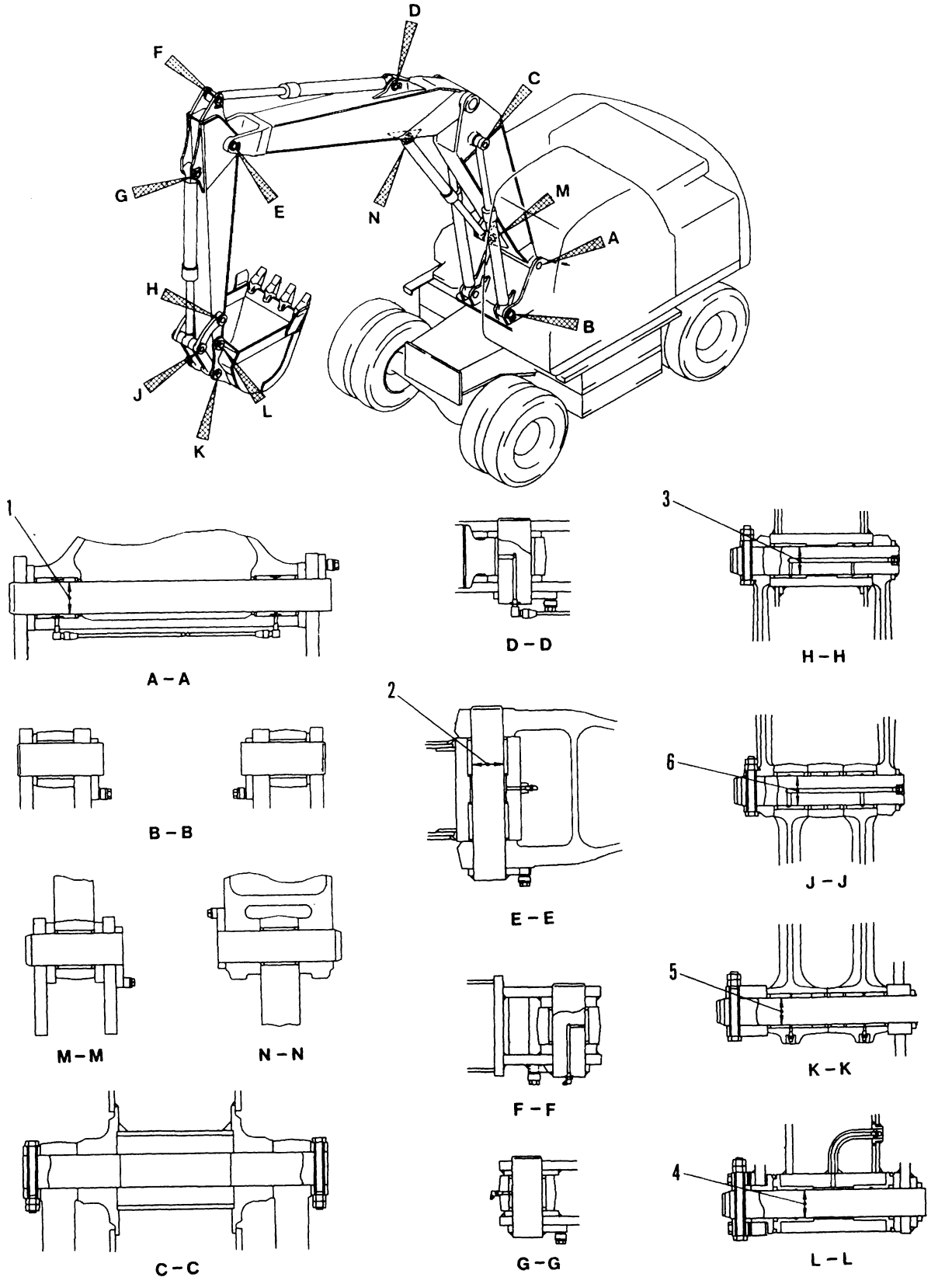
Unit: mm

No.	Check item	Criteria			Remedy
1	Pin	Pin dia.	Max. undersize when new	Max. permissible play	
		45	-0.03	0.2	
2	Pin	70	-0.06	0.23	

WORK EQUIPMENT - ONE PIECE BOOM



WORK EQUIPMENT - TWO PIECE BOOM

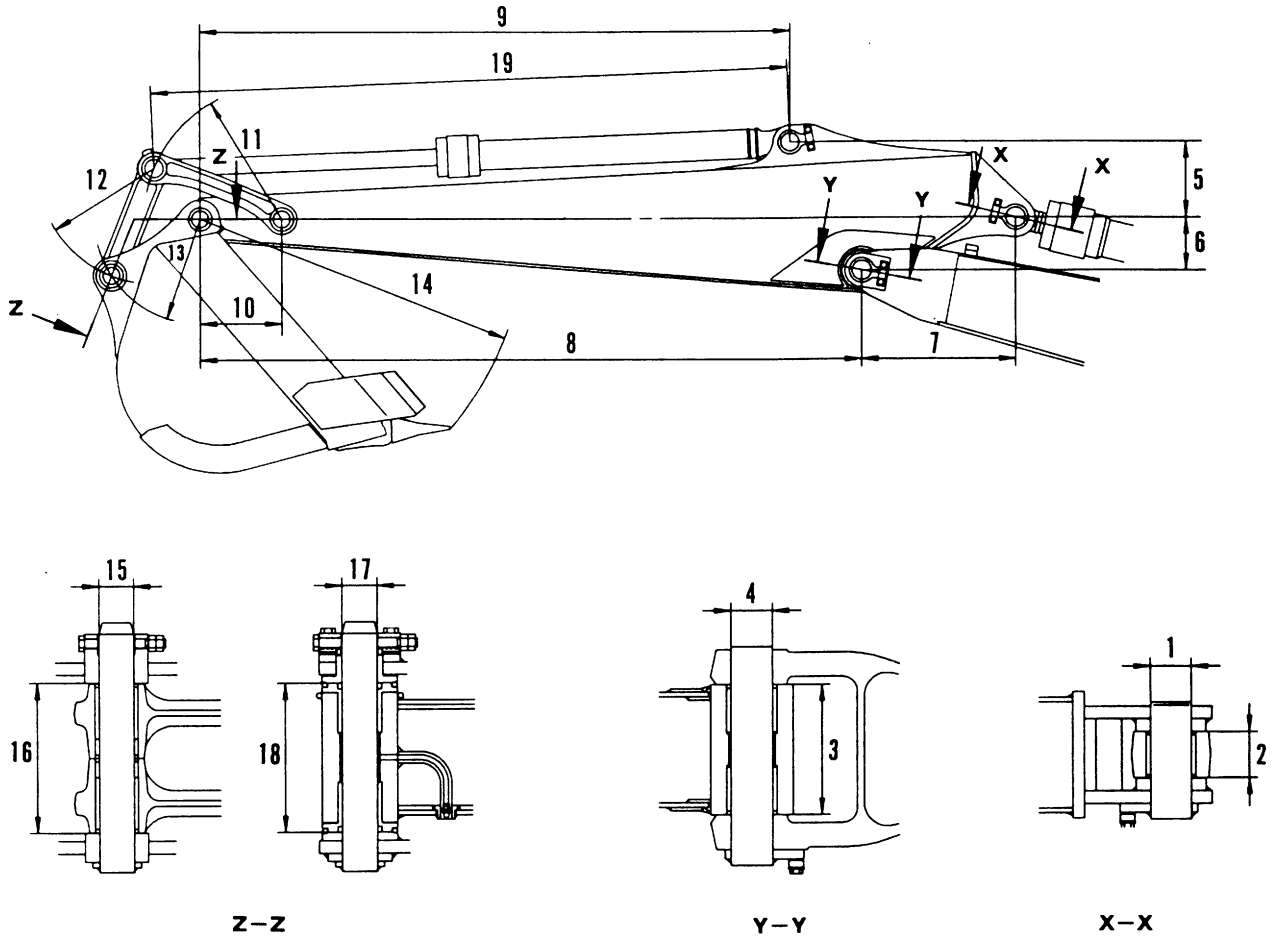


KW130P6168

No.	Check item	Criteria					Remedy
		Standard size	Tolerance		Standard clearance	Clearance limit	
			Shaft	Hole			
1	Clearance between connecting pin and bushing of revolving frame and boom	70	-0.030 -0.100	+0.140 +0.074	0.104- 0.240	0.8	Replace
2	Clearance between connecting pin and bushing of boom and arm	70	-0.030 -0.100	+0.141 +0.074	0.104- 0.241	0.8	
3	Clearance between connecting pin and bushing of arm and link	60	-0.030 -0.080	+0.130 +0.074	0.104- 0.210	0.8	
4	Clearance between connecting pin and bushing of arm and bucket	60	-0.030 -0.080	+0.129 +0.074	0.104- 0.209	0.8	
5	Clearance between connecting pin and bushing of link and bucket	60	-0.030 -0.080	+0.135 +0.074	0.104- 0.215	0.8	
6	Clearance between connecting pin and bushing of link and link	60	-0.030 -0.080	+0.133 +0.074	0.104- 0.213	0.8	

DIMENSION OF WORK EQUIPMENT

1. ARM PORTION



202F0631

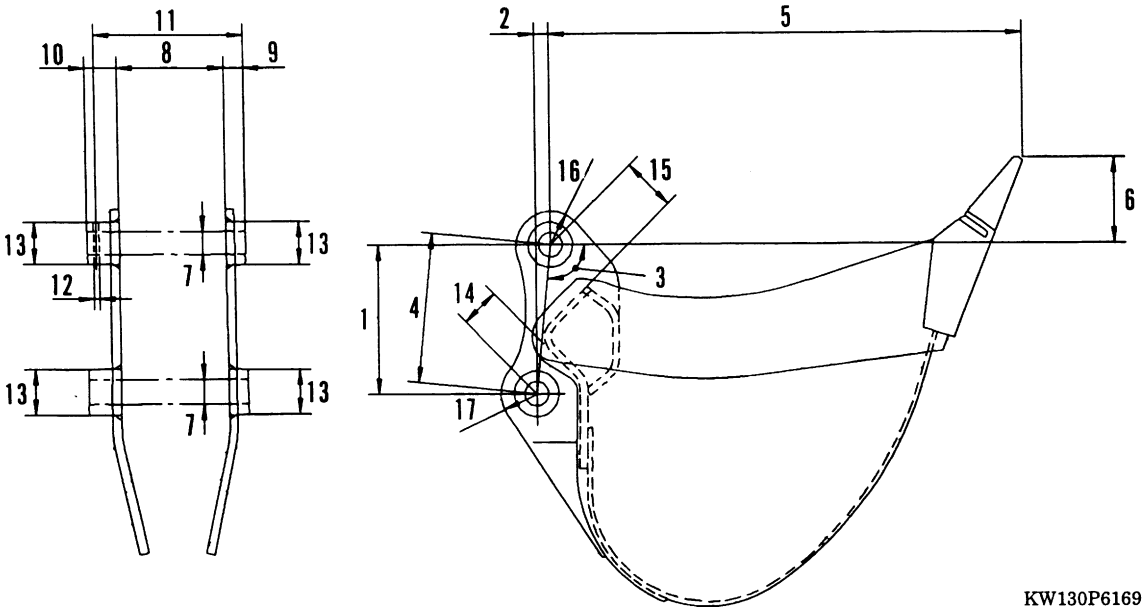
Unit: mm

1	ϕ/ 70
2	80
3	226
4	ϕ/ 70
5	294
6	200
7	635
8	2,090
9	2,100
10	290

Unit: mm

11		493
12		422
13		
14		1,202
15		ϕ/ 60
16		261
17		ϕ/ 60
18		260
19	Min.	1,378
	Max.	2,263

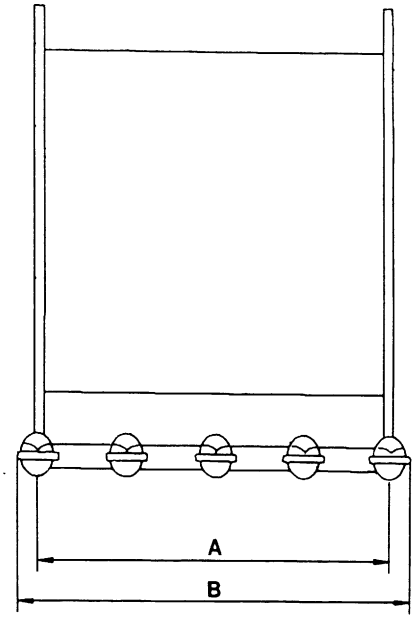
2. BUCKET PORTION



1	373
2	38
3	95.80
4	374.9
5	1,197
6	222
7	0/ 60
8	260
9	50

10	85
11	380
12	0/ 18
13	0/ 110
14	101.5
15	138
16	85
17	85

BUCKET CAPACITIES



KW130P6170

WIDTH A (mm)	WIDTH B (mm)	CAPACITIES (LITRES) SAE/CECE
450	500	235/220
500	550	275/255
550	600	315/290
600	650	350/325
650	700	390/360
700	750	430/395
750	800	470/425
800	850	510/460
850	900	550/495
900	950	590/530
950	1000	630/570
1000	1050	675/605
1050	1100	715/640
1100	1150	755/675
1150	1200	795/710
1200	1250	840/745